



Survey Report

SW TASMAN | Vessel Offset Survey & Sensor Calibration

263615 - Report - DCS – SW TASMAN 02 | 12 December 2024

After client comments

SHEARWATER

shearwater

Document Control

Document Information

Project Title	SW TASMAN
Document Title	Survey Report
Fugro Project No.	263615
Fugro Document No.	263615 - Report - DCS – SW TASMAN
Issue Number	02
Issue Status	After client comments
Fugro Legal Entity	FSAPL
Issuing Office Address	Unit S2, Second Floor, 1 Waterhouse Place, Century City Boulevard, Century City, 7441, South Africa

Client Information

Client	SHEARWATER
Client Address	-
Client Contact	Estee Ashbridge
Client Document No.	-

Document History

Issue	Date	Status	Comments on Content	Prepared By	Checked By	Approved By
01	06/12/2024	First Issue		MAR/AME	PMA	OMI
02	12/12/2024	After client comments		MAR/AME	PMA	OMI

Project Team

Initials	Name	Role
OAD	Orlando Adams	Project Coordinator
OMI	Olivier Mio	Project Director
PMA	Pascale Mabboux	QA/QC Engineer
MAR	Marie Arsac	Senior Dimensional Control Surveyor
AME	Arthur Meunier	Dimensional Control Surveyor

Contents

Table des matières

Document Control	ii
Document Information	ii
Client Information	ii
Document History	ii
Project Team	ii
Contents	i
Table des matières	i
Tables in the Main Text	ii
Abbreviations	vi
1. Introduction	1
1.1 Scope of work	1
1.2 Definition of CRP and Vessel Reference Frame	4
1.2.1 General	4
1.2.2 Vessel Reference Frame for TriNAV suite	4
1.2.3 Vessel Reference Frame for 4D Nav suite	5
1.3 Sign convention	6
2. Results	8
2.1 SW TASMAN Results	8
2.1.1 Vessel Offsets TriNAV	10
2.1.2 Vessel Offsets 4D Nav	12
2.1.3 Gyrocompass and Motion Sensor Calibration	14
2.1.4 GNSS Health check	27
2.1.5 Vessel Reference points TriNAV	30
2.1.6 Vessel Reference points 4D NAV	31
2.2 HD64 results	33
2.2.1 HD64 Offsets	33
2.2.2 HD64 Gyrocompass and Motion Sensor Calibration	33
2.3 HD65 results	35
2.3.1 HD65 Offsets	35
2.3.2 HD65 Gyrocompass and Motion Sensor Calibration	36
3. PICTURES	38
3.1 Reference points	38
3.2 ROV STB	46

3.3	ROV PORT	48
3.4	Antennas	49
3.5	Instruments	52
3.6	HD64	54
3.7	HD65	56
4.	RESOURCES	59
4.1	Summary of operations	59
4.2	Personnel	60
4.3	Equipment	60
5.	Methodology	61
5.1.1	Vessel Offset Survey	61
5.1.2	Vessel Heading and MRU Calibration	61
5.1.3	GNSS Health Check	62
5.1.4	ROV Offset Survey and Heading / MRU calibration	62
6.	CONCLUSION	63
Appendix A	OCTANS 3000	0
Appendix B	7000+ LODESTAR	0
Appendix C	MRU5+	0
Appendix D	GYROCOMPASS2 HDG	0
Appendix E	GYROCOMPASS1 HDG	0
Appendix F	FUGRO HDG	0
Appendix G	GNSS Health Check	0
G.1	Starpack Antenne3 XP3	1
G.2	Starpack Antenne3 G4	2
G.3	Septentrio Antenna2	3
G.4	Trinav GPS1 antenna	4
G.5	Trinav GPS2 antenna	5
Appendix H	HD64 Gyrocompass	0
Appendix I	HD65 Gyrocompass	1

Tables in the Main Text

Table 1.1: Surveyed antennas	1
Table 1.2: Surveyed Sensors	1
Table 1.3: Calibrated sensors	2
Table 1.4: HD64 - Surveyed Sensors	2
Table 1.5: HD65 - Surveyed Sensors	3

Table 1.6: HD64 - Calibrated sensors	3
Table 1.7: HD65 - Calibrated sensors	3
Table 2.1: Vessel Offset Results - TriNAV	10
Table 2.2: Vessel Offset Results – 4D Nav	12
Table 2.3: Octans 3000 C-O	14
Table 2.4: 7000+ Lodestar C-0	17
Table 2.5: MRU5+ C-0	21
Table 2.6: Gyrocompass	23
Table 2.7: Antenna comparison	27
Table 2.8: Reference Point - TriNAV	30
Table 2.9: Reference Point – 4D NAV	31
Table 2.10: HD64 Offset	33
Table 2.11: HD64 C-O	33
Table 2.12: HD65 Reference Point Offset	35
Table 2.13: HD65 C-O	36
Table 4.1: List of equipment	60

Figure 1.1: SW TASMAN - TriNAV VRF and CRP definition - Starboard view	4
Figure 1.2: SW TASMAN - TriNAV VRF and CRP definition - Top view	5
Figure 1.3: SW TASMAN - 4D NAV VRF and CRP definition - Starboard view	6
Figure 1.4: SW TASMAN – 4D Nav VRF and CRP definition - Top view	6
Figure 1.5: Sign convention	7
Figure 2.1: SW TASMAN Offset – Starboard view	8
Figure 2.2: SW TASMAN Offset – Top view	9
Figure 2.3: ROV Baseline	11
Figure 2.4: Octans 3000 - Session 2 - Gyrocompass calibration	14
Figure 2.5: Octans 3000 - Session 2 - Pitch calibration	15
Figure 2.6: Octans 3000 - Session 2 - Roll calibration	15
Figure 2.7: Octans 3000 - Session 3 - Gyrocompass calibration	16
Figure 2.8: Octans 3000 - Session 3 - Pitch calibration	16
Figure 2.9: Octans 3000 - Session 3 - Roll calibration	17
Figure 2.10: 7000+ Lodestar - Session 1 – Gyrocompass calibration	18
Figure 2.11: 7000+ Lodestar - Session 1 - Pitch calibration	18
Figure 2.12: 7000+ Lodestar - Session 1 - Roll calibration	19
Figure 2.13: 7000+ Lodestar - Session 2 – Gyrocompass calibration	19
Figure 2.14: Lodestar - Session 2 - Pitch calibration	20
Figure 2.15: Lodestar - Session 2 - Roll calibration	20
Figure 2.16: MRU5+ - Session 1 - Pitch calibration	21
Figure 2.17: MRU5+ - Session 1 - Roll calibration	22
Figure 2.18: MRU5+ - Session 2 – Pitch calibration	22
Figure 2.19: MRU5+ - Session 2 - Roll calibration	23
Figure 2.20: Gyro1 - Session 1 – Gyrocompass Calibration	24
Figure 2.21: Gyro2 - Session 1 – Gyrocompass Calibration	24
Figure 2.22: Gyro1 - Session 2 – Gyrocompass Calibration	25

Figure 2.23: Gyro2 - Session 2 – Gyrocompass calibration	26
Figure 2.24: Fugro Hdg - Session 2 – Gyrocompass calibration	26
Figure 2.25: Starpack Ant3 XP3 C-O	27
Figure 2.26: Starpack Ant3 G4 C-O	28
Figure 2.27: Septentrio Antenna 2 XP3 C-O	28
Figure 2.28: TriNav1 XP3 C-O	28
Figure 2.29: TriNav2 XP3 C-O	29
Figure 2.30: Reference points	32
Figure 2.31: HD64 Sprint Nav - Heading calibration	34
Figure 2.32: HD64 Sprint Nav - Pitch calibration	34
Figure 2.33: HD64 Sprint Nav - Roll calibration	35
Figure 2.34: HD65 Sprint Nav - Heading calibration	36
Figure 2.35: HD65 Sprint Nav - Pitch calibration	37
Figure 2.36: HD65 Sprint Nav - Roll calibration	37
Figure 3.1: C1	38
Figure 3.2: C2	38
Figure 3.3: C3	38
Figure 3.4: C4	38
Figure 3.5: C6	39
Figure 3.6: C7	39
Figure 3.7: C8	39
Figure 3.8: C9	39
Figure 3.9: C10	40
Figure 3.10: C11	40
Figure 3.11: C12	40
Figure 3.12: C13	40
Figure 3.13: C14	41
Figure 3.14: C15	41
Figure 3.15: C16	41
Figure 3.16: C17	41
Figure 3.17: C18	42
Figure 3.18: C19	42
Figure 3.19: C20	42
Figure 3.20: C21	42
Figure 3.21: C22	43
Figure 3.22: C23	43
Figure 3.23: Helideck Reference	43
Figure 3.24: H1	44
Figure 3.25: H2	44
Figure 3.26: H3	44
Figure 3.27: H4	44
Figure 3.28: H5	45
Figure 3.29: H6	45
Figure 3.30: Kick plate Port	45
Figure 3.31: Kick plate Stb	45
Figure 3.32: Hpr room REF1	46

Figure 3.33: Hpr room REF2/3	46
Figure 3.34: ROV Stb Hanger	46
Figure 3.35: ROV Stb Hanger BL 1A / deck pos	47
Figure 3.36: ROV Stb Hanger BL 2B	47
Figure 3.37: ROV baselines – Punch mark and paint mark	47
Figure 3.38: ROV Port Hanger	48
Figure 3.39: ROV Port Hanger BL 1A / deck pos	48
Figure 3.40: Nav Mast Top Platform - Antenna	49
Figure 3.41: Starpack Ant3	49
Figure 3.42: FWD dynamic cal Antenna	49
Figure 3.43: Trinav VTGP1 Ant.	50
Figure 3.44: Trinav VTGP2 Ant.	50
Figure 3.45: Starpack Ant 1	50
Figure 3.46: Septentrio Ant 2	50
Figure 3.47: Port Dynamic Cal Ant	51
Figure 3.48: Stb Dynamic Cal Ant	51
Figure 3.49: Aft (RT Calib) Ant	51
Figure 3.50: Spot track Antenna	51
Figure 3.51: Octans 3000	52
Figure 3.52: MRU5+	52
Figure 3.53: MRU5-D	52
Figure 3.54: Nortek ADCP	53
Figure 3.55: EA600	53
Figure 3.56: USBL 7000+ Lodestar	54
Figure 3.57: HD64 - Offsets	54
Figure 3.58: HD64 - Sprint Nav measured offset	55
Figure 3.59: HD64-MiniIPS	55
Figure 3.60: HD64-svx2	55
Figure 3.61: HD64-trans/HD64-Resp	55
Figure 3.62: HD64-CRP	56
Figure 3.63: : HD64-TOP	56
Figure 3.64: HD-65 Offset	56
Figure 3.65: HD65-Sprint	57
Figure 3.66: HD65-MiniIPS	57
Figure 3.67: HD65-svx2	57
Figure 3.68: HD65 Trans / HD64 Resp	57
Figure 3.69: HD65-CRP	58
Figure 3.70: HD65-TOP	58

Abbreviations

CRP	Common Reference Point
GNSS	Global Navigation Satellite System
MRU	Motion Reference Unit
POI	Point Of Interest
VRF	Vessel Reference Frame

1. Introduction

Fugro was contracted by Shearwater to perform a vessel offset survey, and sensor calibration on the SW TASMAN. The survey was conducted from October 18th to 28th, 2024. The vessel was in floating dry dock in Durban, South Africa.

1.1 Scope of work

- Measure Vessel offset from CRP, relative to the Vessel Reference Frame to the following points:
 - 9 x GNSS Antennas
 - 2 x MRU
 - 5 x Gyrocompass
 - 1 x HiPAP
 - Additional survey points

The vessel is using two separate CRP and VRF. Offset are provided in both coordinate system.

Table 1.1: Surveyed antennas

Antenna	Maker / Model	S/N
Starpack Ant. 1	Trimble / GA 830 Antenna (Linked to Starpack A)	17019
Septentrio Ant. 2	Trimble / GA 830 Antenna (Linked to Septentrio AsteRx-U)	17120
Starpack Ant. 3	Trimble / GA 830 Antenna (Linked to Starpack A)	16979
Fwd Dynamic Cal Ant.	Fugro / AD492 Antenna	668
Port Dynamic Cal Ant.	Fugro / AD492 Antenna	598
Stb Dynamic Cal Ant.	Fugro / AD492 Antenna	865
Trinav VTGP1 Ant.	Novatel / 702 - GG	470027
Trinav VTGP 2 Ant.	Novatel / 702 – GG	540041
Aft (RTCalib) Ant.	Fugro / AD410 Antenna	1176
SpotTrack Ant.	Kongsberg / SpotTrack Antenna	-

Table 1.2: Surveyed Sensors

Sensor	Survey source	Maker / Model	S/N
7000+ Lodestar	Primary Heading & Motion	Sonardyne / Gyro USBL 7000+	344570-001
Octans 3000	Secondary Heading & Motion	Exail / Octans 3000 Gen 4	PH-839
Fugro Hdg	Tertiary Heading	GNSS Hdg Starpack Ant 1 & 3	5313K92908
MRU5+	Tertiary Motion	Kongsberg / MRU5+	22962
MRU-D	Vsl DP Motion	Kongsberg / MRU D	5730
GyroUSBL 7000+	USBL System	Sonardyne / GyroUSBL 7000+	344570-001
EA600_18kHz	Transducer 18kHz	Kongsberg / EA600	Not Available

Sensor	Survey source	Maker / Model	S/N
EA600_38kHz	Transducer 38kHz	Kongsberg / EA600	2332
EA600_200kHz	Transducer 200kHz	Kongsberg / EA600	2332
Nortek ADCP	Doppler Current Profiler	Nortek / AWAC 1000kHz	7432
Gyro 1	Marine & TriNav Pri Heading	Anschutz / Standard 22	609527003028
Gyro 2	Marine & TriNav Sec Heading	Anschutz / Standard 22	609527003027
Gyro 3	Marine & TriNav Tert Heading	Anschutz / Standard 22	609527003041

- Perform the calibration of following sensors, to advise on the C-O to be entered in navigation software:

Table 1.3: Calibrated sensors

Sensor	Heading C-0	Pitch/Roll C-0
7000+ Lodestar	Y	Y
Octans 3000	Y	Y
Fugro Hdg	Y	Y
MRU5+	N	Y
Gyro 1	Y	N
Gyro 2	Y	N

- Perform a GNSS Health Check of the following antennas:
 - Septentrio Ant. 2
 - Starpack Ant. 3
 - Trinav VTGP1 Ant.
 - Trinav VTGP2 Ant.
- The SW Tasman contains two ROV, HD64 launched from Port side of the vessel, and HD65 launched from Starboard side. For both ROV, measure ROV offset from CRP, relative to the ROV Reference Frame to the following points:
 - 4 x Sensors
 - 1 x Sprint (Navigation instrument)
 - Additional survey points

Table 1.4: HD64 - Surveyed Sensors

Sensor	Maker / Model	S/N
HD64 Sprint	Sonardyne / Sprint Nav 700	344582-001
HD64 MiniIPS2	Valeport / MiniIPS2	90811
HD64 Midas SVX2	Valeport / Midas SVX2	46871
HD64 Resp.	Sonardyne / WSM6+ 4k Transponder	356861-009
HD64 Transp.	Sonardyne / WSM6+ 4k Transponder	356861-010

Table 1.5: HD65 - Surveyed Sensors

Sensor	Maker / Model	S/N
HD65 Sprint	Sonardyne / Sprint Nav 700	344499-001
HD65 MiniIPS2	Valeport / MiniIPS2	90810
HD65 Midas SVX2	Valeport / Midas SVX2	47021
HD65 Resp.	Sonardyne / WSM6+ 4k Transponder	356861-007
HD65 Transp.	Sonardyne / WSM6+ 4k Transponder	356861-008

- Perform the calibration of following sensors, to advise on the C-O to be entered in navigation software:
 - 2 x Sprint Nav

Table 1.6: HD64 - Calibrated sensors

Sensor	Heading C-0	Pitch/Roll C-0
Sprint Nav	Y	Y

Table 1.7: HD65 - Calibrated sensors

Sensor	Heading C-0	Pitch/Roll C-0
Sprint Nav	Y	Y

1.2 Definition of CRP and Vessel Reference Frame

1.2.1 General

The SW Tasman is used for two separate survey activities (Node work & Source work) using two separate Navigation packages (4DNAV & TriNav). As a result, there are two different CRP and VRF on the vessel.

Each one of both coordinate system was established during this dimensional control.

1.2.2 Vessel Reference Frame for TriNAV suite

VRF and CRP are defined by the following:

- CRP Location:
 - The CRP is located at the TriNAV VTGP1 antenna (phase centre) for the X and Y coordinates.
 - The tropical freshwater mark is used as reference for the Z coordinate.
- Vessel Axis Definitions:
 - The two kick plates on either side of the vessel were used to define the horizontal plane (parallel to XY plane).
 - The X axis is positive towards starboard.
 - The Y axis is positive towards forward.
 - The Z axis is positive upwards.

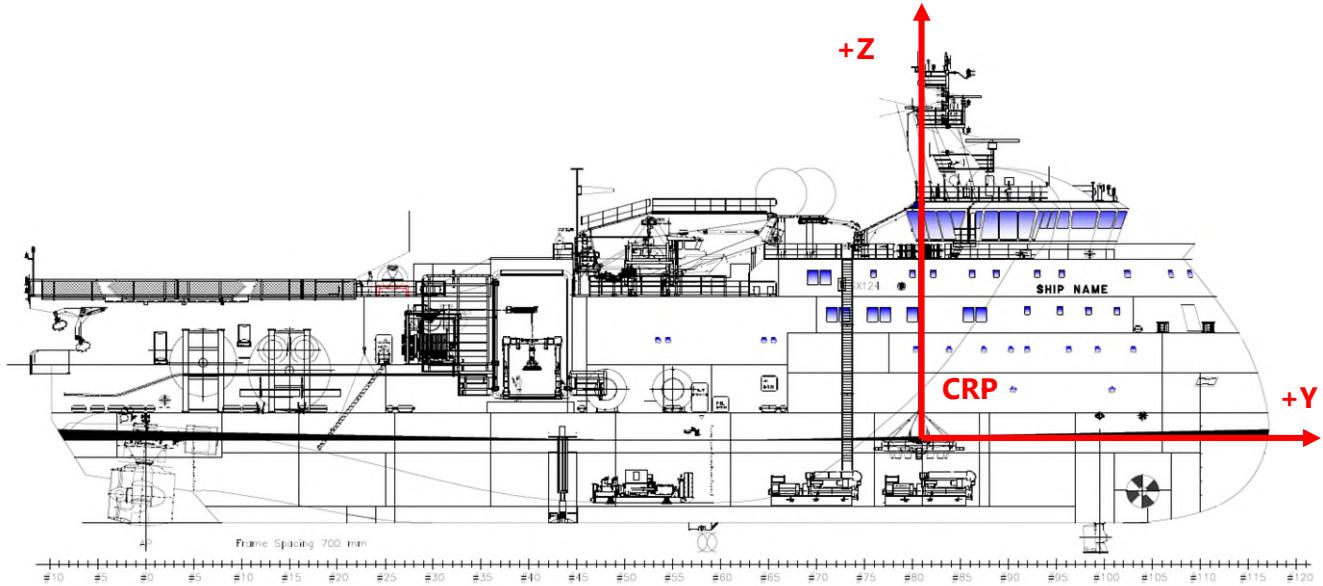


Figure 1.1: SW TASMAN - TriNAV VRF and CRP definition - Starboard view

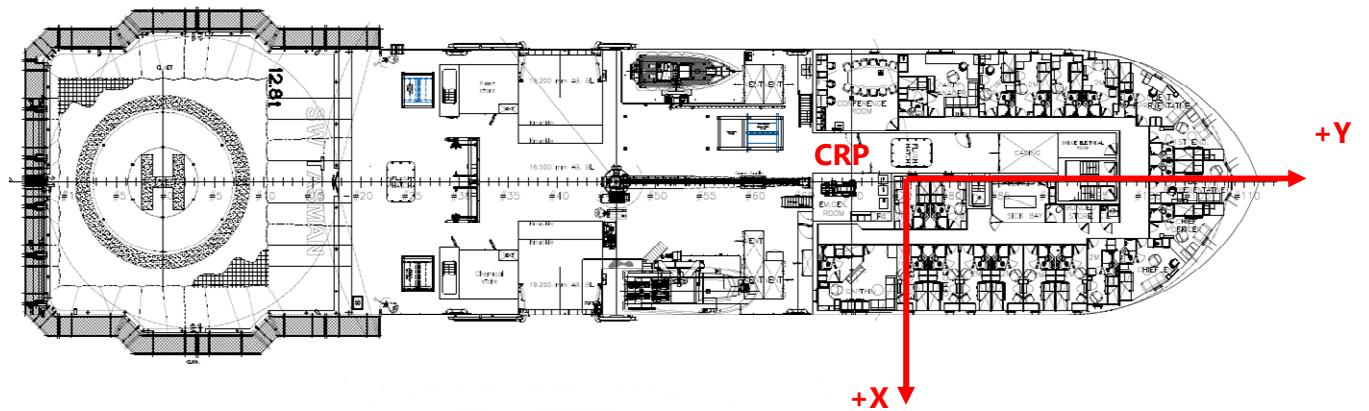


Figure 1.2: SW TASMAN - TriNAV VRF and CRP definition - Top view

1.2.3 Vessel Reference Frame for 4D Nav suite

VRF and CRP are defined by the following:

- CRP Location:
 - The origin of the reference frame is located at the reference point of the USBL when extended.
- Vessel Axis Definition:
 - The two kick plates on either side of the vessel were used to define the horizontal plane (parallel to XY plane).
 - Port and Starboard Vessel edge were used to define the Vessel +Y axis.
 - The X axis is positive to starboard.
 - The Y axis is positive to forward.
 - The Z axis is positive to upward.

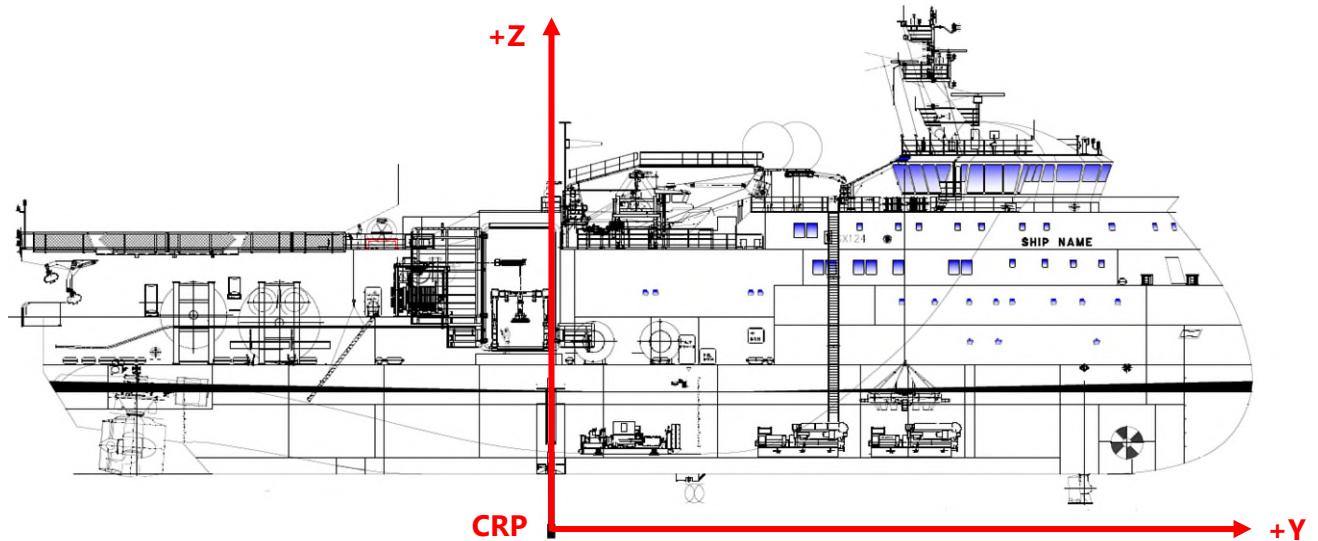


Figure 1.3: SW TASMAN - 4D NAV VRF and CRP definition - Starboard view

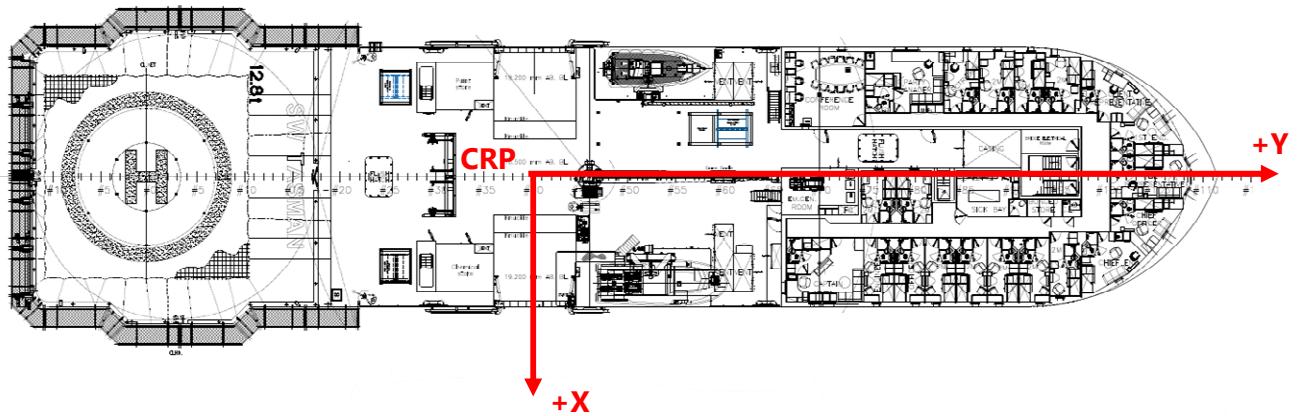


Figure 1.4: SW TASMAN – 4D Nav VRF and CRP definition - Top view

1.3 Sign convention

- The following sign convention is adopted:
- X axis is positive in Starboard direction,
- Y axis is positive in Fore direction,
- Z axis is perpendicular to XY plane and positive up,
- Positive pitch is Fore up,
- Positive roll is Port up,
- Positive yaw is positive clockwise.

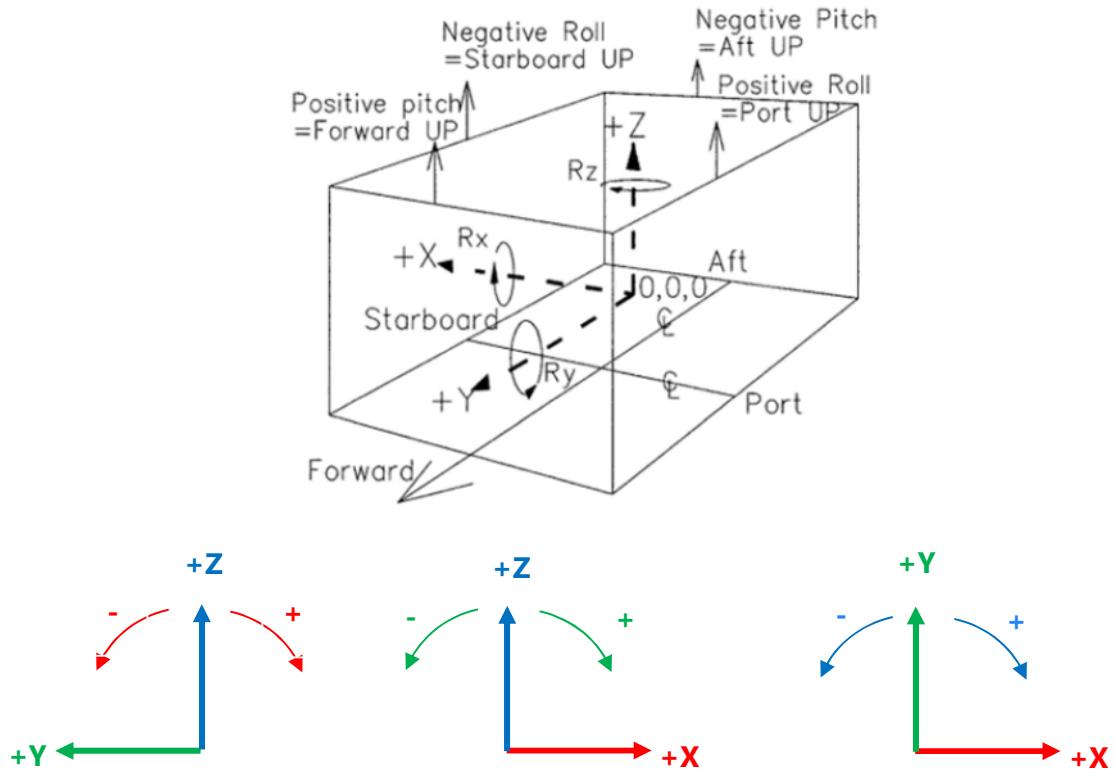


Figure 1.5: Sign convention

2. Results

2.1 SW TASMAN Results

The Figure 2.1 and Figure 2.2 show location of the offsets. Results are given in 2.1.1 (TriNAV coordinate system) and 2.1.2 (4D Nav coordinate system).

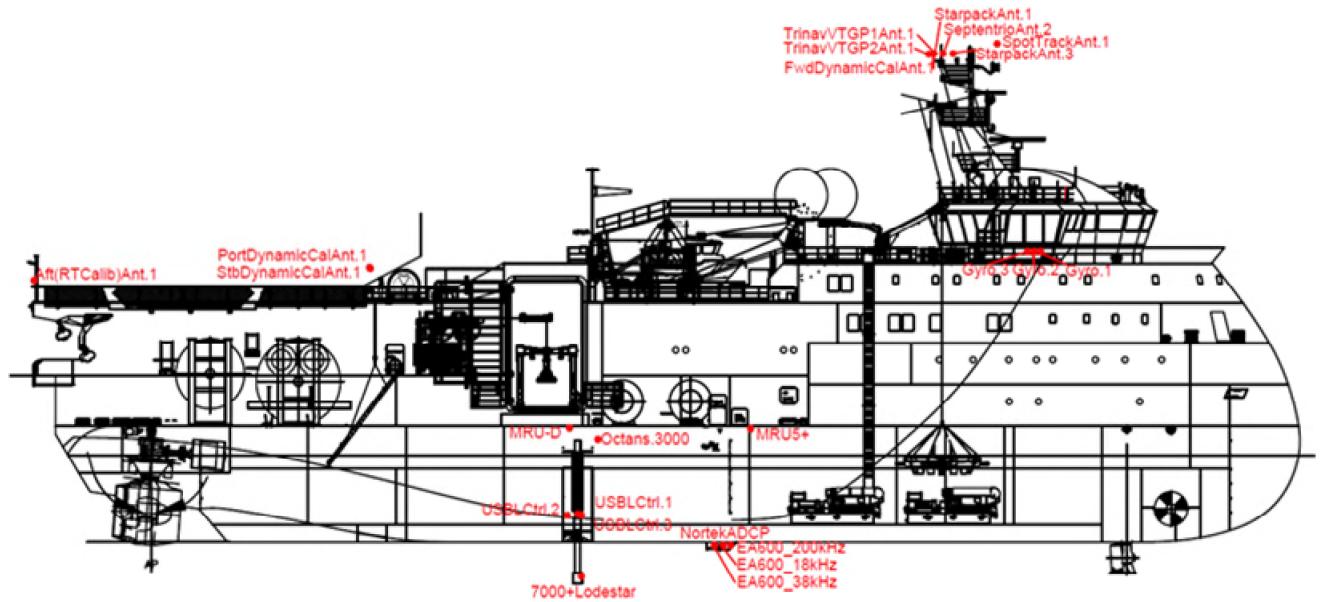


Figure 2.1: SW TASMAN Offset – Starboard view

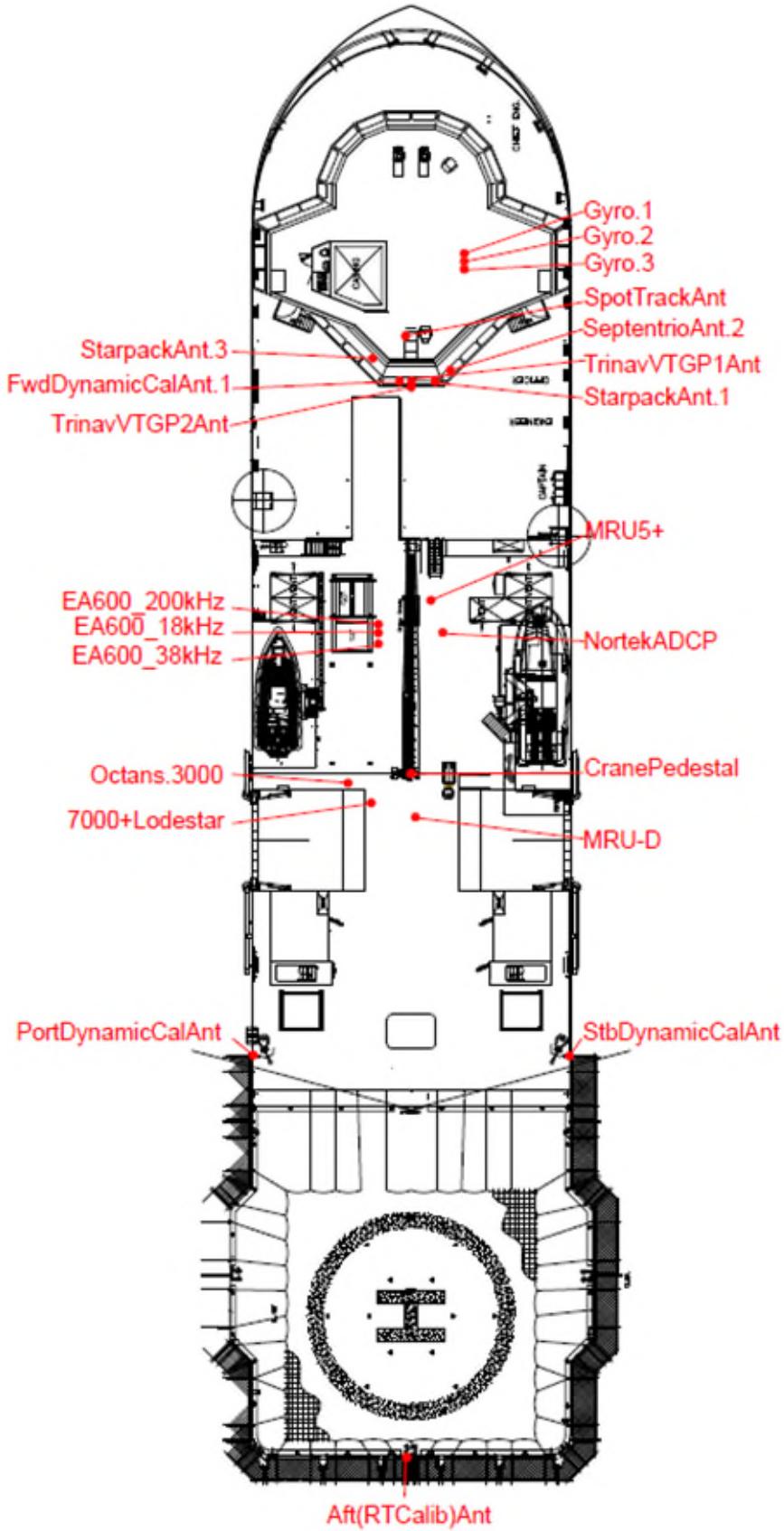


Figure 2.2: SW TASMAN Offset – Top view

2.1.1 Vessel Offsets TriNAV

Table 2.1: Vessel Offset Results - TriNAV

Antenna/Sensor	X [m]	Y [m]	Z [m]	Description
Starpack Ant. 1	1.422	0.005	26.492	Antenna Phase Centre
Septentrio Ant. 2	2.328	0.669	26.487	Antenna Phase Centre
Starpack Ant. 3	-2.304	1.376	26.486	Antenna Phase Centre
Fwd Dynamic Cal Ant.	-0.693	0.012	26.500	Antenna Phase Centre
Port Dynamic Cal Ant.	-9.414	-40.224	11.703	Antenna Phase Centre
Stb Dynamic Cal Ant.	9.432	-40.281	11.766	Antenna Phase Centre
Trinav VTGP1 Ant.	0.000	0.000	26.470	Antenna Phase Centre
Trinav VTGP 2 Ant.	-0.005	-0.351	26.450	Antenna Phase Centre
Aft (RTCalib) Ant.	-0.269	-64.232	10.888	Antenna Phase Centre
SpotTrack Ant.	-0.340	2.716	27.187	Top centre of the plate
7000+ Lodestar	-2.395	-25.159	-9.545	Reference Point
Octans 3000	-3.772	-23.977	-0.082	Base centre
MRU5+	1.166	-13.069	0.628	Bottom centre
MRU-D	0.248	-26.008	0.685	Bottom centre
EA600_18kHz	-1.969	-15.013	-7.422	Circle centre
EA600_38kHz	-1.966	-15.664	-7.425	Circle centre
EA600_200kHz	-1.969	-14.504	-7.421	Circle centre
Nortek ADCP	1.873	-14.990	-7.480	Triangle centre
Gyro 1	3.16	7.64	12.84	Top centre
Gyro 2	3.16	7.17	12.84	Top centre
Gyro 3	3.16	6.70	12.84	Top centre
Draft Mark Port	-	-	9.706	Port mid top deck kickplate, top of plinth elevation
Draft Mark Stbd	-	-	9.707	Stbd mid top deck kickplate, top of plinth elevation
ROV Port Hanger BL 1A	-7.089	-25.824	1.949	Baseline along length ROV, point Port. Punch mark on grating and yellow paintmark
ROV Port Hanger BL 1B	-3.186	-25.822	1.937	Baseline along length ROV, point Starboard. Punch mark on grating and yellow paintmark
ROV Port Hanger BL 2A	-3.032	-26.258	1.934	Baseline along width ROV, point Forward. Punch mark on grating and yellow paintmark
ROV Port Hanger BL 2B	-2.998	-29.460	1.943	Baseline along width ROV, point Aft. Punch mark on grating and yellow paintmark
ROV Stb Hanger BL 1A	6.995	-25.820	1.950	Baseline along length ROV, point Starboard. Punch mark on grating and yellow paintmark
ROV Stb Hanger BL 1B	3.180	-25.687	1.945	Baseline along length ROV, point Port. Punch mark on grating and yellow paintmark

Antenna/Sensor	X [m]	Y [m]	Z [m]	Description
ROV Stb Hanger BL 2A	3.059	-25.807	1.946	Baseline along width ROV, point Forward. Punch mark on grating and yellow paintmark
ROV Stb Hanger BL 2B	3.163	-28.775	1.951	Baseline along width ROV, point Aft. Punch mark on grating and yellow paintmark
Stb ROV deck pos	7.466	-26.458	1.953	Punch mark on grating and yellow paintmark
Port ROV deck pos	-8.380	-26.517	1.950	Punch mark on grating and yellow paintmark
Crane Pedestal	-0.010	-23.422	-	Centre of the crane pedestal
USBL Ctrl 1	-2.321	-25.404	-5.284	Reflective sticker
USBL Ctrl 2	-2.607	-26.164	-5.355	Reflective sticker
USBL Ctrl 3	-2.683	-25.151	-5.349	Reflective sticker

The Figure 2. shows misalignment of the ROV baselines relative to the VRF.

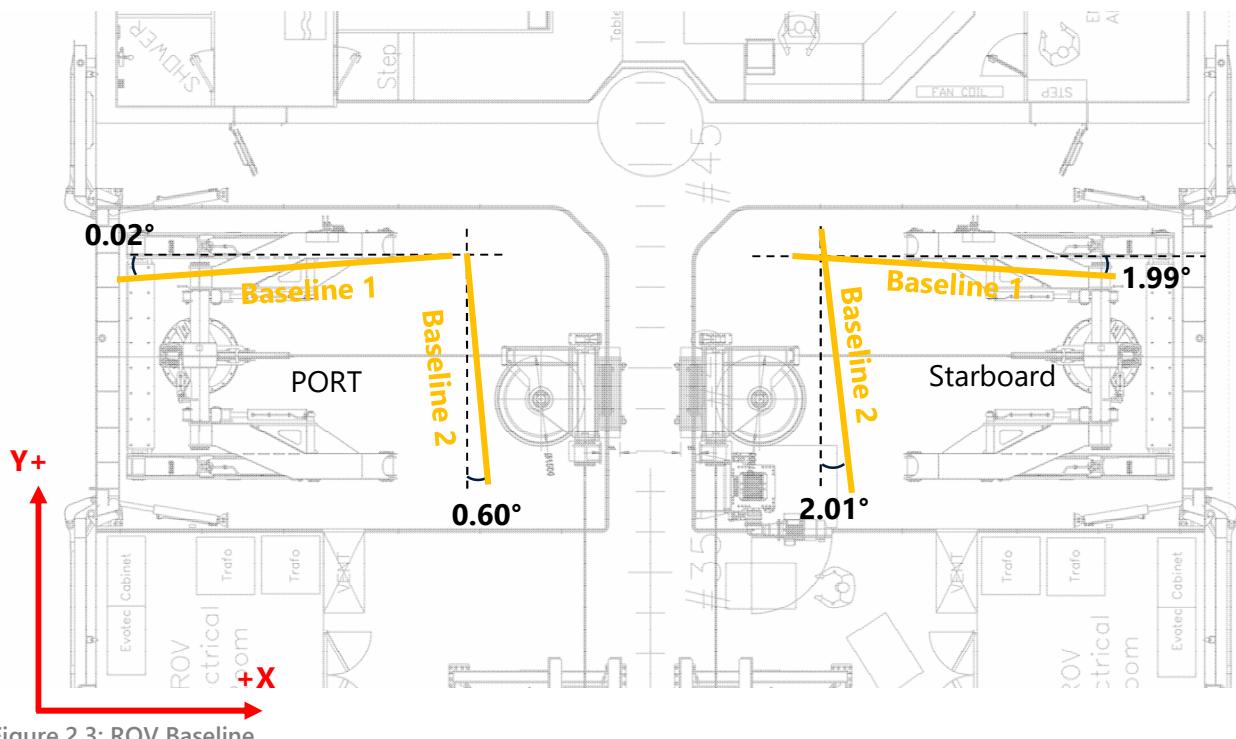


Figure 2.3: ROV Baseline

2.1.2 Vessel Offsets 4D Nav

Table 2.2: Vessel Offset Results – 4D Nav

Antenna/Sensor	X [m]	Y [m]	Z [m]	Description
Starpack Ant. 1	3.817	25.164	36.037	Antenna Phase Centre
Septentrio Ant. 2	4.723	25.828	36.033	Antenna Phase Centre
Starpack Ant. 3	0.091	26.535	36.032	Antenna Phase Centre
Fwd Dynamic Cal Ant.	1.702	25.172	36.045	Antenna Phase Centre
Port Dynamic Cal Ant.	-7.019	-15.065	21.248	Antenna Phase Centre
Stb Dynamic Cal Ant.	11.827	-15.121	21.311	Antenna Phase Centre
Trinav VTGP1 Ant.	2.395	25.159	36.016	Antenna Phase Centre
Trinav VTGP 2 Ant.	2.390	24.808	35.995	Antenna Phase Centre
Aft (RTCalib) Ant.	2.126	-39.073	20.434	Antenna Phase Centre
SpotTrack Ant.	2.055	27.875	36.733	Top centre of the plate
7000+ Lodestar	0.000	0.000	0.000	Reference Point
Octans 3000	-1.377	1.182	9.464	Base centre
MRU5+	3.561	12.091	10.174	Bottom centre
MRU-D	2.644	-0.849	10.230	Bottom centre
EA600_18kHz	0.426	10.147	2.123	Circle centre
EA600_38kHz	0.430	9.496	2.120	Circle centre
EA600_200kHz	0.426	10.655	2.125	Circle centre
Nortek ADCP	4.268	10.169	2.066	Triangle centre
Gyro 1	5.56	32.80	22.38	Top centre
Gyro 2	5.56	32.33	22.38	Top centre
Gyro 3	5.56	31.86	22.38	Top centre
Draft Mark Port	-7.088	9.793	19.251	Port mid top deck kickplate, top of plinth elevation
Draft Mark Stbd	11.910	9.565	19.252	Stbd mid top deck kickplate, top of plinth elevation
ROV Port Hanger BL 1A	-4.694	-0.664	11.495	Baseline along length ROV, point Port. Punch mark on grating and yellow paintmark
ROV Port Hanger BL 1B	-0.791	-0.663	11.482	Baseline along length ROV, point Starboard. Punch mark on grating and yellow paintmark
ROV Port Hanger BL 2A	-0.636	-1.098	11.480	Baseline along width ROV, point Forward. Punch mark on grating and yellow paintmark
ROV Port Hanger BL 2B	-0.603	-4.301	11.488	Baseline along width ROV, point Aft. Punch mark on grating and yellow paintmark
ROV Stb Hanger BL 1A	9.390	-0.661	11.495	Baseline along length ROV, point Starboard. Punch mark on grating and yellow paintmark
ROV Stb Hanger BL 1B	5.575	-0.528	11.490	Baseline along length ROV, point Port. Punch mark on grating and yellow paintmark

Antenna/Sensor	X [m]	Y [m]	Z [m]	Description
ROV Stb Hanger BL 2A	5.454	-0.648	11.491	Baseline along width ROV, point Forward. Punch mark on grating and yellow paintmark
ROV Stb Hanger BL 2B	5.559	-3.616	11.496	Baseline along width ROV, point Aft. Punch mark on grating and yellow paintmark
Stb ROV deck pos	9.861	-1.299	11.498	Punch mark on grating and yellow paintmark
Port ROV deck pos	-5.985	-1.358	11.496	Punch mark on grating and yellow paintmark
Crane Pedestal	2.385	1.737	-	Centre of the pedestal
USBL Ctrl 1	0.075	-0.244	4.261	Reflective sticker
USBL Ctrl 2	-0.212	-1.005	4.190	Reflective sticker
USBL Ctrl 3	-0.288	0.009	4.196	Reflective sticker

2.1.3 Gyrocompass and Motion Sensor Calibration

2.1.3.1 Octans 3000

Table 2.3: Octans 3000 C-O

Equipment	Data type			C-0 [°]	S.D. [°]	Min [°]	Max [°]	
Octans 3000	Heading			-0.04	0.03	-0.15	0.04	
Octans 3000	Pitch			0.17	0.02	0.06	0.27	
Octans 3000	Roll			0.51	0.04	0.30	0.69	
<hr/>								
Octans 3000	Session 2 (26/11/24)				Session 3 (28/11/24)			
Data Type	C-0 [°]	S.D. [°]	Min [°]	Max [°]	C-0 [°]	S.D. [°]	Min [°]	Max [°]
Heading	-0.05	0.03	-0.15	0.04	-0.03	0.02	-0.09	0.03
Pitch	0.18	0.02	0.06	0.27	0.16	0.02	0.07	0.22
Roll	0.51	0.05	0.30	0.69	0.51	0.03	0.38	0.64
	<ul style="list-style-type: none"> ■ Notes: <ul style="list-style-type: none"> • Observation date: 26.11.2024 • Observation time: 16:00-18:00 • All C-0 set to 0° 				<ul style="list-style-type: none"> ■ Notes: <ul style="list-style-type: none"> • Observation date: 28.11.2024 • Observation time: 08:42-11:01 • All C-0 set to 0° 			

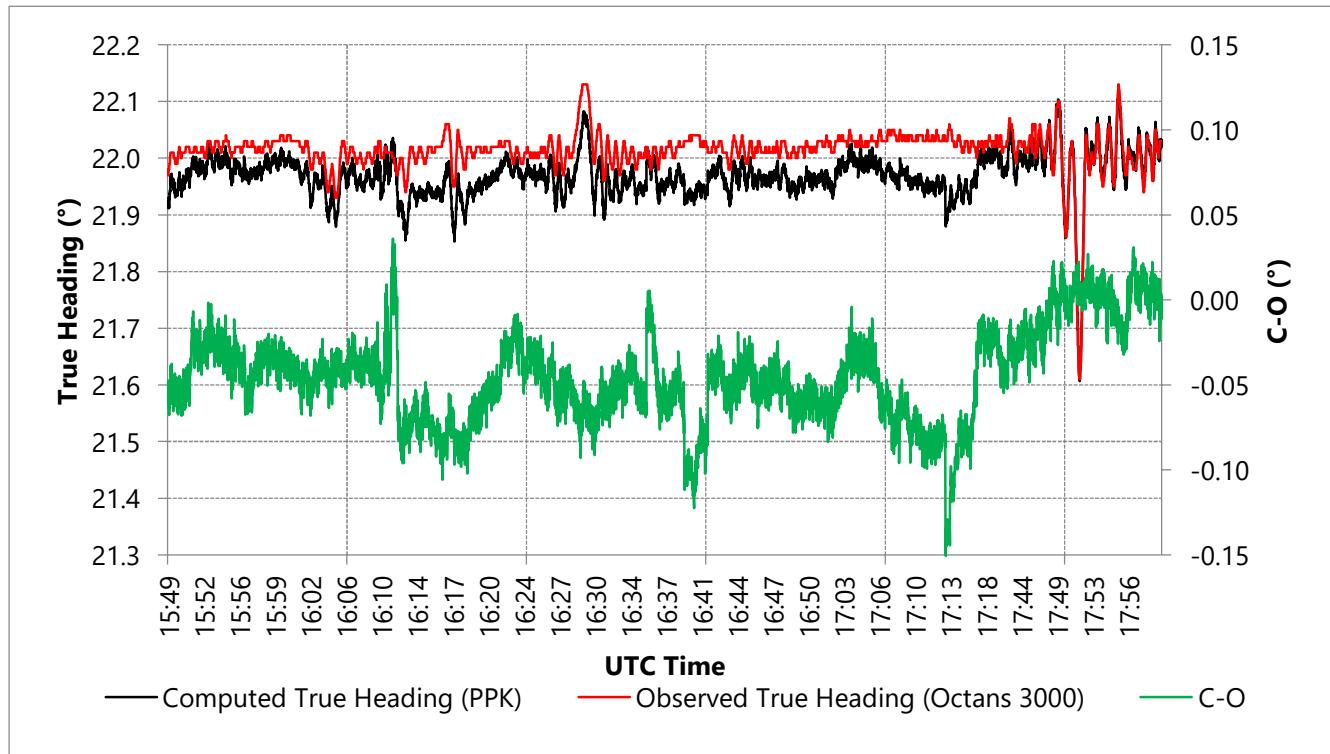


Figure 2.4: Octans 3000 - Session 2 - Gyrocompass calibration

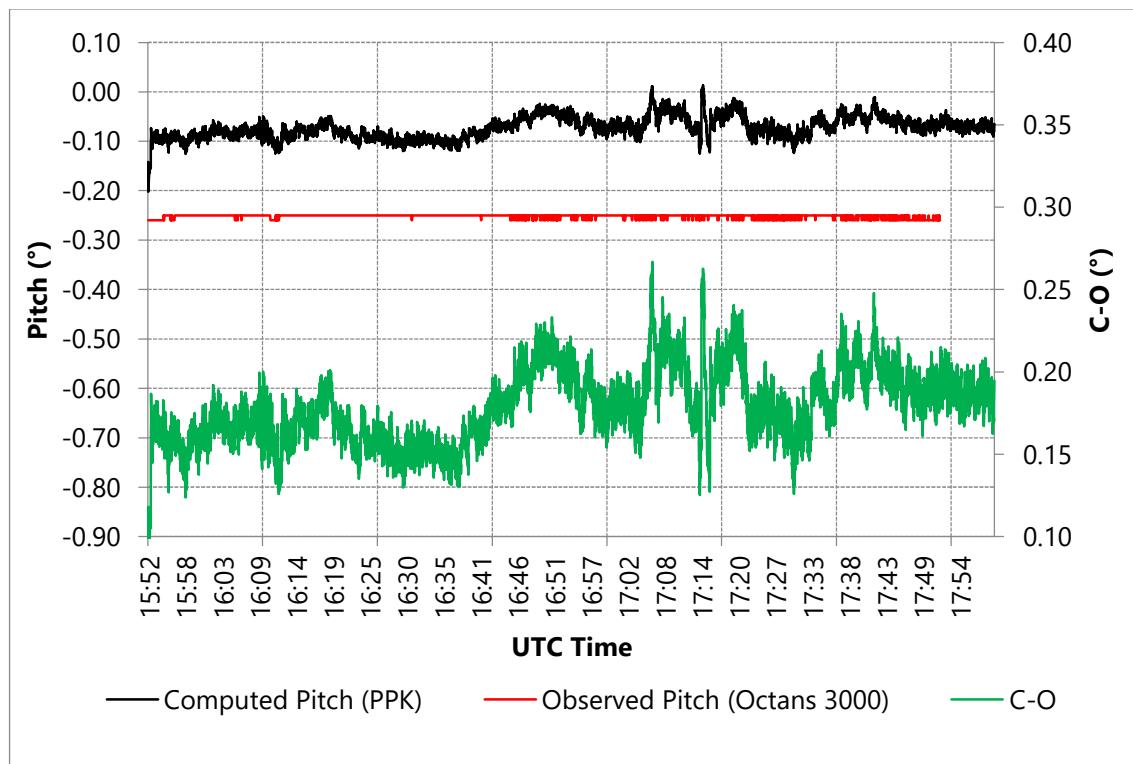


Figure 2.5: Octans 3000 - Session 2 - Pitch calibration

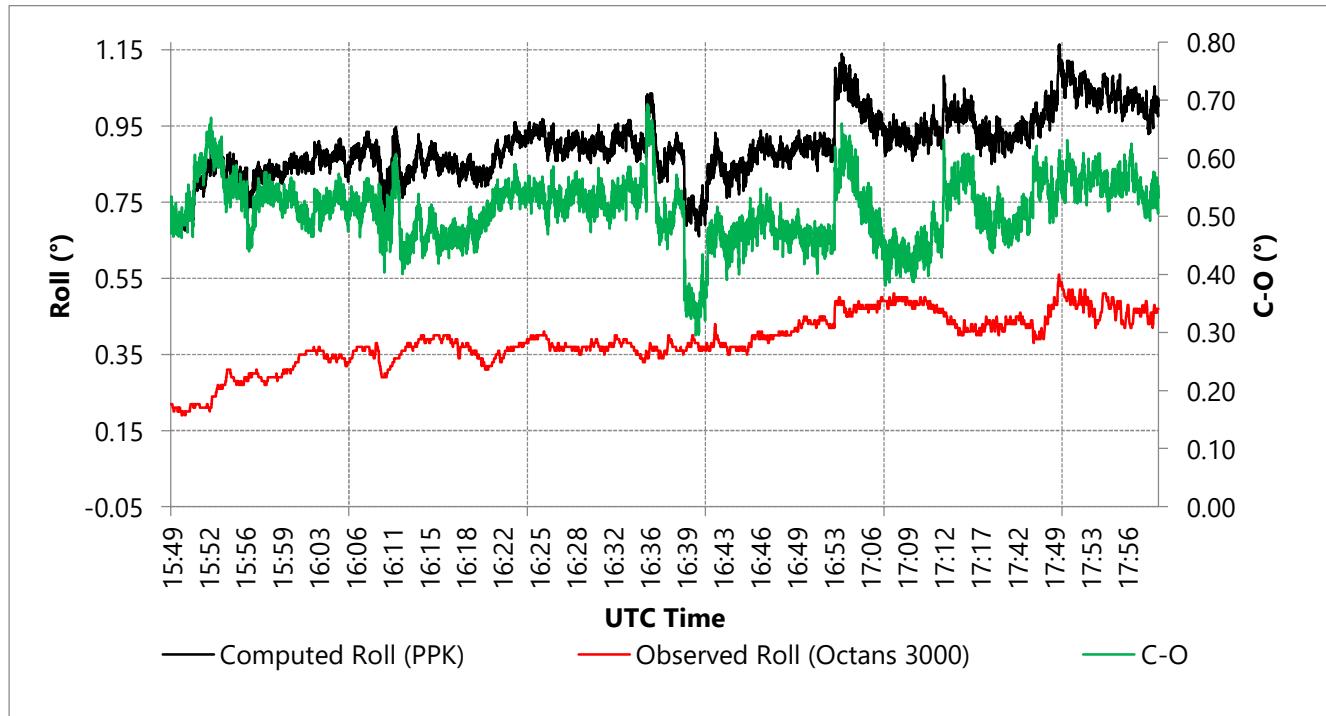


Figure 2.6: Octans 3000 - Session 2 - Roll calibration

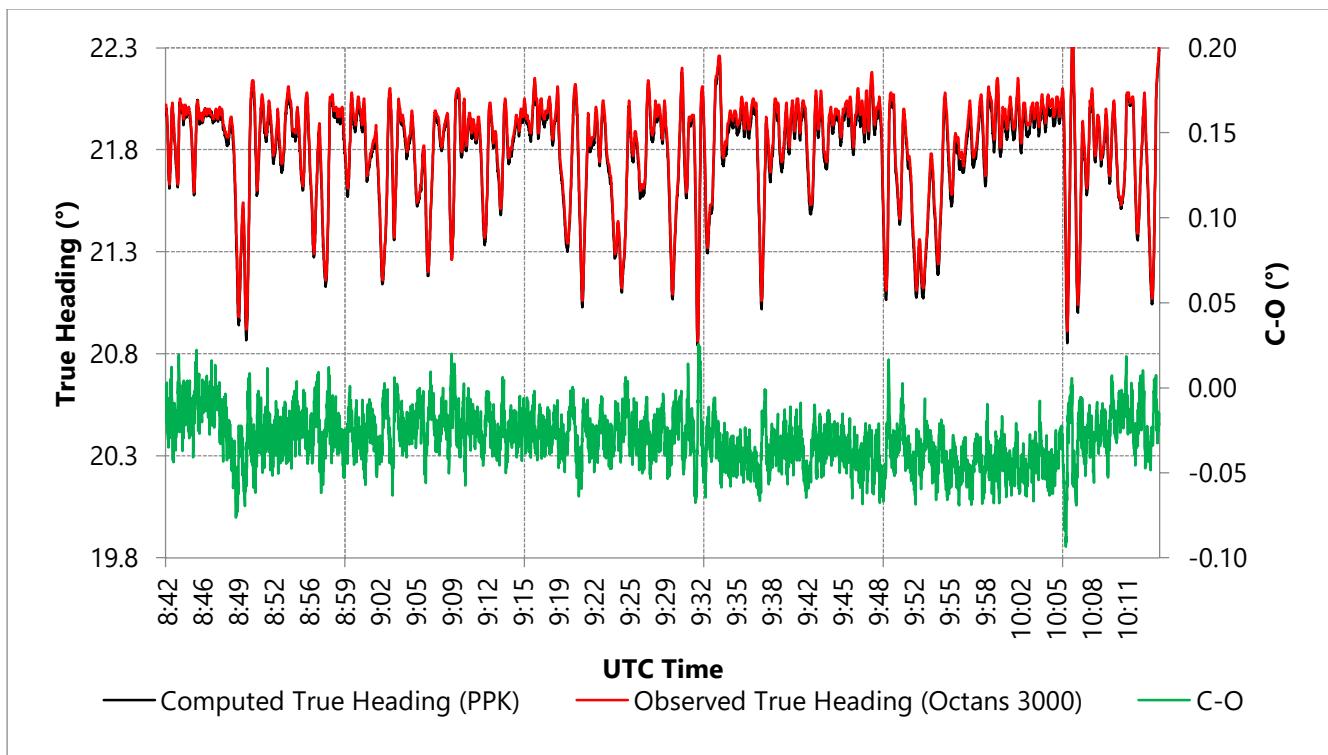


Figure 2.7: Octans 3000 - Session 3 - Gyrocompass calibration

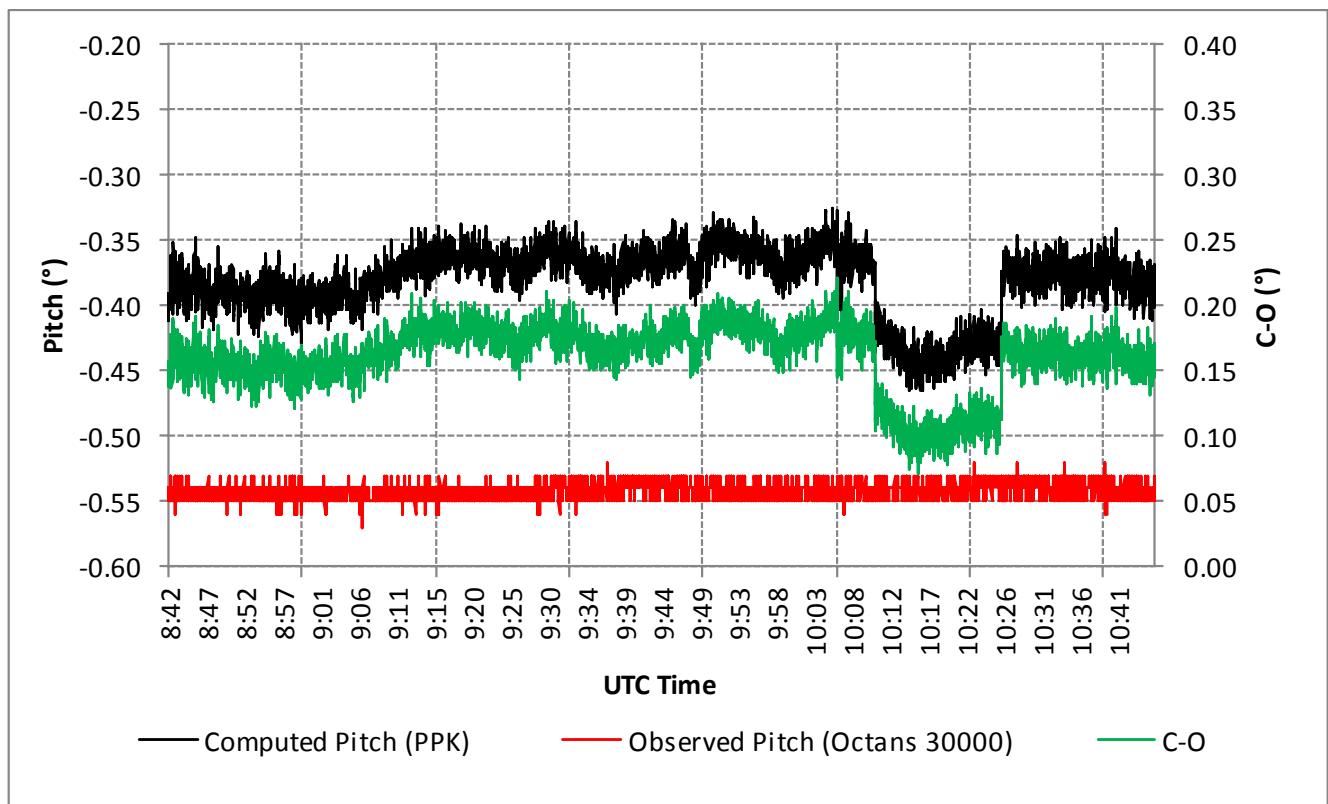


Figure 2.8: Octans 3000 - Session 3 - Pitch calibration

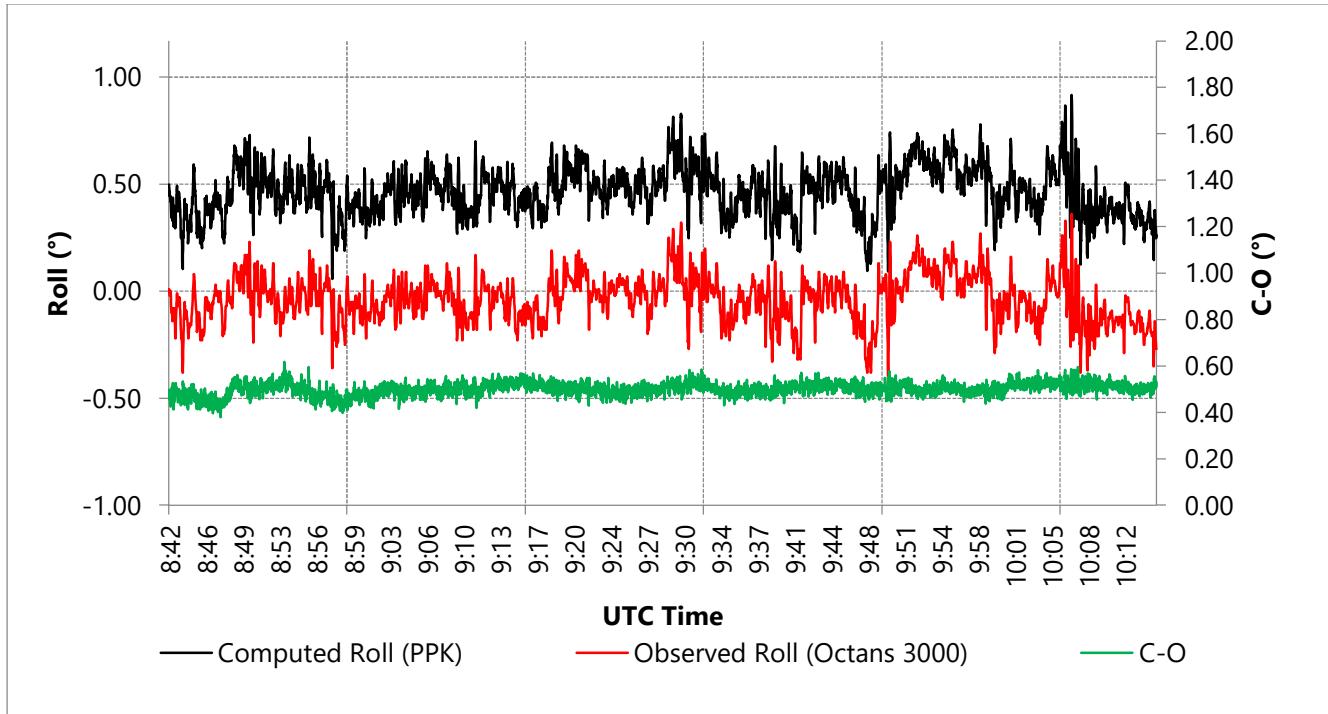


Figure 2.9: Octans 3000 - Session 3 - Roll calibration

2.1.3.2 7000+ Lodestar

Table 2.4: 7000+ Lodestar C-0

Equipment		Data type			C-0 [°]	S.D. [°]	Min [°]	Max [°]			
7000+ Lodestar		Heading			-0.14	0.04	-0.25	-0.06			
7000+ Lodestar		Pitch			0.10	0.02	0.00	0.21			
7000+ Lodestar		Roll			0.74	0.04	0.50	0.90			
<hr/>											
7000+ Lodestar	Session 1 (24/11/24)				Session 2 (26/11/24)						
Data Type	C-0 [°]	S.D. [°]	Min [°]	Max [°]	C-0 [°]	S.D. [°]	Min [°]	Max [°]			
Heading	-0.13	0.04	-0.21	-0.06	-0.15	0.03	-0.25	-0.06			
Pitch	0.11	0.02	0.03	0.16	0.09	0.02	0.00	0.21			
Roll	0.75	0.02	0.64	0.84	0.72	0.05	0.50	0.90			
	<ul style="list-style-type: none"> ■ Notes: <ul style="list-style-type: none"> • Observation date: 24.11.2024 • Observation time: 16:30-20:30 • All C-0 set to 0° 				<ul style="list-style-type: none"> ■ Notes: <ul style="list-style-type: none"> • Observation date: 26.11.2024 • Observation time: 16:00-18:00 • All C-0 set to 0° 						
Notes: To improve and confirm the C-O, two 2-hour sessions were conducted by rotating the vessel 180°.											

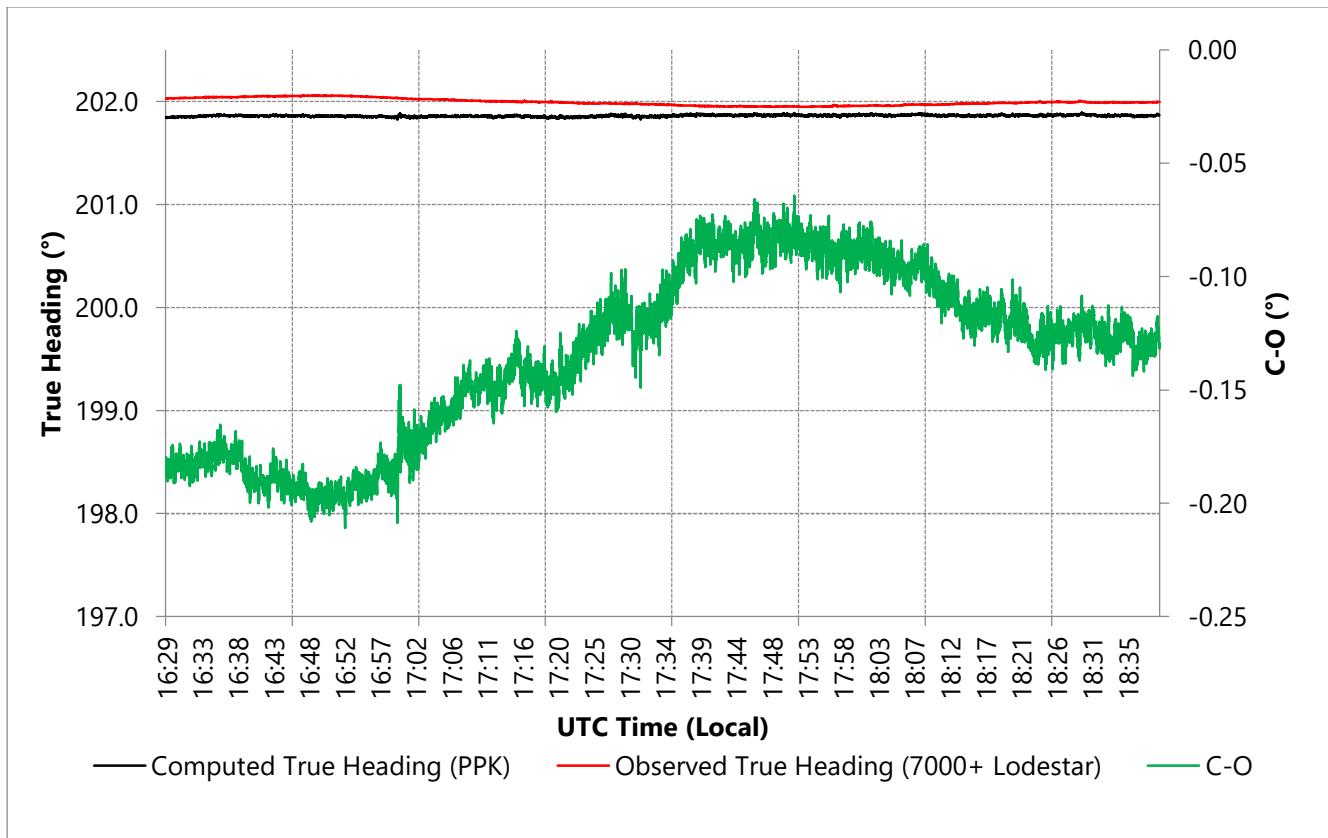


Figure 2.10: 7000+ Lodestar - Session 1 – Gyrocompass calibration

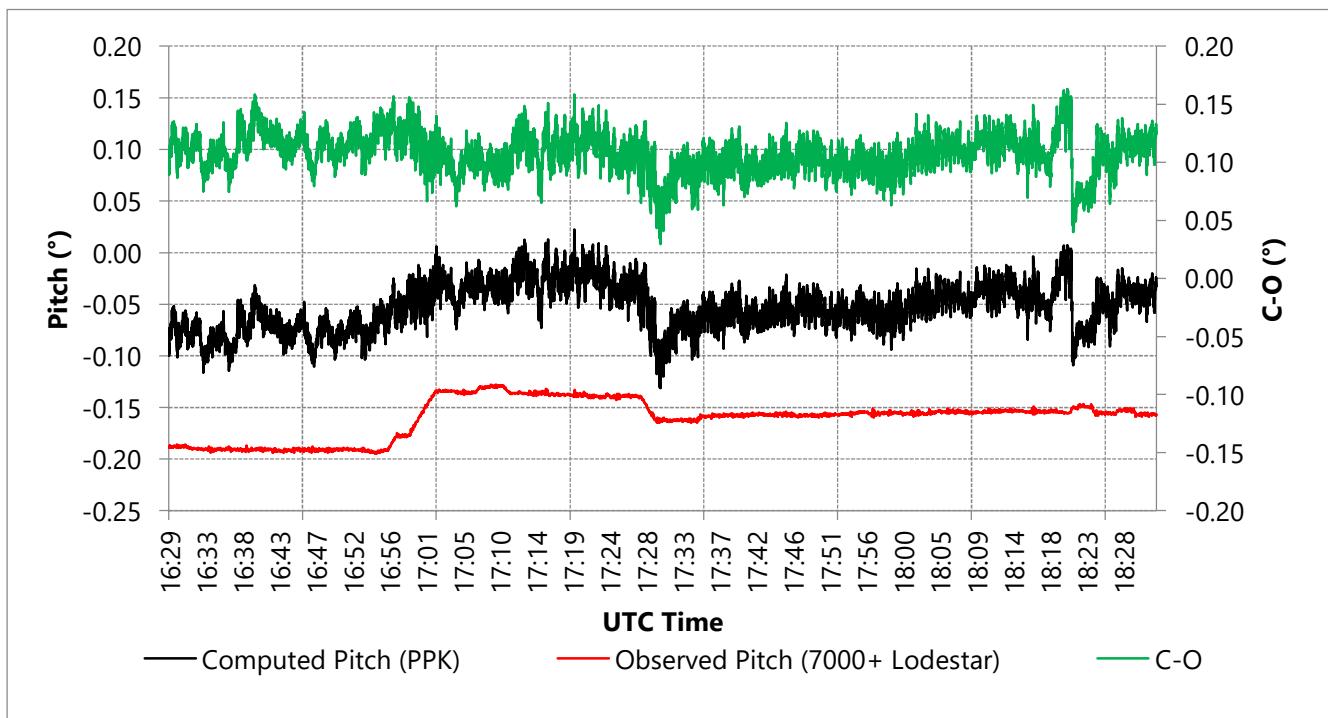


Figure 2.11: 7000+ Lodestar - Session 1 - Pitch calibration

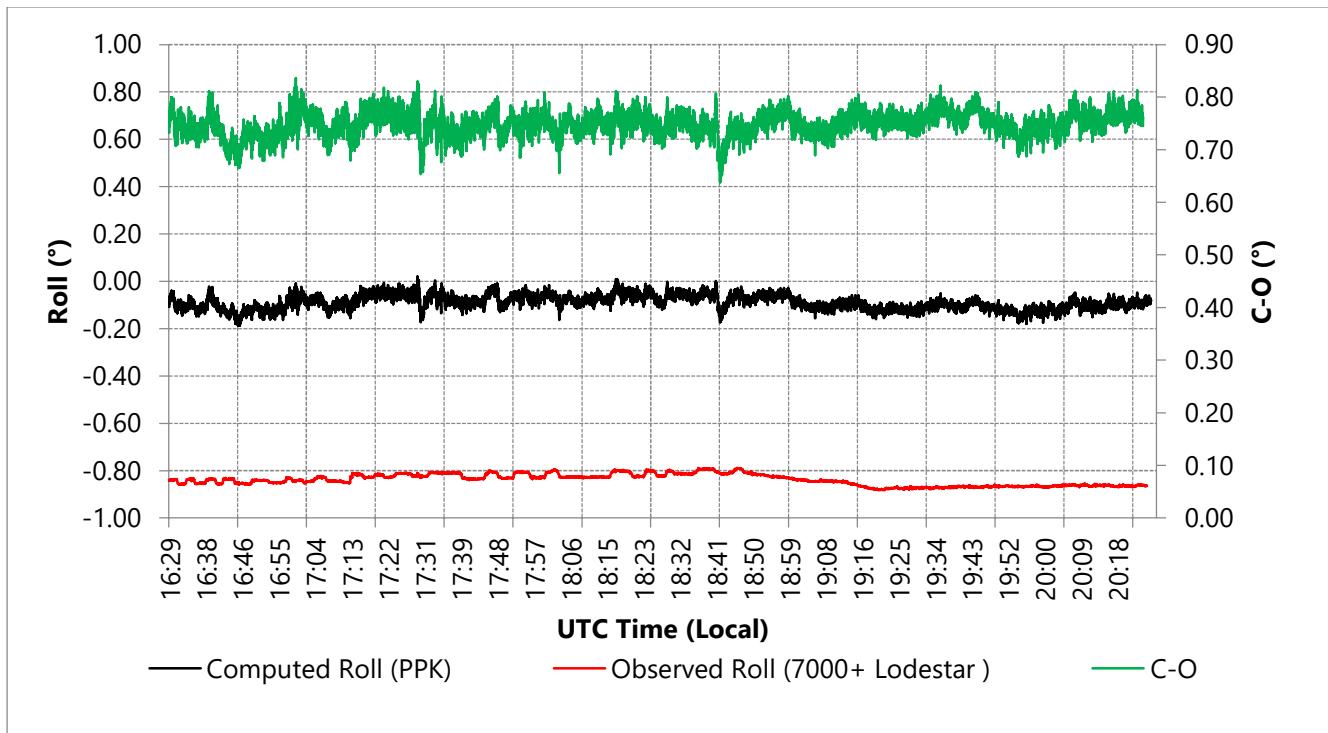


Figure 2.12: 7000+ Lodestar - Session 1 - Roll calibration

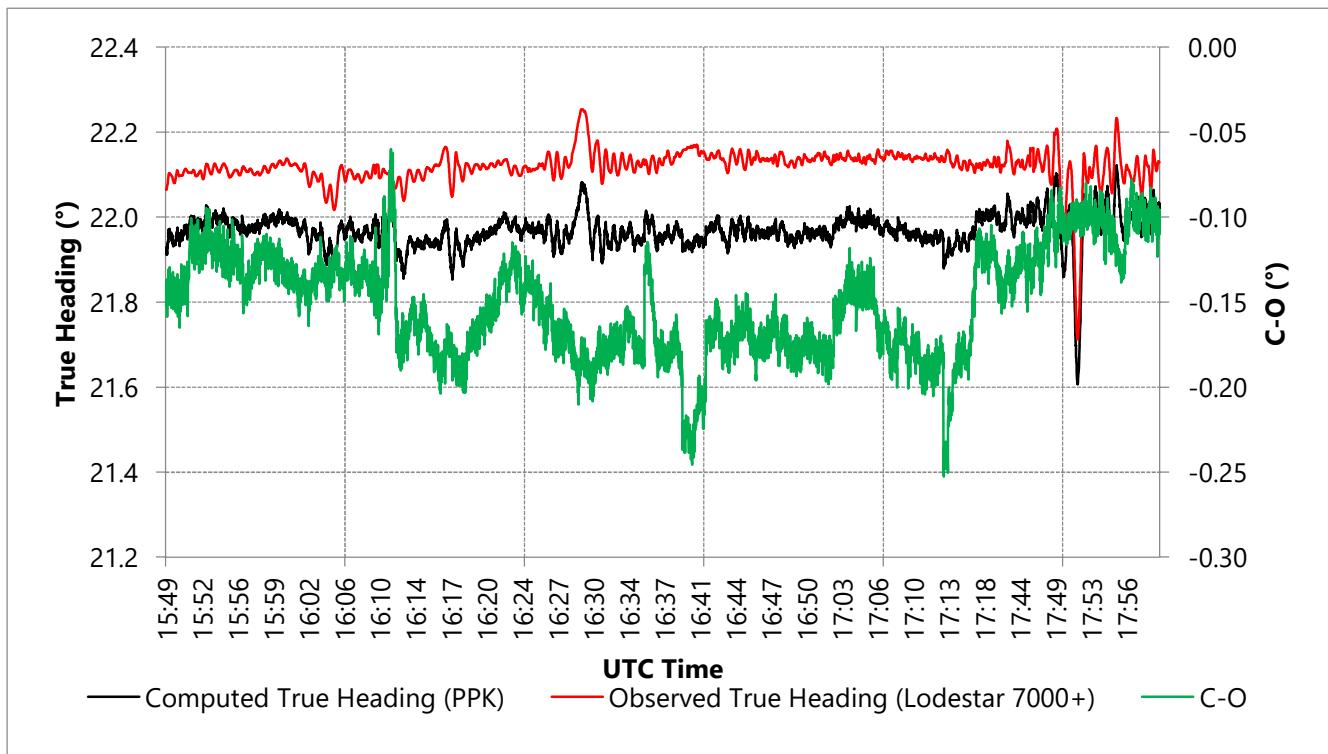


Figure 2.13: 7000+ Lodestar - Session 2 – Gyrocompass calibration

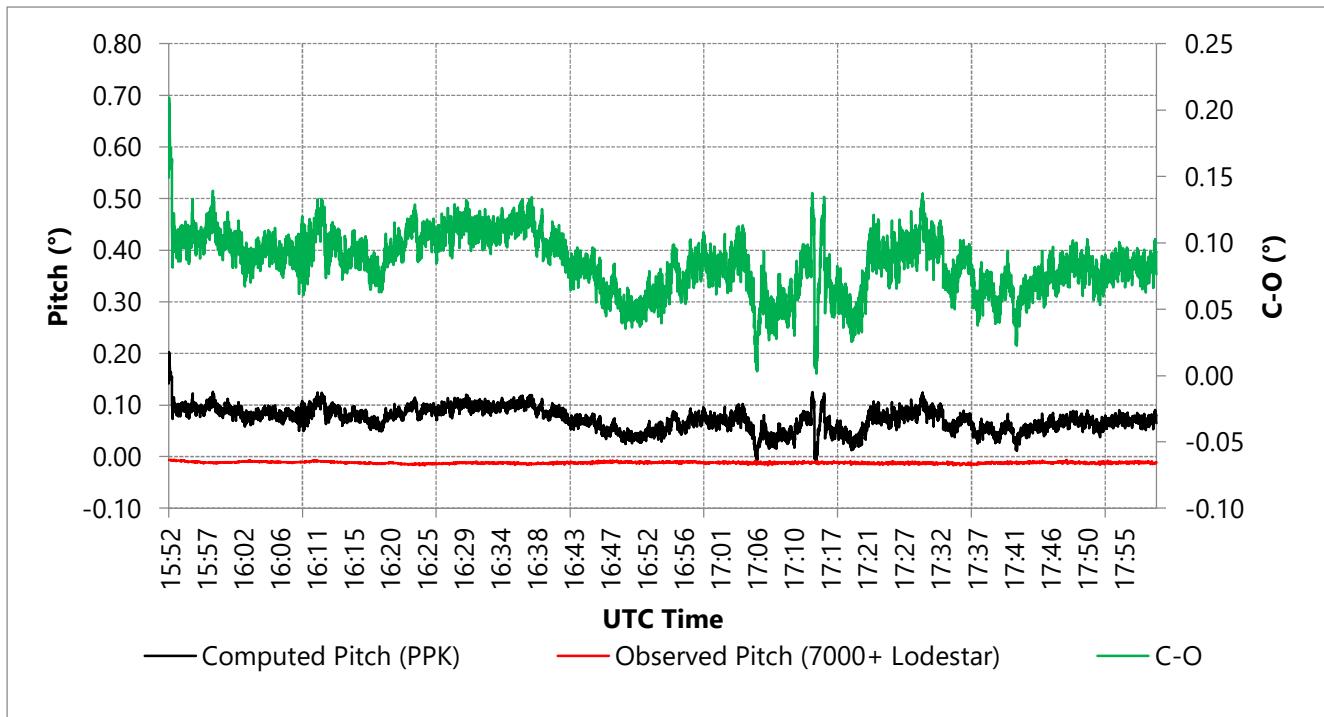


Figure 2.14: Lodestar - Session 2 - Pitch calibration

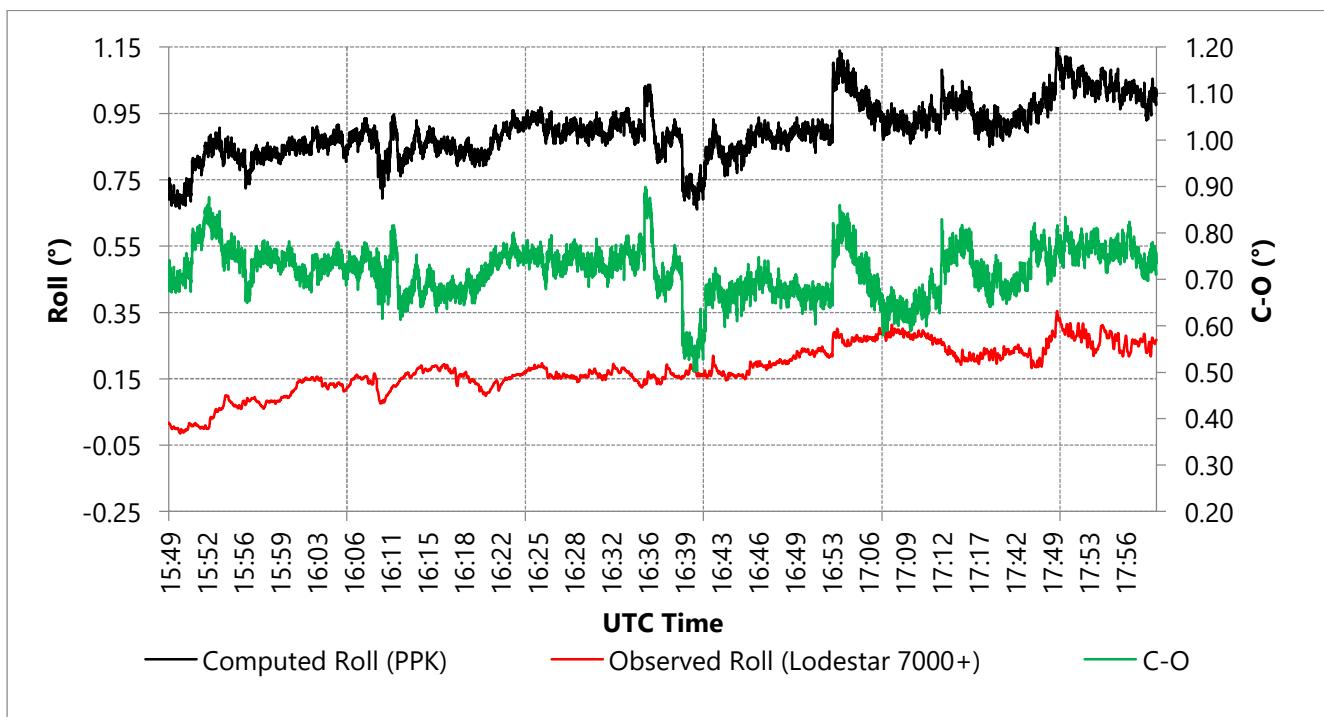


Figure 2.15: Lodestar - Session 2 - Roll calibration

2.1.3.3 MRU5+

Table 2.5: MRU5+ C-0

Equipment		Data type			C-0 [°]	S.D. [°]	Min [°]	Max [°]			
MRU5+		Pitch			-0.30	0.02	-0.40	-0.19			
MRU5+		Roll			-0.16	0.04	-0.39	0.00			
MRU5 +	Session 1 (24/11/24)				Session 2 (26/11/24)						
Data Type	C-0 [°]	S.D. [°]	Min [°]	Max [°]	C-0 [°]	S.D. [°]	Min [°]	Max [°]			
Pitch	-0.29	0.02	-0.39	-0.22	-0.31	0.02	-0.40	-0.19			
Roll	-0.15	0.02	-0.26	-0.07	-0.18	0.05	-0.39	0.00			
	<ul style="list-style-type: none"> ■ Notes: <ul style="list-style-type: none"> • Observation date: 24.11.2024 • Observation time: 16:30-20:30 				<ul style="list-style-type: none"> ■ Notes: <ul style="list-style-type: none"> • Observation date: 26.11.2024 • Observation time: 16:00-18:00 						
Notes: To improve and confirm the C-O, two 2-hour sessions were conducted by rotating the vessel 180°.											

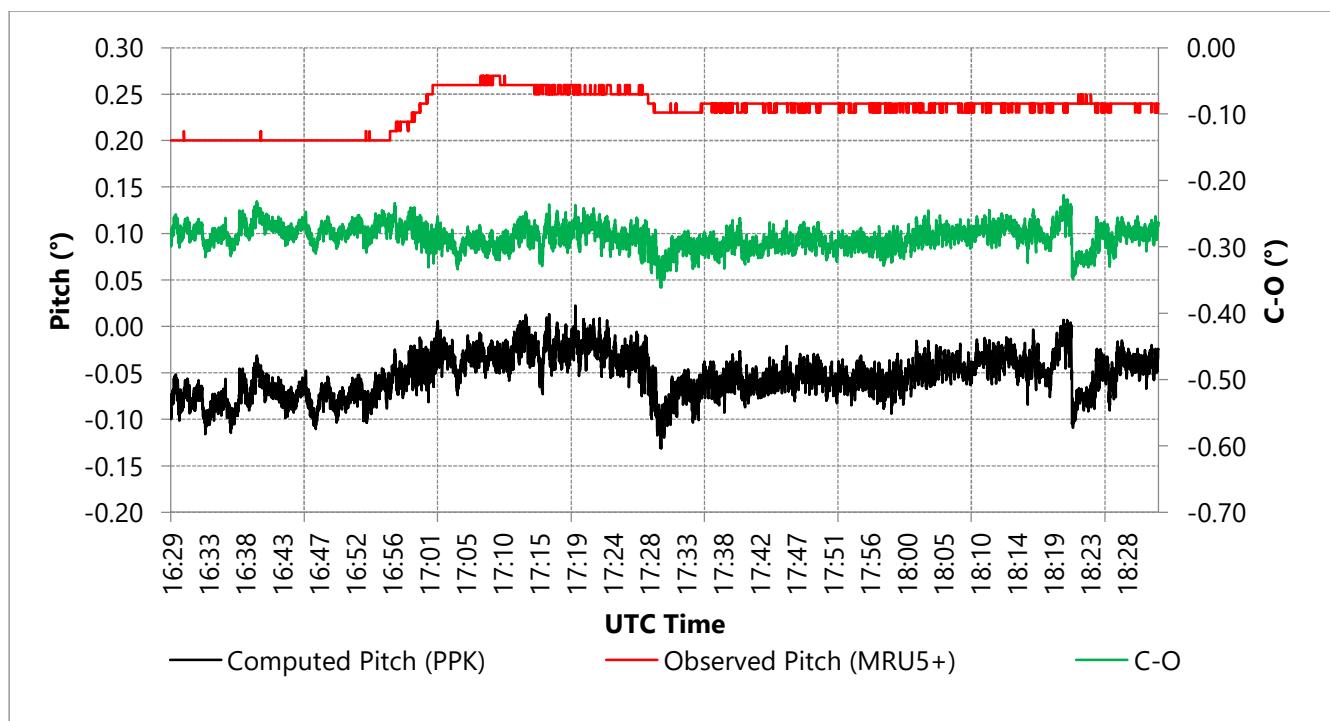


Figure 2.16: MRU5+ - Session 1 - Pitch calibration

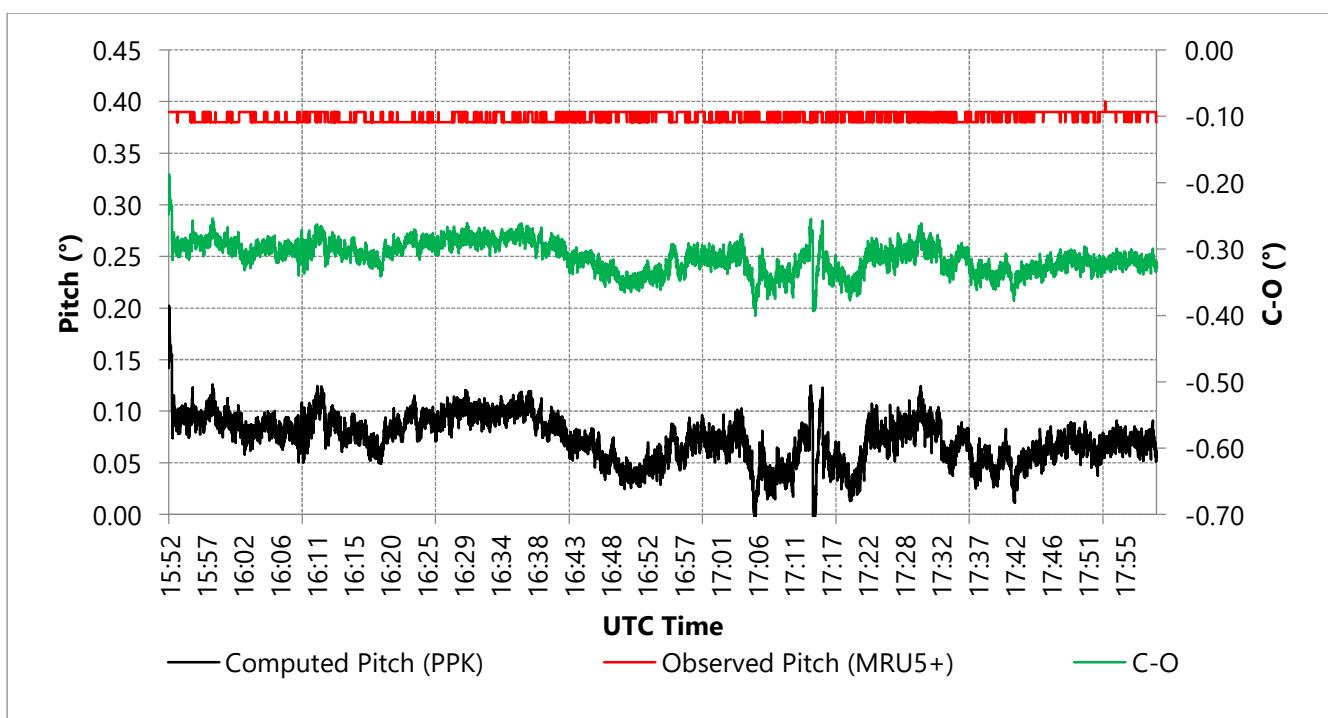
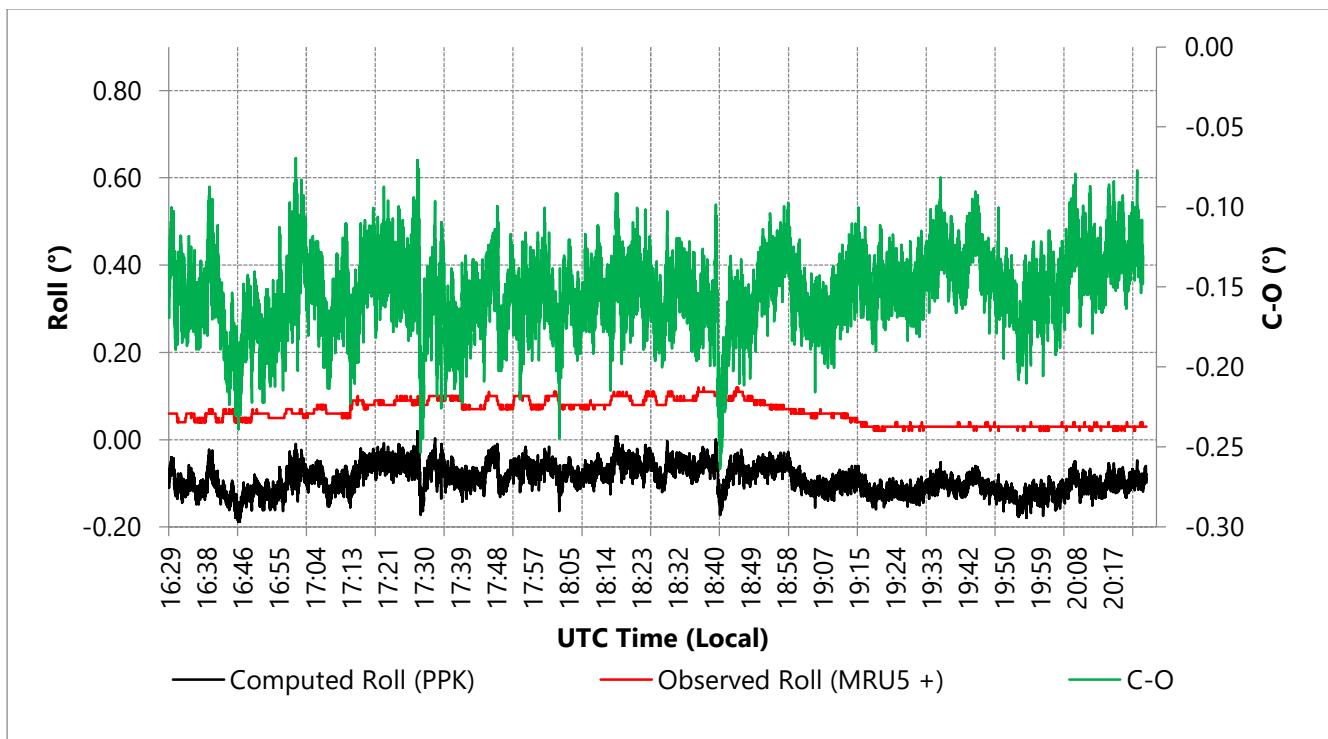


Figure 2.18: MRU5+ - Session 2 – Pitch calibration

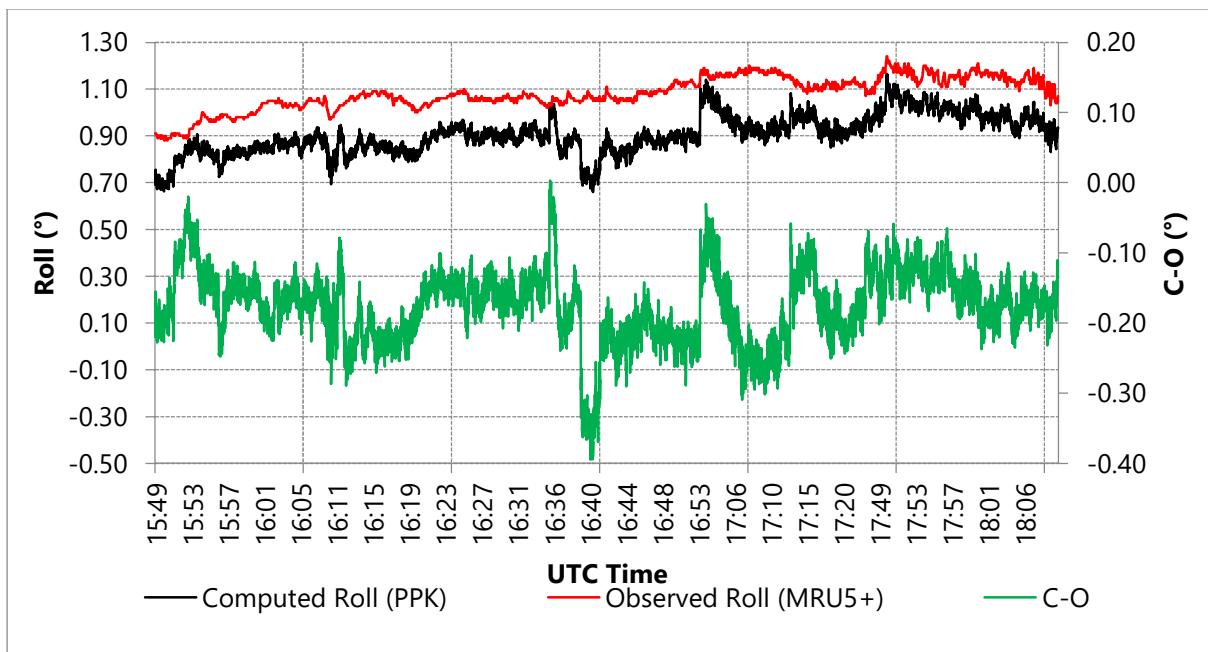


Figure 2.19: MRU5+ - Session 2 - Roll calibration

2.1.3.4 Gyrocompass

Table 2.6: Gyrocompass

Equipment	Data type			C-0 [°]	S.D. [°]	Min [°]	Max [°]
Gyro 1	Heading			0.61	0.07	0.41	0.78
Gyro 2	Heading			0.60	0.27	0.32	0.99
Fugro Hdg	Heading			0.04	0.06	-0.14	0.29
MRU5 +	Session 1 (24/11/24)				Session 2 (26/11/24)		
Data Type	C-0 [°]	S.D. [°]	Min [°]	Max [°]	C-0 [°]	S.D. [°]	Min [°]
Gyro1 Heading	0.64	0.05	0.53	0.78	0.57	0.08	0.41
Gyro 2 Heading	0.53	0.05	0.43	0.59	0.67	0.10	0.32
Fugro Heading	-	-	-	-	0.04	0.06	-0.14
	<ul style="list-style-type: none"> ■ Notes: <ul style="list-style-type: none"> • Observation date: 24.11.2024 • Observation time: 16:30-20:30 • C-O set to 0° • New offset of Starpack antenna 1 and 3 not set-up 				<ul style="list-style-type: none"> ■ Notes: <ul style="list-style-type: none"> • Observation date: 26.11.2024 • Observation time: 16:00-18:00 • C-O set to 0° • New offset of Starpack antenna 1 and 3 in navigation software 		
<p>Notes: To improve and confirm the C-O, two 2-hour sessions were conducted by rotating the vessel 180°.</p> <p><i>During the first dynamic calibration logging, new offsets of the two Starpack antennas were not updated in the navigation system. As these offsets are included in the Fugro heading calculation, the C-O calculated in the first session isn't consistent with the new dimensional control.</i></p>							

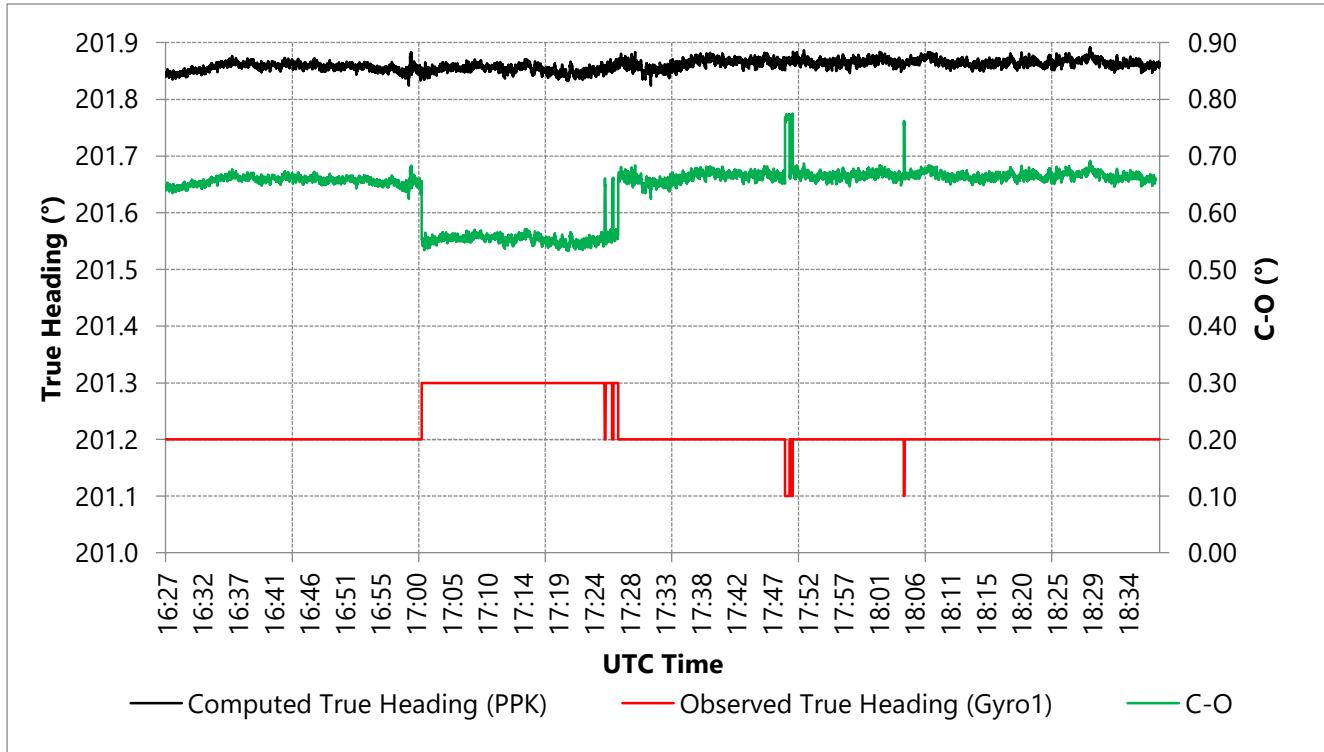


Figure 2.20: Gyro1 - Session 1 – Gyrocompass Calibration

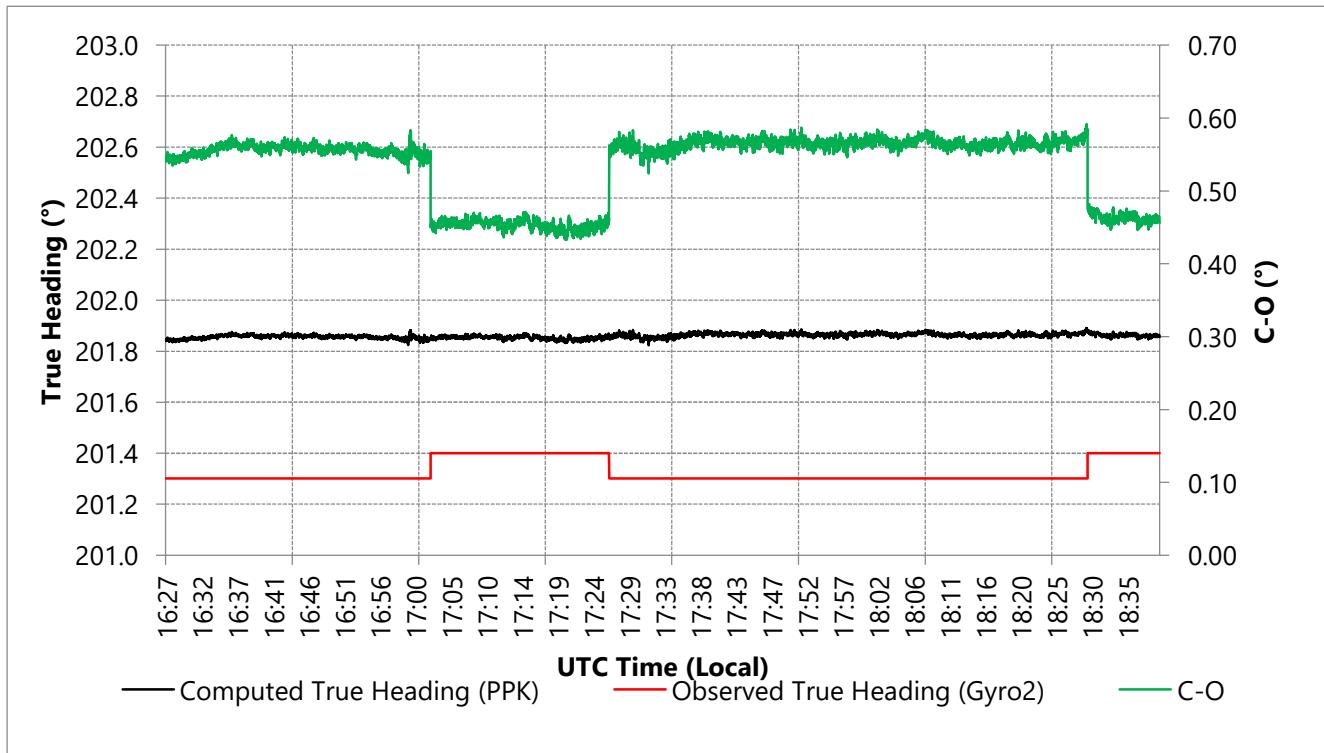


Figure 2.21: Gyro2 - Session 1 – Gyrocompass Calibration

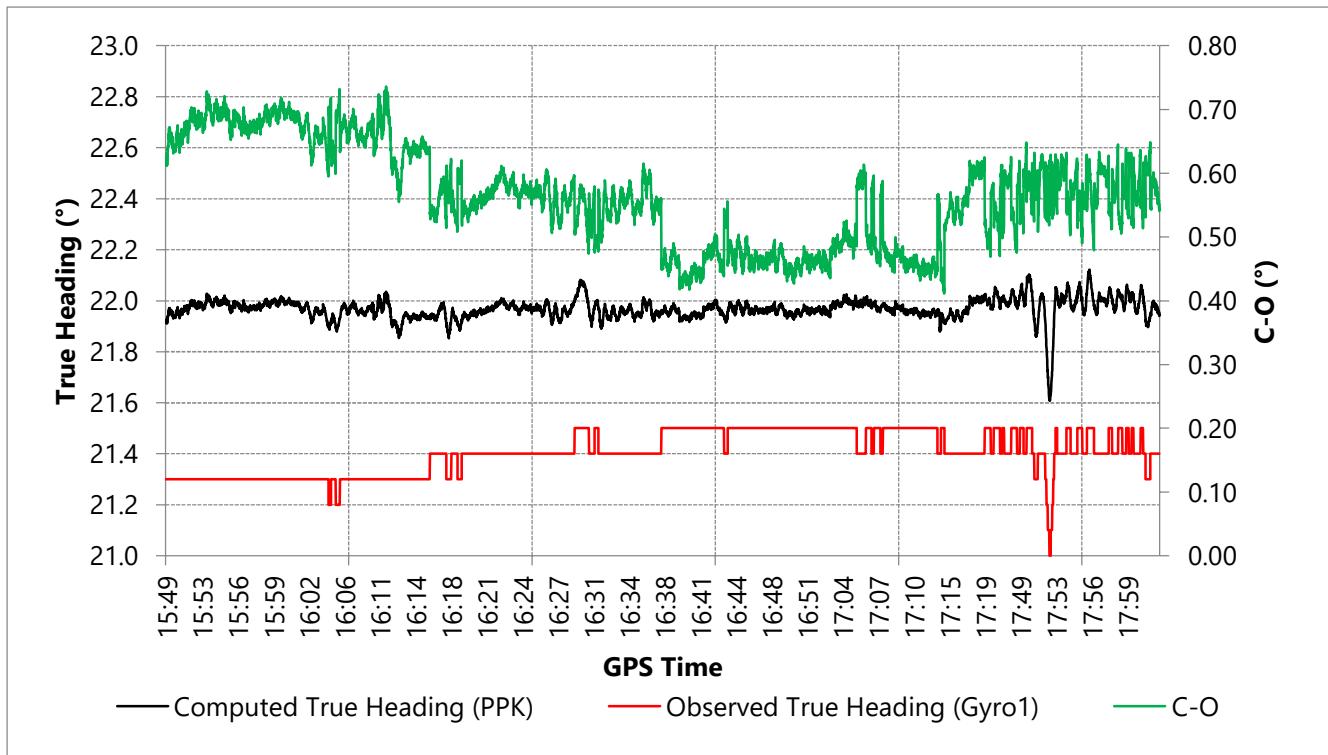


Figure 2.22: Gyro1 - Session 2 – Gyrocompass Calibration

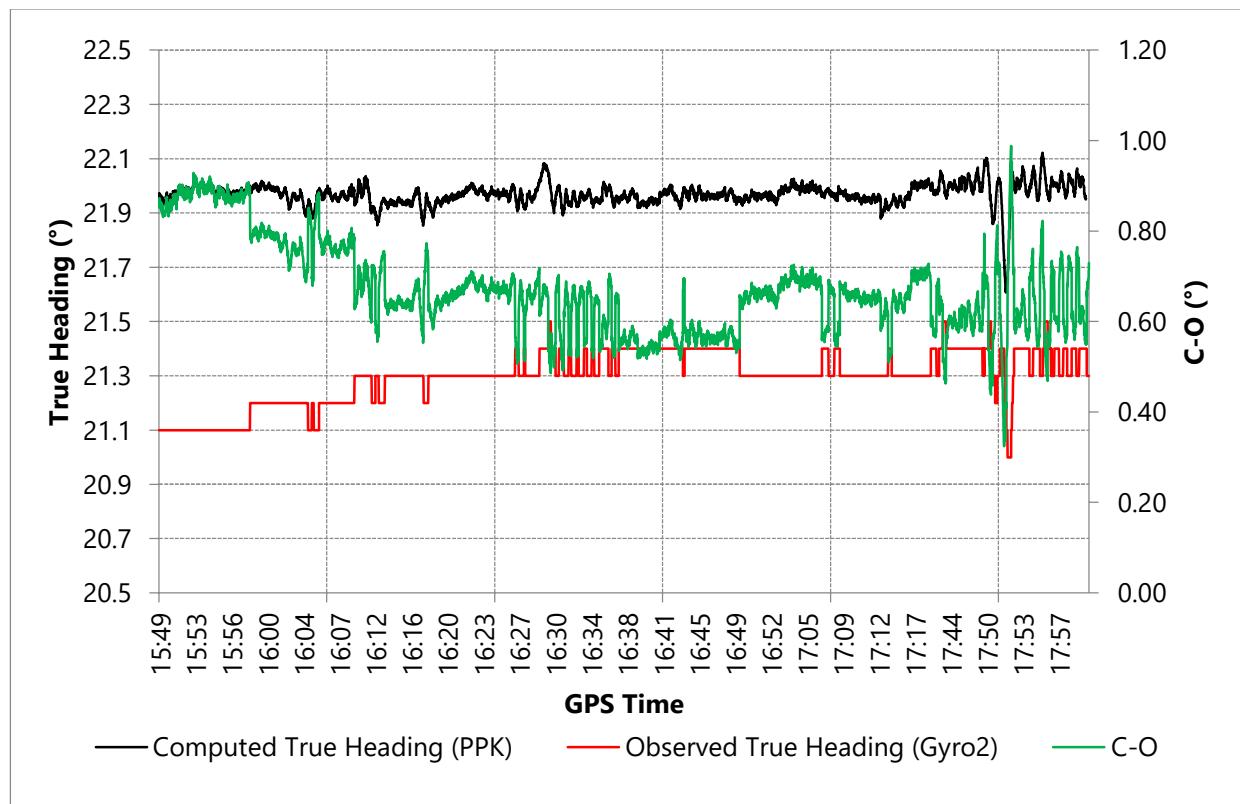


Figure 2.23: Gyro2 - Session 2 – Gyrocompass calibration

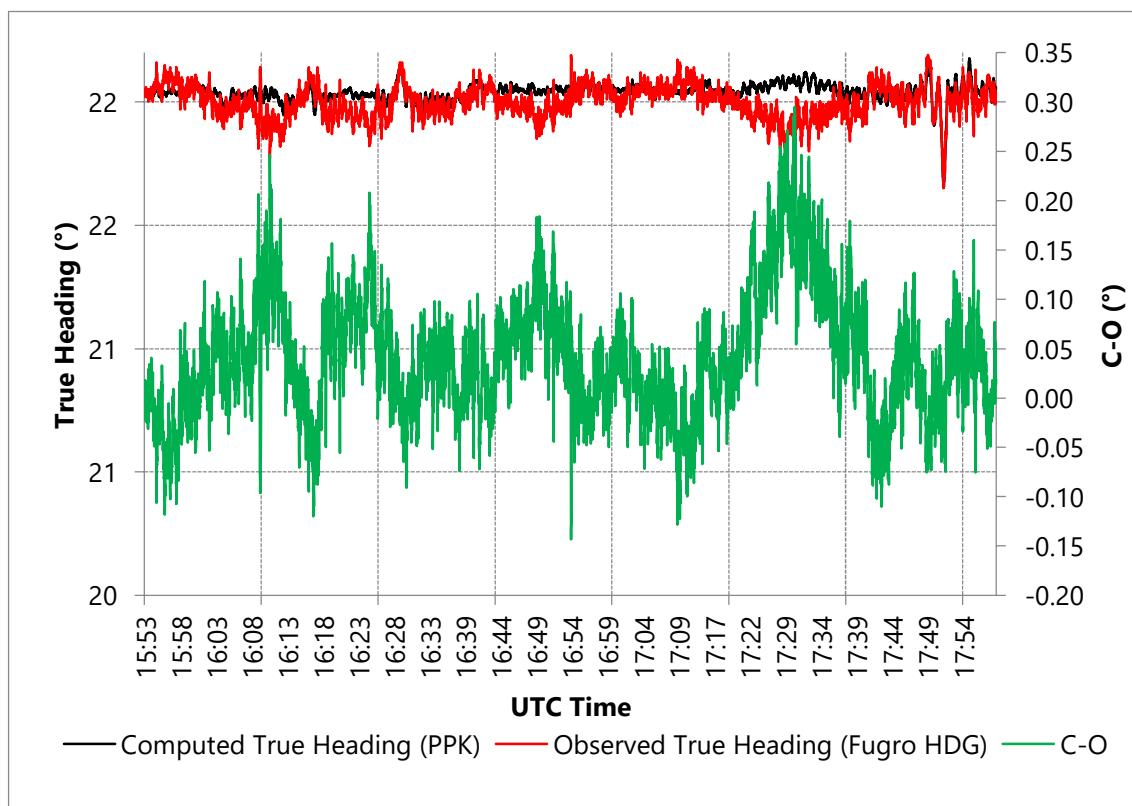


Figure 2.24: Fugro Hdg - Session 2 – Gyrocompass calibration

2.1.4 GNSS Health check

Table 2.7: Antenna comparison

Equipment	Data type	C-0 [°]	S.D. [°]	Min [°]	Max [°]
Starpack Antenna 3 XP3	Easting	-0.05	+0.08	-0.20	+0.07
	Northing	-0.06	+0.07	-0.20	+0.04
Starpack Antenna 3 G4	Easting	-0.07	+0.08	-0.20	+0.05
	Northing	-0.02	+0.06	-0.12	+0.10
Septentrio Antenna 2	Easting	-0.09	+0.08	-0.22	+0.07
	Northing	-0.04	+0.06	-0.17	+0.06
Trinav GPS1 Antenna	Easting	-0.15	+0.04	-0.23	-0.07
	Northing	-0.01	+0.07	-0.18	+0.13
Trinav GPS2 Antenna	Easting	-0.13	+0.04	-0.20	-0.05
	Northing	+0.06	+0.08	-0.12	+0.18

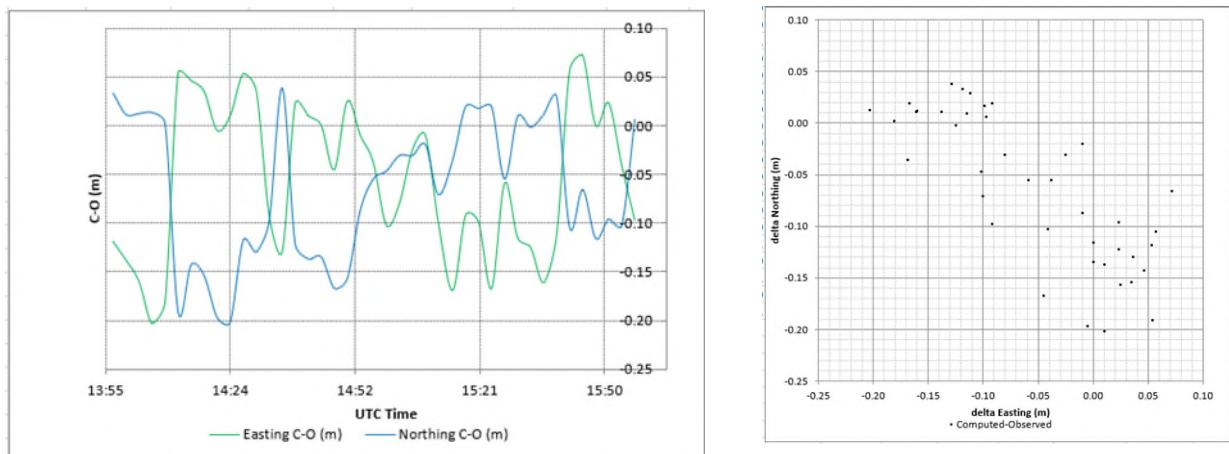


Figure 2.25: Starpack Ant3 XP3 C-O

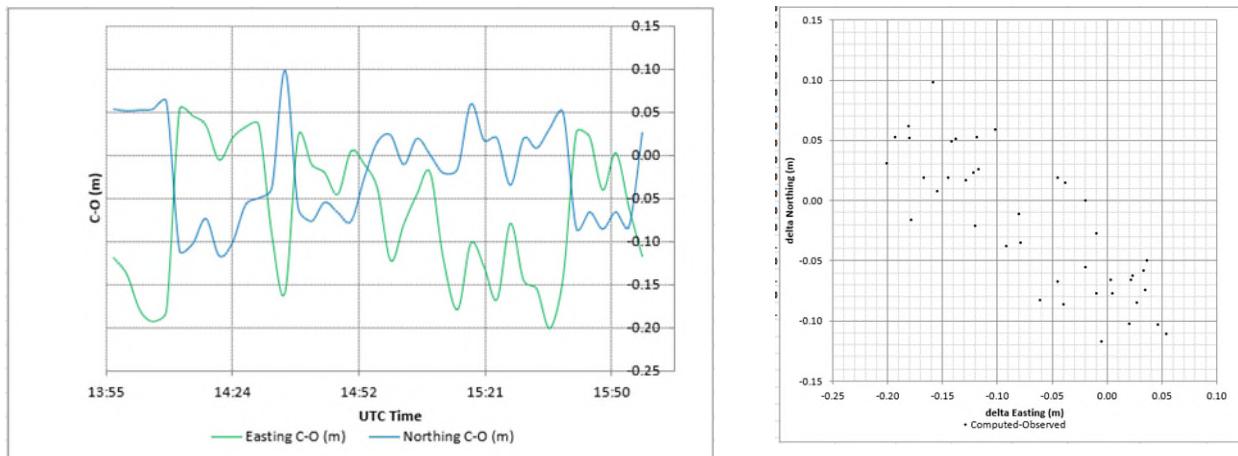


Figure 2.26: Starpack Ant3 G4 C-O

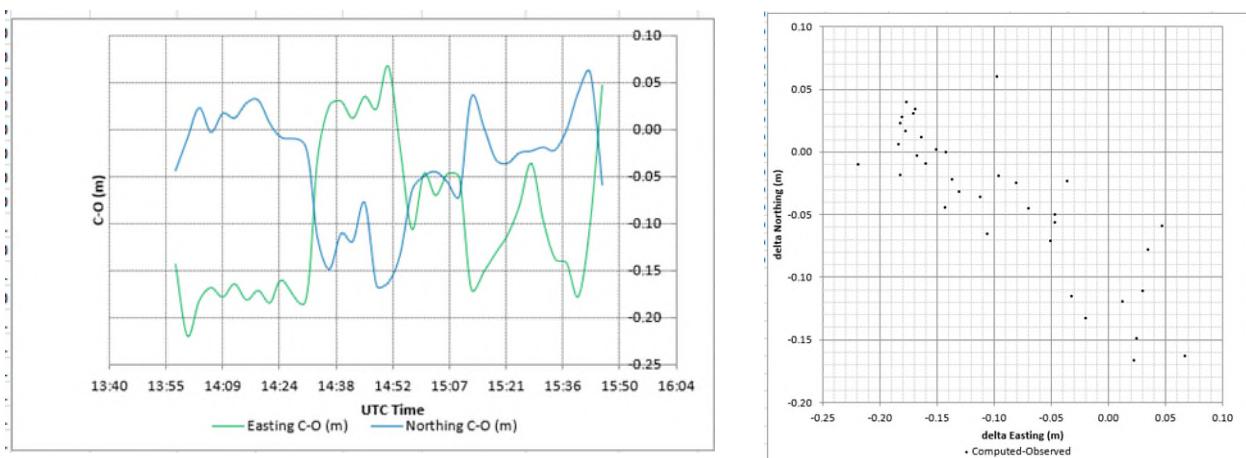


Figure 2.27: Septentrio Antenna 2 XP3 C-O

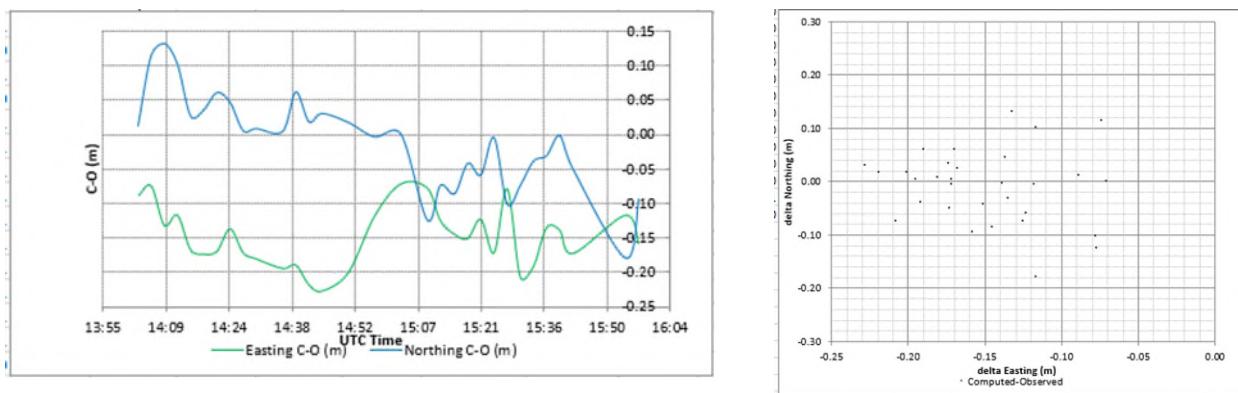


Figure 2.28: TriNav1 XP3 C-O

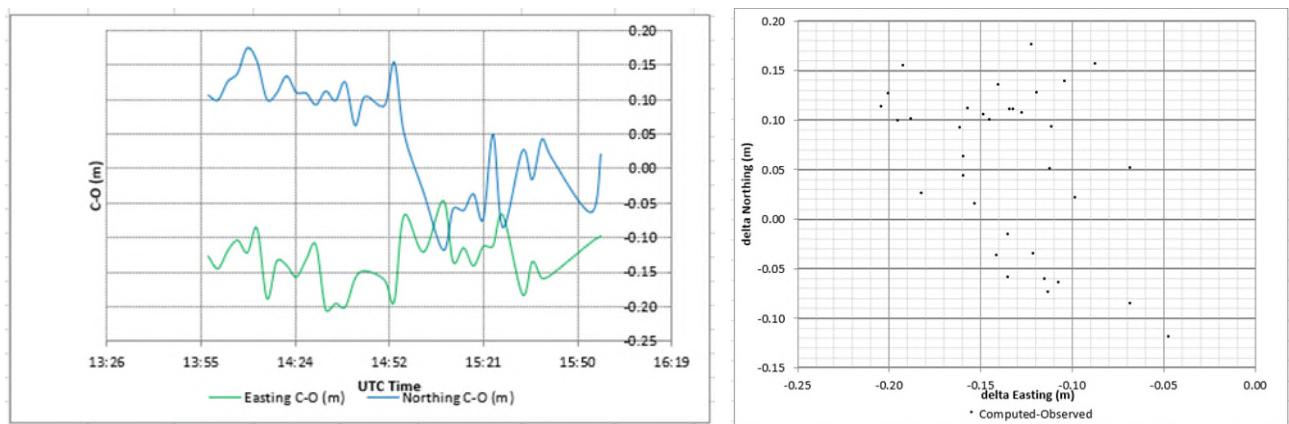


Figure 2.29: TriNav2 XP3 C-O

2.1.5 Vessel Reference points TriNAV

Permanent reference point created or used during the vessel offset survey are given in the following table.

Table 2.8: Reference Point - TriNAV

Point	X	Y	Z	Description
C1	-6.446	4.327	15.082	Reflective Sticker (D- deck)
C2	-1.580	0.337	14.268	Reflective Sticker (D- deck)
C3	6.783	4.408	15.104	Reflective Sticker (D- deck)
C4	0.158	-28.517	4.621	Paint mark on deck (B- deck)
C5	-1.300	0.381	25.121	Reflective Sticker (Antenna deck)
C6	4.083	-29.972	12.362	Reflective Sticker (C- deck)
C7	0.107	-40.055	9.580	Reflective Sticker (C- deck)
C8	4.845	-44.202	6.703	Reflective Sticker (C- deck)
C9	-4.080	-30.010	12.355	Reflective Sticker (C- deck)
C10	-4.891	-43.921	6.921	Reflective Sticker (B- deck)
C11	1.133	-25.233	4.645	Reflective Sticker (B- deck)
C12	2.723	-24.821	4.661	Reflective Sticker (B- deck)
C13	3.785	-23.412	6.551	Reflective Sticker (B- deck)
C14	1.240	-23.419	6.505	Reflective Sticker (B- deck)
C15	-0.695	-63.795	5.681	Reflective Sticker (B- deck)
C16	-3.609	-30.399	4.657	Reflective Sticker (B- deck)
C17	-2.611	-30.396	4.643	Reflective Sticker (B- deck)
C18	3.170	-28.794	4.028	Reflective Sticker (B- deck)
C19	-4.865	-30.556	6.089	Reflective Sticker (B- deck)
C20	-0.967	-11.876	0.016	Reflective Sticker (Tween deck)
C21	-6.245	-22.538	0.262	Reflective Sticker (Tween deck)
C22	4.211	-23.105	-0.025	Reflective Sticker (Tween deck)
C23	6.315	-21.237	0.004	Reflective Sticker (Tween deck)
C24	2.753	-26.193	-2.995	Reflective Sticker (Tank top)
C25	3.176	-26.197	-2.811	Reflective Sticker (Tank top)
H1	5.124	-63.961	9.780	Punch marck (Helideck)
H2	-5.309	-63.945	9.768	Punch marck (Helideck)
H3	-10.773	-53.346	9.786	Punch marck (Helideck)
H4	-9.472	-45.747	9.780	Punch marck (Helideck)
H5	9.457	-45.959	9.770	Punch marck (Helideck)
H6	10.748	-53.292	9.780	Punch marck (Helideck)

2.1.6 Vessel Reference points 4D NAV

Permanent reference point created during the vessel offset survey are given in the following table.

Table 2.9: Reference Point – 4D NAV

Point	X	Y	Z	Description
C1	-4.050	29.486	24.627	Reflective Sticker (D- deck)
C2	0.816	25.496	23.814	Reflective Sticker (D- deck)
C3	9.179	29.567	24.649	Reflective Sticker (D- deck)
C4	2.553	-3.358	14.166	Paint mark on deck (B- deck)
C5	1.095	25.540	34.666	Reflective Sticker (Antenna deck)
C6	6.478	-4.812	21.907	Reflective Sticker (C- deck)
C7	2.503	-14.896	19.126	Reflective Sticker (C- deck)
C8	7.240	-19.042	16.249	Reflective Sticker (C- deck)
C9	-1.685	-4.851	21.900	Reflective Sticker (C- deck)
C10	-2.496	-18.761	16.466	Reflective Sticker (B- deck)
C11	3.529	-0.074	14.191	Reflective Sticker (B- deck)
C12	5.118	0.338	14.206	Reflective Sticker (B- deck)
C13	6.181	1.747	16.096	Reflective Sticker (B- deck)
C14	3.635	1.740	16.050	Reflective Sticker (B- deck)
C15	1.700	-38.636	15.226	Reflective Sticker (B- deck)
C16	-1.213	-5.239	14.202	Reflective Sticker (B- deck)
C17	-0.216	-5.237	14.188	Reflective Sticker (B- deck)
C18	5.565	-3.635	13.574	Reflective Sticker (B- deck)
C19	-2.470	-5.397	15.634	Reflective Sticker (B- deck)
C20	1.428	13.283	9.561	Reflective Sticker (Tween deck)
C21	-3.850	2.622	9.807	Reflective Sticker (Tween deck)
C22	6.606	2.055	9.521	Reflective Sticker (Tween deck)
C23	8.710	3.923	9.549	Reflective Sticker (Tween deck)
C24	5.149	-1.034	6.550	Reflective Sticker (Tank top)
C25	5.572	-1.037	6.734	Reflective Sticker (Tank top)
H1	7.519	-38.801	19.326	Punch mark (Helideck)
H2	-2.914	-38.786	19.313	Punch mark (Helideck)
H3	-8.378	-28.187	19.331	Punch mark (Helideck)
H4	-7.077	-20.587	19.326	Punch mark (Helideck)
H5	11.852	-20.799	19.315	Punch mark (Helideck)
H6	13.144	-28.133	19.326	Punch mark (Helideck)

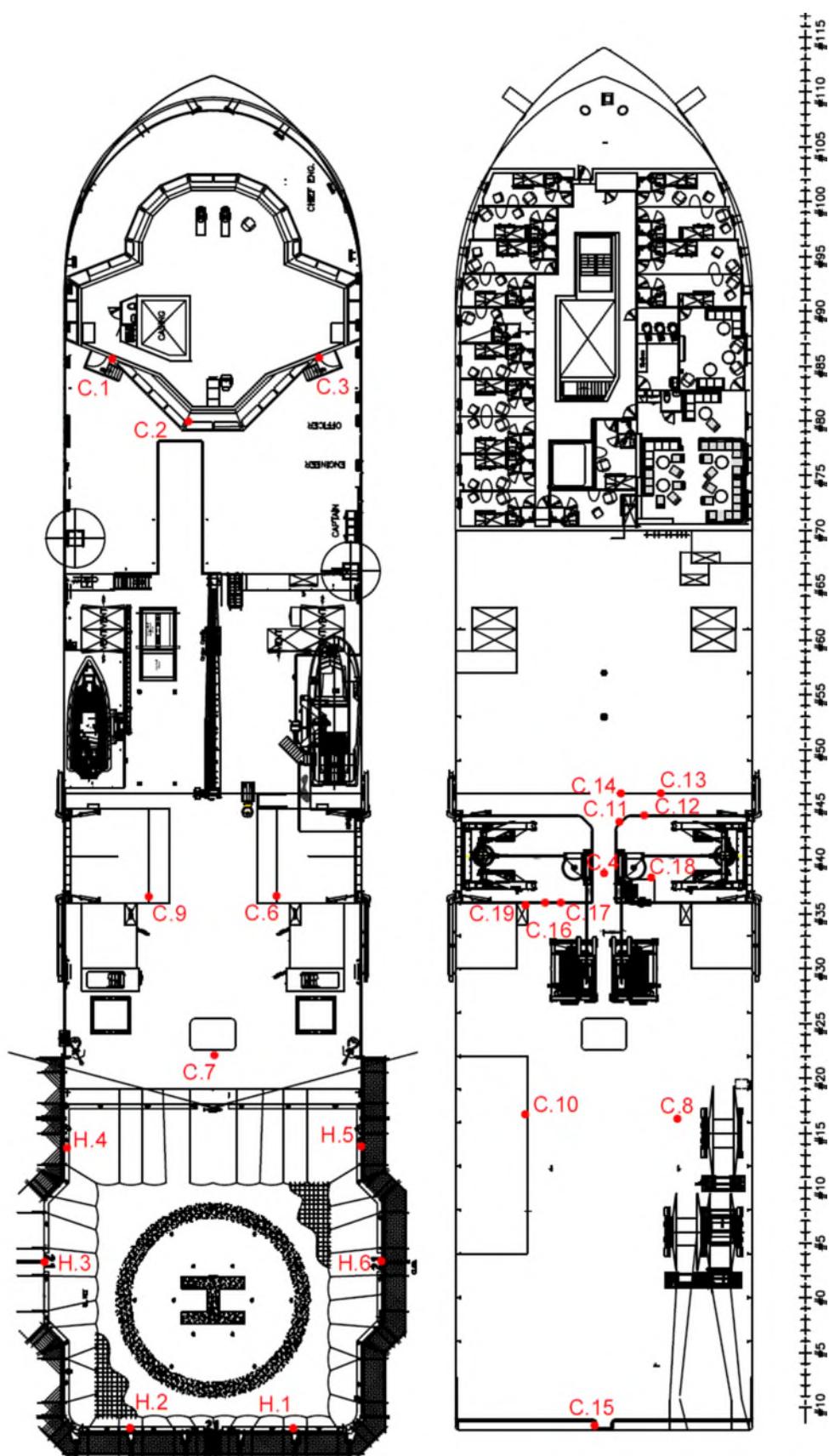


Figure 2.30: Reference points

2.2 HD64 results

2.2.1 HD64 Offsets

Table 2.10: HD64 Offset

Antenna/Sensor	X [m]	Y [m]	Z [m]	Description
HD64-CRP	0.000	0.000	0.000	Punch mark
HD64 Sprint	0.005	-2.900	-0.104	Reference point of Sprint Nav
HD64 MinilPS2	-0.253	-2.787	-0.005	Bottom centre
HD64 Midas SVX2	-0.269	-2.369	0.083	Reference point
HD64 Resp.	-0.501	0.336	1.404	Bottom centre
HD64 Transp.	-0.619	0.321	1.391	Bottom centre
Sprint Bracket Stb	0.270	-2.857	0.364	Punch mark on bracket
Sprint Bracket Port	-0.256	-2.863	0.366	Punch mark on bracket
HD64 Fwd Top	0.003	0.264	1.439	Point on the fwd top centre ROV bumper
HD64 - 1	-0.843	0.006	1.578	Paint mark on port face, top left corner
HD64 - 2	-0.860	-2.256	1.564	Paint mark on port face, top right corner
HD64 - 3	-0.847	-2.266	0.054	Paint mark on port face, bottom right corner
HD64 - 4	-0.848	-0.044	-0.048	Paint mark on port face, bottom left corner
HD64 - 5	0.735	0.194	1.381	Paint mark on forward face, top left corner
HD64 - 6	-0.735	0.192	1.372	Paint mark on forward face, top right corner
HD64 - 7	-0.766	0.017	-0.046	Paint mark on forward face, bottom right corner
HD64 - 8	0.773	0.017	-0.053	Paint mark on forward face, bottom left corner

2.2.2 HD64 Gyrocompass and Motion Sensor Calibration

Table 2.11: HD64 C-O

Equipment	Data type	C-0 [°]	S.D. [°]	Min [°]	Max [°]
Sprint Nav HD64	Heading	0.63	0.00	0.62	0.64
Sprint Nav HD64	Pitch	-0.98	0.00	-0.98	-0.96
Sprint Nav HD64	Roll	-0.05	0.00	-0.05	-0.04
<ul style="list-style-type: none"> ■ Notes: <ul style="list-style-type: none"> • Observation date: 22.11.2024 • Observation time: 8:22-10:16 ■ C-O set to 0° 					

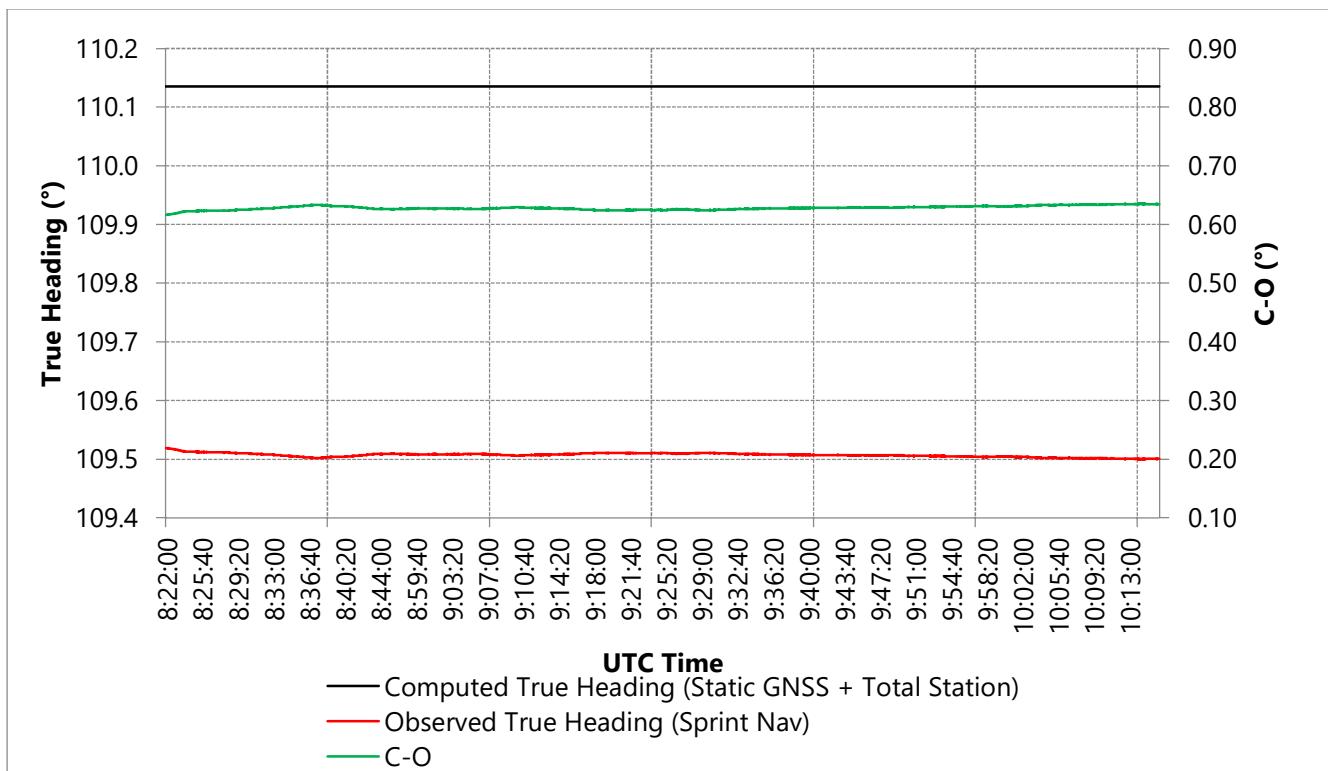


Figure 2.31: HD64 Sprint Nav - Heading calibration

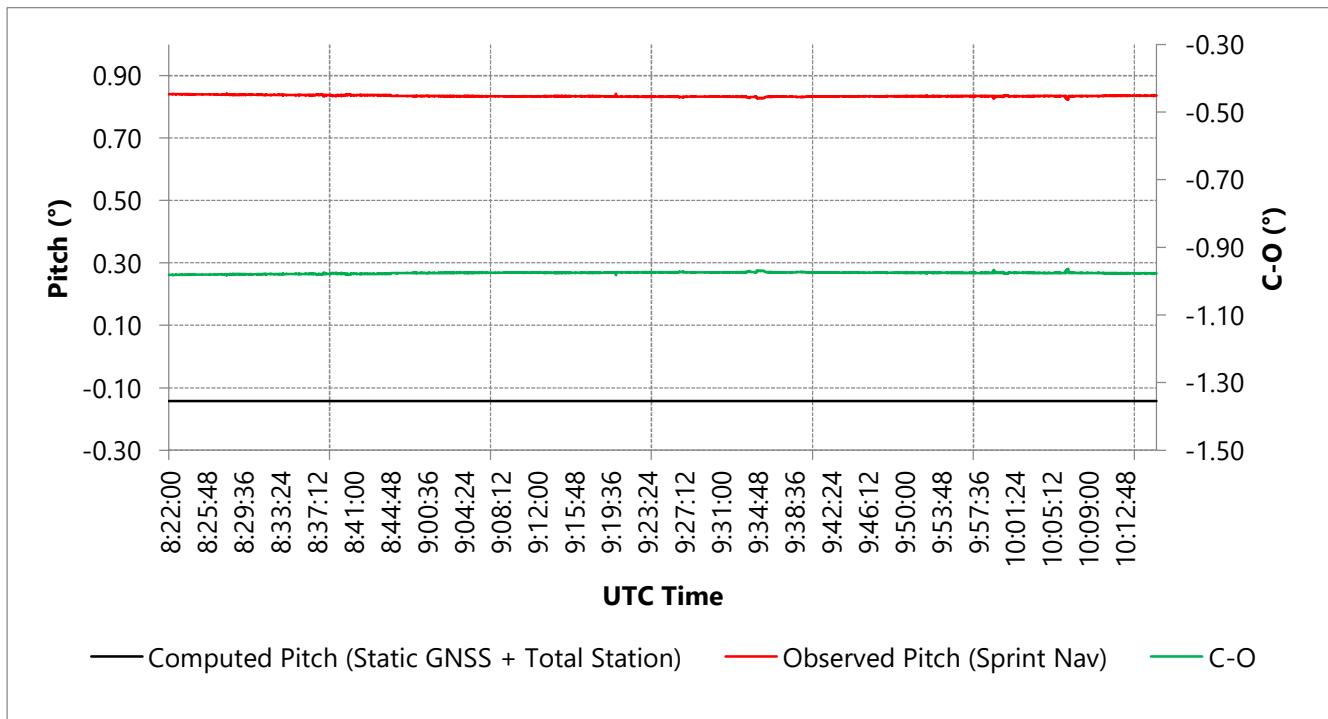
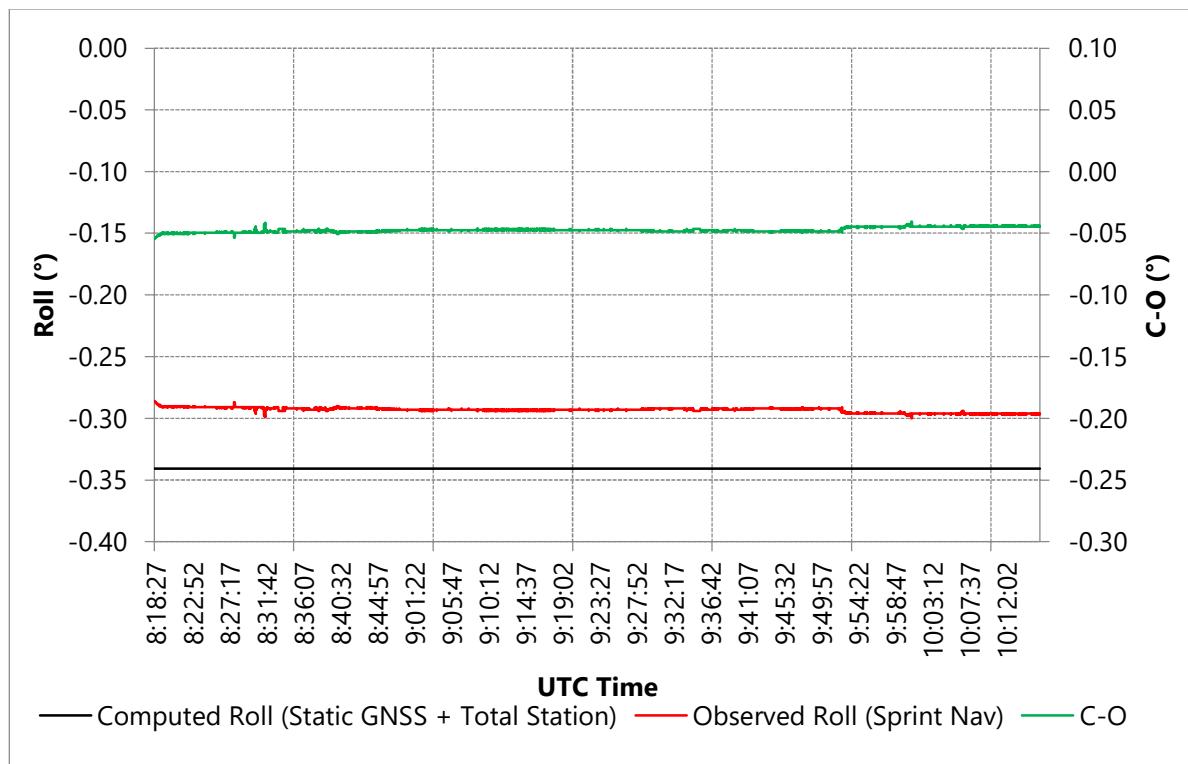


Figure 2.32: HD64 Sprint Nav - Pitch calibration



2.3 HD65 results

2.3.1 HD65 Offsets

Table 2.12: HD65 Reference Point Offset

Antenna/Sensor	X [m]	Y [m]	Z [m]	Description
HD65-CRP	0.000	0.000	0.000	Punch mark
HD65 Sprint	-0.016	-2.876	-0.094	Reference point of Sprint Nav
HD65 MiniIPS2	-0.286	-2.762	-0.007	Bottom centre
HD65 Midas SVX2	-0.299	-2.351	0.095	Reference point
HD65 Resp.	-0.458	0.367	1.375	Bottom centre
HD65 Transp.	-0.703	0.372	1.379	Bottom centre
Sprint Bracket Stb	0.247	-2.841	0.373	Punch mark on bracket
Sprint Bracket Port	-0.281	-2.840	0.371	Punch mark on bracket
HD65 Fwd Top	0.006	0.298	1.422	Point on the fwd top centre ROV bumper
HD65 - 1	0.841	-2.223	1.565	Paint mark on port face, top left corner
HD65 - 2	0.852	0.025	1.582	Paint mark on port face, top right corner
HD65 - 3	0.849	-0.015	-0.059	Paint mark on port face, bottom right corner
HD65 - 4	0.847	-2.234	0.080	Paint mark on port face, bottom left corner
HD65 - 5	0.731	0.223	1.381	Paint mark on forward face, top left corner
HD65 - 6	-0.746	0.225	1.366	Paint mark on forward face, top right corner
HD65 - 7	-0.761	0.039	-0.046	Paint mark on forward face, bottom right corner
HD65 - 8	0.753	0.040	-0.045	Paint mark on forward face, bottom left corner

2.3.2 HD65 Gyrocompass and Motion Sensor Calibration

Table 2.13: HD65 C-O

Equipment	Data type	C-O [°]	S.D. [°]	Min [°]	Max [°]
Sprint Nav HD65	Heading	-0.22	0.01	-0.23	-0.20
Sprint Nav HD65	Pitch	-1.67	0.00	-1.68	-1.67
Sprint Nav HD65	Roll	0.26	0.00	0.26	0.26

■ Notes:

- Observation date: 24.11.2024
- Observation time: 07:30-10:00
- C-O set to 0°

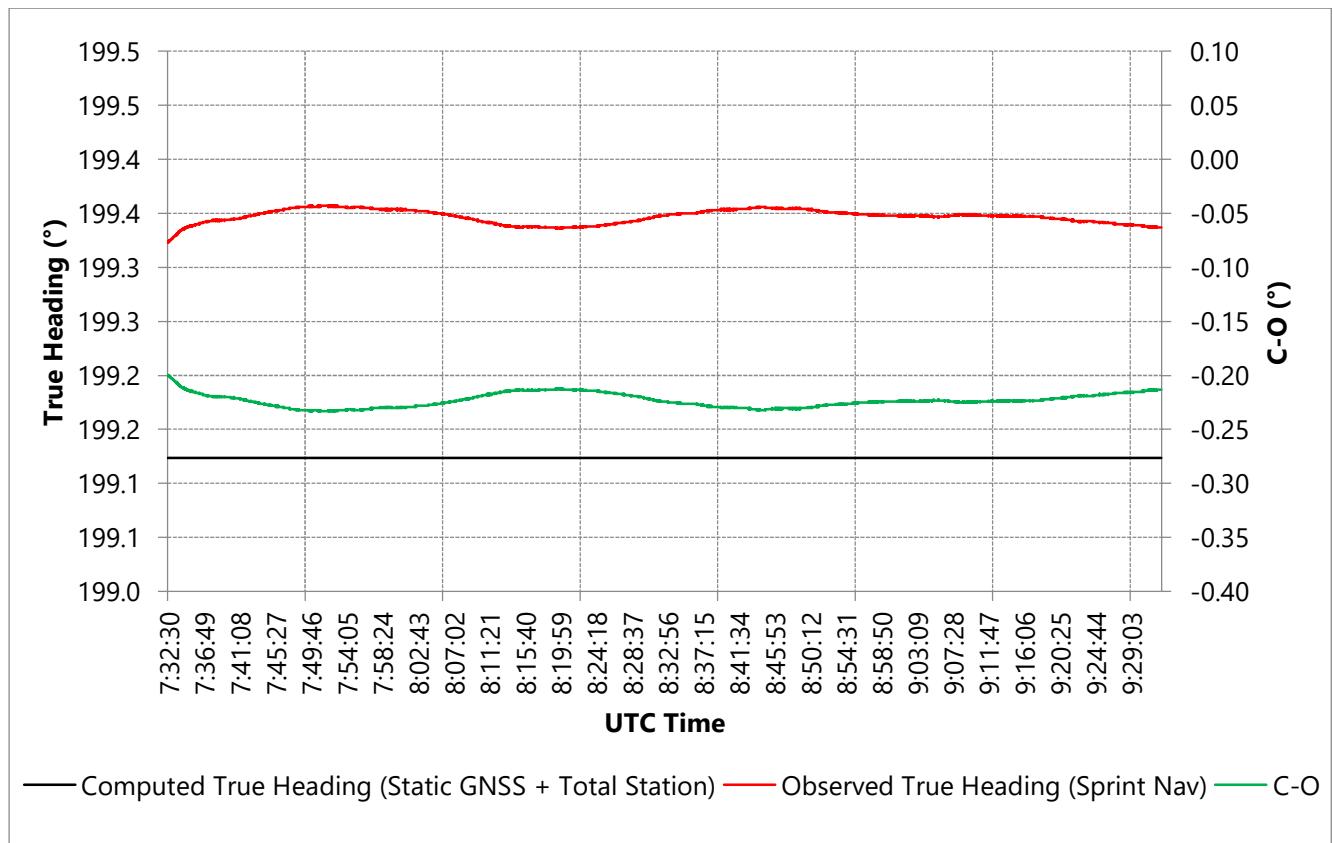


Figure 2.34: HD65 Sprint Nav - Heading calibration

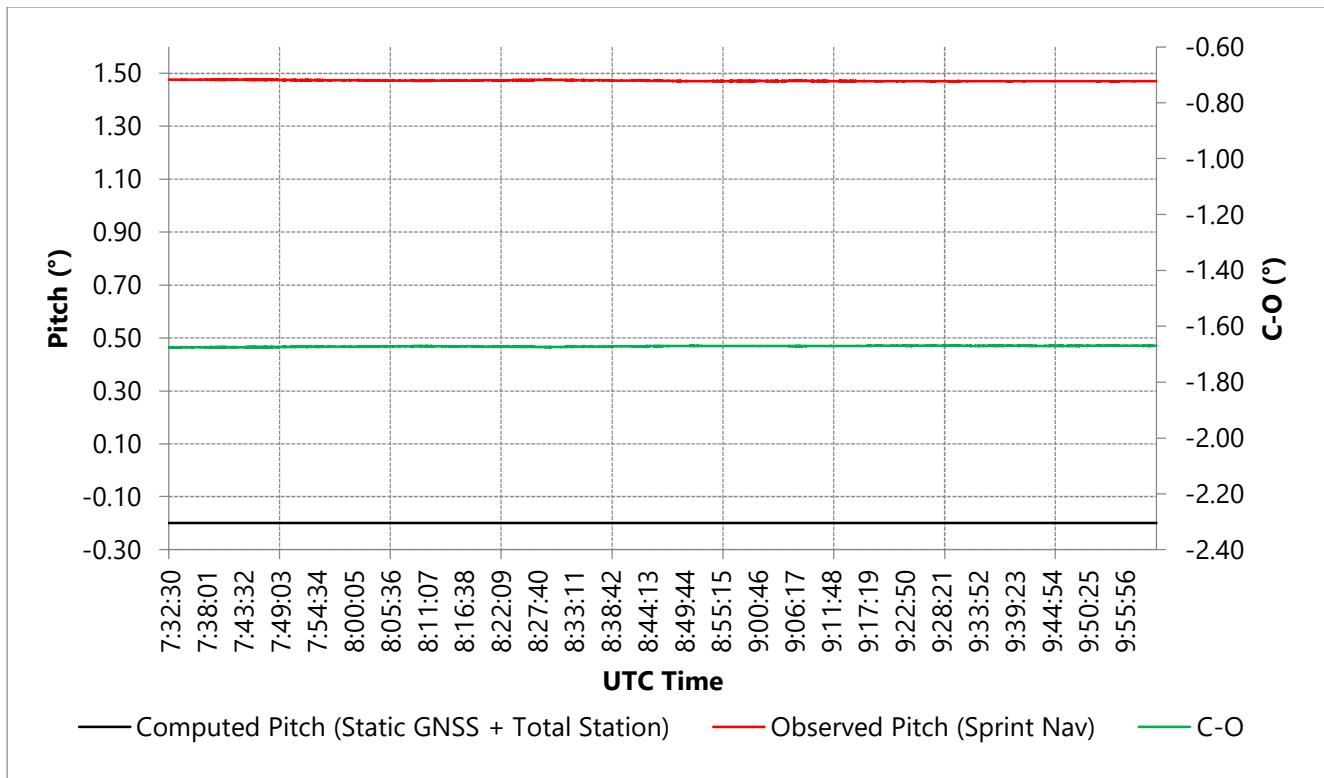


Figure 2.35: HD65 Sprint Nav - Pitch calibration

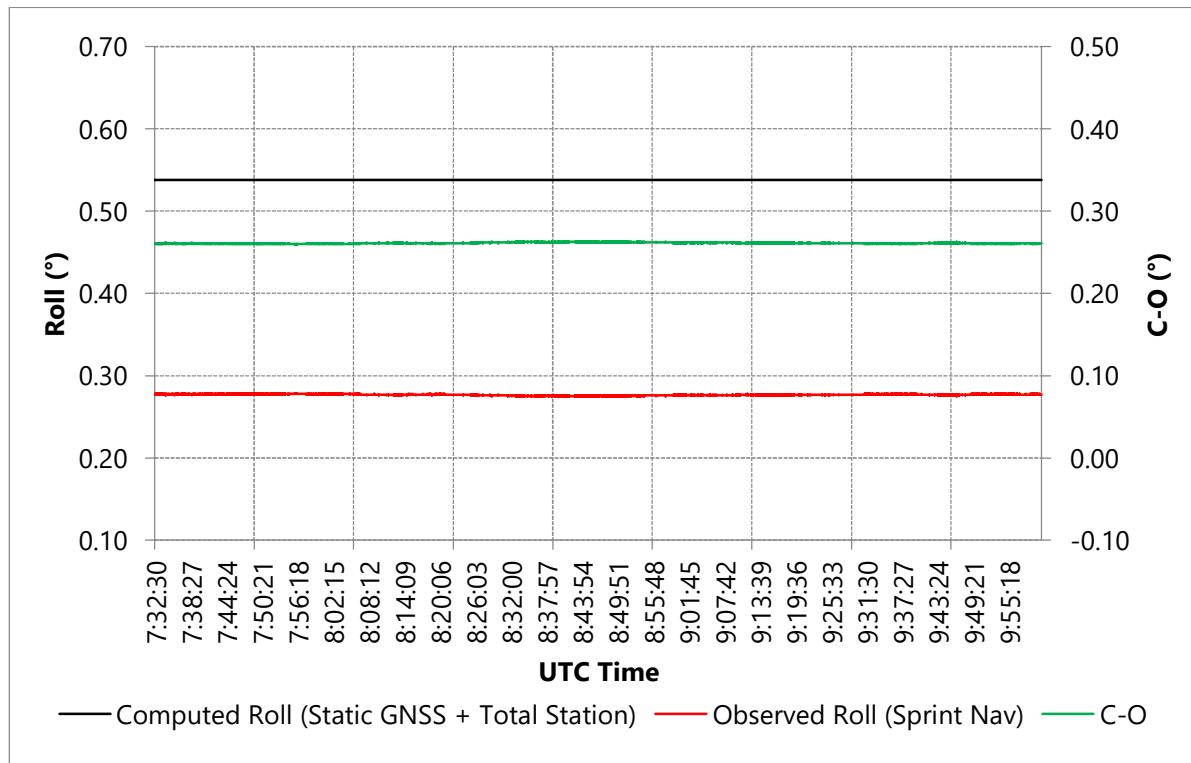


Figure 2.36: HD65 Sprint Nav - Roll calibration

3. PICTURES

3.1 Reference points



Figure 3.1: C1

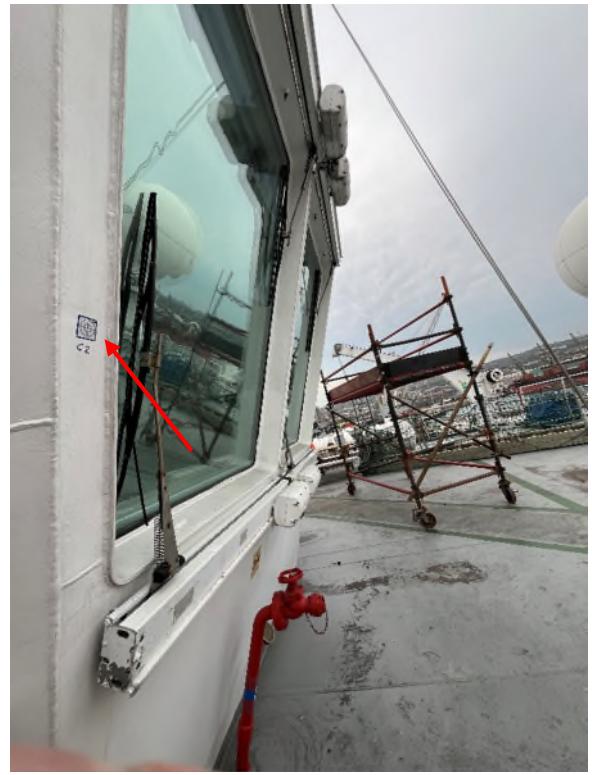


Figure 3.2: C2



Figure 3.3: C3



Figure 3.4: C4



Figure 3.5: C6

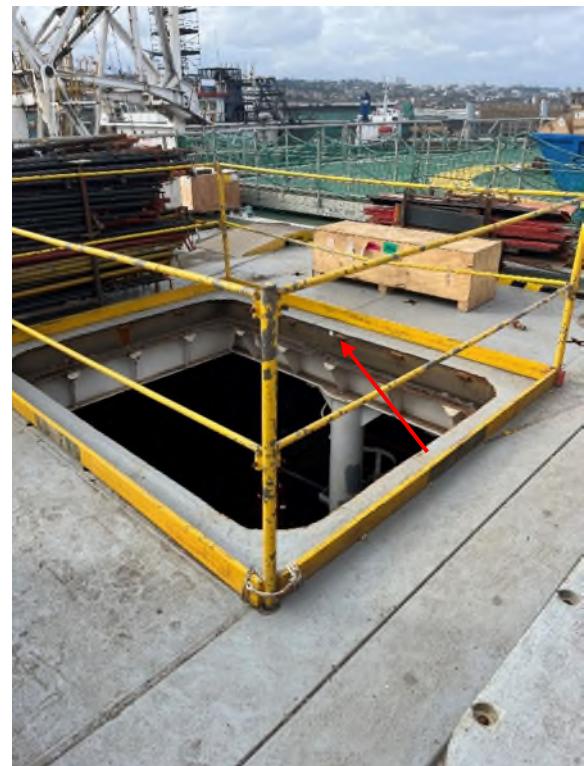


Figure 3.6: C7



Figure 3.7: C8

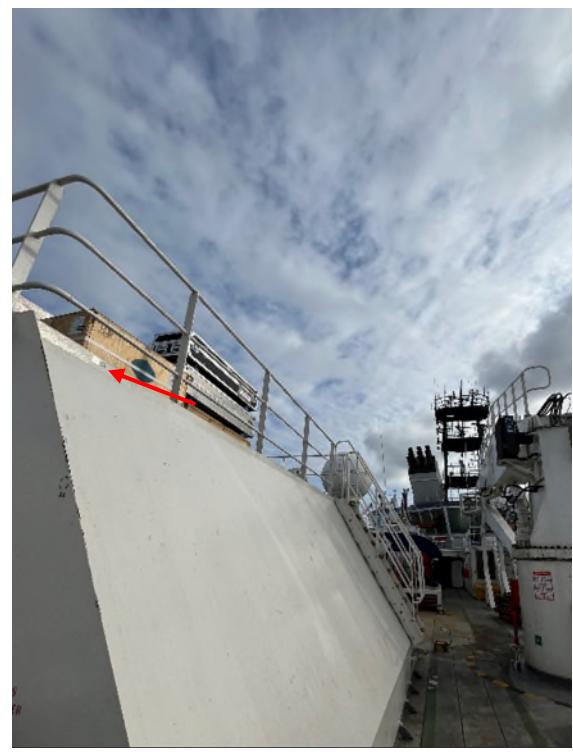


Figure 3.8: C9



Figure 3.9: C10

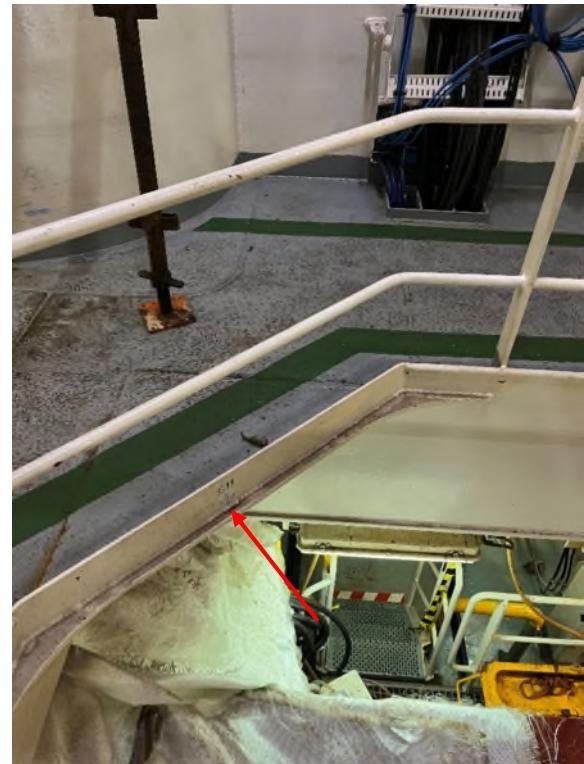


Figure 3.10: C11



Figure 3.11: C12

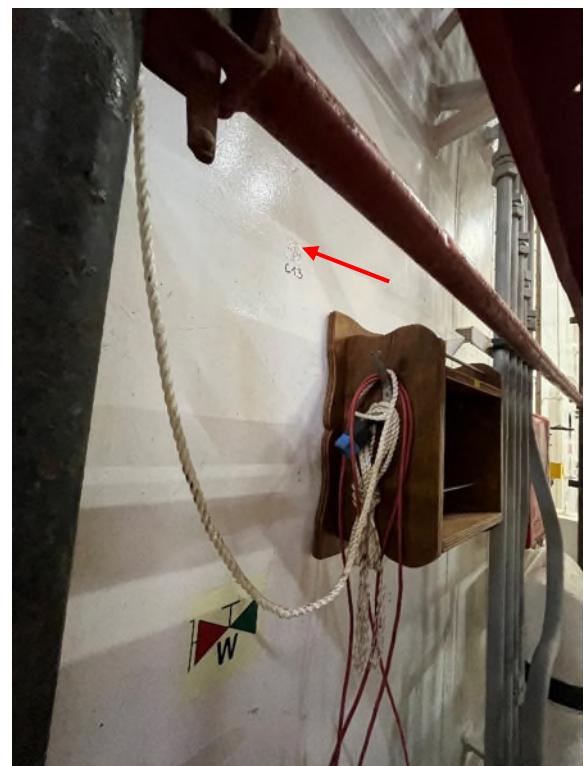


Figure 3.12: C13

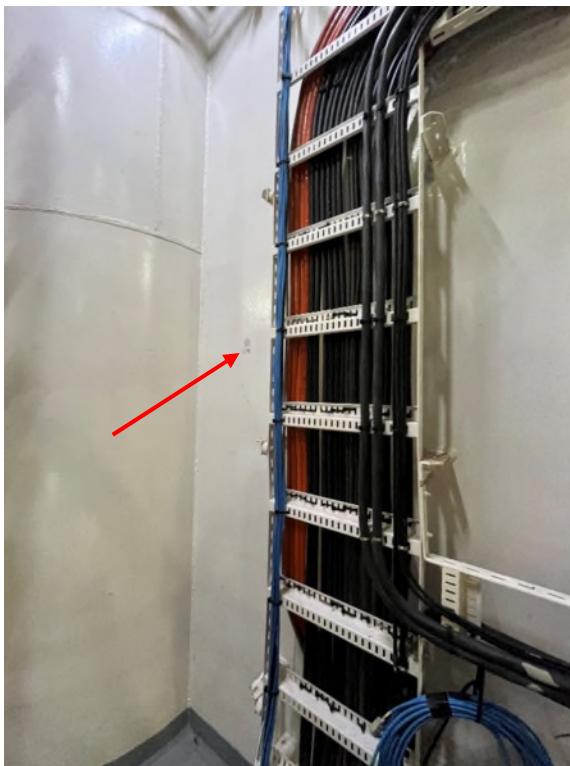


Figure 3.13: C14

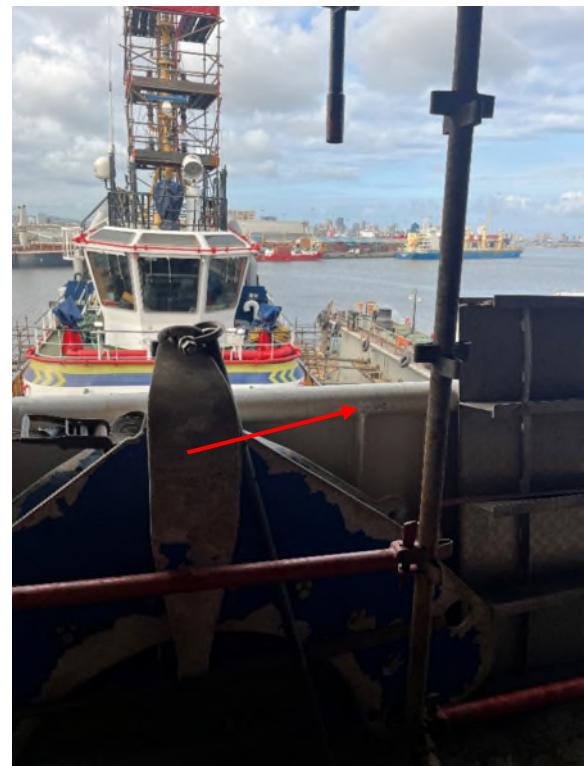


Figure 3.14: C15



Figure 3.15: C16



Figure 3.16: C17

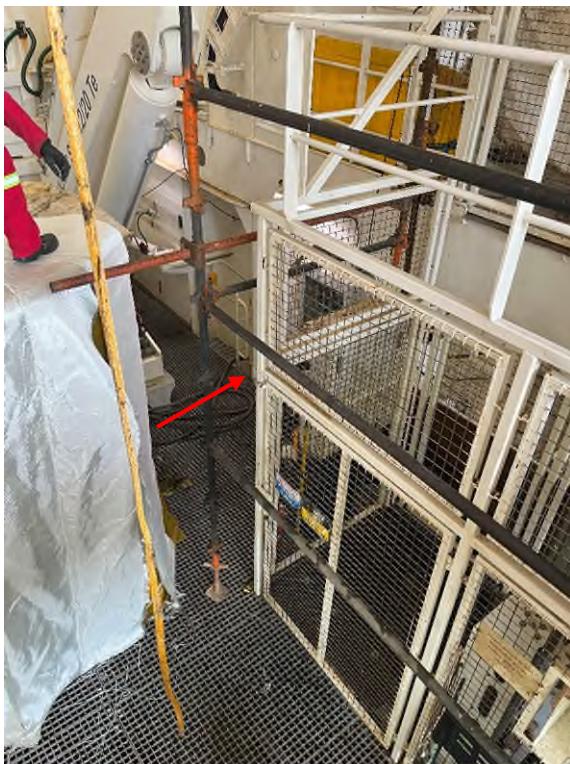


Figure 3.17: C18



Figure 3.18: C19



Figure 3.19: C20

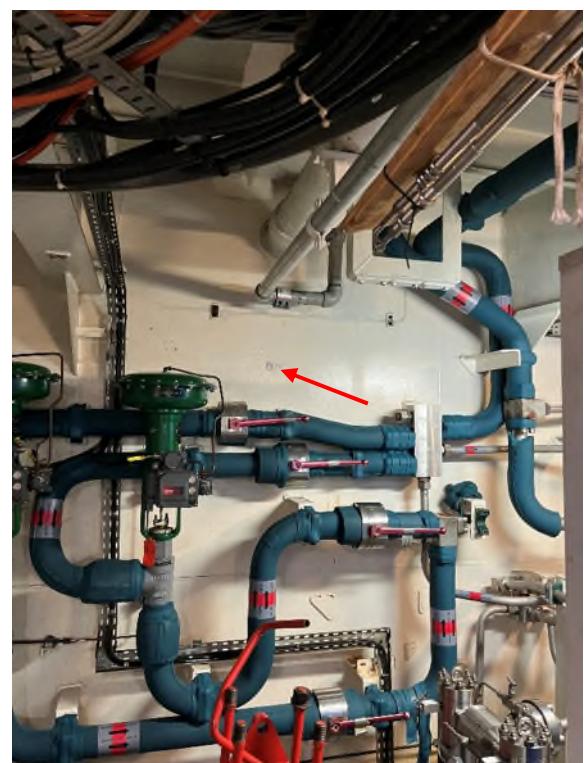


Figure 3.20: C21



Figure 3.21: C22



Figure 3.22: C23



Fig REF3: Helideck Reference



Figure 3.24: H1

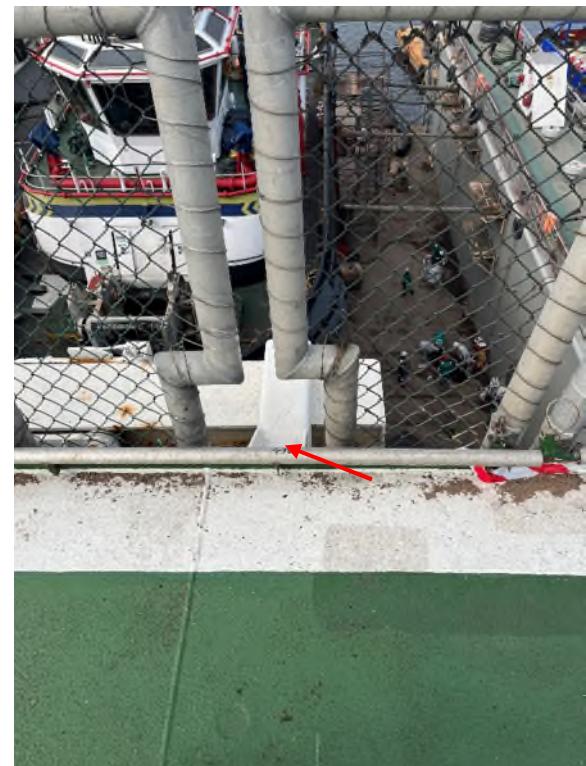


Figure 3.25: H2

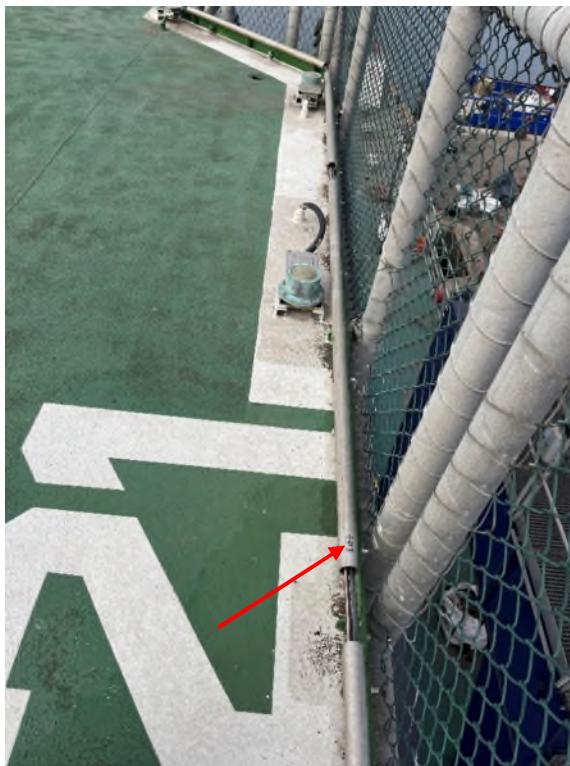


Figure 3.26: H3

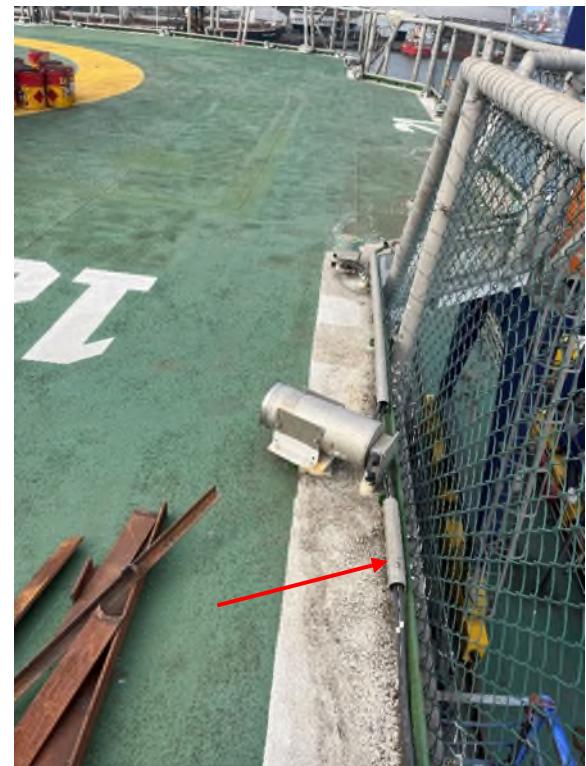


Figure 3.27: H4



Figure 3.28: H5

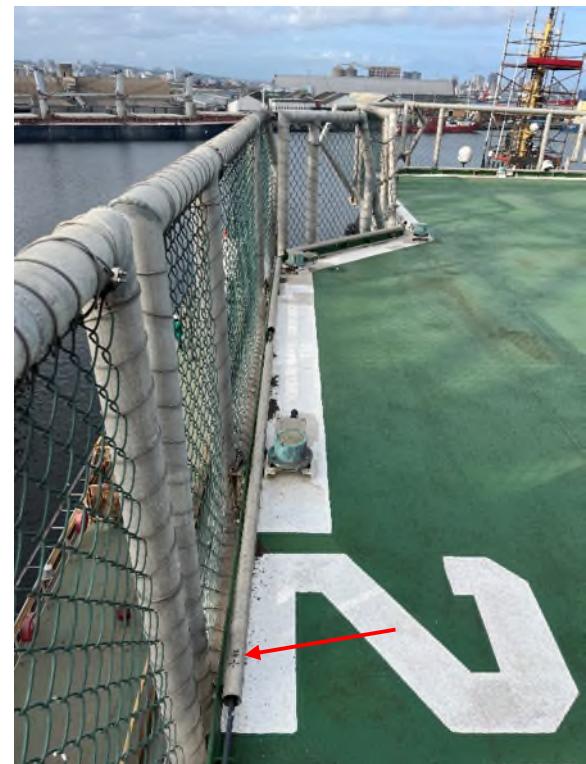


Figure 3.29: H6



Figure 3.30: Kick plate Port

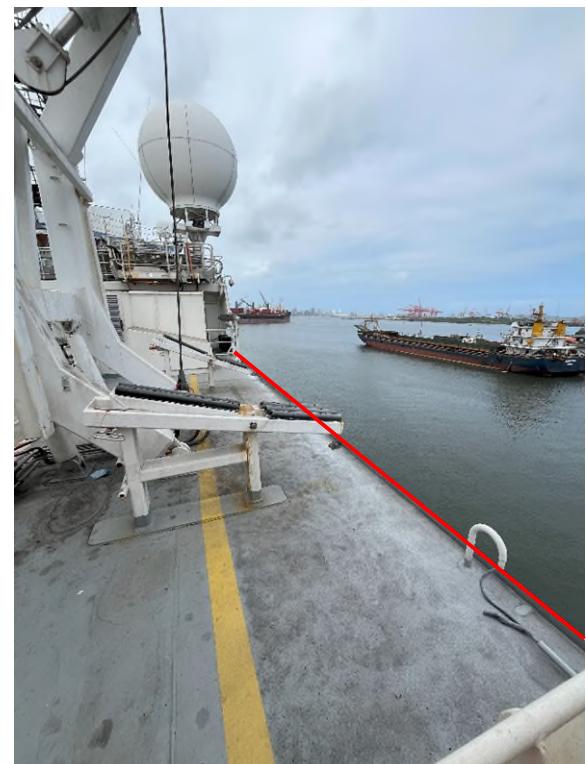


Figure 3.31: Kick plate Stb



Figure 3.32: Hpr room REF1



Figure 3.33: Hpr room REF2/3

3.2 ROV STB

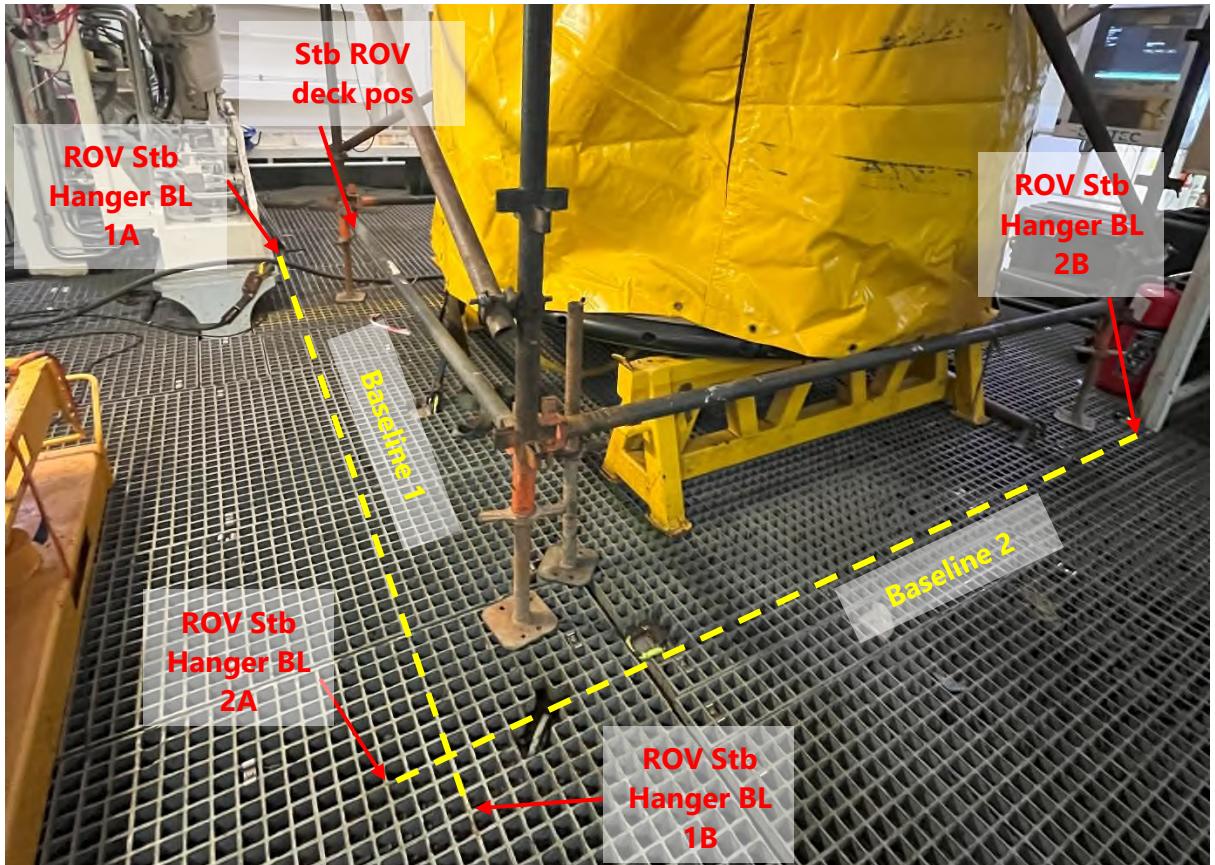


Figure 3.34: ROV Stb Hanger

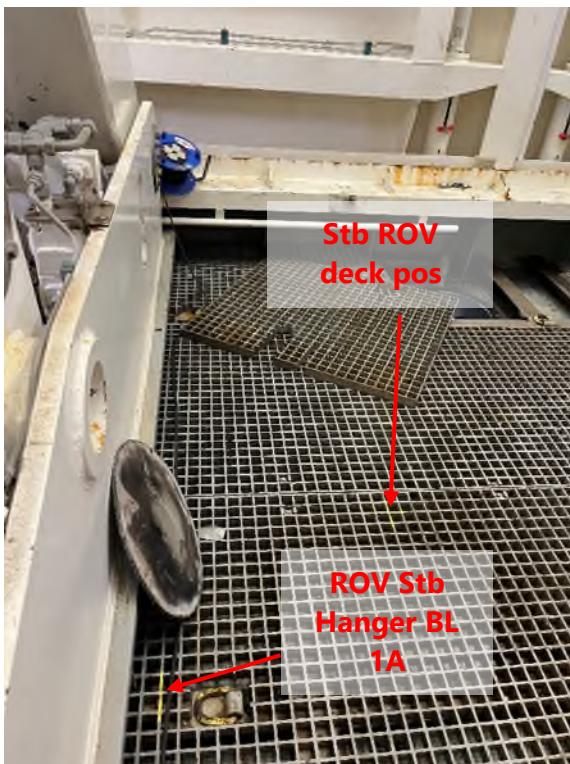


Figure 3.35: ROV Stb Hanger BL 1A / deck pos



Figure 3.36: ROV Stb Hanger BL 2B



Figure 3.37: ROV baselines – Punch mark and paint mark

3.3 ROV PORT

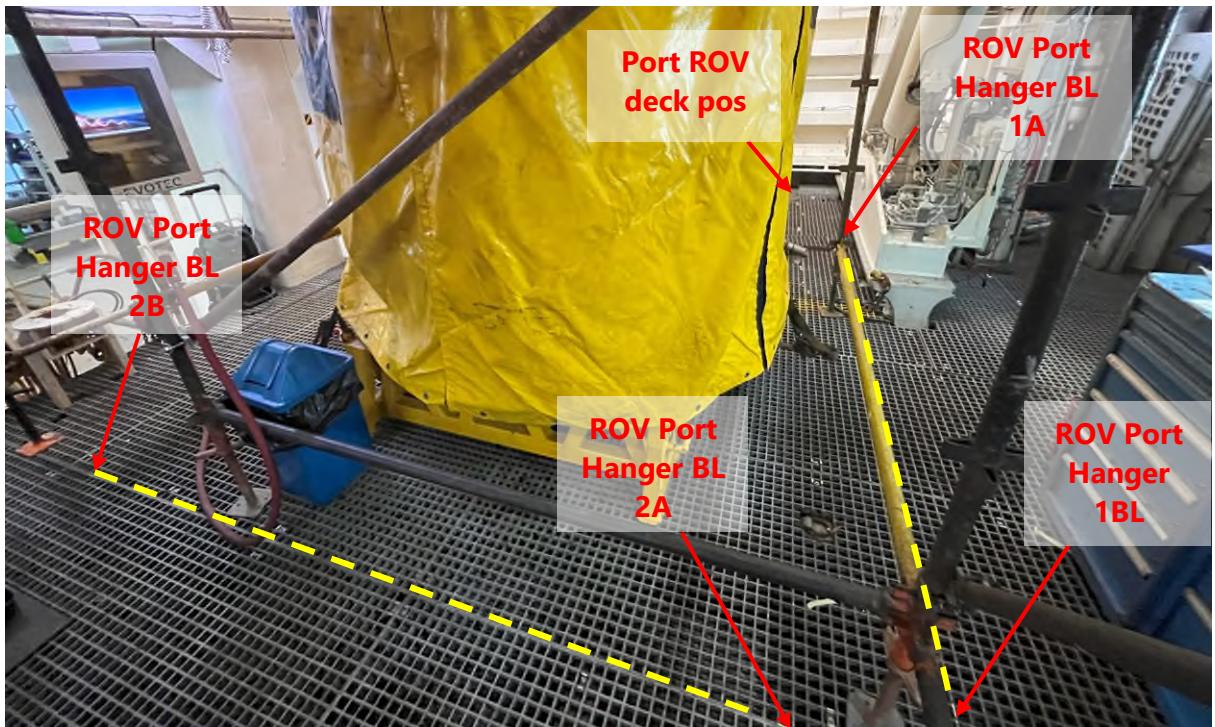


Figure 3.38: ROV Port Hanger

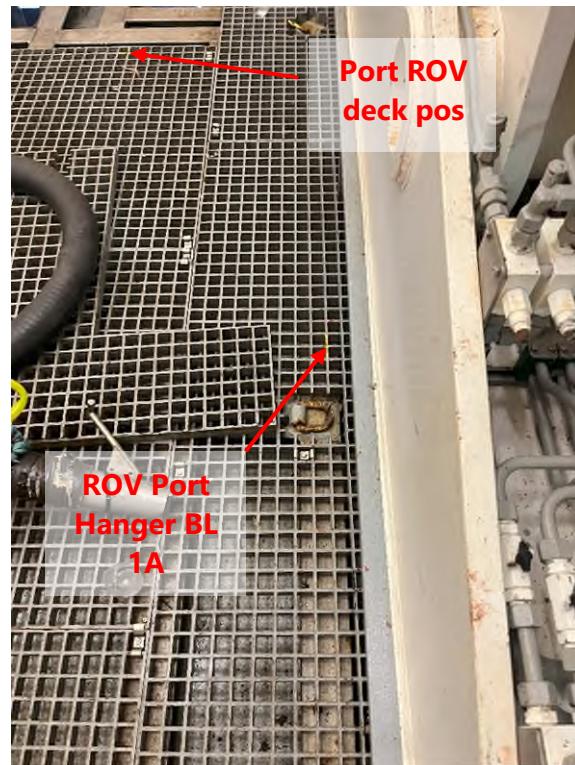


Figure 3.39: ROV Port Hanger BL 1A / deck pos

3.4 Antennas

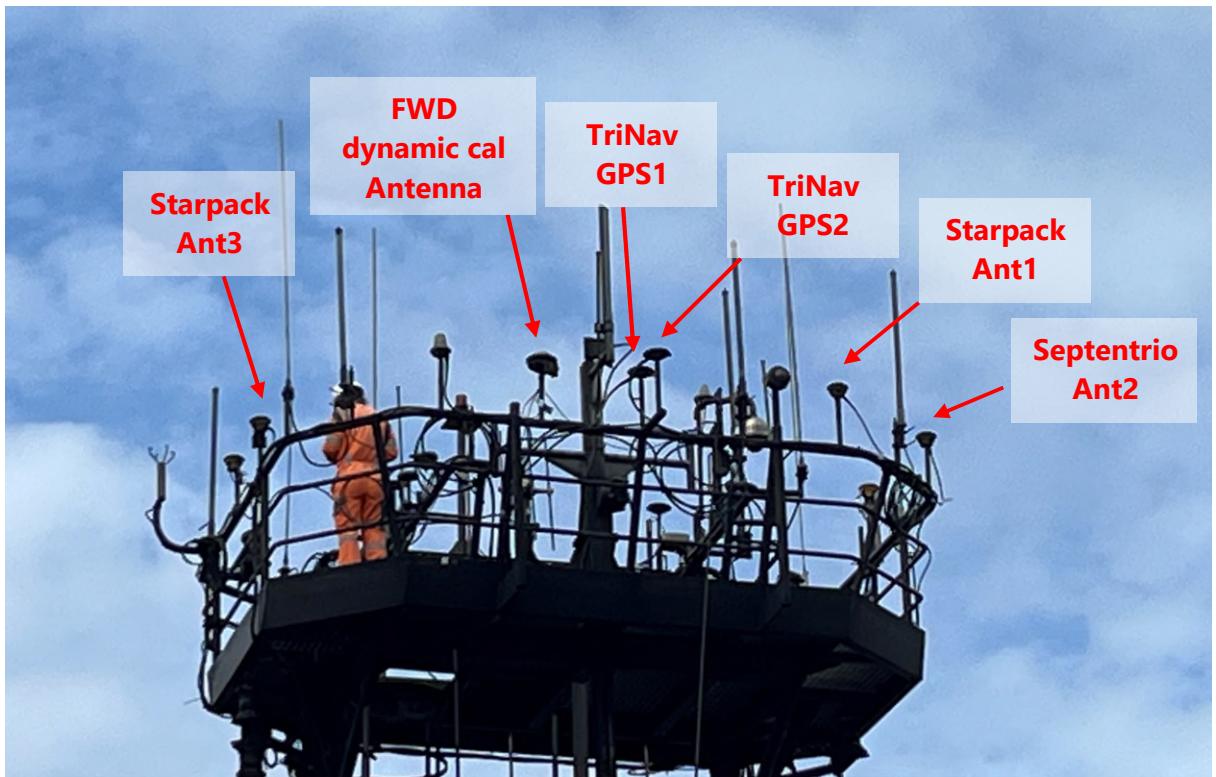


Figure 3.40: Nav Mast Top Platform - Antenna

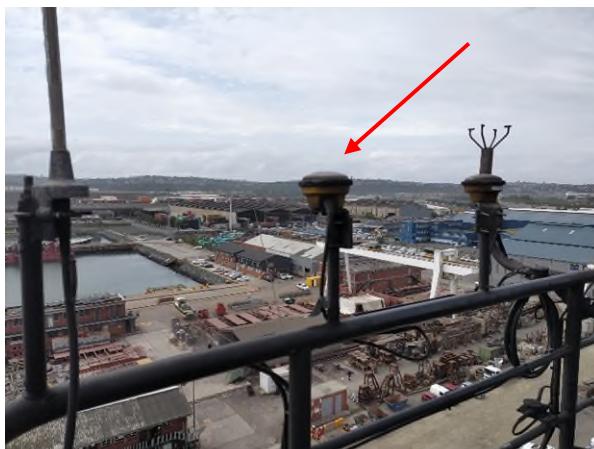


Figure 3.41: Starpack Ant3

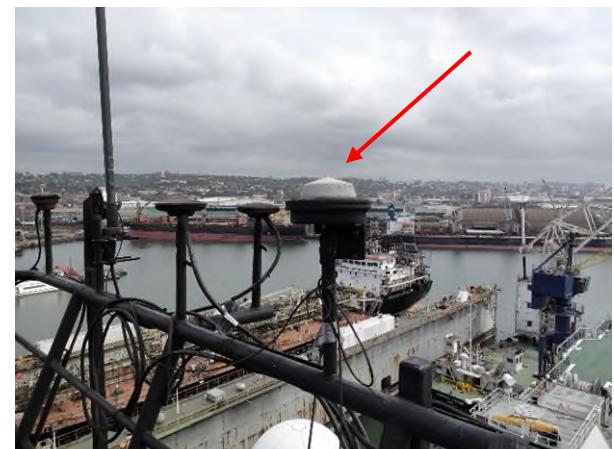


Figure 3.42: FWD dynamic cal Antenna

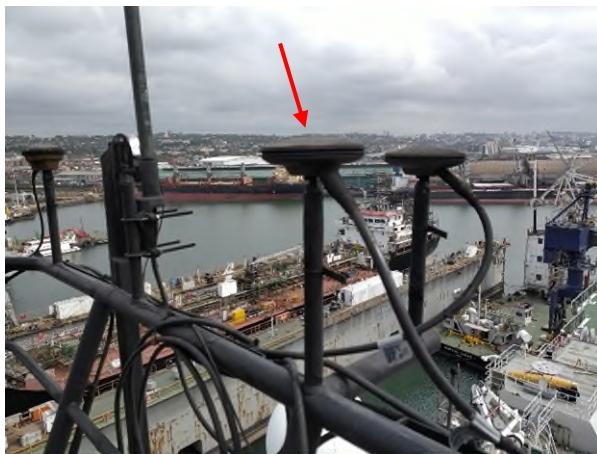


Figure 3.43: Trinav VTGP1 Ant.

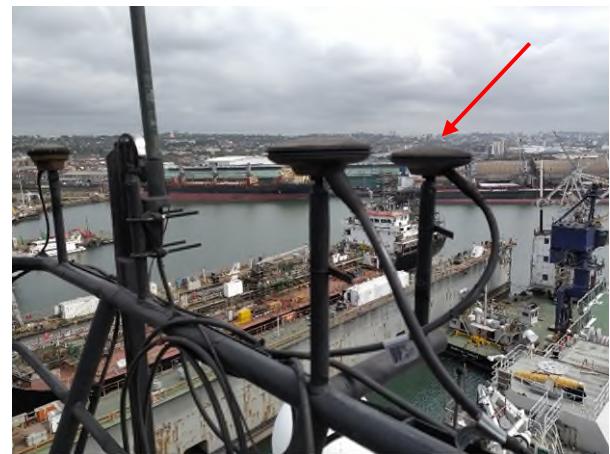


Figure 3.44: Trinav VTGP2 Ant.

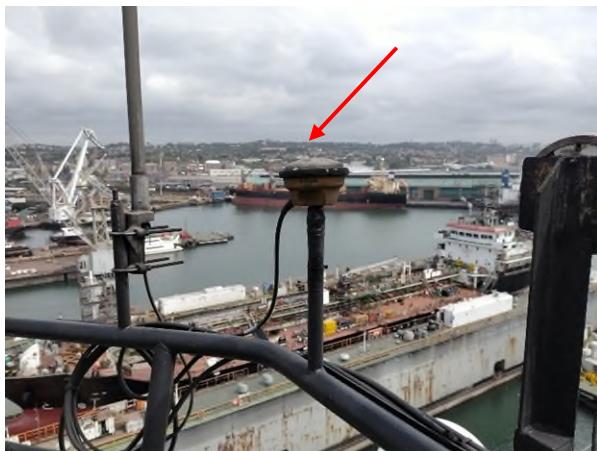


Figure 3.45: Starpack Ant 1

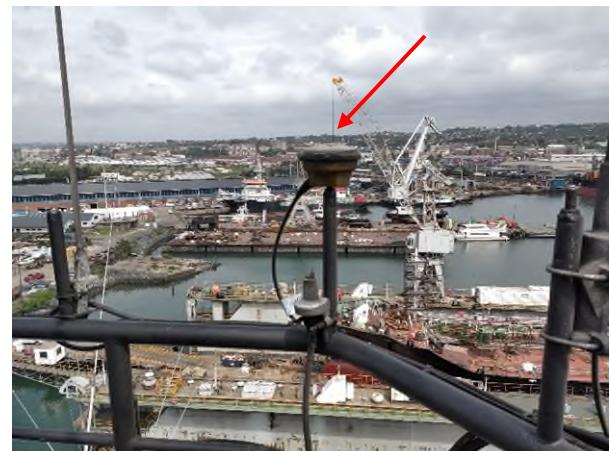


Figure 3.46: Septentrio Ant 2



Figure 3.47: Port Dynamic Cal Ant



Figure 3.48: Stb Dynamic Cal Ant

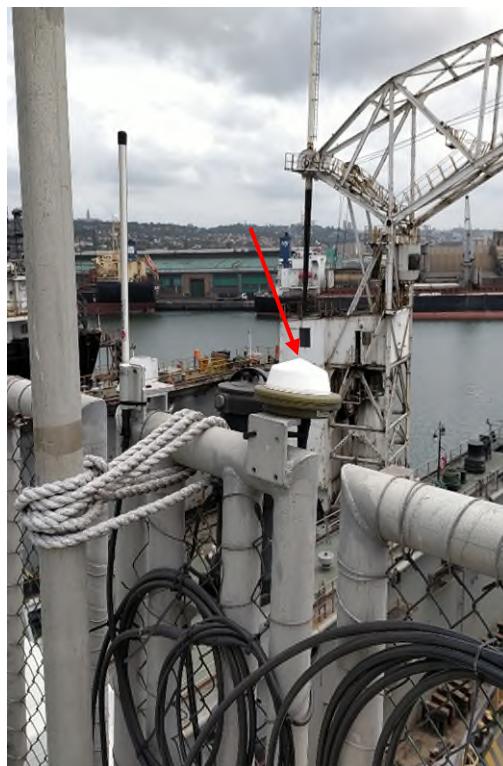


Figure 3.49: Aft (RT Calib) Ant



Figure 3.50: Spot track Antenna

3.5 Instruments



Figure 3.51: Octans 3000



Figure 3.52: MRU5+



Figure 3.53: MRU5-D



Figure 3.54: Nortek ADCP



Figure 3.55: EA600



Figure 3.56: USBL 7000+ Lodestar

3.6 HD64



Figure 3.57: HD64 - Offsets

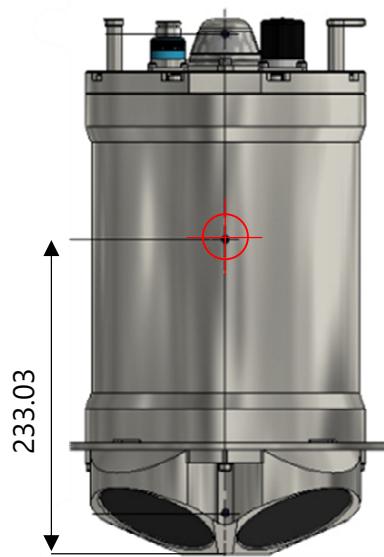


Figure 3.58: HD64 - Sprint Nav measured offset



Figure 3.59: HD64-MiniIPS



Figure 3.60: HD64-svx2



Figure 3.61: HD64-trans/HD64-Resp

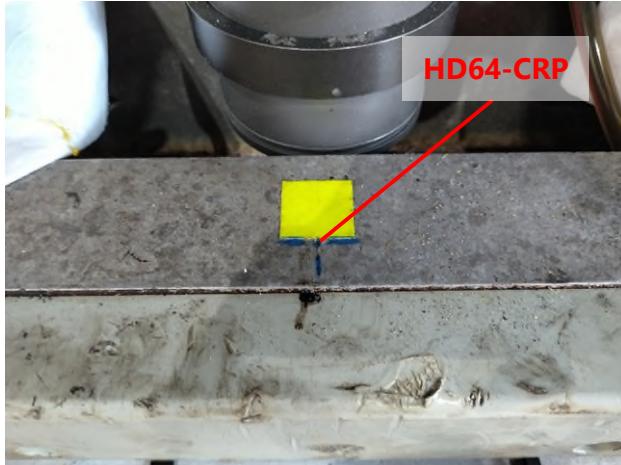


Figure 3.62: HD64-CRP



Figure 3.63: : HD64-TOP

3.7 HD65



Figure 3.64: HD-65 Offset

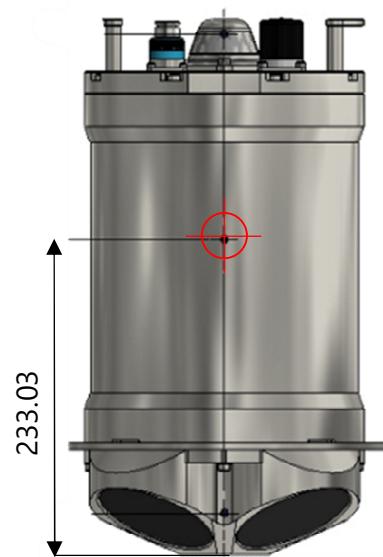


Figure 3.65: HD65-Sprint



Figure 3.66: HD65-MiniIPS



Figure 3.67: HD65-svx2



Figure 3.68: HD65 Trans / HD64 Resp

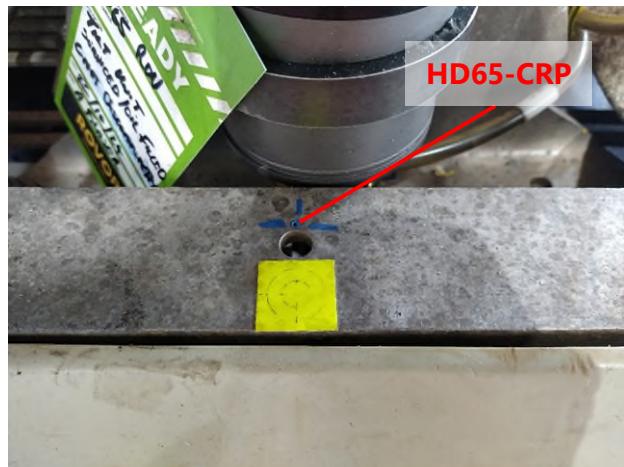


Figure 3.69: HD65-CRP



Figure 3.70: HD65-TOP

4. RESOURCES

4.1 Summary of operations

17/11/2024

- Mobilization to Durban

18/11/2024

- Yard induction
- Vessel visit
- Start vessel offset survey preparation.

19-20/11/2024

- Vessel Offset survey
- Static GNSS observation on quayside reference points

21/11/2024

- Static GNSS observation on quayside reference points
- ROV offset survey

22/11/2024

- ROV offset survey
- ROV calibration

23/11/2024

- Processing
- Awaiting for transducer installation

24/11/2024

- Processing
- Vessel offset survey : Transducer and below vessel hull
- Dynamic calibration : Logging session 1

25/11/2024

- Processing
- Vessel offset survey : HPR room

26/11/2024

- Processing
- Dynamic calibration : Logging session 2

27/11/2024

- Processing

28/11/2024

- Dynamic calibration Octans 3000 : Logging session 3

- Processing / Reporting
- Demobilization from vessel

29/11/2024

- Demobilization from Durban

4.2 Personnel

The following personnel were involved in the survey:

Personnel	Company	Function
Marie ARSAC	Fugro	Senior Dimensional Control Surveyor
Arthur MEUNIER	Fugro	Dimensional Control Surveyor

4.3 Equipment

The following equipment was mobilized to the SW TASMAN:

Table 4.1: List of equipment

#	Equipment	Provided by	Nb.	Comments
<input type="checkbox"/>	Total Station Leica		1	
<input type="checkbox"/>	Mini-Prism		1	
<input type="checkbox"/>	Spherical prism		5	
<input type="checkbox"/>	Set of Reflecting Target		1	
<input type="checkbox"/>	Tribach		2	
<input type="checkbox"/>	GNSS Receiver		4	
<input type="checkbox"/>	GNSS Antenna		4	
<input type="checkbox"/>	Extension pole		4	
<input type="checkbox"/>	Tripods		2	
<input type="checkbox"/>	Measuring tape 5m		1	
<input type="checkbox"/>	Measuring tape 50m		1	
<input type="checkbox"/>	Permanent marker		2	

5. Methodology

5.1.1 Vessel Offset Survey

A conventional land survey methodology (Total Station and prisms or reflective target) was used to determine the position of the points relative to the CRP's. Fifteen (15) Total Station set-ups were necessary to observe all the points and determine the CRP.

The position of Gyro 1, Gyro 2 and Gyro 3 were carried out by tape measurement, from points surveyed by total station.

The HiPAP pole was partially extended while the vessel was in dry dock. It couldn't be fully extended. The axis of the pole was measured, and the offset of the transducer reference point was recalculated including dimensions from drawings of the pole.

The estimated accuracy for antennas and instruments offset, determined by total station, is 5 mm.

The estimated accuracy for Gyro vessel offset (determined by tape measurements) is 50 mm.

The estimated accuracy for deployed HiPAP vessel offset is 5 mm in XY, and 20 mm in Z.

5.1.2 Vessel Heading and MRU Calibration

Two GNSS receivers were installed on the vessel (~on the vessel centreline), and Post processing using PPK methodology allowed obtaining Computed Heading (+90°) values.

At the same time, sensor's Observed values were logged on the online navigation computer.

All C-O were removed from navigation computers, and initialization time was respected.

Computed grid headings were corrected from the convergence (+0.9975°) according to the following:

$$\text{True Heading} = \text{Grid Heading} + \text{Convergence}$$

C-O for Heading was determined from Computed minus Observed, using UTC time as synchronisation for the TriNAV system. The GPS time was used for the 4D Nav system.

Same methodology was applied with 3 receivers (~1*on the vessel centreline and 2*perpendicular to vessel centreline) for pitch and roll C-O computation.

Sign convention of sensors of pitch and roll used for C-O:

Sensors: Sonardyne 7000+ Lodestar, Fugro Hdg, Seatex MRU5+, Anschutz Gyro 1, Anschutz Gyro2, Anschutz Gyro 3:

- HEADING=positive (+) BOW STBD
- ROLL= positive (+) STBD DOWN

- PITCH= positive (+) BOW UP

Sensors: Exail Octans 3000:

- HEADING=positive (+) BOW STBD
- ROLL= positive (+) STBD DOWN
- PITCH= positive (+) BOW DOWN

5.1.3 GNSS Health Check

Three reference points were established on the quayside (GPS1, GPS2 and GPS3), and coordinates were determined by GNSS static observations. Coordinates were determined in WGS84, Epoch 2024.9 / UTM36 S.

The Total Station was set-up on GPS1, and oriented with GPS2 and GPS3. The position of each antenna was measured every three minutes, during two hours.

At the same time, antennas positions were logged on the online navigation computer.

C-O for Heading was determined from Computed minus Observed, using UTC time as synchronisation for the TriNAV system. The GPS time was used for the 4D Nav system.

5.1.4 ROV Offset Survey and Heading / MRU calibration

ROV were located in a maintenance hangar during the survey.

A conventional land survey methodology (Total Station and prisms or reflective target) was used to determine the position of the points relative to the CRP's. Seven (7) Total Station set-ups were necessary to observe all the points and determine the CRP.

The three quayside reference points were measured to tie-in the survey in UTM36S coordinate system.

The attitude of the ROV were also measured (Grid Heading, pitch and roll) by measuring its frame.

Computed grid headings were corrected from the convergence ($+0.9975^\circ$) according to the following:

$$\text{True Heading} = \text{Grid Heading} + \text{Convergence}$$

At the same time, sensor's Observed values were logged.

C-O for Heading, pitch and roll were determined from Computed minus Observed.

6. CONCLUSION

The Dimensional Control and calibration of the SW TASMAN took place in several phases due to some waiting time in Lodestar 7000+ installation and waiting for the vessel to be loaded and able to be turn 180° to log the second dynamic calibration session.

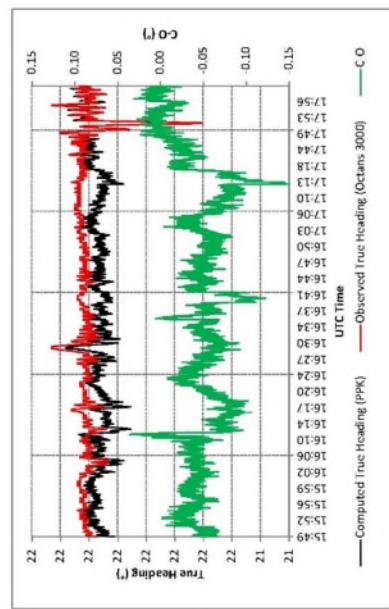
Moreover, it appears after the first dynamic calibration session that the gyrocompass of the Octans 3000 was not properly settled (due to previous vessel shutdown, and the need of movement for the instrument to settle, that was not the case in floating dry dock). A third logging session as therefore been planned on the 28th of November.

Finally, all results proved to be consistent.

Appendix A

OCTANS 3000

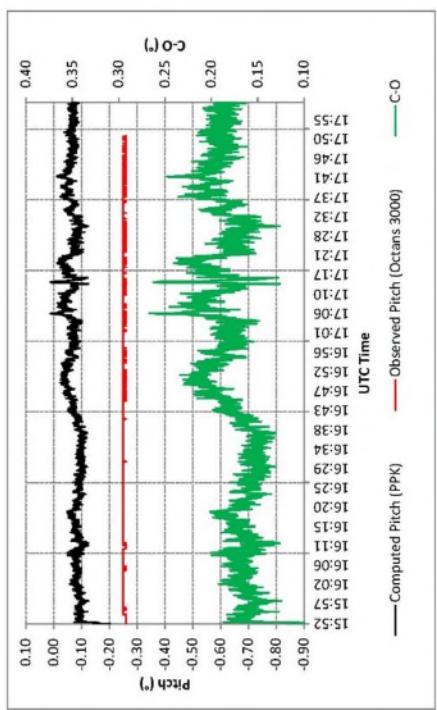
Data Sampling Period (UTC)		15:49:32	to	17:59:59	Date	26/11/2024
Data Sample		5540				
Equipment		Octans 3000	S/N	PH-839	Observed	C-O [°]
DataId	Computed	UTC Time	Heading [°]	UTC Time	Heading [°]	C-O [°]
1	15:49:32	21.92	15:49:32	21.98	-0.06	-0.05
2	15:49:33	21.92	15:49:33	21.97	-0.05	-0.05
3	15:49:34	21.92	15:49:34	21.97	-0.05	-0.05
4	15:49:35	21.92	15:49:35	21.97	-0.05	-0.05
5	15:49:36	21.91	15:49:36	21.97	-0.06	-0.06
6	15:49:37	21.92	15:49:37	21.98	-0.06	-0.06
7	15:49:38	21.93	15:49:38	21.98	-0.05	-0.05
8	15:49:39	21.93	15:49:39	21.98	-0.05	-0.05
9	15:49:40	21.91	15:49:40	21.98	-0.07	-0.07
10	15:49:41	21.92	15:49:41	21.98	-0.06	-0.06
11	15:49:42	21.93	15:49:42	21.99	-0.06	-0.06
12	15:49:43	21.94	15:49:43	21.99	-0.05	-0.05
13	15:49:44	21.94	15:49:44	21.99	-0.05	-0.05
14	15:49:45	21.94	15:49:45	22.00	-0.06	-0.06
15	15:49:46	21.94	15:49:46	22.00	-0.06	-0.06
16	15:49:47	21.95	15:49:47	22.01	-0.06	-0.06
17	15:49:48	21.96	15:49:48	22.01	-0.05	-0.05
18	15:49:49	21.95	15:49:49	22.01	-0.06	-0.06
19	15:49:50	21.97	15:49:50	22.01	-0.04	-0.04
20	15:49:51	21.96	15:49:51	22.01	-0.05	-0.05
21	15:49:52	21.95	15:49:52	22.01	-0.06	-0.06
22	15:49:53	21.97	15:49:53	22.01	-0.04	-0.04
23	15:49:54	21.97	15:49:54	22.01	-0.04	-0.04
24	15:49:55	21.97	15:49:55	22.01	-0.04	-0.04
25	15:49:56	21.96	15:49:56	22.01	-0.05	-0.05
26	15:49:57	21.96	15:49:57	22.01	-0.05	-0.05
27	15:49:58	21.95	15:49:58	22.01	-0.06	-0.06
28	15:49:59	21.96	15:49:59	22.01	-0.05	-0.05
29	15:50:00	21.96	15:50:00	22.00	-0.05	-0.05
30	15:50:01	21.95	15:50:01	22.01	-0.06	-0.06
31	15:50:02	21.96	15:50:02	22.01	-0.05	-0.05
32	15:50:03	21.96	15:50:03	22.01	-0.05	-0.05
33	15:50:04	21.94	15:50:04	22.01	-0.07	-0.07
34	15:50:05	21.96	15:50:05	22.01	-0.05	-0.05
35	15:50:06	21.95	15:50:06	22.00	-0.05	-0.05
36	15:50:07	21.95	15:50:07	22.00	-0.05	-0.05
37	15:50:08	21.95	15:50:08	22.00	-0.05	-0.05
38	15:50:09	21.95	15:50:09	22.00	-0.05	-0.05
39	15:50:10	21.95	15:50:10	22.00	-0.05	-0.05
40	15:50:11	21.94	15:50:11	22.00	-0.06	-0.06
41	15:50:12	21.96	15:50:12	22.00	-0.04	-0.04
42	15:50:13	21.94	15:50:13	22.00	-0.06	-0.06
43	15:50:14	21.93	15:50:14	21.99	-0.06	-0.06
44	15:50:15	21.94	15:50:15	21.99	-0.05	-0.05
45	15:50:16	21.94	15:50:16	21.99	-0.05	-0.05



Data Sampling
Period (UTC) 15:52:57
Data Sample 7935

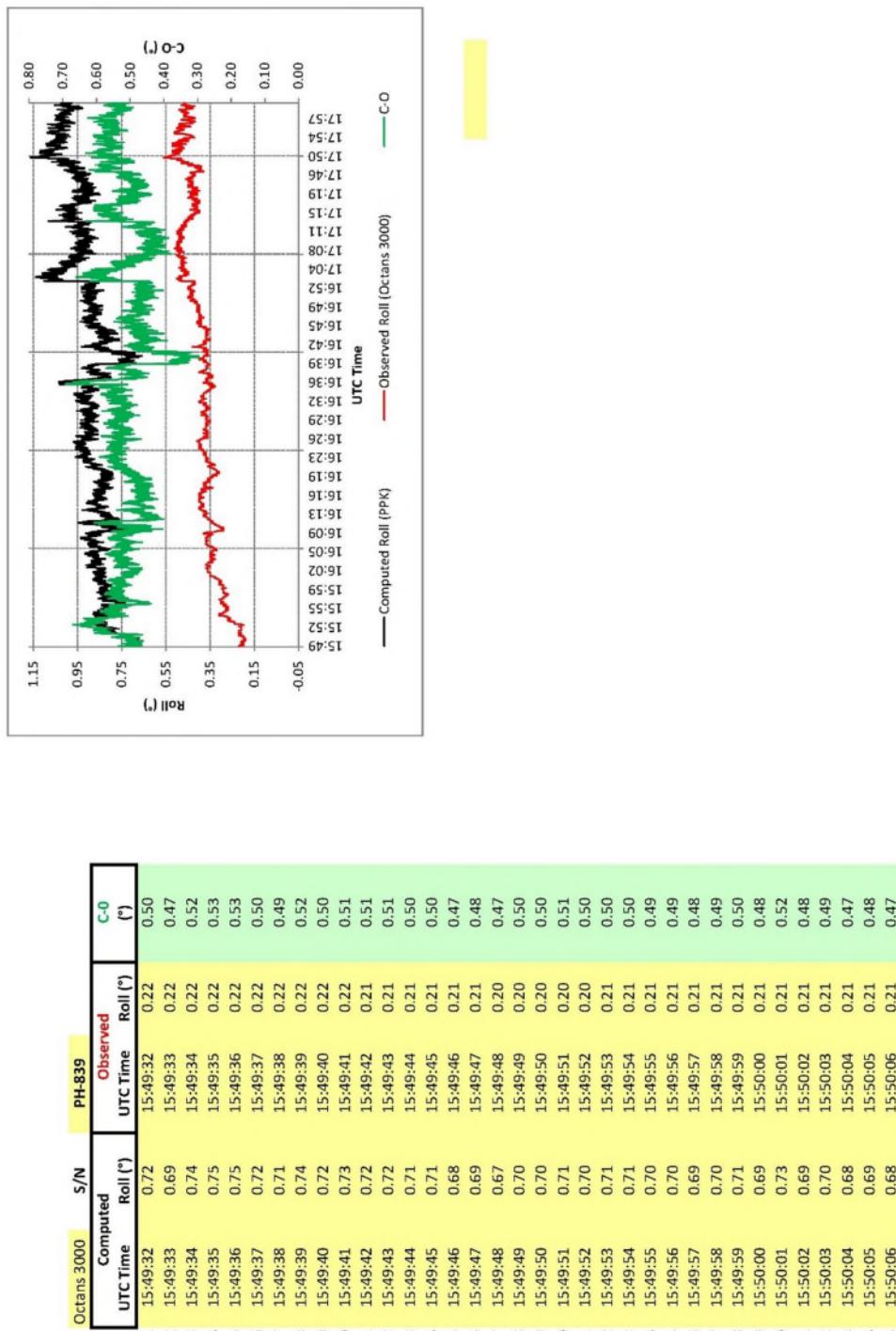
Equipment	Octans 3000	S/N	Computed Pitch (°)	Observed Pitch Time	C-O Pitch (°)	S.D. (°)	Min (°)	Max (°)

Equipment	Octans 3000	S/N	Computed UTC Time	Observed UTC Time	Pitch (°)	C-O (°)
DataId						
1	15:52:57	-0.14	15:52:57	15:52:57	-0.26	0.12
2	15:52:58	-0.17	15:52:58	15:52:58	-0.26	0.09
3	15:52:59	-0.17	15:52:59	15:52:59	-0.26	0.09
4	15:53:00	-0.20	15:53:00	15:53:00	-0.26	0.06
5	15:53:01	-0.19	15:53:01	15:53:01	-0.26	0.07
6	15:53:02	-0.20	15:53:02	15:53:02	-0.26	0.06
7	15:53:03	-0.19	15:53:03	15:53:03	-0.26	0.07
8	15:53:04	-0.18	15:53:04	15:53:04	-0.26	0.08
9	15:53:05	-0.18	15:53:05	15:53:05	-0.26	0.08
10	15:53:06	-0.17	15:53:06	15:53:06	-0.26	0.09
11	15:53:07	-0.16	15:53:07	15:53:07	-0.26	0.10
12	15:53:08	-0.16	15:53:08	15:53:08	-0.26	0.10
13	15:53:09	-0.16	15:53:09	15:53:09	-0.26	0.10
14	15:53:10	-0.16	15:53:10	15:53:10	-0.26	0.10
15	15:53:11	-0.16	15:53:11	15:53:11	-0.26	0.10
16	15:53:12	-0.16	15:53:12	15:53:12	-0.26	0.10
17	15:53:13	-0.16	15:53:13	15:53:13	-0.26	0.10
18	15:53:14	-0.15	15:53:14	15:53:14	-0.26	0.11
19	15:53:15	-0.15	15:53:15	15:53:15	-0.26	0.11
20	15:53:16	-0.15	15:53:16	15:53:16	-0.26	0.11
21	15:53:17	-0.15	15:53:17	15:53:17	-0.26	0.11
22	15:53:18	-0.15	15:53:18	15:53:18	-0.26	0.11
23	15:53:19	-0.15	15:53:19	15:53:19	-0.26	0.11
24	15:53:20	-0.15	15:53:20	15:53:20	-0.26	0.11
25	15:53:21	-0.16	15:53:21	15:53:21	-0.26	0.10
26	15:53:22	-0.11	15:53:22	15:53:22	-0.26	0.15
27	15:53:23	-0.09	15:53:23	15:53:23	-0.26	0.17
28	15:53:24	-0.09	15:53:24	15:53:24	-0.26	0.17
29	15:53:25	-0.07	15:53:25	15:53:25	-0.26	0.19
30	15:53:26	-0.09	15:53:26	15:53:26	-0.26	0.17
31	15:53:27	-0.09	15:53:27	15:53:27	-0.26	0.17
32	15:53:28	-0.11	15:53:28	15:53:28	-0.26	0.15
33	15:53:29	-0.11	15:53:29	15:53:29	-0.26	0.15
34	15:53:30	-0.10	15:53:30	15:53:30	-0.26	0.16
35	15:53:31	-0.09	15:53:31	15:53:31	-0.26	0.17

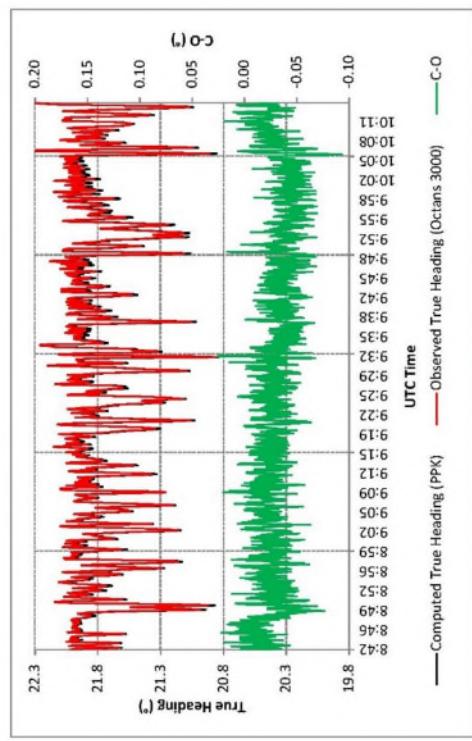


Data Sampling Period (UTC) 15:49:32 to 17:59:59 Date 26/11/2024
Data Sample 5399

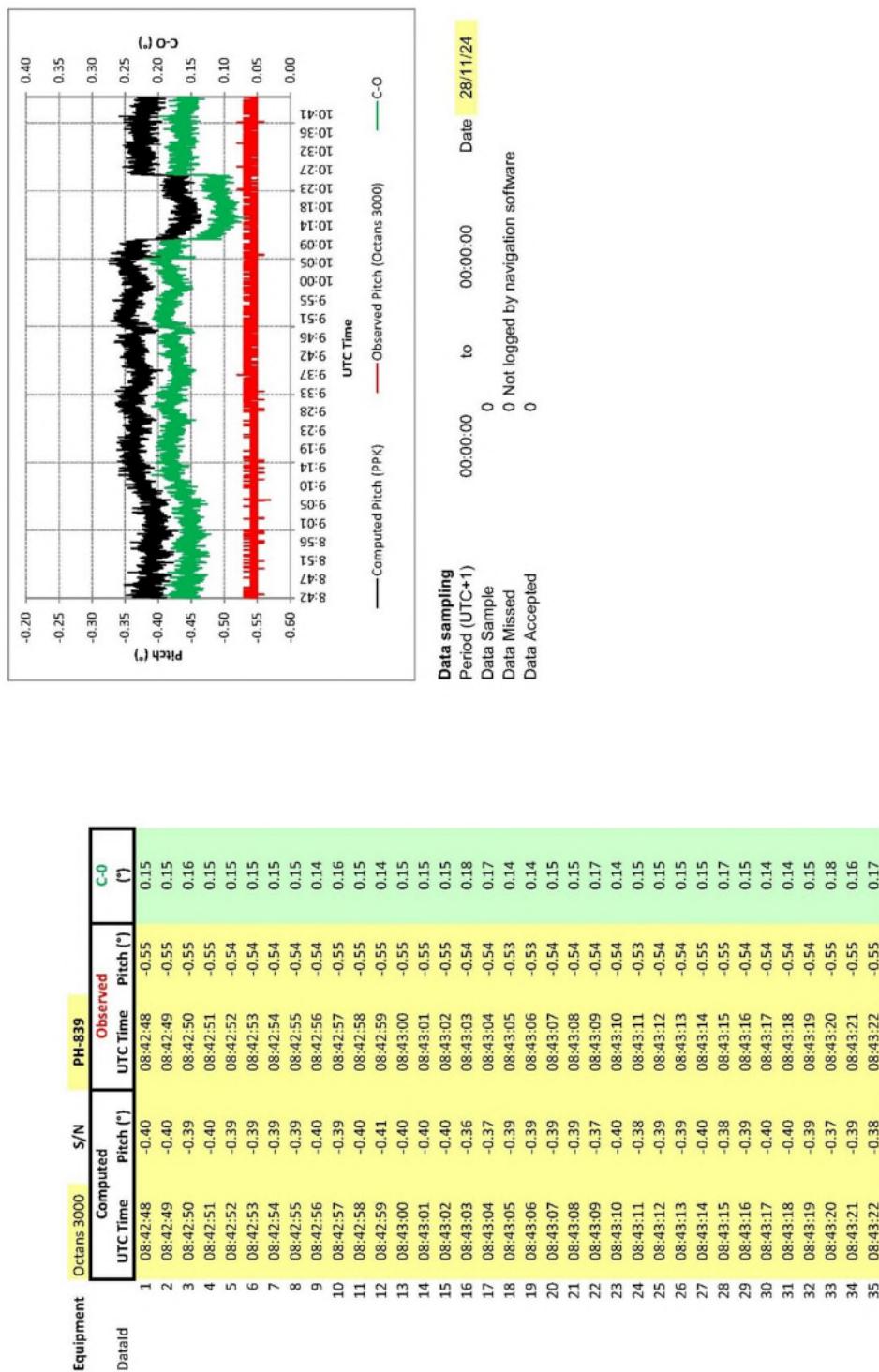
Equipment	Octans 3000	S/N	PH-839	C-O (°)	S.D. (°)	Min (°)	Max (°)	
	Roll			Roll	0.51	0.05	0.30	0.69



Data Sampling		08:42:48	to	11:01:09	Date	28/11/2024
Equipment	Octans 3000	S/N	PH-839			
Data	Octans 3000	Computed	Observed	C-O		
	UTC Time	Heading (°)	UTC Time	Heading (°)	(°)	
1	08:42:48	22.00	08:42:48	22.01	-0.01	
2	08:42:49	22.01	08:42:49	22.02	-0.01	
3	08:42:50	22.00	08:42:50	22.02	-0.02	
4	08:42:51	22.00	08:42:51	22.01	-0.01	
5	08:42:52	22.00	08:42:52	22.00	0.00	
6	08:42:53	21.98	08:42:53	21.99	-0.01	
7	08:42:54	21.96	08:42:54	21.98	-0.02	
8	08:42:55	21.97	08:42:55	21.97	0.00	
9	08:42:56	21.93	08:42:56	21.96	-0.03	
10	08:42:57	21.93	08:42:57	21.94	-0.01	
11	08:42:58	21.91	08:42:58	21.92	-0.01	
12	08:42:59	21.88	08:42:59	21.90	-0.02	
13	08:43:00	21.84	08:43:00	21.87	-0.03	
14	08:43:01	21.81	08:43:01	21.84	-0.03	
15	08:43:02	21.78	08:43:02	21.80	-0.02	
16	08:43:03	21.73	08:43:03	21.76	-0.03	
17	08:43:04	21.69	08:43:04	21.72	-0.03	
18	08:43:05	21.66	08:43:05	21.69	-0.03	
19	08:43:06	21.65	08:43:06	21.67	-0.02	
20	08:43:07	21.64	08:43:07	21.65	-0.01	
21	08:43:08	21.61	08:43:08	21.64	-0.03	
22	08:43:09	21.62	08:43:09	21.63	-0.01	
23	08:43:10	21.62	08:43:10	21.63	-0.01	
24	08:43:11	21.63	08:43:11	21.65	-0.02	
25	08:43:12	21.65	08:43:12	21.66	-0.01	
26	08:43:13	21.67	08:43:13	21.68	-0.01	
27	08:43:14	21.69	08:43:14	21.70	-0.01	
28	08:43:15	21.73	08:43:15	21.72	0.01	
29	08:43:16	21.74	08:43:16	21.75	-0.01	
30	08:43:17	21.78	08:43:17	21.79	-0.01	
31	08:43:18	21.82	08:43:18	21.82	0.00	
32	08:43:19	21.86	08:43:19	21.86	0.00	
33	08:43:20	21.91	08:43:20	21.90	0.01	
34	08:43:21	21.95	08:43:21	21.94	0.01	
35	08:43:22	21.98	08:43:22	21.98	0.00	

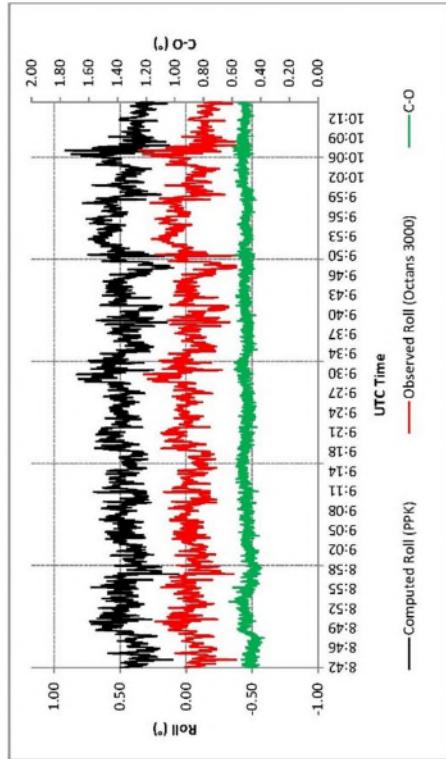


Data sampling
 Period (UTC) 08:42:48 to 10:57:53 Date 28/11/2024
 Data Sample 8164.00



Data Sampling Period (UTC) Data Sample
Octans 3000 08:42:48 to 11:01:09 Date 28/11/2024

Equipment	Data type	C-O (°)	S.D. (°)	Min (°)	Max (°)
Octans 3000	Roll	0.51	0.03	0.38	0.64



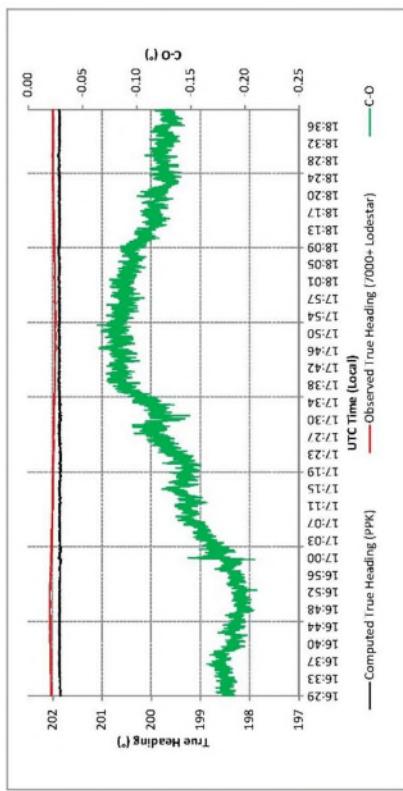
Equipment	Octans 3000			S/N	PH-839	
	Computed	Observed	UTC Time			Roll (°)
1	08:42:48	0.49	08:42:48	0.00	0.49	0.49
2	08:42:49	0.50	08:42:49	0.00	0.50	0.50
3	08:42:50	0.49	08:42:50	0.01	0.48	0.48
4	08:42:51	0.48	08:42:51	0.00	0.48	0.48
5	08:42:52	0.45	08:42:52	-0.01	0.46	0.46
6	08:42:53	0.46	08:42:53	-0.02	0.48	0.48
7	08:42:54	0.45	08:42:54	-0.02	0.47	0.47
8	08:42:55	0.44	08:42:55	-0.02	0.46	0.46
9	08:42:56	0.45	08:42:56	-0.01	0.46	0.46
10	08:42:57	0.44	08:42:57	-0.01	0.45	0.45
11	08:42:58	0.44	08:42:58	0.00	0.44	0.44
12	08:42:59	0.42	08:42:59	-0.01	0.43	0.43
13	08:43:00	0.44	08:43:00	-0.03	0.47	0.47
14	08:43:01	0.40	08:43:01	-0.06	0.46	0.46
15	08:43:02	0.34	08:43:02	-0.09	0.43	0.43
16	08:43:03	0.39	08:43:03	-0.10	0.49	0.49
17	08:43:04	0.39	08:43:04	-0.10	0.49	0.49
18	08:43:05	0.41	08:43:05	-0.10	0.51	0.51
19	08:43:06	0.37	08:43:06	-0.10	0.47	0.47
20	08:43:07	0.33	08:43:07	-0.12	0.45	0.45
21	08:43:08	0.34	08:43:08	-0.14	0.48	0.48
22	08:43:09	0.34	08:43:09	-0.14	0.48	0.48
23	08:43:10	0.34	08:43:10	-0.13	0.47	0.47
24	08:43:11	0.40	08:43:11	-0.11	0.51	0.51
25	08:43:12	0.44	08:43:12	-0.09	0.53	0.53
26	08:43:13	0.36	08:43:13	-0.08	0.44	0.44
27	08:43:14	0.36	08:43:14	-0.09	0.45	0.45
28	08:43:15	0.30	08:43:15	-0.11	0.41	0.41
29	08:43:16	0.37	08:43:16	-0.13	0.50	0.50
30	08:43:17	0.40	08:43:17	-0.12	0.52	0.52
31	08:43:18	0.38	08:43:18	-0.10	0.48	0.48
32	08:43:19	0.36	08:43:19	-0.08	0.44	0.44
33	08:43:20	0.39	08:43:20	-0.08	0.47	0.47
34	08:43:21	0.36	08:43:21	-0.10	0.46	0.46
35	08:43:22	0.37	08:43:22	-0.13	0.50	0.50

Appendix B

7000+ LODESTAR

Data Sampling Period (UTC)
Data Sample
16:29:18
7851

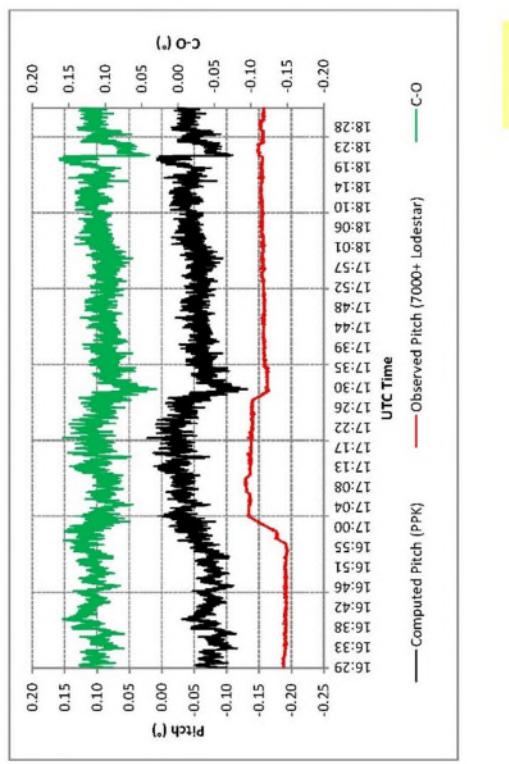
Equipment
7000+ Lodestar
7000+ Lodestar
C-O (°)
Yaw
0.04
S.D. (°)
-0.13
Min (°)
-0.21
Max (°)
-0.06



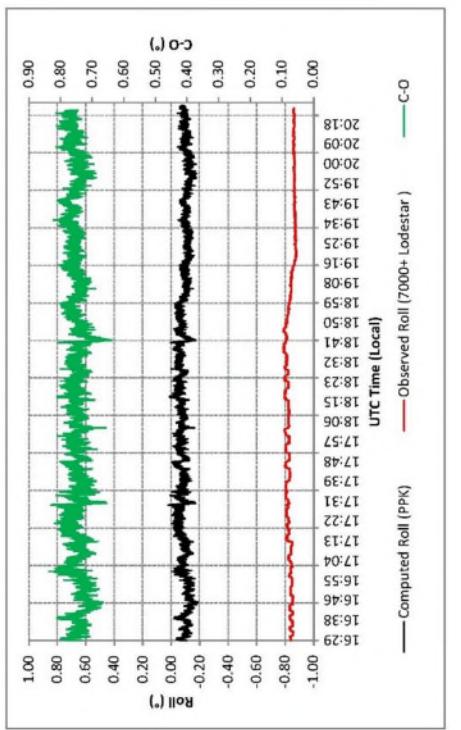
Equipment 344570-001					
	Computed 7000+ Lodestar	Observed	Heading (°)	C-O (°)	
DataId	UTCTime	UTCTime	Heading (°)	Heading (°)	
1	16:29:18	201.84	16:29:18	202.03	-0.19
2	16:29:19	201.85	16:29:19	202.03	-0.18
3	16:29:20	201.84	16:29:20	202.03	-0.18
4	16:29:21	201.84	16:29:21	202.03	-0.19
5	16:29:22	201.84	16:29:22	202.03	-0.19
6	16:29:23	201.84	16:29:23	202.03	-0.18
7	16:29:24	201.85	16:29:24	202.03	-0.18
8	16:29:25	201.84	16:29:25	202.03	-0.18
9	16:29:26	201.84	16:29:26	202.03	-0.19
10	16:29:27	201.84	16:29:27	202.03	-0.19
11	16:29:28	201.84	16:29:28	202.03	-0.19
12	16:29:29	201.84	16:29:29	202.03	-0.19
13	16:29:30	201.85	16:29:30	202.03	-0.18
14	16:29:31	201.84	16:29:31	202.03	-0.19
15	16:29:32	201.84	16:29:32	202.03	-0.19
16	16:29:33	201.85	16:29:33	202.03	-0.18
17	16:29:34	201.85	16:29:34	202.03	-0.18
18	16:29:35	201.85	16:29:35	202.03	-0.18
19	16:29:36	201.85	16:29:36	202.03	-0.18
20	16:29:37	201.85	16:29:37	202.03	-0.18
21	16:29:38	201.85	16:29:38	202.03	-0.18
22	16:29:39	201.85	16:29:39	202.03	-0.18
23	16:29:40	201.85	16:29:40	202.03	-0.18
24	16:29:41	201.85	16:29:41	202.03	-0.18
25	16:29:42	201.85	16:29:42	202.03	-0.18
26	16:29:43	201.85	16:29:43	202.03	-0.18
27	16:29:44	201.85	16:29:44	202.03	-0.18
28	16:29:45	201.84	16:29:45	202.03	-0.19
29	16:29:46	201.85	16:29:46	202.03	-0.18
30	16:29:47	201.85	16:29:47	202.03	-0.18
31	16:29:48	201.85	16:29:48	202.03	-0.18
32	16:29:49	201.84	16:29:49	202.03	-0.19
33	16:29:50	201.85	16:29:50	202.03	-0.18
34	16:29:51	201.84	16:29:51	202.03	-0.19
35	16:29:52	201.84	16:29:52	202.03	-0.19
36	16:29:53	201.84	16:29:53	202.03	-0.19
37	16:29:54	201.84	16:29:54	202.03	-0.19
38	16:29:55	201.84	16:29:55	202.03	-0.19
39	16:29:56	201.84	16:29:56	202.03	-0.19
40	16:29:57	201.84	16:29:57	202.03	-0.19
41	16:29:58	201.84	16:29:58	202.03	-0.19
42	16:29:59	201.85	16:29:59	202.03	-0.18
43	16:30:00	201.84	16:30:00	202.03	-0.19
44	16:30:01	201.85	16:30:01	202.03	-0.18
45	16:30:02	201.84	16:30:02	202.03	-0.19

Data Sampling
Period (UTC) 16:29:18 to 18:40:10 Date 24/11/2024
Data Sample 7912

Equipment	Lodestar 700C		S/N 344570-001		C-O (°)
	Computed UTC Time	Pitch (°)	Observed UTC Time	Pitch (°)	
1	16:29:18	-0.08	16:29:18	-0.19	0.11
2	16:29:19	-0.09	16:29:19	-0.19	0.10
3	16:29:20	-0.10	16:29:20	-0.19	0.09
4	16:29:21	-0.09	16:29:21	-0.19	0.10
5	16:29:22	-0.10	16:29:22	-0.19	0.09
6	16:29:23	-0.08	16:29:23	-0.19	0.11
7	16:29:24	-0.07	16:29:24	-0.19	0.11
8	16:29:25	-0.07	16:29:25	-0.19	0.11
9	16:29:26	-0.08	16:29:26	-0.19	0.10
10	16:29:27	-0.08	16:29:27	-0.19	0.11
11	16:29:28	-0.08	16:29:28	-0.19	0.11
12	16:29:29	-0.07	16:29:29	-0.19	0.12
13	16:29:30	-0.07	16:29:30	-0.19	0.11
14	16:29:31	-0.08	16:29:31	-0.19	0.11
15	16:29:32	-0.08	16:29:32	-0.19	0.10
16	16:29:33	-0.07	16:29:33	-0.19	0.12
17	16:29:34	-0.07	16:29:34	-0.19	0.12
18	16:29:35	-0.07	16:29:35	-0.19	0.12
19	16:29:36	-0.07	16:29:36	-0.19	0.12
20	16:29:37	-0.07	16:29:37	-0.19	0.12
21	16:29:38	-0.07	16:29:38	-0.19	0.12
22	16:29:39	-0.08	16:29:39	-0.19	0.11
23	16:29:40	-0.08	16:29:40	-0.19	0.11
24	16:29:41	-0.07	16:29:41	-0.19	0.12
25	16:29:42	-0.06	16:29:42	-0.19	0.13
26	16:29:43	-0.06	16:29:43	-0.19	0.13
27	16:29:44	-0.07	16:29:44	-0.19	0.12
28	16:29:45	-0.07	16:29:45	-0.19	0.12
29	16:29:46	-0.06	16:29:46	-0.19	0.13
30	16:29:47	-0.05	16:29:47	-0.19	0.13
31	16:29:48	-0.06	16:29:48	-0.19	0.13
32	16:29:49	-0.07	16:29:49	-0.19	0.12
33	16:29:50	-0.07	16:29:50	-0.19	0.12
34	16:29:51	-0.06	16:29:51	-0.19	0.13
35	16:29:52	-0.06	16:29:52	-0.19	0.12

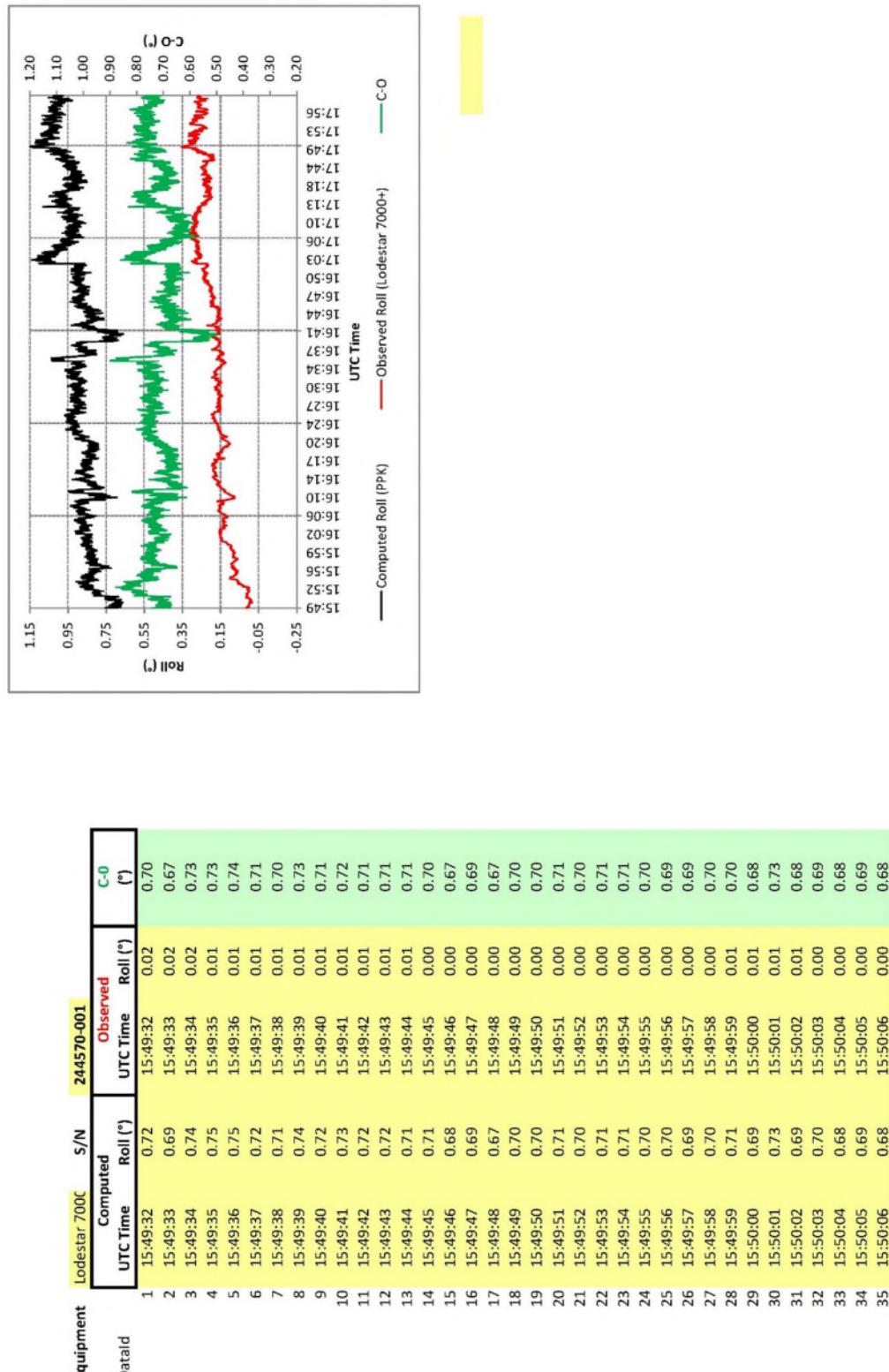


Data Sampling		16:29:18	to	20:26:20	Date	24/11/2024
Period (UTC)		8360				
Equipment	Lodestar:700C	S/N				
DataId	Computed UTC Time	Roll (°)	Observed UTC Time	Roll (°)	C-O (°)	
1	16:29:18	-0.09	16:29:18	-0.84	0.75	
2	16:29:19	-0.08	16:29:19	-0.84	0.76	
3	16:29:20	-0.07	16:29:20	-0.84	0.77	
4	16:29:21	-0.07	16:29:21	-0.84	0.77	
5	16:29:22	-0.08	16:29:22	-0.84	0.76	
6	16:29:23	-0.09	16:29:23	-0.84	0.75	
7	16:29:24	-0.11	16:29:24	-0.84	0.73	
8	16:29:25	-0.10	16:29:25	-0.84	0.74	
9	16:29:26	-0.09	16:29:26	-0.84	0.75	
10	16:29:27	-0.08	16:29:27	-0.84	0.76	
11	16:29:28	-0.10	16:29:28	-0.84	0.74	
12	16:29:29	-0.09	16:29:29	-0.84	0.75	
13	16:29:30	-0.08	16:29:30	-0.84	0.76	
14	16:29:31	-0.08	16:29:31	-0.84	0.75	
15	16:29:32	-0.08	16:29:32	-0.84	0.75	
16	16:29:33	-0.08	16:29:33	-0.84	0.76	
17	16:29:34	-0.09	16:29:34	-0.84	0.75	
18	16:29:35	-0.09	16:29:35	-0.84	0.75	
19	16:29:36	-0.06	16:29:36	-0.84	0.78	
20	16:29:37	-0.07	16:29:37	-0.84	0.77	
21	16:29:38	-0.08	16:29:38	-0.84	0.75	
22	16:29:39	-0.07	16:29:39	-0.84	0.77	
23	16:29:40	-0.07	16:29:40	-0.84	0.77	
24	16:29:41	-0.08	16:29:41	-0.84	0.76	
25	16:29:42	-0.06	16:29:42	-0.84	0.78	
26	16:29:43	-0.07	16:29:43	-0.84	0.77	
27	16:29:44	-0.06	16:29:44	-0.84	0.78	
28	16:29:45	-0.07	16:29:45	-0.84	0.77	
29	16:29:46	-0.07	16:29:46	-0.84	0.77	
30	16:29:47	-0.06	16:29:47	-0.84	0.78	
31	16:29:48	-0.06	16:29:48	-0.84	0.78	
32	16:29:49	-0.07	16:29:49	-0.84	0.77	
33	16:29:50	-0.05	16:29:50	-0.84	0.79	
34	16:29:51	-0.06	16:29:51	-0.84	0.78	

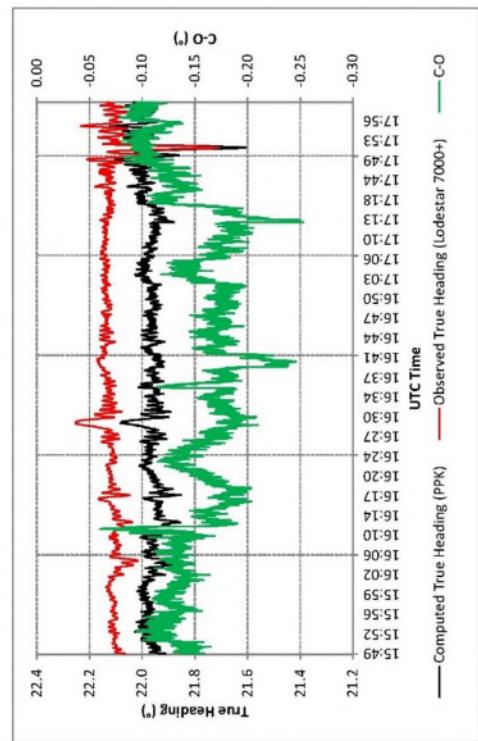


Data Sampling
Period (UTC) 15:49:32 to 17:59:59 Date 26/11/2024
Lodestar 7000 Data Sample 5599

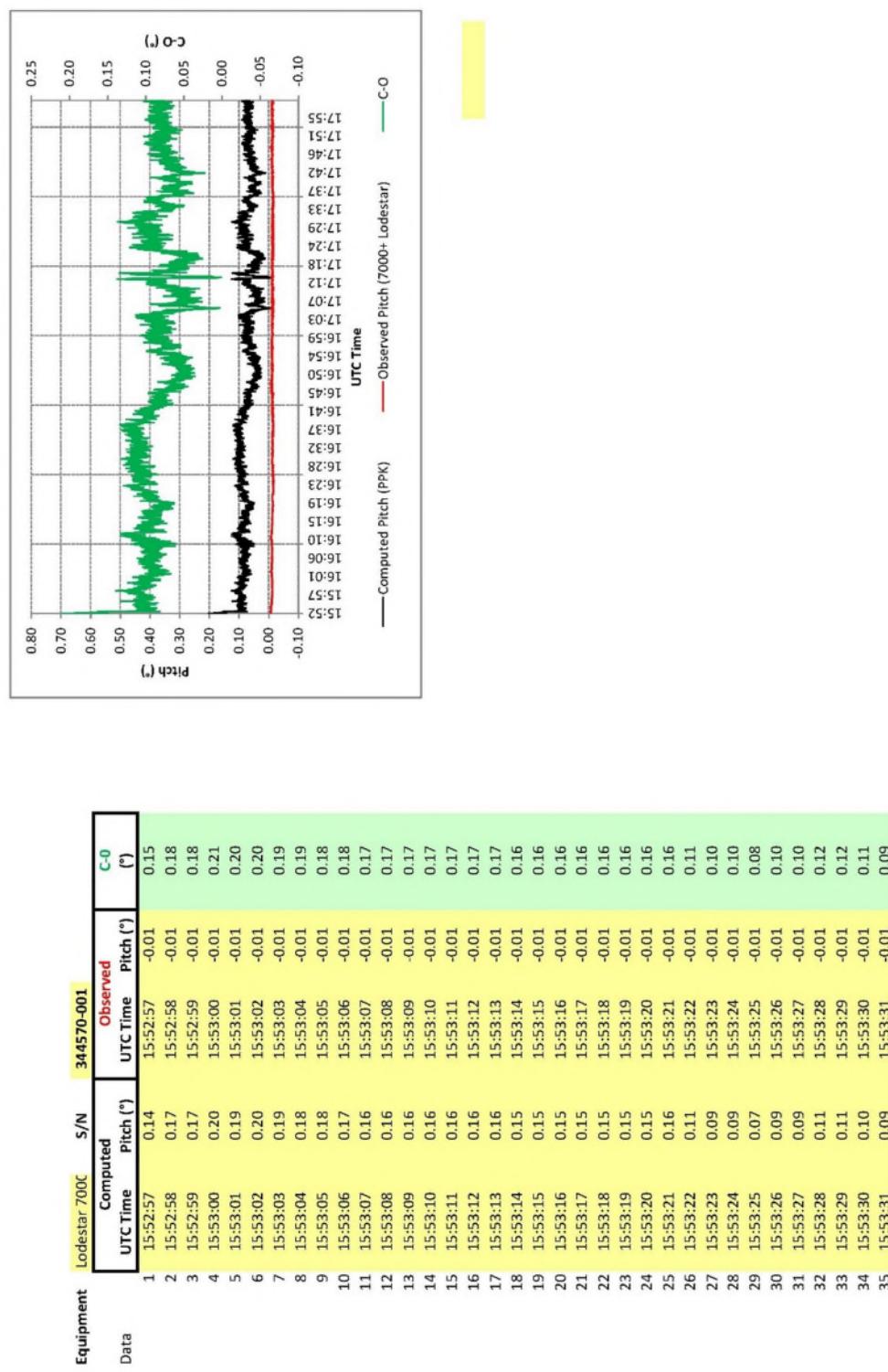
Equipment	Data type	C-O (°)	S.D. (°)	Min (°)	Max (°)
Lodestar 7000	Roll	0.72	0.05	0.50	0.90



Data Sampling Period (UTC)	15:49:32	to	17:59:59	Date	26/11/2024	
Equipment	Lodestar 7000C	S/N	344570-001			
	Computed	Observed	Heading (°)	C-O	C-O (°)	
Data	UTC Time	Heading (°)	UTC Time	Heading (°)		
1	15:49:32	21.92	15:49:32	22.07	-0.15	-0.15
2	15:49:33	21.92	15:49:33	22.07	-0.15	-0.15
3	15:49:34	21.92	15:49:34	22.06	-0.15	-0.15
4	15:49:35	21.92	15:49:35	22.07	-0.14	-0.20
5	15:49:36	21.91	15:49:36	22.07	-0.15	-0.25
6	15:49:37	21.92	15:49:37	22.07	-0.15	-0.25
7	15:49:38	21.93	15:49:38	22.07	-0.14	-0.30
8	15:49:39	21.93	15:49:39	22.07	-0.14	-0.30
9	15:49:40	21.91	15:49:40	22.07	-0.16	-0.30
10	15:49:41	21.92	15:49:41	22.07	-0.15	-0.30
11	15:49:42	21.93	15:49:42	22.08	-0.15	-0.30
12	15:49:43	21.94	15:49:43	22.08	-0.14	-0.30
13	15:49:44	21.94	15:49:44	22.08	-0.15	-0.30
14	15:49:45	21.94	15:49:45	22.09	-0.14	-0.30
15	15:49:46	21.94	15:49:46	22.09	-0.15	-0.30
16	15:49:47	21.95	15:49:47	22.10	-0.15	-0.30
17	15:49:48	21.96	15:49:48	22.10	-0.14	-0.30
18	15:49:49	21.95	15:49:49	22.10	-0.15	-0.30
19	15:49:50	21.97	15:49:50	22.10	-0.13	-0.30
20	15:49:51	21.96	15:49:51	22.10	-0.15	-0.30
21	15:49:52	21.95	15:49:52	22.10	-0.15	-0.30
22	15:49:53	21.97	15:49:53	22.10	-0.13	-0.30
23	15:49:54	21.97	15:49:54	22.10	-0.13	-0.30
24	15:49:55	21.97	15:49:55	22.10	-0.13	-0.30
25	15:49:56	21.96	15:49:56	22.10	-0.14	-0.30
26	15:49:57	21.96	15:49:57	22.10	-0.14	-0.30
27	15:49:58	21.95	15:49:58	22.10	-0.15	-0.30
28	15:49:59	21.96	15:49:59	22.10	-0.14	-0.30
29	15:50:00	21.96	15:50:00	22.10	-0.14	-0.30
30	15:50:01	21.95	15:50:01	22.10	-0.15	-0.30
31	15:50:02	21.96	15:50:02	22.10	-0.14	-0.30
32	15:50:03	21.96	15:50:03	22.10	-0.13	-0.30
33	15:50:04	21.94	15:50:04	22.10	-0.15	-0.30
34	15:50:05	21.96	15:50:05	22.10	-0.14	-0.30
35	15:50:06	21.95	15:50:06	22.10	-0.15	-0.30



Data Sampling Period (UTC)	15:52:57	to	17:59:59	Date	26/11/2024
Data Sample	7460				

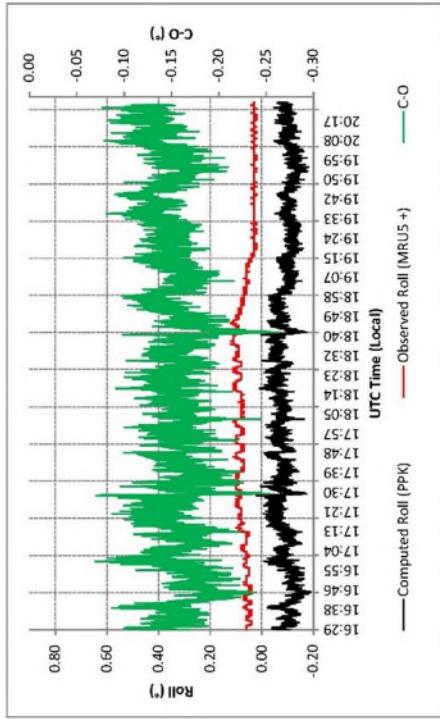


Appendix C

MRU5+

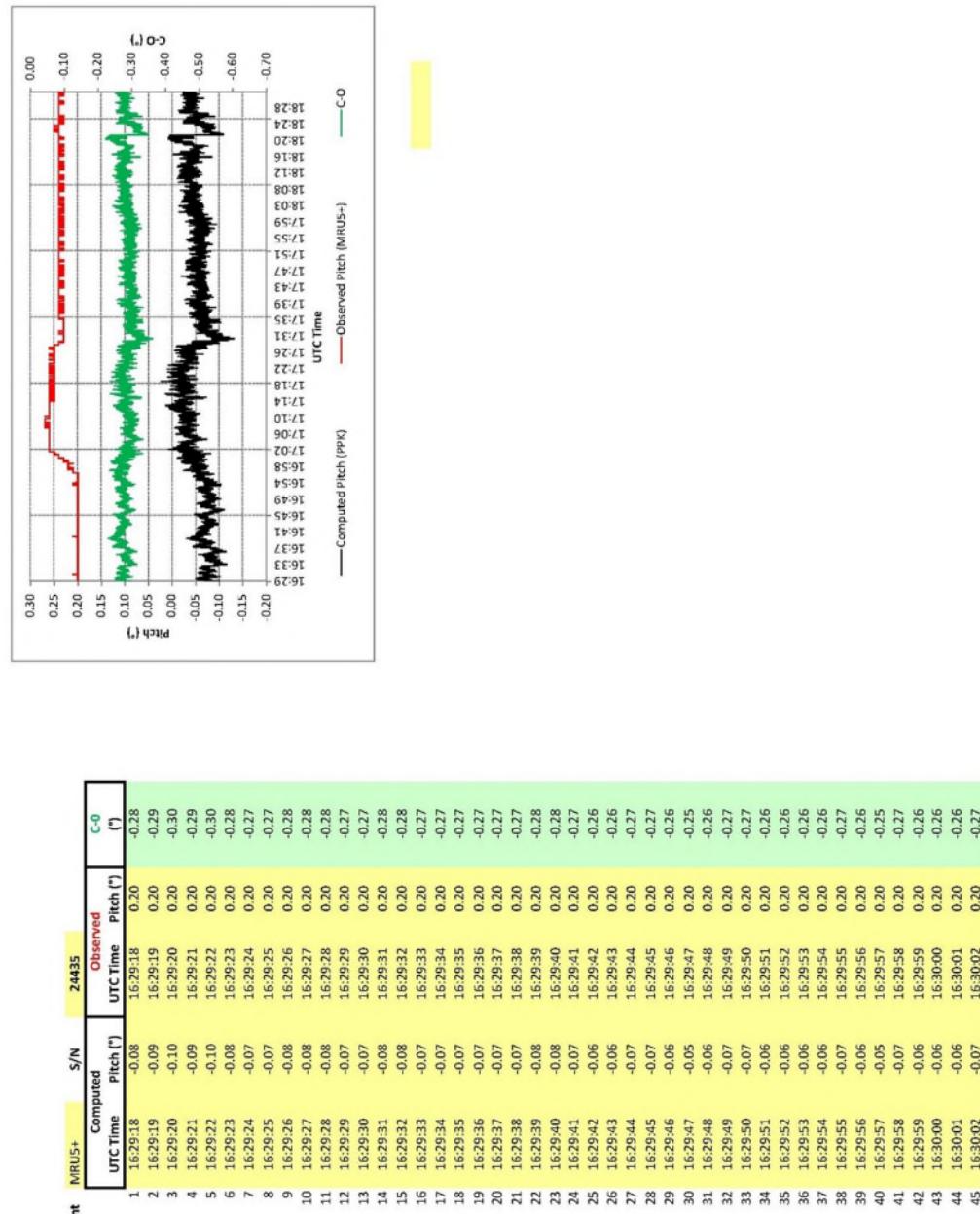
Data Sampling
Period (UTC) 16:29:18 Date 24/11/2024
Data Sample 8360

Equipment	Equipment	Equipment	Equipment	
MRIU5+	MRIU5+	MRIU5+	MRIU5+	
1	16:29:18	-0.09	16:29:18	0.06
2	16:29:19	-0.08	16:29:19	0.06
3	16:29:20	-0.07	16:29:20	0.06
4	16:29:21	-0.07	16:29:21	0.06
5	16:29:22	-0.08	16:29:22	0.06
6	16:29:23	-0.09	16:29:23	0.06
7	16:29:24	-0.11	16:29:24	0.06
8	16:29:25	-0.10	16:29:25	0.06
9	16:29:26	-0.09	16:29:26	0.06
10	16:29:27	-0.08	16:29:27	0.06
11	16:29:28	-0.10	16:29:28	0.06
12	16:29:29	-0.09	16:29:29	0.06
13	16:29:30	-0.08	16:29:30	0.06
14	16:29:31	-0.08	16:29:31	0.06
15	16:29:32	-0.08	16:29:32	0.06
16	16:29:33	-0.08	16:29:33	0.06
17	16:29:34	-0.09	16:29:34	0.06
18	16:29:35	-0.09	16:29:35	0.06
19	16:29:36	-0.06	16:29:36	0.06
20	16:29:37	-0.07	16:29:37	0.06
21	16:29:38	-0.08	16:29:38	0.06
22	16:29:39	-0.07	16:29:39	0.06
23	16:29:40	-0.07	16:29:40	0.06
24	16:29:41	-0.08	16:29:41	0.06
25	16:29:42	-0.06	16:29:42	0.06
26	16:29:43	-0.07	16:29:43	0.06
27	16:29:44	-0.06	16:29:44	0.06
28	16:29:45	-0.07	16:29:45	0.06
29	16:29:46	-0.07	16:29:46	0.06
30	16:29:47	-0.06	16:29:47	0.06
31	16:29:48	-0.06	16:29:48	0.06
32	16:29:49	-0.07	16:29:49	0.06
33	16:29:50	-0.05	16:29:50	0.06
34	16:29:51	-0.06	16:29:51	0.06
35	16:29:52	-0.05	16:29:52	0.06

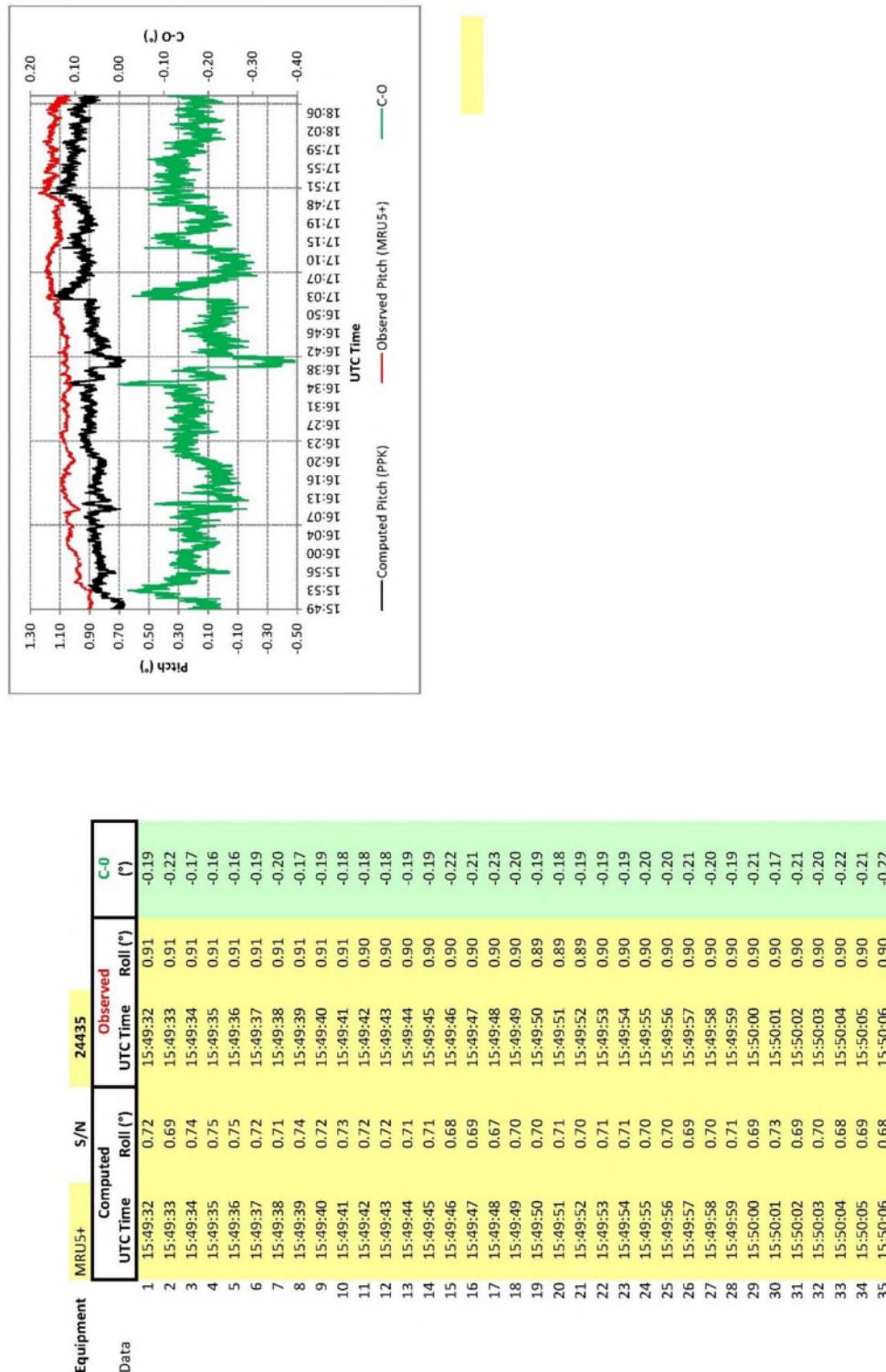


Data Sampling
Period (UTC)
Data Sample

16:29:18	to	18:40:10	Date	24/11/2024
7912				

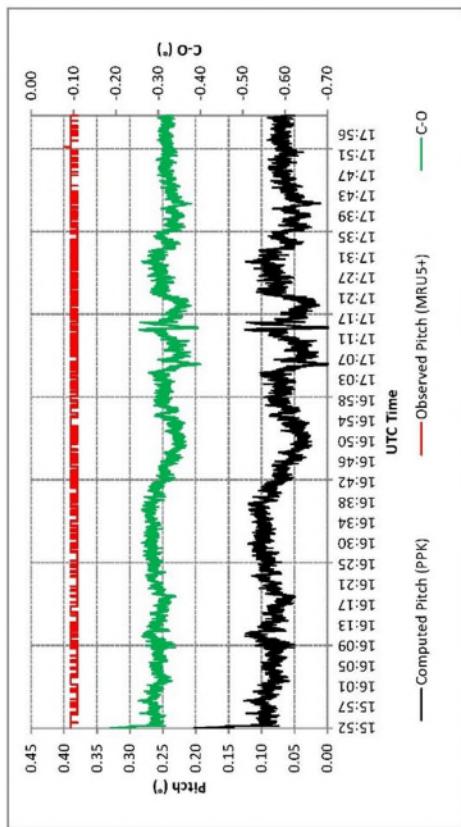


Data Sampling
 Period (UTC) 15:49:32 to 18:09:59 Date 26/11/2024
Data Sample 6153



Data Sampling
Period (UTC) 15:52:57 to 17:59:59 Date 26/11/2024
Data Sample 7460

Equipment	Data type	C-O (°)	S.D. (°)	Min (°)	Max (°)
MRU5+	Pitch	-0.31	0.02	-0.40	-0.19

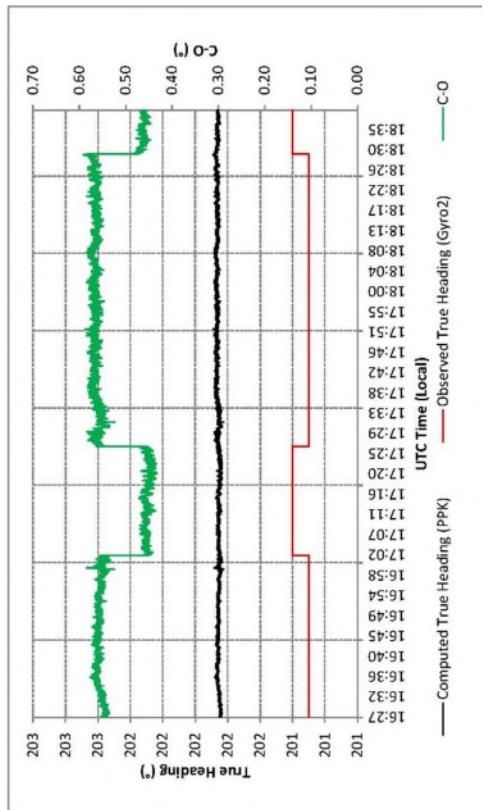


Equipment	MRU5+	S/N		24435		C-O
		Computed	Observed	UTC Time	Pitch (°)	
						— Computed Pitch (PPK)
						— Observed Pitch (MRU5+)
						— C-O
Datald		UTC Time	Pitch (°)	UTC Time	Pitch (°)	
1	15:52:57	0.14	15:52:57	0.39	-0.25	
2	15:52:58	0.17	15:52:58	0.39	-0.22	
3	15:52:59	0.17	15:52:59	0.39	-0.22	
4	15:53:00	0.20	15:53:00	0.39	-0.19	
5	15:53:01	0.19	15:53:01	0.39	-0.20	
6	15:53:02	0.20	15:53:02	0.39	-0.19	
7	15:53:03	0.19	15:53:03	0.39	-0.20	
8	15:53:04	0.18	15:53:04	0.39	-0.21	
9	15:53:05	0.18	15:53:05	0.39	-0.21	
10	15:53:06	0.17	15:53:06	0.39	-0.22	
11	15:53:07	0.16	15:53:07	0.39	-0.23	
12	15:53:08	0.16	15:53:08	0.39	-0.23	
13	15:53:09	0.16	15:53:09	0.39	-0.23	
14	15:53:10	0.16	15:53:10	0.39	-0.23	
15	15:53:11	0.16	15:53:11	0.39	-0.23	
16	15:53:12	0.16	15:53:12	0.39	-0.23	
17	15:53:13	0.16	15:53:13	0.39	-0.23	
18	15:53:14	0.15	15:53:14	0.39	-0.24	
19	15:53:15	0.15	15:53:15	0.39	-0.24	
20	15:53:16	0.15	15:53:16	0.39	-0.24	
21	15:53:17	0.15	15:53:17	0.39	-0.24	
22	15:53:18	0.15	15:53:18	0.39	-0.24	
23	15:53:19	0.15	15:53:19	0.39	-0.24	
24	15:53:20	0.15	15:53:20	0.39	-0.24	
25	15:53:21	0.16	15:53:21	0.39	-0.23	
26	15:53:22	0.11	15:53:22	0.39	-0.28	
27	15:53:23	0.09	15:53:23	0.39	-0.30	
28	15:53:24	0.09	15:53:24	0.39	-0.30	
29	15:53:25	0.07	15:53:25	0.39	-0.32	
30	15:53:26	0.09	15:53:26	0.39	-0.30	
31	15:53:27	0.09	15:53:27	0.39	-0.30	
32	15:53:28	0.11	15:53:28	0.39	-0.28	
33	15:53:29	0.11	15:53:29	0.39	-0.28	
34	15:53:30	0.10	15:53:30	0.39	-0.29	
35	15:53:31	0.09	15:53:31	0.39	-0.30	

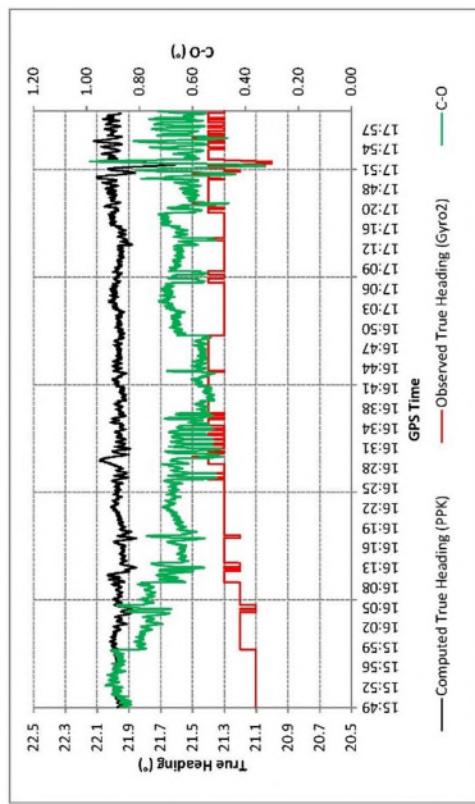
Appendix D

GYROCOMPASS2 HDG

Data Sampling Period (UTC)	16:27:44	to	18:40:10	Date	24/11/2024	
Data Sample	7887					
Equipment	Gyro2	S/N	609327003027	Computed Heading (°T)	Observed Heading (°T)	C-O (°)
DataId	UTC Time	Heading (°T)	UTC Time	Heading (°T)	Heading (°T)	C-O (°)
1	16:27:44	201.85	16:27:44	201.30	0.55	
2	16:27:45	201.84	16:27:45	201.30	0.54	
3	16:27:46	201.85	16:27:46	201.30	0.55	
4	16:27:47	201.84	16:27:47	201.30	0.54	
5	16:27:48	201.85	16:27:48	201.30	0.55	
6	16:27:49	201.84	16:27:49	201.30	0.54	
7	16:27:50	201.84	16:27:50	201.30	0.54	
8	16:27:51	201.84	16:27:51	201.30	0.54	
9	16:27:52	201.85	16:27:52	201.30	0.55	
10	16:27:53	201.85	16:27:53	201.30	0.55	
11	16:27:54	201.85	16:27:54	201.30	0.55	
12	16:27:55	201.85	16:27:55	201.30	0.55	
13	16:27:56	201.85	16:27:56	201.30	0.55	
14	16:27:57	201.84	16:27:57	201.30	0.54	
15	16:27:58	201.85	16:27:58	201.30	0.55	
16	16:27:59	201.85	16:27:59	201.30	0.55	
17	16:28:00	201.84	16:28:00	201.30	0.54	
18	16:28:01	201.85	16:28:01	201.30	0.55	
19	16:28:02	201.85	16:28:02	201.30	0.55	
20	16:28:03	201.85	16:28:03	201.30	0.55	
21	16:28:04	201.85	16:28:04	201.30	0.55	
22	16:28:05	201.85	16:28:05	201.30	0.55	
23	16:28:06	201.85	16:28:06	201.30	0.55	
24	16:28:07	201.84	16:28:07	201.30	0.54	
25	16:28:08	201.84	16:28:08	201.30	0.54	
26	16:28:09	201.84	16:28:09	201.30	0.54	
27	16:28:10	201.85	16:28:10	201.30	0.55	
28	16:28:11	201.84	16:28:11	201.30	0.54	
29	16:28:12	201.84	16:28:12	201.30	0.54	
30	16:28:13	201.84	16:28:13	201.30	0.54	
31	16:28:14	201.85	16:28:14	201.30	0.55	
32	16:28:15	201.84	16:28:15	201.30	0.54	
33	16:28:16	201.84	16:28:16	201.30	0.54	
34	16:28:17	201.84	16:28:17	201.30	0.54	
35	16:28:18	201.85	16:28:18	201.30	0.55	



Data Sampling		15:49:50	to	18:02:26	Date	26/11/2024
Equipment	Gyro2	Period (UTC)	Data Sample	5664		
609527/003027						
Equipment	Gyro2	S/N	Computed	Observed	C-O	
Data	GPS Time	Heading ("T")	GPS Time	Heading ("T")	(°)	
1	15:49:50	21.97	15:49:50	21.10	0.87	
2	15:49:51	21.96	15:49:51	21.10	0.86	
3	15:49:52	21.95	15:49:52	21.10	0.85	
4	15:49:53	21.97	15:49:53	21.10	0.87	
5	15:49:54	21.97	15:49:54	21.10	0.87	
6	15:49:55	21.97	15:49:55	21.10	0.87	
7	15:49:56	21.96	15:49:56	21.10	0.86	
8	15:49:57	21.96	15:49:57	21.10	0.86	
9	15:49:58	21.95	15:49:58	21.10	0.85	
10	15:49:59	21.96	15:49:59	21.10	0.86	
11	15:50:00	21.96	15:50:00	21.10	0.86	
12	15:50:01	21.95	15:50:01	21.10	0.85	
13	15:50:02	21.96	15:50:02	21.10	0.86	
14	15:50:03	21.96	15:50:03	21.10	0.86	
15	15:50:04	21.94	15:50:04	21.10	0.84	
16	15:50:05	21.96	15:50:05	21.10	0.86	
17	15:50:06	21.95	15:50:06	21.10	0.85	
18	15:50:07	21.95	15:50:07	21.10	0.85	
19	15:50:08	21.95	15:50:08	21.10	0.85	
20	15:50:09	21.95	15:50:09	21.10	0.85	
21	15:50:10	21.95	15:50:10	21.10	0.85	
22	15:50:11	21.94	15:50:11	21.10	0.84	
23	15:50:12	21.96	15:50:12	21.10	0.86	
24	15:50:13	21.94	15:50:13	21.10	0.84	
25	15:50:14	21.93	15:50:14	21.10	0.83	
26	15:50:15	21.94	15:50:15	21.10	0.84	
27	15:50:16	21.94	15:50:16	21.10	0.84	
28	15:50:17	21.94	15:50:17	21.10	0.84	
29	15:50:18	21.93	15:50:18	21.10	0.83	
30	15:50:19	21.94	15:50:19	21.10	0.84	
31	15:50:20	21.94	15:50:20	21.10	0.84	
32	15:50:21	21.94	15:50:21	21.10	0.84	
33	15:50:22	21.94	15:50:22	21.10	0.84	
34	15:50:23	21.93	15:50:23	21.10	0.83	
35	15:50:24	21.94	15:50:24	21.10	0.84	

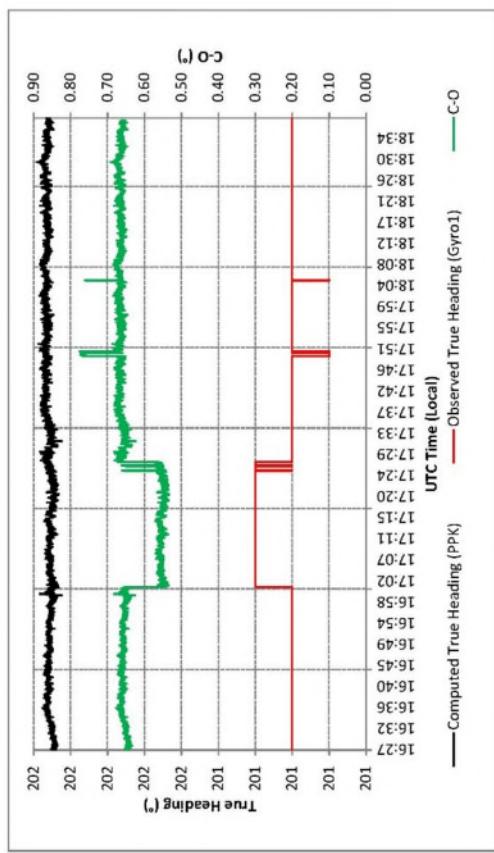


Appendix E

GYROCOMPASS1 HDG

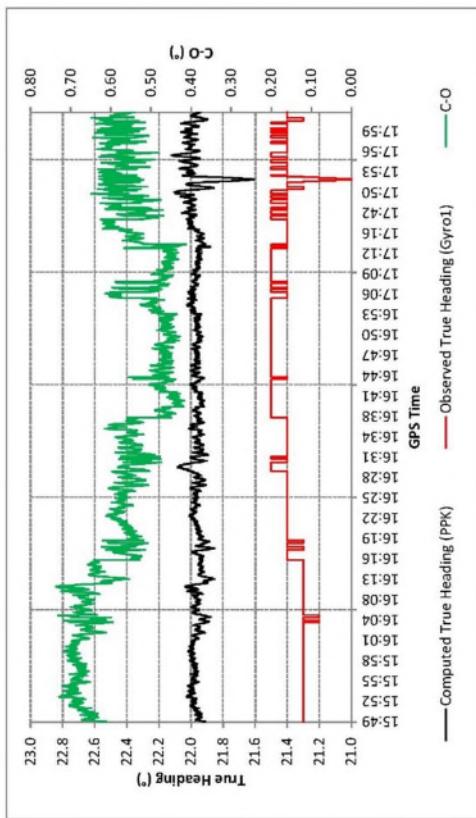
Data Sampling
Period (UTC) 16:27:44
Data Sample 7917

Equipment	Gyro1	Data type	C-O (°)	S.D. (°)	Min (°)	Max (°)
			0.64	0.05	0.53	0.78



Equipment	Gyro1	609527003028			
		S/N	Computed	Observed	C-O
DataId	UTC Time	Heading (°T)	UTC Time	Heading (°T)	(°)
1	16:27:44	201.85	16:27:44	201.20	0.65
2	16:27:45	201.84	16:27:45	201.20	0.64
3	16:27:46	201.85	16:27:46	201.20	0.65
4	16:27:47	201.84	16:27:47	201.20	0.64
5	16:27:48	201.85	16:27:48	201.20	0.65
6	16:27:49	201.84	16:27:49	201.20	0.64
7	16:27:50	201.84	16:27:50	201.20	0.64
8	16:27:51	201.84	16:27:51	201.20	0.64
9	16:27:52	201.85	16:27:52	201.20	0.65
10	16:27:53	201.85	16:27:53	201.20	0.65
11	16:27:54	201.85	16:27:54	201.20	0.65
12	16:27:55	201.85	16:27:55	201.20	0.65
13	16:27:56	201.85	16:27:56	201.20	0.65
14	16:27:57	201.84	16:27:57	201.20	0.64
15	16:27:58	201.85	16:27:58	201.20	0.65
16	16:27:59	201.85	16:27:59	201.20	0.65
17	16:28:00	201.84	16:28:00	201.20	0.64
18	16:28:01	201.85	16:28:01	201.20	0.65
19	16:28:02	201.85	16:28:02	201.20	0.65
20	16:28:03	201.85	16:28:03	201.20	0.65
21	16:28:04	201.85	16:28:04	201.20	0.65
22	16:28:05	201.85	16:28:05	201.20	0.65
23	16:28:06	201.85	16:28:06	201.20	0.65
24	16:28:07	201.84	16:28:07	201.20	0.64
25	16:28:08	201.84	16:28:08	201.20	0.64
26	16:28:09	201.84	16:28:09	201.20	0.64
27	16:28:10	201.85	16:28:10	201.20	0.65
28	16:28:11	201.84	16:28:11	201.20	0.64
29	16:28:12	201.84	16:28:12	201.20	0.64
30	16:28:13	201.84	16:28:13	201.20	0.64
31	16:28:14	201.85	16:28:14	201.20	0.65
32	16:28:15	201.84	16:28:15	201.20	0.64
33	16:28:16	201.84	16:28:16	201.20	0.64
34	16:28:17	201.84	16:28:17	201.20	0.64
35	16:28:18	201.85	16:28:18	201.20	0.65

Data Sampling Period (UTC)	15:49:50	to	18:02:44	Date	26/11/2024
Equipment Gyro1	S/N	609527003028			
	Computed UTC Time	Heading (°T)	Observed UTC Time	Heading (°T)	C-O (°)
1	15:49:50	21.92	15:49:50	21.30	0.62
2	15:49:51	21.92	15:49:51	21.30	0.62
3	15:49:52	21.92	15:49:52	21.30	0.62
4	15:49:53	21.92	15:49:53	21.30	0.62
5	15:49:54	21.91	15:49:54	21.30	0.61
6	15:49:55	21.92	15:49:55	21.30	0.62
7	15:49:56	21.93	15:49:56	21.30	0.63
8	15:49:57	21.93	15:49:57	21.30	0.63
9	15:49:58	21.91	15:49:58	21.30	0.61
10	15:49:59	21.92	15:49:59	21.30	0.62
11	15:50:00	21.93	15:50:00	21.30	0.63
12	15:50:01	21.94	15:50:01	21.30	0.64
13	15:50:02	21.94	15:50:02	21.30	0.64
14	15:50:03	21.94	15:50:03	21.30	0.64
15	15:50:04	21.94	15:50:04	21.30	0.64
16	15:50:05	21.95	15:50:05	21.30	0.65
17	15:50:06	21.96	15:50:06	21.30	0.66
18	15:50:07	21.95	15:50:07	21.30	0.65
19	15:50:08	21.97	15:50:08	21.30	0.67
20	15:50:09	21.96	15:50:09	21.30	0.66
21	15:50:10	21.95	15:50:10	21.30	0.65
22	15:50:11	21.97	15:50:11	21.30	0.67
23	15:50:12	21.97	15:50:12	21.30	0.67
24	15:50:13	21.97	15:50:13	21.30	0.67
25	15:50:14	21.96	15:50:14	21.30	0.66
26	15:50:15	21.96	15:50:15	21.30	0.66
27	15:50:16	21.95	15:50:16	21.30	0.65
28	15:50:17	21.96	15:50:17	21.30	0.66
29	15:50:18	21.96	15:50:18	21.30	0.66
30	15:50:19	21.95	15:50:19	21.30	0.65
31	15:50:20	21.96	15:50:20	21.30	0.66
32	15:50:21	21.96	15:50:21	21.30	0.66
33	15:50:22	21.94	15:50:22	21.30	0.64
34	15:50:23	21.96	15:50:23	21.30	0.66
35	15:50:24	21.95	15:50:24	21.30	0.65



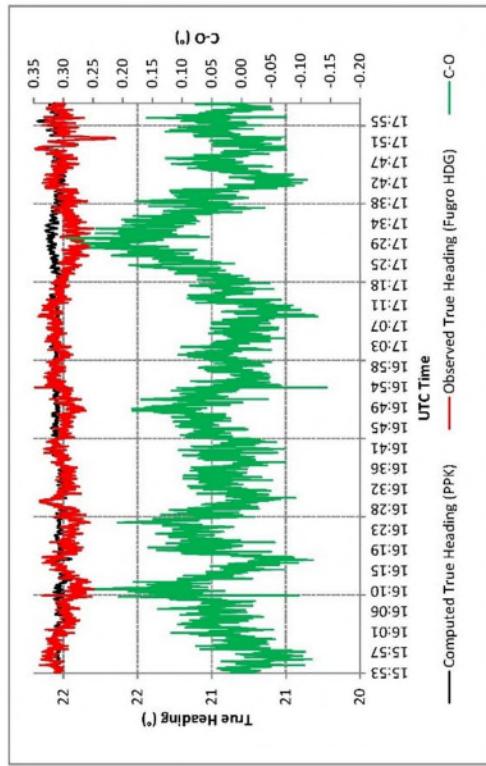
Appendix F

FUGRO HDG

Data Sampling
Period (UTC)
Data Sample
15:53:15
7297

to
17:59:59
Date
26/11/2024

Equipment	Data type	C-O (°)	S.D. (°)	Min (°)	Max (°)
Fugro Hdg	Yaw	0.04	0.06	-0.14	0.29

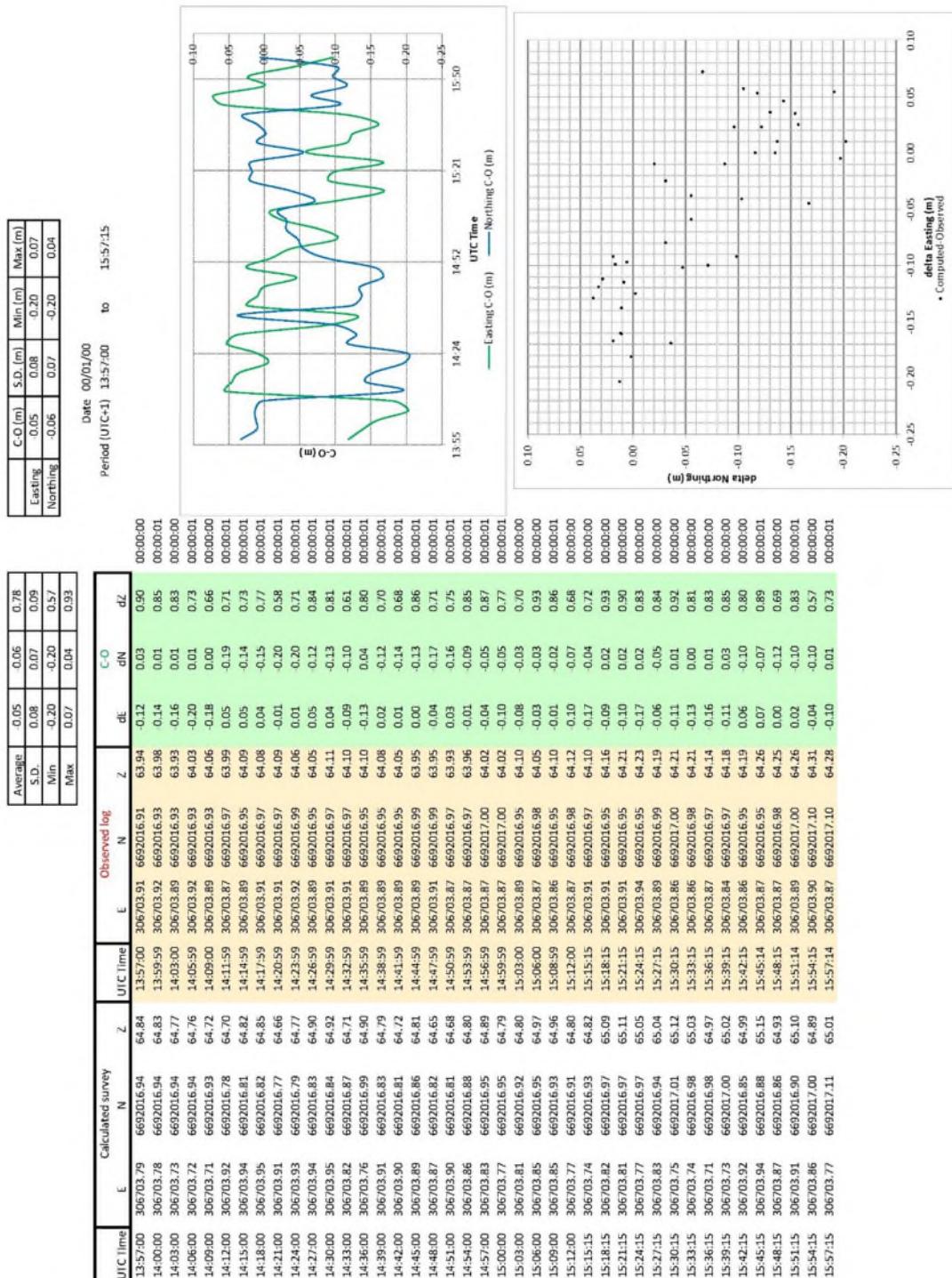


Equipment	S/N 5313K92908			
	Computed UTC Time	Observed UTC Time	Heading [°]	C-O [°]
1	15:53:15	22.03	15:53:15	22.05
2	15:53:16	22.03	15:53:16	-0.02
3	15:53:17	22.04	15:53:17	-0.02
4	15:53:18	22.03	15:53:18	0.02
5	15:53:19	22.04	15:53:19	-0.02
6	15:53:20	22.04	15:53:20	-0.01
7	15:53:21	22.04	15:53:21	0.01
8	15:53:22	22.05	15:53:22	0.02
9	15:53:23	22.05	15:53:23	0.00
10	15:53:24	22.05	15:53:24	0.01
11	15:53:25	22.05	15:53:25	0.01
12	15:53:26	22.04	15:53:26	0.00
13	15:53:27	22.04	15:53:27	-0.02
14	15:53:28	22.04	15:53:28	22.06
15	15:53:29	22.04	15:53:29	-0.02
16	15:53:30	22.04	15:53:30	0.02
17	15:53:31	22.04	15:53:31	0.01
18	15:53:32	22.03	15:53:32	0.00
19	15:53:33	22.03	15:53:33	0.00
20	15:53:34	22.03	15:53:34	0.00
21	15:53:35	22.03	15:53:35	-0.01
22	15:53:36	22.03	15:53:36	-0.02
23	15:53:37	22.02	15:53:37	-0.03
24	15:53:38	22.02	15:53:38	-0.02
25	15:53:39	22.03	15:53:39	-0.02
26	15:53:40	22.02	15:53:40	-0.03
27	15:53:41	22.02	15:53:41	0.00
28	15:53:42	22.02	15:53:42	0.00
29	15:53:43	22.02	15:53:43	-0.01
30	15:53:44	22.03	15:53:44	0.00
31	15:53:45	22.02	15:53:45	-0.03
32	15:53:46	22.02	15:53:46	-0.03
33	15:53:47	22.02	15:53:47	0.00
34	15:53:48	22.02	15:53:48	0.00
35	15:53:49	22.03	15:53:49	0.03

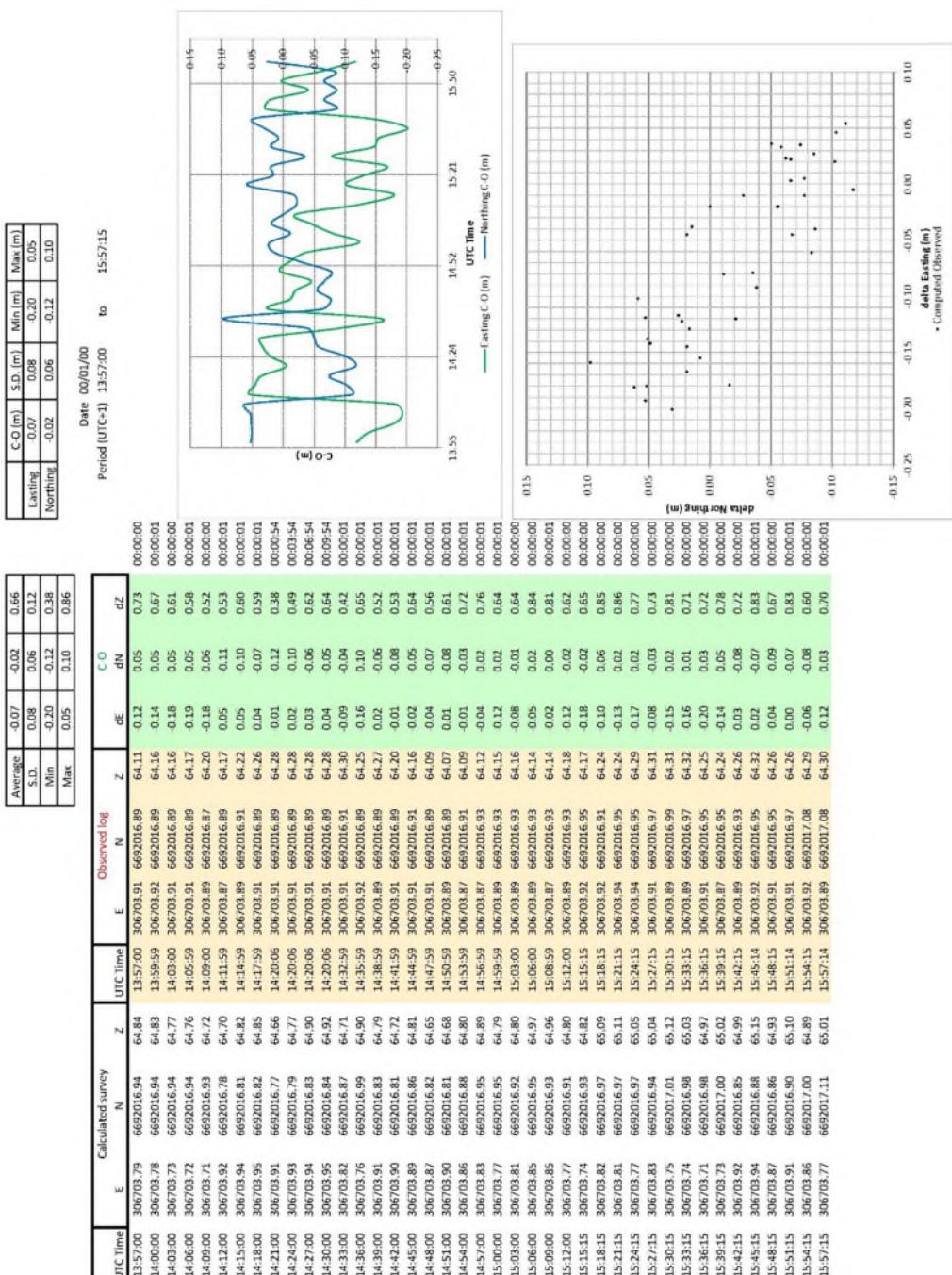
Appendix G

GNSS Health Check

G.1 Starpack Antenne3 XP3

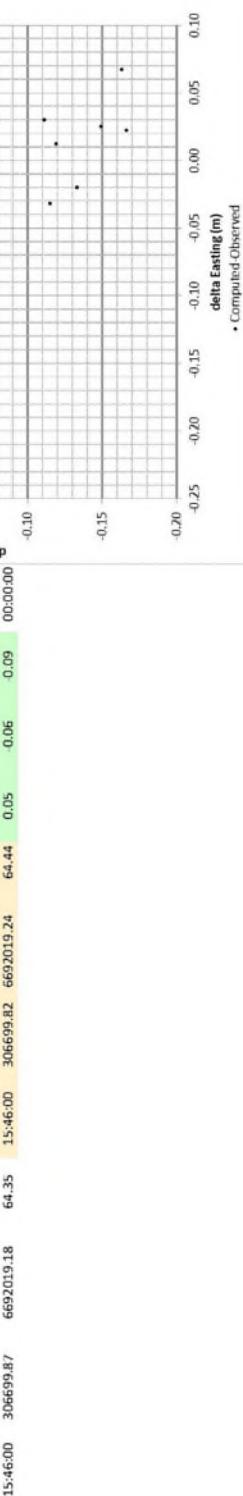


G.2 Starpack Antenne3 G4

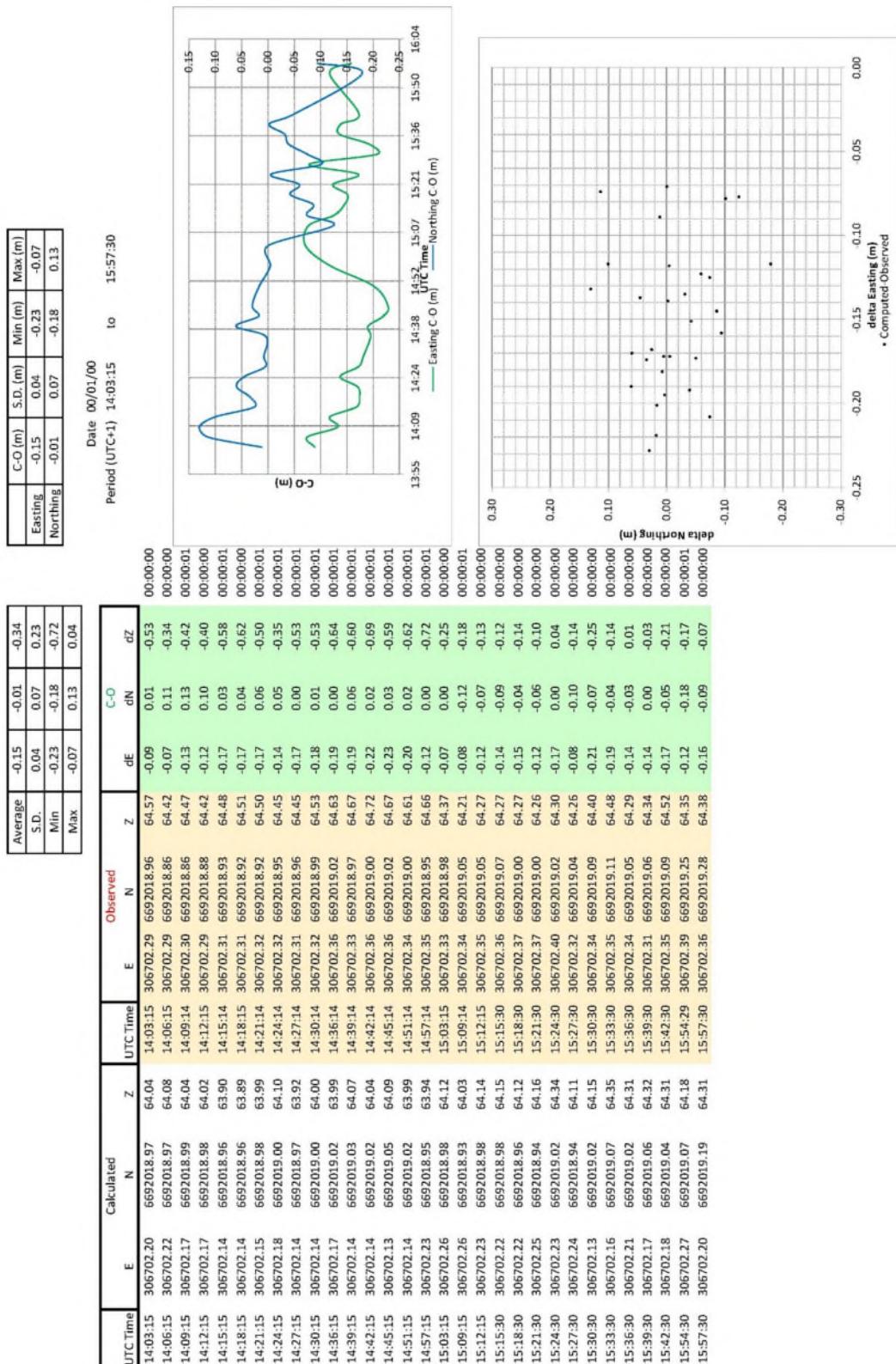


G.3 Septentrio Antenna2

	Calculated survey			Observed log			$C-O$		
UTC Time	E	N	Z	UTC Time	E	N	ΔE	ΔN	ΔZ
13:57:45	306699.76	6692019.20	63.98	13:57:45	306699.90	6692019.24	64.13	0.14	0.04
14:00:45	306699.67	6692019.23	63.94	14:00:45	306699.89	6692019.24	64.16	-0.22	-0.01
14:03:45	306699.69	6692019.24	64.05	14:03:45	306699.87	6692019.22	64.17	-0.18	0.02
14:06:45	306699.70	6692019.24	64.07	14:06:45	306699.87	6692019.24	64.15	-0.17	0.00
14:09:45	306699.68	6692019.24	64.04	14:09:45	306699.86	6692019.22	64.13	-0.18	0.02
14:12:45	306699.70	6692019.23	64.04	14:12:45	306699.86	6692019.22	64.15	-0.16	0.01
14:15:45	306699.68	6692019.29	64.17	14:15:45	306699.86	6692019.25	64.17	0.18	0.03
14:18:45	306699.69	6692019.27	64.14	14:18:45	306699.86	6692019.24	64.18	0.17	0.03
14:21:45	306699.68	6692019.25	64.03	14:21:45	306699.86	6692019.24	64.20	-0.18	0.01
14:24:45	306699.71	6692019.27	64.13	14:24:45	306699.87	6692019.28	64.19	-0.16	0.01
14:30:45	306699.63	6692019.26	63.98	14:30:45	306699.81	6692019.28	64.24	-0.18	-0.02
14:33:45	6692019.15	64.00	14:33:44	306699.84	6692019.26	64.31	-0.03	-0.12	0.31
14:36:45	306699.89	6692019.17	64.03	14:36:45	306699.86	6692019.32	64.24	0.02	-0.15
14:39:45	306699.87	6692019.13	64.09	14:39:44	306699.86	6692019.24	64.25	0.03	-0.16
14:42:45	306699.85	6692019.12	64.03	14:42:45	306699.84	6692019.24	64.26	0.01	-0.23
14:45:45	306699.85	6692019.14	64.05	14:45:44	306699.81	6692019.22	64.17	0.03	-0.13
14:48:45	306699.84	6692019.11	63.96	14:48:44	306699.82	6692019.28	64.14	-0.02	-0.17
14:51:45	306699.86	6692019.12	63.99	14:51:44	306699.79	6692019.28	64.11	0.07	-0.16
14:54:45	306699.79	6692019.15	63.93	14:54:44	306699.82	6692019.28	64.14	-0.02	-0.13
14:57:45	306699.71	6692019.24	63.97	14:57:44	306699.86	6692019.30	64.16	-0.11	-0.07
15:00:45	306699.77	6692019.25	64.15	15:00:44	306699.82	6692019.30	64.16	-0.05	-0.05
15:03:45	306699.77	6692019.24	64.13	15:03:45	306699.84	6692019.28	64.22	-0.07	-0.05
15:06:45	306699.84	6692019.20	64.07	15:06:45	306699.82	6692019.25	64.20	-0.05	-0.09
15:09:45	306699.77	6692019.19	64.06	15:09:45	306699.82	6692019.26	64.22	-0.05	-0.16
15:12:45	306699.69	6692019.29	64.22	15:12:45	306699.86	6692019.25	64.28	-0.17	0.03
15:16:00	306699.71	6692019.26	64.19	15:16:00	306699.86	6692019.26	64.29	-0.15	0.00
15:19:00	306699.73	6692019.23	64.17	15:19:00	306699.86	6692019.26	64.36	-0.13	-0.03
15:22:00	306699.73	6692019.22	64.19	15:22:00	306699.84	6692019.26	64.38	-0.11	-0.04
15:25:00	306699.79	6692019.24	64.30	15:25:00	306699.87	6692019.25	64.44	-0.08	0.03
15:28:00	306699.75	6692019.28	64.39	15:28:00	306699.79	6692019.30	64.49	-0.04	-0.02
15:31:00	306699.72	6692019.30	64.38	15:31:00	306699.82	6692019.32	64.51	-0.10	-0.02
15:34:00	306699.68	6692019.30	64.30	15:34:00	306699.82	6692019.32	64.48	-0.14	-0.02
15:37:00	306699.73	6692019.28	64.31	15:37:00	306699.87	6692019.28	64.48	-0.14	0.00
15:40:00	306699.64	6692019.30	64.22	15:40:00	306699.82	6692019.26	64.43	-0.18	0.04
15:43:00	306699.69	6692019.32	64.38	15:43:00	306699.79	6692019.25	64.42	-0.10	0.06
15:46:00	306699.67	6692019.18	64.35	15:46:00	306699.82	6692019.24	64.44	0.05	-0.06



G.4 Trinav GPS1 antenna



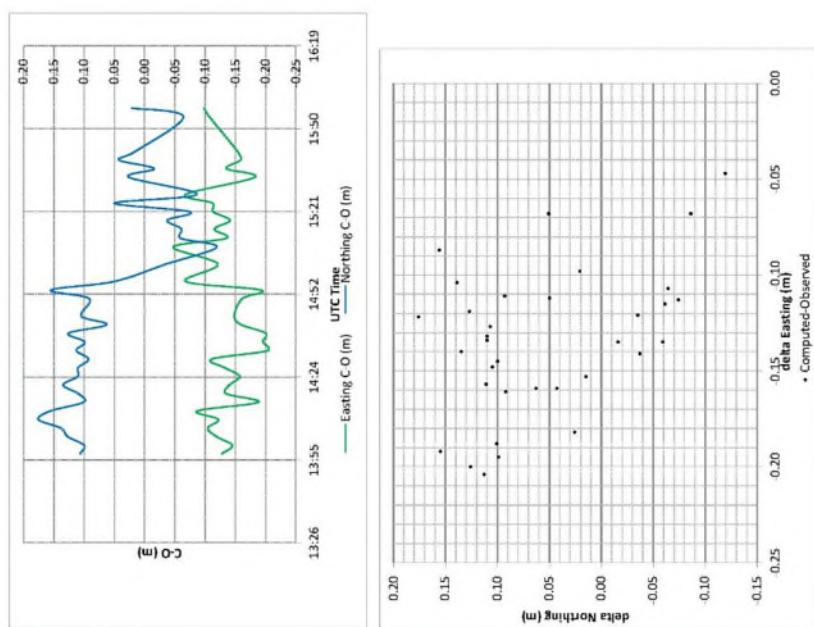
G.5 Trinav GPS2 antenna

Average	-0.13	0.06	-0.14
S.D.	0.04	0.08	0.28
Min	-0.20	-0.12	-0.55
Max	-0.05	0.18	0.36

Period (UTC+1) 13:57:15 to 15:57:30
Date 00/01/00

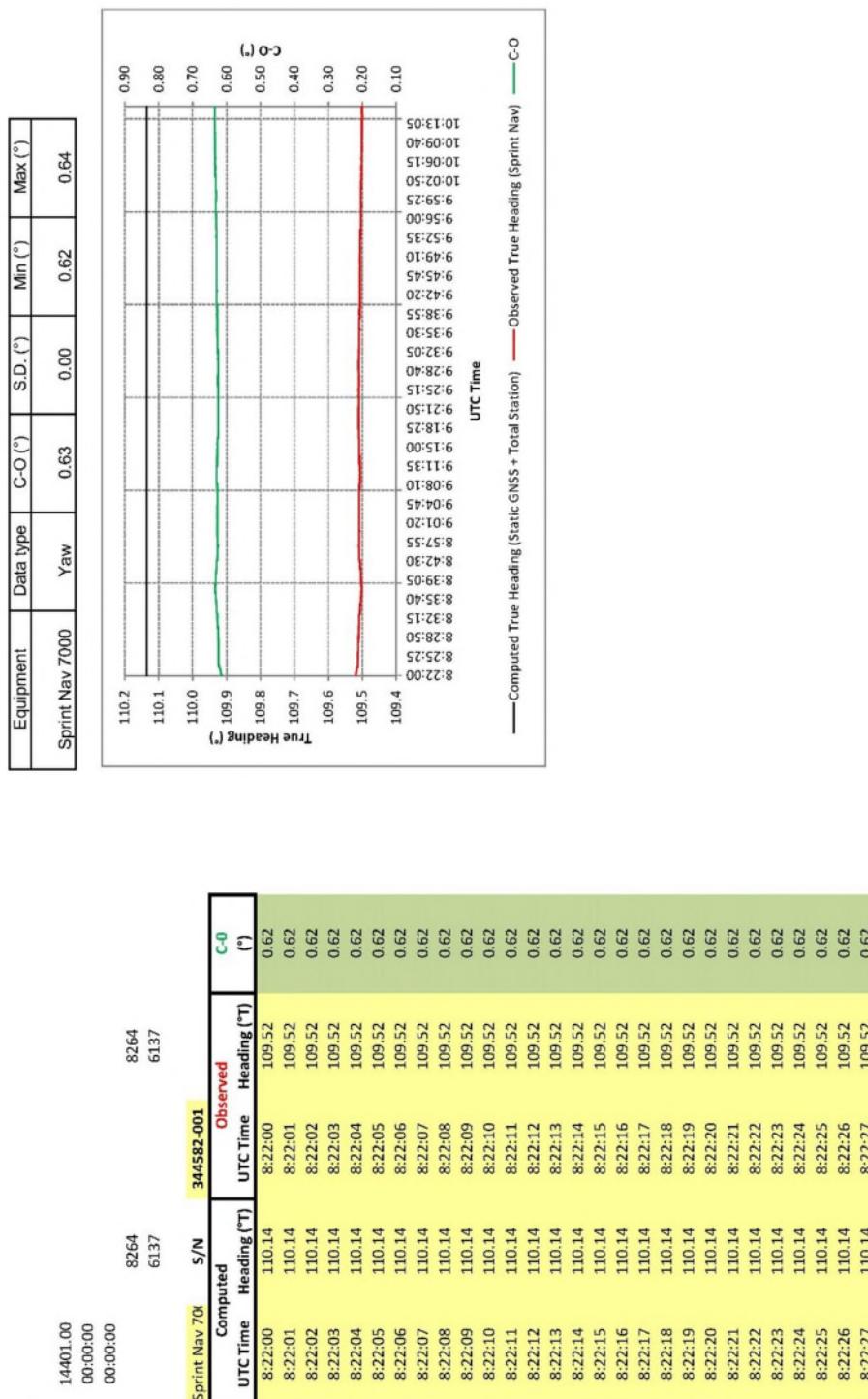
UTC Time Calculated N UTC Time Observed N C-O

UTC Time	Calculated N	UTC Time	Observed N	C-O
13:57:15	306702.37	6692019.29	63.91	13:57:15
14:00:15	306702.34	6692019.30	63.88	14:00:15
14:03:15	306702.35	6692019.33	64.02	14:03:15
14:06:15	306702.37	6692019.33	64.05	14:06:15
14:09:15	306702.32	6692019.35	64.02	14:09:14
14:12:15	306702.32	6692019.34	64.00	14:12:15
14:15:15	306702.29	6692019.31	63.88	14:15:14
14:18:15	306702.29	6692019.31	63.87	14:18:15
14:21:15	306702.30	6692019.34	63.97	14:21:14
14:24:15	306702.33	6692019.35	64.08	14:24:14
14:27:15	306702.29	6692019.32	63.90	14:27:14
14:30:15	306702.29	6692019.35	63.98	14:30:14
14:33:15	306702.23	6692019.41	63.99	14:33:14
14:36:15	306702.32	6692019.38	63.97	14:36:14
14:39:15	306702.29	6692019.39	64.05	14:39:14
14:42:15	306702.29	6692019.37	64.02	14:42:14
14:45:15	306702.28	6692019.41	64.07	14:45:14
14:51:15	306702.29	6692019.37	63.97	14:51:14
14:54:15	306702.21	6692019.39	63.84	14:54:14
14:57:15	306702.38	6692019.30	63.92	14:57:14
15:03:15	306702.41	6692019.24	64.10	15:03:15
15:09:15	306702.41	6692019.28	64.01	15:09:14
15:12:15	306702.38	6692019.33	64.12	15:12:15
15:15:30	306702.37	6692019.34	64.13	15:15:30
15:18:30	306702.37	6692019.31	64.10	15:18:30
15:21:30	306702.40	6692019.30	64.14	15:21:30
15:24:30	306702.38	6692019.37	64.32	15:24:30
15:27:30	306702.39	6692019.29	64.09	15:27:30
15:33:30	306702.31	6692019.43	64.33	15:33:30
15:36:30	306702.36	6692019.37	64.29	15:36:30
15:39:30	306702.32	6692019.41	64.30	15:39:30
15:42:30	306702.33	6692019.40	64.29	15:42:30
15:45:30	306702.42	6692019.43	64.16	15:54:29
15:57:30	306702.35	6692019.54	64.29	15:56:29



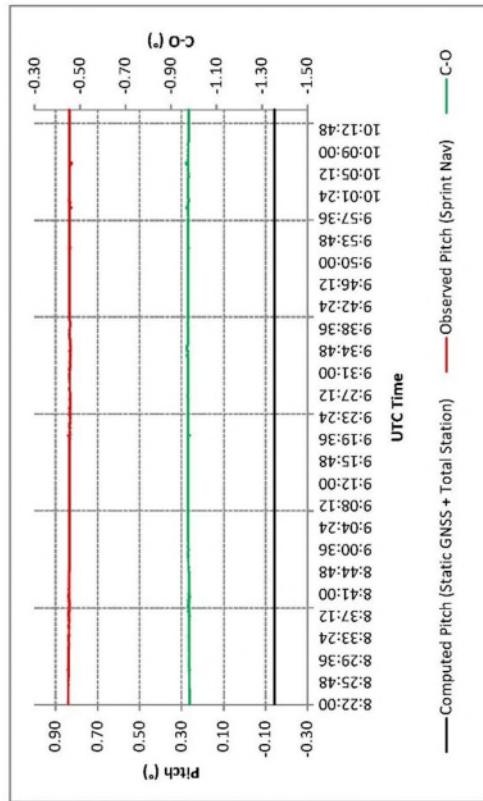
Appendix H

HD64 Gyrocompass

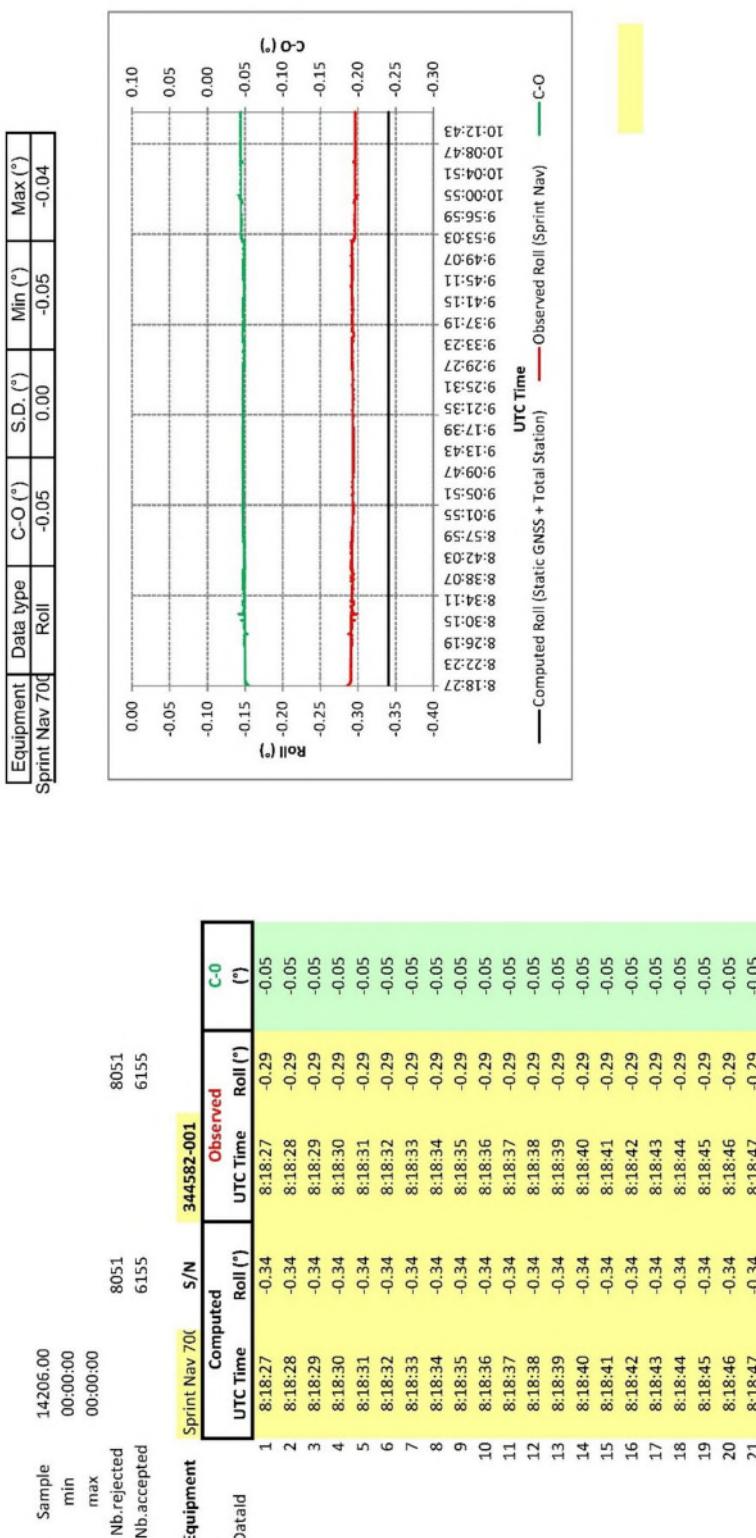


Sprint Nav 7000				S/N	344582-001
Computed	Observed	UTC Time	Heading (°)	UTC Time	Heading (°)
8:22:00	110.14	8:22:00	109.52	109.4	109.52
8:22:01	110.14	8:22:01	109.52		0.62
8:22:02	110.14	8:22:02	109.52		0.62
8:22:03	110.14	8:22:03	109.52		0.62
8:22:04	110.14	8:22:04	109.52		0.62
8:22:05	110.14	8:22:05	109.52		0.62
8:22:06	110.14	8:22:06	109.52		0.62
8:22:07	110.14	8:22:07	109.52		0.62
8:22:08	110.14	8:22:08	109.52		0.62
8:22:09	110.14	8:22:09	109.52		0.62
8:22:10	110.14	8:22:10	109.52		0.62
8:22:11	110.14	8:22:11	109.52		0.62
8:22:12	110.14	8:22:12	109.52		0.62
8:22:13	110.14	8:22:13	109.52		0.62
8:22:14	110.14	8:22:14	109.52		0.62
8:22:15	110.14	8:22:15	109.52		0.62
8:22:16	110.14	8:22:16	109.52		0.62
8:22:17	110.14	8:22:17	109.52		0.62
8:22:18	110.14	8:22:18	109.52		0.62
8:22:19	110.14	8:22:19	109.52		0.62
8:22:20	110.14	8:22:20	109.52		0.62
8:22:21	110.14	8:22:21	109.52		0.62
8:22:22	110.14	8:22:22	109.52		0.62
8:22:23	110.14	8:22:23	109.52		0.62
8:22:24	110.14	8:22:24	109.52		0.62
8:22:25	110.14	8:22:25	109.52		0.62
8:22:26	110.14	8:22:26	109.52		0.62
8:22:27	110.14	8:22:27	109.52		0.62

Equipment	Data type	C-O (°)	S.D. (°)	Min (°)	Max (°)
Sprint Nav 700	Pitch	-0.98	0.00	-0.98	-0.96
Sample	14401.00				
min	00:00:00				
max	00:00:00				
Nb.rejected					
Nb.accepted					



Equipment	S/N 344582-001		
	Computed UTC Time	Observed UTC Time	C-O UTC Time
1	8:22:00	-0.14	8:22:00
2	8:22:01	-0.14	8:22:01
3	8:22:02	-0.14	8:22:02
4	8:22:03	-0.14	8:22:03
5	8:22:04	-0.14	8:22:04
6	8:22:05	-0.14	8:22:05
7	8:22:06	-0.14	8:22:06
8	8:22:07	-0.14	8:22:07
9	8:22:08	-0.14	8:22:08
10	8:22:09	-0.14	8:22:09
11	8:22:10	-0.14	8:22:10
12	8:22:11	-0.14	8:22:11
13	8:22:12	-0.14	8:22:12
14	8:22:13	-0.14	8:22:13
15	8:22:14	-0.14	8:22:14
16	8:22:15	-0.14	8:22:15
17	8:22:16	-0.14	8:22:16
18	8:22:17	-0.14	8:22:17
19	8:22:18	-0.14	8:22:18
20	8:22:19	-0.14	8:22:19
21	8:22:20	-0.14	8:22:20
22	8:22:21	-0.14	8:22:21
23	8:22:22	-0.14	8:22:22
24	8:22:23	-0.14	8:22:23
25	8:22:24	-0.14	8:22:24
26	8:22:25	-0.14	8:22:25



Appendix I

HD65 Gyrocompass

