R/V *Sally Ride*

EM124 & EM712 QAT
January 25-28, 2025
SR2501

Multibeam Advisory Committee

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Supported under NSF grants 1933720 (UNH) and 1933776 (LDEO)

photo: SIO

Executive Summary

1. R/V *Sally Ride* (SR) conducted routing quality assurance testing (QAT) for its EM124 and EM712 multibeam mapping systems at proven test sites off San Diego, CA, upon completion of its winter maintenance period
2. The Multibeam Advisory Committee (MAC) assisted with test planning, configuration review, data collection, and processing in collaboration with SIO and SR personnel
3. Notable changes since the 2024 EM124 and EM712 QAT / Seapath 380-R3 SAT include:
    a. The Seapath MRU 5+ (used for secondary navigation data to both EM systems) was calibrated at the factory and reinstalled in its bracket during this maintenance period
    b. SIS was updated to v5.14.0 ahead of the SAT for both EM systems, with associated changes to Sound Speed Manager (v2025.0.1) in order to use the new #SSM datagram functionality (see later notes)
4. During dockside sensor geometry review, a small error was found in the 2024 Westlake survey report and associated Seapath 380-R3 configuration for primary (stbd / aft) antenna height; a new value was provided by Westlake and applied prior to antenna calibrations on 2025-01-24 (see System Geometry Review for more info)
5. All Seapath antenna locations were adjusted to the L1 phase centers, following 2024 MAC report recommendations and pre-calibration discussions with Westlake; both Seapath antenna baselines were configured with the 2025-01-24 calibration results, which agreed with recent calibrations performed by SIO

Executive Summary

6. Another starboard / aft antenna height correction was identified after the QAT and Westlake released Rev. 1 with these updates on 2025-02-24; the L1 value should be applied only during the next QAT or calibration
7. QAT activities followed the standard MAC SAT/QAT checklist, focusing on:
    a. Configuration review and hardware health testing
    b. Calibrations (‘patch tests’) for both EM systems with both Seapath 380s
    c. RX noise level vs. speed testing
    d. Swath coverage testing
8. The EM124 and EM712 calibration adjustments were small for both Seapath systems, indicating stable system geometry since SR2401 and consistent / repeatable reinstallation of the MRU 5+
9. Built-In Self-Tests (BISTs) conducted throughout SR2501 indicate some new low-Z trends in TX Channels that should be monitored; RX Channels appeared normal and stable from previous years
10. RX noise vs. speed testing confirmed low noise levels for both systems; for the EM124, these tests agree well with ‘normal’ levels from 2021 and 2024, confirming no new noise issues after the latest maintenance period
11. Swath coverage testing was conducted opportunistically on transits and showed expected coverage trends for both systems over the limited depth range (~150-1950 m); additional coverage testing is recommended over a wider range of depths, and the MAC is available to help plan test lines during upcoming transits

Executive Summary

12. Both EM systems experienced frequent SIS crashes that impacted the QAT activities throughout SR2501; Kongsberg has corrected this issue (related to new SSM communications) for the next version of SIS
13. In the meantime, SIS 5.14.0 users should revert to the pre-QAT SSM communication setup and/or apply the patch available from Kongsberg
14. The current settings should be maintained until any mapping sensors are modified or another calibration becomes necessary for other reasons

Survey System Components

The primary mapping system components are:

1. Kongsberg Maritime EM124 multibeam echosounder (12 kHz, 1.0° TX x 2.0° RX), s/n 10027
2. Kongsberg Maritime EM712 multibeam echosounder (40-100 kHz, 0.5° TX x 1.0° RX), s/n 10003
3. Kongsberg Maritime Seafloor Information System (SIS), v5.14
4. Kongsberg Seapath 380-R3 navigation system (primary)
   a. NovAtel GNSS-850 antennas
   b. Kongsberg Seapath MGC-R3
5. Kongsberg Seapath 380-5+ navigation system (secondary)
   a. NovAtel GNSS-850 antennas
   b. Kongsberg Seapath MRU 5+
6. Valeport surface sound speed sensor
7. Turo Quoll XBT sound speed profiling system
8. Seabird SBE 9 CTD profiling system

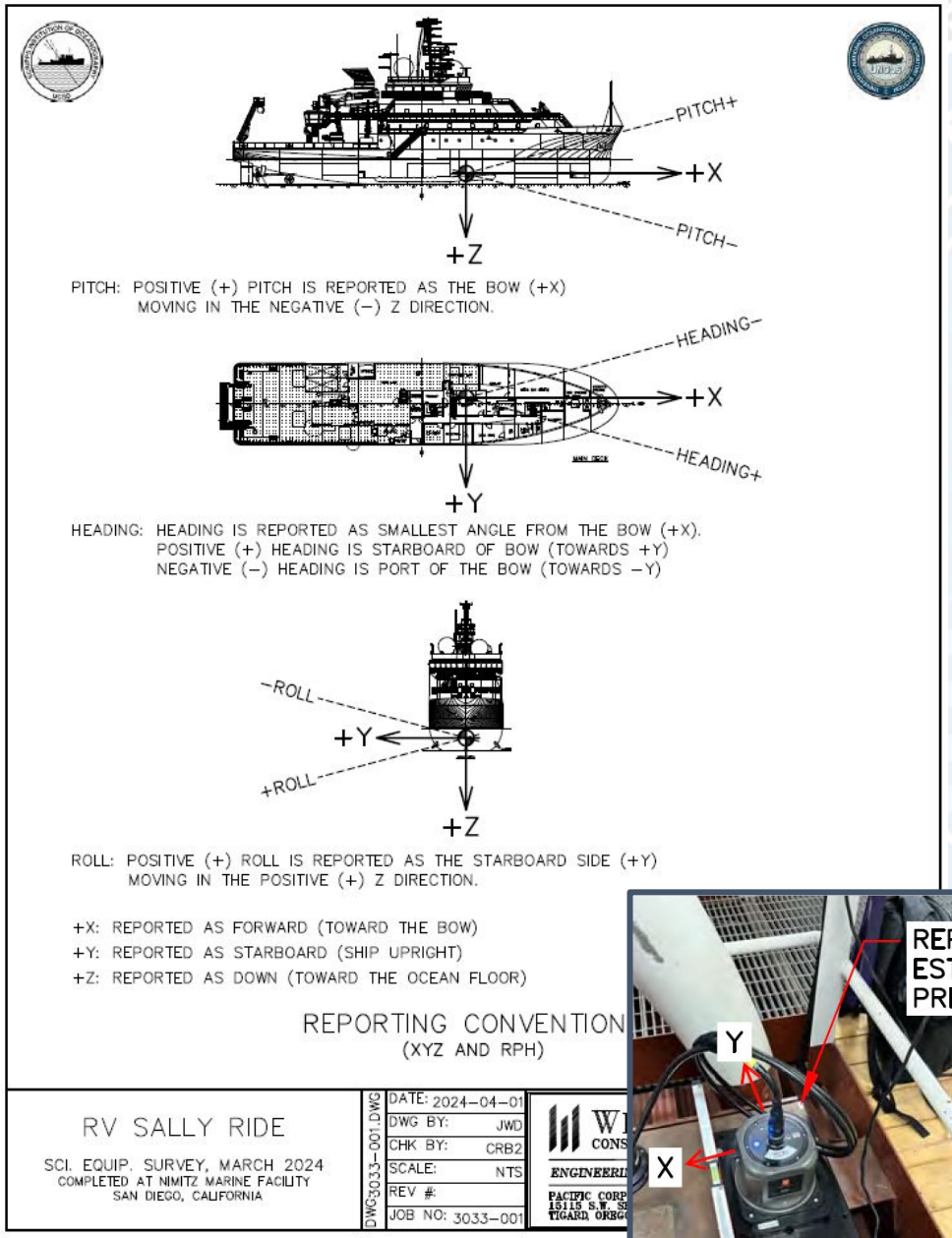
System Geometry Review

Overview: History

The term ‘system geometry’ means the linear and angular offsets of the primary components of the multibeam mapping systems, including the transmit arrays (TX), receive arrays (RX), GNSS antennas, and motion sensors (MGC/MRU). The following table provides an overview of the system geometry history.

Date	Location	Event	References
2016-04-05 to 2016-05-06	Anacortes, WA	IMTEC survey to establish vessel reference frame and offsets of EM122/EM712 arrays, Seapath MRU, iXBlue MRU, and GNSS antennas; offsets reported in Kongsberg convention with origin at top/stbd/aft corner of reference plate (note: not granite block); this survey used the granite block as the baseline (note: some differences in 2021 survey due to change of baseline)	IMTEC survey report provided by R/V *Sally Ride* (see SR1601 QAT report)
2016-07-25 to 2016-07-28	Anacortes, WA	SR1601 quality assurance testing; calibration of EM122 and EM712 with Seapath primary position/attitude system	SR1601 QAT report
2021-05-12 to 2021-05-27	Alameda, CA	IMTEC survey to re-establish vessel reference frame with keel as baseline and existing EM122/EM712 arrays, new SBP29 TX array, Seapath MRU, HYDRINS MRU, and GNSS antennas; offsets reported in Kongsberg convention with origin at top/stbd/aft corner of reference plate; *note same origin as 2016 survey but different baseline for vessel fit, resulting in some differences of up to ~10 cm in reported offsets between 2016 and 2021 reports*	IMTEC survey report (Rev. 2) provided by R/V Sally Ride
2021-06-27 to 2021-07-07	Alameda to San Diego, CA	EM124 SAT (topside upgrade from EM122) and EM712 QAT; system geometry review, Seapath antenna calibration dockside, EM124 / EM712 patch tests, coverage testing, and accuracy assessments; EM124 baseline hardware health and noise testing; SBP29 SAT (not reported here)	SR2104 SAT report
2023-04-05 to 2023-04-06	San Diego, CA	Configuration review; EM124 and EM712 calibration (‘patch test’)	S2307 QAT report
2024-Jan to Mar	Alameda and San Diego, CA	New MGC-R3 and NovAtel GNSS-850 antennas installed; HYDRINS removed; Westlake surveys of MGC and two sets of Seapath antennas; table of preliminary results reported in IMTEC 2021 reference frame (origin on corner or MRU mounting plate) and applied for all QAT configurations	3033-001 UCSD Scripps RV SALLY RIDE GNSS Seapath antenna and MGC r2 2024-03-20.xlsx
2024-04-03 to 2024-04-05	San Diego	Seapath configuration updates based on Westlake prelim table; EM124 and EM712 calibrations and verifications with Seapath 380-R3 as primary and Seapath 380-5+ as secondary navigation sources	SR2401 QAT report
2025-01-25 to 2025-01-28	San Diego	Seapath antenna height updates to L1 phase centers based on Westlake final report, 2024 MAC report, and new Seapath antenna baseline calibrations; EM124 and EM712 calibrations with Seapath 380-R3 and Seapath 380-5+	This document
2025-02-24	San Diego	Updated final starboard/aft Seapath GNSS antenna heights (survey point #8127) after discussion during 2025 QAT	3033-001(0) UCSD Scripps RV SALLY RIDE FINAL survey REPORT r1 2025-02-24

System Geometry Review



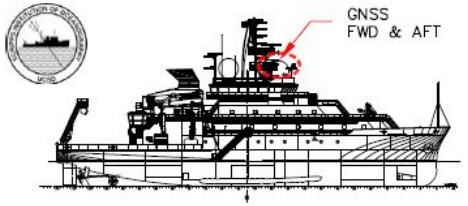
Mapping Reference Frame

1. The mapping system reference frame and surveys follow the Kongsberg axis/sign conventions; see 2021-24 MAC reports for more information
2. **Origin** is the **aft/starboard/top corner of the steel MRU plate**
3. **Linear offsets** are reported in meters in a 'right-handed' system
   a. **+X** forward (**agrees** with Kongsberg/Seapath)
   b. **+Y** starboard (**agrees** with Kongsberg/Seapath)
   c. **+Z** down (**agrees** with Kongsberg/Seapath)
4. **Angular offsets** are reported in decimal degrees
   a. **+Roll** with port side up (**agrees** with Kongsberg/Seapath)
   b. **+Pitch** with bow up (**agrees** with Kongsberg/Seapath)
   c. **+Heading** with bow rotation to starboard (**agrees** with compass convention and Kongsberg/Seapath)

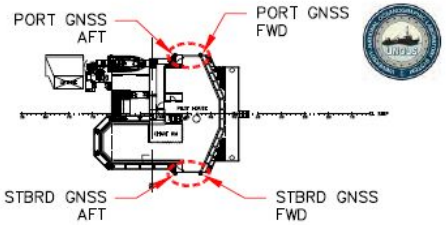
System Geometry Review

1. Seapath antenna pairs are NovAtel GNSS-850 units installed in alongship orientations with the aft antenna as primary
   a. Seapath 380-R3 currently uses the starboard pair
   b. Seapath 380-5+ currently uses the port pair
2. In 2024, Westlake used the NovAtel antenna specification to adjust the surveyed heights to the L1 phase centers (as expected for Seapath configuration); the Westlake antenna results were used directly for configuration and baseline calibration at that time
3. The 2025 offset review revealed a small error for the stbd / aft antenna Z at the phase center (new Z received after the 2024 QAT)
4. Two new Z values (in yellow at right) were provided by Westlake on 2025-01-24; the updated L1 value was used for the Seapath 380-R3 primary antenna for the 2025 QAT configuration and calibration
5. Antenna baseline calibrations were performed dockside in San Diego and applied ahead of the QAT; although small differences were noted from the survey results, these baseline results were consistent with two recent calibrations and the decision was made by MAC and SIO to apply them in lieu of Westlake values for the secondary antennas

Pre-QAT Antenna Lever Arms

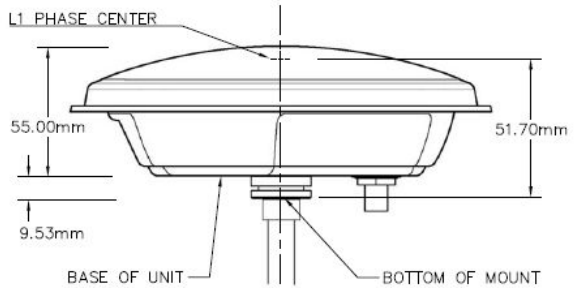


POINT LOCATION ON VESSEL



BRIDGE DECK

WCI REF #	LONGITUDINAL OFFSET (X) POSITIVE FORWARD	TRANSVERSE OFFSET (Y) POSITIVE TO STARBOARD	BASELINE OFFSET (Z) POSITIVE DOWN	SENSOR DESCRIPTION AND NOTES
1015	-7.5786	-7.0582	-21.2910	CENTER OF PORT AFT SEAPATH NOVATEL 850 GNSS ANTENNA @ BASE OF MOUNT
1015	-7.5786	-7.0582	-21.3427	CENTER OF PORT AFT SEAPATH NOVATEL 850 GNSS ANTENNA @ L1 PHASE CENTER
1015	-7.5786	-7.0582	-21.3430	CENTER OF PORT AFT SEAPATH NOVATEL 850 GNSS ANTENNA @ L2 PHASE CENTER
1007	-3.5782	-7.0447	-21.2746	CENTER OF PORT FWD SEAPATH NOVATEL 850 GNSS ANTENNA @ BASE OF MOUNT
1007	-3.5782	-7.0447	-21.3263	CENTER OF PORT FWD SEAPATH NOVATEL 850 GNSS ANTENNA @ L1 PHASE CENTER
1007	-3.5782	-7.0447	-21.3266	CENTER OF PORT FWD SEAPATH NOVATEL 850 GNSS ANTENNA @ L2 PHASE CENTER
8127	-7.7113	6.6391	-21.2974	CENTER OF STBD AFT SEAPATH NOVATEL 850 GNSS ANTENNA @ BASE OF MOUNT
8127	-7.7113	6.6391	-21.3491	CENTER OF STBD AFT SEAPATH NOVATEL 850 GNSS ANTENNA @ L1 PHASE CENTER
8127	-7.7113	6.6391	-21.3494	CENTER OF STBD AFT SEAPATH NOVATEL 850 GNSS ANTENNA @ L2 PHASE CENTER
8117	-3.7061	6.6183	-21.2691	CENTER OF STBD FWD SEAPATH NOVATEL 850 GNSS ANTENNA @ BASE OF MOUNT
8117	-3.7061	6.6183	-21.3208	CENTER OF STBD FWD SEAPATH NOVATEL 850 GNSS ANTENNA @ L1 PHASE CENTER
8117	-3.7061	6.6183	-21.3211	CENTER OF STBD FWD SEAPATH NOVATEL 850 GNSS ANTENNA @ L2 PHASE CENTER



NOVATEL GNSS-850 ANTENNA
L1 PHASE CENTER OFFSET
PER KONGSBERG SEAPATH 380 MANUAL

RV SALLY RIDE
SCI. EQUIP. SURVEY, MARCH 2024
COMPLETED AT NIMITZ MARINE FACILITY
SAN DIEGO, CALIFORNIA

DWG3033-001.DWG
DATE: 2024-04-01
DWG BY: JWD
CHK BY: CRB2
SCALE: NTS
REV #:
JOB NO: 3033-001

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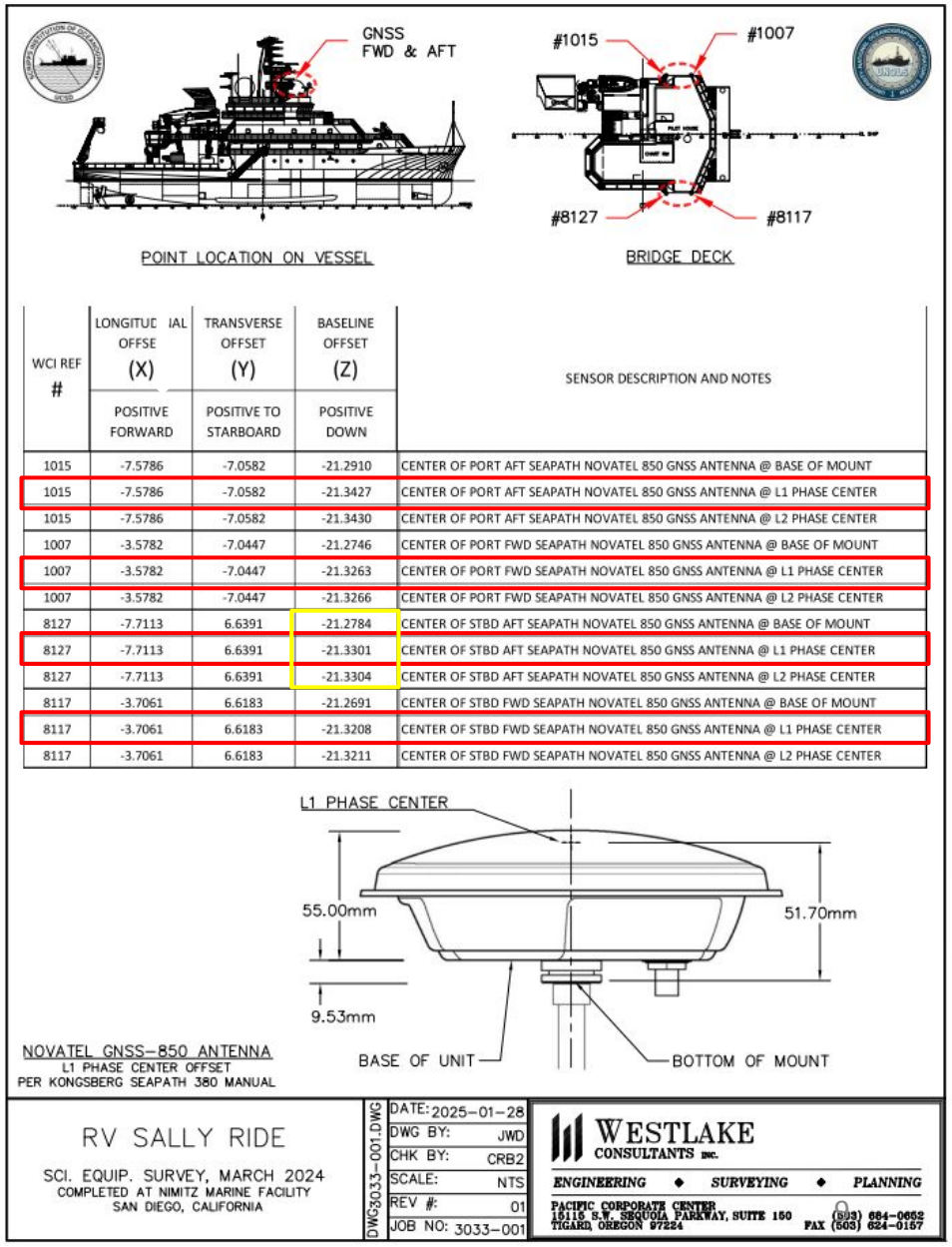
System Geometry Review

Post-QAT Antenna Z Updates

1. Following the 2025 QAT, Westlake provided further height updates for the stbd / aft antenna (#8127) by email on 2025-01-27
2. Westlake provided a new report (Rev. 1, 2025-02-24) with additional updates for this antenna (in yellow at right)
3. The final stbd / aft L1 center should be applied during the next QAT
4. Generally, the Seapath antenna configuration that was used during the calibrations should be maintained until the next opportunity to update Seapath configuration, run baseline calibrations, and repeat multibeam calibrations
5. The MAC is available to discuss the final Westlake report and implementation path for Seapath updates



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1015	-7.5786	-7.0582	-21.3430	CENTER OF PORT AFT SEAPATH NOVATEL 850 GNSS ANTENNA @ L2 PHASE CENTER
1007	-3.5782	-7.0447	-21.2746	CENTER OF PORT FWD SEAPATH NOVATEL 850 GNSS ANTENNA @ BASE OF MOUNT
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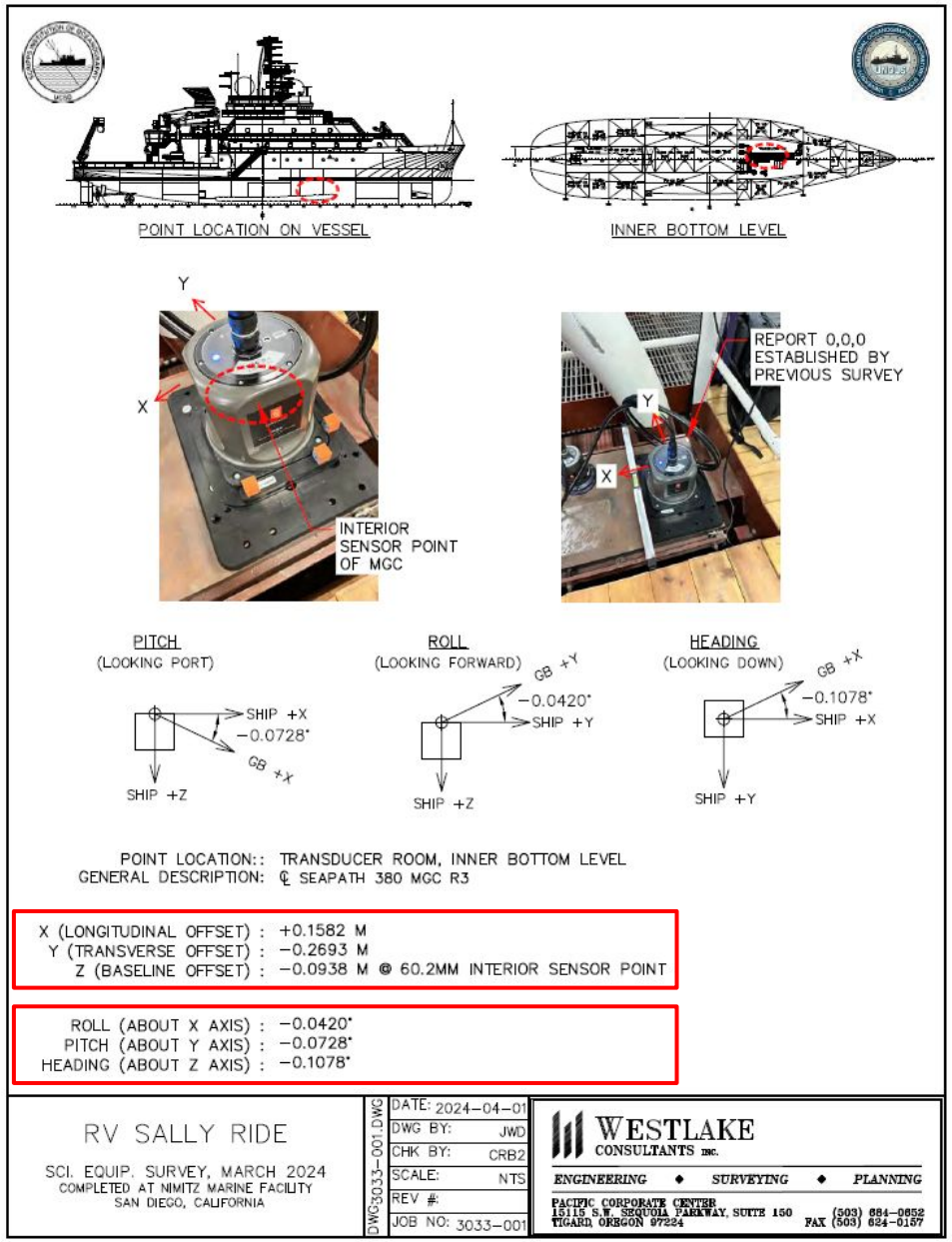
1007	-3.5782	-7.0447	-21.3266	CENTER OF PORT FWD SEAPATH NOVATEL 850 GNSS ANTENNA @ L2 PHASE CENTER
8127	-7.7113	6.6391	-21.2784	CENTER OF STBD AFT SEAPATH NOVATEL 850 GNSS ANTENNA @ BASE OF MOUNT
8127	-7.7113	6.6391	-21.3301	CENTER OF STBD AFT SEAPATH NOVATEL 850 GNSS ANTENNA @ L1 PHASE CENTER
8127	-7.7113	6.6391	-21.3304	CENTER OF STBD AFT SEAPATH NOVATEL 850 GNSS ANTENNA @ L2 PHASE CENTER
8117	-3.7061	6.6183	-21.2691	CENTER OF STBD FWD SEAPATH NOVATEL 850 GNSS ANTENNA @ BASE OF MOUNT
8117	-3.7061	6.6183	-21.3208	CENTER OF STBD FWD SEAPATH NOVATEL 850 GNSS ANTENNA @ L1 PHASE CENTER
8117	-3.7061	6.6183	-21.3211	CENTER OF STBD FWD SEAPATH NOVATEL 850 GNSS ANTENNA @ L2 PHASE CENTER

System Geometry Review

1. **Seapath 380-R3** antenna locations were configured from the Westlake report and email communications:
   a. Antenna 1: updated Z (2025-01-24) in yellow at right
   b. Antenna 2: dockside calibration
2. The following antenna offsets were **applied during the QAT:**
   a. **Antenna 1** (stbd, aft) at L1 phase center:
      i. X = -7.711 m; Y = +6.639 m; Z = -21.349 m
   b. **Antenna 2** (stbd, fwd) from dockside baseline calibration:
      i. X = -3.714 m; Y = +6.618 m; Z = -21.335 m
3. During the **next QAT**, the primary antenna should be updated to Westlake report Rev. 1 and new calibrations should be run:
   a. **Antenna 1** (stbd, aft) at L1 phase center for next QAT:
      i. X = -7.711 m; Y = +6.639 m; Z = -21.330 m

Seapath 380-R3 Antenna Offsets

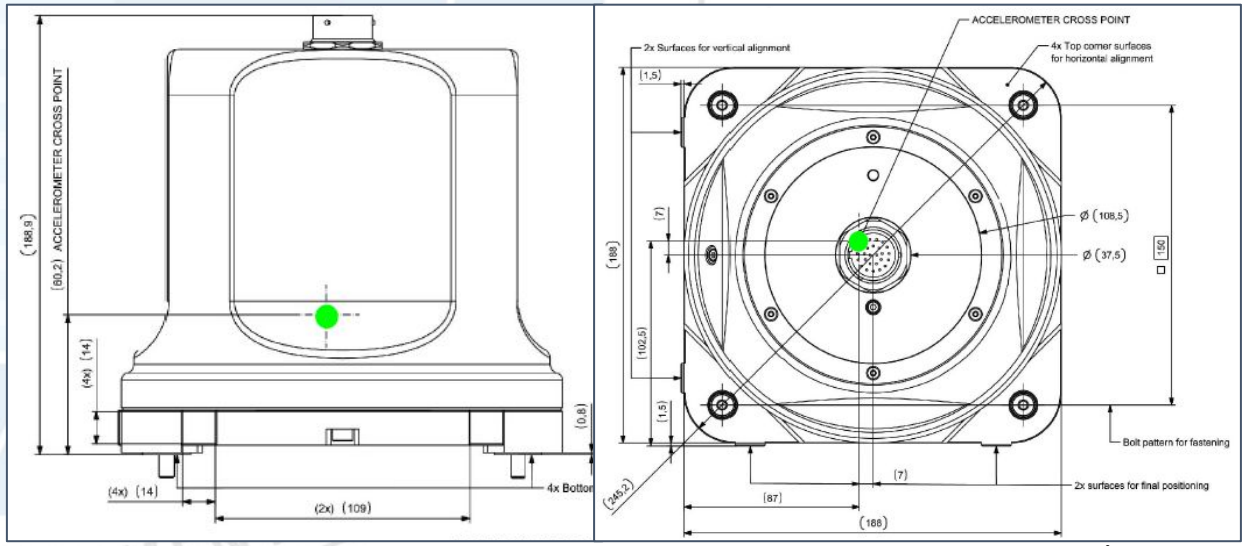
System Geometry Review



Seapath 380-R3 MGC Offsets

1. No changes were made to the MGC installation offsets
2. MGC sensing center offsets in Seapath 380-R3 config:

X: +0.158 m	**Roll: -0.042° (179.958° with cable up)**
Y: -0.269 m	**Pitch: -0.073°**
Z: -0.094 m	**Heading: -0.108°**

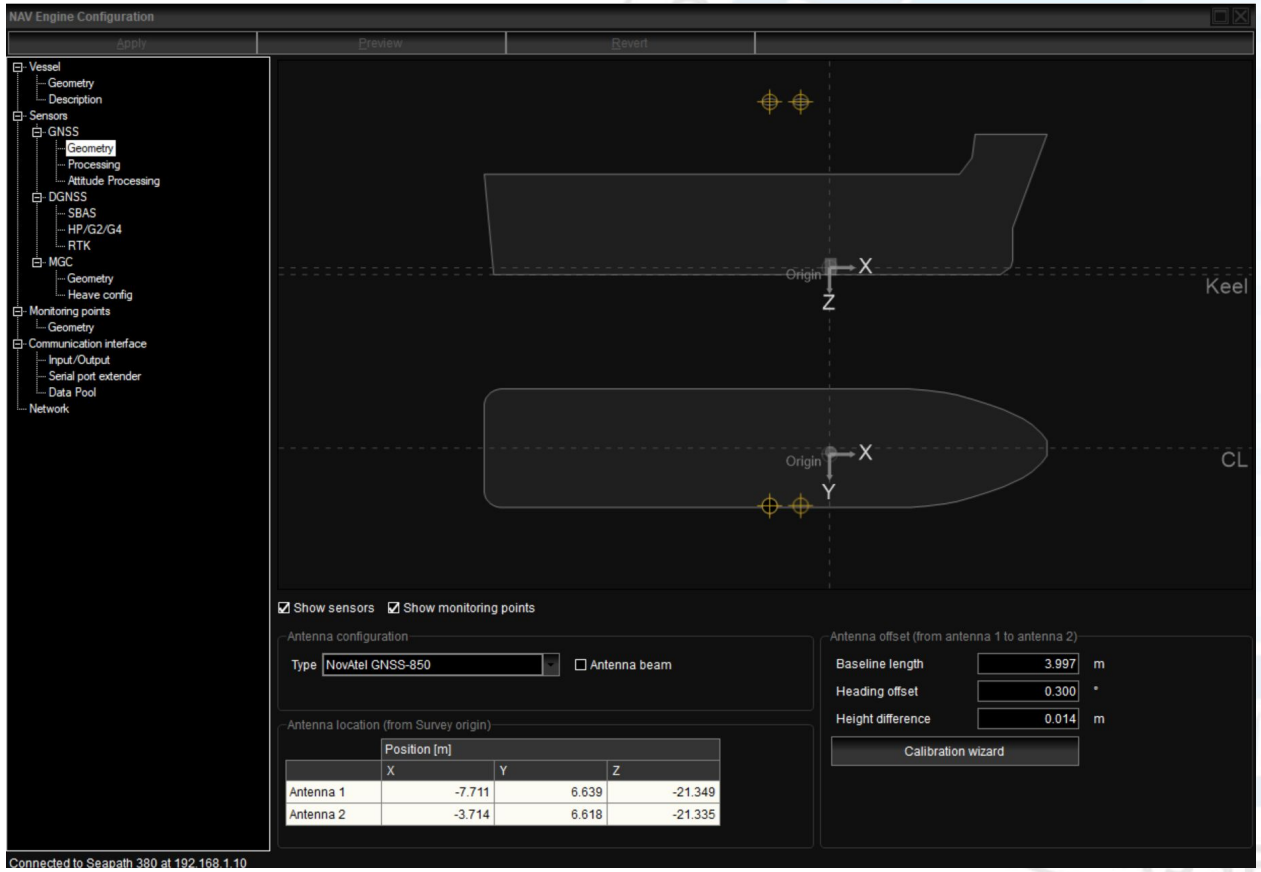


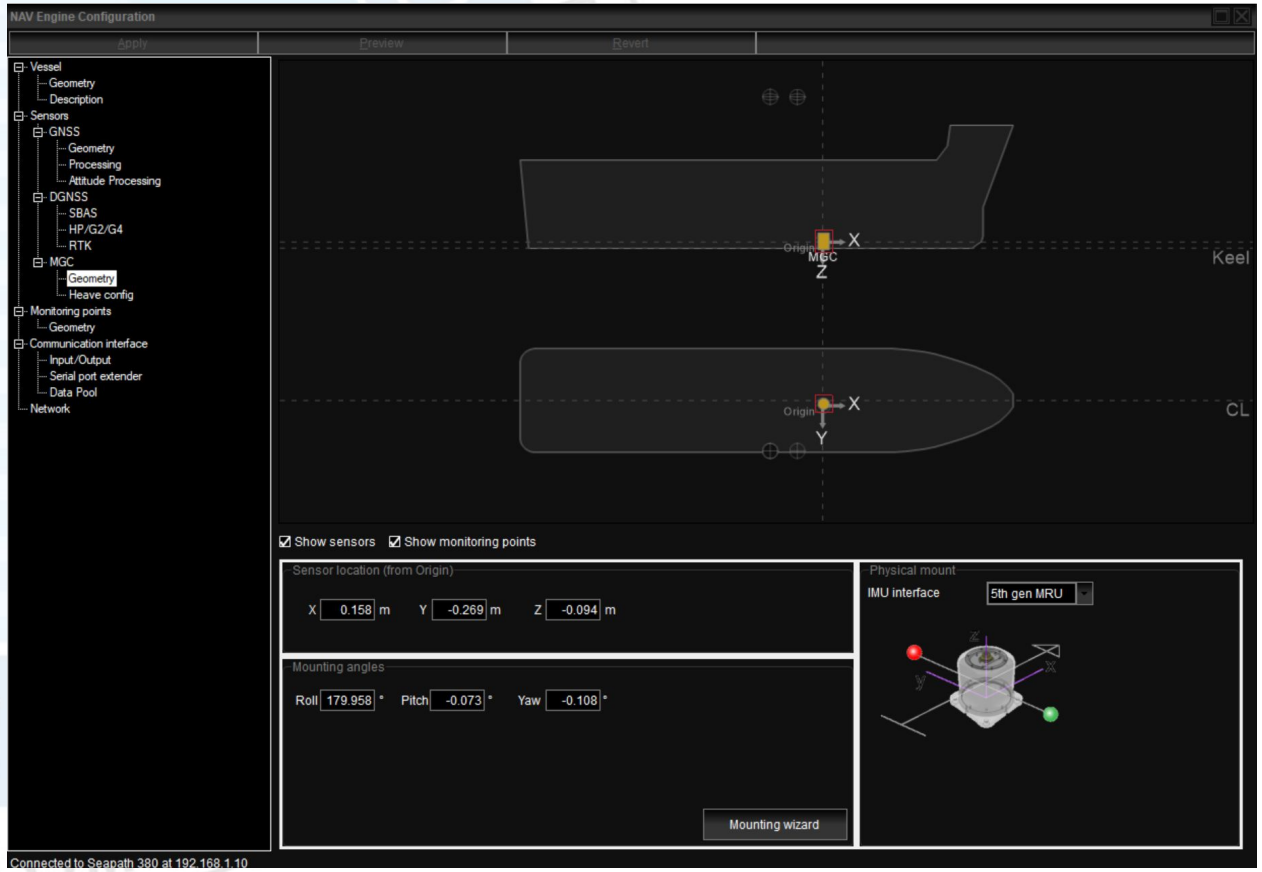
Sensing center location (Seapath MGC Installation Manual MGC-D-115/1 p. 30)

System Geometry Review

Seapath 380-R3 Configuration

1. **Seapath 380-R3 configurations** shown below reflect the updated Westlake L1 phase centers and baseline calibration
2. **Attitude 1 installation angles in SIS** were unchanged from 2024 prior to the 2025 calibration (see calibration section)

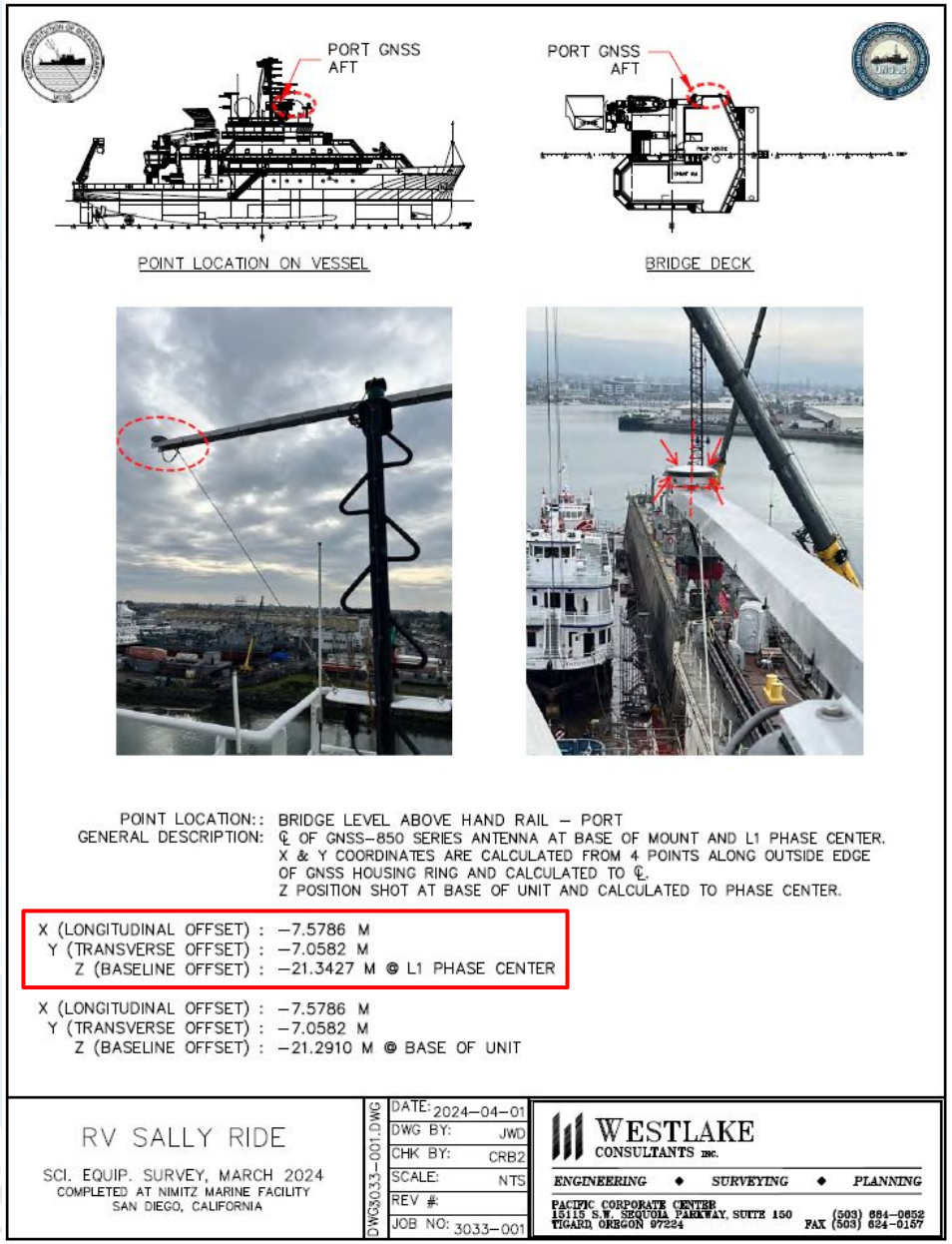




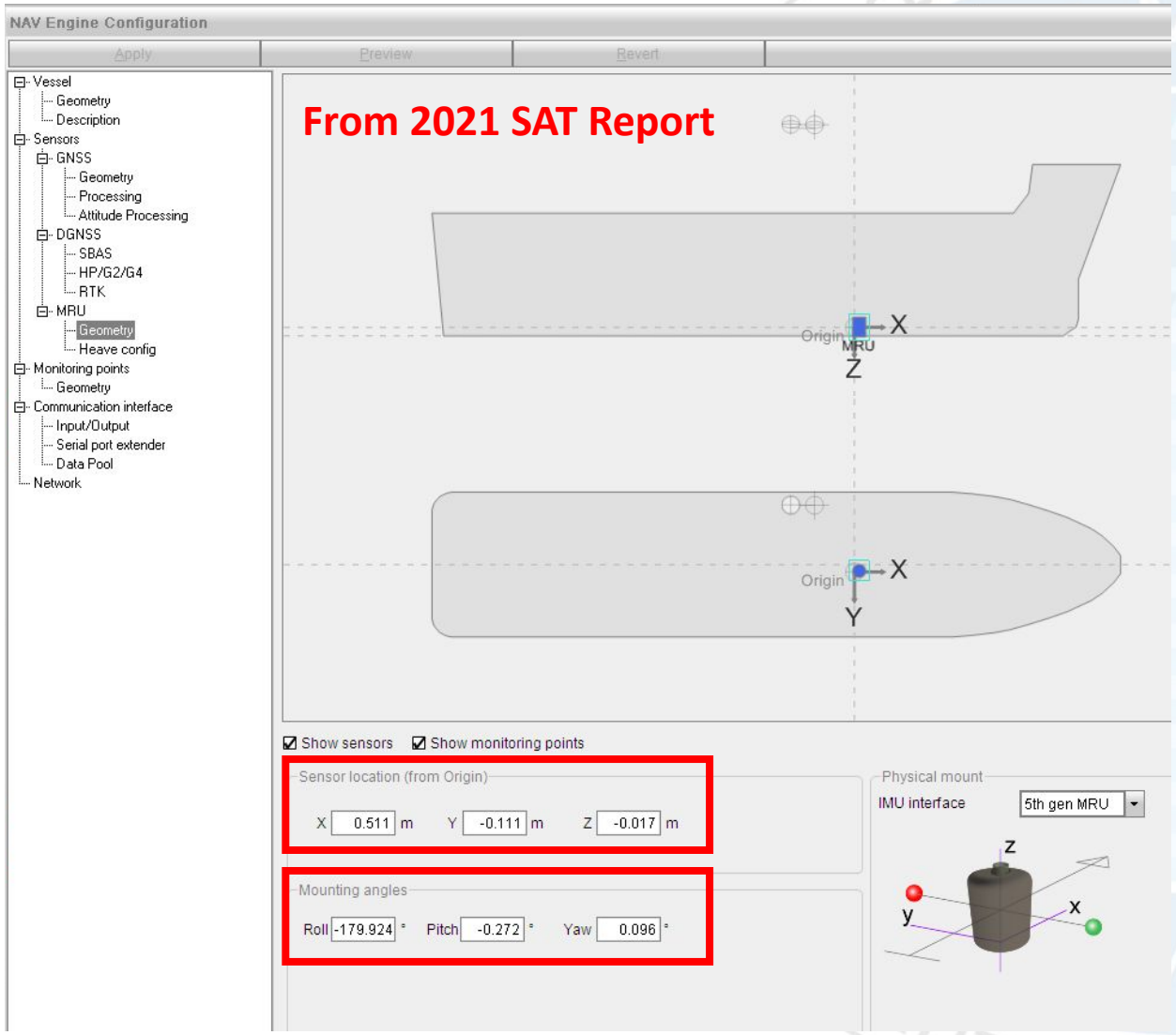
System Geometry Review

1. **Seapath 380-5+** antenna locations were configured from the clarified Westlake results (Antenna 1) and dockside calibration (Antenna 2)
2. The following antenna offsets were **applied during the QAT:**
   a. **Antenna 1** (port, aft) at L1 phase center:
      i. **X = -7.579 m; Y = -7.058 m; Z = -21.343 m**
   b. **Antenna 2** (port, fwd) from dockside baseline calibration:
      i. **X = -3.582 m; Y = -7.045 m; Z = -21.310 m**

Seapath 380-5+ Antenna Offsets



System Geometry Review



Seapath 380-5+ MRU Offsets

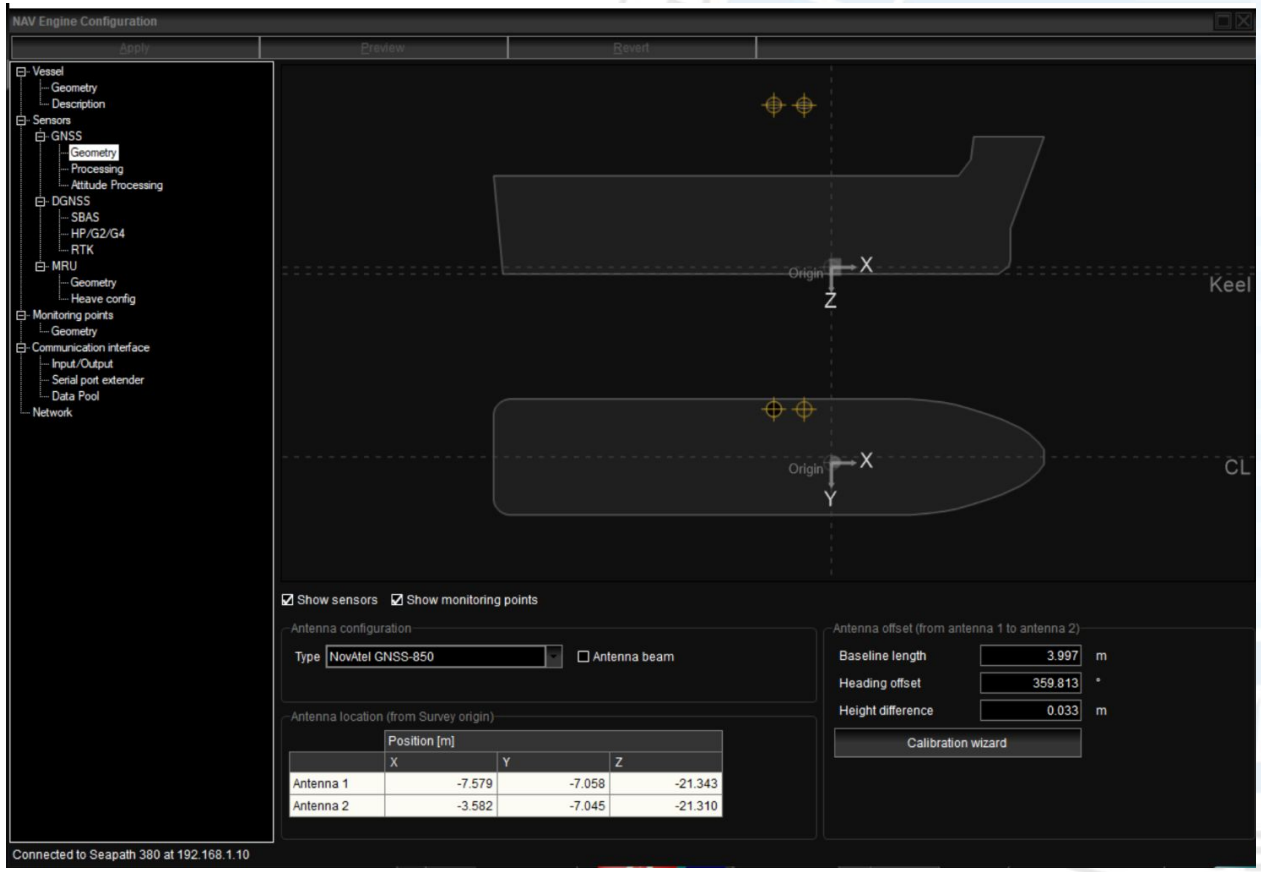
1. No changes were made to MRU installation or configuration since the 2021 IMTEC survey; although the unit was removed for factory calibration in late 2024, a necessary assumption of stable MRU geometry is made because the (surveyed) base plate was not removed
2. The configuration shown at left is from the 2021 geometry review; see SR2104 SAT report for full details
3. MRU offsets in Seapath 380-5+ config:

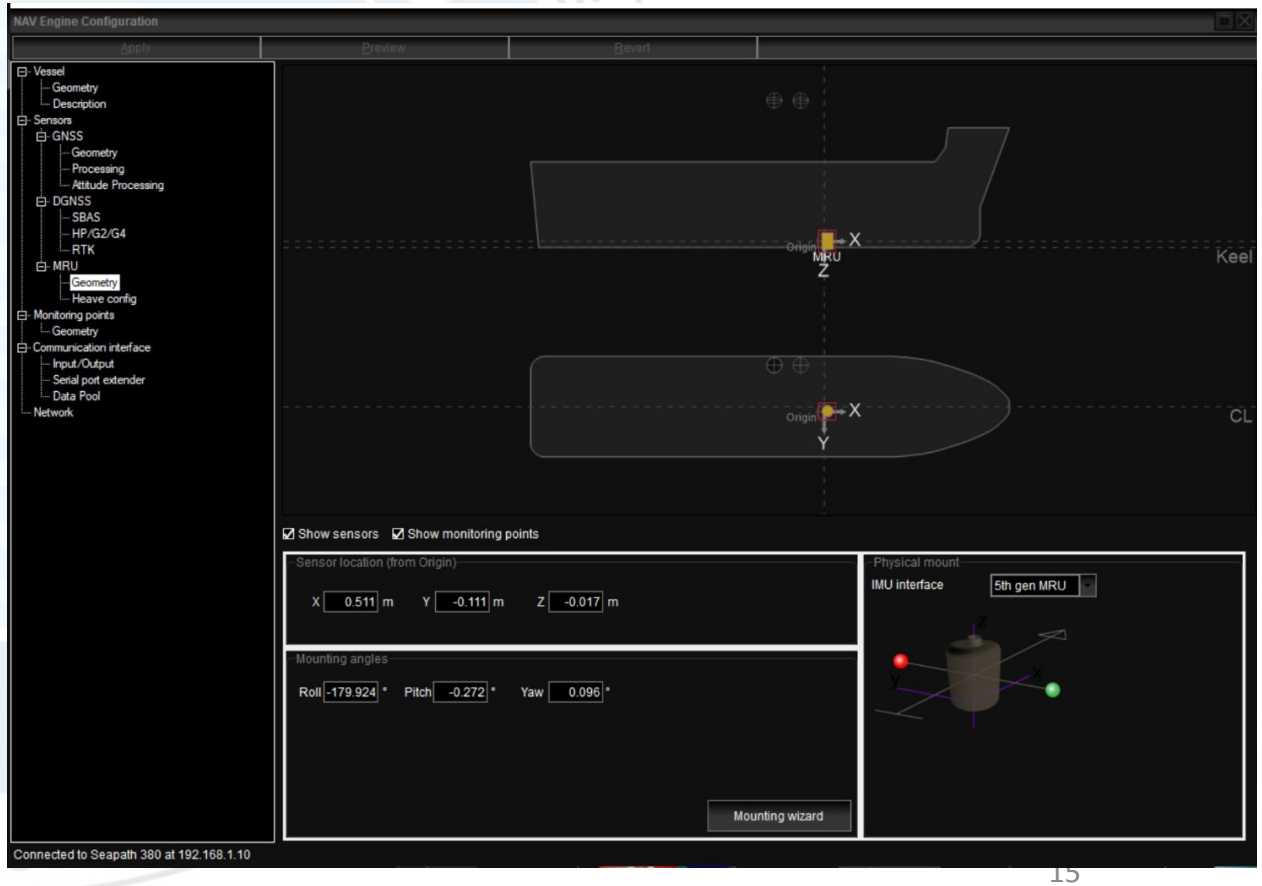
X: +0.511 m	**Roll: -179.924°**
Y: -0.111 m	**Pitch: -0.272°**
Z: -0.017 m	**Heading: +0.096°**

System Geometry Review

Seapath 380-5+ Configuration

1. **Seapath 380-5+ configurations** shown below reflect the updated Westlake L1 phase centers and baseline calibration
2. **Attitude 2 installation angles in SIS** were unchanged from 2024 prior to the 2025 calibration (see calibration section)



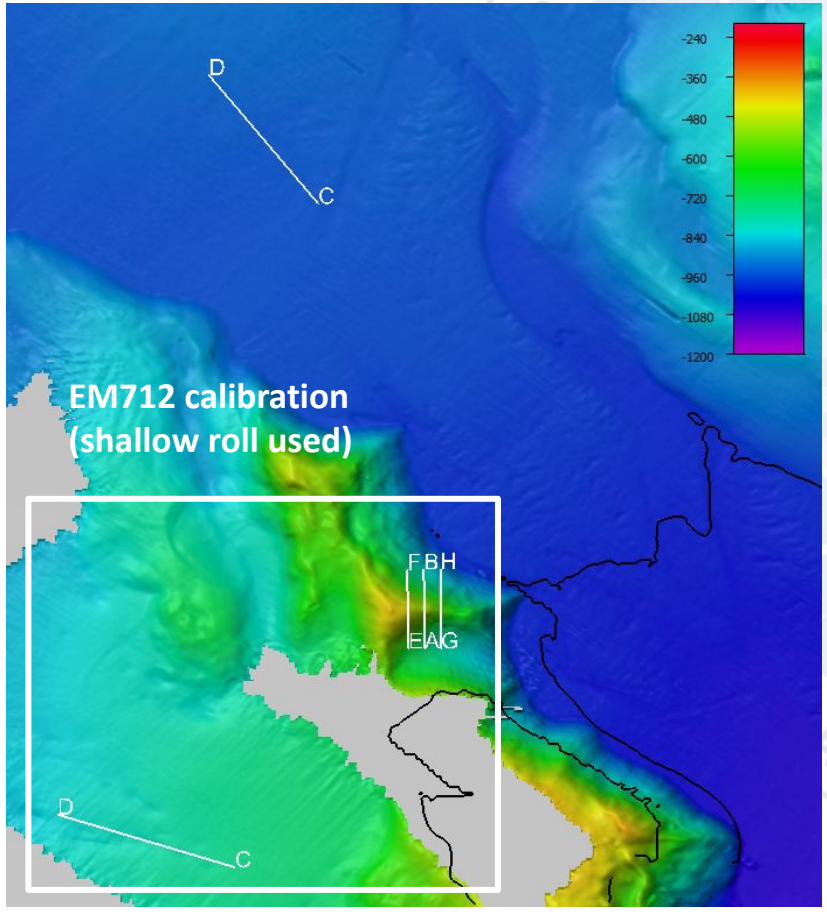


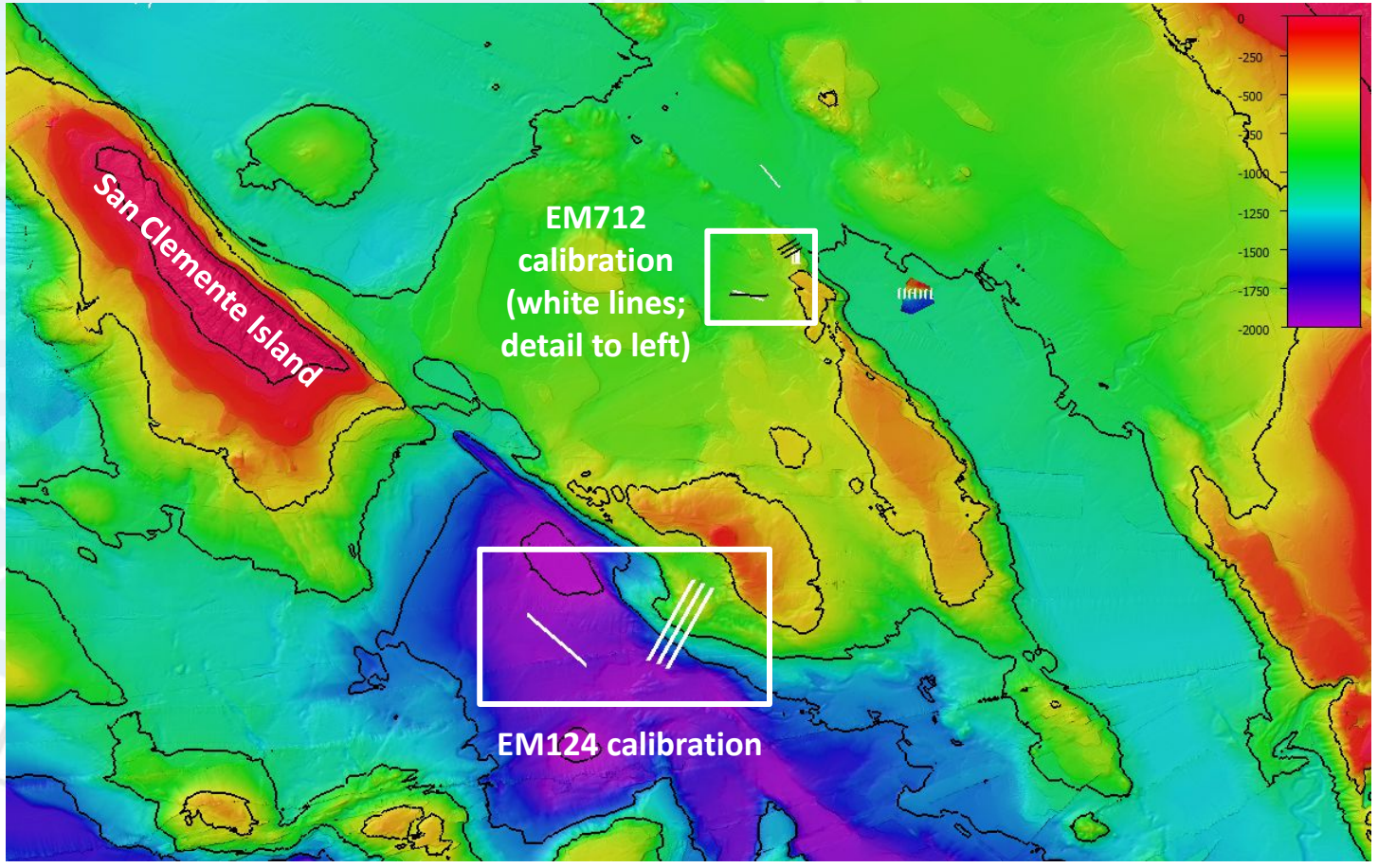
Planning Overview

1. Calibrations were planned at two sites selected to minimize transit time:

   EM712: a site near San Diego used repeatedly by SIO and other vessels

   EM124: a site near San Clemente Island developed during SR2307 in order to reduce transit time compared to a deeper EM122/124 site used previously (e.g., RR2002 SAT, SR2101 SAT, and SR2401 QAT)



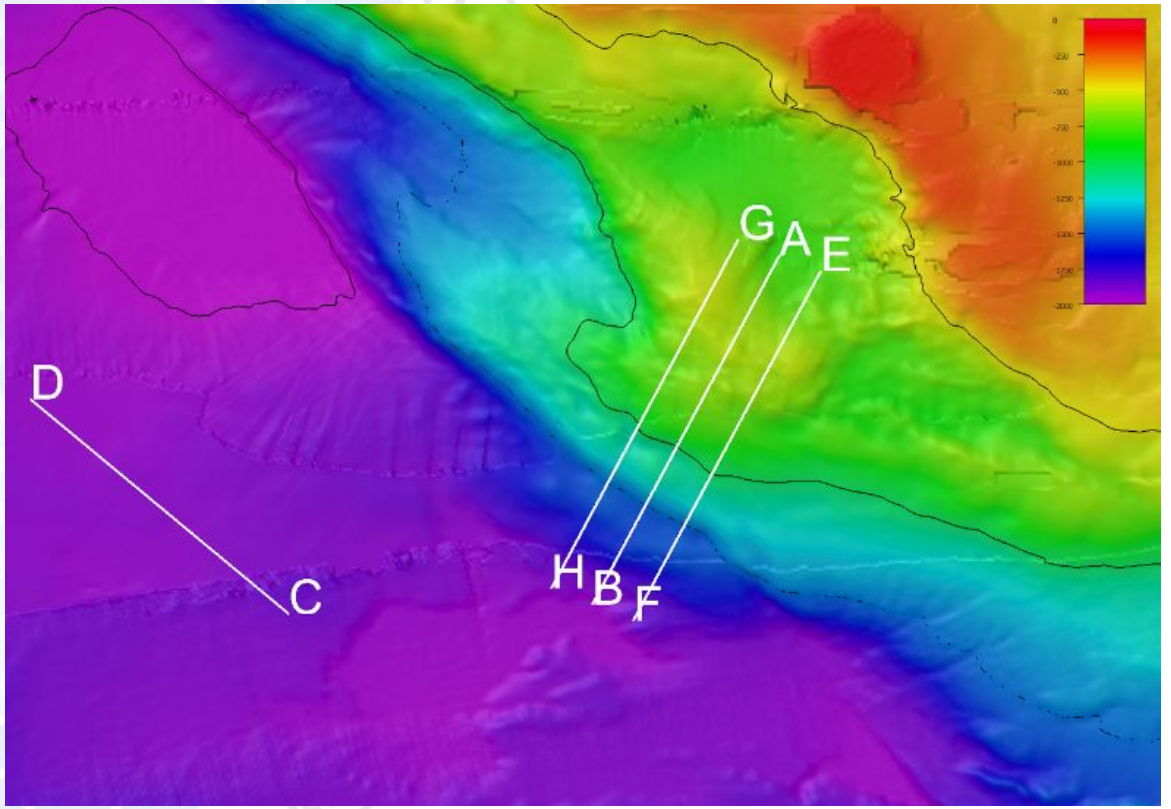


EM124 Calibration

Planning

1. EM124 calibration was conducted at the SR2307 site developed to minimize transit time from San Diego

	Waypoint	Decimal Degrees		Degrees Decimal Minutes			
		Lat.	Lon.	Lat. Deg.	Lat. Min.	Lon. Deg.	Lon. Min.
Pitch	A	32.609052	-117.989941	32	36.543	-117	59.397
	B	32.526944	-118.034039	32	31.617	-118	2.042
Roll	C	32.524758	-118.105567	32	31.486	-118	6.334
	D	32.575234	-118.166450	32	34.514	-118	9.987
Heading 1	E	32.605316	-117.980242	32	36.319	-117	58.815
	F	32.523211	-118.024346	32	31.393	-118	1.461
Heading 2	G	32.612787	-117.999642	32	36.767	-117	59.979
	H	32.530676	-118.043732	32	31.841	-118	2.624

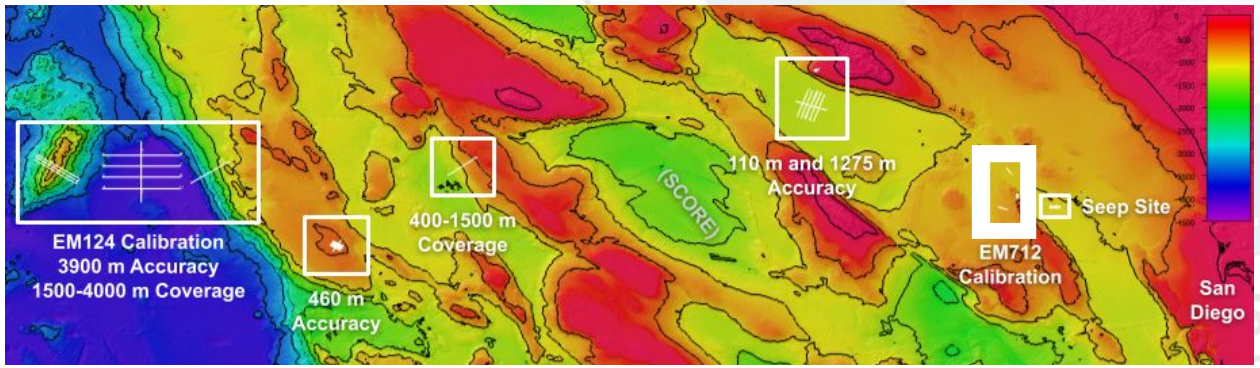


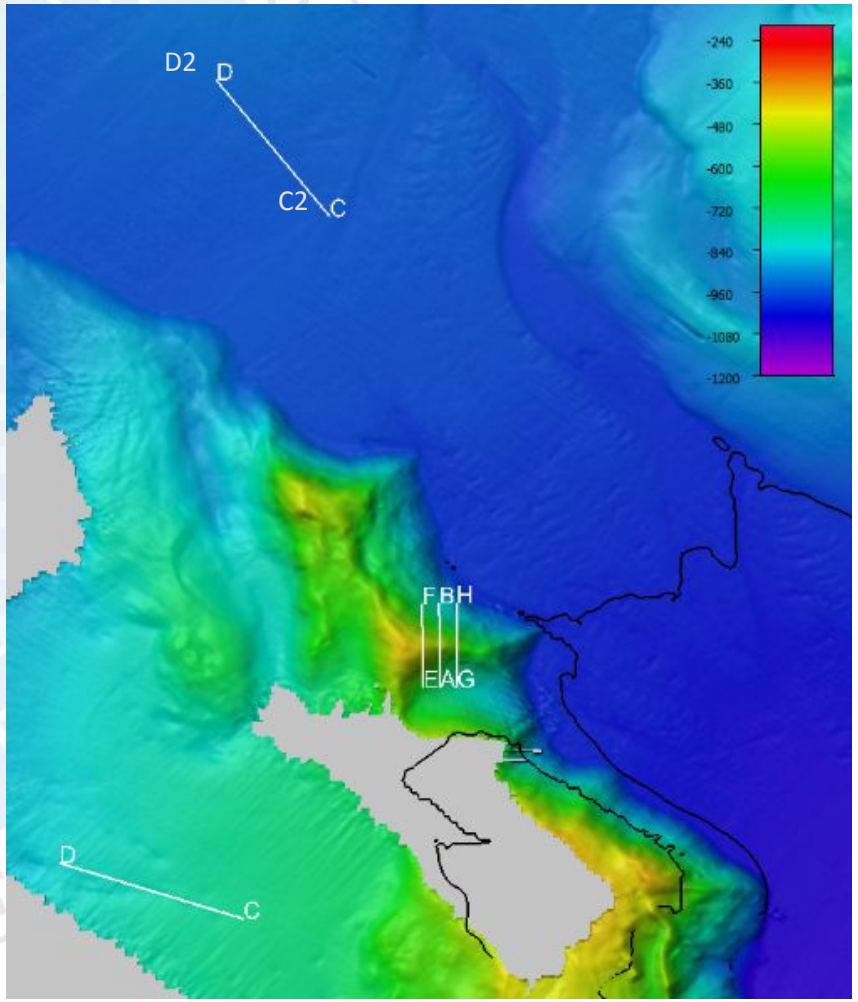
EM712 Calibration **Planning**

1. EM712 calibration was conducted at a site used successfully for several vessels (e.g., SR2401 QAT); the 'Deep Roll' line to the north is intended for EM30X systems and was not run, but is included here for reference

	Waypoint	Decimal Degrees		Degrees Decimal Minutes			
		Lat.	Lon.	Lat. Deg.	Lat. Min.	Lon. Deg.	Lon. Min.
Pitch	A	32.932876	-117.902559	32	55.973	-117	54.154
	B	32.946406	-117.902697	32	56.784	-117	54.162
Roll	C	32.895486	-117.934882	32	53.729	-117	56.093
	D	32.904512	-117.965120	32	54.271	-117	57.907
Heading 1	E	32.932856	-117.905367	32	55.971	-117	54.322
	F	32.946385	-117.905505	32	56.783	-117	54.330
Heading 2	G	32.932897	-117.899752	32	55.974	-117	53.985
	H	32.946426	-117.899889	32	56.786	-117	53.993
Deep Roll	C2	33.008986	-117.920674	33	0.539	-117	55.240
	D2	33.031013	-117.939328	33	1.861	-117	56.360

Overview of nearby test sites from RR2002 and SR2104



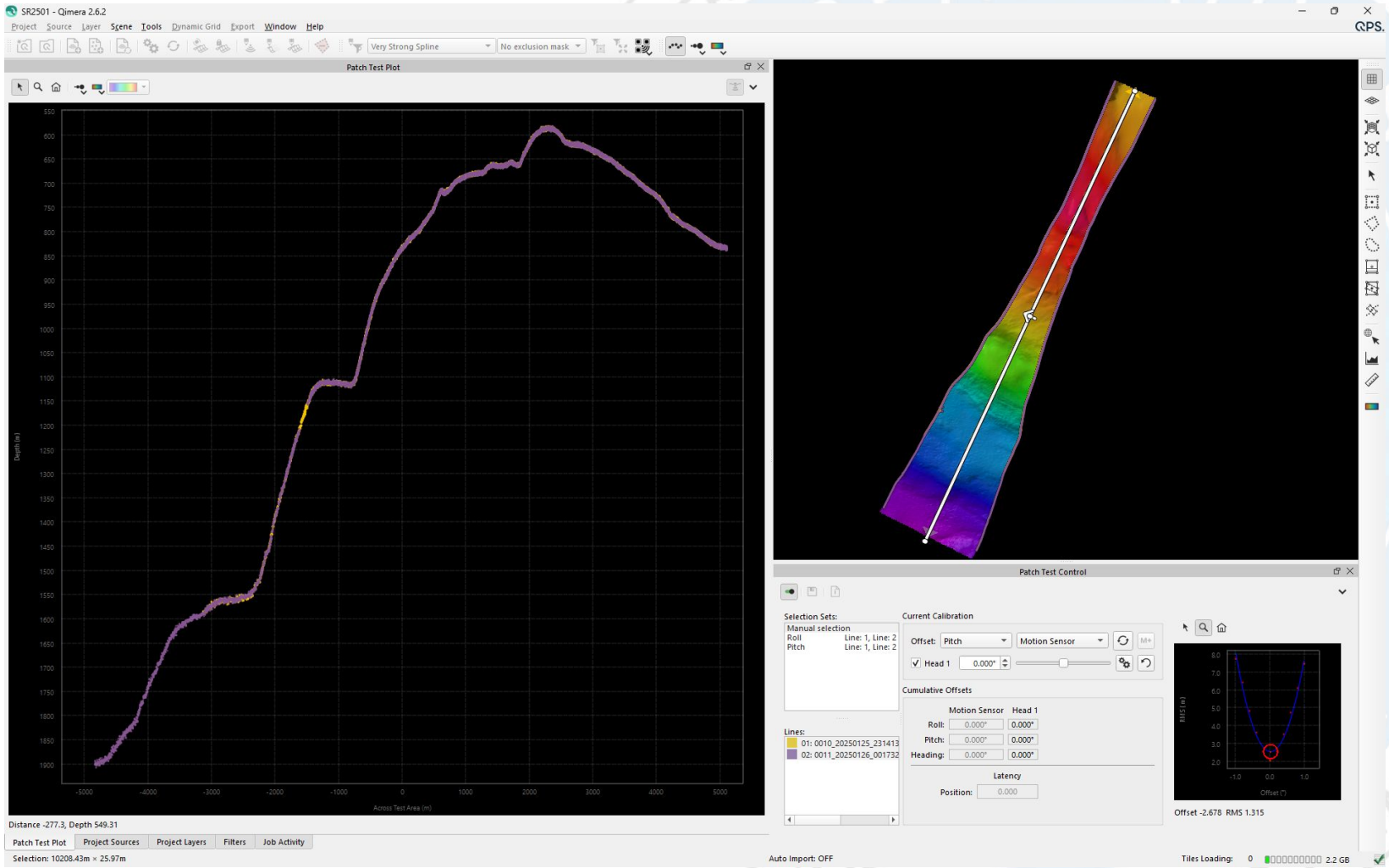


EM124 and EM712 Calibration **Data Collection and Processing**

1. Sound speed profiles were acquired with the CTD, processed in Sound Speed Manager, and applied in SIS ahead of calibration for each system
2. Calibration data were examined in QPS Qimera by MAC and SIO personnel on board; during Qimera analysis, files were processed with nearest-in-time sound speed scheduling, edited to remove outlier soundings, and then scrutinized with the patch test tool using a combination of:
   a. visual assessment and adjustment of the biases across a wide variety of large and small data subsets
   b. 'Autosolver' method to confirm minimum RMS differences between suitable subsets
3. Results were discussed by MAC and SIO at each stage before application in SIS
4. Calibration results shown on the following slides should remain unchanged until sensors are modified, the next routine assessment, or the need for additional patch testing is indicated by bathymetric artifacts

EM124 Calibration

Results: Pitch (Seapath 380-R3)

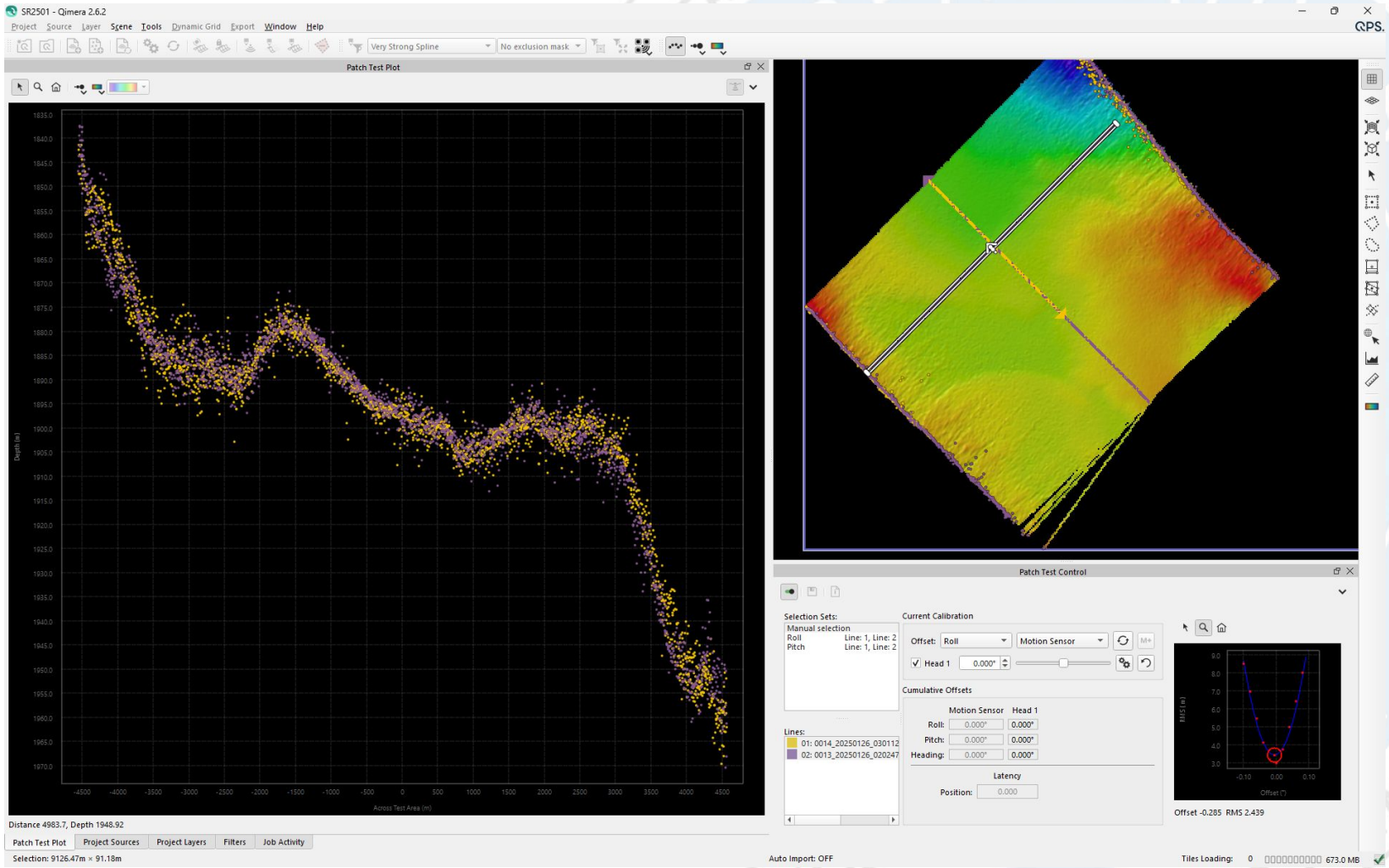


Pitch verification lines shown at left in the Qimera Patch Test Tool

1. Attitude 1 initial setting: -0.04°
2. Calibration adjustment: 0.00°
3. **Final pitch offset: -0.04° in SIS**

EM124 Calibration

Results: Roll (Seapath 380-R3)

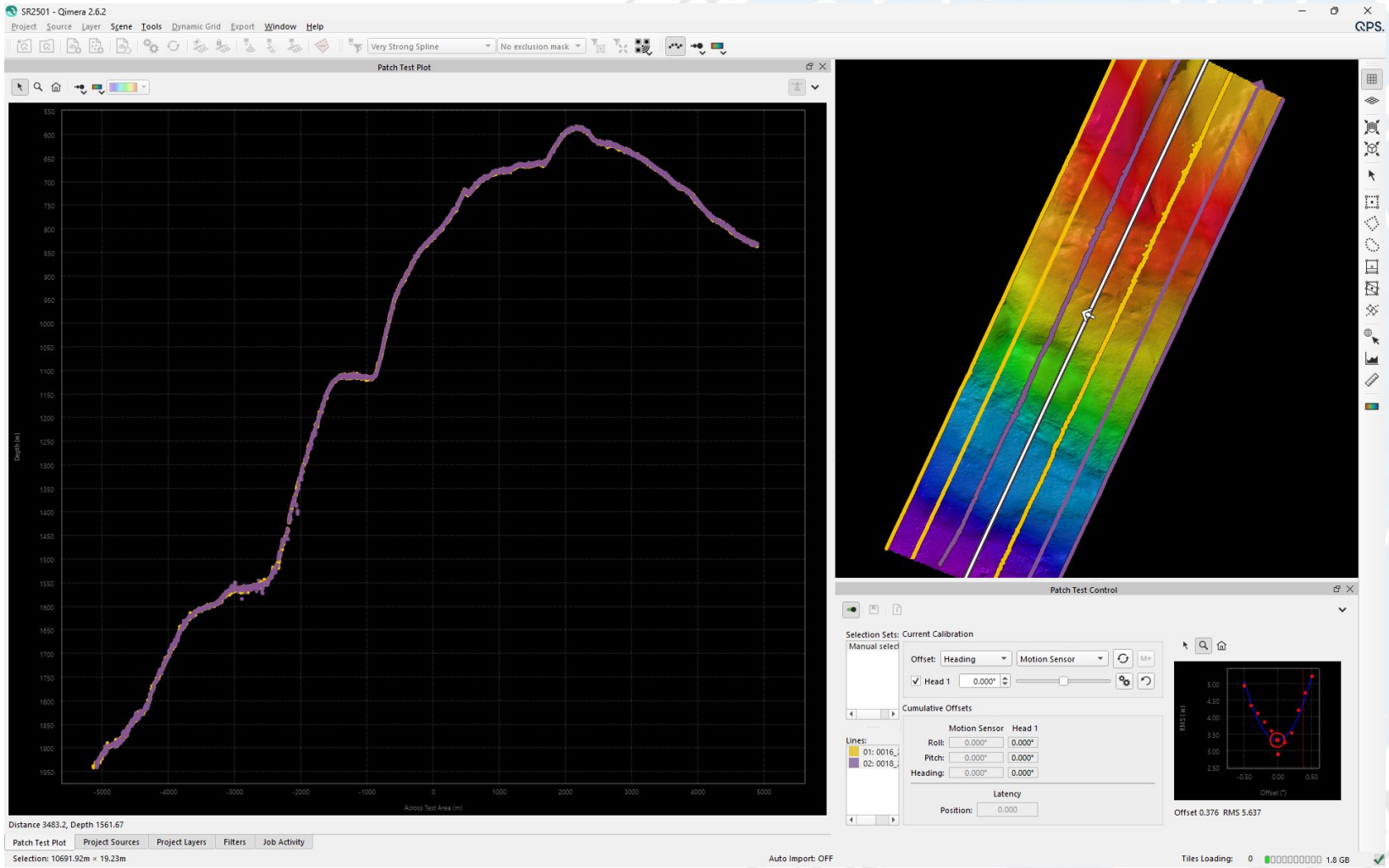


Roll verification lines shown at left in the Qimera Patch Test Tool

1. Attitude 1 initial setting: -0.14°
2. Calibration adjustment: 0.00°
3. **Final roll offset: -0.14° in SIS**

EM124 Calibration

Results: Heading (Seapath 380-R3)

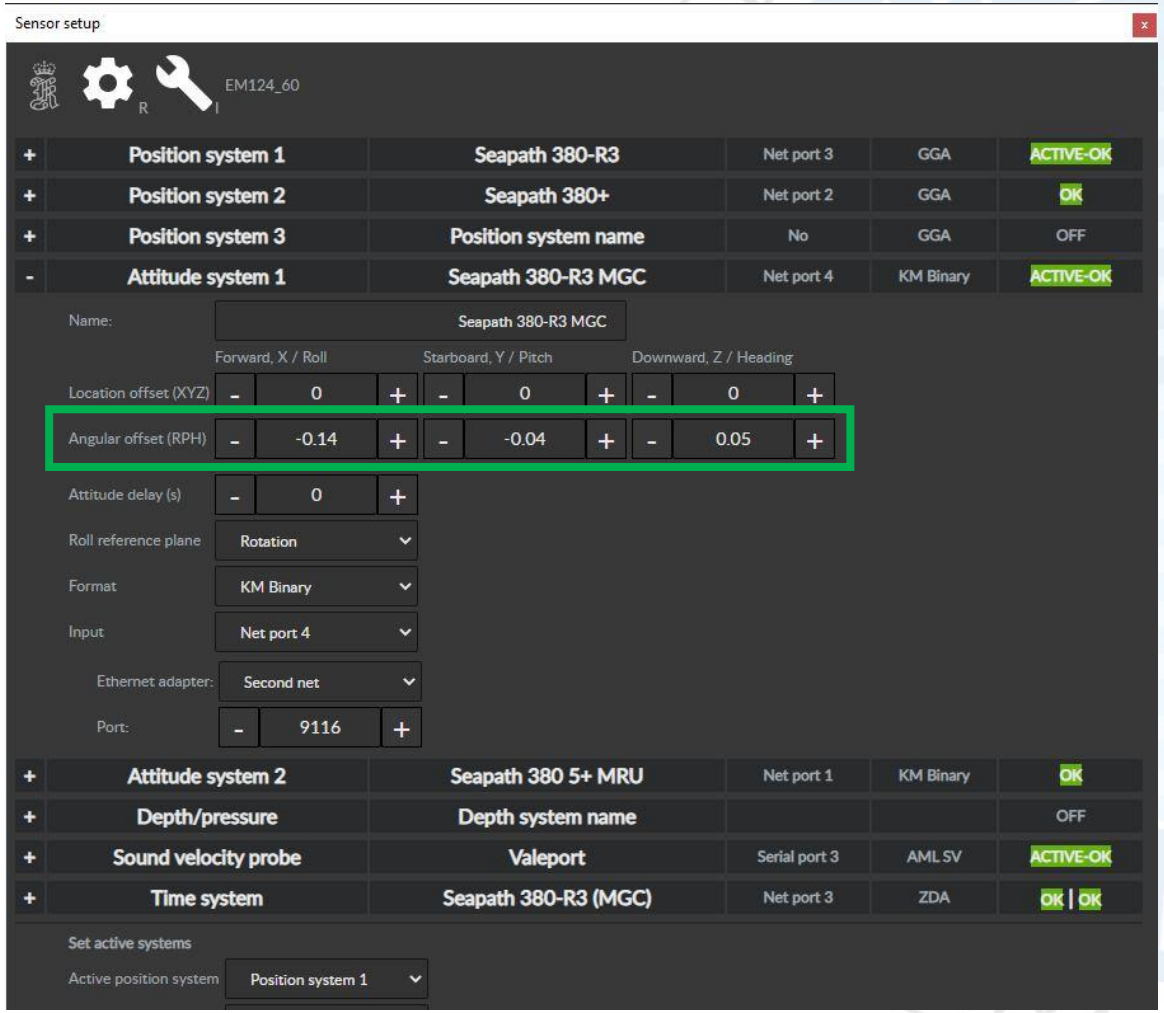


Heading calibration lines shown at left in the Qimera Patch Test Tool

1. Attitude 1 initial setting: +0.02°
2. Calibration adjustment: +0.03°
3. **Final heading offset: +0.05° in SIS**

EM124 Calibration

POST-CALIBRATION (EM124)



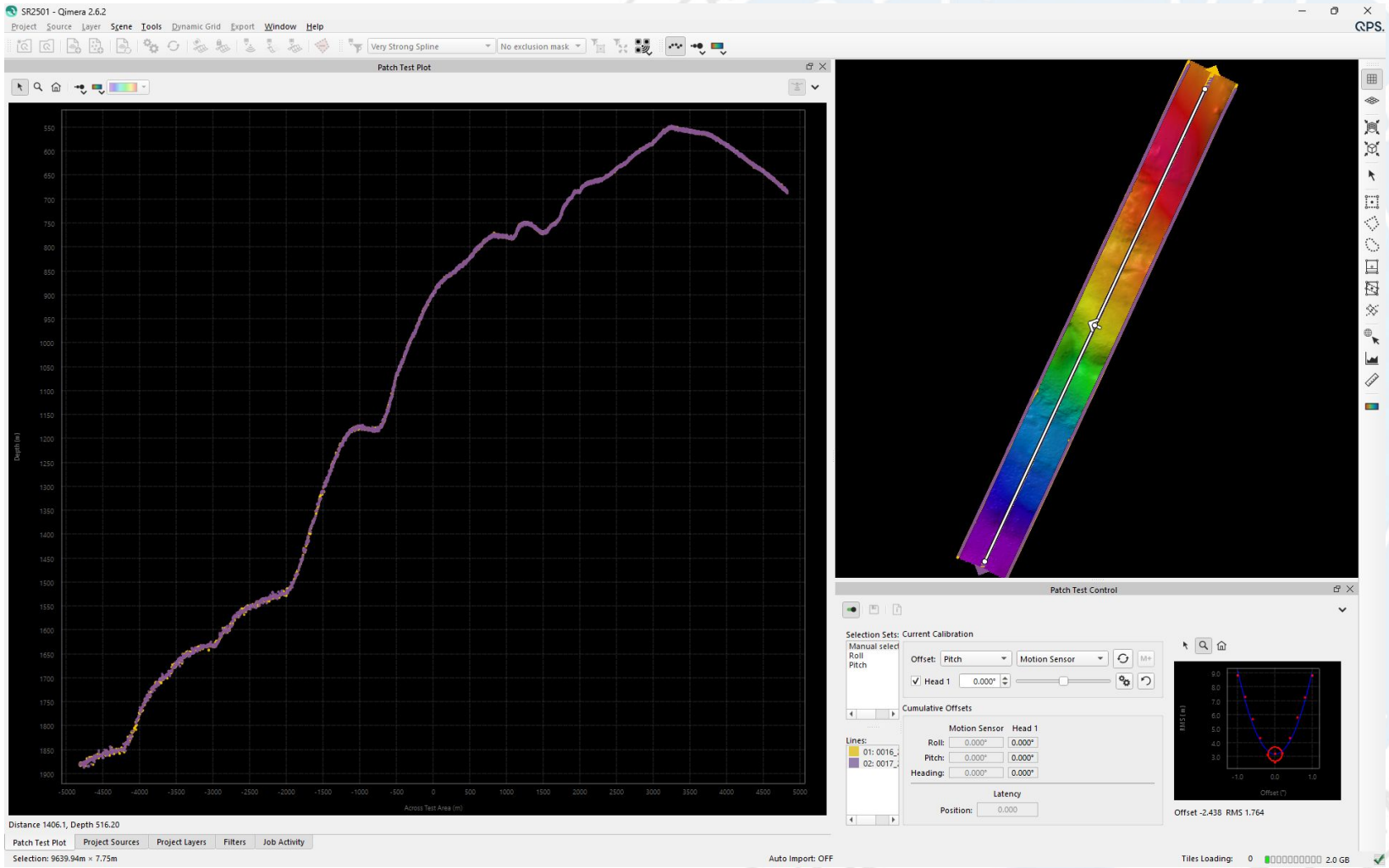
Attitude 1 Post-Cal. Configuration

1. The EM124 *Attitude 1* adjustments from SR2501 are very small, suggesting stable system geometry since the 2024 EM124 QAT and Seapath 380-R3 SAT

2. The *Installation Parameters: Angular Offsets* shown at left should be maintained until any modification is made to the EM124 or Seapath 380-R3, or another calibration becomes necessary for other reasons

EM124 Calibration

Results: Pitch (Seapath 380-5+)

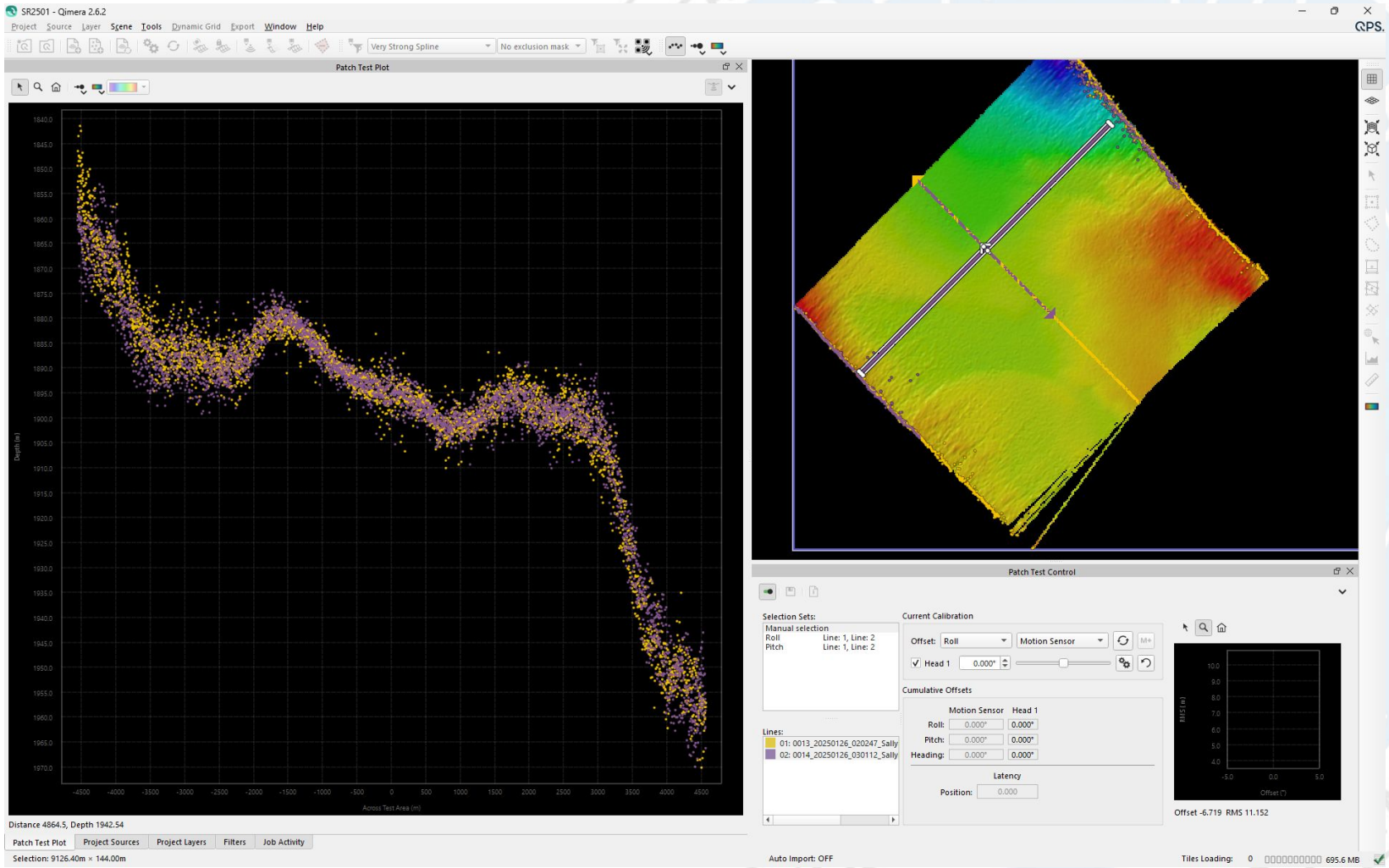


Pitch verification lines shown at left in the Qimera Patch Test Tool

1. Attitude 2 initial setting: -0.33°
2. Calibration adjustment: +0.01°
3. **Final pitch offset: -0.32° in SIS**

EM124 Calibration

Results: Roll (Seapath 380-5+)

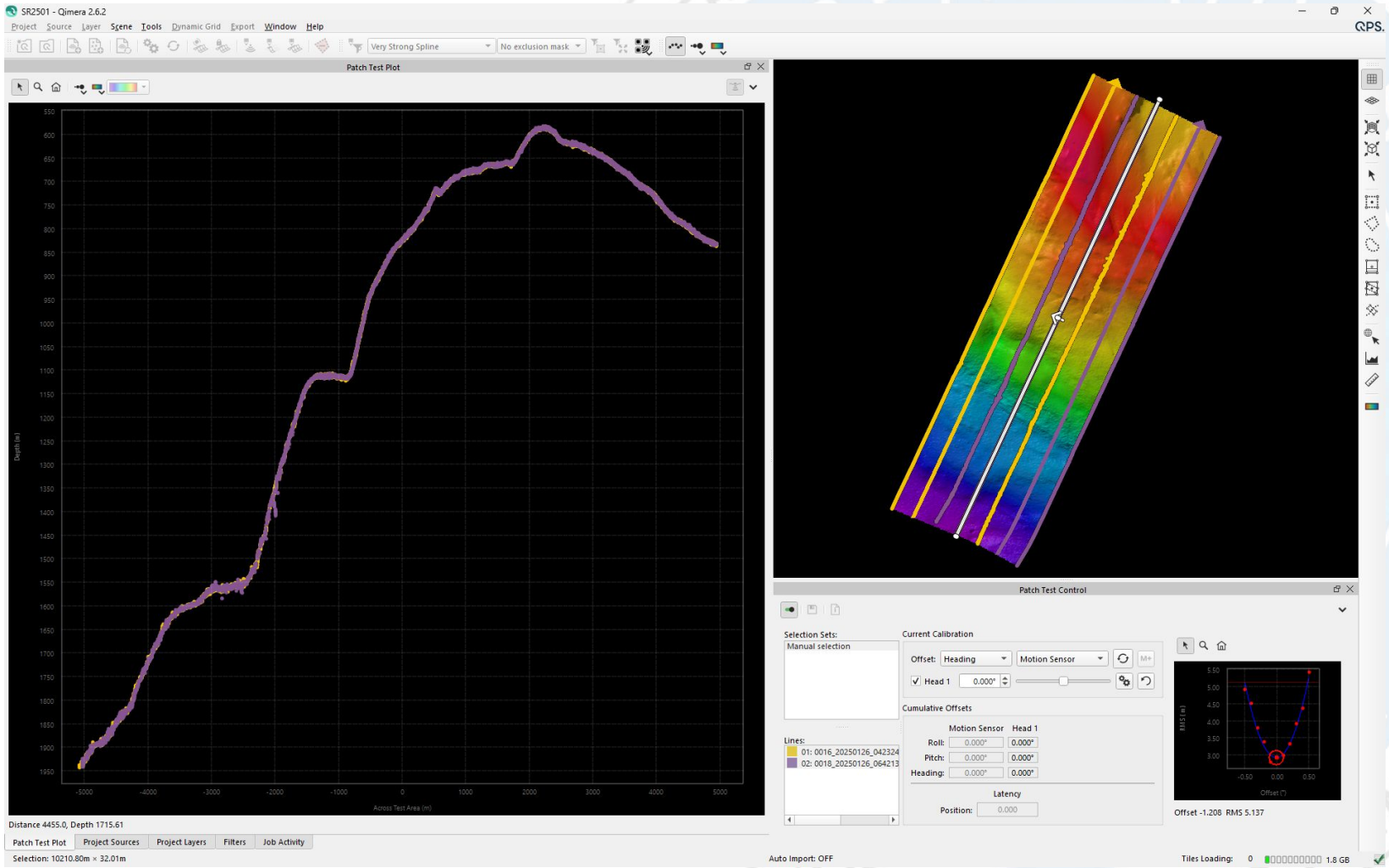


Roll verification lines shown at left in the Qimera Patch Test Tool

1. Attitude 2 initial setting: -0.185°
2. Calibration adjustment: +0.03°
3. **Final roll offset: -0.155° in SIS**

EM124 Calibration

Results: Heading (Seapath 380-5+)

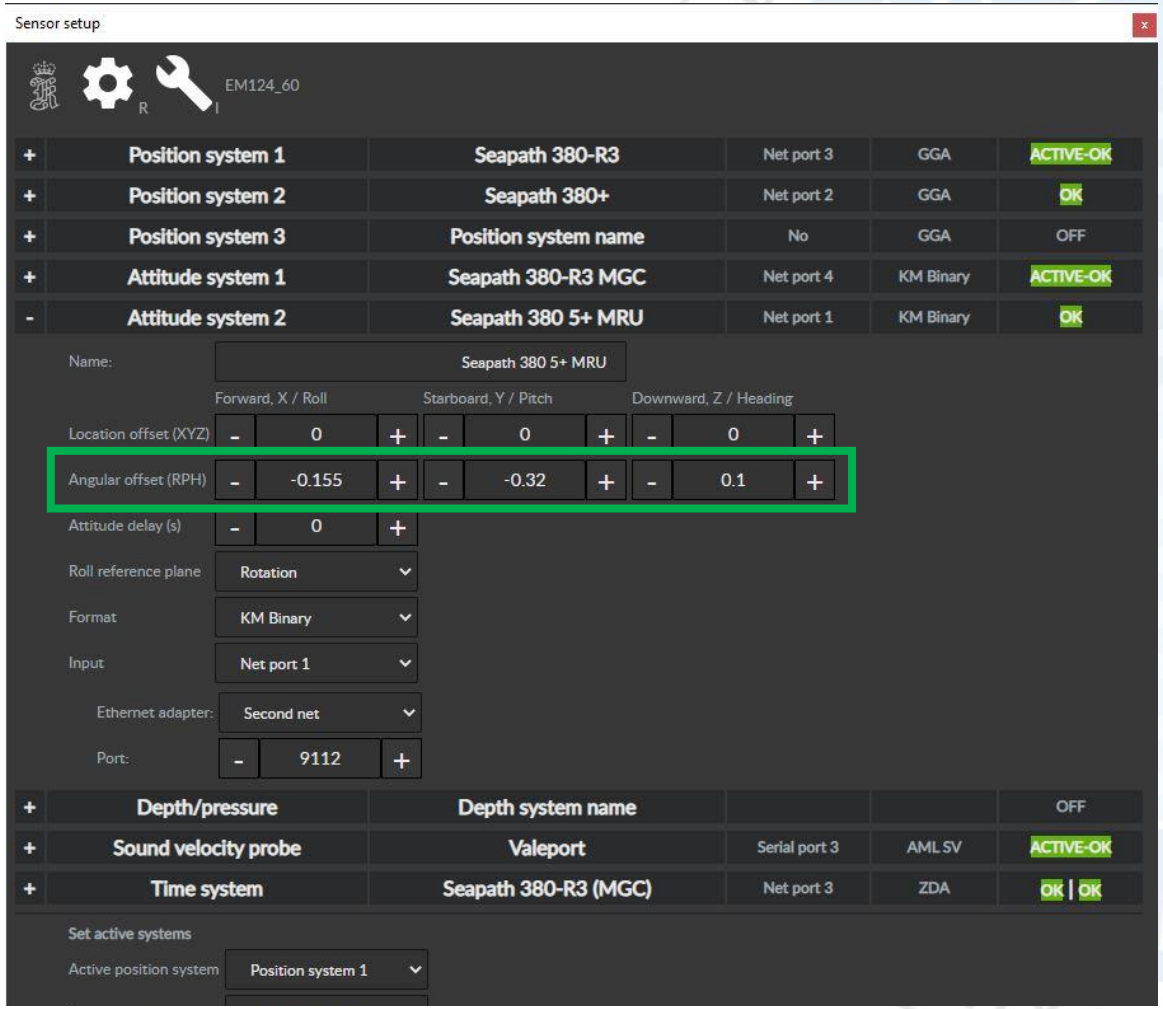


Heading calibration lines shown at left in the Qimera Patch Test Tool

1. Attitude 2 initial setting: +0.05°
2. Calibration adjustment: +0.05°
3. **Final heading offset: +0.10° in SIS**

EM124 Calibration

POST-CALIBRATION (EM124)



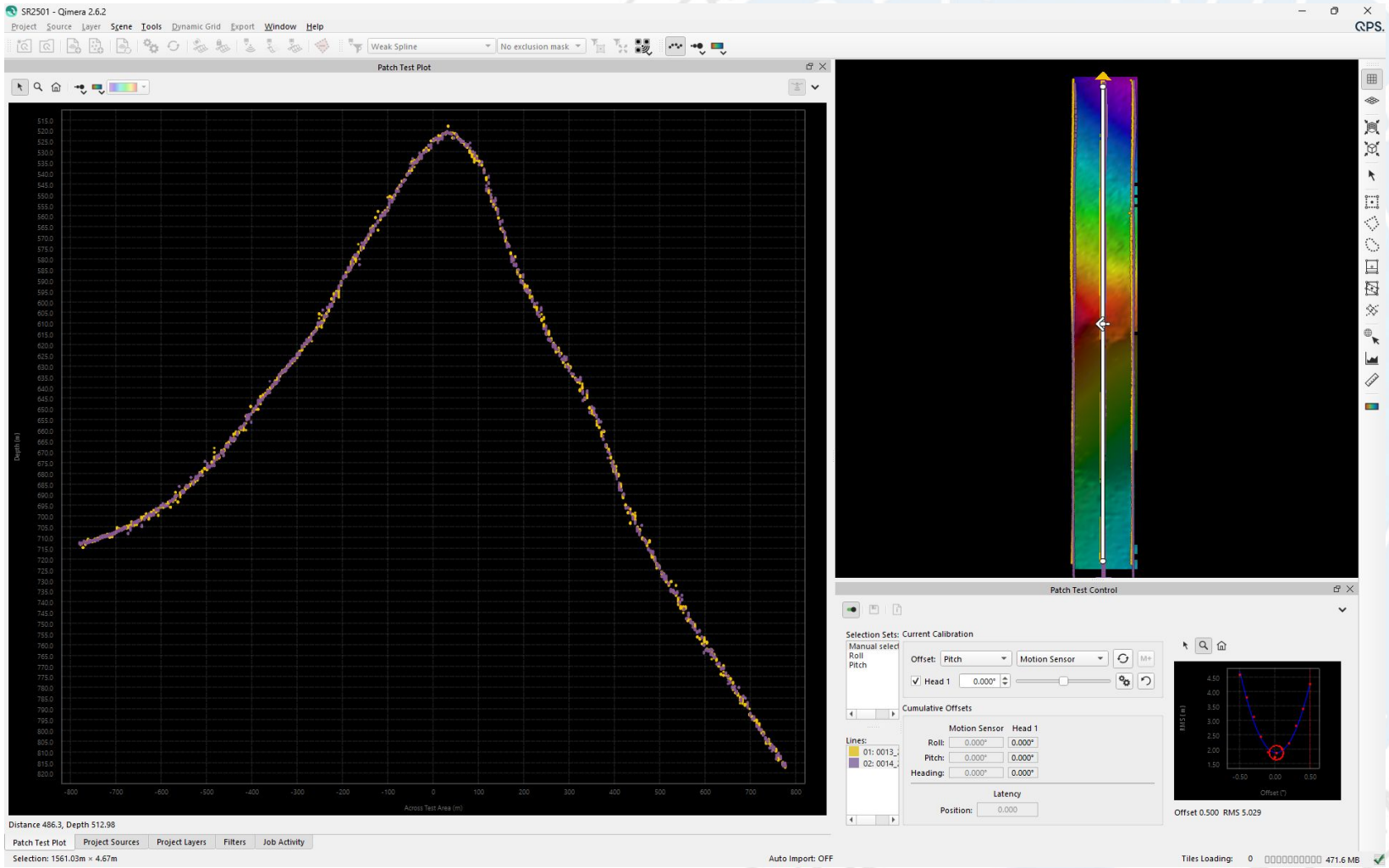
Attitude 2 Post-Cal. Configuration

1. The EM124 *Attitude 2* adjustments from SR2501 are very small, suggesting stable system geometry since the 2024 EM124 QAT

2. The *Installation Parameters: Angular Offsets* shown at left should be maintained until any modification is made to the EM124 or Seapath 380-5+, or another calibration becomes necessary for other reasons

EM712 Calibration

Results: Pitch (Seapath 380-R3)

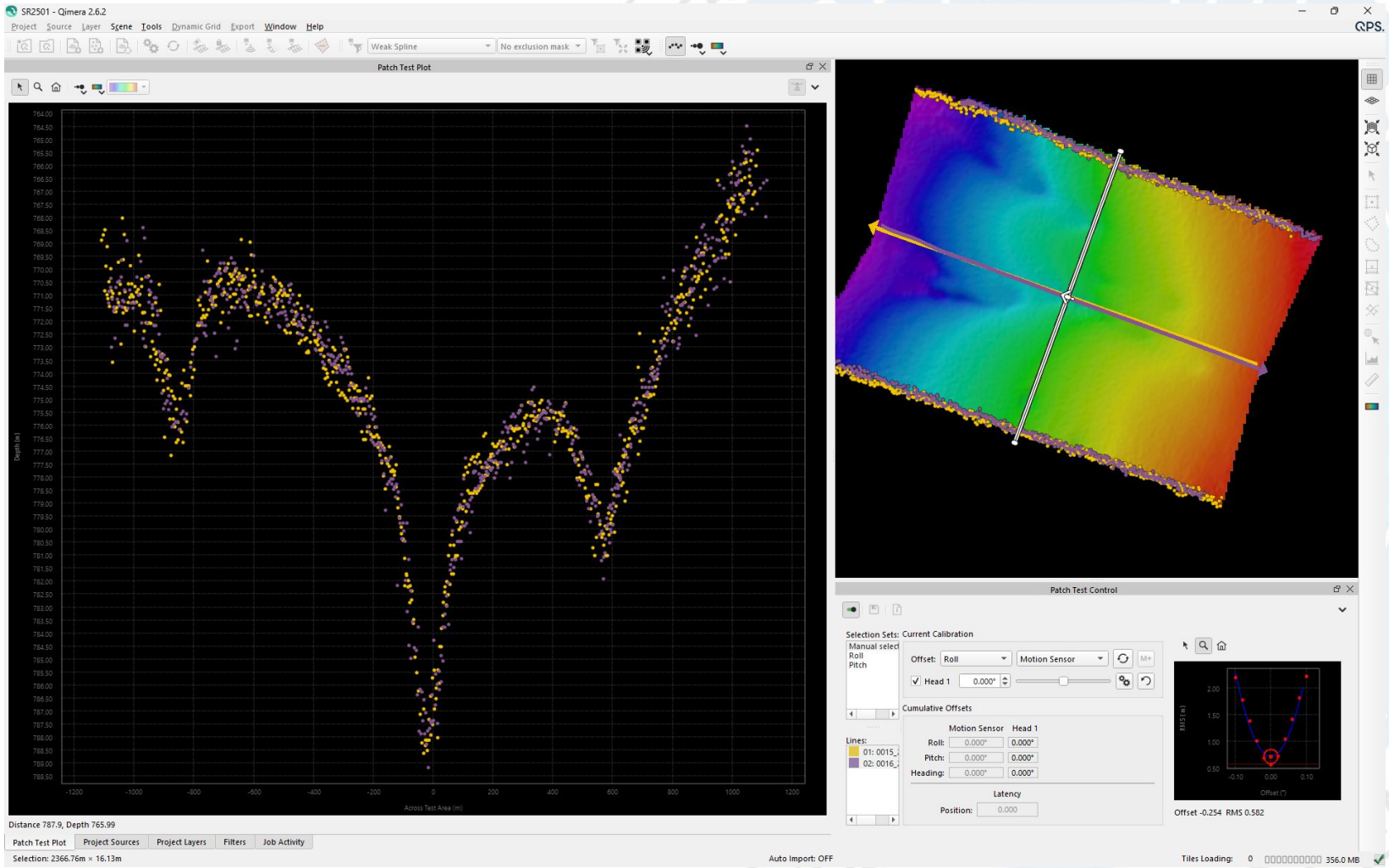


Pitch calibration lines shown at left in the Qimera Patch Test Tool

1. Attitude 1 initial setting: -0.08°
2. Calibration adjustment: -0.02°
3. **Final pitch offset: -0.10° in SIS**

EM712 Calibration

Results: Roll (Seapath 380-R3)

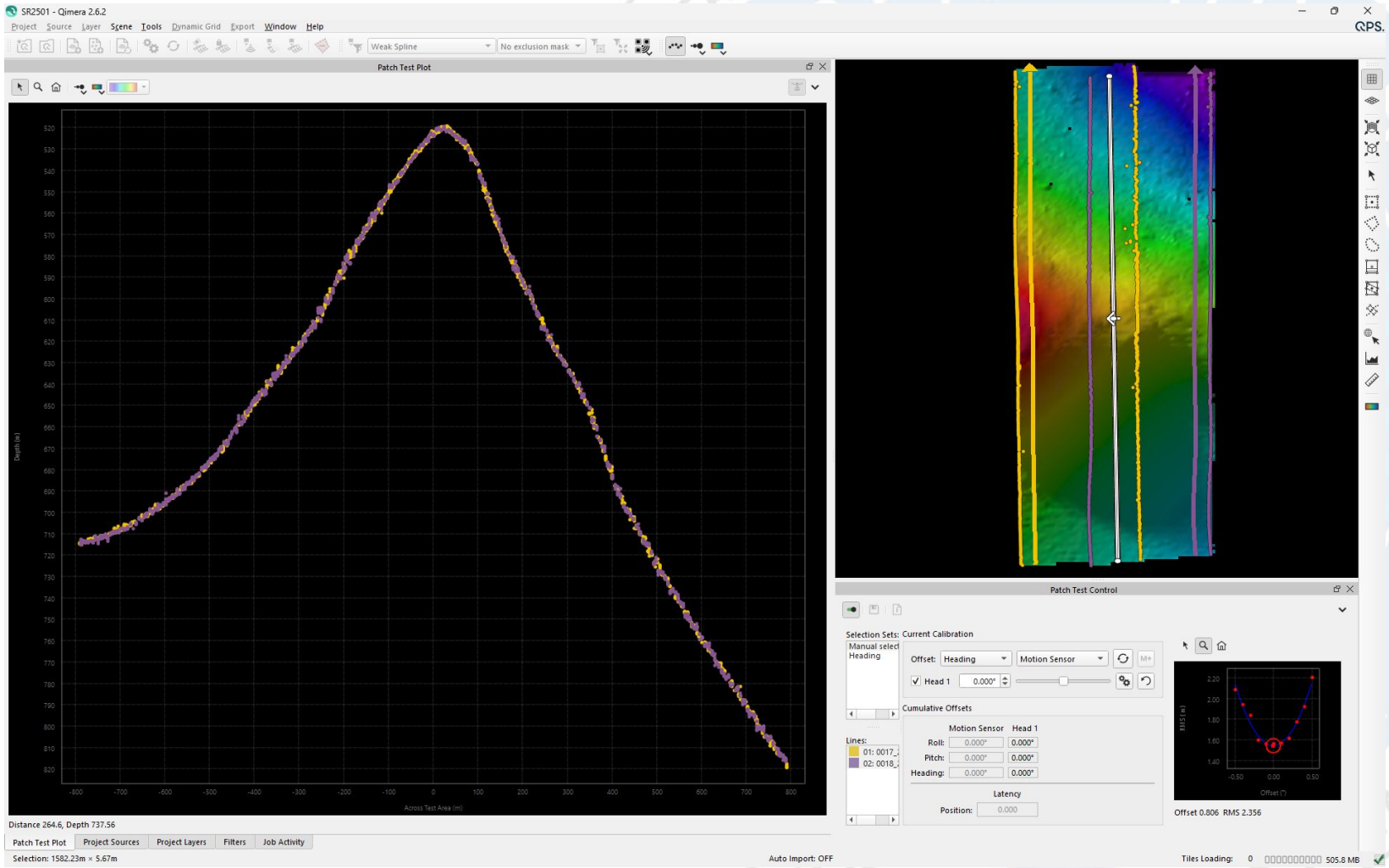


Roll verification lines shown at left in the Qimera Patch Test Tool

1. Attitude 1 initial setting: -0.07°
2. Calibration adjustment: -0.01°
3. **Final roll offset: -0.08° in SIS**

EM712 Calibration

Results: Heading (Seapath 380-R3)

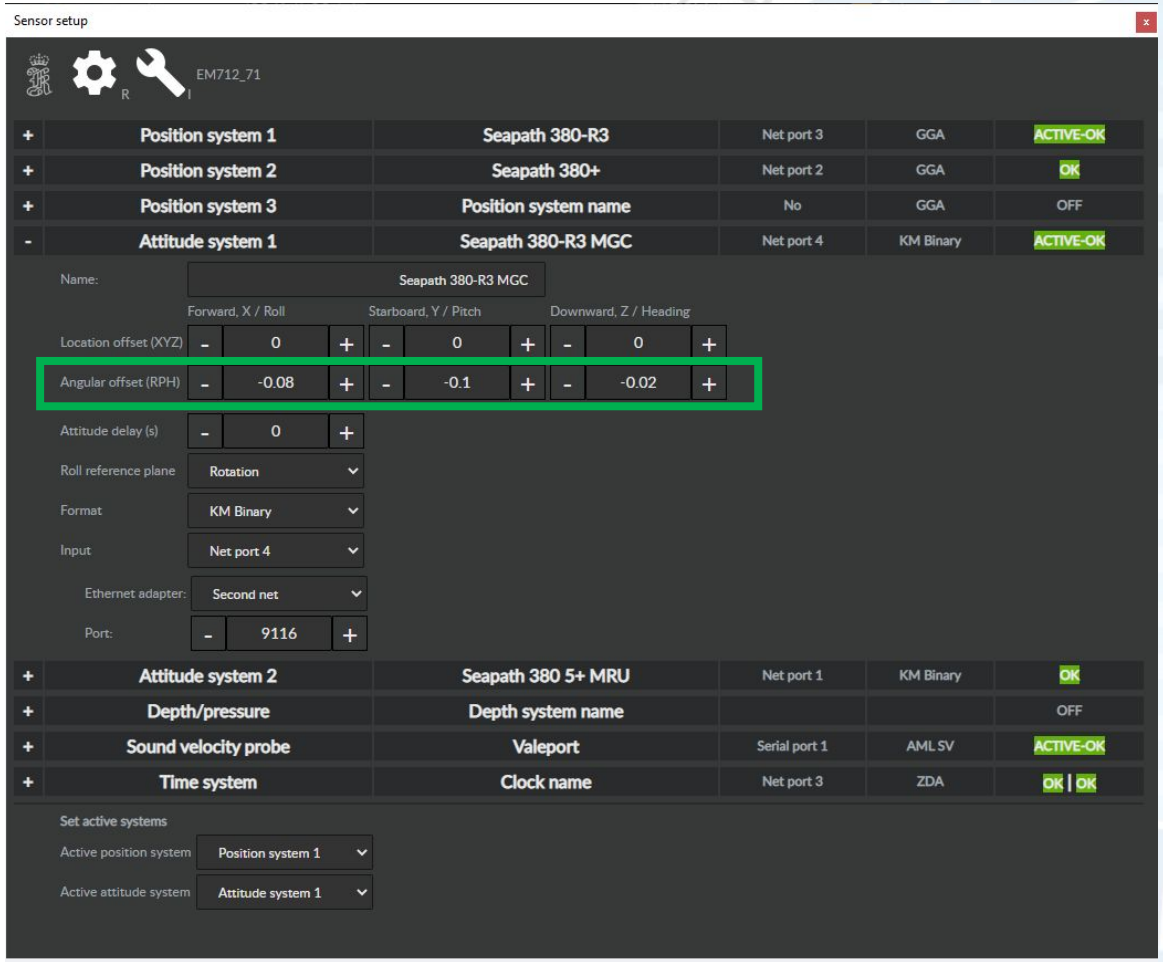


Heading calibration lines shown at left in the Qimera Patch Test Tool

1. Attitude 1 initial setting: -0.02°
2. Calibration adjustment: 0.00°
3. **Final heading offset: -0.02° in SIS**

EM712 Calibration

POST-CALIBRATION (EM712)



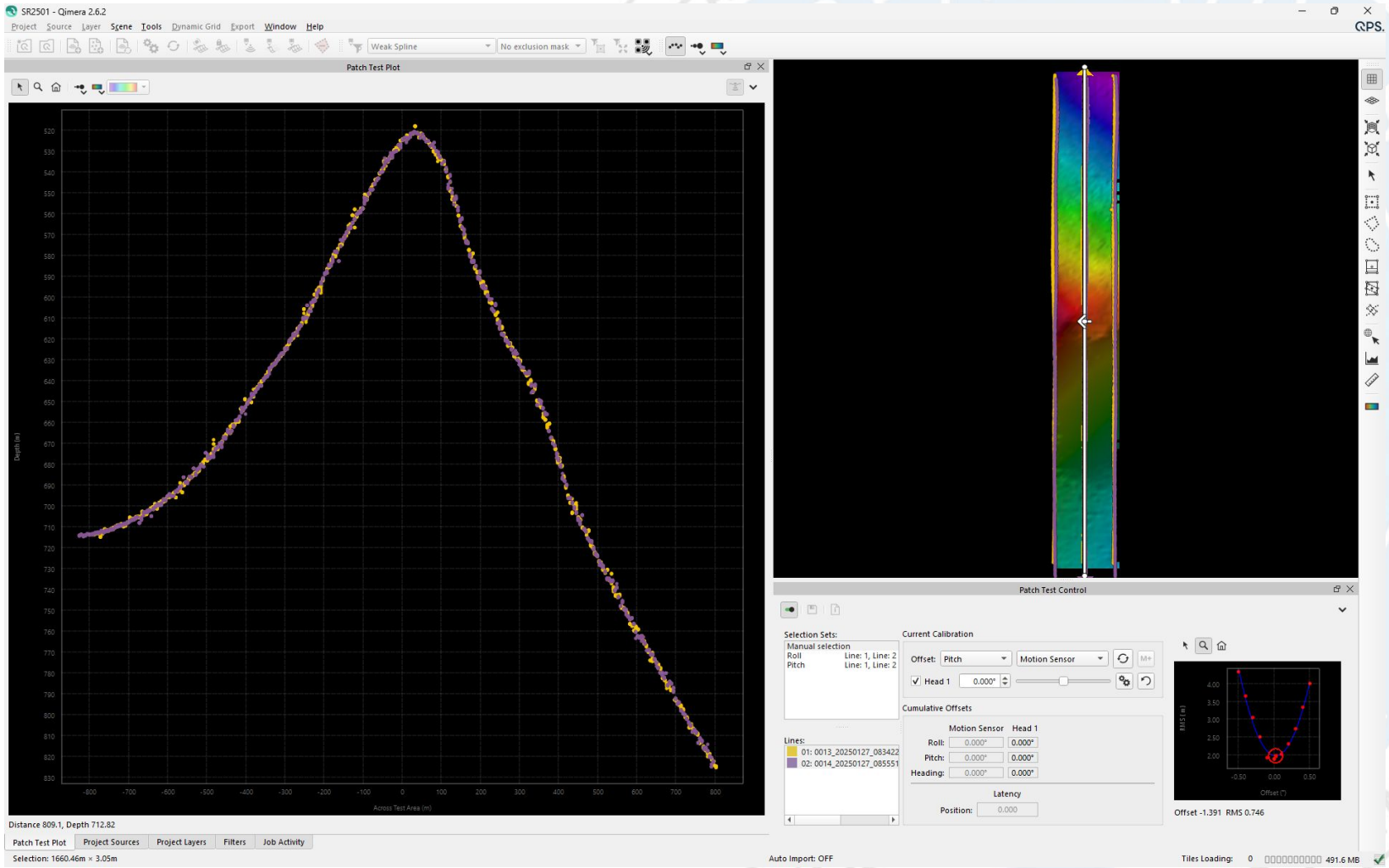
Attitude 1 Post-Cal. Configuration

1. The EM712 *Attitude 1* adjustments from SR2501 are very small, suggesting stable system geometry since the 2024 EM712 QAT and Seapath 380-R3 SAT

2. The *Installation Parameters: Angular Offsets* shown at left should be maintained until any modification is made to the EM712 or Seapath 380-R3, or another calibration becomes necessary for other reasons

EM712 Calibration

Results: Pitch (Seapath 380-5+)

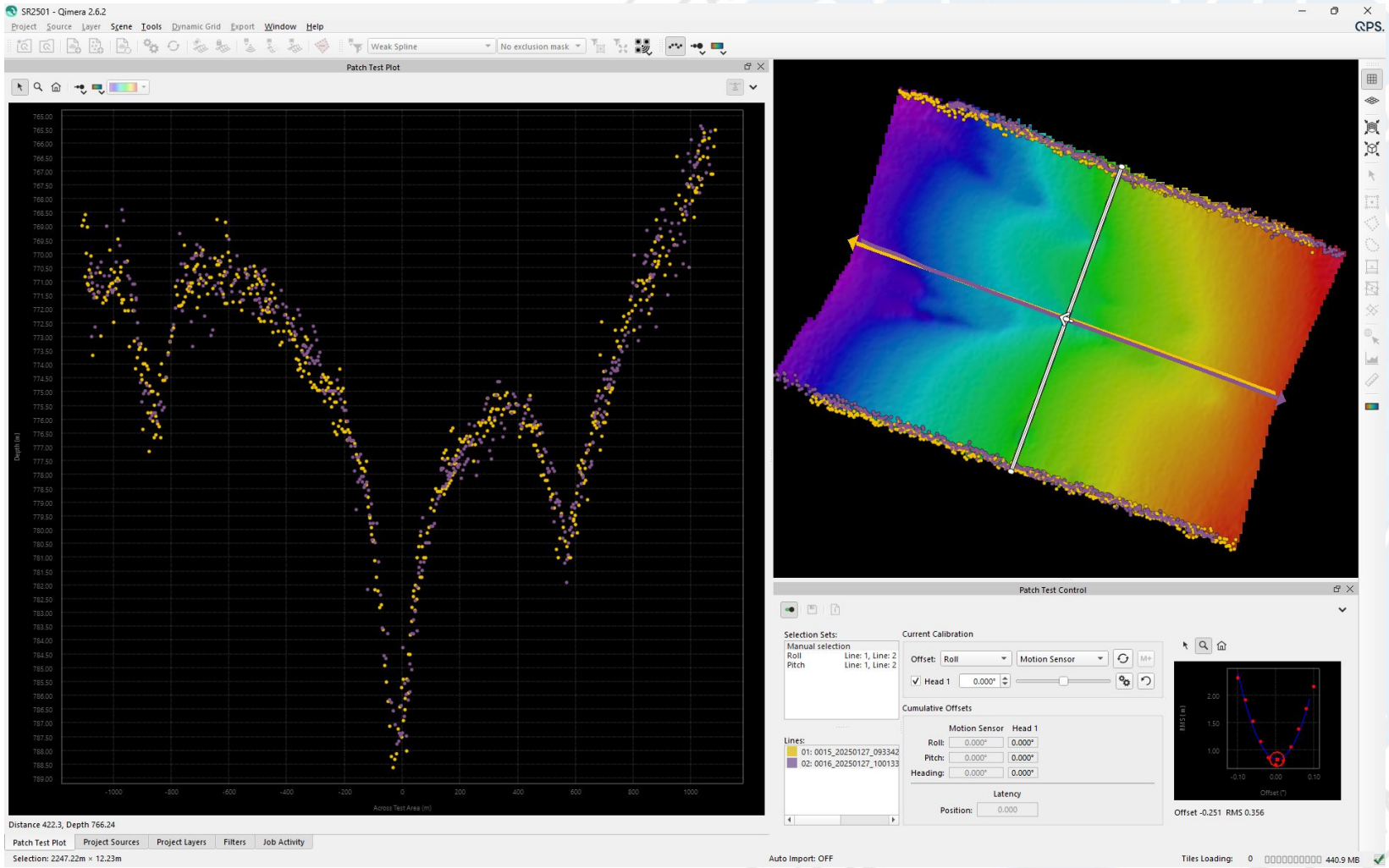


Pitch calibration lines shown at left in the Qimera Patch Test Tool

1. Attitude 2 initial setting: -0.38°
2. Calibration adjustment: 0.00°
3. **Final pitch offset: -0.38° in SIS**

EM712 Calibration

Results: Roll (Seapath 380-5+)

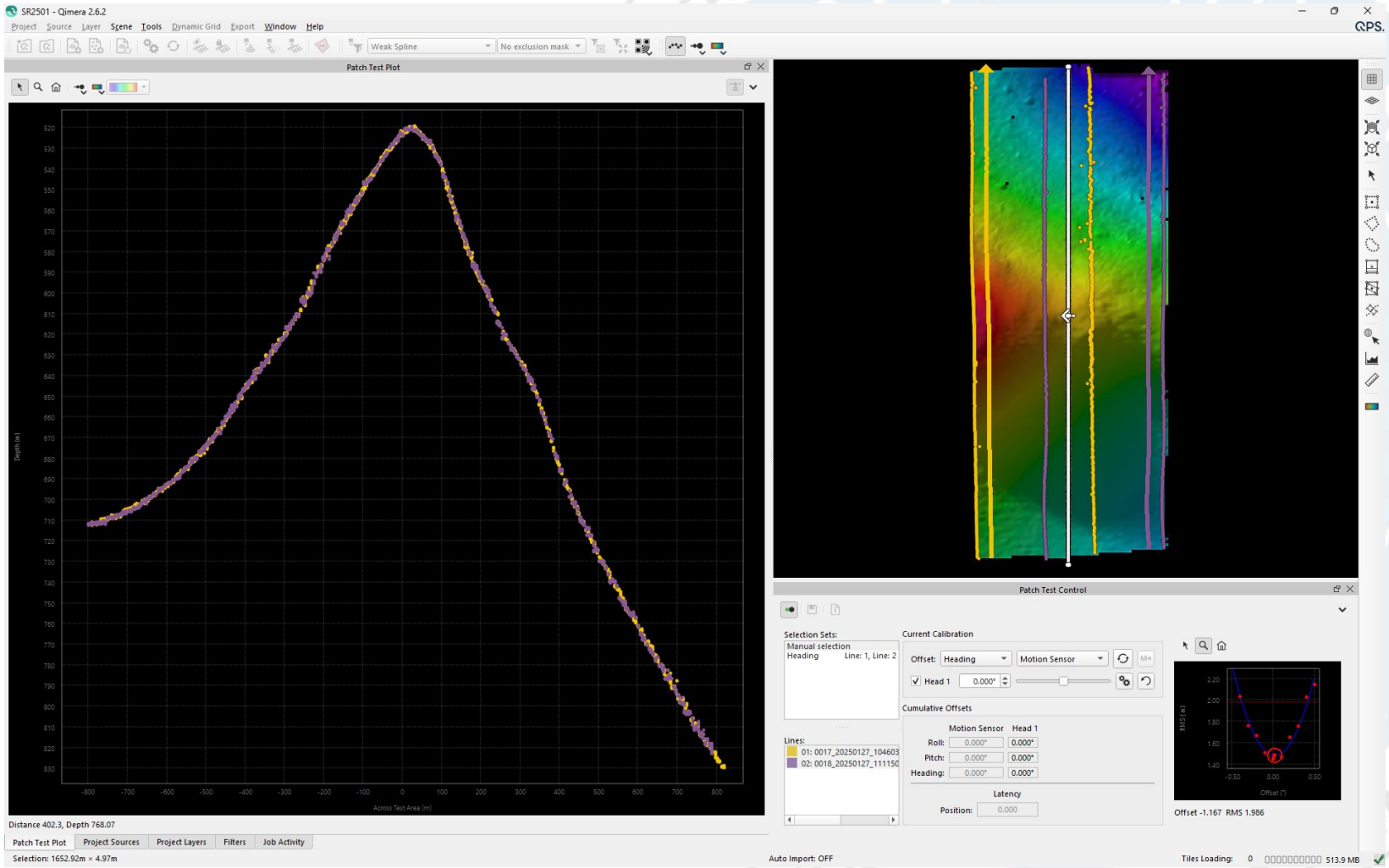


Roll verification lines shown at left in the Qimera Patch Test Tool

1. Attitude 2 initial setting: -0.12°
2. Calibration adjustment: +0.03°
3. **Final roll offset: -0.09° in SIS**

EM712 Calibration

Results: Heading (Seapath 380-5+)

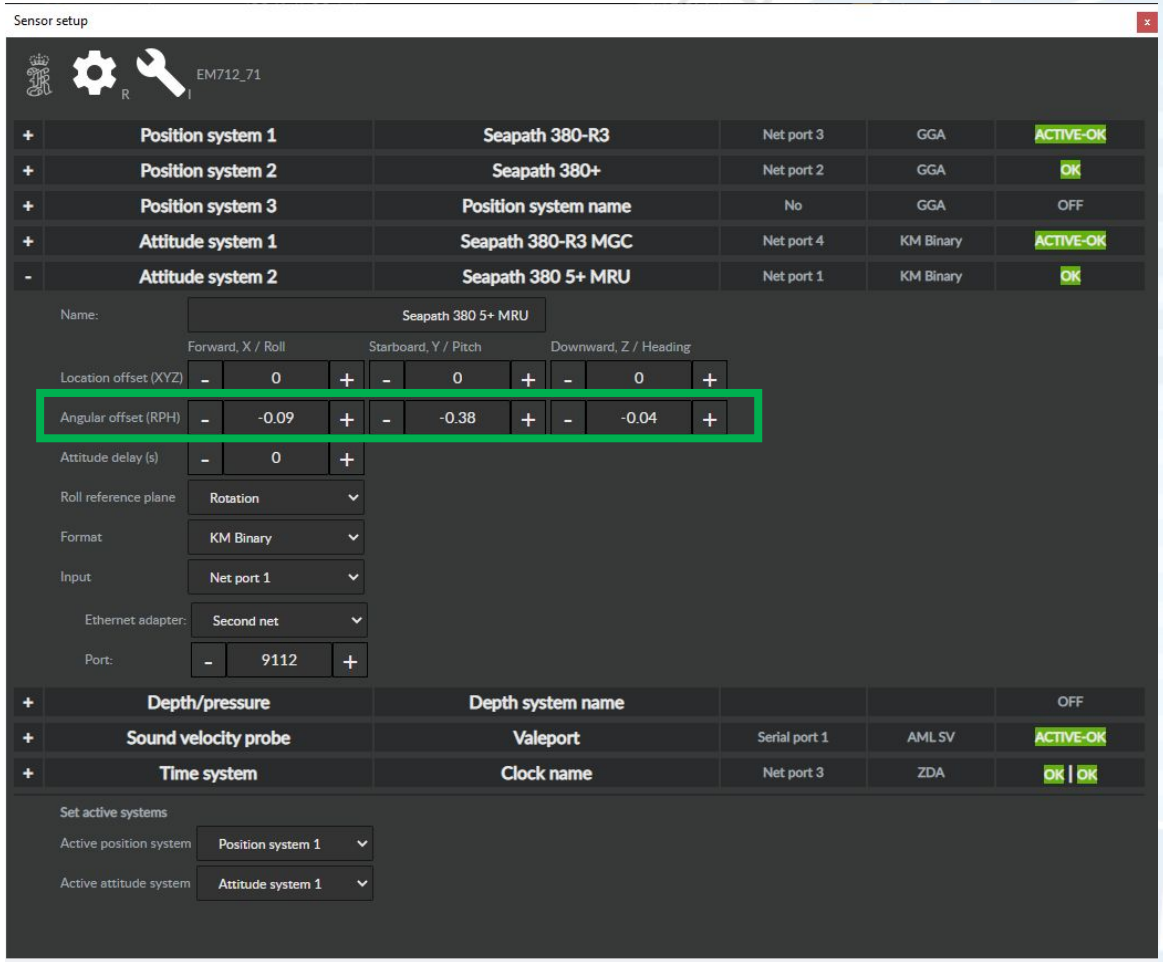


Heading calibration lines shown at left in the Qimera Patch Test Tool

1. Attitude 2 initial setting: -0.04°
2. Calibration adjustment: 0.00°
3. **Final heading offset: -0.04° in SIS**

EM712 Calibration

POST-CALIBRATION (EM712)



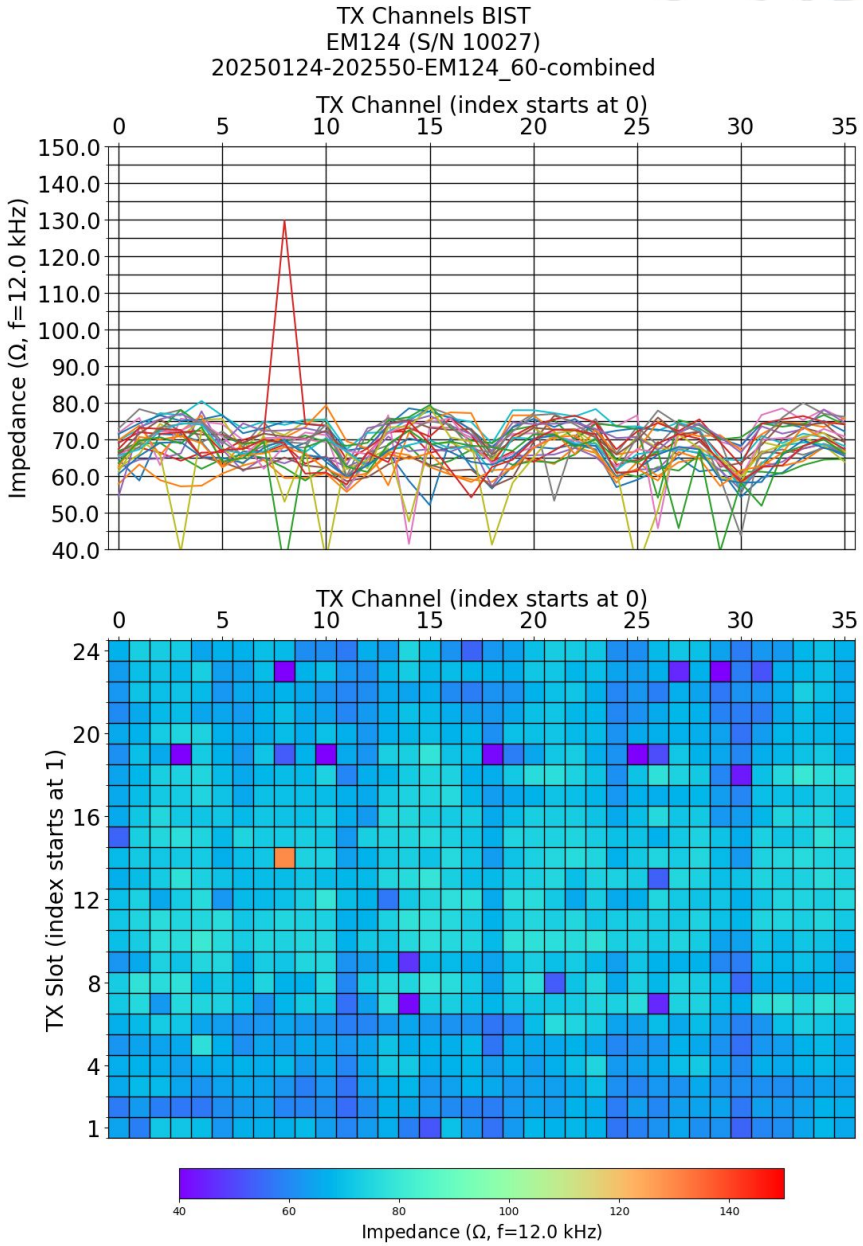
Attitude 2 Post-Cal. Configuration

1. The EM712 *Attitude 2* adjustments from SR2501 are very small, suggesting stable system geometry since the 2024 EM712 QAT

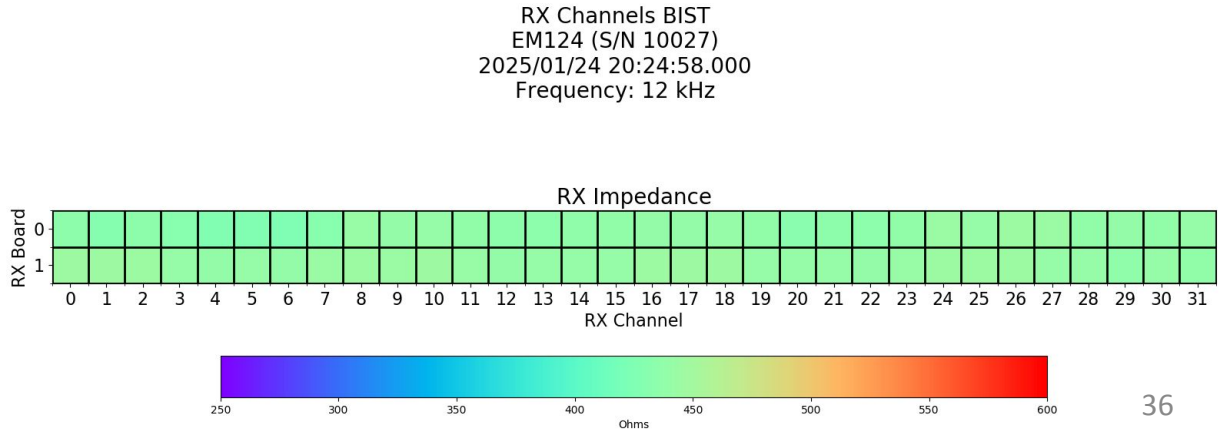
2. The *Installation Parameters: Angular Offsets* shown at left should be maintained until any modification is made to the EM712 or Seapath 380-5+, or another calibration becomes necessary for other reasons

EM124 Hardware Health

TX/RX Channels

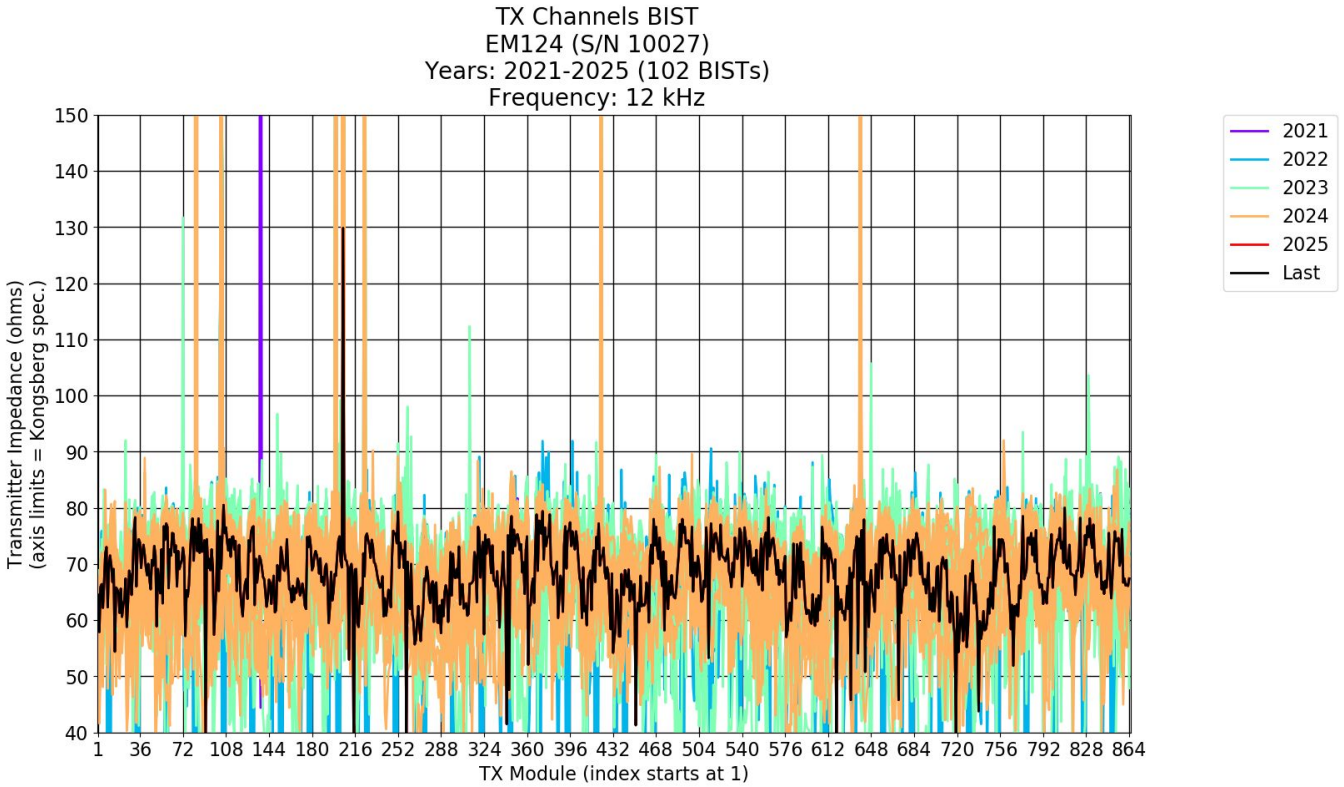


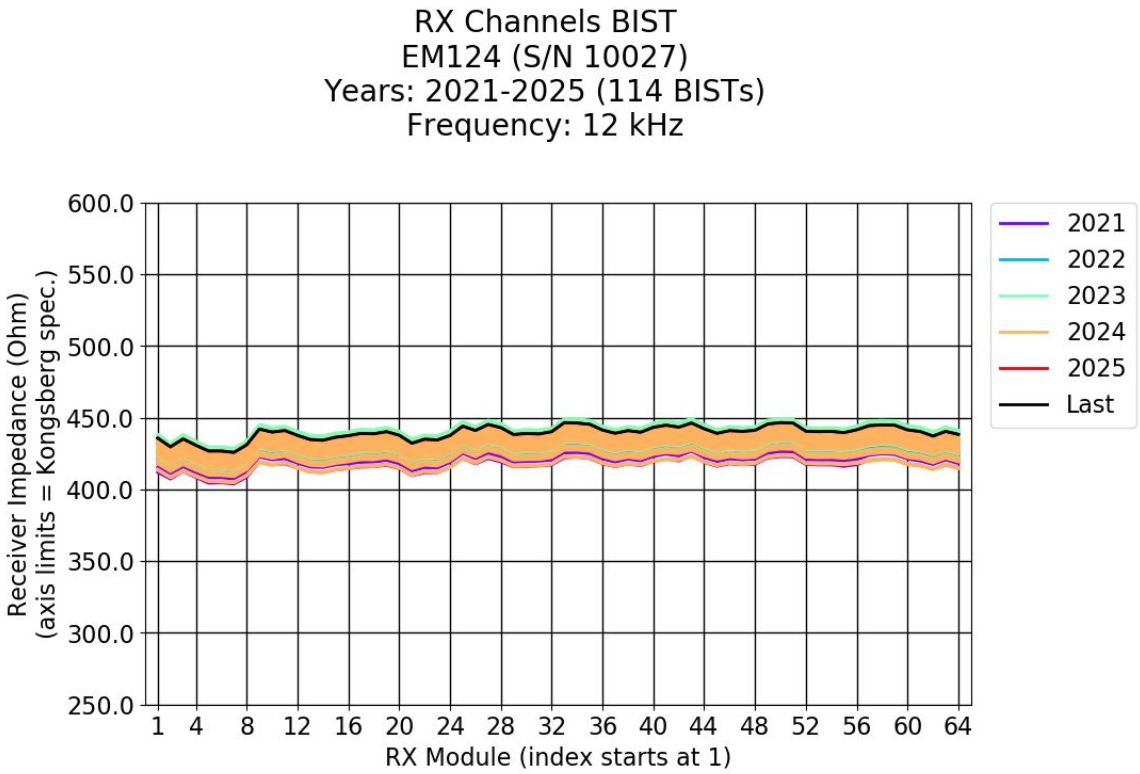
- EM124 Built-In Self-Tests (BISTs) have been collected routinely since the HAT and SAT portions of SR2104, including TX and RX Channels data that are useful as proxies for hardware health
- The color scale on each plot is based on the acceptable impedance range to pass a BIST, as defined by Kongsberg
- The most recent TX and RX Channels tests (2025-01-24) are shown here; the next slide presents their 2021-25 histories
- While only two EM124 TX elements appear to be outside factory limits, around a dozen TX elements have started to show significantly lower Z since last year (see SR2401 report)



EM124 Hardware Health

TX/RX Channels History



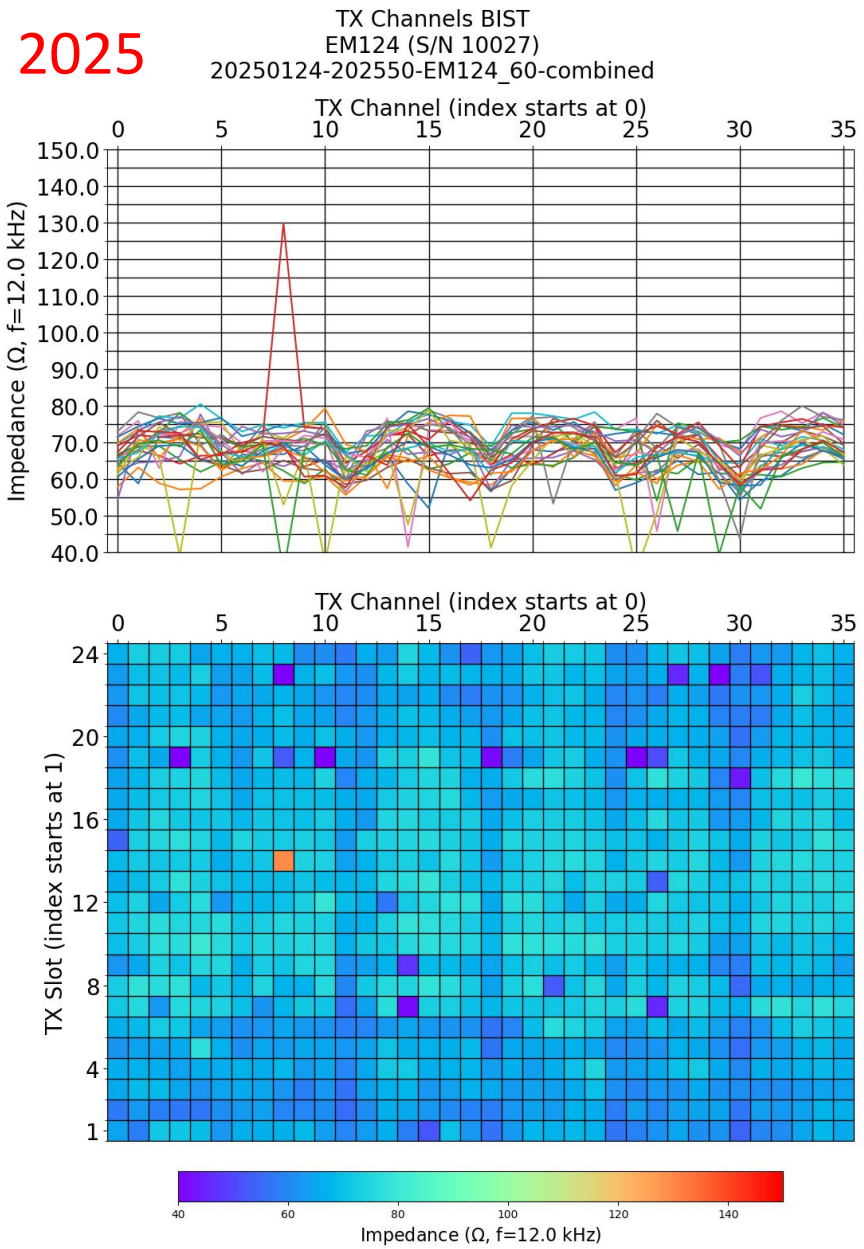


- All available TX and RX Channels BIST files (that parse correctly) are presented here for the EM124
- While these are not a replacement for direct impedance tests, TX and RX Channels BISTs should be performed routinely (e.g., before and after each mapping mission) to monitor for channel failures and shifts over time

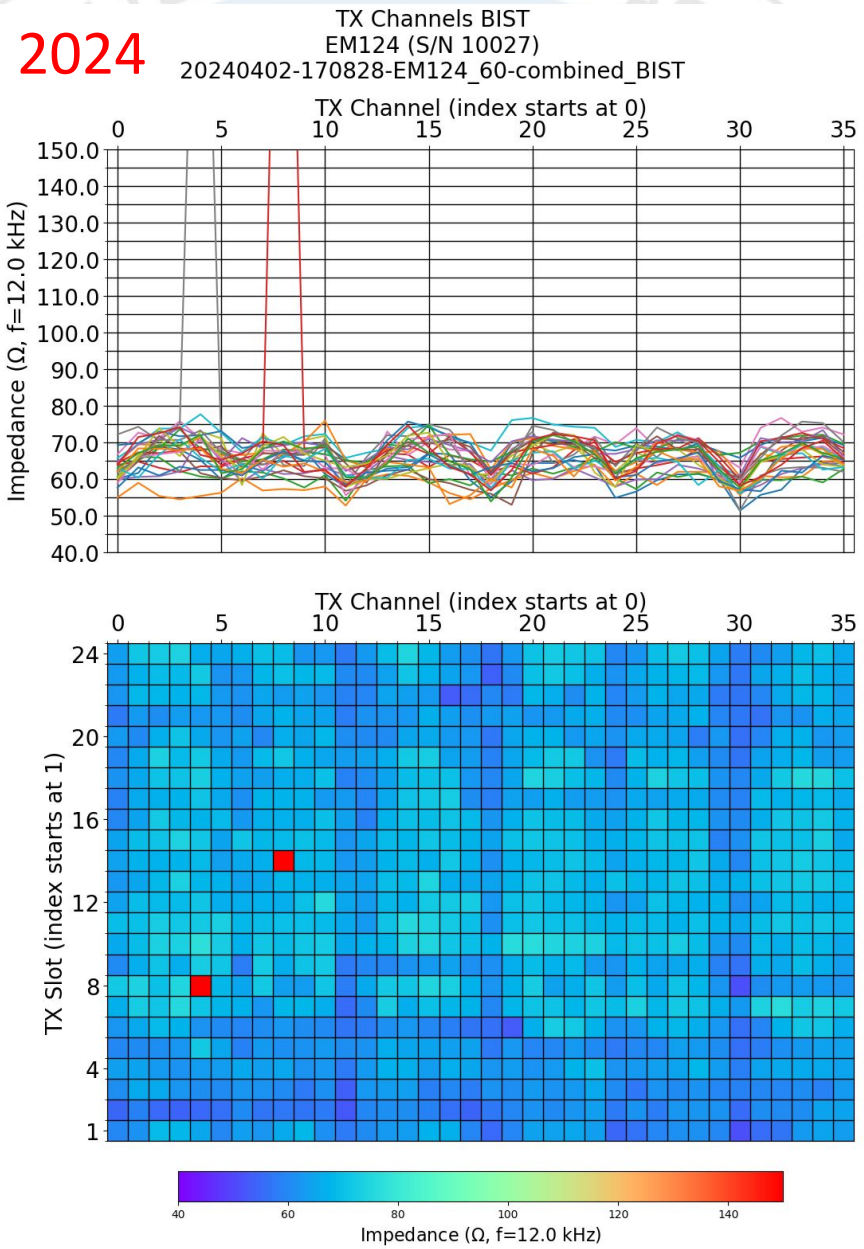
EM124 Hardware Health

TX Channels Changes 2024-25

2025

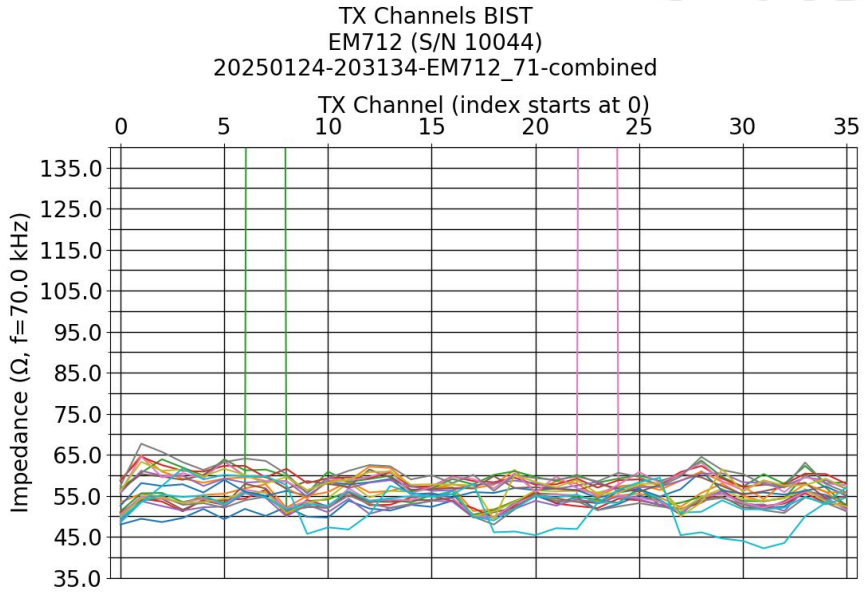


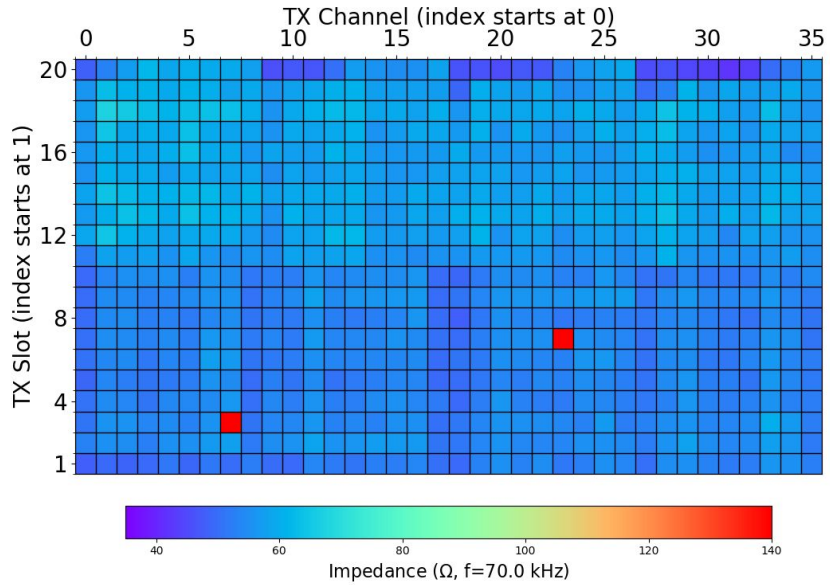
2024



- There are notable changes in TX Channels from 2024 to 2025
- High Z: the two high-Z elements have returned within spec (e.g., possibly related to a cable pin connection issue that has been partially resolved)
- Low Z: approximately a dozen channels have started to show significantly lower Z in one year; these appear as purple elements in the 2025 plot at left
- These low-Z channels should be monitored with routine BISTs and investigated with Kongsberg support if the trend continues

EM712 Hardware Health

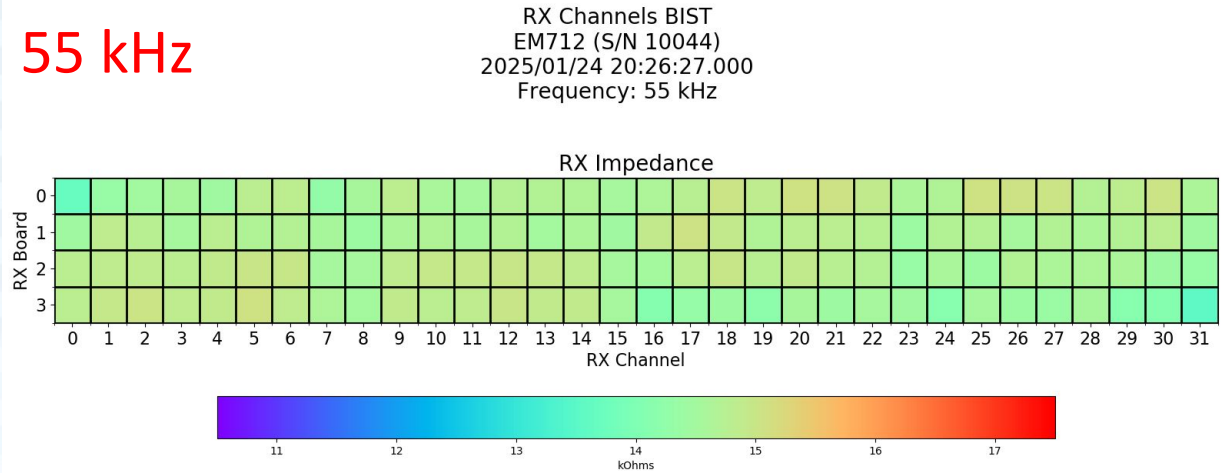




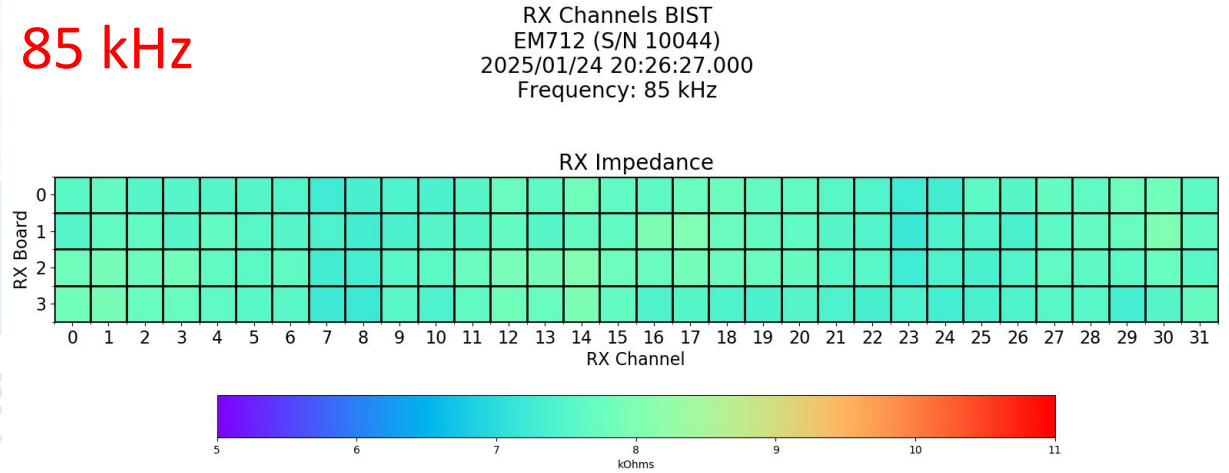
TX/RX Channels

- EM712 Built-In Self-Tests (BISTs) have been collected routinely since the HAT and SAT portions of SR1601, including TX and RX Channels data that are useful as proxies for hardware health
- All but one TX channel and all RX channels are within spec.

55 kHz

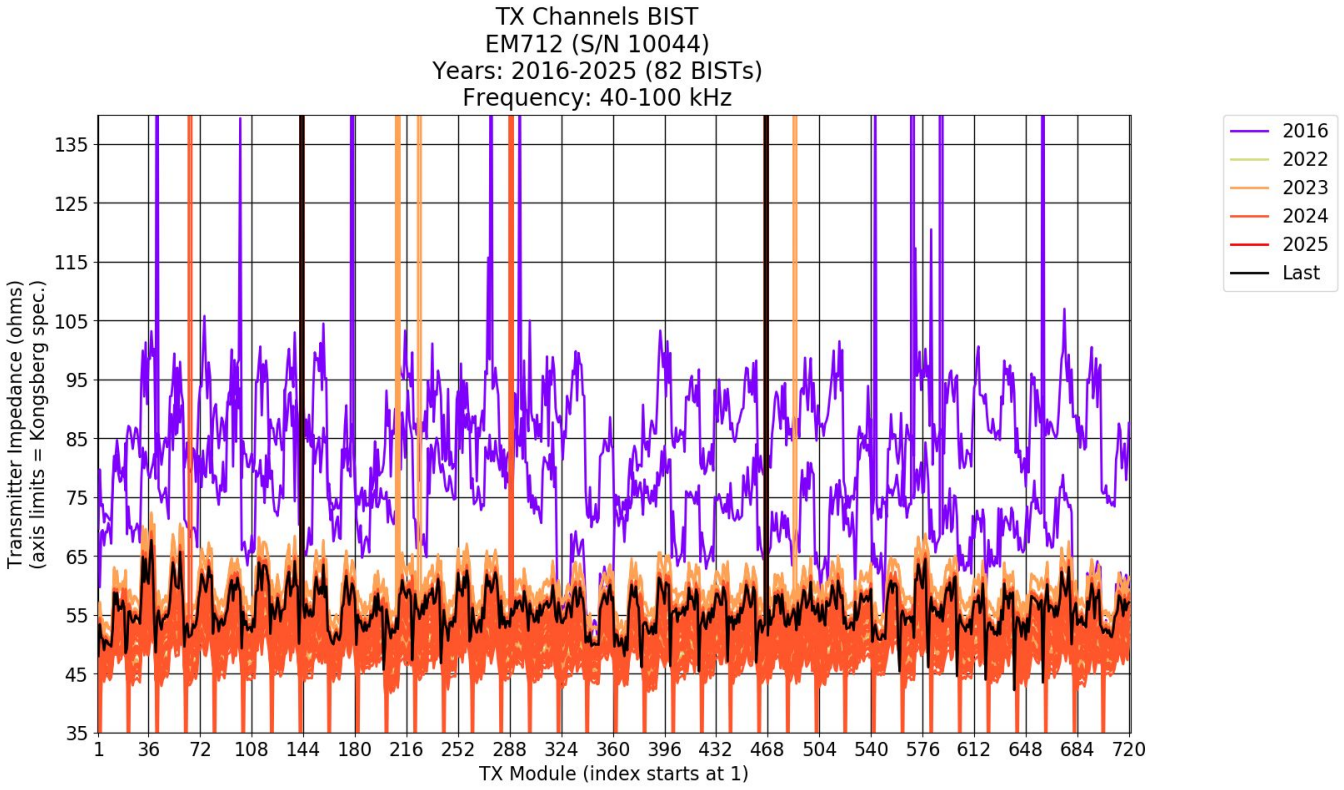


85 kHz

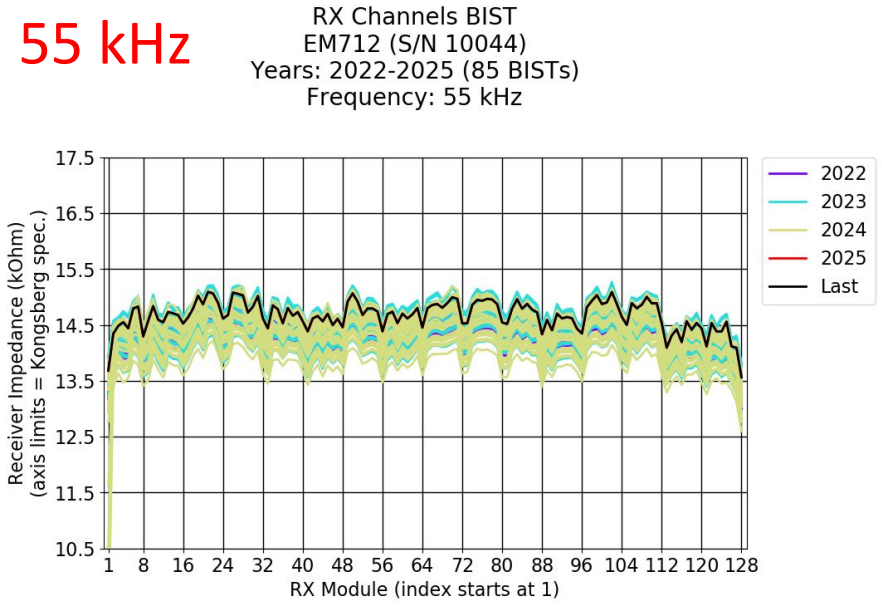


EM712 Hardware Health

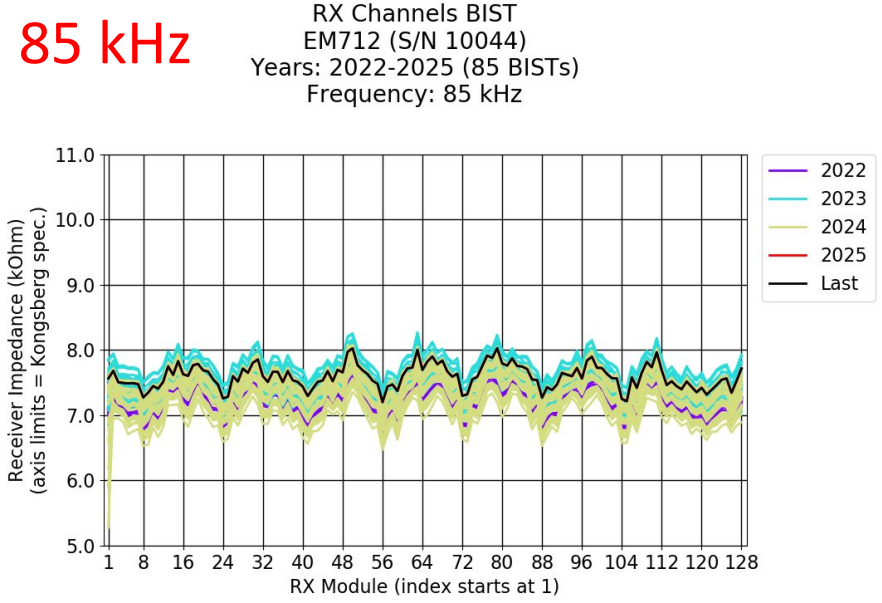
TX/RX Channels History



55 kHz



85 kHz



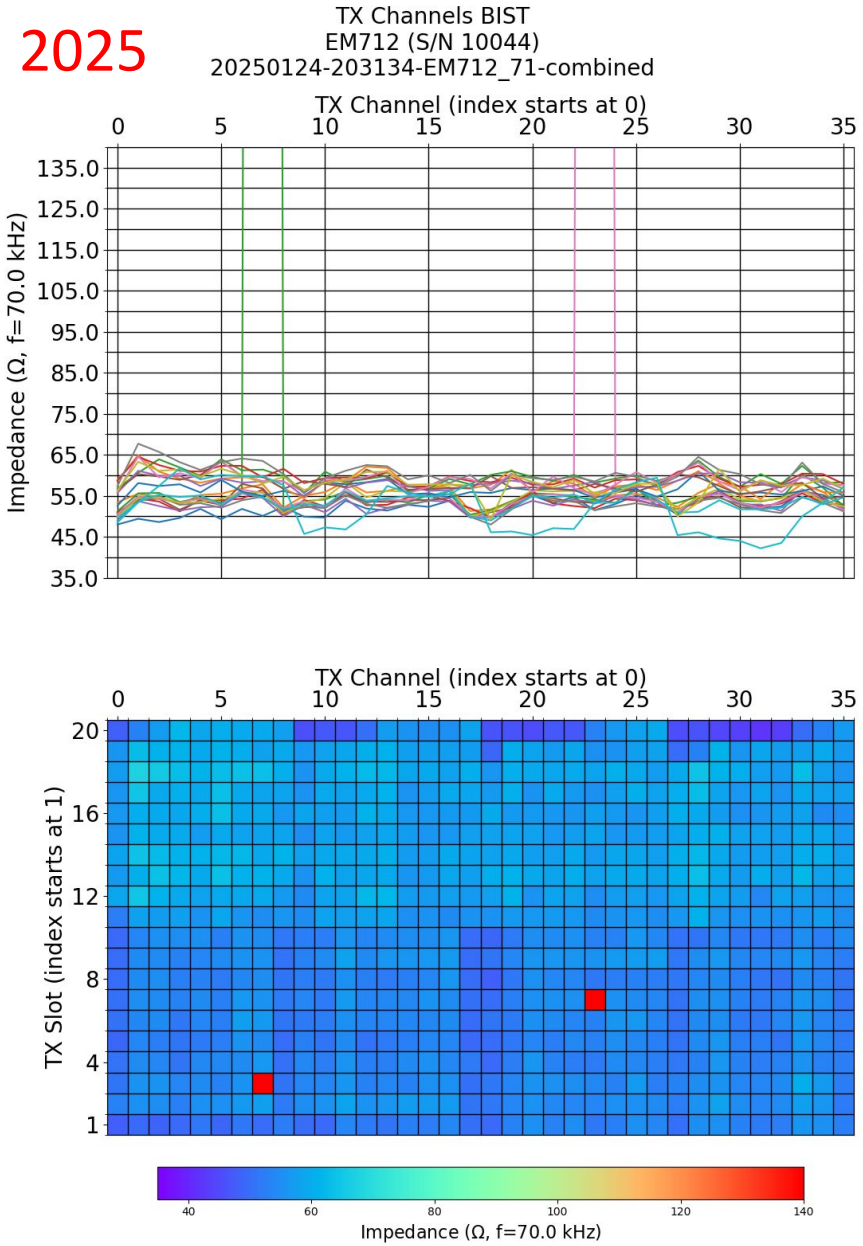
As noted in 2024, the cause of the general downward shift of TX Channels results between 2016 and 2022 is not known (no BISTs from 2017-2021 are included); the 2022-25 results appear stable and within spec. aside from two TX elements

RX Channels BISTs from 2016-21 are available but do not parse and plot correctly; all 2022-25 RX data are within spec.

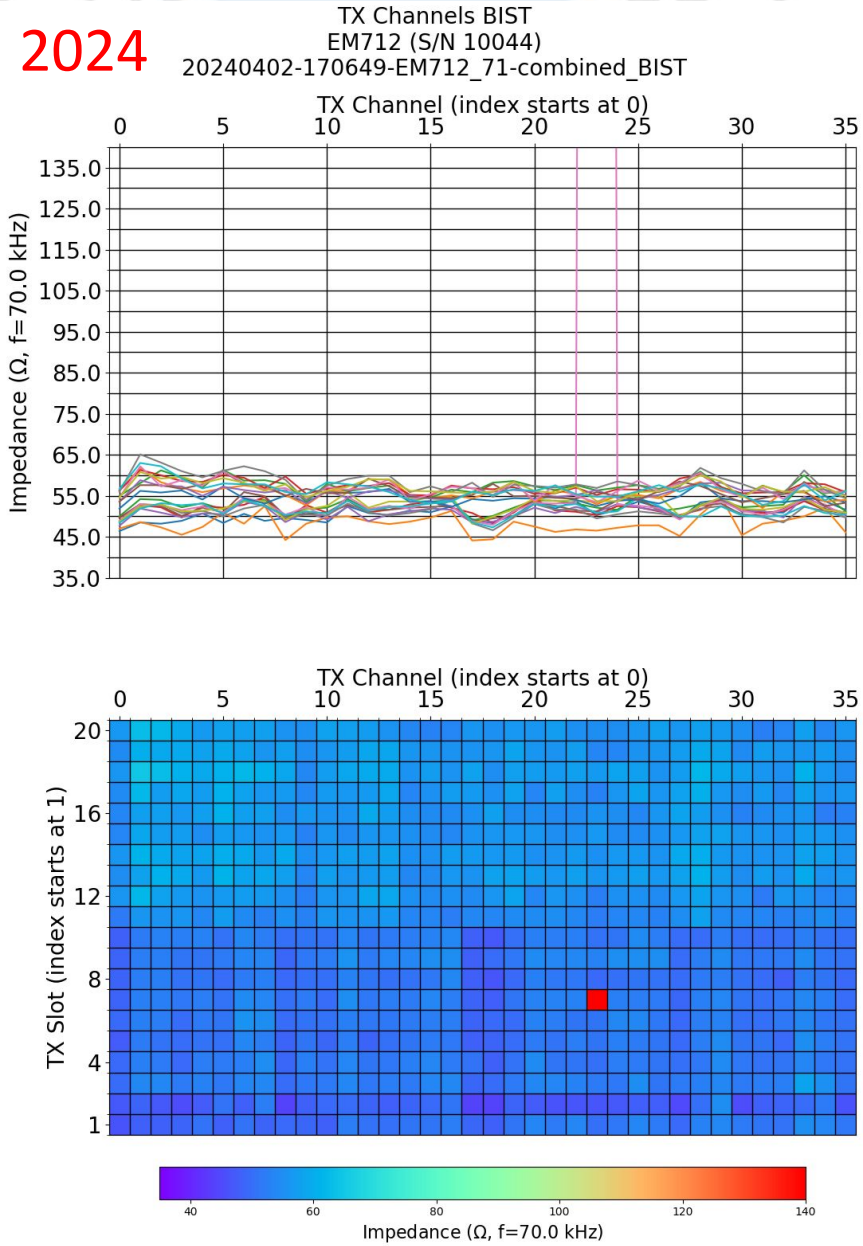
EM712 Hardware Health

TX Channels Changes 2024-25

2025



2024

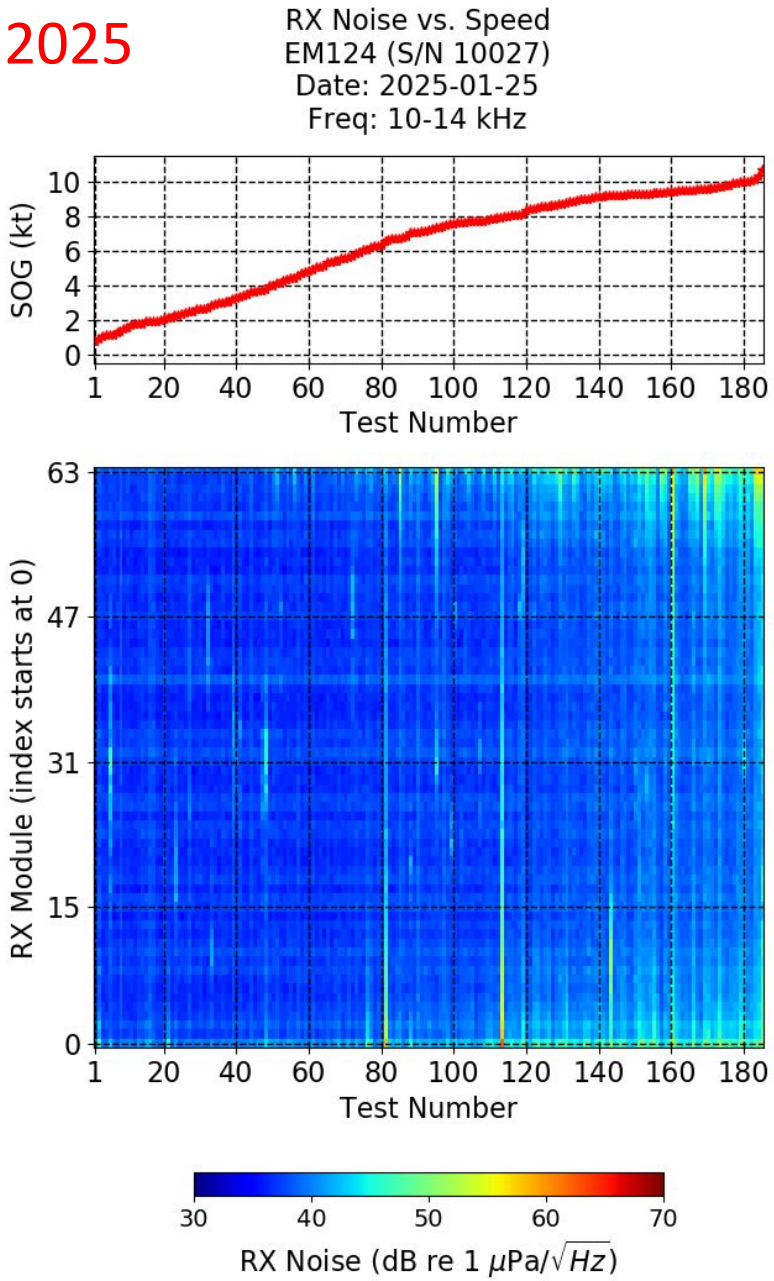


- There are a few changes in TX Channels from 2024 to 2025
- High Z: the single high-Z element from 2024 persists and another high-Z element has appeared
- Low Z: Approximately half of the elements associated with slot 20 have started to show lower Z than last year; these appear as small batches of purple elements at the top of the 2025 plot at left
- As with the EM124, these low-Z channels should be monitored with routine BISTs; unlike the EM124, these are associated with a single slot and may be related to a card issue rather than scattered single elements or cables across the array

RX Noise BIST Assessment

EM124 Noise Level vs. Speed

2025



Major limitations of multibeam performance can stem from elevated noise levels due to hull design, engines and other machinery, sea state, biofouling, electrical interference, etc.

To characterize the vessel's noise environment as perceived by the EM systems, a series of continuous RX Noise Level Built-In Self-Tests (BISTs) were recorded while slowly accelerating and decelerating over a range of 0-10 kn in deep water (>1000 m) and calm seas

All tests from both series (accelerating and decelerating) are combined into single plots because there were no appreciable differences in trends between the two test conditions

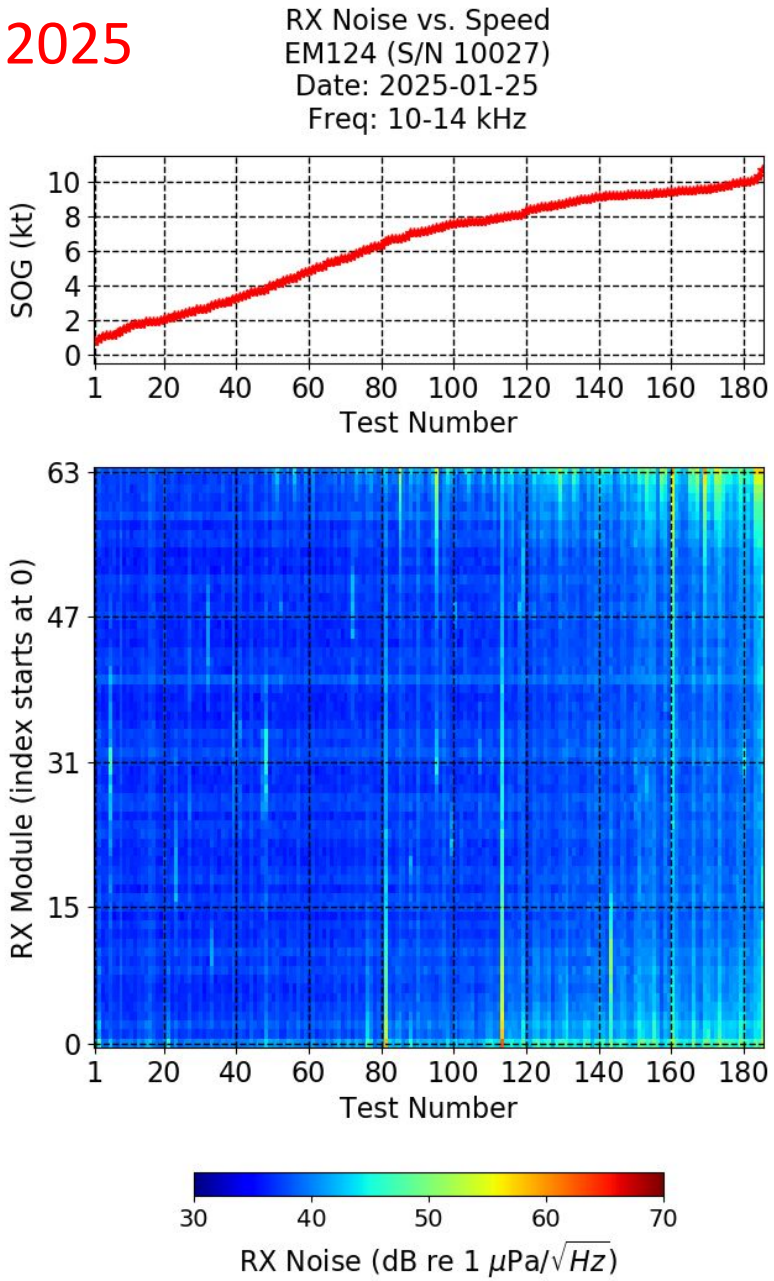
EM124 RX Noise Level versus speed on 2025-01-25 is shown at left

The 2025 EM124 data show low noise levels across the speed range, consistent with testing in 2021 (SAT) and 2024 (QAT), and a stable recovery from the high noise levels observed in 2023

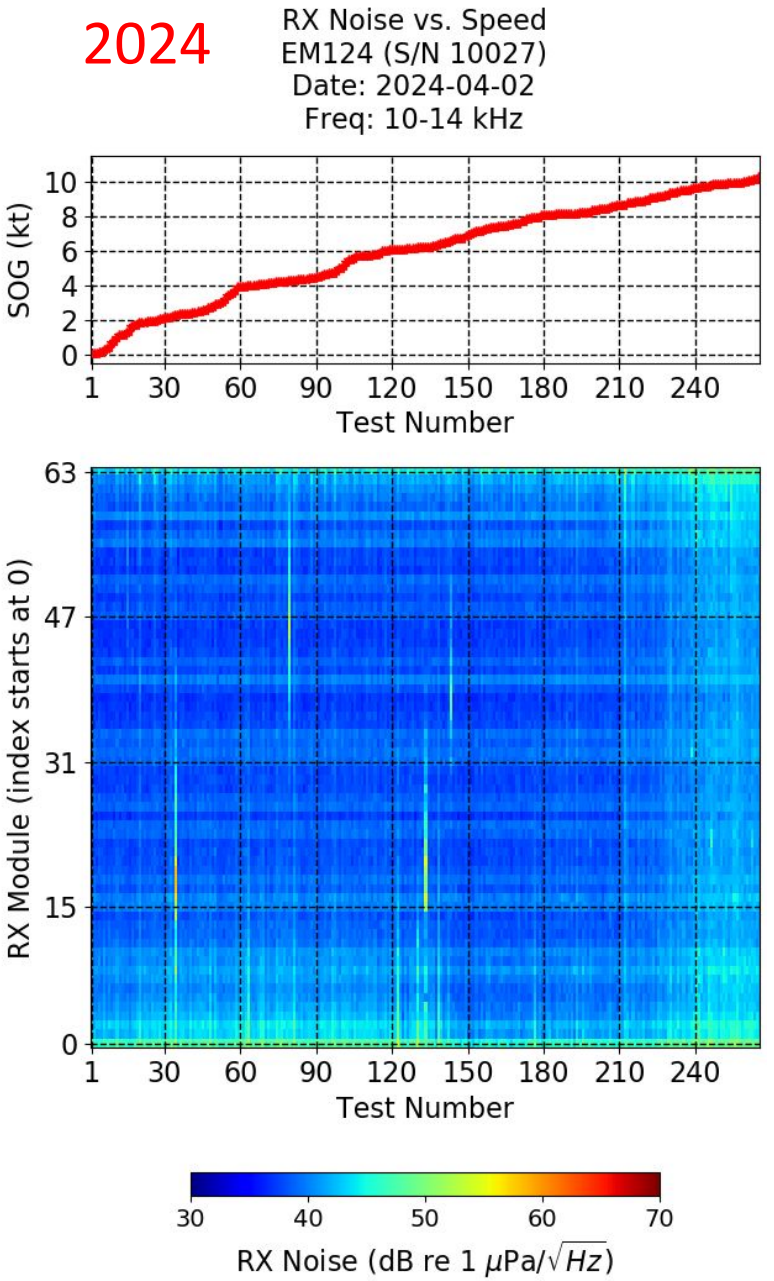
RX Noise BIST Assessment

EM124 Noise vs. Speed History

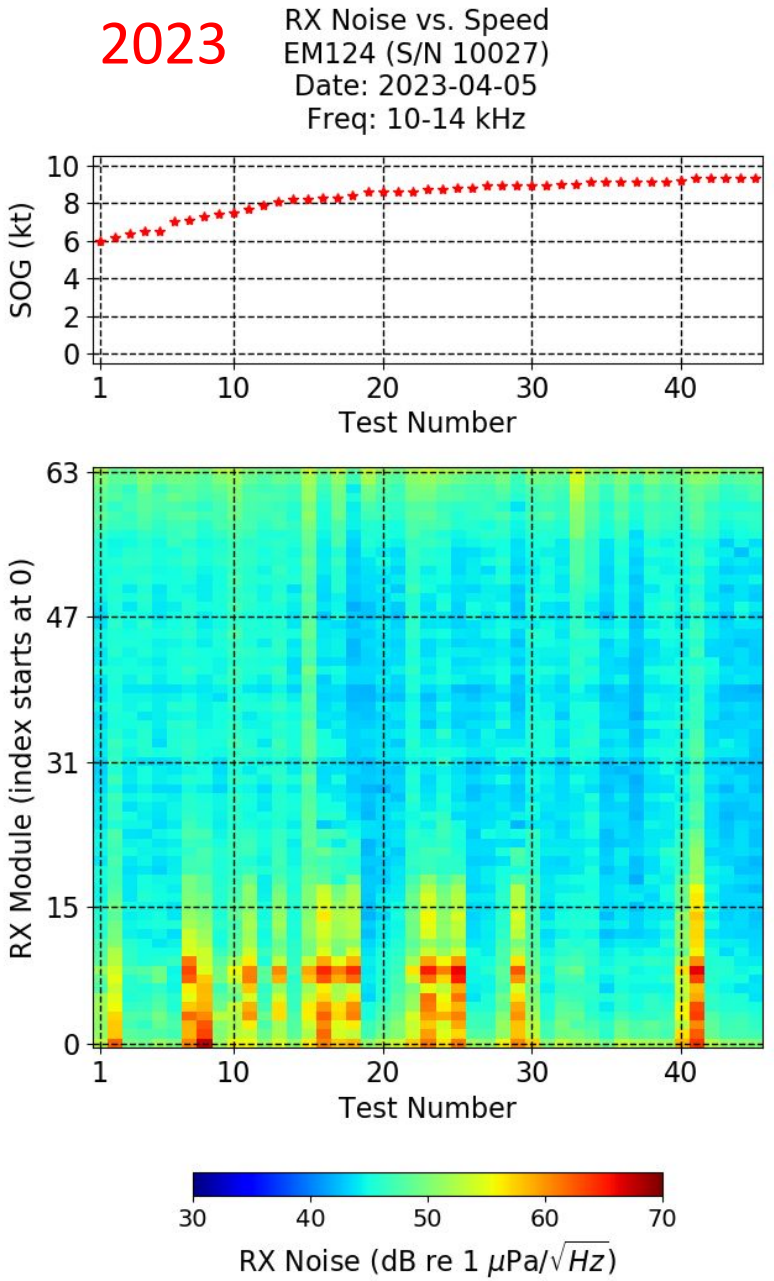
2025



2024



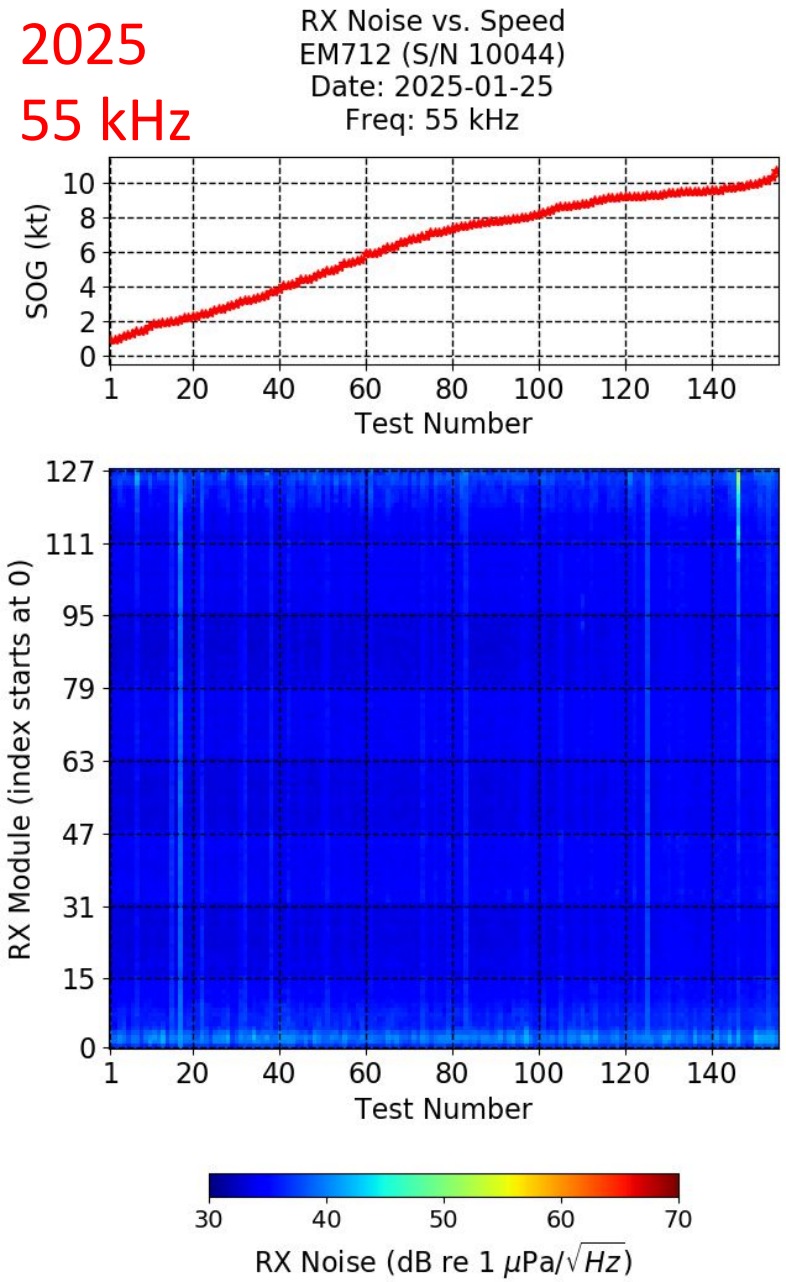
2023



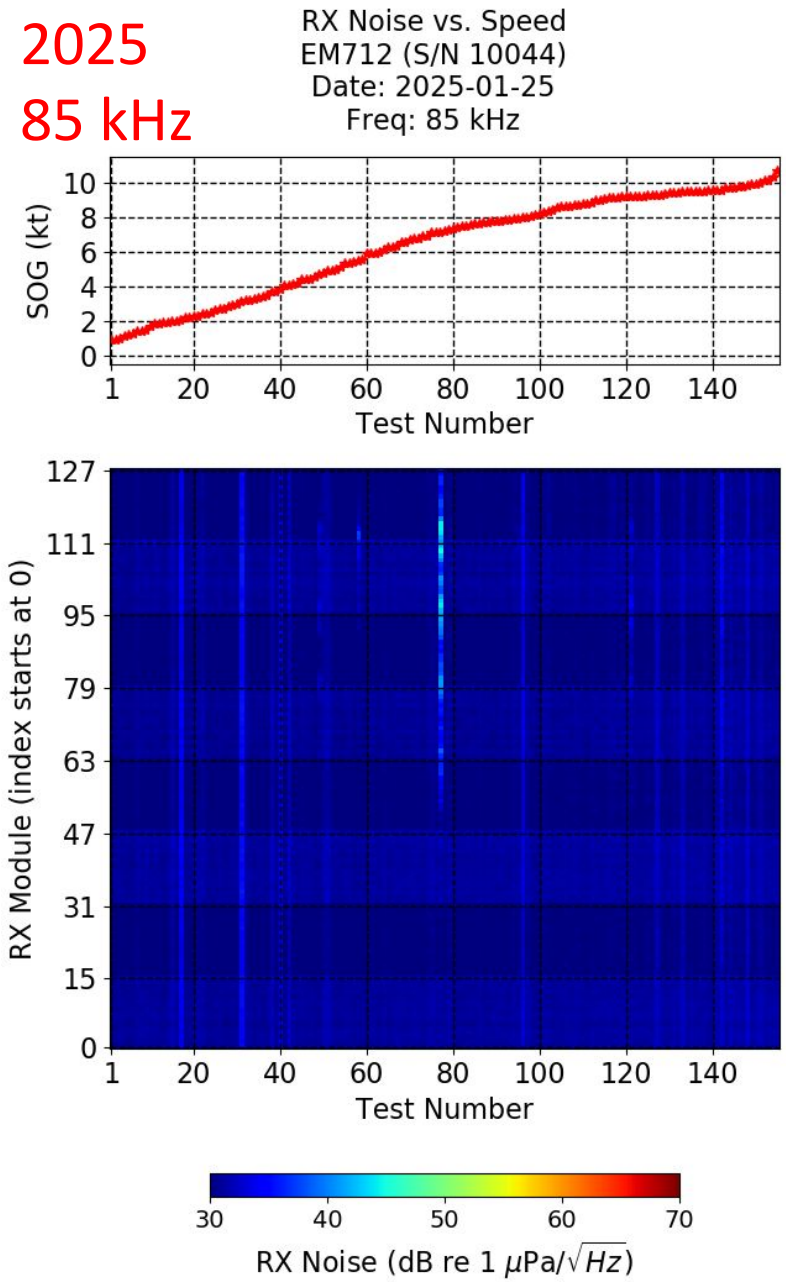
RX Noise BIST Assessment

EM712 Noise Level vs. Speed

2025
55 kHz



2025
85 kHz



EM712 RX Noise testing was run simultaneously with the EM124 tests over the same speed range

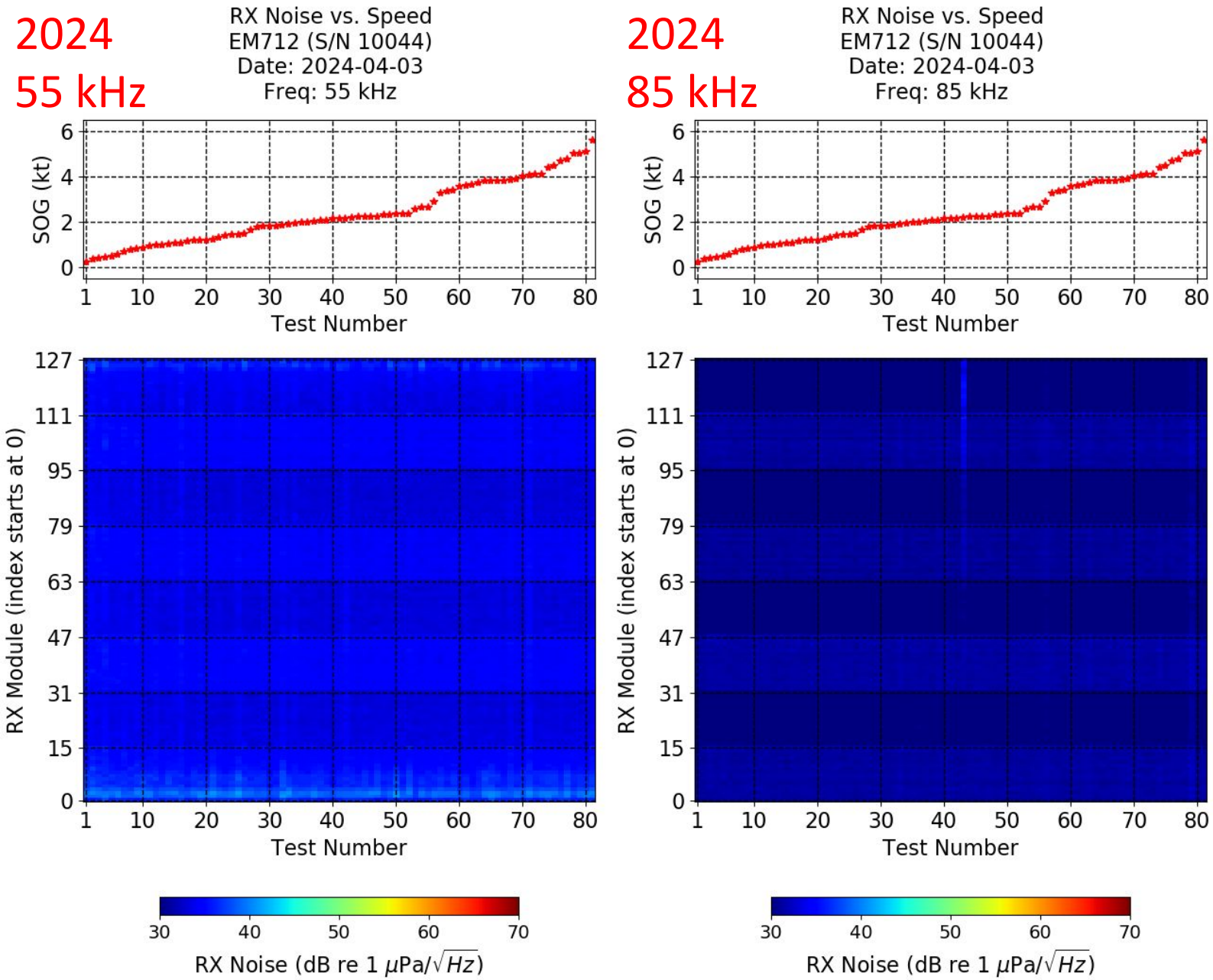
Results show very low and stable noise levels for both frequencies recorded in the EM712 BISTs

These trends are consistent with the 2024 tests conducted in calm seas (next slide); no earlier EM712 RX Noise tests are available due to historic complications with BIST logging for this particular system

RX Noise BIST Assessment

EM712 Noise Level vs. Speed

2024
55 kHz



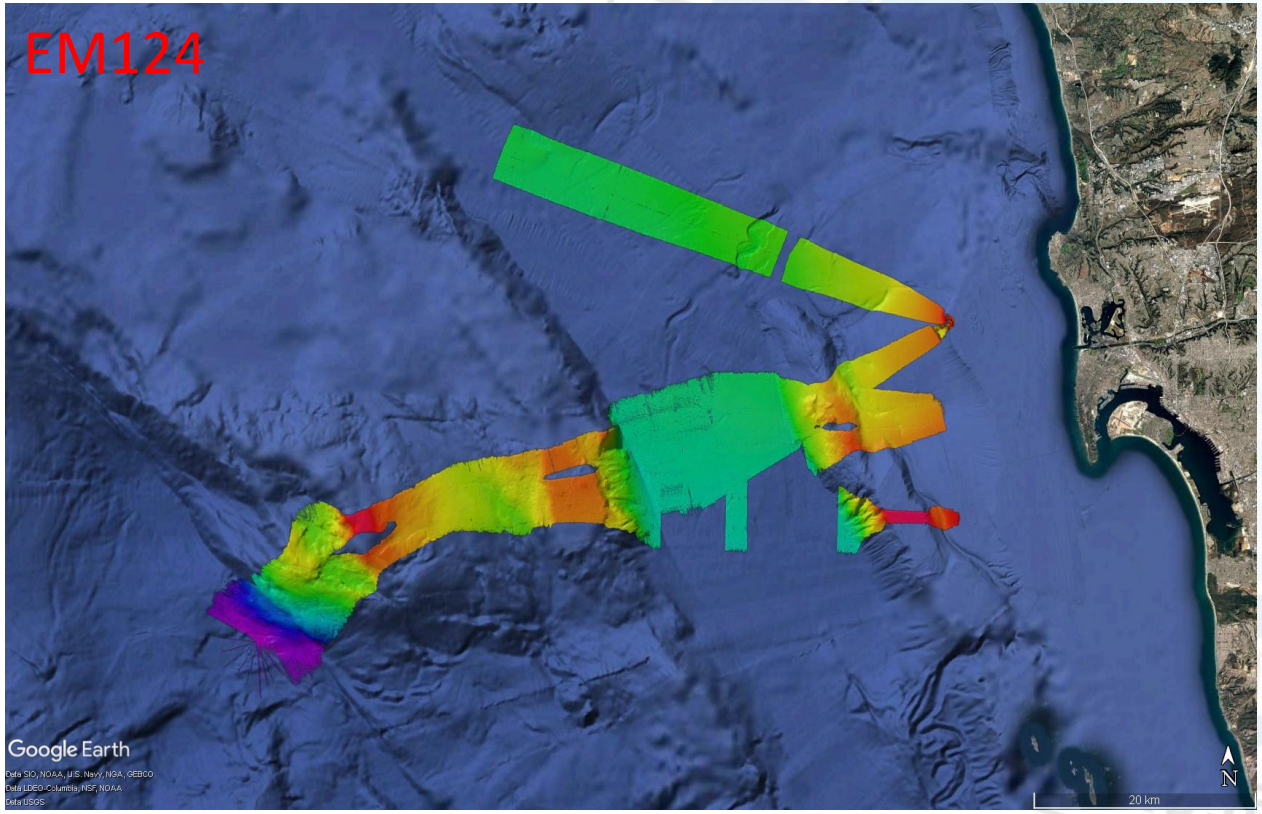
2024
85 kHz

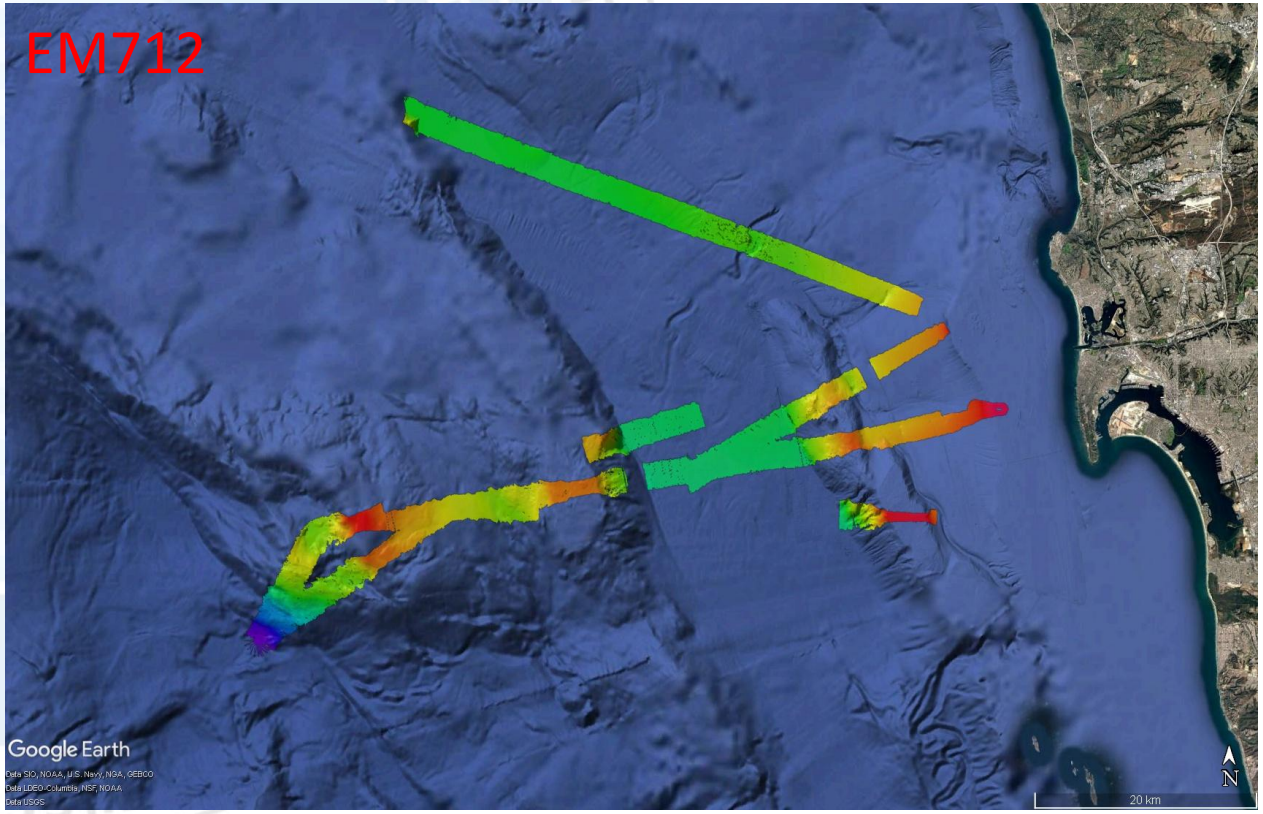
The limited 0-6 kn speed data from 2024-04-03 are shown here for reference, highlighting the consistently low levels in calm water (i.e., no swell impacts or vertical 'striping' in the noise plots)

Swath Coverage Assessment

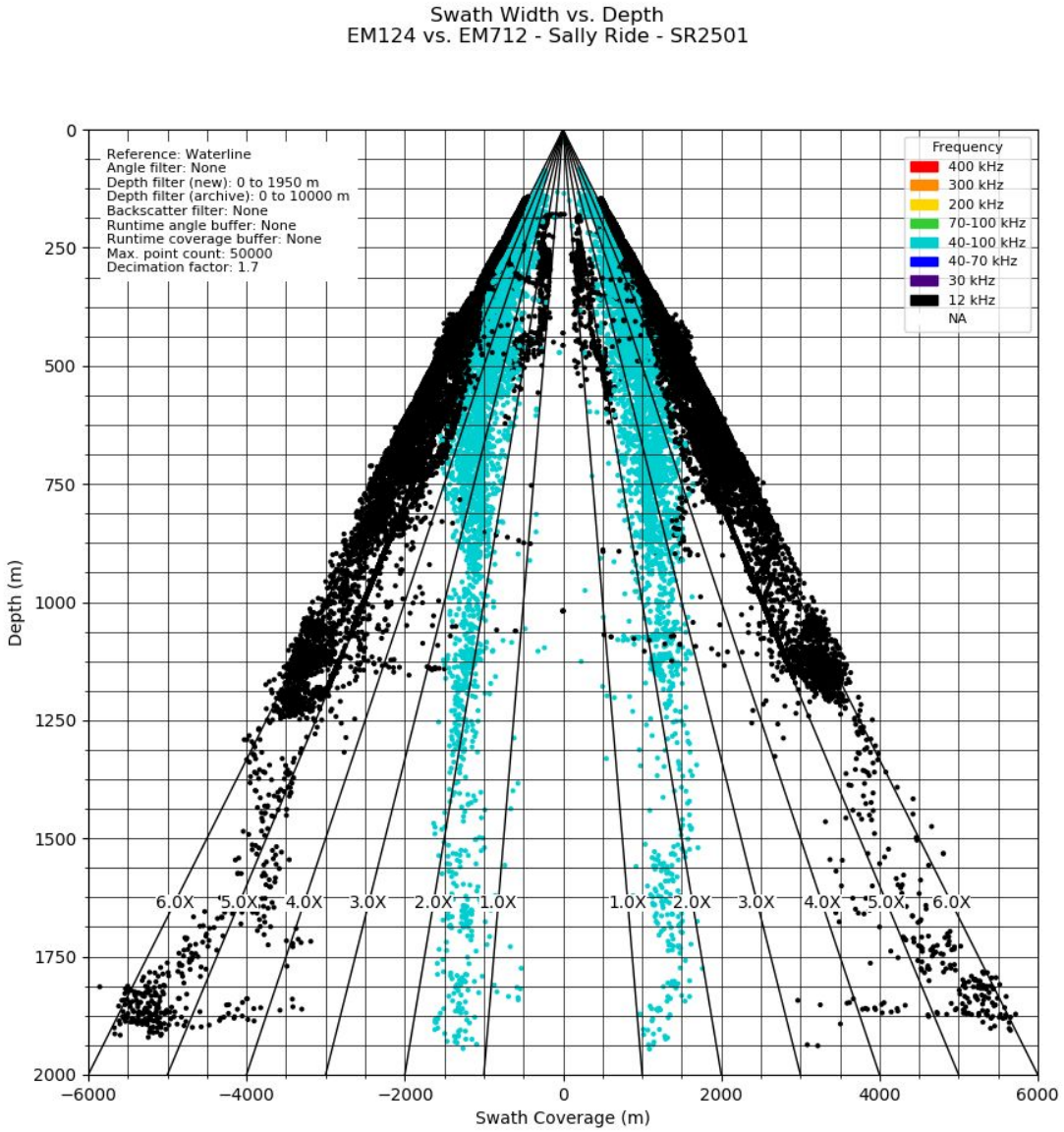
Overview

- EM124 and EM712 swath coverage data were collected over a depth range of ~150-1950 m on various transits during SR2501 (overview images below); runtime parameters followed the recommended coverage test settings, though results may be impacted by slopes (crossing contours obliquely) due to constraints of the transit routes
- Both systems achieved expected coverage over this depth range (see following slides); additional testing is recommended over a deeper range, such as the 1500-4000 m swath coverage test line offshore San Diego





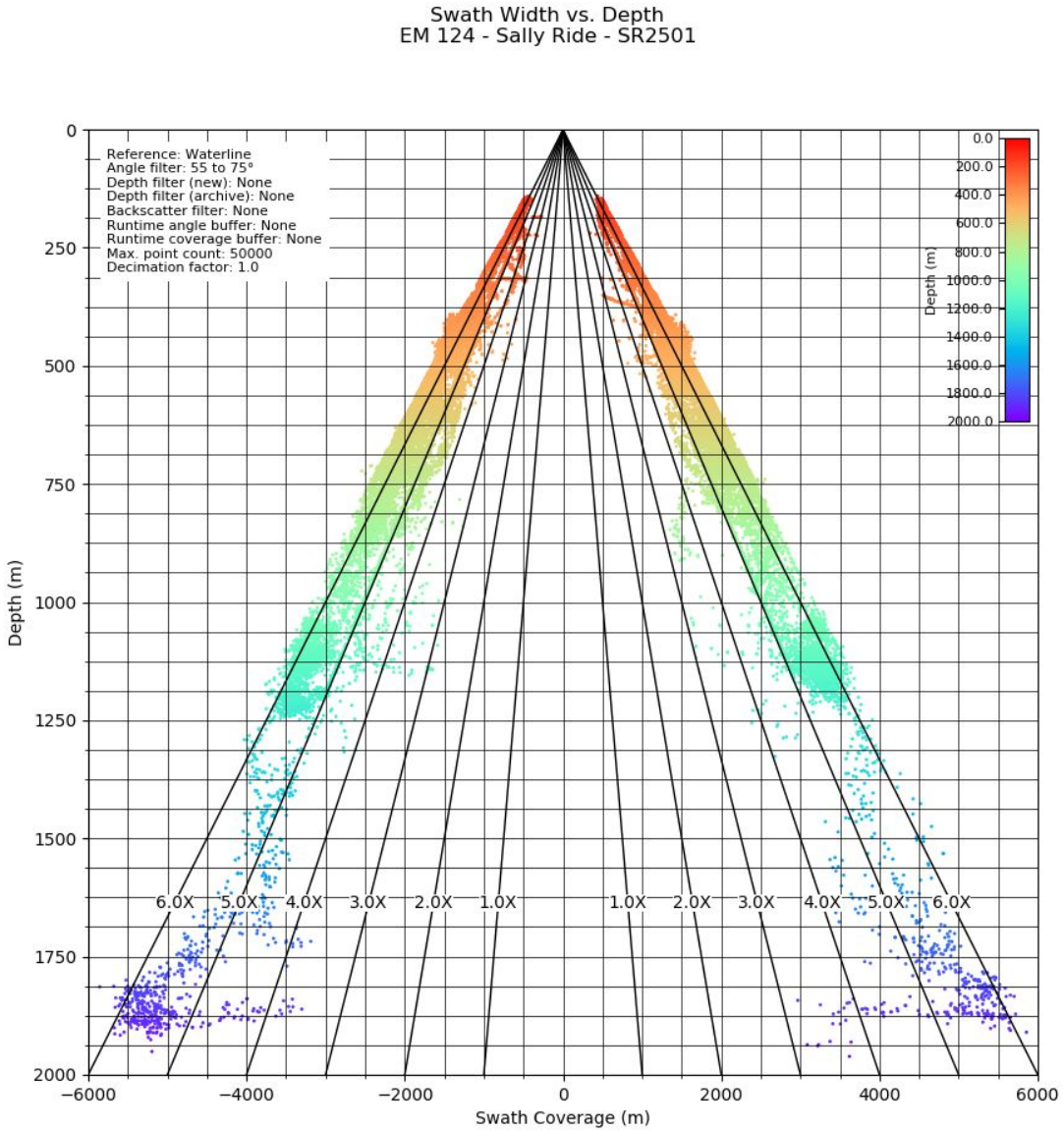
Swath Coverage Assessment

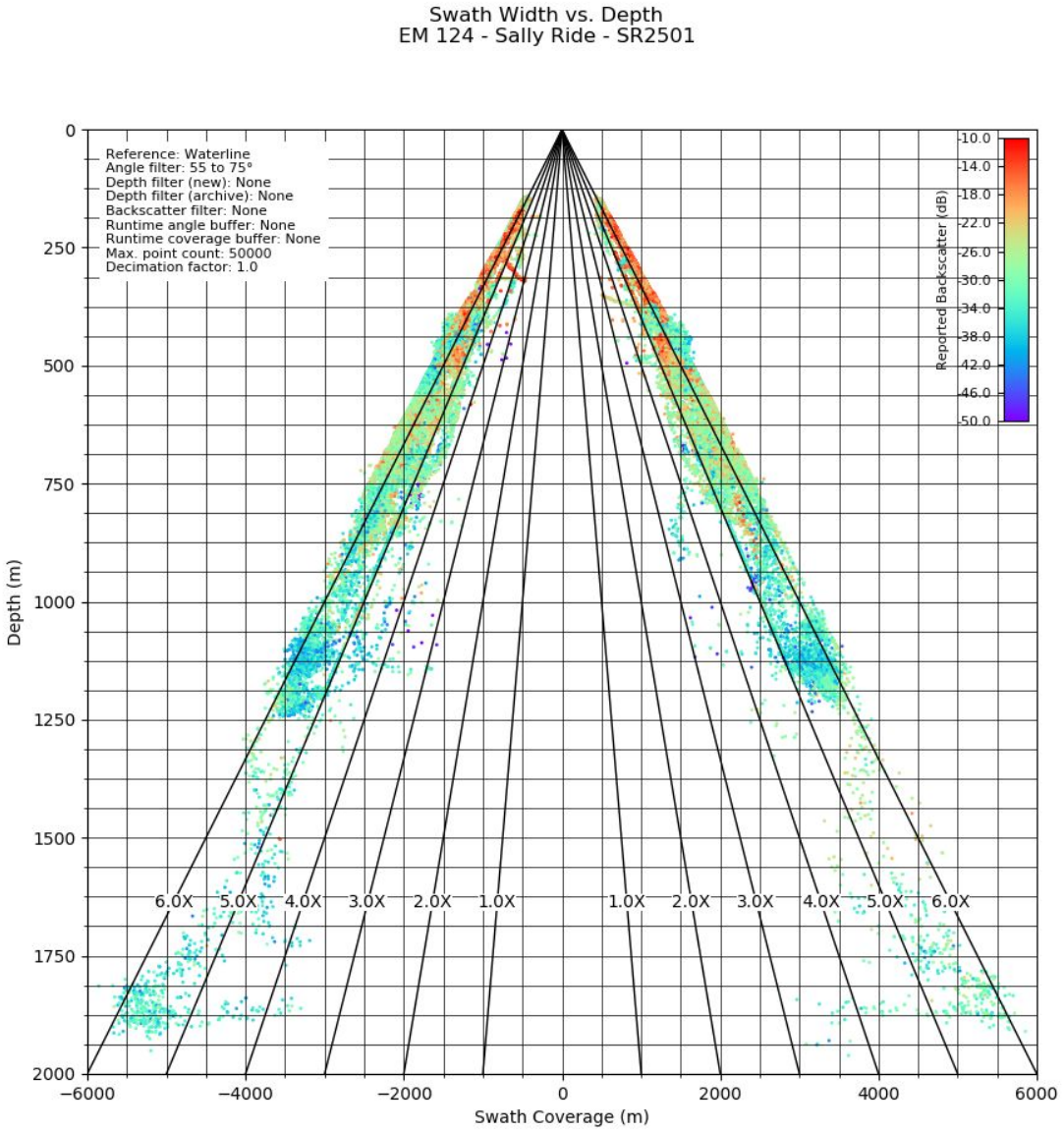


Overview

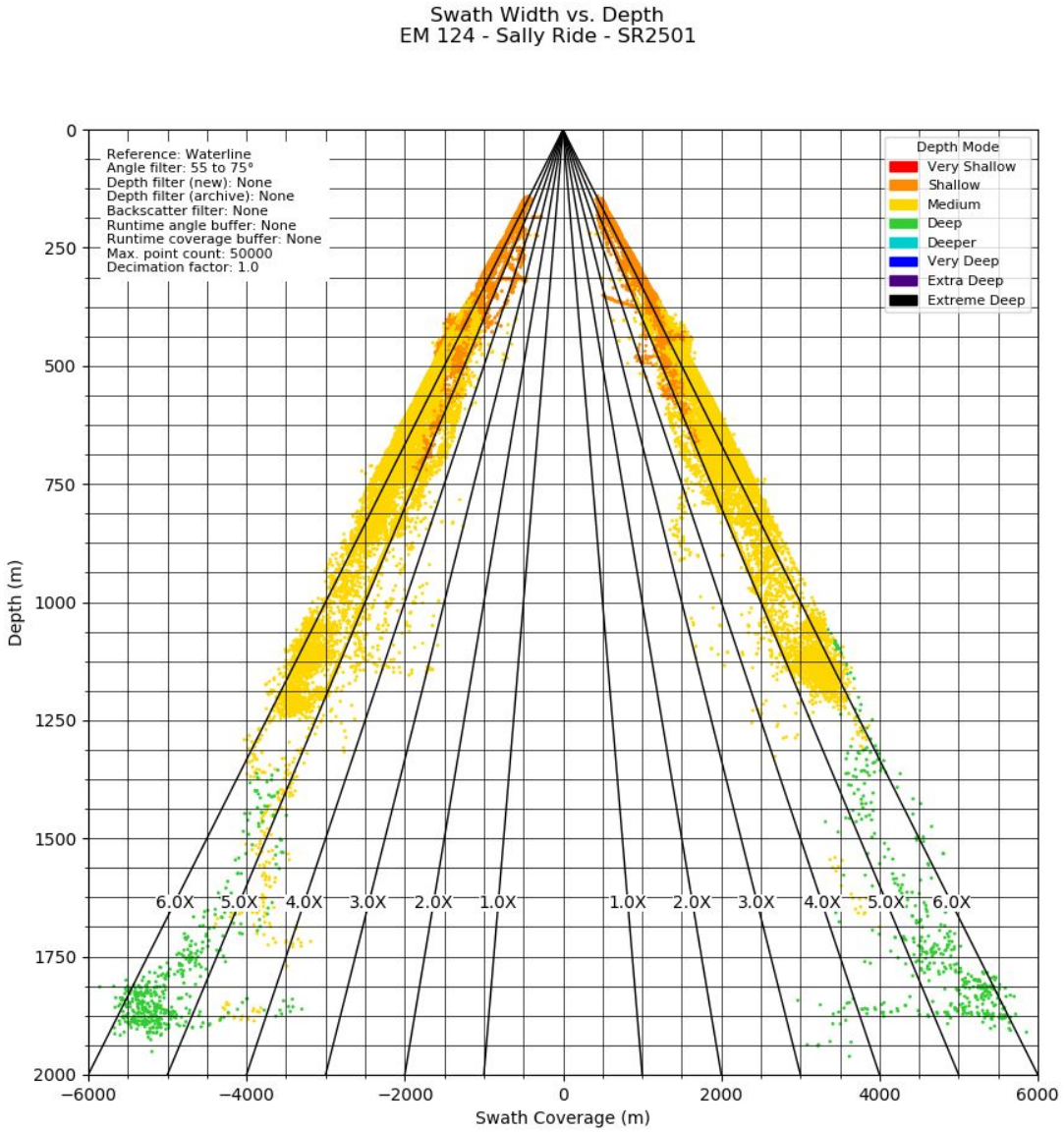
- Across-swath distance from nadir was calculated for the outermost port and starboard 'valid' sounding for each ping and then plotted against depth to evaluate trends in the achieved swath width versus depth
- The following slides present the achieved swath coverage versus depth, colored by a variety of parameters to illustrate performance in these modes
- Additional plots include estimated data rates (.kmall only; not including .kmwcd) and comparison of raw MRU data time with EM acquisition timestamps to identify potential latencies (no major issues shown)
- ***Additional swath coverage data collection is recommended for both systems, with maximum swath angles and Automatic depth modes for both systems, transiting at typical mapping speeds across a wider range of depths and crossing contours as directly up and down the slope as possible***
- The MAC is available to help plan coverage test lines opportunistically during upcoming transits

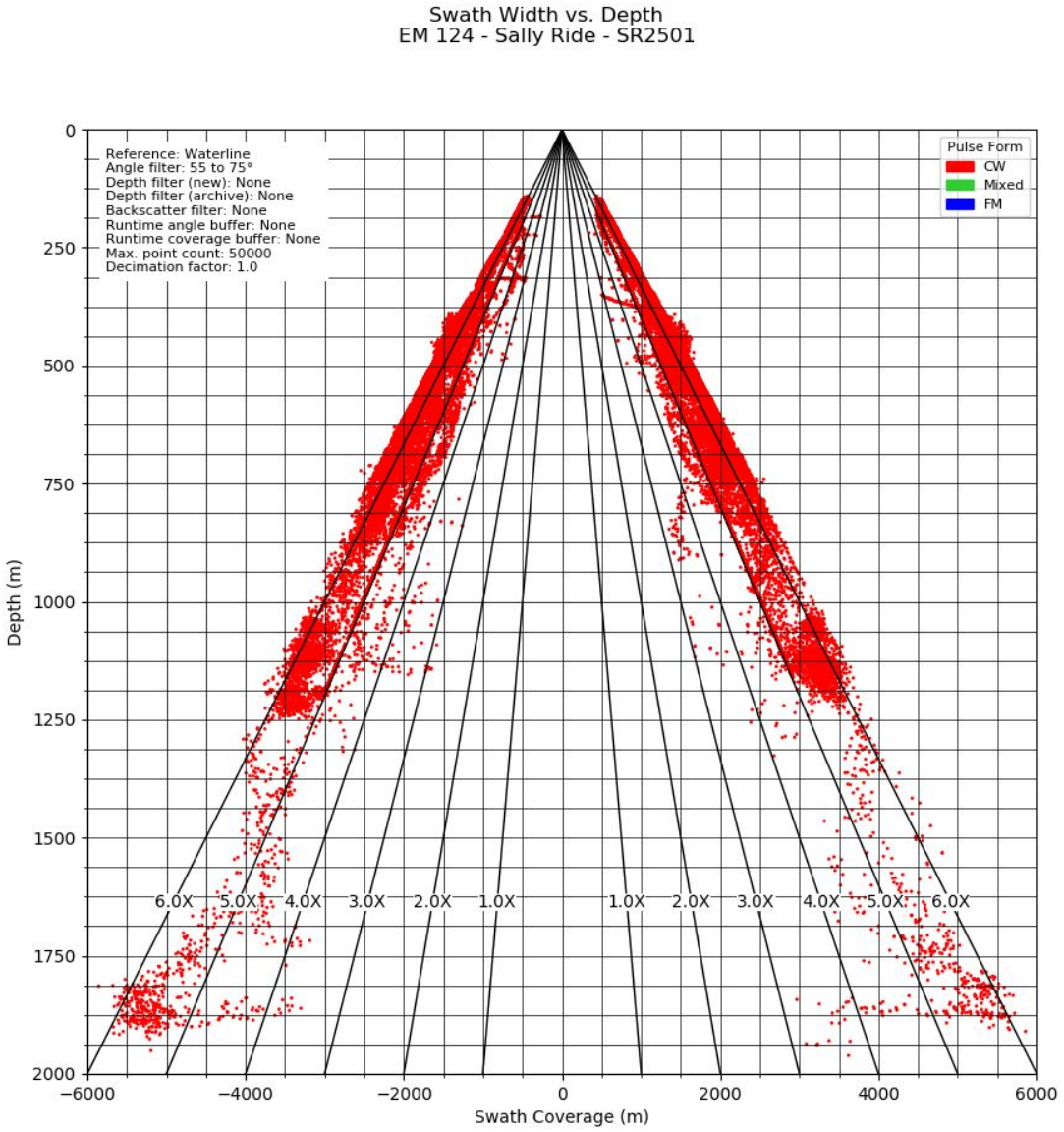
EM124 Swath Coverage **Results**





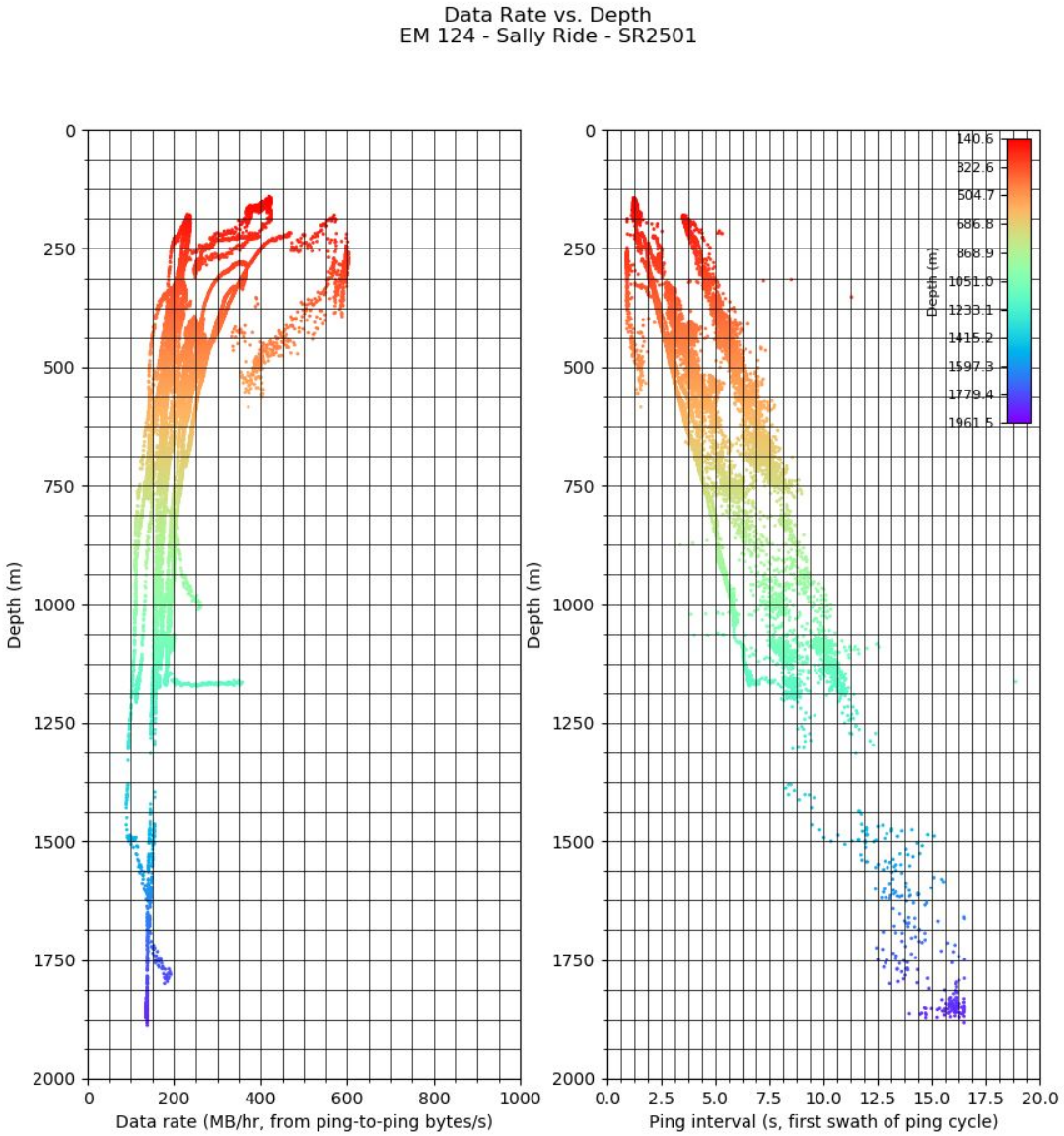
EM124 Swath Coverage **Results**

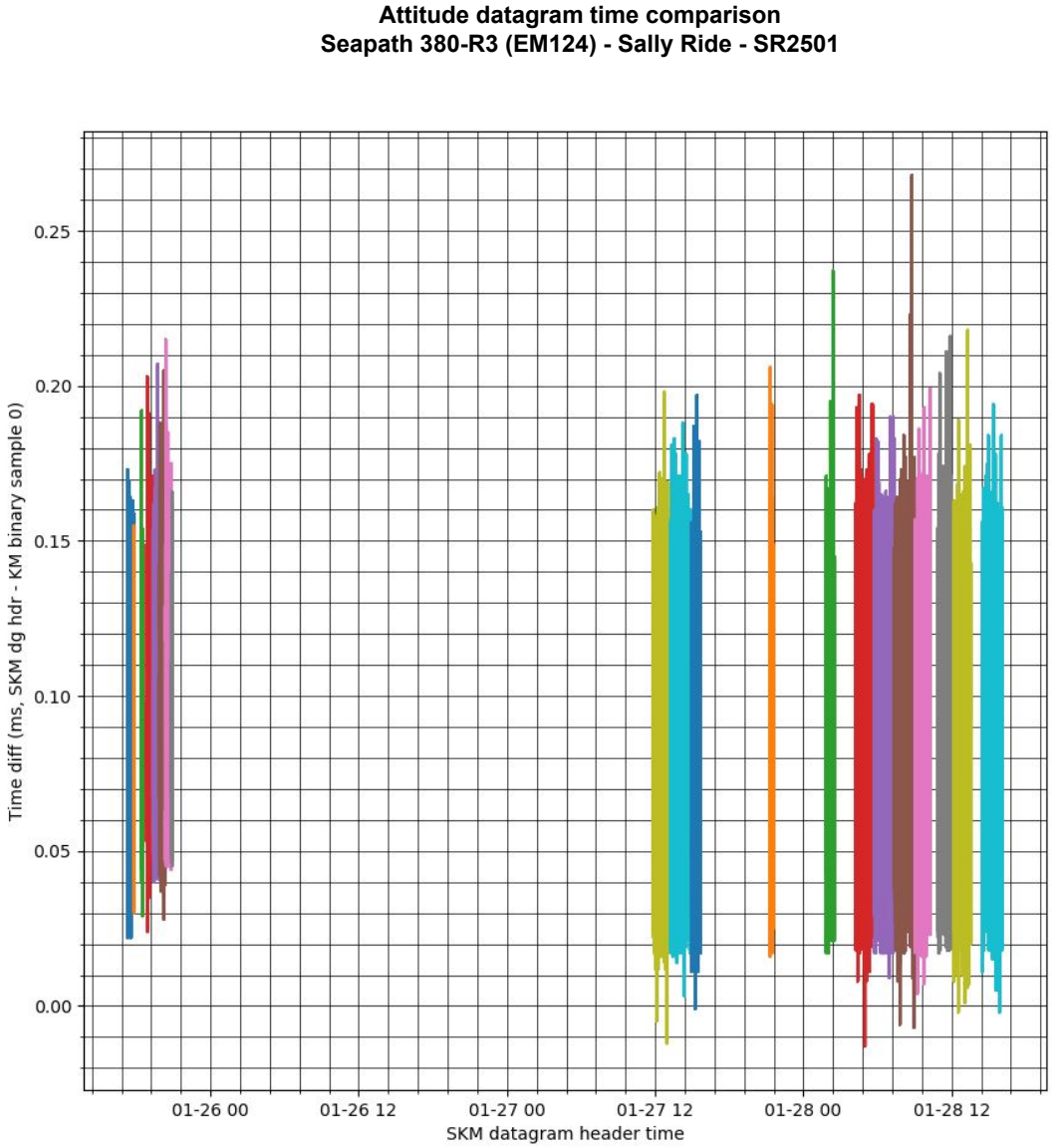




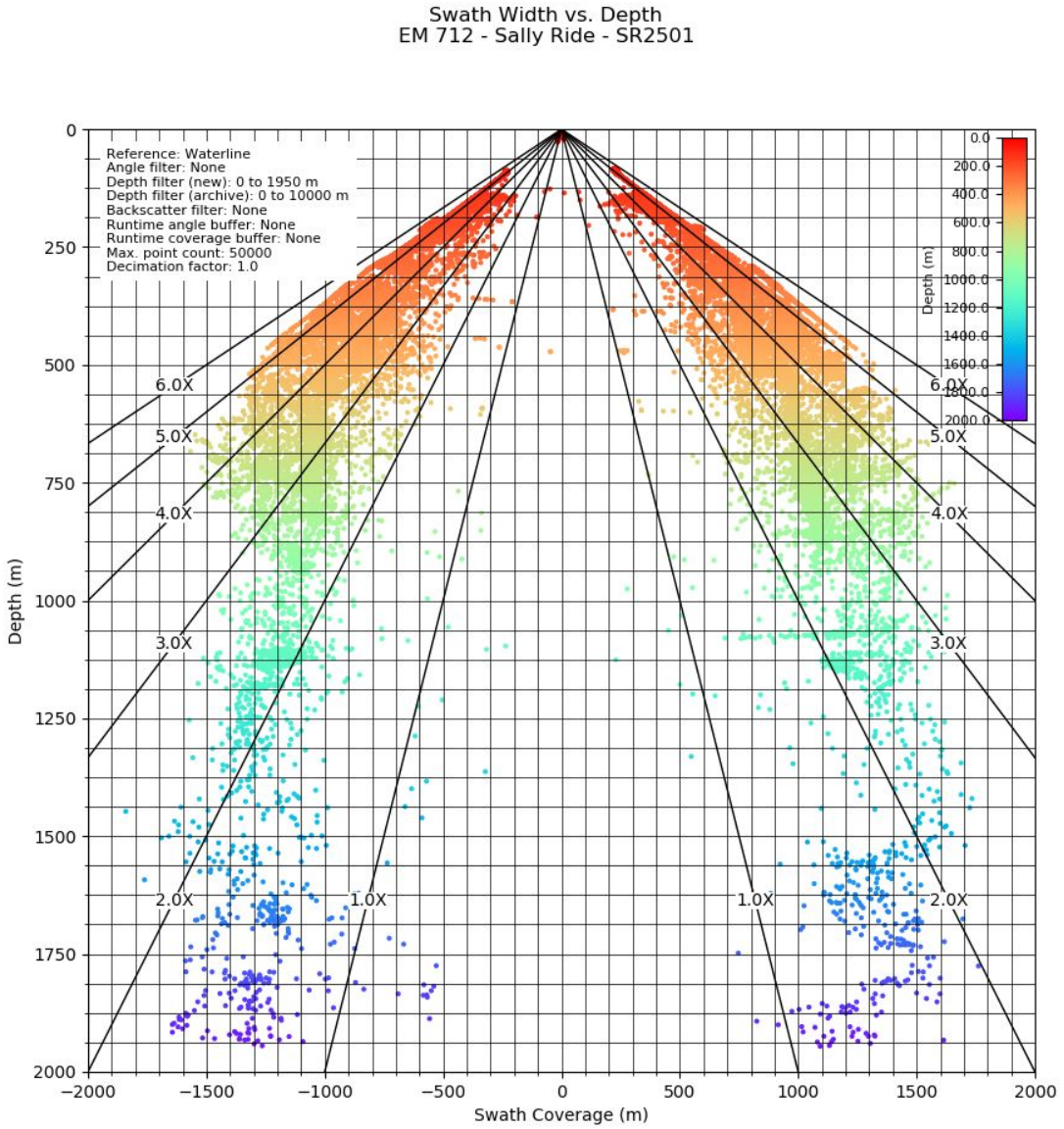
EM124 Swath Coverage

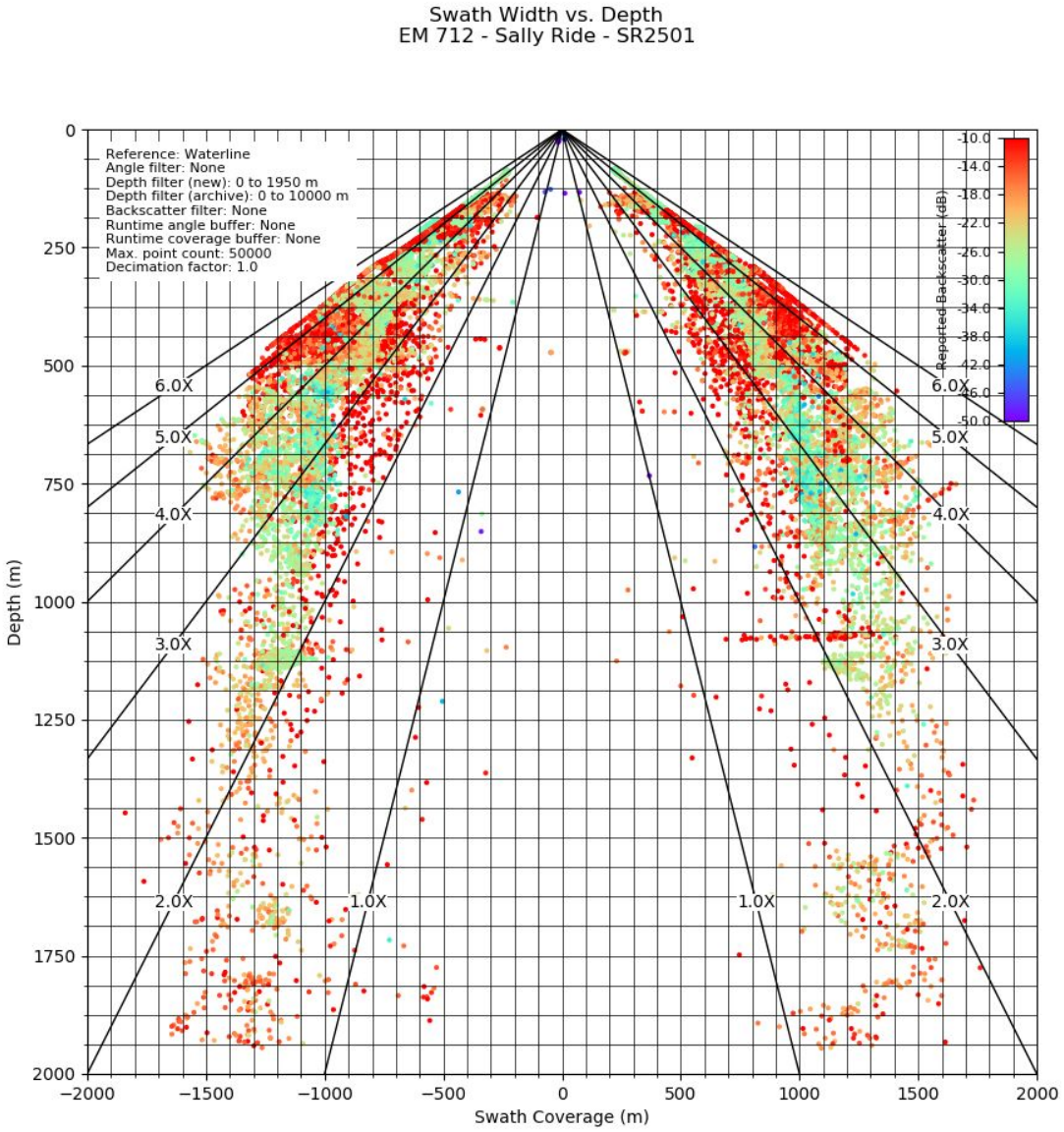
Results



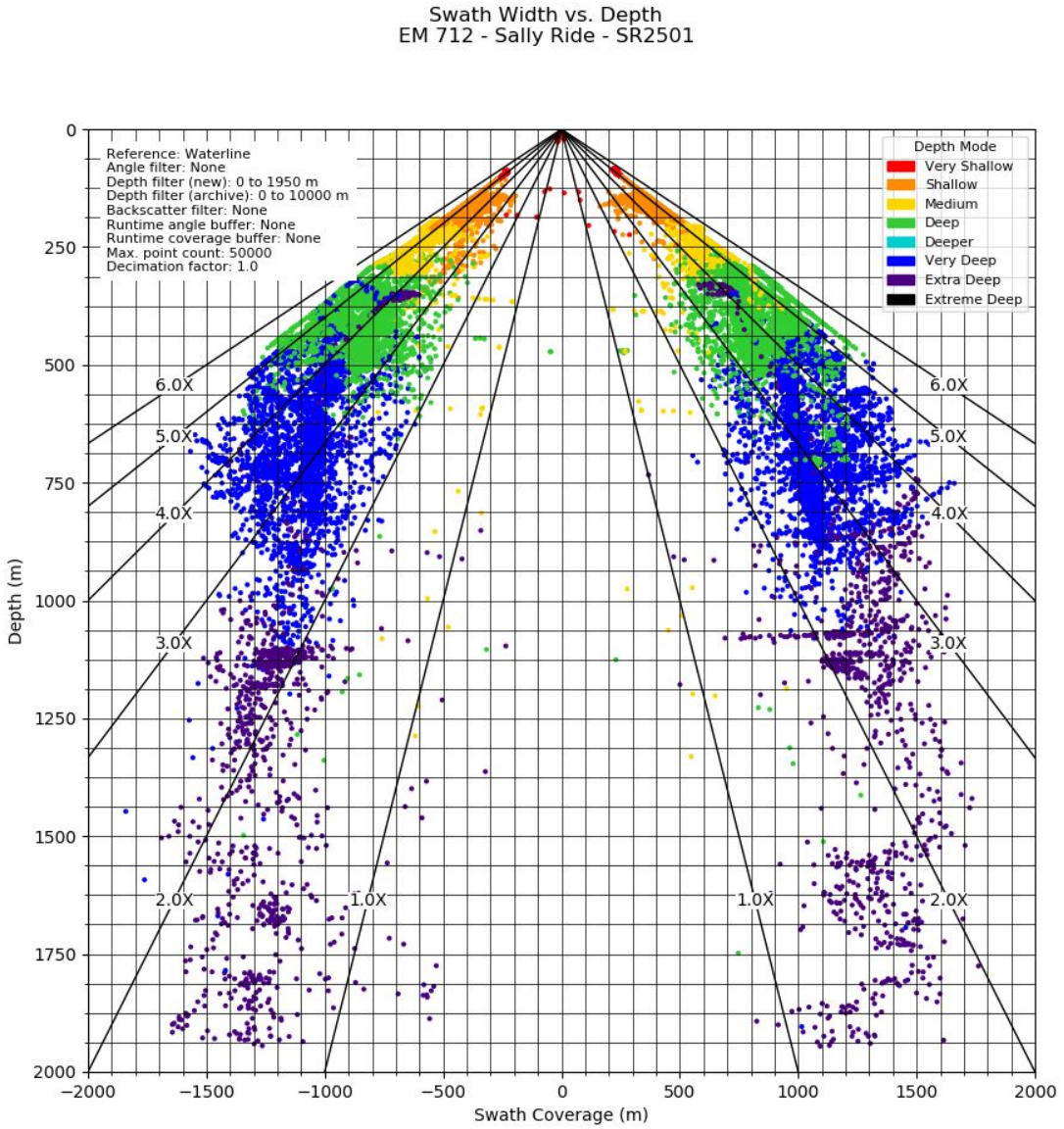


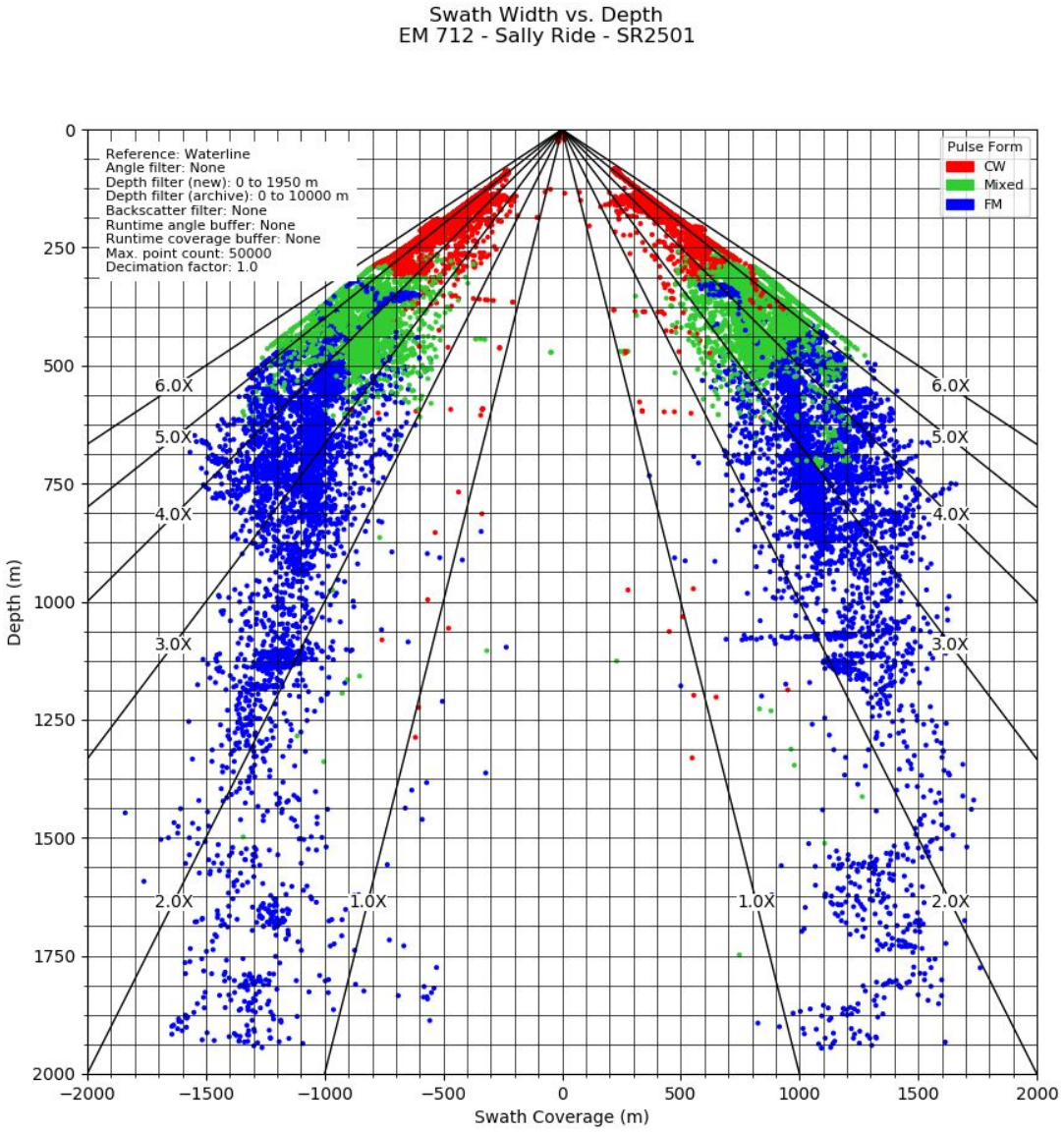
EM712 Swath Coverage **Results**





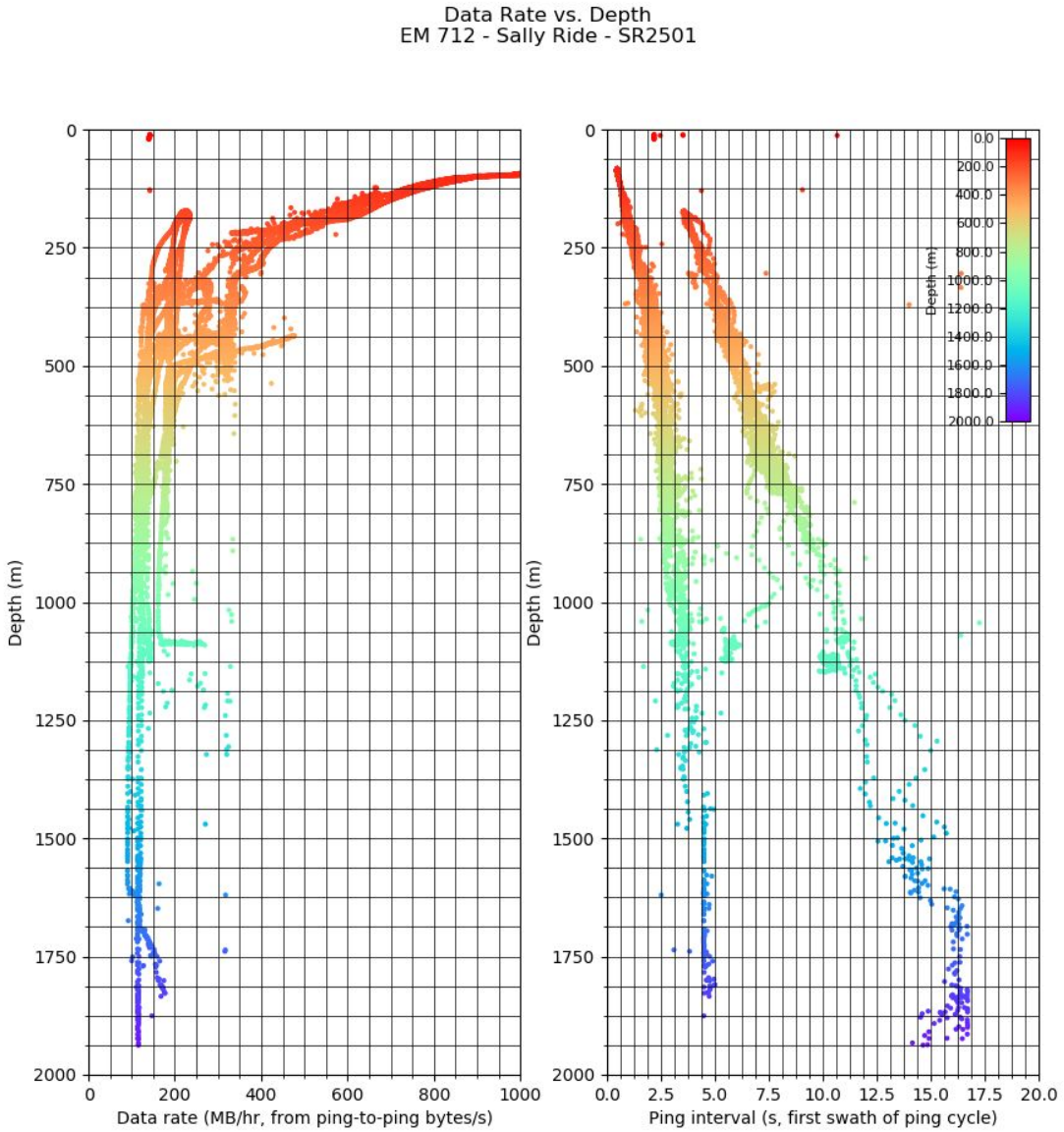
EM712 Swath Coverage **Results**

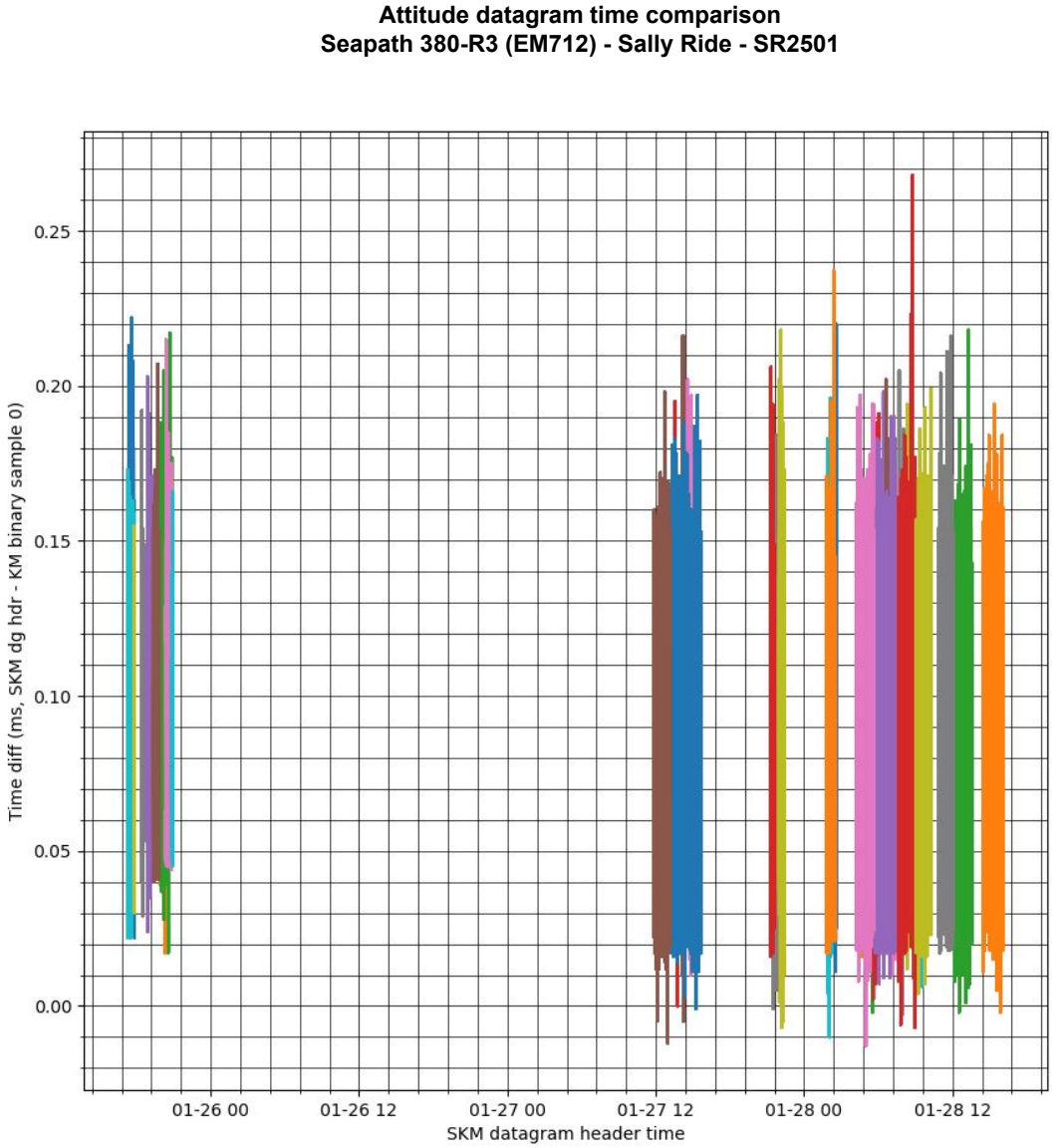




EM712 Swath Coverage

Results





Configuration Appendices Available Separately

photo: SIO