OFFSHORE SURVEY AND ENGINEERING
Gesellschaft für Seevermessung mbH.
Fahrenheitstr. 7, 28359 Bremen, Germany
Tel. + 49 (0) 421 2239150 Fax 2239151
E-Mail: info@osae.de
internet: www.osae.de

SEA6_Meridian

CRUISE A & B - IRISH SEA

Calibration Report Meridian

prepared for:

Geotek Ltd
3 Faraday Close
Drayton Fields
Daventry
Northants
NN11 5EA
Tel: +44 (0) 1327 311666
Fax: +44 (0) 1327 311555

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1. Introduction

This document contains the calibration data for the survey vessel *Meridian*.
The following calibrations were carried out prior or during the SEA 6 survey .

- Static GPS Calibration
- Gyro Calibration
- USBL Calibration
- MBES Calibration

2. Static GPS Calibration

The GPS Calibration was carried out prior sailing to the survey site in Norddeich Germany . Therefore a RTK GPS system was mobilised onboard the Meridian to calibrate the C-Nav GPS receiver. Both systems were logged over a period of 15min and compared against each other.The RTK solution quaranties an acccuracy of +/- 5cm . Both systems were logged on their antenna node and later recuced to COG (Centre of Gravity)

Trimble RTK		Cnav		Trimble - Cnav	
E	N	E	N	dE	dN
378360,283	5943447,772	378360,369	5943449,826	-0,086	-2,054
378360,283	5943447,769	378360,482	5943449,953	-0,199	-2,184
378360,279	5943447,775	378360,594	5943450,006	-0,315	-2,231
378360,277	5943447,766	378360,621	5943450,191	-0,344	-2,425
378360,281	5943447,763	378360,692	5943450,374	-0,411	-2,611
378360,277	5943447,769	378360,748	5943450,410	-0,471	-2,641
378360,275	5943447,769	378360,806	5943450,520	-0,531	-2,751
378360,277	5943447,763	378360,884	5943450,573	-0,607	-2,810
378360,275	5943447,760	378360,930	5943450,628	-0,655	-2,868
378360,277	5943447,760	378360,973	5943450,590	-0,696	-2,830
378360,281	5943447,763	378361,049	5943450,551	-0,768	-2,788
378360,280	5943447,748	378361,114	5943450,512	-0,834	-2,764
378360,279	5943447,772	378361,179	5943450,455	-0,900	-2,683
378360,279	5943447,763	378361,190	5943450,436	-0,911	-2,673
378360,277	5943447,754	378361,222	5943450,398	-0,945	-2,644
378360,279	5943447,757	378361,222	5943450,416	-0,943	-2,659
378360,284	5943447,754	378361,226	5943450,416	-0,942	-2,662
378360,288	5943447,757	378361,255	5943450,415	-0,967	-2,658
378360,287	5943447,744	378361,244	5943450,397	-0,957	-2,653
378360,286	5943447,741	378361,246	5943450,471	-0,960	-2,730
378360,287	5943447,741	378361,256	5943450,434	-0,969	-2,693
378360,289	5943447,750	378361,246	5943450,471	-0,957	-2,721
378360,293	5943447,760	378361,235	5943450,490	-0,942	-2,730
378360,301	5943447,756	378361,303	5943450,544	-1,002	-2,788
378360,299	5943447,756	378361,280	5943450,526	-0,981	-2,770
378360,295	5943447,769	378361,292	5943450,563	-0,997	-2,794
378360,301	5943447,756	378361,291	5943450,526	-0,990	-2,770
378360,303	5943447,766	378361,292	5943450,544	-0,989	-2,778
378360,303	5943447,766	378361,302	5943450,507	-0,999	-2,741
378360,303	5943447,766	378361,290	5943450,470	-0,987	-2,704
378360,303	5943447,766	378361,267	5943450,452	-0,964	-2,686
378360,286	**5943447,760**	**378361,068**	**5943450,421**	**Co = -0,781**	**Co = -2,661**
0,010	**0,009**	**0,278**	**0,185**	**0,272**	**0,188**
				O = -0,787	**O = -2,803**
				Co-O = +0.006	**Co-O = +0,142**
StdDev.	**+/- 0,068m**				

Table 2-1 Comparison between RTK and CNav

Result : The calibration result verified the expected system accuracy which is according manufacturers specification better +/- 0,25m .

To observe a possible drift on the C-Nav receiver a second and third static calibration was carried out in Heysham during the mobilistaion (05.08.2004 and 07.08.2004) . Therefore the primary and the secondary receiver were logged over a period of 60 min . Both receivers were set to log COG .
The C-Nav receiver was fed with starfire sattelite correction signals which combines pseudo range corrections and range rate corrections for each sattelite . –
The Trimble receiver was fed with RTCM sattelite pseudo range corrrections. (Station Aberdeen)

Result:
No significant drift was observed!

Timeplot CNav vs Trimble solution RTCM corrected

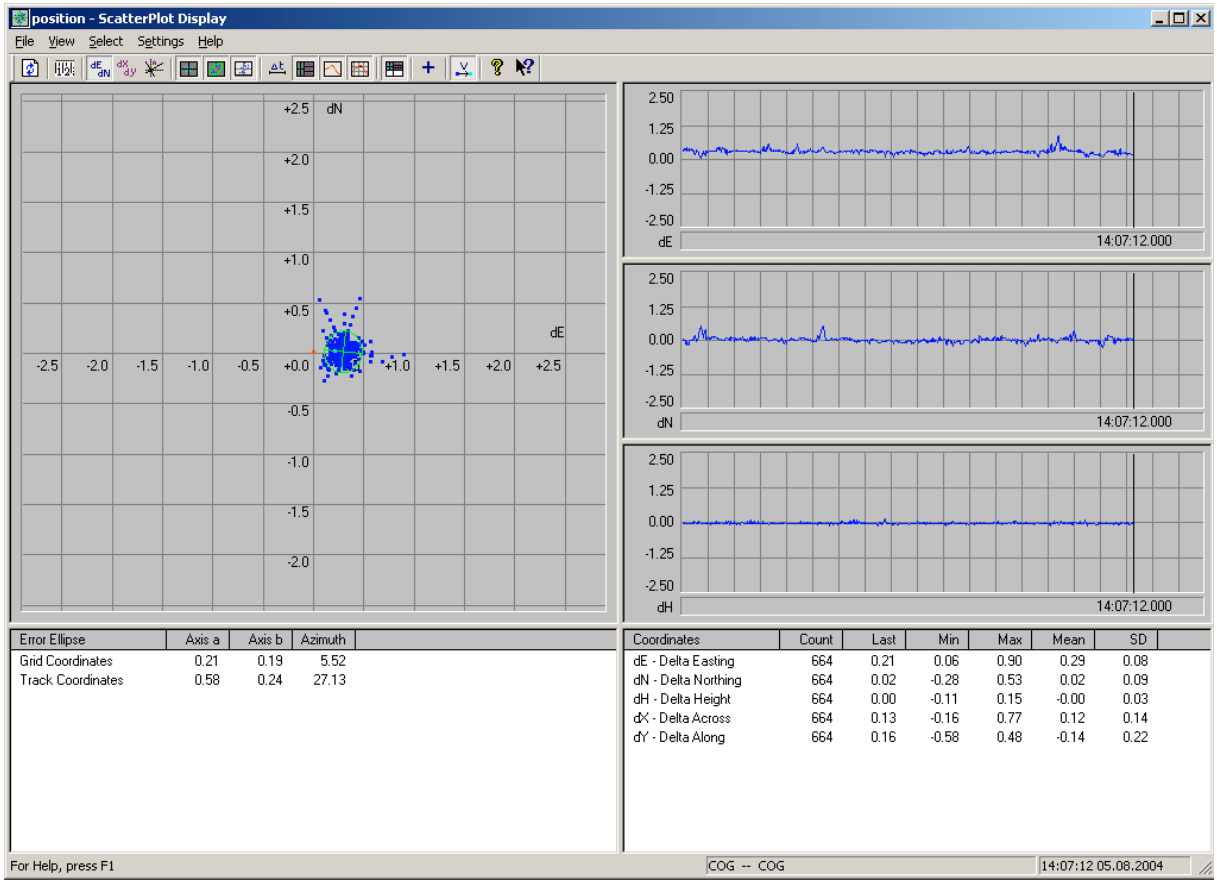


Figure 2-1 CNav DGPS vs Trimble DGPS

Figure 2-1 shows a comparison between CNav and Trimble DGPS.CNav is set to the centre and is represented by the red dot. The blue dots representing the Trimble data. On the right hand side are displays representing time via delta easting/delta northing and delta height.

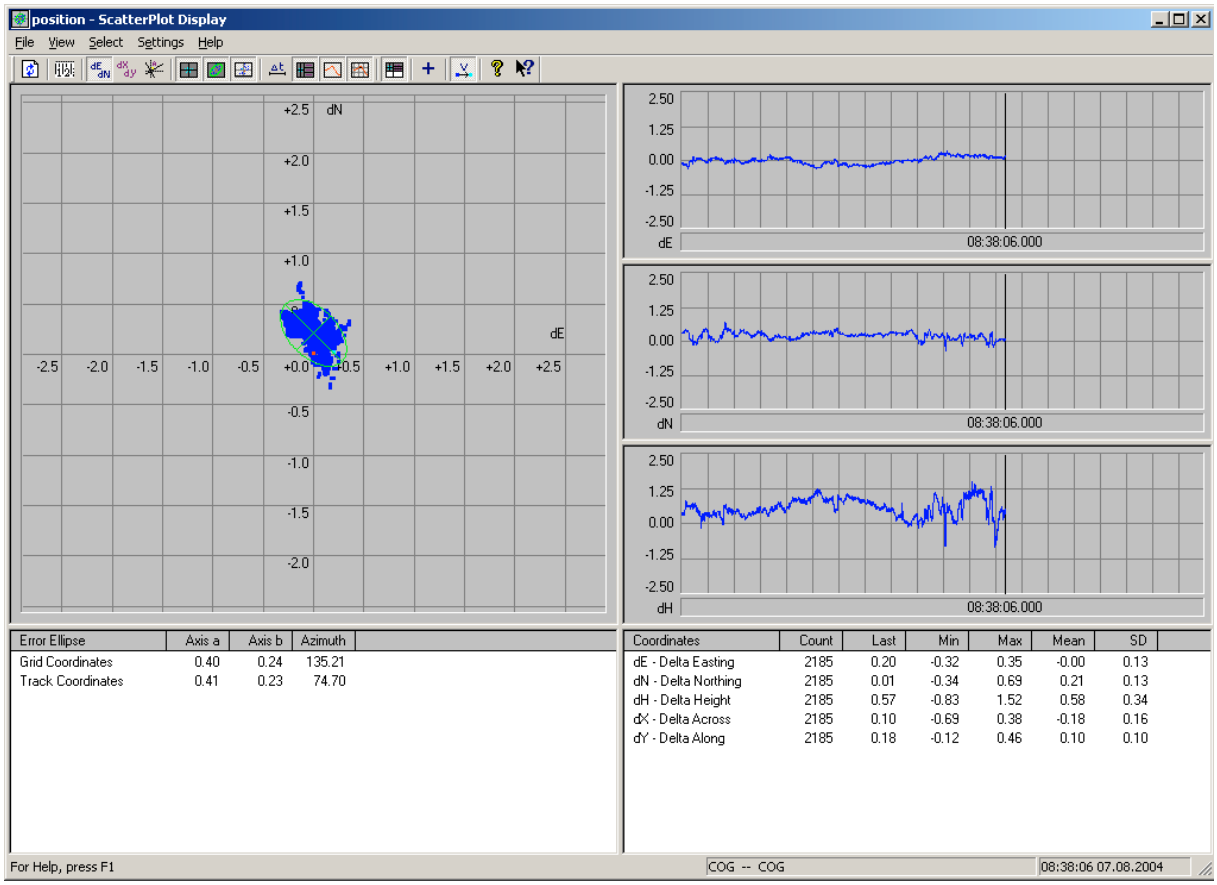


Figure 2-2 CNav DGPS vs Trimble DGPS

Figure 2-2 shows a comparison between CNav and Trimble DGPS.CNav is set to the centre and is represented by the red dot. The blue dots representing the Trimble data. On the right hand side are displays representing time via delta easting/delta northing and delta height

3. Gyro Calibration

To calibrate the fibre optical survey gyro compass the device was left running for more than 12 hours. The calibration was carried out in Norddeich, Germany on the 30.07.2004.

The vessel was moored tightly to the quayside, and left for two hours as to allow the gyro to settle before comencing the calibration.. The positions of the stern and bow centreline were determined via theodolite for approx. thirty minutes as the gyro reading was being logged ondoard. Thereafter, mean positions for bow and stern were calculated. Then the heading of the vessel was calculated. This value was compared to the observed heading, resulting in a mean gyro heading over the mentioned 30 minute period. The difference between computed and observed heading (C-O) results in the current deviation value of the gyro.
Then the vessel was turned 180° and the procedure described above was repeated. Finally, the mean of both deviation values was calculated and fed into QINSy .

Result :

Octans survey gyro : (- 0.144°)

Stand	Ziel	Zeit	Winkel gon	°	Richtung °	Strecke m	Lat °	Long °	S-achse °	Gyro °	Verb. °
1	2		10,956	9,860		85,926					
			10,957	9,861		85,925					
			10,957	9,861		85,924					
			10,958	9,862		85,925					
			10,956	9,860		85,927					
			10,956	9,860							
Mittel				9,861							
Richtung 1-->2				319,321							
Orientierung				309,460							
	Bug		110,128	99,115	48,575	83,888	53,6260	7,1606			
	Heck		135,598	122,038	71,498	69,138	53,6257	7,1607	355,464	355,489	-0,025
	Heck	20:09	135,616	122,054	71,514	69,163	53,6257	7,1607			
	Bug		110,101	99,091	48,551	83,902	53,6260	7,1606	355,398	355,588	-0,190
	Bug	20:10	110,111	99,100	48,560	83,899	53,6260	7,1606			
	Heck	20:12	135,659	122,093	71,553	69,126	53,6257	7,1607	355,448	355,526	-0,077
	Heck		135,659	122,093	71,553	69,125	53,6257	7,1607			
	Bug	20:12	110,139	99,125	48,585	83,871	53,6260	7,1606	355,450	355,525	-0,075
	Bug		110,132	99,119	48,578	83,872	53,6260	7,1606			
	Heck		135,659	122,093	71,553	69,126	53,6257	7,1607	355,440	355,537	-0,097
	Heck	20:13	135,664	122,098	71,557	69,123	53,6257	7,1607			
	Bug		110,133	99,120	48,579	83,872	53,6260	7,1606	355,444	355,535	-0,091
	Bug		110,136	99,122	48,582	83,876	53,6260	7,1606			
	Heck		135,665	122,099	71,558	69,135	53,6257	7,1607	355,433	355,538	-0,105
	Heck	20:13	135,665	122,099	71,558	69,135	53,6257	7,1607			
	Bug	20:14	110,136	99,122	48,582	83,877	53,6260	7,1606	355,435	355,536	-0,102
	Bug	20:15	110,140	99,126	48,586	83,873	53,6260	7,1606			
	Heck		135,662	122,096	71,555	69,139	53,6257	7,1607	355,427	355,554	-0,127
	Heck	20:16	135,679	122,111	71,571	69,139	53,6257	7,1607			
	Bug		110,149	99,134	48,594	83,862	53,6260	7,1606	355,419	355,614	-0,195
	Bug	20:17	110,152	99,137	48,596	83,880	53,6260	7,1606			
	Heck		135,670	122,103	71,563	69,117	53,6257	7,1607	355,488	355,593	-0,105
	Heck	20:18	135,667	122,100	71,560	69,121	53,6257	7,1607			
	Bug		110,145	99,131	48,590	83,873	53,6260	7,1606	355,463	355,602	-0,139
	Bug	20:19	110,148	99,133	48,593	83,871	53,6260	7,1606			
	Heck		135,688	122,119	71,579	69,104	53,6257	7,1607	355,483	355,611	-0,128
	Heck	20:20	135,686	122,117	71,577	69,110	53,6257	7,1607			
	Bug		110,161	99,145	48,605	83,860	53,6260	7,1606	355,474	355,626	-0,152
	Bug	20:21	110,162	99,146	48,605	83,869	53,6260	7,1606			
	Heck		135,688	122,119	71,579	69,104	53,6257	7,1607	355,514	355,644	-0,130
	Heck	20:22	135,692	122,123	71,582	69,092	53,6257	7,1607			
	Bug		110,171	99,154	48,614	83,857	53,6260	7,1606	355,513	355,651	-0,138
	Bug	20:23	110,173	99,156	48,615	83,855	53,6260	7,1606			
	Heck		135,703	122,133	71,592	69,095	53,6257	7,1607	355,503	355,674	-0,170
	Heck	20:24	135,701	122,131	71,591	69,092	53,6257	7,1607			
	Bug		110,173	99,156	48,615	83,857	53,6260	7,1606	355,512	355,692	-0,181
	Bug	20:25	110,183	99,165	48,624	83,854	53,6260	7,1606			
	Heck		135,709	122,138	71,598	69,066	53,6257	7,1607	355,561	355,727	-0,167
	Heck	20:26	135,709	122,138	71,598	69,041	53,6257	7,1607			
	Bug		110,192	99,173	48,632	83,863	53,6260	7,1606	355,626	355,784	-0,158
	Bug	20:27	110,198	99,178	48,638	83,859	53,6260	7,1606			
	Heck		135,733	122,160	71,619	69,056	53,6257	7,1607	355,594	355,828	-0,235
	Heck	20:28	135,728	122,155	71,615	69,058	53,6257	7,1607			
	Bug		110,204	99,184	48,643	83,845	53,6260	7,1606	355,541	355,789	-0,248
	Bug	20:29	110,202	99,182	48,641	83,847	53,6260	7,1606			
	Heck		135,726	122,153	71,613	69,059	53,6257	7,1607	355,580	355,796	-0,216
	Heck	20:30	135,730	122,157	71,617	69,063	53,6257	7,1607			
	Bug		110,203	99,183	48,642	83,844	53,6260	7,1606	355,569	355,796	-0,227
										d=	-0,145

Table 3-1 Fieldsheet theodolite measurement no1

Stand	Ziel	Zeit	Winkel gon	°	Richtung °	Strecke m	Lat °	Long °	S-achse °	Gyro °	Verb. °
2	1		135,702	122,132							
			135,701	122,131							
			135,699	122,129							
			135,702	122,132							
			135,704	122,134							
			135,703	122,133							
			135,702	122,132							
			135,701	122,131							
Mittel				122,132							
Richtung 2-->1				139,321							
Orientierung				17,189							
	Heck	21:32	94,176	84,758	101,947	122,744	53,6259	7,1606	175,324	175,381	-0,057
	Bug		109,410	98,469	115,658	136,271	53,6256	7,1607			
	Bug	21:33	109,413	98,472	115,661	136,273	53,6256	7,1607			
	Heck		94,180	84,762	101,951	122,728	53,6259	7,1606	175,297	175,379	-0,082
	Heck	21:34	94,177	84,759	101,948	122,744	53,6259	7,1606	175,323	175,400	-0,077
	Bug		109,409	98,468	115,657	136,270	53,6256	7,1607			
	Bug	21:35	109,413	98,472	115,661	136,273	53,6256	7,1607			
	Heck		94,180	84,762	101,951	122,716	53,6259	7,1606	175,277	175,396	-0,119
	Heck	21:36	94,177	84,759	101,948	122,736	53,6259	7,1606	175,280	175,403	-0,123
	Bug		109,409	98,468	115,657	136,290	53,6256	7,1607			
	Bug	21:37	109,419	98,477	115,666	136,289	53,6256	7,1607			
	Heck		94,180	84,762	101,951	122,738	53,6259	7,1606	175,300	175,423	-0,122
	Heck	21:38	94,179	84,761	101,950	122,743	53,6259	7,1606	175,325	175,451	-0,126
	Bug		109,413	98,472	115,661	136,271	53,6256	7,1607			
	Bug	21:39	109,414	98,473	115,662	136,290	53,6256	7,1607			
	Heck		94,184	84,766	101,955	122,713	53,6259	7,1606	175,245	175,407	-0,162
	Heck	21:40	94,187	84,768	101,957	122,721	53,6259	7,1606	175,250	175,413	-0,163
	Bug		109,410	98,469	115,658	136,289	53,6256	7,1607			
	Bug	21:41	109,413	98,472	115,661	136,289	53,6256	7,1607			
	Heck		94,178	84,760	101,949	122,749	53,6259	7,1606	175,309	175,455	-0,145
	Heck	21:42	94,189	84,770	101,959	122,720	53,6259	7,1606	175,245	175,453	-0,208
	Bug		109,412	98,471	115,660	136,292	53,6256	7,1607			
	Bug	21:43	109,414	98,473	115,662	136,278	53,6256	7,1607			
	Heck		94,186	84,767	101,956	122,727	53,6259	7,1606	175,284	175,433	-0,149
	Heck	21:44	94,192	84,773	101,962	122,705	53,6259	7,1606	175,219	175,393	-0,174
	Bug		109,415	98,474	115,663	136,295	53,6256	7,1607			
	Bug	21:45	109,412	98,471	115,660	136,302	53,6256	7,1607			
	Heck		94,190	84,771	101,960	122,706	53,6259	7,1606	175,207	175,417	-0,210
	Heck	21:46	94,190	84,771	101,960	122,707	53,6259	7,1606	175,207	175,394	-0,187
	Bug		109,414	98,473	115,662	136,306	53,6256	7,1607			
	Bug	21:47	109,414	98,473	115,662	136,298	53,6256	7,1607			
	Heck		94,193	84,774	101,963	122,698	53,6259	7,1606	175,201	175,396	-0,195
										d=	-0,144

Gyro Calibration

Norddeich 30/07/2004

Results

	1. Measurement	2.Measurement: ship turned 180°	Mean
Heading from coordinates	355.491°	175.268°	
Deviation from ships axe	0°	0°	
Calculated Heading (C)	**355.491°**	**175.268°**	
Mean: Survey Gyro (O)	355,636°	175.412	
Adjustment: Survey Gyro C -O	-0.145°	-0.144	**-0.144°**

Table 3-2 Fieldsheet theodolite measurement no 2 and final result

4 USBL Calibration – four quadrant method

The calibration of the USBL (Ultra Short Base Line) system was carried out in the survey area on the 05.08.2004. A location was chosen at 445228 E 5994207 N with water depth of 46m. A S/V – Dip was performed and a predicted tide file was load into QINSy to avoid scaling and calculation errors .
An omni-directional beacon was deployed on a buoyed line so that it was held 2.4m above the seabed. The vessel acquired USBL data from this beacon whilst holding position on four points created around the beacon location. The vessel kept the same heading on all four locations and repeated the procedure with a reversed heading to determine roll , pitch errors. OSAE found it more accurate not to swap the heading on each point in order to reduce the potential of gyro errors .
Alignment was determined via least square and z-check method.
The circuit of observations was attempted at a standoff distance of 20m .

Results :

Scale Factor:	0.99686
Roll Angle:	0.010°
Pitch Angle:	1.738°
Heading:	2.467°

Least Squares

LEAST SQUARES DEFINITIONS

Project I:\216-04-803_raw_von_online_mb_sb\mb\040805\cali_ats

Databases

0009 -1_Head_NE		05.08.2004	15:17:41
0003 -1_Head_SW		05.08.2004	12:28:19
0003 -3_Head_SW		05.08.2004	13:25:36
0005 -2_Head_SW		05.08.2004	13:55:39
0006 -2_Head_NE		05.08.2004	14:34:29
0007 -3_Head_NE		05.08.2004	14:48:17
0008 -4_Head_NE		05.08.2004	15:04:09
0002 -4_Head_SW		05.08.2004	12:55:55

Properties

Vessel Object	**Meridian**	Computation	**C-NAV**
USBL System	**ATS**	Gyro System	**Octans Gyro**
Transducer Node	**Hydrophone**	VRU System	**Motion**
Transponder Node	**Beacon**	Echosounder	**Manual**

Statistics

Number of USBL observations	**3442**	**100** %
Number of used observations	**3397**	**98** %
Number of disabled observations	**45**	**1** %

Least Square settings

Alignment corrections	**No corrections**
Computation parameters	**Scale, Angles, Transponder Position**

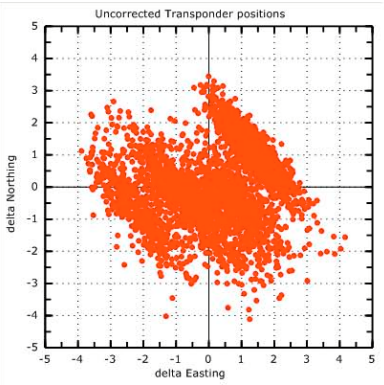
LEAST SQUARES RESULTS

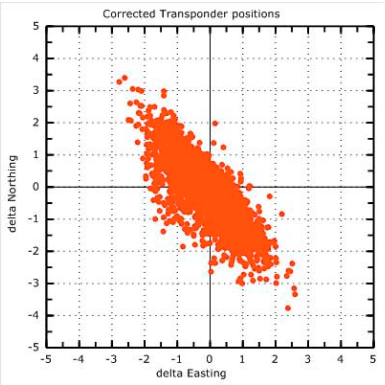
Computation Results

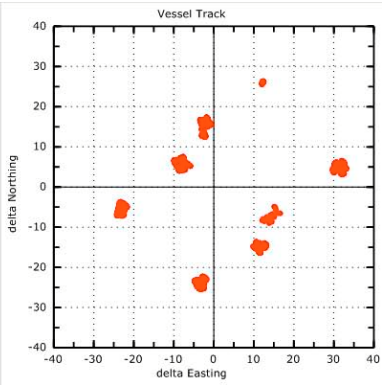
Parameter	Value	SD
Scale Factor	**0.99686**	**0.00089**
Roll Angle	**0.010** °	**0.024** °
Pitch Angle	**1.738** °	**0.024** °
Heading Angle	**2.467** °	**0.052** °
Transponder Position	Coordinate Value	SD
Easting TP	**445228.67** m	**0.02** m
Northing TP	**5994207.79** m	**0.02** m
Height TP	**-35.87** m	**0.04** m

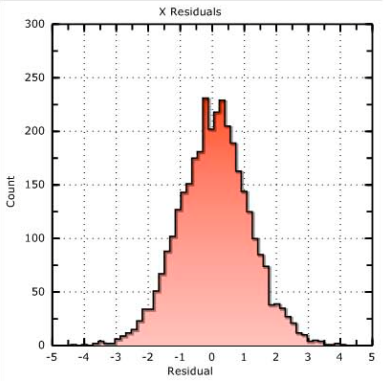
Least Squares

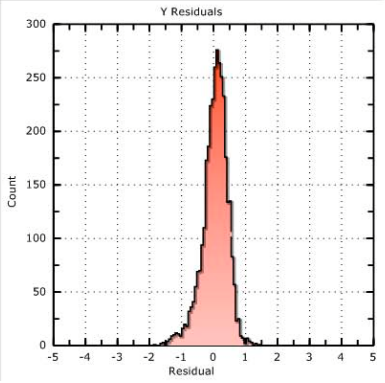
LEAST SQUARES GRAPHS

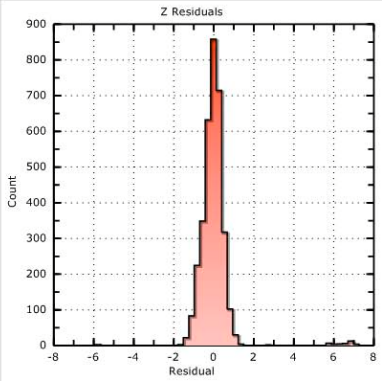












Z-Check

Databases

0009 -1_Head_NE		05.08.2004	15:17:41
0003 -1_Head_SW		05.08.2004	12:28:19
0003 -3_Head_SW		05.08.2004	13:25:36
0005 -2_Head_SW		05.08.2004	13:55:39
0006 -2_Head_NE		05.08.2004	14:34:29
0007 -3_Head_NE		05.08.2004	14:48:17
0008 -4_Head_NE		05.08.2004	15:04:09
0002 -4_Head_SW		05.08.2004	12:55:55
Properties			
Vessel Object	**Meridian**	Computation	**C-NAV**
USBL System	**ATS**	Gyro System	**Octans Gyro**
Transducer Node	**Hydrophone**	VRU System	**Motion**
Transponder Node	**Beacon**	Echosounder	**Manual**

Statistics

Number of USBL observations	**3442**	**100** %
Number of used observations	**3397**	**98** %
Number of disabled observations	**45**	**1** %

Z-CHECK SETTINGS - Alignment Corrections

Used alignment corrections	No corrections
Manual Depth	**46.50** m
Transponder Height	**2.40** m

Z-CHECK RESULTS

Computation Results

Parameter	Value	SD
Average Offset Z	**0.10** m	**0.01** m

Alignments

USBL Calibration Results

Parameter	Value	SD
Scale Factor	**0.99686**	**0.00089**
Roll Angle	**0.010** °	**0.024** °
Pitch Angle	**1.738** °	**0.024** °
Heading Angle	**2.467** °	**0.052** °
Offset X	**0.00** m	**0.00** m
Offset Y	**0.00** m	**0.00** m
Offset Z	**0.10** m	**0.01** m
Easting TP	**445228.67** m	**0.02** m
Northing TP	**5994207.79** m	**0.02** m
Height TP	**-35.87** m	**0.04** m

QINSy Database Settings

Parameter	Value	SD
Roll Angle	**0.000** °	**0.000** °
Pitch Angle	**0.000** °	**0.000** °
Heading Angle	**0.000** °	**0.000** °

5 Reson 8101 Calibration on Meridian (11.08.2004)

According to the specifications within the contract, all systems have to be tested for functionality and to be calibrated before start of the survey. One of the system component for this survey is the multibeam system Reson Seabat 8101 on board of the SV *MERIDIAN*.

At the moment collected multibeam data are to be combined with the motion sensor and heading (gyro) data of a IXSEA Octans unit and a positioning system such as Trimble 4000 SSI using cnav corrections or C-Nav.

The different calibration steps are carried out in the calibration menu within the subset editor of the postprocessing software CARIS/HIPS. That tool is used for processing of all multibeam data throughout this project. Here un-calibrated data can be visualised. The corrections of any type of acquired data can be determined separately step by step by changing the respecting correction value while visualising the effect on the screen. The result is a homogeneous display of the sea floor. The calibration values can be taken from the calibration menu and have to be added to the vessel configuration file, which is responsible for applying all vessel offsets to the data.
Collected raw survey data are then corrected with these offsets and the determined calibration values so that the final set of data is properly adjusted.

5.1 Determination of the Latency Error

The latency is to be determined by comparing two calibration runlines with different speed carried out in the same direction at an evenly falling slope or seabed feature. The relevant beams are the nadir beams, as they are less affected by any other error than outer beams. The latency value is derived from the speed of both profiles and the position mismatch that can be measured between.

The following Figure 5-1 shows an uncalibrated longitudinal view trough the nadir beams of a slope.

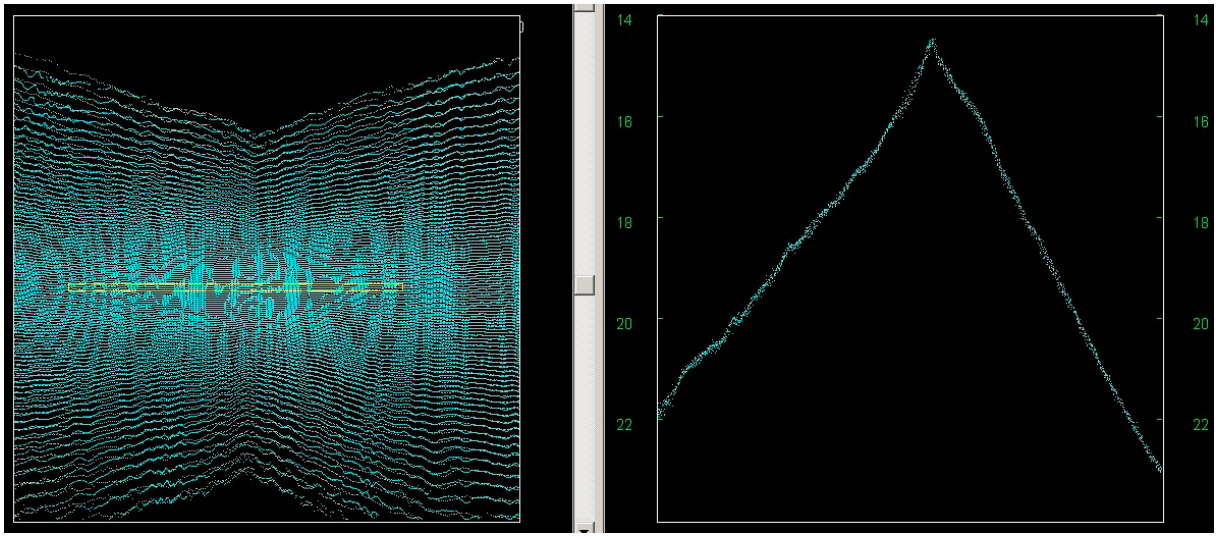


FIGURE 5-1 CALIBRATION FOR LATENCY WITH TWO LINES (3KN AND 6KN) IN SAME DIRECTION, NO LATENCY IS ESTABLISHED

There is no obvious position mismatch between the blue profile and the grey profile. The value of 0.0 seconds for latency will be used.

5.2 Determination of the Pitch Error

The pitch error can be determined from two calibration runs with the same speed in opposite direction carried out covering an even falling slope. This slope should cover a depth range witch is representativ for the survey area. A pitch error exists, when there is a position mismatch between both files that increases with the depth. Only the nadir beams can be used for the calibration, as they are less affected by any roll or yaw error.

The following Figures 5-2-1 and 5-2-2 show uncorrected and corrected pitch.

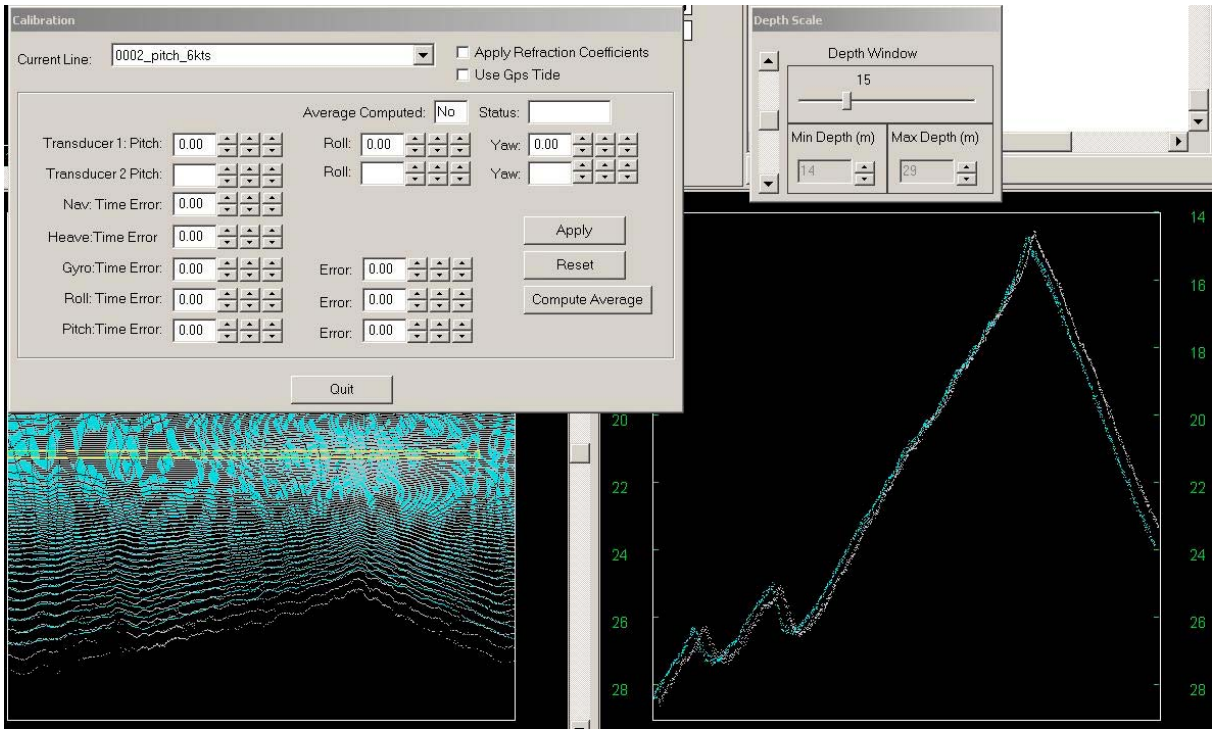


FIGURE 5.2-1 CALIBRATION FOR PITCH WITH TWO LINES(6KTS) IN OPPOSITE DIRECTION , PITCH ERROR IS DETECTED

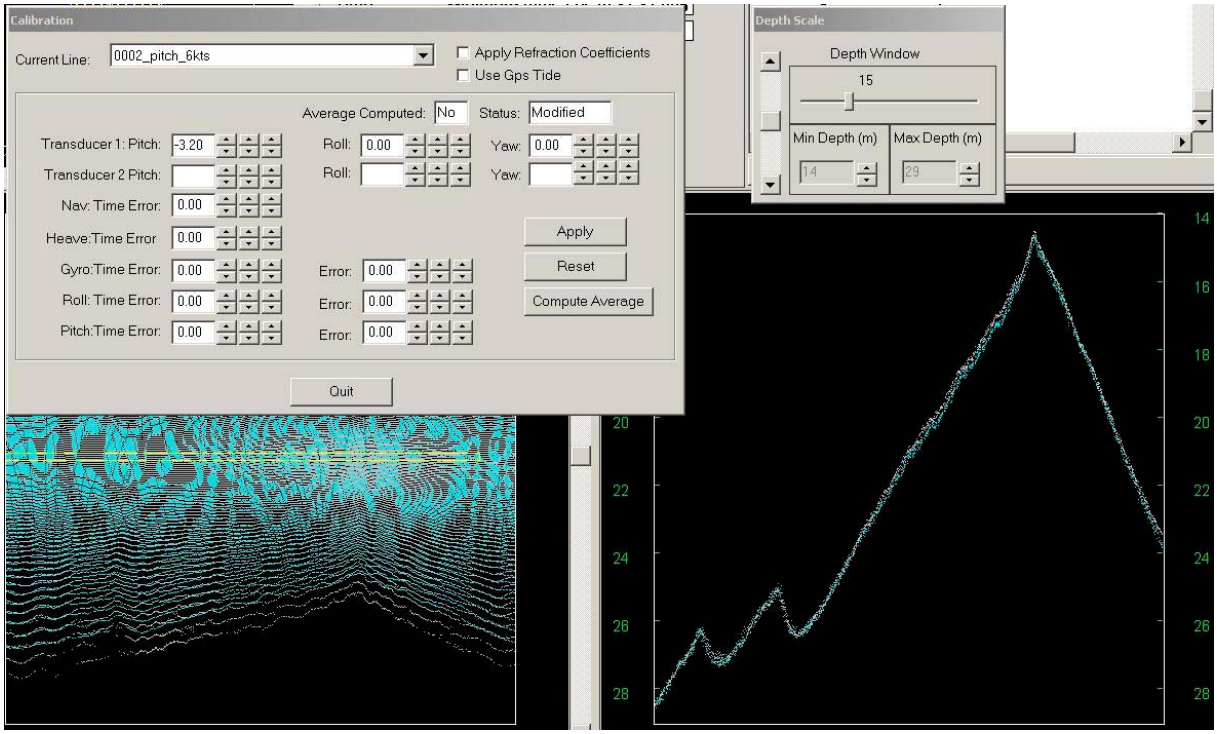


Figure 5.2-2 Calibration for pitch with two lines (6kn) in opposite direction, pitch error is corrected with a value of -3.20°

The correction value for the pitch error has been determined as -3.20°. This value is entered as corrected mounting angle for the transducer in the CARIS/HIPS vessel configuration file. Using this value the result is a homogeneous representation of the slope with no remaining mismatches. Figure 5.2-2 shows the final cross view with coinciding swathes after correction.

5.3 Determination of the Roll Error

The roll error can be determined in a flat survey area at greater depths. Two calibration run lines with the same speed in opposite directions have to be collected. In principle the double roll error can be determined from the depth difference of the outer beams and the distance from the centre beam.

The following Figures 5.3-1 and 5.3-2 show uncorrected and corrected roll.

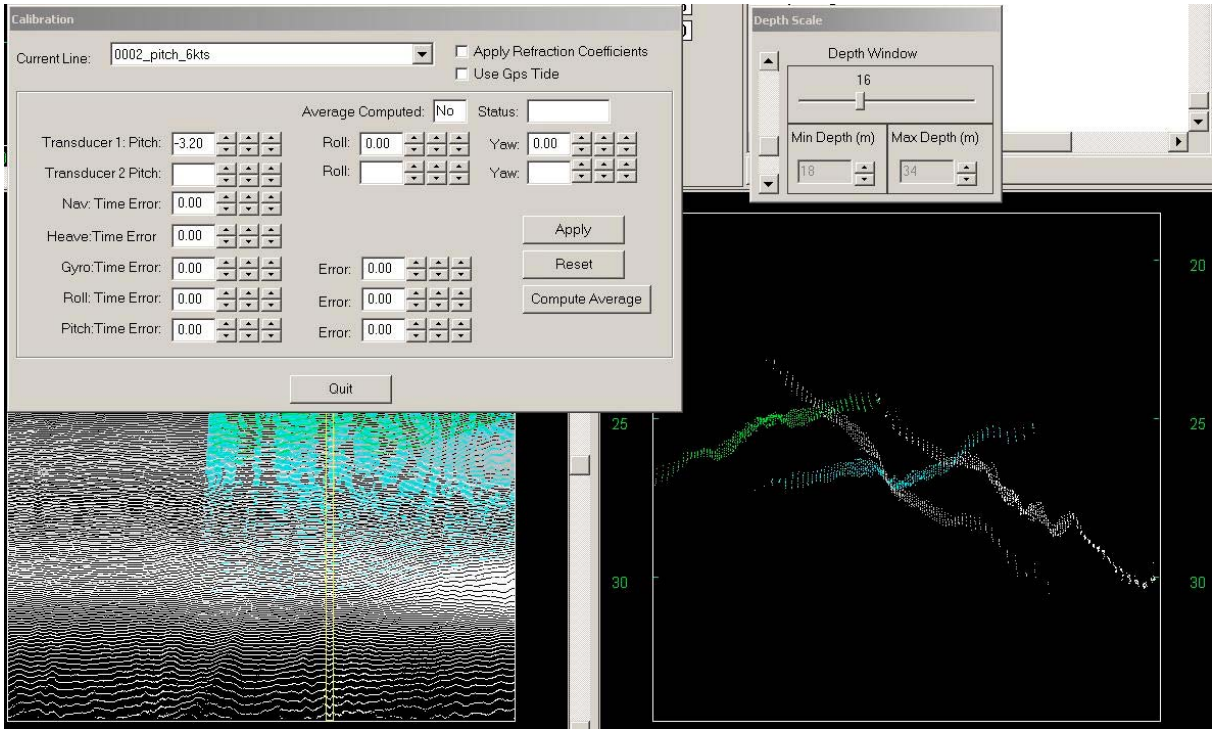


Figure 5.3-1 Calibration for roll with four lines (6kn), two in each direction, roll error is detected

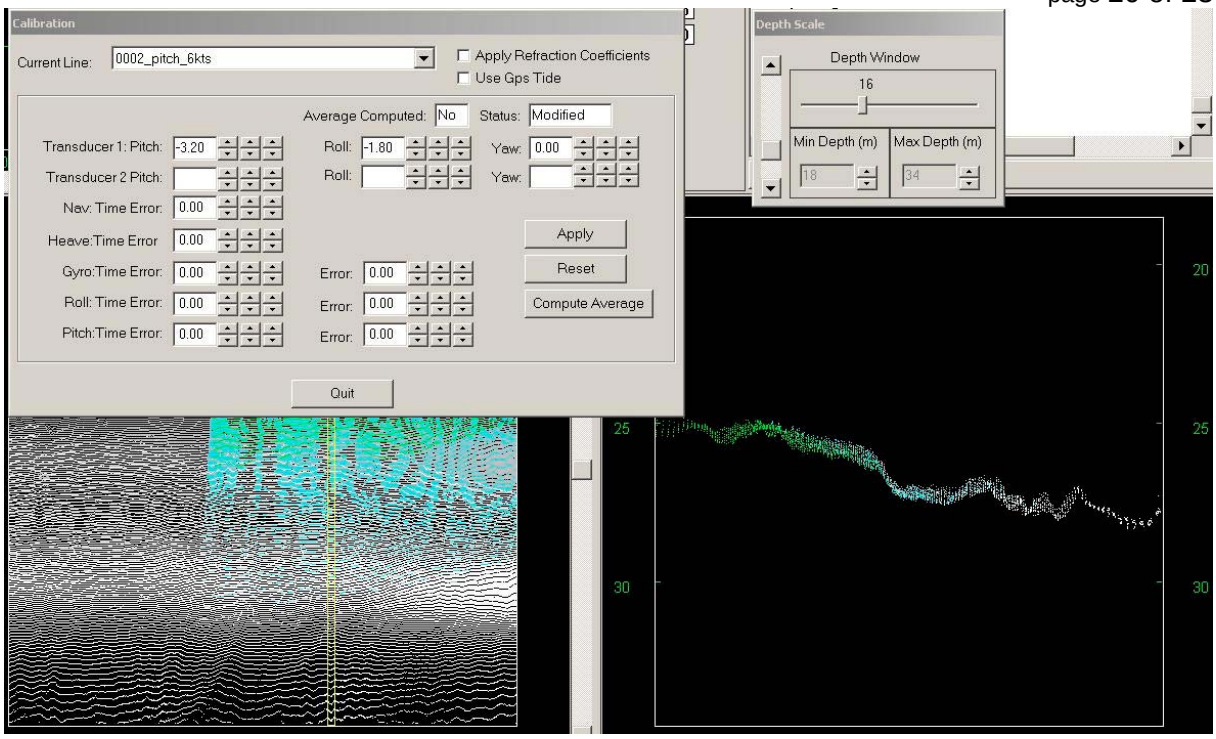


Figure 5.3-2 Calibration for roll with four lines (6kn), two in each direction, roll error is corrected with a value of -1.80°

The correction value for the roll error has been determined as -1.80°. This value is entered as corrected mounting angle for the transducer in the CARIS/HIPS vessel configuration file. Using this value the result is a homogeneous representation of the seabed with no remaining mismatches. The Figure 5.3-2 shows the final cross view with coinciding swathes after correction.

5.4 Determination of the Yaw Heading Error

The yaw error is to be determined by comparing two parallel calibration runs with same speed and same direction covering a specific object or along an evenly falling slope. The relevant beams are the outer beams of the head. In case of a yaw error the object or slope will be shown twice and the mismatch has to be corrected.

The following Figures 5.4-1 and 5.4-2 show uncorrected and corrected yaw.

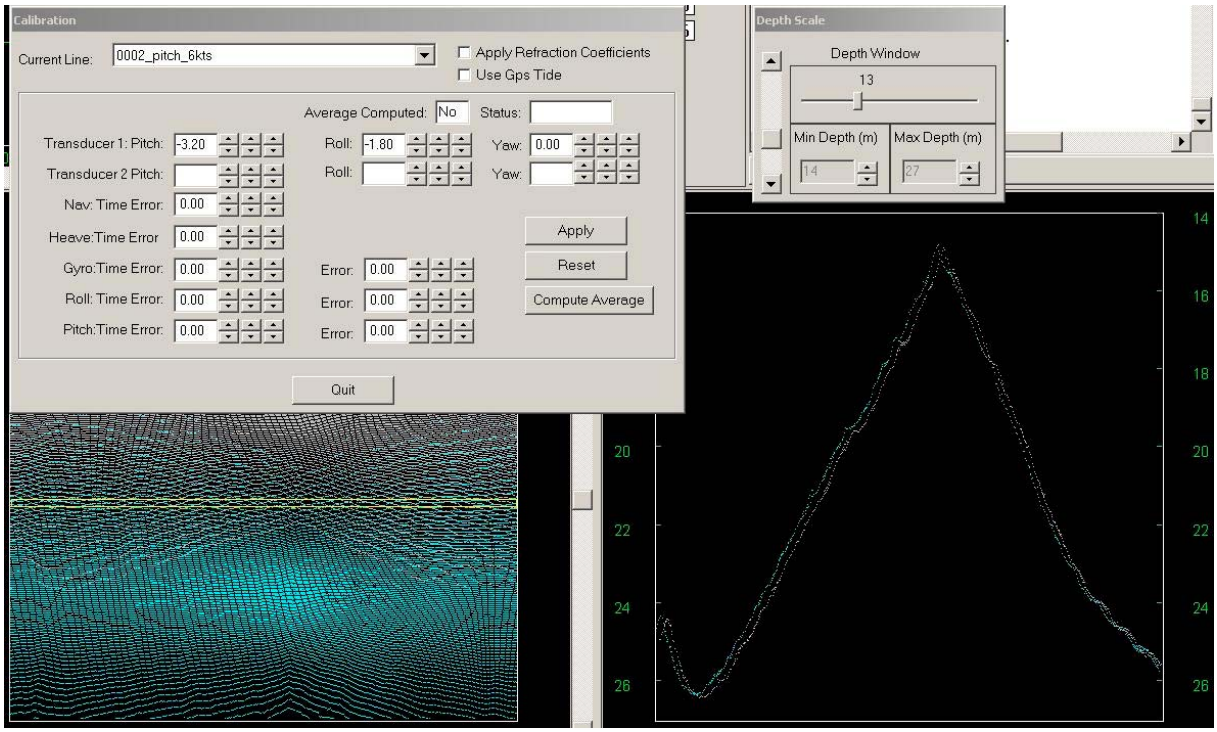


Figure 5.4-1 Calibration for yaw with two offset-lines (6kn) in same direction, yaw error is detected

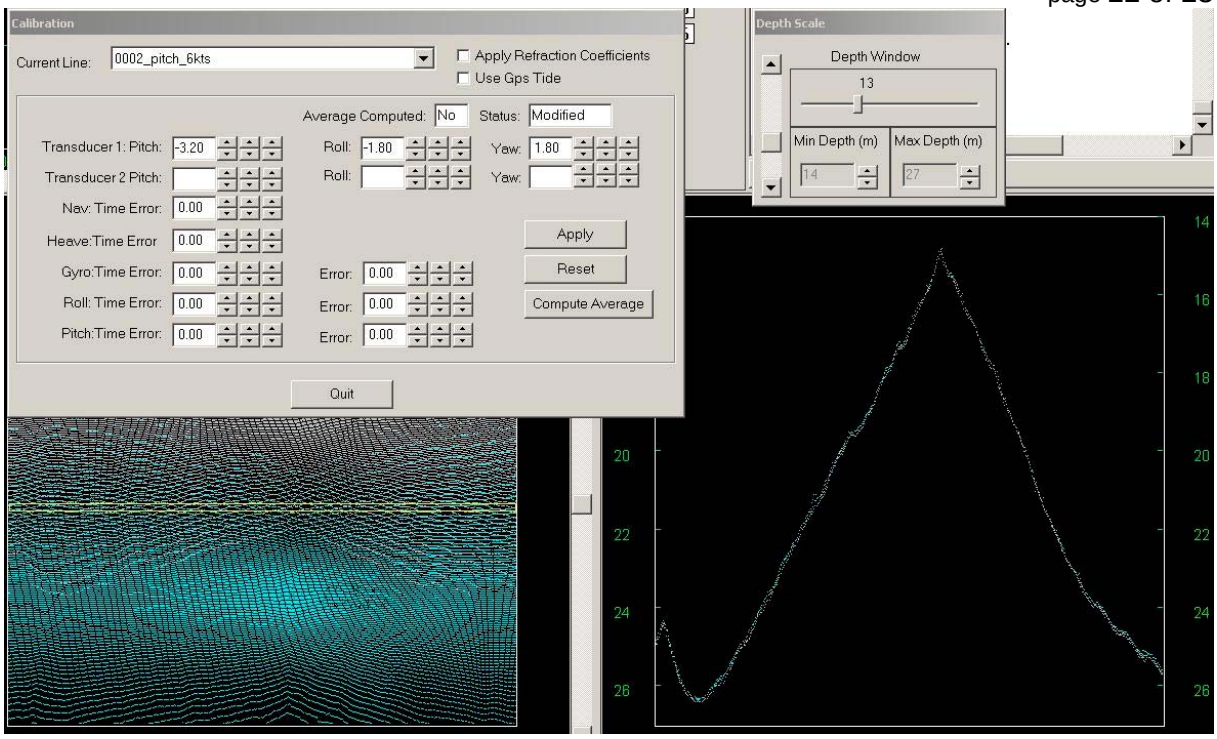


Figure 5.4-2 Calibration for yaw with two offset-lines (6kn) in same direction, yaw error is corrected with a value of 1.80°

The determined value for correction of the yaw error is 1.80°. This value is entered as corrected mounting angle for the transducer in the CARIS/HIPS vessel configuration file. Using this value the result is a homogeneous representation of the slope with no remaining mismatches. The Figure 5.4-2 show the final view with coinciding swathes after correction.

Results

Results of the **Reson 8101** calibration are as follows:

Navigation time error:	0,0 sec
Roll error:	-1.80 degrees
Pitch error	-3.20 degrees
Yaw / Heading	+1.80 degrees