Operations Report – Fugro Pioneer

North Sea OWF Zone West (Lot 2) Noise Monitoring | Danish North Sea

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Complete

Energinet Eltransmission A/S

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Project Team

Initials	Name	Role
APA	A Padwalkar	Project Manager/ Vessel Manager Fugro Pioneer
SA	Safey Attia	Deputy/ Assistant Project Manager
PMI	Paul Miller	Party Chief Fugro Pioneer
JDB	Jaco de Beer	Party Chief Fugro Pioneer
JE	James Egan	Geophysicist
KES	Kareem El Sayed	Geophysicist
EF	Edward Favell	Geophysicist
VW	Vicky Wickham	Geophysicist
RM	Robert Mills	JASCO Field Lead
CR	Calder Robinson	JASCO Field Technician
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28 September 2021

Dear Sir/Madam,

We have the pleasure of submitting the 'Operations Report – Fugro Pioneer' for the 'North Sea OWF Zone West (Lot 2) Noise Monitoring'. This report presents the details of the vessel's operations.

This report was prepared by James Egan, Edward Favell, Vicky Wickham and Kareem El Sayed under the supervision of Jaco de Beer (Fugro Pioneer Party Chief). Additional input was provided by Federica Pace (JASCO Technical Projects Lead).

We hope that you find this report to your satisfaction; should you have any queries, please do not hesitate to contact us.

Yours faithfully,

Jaco de Beer

Jaco de Beer
Fugro Pioneer Party Chief

Executive Summary

Energinet Eltransmission A/S (Energinet) is developing a new offshore wind farm in the Danish North Sea. The project area is located offshore Denmark approximately 32 NM West of Thorsminde.

This report provides information relating to the operations onboard the survey vessel Fugro Pioneer working on the project.

Vessel mobilisation and calibrations for survey operations were undertaken between 14 and 31 May 2021 in the port of IJmuiden, NL, and at an offshore calibration site during the transit to the survey area and completed on site (see report number *F176286-REP-MOB-001*).

All equipment was subject to rigorous testing and calibration with reference to Fugro procedures. The calibration procedures were carried out in order to demonstrate the effective and safe functionality of equipment and satisfy the requirements of Energinet Eltransmission A/S and the survey specification.

Noise monitoring equipment (AMAR) mobilisation and calibrations were undertaken between 13 August and 17 August 2021 in Dartmouth, Canada. The results are presented in Appendix G. Additionally, tests and calibrations took place onboard the Fugro Pioneer on 18 and 19 September 2021 upon each deployment and recovery of AMARs (see Appendix H).

Survey operations for the purpose of noise monitoring on the Fugro Pioneer occurred between 18 September and 22 September 2021. Demobilisation of JASCO personnel and equipment occurred on 22 September 2021.

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Abbreviations

AMAR	Autonomous multichannel acoustic recorder
APOS	Acoustic position operator station
COVID	Coronavirus disease
CRP	Common reference point
CTD	Conductivity, Temperature and Density
DGPS	Differential global positioning system
DTM	Digital terrain model
EIA	Environmental Impact Assessment
ERP	Emergency response plan
GNSS	Global navigation satellite system
HF	High frequency
HOC	Hazard observation card
HSSE/HSE	Health safety (security) environment
IHO	International Hydrographic Organization
IMU	Inertial measurement unit
INS	Inertial navigation sensor
ISO	International Standards Organisation
Kts	Knots
LAT	Lowest astronomical tide
LF	Low frequency
MBES	Multibeam echosounder
MLSS	Multi-level Stacked Sparker
MRU	Motion reference unit
MSL	Mean sea level
NM	Nautical Mile
OHSAS	Occupational Health and Safety Assessment Series
OWF	Offshore wind farm
PEP	Project execution plan
PPE	Personal protective equipment
PPP	Precise point positioning
QA	Quality assurance
QC	Quality control
RTK	Real time kinematic
SBES	Single beam echosounder
SBP	Sub-bottom profiler
SPL	Sound pressure levels
SSC	Sound source characterisation

SSS	Side scan sonar
SVP	Sound velocity probe
SVS	Sound velocity sensor
THU	Total horizontal uncertainty
TP	Tow point
TVU	Total vertical uncertainty
UHRS	Ultra High Resolution Seismic
USBL	Ultra-Short Baseline
UTM	Universal Transverse Mercator
VRF	Vessel reference frame
WGS84	World Geodetic System 1984
WHO	World health organisation
WI	Work instruction

1. Introduction

Energinet Eltransmission A/S (Energinet) is developing a new offshore wind farm in the Danish North Sea. The project area is located offshore Denmark approximately 32 NM West of Thorsminde.

This report provides information relating to the noise monitoring operations onboard the survey vessel Fugro Pioneer working on the project in cooperation with JASCO Applied Sciences GmbH (JASCO).

Vessel mobilisation and calibrations for survey operations were undertaken between 14 and 31 May 2021 in the port of IJmuiden, NL, and at an offshore calibration site during the transit to the survey area and completed on site (see report number *F176286-REP-MOB-001*).

All equipment was subject to rigorous testing and calibration with reference to Fugro procedures. The calibration procedures were carried out in order to demonstrate the effective and safe functionality of equipment and satisfy the requirements of Energinet Eltransmission A/S and the survey specification.

Noise monitoring equipment (AMAR) mobilisation and calibrations were undertaken between 13 August and 17 August 2021 in Dartmouth, Canada. The results are presented in Appendix G. Further deck tests and calibration checks were performed in the port of Esbjerg, Denmark, on the 10 September 2021. Additionally, tests and calibrations took place onboard the Fugro Pioneer on 18 and 19 September 2021 upon each deployment and recovery of AMARs (see Appendix H).

Noise monitoring survey operations on the Fugro Pioneer occurred between 18 and 20 September 2021, whilst demobilisation of JASCO personnel and equipment was on 22 September 2021.

The QA of navigational data was done onboard the vessel and the data were provided to JASCO. The QA of sub-bottom profiler, multibeam echosounder and side scan sonar data was limited to ensuring proper data recording as would normally take place during a geophysical survey. It was agreed on site that the deployment of the streamer for 2D UHR seismic acquisition was not necessary to meet the requirements of the tests. Therefore, there was no 2D UHR seismic data to check.

Guidelines on the use of this report have been provided in Appendix A.

1.1 Survey Aims and Overview

The following sub-sections provide details about the main survey requirements and the scope of work for the North Sea OWF Zone West (Lot 2) Noise Monitoring.

1.1.1 Survey Aims

The aim of the offshore noise monitoring survey is to measure underwater sound emissions as a function of distance, frequency and direction from the vessel associated with geophysical operations at the North Sea OWF Zone West (Lot 2) site.

The Sounds Source Characterization (SSC) study was performed by JASCO using its Autonomous Multichannel Acoustic Recorders (AMARs) to measure underwater sound produced by the multiple sources deployed by Fugro both in isolation and in combination. The SSC study is needed as an input to the Environmental Impact Assessment (EIA) work that will be conducted by a third party.

To achieve this objective Fugro deployed geophysical equipment including 2D UHR seismic, sub-bottom profiler, multibeam echosounder and side scan sonar along the defined test lines.

1.1.2 Survey Overview

A summary of the main survey requirements for the noise monitoring operations is presented in Table 1.1.

Table 1.1: Survey Requirements Overview – Noise Monitoring Operations

Equipment Method	Energinet Noise Monitoring requirements
Vessels	■ Fugro Pioneer
Line Tracks	■ Test track for each source to pass directly over AMAR 1 (+/- 20 m) ■ Baseline test sequence to start 2 km before and end 2 km past AMAR 1, to be ran in reciprocal directions ■ Additional 3 km lines with sparker sensor parallel and offset 5 km and 10 km from AMAR 1-3
Max Vessel Speed	■ Maximum of 4.5 knots (±10%)
Surface Positioning	■ Dynamic heading accuracy of ± 0.2° or better ■ Static heading accuracy of ± 0.05° or better ■ Horizontal uncertainty of the vessel of ± 0.5m or better
USBL	■ USBL accuracy. Fugro will only be able to repeatedly achieve +/- 1m accuracy for USBL calibration and +/-2 m accuracy for data acquired from towed sensors. i.e. a processed target accuracy of +/-2m
2D UHRS	■ 360 tips MLSS @900J (160,120, 80 tips) ■ Frequency 0.2 – 3 kHz ■ Tow depth ~0.5 -1.1m ■ RTK positioning for UHR system (source) ■ > 100m penetration
Multibeam Echosounder	■ Hull mounted ■ Frequency 200/400 kHz
Innomar SBP	■ Hull mounted

Equipment Method	Energinet Noise Monitoring requirements
	■ Frequency: 8 - 12 kHz
Side Scan Sonar	■ Towed sensor with USBL HiPAP position tracking ■ Frequency 300/600 kHz ■ Altitude to be set to 8-12% of range (range 75 m)
SVP	■ The speed of sound in water shall be measured in the survey area ■ The Vertical Sound Velocity Profiles should be undertaken with a resolution of 0.1 m/s and an accuracy of ±0.15 m/s ■ The Vertical Sound Velocity Profiles should be able to measure within the range 1,350-1,600 m/s
AMAR	■ Autonomous Multichannel Acoustic Recorders, Generation 4 ■ Sampling Frequency 256kHz ■ Dual hydrophone setup: standard sensitivity hydrophone -164 dB re 1V/µPa and low sensitivity hydrophone -220 dB re 1V/µPa (or -200 dB re 1V/µPa for stations D and E)

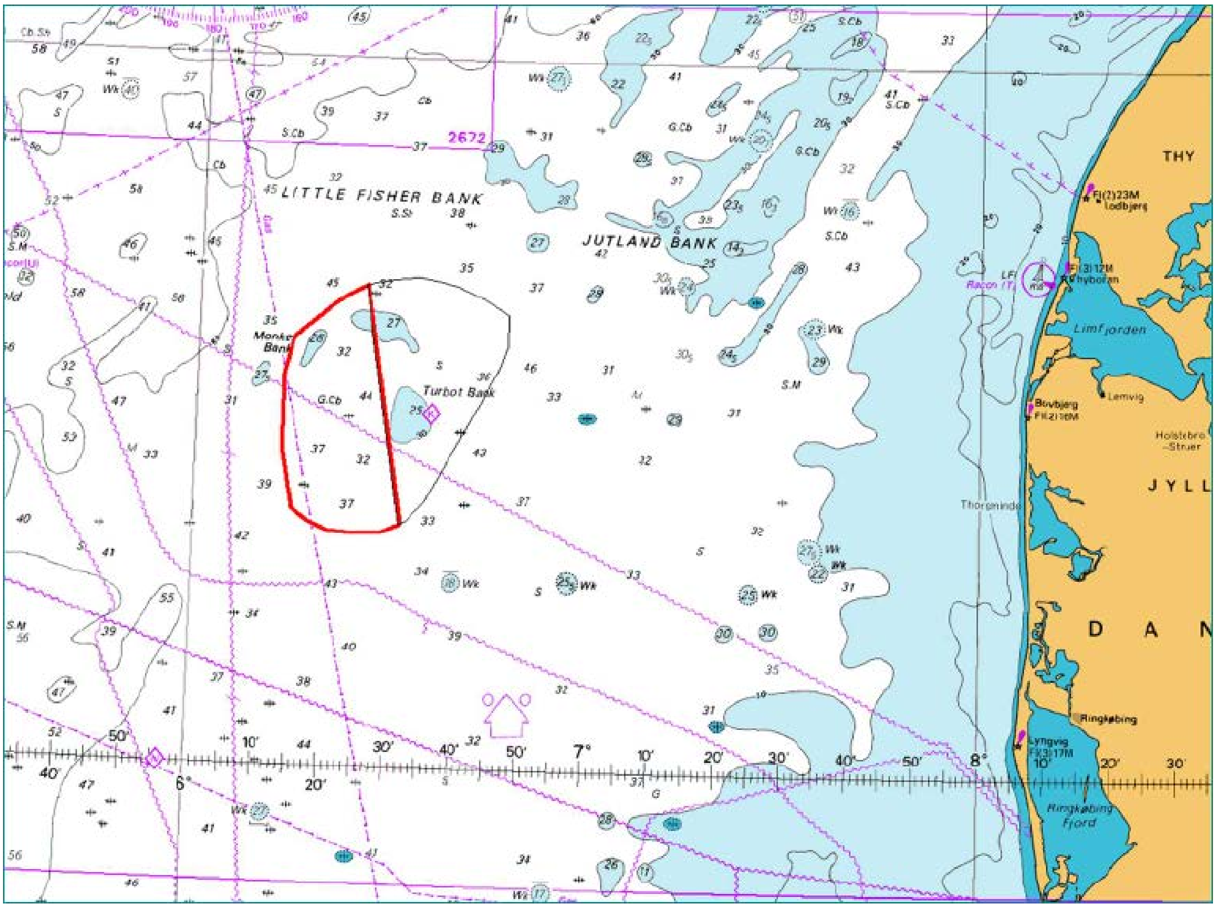

Figure 1.1: Project area overview, the Energy Island LOT 2 boundary is outlined in red

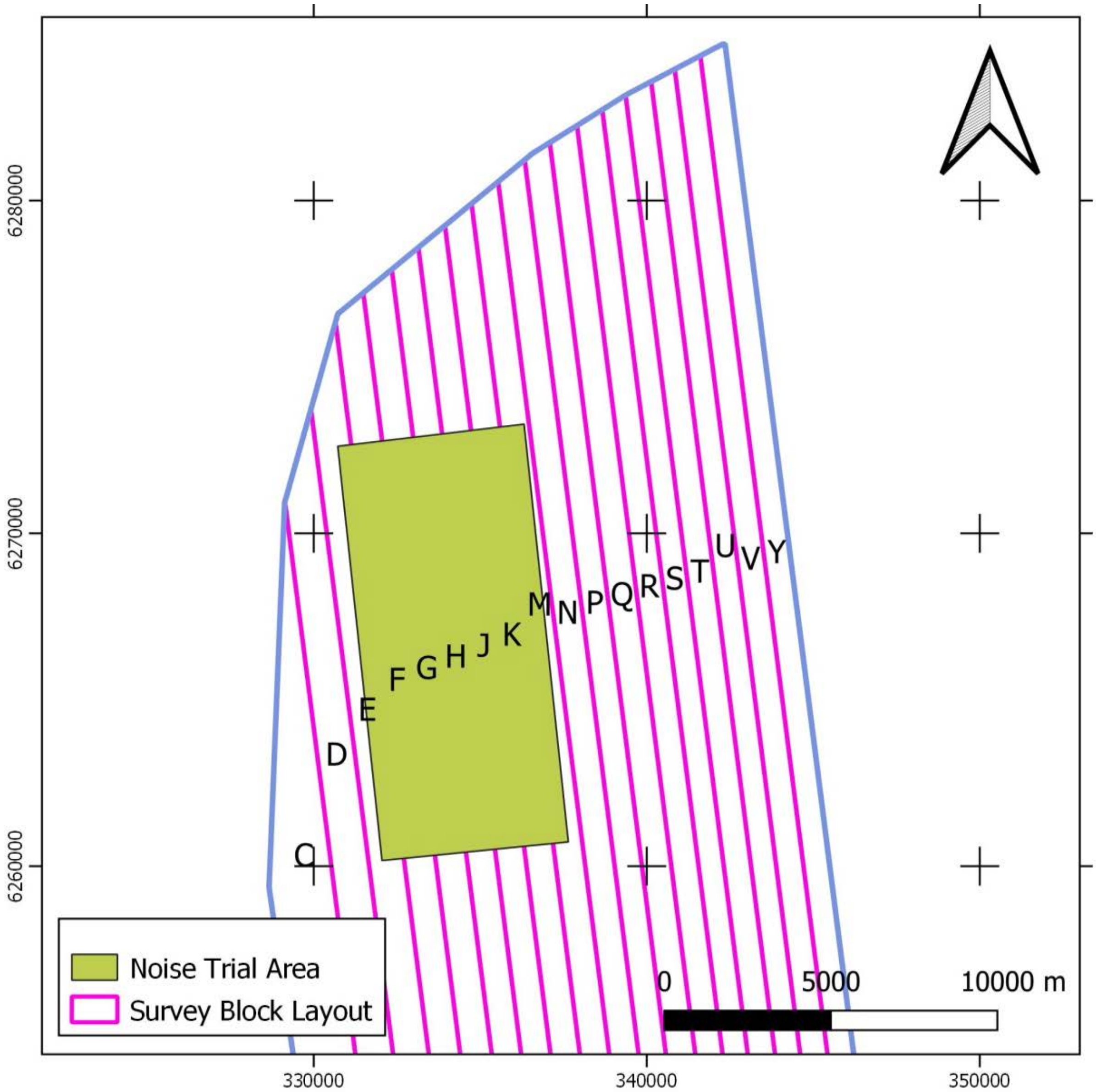

Figure 1.2: Project area overview

The project area is located offshore Denmark approximately 32 NM West of Thorsminde (Figure 1.1). The noise trials were conducted within blocks F, G, H, J, K and M (Figure 1.2), the water depth varied between 22 m and 46 m MSL.

1.2 Geodetic Parameters

The project geodetic and projection parameters are summarised in Figure 1.3 and Figure 1.4.

Name: ETRS89 / UTM zone 32N [ETRF2000-ITRF2014],DTU18 MSS height [DTU18 MSS]		
EPSG Code	EPSG:25832	
Global Navigation Satellite System (GNSS) Geodetic Parameters*		
Datum	International Terrestrial Reference Frame 2014	EPSG:1165
Ellipsoid	GRS 1980	
Semi major axis	a = 6 378 137.00 m	
Inverse flattening	1/f = 298.257222101	
Local Geodetic Datum Parameters		
Datum	European Terrestrial Reference System 1989	EPSG:6258
Ellipsoid	GRS 1980	
Semi major axis	a = 6 378 137.00 m	
Inverse flattening	1/f = 298.257222101	
Datum Transformation Parameters from ITRF2014 to ETRS89		
X-axis translation 0.05584 m	X-axis rotation -0.0026255"	Scale difference 0.00337551 ppm
Y-axis translation 0.05334 m	Y-axis rotation -0.0158827"	Coordinate Frame rotation
Z-axis translation -0.09579 m	Z-axis rotation 0.0256716"	FUGRO:41366
Local Projection Parameters		
Map projection	Transverse Mercator	
Grid system	UTM zone 32N	EPSG:16032
Latitude origin	00° 00′ 00.000″ N	
Central meridian	009° 00′ 00.000″ E	
Scale factor on central meridian	0.9996	
False easting	500 000 m	
False northing	0 m	
Project Vertical Parameters		
Vertical coordinate reference system	DTU18 MSS height	FUGRO:41073
Datum	DTU18 MSS height	FUGRO:40939
Transformation	WGS 84 to DTU18 MSS height	FUGRO:41429
Notes * The geodetic datum of Fugro's global GNSS correction data is ITRF2014, epoch 2021.414 (01/06/2021)		

Figure 1.3: Project geodetic and projection parameters

ITRF2014	Test Point [Position]	Computed Point
Latitude	56° 18′ 54.00000″ N	56° 18′ 54.00000″ N
Longitude	008° 30′ 00.00000″ E	008° 30′ 00.00000″ E
Ellipsoidal height	0.000 m Ell.	0.000 m Ell.
ETRS89		
Latitude	56° 18′ 53.98130″ N	56° 18′ 53.98130″ N
Longitude	008° 29′ 59.96955″ E	008° 29′ 59.96955″ E
Ellipsoidal height	-0.025 m Ell.	-0.025 m Ell.
UTM zone 32N		
Easting	469 069.831 m	469 069.831 m
Northing	6 241 250.858 m	6 241 250.858 m
Mean sea surface height	-39.924 m	-39.932 m

Figure 1.4: Project test coordinates

1.3 Vertical Datum

All vertical data for North Sea OWF Zone West (Lot 2) Geophysical Survey will be reduced to Mean Sea Level (MSL) utilising the DTU18 MSL Tide Model as a vertical offshore reference frame supplied by the Technical University of Denmark (DTU).

2. Calibrations

All equipment was subject to rigorous testing and calibration with reference to Fugro procedures. The calibration procedures were carried out in order to demonstrate effective functionality of equipment and satisfy the requirements of Energinet Eltransmission A/S and the survey specification.

Vessel mobilisation and calibrations were undertaken between 14 and 31 May 2021 in the port of Ijmuiden, NL, at an offshore calibration site during the transit to the survey area and completed on site.

The following verifications and validation checks for Fugro survey equipment were carried out prior to the start of survey operations:

- Vessel dimensional control survey (March 2019);
- Positioning and heading verifications (16 and 27 May 2021);
- Multibeam echosounder (MBES) calibration and verification (24 May 2021);
- Side scan sonar (SSS) verification (28 and 31 May 2021);
- Single magnetometer verification (28 May 2021);
- Ultra-Short Baseline (USBL) calibration and verifications (22 May 2021);
- Innomar Sub-bottom profiler (SBP) verifications (28 May 2021);
- 2DUHRS system verifications (28 May 2021).

Details of this are outlined in the Fugro Pioneer mobilisation report (Fugro Document No. *F176286-REP-MOB-001* provided in Appendix B).

Noise monitoring equipment (AMAR) mobilisation and calibrations were undertaken between 13 August and 17 August 2021 in Dartmouth, Canada. The results are presented in Appendix G. Additionally, tests and calibrations took place onboard the Fugro Pioneer on 18 and 19 September 2021 upon each deployment and recovery of AMARs (see Appendix H).

The following verifications and validation checks for JASCO equipment were carried out prior to the start of survey operations:

- Pre-mobilisation testing and calibration (13 August 2021);
- Equipment data sampling (11 and 16 September 2021) prior to each deployment;
- Hydrophone calibration and verification 11 September 2021 prior to deployment;
- Hydrophone calibration on retrieval of the equipment on 15th of September 2021;
- Data verification and equipment testing on 15-16th September 2021, following incident (see Appendix I)

- Data verification on test A (19 September 2021);
- Redeployment calibration of Station B AMAR (623) and Station D AMAR (624) (19 September 2021);
- Post deployment calibration of all three AMARs (20 September 2021).

Noise monitoring survey operations on the Fugro Pioneer occurred between 18 and 20 September 2021.

3. Operations

3.1 Summary of Events

The project Energy Islands Lot 2 commenced with the mobilisation of Fugro Pioneer on 14 May 2021. The noise monitoring survey commenced with the mobilisation of JASCO personnel and equipment on 10 September 2021 in Esbjerg, Denmark. Daily progress reports detailing all noise monitoring operations have been provided in Appendix C.

Calibrations and verifications of the geophysical equipment were carried out in the port of IJmuiden, NL, at an offshore calibration site during the transit to the survey area and completed on site.

All equipment was subject to rigorous testing and calibration with reference to Fugro procedures. The calibration procedures were carried out in order to demonstrate effective functionality of equipment and satisfy the requirements of Energinet Eltransmission A/S and the survey specification. Mobilisation was conducted in port and verifications were conducted in offshore verification sites. Details of this are outlined in the Fugro Pioneer mobilisation report (Fugro Document No. *F176286-REP-MOB-001* provided in Appendix B).

Noise monitoring equipment (AMAR) mobilisation and calibrations were undertaken between 13 August and 17 August 2021 in Dartmouth, Canada. The results are presented in Appendix G.

Noise monitoring operations on the North Sea OWF Zone West (Lot 2) site commenced on 18 September 2021. Survey operations were run on a 24-hour operational basis. Side scan sonar, multibeam echosounder and SBP data were collected along with 2D UHR seismic data. Noise monitoring operations were completed on 20 September 2021. Table 3.1 presents a summary of the key events during noise monitoring survey operations. A break-down of operational time (days) for the Fugro Pioneer during operations is provided in Figure 3.1 (note that percentages include all activities between the start and end of operations).

Table 3.1: Summary of Key Events

Event	Dates
Mobilisation of Fugro Pioneer (IJmuiden, NL)	14 May 2021
Alongside calibrations complete, Fugro Pioneer departed (IJmuiden, NL)	19 May 2021
MBES patch test	24 May 2021

Event	Dates
USBL verification	22 May 2021
SSS verification	28 May and 31 May 2021
SBP verification	28 May 2021
Magnetometer verification	28 May 2021
2D UHRS Streamer Depth Monitoring & Balancing Test	28 May 2021
Calibration and tests of JASCO equipment in Dartmouth, Canada	13 August 2021
Equipment mobilisation from JASCO warehouse	20 August 2021
Mobilisation of JASCO personnel and equipment	10 September 2021
Waiting on weather	11-13 September 2021
First noise monitoring survey	14 September 2021
Retrieval of equipment – incident report	15 September 2021
Crew change and waiting on weather	15-17 September 2021
Commencement of noise monitoring survey operations	18 September 2021
Completion of noise monitoring survey operations	20 September 2021
Demobilisation of JASCO personnel and equipment	22 September 2021

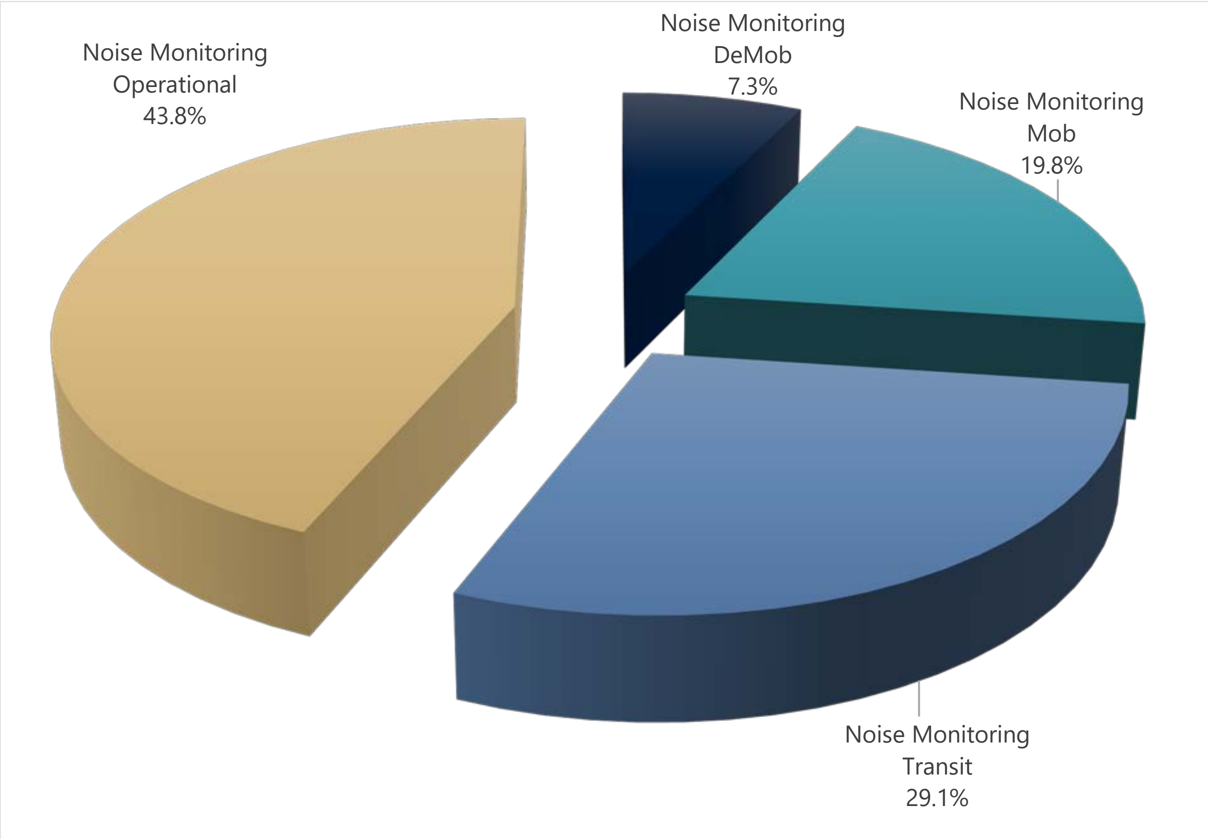

Figure 3.1: Fugro Pioneer Project Breakdown OCP (%days)

Full daily progress reports for the duration of the noise monitoring survey (10 September – 22 September 2021) are presented in Appendix C.

3.1.1 Key Personnel

A list of the key personnel is presented in Table 3.2.

Table 3.2: Key Personnel

Position	Name	Dates on Project
Project Managers	A. Padwalkar	Full duration
Fugro Vessel Manager	A. Padwalkar	Full duration
Party Chief	Paul Miller	10 September –17 September 2021
	Jaco de Beer	17 September – 22 September 2021
Technical Coordinator	Gary Reynolds	10 September –17 September 2021
	Malcolm Needham	17 September – 22 September 2021
Hydrographic Surveyors	Piotr Dynia	10 September –17 September 2021
	Marko Nekic	
	Vincenzo Cedro	17 September – 22 September 2021
	Kris Bos	
Survey Engineers	Richard Belfiore	10 September –17 September 2021
	Mark Gordon	
	Victor Apiafi	17 September – 22 September 2021
	Giorgio Focosi	
Data Processors	Fred Giraud	10 September –17 September 2021
	Bruno de Tommaso	
	Jo-Anna Damstra	17 September – 22 September 2021
	Eugenio Beccornia	
Geophysicists	James Egan	10 September –17 September 2021
	Edward Favell	
	Vicky Wickham	17 September – 22 September 2021
	Kareem El Sayed	
JASCO Personnel	Robert Mills	10 September – 22 September 2021
	Calder Robinson	
JASCO Technical Projects Lead	Federica Pace	10 September – 22 September 2021
Lead Geophysicist (office)	Julia Szudzinska	Full duration
Lead Processor (office)	Mohamed Samir Mourad	Full duration
Reporting Coordinator	Julia Szudzinska	Full duration

3.1.2 Equipment

The equipment used for the survey is presented in Table 3.3.

Table 3.3: Equipment List

Requirement	Equipment

Requirement	Equipment
Primary GNSS	Fugro StarPack GNSS receiver with StarFix.G2+ corrections
Secondary GNSS	Fugro StarPack GNSS receiver with StarFix.G2+ corrections
MRU and heading sensor	iXSea Hydrins, iXblue Octans 3000
USBL	Kongsberg HiPAP 501 with C-Node beacons
Multibeam echosounder	Dual Head Kongsberg EM2040
Side scan sonar	Edgetech 4200 (300/600 kHz), S/N 42378, EdgeTech Discover software (v. 40.01.1.119)
Parametric Sub-bottom Profiler	Innomar Medium SES-2000 (8 kHz, single pulse)
Sound velocity probe	2x SAIV CTD
Sound velocity sensor	1x Valeport Mini SVS installed near MBES head with 1x spare
Tidal heights	Fugro StarPack GNSS receiver with Starfix.G2+ corrections
2D UHRS Source	Fugro Multi-Level Stacked Sparker (360 tips), StarfixNG
AMAR	3x Autonomous Multichannel Acoustic Recorder Generation 4

3.1.3 Vessel Details

The Fugro Pioneer (Figure 3.2) is a 53 m vessel built at Damen Shipyards in 2014. Being purpose designed for the demanding environments in which Fugro's coastal fleet operate, the Pioneer has excellent weather capabilities and is an ideal platform for 2D UHRS and geophysical surveys.

Figure 3.2: Fugro Pioneer

The Fugro Pioneer is equipped for 24-hour operations with space for a maximum of 31 persons. Further details of the vessel can be found in Appendix D. Table 3.4 details the weather limitations for onboard operations.

Table 3.4: Weather Limitations of Fugro Pioneer

Mode of Operation	Significant Wave Height Hs [m]	Max Wind Speed [kts]	Max Current [kts]
Deployment and recovery of towed equipment	1.5 [1]	20.0	2.0 [2]
Geophysical Survey	1.5 [1]	20.0	2.0 [2]
Field Verifications	1.5 [1]	20.0	2.0 [2]
1. subject to wave heading 2. subject to current heading			

3.2 Survey Strategy

The orientation of the test lines was designed relative to the deployment of the three AMARs to capture sound levels as a function of range and direction, in the Energy Islands Lot 2 lease area (Figure 3.3).

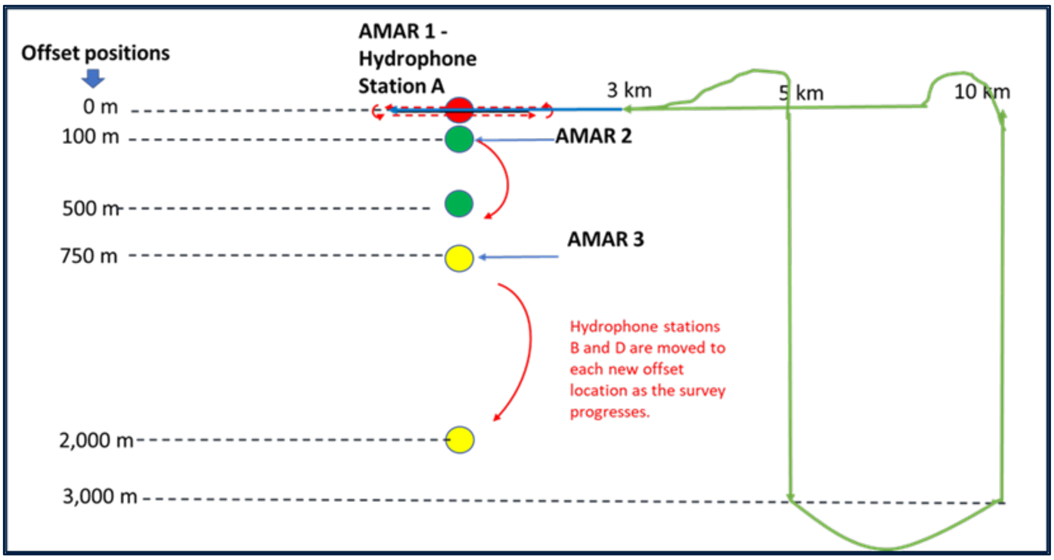

Figure 3.3: Recorder deployment geometry and test track for the sound source characterization (SSC) tests. AMAR stations are indicated by the circles (red for the static AMAR 1 station along the sail line, green for the AMAR 2 station that will be moved from 100m to 500m between two sailings with the same sources, and yellow for AMAR 3 that will be moved from 750m to 2km). The blue line indicates the standard sailing line for all the tests; the green lines and arrows indicated the additional sailing lines required for the tests (including direction of travel) with the sparker source

AMARs 1, 2 and 3 were deployed at stations A (0 m offset), B (100 m offset) and D (750 m offset), perpendicular to the planned vessel track lines. The vessel ran scouting lines East to West with the MBES and SSS to locate the as laid positions (Figure 3.4). These positions are shown in Table 3.5.

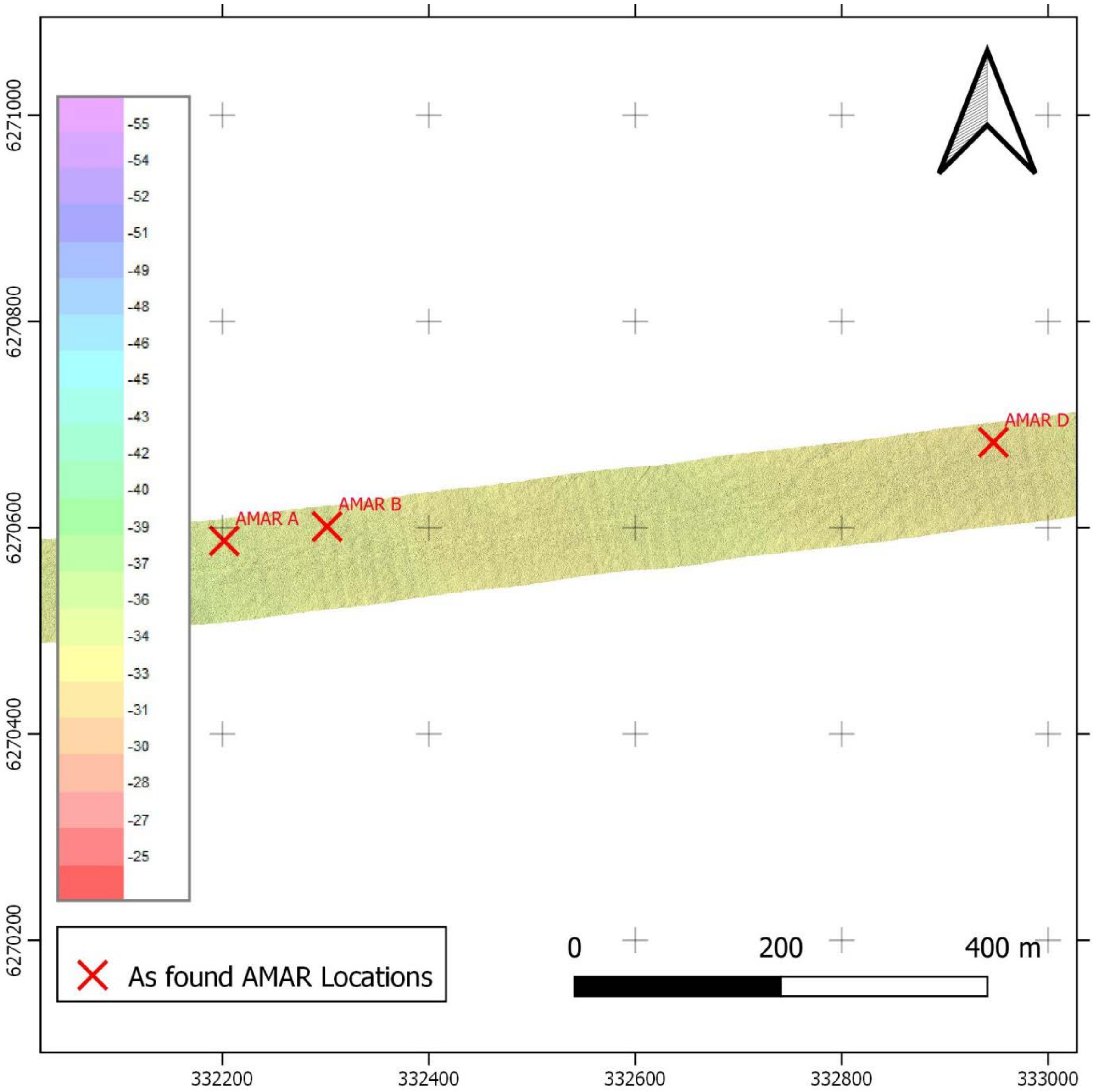

Figure 3.4: MBES scouting line data example following deployment 1, showing the as found locations of AMAR stations A, B and D

Table 3.5: AMAR as found positions after deployment 1 at stations A, B and D

Location	Station ID	Instrument	Latitude	Longitude	Depth (m)
0m	A	AMAR 1	N 56°54′95.99	E 06°27′02.71	33.50
100m	B	AMAR 2	N 56°54′97.59	E 06°27′18.84	33.00
750m	D	AMAR 3	N 56°55′07.22	E 06°28′23.18	31.80

The vessel then proceeded with the survey lines, transiting 4 km along a test line in reciprocal directions over the zero offset station A location. For the tests with the sparker source, and an additional 12 km track was required as well as two additional tracks parallel to the instruments at 5 km and 10 km distance. For each test the respective equipment was used as the tracking sensor when tracking over the zero offset station A location. In the case of the combined tests the seismic source was used as the tracking sensor, Figure 3.5 shows the track lines from all sensors.

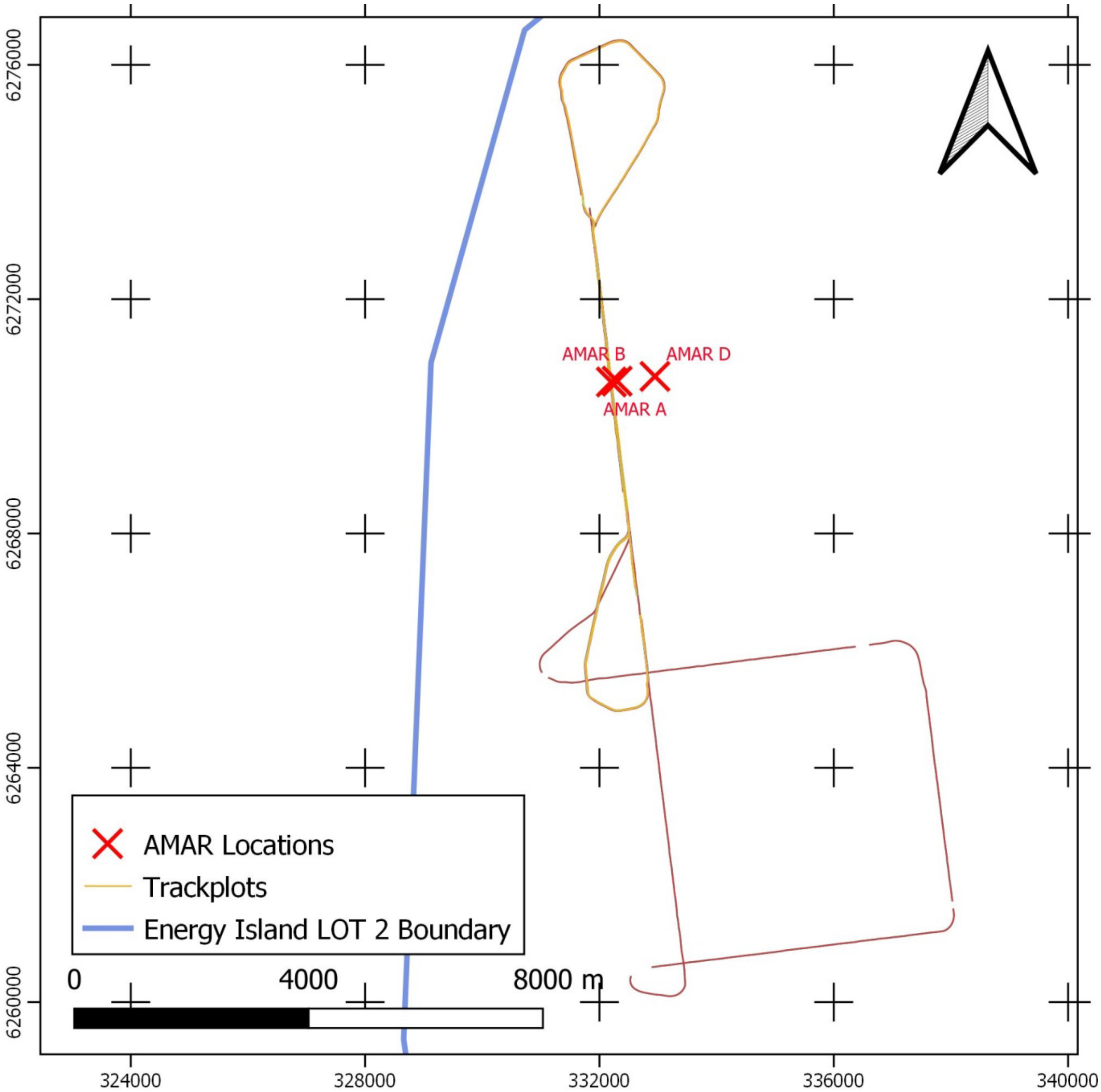

Figure 3.5: Tracks for all lines conducted following deployment 1 at stations A, B and D

AMARs 2 and 3 were then recovered and re-deployed to station C (500 m offset) and station E (2000 m offset), perpendicular to the planned vessel track lines. The vessel ran scouting lines East to West with the MBES and SSS to locate the as laid positions (Figure 3.6). These positions are shown in Table 3.6.

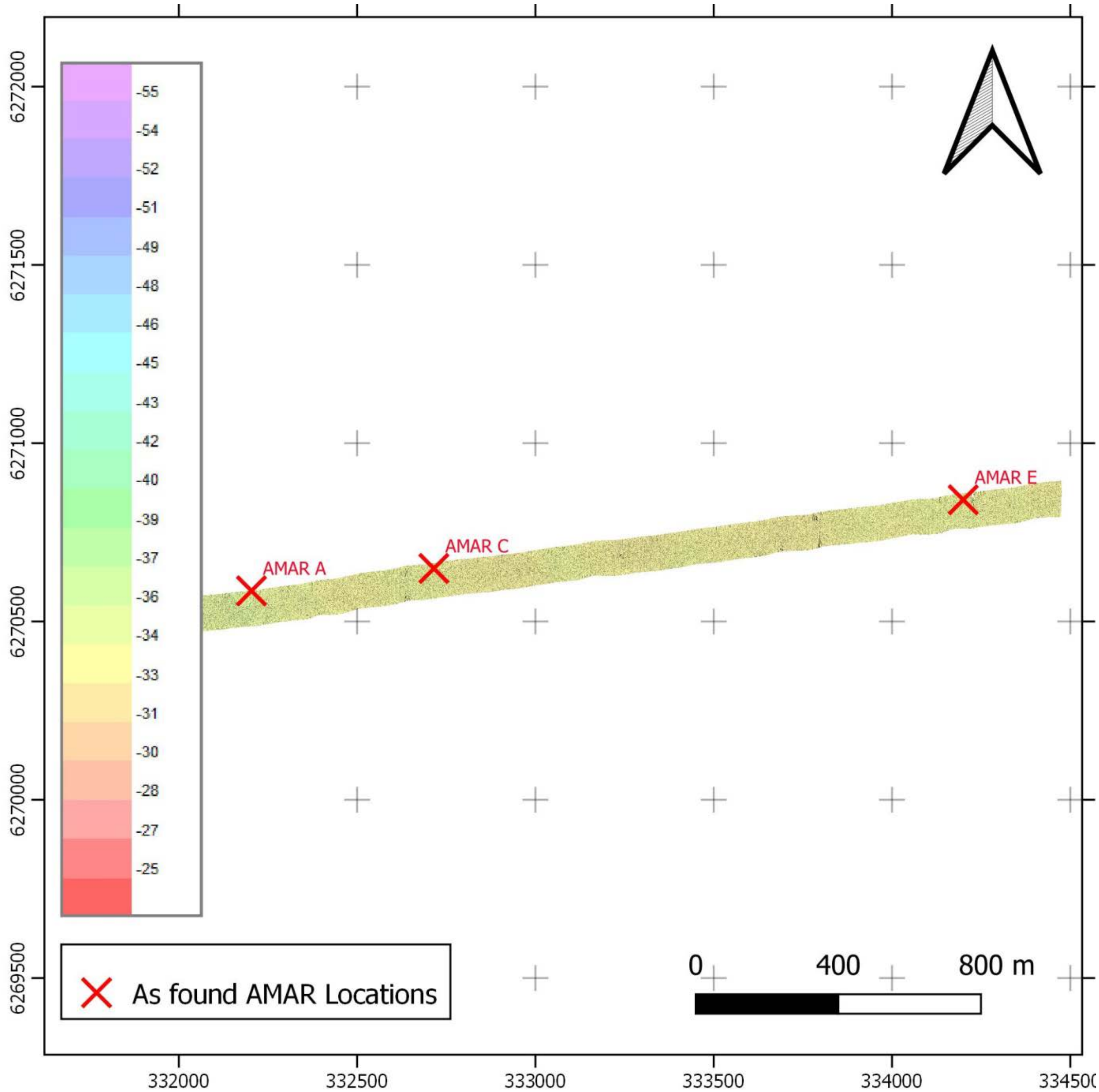

Figure 3.6: MBES scouting line data example following deployment 2, showing the as found locations of AMAR stations A, C and E

Table 3.6: AMAR as found positions after deployment 2 at stations A, C and E

Location	Station ID	Instrument	Latitude	Longitude	Depth (m)
0m	A	AMAR 1	N 56°54’95.84	E 06°27’02.96	33.20
500m	C	AMAR 2	N 56°55’03.29	E 06°27’85.66	32.80
2000m	E	AMAR 3	N 56°55’25.83	E 06°30’25.60	32.30

The vessel then proceeded with the survey lines, transiting 4 km along a test line in reciprocal directions over the zero offset station A location. For each test the respective equipment was used as the tracking sensor when tracking over the zero offset station A location. In the case of the combined tests the seismic source was used as the tracking sensor, Figure 3.5 shows the track lines from all sensors.

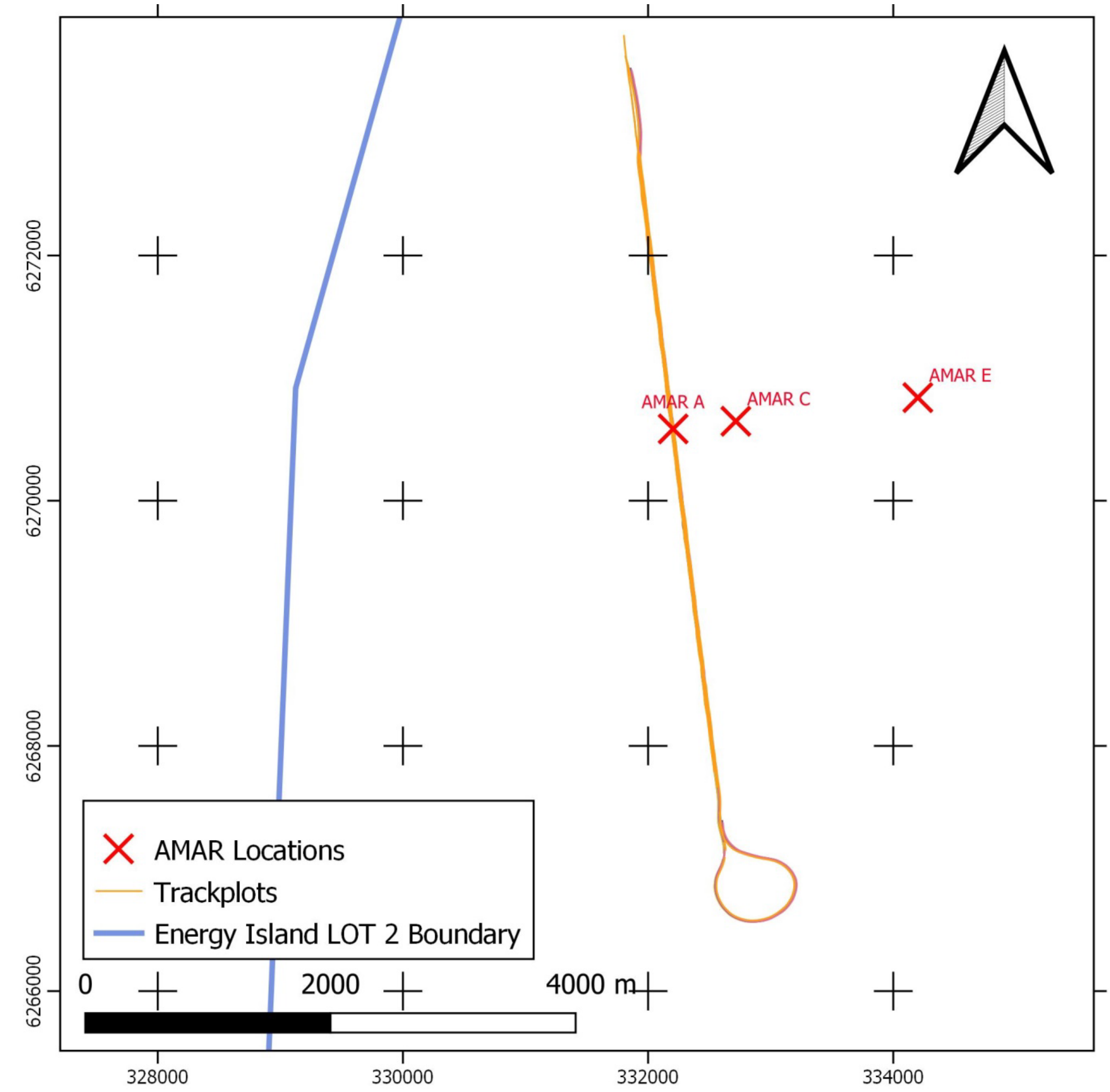

Figure 3.7: Tracks for all lines conducted following deployment 2 at stations C and E

The below matrix shows the tests lines ran for each sensor, for the two stages of AMAR deployment.

Table 3.7: Test sequence as surveyed

Line Name	AMAR Offset Distance	Deployment	Direction (°)	MBES	SBP	UHR (900J)	SSS
	Deployed AMAR A, B and D						
	Lines ran with 0 m offset from AMAR 1. Recording from 2 km before to 2 km after AMAR 1 location.						
ENT0A01_01	0 m, 100 m, 750 m	1	171	off	off	off	off
ENT0A02_01			351	off	off	off	off
ENT1A01_01			171	on	off	off	off
ENT1A02_01			351	on	off	off	off
ENT2A01_01			171	off	on	off	off

Line Name	AMAR Offset Distance	Deployment	Direction (°)	MBES	SBP	UHR (900J)	SSS
ENT2A02_01			351	off	on	off	off
ENT4A01_01			171	off	off	off	on (no beacon)
ENT4A02_01			351	off	off	off	on (beacon on)
ENT3A01_01			171	off	off	on	off
ENT3AT1_01			170	off	off	on	off
ENT3AP1_01			81	off	off	on	off
ENT3AT2_01			80	off	off	on	off
ENT3AP2_01			261	off	off	on	off
ENT3A02_01 (extended line to cover 5 km &10 km offsets)			351	off	off	on	off
ENT5AT21			167	on	on	on	on
ENT5A01_01			171	on	on	on	on
ENT5AT22			174	on	on	on	on
ENT5A02_01			351	on	on	on	on
	Recover AMAR B and D and deploy at location C and E						
	Lines ran with 0 m offset from AMAR 1. Recording from 2 km before to 2 km after AMAR 1 location.						
ENT0B01	0 m, 500 m, 2000m	2	171	off	off	off	off
ENT0B02			351	off	off	off	off
ENT1B01			171	on	off	off	off
ENT1B02			351	on	off	off	off
ENT2B01			171	off	on	off	off
ENT2B02			351	off	on	off	off
ENT4B01			171	off	off	off	on (no beacon)
ENT4B02			351	off	off	off	on (beacon on)
ENT3B01			171	off	off	on	off
ENT3B02			351	off	off	on	off
ENT5AT21			24	on	on	on	on
ENT5B01_01			171	on	on	on	on
ENT5AT22			174	on	on	on	on
ENT5B02_01			351	on	on	on	on

4. Field Procedures

4.1 Vessel Offsets

All systems on the vessel were mounted relative to the XYZ reference frame of the vessel. The Y-axis being the fore-aft centre line, the X-axis running perpendicular to the Y-axis through the Common Reference Point (CRP), and the Z axis being positive upwards from the CRP. The online navigation software Starfix.NG uses this reference frame to correct vessel nodes for position.

The Vessel Reference Frame (VRF) was derived using 3D laser scan as part of the vessel dimensional control in June 2014. The CRP on Fugro Pioneer has been defined in the survey navigation software, Starfix.NG, to be the starboard aft corner on the inside rim of the moonpool.

All instrument offsets have been provided in Table 4.1 and a corresponding vessel offset diagram in Figure 4.1.

Table 4.1: Fugro Pioneer Instruments Offsets

Offset Name	Starboard Positive (X) [m]	Forward Positive (Y) [m]	Up Positive (Z) [m]
CRP	0.00	0.00	0.00
USBL (deployed position)	3.91	3.56	-7.05
DS1 Draught transducer (for Single beam echosounder (SBES))	−2.22	18.24	-5.54
DS2 Draught transducer (for MBES)	−0.83	1.37	-5.53
SBES transducer	−0.66	20.19	-5.79
DMS	-0.35	21.90	-4.58
SBP 4x4 (centre of array)	0.01	22.24	-5.73
MBES	−0.70	0.49	-6.05
HydrINS (Primary MRU/Heading)	0.39	0.77	0.46
Subsea Octans (MRU/Heading)	−0.74	0.96	-5.33
Innomar	−1.49	0.42	-5.73
DGPS3	−0.75	3.99	12.13
DGPS4	−3.16	5.09	12.13
DGPS_Tide	−5.83	-7.31	7.89
SSS TP_STBD	3.02	-24.24	3.72
SSS TP_PORT	-4.32	-24.24	3.72
Sparker TP	-10.25	-21.05	0.95
Streamer TP	-14.31	-21.05	0.95

Table 4.2: 2D UHRS Source Offsets

Offset Name	Starboard Positive (X) [m]	Forward Positive (Y) [m]	Up Positive (Z) [m]
CRP	0.00	0.00	0.00
Centre of source	0.00	0.00	0.00
RTK Front	0.00	-0.45	1.72
RTK Rear	0.00	-1.13	1.72
Towpoint (tp)	0.00	0.94	0.00

To guarantee that the moon-pool cart is in the same position when deployed, two pistons and four guides are installed - ensuring the offsets are consistently repeated whenever deployment/recovery takes place.

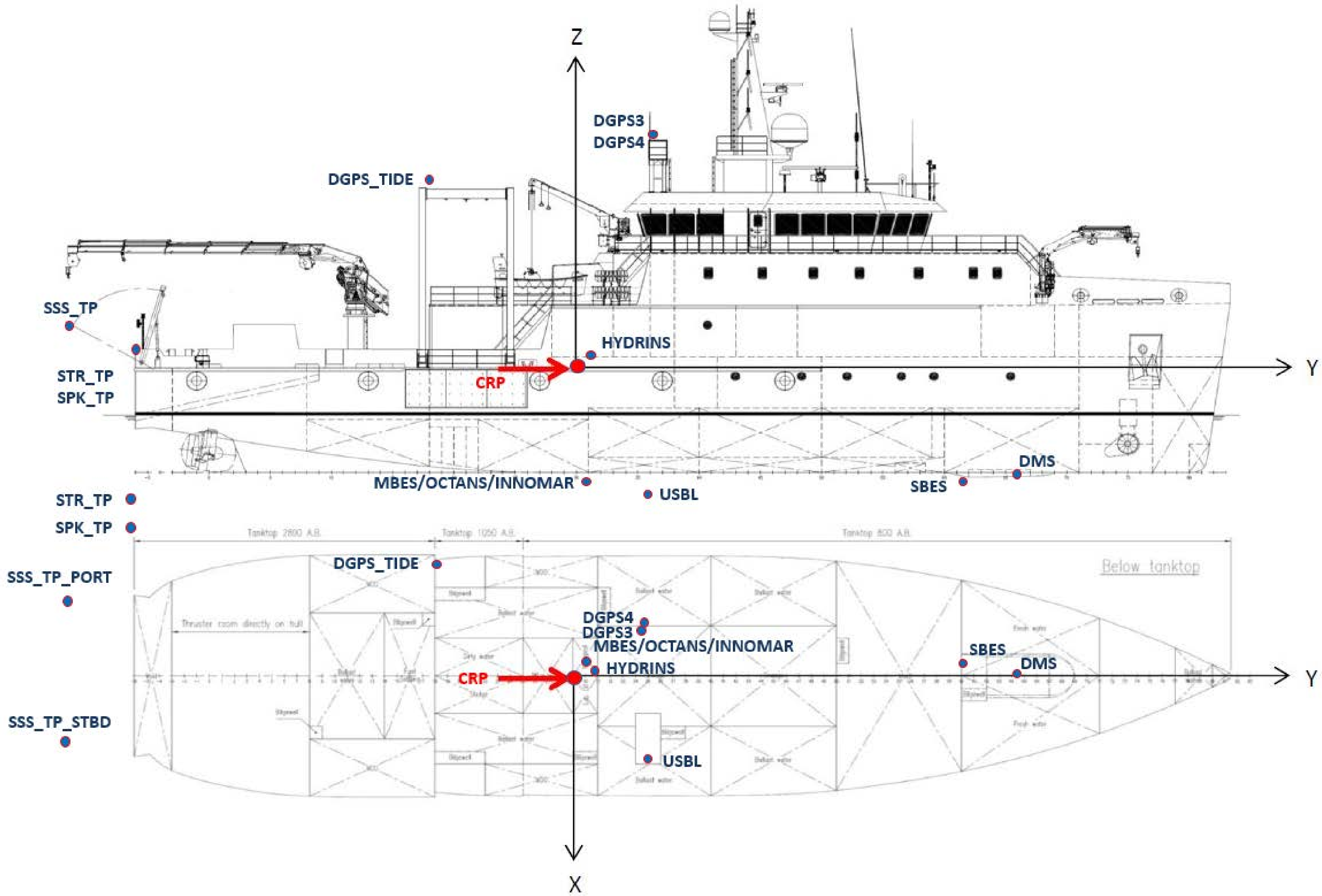

Figure 4.1: Fugro Pioneer Offset Diagram

4.2 Navigation and Vertical Control

Table 4.3: Vessel Navigation and Vertical Control

Vessel Navigation and Vertical Control	
Requirement	■ Horizontal: Accurate vessel positioning for all aspects of the marine survey. Vessel positioning has a horizontal accuracy of better than ± 0.1 m and a vertical accuracy better than ± 0.2 m ■ Vertical: All vertical data for North Sea Geophysical Survey will be reduced to Mean Sea Level (MSL) utilising the DTU21 MSL Tide Model as a vertical offshore reference frame supplied by the Technical University of Denmark (DTU).
Equipment	■ Positioning System: 2 x Fugro StarPack with Starfix G2+ corrections; ■ Heading and attitude: iXSea Hydrins, iXblue Octans ■ Navigation Software: Starfix
Data Collection	■ All global navigation satellite system (GNSS) positions were acquired in geographic coordinates relative to the World Geodetic System 1984 (WGS84) datum. Subsequent positions were projected to ETRS89 Universal Transverse Mercator Zone 32 north (UTM Zone 32N) projection. ■ The GNSS system antennas were mounted at the top of the vessel mast for unrestricted hemispherical views and clear of any ships radar systems. ■ Starfix.G2+ utilised corrections from the Fugro network of precise point positioning (PPP) G2+ solution to provide sub-decimetre horizontal accuracy. Secondary positioning was setup to automatically become active if the primary system dropped out of specification. ■ Hydrins utilised a tightly coupled navigation solution, which incorporated both the IMU and GNSS antennas to resolve a heading. Hydrins was mounted close to the vessel centre line and provided both heading and attitude.

4.3 Subsea Positioning

Table 4.4: Subsea Positioning

Subsea Positioning	
Requirement	Provide positioning information to towed seabed sensors ■ Update rate of 0.5 Hz or better (preferred is 1 Hz); ■ Consistent dropouts of duration > 5 seconds not accepted; ■ Following calibration of the USBL system, 95% (2 sigma) of transponder positions within ± 1 m.
Equipment	■ Kongsberg HiPAP 501 ■ Kongsberg cNODE Micro 31-180 transponders ■ Kongsberg acoustic position operator station (APOS) software
Data Collection	Underwater positioning data were collected and processed in accordance with Fugro's quality management system, which complies with the requirements of ISO 9001:2015 with specific reference to work instruction WI-212. On the vessels, the USBL transceiver was pole mounted on a dedicated USBL pole. The USBL system received the following data corrected for the USBL transceiver location from the Fugro StarfixNG navigation system: ■ Position (from Fugro StarPack GNSS); ■ Heading, Pitch, Roll and Heave (from iXSea Hydrins INS); Additionally, Sound velocity probe (SVP) cast information was uploaded to the USBL system after each SVP was undertaken. The Fugro Starfix.NG navigation software was setup with a visual alert to highlight consistent and/or long-duration beacon dropouts to the online surveyor. cNODE Micro transponder duration was over 2 days at a 1 Hz interrogation rate. At the start of the survey USBL system was verified by "boxing in" a seabed feature by SSS positioned by transponder. The SSS is a sub-towed sensor. USBL transponders were attached to tow-cable ahead of the SSS fish. Accurate real time positioning was then provided at 1 Hz to the relevant acquisition software, which then applied an offset from the beacon to the sensors. Layback or offset were calculated and remain not changed during operation. Records were stored in the online survey logs.

4.4 Multibeam Echosounder

Table 4.5: Multibeam Echosounder

Multibeam Echosounder	
Requirement	Bathymetry data shall be achieved in accordance with IHO S-44 Order 1A which includes the identification of all objects greater than 1 m in any dimension. The horizontal resolution and the data-density should be sufficient to achieve a grid cell size of 0.25 m and 1.0 m for DTM calculations.
Equipment	Kongsberg dual-head EM 2040 (0.4° at 400 kHz) multibeam echo sounder, with dual-swath functionality); ■ iXSea Hydrins INS motion reference unit (MRU); ■ iXBlue Octans 3000 motion reference unit (MRU); ■ Valeport mini Sound Velocity Sensor (SVS);

Multibeam Echosounder	
	■ SAIV SD204 CTD probe with wireless controller; ■ AML MVP30 – moving velocity profiler ■ Caris HIPS & SIPS processing software; ■ Starfix.VBAProc processing software.
Data Collection	Multibeam data were collected in accordance with Fugro's standard work instructions, a component of Fugro's quality management system, which complies with the requirements of ISO 9001:2015, ensuring that data is collected in accordance with the scope of work and Fugro NL Marine work instructions WI-207, WI-214, WI-215, WI-224, WI-227 and WI-229. On Fugro Pioneer a dual-head Kongsberg EM 2040 400/200 kHz system was pre-mobilised and consists of a single transmit array and two separate receive arrays, with each receive array mounted on specific designed Kongsberg bracket in the moon pool. The depth resolution of the system is better than 1 cm. The system was run in 400 kHz configuration. Operating in high density equidistant mode, 400 sounding are generated per ping per multibeam head. The Kongsberg system is capable of multi-pings (Dual Swath) which enables a faster rate of sounding acquisition. The Hydrins and Octans supplied heading and attitude information directly to the Kongsberg SIS topside unit at a rate of 100 Hz. Sound velocity of the water column was measured, prior to the start of survey operations and at least once during each 6 to12 hour period. The SVP has an accuracy of ±0.2 m/s. A Valeport mini SVS is mounted near the transmit array to determine the speed of sound at the transducer face and account for ray bending at the acoustic source. Continuous speed of sound measurements was provided by the SVS to the multibeam system. The SVS has an accuracy of +/-0.05 m/s. Fugro used best industry practice to achieve the required 16 hits per 1 m^2 bin requirement in the first instance by operating the multibeam echosounder at full rate dual head mode. During survey operations multibeam settings were constantly monitored to ensure optimal performance. Prior to commencement of the survey a complete calibration was undertaken for the following variables: i) latency, ii) pitch, iii) roll, iv) yaw, v) pitch/roll correlation. The calibration data was processed before the start of the survey as described in Fugro work instruction WI-207 and WI-229. During vessel mobilisation, a comparison of all SVP's was carried out with a simultaneous cast in a water depth like that expected during the survey. The hull mounted SVS was also included in the comparison. Survey data was collected to the required survey specification and monitored using Kongsberg SIS and Caris HIPS&SIPS was used offline for QC.

4.5 Side Scan Sonar

Table 4.6: Side scan Sonar

Side scan Sonar	
Requirement	To achieve high quality the side scan sonar shall be operated at high frequency with a 75m range along the proposed survey lines at 62.5 m spacing. ■ Survey speed will be limited to 4.5 knots.
Equipment	■ 2 x Edgetech 4200 side scan sonar (300/600kHz); ■ Operating mode multi-pulse/ HS mode; ■ 1 x STR ESW-500 series winch with soft-tow cable; ■ USBL sub-sea positioning; ■ Edgetech Discover data acquisition software; ■ Chesapeake SonarWiz data processing software.
Data Collection	Side scan sonar data was collected in accordance with Fugro Standard Procedures WI02_351, WI02_353 and WI02_354; a component of Fugro's quality management system, which complies with the requirements of ISO 9001:2015. The side scan sonar was towed on an armoured cable off the STR-500 winch astern of the vessel. The cable out was shortened or lengthened as necessary by high speed, remote control winch to control a tow fish altitude above seabed of between 10% and 12% of the range operated. The dual channel, dual frequency side scan sonar operated at a 75 m range to achieve the project requirements for coverage and resolution. Throughout the survey, both the high and low frequencies were recorded. Data was recorded as both XTF and JSF formats. Survey logs listing the data collection parameters were maintained throughout the survey. The data was positioned using USBL for lines acquired with the beacon on; with a beacon mounted a fixed distance up the cable from the sensor. For lines with USBL turned off, a layback from the vessel was applied. These distances were entered into the online acquisition software to account for the offset. The system was set up, and data recorded in adherence to WI02_120 and WI02_220. Comprehensive survey logs listing the data collection parameters were maintained throughout the survey.

4.6 Parametric Sub-bottom Profiler

Table 4.7: Parametric Sub-bottom Profiler

Parametric Sub-bottom Profiler	
Survey Parameters	■ Frequency 8 kHz ■ Power output ■ Ping rate 10pps
Equipment	■ System: Innomar SES-2000 Medium-100 Parametric sub-bottom profiler; ■ Acquisition system: SESWIN;
Data Collection	Sub-bottom profiler data was collected in accordance with Fugro's standard procedures, a component of Fugro's Quality Management System, which complies with the requirements of ISO 9001:2015, ensuring that data is collected in accordance with the scope of work and Fugro procedures.

Parametric Sub-bottom Profiler	
	A digital transmitter/transducer unit was supplied for ultra-high resolution seismic data collection. The parametric system has a narrow beam and is based on low frequency sound generation from two high intensity sound beams at higher frequencies. The system provided resolution of up to 0.2 m and penetration through unconsolidated sediments of 8-10 m depending on geological conditions and water depths. All data was recorded digitally in the SESWIN acquisition system along with positional data from the positioning system provided by Fugro Starfix. Any duplicates in source coordinates caused by shot interval and navigation point separation were corrected using an interpolation method. Comprehensive survey logs listing the data collection parameters were maintained throughout the survey.

4.7 2D UHRS

Table 4.8: 2D UHRS Spread

2DUHR Seismic	
Requirement	■ Source Output: To be optimally tuned based on the site conditions; ■ Source Bandwidth: 0.3-1.2 kHz;
Equipment	■ Fugro Multi-level Stacked Sparker (MLSS) • Fugro MLSS power supply (700 J/ 1100 J) • 3 array multi-level sparker: 360/440 tips corresponding to 700 J/ 1100 J • 70 m HV cable • Sea ground cable
Data Collection	Positioning of the sparker was achieved by layback and offset calculations. Triggering of the sparker was controlled in Starfix NG and was done based on distance at a 0.5s interval. p190's were recorded online and provided to JASCO to capture time and position for each shot

4.8 JASCO Autonomous Multichannel Acoustic Recorders

2DUHR Seismic	
Requirement	■ Deployed nominally +/- 10m of survey line for station A ■ Known on bottom positioning for all other stations
Equipment	■ JASCO Autonomous Multichannel Acoustic Recorders (AMARs) ■ 256 kbps sample rate (10 Hz to 128 kHz recording bandwidth) ■ 24-bit resolution ■ 2x512 GB storage memory ■ 0 dB gain ■ 5 days continuous recording (battery limited)
Data Collection	Positioning of the AMARs based on sidescan and multibeam data. 755 GB of acoustic data collected across 3 systems. Calibrations and data verifications preformed on stations B and D between tests A and B.

2DUHR Seismic	
	Survey logs and p190s collected to parse acoustic data for critical times during survey.

5. Field Processing

Only the navigational and positioning data were fully processed. 2D UHRS, SSS, SBP and MBES data were collected and recorded for the purpose of noise monitoring. SSS, SBP and MBES were processed on board to check the data was recording correctly in accordance with the survey requirements.

JASCO processing was done using JASCO's in house analysis suite to generate time and octave based SEL, and SPL statistics. Initial "first look" processing was conducted immediately following the departure of the JASCO team from the survey vessel.

5.1 Navigation and Vertical Control

Table 5.1: Vessel Navigation and Vertical Control

Vessel Navigation and Vertical Control	
Processing	All data was processed and reported according to Fugro standard procedures. ■ All depths were reduced to MSL using the DTU21 model within Caris HIPS & SIPS. ■ Navigation, motion and Starfix.G2+ GNSS elevation data were processed using Fugro Starfix.VBAProc. ■ Ellipsoidal heights of the GNSS antennas were corrected for motion. ■ The heights were reduced to the water line using draught measurements. ■ Waterline elevations were further reduced to the vertical datum (MSL) by means of DTU21 ellipsoidal to datum separation model. ■ A smooth tide curve was created to reduce MBES data to datum and apply trace-to-trace tidal corrections to SBP data.
Data Outputs	■ Navigation tracks of each sensor (.pos) ■ Tidal curve (.pos/.tid) ■ Tidal curve for SBP (.txt)

5.2 Subsea Positioning

Table 5.2: Subsea Positioning

Subsea Positioning	
Processing	All data was processed and reported according to Fugro standard procedures. ■ USBL data was processed in VBA.Proc by recalculating the dx, dy, dz of the beacon to transducer distance. The calculation was done by the surface HiPAP unit based on the average sound velocity (as measured by SVP) and applying heading, pitch and roll corrections. ■ SSS positions were calculated by extending a layback from the beacon position.
Data Outputs	■ SSS navigation track (.pos) ■ MAG navigation track (.pos/shp) – *issued as a geotechnical clearance deliverable* ■ MAG position data (.txt)

5.3 Acoustic Sources Operational Time

Table 5.3: Acoustic Source Operational Time

Line Name	Start Time	End Time	Vessel Speed	Sensor Requirement					Sensor Time		Sensor over station
				MBES	SBP	SSS	Sparker (MLSS)	SBES Survey and SBES Vessel	On	Off	
AMAR Locations A - B - D											
ENT0A01_01	11:09	11:42	4kn						-	-	11:26
ENT0A02_01	11:56	12:27	4.5kn						-	-	12:12
ENT1A01_01	12:51	13:22	4.5kn						12:38	ON	13:07
ENT1A02_01	13:32	14:03	4.5kn						ON	14:03	13:48
ENT2A01_01	14:14	14:46	4.5kn						14:05	ON	14:31
ENT2A02_01	14:56	15:27	4.5kn						ON	15:28	15:13
ENT4A01_01	16:03	16:35	4.5kn			No Beacon			15:51	ON	16:20
ENT4A02_01	16:51	17:24	4.5kn			Beacon On			SSS ON USBL: 16:37	SSS & USBL 17:27	17:06
ENT3A01_01	19:33	20:10	4.5kn						Soft start 19:08	20:10	19:55
ENT3AT1_01	20:12	20:35	4.5kn						20:10	20:35	-
ENT3AP1_01	20:36	21:14	4.5kn						20:36	21:14	-
ENT3AT2_01	21:16	21:53	4.5kn						21:16	21:53	N/A
ENT3AP2_01	21:55	22:34	4.5kn						21:55	22:34	-
ENT3A02_01	22:37	00:17	4.5kn						22:37	00:17	00:01
ENT5AT21	00:20	01:11	4.5kn						00:20	01:12	-
ENT5A01_01	01:12	01:48	4.5kn						01:12	01:49	01:35
ENT5AT22	01:52	02:32	4.5kn						01:52	02:33	-
ENT5A02_01	02:36	03:17	4.5kn						02:36	03:18	03:01
AMAR Locations A - C - E											

Line Name	Start Time	End Time	Vessel Speed	Sensor Requirement					Sensor Time		Sensor over station
				MBES	SBP	SSS	Sparker (MLSS)	SBES Survey and SBES Vessel	On	Off	
ENT0B01	13:28	13:58	4.5kn						-	-	13:43
ENT0B02	14:08	14:39	4.5kn						-	-	14:24
ENT1B01	14:53	15:23	4.5kn						14:45	ON	15:08
ENT1B02	15:33	16:03	4.5kn						ON	16:04	15:49
ENT2B01	16:15	16:45	4.5kn						16:05	ON	16:30
ENT2B02	16:53	17:23	4.5kn						ON	17:32	17:09
ENT4B01	17:46	18:20	4.5kn			No Beacon			17:32 SSS 17:32 USBL	SSS ON 17:34 USBL off	18:06
ENT4B02	18:35	19:07	4.5kn			Beacon On			18:31 USBL	19:07 USBL and SSS	18:53
ENT3B01	20:44	21:22	4.5kn						20:20 Soft Start	21:22	21:07
ENT3B02	21:43	22:18	4.5kn						21:22 Soft Start	22:19	22:04
ENT5AT21	22:22	23:12	4.5kn						22:19	23:13	-
ENT5B01_01	23:15	23:57	4.5kn						23:06 MBE 23:07 SBES 23:08 USBL 23:10 SBP 23:15 SPK	23:58	23:38
ENT5AT22	23:59	00:15	4.5kn						23:59	00:15	-
ENT5B02_01	00:15	00:56	4.5kn						00:15	00:56	00:40

5.4 Acoustic Data Processing

While a detailed description of the data analysis process and the acoustics metrics used will be provided in the interpretative report, here we describe the quick data post-processing that took place immediately following the data collection to obtain some initial results, as agreed with the stakeholders. . Acoustic terminology and analysis are in accordance with ISO standard 18405 (ISO 2017a).

Acoustic data was download from the SD cards of the AMARs and two identical copies of the data were created on separate hard drives. Only one of the hard drive copies was used for processing to ensure a pristine backup of the data was always available, in addition to the original on the SD cards.

Data was visually and acoustically inspected by the JASCO field team with remote input and support from JASCO's main office. Spectrograms were generated using JASCO's PAMLab software©.

For each of the sources and recording positions, the acoustic Closest Point of Approach (CPA) was identified and noted in a dedicated log. Furthermore, individual pings were automatically marked, whenever possible using an impulse detector, and then inspected for accuracy. When necessary, manual refinement of the annotations was implemented to ensure each peak was captured correctly for further processing.

The loudness or magnitude of each identified pulse was quantified by computing the peak pressure level (PK), 90% SPL, and SEL of the pulse. The digital recording units were converted to micropascals (µPa) by applying the hydrophone sensitivity, the analogue circuit frequency response, and the digital conversion gain. An automated feature detection algorithm picked the start and end times of the individual airgun pulses in the acoustic data. These automated detections were supplemented with manual picks as required. Each pulse was then analysed as follows:

1. The PK was computed.
2. The cumulative square pressure was computed over the duration of the pulse.
3. The 90% energy pulse duration (T_{90}) was determined and the 90% SPL was computed.
4. The SEL was computed according over the duration of the entire pulse.
5. One-third octave band levels were calculated over the full frequency range of the monitoring.

Auditory weighting functions for marine mammals—called M-weighting functions—were proposed by (Southall et al. 2007). Functions were defined for five hearing groups of marine mammals:

6. Low-frequency cetaceans (LFCs)—mysticetes (baleen whales)
7. Mid-frequency cetaceans (MFCs)—some odontocetes (toothed whales)

8. High-frequency cetaceans (HFCs)—odontocetes specialized for using high-frequencies
9. Pinnipeds in water—seals, sea lions, and walrus.

A detailed description of the marine mammal weighting functions applied will be provided in the Interpretative report.

6. Data Examples of Noise Monitoring Survey

The brief descriptions and images presented in this section represent the data collected and recorded for the purpose of noise monitoring.

6.1 Multibeam Echosounder

Multibeam echosounder frequency was above the maximum usable frequency range for equipment; therefore, no signal was detected on the AMARs. The settings and characteristics of the recording equipment had been decided on an approved based on the TQ-002 (Appendix J) requirements for a sampling frequency of 128kHz before mobilisation and could not be adjusted. A data example of MBES data, gridded at 0.25m, for area designated as AMAR A is shown below.

The spatial accuracy achieved for MBES sensor for the present survey are resolution 0.25m and 1m. Standard deviation (2 sigma) was <0.2. THU was <0.5m and TVU are depth dependent values and the results were satisfying IHO special order 44.

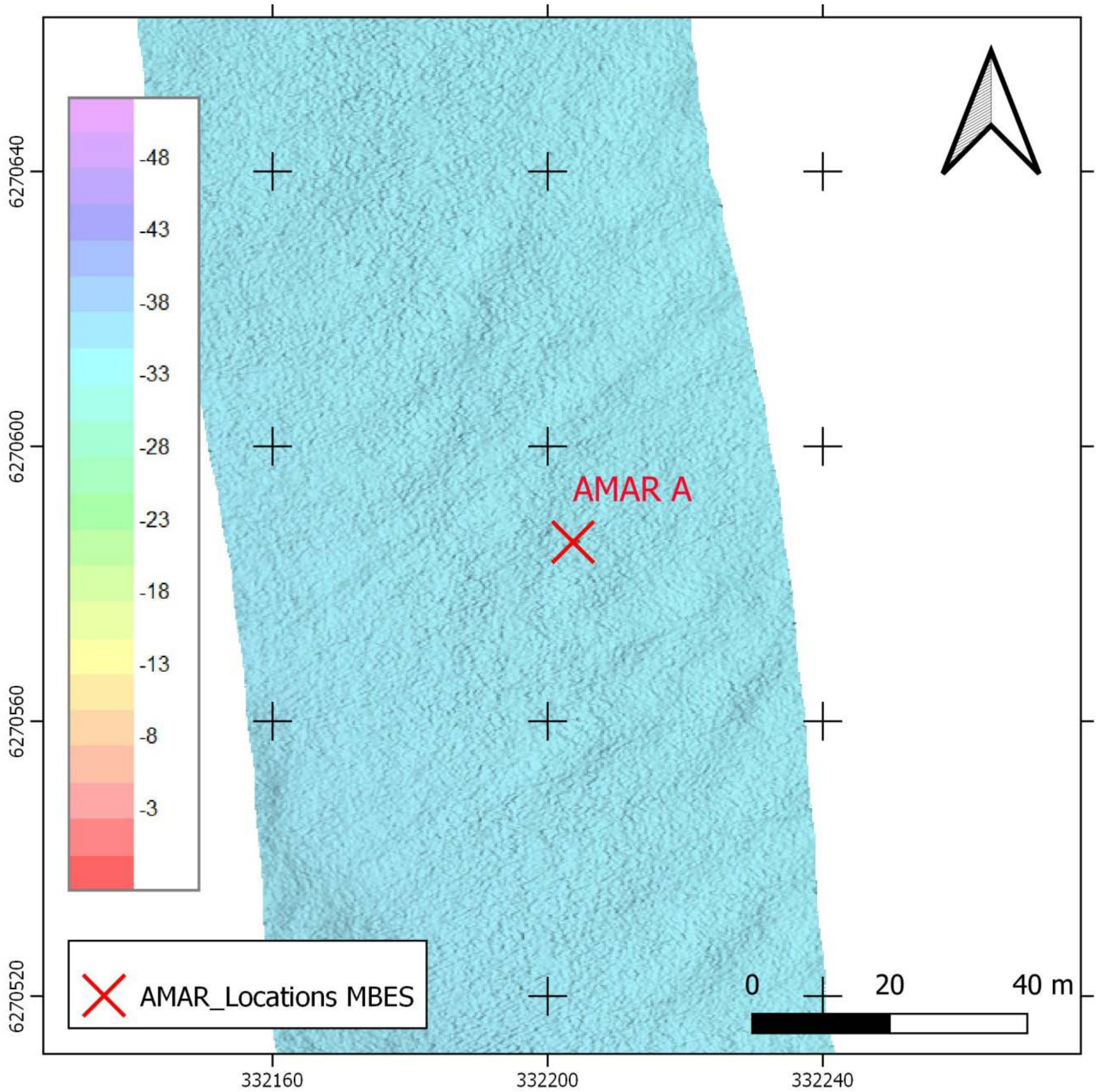

Figure 6.1: MBES Data example for line ENT5B02 crossing AMAR A gridded at 25cm.

6.2 Side Scan Sonar

The side scan sonar (SSS) was used first for the scouting lines to help locate the AMAR on the seabed. The SSS was then turned on for eight lines in total, recording high frequency (HF) and low frequency (LF) data. The SSS was operating at 300 kHz and 600 kHz frequency and 75 m range.

SSS data was imported into SonarWiz 7. Position was provided by the USBL for the lines where the USBL was turned on.

Figure 6.2 shows an example LF SSS data collected over AMAR A. The frequency of the SSS was above the maximum usable frequency range for equipment; therefore, no signal was detected on the AMAR. Also in this case the settings for the configuration and characteristics of the recording equipment were agreed prior to mobilisation based on the TQ-002 (Appendix J) .

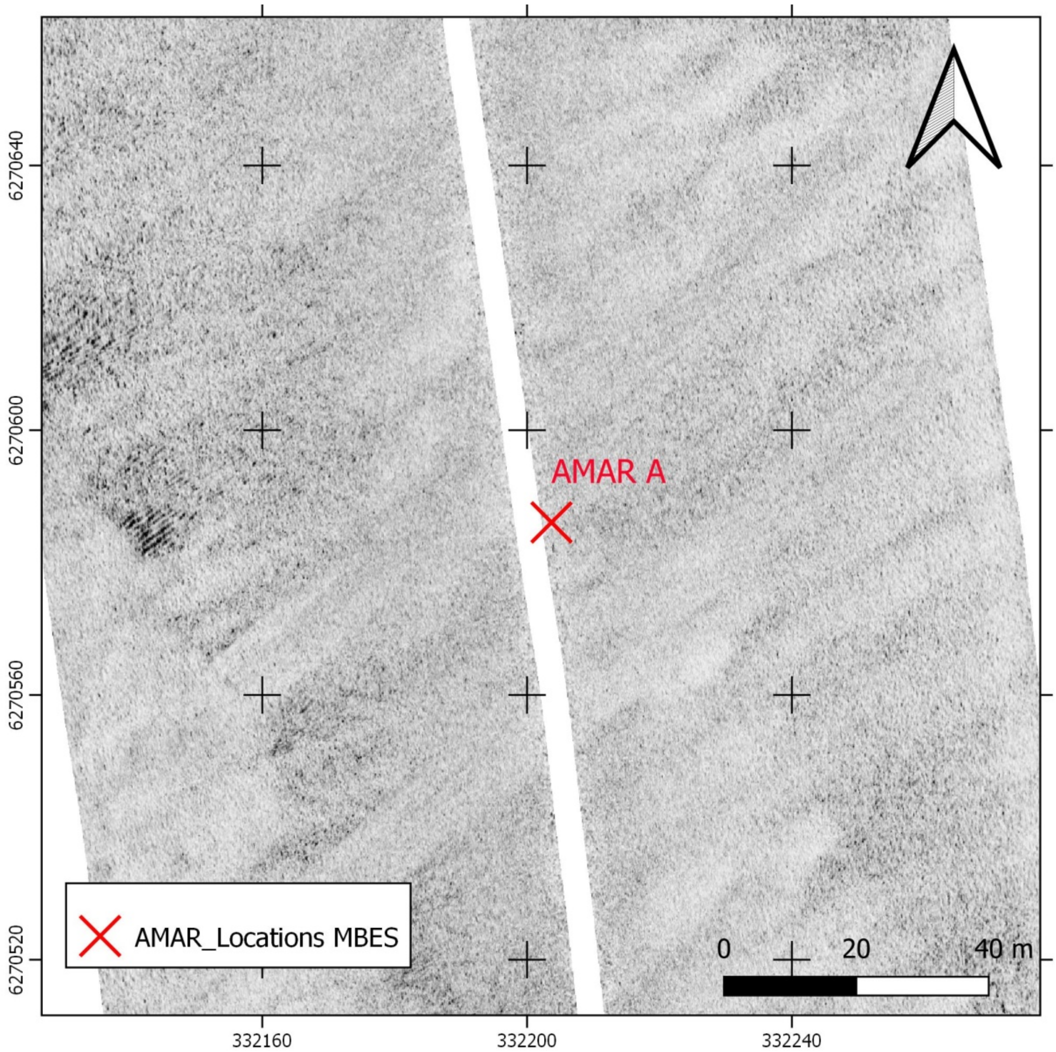

Figure 6.2: SSS LF Data example for line ENT4A02 crossing AMAR A

6.3 Parametric Sub-Bottom Profiler

Sub-bottom profiler (SBP) data quality overall was within the specification for the noise monitoring survey. Vertical data resolution and ping rate were 0.3m and >8 Hz (pulse per seconds). The high and low frequency acquisition, the high frequency gain value, power output and number of pulses (1) were kept constant throughout the project.

A data example of SBP data as it passed over AMAR A is shown in Figure 6.3.

The amplitude and spectrogram of the signal recorded on AMAR A are presented in Figure 6.4

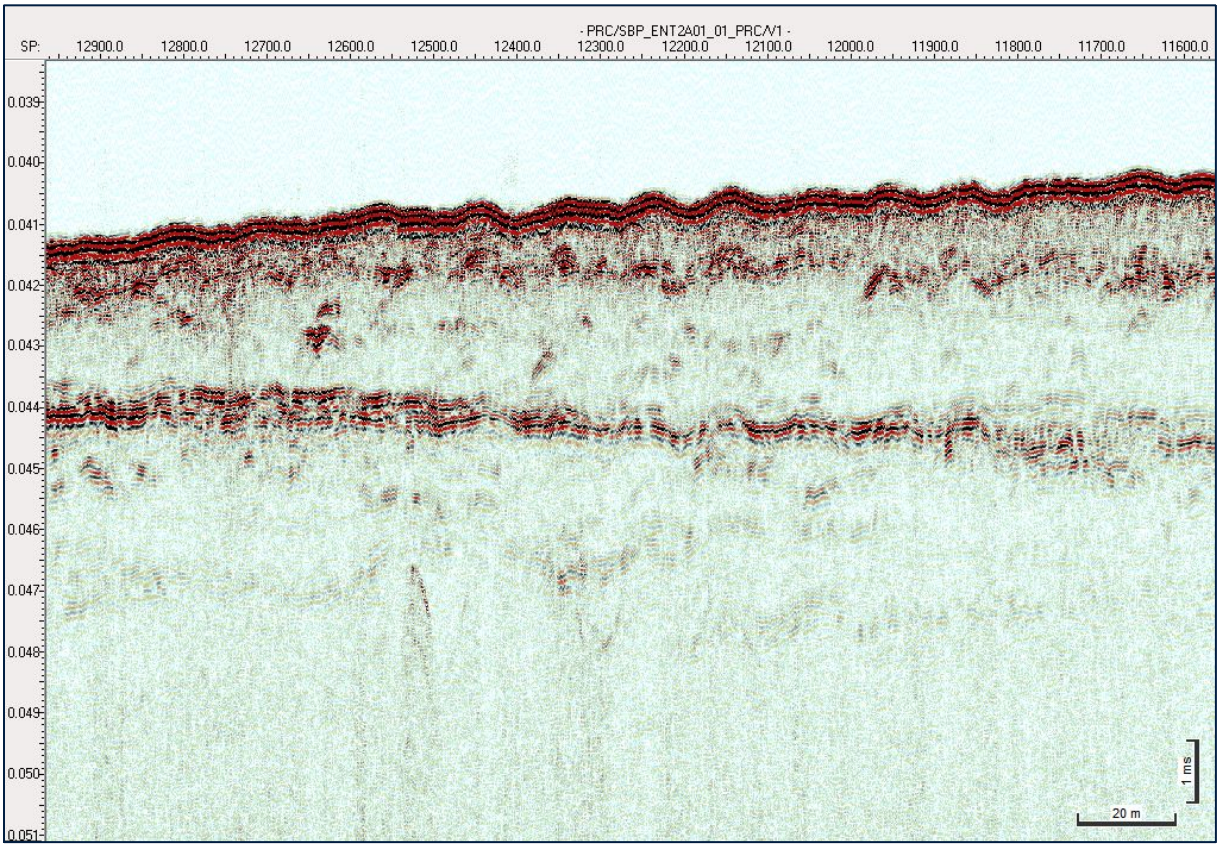

Figure 6.3: SBP data example showing a section of line ENT2A01_01 as it passed the AMAR A sensor

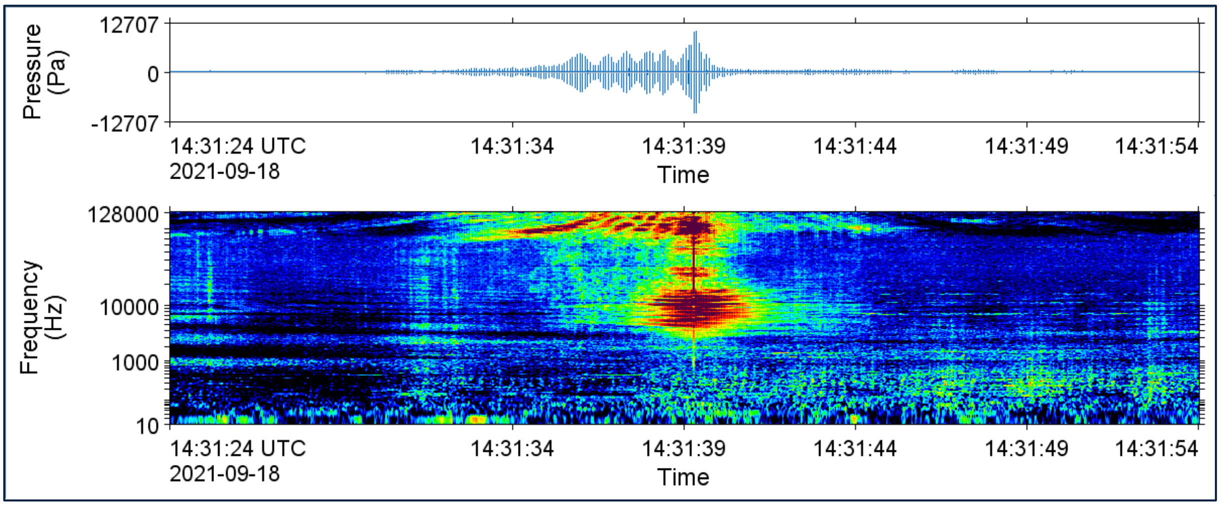

Figure 6.4: Amplitude (top) and Spectrogram (bottom) of SBP: example showing a section of data as the source transited over AMAR A sensor

6.4 2DUHR Seismic

It was agreed on site that the deployment of the streamer for 2D UHR seismic acquisition was not necessary to the tests. Therefore, there was no 2D UHR seismic data to QC.

The sparker source was shot every meter, this corresponded to approximately 2 shots for every 1 second. An example of the amplitude and spectrogram of the signal recorded during passing over AMAR A is presented in Figure 6.6.

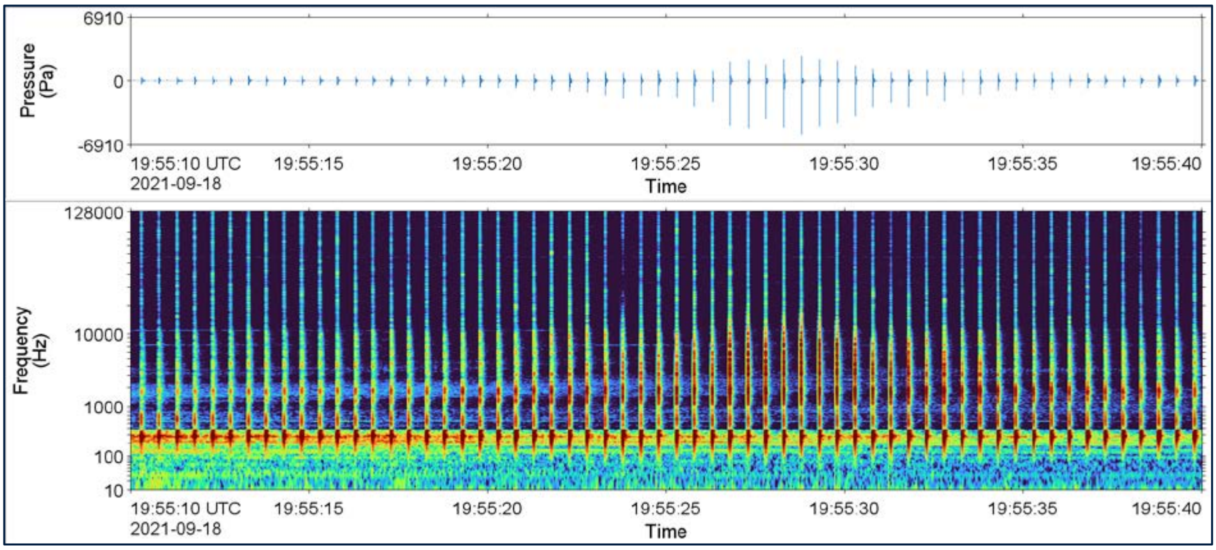

Figure 6.5: Amplitude (top) and Spectrogram (bottom) of Sparker: example showing a section of data as the source transited over AMAR A sensor

6.5 USBL

The USBL system was used to provide positioning for the towed equipment and was switched on during the SSS tests unless stated otherwise in the Table 3.7.

The amplitude and spectrogram of the signal recorded on AMAR A are presented in Figure 6.6. A clear series of impulses was detectable against the ambient sound levels. The peak frequency of the signals is visible at around 25kHz.

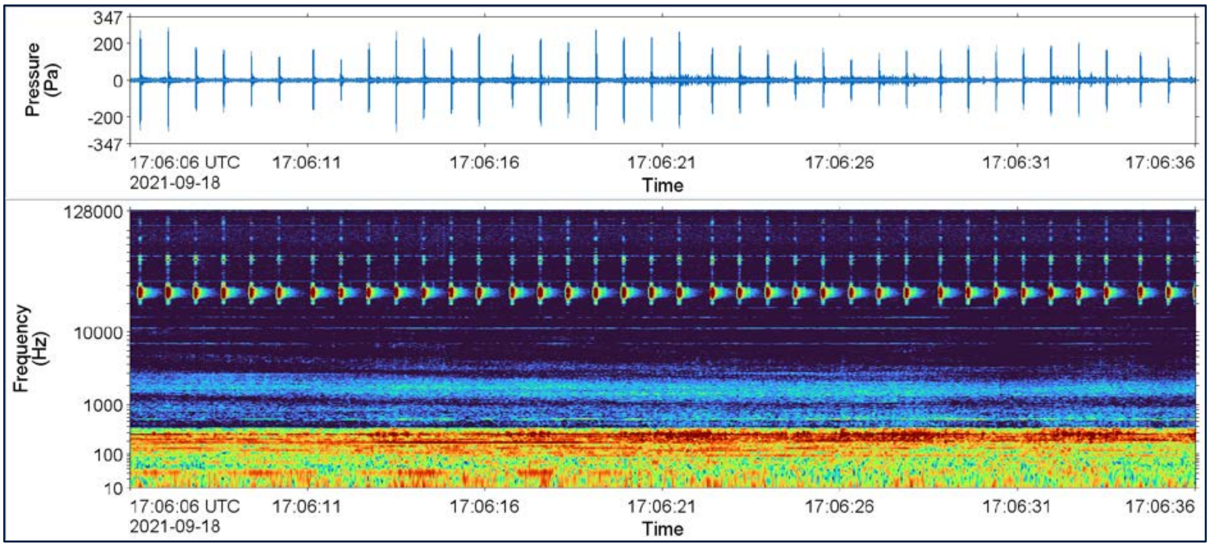

Figure 6.6: Amplitude and Spectrogram of the USBL source example showing a section of data as the source transited over AMAR A sensor

7. Quality Assurance and Control

7.1 Quality Assurance

All sensor data was acquired according to operational procedures and work practices written and in use on the Fugro Pioneer.

All operational procedures and work practices were in place and are currently available on the vessels. They are used to ensure that data is acquired as per Fugro requirements and is acquired consistently across shifts and across vessels.

7.2 Quality Control

Online surveyors and engineers onboard the vessels monitored the acquisition of data on a 24h basis. The online personnel completed the Online Log and Engineers' Log to detail equipment in use, vessel characteristics (heading, speed etc), equipment settings and importantly any problems seen with the data acquisition during the survey.

The online log is presented in Appendix F.

8. Quality, Health, Safety and Environment

The survey was planned and carried out in conformance with Fugro's quality management system, which complies with the requirements of ISO 9001:2015, ISO 14001:2015 and OHSAS 18001:2007. More detailed descriptions of specific survey techniques and procedures are contained within Fugro standard procedures (a component of Fugro's QHSE Manual - details of which can be inspected at the Fugro offices on request).

Prior to the commencement of survey operations, a project execution plan (PEP) consisting of Project Overview, Operations Plan, Quality Plan, Health, Safety, Security and Environment Plan (HSSE) and Emergency Response Plan (ERP) were submitted to Energinet Eltransmission A/S as per Table 8.1. These documents formed the basis for all planning in relation to this project.

Table 8.1: Project Execution Plan Documents

Fugro Document	Revision	Revision Date
F176286-PEP-001_Overview (03)	3	17 May 2021
F176286-PEP-002_Quality Plan (02)	2	17 May 2021
F176286-PEP-003_HSSE Plan (03)	3	24 August 2021
F176286-PEP-004_ERP Plan (03)	3	17 May 2021
F176286-PEP-007_Ops Plan (04)	4	16 September 2021

A digital online survey log was completed during online operations and provided a detailed record of all activities and events that occurred onboard the survey vessel. Detailed information relating to each surveyed line was recorded. This included date, time, line name, instrument setup parameters and highlighted any events or data quality issues.

The performance of the survey instrumentation was constantly monitored by the online surveyor and online geophysicist. Data quality was also monitored by the offline processors soon after data acquisition to ensure the data was typical of survey quality.

Data storage, control and archiving of the data were undertaken in compliance with the PEP and Fugro's data management policy.

8.1 Quality Control

Information has been provided below on the quality control checks carried out during the operational phase of this project (Table 8.2).

Table 8.2: Summary of Quality Control Checks Carried Out

Stage of Survey	Check
Mobilisation	■ GNSS Health Check of primary navigation system using third party processing; ■ Node offset check and position comparison of primary and secondary navigation systems to a Leica 1200 PPK system; ■ Vessel draught check for MBES and navigation software; ■ Datum transformation verification from WGS84 to ETRS89 and vertical datum LAT; ■ Validation of heading sensor using RTK derived baseline;

Stage of Survey	Check
	■ Conduct USBL verification/walk away check; ■ Beacon battery interrogation to prove battery life; ■ Undertake patch test to calibrate the alignment of the multibeam transducer and conduct latency check; ■ MBES repeatability test, noise test and system verification; ■ SVP and SVS comparison; ■ SSS heading calibrations, rub test, wet test and I/O test; ■ Verification of SSS and SBP positioning; ■ Check all instruments logging correctly.
On survey	■ Check MBES for data quality (power/gain/range, motion/weather artefacts, SVP vs SVS accuracy, feature resolution coverage, sounding density, noise interference, THU, TVU); ■ Check MBES files are being recorded (SIS) populating the correct folders; ■ Check GNSS navigation quality; ■ Check SSS data quality (snatch/weather artefacts, resolution, survey speed, layback); ■ Check SSS files are being recorded (both low and high frequency, XTF and JSF); ■ Check SSS data consistency, USBL navigation quality, correct range being recorded, towfish altitude; ■ Check SBP data recording at correct frequency and pulse rate for suitable data quality ■ Check SBP headers are correctly populated ■ Check SBP positioning relative to items observed in a secondary sensor ■ 2DUHRS bird depth constantly monitored online.
In Dock	■ Vessel draught check for MBES and navigation software; ■ Cross check all sensor data quality and coverage to ensure specification has been met; ■ Back up data onto vessel server and hard drive; ■ Send back data to Fugro Netherlands office.

8.2 Vessel Navigation

Position quality for the primary and secondary GNSS receivers was continually monitored throughout the project and all positioning criteria were met. A navigation comparison check was performed prior to the start of the survey and confirmed that both the primary and secondary StarPack antennas on both vessels were providing consistent position information. Vessel navigation was consistently maintained at an accuracy better than 0.1 m horizontally and vertically, through the StarPack primary and secondary systems.

8.3 Multibeam Echosounder

The multibeam bathymetry data collected were of good quality. Any noise present in the data was removed and the remaining data were corrected for variations in tidal height.

The multibeam backscatter data collected were of good quality. Optimum power and gain settings were utilised during data acquisition to ensure high quality acquisition. During the survey, multibeam range changes were minimised to maintain the quality of the MBES data.

8.4 Subsea Positioning

The subsea positioning from data acquired with the USBL on, was generally good throughout the survey. During the scouting lines, the AMAR stations were detected in the MBES and SSS data and these positions compared. The SSS data for the scouting lines was found to have an average target position deviating less than < 2.0 m from the position of the same target derived from MBES. Magnetometer data was found to have an average target position deviating less than < 2.0 m from the position of the same target derived from MBES. Reference is made to the Mobilisation and Calibration Report (Fugro Document No.: *F172145-REP-MOB-001* in Appendix B).

The acoustic data recorded for this source on the AMARs was of good quality with pulses clearly detectable above ambient sound levels.

8.5 Side scan Sonar Data

SSS data quality was monitored throughout the survey and deemed to be representative of what we see during standard geophysical survey. Data was recorded in both the HF and LF channels to the full extent of the 75 m range.

8.6 Parametric Sub-bottom Profiler Data

SBP data was monitored throughout the survey to ensure the headers were correctly populated and shot point intervals were regular. Whilst the effects of marginal weather were apparent in some of the lines in the form of burst noise, the quality of the data was generally acceptable.

The acoustic data recorded for this source on the AMARs was of good quality with pulses clearly detectable above ambient sound levels.

8.7 2D UHR Seismic

Once at site, it was confirmed by JASCO representatives on board that the streamer did not need to be deployed, as originally planned. The Fugro Multi-Level Stacked Sparker (360 tips) was deployed off a boom to the starboard side and fired every 0.5 seconds. The p190's were recorded online and will be provided to JASCO to capture time and position for each shot.

The acoustic data recorded for this source on the AMARs was of good quality with pulses clearly detectable above ambient sound levels.

8.8 Health, Safety and Environment

Fugro performed the survey operations with high regard for health and safety and the environment. An HSE plan was completed prior to the start of the survey. This was produced in accordance with the company's HSE Management System manual. All survey and crew members were required to read and sign this plan, to ensure they understood the work to be performed and the mitigating measures employed to minimise the identified risks.

During mobilisation and at regular intervals thereafter, safety briefings and toolbox talks were conducted to reiterate the risks relating to survey operations and steps taken to minimise these risks. A full safety briefing was also undertaken after each crew change. Further details have been provided in Table 8.3.

Table 8.3: Summary of HSE Meetings Conducted

Date	Meeting
11/09/2021	Daily HOD Meeting.
12/09/2021	Daily HOD Meeting, Cross departmental safety tour & Sound bite training.
13/09/2021	Daily HOD Meeting.
14/09/2021	Daily HOD Meeting.
15/09/2021	Daily HOD Meeting.
16/09/2021	Daily HOD Meeting, sound bite training
17/09/2021	Vessel inductions.
18/09/2021	Daily HOD Meeting & Vessel Kick-off meeting.
19/09/2021	Daily HOD Meeting.
20/09/2021	Daily HOD Meeting.
21/09/2021	Daily HOD Meeting.
22/09/2021	Daily HOD Meeting & cross departmental safety tour.

Upon joining the vessel, all members of crew were given a vessel safety induction tour by the vessel master. Vessel muster drills were performed approximately every two weeks depending on operations and weather.

All crew were required to wear lifejackets, hardhats, safety boots, safety glasses, and gloves for all back-deck operations.

During OCP operations a hazard observation card (HOC) system was operated on board allowing crew to report unsafe acts, unsafe conditions, safe acts, or make HSE suggestions. In total 22 HOCs were submitted. The HOC register is provided within Appendix E. There were no incidents and near misses during the project.

8.9 COVID-19 Pandemic Measure and Procedure

Following the announcement of clusters of unidentified cases of pneumonia in China towards the end of December 2019, The World Health Organisation (WHO) announced on the 11 February 2020 a new name for the disease: Coronavirus disease (COVID-19). It is a highly contagious is infectious disease and was declared a global pandemic on 11 March 2020. All countries were urged to implement a containment strategy in order to control the disease. In order to prevent further spread of the disease WHO urged countries to implement social distancing and quarantine measures.

As a result, Fugro has issued specific guidelines to all employees and contractors which are under constant review. Guidelines issued by Fugro at the start of the survey and a COVID-19

Outbreak Management Plan can be found in Appendix K. In conjunction with those guidelines the following specific measures were carried out by Fugro Pioneer as mentioned below.

- Prior to embarking, each crew member was asked to self-isolate for at least 11 days;
- Each crew member was required to a 14 day record of temperatures prior to travelling to the vessel along with a self-health declaration form. Each of these forms were checked by the Safety Officer for all vessel crews on arrival on the vessel gangway;
- Any third part contractors required on the vessel where subjected to similar health declaration forms and temperatures taken prior to boarding, no third party contractors were admitted inside the vessel without a 14 day temperature record and health declaration form;
- Temperature monitoring was completed twice a day for all vessel crew once onboard for the entirety of their stay;
- In line with Fugro risk assessments, all shore leave was prohibited;
- Additional PPE and precautions were put in place for the vessel gangway watch during port calls;
- Produced TRAs for port calls.

Appendices

Appendix A

Guidelines on Use of Report

This report (the "Report") was prepared as part of the services (the "Services") provided by Fugro for its client (the "Client") and in accordance with the terms of the relevant contract between the two parties (the Contract"). The Services were performed by Fugro in accordance with the obligations in the Contract and based on requirements of the Client set out in the Contract or otherwise made known by the Client to Fugro and any other information affecting the Services at the time; save that the extent to which Fugro relied on Client or third party information in carrying out the Services was set out in the Contract.

Fugro's obligations and liabilities to the Client or any other party in respect of the Services and this Report are limited to the extent and for the time period set out in the Contract (or in the absence of any express provision in the Contract as implied by the law of the Contract) and Fugro provides no other representation or warranty whether express or implied, in relation to the Services, or for the use of this Report, for any other purpose. Furthermore, Fugro has no obligation to update or revise this Report based on any future changes in conditions or information which emerge following issue of this Report unless expressly required by the provisions of the Contract.

The Services were performed by Fugro exclusively for the Client and any other party expressly identified in the Contract, and any use and/or reliance on the Report or the Services for purposes not expressly stated in the Contract, will be at the Client's sole risk. Any other party seeking to rely on this Report does so wholly at its own and sole risk and Fugro accepts no liability whatsoever for any such use and/or reliance."

Appendix B

Mobilisation Report

Mobilisation Report – Fugro Pioneer

North Sea OWF Zone West (Lot 2) Geophysical Survey | Danish North Sea

F176286-REP-MOB-001 01 | 9 June 2021

Complete

Energinet Eltransmission A/S

Document Control

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9 June 2021

Dear Sir/Madam,

We have the pleasure of submitting the ‘Mobilisation Report – Fugro Pioneer’ for the ‘North Sea OWF Zone West (Lot 2) Geophysical Survey’. This report presents the details of the vessel’s mobilisation and calibration operations.

This report was prepared by Edward Favell and James Egan under the supervision of Paul Miller and Jaco de Beer (Fugro Pioneer Party Chiefs).

We hope that you find this report to your satisfaction; should you have any queries, please do not hesitate to contact us.

Yours faithfully,

Jaco de Beer

Jaco de Beer
Fugro Pioneer Party Chief

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Abbreviations

BSF	Below seafloor
C-O	Computed minus observed
CR	Client representative
CRP	Common reference point
CTD	Conductivity, Temperature and Density
dB/m	Decibels per meter
DP	Dynamic positioning
ENC	Electronic nautical chart
ESAT	European satellite
GNSS	Global navigation satellite system
ITRF	International terrestrial reference frame
ITT	Invitation to tender
kHz	Kilohertz
Kts	Knots
LAT	Lowest astronomical tide
m/s	Meters per second
MBES	Multibeam echosounder
NRCAN	Natural Resources Canada
PEP	Project execution plan
PPP	Precise point positioning
PPS	Pulse per second
RINEX	Receiver Independent Exchange Format
SBES	Single beam echosounder
SBP	Sub-bottom profiler
SSS	Side scan sonar
SVP	Sound velocity probe
SVS	Sound velocity sensor
UHRS	Ultra High Resolution Seismic
UKHO	United Kingdom Hydrographic Office
USBL	Ultra Short Baseline
UTM	Universal transverse Mercator
UXO	Unexploded ordnance
VRF	Vessel reference frame
VORF	Vertical Offshore Reference Frame
WGS84	World Geodetic System 1984

1. Introduction

Energinet Eltransmission A/S (Energinet) is developing a new offshore wind farm in the Danish North Sea. The project area is located offshore Denmark approximately 32 NM West of Thorsminde.

This report provides information relating to the mobilisation and calibration of equipment onboard the survey vessel Fugro Pioneer working on the project.

Vessel mobilisation and calibrations were undertaken between 14 and 31 May 2021 in the port of Ijmuiden, NL, at an offshore calibration site during the transit to the survey area and completed on site.

All equipment was subject to rigorous testing and calibration with reference to Fugro procedures. The calibration procedures were carried out in order to demonstrate effective and safe functionality of equipment and satisfy the requirements of Energinet Eltransmission A/S and the survey specification

Guidelines on the use of this report have been provided in Appendix A.

The following verifications and validation checks were carried out prior to the start of survey operations and are described in detail within this report:

- Vessel dimensional control survey (March 2019);
- Positioning and heading verifications (16 and 27 May 2021);
- Multibeam echosounder (MBES) calibration and verification (24 May 2021);
- Side scan Sonar (SSS) verification (28 and 31 May 2021);
- Single magnetometer verification (28 May 2021);
- Ultra-Short Baseline (USBL) calibration and verifications (22 May 2021);
- Innomar Sub-bottom profiler (SBP) verifications (28 May 2021);
- 2DUHRS system verifications (28 May 2021).

1.1 Survey Aims and Overview

The following sub-sections provide details about the main survey requirements and the scope of work for the Client's Work Package A (WPA) for the North Sea OWF Zone West (Lot 2) Geophysical Survey.

1.1.1 Survey Aims

The aim of the offshore geophysical survey is:

- The commencement in May 2021 and completion as soon as possible of the survey, acquiring full coverage in the Offshore Wind Farm (OWF) area. The survey must map the bathymetry, the static and dynamic elements of the seabed surface and the sub-surface geological soil layers to at least 100 m below seabed.

The results of the survey will then be used as the basis for:

- Initial marine archaeological site assessment;
- Planning of environmental investigations;
- Planning of initial geotechnical investigations;
- Decision of foundation concept and preliminary foundation design;
- Assessment of subsea inter-array cable burial design;
- Assessment of installation conditions for foundations and subsea cables;
- Site information enclosed the tender for the offshore wind farm concession.

To achieve these objectives Fugro will:

- Acquire accurate site wide bathymetric data in order to determine site water depths, topography, gradients etc. using multi beam echosounder (MBES);
- Acquire site wide, high-resolution side scan sonar (SSS) data to determine seabed features and the possible presence of boulders, seabed sediments, debris and items that may impact foundation and cable installation;
- Acquire multichannel 2D UHRS (ultra-high resolution seismic) data to 100 m to determine the deeper sub-surface soil conditions that may influence foundation design below the effective penetration of the SBP;
- Acquire high-resolution sub-bottom profiler (SBP) data to determine the shallow sub-surface soil conditions that may influence foundation and cable installation such as boulders and shallow geological features;
- Acquire magnetometer data across the site (along the planned survey lines) to support the ALARP principle of UXO risk mitigation prior to grab sampling and geotechnical operations and to identify any other ferrous debris, uncharted wrecks and existing infrastructure.

1.1.2 Survey Overview

A summary of the main survey requirements for the geophysical survey operations is presented in Table 1.1.

Table 1.1: Survey Requirements Overview – OWF 2D UHR Operations

Equipment Method	Energinet Hesselø requirements
Vessel	▪ Fugro Pioneer
Line Spacing	▪ Geophysical lines are to be run at 62.5 m spacing ▪ Every 250 m lines and 1km cross lines will also be run with 2D UHR
Survey Priority	▪ Refer to F172145-PEP-005 Ops Plan for full details
Max Vessel Speed	▪ Maximum of 4.0 knots (±10%)
Surface Positioning	▪ Dynamic heading accuracy of ± 0.2° or better ▪ Static heading accuracy of ± 0.05° or better ▪ Horizontal uncertainty of the vessel of ± 0.5 m or better
USBL	▪ USBL accuracy. Fugro will only be able to repeatedly

Equipment Method	Energinet Hesselø requirements
	achieve +/- 1m accuracy for USBL calibration and +/-2 m accuracy for data acquired from towed sensors. i.e. a processed target accuracy of +/-2m
2D UHRS	■ Fugro Multi-level Stacked Sparker (MLSS) • Fugro MLSS power supply (900 J) • 3 array multi-level Sparker: 360 tips corresponding to achieve power 900 J was used for survey acquisition • 70 m HV cable • Sea earth cable ■ 96-channel streamer • Geometrics Geo Eel digital streamer • 96 channels at 1m interval • 1.4 m flat tow • Head buoy and Tail buoy • Tension control with 3 x Fugro adaptive drogues • CNT-2 recorder • Record length of 220 ms • Sampling interval of 0.125 ms • Recording format: SEG-D ■ Sparker and streamer positioning • Fugro PBP v1.0 on Fugro Multi Level Stacked Sparker • Fugro PBP v1.0 on Head buoy and Tail buoy
Multibeam Echosounder/Backscatter	■ 100% coverage ■ 0.25 m x 0.25 m bin size / 16 x pings per 1.0 m x 1.0 m ■ THU is <0.5 m ■ TVU is compliant with IHO Special Order ■ Grid standard deviation (95% confidence interval) is less than 0.2 m
Innomar SBP	■ Transmit and receive frequency: 8 - 12 kHz (adjustable) ■ Minimum penetration: 10 m, dependent on Geology ■ Vertical Resolution: Better than 0.3 m ■ Compensated for vessel motion
Side Scan Sonar	■ 0.5 m x 0.5 m x 0.1 m minimum target size insonification ■ 200% coverage including nadir ■ Altitude to be set to 8-12% of range ■ Survey speed to be a maximum of 4.0 knots (±10%) ■ Infill required where USBL gaps of more than 10 s
Magnetometer	■ 5 m maximum altitude ■ Magnetometer sampling frequency: 10 Hz ■ Maximum noise level: 2 nT ■ Lateral blanking distance shall be 5 m ■ Infill required where USBL gaps of more than 10s, or

Equipment Method	Energinet Hesselø requirements
	altitude out of spec for more than 10m.
SVP	■ The speed of sound in water shall be measured in the survey area. ■ The Vertical Sound Velocity Profiles should be undertaken with a resolution of 0.1 m/s and an accuracy of ±0.15 m/s ■ The Vertical Sound Velocity Profiles should be able to measure within the range 1,350-1,600 m/s

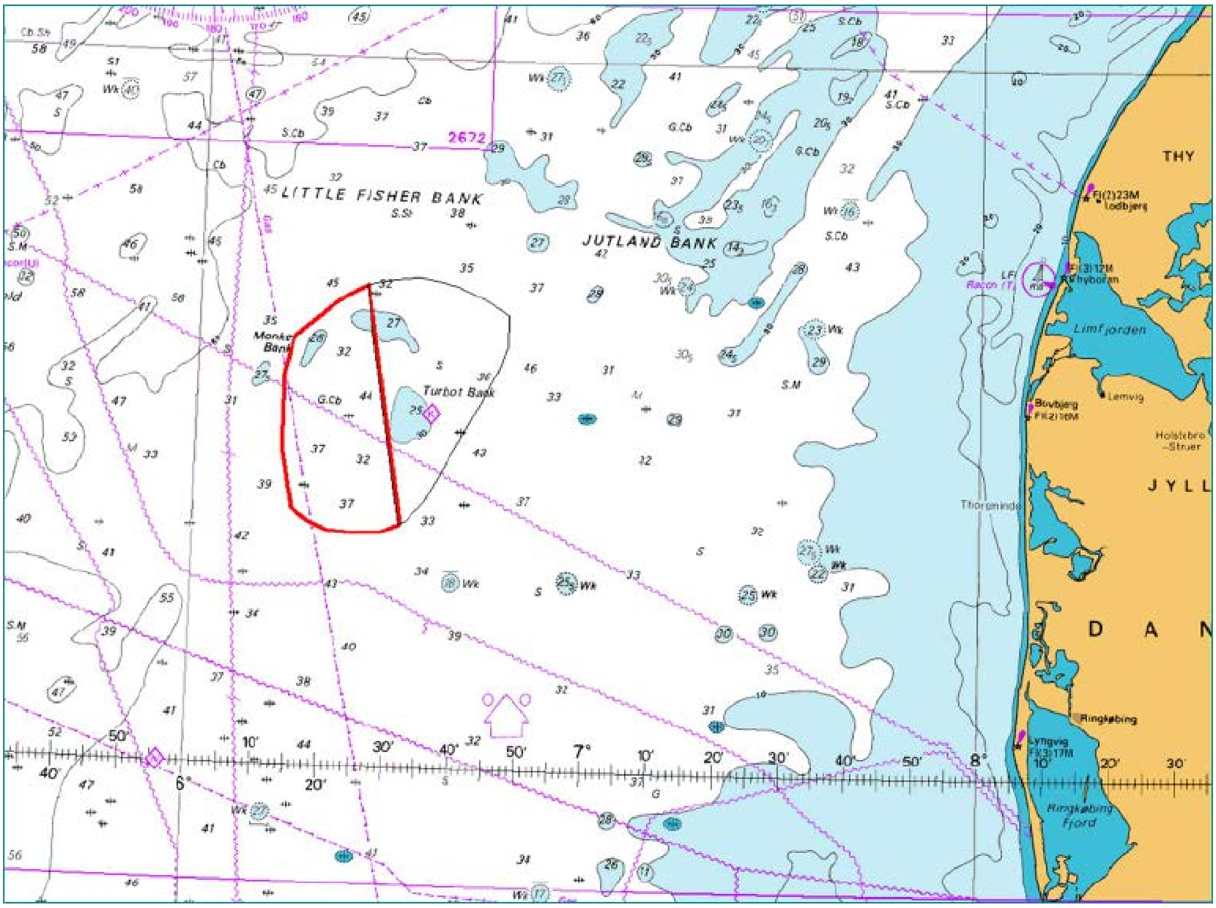


Figure 1.1: Project location

The project area is located offshore Denmark approximately 32 NM West of Thorsminde. (Figure 1.1). The water depth varies between 25 m and 50 m MSL.

1.2 Geodetic Parameters

The project geodetic and projection parameters are summarised in Figure 1.2 and Figure 1.3.

Name: ETRS89 / UTM zone 32N [ETRF2000-ITRF2014],DTU18 MSS height [DTU18 MSS]		
EPSG Code	EPSG:25832	
Global Navigation Satellite System (GNSS) Geodetic Parameters*		
Datum	International Terrestrial Reference Frame 2014	EPSG:1165
Ellipsoid	GRS 1980	
Semi major axis	a = 6 378 137.00 m	
Inverse flattening	1/f = 298.257222101	
Local Geodetic Datum Parameters		
Datum	European Terrestrial Reference System 1989	EPSG:6258
Ellipsoid	GRS 1980	
Semi major axis	a = 6 378 137.00 m	
Inverse flattening	1/f = 298.257222101	
Datum Transformation Parameters from ITRF2014 to ETRS89		
X-axis translation 0.05584 m	X-axis rotation -0.0026255"	Scale difference 0.00337551 ppm
Y-axis translation 0.05334 m	Y-axis rotation -0.0158827"	Coordinate Frame rotation
Z-axis translation -0.09579 m	Z-axis rotation 0.0256716"	FUGRO:41366
Local Projection Parameters		
Map projection	Transverse Mercator	
Grid system	UTM zone 32N	EPSG:16032
Latitude origin	00° 00′ 00.000″ N	
Central meridian	009° 00′ 00.000″ E	
Scale factor on central meridian	0.9996	
False easting	500 000 m	
False northing	0 m	
Project Vertical Parameters		
Vertical coordinate reference system	DTU18 MSS height	FUGRO:41073
Datum	DTU18 MSS height	FUGRO:40939
Transformation	WGS 84 to DTU18 MSS height	FUGRO:41429
Notes * The geodetic datum of Fugro's global GNSS correction data is ITRF2014, epoch 2021.414 (01/06/2021)		

Figure 1.2: Project geodetic and projection parameters

ITRF2014	Test Point [Position]	Computed Point
Latitude	56° 18′ 54.00000″ N	56° 18′ 54.00000″ N
Longitude	008° 30′ 00.00000″ E	008° 30′ 00.00000″ E
Ellipsoidal height	0.000 m Ell.	0.000 m Ell.
ETRS89		
Latitude	56° 18′ 53.98130″ N	56° 18′ 53.98130″ N
Longitude	008° 29′ 59.96955″ E	008° 29′ 59.96955″ E
Ellipsoidal height	-0.025 m Ell.	-0.025 m Ell.
UTM zone 32N		
Easting	469 069.831 m	469 069.831 m
Northing	6 241 250.858 m	6 241 250.858 m
Mean sea surface height	-39.924 m	-39.932 m

Figure 1.3: Project test coordinates

1.3 Vertical Datum

All vertical data for Energinet Energy Islands LOT2 project will be reduced to Mean Sea Level (MSL) utilising the DTU18 MSL Tide Model as a vertical offshore reference frame supplied by the Technical University of Denmark (DTU). Contractually the project should be reduced using DTU21, however given the inability of this to be completed offshore, processing to DTU21 will be completed during post processing onshore.

2. Survey Equipment

2.1 Vessel Dimensional Control

An initial dimensional control survey of the Fugro Pioneer was conducted in April 2014 with 3D laser scanning technology. In March 2019, Fugro staff conducted an additional offset verification survey of the vessel to verify the correctness of the calibrated primary motion reference unit and selected offsets location (Appendix B). The offsets of key instruments were computed and entered into Starfix.NG acquisition software. These offsets included primary and secondary positioning systems, MBES, inertial measurement units and various nodes throughout the vessel. The mounting angle offsets of the MBES compared with the vessel reference frame are also calculated as part of this procedure. The mounting angle offsets of the MBES measured during the dimensional control survey were confirmed or improved when conducting the patch test. Offsets of new sensors (antenna position for tide computation and tow points) have since been tied in to the original dimensional control survey either by total station or by tape, all to centimetre level of accuracy (Appendix B).

2.2 Survey Positioning

2.2.1 Primary and Secondary Surface Positioning

Primary and Secondary Global Navigation Satellite System (GNSS) positioning was provided from a Fugro StarPack GNSS receivers. The antenna was installed on an antenna mount with clear and unobstructed hemispherical views. The system was interfaced directly to the online navigation system providing positional accuracies better than 0.04 m horizontally and 0.05 m vertically using Fugro Starfix.G2+ positioning solution, with backups from Starfix.XP2 and Starfix.HP positioning solutions. Real-time correction solutions were received from the geostationary ESAT and AORET satellites.

2.3 Attitude and Heading Sensor

Two (2) motion sensors are installed onboard Fugro Pioneer to compensate different equipment for the vessel’s motion (roll, pitch and heave) and to provide vessel heading information.

The iXSea Hydrins (primary motion and heading sensor) is interfaced to the navigation system, the multibeam echosounder (MBES), the HiPAP ultra short baseline (USBL) system and the sub-bottom profiler (SBP). The iXblue Octans 3000 (secondary motion and heading sensor) is interfaced to the navigation system, the single beam echosounder (SBES), the MBES and the sub-bottom profiler (SBP).

The iXblue Octans 3000 is mounted in the moon pool cart close to the MBES. The iXSea Hydrins is mounted close to the centreline of the vessel next to the moon pool. The common reference point (CRP) of the vessel was defined as the top of the moon pool on the starboard side aft corner. Lever arm measurements were calculated during the vessel's dimensional control survey and entered in the iXSea Hydrins and iXblue Octans Web UI.

2.4 Multibeam Echosounder

Fugro Pioneer is permanently equipped with dual head Kongsberg EM2040 multibeam echosounder (MBES) installed in the moon pool cart with the iXblue Octans 3000 and the Innomar SBP transducer. Position, attitude, velocity, time and sound velocity are interfaced to the multibeam processors to aid in their operation. MBES bathymetry data is acquired using SIS acquisition software (v. 4.3.2). The MBES and Backscatter data will be acquired but not fully processed offshore.

2.5 Single Beam Echosounder

Fugro Pioneer is equipped with a hull mounted Kongsberg EA400 single beam echosounder (SBES). Attitude is interfaced into the system. SBES data is acquired using Starfix.NG. The 33 kHz frequency is used (and the 200 kHz turned off).

2.6 Magnetometer

A geometrics G882 magnetometer, along with spare, are mobilised on the Fugro Pioneer. The magnetometer is towed behind the SSS fish, using a soft tow cable at a fixed length of 10.00 m. The towing arrangement may be subject to change given environmental conditions onsite. The magnetometer is tracked using the Kongsberg HiPAP 501 Ultra Short Baseline (USBL) underwater positioning system. Magnetometer data will be logged using Starfix.NG software. The magnetometers' depth and altitude sensors were calibrated prior to the start of survey operations (Section 8).

2.7 Side Scan Sonar

Two EdgeTech 4200 side scan sonar (100/600 kHz) towfish are mobilised on Fugro Pioneer. The primary EdgeTech 4200 SSS is towed by the EMCE winch from the stern of the vessel with an armoured cable. SSS data is acquired with EdgeTech Discover software (v. 40.01.1.119). The side scan sonar is tracked using the Kongsberg HiPAP 501 Ultra Short Baseline (USBL) underwater positioning system. A USBL beacon is installed on the tow cable, 0.5 m (horizontal) in front of the side scan sonar fish. High and low frequency SSS data will be acquired and processed offshore. High Frequency data will be fully processed and limited interpretation will take place offshore. Low Frequency data will be fully processed and no interpretation will take place offshore.

2.8 GNSS Tidal Heights

Near real-time tidal data is provided by GNSS elevation data from the Fugro StarPack G2+ primary positioning solution. The tides will be processed in Starfix VBA.Proc and will be reduced to MSL using the DTU18 MSL Tide Model. Onshore post processing will reduce all tides to MSL using DTU21 MSL Tide Model.

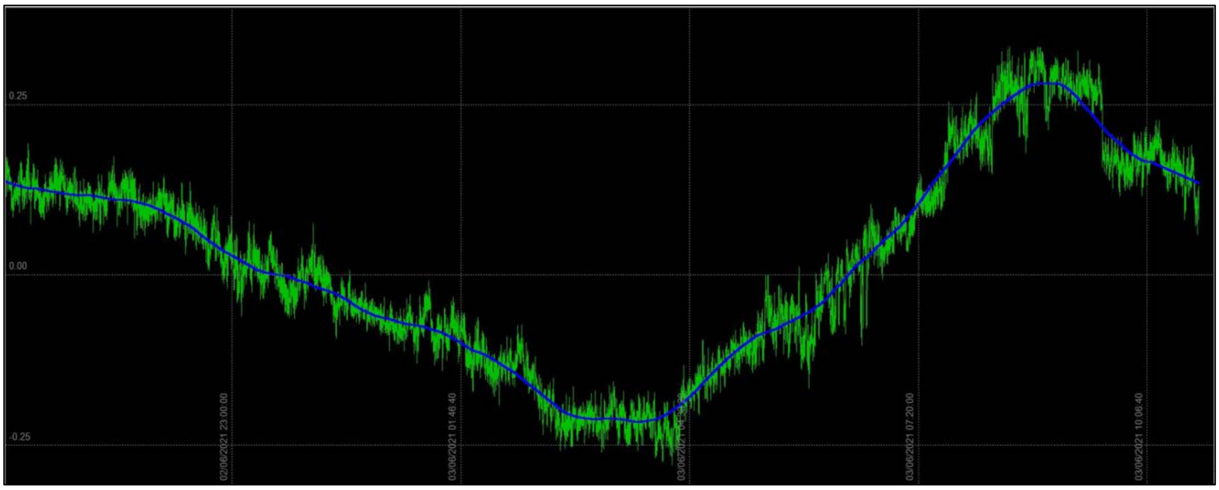


Figure 2.1: Example showing Raw and Processed tidal data, Green and Blue respectively

2.9 USBL System

A Kongsberg HiPAP 501 USBL system is permanently mobilised on the Fugro Pioneer. This system is mounted on a remotely operated extendable pole allowing it to be deployed and recovered easily through a gate valve in the hull. The USBL system has an omnidirectional transducer mounting allowing for improved tracking of towed sensors around the vessel. Heading and attitude are interfaced to the processing unit from the iXsea Hydrins, with time and PPS from the navigation software Starfix.NG. Computed range and bearing measurements for deployed beacons are interfaced to Starfix.NG. The Kongsberg Mini cNODE Beacon is installed on the sidescan sonar (SSS) and is self-powered.

2.10 Sub-bottom Profiler

An Innomar SES-2000 Medium parametric sub-bottom profiler is permanently mobilised on the Fugro Pioneer. The system is mounted on the vessel's moon pool cart. Positioning and heading are provided from Starfix.NG, with iXblue Octans 3000 feeding the heave data for the system.

2.11 2DUHR Seismic System

The 2D UHRS system consists of the Fugro Multi-level Stacked Sparker (MLSS) source and a Geometrics Geo Eel streamer as the receiver.

The stacked Sparker consists of 360 tips on three levels, at depths of 0.77 m, 0.92 m and 1.12m. Three applied acoustics CSP-Nv power supply units provide the Sparker tips with the required energy.

The streamer is towed from the port side of the vessel at a depth of 1.4 m. Precise positioning is obtained using two RTK pods placed on the Head buoy and Tail buoy of the streamer. Processing will be carried out in UniSeis seismic processing software. Table 2.1, Table 2.2 and Table 2.3 respectively show sparker source, streamer and recording system details.

Table 2.1: Sparker Source Details

Source	Fugro Multi-Level Stacked Sparker
Electrode arrays	Three arrays: 160 (80x80), 120 (80-40) & 80 (40-40)
Energy per shot per Sparker	900J
Shot Interval	1 m

Table 2.2: Streamer Details

Receivers	Geometrics 96 channel hydrophone streamer
Active length / Group interval	96 @1m channel
Target tow depth	1.4 m
Sampling rate	0.125 ms (1/8th)
Record length	200 ms

Table 2.3: Recording System

System	CNT-LH VHR
Channels per Module	16
Dead time between shots	Dead time: 10 ms with max average data rate of 2.1 M samples/s (dead time is 15% of recording time with 160 channels @ 16 kHz).
Bandwidth	Dynamic range: >120 dB typical @ 16 Khz.
Gain Accuracy	<2% Gain, THD, Sim X1, 1/4mS, 100Hz
Gain Similarity	<2% Gain Similarly, THD, Sim X1, 1/4mS, 100Hz
Phase Similarity	<2% Phase similarity THD, Sim X8.5, 1/4mS, 100Hz

2.12 Sound Velocity Probe

Three Valeport mini sound velocity sensors (SVS) (serial numbers 65638, 71201 and 32017) are mobilised to monitor the speed of sound at the sonar head of the MBES for beam forming purposes.

Two CDT SD204 sound velocity probes (S/N 519 and S/N 951) are mobilised for this project. This probe will be used to collect sound velocity data through the entire water column. The sound velocity data is then inserted to MBES, SBES, USBL and SSS acquisition software and is also used to correct refraction errors in MBES data and in Seismic data during processing. The calibration certificates for the above units are included in Appendix F.

A Moving Vessel Profiler has been mobilised and will be used to supplement velocity profiles acquired with the Mini SVS and CTDs.

3. Vessel Reference Frame

All systems on the vessel were mounted relative to the XYZ reference frame of the vessel. The Y-axis being the fore-aft centre line, the X-axis running perpendicular to the Y-axis through the common reference point (CRP), and the Z axis being positive upwards from the CRP (see Figure 3.1). The online navigation software Starfix.NG uses this reference frame to correct vessel nodes for position.

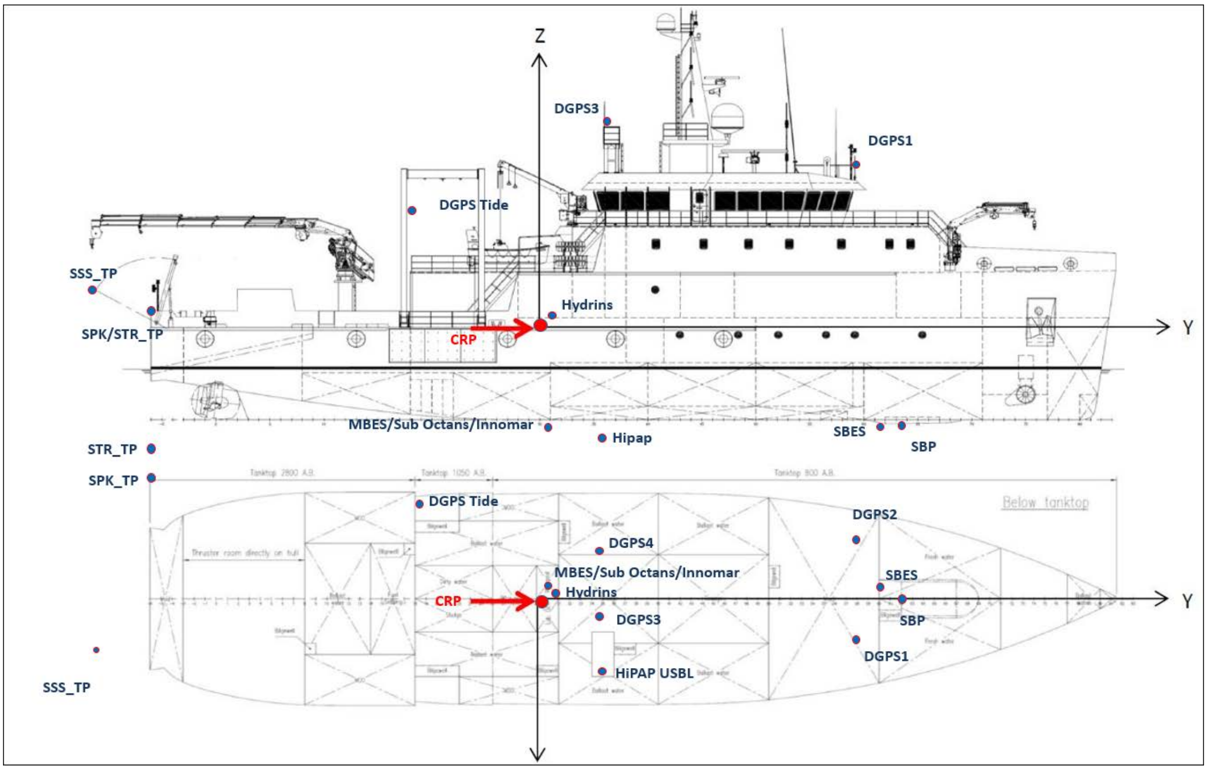


Figure 3.1: Vessel Reference Frame for Geophysical Survey

The CRP on Fugro Pioneer has been defined in the survey navigation software – Starfix.NG, to be the starboard aft corner on the inside rim of the moon pool. The distance offsets, angular offsets and rotations were calculated and Vessel Reference Frame (VRF) derived using 3D laser scan as part of the vessel dimensional control in April 2014. Table 3.1 shows calculated offsets used and Figure 3.1 shows the plan and profile views of the vessel.

To ensure that the moon pool cart is in the same position when deployed, two pistons and four guides are installed to ensure there is repeatability ensuring the offsets are consistently repeated whenever deployment/recovery takes place.

Table 3.1: Instrument Offsets

Offset Name	Starboard Positive (X) [m]	Forward Positive (Y) [m]	Up Positive (Z) [m]
CRP	0.00	0.00	0.00
USBL (deployed position)	3.91	3.56	-7.05
DS1 Draught transducer	−2.22	18.24	-5.54

Offset Name	Starboard Positive (X) [m]	Forward Positive (Y) [m]	Up Positive (Z) [m]
(for SBES)			
DS2 Draught transducer (for MBES)	−0.83	1.37	-5.53
SBES transducer	−0.66	20.19	-5.79
MBES transducer	−0.70	0.49	-6.05
HydrINS (Primary MRU/Heading)	0.39	0.77	0.46
Subsea Octans (MRU/Heading)	−0.74	0.96	-5.33
Innomar	−1.49	0.42	-5.73
DGPS3_1 (Starboard)	−0.75	3.99	12.13
DGPS3_2 (Portside)	−3.17	4.26	12.13
DGPS4	−3.16	5.09	12.13
DGPS_Tide	−5.83	-7.31	7.89
SSS TP	3.05	-24.02	3.85
Sparker TP	-10.25	-21.05	0.95
Streamer TP	-14.25	-21.05	0.95

Table 3.2: Sparker offsets

Offset Name	Starboard Positive (X) [m]	Forward Positive (Y) [m]	Up Positive (Z) [m]
CRP	0.00	0.00	0.00
Centre Of Source	0.00	0.00	0.00
RTK Front	0.00	-0.45	1.72
RTK Rear	0.00	-1.13	1.72
Towpoint	0.00	0.94	0.00

Table 3.3 Headbuoy offsets

Offset Name	Starboard Positive (X) [m]	Forward Positive (Y) [m]	Up Positive (Z) [m]
CRP	0.00	0.00	0.00
GPS_HB	0.00	-0.10	0.73
HB_TP	0.00	0.00	-1.40

Table 3.4: Tailbuoy offsets

Offset Name	Starboard Positive (X) [m]	Forward Positive (Y) [m]	Up Positive (Z) [m]
CRP	0.00	0.00	0.00
GPS_TB	0.00	-0.10	0.75
TB_TP	0.00	0.00	-1.40

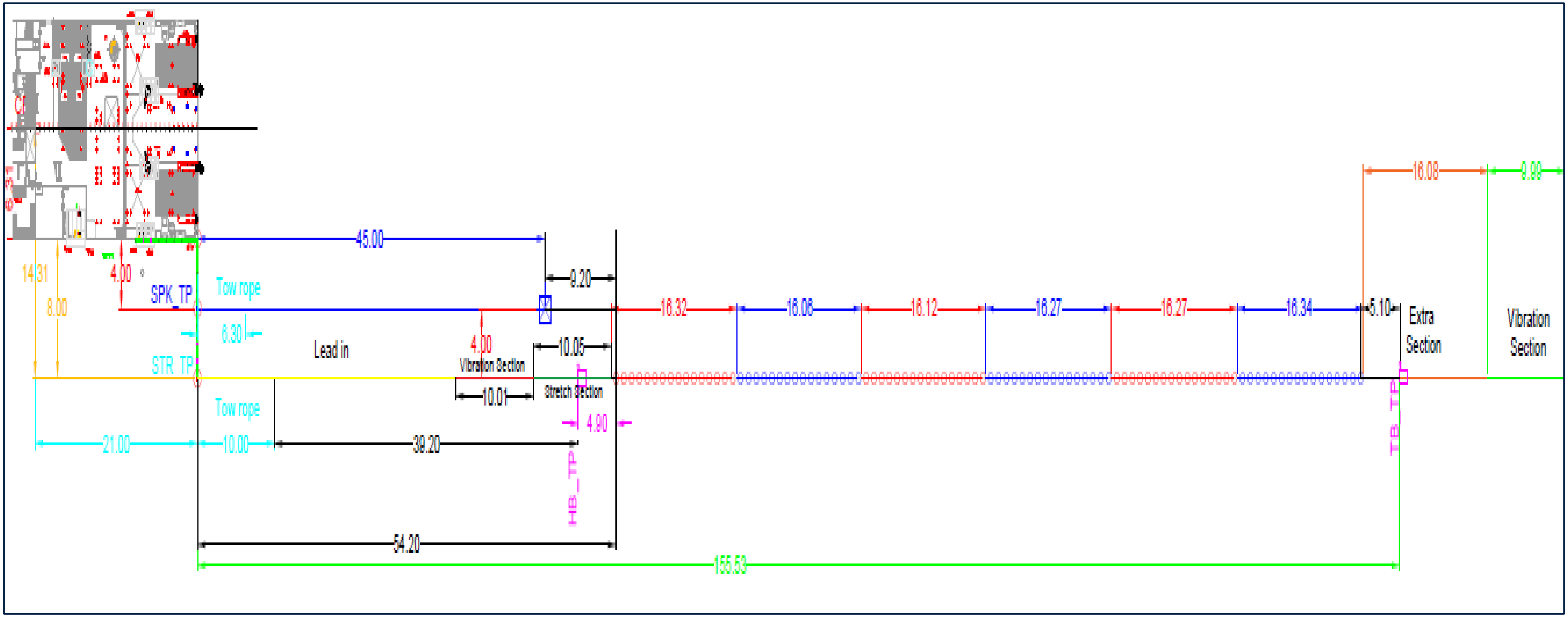


Figure 3.2: Streamer offsets

3.1 Position System Verification

The positioning system on Fugro Pioneer uses a Starfix.G2+ solution. This solution is Fugro's positioning solution based on GLONASS, GPS satellites and clock and orbit corrections received by the StarPack DGNSS receiver from Fugro's independent network of reference stations by geostationary satellites.

The positioning systems will operate under the following conditions:

- Minimum elevation mask of 10 degrees;
- PDOP less than 5;
- Minimum number of satellites: 5

The primary positioning system (DGPS3 with G2+ solution) was verified onboard Fugro Pioneer during vessel mobilisation in Ijmuiden, NL, on 11 May 2021 using land survey techniques and known points on the quayside. Starfix.G2+ solution of the primary Fugro StarPack positioning system was logged in Starfix.NG for the duration of the total station measurements. Simultaneously, with a total station set up over a known benchmark on the quayside, oriented bearing and range measurements were taken to the primary GNSS antenna. For each measurement the position of the antenna was calculated and compared to corresponding Starfix.G2+ solution derived position.

The comparison of Starfix.G2+ GNSS antenna positions and total station derived positions shows a mean difference 0.04 m (range) at 117.0° N (azimuth).

The results of the verification are shown in Appendix C.

3.2 Positioning System Comparison

Position data from four (4) positioning systems including the primary and secondary Fugro StarPack differential positioning systems: DGPS3 G2+ and XP2, DGPS4 G2+ and XP2 were logged on the navigation software Starfix.NG for 59 minutes 59 seconds on 27 May 2021 whilst the vessel was alongside in Ijmuiden, NL. The results of the comparison are shown in Appendix C and presented here in Table 3.5.

Table 3.5: Positioning System Horizontal Comparison Fugro Pioneer

Date	Description	∆Lat [m]	∆Long [m]
27/05/2021	DGPS3 G2+ vs DGPS4 G2+	-0.02	-0.04

3.3 Heading Verification: Hydrins and Octans

Heading data from the vessel's Hydrins and Octans were verified using the static method with a total station whilst the vessel was alongside in Ijmuiden, NL on 27 May 2021.

The resulting C-O values confirmed the accuracy of existing C-O values already entered into both sensors, satisfying project requirements. The results of the heading verification are shown in Table 3.6 and are included in Appendix C.

Table 3.6: Results of Heading System Verification

Heading System	Average Heading C-O [°]	SD
Hydrins	0.1	±0.13
Octans	-0.1	±0.13

3.4 Draught Check

The vessel's draught was measured alongside in Ijmuiden, NL on 27 May 2021. A measurement of 2.46 m was taken in the moon pool, from the CRP down to the waterline. The online log then calculates the draught of submerged sensors by applying the sensor offset. The depth measured by an Adams draught sensor in the moon pool was also recorded and used to confirm the manually measured draught. This value will be updated every time the vessel departs port following bunkering, provision or loading/offloading of equipment. The draught value of 2.46 m was applied in Starfix.NG online navigation system and the MBES software (SIS 4.3.2). The draught values were applied in the SBES software (EA400) and HiPAP 501 USBL software (APOS 4.35.5). The distance between the GPS antennas and the CRP along with the CRP to WL are input on the tide reduction software to guarantee the tide reduction is applied correctly.

4. Multibeam Echosounder

On 24 May 2021, a MBES calibration was conducted over the wreck 'Fallwind'. The 'Fallwind' is a 79m x 20m x 8m wreck within the survey area. The purpose of the MBES was to demonstrate the capability of the system to achieve the primary dataset requirements.

The MBES verification comprised of six lines run in a traditional patch test manner. Two lines run with an offset of 50 m from either side of centreline in same direction; two centrelines on top of each other with same direction, one centreline in opposite directions with same speed and the last one at double speed. Refer to Table 4.1 for the reference point positioning details, Table 4.2 for acquisitional parameters and Figure 4.1 for an overview of the MBES calibration area.

Table 4.1: Reference Point Position

Geodetic Datum and Projection: ETRS89, UTM 32N		
Location	Easting (m)	Northing (m)
Wreck Position (Fallwind)	340611.48 m	6263657.75 m

Table 4.2: Acquisitional Parameters MBES Verifications

Acquisitional parameters	MBES Kongsberg EM2040
	Water depth approximately 46m
	Multibeam Draft 2.99 m, Water Line (CRP to MBES) 2.55 m
	Speed of sound in water at surface 1483.41 m/s from CTD probe
	Speed of sound in water at seabed 1478.58 m/s from CTD probe
	Hydrins Gyrocompass and Octans Motion Sensor

Table 4.3: Survey Line Configuration

Correction	Survey line configuration
System Latency	Two lines run in the same direction at different survey speeds over the feature (3.0 knots and 6.0 knots).
Pitch	Two lines run at the same speed in opposite directions over the feature.
Roll	Three lines run at the same speed in opposite directions over a flat seabed
Yaw	Three lines run at the same speed in same direction over the feature

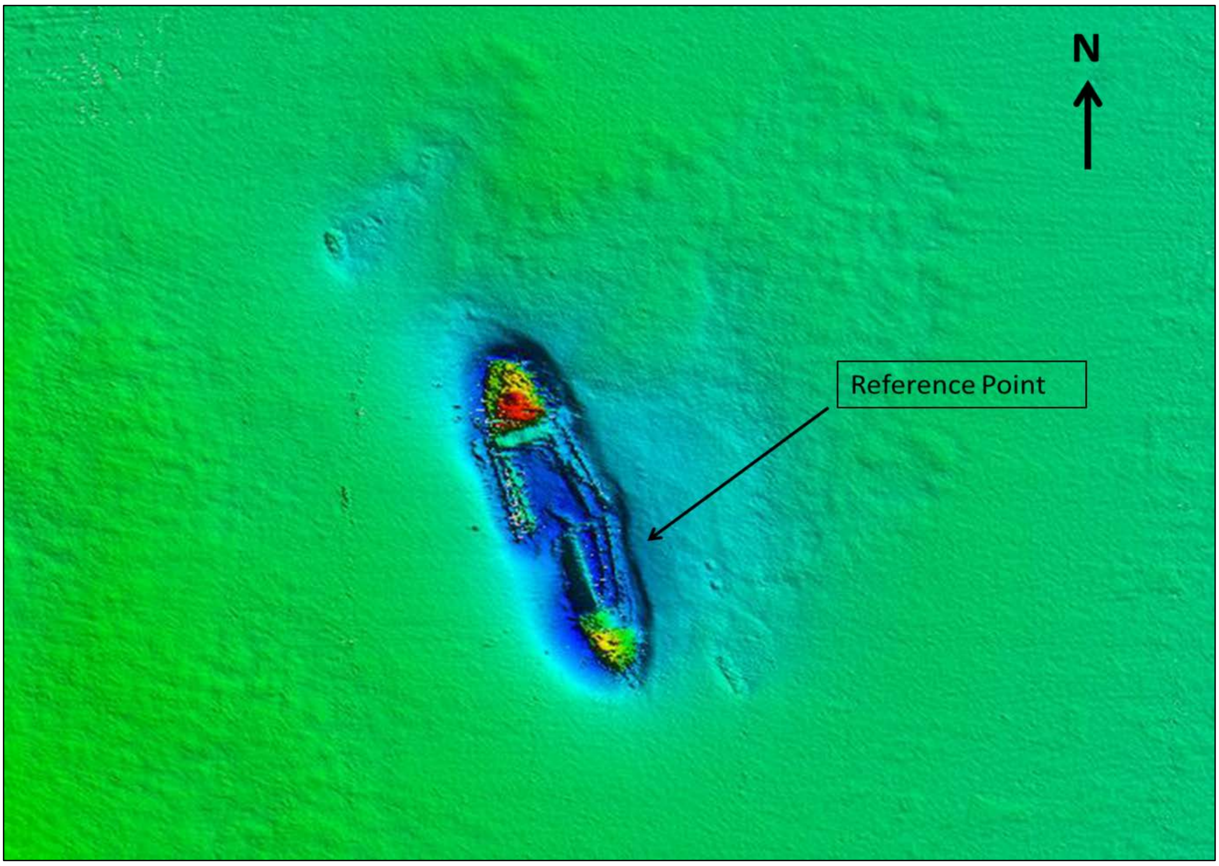


Figure 4.1: Overview of the MBES Calibration area

4.1 Results

Table 4.4: Calibration Results from CARIS

Calibration System Values		
Receiver	Rx PORT	Rx STBD
Latency	+0.000 sec	+0.000 sec
Pitch	-0.650°	-0.650°
Roll	-0.020°	+0.200°
Yaw	+0.040°	+0.040°

Table 4.5: Mounting angles as entered in SIS, post patch test

Mounting Angles Values		
Receiver	Rx PORT	Rx STBD
Latency	+0.000 sec	+0.000 sec
Pitch	-0.650°	-0.650°
Roll	+40.020°	-39.800°
Yaw	+0.040°	+0.040°

The Kongsberg SIS screen prints below show profiles of the grid data from the alignment calibration. The data was corrected for pitch, roll, latency and yaw. The X axis is in meters along the profile and the Y axis is in meters of water depth.

For the Kongsberg EM2040 system, pitch and yaw is calculated from the transducer head, therefore, the corrections for pitch and yaw for both receiver heads are the same respectively. Roll however, is corrected separately for each port and starboard receiver. Latency corrections are for both heads as in the case of pitch and yaw.

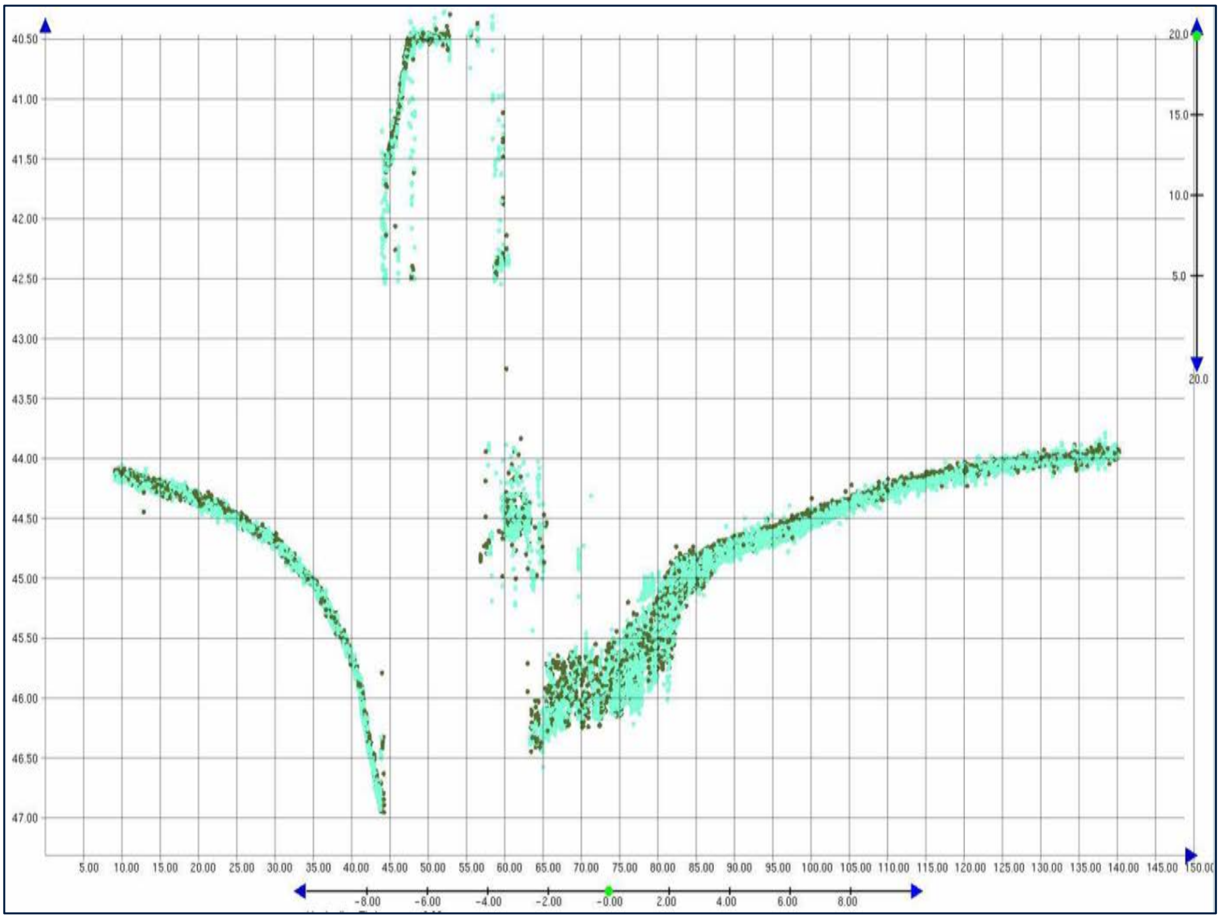


Figure 4.2: Latency 0.000 sec

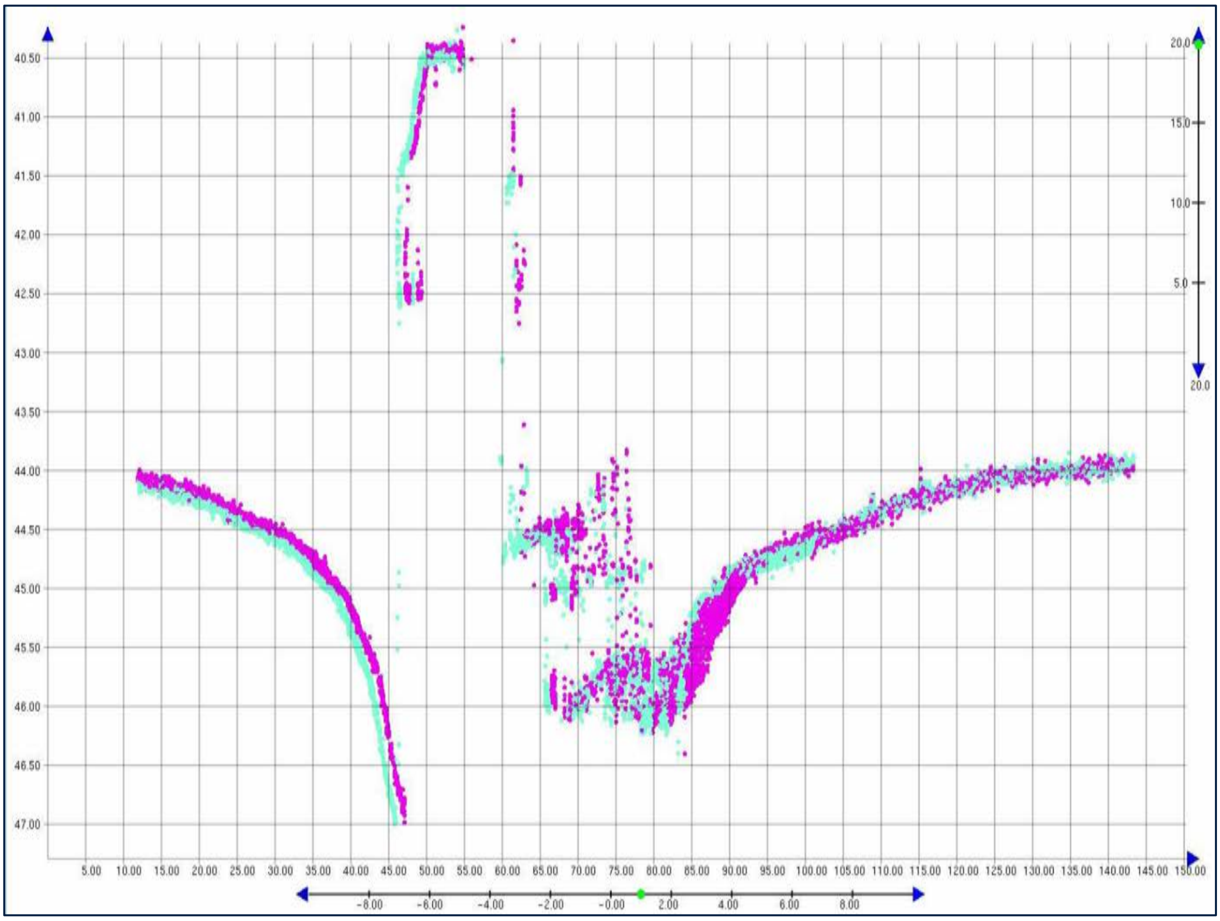


Figure 4.3: Pitch 0.000°

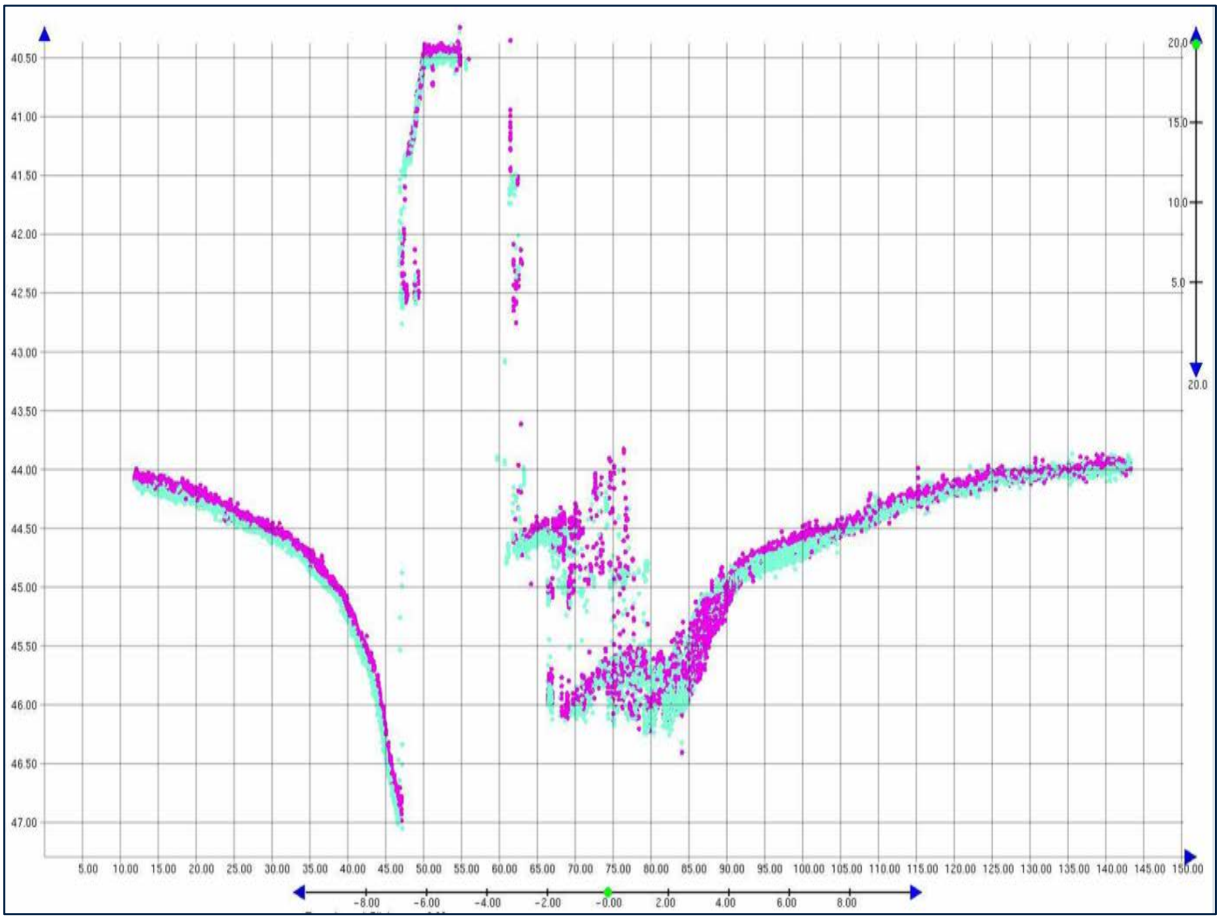


Figure 4.4: Pitch -0.650°

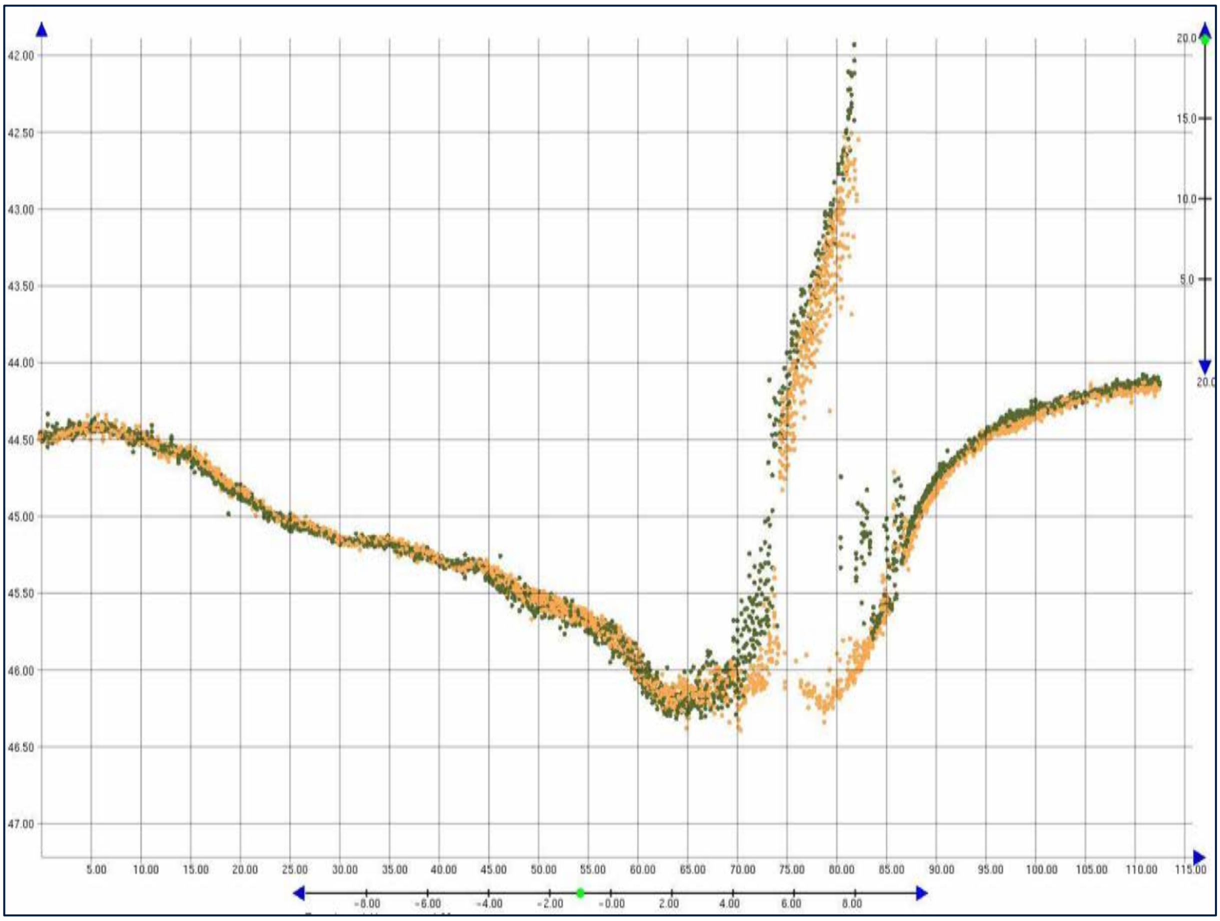


Figure 4.5: Heading 0.00°

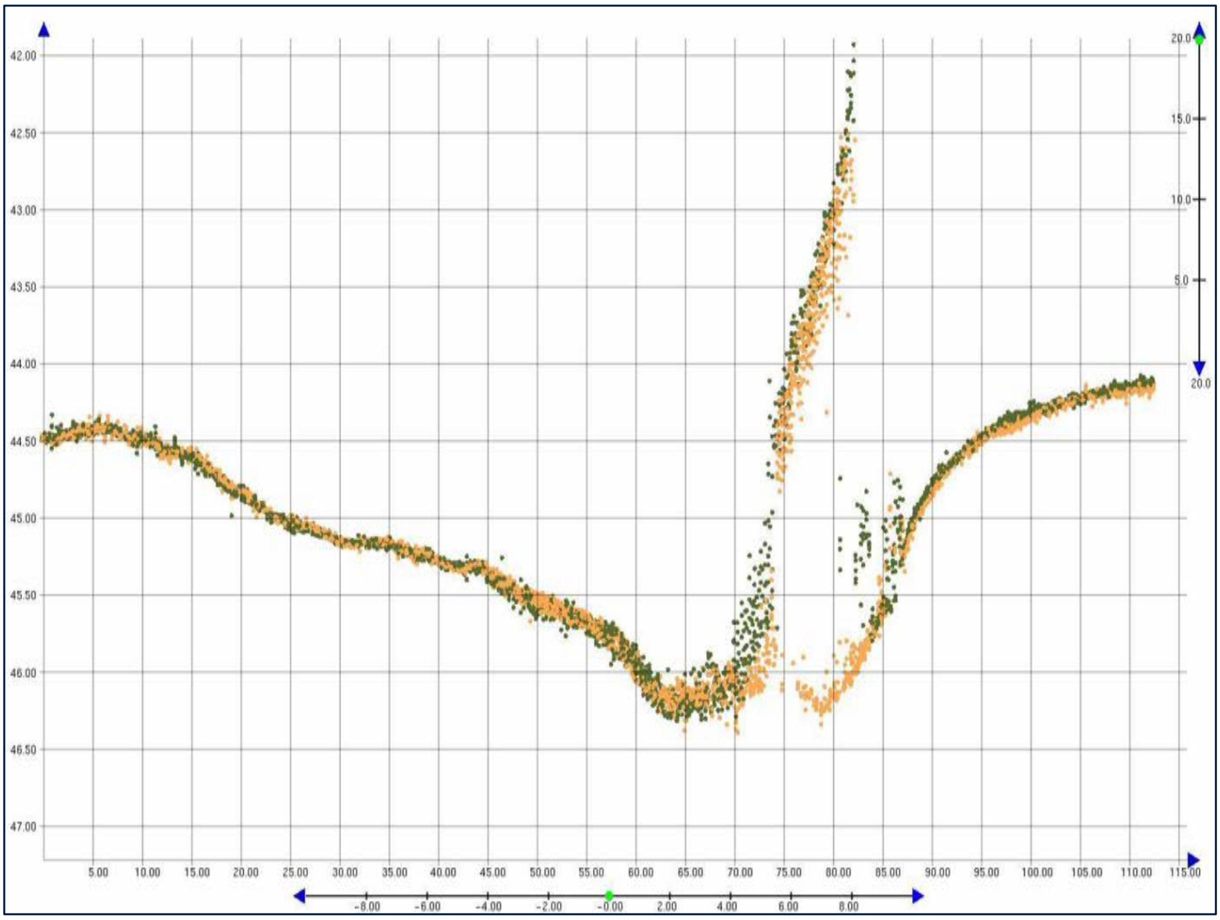


Figure 4.6: Heading 0.040°

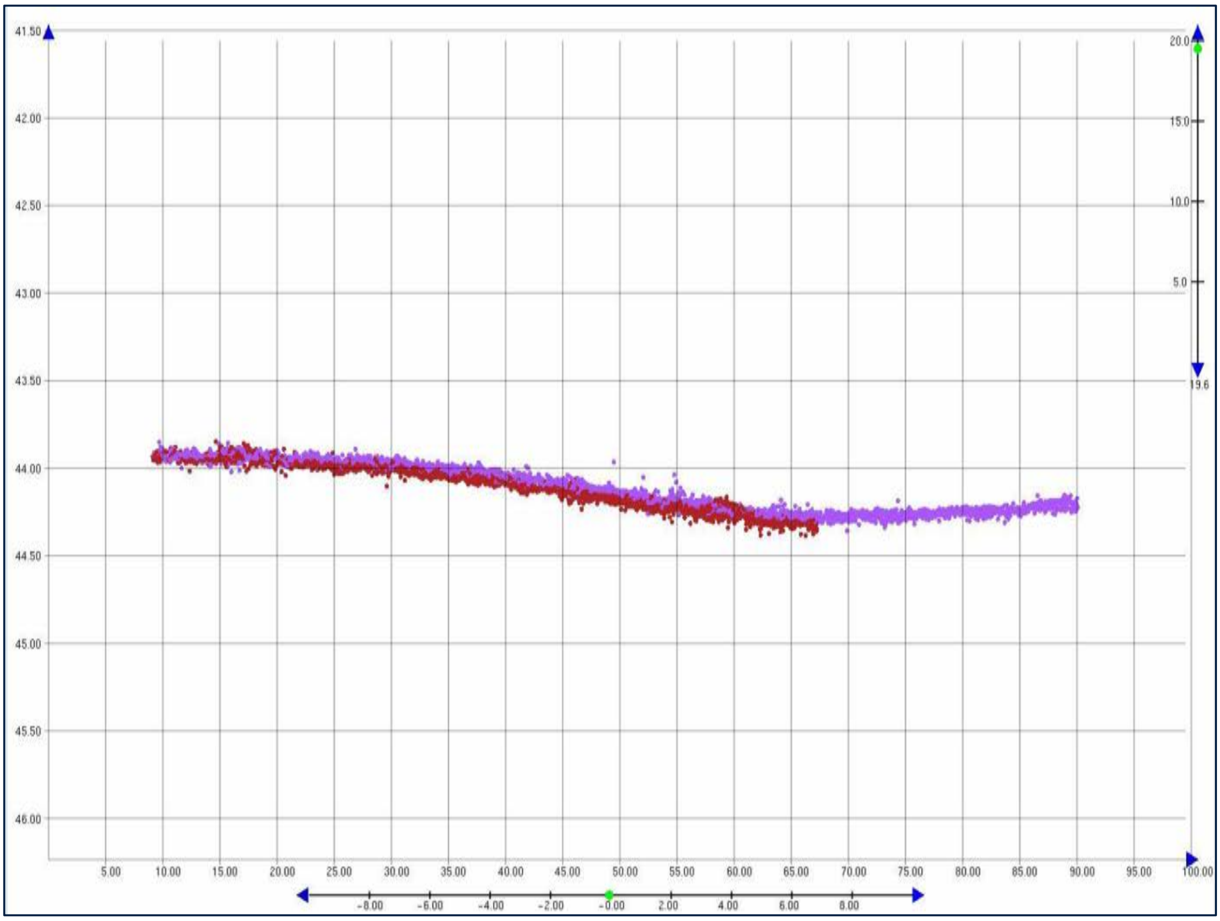


Figure 4.7: Roll (Port) 0.000°

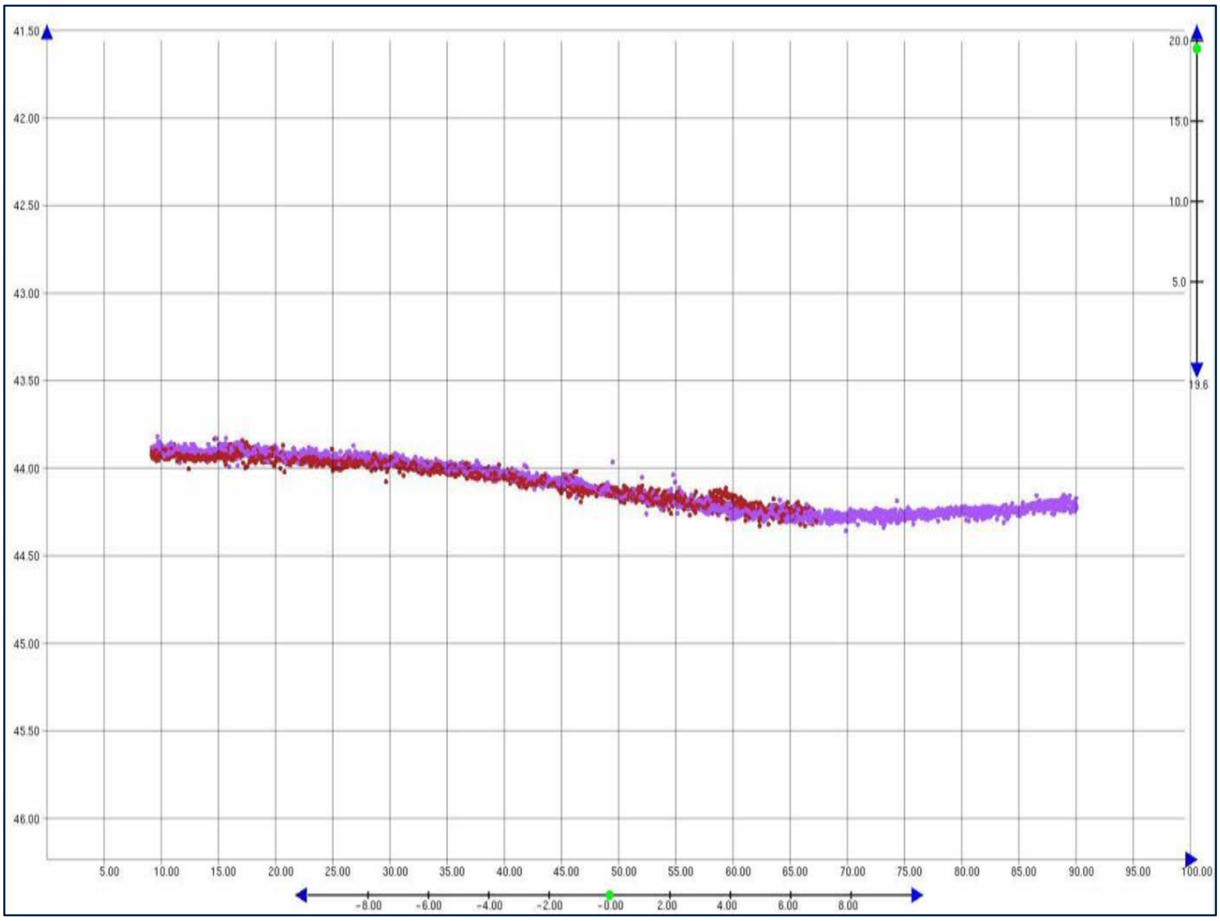


Figure 4.8: Roll (Port) 0.020°

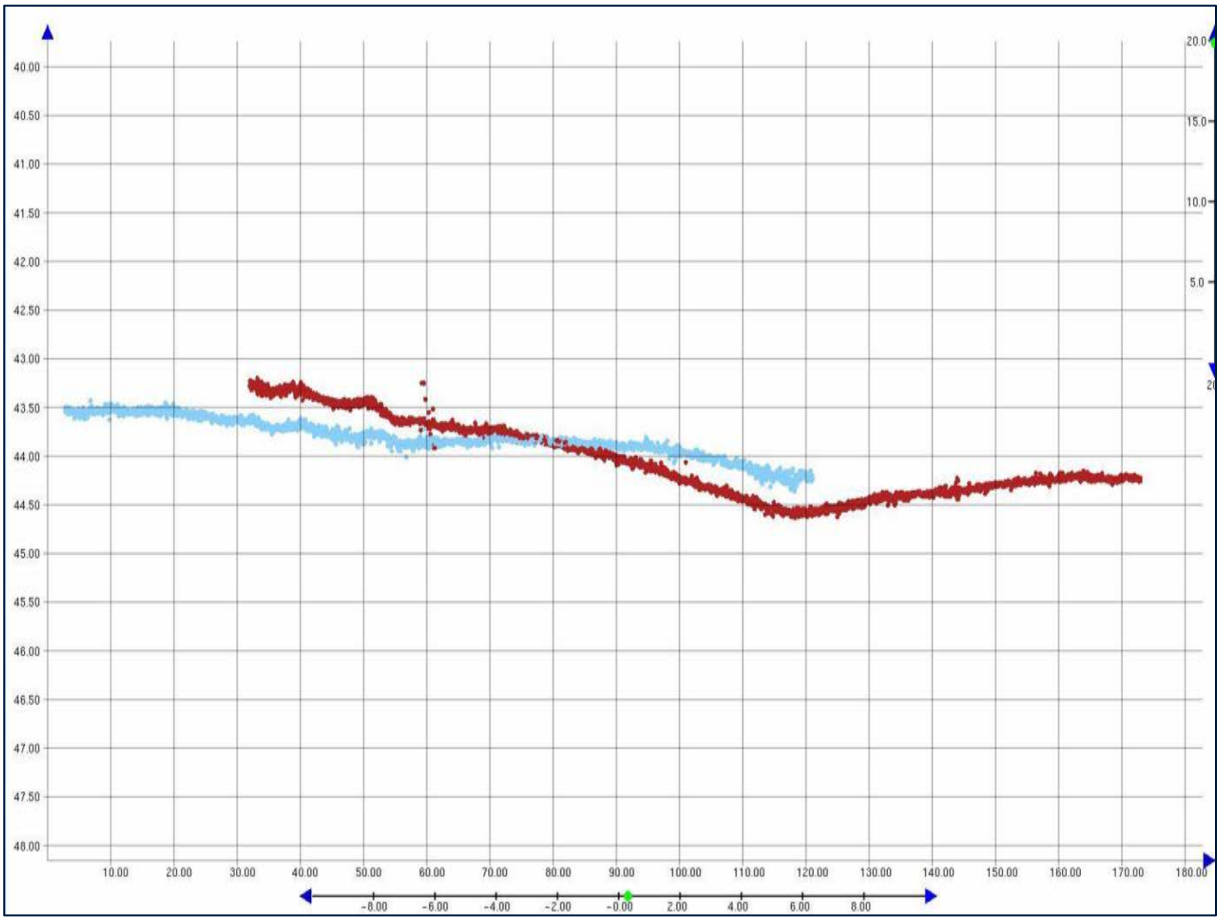


Figure 4.9: Roll (Stbd) 0.000°

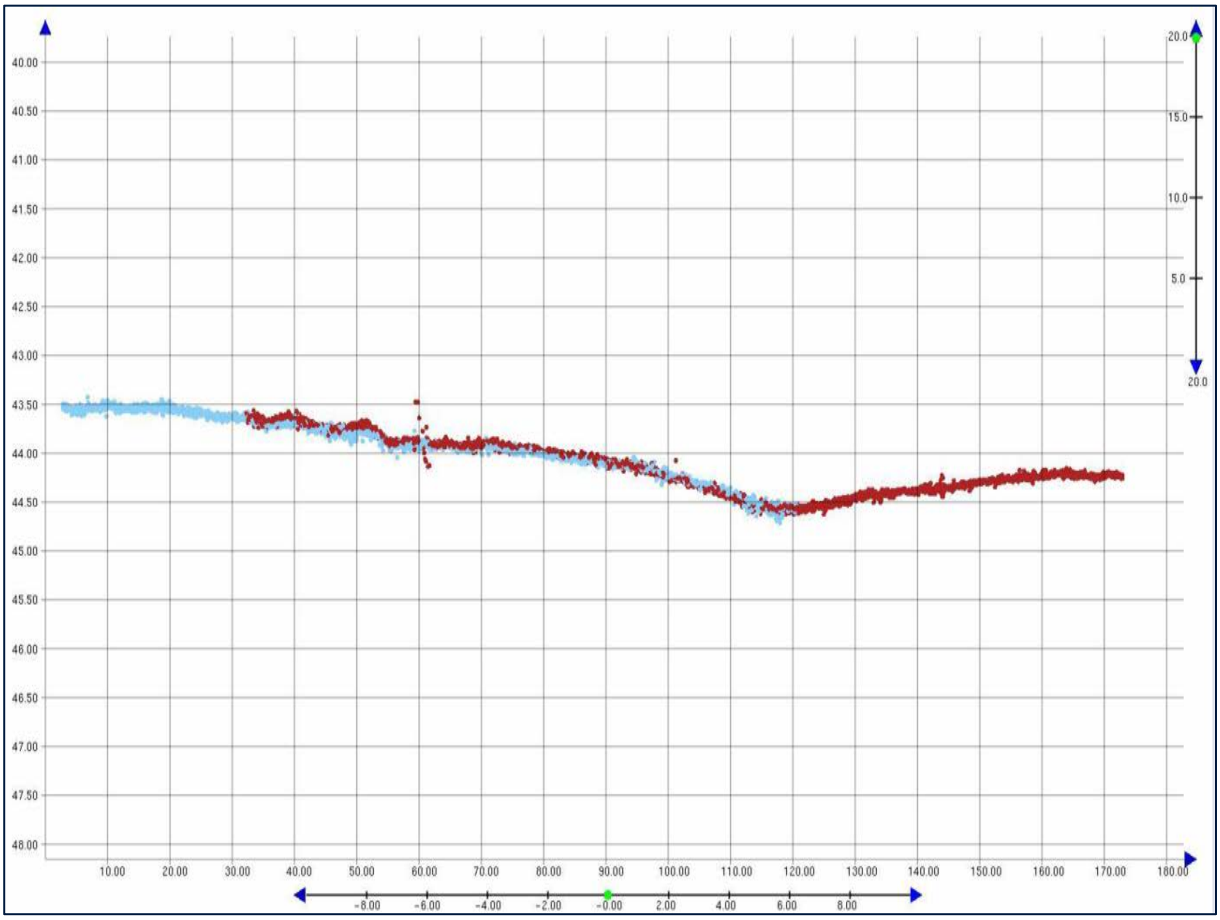


Figure 4.10: Roll (Stbd) +0.200°

4.2 Conclusion

The Multibeam system was calibrated to the system tolerances as based on the project specification.

5. Sound Velocity Probe

5.1 Certificates

Three mini sound velocity sensors (SVS) (S/N 32017, 69538 and 71201) are mobilised for this project. The first one is installed onto the moon pool bracket to monitor the speed of sound at the MBES sonar head for beam forming purposes; the others are kept as spares.

Three CTD SAIV SD204 (S/N 951, 519 and 1166) are mobilised and are available to collect sound velocity data throughout the entire water column. The sound velocity profile is then applied in MBES, SBES, USBL and SSS system software. The calibration certificates for all the above units are shown in Appendix F.

5.2 SVP Comparison

The two SAIV CTDs SD204 (S/N 951 and 519) were deployed simultaneously at an offshore calibration site down through the water column. The results of the comparison test are shown in

Figure 5.1. The sound velocity of both CTDs was within 1.60 m/s.

A Moving Vessel Profiler (MVP) was mobilised on the vessel in the port of Ijmuiden for use in this project. Figure 5.2 show the comparison between velocities recorded on CTD(951) and the MVP on 25 May 2021, in water depth of 31 m. The sound velocity of both CTDs was within 1.90 m/s.

Profile	Position WGS 84	Time	Average Sound Velocity [m/s]	Color
20210524_1823_915	56° 30' 18.30903" N 006° 19' 55.21109" E	24 May 2021, 18:23:47Z	1481.0	
20210524_1823_519	56° 30' 18.30903" N 006° 19' 55.21109" E	24 May 2021, 18:23:33Z	1479.4	

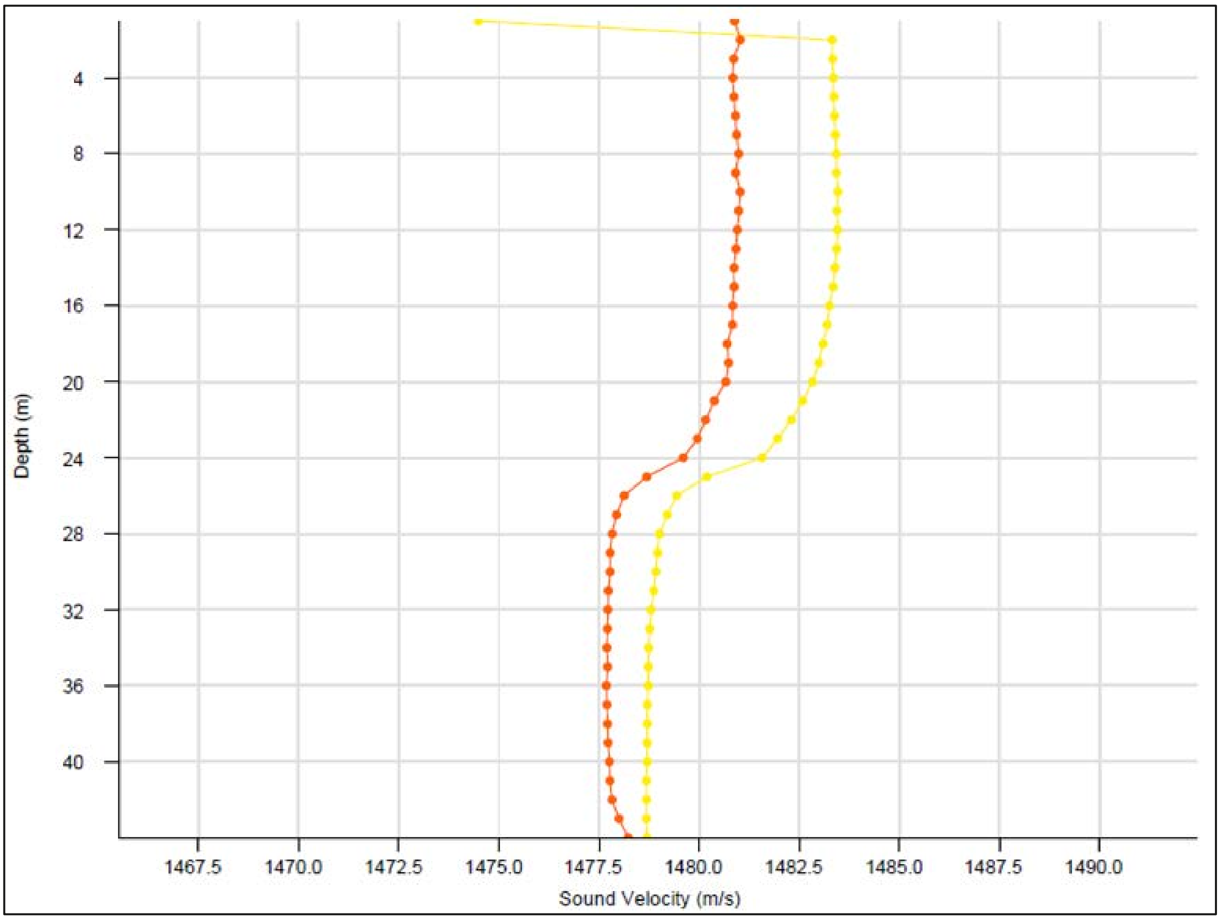


Figure 5.1: Comparison of SVP Units

Profile	Position WGS 84	Time	Average Sound Velocity [m/s]	Color
20210525_1953_951	56° 31' 03.81000" N 006° 14' 30.37000" E	25 May 2021, 19:53:46Z	1483.7	Red
20210525_1753_MVP	56° 31' 03.81000" N 006° 14' 30.37000" E	25 May 2021, 19:57:16Z	1481.8	Blue

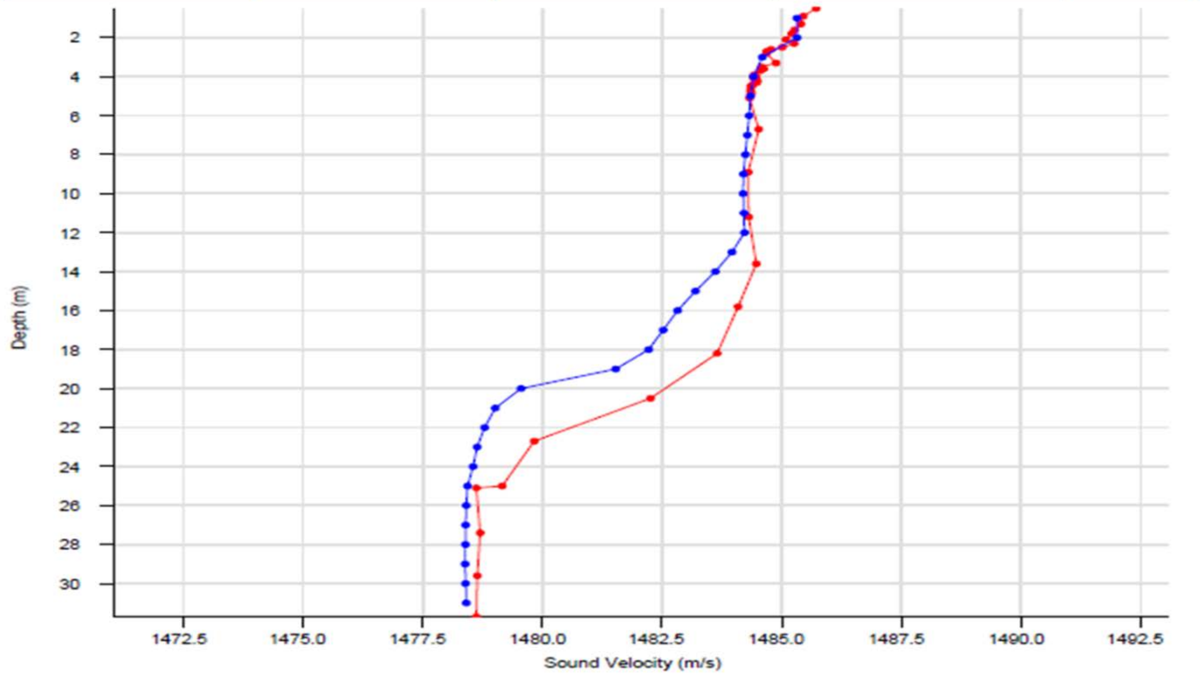


Figure 5.2: Comparison of SVP and MVP

6. USBL

6.1 USBL Static Calibration

A static calibration of the HiPAP 501 USBL was carried out on 22 May 2021 in the Skagerrack Strait, Denmark at water depth of 345.5 m. The Hydrins was providing corrected pitch, roll and heading to the HiPAP system. The Hydrins was corrected for attitudes and was aligned with the vessel reference frame. The Hydrins' lever arms were set for the HiPAP position. The DGNSS data received by the HiPAP system were already CRP referenced so there was no need to enter offsets in APOS.

The calibrated hull unit depth offset (the laser measure) was verified. The HiPAP pole was lowered to its full position. An SVP was carried out on arrival at the calibration site and entered into APOS and the EA400 single beam echosounder. The M37 cNODE Maxi transponder was deployed to the seabed. Once settled, the mean position of the transponder was recorded using Starfix.NG. This position was used to centre the cardinal points setup. The height from seabed clump weight to the M37 transponder's head was 3 m. The transponder water depth was calculated as 255.3 m. The transponder Z values were referenced to CRP. Distance between WL to CRP was 2.5 m.

Starfix.NG was used to create the waypoints for vessel navigation. The four cardinal points were set 140 m away from the deployed transponder.

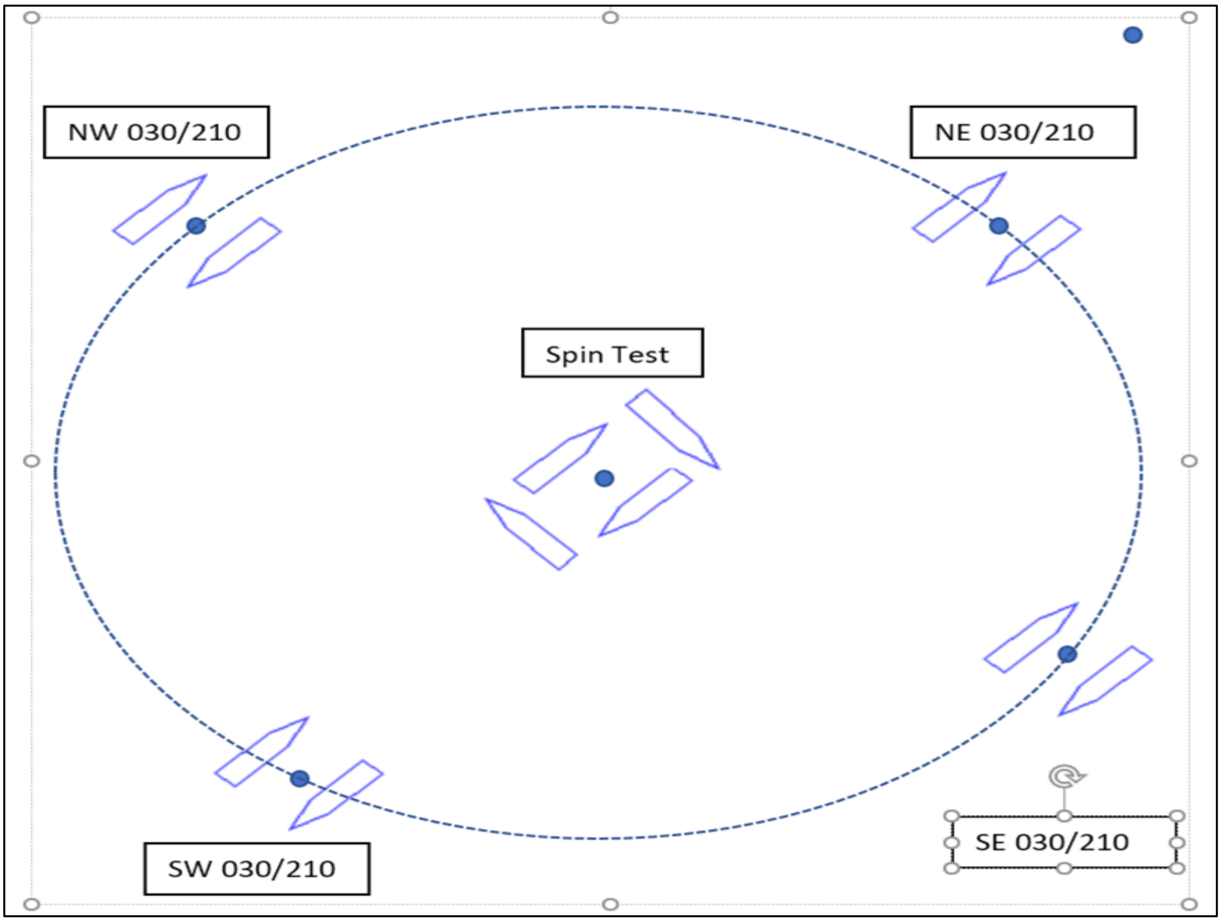


Figure 6.1: USBL Static Calibration over cardinal points

The vessel used dynamic positioning to hold the HiPAP transceiver stationary over one of the cardinal waypoints, on a 30° and 210° heading. 600 records at 1.0 second intervals were taken. Complete logging at one location took 10 minutes. This procedure was repeated for all four cardinal waypoints. Then vessel moved over transponder location, and whilst stationary, recorded 600 readings at four orientations, 035°, 125°, 215° and 305° heading.

The transducer alignment results calculated by APOS were based on 1591 observations used in calculations.

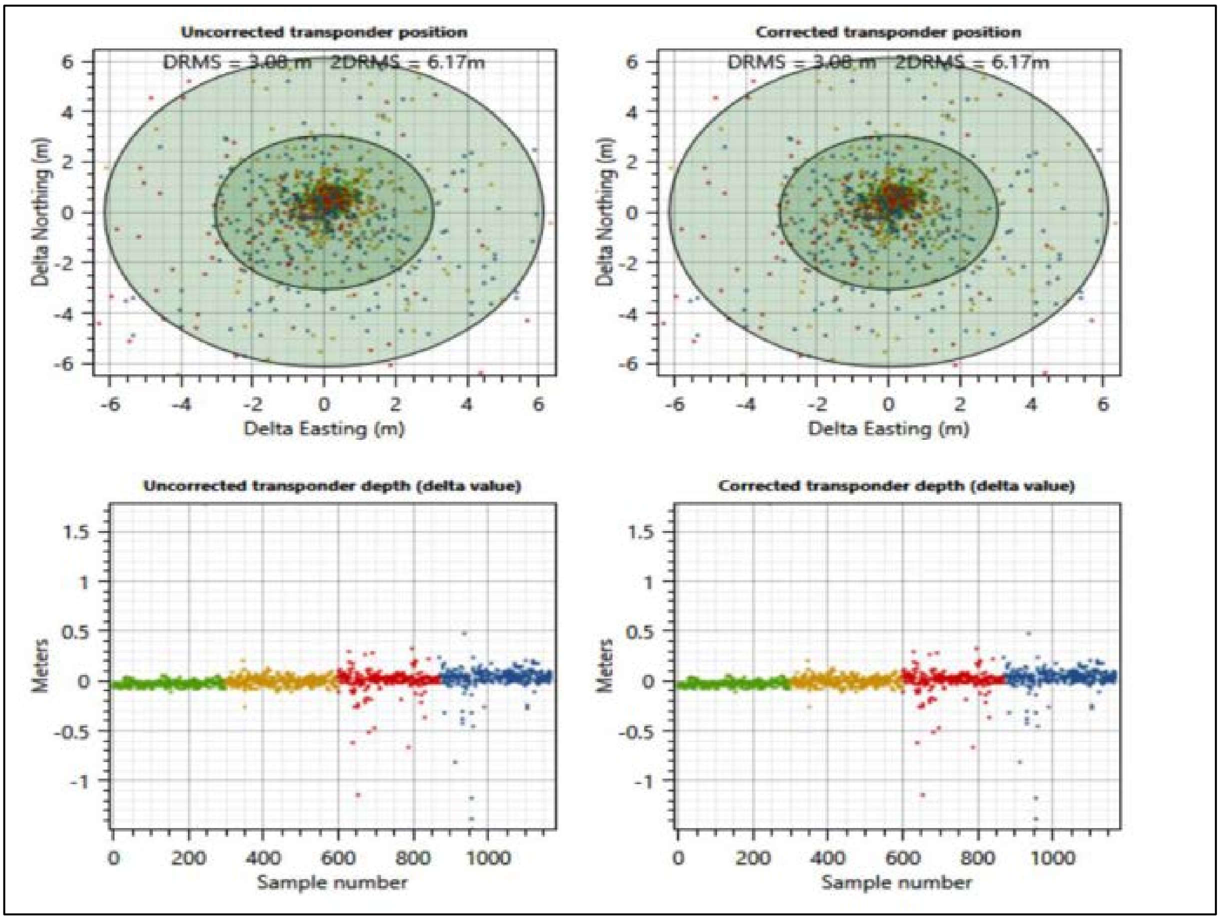


Figure 6.2: Scatter Plots (After Calibration)-Beacon Position

Once calibrated, a static spin check and walk away drift were run to test the new pitch, roll and heading values.

Once satisfied with the results of the calibration, the buoy was recovered and the USBL beacon brought to the surface and collected. The transponder position generated by APOS, after processing, is shown in Table 6.1.

Table 6.1: Statistics for Calibrated Transponder Positions

Geodetic Parameters: ETRS89, UTM 31 N				
	Easting [m]	S.D. 1σ Easting [m]	Northing [m]	S.D. 1σ Northing [m]
APOS	542627.052	0.01	6437751.258	0.01

The results show that the standard deviations 2DRMS of beacon observation positions meet the specified accuracy of ±1 m (1σ).

The APOS USBL Calibration tool calculated new values for roll, pitch and heading (Table 6.2), which were then applied to APOS software. In Figure 6.2, APOS scatter plots after calibration are shown.

Table 6.2: Updated USBL Calibration Values in APOS

Parameter	Before Calibration (°)	After Calibration (°)	S.D. 1σ (°)
Roll	0.04	0.07	0.01

Parameter	Before Calibration (°)	After Calibration (°)	S.D. 1σ (°)
Pitch	-0.07	-0.01	0.01
Heading	269.78	269.77	0.02

6.2 Static Spin Check

After the calibrations, the newly calculated values were updated in APOS system. The static spin check was conducted with the USBL transducer over the transponder. Four sets of 300 observations were recorded over the verification waypoint at 035°, 125°, 215° and 305° vessel headings. The purpose of these tests was to verify that the new alignment values were effective and that the range was being accurately measured. The groupings are tight and within the expected tolerances. This demonstrates the reliability of the new USBL calibration results updated in APOS.

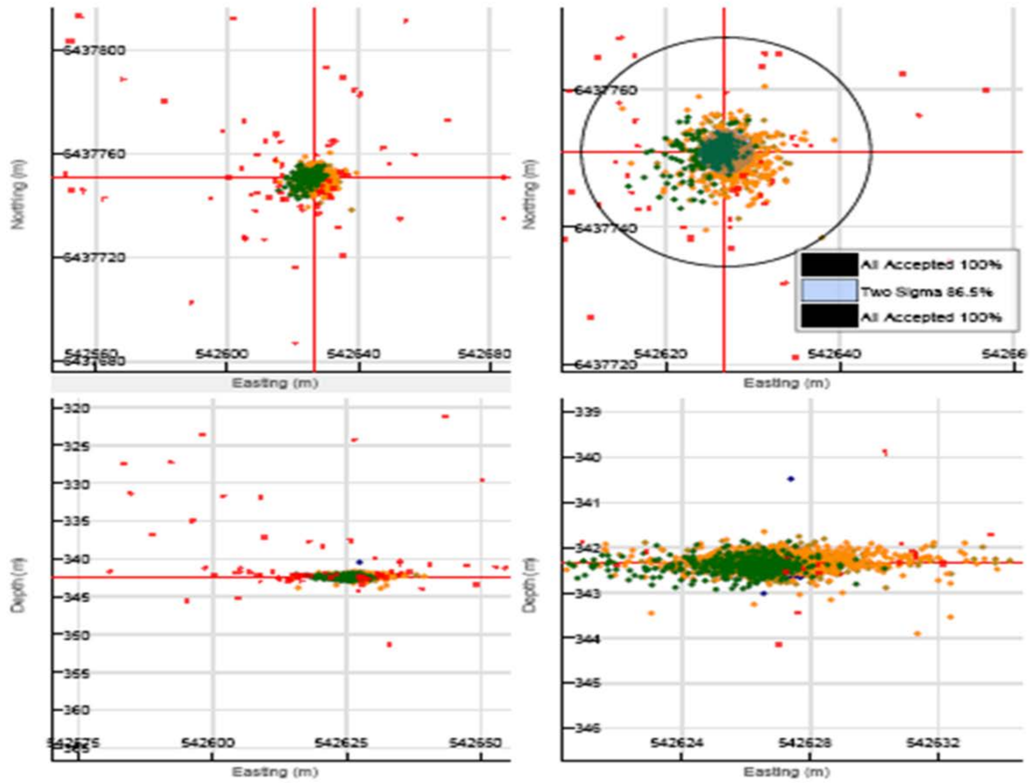


Figure 6.3: Static Spin Check Scatter Plots (before/after) – Beacon Position

The calibration report statistics are provided in Appendix E.

7. Side scan Sonar

Two (2) EdgeTech 4200 100/600 kHz (primary S/N: 37759, and spare S/N: 51846) SSS tow fish were mobilised on the Fugro Pioneer in port of Ijmuiden, NL.

7.1 Rub Test

The two EdgeTech 4200 SSS tow fish were tested on 19 May 2021 on the back deck of the Fugro Pioneer with a conventional rub test. The purpose of this test was to demonstrate that all sonar channels were being received by the acquisition software and to show correct port and starboard transducer wiring see Figure 7.1.

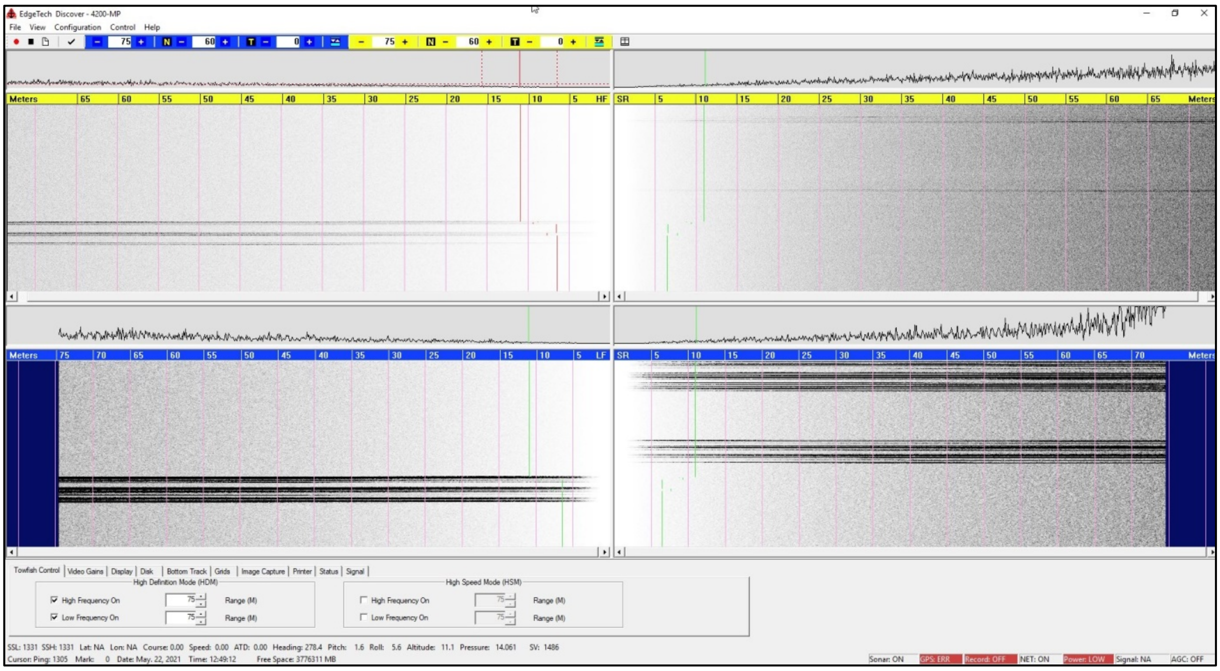


Figure 7.1: Side scan Sonar rub test: S/N 37759

7.2 Wet Test

The main and spare SSS tow fish were wet tested and overall system was monitored at the quayside in Ijmuiden prior to sailing. These were done to ensure that sonar data, heading, time and navigation were recorded, and no overflow errors occurred. The SSS data was logged in EdgeTech Discover in native JSF format and output in XTF format and to allow for real time data monitoring, gain control and bottom tracking.

7.3 SSS-USBL System Verification

On 28 and 31 May 2021 a Side Scan Sonar-USBL position verification survey was carried out over a discrete point feature with side scan sonar to verify the SSS-USBL system for operations. The point feature was identified with an MBES scouting line to the North East of the wrecked coaster, 'Fallwind'. The survey took place over two separate days due to inclement weather during the 28 May 2021. The point feature (reference point) was delineated from the MBES. The position of the contact on MBES was used as reference to verify to SSS-USBL positioning system. The position of the reference point as derived from the MBES data is given in Table 7.1.

Table 7.1: Reference Point Position as Derived from MBES Data

Geodetic Datum and Projection: ETRS89, UTM 32N		
Location ID	Easting [m]	Northing [m]
Point Feature	340725.00	6263755.40

The verification lines comprised of three survey lines in three directions run in box-in pattern at an offset of 30 m from an identified point feature on the seafloor within the survey area. Two verification lines were run at a slight angle due to navigational and equipment safety due to the close proximity to the wreck location. All lines used in the verification were sailed at approximately the same speed. Side scan sonar was operating in 100 kHz and 600 kHz frequency and 75 m range. A USBL beacon was installed on the tow cable at 1m from the SSS tow fish. The SSS was towed behind the vessel from the tow point located at stern of the vessel, with a G882 magnetometer piggybacked to the to the SSS tow fish. Approximate water depth of the area was 40.3 m.

The identified point feature on the seabed was digitised from the box-in survey lines individually and was compared with the multi-beam echosounder derived position of the same target.

Figure 7.2 to Figure 7.4 show the individual side scan sonar images showing the identified point feature item from the three survey lines. Figure 7.5 shows the identified debris target item in MBES data with all the side scan sonar derived target positions from all the survey lines.

The comparison of the identified target debris item positions derived from the side scan sonar lines with respect to the MBES data derived position are given in Table 7.2.

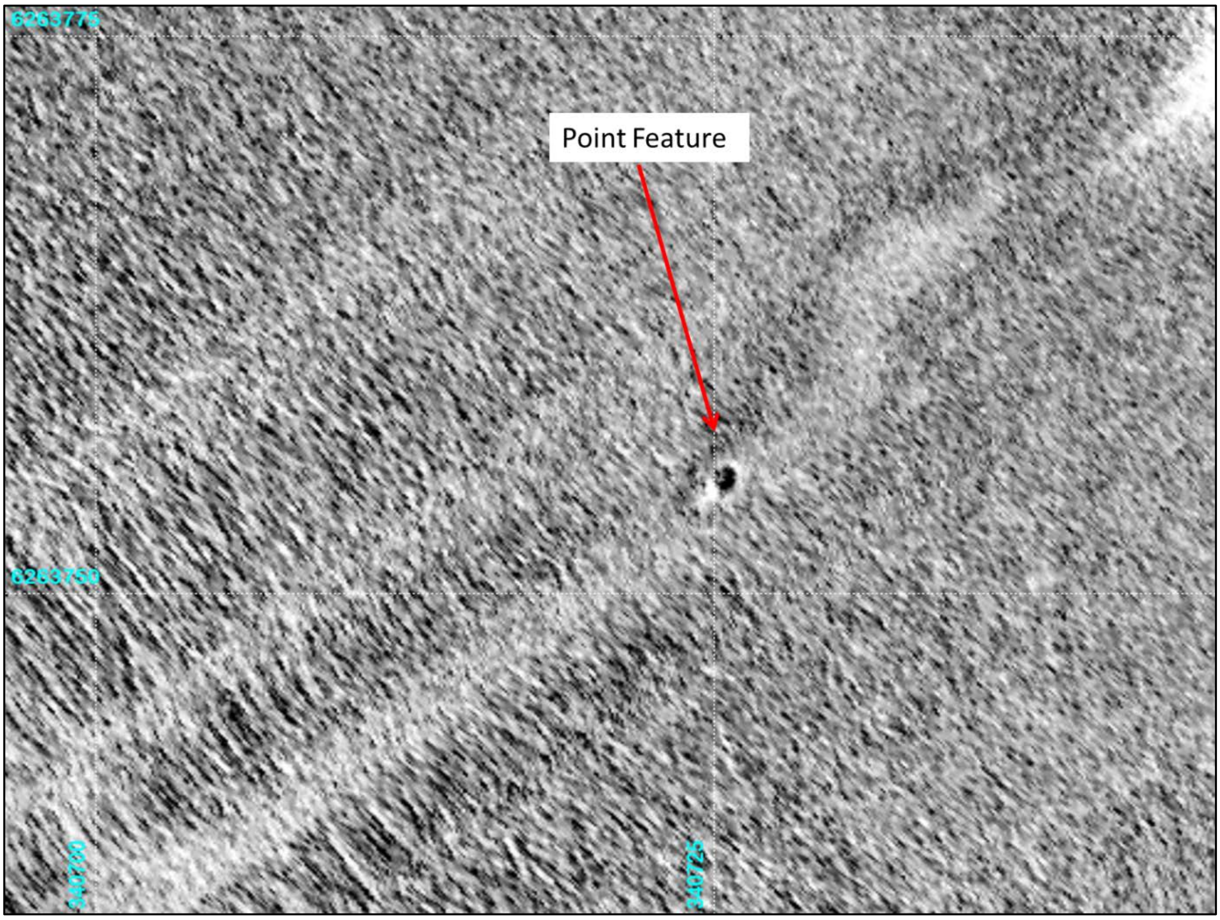


Figure 7.2: SSS image showing the identified target – Point feature position derived from Line EAR9001

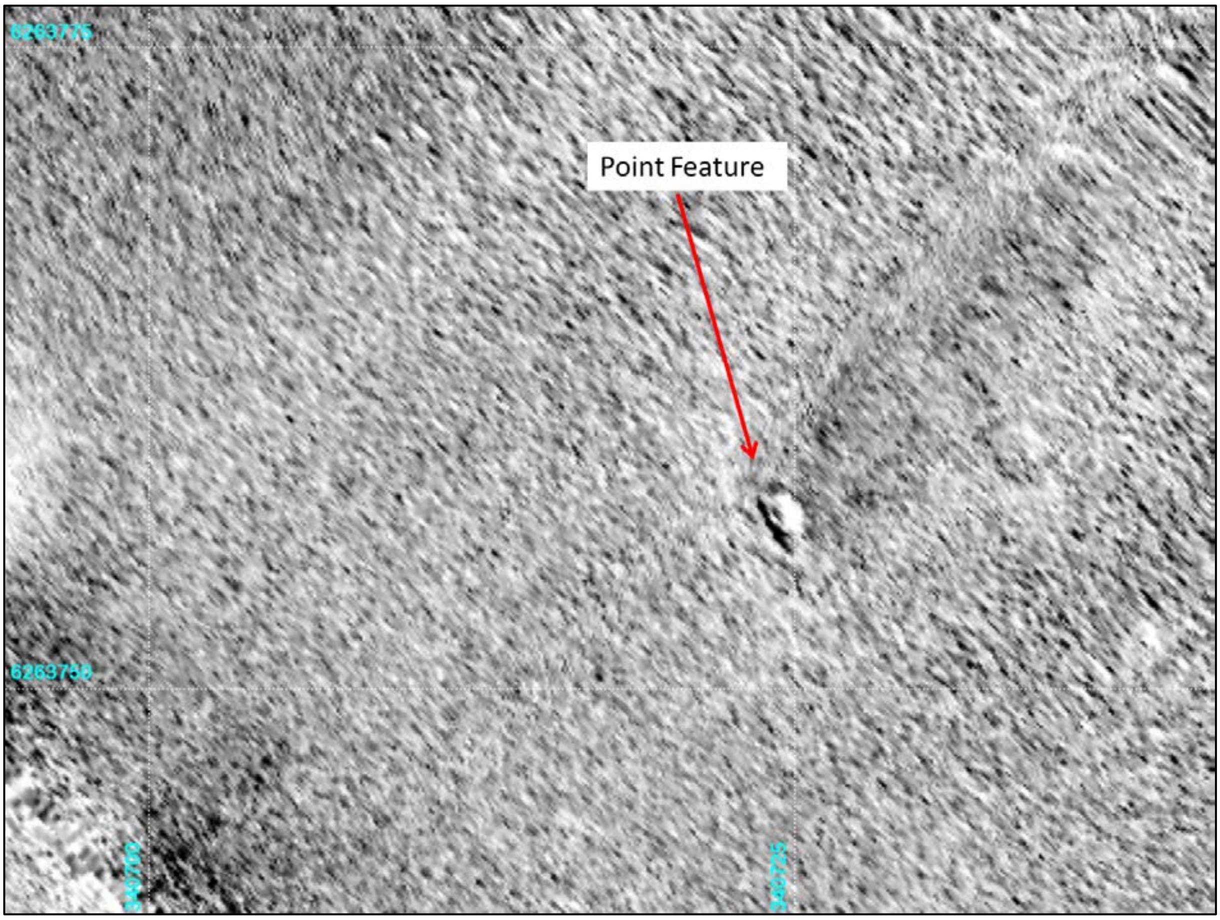


Figure 7.3: SSS image showing the identified target – Point Feature position derived from Line EAR9008

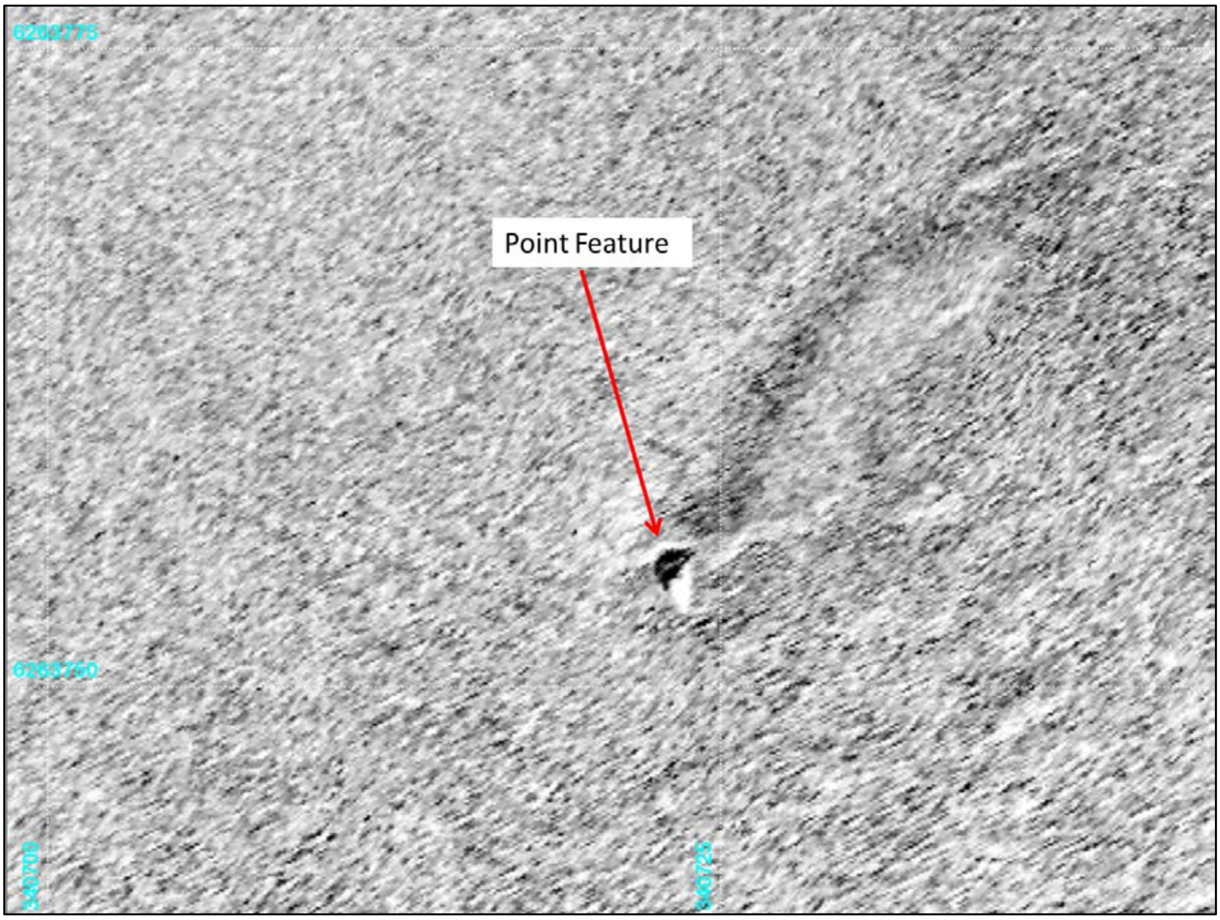


Figure 7.4: SSS image showing the identified target – Point Feature position derived from Line EAR9022

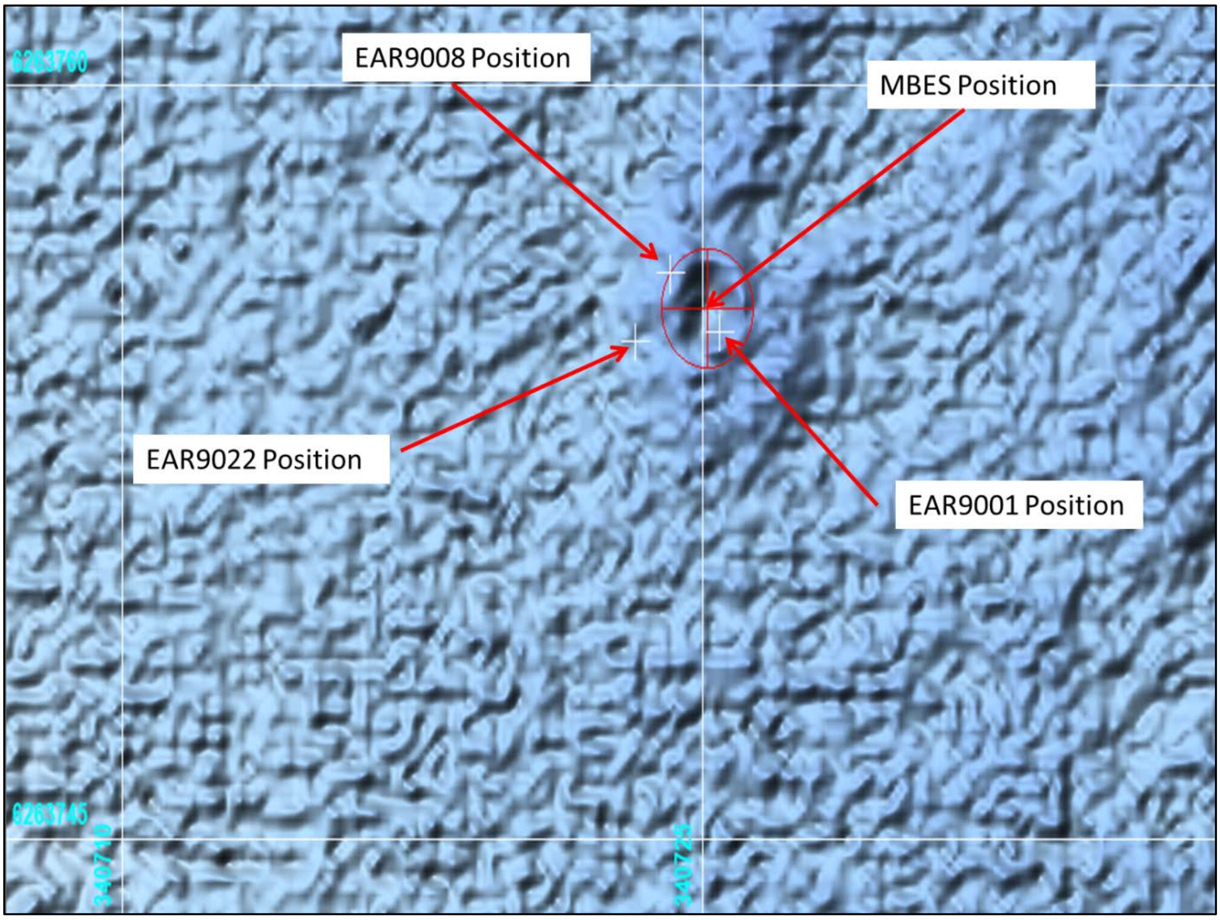


Figure 7.5: MBES image showing the identified target – Point Feature (Red Crosshair) and the respective target positions as derived from SSS lines (white crosses)

Table 7.2: Locations of Reference Point Derived from SSS Data from Verification Lines

Geodetic Datum and Projection: ETRS89, UTM 32N				
Line	Heading	Easting [m]	Northing [m]	Difference with MBES position [m]
MBES		340725.0	6263755.40	-
EAR9001	135°	340725.46	6263755.14	0.55 m
EAR9008	315°	340724.21	6263756.21	1.15 m
EAR9022	239°	340723.50	6263755.05	1.95 m
Verification Lines Average		340724.28	6263755.43	0.74 m

The SSS data exhibited good quality and the positioning system was verified and deemed fit for survey operations.

8. Magnetometer

Two Geometrics G882 magnetometers, one primary and a spare (S/N 883119 and 883126) are mobilised on the Fugro Pioneer. Both magnetometers are fitted with digital depth sensors and altimeters.

8.1 Magnetometer Altimeter and Depth Sensor Calibration

Magnetometers and altimeters were tested as pairs; therefore, the scale and bias values for each altimeter is only valid with a specific magnetometer. Altimeters were verified prior to the mobilisation of the project by using a setup of drainpipes filled with seawater (Figure 8.1). The first opening in the drainpipe is used for the altimeter, and a metal plate inserted at the opening at approximately 1 m. The true distance between the metal plate and the altimeter is measured with a tape measure and the altimeter reading is logged. The process is repeated at 2 m, 3 m etc. From this, altimeter readings, based on scale and bias values programmed by manufacturer, were verified.

Figure 8.1: Example of Altimeter Verification Setup

Depth sensors in the magnetometers were verified prior to mobilisation using a pressure gauge. The pressure gauge is connected to the depth sensor connector of the magnetometer (Figure 8.2). Using the hand pump, the pressure was increased to correspond to the pressure at a certain depth in seawater. During the test 0 – 50 m was tested in 10 m intervals. From this, depth sensor scale and bias values were determined.

Figure 8.2: Pressure Gauge Connected to a G882 Magnetometer

The scale and bias values for the calibrated Altimeter and Depth Sensors can be found in Table 8.1.

Table 8.1: Altimeter and Depth Sensor Scale and Bias

Serial Number Magnetometers	Altimeter		Depth	
	Scale	Bias	Scale	Bias
SN883119	0.98	0.05	1.0	0
SN883126	1.0	0.1	1.0	0

8.2 Inclination Calibration

To ensure that the magnetometers operate with strong and consistent signal strength throughout the survey, it was necessary to check the optimum sensor alignment for the survey area. Changes in the inclination and declination of the Earth's magnetic field affect the magnetometer signal strength, and certain sensor alignments provide better results than others.

This check was conducted using Geometrics' CSAZ software, which states the inclination and declination of the Earth's magnetic field for a given latitude and longitude and determines the optimum sensor alignment. The software indicated that although a 0° sensor orientation would give the most consistent signal in all directions, a sensor orientation of 45° would result in the highest signal strength (Figure 8.3). A sensor orientation of 45° was used in the project.

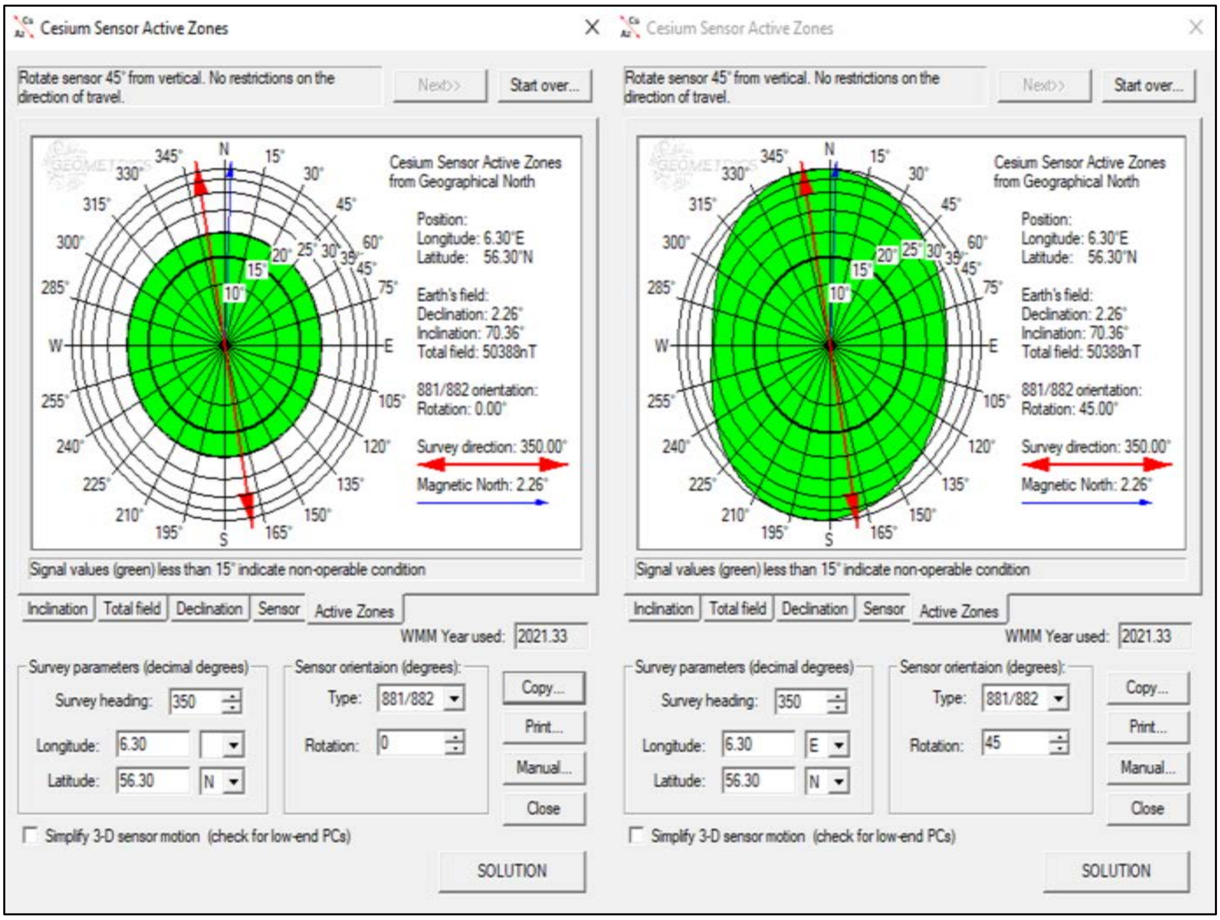


Figure 8.3: Active zones from CSAZ software. 0° Sensor orientation (left) and 45° sensor orientation (right)

8.3 Wet Test

The main and spare Magnetometers were wet tested and overall system was monitored at the quayside in Ijmuiden prior to sailing. These were done to ensure that magnetometer data, heading, time and navigation were recorded.

8.4 Spanner Test

The primary and spare Magnetometers were 'Spanner Tested' whilst alongside in the Port of Ijmuiden prior to sailing on the 19 May 2021. Each Magnetometer was raised off the deck using non-ferrous pallets. A large spanner is then passed underneath each sensor in-turn and the magnetic field fluctuations recorded. The results were good, with strong fluctuation in magnetic field shown by each sensor, see Figure 8.5.

Figure 8.4: Magnetometer Spanner Test

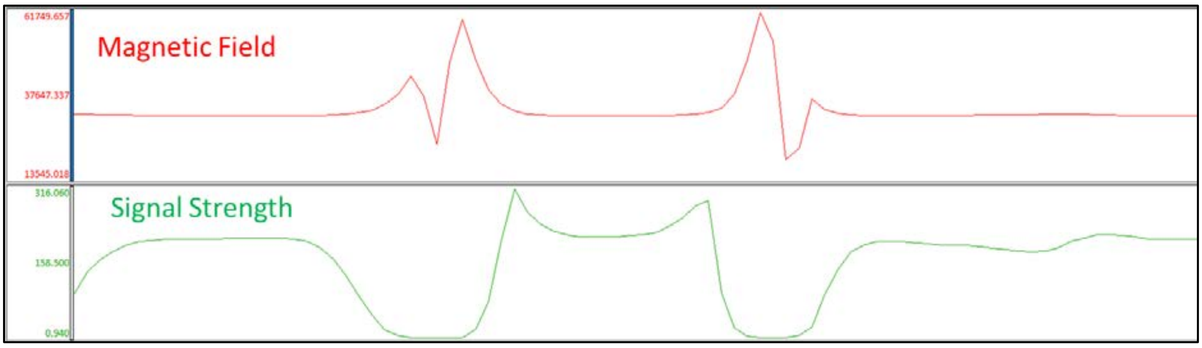


Figure 8.5: Magnetometer Spanner Test

8.5 System Verification

A known, buried, submarine cable was used for magnetometer system verification and wet test. Data was acquired in reciprocal headings, crossing above the cable (lines sailed perpendicular to the charted cable). All the lines showed a prominent magnetic anomaly at the cable crossing location. See below figures and tables for the verification results.

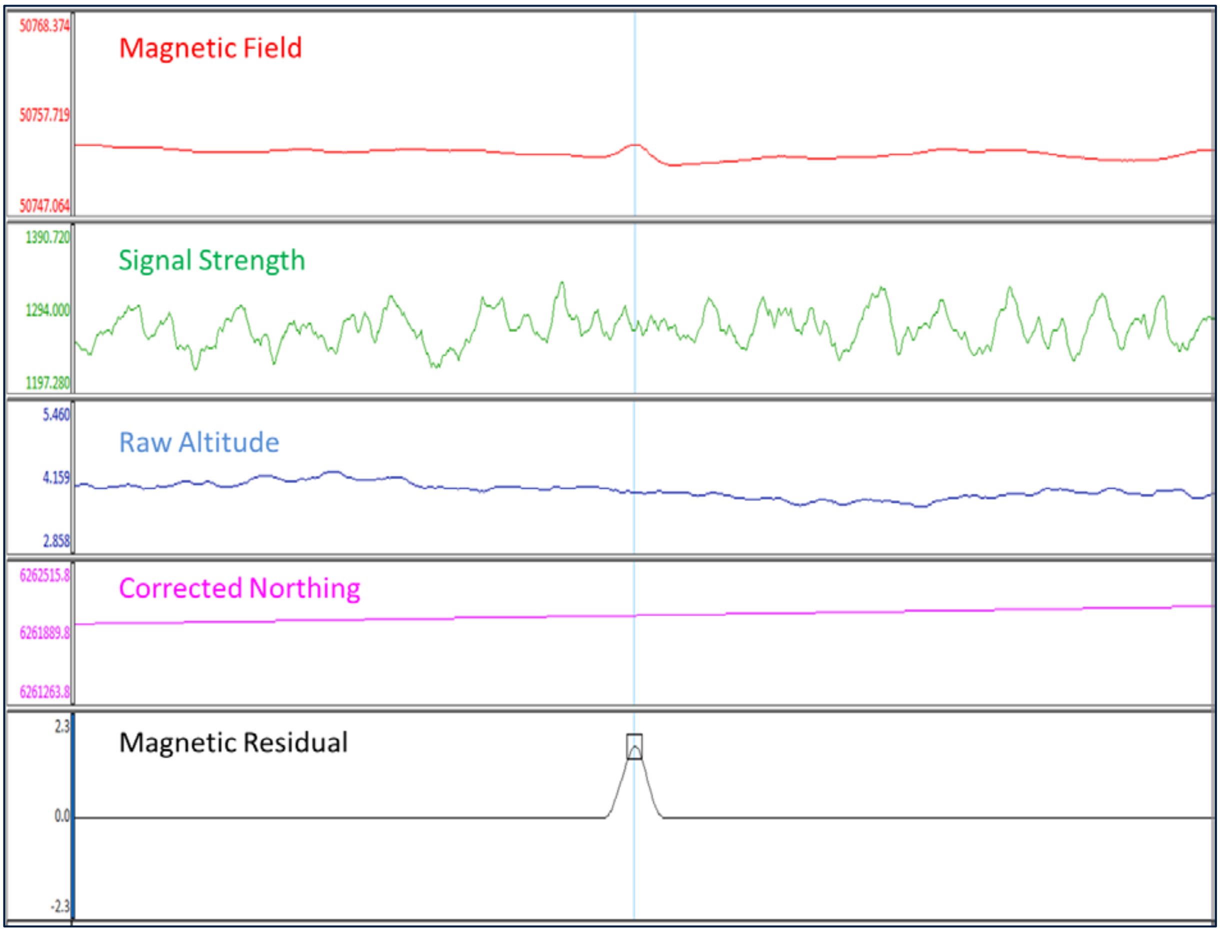


Figure 8.6: Magnetic field data profiles, line EAR9011, with observed anomaly over the buried cable

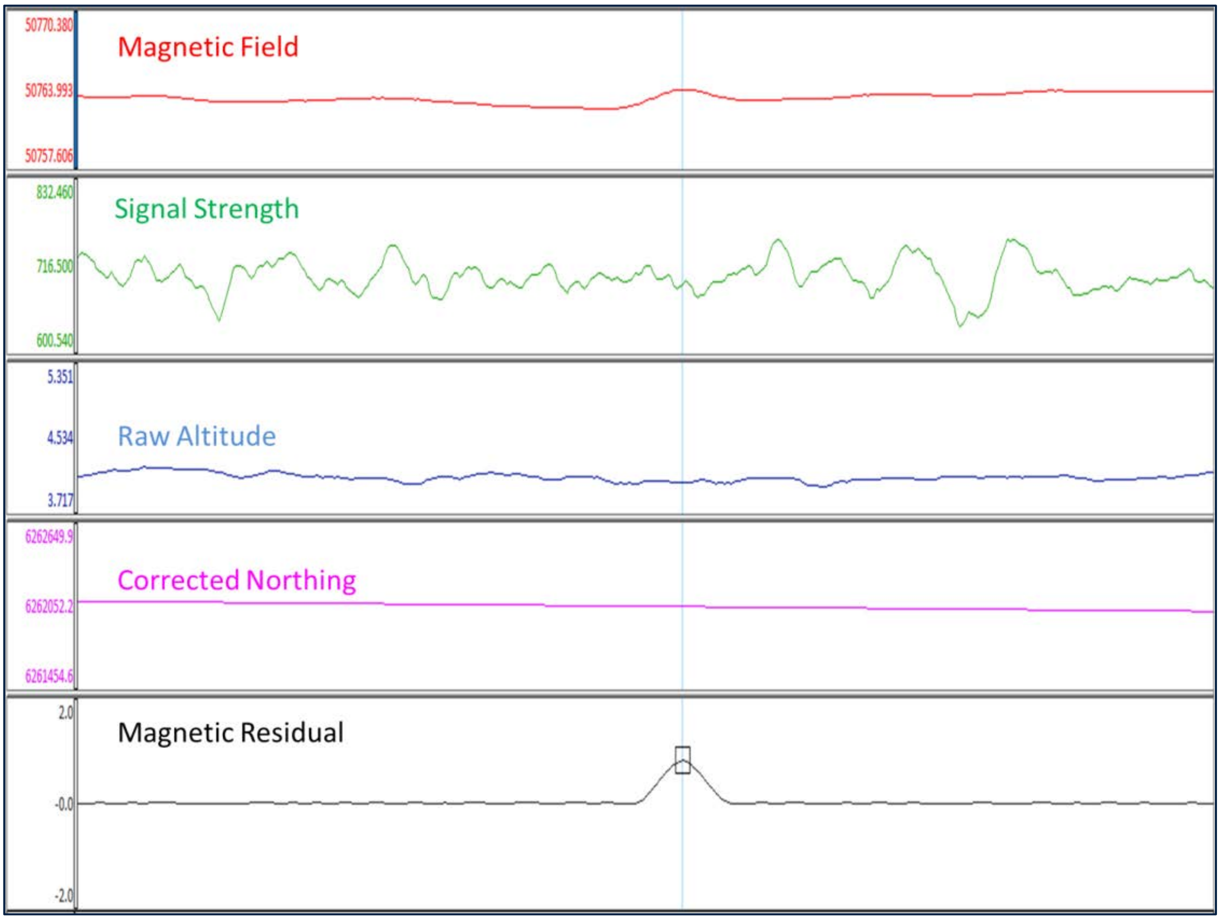


Figure 8.7: Magnetic field data profiles, line EAR9010, with observed anomaly over the buried cable

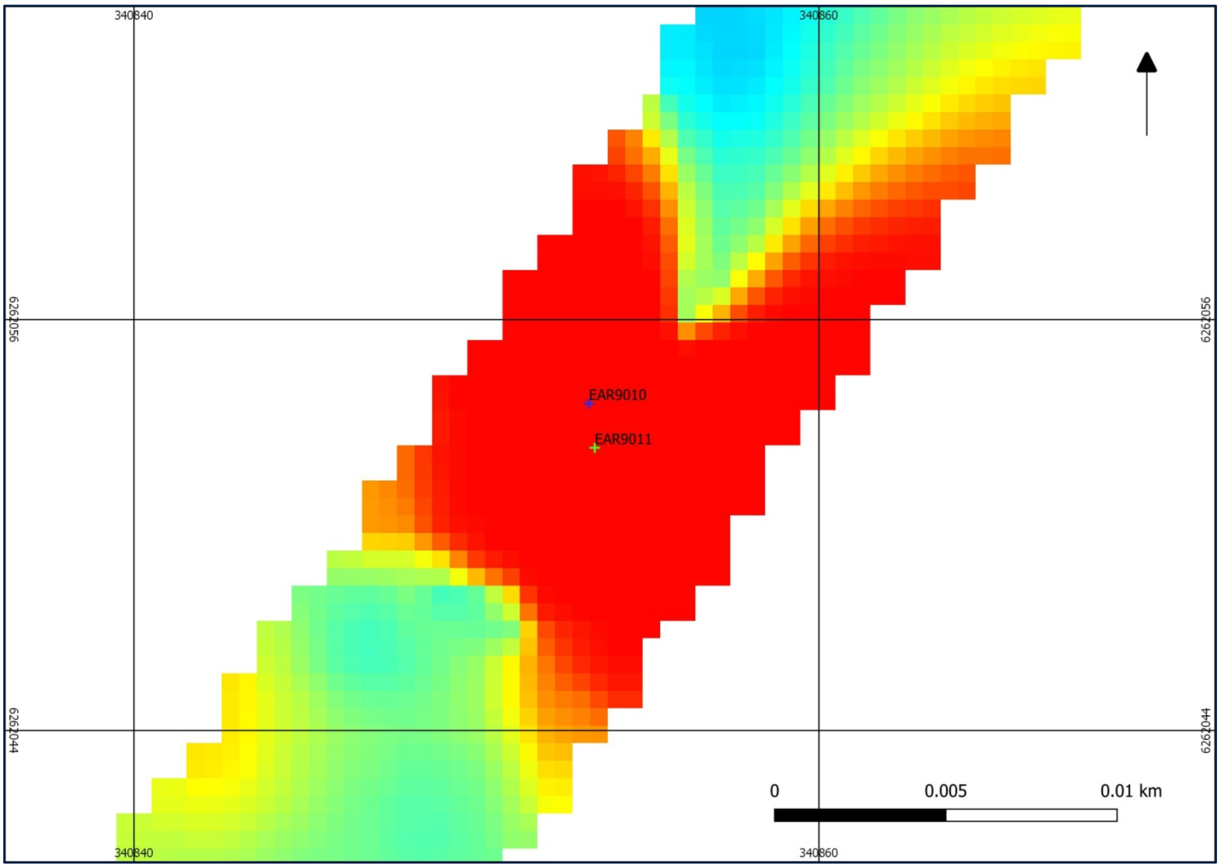


Figure 8.8: Magnetic TF Grid showing targets picked on lines EAR9010 and EAR9011

9. Sub-Bottom Profiler

An Innomar SES-2000 Medium Parametric sub-bottom profiler (SBP) is permanently mobilised on the moon pool cart on the Fugro Pioneer. The SBP transducer was installed in the moonpool cart with the EM2040 multibeam echosounder (MBES) and the iXblue Octans 3000 motion sensor.

9.1 Wet Test

The Innomar sub-bottom profiler was tested prior to the sensor verification operation to demonstrate that SBP data, heave and navigation were received and logged to each record online. The vessel was alongside in Ijmuiden during the test. All the incoming data was monitored online, and it was confirmed that all the required information (navigation, motion sensor data) is received, and logging as required.

9.2 Field Verification Test

To verify the positional accuracy of the SBP system, positioning verifications were conducted on 28 May 2021. Positioning verification was achieved by running 2 reciprocal lines in over the charted wreck, ‘Fallwind’. All lines used in the verification were sailed at approximately the same speed of 4 knots. Average water depth of the area was 44-45 m.

The identified target was located from reciprocal survey lines individually and was compared with the multi beam echosounder derived position of the same target.

Figure 9.1 and Figure 9.2 show the charted wreck from the individual Innomar survey lines, with MBES data overlaid. The SBP data is not tidally corrected. Figure 9.3 shows the ‘Fallwind’ in MBES data along with the survey line tracks.

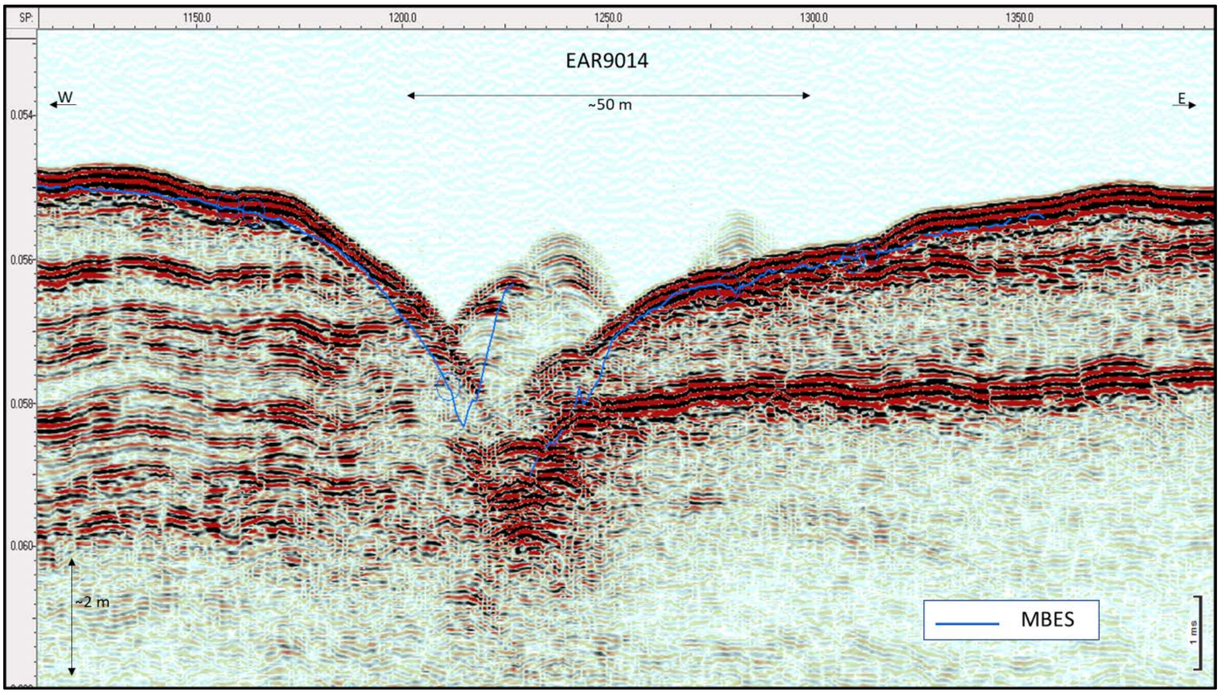


Figure 9.1: Innomar SES-2000 Medium Parametric data record, line EAR9014, over the charted wreck 'Fallwind'

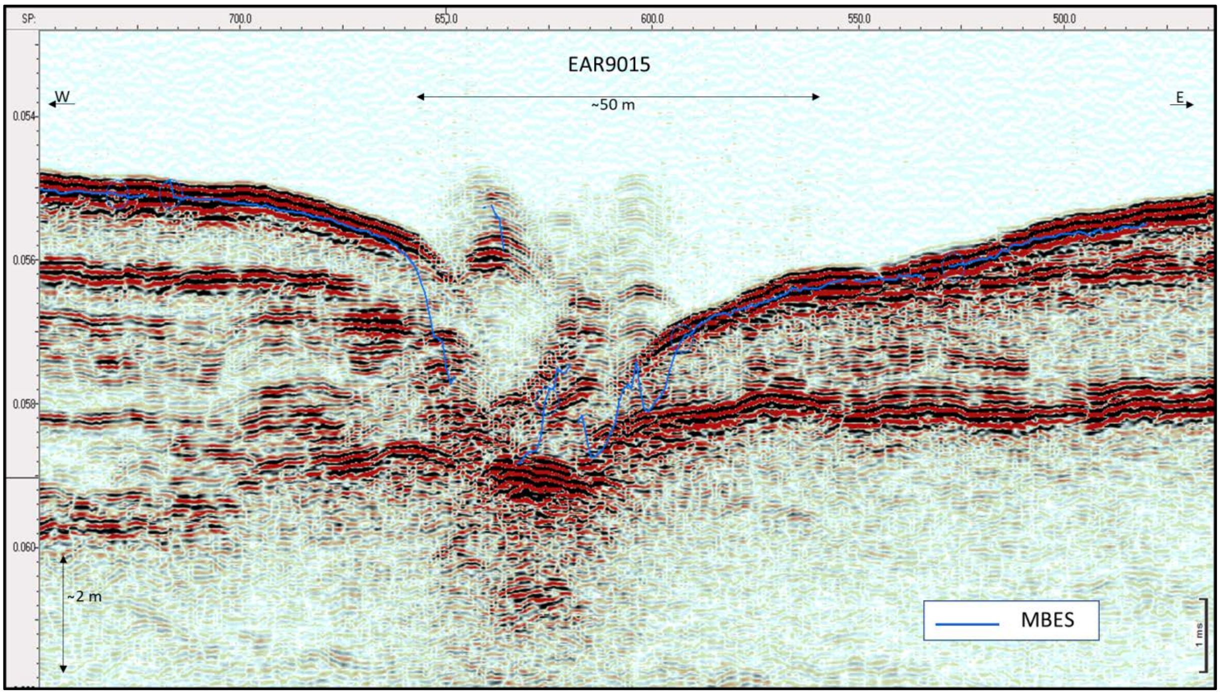


Figure 9.2 Innomar SES-2000 Medium Parametric data record, line EAR9015, over the charted wreck 'Fallwind'

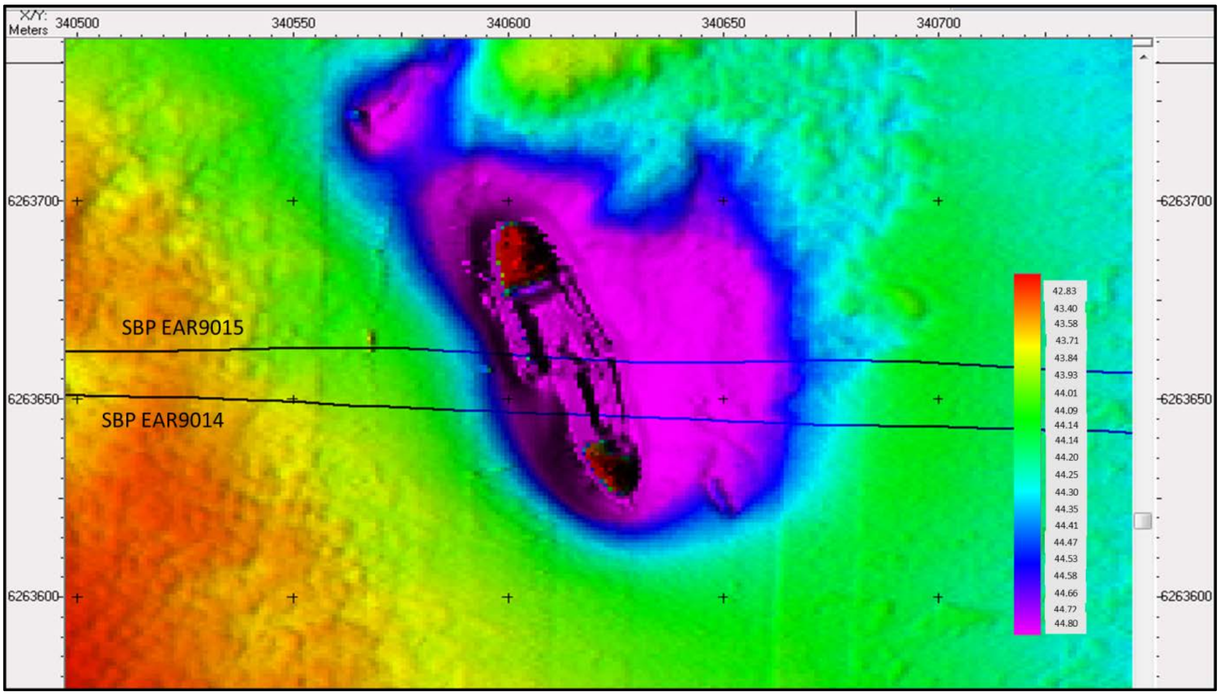


Figure 9.3: Image showing MBES data of the 'Fallwind' (highest point in red. Track plots of the SBP Verification lines are shown for reference.

As observed from the results from the field verification and positioning verification test, the Innomar Sub Bottom Profiler position was checked and found within the limits based on the project specification.

10. 2DUHR Seismic System

The 2D UHR system equipment was mobilized onboard on 15 May 2021 These include the Fugro Multi Level Stacked Sparker (MLSS), HV cable, a 96-channel 1m group interval streamer, sea ground cable, UHRS winch and receiver system with associated top sides, and RTK (Fugro Precise Buoy Positioning v1.0) pods. The MLSS is a 3 array multi-level Sparker with 360 tips on three levels, at depths of 0.77 m, 0.92 m and 1.12m. Three applied acoustics CSP-Nv power supply units provide the Sparker tips with the required energy. Positioning will be achieved by an RTK pod mounted on the frame of the Sparker, head buoy and tail buoy.

The receiver is a Geometrics Geo Eel solid streamer comprised of 96 channels at 1m intervals. Precise positioning will be obtained using two RTK pods placed on the Head buoy and Tail buoy of the streamer respectively. Calibration and verification of the 2D UHRS system included Streamer depth verification & balancing.

10.1 Tap test

A tap test was conducted whilst the vessel was alongside in Ijmuiden, NL on 18 May 2021. The figure below shows an example of the tap test response for one channel, however all the response from the individual channels was recorded. The onset of initial recorded tap energy can be seen on each channel.

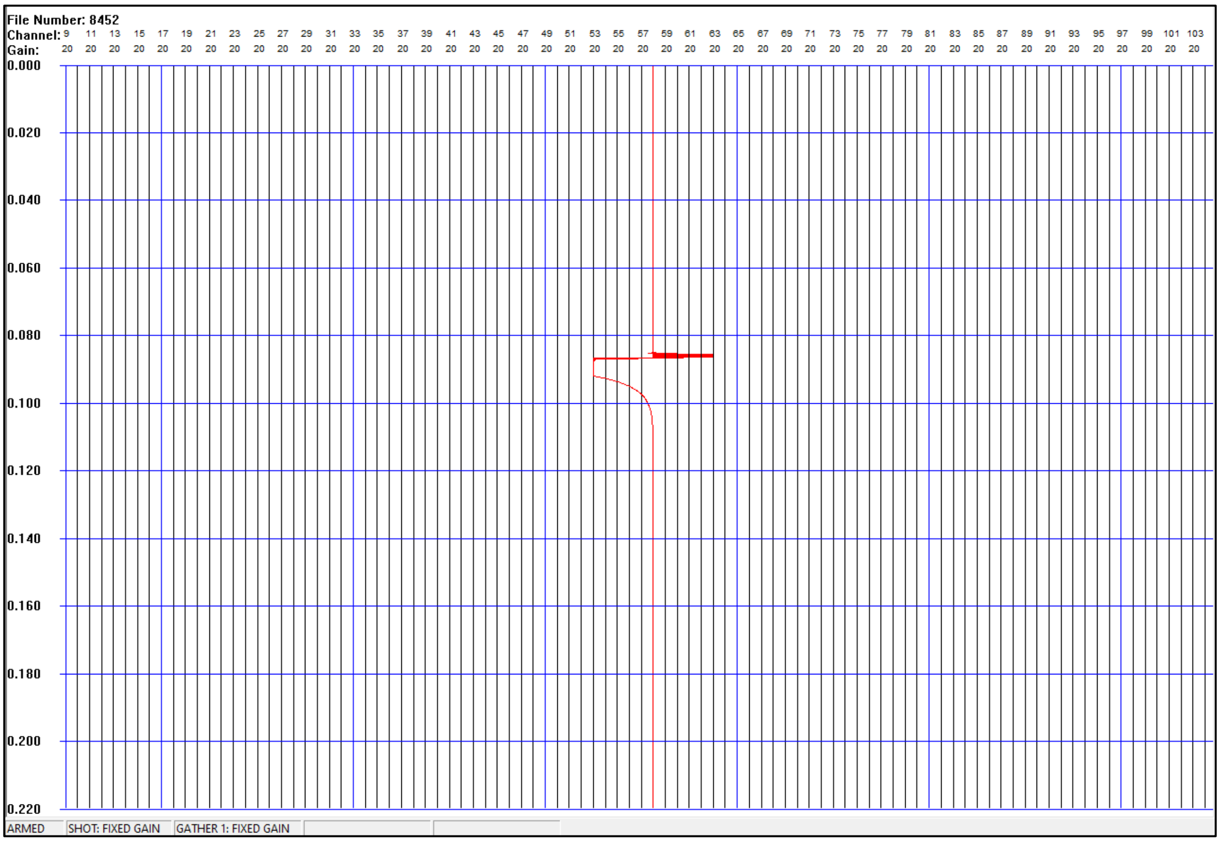


Figure 10.1: Trace display of tap test for channel 58.

10.2 White Noise Test

A set of SEGD files were recorded whilst the streamer was on deck, an amplitude spectrum was obtained from these noise records.

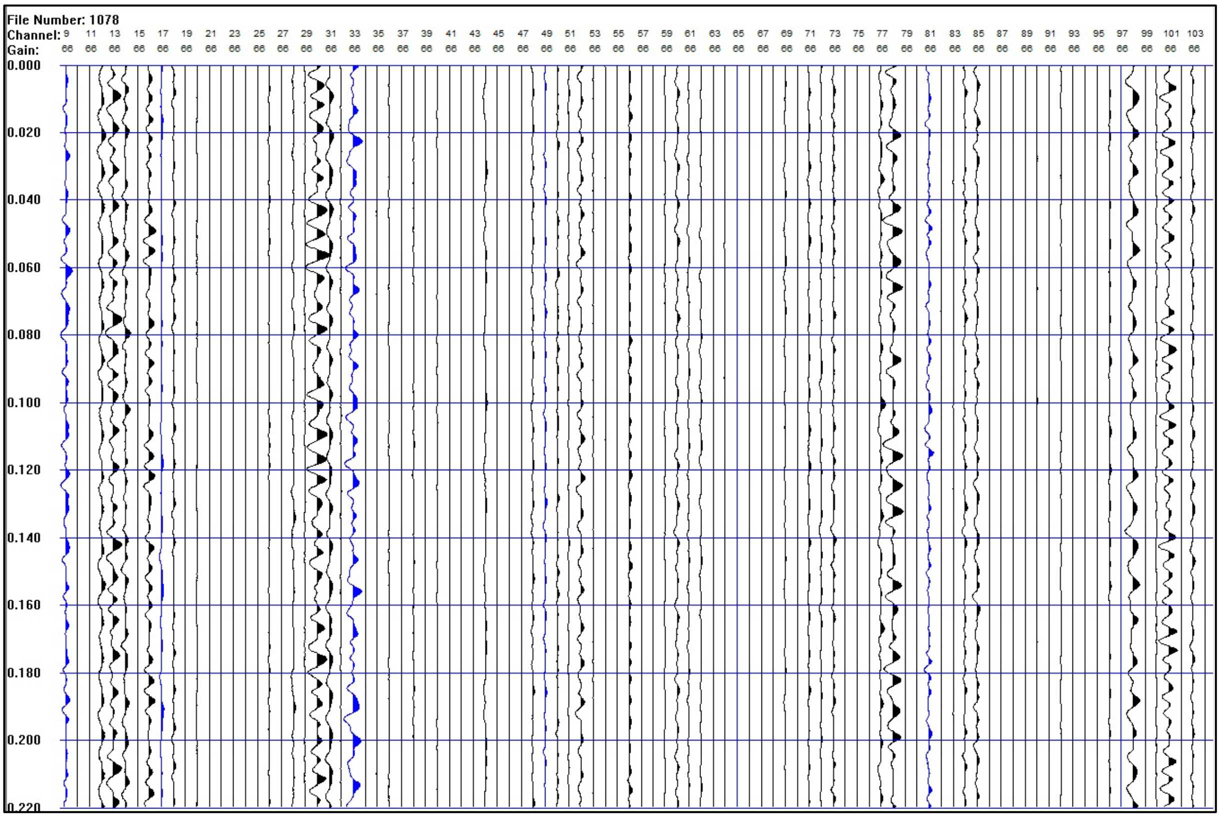


Figure 10.2: Trace display of noise record, for the streamer spooled out on deck.

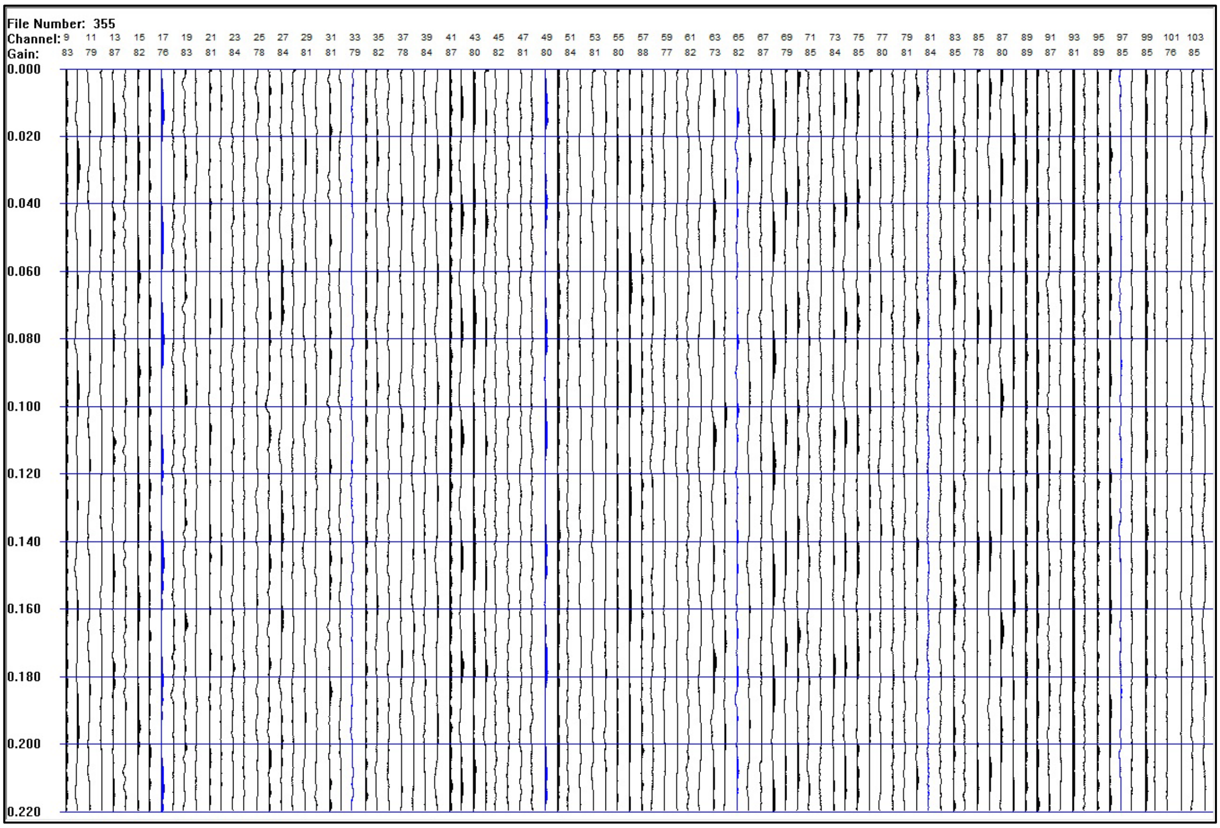


Figure 10.3: Trace display of noise record, for the streamer on the winch.

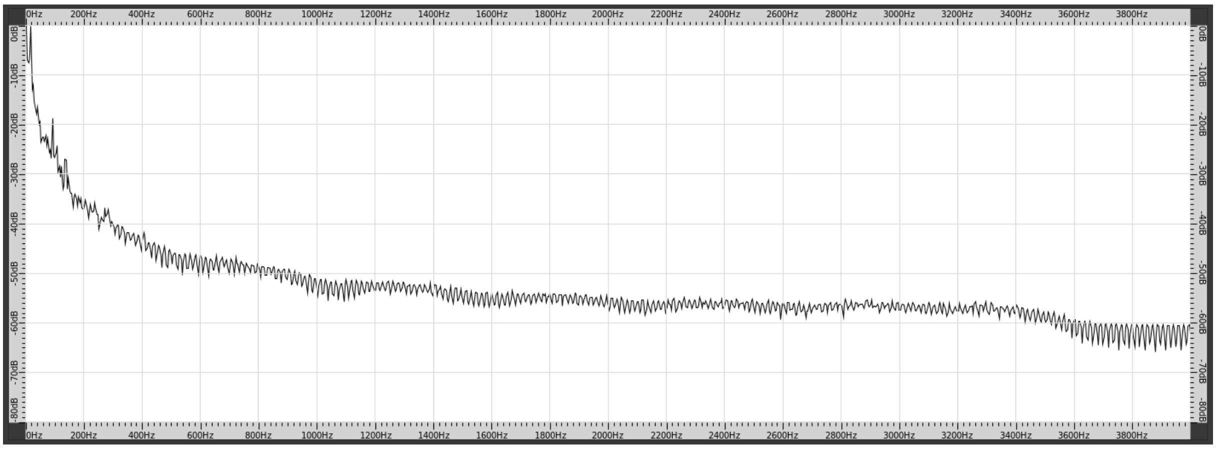


Figure 10.4: Amplitude Spectrum of noise record.

10.3 Streamer Depth Monitoring & Balancing

The 2D UHRS streamer depth and balance was monitored passively through notch frequency analysis and target depth obtained by the use of flotation along the streamer. The flotation was added to the data modules so as to avoid dampening of the hydrophones. Closed cell foam matting was used for buoyancy to achieve the target depth of 1.4 m (±0.2 m). To verify that the streamer depth was within contractual specifications, streamer depth verification was carried out. This involved picking channel consistent ghost notch frequencies at set offset intervals along the streamer and converting them to an actual streamer depth. The spreadsheet used to calculate streamer depth from a given notch frequency considered the offset from the source to the channel being analysed for notch frequency, the water depth of the line acquired for streamer balancing and the average near surface water velocity.

Figure 10.5 shows the analysis location on the constant channel display where the receiver ghost notch is picked. Figure 10.6 below shows graphically the streamer depth profile obtained from the receiver ghost notch analysis.

The notch frequencies for the channels analysed can be seen in Figure 10.7.

Full details of streamer depth and balancing verifications can be found in Appendix I.

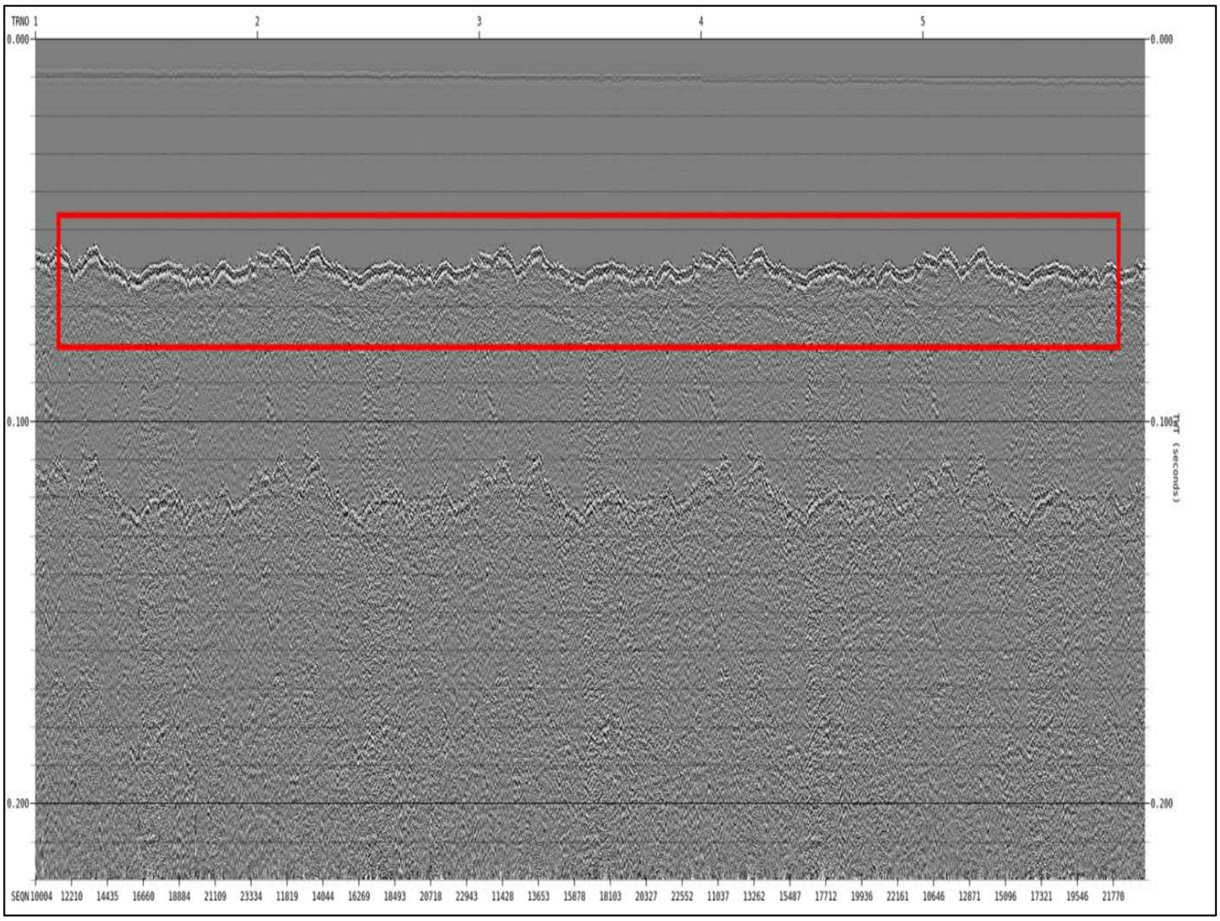


Figure 10.5 Analysis window for receiver ghost notch

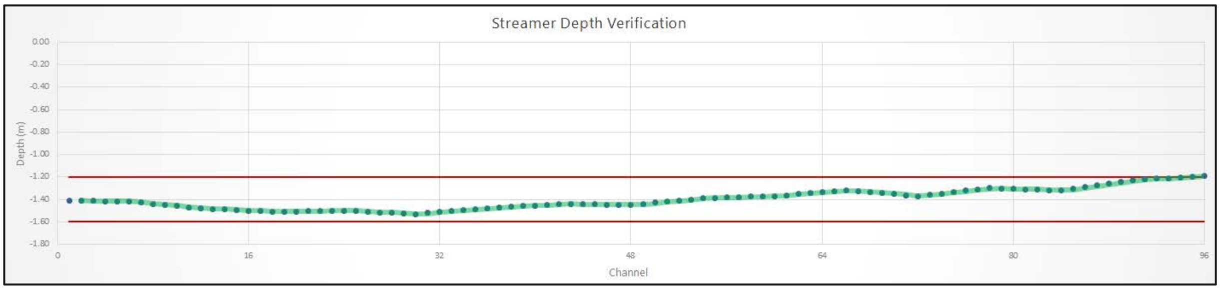


Figure 10.6 Calculated streamer depths

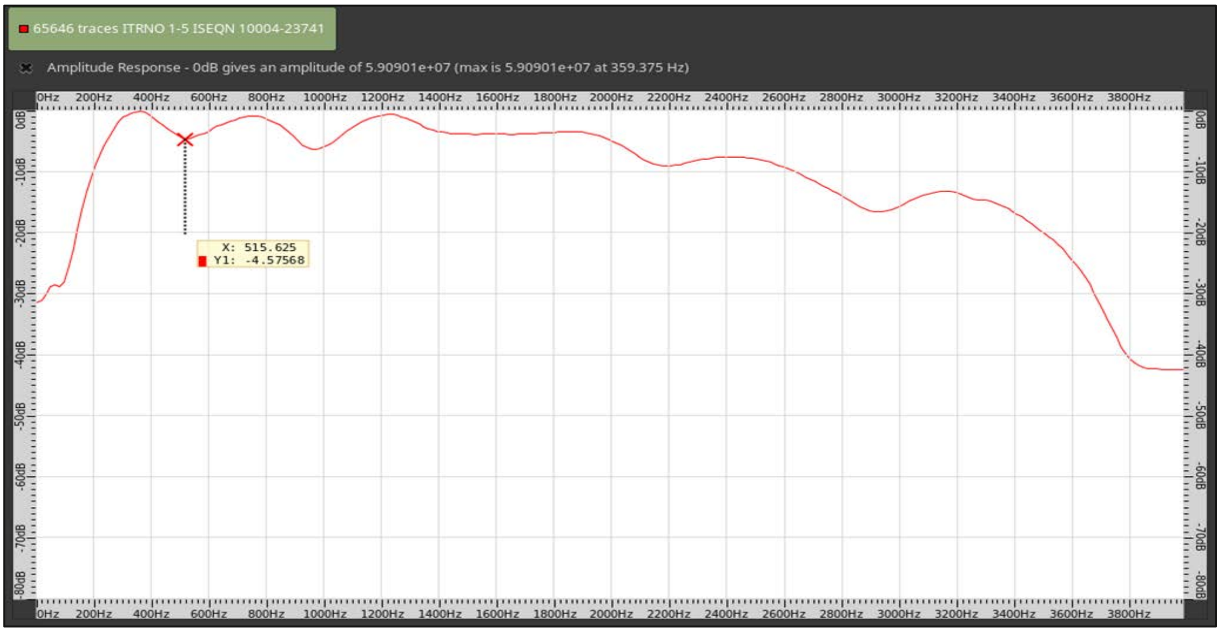


Figure 10.7 The combined notch frequencies of the channels analysed

10.4 Sparker Power Settings and Pulse Test

The Fugro Pioneer has recently undertaken power setting trials at 700 J, 900 J and 1100J at a variety of tip depths. It was found with a power of 900 J and tip depths of 0.77m, 0.92m and 1.12m, an optimum sweet spot was proved, that garnered good results in both penetration and resolution. Since the Fugro Pioneer acquired the pulse test data during pulse test trials earlier in the year, (March 2021), it was decided that legacy pulse tests will be used, without the requirement for further pulse test verifications. If there is a noticed degradation of the pulse during operations, there is a spare sparker and parts mobilised to switch out.

See Pulse Test results of the MLSS system in Appendix H.

10.5 Offshore QC

The acquired 2DUHR data will be QC'd onboard on a line by line basis. Observer and Navigation logs will be checked after each acquisition line and any problems noted and/or rectified. Shot record displays are used to check offsets, analyse noise levels and identify bad shotpoints and channels, (dead, reversed or low amplitude), with any examples failing the specification criteria being flagged or removed. Ambient noise levels are assessed. Near trace plots are used to identify sparker, offset or recording system problems. Brute stack displays are analysed to observe overall data quality and to assess noise characteristics in the data. Navigation data files are QC'd and checks made between the observed data and the calculated navigation positioning to ensure offset stability. The navigation is applied and the brute stack and raw shots with navigation SEGDs will be output as deliverables. An End of Line QC pdf is produced for each line. The brute stack SEGDs and end of line QC PDF's will be forwarded to the Offshore Client Representative (OCR). An example of the EOL QC pdf output is presented in Appendix G.

10.6 Position Verification

To verify the positional accuracy of the 2D UHR seismic system, a positioning verification was conducted on 28 May 2021. The positioning verification was conducted by running 2 lines in opposite directions over a section of a known wreck, the ‘Fallwind’. All lines used in the verification were sailed at approximately the same speed of 4 knots. Approximately water depth of the area was 44-45 m.

The identified wreck was located from the reciprocal survey lines individually and was compared with the multi beam echosounder derived position.

Figure 10.9 and Figure 10.10 are the 2D UHR seismic profiles showing the identified object from the individual survey lines. Figure 10.8 shows the identified target item in MBES data along with the survey line tracks and 2D UHR seismic derived target positions.

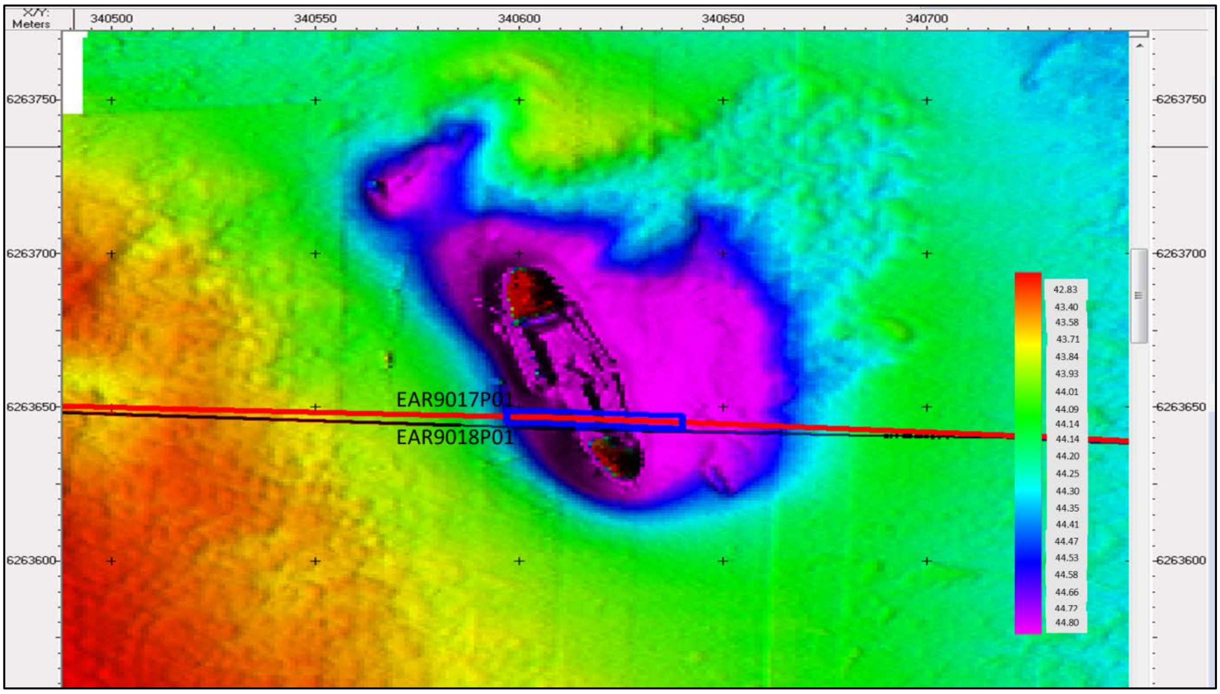


Figure 10.8 2D UHR position verification. ‘Fallwind’ location 2DUHR vs MBES

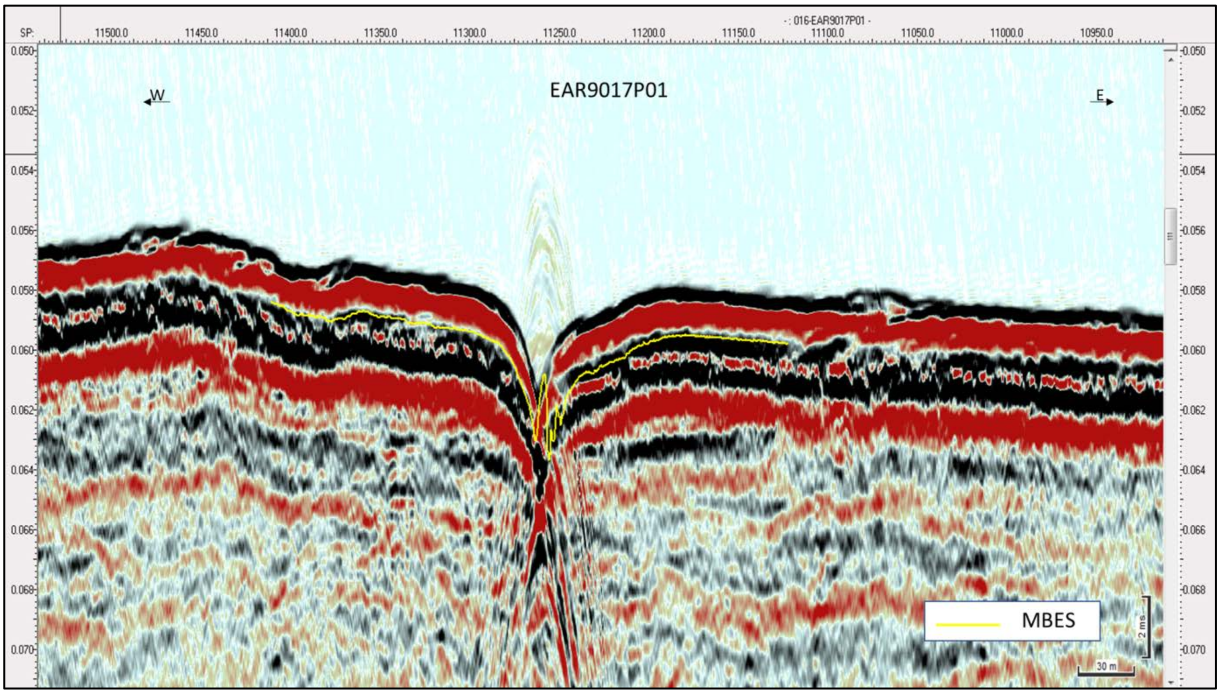


Figure 10.9 2D UHR position of the 'Fallwind' from line EAR9017P01

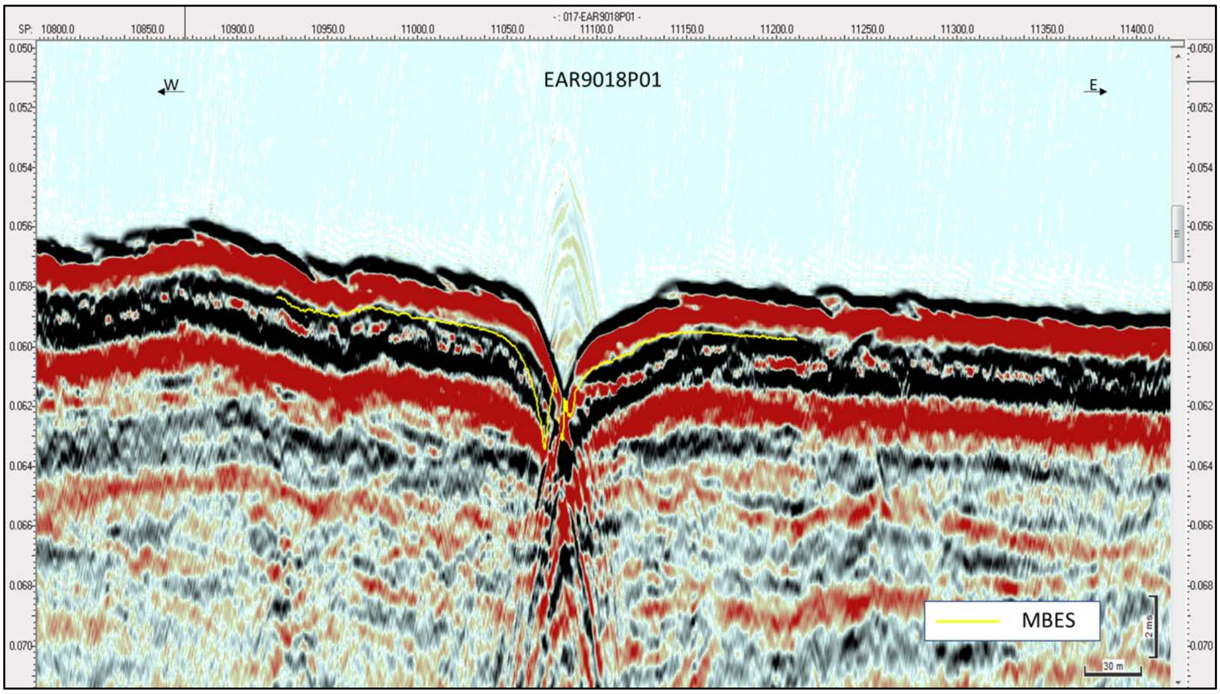


Figure 10.10 2D UHR position of the 'Fallwind' from line EAR9018P01

11. Data Management

Data acquired on-board is stored in a server located in the offline room in the server. A backup of the data completes every 30 minutes to a second server in a separate location.

Appendices

Appendix A	Guidelines on Use of Report
Appendix B	Dimensional Control Report
Appendix C	Positioning and Heading Verification
Appendix D	MBES Calibration Report
Appendix E	USBL Calibration Report
Appendix F	SVP Calibration Certificates
Appendix G	EOL QC Report
Appendix H	MLSS Pulse Test
Appendix I	Streamer Depth and Balancing Verification
Appendix J	SSS verification
Appendix K	Mobilisation Completion Certificate

Appendix A

Guidelines on Use of Report

This report (the "Report") was prepared as part of the services (the "Services") provided by Fugro for its client (the "Client") and in accordance with the terms of the relevant contract between the two parties (the Contract") and to the extent to which Fugro relied on Client or third party information as was set out in the Contract.

Fugro's obligations and liabilities to the Client or any other party in respect of this Report are limited to the extent and for the time period set out in the Contract (or in the absence of any express provision in the Contract as implied by the law of the Contract) and Fugro provides no other representation or warranty whether express or implied, in relation to the use of this Report, for any purpose. Furthermore, Fugro has no obligation to update or revise this Report based on any future changes in conditions or information which emerge following issue of this Report unless expressly required by the provisions of the Contract.

This Report was formed and released by Fugro exclusively for the Client and any other party expressly identified in the Contract, and any use and/or reliance on the Report or the Services for purposes not expressly stated in the Contract, will be at the Client's sole risk. Any other party seeking to rely on this Report does so wholly at its own and sole risk and Fugro accepts no liability whatsoever for any such use and/or reliance."

Appendix B

Dimensional Control Report

Field Report

Subject	The verification of heading, pitch, roll and GNSS antenna offsets onboard Fugro Pioneer		
Date	7 - 8 March 2019	**Page**	1 of 2
To	R. Williams	**File**	Offsets verification survey - Fugro Pioneer - March 2019
From	K. Bos	**E-mail Address**	k.bos@fugro.com

1. INTRODUCTION

The purpose of the survey was to verify the correctness of the calibrated primary motion reference unit and selected offsets location. The original survey sensors alignment with vessel frame was performed onboard Fugro Pioneer on 19 October 2014 in Scheveningen, The Netherlands.

2. SCOPE OF WORK

Fugro performed the verification task of the navigation equipment:

- Heading system: Hydrins,
- Pitch and roll system: Hydrins,
- Positioning systems' offsets: DGPS3, DGPS4, DGPS_Tide.

The survey has been executed on 7 and 8 March 2019, whilst vessel was stationary at the dry-dock, in Harlingen, The Netherlands.

3. OPERATIONS

Dual GNSS cards Starpack receiver (with bow and stern antenna) was used to validate the Hydrins orientation.

Total station was operated to verify the pitch, roll and navigational GNSS antenna offsets' positions.

The previously calibrated Hydrins was logging data in the vessel coordinate system during the check. All required observed data were then processed and compared with newly obtained calculated results.

The entire survey and data collection was executed by onboard surveyors.

4. RESULTS

The results of the heading, pitch and roll verification are presented below.

Statistics	Hydrins Verification		
	Δ Heading (deg)	Δ Pitch (deg)	Δ Roll (deg)
Mean	**-0.05**	**-0.01**	**0.01**
SD	0.01	0.01	0.02

The results of the GNSS antenna offset check are enclosed in beneath tables.

Old Observed	**Offset name**	X (m)	Y (m)	Z (m)
	DGPS3_1	-0.754	3.995	12.134
	DGPS3_2	-3.166	4.260	12.130
	DGPS4	-3.161	5.088	12.130
	DGPS_Tide	-5.825	-7.306	7.923

New Calculated	**Offset name**	X (m)	Y (m)	Z (m)
	DGPS3_1	-0.744	3.992	12.127
	DGPS3_2	-3.152	4.251	12.125
	DGPS4	-3.147	5.079	12.124
	DGPS_Tide	-5.813	-7.306	7.894

Deltas C - O	**Offset name**	ΔX (m)	ΔY (m)	ΔZ (m)
	DGPS3_1	**0.010**	**-0.003**	**-0.007**
	DGPS3_2	**0.014**	**-0.009**	**-0.005**
	DGPS4	**0.014**	**-0.009**	**-0.006**
	DGPS_Tide	**0.012**	**0.000**	**-0.029**

5. CONCLUSIONS

The verification proved, that Hydrins - primary heading and motion reference unit - is correctly calibrated and navigational installation parameters are properly applied in the survey system. The antennas' offset check shows high-quality correlation between old and new offsets (≤0.014m). Recommendation is made to revise the height coordinate for DGPS_Tide antenna by -0.029 m.

6. HSE

No safety or HSE incidents were reported.

Appendix C

Positioning and Heading Verification

Project Details

Project Number	F176286_Energinet E Islands_LOT2
Client	Energinet
Vessel	Fugro Pioneer

Report Details

Total Station Name (Serial no)	Trimble (0)
Device	Fugro Pioneer / DGPS3 / Starfix.G4 Plus-38603
Start Time	16 May 2021, 04:14:07Z (Local)
End Time	16 May 2021, 04:22:25Z (Local)
Total Station Location	IJ48 (200,129.791m E, 5,821,466.576m N)
Reference Object Location	IJ47 (200,204.060m E, 5,821,412.030m N)
Reference Object Backsight Angle	47.90°
Datum/Projection	ETRS89 / UTM zone 32N [ETRF2000-ITRF2014],DTU13 MSS height [DTU13]

Results using 27 of 27 observations

Mean of Calculated Position	200,147.941m E, 5,821,484.391m N
Mean of Observed Position	200,147.912m E, 5,821,484.406m N
Calculated - Observed (C-O)	0.04m(Range) & 117.0° N(Azimuth)
Std Deviation	±0.01m(Range) & ±30.07°(Azimuth)

Observations

Observation		Antenna Observations			Calculated Position		Observed Position		Results (C-O)			
Time (Local)	Used	Horizontal Angle	Vertical Angle	Slant Range	Easting	Northing	Easting	Northing	dE	dN	Range	Azimuth
04:14:07	Yes	327°09'49"	068°39'34"	27.30m	200,147.959m E	5,821,484.393m N	200,147.929m E	5,821,484.375m N	0.03m	0.02m	0.04m	59.32°
04:14:26	Yes	327°08'24"	068°39'32"	27.31m	200,147.955m E	5,821,484.404m N	200,147.922m E	5,821,484.416m N	0.03m	-0.01m	0.04m	110.54°
04:14:48	Yes	327°08'17"	068°40'23"	27.29m	200,147.946m E	5,821,484.396m N	200,147.903m E	5,821,484.410m N	0.04m	-0.01m	0.04m	108.62°
04:15:23	Yes	327°07'32"	068°40'11"	27.28m	200,147.935m E	5,821,484.393m N	200,147.935m E	5,821,484.412m N	0.00m	-0.02m	0.02m	181.93°
04:15:44	Yes	327°07'51"	068°39'41"	27.29m	200,147.941m E	5,821,484.396m N	200,147.924m E	5,821,484.418m N	0.02m	-0.02m	0.03m	144.35°
04:15:44	Yes	327°08'44"	068°40'28"	27.29m	200,147.948m E	5,821,484.393m N	200,147.924m E	5,821,484.418m N	0.02m	-0.03m	0.03m	137.35°
04:16:00	Yes	327°08'58"	068°38'31"	27.29m	200,147.943m E	5,821,484.386m N	200,147.915m E	5,821,484.426m N	0.03m	-0.04m	0.05m	145.15°
04:16:29	Yes	327°08'48"	068°39'11"	27.29m	200,147.948m E	5,821,484.393m N	200,147.922m E	5,821,484.420m N	0.03m	-0.03m	0.04m	136.94°

Observations

Observation		Antenna Observations			Calculated Position		Observed Position		Results (C-O)			
Time (Local)	Used	Horizontal Angle	Vertical Angle	Slant Range	Easting	Northing	Easting	Northing	dE	dN	Range	Azimuth
04:16:45	Yes	327°07’48”	068°39’11”	27.29m	200,147.943m E	5,821,484.398m N	200,147.913m E	5,821,484.417m N	0.03m	-0.02m	0.04m	122.59°
04:17:06	Yes	327°08’16”	068°39’25”	27.29m	200,147.942m E	5,821,484.392m N	200,147.919m E	5,821,484.419m N	0.02m	-0.03m	0.03m	139.12°
04:17:20	Yes	327°08’45”	068°37’24”	27.30m	200,147.950m E	5,821,484.395m N	200,147.919m E	5,821,484.398m N	0.03m	0.00m	0.03m	95.15°
04:17:37	Yes	327°08’17”	068°37’51”	27.30m	200,147.950m E	5,821,484.400m N	200,147.918m E	5,821,484.426m N	0.03m	-0.03m	0.04m	129.42°
04:17:55	Yes	327°08’32”	068°37’57”	27.29m	200,147.943m E	5,821,484.391m N	200,147.908m E	5,821,484.415m N	0.03m	-0.02m	0.04m	124.97°
04:18:28	Yes	327°09’28”	068°36’59”	27.29m	200,147.942m E	5,821,484.380m N	200,147.905m E	5,821,484.382m N	0.04m	0.00m	0.04m	93.07°
04:18:54	Yes	327°07’20”	068°38’24”	27.27m	200,147.923m E	5,821,484.383m N	200,147.917m E	5,821,484.406m N	0.01m	-0.02m	0.02m	165.27°
04:19:14	Yes	327°08’34”	068°37’43”	27.28m	200,147.936m E	5,821,484.384m N	200,147.901m E	5,821,484.399m N	0.04m	-0.02m	0.04m	113.24°
04:19:35	Yes	327°09’01”	068°36’49”	27.28m	200,147.937m E	5,821,484.380m N	200,147.893m E	5,821,484.415m N	0.04m	-0.03m	0.06m	128.86°
04:20:04	Yes	327°08’35”	068°36’00”	27.29m	200,147.940m E	5,821,484.387m N	200,147.916m E	5,821,484.430m N	0.02m	-0.04m	0.05m	150.34°
04:20:22	Yes	327°07’09”	068°35’09”	27.30m	200,147.934m E	5,821,484.397m N	200,147.914m E	5,821,484.417m N	0.02m	-0.02m	0.03m	135.29°
04:20:37	Yes	327°08’46”	068°34’31”	27.30m	200,147.943m E	5,821,484.389m N	200,147.901m E	5,821,484.395m N	0.04m	-0.01m	0.04m	99.14°
04:20:51	Yes	327°08’16”	068°35’26”	27.30m	200,147.941m E	5,821,484.392m N	200,147.900m E	5,821,484.407m N	0.04m	-0.01m	0.04m	109.63°
04:21:04	Yes	327°08’28”	068°35’36”	27.30m	200,147.940m E	5,821,484.389m N	200,147.909m E	5,821,484.410m N	0.03m	-0.02m	0.04m	124.51°
04:21:20	Yes	327°08’38”	068°35’15”	27.30m	200,147.941m E	5,821,484.388m N	200,147.912m E	5,821,484.399m N	0.03m	-0.01m	0.03m	110.57°
04:21:32	Yes	327°08’28”	068°36’04”	27.29m	200,147.938m E	5,821,484.387m N	200,147.905m E	5,821,484.384m N	0.03m	0.00m	0.03m	85.09°
04:21:49	Yes	327°07’21”	068°35’41”	27.29m	200,147.931m E	5,821,484.391m N	200,147.905m E	5,821,484.380m N	0.03m	0.01m	0.03m	67.12°
04:22:02	Yes	327°08’10”	068°35’19”	27.29m	200,147.936m E	5,821,484.388m N	200,147.893m E	5,821,484.383m N	0.04m	0.00m	0.04m	83.86°
04:22:25	Yes	327°07’38”	068°35’32”	27.29m	200,147.934m E	5,821,484.392m N	200,147.906m E	5,821,484.373m N	0.03m	0.02m	0.03m	56.86°

Paul Miller
Party Chief
FSBV (Fugro Survey B.V.)

Morgan Hannah
Client Representative
Energinet

Terry Wiseman
Client Representative
Energinet

Project Details

Project Number	F176286_Energinet E Islands_LOT2
Client	Energinet
Vessel	Fugro Pioneer
Calibration Location	Ijmuiden
Details	Alongside 06/05/2021
Remarks	Operators VC-JE
Data Acquisition Date	Sunday, 16 May 2021

Report Details

Total Station Name (Serial no)	Trimble (000)
Device	Fugro Pioneer / Hydrins
Start Time	16 May 2021, 03:44:10Z
End Time	16 May 2021, 04:02:08Z
Total Station Location	S1 (200,142.617m E, 5,821,461.208m N, 0.232m)
Reference Object Location	IJ47 (200,204.060m E, 5,821,412.030m N, 0.251m)
Reference Object Backsight Angle	80.15°
Datum/Projection	ETRS89 / UTM zone 32N [ETRF2000-ITRF2014],DTU13 MSS height [DTU13]

Results using 23 of 23 observations

Post Calibrated(C-O)	0.02°
Std Deviation	±0.01°

Observations

Observation		Bow Observations		Stern Observations		Azimuth		Result
Time(Local)	Used	Angle	Distance	Angle	Distance	Calculated	Observed	(C-O)
03:44:10	Yes	028°18'23.000"	29.15m	290°15'11.000"	40.35m	122.3° T	122.3° T	0.02°
03:45:19	Yes	028°21'10.000"	29.13m	290°15'24.000"	40.35m	122.3° T	122.3° T	0.03°
03:46:13	Yes	028°20'59.000"	29.13m	290°14'58.000"	40.35m	122.3° T	122.3° T	0.03°
03:46:58	Yes	028°19'51.000"	29.13m	290°16'50.000"	40.36m	122.3° T	122.3° T	0.04°
03:47:40	Yes	028°21'14.000"	29.13m	290°14'42.000"	40.36m	122.3° T	122.3° T	0.02°
03:48:22	Yes	028°20'54.000"	29.12m	290°14'58.000"	40.36m	122.3° T	122.3° T	0.03°
03:49:05	Yes	028°21'30.000"	29.12m	290°14'25.000"	40.36m	122.3° T	122.3° T	0.02°
03:50:24	Yes	028°21'22.000"	29.12m	290°15'30.000"	40.36m	122.3° T	122.3° T	0.03°
03:51:17	Yes	028°22'21.000"	29.13m	290°14'46.000"	40.35m	122.3° T	122.3° T	0.02°
03:52:03	Yes	028°23'02.000"	29.12m	290°15'12.000"	40.37m	122.3° T	122.3° T	0.03°
03:52:46	Yes	028°28'09.000"	29.12m	290°15'49.000"	40.37m	122.4° T	122.3° T	0.04°
03:53:27	Yes	028°23'31.000"	29.12m	290°15'10.000"	40.36m	122.3° T	122.3° T	0.02°
03:54:11	Yes	028°23'03.000"	29.11m	290°15'48.000"	40.36m	122.3° T	122.3° T	0.01°
03:54:50	Yes	028°22'55.000"	29.11m	290°15'20.000"	40.36m	122.3° T	122.3° T	0.02°
03:55:30	Yes	028°28'30.000"	29.11m	290°14'49.000"	40.36m	122.4° T	122.3° T	0.03°
03:56:13	Yes	028°27'31.000"	29.10m	290°15'03.000"	40.36m	122.4° T	122.4° T	0.01°
03:56:49	Yes	028°24'20.000"	29.09m	290°14'37.000"	40.36m	122.4° T	122.3° T	0.02°
03:57:34	Yes	028°24'56.000"	29.10m	290°14'52.000"	40.36m	122.4° T	122.3° T	0.03°
03:58:17	Yes	028°24'18.000"	29.09m	290°15'42.000"	40.37m	122.4° T	122.3° T	0.02°
04:00:16	Yes	028°26'24.000"	29.09m	290°16'09.000"	40.38m	122.4° T	122.4° T	0.02°
04:00:54	Yes	028°28'11.000"	29.09m	290°14'27.000"	40.36m	122.4° T	122.3° T	0.02°
04:01:28	Yes	028°28'26.000"	29.09m	290°15'03.000"	40.37m	122.4° T	122.4° T	0.03°
04:02:08	Yes	028°28'30.000"	29.08m	290°15'22.000"	40.38m	122.4° T	122.4° T	0.03°

Paul Miller	Morgan Hannah	Terry Wiseman
Party Chief	Client Representative	Client Representative
FSBV (Fugro Survey B.V.)	Energinet	Energinet

Project Details

Project Number	F176286_Energinet E Islands_LOT2
Client	Energinet
Vessel	Fugro Pioneer
Calibration Location	Ijmuiden
Details	Alongside 06/05/2021
Remarks	Operators VC-JE
Data Acquisition Date	Sunday, 16 May 2021

Report Details

Total Station Name (Serial no)	Trimble (000)
Device	Fugro Pioneer / Octans
Start Time	16 May 2021, 03:44:10Z
End Time	16 May 2021, 04:02:08Z
Total Station Location	S1 (200,142.617m E, 5,821,461.208m N, 0.232m)
Reference Object Location	IJ47 (200,204.060m E, 5,821,412.030m N, 0.251m)
Reference Object Backsight Angle	80.15°
Datum/Projection	ETRS89 / UTM zone 32N [ETRF2000-ITRF2014],DTU13 MSS height [DTU13]

Results using 23 of 23 observations

Post Calibrated(C-O)	0.01°
Std Deviation	±0.01°

Observations

Observation		Bow Observations		Stern Observations		Azimuth		Result
Time(Local)	Used	Angle	Distance	Angle	Distance	Calculated	Observed	(C-O)
03:44:10	Yes	028°18'23.000"	29.15m	290°15'11.000"	40.35m	122.3° T	122.3° T	0.01°
03:45:19	Yes	028°21'10.000"	29.13m	290°15'24.000"	40.35m	122.3° T	122.3° T	0.02°
03:46:13	Yes	028°20'59.000"	29.13m	290°14'58.000"	40.35m	122.3° T	122.3° T	0.02°
03:46:58	Yes	028°19'51.000"	29.13m	290°16'50.000"	40.36m	122.3° T	122.3° T	0.03°
03:47:40	Yes	028°21'14.000"	29.13m	290°14'42.000"	40.36m	122.3° T	122.3° T	0.01°
03:48:22	Yes	028°20'54.000"	29.12m	290°14'58.000"	40.36m	122.3° T	122.3° T	0.02°
03:49:05	Yes	028°21'30.000"	29.12m	290°14'25.000"	40.36m	122.3° T	122.3° T	0.01°
03:50:24	Yes	028°21'22.000"	29.12m	290°15'30.000"	40.36m	122.3° T	122.3° T	0.02°
03:51:17	Yes	028°22'21.000"	29.13m	290°14'46.000"	40.35m	122.3° T	122.3° T	0.01°
03:52:03	Yes	028°23'02.000"	29.12m	290°15'12.000"	40.37m	122.3° T	122.3° T	0.02°
03:52:46	Yes	028°28'09.000"	29.12m	290°15'49.000"	40.37m	122.4° T	122.3° T	0.03°
03:53:27	Yes	028°23'31.000"	29.12m	290°15'10.000"	40.36m	122.3° T	122.3° T	0.01°
03:54:11	Yes	028°23'03.000"	29.11m	290°15'48.000"	40.36m	122.3° T	122.3° T	0.00°
03:54:50	Yes	028°22'55.000"	29.11m	290°15'20.000"	40.36m	122.3° T	122.3° T	0.01°
03:55:30	Yes	028°28'30.000"	29.11m	290°14'49.000"	40.36m	122.4° T	122.4° T	0.01°
03:56:13	Yes	028°27'31.000"	29.10m	290°15'03.000"	40.36m	122.4° T	122.4° T	0.00°
03:56:49	Yes	028°24'20.000"	29.09m	290°14'37.000"	40.36m	122.4° T	122.3° T	0.01°
03:57:34	Yes	028°24'56.000"	29.10m	290°14'52.000"	40.36m	122.4° T	122.3° T	0.02°
03:58:17	Yes	028°24'18.000"	29.09m	290°15'42.000"	40.37m	122.4° T	122.4° T	0.00°
04:00:16	Yes	028°26'24.000"	29.09m	290°16'09.000"	40.38m	122.4° T	122.4° T	0.01°
04:00:54	Yes	028°28'11.000"	29.09m	290°14'27.000"	40.36m	122.4° T	122.4° T	0.01°
04:01:28	Yes	028°28'26.000"	29.09m	290°15'03.000"	40.37m	122.4° T	122.4° T	0.01°
04:02:08	Yes	028°28'30.000"	29.08m	290°15'22.000"	40.38m	122.4° T	122.4° T	0.01°

Paul Miller	Morgan Hannah	Terry Wiseman
Party Chief	Client Representative	Client Representative
FSBV (Fugro Survey B.V.)	Energinet	Energinet

Position comparison

Table 1: Project details

Project Name	F176286_Energinet_E_Islands_LOT2_A
Project Number	F176286_Energinet_E_Islands_LOT2_Copy
Client	Energinet
Project Type	Site Survey
Starfix Version	v2020.1124.9 (build 0)

Table 2: Session

Session name	20210527-154459-v3
Units and Format	WGS84 geographical (World Standard)
Start Time	27 May 2021, 15:47:08Z
End Time	27 May 2021, 16:47:07Z
Duration	59m 59s
Number of Observations	3599

Table 3: Positioning system CRS and offsets

	System	CRS	X [m]	Y [m]	Z [m]
1	DGPS3-Starfix.G4 Plus 38603	WGS 84(2D)	-0.75	4.00	12.13
2	DGPS4-Starfix.G4 Plus 6904	WGS 84(2D)	-3.16	5.09	12.13
3	DGPS_Tide-Starfix.G4 Plus 42503	WGS 84(2D)	-5.83	-7.31	7.89

Table 4: Sensor data (mean values over data periods)

	Antenna Positions	Lat	Long	H [m]	Lat SD [m]	Long SD [m]	H SD [m]	Obs
1	DGPS3-Starfix.G4 Plus 38603	55° 27′ 43.93820″ N	008° 26′ 37.69836″ E	55.761 Ell.	± 0.07	± 0.13	± 0.10	3599
2	DGPS4-Starfix.G4 Plus 6904	55° 27′ 44.01965″ N	008° 26′ 37.65896″ E	55.777 Ell.	± 0.07	± 0.16	± 0.09	3600
3	DGPS_Tide-Starfix.G4 Plus 42503	55° 27′ 43.83289″ N	008° 26′ 37.01726″ E	51.579 Ell.	± 0.07	± 0.13	± 0.12	3600

Table 5: Heading sensor data

	Heading Sensors	Obs T [°]	Obs G [°]	Conv [°]	SD [°]	(C-O) [°]	Obs T [°]	Obs G [°]	Diff [°]	Records
1	Hydrins	50.9	51.3	-0.45821	0.13	0.00	50.9	51.3	0.00	3599
2	Octans	51.0	51.4	-0.45821	0.13	0.00	51.0	51.4	-0.10	3599
3	Azimuth	51.0	51.4	-0.45821	0.13	0.00	51.0	51.4	-0.10	3599

Table 6: Pitch sensor data

	Pitch Sensors	Observed [°]	SD [°]	(C-O) [°]	Computed [°]	Difference [°]	Records
1	Hydrins	-0.24	0.01	0.00	-0.24	0.00	3599
2	Octans	-0.23	0.01	0.00	-0.23	-0.02	3599
3	PitchRoll	-0.28	0.02	0.00	-0.28	0.04	3599

Table 7: Roll sensor data

	Roll Sensors	Observed [°]	SD [°]	(C-O) [°]	Computed [°]	Difference [°]	Records
1	Hydrins	-0.62	0.09	0.00	-0.62	0.00	3599
2	Octans	-0.65	0.09	0.00	-0.65	0.03	3599
3	PitchRoll	-0.43	0.14	0.00	-0.43	-0.19	3599

Table 8: Results (computed CRP position comparison)

	Name	Lat	Long	H [m]	1xDRMS [m]	ΔLat [m]	ΔLong [m]	ΔH [m]	Obs
1	DGPS3-Starfix.G4 Plus 38603	55° 27′ 43.83345″ N	008° 26′ 37.55148″ E	43.653 Ell.	0.10	0.00	0.00	0.00	3599
2	DGPS4-Starfix.G4 Plus 6904	55° 27′ 43.83222″ N	008° 26′ 37.55025″ E	43.707 Ell.	0.11	-0.04	-0.02	0.05	3600
3	DGPS_Tide-Starfix.G4 Plus 42503	55° 27′ 43.83300″ N	008° 26′ 37.55059″ E	43.718 Ell.	0.09	-0.01	-0.02	0.07	3600

Table 9: Geodetic parameters

Name: ETRS89 / UTM zone 32N [ETRF2000-ITRF2014],DTU18 MSS height [DTU18 MSS]		
EPSG Code	EPSG:25832	
Global Navigation Satellite System (GNSS) Geodetic Parameters*		
Datum	International Terrestrial Reference Frame 2014	EPSG:1165
Ellipsoid	GRS 1980	
Semi major axis	a = 6 378 137.00 m	
Inverse flattening	1/f = 298.257222101	
Local Geodetic Datum Parameters		
Datum	European Terrestrial Reference System 1989	EPSG:6258
Ellipsoid	GRS 1980	
Semi major axis	a = 6 378 137.00 m	
Inverse flattening	1/f = 298.257222101	
Datum Transformation Parameters from ITRF2014 to ETRS89		
X-axis translation 0.05584 m	X-axis rotation -0.0026255″	Scale difference 0.00337551 ppm
Y-axis translation 0.05334 m	Y-axis rotation -0.0158827″	Coordinate Frame rotation
Z-axis translation -0.09579 m	Z-axis rotation 0.0256716″	FUGRO:41366
Local Projection Parameters		
Map projection	Transverse Mercator	
Grid system	UTM zone 32N	EPSG:16032
Latitude origin	00° 00′ 00.000″ N	
Central meridian	009° 00′ 00.000″ E	
Scale factor on central meridian	0.9996	
False easting	500 000 m	
False northing	0 m	
Project Vertical Parameters		
Vertical coordinate reference system	DTU18 MSS height	FUGRO:41073
Datum	DTU18 MSS height	FUGRO:40939
Transformation	WGS 84 to DTU18 MSS height	FUGRO:41429
Notes * The geodetic datum of Fugro's global GNSS correction data is ITRF2014, epoch 2021.414 (01/06/2021)		

Table 10: Validation calculation

ITRF2014	Test Point [Position]	Computed Point
Latitude	56° 18′ 54.00000″ N	56° 18′ 54.00000″ N
Longitude	008° 30′ 00.00000″ E	008° 30′ 00.00000″ E
Ellipsoidal height	0.000 m Ell.	0.000 m Ell.
ETRS89		
Latitude	56° 18′ 53.98130″ N	56° 18′ 53.98130″ N
Longitude	008° 29′ 59.96955″ E	008° 29′ 59.96955″ E
Ellipsoidal height	-0.025 m Ell.	-0.025 m Ell.
UTM zone 32N		
Easting	469 069.831 m	469 069.831 m
Northing	6 241 250.858 m	6 241 250.858 m
Mean sea surface height	-39.932 m	-39.932 m

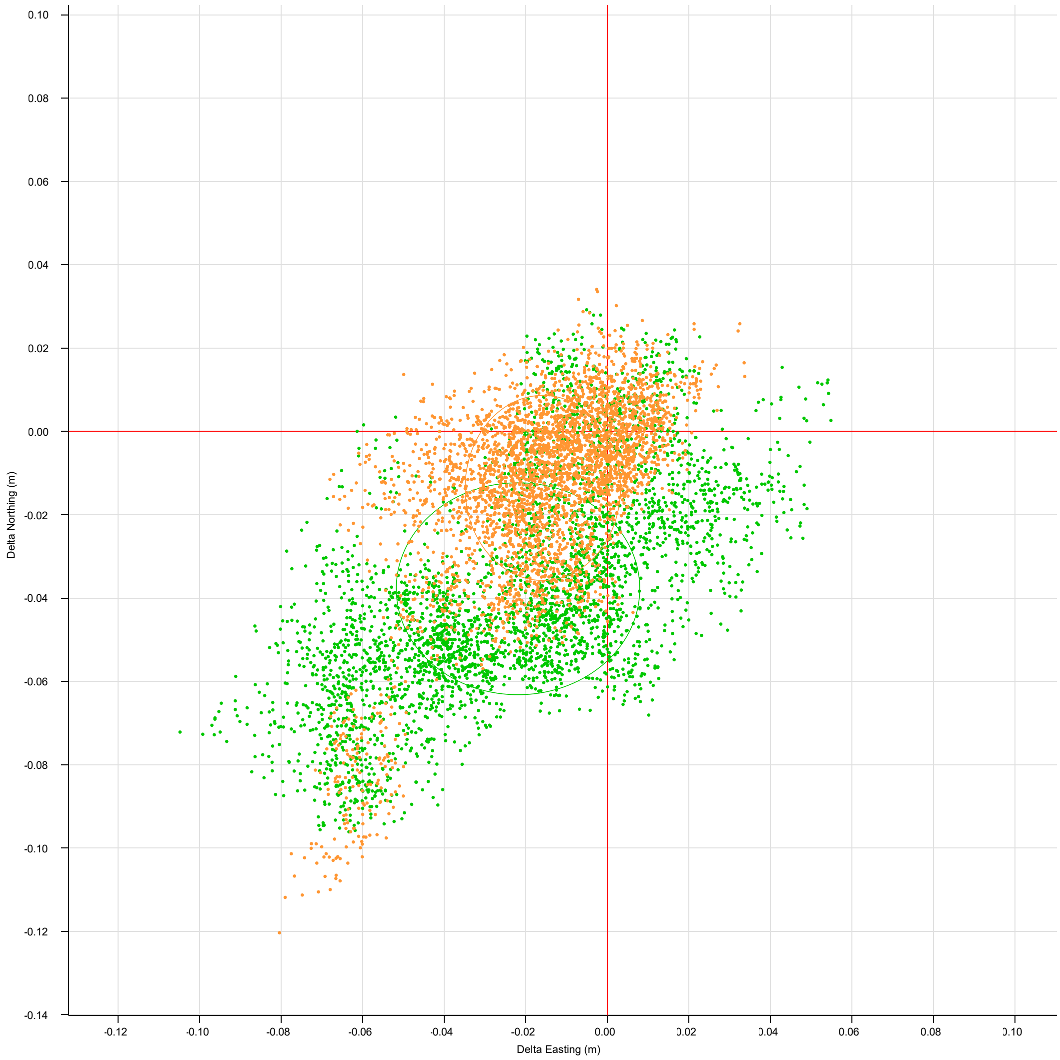


Figure 1: Delta scatter plot

Table 11: Delta scatter groups

	Sensor Group	ΔLat [m]	ΔLong [m]	ΔH [m]	ΔLat SD [m]	ΔLong SD [m]	ΔH SD [m]
	DGPS3-Starfix.G4 Plus 38603	0.00	0.00	0.0	±0.00	±0.00	±0.00
	DGPS4-Starfix.G4 Plus 6904	-0.02	-0.04	0.1	±0.03	±0.03	±0.05
	DGPS_Tide-Starfix.G4 Plus 42503	-0.02	-0.01	0.1	±0.02	±0.02	±0.04

P.Miller	T.Wiseman	M.Hannah
Party Chief	Client Representative	Client Representative
FSBV (Fugro Survey B.V.)	Energinet	Energinet

Appendix D

MBES Calibration Report

Multibeam Echo Sounder Calibration Report Fugro Pioneer

Energinet Denmark Energy Islands Lot 2 (Zone West) Geophysical Survey | Denmark, North Sea

F176286_Energinet_E_Islands_LOT2_MBES_Calibration 00 | 25 May 2021

Energinet Eltransmission A/S

Document Control

Document Information

Project Title	Energinet Denmark Energy Islands Geophysical Survey Lot 2 (Zone West)
Document Title	Multibeam Echo Sounder Calibration Report Fugro Pioneer
Fugro Project No.	F176286
Fugro Document No.	F176286_Energinet_E_Islands_LOT2_MBES_Calibration
Issue Number	00
Issue Status	Final

Client Information

Client	Energinet Eltransmission A/S
Client Address	Tonne Kjærsvej 65, DK-7000 Fredericia, Denmark
Client Contact	Giel Menijn, Rick Green, , Esther Grootjans
Client Document No.	N/A

Revision History

Issue	Date	Status	Comments on Content	Prepared By	Checked By	Approved By
00	25 May 2021	For Review	Awaiting client comments	BDT & FG	P. Miller	

Project Team

Initials	Name	Role
BDT	Bruno De Tommaso	Processor
FG	Frederic Giraud	Processor
PM	Paul Miller	Party Chief
CW	Chris Wright	Reporting Coordinator
APA	A Padwalkar	Fugro Project Manager

1. Introduction

The purpose of the multi-beam echo sounder calibration is:

- To determine the Pitch, Roll, Yaw and Latency corrections required for calibrate the Kongsberg EM 2040, dual head system for bathymetric survey purposes.

2. Scope of Work

The calibration comprised of six lines run in a traditional patch test manner. Two lines run with an offset of 50 m from either side of centreline in same direction; two centrelines on top of each other with same direction, one centreline in opposite directions with same speed and the last one at double speed. See Table 1 for the survey line configuration for multibeam corrections.

Table 1: Survey Line Configuration for Multibeam Corrections

Correction	Survey line configuration
System Latency	Two lines run in the same direction at different survey speeds over the feature (3.0 knots and 6.0 knots).
Pitch	Two lines run at the same speed in opposite directions over the feature.
Roll	Three lines run at the same speed in opposite directions over a flat seabed
Yaw	Three lines run at the same speed in same direction over the feature

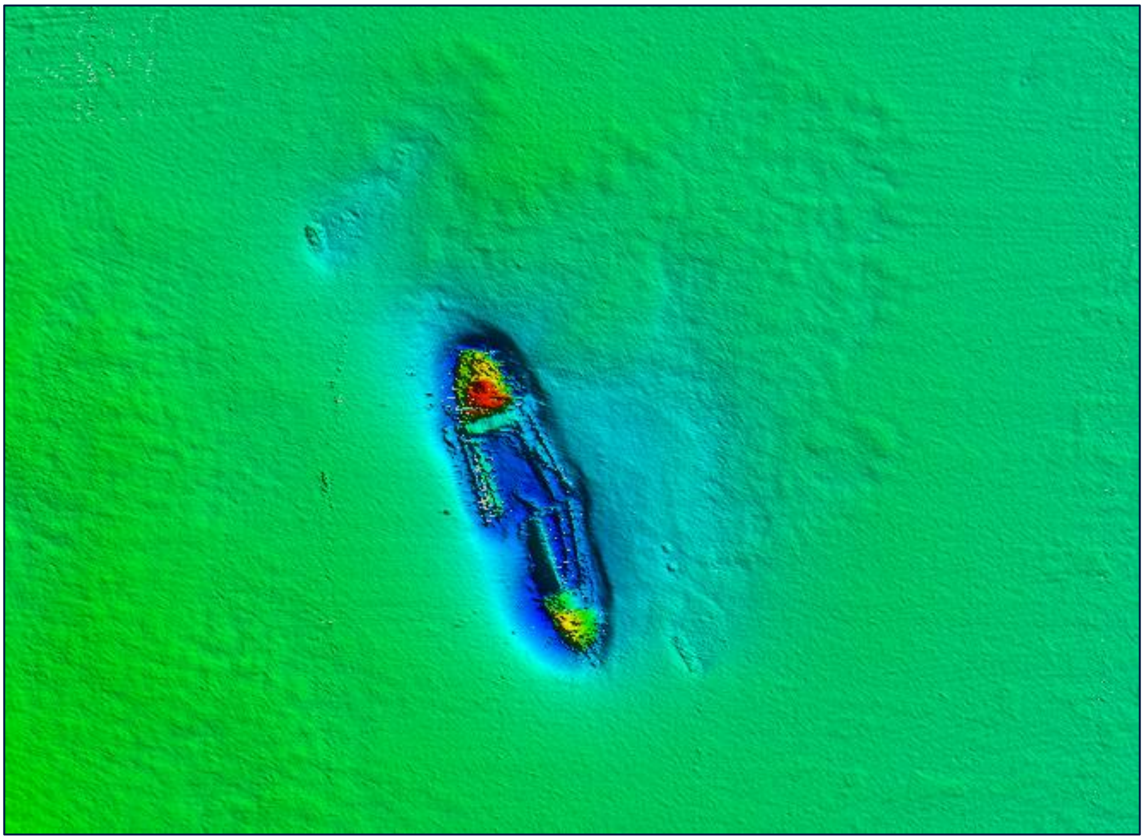


Figure 1: Survey area after Calibration corrections applied

3. Operations

The calibration was carried out onboard the vessel MV Fugro Pioneer on 24th of May 2021 to determine corrections for the multibeam echo sounder acquisition system.

The calibration was conducted over a wreck which is located at 340611.48mE, 6263657.75mN (ETRS89 Zone 32N) in approximately 46 metres water depth.

Before commencement of the patch test, the previous calibration values in SIS were removed:

Table 2: SIS Values before Patch Test

SIS values before Patch Test		
Receiver	Rx PORT	Rx STBD
Latency	+0.000 sec	+0.000 sec
Pitch	+0.000°	+0.000°
Roll	+40.000°	-40.000°
Yaw	+0.000°	+0.000°

Table 3: Position and Navigation information

Positioning and Navigation	MBES Kongsberg EM2040
	Water depth approximately 46m
	Multibeam Draft 2.99 m, Water Line (CRP to MBES) 2.55m
	Speed of sound in water at surface 1483.41m/s from CTD probe
	Speed of sound in water at seabed 1478.58 m/s from CTD probe
	Hydrins Gyrocompass and Octans Motion Sensor

4. Results

The tables below indicate the results of the MBE Calibration.

Table 4: Calibration System Values

Calibration System Values		
Receiver	**Rx PORT**	**Rx STBD**
Latency	+0.000 sec	+0.000 sec
Pitch	-0.650°	-0.650°
Roll	-0.020°	+0.200°
Yaw	+0.040°	+0.040°

Table 5: SIS Values after Patch Test

SIS Values after Patch Test		
Receiver	**Rx PORT**	**Rx STBD**
Latency	+0.000 sec	+0.000 sec
Pitch	-0.650°	-0.650°
Roll	+40.020°	-39.800°
Yaw	+0.040°	+0.040°

The Caris screen prints below show profiles of the grid data from the alignment calibration. The data was corrected for pitch, roll, latency and yaw. The X axis is in meters along the profile and the Y axis is in meters of water depth.

For the Kongsberg EM2040 system, pitch and yaw is calculated from the transducer head, therefore, the corrections for pitch and yaw for both receiver heads are the same respectively. Roll however, is corrected separately for each port and starboard receiver. Latency corrections are for both heads as in the case of pitch and yaw.

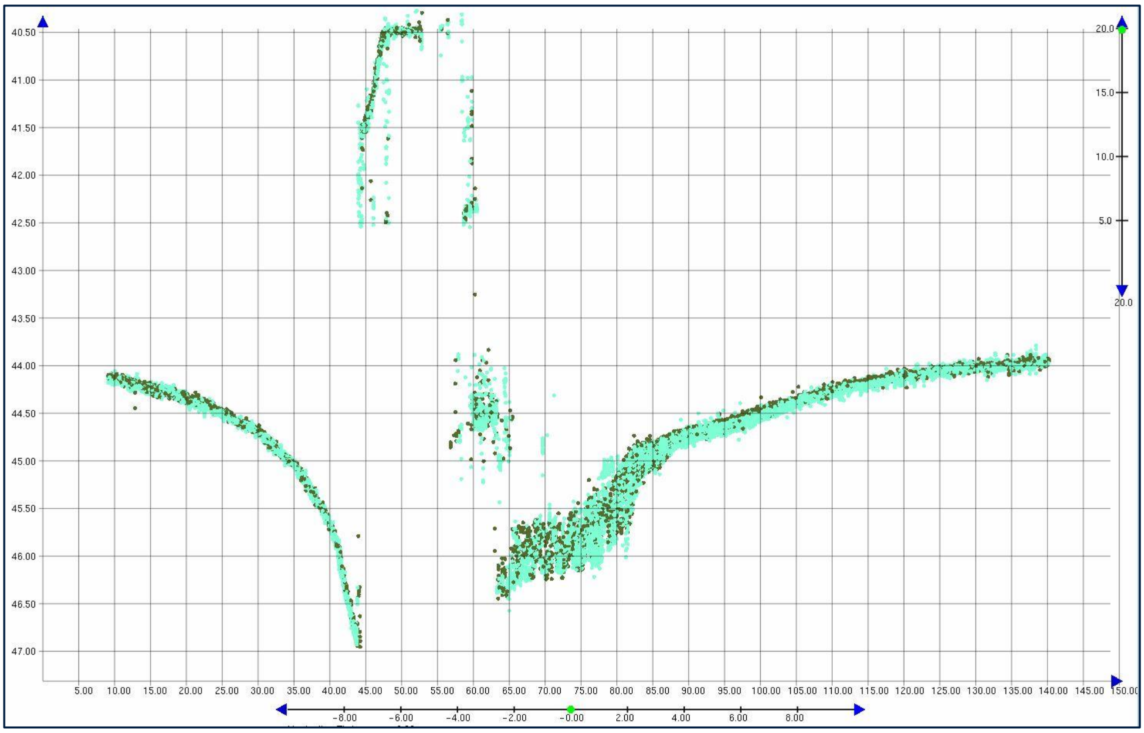


Figure 2: Latency 0.000 sec

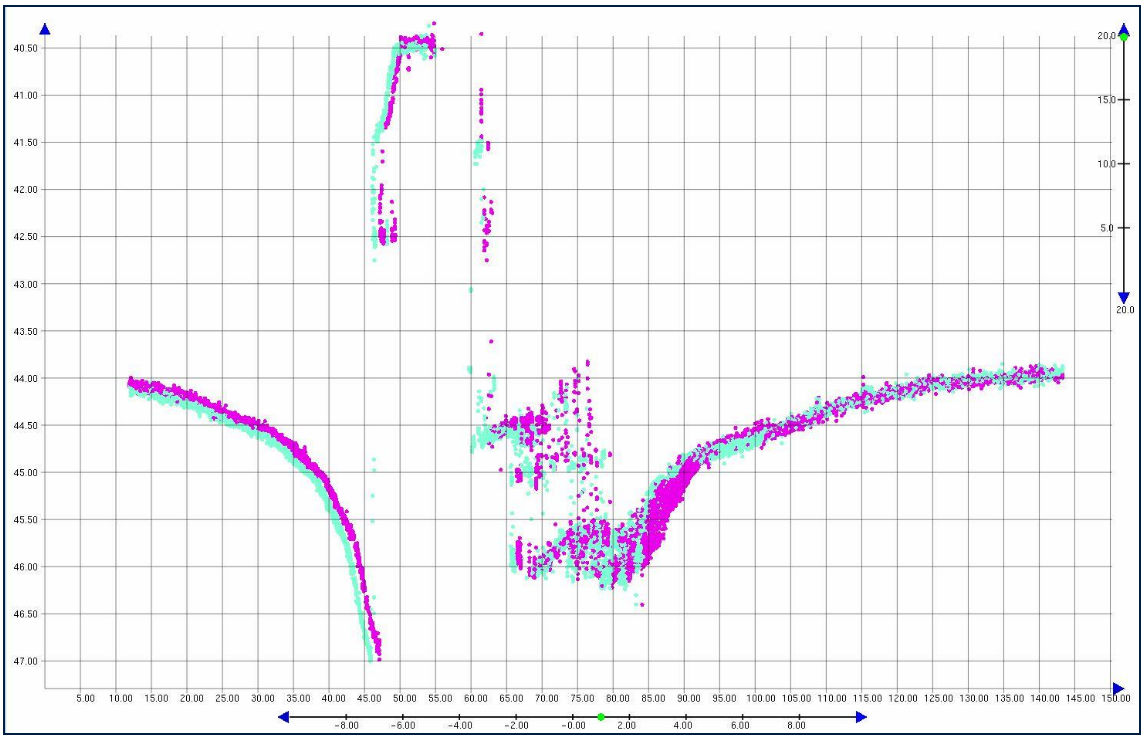


Figure 3: Pitch 0.000°

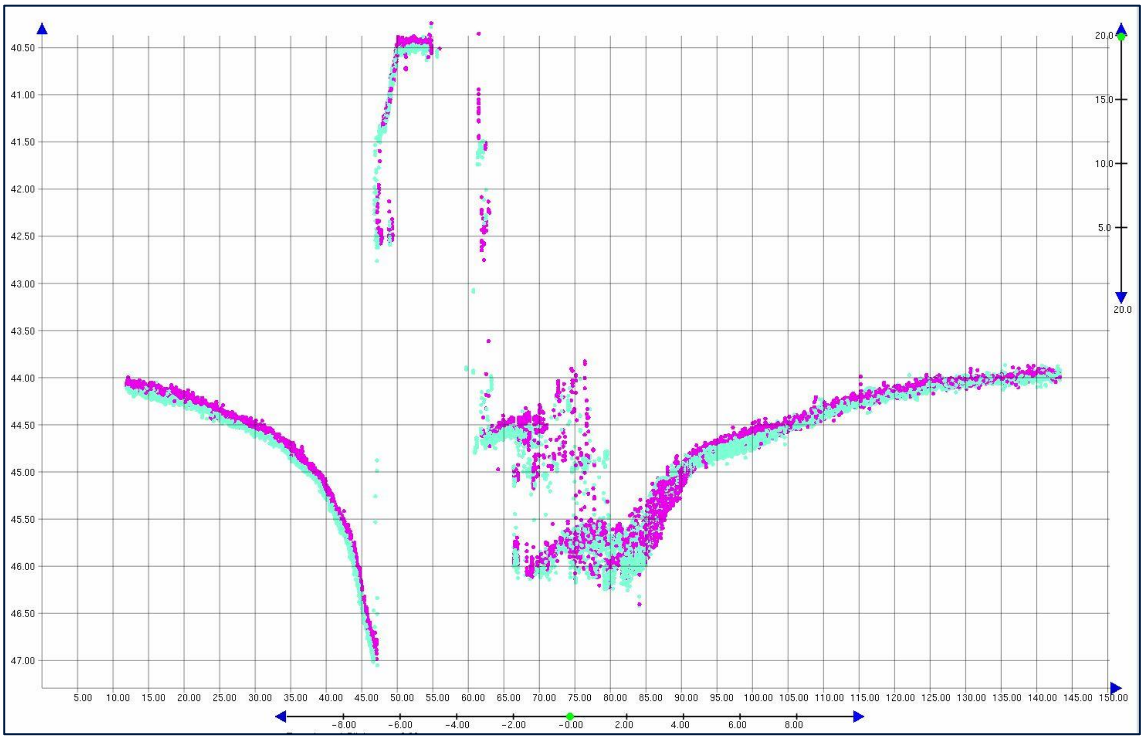


Figure 4: Pitch -0.650°

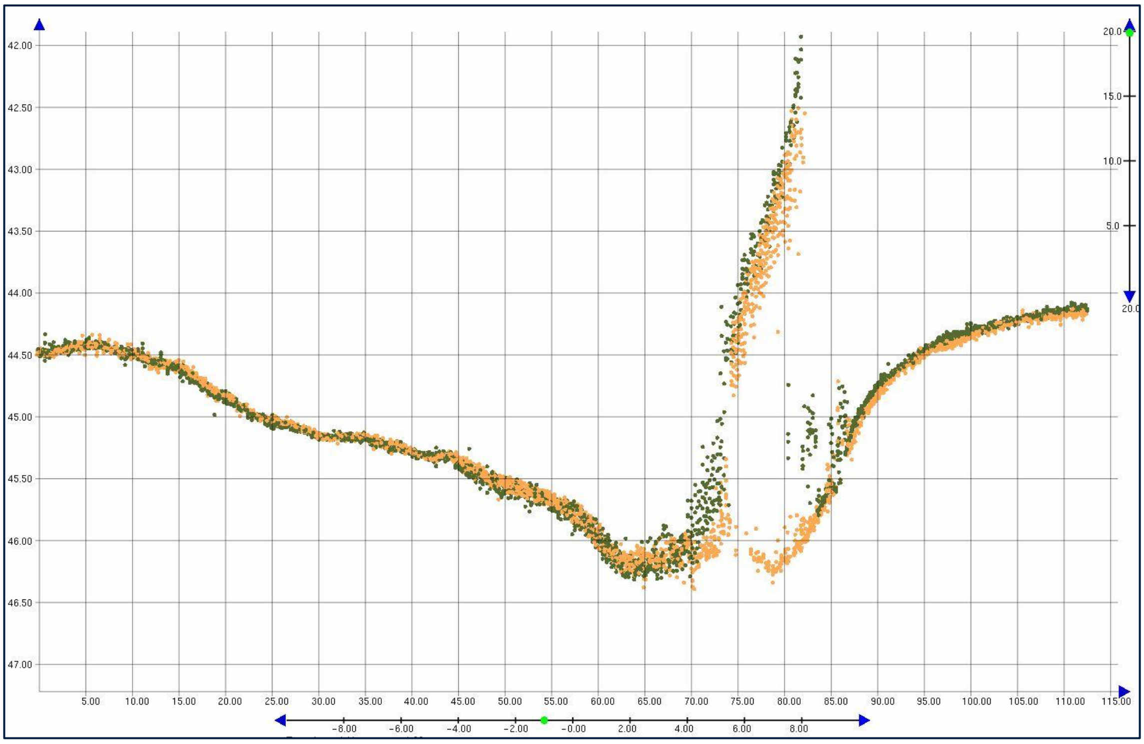


Figure 5: Heading 0.000°

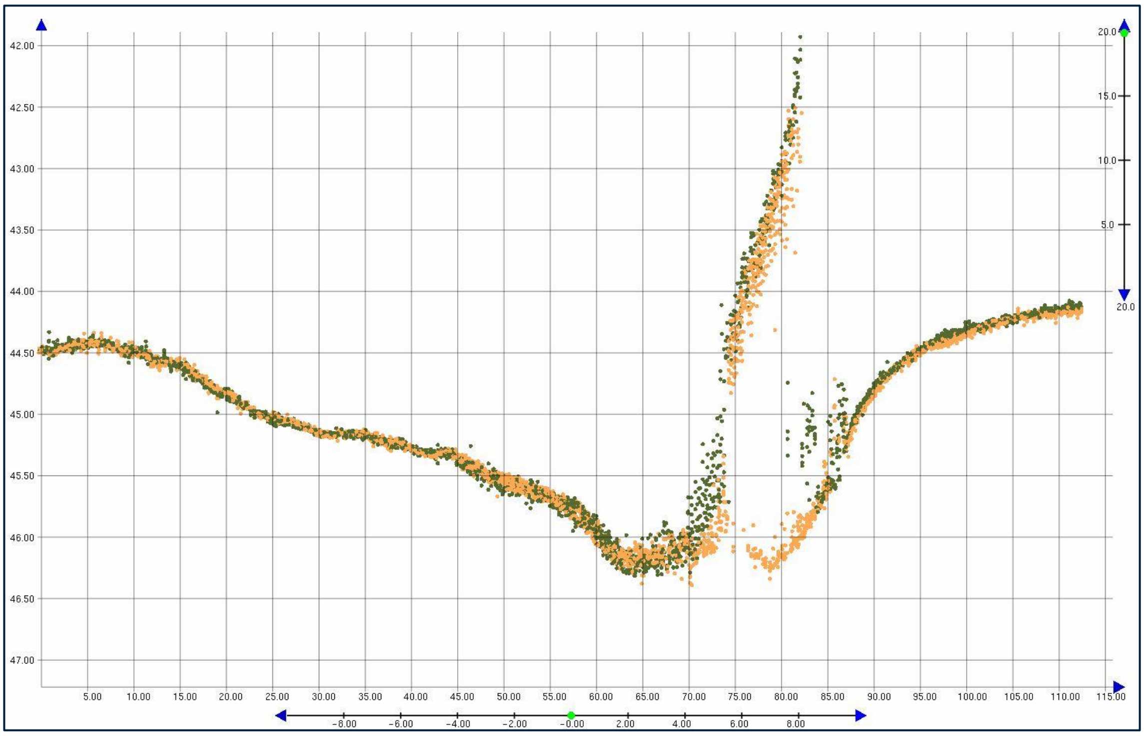


Figure 6: Heading 0.040°

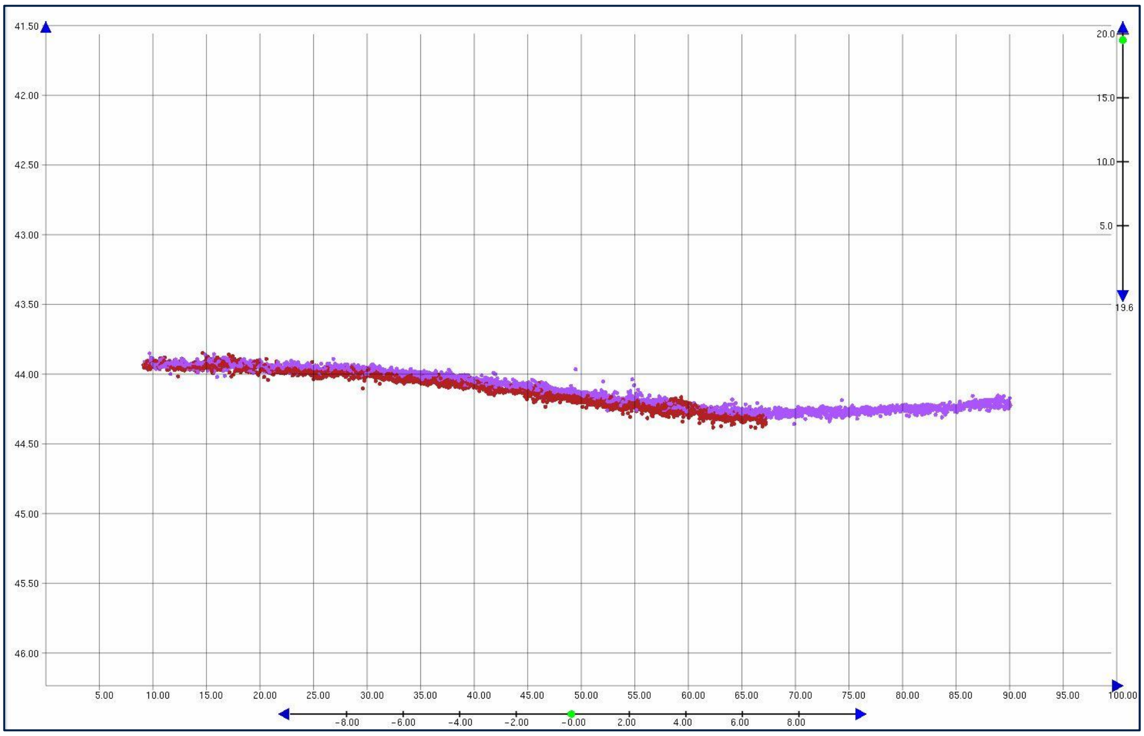


Figure 7: Roll (Port) 0.000°

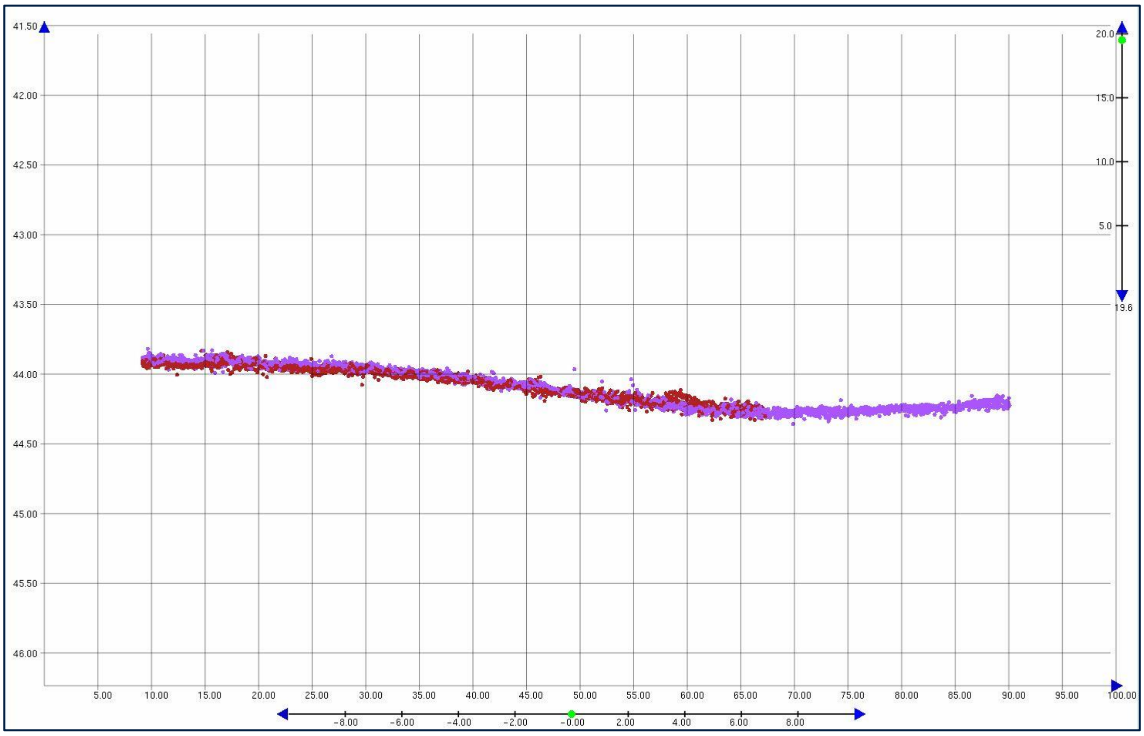


Figure 8: Roll (Port) 0.020°

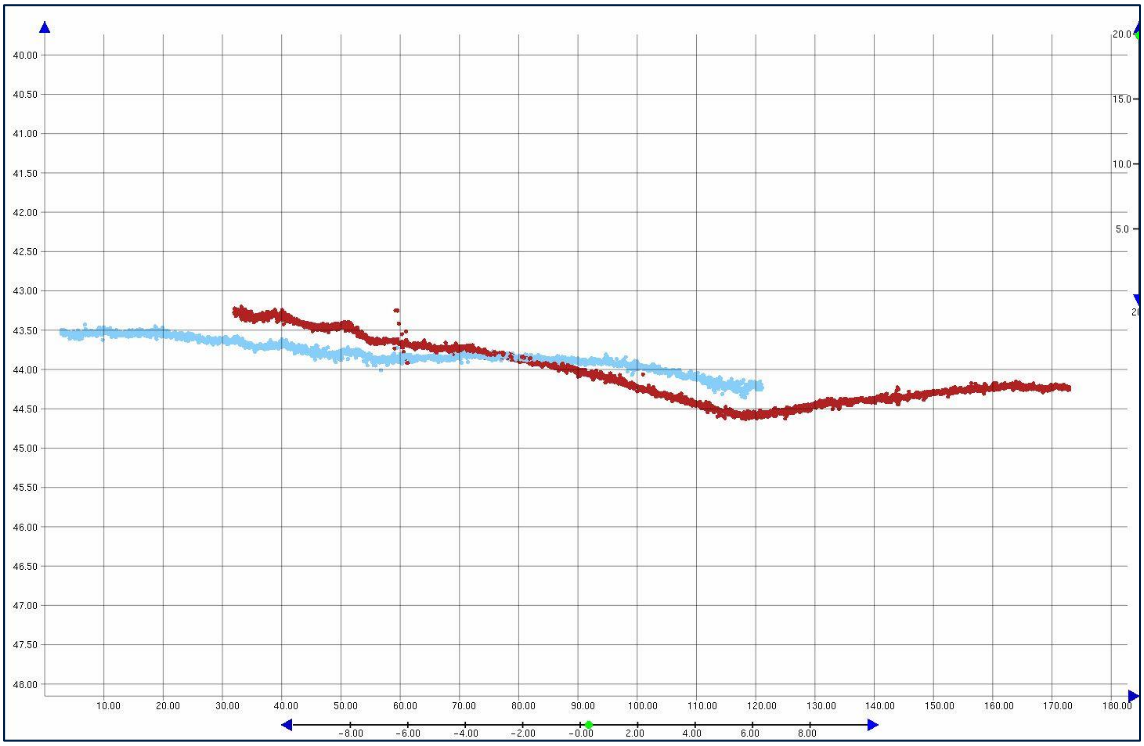


Figure 9: Roll (Stbd) 0.000°

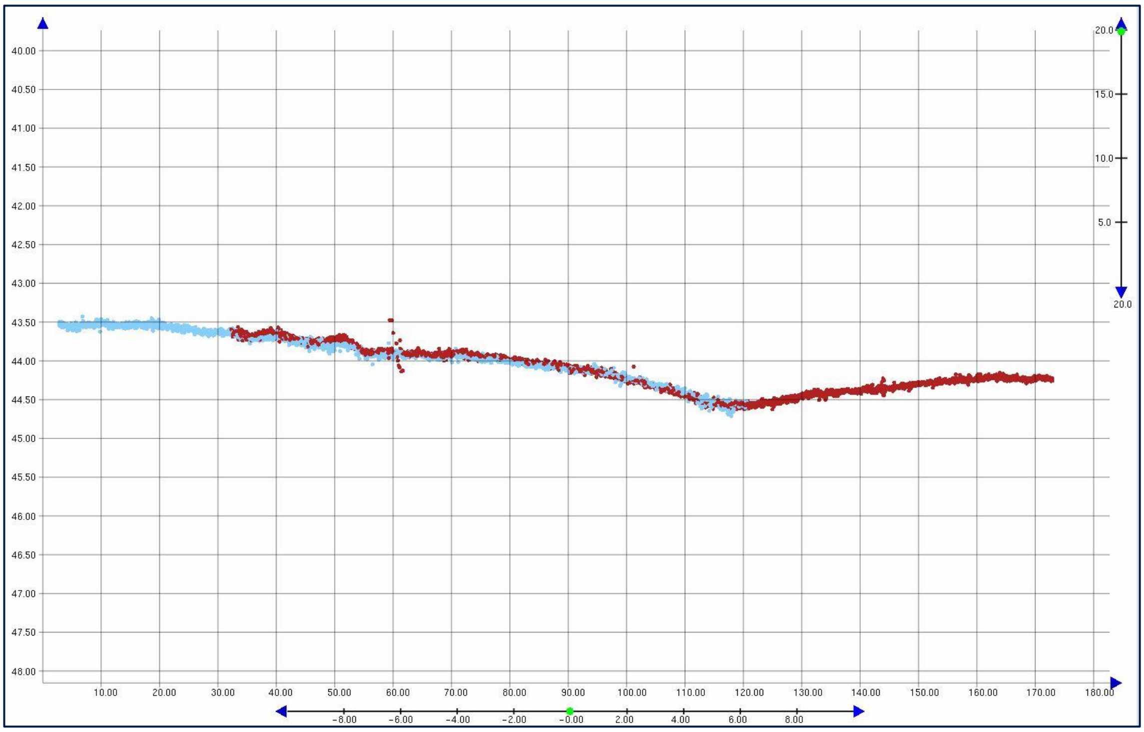


Figure 10: Roll (Stbd) +0.200°

5. Conclusion

The multibeam system was calibrated to within the system tolerances as based on the project specification.

6. HSE

No safety or HSE incidents were reported.

Signed:		Signed:	
	Paul Miller **Party Chief** **(Fugro Pioneer)** **Date: 25/05/2021**		**M. Hannah and T. Wiseman** **Client Representatives** **(Energinet Eltransmission A/S)** **Date: 25/05/2021**

Appendix E

USBL Calibration Report

Transducer alignment report
Fugro Pioneer

KONGSBERG

REPORT INFORMATION	
Vessel name	Fugro Pioneer
Vessel info	
Vessel type and size	
Area	
Weather condition	Accettable
Wave direction and speed	SW 0.8
Wind direction and speed	SW 15Kn
Encountered problems	
Report date	2021-05-23
Report generated by	
Additional information	Extendend Cardinal Point

LOGGED DATA	
Time first sample	2021-05-22 14:51:24
Time last sample	2021-05-22 12:34:01
Total number of samples	1600
Used samples	1592 (99.5%)
Excluded samples	8 (0.5%)

SOUND VELOCITY	
Mean velocity	1482.2 m/s

SYSTEM DATA	
Aligned system	HiPAP
HiPAP type	HiPAP 501
APOS version	6.8.2.3
HiPAP version	H 4.3.5.5

TRANSPONDER	
Type	HiPAP cNODE
Channel	B18
Serial number	19518
Transducer type	No ID

GPS/ATTITUDE SENSOR USED	
GPS used	1
VRS used	1
Gyro used	1

Transducer alignment report
Fugro Pioneer

KONGSBERG

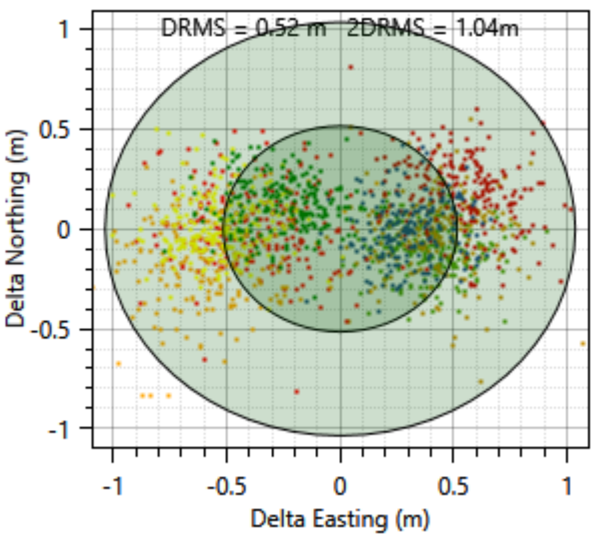
GEODESY		
	Input	**Output**
Datum name	WGS 84	WGS 84
Projection name	WGS 84 / UTM zone 32N	WGS 84 / UTM zone 32N
Transformation name		
Transformation details		

	BEFORE CORRECTION		AFTER CORRECTION [3]	
Transponder position		**Std.dev**		**Std.dev**
Northing	6437751.84 m	0.20 m	6437751.83 m	0.20 m
Easting	542627.54 m	0.48 m	542627.54 m	0.22 m
Depth	344.60 m	0.15 m	344.59 m	0.11 m
Position DRMS	0.52 m		0.30 m	
Position 2DRMS	1.04 m		0.60 m	
Average range	376.74 m		376.73 m	
Estimated angle accuracy [1]	0.08 °		0.05 °	
Estimated accuracy [2]	0.14 %		0.08 %	
Transducer offset				**1-sigma [4]**
Forward	3.56 m			
Starboard	3.91 m			
Down (CG)	7.05 m		-	
Below (waterline)	4.55 m		-	
Roll	0.04 °		0.07 °	0.01 °
Pitch	-0.07 °		-0.01 °	0.01 °
Gear	269.78 °		269.77 °	0.02 °
Transducer acoustic center offset				
Down	0.0 mm			
GPS antenna offset				
Forward	0.00 m			
Starboard	0.00 m			
Height	0.00 m			
Roll/pitch compensated	YES			
Tide compensated			YES	
Sound velocity				
Mean [5]	1482.2 m/s			
Attitude sensors				
Gyro rotation	0.00 °			
VRS heading misalignment	0.00 °			

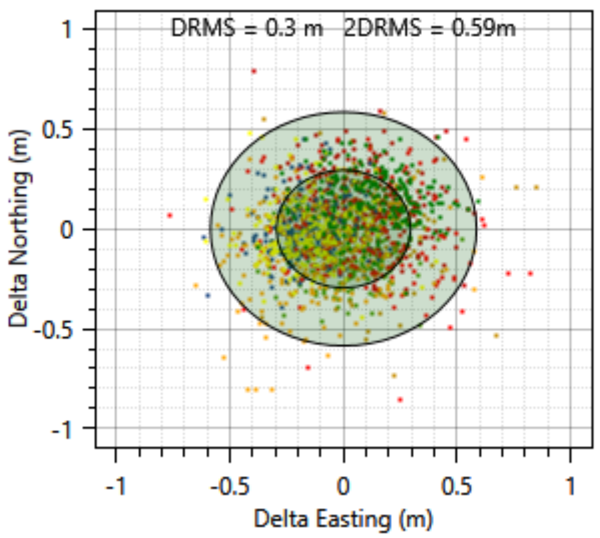
Transducer alignment report
Fugro Pioneer

KONGSBERG

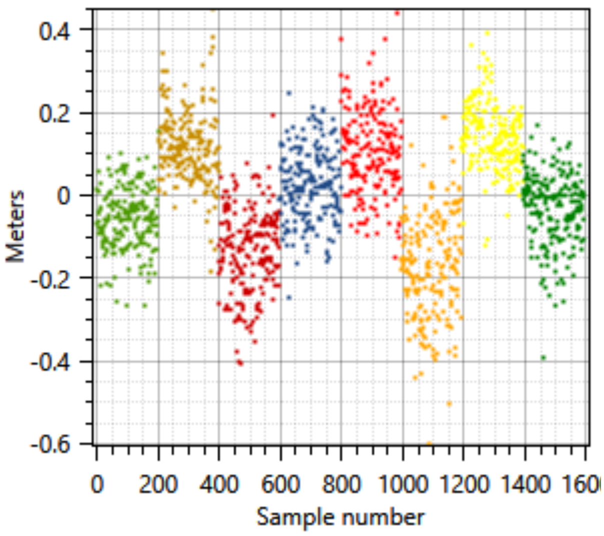
Uncorrected transponder position



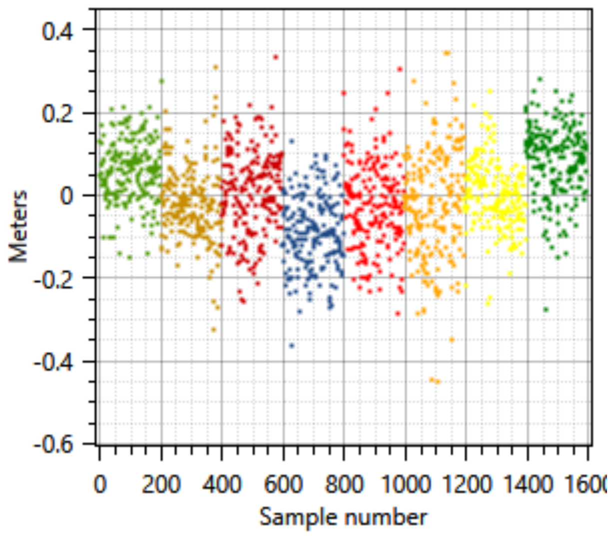
Corrected transponder position



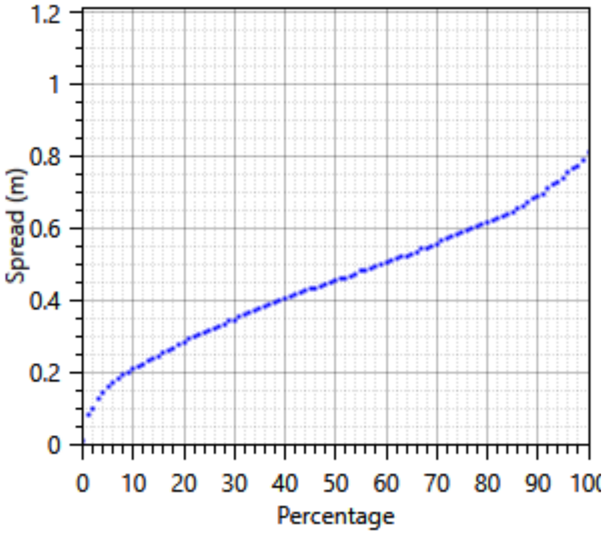
Uncorrected transponder depth (delta value)



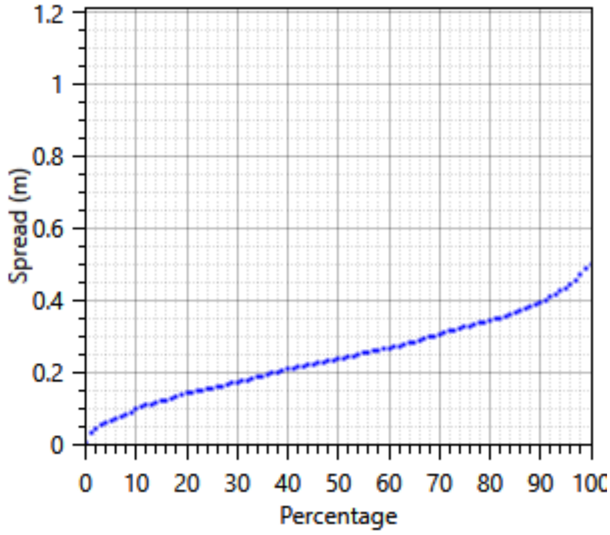
Corrected transponder depth (delta value)



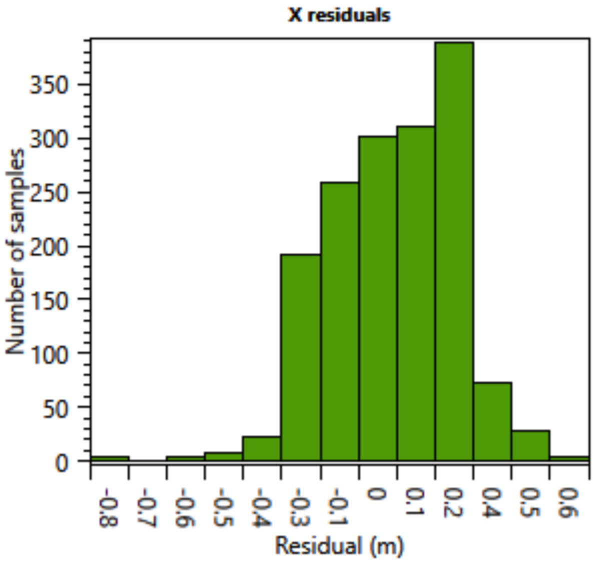
Position spread uncorrected

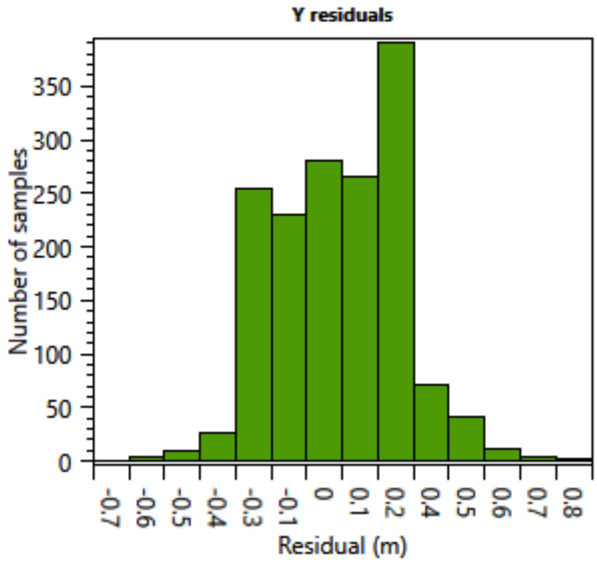


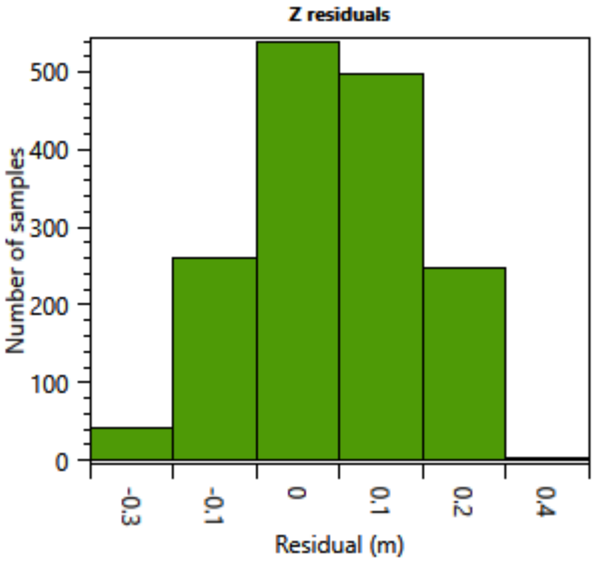
Position spread corrected

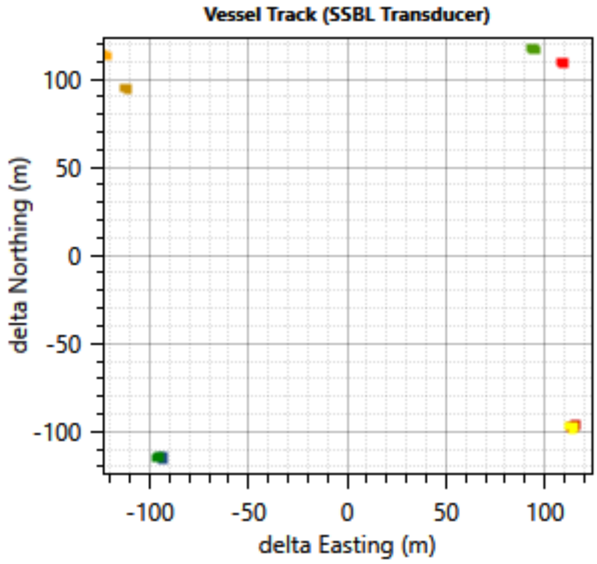


Transducer alignment report
Fugro Pioneer









QC

Acoustic

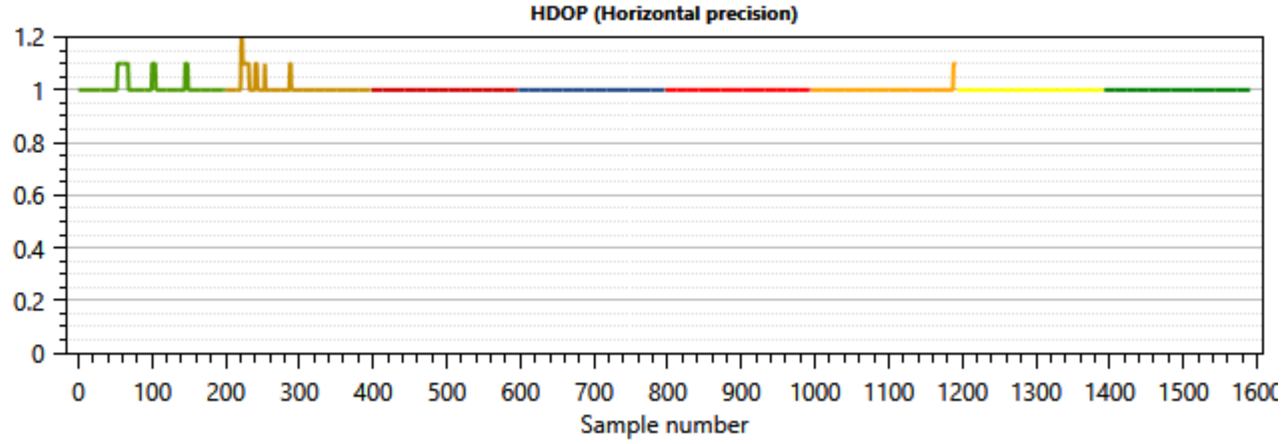
Logged series	Time start	Time stop	Avg. vessel hdg	Horizontal range to TP	Bearing to TP	Measured in series	Measurements used	# excluded (%)
1	14:51:24	14:56:26	29 °	150 m	29 °	200	200	0 (0.0)
2	15:18:29	15:23:02	29 °	146 m	29 °	200	198	2 (1.0)
3	13:20:41	13:25:11	29 °	150 m	29 °	200	199	1 (0.5)
4	12:53:08	12:57:49	30 °	147 m	30 °	200	200	0 (0.0)
5	14:18:48	14:23:26	210 °	154 m	210 °	200	198	2 (1.0)
6	15:51:49	15:56:30	209 °	168 m	209 °	200	198	2 (1.0)
7	13:48:06	13:52:50	209 °	149 m	209 °	200	200	0 (0.0)
8	12:29:21	12:34:01	210 °	149 m	210 °	200	199	1 (0.5)
					Total samples	1600	1592 (99.5%)	8 (0.5%)

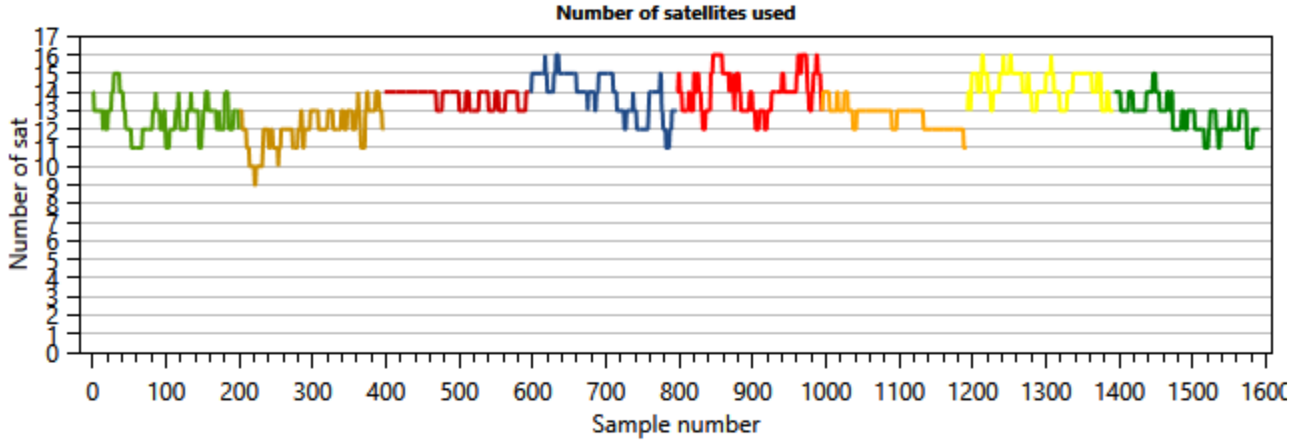
Sensor summary

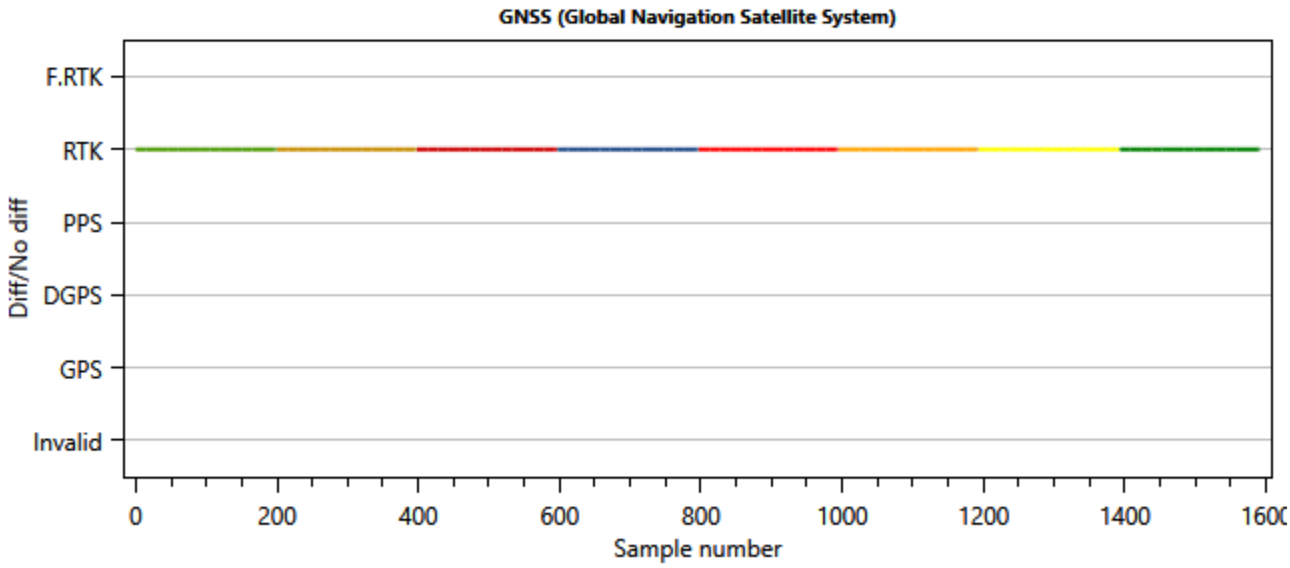
Sensor	Parameter	Min	Average	Max
GPS	HDOP	1.00	1.00	1.20
	Satellite used	9	13	16
	Antenna delta height	-0.55 m	0.00 m	0.46 m
Attitude	Roll	-1.78 °	-0.28 °	1.75 °
	Pitch	-1.32 °	-0.08 °	1.16 °
	Heave	-0.39 m	-0.00 m	0.30 m
	Heading	26.98 °	119.85 °	212.43 °
Calculated tide	Tide	1.96 m	2.08 m	2.21 m

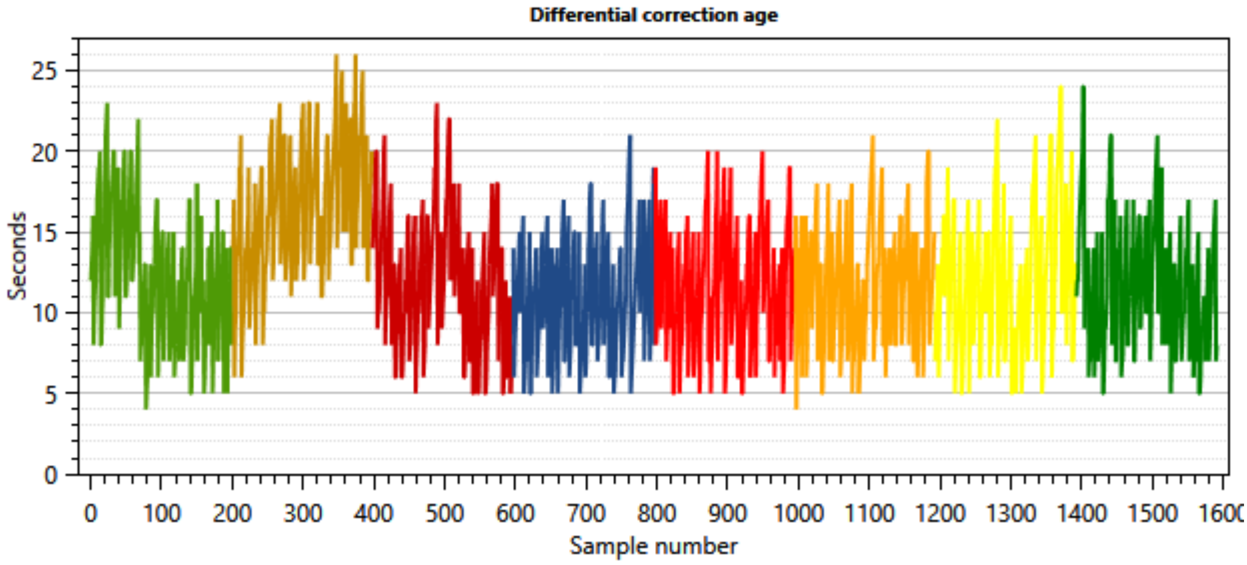
KONGSBERG

GPS

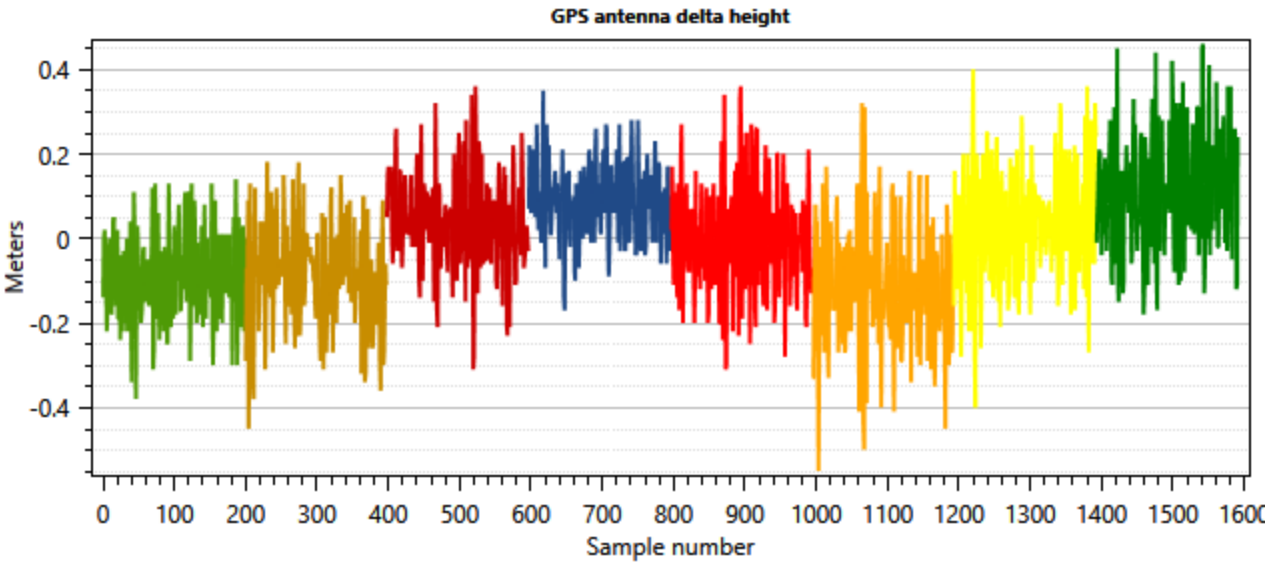








Differential correction age
Seconds
0
5
10
15
20
25
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
Sample number



GPS antenna delta height
Meters
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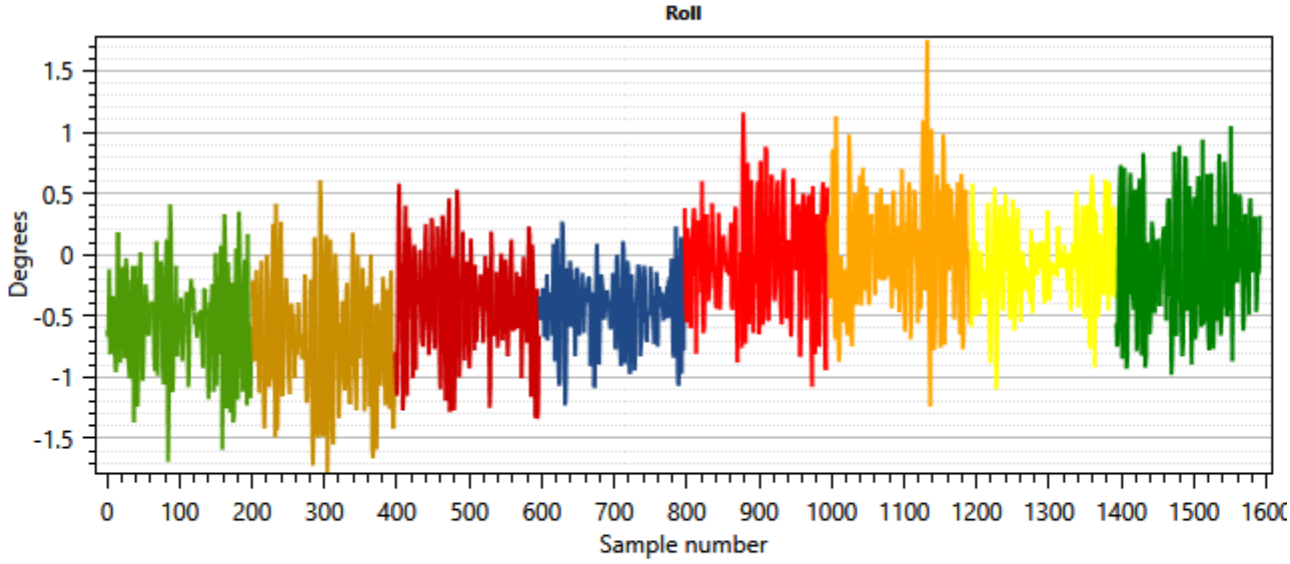
0.2
0
-0.2
-0.4
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
Sample number

Attitude


Roll
Degrees
Sample number
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-0.5
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-1.5
0
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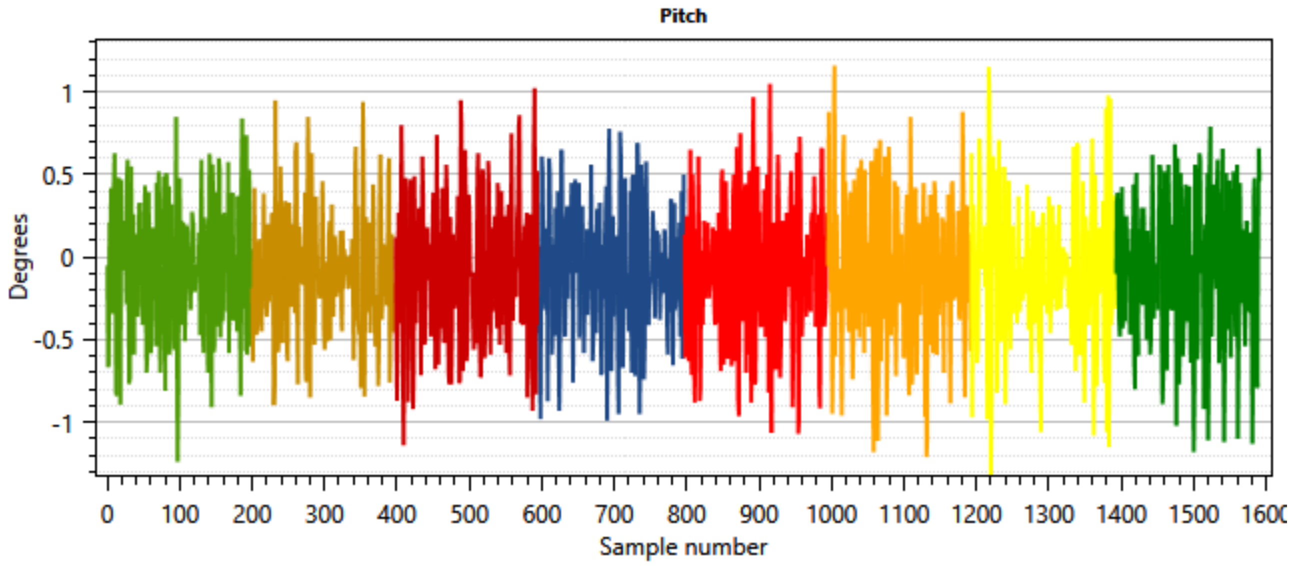
1200
1300
1400
1500
1600


Pitch
Degrees
Sample number
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0
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200
300
400
500
600
700
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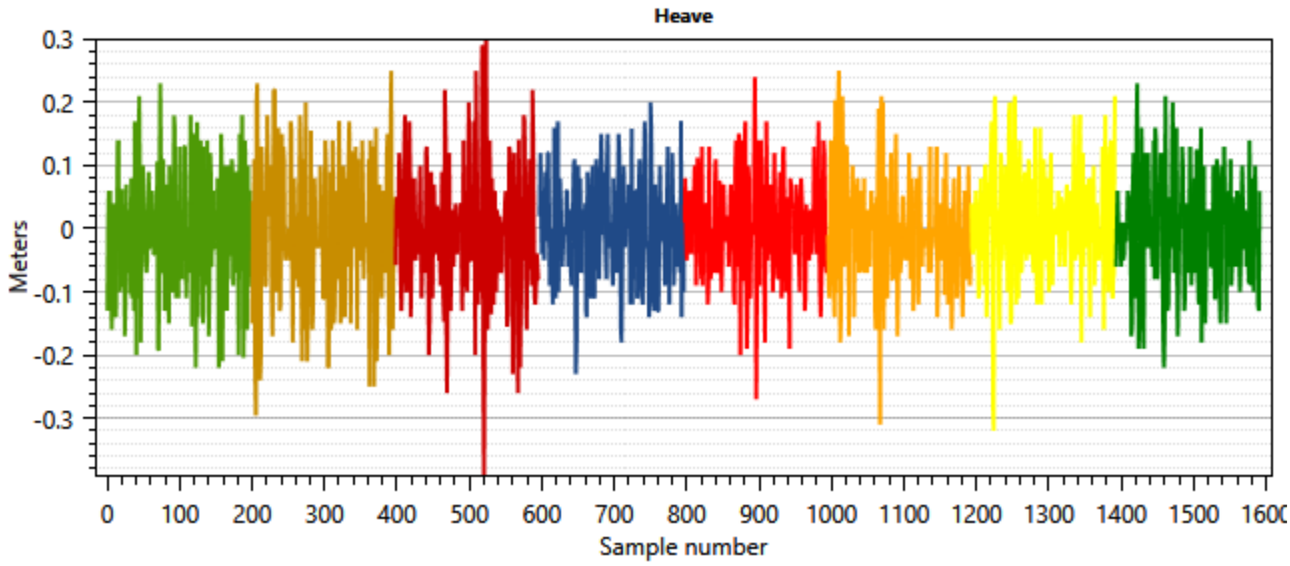
1200
1300
1400
1500
1600


Heave
Meters
Sample number
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0.1
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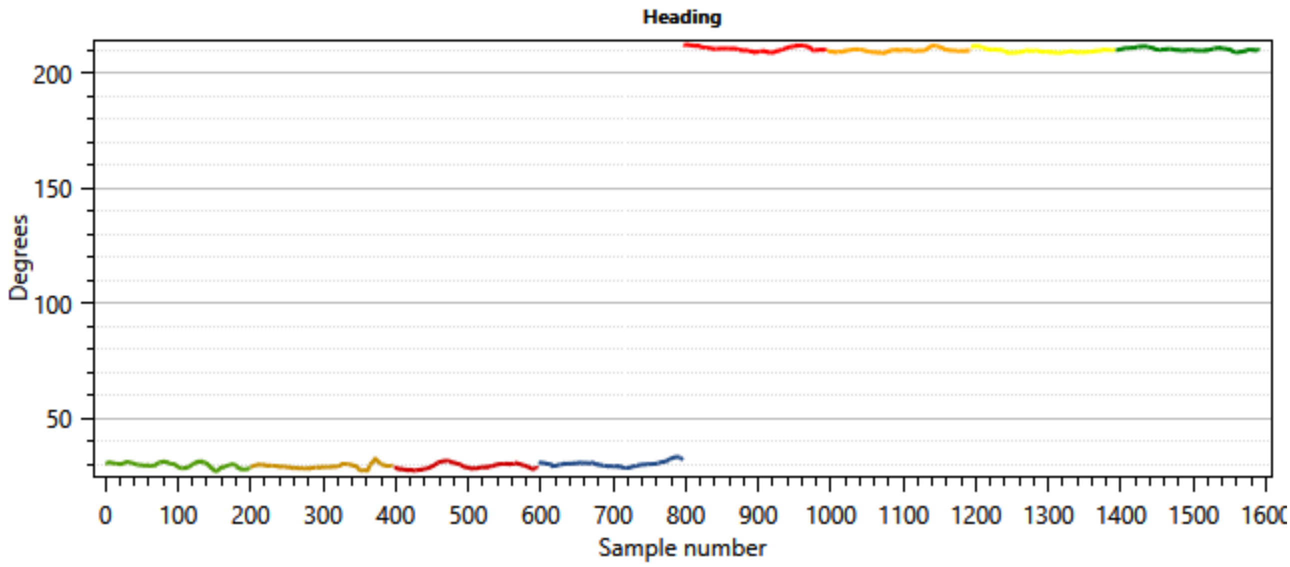
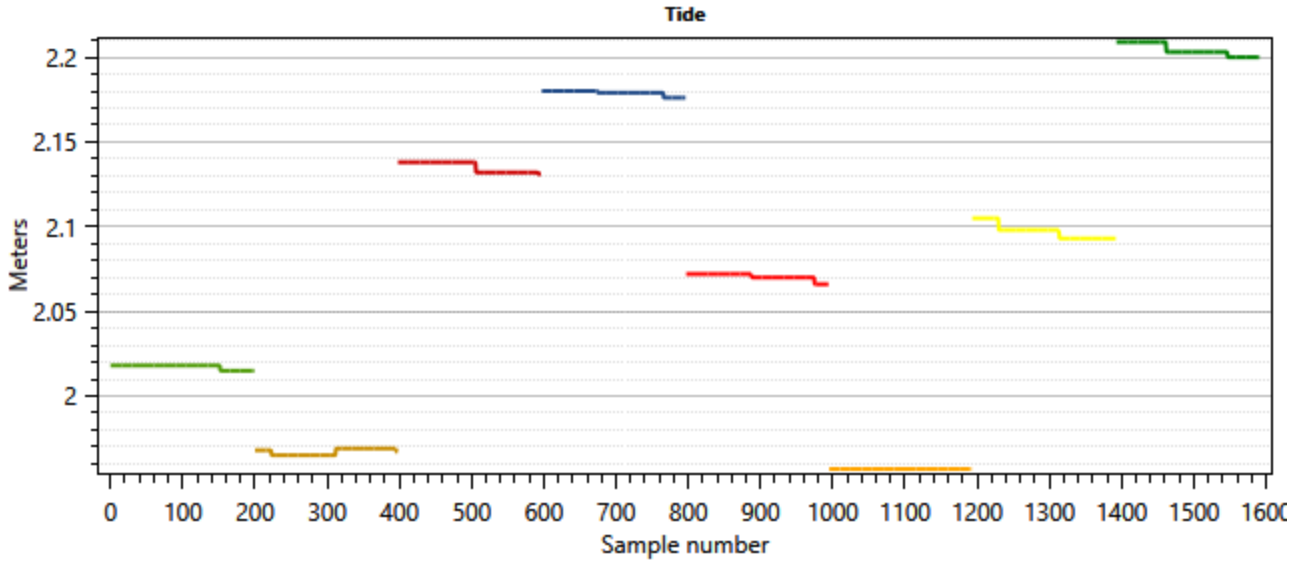
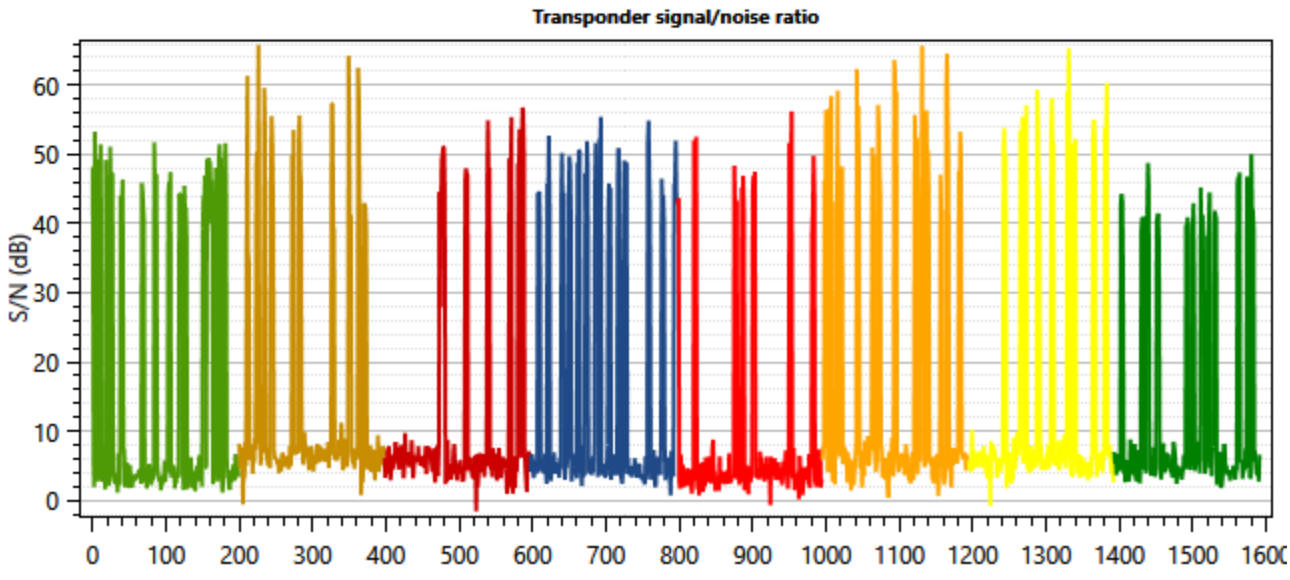
-0.2
-0.3
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600

Transducer alignment report
Fugro Pioneer







Appendix

Explanation to page 1:

[1] Estimated angle accuracy
The angle accuracy is calculated based on the DRMS value for the horizontal transponder position and the average slant range to the transponder.

Angle accuracy (°) =ArcTan(DRMS/(average slant range))

[2] Estimated accuracy
The estimated angle accuracy presented as % of average slant range.

Calculated accuracy (%) =DRMS/(average slant range)*100

NOTE:
The estimated accuracies above includes error contribution from all sources (GPS, gyro, motion sensor, all lever arms, sound velocity, signal/noise, reflections). The accuracy specification for Kongsberg acoustic systems in technical documents are without error contribution from any of the above factors.

[3] Values "After correction"
APOS calculates these values for the various parameters based on a best-fit for the transponder position using the least squares method.

[4] 1-sigma values
This indicates what certainty the calculated values have. The values are one time the standard deviation of the measurements.

[5] Mean sound velocity
The mean value from the sound profile used. (Value calculated between the HiPAP Transducer depth and Transponder depth)

Company logo in the report header:
The Kongsberg logo can be replaced by a user-defined logo. The logo file must be in JPG or PNG format.

The logo file must be named "customer_logo.jpg" or "customer_logo.png" and copied to the \APOS\DATA folder.

Transducer alignment report
Fugro Pioneer

KONGSBERG

REPORT INFORMATION	
Vessel name	Fugro Pioneer
Vessel info	
Vessel type and size	
Area	
Weather condition	Accettable
Wave direction and speed	Sw 0.8
Wind direction and speed	SW 15Kn
Encountered problems	
Report date	2021-05-23
Report generated by	
Additional information	

LOGGED DATA	
Time first sample	2021-05-22 22:27:37
Time last sample	2021-05-22 19:23:17
Total number of samples	1200
Used samples	1169 (97.4%)
Excluded samples	31 (2.6%)

TRANSPONDER	
Type	HiPAP cNODE
Channel	B18
Serial number	19518
Transducer type	No ID

SOUND VELOCITY	
Mean velocity	1482.2 m/s

GPS/ATTITUDE SENSOR USED	
GPS used	1
VRS used	1
Gyro used	1

SYSTEM DATA	
Aligned system	HiPAP
HiPAP type	HiPAP 501
APOS version	6.8.2.3
HiPAP version	H 4.3.5.5

Transducer alignment report
Fugro Pioneer

KONGSBERG

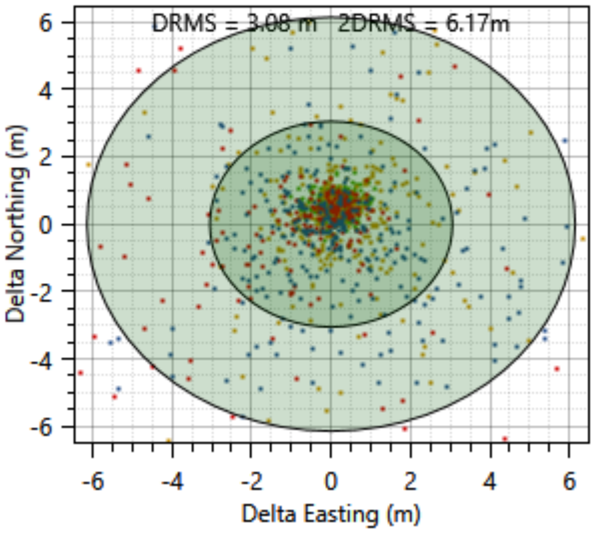
GEODESY		
	Input	**Output**
Datum name	WGS 84	WGS 84
Projection name	WGS 84 / UTM zone 32N	WGS 84 / UTM zone 32N
Transformation name		
Transformation details		

	BEFORE CORRECTION		AFTER CORRECTION [3]	
Transponder position		**Std.dev**		**Std.dev**
Northing	6437751.34 m	2.17 m	6437751.34 m	2.17 m
Easting	542627.31 m	2.19 m	542627.31 m	2.19 m
Depth	344.90 m	0.12 m	344.90 m	0.12 m
Position DRMS	3.08 m		3.08 m	
Position 2DRMS	6.16 m		6.16 m	
Average range	344.92 m		344.92 m	
Estimated angle accuracy [1]	0.51 °		0.51 °	
Estimated accuracy [2]	0.89 %		0.89 %	
Transducer offset				**1-sigma [4]**
Forward	3.56 m			
Starboard	3.91 m			
Down (CG)	7.05 m		-	
Below (waterline)	4.55 m		-	
Roll	0.04 °			
Pitch	-0.07 °			
Gear	269.78 °			
Transducer acoustic center offset				
Down	0.0 mm			
GPS antenna offset				
Forward	0.00 m			
Starboard	0.00 m			
Height	0.00 m			
Roll/pitch compensated	YES			
Tide compensated			YES	
Sound velocity				
Mean [5]	1482.2 m/s			
Attitude sensors				
Gyro rotation	0.00 °			
VRS heading misalignment	0.00 °			

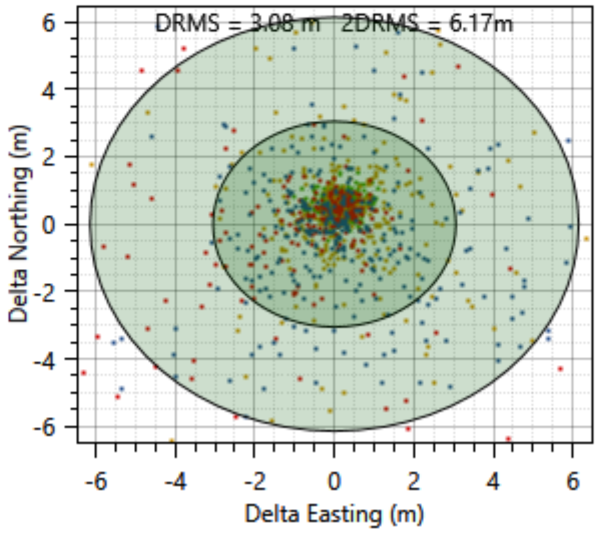
Transducer alignment report
Fugro Pioneer

KONGSBERG

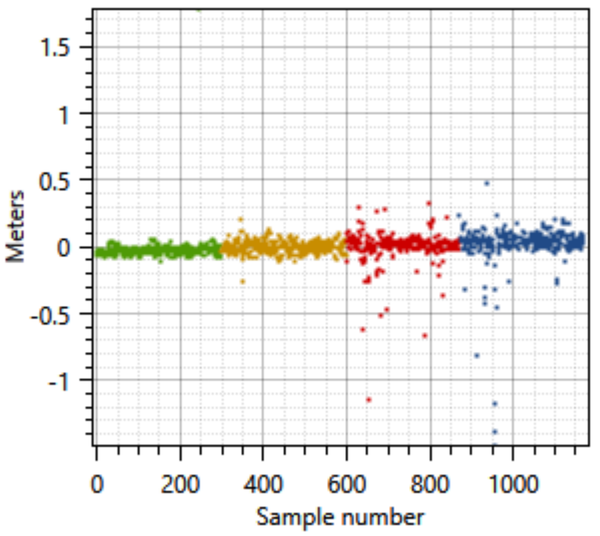
Uncorrected transponder position



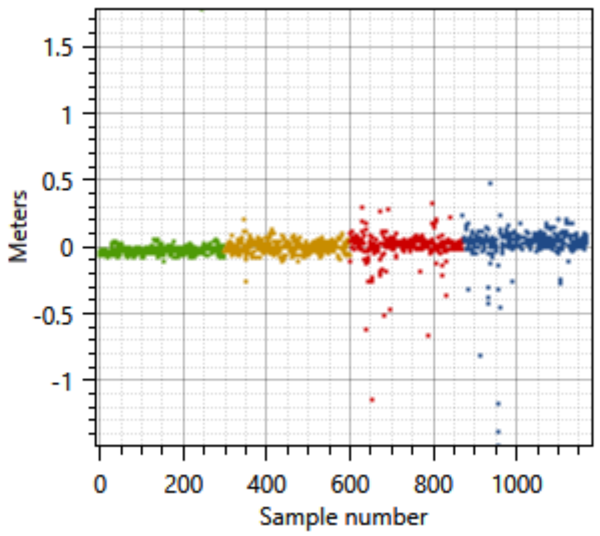
Corrected transponder position



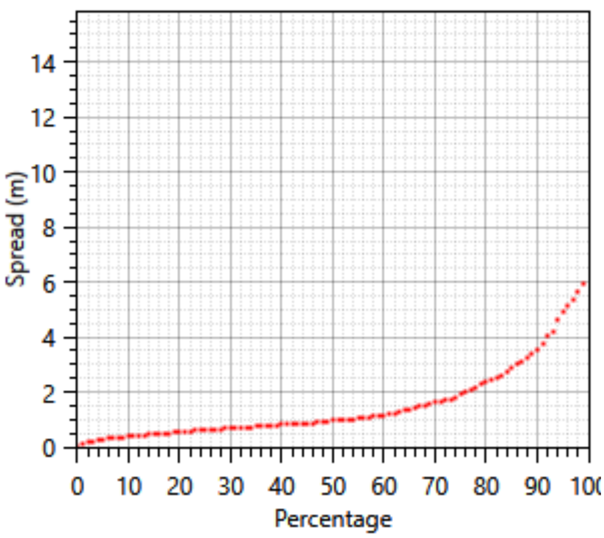
Uncorrected transponder depth (delta value)



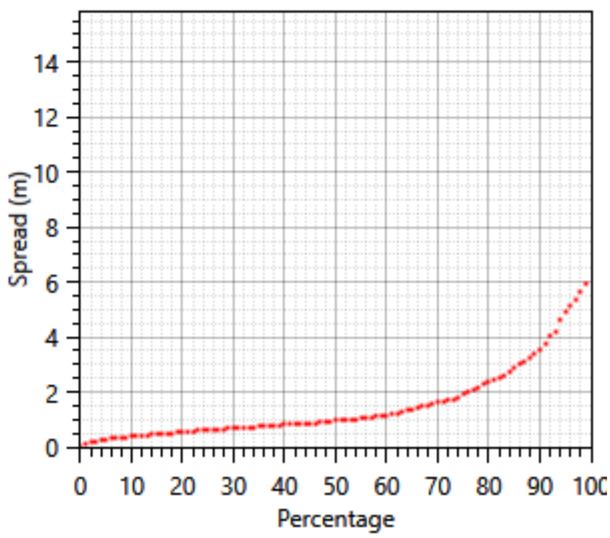
Corrected transponder depth (delta value)



Position spread uncorrected

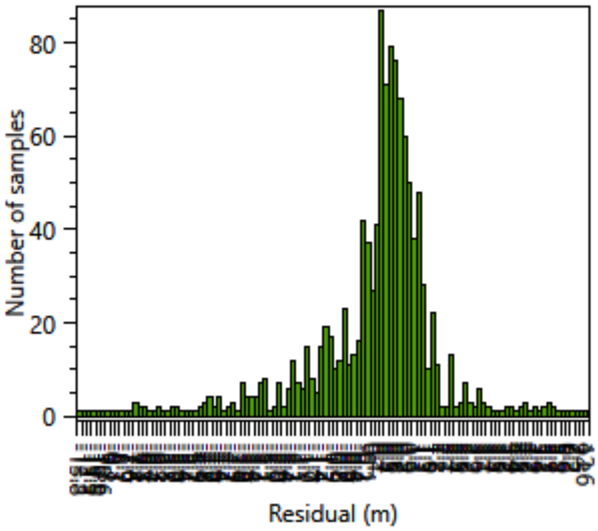


Position spread corrected

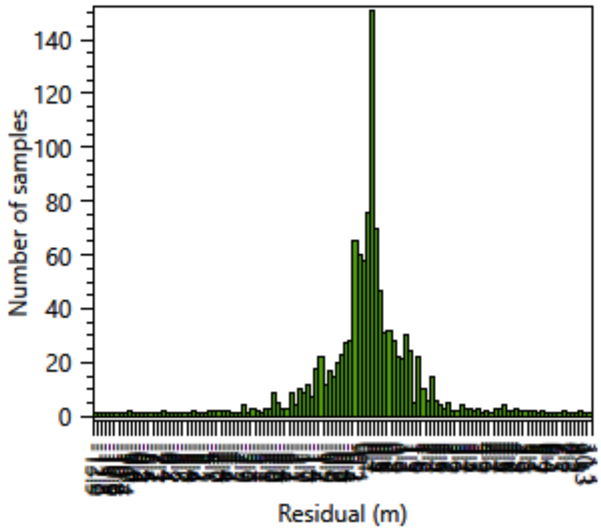


Transducer alignment report
Fugro Pioneer

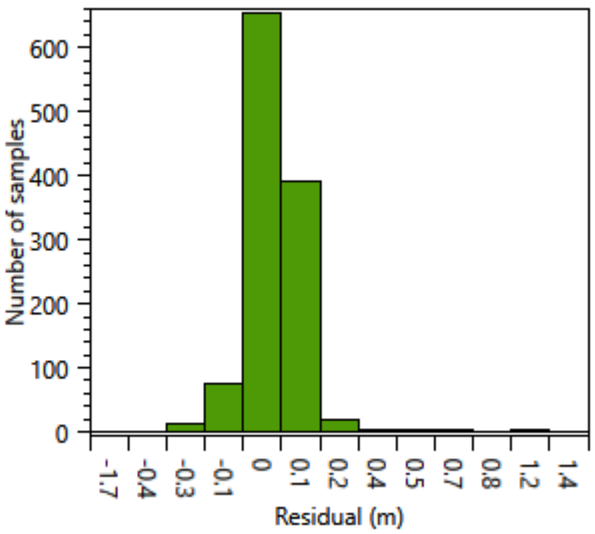
X residuals



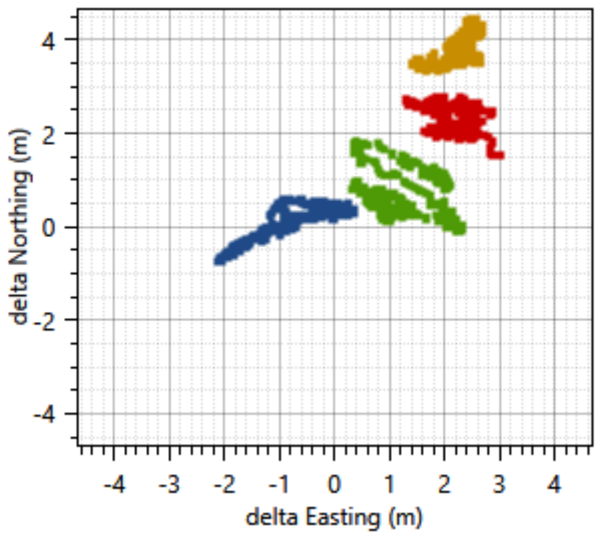
Y residuals



Z residuals



Vessel Track (SSBL Transducer)



QC

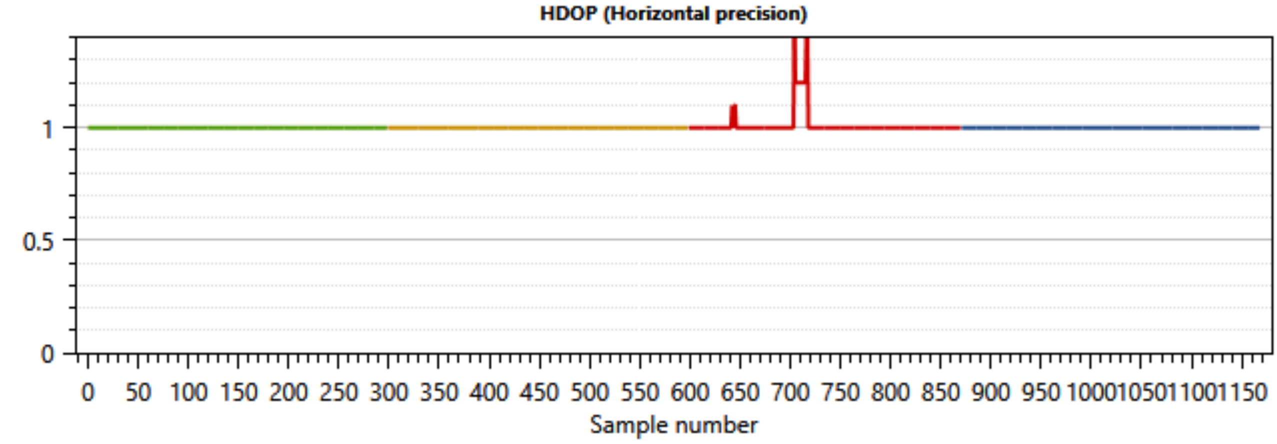
Acoustic

Logged series	Time start	Time stop	Avg. vessel hdg	Horizontal range to TP	Bearing to TP	Measured in series	Measurements used	# excluded (%)
1	22:27:37	22:33:46	35 °	1 m	35 °	300	299	1 (0.3)
2	18:32:24	18:38:29	125 °	4 m	125 °	300	300	0 (0.0)
3	21:59:46	22:06:46	215 °	4 m	215 °	300	272	28 (9.3)
4	19:17:26	19:23:17	320 °	2 m	320 °	300	298	2 (0.7)
					Total samples	1200	1169 (97.4%)	31 (2.6%)

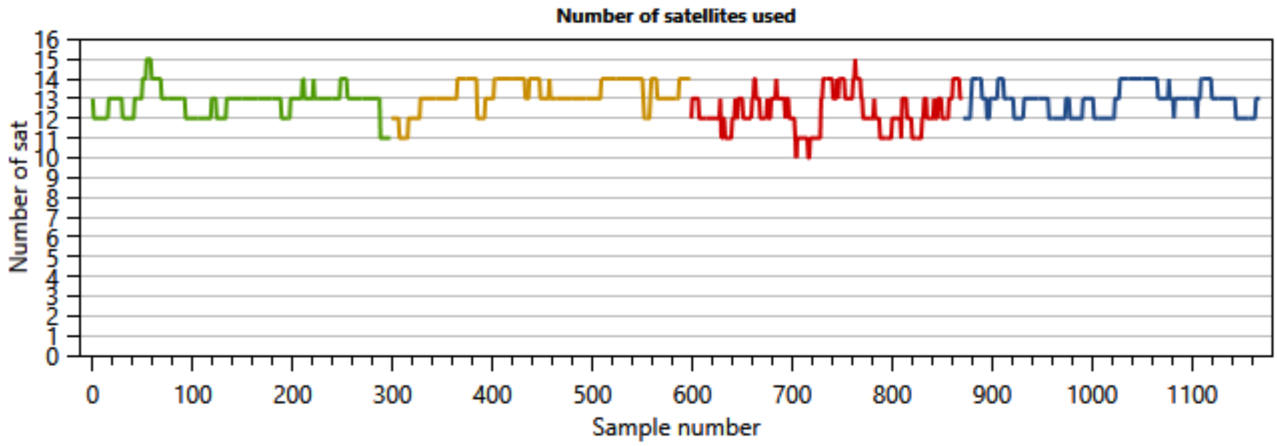
Sensor summary

Sensor	Parameter	Min	Average	Max
GPS	HDOP	1.00	1.00	1.40
	Satellite used	10	13	15
	Antenna delta height	-0.61 m	0.00 m	0.61 m
Attitude	Roll	-2.51 °	-0.28 °	1.44 °
	Pitch	-1.36 °	-0.07 °	1.50 °
	Heave	-0.32 m	0.00 m	0.35 m
	Heading	32.41 °	173.01 °	324.22 °
Calculated tide	Tide	1.97 m	2.13 m	2.26 m

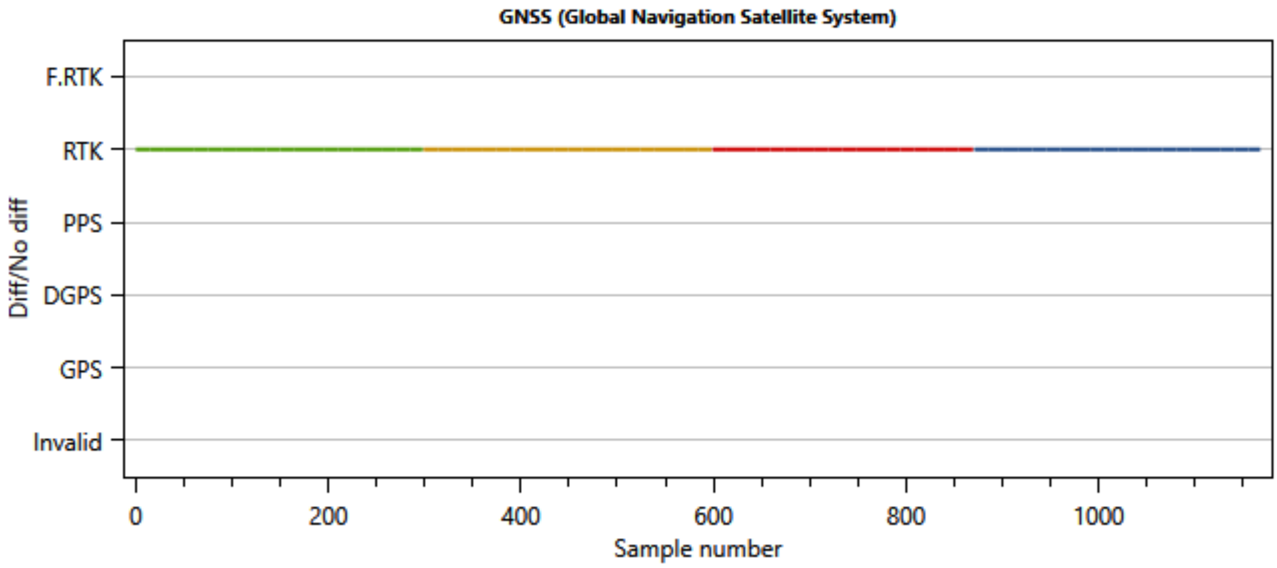
GPS



HDOP (Horizontal precision)
1
0.5
0
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050 1100 1150
Sample number

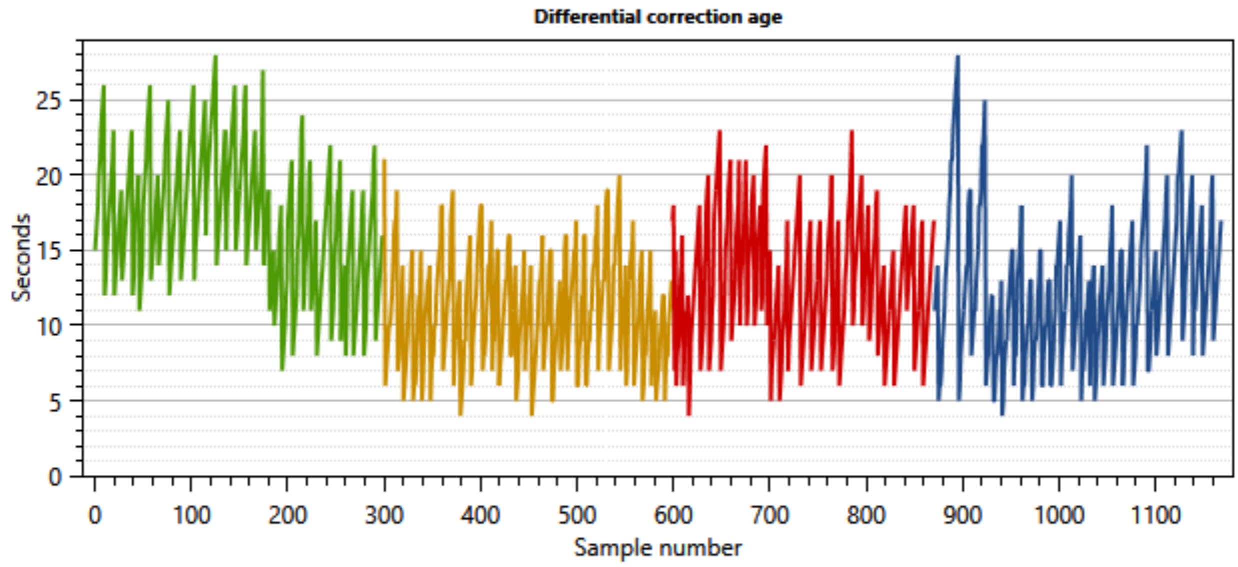


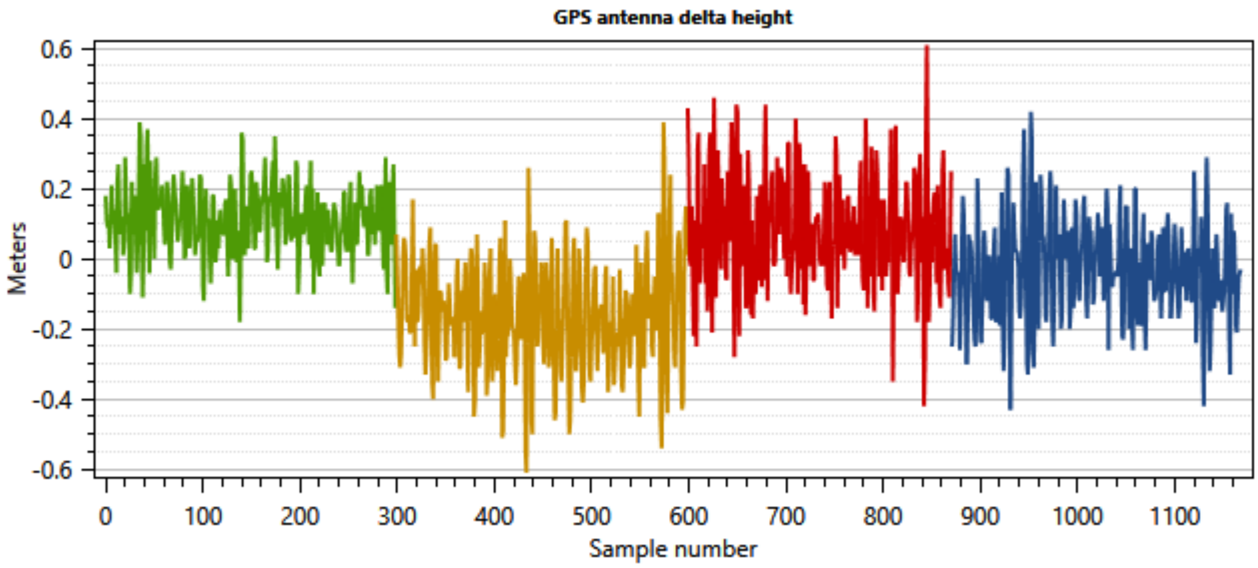
Number of satellites used
Number of sat
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
0 100 200 300 400 500 600 700 800 900 1000 1100
Sample number



GNSS (Global Navigation Satellite System)
Diff/No diff
F.RTK
RTK
PPS
DGPS
GPS
Invalid
0 200 400 600 800 1000
Sample number

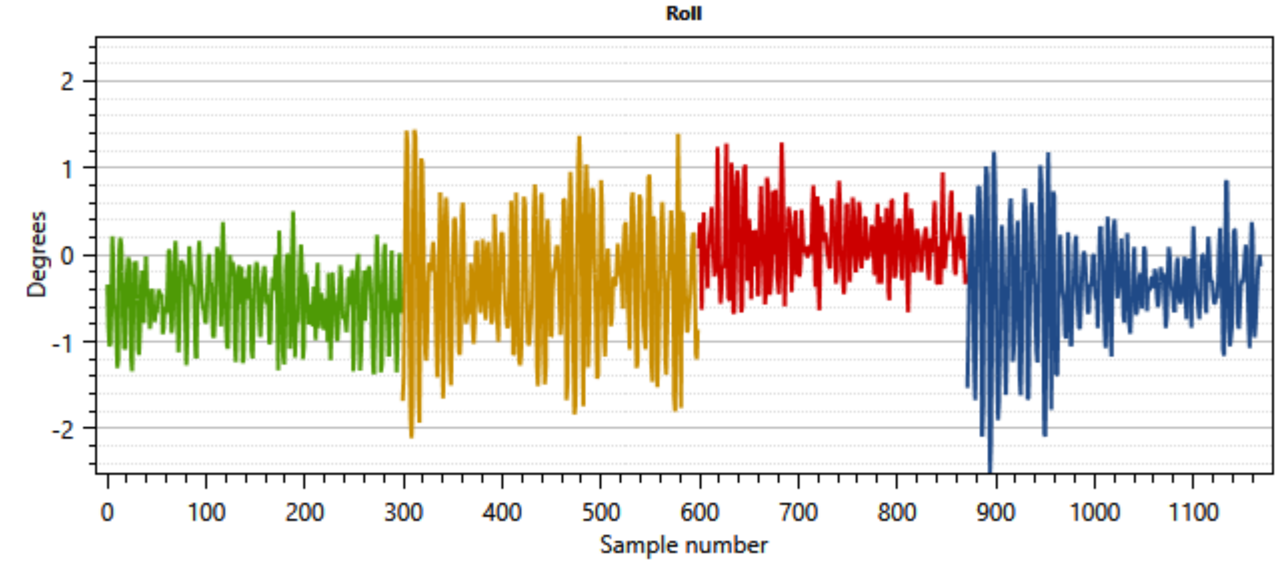
Transducer alignment report
Fugro Pioneer

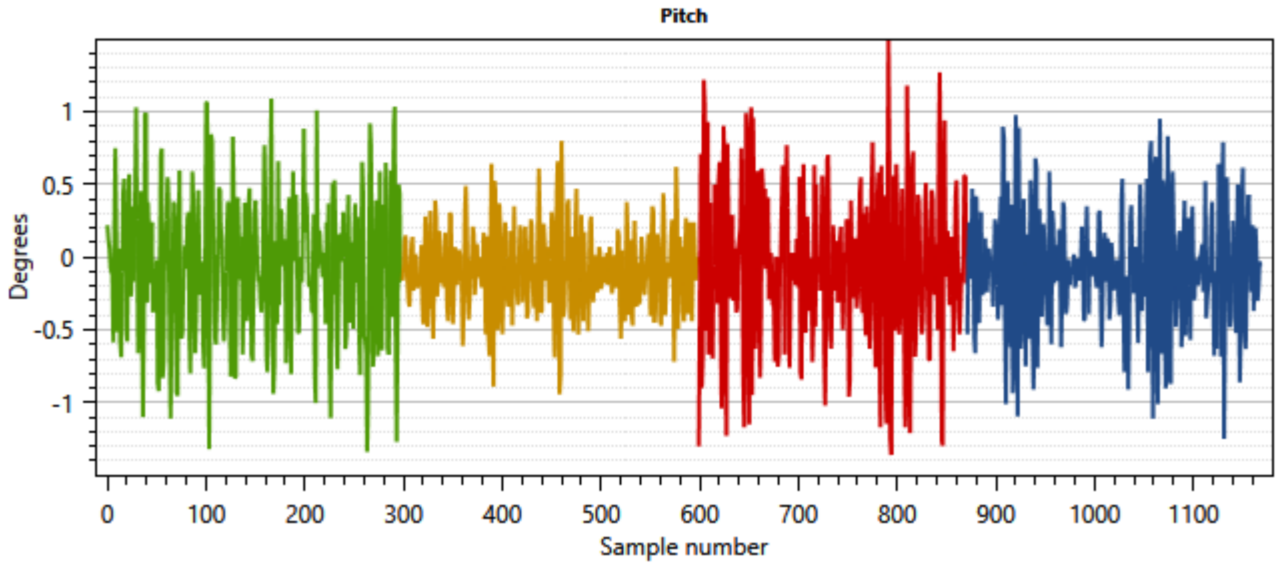


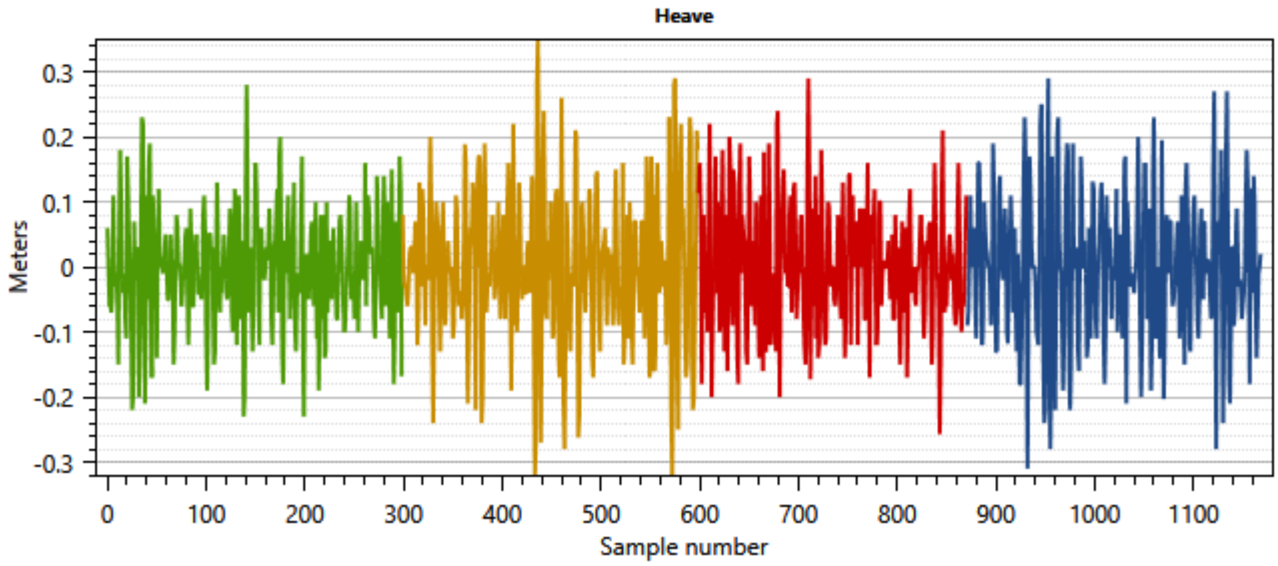


Transducer alignment report
Fugro Pioneer

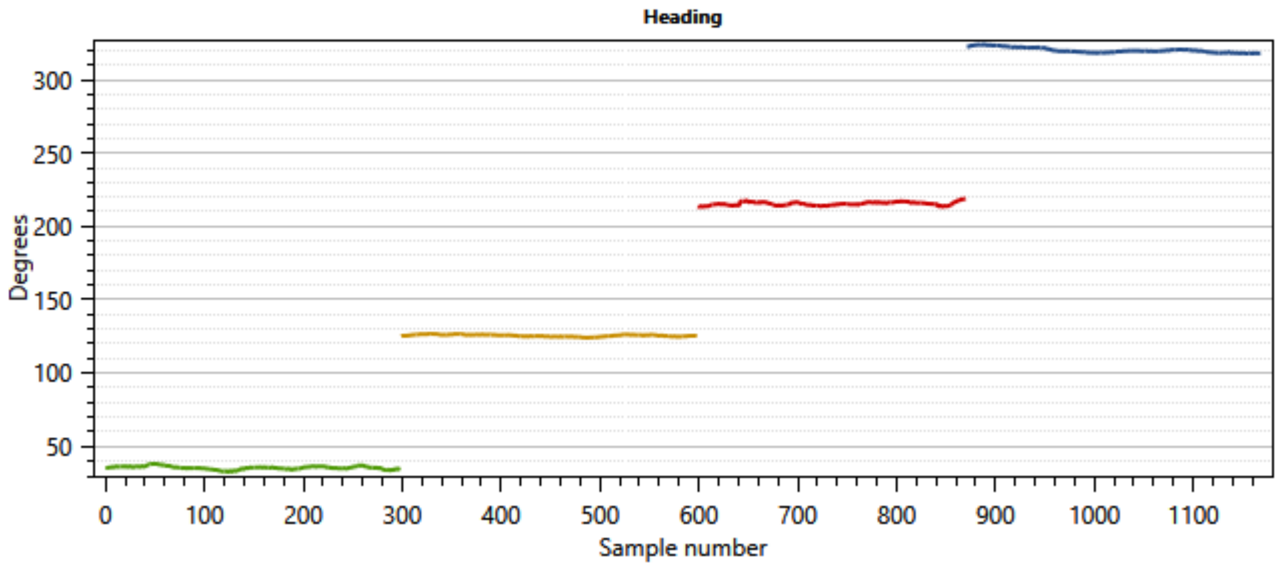
Attitude

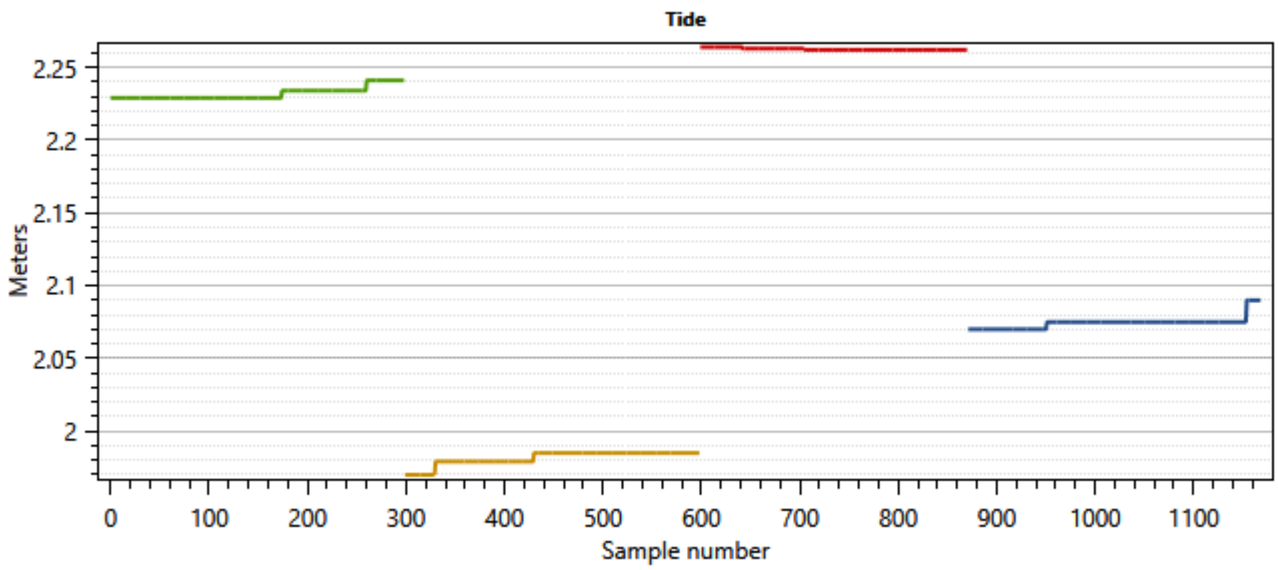


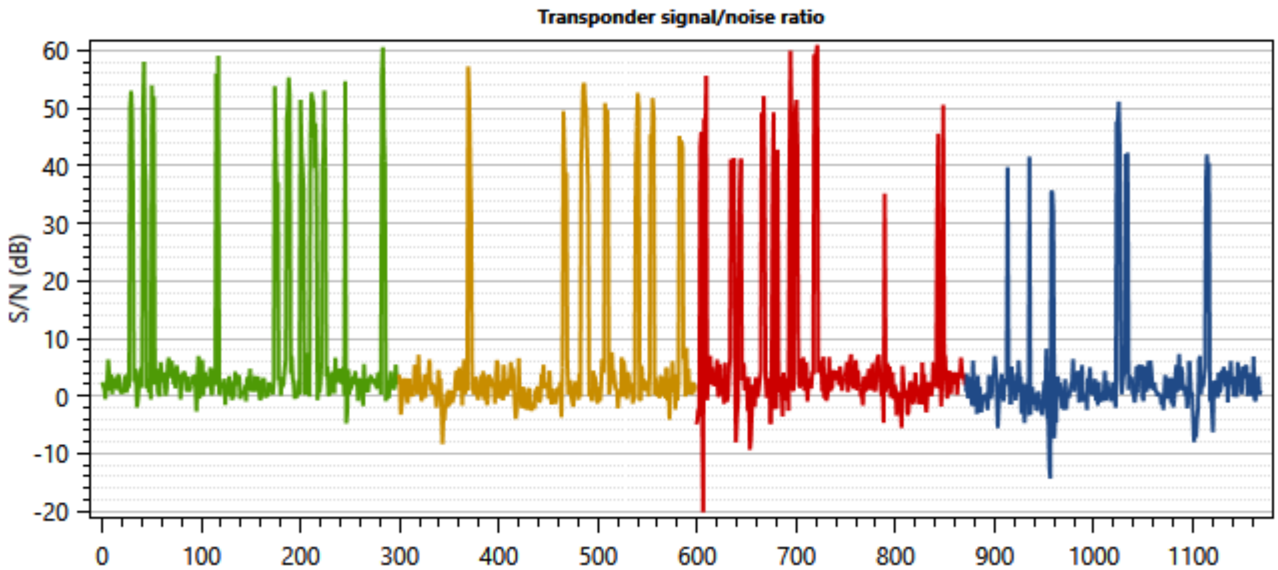




Transducer alignment report
Fugro Pioneer







Appendix

Explanation to page 1:

[1] Estimated angle accuracy
The angle accuracy is calculated based on the DRMS value for the horizontal transponder position and the average slant range to the transponder.

Angle accuracy (°) =ArcTan(DRMS/(average slant range))

[2] Estimated accuracy
The estimated angle accuracy presented as % of average slant range.

Calculated accuracy (%) =DRMS/(average slant range)*100

NOTE:
The estimated accuracies above includes error contribution from all sources (GPS, gyro, motion sensor, all lever arms, sound velocity, signal/noise, reflections). The accuracy specification for Kongsberg acoustic systems in technical documents are without error contribution from any of the above factors.

[3] Values "After correction"
APOS calculates these values for the various parameters based on a best-fit for the transponder position using the least squares method.

[4] 1-sigma values
This indicates what certainty the calculated values have. The values are one time the standard deviation of the measurements.

[5] Mean sound velocity
The mean value from the sound profile used. (Value calculated between the HiPAP Transducer depth and Transponder depth)

Company logo in the report header:
The Kongsberg logo can be replaced by a user-defined logo. The logo file must be in JPG or PNG format.

The logo file must be named "customer_logo.jpg" or "customer_logo.png" and copied to the \APOS\DATA folder.

Mean Position Report

Table 1: Project details

Project Name	F176286_Energinet_E_Islands_LOT2_A
Project Number	F176286_Energinet_E_Islands_LOT2_A
Client	Energinet
Project Type	Site Survey
Starfix Version	v2020.1124.9 (build 0)

Table 2: Geodesy summary

Name	ETRS89 / UTM zone 32N [ETRF2000-ITRF2014],DTU18 MSS height [DTU18 MSS]
Area of Use	Europe - 5°E to 12°E and ETRS89 by country
Code	25832,41366::2021.414,41073,41429
Type	Compound

Table 3: Session Details

Session	MPR-20210522233725-v1
Start Time	22 May 2021, 23:37:25Z
End Time	22 May 2021, 23:53:02Z
Session Length	15m 37s

Table 4: Mean Position for at

	ETRS89 / UTM zone 32N [ETRF2000-ITRF2014],DTU18 MSS height [DTU18 MSS]	ITRF2014 (EGM2008)
Latitude	58° 04′ 44.96014″ N	58° 04′ 44.97870″ N
Longitude	009° 43′ 21.95405″ E	009° 43′ 21.98549″ E
Height	-304.507 m Ell., 0.000 m	-304.479 m Ell., -342.934 m Ort.
Easting	542 627.253 m E (± 1.28 m)	
Northing	6 437 751.062 m N (± 0.97 m)	
Height	-342.330 m MSS (± 1.31 m) , 0.000 m (± 0.00 m)	

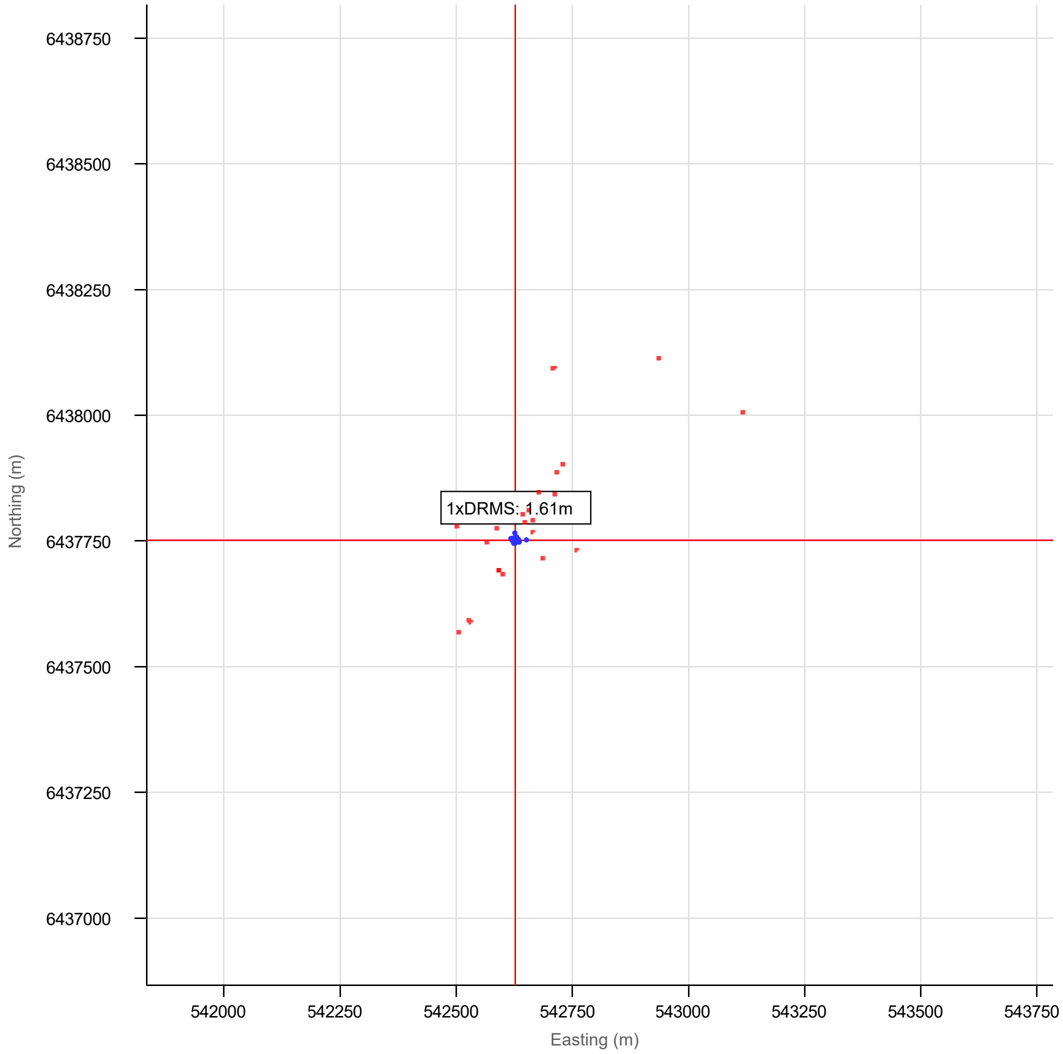
Table 5: Sensor Averages

Sensor	Sensor Average	SD
Heading	0.0° T, 0.0° G	± 0.0°
Pitch	0.00 °	± 0.00 °
Roll	0.00°	± 0.00°
Depth (Manual)	0.0 m	

Table 6: Usbl positioning - SIMRAD_HiPAP500/Usbl Calculation/B18 position

Position Source	Usbl positioning - SIMRAD_HiPAP500/Usbl Calculation/B18 position
Records	671 of 693
Position	542 627.253 m E, 6 437 751.062 m N ,-342.330 m MSS

Scatter Plot



Sensor Group	Easting	Northing
Usbl positioning - SIMRAD_HiPAP500/Usbl Calculation/B18 position	542 627.253 m E	6 437 751.062 m N

P.Miller	T.Wiseman	M.Hannah
Party Chief	Client Representative	Client Representative
FSBV (Fugro Survey B.V.)	Energinet	Energinet

USBL Calibration

Table 1: Project details

Project Name	F176286_Energinet_E_Islands_LOT2_A
Project Number	F176286_Energinet_E_Islands_LOT2_A
Data Logged Between	22 May 2021, 11:01:51Z and 22 May 2021, 16:06:24Z
Vessel	Fugro Pioneer
Client	Energinet
Project Type	Site Survey

Table 2: Calibration settings

Position Sensor	DGPS3-Starfix.G4 Plus-38603-Nmea filter (Offset: CentreOfGravity, X=0.00 m, Y=5.37 m, Z=-0.91 m)
Motion Sensor	Hydrins - PhoctInput (Offset: Pitch=0.00°, Roll=0.00°, Heading=0.00°)
Heading Sensor	Hydrins - NavigationLongInput (C-O: 0.00°)
USBL Sensor	SIMRAD_HiPAP500 (Offset: USBL low position, X=3.91 m, Y=3.56 m, Z=-7.05 m)
USBL Reference Location	CommonReferencePoint, X=0.00 m, Y=0.00 m, Z=0.00 m
Orientation	Vessel up, motion corrected
Beacon ID and/or Number	B18
Calculation Method	Single-stage
Sound Velocity Profile	Profile summarized below (Ray tracing done in USBL Topside, not Starfix)
Error Estimation	Position=50.00 m, Depth=10.0 m and Speed of Sound=3.0 m/s
Calibration Results Will Be Applied In	Starfix (not applied in Usbl Processor)

Table 3: Calibration results

		Before Calibration (Initial Settings)	After Calibration (Extended Cardinal Point)
Beacon Position			
Easting		542 626.803 m E	542 627.052 m E ± 0.01 m
Northing		6 437 751.293 m N	6 437 751.258 m N ± 0.01 m
Depth [m]		350.000 ISS	342.111 ISS ± 0.03
Transducer Offset Error			
Transducer to antenna [m]	X	0.00	0.00 ± 0.00
	Y	0.00	0.00 ± 0.00
	Z	0.00	0.00 ± 0.00
Sound Velocity			
Observed or calculated [m/s]		1482.2	1481.7 ± 0.14
Scale factor		1.000000000	0.999644541 ± 0.00
Attitude Corrections			
Pitch [°]		0.00	-0.03 ± 0.00
Roll [°]		0.00	0.06 ± 0.00
Orientation [°]		0.00	-0.03 ± 0.01
			Observations accepted: 6336 Observations rejected: 131

Table 4: Statistics of calculated horizontal beacon positions

	Before Calibration (Initial Settings)		After Calibration (Extended Cardinal Point)	
Percentile [%]	Distance [m]	Percentage of Depth [%]	Distance [m]	Percentage of Depth [%]
39.4 (1 sigma)	0.38	0.11	0.19	0.06
50.0 (CEP)	0.44	0.13	0.23	0.07
63.2 (1 DRMS)	0.51	0.15	0.28	0.08
86.5 (2 sigma)	0.69	0.20	0.41	0.12
98.2 (2 DRMS)	1.02	0.30	0.81	0.24

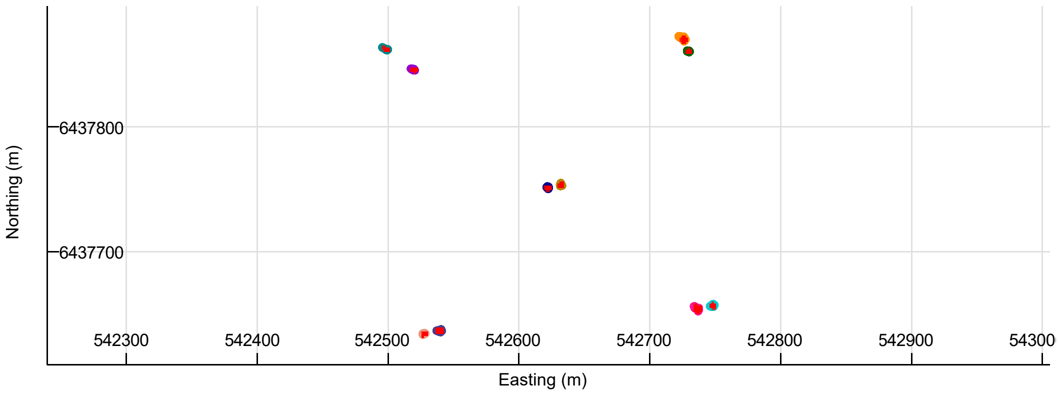


Figure 1: Position plot - vessel position

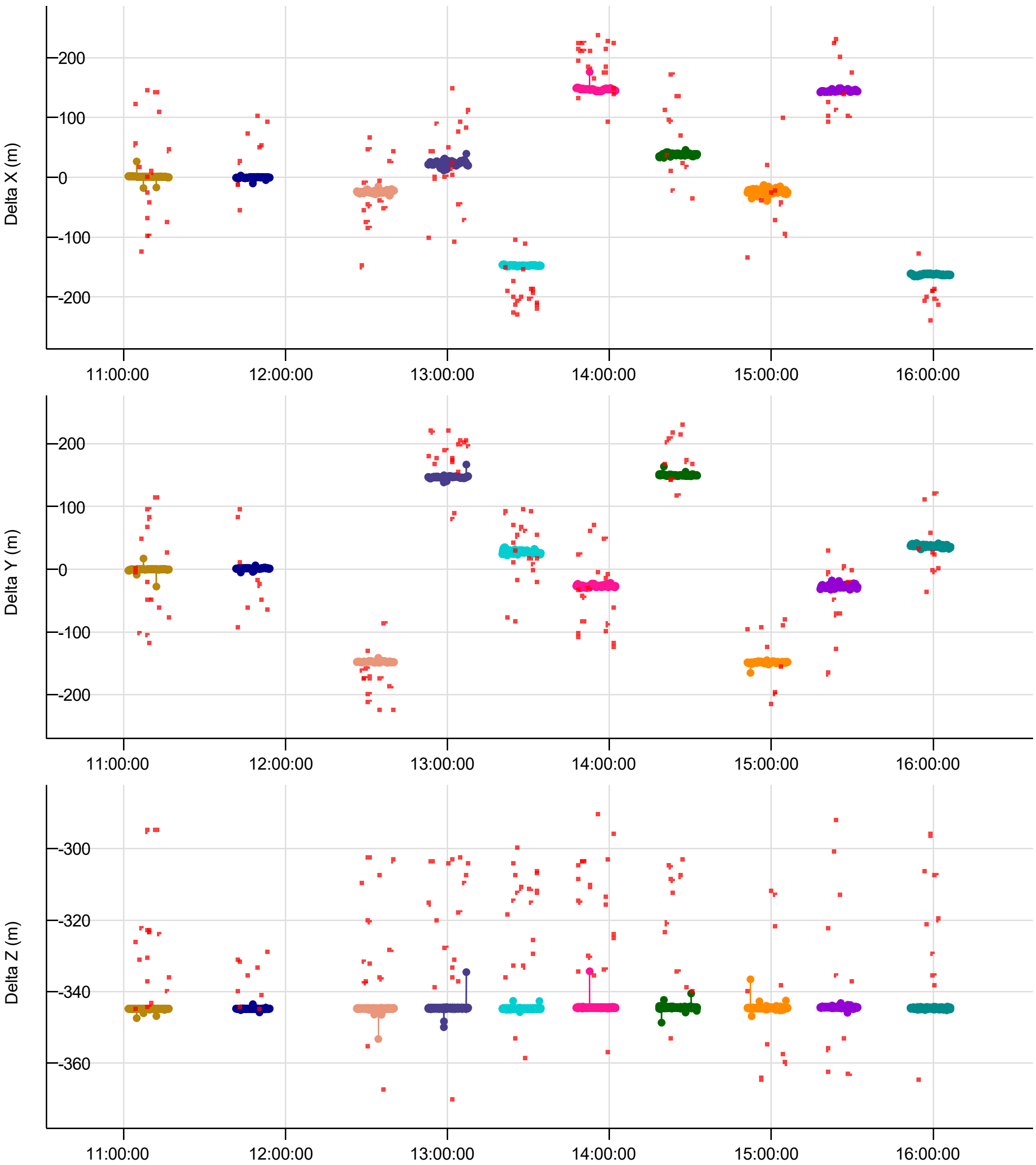


Figure 2: Time series plots

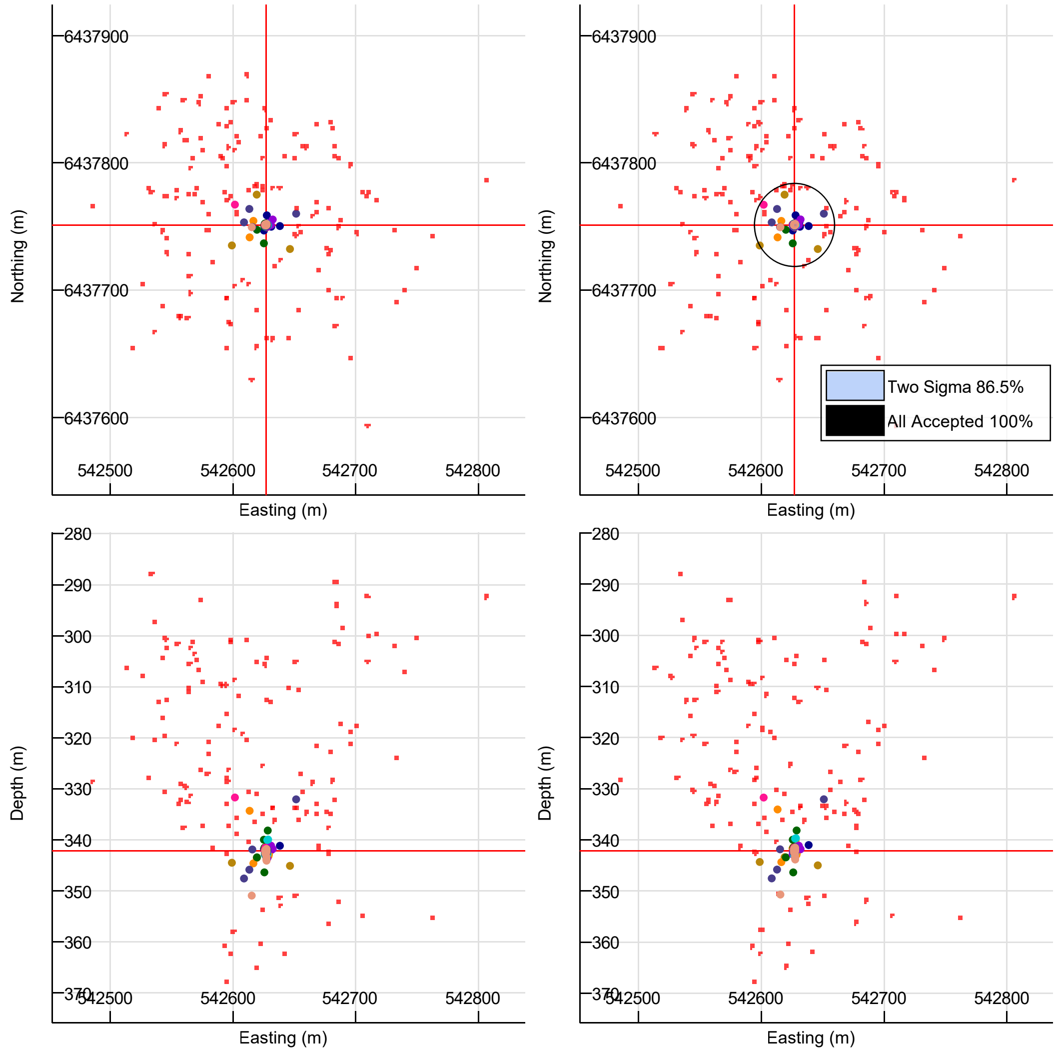


Figure 3: Scatter plots (before and after) - beacon position

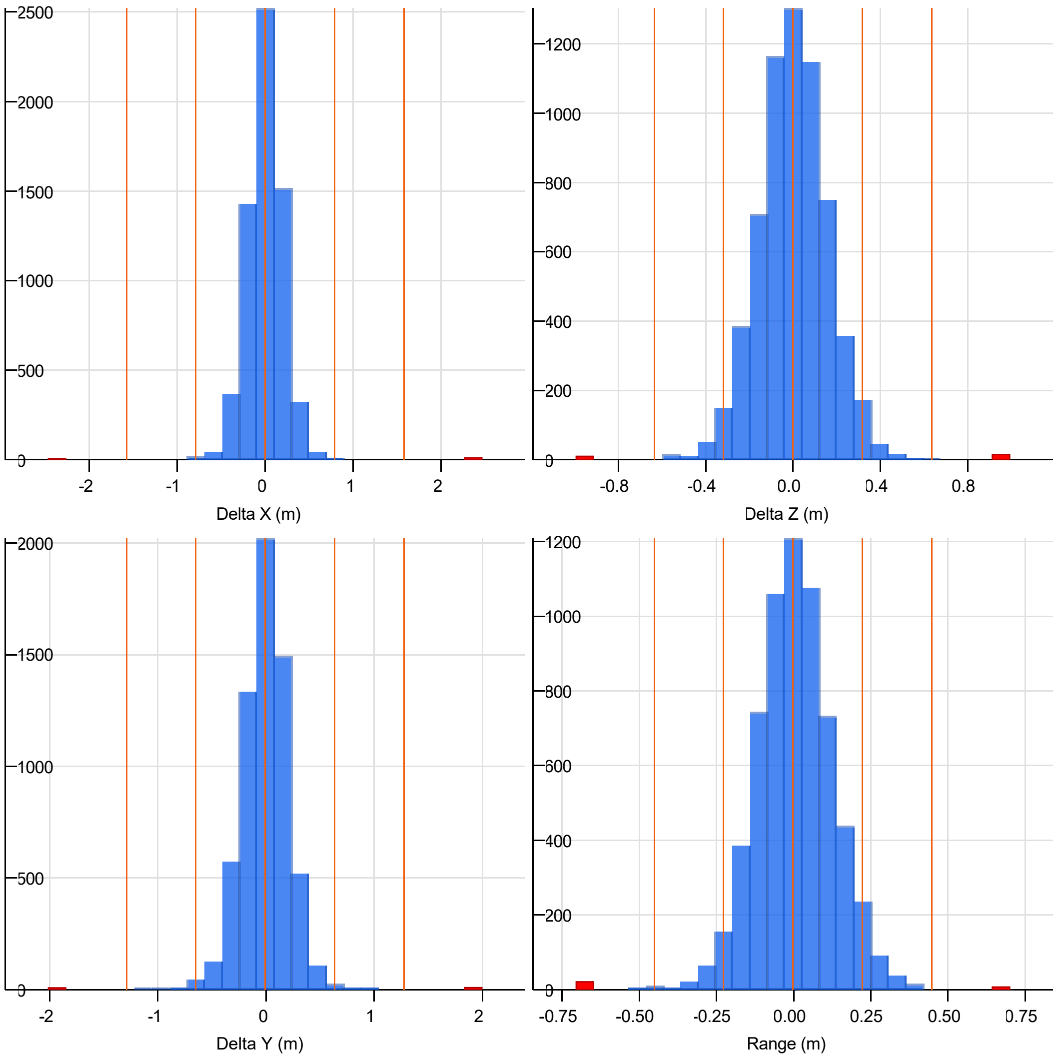


Figure 4: Range and delta residuals

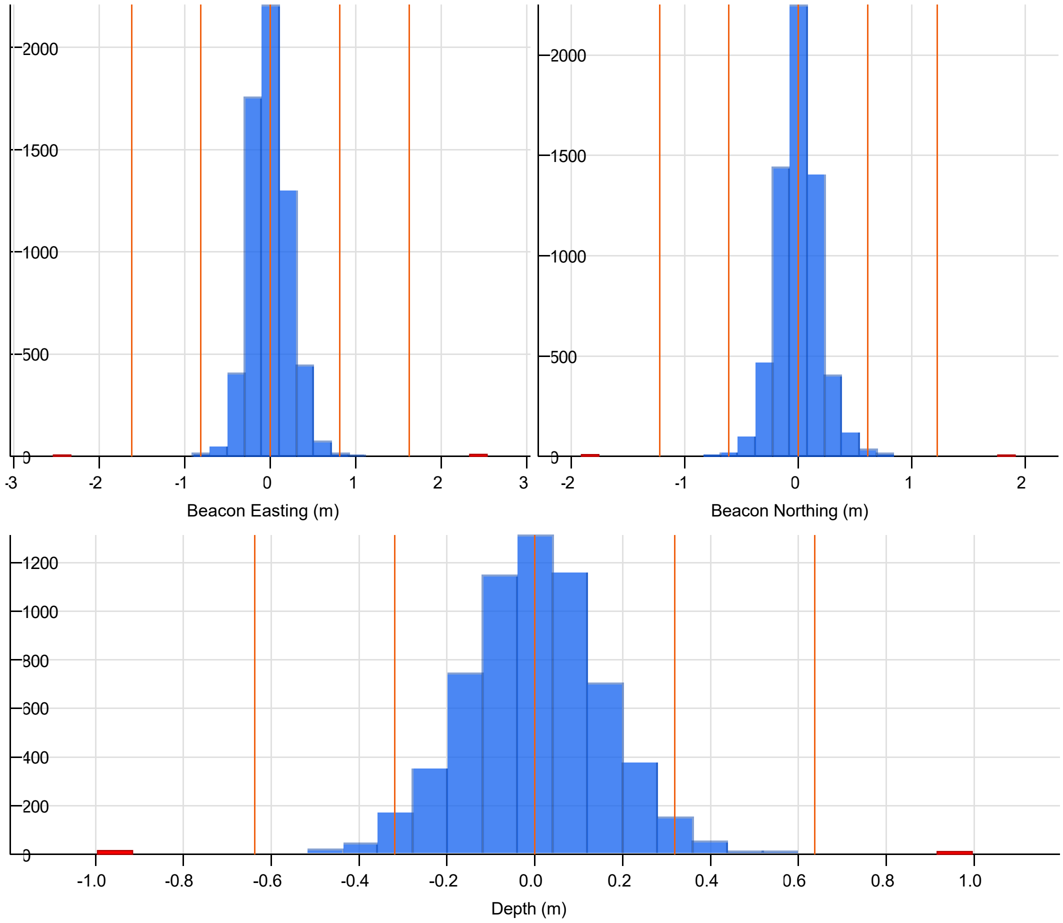


Figure 5: Position residuals

Table 5: Sound velocity profiles

Profile	Position WGS 84	Time	Average Sound Velocity [m/s]	Color
167		12 May 2021, 00:00:59Z	1502.7	

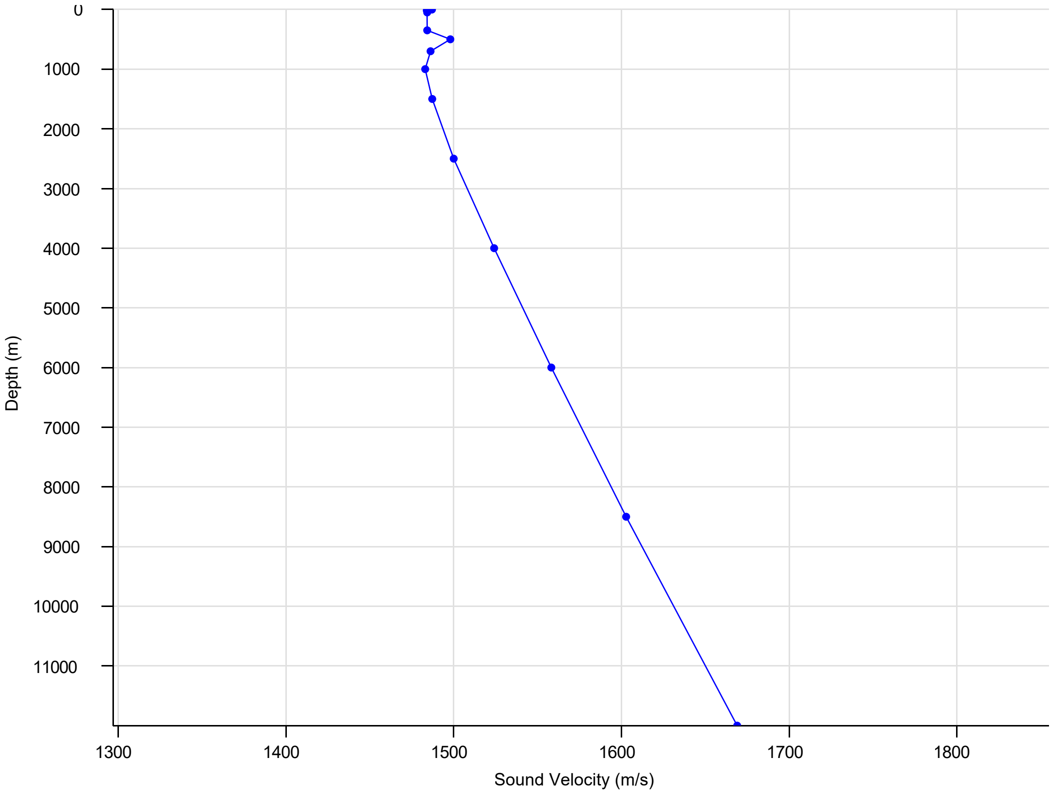


Figure 6: Sound velocity graph

P.Miller	T.Wiseman	M.Hannah
Party Chief	Client Representative	Client Representative
FSBV (Fugro Survey B.V.)	Energinet	Energinet

Mean Position Report

Table 1: Project details

Project Name	F176286_Energinet_E_Islands_LOT2_A
Project Number	F176286_Energinet_E_Islands_LOT2_A
Client	Energinet
Project Type	Site Survey
Starfix Version	v2020.1124.9 (build 0)

Table 2: Geodesy summary

Name	ETRS89 / UTM zone 32N [ETRF2000-ITRF2014],DTU18 MSS height [DTU18 MSS]
Area of Use	Europe - 5°E to 12°E and ETRS89 by country
Code	25832,41366::2021.414,41073,41429
Type	Compound

Table 3: Session Details

Session	MPR_Bcn B18-20210521195113-v1
Start Time	22 May 2021, 10:06:29Z
End Time	22 May 2021, 10:23:08Z
Session Length	16m 39s

Table 4: Mean Position for at

	ETRS89 / UTM zone 32N [ETRF2000-ITRF2014],DTU18 MSS height [DTU18 MSS]	ITRF2014 (EGM2008)
Latitude	58° 04′ 44.96777″ N	58° 04′ 44.98633″ N
Longitude	009° 43′ 21.92675″ E	009° 43′ 21.95819″ E
Height	-304.191 m Ell., 0.000 m	-304.163 m Ell., -342.618 m Ort.
Easting	542 626.803 m E (± 0.17 m)	
Northing	6 437 751.293 m N (± 0.20 m)	
Height	-342.014 m MSS (± 0.16 m) , 0.000 m (± 0.00 m)	

Table 5: Sensor Averages

Sensor	Sensor Average	SD
Heading	0.0° T, 0.0° G	± 0.0°
Pitch	0.00 °	± 0.00 °
Roll	0.00°	± 0.00°
Depth (Manual)	350.0 m	

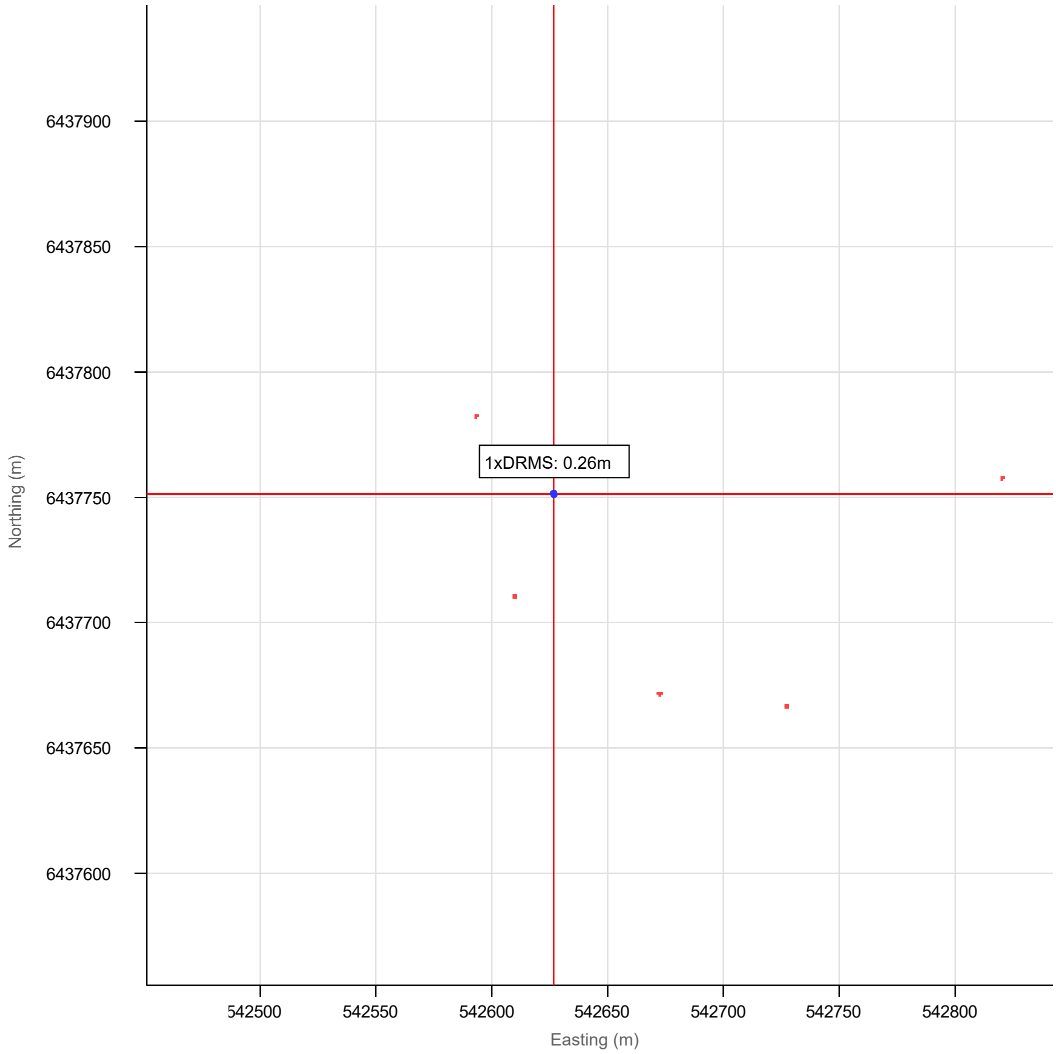
Table 6: Mean Position to Target

Target	Transponder B18
Position	542 627.107 m E, 6 437 751.025 m N
Range	0.24 m Grid
Bearing To	82.0° G
Bearing From	262.0° G

Table 7: Usbl positioning - SIMRAD_HiPAP500/Usbl Calculation/B18 position

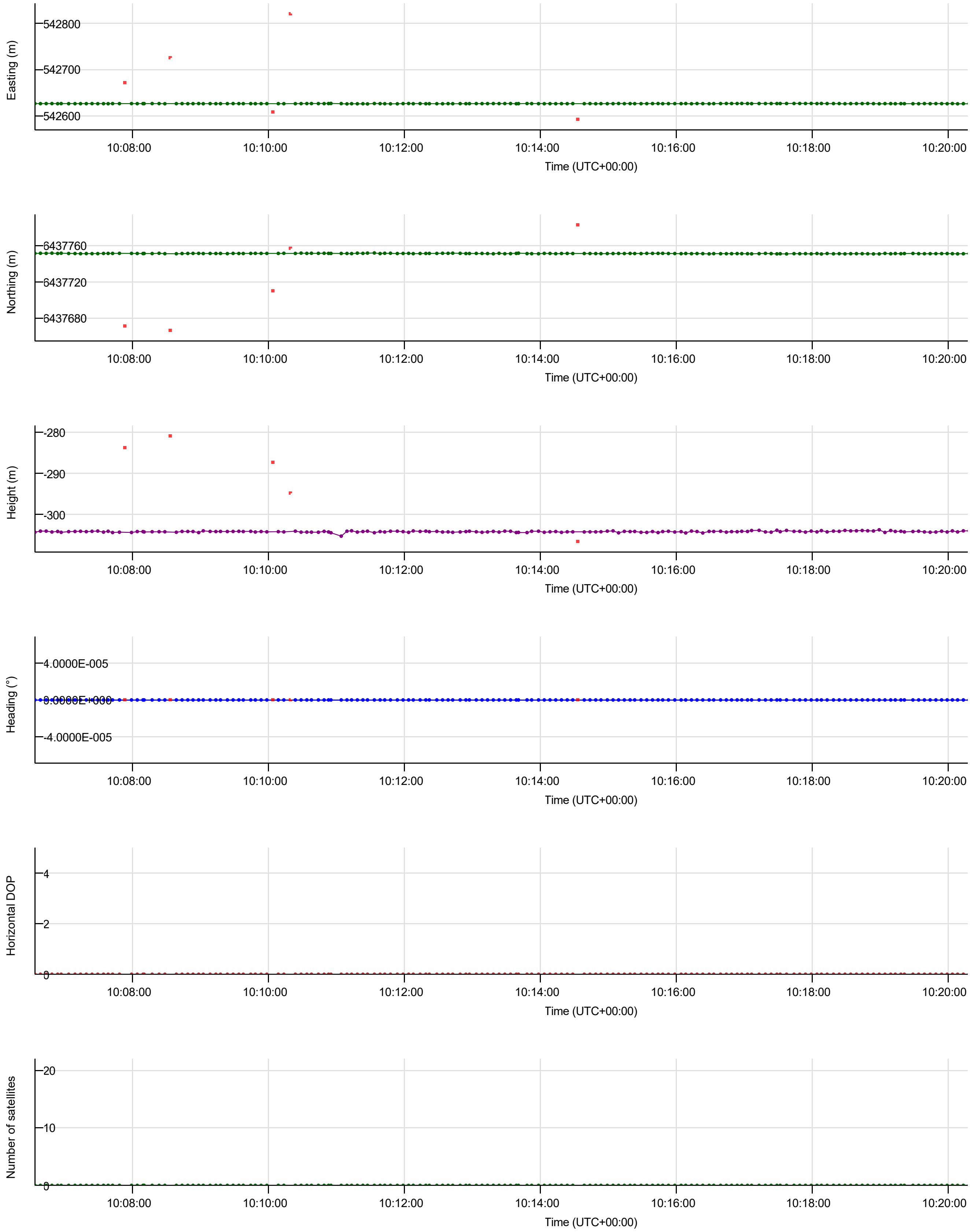
Position Source	Usbl positioning - SIMRAD_HiPAP500/Usbl Calculation/B18 position
Records	195 of 200
Position	542 626.803 m E, 6 437 751.293 m N ,-342.014 m MSS

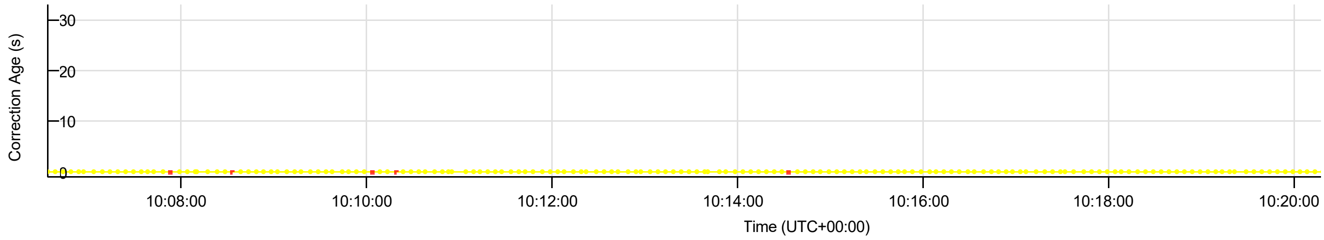
Scatter Plot



Sensor Group	Easting	Northing
Usbl positioning - SIMRAD_HiPAP500/Usbl Calculation/B18 position	542 626.803 m E	6 437 751.293 m N

Time series plots for Usbl positioning - SIMRAD_HiPAP500/Usbl Calculation/B18 position





P.Miller	T.Wiseman	M.Hannah
Party Chief	Client Representative	Client Representative
FSBV (Fugro Survey B.V.)	Energinet	Energinet

USBL Calibration

Table 1: Project details

Project Name	F176286_Energinet_E_Islands_LOT2_A
Project Number	F176286_Energinet_E_Islands_LOT2_A
Data Logged Between	22 May 2021, 18:30:53Z and 22 May 2021, 22:39:40Z
Vessel	Fugro Pioneer
Client	Energinet
Project Type	Site Survey

Table 2: Calibration settings

Position Sensor	DGPS3-Starfix.G4 Plus-38603-Nmea filter (Offset: CentreOfGravity, X=0.00 m, Y=5.37 m, Z=-0.91 m)
Motion Sensor	Hydrins - PhoctInput (Offset: Pitch=0.00°, Roll=0.00°, Heading=0.00°)
Heading Sensor	Hydrins - NavigationLongInput (C-O: 0.00°)
USBL Sensor	SIMRAD_HiPAP500 (Offset: USBL low position, X=3.91 m, Y=3.56 m, Z=-7.05 m)
USBL Reference Location	CommonReferencePoint, X=0.00 m, Y=0.00 m, Z=0.00 m
Orientation	Vessel up, motion corrected
Beacon ID and/or Number	B18
Calculation Method	Single-stage
Sound Velocity Profile	Not used in StarfixNG
Error Estimation	Position=50.00 m, Depth=10.0 m and Speed of Sound=3.0 m/s
Calibration Results Will Be Applied In	Starfix (not applied in Usbl Processor)

Table 3: Calibration results

		Before Calibration (Initial Settings)	After Calibration (Spin Test)
Beacon Position			
Easting		542 626.803 m E	542 626.719 m E ± 0.02 m
Northing		6 437 751.293 m N	6 437 750.902 m N ± 0.02 m
Depth [m]		350.000 ISS	342.334 ISS ± 0.02
Transducer Offset Error			
Transducer to antenna [m]	X	0.00	0.00 ± 0.00
	Y	0.00	0.00 ± 0.00
	Z	0.00	0.00 ± 0.00
Sound Velocity			
Observed or calculated [m/s]		1482.2	1482.2 ± 0.00
Scale factor		1.000000000	1.000000000 ± 0.00
Attitude Corrections			
Pitch [°]		0.00	0.00 ± 0.00
Roll [°]		0.00	0.00 ± 0.00
Orientation [°]		0.00	0.00 ± 0.00
			Observations accepted: 2488 Observations rejected: 59

Table 4: Statistics of calculated horizontal beacon positions

	Before Calibration (Initial Settings)		After Calibration (Spin Test)	
Percentile [%]	Distance [m]	Percentage of Depth [%]	Distance [m]	Percentage of Depth [%]
39.4 (1 sigma)	0.81	0.24	0.81	0.24
50.0 (CEP)	0.99	0.29	0.99	0.29
63.2 (1 DRMS)	1.33	0.39	1.33	0.39
86.5 (2 sigma)	3.13	0.91	3.13	0.91
98.2 (2 DRMS)	7.05	2.06	7.05	2.06

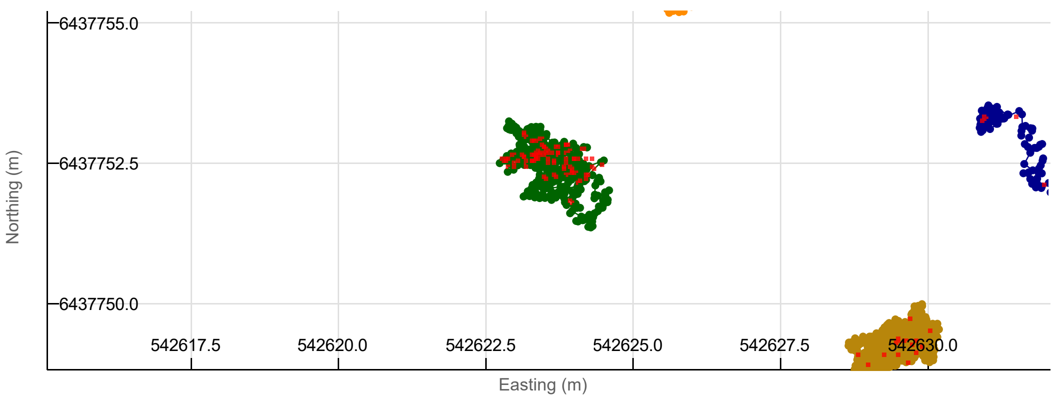


Figure 1: Position plot - vessel position

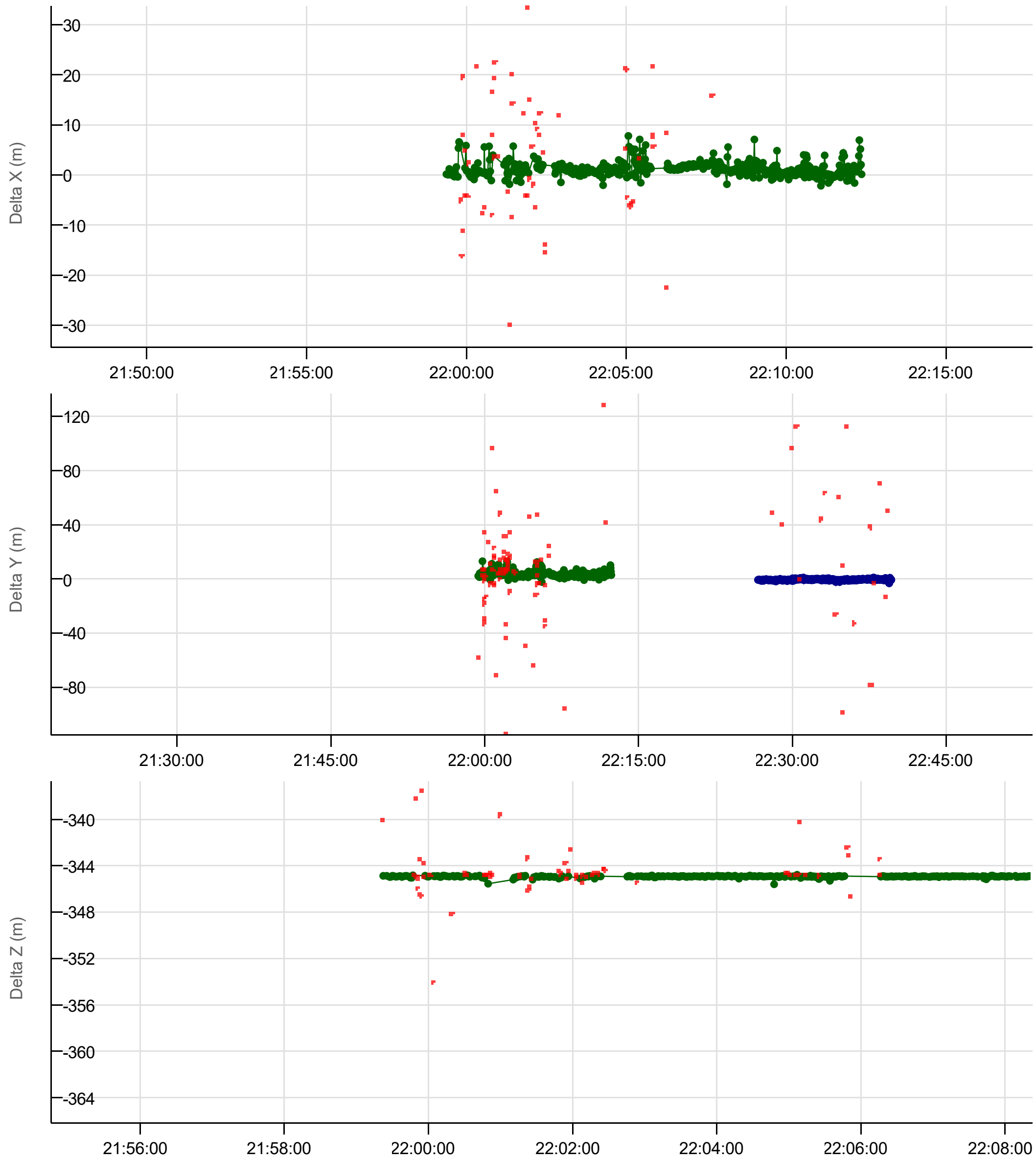


Figure 2: Time series plots

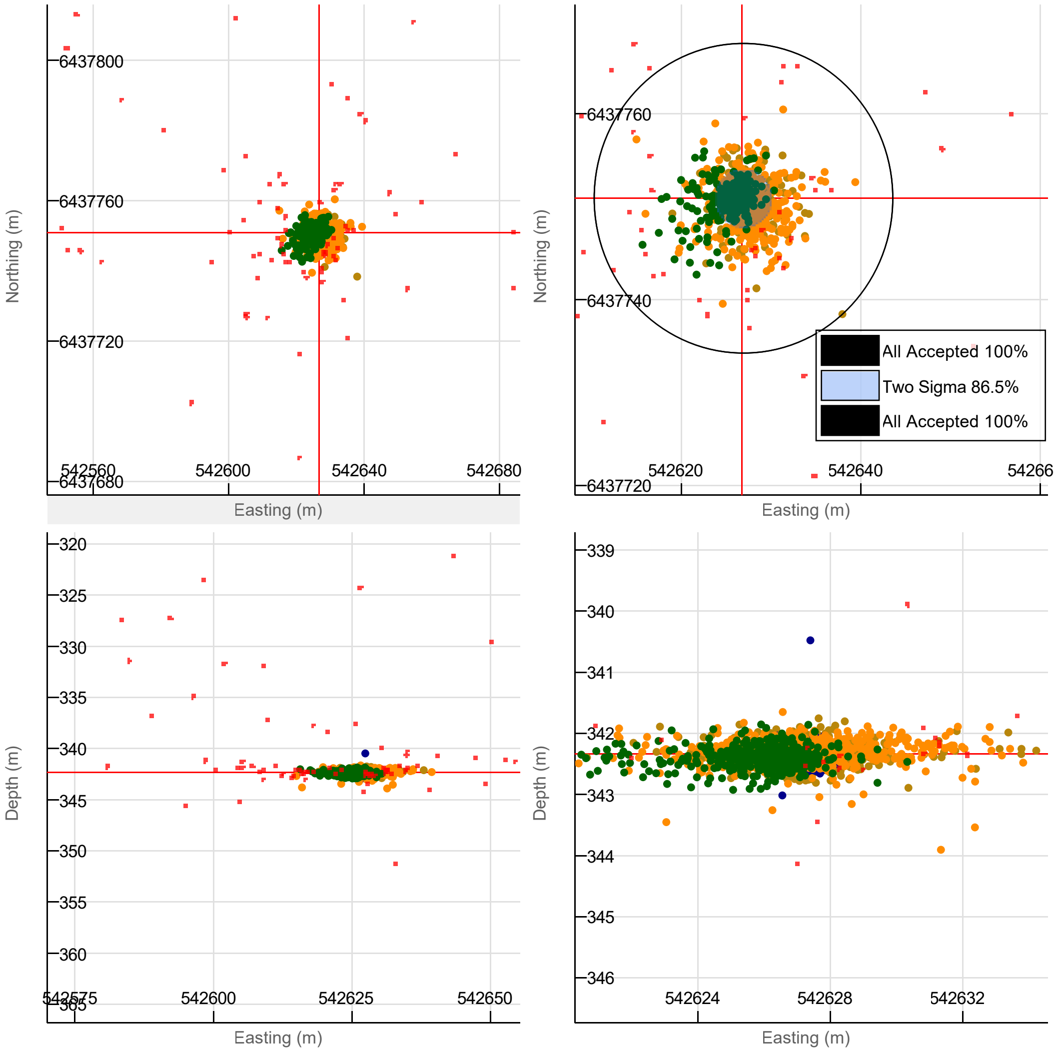


Figure 3: Scatter plots (before and after) - beacon position

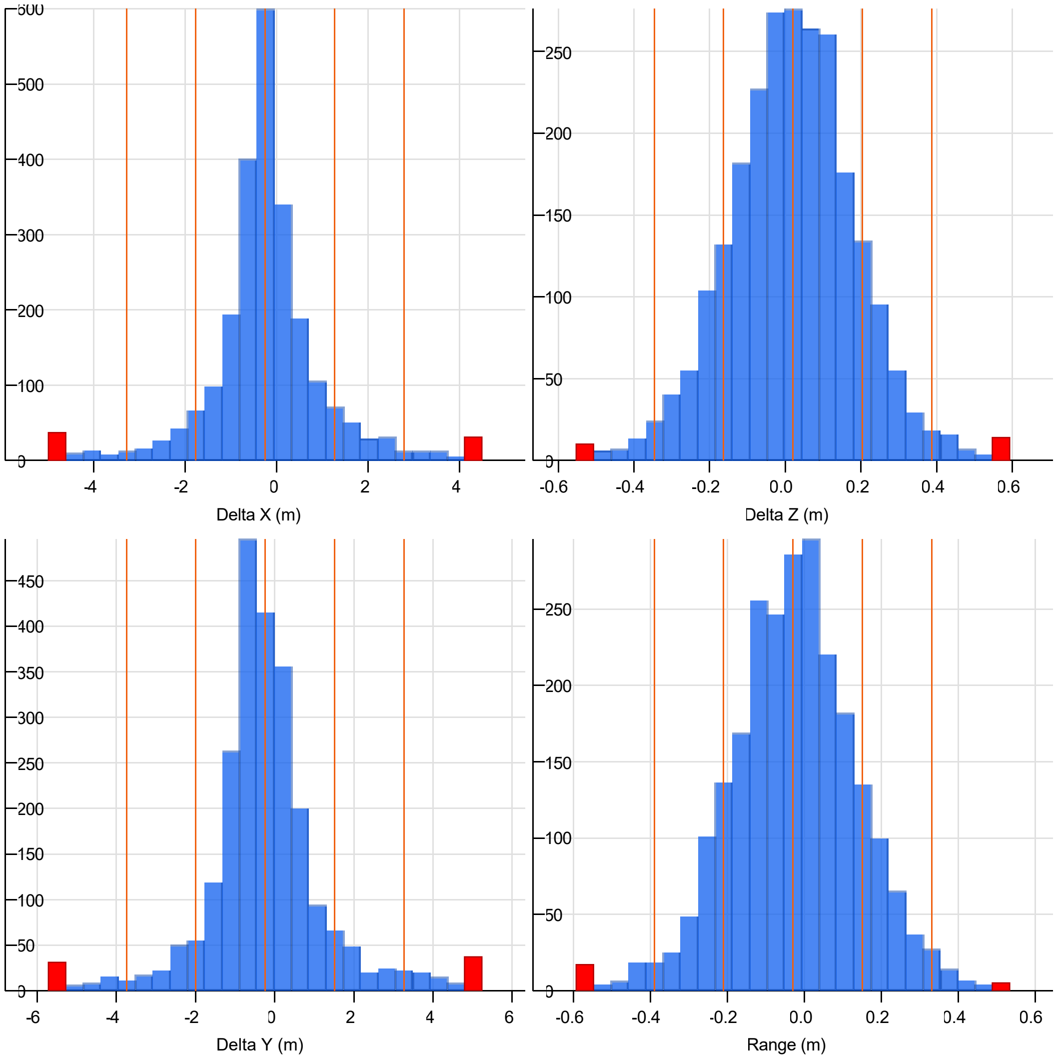


Figure 4: Range and delta residuals

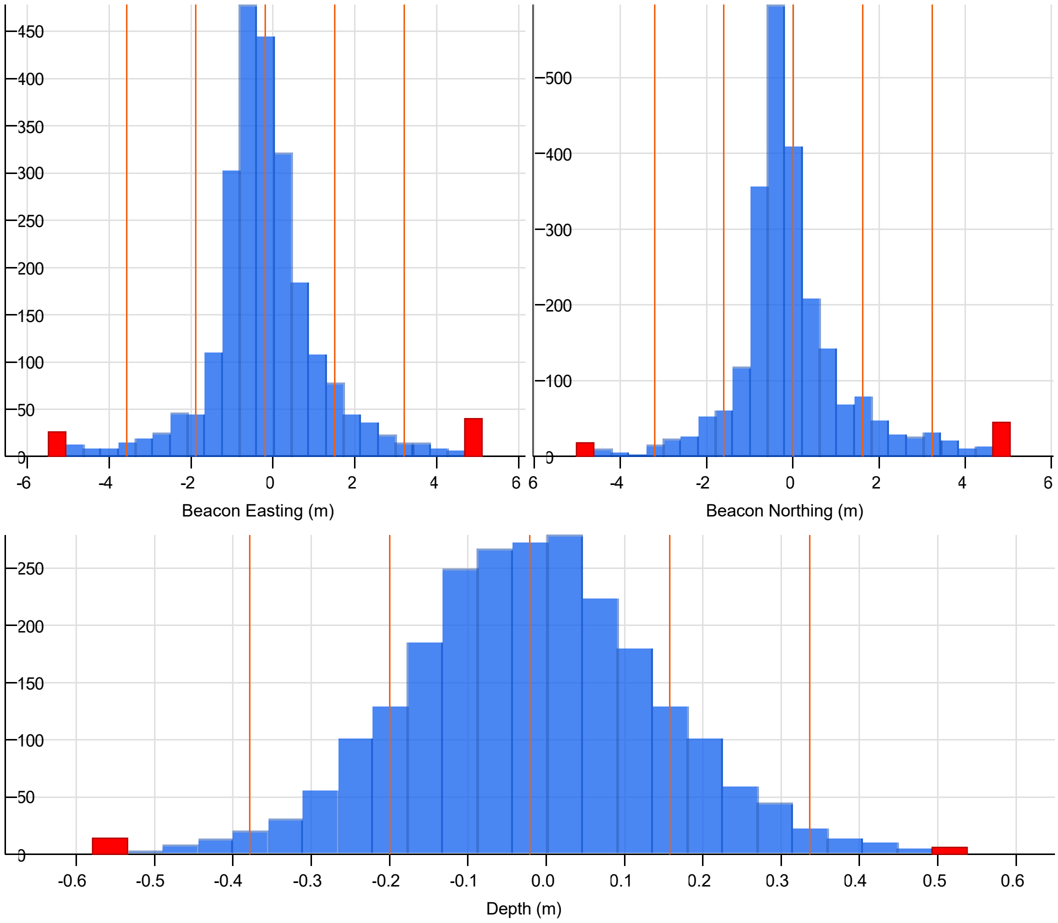


Figure 5: Position residuals

P.Miller	T.Wiseman	M.Hannah
Party Chief	Client Representative	Client Representative
FSBV (Fugro Survey B.V.)	Energinet	Energinet

Fugro Pioneer USBL Calibration Report

SUMMARY

Table 1.1: Summary

Introduction	
Survey Date:	22 May 2021. All times Local (UTC+2)
Location:	Skagerrak, Denmark. WGS-84 position: 58°04'44.98"N, 009°43'21.95"E, WD: 350 m
Weather Conditions:	Wind: WSW 4/5, Sea state 3, Waves height: 0.8 – 1.1m
Coordinate System:	Datum: ETRS89. Projection: UTM Zone 32N, CM 9°W
Personnel:	Ricardo Williams, Vincenzo Cedro
Equipment	
Kongsberg HiPAP 501 USBL SW H 4.3.5.5 Kongsberg APOS WinHPRU Version 6.8.2.3 Kongsberg cNODE Maxi (S/N 119518 B18) Fugro StarPack (DGPS 3 G4+) iXblue Hydrins	
Sequence of Events	
Before departure to the survey site, the cNode Maxi transponder was tested over the side to verify acoustic connection and battery capacity. Fugro Pioneer then transited to Skagerrak and arrived at 09:50. After a toolbox talk, an SVP was carried out and the HiPAP pole was deployed. The cNode Maxi was deployed to the seabed with clump weights (approx. 125kg) at 12:00. The extended 4-cardinal points survey procedure commenced at 13:00 and finished at 18:00, results were then computed. An offset spin verification was carried out between 21:00 and 00:30 overnight with a couple of hours break for poor weather conditions. Thereafter the vessel stood by, awaiting first light. At 07:30 a toolbox was conducted for the recovery. The transponder was released from the seabed with the hydrostatic release and recovered to Fugro Pioneer at 08:00.	
Conclusion	
The HiPAP USBL system on board Fugro Pioneer was successfully calibrated for Roll, Pitch and Orientation. Calibration results were confirmed by a USBL verification.	

1. PREPARATION

1.1 Attitude and Heading

The Hydrins was providing corrected pitch, roll and heading to the HiPAP system. The Hydrins was corrected for attitudes and was aligned with the vessel reference frame. The Hydrins lever arms were set for the HiPAP reference position.

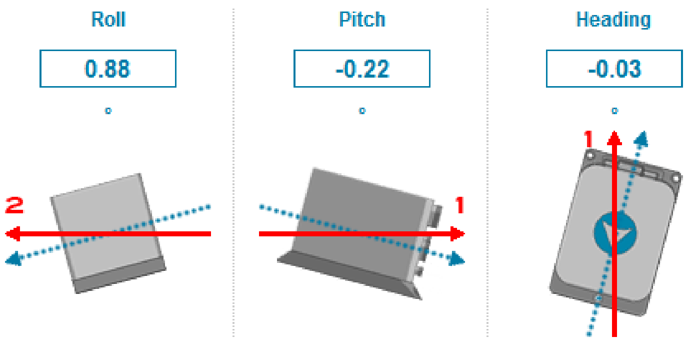


Figure 1.1: Hydrins alignments

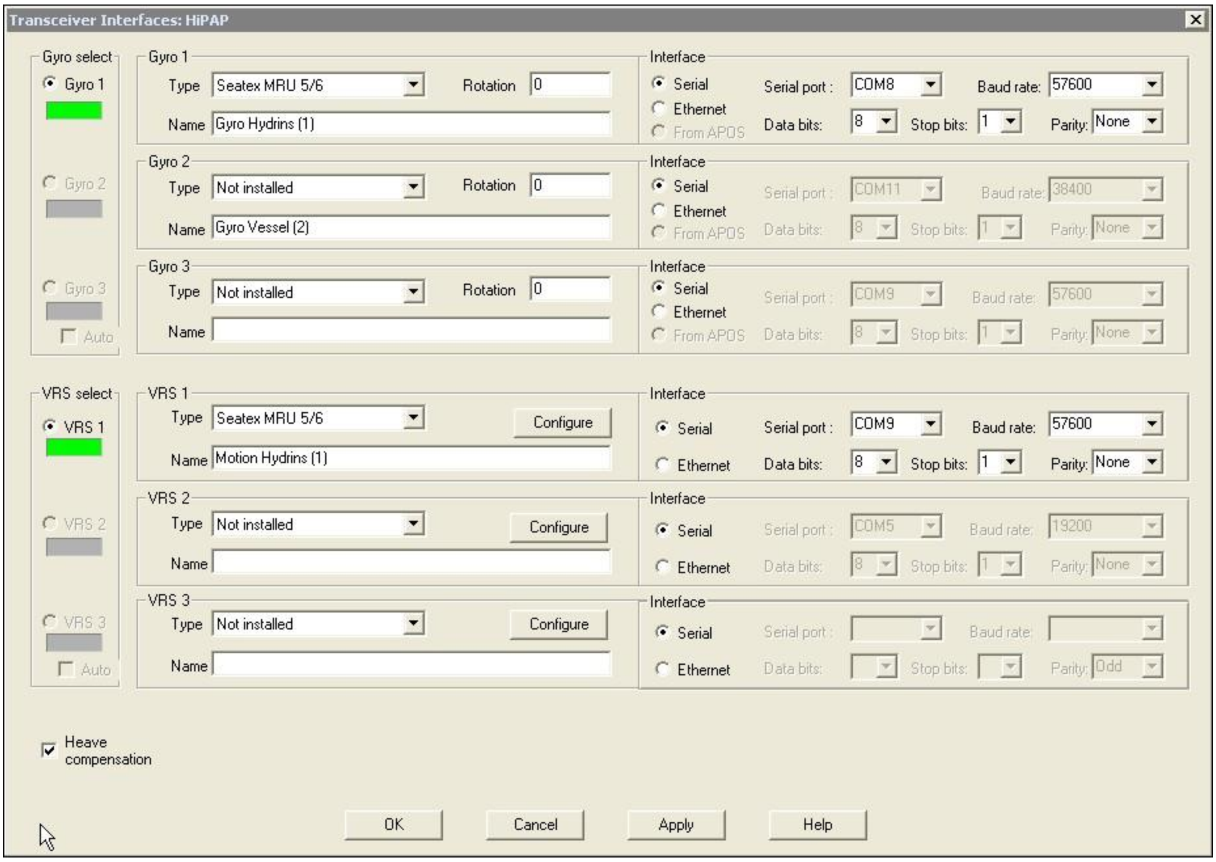


Figure 1.2: HiPAP Attitude sensors in APOS

1.2 Offsets

USBL transceiver offsets were measured by laser scanner in dry dock during construction in 2014, both in the raised and deployed (lowered) position. The deployed offsets were entered into the APOS transceiver configuration.

The DGPS and motion data received by the HiPAP system were already CRP referenced so there was no need to enter offsets in APOS.

Table 1.1: Calibration Offsets

Name	X	Y	Z	Remarks
HiPAP raised	3.91	3.56	-4.31	To CRP
HiPAP deployed	3.91	3.56	-7.05	To CRP
DGPS 3	-0.754	3.995	12.134	To CRP

The USBL calibration was completed using the "Installation" parameters calculated by the previous USBL adjustment (on 2020.01.19 at Fraserburgh).

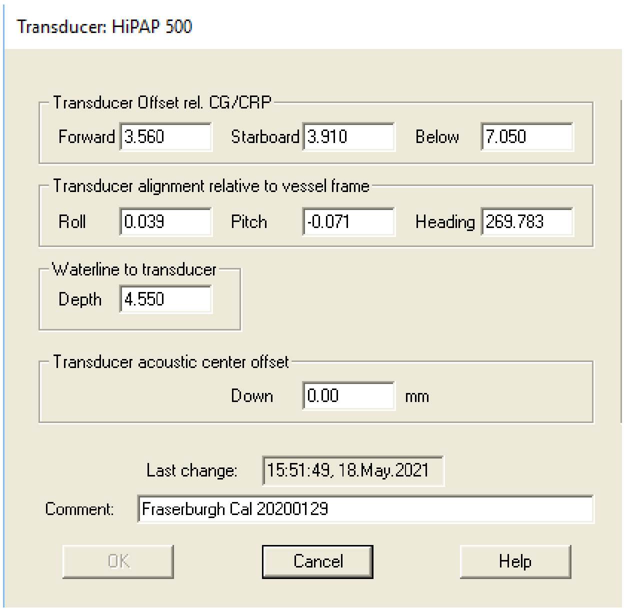


Figure 1.3: HiPAP Transceiver offsets in APOS (Installation parameters prior to new Calibration)

The calibrated Hull Unit Depth offset (the laser measure) was verified. The HiPAP pole was lowered to its full position.

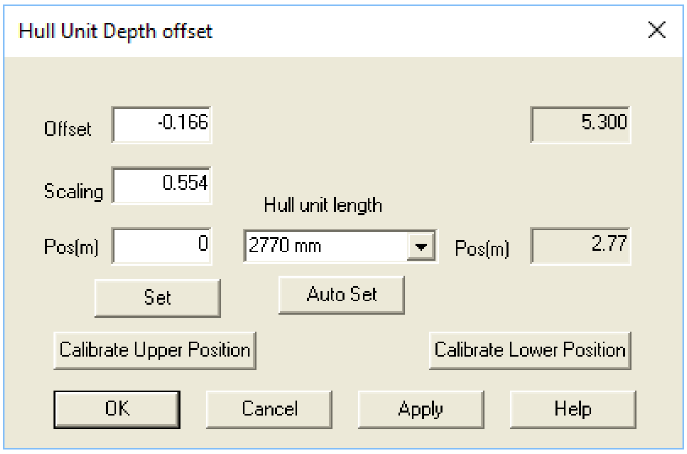


Figure 1.4: HiPAP hull unit depth offset

1.3 Sound Velocity Profile

An SVP was carried out on arrival to the calibration site and entered into APOS and EA400 single beam echosounder.

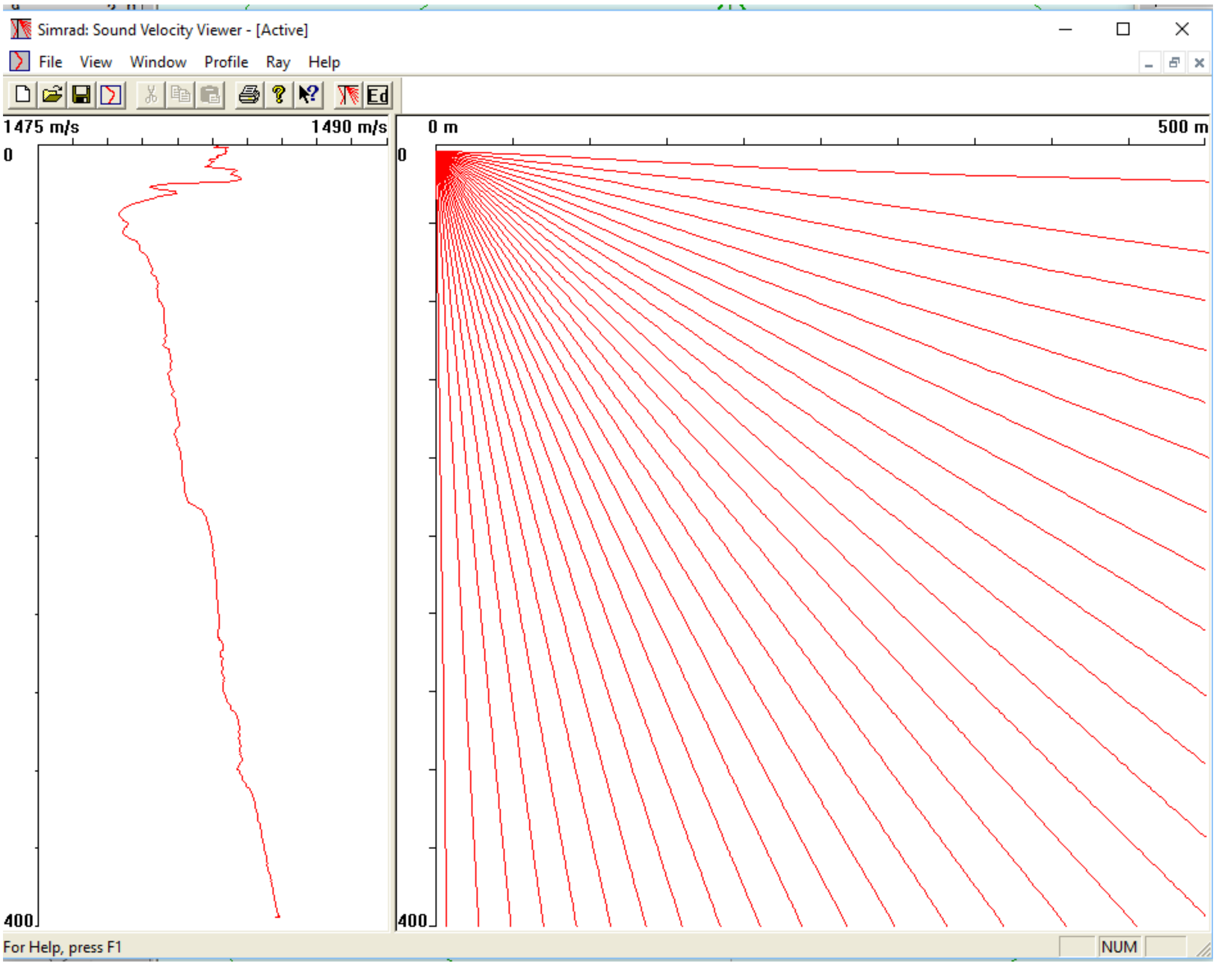


Figure 1.5: Active SVP in APOS

2. ACQUISITION

2.1 Transponder Position

The B18 cNODE Maxi transponder was deployed to the seabed. Once settled, the mean position of the instrument was calculated using StarfixNG. This position was used to centre the cardinal points pattern. The average position read as: 542626E, 6437751N.

2.2 Water Depth and Transponder Height

The EA400 echosounder displayed a seabed water depth of 345.5 m at transponder location.

The height from the seabed clump weight to the B18 transponder head was 3.0m. The transponder Z values were referenced to water line. Water line to CRP was 2.5m.

2.3 Transducer Alignment Properties

The acceptance criteria for Expected Accuracy were set in APOS (both for Acoustics and dGPS measurements).

No new offsets were set for the GPS Antenna offset as the position sent to APOS was already the vessel CRP, with correct offsets. No Gyro rotation was entered as the heading sent to APOS from Hydrins is already corrected.

Only the Transducer inclinations parameter group was selected for calculation. The previous calibration values were set as initial values. High 1-sigma accuracy values (15) were set for each of the three inclination parameters. This allowed roll, pitch and gear to be freely computed by APOS.

In Calculation, the Auto exclude option was enabled and Automatic compensation for tidal variations was switched on. The Tidal Range in the calibration area was 0.2m.

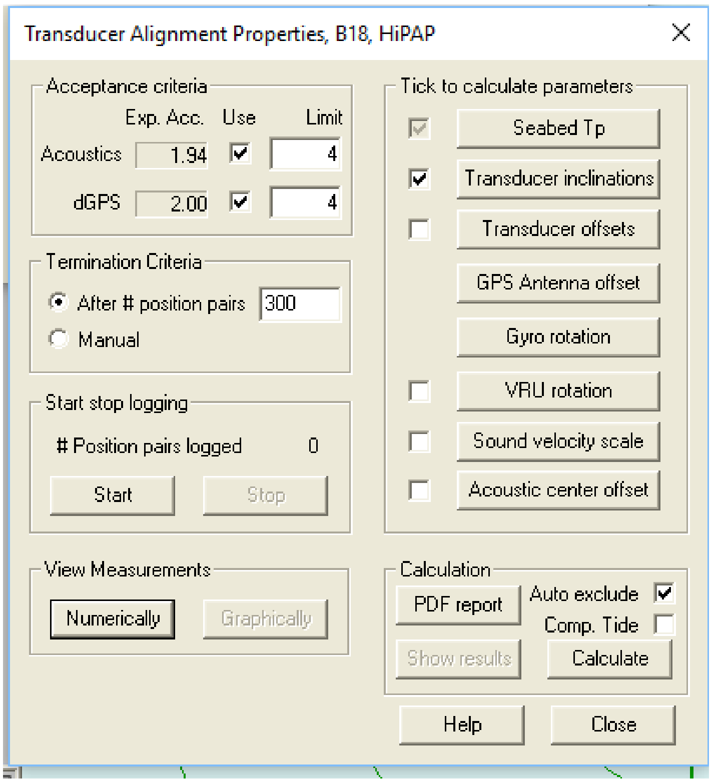


Figure 2.1: Transducer Alignment properties

2.4 Acquisition Method

StarfixNG was used to create the waypoints for vessel navigation, The Extended Cardinal Points calibration method was used for Calibration. The four Cardinal points were established at 140m from the deployed transponder and data was acquired on reciprocal headings for each location.

The vessel used dynamic positioning to hold the HiPAP transceiver stationary over the cardinal waypoint, on a 30° and 210° heading. 600 readings at 1.0 second intervals were taken. Complete logging at one location took 10 minutes. This procedure was repeated for all four cardinal waypoints. The vessel then moved above the transponder location, and whilst stationary, recorded 600 readings at each of the four orientations, 035°, 125°, 215° and 305° heading. A pause in acquisition was required as prevailing weather conditions made station keeping difficult.

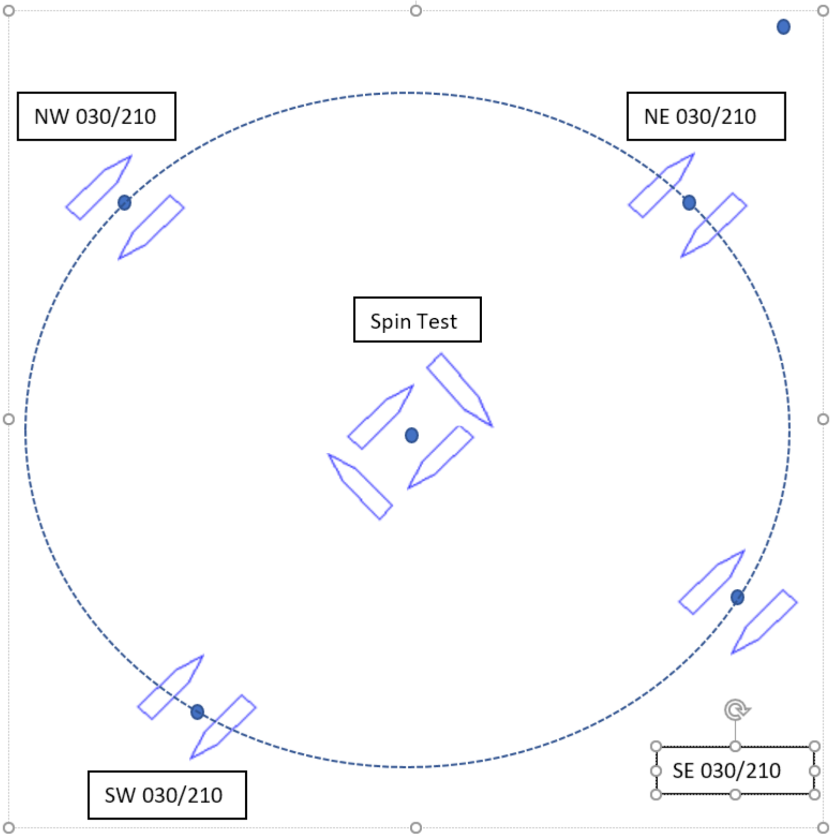


Figure 2.2: Calibration waypoints pattern

3. CALCULATIONS

3.1 Measurements

At the end of acquisition, a total of 1591 readings had been recorded. The figure below shows the raw, uncorrected measurements and the corrected position (Measurements were auto-excluded by APOS and are marked as red Symbols).

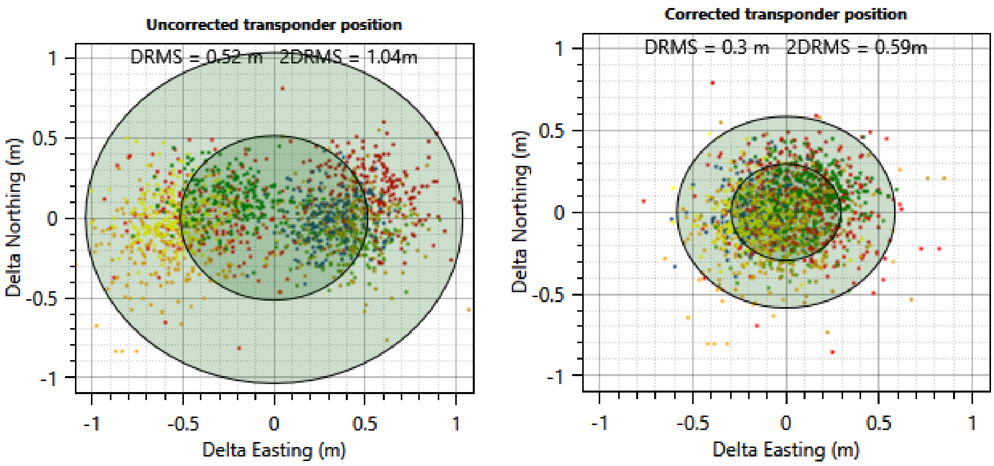


Figure 3.1: Measured Transponder position

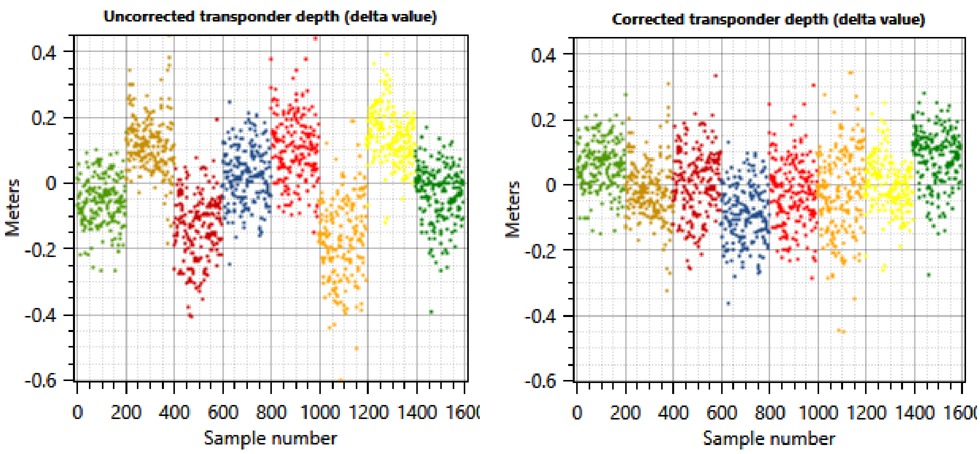


Figure 3.2: Measured Transponder Depth

4. COMPUTED RESULTS

4.1 Transducer Alignment results

The transducer alignment results, calculated by APOS, were based on 1521 observation.

Table 4.1: Transducer alignment results

Name	Calculated	SD	Initial (previous calibration)
Roll	**0.07°**	0.01°	0.04°
Pitch	**-0.01°**	0.01°	-0.07°
Orientation	**269.77°**	0.02°	269.78°

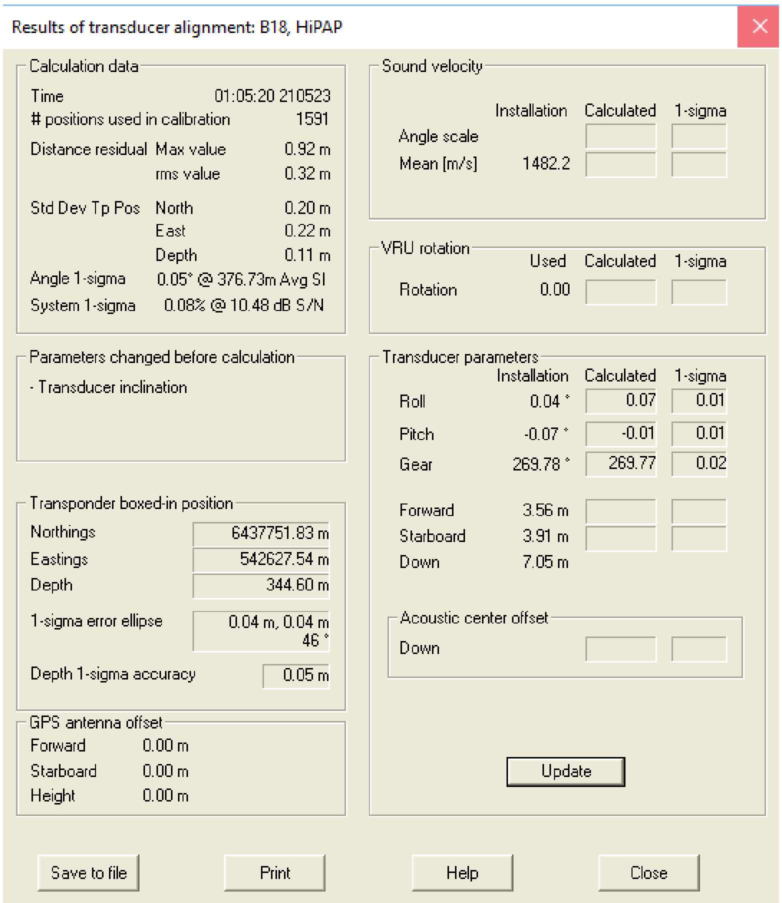


Figure 4.1: Calculated Parameters

 This document is uncontrolled once printed or downloaded and may not reflect the latest version.

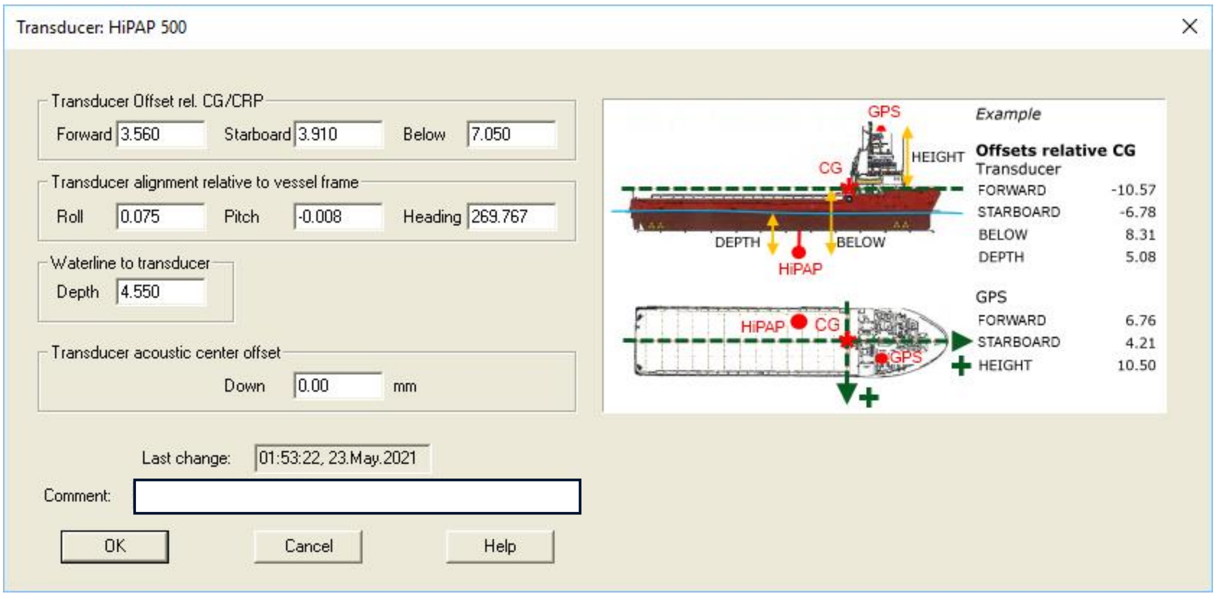


Figure 4.2: Applied results in APOS

5. POST CALIBRATION VERIFICATION (Spin Test)

After the calibration, the newly calculated values were updated in the APOS system (Figure 4.2). Verification SPIN Test was then completed in APOS and StarfixNG. Four sets of 300 observations were recorded over the verification waypoint at 035°, 125°, 215° and 305° vessel heading respectively.

The plots below show the beacon position for the verification sessions. The groupings are tight and within the expected tolerance. This demonstrates reliability of the new USBL calibration results updated in APOS.

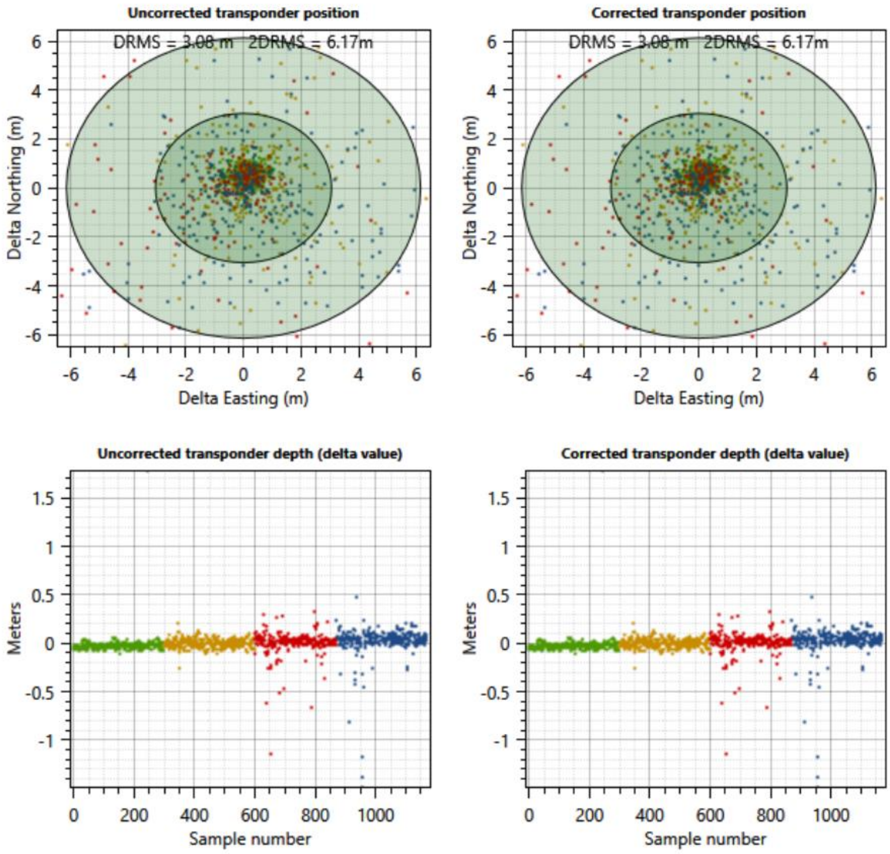


Figure 5.1: Scatter Plots of Spin Test Verification (before and after Calibration)

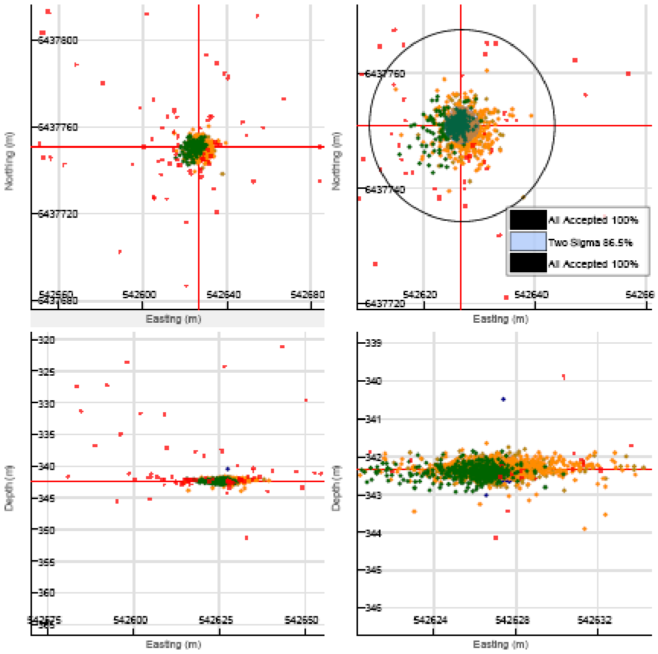


Figure 3: Scatter plots (before and after) - beacon position

Figure 5.2: Cardinal Point Calibration completed in NG

As an additional check, the Cardinal point calibration was run to calculate calibration parameters for pitch roll and Heading in NG to compare both results. These results are presented below. They show a negligible difference and were not applied in StarfixNG as all correction will be applied in APOS.

Table 5.1: NG Calibration Results

Attitude Corrections		
Pitch [°]	0.00	-0.03 ± 0.00
Roll [°]	0.00	0.06 ± 0.00
Orientation [°]	0.00	-0.03 ± 0.01
Observations Accepted: 6336 Observations Rejected: 131		

6. WALK Away Test

Following the Spin Test verification, a walk away test was performed. This is a simple test where the vessel recorded transponder positions while travelling away from the transponder on a constant heading. This was completed in order to confirm that the alignment values obtained from the calibration were effective and that the range is accurately being measured by the USBL system.

Error! Reference source not found. shows Scatter plots of the Walk Away test before and after the alibration; this confirms the accuracy of the calibration as the Beacon position did not move while the vessel was moving away from the BC (700 m approximately). The weather conditions during this test were marginal and we stopped acquisition around 700 m, as this distance is well in excess of normal surveying distances.

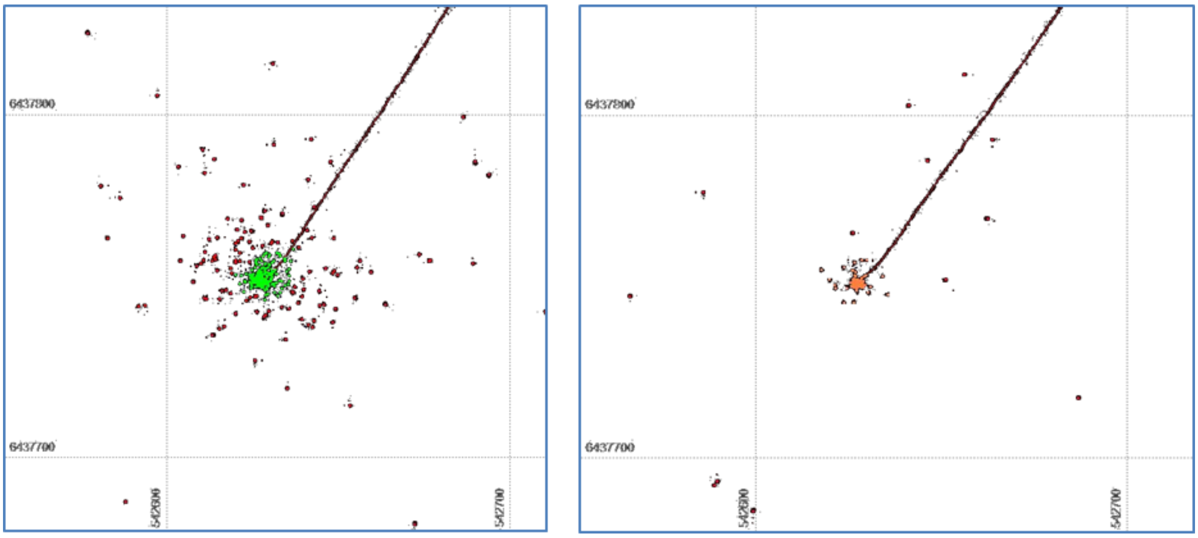


Figure 6.1: Walk Away Test completed before (Left) and after (Right) Calibration

The plot below, Figure 6.2, confirms that the range is accurately being measured by the USBL system.

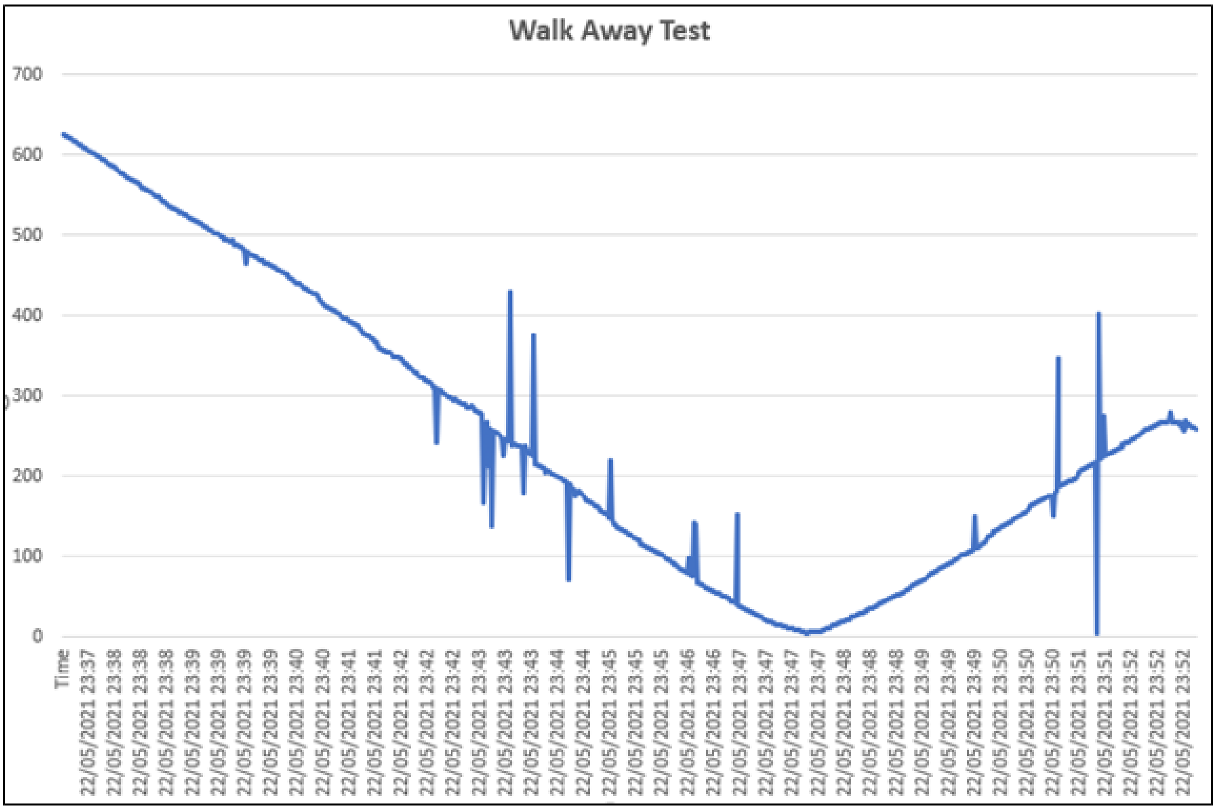


Figure 6.2: Range measurement plot of Walk Away Test

Signed:		Signed:	
	Paul Miller **Party Chief** **(Fugro Pioneer)** **Date: 25/05/2021**		**M. Hannah and T. Wiseman** **Client Representatives** **(Energinet Eltransmission A/S)** **Date: 25/05/2021**

Appendix F

SVP Calibration Certificates

Instrument type	miniSVS - SV only
Serial number	32017
Path Length, mm	50
Baud rate set ex factory	19200

Calibration History:	Certificate	Date
	25354	31/03/2010
	34522	07/06/2013
	49144	19/05/2017
	57208	24/12/2018
	66663	26/04/2021

System Components	As Received				Modification				Modification				Modification			
	Part	Iss	Serial Number	Range / Firmware	Part	Iss	Serial Number	Range / Firmware	Part	Iss	Serial Number	Range / Firmware	Part	Iss	Serial Number	Range / Firmware
Main Board	0650505	D2	47386	0650713B5				0650713B6								
				0650714C												
SV Sensor			136029													
Bootloader Fitted	YES															
	Name				Name			M.Buckle	Name				Name			
	Date				Date			19/04/2021	Date				Date			
	Signed				Signed			MB	Signed				Signed			

Instrument Serial Number	32017
Transducer Type, mm	50
Transducer Ser No	136029
PCB Part No	0650505D2
PCB Ser No	47386
Processor Firmware Version	0650713B6
FPGA Firmware Version	0650714C
Certificate Number	66663

Calibration Equipment used

Instrument	Type	Serial No
Temp Bridge	Micro K 250	33492/1
PRT	909L	15

As Received Spot Check

	SOS from unit	SOS from Standard	Error
Fresh	1412.729	1412.714	0.015
Saline	#	#	#VALUE!

Stage 1: First order fit

Temp °C90	SoS from Bilaniuk & Wong m/s	Measured ToF nsec*100	Coefficients	Calc SoS from coefficients m/s	Error (Calc - True) m/s	Acceptable Error m/s	Pass/Fail
2.0998	1412.714	7479971	3.877160E+05	1412.714	0.000	±0.001	Pass
16.1158	1469.795	7204537	9.980711E+06	1469.795	0.000	±0.001	Pass

Stage 2: Enter calibration string

#022;9980711;387716

Stage 3: Check point

Temp °C90	Actual SoS m/s	Measured SoS m/s	Error SoS Reading-Actual m/s	Acceptable Error m/s	Pass/Fail
16.1146	1469.791	1469.789	-0.002	±0.005	Pass

Name:	L.Bicknell
Date:	22/04/2021
Signature:	

Calibrated to Valeport's procedures using test equipment with calibrations traceable to UKAS or national standards

CALIBRATION CERTIFICATE

12

This document certifies that the instrument detailed below has been calibrated according to Valeport Limited's Standard Procedures, using equipment with calibrations traceable to UKAS or National Standards.

Calibration Certificate Number:	**66663**
Instrument Type:	miniSVS – SV only
Instrument Serial Number:	32017
Calibrated By:	L. Bicknell
Date:	26/04/2021
Signed:	

Full details of the results from the calibration procedure applied to each fitted sensor are available, on request, via email. This summary certificate should be kept with the instrument.

Valeport Limited
St. Peter's Quay, Totnes,
Devon TQ9 5EW UK

+44 (0) 1803 869292
sales@valeport.co.uk
www.valeport.co.uk

VAT No: GB 165 8753 67
Registered in England No: 1950444

Instrument type	miniSVS - SV only
Serial number	69538
Path Length, mm	50
Baud rate set ex factory	19200

Calibration History:	Certificate	Date
	57364	16/01/2019
	62760	20/04/2020

System Components	As Received				Modification				Modification				Modification			
	Part	Iss	Serial Number	Range / Firmware	Part	Iss	Serial Number	Range / Firmware	Part	Iss	Serial Number	Range / Firmware	Part	Iss	Serial Number	Range / Firmware
Main Board	0650505	F	153727	0650713B5				0650713B6								
				0650714C												
SV Sensor			153627													
Bootloader Fitted	YES															

	As Received	Modification	Modification	Modification
Name		J.Swann		
Date		28/02/2020		
Signed				

Instrument Serial Number	69538
Transducer Type, mm	50
Transducer Ser No	153627
PCB Part No	0650505F
PCB Ser No	153727
Processor Firmware Version	0650713B6
FPGA Firmware Version	0650714C
Certificate Number	62760

Calibration Equipment used

Instrument	Type	Serial No
Temp Bridge	Micro K 250	27093/3
PRT	909L	63

As Received Spot Check

	SOS from unit	SOS from Standard	Error
Fresh	1412.761	1412.784	-0.023
Saline	#	#	#VALUE!

Stage 1: First order fit

Temp °C90	SoS from Bilaniuk & Wong m/s	Measured ToF nsec*100	Coefficients	Calc SoS from coefficients m/s	Error (Calc - True) m/s	Acceptable Error m/s	Pass/Fail
2.1137	1412.781	7429961	3.863230E+05	1412.780	0.000	±0.001	Pass
16.0735	1469.651	7157398	1.004913E+07	1469.651	0.000	±0.001	Pass

Stage 2: Enter calibration string

#022;10049126;386323

Stage 3: Check point

Temp °C90	Actual SoS m/s	Measured SoS m/s	Error SoS Reading-Actual m/s	Acceptable Error m/s	Pass/Fail
16.0740	1469.652	1469.653	0.001	±0.005	Pass

Name:	L.Bicknell
Date:	20/04/2020
Signature:	

CALIBRATION CERTIFICATE

This document certifies that the instrument detailed below has been calibrated according to Valeport Limited's Standard Procedures, using equipment with calibrations traceable to UKAS or National Standards.

Calibration Certificate Number:	**62760**
Instrument Type:	miniSVS – SV only
Instrument Serial Number:	69538
Calibrated By:	L. Bicknell
Date:	20/04/2020
Signed:	

Full details of the results from the calibration procedure applied to each fitted sensor are available, on request, via email. This summary certificate should be kept with the instrument.

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www.valeport.co.uk

VAT No: GB 165 8753 67
Registered in England No: 1950444

Build and Calibration Record - 0652804C © Valeport Limited

Instrument type	miniSVS - SV only
Serial number	71201
Path Length, mm	25
Baud rate set ex factory	19200

Calibration History:	Certificate	Date
	59420	24/06/2019

System Components	Original Manufacture				Modification				Modification				Modification			
	Part	Iss	Serial Number	Range / Firmware	Part	Iss	Serial Number	Range / Firmware	Part	Iss	Serial Number	Range / Firmware	Part	Iss	Serial Number	Range / Firmware
Main Board	0650505	F	161600	0650713B6												
				0650714C												
SV Sensor			161601													
Bootloader Fitted	YES															

Name	E.Laight	Name		Name		Name	
Date	21/06/2019	Date		Date		Date	
Signed		Signed		Signed		Signed	

Instrument Serial Number	71201
Transducer Type, mm	25
Transducer Ser No	161601
PCB Part No	0650505F
PCB Ser No	161600
Processor Firmware Version	0650713B6
FPGA Firmware Version	0650714C
Certificate Number	59420

Calibration Equipment used		
Instrument	Type	Serial No
Temp Bridge	Micro K 250	311063/1
PRT	909L	63

Stage 1: First order fit

Temp °C90	SoS from Bilaniuk & Wong m/s	Measured ToF nsec*100	Coefficients	Calc SoS from coefficients m/s	Error (Calc - True) m/s	Acceptable Error m/s	Pass/Fail
2.1259	1412.839	3897521	3.937290E+05	1412.839	0.000	±0.001	Pass
16.2828	1470.362	3760448	2.020082E+07	1470.361	0.000	±0.001	Pass

Stage 2: Enter calibration string

#022;20200821;393729

Stage 3: Check point

Temp °C90	Actual SoS m/s	Measured SoS m/s	Error SoS Reading-Actual m/s	Acceptable Error m/s	Pass/Fail
16.2839	1470.365	1470.364	-0.001	±0.005	Pass

Name:	N.Paddon
Date:	24/06/2019
Signature:	

This document certifies that the instrument detailed below has been calibrated according to Valeport Limited's Standard Procedures, using equipment with calibrations traceable to UKAS or National Standards.

Calibration Certificate Number:	59420
Instrument Type:	miniSVS
Instrument Serial Number:	71201
Calibrated By:	N.Paddon
Date:	24/06/2019
Signed:	

Full details of the results from the calibration procedure applied to each fitted sensor are available, on request, via email. This summary certificate should be kept with the instrument.

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MINI STD/CTD Calibration Certificate

Certificate no: 5081

Instrument model: *SD204* Serial number: 519 Owner: FUGRO

Calibrated date: 2021-05-06 Certificate issued date: 2021-05-06 Env. temp (degr. C): 19°

Calibrated by: Sensordata a.s and *SAIV A/S* Bergen Norway

Calibration procedure:
Conductivity and temperature are calibrated by setting the MINI STD/CTD instrument in raw data mode and keeping it in three 200 l stirred, temperature stabilised calibration baths. Raw conductivity and temperature data are recorded with bath temperature and bath conductivity as measured by reference temperature* and conductivity** instruments. Calibration coefficients A1, B1, C1 for temperature and A3, B3, C3, D3 for conductivity are calculated from least square equations included in the MINISOFT software packet. Output temperature and conductivity from calibrated instrument must correspond with reference readings within +/- 1/100 degr. C and +/- 1/100 mmho/cm. Pressure is calibrated by connecting to a reference DWT*** and successively generate 6 pressures from 1 bar to FS. Pressure coefficients A2, B2, C2, D2 are calculated from least squares equations included in the instruments software. Output CTD data must correspond to data from reference instruments within specified accuracy.

TEMPERATURE degr. C			CONDUCTIVITY mmho/cm			PRESSURE dbar		
Bef. cal.	After cal.	Reference	Bef. cal.	After cal.	Reference	Bef. cal.	After cal.	Reference
19.62	19.61	19.612	50.47	50.48	50.482		10,02	10.01
12.16	12.16	12.161	34.37	34.38	34.382		100,12	100,13
0.41	0.41	0.412	9.47	9.47	9.472		400,53	400,52
							600,79	600,78
							1001,32	1001,30
							2002,57	2002,60

All calibration coefficients are shown on attached calibration sheet

Working references:
Temperature* Falmouth Scientfic Model OTM S-112 S/N 1377-09JUL96 Accuracy +/- 2/1000 deg.C
Conductivity** Falmouth Scientfic Model OCM S-112 S/N 1354-09JUL96 Accuracy +/- 2/1000 mmho/cm
Pressure*** Budenberg DWT Model 280L S/N 9050 Accuracy 0.008% FS (600 bar)

Traceable references:
Temperature:
Subreference 1:
General Oceanics ATB 1250 temp. bridge serial no 1235
(Working ref. Is controlled by subref.1 four times per year)
(Subref.1 is controlled by subref.2 twice per year)

Subreference 2:
Destilled water tripple point cell at +0.010 degr.C
Phenoxybenzene tripple point cell at +26.868 degr.C

Conductivity:
Subreference 1:
Neil Brown Cond./Temp. transfer standard mod. CT-2 serial no.3
(Working reference is controlled by subref.1 four times per year)
(Subref.1 is controlled by subref.2 four times per year)
(Subref.2 is controlled by subref.3 four times per year)

Subreference 2:
Guildline Portasal 8410 Portable Salinometer serial no.59

Subreference 3:
Ocean Scientific International Standard Seawater

Pressure:
Subreference:
Pressure reference at FIMAS Coastal Base Calibration Center
5363 Ågotnes Norway
Control frequency Calibration equipment: Once per year

Calibrated by STEINAR LUERSEN
Signature S. Lue

Date 21-05-06
Time 13-16-17 GMT
CALIBRATION SHEET SD204 Serial no.519

Temperature (T) Deg.C:
A1+1.4774369851E-03 B1+2.6674971146E-04
C1+1.9778653376E-07

Pressure (P) decibar:
A2-1.3704328626E-02 B2+1.0851050510E-04
C2+6.1710669500E-12 D2-1.7797362810E-17
E2+2.6869723449E-23 F2-2.0407081646E-29
G2+6.1384205159E-36

Conductivity (C) mmho/cm:
A3-1.5640384767E-01 B3+1.8941145734E-02
C3+2.1694759098E-08 D3+0.0000000000E+00

Other sensor (0-2.5V)
AO+0.0000000000E+00 BO+1.0000000000E+00
CO+0.0000000000E-00 DO+0.0000000000E-00

Turbidity (0-12.5 FTU)
AT-1.6484591470E-12 BT+5.0000000000E-03
CT+2.1684043450E-19 DT-1.5881867761E-22

Oxygen (OX) in per cent:
V +1.0131144422E+02

Pressure sensor mathem.comp.coeff.
K0+7.10751820706E+02 K1-2.04992503862E+00
K2+1.88083746267E-03 K3-5.74953628968E-07
L0-1.16353288293E+02 L1+3.28350273350E-01
L2-3.02979117344E-04 L3+9.31019647944E-08
M0+6.88591541164E+00 M1-1.91519703303E-02
M2+1.77404661037E-05 M3-5.47292775962E-09
N0-1.88500986359E-01 N1+5.24625553826E-04
N2-4.86284234064E-07 N3+1.50121280844E-10
O0+2.60017717882E-03 O1-7.24017082086E-06
O2+6.71442388946E-09 O3-2.07389608422E-12
P0-1.75793728058E-05 P1+4.89681611258E-08
P2-4.54301786292E-11 P3+1.40377682624E-14
Q0+4.63111360167E-08 Q1-1.29042067775E-10
Q2+1.19757199127E-13 Q3-3.70167164298E-17

X1-6.1440916207E-01 X2+1.0219933212E-04
X3-4.0364358353E-12 X4+2.2176767636E-18
S1+7.2819447097E-01 S2+4.0561454377E-03
S3+2.4546633249E-11 S4+0.0000000000E+00
S5+0.0000000000E+00 S6+0.0000000000E+00
S7+0.0000000000E+00 Y4+1.6431380603E-01
Y5+2.3762727797E-03 Y6+3.6815825688E-12
Y7+1.6933904091E-18 PC+4.5000000000E-03

MINI STD/CTD Calibration Certificate

Certificate no: 4774

Instrument model: ***SD204*** Serial number: 951 Owner: FUGRO

Calibrated date: 2020-03-18 Certificate issued date: 2020-03-18 Env. temp (degr. C): 19

Calibrated by: Sensordata a.s and *SAIV A/S* Bergen Norway

Calibration procedure:
Conductivity and temperature are calibrated by setting the MINI STD/CTD instrument in raw data mode and keeping it in three 200 l stirred, temperature stabilised calibration baths. Raw conductivity and temperature data are recorded with bath temperature and bath conductivity as measured by reference temperature* and conductivity** instruments. Calibration coefficients A1, B1, C1 for temperature and A3, B3, C3, D3 for conductivity are calculated from least square equations included in the MINISOFT software packet. Output temperature and conductivity from calibrated instrument must correspond with reference readings within +/- 1/100 degr. C and +/- 1/100 mmho/cm. Pressure is calibrated by connecting to a reference DWT*** and successively generate 6 pressures from 1 bar to FS. Pressure coefficients A2, B2, C2, D2 are calculated from least squares equations included in the instruments software. Output CTD data must correspond to data from reference instruments within specified accuracy.

TEMPERATURE degr. C			CONDUCTIVITY mmho/cm			PRESSURE dbar		
Bef. cal.	After cal.	Reference	Bef. cal.	After cal.	Reference	Bef. cal.	After cal.	Reference
19.61	19.61	19.612	50.47	50.48	50.482	10.00		10.01
12.16	12.16	12.162	34.37	34.38	34.381	100.12	No CHANGE	100.13
0.41	0.41	0.411	9.47	9.47	9.472	600.80		600.78
						1001.39		1001.30
						2002.72		2002.60
						3004.05		3003.90

All calibration coefficients are shown on attached calibration sheet

Working references:

Temperature*	Falmouth Scientfic Model OTM S-112 S/N 1377-09JUL96	Accuracy +/- 2/1000 deg.C
Conductivity**	Falmouth Scientfic Model OCM S-112 S/N 1354-09JUL96	Accuracy +/- 2/1000 mmho/cm
Pressure***	Budenberg DWT Model 280L S/N 9050	Accuracy 0.008% FS (600 bar)

Traceable references:

Temperature:
Subreference 1:
General Oceanics ATB 1250 temp. bridge serial no 1235
(Working ref. Is controlled by subref.1 four times per year)
(Subref.1 is controlled by subref.2 twice per year)

Subreference 2:
Destilled water tripple point cell at +0.010 degr.C
Phenoxybenzene tripple point cell at +26.868 degr.C

Conductivity:
Subreference 1:
Neil Brown Cond./Temp. transfer standard mod. CT-2 serial no.3
(Working reference is controlled by subref.1 four times per year)
(Subref.1 is controlled by subref.2 four times per year)
(Subref.2 is controlled by subref.3 four times per year)

Subreference 2:
Guildline Portasal 8410 Portable Salinometer serial no.59

Subreference 3:
Ocean Scientific International Standard Seawater

Pressure:
Subreference:
Pressure reference at FIMAS Coastal Base Calibration Center

Control frequency Calibration equipment: Once per year

Calibrated by STEINAR IVERSEN
Signature S. Iver...

MINI STD/CTD Calibration Certificate

Certificate no: 4567

Instrument model: ***SD204*** Serial number: 1166 Owner: FUGRO

Calibrated date: 2019-05-28 Certificate issued date: 2019-05-28 Env. temp (degr. C): 19

Calibrated by: Sensordata a.s and *SAIV A/S* Bergen Norway

Calibration procedure:
Conductivity and temperature are calibrated by setting the MINI STD/CTD instrument in raw data mode and keeping it in three 200 l stirred, temperature stabilised calibration baths. Raw conductivity and temperature data are recorded with bath temperature and bath conductivity as measured by reference temperature* and conductivity** instruments. Calibration coefficients A1, B1, C1 for temperature and A3, B3, C3, D3 for conductivity are calculated from least square equations included in the MINISOFT software packet. Output temperature and conductivity from calibrated instrument must correspond with reference readings within +/- 1/100 degr. C and +/- 1/100 mmho/cm. Pressure is calibrated by connecting to a reference DWT*** and successively generate 6 pressures from 1 bar to FS. Pressure coefficients A2, B2, C2, D2 are calculated from least squares equations included in the instruments software. Output CTD data must correspond to data from reference instruments within specified accuracy.

TEMPERATURE degr. C			CONDUCTIVITY mmho/cm			PRESSURE dbar		
Bef. cal.	After cal.	Reference	Bef. cal.	After cal.	Reference	Bef. cal.	After cal.	Reference
19.61	19.61	19.611	50.47	50.48	50.481	10.01	NO CHANGE	10.01
12.16	12.16	12.161	34.38	34.38	34.382	100.11		100.13
0.41	0.41	0.412	9.47	9.47	9.472	400.49		400.52
						600.76		600.78
						1001.27		1001.30
						2002.55		2002.60

All calibration coefficients are shown on attached calibration sheet

Working references:
Temperature* Falmouth Scientfic Model OTM S-112 S/N 1377-09JUL96 Accuracy +/- 2/1000 deg.C
Conductivity** Falmouth Scientfic Model OCM S-112 S/N 1354-09JUL96 Accuracy +/- 2/1000 mmho/cm
Pressure*** Budenberg DWT Model 280L S/N 9050 Accuracy 0.008% FS (600 bar)

Traceable references:
Temperature:
Subreference 1:
General Oceanics ATB 1250 temp. bridge serial no 1235
(Working ref. Is controlled by subref.1 four times per year)
(Subref.1 is controlled by subref.2 twice per year)

Subreference 2:
Destilled water tripple point cell at +0.010 degr.C
Phenoxybenzene tripple point cell at +26.868 degr.C

Conductivity:
Subreference 1:
Neil Brown Cond./Temp. transfer standard mod. CT-2 serial no.3
(Working reference is controlled by subref.1 four times per year)
(Subref.1 is controlled by subref.2 four times per year)
(Subref.2 is controlled by subref.3 four times per year)

Subreference 2:
Guildline Portasal 8410 Portable Salinometer serial no.59

Subreference 3:
Ocean Scientific International Standard Seawater

Pressure:
Subreference:
Pressure reference at FIMAS Coastal Base Calibration Center

Control frequency Calibration equipment: Once per year

Calibrated by STEINAR IVERSEN
Signature S. Iver

Date 19-05-28
Time 07-47-43 GMT
CALIBRATION SHEET SD204 Serial no.1166

Temperature (T) Deg.C:
A1+1.4678555786E-03 B1+2.6890730572E-04
C1+1.9151941499E-07

Pressure (P) decibar:
A2-5.5724859929E-01 B2+1.0885886168E-04
C2+2.7471449443E-12 D2-3.8386879542E-18
E2+6.4304589439E-25 F2+2.5769192641E-30
G2-1.4798801219E-36

Conductivity (C) mmho/cm:
A3-1.3283031592E-01 B3+1.9011340537E-02
C3+1.6465384508E-08 D3+0.0000000000E+00

Other sensor (0-2.5V)
AO+0.0000000000E+00 BO+1.0000000000E+00
CO+0.0000000000E-00 DO+0.0000000000E-00

Turbidity auto range
AT-1.6484591470E-12 BT+5.0000000000E-03
CT+2.1684043450E-19 DT-1.5881867761E-22

Oxygen (OX) in per cent:
V +1.0131144422E+02

Pressure sensor mathem.comp.coeff.
K0+2.25689098049E+01 K1-1.72450805634E-01
K2+1.61969049888E-04 K3-5.39462918366E-08
L0+2.01167370678E+01 L1-4.92509949004E-02
L2+4.48255578952E-05 L3-1.34741972097E-08
M0-1.65578729952E+00 M1+4.57428406902E-03
M2-4.19182690836E-06 M3+1.27376737120E-09
N0+4.76350972435E-02 N1-1.32355521587E-04
N2+1.22095885222E-07 N3-3.73801822450E-11
O0-6.18321632741E-04 O1+1.72254059109E-06
O2-1.59310561473E-09 O3+4.88977406995E-13
P0+3.60252787151E-06 P1-1.00471212504E-08
P2+9.29757247853E-12 P3-2.85378298744E-15
Q0-7.36679719405E-09 Q1+2.05451273988E-11
Q2-1.89892803273E-14 Q3+5.81363558115E-18

X1-5.4336650116E-01 X2+1.0177548519E-04
X3-3.5809434057E-12 X4+2.0282197254E-18
S1+3.0367691232E-01 S2+4.0608444392E-03
S3+2.0103742959E-11 S4+0.0000000000E+00
S5+0.0000000000E+00 S6+0.0000000000E+00
S7+0.0000000000E+00 Y4-1.2973009905E-02
Y5+2.3772836684E-03 Y6-3.8989143561E-12
Y7+7.9426251910E-18 PC+1.0000000000E-03

Sound Velocity Profiles

Table 1: Project details

Project Name	F176286_Energinet_E_Islands_LOT2_A
Project Number	F176286_Energinet_E_Islands_LOT2_Copy
Vessel	Fugro Pioneer
Client	Energinet
Project Type	Site Survey
Location	North Sea

Table 2: Transducers

Vessel	Offset	Draft [m]	Sound Velocity [m/s]
Fugro Pioneer	SBES	3.4	1483.3

Table 3: Sound velocity misc

Vessel	Description	Depth [m]	Sound Velocity [m/s]
Fugro Pioneer	Seabed	44.0	1478.7

Table 4: Sound velocity profiles

Profile	Position WGS 84	Time	Average Sound Velocity [m/s]	Color
20210524_1823_915	56° 30′ 18.30903″ N 006° 19′ 55.21109″ E	24 May 2021, 18:23:47Z	1481.0	
20210524_1823_519	56° 30′ 18.30903″ N 006° 19′ 55.21109″ E	24 May 2021, 18:23:33Z	1479.4	

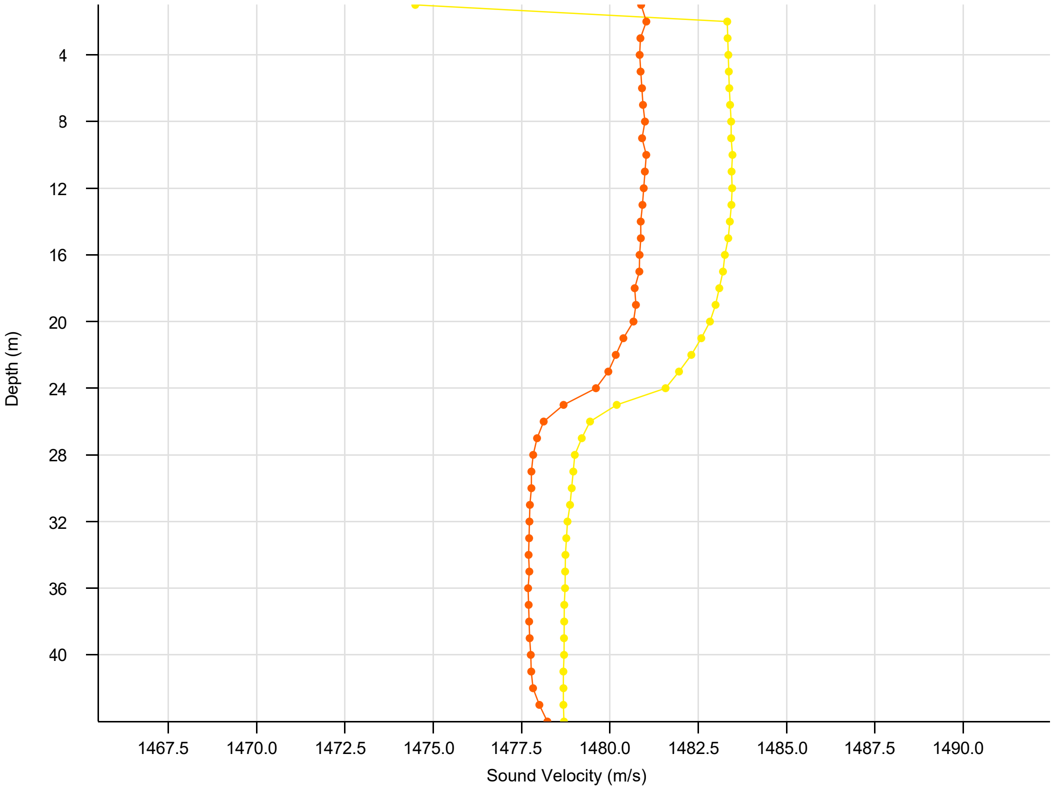


Figure 1: Sound velocity graph

P.Miller	T.Wiseman	M.Hannah
Party Chief	Client Representative	Client Representative
FSBV (Fugro Survey B.V.)	Energinet	Energinet

Sound Velocity Profiles

Table 1: Project details

Project Name	F176286_Energinet_E_Islands_LOT2_A
Project Number	F176286_Energinet_E_Islands_LOT2_Copy
Vessel	Fugro Pioneer
Client	Energinet
Project Type	Site Survey
Location	North Sea

Table 2: Transducers

Vessel	Offset	Draft [m]	Sound Velocity [m/s]
Fugro Pioneer	SBES	3.2	1484.6

Table 3: Sound velocity misc

Vessel	Description	Depth [m]	Sound Velocity [m/s]
Fugro Pioneer	Seabed	31.0	1478.4

Table 4: Sound velocity profiles

Profile	Position WGS 84	Time	Average Sound Velocity [m/s]	Color
20210525_1953_951	56° 31′ 03.81000″ N 006° 14′ 30.37000″ E	25 May 2021, 19:53:46Z	1483.7	
20210525_1753_MVP	56° 31′ 03.81000″ N 006° 14′ 30.37000″ E	25 May 2021, 19:57:16Z	1481.8	

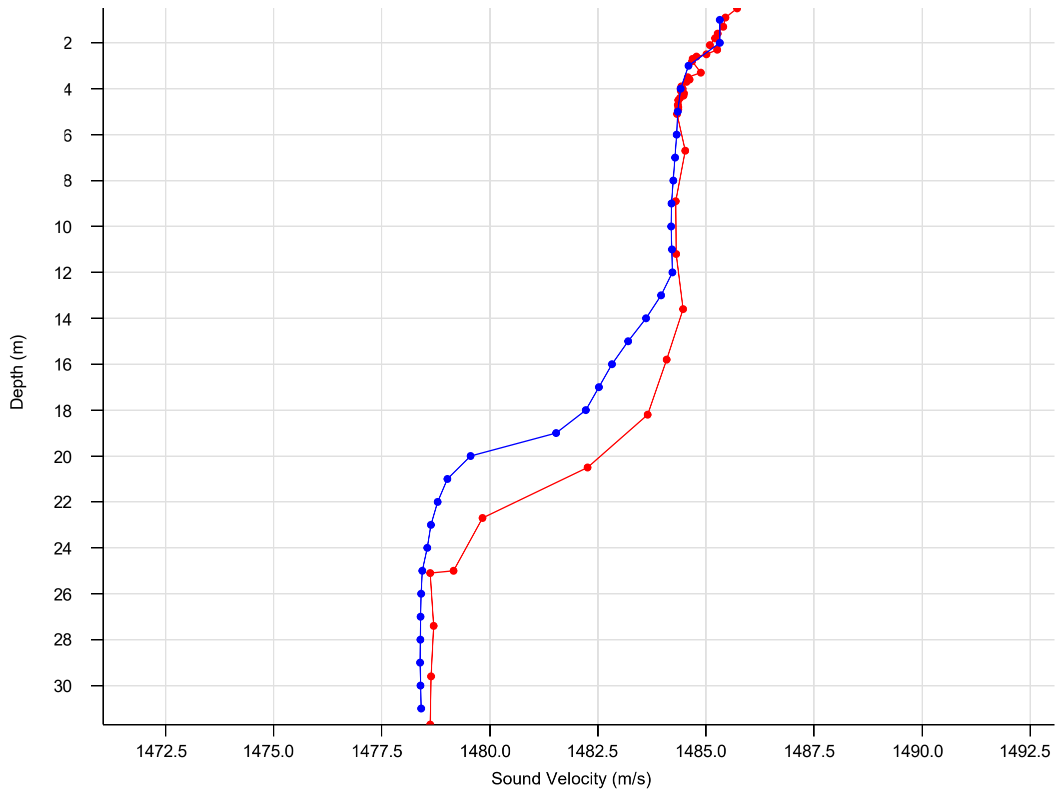


Figure 1: Sound velocity graph

P.Miller	T.Wiseman	M.Hannah
Party Chief	Client Representative	Client Representative
FSBV (Fugro Survey B.V.)	Energinet	Energinet

FUGRO

Appendix G

EOL QC Report

Seismic EOL QC Report

Client: Energinet

Project: EnergyIslands

Vessel: Fugro Pioneer

Line: EAX2289P01

SOURCE:

Source type: Multi-Level Stacked Sparker

Source volume: 900J

Shotpoint interval: 1 m

Source depth: 0.77 m

STREAMER:

Model: Geometrics LH-16

Medium: Solid

Number of groups: 96

Group interval: 1 m

Streamer depth: 1.4 m

RECORDING SYSTEM:

Model: CNT-2

Record length: 219.875 ms

Sample rate: 0.125 ms

Recording delay: 0 ms

OFFSETS:

Inline offset: 10 m

Lateral offset: 4 m

LINE INFORMATION:

Line name: EAX2289P01

File range: 10004 - 23741

Shot range: 10004 - 23741 (13738 Total SPs)

P190 range: 10001 - 23741 (13741 Total SPs)

Total KM: 13.738

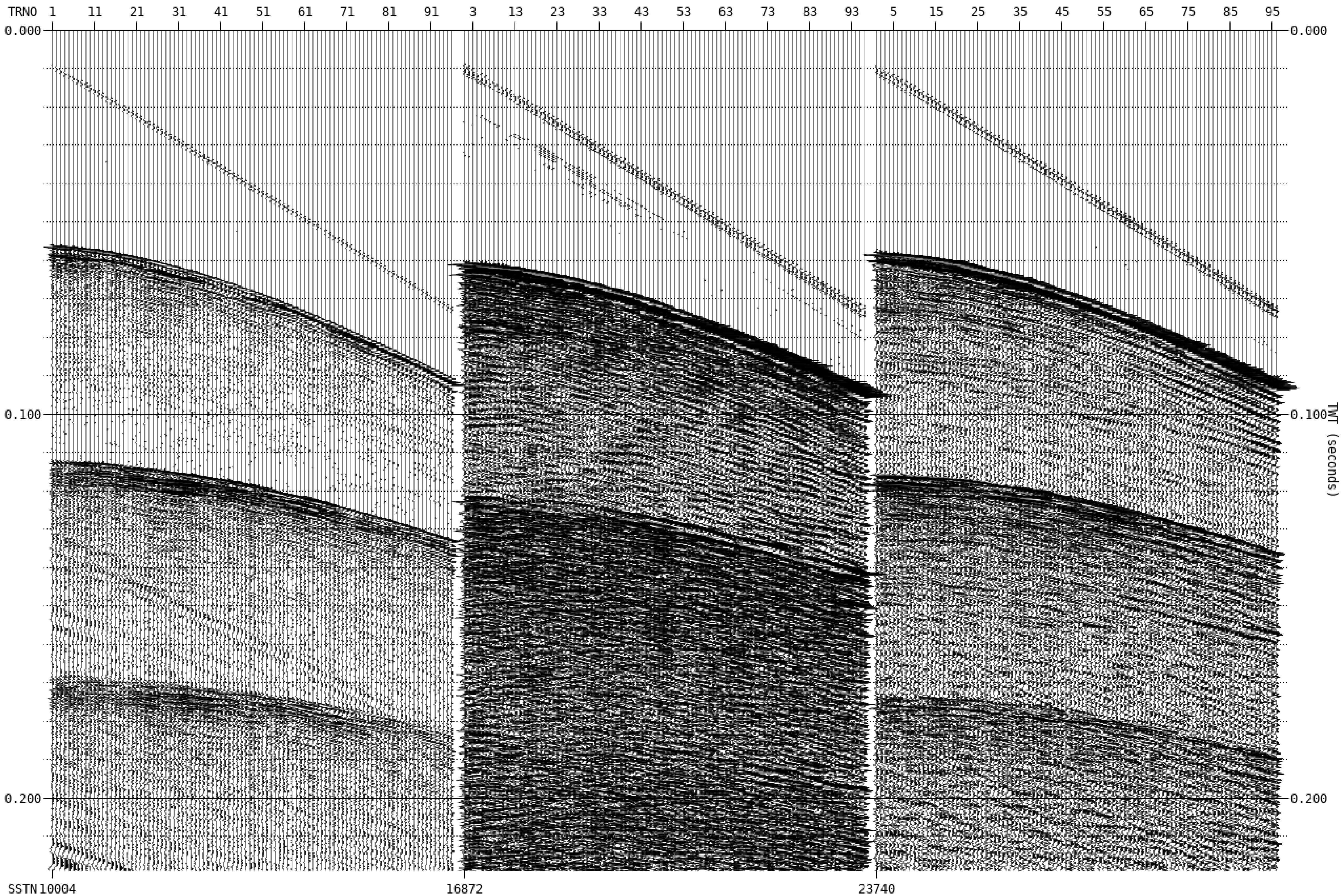
Full fold KM: 13.737

STACKING PARAMETERS:

Percentage stretch mute: 30 %

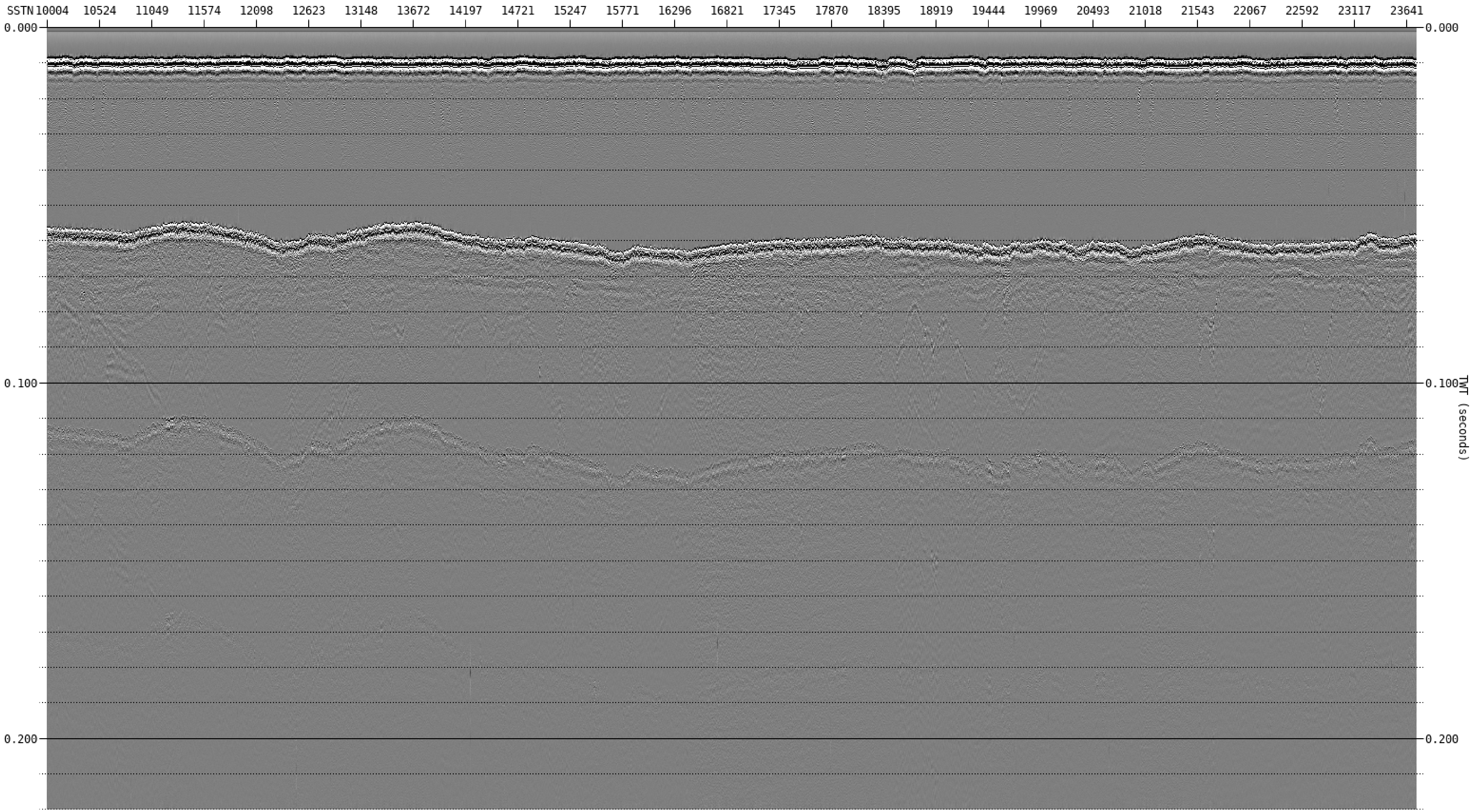
Brute stacking velocity (time,velocity): 50,1485,100,1550,250,1750

Shot Gathers



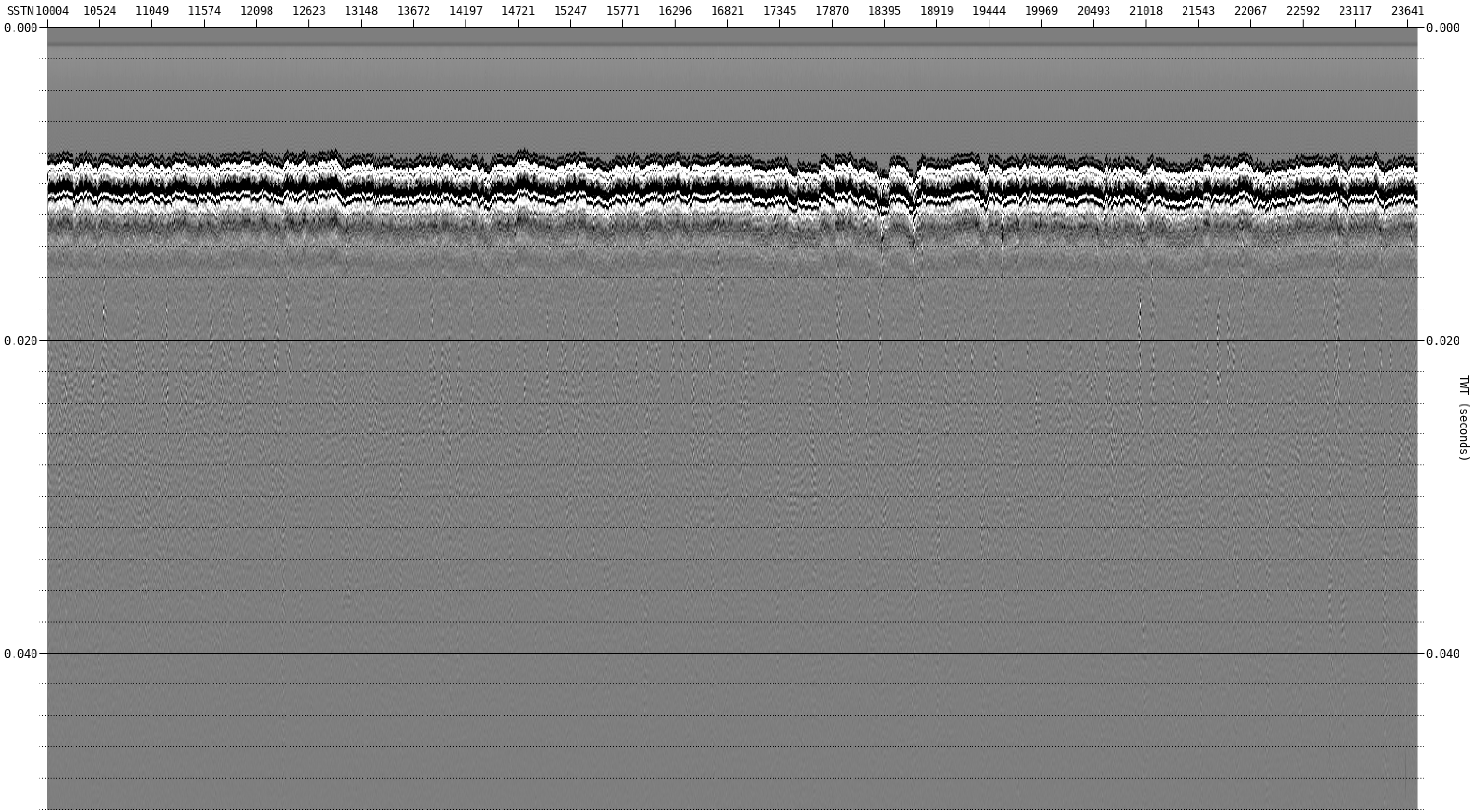
Low cut filter: 65 Hz - 18 dB/oct
Geometrical spreading correction: T^2

Neartrace

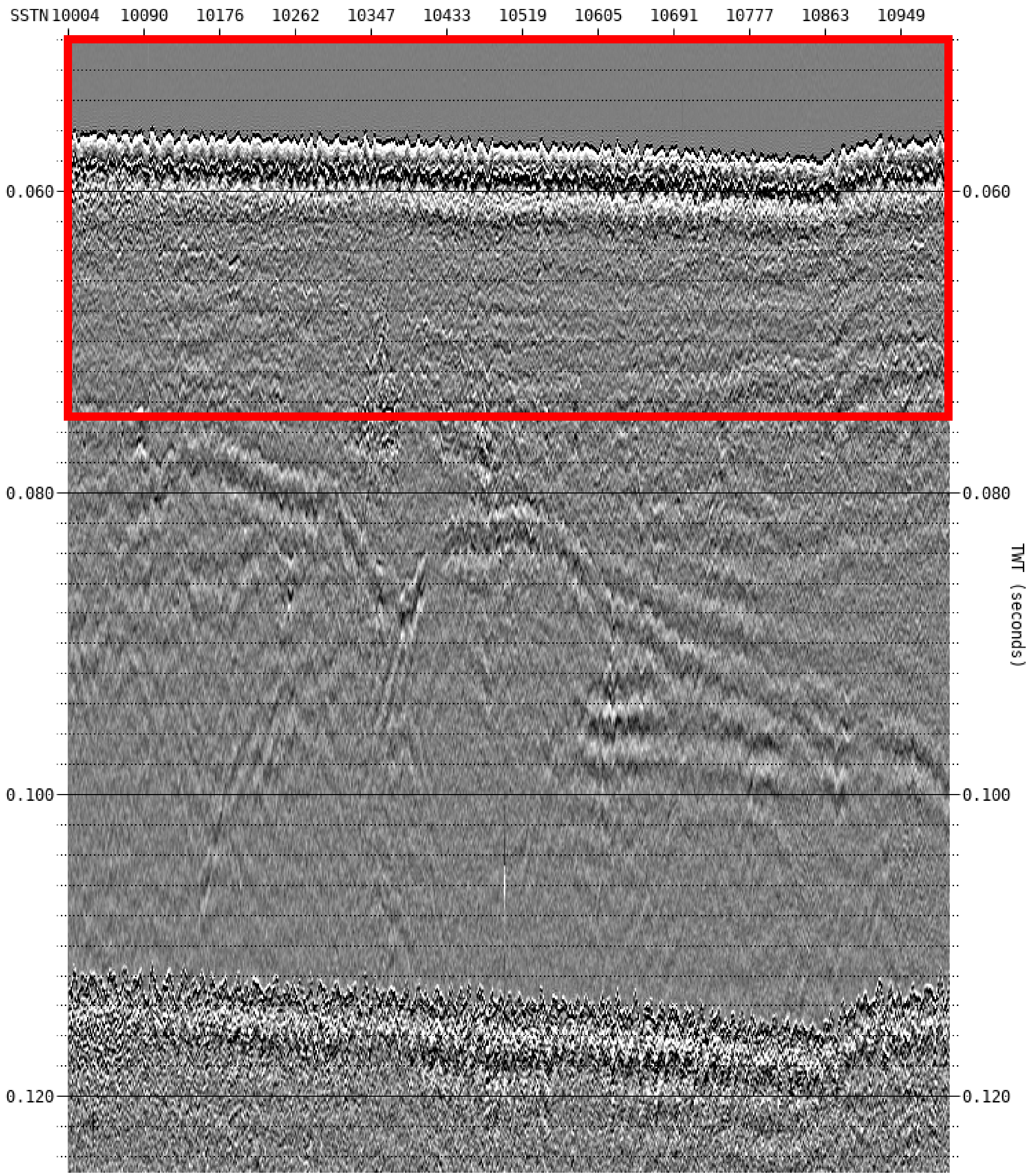


Low cut filter: 65 Hz - 18 dB/oct
Geometrical spreading correction: T^2

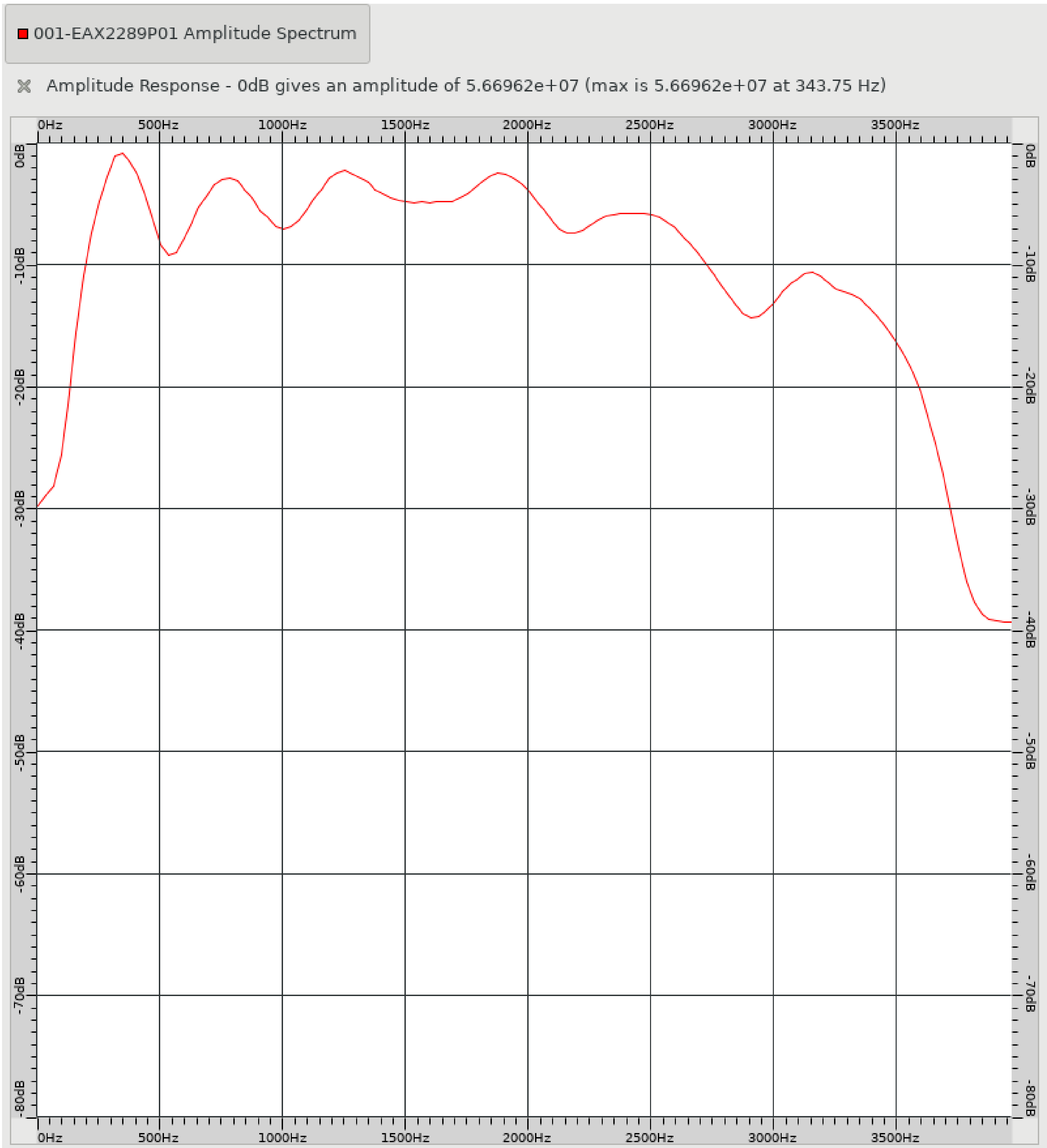
Neartrace - Direct Arrival Check - 001-EAX2289P01



Low cut filter: 65 Hz - 18 dB/oct
Geometrical spreading correction: T^2

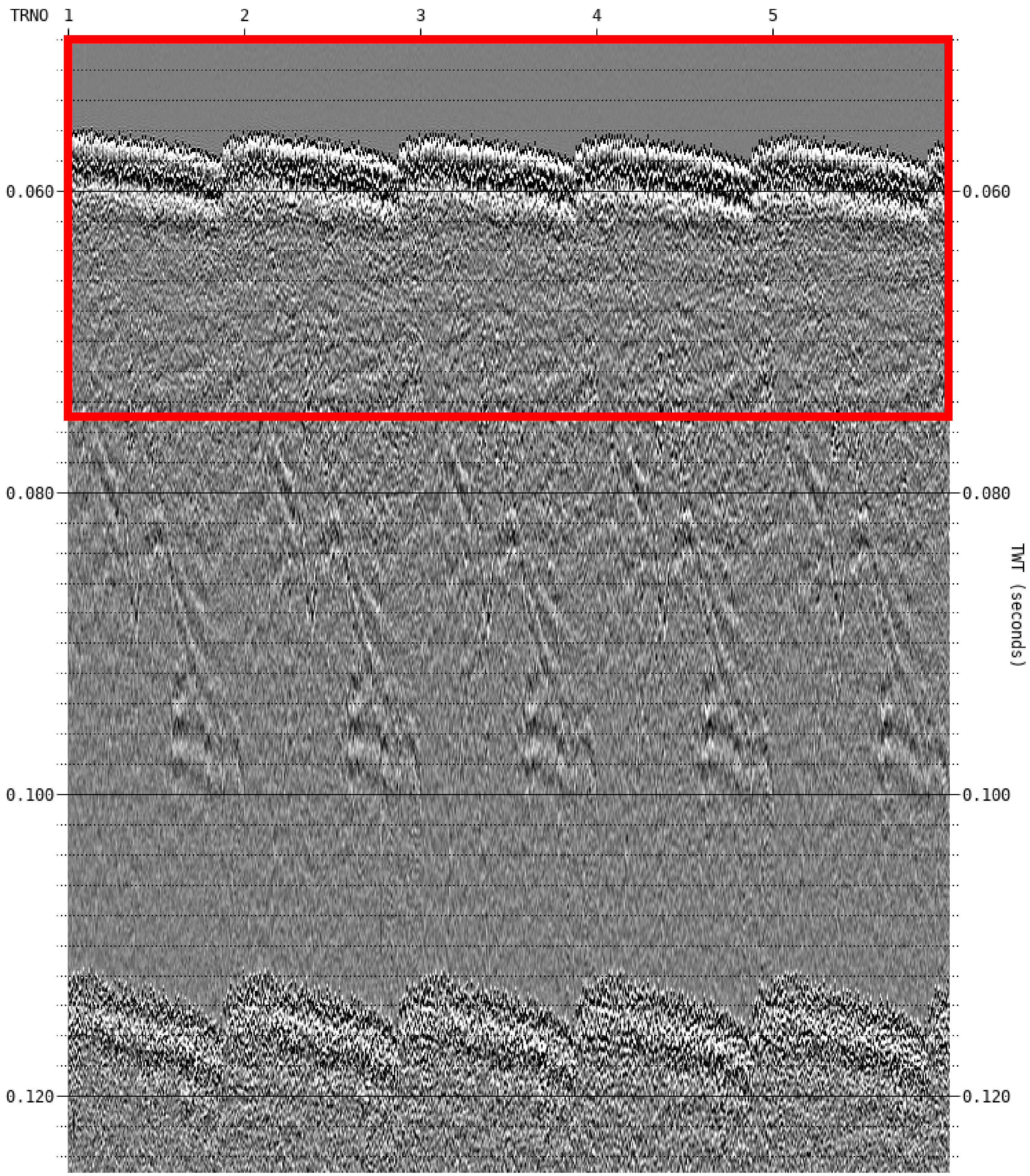


Neartrace

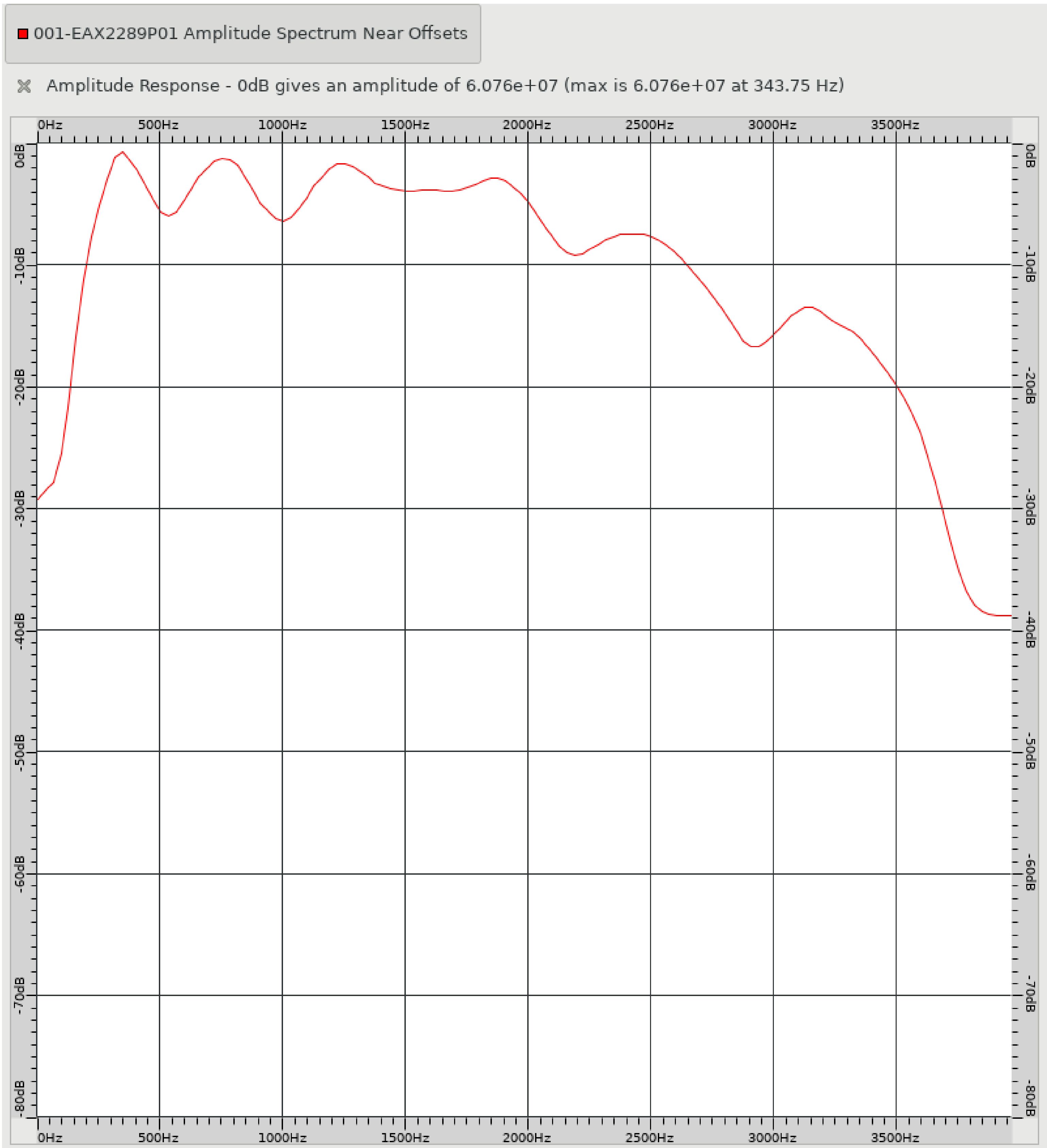


Low cut filter: 65 Hz - 18 dB/oct
Geometrical spreading correction: T^2

Overlaid in red analysis window: 50 - 75 ms

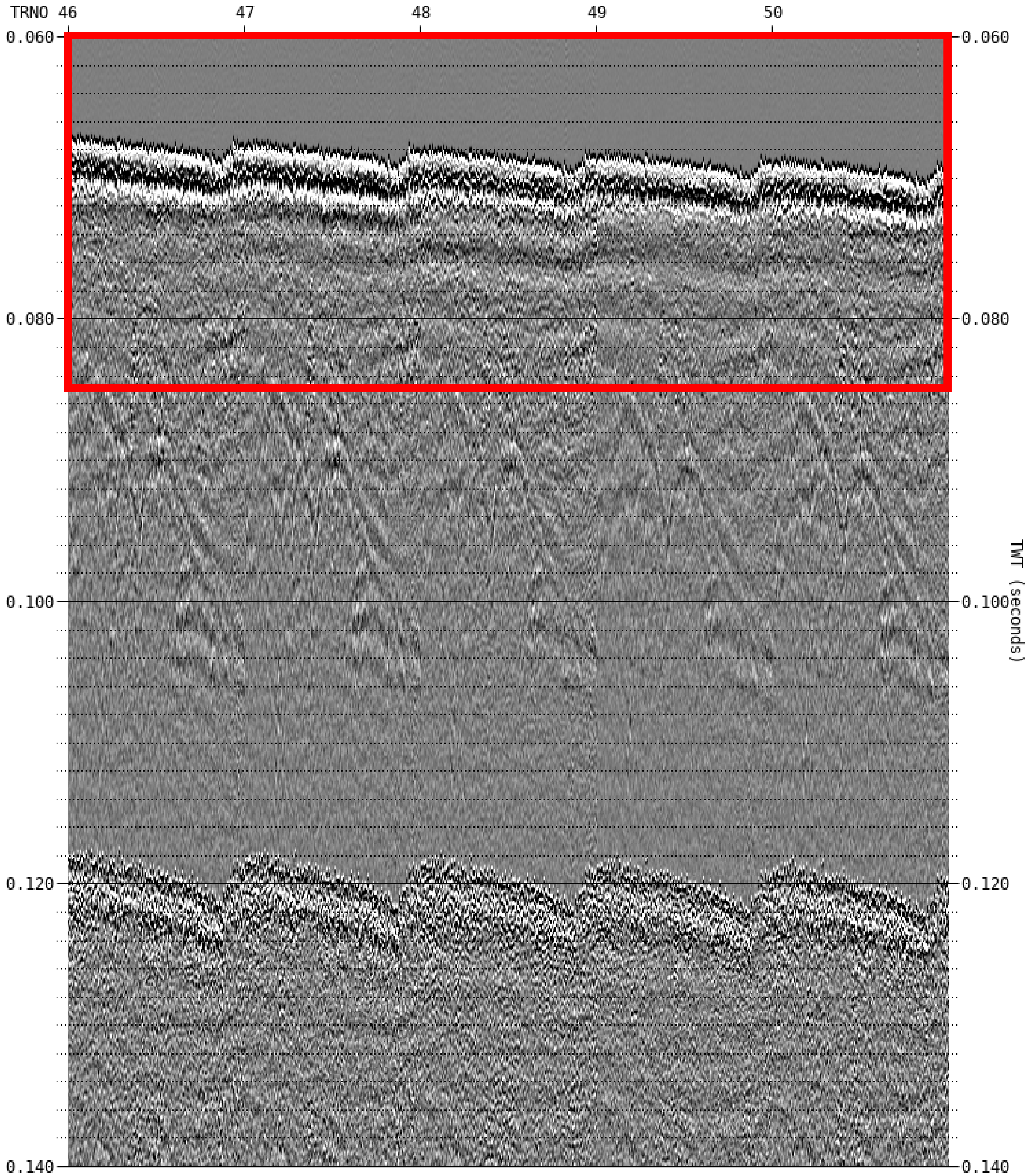


Near Offsets

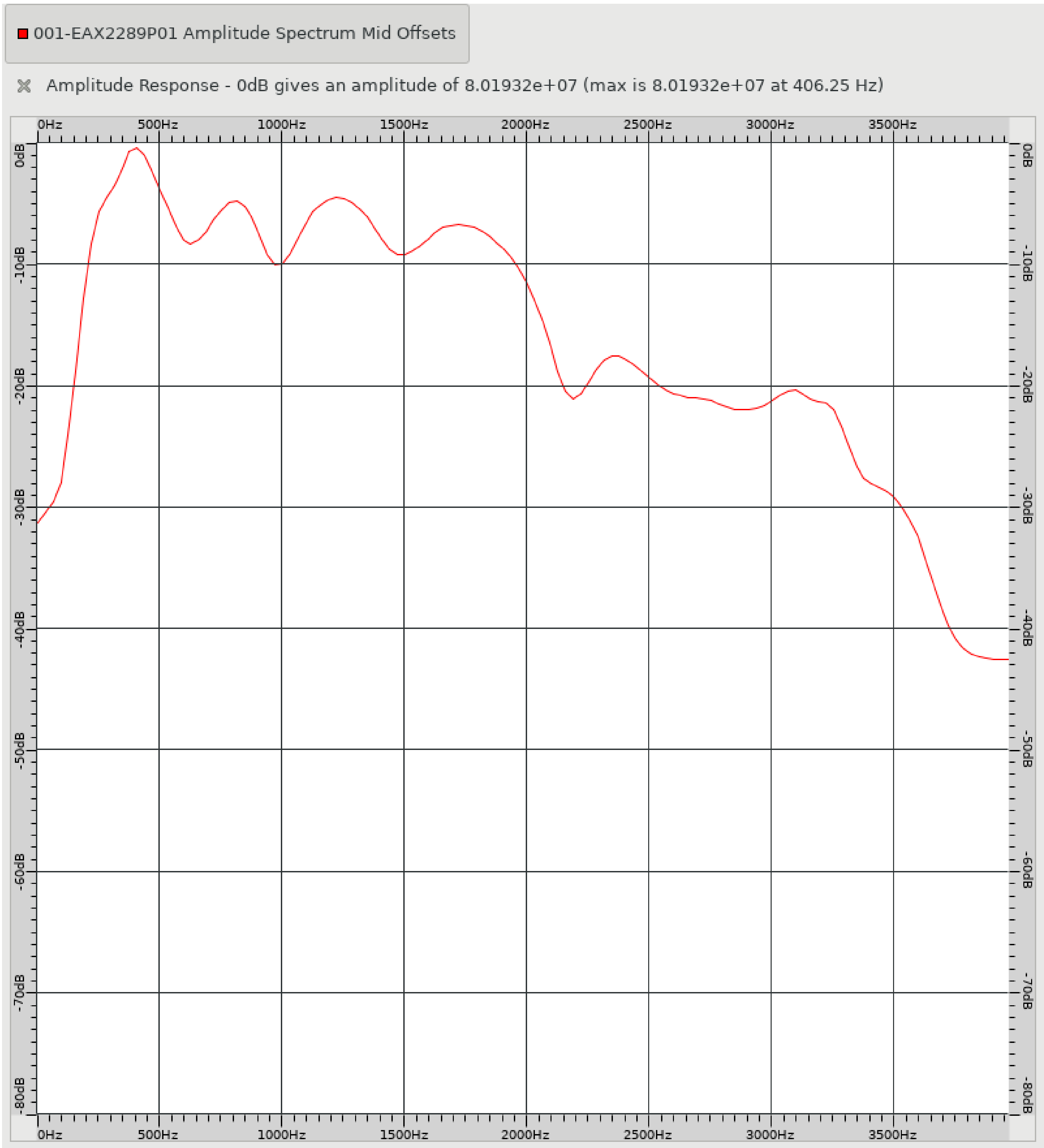


Low cut filter: 65 Hz - 18 dB/oct
Geometrical spreading correction: T^2

Overlaid in red analysis window: 50 - 75 ms
Channel range 1-5

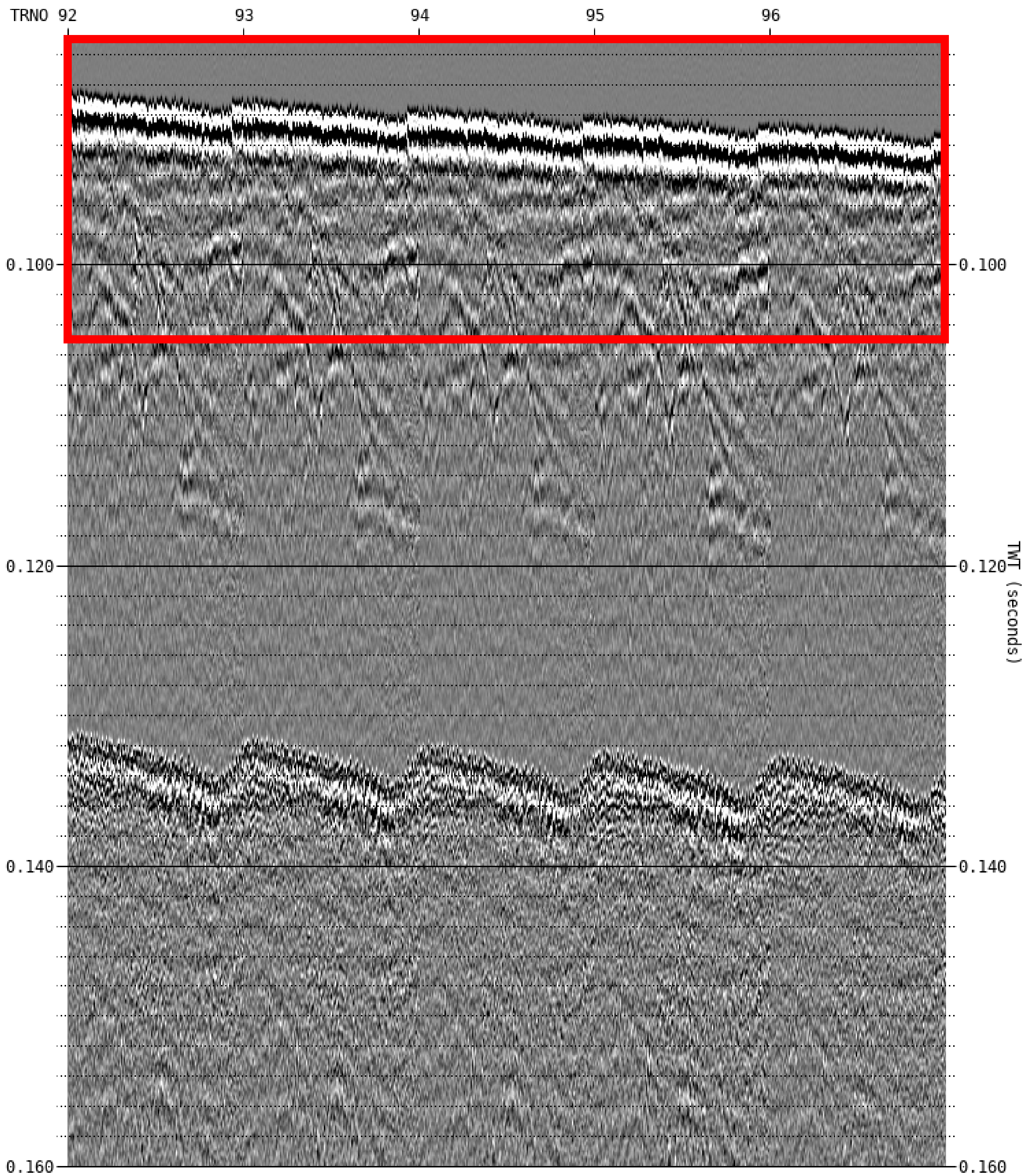


Mid Offsets

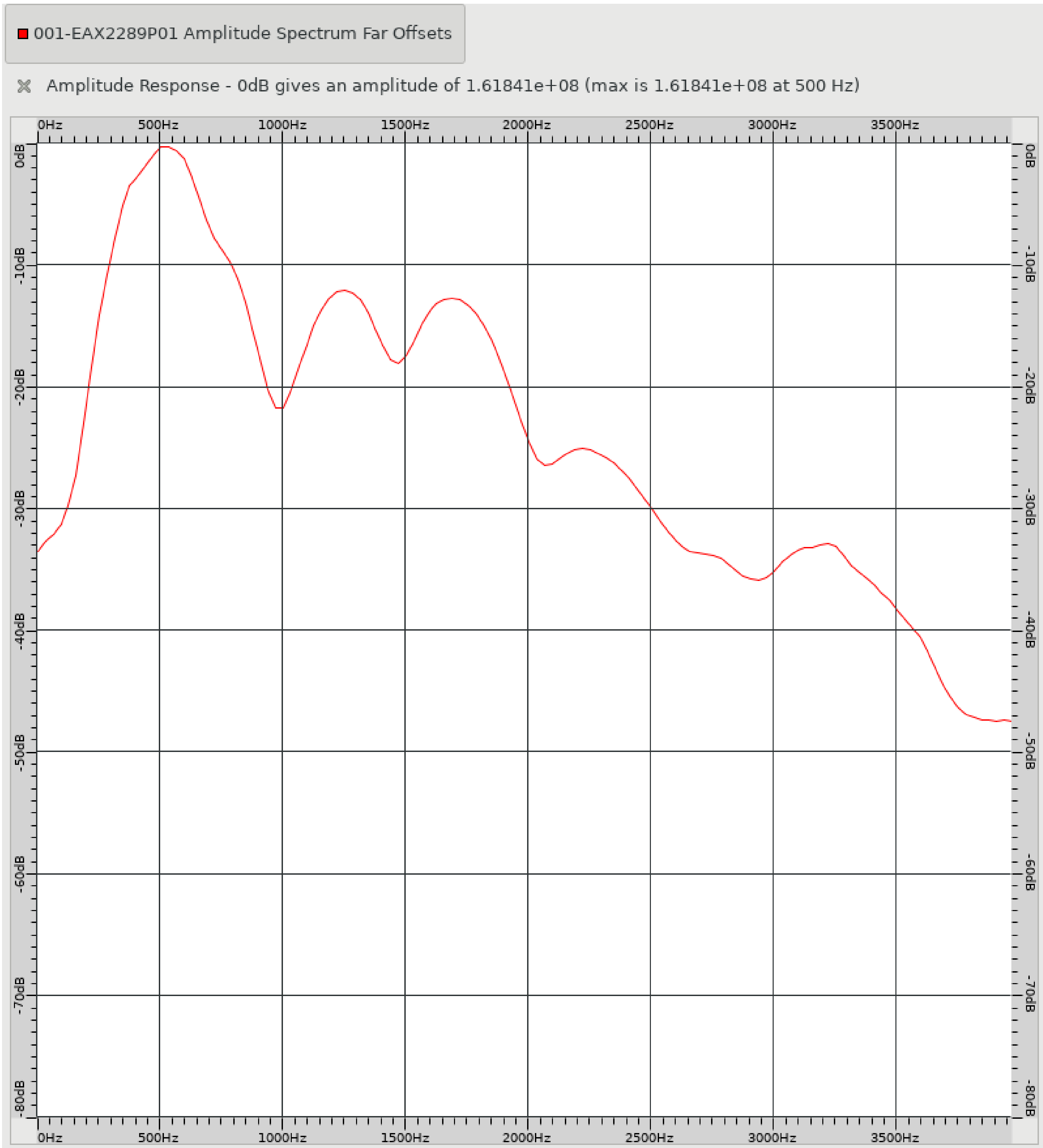


Low cut filter: 65 Hz - 18 dB/oct
Geometrical spreading correction: T^2

Overlaid in red analysis window: 60 - 85 ms
Channel range 46-50



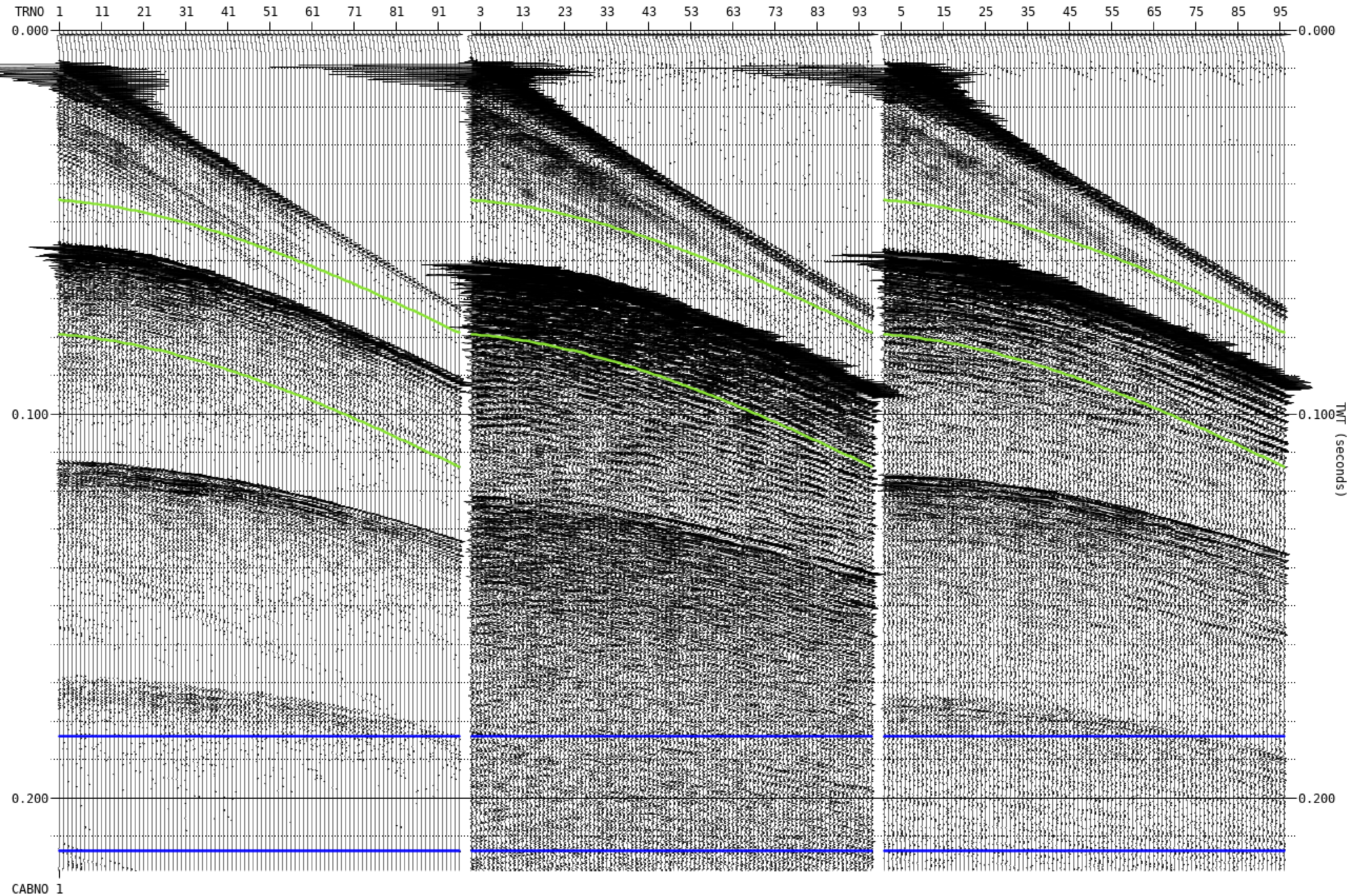
Far Offsets



Low cut filter: 65 Hz - 18 dB/oct
Geometrical spreading correction: T^2

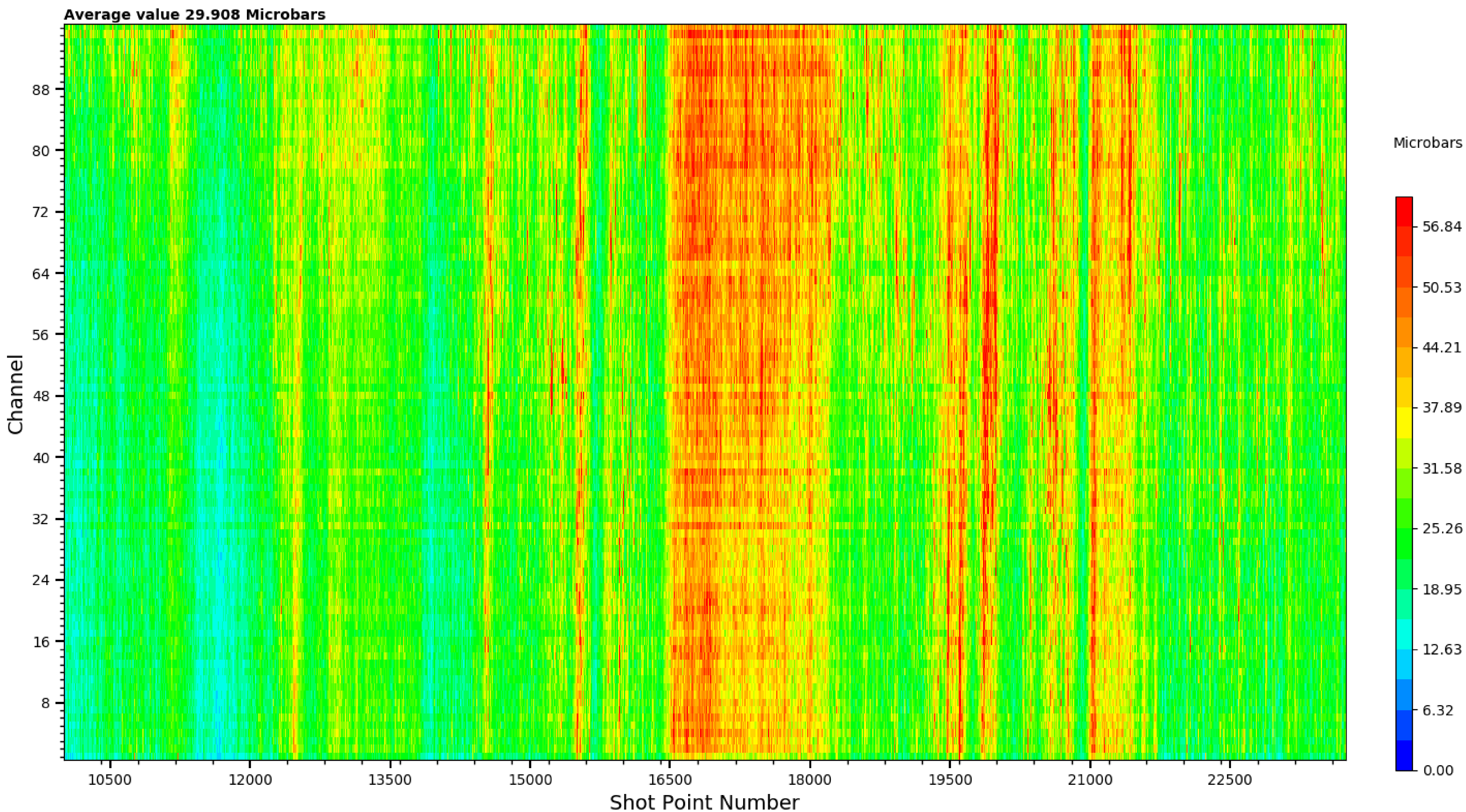
Overlaid in red analysis window: 85 - 105 ms
Channel range 92-96

RMS Signal/Noise Analysis Windows



Signal analysis window (green): start window, hyperbola above seabed; 35 ms length
Noise analysis window (blue): channel 1 184.875-214.875 ms / channel 96 184.875-214.875 ms

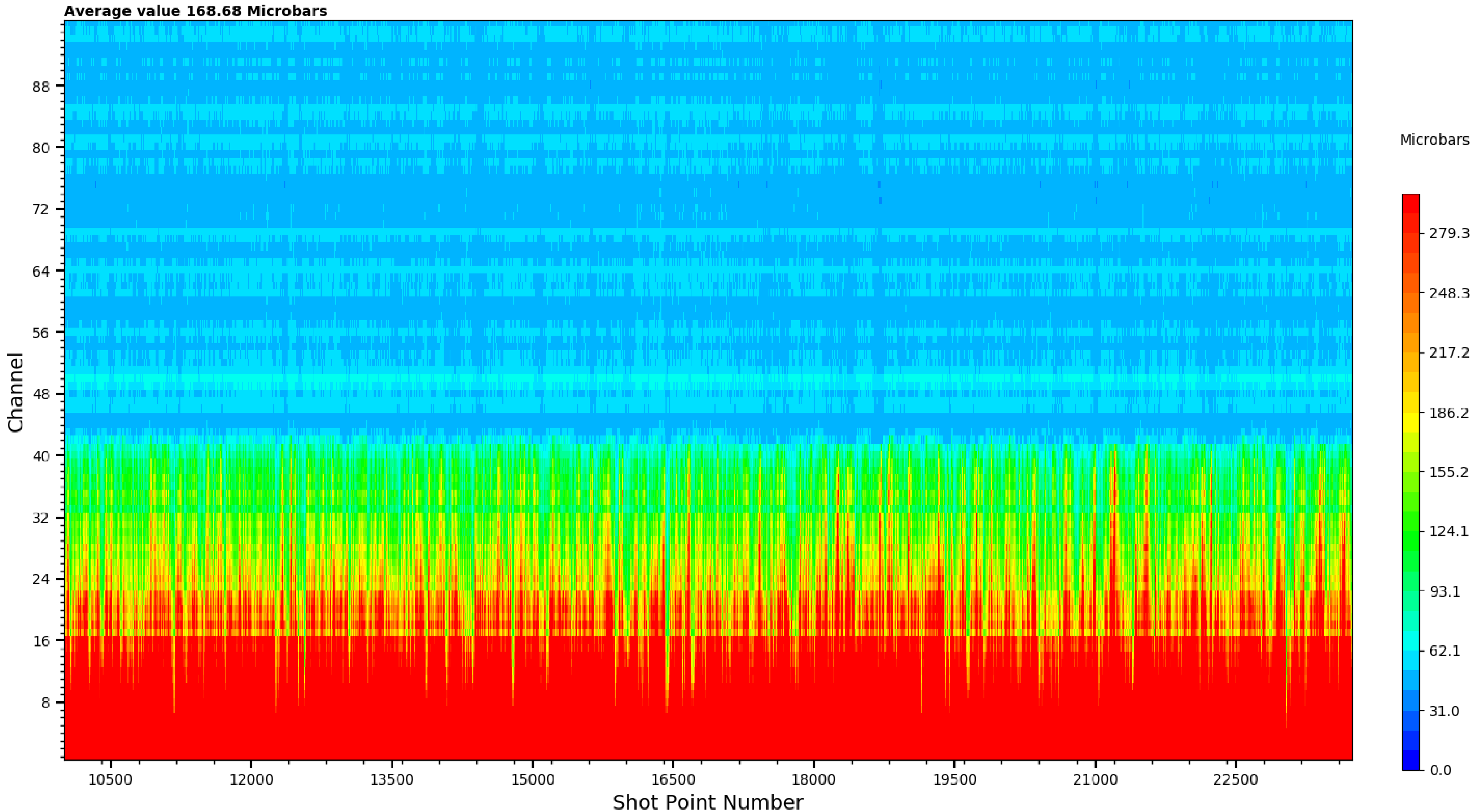
Noise RMS Amplitude



Low cut filter: 65 Hz - 18 dB/oct

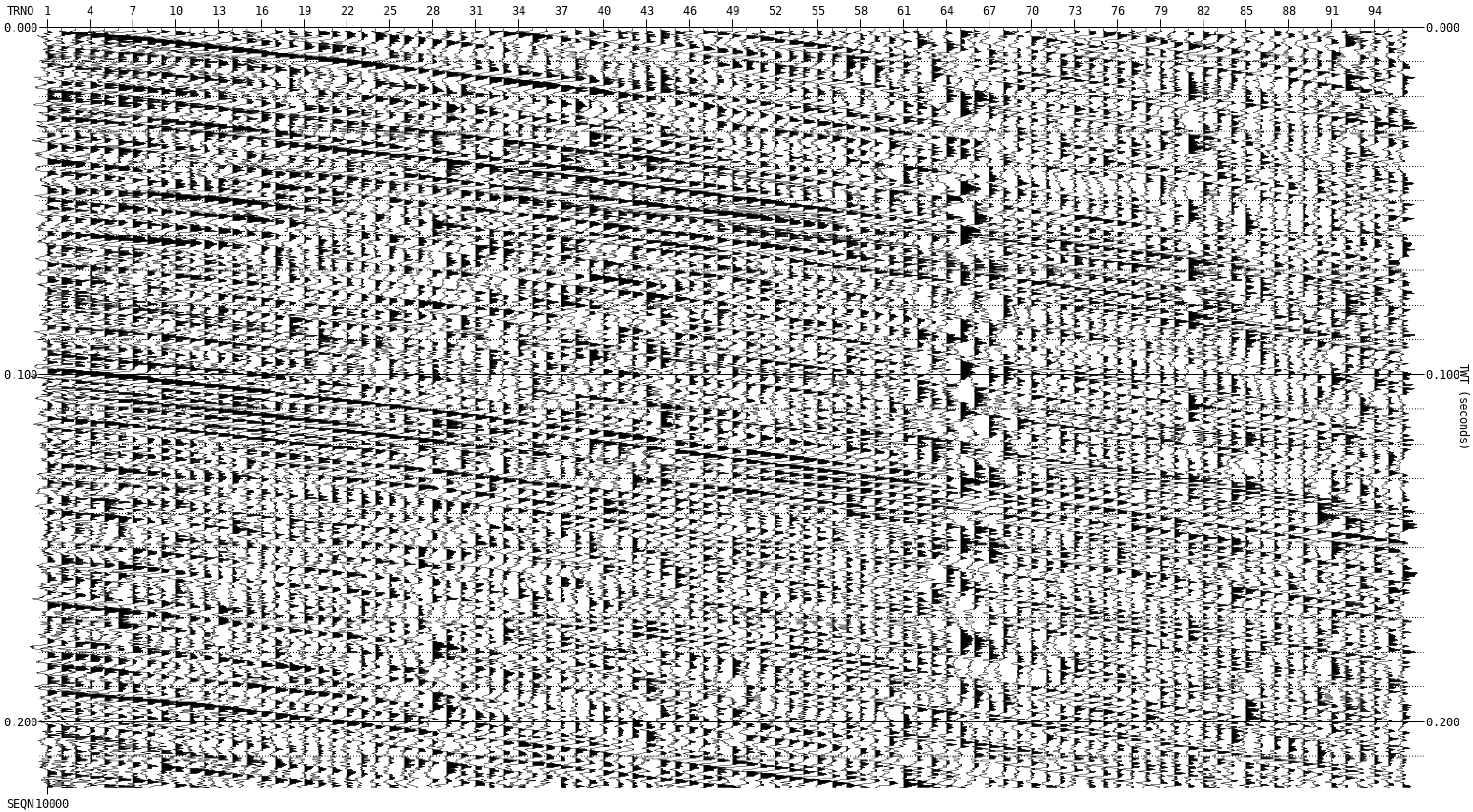
Analysis window: 1 ch 184.875-214.875 ms / 96 ch 184.875-214.875 ms

Signal RMS Amplitude



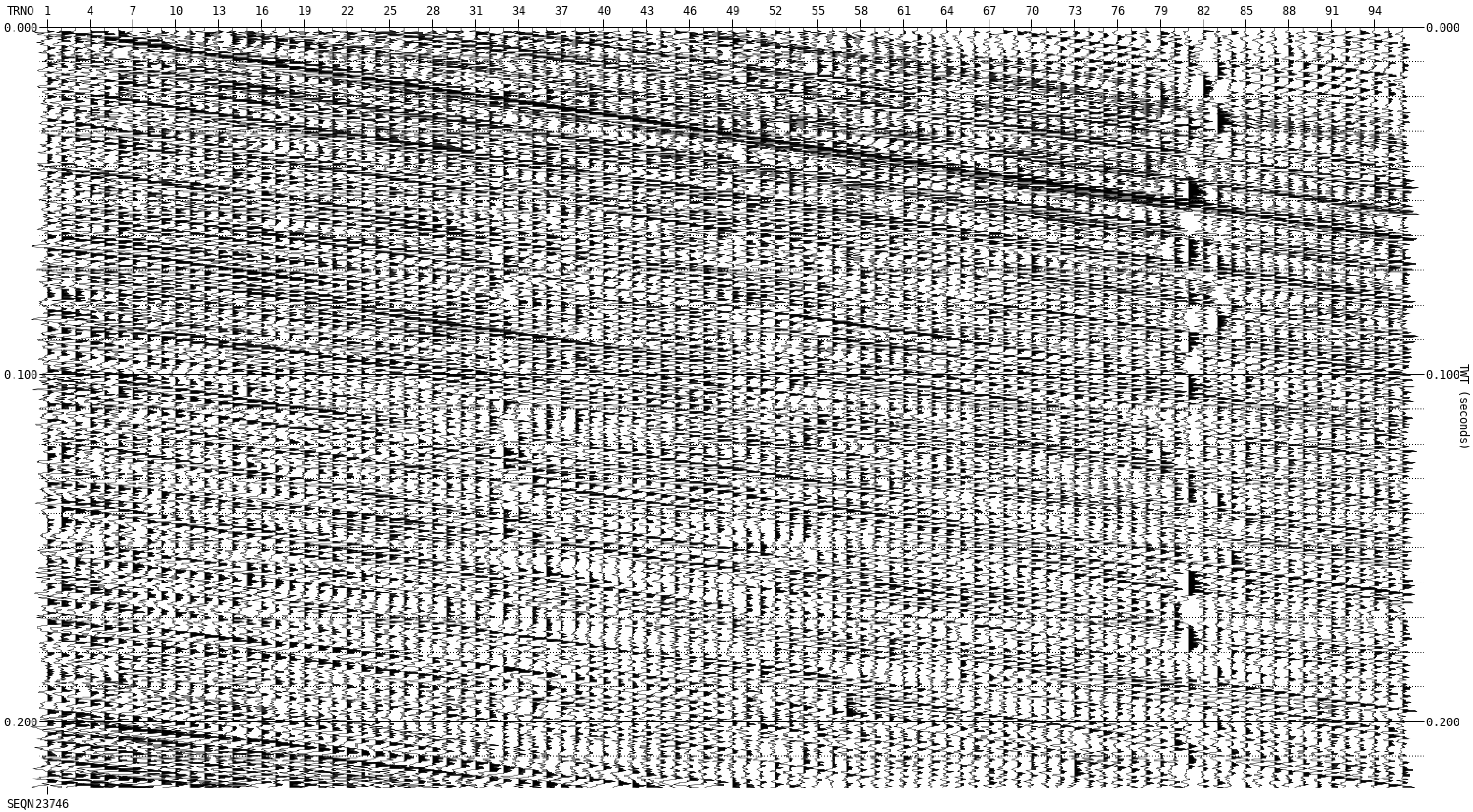
Low cut filter: 65 Hz - 18 dB/oct
Analysis window: top window -> seabed hyperbola / window length -> 35 ms

Start of Line Noise File

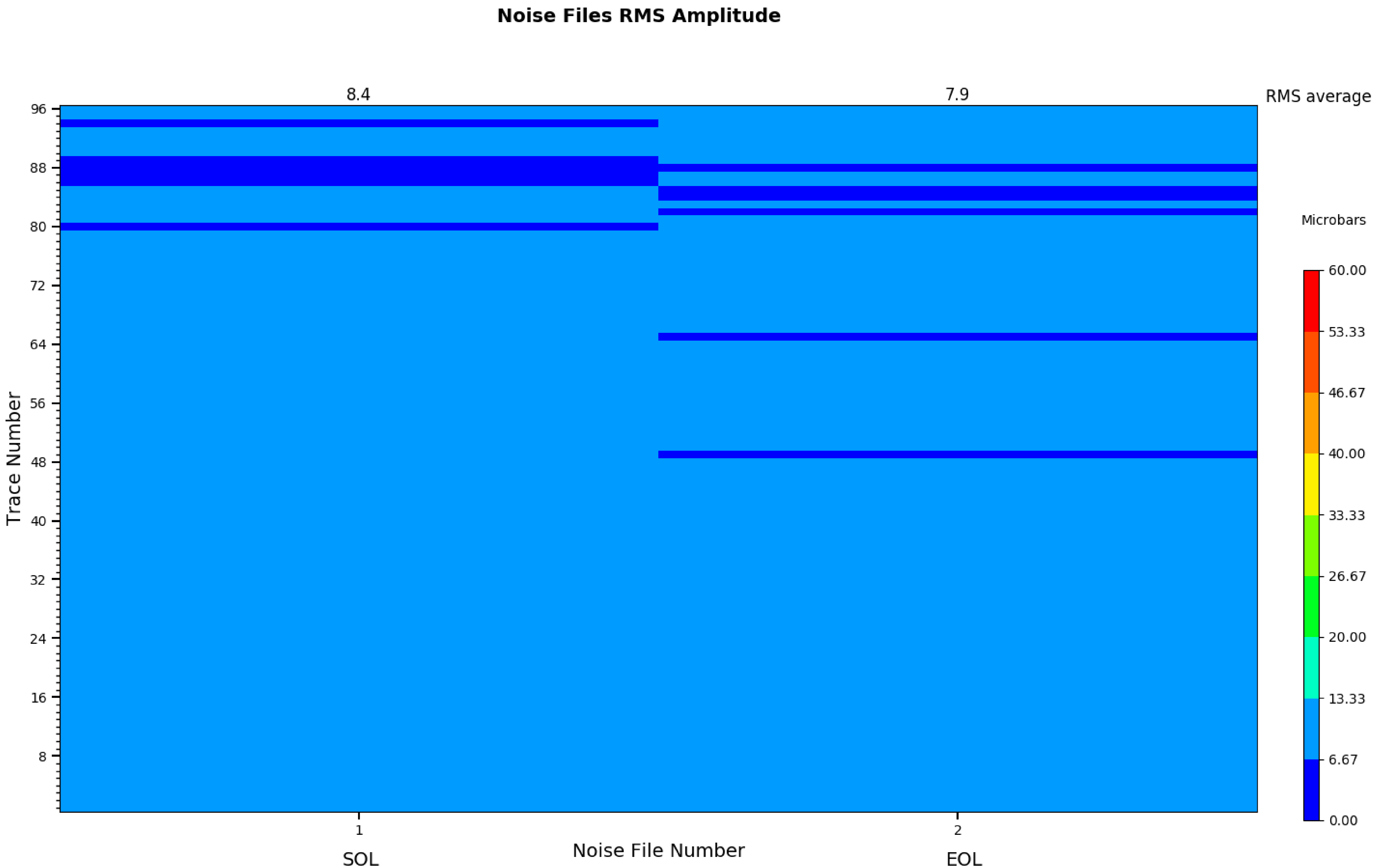


Low cut filter: 65 Hz - 18 dB/oct
No geometrical spreading correction

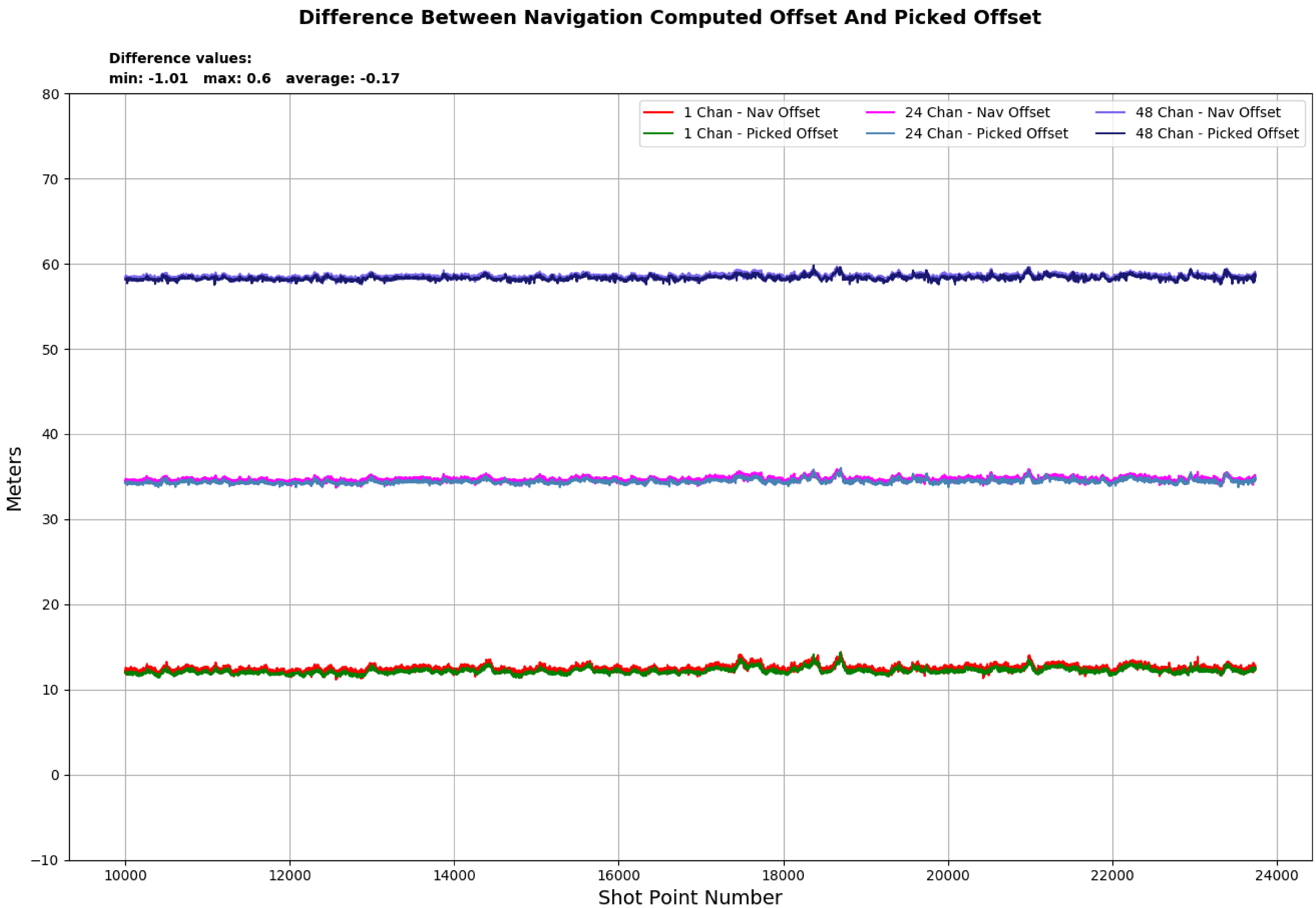
End of Line Noise File



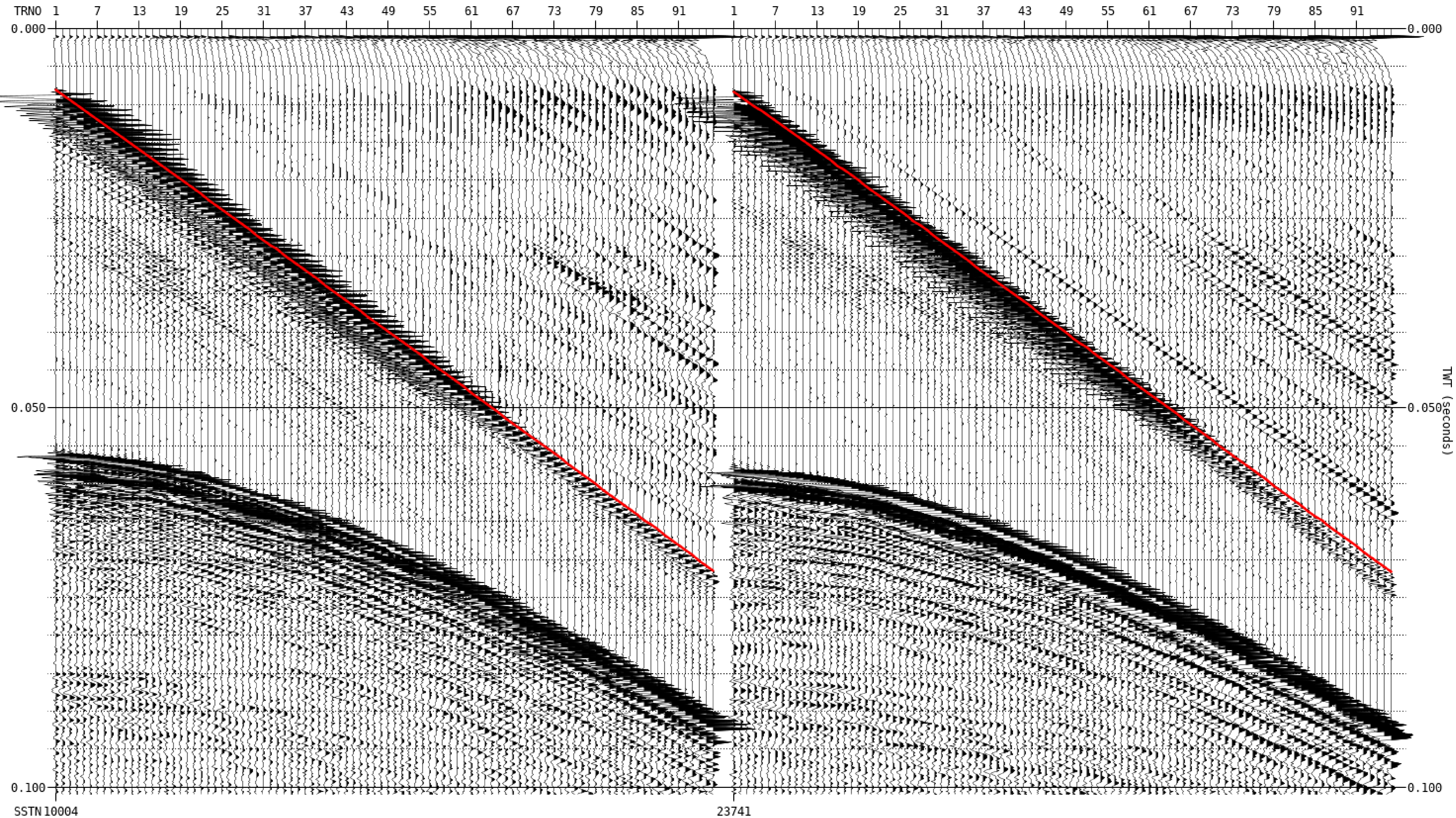
Low cut filter: 65 Hz - 18 dB/oct
No geometrical spreading correction



Low cut filter: 65 Hz - 18 dB/oct

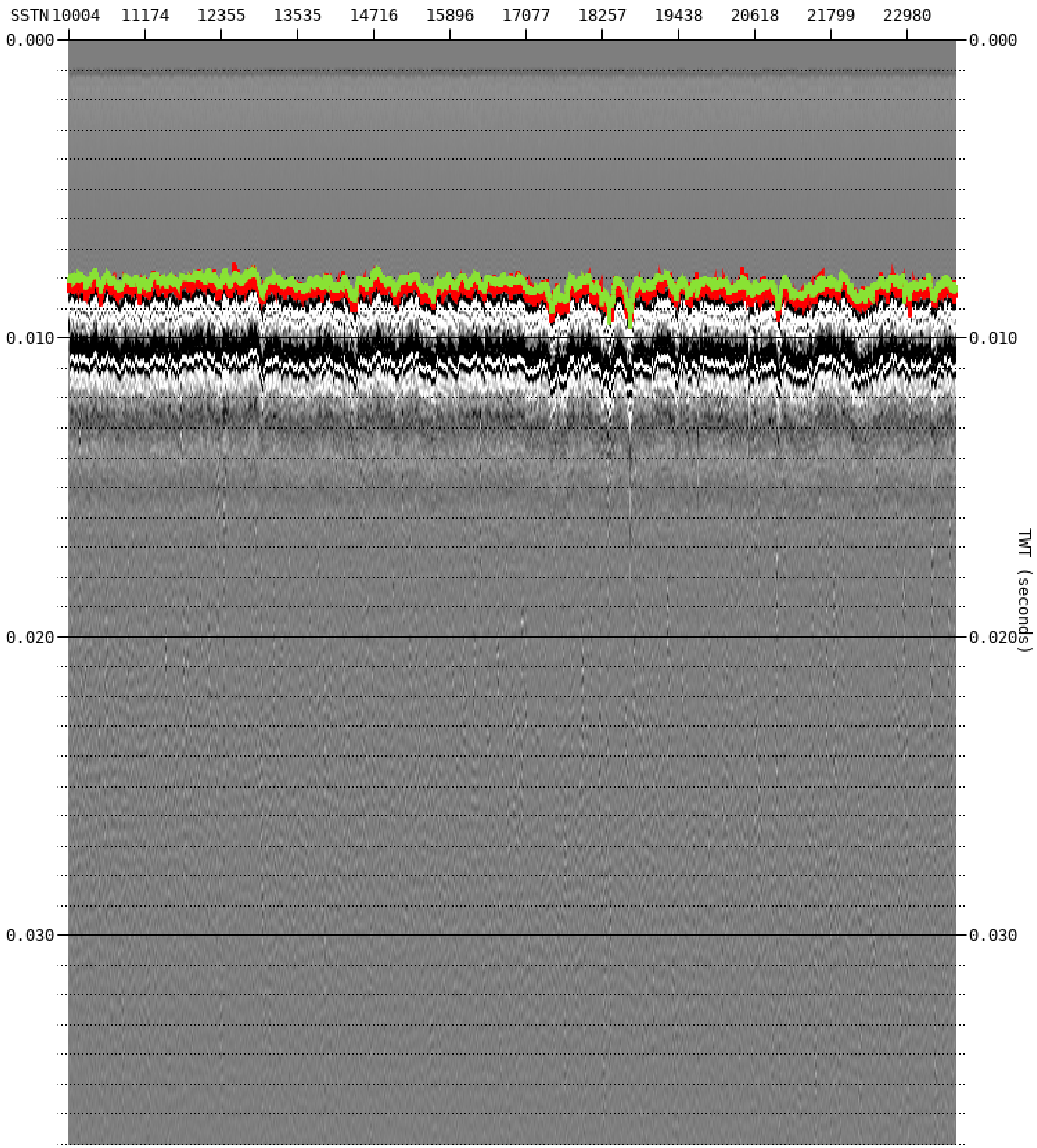

Difference Between Navigation Computed Offset And Picked Offset
Difference values:
min: -1.01   max: 0.6   average: -0.17
1 Chan - Nav Offset
1 Chan - Picked Offset
24 Chan - Nav Offset
24 Chan - Picked Offset
48 Chan - Nav Offset
48 Chan - Picked Offset
Meters
Shot Point Number
80
70
60
50
40
30
20
10
0
−10
10000
12000
14000
16000
18000
20000
22000
24000

Direct Arrival Check



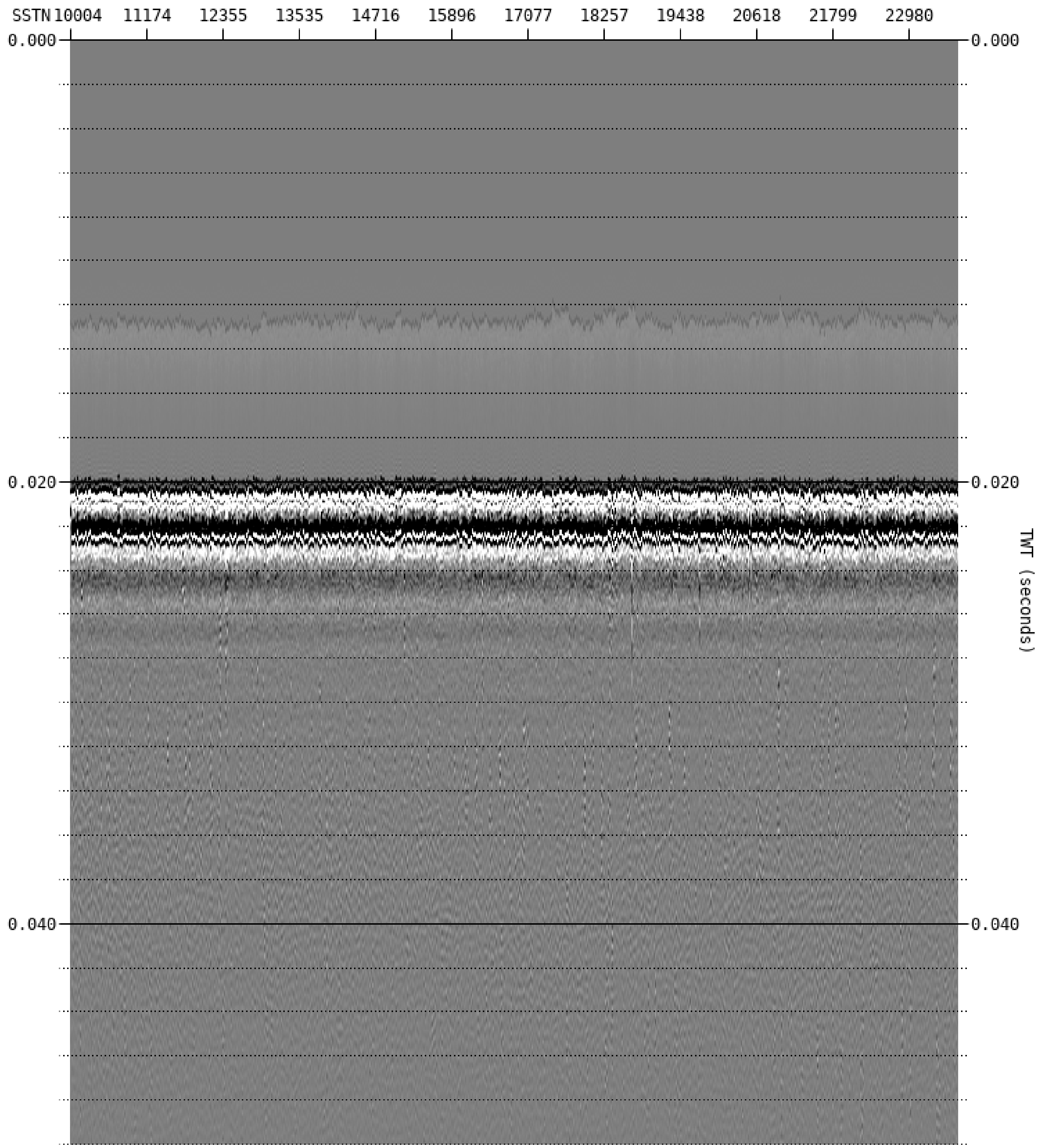
Low cut filter: 65 Hz - 18 dB/oct
AGC equalisation, window length: 50 ms
Overlaid in red direct arrival computed from offset

Direct Arrival - Chan 1



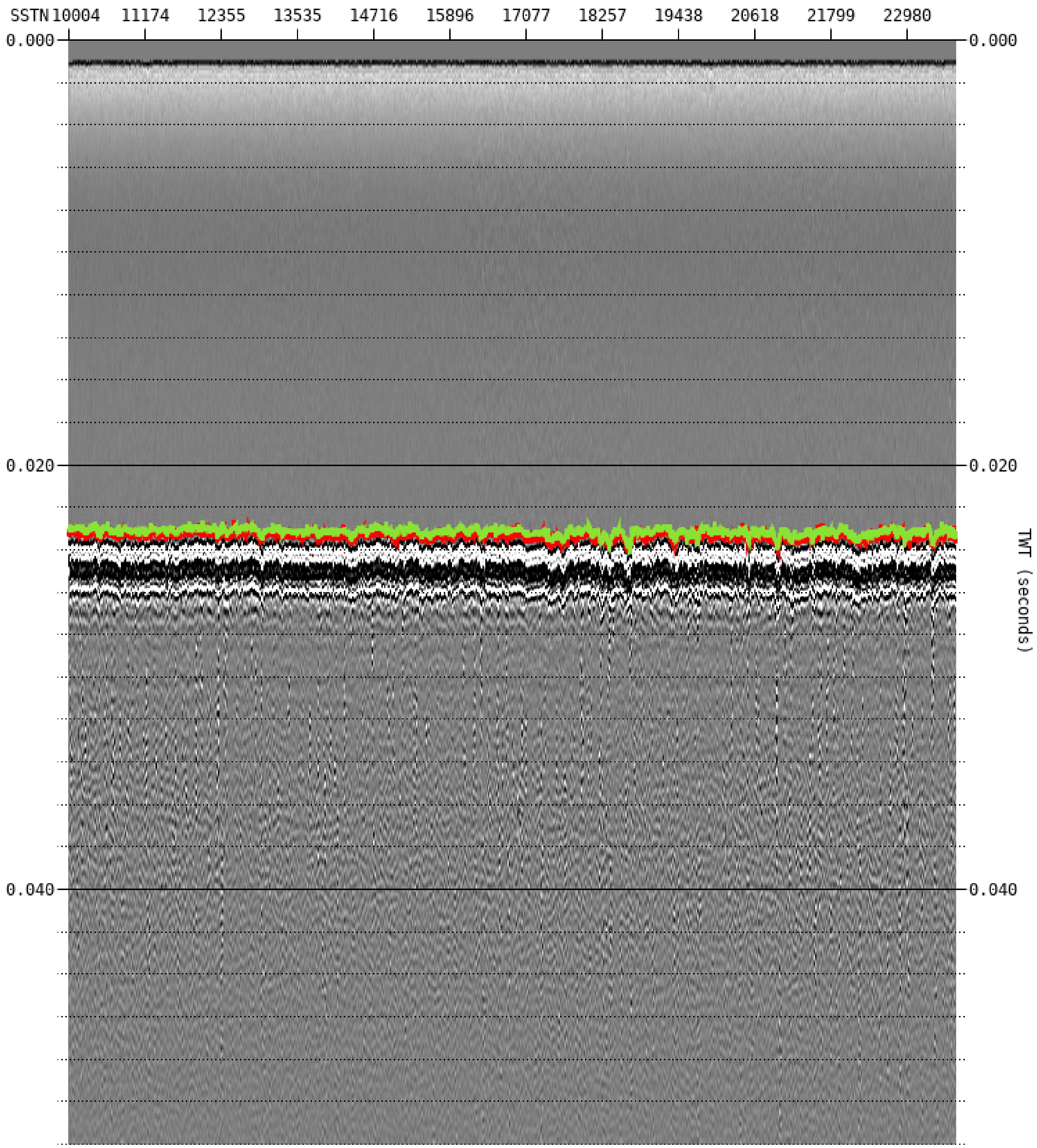
Low cut filter: 65 Hz - 18 dB/oct
Overlaid in red direct arrival computed from offset
Overlaid in green picking of the direct arrival

Linear Moveout - Chan 1



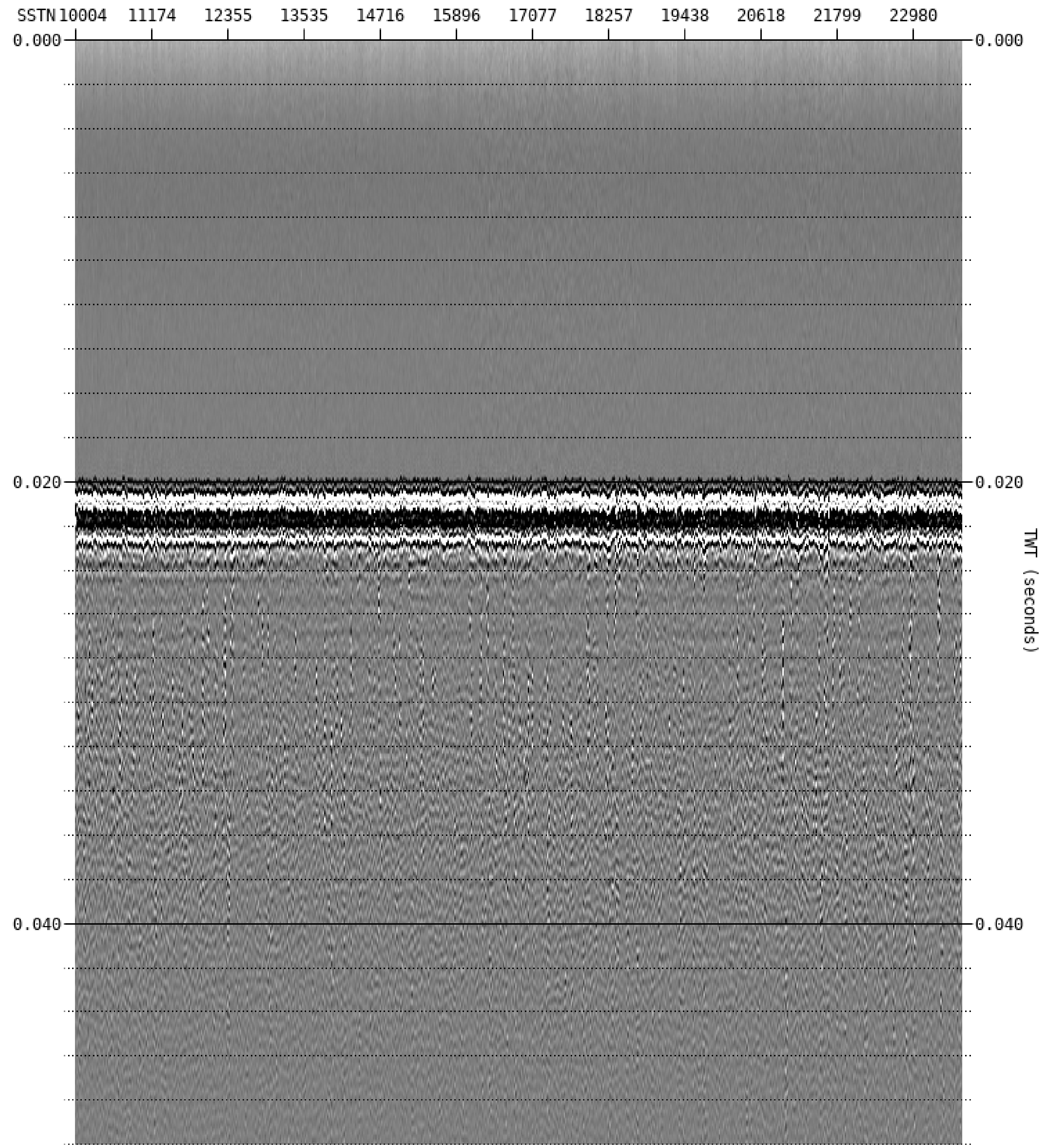
Low cut filter: 65 Hz - 18 dB/oct
Linear moveout to 20 ms (0.02 sec), reference time using 1485 m/s velocity

Direct Arrival - Chan 24



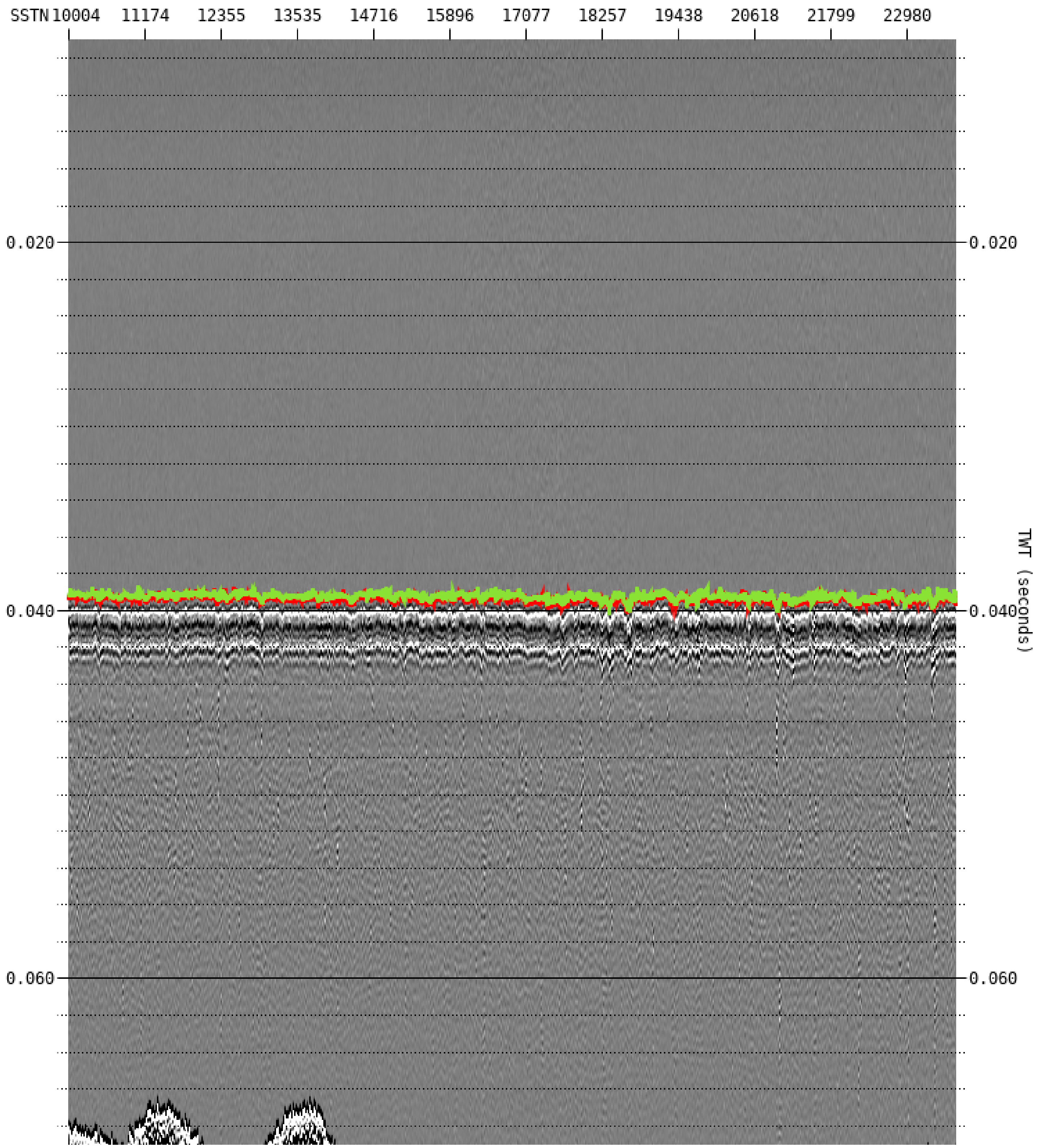
Low cut filter: 65 Hz - 18 dB/oct
Overlaid in red direct arrival computed from offset
Overlaid in green picking of the direct arrival

Linear Moveout - Chan 24



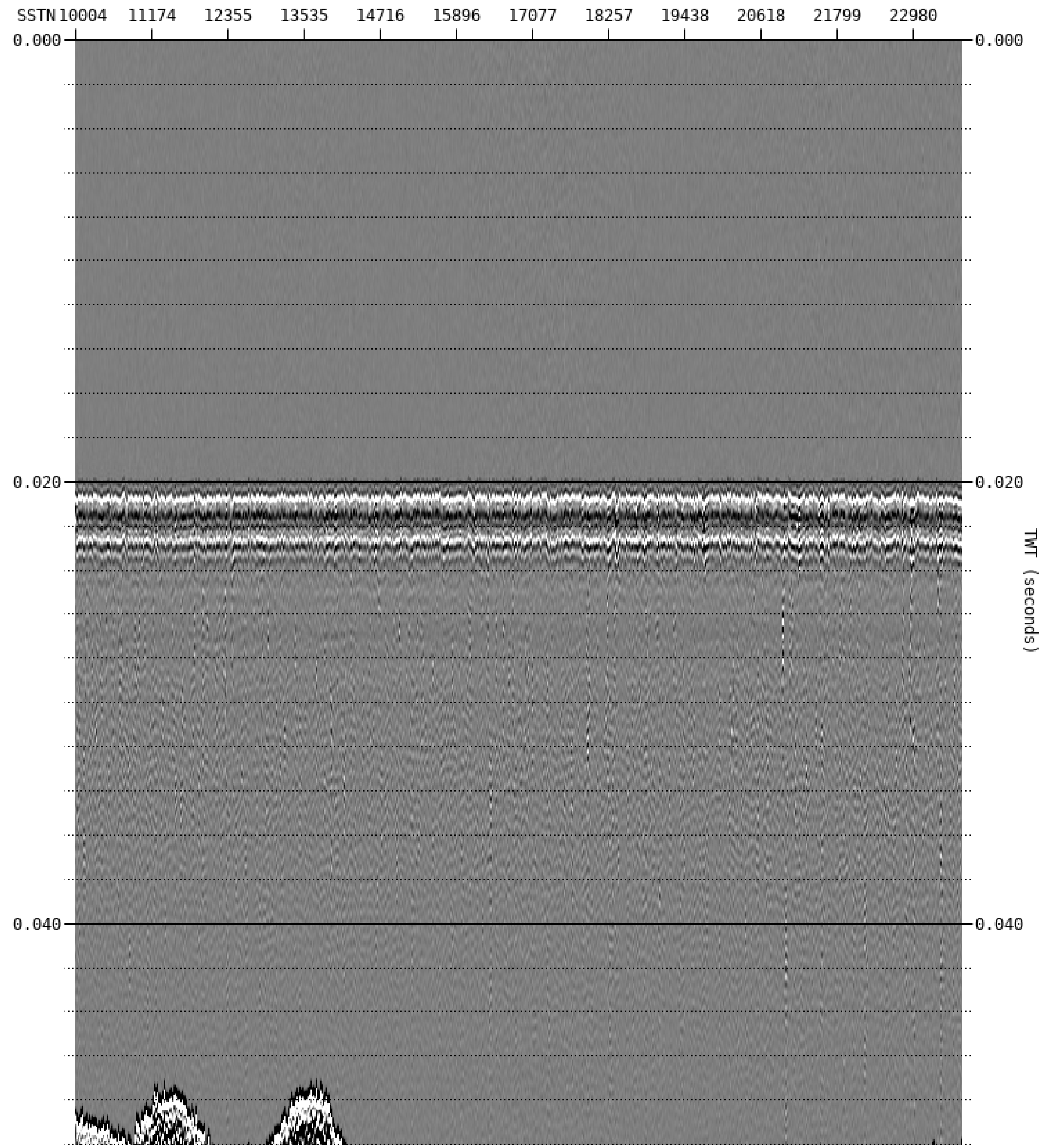
Low cut filter: 65 Hz - 18 dB/oct
Linear moveout to 20 ms (0.02 sec), reference time using 1485 m/s velocity

Direct Arrival - Chan 48



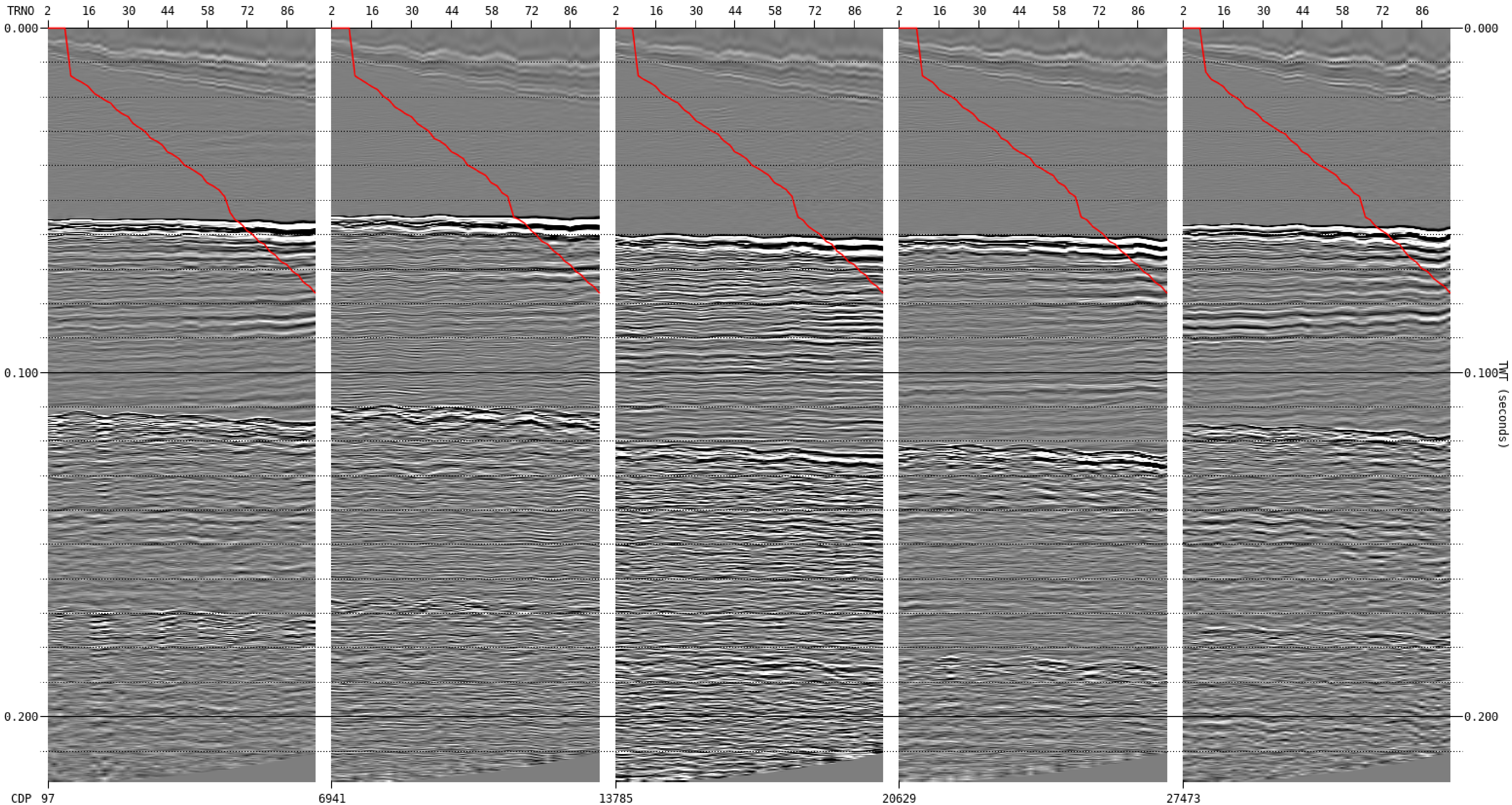
Low cut filter: 65 Hz - 18 dB/oct
Overlaid in red direct arrival computed from offset
Overlaid in green picking of the direct arrival

Linear Moveout - Chan 48



Low cut filter: 65 Hz - 18 dB/oct
Linear moveout to 20 ms (0.02 sec), reference time using 1485 m/s velocity

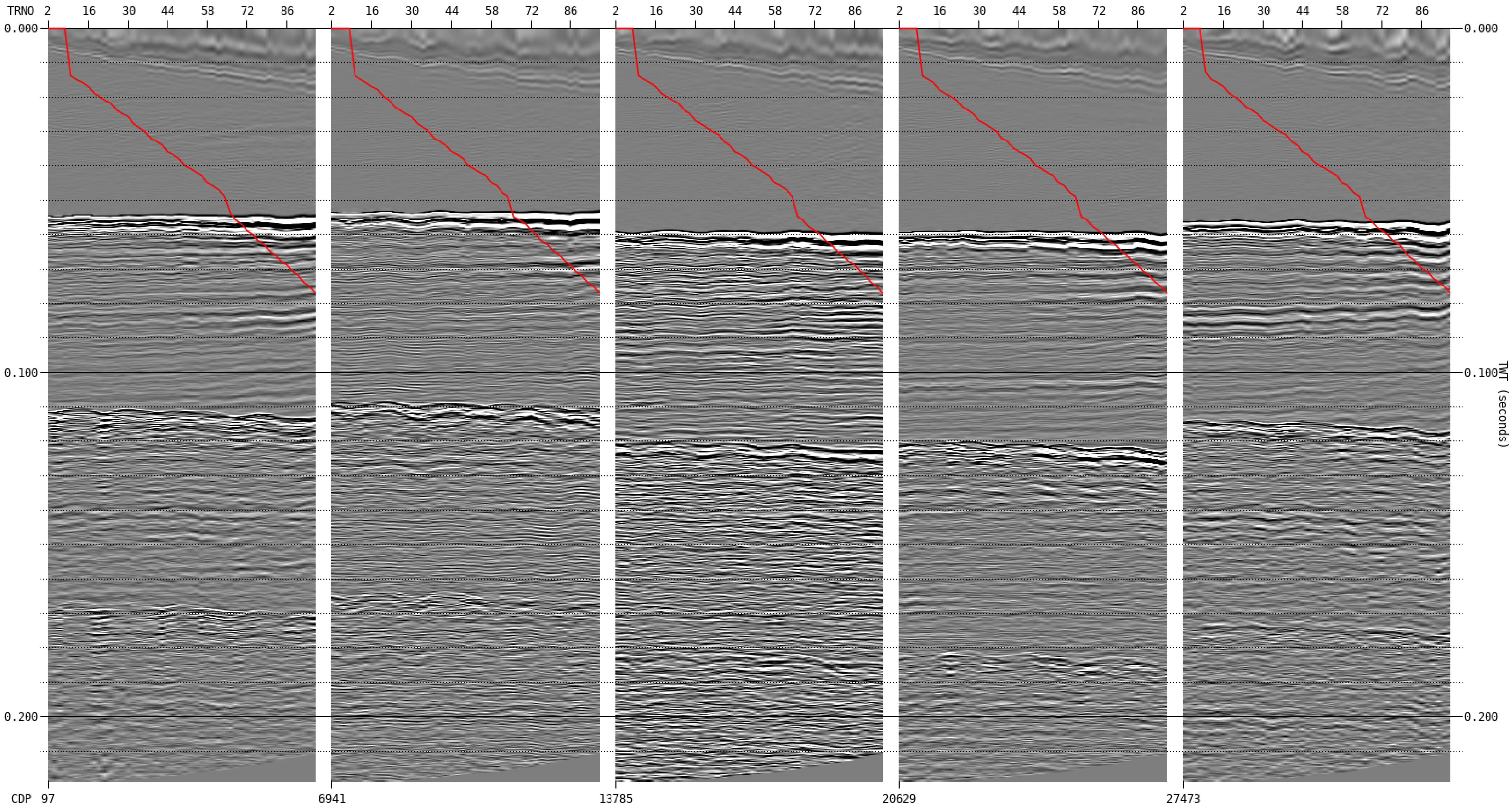
NMO'd CMP Gathers



Low cut filter: 65 Hz - 18 dB/oct
Geometrical spreading correction: T^2
Brute stacking velocity (time,velocity): 50,1485,100,1550,250,1750

Overlaid in red percentage stretch mute: 30 %

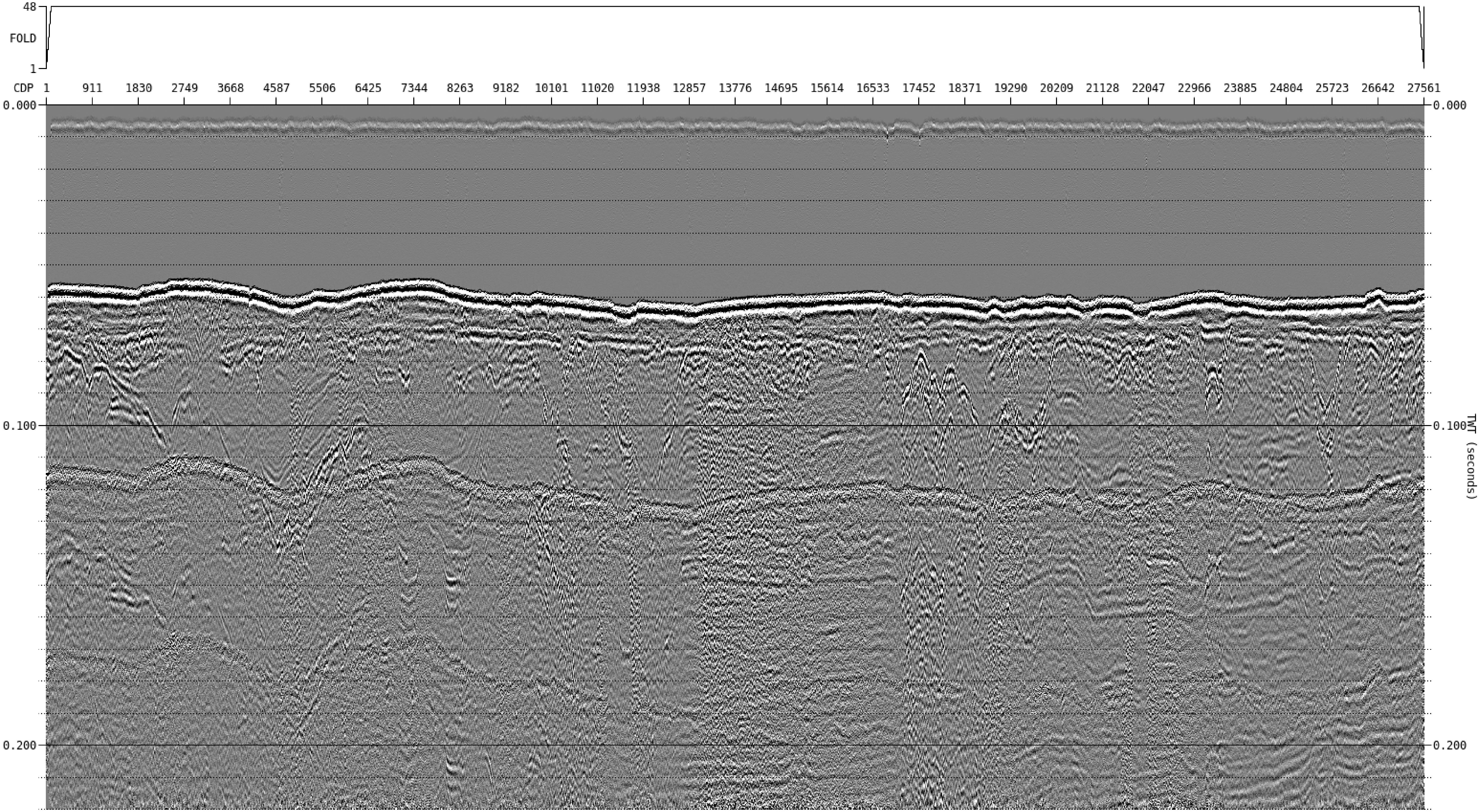
NMO'd Denoise CMP Gathers



Low cut filter: 65 Hz - 18 dB/oct
Geometrical spreading correction: T^2
Brute stacking velocity (time,velocity): 50,1485,100,1550,250,1750

Overlaid in red percentage stretch mute: 30 %
Shot gather denoise (SWELL, TFDN, SWNA)

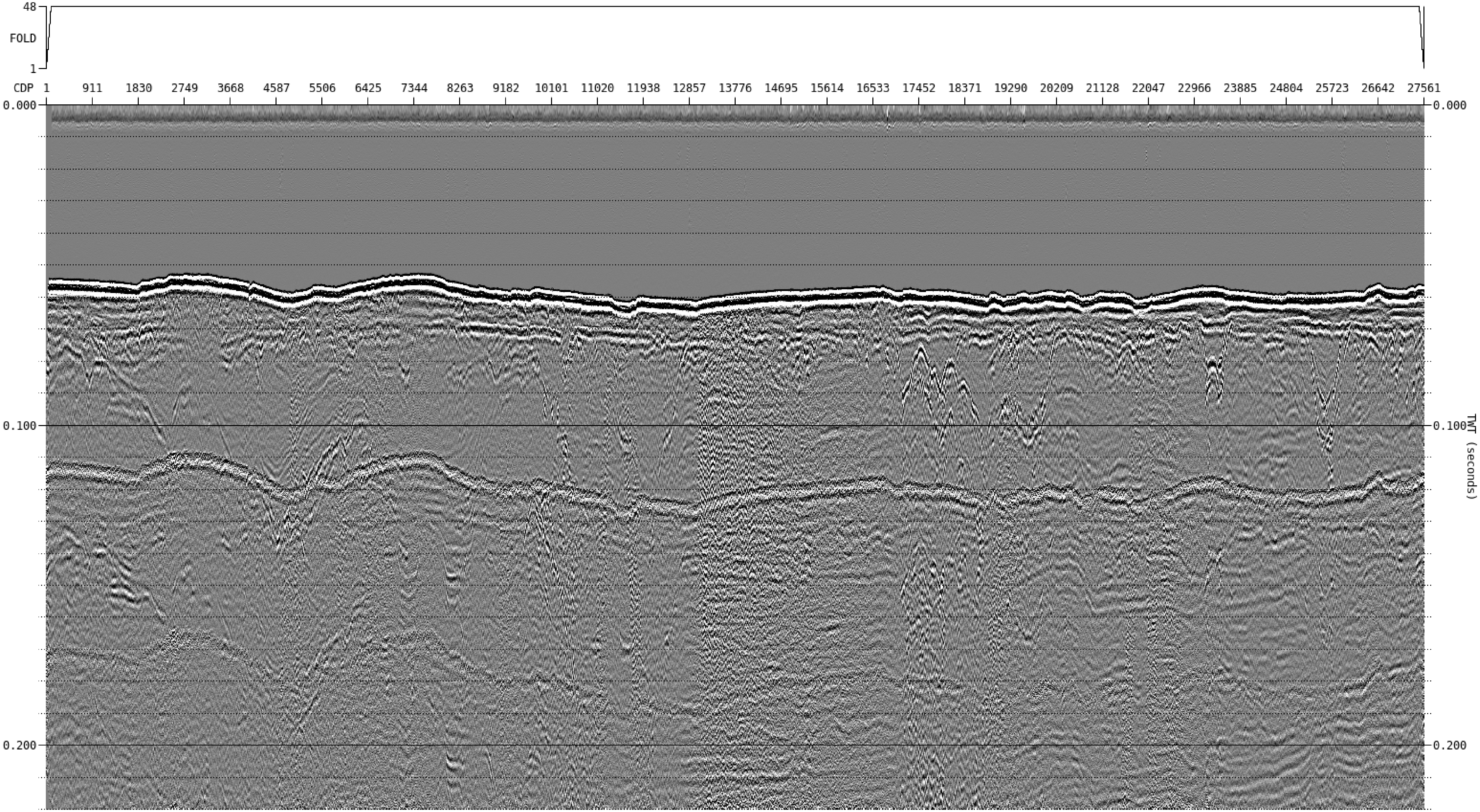
Brute Stack



Low cut filter: 65 Hz - 18 dB/oct
Geometrical spreading correction: T^2
Brute stacking velocity (time,velocity): 50,1485,100,1550,250,1750

Percentage stretch mute: 30 %

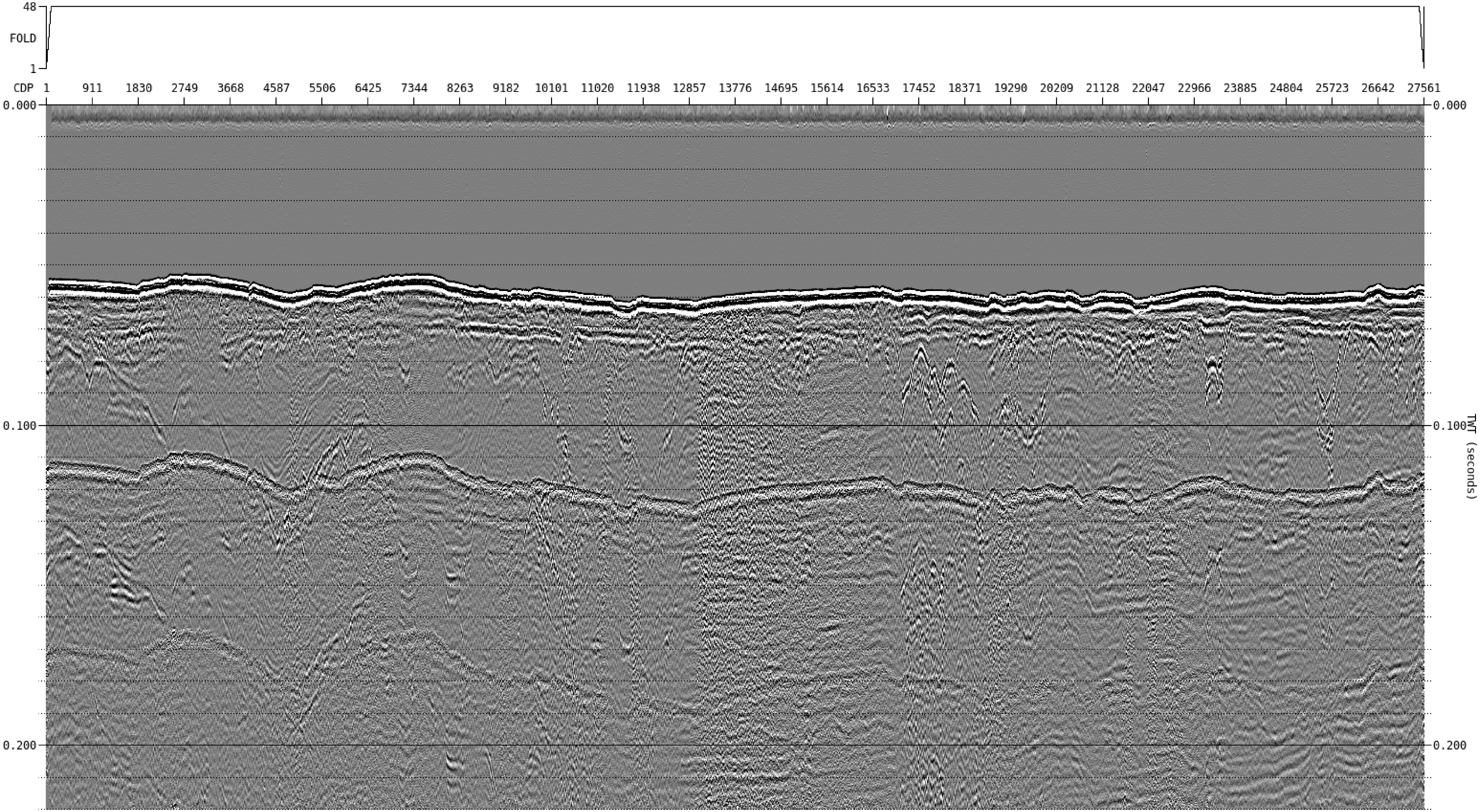
Denoise Stack



Low cut filter: 65 Hz - 18 dB/oct
Geometrical spreading correction: T^2
Brute stacking velocity (time,velocity): 50,1485,100,1550,250,1750

Percentage stretch mute: 30 %
Shot gather denoise (SWELL, TFDN, SWNA)

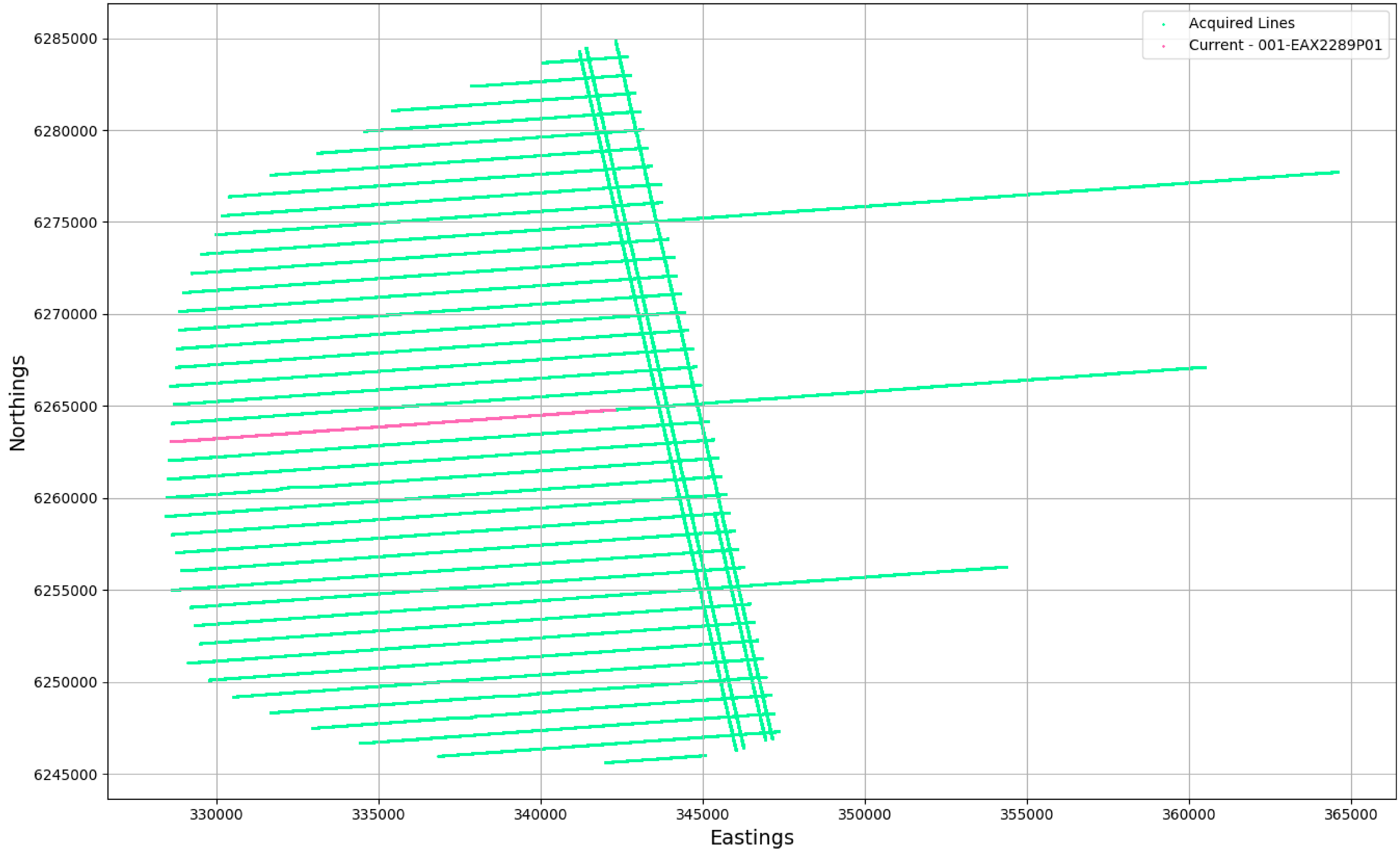
Statics Stack



Low cut filter: 65 Hz - 18 dB/oct
Geometrical spreading correction: T^2
Brute stacking velocity (time,velocity): 50,1485,100,1550,250,1750

Percentage stretch mute: 30 %
Shot gather denoise (SWELL, TFDN, SWNA)
Shot statics

Navigation and Survey Progress



Thank you

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Appendix H

MLSS Pulse Test

Energinet Energy Islands

Fugro Multi-level Stacked Sparker Pulse Test Results

May 2021

Fugro presents the results of pulse test that was conducted recently with the MLSS that has the exact same configuration as is mentioned in the present scope of work.

The purpose of the pulse tests were to investigate the signal and consistency of the Fugro MLSS sparker, in the individual electrode arrays, positioned at different tip depths and the stacked sparker, at different energy levels, using a high sampling oscilloscope.

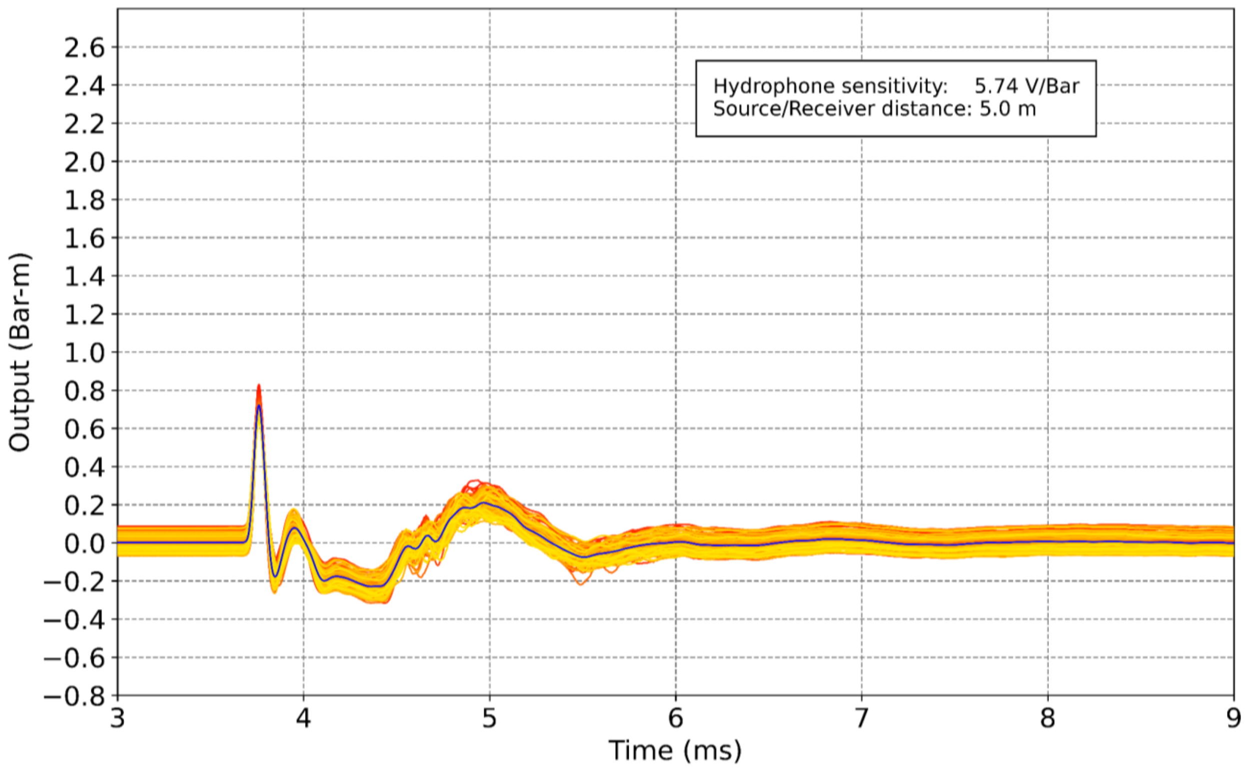
- Top array at ~0.72m firing at 300J (i.e., 160 tips @ 1.875J/tip)
- Middle array at ~0.87m firing at 300J (i.e., 120 tips @ 2.50J/tip)
- Bottom array at ~1.12m firing at 300J (i.e., 80 tips @ 3.75J/tip)
- All arrays, 360 tips firing at 900J (i.e., 300+300+300)

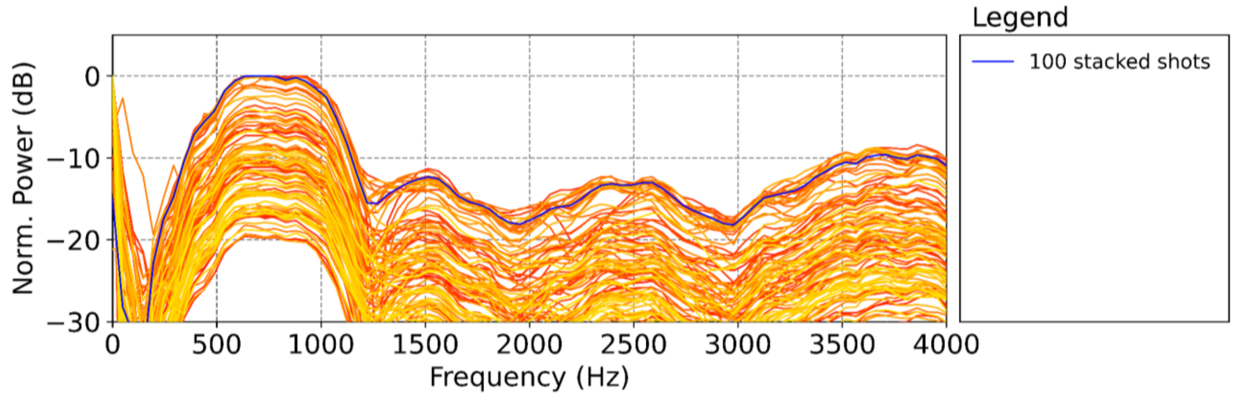
A calibrated hydrophone was towed below the sparker. The analogue signal was plugged into an oscilloscope and 100 shots per setting were logged at a sampling rate of 400kHz in csv files and 100 shots was recorded in seg-y using the GeoEel recording unit at the sampling rate of 8 kHz (SI=0.125ms).

- Vessel speed over ground between ~0.8 and 1.0 knot.
- Sparker deployed approximately 15m behind stern of vessel.
- Hydrophone is placed at 5.0m below the sparker.
- Hydrophone sensitivity: 5.74 V/Bar.
- Weather: 0.5m waves and 10 knot winds.
- Oscilloscope record length: 20.5ms (8192 samples at 400 kHz)

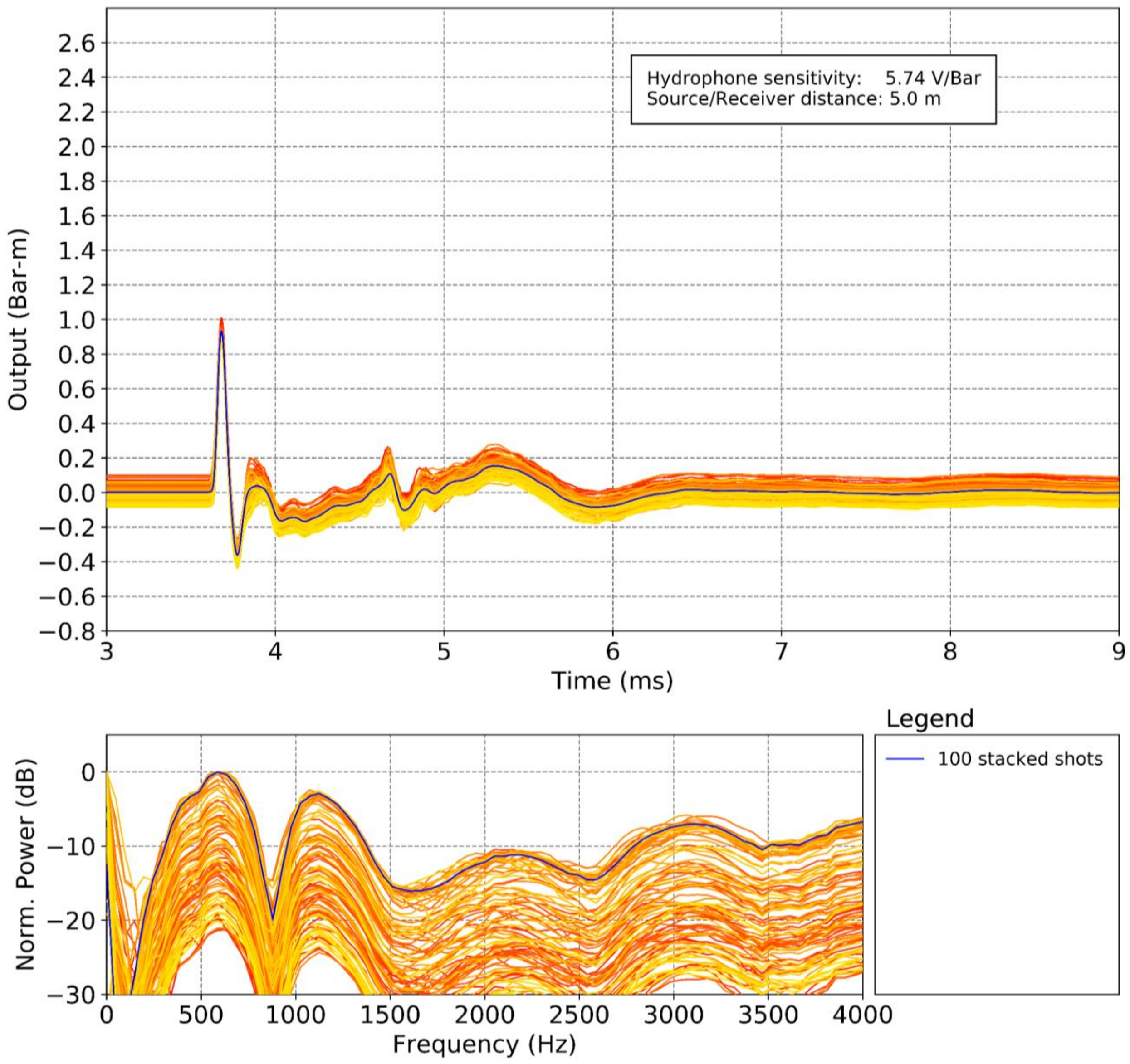
Individual Arrays (Top-Middle-Bottom) Signal

MLSS 900J @ 360 Tips					
	No. of Tips	Total Energy (J)	Energy/ Tip (J)	Tip Depth (m)	Sync. Delay (µs)
Top Array	160	300	1.88	0.72	0
Middle Array	120	300	2.50	0.87	100
Bottom Array	80	300	3.75	1.12	270

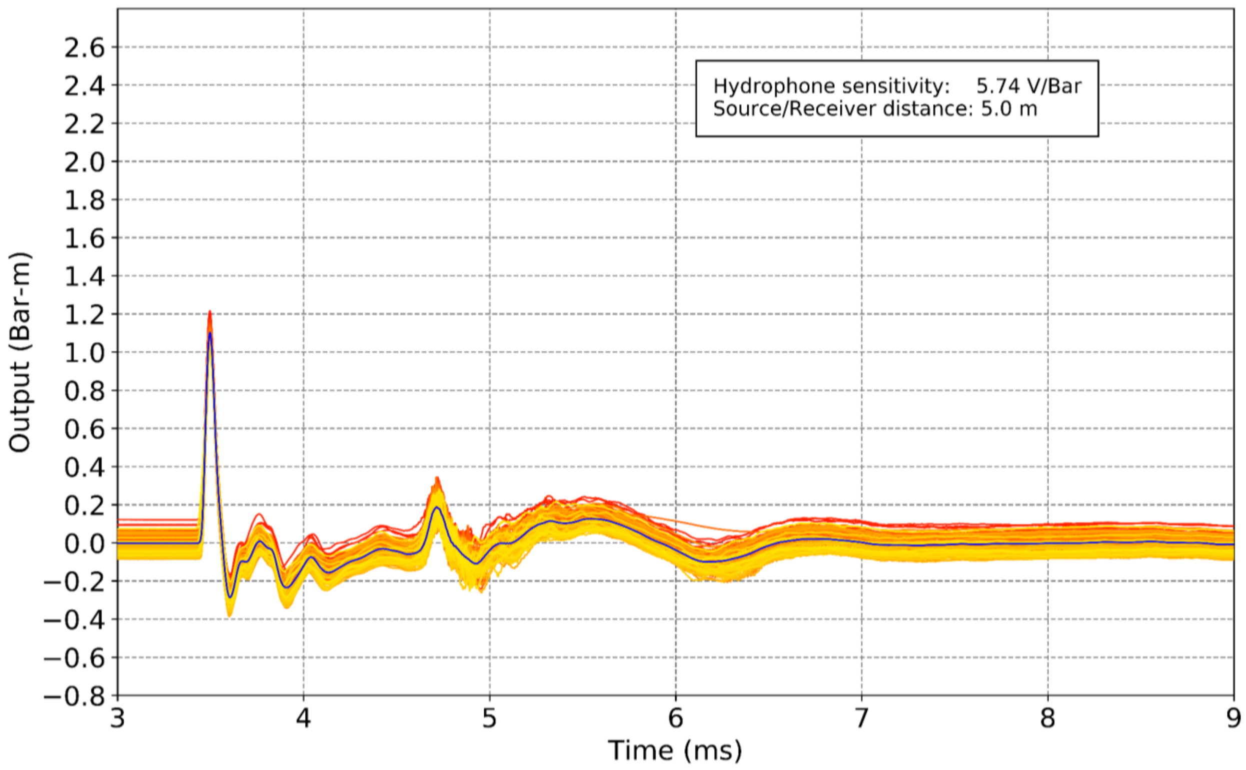


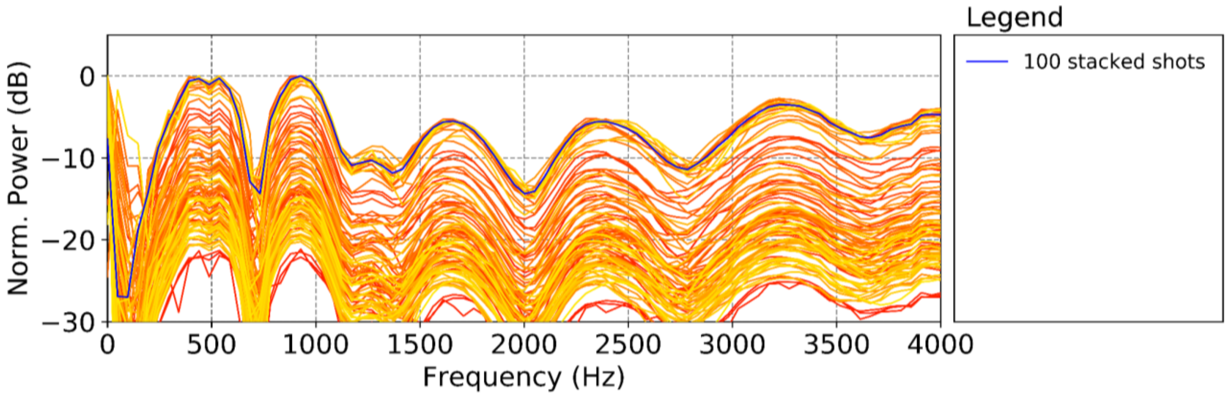


MLSS 900J @ 360 Tips					
	No. of Tips	Total Energy (J)	Energy/ Tip (J)	Tip Depth (m)	Sync. Delay (μs)
Top Array	160	300	1.88	0.72	0
Middle Array	120	300	2.50	0.87	100
Bottom Array	80	300	3.75	1.12	270



MLSS 900J @ 360 Tips					
	No. of Tips	Total Energy (J)	Energy/ Tip (J)	Tip Depth (m)	Sync. Delay (μs)
Top Array	160	300	1.88	0.72	0
Middle Array	120	300	2.50	0.87	100
Bottom Array	80	300	3.75	1.12	270

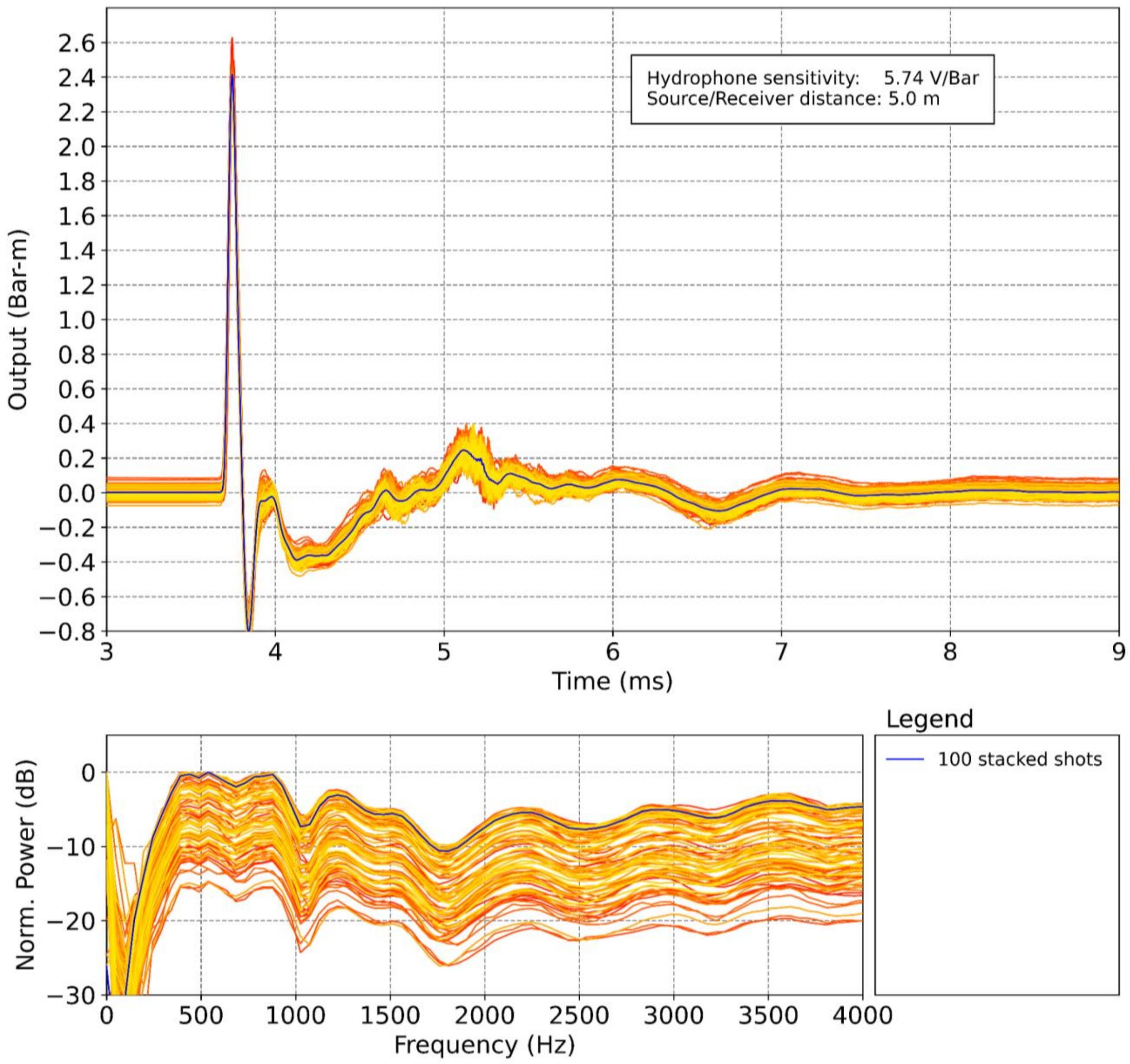




Fugro Multi-Level Stacked Sparker

All Arrays Combined Signal

MLSS 900J @ 360 Tips					
	No. of Tips	Total Energy (J)	Energy/ Tip (J)	Tip Depth (m)	Sync. Delay (μs)
Top Array	160	300	1.88	0.72	0
Middle Array	120	300	2.50	0.87	100
Bottom Array	80	300	3.75	1.12	270



- Repeatability and pulse quality: individual depth arrays show good repeatability with respect to pulse shape and frequency content. The same is for the multi-level stacked sparker signal as well.

- Analysing the multi-level stacked sparker signal for each setting and all arrays combined, 900 J (i.e., with 160,120 and 80 tips in top, middle and bottom array respectively) was chosen as the survey setting to achieve both highest signal to noise ratio and best penetration.

Thank you

Appendix I

Streamer Depth and Balancing Verification

Streamer Balancing Report

Client: Energinet

Project: EnergyIslands

Vessel: Fugro Pioneer

Line: EAX2289P01

LINE EAX2289P01:

Number of channels: 96

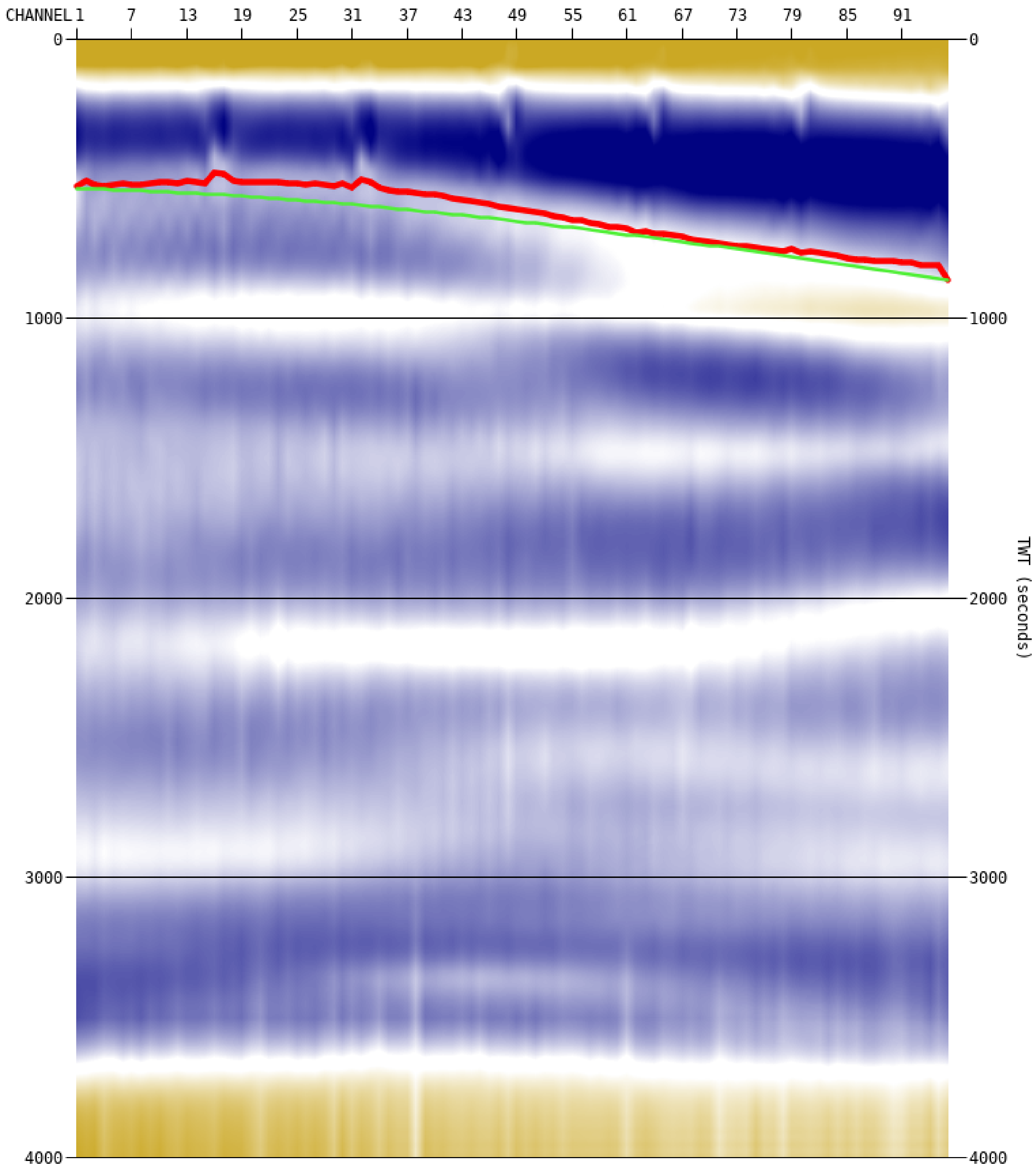
Target streamer depth: Flat - 1.4 m

Target source depth: 0.77 m

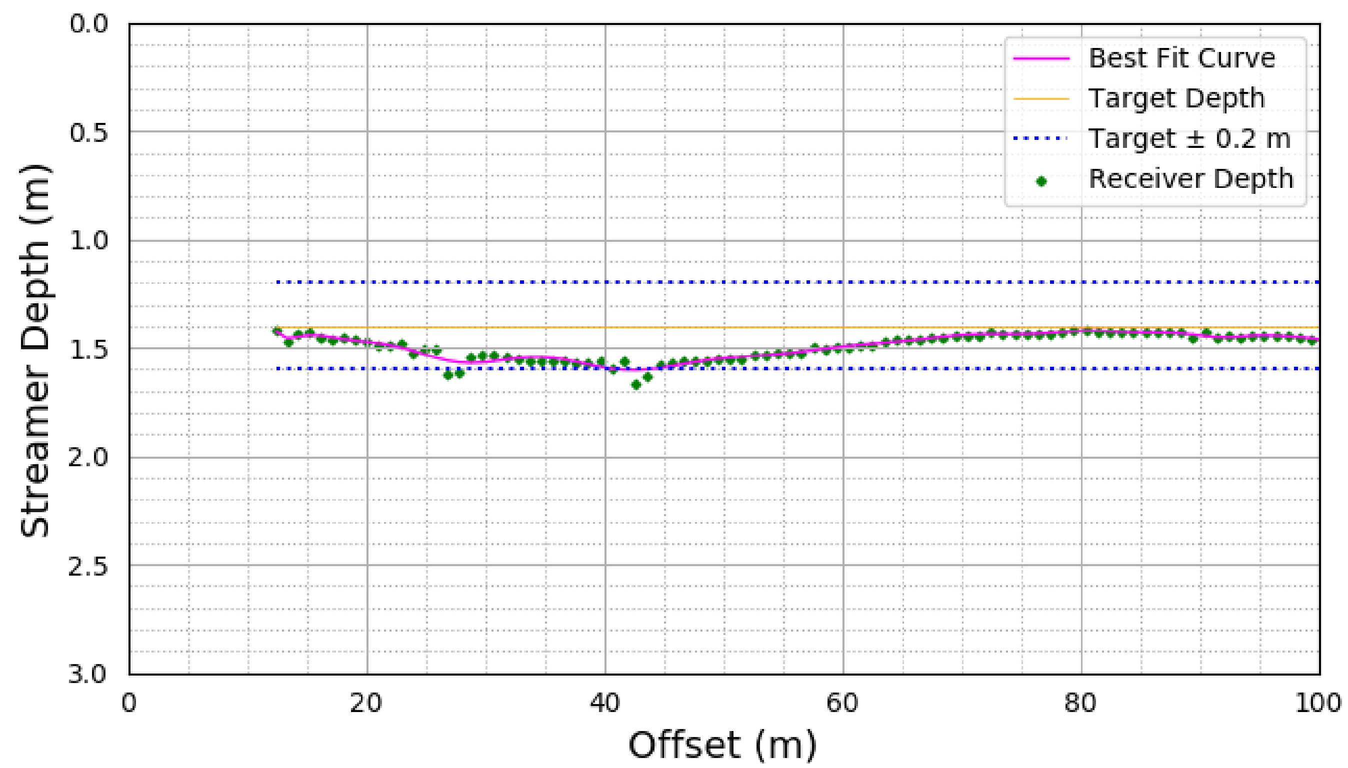
Assessment resolution: Every 1 shot(s)

CONTENTS:

Executive Summary 001-EAX2289P01

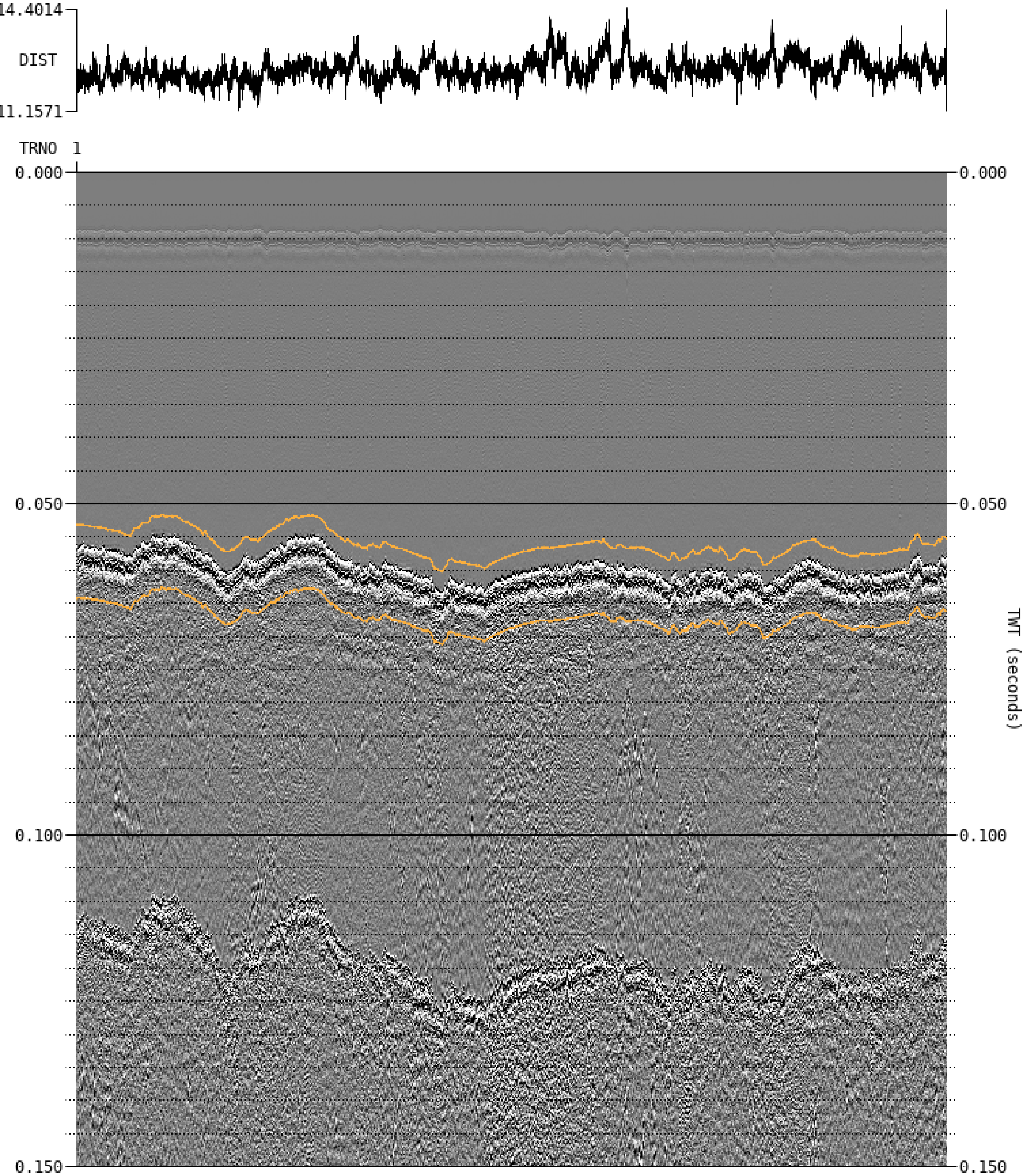


Channel vs Frequency (Hz) Plot
Average frequency spectrum per channel
Red line is picked receiver notch / green is nominal

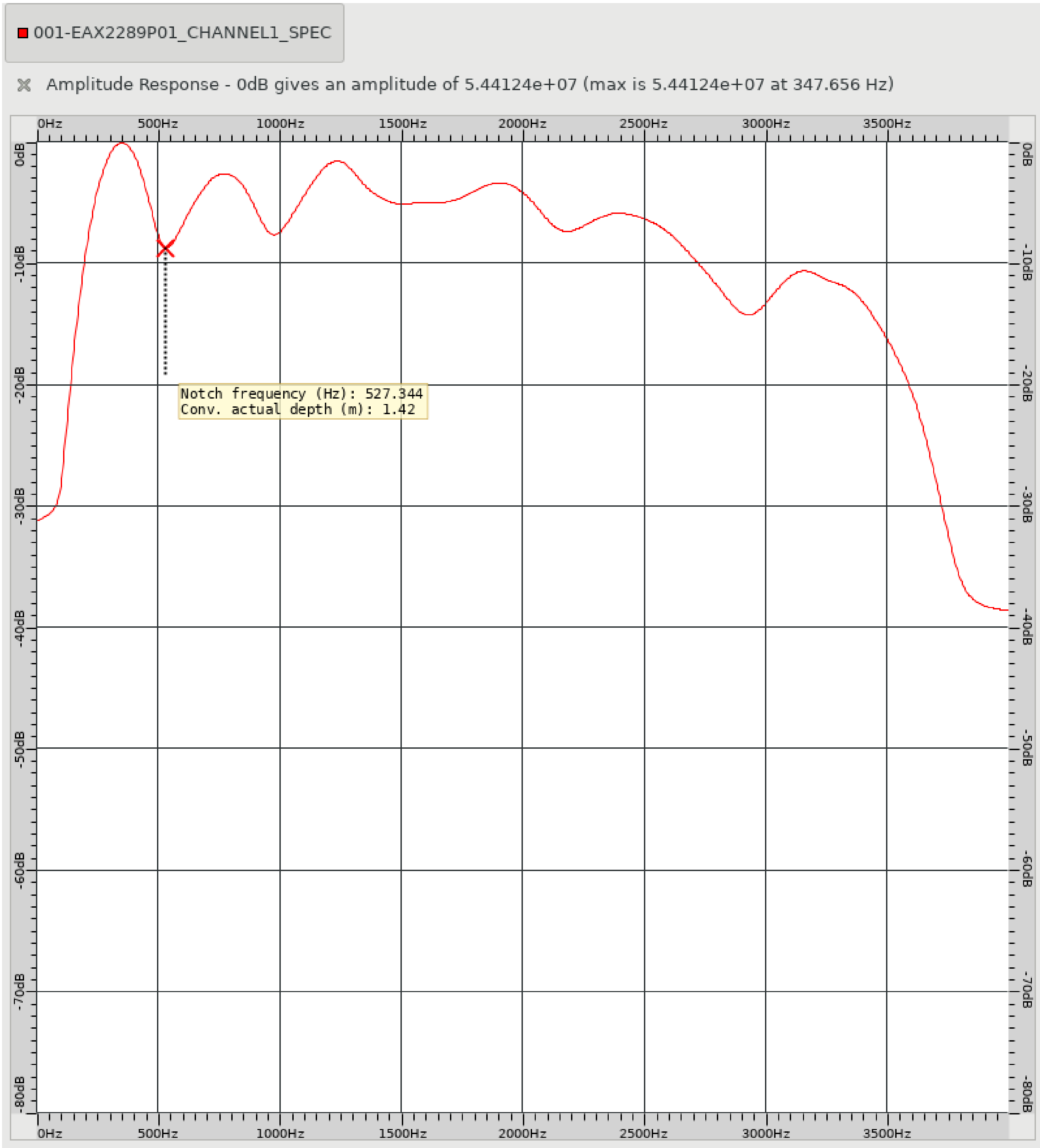


Streamer Depth Plot
Average notch pick per channel (converted to actual depth)

Frequency Analysis: Channel 1

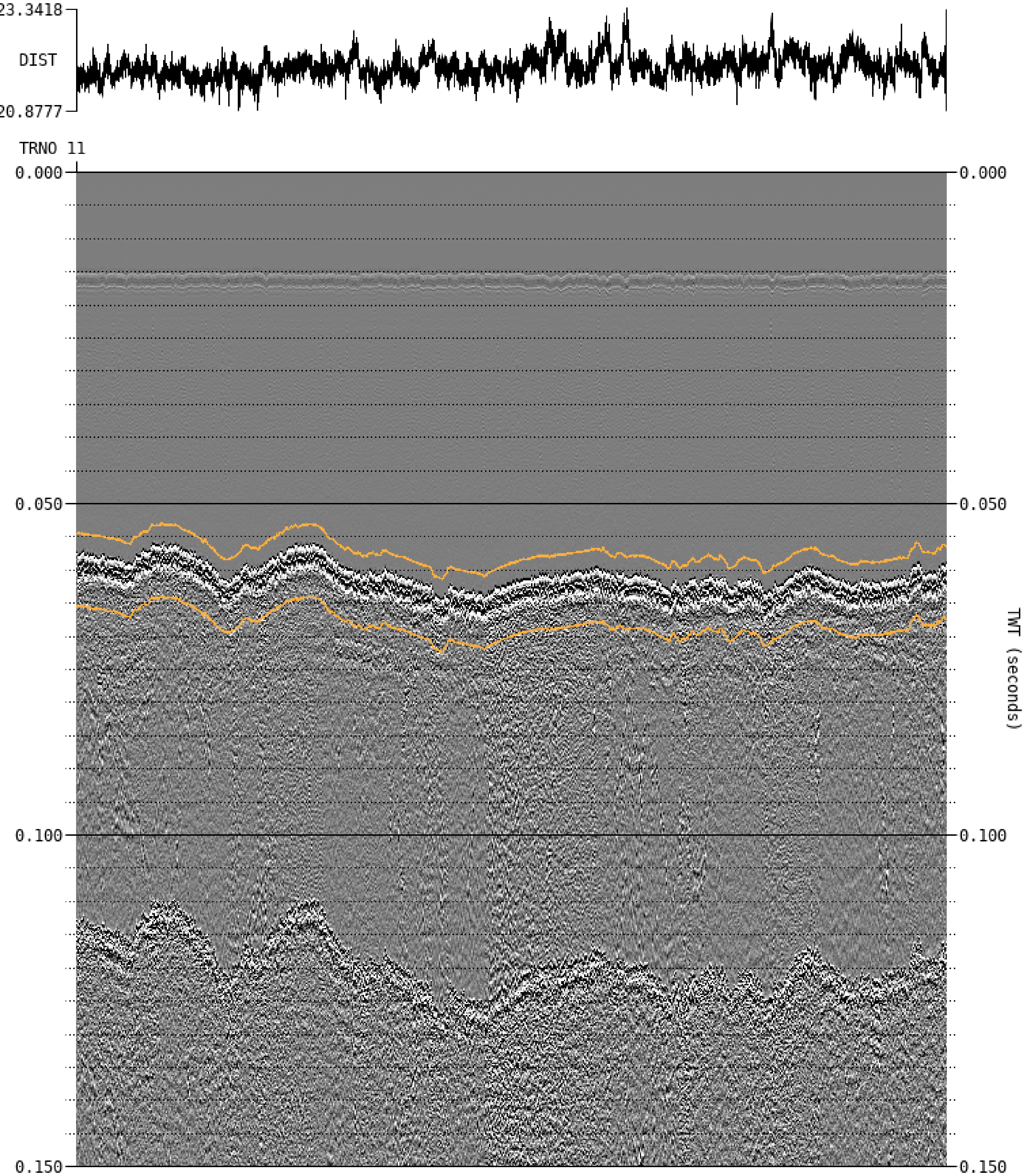


Channel 1 trace ensemble (zoom window 0 - 150 ms TWT)
Analysis window overlaid in orange

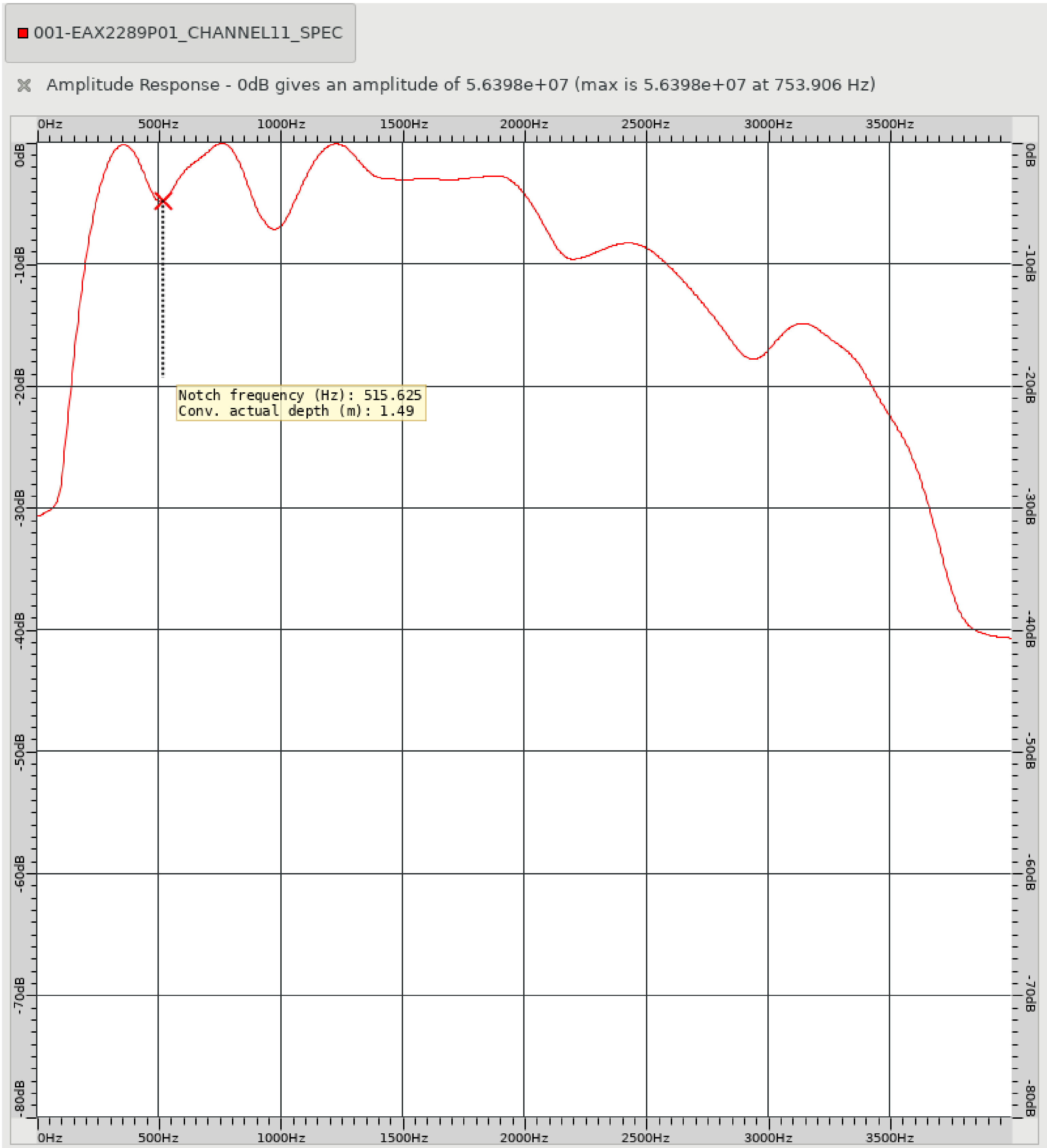


Channel 1 frequency spectrum (calculated over analysis window)
Receiver notch frequency and converted actual depth plotted

Frequency Analysis: Channel 11

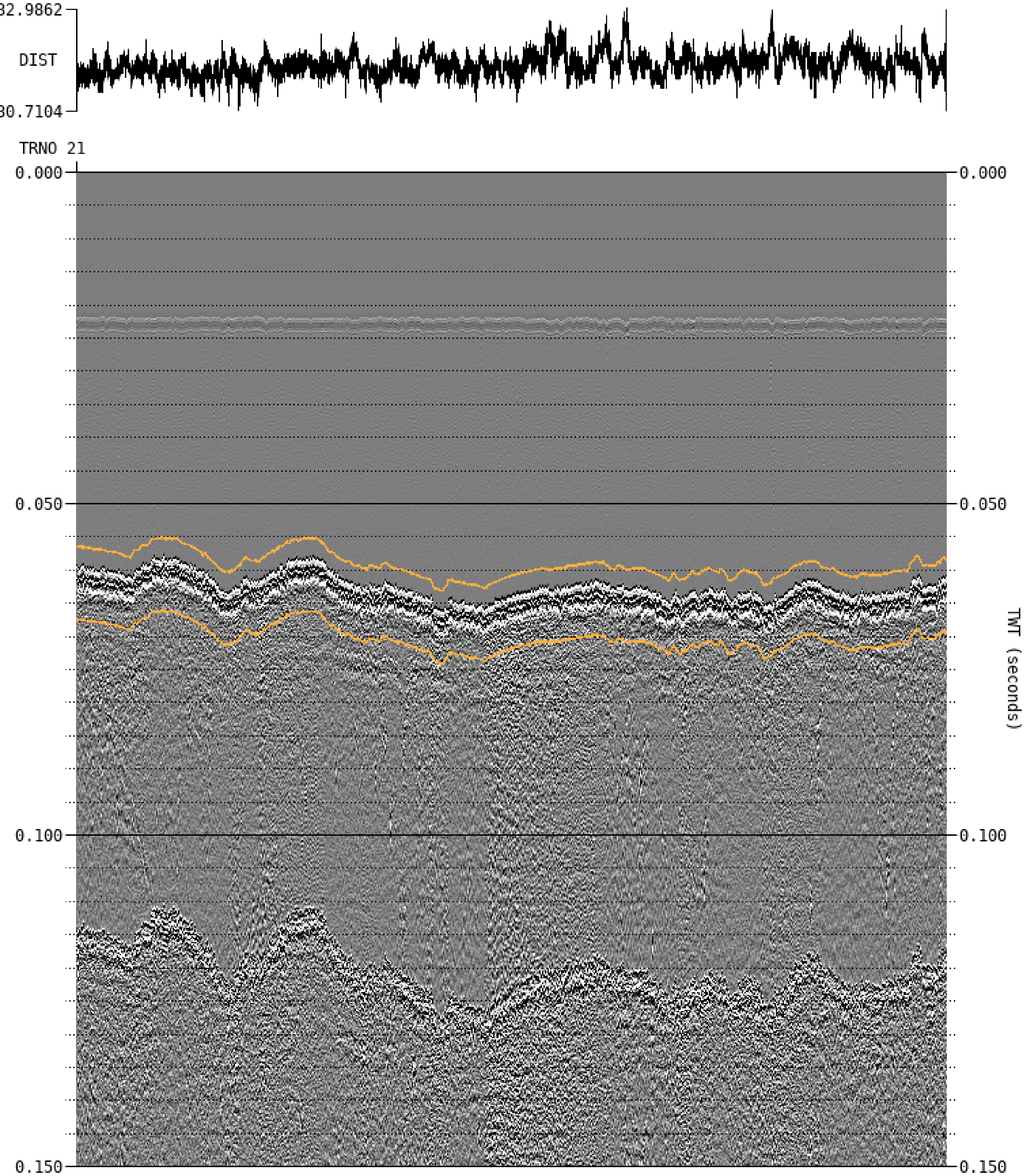


Channel 11 trace ensemble (zoom window 0 - 150 ms TWT)
Analysis window overlaid in orange

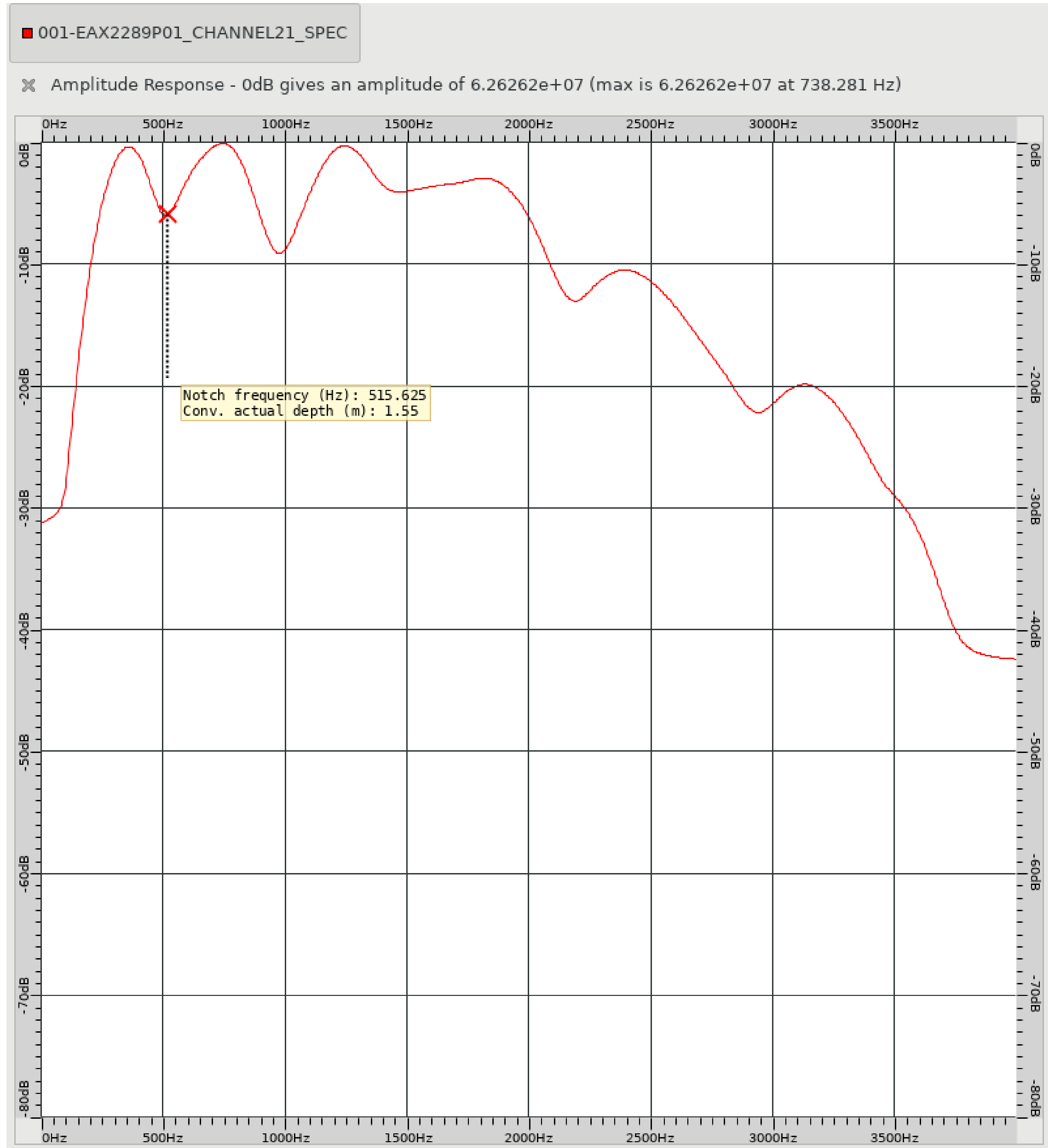


Channel 11 frequency spectrum (calculated over analysis window)
Receiver notch frequency and converted actual depth plotted

Frequency Analysis: Channel 21

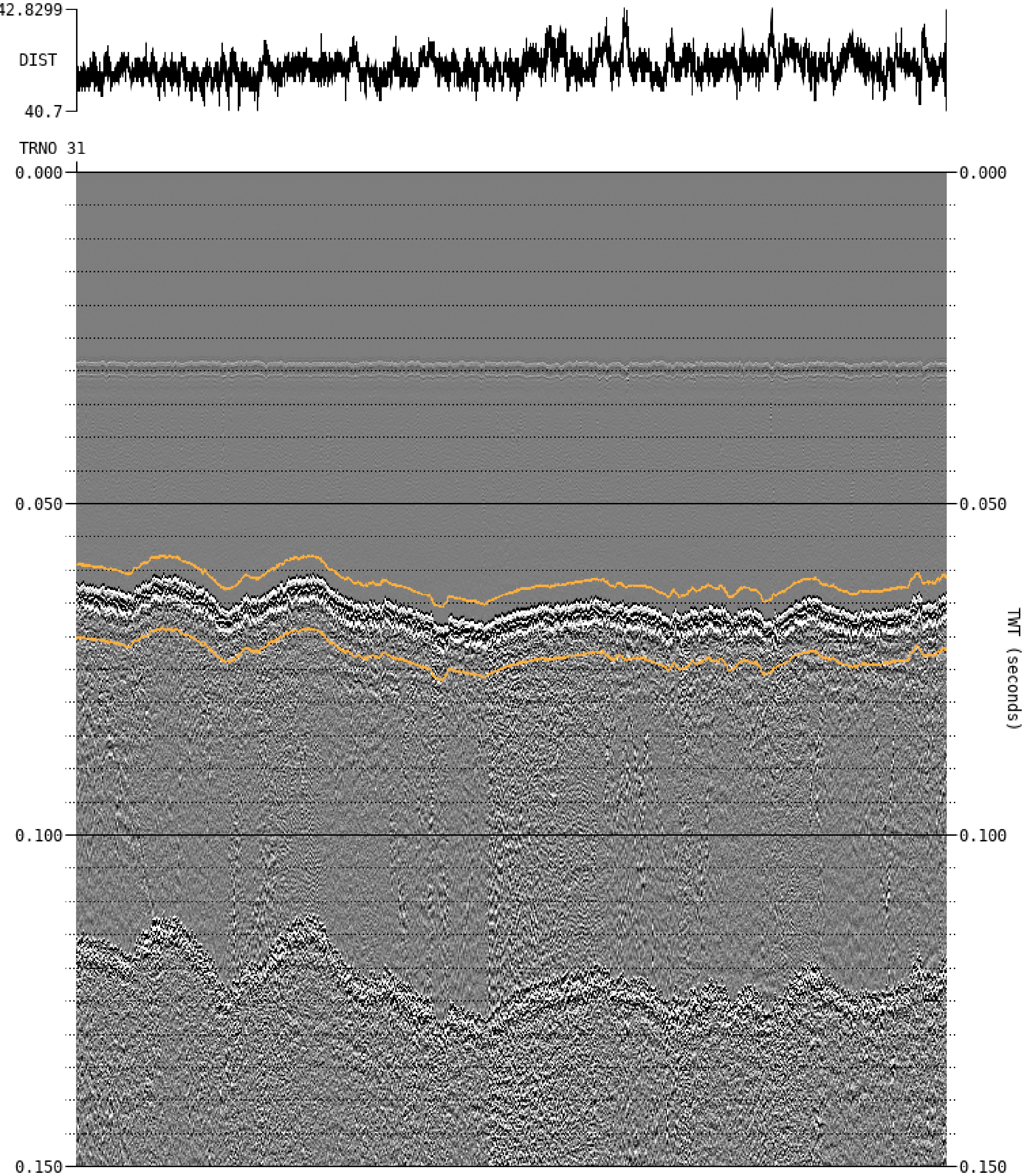


Channel 21 trace ensemble (zoom window 0 - 150 ms TWT)
Analysis window overlaid in orange

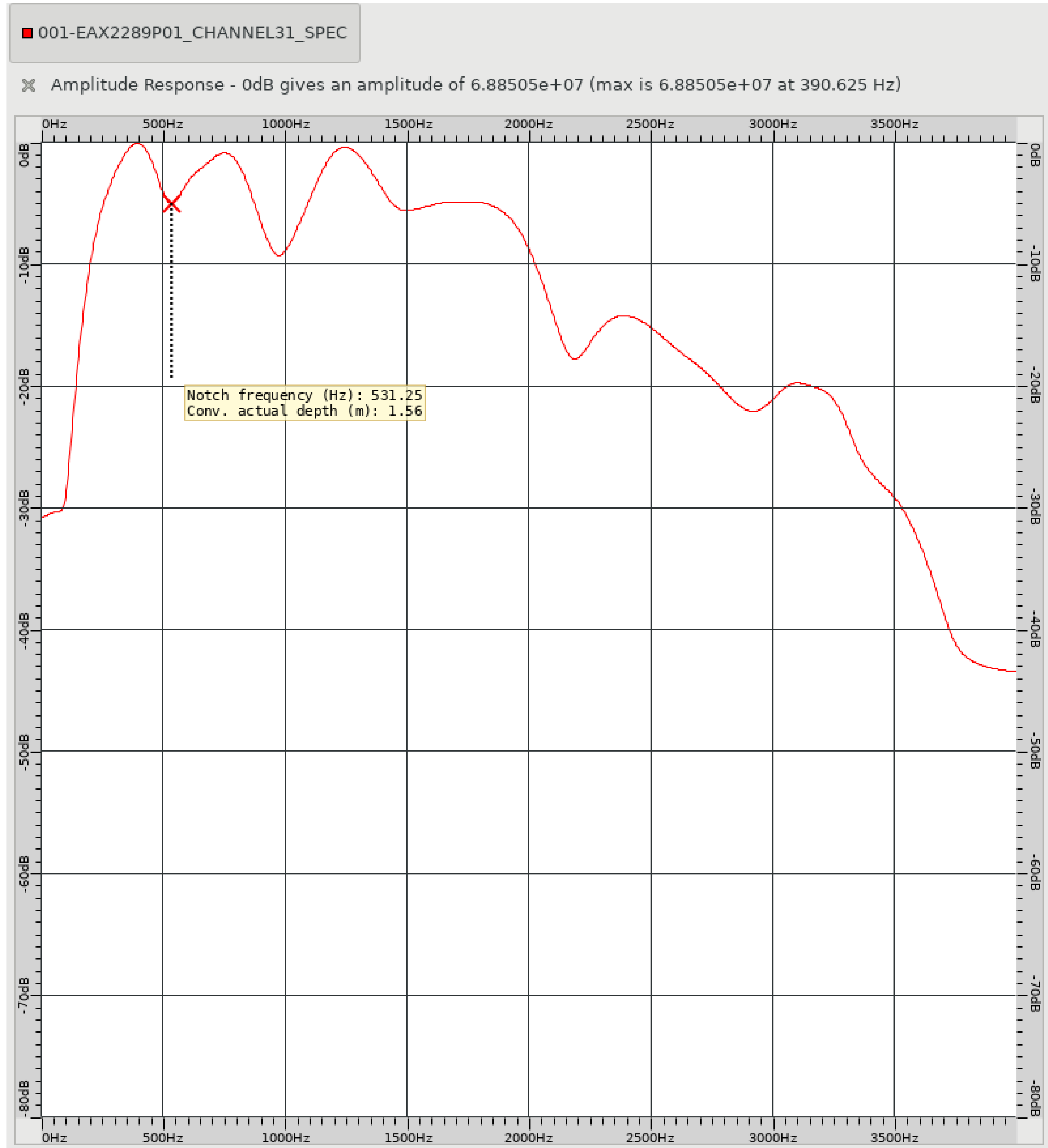


Channel 21 frequency spectrum (calculated over analysis window)
Receiver notch frequency and converted actual depth plotted

Frequency Analysis: Channel 31

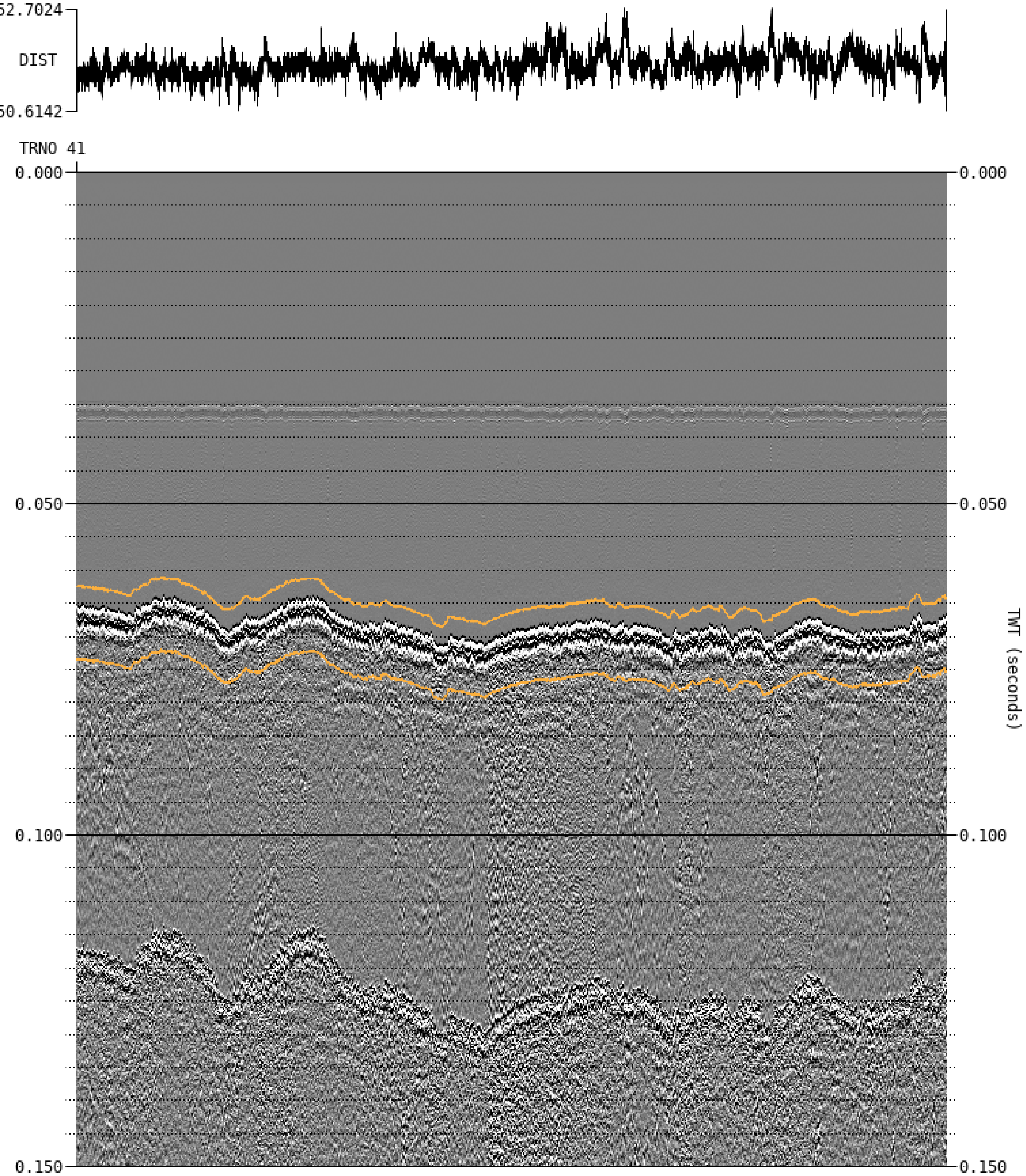


Channel 31 trace ensemble (zoom window 0 - 150 ms TWT)
Analysis window overlaid in orange

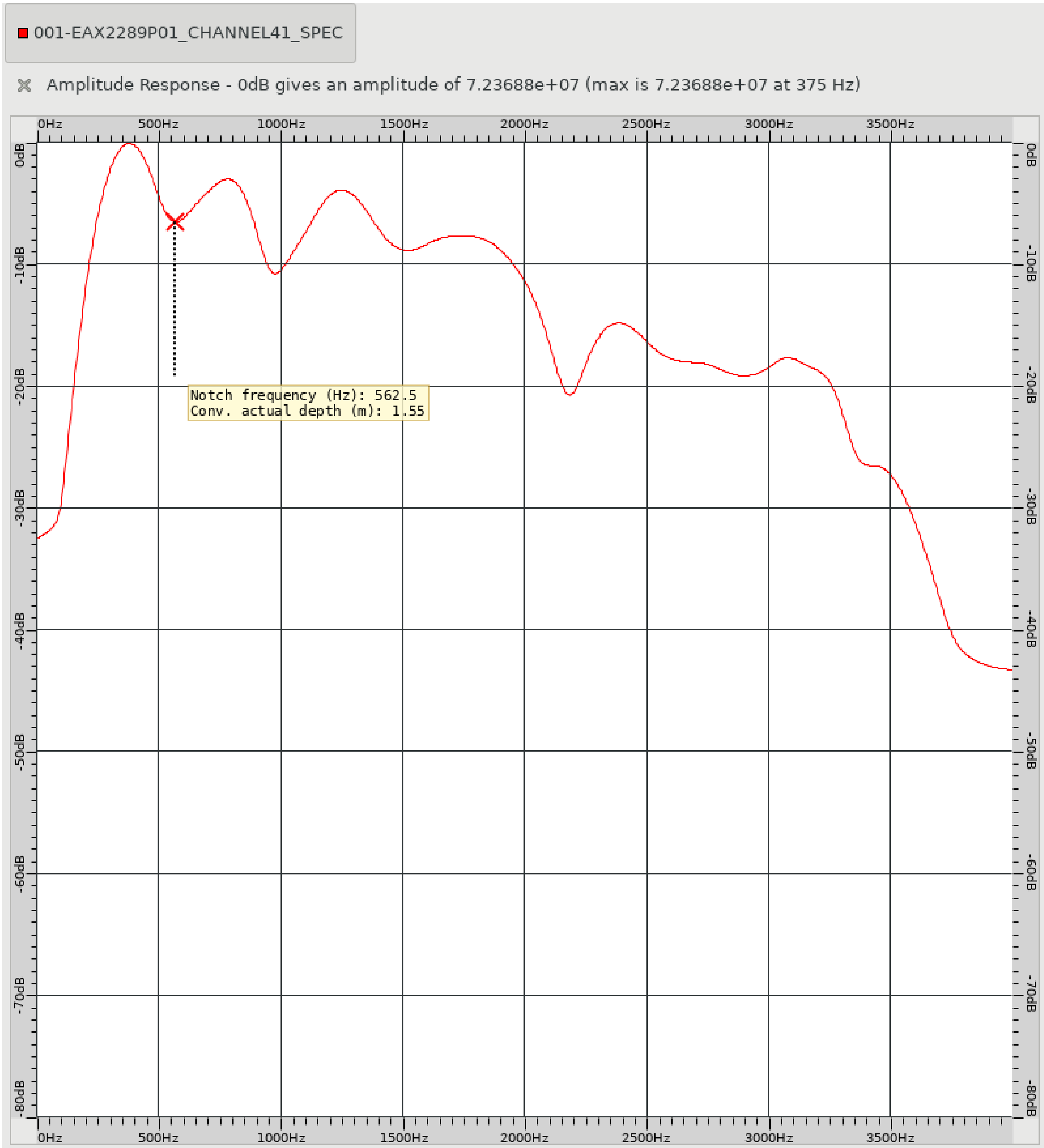


Channel 31 frequency spectrum (calculated over analysis window)
Receiver notch frequency and converted actual depth plotted

Frequency Analysis: Channel 41

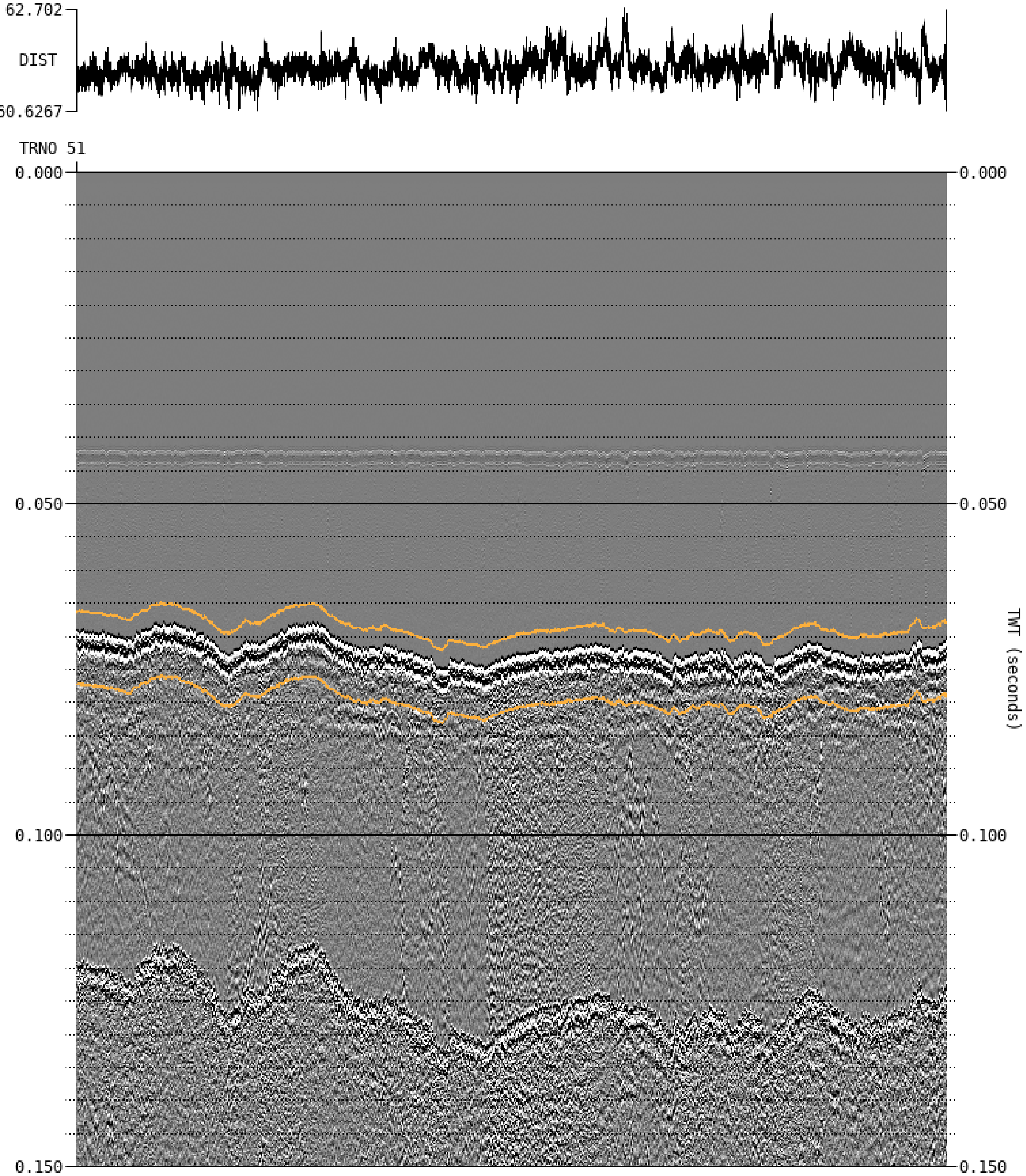


Channel 41 trace ensemble (zoom window 0 - 150 ms TWT)
Analysis window overlaid in orange

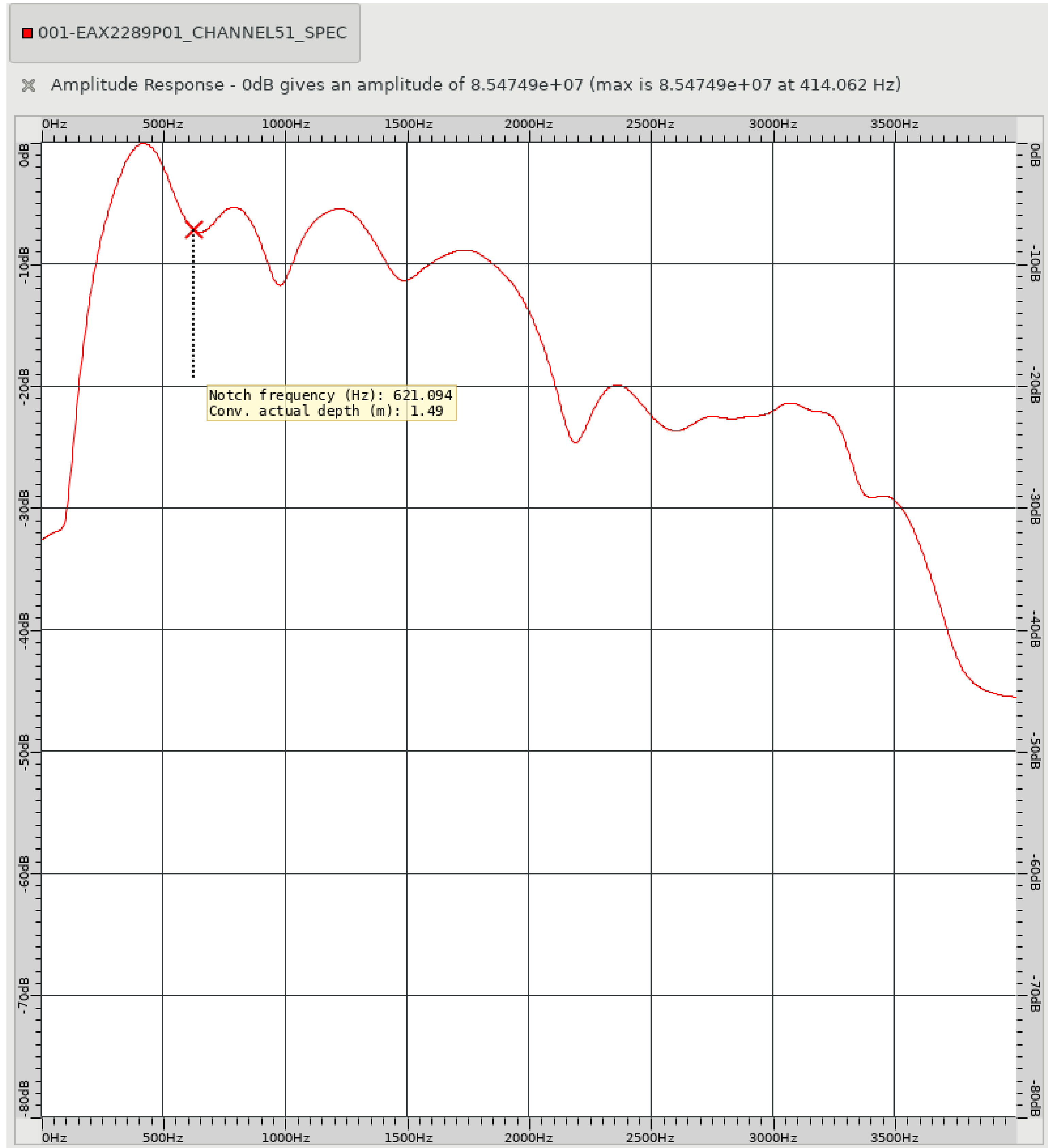


Channel 41 frequency spectrum (calculated over analysis window)
Receiver notch frequency and converted actual depth plotted

Frequency Analysis: Channel 51

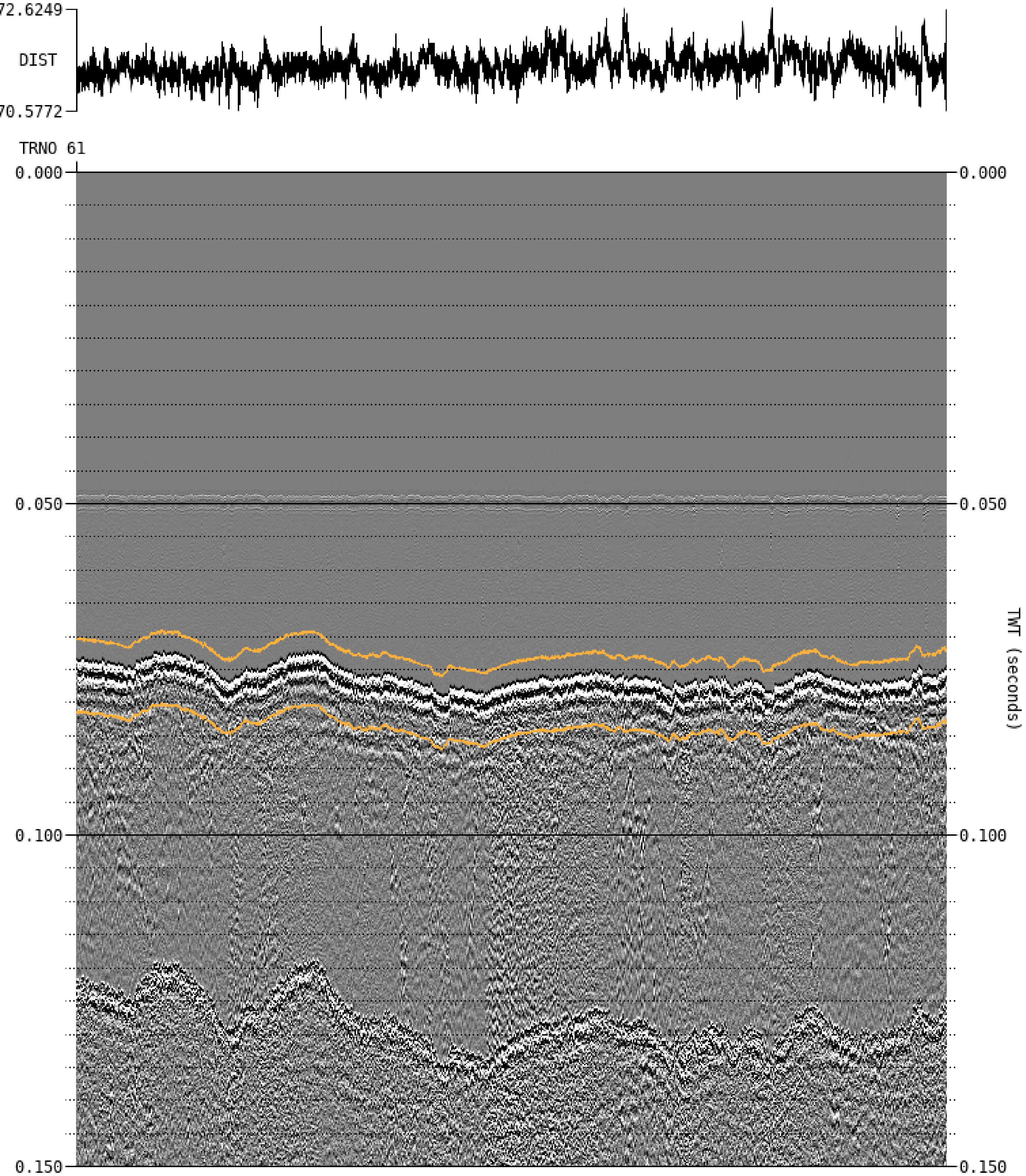


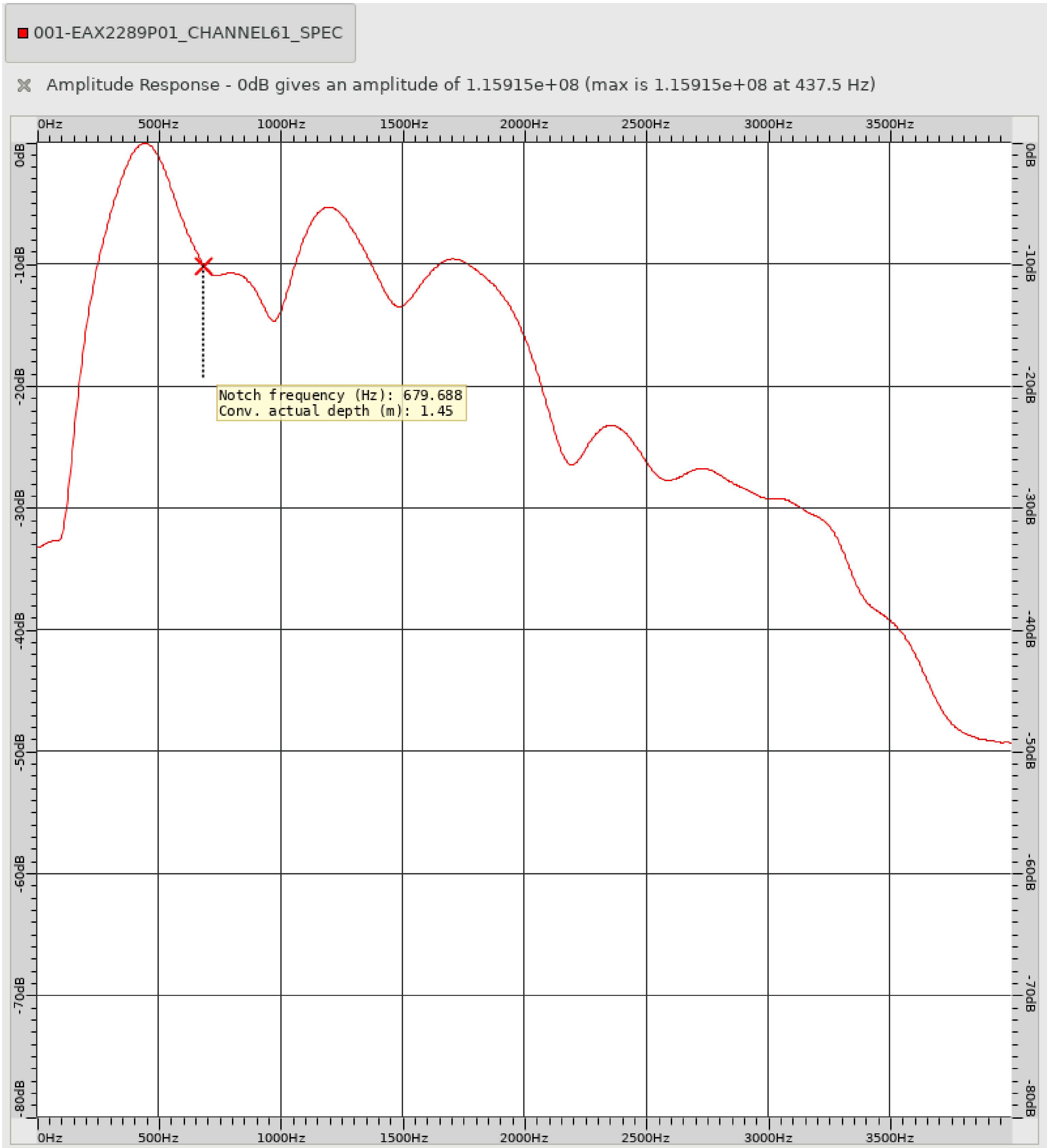
Channel 51 trace ensemble (zoom window 0 - 150 ms TWT)
Analysis window overlaid in orange



Channel 51 frequency spectrum (calculated over analysis window)
Receiver notch frequency and converted actual depth plotted

Frequency Analysis: Channel 61

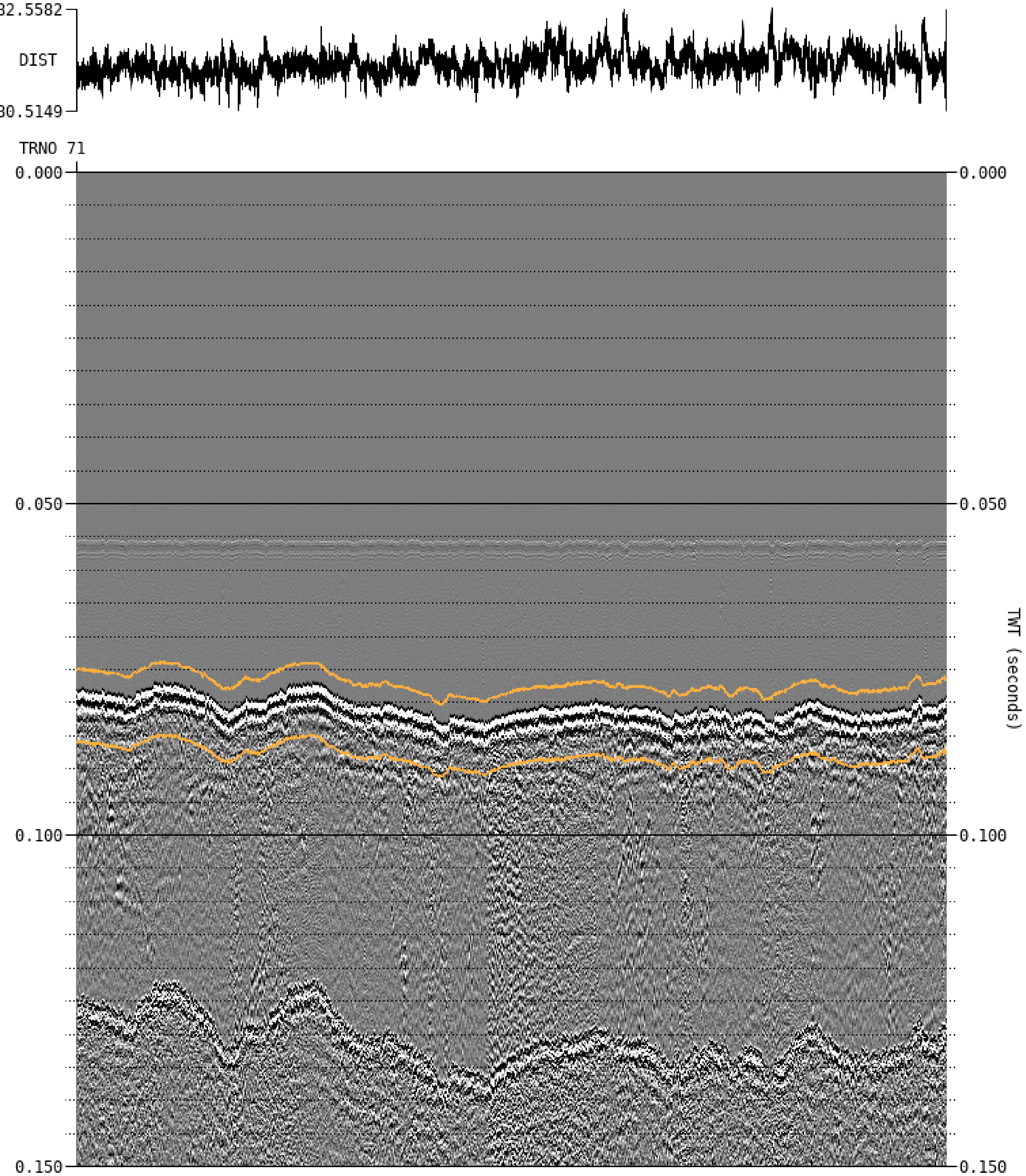


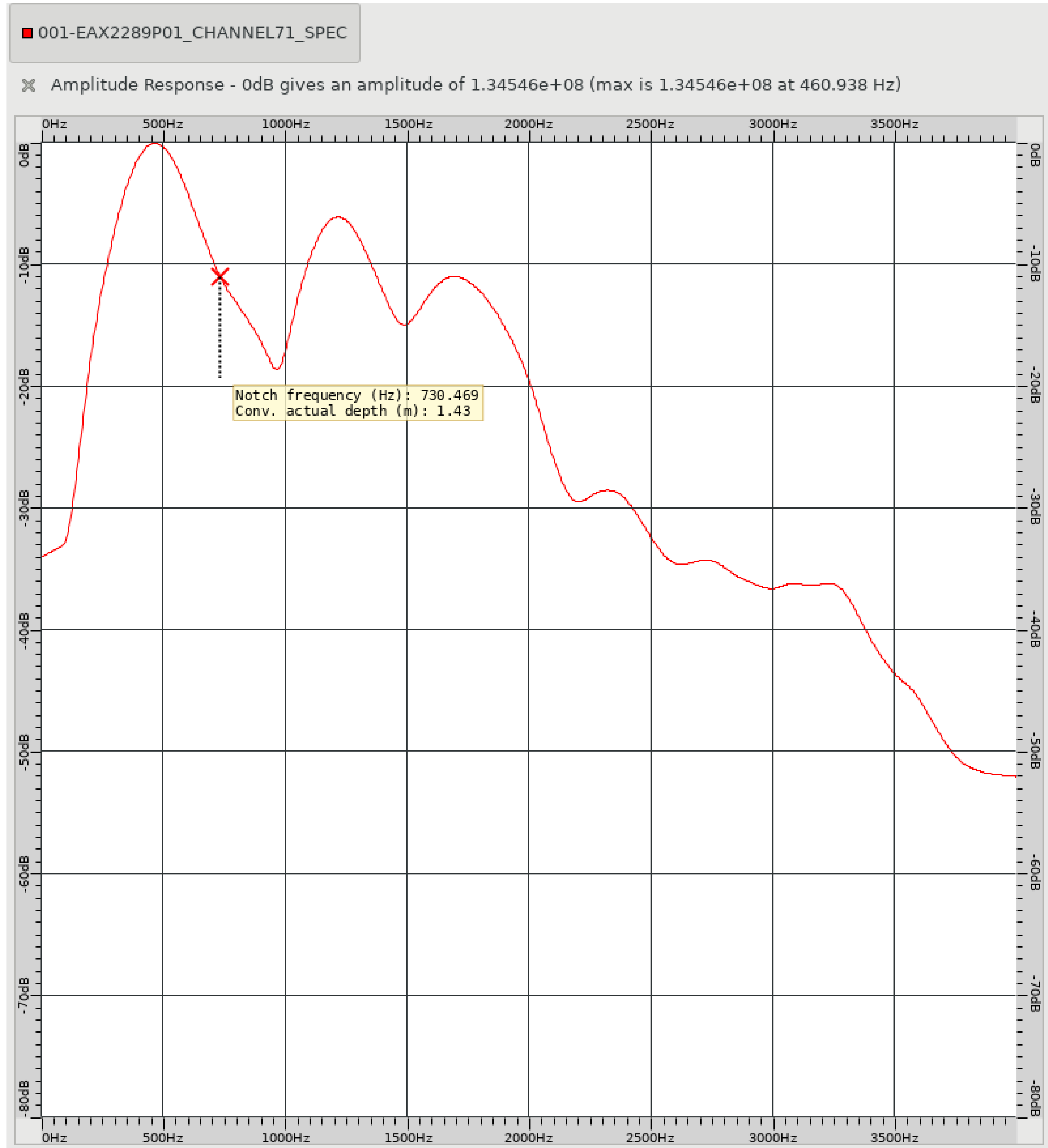


Channel 61 trace ensemble (zoom window 0 - 150 ms TWT)
Analysis window overlaid in orange

Channel 61 frequency spectrum (calculated over analysis window)
Receiver notch frequency and converted actual depth plotted

Frequency Analysis: Channel 71

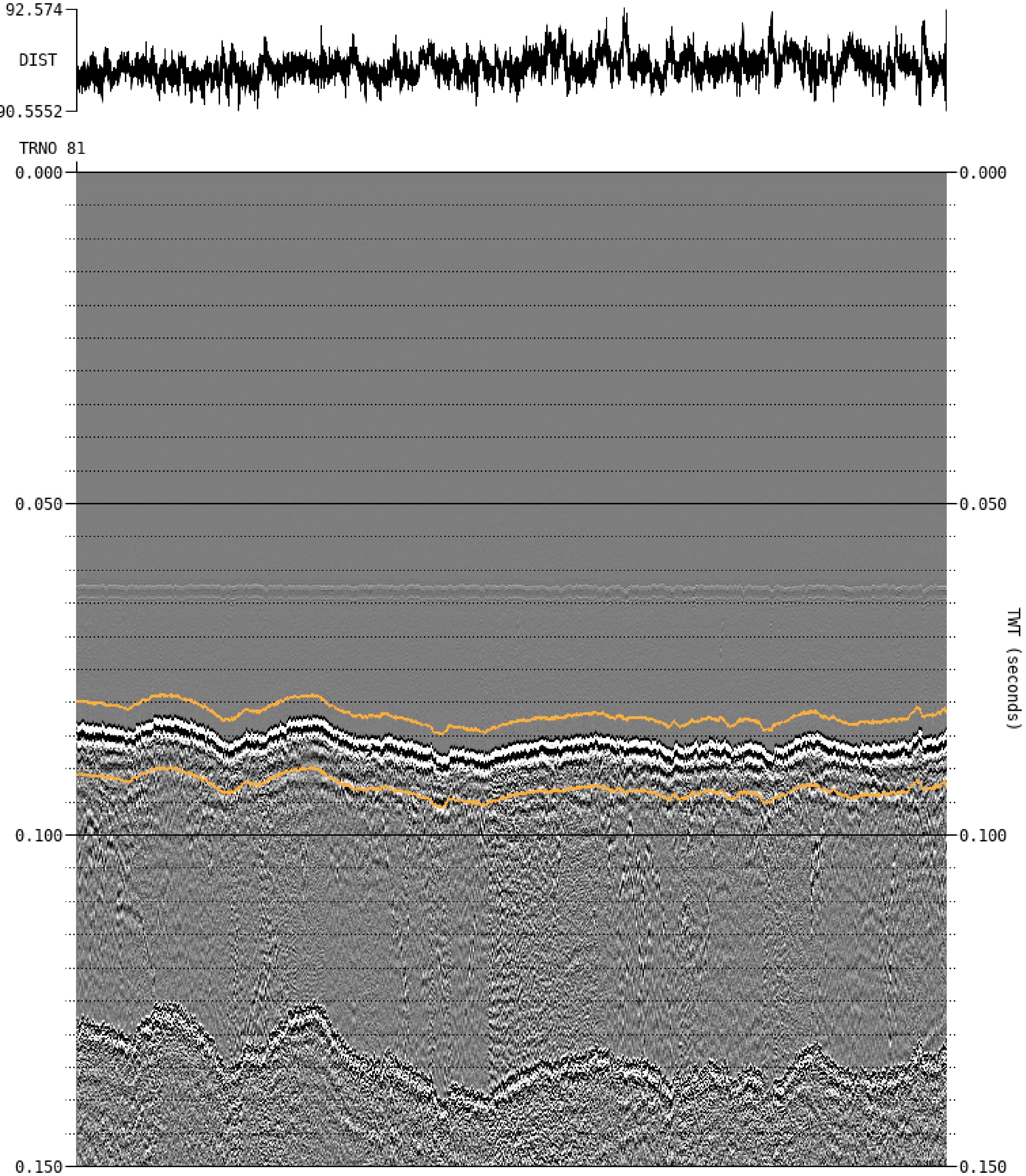




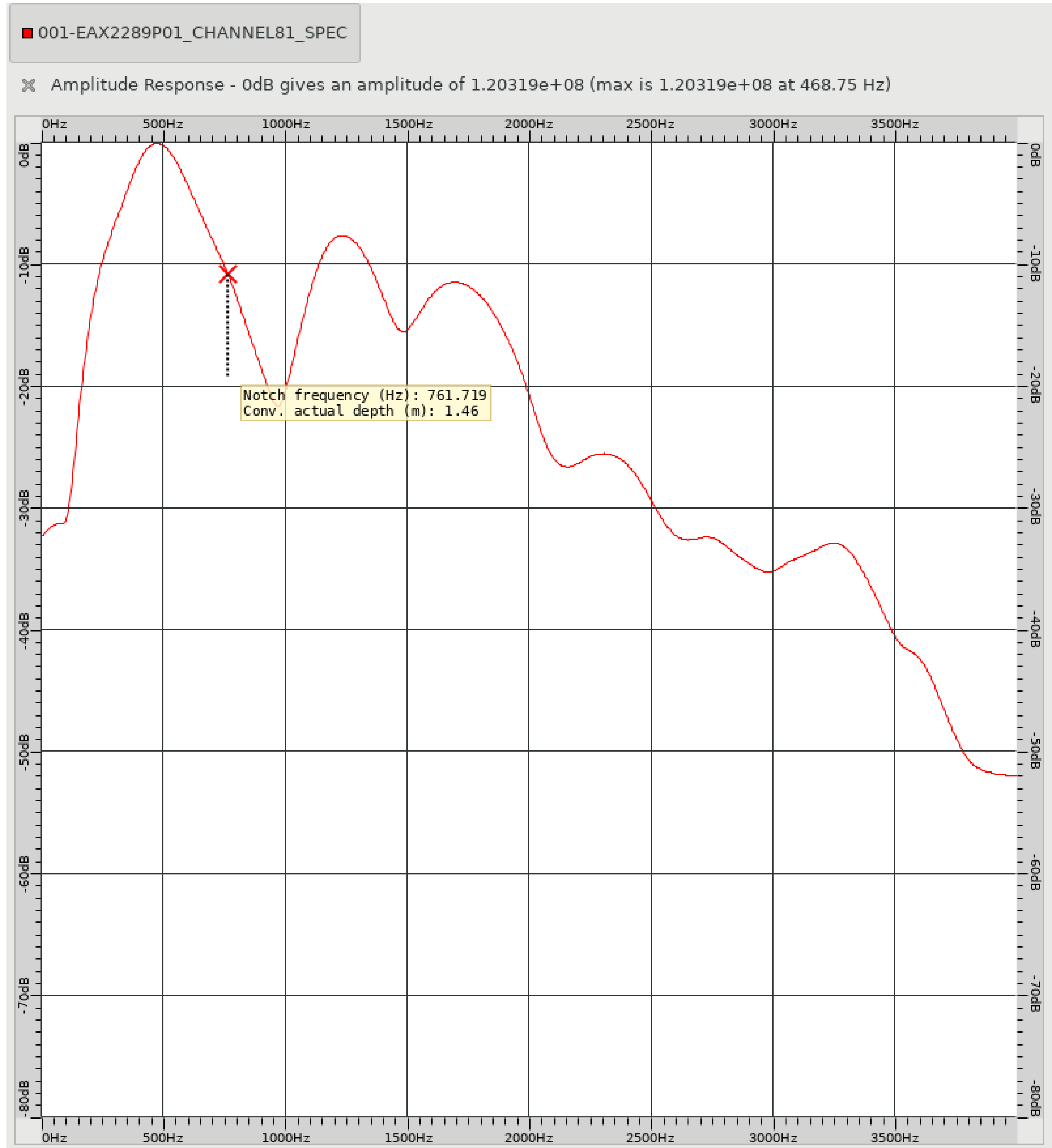
Channel 71 trace ensemble (zoom window 0 - 150 ms TWT)
Analysis window overlaid in orange

Channel 71 frequency spectrum (calculated over analysis window)
Receiver notch frequency and converted actual depth plotted

Frequency Analysis: Channel 81

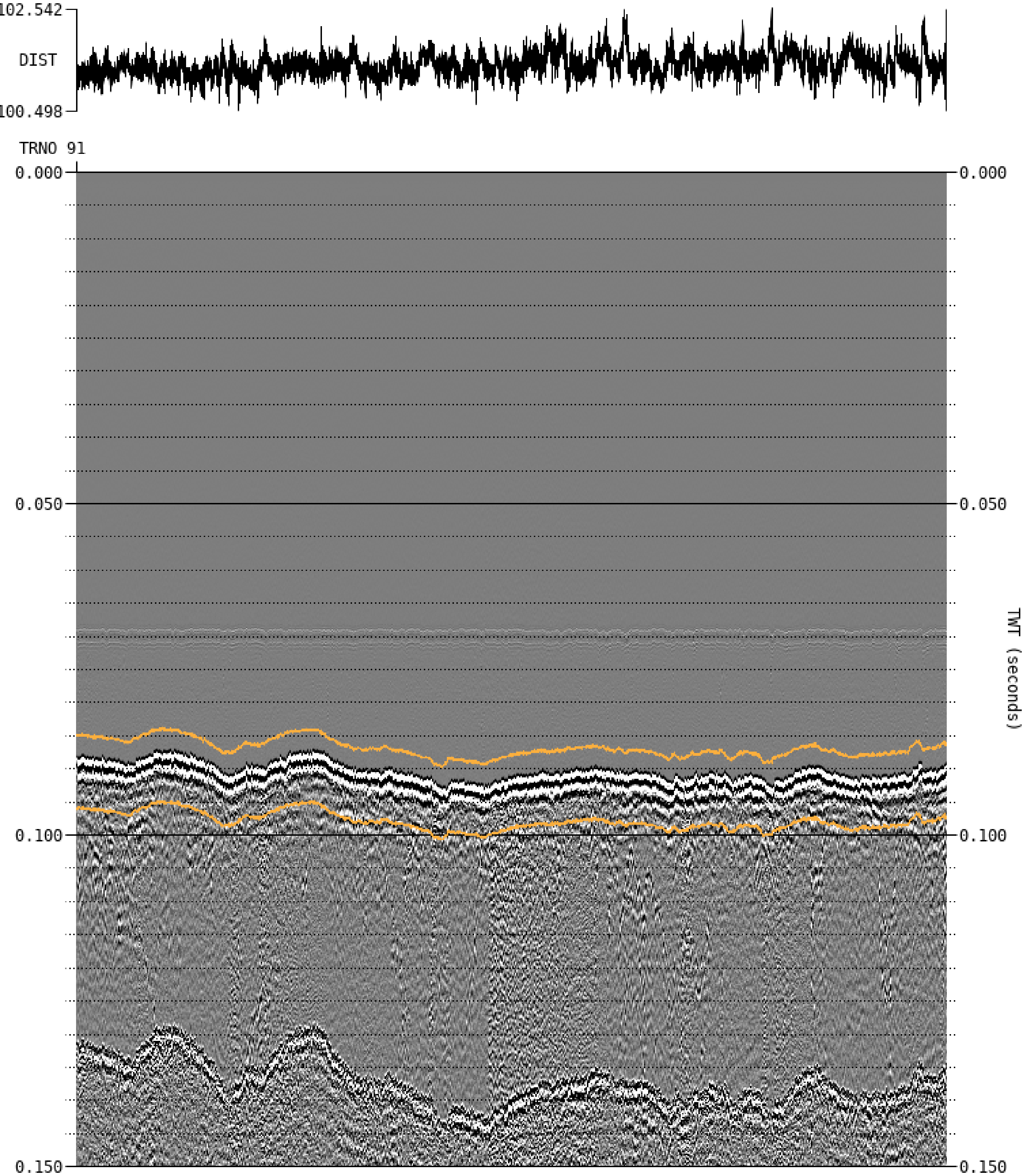


Channel 81 trace ensemble (zoom window 0 - 150 ms TWT)
Analysis window overlaid in orange

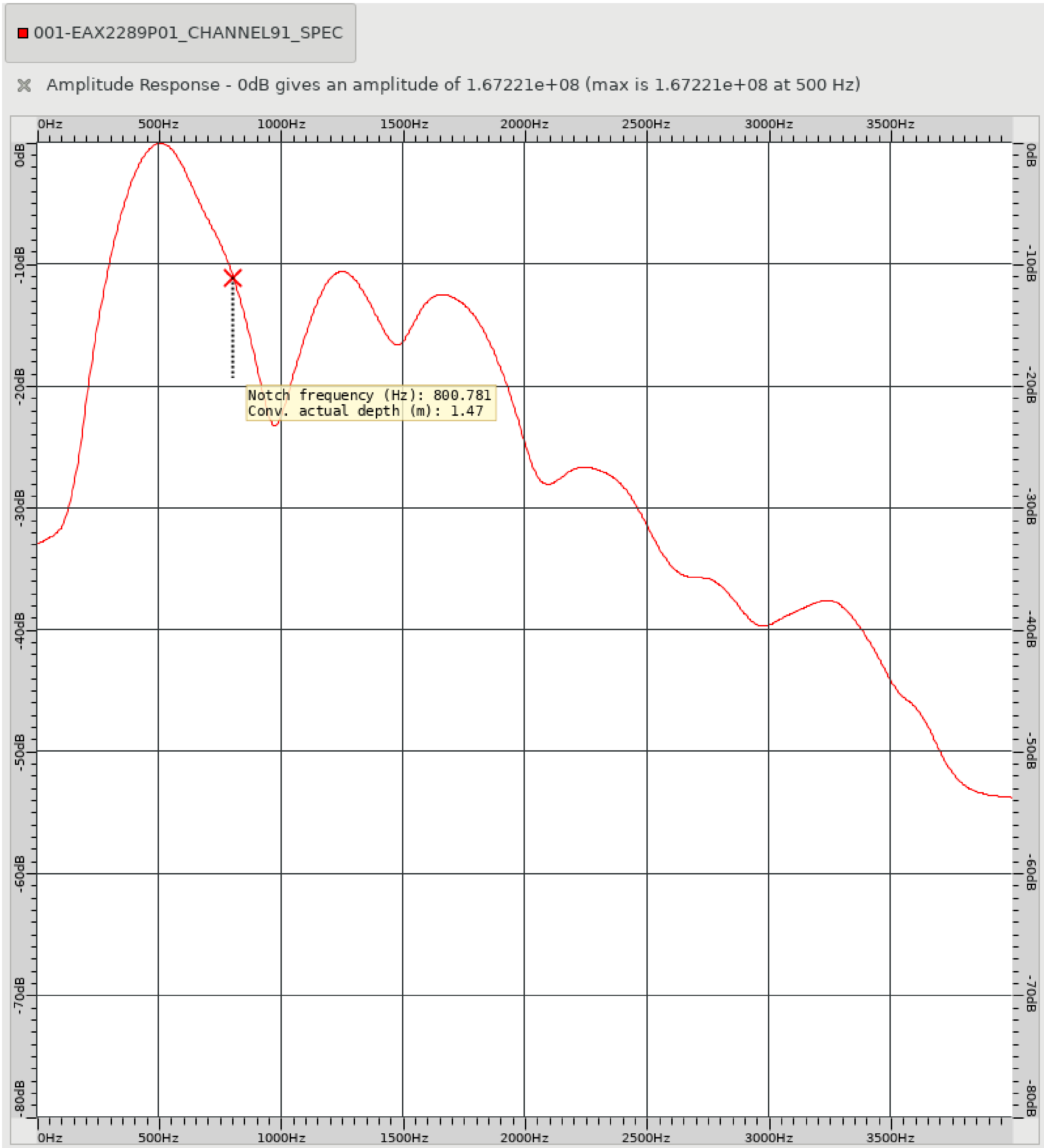


Channel 81 frequency spectrum (calculated over analysis window)
Receiver notch frequency and converted actual depth plotted

Frequency Analysis: Channel 91



Channel 91 trace ensemble (zoom window 0 - 150 ms TWT)
Analysis window overlaid in orange



Channel 91 frequency spectrum (calculated over analysis window)
Receiver notch frequency and converted actual depth plotted

Thank you

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Appendix J

SSS verification

SSS-USBL positioning system Verification Report – Fugro Pioneer

Energinet Denmark Energy Islands Lot 2 (Zone West) Geophysical Survey | Denmark, North Sea

F176286_SSS-USBL system positioning verification 01 | 1 June 2021

01

Energinet Eltransmission A/S

Document Control

Document Information

Project Title	Energinet Denmark Energy Islands Geophysical Survey Lot 2 (Zone West)
Document Title	SSS-USBL positioning system Verification Report – Fugro Pioneer
Fugro Project No.	F176286
Fugro Document No.	F176286_SSS-USBL system positioning verification
Issue Number	01
Issue Status	01

Client Information

Client	Energinet Eltransmission A/S
Client Address	Tonne Kjærsvej 65, DK-7000 Fredericia, Denmark
Client Contact	Martin Bak Hansen
Client Document No.	N/A

Revision History

Issue	Date	Status	Comments on Content	Prepared By	Checked By	Approved By
01		Final	Client comments addressed	KS/JE		

Project Team

Initials	Name	Role
APA	A Padwalkar	Fugro Project Manager
CW	Chris Wright	Reporting Coordinator
JDB	Jaco de Beer	Party Chief
JE	James Egan	Geophysicist
KES	Kareen El Sayed	Geophysicist
JSZ	Julia Szudzinska	Office Lead Geophysicist

Report Amendment sheet

Issue	Report Section	Page No.	Table No.	Figure No.	Description
01					

1. Introduction

The purpose of the SSS-USBL system positioning verification was:

- To determine the functionality of the SSS
- To determine the SSS-USBL system positioning accuracy

2. Scope of Work

The verification was conducted over a discrete point feature, to the northeast of the wrecked coaster, 'Fallwind', at a depth of 40.3 m; details of the target location derived from MBES are presented in the table below (Table 2.1).

The verification was performed by running three lines in different directions at a given offset from the target position. Two reciprocal lines in opposite directions and one line run perpendicular to the reciprocals see Figure 3.1.

Table 2.1 Location details of the discrete Point Feature

Datum: ETRS89, UTM Zone 32 N		
Target Name	Easting (m)	Northing (m)
Discrete Pinnacle	340725.0	6263755.40

3. Operations

The SSS-USBL system positioning verification was carried out onboard Fugro Pioneer on 31 May 2021. The SSS was operated at 75 m range for both Port and Starboard channels. The target used for verification was a discrete Point Feature. Three lines were sailed in three directions at an offset from the target position.

Initially, the three lines were all planned to be offset 30 m and 40 m from the target location, which resulted in a better SSS results for verification purposes.

Line name	Direction	Offset from target
EAR9001	135°	30 m
EAR9008	315°	30 m
EAR9022	239°	40 m

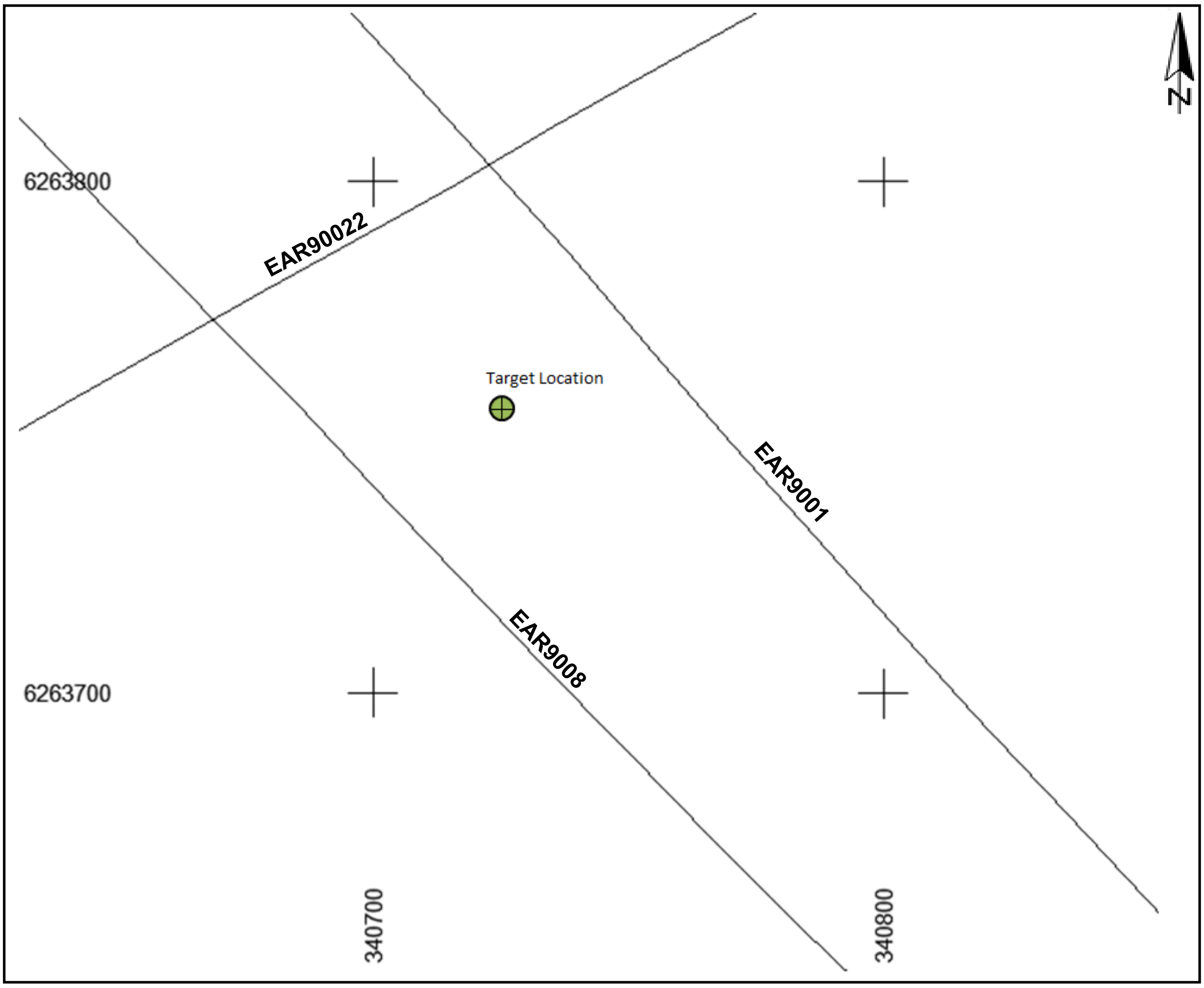


Figure 3.1: Plan view map of the SSS verification.

4. Result

The SSS exhibits good quality data and fit for purpose. The target was observed and identified on all surveyed lines. The location was digitised on the SSS data on each of the surveyed lines. The digitized positions of the target from different SSS data is compared to each other and also compared to the digitized target position on the MBES gridded data to further validate the positioning accuracy of the system.
Details of the digitized target positions and calculated offsets are tabulated in Table 4.1and Table 4.2 and illustrated in Figure 4.1, Figure 4.2 and Figure 4.3.

Table 4.1 : Target location from MBES gridded data.

Datum: ETRS, UTM Zone 32 N		
Position of the target used for verification	Easting (m)	Northing (m)
	340725.0	6263755.40

Table 4.2: Target locations from SSS data compared to each other and compared to MBES gridded data.

<table>
<tr><th>Line Name</th><th>Heading</th><th>Easting [m]</th><th>Northing [m]</th><th>Difference to MBES position [m]</th><th>Line Name
Line Name</th><th>Difference between SSS Data</th></tr>
<tr><td rowspan="2">EAR9001</td><td rowspan="2">NW-SE</td><td rowspan="2">340725.46</td><td rowspan="2">6263755.14</td><td rowspan="2">0.55</td><td>EAR9001</td><td rowspan="2">1.63</td></tr>
<tr><td>EAR9008</td></tr>
<tr><td rowspan="2">EAR9008</td><td rowspan="2">SE-NW</td><td rowspan="2">340724.21</td><td rowspan="2">6263756.21</td><td rowspan="2">1.15</td><td>EAR9001</td><td rowspan="2">1.90</td></tr>
<tr><td>EAR9022</td></tr>
<tr><td rowspan="2">EAR9022</td><td rowspan="2">NE-SW</td><td rowspan="2">340723.50</td><td rowspan="2">6263755.05</td><td rowspan="2">1.95</td><td>EAR9008</td><td rowspan="2">1.35</td></tr>
<tr><td>EAR9022</td></tr>
<tr><td colspan="2">Verification Lines Average</td><td>340724.28</td><td>6263755.43</td><td>0.74</td><td></td><td></td></tr>
</table>

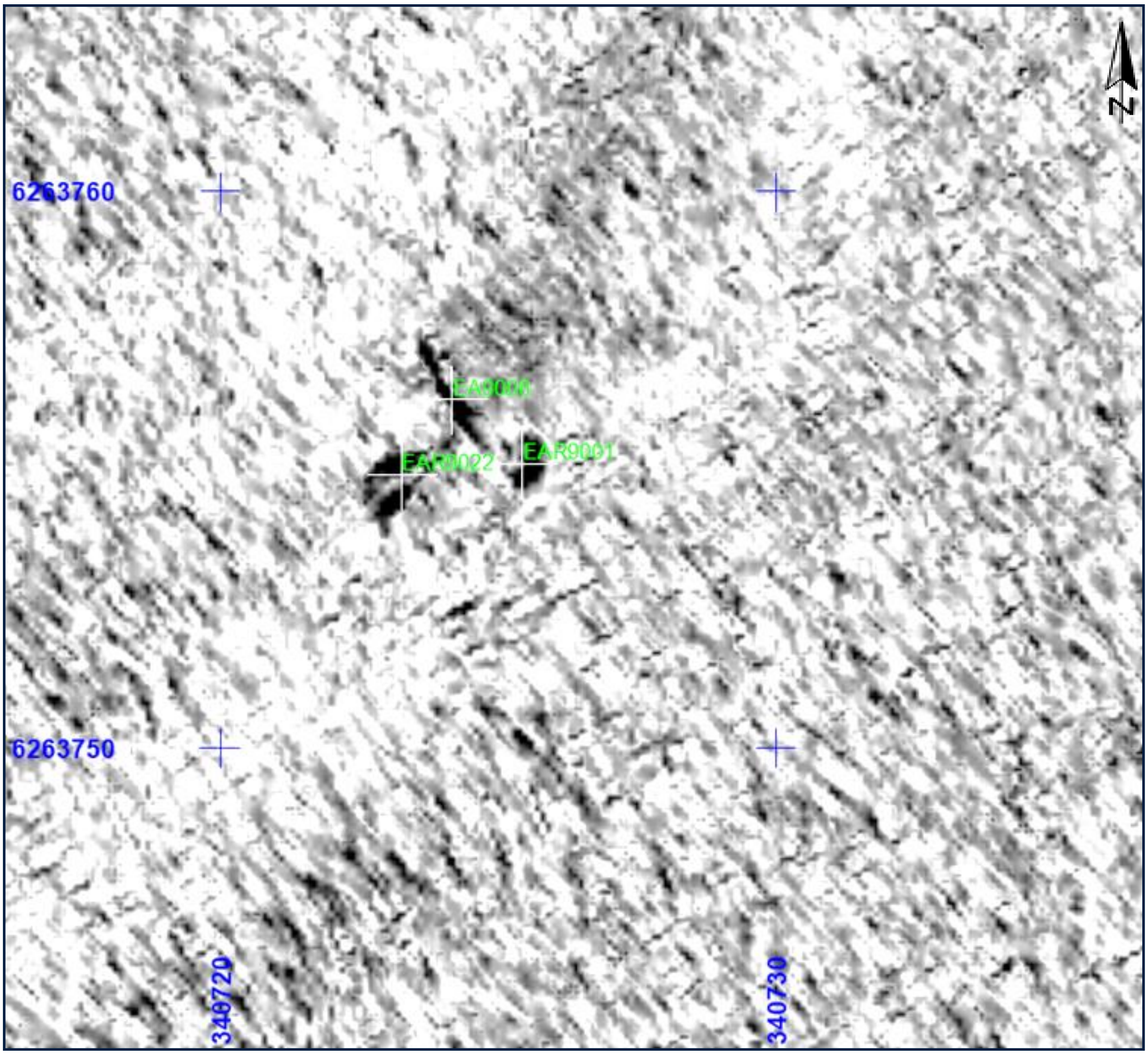


Figure 4.1: SSS data image with picks of the target on the three SSS lines.

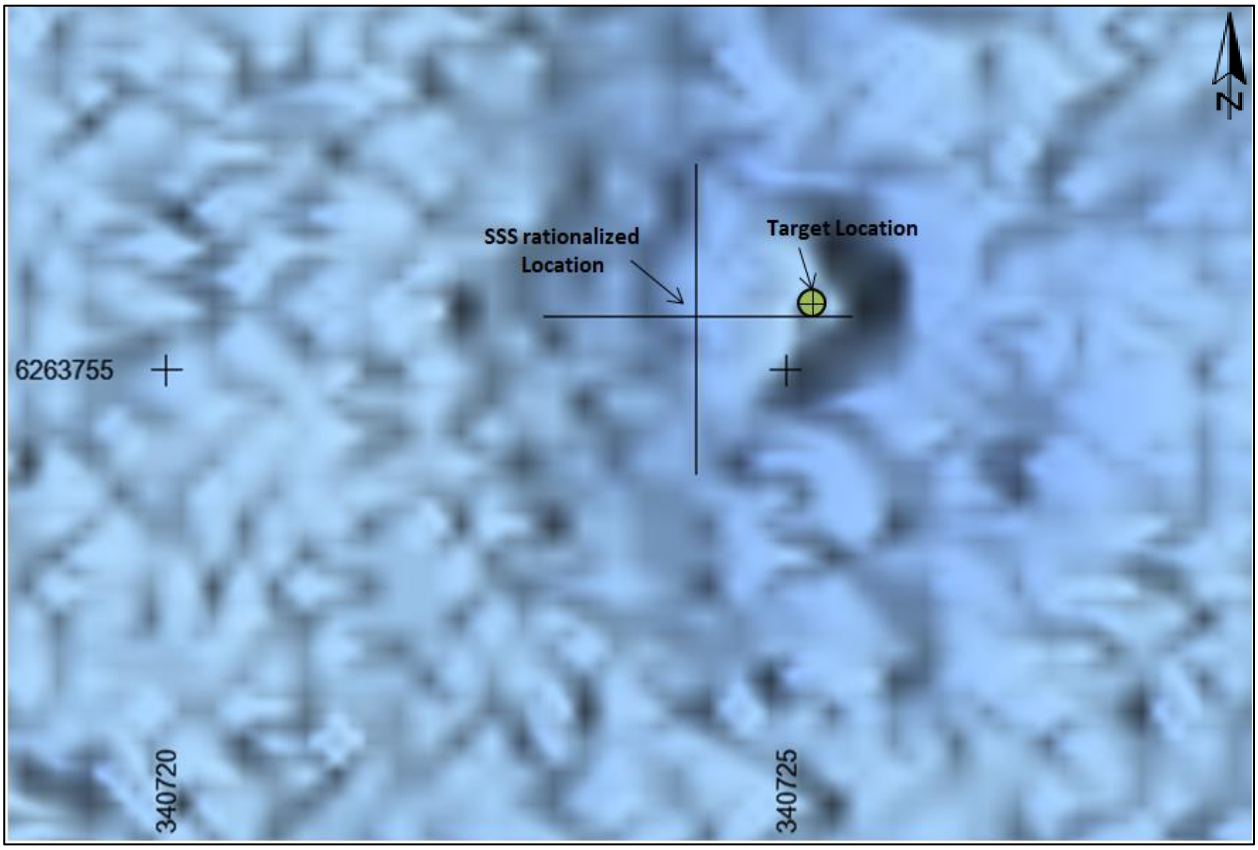


Figure 4.2: MBES image showing rationalized location from the three SSS lines and MBES target location.

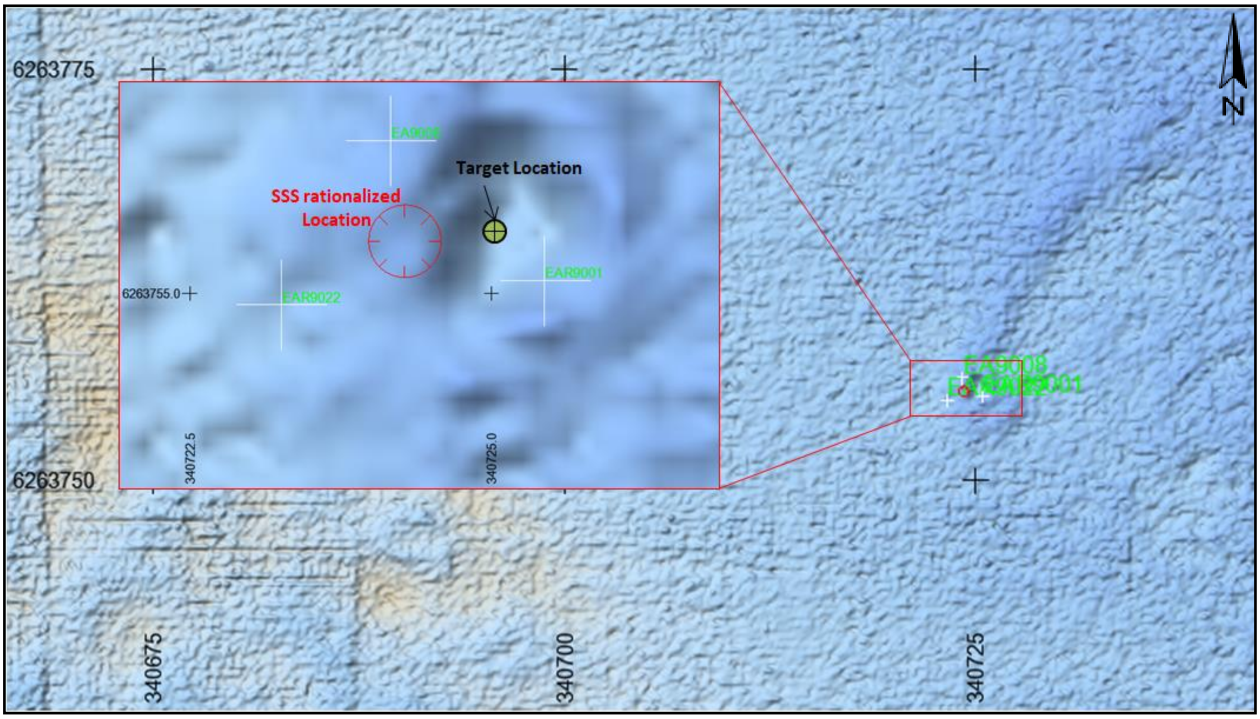


Figure 4.3: MBES gridded data image with picks of the target from the three SSS lines, SSS rationalized location and MBES gridded target location.

5. Conclusion

Based on the obtained results, the SSS-USBL system positioning accuracy is within the requested tolerances and is deemed fit for survey.

6. HSE

No safety or HSE incidents were reported. A safety tour and a toolbox meeting were conducted prior to the start of the survey. A toolbox talk to discuss the planned operations, including vessel run lines and the sequence of survey operations, was also conducted.

Client Comments

Signed:	Jaco de Beer.	Signed:	Morgan Hannah
	J De Beer Party Chief (Fugro Pioneer) Date: 31/05/2021		M. Hannah and T. Wiseman Client Representatives (Energinet Eltransmission A/S) Date: 31/05/2021

Appendix K

Mobilisation Completion

Certificate

Milestone Completion Acceptance Certificate

Project Title	Energinet Denmark Energy Islands Geophysical Survey Lot 2 (Zone West)
Fugro Project No.	F176286
Contractor	Fugro Netherlands Marine B.V.
Company	Energinet Eltransmission A/S
Date	01 June 2021
Milestone	Completion of Mobilisation/ Commencement of Field Work – Energinet Denmark Energy Islands Geophysical Survey Lot 2

The following calibrations and/or verifications have been completed and evidence has been reviewed by the offshore client representative (OCR).

Harbour Verifications:

- Positioning verification (16/ 05/ 2021)
- Gyro alignment (16/ 05/ 2021)
- 2DUHRS Tap Test and noise Test (18/05/2021)
- SSS rub-test and wet-test (19/ 05/ 2021)
- MAG Spanner Test (19/05/2021)
- MBES and SBP wet-test (19/05/2021)
- Positioning comparison (27/ 05/ 2021)

Offshore Verifications:

- USBL Calibration (22/05/2021)
- MBES Calibration (24/05/2021)
- 2DUHRS Streamer Depth, Balance and system verification (28/05/2021)
- SSS USBL system positioning verification (28/05/2021 and 31/05/2021)
- MAG verification (28/05/2021)
- SBP Verification (28/05/2021)

The undersigned PARTIES agree that Fugro Netherlands Marine B.V. (CONTRACTOR) has completed and fulfilled all mobilisation and calibration obligations under the above-mentioned contract to the satisfaction of Energinet Eltransmission A/S (CLIENT).

Mobilisation was completed with the completion of equipment calibrations, offshore verifications and arrival on site.

CLIENT agrees with the CONTRACTOR that the CONTRACTOR shall commence the fieldwork at the project area, following completion of above verifications.

Client Comments

Signed:	Jaco de Beer.	Signed:	Morgan Hannah
	J De Beer Party Chief (Fugro Pioneer) Date: 01/06/2021		M. Hannah and T. Wiseman Client Representatives (Energinet Eltransmission A/S) Date: 01/06/2021

Appendix C

Daily Progress Reports

DAILY PROGRESS REPORT

PIO/Energinet DK Energy Islands
Geophysical Survey WPA

ENERGINET

Fugro Pioneer

Project No.:	190532	**Report No.:**	115	**Date:**	10/09/2021
Client:	Energinet			**Timezone:**	UTC+02:00
Location:	Transit to Esbjerg. Alongside Esbjerg for Noise Monitoring Campiagn				

Quality, Health, Safety and Environment

Safety Information	Today	/	To Date
Quality Related Incident	1	/	3
Security Incident	0	/	0
Environmental Incident	0	/	0
Health and Safety Incident	0	/	0
Vessel Led Kick of Meeting (KOM)	0	/	4
Two-Part HIRA	0	/	0
Toolbox TBT (led by others)	0	/	276
Sound bite training	0	/	26
Cross Departmental Tours	0	/	17
Permit to Work	4	/	14
Vessel Drills	0	/	27
Toolbox Talk (TBT)	3	/	16
Safety Meetings	0	/	9
Audits / Inspections	1	/	12
Inductions	0	/	22
Total Persons Onboard	28		
HOC Cards	2	/	277
Total Exposure Hours	336	/	37106
Near Miss	0	/	0
Daily HOD Meetings	1	/	111

HSE Comments

Quality Incident: Delayed notification to Pioneer of latest version of TQ14, dated 29 June, results in acquiring unnecessary magnetometer infill

PTW's: Electrical isolations; Lifting operations; Hot work; Working at height

- HOC_21.515 - Unsafe condition - Wearing both covid face masks & safety glasses results in safety glasses becoming steamed-up
- HOC_21.516 - Unsafe act - Person stands under boom to crane during lifting operations

Summary of Activities

Begin	End	Duration	Type	Description
00:00	08:15	08:15	Transit to/from Site	Transit to Esbjerg in preparation for mobilisation of Noise Monitoring Campaign
08:15	24:00	15:45	Noise Monitoring Mob	Alongside Esbjerg for mobilisation of Noise Monitoring Campaign - Class Audit - all day - Sat TV engineer on-board - Embarked UHR & JASCO equipment - Hotwork: welding twist lock feet to base plate - Reconfigured blocks to stern A-frame - Commenced mobilising UHR equipment - Measured offsets for UHR equipment

DOME

Time Summary

Activity	Today	/	To Date	Progress
Noise Monitoring Mob	15:45	/	15:45	0.57%
Infill - 2D UHRS	0:00	/	0:48	0.03%
Ops - 2D UHRS	0:00	/	79:32	2.90%
General Mob	0:00	/	169:14	6.16%
Equipment Cal	0:00	/	44:04	1.60%
Transit to/from Site	8:15	/	175:10	6.38%
Port Call	0:00	/	61:30	2.24%
W/S in Port	0:00	/	166:24	6.06%
W/S at Sea	0:00	/	633:40	23.08%
Weather - Mob	0:00	/	34:00	1.24%
Ops - Equipment Dep/Rec	0:00	/	22:33	0.82%
Transit between locations	0:00	/	10:54	0.40%
Ops - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	292:53	10.67%
Ops - Geophysical	0:00	/	696:48	25.38%
Infill - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	4:21	0.16%
Infill - MBES, SSS, SBP, MAG	0:00	/	117:11	4.27%
Infill - due to pycnocline	0:00	/	26:39	0.97%
Line turn - due to pycnocline	0:00	/	9:09	0.33%
Ops - Line Turn 2D UHRS	0:00	/	45:15	1.65%
Line Turn - MBES, SSS, SBP, MAG	0:00	/	49:07	1.79%
Ops - Extended Line Turn	0:00	/	31:03	1.13%
Downtime - Survey	0:00	/	29:22	1.07%
Standby - Other	0:00	/	14:26	0.53%
Standby - Fishing	0:00	/	16:12	0.59%
Total	24:00	/	2746:00	

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Noise monitoring survey	LS	4.0	0.0	0.0	Days	0.0%
Block Y Geophysical mainlines	LS	342.0	0.0	0.0	km	0.0%
Block V Geophysical mainlines	LS	380.0	0.0	0.0	km	0.0%
Block U Geophysical mainlines	LS	342.0	0.0	38.0	km	11.1%
Block T Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block S Geophysical mainlines	LS	340.0	0.0	340.0	km	100.0%
Block R Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Block Q Geophysical mainlines	LS	365.0	0.0	365.0	km	100.0%
Block P Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block N Geophysical mainlines	LS	356.0	0.0	356.0	km	100.0%
Block M Geophysical mainlines	LS	384.0	0.0	384.0	km	100.0%
Block K Geophysical mainlines	LS	342.0	0.0	342.0	km	100.0%
Block J Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block H Geophysical mainlines	LS	324.0	0.0	324.0	km	100.0%
Block G Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block F Geophysical mainlines	LS	338.0	0.0	338.0	km	100.0%
Block Y 2D UHRs and Geophysical mainlines	LS	152.0	0.0	152.2	km	100.1%
Block V 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block U 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Block T 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block S 2D UHRs and Geophysical mainlines	LS	113.0	0.0	113.0	km	100.0%
Block R 2D UHRs and Geophysical mainlines	LS	111.0	0.0	111.0	km	100.0%
Block Q 2D UHRs and Geophysical mainlines	LS	147.0	0.0	147.0	km	100.0%
Block P 2D UHRs and Geophysical mainlines	LS	109.0	0.0	109.0	km	100.0%
Block N 2D UHRs and Geophysical mainlines	LS	142.0	0.0	142.0	km	100.0%
Block M 2D UHRs and Geophysical mainlines	LS	105.0	0.0	105.0	km	100.0%
Block K 2D UHRs and Geophysical mainlines	LS	137.0	0.0	137.0	km	100.0%
Block J 2D UHRs and Geophysical mainlines	LS	101.0	0.0	101.0	km	100.0%
Block H 2D UHRs and Geophysical mainlines	LS	129.0	0.0	129.0	km	100.0%
Block G 2D UHRs and Geophysical mainlines	LS	95.0	0.0	95.0	km	100.0%
Block F 2D UHRs and Geophysical mainlines	LS	124.0	0.0	124.0	km	100.0%
Grab samples	LS	150.0	0.0	0.0	N°	0.0%
Block X 2D UHRs mainlines	LS	588.0	0.0	588.0	km	100.0%
Block C 2D UHRs and Geophysical mainlines	LS	134.0	0.0	134.0	km	100.0%
Block D 2D UHRs and Geophysical mainlines	LS	126.0	0.0	126.0	km	100.0%
Block E 2D UHRs and Geophysical mainlines	LS	115.0	0.0	115.0	km	100.0%
UHRS and Geophysical Survey - Infill	LS	63.0	0.0	93.1	km	147.8%
Block C Geophysical mainlines	LS	397.0	0.0	397.3	km	100.1%
Block D Geophysical mainlines	LS	326.0	0.0	326.0	km	100.0%
Block E Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Geophysical Survey - Infill	LS	600.0	0.0	839.6	km	139.9%
Infill - due to pycnocline	LS	160.0	0.0	127.3	km	79.6%

Personnel Status

	Yesterday	Arrived	Departed	Onboard
Project crew	12	0	0	12
Client representative	2	0	0	2
Marine crew	13	0	0	13
FLO	1	0	0	1
Noise Monitoring Personnel	0	0	0	0
Total	28	0	0	28

Weather and Sea State Status

Weather and Sea State	Unit	06:00	12:00	18:00	24:00	Comments
Wind Direction	Coords	ESE	SE	SE	SE	Alongside: 08:15 to 24:00
Wind Speed	Beaufort	3	3	2	3	Alongside: 08:15 to 24:00
Sig Wave Height	m	0.4	0.1	0.1	0.1	Alongside: 08:15 to 24:00

Weather Forecast

A low is centred over the N North Sea, with associated showery troughs moving ENE over the sea. Tomorrow, the low remains slow moving between Shetland and S Norway but with showery troughs over the S North Sea beginning to fill. On Sunday morning, the low clears E over Norway as high pressure builds over Scotland. This high approaches the W North Sea by Sunday evening.

Liquids Status

Item	Amount at start	Added today	Used Today	Amount at End	Used to Date	Unit
Fuel	134.60	0.00	2.30	132.30	221.70	m³
Water	46.00	0.00	5.00	41.00	531.00	m³
Lube oil	1,080.00	0.00	0.00	1,080.00	850.00	L

Other Comments

Planned work for the next 24 hours

Continue with mobilisation for Noise Monitoring Campaign

Client Representative Comments

Party Chief Comments

Fugro Representative

Paul Miller
Fugro Pioneer Party Chief
10/09/2021

Client Representative

Mark Herczeg
Energinet Client Representative
10/09/2021

DAILY PROGRESS REPORT

PIO/Energinet DK Energy Islands
Geophysical Survey WPA

Fugro Pioneer

Project No.:	190532	**Report No.:**	116	**Date:**	11/09/2021
Client:	Energinet			**Timezone:**	UTC+02:00
Location:	Alongside Esbjerg for mobilisation of Noise Monitoring Campiagn				

Quality, Health, Safety and Environment

Safety Information	Today	/	To Date
Quality Related Incident	0	/	3
Security Incident	0	/	0
Environmental Incident	0	/	0
Health and Safety Incident	0	/	0
Vessel Led Kick of Meeting (KOM)	0	/	4
Two-Part HIRA	0	/	0
Toolbox TBT (led by others)	2	/	278
Sound bite training	0	/	26
Cross Departmental Tours	0	/	17
Permit to Work	0	/	14
Vessel Drills	0	/	27
Toolbox Talk (TBT)	0	/	16
Safety Meetings	0	/	9
Audits / Inspections	0	/	12
Inductions	0	/	22
Total Persons Onboard	29		
HOC Cards	1	/	278
Total Exposure Hours	348	/	37454
Near Miss	0	/	0
Daily HOD Meetings	1	/	112

HSE Comments

- HOC_21.517 - Positive observation - Good and safe work procedure done for sparker Mob and testing when in port

Summary of Activities

Begin	End	Duration	Type	Description
00:00	20:50	20:50	Noise Monitoring Mob	Alongside Esbjerg for mobilisation of Noise Monitoring Campaign - Mobilising of UHR equipment (Sparker & streamer) - Sparker wet test - Seismic recorder & integrated seismic spread test - 2 x JASCO engineer's on-signed; 1 x university intern off-signed - Dry run of deployment and recovery of AMAR's - Tested hydrophones to AMAR's
20:50	24:00	03:10	W/S in Port	Weather standby alongside in port

Time Summary

Activity	Today	/	To Date	Progress
Noise Monitoring Mob	20:50	/	36:35	1.32%

DOME

Time Summary

Activity	Today	/	To Date	Progress
Infill - 2D UHRS	0:00	/	0:48	0.03%
Ops - 2D UHRS	0:00	/	79:32	2.87%
General Mob	0:00	/	169:14	6.11%
Equipment Cal	0:00	/	44:04	1.59%
Transit to/from Site	0:00	/	175:10	6.32%
Port Call	0:00	/	61:30	2.22%
W/S in Port	3:10	/	169:34	6.12%
W/S at Sea	0:00	/	633:40	22.88%
Weather - Mob	0:00	/	34:00	1.23%
Ops - Equipment Dep/Rec	0:00	/	22:33	0.81%
Transit between locations	0:00	/	10:54	0.39%
Ops - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	292:53	10.57%
Ops - Geophysical	0:00	/	696:48	25.16%
Infill - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	4:21	0.16%
Infill - MBES, SSS, SBP, MAG	0:00	/	117:11	4.23%
Infill - due to pycnocline	0:00	/	26:39	0.96%
Line turn - due to pycnocline	0:00	/	9:09	0.33%
Ops - Line Turn 2D UHRS	0:00	/	45:15	1.63%
Line Turn - MBES, SSS, SBP, MAG	0:00	/	49:07	1.77%
Ops - Extended Line Turn	0:00	/	31:03	1.12%
Downtime - Survey	0:00	/	29:22	1.06%
Standby - Other	0:00	/	14:26	0.52%
Standby - Fishing	0:00	/	16:12	0.58%
Total	24:00	/	2770:00	

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Noise monitoring survey	LS	4.0	0.0	0.0	Days	0.0%
Block Y Geophysical mainlines	LS	342.0	0.0	0.0	km	0.0%
Block V Geophysical mainlines	LS	380.0	0.0	0.0	km	0.0%
Block U Geophysical mainlines	LS	342.0	0.0	38.0	km	11.1%
Block T Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block S Geophysical mainlines	LS	340.0	0.0	340.0	km	100.0%
Block R Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Block Q Geophysical mainlines	LS	365.0	0.0	365.0	km	100.0%
Block P Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block N Geophysical mainlines	LS	356.0	0.0	356.0	km	100.0%
Block M Geophysical mainlines	LS	384.0	0.0	384.0	km	100.0%
Block K Geophysical mainlines	LS	342.0	0.0	342.0	km	100.0%
Block J Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block H Geophysical mainlines	LS	324.0	0.0	324.0	km	100.0%
Block G Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block F Geophysical mainlines	LS	338.0	0.0	338.0	km	100.0%
Block Y 2D UHRs and Geophysical mainlines	LS	152.0	0.0	152.2	km	100.1%
Block V 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block U 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block T 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Block S 2D UHRs and Geophysical mainlines	LS	113.0	0.0	113.0	km	100.0%
Block R 2D UHRs and Geophysical mainlines	LS	111.0	0.0	111.0	km	100.0%
Block Q 2D UHRs and Geophysical mainlines	LS	147.0	0.0	147.0	km	100.0%
Block P 2D UHRs and Geophysical mainlines	LS	109.0	0.0	109.0	km	100.0%
Block N 2D UHRs and Geophysical mainlines	LS	142.0	0.0	142.0	km	100.0%
Block M 2D UHRs and Geophysical mainlines	LS	105.0	0.0	105.0	km	100.0%
Block K 2D UHRs and Geophysical mainlines	LS	137.0	0.0	137.0	km	100.0%
Block J 2D UHRs and Geophysical mainlines	LS	101.0	0.0	101.0	km	100.0%
Block H 2D UHRs and Geophysical mainlines	LS	129.0	0.0	129.0	km	100.0%
Block G 2D UHRs and Geophysical mainlines	LS	95.0	0.0	95.0	km	100.0%
Block F 2D UHRs and Geophysical mainlines	LS	124.0	0.0	124.0	km	100.0%
Grab samples	LS	150.0	0.0	0.0	N°	0.0%
Block X 2D UHRs mainlines	LS	588.0	0.0	588.0	km	100.0%
Block C 2D UHRs and Geophysical mainlines	LS	134.0	0.0	134.0	km	100.0%
Block D 2D UHRs and Geophysical mainlines	LS	126.0	0.0	126.0	km	100.0%
Block E 2D UHRs and Geophysical mainlines	LS	115.0	0.0	115.0	km	100.0%
UHRS and Geophysical Survey - Infill	LS	63.0	0.0	93.1	km	147.8%
Block C Geophysical mainlines	LS	397.0	0.0	397.3	km	100.1%
Block D Geophysical mainlines	LS	326.0	0.0	326.0	km	100.0%
Block E Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Geophysical Survey - Infill	LS	600.0	0.0	839.6	km	139.9%
Infill - due to pycnocline	LS	160.0	0.0	127.3	km	79.6%

Personnel Status

	Yesterday	Arrived	Departed	Onboard
Project crew	12	0	1	11
Client representative	2	0	0	2
Marine crew	13	0	0	13
FLO	1	0	0	1
Noise Monitoring Personnel	0	2	0	2
Total	28	2	1	29

Weather and Sea State Status

Weather and Sea State	Unit	06:00	12:00	18:00	24:00	Comments
Wind Direction	Coords	SW	SW	SW	SW	Alongside: 00:00 to 24:00
Wind Speed	Beaufort	3	3	2	2	Alongside: 00:00 to 24:00
Sig Wave Height	m	0.1	0.1	0.1	0.1	Alongside: 00:00 to 24:00

Weather Forecast

A low centred over the N North Sea clears E over Norway tonight as high pressure builds over Scotland tomorrow morning. This high then slowly drifts E and elongates across much of the North Sea through tomorrow/Monday.

Liquids Status

Item	Amount at start	Added today	Used Today	Amount at End	Used to Date	Unit

Liquids Status

Item	Amount at start	Added today	Used Today	Amount at End	Used to Date	Unit
Fuel	132.30	0.00	0.80	131.50	222.50	m³
Water	41.00	75.00	5.00	111.00	536.00	m³
Lube oil	1,080.00	0.00	0.00	1,080.00	850.00	L

Other Comments

Planned work for the next 24 hours

Weather standby alongside in port whilst monitoring all weather forecasts for timely return to survey area

Client Representative Comments

Party Chief Comments

Fugro Representative

Paul Miller
Fugro Pioneer Party Chief
11/09/2021

Client Representative

Mark Herczeg
Energinet Client Representative
11/09/2021

DAILY PROGRESS REPORT

PIO/Energinet DK Energy Islands
Geophysical Survey WPA

ENERGINET

Fugro Pioneer

Project No.:	190532	**Report No.:**	117	**Date:**	12/09/2021
Client:	Energinet			**Timezone:**	UTC+02:00
Location:	Alongside Esbjerg				

Quality, Health, Safety and Environment

Safety Information	Today	/	To Date
Quality Related Incident	0	/	3
Security Incident	0	/	0
Environmental Incident	0	/	0
Health and Safety Incident	0	/	0
Vessel Led Kick of Meeting (KOM)	0	/	4
Two-Part HIRA	0	/	0
Toolbox TBT (led by others)	0	/	278
Sound bite training	2	/	28
Cross Departmental Tours	1	/	18
Permit to Work	0	/	14
Vessel Drills	2	/	29
Toolbox Talk (TBT)	0	/	16
Safety Meetings	0	/	9
Audits / Inspections	0	/	12
Inductions	0	/	22
Total Persons Onboard	29		
HOC Cards	2	/	280
Total Exposure Hours	348	/	37802
Near Miss	0	/	0
Daily HOD Meetings	1	/	113

HSE Comments

2 x Vessel drills: Enclosed space drill & Emergency steering drill
Cross department safety tour
Sound bite training: Correct donning of safety harness; Deployment & recovery of AMAR's
- HOC_21.518 - Positive observation - Cross department safety tour of Engine Room compartments found no deficiencies. All in very good order
- HOC_21.519 - Positive observation - The procedures for switching to emergency steering are clearly displayed and easy to understand next to emergency steering console

Summary of Activities

Begin	End	Duration	Type	Description
00:00	24:00	24:00	W/S in Port	Weather standby alongside Esbjerg - Project preparations - Day & night shift dry-runs for deployment & recovery of AMAR's

Time Summary

Activity	Today	/	To Date	Progress
Noise Monitoring Mob	0:00	/	36:35	1.31%

DOME

Time Summary

Activity	Today	/	To Date	Progress
Infill - 2D UHRS	0:00	/	0:48	0.03%
Ops - 2D UHRS	0:00	/	79:32	2.85%
General Mob	0:00	/	169:14	6.06%
Equipment Cal	0:00	/	44:04	1.58%
Transit to/from Site	0:00	/	175:10	6.27%
Port Call	0:00	/	61:30	2.20%
W/S in Port	24:00	/	193:34	6.93%
W/S at Sea	0:00	/	633:40	22.68%
Weather - Mob	0:00	/	34:00	1.22%
Ops - Equipment Dep/Rec	0:00	/	22:33	0.81%
Transit between locations	0:00	/	10:54	0.39%
Ops - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	292:53	10.48%
Ops - Geophysical	0:00	/	696:48	24.94%
Infill - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	4:21	0.16%
Infill - MBES, SSS, SBP, MAG	0:00	/	117:11	4.19%
Infill - due to pycnocline	0:00	/	26:39	0.95%
Line turn - due to pycnocline	0:00	/	9:09	0.33%
Ops - Line Turn 2D UHRS	0:00	/	45:15	1.62%
Line Turn - MBES, SSS, SBP, MAG	0:00	/	49:07	1.76%
Ops - Extended Line Turn	0:00	/	31:03	1.11%
Downtime - Survey	0:00	/	29:22	1.05%
Standby - Other	0:00	/	14:26	0.52%
Standby - Fishing	0:00	/	16:12	0.58%
Total	24:00	/	2794:00	

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Noise monitoring survey	LS	4.0	0.0	0.0	Days	0.0%
Block Y Geophysical mainlines	LS	342.0	0.0	0.0	km	0.0%
Block V Geophysical mainlines	LS	380.0	0.0	0.0	km	0.0%
Block U Geophysical mainlines	LS	342.0	0.0	38.0	km	11.1%
Block T Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block S Geophysical mainlines	LS	340.0	0.0	340.0	km	100.0%
Block R Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Block Q Geophysical mainlines	LS	365.0	0.0	365.0	km	100.0%
Block P Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block N Geophysical mainlines	LS	356.0	0.0	356.0	km	100.0%
Block M Geophysical mainlines	LS	384.0	0.0	384.0	km	100.0%
Block K Geophysical mainlines	LS	342.0	0.0	342.0	km	100.0%
Block J Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block H Geophysical mainlines	LS	324.0	0.0	324.0	km	100.0%
Block G Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block F Geophysical mainlines	LS	338.0	0.0	338.0	km	100.0%
Block Y 2D UHRs and Geophysical mainlines	LS	152.0	0.0	152.2	km	100.1%
Block V 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block U 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block T 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Block S 2D UHRs and Geophysical mainlines	LS	113.0	0.0	113.0	km	100.0%
Block R 2D UHRs and Geophysical mainlines	LS	111.0	0.0	111.0	km	100.0%
Block Q 2D UHRs and Geophysical mainlines	LS	147.0	0.0	147.0	km	100.0%
Block P 2D UHRs and Geophysical mainlines	LS	109.0	0.0	109.0	km	100.0%
Block N 2D UHRs and Geophysical mainlines	LS	142.0	0.0	142.0	km	100.0%
Block M 2D UHRs and Geophysical mainlines	LS	105.0	0.0	105.0	km	100.0%
Block K 2D UHRs and Geophysical mainlines	LS	137.0	0.0	137.0	km	100.0%
Block J 2D UHRs and Geophysical mainlines	LS	101.0	0.0	101.0	km	100.0%
Block H 2D UHRs and Geophysical mainlines	LS	129.0	0.0	129.0	km	100.0%
Block G 2D UHRs and Geophysical mainlines	LS	95.0	0.0	95.0	km	100.0%
Block F 2D UHRs and Geophysical mainlines	LS	124.0	0.0	124.0	km	100.0%
Grab samples	LS	150.0	0.0	0.0	N°	0.0%
Block X 2D UHRs mainlines	LS	588.0	0.0	588.0	km	100.0%
Block C 2D UHRs and Geophysical mainlines	LS	134.0	0.0	134.0	km	100.0%
Block D 2D UHRs and Geophysical mainlines	LS	126.0	0.0	126.0	km	100.0%
Block E 2D UHRs and Geophysical mainlines	LS	115.0	0.0	115.0	km	100.0%
UHRS and Geophysical Survey - Infill	LS	63.0	0.0	93.1	km	147.8%
Block C Geophysical mainlines	LS	397.0	0.0	397.3	km	100.1%
Block D Geophysical mainlines	LS	326.0	0.0	326.0	km	100.0%
Block E Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Geophysical Survey - Infill	LS	600.0	0.0	839.6	km	139.9%
Infill - due to pycnocline	LS	160.0	0.0	127.3	km	79.6%

Personnel Status

	Yesterday	Arrived	Departed	Onboard
Project crew	11	0	0	11
Client representative	2	0	0	2
Marine crew	13	0	0	13
FLO	1	0	0	1
Noise Monitoring Personnel	2	0	0	2
Total	29	0	0	29

Weather and Sea State Status

Weather and Sea State	Unit	06:00	12:00	18:00	24:00	Comments
Wind Direction	Coords	SW	SW	SW	W	Alongside: 00:00 to 24:00
Wind Speed	Beaufort	2	3	3	2	Alongside: 00:00 to 24:00
Sig Wave Height	m	0.1	0.1	0.1	0.1	Alongside: 00:00 to 24:00

Weather Forecast

A low over the Skagerrak combines with a high over Scotland to create a NNW'ly flow across much of the North Sea this evening. The high then drifts ESE and broadens across much of the North Sea tomorrow. Overnight into Tuesday this retreats NE towards Norway, allowing a frontal trough to drift NE across the S North Sea, with a shallow low centre forming on the trough over the Low Countries later on Tuesday.

Liquids Status

Item	Amount at start	Added today	Used Today	Amount at End	Used to Date	Unit
Fuel	131.50	0.00	0.80	130.70	223.30	m³
Water	111.00	0.00	4.00	107.00	540.00	m³
Lube oil	1,080.00	0.00	70.00	1,010.00	920.00	L

Other Comments

Planned work for the next 24 hours

Weather standby alongside in port. 07:00 Sail to survey area. Weather assessment on arrival for operations

Client Representative Comments

With regard to the forth coming noise trials, Fugro/JASCO have been asked whether the single beam echo-sounders - which are always active whilst surveying - should be included in the Sound Source Characterisation Survey program. At present the single beam echo-sounders are not included in the test schedule presented in the Project Execution Plan (F176286-PEP-007 02 dated 07th September). Feedback from JASCO is to run the single beam echo-sounders during the tests. Awaiting further guidance via Fugro/JASCO as to whether additional test sequences specific to the single beam echo-sounders are required.

Party Chief Comments

Fugro Representative

Paul Miller
Fugro Pioneer Party Chief
12/09/2021

Client Representative

Mark Herczeg
Energinet Client Representative
12/09/2021

DAILY PROGRESS REPORT

PIO/Energinet DK Energy Islands
Geophysical Survey WPA

ENERGINET

Fugro Pioneer

Project No.:	190532	**Report No.:**	118	**Date:**	13/09/2021
Client:	Energinet			**Timezone:**	UTC+02:00
Location:	Alongside Esbjerg. Transit to survey area. Energinet Energy Island, Lot 2. Operations in Block R				

Quality, Health, Safety and Environment

Safety Information	Today	/	To Date
Quality Related Incident	0	/	3
Security Incident	0	/	0
Environmental Incident	0	/	0
Health and Safety Incident	0	/	0
Vessel Led Kick of Meeting (KOM)	0	/	4
Two-Part HIRA	0	/	0
Toolbox TBT (led by others)	4	/	282
Sound bite training	0	/	28
Cross Departmental Tours	0	/	18
Permit to Work	0	/	14
Vessel Drills	0	/	29
Toolbox Talk (TBT)	0	/	16
Safety Meetings	0	/	9
Audits / Inspections	0	/	12
Inductions	0	/	22
Total Persons Onboard	29		
HOC Cards	1	/	281
Total Exposure Hours	348	/	38150
Near Miss	0	/	0
Daily HOD Meetings	1	/	114

HSE Comments

- HOC_21.520 - Positive observation - Very detailed instruction + practical demonstration by TC of how to manufacture Dyneema tow points

Summary of Activities

Begin	End	Duration	Type	Description
00:00	07:00	07:00	W/S in Port	Weather standby alongside Esbjerg
07:00	22:00	15:00	Noise Monitoring Transit	Transit to survey area
22:00	22:15	00:15	Ops - Equipment Dep/Rec	Weather assessment. Not suitable for deploying AMAR's. Toolbox talks: Open HiPAP gate valve, Deploy moonpool, SSS, magnetometer & MVP
22:15	23:00	00:45	Ops - Equipment Dep/Rec	Opened HiPAP gate valve; Deployed moonpool. SSS, magnetometer & MVP
23:00	23:36	00:36	Line turn - due to pycnocline	Heading to first infill
23:36	23:43	00:07	Infill - due to pycnocline	Block R: Infill line EAR1199J01; Hdg: 171°. Infill for pycnocline.
23:43	24:00	00:17	Line turn - due to pycnocline	Line turn

Time Summary

Activity	Today	/	To Date	Progress
Noise Monitoring Mob	0:00	/	36:35	1.30%
Noise Monitoring Transit	15:00	/	15:00	0.53%
Infill - 2D UHRS	0:00	/	0:48	0.03%
Ops - 2D UHRS	0:00	/	79:32	2.82%
General Mob	0:00	/	169:14	6.01%
Equipment Cal	0:00	/	44:04	1.56%
Transit to/from Site	0:00	/	175:10	6.22%
Port Call	0:00	/	61:30	2.18%
W/S in Port	7:00	/	200:34	7.12%
W/S at Sea	0:00	/	633:40	22.49%
Weather - Mob	0:00	/	34:00	1.21%
Ops - Equipment Dep/Rec	1:00	/	23:33	0.84%
Transit between locations	0:00	/	10:54	0.39%
Ops - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	292:53	10.39%
Ops - Geophysical	0:00	/	696:48	24.73%
Infill - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	4:21	0.15%
Infill - MBES, SSS, SBP, MAG	0:00	/	117:11	4.16%
Infill - due to pycnocline	0:07	/	26:46	0.95%
Line turn - due to pycnocline	0:53	/	10:02	0.36%
Ops - Line Turn 2D UHRS	0:00	/	45:15	1.61%
Line Turn - MBES, SSS, SBP, MAG	0:00	/	49:07	1.74%
Ops - Extended Line Turn	0:00	/	31:03	1.10%
Downtime - Survey	0:00	/	29:22	1.04%
Standby - Other	0:00	/	14:26	0.51%
Standby - Fishing	0:00	/	16:12	0.57%
Total	24:00	/	2818:00	

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Noise monitoring survey	LS	4.0	0.0	0.0	Days	0.0%
Block Y Geophysical mainlines	LS	342.0	0.0	0.0	km	0.0%
Block V Geophysical mainlines	LS	380.0	0.0	0.0	km	0.0%
Block U Geophysical mainlines	LS	342.0	0.0	38.0	km	11.1%
Block T Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block S Geophysical mainlines	LS	340.0	0.0	340.0	km	100.0%
Block R Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Block Q Geophysical mainlines	LS	365.0	0.0	365.0	km	100.0%
Block P Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block N Geophysical mainlines	LS	356.0	0.0	356.0	km	100.0%
Block M Geophysical mainlines	LS	384.0	0.0	384.0	km	100.0%
Block K Geophysical mainlines	LS	342.0	0.0	342.0	km	100.0%
Block J Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block H Geophysical mainlines	LS	324.0	0.0	324.0	km	100.0%
Block G Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block F Geophysical mainlines	LS	338.0	0.0	338.0	km	100.0%
Block Y 2D UHRs and Geophysical mainlines	LS	152.0	0.0	152.2	km	100.1%
Block V 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Block U 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block T 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block S 2D UHRs and Geophysical mainlines	LS	113.0	0.0	113.0	km	100.0%
Block R 2D UHRs and Geophysical mainlines	LS	111.0	0.0	111.0	km	100.0%
Block Q 2D UHRs and Geophysical mainlines	LS	147.0	0.0	147.0	km	100.0%
Block P 2D UHRs and Geophysical mainlines	LS	109.0	0.0	109.0	km	100.0%
Block N 2D UHRs and Geophysical mainlines	LS	142.0	0.0	142.0	km	100.0%
Block M 2D UHRs and Geophysical mainlines	LS	105.0	0.0	105.0	km	100.0%
Block K 2D UHRs and Geophysical mainlines	LS	137.0	0.0	137.0	km	100.0%
Block J 2D UHRs and Geophysical mainlines	LS	101.0	0.0	101.0	km	100.0%
Block H 2D UHRs and Geophysical mainlines	LS	129.0	0.0	129.0	km	100.0%
Block G 2D UHRs and Geophysical mainlines	LS	95.0	0.0	95.0	km	100.0%
Block F 2D UHRs and Geophysical mainlines	LS	124.0	0.0	124.0	km	100.0%
Grab samples	LS	150.0	0.0	0.0	N°	0.0%
Block X 2D UHRs mainlines	LS	588.0	0.0	588.0	km	100.0%
Block C 2D UHRs and Geophysical mainlines	LS	134.0	0.0	134.0	km	100.0%
Block D 2D UHRs and Geophysical mainlines	LS	126.0	0.0	126.0	km	100.0%
Block E 2D UHRs and Geophysical mainlines	LS	115.0	0.0	115.0	km	100.0%
UHRS and Geophysical Survey - Infill	LS	63.0	0.0	93.1	km	147.8%
Block C Geophysical mainlines	LS	397.0	0.0	397.3	km	100.1%
Block D Geophysical mainlines	LS	326.0	0.0	326.0	km	100.0%
Block E Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Geophysical Survey - Infill	LS	600.0	0.0	839.6	km	139.9%
Infill - due to pycnocline	LS	160.0	0.2	127.5	km	79.7%

Personnel Status

	Yesterday	Arrived	Departed	Onboard
Project crew	11	0	0	11
Client representative	2	0	0	2
Marine crew	13	0	0	13
FLO	1	0	0	1
Noise Monitoring Personnel	2	0	0	2
Total	29	0	0	29

Weather and Sea State Status

Weather and Sea State	Unit	06:00	12:00	18:00	24:00	Comments
Wind Direction	Coords	W	NW	NW	NW	
Wind Speed	Beaufort	4	4	3	3	
Sig Wave Height	m	0.1	2.2	1.8	1.5	

Weather Forecast

A high is centred over the North Sea. Tomorrow the high clears ENE over S Norway, extending a ridge SW across the N/Central North Sea. Meanwhile a low moving NE across S England, driving a frontal trough into the S North Sea. Into Wednesday the low becomes centred over the S North Sea. Later on Wednesday the low continues NE

Weather Forecast

into the Central North Sea, towards Denmark.

Liquids Status

Item	Amount at start	Added today	Used Today	Amount at End	Used to Date	Unit
Fuel	130.70	0.00	3.50	127.20	226.80	m³
Water	107.00	2.00	4.00	105.00	544.00	m³
Lube oil	1,010.00	0.00	0.00	1,010.00	920.00	L

Other Comments

Planned work for the next 24 hours

Geophysical infill until daylight. Deploy 3 x AMAR's. Commence test sequences 0a, 1a to 5a

Client Representative Comments

With respect to the noise trials it was agreed that the vessels (marine) single beam echo sounder would be turned off for all sequences except the "All Sources" sequences (sequences 5a and 5b in the Operations Plan Rev 3). This was discussed and agreed between parties (Energinet/Fugro/OCR's) after the issue of the Operations Plan Rev 3.

Party Chief Comments

Fugro Representative

Paul Miller
Fugro Pioneer Party Chief
13/09/2021

Client Representative

Mark Herczeg
Energinet Client Representative
13/09/2021

DAILY PROGRESS REPORT

PIO/Energinet DK Energy Islands
Geophysical Survey WPA

Fugro Pioneer

Project No.:	190532	**Report No.:**	119	**Date:**	14/09/2021
Client:	Energinet			**Timezone:**	UTC+02:00
Location:	Energinet Energy Island, Lot 2. Operations in Block S & T				

Quality, Health, Safety and Environment

Safety Information	Today	/	To Date
Quality Related Incident	0	/	3
Security Incident	0	/	0
Environmental Incident	0	/	0
Health and Safety Incident	0	/	0
Vessel Led Kick of Meeting (KOM)	0	/	4
Two-Part HIRA	0	/	0
Toolbox TBT (led by others)	8	/	290
Sound bite training	0	/	28
Cross Departmental Tours	0	/	18
Permit to Work	0	/	14
Vessel Drills	0	/	29
Toolbox Talk (TBT)	0	/	16
Safety Meetings	0	/	9
Audits / Inspections	0	/	12
Inductions	0	/	22
Total Persons Onboard	29		
HOC Cards	2	/	283
Total Exposure Hours	348	/	38498
Near Miss	0	/	0
Daily HOD Meetings	1	/	115

HSE Comments

- HOC_21.521 - Positive observation - Safe operations by all survey team and Bridge Staff for deployment of 3 x AMARs
- HOC_21.522 - Unsafe act - Chin strap to safety helmet too loose and not under chin when worn

Summary of Activities

Begin	End	Duration	Type	Description
00:00	00:12	00:12	Line turn - due to pycnocline	Line turn
00:12	00:25	00:13	Infill - due to pycnocline	Block S: Infill line EAS1207J01; Hdg: 171°. Infill for pycnocline.
00:25	00:47	00:22	Line turn - due to pycnocline	Line turn
00:47	00:55	00:08	Infill - due to pycnocline	Block Q: Infill line EAQ1188J02; Hdg: 171°. Infill for pycnocline.
00:55	01:11	00:16	Line turn - due to pycnocline	Line turn
01:11	01:20	00:09	Infill - due to pycnocline	Block S: Infill line EAS1207J02; Hdg: 171°. Infill for pycnocline.
01:20	02:26	01:06	Infill - MBES, SSS, SBP, MAG	Line turn
02:26	02:35	00:09	Infill - MBES, SSS, SBP, MAG	Block R: Infill line EAR1204J04; Hdg: 171°. Infill for SSS.
02:35	02:53	00:18	Line turn - due to pycnocline	Line turn

Summary of Activities

Begin	End	Duration	Type	Description
02:53	02:59	00:06	Infill - due to pycnocline	Block S: Infill line EAS1214J03; Hdg: 171°. Infill for pycnocline.
02:59	03:21	00:22	Line turn - due to pycnocline	Line turn
03:21	03:37	00:16	Infill - due to pycnocline	Block T: Infill line EAT1224J01; Hdg: 351°. Infill for pycnocline.
03:37	03:41	00:04	Standby - Fishing	Line turn
03:41	03:49	00:08	Standby - Fishing	Block T: Infill line EAT1225J01; Hdg: 171°. Infill for fishing buoy.
03:49	04:00	00:11	Line turn - due to pycnocline	Line turn
04:00	04:09	00:09	Infill - due to pycnocline	Block T: Infill line EAT1226J01; Hdg: 351°. Infill for pycnocline.
04:09	04:14	00:05	Line turn - due to pycnocline	Line turn
04:14	04:29	00:15	Infill - due to pycnocline	Block T: Infill line EAT1225J02; Hdg: 351°. Infill for pycnocline.
04:29	04:55	00:26	Ops - Equipment Dep/Rec	Toolbox talks followed by recovery of SSS, magnetometer & MVP
04:55	06:10	01:15	Noise Monitoring Operational	Heading to AMAR location. Preparing hydrophones for deployment
06:10	07:30	01:20	Noise Monitoring Operational	Preparing seabed AMAR's and rigging for deployment
07:30	07:55	00:25	Noise Monitoring Operational	Toolbox talk: Deployment of 3 x AMARs
07:55	08:27	00:32	Noise Monitoring Operational	AMAR Station D: Final deck preparations
08:27	08:40	00:13	Noise Monitoring Operational	AMAR Station D: Deployed AMAR and mooring arrangement
08:40	09:13	00:33	Noise Monitoring Operational	AMAR Station B: Deck preparations. Vessel takes station at Station B
09:13	09:24	00:11	Noise Monitoring Operational	AMAR Station B: Deployed AMAR and mooring arrangement
09:24	09:54	00:30	Noise Monitoring Operational	AMAR Station A: Deck preparations. Vessel takes station at Station A
09:54	10:10	00:16	Noise Monitoring Operational	AMAR Station A: Deployed AMAR and mooring arrangement
10:10	10:37	00:27	Noise Monitoring Operational	Securing back deck
10:37	10:47	00:10	Noise Monitoring Operational	MBES scouting line to position AMAR's at Stations: A, B & D
10:47	11:30	00:43	Noise Monitoring Operational	Checking MBES data to confirm positions of AMARs. Stn B & D located
11:30	11:55	00:25	Noise Monitoring Operational	Toolbox talk followed by deployment of SSS
11:55	12:11	00:16	Noise Monitoring Operational	SSS scouting line to position AMAR at Stations: A
12:11	14:18	02:07	Noise Monitoring Operational	Checking data from scouting lines and creating line plans for test sequences
14:18	14:47	00:29	Noise Monitoring Operational	Noise Monitoring Test Seq 0a: Line ENT0A01; Hdg: 351°. No sensors
14:47	14:58	00:11	Noise Monitoring Operational	Line turn
14:58	15:27	00:29	Noise Monitoring Operational	Noise Monitoring Test Seq 0a: Line ENT0A02; Hdg: 171°. No sensors
15:27	16:05	00:38	Noise Monitoring Operational	Line turn. SVP via CTD winch
16:05	16:34	00:29	Noise Monitoring Operational	Noise Monitoring Test Seq 1a: Line ENT1A01; Hdg: 351°. MBES sensor
16:34	16:44	00:10	Noise Monitoring Operational	Line turn
16:44	17:13	00:29	Noise Monitoring Operational	Noise Monitoring Test Seq 1a: Line ENT1A02; Hdg: 171°. MBES sensor
17:13	17:28	00:15	Noise Monitoring Operational	Line turm
17:28	17:57	00:29	Noise Monitoring Operational	Noise Monitoring Test Seq 2a: Line ENT2A01; Hdg: 351°. Innomar sensor
17:57	18:10	00:13	Noise Monitoring Operational	Line turn
18:10	18:40	00:30	Noise Monitoring Operational	Noise Monitoring Test Seq 2a: Line ENT2A02; Hdg: 171°. Innomar sensor
18:40	19:22	00:42	Noise Monitoring Operational	Line turn. Toolbox talk followed by deployment of SSS
19:22	19:53	00:31	Noise Monitoring Operational	Noise Monitoring Test Seq 4a: Line ENT4A01; Hdg: 351°. SSS sensor (using beacon)
19:53	20:10	00:17	Noise Monitoring Operational	Line turn
20:10	20:41	00:31	Noise Monitoring Operational	Noise Monitoring Test Seq 4a: Line ENT4A02; Hdg: 351°. SSS sensor (no beacon). Deployed PAM in preparation for MMO ops. Commenced MMO observations
20:41	23:06	02:25	Noise Monitoring Operational	Recovered SSS. Toolbox talk followed by deployment of sparker & outrigger
23:06	23:45	00:39	Noise Monitoring Operational	Noise Monitoring Test Seq 3a: Line ENT3A01; Hdg: 171°. Sparker
23:45	24:00	00:15	Noise Monitoring Operational	Noise Monitoring Test Seq 3a: Line ENT3AT1; Hdg: 183°. Extended line heading towards 5km line

Time Summary

Activity	Today	/	To Date	Progress
Noise Monitoring Mob	0:00	/	36:35	1.29%

DOME

Time Summary

Activity	Today	/	To Date	Progress
Noise Monitoring Transit	0:00	/	15:00	0.53%
Noise Monitoring Operational	19:05	/	19:05	0.67%
Infill - 2D UHRS	0:00	/	0:48	0.03%
Ops - 2D UHRS	0:00	/	79:32	2.80%
General Mob	0:00	/	169:14	5.95%
Equipment Cal	0:00	/	44:04	1.55%
Transit to/from Site	0:00	/	175:10	6.16%
Port Call	0:00	/	61:30	2.16%
W/S in Port	0:00	/	200:34	7.06%
W/S at Sea	0:00	/	633:40	22.30%
Weather - Mob	0:00	/	34:00	1.20%
Ops - Equipment Dep/Rec	0:26	/	23:59	0.84%
Transit between locations	0:00	/	10:54	0.38%
Ops - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	292:53	10.31%
Ops - Geophysical	0:00	/	696:48	24.52%
Infill - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	4:21	0.15%
Infill - MBES, SSS, SBP, MAG	1:15	/	118:26	4.17%
Infill - due to pycnocline	1:16	/	28:02	0.99%
Line turn - due to pycnocline	1:46	/	11:48	0.42%
Ops - Line Turn 2D UHRS	0:00	/	45:15	1.59%
Line Turn - MBES, SSS, SBP, MAG	0:00	/	49:07	1.73%
Ops - Extended Line Turn	0:00	/	31:03	1.09%
Downtime - Survey	0:00	/	29:22	1.03%
Standby - Other	0:00	/	14:26	0.51%
Standby - Fishing	0:12	/	16:24	0.58%
Total	24:00	/	2842:00	

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Noise monitoring survey	LS	4.0	0.8	0.8	Days	20.0%
Block Y Geophysical mainlines	LS	342.0	0.0	0.0	km	0.0%
Block V Geophysical mainlines	LS	380.0	0.0	0.0	km	0.0%
Block U Geophysical mainlines	LS	342.0	0.0	38.0	km	11.1%
Block T Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block S Geophysical mainlines	LS	340.0	0.0	340.0	km	100.0%
Block R Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Block Q Geophysical mainlines	LS	365.0	0.0	365.0	km	100.0%
Block P Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block N Geophysical mainlines	LS	356.0	0.0	356.0	km	100.0%
Block M Geophysical mainlines	LS	384.0	0.0	384.0	km	100.0%
Block K Geophysical mainlines	LS	342.0	0.0	342.0	km	100.0%
Block J Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block H Geophysical mainlines	LS	324.0	0.0	324.0	km	100.0%
Block G Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block F Geophysical mainlines	LS	338.0	0.0	338.0	km	100.0%
Block Y 2D UHRs and Geophysical mainlines	LS	152.0	0.0	152.2	km	100.1%
Block V 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Block U 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block T 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block S 2D UHRs and Geophysical mainlines	LS	113.0	0.0	113.0	km	100.0%
Block R 2D UHRs and Geophysical mainlines	LS	111.0	0.0	111.0	km	100.0%
Block Q 2D UHRs and Geophysical mainlines	LS	147.0	0.0	147.0	km	100.0%
Block P 2D UHRs and Geophysical mainlines	LS	109.0	0.0	109.0	km	100.0%
Block N 2D UHRs and Geophysical mainlines	LS	142.0	0.0	142.0	km	100.0%
Block M 2D UHRs and Geophysical mainlines	LS	105.0	0.0	105.0	km	100.0%
Block K 2D UHRs and Geophysical mainlines	LS	137.0	0.0	137.0	km	100.0%
Block J 2D UHRs and Geophysical mainlines	LS	101.0	0.0	101.0	km	100.0%
Block H 2D UHRs and Geophysical mainlines	LS	129.0	0.0	129.0	km	100.0%
Block G 2D UHRs and Geophysical mainlines	LS	95.0	0.0	95.0	km	100.0%
Block F 2D UHRs and Geophysical mainlines	LS	124.0	0.0	124.0	km	100.0%
Grab samples	LS	150.0	0.0	0.0	N°	0.0%
Block X 2D UHRs mainlines	LS	588.0	0.0	588.0	km	100.0%
Block C 2D UHRs and Geophysical mainlines	LS	134.0	0.0	134.0	km	100.0%
Block D 2D UHRs and Geophysical mainlines	LS	126.0	0.0	126.0	km	100.0%
Block E 2D UHRs and Geophysical mainlines	LS	115.0	0.0	115.0	km	100.0%
UHRS and Geophysical Survey - Infill	LS	63.0	0.0	93.1	km	147.8%
Block C Geophysical mainlines	LS	397.0	0.0	397.3	km	100.1%
Block D Geophysical mainlines	LS	326.0	0.0	326.0	km	100.0%
Block E Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Geophysical Survey - Infill	LS	600.0	1.9	841.5	km	140.3%
Infill - due to pycnocline	LS	160.0	6.9	134.4	km	84.0%

Personnel Status

	Yesterday	Arrived	Departed	Onboard
Project crew	11	0	0	11
Client representative	2	0	0	2
Marine crew	13	0	0	13
FLO	1	0	0	1
Noise Monitoring Personnel	2	0	0	2
Total	29	0	0	29

Weather and Sea State Status

Weather and Sea State	Unit	06:00	12:00	18:00	24:00	Comments
Wind Direction	Coords	NW	NW	SW	SW	
Wind Speed	Beaufort	3	3	2	3	
Sig Wave Height	m	1.3	1.1	1.0	1.2	

Weather Forecast

A deepening low and associated troughs move NE across the S North Sea, reaching Denmark later tomorrow. On Thursday the low clears E as a ridge builds NE-NNE astern across the S North Sea.

Liquids Status

Item	Amount at start	Added today	Used Today	Amount at End	Used to Date	Unit
Fuel	127.20	0.00	1.60	125.60	228.40	m³
Water	105.00	5.00	4.00	106.00	548.00	m³
Lube oil	1,010.00	0.00	0.00	1,010.00	920.00	L

Other Comments

Planned work for the next 24 hours

Continue with Noise Monitoring campaign where progress could be subject to weather

Client Representative Comments

Party Chief Comments

Fugro Representative

Paul Miller
Fugro Pioneer Party Chief
14/09/2021

Client Representative

Mark Herczeg
Energinet Client Representative
14/09/2021

DAILY PROGRESS REPORT

PIO/Energinet DK Energy Islands
Geophysical Survey WPA

Fugro Pioneer

Project No.:	190532	**Report No.:**	120	**Date:**	15/09/2021
Client:	Energinet			**Timezone:**	UTC+02:00
Location:	Energinet Energy Island, Lot 2. Transit to Esbjerg				

Quality, Health, Safety and Environment

Safety Information	Today	/	To Date
Quality Related Incident	1	/	4
Security Incident	0	/	0
Environmental Incident	0	/	0
Health and Safety Incident	0	/	0
Vessel Led Kick of Meeting (KOM)	0	/	4
Two-Part HIRA	0	/	0
Toolbox TBT (led by others)	6	/	296
Sound bite training	0	/	28
Cross Departmental Tours	0	/	18
Permit to Work	0	/	14
Vessel Drills	0	/	29
Toolbox Talk (TBT)	0	/	16
Safety Meetings	0	/	9
Audits / Inspections	0	/	12
Inductions	0	/	22
Total Persons Onboard	29		
HOC Cards	3	/	286
Total Exposure Hours	348	/	38846
Near Miss	0	/	0
Daily HOD Meetings	1	/	116

HSE Comments

Quality incident: Data not logged on 3 x AMARs
- HOC_21.523 - Positive observation - Excellent seamanship practices on the back deck by Marine & survey + excellent bridgemanship on the Bridge during AMAR recovery
- HOC_21.524 - Unsafe condition - A faulty intermittent switch for the port capstan
- HOC_21.525 - Positive observation - Excellent teamwork by all for the safe recovery of three seabed acoustic sensors during poor weather control of clockwise direction

Summary of Activities

Begin	End	Duration	Type	Description
00:00	00:23	00:23	Noise Monitoring Operational	Noise Monitoring Test Seq 3a: Line ENT3AT1; Hdg: 183°. Extended line heading towards 5km line - Sparker only
00:23	00:25	00:02	Noise Monitoring Operational	Line turn
00:25	00:58	00:33	Noise Monitoring Operational	Noise Monitoring Test Seq 3a: Line ENT3AP1; Hdg: 081°. 5km line - Sparker only
00:58	01:51	00:53	Noise Monitoring Operational	Noise Monitoring Test Seq 3a: Line ENT3AT2; Hdg: 171°. Extended line heading towards 10km line - Sparker only. SVP via CTD
01:51	02:27	00:36	Noise Monitoring Operational	Noise Monitoring Test Seq 3a: Line ENT3AP2; Hdg: 261°. 10km line - Sparker only

DOME

Summary of Activities

Begin	End	Duration	Type	Description
02:27	02:29	00:02	Noise Monitoring Operational	Line turn
02:29	03:03	00:34	Noise Monitoring Operational	Noise Monitoring Test Seq 3a: Line ENT3AT3; Hdg: 250°. Extended line heading back towards 10km line - Sparker only.
03:03	03:37	00:34	Noise Monitoring Operational	Noise Monitoring Test Seq 3a: Line ENT3AP3; Hdg: 081°. 10km line - Sparker only
03:37	04:20	00:43	Noise Monitoring Operational	Noise Monitoring Test Seq 3a: Line ENT3AT4; Hdg: 350°. Extended line heading back towards 5km line - Sparker only.
04:20	04:53	00:33	Noise Monitoring Operational	Noise Monitoring Test Seq 3a: Line ENT3AP4; Hdg: 261°. 5km line - Sparker only
04:53	05:22	00:29	Noise Monitoring Operational	Noise Monitoring Test Seq 3a: Line ENT3AT5; Hdg: 183°. Extended line heading back towards main 4km line - Sparker only
05:22	05:53	00:31	Noise Monitoring Operational	Noise Monitoring Test Seq 3a: Line ENT3A02; Hdg: 351°. Sparker
05:53	06:35	00:42	Noise Monitoring Operational	Noise Monitoring Test Seq 3a: Line ENT3AT6; Hdg: 025°. Continuous line turn for ALL sensors line
06:35	07:06	00:31	Noise Monitoring Operational	Noise Monitoring Test Seq 5a: Line ENT5A01; Hdg: 171°. ALL sensors
07:06	07:43	00:37	Noise Monitoring Operational	Noise Monitoring Test Seq 3a: Line ENT3AT7; Hdg: 183°. Continuous line turn for ALL sensors line
07:43	08:14	00:31	Noise Monitoring Operational	Noise Monitoring Test Seq 5a: Line ENT5A02; Hdg: 351°. ALL sensors
08:14	08:30	00:16	Noise Monitoring Operational	Toolbox talks: Recovery of sparker & SSS
08:30	08:50	00:20	Noise Monitoring Operational	Recovered sparker & SSS
08:50	09:15	00:25	Noise Monitoring Operational	Prepared back deck for recovery of AMAR's
09:15	09:45	00:30	Noise Monitoring Operational	Toolbox talks: Recovery of AMARs
09:45	10:20	00:35	Noise Monitoring Operational	Recovery of AMAR at station D
10:20	10:55	00:35	Noise Monitoring Operational	Recovery of AMAR at station B
10:55	11:45	00:50	Noise Monitoring Operational	Checked data on AMARs from stations D & B.
11:45	12:10	00:25	Noise Monitoring Operational	Recovery of AMAR at station A
12:10	12:30	00:20	Noise Monitoring Operational	Checking data from AMAR at station A
12:30	21:45	09:15	W/S at Sea	Weather standby at survey location due to poor weather
21:45	24:00	02:15	Noise Monitoring Transit	Transit to port due to poor weather outlook

Time Summary

Activity	Today	/	To Date	Progress
Noise Monitoring Mob	0:00	/	36:35	1.28%
Noise Monitoring Transit	2:15	/	17:15	0.60%
Noise Monitoring Operational	12:30	/	31:35	1.10%
Infill - 2D UHRS	0:00	/	0:48	0.03%
Ops - 2D UHRS	0:00	/	79:32	2.78%
General Mob	0:00	/	169:14	5.90%
Equipment Cal	0:00	/	44:04	1.54%
Transit to/from Site	0:00	/	175:10	6.11%
Port Call	0:00	/	61:30	2.15%
W/S in Port	0:00	/	200:34	7.00%
W/S at Sea	9:15	/	642:55	22.43%
Weather - Mob	0:00	/	34:00	1.19%
Ops - Equipment Dep/Rec	0:00	/	23:59	0.84%
Transit between locations	0:00	/	10:54	0.38%
Ops - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	292:53	10.22%
Ops - Geophysical	0:00	/	696:48	24.31%
Infill - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	4:21	0.15%
Infill - MBES, SSS, SBP, MAG	0:00	/	118:26	4.13%
Infill - due to pycnocline	0:00	/	28:02	0.98%
Line turn - due to pycnocline	0:00	/	11:48	0.41%
Ops - Line Turn 2D UHRS	0:00	/	45:15	1.58%

Time Summary

Activity	Today	/	To Date	Progress
Line Turn - MBES, SSS, SBP, MAG	0:00	/	49:07	1.71%
Ops - Extended Line Turn	0:00	/	31:03	1.08%
Downtime - Survey	0:00	/	29:22	1.02%
Standby - Other	0:00	/	14:26	0.50%
Standby - Fishing	0:00	/	16:24	0.57%
Total	24:00	/	2866:00	

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Noise monitoring survey	LS	4.0	0.5	1.3	Days	32.5%
Block Y Geophysical mainlines	LS	342.0	0.0	0.0	km	0.0%
Block V Geophysical mainlines	LS	380.0	0.0	0.0	km	0.0%
Block U Geophysical mainlines	LS	342.0	0.0	38.0	km	11.1%
Block T Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block S Geophysical mainlines	LS	340.0	0.0	340.0	km	100.0%
Block R Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Block Q Geophysical mainlines	LS	365.0	0.0	365.0	km	100.0%
Block P Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block N Geophysical mainlines	LS	356.0	0.0	356.0	km	100.0%
Block M Geophysical mainlines	LS	384.0	0.0	384.0	km	100.0%
Block K Geophysical mainlines	LS	342.0	0.0	342.0	km	100.0%
Block J Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block H Geophysical mainlines	LS	324.0	0.0	324.0	km	100.0%
Block G Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block F Geophysical mainlines	LS	338.0	0.0	338.0	km	100.0%
Block Y 2D UHRs and Geophysical mainlines	LS	152.0	0.0	152.2	km	100.1%
Block V 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block U 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block T 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block S 2D UHRs and Geophysical mainlines	LS	113.0	0.0	113.0	km	100.0%
Block R 2D UHRs and Geophysical mainlines	LS	111.0	0.0	111.0	km	100.0%
Block Q 2D UHRs and Geophysical mainlines	LS	147.0	0.0	147.0	km	100.0%
Block P 2D UHRs and Geophysical mainlines	LS	109.0	0.0	109.0	km	100.0%
Block N 2D UHRs and Geophysical mainlines	LS	142.0	0.0	142.0	km	100.0%
Block M 2D UHRs and Geophysical mainlines	LS	105.0	0.0	105.0	km	100.0%
Block K 2D UHRs and Geophysical mainlines	LS	137.0	0.0	137.0	km	100.0%
Block J 2D UHRs and Geophysical mainlines	LS	101.0	0.0	101.0	km	100.0%
Block H 2D UHRs and Geophysical mainlines	LS	129.0	0.0	129.0	km	100.0%
Block G 2D UHRs and Geophysical mainlines	LS	95.0	0.0	95.0	km	100.0%
Block F 2D UHRs and Geophysical mainlines	LS	124.0	0.0	124.0	km	100.0%
Grab samples	LS	150.0	0.0	0.0	N°	0.0%
Block X 2D UHRs mainlines	LS	588.0	0.0	588.0	km	100.0%
Block C 2D UHRs and Geophysical mainlines	LS	134.0	0.0	134.0	km	100.0%

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Block D 2D UHRs and Geophysical mainlines	LS	126.0	0.0	126.0	km	100.0%
Block E 2D UHRs and Geophysical mainlines	LS	115.0	0.0	115.0	km	100.0%
UHRS and Geophysical Survey - Infill	LS	63.0	0.0	93.1	km	147.8%
Block C Geophysical mainlines	LS	397.0	0.0	397.3	km	100.1%
Block D Geophysical mainlines	LS	326.0	0.0	326.0	km	100.0%
Block E Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Geophysical Survey - Infill	LS	600.0	0.0	841.5	km	140.3%
Infill - due to pycnocline	LS	160.0	0.0	134.4	km	84.0%

Personnel Status

	Yesterday	Arrived	Departed	Onboard
Project crew	11	0	0	11
Client representative	2	0	0	2
Marine crew	13	0	0	13
FLO	1	0	0	1
Noise Monitoring Personnel	2	0	0	2
Total	29	0	0	29

Weather and Sea State Status

Weather and Sea State	Unit	06:00	12:00	18:00	24:00	Comments
Wind Direction	Coords	NW	NW	NE	NE	
Wind Speed	Beaufort	3	4	5	7	
Sig Wave Height	m	0.9	1.2	1.6	2.5	

Weather Forecast

A low and associated troughs are centred over the E North Sea/Denmark. Tomorrow the low clears E into the S Baltic as a ridge builds NE-NNE astern across the S North Sea. Into Friday the ridge declines as an Atlantic trough approaches the British Isles.

Liquids Status

Item	Amount at start	Added today	Used Today	Amount at End	Used to Date	Unit
Fuel	125.60	0.00	1.90	123.70	230.30	m³
Water	106.00	5.00	4.00	107.00	552.00	m³
Lube oil	1,010.00	0.00	0.00	1,010.00	920.00	L

Other Comments

Planned work for the next 24 hours

Due to poor weather outlook until the planned crew change on 17 September, Pioneer will transit to port. ETA Esbjerg is AM on 16 September.

Client Representative Comments

Regarding the data logging failures JASCO are reviewing their power-on procedures and will provide more feedback, including corrective actions, in due course. JASCO have ordered additional battery packs for the logging modules to extend the in-water duration to in excess of five days. It is planned that these will arrive for the forth coming crew change on the 17th September.

Party Chief Comments

Reference AMAR's: On checking memory cards to seabed AMAR's post recovery of stations: D, B & A, it was confirmed no data had been recorded from all 3 x AMARs. Under investigation by the JASCO team.

Fugro Representative

Paul Miller **Fugro Pioneer Party Chief**	**15/09/2021**

Client Representative

Mark Herczeg **Energinet Client Representative**	**15/09/2021**

DOME

DAILY PROGRESS REPORT

PIO/Energinet DK Energy Islands
Geophysical Survey WPA

ENERGINET

Fugro Pioneer

Project No.:	190532	**Report No.:**	121	**Date:**	16/09/2021
Client:	Energinet			**Timezone:**	UTC+02:00
Location:	Transit to Esbjerg. Alongside Esbjerg				

Quality, Health, Safety and Environment

Safety Information	Today	/	To Date
Quality Related Incident	0	/	4
Security Incident	0	/	0
Environmental Incident	0	/	0
Health and Safety Incident	0	/	0
Vessel Led Kick of Meeting (KOM)	0	/	4
Two-Part HIRA	0	/	0
Toolbox TBT (led by others)	0	/	296
Sound bite training	1	/	29
Cross Departmental Tours	0	/	18
Permit to Work	0	/	14
Vessel Drills	0	/	29
Toolbox Talk (TBT)	0	/	16
Safety Meetings	0	/	9
Audits / Inspections	0	/	12
Inductions	0	/	22
Total Persons Onboard	29		
HOC Cards	0	/	286
Total Exposure Hours	348	/	39194
Near Miss	0	/	0
Daily HOD Meetings	1	/	117

HSE Comments

Sound bite training: Performing a re-termination to SSS winch

Summary of Activities

Begin	End	Duration	Type	Description
00:00	10:05	10:05	Noise Monitoring Transit	Transit to Esbjerg due to poor weather outlook
10:05	24:00	13:55	W/S in Port	Weather standby alongside Esbjerg

Time Summary

Activity	Today	/	To Date	Progress
Noise Monitoring Mob	0:00	/	36:35	1.27%
Noise Monitoring Transit	10:05	/	27:20	0.95%
Noise Monitoring Operational	0:00	/	31:35	1.09%
Infill - 2D UHRS	0:00	/	0:48	0.03%
Ops - 2D UHRS	0:00	/	79:32	2.75%

DOME

Time Summary

Activity	Today	/	To Date	Progress
General Mob	0:00	/	169:14	5.86%
Equipment Cal	0:00	/	44:04	1.52%
Transit to/from Site	0:00	/	175:10	6.06%
Port Call	0:00	/	61:30	2.13%
W/S in Port	13:55	/	214:29	7.42%
W/S at Sea	0:00	/	642:55	22.25%
Weather - Mob	0:00	/	34:00	1.18%
Ops - Equipment Dep/Rec	0:00	/	23:59	0.83%
Transit between locations	0:00	/	10:54	0.38%
Ops - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	292:53	10.13%
Ops - Geophysical	0:00	/	696:48	24.11%
Infill - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	4:21	0.15%
Infill - MBES, SSS, SBP, MAG	0:00	/	118:26	4.10%
Infill - due to pycnocline	0:00	/	28:02	0.97%
Line turn - due to pycnocline	0:00	/	11:48	0.41%
Ops - Line Turn 2D UHRS	0:00	/	45:15	1.57%
Line Turn - MBES, SSS, SBP, MAG	0:00	/	49:07	1.70%
Ops - Extended Line Turn	0:00	/	31:03	1.07%
Downtime - Survey	0:00	/	29:22	1.02%
Standby - Other	0:00	/	14:26	0.50%
Standby - Fishing	0:00	/	16:24	0.57%
Total	24:00	/	2890:00	

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Noise monitoring survey	LS	4.0	0.0	1.3	Days	32.5%
Block Y Geophysical mainlines	LS	342.0	0.0	0.0	km	0.0%
Block V Geophysical mainlines	LS	380.0	0.0	0.0	km	0.0%
Block U Geophysical mainlines	LS	342.0	0.0	38.0	km	11.1%
Block T Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block S Geophysical mainlines	LS	340.0	0.0	340.0	km	100.0%
Block R Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Block Q Geophysical mainlines	LS	365.0	0.0	365.0	km	100.0%
Block P Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block N Geophysical mainlines	LS	356.0	0.0	356.0	km	100.0%
Block M Geophysical mainlines	LS	384.0	0.0	384.0	km	100.0%
Block K Geophysical mainlines	LS	342.0	0.0	342.0	km	100.0%
Block J Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block H Geophysical mainlines	LS	324.0	0.0	324.0	km	100.0%
Block G Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block F Geophysical mainlines	LS	338.0	0.0	338.0	km	100.0%
Block Y 2D UHRs and Geophysical mainlines	LS	152.0	0.0	152.2	km	100.1%
Block V 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block U 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block T 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block S 2D UHRs and Geophysical mainlines	LS	113.0	0.0	113.0	km	100.0%
Block R 2D UHRs and Geophysical mainlines	LS	111.0	0.0	111.0	km	100.0%

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Block Q 2D UHRs and Geophysical mainlines	LS	147.0	0.0	147.0	km	100.0%
Block P 2D UHRs and Geophysical mainlines	LS	109.0	0.0	109.0	km	100.0%
Block N 2D UHRs and Geophysical mainlines	LS	142.0	0.0	142.0	km	100.0%
Block M 2D UHRs and Geophysical mainlines	LS	105.0	0.0	105.0	km	100.0%
Block K 2D UHRs and Geophysical mainlines	LS	137.0	0.0	137.0	km	100.0%
Block J 2D UHRs and Geophysical mainlines	LS	101.0	0.0	101.0	km	100.0%
Block H 2D UHRs and Geophysical mainlines	LS	129.0	0.0	129.0	km	100.0%
Block G 2D UHRs and Geophysical mainlines	LS	95.0	0.0	95.0	km	100.0%
Block F 2D UHRs and Geophysical mainlines	LS	124.0	0.0	124.0	km	100.0%
Grab samples	LS	150.0	0.0	0.0	N°	0.0%
Block X 2D UHRs mainlines	LS	588.0	0.0	588.0	km	100.0%
Block C 2D UHRs and Geophysical mainlines	LS	134.0	0.0	134.0	km	100.0%
Block D 2D UHRs and Geophysical mainlines	LS	126.0	0.0	126.0	km	100.0%
Block E 2D UHRs and Geophysical mainlines	LS	115.0	0.0	115.0	km	100.0%
UHRS and Geophysical Survey - Infill	LS	63.0	0.0	93.1	km	147.8%
Block C Geophysical mainlines	LS	397.0	0.0	397.3	km	100.1%
Block D Geophysical mainlines	LS	326.0	0.0	326.0	km	100.0%
Block E Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Geophysical Survey - Infill	LS	600.0	0.0	841.5	km	140.3%
Infill - due to pycnocline	LS	160.0	0.0	134.4	km	84.0%

Personnel Status

	Yesterday	Arrived	Departed	Onboard
Project crew	11	0	0	11
Client representative	2	0	0	2
Marine crew	13	0	0	13
FLO	1	0	0	1
Noise Monitoring Personnel	2	0	0	2
Total	29	0	0	29

Weather and Sea State Status

Weather and Sea State	Unit	06:00	12:00	18:00	24:00	Comments
Wind Direction	Coords	NW	NW	NW	NW	
Wind Speed	Beaufort	3	4	4	4	
Sig Wave Height	m	0.9	0.1	0.1	0.1	

Weather Forecast

Slow moving low over southern Sweden and the Kattegat, drifts slowly south and fills through tomorrow whilst high pressure across SW across southern Norway amplifies a ridge SSW across the North Sea to links to high pressure across France and Germany. weak showery troughs continue to affect the eastern North Sea and a weak frontal trough become slow moving across northern Scotland on Saturday.

Liquids Status

Item	Amount at start	Added today	Used Today	Amount at End	Used to Date	Unit
Fuel	123.70	0.00	2.20	121.50	232.50	m³

Liquids Status

Item	Amount at start	Added today	Used Today	Amount at End	Used to Date	Unit
Water	107.00	0.00	5.00	102.00	557.00	m³
Lube oil	1,010.00	0.00	70.00	940.00	990.00	L

Other Comments

Planned work for the next 24 hours

Weather standby alongside Esbjerg. Crew change and replenishment of stores in Esbjerg. ETD for survey area is 19:00

Client Representative Comments

OCR's Mark Herczeg and Colin Poat will depart the vessel today as part of the scheduled crew change. We would like to take this opportunity to thank the vessel marine and survey crew for their diligence and attention to detail who made this a safe and successful cruise. Safe travels to all off-signers.

Party Chief Comments

Fugro Representative		Client Representative	
Paul Miller **Fugro Pioneer Party Chief**	**16/09/2021**	**Mark Herczeg** **Energinet Client Representative**	**16/09/2021**

DAILY PROGRESS REPORT

PIO/Energinet DK Energy Islands
Geophysical Survey WPA

ENERGINET

Fugro Pioneer

Project No.:	190532	**Report No.:**	122	**Date:**	17/09/2021
Client:	Energinet			**Timezone:**	UTC+02:00
Location:	Alongside Esbjerg				

Quality, Health, Safety and Environment

Safety Information	Today	/	To Date
Quality Related Incident	0	/	4
Security Incident	0	/	0
Environmental Incident	0	/	0
Health and Safety Incident	0	/	0
Vessel Led Kick of Meeting (KOM)	0	/	4
Two-Part HIRA	0	/	0
Toolbox TBT (led by others)	0	/	296
Sound bite training	0	/	29
Cross Departmental Tours	0	/	18
Permit to Work	0	/	14
Vessel Drills	1	/	30
Toolbox Talk (TBT)	4	/	20
Safety Meetings	0	/	9
Audits / Inspections	0	/	12
Inductions	3	/	25
Total Persons Onboard	28		
HOC Cards	0	/	286
Total Exposure Hours	336	/	39530
Near Miss	0	/	0
Daily HOD Meetings	0	/	117

HSE Comments

Safety inductions
Vessel Drills
- Abandon ship, ISPS & firefighting drills
AMAR deployment & recovery dry run.

Summary of Activities

Begin	End	Duration	Type	Description
00:00	09:00	09:00	W/S in Port	Weather standby alongside Esbjerg
09:00	16:00	07:00	Port Call	Crew change and replenishment of stores
16:00	24:00	08:00	Noise Monitoring Transit	Transit to site for the noise monitoring tests.

Time Summary

Activity	Today	/	To Date	Progress
Noise Monitoring Mob	0:00	/	36:35	1.26%
Noise Monitoring Transit	8:00	/	35:20	1.21%

DOME

Time Summary

Activity	Today	/	To Date	Progress
Noise Monitoring Operational	0:00	/	31:35	1.08%
Infill - 2D UHRS	0:00	/	0:48	0.03%
Ops - 2D UHRS	0:00	/	79:32	2.73%
General Mob	0:00	/	169:14	5.81%
Equipment Cal	0:00	/	44:04	1.51%
Transit to/from Site	0:00	/	175:10	6.01%
Port Call	7:00	/	68:30	2.35%
W/S in Port	9:00	/	223:29	7.67%
W/S at Sea	0:00	/	642:55	22.06%
Weather - Mob	0:00	/	34:00	1.17%
Ops - Equipment Dep/Rec	0:00	/	23:59	0.82%
Transit between locations	0:00	/	10:54	0.37%
Ops - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	292:53	10.05%
Ops - Geophysical	0:00	/	696:48	23.91%
Infill - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	4:21	0.15%
Infill - MBES, SSS, SBP, MAG	0:00	/	118:26	4.06%
Infill - due to pycnocline	0:00	/	28:02	0.96%
Line turn - due to pycnocline	0:00	/	11:48	0.40%
Ops - Line Turn 2D UHRS	0:00	/	45:15	1.55%
Line Turn - MBES, SSS, SBP, MAG	0:00	/	49:07	1.69%
Ops - Extended Line Turn	0:00	/	31:03	1.07%
Downtime - Survey	0:00	/	29:22	1.01%
Standby - Other	0:00	/	14:26	0.50%
Standby - Fishing	0:00	/	16:24	0.56%
Total	24:00	/	2914:00	

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Noise monitoring survey	LS	4.0	0.0	1.3	Days	32.5%
Block Y Geophysical mainlines	LS	342.0	0.0	0.0	km	0.0%
Block V Geophysical mainlines	LS	380.0	0.0	0.0	km	0.0%
Block U Geophysical mainlines	LS	342.0	0.0	38.0	km	11.1%
Block T Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block S Geophysical mainlines	LS	340.0	0.0	340.0	km	100.0%
Block R Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Block Q Geophysical mainlines	LS	365.0	0.0	365.0	km	100.0%
Block P Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block N Geophysical mainlines	LS	356.0	0.0	356.0	km	100.0%
Block M Geophysical mainlines	LS	384.0	0.0	384.0	km	100.0%
Block K Geophysical mainlines	LS	342.0	0.0	342.0	km	100.0%
Block J Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block H Geophysical mainlines	LS	324.0	0.0	324.0	km	100.0%
Block G Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block F Geophysical mainlines	LS	338.0	0.0	338.0	km	100.0%
Block Y 2D UHRs and Geophysical mainlines	LS	152.0	0.0	152.2	km	100.1%
Block V 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block U 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Block T 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block S 2D UHRs and Geophysical mainlines	LS	113.0	0.0	113.0	km	100.0%
Block R 2D UHRs and Geophysical mainlines	LS	111.0	0.0	111.0	km	100.0%
Block Q 2D UHRs and Geophysical mainlines	LS	147.0	0.0	147.0	km	100.0%
Block P 2D UHRs and Geophysical mainlines	LS	109.0	0.0	109.0	km	100.0%
Block N 2D UHRs and Geophysical mainlines	LS	142.0	0.0	142.0	km	100.0%
Block M 2D UHRs and Geophysical mainlines	LS	105.0	0.0	105.0	km	100.0%
Block K 2D UHRs and Geophysical mainlines	LS	137.0	0.0	137.0	km	100.0%
Block J 2D UHRs and Geophysical mainlines	LS	101.0	0.0	101.0	km	100.0%
Block H 2D UHRs and Geophysical mainlines	LS	129.0	0.0	129.0	km	100.0%
Block G 2D UHRs and Geophysical mainlines	LS	95.0	0.0	95.0	km	100.0%
Block F 2D UHRs and Geophysical mainlines	LS	124.0	0.0	124.0	km	100.0%
Grab samples	LS	150.0	0.0	0.0	N°	0.0%
Block X 2D UHRs mainlines	LS	588.0	0.0	588.0	km	100.0%
Block C 2D UHRs and Geophysical mainlines	LS	134.0	0.0	134.0	km	100.0%
Block D 2D UHRs and Geophysical mainlines	LS	126.0	0.0	126.0	km	100.0%
Block E 2D UHRs and Geophysical mainlines	LS	115.0	0.0	115.0	km	100.0%
UHRS and Geophysical Survey - Infill	LS	63.0	0.0	93.1	km	147.8%
Block C Geophysical mainlines	LS	397.0	0.0	397.3	km	100.1%
Block D Geophysical mainlines	LS	326.0	0.0	326.0	km	100.0%
Block E Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Geophysical Survey - Infill	LS	600.0	0.0	841.5	km	140.3%
Infill - due to pycnocline	LS	160.0	0.0	134.4	km	84.0%

Personnel Status

	Yesterday	Arrived	Departed	Onboard
Project crew	11	10	11	10
Client representative	2	2	2	2
Marine crew	13	3	3	13
FLO	1	1	1	1
Noise Monitoring Personnel	2	0	0	2
Total	29	16	17	28

Weather and Sea State Status

Weather and Sea State	Unit	06:00	12:00	18:00	24:00	Comments
Wind Direction	Coords	NNW	NNW	NE	ENE	
Wind Speed	Beaufort	3	3	4	4	
Sig Wave Height	m	-	-	1.0	1.1	

Weather Forecast

High pressure over southern Scandinavia maintains a ridge SW across the North Sea stopping the eastward progress of approaching frontal troughs which stall and dissipate across eastern Scotland from tomorrow. Further weak showery troughs move NW across the North Sea on Sunday.

Liquids Status

Item	Amount at start	Added today	Used Today	Amount at End	Used to Date	Unit
Fuel	121.50	0.00	1.60	119.90	234.10	m³
Water	102.00	0.00	5.00	97.00	562.00	m³
Lube oil	940.00	0.00	0.00	940.00	990.00	L

Other Comments

Planned work for the next 24 hours

Continue with the noise trials.

Client Representative Comments

Party Chief Comments

Fugro Representative		Client Representative	
Jaco de Beer		Morgan Hannah	
Jaco de Beer **Fugro Pioneer Party Chief**	**18/09/2021**	**Morgan Hannah** **Energinet Client Representative**	**18/09/2021**

DAILY PROGRESS REPORT

PIO/Energinet DK Energy Islands
Geophysical Survey WPA

ENERGINET

Fugro Pioneer

Project No.:	190532	**Report No.:**	123	**Date:**	18/09/2021
Client:	Energinet			**Timezone:**	UTC+02:00
Location:	Energinet Energy Island, Lot 2.				

Quality, Health, Safety and Environment

Safety Information	Today	/	To Date
Quality Related Incident	0	/	4
Security Incident	0	/	0
Environmental Incident	0	/	0
Health and Safety Incident	0	/	0
Vessel Led Kick of Meeting (KOM)	1	/	5
Two-Part HIRA	0	/	0
Toolbox TBT (led by others)	8	/	304
Sound bite training	0	/	29
Cross Departmental Tours	0	/	18
Permit to Work	0	/	14
Vessel Drills	0	/	30
Toolbox Talk (TBT)	0	/	20
Safety Meetings	0	/	9
Audits / Inspections	0	/	12
Inductions	0	/	25
Total Persons Onboard	28		
HOC Cards	0	/	286
Total Exposure Hours	336	/	39866
Near Miss	0	/	0
Daily HOD Meetings	1	/	118

HSE Comments

Kick-off meeting for the Noise Trials

Summary of Activities

Begin	End	Duration	Type	Description
00:00	07:00	07:00	Noise Monitoring Transit	Transit from the location identified for noise monitoring.
07:00	07:30	00:30	Noise Monitoring Operational	Toolbox talks for deployment of the survey sensors and AMARs
07:30	08:30	01:00	Noise Monitoring Operational	Deployment of the CTD, HiPAP and MBES.
08:30	09:52	01:22	Noise Monitoring Operational	Deployment of AMARs at locations A, B & D.
09:52	10:15	00:23	Noise Monitoring Operational	Toolbox and deployment of the SSS.
10:15	11:57	01:42	Noise Monitoring Operational	Survey the locations for AMARs A, B & D.
11:57	13:09	01:12	Noise Monitoring Operational	Recovering SSS, confirming the AMARs' locations and turning to line.
13:09	14:27	01:18	Noise Monitoring Operational	Noise Monitoring Test Seq 0a - No sensors.
14:27	14:51	00:24	Noise Monitoring Operational	Line turn.
14:51	16:03	01:12	Noise Monitoring Operational	Noise Monitoring Test Seq 1a - MBES sensor.

DOME

Summary of Activities

Begin	End	Duration	Type	Description
16:03	16:15	00:12	Noise Monitoring Operational	Line turn.
16:15	17:27	01:12	Noise Monitoring Operational	Noise Monitoring Test Seq 2a - SBP sensor.
17:27	18:03	00:36	Noise Monitoring Operational	Deployment of the SSS; Turning to line.
18:03	19:24	01:21	Noise Monitoring Operational	Noise Monitoring Seq 4a - SSS
19:24	20:35	01:11	Noise Monitoring Operational	Recovered SSS, toolbox followed by deployment of the sparker & outrigger.
20:35	21:33	00:58	Noise Monitoring Operational	Deployed PAMS & MMO observations
21:33	24:00	02:27	Noise Monitoring Operational	Noise Monitoring Seq 3a - Sparker; Continued over midnight.

Time Summary

Activity	Today	/	To Date	Progress
Noise Monitoring Mob	0:00	/	36:35	1.25%
Noise Monitoring Transit	7:00	/	42:20	1.44%
Noise Monitoring Operational	17:00	/	48:35	1.65%
Infill - 2D UHRS	0:00	/	0:48	0.03%
Ops - 2D UHRS	0:00	/	79:32	2.71%
General Mob	0:00	/	169:14	5.76%
Equipment Cal	0:00	/	44:04	1.50%
Transit to/from Site	0:00	/	175:10	5.96%
Port Call	0:00	/	68:30	2.33%
W/S in Port	0:00	/	223:29	7.61%
W/S at Sea	0:00	/	642:55	21.88%
Weather - Mob	0:00	/	34:00	1.16%
Ops - Equipment Dep/Rec	0:00	/	23:59	0.82%
Transit between locations	0:00	/	10:54	0.37%
Ops - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	292:53	9.97%
Ops - Geophysical	0:00	/	696:48	23.72%
Infill - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	4:21	0.15%
Infill - MBES, SSS, SBP, MAG	0:00	/	118:26	4.03%
Infill - due to pycnocline	0:00	/	28:02	0.95%
Line turn - due to pycnocline	0:00	/	11:48	0.40%
Ops - Line Turn 2D UHRS	0:00	/	45:15	1.54%
Line Turn - MBES, SSS, SBP, MAG	0:00	/	49:07	1.67%
Ops - Extended Line Turn	0:00	/	31:03	1.06%
Downtime - Survey	0:00	/	29:22	1.00%
Standby - Other	0:00	/	14:26	0.49%
Standby - Fishing	0:00	/	16:24	0.56%
Total	24:00	/	2938:00	

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Noise monitoring survey	LS	4.0	1.0	2.3	Days	57.5%
Block Y Geophysical mainlines	LS	342.0	0.0	0.0	km	0.0%
Block V Geophysical mainlines	LS	380.0	0.0	0.0	km	0.0%
Block U Geophysical mainlines	LS	342.0	0.0	38.0	km	11.1%
Block T Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block S Geophysical mainlines	LS	340.0	0.0	340.0	km	100.0%
Block R Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Block Q Geophysical mainlines	LS	365.0	0.0	365.0	km	100.0%

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Block P Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block N Geophysical mainlines	LS	356.0	0.0	356.0	km	100.0%
Block M Geophysical mainlines	LS	384.0	0.0	384.0	km	100.0%
Block K Geophysical mainlines	LS	342.0	0.0	342.0	km	100.0%
Block J Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block H Geophysical mainlines	LS	324.0	0.0	324.0	km	100.0%
Block G Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block F Geophysical mainlines	LS	338.0	0.0	338.0	km	100.0%
Block Y 2D UHRs and Geophysical mainlines	LS	152.0	0.0	152.2	km	100.1%
Block V 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block U 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block T 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block S 2D UHRs and Geophysical mainlines	LS	113.0	0.0	113.0	km	100.0%
Block R 2D UHRs and Geophysical mainlines	LS	111.0	0.0	111.0	km	100.0%
Block Q 2D UHRs and Geophysical mainlines	LS	147.0	0.0	147.0	km	100.0%
Block P 2D UHRs and Geophysical mainlines	LS	109.0	0.0	109.0	km	100.0%
Block N 2D UHRs and Geophysical mainlines	LS	142.0	0.0	142.0	km	100.0%
Block M 2D UHRs and Geophysical mainlines	LS	105.0	0.0	105.0	km	100.0%
Block K 2D UHRs and Geophysical mainlines	LS	137.0	0.0	137.0	km	100.0%
Block J 2D UHRs and Geophysical mainlines	LS	101.0	0.0	101.0	km	100.0%
Block H 2D UHRs and Geophysical mainlines	LS	129.0	0.0	129.0	km	100.0%
Block G 2D UHRs and Geophysical mainlines	LS	95.0	0.0	95.0	km	100.0%
Block F 2D UHRs and Geophysical mainlines	LS	124.0	0.0	124.0	km	100.0%
Grab samples	LS	150.0	0.0	0.0	N°	0.0%
Block X 2D UHRs mainlines	LS	588.0	0.0	588.0	km	100.0%
Block C 2D UHRs and Geophysical mainlines	LS	134.0	0.0	134.0	km	100.0%
Block D 2D UHRs and Geophysical mainlines	LS	126.0	0.0	126.0	km	100.0%
Block E 2D UHRs and Geophysical mainlines	LS	115.0	0.0	115.0	km	100.0%
UHRS and Geophysical Survey - Infill	LS	63.0	0.0	93.1	km	147.8%
Block C Geophysical mainlines	LS	397.0	0.0	397.3	km	100.1%
Block D Geophysical mainlines	LS	326.0	0.0	326.0	km	100.0%
Block E Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Geophysical Survey - Infill	LS	600.0	0.0	841.5	km	140.3%
Infill - due to pycnocline	LS	160.0	0.0	134.4	km	84.0%

Personnel Status

	Yesterday	Arrived	Departed	Onboard
Project crew	10	0	0	10
Client representative	2	0	0	2
Marine crew	13	0	0	13
FLO	1	0	0	1
Noise Monitoring Personnel	2	0	0	2

Personnel Status

	Yesterday	Arrived	Departed	Onboard
Total	28	0	0	28

Weather and Sea State Status

Weather and Sea State	Unit	06:00	12:00	18:00	24:00	Comments
Wind Direction	Coords	E	ESE	ESE	ESE	
Wind Speed	Beaufort	4	5	4	4	
Sig Wave Height	m	1.5	1.4	1.3	1.1	

Weather Forecast

High pressure over S Scandinavia maintains a ridge SW across the North Sea stopping the E progress of approaching frontal troughs which stall and dissipate across E Scotland. Another frontal trough moves E across the UK tomorrow, before filling tomorrow night/Monday morning over the W North Sea, as the ridge persists SW. Later on Monday a col develops over the central North Sea.

Liquids Status

Item	Amount at start	Added today	Used Today	Amount at End	Used to Date	Unit
Fuel	119.90	0.00	2.10	117.80	236.20	m³
Water	97.00	0.00	5.00	92.00	567.00	m³
Lube oil	940.00	0.00	0.00	940.00	990.00	L

Other Comments

Planned work for the next 24 hours

Endeavour to complete the Noise Monitoring trials and continue with the geophysical survey.

Client Representative Comments

Party Chief Comments

Fugro Representative

Jaco de Beer

Jaco de Beer
Fugro Pioneer Party Chief

19/09/2021

Client Representative

Morgan Hannah

Morgan Hannah
Energinet Client Representative

19/09/2021

DAILY PROGRESS REPORT

PIO/Energinet DK Energy Islands
Geophysical Survey WPA

Fugro Pioneer

Project No.:	190532	**Report No.:**	124	**Date:**	19/09/2021
Client:	Energinet			**Timezone:**	UTC+02:00
Location:	Energinet Energy Island, Lot 2.				

Quality, Health, Safety and Environment

Safety Information	Today	/	To Date
Quality Related Incident	0	/	4
Security Incident	0	/	0
Environmental Incident	0	/	0
Health and Safety Incident	0	/	0
Vessel Led Kick of Meeting (KOM)	0	/	5
Two-Part HIRA	0	/	0
Toolbox TBT (led by others)	7	/	311
Sound bite training	0	/	29
Cross Departmental Tours	0	/	18
Permit to Work	0	/	14
Vessel Drills	0	/	30
Toolbox Talk (TBT)	0	/	20
Safety Meetings	0	/	9
Audits / Inspections	0	/	12
Inductions	0	/	25
Total Persons Onboard	28		
HOC Cards	6	/	292
Total Exposure Hours	336	/	40202
Near Miss	0	/	0
Daily HOD Meetings	1	/	119

HSE Comments

6x HOCs

- HOC_21.526 - Unsafe Condition - Extension cord may block the ventilation flap – 20210919
- HOC_21.527 - Unsafe Act - Garbage segregation scheme ignored – 20210919
- HOC_21.528 - Unsafe Condition - Unused equipment left deployed – 20210919
- HOC_21.529 - Unsafe Condition - Deployed strobe light malfunctioned – 20210919
- HOC_21.530 - Positive Observation - Good communication and teamwork between bridge and survey during recovery – 20210919
- HOC_21.531 - Unsafe Act - Wet alleyway is a potential slip hazard - 20210919

Summary of Activities

Begin	End	Duration	Type	Description
00:00	02:17	02:17	Noise Monitoring Operational	Noise Monitoring Seq 3a - Sparker; Continued over midnight.
02:17	03:11	00:54	Noise Monitoring Operational	Deploying SSS while turning to line.
03:11	05:17	02:06	Noise Monitoring Operational	Noise Monitoring Seq 5a - All instruments.
05:17	08:50	03:33	Noise Monitoring Operational	Toolbox talk followed by recovery of the SSS, sparker and AMARs B & D.
08:50	10:48	01:58	Noise Monitoring Operational	Toolbox talk followed by redeployment of the AMARs at locations C & E.
10:48	14:29	03:41	Noise Monitoring Operational	Verifying locations of the AMARs at location A, C & E.

Summary of Activities

Begin	End	Duration	Type	Description
14:29	15:29	01:00	Noise Monitoring Operational	Turning to line.
15:29	16:29	01:00	Noise Monitoring Operational	Noise Monitoring Seq 0b - No sensors.
16:29	16:53	00:24	Noise Monitoring Operational	Line turn.
16:53	18:03	01:10	Noise Monitoring Operational	Noise Monitoring Seq 1b - MBES sensor.
18:03	18:15	00:12	Noise Monitoring Operational	Line turn.
18:15	19:23	01:08	Noise Monitoring Operational	Noise Monitoring Seq 2b - SBP.
19:23	19:46	00:23	Noise Monitoring Operational	Deploying SSS while turning to line.
19:46	21:07	01:21	Noise Monitoring Operational	Noise Monitoring Seq 4b - SSS.
21:07	22:20	01:13	Noise Monitoring Operational	Toolbox talk, followed by deployment of the sparker and MMO watch.
22:20	24:00	01:40	Noise Monitoring Operational	Noise Monitoring Seq 3b - Sparker; continued over midnight.

Time Summary

Activity	Today	/	To Date	Progress
Noise Monitoring Mob	0:00	/	36:35	1.24%
Noise Monitoring Transit	0:00	/	42:20	1.43%
Noise Monitoring Operational	24:00	/	72:35	2.45%
Infill - 2D UHRS	0:00	/	0:48	0.03%
Ops - 2D UHRS	0:00	/	79:32	2.69%
General Mob	0:00	/	169:14	5.71%
Equipment Cal	0:00	/	44:04	1.49%
Transit to/from Site	0:00	/	175:10	5.91%
Port Call	0:00	/	68:30	2.31%
W/S in Port	0:00	/	223:29	7.55%
W/S at Sea	0:00	/	642:55	21.71%
Weather - Mob	0:00	/	34:00	1.15%
Ops - Equipment Dep/Rec	0:00	/	23:59	0.81%
Transit between locations	0:00	/	10:54	0.37%
Ops - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	292:53	9.89%
Ops - Geophysical	0:00	/	696:48	23.52%
Infill - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	4:21	0.15%
Infill - MBES, SSS, SBP, MAG	0:00	/	118:26	4.00%
Infill - due to pycnocline	0:00	/	28:02	0.95%
Line turn - due to pycnocline	0:00	/	11:48	0.40%
Ops - Line Turn 2D UHRS	0:00	/	45:15	1.53%
Line Turn - MBES, SSS, SBP, MAG	0:00	/	49:07	1.66%
Ops - Extended Line Turn	0:00	/	31:03	1.05%
Downtime - Survey	0:00	/	29:22	0.99%
Standby - Other	0:00	/	14:26	0.49%
Standby - Fishing	0:00	/	16:24	0.55%
Total	24:00	/	2962:00	

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Noise monitoring survey	LS	4.0	1.0	3.3	Days	82.5%
Block Y Geophysical mainlines	LS	342.0	0.0	0.0	km	0.0%
Block V Geophysical mainlines	LS	380.0	0.0	0.0	km	0.0%
Block U Geophysical mainlines	LS	342.0	0.0	38.0	km	11.1%
Block T Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Block S Geophysical mainlines	LS	340.0	0.0	340.0	km	100.0%
Block R Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Block Q Geophysical mainlines	LS	365.0	0.0	365.0	km	100.0%
Block P Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block N Geophysical mainlines	LS	356.0	0.0	356.0	km	100.0%
Block M Geophysical mainlines	LS	384.0	0.0	384.0	km	100.0%
Block K Geophysical mainlines	LS	342.0	0.0	342.0	km	100.0%
Block J Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block H Geophysical mainlines	LS	324.0	0.0	324.0	km	100.0%
Block G Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block F Geophysical mainlines	LS	338.0	0.0	338.0	km	100.0%
Block Y 2D UHRs and Geophysical mainlines	LS	152.0	0.0	152.2	km	100.1%
Block V 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block U 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block T 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block S 2D UHRs and Geophysical mainlines	LS	113.0	0.0	113.0	km	100.0%
Block R 2D UHRs and Geophysical mainlines	LS	111.0	0.0	111.0	km	100.0%
Block Q 2D UHRs and Geophysical mainlines	LS	147.0	0.0	147.0	km	100.0%
Block P 2D UHRs and Geophysical mainlines	LS	109.0	0.0	109.0	km	100.0%
Block N 2D UHRs and Geophysical mainlines	LS	142.0	0.0	142.0	km	100.0%
Block M 2D UHRs and Geophysical mainlines	LS	105.0	0.0	105.0	km	100.0%
Block K 2D UHRs and Geophysical mainlines	LS	137.0	0.0	137.0	km	100.0%
Block J 2D UHRs and Geophysical mainlines	LS	101.0	0.0	101.0	km	100.0%
Block H 2D UHRs and Geophysical mainlines	LS	129.0	0.0	129.0	km	100.0%
Block G 2D UHRs and Geophysical mainlines	LS	95.0	0.0	95.0	km	100.0%
Block F 2D UHRs and Geophysical mainlines	LS	124.0	0.0	124.0	km	100.0%
Grab samples	LS	150.0	0.0	0.0	N°	0.0%
Block X 2D UHRs mainlines	LS	588.0	0.0	588.0	km	100.0%
Block C 2D UHRs and Geophysical mainlines	LS	134.0	0.0	134.0	km	100.0%
Block D 2D UHRs and Geophysical mainlines	LS	126.0	0.0	126.0	km	100.0%
Block E 2D UHRs and Geophysical mainlines	LS	115.0	0.0	115.0	km	100.0%
UHRS and Geophysical Survey - Infill	LS	63.0	0.0	93.1	km	147.8%
Block C Geophysical mainlines	LS	397.0	0.0	397.3	km	100.1%
Block D Geophysical mainlines	LS	326.0	0.0	326.0	km	100.0%
Block E Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Geophysical Survey - Infill	LS	600.0	0.0	841.5	km	140.3%
Infill - due to pycnocline	LS	160.0	0.0	134.4	km	84.0%

Personnel Status

	Yesterday	Arrived	Departed	Onboard
Project crew	10	0	0	10
Client representative	2	0	0	2

Personnel Status

	Yesterday	Arrived	Departed	Onboard
Marine crew	13	0	0	13
FLO	1	0	0	1
Noise Monitoring Personnel	2	0	0	2
Total	28	0	0	28

Weather and Sea State Status

Weather and Sea State	Unit	06:00	12:00	18:00	24:00	Comments
Wind Direction	Coords	SE	E	E	E	
Wind Speed	Beaufort	5	5	4	5	
Sig Wave Height	m	1.7	1.9	1.6	1.5	

Weather Forecast

A high over Scandinavia maintains a ridge SW across the North Sea, stopping the E progress of a frontal trough. The trough stalls over the W North Sea and fills tonight, as a col develops over the North Sea. The col is squeezed over the S North Sea tomorrow, as frontal troughs move E across the Northern Isles. Tomorrow night/Tuesday morning the col is absorbed by a ridge broadening NE across the UK/North Sea.

Liquids Status

Item	Amount at start	Added today	Used Today	Amount at End	Used to Date	Unit
Fuel	117.80	0.00	2.00	115.80	238.20	m³
Water	92.00	0.00	4.00	88.00	571.00	m³
Lube oil	940.00	0.00	0.00	940.00	990.00	L

Other Comments

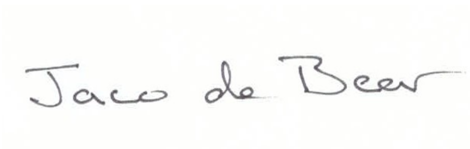
Planned work for the next 24 hours

Commence with the geophysical survey upon completion of the noise trials.

Client Representative Comments

Party Chief Comments

Fugro Representative



Jaco de Beer
Fugro Pioneer Party Chief

20/09/2021

Client Representative

Morgan Hannah
Energinet Client Representative

20/09/2021

DAILY PROGRESS REPORT

PIO/Energinet DK Energy Islands
Geophysical Survey WPA

ENERGINET

Fugro Pioneer

Project No.:	190532	**Report No.:**	125	**Date:**	20/09/2021
Client:	Energinet			**Timezone:**	UTC+02:00
Location:	Energinet Energy Island, Lot 2.				

Quality, Health, Safety and Environment

Safety Information	Today	/	To Date
Quality Related Incident	0	/	4
Security Incident	0	/	0
Environmental Incident	0	/	0
Health and Safety Incident	0	/	0
Vessel Led Kick of Meeting (KOM)	0	/	5
Two-Part HIRA	0	/	0
Toolbox TBT (led by others)	8	/	319
Sound bite training	0	/	29
Cross Departmental Tours	0	/	18
Permit to Work	0	/	14
Vessel Drills	0	/	30
Toolbox Talk (TBT)	0	/	20
Safety Meetings	0	/	9
Audits / Inspections	0	/	12
Inductions	0	/	25
Total Persons Onboard	28		
HOC Cards	1	/	293
Total Exposure Hours	336	/	40538
Near Miss	0	/	0
Daily HOD Meetings	1	/	120

HSE Comments

1x HOC

- HOC_21.532 - Unsafe Act - Member not following working at height procedures - 20210920

Summary of Activities

Begin	End	Duration	Type	Description
00:00	00:18	00:18	Noise Monitoring Operational	Noise Monitoring Seq 3b - Sparker; continued over midnight.
00:18	01:15	00:57	Noise Monitoring Operational	Toolbox talk, followed by deployment of the SSS. Turning to line.
01:15	02:50	01:35	Noise Monitoring Operational	Noise Monitoring Seq 5b - All sensors.
02:50	08:20	05:30	Noise Monitoring Operational	Toolbox talk, followed by recovery of the SSS, sparker and AMARs. Noise Monitoring Tests completed.
08:20	09:50	01:30	Transit to/from Site	Transit to the start of the geophysical site.
09:50	10:35	00:45	Ops - Equipment Dep/Rec	Toolbox talk, deployment of the SSS and SVP.
10:35	10:40	00:05	Line Turn - MBES, SSS, SBP, MAG	Turning to line.
10:40	15:23	04:43	Ops - Geophysical	Survey line EAU1234P01; Hdg 171°

Summary of Activities

Begin	End	Duration	Type	Description
15:23	15:34	00:11	Ops - Geophysical	Line turn.
15:34	20:11	04:37	Ops - Geophysical	Survey line EAU1235P01: Hdg 351°
20:11	21:00	00:49	Ops - Extended Line Turn	Line turn; Changing SSS.
21:00	21:45	00:45	Downtime - Survey	Fault finding absent magnetometer data.
21:45	23:05	01:20	Downtime - Survey	Winch cable caught between the sheave block drum and pillar. Efforts to remove it.
23:05	23:26	00:21	Line Turn - MBES, SSS, SBP, MAG	Turning to line.
23:26	24:00	00:34	Ops - Geophysical	Survey line EAU1236P01; Hdg: 171°

Time Summary

Activity	Today	/	To Date	Progress
Noise Monitoring Mob	0:00	/	36:35	1.23%
Noise Monitoring Transit	0:00	/	42:20	1.42%
Noise Monitoring Operational	8:20	/	80:55	2.71%
Infill - 2D UHRS	0:00	/	0:48	0.03%
Ops - 2D UHRS	0:00	/	79:32	2.66%
General Mob	0:00	/	169:14	5.67%
Equipment Cal	0:00	/	44:04	1.48%
Transit to/from Site	1:30	/	176:40	5.92%
Port Call	0:00	/	68:30	2.29%
W/S in Port	0:00	/	223:29	7.48%
W/S at Sea	0:00	/	642:55	21.53%
Weather - Mob	0:00	/	34:00	1.14%
Ops - Equipment Dep/Rec	0:45	/	24:44	0.83%
Transit between locations	0:00	/	10:54	0.37%
Ops - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	292:53	9.81%
Ops - Geophysical	10:05	/	706:53	23.67%
Infill - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	4:21	0.15%
Infill - MBES, SSS, SBP, MAG	0:00	/	118:26	3.97%
Infill - due to pycnocline	0:00	/	28:02	0.94%
Line turn - due to pycnocline	0:00	/	11:48	0.40%
Ops - Line Turn 2D UHRS	0:00	/	45:15	1.52%
Line Turn - MBES, SSS, SBP, MAG	0:26	/	49:33	1.66%
Ops - Extended Line Turn	0:49	/	31:52	1.07%
Downtime - Survey	2:05	/	31:27	1.05%
Standby - Other	0:00	/	14:26	0.48%
Standby - Fishing	0:00	/	16:24	0.55%
Total	24:00	/	2986:00	

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Noise monitoring survey	LS	4.0	0.3	3.6	Days	90.0%
Block Y Geophysical mainlines	LS	342.0	0.0	0.0	km	0.0%
Block V Geophysical mainlines	LS	380.0	0.0	0.0	km	0.0%
Block U Geophysical mainlines	LS	342.0	81.5	119.5	km	34.9%
Block T Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block S Geophysical mainlines	LS	340.0	0.0	340.0	km	100.0%
Block R Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Block Q Geophysical mainlines	LS	365.0	0.0	365.0	km	100.0%
Block P Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block N Geophysical mainlines	LS	356.0	0.0	356.0	km	100.0%
Block M Geophysical mainlines	LS	384.0	0.0	384.0	km	100.0%
Block K Geophysical mainlines	LS	342.0	0.0	342.0	km	100.0%
Block J Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block H Geophysical mainlines	LS	324.0	0.0	324.0	km	100.0%
Block G Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block F Geophysical mainlines	LS	338.0	0.0	338.0	km	100.0%
Block Y 2D UHRs and Geophysical mainlines	LS	152.0	0.0	152.2	km	100.1%
Block V 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block U 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block T 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block S 2D UHRs and Geophysical mainlines	LS	113.0	0.0	113.0	km	100.0%
Block R 2D UHRs and Geophysical mainlines	LS	111.0	0.0	111.0	km	100.0%
Block Q 2D UHRs and Geophysical mainlines	LS	147.0	0.0	147.0	km	100.0%
Block P 2D UHRs and Geophysical mainlines	LS	109.0	0.0	109.0	km	100.0%
Block N 2D UHRs and Geophysical mainlines	LS	142.0	0.0	142.0	km	100.0%
Block M 2D UHRs and Geophysical mainlines	LS	105.0	0.0	105.0	km	100.0%
Block K 2D UHRs and Geophysical mainlines	LS	137.0	0.0	137.0	km	100.0%
Block J 2D UHRs and Geophysical mainlines	LS	101.0	0.0	101.0	km	100.0%
Block H 2D UHRs and Geophysical mainlines	LS	129.0	0.0	129.0	km	100.0%
Block G 2D UHRs and Geophysical mainlines	LS	95.0	0.0	95.0	km	100.0%
Block F 2D UHRs and Geophysical mainlines	LS	124.0	0.0	124.0	km	100.0%
Grab samples	LS	150.0	0.0	0.0	N°	0.0%
Block X 2D UHRs mainlines	LS	588.0	0.0	588.0	km	100.0%
Block C 2D UHRs and Geophysical mainlines	LS	134.0	0.0	134.0	km	100.0%
Block D 2D UHRs and Geophysical mainlines	LS	126.0	0.0	126.0	km	100.0%
Block E 2D UHRs and Geophysical mainlines	LS	115.0	0.0	115.0	km	100.0%
UHRS and Geophysical Survey - Infill	LS	63.0	0.0	93.1	km	147.8%
Block C Geophysical mainlines	LS	397.0	0.0	397.3	km	100.1%
Block D Geophysical mainlines	LS	326.0	0.0	326.0	km	100.0%
Block E Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Geophysical Survey - Infill	LS	600.0	0.0	841.5	km	140.3%
Infill - due to pycnocline	LS	160.0	0.0	134.4	km	84.0%

Personnel Status

	Yesterday	Arrived	Departed	Onboard
Project crew	10	0	0	10
Client representative	2	0	0	2
Marine crew	13	0	0	13
FLO	1	0	0	1

Personnel Status

	Yesterday	Arrived	Departed	Onboard
Noise Monitoring Personnel	2	0	0	2
Total	28	0	0	28

Weather and Sea State Status

Weather and Sea State	Unit	06:00	12:00	18:00	24:00	Comments
Wind Direction	Coords	ESE	SE	S	S	
Wind Speed	Beaufort	4	3	3	4	
Sig Wave Height	m	1.2	0.9	0.8	0.8	

Weather Forecast

This morning a col develops over the North Sea, as frontal troughs move E across the Northern Isles. Tomorrow night/Tuesday morning the col is absorbed by a ridge broadening NE across the UK/North Sea, with an elongated high centre forming on the ridge over SW England tomorrow night/Wednesday morning.

Liquids Status

Item	Amount at start	Added today	Used Today	Amount at End	Used to Date	Unit
Fuel	115.80	0.00	1.70	114.10	239.90	m³
Water	88.00	0.00	4.00	84.00	575.00	m³
Lube oil	940.00	0.00	0.00	940.00	990.00	L

Other Comments

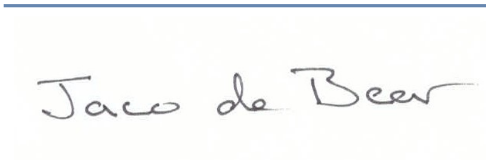
Planned work for the next 24 hours

Continue with the geophysical survey in Block U.

Client Representative Comments

Party Chief Comments

Fugro Representative



Jaco de Beer
Fugro Pioneer Party Chief
21/09/2021

Client Representative

Morgan Hannah
Energinet Client Representative
21/09/2021

DAILY PROGRESS REPORT

PIO/Energinet DK Energy Islands
Geophysical Survey WPA

ENERGINET

Fugro Pioneer

Project No.:	190532	**Report No.:**	126	**Date:**	21/09/2021
Client:	Energinet			**Timezone:**	UTC+02:00
Location:	Energinet Energy Island, Lot 2.				

Quality, Health, Safety and Environment

Safety Information	Today	/	To Date
Quality Related Incident	1	/	5
Security Incident	0	/	0
Environmental Incident	0	/	0
Health and Safety Incident	0	/	0
Vessel Led Kick of Meeting (KOM)	0	/	5
Two-Part HIRA	0	/	0
Toolbox TBT (led by others)	5	/	324
Sound bite training	0	/	29
Cross Departmental Tours	0	/	18
Permit to Work	0	/	14
Vessel Drills	0	/	30
Toolbox Talk (TBT)	0	/	20
Safety Meetings	0	/	9
Audits / Inspections	0	/	12
Inductions	0	/	25
Total Persons Onboard	28		
HOC Cards	0	/	293
Total Exposure Hours	336	/	40874
Near Miss	0	/	0
Daily HOD Meetings	1	/	121

HSE Comments

1x Quality Incident reported
- Defective SSS selected for data acquisition.

Summary of Activities

Begin	End	Duration	Type	Description
00:00	01:25	01:25	Ops - Geophysical	Continue the survey of line EAU1236P01; Hdg: 171°
01:25	03:10	01:45	Downtime - Survey	Lost connection to the SSS - defective winch cable. SSS swaped to the backup winch.
03:10	06:01	02:51	Ops - Geophysical	Continue the survey of EAU1236P02; Hdg: 171°
06:01	06:20	00:19	Line Turn - MBES, SSS, SBP, MAG	Line turn.
06:20	11:03	04:43	Ops - Geophysical	Survey line EAU1239P01; Hdg: 351°
11:03	12:02	00:59	Downtime - Survey	Toolbox talk - Recovery & deployment of the SSS. Swaped back to primary winch.
12:02	12:27	00:25	Line Turn - MBES, SSS, SBP, MAG	Line turn.
12:27	17:04	04:37	Ops - Geophysical	Survey line EAU1238P01; Hdg: 171°

DOME

Summary of Activities

Begin	End	Duration	Type	Description
17:04	17:24	00:20	Infill - due to pycnocline	Survey Infill EAT1228J01 for pycnocline.
17:24	17:52	00:28	Infill - due to pycnocline	Survey infill EAT1223J01 for pycnocline.
17:52	18:16	00:24	Infill - due to pycnocline	Survey infill EAT1230J01 for pycnocline.
18:16	18:29	00:13	Infill - MBES, SSS, SBP, MAG	Survey infill EAT2229J03 for poor magnetometer data.
18:29	19:00	00:31	Standby - Fishing	Survey infill EAT2229J04 for fishing gear.
19:00	19:32	00:32	Infill - MBES, SSS, SBP, MAG	Survey infill EAT2221J01 for poor MBES data.
19:32	20:02	00:30	Infill - MBES, SSS, SBP, MAG	Survey infill EAT2225J04 for poor MBES data.
20:02	20:30	00:28	Infill - due to pycnocline	Survey infill EAT1228J03 for pycnocline.
20:30	20:55	00:25	Infill - due to pycnocline	Surveu infill EAT1227J01 for pycnocline.
20:55	21:16	00:21	Infill - due to pycnocline	Survey infill EAT1228J04 for pycnocline.
21:16	21:44	00:28	Infill - due to pycnocline	Survey infill EAT1230J02 for pycnocline.
21:44	21:59	00:15	Infill - due to pycnocline	Survey infill EAT1231J02 for pycnocline.
21:59	22:24	00:25	Infill - due to pycnocline	Survey infill EAT2229J01 for Pycnocline.
22:24	22:45	00:21	Infill - due to pycnocline	Survey infill EAT1228J05 for pycnocline.
22:45	23:05	00:20	Ops - Equipment Dep/Rec	Recover all survey instruments.
23:05	24:00	00:55	Noise Monitoring Transit	Transit to Esbjerg to demobilise the noise monitoring equipment.

Time Summary

Activity	Today	/	To Date	Progress
Noise Monitoring Mob	0:00	/	36:35	1.22%
Noise Monitoring Transit	0:55	/	43:15	1.44%
Noise Monitoring Operational	0:00	/	80:55	2.69%
Infill - 2D UHRS	0:00	/	0:48	0.03%
Ops - 2D UHRS	0:00	/	79:32	2.64%
General Mob	0:00	/	169:14	5.62%
Equipment Cal	0:00	/	44:04	1.46%
Transit to/from Site	0:00	/	176:40	5.87%
Port Call	0:00	/	68:30	2.28%
W/S in Port	0:00	/	223:29	7.42%
W/S at Sea	0:00	/	642:55	21.36%
Weather - Mob	0:00	/	34:00	1.13%
Ops - Equipment Dep/Rec	0:20	/	25:04	0.83%
Transit between locations	0:00	/	10:54	0.36%
Ops - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	292:53	9.73%
Ops - Geophysical	13:36	/	720:29	23.94%
Infill - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	4:21	0.14%
Infill - MBES, SSS, SBP, MAG	1:15	/	119:41	3.98%
Infill - due to pycnocline	3:55	/	31:57	1.06%
Line turn - due to pycnocline	0:00	/	11:48	0.39%
Ops - Line Turn 2D UHRS	0:00	/	45:15	1.50%
Line Turn - MBES, SSS, SBP, MAG	0:44	/	50:17	1.67%
Ops - Extended Line Turn	0:00	/	31:52	1.06%
Downtime - Survey	2:44	/	34:11	1.14%
Standby - Other	0:00	/	14:26	0.48%
Standby - Fishing	0:31	/	16:55	0.56%
Total	24:00	/	3010:00	

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Noise monitoring survey	LS	4.0	0.0	3.6	Days	90.0%
Block Y Geophysical mainlines	LS	342.0	0.0	0.0	km	0.0%
Block V Geophysical mainlines	LS	380.0	0.0	0.0	km	0.0%
Block U Geophysical mainlines	LS	342.0	109.0	228.5	km	66.8%
Block T Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block S Geophysical mainlines	LS	340.0	0.0	340.0	km	100.0%
Block R Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Block Q Geophysical mainlines	LS	365.0	0.0	365.0	km	100.0%
Block P Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block N Geophysical mainlines	LS	356.0	0.0	356.0	km	100.0%
Block M Geophysical mainlines	LS	384.0	0.0	384.0	km	100.0%
Block K Geophysical mainlines	LS	342.0	0.0	342.0	km	100.0%
Block J Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block H Geophysical mainlines	LS	324.0	0.0	324.0	km	100.0%
Block G Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block F Geophysical mainlines	LS	338.0	0.0	338.0	km	100.0%
Block Y 2D UHRs and Geophysical mainlines	LS	152.0	0.0	152.2	km	100.1%
Block V 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block U 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block T 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block S 2D UHRs and Geophysical mainlines	LS	113.0	0.0	113.0	km	100.0%
Block R 2D UHRs and Geophysical mainlines	LS	111.0	0.0	111.0	km	100.0%
Block Q 2D UHRs and Geophysical mainlines	LS	147.0	0.0	147.0	km	100.0%
Block P 2D UHRs and Geophysical mainlines	LS	109.0	0.0	109.0	km	100.0%
Block N 2D UHRs and Geophysical mainlines	LS	142.0	0.0	142.0	km	100.0%
Block M 2D UHRs and Geophysical mainlines	LS	105.0	0.0	105.0	km	100.0%
Block K 2D UHRs and Geophysical mainlines	LS	137.0	0.0	137.0	km	100.0%
Block J 2D UHRs and Geophysical mainlines	LS	101.0	0.0	101.0	km	100.0%
Block H 2D UHRs and Geophysical mainlines	LS	129.0	0.0	129.0	km	100.0%
Block G 2D UHRs and Geophysical mainlines	LS	95.0	0.0	95.0	km	100.0%
Block F 2D UHRs and Geophysical mainlines	LS	124.0	0.0	124.0	km	100.0%
Grab samples	LS	150.0	0.0	0.0	N°	0.0%
Block X 2D UHRs mainlines	LS	588.0	0.0	588.0	km	100.0%
Block C 2D UHRs and Geophysical mainlines	LS	134.0	0.0	134.0	km	100.0%
Block D 2D UHRs and Geophysical mainlines	LS	126.0	0.0	126.0	km	100.0%
Block E 2D UHRs and Geophysical mainlines	LS	115.0	0.0	115.0	km	100.0%
UHRS and Geophysical Survey - Infill	LS	63.0	0.0	93.1	km	147.8%
Block C Geophysical mainlines	LS	397.0	0.0	397.3	km	100.1%
Block D Geophysical mainlines	LS	326.0	0.0	326.0	km	100.0%
Block E Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Geophysical Survey - Infill	LS	600.0	13.4	854.9	km	142.5%
Infill - due to pycnocline	LS	160.0	0.0	134.4	km	84.0%

Personnel Status

	Yesterday	Arrived	Departed	Onboard
Project crew	10	0	0	10
Client representative	2	0	0	2
Marine crew	13	0	0	13
FLO	1	0	0	1
Noise Monitoring Personnel	2	0	0	2
Total	28	0	0	28

Weather and Sea State Status

Weather and Sea State	Unit	06:00	12:00	18:00	24:00	Comments
Wind Direction	Coords	W	NW	NW	SW	
Wind Speed	Beaufort	4	5	5	5	
Sig Wave Height	m	0.9	1.5	1.6	2.2	

Weather Forecast

A ridge broadens ENE across the UK/North Sea today, before it sinks S from the afternoon to lie over the English Channel and the Benelux as a frontal trough approaches from NW. The trough crosses Scotland on Wednesday morning, fragmenting as it drifts SE over the N North Sea through the afternoon. Into Thursday a low develops on the front over the N North Sea.

Liquids Status

Item	Amount at start	Added today	Used Today	Amount at End	Used to Date	Unit
Fuel	114.10	0.00	1.70	112.40	241.60	m³
Water	84.00	0.00	3.00	81.00	578.00	m³
Lube oil	940.00	0.00	70.00	870.00	1,060.00	L

Other Comments

Planned work for the next 24 hours

Pioneer will be alongside in Esbjerg, waiting on weather.

Client Representative Comments

Party Chief Comments

Fugro Representative

Jaco de Beer

Jaco de Beer
Fugro Pioneer Party Chief

22/09/2021

Client Representative

Morgan Hannah

Morgan Hannah
Energinet Client Representative

22/09/2021

DAILY PROGRESS REPORT

PIO/Energinet DK Energy Islands
Geophysical Survey WPA

Fugro Pioneer

Project No.:	190532	**Report No.:**	127	**Date:**	22/09/2021
Client:	Energinet			**Timezone:**	UTC+02:00
Location:	Alongside Esbjerg.				

Quality, Health, Safety and Environment

Safety Information	Today	/	To Date
Quality Related Incident	0	/	5
Security Incident	0	/	0
Environmental Incident	0	/	0
Health and Safety Incident	0	/	0
Vessel Led Kick of Meeting (KOM)	0	/	5
Two-Part HIRA	0	/	0
Toolbox TBT (led by others)	0	/	324
Sound bite training	0	/	29
Cross Departmental Tours	1	/	19
Permit to Work	0	/	14
Vessel Drills	0	/	30
Toolbox Talk (TBT)	0	/	20
Safety Meetings	0	/	9
Audits / Inspections	0	/	12
Inductions	0	/	25
Total Persons Onboard	26		
HOC Cards	6	/	299
Total Exposure Hours	312	/	41186
Near Miss	0	/	0
Daily HOD Meetings	1	/	122

HSE Comments

Cross departmental tour
6x HOCs
- HOC_21.533 - Suggestion - Monkey Island dirty with soot will be cleaned – 20210922
- HOC_21.534 - Safe Act - COSHH register in good order – 20210922
- HOC_21.535 - Unsafe Condition - GPS cable laid incorrectly – 20210922
- HOC_21.536 - Unsafe Condition - Paint store door locking mechanism fixed – 20210922
- HOC_21.536 - Unsafe Condition - Gym equipment incorrectly stored – 20210922
- HOC_21.536 - Unsafe Condition - Laptop left on the floor during transit – 20210922

Summary of Activities

Begin	End	Duration	Type	Description
00:00	10:30	10:30	Noise Monitoring Transit	Transit to Esbjerg for demobilisation of the Noise Monitoring equipment.
10:30	24:00	13:30	Noise Monitoring DeMob	Demobilising Noise Monitoring equipment. 2x JASCO engineers signed off.

Time Summary

Activity	Today	/	To Date	Progress
Noise Monitoring DeMob	13:30	/	13:30	0.44%
Noise Monitoring Mob	0:00	/	36:35	1.21%
Noise Monitoring Transit	10:30	/	53:45	1.77%
Noise Monitoring Operational	0:00	/	80:55	2.67%
Infill - 2D UHRS	0:00	/	0:48	0.03%
Ops - 2D UHRS	0:00	/	79:32	2.62%
General Mob	0:00	/	169:14	5.58%
Equipment Cal	0:00	/	44:04	1.45%
Transit to/from Site	0:00	/	176:40	5.82%
Port Call	0:00	/	68:30	2.26%
W/S in Port	0:00	/	223:29	7.37%
W/S at Sea	0:00	/	642:55	21.19%
Weather - Mob	0:00	/	34:00	1.12%
Ops - Equipment Dep/Rec	0:00	/	25:04	0.83%
Transit between locations	0:00	/	10:54	0.36%
Ops - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	292:53	9.65%
Ops - Geophysical	0:00	/	720:29	23.75%
Infill - 2D UHRS MBES, SSS, SBP, MAG	0:00	/	4:21	0.14%
Infill - MBES, SSS, SBP, MAG	0:00	/	119:41	3.94%
Infill - due to pycnocline	0:00	/	31:57	1.05%
Line turn - due to pycnocline	0:00	/	11:48	0.39%
Ops - Line Turn 2D UHRS	0:00	/	45:15	1.49%
Line Turn - MBES, SSS, SBP, MAG	0:00	/	50:17	1.66%
Ops - Extended Line Turn	0:00	/	31:52	1.05%
Downtime - Survey	0:00	/	34:11	1.13%
Standby - Other	0:00	/	14:26	0.48%
Standby - Fishing	0:00	/	16:55	0.56%
Total	24:00	/	3034:00	

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Noise monitoring survey	LS	4.0	0.5	4.1	Days	102.5%
Block Y Geophysical mainlines	LS	342.0	0.0	0.0	km	0.0%
Block V Geophysical mainlines	LS	380.0	0.0	0.0	km	0.0%
Block U Geophysical mainlines	LS	342.0	0.0	228.5	km	66.8%
Block T Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block S Geophysical mainlines	LS	340.0	0.0	340.0	km	100.0%
Block R Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Block Q Geophysical mainlines	LS	365.0	0.0	365.0	km	100.0%
Block P Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block N Geophysical mainlines	LS	356.0	0.0	356.0	km	100.0%
Block M Geophysical mainlines	LS	384.0	0.0	384.0	km	100.0%
Block K Geophysical mainlines	LS	342.0	0.0	342.0	km	100.0%
Block J Geophysical mainlines	LS	368.0	0.0	368.0	km	100.0%
Block H Geophysical mainlines	LS	324.0	0.0	324.0	km	100.0%
Block G Geophysical mainlines	LS	379.0	0.0	379.0	km	100.0%
Block F Geophysical mainlines	LS	338.0	0.0	338.0	km	100.0%

Production Summary

Product	DR/ LS	Estimated	Produced	To Date	Unit	Progress
Block Y 2D UHRs and Geophysical mainlines	LS	152.0	0.0	152.2	km	100.1%
Block V 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block U 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block T 2D UHRs and Geophysical mainlines	LS	114.0	0.0	114.0	km	100.0%
Block S 2D UHRs and Geophysical mainlines	LS	113.0	0.0	113.0	km	100.0%
Block R 2D UHRs and Geophysical mainlines	LS	111.0	0.0	111.0	km	100.0%
Block Q 2D UHRs and Geophysical mainlines	LS	147.0	0.0	147.0	km	100.0%
Block P 2D UHRs and Geophysical mainlines	LS	109.0	0.0	109.0	km	100.0%
Block N 2D UHRs and Geophysical mainlines	LS	142.0	0.0	142.0	km	100.0%
Block M 2D UHRs and Geophysical mainlines	LS	105.0	0.0	105.0	km	100.0%
Block K 2D UHRs and Geophysical mainlines	LS	137.0	0.0	137.0	km	100.0%
Block J 2D UHRs and Geophysical mainlines	LS	101.0	0.0	101.0	km	100.0%
Block H 2D UHRs and Geophysical mainlines	LS	129.0	0.0	129.0	km	100.0%
Block G 2D UHRs and Geophysical mainlines	LS	95.0	0.0	95.0	km	100.0%
Block F 2D UHRs and Geophysical mainlines	LS	124.0	0.0	124.0	km	100.0%
Grab samples	LS	150.0	0.0	0.0	N°	0.0%
Block X 2D UHRs mainlines	LS	588.0	0.0	588.0	km	100.0%
Block C 2D UHRs and Geophysical mainlines	LS	134.0	0.0	134.0	km	100.0%
Block D 2D UHRs and Geophysical mainlines	LS	126.0	0.0	126.0	km	100.0%
Block E 2D UHRs and Geophysical mainlines	LS	115.0	0.0	115.0	km	100.0%
UHRS and Geophysical Survey - Infill	LS	63.0	0.0	93.1	km	147.8%
Block C Geophysical mainlines	LS	397.0	0.0	397.3	km	100.1%
Block D Geophysical mainlines	LS	326.0	0.0	326.0	km	100.0%
Block E Geophysical mainlines	LS	370.0	0.0	370.0	km	100.0%
Geophysical Survey - Infill	LS	600.0	0.0	854.9	km	142.5%
Infill - due to pycnocline	LS	160.0	0.0	134.4	km	84.0%

Personnel Status

	Yesterday	Arrived	Departed	Onboard
Project crew	10	0	0	10
Client representative	2	0	0	2
Marine crew	13	0	0	13
FLO	1	0	0	1
Noise Monitoring Personnel	2	0	2	0
Total	28	0	2	26

Weather and Sea State Status

Weather and Sea State	Unit	06:00	12:00	18:00	24:00	Comments
Wind Direction	Coords	W	SW	WSW	WSW	
Wind Speed	Beaufort	5	4	3	3	
Sig Wave Height	m	1.7	-	-	-	

Weather Forecast

Weather Forecast

A ridge extending ENE over the S North Sea declines as a fragmenting trough drifts SE over the central North Sea this evening, followed by another trough moving ESE over the far N North Sea overnight/early tomorrow. Tomorrow the trough clears E with a transient ridge building NNE astern. The ridge declines early Friday as another trough moves over the Northern Isles. A broad ridge builds N over England by Friday evening.

Liquids Status

Item	Amount at start	Added today	Used Today	Amount at End	Used to Date	Unit
Fuel	112.40	0.00	2.40	110.00	244.00	m³
Water	81.00	0.00	3.00	78.00	581.00	m³
Lube oil	870.00	0.00	70.00	800.00	1,130.00	L

Other Comments

Planned work for the next 24 hours

Pioneer will be alongside Esbjerg, waiting on weather.

Client Representative Comments

Party Chief Comments

Fugro Representative

Jaco de Beer

Jaco de Beer
Fugro Pioneer Party Chief

23/09/2021

Client Representative

Morgan Hannah

Morgan Hannah
Energinet Client Representative

23/09/2021

Appendix D

Fugro Pioneer Vessel

Specification

FUGRO
M.V. FUGRO PIONEER

M.V. Fugro Pioneer has been built to the highest standards demanded of a modern internationally operating multi-purpose survey vessel.

The diesel electric propulsion, specially designed hull, resilient engine mounts and rudder propellers maximize station keeping and navigational control while ensuring acoustically quiet running at survey speeds.

Designed with consideration for safety and environment, Fugro Pioneer is a compact flexible platform supporting a wide range of offshore services with a typical operational profile of geophysical, geotechnical survey operations up to 1000m WD.

It's limited 3m draft adds to its capabilities to operate in shallow water nearshore. The vessel can easily be configured to support light ROV and environmental operations. The 53 metre-long vessel is prepared for dynamic positioning and equipped with state-of-the-art survey equipment.

State of the Art Kongsberg Dual Head Dual Ping Multibeam in retractable moonpool system.

Limited draft makes it specifically suitable for survey nearshore.

M.V. FUGRO PIONEER

Technical specifications

General info

Name	Fugro Pioneer
Classification society	DNVGL
Flag state / Port	Bahamas Maritime Authority / Nassau
Build(er)	September 2014 – Damen Shipyards Galati
IMO / Cal sign	9701645 / C6BH3
Official Number	7000674

Dimensions

LOA.	53.7m
Beam	12.5m
Draught (summer) max.	3.1m + 0.26m blister
Tonnage	1322T
Deck area aft	250m^2
Deck strength	5T / m^2
Deck load	81,6T

Accommodation

Cabins	30+4 Bunks / 10x Single cabins, 10x Double cabins
Crew (Typical)	11x Marine Crew, 20x Survey Crew
Recreational	1x Dayroom, 1x Gym
Work Offices	2x Survey, 1x Meeting room

Machinery

Propulsion	2x Azimuth thrusters (electric)
Bow thrusters	1x Tunnel thrusters (electric)
Cruising speed	10 kn
Survey speed	Variable as required
Maximum speed	11.2 kn

Electrical power

Diesel generator sets	4x 372kW
UPS supply survey	1x 30VA, 220vac

Capacities

Fuel capacity	305 m^3
Fuel consumption (FOC t/day)	Survey 3t / Stationary (DP) 4.2t / Transit 6t
Potable water capacity	115 m^3
Water making	6 m^3/d

Control and navigation

DP System	Imtech DP-0
Radar	Hagenuk Bridgemaster FT CAT1/2 S-band and X-band
Electronic chart	Imtech ECDIS (Single)
DGPS	1x Koden KGPGZO / 2x Fugro Starpack
Magnetic compass	Sperry Jupiter

Deck Machinery

Deck crane aft	Palfinger PK65002 MD
Storage crane forward	Palfinger PK15000 MC
Hydraulics Ring Main system	300bar / 200ltr.
A-frame aft (geophysical)	2x 3/6T SWL
A-frame side (geotechnical)	1x 9T SWL
CTD winch/davit	1x 300 kg / 1000m (environmental sampling)
Tugger winch aft deck	4x 3T SWL
Moonpool	Rectangular 1630x883mm (free space)

Communications

GMDSS	Motorola - 3x VHF Handheld
Vsat	2x Seatel 5009 Ku-band
Iridium	Iridium Openport (Fall back)
UHF / VHF Radios (Operational coms)	Motorola - 2x VHF Handheld / 3x UHF Mobile / 9x UHF Portable
CCTV Camera system	Orlaco
TVRO	Intellian t40W

Safety

MOB boat	RIB
Life rafts	6 x 20 persons
Survival suits & Life jackets	44 pcs
Lifeline Pulley System	Yes
Personal Locator Beacons (PLB)	SeaMarshall

Survey equipment

DGPS Positioning	Fugro Starfix Starpacks
Navigation package	Fugro Starfix Suite
Acoustic positioning	Kongsberg HiPap 501 incl Cymbal
Motion Reference Unit	Hydrins + Octans
Echosounder	Simrad EA400
Draft monitoring	2x Rosemount Pressure Sensors
Multibeam Echosounder	Kongsberg Maritime EM 2040 (Dual head/ Dual ping)
Side Scan Sonar	Edgetech 4200 (100/600)
Sub Bottom Profiler	Hullmount Array/ Fugro Glog, Boomer, Sparker
Magnetometer	Geometrics G-882
Geophysical tow winch	2x EMCE (3.5Te/ 4000m/ Rochester)
Geotechnical hoisting winch	1x EMCE (9Te/ 1500m/ 19mm)
Seismic Compressor	Wärtsilä Water Systems Ltd Hamworthy 185E MK2
2D-Seismic gear	as required
Geotechnical sampling	as required
Environmental sampling	as required

Fugro N.V.
Veurse Achterweg 10
2264 SG, Leidschendam
The Netherlands
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Appendix E

Hazard Observation Cards

Table 8.4: Hazard Observation Card Register

Ref No.	Date	Exact location of observation	Positive Observation	Suggestion	Unsafe Act	Unsafe Condition	Description of Observation	Category
HOC_21.515	2021-09-10	Back deck				X	Working with safety glasses and face mask results in steaming-up glasses	Risk Awareness
HOC_21.516	2021-09-10	Back deck			X		During loading of container, Stevedore stood under the boom to the crane	Lifting & Rigging
HOC_21.517	2021-09-11	Back deck	X				Good and safe work procedure done for sparker Mob and testing when in port	Safety Culture
HOC_21.518	2021-09-12	Engine Room	X				Cross department safety tour of Engine Room compartments found no deficiencies. All in very good order	Safety Culture
HOC_21.519	2021-09-12	Thruster Room	X				The procedures for switching to emergency steering are clearly displayed and easy to understand next to emergency steering console	Safety Culture
HOC_21.520	2021-09-13	Back deck	X				Very detailed instruction + practical demonstration by TC of how to manufacture dyneema tow points	Safety Culture
HOC_21.521	2021-09-14	Back deck	X				Safe operations by all survey team and Bridge Staff for deployment of 3 x AMARs	Safety Culture
HOC_21.522	2021-09-14	Back deck			X		Chin strap to safety helmet was too slack and not tight under chin	Risk Awareness
HOC_21.523	2021-09-15	Back deck & Bridge	X				Excellent seamanship practices on the back deck by Marine & survey + excellent bridgemanship on the Bridge ensured all 3 x seabed AMARs were recovered in challenging conditions	Safety Culture
HOC_21.524	2021-09-15	Back deck				X	A faulty intermittent switch for the port capstan control of clockwise direction	Risk Awareness
HOC_21.525	2021-09-15	Back deck	X				Excellent teamwork by all for the safe recovery of three seabed acoustic sensors during poor weather	Safety Culture
HOC_21.526	2021-09-19	Wet Store				X	Extension cord blocking the vent flaps	Risk Awareness

Ref No.	Date	Exact location of observation	Positive Observation	Suggestion	Unsafe Act	Unsafe Condition	Description of Observation	Category
HOC_21.527	2021-09-19	Laundry			X		Not adhering to garbage segragation: a plastic boot cover was diposed of in the domestic waste.	Environmental (ISO 14001)
HOC_21.528	2021-09-19	A-frame				X	After use the PAMS system was left deployed, where it stayed until the following morning.	Safety Culture
HOC_21.529	2021-09-19	Back deck				X	The strobe light of a deployed buoy isn't flashing. It should be replaced at the earliest opportunity.	Job preparation
HOC_21.530	2021-09-19	Pioneer	X				Good teamwork between the bridge and survey during the recovery and deployment of the AMARs	Communication
HOC_21.531	2021-09-19	Public toilet			X		A team member left the pubilc toilet with wet hands, dripping in the alley way. It is a trip hazzard	Slips, Trips & Falls
HOC_21.532	2021-09-20	Emergency Escape Hatch			X		During operations the winch cable was caught in the block. A crew member was standing on the EM escape hatch on the edge of the bulwark trying to free the cable.	Risk Awareness
HOC_21.533	2021-09-21	Monkey island		X			The monkey island is dirty with soot.	Housekeeping
HOC_21.534	2021-09-21	Garbage Store	X				MSDS COSHH locker is in good order. All prosucts have a relevant sheet.	COSHH
HOC_21.535	2021-09-21	Bridge deck				X	GPS cable is exposed and incorrectly laid.	Housekeeping
HOC_21.536	2021-09-21	Paint store				X	The paint store door lock is broken.	Housekeeping
HOC_21.537	2021-09-21	Bridge deck				X	Dip bars left facing towards the walkway where passersby may potentially walk into them.	Risk Awareness
HOC_21.538	2021-09-21	Electrical Cabinet 511				X	Unsecured laptop left on the floor during transit.	Risk Awareness

Appendix F

QC Logs

Online Survey Log

Project No.:	F176286		Energinet	Day:	KB	VC	CC	MN	MB Transducer :	167
Project title:	Energinet_E_Islands_LOT2		FUGRO PIONEER	Night:	PD	MN	PD	PD		

Logging Time (UTC)			Line				KP		Weather			Nav				Edgetech 4200				MBES								
Date	Start	End	Task	Line Name	SPL File Name	Dir. (deg)	From	To	Beaufort (Scale)	Wind Dir. (deg)	Sig. Wave Height (m)	Heading	SOG	STW	Depth	SSS	Beacon	Cable Out	Range	MBES	SIS Count from	SIS Count to	Ping HZ	Coverage	SBP	MAG	SBES	Remark
UHR Verification NL																												
11/09/2021	08:26	08:27	test	Survey Line4	20210911-082648	353	#####	#####	4	208	0.0	21	0.0	-0.1	7.8			21										Top layer 100J - 1 s interval
11/09/2021	08:28	08:28	test	Survey Line4	20210911-082759	353	#####	#####	4	211	0.0	21	0.0	-0.1	7.8			129										Top layer 300J - 1 s interval
11/09/2021	08:28	08:28	test	Survey Line4	20210911-082824	353	#####	#####	5	203	0.0	21	0.0	-0.1	7.8			186										Medium layer 100J - 1 s interval
11/09/2021	08:28	08:36	test	Survey Line4	20210911-082848	6	0.0	1.0	5	212	0.0	21	0.0	-0.1	7.7			238										Medium layer 300J - 1 s interval
11/09/2021	08:42	08:44	test	Survey Line4	20210911-084222	5	#####	#####	4	205	0.0	21	0.0	0.0	7.6			6196318										Bottom layaer 100J - 1 s interval
11/09/2021	08:44	08:45	test	Survey Line4	20210911-084510	5	#####	#####	4	219	0.0	21	0.0	0.0	7.6			6196318										Bottom layaer 300J - 1 s interval
11/09/2021	09:20	09:38	test	Survey Line8	20210911-094547	20	0.2	0.2	5	205	0.0	20	0.0	-0.1	7.1	0.0	0.0	6198205	0.0	0	1		0	0	0	0	0	All layers 900J - 1s interval
11/09/2021	09:46	10:09	test	Survey Line8	20210911-094640	20	0.3	2.5	5	213	0.0	20	0.0	-0.1	7.1	0.0	0.0	6198313	0.0	0	2		0	0	0	0	0	endurance test
11/09/2021	20:22	20:29	test	Survey Line8	20210911-202200	20	-1.7	-1.7	4	250	0.0	21	0.0	-0.1	7.8	0.0	0.0	6196318	0.0	0	3		0	0	0	0	0	plots test
11/09/2021	21:02	21:05	test	Survey Line8	20210911-210159	20	-1.7	-1.7	5	238	0.0	21	0.0	-0.1	7.5	0.0	0.0	6196318	0.0	0	4		0	0	0	0	0	plots test
13/09/2021	21:36	21:43	R	EAR1199J01	20210913-213640	171	-0.2	0.7	3	335	1.3	171	4.8	3.0	47.2	Y	M02	215	75.0	Y	2957		8	100	Y	Y	Y	PYCL
13/09/2021	22:12	22:25	S	EAS1207J01	20210913-221238	171	-0.3	1.4	3	327	1.3	172	4.2	3.0	32.2	Y	M02	133	75.0	Y	2961		8	100	Y	Y	Y	PYCL
13/09/2021	22:47	22:55	Q	EAQ1188J02	20210913-224746	170	-0.6	0.4	3	329	1.2	172	4.6	3.7	36.0	Y	M02	156	75.0	Y	2963		8	100	Y	Y	Y	PYCL
13/09/2021	23:11	23:20	S	EAS1207J02	20210913-231055	171	-0.3	1.0	3	308	1.2	176	4.4	3.5	43.6	Y	M02	202	75.0	Y	2964		8	100	Y	Y	Y	PYCL
14/09/2021	00:26	00:35	R	EAR1204J04	20210914-002622	171	-0.5	0.8	3	330	1.3	176	4.5	3.1	37.8	Y	M02	169	75.0	Y	2965		8	100	Y	Y	Y	SSS infill - OFFTRACK
14/09/2021	00:53	00:59	S	EAS1214J03	20210914-005308	170	-0.3	0.6	3	338	1.2	173	4.4	2.9	39.4	Y	M02	162	75.0	Y	2966		8	100	Y	Y	Y	PYCL
14/09/2021	01:21	01:31	T	EAT1224J01	20210914-012140	351	-0.2	1.1	4	318	1.2	349	4.7	3.5	38.5	Y	M02	187	75.0	Y	2967		8	100	Y	Y	Y	PYCL
14/09/2021	01:41	01:49	T	EAT2225J01	20210914-014054	171	-0.1	1.1	4	342	1.2	172	4.8	3.0	38.2	Y	M02	165	75.0	Y	2968		8	100	Y	Y	Y	Infill due to fishing buoy EAT2225J05 is also covered with this line
14/09/2021	02:00	02:09	T	EAT1226J01	20210914-020051	350	-0.1	1.1	4	335	1.2	348	4.6	3.4	39.2	Y	M02	204	75.0	Y	2969		8	100	Y	Y	Y	PYCL
14/09/2021	02:14	02:24	T	EAT2225J02	20210914-021402	350	0.0	1.3	3	323	1.2	350	4.3	4.0	38.6	Y	M02	146	75.0	Y	2970		8	100	Y	Y	Y	PYCL - transit to D1 (AMOR location)
14/09/2021	05:58	06:12	test	Test	20210914-055820	0	0.0	0.0	3	338	1.0	2	0.1	0.0	32.4													
14/09/2021	06:27	06:40	noise trials	D1	20210914-062743	0	0.0	0.0	3	322	1.0	2	0.1	-0.1	32.4													
14/09/2021	07:13	07:23	noise trials	B1	20210914-071257	0	0.0	0.0	3	329	1.1	1	0.0	-0.1	33.4													
14/09/2021	07:54	08:10	noise trials	A1	20210914-075437	0	0.0	0.0	3	338	1.0	270	0.2	-0.1	34.3													
14/09/2021	08:37	08:47	noise trials	Scouting_Line	20210914-083658	81	-0.1	1.1	3	335	1.0	83	4.0	3.4	33.0	N	-	-	-	Y	2972		12	70	N	N	Y	Scouting line MBES
14/09/2021	09:55	10:11	noise trials	Scouting_Line_SSS	20210914-095511	261	-0.5	1.6	2	321	1.1	263	3.9	1.5	32.3			107										
14/09/2021	11:25	11:27		Survey Line1	20210914-112525	170	0.0	0.2	2	335	1.0	172	2.9	1.2	34.9			990										
14/09/2021	11:27	11:28		Survey Line1	20210914-112737	170	0.2	0.3	2	323	1.0	172	2.8	1.1	35.1			1127										
14/09/2021	12:18	12:47	noise trials	ENT0A01	20210914-121813	351	0.0	4.0	2	352	0.9	348	4.6	3.7	34.4	N				N					N	N	N	No sensors, 12:33 UTC at A station
14/09/2021	12:58	13:27	noise trials	ENT0A02	20210914-125828	171	0.0	4.0	2	327	1.0	172	4.5	2.6	34.4	N				N				0	N	N	N	No sensors, 13:13 UTC at A station
14/09/2021	14:05	14:34	noise trials	ENT1A01	20210914-140507	351	0.0	4.1	2	359	0.9	350	4.2	3.9	34.4	N				Y	2996		0	100	N	N	N	MBES, start pinging 13:57 UTC, 14:19 UTC at A station
14/09/2021	14:44	15:13	noise trials	ENT1A02	20210914-144414	171	0.0	4.0	2	2	1.0	170	4.5	2.6	34.4	N				Y	2997		0	100	N	N	N	MBES, start pinging 13:57 UTC stop pinging 15:14 UTC, 14:59 UTC at A station
14/09/2021	15:28	15:57	noise trials	ENT2A01	20210914-152754	351	0.0	4.1	2	24	0.9	352	4.7	3.0	34.4	N				N			0		Y	N	N	SBP, start pinging 15:14 UTC, 15:42 UTC at A station
14/09/2021	16:10	16:40	noise trials	ENT2A02	20210914-161027	171	0.0	4.0	2	7	1.0	167	5.4	2.6	34.4	N				N			0		Y	N	N	SBP, start pinging 15:14 UTC stop pinging 16:40 UTC, 16:25 UTC at A station
14/09/2021	17:22	17:53	noise trials	ENT4A01	20210914-172248	351	0.0	4.2	2	7	1.0	353	4.4	3.5	34.4	Y	M02	119	75.0	N			0	0	N	N	N	SSS, start pinging 16:58 UTC, Start USBL 16:59 stop 17:53 UTC, 17:38 UTC at A station
14/09/2021	18:10	18:41	noise trials	ENT4A02	20210914-181026	171	0.0	4.3	2	21	1.0	166	4.2	2.9	34.4	Y		8	75.0	N			0	0	N	N	N	SSS, start pinging 16:58 stop pinging 18:45 UTC, 18:26 UTC at A station
14/09/2021	21:06	21:45	noise trials	ENT3A01	20210914-210608	171	-0.8	4.1	4	72	1.0	166	5.0	2.1	34.4	N	0.0	719	75.0	N			0	0	N	N	N	SPK, start firing 20:12, full power firing 20:37, UTC stop : UTC, 21:28 at A station
14/09/2021	21:45	22:23	noise trials	ENT3AT1	20210914-214535	183	0.0	2.9	4	71	1.0	163	4.0	2.4	34.4	N	0.0	4201	75.0	N	1		0	0	N	N	N	SPK guild line
14/09/2021	22:23	22:58	noise trials	ENT3AP1	20210914-222352	81	-0.1	4.1	4	72	0.9	82	4.1	2.9	34.4	N	0.0	7114	75.0	N	2		0	0	N	N	N	SPK 3km line, 5km from station A
14/09/2021	22:58	23:51	noise trials	ENT3AT2	20210914-225815	171	-0.3	4.8	4	80	0.9	85	3.8	2.1	34.4	N	0.0	7896	75.0	N	3		0	0	N	N	N	SPK guild line
14/09/2021	23:51	00:27	noise trials	ENT3AP2	20210914-235138	261	-0.3	4.2	5	82	1.0	255	4.1	1.6	34.4	N	0.0	12653	75.0	N	4		0	0	N	N	N	SPK 3km line, 10km from station A
15/09/2021	00:29	01:03	noise trials	ENT3AT3	20210915-002906	250	0.1	4.2	5	82	1.0	246	4.0	2.3	34.4	N	0.0	12111	75.0	N	5		0	0	N	N	N	SPK guild line
15/09/2021	01:04	01:37	noise trials	ENT3AP3	20210915-010431	81	-0.2	4.2	4	91	1.1	82	4.1	2.4	34.4	N	0.0	12092	75.0	N	6		0	0	N	N	N	SPK 3km line, 10km from station A
15/09/2021	01:37	01:39	noise trials	ENT3AT4	20210915-013740	350	-0.3	-0.3	5	98	1.1	82	4.3	2.2	34.4	N	0.0	12579	75.0	N	7		0	0	N	N	N	SPK guild line
15/09/2021	01:39	02:20	noise trials	ENT3AT4	20210915-013914	350	-0.3	4.7	4	93	1.1	66	4.4	1.7	34.4	N	0.0	12642	75.0	N	8		0	0	N	N	N	SPK guild line-count
15/09/2021	02:21	02:53	noise trials	ENT3AP4	20210915-022111	261	-0.2	4.1	4	84	1.2	261	4.2	2.7	34.4	N	0.0	7971	75.0	N	9		0	0	N	N	N	SPK 3km line, 5km from station A
15/09/2021	02:53	03:22	noise trials	ENT3AT5	20210915-025323	3	0.0	2.9	4	97	1.2	264	4.3	2.5	34.4	N	0.0	7971	75.0	N	10		0	0	N	N	N	SPK guild line
15/09/2021	03:22	03:53	noise trials	ENT3A02	20210915-032230	351	-0.1	4.1	4	83	1.2	355	4.4	3.2	34.4	N	0.0	4178	75.0	N	11		0	0	N	N	N	03:38:40 control port
15/09/2021	03:59	04:34	noise trials	ENT3AT6	20210915-035853	25	0.2	0.0	4	92	1.2	13	3.1	1.7	34.8	N	0.0	533	75.0	N	12		0	0	N	N	N	3:55 marine SBES, 3:55 MBES, 3:57 survey SBES, 3:57 Innomar, 3:59 SSS/Sparker start
15/09/2021	04:35	05:06	noise trials	ENT5A01	20210915-043550	171	-0.1	4.2	4	70	1.2	163	4.8	3.3	32.3	N	0.0	108	75.0	N	13		0	0	N	N	N	ALL sensors on, SPK pass A 04:51, SSS pass A 04:52
15/09/2021	05:07	05:43	noise trials	ENT3AT7	20210915-050707	183	0.1	0.1	4	71	1.2	165	4.4	3.3	34.5	N	0.0	102	75.0	N	14		0	0	N	N	N	SPK guild line
15/09/2021	05:43	06:14	noise trials	ENT5A02	20210915-054327	351	-0.1	4.2	4	82	1.1	358	4.6	2.6	34.3	N	0.0	119	75.0	N	15		0	0	N	N	N	ALL sensors on, SPK pass A 5:59, SSS pass A 6:00
18/09/2021	06:31	06:32	AMAR Deploy	D1	20210918-063121	0	0.0	0.0	5	110	1.4	306	0.9	-0.1	32.1	N	0.0	6	75.0	N	16		0	0	N	N	N	
18/09/2021	07:05	07:06	AMAR Deploy	B1	20210918-070534	0	0.0	0.0	5	112	1.4	312	0.5	-0.1	33.2	N	0.0	7	75.0	N	17		0	0	N	N	N	
18/09/2021	07:36	07:38	AMAR Deploy	A1	20210918-073629	0	0.0	0.0	5	102	1.4	271	0.1	-0.1	34.1	N	0.0	7	75.0	N	18		0	0	N	N	N	
18/09/2021	09:19	09:31	Scouting BD Pos	Scouting_BD1	20210918-091856	81	-0.2	1.4	5	118	1.5	84	3.7	1.1	33.2	Y	M02	87	75	Y	2988		9.6	100	N	N	Y	BC to CRP SSS Y=0.7 Z=1.22
18/09/2021	09:44	09:57	Scouting BD Pos	Scouting_BD2	20210918-094436	261	-0.3	1.3	5	128	1.6	251	4.2	3.1	32.5	Y	M02	96	75	Y	2989		9.6	100	N	N	Y	
18/09/2021	11:09	11:42	noise trials	ENT0A01_01	20210918-110913	171	0.0	4.1	6	114	1.6	164	4.1	4.0	48.1	N	-	-	-	N	-	-	-	-	N	N	N	Test 0a. SOG: 4.0kn - sensors OFF
18/09/2021	11:57	12:27	noise trials	ENT0A02_01	20210918-115659	351	-0.2	4.0	3	130	1.7	359	4.6	1.3	46.8	N	-	-	-	N	-	-	-	-	N	N	N	Test 0a. SOG: 4.5kn - sensors OFF
18/09/2021	12:51	13:22	noise trials	ENT1A01_01	20210918-125126	171	-0.2	4.0	5	118	1.5	166	4.6	4.3	30.3	N	-	-	-	Y	2990	2991	9	100	N	N	N	Test 1a. SOG: 4.5kn - MBES ON only
18/09/2021	13:32	14:03	noise trials	ENT1A02_01	20210918-133253	351	-0.1	4.0	3	129	1.4	353	4.8	2.6	42.2	N	-	-	-	Y	2992	2993	9	100	N	N	N	Test 1a. SOG: 4.5kn - MBES ON only
18/09/2021	14:15	14:46	noise trials	ENT2A01_01	20210918-141456	171	-0.3	4.0	5	119	1.4	167	4.7	4.1	52.3	N	-	-	-	N	-	-	-	-	Y	N	N	Test 2a. SOG: 4.5kn - SBP ON only
18/09/2021	14:56	15:27	noise trials	ENT2A02_01	20210918-145620	351	-0.4	4.0	4	110	1.4	358	4.6	1.0	54.0	N	-	-	-	N	-	-	-	-	Y	N	N	Test 2a. SOG: 4.5kn - SBP ON only
18/09/2021	16:03	16:35	noise trials	ENT4A01_01	20210918-160303	171	-0.3	4.1	6	113	1.3	168	4.3	4.3	39.5	Y	-	108	75	N	-	-	-	-	N	N	N	Test 4a. SOG: 4.5kn - SSS ON only
18/09/2021	16:51	17:24	noise trials	ENT4A02_01	20210918-165112	351	-0.1	4.4	5	121	1.2	349	4.5	2.6	32.9	Y	M02	108	75	N	-	-	-	-	N	N	N	Test 4a. SOG: 4.5kn - SSS ON only, USBL ON
18/09/2021	19:33	20:10	noise trials	ENT3A01_01	20210918-193352	171	-0.9	4.1	5	128	1.2	169	4.5	4.1	43.1	N	-	-	-	N	-	-	-	-	N	N	N	Test 3a. SOG: 4.5kn - SPK ON only
18/09/2021	20:12	20:35	noise trials	ENT3AT1_01	20210918-201220	170	0.2	2.8	5	119	1.1	168	4.3	3.8	48.5	N	-	-	-	N	-	-	-	-	N	N	N	Test 3a. SOG: 4.5kn - SPK ON only
18/09/2021	20:36	21:14	noise trials	ENT3AP1_01	20210918-203633	81	-1.1	4.1	6	133	1.1	115	4.7	2.6	47.4	N	-	-	-	N	-	-	-	-	N	N	N	Test 3a. SOG: 4.5kn - SPK ON only
18/09/2021	21:16	21:53	noise trials	ENT3AT2_01	20210918-211632	80	0.1	5.1	6	126	1.1	87	4.6	2.0	54.3	N	-	-	-	N	-	-	-	-	N	N	N	Test 3a. SOG: 4.5kn - SPK ON only
18/09/2021	21:55	22:34	noise trials	ENT3AP2_01	20210918-215501	261	-1.2	4.0	6	137	1.3	169	4.4	4.1	44.1	N	-		-	N	-	-	-	-	N	N	N	Test 3a. SOG: 4.5kn - SPK ON only
18/09/2021	22:37	00:17	noise trials	ENT3A02_01	20210918-223733	351	-0.2	12.4	6	134	1.3	158	4.5	4.8	32.4	N	-	-	-	N	-	-	-	-	N	N	N	Test 3a. SOG: 4.5kn - SPK ON only
19/09/2021	00:20	01:11	noise trials	ENT5AT21	20210919-002013	167	6.9	6.4	5	122	1.6	32	3.9	1.5	55.5	N	-	-	-	N	-	-	-	-	N	N	N	SPK triggering - Transit line
19/09/2021	01:12	01:48	noise trials	ENT5A01_01	20210919-011223	171	-1.0	3.9	6	135	1.7	154	4.3	5.4	36.8	Y	M02	117	75	Y	2995	2996	9	100	N	N	Y	Test 5a. SOG: 4.5kn - ALL Instruments ON
19/09/2021	01:52	02:32	noise trials	ENT5AT22	20210919-015155	174	0.2	5.9	5	140	1.7	159	4.5	3.9	35.8	Y	M02	34	75	Y	2997	2998	9	100	N	N	Y	SPK triggering - Transit line
19/09/2021	02:36	03:17	noise trials	ENT5A02_01	20210919-023558	351	-1.5	4.2	6	136	1.7	354	4.7	2.4	38.3	Y	M02	100	75	Y	2999	3000	9	100	N	N	Y	Test 5a. SOG: 4.5kn - ALL Instruments ON
19/09/2021	09:18	09:42	Scouting CE Pos	A1_E1_MBES	20210919-091849	261	-0.5	2.5	6	115	2.1	253	4.6	5.5	33.7	N	-	-	-	Y	3001	-	9	100	N	N	Y	Scouting MBE Line
19/09/2021	10:43	10:47	Scouting CE Pos	Scouting_A1	20210919-104300	91	-0.2	0.4	6	105	1.8	102	4.6	2.8	32.7	N	M02	94	75	Y	3002	-	9	100	N	N	Y	Scouting SSS Line
19/09/2021	10:47	11:04	Scouting CE Pos	Scouting_CE1	20210919-104733	80	-0.2	1.8	5	103	1.8	80	4.6	2.8	32.7	N	M02	104	75	Y	3003	-	9	100	N	N	Y	Scouting SSS Line
19/09/2021	12:09	12:29	Scouting CE Pos	Scouting_CE1_01	20210919-120914	80	-0.6	1.8	5	110	1.7	94	3.4	2.2	33.8	N	M02	95	75	Y	3004		9	100	N	N	Y	Scouting SSS Line
19/09/2021	13:28	13:58	noise trials	ENT0B01	20210919-132753	171	-0.1	4.2	5	90	1.4	163	4.6	4.8	40.0	N	-	-	-	N	-	-	-	-	N	N	N	Test 0b. SOG: 4.5kn - sensors OFF
19/09/2021	14:08	14:39	noise trials	ENT0B02	20210919-140809	351	-0.3	4.0	4	113	1.5	356	4.7	1.8	36.1	N	-	-	-	N	-	-	-	-	N	N	N	Test 0b. SOG: 4.5kn - sensors OFF
19/09/2021	14:53	15:23	noise trials	ENT1B01	20210919-145353	171	-0.1	4.0	6	96	1.6	164	4.6	4.8	38.9	N	-	-	-	Y	3005	-	9	100	N	N	N	Test 1b. SOG: 4.5kn - MBES ON
19/09/2021	15:33	16:03	noise trials	ENT1B02	20210919-153305	351	-0.2	4.0	4	90	1.6	355	4.4	2.1	44.4	N	-	-	-	Y	3006	-	9	100	N	N	N	Test 1b. SOG: 4.5kn - MBES ON
19/09/2021	16:15	16:45	noise trials	ENT2B01	20210919-161512	171	-0.2	4.0	4	94	1.6	167	4.9	4.5	39.5	N	-	-	-	N	-	-	-	-	Y	N	N	Test 2b. SOG: 4.5kn - SBP ON
19/09/2021	16:53	17:23	noise trials	ENT2B02	20210919-165319	351	-0.2	4.0	4	86	1.7	352	5.0	2.2	51.0	N	-	-	-	N	-	-	-	-	Y	N	N	Test 2b. SOG: 4.5kn - SBP ON
19/09/2021	17:46	18:20	noise trials	ENT4B01	20210919-174631	171	-0.6	4.1	6	99	1.5	168	4.6	4.1	40.8	Y	-	105	75	N	-	-	-	-	N	N	N	Test 4b. SOG: 4.5kn - SSS ON
19/09/2021	18:35	19:07	noise trials	ENT4B02	20210919-183549	351	-0.3	4.1	3	121	1.5	347	4.7	2.6	44.1	Y	M02	118	75	N	-	-	-	-	N	N	N	Test 4b. SOG: 4.5kn - SSS ON, USBL ON
19/09/2021	20:44	21:22	noise trials	ENT3B01	20210919-204434	171	-1.2	4.1	6	97	1.5	165	4.9	4.9	59.0	-	-	-	-	N	-	-	-	-	N	N	N	Test 3b. SOG: 4.5kn - SPK ON
19/09/2021	21:43	22:18	noise trials	ENT3B02	20210919-214316	351	-0.9	4.1	4	90	1.5	356	5.0	3.8	44.3	-	-	-	-	N	-	-	-	-	N	N	N	Test 3b. SOG: 4.5kn - SPK ON
19/09/2021	22:22	23:12	noise trials	ENT5AT21	20210919-222228	24	0.2	6.3	6	115	1.5	49	4.7	2.1	41.9	-	-	-	-	N	-		-	-	N	N	N	SPK triggering - Transit line
19/09/2021	23:15	23:57	noise trials	ENT5B01_01	20210919-231513	171	-1.0	4.9	6	109	1.6	150	4.1	3.2	36.1	Y	M02	83	75	Y	3009	3010	9	100	Y	Y	Y	Test 5b. SOG: 4.5kn - All instruments ON
19/09/2021	23:59	00:15	noise trials	ENT5AT22	20210919-235953	174	1.0	1.2	5	105	1.8	159	4.8	2.3	37.9	Y	M02	62	75	Y	3011		9	100	Y	Y	Y	SPK triggering - Transit line

20/09/2021	00:15	00:56	noise trials	ENT5B02_01	20210920-001550	351	-1.4	4.3	4	93	1.8	352	4.7	1.2	38.3	Y	M02	72	75	Y	3012	3013	9	100	Y	Y	Y	Test 5b. SOG: 4.5kn - All instruments ON
20/09/2021	08:40	13:23	U	EAU1234P01	20210920-083959	171	-0.2	38.2	4	120	0.9	171	4.0	3.0	44.4	Y	M02	170	75	Y	3014	3023	9	100	Y	Y	Y	
20/09/2021	13:34	18:11	U	EAU1235P01	20210920-133452	351	-0.1	38.2	4	157	0.8	351	4.6	3.1	40.5	Y	M02	145	75	Y	3024	3033	9	100	Y	Y	Y	
20/09/2021	21:26	23:24	U	EAU1236P01	20210920-212652	171	-0.1	15.8	5	186	0.8	174	3.9	2.5	44.2	Y	M11	140	75	Y	3034	3037	9	100	Y	Y	Y	New SSS S/N 42378 engaged. Lost connection with SSS
21/09/2021	01:10	04:01	U	EAU1236P02	20210921-011048	171	15.2	38.5	6	238	0.6	178	4.0	2.3	44.0	Y	M02	128	75	Y	3038	3043	9	100	Y	Y	Y	BC changed to M02 - SSS TP moved to Stbd
21/09/2021	04:20	09:03	U	EAU1239P01	20210921-042020	351	-0.1	39.2	6	270	0.9	341	4.6	2.7	39.6	Y	M02	120	75	Y	3044	3053	9	100	Y	Y	Y	
21/09/2021	10:27	15:04	U	EAU1238P01	20210921-102656	171	-0.2	38.3	5	307	1.5	184	3.6	1.4	44.2	Y	M02	112	75	Y	3054	3063	9	100	Y	Y	Y	SSS TP moved to Port. Marginal weather
21/09/2021	15:15	15:24	T - infill	**EAT1228J01**	20210921-151545	351	-0.3	1.0	5	302	1.6	333	4.4	3.1	42.8	Y	M02	144	75	Y	3064	-	9	100	Y	Y	Y	SSS infill
21/09/2021	15:37	15:52	T - infill	**EAT1223J01**	20210921-153702	171	-0.1	1.8	5	308	1.6	176	4.4	2.7	40.8	Y	M02	169	75	Y	3065	-	9	100	Y	Y	Y	SSS infill
21/09/2021	16:04	16:16	T - infill	**EAT1230J01**	20210921-160358	351	-0.1	1.3	5	297	1.7	338	4.3	3.5	42.5	Y	M02	147	75	Y	3066	-	9	100	Y	Y	Y	SSS infill
21/09/2021	16:24	16:29	T - infill	**EAT2229J03**	20210921-162429	351	-0.1	0.5	5	293	1.7	342	4.0	1.2	42.4	Y	M02	141	75	Y	3067	-	9	100	Y	Y	Y	MAGGY infill
21/09/2021	16:45	17:00	T - infill	**EAT2229J04**	20210921-164542	171	-0.5	1.4	3	309	1.7	174	3.6	3.4	42.6	Y	M02	184	75	Y	3068	-	9	100	Y	Y	Y	MBES infill
21/09/2021	17:29	17:32	T - infill	**EAT2221J01**	20210921-172925	352	-0.2	0.3	5	285	1.7	341	4.3	2.1	39.2	Y	M02	166	75	Y	3069	-	9	100	Y	Y	Y	MBES infill
21/09/2021	17:58	18:02	T - infill	**EAT2225J04**	20210921-175849	351	-0.1	0.4	5	278	1.7	341	4.4	4.3	38.8	Y	M02	157	75	Y	3070	-	9	100	Y	Y	Y	MAGGY infill
21/09/2021	18:20	18:30	T - infill	**EAT1228J03**	20210921-182043	351	-0.2	1.2	4	261	1.7	344	4.3	1.6	36.7	Y	M02	140	75	Y	3071	-	9	100	Y	Y	Y	SSS infill
21/09/2021	18:45	18:55	T - infill	**EAT1227J01**	20210921-184525	171	-0.2	1.3	5	258	1.8	183	4.3	2.2	37.9	Y	M02	179	75	Y	3072	-	9	100	Y	Y	Y	SSS infill
21/09/2021	19:00	19:16	T - infill	**EAT1228J04**	20210921-190003	171	-0.2	2.0	4	259	1.8	174	4.6	3.2	36.2	Y	M02	167	75	Y	3073		9	100	Y	Y	Y	SSS infill
21/09/2021	19:28	19:44	T - infill	**EAT1230J02**	20210921-192828	351	-0.3	1.9	4	263	1.8	341	4.5	3.7	40.2	Y	M02	173	75	Y	3074		9	100	Y	Y	Y	SSS infill
21/09/2021	19:50	19:59	T - infill	**EAT1231J02**	20210921-194955	350	-0.2	1.1	4	259	1.8	339	4.4	3.3	36.9	Y	M02	146	75	Y	3075		9	100	Y	Y	Y	SSS infill
21/09/2021	20:14	20:24	T - infill	**EAT2229J01**	20210921-201439	171	-0.2	1.2	5	262	1.8	182	5.1	3.5	38.7	Y	M02	179	75	Y	3076		9	100	Y	Y	Y	SSS infill
21/09/2021	20:29	20:45	T - infill	**EAT1228J05**	20210921-202905	171	0.0	2.2	5	250	1.9	181	4.3	2.5	36.4	Y	M02	159	75	Y	3077		9	100	Y	Y	Y	SSS infill

Appendix G

Mobilisation and Calibration Reports JASCO

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CALIBRATION LOG

Doc# 00191

Calibration Type: MOB

Recorder Type: AMAR G4 | Board/Recorder S/N: 826 | Unit S/N: 621

Date YYYY-MM-DD	Cal performed by	Location	PM	Alternate PM
2021-08-16	S. Fenton	Dartmouth Office		

Project #	Project Name	Project Site (link)	PM	Alternate PM
P001631-001	2021 Energy Island Denmark SSV	https://jascoweb.jasco.com/Projec	Federica Pace	N/A

Conditions

Rec Firmware Ver.	Cal Model	Cal Kit #	Cal S/N	Air Temp (°C)	Recorder Temp (°C)
2.4.9	42AC	16	364724	23.5	23.5

Amb Pressure Source	Amb Press Source S/N	Ambient Press (hPA)	Calibration file(s) path:
Lab Baro	160754626	1013	\\jso-dmfs02\Products\AMAR\mobilizations\EnergyIslandDenmarkSS

H-phone Model:	M36-V35-900		M36-V0-901						
H-phone S/N:	G000311		G000462						
Paired HEC S/N:	HEC-254		HEC-341						
Channel:	1		2	3	4	5	6	7	8
Channel Gain (dB):	13.98		13.98						
Channel Resolution (bit):	24-bit		24-bit	24-bit	24-bit	24-bit	24-bit	24-bit	24-bit
Channel Sample Rate (sps):	256 ksps		256 ksps						
H-phone FAT Sens @ 250 Hz (dBV):	-164.32		-219.22						
H-phone Factory Sens @ 250 Hz (dBV):									

Results

Cal Start (UTC):	18:06:23		18:08:57						
Cal Stop (UTC):	18:08:23		18:10:57						
System Gain @250 Hz (dB re FS/µPa):	-163.40		-218.70						
H-phone Sens @250 Hz (dB re 1 V/µPa):	-164.32		-219.62	13.06	13.06	13.06	13.06	13.06	13.06
Digitization Gain (dB re FS/V):	-13.06		-13.06	-13.06	-13.06	-13.06	-13.06	-13.06	-13.06
MOB/FQT H-phone Sens Check:	**OK**		**OK**	**Questionable**	**Questionable**	**Questionable**	**Questionable**	**Questionable**	**Questionable**
FAT H-phone Sens Check:									
SysGain Check:	**OK**		**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**

[redacted]

NOTES:
2-1 voltage splitter cable HEC-659

Created from *00191 - YYYY-MM-DD RECORDERTYPE XXXXXX Calibration Log Sheet P001XXX-XXX ProjectName.xlsx* v1.6

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CALIBRATION LOG

Doc# 00191

Calibration Type: MOB

Recorder Type: AMAR G4 | Board/Recorder S/N: 749 | Unit S/N: 623

Date YYYY-MM-DD	Cal performed by	Location		
2021-08-16	S. fenton	Dartmouth Office		
Project #	**Project Name**	**Project Site (link)**	**PM**	**Alternate PM**
P001631-001	2021 Energy Island Denmark SSV	https://jascoweb.jasco.com/Projec	Federica Pace	N/A

Conditions

Rec Firmware Ver.	Cal Model	Cal Kit #	Cal S/N	Air Temp (°C)	Recorder Temp (°C)
2.4.9	42AC	16	364724	23.8	23.8
Amb Pressure Source	**Amb Press Source S/N**	**Ambient Press (hPA)**	**Calibration file(s) path:**		
Lab Baro	160754626	1013	\\jso-dmfs02\Products\AMAR\mobilizations\EnergyIslandDenmarkSS		

H-phone Model:	M36-V35-900	M36-V0-901						
H-phone S/N:	G000306	G000461						
Paired HEC S/N:	HEC-173	HEC-217						
Channel:	1	2	3	4	5	6	7	8
Channel Gain (dB):	13.98	13.98						
Channel Resolution (bit):	24-bit	24-bit	24-bit	24-bit	24-bit	24-bit	24-bit	24-bit
Channel Sample Rate (sps):	256 ksps	256 ksps						
H-phone FAT Sens @ 250 Hz (dBV):	-164.12	-219.62						
H-phone Factory Sens @ 250 Hz (dBV):								

Results

Cal Start (UTC):	18:54:41	18:57:06						
Cal Stop (UTC):	18:56:41	18:59:06						
System Gain @250 Hz (dB re FS/µPa):	-163.50	-218.70						
H-phone Sens @250 Hz (dB re 1 V/µPa):	-164.42	-219.62	13.06	13.06	13.06	13.06	13.06	13.06
Digitization Gain (dB re FS/V):	-13.06	-13.06	-13.06	-13.06	-13.06	-13.06	-13.06	-13.06
MOB/FQT H-phone Sens Check:	**OK**	**OK**	**Questionable**	**Questionable**	**Questionable**	**Questionable**	**Questionable**	**Questionable**
FAT H-phone Sens Check:								
SysGain Check:	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**

[redacted]

NOTES:

2-1 Voltage splitter cable HEC-662

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CALIBRATION LOG

Doc# 00191

Calibration Type: MOB

Recorder Type: AMAR G4 | Board/Recorder S/N: 806 | Unit S/N: 624

Date YYYY-MM-DD	Cal performed by	Location	PM	Alternate PM
2021-08-17	S. Fenton	Dartmouth Office		

Project #	Project Name	Project Site (link)	PM	Alternate PM
P001631-001	2021 Energy Island Denmark SSV	https://jascoweb.jasco.com/Projec	Federica Pace	N/A

Conditions

Rec Firmware Ver.	Cal Model	Cal Kit #	Cal S/N	Air Temp (°C)	Recorder Temp (°C)
2.4.9	42AC	16	364724	23.4	23.4

Amb Pressure Source	Amb Press Source S/N	Ambient Press (hPA)	Calibration file(s) path:
Lab Baro	160754626	1015	\\jso-dmfs02\Products\AMAR\mobilizations\EnergyIslandDenmarkSS

H-phone Model:	M36-V35-900	M36-V0-900						
H-phone S/N:	G000307	D000760						
Paired HEC S/N:	HEC-427	HEC-266						
Channel:	1	2	3	4	5	6	7	8
Channel Gain (dB):	13.98	13.98						
Channel Resolution (bit):	24-bit	24-bit	24-bit	24-bit	24-bit	24-bit	24-bit	24-bit
Channel Sample Rate (sps):	256 ksps	256 ksps						
H-phone FAT Sens @ 250 Hz (dBV):	-163.92	-200.74						
H-phone Factory Sens @ 250 Hz (dBV):								

Results

Cal Start (UTC):	14:41:29	14:44:45						
Cal Stop (UTC):	14:43:29	14:46:45						
System Gain @250 Hz (dB re FS/µPa):	-163.30	-199.50						
H-phone Sens @250 Hz (dB re 1 V/µPa):	-164.22	-200.42	13.06	13.06	13.06	13.06	13.06	13.06
Digitization Gain (dB re FS/V):	-13.06	-13.06	-13.06	-13.06	-13.06	-13.06	-13.06	-13.06
MOB/FQT H-phone Sens Check:	**OK**	**OK**	**Questionable**	**Questionable**	**Questionable**	**Questionable**	**Questionable**	**Questionable**
FAT H-phone Sens Check:								
SysGain Check:	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**

[redacted]

NOTES:
2-1 voltage splitter cable HEC-660

Project #	P001631-001	**Housing S/N:**	**621**
Date:	2021-08-13	**Board S/N:**	**826**

Test ID refers to Document 00186 AMAR Mobilization Test Procedure.
Yes/No questions are left-aligned, items to record are right-aligned.

Test ID	Description	Result	Notes	Tech Sign
	FQT record complete?	Yes		
	AMARlink Version:	4.11.3		
	S/W update required?	No		
	S/W updated?			
	Board ID:	826		
	IP Address:	192.168.88.5		
	S/W Version:	2019.09.26-2.4.9		
	CPLD Version:	5		
	WIFI Module Installed?	Yes		
	WIFI SSID:	AMAR621		SMF
	SD Card adjustment required?	Yes		
	Total number of modules installed now:	2		
	Size of SD Cards:	512		
	Amount of memory installed (GB):	1024		
	Memory securing screw re-installed?	Yes		
	SharePoint updates completed for new/removed SD Cards?	Yes		
	AMARlink and SharePoint module S/N match?	Yes		
	Verify hydrogen combiner pellets installed?	Yes		
	Inspection o-ring surface of housing OK?	Yes		
	Thorough inspection of all bulkhead connectors OK?	Yes		
	Visual inspection of wires from top cap connectors OK?	Yes		SMF
	Connector terminations correct and secure?	Yes		
	Connector latches OK?	Yes		
	HTI-99-HF hydrophone to be installed?	No		SMF
	Internal Battery Pack required?	Yes		
	Wire terminations seated correctly?	Yes		
	Connector latch OK?	Yes		
	Total pack voltage (V)	16.24		
	Washer and nut loctited on with battery installed?	Yes		
	New desiccant pack(s) installed? (Indicated Qty in notes)	Yes	1	
	Top end cap installed and tightened?	Yes		
	Bottom endcap inspection OK?	Yes		
	Connectors and PRV check OK?	Yes		
	Top endcap inspection OK?	Yes		SMF
	PRV inspection OK?	Yes		
	PRV core set to 4.5 turns out? (Record PRV S/N in notes)	Yes	PRV S/N: 06148A	
	External battery pack required?	No		
	External Battery pack type:			
	External battery pack housing S/N			
	PRV inspection OK?			
	PRV core set to 4.5 turns out? (Record PRV S/N in notes)		PRV S/N:	
	Total pack voltage (V)			
	Verify hydrogen combiner pellets installed?			
	Voltage at cable end and correct? >12V			
	Hydrophone FQT record after last deployment complete?	Yes		
	Open issues on hydrophone?	No		
	H-Phone 1 Model:	M36-V35-900		
	H-Phone 1 S/N:	G000311		
	HEC S/N:	HEC-254		
	H-Phone 2 Model:	M36-V0-901		
	H-Phone 2 S/N:	G000462		SMF
	HEC S/N:	HEC-341		
	H-Phone 3 Model:	N/A		
	H-Phone 3 S/N:	N/A		
	HEC S/N:	N/A		
	H-Phone 4 Model:	N/A		
	H-Phone 4 S/N:	N/A		
	HEC S/N:	N/A		
	sensors.xml file set to match installed sensors?	Yes		SMF
	Memory erased?	Yes		SMF
	AMAR configured as per RCW? (Record RCW# in notes)	Yes	RCW#: PPW0489	
	Verify/Update AMAR ID in AMARlink?	Yes		SMF
	AMAR time sync with NTP/PC?	Yes		
	Sample rate (Ch1-4):	256 ksps		
	Ambient Temperature (°C):	23.8		
	Verify active NAD channels recorded?	Yes		
	Humidity(CH 26)(RH%):	23.2		
	Primary supply current(CH 22)(A):	0.051		
	DC Input 2 Voltage(Main, CH 23)(V):	15.25		
	DC Input 1 Voltage(Aux, CH 24)(V):	1.88		
	Temp(CH 25) (°C):	25.88		SMF
	Temp reading within ± 2°C of ambient?	Yes		
	Calibration completed?	Yes		
	Verified recording configuration still matches RCW?	Yes		
	sensors.xml and deployment.xml files uploaded to SharePoint?	Yes		
	Updated SYSGAIN field for AMAR on SharePoint?	No	Dual h-phone	
	All test records completed properly and uploaded?	Yes		
	Sales Units without WIFI Module Only			
	WIFI module sales unit?	N/A		
	AMAR IP set to 192.168.2.1?			
	AMAR Netmask set to 255.255.255.0?			
	AMAR Gateway set to 192.168.2.100?			
	AMAR Name Server set to 192.168.2.235?			SMF
	AMAR Broadcast set to 192.168.2.255?			
	Power cycle AMAR, IP verified as 192.168.2.1?			
	AMAR memory erased?			
	SharePoint electronics board IP updated to 192.168.2.1?			
	FINAL CHECK - To be completed before QA notification of mobilization completion			
	External power dummy plug(s) installed?	Yes		
	External power interconnect cable installed/present?	N/A		
	Hydrophone dummy plug installed, if hydrophone not?	N/A		SMF
	Hydrophone mount OK?	N/A		
	Hydrophone stabilzer boot installed?	N/A		
	Accessories installed and per RCW requirements?	Yes		
	IP address label installed? IP:192.168.88.5	Yes		
	All test records completed properly and uploaded?	Yes		

Notes: 2-1 voltage splitter cable HEC-659

JASCO APPLIED SCIENCES

Project #	P001631-001	Housing S/N:	623
Date:	2021-08-13	Board S/N:	749

Test ID refers to Document 00186 AMAR Mobilization Test Procedure.
Yes/No questions are left-aligned, items to record are right-aligned.

Test ID	Description	Result	Notes	Tech Sign
	FQT record complete?	Yes		
	AMARlink Version:	4.11.3		
	S/W update required?	No		
	S/W updated?			
	Board ID:	749		
	IP Address:	192.168.88.5		
	S/W Version:	2.4.9		
	CPLD Version:	5		
	WIFI Module Installed?	Yes		
	WIFI SSID:	AMAR623		SMF
	SD Card adjustment required?	Yes		
	Total number of modules installed now:	2		
	Size of SD Cards:	512		
	Amount of memory installed (GB):	1024		
	Memory securing screw re-installed?	Yes		
	SharePoint updates completed for new/removed SD Cards?	Yes		
	AMARlink and SharePoint module S/N match?	Yes		
	Verify hydrogen combiner pellets installed?	Yes		
	Inspection o-ring surface of housing OK?	Yes		
	Thorough inspection of all bulkhead connectors OK?	Yes		
	Visual inspection of wires from top cap connectors OK?	Yes		SMF
	Connector terminations correct and secure?	Yes		
	Connector latches OK?	Yes		
	HTI-99-HF hydrophone to be installed?	No		SMF
	Internal Battery Pack required?	Yes		
	Wire terminations seated correctly?	Yes		
	Connector latch OK?	Yes		
	Total pack voltage (V)	16.23		
	Washer and nut loctited on with battery installed?	Yes		
	New desiccant pack(s) installed? (Indicated Qty in notes)	Yes	1	
	Top end cap installed and tightened?	Yes		
	Bottom endcap inspection OK?	Yes		
	Connectors and PRV check OK?	Yes		
	Top endcap inspection OK?	Yes		SMF
	PRV inspection OK?	Yes		
	PRV core set to 4.5 turns out? (Record PRV S/N in notes)	Yes	PRV S/N: 06211A	
	External battery pack required?	No		
	External Battery pack type:			
	External battery pack housing S/N			
	PRV inspection OK?			
	PRV core set to 4.5 turns out? (Record PRV S/N in notes)		PRV S/N:	
	Total pack voltage (V)			
	Verify hydrogen combiner pellets installed?			
	Voltage at cable end and correct? >12V			
	Hydrophone FQT record after last deployment complete?	Yes		
	Open issues on hydrophone?	No		
	H-Phone 1 Model:	M36-V35-900		
	H-Phone 1 S/N:	G000306		
	HEC S/N:	HEC-173		
	H-Phone 2 Model:	M36-V0-901		
	H-Phone 2 S/N:	HEC-217		SMF
	HEC S/N:	N/A		
	H-Phone 3 Model:	N/A		
	H-Phone 3 S/N:	N/A		
	HEC S/N:	N/A		
	H-Phone 4 Model:	N/A		
	H-Phone 4 S/N:	N/A		
	HEC S/N:	N/A		
	sensors.xml file set to match installed sensors?	Yes		SMF
	Memory erased?	Yes		SMF
	AMAR configured as per RCW? (Record RCW# in notes)	Yes	RCW#: PPW0489	
	Verify/Update AMAR ID in AMARlink?	Yes		SMF
	AMAR time sync with NTP/PC?	Yes		
	Sample rate (Ch1-4):	256 ksps		
	Ambient Temperature (°C):	23.8		
	Verify active NAD channels recorded?	Yes		
	Humidity(CH 26)(RH%):	21.32		
	Primary supply current(CH 22)(A):	0.05		
	DC Input 2 Voltage(Main, CH 23)(V):	15.11		
	DC Input 1 Voltage(Aux, CH 24)(V):	1.65		
	Temp(CH 25) (°C):	26.39	Okay to apss, not critical	SMF
	Temp reading within ± 2°C of ambient?	No		
	Calibration completed?	Yes		
	Verified recording configuration still matches RCW?	Yes		
	sensors.xml and deployment.xml files uploaded to SharePoint?	Yes		
	Updated SYSGAIN field for AMAR on SharePoint?	No	Dual h-phone	
	All test records completed properly and uploaded?	Yes		
	Sales Units without WIFI Module Only			
	WIFI module sales unit?	Yes		
	AMAR IP set to 192.168.2.1?			
	AMAR Netmask set to 255.255.255.0?			
	AMAR Gateway set to 192.168.2.100?			
	AMAR Name Server set to 192.168.2.235?			SMF
	AMAR Broadcast set to 192.168.2.255?			
	Power cycle AMAR, IP verified as 192.168.2.1?			
	AMAR memory erased?			
	SharePoint electronics board IP updated to 192.168.2.1?			
	FINAL CHECK - To be completed before QA notification of mobilization completion			
	External power dummy plug(s) installed?	Yes		
	External power interconnect cable installed/present?	N/A		
	Hydrophone dummy plug installed, if hydrophone not?	N/A		SMF
	Hydrophone mount OK?	N/A		
	Hydrophone stabilzer boot installed?	N/A		
	Accessories installed and per RCW requirements?	Yes		
	IP address label installed? IP:192.168.88.5	Yes		
	All test records completed properly and uploaded?	Yes		

Notes: 2-1 voltrage splitter HEC-662

Project #	P001631-001	**Housing S/N:**	**624**
Date:	2021-08-13	**Board S/N:**	**806**

Test ID refers to Document 00186 AMAR Mobilization Test Procedure.
Yes/No questions are left-aligned, items to record are right-aligned.

Test ID	Description	Result	Notes	Tech Sign
	FQT record complete?	Yes		
	AMARlink Version:	4.11.3		
	S/W update required?	No		
	S/W updated?	[redacted]		
	Board ID:	806		
	IP Address:	192.168.88.5		
	S/W Version:	2.4.9		
	CPLD Version:	5		
	WIFI Module Installed?	Yes		
	WIFI SSID:	AMAR624		SMF
	SD Card adjustment required?	Yes		
	Total number of modules installed now:	2		
	Size of SD Cards:	512		
	Amount of memory installed (GB):	1024		
	Memory securing screw re-installed?	Yes		
	SharePoint updates completed for new/removed SD Cards?	Yes		
	AMARlink and SharePoint module S/N match?	Yes		
	Verify hydrogen combiner pellets installed?	Yes		
	Inspection o-ring surface of housing OK?	Yes		
	Thorough inspection of all bulkhead connectors OK?	Yes		
	Visual inspection of wires from top cap connectors OK?	Yes		SMF
	Connector terminations correct and secure?	Yes		
	Connector latches OK?	Yes		
	HTI-99-HF hydrophone to be installed?	No		SMF
	[redacted]			
	Internal Battery Pack required?	Yes		
	Wire terminations seated correctly?	Yes		
	Connector latch OK?	Yes		
	Total pack voltage (V)	16.23		
	Washer and nut loctited on with battery installed?	Yes		
	[redacted]			
	New desiccant pack(s) installed? (Indicated Qty in notes)	Yes	1	
	Top end cap installed and tightened?	Yes		
	Bottom endcap inspection OK?	Yes		
	Connectors and PRV check OK?	Yes		
	Top endcap inspection OK?	Yes		SMF
	PRV inspection OK?	Yes		
	PRV core set to 4.5 turns out? (Record PRV S/N in notes)	Yes	PRV S/N: 06162A	
	External battery pack required?	No		
	External Battery pack type:	[redacted]		
	External battery pack housing S/N	[redacted]		
	PRV inspection OK?	[redacted]		
	PRV core set to 4.5 turns out? (Record PRV S/N in notes)	[redacted]	PRV S/N:	
	Total pack voltage (V)	[redacted]		
	Verify hydrogen combiner pellets installed?	[redacted]		
	Voltage at cable end and correct? >12V	[redacted]		
	Hydrophone FQT record after last deployment complete?	Yes		
	Open issues on hydrophone?	No		
	H-Phone 1 Model:	M36-V35-900		
	H-Phone 1 S/N:	G000307		
	HEC S/N:	HEC-427		
	H-Phone 2 Model:	M36-V0-900		
	H-Phone 2 S/N:	D000760		SMF
	HEC S/N:	HEC-266		
	H-Phone 3 Model:	N/A		
	H-Phone 3 S/N:	N/A		
	HEC S/N:	N/A		
	H-Phone 4 Model:	N/A		
	H-Phone 4 S/N:	N/A		
	HEC S/N:	N/A		
	sensors.xml file set to match installed sensors?	Yes		SMF
	Memory erased?	Yes		SMF
	AMAR configured as per RCW? (Record RCW# in notes)	Yes	RCW#: PPW0489	
	Verify/Update AMAR ID in AMARlink?	Yes		SMF
	AMAR time sync with NTP/PC?	Yes		
	Sample rate (Ch1-4):	256 ksps		
	Ambient Temperature (°C):	23.5		
	Verify active NAD channels recorded?	Yes		
	Humidity(CH 26)(RH%):	27.9		
	Primary supply current(CH 22)(A):	0.05		
	DC Input 2 Voltage(Main, CH 23)(V):	15.37		
	DC Input 1 Voltage(Aux, CH 24)(V):	2		
	Temp(CH 25) (°C):	25.62		SMF
	Temp reading within ± 2°C of ambient?	No	okay as is	
	Calibration completed?	Yes		
	Verified recording configuration still matches RCW?	Yes		
	sensors.xml and deployment.xml files uploaded to SharePoint?	Yes		
	Updated SYSGAIN field for AMAR on SharePoint?	No	Dual h-phone	
	All test records completed properly and uploaded?	Yes		
	Sales Units without WIFI Module Only			
	WIFI module sales unit?	N/A		
	AMAR IP set to 192.168.2.1?	[redacted]		
	AMAR Netmask set to 255.255.255.0?	[redacted]		
	AMAR Gateway set to 192.168.2.100?	[redacted]		
	AMAR Name Server set to 192.168.2.235?	[redacted]		SMF
	AMAR Broadcast set to 192.168.2.255?	[redacted]		
	Power cycle AMAR, IP verified as 192.168.2.1?	[redacted]		
	AMAR memory erased?	[redacted]		
	SharePoint electronics board IP updated to 192.168.2.1?	[redacted]		
	FINAL CHECK - To be completed before QA notification of mobilization completion			
	[redacted]			
	External power dummy plug(s) installed?	Yes		
	External power interconnect cable installed/present?	Yes		
	Hydrophone dummy plug installed, if hydrophone not?	N/A		SMF
	Hydrophone mount OK?	N/A		
	Hydrophone stabilzer boot installed?	N/A		
	Accessories installed and per RCW requirements?	Yes		
	IP address label installed? IP:192.168.88.5	Yes		
	All test records completed properly and uploaded?	Yes		

Notes: 2-1 voltage splitter HEC-660

Appendix H

Deployment and Retrieval Logs

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AMAR Mooring Deployment Log

AcRelease Codes (record again to confirm)		Station	AMAR S/N
NA	NA	A	621

General

Project #	Project Name	Project Manager (PM)	Alternate PM
P001631-001	Fugro Energy Island SSC	Federica Pace	Robin Burns

JASCO Team (Inits)	Location	Vessel	Captain, Crew
RM CR	Denmark	Fugro Pioneer	Rob, Calder, Misha, Vicky, Eduardino, Malcolm, Vincenzo, Georgio, Eugenio
Local Time re UTC: +2	Weather, sea state, drift bearing, etc.		

Equipment ID

AMAR S/N	IP Address	Battery Pack(s) S/N: Ch 22 V:	Ch 23 V:
621	192.168.88.5		

	Beacon	H-phone Chan 1	H-phone Chan 2
Model:		M36-V35-90	M36-V00-901
S/N:		G000311	G000462
Verified by:	Inits:	Inits:	Inits:

	AcRel 1	AcRel 2
Model:	N/A	N/A
S/N:		
RELEASE Code:		
Enable Code:		
Disable Code:		
Verified by:	Inits:	Inits:

Start

Record all dates and times in UTC.

Rec Start yyyy-mm-dd	Rec Start Time (UTC)	Sync Event Time
2021-Sep-18	05:03:53	"

Calibration

* AMBIENT pressure, which is the direct measurement, not barometric pressure.

Cal Date (UTC)	Calibrator Kit #	Calibrator Model	Calibrator S/N
2021-Sep-16	10	42AC	43119

*Amb Pressure (hPa)	Pressure Sensor used (incl. S/N)
1008.9	Ships Sensor

	H-phone Chan 1	H-phone Chan 2
Tone Start (UTC):	Streaming	"
Tone Stop (UTC):	Streaming	"
CAL_GUI Rev. #	46	"
² Deployment System Gain (dB re 1 µPa):	-164.0	-218.7
² Mobilzation Sys Gain (dB re 1 µPa):	-163.4	-218.7
[+] Peak SPL clipping threshold (dB re 1 µPa):		
[–] Peak SPL clipping threshold (dB re 1 µPa):		

² Difference in Sys Gain between deployment and the mobilization should be < 0.75 dB.

Deployment

Deploy Date (UTC)	Water Depth	Units
2021-Sep-18	33.485	m

GPS S/N(s)	+ Ship Draft or n/a	= Net Water Depth
DZ GPS	0	33.485

	Time (UTC)	Lat (d°mm.mmm' N/S)	Lon (d°mm.mmm' E/W)	GPS Waypoint	GPS Accuracy(m)
Proposed:	N/A	Multiple	Multiple		N/A
Controlled Drop Start:	07:35:30			019	N/A
FreeDrop/ On Bottom:	07:37:40	56 32' 58.54" N	6 16' 13.00" E	020	N/A
Grapple Weight Drop:	07:49:28	56 32' 58. 61" N	6 16" 2.02" E	021	N/A

Note: while waypoints are provided, the lat and lon are from the ships Survey GPS/ sidescan run, and should be taken as the correct locations. On bottom (Easting northing) locations are: 332203.717 6270586.105, with reference 32N-EE21. confirm hydrophone one y+y, see video.

All required deck checks and deployment steps complete:

Note locations for multiple hydrophones here

All fields complete, as verified by (Inits):

Created from Deployment-Retrieval Log Template 00181 v3.3

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AMAR Mooring Retrieval Log

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Confirmed Release Code(s)		Station	AMAR S/N
NA	NA	A	621

General

Project #	Project Name	Project Manager (PM)	Alternate PM
P001631-001	Fugro Energy Island SSC	Federica Pace	Robin Burns

JASCO Team (Inits)	Location	Vessel	Captain, Crew
RM CR	Denmark	*Fugro Pioneer*	Rob, Calder, Misha, Vicky, Eduardino, Malcolm, Vincenzo, Georgio, Eugenio
Local Time re UTC: +2	Weather, sea state, drift bearing, etc.	dark, 1.5m to 2 m lot of heave.	

Deployment

Record Start Date	Record Start Time	Deploy Date	Net Water Depth
2021-Sep-18	05:03:53	2021-Sep-18	33.485 m

	AcRel 1	AcRel 2
S/N:	NA	NA
RELEASE Code:		
Enable Code:		
Disable Code:		

	Lat (d°mm.mmm' N/S)	Lon (d°mm.mmm' E/W)	GPS Waypoint	GPS Accuracy(m)
Controlled Drop Start:			019	N/A
FreeDrop/ On Bottom:	56 32' 58.54" N	6 16' 13.00" E	020	N/A
Grapple Weight Drop:	56 32' 58. 61" N	6 16" 2.02" E	021	N/A

Retrieval

Retrieve Date (UTC)	GPS S/N(s)
9/20/2021	DZ gps

	Time (UTC)	Lat (d°mm.mmm' N/S)	Lon (d°mm.mmm' E/W)	GPS Waypoint	GPS Accuracy(m)
Release Code Sent:	"	"	"	"	"
Surfaced/End of Data:	04:16:45				
On deck:	04:40:17				

Calibration

*AMBIENT pressure, which is the direct measurement, not barometric pressure.

Cal Date (UTC)	Calibrator Kit #	Calibrator Model	Calibrator S/N
2021-Sep-20	10	42AC	43119

*Amb Pressure (hPa)	Ambient Pressure Source (incl. S/N)
1023.2	Ships sensor

	H-phone 1	H-phone 2
Tone Start (UTC):	Streaming	"
Tone Stop (UTC):	Streaming	"
CAL_GUI Rev. #	46	"
² Retrieval System Gain (dB re 1 µPa):	-163.3	-218.3
² Mobilization System Gain (dB re 1 µPa):	-163.4	-218.7

² Difference in Sys Gain between retrieval and the mobilization should be < 1.0 dB.
Retrieval cal required for M8 series hydrophones or as required by project.

Stop Time

² Actual stop time (UTC). ³ Stop time according to the AMAR clock.

Sync Event Time	² Record Stop, UTC	³ Record Stop, AMAR
	04:49:05	"

Eqpmnt ID

AMAR S/N	
621	Inits:

	H-phone Chan 1	H-phone Chan 2
Model:	M36-V35-900	M36-V00-901
S/N:	G000311	G000462
Verified by:	Inits:	Inits:

All fields complete, as verified by (Inits):

AMAR stopped, green dummy plug installed, pressure equalized, and PRV reset, as verified by (Inits):

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AMAR Mooring Deployment Log

AcRelease Codes (record again to confirm)		Station	AMAR S/N
NA	NA	B	623

General

Project #	Project Name	Project Manager (PM)	Alternate PM
P001631-001	Fugro Energy Island SSC	Federica Pace	Robin Burns

JASCO Team (Inits)	Location	Vessel	Captain, Crew
RM CR	Denmark	Fugro Pioneer	Rob, Calder, Misha, Vicky, Eduardino, Malcolm, Vincenzo, Georgio, Eugenio
Local Time re UTC: +2	Weather, sea state, drift bearing, etc.		

Equipment ID

AMAR S/N	IP Address	Battery Pack(s) S/N: Ch 22 V:	Ch 23 V:
623	192.168.99.5		

	Beacon	H-phone Chan 1	H-phone Chan 2
Model:		M36-V35-90	M36-V00-901
S/N:		G000306	G000461
Verified by:	Inits:	Inits:	Inits:

	AcRel 1	AcRel 2
Model:	N/A	N/A
S/N:		
RELEASE Code:		
Enable Code:		
Disable Code:		
Verified by:	Inits:	Inits:

Start

Record all dates and times in UTC.

Rec Start yyyy-mm-dd	Rec Start Time (UTC)	Sync Event Time
2021-Sep-18	05:04:31	"

Calibration

* AMBIENT pressure, which is the direct measurement, not barometric pressure.

Cal Date (UTC)	Calibrator Kit #	Calibrator Model	Calibrator S/N
2021-Sep-16	10	42AC	43119
*Amb Pressure (hPa)	Pressure Sensor used (incl. S/N)		
1008.9	Ships Sensor		

	H-phone Chan 1	H-phone Chan 2
Tone Start (UTC):	Stream	"
Tone Stop (UTC):	Stream	"
CAL_GUI Rev. #	46	"
² Deployment System Gain (dB re 1 µPa):	-163.8	-218.8
² Mobilzation Sys Gain (dB re 1 µPa):	-163.5	-218.7
[+] Peak SPL clipping threshold (dB re 1 µPa):		
[–] Peak SPL clipping threshold (dB re 1 µPa):		

² Difference in Sys Gain between deployment and the mobilization should be < 0.75 dB.

Deployment

Deploy Date (UTC)	Water Depth	Units
2021-Sep-18	32.99	m
GPS S/N(s)	+ Ship Draft or n/a	
DZ GPS	= Net Water Depth: 32.99	

	Time (UTC)	Lat (d°mm.mmm' N/S)	Lon (d°mm.mmm' E/W)	GPS Waypoint	GPS Accuracy(m)
Proposed:	N/A	Multiple	Multiple		N/A
Controlled Drop Start:	07:02:37			15	
FreeDrop/ On Bottom:	07:04:30	56 32' 59.13" N	6 16' 18.8" E	16/17	
Grapple Weight Drop:	07:10:39	56 33' 0.29" N	6 16' 16.31" E	18	

Note: while gps points are provided the lat lons are from the ships survey gps, and are to be considered more correct. On bottom easting northing (32N-EE21) 332302.101 6270599.642. confirm phones on y+y see video.

All required deck checks and deployment steps complete:

Note locations for multiple hydrophones here

All fields complete, as verified by (Inits):

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AMAR Mooring Retrieval Log

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Confirmed Release Code(s)		Station	AMAR S/N
NA	NA	B	623

General

Project #	Project Name	Project Manager (PM)	Alternate PM
P001631-001	Fugro Energy Island SSC	Federica Pace	Robin Burns

JASCO Team (Inits)	Location	Vessel	Captain, Crew
RM CR	Denmark	*Fugro Pioneer*	Rob, Calder, Misha, Vicky, Eduardino, Malcolm, Vincenzo, Georgio, Eugenio

Local Time re UTC	Weather, sea state, drift bearing, etc.
+2	2.1 m sig, 3.3m max 23kn breeze

Deployment

Record Start Date	Record Start Time	Deploy Date	Net Water Depth
2021-Sep-18	05:04:31	2021-Sep-18	32.99 m

	AcRel 1	AcRel 2
S/N:	NA	NA
RELEASE Code:		
Enable Code:		
Disable Code:		

	Lat (d°mm.mmm' N/S)	Lon (d°mm.mmm' E/W)	GPS Waypoint	GPS Accuracy(m)
Controlled Drop Start:			15	
FreeDrop/ On Bottom:	56 32' 59.13" N	6 16' 18.8" E	16/17	
Grapple Weight Drop:	56 33' 0.29" N	6 16' 16.31" E	18	

Retrieval

Retrieve Date (UTC)	GPS S/N(s)
9/19/2021	DZ-GPS

	Time (UTC)	Lat (d°mm.mmm' N/S)	Lon (d°mm.mmm' E/W)	GPS Waypoint	GPS Accuracy(m)
Release Code Sent:	"	"	"	"	"
Surfaced/End of Data:	06:32:20				
On deck:	06:47:36				

Calibration

*AMBIENT pressure, which is the direct measurement, not barometric pressure.

Cal Date (UTC)	Calibrator Kit #	Calibrator Model	Calibrator S/N
2021-Sep-19	10	42AC	43119

*Amb Pressure (hPa)	Ambient Pressure Source (incl. S/N)
1018.9	Ships Sensor

	H-phone 1	H-phone 2
Tone Start (UTC):	streaming	"
Tone Stop (UTC):	streaming	"
CAL_GUI Rev. #	46	"
² Retrieval System Gain (dB re 1 µPa):	-163.3	-219.4
² Mobilization System Gain (dB re 1 µPa):	-163.5	-218.7

² Difference in Sys Gain between retrieval and the mobilization should be < 1.0 dB.

Retrieval cal required for M8 series hydrophones or as required by project.

Stop Time

² Actual stop time (UTC). ³ Stop time according to the AMAR clock.

Sync Event Time	² Record Stop, UTC	³ Record Stop, AMAR
	06:59:30	

Eqpmnt ID

AMAR S/N
623
Inits:

	H-phone Chan 1	H-phone Chan 2
Model:	M36-V35-900	M36-V00-901
S/N:	G000306	G000461
Verified by:	Inits:	Inits:

confirmed recording on retreival

All fields complete, as verified by (Inits):

AMAR stopped, green dummy plug installed, pressure equalized, and PRV reset, as verified by (Inits):

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AMAR Mooring Deployment Log

AcRelease Codes (record again to confirm)		Station	AMAR S/N
NA	NA	D	624

General

Project #	Project Name	Project Manager (PM)	Alternate PM
P001631-001	Fugro Energy Island SSC	Federica Pace	Robin Burns

JASCO Team (Inits)	Location	Vessel	Captain, Crew
RM CR	Denmark	Fugro Pioneer	Rob, Calder, Misha, Vicky, Malcolm, Vincenzo, Georgio, Eugenio
Local Time re UTC: +2	Weather, sea state, drift bearing, etc.		

Equipment ID

AMAR S/N	IP Address	Battery Pack(s) S/N: Ch 22 V:	Ch 23 V:
624	192.168.88.5		

	Beacon	H-phone Chan 1	H-phone Chan 2
Model:		M36-V35-90	M36-V00-901
S/N:		G000307	D000760
Verified by:	Inits:	Inits:	Inits:

	AcRel 1	AcRel 2
Model:	N/A	N/A
S/N:		
RELEASE Code:		
Enable Code:		
Disable Code:		
Verified by:	Inits:	Inits:

Start

Record all dates and times in UTC.

Rec Start yyyy-mm-dd	Rec Start Time (UTC)	Sync Event Time
2021-Sep-18	05:05:08	

Calibration

* AMBIENT pressure, which is the direct measurement, not barometric pressure.

Cal Date (UTC)	Calibrator Kit #	Calibrator Model	Calibrator S/N
2021-Sep-16	10	42AC	43119
*Amb Pressure (hPa)	Pressure Sensor used (incl. S/N)		
1008.9	Ships Sensor		

	H-phone Chan 1	H-phone Chan 2
Tone Start (UTC):	Streaming	"
Tone Stop (UTC):	Streaming	"
CAL_GUI Rev. #	46	"
² Deployment System Gain (dB re 1 µPa):	-163.6	-200.0
² Mobilzation Sys Gain (dB re 1 µPa):	-163.6	-199.5
[+] Peak SPL clipping threshold (dB re 1 µPa):		
[–] Peak SPL clipping threshold (dB re 1 µPa):		

² Difference in Sys Gain between deployment and the mobilization should be < 0.75 dB.

Deployment

Deploy Date (UTC)	Water Depth	Units
2021-Sep-18	31.878	m
GPS S/N(s): DZ GPS	+ Ship Draft or n/a: 0	
	= Net Water Depth: 31.878	

	Time (UTC)	Lat (d°mm.mmm' N/S)	Lon (d°mm.mmm' E/W)	GPS Waypoint	GPS Accuracy(m)
Proposed:	N/A	Multiple	Multiple		N/A
Controlled Drop Start:	06:29:31	"	"	011	"
FreeDrop/ On Bottom:	06:31:13	56 33' 2.58" N	6 16' 56.35" E	12/13	"
Grapple Weight Drop:	06:37:10	56 33' 3.51" N	6 16' 54.06" E	14	"

while waypoint number are provided, the lat and lon are from the ships gps and sidescan, and should be taken as the correct on. On bottom sidescan location are 32N-EE21 easting northing: 332952.533 6270678.967, confirm recording on deployent y+y

All required deck checks and deployment steps complete:

Note locations for multiple hydrophones here

All fields complete, as verified by (Inits):

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AMAR Mooring Retrieval Log

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Confirmed Release Code(s)		Station	AMAR S/N
NA	NA	D	624

General

Project #	Project Name	Project Manager (PM)	Alternate PM
P001631-001	Fugro Energy Island SSC	Federica Pace	Robin Burns

JASCO Team (Inits)	Location	Vessel	Captain, Crew
RM CR	Denmark	*Fugro Pioneer*	Rob, Calder, Misha, Vicky, Malcolm, Vincenzo, Georgio, Eugenio

Local Time re UTC	Weather, sea state, drift bearing, etc.
+2	2.1m sig, 3.3m max 23kn breeze

Deployment

Record Start Date	Record Start Time	Deploy Date	Net Water Depth
2021-Sep-18	05:05:08	2021-Sep-18	31.878 m

	AcRel 1	AcRel 2
S/N:		
RELEASE Code:		
Enable Code:		
Disable Code:		

	Lat (d°mm.mmm' N/S)	Lon (d°mm.mmm' E/W)	GPS Waypoint	GPS Accuracy(m)
Controlled Drop Start:	"	"	011	"
FreeDrop/ On Bottom:	56 33' 2.58" N	6 16' 56.35" E	12/13	"
Grapple Weight Drop:	56 33' 3.51" N	6 16' 54.06" E	14	"

Retrieval

Retrieve Date (UTC)	GPS S/N(s)
9/19/2021	DZ gps

	Time (UTC)	Lat (d°mm.mmm' N/S)	Lon (d°mm.mmm' E/W)	GPS Waypoint	GPS Accuracy(m)
Release Code Sent:	"	"	"	"	"
Surfaced/End of Data:	05:45:04				
On deck:	05:57:52				

Calibration

*AMBIENT pressure, which is the direct measurement, not barometric pressure.

Cal Date (UTC)	Calibrator Kit #	Calibrator Model	Calibrator S/N
2021-Sep-19	10	42AC	43119

*Amb Pressure (hPa)	Ambient Pressure Source (incl. S/N)
1018.9	Ships Sensor

	H-phone 1	H-phone 2
Tone Start (UTC):	Streaming	"
Tone Stop (UTC):	Streaming	"
CAL_GUI Rev. #	46	46
² Retrieval System Gain (dB re 1 µPa):	-163.7	-199.9
² Mobilization System Gain (dB re 1 µPa):	-163.6	-199.5

² Difference in Sys Gain between retrieval and the mobilization should be < 1.0 dB.

Retrieval cal required for M8 series hydrophones or as required by project.

Stop Time

² Actual stop time (UTC). ³ Stop time according to the AMAR clock.

Sync Event Time	² Record Stop, UTC	³ Record Stop, AMAR
	06:03:05	"

Eqpmnt ID

AMAR S/N	Inits:
624	

	H-phone Chan 1	H-phone Chan 2
Model:	M36-V35-900	M36-V00-901
S/N:	G000307	D000760
Verified by:	Inits:	Inits:

confirmed recording on retreival, see vids.

All fields complete, as verified by (Inits):

AMAR stopped, green dummy plug installed, pressure equalized, and PRV reset, as verified by (Inits):

Created from Deployment-Retrieval Log Template 00181 v3.3

JASCO APPLIED SCIENCES

AMAR Mooring Deployment Log

www.jasco.com Toll free: +1.866.825.2466
Please return if found.

AcRelease Codes (record again to confirm)		Station	AMAR S/N
NA	NA	C	623

General

Project #	Project Name	Project Manager (PM)	Alternate PM
P001631-001	Fugro Energy Island SSC	Federica Pace	Robin Burns

JASCO Team (Inits)	Location	Vessel	Captain, Crew
RM CR	Denmark	Fugro Pioneer	Calder Rob,

Local Time re UTC	Weather, sea state, drift bearing, etc.
+2	2.1m sig 3.5m max 23kn wind

Equipment ID

AMAR S/N	IP Address	Battery Pack(s) S/N: Ch 22 V:	Ch 23 V:
623	192.168.88.5		

	Beacon	H-phone Chan 1	H-phone Chan 2
Model:		M36-V35-90	M36-V00-901
S/N:		G000306	G000461
Verified by:	Inits:	Inits:	Inits:

	AcRel 1	AcRel 2
Model:	N/A	N/A
S/N:		
RELEASE Code:		
Enable Code:		
Disable Code:		
Verified by:	Inits:	Inits:

Record all dates and times in UTC.

Start

Rec Start yyyy-mm-dd	Rec Start Time (UTC)	Sync Event Time
2021-Sep-19	07:32:53	

Calibration

* AMBIENT pressure, which is the direct measurement, not barometric pressure.

Cal Date (UTC)	Calibrator Kit #	Calibrator Model	Calibrator S/N
2021-Sep-19	10	42AC	43119

*Amb Pressure (hPa)	Pressure Sensor used (incl. S/N)
1018.9	Ships sensor

	H-phone Chan 1	H-phone Chan 2
Tone Start (UTC):	Streaming	
Tone Stop (UTC):	Streaming	
CAL_GUI Rev. #	46	
² Deployment System Gain (dB re 1 µPa):	-163.3	-219.4
² Mobilzation Sys Gain (dB re 1 µPa):	-163.5	-218.7
[+] Peak SPL clipping threshold (dB re 1 µPa):		
[–] Peak SPL clipping threshold (dB re 1 µPa):		

² Difference in Sys Gain between deployment and the mobilization should be < 0.75 dB.

Deployment

Deploy Date (UTC)	Water Depth	Units
2021-Sep-19	32.726	m

GPS S/N(s)	+ Ship Draft or n/a
DZ GPS	0
	= Net Water Depth: 32.726

	Time (UTC)	Lat (d°mm.mmm' N/S)	Lon (d°mm.mmm' E/W)	GPS Waypoint	GPS Accuracy(m)
Proposed:	N/A	Multiple	Multiple		N/A
Controlled Drop Start:					
FreeDrop/ On Bottom:	"	56 33' 1.04" N	6 16' 43.55" E	"	"
Grapple Weight Drop:	"	56 33' 0.59" N	6 16' 46.36" E	"	"

locations are provided by ship survey gps, on bottom sidescan locations are 32N-EE21 easting northing: 332714.607 6270648.711. confirm hydrophone on y+y.

All required deck checks and deployment steps complete:

Note locations for multiple hydrophones here

All fields complete, as verified by (Inits):

Created from Deployment-Retrieval Log Template 00181 v3.3

JASCO APPLIED SCIENCES

AMAR Mooring Retrieval Log

www.jasco.com Toll free: +1.866.825.2466
Please return if found.

Confirmed Release Code(s)		Station	AMAR S/N
NA	NA	C	623

General

Project #	Project Name	Project Manager (PM)	Alternate PM
P001631-001	Fugro Energy Island SSC	Federica Pace	Robin Burns

JASCO Team (Inits)	Location	Vessel	Captain, Crew
RM CR	Denmark	*Fugro Pioneer*	Rob, Calder, Misha, Vicky, Malcolm, Vincenzo, Georgio, Eugenio
Local Time re UTC: +2	Weather, sea state, drift bearing, etc.	1.5 2m waves	

Deployment

Record Start Date	Record Start Time	Deploy Date	Net Water Depth
2021-Sep-19	07:32:53	2021-Sep-19	32.726 m

	AcRel 1	AcRel 2
S/N:	NA	NA
RELEASE Code:		
Enable Code:		
Disable Code:		

	Lat (d°mm.mmm' N/S)	Lon (d°mm.mmm' E/W)	GPS Waypoint	GPS Accuracy(m)
Controlled Drop Start:	"			
FreeDrop/ On Bottom:	56 33' 1.04" N	6 16' 43.55" E	"	"
Grapple Weight Drop:	56 33' 0.59" N	6 16' 46.36" E	"	"

Retrieval

Retrieve Date (UTC)	GPS S/N(s)
9/20/2021	DZ GPS

	Time (UTC)	Lat (d°mm.mmm' N/S)	Lon (d°mm.mmm' E/W)	GPS Waypoint	GPS Accuracy(m)
Release Code Sent:	"	"	"	"	"
Surfaced/End of Data:	05:13:32				
On deck:	05:25:27				

Calibration

*AMBIENT pressure, which is the direct measurement, not barometric pressure.

Cal Date (UTC)	Calibrator Kit #	Calibrator Model	Calibrator S/N
2021-Sep-20	10	42AC	43119

*Amb Pressure (hPa)	Ambient Pressure Source (incl. S/N)
1028.2	Ships sensor

	H-phone 1	H-phone 2
Tone Start (UTC):		
Tone Stop (UTC):		
CAL_GUI Rev. #		
² Retrieval System Gain (dB re 1 µPa):	-163.7	-219.2
² Mobilization System Gain (dB re 1 µPa):	-163.5	-218.7

² Difference in Sys Gain between retrieval and the mobilization should be < 1.0 dB.
Retrieval cal required for M8 series hydrophones or as required by project.

Stop Time

² Actual stop time (UTC). ³ Stop time according to the AMAR clock.

Sync Event Time	² Record Stop, UTC	³ Record Stop, AMAR
	05:51:56	

Eqpmnt ID

AMAR S/N	Inits:
623	

	H-phone Chan 1	H-phone Chan 2
Model:	M36-V35-900	M36-V00-901
S/N:	G000306	G000461
Verified by:	Inits:	Inits:

Flasher SN V06-18 (Yellow Tape) not working

All fields complete, as verified by (Inits):

AMAR stopped, green dummy plug installed, pressure equalized, and PRV reset, as verified by (Inits):

Created from Deployment-Retrieval Log Template 00181 v3.3

AMAR Mooring Deployment Log

JASCO Applied Sciences
www.jasco.com Toll free: +1.866.825.2466
Please return if found.

AcRelease Codes (record again to confirm)		Station	AMAR S/N
NA	NA	E	624

General

Project #	Project Name	Project Manager (PM)	Alternate PM
P001631-001	Fugro Energy Island SSC	Federica Pace	Robin Burns

JASCO Team (Inits)	Location	Vessel	Captain, Crew
RM CR	Denmark	Fugro Pioneer	Rob, Calder, Misha, Vicky, Malcolm, Vincenzo, Georgio, Eugenio
Local Time re UTC: +2	Weather, sea state, drift bearing, etc.	2.1m 3.3m waves 23 kn wind	

Equipment ID

AMAR S/N	IP Address	Battery Pack(s) S/N: Ch 22 V:	Ch 23 V:
624	192.168.88.5		

	Beacon	H-phone Chan 1	H-phone Chan 2
Model:		M36-V35-90	M36-V00-901
S/N:		G000307	D000760
Verified by:	Inits:	Inits:	Inits:

	AcRel 1	AcRel 2
Model:	N/A	N/A
S/N:		
RELEASE Code:		
Enable Code:		
Disable Code:		
Verified by:	Inits:	Inits:

Record all dates and times in UTC.

Start

Rec Start yyyy-mm-dd	Rec Start Time (UTC)	Sync Event Time
2021-Sep-19	06:54:11	

Calibration

* AMBIENT pressure, which is the direct measurement, not barometric pressure.

Cal Date (UTC)	Calibrator Kit #	Calibrator Model	Calibrator S/N
2021-Sep-19	10	42AC	43119

*Amb Pressure (hPa)	Pressure Sensor used (incl. S/N)
1018.9	Ships Sensor

	H-phone Chan 1	H-phone Chan 2
Tone Start (UTC):	Stream	"
Tone Stop (UTC):	Stream	"
CAL_GUI Rev. #	46	"
² Deployment System Gain (dB re 1 µPa):	-163.7	-199.9
² Mobilzation Sys Gain (dB re 1 µPa):	-163.6	-199.5
[+] Peak SPL clipping threshold (dB re 1 µPa):		
[–] Peak SPL clipping threshold (dB re 1 µPa):		

² Difference in Sys Gain between deployment and the mobilization should be < 0.75 dB.

Deployment

Deploy Date (UTC)	Water Depth	Units
2021-Sep-19	32.449	m

GPS S/N(s)	+ Ship Draft or n/a	= Net Water Depth
DZ gps	0	32.449

	Time (UTC)	Lat (d°mm.mmm' N/S)	Lon (d°mm.mmm' E/W)	GPS Waypoint	GPS Accuracy(m)
Proposed:	N/A	Multiple	Multiple		N/A
Controlled Drop Start:	"	"	"	"	"
FreeDrop/ On Bottom:	"	56 33' 9.09" N	6 18' 8.97" E	"	"
Grapple Weight Drop:	"	56 33' 8.76" N	6 18' 12.27" E	"	"

GPS points are from ship survey gps + sidescan, on bottom location in easting northings 32N-EE21: 334199.553 6270841.325. confirm recording on deployment y+y.

All required deck checks and deployment steps complete:

Note locations for multiple hydrophones here

All fields complete, as verified by (Inits):

Created from Deployment-Retrieval Log Template 00181 v3.3

JASCO APPLIED SCIENCES

AMAR Mooring Retrieval Log

www.jasco.com Toll free: +1.866.825.2466
Please return if found.

Confirmed Release Code(s)		Station	AMAR S/N
NA	NA	E	624

General

Project #	Project Name	Project Manager (PM)	Alternate PM
P001631-001	Fugro Energy Island SSC	Federica Pace	Robin Burns

JASCO Team (Inits)	Location	Vessel	Captain, Crew
RM CR	Denmark	*Fugro Pioneer*	Rob, Calder, Misha, Vicky, Malcolm, Vincenzo, Georgio, Eugenio
Local Time re UTC: +2	Weather, sea state, drift bearing, etc.		

Deployment

Record Start Date	Record Start Time	Deploy Date	Net Water Depth
2021-Sep-19	06:54:11	2021-Sep-19	32.449 m

	AcRel 1	AcRel 2
S/N:		
RELEASE Code:		
Enable Code:		
Disable Code:		

	Lat (d°mm.mmm' N/S)	Lon (d°mm.mmm' E/W)	GPS Waypoint	GPS Accuracy(m)
Controlled Drop Start:	"	"	"	"
FreeDrop/ On Bottom:	56 33' 9.09" N	6 18' 8.97" E	"	"
Grapple Weight Drop:	56 33' 8.76" N	6 18' 12.27" E	"	"

Retrieval

Retrieve Date (UTC)	GPS S/N(s)
9/20/2021	DZ GPS

	Time (UTC)	Lat (d°mm.mmm' N/S)	Lon (d°mm.mmm' E/W)	GPS Waypoint	GPS Accuracy(m)
Release Code Sent:	"	"	"	"	"
Surfaced/End of Data:	05:57:02				
On deck:	06:04:40				

Calibration

*AMBIENT pressure, which is the direct measurement, not barometric pressure.

Cal Date (UTC)	Calibrator Kit #	Calibrator Model	Calibrator S/N
2021-Sep-20	10	42AC	43119

*Amb Pressure (hPa)	Ambient Pressure Source (incl. S/N)
1028.2	Ships Sensor

	H-phone 1	H-phone 2
Tone Start (UTC):	Streaming	"
Tone Stop (UTC):	Streaming	"
CAL_GUI Rev. #	46	"
² Retrieval System Gain (dB re 1 µPa):	-163.5	-200.2
² Mobilization System Gain (dB re 1 µPa):	-163.6	-199.5

² Difference in Sys Gain between retrieval and the mobilization should be < 1.0 dB.
Retrieval cal required for M8 series hydrophones or as required by project.

Stop Time

² Actual stop time (UTC). ³ Stop time according to the AMAR clock.

Sync Event Time	² Record Stop, UTC	³ Record Stop, AMAR
	06:10:46	

Eqpmnt ID

AMAR S/N
624
Inits:

	H-phone Chan 1	H-phone Chan 2
Model:	M36-V35-900	M36-V00-901
S/N:	G000307	D000760
Verified by:	Inits:	Inits:

All fields complete, as verified by (Inits):

AMAR stopped, green dummy plug installed, pressure equalized, and PRV reset, as verified by (Inits):

Created from Deployment-Retrieval Log Template 00181 v3.3

Appendix I

Equipment Incident Report

JASCO

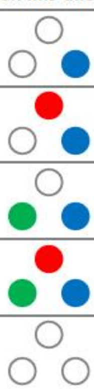
Issue entry number:	**4880**
Project number:	**P001631-001**
Project Description:	**2021, Fugro Netherlands Marine BV, Energy Island SSC**
Date Initiated:	**2021-09-15**

SECTION 1 – ROOT CAUSE INVESTIGATION

Identify the quality issue observed (what happened) as well as the circumstances surrounding the incident (when and where it happened, steps in process followed at the time of the incident, and any other factors that could have contributed to the incident such as equipment or environmental issues).

Deployment:

3 JASCO AMARs were deployed from the Fugro Pioneer on 2021-09-14 starting at 07:00UTC. Conditions were a clear sunny day with <1m seas. The instruction manual was consulted to verify the activation sequence prior to deployment, while the work area and AMARs were prepared and readied for deployment. On activation it was noticed that all AMAR LEDs were difficult to see due to bright direct sunlight. Consequently, steps were taken to shade the AMAR LEDs and the opaque AMAR housing, moving them into the shade of a workshop and covering them. The manual was consulted again, and care was taken to make sure that the red and blue recording LEDs were activated as indicated in the relevant sections from the AMAR manual shown in figures 1 through 4 below.



If the LEDs come on like this:	The AMAR is:
	Turning on
	Recording
	Sleeping
	Stopped
	Off, or has been powered on for more than 10 minutes and the LEDs went off

Figure 1: AMAR LED status codes, taken from the manual used.

To turn on the AMAR:

- Hold the magnet over the ⏻ (power) switch for at least 3 seconds.

  The blue LED flashes once, then the green LED comes on as the AMAR sleeps for up to 15 seconds (depending on the amount of memory installed).

  After the ~15 seconds of sleep, the AMAR initiates the Recording Schedule. The red or green LED comes on to indicate the status of the AMAR as described on page5.

  When the AMAR is powered on and recording, the LEDs turn off after 10 minutes to conserve power. For related information, see Re-activating the LEDs to check the AMAR's status on page 7.

Figure 2: AMAR turn on sequence, taken from the manual used.

To re-activate the LEDs to check the AMAR's status:

Hold the magnet over the **?** (status) switch for at least 3 seconds.

If the AMAR is on: then the blue LED flashes once and then the red or green LED comes on to indicate the status of the AMAR as described on page 5. After 10 minutes, the LEDs go off again to conserve power.

If the AMAR is off: the LEDs don't come on because (you guessed it) the AMAR is off.

Figure 3: AMAR status check sequence, taken from the manual used.

To stop the AMAR Recording Schedule:

- Hold the magnet over the STOP switch for at least 3 seconds.

  The red LED goes off and the green LED comes on and goes off while the Recording Schedule is stopping.

  When all three LEDs have come on, the Schedule is stopped and you can now connect to the AMAR with AMARlink.

✓ **TIP** When the AMAR is powered on and stopped, it uses a lot of battery power. So do not leave the AMAR in this state for a long time.

Figure 4: AMAR stop sequence, taken from the manual used.

<u>Retrieval</u>:

The team proceeded to retrieve the instruments at locations B and D on 2021-09-15, following the first round of surveys, and planned to re-deploy them to locations C and E. The project's QA process required the team to check that data was recorded correctly before re-deploying the instruments. Following this check, the field team discovered that no visible data was present on the instruments for the deployment period while the calibration data prior to deployment was recorded correctly. Therefore, they proceeded to retrieve the instrument at location A to check if it had recorded correctly also considering that the weather was deteriorating beyond the workable site conditions. No raw files were found other than the calibration also on the latter AMAR.

The field team then immediately started an investigation into the cause of the incident. The team were able to replicate the issue. Leaving the activation magnet in place long enough to have the red and blue LEDs on at the same time caused the AMAR to move from activation to deactivation; however, the field team believed the AMAR was still on and recording as the blue and red LEDs were on (consistent with Figure 1 above) despite having been deactivated.

The field team was also informed, at this time, that there was a magnetometer quite close to the instruments, which is known to emit a magnetic field.

Document results of investigation (document analysis & conclusions, include/attach relevant data, identify root cause of nonconformity).

<u>Post-retrieval investigation</u>:

The AMAR manual used was taken from the "Field CD", which is a folder maintained on each field laptop that is synced to an identical folder prior on the JASCO server prior to each field trip. The syncing program automatically looks on the server for newer versions of the documents on the laptop and updates the laptop accordingly. The field team confirmed they did this prior to departing for the field. The "Field CD" on the server was examined and found to contain two manuals for the AMAR G4 ACE with different names. One was dated 2018-12-14 and one was dated 2018-04-11. The field team used the 2018-04-11 document, which contained the instructions in Figures 1 through 3 above. The corresponding instructions in the 2018-12-14 document are shown in the Figures 5 through 8 below.

According to these instructions if the red and blue light were on at the same time that would indicate a transition from recording to stopping. This indicates the recording schedule may have been stopped prior to deployment, although the field team may have thought that indicated the recording had started based on the older instructions.

About the LEDs on the AMAR

There are 3 status LEDs on the top endcap of the AMAR. When the AMAR is powered on, these LEDs come on to indicate the status of the AMAR:

Blue LED flashing: AMAR is transitioning between states (i.e., turning on, turning off, or stopping)

Red LED on: AMAR is recording

Green LED on: AMAR is sleeping

Red and green LEDs on: AMAR is stopped (and ready to connect with AMARlink)

All LEDs off: AMAR is off or has been powered on for more than 10 minutes and the LEDs went off to conserve power

After the AMAR has been powered on for 10 minutes, the LEDs go off to conserve power. For related information, see Re-activating the LEDs to check the AMAR's status on page 7.

NOTE During a deployment, if the AMAR memory becomes full or if the batteries become nearly depleted, then the AMAR will go to sleep. So upon re-activating the LEDs at retrieval, the green LED would come on.

Figure 5: AMAR LED status codes, taken from the current version of the manual.

To turn on the AMAR:

- Hold the magnet over the ⏻ (power) switch for at least 3 seconds.

  The blue LED flashes once, then the green LED comes on as the AMAR sleeps for up to 15 seconds (depending on the amount of memory installed).

  After the ~15 seconds of sleep, the AMAR initiates the Recording Schedule. The red or green LED comes on to indicate the status of the AMAR as described on page5.

  When the AMAR is powered on and recording, the LEDs turn off after 10 minutes to conserve power. For related information, see Re-activating the LEDs to check the AMAR's status on page 7.

Figure 6: AMAR turn on sequence, taken from the current version of the manual.

Re-activating the LEDs to check the AMAR's status

After the AMAR has been powered on for 10 minutes, the LEDs go off to conserve power. To check the AMAR's status, you can turn the LEDs back on at any time.

To re-activate the LEDs to check the AMAR's status:

- Hold the magnet over the **?** (status) switch for at least 3 seconds.

  If the AMAR is on: then the blue LED flashes once and then the red or green LED comes on to indicate the status of the AMAR as described on page 5. After 10 minutes, the LEDs go off again to conserve power.

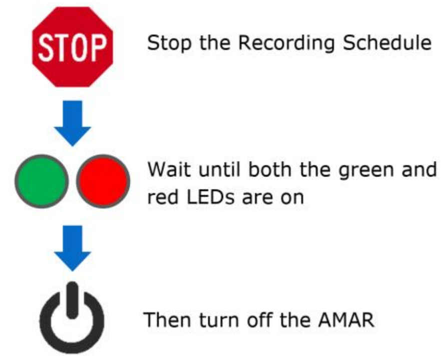
  If the AMAR is off: the LEDs don't come on because (you guessed it) the AMAR is off.

Figure 7: AMAR status check sequence, taken from the current version of the manual.

Turning off the AMAR

To turn off the AMAR, you must first stop the Recording Schedule.

! CAUTION Always stop the recording Schedule before turning off the AMAR. Factory testing has revealed that if the AMAR is sleeping and you turn it off without first stopping the Recording Schedule, then the AMAR can enter a mode in which power from the RTC backup battery is drained relatively quickly. Once in this mode, a new RTC backup battery would be drained in about 1 month, and a partially used battery would be drained in even less time.



To turn off the AMAR:

1 Stop the Recording Schedule by holding the magnet over the STOP switch for at least 3 seconds.

The blue LED flashes for a few seconds while the Recording Schedule is stopping. When both the red and green LEDs are on, the Schedule is stopped and you can now turn off the AMAR.

2 Hold the magnet over the ⏻ (power) switch for at least 3 seconds.

The blue LED flashes for a few seconds and then all the LEDs go off as the AMAR turns off.

Wait at least 5 seconds for the AMAR to power down completely before turning it on again (if applicable).

Figure 8: AMAR stop sequence, taken from the current version of the manual.

List root cause(s):

There were two AMAR G4 ACE manuals on the Field CD. The older one was not removed when the new one was uploaded, and the field team unknowingly used the older manual.

Possible contributing factor: The activation/deactivation switches of the AMARs are triggered using a magnet. As noted by vessel crew, the magnetometer was right next to activation site for the instruments and could have caused interference. The magnets used to activate the AMARs are not powerful enough to be classified as magnetized material according to international regulations for the transportation of dangerous goods, so it may not take a very powerful magnetic field to cause interference.

SECTION 2 – CONTAINMENT AND CORRECTION

What needs to be done to contain this issue? Determine correction(s) required to resolve the current occurrence(s) and list steps required to implement.

The field team performed the following actions to verify the equipment is not faulty:

- Power cycled the AMARs 3 times for each instrument to make sure they powered on, verifying start-up sequence is functioning correctly.
- Also collected data during the power cycling test to confirm the AMARs were recording and saving files.
- The recordings form the AMARs were check using PAMlab for validity.

The following further actions will be taken prior to redeployment:

- AMARs will be started with the correct starting and status check sequences as per figures 5 through 7 in a sheltered location out of direct sunlight, 45 minutes before deployment. This will allow the red recording LED its 10 minutes of time to cycle prior to turning off to conserve power, whereupon the separate query switch will be used to check the status of the AMAR.
- The status of the AMAR will be checked a total of two times before deployment to verify the status of the AMARs.
- The field team will verify the magnetometer is either off or not next to the deployment site prior to deployment.
- Perform a round of streaming calibrations prior to redeployment to further confirm AMAR functionality and precision.

Furthermore, a set of external battery packs have been ordered from Dartmouth Canada to extend the lifetime of the AMARs (along with appropriate mounding hardware).

SECTION 3 – CORRECTIVE ACTION

Determine corrective action(s) required to prevent recurrence on future projects and list steps required to implement.

- The out-of-date AMAR G4 ACE manuals will be removed from the Field CD on the server.
- The Field CD will be checked to make sure there are no other out of date manuals (any found will be removed) and all remaining manuals are current.
- All field staff will be advised to update their laptop version of the Field CD.
- Personnel responsible for updating the Field CD will receive refresher training regarding the importance of verifying any out-of-date material is removed when uploading new material, especially when a document is given a different file name as the older version will not then be overwritten.

SECTION 4 – VERIFICATION OF ACTION EFFECTIVENESS

Evaluate effectiveness of the correction(s) implemented.

Evaluate effectiveness of the corrective action(s) implemented.

If the correction(s) and corrective action(s) are deemed effective, then this Quality Issue may be closed. If actions are not deemed effective, then Sections 2 through 4 will need to be repeated.

Appendix J

TQ-002 Sparker Noise Monitoring Program

Query (TQ)

Project: Energy islands North Sea zone west – Geophysical site survey (Fugro)

Subject	Sparker noise monitoring program	**TQ-no.:**	**002**
Issue date:	2021-04-23	**Revision date:**	
Latest reply:		**Actual reply date:**	
Issued by:	Energinet/XMBHA Energinet/SID	**Issued to:**	Fugro
Issue ref.:		**Reply ref.:**	

(clarification sequence)	*(clarification details)*
Date: 2021-04-23 Initials: XMBHA	Please, can Fugro propose a solution for monitoring of noise from seismic sparker sources applied during 2D UHR survey? **Background** Energinet is challenged by increasing restrictions towards sparker surveys from the environmental protection authorities. They are concerned about the impact on the marine life. Currently the restrictions are determined based on noise models suffering from a limited level of evidence. This is currently mitigated by making the models more conservative which again leads to tighter restrictions. Energinet is in dialogue with researchers and consultants and see a potential, to get better models and lesser restrictions, if actual evidence could be established. Appendix 1 below include a statement from researchers / consultants regarding possible requirements for a setup to monitor sparker noise during survey. Energinet requests Fugro to propose a setup based on a pragmatic view on the input in Appendix 1. Energinet understands, that the complete list of requirements from Appendix 1 might not be realistic or possible to provide. Furthermore, Energinet don't want to increase risk for Fugro infer challenges to the time schedule.
Date: 2021-07-13 Initials: JCO	**From:** Jens Colberg-Larsen <jco@energinet.dk> **Sent:** maandag 12 juli 2021 16:12 **To:** Padwalkar, A. <A.Padwalkar@fugro.com> **Cc:** Martin Bak Hansen <XMBHA@energinet.dk> **Subject:** Energy islands. Geophysical survey - noise monitoring Dear Pad, I have an urgent request for which I would kindly ask your attention.

Query (TQ)

Project: Energy islands North Sea zone west – Geophysical site survey (Fugro)

Energinet and the Danish Energy Agency are re-considering to carry out a simple test program using a buoy with hydrophones to record noise from the various geophysical sensors (Sparker, SBP, SSS and MBES).

FIGURE 1 below provide a simple illustration of the concept we are looking for.

We wish to take advantage of existing mobilization with Pioneer (although I know that you might have demob'ed the Sparker System).

Please can you provide the following?

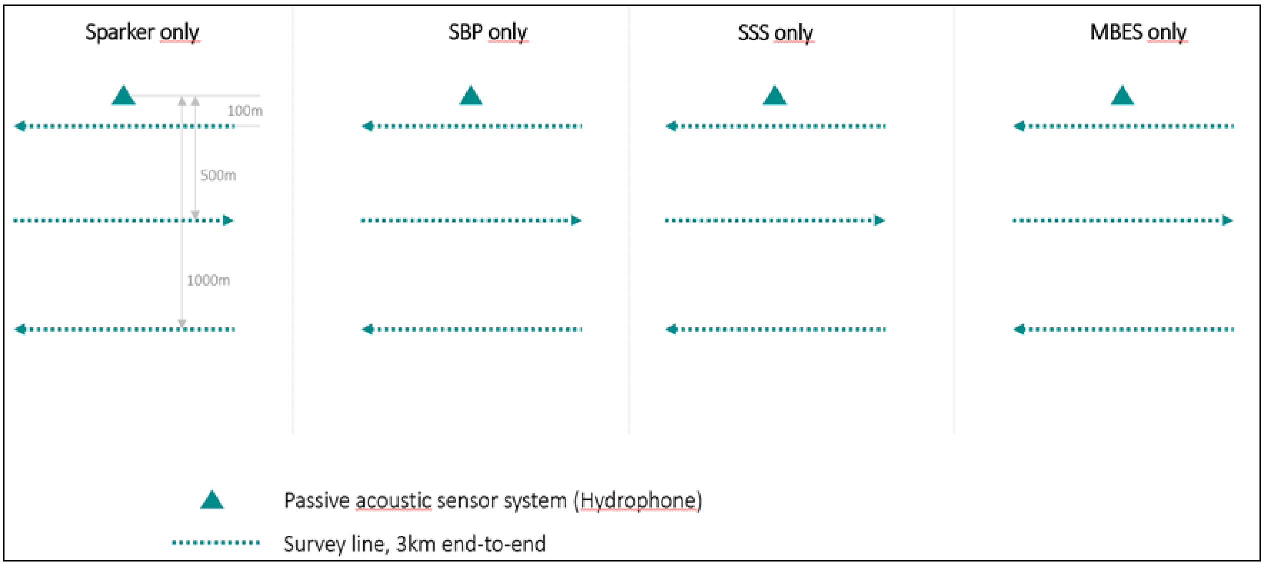
1. Fixed price for carrying out this activity

   - price include mob/demob, deployment and recovery of buoy including hydrophones sensitive for both near- and far-fields
   - test performed within existing AOI
   - price include possible mob/demob of a Sparker system
   - price include survey as described by the concept illustrated in FIGURE 1.
   - price include processing and reporting
   - any weather down-time will be picked up by our ordinary contract

2. Latest date for Energinet to decide commencement using the existing mobilization of Pioneer

The purpose of this additional work is that we are severely challenged by authorities that currently evaluate the environmental effects of survey more and more negatively.

FIGURE 1



Query (TQ)

Project: Energy islands North Sea zone west – Geophysical site survey (Fugro)

ENERGINET

Date: 2021-07-14 Initials: AP	**From:** Padwalkar, A. **Sent:** maandag 12 juli 2021 17:31 **To:** Jens Colberg-Larsen <jco@energinet.dk> **Cc:** Martin Bak Hansen <XMBHA@energinet.dk> **Subject:** F176286/190532_Energy islands. Geophysical survey - noise monitoring Good afternoon Jens Message received. I shall review the email with my team and revert to you. A few preliminary questions from my end : 1. Anticipated time for carrying out these test? I will check for Seismic personnel and equipment availability. 2. Do you want us to also quote for a Passive acoustic monitoring (PAM) equipment for noise monitoring as well or will DMA employ a separate contractor to perform the noise monitoring ? FYI : During Hesselo Project Danish university DCE were planning to perform similar noise monitoring but couldn't as their vessel wasn't ready . 3. Will the 3km test lines be performed on Fugro LOT#2 site or in a separate location? 4. Will this scope be a part of the Energy Island project ? 5. Apart from noise monitoring , if performed by Fugro , do you wish us to process survey data for Sparker, SBP, SSS and MBES recoded on the 3km test lines? Thank you. Met vriendelijke groet, **Pad**
Date: 2021-07-15 Initials: JCO	1. Anticipated time for carrying out these test? I will check for Seismic personnel and equipment availability. JCO: Preferable over the late summer July – August. Energinet is flexible to see which opportunities that the present mobilization might offer. 2. Do you want us to also quote for a Passive acoustic monitoring (PAM) equipment for noise monitoring as well or will DMA employ a separate contractor to perform the noise monitoring ? FYI : During Hesselo Project Danish university DCE were planning to perform similar noise monitoring but couldn't as their vessel wasn't ready . JCO: Yes. Energinet is looking for an all-inclusive also providing the buoy system and the acoustic monitoring system with data logger and hydrophones. Please see comments below in APPENDIX 1 provided by underwater noise specialist regarding the receiver system specifications. 3. Will the 3km test lines be performed on Fugro LOT#2 site or in a separate location? JCO: Yes. Preferably perform the test at the present AOI. 4. Will this scope be a part of the Energy Island project ? JCO: Energinet request to use the present contract for setup op a variation order to cover noise test. Any weather down-time associated with the noise test is compensated using the present contract. 5. Apart from noise monitoring , if performed by Fugro , do you wish us to process survey data for Sparker, SBP, SSS and MBES recoded on the 3km test lines? JCO: This would probably not make any sense. The purpose is to measure the noise levels at the receiver buoy from the geophysical instruments.

Query (TQ)

Project: Energy islands North Sea zone west – Geophysical site survey (Fugro)

Date: 2021-08-04
Initials: AP
	Fra: Padwalkar, A. <A.Padwalkar@fugro.com>
	Sendt: 4. august 2021 11:11
	Til: Jens Colberg-Larsen <jco@energinet.dk>; Martin Bak Hansen <XMBHA@energinet.dk>; Mark Aarup Mikaelsen (MAM) <MAM@NIRAS.DK>; Federica Pace <federica.pace@jasco.com>
	Cc: Attia, Safey <s.attia@fugro.com>; Theander, Maria <m.theander@fugro.com>; McGunnigle, Blair <b.mcgunnigle@fugro.com>; Burn, Patrick <p.burn@fugro.com>; Joyce, Miranda <m.joyce@fugro.com>; Schreiber, Mark <m.schreiber@fugro.com>; Davies, Richard <r.davies@fugro.com>; robert.mills@jasco.com; Szudzinska, Julia <j.szudzinska@fugro.com>
	Emne: RE: F176286/190532/196959_Energy islands. Geophysical survey - Noise monitoring
	20210803_Noise monitoring Discussi
	
	*** Vær opmærksom på afsender, links og filer.
	Good morning Jens, Martin, Mark and Federica
	
	Thank you for your contribution and agreements during the Noise monitoring campaign meeting held yesterday .
	
	The PowerPoint presentation is attached for your reference and the meeting recording for future reference / minutes is store in the Energinet SharePoint link here.
	
	A few points that jump out:
	1. Energinet and NIRAS are in acceptance of the proposed noise monitoring execution strategy outlined by Fugro/JASCO -Jens kindly confirm
	2. Fugro to assist JASCO where possible to schedule mobilization of noise monitoring before 15 September. JASCO – we can confirm staff will be available to travel as from 9 september. Ability to execute project before depends then largely on any quarantine requirements (an exemption may be possible for offshore works) and on the transport time of the equipment which is mainly out of JASCO's control.
	3. Further to point #2 , Energinet and NIRAS suggests Fugro/JASCO to consider interim reporting (within **x** days of survey completion) followed by final reporting (4-6 weeks) – Energinet to outline the requirement of interim deliverable in TQ
	4. JASCO to revert on proposed system measurement of directionality/ directivity. JASCO – additional directional data for input to a Ray tracing model would require a setup with a vertical array with several sensors spaced ~1m apart. This cannot be provided within the requested timeframe. Mobilization of such systems require approximately 6 months and would add considerable cost to the survey
	5. JACSO/ Fugro to propose a matrix of trails in the ops plan. JASCO- Yes this will be included in the Ops plan.
	
	▪ Sample JASCO's public reports involving source characterization
	    ▪ Scotian Basin Monitoring project
	    ▪ Barossa field monitoring
	    ▪ Shelburne drilling sound source characterization

Date: 2021-08-05 Initials: JCO	Fra: Jens Colberg-Larsen Sendt: 4. august 2021 14:27 Til: 'Padwalkar, A.' <A.Padwalkar@fugro.com> Cc: mam@niras.dk; Martin Bak Hansen <XMBHA@energinet.dk> Emne: SV: F176286/190532/196959_Energy islands. Geophysical survey - Noise monitoring Hi Pad Thank you a very well organized meeting with Fugro and JASCO! Add #1: Yes – Energinet confirms the general strategy outlined by Fugro / JASCO with the following remarks:

Query (TQ)

Project: Energy islands North Sea zone west – Geophysical site survey (Fugro)

<table>
<tr><td></td><td>

a. It was discussed to add a secondary hydrophone receiver "above" the bottom-fixed AMAR plate to optimize to mapping of the directionality of the sound field. Please let us know if this could be accomplished within the present setup. We see this as highly beneficial for the tests. JASCO – an additional sensor would not provide the desired information. Furthermore, no additional hydrophones of the required sensitivity are in stock at the moment. NIRAS: if the equipment is not available, I guess we have to discard this part of the investigation. FUGRO/JASCO : Noted

b. It was further discussed to sample the sparker from "far" distances such as 5km and 10km from the receivers. We see this could be accomplished by extending the planned survey lines from 3km to 10km instead of moving the buoy configuration. JASCO – yes that is an option if the goal of the data obtained from the extended lines is to confirm if sparker levels are above/below ambient noise. This approach would not allow collecting results along the perpendicular line of the transect as for the other tests. NIRAS: Could you please elaborate on why it would not allow collecting results along the perpendicular line? If the concern is regarding the TL between B,C and perpendicular lines, I would assume the TL from A -> 10 km could be used. JASCO : The data along the new proposed perpendicular line can be collected. Previous response just meant to say that it is a different transect compared to the other data collected as clear from the drawing. I do not see it as an issue.

Add #3: Yes – Energinet will provide details for the reporting (interim and final) via suitable TQ. Please standby.
</td></tr>
<tr><td>Date: 2021-08-05
Initials:
Mark A Mikaelsen</td><td>

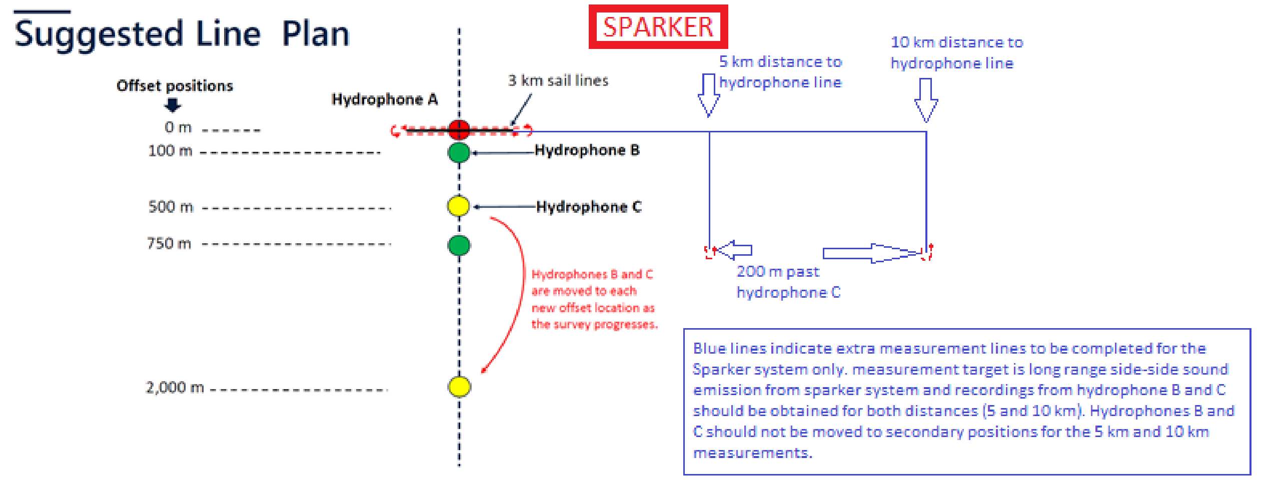
This note aims to specify which results should be delivered by FUGRO/JASCO, as part of an early interim delivery package to Energinet as soon as possible following conclusion of Noise monitoring trials. JASCO : interim deliverable 7-10 days after demob from vessel (time necessary for data download, transfer to secure server and automated processing)

The list below should be seen as the most important metrics to present in the interim delivery package, and does not include all required metrics, to be delivered in the final report.

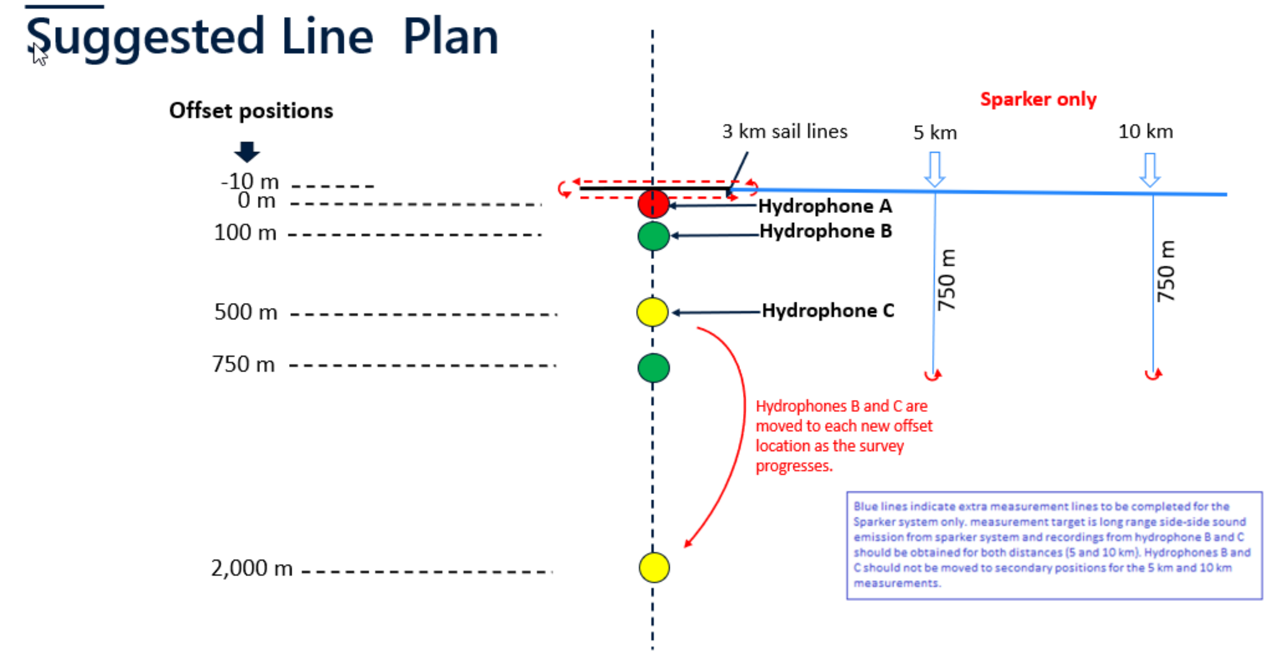
Results to be presented in the interim delivery package must (at least) include the following <u>for each source type</u>:

1. Sound Exposure Level (SEL) and $SPL_{rms,fast}$ (125 ms):
   a. **Distance(s):** from measurement stations B and C, when distance to vessel is 100m, 500m, 750m, 2km, (as well as 5km and 10km for Sparker) (when vessel is perpendicular on proposed measurement system line). Similarly, from measurement station A (on vessel transect) at horizontal distances of 0m (directly above), 100m, 500m, 750m, 1.5 km before and after measurement station A. Also at 5 km and 10 km distance after passing station A when using the Sparker system. JASCO: Do you mean SEL single strike or cumulative? For cumulative, do you require averaging over 24 hours or some other interval? NIRAS: Single Strike SEL only. JASCO: Noted, thank you for the clarification.
   b. **Frequency weighting:** All results given both unweighted and using each of the NOAA 2018 (Southall 2019) filters for LF, HF and VHF and PW species. JASCO:I believe some of the filters from Southall 2019 are slightly different from NOAA 2018. Can you confirm if your preference is to follow NOAA 2018or Southall 2019? The thresholds are unchanged between the two references. NIRAS: I believe the only change between NOAA 2018 and Southall 2019 is the "label". That is, LF,MF,HF (NOAA) -> LF, HF, VHF (Southall). If there are minor differences in the filters, Southall 2019 would be the ones to use, however if this is indeed the case, a brief illustration of the difference would be greatly appreciated. JASCO: Sure we will verify and highlight if any difference is present in the filters.
</td></tr>
</table>

	c. **Numerical result presentation**: 1/3 octave bands and single value broadband in table format for all combinations of item a. and b. Individual results must be labelled with Measurement distance and measurement station ID. JASCO: Noted d. **Graphical result presentation**: 1/3 octave bands, time signal and PSD of single pulse / 125ms window at each distance mentioned in 1a. JASCO: Noted e. **Source level**: Source level estimate from measurement station A at horizontal distance of 0 m (directly above measurement system). JASCO: Noted 2. Sound Pressure Level (SPLp and SPLpp): a. **Distance(s):** same as for SEL, as described in item 1a. JASCO: All below noted. b. **Frequency weighting:** Unweighted results only c. **Numerical result presentation:** same as item 1c d. **Graphical result representation:** none e. **Source level:** same as item 1e 3. Sound Speed Profile
Date: 2021-08-05 Initials: Mark A Mikaelsen	In addition to the strategy for noise monitoring outlined by Fugro, "far distance" tests as specified in the following illustration is requested as part of the sparker tests only: JASCO: suggested line plan below



Date: 2021-08-06 Initials: APA	JASCO comments in Red above . Please not the hydrophones which do require an export permit are not available immediately and would take 3-4 weeks which is not compatible with the schedule. JASCO have hydrophones with a sensitivity of -220 dB V/uPa (instead of -240) for stations A and B and -200 dB V/uPa at station C. Looking at the sources you listed, combined with the experimental design I believe this is still fine but I wanted to flag it up as a deviation from what we presented at the meeting Suggested line plan for test of all sources combined is proposed with an offset of -10m . This is to ensure the source levels do not exceed the sensitivity of the hydrophone.



Date: 2021-08-09 Initials: MAM / NIRAS	Please see replies to questions in this TQ dated 2021-08-05 in green font color above. /MAM
Date: 2021-08-10 Initials: APA	Please see responses in this TQ dated 2021-08-09 in Blue font above.
Date: 2021-08-19 Initials: MAM / NIRAS	Responses from JASCO and FUGRO accepted. No further clarifications.
Date: 2021-09-13 Initials: APA/ JASCO Date: 2021-09-13 Initials: MAM / NIRAS	Test for Marine and survey echosounder (SBES) separately with inclusion of 2 additional test sequence? Survey SBES is traditionally used with various combinations of survey equipment, such as: MBES, SSS, Innomar and 2DUHR (sparker) equipment. **Marine SBES is always switched-on for safe navigation – never switched-off** It is understood that MBES, SSS, and other sources are always used with SBES activated for normal operations. In the current and approved test plan, each source is planned to be tested without the SBES. Questions? -Should this be modified to have survey SBES on? **NIRAS: SBES should be off during test of MBES, SSS, UHR and Innomar.** - Should a single pass with only survey SBES on be included in the testing or should this be incorporated in the vessel pass? **NIRAS: Not required / Not relevant – please skip.** Client to indicated if Option 1 or Option 2 is the desired outcome. **Option 1: always run tests with Survey SBES ON.** **Option 2: run test with SBES ON only for the All sources scenario, as per Revised test plan document . NIRAS: Recommended option**

Query (TQ)

Project: Energy islands North Sea zone west – Geophysical site survey (Fugro)

Conclusion Date: 2021-08-10 Initials: JCO	TQ describe how a noise test from geophysical acoustic sources is performed. Refer to TQ for details. TQ closed.

Query (TQ)

Project: Energy islands North Sea zone west – Geophysical site survey (Fugro)

Appendix 1 – Statement from noise modelling engineer

As discussed, the more data we can acquire, the more we will learn. Energinet is however fully aware that the budget is a factor, and we assume that the operation of the survey equipment should generally be in line with normal survey operation (that is, we cannot define how they should operate their equipment to suit our measurements, rather we will take what we can get).

Energinet's comments/suggestions are as follows.

1. Data acquisition must be using calibrated recorder(s) and generally follow NPL guidelines (attached).
2. Frequency range to be recorded must be as large as possible – ideally 10 Hz – 128 kHz
3. Dynamic range should be considered carefully based on the deployment distance from the survey equipment – optionally a multi hydrophone-recorder setup with a high sensitivity hydrophone and a low-sensitivity hydrophone should be used to ensure full valid data coverage
4. Deployment depth should ideally be between 0,5 – 0,75 x water depth (e.g. at 50 m depth, the system should be deployed at 25 – 37 m depth)
5. Recorders should record for as long as possible with as many passes close by and far away as possible
6. Survey equipment should – to the extent possible – be operated with time-separated pulses between different equipment models. That is, in order to be able to isolate the contribution from the individual sources, each piece of survey equipment should be fired with a time offset relative to the other equipment models.
7. Survey vessel log must include GPS time stamps
8. Survey equipment operational data must be supplied
9. Sea state should be logged during the entire recording period
10. CTD probe(s) should be deployed to provide information on temperature and salinity. If possible, a depth dependent measurement should be obtained (that is, measurements should be obtained at every 1 m of water depth throughout the entire water column).
11. Recorder(s) or mooring system/buoy must include GPS
12. Deployment position should be at a relatively flat area (as uniform bathymetry and sediment as possible for > 5 km radius)
13. Examples of recorder that could be used are: JASCO "amar-g4" or RTSYS RESEA

And a few nice to have additions if the budget allows:

1. 2 separate recording systems with the above specifications, placed on the same seismic vessel transect but offset by 1 km. This to record the same exact pulses at two ranges to give better indications of sound propagation loss over distance during the recordings
2. 2 separate recording systems at different depths, one as specified above, another in the upper 25% of the water column, but at the same location (x,y)
3. If the budget allows, a vessel deployed line of hydrophones could be added to record the near-field levels at multiple depths (to get information on the directivity of the equipment)

NPL guide 133.pdf

Appendix K

COVID-19 Outbreak

Management Plan

Outbreak Management Plan for COVID-19 disease

Procedure | FVMS-PIO-WOR-50121

Issue	Rev	Date	Prepared By	Reviewed By	Approved By
1	0	16 March 2020	Z. Lasauskas	J. Kerssen	G. de Jeu
1	1	25March 2020	Z. Lasauskas	J. Kerssen	G. de Jeu
1	2	31 March 2020	Z. Lasauskas	J. Kerssen	G. de Jeu
1	3	24 April 2020	Z. Lasauskas	J. Kerssen	G. de Jeu
1	4	22 June 2020	Capt / MAO	J. Kerssen	M. Goddijn
1	5	13 Nov 2020	J. Kerssen	A. Aleksandrov	RFM

Procedure

1. Objectives c

To manage a suspected COVID-19 case and possible spread of the virus on board Fugro Pioneer

2. Scope

Applies to all visitors and crew, on board Fugro Pioneer during transits, port calls and on project site.

3. Responsibilities

Table 3.1: Responsibilities of given roles for the activities described in this document

Role	Responsibility
Master	Preparing the vessel and crew as per procedure and responsible for enforcing procedure as defined
Medic	Assisting master, communicates with ISOS top-site, ensuring workflow annex A followed

4. Definitions and Abbreviations

Table 4.1: Definitions

Suspected case of COVID-19	A. A patient with acute respiratory illness (fever and at least one sign/symptom of respiratory disease, e.g., cough, shortness of breath), AND a history of travel to or residence in a location reporting community transmission of COVID-19 disease during the 14 days prior to symptom onset. OR B. A patient with any acute respiratory illness AND having been in contact with a confirmed or probable COVID-19 case (see definition of contact) in the last 14 days prior to symptom onset; OR C. A patient with severe acute respiratory illness (fever and at least one sign/symptom of respiratory disease, e.g., cough, shortness of breath; AND requiring hospitalization) AND in the absence of an alternative diagnosis that fully explains the clinical presentation.
Confirmed case	A person with laboratory confirmation of COVID-19 infection, irrespective of clinical signs and symptoms. Technical guidance for laboratory testing can be found https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical guidance/laboratory-guidance
Definition of contact	A contact is a person who experienced any one of the following exposures during the 2 days before and the 14 days after the onset of symptoms of a probable or confirmed case: 1. Face-to-face contact with a probable or confirmed case within 1 meter and for more than 15 minutes; 2. Direct physical contact with a probable or confirmed case;

	3. Direct care for a patient with probable or confirmed COVID-19 disease without using proper personal protective equipment1 ; OR 4. Other situations as indicated by local risk assessments. Note: for confirmed asymptomatic cases, the period of contact is measured as the 2 days before through the 14 days after the date on which the sample was taken which led to confirmation.
Close contact	Crew working with (suspected) infected crew in same department, been in close proximity (at least 1.5m) with suspected crew, sharing a cabin, stewards cleaning the cabin of suspected case. If widespread transmission is identified, then all persons on board could be considered as close contacts having had high risk exposure.
PUI Person under investigation	Fever OR acute respiratory infection (sudden onset of respiratory infection with at least on of shortness of breath, cough or sore throat) AND Travel to or reside in Covid-19 outbreak area in the 14 days before the onset of illness OR Close contact in 14 days before illness onset with a confirmed case of COVID-19.

Table 4.2: Abbreviations

COVID-19	Corona virus disease 2019
ERT	Emergency Response Team
FFP	Filtering face piece
H	Hours
IP	Ill Person
ISOS	International SOS
MERP	Medical emergency response plan
PPE	Personal protective equipment
PUI	Person Under Investigation
RMA	Radio Medical Advice from nearest Coast Guard
WHO	World Health Organisation
°C	Degrees Celsius
PUI	Person Under Investigation

5. Vessel alongside

5.1 Prior to Boarding

During crew changes and sign on of crew, if there is more than five sign on crew, the agent will be advised to send the on-signing crew in batches. This would facilitate on-signing formalities to be prudently completed while maintain social distancing. This is communicated with the agent by the FPA and OPA.

It's mandatory for all joining crew to complete temperature tracking form with 14 days history and health declaration form, unless otherwise stated by means of a MOC. It is mandatory for all visitors who wish to attend on board are willing to do a health declaration. Communication with visitors is via VSI or PM. All Fugro Fleet Services circulars and guidelines will be strictly followed.

Any crew feeling unwell after their travel and while waiting for boarding should immediately report to the agent and seek medical advice. All crew on board are to have the temperatures taken twice a day until they are disembarked. Guidance for protecting everyone during ship visits can be found in Appendix E.

5.2 Pre-Boarding screening

During the port call while alongside the watchman stand will be placed at quay side next to the gangway and manned by a trained crew (preferably officer) who would on boarding formalities. When port authorities do not permit the stand at quay side, the watchkeeping stand would be next to the gangway on board the vessel. There would also be a hand sanitizer station at the quay side. It is mandatory for all crew and visitors to appropriately sanitize their hands before boarding. The gangway watchkeeping crew is advised to put on medical PPE consisting of FFP2 mask, safety glasses and medical gloves. In the instance the watchkeeping crew is not wearing the mask, it is advised to wear a faceshield. At least 1.5 metre (5 feet) distance should be kept between yourself and others as practicable as possible

On-signing crew are required to present temperature tracking form and health declaration form upon arrival. If crew not able to present the forms, they can be refused boarding on board the vessel. All visitors are to complete a health declaration before boarding the vessel. The records will be checked for completeness and identifying suspected cases that require further assessment. All visitors and crew that have cleared their declarations, will have their temperature measured using a infra-red touch free thermometer, and if the temperature is above 37.5 degree celsius, boarding will be refused.

If a crewmember will develop symptoms while already signed on but vessel still (mobilising) alongside, crew member will be isolated as per isolation plan under 7. and send to doctor at first opportunity.

Visitors if on board for more than 12 hours, they will have temperatures taken twice a day or if they are noticed to have Covid-19 like symptoms, they may be asked to disembark vessel and seek further medical advice.

6. Vessel offshore

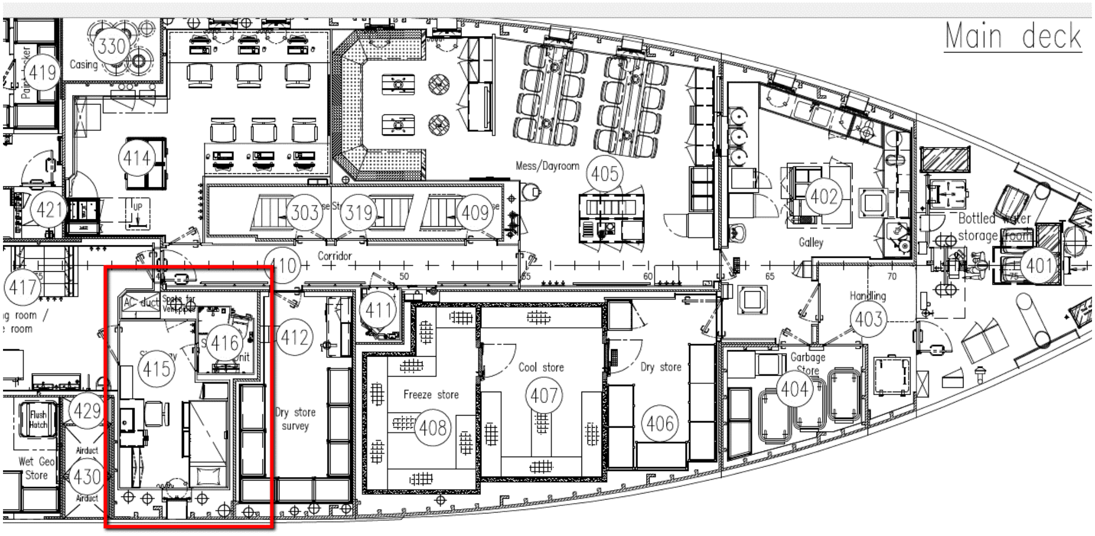
When the vessel has a suspected COVID-19 case as per definitions , the ISOS "workflow COVID-19 on site management as per Appendix A will be activated. Following this flow diagram, it deemed necessary the suspected case will be placed in an isolation cabin on board the vessel. His / her symptoms should be recorded in the 'Crew COVID-19 health check' tracker. (Sent by RFM on 11th November 2020). Local port authorities shall be informed as per port circulars and guidelines. The initial assessment and treatment shall be provided by the on board medic. A medical evacuation of the suspected case shall be carried out as per the FVMS MEDEVAC, project specific Medical Emergency Response Plan and local authority requirements and guidelines. Every effort would be made to disembark the suspected for on shore treatment at the earliest opportunity. (example as below)

7. Isolation Plan

On the Main deck the Sickbay (Cabin 415) will act as Isolation Cabin. Due to the size of the vessel, a 2nd matrass have to be placed in the cabin if a 2nd person need to be isolated. A isolation curtain need to be placed in the changing room, to indicate the location of Isolation room, and segregate this from the remaining space. The area between the curtain and the isolation room is the area for the medic and caretakers to prepare and discard themselves before entering the isolation area, the so called Ante Area. It is recommended that there is stock of disposal coveralls. The isolation cabin should remain vacant and ready to receive suspected cases and should not be used, even during project.

Shortly before the sickbay (Cabin 415) is taken into use as Isolation Cabin, all not COVID-19 related medical equipment and medicine/ bandages should be temporarily stores outside the sickbay.

The Washing machine in the Changing room (normally only to be used for the coveralls) should be used for the laundry from the Isolation room only, and strictly isolated from all other laundry. The care taker is to immediately wash the laundry of the suspected crew immediately upon collecting it. Medical PPE are to be worn when handling such laundry.


Main deck
Casing
Mess/Dayroom
Corridor
Galley
Bottled water storage room
Handling
Garbage Store
Freeze store
Cool store
Dry store
Dry store survey
AC duct
Flush Hatch
Wet Geo Store
Airduct
330
419
414
421
417
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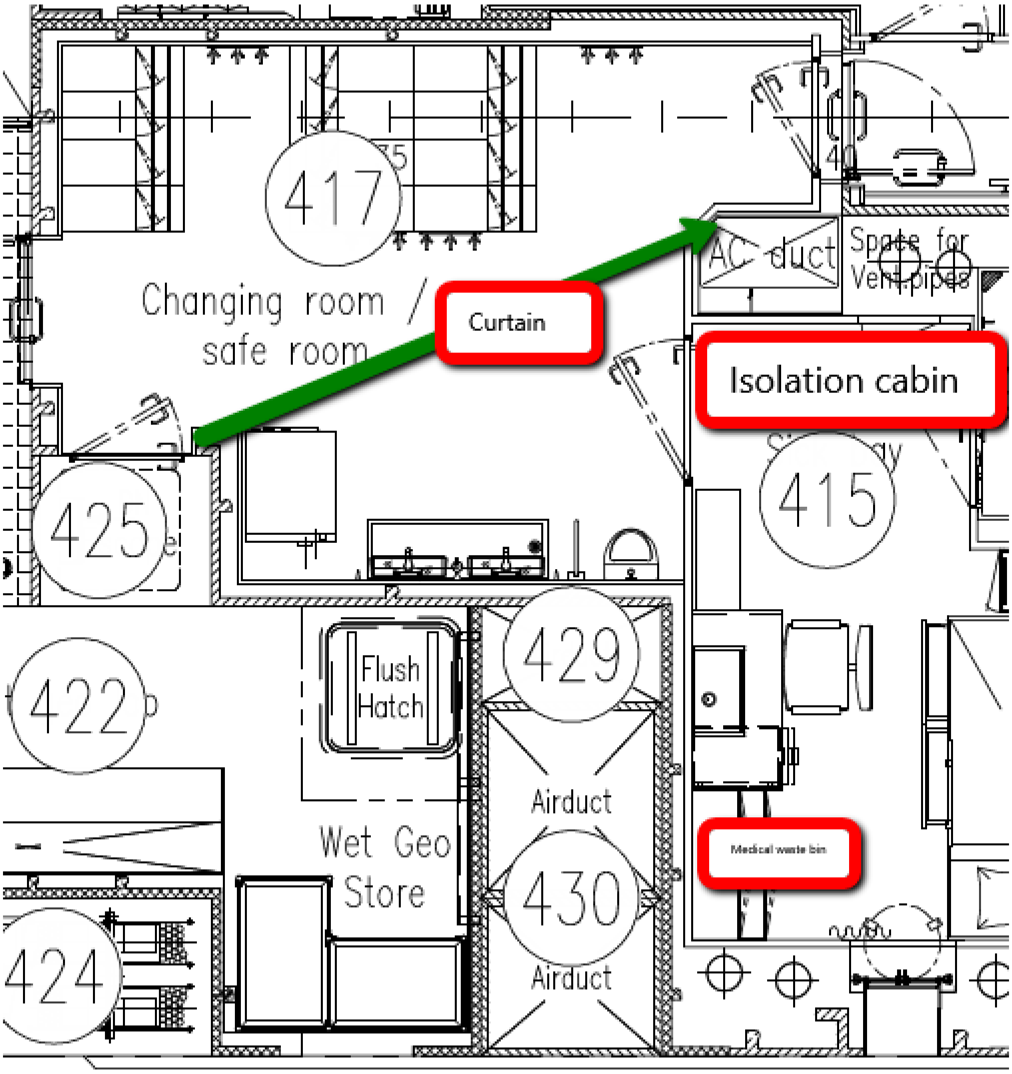

417
Changing room / safe room
Curtain
AC duct
Space for Vent pipes
Isolation cabin
425
415
422
Flush Hatch
429
Airduct
Wet Geo Store
430
Airduct
424
Medical waste bin

7.1 Isolation rooms layout

The access to isolated cabin will be from alleyway accommodation. The cabin is separated from the other cabins by curtains as indicated above drawing. Signs are posted on the outer curtain that this is an isolation area. The cabin have a shower cabin available, with washing and hygiene supplies available. The importance of having the ventilation running and no shut-downs have been discussed with the Engineers. The cabin doors ventilation rosters have been closed and tapped off with plastic. Inside the isolation are there is:

- ☑ Telephone in cabin
- ☑ Fresh Water in 10 ltr bottles inside cabins, included disposable paper cups.
- ☑ Touch free waste bins inside cabins for IP own use
- ☑ Medical waste bin for caretaker use
- ☑ Soap and detergent (hand-rub) inside shower cabins, including cleaning materials for cabins
- ☑ Basic caretaker instruments, stethoscope, thermometer, blood pressure cuff)
- ☑ Disposal Overall/ clothing for suspected isolated crew to use.

Inside the Ante Area there is:

- ☑ Medical waste bin
- ☑ Hand rub, detergent

Outside of the isolation area there is:

- ☑ PPE stocked for caretaker table
- ☑ Eye protection
- ☑ Gloves, latex single use
- ☑ Particulate respirators FFP2
- ☑ Gowns
- ☑ 10 Ltr pressure sprayer

7.2 Managing the suspected case

The medic with the advice from a shore doctor (usually from ISOS) shall medically manage the suspected crew until he is MEDEVAC for shore treatment. It is important that the crew is kept in high spirits during his isolation.

A useful assessment tool to see whether a seafarer might have COVID-19 can be found at

COVID19atsea.no

Further guidance can be found at

who.int/publications-detail/global-surveillance-for-human-infection-with-novel-coronavirus-(2019-ncov)

COVID-19 affects different people in different ways. Symptoms is identified in the International Chambers of Shipping COVID-19 guidance is provided below.

Common Symptoms	Other Symptoms	Occasional Symptoms
Fever	Shortness of Breath	Diarrhoea
Dry Cough	Aches and Pains	Nausea
Tiredness	Sore Throat	Runny Nose
		Loss or change in taste/ smell
		Rash

Anyone displaying the above symptoms should be reported immediately, the outbreak management plan should be activated, the person should be considered as a suspected case of COVID-19, and they should be isolated in their own cabin or ship's medical facility to await further assessment. The 'Crew COVID-19 health check tracker' shall be filled in with the required data. This assessment should inter alia ascertain whether there is another likely cause, e.g. allergy, tonsillitis, etc.

Any crew onboard who has been traced back by authorities/airlines as close contact should be premilinarily treated as suspected case and ISOS must be contacted for further advice and actions required.

The following precautions should be taken:

- All patients must wear the facemask. This should be followed by performing hand hygiene with an alcohol-based hand rub (at least 65–70%) or soap and hot water for 20 seconds.
- Careful hand washing should occur after contact with respiratory secretions.
- Suspect cases must wear a medical mask once identified and evaluated in a private room with the door closed, ideally an isolation room;
- Any person, including caring crews, entering the room should apply appropriate precautions in accordance with the requirements of WHO infection prevention and control during healthcare when COVID-19 is suspected; and
- After preliminary medical examination, if the ship's medical officer or person responsible for the provision of medical care believes a suspect case exists, the patient should be isolated.

Medical care providers should:

- Ensure a suspect case is interviewed and provide information about the places they have visited within the last 14 days prior to the onset of symptoms and their contacts, including the period from one day before the onset of symptoms on board the ship or ashore; and
- Keep records regarding:
  - Anyone on board who has visited the medical facility as a suspect case and the isolation and hygiene measures taken;
  - Any close contact or casual contact with low risk exposure to monitor their health.

Close contacts should be asked to:

- Self-monitor for COVID-19 symptoms, including fever of any grade, cough or difficulty breathing, for 14 days from their last exposure; and
- Immediately self-isolate and contact health services in the event of any symptom appearing within 14 days. If no symptoms appear within 14 days of their last exposure, the contact person is no longer considered likely to develop COVID-19.

Port State health authorities should be informed of any suspect cases and they may also guide how close contacts and others are managed in line with their national requirements.

Implementation of specific precautions may be modified following risk assessment of individual cases and advice from port health authorities.

Annex D is a poster which advises on shipboard care for people with suspected or confirmed COVID-19.

The vessel is to maintain high level cleaning and disinfection measures during ongoing on-board case management. Patients and 'close contacts'' cabins and quarters should be cleaned and using cleaning and disinfection protocols in section 7.6.

7.3 Isolation procedure

After preliminary medical examination, if the ship's medical officer or person responsible for the provision of medical care believes a suspect case exists, the suspect case should be isolated in the isolation rooms.

The crew member and his/ her personal belongings will be moved to the isolation cabin. If the crew member is still able to pack his own belongings in a suitcase or bag, this would be allowed. Otherwise, appointed caretaker will wear medical PPE as defined and will move the personal belongings to the isolation room. Cleaning of the cabin will be done as per section 7.6.

The only crew who is permitted to enter the isolation area and rooms are the on-board medic and by master appointed caretaker. Caretaker(s) will be trained by on board medic in procedures as per Annex B and C.

Before entering, hand hygiene with alcohol based hand rub to be performed. After this PPE to be put on in the order that ensures adequate placement of PPE items and prevents self-contamination and self-inoculation while using and taking off PPE. For illustrated order of donning PPE, see Annex B

When leaving the isolation area, the PPE needs to be removed in the Ante Area. Remove PPE in a manner as illustrated in Annex C that prevents self-contamination or self-inoculation with contained PPE or hands. General principles are:

- Remove the most contaminated PPE items First
- Preform hand hygiene immediately after removing gloves
- Remove the mask or particulate respirator last
- Discard disposable items in medical waste bin

Medical waste from medical waste bin shall be transported by crewmember wearing full PPE, And all medical waste shall be collected on board in a separate container for disposal ashore.

7.4 Disembarkation of suspected case

The vessel Master, shall in consultation with the Medic, prepare a MEDEVAC for the suspected crew as per the project Medical Emergency Response Plan (MERP) or the FVMS Emergency Response Plan Health Emergency Procedure. The local agents shall be contacted and local port state requirements shall also be complied. All requirements for flag state reporting shall also be complied. Vessels engaged in international voyages shall make contact with the nearest port of refuge or follow guidance as provided by MEDEVAC providers such as ISOS and P&I. When a port of refuge is identified, it is prudent that contact is made with port authorities to seek permission for the MEDEVAC of sick crew at the earliest.

When suspected crew needs to disembark for transport to the hospital, effort should be made to minimize the exposure of other persons and environmental contamination. Suspected cases to be provided with a FFP2 mask to minimize the risk of transmission and other medical precaution guidelines as per the shore medical team. It is not advised the disembarking crew is accompanied provided shore assistance is arranged to support the crew. If care taker from the vessel need to accompany the suspected crew, then he should wear suitable PPE (gloves, impermeable gown, goggles and medical mask).

7.5 Vessel Quarantine

If the vessel has a confirmed case, it is necessary that all close contacts are identified, isolated as per the isolation procedure. The requirement for vessel to quarantine will be dependent on the local port state requirements and this shall be strictly followed. In the instance the port state requirements are not available, a task risk assessment with involvement of the regional fleet manager, business line manager, vessel superintendent, vessel master and offshore manager/ party chief shall be prepared taking into consideration professional medical advice given by the medical experts on the subject matter such as those of ISOS and a risk-based decision shall be made.

7.6 Cleaning and disinfection

Food service utensils are disposable and to be discarded together with waste from the cabins. It is essential that the ship remain at port for the time required to thoroughly clean and disinfect the cabins, preferably by third party. Cabins to be disinfected by bleach. Bleach can be used as a disinfectant for cleaning and disinfecting (dilute 1-part bleach in 50 parts water, or 1000 ppm). Bleach solutions should be prepared fresh. Leaving the bleach solution for a contact time of at least 10 minutes is recommended. If no Bleach is available on board, use other Disinfectants like Dettol.

Alcohol (e.g. isopropyl 70%, ethyl alcohol 60%) can be used to wipe down surfaces where use of bleach is not suitable e.g. metal. If other disinfectants are considered, check with the manufacturer that they are active against coronaviruses. Disinfectants should be prepared and applied in accordance with the manufacturer's guidelines. Ensure that appropriate contact time is given before removing any disinfected materials.

8. Associated Controlled Documents

- Health declaration form
- Pre-boarding Temperature tracking form
- Temperature tracking form
- Crew COVID-19 Health check tracker
- Mobilisation plan
- Port call plan

9. References

Infection prevention and control of epidemic-and pandemic-prone acute respiratory infections in healthcare WHO guidelines.

Fugro Pioneer Medical Evacuation response plan (MERP) International SOS

10. Revision History

Table 10.1: Description of revision to document

Issue	Rev	Description of changes
1	1	New section on Vessel Quarantine; New details on Cleaning and Disinfection; Further guidance on managing the suspected case; Changes to crew temperature monitoring; Updated the isolation procedure to incorporate procedure for suspected crew belongings; New Annex A issued;
1	2	Changes in definitions of Suspected case of COVID-19 case on board a vessel and Close Contact. "All crew on board are to have the temperatures taken twice a day until they are disembarked" inserted in Section 5.1 Prior to Boarding. Inserted "The gangway watchkeeping crew is advised to put on medical PPE consisting of FFP2 mask, safety glasses and medical gloves. In the instance the watchkeeping crew is not wearing the mask, it is advised to wear a faceshield. At least 1.5 metre (5 feet) distance should be kept between yourself and others as practicable as possible." In Section 5.2 – Pre Screening Boarding. Inserted "Any crew onboard who has been traced back by authorities/airlines as close contact should be premilinarily treated as suspected case and ISOS must be contacted for further advice and actions required." in Section 7.2 Managing the suspected case.
1	3	Changes in definitions of Suspected case of COVID-19 case on board a vessel and inserted the definition of confirmed case and definition of contact.
1	4	Added Guidance for protecting everyone during ship visits can be found in Appendix E in Section 5.1 - Prior to Boarding. Added Appendix E. and added unless otherwise stated by means of a MOC Added widespread transmission in close contact definition. Updated Section 7.2 - Managing the suspected case with Symptoms Table and some additional points including Appendix D which is is a poster which advises on shipboard care for people with suspected or confirmed COVID-19 as per the International Chambers of Shipping COVID-19 guidance.
1	5	Updated reference to 'Crew COVID-19 Health Check tracker' in section 6, section 7.2 and section 8.

Annex A

WORKFLOW FOR ON-SITE MANAGEMENT OF SUSPECTED COVID-19

The following must be in place:

- Each facility should have an identified isolation room (with en-suite bathroom preferably) where a suspected patient may be placed. Further criteria for isolation room to Outbreak Management Plan.
- All staff who have contact with a suspected patient must be logged onto a contact register.
- Identified housekeeping personnel is/are assigned to do the disinfection process. PPE for the housekeeping personnel: FFP2 mask, disposable gown, face shield/goggle, gloves.
- PPE for Site Medic: FFP2 mask, disposable gown, face shield/goggle, gloves,(head cover, plastic apron If available on board.)

Definition of PUI:

Fever OR acute respiratory infection (sudden onset of respiratory infection with at least on of shortness of breath, cough or sore throat)

AND

Travel to or reside in Covid-19 outbreak area. in the 14 days before the onset of illness OR Close contact in 14 days before illness onset with a confirmed case of COVID-19.

Does IP fulfill the above criteria?

No

Person is symptomatic either having fever or respiratory infection symptoms

Provide IP with a surgical mask and move immediately to a nominated isolation area

Case escalation to medical RMA and/or ISOS. FS ERT to be activated.

RMA and/or ISOS provide further direction

IP to be managed on-site

If IP is for on-shore /out of site referral
To follow the same flow of suspected COVID-19

(fulfill PUI criteria)

Either one of the recommendations will take place after discussion with ERT/Master/RMA/ISOS

Yes

Case escalation to medical RMA and/or ISOS. FS ERT to be activated.

RMA and/or ISOS provide further direction

Site medic

Pre-embarkation

- Provide IP with a surgical mask and move IP
- immediately to a nominated isolation room
- Liaise with Bosun to activate housekeeping for disinfection process
- Liaise with RMA/ISOS for preparation on documentation for IP immediate disembarkation to shore/ nearest designated hospital
- Site Medic to initiate contact tracing

During embarkation

- Site Medic to ensure IP is wearing PPE as required (surgical facemask, disposable gown, glove)
- If disembarkation is using standby boat/vessel, IP needs to be put in
- nominated isolation area/room

Post embarkation

- Site Medic to ensure disinfection of IP's room, work space, and all the common areas IP came into contact with onboard (e.g. hand railings, table, chair and et cetera). Isolation Room and Sick Bay have to be disinfected as well after IP disembarked from vessel.
- Site Medic to monitor all other POBs on board for possible similar symptoms. Should anyone is unwell; he/she shall see Site Medic
- immediately, and Site Medic to escalate to RMA accordingly.
- Site Medic to speak to all POBs on-board in the next upcoming toolbox/ morning meeting regarding the importance of hand hygiene, cough etiquette and personal hygiene.
- Site medic to continue identifying the close contact of IP onboard.
- Close contact of IP to be quarantine (preferably each one in single room) until confirmation test for COVID-19 is ready.

RMA / ISOS

Coordinate all shore activities.

- Ensure ground transport team is ready to receive the IP at handover point
- Ensure designated hospital is aware IP that is coming

- Company to keep contact with IP and NOK

PUI: Person Under Investigation
IP : ill person
Close contact:

- Healthcare associated exposure without appropriate PPE (including providing direct care for COVID-19 patients, working with healthcare workers infected with COVID-19, visiting patients or staying in the same close environment of a COVID-19 patient).
- Working together in close proximity or sharing the same classroom environment with a with COVID-19 patient.
- Travelling together with COVID-19 patient in any kind of conveyance.
- Living in the same household as a COVID-19 patient.

RMA: Radio Medical Advice from nearest Coast Guard
ISOS: International SOS
MERP: Medical Evacuation Response Plan
ERT: Emergency Response Team

Annex B

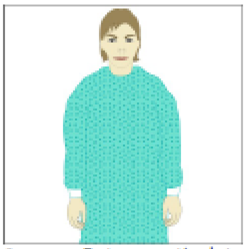
Isolation rooms or areas

Figure E.1 Putting on and removing personal protective equipment

A. Putting on PPE (when all PPE items are needed)

1

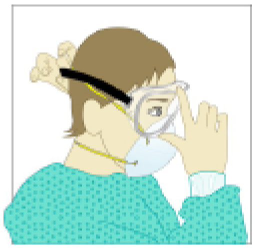
- Identify hazards and manage risk.
- Gather the necessary PPE.
- Plan where to put on and take off PPE.
- Do you have a buddy? Mirror?
- Do you know how you will deal with waste?

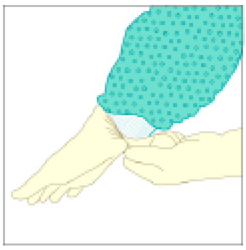


2 Put on a gown.

3 Put on particulate respirator or medical mask; perform user seal check if using a respirator.

4 Put on eye protection, e.g. face shield/goggles (consider anti-fog drops or fog-resistant goggles). Caps are optional: if worn, put on after eye protection.





5 Put on gloves (over cuff).

Annex C

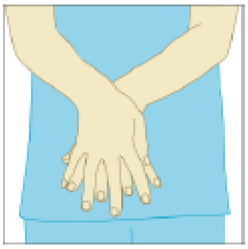
Isolation rooms or areas

B. Taking off PPE

1

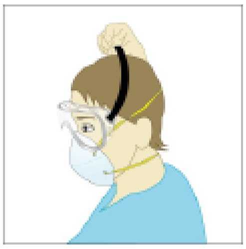
- Avoid contamination of self, others and the environment.
- Remove the most heavily contaminated items first.

Remove gloves and gown:
- peel off gown and gloves and roll inside, out;
- dispose of gloves and gown safely.



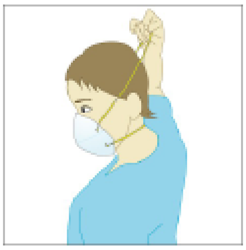
2

Perform hand hygiene.



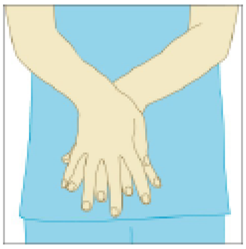
3

- Remove cap (if worn).
- Remove goggles from behind.
- Put goggles in a separate container for reprocessing.



4

Remove respirator from behind.



5

Perform hand hygiene.

Annex D

Shipboard care for people with suspected or confirmed COVID-19

For ill crew members

Clean hands frequently with soap and water or with alcohol-based hand rub.

Stay in your cabin and do not attend work. Rest, drink plenty of fluids and eat healthy food.

Stay in a separate cabin from other people. If this is not possible, wear a mask and keep a distance of at least 1m away. Keep the cabin well-ventilated and if possible use a dedicated bathroom.

When coughing or sneezing, cover your mouth and nose with flexed elbow or use disposable tissue and discard after use. If you experience difficulty breathing, contact radio medical.

For caregivers

Clean hands frequently with soap and water or with alcohol-based hand rub.

Wear a medical mask when in the same cabin with an ill person. Do not touch your face during use and discard it afterward.

Use dedicated dishes, cups, eating utensils, towels and bed linen for the ill person. Wash everything used by the ill person with soap and water.

Identify surfaces frequently touched by the ill person and clean and disinfect them daily.

Contact radio medical immediately if the ill person worsens or experiences difficulty breathing.

For all crew members

Clean hands frequently with soap and water or with alcohol-based hand rub.

Avoid unnecessary exposure to the ill crew member and avoid sharing items, such as eating utensils, dishes, drinks and towels.

When coughing or sneezing, cover your mouth and nose with flexed elbow or use disposable tissue and discard after use.

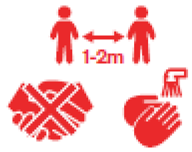
Monitor everyone's health for symptoms such as fever or a cough. If anyone has difficulty breathing, contact radio medical immediately.

Annex E

Protecting everyone during ship visits

COVID-19 is spread through small droplets from the nose or mouth of an infected person which may be inhaled or land on objects and surfaces other people touch, after which they then touch their eyes, nose or mouth.

Protect through social distancing and good hygiene



Keep a minimum of 1–2 metres distance.

No handshakes or physical contact.

Wash hands frequently and thoroughly, keeping contact surfaces clean, and touch your face less.

Prepare for visitors

Wipe down areas and objects visitors are likely to touch with an anti-bacterial solution.

Restrict access into the ship's accommodation – keeps doors locked and post 'no entry' signs.

Provide alcohol hand gel ready for use upon entry onto the ship and around the ship.

Have designated toilet and handwashing facilities for visitors, which are well-stocked with soap.

Try to prepare and complete documents digitally – avoid handling paper and laminated documents.

Have PPE, such as disposable gloves, ready to use in unavoidable close contact situations.

Keep your guard up

Maintain effective ship and gangway security and prevent unauthorised personnel boarding the ship.

If someone trying to board the ship exhibits symptoms – refuse access and report it.

Continue to sanitise contact areas throughout the ship's stay in port.

Take it outside

Where possible, hold conversations and meetings with visitors on the open deck or open bridge wings.

If visitors must be inside, limit the number of crew nearby to the absolute minimum.

Based on information kindly provided by the North of England P & I Club