

R/V *Sikuliaq*

EM302 / EM710

Multibeam Echosounder

Calibration Report

SKQ201907T

Multibeam Advisory Committee

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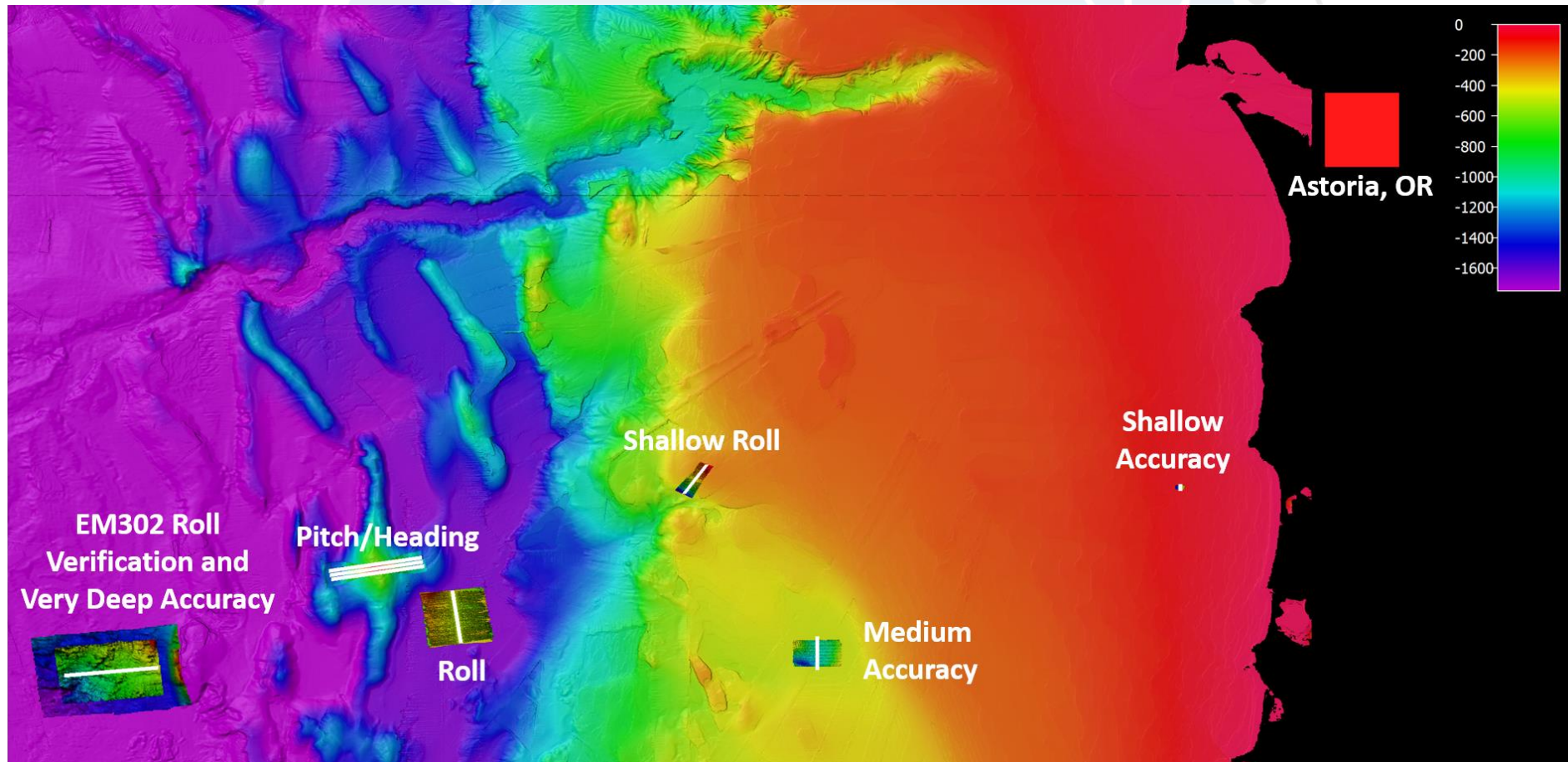
credit: nsf.gov

SKQ201907T Planning Overview

- The University of Alaska's UNOLS vessel R/V *Sikuliaq* (SKQ) is equipped with Kongsberg Maritime EM302 and EM710 multibeam echosounders and a Seapath 320 positioning / attitude system
- The Multibeam Advisory Committee (MAC) was asked to assist with Quality Assurance Testing (QAT) of the ship's EM302 and EM710 ahead of the 2019 field season; due to scheduling constraints, MAC personnel (Kevin Jerram and Tomer Ketter) provided remote support for line planning and data analysis from shore
- MAC communication with SKQ personnel (Steven Roberts and Steven Hartz) commenced in spring 2019 with planning for calibrations ('patch tests') and accuracy testing for both systems during a transit from Newport to Astoria, OR
- The calibration and accuracy test plans were developed at sites successfully used for previous EM302 and EM710 testing aboard R/V *Falkor* (FK170602; not funded by NSF)
- This report describes the calibration results and implementation in SIS; additional swath accuracy and swath coverage processing using the full SKQ201907T dataset are ongoing, and this report will be updated as results become available

SKQ201907T Data Collection

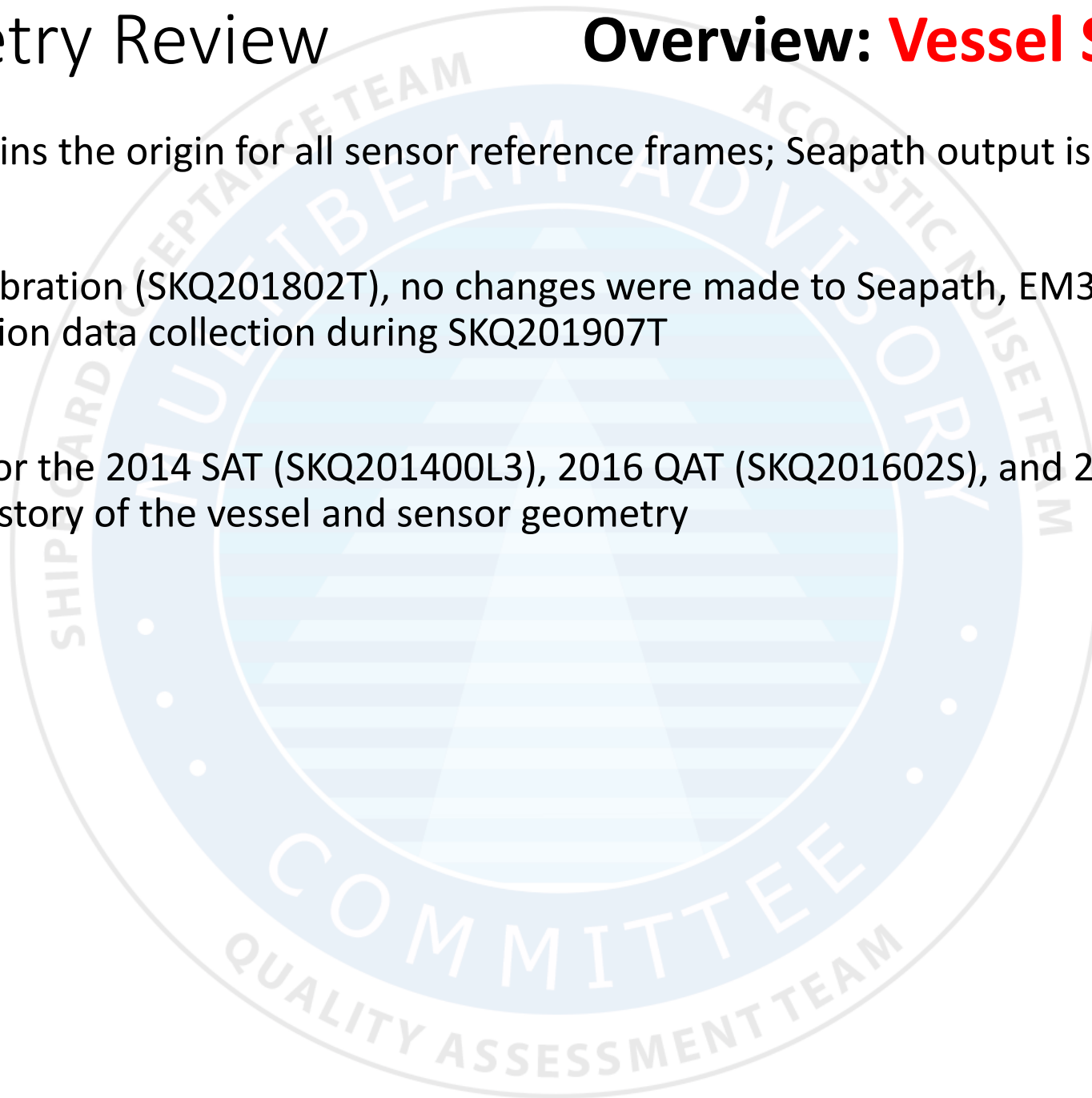
- EM302 / EM710 calibrations and accuracy testing were planned over features and reference areas used successfully for similar systems on R/V *Falkor* in 2017
- The shallow accuracy reference surface is significantly south of the Columbia River outlet to try to minimize impacts of sound speed variability



System Geometry Review

Overview: **Vessel Survey**

- The granite block remains the origin for all sensor reference frames; Seapath output is valid at the granite block
- Following the 2018 calibration (SKQ201802T), no changes were made to Seapath, EM302, or EM710 installation offsets prior to calibration data collection during SKQ201907T
- Refer to MAC reports for the 2014 SAT (SKQ201400L3), 2016 QAT (SKQ201602S), and 2018 QAT (SKQ201802T) for a more complete history of the vessel and sensor geometry



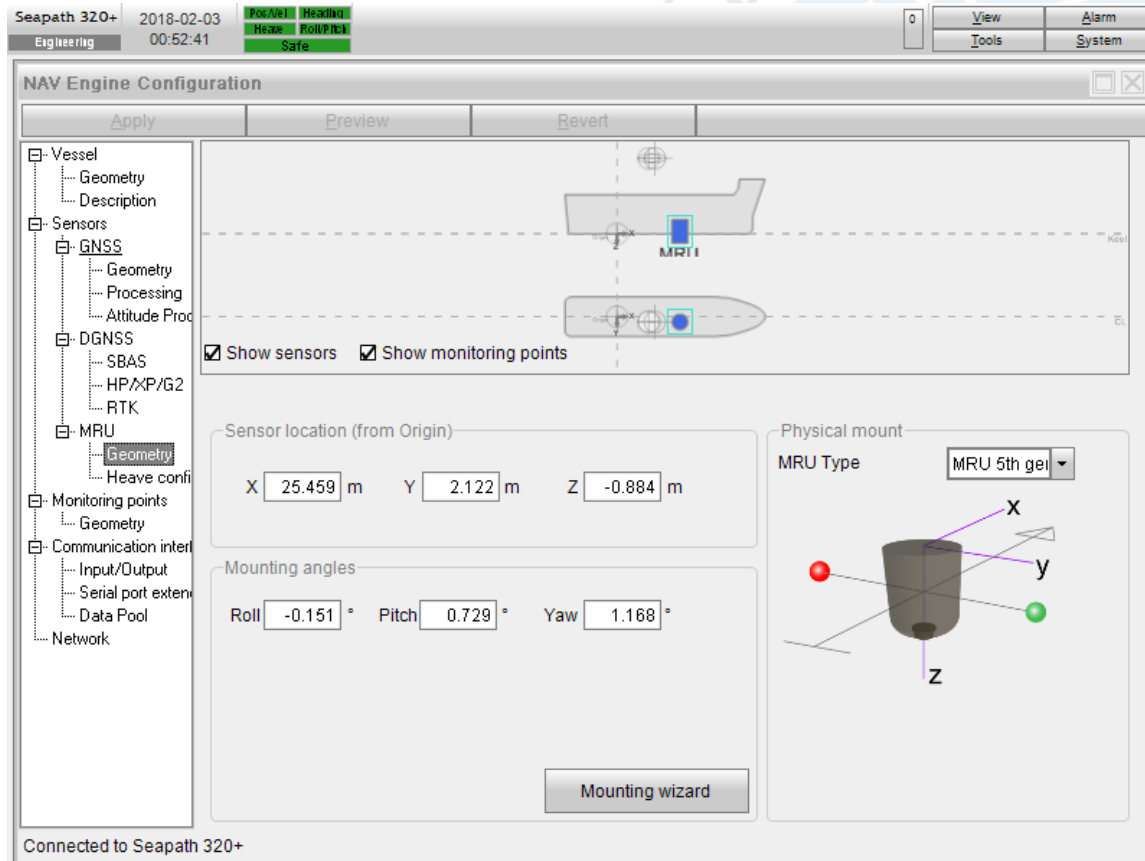
Seapath 320 Configuration

MRU Lever Arms and Angles

The Seapath MRU is the only mapping system component to have undergone any modification since the 2016 QAT

In 2018, the MRU 'bottle' was removed and shipped to Kongsberg for a factory calibration, then reinstalled in its mounting bracket prior to SKQ201802T

Because the MRU bottle is a reasonably tight fit in the bracket (expected to be repeatable to within a few hundredths of a degree), and the bracket was not altered, MAC and SKQ personnel agreed in 2018 to maintain the existing MRU installation angles in the Seapath Nav Engine ahead of the 2018 calibrations; likewise, no changes were made prior to the 2019 calibrations



Seapath 320 Configuration

Antenna Lever Arms

Seapath GNSS antenna offsets are based on the original vessel survey and an updated survey after antenna relocation in 2016

See the SKQ201602S QAT report for more details of the antenna geometry

No changes have been made to antenna offsets after SK201602S

The screenshot displays the Seapath 320+ software interface. The top status bar shows the date 2018-02-03, time 01:04:01, and system status (Position, Heading, Roll/Pitch, Safe). The main window is divided into a left sidebar with a tree view, a central 3D vessel model, and a right-hand configuration panel.

Antenna configuration:

- Type: Antenna beam

Antenna offset (from antenna 1 to antenna 2):

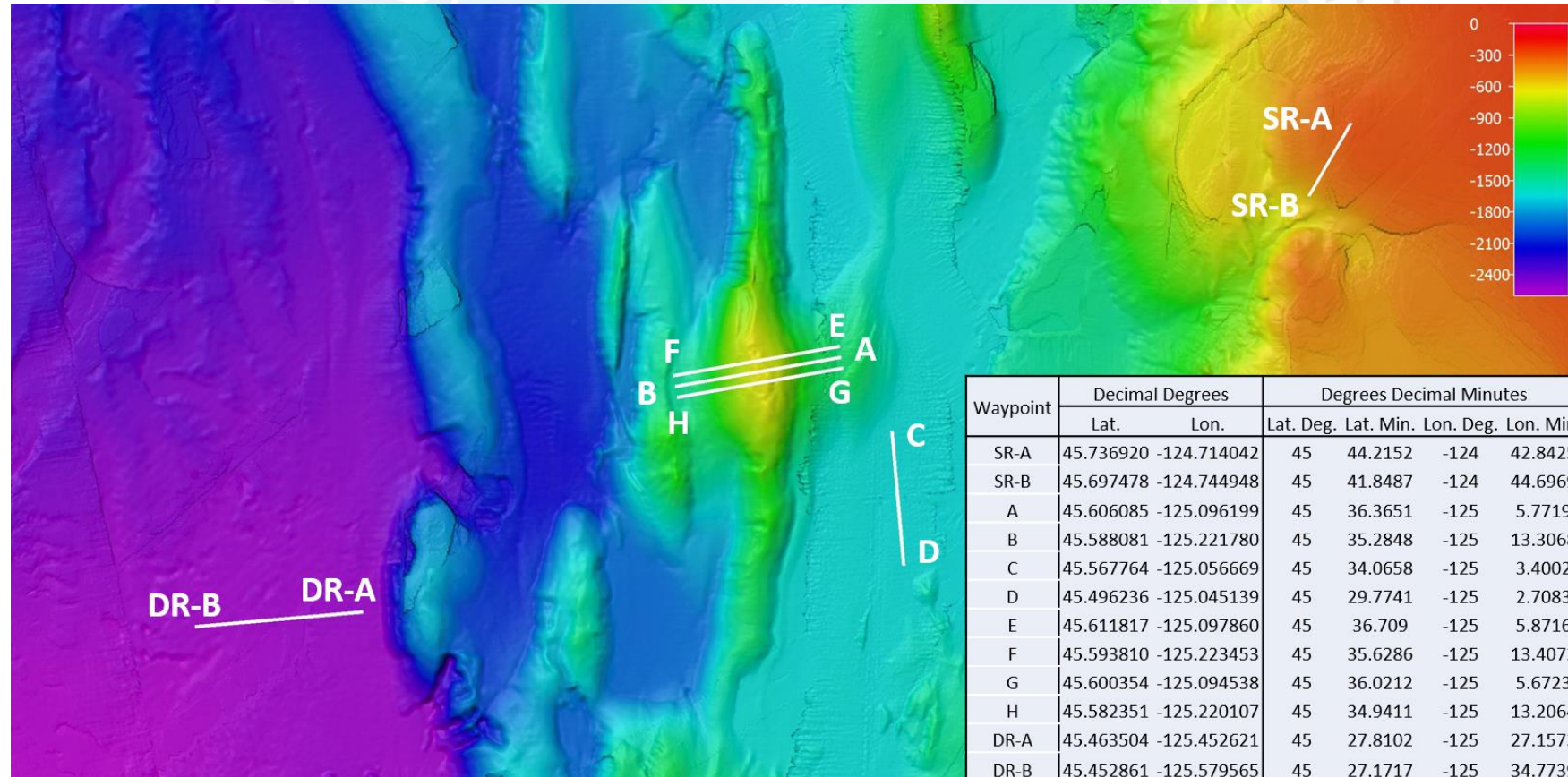
- Baseline length: m
- Heading offset: °
- Height difference: m

Antenna location (from Origin):

	Position [m]			
	X	Y	Z	
Antenna 1	12.821	2.064	-30.521	
Antenna 2	15.309	2.082	-30.537	

Connected to Seapath 320+

1. Calibration sites were selected based on availability of seafloor features between Portland and Astoria, Oregon, with optimal slopes and depths within the suitable operational ranges of both echosounders
2. Roll verification lines were run in shallow and deep waters to further exaggerate roll biases for each system
3. 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



EM302 / EM710 Calibration

Pre-Calibration Configuration

Installation parameters

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:	-0.13588	-0.00033	0.02177
RX Transducer:	0.00460	-0.18122	359.838
Attitude 1, COM2/UDP5:	0.14	-0.10	-0.11
Attitude 2, COM3/UDP6:	0.00	0.00	0.00
Stand-alone Heading:			0.00

PRE-CALIBRATION (EM302)

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. RX Transducer Orient. Offset angles (deg.)

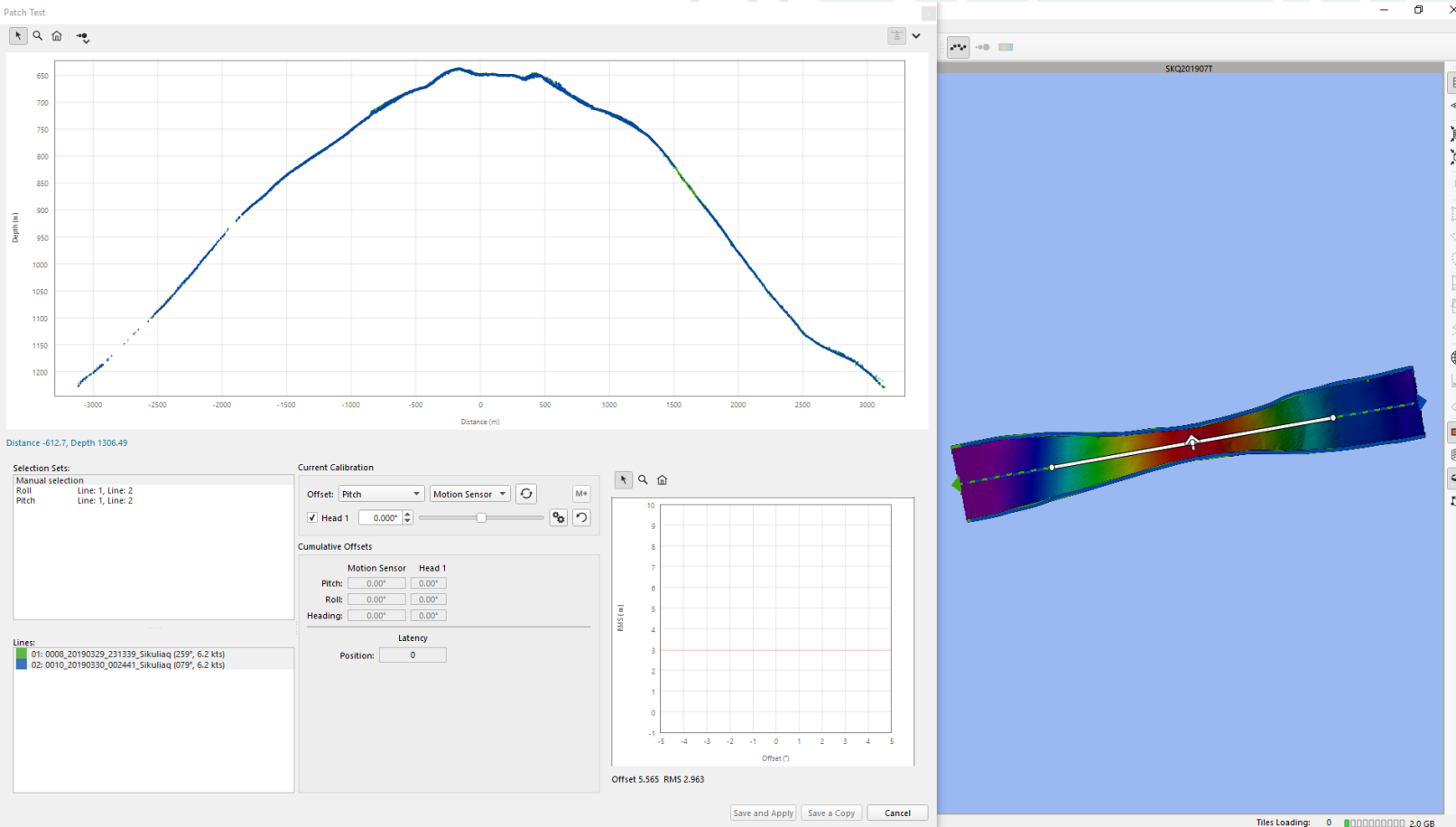
	Roll	Pitch	Heading
TX Transducer:	0.03240	0.04516	0.17085
RX Transducer:	-0.025	0.137	359.748
Attitude 1, COM2/UDP5:	0.16	-0.05	-0.08
Attitude 2, COM3/UDP6:	0.00	0.00	0.00
Stand-alone Heading:			0.00

PRE-CALIBRATION (EM710)

1. All *Attitude 1* angular offsets were left unchanged in *SIS Installation Parameters* prior to data collection
2. Calibration data were examined on shore with patch test tools in QPS Qimera; results were agreed upon by multiple personnel before communication to *SKQ*
3. Only one set of calibration lines were run; no verification lines were run, due to time constraints of the transit and data transfer to shore
4. During analysis on shore, results from each test were applied in the Qimera vessel configuration for each system prior to subsequent tests, then reviewed in an iterative process to minimize the effects of coupling between offsets
5. Results were updated in the *SIS Installation Parameters* for *Attitude 1* after SKQ201907T
6. No latency test was performed, as it is not clear that any small positioning latency would be evident in deep water; no latency-related bathymetric artifacts were noted

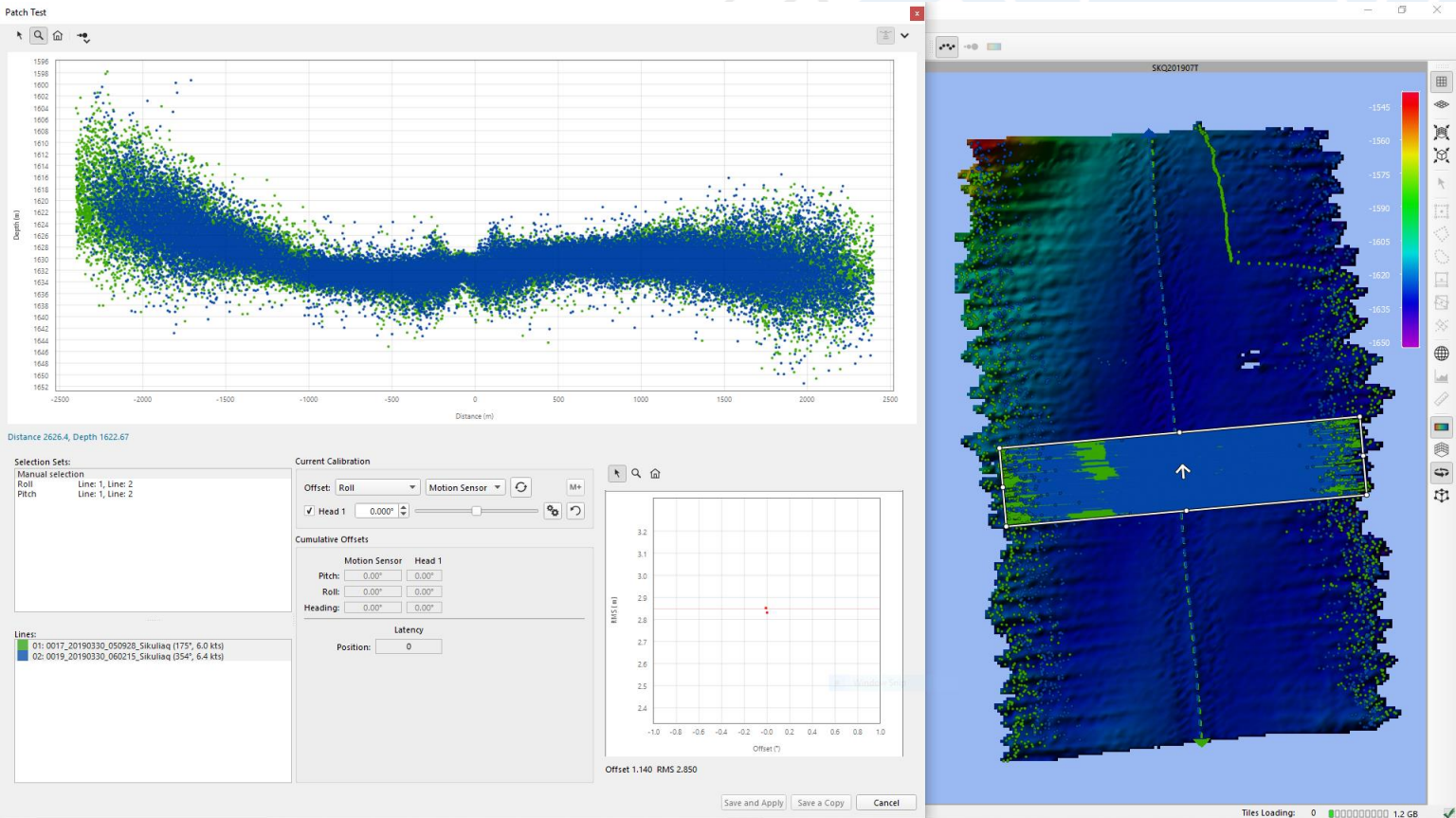
EM302 Calibration

Results: Pitch



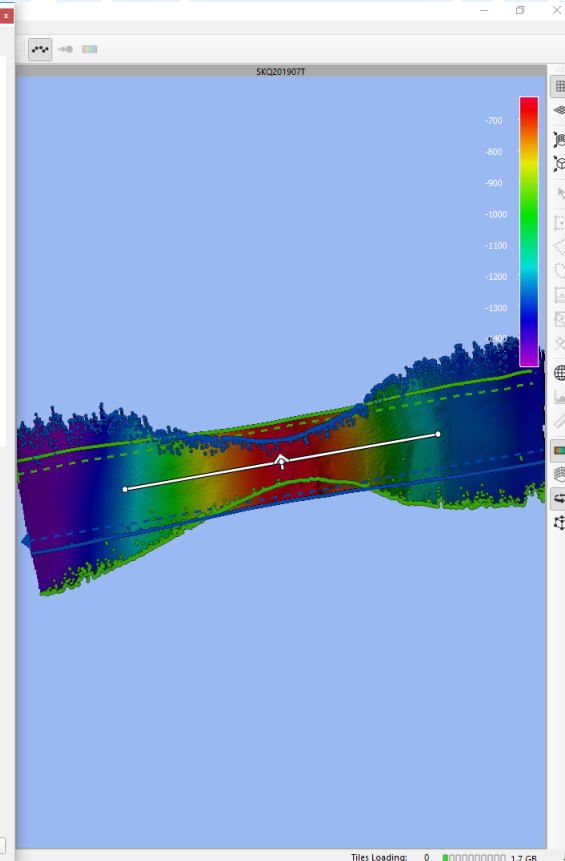
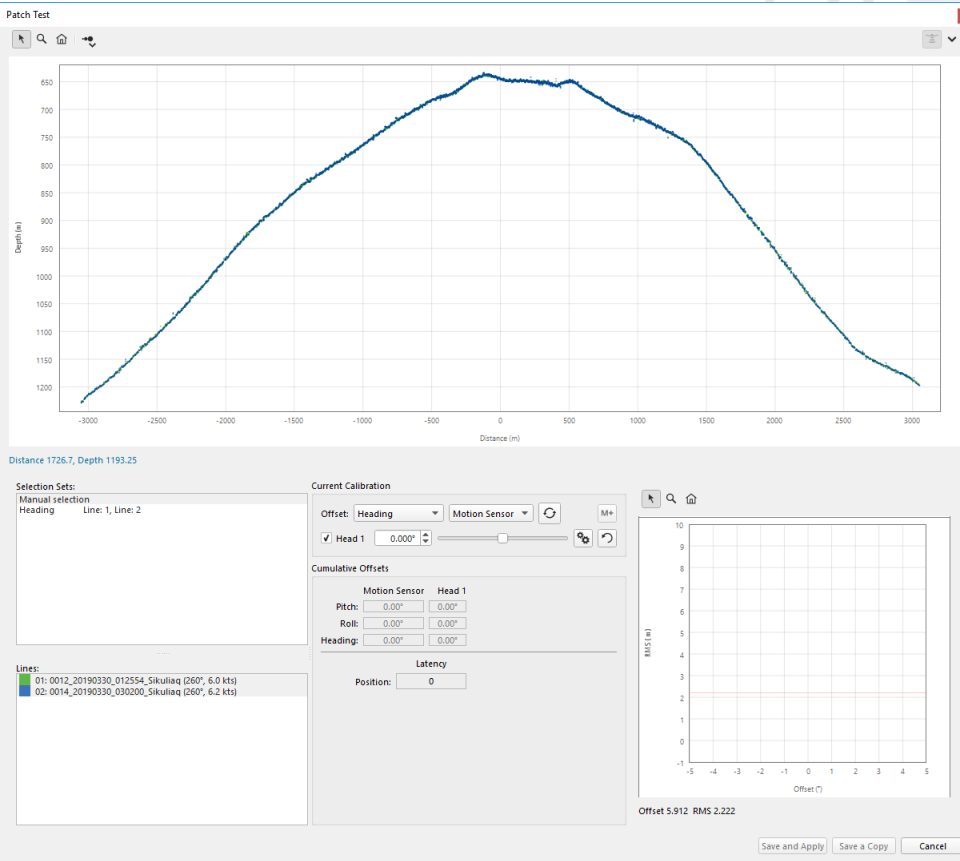
Pitch calibration lines shown at left in the Qimera Patch Test Tool

1. Attitude 1 initial setting: -0.10°
2. Calibration adjustment: $+0.02^\circ$
3. No pitch verification performed
4. **Final pitch offset: -0.08° in SIS**



Roll calibration lines shown at left in the Qimera Patch Test Tool (Deep Roll lines were also reviewed, but did not provide full swath angles)

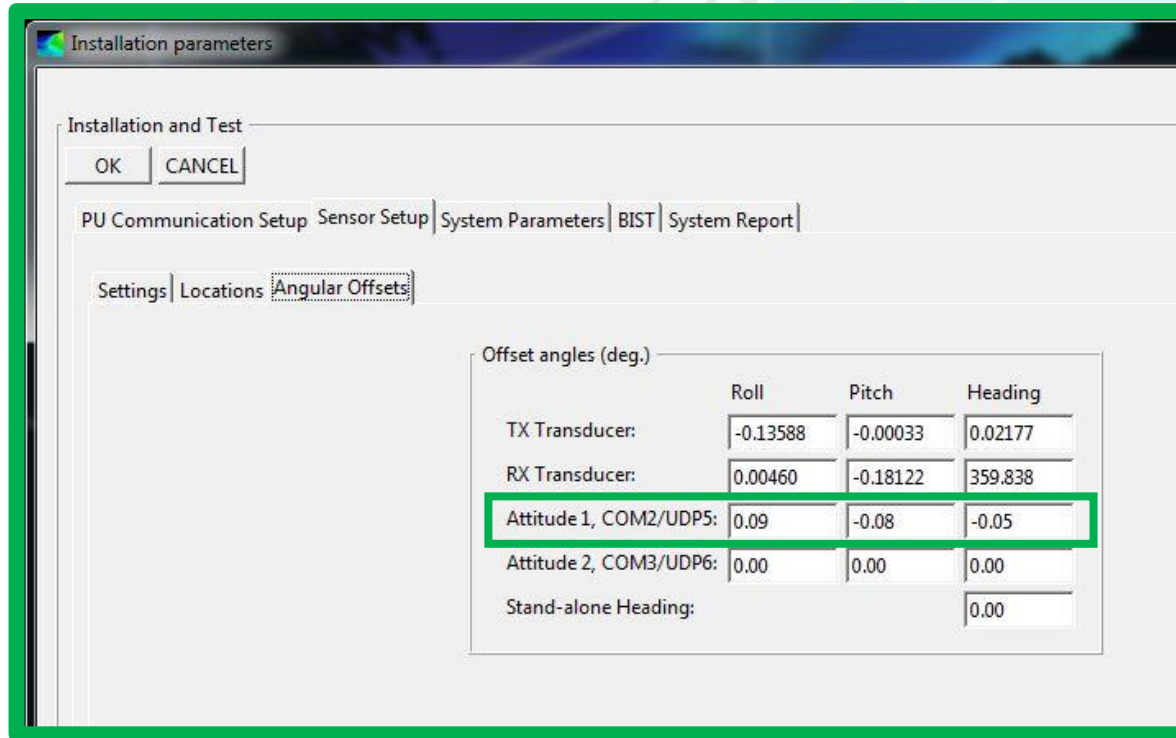
1. Attitude 1 initial setting: $+0.14^\circ$
2. Calibration adjustment: -0.05°
3. **Final roll offset: $+0.09^\circ$ in SIS**



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

1. Attitude 1 initial setting: -0.11°
2. Calibration adjustment: $+0.06^\circ$
3. **Final hdg. offset: -0.05° in SIS**

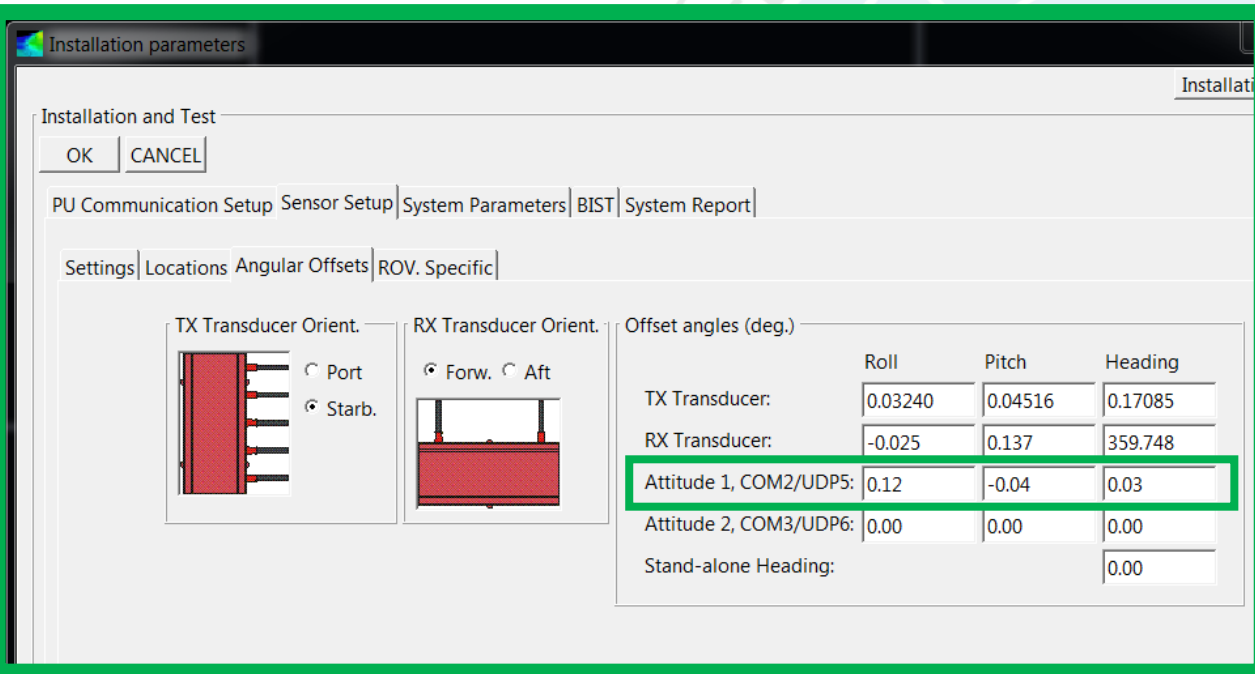
POST-CALIBRATION (EM302)

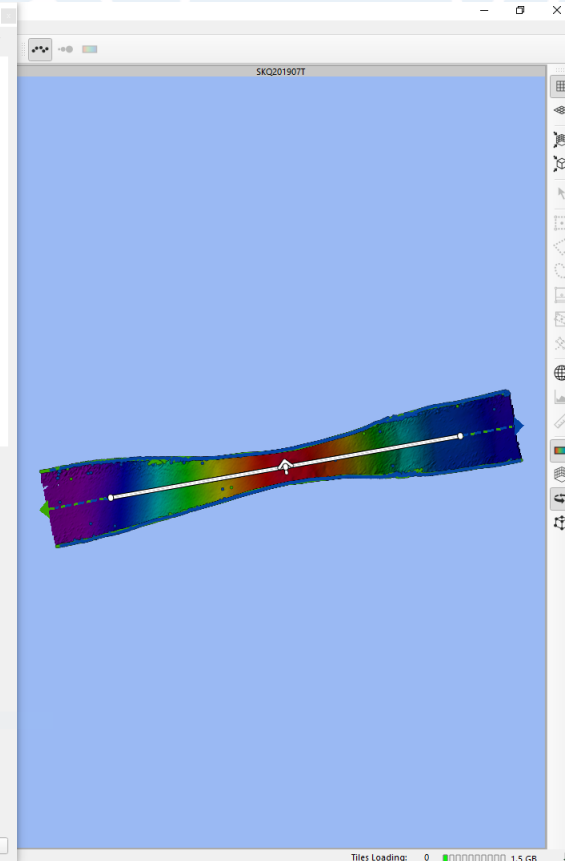
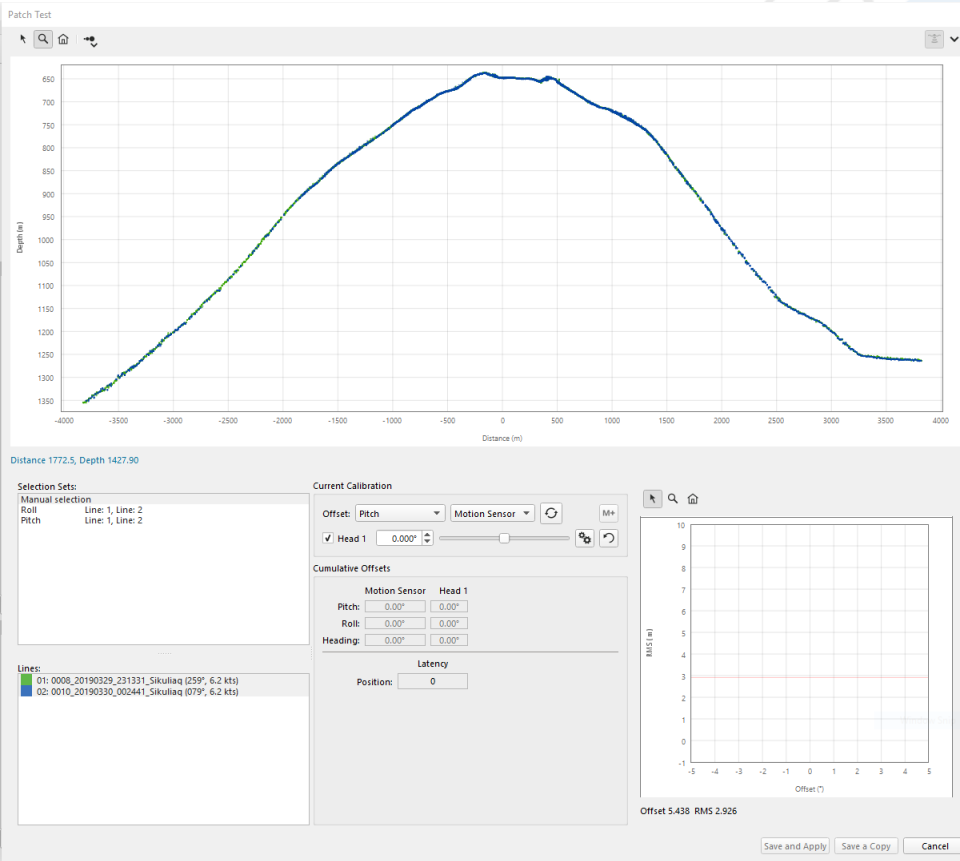


1. While larger than the 2018 results, the relatively small *Attitude 1* adjustments made during the 2019 EM302 calibration confirm a high-quality vessel offset survey, consistent integration, and no significant changes across the Seapath and EM302 sensor layouts since the last QAT in 2018
2. The *Installation Parameters: Angular Offsets* shown at left should be maintained until any modification is made to the Seapath 320 or EM302 arrays, or another calibration becomes necessary for other reasons

POST-CALIBRATION (EM710)

1. As with the EM302, the relatively small *Attitude 1* adjustments made during the EM710 calibration confirm a high-quality vessel offset survey, consistent integration, and no significant changes across the Seapath and EM710 sensor layouts since the last QAT in 2016
2. While the heading adjustment for the EM710 is the largest of all results in this calibration, it should be noted that the adjustments applied to each system tended to be similar in magnitude and direction for each test (e.g., adjustments of +0.01 and +0.02 for pitch in the EM302 and EM710, respectively; adjustments of -0.05 and -0.04 for roll; and adjustments of +0.06 and +0.11 for heading, which is typically the least-clear test of the three)
3. The *Installation Parameters: Angular Offsets* shown at left should be maintained until any modification is made to the Seapath 320 or EM710 arrays, or another calibration becomes necessary for other reasons



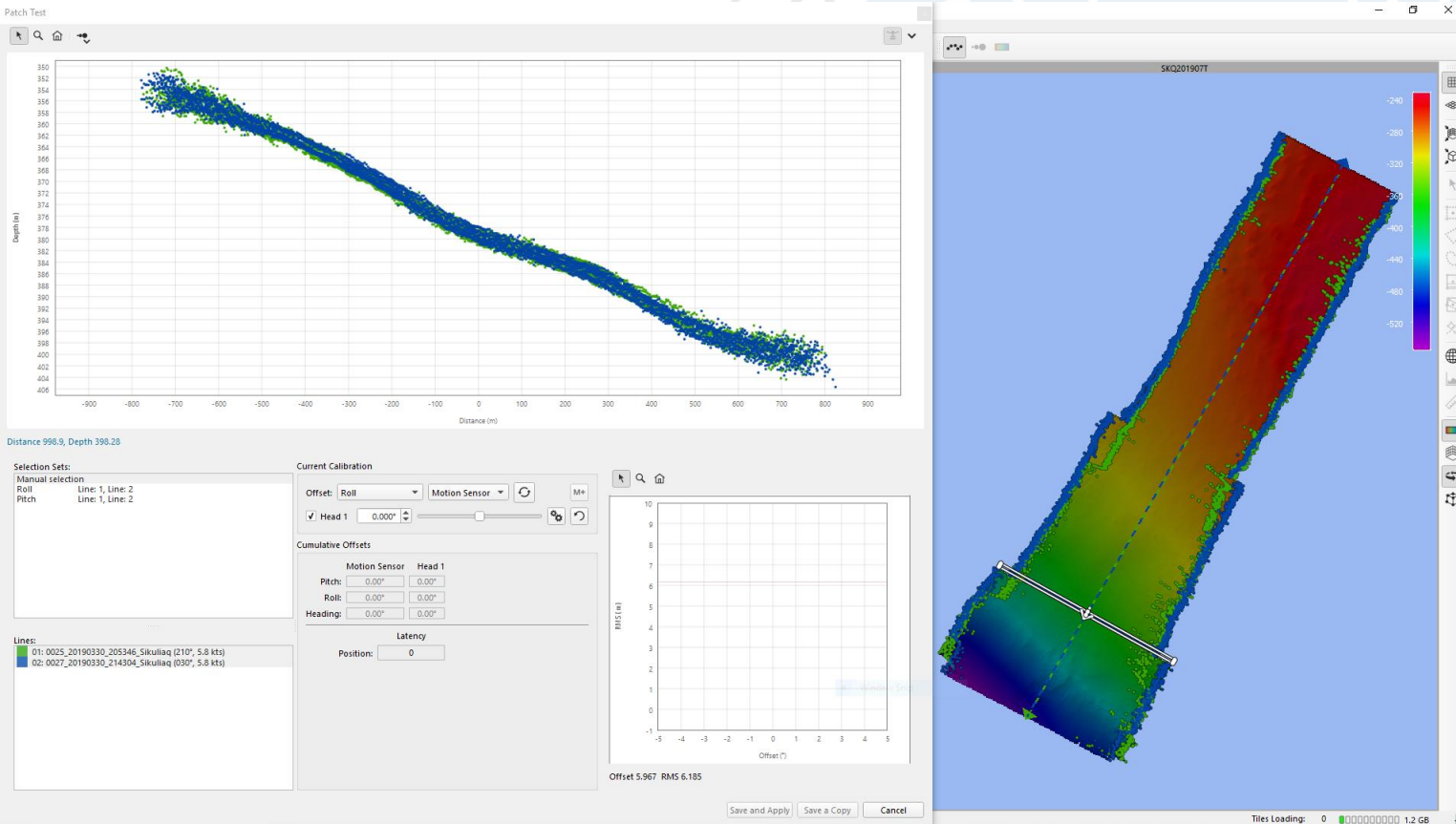


Pitch calibration lines shown at left in the Qimera Patch Test Tool

1. Attitude 1 initial setting: -0.05°
2. Calibration adjustment: 0.01°
3. **Final pitch offset: -0.04° in SIS**

EM710 Calibration

Results: **Roll**



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

1. Attitude 1 initial setting: $+0.16^\circ$
2. Calibration adjustment: -0.04°
3. **Final roll offset: $+0.12^\circ$ in SIS**

EM710 Calibration

Results: **Heading**

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

1. Attitude 1 initial setting: -0.08°
2. Calibration adjustment: 0.11°
3. **Final hdg. offset: $+0.03^\circ$ in SIS**

