ATLANTIS EM122 LONG-PERIOD BATHYMETRY ARTIFACT
Notes and questions for further investigation
Multibeam Advisory Committee (2017-03-23)

Documents describing previous tests/notes on this topic

1. *20161026 Atlantis EM122 recap*
    a. net result: need to confirm array angles, correct PHINS IMU pitch angle sign, and perform calibration

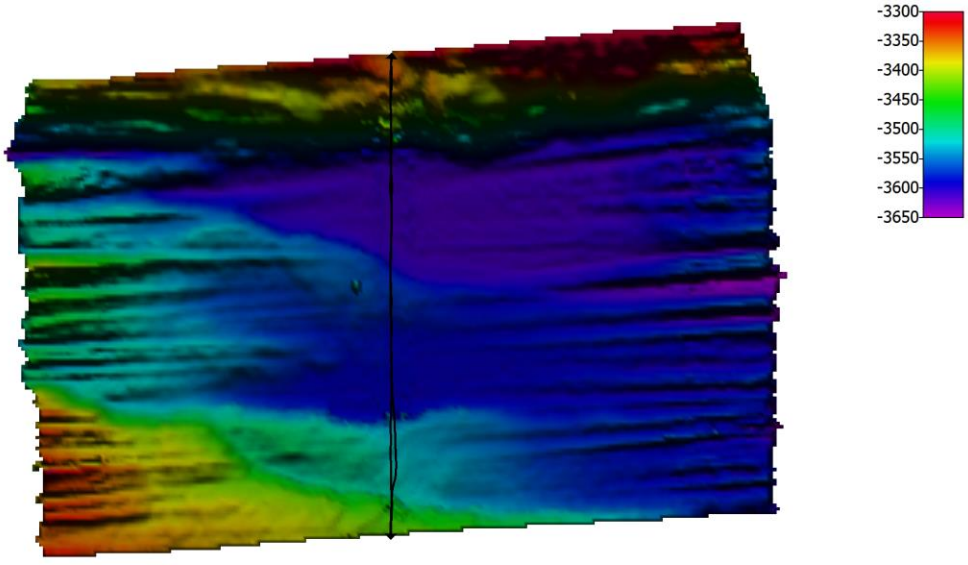
2. *ATLANTIS EM122 array angles from survey data (Feb 2017)*
    a. net result: IMTEC survey array angles left unchanged in SIS

3. *ATL EM122 calibration 20170319*
    a. net result: reasonably small offsets to enter in SIS; depth artifact highly pronounced during roll lines

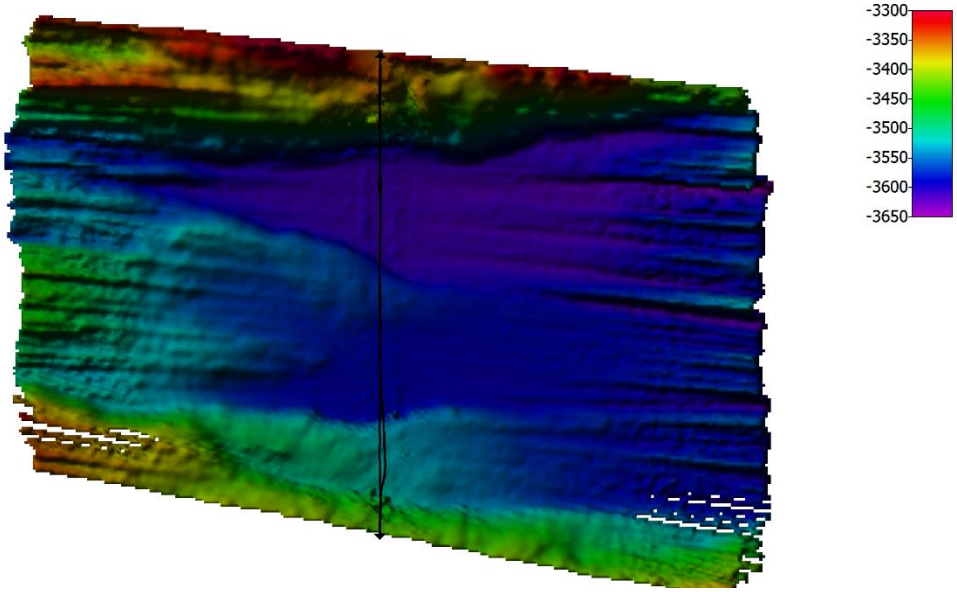
A bathymetry artifact in Atlantis's EM122 was notably exaggerated during the roll lines of a calibration conducted in strong currents on 2017-03-19. This calibration was conducted after correction of the IMU pitch installation angle sign in the PHINS configuration (see 'ATL EM122 calibration 20170319'). An XBT profile was collected and applied immediately prior to the calibration.

The EM122 was configured in Auto depth mode, HD Equidistant beam spacing, with yaw and pitch stabilization enabled. Yaw stabilization was set to Medium, relative to mean heading, and disabled during turns in order to reset the heading filter once the vessel was lined up for the survey pass. Both roll calibration lines are presented separately below.

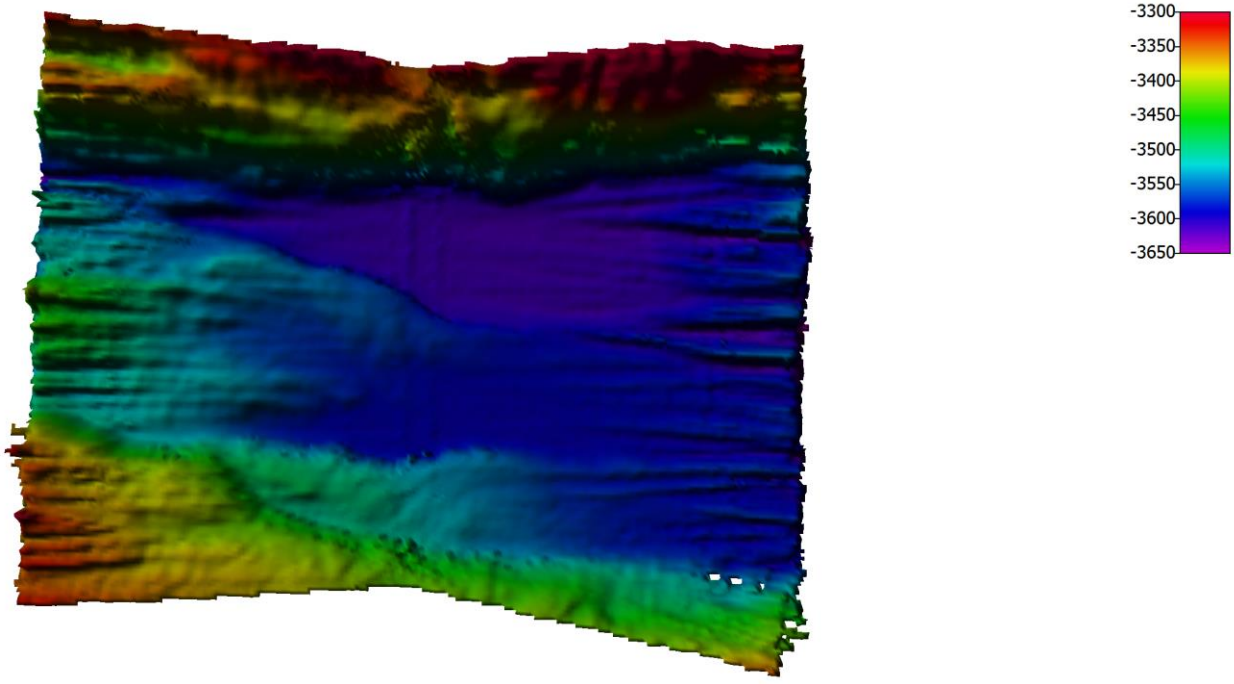
Line 0006, CUBE 60 m



Line 0007, CUBE 60 m



Line 0006 + 0007, CUBE 60 m

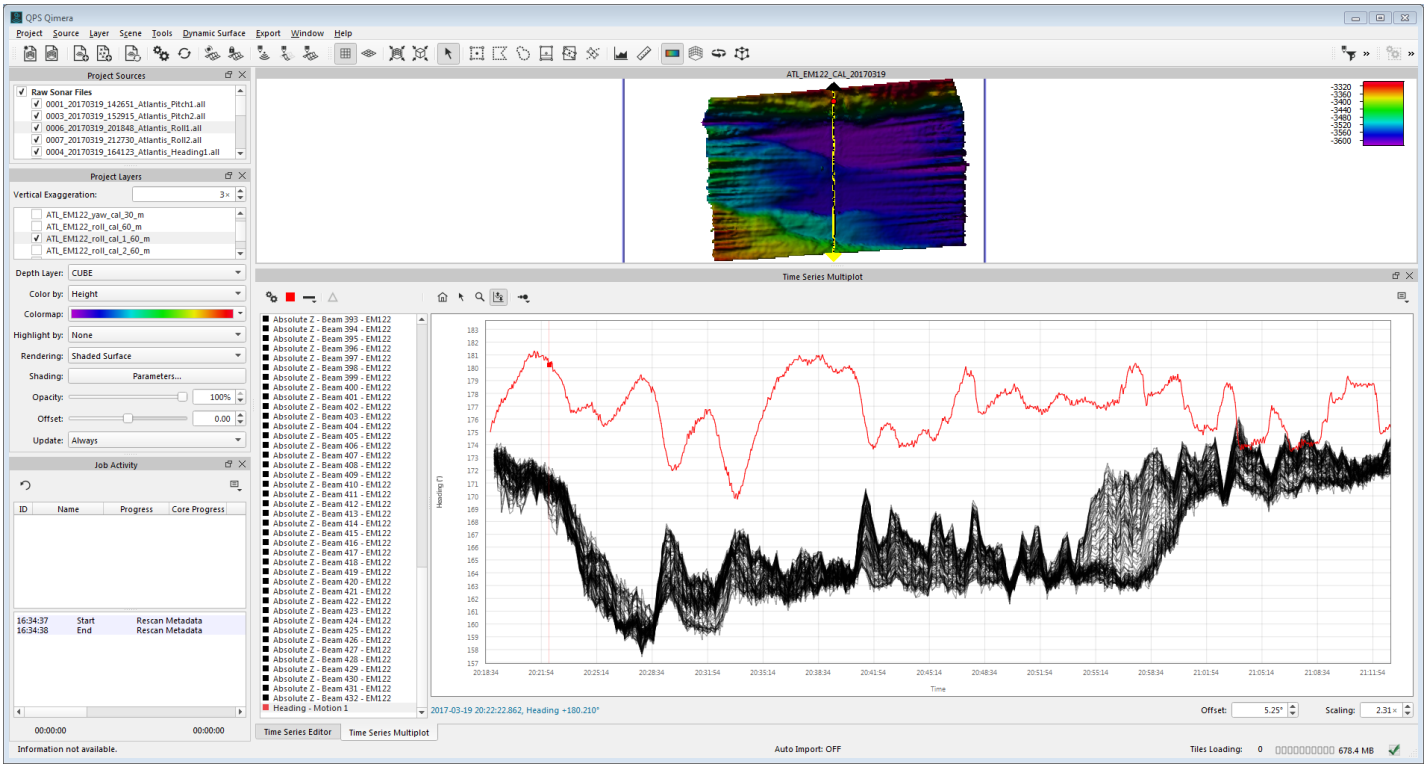


The bathymetry artifacts extend across the swath, with port side up when starboard side is down, and vice versa. These are not refraction, pitch, or roll artifacts, judging from the behavior of the bias across the swath and the lack of correlation between the biases and the high-frequency pitch and roll time series. The biases observed during the calibration appear similar in nature to previous (lower-amplitude) observations dating back to 2012 (and possibly earlier). Importantly, the artifacts have periods of several minutes (many times the roll and pitch periods, and many ping cycles).

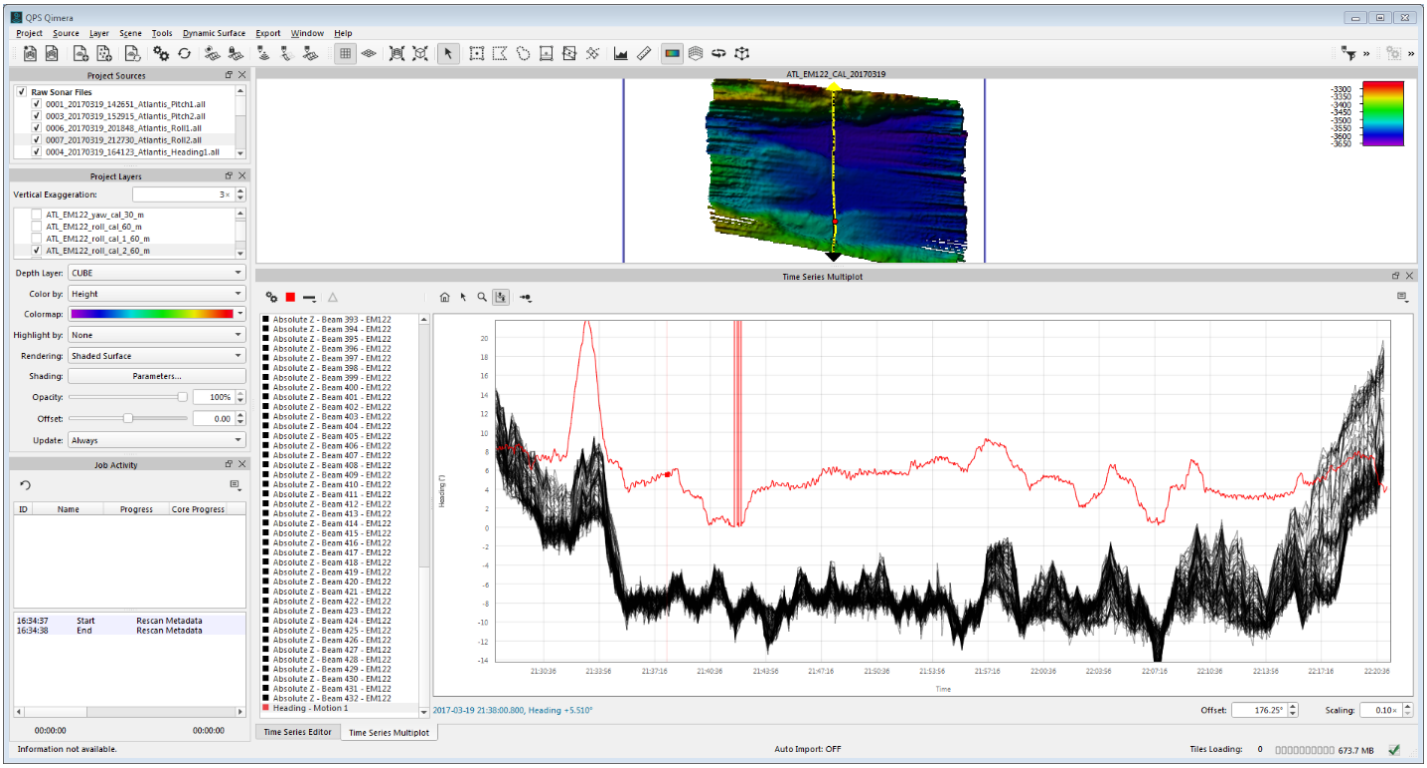
After much scrutiny, these artifacts appear to occur exclusively during heading excursions of several degrees from the mean course. The depth biases are similar in nature to the well-known Kongsberg depth biases associated with yaw stabilization. However, those stabilization biases tend to occur in other installations only during major heading changes over short time scales (e.g., turns at ends of survey lines), not long-period wandering of the vessel of several degrees about its mean heading as seen on Atlantis.

The plots below show this relationship fairly clearly: absolute depths for RX beams 322-432 (black, corresponding to the outermost starboard TX sector) are plotted versus heading (red) for each of the roll calibration lines where this artifact was most severe. Note that the artifact scales in amplitude across the swath and is not limited to the outermost sector on either side, even though only the outermost beams are plotted for clarity. In both examples, the similar timing of heading changes and depth artifacts is clear.

Roll Line 1



Roll Line 2

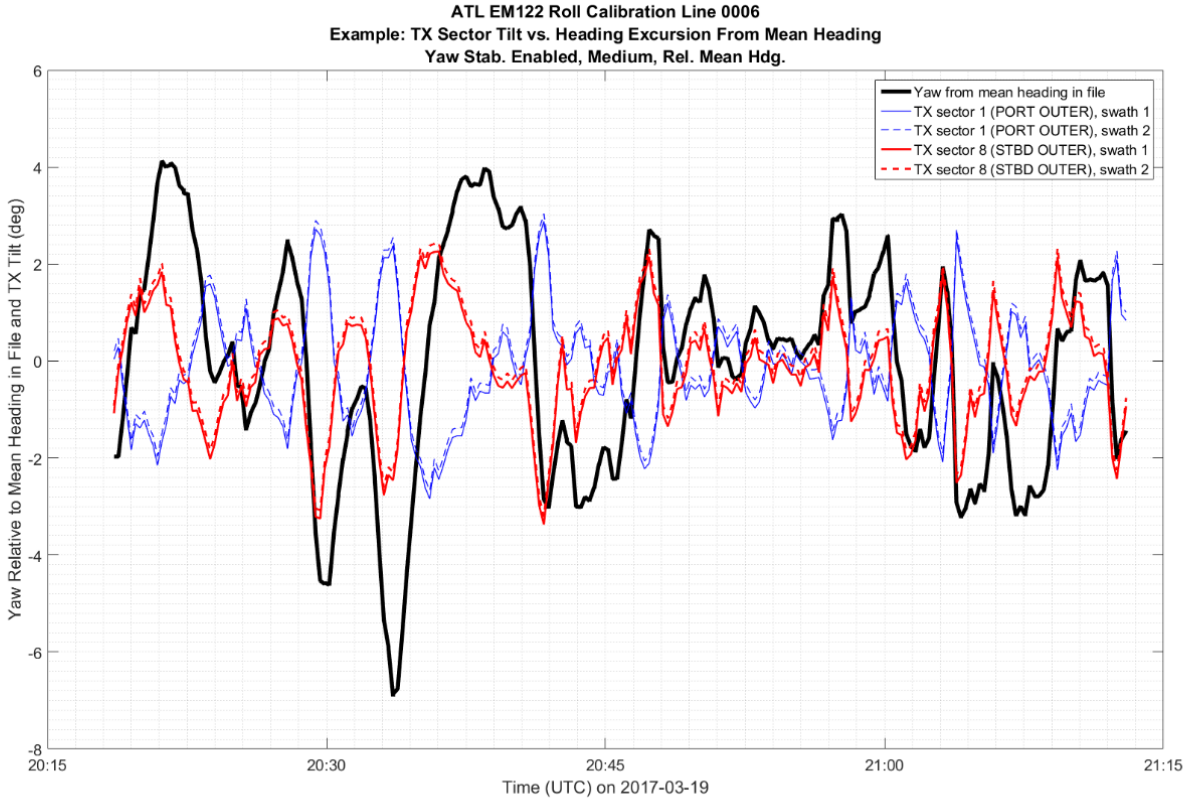


Relationship between yaw, TX tilt, and sounding spacing

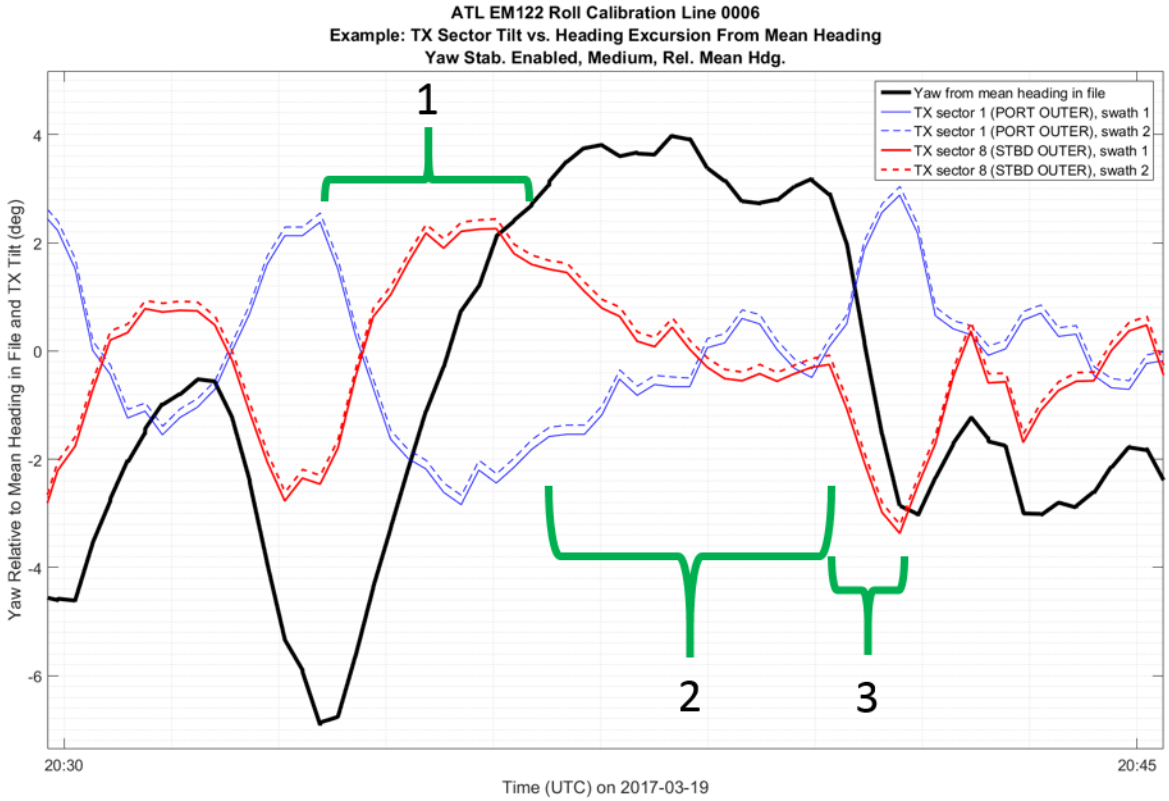
It is assumed that yaw stabilization relative to a mean heading uses a certain time window to establish that mean heading reference, and that this mean heading reference is updated continually during data collection. This is why we disable yaw stabilization during turns, then re-enable at the start of a new line: to reset the heading reference using a new time window starting on the new line.

In the simplest of terms, and not knowing much else about how the EM122 determines the reference to use as its mean heading, the EM122 is attempting to compensate for yaw by steering the TX sectors in the correct directions. Previous testing (October 2016) showed that yaw stabilization did improve the uniformity of sounding spacing when yaw amplitudes were small but did not seem to affect the depth artifacts. The plots below show the alongtrack TX tilt for the outermost port and starboard sectors and the yaw relative to the mean heading in the first example roll calibration line.

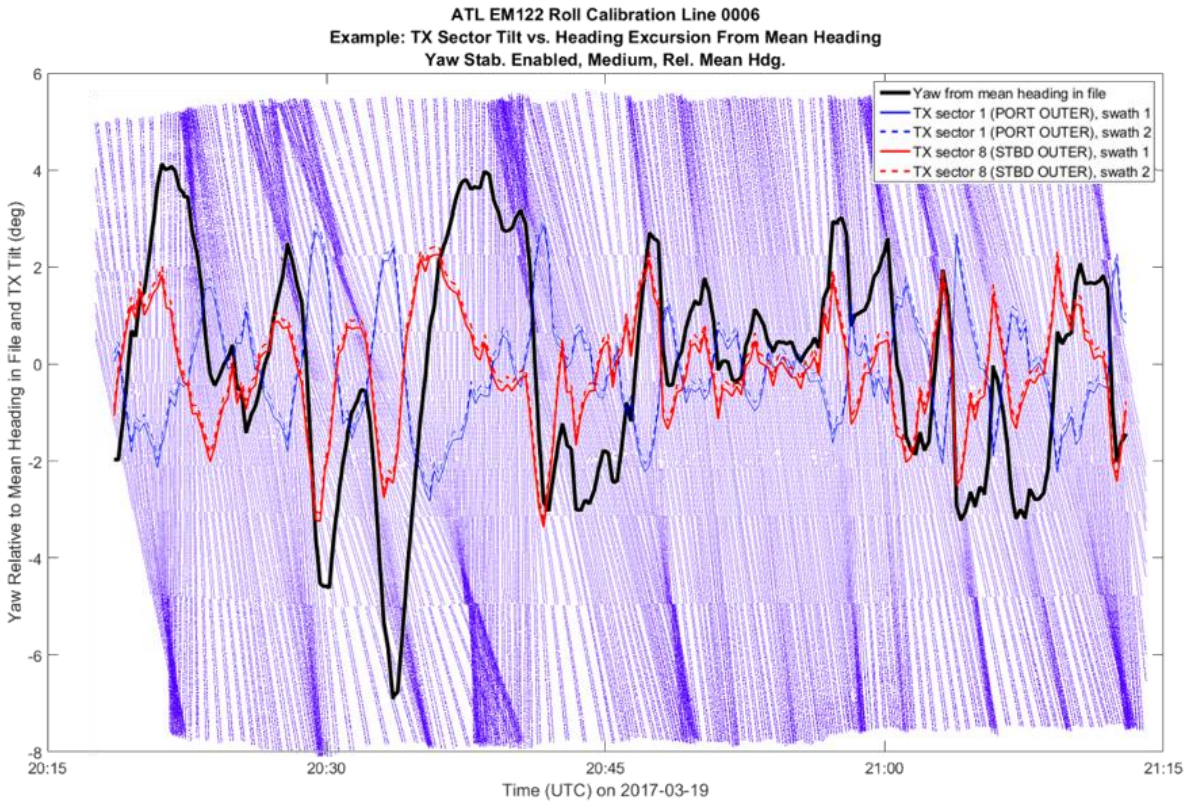
These time series show that the port outermost sector (blue) was correctly steered aft (negative tilt) when the heading changed positively (bow movement to starboard, positive compass direction) and steered forward (positive tilt) when the heading changed negatively (bow movement to port). The starboard outermost sector responds correctly in opposite fashion, as expected for yaw stabilization across the swath. Plots of the other six TX sectors (not shown below) indicated that all other sectors across the swath responded in the correct directions, with tilt amplitudes scaling with their across-swath position and approaching zero toward nadir, as expected.



Zooming in on a few heading excursions shows the TX tilt behavior more clearly. Section 1 shows an 11 degree change in ship's heading over four minutes from ~20:33 to ~20:37, which drives a 4 degree change in TX tilt. Section 2 shows the expected decay of the tilt angles back toward zero as the vessel settles onto a new heading (from ~20:37 through ~20:40, when yaw settles at ~+4 deg. rel. mean heading). Rapid changes in TX tilt are then seen in Section 3 when the vessel again starts to stray from this new 'settled' heading (e.g., sharp direction change from ~+4 to ~-3 deg. rel. mean heading from ~20:40 to ~20:41).



We have focused on these examples because the calibration data collected on March 19, 2017, demonstrate the artifact that we have been chasing in a much greater amplitude than previously seen. While the directional behavior of the TX tilt appears to be correct for attempted yaw stabilization, it seems that the yaw stabilization is possibly using an incorrect mean heading reference, over-reacting to the real-time heading difference from that reference, or suffering from a timing discrepancy. This is more plainly obvious in the resulting sounding spacing. The plot below shows the heading and TX tilt time series (identical to above) over a top-down view of the soundings in that file to show the direct relationship between these yaw events, TX tilt (only outermost sectors shown, as above), and the highly uneven spacing of soundings on the seafloor.



Questions based on these observations and prior testing

At this point, we have examined the calibration data and arrived at initial results that seem reasonable (see 'ATL EM122 calibration 20170319' notes and results). This calibration was simply the next step in a troubleshooting process that has analyzed the vessel surveys, SIS configuration, PHINS configuration, and several test data sets using a variety of EM runtime and installation parameters, and verified the transducer array offsets. We admittedly have limited experience with PHINS systems and have relied heavily on WHOI expertise in assessing the quality of position and attitude data fed to the EM122. The PU Parameters that were applied during calibration are presented below for reference.

The following questions come to mind for 'next steps' with iXBlue and/or Kongsberg:

1. Can the PHINS attitude time series be exported directly? This would allow direct comparison to the attitude received by the EM122 and recorded in the .all files.

2. If possible, please run BISTs and collect an hour or two of EM122 data (passive mode) while tied up dockside before the next transit. Please also export PHINS time series for this period if possible.

3. What is the calibration / maintenance interval for the PHINS IMU, and when was it last serviced?

4. How does the PHINS produce heading? All other surface position/attitude systems feeding multibeam sonars in our experience use antenna phase measurements to improve accuracy, so this seems to be an area requiring clarification from iXBlue.

PU PARAMETERS DURING CALIBRATION

#// Database Parameters

#// Seafloor Information System
#// Kongsberg Maritime AS
#// Saved: 2017.03.19 13:27:22

#// Build info:
#* SIS: [Version: 4.3.2, Build: 31, DBVersion 30.0 CD generated: Wed Feb 24 08:46:59 2016]
[Fox ver = 1.6.47]
[db ver = 30, proc = 30.0]
[OTL = 4.1.61]
[ACE ver = 5.8.3]
[Coin ver = 2.5.0]
[Simage ver = 1.6.2a]
[Dime ver = DIME v0.9]
[FreeType ver = 2.3.7]
[TIFF ver = 3.9.2]
[GeoTIFF ver = 1250]
[GridEngine ver = 3.1.6.1]

#* Language [3] #// Current language, 1-Norwegian, 2-German,3-English, 4-Spanish|Remember to restart SIS after a change.
German is currently not available.

#* Type [122]
#* Serial no. [118]
#* Number of heads [2]
#* System descriptor [83886082] #// 05000002

#// **
#{ User comment #//

Automatically generated PU parameter backup file for EM122.

#} User comment

#// **

#// **
#// Installation parameters

#{ Input Setup #// All Input setup parameters

  #{ COM1 #// Link settings.

    #{ Com. settings #// Serial line parameter settings.
      #* Baud rate: [19200]
      #* Data bits [8]
      #* Stop bits: [1]
      #* Parity: [NONE]
      #* Interface: [RS232]
    #} Com. settings

    #{ Position #// Position input settings.
      #* None [1] [0]
      #* GGK [1] [0]
      #* GGA [1] [1]
      #* GGA_RTK [1] [0]
      #* SIMRAD90 [1] [0]
    #} Position

    #{ Input Formats #// Format input settings.
      #* Attitude [0] [0]
      #* MK39 Mod2 Attitude, [0] [0]
      #* ZDA Clock [1] [1]

```
    #* HDT Heading         [0] [0]
    #* SKR82 Heading       [0] [0]
    #* DBS Depth           [1] [0]
    #* DPT Depth           [1] [0]
    #* EA500 Depth         [0] [0]
    #* ROV. depth          [0] [0]
    #* Height, special purp [1] [0]
    #* Attitude/Velocity    [0] [0]
  #} Input Formats

#} COM1

#{ COM2 #// Link settings.

  #{ Com. settings #// Serial line parameter settings.
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    #* Data bits           [8]
    #* Stop bits:          [1]
    #* Parity:             [NONE]
    #* Interface:          [RS232]
  #} Com. settings

  #{ Position #// Position input settings.
    #* None                [0] [1]
    #* GGK                 [0] [0]
    #* GGA                 [0] [0]
    #* GGA_RTK             [0] [0]
    #* SIMRAD90            [0] [0]
  #} Position

  #{ Input Formats #// Format input settings.
    #* Attitude            [1] [1]
    #* MK39 Mod2 Attitude,  [0] [0]
    #* ZDA Clock           [0] [0]
    #* HDT Heading         [0] [0]
    #* SKR82 Heading       [0] [0]
    #* DBS Depth           [0] [0]
    #* DPT Depth           [0] [0]
    #* EA500 Depth         [0] [0]
    #* ROV. depth          [0] [0]
    #* Height, special purp [0] [0]
    #* Attitude/Velocity    [0] [0]
  #} Input Formats

#} COM2

#{ COM3 #// Link settings.

  #{ Com. settings #// Serial line parameter settings.
    #* Baud rate:          [4800]
    #* Data bits           [8]
    #* Stop bits:          [1]
    #* Parity:             [NONE]
    #* Interface:          [RS232]
  #} Com. settings

  #{ Position #// Position input settings.
    #* None                [1] [1]
    #* GGK                 [1] [0]
    #* GGA                 [1] [0]
    #* GGA_RTK             [1] [0]
    #* SIMRAD90            [1] [0]
  #} Position

  #{ Input Formats #// Format input settings.
    #* Attitude            [0] [0]
    #* MK39 Mod2 Attitude,  [0] [0]
    #* ZDA Clock           [0] [0]
```

```
    #* HDT Heading         [1] [1]
    #* SKR82 Heading       [0] [0]
    #* DBS Depth           [1] [0]
    #* DPT Depth           [1] [0]
    #* EA500 Depth         [0] [0]
    #* ROV. depth          [0] [0]
    #* Height, special purp [1] [0]
    #* Attitude/Velocity    [0] [0]
  #} Input Formats

#} COM3

#{ COM4 #// Link settings.

  #{ Com. settings #// Serial line parameter settings.
    #* Baud rate:          [4800]
    #* Data bits           [8]
    #* Stop bits:          [1]
    #* Parity:             [NONE]
    #* Interface:          [RS232]
  #} Com. settings

  #{ Position #// Position input settings.
    #* None                [1] [1]
    #* GGK                 [1] [0]
    #* GGA                 [1] [0]
    #* GGA_RTK             [1] [0]
    #* SIMRAD90            [1] [0]
  #} Position

  #{ Input Formats #// Format input settings.
    #* Attitude            [0] [0]
    #* MK39 Mod2 Attitude,  [0] [0]
    #* ZDA Clock           [0] [0]
    #* HDT Heading         [0] [0]
    #* SKR82 Heading       [0] [0]
    #* DBS Depth           [1] [0]
    #* DPT Depth           [1] [0]
    #* EA500 Depth         [0] [0]
    #* ROV. depth          [0] [0]
    #* Height, special purp [1] [0]
    #* Attitude/Velocity    [0] [0]
  #} Input Formats

#} COM4

#{ UDP2 #// Link settings.

  #{ Com. settings #// Serial line parameter settings.
    #// N/A
  #} Com. settings

  #{ Position #// Position input settings.
    #* None                [1] [1]
    #* GGK                 [1] [0]
    #* GGA                 [1] [0]
    #* GGA_RTK             [1] [0]
    #* SIMRAD90            [1] [0]
  #} Position

  #{ Input Formats #// Format input settings.
    #* Attitude            [0] [0]
    #* MK39 Mod2 Attitude,  [0] [0]
    #* ZDA Clock           [0] [0]
    #* HDT Heading         [0] [0]
    #* SKR82 Heading       [0] [0]
    #* DBS Depth           [0] [0]
    #* DPT Depth           [0] [0]
```

```
    #* EA500 Depth         [1] [0]
    #* ROV. depth          [0] [0]
    #* Height, special purp [0] [0]
    #* Attitude/Velocity    [0] [0]
  #} Input Formats

#} UDP2

#{ UDP3 #// Link settings.

  #{ Com. settings #// Serial line parameter settings.
    #// N/A
  #} Com. settings

  #{ Position #// Position input settings.
    #* None               [0] [1]
    #* GGK                [0] [0]
    #* GGA                [0] [0]
    #* GGA_RTK            [0] [0]
    #* SIMRAD90           [0] [0]
  #} Position

  #{ Input Formats #// Format input settings.
    #* Attitude           [0] [0]
    #* MK39 Mod2 Attitude,  [0] [0]
    #* ZDA Clock          [0] [0]
    #* HDT Heading         [1] [0]
    #* SKR82 Heading       [0] [0]
    #* DBS Depth          [1] [0]
    #* DPT Depth          [1] [0]
    #* EA500 Depth         [0] [0]
    #* ROV. depth          [0] [0]
    #* Height, special purp [1] [0]
    #* Attitude/Velocity    [0] [0]
  #} Input Formats

#} UDP3

#{ UDP4 #// Link settings.

  #{ Com. settings #// Serial line parameter settings.
    #// N/A
  #} Com. settings

  #{ Position #// Position input settings.
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    #* GGK                [0] [0]
    #* GGA                [0] [0]
    #* GGA_RTK            [0] [0]
    #* SIMRAD90           [0] [0]
  #} Position

  #{ Input Formats #// Format input settings.
    #* Attitude           [1] [0]
    #* MK39 Mod2 Attitude,  [0] [0]
    #* ZDA Clock          [0] [0]
    #* HDT Heading         [1] [0]
    #* SKR82 Heading       [0] [0]
    #* DBS Depth          [1] [0]
    #* DPT Depth          [1] [0]
    #* EA500 Depth         [0] [0]
    #* ROV. depth          [0] [0]
    #* Height, special purp [1] [0]
    #* Attitude/Velocity    [0] [0]
  #} Input Formats

#} UDP4
```

```
#{ UDP5 #// Link settings.

  #{ Com. settings #// Serial line parameter settings.
    #// N/A
  #} Com. settings

  #{ Position #// Position input settings.
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    #* GGK               [0] [0]
    #* GGA               [0] [0]
    #* GGA_RTK           [0] [0]
    #* SIMRAD90          [0] [0]
  #} Position

  #{ Input Formats #// Format input settings.
    #* Attitude          [0] [0]
    #* MK39 Mod2 Attitude,  [0] [0]
    #* ZDA Clock          [0] [0]
    #* HDT Heading        [0] [0]
    #* SKR82 Heading      [0] [0]
    #* DBS Depth          [0] [0]
    #* DPT Depth          [0] [0]
    #* EA500 Depth        [0] [0]
    #* ROV. depth         [0] [0]
    #* Height, special purp [0] [0]
    #* Attitude/Velocity   [1] [1]
  #} Input Formats

  #{ Ethernet Interface Settings #// Only relevant for UDP5 on EM 122, EM 302, EM 710, EM 712,  EM 2040, EM 2040C, EM 2040Q, EM 2040P currently
    #* VSU               [8120] #// UDP5:
    #* VSE               [2] #// 0= Not in use, 1= Use legacy Ethernet, 2=Use Ethernet 2
    #* VSI               [192.168.36.102] #// IP addr.:
    #* VSM               [255.255.0.0] #// Net mask:
  #} Ethernet Interface Settings

#} UDP5

#{ UDP6 #// Link settings.

  #{ Com. settings #// Serial line parameter settings.
    #// N/A
  #} Com. settings

  #{ Position #// Position input settings.
    #* None              [0] [0]
    #* GGK               [0] [0]
    #* GGA               [0] [0]
    #* GGA_RTK           [0] [0]
    #* SIMRAD90          [0] [0]
  #} Position

  #{ Input Formats #// Format input settings.
    #* Attitude          [0] [0]
    #* MK39 Mod2 Attitude,  [0] [0]
    #* ZDA Clock          [0] [0]
    #* HDT Heading        [0] [0]
    #* SKR82 Heading      [0] [0]
    #* DBS Depth          [0] [0]
    #* DPT Depth          [0] [0]
    #* EA500 Depth        [0] [0]
    #* ROV. depth         [0] [0]
    #* Height, special purp [0] [0]
    #* Attitude/Velocity   [1] [0]
  #} Input Formats

  #{ Ethernet Interface Settings #// Only relevant for UDP6 on EM 122, EM 302, EM 710, EM 712, EM 2040, EM 2040C, EM 2040Q, EM2040P currently
    #* VTU               [3000] #// UDP6:
    #* VTE               [0] #// 0= Not in use, 1= Use legacy Ethernet, 2=Use Ethernet 2
```

```
    #* VSI              [192.168.36.102] #// IP addr.:
    #* VSM              [255.255.0.0] #// Net mask:
  #} Ethernet Interface Settings

#} UDP6

#{ MCAST1 #// Link settings.

  #{ Com. settings #// Serial line parameter settings.
    #// N/A
  #} Com. settings

  #{ Position #// Position input settings.
    #* None             [1] [1]
    #* GGK              [0] [0]
    #* GGA              [0] [0]
    #* GGA_RTK          [0] [0]
    #* SIMRAD90         [0] [0]
  #} Position

  #{ Input Formats #// Format input settings.
    #* Attitude         [0] [0]
    #* MK39 Mod2 Attitude,  [0] [0]
    #* ZDA Clock        [0] [0]
    #* HDT Heading      [0] [0]
    #* SKR82 Heading    [0] [0]
    #* DBS Depth        [0] [0]
    #* DPT Depth        [0] [0]
    #* EA500 Depth      [0] [0]
    #* ROV. depth       [0] [0]
    #* Height, special purp [0] [0]
    #* Attitude/Velocity    [1] [0]
  #} Input Formats

#} MCAST1

#{ MCAST2 #// Link settings.

  #{ Com. settings #// Serial line parameter settings.
    #// N/A
  #} Com. settings

  #{ Position #// Position input settings.
    #* None             [1] [1]
    #* GGK              [1] [0]
    #* GGA              [1] [0]
    #* GGA_RTK          [1] [0]
    #* SIMRAD90         [1] [0]
  #} Position

  #{ Input Formats #// Format input settings.
    #* Attitude         [0] [0]
    #* MK39 Mod2 Attitude,  [0] [0]
    #* ZDA Clock        [0] [0]
    #* HDT Heading      [0] [0]
    #* SKR82 Heading    [0] [0]
    #* DBS Depth        [0] [0]
    #* DPT Depth        [0] [0]
    #* EA500 Depth      [0] [0]
    #* ROV. depth       [0] [0]
    #* Height, special purp [0] [0]
    #* Attitude/Velocity    [1] [0]
  #} Input Formats

#} MCAST2

#{ MCAST3 #// Link settings.
```

```
  #{ Com. settings #// Serial line parameter settings.
    #// N/A
  #} Com. settings

  #{ Position #// Position input settings.
    #* None              [1] [1]
    #* GGK               [1] [0]
    #* GGA               [1] [0]
    #* GGA_RTK           [1] [0]
    #* SIMRAD90          [1] [0]
  #} Position

  #{ Input Formats #// Format input settings.
    #* Attitude          [0] [0]
    #* MK39 Mod2 Attitude,  [0] [0]
    #* ZDA Clock         [0] [0]
    #* HDT Heading       [0] [0]
    #* SKR82 Heading     [0] [0]
    #* DBS Depth         [0] [0]
    #* DPT Depth         [0] [0]
    #* EA500 Depth       [0] [0]
    #* ROV. depth        [0] [0]
    #* Height, special purp [0] [0]
    #* Attitude/Velocity   [1] [0]
  #} Input Formats

#} MCAST3

#{ MCAST4 #// Link settings.

  #{ Com. settings #// Serial line parameter settings.
    #// N/A
  #} Com. settings

  #{ Position #// Position input settings.
    #* None              [0] [1]
    #* GGK               [0] [0]
    #* GGA               [0] [0]
    #* GGA_RTK           [0] [0]
    #* SIMRAD90          [0] [0]
  #} Position

  #{ Input Formats #// Format input settings.
    #* Attitude          [0] [0]
    #* MK39 Mod2 Attitude,  [0] [0]
    #* ZDA Clock         [0] [0]
    #* HDT Heading       [0] [0]
    #* SKR82 Heading     [0] [0]
    #* DBS Depth         [0] [0]
    #* DPT Depth         [0] [0]
    #* EA500 Depth       [0] [0]
    #* ROV. depth        [0] [0]
    #* Height, special purp [0] [0]
    #* Attitude/Velocity   [1] [0]
  #} Input Formats

#} MCAST4

#{ MCAST5 #// Link settings.

  #{ Com. settings #// Serial line parameter settings.
    #// N/A
  #} Com. settings

  #{ Position #// Position input settings.
    #* None              [1] [0]
    #* GGK               [1] [0]
    #* GGA               [1] [0]
```

```
    #* GGA_RTK            [1] [0]
    #* SIMRAD90           [1] [0]
  #} Position

  #{ Input Formats #// Format input settings.
    #* Attitude           [1] [0]
    #* MK39 Mod2 Attitude,  [1] [0]
    #* ZDA Clock          [1] [0]
    #* HDT Heading        [1] [0]
    #* SKR82 Heading      [1] [0]
    #* DBS Depth          [1] [0]
    #* DPT Depth          [1] [0]
    #* EA500 Depth        [1] [0]
    #* ROV. depth         [0] [0]
    #* Height, special purp [1] [0]
    #* Attitude/Velocity   [1] [0]
  #} Input Formats

#} MCAST5


#{ Misc. #// Misc. input settings.
  #* External Trigger    [1] [0]
#} Misc.

#} Input Setup

#{ Output Setup #// All Output setup parameters

  #* Log watercolumn to s [1] [1]

  #{ Host UDP1 #// Host UDP1 Port: 16100

    #{ Datagram subscription #//
      #* Depth             [0] [0]
      #* Raw range and beam a [0] [0]
      #* Seabed Image       [0] [0]
      #* Central Beams      [0] [0]
      #* Position           [0] [0]
      #* Attitude           [0] [0]
      #* Heading            [0] [0]
      #* Height             [0] [0]
      #* Clock              [0] [0]
      #* Single beam echosoun [0] [0]
      #* Sound Speed Profile  [0] [1]
      #* Runtime Parameters   [0] [1]
      #* Installation Paramet [0] [1]
      #* BIST Reply          [0] [1]
      #* Status parameters    [0] [1]
      #* PU Broadcast        [0] [0]
      #* Detection quality    [0] [0]
      #* Stave Display       [0] [0]
      #* Water Column        [0] [0]
      #* Internal, Range Data [0] [0]
      #* Internal, Scope Data [0] [0]
    #} Datagram subscription

  #} Host UDP1


  #{ Host UDP2 #// Host UDP2 Port: 16101

    #{ Datagram subscription #//
      #* Depth             [1] [1]
      #* Raw range and beam a [1] [1]
      #* Seabed Image       [1] [1]
      #* Central Beams      [0] [0]
      #* Position           [1] [1]
```

```
    #* Attitude            [1] [1]
    #* Heading             [1] [1]
    #* Height              [1] [1]
    #* Clock               [1] [1]
    #* Single beam echosoun [1] [1]
    #* Sound Speed Profile  [0] [1]
    #* Runtime Parameters   [0] [1]
    #* Installation Paramet [0] [1]
    #* BIST Reply          [1] [1]
    #* Status parameters    [0] [1]
    #* PU Broadcast        [1] [0]
    #* Detection quality    [1] [0]
    #* Stave Display        [0] [1]
    #* Water Column         [0] [1]
    #* Internal, Range Data [1] [0]
    #* Internal, Scope Data [1] [0]
  #} Datagram subscription

#} Host UDP2


#{ Host UDP3 #// Host UDP3 Port: 16102

  #{ Datagram subscription #//
    #* Depth               [0] [1]
    #* Raw range and beam a [0] [0]
    #* Seabed Image        [0] [0]
    #* Central Beams       [0] [0]
    #* Position            [0] [0]
    #* Attitude            [0] [1]
    #* Heading             [0] [0]
    #* Height              [0] [1]
    #* Clock               [0] [0]
    #* Single beam echosoun [0] [1]
    #* Sound Speed Profile  [0] [1]
    #* Runtime Parameters   [0] [0]
    #* Installation Paramet [0] [1]
    #* BIST Reply          [0] [0]
    #* Status parameters    [0] [0]
    #* PU Broadcast        [0] [0]
    #* Detection quality    [0] [1]
    #* Stave Display        [0] [0]
    #* Water Column         [0] [0]
    #* Internal, Range Data [0] [0]
    #* Internal, Scope Data [0] [1]
  #} Datagram subscription

#} Host UDP3


#{ Host UDP4 #// Host UDP4 Port 16103

  #{ Datagram subscription #//
    #* Depth               [1] [1]
    #* Raw range and beam a [1] [0]
    #* Seabed Image        [1] [0]
    #* Central Beams       [0] [0]
    #* Position            [1] [1]
    #* Attitude            [1] [0]
    #* Heading             [1] [0]
    #* Height              [1] [0]
    #* Clock               [1] [0]
    #* Single beam echosoun [1] [0]
    #* Sound Speed Profile  [1] [1]
    #* Runtime Parameters   [1] [0]
    #* Installation Paramet [1] [0]
    #* BIST Reply          [1] [0]
    #* Status parameters    [1] [0]
```

```
      #* PU Broadcast        [1] [0]
      #* Detection quality    [1] [0]
      #* Stave Display       [1] [0]
      #* Water Column        [1] [0]
      #* Internal, Range Data [1] [0]
      #* Internal, Scope Data [1] [0]
    #} Datagram subscription

  #} Host UDP4


  #{ Watercolumn #// Host UDP4 Port 16103

    #{ Datagram subscription #//
      #* Depth              [1] [0]
      #* Raw range and beam a [1] [0]
      #* Seabed Image        [1] [0]
      #* Central Beams       [1] [0]
      #* Position           [1] [0]
      #* Attitude           [1] [0]
      #* Heading            [1] [0]
      #* Height             [1] [0]
      #* Clock              [1] [0]
      #* Single beam echosoun [1] [0]
      #* Sound Speed Profile  [1] [0]
      #* Runtime Parameters   [1] [0]
      #* Installation Paramet [1] [0]
      #* BIST Reply          [1] [0]
      #* Status parameters    [1] [0]
      #* PU Broadcast        [1] [0]
      #* Detection quality    [1] [0]
      #* Stave Display       [1] [0]
      #* Water Column        [1] [1]
      #* Internal, Range Data [1] [0]
      #* Internal, Scope Data [1] [0]
    #} Datagram subscription

  #} Watercolumn

#} Output Setup

#{ Clock Setup #// All Clock setup parameters

  #{ Clock #// All clock settings.
    #* Source:           [1] #// External ZDA Clock
    #* 1PPS Clock Synch.   [1] #// Falling Edge
    #* Offset (sec.):      [0]
  #} Clock

#} Clock Setup

#{ Settings #// Sensor setup parameters

  #{ Positioning System Settings #// Position related settings.

    #{ COM1 #// Positioning System Ports:
      #* P1S              [1] #// Serial
      #* P1T              [1] #// Datagram
      #* P1M               [0] #// Enable position motion correction
      #* P1D              [0.00] #// Position delay (sec.):
      #* P1G              [WGS84] #// Datum:
      #* P1Q              [1] #// Enable
      #* Pos. qual. indicator [] #//
    #} COM1

  #} Positioning System Settings

  #{ Attitude Sensor Settings #// Attitude related settings.
```

```
    #{ COM2 #// Attitude Sensor Ports:
      #* MRP            [RP] #// Rotation (POSMV/MRU)
      #* MSD            [0] #// Attitude Delay (msec.):
      #* MAS            [1.00] #// Motion Sensor Roll Scaling:
    #} COM2

    #{ UDP5 #// Attitude Sensor Ports:
      #* MRP            [RP] #// Rotation (POSMV/MRU)
      #* MSD            [0] #// Attitude Delay (msec.):
      #* MAS            [1.00] #// Motion Sensor Roll Scaling:
    #} UDP5

  #} Attitude Sensor Settings

  #{ Active Sensors #//
    #* APS             [0] [COM1] #// Position:
    #* ARO             [2] [COM2] #// Attitude:
    #* AHE             [2] [COM2] #// Attitude:
    #* AHS             [2] [COM2] #// Heading:
    #* VSN             [1] [UDP5] #// Velocity:
  #} Active Sensors

#} Settings

#{ Locations #// All location parameters

  #{ Location offset (m) #//

    #{ Pos, COM1: #//
      #* P1X            [-27.26953] #// Forward (X)
      #* P1Y            [0.45374] #// Starboard (Y)
      #* P1Z            [-2.85523] #// Downward (Z)
    #} Pos, COM1:

    #{ Pos, COM3: #//
      #* P2X            [0.00] #// Forward (X)
      #* P2Y            [0.00] #// Starboard (Y)
      #* P2Z            [0.00] #// Downward (Z)
    #} Pos, COM3:

    #{ Pos, COM4/UDP2: #//
      #* P3X            [0.00] #// Forward (X)
      #* P3Y            [0.00] #// Starboard (Y)
      #* P3Z            [0.00] #// Downward (Z)
    #} Pos, COM4/UDP2:

    #{ TX Transducer: #//
      #* S1X            [-30.18129] #// Forward (X)
      #* S1Y            [-0.39007] #// Starboard (Y)
      #* S1Z            [0.42354] #// Downward (Z)
    #} TX Transducer:

    #{ RX Transducer: #//
      #* S2X            [-25.71581] #// Forward (X)
      #* S2Y            [-0.01110] #// Starboard (Y)
      #* S2Z            [0.50488] #// Downward (Z)
    #} RX Transducer:

    #{ Attitude 1, COM2/UDP5: #//
      #* MSX            [-27.26953] #// Forward (X)
      #* MSY            [0.45374] #// Starboard (Y)
      #* MSZ            [-2.85523] #// Downward (Z)
    #} Attitude 1, COM2/UDP5:

    #{ Attitude 2, COM3/UDP6: #//
      #* NSX            [0.00] #// Forward (X)
      #* NSY            [0.00] #// Starboard (Y)
```

```
      #* NSZ              [0.00] #// Downward (Z)
    #} Attitude 2, COM3/UDP6:

    #{ Waterline: #//
      #* WLZ              [-5.270] #// Downward (Z)
    #} Waterline:

  #} Location offset (m)

#} Locations

#{ Angular Offsets #// All angular offset parameters

  #{ Offset angles (deg.) #//

    #{ TX Transducer: #//
      #* S1R              [-0.1469] #// Roll
      #* S1P              [0.0581] #// Pitch
      #* S1H              [0.00568] #// Heading
      #* SonarHead1 orient.   [1] #// 1=port, 2=starb.
    #} TX Transducer:

    #{ RX Transducer: #//
      #* S2R              [-0.088] #// Roll
      #* S2P              [0.0277] #// Pitch
      #* S2H              [359.86199] #// Heading
      #* SonarHead2 orient.   [1] #// 1=forw., 2=aft
    #} RX Transducer:

    #{ Attitude 1, COM2/UDP5: #//
      #* MSR              [0] #// Roll
      #* MSP              [0] #// Pitch
      #* MSG              [0.00] #// Heading
    #} Attitude 1, COM2/UDP5:

    #{ Attitude 2, COM3/UDP6: #//
      #* NSR              [0.00] #// Roll
      #* NSP              [0.00] #// Pitch
      #* NSG              [0] #// Heading
    #} Attitude 2, COM3/UDP6:

    #{ Stand-alone Heading: #//
      #* GCG              [0.00] #// Heading
    #} Stand-alone Heading:

  #} Offset angles (deg.)

#} Angular Offsets

#{ ROV. Specific #// All ROV specific parameters

  #{ Depth/Pressure Sensor #//
    #* DSF              [1.00] #// Scaling:
    #* DSO              [0.00] #// Offset:
    #* DSD              [0] #// Delay (msec.):
    #* DSH              [NI] #// Disable Heave Sensor
  #} Depth/Pressure Sensor

#} ROV. Specific

#{ System Parameters #// All system parameters

  #{ System Gain Offset #//
    #* GO1              [0.0] #// BS Offset (dB)
  #} System Gain Offset

  #{ Opening angles #//
    #* S1S              [1] #// TX Opening angle: 1
```

```
    #* S2S             [1] #// RX Opening angle: 1
  #} Opening angles

  #{ Misc. parameters #//
    #* SNL             [0] #// Ship's noise level: NORMAL
  #} Misc. parameters

#} System Parameters

#// ********************************************************************
#// Runtime parameters


#{ Sounder Main #//

  #{ Sector Coverage #//

    #{ Max. angle (deg.): #//
      #* MPA           [30] #// Port
      #* MSA           [30] #// Starboard
    #} Max. angle (deg.):

    #{ Max. Coverage (m): #//
      #* MPC           [30000] #// Port
      #* MSC           [30000] #// Starboard
    #} Max. Coverage (m):

    #* ACM             [1] #// Angular Coverage mode: AUTO
    #* BSP             [2] #// Beam Spacing: HD EQDST

  #} Sector Coverage

  #{ Depth Settings #//
    #* FDE             [3000] #// Force Depth (m):
    #* MID             [500] #// Min. Depth (m):
    #* MAD             [2500] #// Max. Depth (m):
    #* DSM             [2] #// Dual swath mode: DYNAMIC
    #* PMO             [0] #// Ping Mode: AUTO
    #* FME             [1] #// FM disable
  #} Depth Settings

  #{ Stabilization #//
#// For EM 122, EM 302, EM 710, EM 712, EM 2040, EM 2040C, EM 2040Q, EM 2040P this block is now called Transmit Control in SIS GUI.
    #* YPS             [1] #// Pitch stabilization
    #* MPK             [0.0] #// Min. Swath Dist. (m):       Required minimum distance between individual swats. 0 is off.
    #* TXA             [0] #// Along Direction (deg.):

    #{ Yaw Stabilization #//
      #* YSM           [2] #// Mode: REL. MEAN HEADING
      #* YMA           [0] #// Heading:
      #* HFI           [1] #// Heading filter: MEDIUM
    #} Yaw Stabilization

    #{ 3D Scanning #//
      #* Enable scanning    [1] [0]
      #* SM1           [-5] #// Min. (deg.):
      #* SM2           [5] #// Max. (deg.):
      #* SCS           [0.0] #// Step (deg.):
    #} 3D Scanning

  #} Stabilization
#} Sounder Main

#{ Sound Speed #//

  #{ Sound Speed at Transducer #//
    #* SHS             [0] #// Source SENSOR
    #* SST             [15360] #// Sound Speed (dm/sec.):
```

```
    #* Sensor Offset (m/sec [0] #//
    #* Filter (sec.):      [60] #//
  #} Sound Speed at Transducer

#} Sound Speed

#{ Filter and Gains #//

  #{ Filtering #//
    #* SFS               [2] #// Spike Filter Strength: MEDIUM
    #* PEF               [1] #// Penetration Filter Strength: WEAK
    #* RGS               [1] #// Range Gate: NORMAL
    #* PHR               [1] #// Phase ramp: NORMAL
    #* SLF               [1] #// Slope
    #* AEF               [0] #// Aeration
    #* STF               [0] #// Sector Tracking
    #* IFF               [0] #// Interference
  #} Filtering

  #{ Absorption Coefficient #//
    #* Source:           [1] #// CTD profile. Note: This is not a PU parameter.
    #* ABS120            [1.255] #// 12.0 kHz
  #} Absorption Coefficient

  #{ Backscatter Adjustment #//
    #* TCA               [6] #// Normal incidence corr. (deg.):
    #* BIC               [0] #// Use Lambert's law
  #} Backscatter Adjustment


  #{ Mammal protection #//
    #* TXP               [0] #// TX power level (dB): Max.
    #* SSR               [0] #// Soft startup ramp time (min.):
  #} Mammal protection

  #{ Water Column #//
    #* WCX               [30] #// log R
    #* WCO               [20] #// dB Offset
  #} Water Column

  #{ Special Mode #//
    #* SOM               [0] #// Sonar
    #* PAM               [0] #// Passive
  #} Special Mode
#} Filter and Gains

#{ Extra Detections #//
#} Extra Detections

#{ Data Cleaning #//
  #* Number of user rules [1]
  #* User rule 1        [STANDARD] #//

  #* Active rule:       [AUTOMATIC1] #//

  #{ AUTOMATIC1 #//
    #* PingProc.maxPingCountRadius          [10]
    #* PingProc.radiusFactor                [0.050000]
    #* PingProc.medianFactor                [1.500000]
    #* PingProc.beamNumberRadius            [3]
    #* PingProc.sufficientPointCount        [40]
    #* PingProc.neighborhoodType            [Elliptical]
    #* PingProc.timeRule.use                [false]
    #* PingProc.overhangRule.use            [false]
    #* PingProc.medianRule.use              [false]
    #* PingProc.medianRule.depthFactor      [0.050000]
    #* PingProc.medianRule.minPointCount    [6]
    #* PingProc.quantileRule.use            [false]
```

```
  #* PingProc.quantileRule.quantile                [0.100000]
  #* PingProc.quantileRule.scaleFactor             [6.000000]
  #* PingProc.quantileRule.minPointCount           [40]
  #* GridProc.minPoints                           [8]
  #* GridProc.depthFactor                         [0.200000]
  #* GridProc.removeTooFewPoints                  [false]
  #* GridProc.surfaceFitting.surfaceDegree        [1]
  #* GridProc.surfaceFitting.tukeyConstant        [6.000000]
  #* GridProc.surfaceFitting.maxIteration         [10]
  #* GridProc.surfaceFitting.convCriterion        [0.010000]
  #* GridProc.surfaceDistanceDepthRule.use        [false]
  #* GridProc.surfaceDistanceDepthRule.depthFactor   [0.050000]
  #* GridProc.surfaceDistancePointRule.use        [false]
  #* GridProc.surfaceDistancePointRule.scaleFactor   [1.000000]
  #* GridProc.surfaceDistanceUnitRule.use         [false]
  #* GridProc.surfaceDistanceUnitRule.scaleFactor    [1.000000]
  #* GridProc.surfaceDistanceStDevRule.use        [false]
  #* GridProc.surfaceDistanceStDevRule.scaleFactor   [2.000000]
  #* GridProc.surfaceAngleRule.use                [false]
  #* GridProc.surfaceAngleRule.minAngle           [20.000000]
  #* SonarProc.use                                [false]
  #* SonarProc.gridSizeFactor                     [4]
  #* SonarProc.mergerType                         [Average]
  #* SonarProc.interpolatorType                   [TopHat]
  #* SonarProc.interpolatorRadius                 [1]
  #* SonarProc.fillInOnly                         [true]
#} AUTOMATIC1
#{ STANDARD #//
  #* PingProc.maxPingCountRadius                  [10]
  #* PingProc.radiusFactor                        [0.050000]
  #* PingProc.medianFactor                        [1.500000]
  #* PingProc.beamNumberRadius                    [3]
  #* PingProc.sufficientPointCount                [40]
  #* PingProc.neighborhoodType                    [Elliptical]
  #* PingProc.timeRule.use                        [false]
  #* PingProc.overhangRule.use                    [false]
  #* PingProc.medianRule.use                      [false]
  #* PingProc.medianRule.depthFactor              [0.050000]
  #* PingProc.medianRule.minPointCount            [6]
  #* PingProc.quantileRule.use                    [false]
  #* PingProc.quantileRule.quantile               [0.100000]
  #* PingProc.quantileRule.scaleFactor            [6.000000]
  #* PingProc.quantileRule.minPointCount          [40]
  #* GridProc.minPoints                           [8]
  #* GridProc.depthFactor                         [0.200000]
  #* GridProc.removeTooFewPoints                  [false]
  #* GridProc.surfaceFitting.surfaceDegree        [1]
  #* GridProc.surfaceFitting.tukeyConstant        [6.000000]
  #* GridProc.surfaceFitting.maxIteration         [10]
  #* GridProc.surfaceFitting.convCriterion        [0.010000]
  #* GridProc.surfaceDistanceDepthRule.use        [false]
  #* GridProc.surfaceDistanceDepthRule.depthFactor   [0.050000]
  #* GridProc.surfaceDistancePointRule.use        [false]
  #* GridProc.surfaceDistancePointRule.scaleFactor   [1.000000]
  #* GridProc.surfaceDistanceUnitRule.use         [false]
  #* GridProc.surfaceDistanceUnitRule.scaleFactor    [1.000000]
  #* GridProc.surfaceDistanceStDevRule.use        [false]
  #* GridProc.surfaceDistanceStDevRule.scaleFactor   [2.000000]
  #* GridProc.surfaceAngleRule.use                [false]
  #* GridProc.surfaceAngleRule.minAngle           [20.000000]
  #* SonarProc.use                                [false]
  #* SonarProc.gridSizeFactor                     [4]
  #* SonarProc.mergerType                         [Average]
  #* SonarProc.interpolatorType                   [TopHat]
  #* SonarProc.interpolatorRadius                 [1]
  #* SonarProc.fillInOnly                         [true]
#} STANDARD
```

```
  #{ Seabed Image Processing #//
    #* Seabed Image Process [1] [0]
  #} Seabed Image Processing
#} Data Cleaning

#{ Advanced param. #//
#} Advanced param.
```