

USCGC Healy

EM122 Quality Assurance Testing

HLY25TA - May 27-31, 2025

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Multibeam Advisory Committee

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credit: Grant DeVuyst, USCG

HLY 2025 QAT Executive Summary

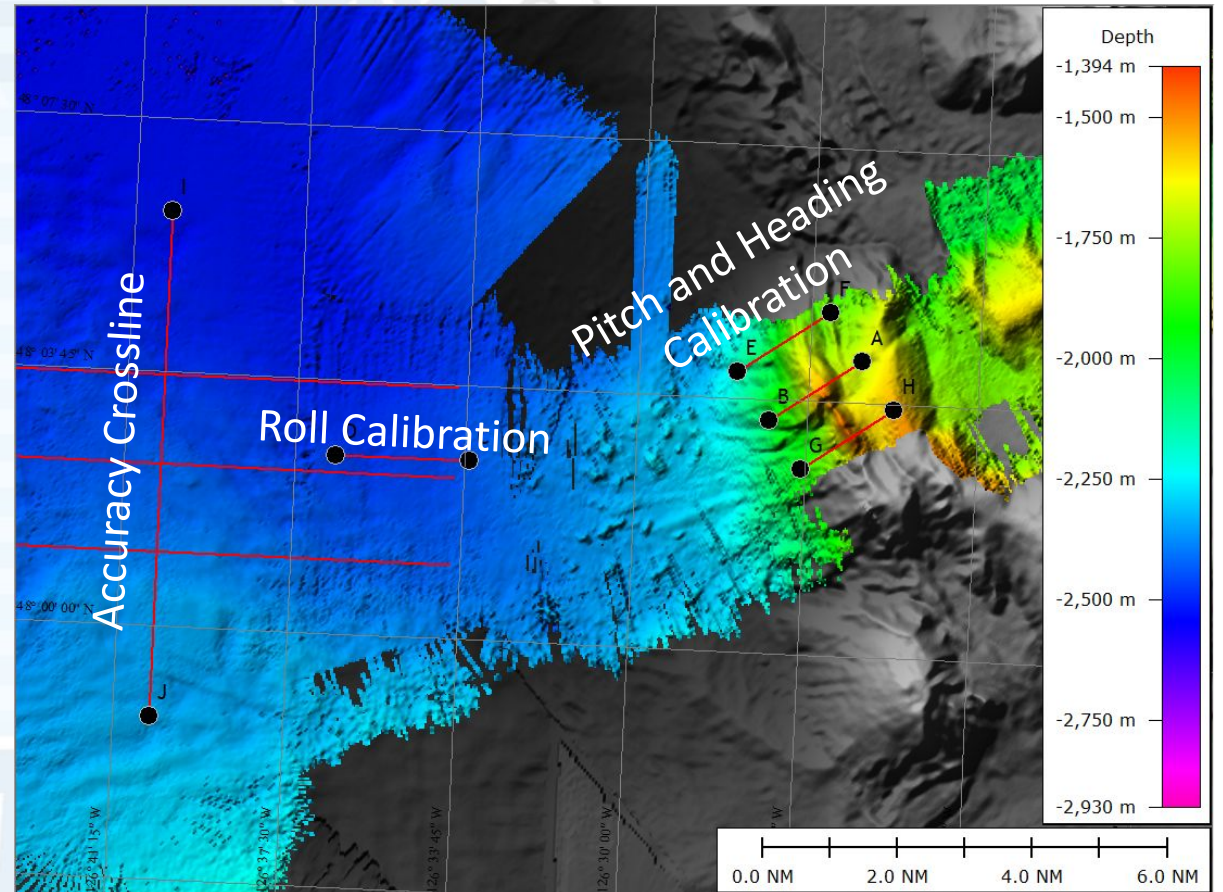
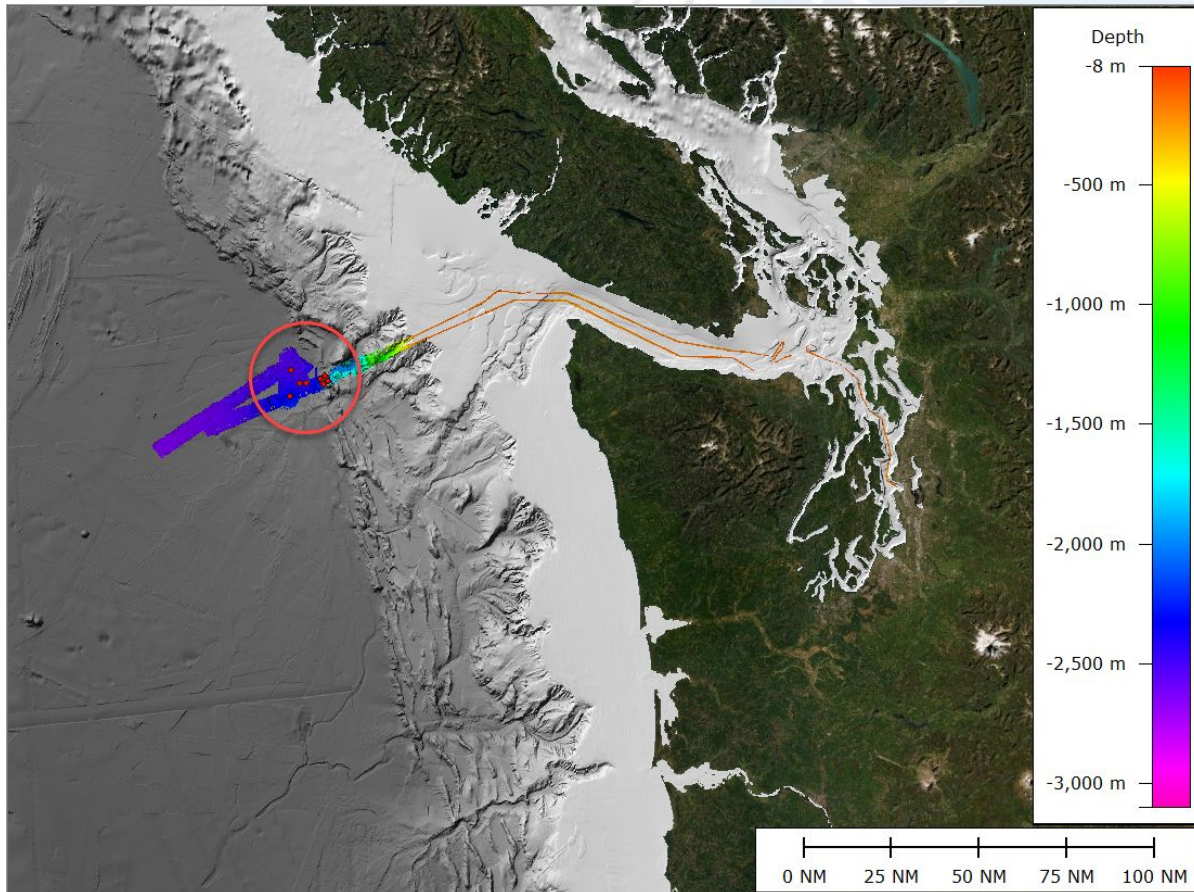
- The USCGC Healy (HLY) is equipped with a Kongsberg Maritime EM122 multibeam echosounder (1° TX x 2° RX) with Seapath 330+ (primary), Applanix POS MV (secondary), and Seapath 385-R3 (new) navigation systems
- The new Seapath 385-R3 navigation system was installed during the 2024-25 maintenance period and its MGC was surveyed by LaserMetrix in Sept 2024; this system shares the same NovAtel GNSS-850 antenna pair (new, upgraded from GPS-713 units as noted in the 2024 report) with the Seapath 330+
- The Multibeam Advisory Committee (MAC) was asked to assist with system geometry reviews and Quality Assurance Testing (QAT) of the ship's multibeam echosounder ahead of the 2025 field season; due to scheduling constraints, MAC personnel provided remote support for configuration review, test planning and data analysis
- MAC communication with *Healy* and UCSD/STARC personnel (primarily Max Hughes and Brendon Mendenhall) commenced in April 2025 with plans to effectively repeat the 2020-24 QATs off the coast of Washington, including:
 - calibrations ('patch tests') for the EM122 with the new Seapath 385-R3, logging the Seapath 330+ and POS MV as secondary navigation sources for verification in post-processing
 - opportunistic testing of swath accuracy, swath coverage, EM hardware health, and RX noise level vs. speed
- The calibration and accuracy test plan was developed with proven test sites used for other vessels, including the 2017 and 2020-24 *Healy* EM122 QATs; detailed reports of the 2014 (Alaska), 2017, and 2020-24 testing are available at <https://mac.unols.org/ship/healy/>

HLY 2025 QAT Executive Summary

- Approximately 24 hours was allotted for the QAT, broken up over several test windows around other ship tests
- Due to uncertainty and constraints around the ship schedule, the QAT plans were reduced to RX noise and swath coverage testing; the Seapath 330+ and POS MV remain the primary and secondary navigation sources, respectively, until the Seapath 385-R3 can be calibrated
- EM122 RX noise level testing over an extended speed range of 0-16 kn in 2025 indicated a slight increase from 2024 levels; the 2023-2025 plots (i.e., with the 'new' RX array) are presented in this report with an extended color scale to accommodate the higher 2025 levels (due in part to the higher speeds than 2023-24)
- Swath coverage testing was carried out opportunistically during ship testing and transits using recommended runtime parameters; results show expected performance for this system, given its age and high noise levels, with no significant change from 2024
- No TX Channels BISTs were collected in 2025; however, new RX Channels BISTs show stable hardware health since the 'new' RX array was installed in 2023
- This report describes the hardware health, swath coverage, and noise testing processes and results for 2025, as well as a system geometry review for the new Seapath 385-R3 ahead of its EM122 integration and calibration
- The MAC is available to assist with EM122 calibration using the new Seapath 385-R3 if opportunities arise throughout the field season, and appreciates the efforts of the ship and technical personnel to make remote support possible, including the clear communication around scheduling and high degree of data organization

HLY 2025 QAT Planning Overview

- EM122 calibration and accuracy tests were planned using the 2017-24 Healy QAT lines off Washington
- Although these sites were not used in 2025, they are included here for reference during future opportunities
- For more details, see previous reports on the MAC website: <https://mac.unols.org/ship/healy/>



System Geometry Review

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 (MRU/IMU); these are measured and reported from a common mapping system origin

Note: the 2023 QAT involved a complete update/reconfiguration of mapping system geometry; the full pre-2023 configuration history is not relevant for the results discussed in this report or future data collection (see previous MAC reports for details of pre-2023 configurations and calibrations)

The table below presents the relevant surveys and mapping system geometry updates through the 2025 QAT

Date	Location	Event	References
2010		IMTEC survey to establish ship reference frame with origin at Master Reference Plate (MRP); calculate EM122, IMU and MRU, and antenna offsets	2010 IMTEC report Rev. 0
2014 Feb 17		IMTEC supplemental survey of Seapath MRU and POS MV antennas	2014 IMTEC Supplemental
2023 Mar - May	Vallejo, CA	New EM122 RX array and EK80 transducers installed; LaserMetrix survey to re-establish vessel frame with origin at MRP; all mapping sensors surveyed; antennas reported at phase centers; EM122, POS MV, and Seapath configured from LaserMetrix summary ahead of initial calibration attempt (May 23)	USCGC HEALY Coordinate-Angle Summary 2023 (May 18, 2023)
2023 July 10	Vallejo, CA	LaserMetrix final report with additional context and diagrams; no changes from preliminary report	HEALY FINAL REPORT REV 0
2023 July 12	Washington	EM122 calibrated with Seapath and POS MV applied separately as active navigation source	2023 EM122 QAT Report
2024 Aug - Sep	Washington	EM122 calibrated with Seapath applied in real time and POS MV logged to .all (post-processed); post-QAT Seapath antenna replacement; phase center adjustment 13.3 mm down (+Z) for both	2024 EM122 QAT report
2024 Sep 12	Vallejo, CA	Updated LaserMetrix survey report with MGC base plate and sensing center for SP385 configuration	HEALY FINAL REPORT REV 1

System Geometry Review

Pre-QAT Review

- *Healy* and STARC personnel confirmed that no physical modifications had been made to the EM122, Seapath 330+, or POS MV since the 2024 QAT; the new Seapath 385-R3 was configured with LaserMetrix results (Rev. 1)
- The Master Reference Plate (MRP) remains the origin for all sensor reference frames; all Seapath and POS MV navigation outputs are valid at the MRP (origin), as expected by the EM122
- Antenna baseline calibrations were performed dockside ahead of the 2025 QAT for the Seapath 330+ and Seapath 385-R3, confirming the LaserMetrix baseline within a few mm for each system; antenna offsets were set to the LaserMetrix results for both Seapath systems, as they share a common antenna pair
- All EM122 configurations were reviewed and maintained from the [2024 EM122 QAT report](#); no changes were made during the 2025 QAT
- The MAC is available to assist with additional configuration reviews and calibration with the Seapath 385-R3 as opportunities arise during the 2025 field season

System Geometry Review

Seapath MGC-R3 Lever Arms

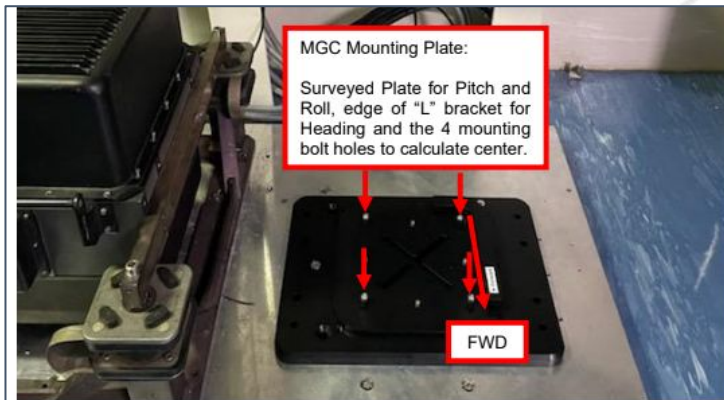


Figure 10 – MGC Mounting Plate

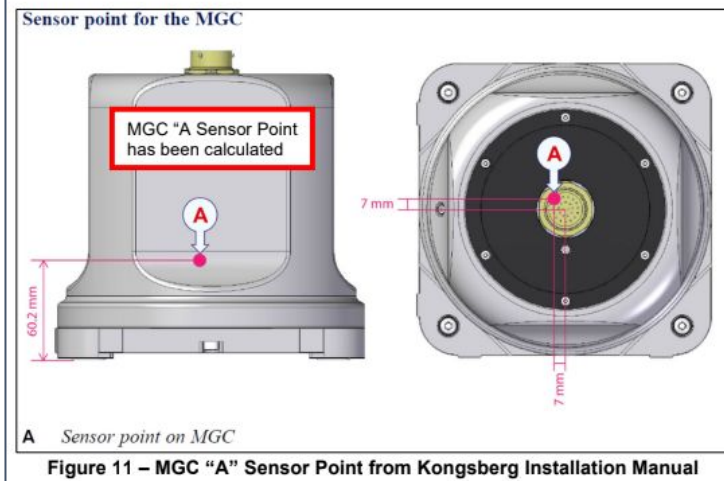


Figure 11 – MGC “A” Sensor Point from Kongsberg Installation Manual

1. The MGC mounting plate was surveyed by LaserMetrix and reported in the same mapping system reference frame used for previous reports and configurations (see [2023 QAT report](#) and LaserMetrix report Rev. 1 for more details)

2. The MGC sensing center used for Seapath configuration was reported by LaserMetrix using the Kongsberg specification

3. MGC-R3 linear offsets in Seapath:

X: -1.637 m

Y: -0.394 m

Z: -0.102 m

4. Seapath navigation is output at the NRP/origin; this is not yet configured in SIS, but will be expected at the NRP/origin

5. Position / Attitude linear offsets in SIS:

X: 0.000 m

Y: 0.000 m

Z: 0.000 m

USCGC Healey (WAGB-20) Orthogonal Survey March 2023 Final Report- Rev “1”

Table 1 - USCGC HEALY Coordinate Summary - March 2023
(Meters)

MARK	ELEMENTS	X	Y	Z
MRP	MASTER REFERENCE PLATE	0.0000	0.0000	0.0000
MRU	MRU (REPORT @ BASE)	-2.0420	-0.3320	-0.5690
IMU	HCC IMU (REPORTED @ TDC)	-49.9620	1.6640	-16.9220
MGC	MGC “A” SENSOR POINT	-1.6370	-0.3940	-0.1020

System Geometry Review

Seapath MGC-R3 Mounting Angles

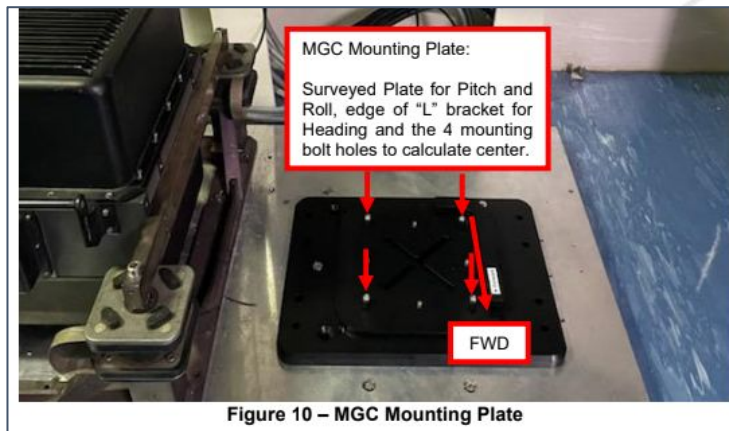


Figure 10 – MGC Mounting Plate

1. LaserMetrix reported installation angles for the MGC using descriptions that could be easily interpreted under the [Seapath sign convention](#); these were used directly for configuring MGC orientation in the Seapath software

2. MGC-R3 installation angles in Seapath:

Roll: -0.294° ($+179.706^\circ$ for Seapath on $[-180^\circ, +180^\circ]$)

Pitch: $+0.254^\circ$

Heading: -0.298°

3. SIS does not yet receive the Seapath 385-R3 navigation; when this is configured, all **SIS Attitude angles for this system should be set to zero prior to calibration**

4. MGC installation angles based on the LaserMetrix survey should remain unchanged in the Seapath software until the MGC is moved (and/or re-surveyed)

USCGC Healey (WAGB-20) Orthogonal Survey March 2023 Final Report- Rev "1"

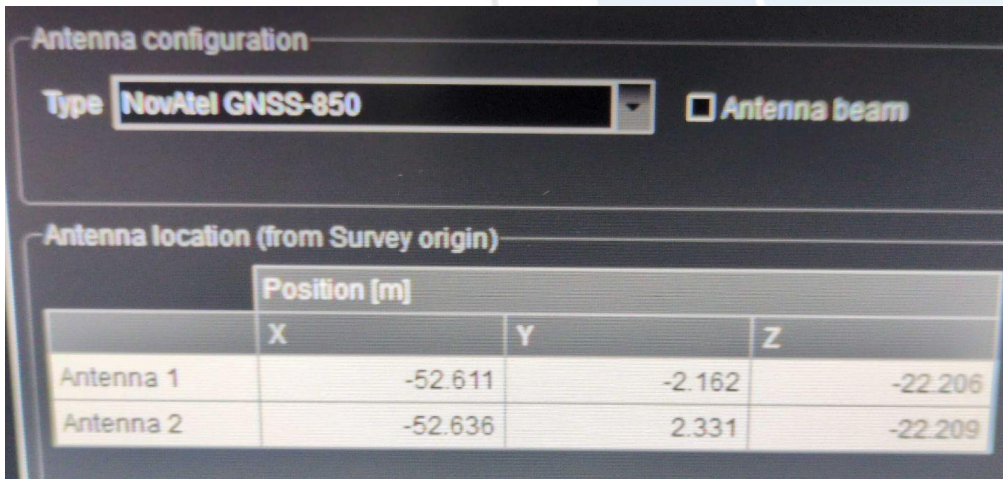
Table 2 - USCGC HEALY Pitch, Roll & Heading Summary - March 2023

MARK	FEATURE	Azimuth	Rotation	Pitch	Rotation	Roll	Rotation
MRP	MASTER REFERENCE PLATE	1.1114	STBD	0.1727	BOW UP	0.0449	STBD UP
MRU	MRU @ BASE	0.2877	PORT	0.0113	BOW UP	0.2619	STBD DN
IMU	HCC IMU @ BASE	0.4398	STBD	0.2801	BOW DN	0.0744	STBD DN
MGC	MGC MOUNTING PLATE (PITCH/ROLL) & "L" BRACKET (AZIMUTH)	0.2979	PORT	0.2536	BOW UP	0.2942	STBD UP
EK80 STBD	EK80 38KHZ (STBD) @ TRANSDUCER FACE CENTER	5.3372	STBD	0.0041	BOW DN	0.2000	STBD DN
EK80 PORT	EK80 18KHZ (PORT) @ TRANSDUCER FACE CENTER	1.4995	STBD	0.4468	BOW UP	0.1801	STBD UP
EM122 TX	122 TX TRANSDUCER	0.0000		0.0000		0.0065	STBD DN
EM122 RX	122 RX TRANSDUCER	0.0158	STBD FWD	0.1202	BOW DN	0.0004	STBD UP

2024 Seapath Antenna Update Seapath Antenna Lever Arms

Seapath antenna notes adapted from the [2024 QAT report](#)

As these antennas are shared by / apply to both Seapath systems, GNSS configuration should remain identical for clarity of documentation (e.g., Seapath 385 GNSS configuration at left)



1. The NovAtel GPS-713-GGG-N antennas used through the 2024 QAT and field season were swapped with NovAtel GNSS-850 units on September 11, 2024
2. Both antenna models were mounted with their Antenna Reference Point (ARP) secured against the double lock nuts
3. The new antennas require a phase center height adjustment of 13.3 mm downward (positive in Seapath convention) from 65 mm above ARP (see [2023 MAC report](#) for more details) to 51.7 mm above ARP (see antenna, left, from Emily Shimada)
4. The final Seapath values are configured as follows:
 - a. **Antenna 1 (primary, port aft) Z with GNSS-850:**
 $X = -52.611$ $Y = -2.162$ $Z = -22.206$ m
 - b. **Antenna 2 (secondary, stbd aft) with GNSS-850:**
 $X = -52.636$ $Y = 2.331$ $Z = -22.209$ m

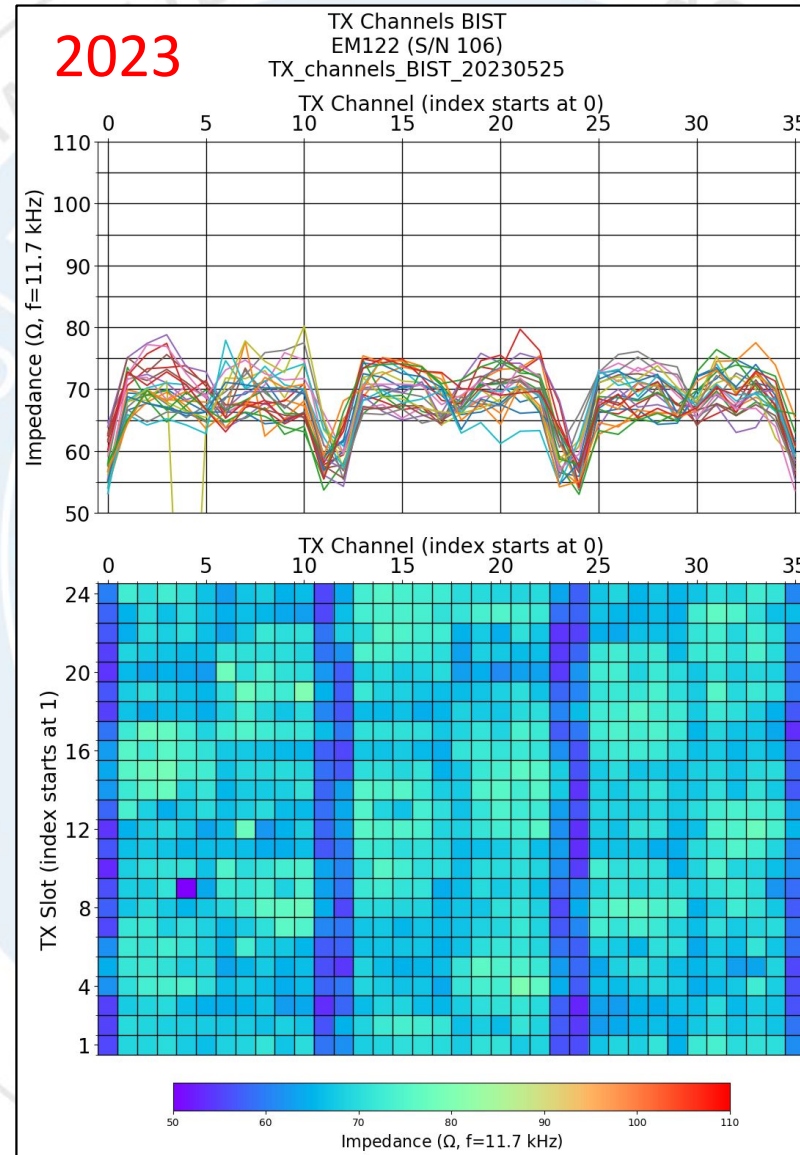
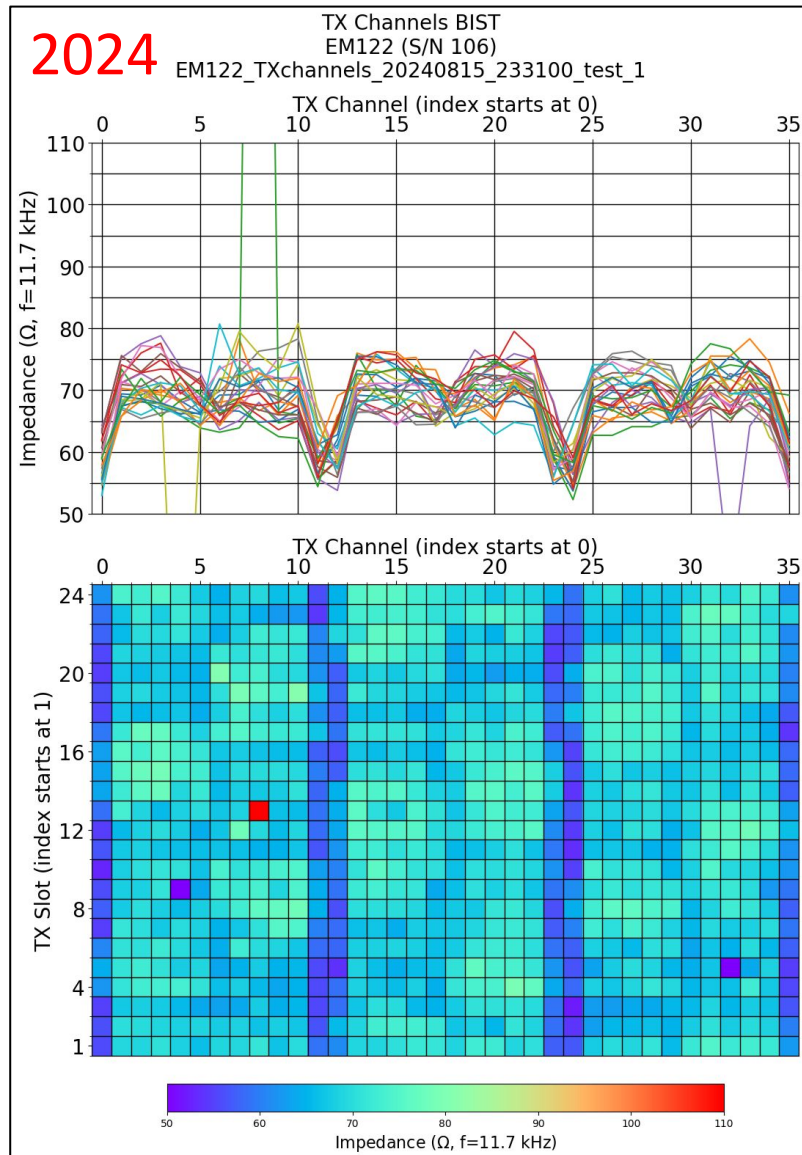
Transducer Health

Overview

1. Built-In Self-Test (BIST) routines have been run for the EM122 routinely since 2012 to assess system hardware health during each operating season
2. BISTs provide impedance measurements of the transmitter array, receiver array, and receiver
3. These test results may be used as proxies for the health of transducer elements and receiver electronics
4. Routine RX and TX Channel BISTs may aid early detection of element degradation; this is important to monitor, as these arrays have been observed to degrade with time
5. ***It is important to note that the BIST impedance measurements include the effects of cables and do not provide a full or exact characterization of transducer element properties as a function of frequency***
6. A large batch of BIST files collected since 2012 was provided to the MAC in 2024; all relevant files (collected under non-troubleshooting circumstances) and more recent BISTs are plotted here to provide an overview of TX Channels and RX Channels BIST results through time
7. Note the EM122 RX Channels data format include receiver impedance but not transducer impedance (resulting in blank plots for some configurations)
8. The TX Channels history data remain relevant with no hardware changes; RX Channels history shows no appreciable changes after the RX array replacement in 2023 (it is unclear whether new modules and cables may impact RX Channels results for the receiver, and transducer data is not included in this format)
9. Note: the EM122 is expected to be replaced with an EM304 MKII within the next few years

EM122 Transducer Health

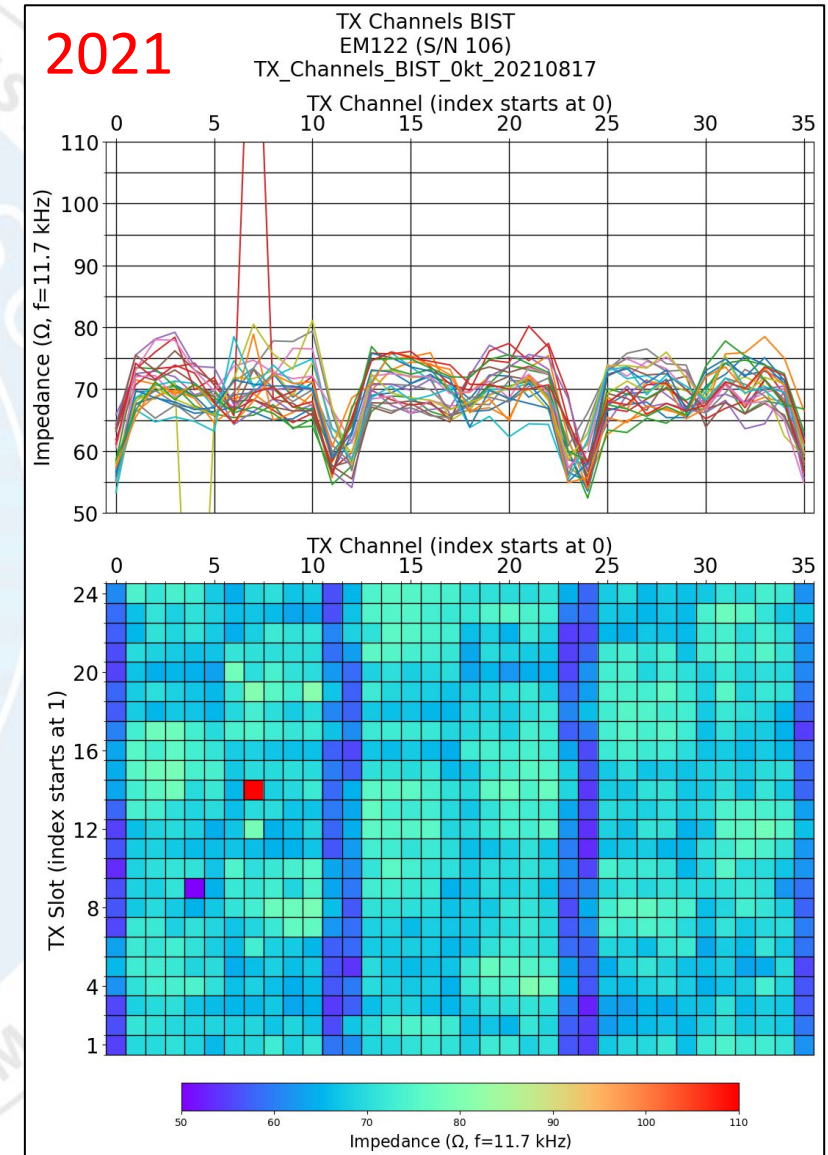
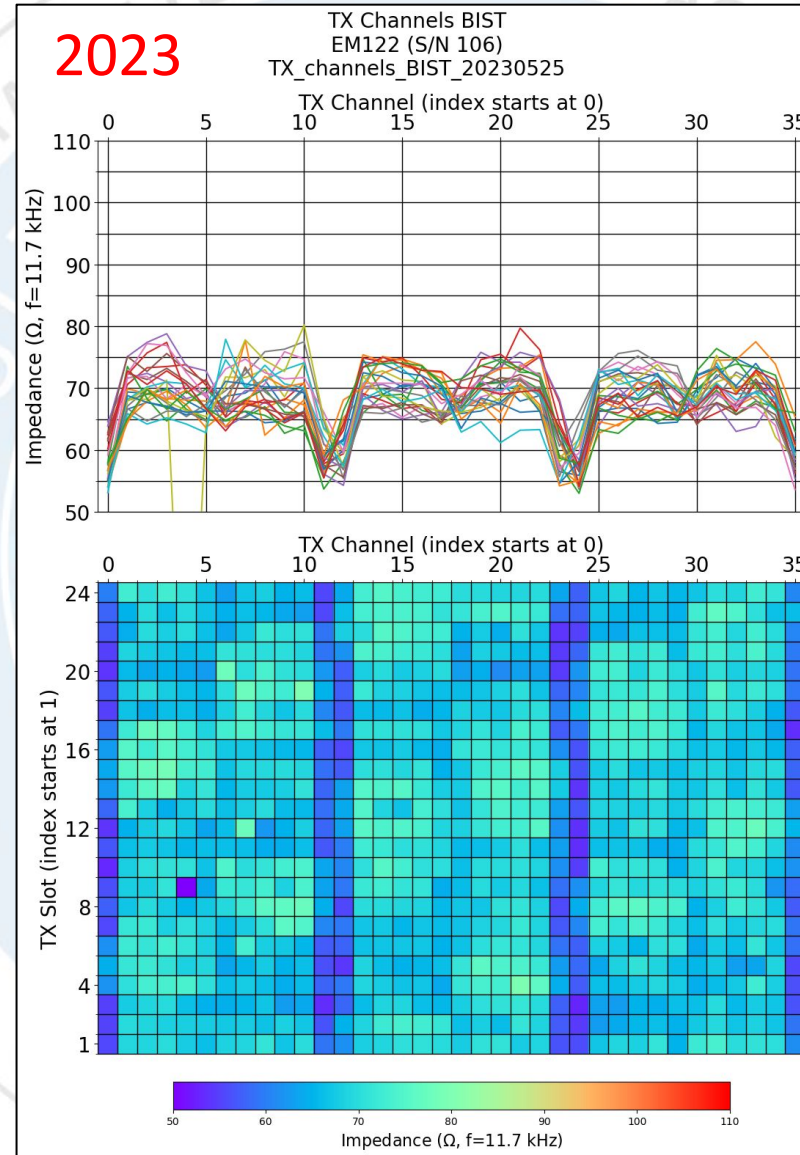
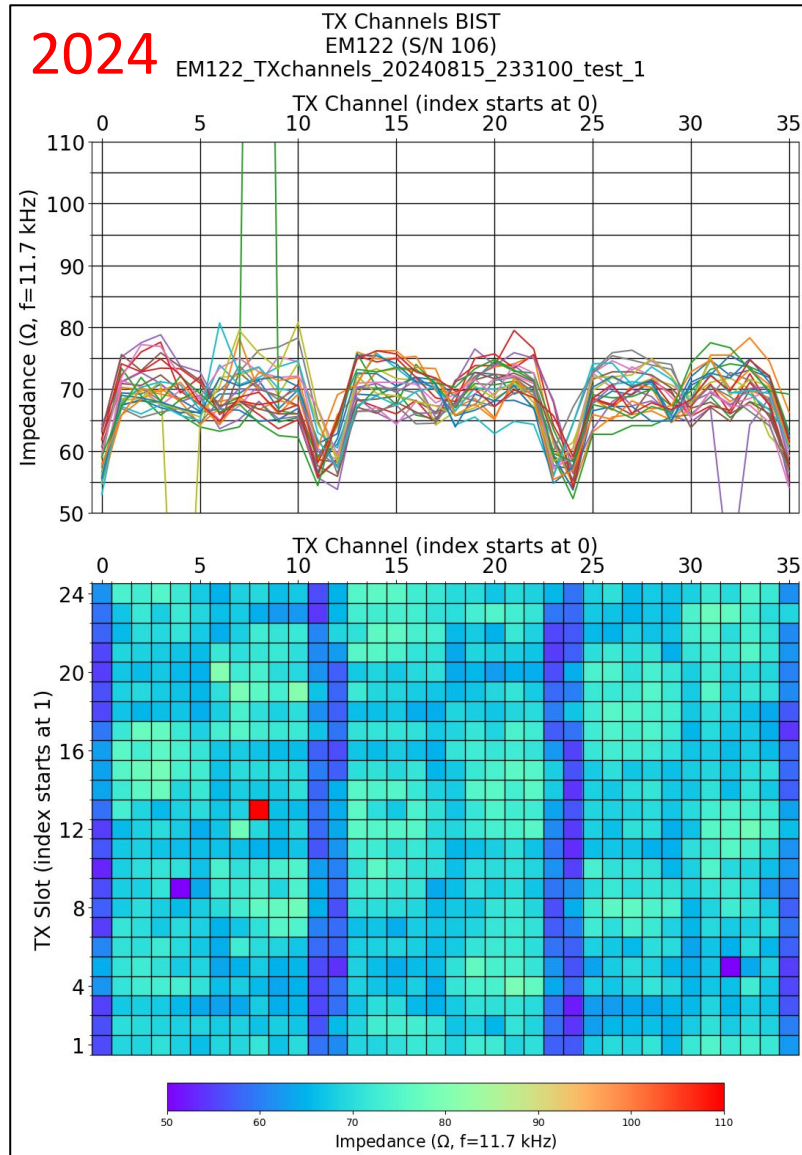
TX Channels (2024 Reference)



1. No TX Channels BISTs were collected in 2025; the 2024 results are shown at left for reference (collected on Aug 15 in Puget Sound at ~100 m water depth)

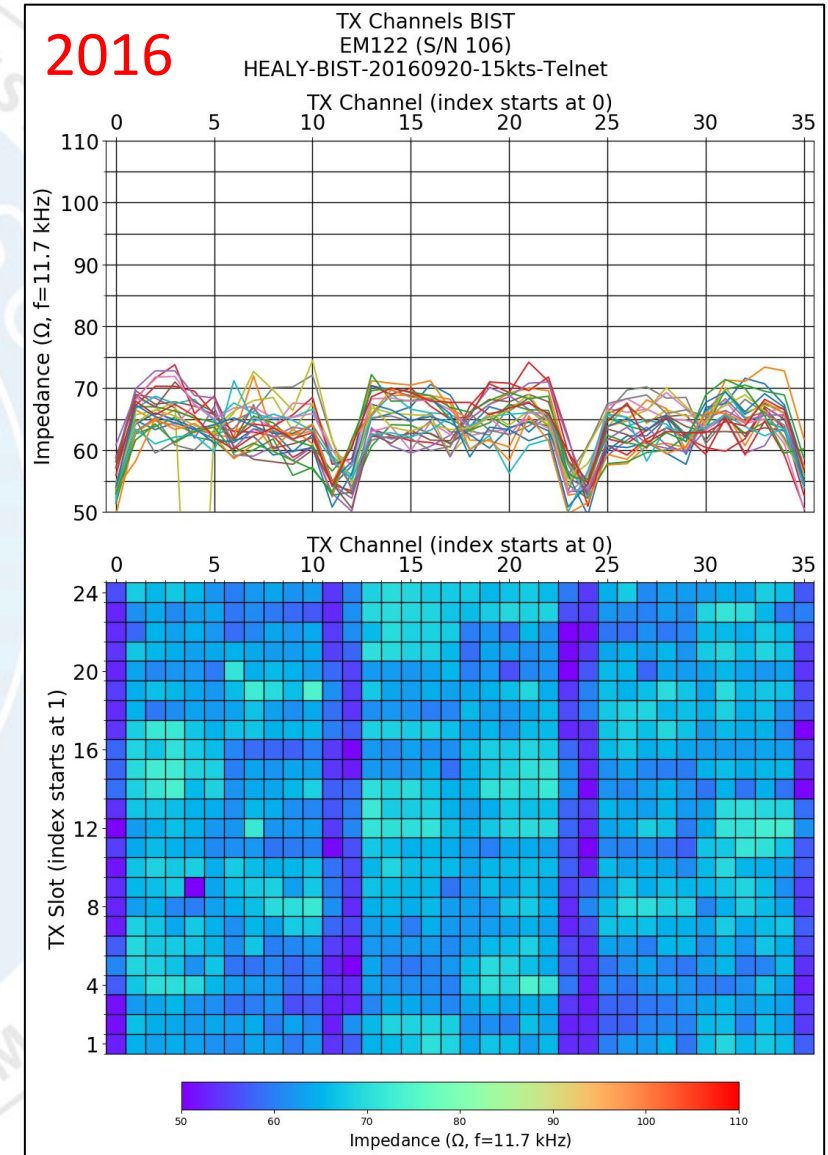
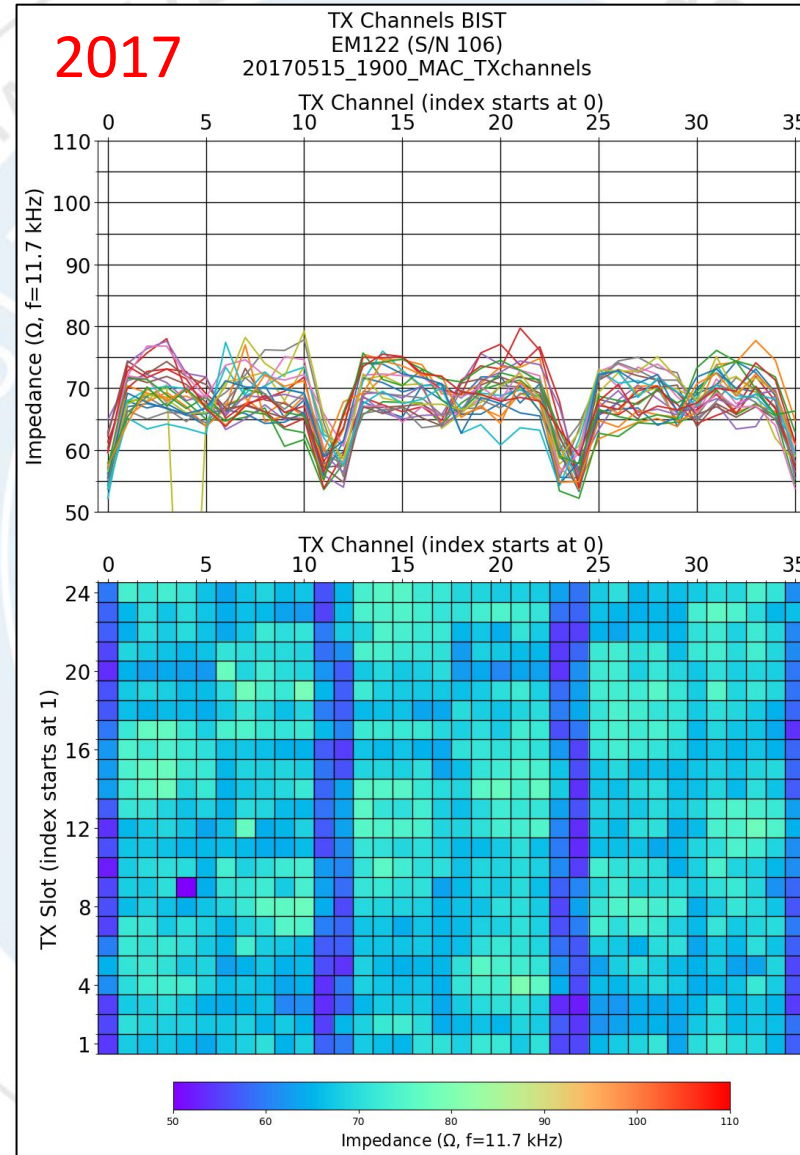
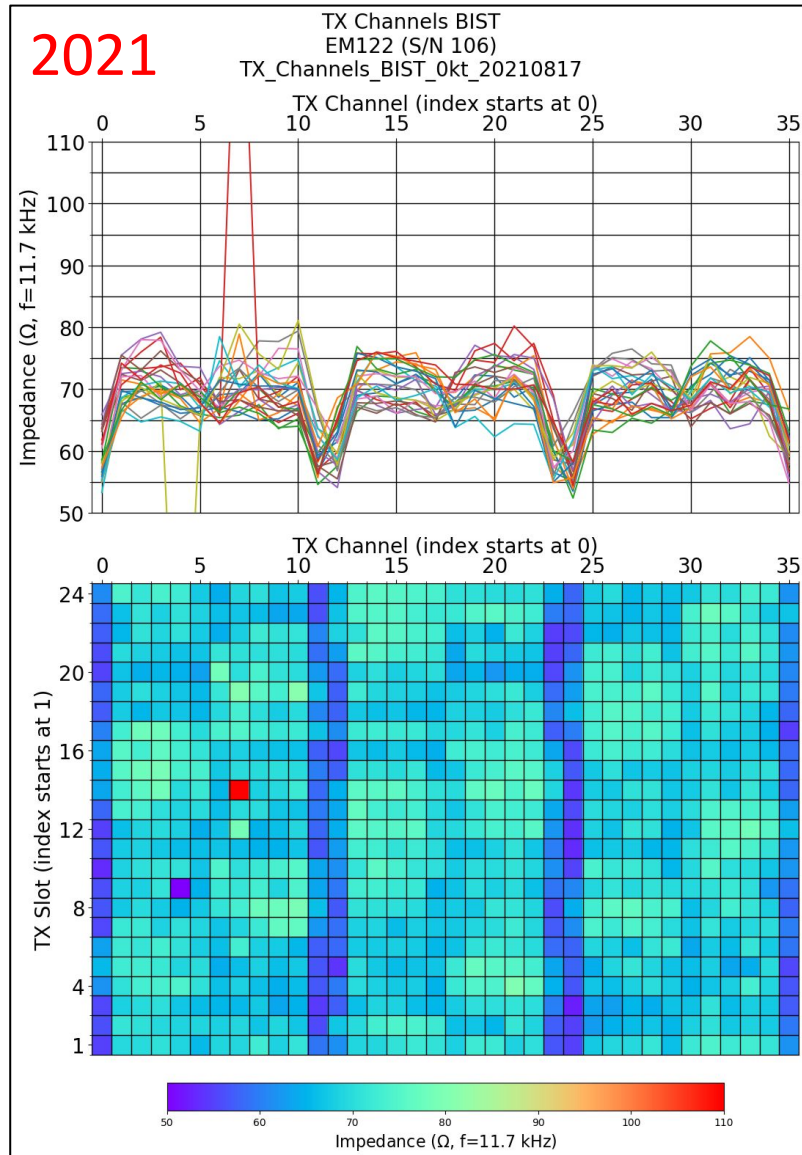
EM122 Transducer Health

TX Channels (2021-24 History)



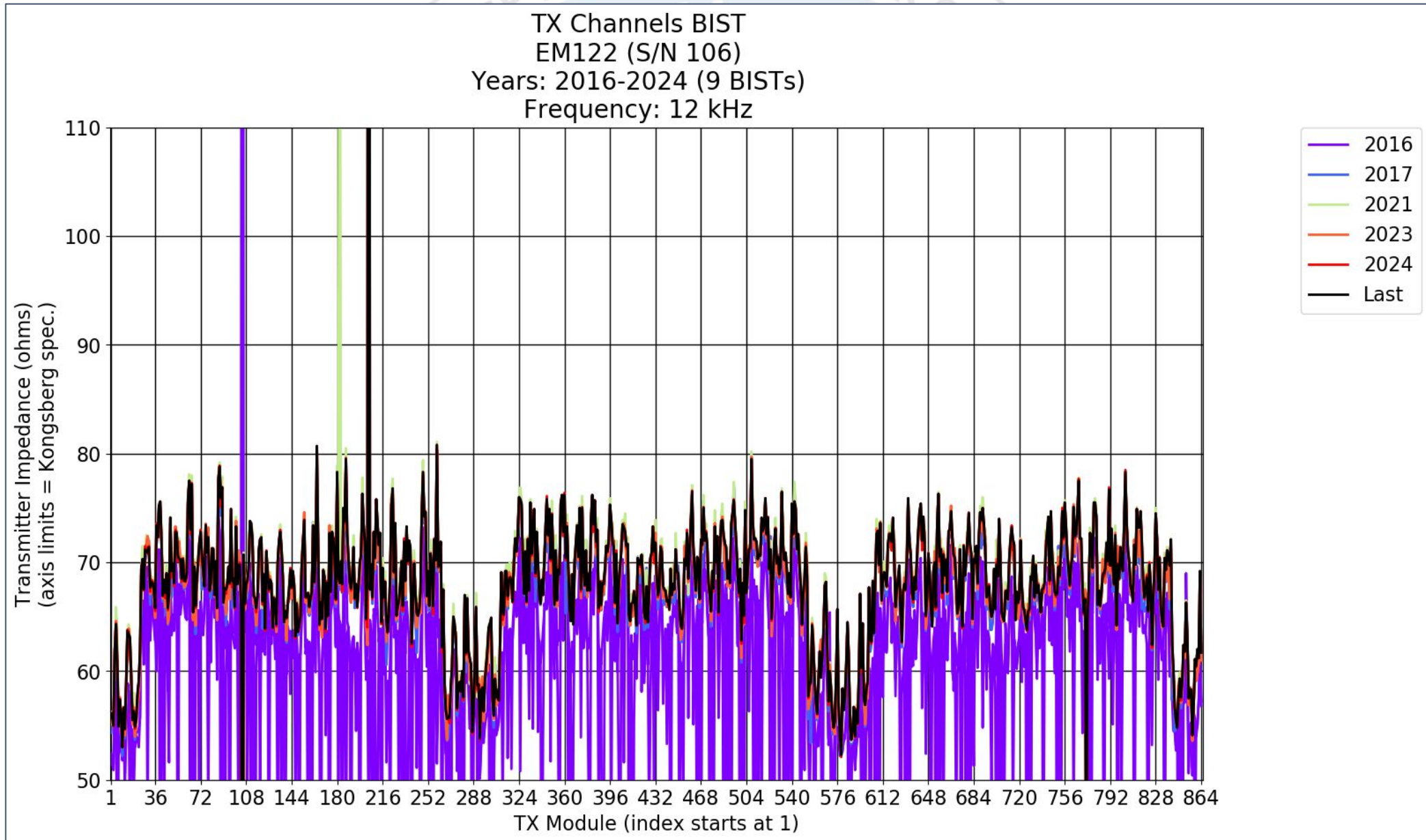
EM122 Transducer Health

TX Channels (2016-21 History)



EM122 Transducer Health

TX Channels (2016-24 History)

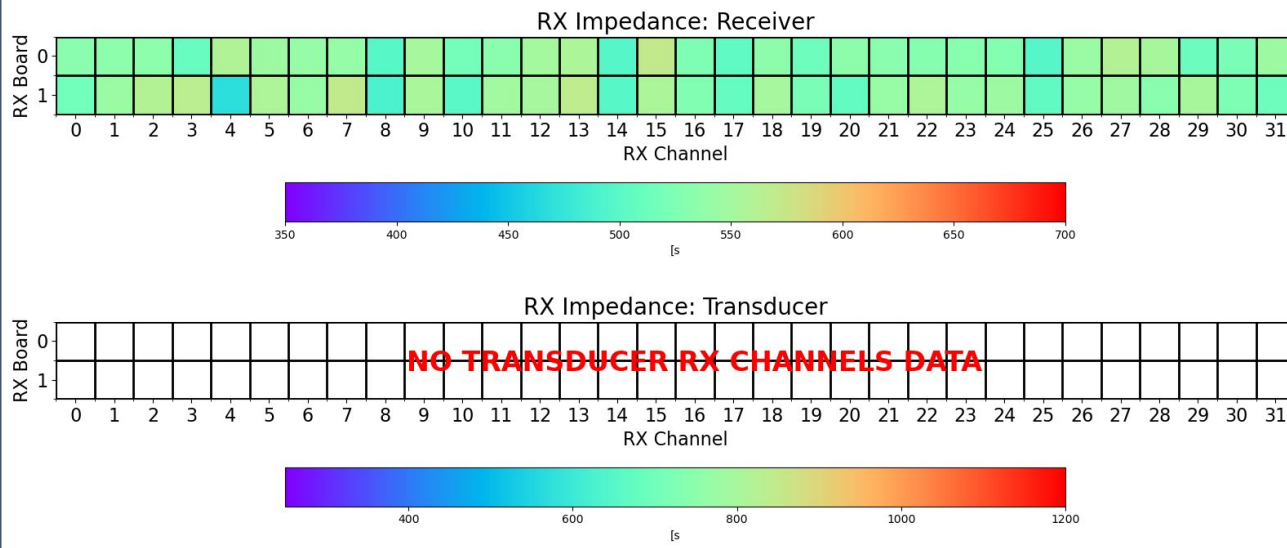


EM122 Transducer Health

RX Channels (2025 New Test)

2025

RX Channels BIST
EM122 (S/N 106)
2025/05/27 22:28:03.553
Frequency: 12 kHz



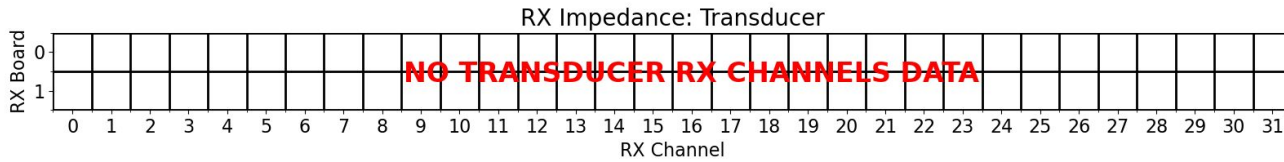
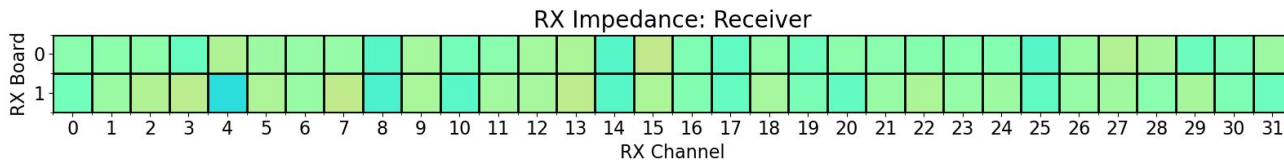
1. An EM122 RX Channels BIST was run on May 27
2. The color scale on each plot is based on the acceptable impedance range to pass a BIST, as defined by Kongsberg
3. For this EM122 BIST format, the text file does not include transducer element impedance data; this should be tested with direct measurements (e.g., Cypher tool) as the array elements may degrade without impacting receiver impedance results
4. EM122 RX Channels data collected since 2012 are plotted on the next slide, showing relatively stable results for the receiver; as with this most recent test, transducer (proxy) impedance was not included
5. It is not clear whether (or how) RX module/cable replacement factors into RX Channels results for the receiver unit (shown)
6. As noted elsewhere, replacement planning is underway for the EM122

EM122 Transducer Health

RX Channels (2012-25 History)

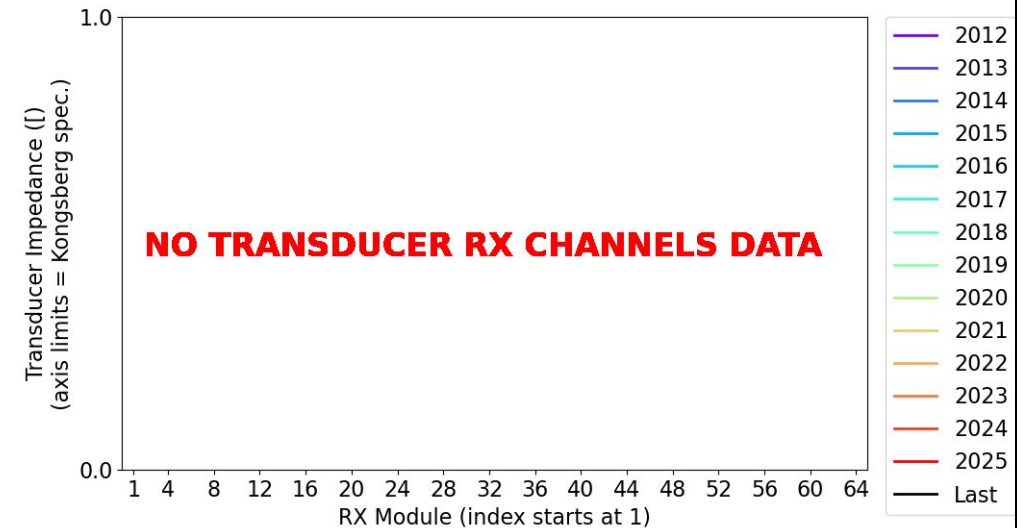
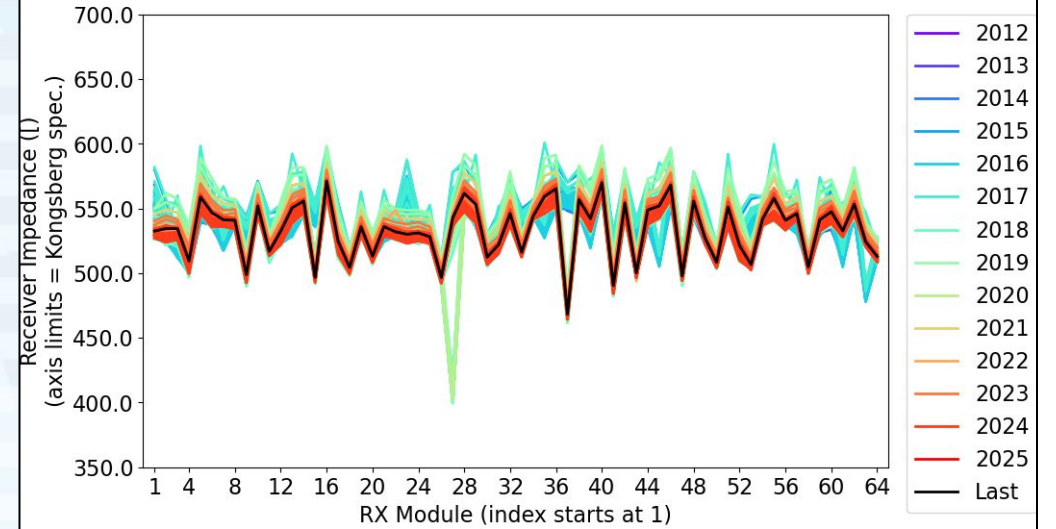
2025

RX Channels BIST
EM122 (S/N 106)
2025/05/27 22:28:03.553
Frequency: 12 kHz



2012-2025

RX Channels BIST
EM122 (S/N 106)
Years: 2012-2025 (172 BISTs)
Frequency: 12 kHz



1. 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.
2. To characterize the vessel's noise environment as perceived by the EM122, a series of RX Noise Level Built-In Self-Tests (BISTs) were recorded while gently accelerating across the max speed range of 0-16 kn for comparison to recent tests following over similar ranges (0-10 kn in 2021-22 and 0-14 kn in 2022-24)
3. The 2025 data were collected in calm conditions and deep water (>1000 m) to help isolate vessel noise and reduce the effects of sea state and reverberation; levels appear slightly higher than previous years
4. At all speeds, high noise levels on the edges of the array (top and bottom edges of image) may indicate localized impacts of flow noise at the ice window edges and machinery noise arriving through the hull
5. Vertical stripes are likely caused by waves impacting the hull 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
6. Plots are presented with an extended color scale (30-80 dB) to better illustrate the 2025 noise trends at higher speeds; these would otherwise saturate the standard color scale of 30-70 dB used in other reports

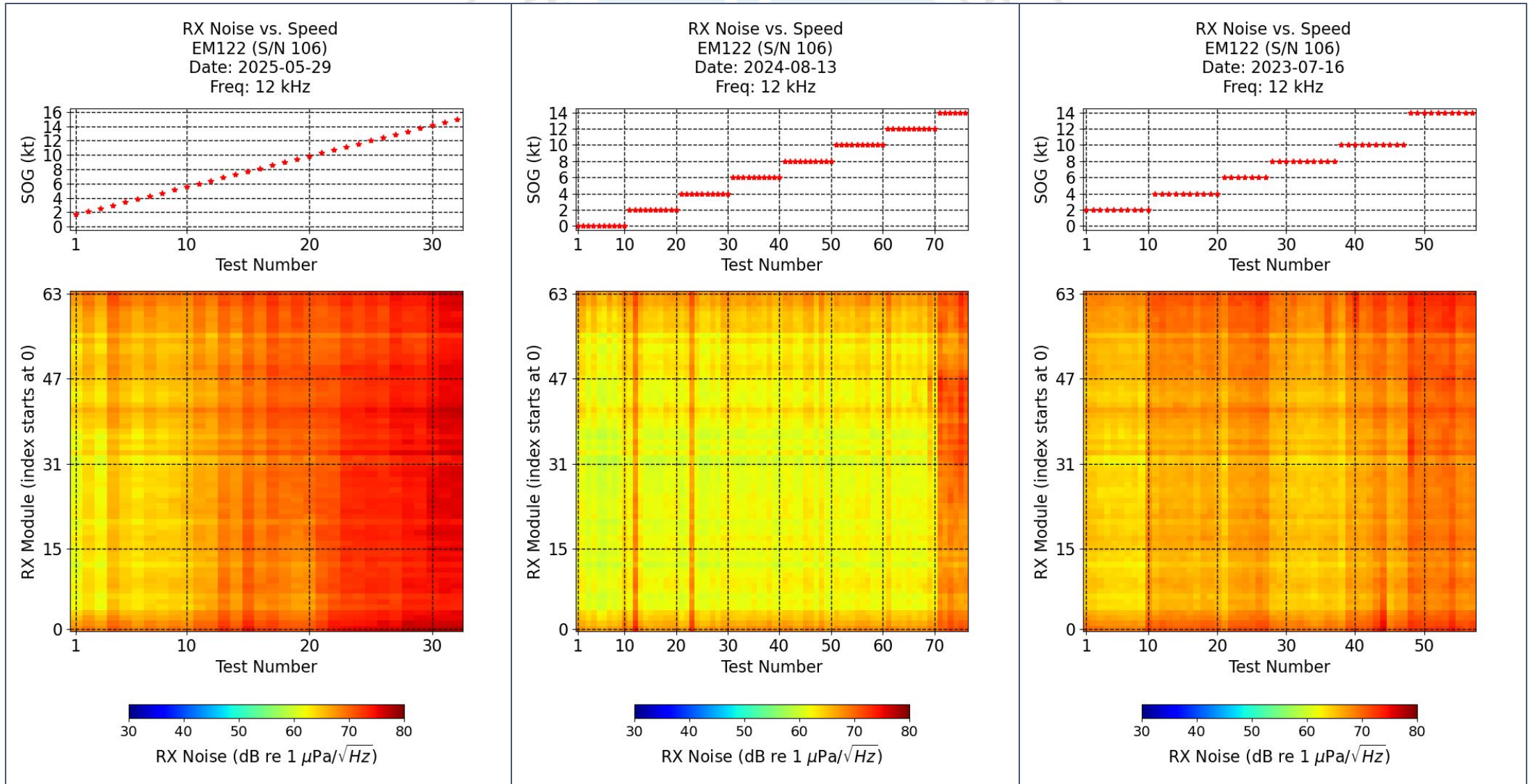
RX Noise BIST Assessment

EM122 Noise Level vs. Speed

2025

2024

2023

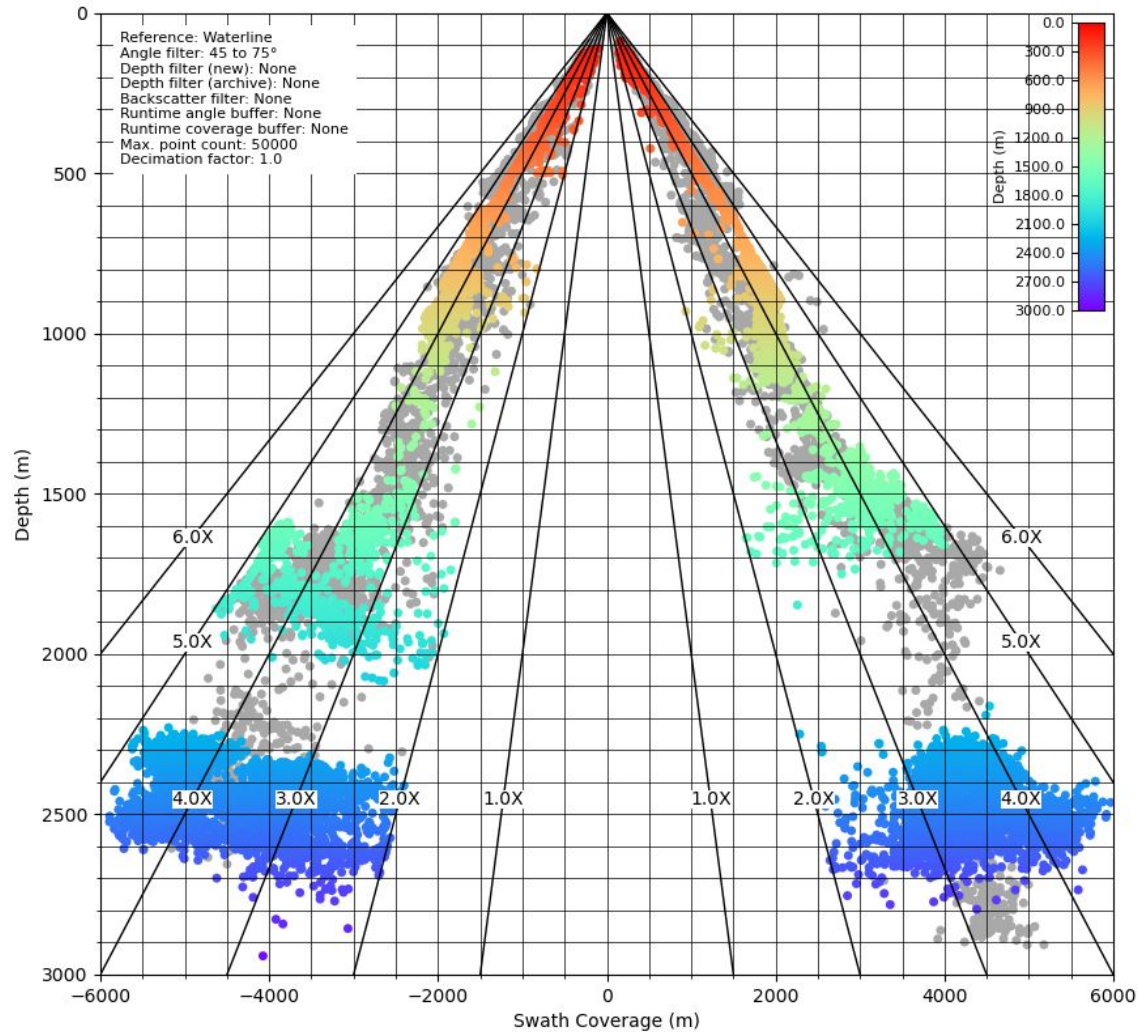


1. All 2023-2025 data from 'new' RX array
2. Plots use an extended color scale (30-80 dB) for comparison with the higher levels (at higher speeds) in 2025

EM122 Swath Coverage

2025 vs. 2024

Swath Width vs. Depth
EM 122 - Healy - HLY25TA



Transit Coverage Testing (2025)

Swath coverage test data were acquired during transits and ship testing in May 2025 (colored by depth), showing no significant change from 2024 (gray points)

Coverage plots shown here are based on a small number of files that were collected:

- with suitable runtime parameters (e.g., following recommended settings outlined on the [Ocean Mapping Community Wiki](#))
- under 'typical' mapping operating parameters with appropriate data quality (e.g., at transit speed in low sea state, tracking the seafloor normally)
- crossing the maximum depth range observed during the transit (e.g., 100-2600 m)

This dataset indicated expected performance over this depth range, given the system's associated factors (e.g., age of hardware, high vessel noise levels, and acoustic attenuation through ice windows)

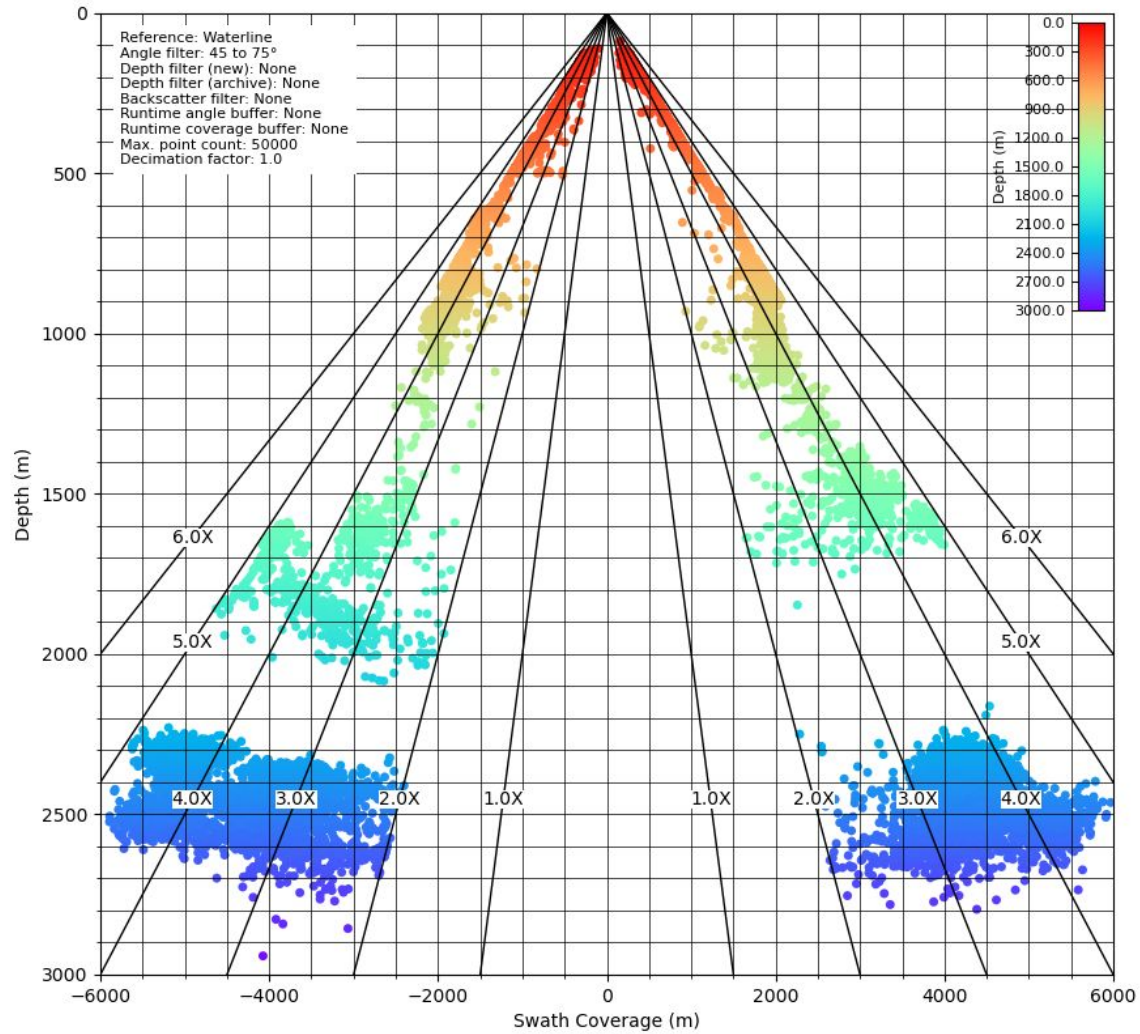
EM122 Swath Coverage



Results

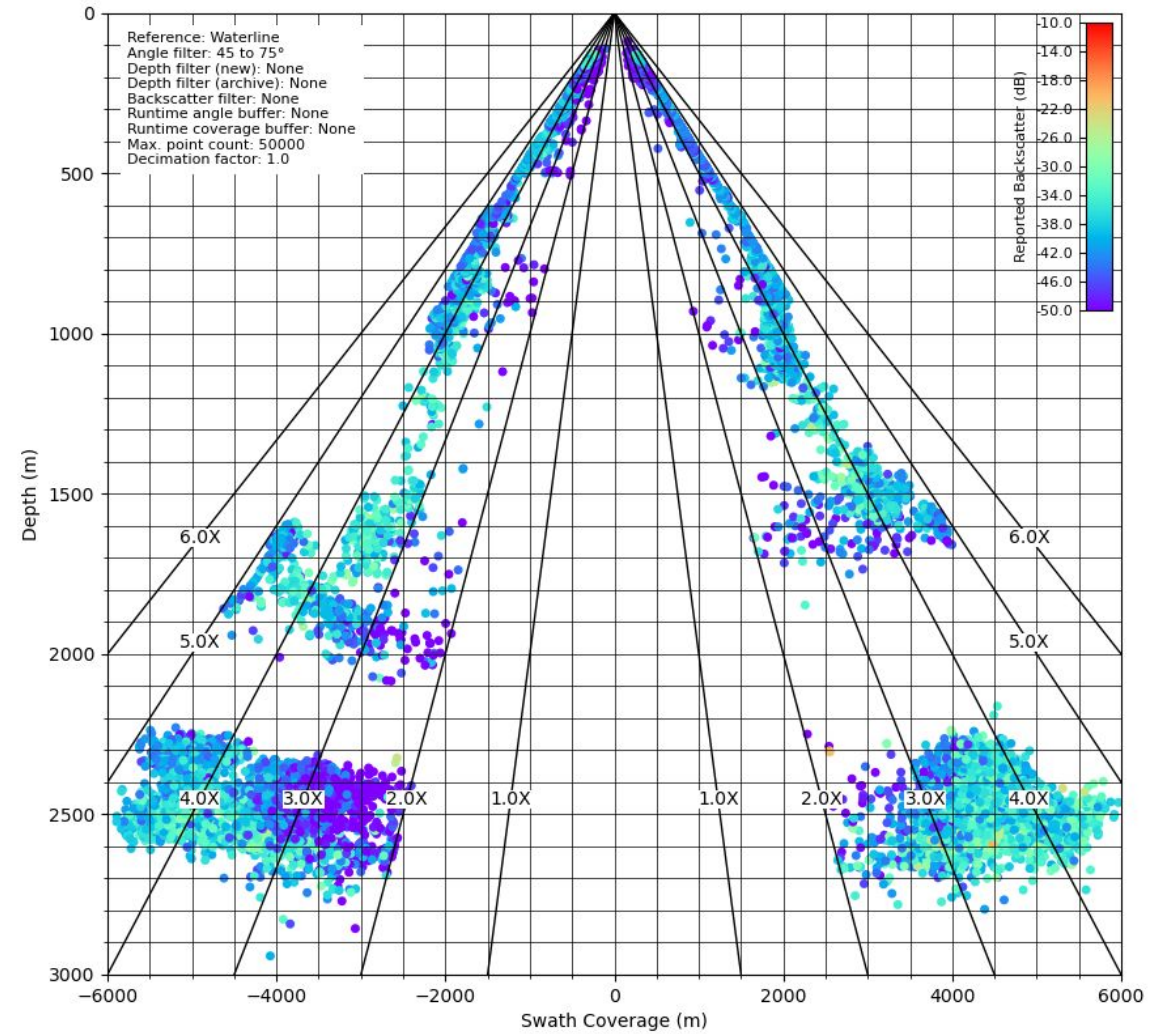
Depth

Swath Width vs. Depth
EM 122 - Healy - HLY25TA



Backscatter

Swath Width vs. Depth
EM 122 - Healy - HLY25TA



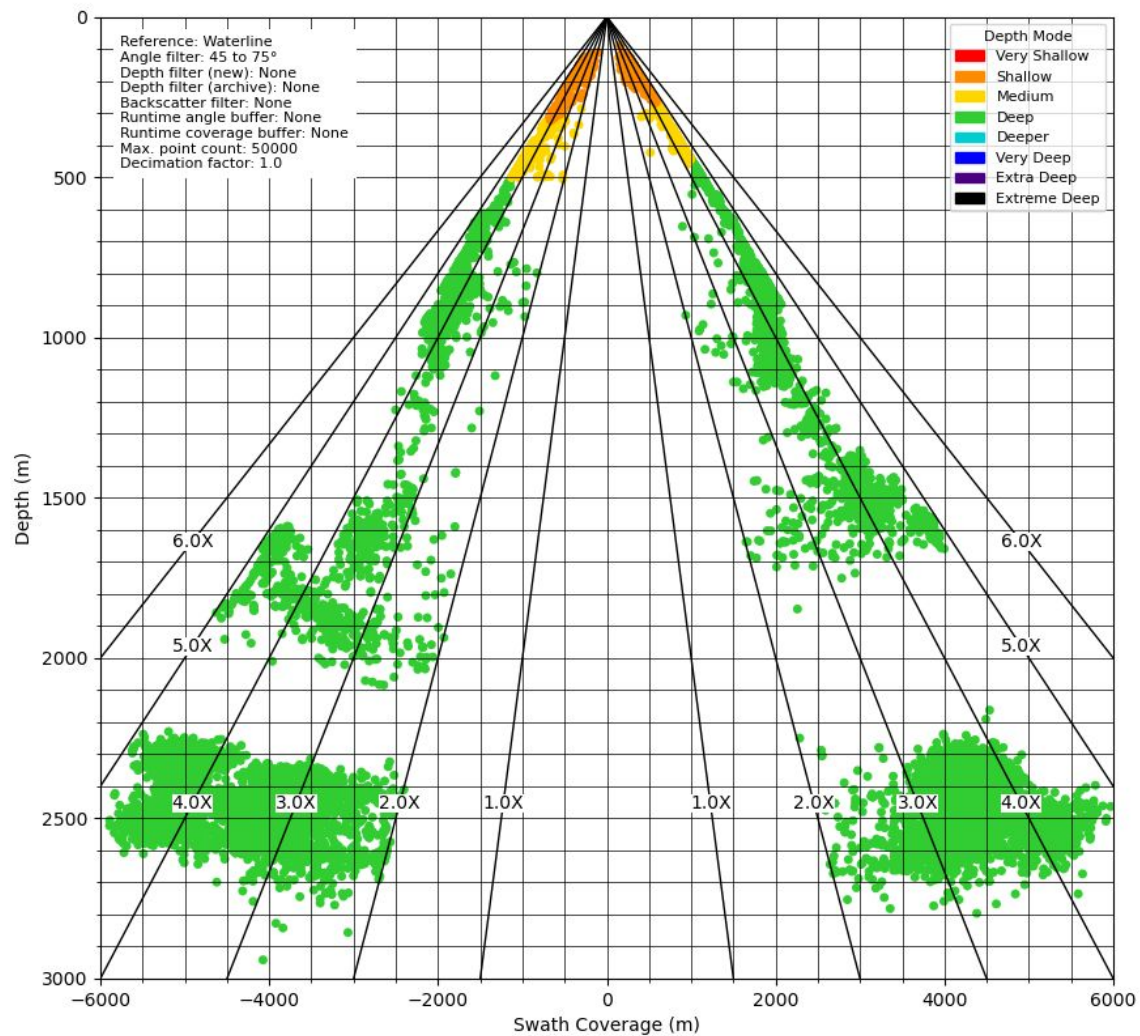
EM122 Swath Coverage



Results

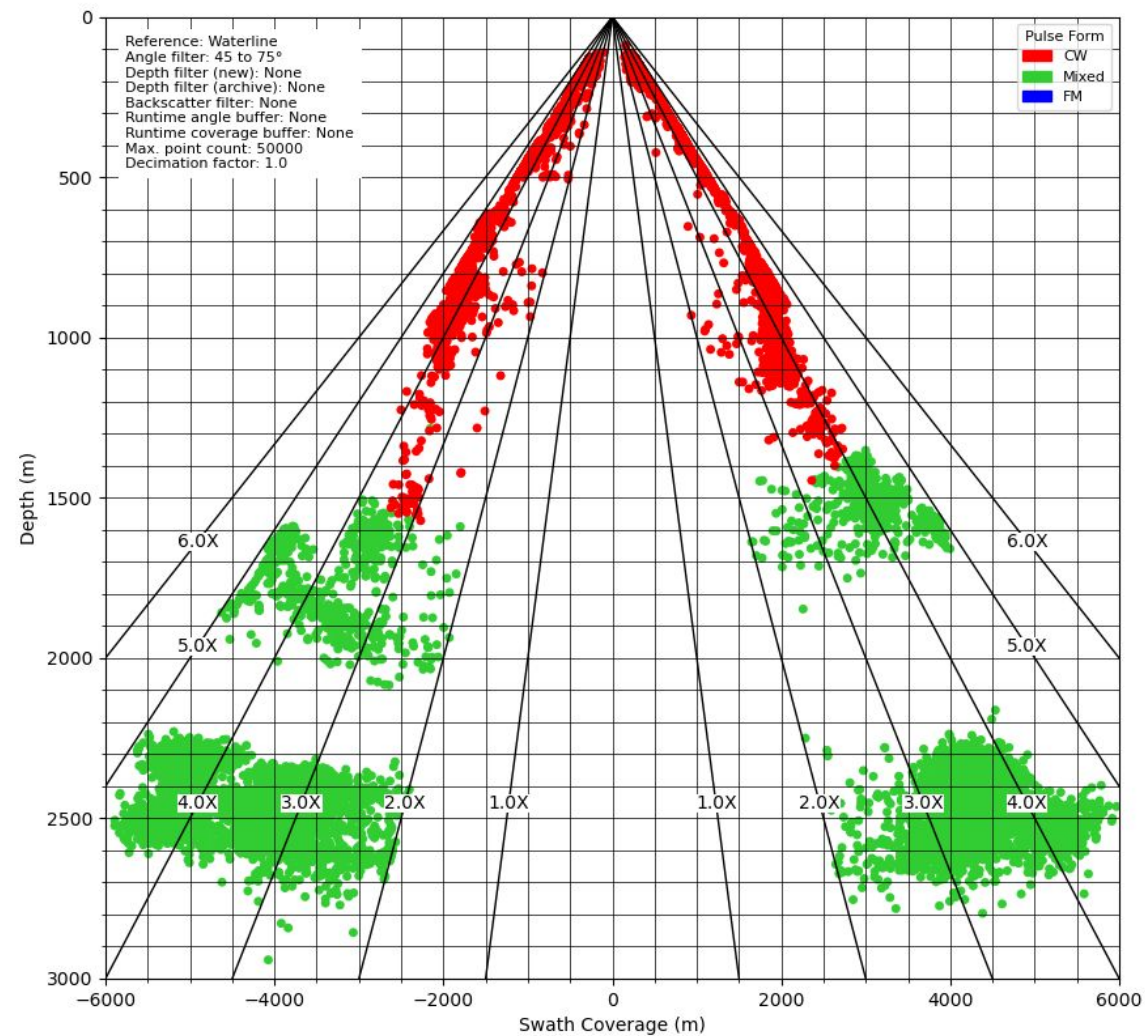
Depth Mode

Swath Width vs. Depth
EM 122 - Healy - HLY25TA



Pulse Form

Swath Width vs. Depth
EM 122 - Healy - HLY25TA





U. S. COAST GUARD

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credit: Grant DeVuyst, USCG