

R/V Kilo Moana

*2025-26 EM122 / EM710
Multibeam Echosounder
Quality Assurance Testing*

*Multibeam Advisory Committee
July 12-25, 2025
Dec 6, 2025
Jan 8, 2026*

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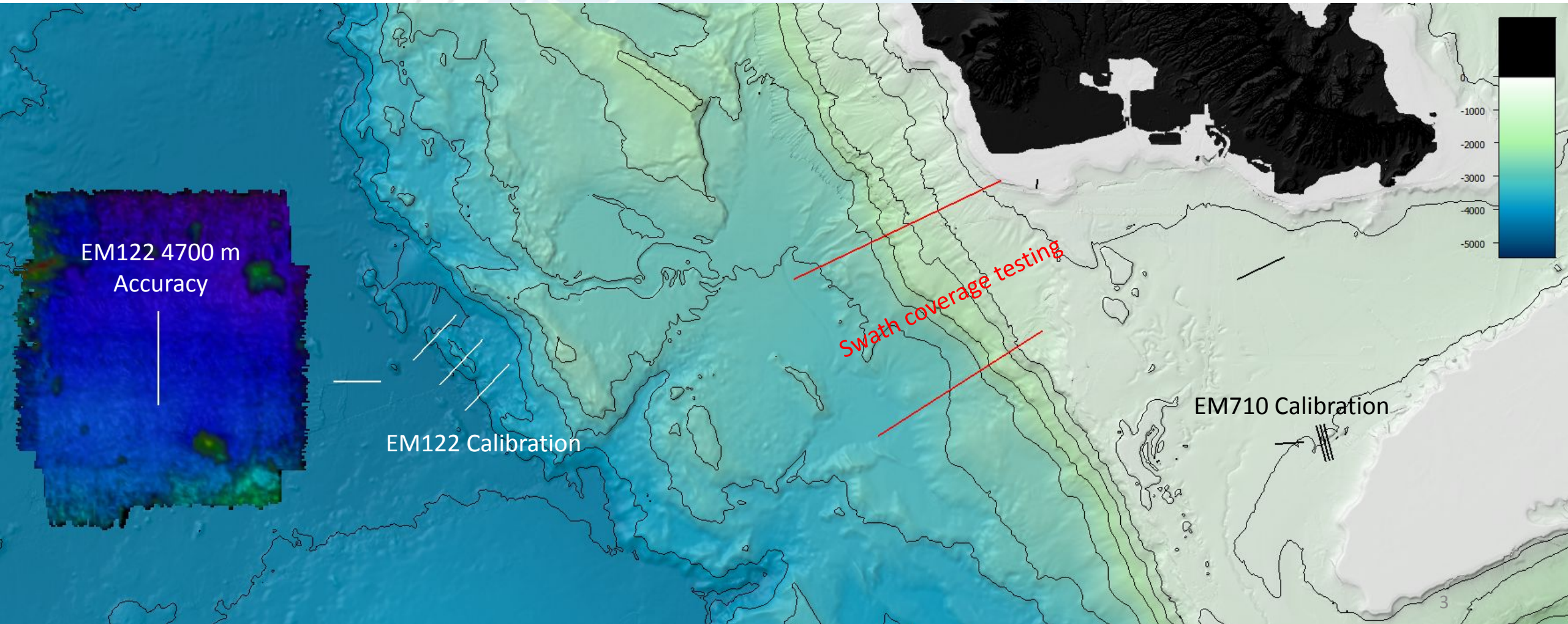
credit: soest.hawaii.edu

Executive Summary

1. The University of Hawaii's UNOLS vessel R/V *Kilo Moana* (KM) is equipped with Kongsberg Maritime EM122 and EM710 multibeam echosounders and an Applanix POS MV-320 V5 Ocean Master navigation system
2. R/V *Kilo Moana* conducted opportunistic Quality Assurance Testing (QAT) for the EM122 and EM710 multibeam mapping systems over several short windows between July 2025 and January 2026
3. QAT planning followed standard MAC priorities, including system configuration review, hardware health checks via Built-In Self-Tests, calibrations (patch testing) for both EM systems, RX noise assessments, and swath coverage testing; test site selection was based on previous testing with *Kilo Moana* and other vessels
4. Given the age of the EM122 and EM710, hardware health trends, and the end of maintenance support from Kongsberg (e.g., decreasing availability of spare parts), the MAC recommends planning the replacement/upgrade process for the *Kilo Moana's* multibeam mapping systems
5. Calibrations proceeded smoothly for both EM systems and produced reasonable adjustments, suggesting stable system geometry; Attitude 1 values shown in this report should be maintained for the 2026 field season
6. RX noise testing confirmed low / improved levels for the EM710 and increases for the EM122 at shaft speeds of 100-112 RPM compared to 2023-24; this may result from higher flow noise due to biofouling (unlikely if the hull was cleaned in the shipyard) or potentially new 12 kHz interference from machinery at high shaft speeds
7. EM122 swath coverage testing revealed improvements over the high-noise data collected in 2023 and comparable performance with a similar 'benchmark' system; no EM710 swath coverage data were collected
8. The MAC is available to assist with additional testing and replacement planning as requested

KM 2025-26 QAT Planning Overview

- QAT operating areas from 2022-26 are shown below for reference
- EM122 calibration and alternative EM122 transit coverage lines (south of area shown in image) were completed in July-Dec 2025; EM710 calibration was completed in Jan 2026



System Geometry Review

Overview: Vessel Survey

- The granite block remains the origin for all sensor reference frames; POS MV output is valid at the granite block
- POS MV, EM122, and EM710 configurations are based on vessel surveys performed by BLOM (2005), IMTEC (2012), and Westlake (2015), with appropriate modifications based on calibration results (most recently in 2023)
- Refer to previous MAC reports (<https://mac.unols.org/ship/kilo-moana>) for additional documentation of system geometry and modifications since 2012

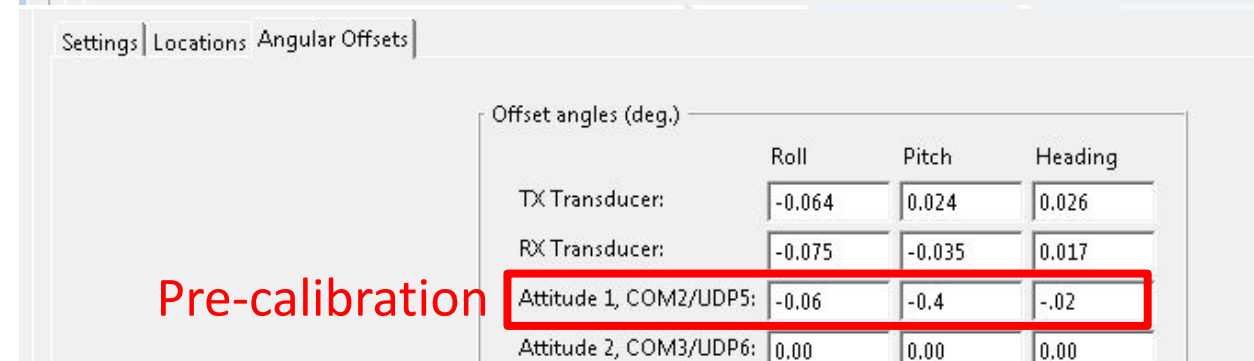
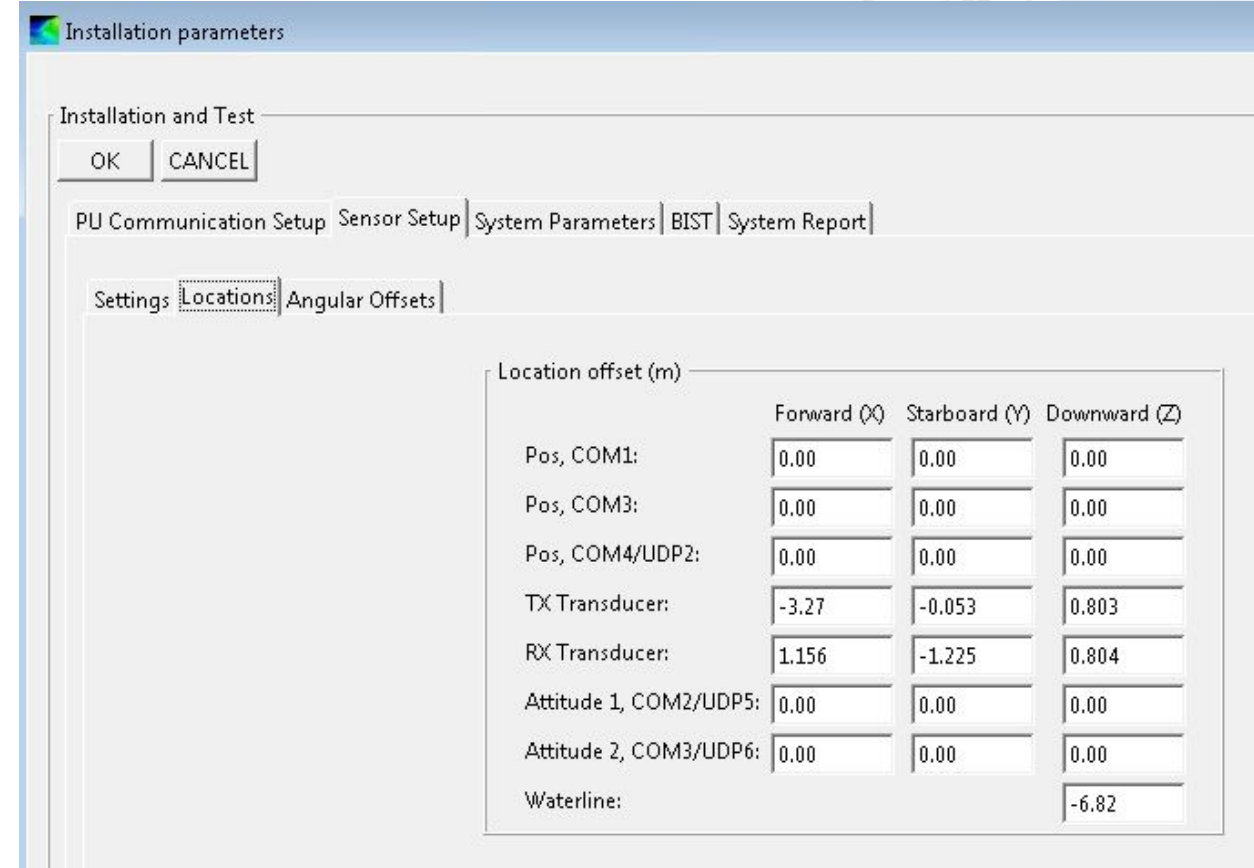
EM122 Configuration

Installation Parameters

The EM122 configuration is based on earlier system geometry reviews in 2012-23

Screenshots at left show the EM122 transducer offsets applied through the 2025 QAT, as well as the pre-cal Attitude 1 settings (i.e., from the previous calibration)

The [Calibration](#) section presents 2025 Attitude 1 results



Pre-calibration

EM710 Configuration

Installation Parameters

The EM710 configuration is based on earlier system geometry reviews in 2012-23

Screenshots at left show the EM710 transducer offsets applied through the 2026 QAT, as well as the pre-cal Attitude 1 settings (i.e., from the previous calibration)

The [Calibration](#) section presents 2026 Attitude 1 results

Installation parameters

Installation and Test

OK CANCEL

PU Communication Setup Sensor Setup System Parameters BIST System Report

Settings Locations Angular Offsets ROV. Specific

Location offset (m)

	Forward (X)	Starboard (Y)	Downward (Z)
Pos, COM1/MCAST1:	0.00	0.00	0.00
Pos, COM3/MCAST2:	0.00	0.00	0.00
Pos, COM4/UDP2/MCAST3:	0.00	0.00	0.00
TX Transducer:	11.8435	-1.1197	0.5531
RX Transducer:	10.8252	-1.2274	0.5561
Attitude 1, COM2/UDP5:	0.00	0.00	0.00
Attitude 2, COM3/UDP6:	0.00	0.00	0.00
Waterline:			-6.82
Depth Sensor:	0.00	0.00	0.00

Settings Locations Angular Offsets ROV. Specific

TX Transducer Orient.

Port Starb.

RX Transducer Orient.

Forw. Aft

Offset angles (deg.)

	Roll	Pitch	Heading
TX Transducer:	0.233	-0.190	0.016
RX Transducer:	0.265	0.007	0.101
Attitude 1, COM2/UDP5:	-0.06	.01	0.37
Attitude 2, COM3/UDP6:	0.00	0.00	0.00

Pre-calibration

POS MV 320 Configuration

IMU Lever Arms and Angles

The POS MV configuration is based on earlier system geometry reviews in 2012-23

Aside from firmware updates and GAMS calibrations (antenna baseline vector updates), no changes have been made to the POS MV IMU, antennas, or configuration since Sea Acceptance Testing in 2017

Screenshots at left show IMU lever arms and mounting angles as configured through the 2025-26 calibrations

GAMS calibrations were run on 2025-07-12; results agreed well with the post-2023 value and the current GAMS configuration was maintained for this QAT

Lever Arms & Mounting Angles

Lever Arms & Mounting Angles | Sensor Mounting | Tags, AutoStart

Ref. to IMU Target		IMU Frame w.r.t. Ref. Frame		Target to Sensing Centre		Resulting Lever Arm	
X (m)	0.754	X (deg)	0.000	X (m)	0.000	X (m)	0.754
Y (m)	-1.218	Y (deg)	0.000	Y (m)	0.001	Y (m)	-1.217
Z (m)	-0.342	Z (deg)	0.000	Z (m)	0.086	Z (m)	-0.256

Ref. to Primary GNSS Lever Arm		Ref. to Vessel Lever Arm		Ref. to Centre of Rotation Lever Arm	
X (m)	6.439	X (m)	0.000	X (m)	-9.050
Y (m)	6.505	Y (m)	0.000	Y (m)	8.500
Z (m)	-27.761	Z (m)	0.000	Z (m)	-8.153

Notes:

1. Ref. = Reference
2. w.r.t. = With Respect To
3. Reference Frame and Vessel Frame are co-aligned

Enable Bare IMU

In Navigation Mode , to change parameters go to Standby Mode !

Lever Arms & Mounting Angles

Lever Arms & Mounting Angles | Sensor Mounting | Tags, AutoStart

Ref. to Aux. 1 GNSS Lever Arm		Ref. to Aux. 2 GNSS Lever Arm	
X (m)	0.000	X (m)	0.000
Y (m)	0.000	Y (m)	0.000
Z (m)	0.000	Z (m)	0.000

Ref. to Sensor 1 Lever Arm		Sensor 1 Frame w.r.t. Ref. Frame	
X (m)	0.000	X (deg)	0.000
Y (m)	0.000	Y (deg)	0.000
Z (m)	0.000	Z (deg)	0.000

Ref. to Sensor 2 Lever Arm		Sensor 2 Frame w.r.t. Ref. Frame	
X (m)	-39.298	X (deg)	0.000
Y (m)	8.522	Y (deg)	0.000
Z (m)	-16.726	Z (deg)	0.000

In Navigation Mode , to change parameters go to Standby Mode !

GAMS Parameter Setup **Pre-2023**

Heading Calibration Threshold (deg)	0.500
Heading Correction (deg)	0.000

Baseline Vector

X Component (m)	0.032
Y Component (m)	3.948
Z Component (m)	0.002

GAMS Parameter Setup **2023-25**

Heading Calibration Threshold (deg)	0.500
Heading Correction (deg)	0.000

Baseline Vector

X Component (m)	0.036
Y Component (m)	3.964
Z Component (m)	0.007

EM122/EM710 Calibration

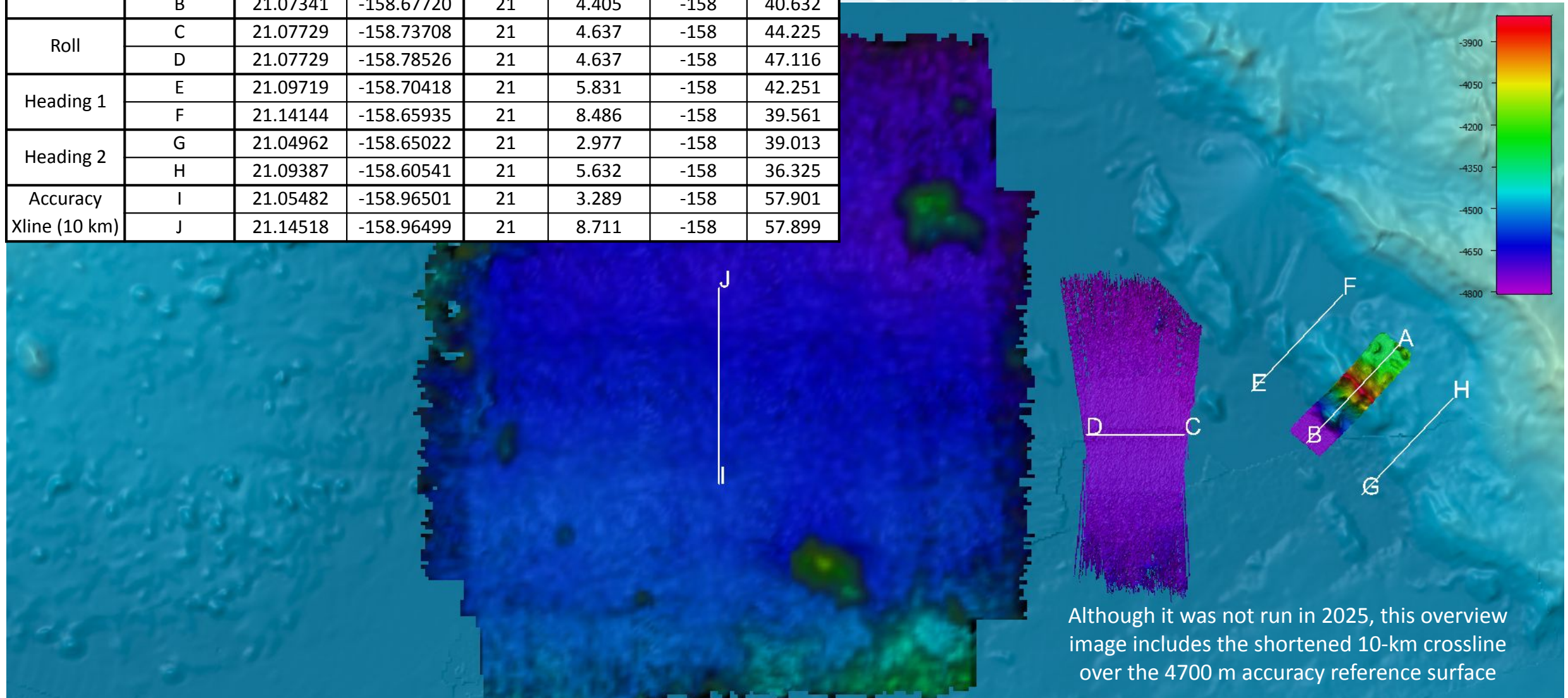
Site Selection and Data Collection

1. EM122 and EM710 calibration plans were developed at the same site used in recent years by R/V *Kilo Moana* and other vessels; EM122 calibration lines were run in a non-standard order to reduce transit time, as the data were processed on shore after all data collection was complete
2. A POS MV GAMS calibration was conducted immediately after leaving port in July and ahead of all other testing
3. Calibration data were collected by Frymire on board, reduced using the MAC 'file trimmer' app to remove 100-Hz attitude velocity datagrams, and sent to the MAC for processing on shore via Google Drive
4. XBT profiles were collected throughout calibration, processed in Sound Speed Manager, and applied in SIS during data collection; these profiles were applied using 'nearest in time' scheduling during Qimera processing
5. Due to an issue with runtime settings, the second EM122 heading calibration line did not provide sufficient overlap with the first; pitch and roll calibration lines were processed and applied in July 2025
6. The second EM122 heading calibration line was collected successfully in Dec 2025, processed, and applied in SIS
7. All EM710 calibration data were collected, processed, and applied in Jan 2026
8. Data quality on all calibration lines was better than expected; EM122 calibration results for all tests were reasonably small, as expected for verification, and indicate stable system geometry
9. EM710 calibration results were larger than those for the EM122, possibly due to the significantly longer time period between calibrations for this system; although final adjustments were larger for the EM710 than EM122, both datasets provided clear results that have been applied successfully

EM122 Calibration

Site Selection and Data Collection

	Waypoint	Decimal Degrees		Degrees Decimal Minutes			
		Lat.	Lon.	Lat. Deg.	Lat. Min.	Lon. Deg.	Lon. Min.
Pitch	A	21.11766	-158.63238	21	7.060	-158	37.943
	B	21.07341	-158.67720	21	4.405	-158	40.632
Roll	C	21.07729	-158.73708	21	4.637	-158	44.225
	D	21.07729	-158.78526	21	4.637	-158	47.116
Heading 1	E	21.09719	-158.70418	21	5.831	-158	42.251
	F	21.14144	-158.65935	21	8.486	-158	39.561
Heading 2	G	21.04962	-158.65022	21	2.977	-158	39.013
	H	21.09387	-158.60541	21	5.632	-158	36.325
Accuracy Xline (10 km)	I	21.05482	-158.96501	21	3.289	-158	57.901
	J	21.14518	-158.96499	21	8.711	-158	57.899

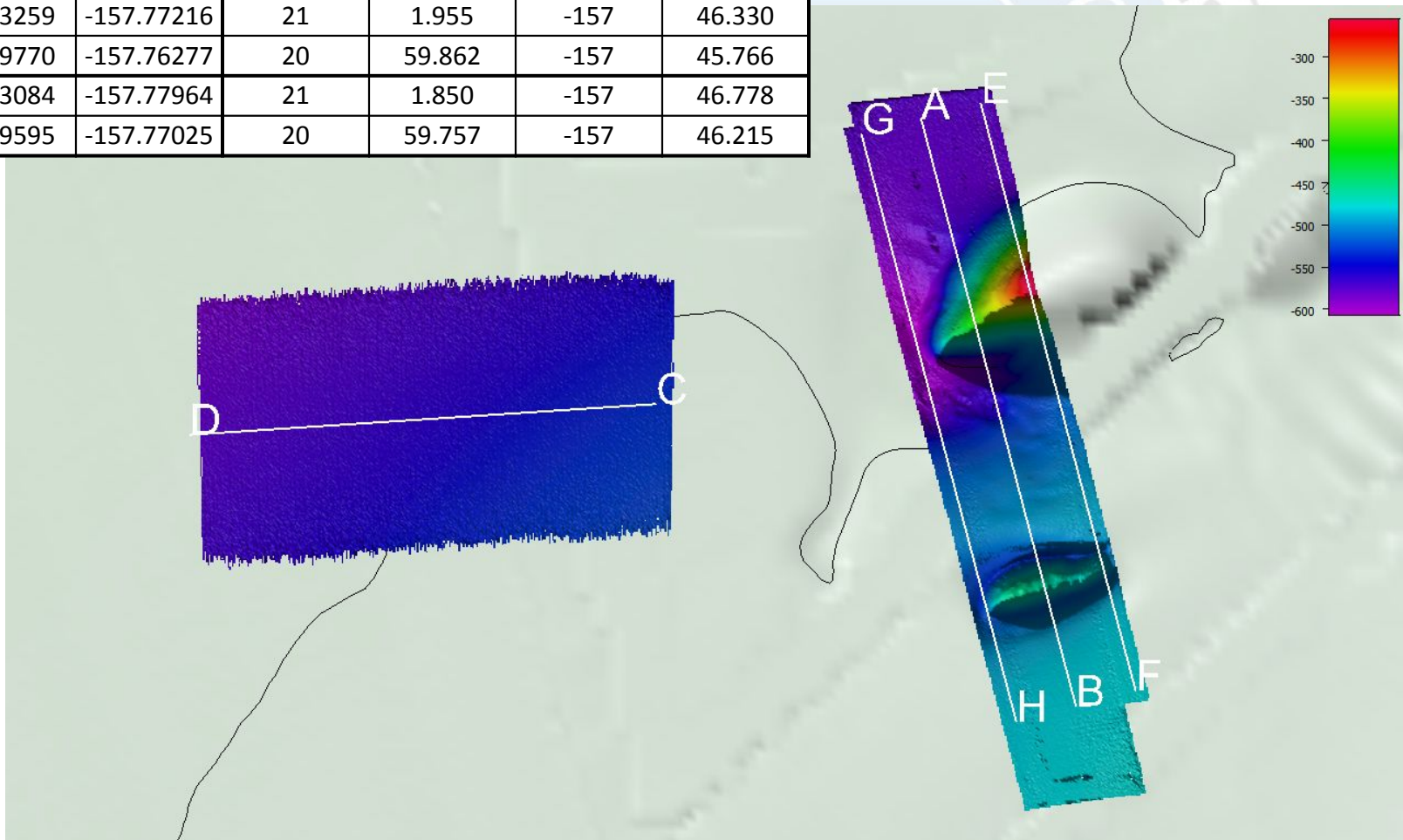


Although it was not run in 2025, this overview image includes the shortened 10-km crossline over the 4700 m accuracy reference surface

EM710 Calibration

Site Selection and Data Collection

	Waypoint	Decimal Degrees		Degrees Decimal Minutes			
		Lat.	Lon.	Lat. Deg.	Lat. Min.	Lon. Deg.	Lon. Min.
Pitch	A	21.03171	-157.77590	21	1.903	-157	46.554
	B	20.99682	-157.76651	20	59.809	-157	45.990
Roll	C	21.01492	-157.79259	21	0.895	-157	47.555
	D	21.01330	-157.82174	21	0.798	-157	49.304
Heading 1	E	21.03259	-157.77216	21	1.955	-157	46.330
	F	20.99770	-157.76277	20	59.862	-157	45.766
Heading 2	G	21.03084	-157.77964	21	1.850	-157	46.778
	H	20.99595	-157.77025	20	59.757	-157	46.215



EM122 / EM710 Calibration

Pre-Calibration Configuration

PRE-CALIBRATION (EM122)

Installation and Test
OK CANCEL

PU Communication Setup | Sensor Setup | System Parameters | BIST | System Report

Settings | Locations | Angular Offsets

Offset angles (deg.)

	Roll	Pitch	Heading
TX Transducer:	-0.064	0.024	0.026
RX Transducer:	-0.075	-0.035	0.017
Attitude 1, COM2/UDP5:	-0.06	-0.4	-.02
Attitude 2, COM3/UDP6:	0.00	0.00	0.00
Stand-alone Heading:			0.00

PRE-CALIBRATION (EM710)

Installation Parameters
Installation and Test
OK CANCEL

PU Communication Setup | Sensor Setup | System Parameters | BIST | System Report

Settings | Locations | Angular Offsets | ROV Specific

TX Transducer Orient.
 Port
 Starb.

RX Transducer Orient.
 Forw.
 Aft

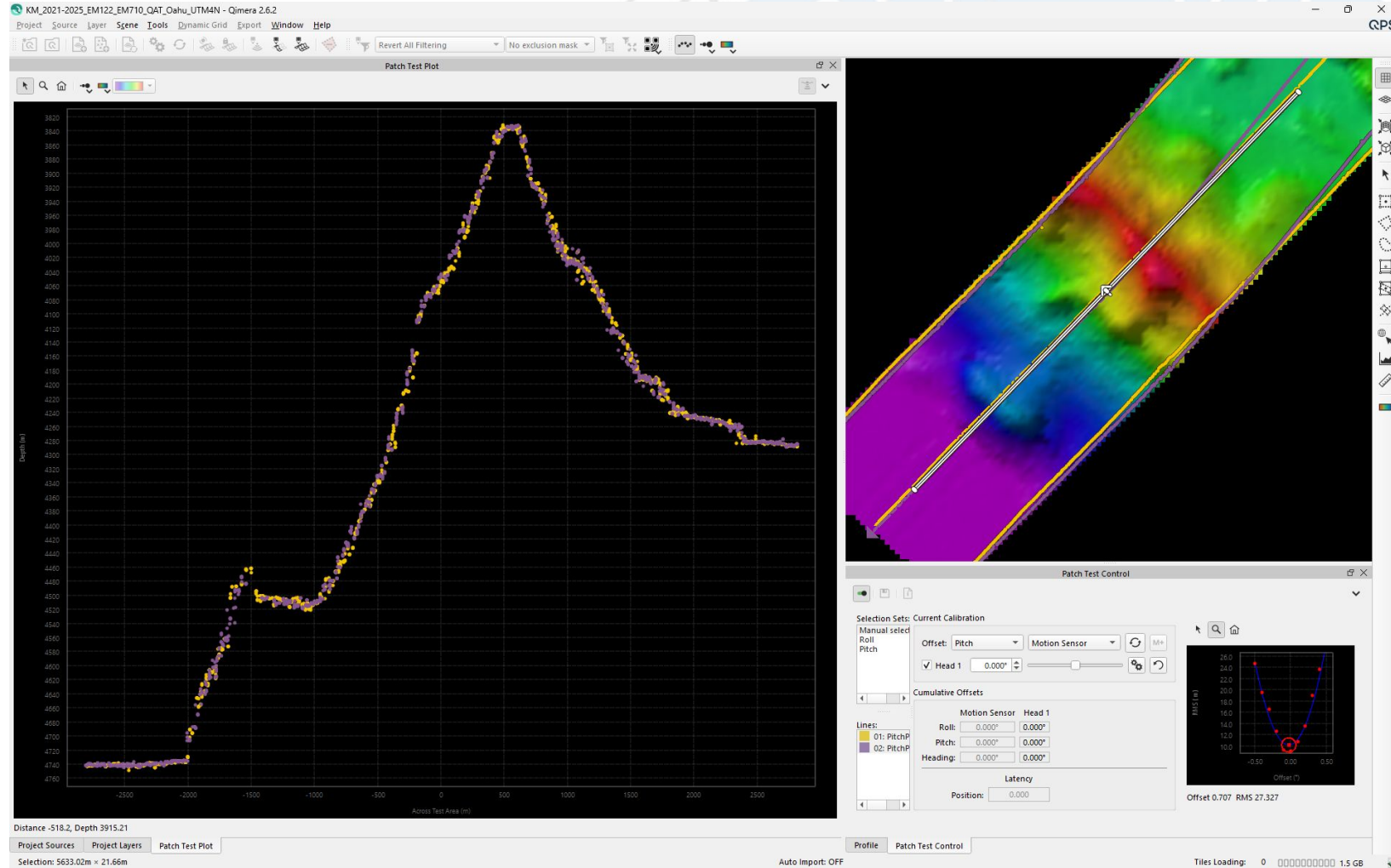
Offset angles (deg.)

	Roll	Pitch	Heading
TX Transducer:	0.233	-0.190	0.016
RX Transducer:	0.265	0.007	0.101
Attitude 1, COM2/UDP5:	-0.06	.01	0.37
Attitude 2, COM3/UDP6:	0.00	0.00	0.00
Stand-alone Heading:			0.00

1. All *Attitude 1* angular offsets were left unchanged in *SIS Installation Parameters* prior to data collection
2. Calibration data were edited and examined on shore with processing and patch test tools in QPS Qimera; small and large subsets of cleaned data were scrutinized visually (i.e., qualitatively) and with the 'Autosolver' to confirm minimum RMS differences between lines (i.e., quantitatively) using final results
3. EM122 pitch/roll results were applied on 2025-07-22; heading line #2 was rerun on 2025-12-06 and processed with heading line #1 using the updated pitch/roll calibration results in Qimera's vessel editor
4. EM710 data were processed and applied in Jan 2026
5. No latency test was performed for the EM122, as a small positioning latency would not be evident in deep water and no latency-related artifacts were noted; latency test lines for the EM710 showed no obvious positioning delay, and neither system exhibited any artifacts related to attitude latency

EM122 Calibration

Results: **Pitch**

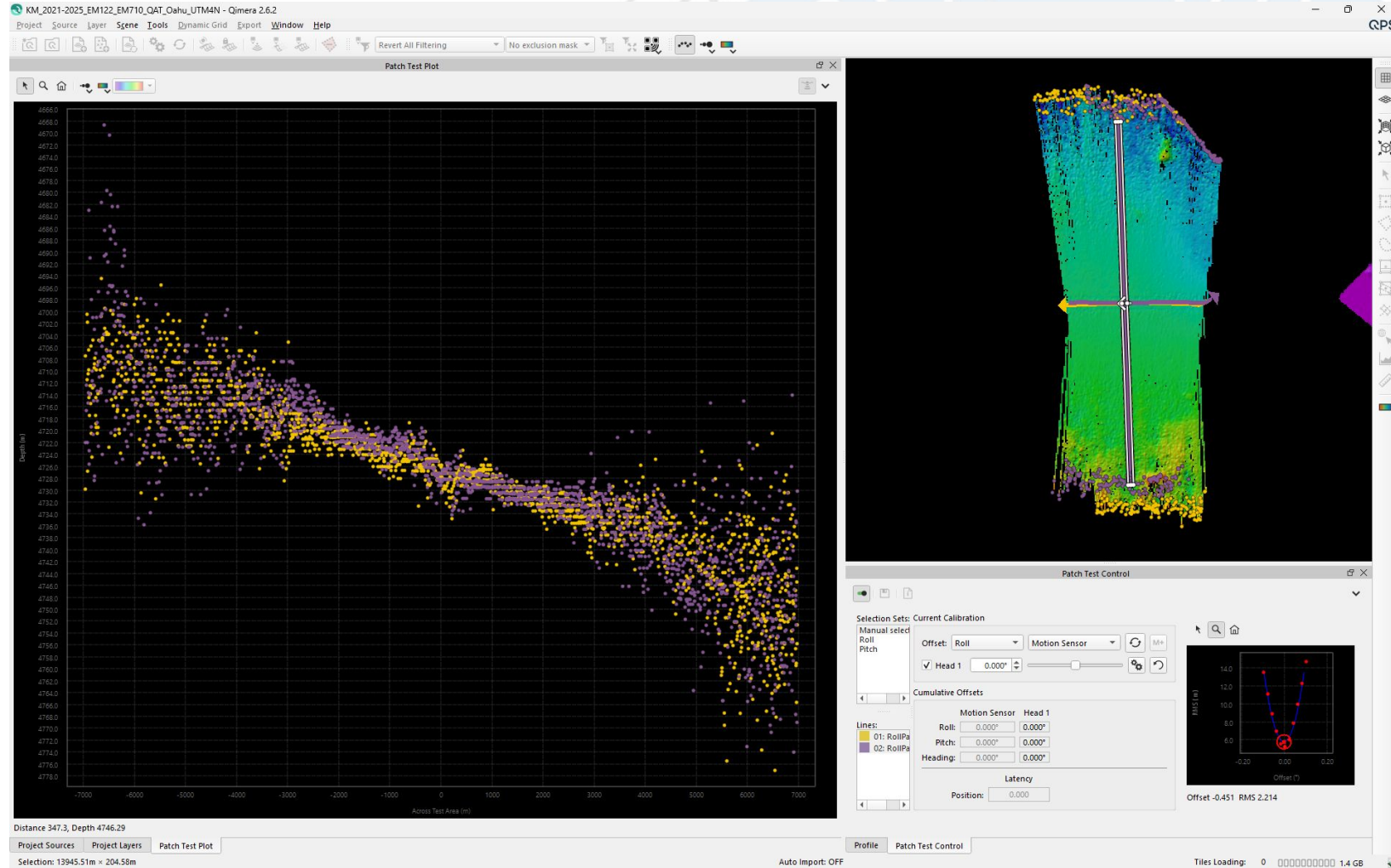


Pitch calibration lines shown at left in the Qimera Patch Test Tool

1. Attitude 1 initial setting: -0.40°
2. Calibration adjustment: $+0.05^\circ$
3. **Final pitch offset: -0.35° in SIS**

EM122 Calibration

Results: **Roll**

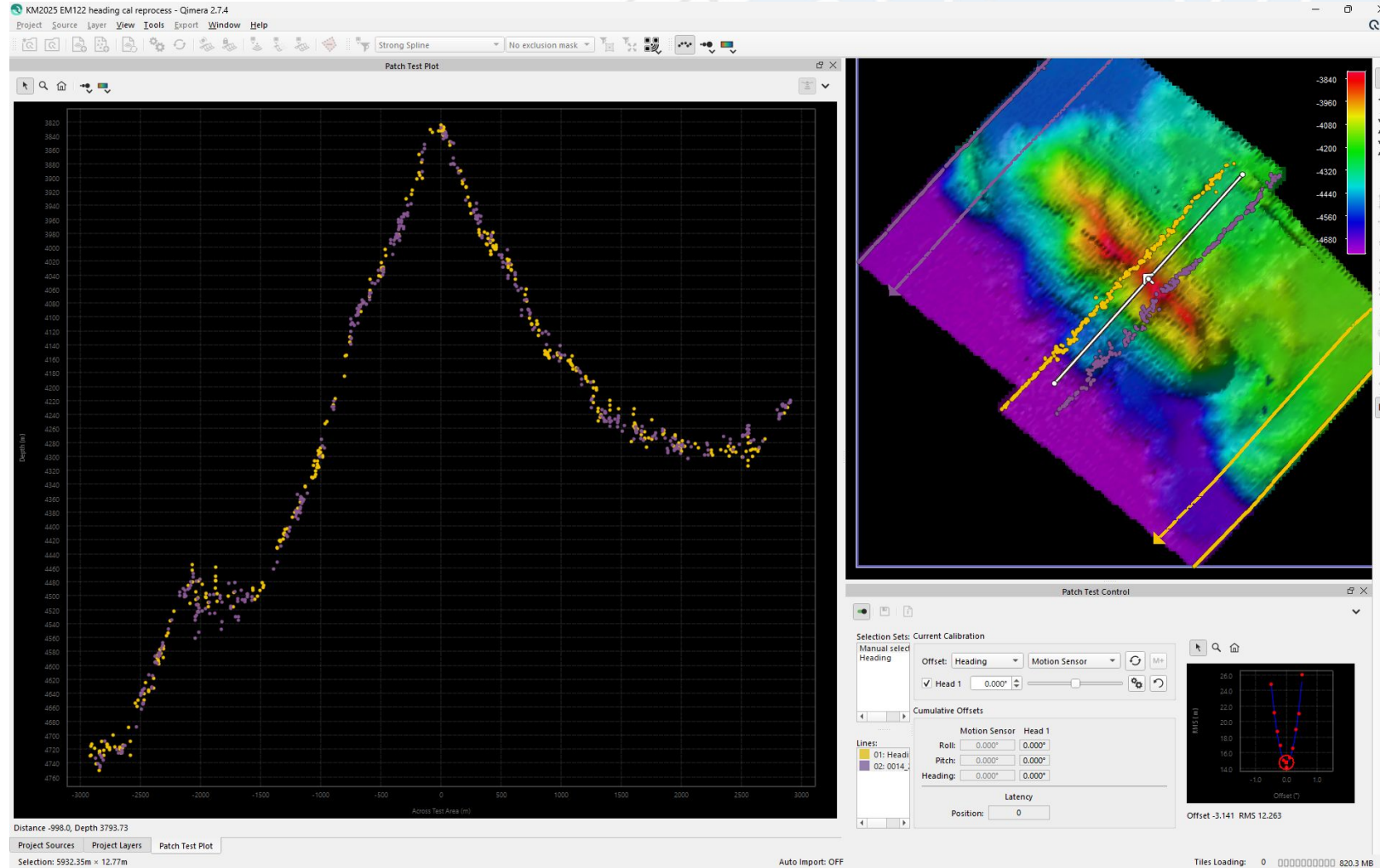


Roll calibration lines shown at left in the Qimera Patch Test Tool

1. Attitude 1 initial setting: -0.06°
2. Calibration adjustment: $+0.01^\circ$
3. **Final roll offset: -0.05° in SIS**

EM122 Calibration

Results: **Heading**



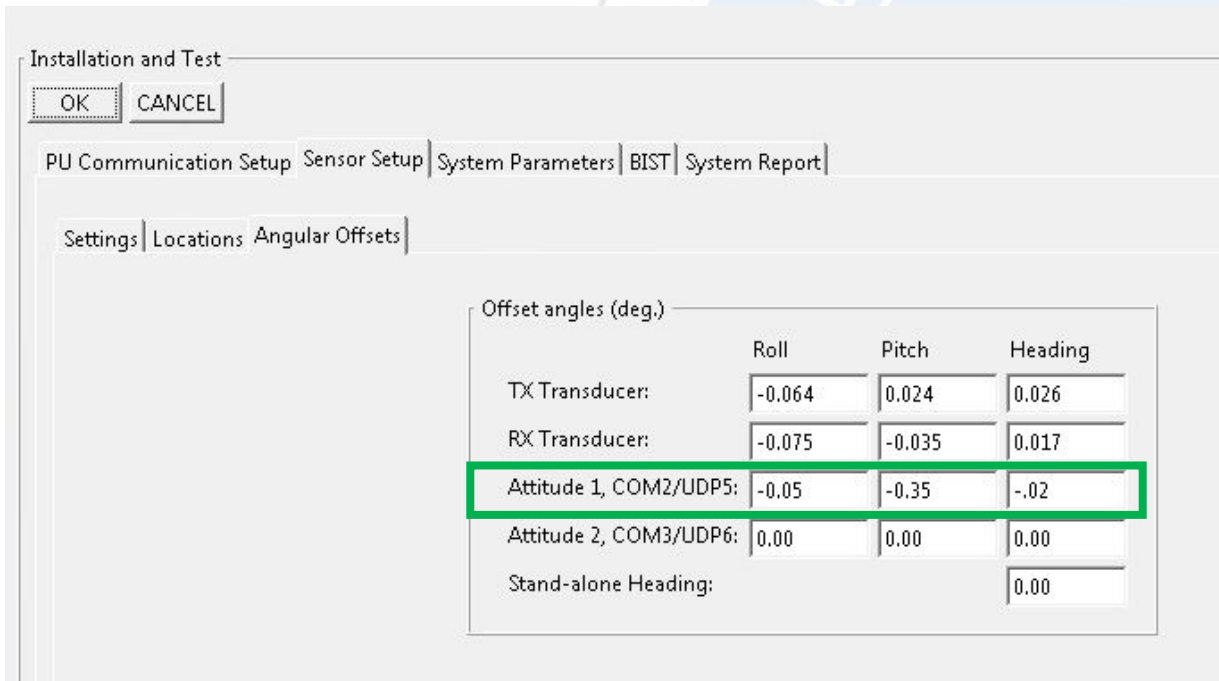
Heading calibration lines are shown at left in the Qimera Patch Test Tool

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

EM122 Calibration

Post-Calibration Configuration

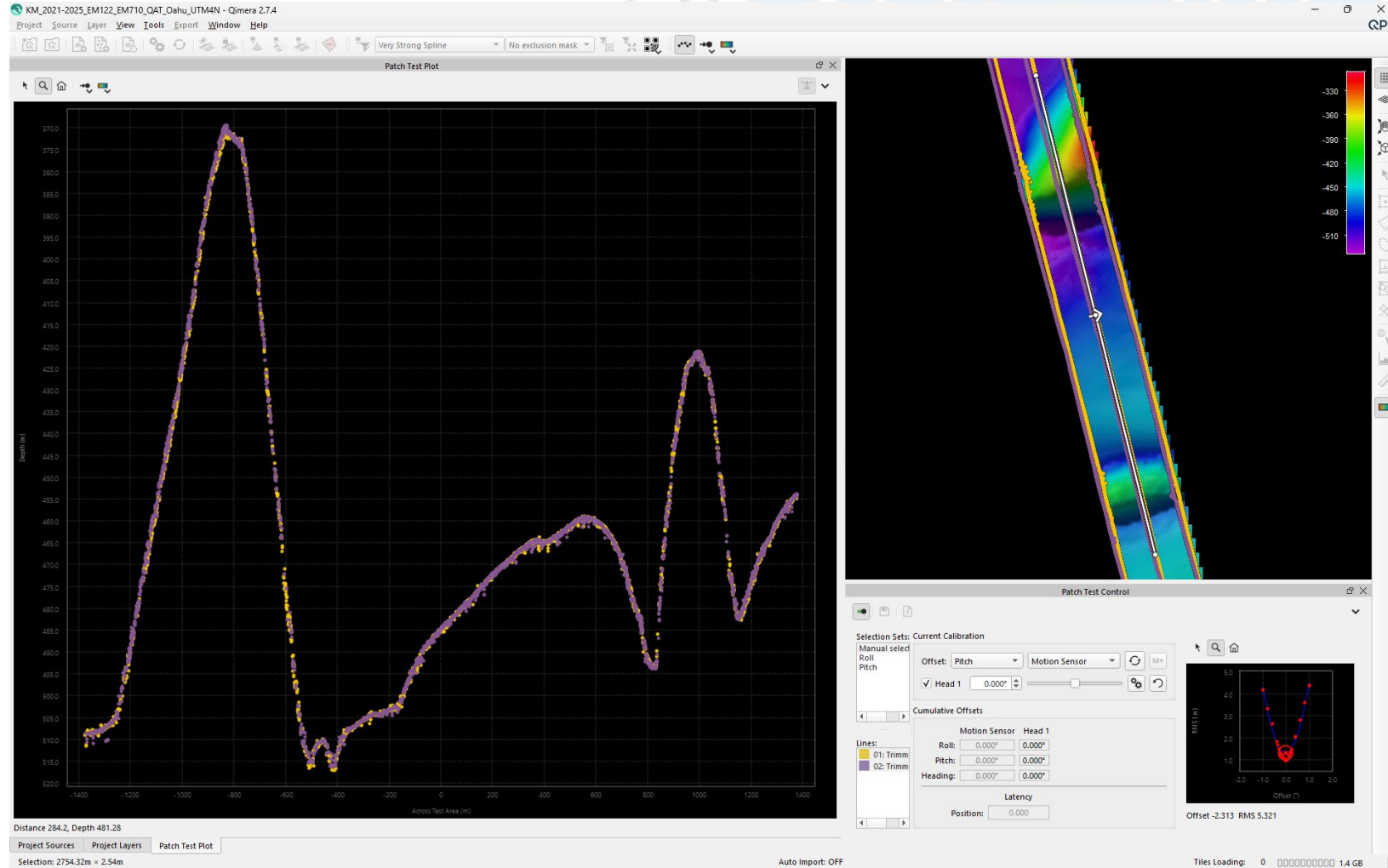
POST-CALIBRATION (EM122)



1. The *Attitude 1* adjustments made during the 2025 EM122 calibration are within the range of typical calibration adjustments; these generally confirm a high-quality vessel offset survey, consistent integration, and no significant changes across the POS MV and EM122 installations since 2017
2. The *Installation Parameters: Angular Offsets* shown at left should be maintained until any modification is made to the POS MV or EM122 arrays, or another calibration becomes necessary for other reasons
3. As mentioned in the 2020 QAT report, a pitch sign error was detected during a previous calibration; any EM122 data collected in 2017-2020 with the *Attitude 1* pitch offset of $+0.35^\circ$ should be flagged for users and this value should be adjusted to -0.35° in data processing, based on the 2017 QAT report

EM710 Calibration

Results: Pitch

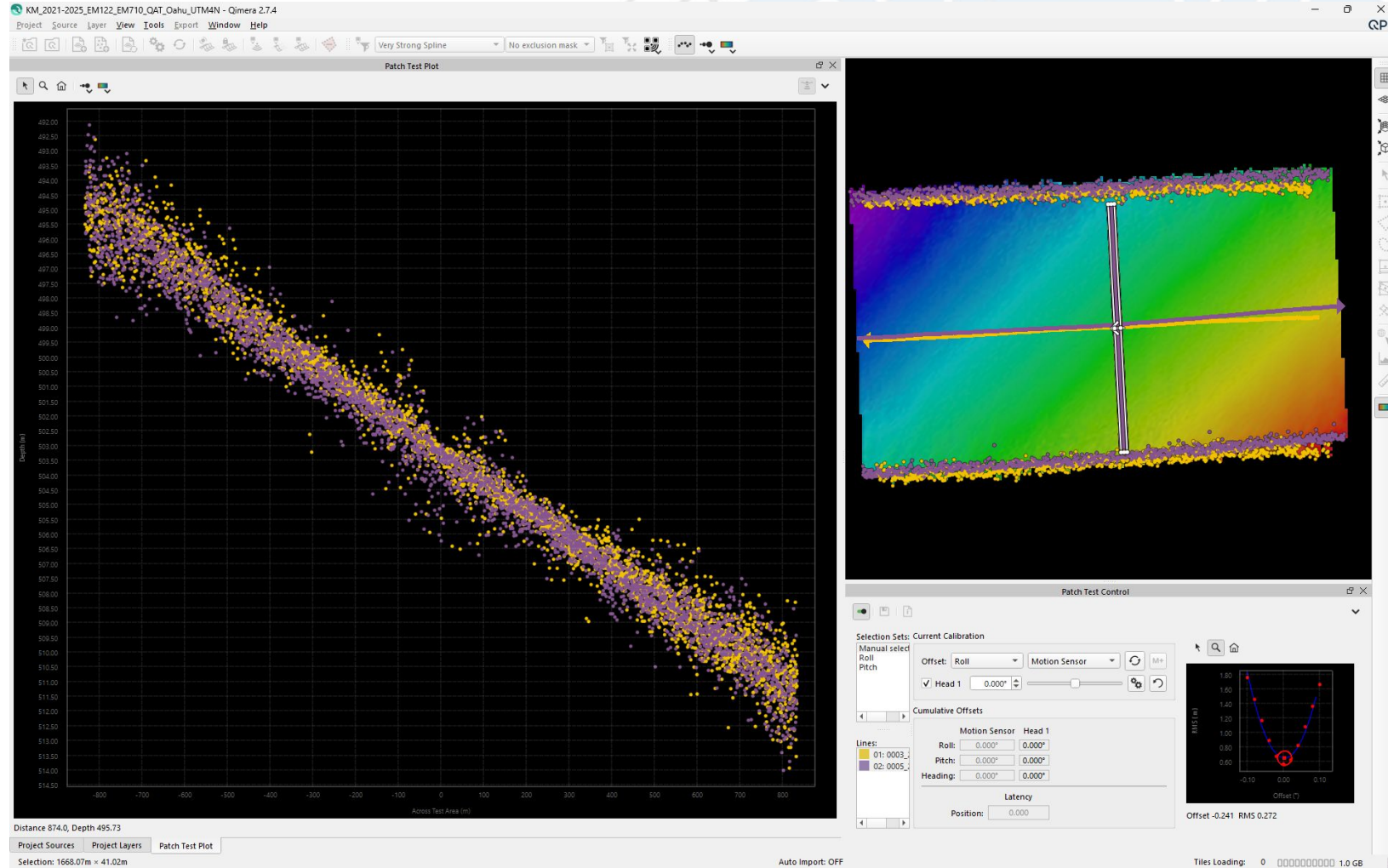


Pitch calibration lines are shown at left in the Qimera Patch Test Tool

1. Attitude 1 initial setting: $+0.01^\circ$
2. Calibration adjustment: -0.16°
3. **Final pitch offset: -0.15° in SIS**

EM710 Calibration

Results: **Roll**



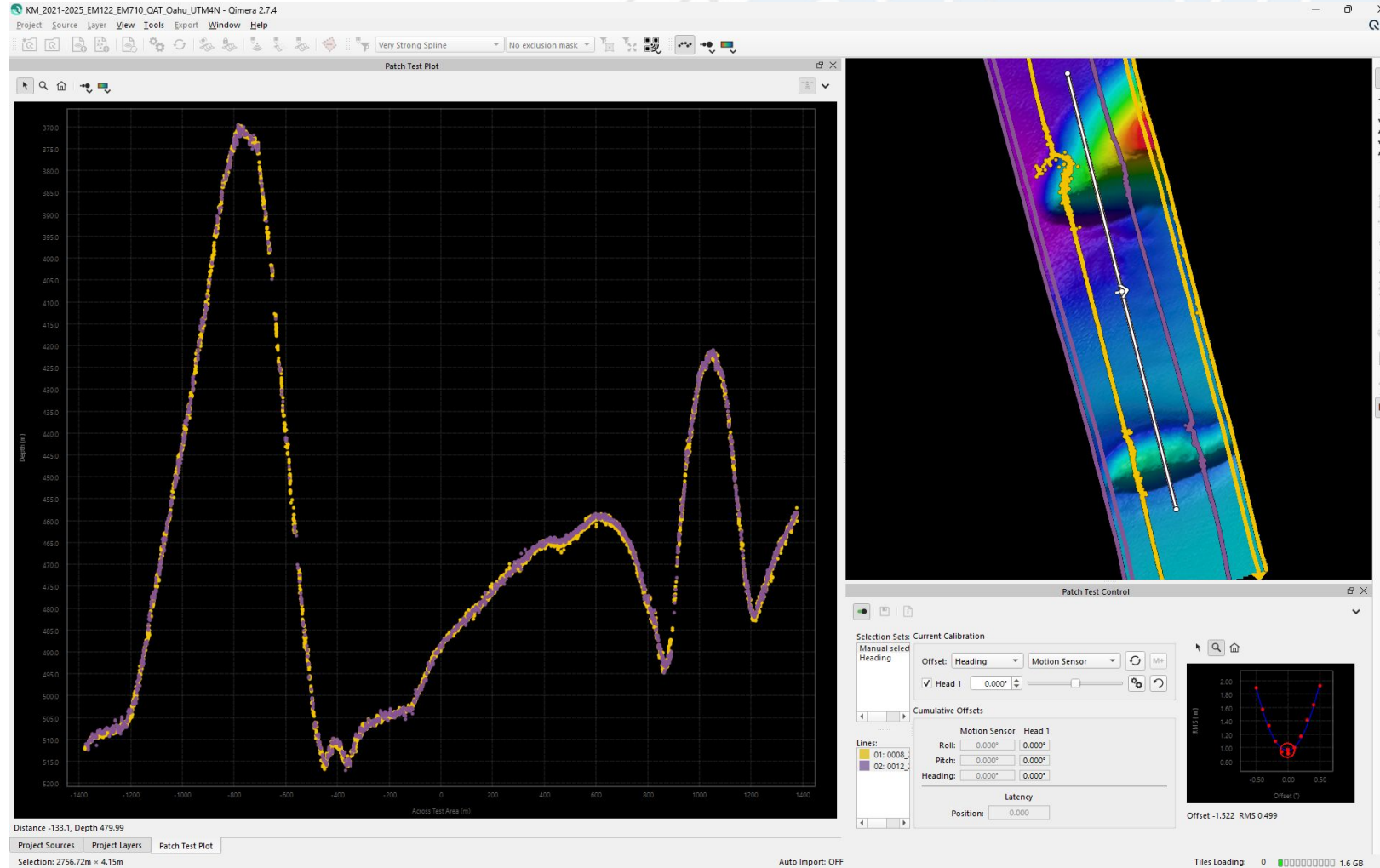
Roll calibration lines are shown at left in the Qimera Patch Test Tool

1. Attitude 1 initial setting: -0.06°
2. Calibration adjustment: -0.02°
3. **Final roll offset: -0.08° in SIS**

Note: The final roll result reflects an average of processing with many small subsets of soundings in the calibration area (example at left) as well as a 'large subset' (not shown) with all data

EM710 Calibration

Results: **Heading**



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

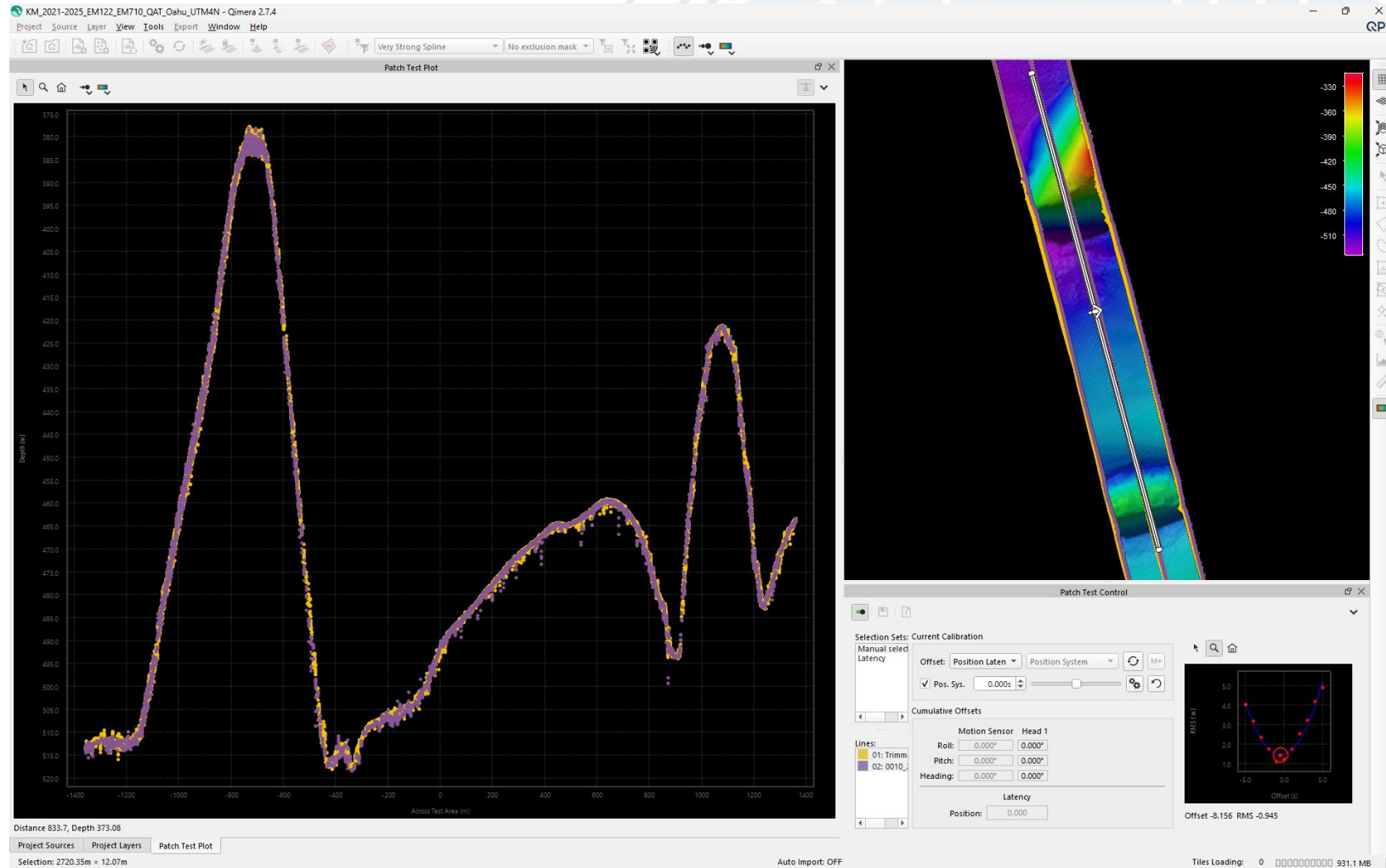
1. Attitude 1 initial setting: $+0.37^\circ$
2. Calibration adjustment: -0.15°
3. **Final hdg. offset: $+0.22^\circ$ in SIS**

EM710 Calibration

Results: **Position Latency**

Position latency test lines are shown at left in the Qimera Patch Test Tool

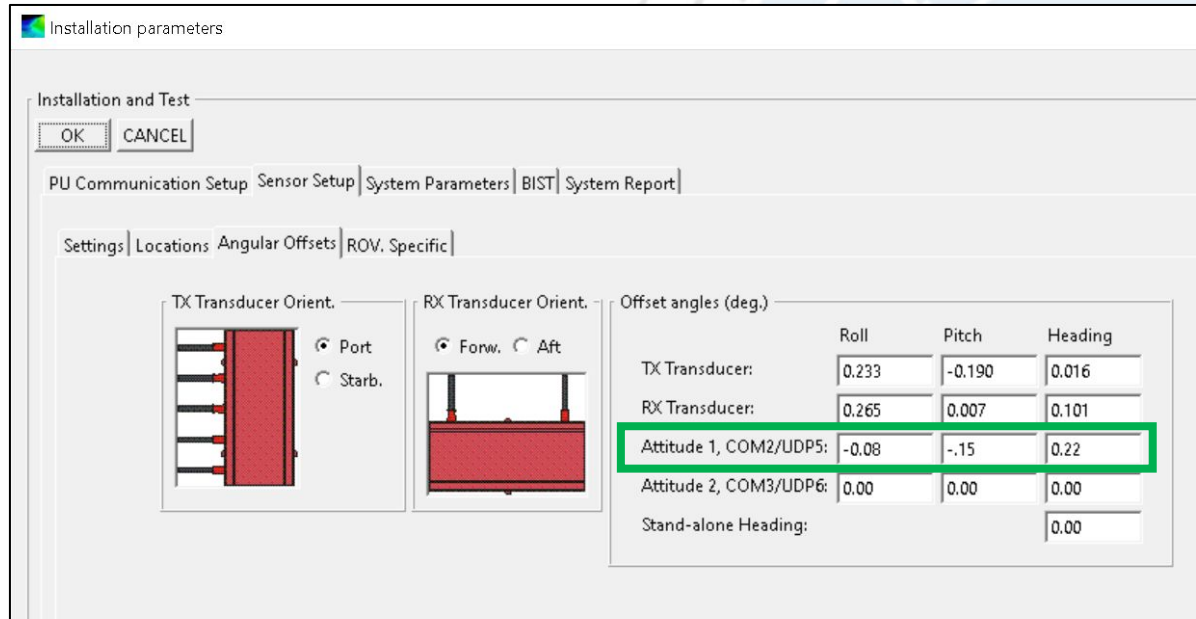
- 1. No obvious positioning latency was noted for the EM710**



EM710 Calibration

Post-Calibration Configuration

POST-CALIBRATION (EM710)



1. The EM710 *Attitude 1* adjustments in 2026 are on the upper end of typical ranges for year-to-year testing; however, they reflect a return toward the 'middle' of the range of historic results and appear reasonable given the interval since the last calibration (2022)
2. Taken together, these latest results generally confirm a high-quality vessel offset survey, consistent integration, and no significant changes across the POS MV and EM710 installations since 2017
3. The *Installation Parameters: Angular Offsets* shown at left should be maintained until any modification is made to the POS MV or EM710 arrays, or another calibration becomes necessary for other reasons

Hardware Health

Overview

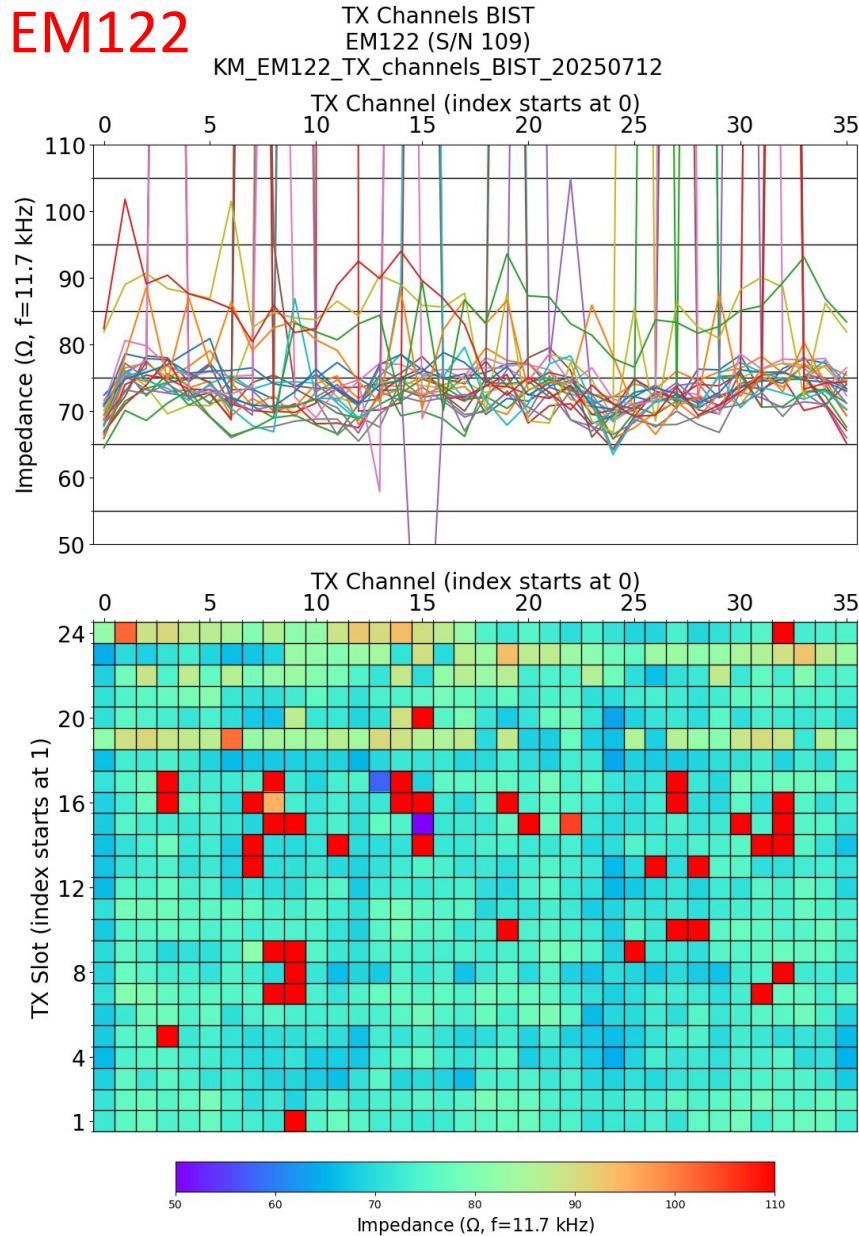
- Built-In Self-Tests (BISTs) were collected in January 2025 (pre-shipyard) and July 2025 (post-shipyard)
- BISTs provide proxies for impedance measurements of the transmitter elements, receiver elements, and receiver; routine RX and TX Channel BISTs may aid early detection of element degradation, which can affect swath coverage and swath accuracy over the life cycle of the multibeam system
- **It is important to note that the BISTs do not provide a full characterization of transducer properties as a function of frequency (as by direct measurements, e.g., with the Kongsberg Cypher tool)**
 - *A Kongsberg field engineer visited the Kilo Moana in Feb 2023 (see [2023 QAT report](#) for impedance checks)*
- The EM122 RX Channels BIST format includes receiver data but no transducer data (resulting in empty plots)
- All BISTs available on the EM710 and EM122 work stations are plotted here to provide an overview of *proxy* impedance measurements through time
- **Notes for EM710 BIST data and plots:** The EM710 TX Channels BIST menu (via telnet, right) includes options to test Slots 11-15 and 16-20 (tests #32 and #33 in red), which **do not exist** for a 1.0° TX system; 'extra' tests beyond Slot 10 caused the BIST plotter to fail and should be skipped during future telnet logging sessions (extra tests were removed from the text files to generate the plots shown here)

```
Detailed reports:  
30: TX channels slot 1 - 5  
31: TX channels slot 6 - 10  
32: TX channels slot 11 - 15  
33: TX channels slot 16 - 20
```

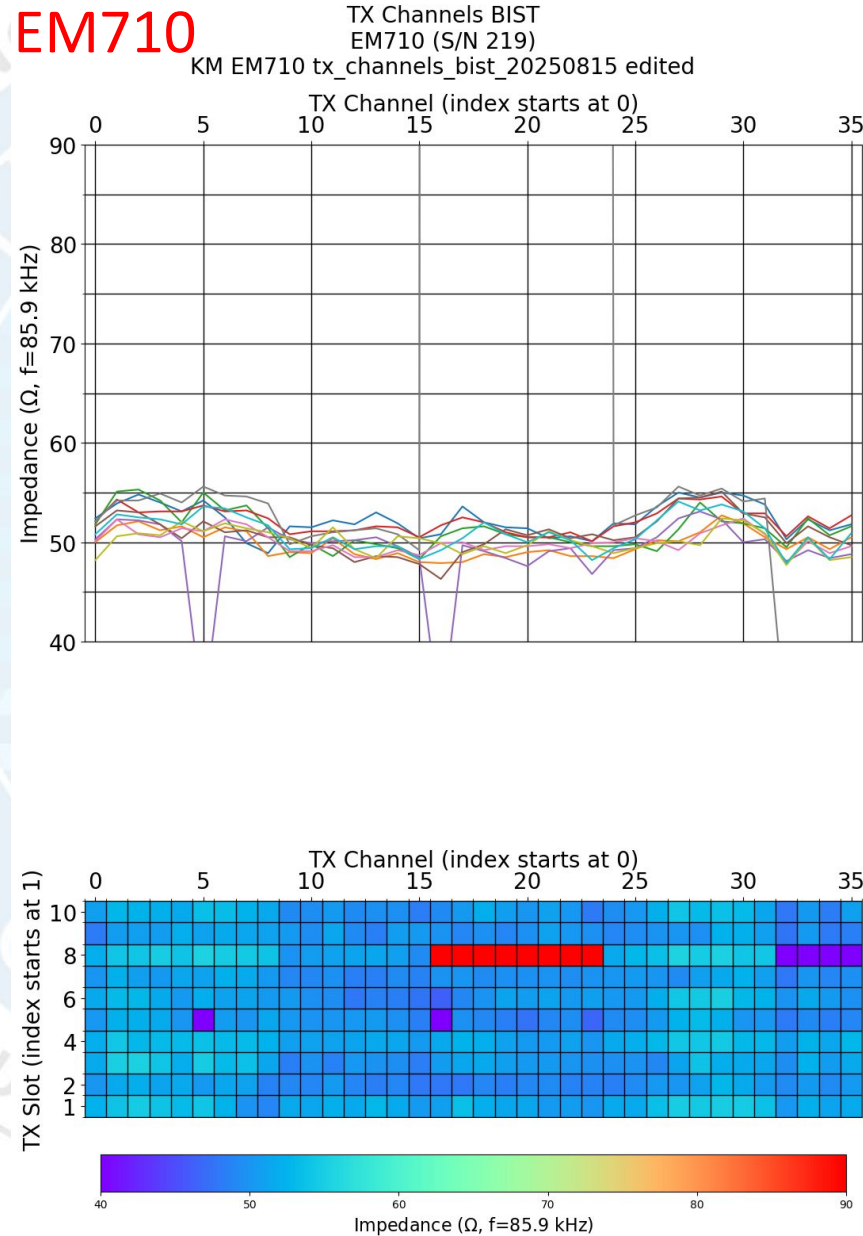
EM122/710 Hardware Health

TX Channels (2025)

EM122



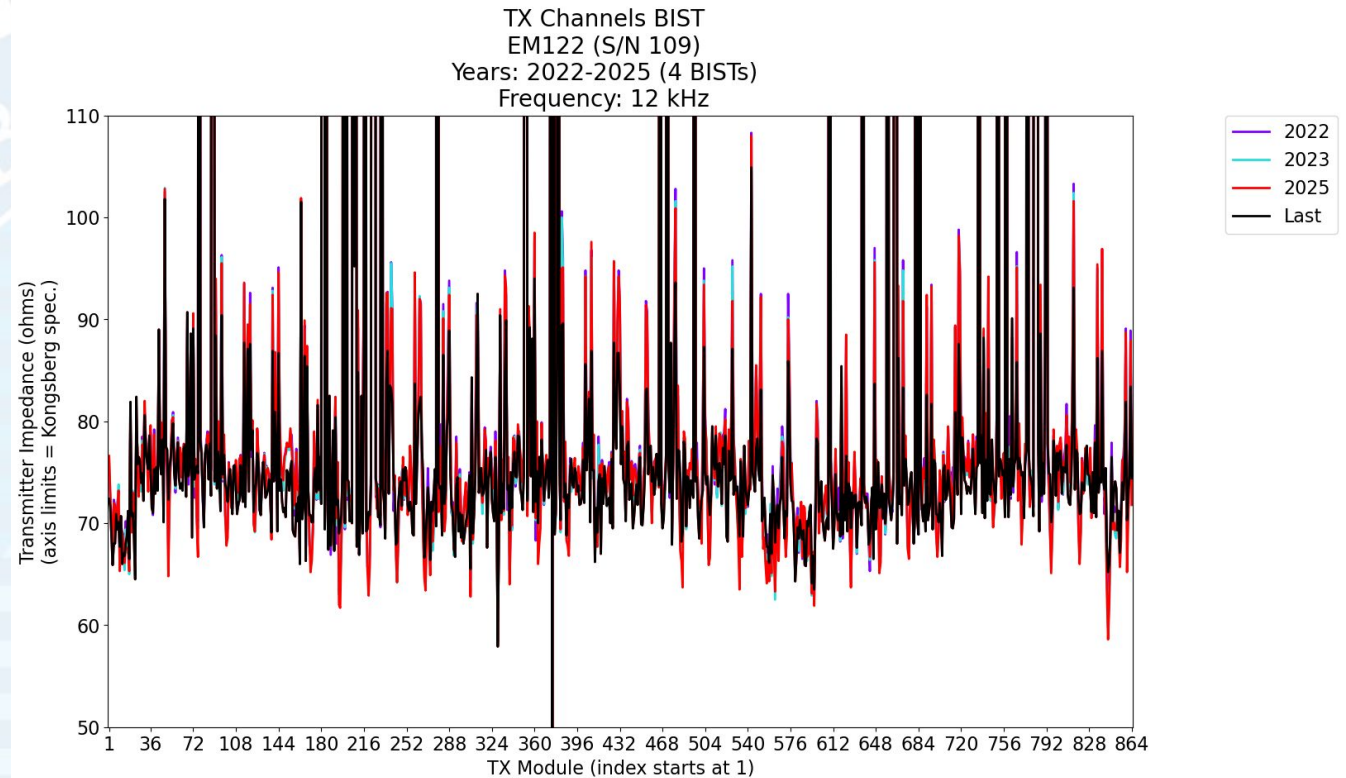
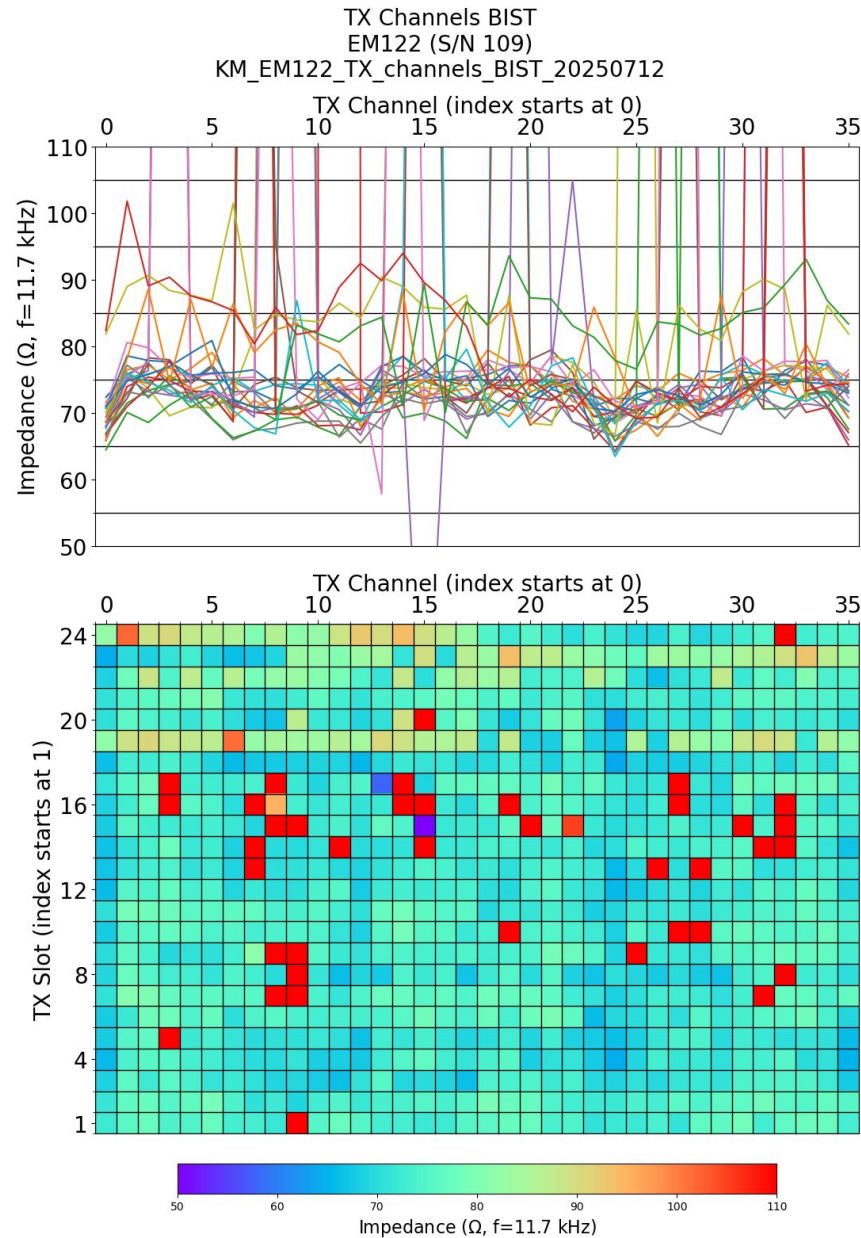
EM710



1. TX Channels BISTs were collected via telnet on July 12 and August 15, 2025
2. The color scales are based on Kongsberg specs included in the BIST files, with red (high Z, open) and purple (low Z, short) indicating element failure
3. EM710 TX slot #2 was missing in earlier BIST files (Jan 7, July 12); later BISTs included this slot as normal, as shown here (Aug 15, left) and included in the history plots (next slides)

EM122 Hardware Health

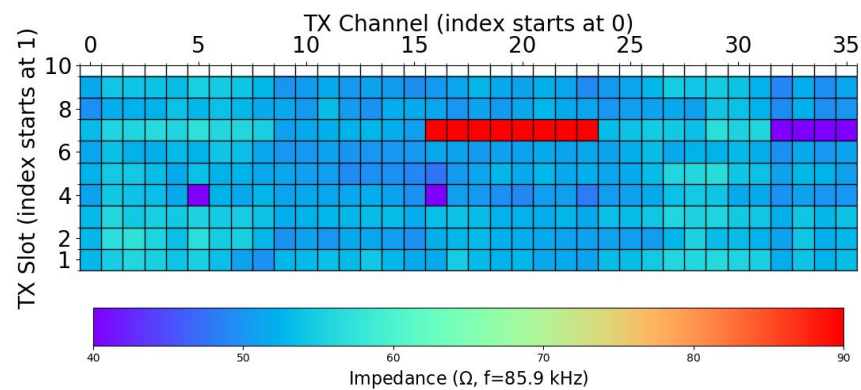
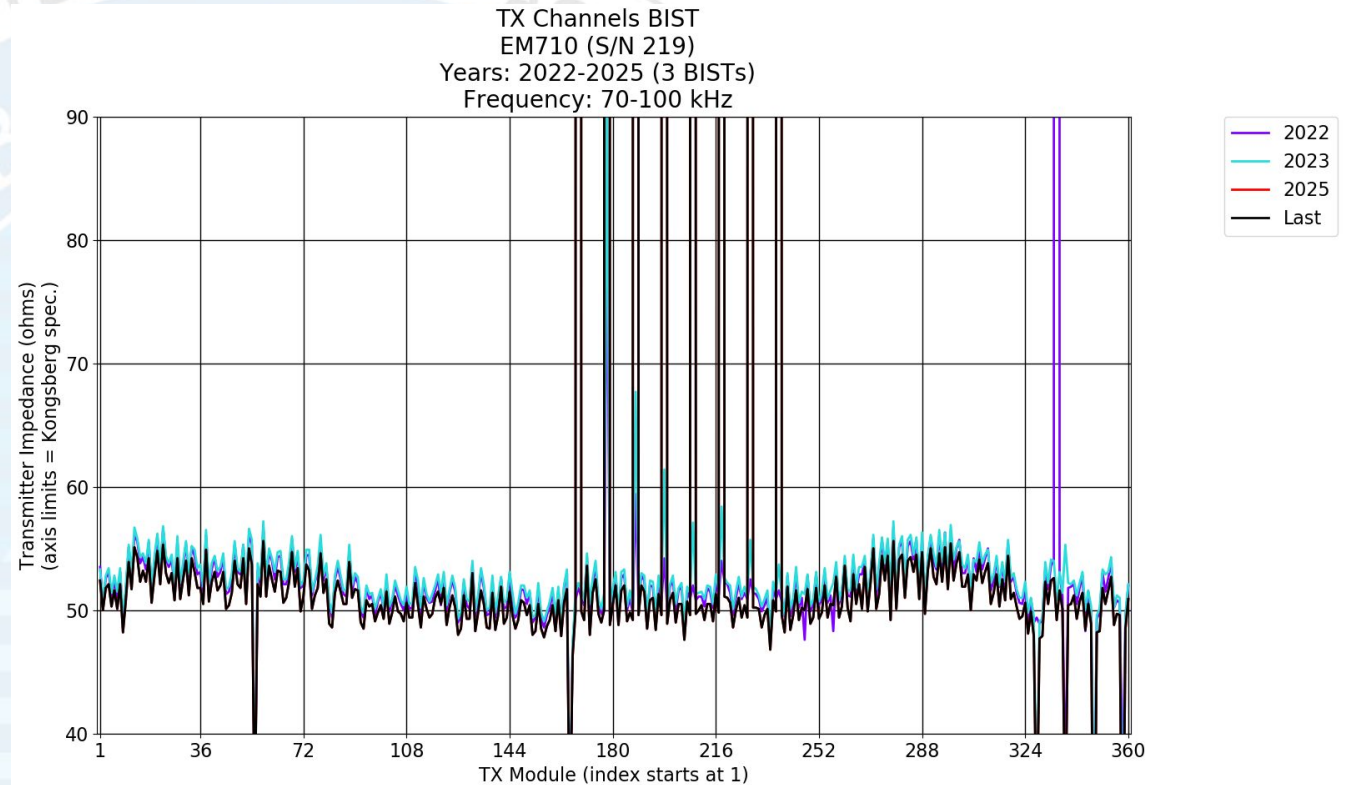
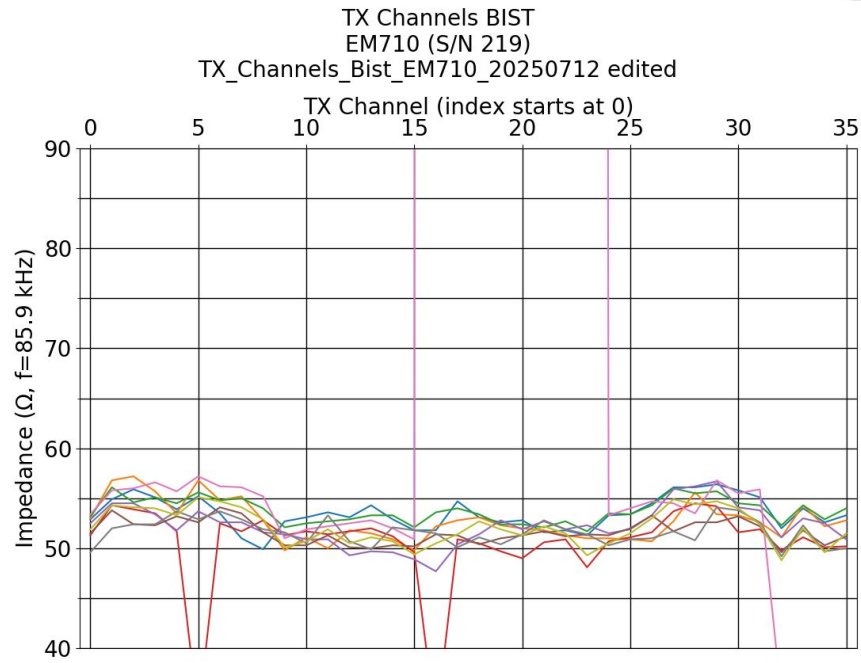
TX Channels History



1. An EM122 TX Channels BIST was logged on 2025-07-12, showing 38 errors (37 High Z and 1 Low Voltage) out of 864 channels, or ~4%; this represents a small increase of two more failures since direct Z measurements were taken by Kongsberg in Feb 2023, as expected for hardware of this age
2. **EM122 replacement planning should be underway due to the potential for more rapid / unplanned hardware failure and the end of manufacturer support for this generation of multibeam systems**

EM710 Hardware Health

TX Channels History

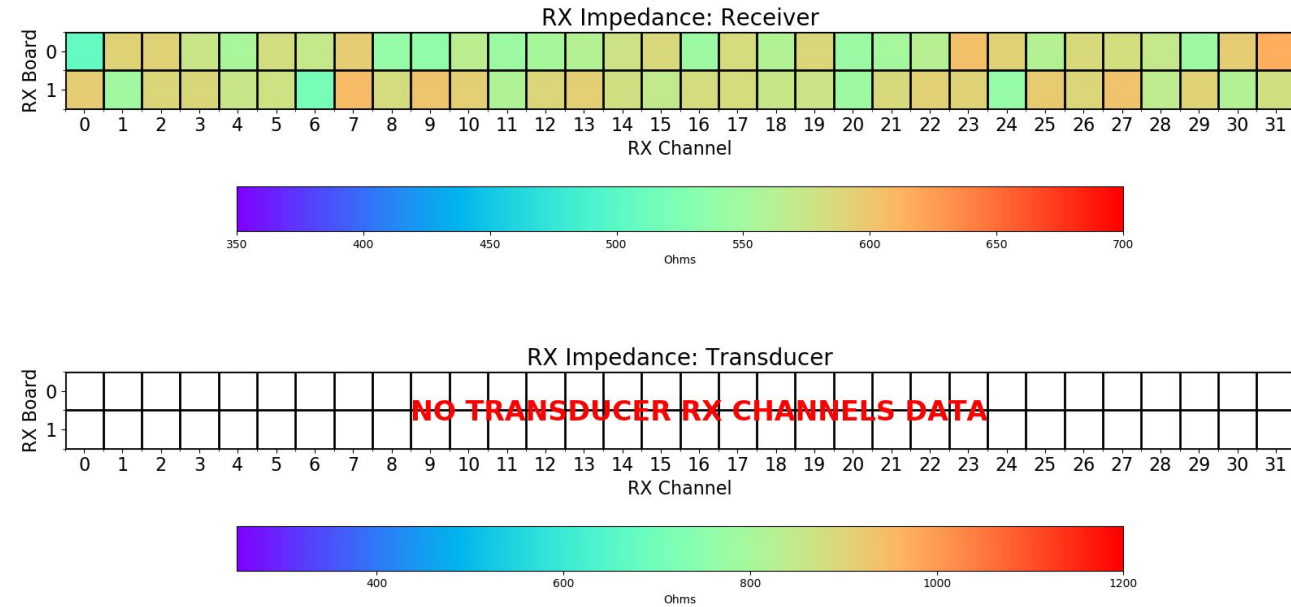


1. No TX Channels data are available prior to 2022
2. The 2025 results indicate an increase in the number of 'Open' and 'Low Z' channels; these occur in blocks of 4-8, possibly suggesting module-level failures that should be monitored with routine BISTs

EM122 Hardware Health

2025

RX Channels BIST
EM122 (S/N 109)
2025/07/12 20:29:05.975
Frequency: 12 kHz



RX Channels and Receiver

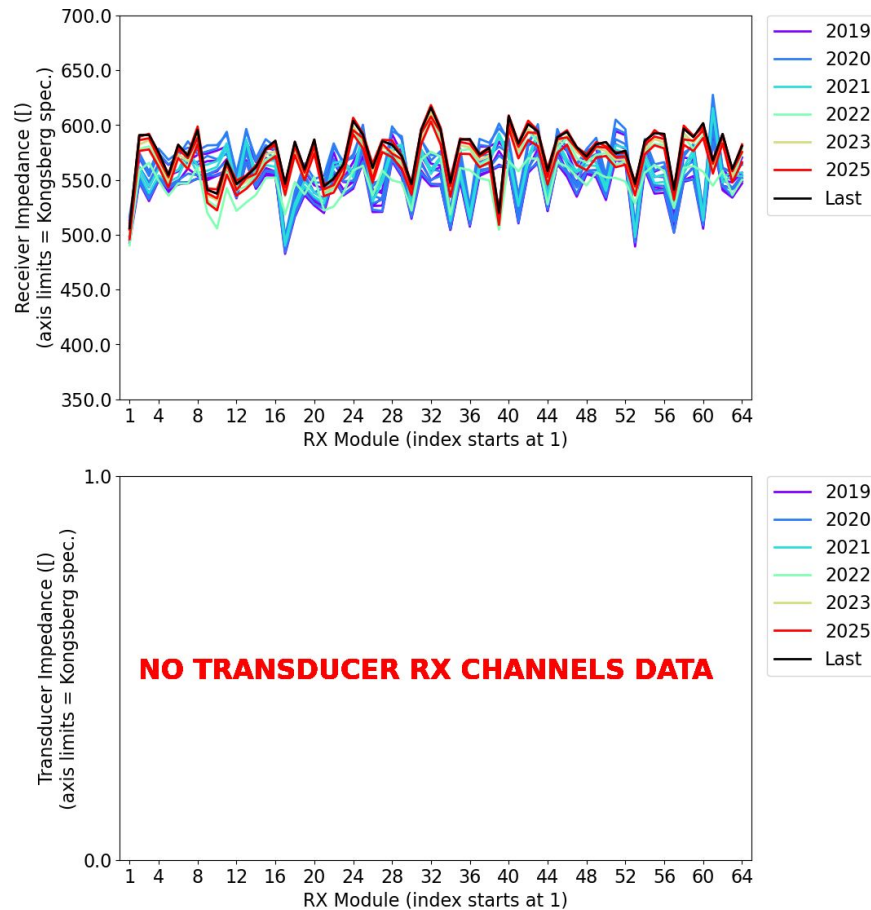
- EM122 RX channels data for the receiver (top) and transducer (bottom) were logged on 2025-07-12
- The color scale on each plot is based on the acceptable impedance range to pass a BIST, as defined by Kongsberg
- All receiver impedance values are well within spec
- For this EM122 BIST format, the text file does not include transducer element impedance data; this should be tested with direct measurements (e.g., Cypher tool) as the array elements may degrade without impacting receiver impedance results

EM122 Hardware Health

RX Channels and Receiver

Historic BISTs

RX Channels BIST
EM122 (S/N 109)
Years: 2019-2025 (19 BISTs)
Frequency: 12 kHz



- EM122 RX channels impedance data for the receiver (top) and transducer (bottom) are shown for all available BISTs (2019-2025); the last BIST plotted (black) is from 2025-07-10
- These plots show consistent trends for each module and no significant changes in the 19 available files
- For this EM122 BIST format, the text file does not include transducer element impedance data

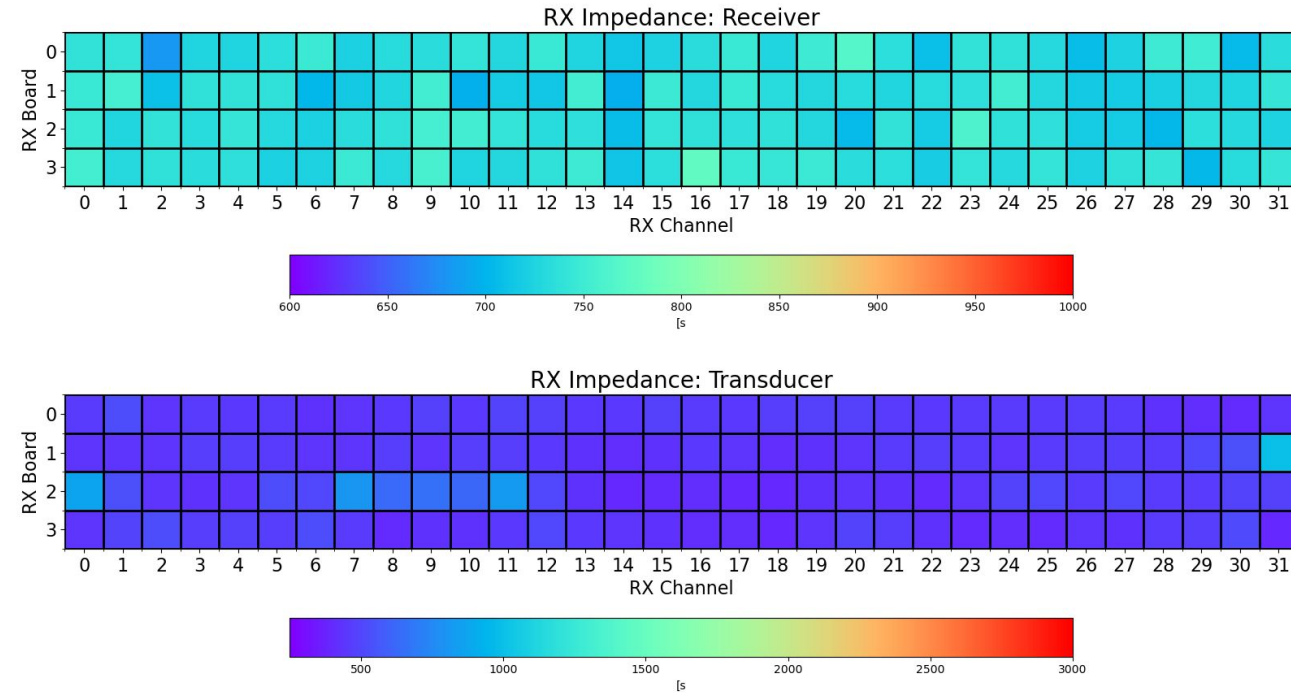
EM710 Hardware Health

2025

RX Channels BIST
EM710 (S/N 219)
2025/08/15 11:46:21.012
Frequency: 70-100 kHz

RX Channels and Receiver

- EM710 RX channels data for the receiver (top) and transducer (bottom) were logged on 2025-08-15
- The color scale on each plot is based on the acceptable impedance range to pass a BIST, as defined by Kongsberg
- Aside from a few clustered high values (e.g., elements 7-11 on board 2), the receiver and transducer impedance values appear to remain well within specification for all elements

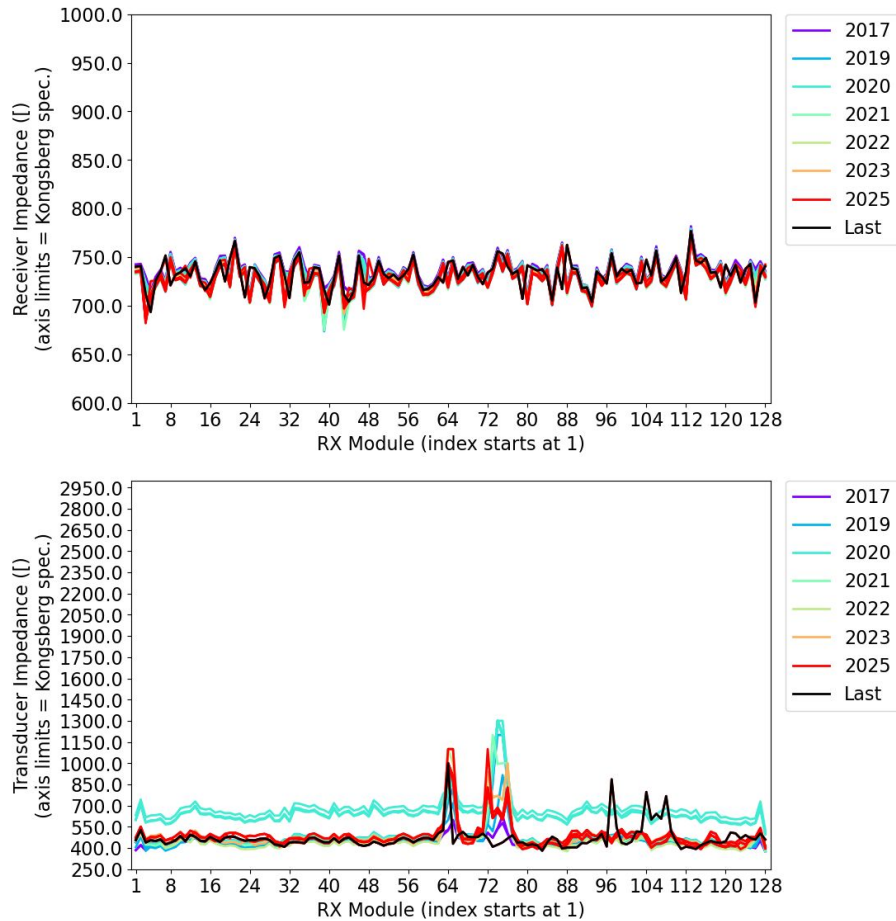


EM710 Hardware Health

RX Channels and Receiver

Historic BISTs

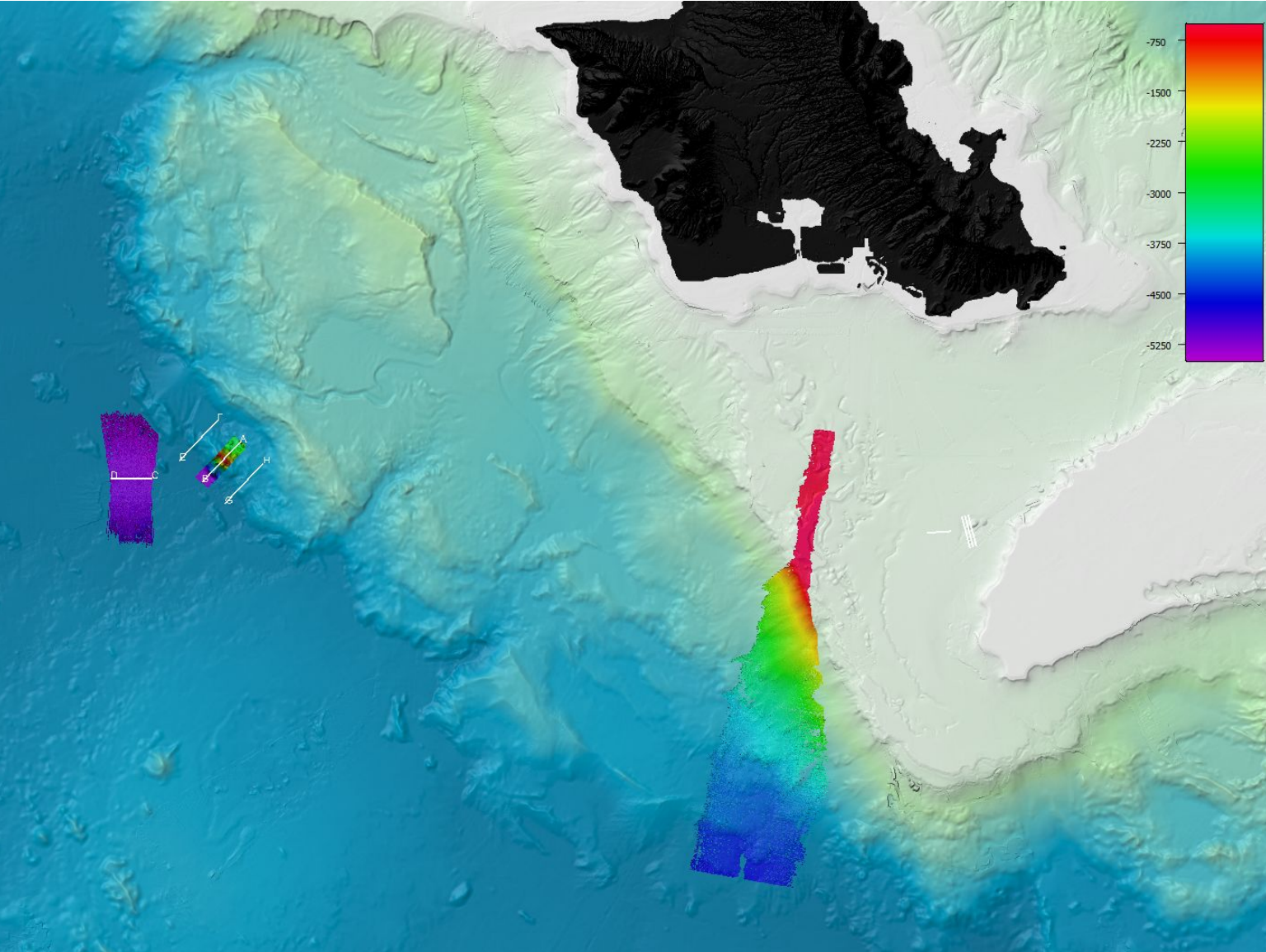
RX Channels BIST
EM710 (S/N 219)
Years: 2017-2025 (19 BISTs)
Frequency: 70-100 kHz



- EM710 RX channels impedance data for the receiver (top) and transducer (bottom) are shown for all available BISTs (2017-2025); the last BIST plotted (black) is from 2025-08-15
- These plots show consistent trends for each module in the array and no significant changes for the receiver impedance in the 19 available files
- The transducer impedance history shows an increase across the array in 2020, possibly associated with temperature, that returned to its baseline in 2021
- The history also shows upward trends for several clusters in the middle of the array; while these clusters have not degraded significantly since 2021, they should be monitored with routine BISTs

Swath Coverage Assessment

Overview



1. EM122 swath coverage testing was conducted in three segments during the 2025 QAT:

Segment 1: heading offshore and crossing contours from 200-4500 m at a $\sim 45^\circ$ angle (shown at left), resulting in some biases from slopes facing toward / away from the EM122

Segment 2: transiting offshore over flat abyssal plain at ~ 5600 (not shown)

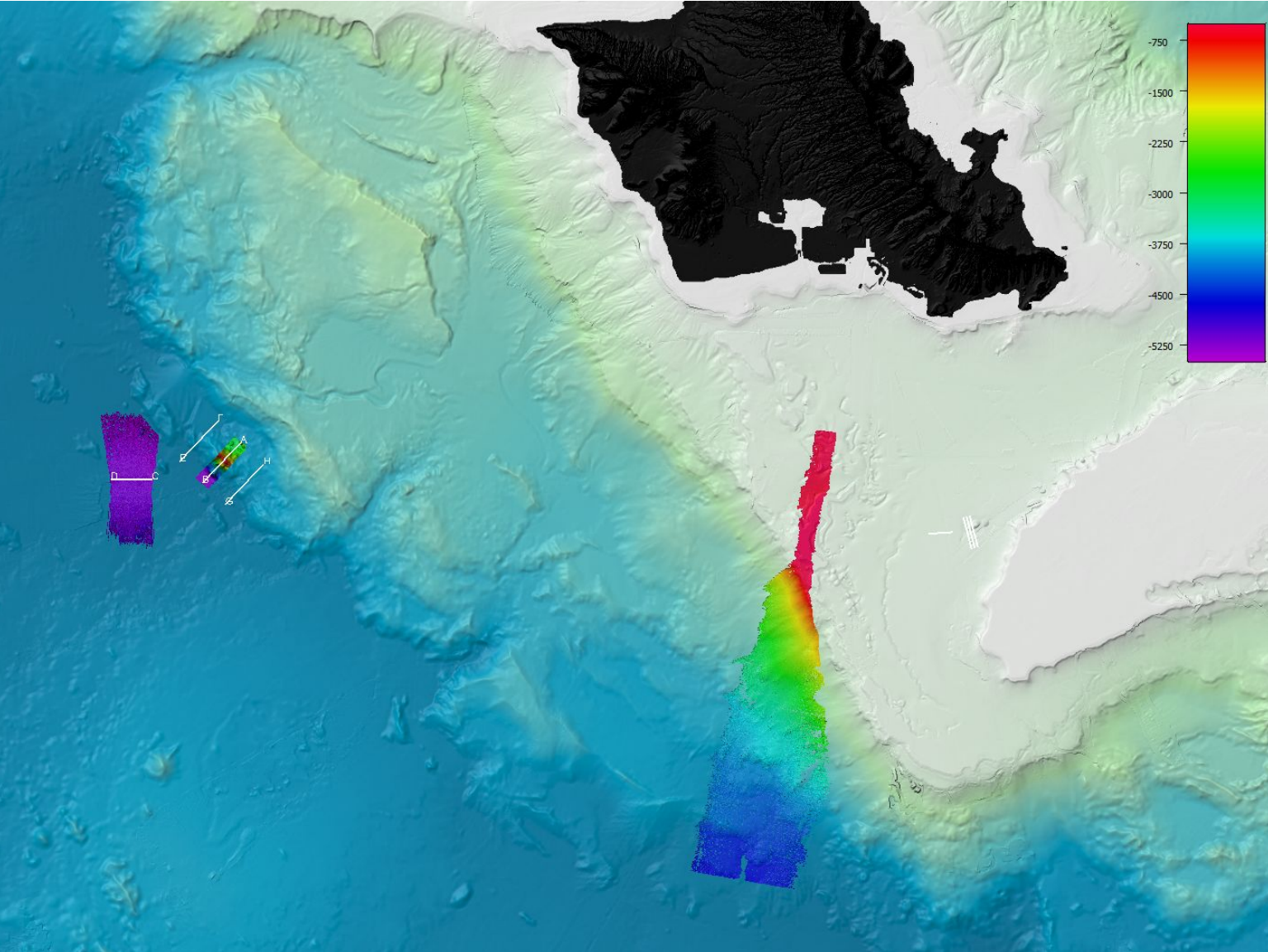
Segment 3: survey files to ~ 7800 m off Samoa (not shown)

2. Due to the high transit speed (11 kts) and correspondingly high noise levels, swath coverage plots shown here may under-represent the 'typical' coverage achieved at lower survey speeds

Note: the calibration site is shown at left for reference; the color scale applies to the swath coverage dataset

Swath Coverage Assessment

Overview



3. No EM710 swath coverage testing was completed during the initial QAT, but may be added later in the field season
4. Swath coverage results on the following slides clearly indicate biases toward the port side, facing the prevailing slopes over the majority of the dataset
5. Likewise, coverage on the starboard side is reduced by slopes facing away from the EM122 (i.e., weaker seafloor returns)
6. While the transit route could not be changed for this test, these results highlight the importance of crossing contours perpendicularly to reduce bias
7. Generally, the total achieved coverage agrees with previous testing and other EM122 installations in the UNOLS fleet

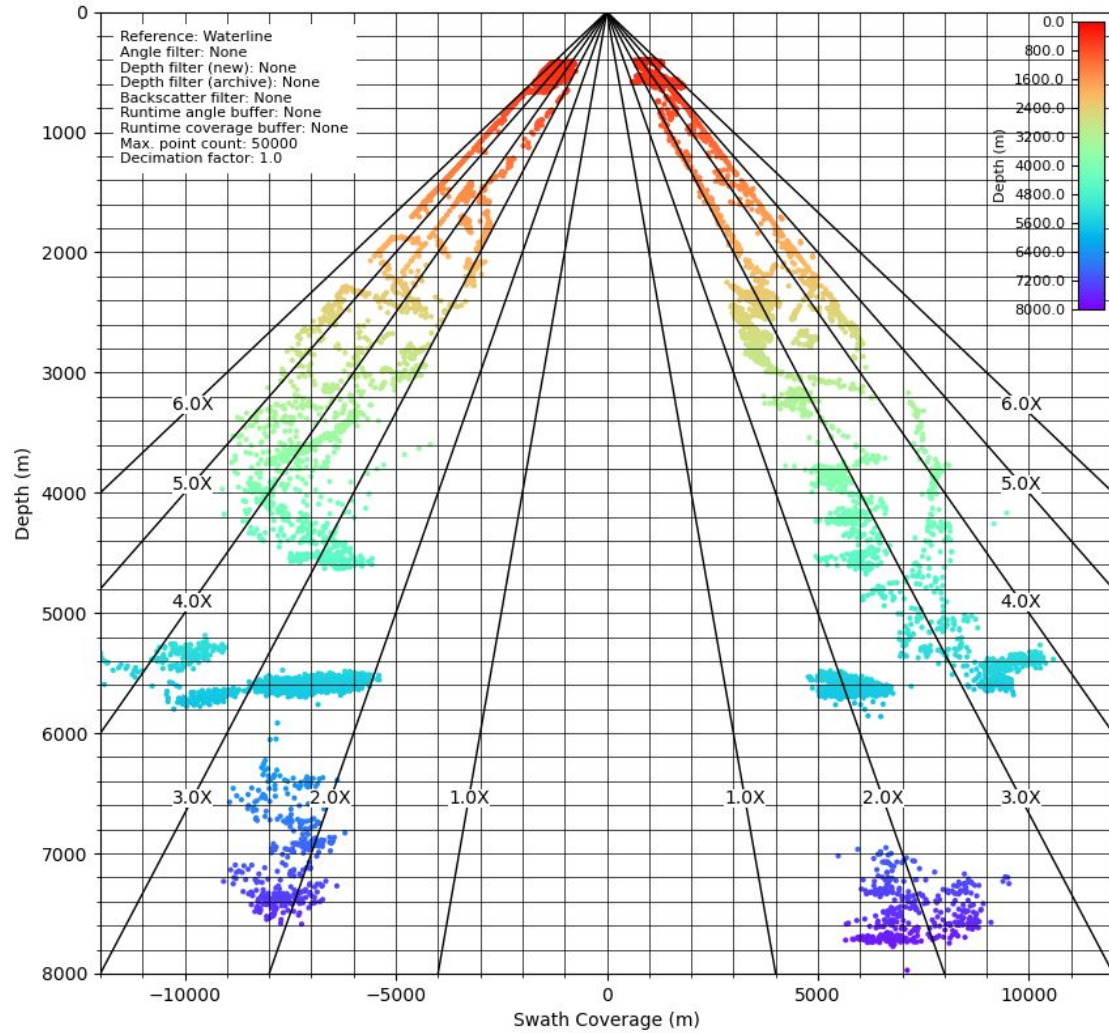
Note: the calibration site is shown at left for reference; the color scale applies to the swath coverage dataset

EM122 Swath Coverage

Results

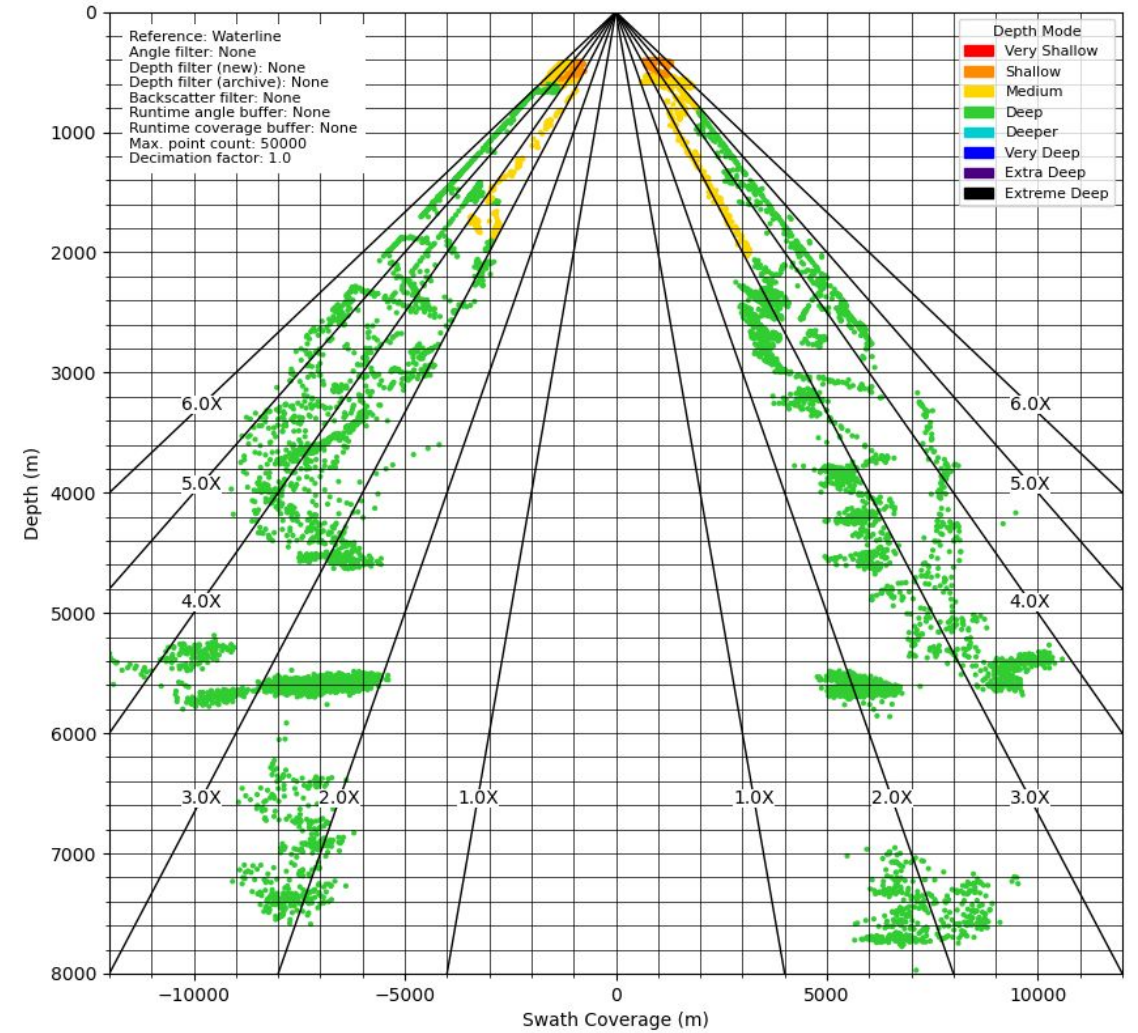
2025 (Depth)

Swath Width vs. Depth
EM 122 - Kilo Moana - 2025 QAT



2025 (Mode)

Swath Width vs. Depth
EM 122 - Kilo Moana - 2025 QAT

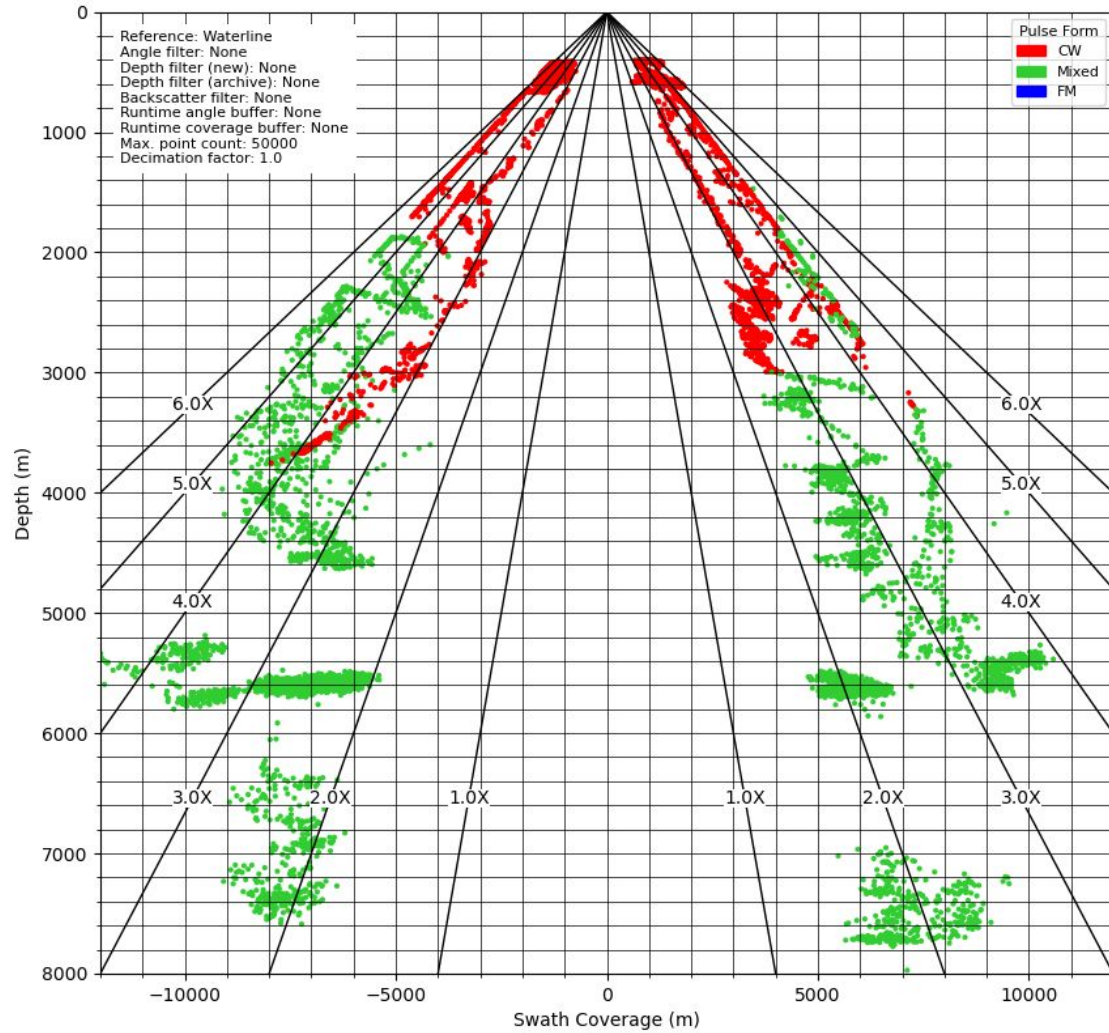


EM122 Swath Coverage

Results

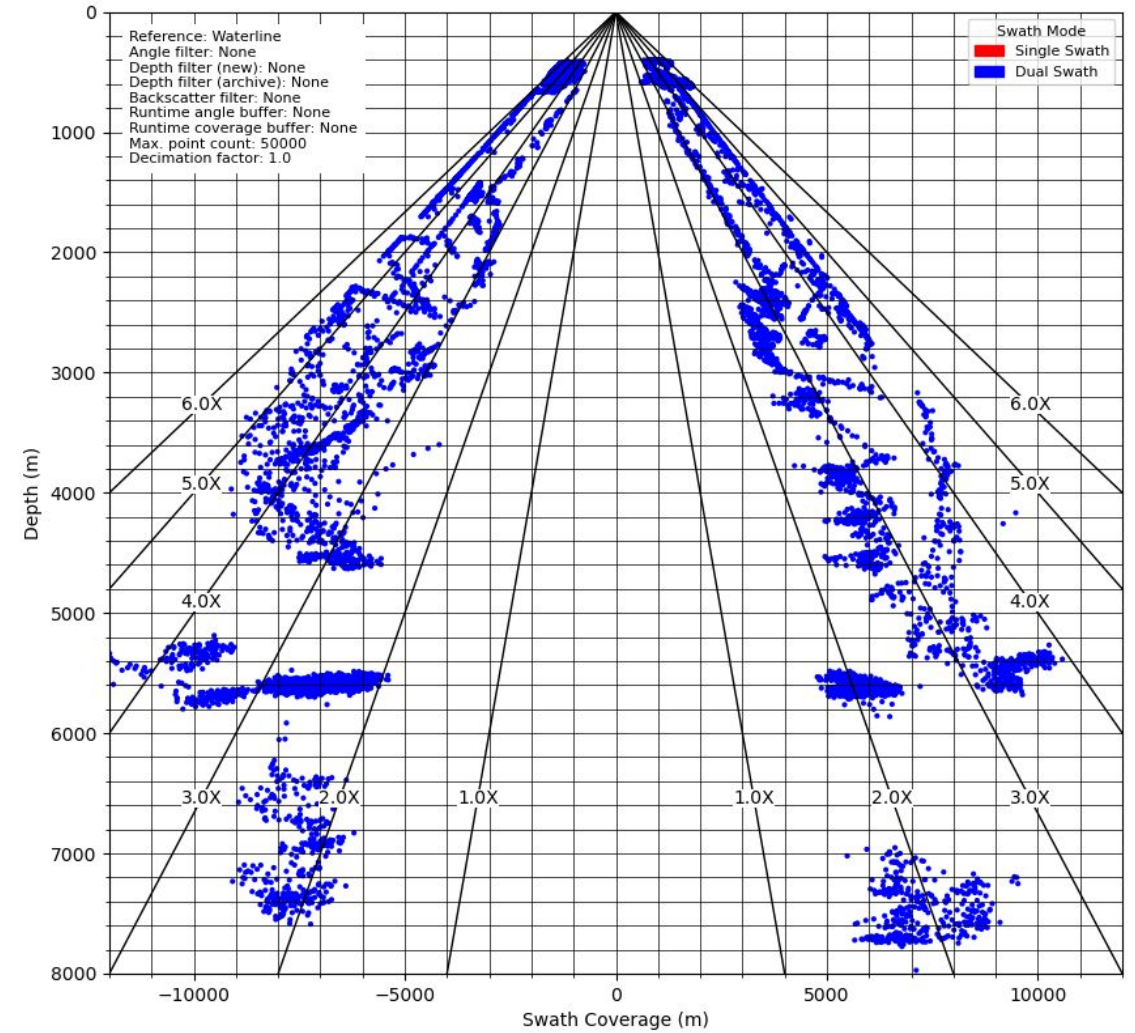
2025 (Pulse Form)

Swath Width vs. Depth
EM 122 - Kilo Moana - 2025 QAT



2025 (Swath Mode)

Swath Width vs. Depth
EM 122 - Kilo Moana - 2025 QAT

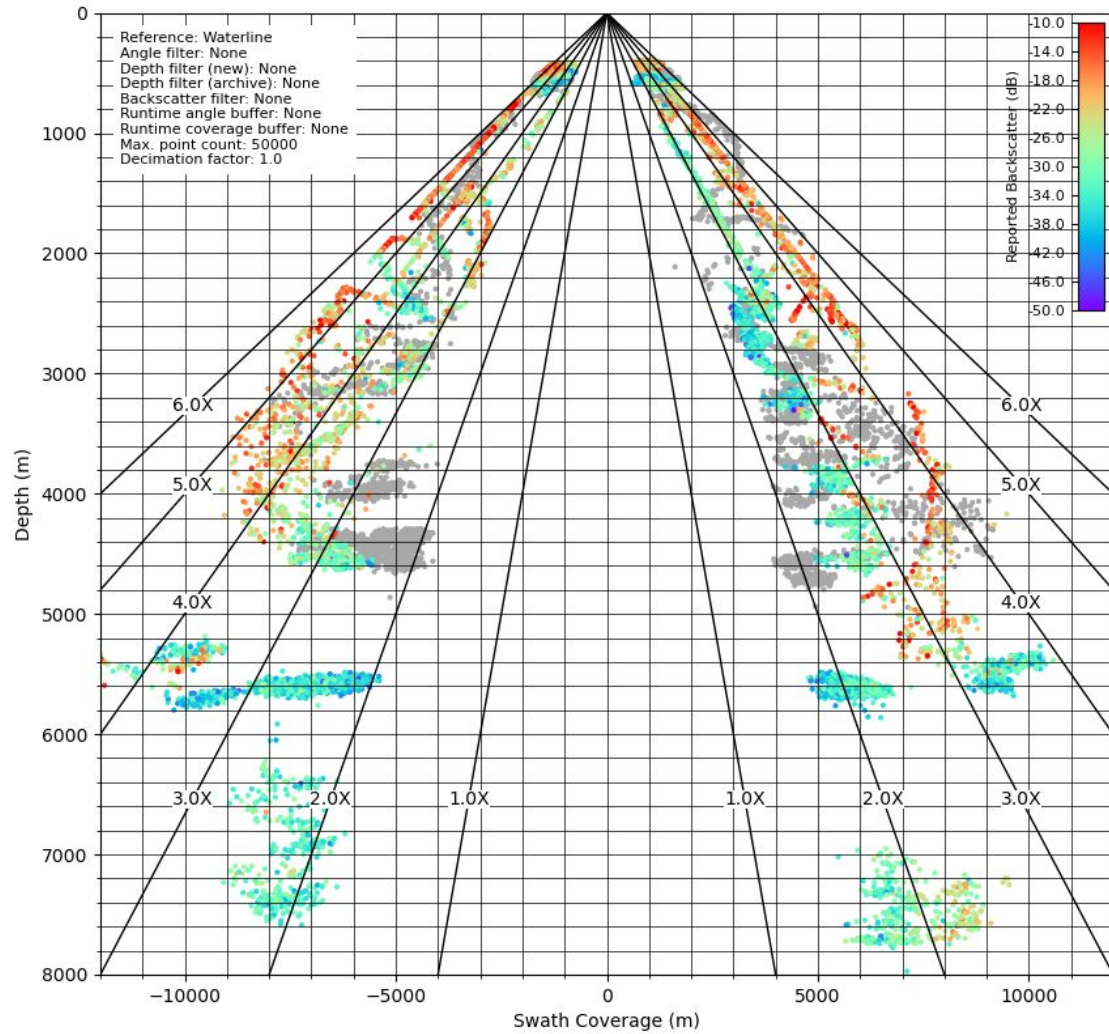


EM122 Swath Coverage

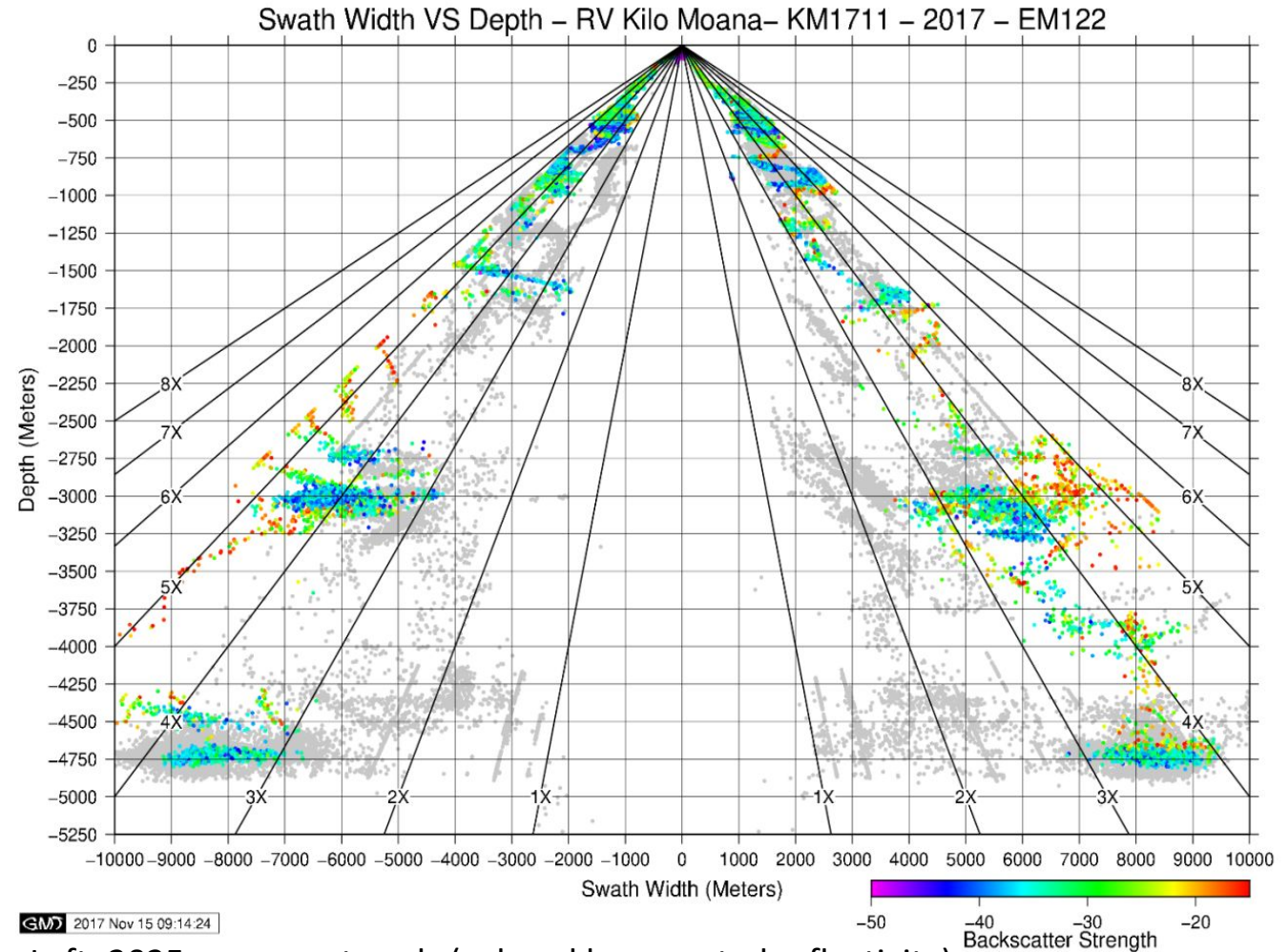
Results

2025 (Backscatter)

Swath Width vs. Depth
EM 122 - Kilo Moana - 2025 vs. 2023



2017 (Backscatter) vs. 2012 (Gray)



Left: 2025 coverage trends (colored by reported reflectivity)

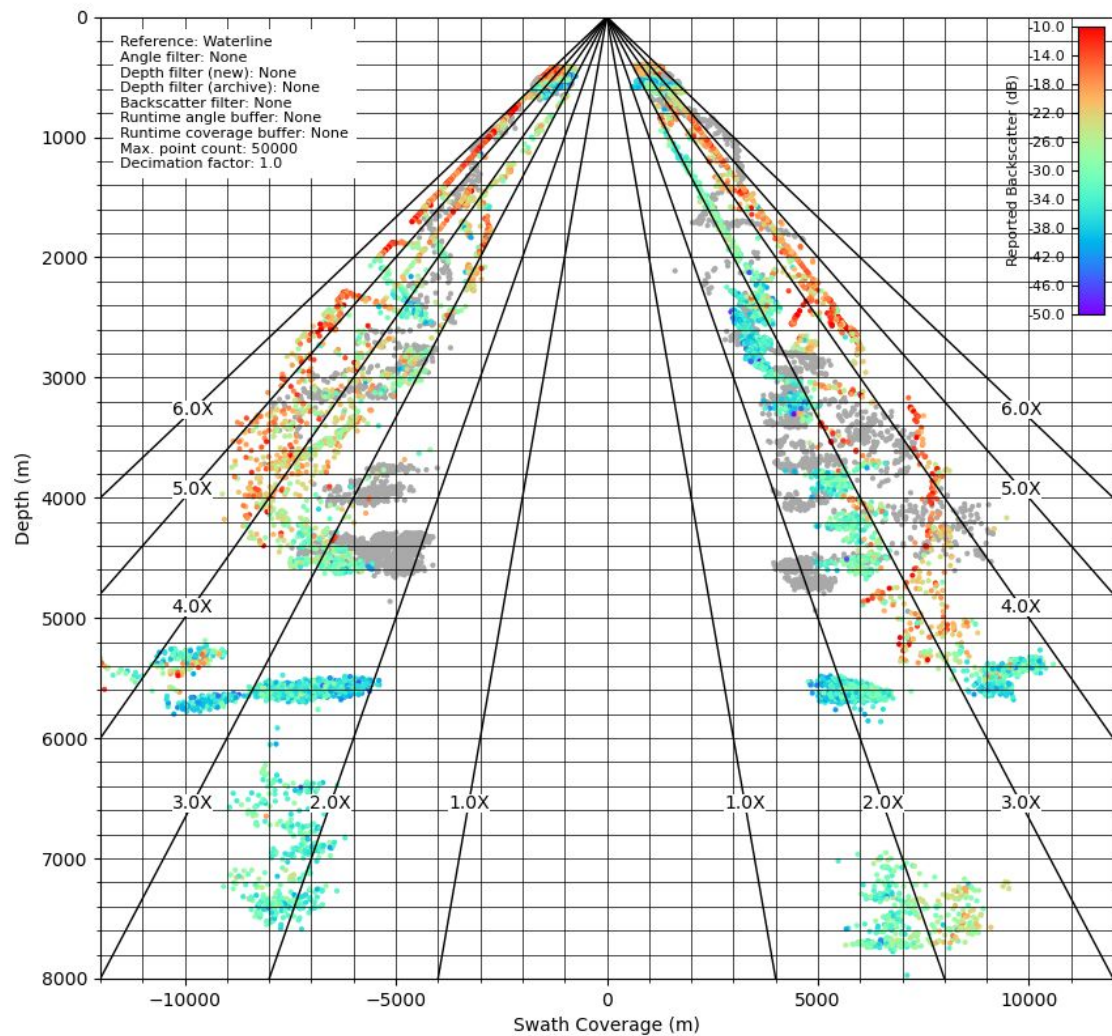
Right: 2017 results (colored by reported reflectivity) versus 2012 (gray)

EM122 Swath Coverage

Results: 2012-2025 (Backscatter)

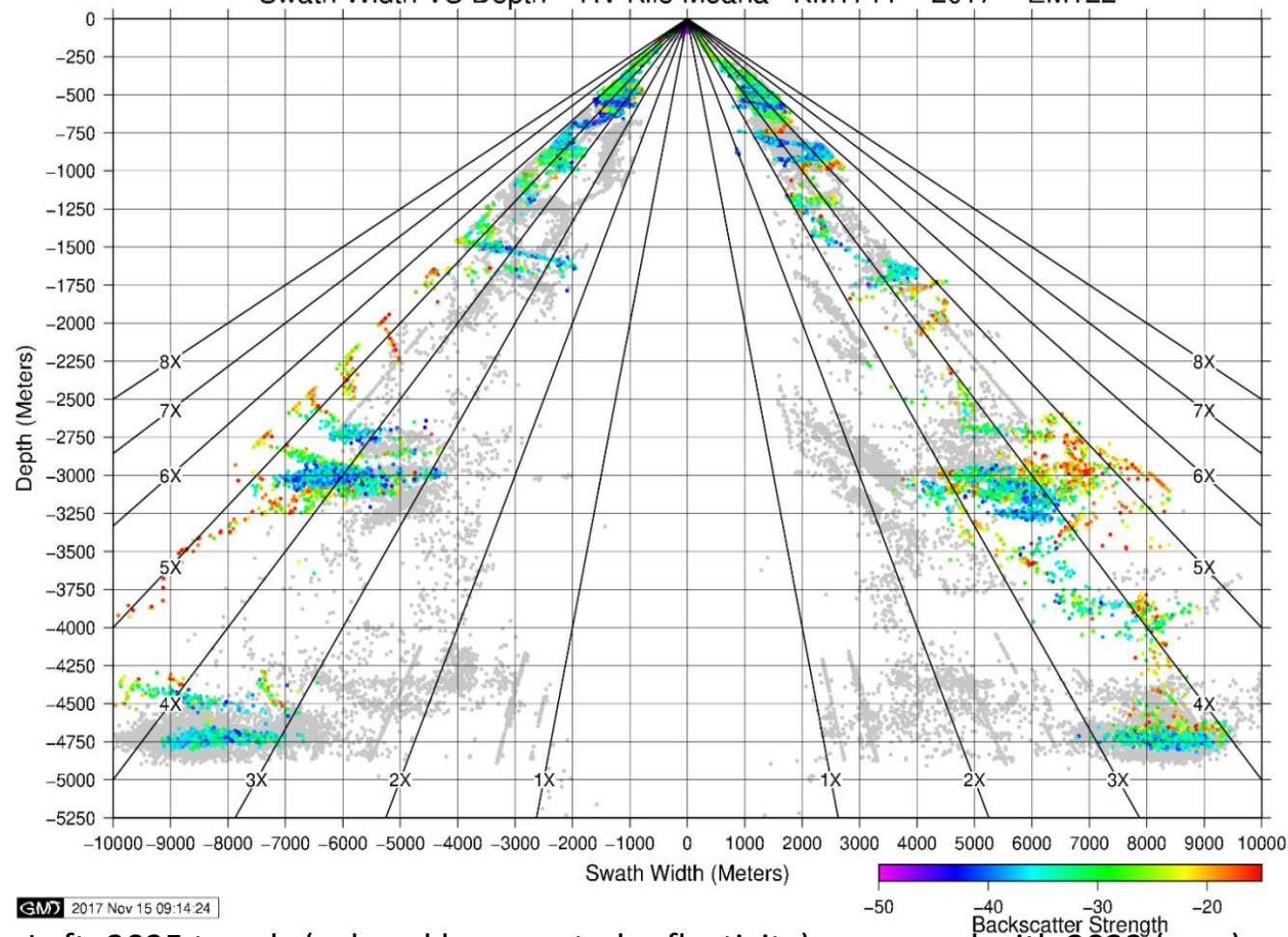
2025 vs. 2023

Swath Width vs. Depth
EM 122 - Kilo Moana - 2025 vs. 2023



2017 vs. 2012

Swath Width VS Depth – RV Kilo Moana– KM1711 – 2017 – EM122



Left: 2025 trends (colored by reported reflectivity) compared with 2023 (gray)

Right: 2017 results (colored by reported reflectivity) versus 2012 (gray)

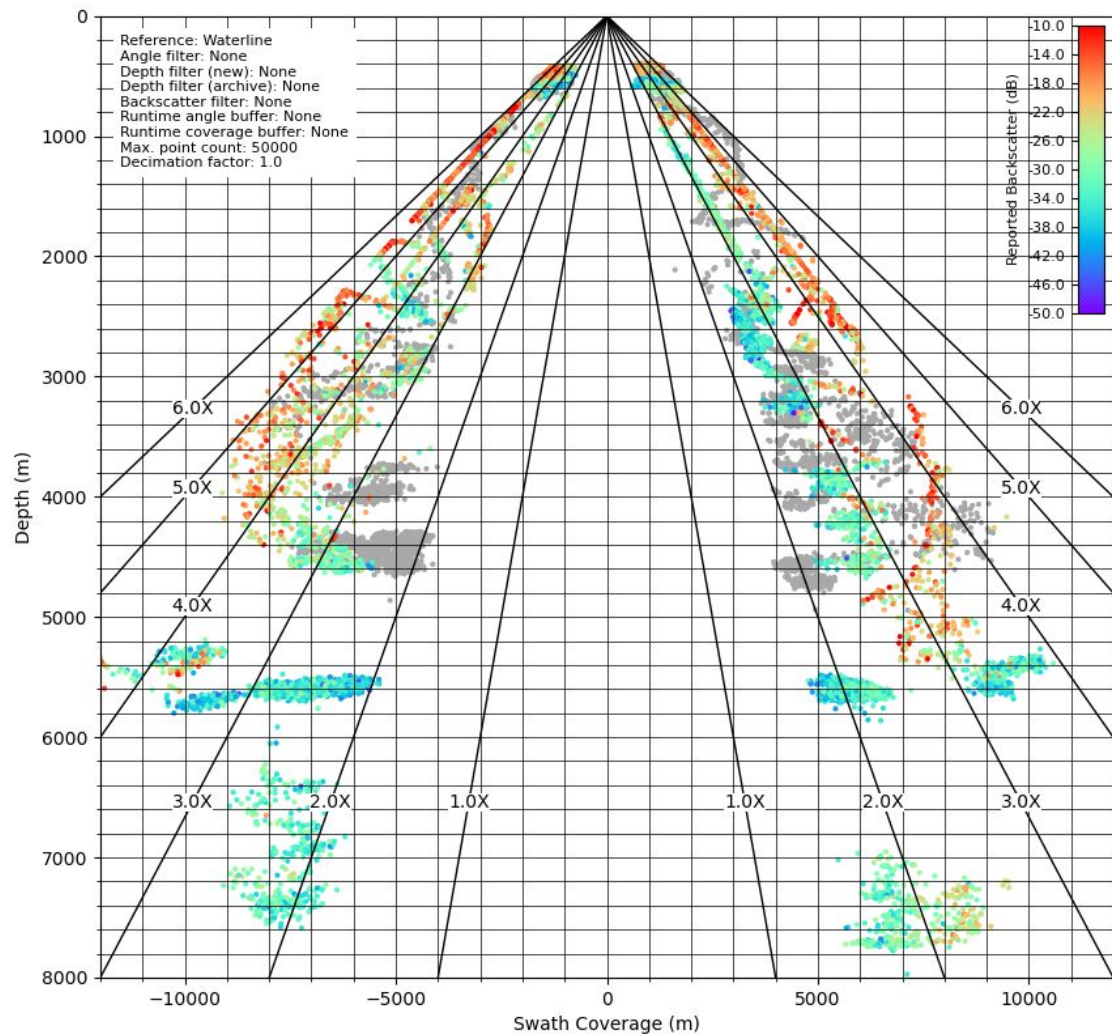
Consistent with the [2023 QAT report](#), the 2025 results show a ~1X WD reduction in total coverage from 2012-17 trends at depths >2000 m

EM122 Swath Coverage

Results: Comparison to MGL

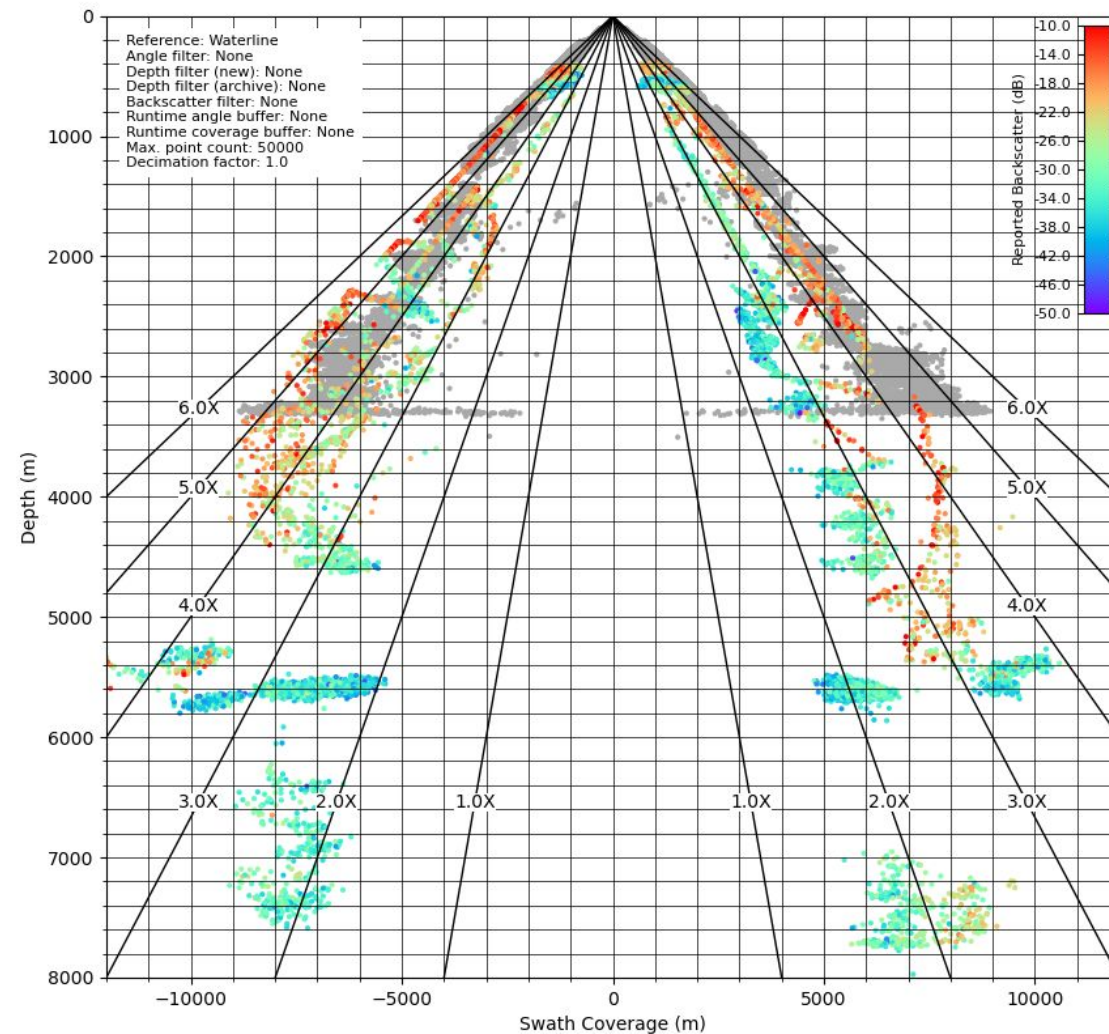
2025 vs. 2023

Swath Width vs. Depth
EM 122 - Kilo Moana - 2025 vs. 2023



2025 vs. MGL

Swath Width vs. Depth
EM 122 - KM 2025 vs. MGL 2023



2023-25 coverage trends (left) illustrate ~1X WD less total coverage than the EM122 installed aboard *Marcus G. Langseth* (2023, right) across depths up to 3200 m; this may result from higher noise levels for the *Kilo Moana* at transit speed, as well as greater variability in the observed slopes and orientations

RX Noise BIST Assessment

Noise Level vs. Speed and System

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 EM710 and EM122, a series of RX Noise Level Built-In Self-Tests (BISTs) were recorded over a range of shaft speeds (0-120 RPM in 20-RPM increments); this test has been repeated multiple times in recent years, helping to detect changes and take corrective action (e.g., hull cleaning)

Whereas previous tests were recorded at incremental speeds over ground (SOG), shaft speed (RPM) is used here as a more repeatable metric of engine load and speed through water (STW), given the uncertainty over currents and lack of direct STW information with all other acoustic systems secured (e.g., Doppler speed log); the top speed of 117 RPM / ~12 kts SOG is consistent across tests in 2020-24

The [2023 QAT report](#) includes a much broader history of noise testing for the Kilo Moana from 2020, spanning several shipyard periods and other testing; this report presents only the more recent 2024-25 results for simplicity and relevance to current multibeam mapping conditions

Generally, the 2025 results compare favorably with previous testing for these installations; the EM122, however, appears more susceptible to noise at 100+ RPM shaft speed, which should be considered for mapping data quality

RX Noise BIST Assessment

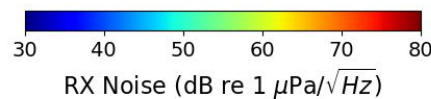
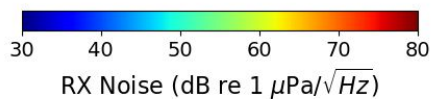
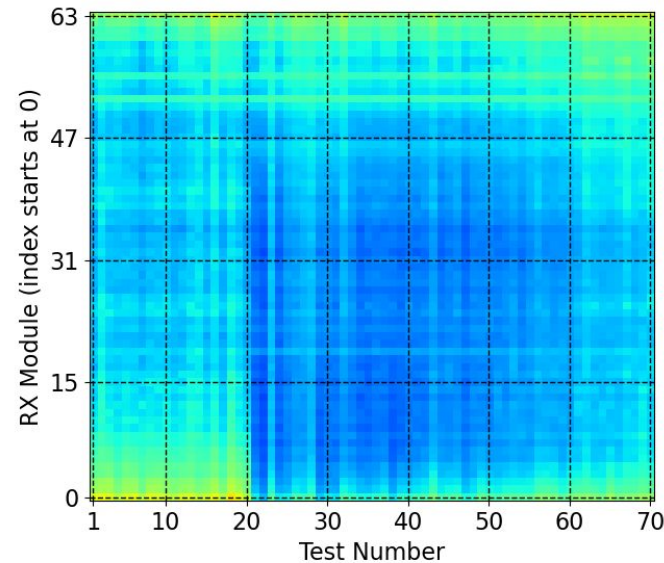
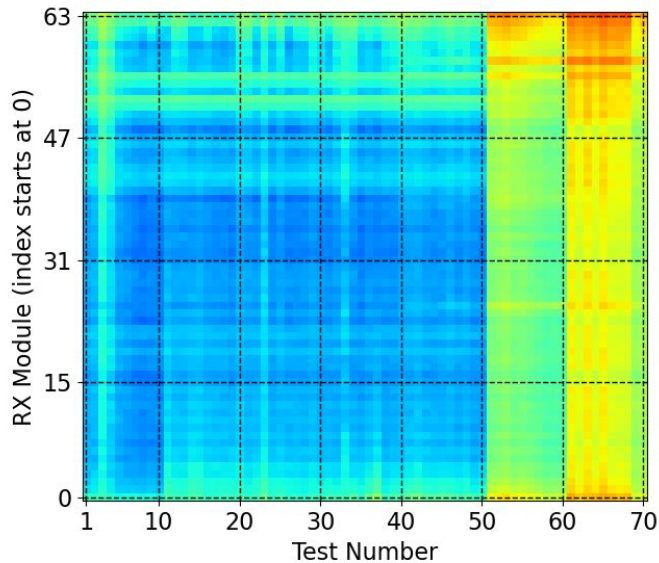
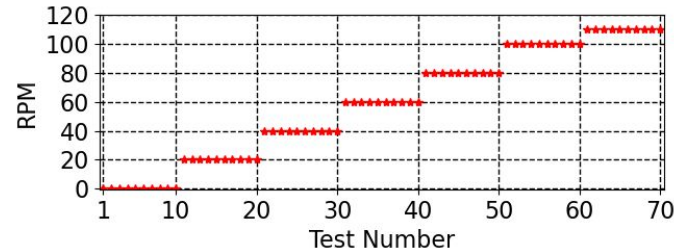
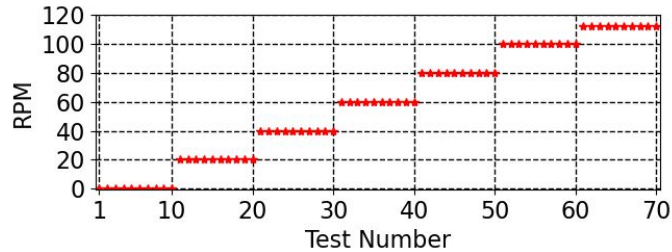
EM122 Noise Level vs. Speed

2025 Post-shipyard

2024 Pre-shipyard

RX Noise vs. Speed
EM122 (S/N 109)
Date: 2025-07-25
Freq: 12 kHz

RX Noise vs. Speed
EM122 (S/N 109)
Date: 2024-12-22
Freq: 12 kHz



Pre- and post-shipyard RX noise test results fall in line with the history of this EM122 installation over most of the speed range; notably, the 2025 tests clearly show higher levels at 100+ RPM that could impact multibeam swath quality and coverage at these speeds (e.g., during transit mapping)

Overall, the 2024-25 data show important reductions from 2023 data collected with severe biofouling on the arrays/hull (next)

Higher levels on the edges of the array (top and bottom edges of image) indicate local impacts of noise arriving through the hull

Thin vertical stripes are likely caused by swell impacting the hull or other machinery impulses during single RX noise test cycles; these illustrate the broadband noise perceived due to sea state but do not represent typical machinery or flow noise

Tests at 0 and 112 RPM from other dates in July are included in plots for completeness

RX Noise BIST Assessment

EM122 Noise Level vs. Speed

2025 Post-shipyard

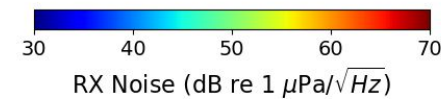
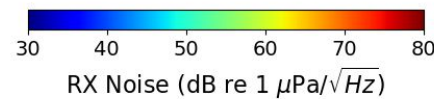
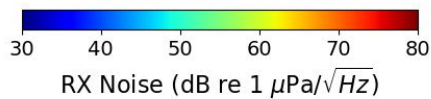
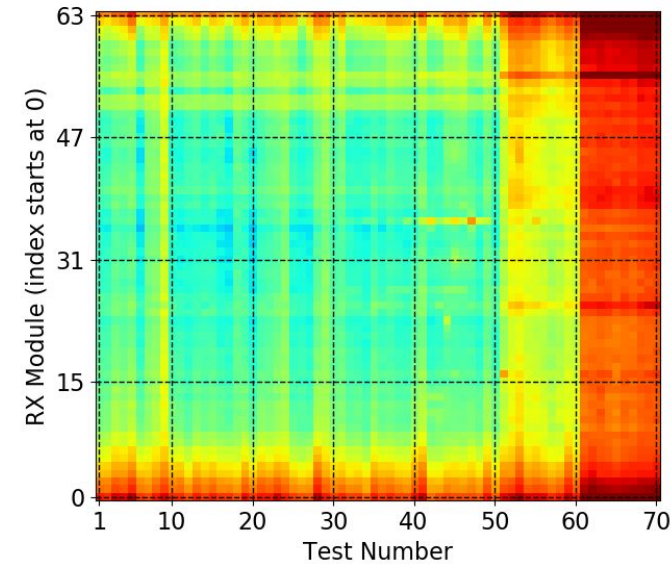
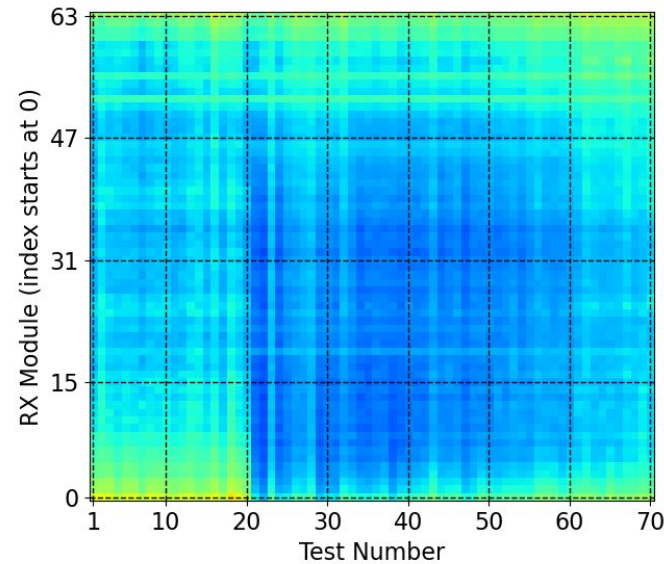
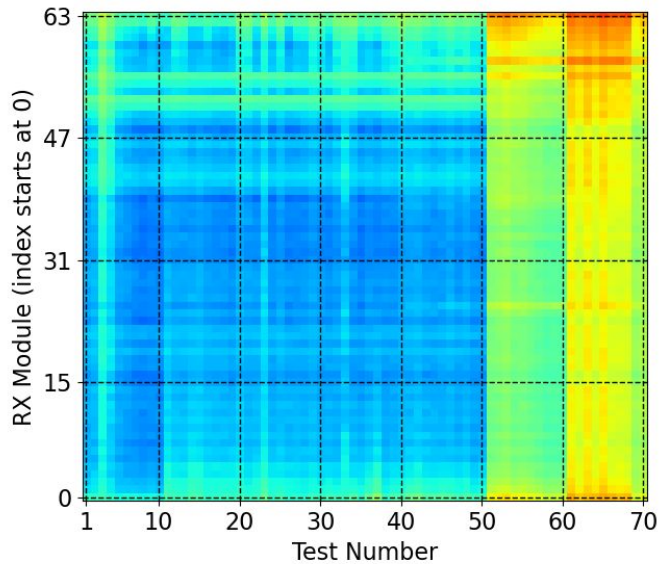
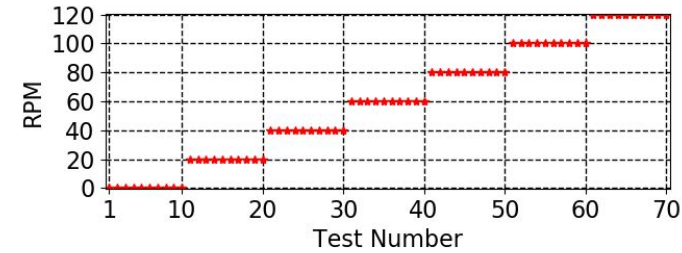
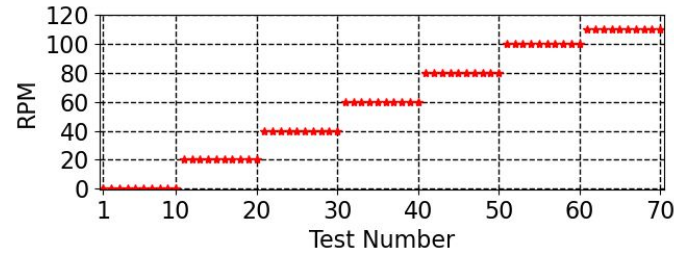
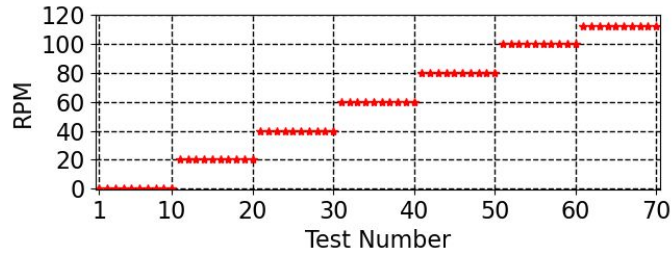
2024 Pre-shipyard

2023 Biofouling

RX Noise vs. Speed
EM122 (S/N 109)
Date: 2025-07-25
Freq: 12 kHz

RX Noise vs. Speed
EM122 (S/N 109)
Date: 2024-12-22
Freq: 12 kHz

RX Noise vs. Speed
EM122 (S/N 109)
Date: 2023-03-22
Freq: 12 kHz



RX Noise BIST Assessment

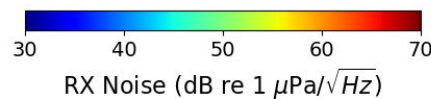
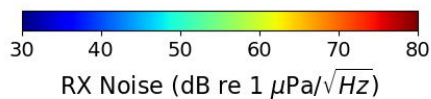
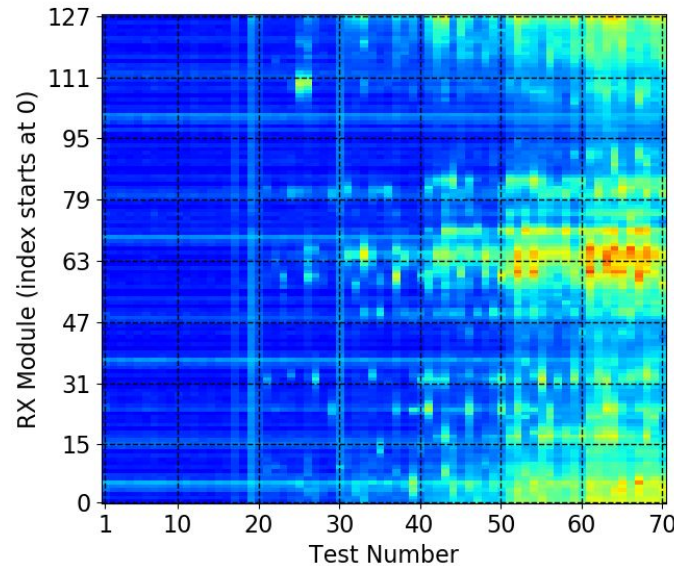
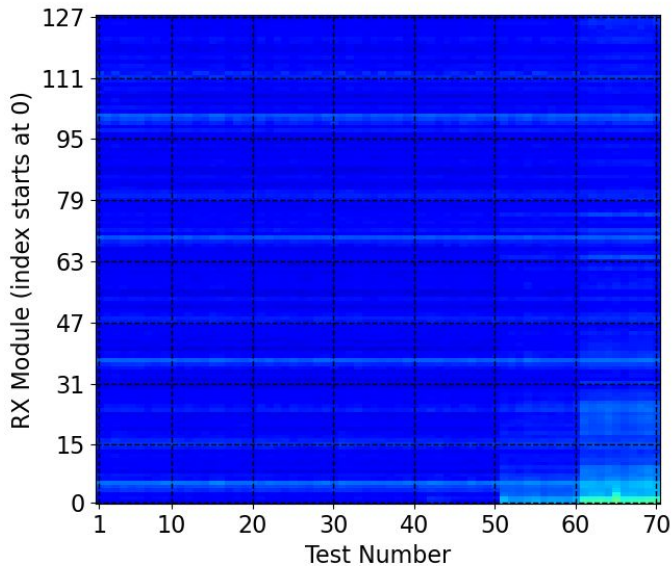
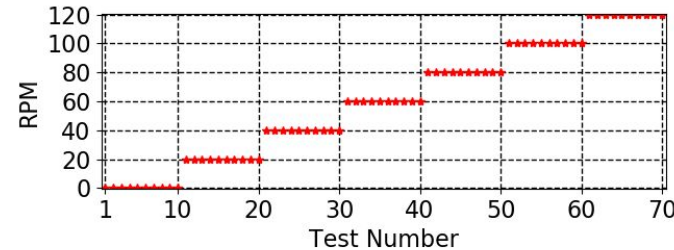
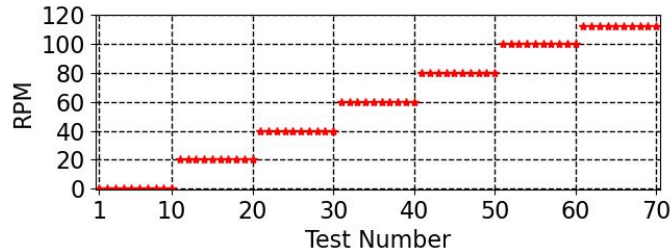
EM710 Noise Level vs. Speed

2025 Post-shipyard

2023 Biofouling

RX Noise vs. Speed
EM710 (S/N 219)
Date: 2025-07-12
Freq: 70-100 kHz

RX Noise vs. Speed
EM710 (S/N 219)
Date: 2023-03-22
Freq: 70-100 kHz



As with the EM122, post-shipyard RX noise test results show typical levels for the EM710 compared to pre-cleaning tests in 2023

Although no pre-shipyard tests are available from 2024, the 2025 post-shipyard files suggest no appreciable changes (or damage)

At all speeds and across all test data, high noise levels on the edges of the array (top and bottom edges of image) indicate local impacts of flow and machinery noise arriving through the hull

Vertical stripes are likely caused by swell impacting the hull or other machinery impulses during the RX noise test cycle; these illustrate the broadband noise perceived due to sea state but do not represent typical machinery or flow noise

Together, the plots illustrate the benefits of hull cleaning and reduced flow noise³⁹

RX Noise BIST Assessment

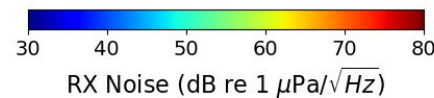
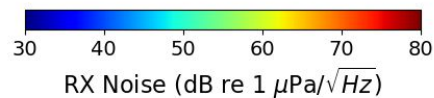
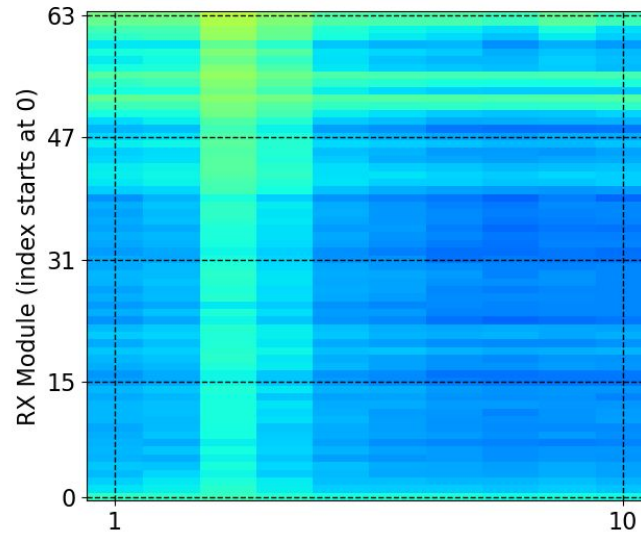
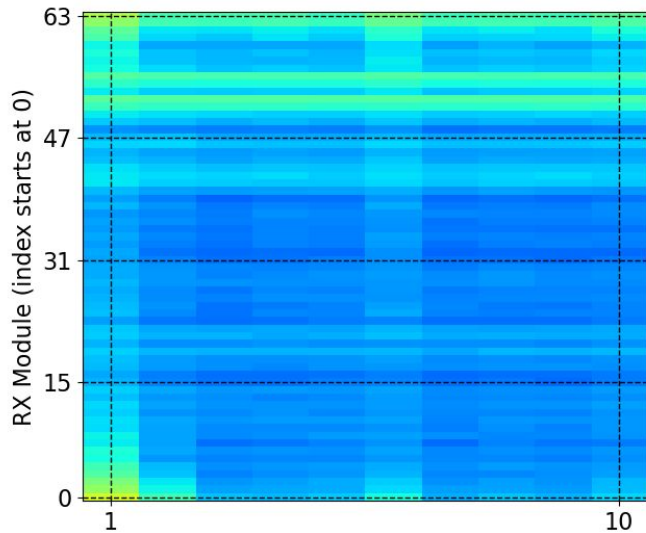
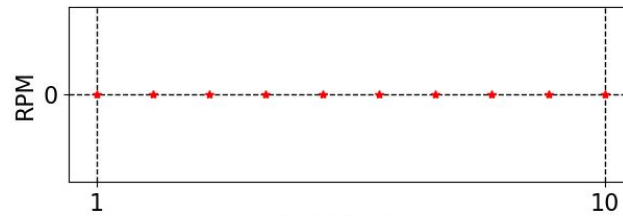
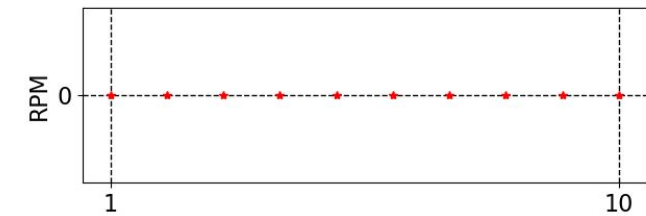
EM122/710 Noise Level vs. Other

EM122: Gens 1/2/3

EM122: ADCP and DP ON

RX Noise vs. Speed
EM122 (S/N 109)
Date: 2025-07-12
Freq: 12 kHz

RX Noise vs. Speed
EM122 (S/N 109)
Date: 2025-07-12
Freq: 12 kHz



The [2023 QAT report](#) includes noise testing across all combinations of generators to identify any particularly detrimental settings

In July 2025, additional EM122 noise testing was conducted while holding station to check baseline machinery noise in absence of flow noise (left) and examine impacts of the ADCP and Dynamic Positioning system (right)

These tests show minimal impacts of the ADCP or DP systems on the EM122 with Generators 1, 2, and 3 online

EM710 data collected at the same time (next slide) also indicate minimal impacts with Generators 1, 2, and 3 (note: no EM710 data were collected during the ADCP and DP test)

RX Noise BIST Assessment

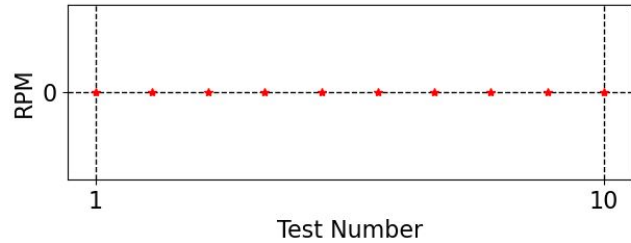
EM122/710 Noise Level vs. Other

EM122: Gens 1/2/3

EM122: ADCP and DP ON

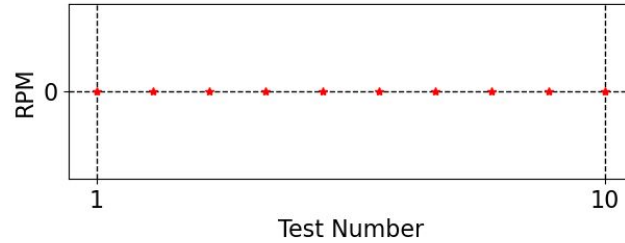
EM710: Gens 1/2/3

RX Noise vs. Speed
EM122 (S/N 109)
Date: 2025-07-12
Freq: 12 kHz



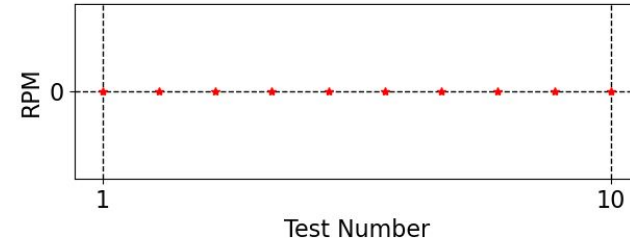
Test Number

RX Noise vs. Speed
EM122 (S/N 109)
Date: 2025-07-12
Freq: 12 kHz

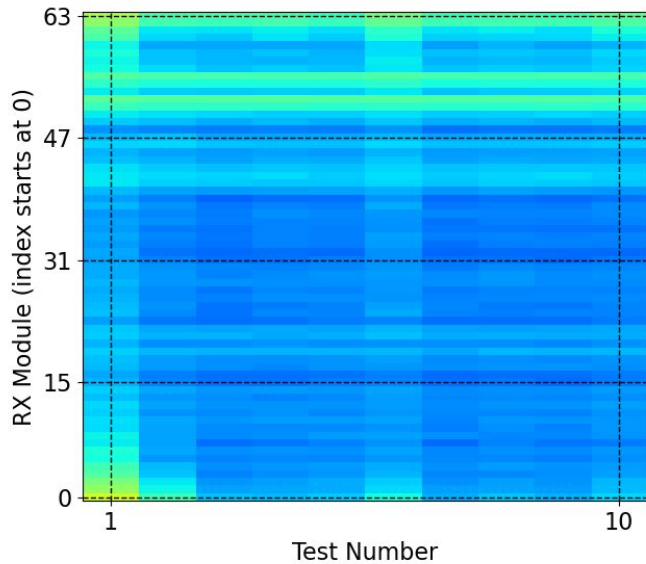


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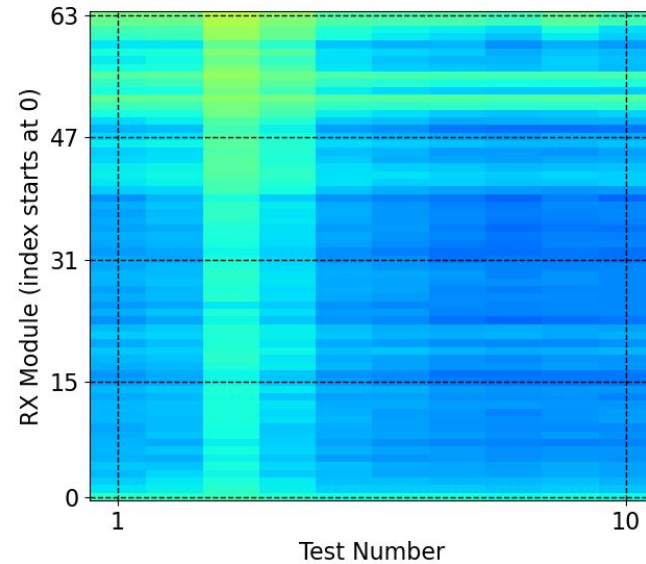
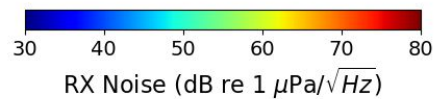
RX Noise vs. Speed
EM710 (S/N 219)
Date: 2025-07-12
Freq: 70-100 kHz



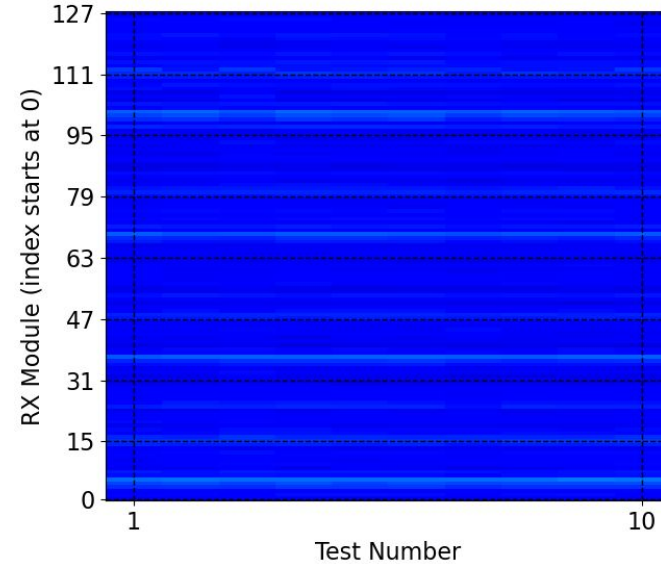
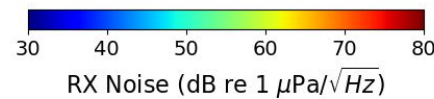
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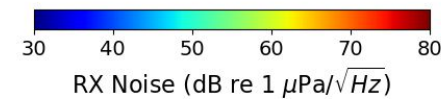
Test Number



Test Number



Test Number





credit: soest.hawaii.edu