

# *R/V Thomas G. Thompson*

*EM124 Sea Acceptance Testing  
Multibeam Advisory Committee  
Dec 1-8, 2025 (TN-447)*

*Report prepared by:*

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

*Image credit: ocean.washington.edu*

# Executive Summary

1. R/V *Thomas G. Thompson (TGT)* underwent a significant shipyard period in Singapore in late 2025 to install a new gondola for improved noise reduction and bubble mitigation of its upgraded acoustic sensor suite
2. As part of this upgrade, the [30-kHz EM302 multibeam echosounder installed in 2018](#) was replaced with a 12-kHz EM124 (1.0° TX x 1.0° RX) to broaden the vessel's deepwater seafloor and water column mapping capabilities and more closely align with other Global Class vessels (e.g., R/V *Atlantis* and R/V *Roger Revelle*)
3. The EM124 upgrade also supports two new subbottom profiling capabilities that were tested and reported by other TN-447 science parties:
  - a. A new SBP29 subbottom profiling system that uses a dedicated TX array and shares the EM124 RX array
  - b. New 'EM SBP' software options for subbottom profile processing using only EM124 hardware and data
4. Surveys for gondola alignment, array flatness, and final sensor offsets were conducted throughout the shipyard period by On Site Alignment (OSA) with guidance and review by Anand Hiroji (USM), Kongsberg, and UW
5. The MAC was asked to assist with conducting Sea Acceptance Testing (SAT) of the new EM124 using the ship's Applanix POS MV and Seapath 380 navigation systems; EM124 test areas were developed in the Sulu Sea (within the Philippines EEZ) to align with permitting approvals along the transit route from Singapore
6. Due to schedule constraints, the MAC provided remote support from shore throughout the SAT; the on-board mapping team included UW and USM personnel with extensive multibeam experience as well as two Kongsberg field engineers

# Executive Summary

7. Planning followed the standard [MAC SAT/QAT checklist](#), starting with system geometry review, antenna calibration, hardware health, and noise testing to verify basic functionality; multibeam calibration, accuracy, and swath coverage testing were organized to maximize efficiency with the ship's schedule and transit route
8. This report describes the procedures and results for system geometry review, hardware health monitoring, RX noise characterization, geometric calibrations ('patch tests'), accuracy testing, and swath coverage assessment, with recommendations for future data collection to more fully document the EM124's baseline performance
9. Built-In Self-Tests (BISTs) were carried out throughout the Factory Acceptance, Harbor Acceptance, and Sea Acceptance Tests to verify hardware health and document the baseline conditions for both systems
10. All BISTs should be conducted routinely for both systems (e.g., before and after any maintenance period, at the start and end of every cruise, and daily during mapping missions) to detect failures quickly and track hardware health over time; these long-term trends can be incorporated into future MAC reports
11. The vessel survey report provided by OSA included a simple table of results; the MAC urges UW to request a final version of this report with the origin defined at the POS MV IMU target, as well as additional images and annotations to clarify interpretation for future users (e.g., see [MAC Survey Report Recommendations](#))
12. The SIS Waterline configuration was configured from real-time draft readings and can be updated periodically using the [MAC Waterline Worksheet](#)

# Executive Summary

13. Antenna baseline calibrations were conducted at sea, confirming the OSA survey results to within several mm; both navigation systems were configured to use the OSA antenna survey results for this SAT
14. EM124 calibration and verification proceeded efficiently and produced clear results for on-board and shoreside processors, suggesting correct implementation of the report across the configurations
15. Two calibration results (POS MV heading and Seapath roll) fell well outside the expected range (see Calibration)
16. Based on the calibration results, On Site Alignment was contacted (without reply) during the SAT for further review of the IMU and MRU mounting angles; UW is strongly encouraged to follow up with OSA on this topic
17. RX noise testing was conducted to assess perceived noise levels versus speed in calm conditions under a typical machinery lineup; while the results confirmed acceptably low noise trends over the speed range of 0-12 kn, they also revealed a number of high-noise RX elements that should be investigated and resolved with Kongsberg support to establish full performance for this new system
18. Accuracy testing was carried out at 4500 m to assess performance in the EM124's intended deepwater environment; schedule constraints limited crossline testing to one depth mode with both navigation sources
19. The overall data quality and distributions of soundings were generally as expected, though a significant nadir-ring tracking artifact ('Erik's horns' or 'railroad tracks') is persistent across this SAT dataset
20. Whole-swath outliers ('bad pings') occasionally occurred during the 4500 m accuracy testing; the root cause is not clear, but may be related to an unknown 12-kHz source or possibly due to lightning strikes near the vessel

# Executive Summary

21. Swath coverage test data were collected opportunistically on transits over a total depth range of 1200-5000 m; where coverage data were collected, the achieved coverage trends compared favorably against a 'benchmark' dataset acquired with a similar EM124 across the Puerto Rico Trench in 2022
22. There are several depth ranges that require additional data to assess coverage performance and verify correct depth mode transitions, specifically in the ranges of <1200 m, 1600-2800 m, and >5000 m; the MAC is eager to assist with planning for data collection to establish a full coverage assessment at the start of service for this new EM124, as this provides an important baseline for early detection of complications in the future
23. The final configurations reflect a well-integrated mapping system and should be maintained until any mapping sensors are modified or new calibrations become necessary for other reasons (e.g., seasonal readiness testing or updates from OSA regarding final sensor installation angles)
24. The MAC thanks UW, USM, and Kongsberg personnel for their communication and flexibility to enable remote support throughout the shipyard and SAT periods

# System Overview



# Mapping System Components

The primary mapping system components are:

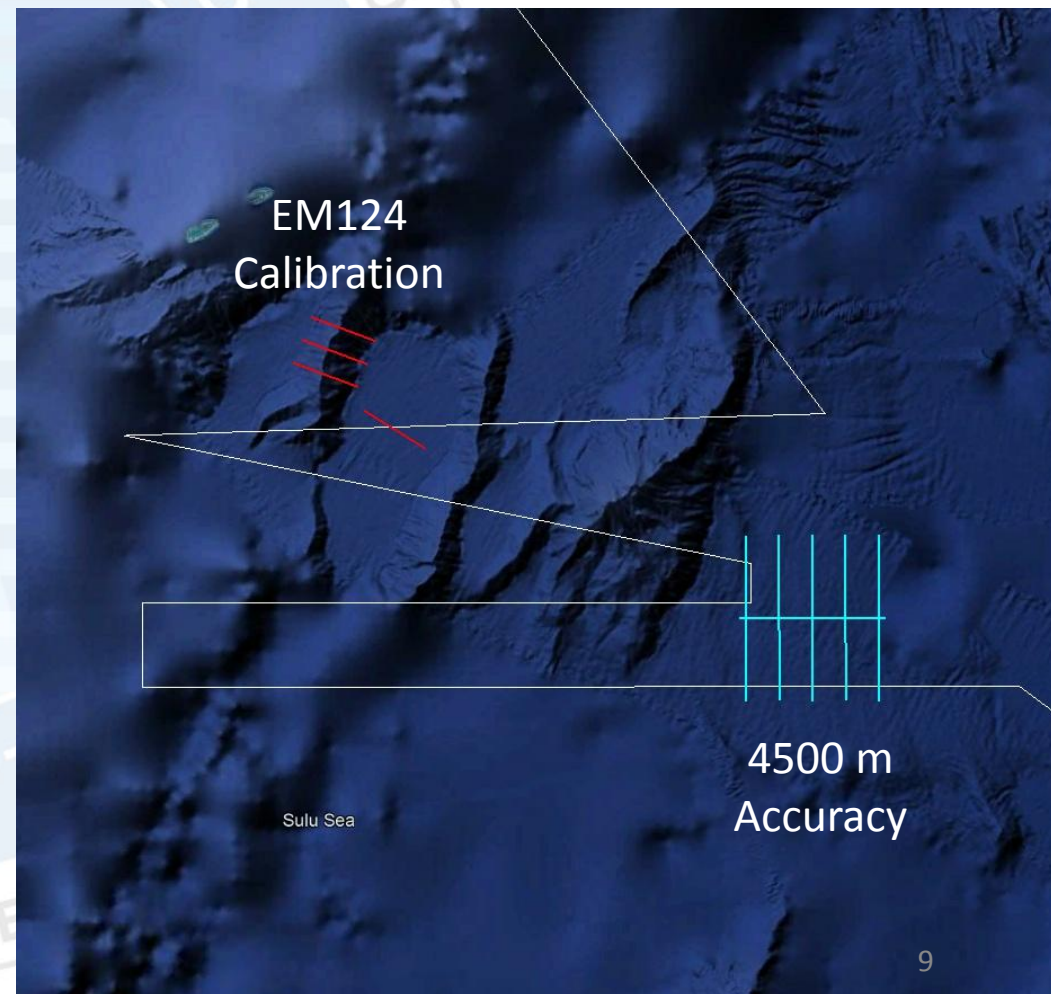
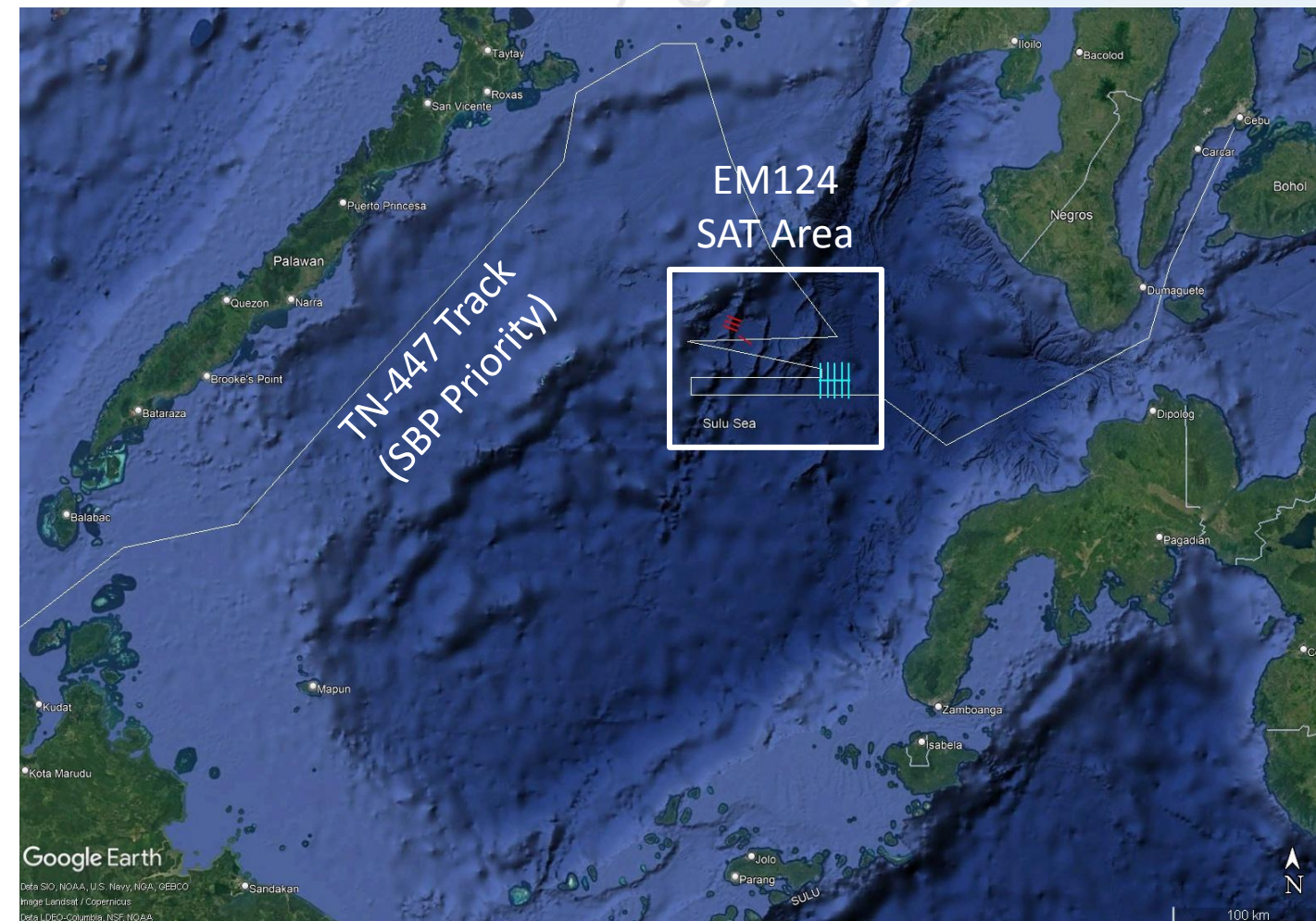
1. Kongsberg EM124 multibeam echosounder (10-14 kHz, 1.0° TX x 1.0° RX), s/n 10055
2. Kongsberg Maritime Seafloor Information System (SIS) v5.15.1
3. Kongsberg Seapath 380-5+ navigation system
  - a. NovAtel GPS-713-GGG antennas
  - b. Seatex MRU 5+ inertial navigation unit
4. Applanix POS MV V5 navigation system
  - a. NovAtel GNSS-850 antennas
  - b. Applanix IMU V5
5. AML SVS surface sound speed sensor
6. Sippican XBT sound speed profiling system
7. Seabird SBE 9plus CTD profiling system

# SAT Planning



# Planning Overview

EM124 SAT planning was limited to approximately 40 hours in the Sulu Sea due to scheduling and permitting constraints during the transit from Singapore to Cebu, Philippines; calibration and accuracy test sites were selected at suitable sites to minimize distance from the cruise track (white line) prioritized for SBP29 SAT activities

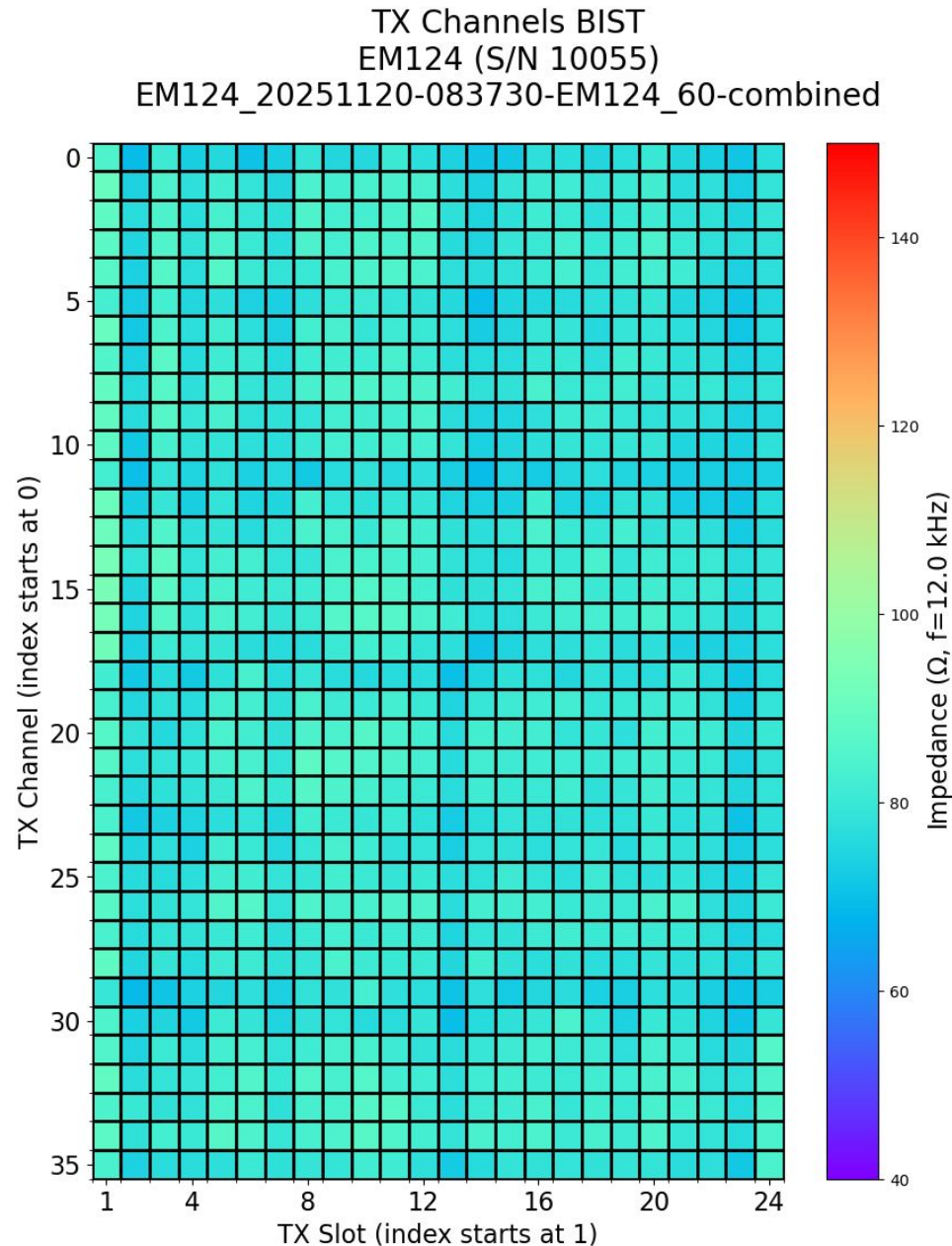


# Hardware Health

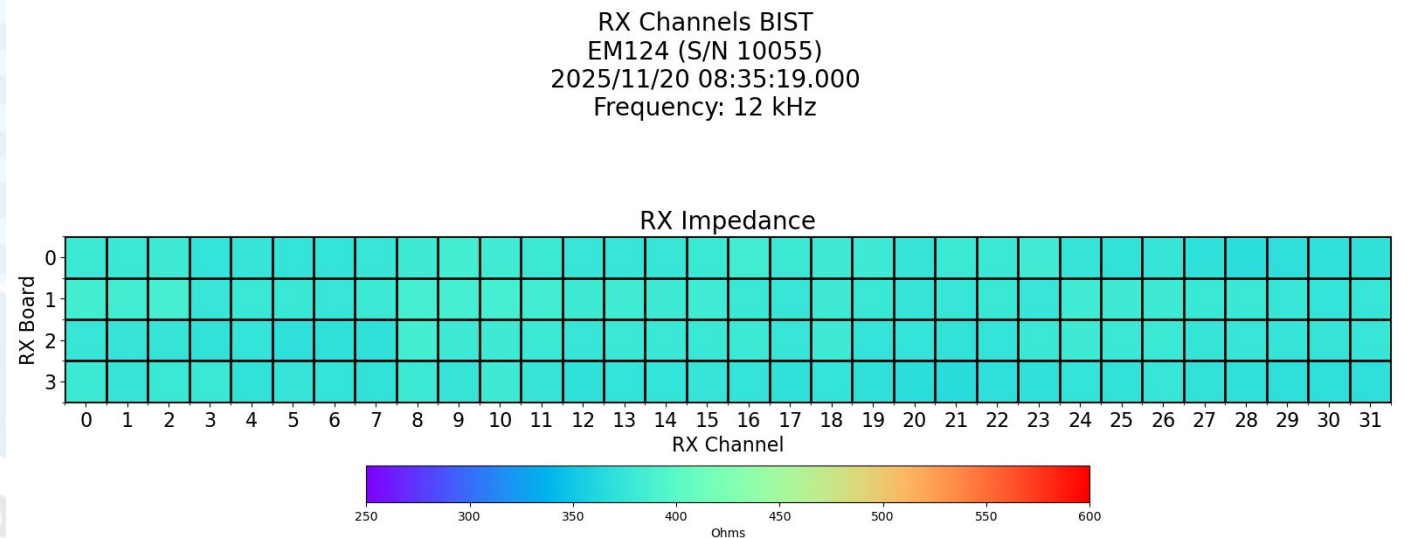


# EM124 Hardware Health

# TX/RX Channels



1. Built-In Self-Tests (BISTs) were collected during the Harbor Acceptance Test (HAT), including TX and RX Channels as proxies for hardware health
2. The color scale on each plot is based on the acceptable impedance range to pass a BIST, as defined by Kongsberg
3. TX and RX Channels BISTs should be performed routinely (e.g., at the start and end of each mapping cruise) to identify trends
4. All TX and RX Channels data are within factory limits at the start of the EM124 service life



# System Geometry



# 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 TX and RX arrays, GNSS antennas, and motion sensors

Because the 2025 SAT involved a completely new survey and updated mapping system configurations, the full history of system geometry is not relevant for this report (see [previous MAC reports](#) for more information)

The table below presents only the most recent survey and system geometry updates through the 2025 SAT

| Date         | Location  | Event   | References   |
|--------------|-----------|---|--|
| Oct-Nov 2025 | Singapore | Gondola and EM124 installation (replacement of EM302); On Site Alignment survey to re-establish mapping system reference frame defined by previous Westlake surveys and determine offsets for EM124 arrays (including flatness), POS MV IMU, Seapath MRU, and all GNSS antennas | On Site Alignment report (14 Oct 2025) and appendix Rev. 1 |
| Dec 2025     | Sulu Sea  | EM124 Sea Acceptance Trials between Singapore and Philippines with Kongsberg field engineer support; EM124, POS MV, and Seapath config review; antenna baseline calibrations; calibrations and verifications with POS MV and Seapath applied as primary navigation sources      | This document  |

# System Geometry Review

## Mapping Reference Frame

1. The EM124, POS MV, and Seapath systems were surveyed by On Site Alignment (OSA) following guidance provided by UW, MAC, and others to try to meet the survey specifications outlined by Kongsberg; the MAC thanks Dr. Anand Hiroji (USM) and UW technicians for providing critical support throughout the survey process
2. OSA provided sensor offsets in a *mapping system reference frame with its origin at the POS MV IMU target, as surveyed by Westlake in 2023*, adhering to Kongsberg axis and sign conventions
3. Small adjustments of +0.001 m in X and Y were made to set the POS MV IMU target *as surveyed in 2025 by OSA* as the origin moving forward; there was no difference in IMU target Z from the Westlake 2023 survey
4. All OSA results were used directly for configuration with small adjustments, as described above and as necessary for antenna phase center heights; IMU and MRU angles were configured by entering OSA results in the mounting angle 'wizards' provided within POS MV and Seapath software, respectively
5. Based on the calibration and verification results during TN-447, the MAC strongly recommends following up with OSA to verify several survey results:
  - a. POS MV IMU heading
  - b. POS MV antenna positions
  - c. Seapath MRU roll
6. All configurations were reviewed by UW, MAC, and Kongsberg personnel prior to departure to ensure agreement of OSA survey interpretation and application in the EM124, POS MV, and Seapath software


# System Geometry Review

## Mapping Reference Frame

### On Site Alignment Convention

Source: 2025 OSA report (images copied from Westlake)


Reference: R-SG25-0137-01-SV



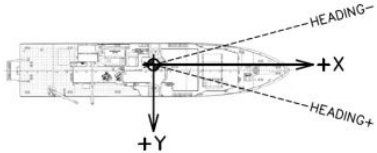
### 3 Methodology

#### 3.1 Ship Reference Frame Definition & Convention for Pitch, Roll, Yaw (Heading)

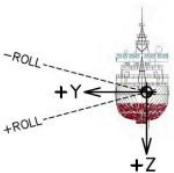
- +X: Toward Forward (+ Bow)
- +Y: Toward STBD
- +Z: Toward down (Toward the Ocean Floor)
- Coordinates per VS IMU TDC as the system Origin (0,0,0)
- Coordinate Origin to Ships Centreline Offset: X 0m, Y 1.517m, Z 0m



PITCH: Positive (+) pitch is reported as the bow (+) moving in the negative (-) Z direction.



HEADING: Heading is reported as smallest angle from the bow (+X). Positive (+) heading is STBD of Bow (Towards +Y) and Negative (-) heading is Port of the Bow (Towards -Y).



ROLL: Positive (+) roll is reported as the STBD side (+Y) moving in the positive (+) Z direction.

On Site Alignment Pte. Ltd.  
1 Sunview road #08-21 | Singapore | 627615  
Phone: +65 6910 4188 | [www.osa.ltd](http://www.osa.ltd)

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1. The OSA survey results followed Kongsberg axis/sign conventions
2. **Origin** is the target on top of the **POS MV IMU as surveyed by OSA\***
3. **Linear offsets** were reported in meters in a 'right-handed' system
  - a. **+X** forward (**agrees** with Kongsberg/Applanix/Seapath)
  - b. **+Y** starboard (**agrees** with Kongsberg/Applanix/Seapath)
  - c. **+Z** down (**agrees** with Kongsberg/Applanix/Seapath)
4. **Angular offsets** were reported in decimal degrees from the vessel planes defined by Westlake
  - a. **+Roll** with port side up (**agrees** with Kongsberg/Applanix/Seapath)
  - b. **+Pitch** with bow up (**agrees** with Kongsberg/Applanix/Seapath)
  - c. **+Heading** with bow rotation to starboard (**agrees** with compass convention and Kongsberg/Applanix/Seapath)

**\*OSA reported all offsets in the reference frame established by Westlake; because the POS MV IMU differed by 1 mm in X and Y from Westlake results, the definition of the mapping system origin at the IMU target required corresponding 1 mm adjustments in X and Y (no adjustment in Z) to the OSA reported results for consistency across configurations**

# System Geometry Review

## EM124 TX & RX Offsets

### 5.1 Offset Coordinate of the Scientific Equipment on Gondola

| Array       | X (+FWD) | Y (+STB) | Z (+DOWN) | Description |
|-------------|----------|----------|-----------|-------------|
| EK 80-18kHz | 9.3540   | 3.3719   | 6.2248    | Centre Face |
| EK80-120kHz | 9.5533   | 2.6279   | 6.2223    | Centre Face |
| EK80-200kHz | 9.1488   | 2.4671   | 6.2276    | Centre Face |
| EK80-38kHz  | 10.0571  | 2.6289   | 6.2250    | Centre Face |
| EK80-70kHz  | 9.1480   | 2.7271   | 6.2261    | Centre Face |
| EM124 RX    | 8.5571   | 1.5157   | 6.2253    | Centre Face |
| EM124 TX    | 4.2201   | 0.9133   | 6.2248    | Centre Face |
| SBP         | 4.3995   | 2.1587   | 6.2257    | Centre Face |

Units are in Meter  
All the coordinate provided offset from ship primary coordinate systems.

### 5.2 Angle of the Scientific Equipment on Gondola

| Array       | Roll (°) | Pitch (°) | Yaw (°) |
|-------------|----------|-----------|---------|
| EK 80-18kHz | -0.13    | 0.53      | NA      |
| EK80-120kHz | -0.13    | 0.30      | NA      |
| EK80-200kHz | -1.10    | 0.94      | NA      |
| EK80-38kHz  | -0.41    | -0.11     | NA      |
| EK80-70kHz  | 0.43     | 1.02      | NA      |
| EM124 RX    | 0.00     | -0.18     | 0.06    |
| EM124 TX    | 0.06     | -0.07     | 0.12    |
| SBP         | -0.28    | -0.14     | 0.06    |

#### TX

|   |  |   |
|---|--|---|
| View from aft<br>TX 1 LOCATION OFFSET (FORWARD, X)<br>4.221 | View from port<br>TX 1 LOCATION OFFSET (STARBOARD, Y)<br>0.914 | View from mast<br>TX 1 LOCATION OFFSET (DOWNWARD, Z)<br>6.225 |
| TX 1 ANGULAR OFFSET (ROLL)<br>0.060                         | TX 1 ANGULAR OFFSET (PITCH)<br>-0.070                          | TX 1 ANGULAR OFFSET (HEADING)<br>0.120                        |

#### RX

|   |  |   |
|---|--|---|
| View from aft<br>RX 1 LOCATION OFFSET (FORWARD, X)<br>8.558 | View from port<br>RX 1 LOCATION OFFSET (STARBOARD, Y)<br>1.517 | View from mast<br>RX 1 LOCATION OFFSET (DOWNWARD, Z)<br>6.225 |
| RX 1 ANGULAR OFFSET (ROLL)<br>0.000                         | RX 1 ANGULAR OFFSET (PITCH)<br>-0.180                          | RX 1 ANGULAR OFFSET (HEADING)<br>0.060                        |
| RX 1 BS OFFSET<br>0.00                                      |  |   |

- Linear and angular offsets of the **EM124** transducer array (X, Y, Z to center of face) were provided using the Kongsberg convention; these offsets were adjusted by 1 mm in X and Y to maintain the origin as defined at the IMU target (see Mapping Reference Frame section for detail)
- EM124 SIS Installation Parameters were configured using the adjusted / rounded OSA results as follows:

#### EM124 TX Transducer

X: +4.221 m      Roll: +0.06°  
Y: +0.914 m      Pitch: -0.07°  
Z: +6.225 m      Heading: +0.12°

#### EM124 RX Transducer

X: +8.558 m      Roll: 0.000°  
Y: +1.517 m      Pitch: -0.18°  
Z: +6.225 m      Heading: +0.06°

# System Geometry Review

## Seapath Antenna Lever Arms

1. Seapath antennas are NovAtel GPS-713-GGG models installed in an athwartship orientation with the port antenna as primary
2. OSA reported the L1 phase center for each antenna from the average of two sets of measurements
3. Seapath antenna baseline calibration was carried out with the vessel holding station in DP; results agreed to within several mm of the OSA results, and OSA results were re-applied for both antennas in the Seapath software for traceability
4. **Antenna 1** (port) height at the L1 phase center (m, +Z down from origin, adjusted and rounded to the nearest 0.001 m):

**X = +22.884 ; Y = -0.716 m; Z = -9.354 m**

5. **Antenna 2** (stbd) offsets following the same approach:

**X = +22.886 m; Y = +1.786 m; Z = -9.372 m**

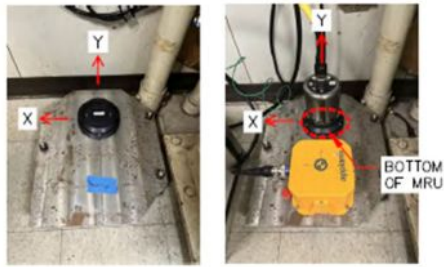
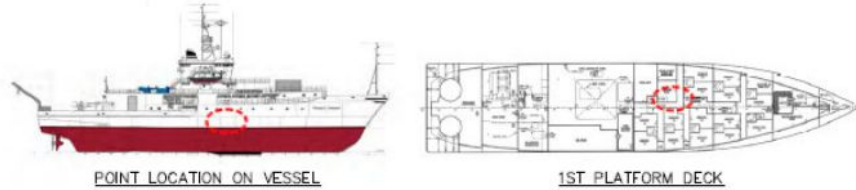
6.1 GNSS -802 ANTENNA COORDINATE FWD

| WCI REF # | LONGITUDINAL OFFSET (X) | TRANSVERSE OFFSET(Y)  | BASILINE OFFSET (Z) | SENSOR DESCRIPTION AND NOTES          |
|-----------|-------------------------|-----------------------|---------------------|---------------------------------------|
|           | POSITIVE FORWARD        | POSITIVE TO STARBOARD | POSITIVE DOWN       |                                       |
| 3075.1    | 22.8870                 | 1.7850                | -9.3299             | CL STB GNSS @BASE (1ST READING)       |
| 3075.2    | 22.8838                 | 1.7843                | -9.3293             | CL STB GNSS @BASE (2ND READING)       |
| 3075      | 22.8854                 | 1.7846                | -9.3296             | CL STB GNSS @BASE -AVERAGE            |
|           | 22.8870                 | 1.7850                | -9.3721             | CL STB GNSS @L1 PHASE CENTER (1ST)    |
|           | 22.8838                 | 1.7843                | -9.3715             | CL STB GNSS @L1 PHASE CENTER (2ND)    |
|           | 22.8854                 | 1.7846                | -9.3718             | CL STB GNSS @L1 PHASE CENTER -AVERAGE |
| 3069.1    | 22.8829                 | -0.7176               | -9.3117             | CL PRT GNSS @BASE (1ST READING)       |
| 3069.2    | 22.8820                 | -0.7166               | -9.3123             | CL PRT GNSS @BASE (2ND READING)       |
| 3069      | 22.8825                 | -0.7171               | -9.3120             | CL PRT GNSS @BASE-AVERAGE             |
|           | 22.8829                 | -0.7176               | -9.3539             | CL PRT GNSS @L1 PHASE CENTER (1ST)    |
|           | 22.8820                 | -0.7166               | -9.3545             | CL PRT GNSS @L1 PHASE CENTER (2ND)    |
|           | 22.8825                 | -0.7171               | -9.3542             | CL PRT GNSS @L1 PHASE CENTER -AVERAGE |

# System Geometry Review

## Seapath MRU Lever Arms

### 6.6 SEATEX MRU 5+



| READINGS | LONGITUDINAL OFFSET (X) | TRANSVERSE OFFSET(Y)  | BASELINE OFFSET (Z) | SENSOR DESCRIPTION AND NOTES |
|----------|-------------------------|-----------------------|---------------------|------------------------------|
|          | POSITIVE FORWARD        | POSITIVE TO STARBOARD | POSITIVE DOWN       |                              |
| 1ST      | -0.0043                 | 0.2268                | 0.1031              | SEATEX MRU 5+                |
| 2ND      | -0.0038                 | 0.2269                | 0.1026              | SEATEX MRU 5+                |
| 3RD      | -0.0041                 | 0.2265                | 0.1029              | SEATEX MRU 5+                |
| AVERAGE  | -0.0041                 | 0.2267                | 0.1028              | SEATEX MRU 5+                |

| READINGS | ROLL (X) | PITCH (Y) | HEADING (Z) | SENSOR DESCRIPTION AND NOTES |
|----------|----------|-----------|-------------|------------------------------|
| 1ST      | -0.20°   | -0.03°    | 0.9475°     | SEATEX MRU 5+                |
| 2ND      | -0.21°   | -0.01°    | 0.9669°     | SEATEX MRU 5+                |
| 3RD      | -0.20°   | -0.03°    | 0.7362°     | SEATEX MRU 5+                |
| AVERAGE  | -0.20°   | -0.02°    | 0.8835°     | SEATEX MRU 5+                |

1. The MRU was surveyed by OSA following guidance from Kongsberg and configured using the average of three sets of measurements
2. The base of the MRU is assumed coincident with the reference target on the bottom of the bottle housing
3. OSA angles were entered into the Seapath MRU Mounting Wizard for final determination of angles of the aft-facing, cable-up MRU orientation (see Seapath manual for details)
4. MRU reference target offsets in Seapath (as calculated by the Mounting Wizard from OSA results):

**X: -0.003 m**

**Roll: -179.800°**

**Y: +0.228 m**

**Pitch: +0.023°**

**Z: +0.103 m**

**Heading: -179.116°**

# System Geometry Review

# Seapath 380-5+ Configuration

1. The installation offsets shown below should remain unchanged until the MRU or antennas are moved (and re-surveyed)
2. Note: Seapath configuration stems directly from the OSA survey report (with potential rounding to 0.001 m within the software, as below); all EM124 calibration ('patch test') results are applied in SIS under the relevant Attitude source, separately from transducer installation angles (see *Calibration* section)

NAV Engine Configuration

Apply Preview Revert

Vessel

- Geometry
- Description

Sensors

- GNSS
  - Geometry
  - Processing
  - Attitude Processing
- DGNSS
  - SBAS
  - HP/G2/G4
  - RTK
- MRU
  - Geometry
  - Heave config

Monitoring points

- Geometry

Communication interface

- Input/Output
- Serial port extender
- Data Pool
- Network

Keel

CL

Origin X Z

Origin X Y

Show sensors  Show monitoring points

Antenna configuration

Type:   Antenna beam

Antenna offset (from antenna 1 to antenna 2)

Baseline length:  m

Heading offset:  °

Height difference:  m

Calibration wizard

Antenna location (from Survey origin)

|           | Position [m] |        |        |
|-----------|--------------|--------|--------|
|           | X            | Y      | Z      |
| Antenna 1 | 22.884       | -0.716 | -9.354 |
| Antenna 2 | 22.887       | 1.786  | -9.374 |

Connected to Seapath 380 at 192.168.1.10

NAV Engine Configuration

Apply Preview Revert

Vessel

- Geometry
- Description

Sensors

- GNSS
  - Geometry
  - Processing
  - Attitude Processing
- DGNSS
  - SBAS
  - HP/G2/G4
  - RTK
- MRU
  - Geometry
  - Heave config

Monitoring points

- Geometry

Communication interface

- Input/Output
- Serial port extender
- Data Pool
- Network

Keel

CL

Origin X Z

Origin X Y

Show sensors  Show monitoring points

Sensor location (from Origin)

X:  m Y:  m Z:  m

Physical mount

IMU interface:

Mounting angles

Roll:  ° Pitch:  ° Yaw:  °

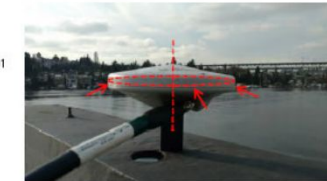
Mounting wizard

Connected to Seapath 380 at 192.168.1.10

# System Geometry Review

## POS MV Antenna Lever Arms

1. POS MV antennas are NovAtel GNSS-850 models installed in an athwartship orientation with the starboard antenna as primary; OSA reported the center of the 'seam' around the housing, as provided by Westlake in earlier surveys
2. Adjustments of 16 mm upward were applied to determine the L1 phase centers, following the [2018 EM302 SAT report](#) (p. 12)
3. A GAMS calibration was carried out as one of the first SAT activities; results agreed to within several mm of the OSA results, and OSA results were re-applied for both antennas in the POS MV software for traceability
4. **Antenna 1** (stbd) height at the L1 phase center (m, +Z down from origin, adjusted and rounded to the nearest 0.001 m):  
 $X = -28.282$  ;  $Y = +2.917$  m;  $Z = -12.190$  m
5. **Antenna 2** (port) offsets following the same approach:  
 $X = -28.245$  m;  $Y = +0.811$  m;  $Z = -12.190$  m
6. The **GAMS parameter** for baseline between the antennas was set as the difference between surveyed / adjusted locations:  
 $dX = +0.037$  m;  $dY = -2.106$  m;  $dZ = 0.000$  m



| WCI REF # | LONGITUDINAL OFFSET (X) | TRANSVERSE OFFSET(Y)  | BASELINE OFFSET (Z) | SENSOR DESCRIPTION AND NOTES   |
|-----------|-------------------------|-----------------------|---------------------|--------------------------------|
|           | POSITIVE FORWARD        | POSITIVE TO STARBOARD | POSITIVE DOWN       |                                |
| 3001.1    | -28.2839                | 2.9165                | -12.1747            | POSMV STBD GPS ANTENNA(1ST)    |
| 3001.2    | -28.2825                | 2.9145                | -12.1739            | POSMV STBD GPS ANTENNA(2ND)    |
| 3001      | -28.2832                | 2.9155                | -12.1743            | POSMV STBD GPS ANTENNA-AVERAGE |

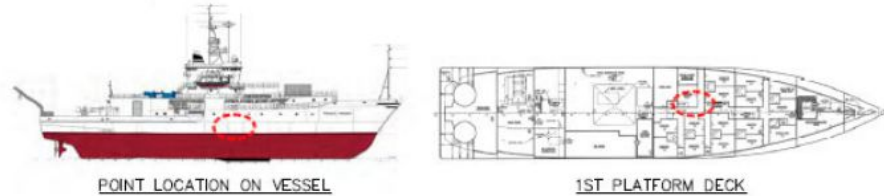


| WCI REF # | LONGITUDINAL OFFSET (X) | TRANSVERSE OFFSET(Y)  | BASELINE OFFSET (Z) | SENSOR DESCRIPTION AND NOTES    |
|-----------|-------------------------|-----------------------|---------------------|---------------------------------|
|           | POSITIVE FORWARD        | POSITIVE TO STARBOARD | POSITIVE DOWN       |                                 |
| 3002.1    | -28.2437                | 0.8098                | -12.1756            | POSMV PORT GPS ANTENNA(1ST)     |
| 3002.2    | -28.2479                | 0.8088                | -12.1734            | POSMV PORT GPS ANTENNA(2ND)     |
| 3002      | -28.2458                | 0.8093                | -12.1745            | POSMV PORT GPS ANTENNA -AVERAGE |

# System Geometry Review

## POS MV IMU Lever Arms

### 6.5 TDC APPLANIX V5 POSMV IMU



1. The IMU reference target was surveyed by OSA and configured using the average of three sets of measurements
2. Adjustments of 0.001 m in X and Y were applied to all results to define the IMU target as the mapping system origin
3. OSA results were entered into the POS MV software for final configuration of IMU installation angles (e.g., pitch result below differs by +0.005° from OSA survey)

4. IMU reference target offsets as configured:

**X: 0.000 m**

**Roll: -0.420°**

**Y: 0.000 m**

**Pitch: +0.025°**

**Z: 0.000 m**

**Heading: +0.637°**

| READINGS | LONGITUDINAL OFFSET (X) | TRANSVERSE OFFSET (Y) | BASELINE OFFSET (Z) | SENSOR DESCRIPTION AND NOTES |
|----------|-------------------------|-----------------------|---------------------|------------------------------|
|          | POSITIVE FORWARD        | POSITIVE TO STARBOARD | POSITIVE DOWN       |                              |
| 1ST      | -0.001                  | -0.001                | -0.001              | TDC APPLANIX V5 POSMV IMU    |
| 2ND      | -0.001                  | -0.001                | -0.000              | TDC APPLANIX V5 POSMV IMU    |
| 3RD      | -0.001                  | -0.001                | 0.001               | TDC APPLANIX V5 POSMV IMU    |
| AVERAGE  | -0.001                  | -0.001                | 0.000               | TDC APPLANIX V5 POSMV IMU    |

| READINGS | ROLL (X) | PITCH (Y) | HEADING (Z) | SENSOR DESCRIPTION AND NOTES |
|----------|----------|-----------|-------------|------------------------------|
| 1ST      | -0.46°   | 0.01°     | 0.6331°     | TDC APPLANIX V5 POSMV IMU    |
| 2ND      | -0.38°   | 0.02°     | 0.6394°     | TDC APPLANIX V5 POSMV IMU    |
| 3RD      | -0.41°   | 0.04°     | 0.6392°     | TDC APPLANIX V5 POSMV IMU    |
| AVERAGE  | -0.42°   | 0.02°     | 0.6370°     | TDC APPLANIX V5 POSMV IMU    |

# System Geometry Review

## POS MV Configuration

1. The installation offsets shown below should remain unchanged until the MRU or antennas are moved (and re-surveyed)
2. Note: POS MV configuration stems directly from the OSA survey report; all EM124 calibration ('patch test') results are applied in SIS under the relevant Attitude source, separately from transducer installation angles (see *Calibration* section)

**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): 0.000       | X (deg): -0.420             | X (m): 0.000             | X (m): 0.000        |
| Y (m): 0.000       | Y (deg): 0.025              | Y (m): 0.001             | Y (m): 0.002        |
| Z (m): 0.000       | Z (deg): 0.637              | Z (m): 0.086             | Z (m): 0.086        |

| Ref. to Primary GNSS Lever Arm | Ref. to Vessel Lever Arm | Ref. to Centre of Rotation Lever Arm |
|--------------------------------|--------------------------|--------------------------------------|
| X (m): -28.282                 | X (m): 0.000             | X (m): 0.000                         |
| Y (m): 2.917                   | Y (m): 0.000             | Y (m): 1.517                         |
| Z (m): -12.190                 | Z (m): 0.000             | Z (m): 0.000                         |

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

Compute IMU w.r.t. Ref. Misalignment

Enable Bare IMU

Ok Close Apply View

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

**GAMS Parameter Setup**

Heading Calibration Threshold (deg): 0.500

Heading Correction (deg): 0.000

Baseline Vector

X Component (m): 0.037

Y Component (m): -2.106

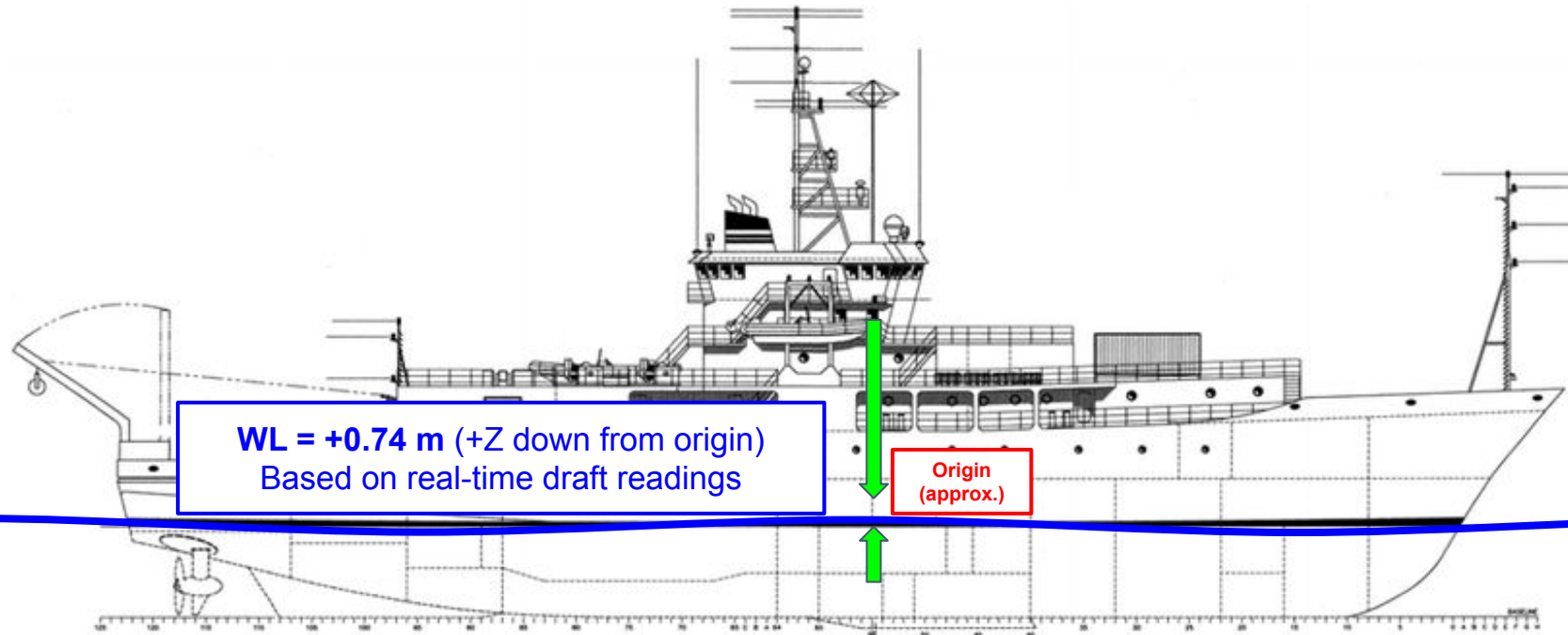
Z Component (m): 0.000

Ok Close Apply View

# System Geometry Review

## Waterline Configuration

1. Waterline (WL) in SIS is the sea surface height from the origin (meters, +Z down); *note that WL is not draft*
2. Waterline was calculated on 12/2/2025 using real-time draft measurement in the ship stability software
3. The origin at the POS MV IMU target is 6.225 m above the draft reference on the gondola (i.e., TX/RX array Z)
4. The draft reading of 5.49 m (from the gondola) yields a difference of 0.735 m between the origin and sea surface and a WL parameter of +0.74 m (positive down) after rounding
5. This Waterline can be verified in future reviews using the [MAC Waterline Worksheet](#)



# Calibration

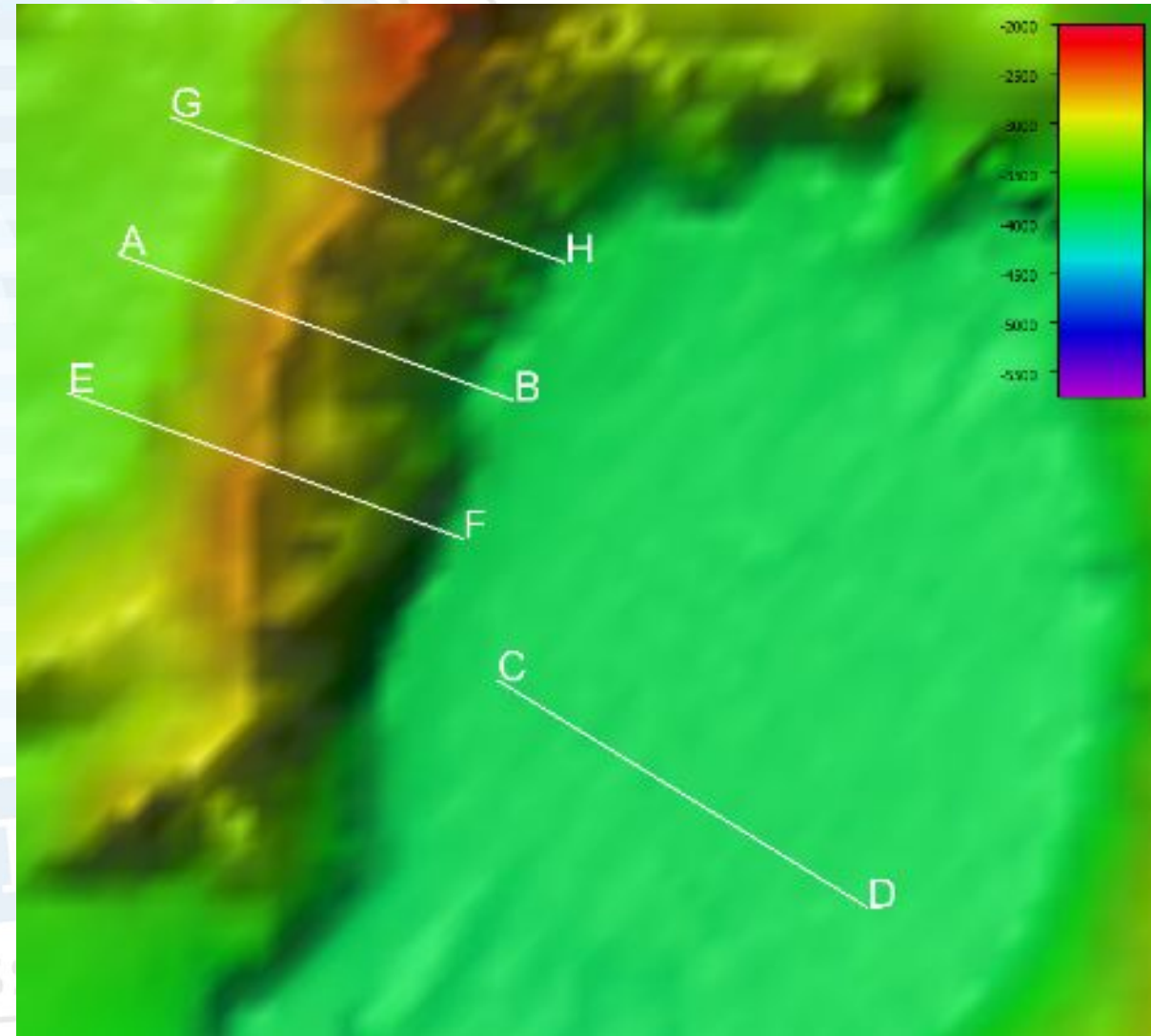


# EM124 Calibration

# Planning

- EM124 calibration planning took advantage of a deepwater ridge feature with suitable slopes and relief near the intended cruise track; waypoints and settings are available at [Pacific Sulu Sea EM124 calibration](#)

|           | Waypoint | Decimal Degrees |            | Degrees Decimal Minutes |           |           |           |
|-----------|----------|-----------------|------------|-------------------------|-----------|-----------|-----------|
|           |          | Lat.            | Lon.       | Lat. Deg.               | Lat. Min. | Lon. Deg. | Lon. Min. |
| Pitch     | A        | 9.104782        | 120.874883 | 9                       | 6.287     | 120       | 52.493    |
|           | B        | 9.075055        | 120.955506 | 9                       | 4.503     | 120       | 57.330    |
| Roll      | C        | 9.018063        | 120.952140 | 9                       | 1.084     | 120       | 57.128    |
|           | D        | 8.971655        | 121.027752 | 8                       | 58.299    | 121       | 1.665     |
| Heading 1 | E        | 9.076659        | 120.864391 | 9                       | 4.600     | 120       | 51.864    |
|           | F        | 9.046933        | 120.945015 | 9                       | 2.816     | 120       | 56.701    |
| Heading 2 | G        | 9.132904        | 120.885377 | 9                       | 7.974     | 120       | 53.123    |
|           | H        | 9.103178        | 120.965999 | 9                       | 6.191     | 120       | 57.960    |



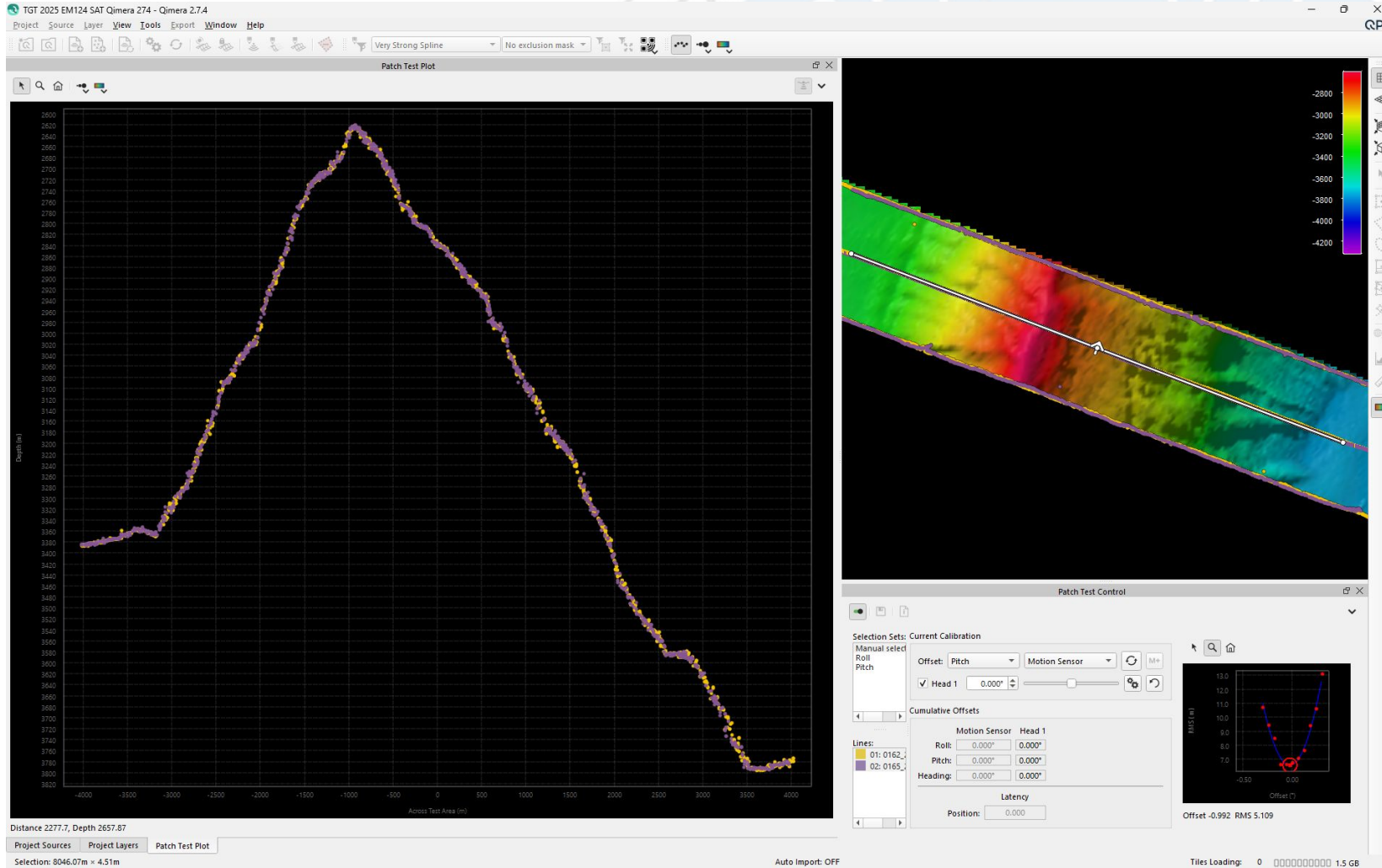
# EM124 Calibration

## Data Collection and Processing

1. Sound speed profiles were acquired with CTDs and XBTs, processed in Sound Speed Manager, and applied in SIS throughout the calibration and verification
2. Calibration data were examined by MAC (in Qimera), Kongsberg (in SIS), and UW and USM personnel (in Qimera) to determine results independently, with group discussion before application in SIS
3. During Qimera analysis, files were processed with nearest-in-time sound speed scheduling, edited to remove outlier / mistracking 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 small and large data subsets
  - b. 'Autosolver' method to confirm minimum RMS differences between suitable subsets
4. These widely documented approaches are repeatable, efficient, and supported by Kongsberg; Qimera processing yielded nearly identical results (typically within  $0.01^\circ$ ) as the on-board processing in SIS by the Kongsberg field engineers and in Qimera by UW and USM personnel
5. The result of each calibration step was updated in the *SIS Installation Parameters* prior to data collection of the subsequent test (e.g., applying the pitch result before roll calibration, and roll result before heading calibration)
6. Results were acceptably small with the exception of POS MV (Attitude 1) heading and Seapath (Attitude 2) roll; these relatively high results suggest that additional follow-up is warranted with the surveyor to confirm IMU and MRU mounting angles, as well as confirmation with Kongsberg for MRU mounting wizard results
7. Final results applied in the EM124 should remain unchanged until sensors are modified, the next routine assessment, or the sensor offset survey is updated by OSA and additional time is available for re-calibration

# EM124 Calibration

## Results: Pitch (**POS MV**)

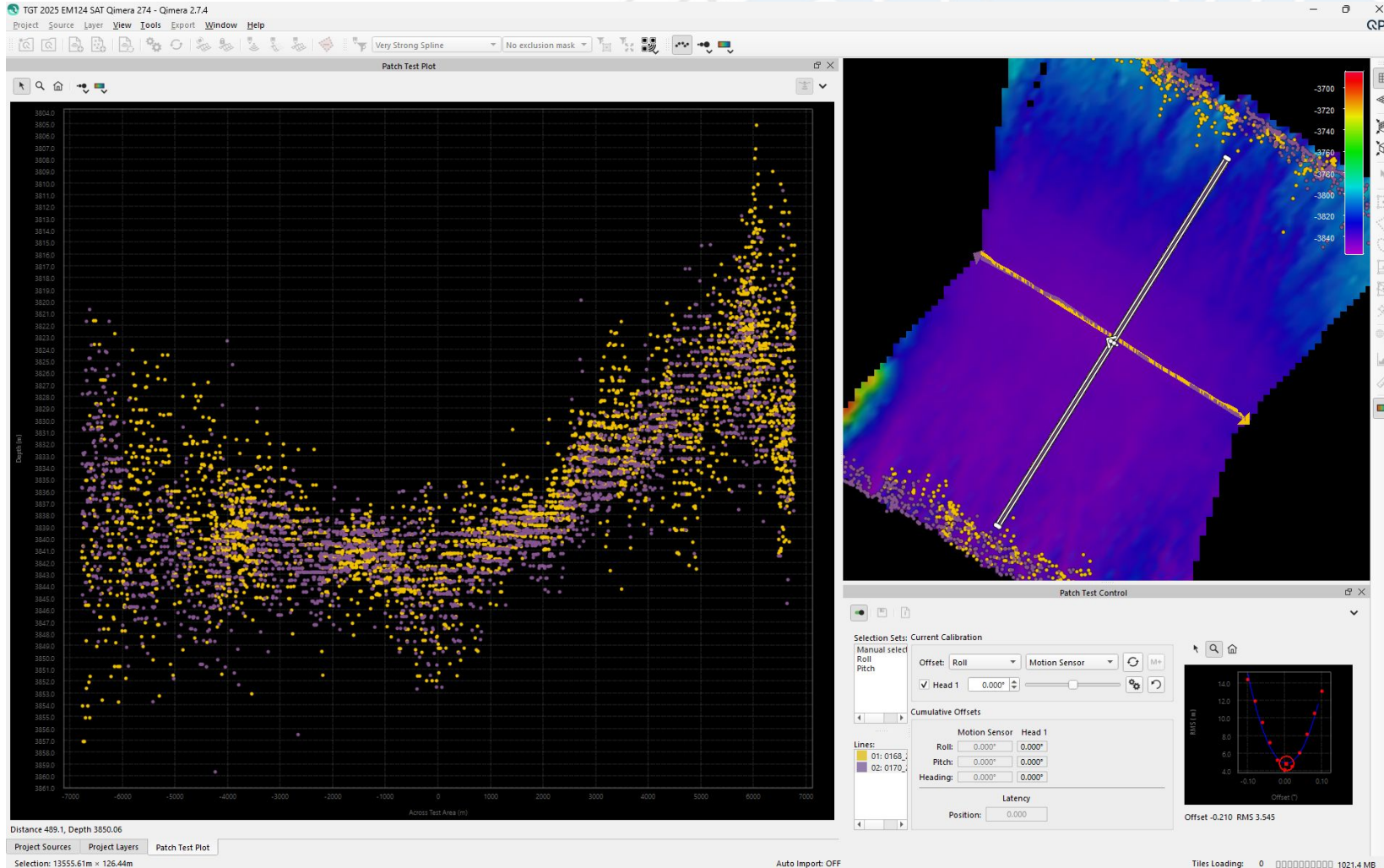


Pitch verification lines shown at left in the Qimera Patch Test Tool

1. Attitude 1 initial setting:  $0.00^\circ$
2. Calibration adjustment:  $-0.02^\circ$
3. Verification adjustment:  $-0.01^\circ$
4. **Final offset:  $-0.03^\circ$  in SIS**

# EM124 Calibration

## Results: Roll (**POS MV**)



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

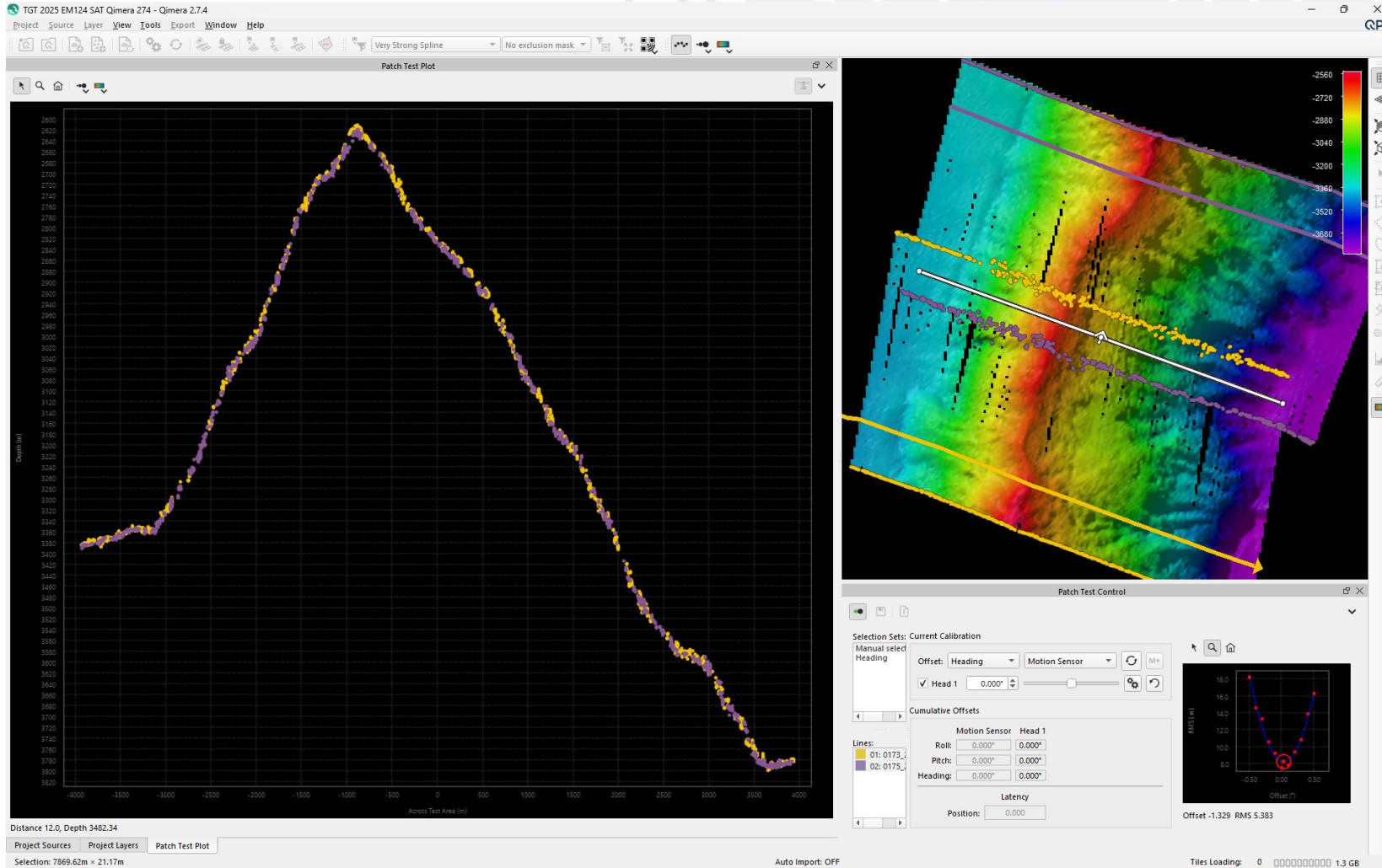
1. Attitude 1 initial setting:  $0.00^\circ$
2. Calibration adjustment:  $-0.13^\circ$
3. Verification adjustment:  $0.00^\circ$
4. **Final offset:  $-0.13^\circ$  in SIS**

**Note: small and large subsets were used for processing in SIS and Qimera**

**Left subplot: ~250X vertical exaggeration**

# EM124 Calibration

## Results: Heading (**POS MV**)

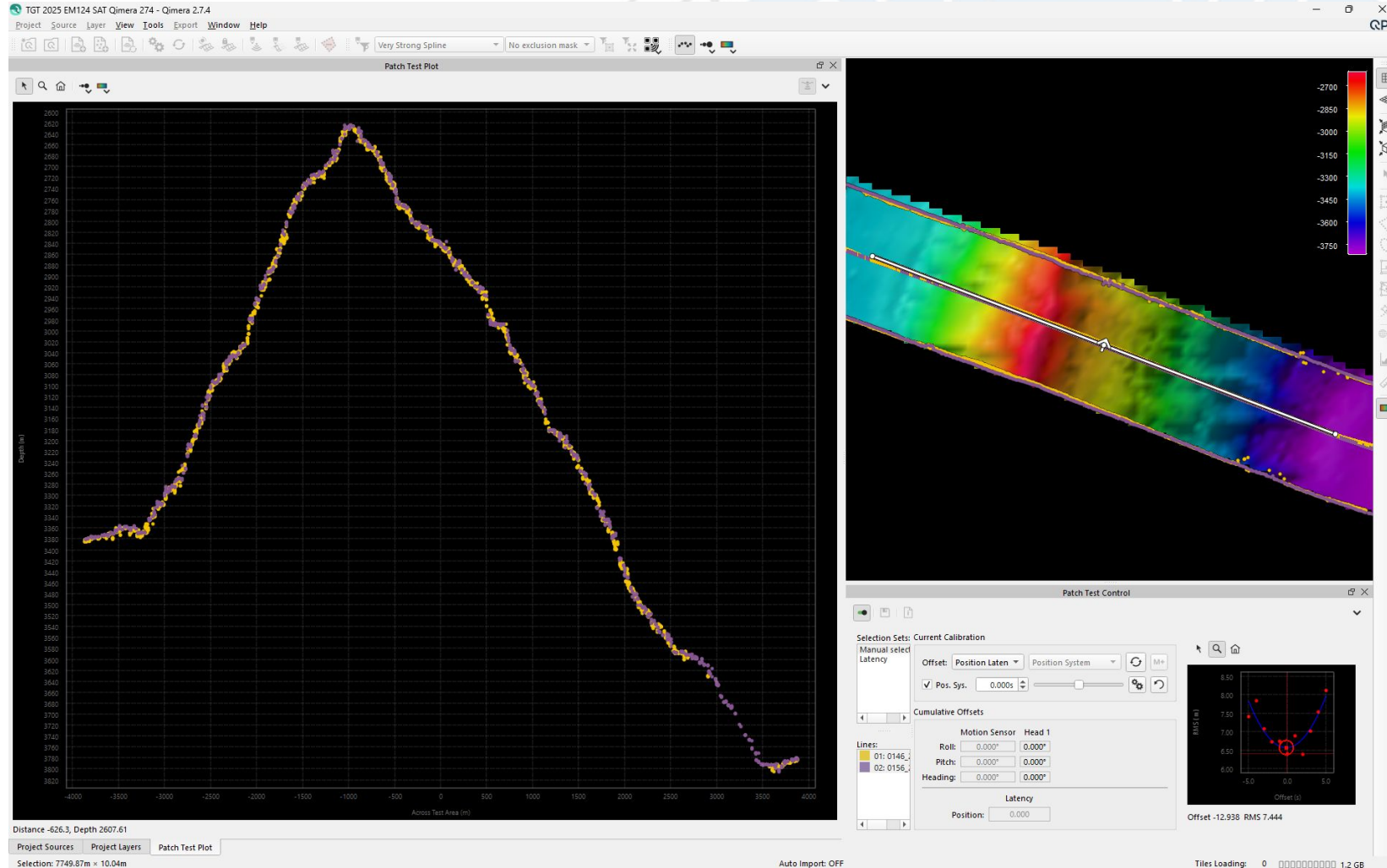


Heading verification lines shown at left in the Qimera Patch Test Tool

1. Attitude 1 initial setting:  $0.00^\circ$
2. Calibration adjustment:  $+0.68^\circ$
3. Verification adjustment:  $-0.05^\circ$
4. **Final offset:  $+0.63^\circ$  in SIS**

# EM124 Calibration

## Results: Latency (**POS MV**)



Latency check lines shown at left in the Qimera Patch Test Tool

This check was performed for completeness, although it is unlikely that a small position latency would be detectable in deep water

No obvious position or attitude latency issues were observed during the EM124 SAT

# EM124 Calibration

# Post-Calibration Configuration

## POST-CALIBRATION (POS MV)

1. The final EM124 *Attitude 1* (POS MV) adjustments are acceptably small for pitch and roll, suggesting accurate vessel survey results and consistent sensor integration for these parameters
2. POS MV IMU heading should be verified by OSA and the IMU mounting wizard results should be checked by Applanix; no changes should be made until a suitable opportunity is available for re-calibration with an updated POS MV configuration
3. The *Installation Parameters: Angular Offsets* shown at left should be maintained until any modification is made to the EM124 or POS MV, or a new calibration becomes necessary for other reasons

The device is pinging.  
No changes to installation parameters are possible.

| System            | Configuration      | Port       | Status    |
|-------------------|--------------------|------------|-----------|
| Position system 1 | POSMV Pos          | Net port 1 | ACTIVE-OK |
| Position system 2 | SEPATH POS         | Net port 2 | OK        |
| Position system 3 | Seapath Pos Serial | No         | GGA       |
| Attitude system 1 | POSMV Att          | Net port 5 | ACTIVE-OK |

NAME: POSMV Att

LOCATION OFFSET FORWARD, X: 0.000    LOCATION OFFSET STARBOARD, Y: 0.000    LOCATION OFFSET DOWNWARD, Z: 0.000

ANGULAR OFFSET ROLL: -0.130    ANGULAR OFFSET PITCH: -0.030    ANGULAR OFFSET HEADING: 0.630

ROLL REFERENCE PLANE: Rotation

FORMAT: POS MV GRP 102/103

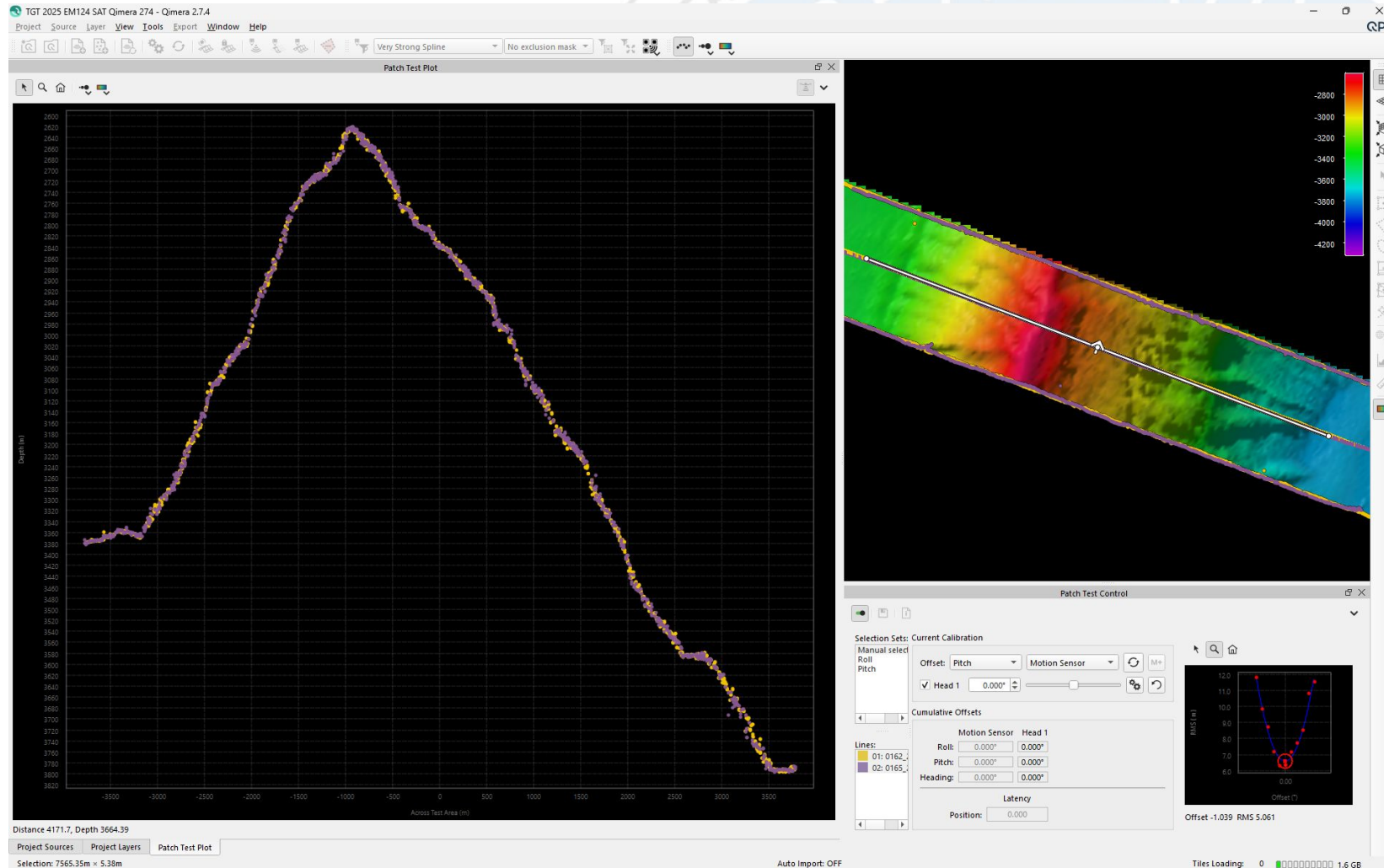
INPUT: Net port 5

Second net

5602

# EM124 Calibration

## Results: Pitch (**Seapath**)

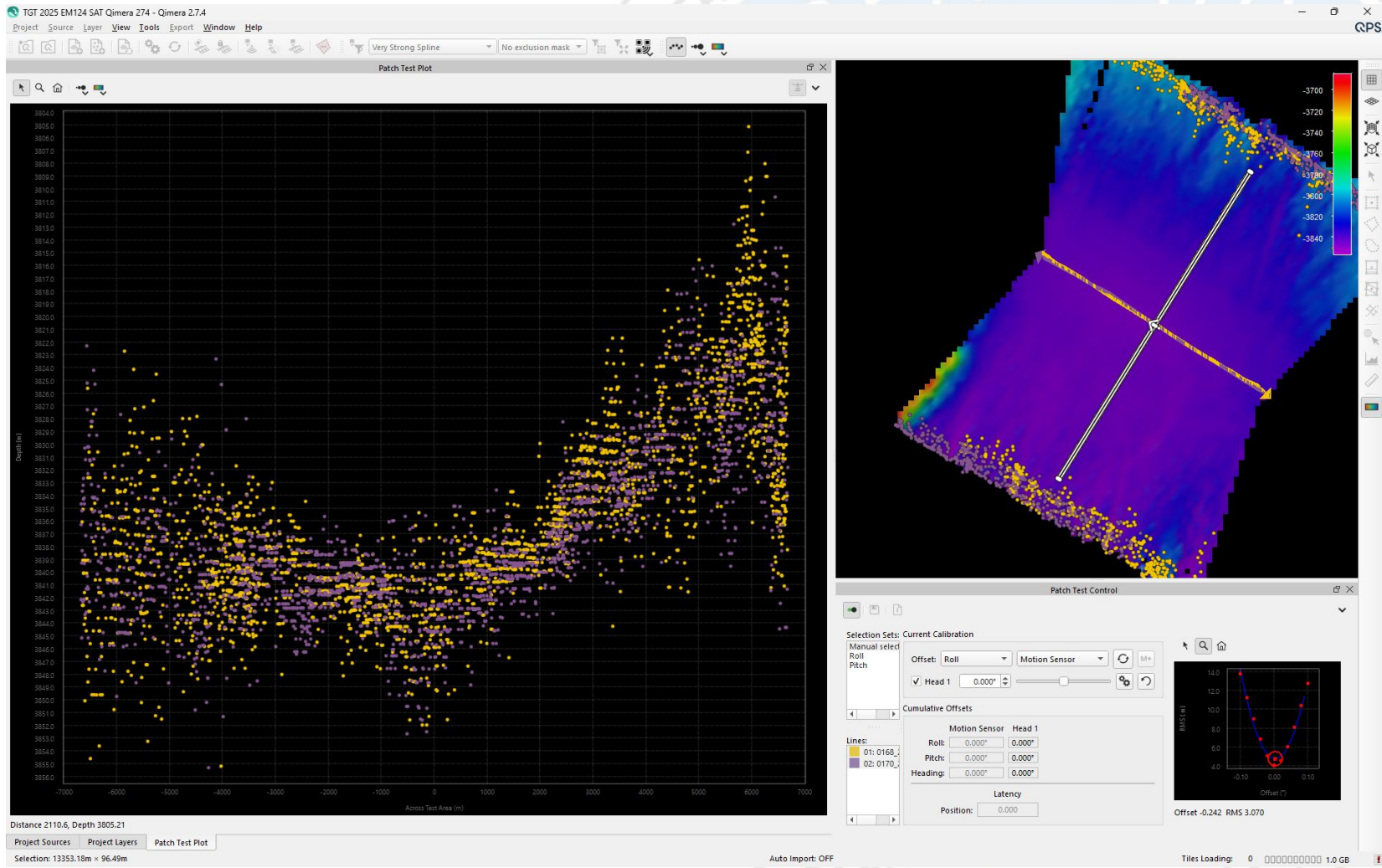


Pitch verification lines shown at left in the Qimera Patch Test Tool

1. Attitude 2 initial setting:  $0.00^\circ$
2. Calibration adjustment:  $-0.14^\circ$
3. Verification adjustment:  $+0.01^\circ$
4. **Final offset:  $-0.13^\circ$  in SIS**

# EM124 Calibration

# Results: Roll (**Seapath**)



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

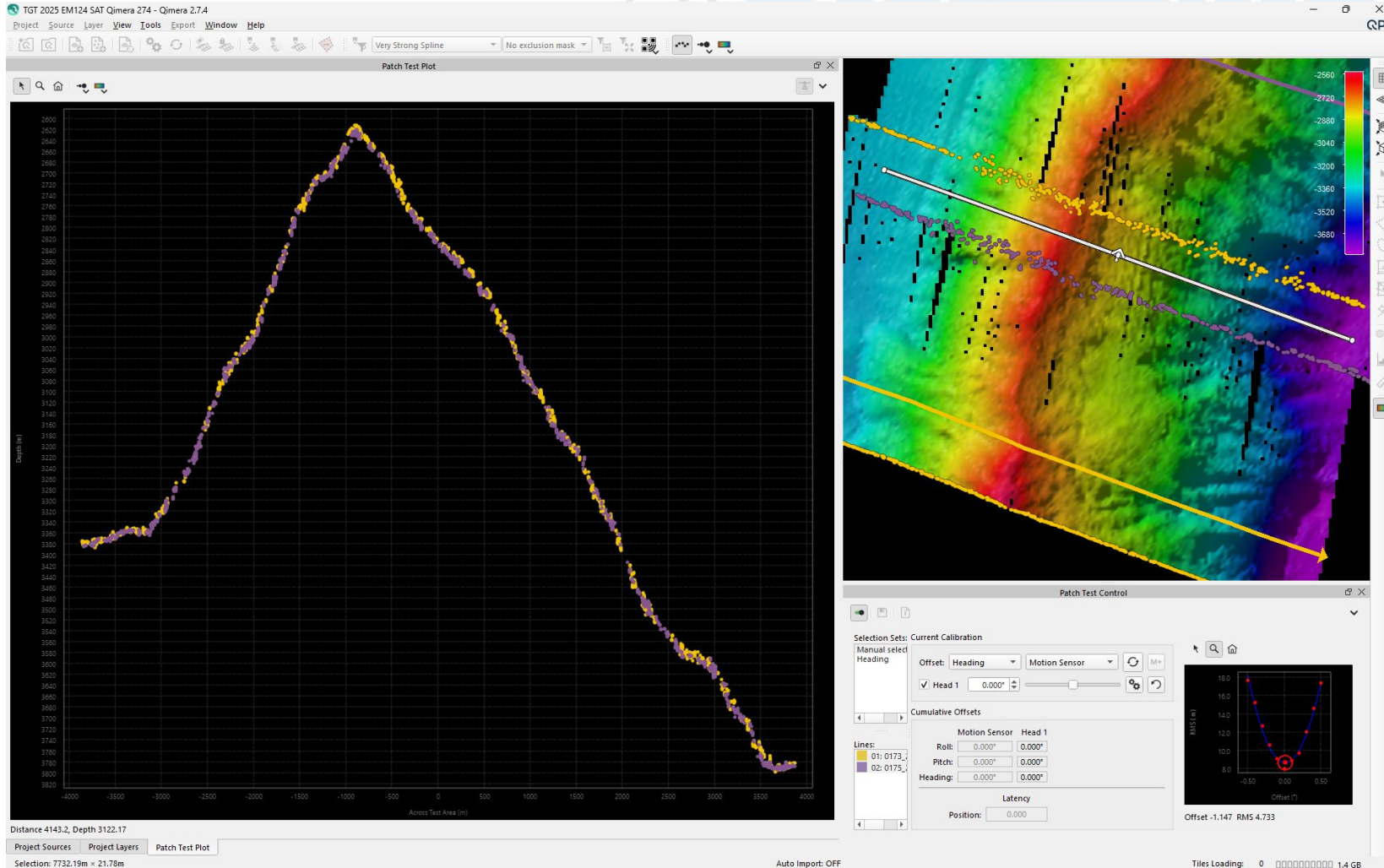
1. Attitude 2 initial setting:  $0.00^\circ$
2. Calibration adjustment:  $+0.38^\circ$
3. Verification adjustment:  $+0.01^\circ$
4. **Final offset:  $+0.39^\circ$  in SIS**

**Note: small and large subsets were used for processing in SIS and Qimera**

**Left subplot: ~250X vertical exaggeration**

# EM124 Calibration

## Results: Heading (**Seapath**)

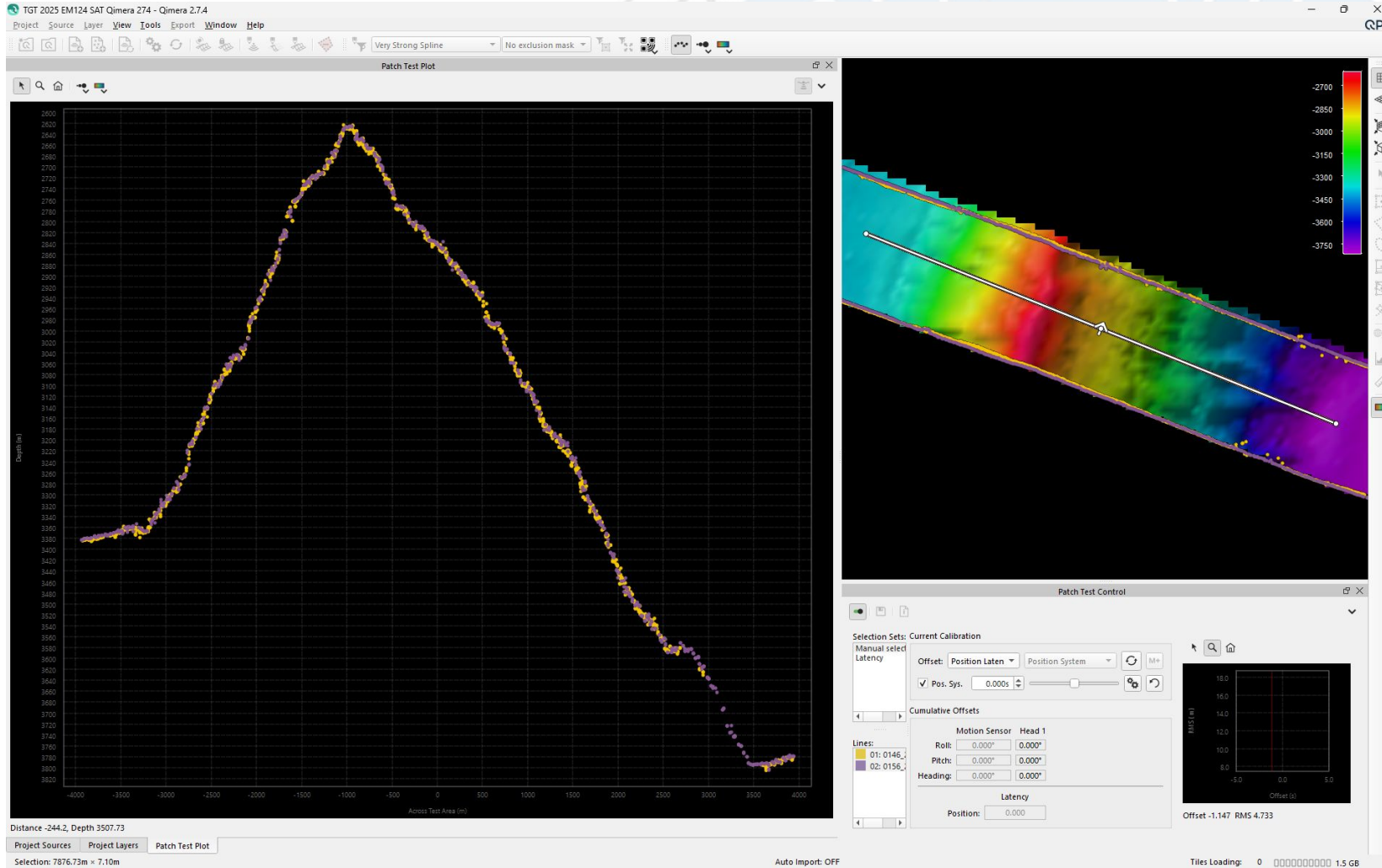


Heading verification lines shown at left in the Qimera Patch Test Tool

1. Attitude 2 initial setting:  $0.00^\circ$
2. Calibration adjustment:  $-0.20^\circ$
3. Verification adjustment:  $-0.03^\circ$
4. **Final offset:  $-0.23^\circ$  in SIS**

# EM124 Calibration

## Results: Latency (**Seapath**)



Latency check lines shown at left in the Qimera Patch Test Tool

This check was performed for completeness, although it is unlikely that a small position latency would be detectable in deep water

No obvious position or attitude latency issues were observed during the EM124 SAT

# EM124 Calibration

# Post-Calibration Configuration

## POST-CALIBRATION (Seapath)

1. The final EM124 *Attitude 2* (Seapath) adjustments are acceptably small for pitch and heading, suggesting accurate vessel survey results and consistent sensor integration for these parameters
2. Seapath MRU roll should be verified by OSA and the MRU mounting wizard results should be confirmed by Kongsberg; no changes should be made until a suitable opportunity is available for re-calibration with an updated Seapath configuration
3. The *Installation Parameters: Angular Offsets* shown at left should be maintained until any modification is made to the EM124 or Seapath, or a new calibration becomes necessary for other reasons

| System            | Device             | Port       | Status    |
|-------------------|--------------------|------------|-----------|
| Position system 1 | POSMV Pos          | Net port 1 | ACTIVE-OK |
| Position system 2 | SEPATH POS         | Net port 2 | OK        |
| Position system 3 | Seapath Pos Serial | No         | GGA       |
| Attitude system 1 | POSMV Att          | Net port 5 | ACTIVE-OK |
| Attitude system 2 | SEPATH Att         | Net port 4 | OK        |

|                            |                              |                             |  |
|----------------------------|------------------------------|-----------------------------|--|
| NAME:                      | SEPATH Att                   |                             |  |
| LOCATION OFFSET FORWARD, X | LOCATION OFFSET STARBOARD, Y | LOCATION OFFSET DOWNWARD, Z |  |
| 0.000                      | 0.000                        | 0.000                       |  |
| ANGULAR OFFSET ROLL        | ANGULAR OFFSET PITCH         | ANGULAR OFFSET HEADING      |  |
| 0.390                      | -0.130                       | -0.230                      |  |
| ROLL REFERENCE PLANE       | Rotation                     |                             |  |
| FORMAT                     | KM Binary                    |                             |  |
| INPUT                      | Net port 4                   |                             |  |
| Second net                 | 13004                        |                             |  |

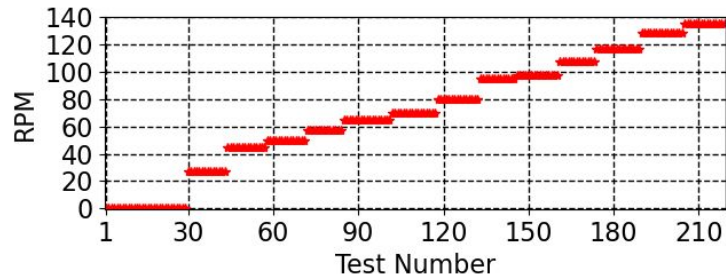
# RX Noise Testing



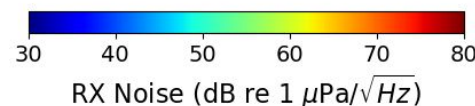
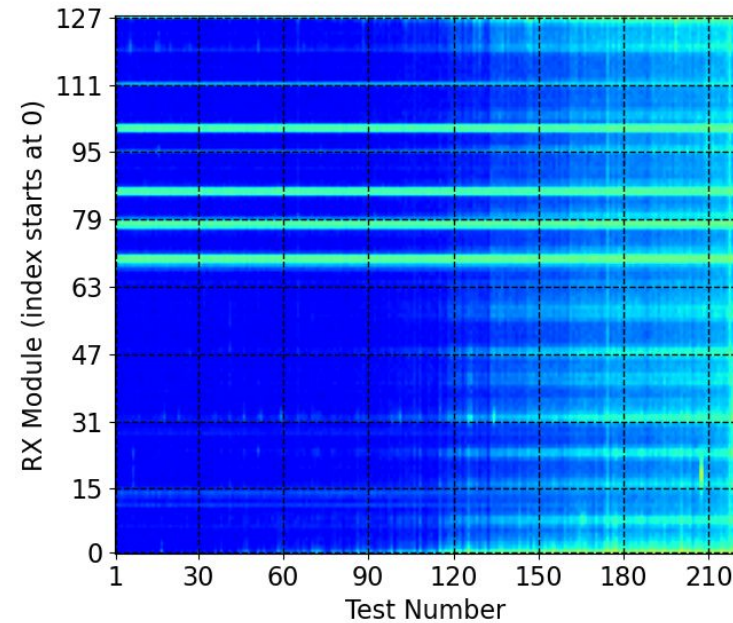
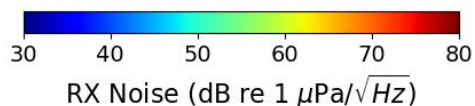
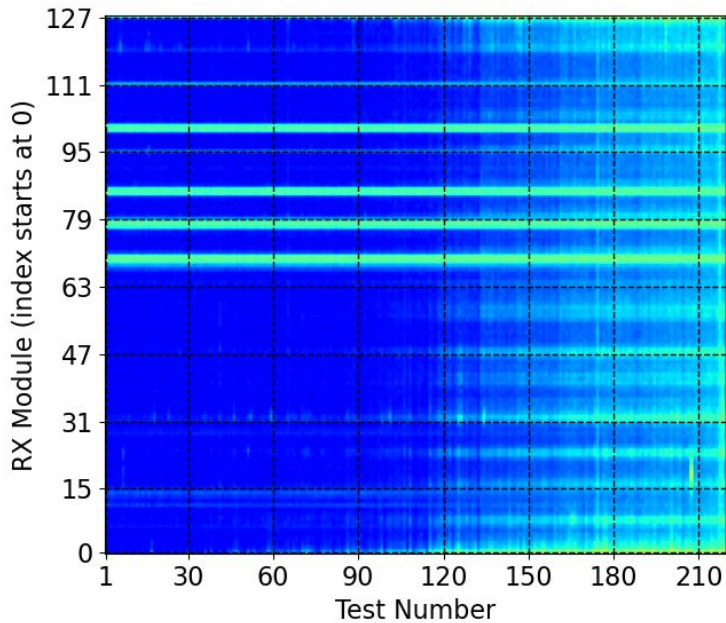
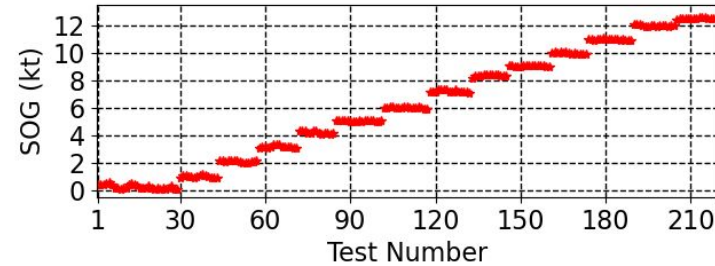
# RX Noise BIST Assessment

# Noise Level vs. Throttle and Speed

RX Noise vs. Speed  
EM124 (S/N 10055)  
Date: 2025-12-03  
Freq: 10-14 kHz



RX Noise vs. Speed  
EM124 (S/N 10055)  
Date: 2025-12-03  
Freq: 10-14 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. EM124 RX Noise Built-In Self-Test (BIST) data were logged across a range of speeds, moving incrementally from drifting to maximum speed; the same tests are shown vs. RPM and SOG (left)
3. The EM124 shows relatively low noise levels across the entire speed range, likely owing to improvements with the new gondola and clean hull; comparison to the EM302 historic noise data is not meaningful due to differences in hull shapes and frequency bands
4. Several RX channels show high noise levels across all tests; these channels should be investigated with Kongsberg support to ensure full RX array performance at the start of its service life

# Accuracy Testing



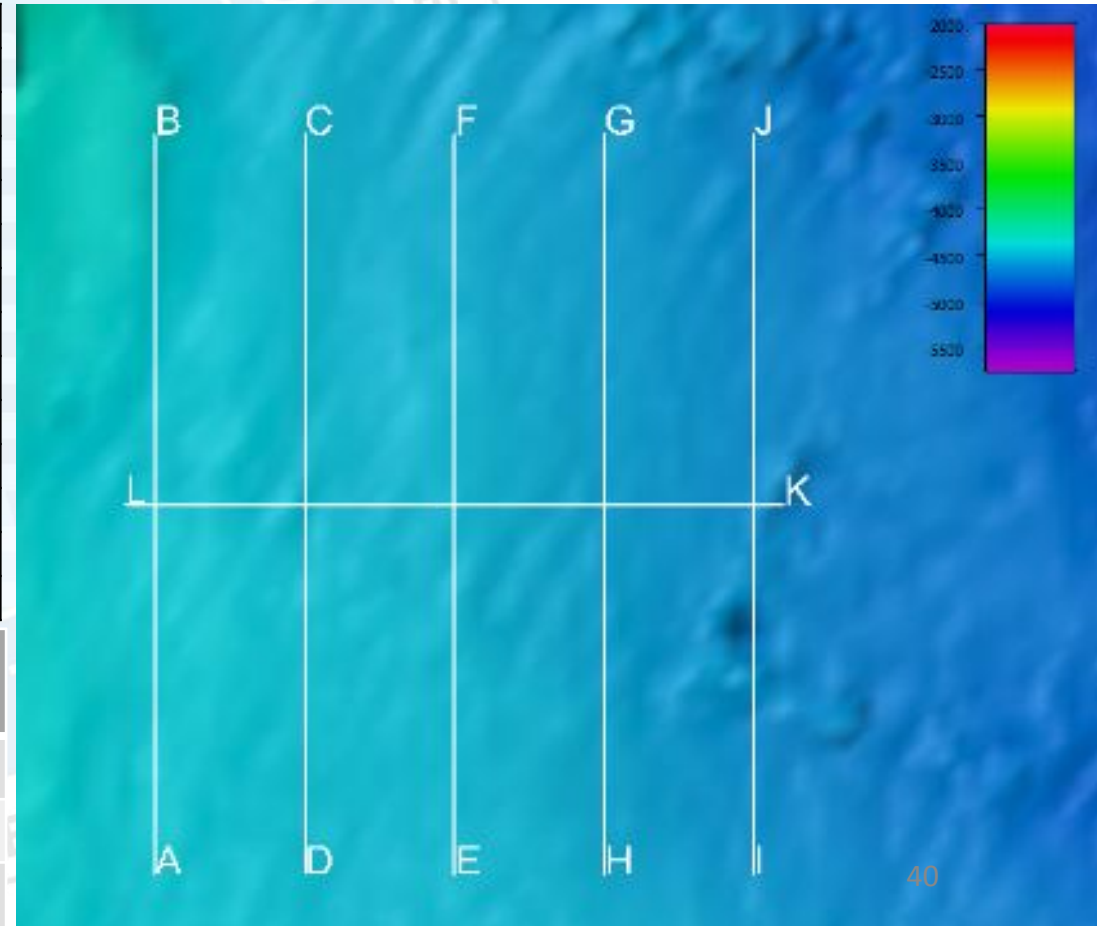
# Accuracy Testing

## 4500 m Overview

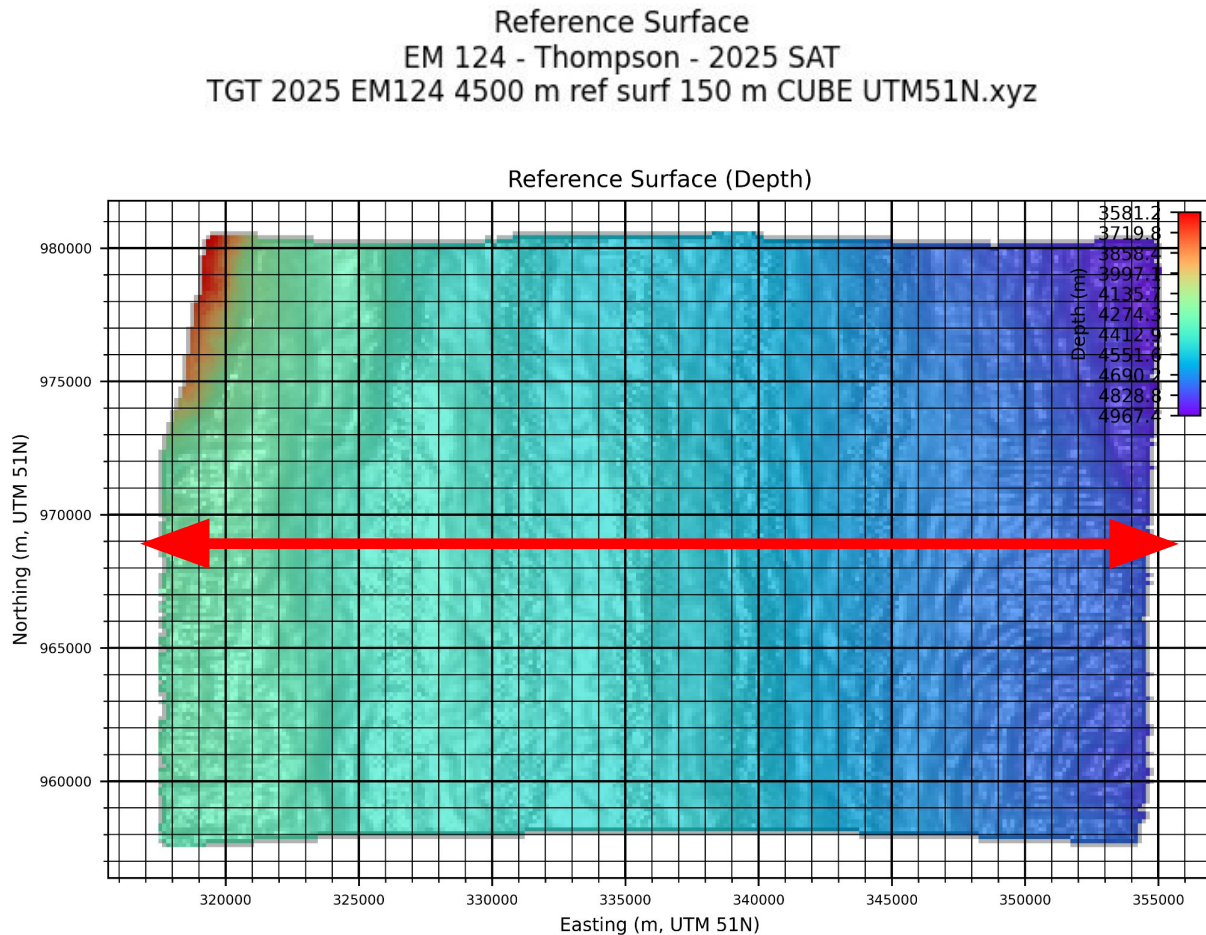
1. Following EM124 calibration, accuracy testing was carried out at a new 4500 m site developed for this SAT; Deeper mode (CW/FM) is the 'default' mode at this depth and was used for reference surface survey
2. Two crossline passes were run in Deeper mode, one with POS MV and one with Seapath applied in real time
3. See [Pacific Sulu Sea accuracy 4500 m](#) for settings and waypoints in multiple formats

|           | Waypoint | Decimal Degrees |            | Degrees Decimal Minutes |           |           |           |
|-----------|----------|-----------------|------------|-------------------------|-----------|-----------|-----------|
|           |          | Lat.            | Lon.       | Lat. Deg.               | Lat. Min. | Lon. Deg. | Lon. Min. |
| Line 1    | A        | 8.663958        | 121.422184 | 8                       | 39.838    | 121       | 25.331    |
|           | B        | 8.866030        | 121.422184 | 8                       | 51.962    | 121       | 25.331    |
| Line 2    | C        | 8.866036        | 121.463136 | 8                       | 51.962    | 121       | 27.788    |
|           | D        | 8.663965        | 121.463136 | 8                       | 39.838    | 121       | 27.788    |
| Line 3    | E        | 8.663967        | 121.504088 | 8                       | 39.838    | 121       | 30.245    |
|           | F        | 8.866038        | 121.504088 | 8                       | 51.962    | 121       | 30.245    |
| Line 4    | G        | 8.866036        | 121.545040 | 8                       | 51.962    | 121       | 32.702    |
|           | H        | 8.663965        | 121.545040 | 8                       | 39.838    | 121       | 32.702    |
| Line 5    | I        | 8.663958        | 121.585992 | 8                       | 39.838    | 121       | 35.160    |
|           | J        | 8.866030        | 121.585992 | 8                       | 51.962    | 121       | 35.160    |
| Crossline | K        | 8.764996        | 121.594182 | 8                       | 45.900    | 121       | 35.651    |
|           | L        | 8.764992        | 121.413994 | 8                       | 45.900    | 121       | 24.840    |

| Crossline Setting | Depth Mode | Swath Mode | Pulse Form | Yaw Stabilization <sup>1</sup> | Navigation Source |
|-------------------|------------|------------|------------|--------------------------------|-------------------|
| Reference         | Deeper     | Dual       | CW/FM Mix  | Rel. Mean Hdg.                 | POS MV            |
| 1                 | Deeper     | Dual       | CW/FM Mix  | Rel. Mean Hdg.                 | POS MV            |
| 2                 | Deeper     | Dual       | CW/FM Mix  | Rel. Mean Hdg.                 | Seapath           |



# Accuracy Testing

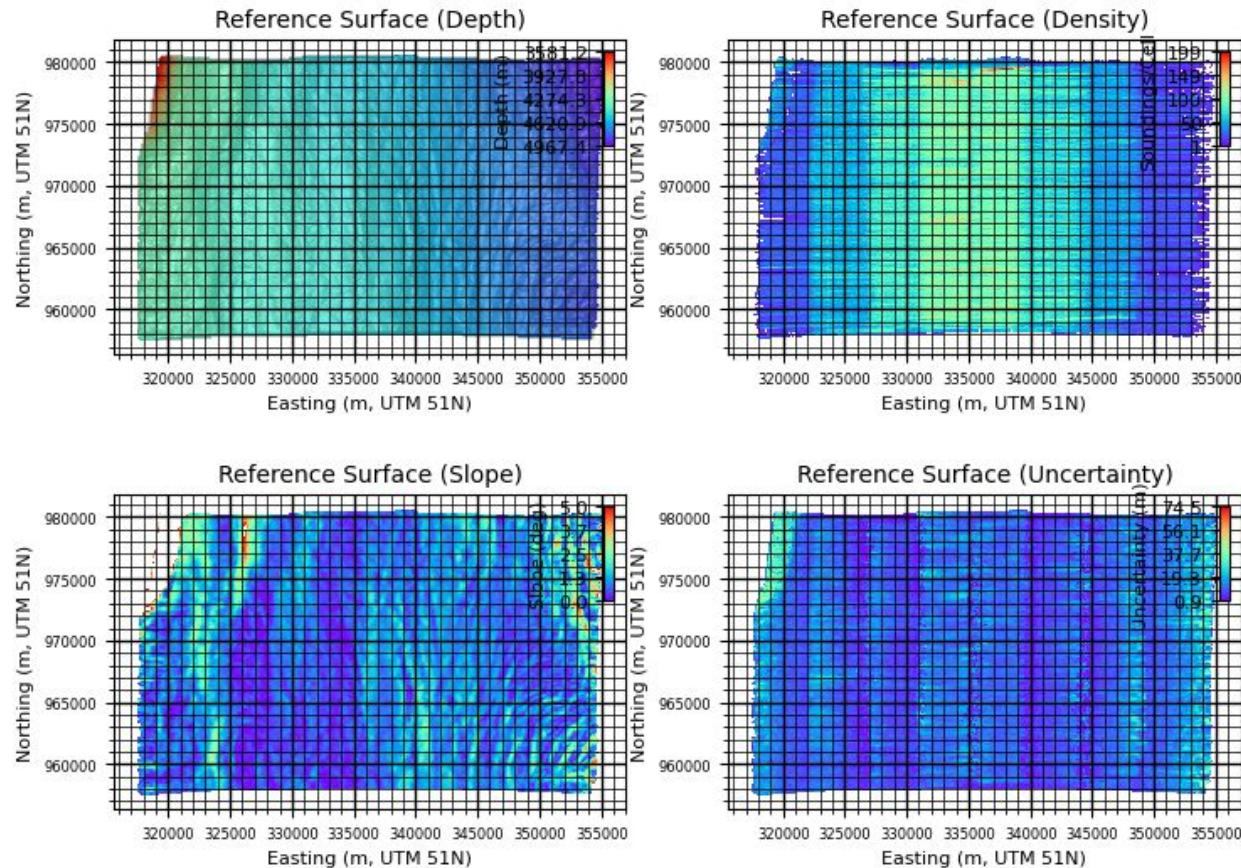


# Testing Procedure

1. Swath accuracy (i.e., self-consistency) and sounding distributions were assessed by surveying a reference surface and running crosslines (e.g., red line) in typical modes appropriate for each depth range
2. A single accuracy test site was developed at the deepest accessible region, using suitable terrain within transit route and schedule constraints, in order to prioritize Deeper (CW/FM) mode and verify FM-enabled behavior in this target depth range
3. The crossline was oriented to maximize coverage across the reference surface; this line was oriented orthogonal to the reference surface survey lines in order to reduce any potential coupling of echosounder biases across the swath
4. Sound speed profiles were collected and applied in SIS during data collection (with 'nearest in time' scheduling during reference surface processing)

# Accuracy Testing

Reference Surface  
EM 124 - Thompson - 2025 SAT  
TGT 2025 EM124 4500 m ref surf 150 m CUBE UTM51N.xyz

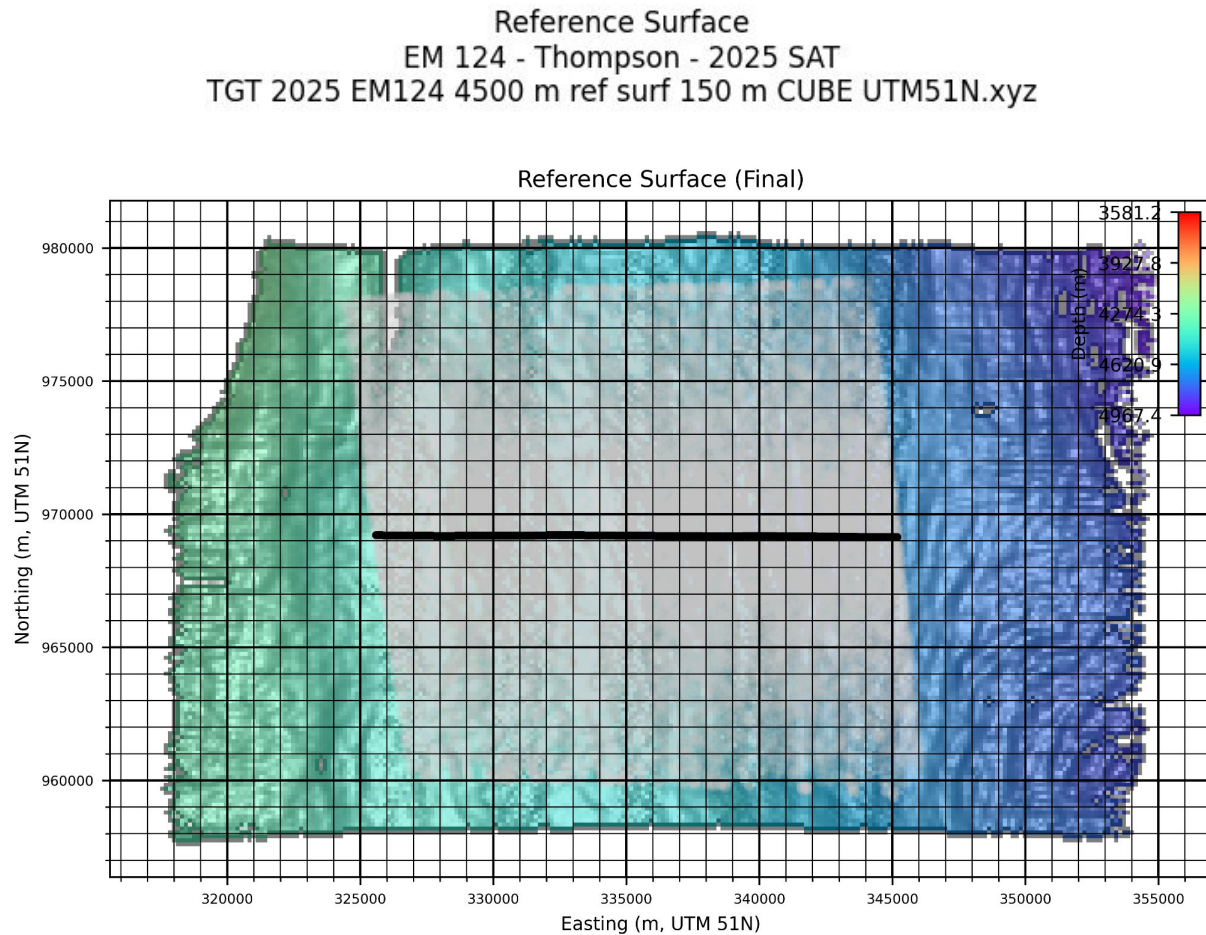


# Testing Procedure

- No tide was applied in processing, as the tidal amplitude is typically <1 m (insignificant at 4500 m)
- The reference surface was gridded with the CUBE algorithm in QPS Qimera at an appropriate resolution, then filtered by slope, sounding density, and uncertainty in the [MAC accuracy plotter app](#)
- Only reference surface cells meeting the slope, density, uncertainty criteria outlined below were used for analyses of crossline data (e.g., see filtered reference surface example on next slide)

| Ref. Surface               | 4500 m |
|----------------------------|--------|
| Mean Depth (m)             | 4500   |
| Grid size (m)              | 150    |
| Min. soundings/cell        | 5      |
| Max. slope (deg)           | 3      |
| Max. uncertainty (m)       | 30     |
| Crossline max. diff. (%WD) | 5      |

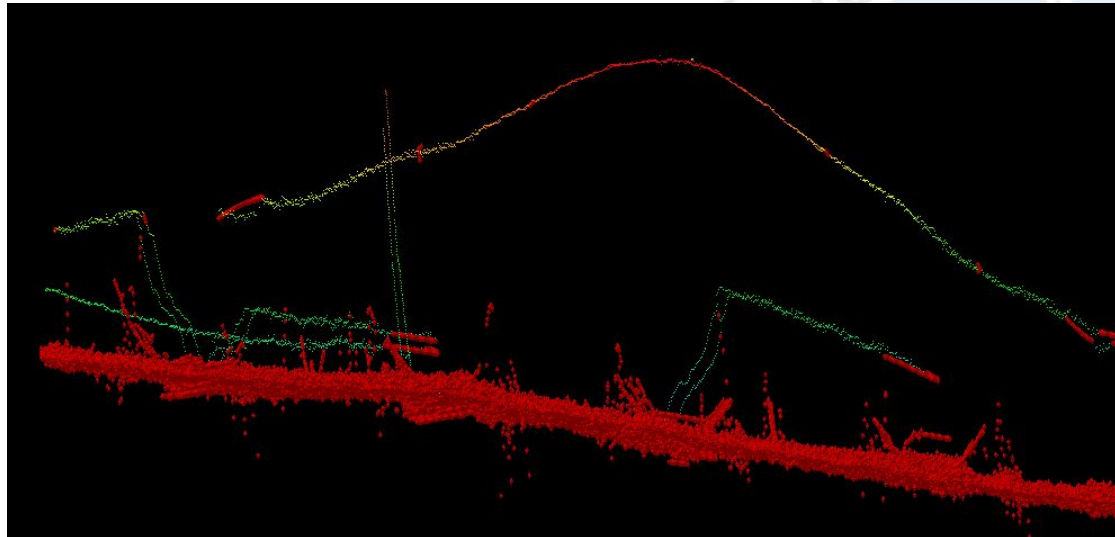
# Accuracy Testing



# Testing Procedure

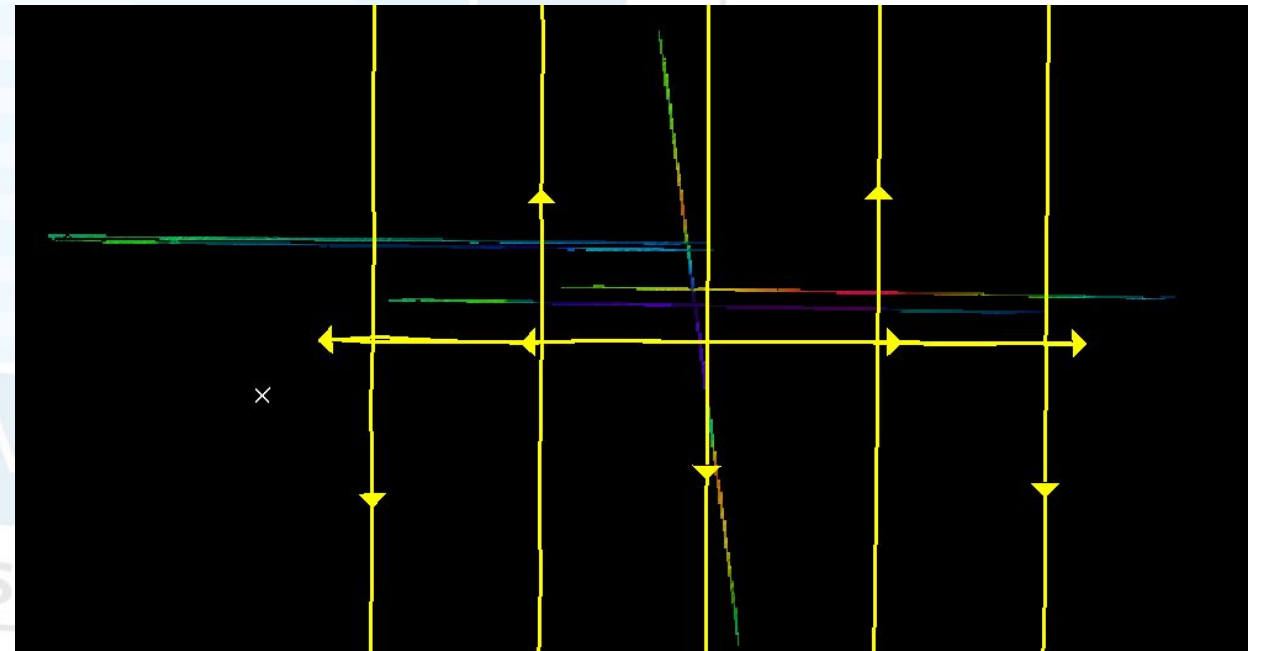
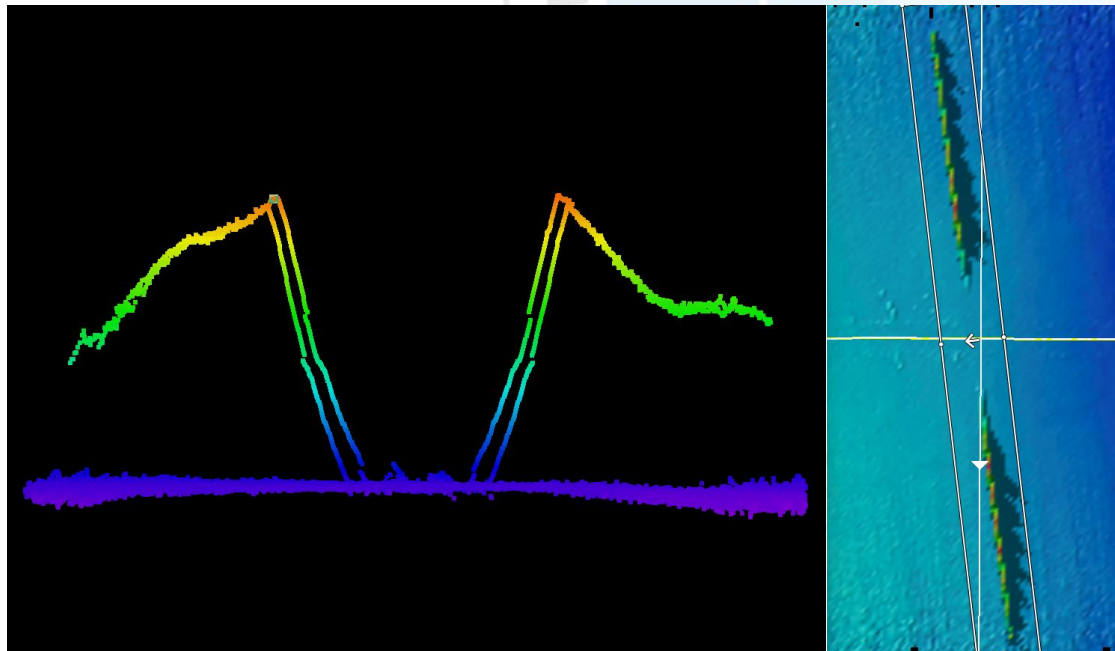
8. The filtered reference surface (final grid used for comparison) is shown with coverage for crossline 1
9. Examples of individual reference grid filter results are shown on preceding and following slides
10. Crossline soundings (e.g., gray points at left; track line in black) were filtered to remove outliers that are not representative of the near-seafloor swath behavior and would be readily flagged during routine processing; other systemic behaviors of the echosounder were not edited or impacted by this depth difference filter
11. Sounding depths were compared to reference grid depths (interpolated onto the sounding horizontal position); depth bias means and standard deviations were then computed in  $1^\circ$  angular bins across the swath for each configuration and presented as a percentage of water depth (see following slides)

# Accuracy Testing

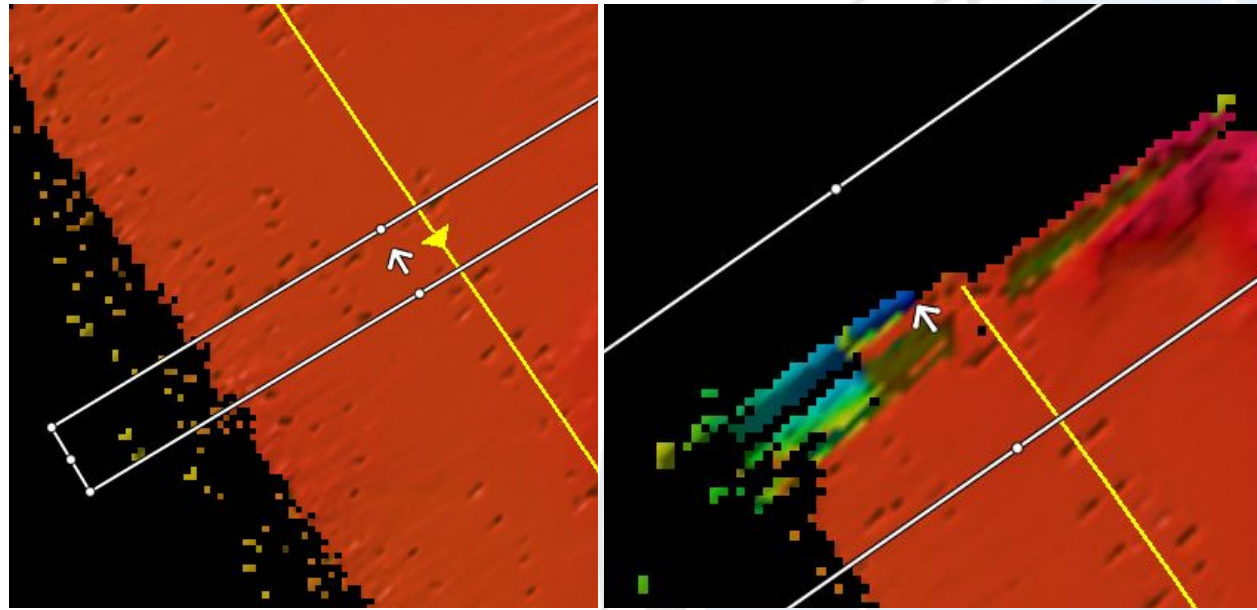


## Ref Surface and Crossline Outliers

1. Accuracy test data collection was complicated by occasional outlier swaths from an unknown cause; selected examples are isolated in Qimera 3D Editor (left) and plan view (below)
2. Outliers were removed manually from the reference surface in Qimera processing; however, the Accuracy Plotter does not offer manual editing for crosslines and relies on a difference filter (e.g.,  $>5\%$  WD from the ref surface) to remove outliers during plotting

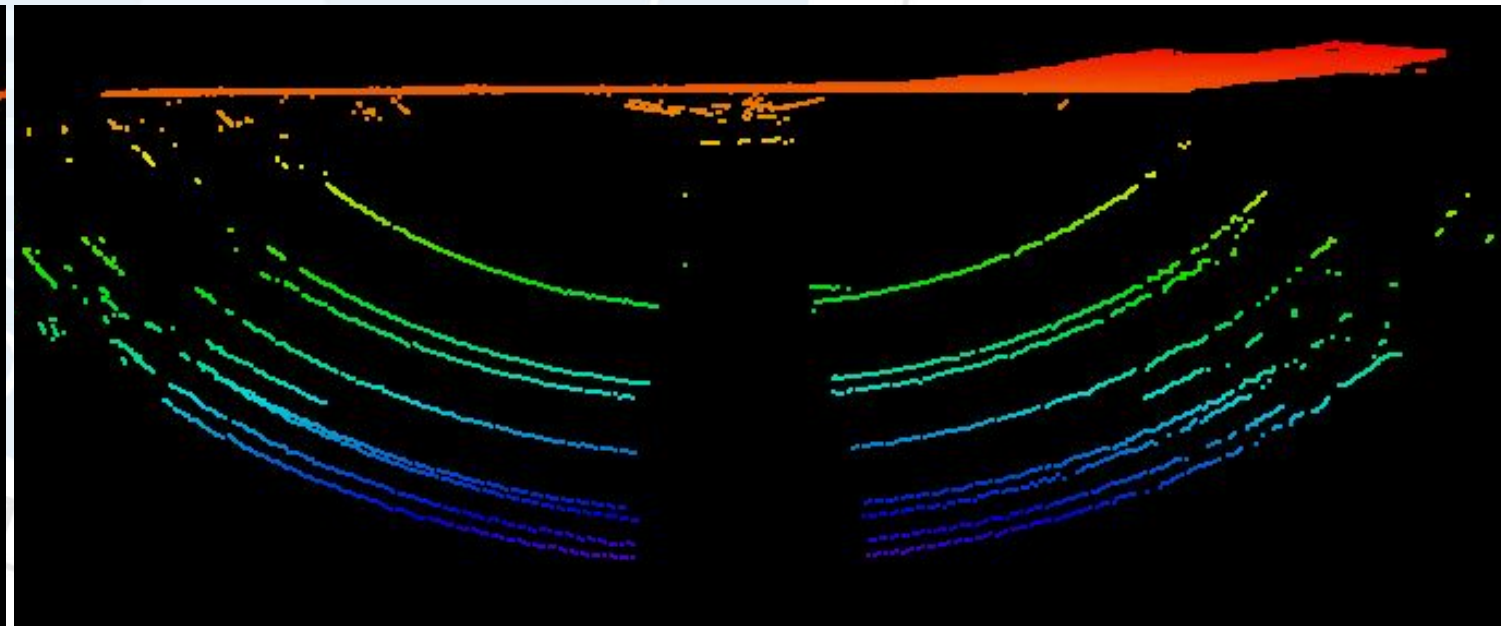
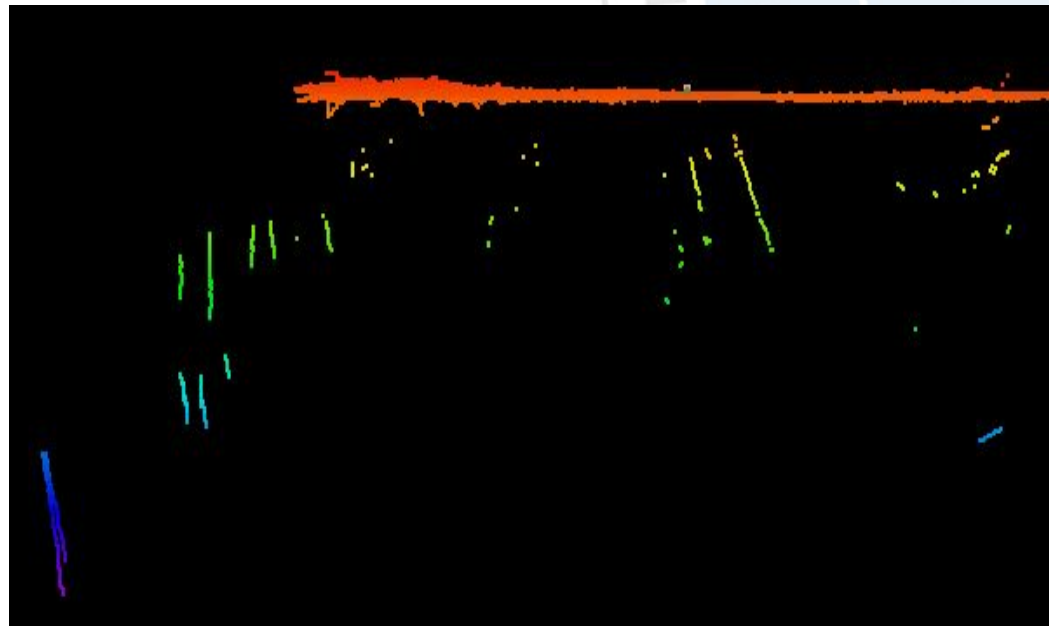


# Accuracy Testing



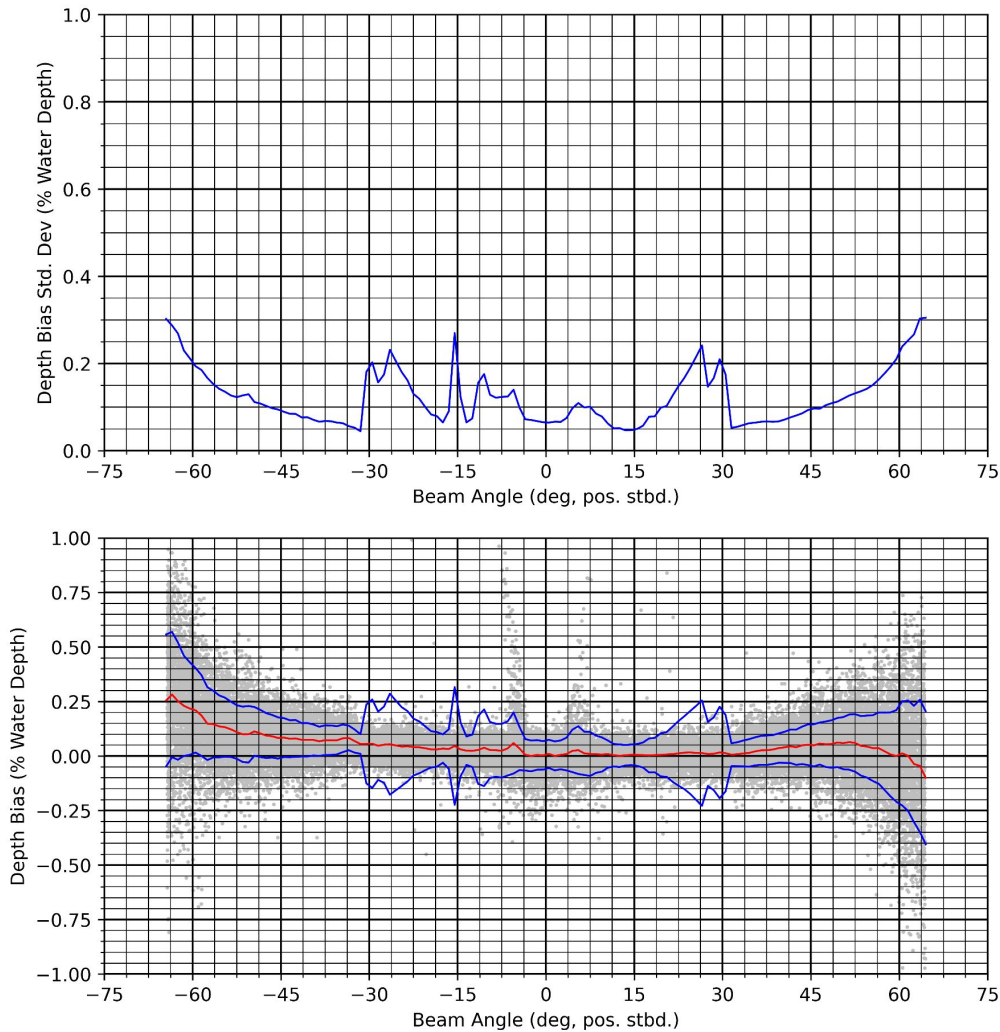
# Other Interference Sources

1. Severe interference was noted during transits, manifesting as 'bad data' in the outer swath and sub-bottom 'rings' (shown here in Qimera 3D Editor)
2. Interference was ultimately traced to the bridge's Doppler speed log and eliminated during testing
3. While this complication was resolved prior to the accuracy testing, and did not impact results, it is highlighted here for awareness and to build on the theme of outlier swaths on the previous slide



# Accuracy Testing

## Results Overview

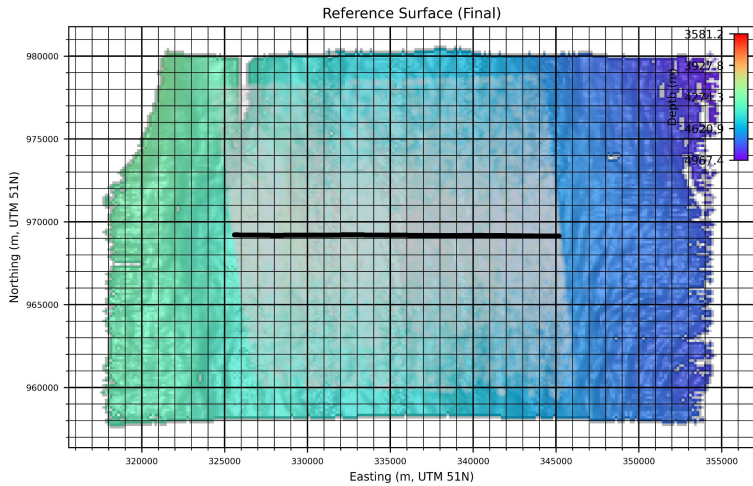


1. Results shown on the following slides present the 'default' settings for this depth yaw stabilization (rel. mean heading), and dual-swath (dynamic) enabled; results are presented for both available navigation sources (POS MV and Seapath) applied in real time
2. The results for crossline pass 1 (POS MV) are impacted by a single outlier ping cycle (see previous slide); the root cause of this behavior, observed occasionally throughout the 4500 m accuracy testing, should be investigated with Kongsberg support
3. To a lesser degree, small refraction artifacts appear that generally 'lift' the outer sectors of the crosslines; despite routine sound speed profiling, these refraction artifacts may be related to very large internal waves known to propagate throughout the Sulu Sea (e.g., [The Sulu Sea Internal Soliton Experiment](#))

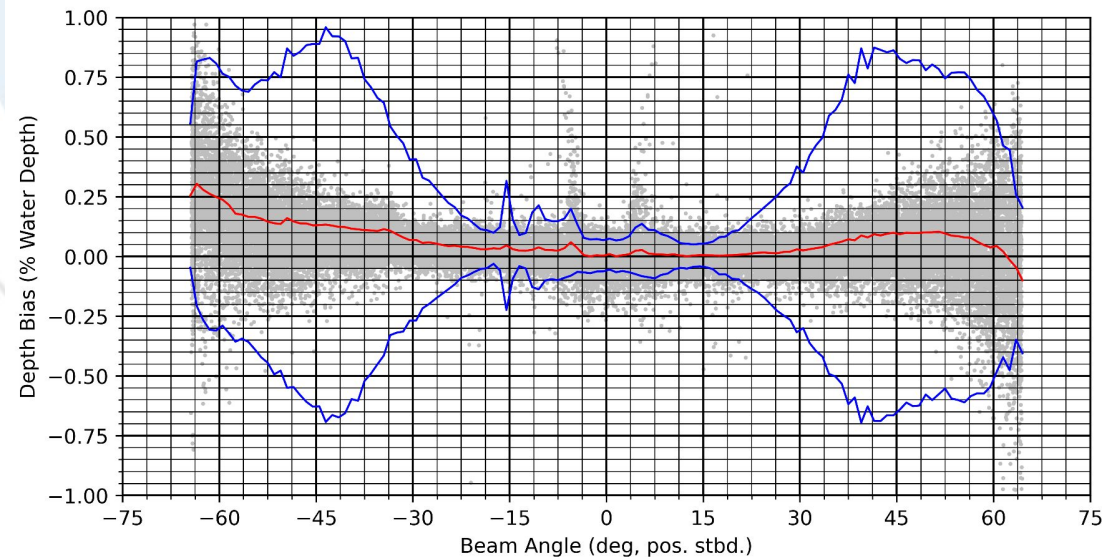
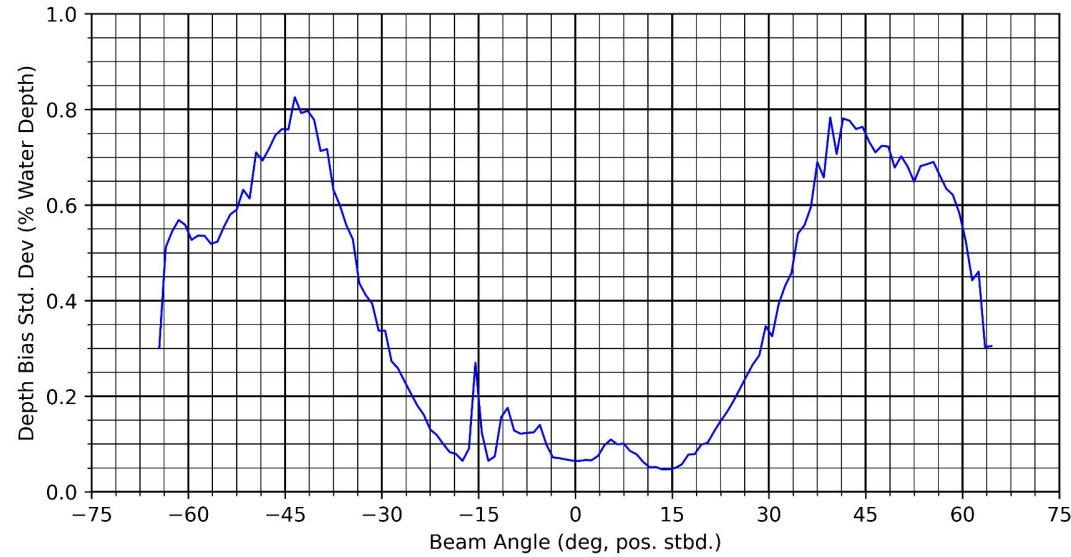
Example of swath accuracy as a percentage of water depth  
Results for each setting are presented in the following slides

# EM124 Accuracy Testing

# 4500 m: Deeper/Dual/Mix/RMH/POS MV



Swath Accuracy vs. Beam Angle  
EM 124 - Thompson - 2025 SAT (POS MV)  
Deeper (Manual) / Dual Swath (Dynamic) / Mixed



**Crossline setting 1**

Depth Mode: Deeper

Swath Mode: Dual

Yaw Stabilization: RMH

Nav Source: POS MV

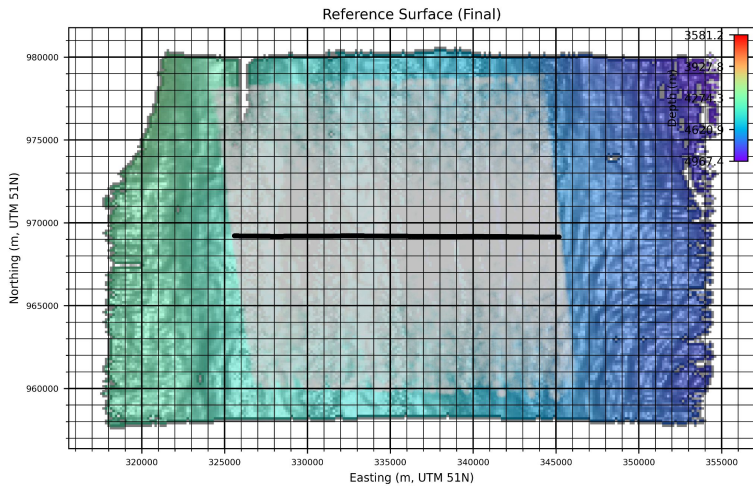
Files: 198, 199

2025-12-07

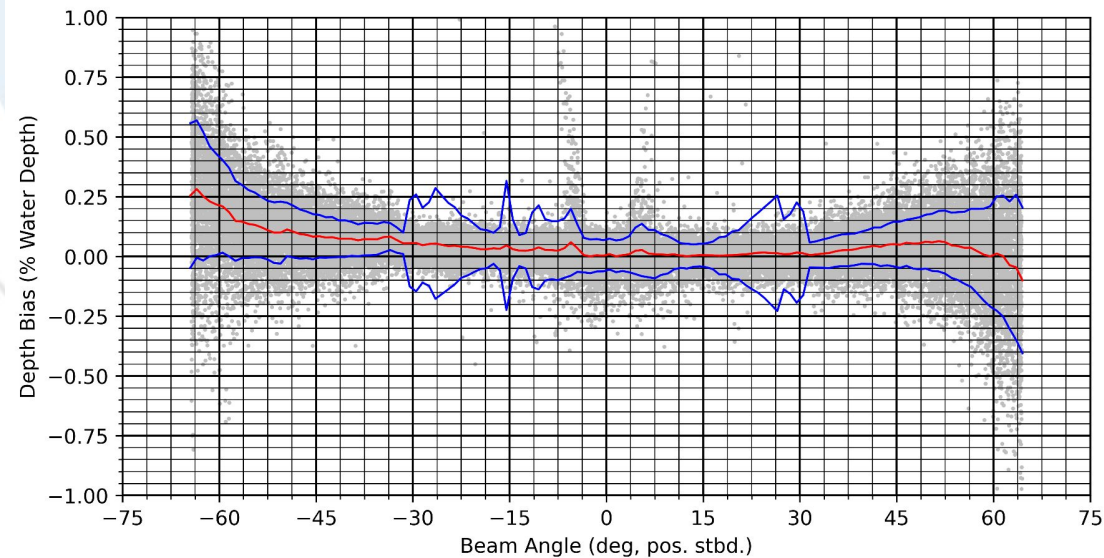
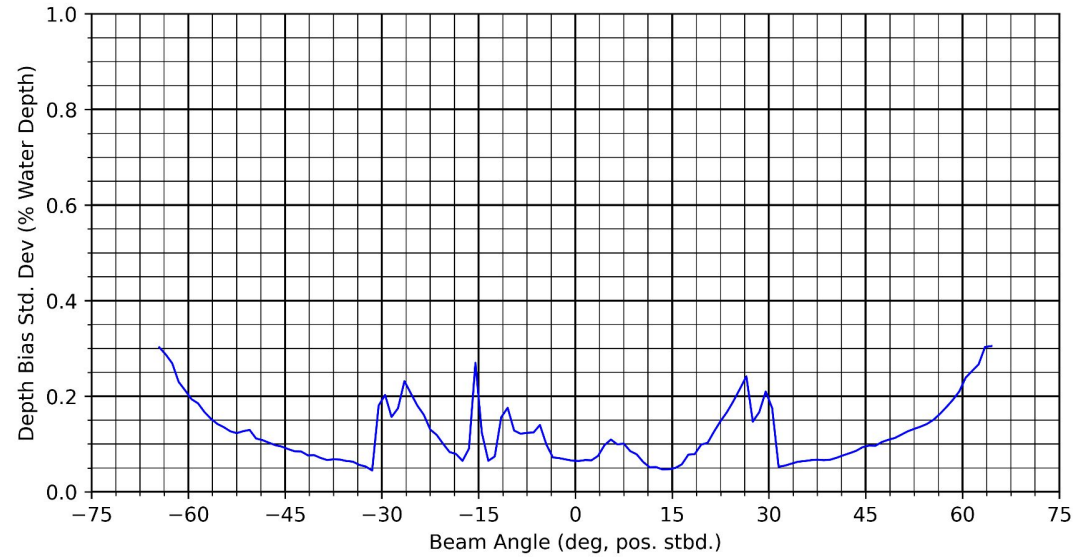
Unfiltered showing  
impacts of outlier swaths  
(see previous slides)

# EM124 Accuracy Testing

# 4500 m: Deeper/Dual/Mix/RMH/POS MV



Swath Accuracy vs. Beam Angle  
EM 124 - Thompson - 2025 SAT (POS MV)  
Deeper (Manual) / Dual Swath (Dynamic) / Mixed



## Crossline setting 1

Depth Mode: Deeper

Swath Mode: Dual

Yaw Stabilization: RMH

Nav Source: POS MV

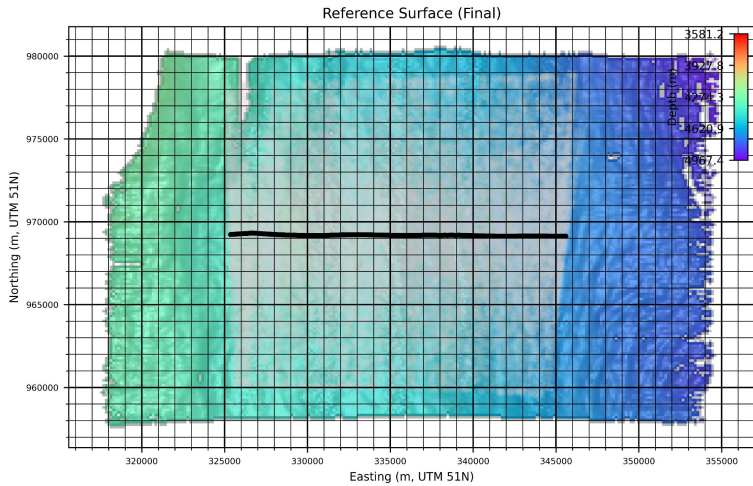
Files: 198, 199

2025-12-07

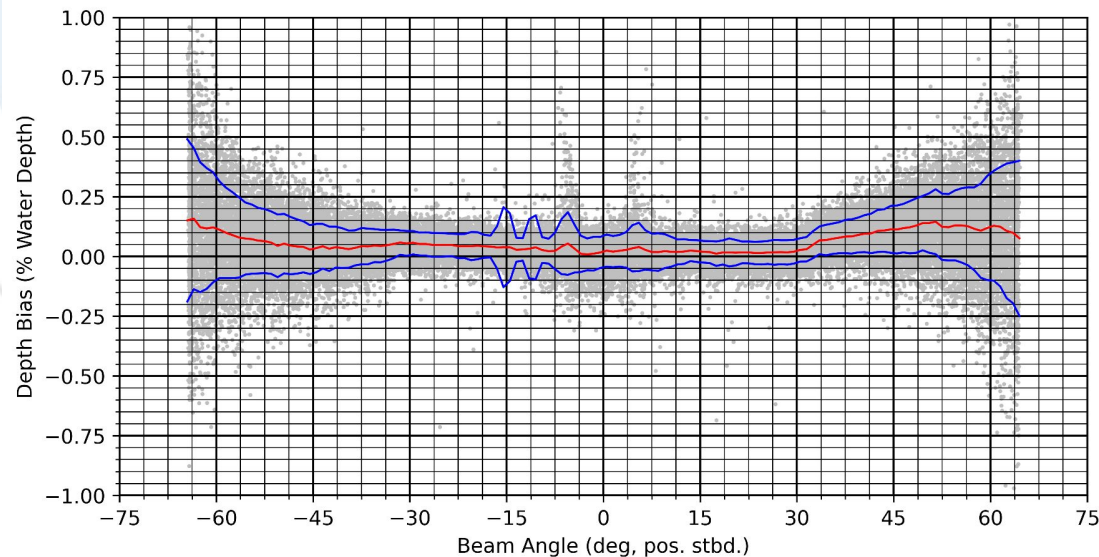
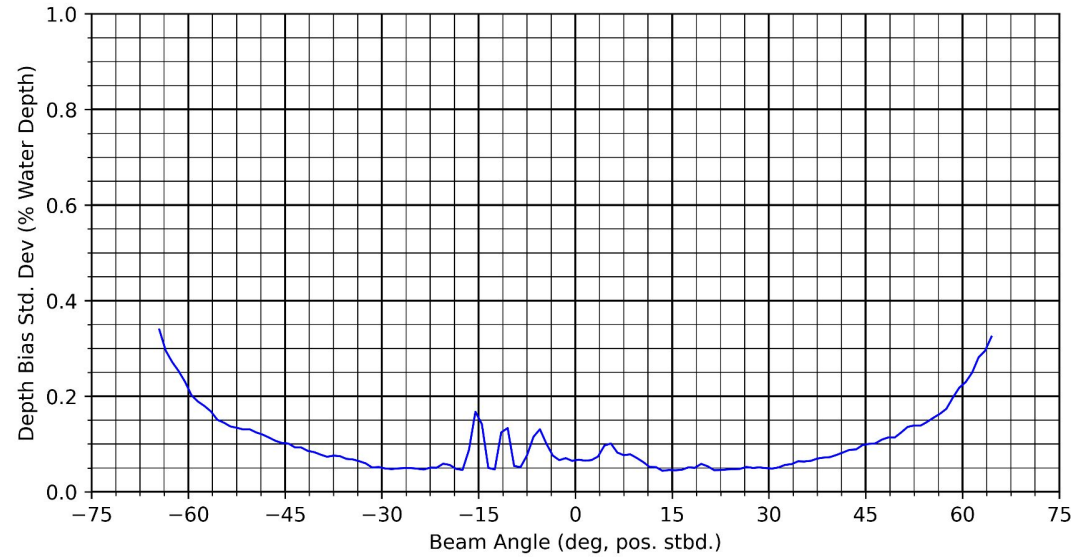
Filtered to remove outliers >5% WD from the reference surface

# EM124 Accuracy Testing

# 4500 m: Deeper/Dual/Mix/RMH/SP380



Swath Accuracy vs. Beam Angle  
EM 124 - Thompson - 2025 SAT (Seapath)  
Deeper (Manual) / Dual Swath (Dynamic) / Mixed



Crossline setting 2

Depth Mode: Deeper

Swath Mode: Dual

Yaw Stabilization: RMH

Nav Source: Seapath 380

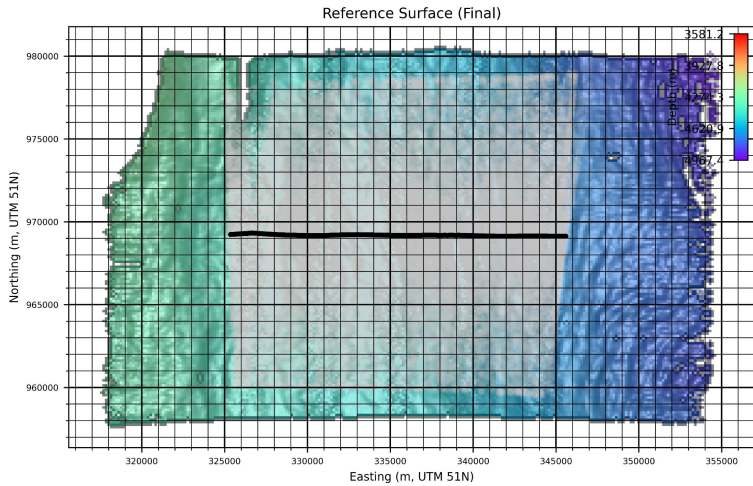
Files: 202, 203

2025-12-07

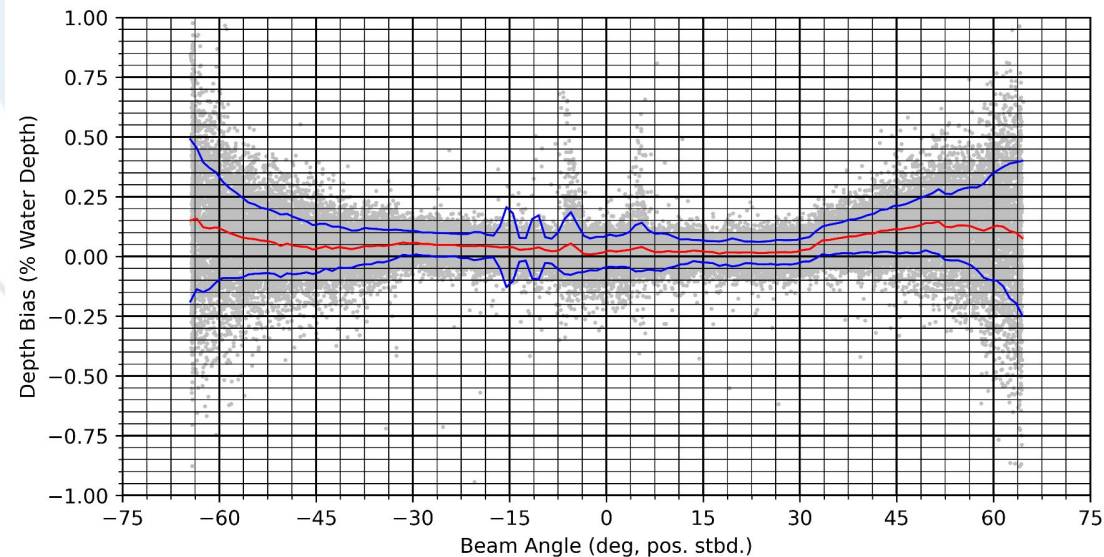
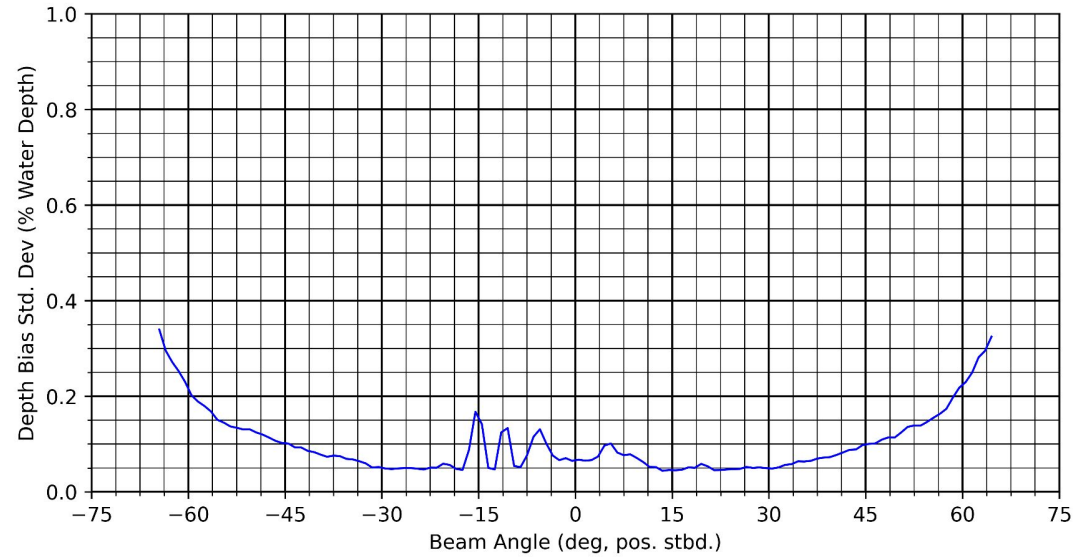
Unfiltered; no outlier swaths were observed during this crossline

# EM124 Accuracy Testing

# 4500 m: Deeper/Dual/Mix/RMH/SP380



Swath Accuracy vs. Beam Angle  
EM 124 - Thompson - 2025 SAT (Seapath)  
Deeper (Manual) / Dual Swath (Dynamic) / Mixed



Crossline setting 2

Depth Mode: Deeper

Swath Mode: Dual

Yaw Stabilization: RMH

Nav Source: Seapath 380

Files: 202, 203

2025-12-07

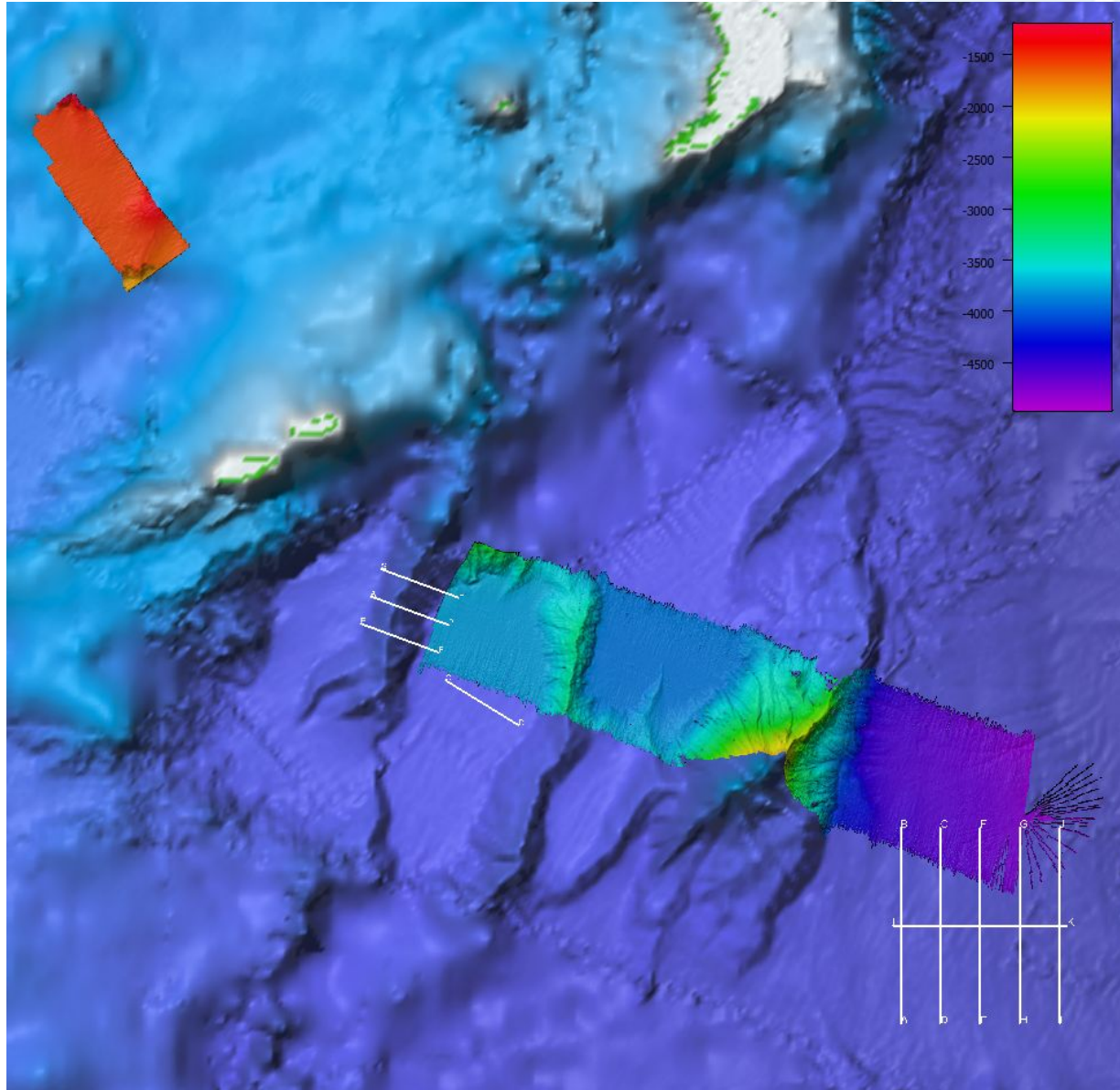
Filtered to remove outliers >5% WD from the reference surface

# Coverage Testing



# Swath Coverage Assessment

## Overview

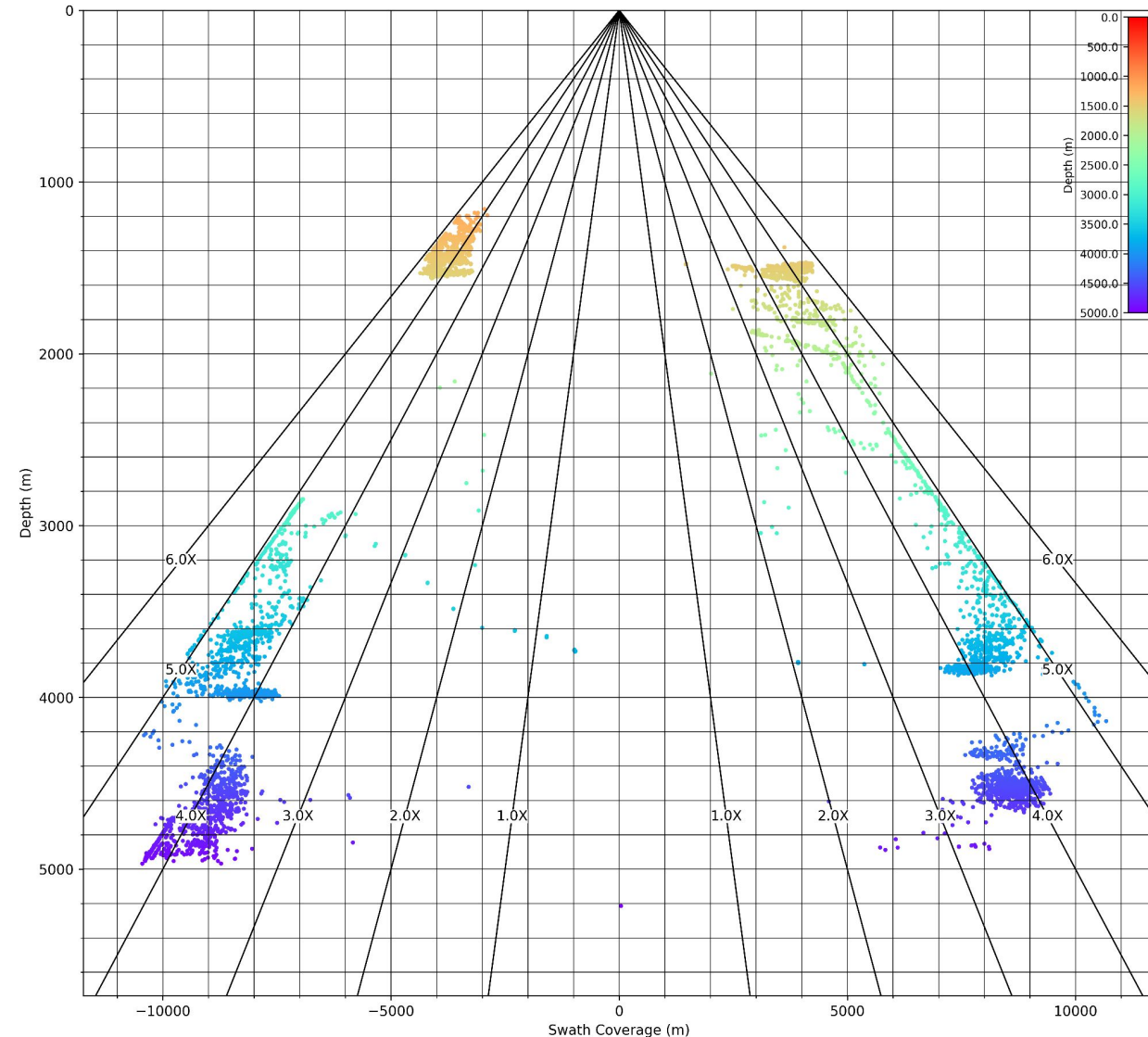


1. Swath coverage data were collected opportunistically on Dec 06-07 during transits and between other tests
2. An overview of the EM124 coverage dataset is shown at left with SAT lines over GMRT background data
3. The EM124 was operated with Auto depth mode, FM enabled, and  $\pm 75^\circ$  max. swath angles according to [recommended swath coverage settings](#)
4. Sea state was relatively calm during the EM124 SAT and no particular impacts of swell or bubbles are noted in the transit / swath coverage data

# Swath Coverage Assessment

## Overview

Swath Width vs. Depth  
EM 124 - Thomas G. Thompson - 2025 SAT

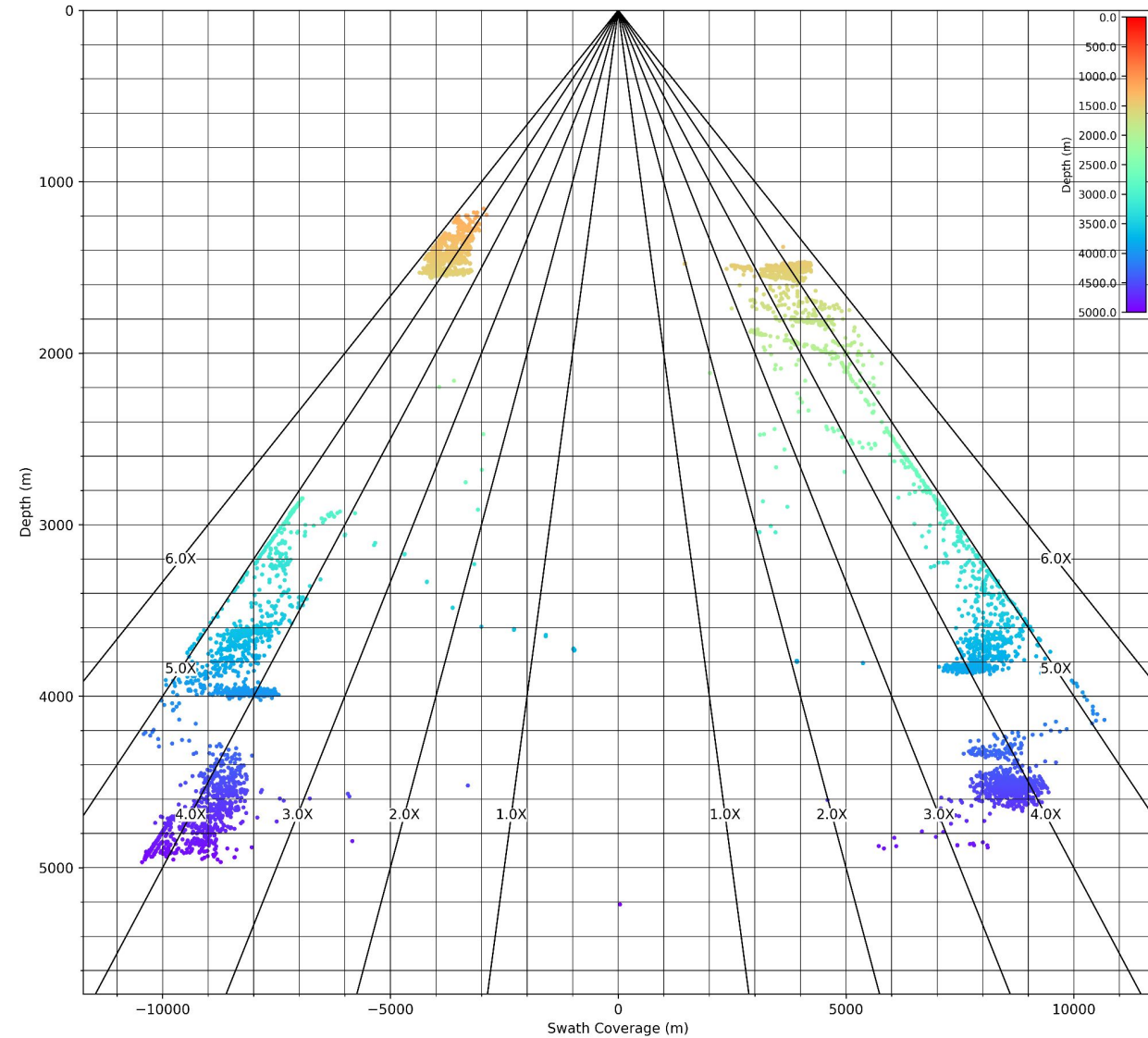


1. Across-swath distance from nadir was calculated for the outermost port and starboard 'valid' sounding for each ping and then plotted against depth to evaluate the achieved swath width versus depth
2. The plot at left shows achieved coverage colored by depth, with reference lines for multiples of water depth, over a range of 0-5000 m
3. The following slides present the achieved swath coverage versus depth, colored by a variety of parameters to illustrate performance versus mode
4. Despite a limited total depth range and missing segments across the slopes, the Thompson's EM124 coverage appears to compare favorably with a relevant benchmark dataset (from R/V *Atlantis*)
5. The achieved coverage generally met expectations over the observed depth range; **additional data should be collected in depths <1000 m, between 1500-3000 m, and >5000 m to fill in the 'gaps' of the coverage curves and verify depth mode transitions**

# EM124 Swath Coverage

Depth

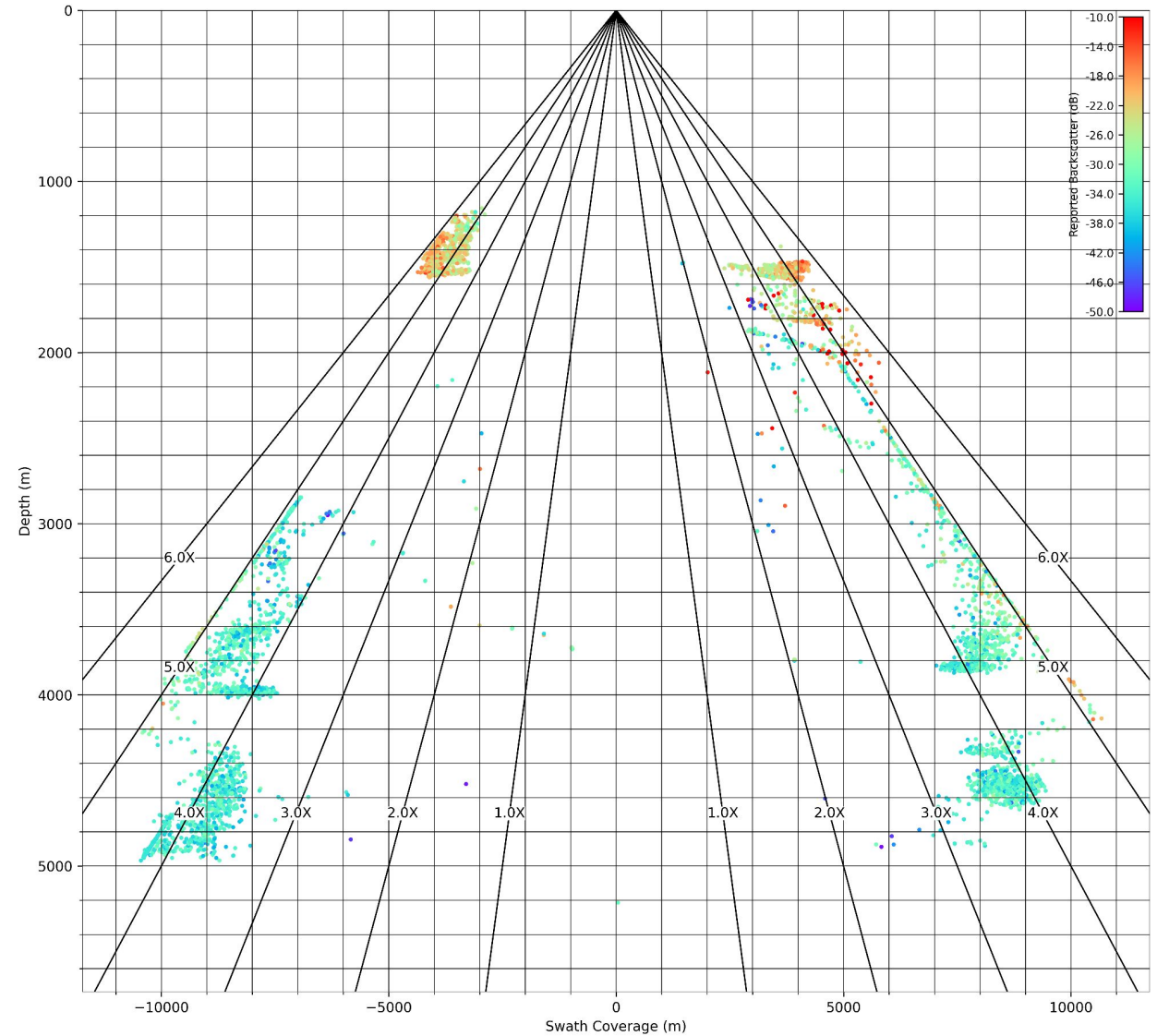
Swath Width vs. Depth  
EM 124 - Thomas G. Thompson - 2025 SAT



# Results

Backscatter

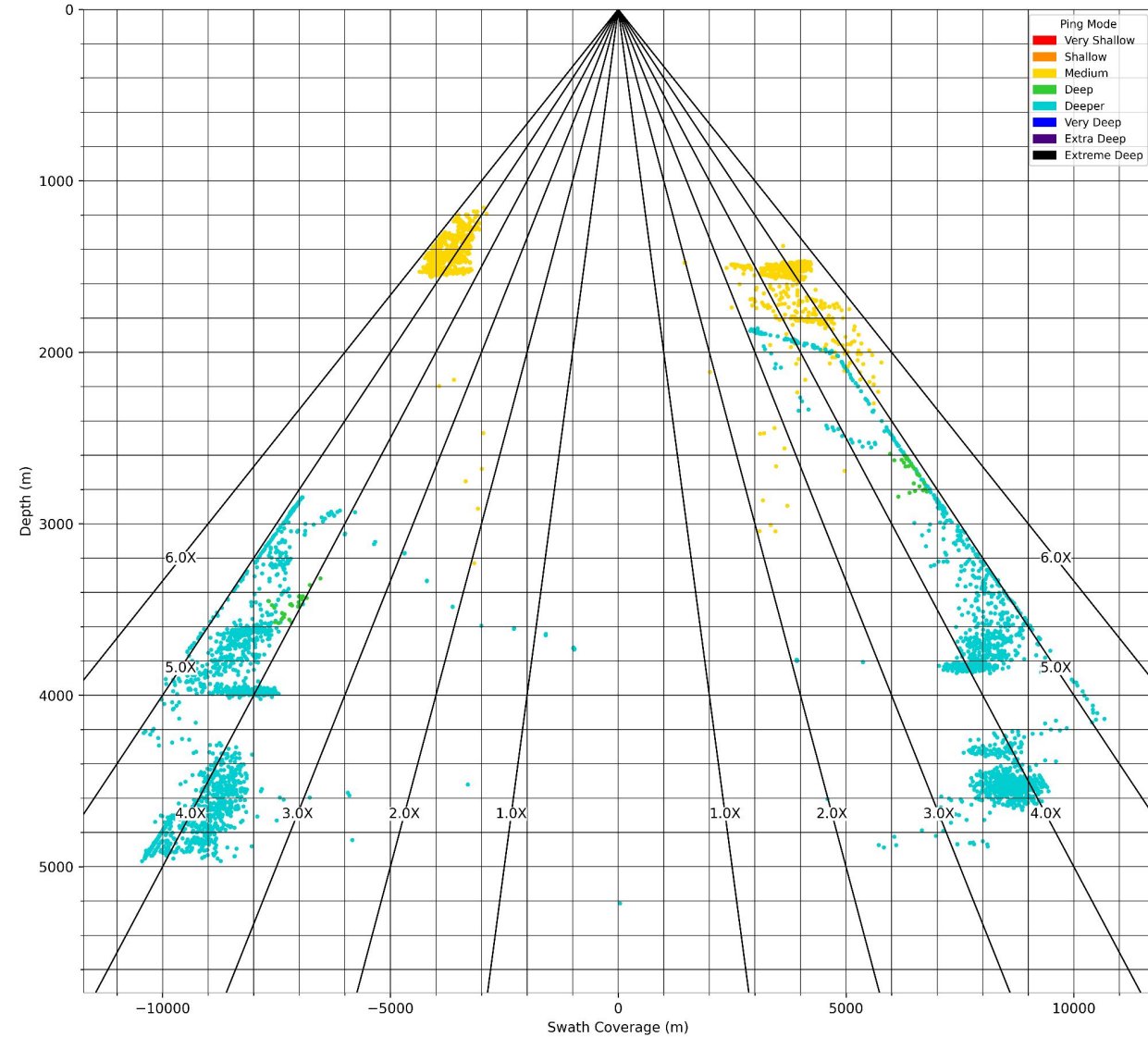
Swath Width vs. Depth - Backscatter  
EM 124 - Thomas G. Thompson - 2025 SAT



# EM124 Swath Coverage

## Depth Mode

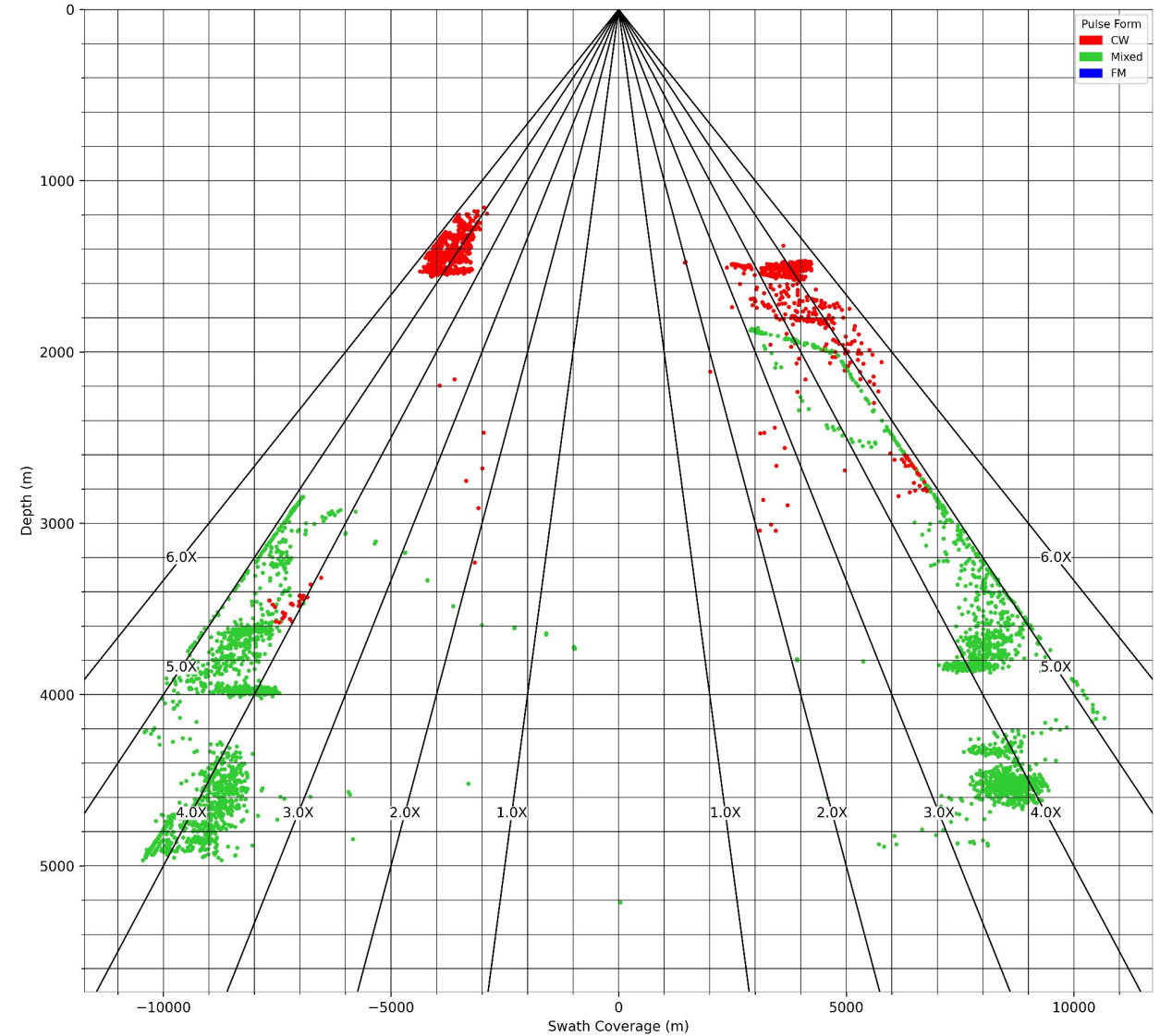
Swath Width vs. Depth - Ping Mode  
EM 124 - Thomas G. Thompson - 2025 SAT



# Results

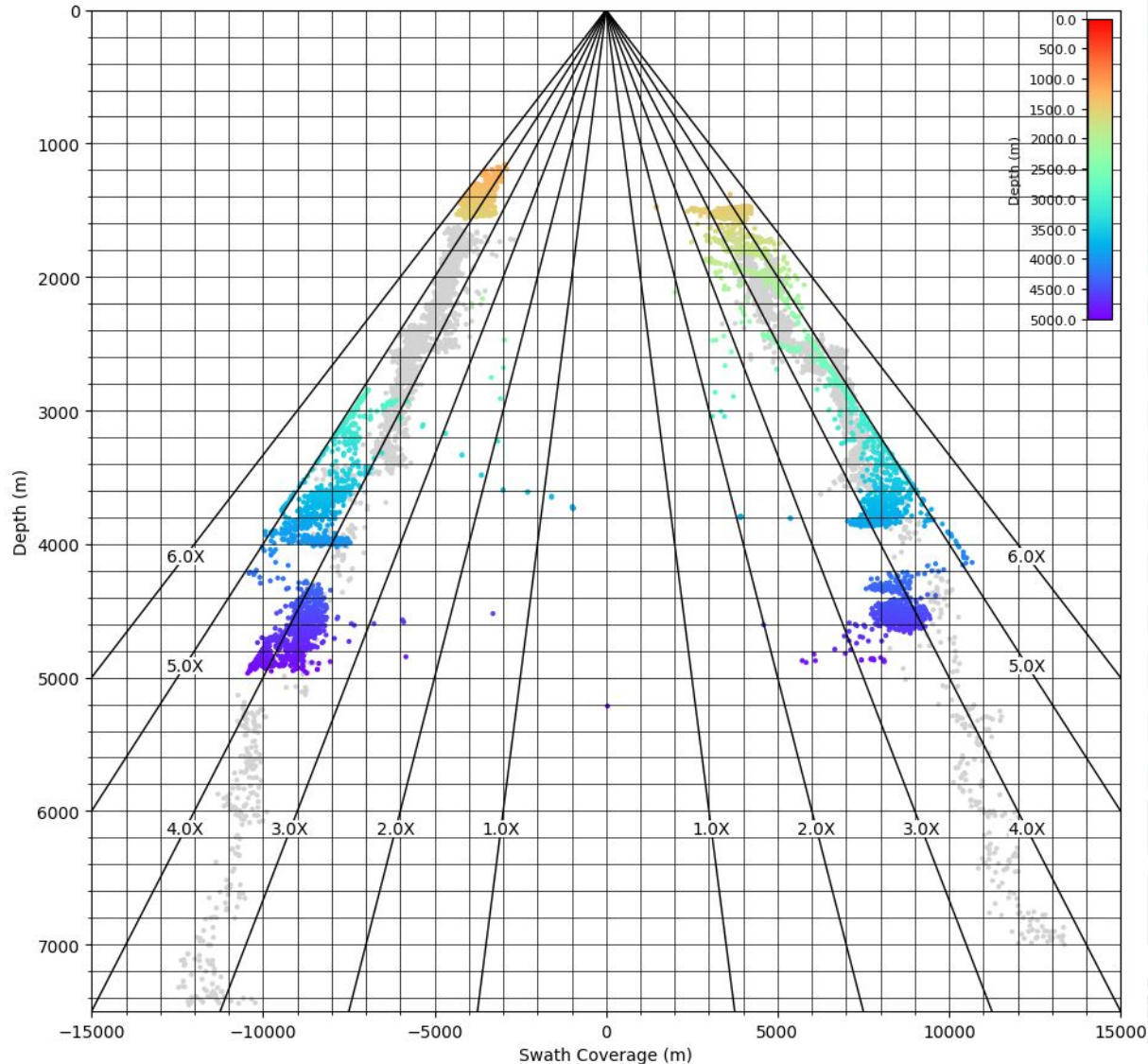
## Pulse Form

Swath Width vs. Depth - Pulse Form  
EM 124 - Thomas G. Thompson - 2025 SAT



# EM124 Swath Coverage

Swath Width vs. Depth  
EM 124 - Thomas G. Thompson - 2025 SAT vs. 2021 ATL PR Trench



# EM124 Benchmark Comparison

1. As swath coverage can be an early indicator of noise limitations or other hardware health issues, the SAT baseline trends can be compared against future coverage tests to help detect these complications
2. Likewise, comparison against other EM124 systems can provide a sense of relative performance and highlight differences in installations / platforms
3. The *Thompson's* EM124 coverage data (colored by depth) compare well with 'benchmark' data (gray points) collected with a similar 1° TX array by R/V *Atlantis* over the Puerto Rico Trench (reaching ~7500 m during 2022 follow-up to the 2021 SAT)
4. This comparison confirms similar performance across both EM124 systems and helps to rule out serious complications over the tested depth ranges
5. The MAC is available to help plan additional data collection in shallower and deeper regions to more fully characterize the baseline performance for this EM124 at the start of its service life

