FACULTY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF GEOLOGY

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UNIVERSITY OF TROMSØ cruise report

Longyearbyen – Longyearbyen 07-07-15 to 11-07-15

R/V Helmer Hanssen

Cruise CAGE15-4

Centre for Arctic Gas Hydrate, Environment and Climate (CAGE))

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INTRODUCTION AND OBJECTIVES

Cruise CAGE15-4 with UiT's research vessel Helmer Hanssen is the third of several cruises that will be carried out to collect cross-disciplinary data for addressing the objectives of the Norwegian Centre for Arctic Gas Hydrate, Environment and Climate, CAGE.

The short 3-day cruise has only one major objective which is to repeat a P-cable survey covering the active seeps on the Vestnesa Ridge (Figure 1) in order to develop time-lapse 4D seismic studies of gas leakage. We also deployed three more OBS stations during the 3D seismic survey to get additional velocity information at selected locations.

Figure 1: Location of the study area.

METHODS

Seismic methods

The CAGE part of the R/V Helmer Hanssen cruise is aimed to acquire P-Cable high-resolution 3D seismic data over pockmark fields, gas chimneys, shallow gas accumulations, and hydrate-bearing sediments on the Vestnesa Ridge. We plan to acquire a second repeat survey of P-Cable 3D seismic cube shot over the active seeps in 2012.

The high-resolution P-Cable 3Dseismic system was used together with a Granzow high-pressure (210bar) compressor and one mini-GI gun (15/15 in^3). Onboard seismic processing and QC of P-Cable seismic data provided preliminary 3D cubes for quality assessment and geofluid interpretations.

During this cruise we used SIMRAD EM300 high-resolution multibeam seabed mapping see report C), P-Cable high-resolution seismic, SIMRAD EK 60 38 and 18 kHz echolot, and the Edgetech Discover penetration echolot. CTD stations are carried out to extract information about different (T, S) properties of water masses to calculate the speed of sound for calibrating the EM300.

The P-Cable 3D seismic system

The P-Cable 3D high-resolution seismic system consists of a seismic cable towed perpendicular (cross cable) to the vessel's steaming direction (Figure 2 and 3). An array of multi-channel streamers is used to acquire many seismic lines simultaneously, thus covering a large area with close in-line spacing in a cost efficient way. The cross cable consists of two 62,5-m long and one 87,5-m long section with a total of 14 streamers attached to it. Including lead-in cables, the cross cable has a total length of 233 m between paravanes (doors) (Figure 2). The cross-cable is spread by two paravanes that due to their deflectors attempt to move away from the ship. The paravanes itself are towed using R/V Helmer Hanssen's large trawl winches. The spacing between the streamers is 12.5 m but due to curvature of the cross-cable, the effective spacing between the streamers may be shortened in cross line direction to about 6-12 m. Each digital streamer is 25 meters long and consists of an A/D-module and 8 channels. New Geometrics solid state streamers are used that are much less affected by sea swell and hence provide data with significantly less noise. The A/D-module converts the analogical signal from the channels to digital signals. The group spacing of channels along the streamer is of 3.125 m.

A 300-m long signal cable is run off the P-Cable winch and connects to the starboard termination of the cross cable (Figure 3). It contains wiring for power and data transmission. The data is transferred via Ethernet protocol. Ethernet-to-Coax switches at the ends of the signal cable allow data transmission over long distances. The digital data is recorded using Geometrics GeoEel software.

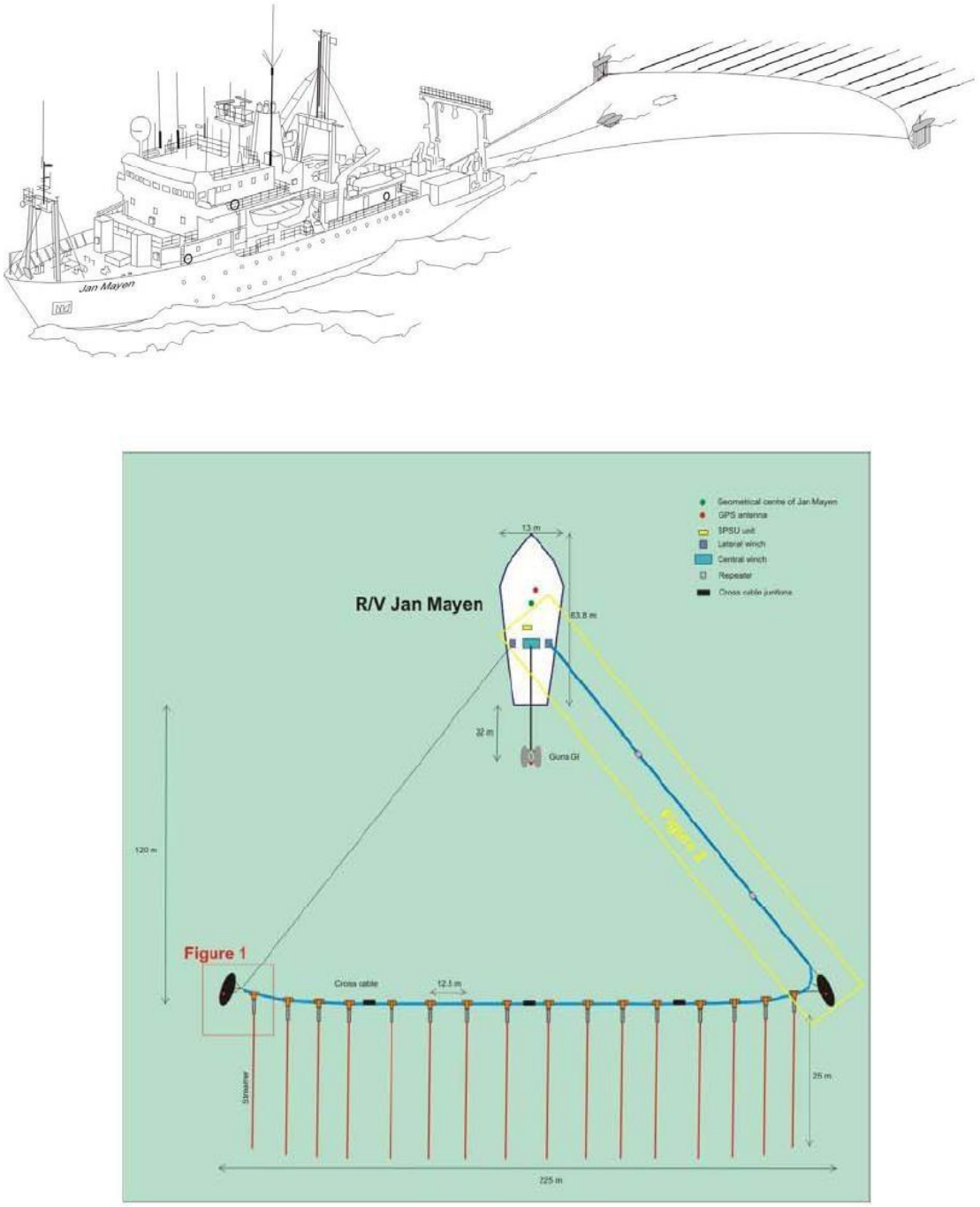


Figure 2: Schematic sketch (top) and technical drawing (bottom) of the P-Cable high-resolution 3D seismic system.

Figure 3: Images of the P-Cable system during deployment and recovery. Top left: the cross cable is being deployed, streamer sections are connected during deployment; top and bottom right: The cross cable is recovered and spooled back on the winch while streamers as disconnected from the cross cable. The small winch next to the cross cable holds the signal cable; bottom left: inspection of cross cable junction boxes during deployment and recover.

Multi-component ocean bottom seismometer (OBS)

Multi-component Ocean Bottom Seismometer (OBS) were deployed to record compressional and shear wave velocities. Four multi-component Ocean Bottom Seismometer (OBS) were deployed in approx 325 m water depth in area 1. The main purpose of the survey was to acquire P and S wave reflection data above seismic amplitude anomalies observed during the high-resolution 3D seismic survey. The aim is to model more accurately potential gas hydrate and free-gas accumulations.

The OBS systems used represent two design types that serve the same purpose (Figure 3). They are autonomous sea floor recording platforms, designed to record both, compressional and shear waves reflected and refracted through the sediments. It consists of a titanium frame with buoyancy made of syntactic foam, a KUMQUAT acoustic release system, and a digital data recorder in a separate pressure case[1]. A hydrophone and a 3-component geophone are
used to record the seismic wavefield. The Tromsø OBS has a 4.5 Hz geophone attached. While the hydrophone is fixed to the frame of the OBS, the geophone is detached from it. This design insures that the geophone is mechanically decoupled from the frame, to avoid noise generated by the frame being recorded by the geophone. The whole system is rated for a water depth of up to 6000 m.

The OBS is attached to a ground weight via the acoustic release system, to make it sink to the sea floor after deployment. When the seismic experiment is completed, the OBS is released from its ground weight by sending an acoustic code and it rises to the sea surface by its buoyancy.

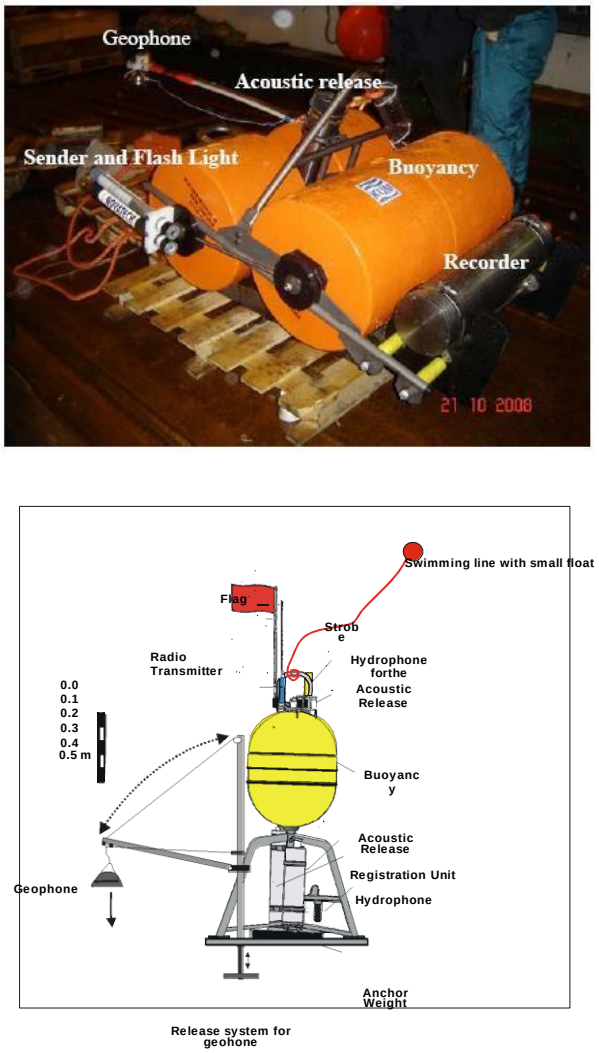


Figure 3: The old (bottom) and the new (top) Ocean Bottom Seismometer (OBS) system (UiT).

The OBS systems were prepared and programmed prior to deployment. The first channel records the hydrophone data, while channel two, three and four are connected to horizontal and vertical components of the geophone. The locations were selected based on seismic anomalies in the conventional 3D seismic data. The station list is given in the appendix and the positions of the OBS on the seafloor in area 1 is indicated in Figure 4.

PRELIMINARY RESULTS

The cruise left Longyearbyen on the 7th of July at 20:00. Initial weather conditions were poor in the Vestnesa Ridge area so we steamed into Kongsfjorden overnight. At 08:00 on the 8yh of July, we started a deployment and recovery test in order to test the system and train new personnel who had not worked with the P-Cable system. The test went very well without any failures. In the early afternoon, weather conditions had calmed down and we steamed to the Vestnesa Ridge where we arrived at 19:00. Three OBS were deployed at selected locations based on an analysis of the seismic quality factor Q that indicates an elevated concentration of gas hydrates. Shortly thereafter we deployed the P-Cable system.

The cruise successfully acquired a P-Cable 3D seismic data set in good weather conditions and without any failure over a period of 2 days. Due to the brevity of the cruise, onboard processing could not be completed. Initial QC of the data showed that it is of good quality.

The three OBS were successfully recovered and back onboard at 16:00 in the afternoon. All three OBS have recorded data. Helmer Hanssen then steamed back to Longyearbyen were we arrived at 08:00 on the 11th of July.

Further details are given in the 3D seismic log which also is the narrative of the cruise.

ACKNOWLEDGEMENT

We thank the captain and his crew of R/V Helmer Hanssen of the University of Tromsø for their excellent support during the 3D and multicomponent seismic survey. This part of the cruise was conducted under the framework of the Centre of Excellence on Gas Hydrates, Environment and Climate (CAGE) (Norwegian Research Council (NFR) project number 223259/F5 at the University of Tromsø.

APPENDIX

OBS Stations

OBS Locations (2015_CAGE)

	OBS 1	OBS 2	OBS 3
X	454184	453846	452826
Y	8772157	8772494	8773458
Z (m)	1200	1198	1207
Vw (m/s)	1464	1467	1465

Coordinates in UTM zone 32.

3D seismic line log

Expedition: Helmer Hanssen July 2015 Survey: Vestnesa 08.07 – 10.07 Sheet #: 1 - 5

Survey configuration: see end of document Times are UTC

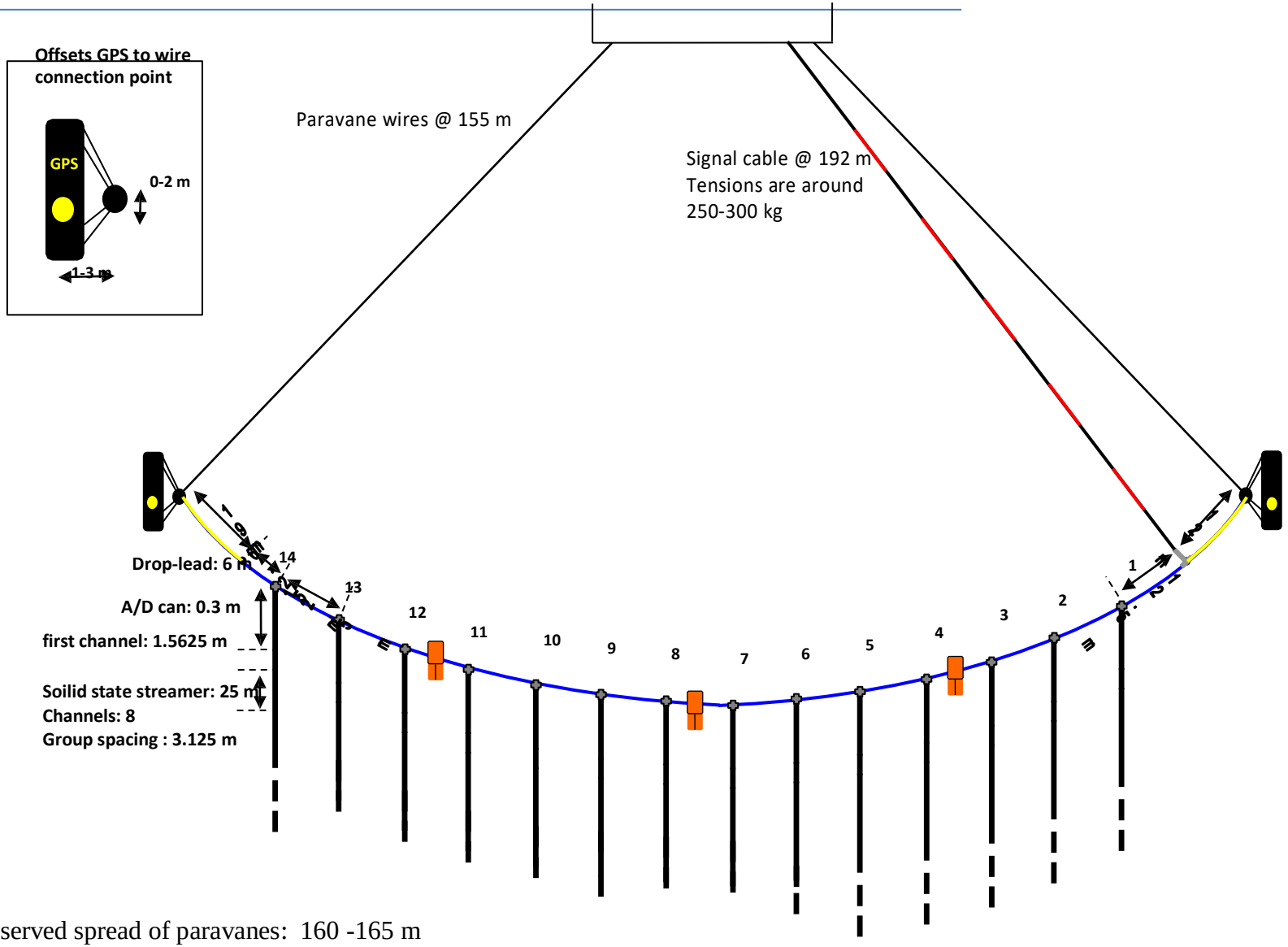
3D line number:	Date: Start - end	Time (UTC): Start - end	Shot point number First - last	Shot point number when crossing planned start and end of line	Comments (sailing direction, ship speed, depth sensor, wind speed, air temperature downtime, etc.)
					Channel 57 deactivated due to high noise,
0000	08.07-08.07	21:01-22:40	1-1315	N/A	Ship speed: 3 kn Wind: 8.0 m/s Wind dir: 19 deg. Shot 1279 Channels 42 and 24 disabled Channels 24, 42, 57 disabled.
01	08.07-08.07	22:40-23:46	1316-2312	1427-2279	Sailing direction NW, wind speed 6.3 m/s, wind dir 20 deg. Ship speed 3.8 knts Slight manoeuvre to the north of line, didn't run straight and missed start by ~40m but kept recording and sailing line 1 Incomplete datafile 1826
02	09.07-09.07	00:09 – 01:15	2313-3296	2400-3291	Sailing SE, wind speed 7,5 m/s; wind dir 30 deg, ship speed 4.3 kn
03	09.07-09.07	01:34-02:38	3297-4261	3368-4255	Sailing NW, wind speed 5.5 m/s;wind dir 37 deg, ship speed 4.4 kn
04	09.07-09.07	02:56-04:01	4262-5234	4362-5223	Sailing SE, wind speed 7.0 m/s;wind dir 40 deg, ship speed 4.3 kn Incomplete datafile 4684 Incomplete datafile 4685
05	09.07-09.07	04:16-05:24	5235-6251	5330-6205	Sailing NW, wind speed 3.5-5.5 m/s;wind dir 65 deg, ship speed 4.0 kn Incomplete datafile 5887

					Incomplete datafile 5889
06	09.07-09.07	05:35-06:42	6252-7252	6358-7220	Sailing SE, wind speed 5.0 m/s; wind dir 48 deg, ship speed 4.2 kn Incomplete datafile 6613
07	09.07-09.07	07:00-08:02	7253-8152	7311-8124	Sailing NW, wind speed 4.0 m/s; wind dir 24 deg, ship speed 4.3 kn
08	09.07-09.07	08:15-0925	8153-9196	8275-9160	Sailing SE, Wind speed 5.43 m/sec; wind direction: 30 deg, ship speed 4.2 kn Incomplete datafile 8625
09	09.07-09.07	09:48-10:51	9197-10138	9230-10062	Sailing NW, wind speed 5.0 m/s; wind dir 4 deg, ship speed 4.3 kn Ship out of track at beginning of line
10	09.07-09.07	11:03-12:07	10139-11141	10192-11093	Sailing SE, Wind speed 6.43 m/sec; wind direction: 10 deg, ship speed 4.2 kn
11	09.07-09.07	12:17-13:22	11142-12122	11191-12066	Sailing NW, wind speed 8.5 m/s; wind direction 14 deg; ship speed 4.2 kn Incomplete datafile 11625
12	09.07-09.07	13:33-14:40	12123-13128	12150-13070	Sailing SE, wind speed 9.9 m/s; wind direction 18 deg; ship speed 4.1 kn
13	09.07-09.07	14:48-15:51	13129-14069	13180-14062	Sailing NW, wind speed 9.0 m/s; wind direction 9 deg; ship speed 4.2 kn Incomplete datafile 13359
14	09.07-09.07	16:04-17:06	14070-1499	14107-1497	Sailing SE, wind speed 11 m/s; wind direction 12 deg; ship speed 4.1 kn
15	09.07-09.07	17:22-18:29	15000-15958	15016-15900	Sailing NW, wind speed 10.5 m/s; wind direction 11 deg; ship speed 4.1 kn
16	09.07-09.07	18:38-19:44	15959-16957	16006-16924	Sailing SE, wind speed 8,8 m/s; wind direction 8 deg; ship speed 4.0 kn

					Missing data on file 16443,16444
17	09.07-09.07	19:56-20:58	16958-17889	17024-17855	Sailing NW, 11.9 m/s, wind direction 1 deg; ship speed 4.3 kn
18	09.07-09.07	21:11-22:17	17890-18882	17957-18852	Sailing SE, wind speed 8.2 m/s, wind direction 5 deg; ship speed 4.1 kn Incomplete datafile 18458.
19	09.07-09:07	22:27-23:32	18883-19867	18974-19835	Sailing NW, 9.70 m/s, wind direction 1 deg; ship speed 4.3 kn
20	09:07-10:07	23:44-00:49	19868-20830	19915-20802	Sailing SE, wind speed 9.2 m/s, wind direction 4 deg; ship speed 4.1 kn 72 channel bad signal
21	10.07-10.07	01:03-02:06	20831-21780	20863-21760	Sailing NW, 11.5 m/s, wind direction 10 deg; ship speed 4.0 kn A few missed/gaps nav files in the AFT antenna on the Seatrack at the start of the line
22	10.07-10.07	02:24-3:28	21781-22739	21810-22722	Sailing SE, wind speed 9 m/s, wind direction 17 deg; ship speed 3.9 kn. Lost GUN nav after line 22 end
23	10.07-10.07	04:46-05:52	22740-23733	22796-23705	GUN nav missing in beginning of file, starts again at 04:03 following battery replacement. Sailing NW, wind speed 11.5 m/s; wind direction 17 deg; ship speed 4.0kn. Incomplete Datafile 23392
24	10.07-10.07	06:14-07:20	23734-24716	23756-24665	Sailing SE, wind speed 12 m/s, wind direction 19 deg; ship speed 4.3 kn Incomplete data files 24658 24659
25	10.07-10.07	07:33-08:35	24717-25637	24770-25604	Sailing NW, wind speed 12.5 m/s; wind direction 23 deg; ship speed 4.0kn. Channel 72 deactivated due to high noise

26	10.07-10.07	08:57-10:03	25638-26629	25667-26603	Sailing SE, wind speed 9.7 m/s; wind direction 37 deg; ship speed 4.1 kn. Incomplete data files 26098,26100
27	10.07-10.07	10:18-11:25	26630-27592	26680-27584	Sailing NW, wind speed 8 m/s; wind direction 30 deg; ship speed 4.0kn. Ship went out of track for about 400 m near the end of line and came back on track near shot number 27460

Survey configuration:



Observed spread of paravanes: 160 -165 m
Observed distance between gun and paravanes: 98 – 113 m, deviations between distances to both paravanes up to 5 m

Ship's speed: 4 kn ± 0,3 kn
Gun system: mini-GI (15/15 in^3)
Shooting pressure: ~170-180 bar
Shooting interval: 4 sec
Recording window: 3 sec
Recording delay: 0 sec
Sampling interval: 0.25ms
Streamer depth: 1.5m

Switch no	6013	6033	6031	6012	6017	6028	6011	6030	6023	6034	6025	6026	6022	6019
Depth reading on deck after survey (m)	-1,54	0,47	-0,47	0,25	0,42	0,17	0,41	0,23	0,28	0,36	0,3	-16,14	0,39	70,32

Yellow: kind of okay
Red: Wrong. Recalibration required