**NOAA** FORM 76-35A

**U.S. DEPARTMENT OF COMMERCE**
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE

# DESCRIPTIVE REPORT

*Type of Survey* **Hydrographic**

*Field No.* **PC-13-04**

*Registry No.* **W00269**

## LOCALITY

*State* **Florida**

*General Locality* **Atlantic Ocean**

*Sublocality* **From Savannah, GA, to Port Canaveral, FL, up to 62 NM offshore**

**2013**

CHIEF OF PARTY

**Matthew J. Wilson**

## LIBRARY & ARCHIVES

DATE **9/23/2013**

NOAA FORM 77-28
(11-72)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

# HYDROGRAPHIC TITLE SHEET

REGISTRY No **W00269**

**INSTRUCTIONS** – The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.

FIELD No **PC-13-04**

State: **Florida**

General Locality: **Atlantic Ocean**

Sub-Locality: **From Savannah, GA, to Port Canaveral, FL, up to 62nm offshore.**

Scale: **N/A**

Date of Survey: **June 12th - July 31st, 2013**

Instructions dated: **N/A**

Project No.: **PC-13-04**

Vessel: **NOAA Ship Pisces**

Chief of party: **Matthew J. Wilson**

Surveyed by: **SEFIS, OCS, and College of Charleston**

Soundings by echo sounder, hand lead, pole: **Simrad ME70**

Graphic record scaled by:

Graphic record checked by:

Automated Plot:

Verification by: **Atlantic Hydrographic Branch**

Soundings in [✓ fathoms] [✓ feet] at MLW [✓ MLLW]

REMARKS: **The Simrad ME70 multibeam data was collected over hardbottom habitats as part of fishery sampling research.**

NOAA FORM 77-28 SUPERSEDES FORM C&GS-537

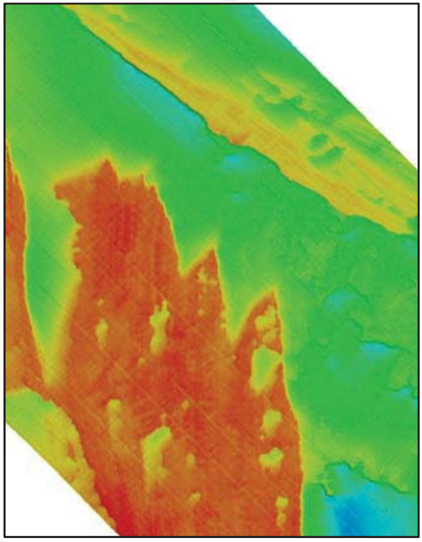
***The purpose of this survey is to provide contemporary surveys to update National Ocean Service (NOS) nautical charts. All separates are filed with the hydrographic data. Any revisions to the Descriptive Report (DR) generated during office processing are shown in bold red italic text. The processing branch maintains the DR as a field unit product, therefore, all information and recommendations within the body of the DR are considered preliminary unless otherwise noted. The final disposition of surveyed features is represented in the OCS nautical chart update products. All pertinent records for this survey, including the DR, are archived at the National Geophysical Data Center (NGDC) and can be retrieved via http://www.ngdc.noaa.gov/.***

Table of Contents Page

List of Tables Page

List of Figures Page

# NOAA Ship *Pisces* Cruise PC-13-04



## OBJECTIVES AND BACKGROUND

The objective of NOAA Ship *Pisces* during cruise PC-13-04 was to conduct applied fishery-independent research in continental shelf and shelf-break waters off the southeastern U.S., on behalf of the NMFS SEFSC Southeast Fishery-Independent Survey (SEFIS). A key focus of this research was the acoustic mapping of hardbottom, reef fish habitats using the Simrad ME70 multibeam sonar. Data were collected for non-standard hydrographic purposes, thus do not conform to required OCS specifications. **These data are hereby submitted to the National Ocean Service (NOS) Office of Coast Survey (OCS) as outside source data, should additional uses be deemed beneficial (e.g., potential nautical chart updates).**

A secondary objective of cruise PC-13-04 has been to build the capacity for the NOAA Ship *Pisces* and the SEFIS program to conduct acoustic mapping operations, and for this document to serve as a reference for such future endeavors. With this objective in mind, the report has been prepared and submitted.

Mapping operations occurred overnight (usually between 1800-0600 local time). The data were processed and assessed rapidly for immediate use. Multibeam bathymetry and backscatter geotiffs were delivered to SEFIS each morning. Maps were then used to select fish sampling sites that targeted hardbottom habitat.

Special thanks to Glen Rice (NOS HSTP) for invaluable information and advice, and ET Patrick Bergin, ST Kathy Hough, and ST Laurette Roy for their hard work and mission support. Thanks to SEFIS Chief Scientists Nathan Bacheler and Zeb Schobernd, and Commanding Officer CDR Peter Fischel and all officers and crew of NOAA Ship *Pisces*. Surveys were operated by David Berrane (SEFIS), Erik Ebert (NOS NCCOS), Dawn Glasgow (SCDNR), Neah Baechler and Robin Banner (College of Charleston), and the report authors.

This report prepared and submitted by Matthew Wilson (OCS) and Warren Mitchell (SEFIS).

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| BITE | Built-In Test Equipment |
| CTD | Conductivity Temperature Depth |
| DGPS | Differential Global Positioning System |
| FMGT | Fledermaus Geocoder Toolbox |
| GAMS | GPS Measurement Azimuth Subsystem |
| GPS | Global Positioning System |
| GSF | Generic Sensor Format |
| HDCS | Hydrographic Data Cleaning System |
| HIPS | Hydrographic Information Processing System |
| HSSD | Hydrographic Survey Specifications and Deliverables |
| HSTP | Hydrographic Systems and Technology Programs |
| HVF | HIPS Vessel File |
| IMU | Inertial Measurement Unit |
| IOCM | Integrated Ocean and Coastal Mapping |
| LNM | Local Notice to Mariners |
| MBES | Multibeam Echo Sounder |
| MLLW | Mean Lower Low Water |
| NCCOS | National Centers for Coastal and Ocean Science |
| NGS | National Geodetic Survey |
| NMFS | National Marine Fisheries Service |
| NOAA | National Oceanic and Atmospheric Administration |
| NOS | National Ocean Service |
| NTM | Notice to Mariners |
| NWLON | National Water Level Observation Network |
| OCS | Office of Coast Survey |
| POS MV | Position and Orientation System for Marine Vessels |
| SBE | Sea Bird Electronics |
| SBET | Smoothed Best Estimate of Trajectory |
| SCDNR | South Carolina Department of Natural Resources |
| SCS | Scientific Computer Systems |
| SEFSC | Southeast Fisheries Science Center |
| SEFIS | Southeast Fisheries-Independent Survey |
| XBT | Expendable Bathythermograph |
| XML | Extensible Markup Language |
| UNH-CCOM | University of New Hampshire, Center for Coastal and Ocean Mapping |

# Descriptive Report to Accompany NOAA Ship *Pisces* 2013

Project PC-13-04, OCS Registry # W00269
Savannah, Georgia, to Cape Canaveral, Florida
June 12-27, July 17-31, 2013

## A. AREA SURVEYED

The survey areas were in the southeast U.S. continental shelf waters offshore of Florida and Georgia, ranging from over 60nm east of Savannah on the northern extent, to 25nm off Cape Canaveral on the southern extent (see Figure 1). The survey consisted of complete coverage multibeam using the Simrad ME70 (fisheries MBES) over a series of boxes predetermined by SEFIS based on external information (e.g., legacy fishery-independent monitoring sites, observed commercial catches, partial bathymetry). Approximately 1700 lineal nautical miles of ME70 data were collected over the two survey legs.

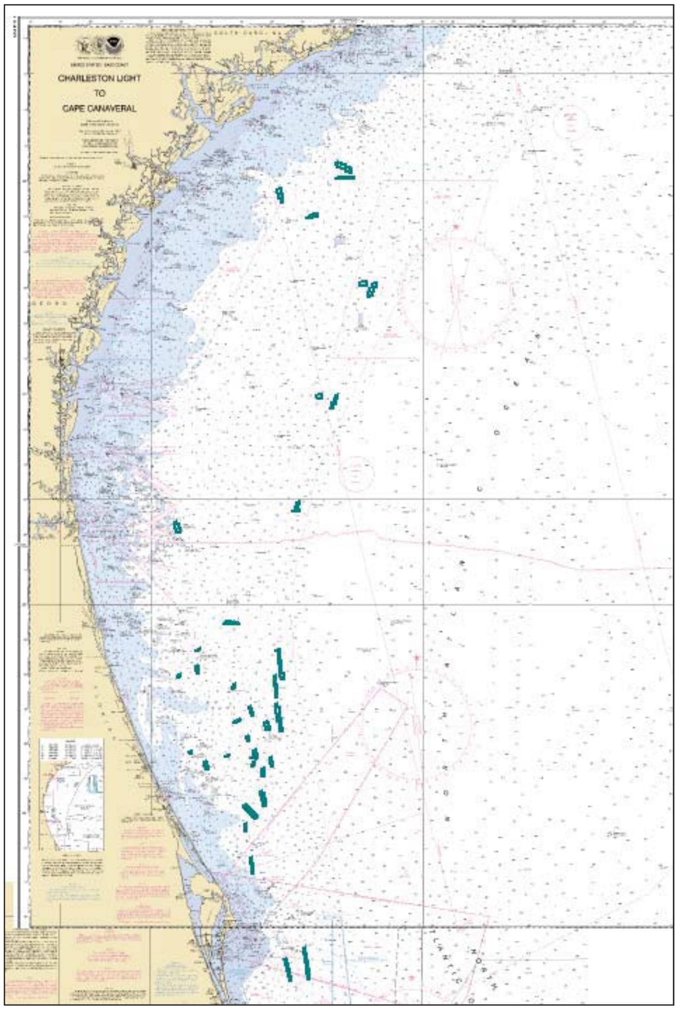


Figure 1. W00269 survey areas (NOAA Raster Charts 14480 and 11460 in background).

## B. DATA ACQUISITION AND PROCESSING

## B1. Equipment

### B1a. Vessel

Specifications for the NOAA Ship *Pisces* are listed below in Table 1.

Table 1. Vessel and equipment

| | <br>**NOAA Ship *Pisces*** |
|---|---|
| **Hull Number** | R226 |
| **Builder** | VT Halter Marine, Inc., Moss Point, MS |
| **Length** | 63.8 m (209 ft) |
| **Beam** | 15.0 m (49.2 ft) |
| **Draft (centerboard retracted)** | 6.0 m (19.4 ft) Full load |
| **Draft (centerboard extended)** | 9.05 m (29.7 ft) |
| **Cruising Speed** | 14.5 knots (16.0 knots max) |
| **Survey Speed** | 0 – 11 knots |
| **Primary Echosounder** | Simrad ME70 |
| **Sound Speed Equipment** | Seabird CTD, Sippican XBT, SBE45, SBE21 |
| **Attitude and Positioning Equipment** | Applanix POS MV V3, Leica MX420 DGPS |

### B1b. Multibeam echo sounder

The Simrad ME70 is a multibeam echo sounder designed for fishery research applications, and therefore can collect information from the full water-column while minimizing side-lobe levels (Trenkel et al. 2008). The system operates in the 70 to 120 kHz over a 150° maximum total swath width. The beam parameters of the system are configurable and designated by an XML file. Note that each of the beams can be set at a different frequency.

There were two beam configurations used during W00269, one written by Randy Cutter of the NMFS Southwest Fisheries Science Center, and one by Dr. Tom Weber from the University of New Hampshire Center for Coastal and Ocean Mapping. For display purposes, beam characteristics were read directly from example *.raw files, via Myriax Echoview fisheries acoustics software, and reformatted in spreadsheet form by Erik Ebert (NCCOS). Configurations are included in Appendix II: ME70 Beam Configurations.

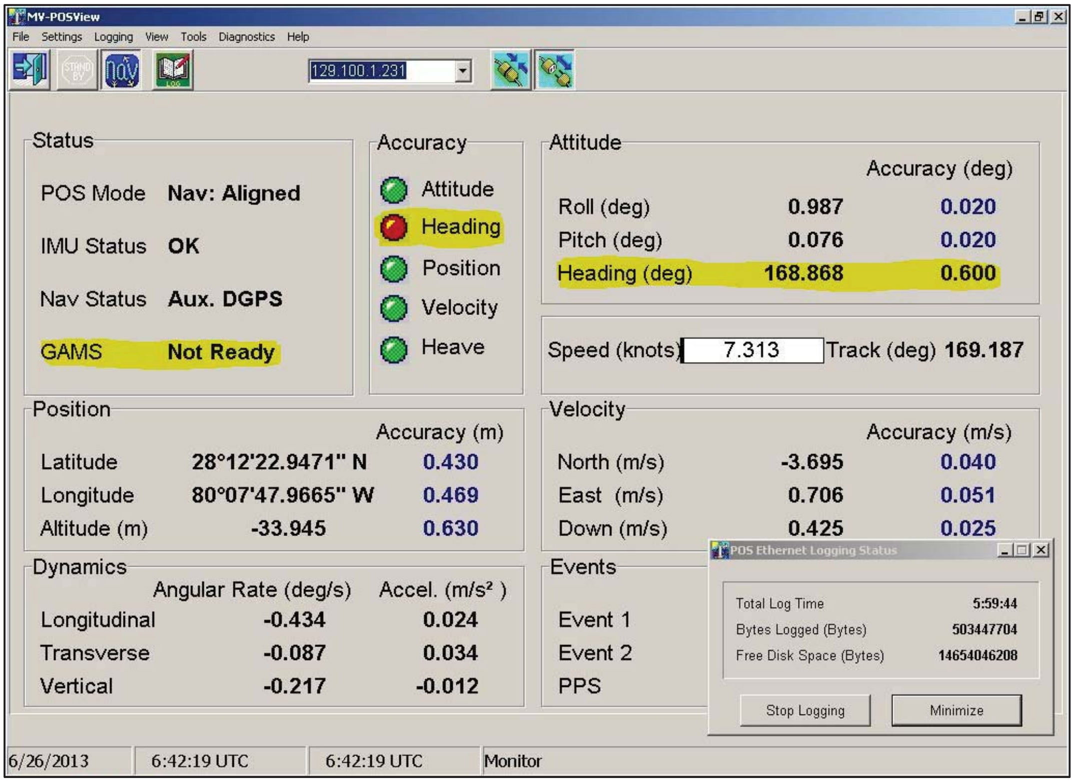
Prior to arriving to the ship, there were known issues with two of the ME70 transceiver boards, indicated by numerous errors and warnings in the acquisition software. Built-In Test Equipment (BITE) revealed numerous (30+) defective array elements. After the boards were replaced on 6/18/2013, subsequent BITE attempts showed 4-9 defective elements (see Appendix II: Vessel Documents). The ME70 Operator Manual states "... up to four defect elements show no significant degradation of performance.

### B1c. Position, heading, and motion reference systems

The POS MV system with DGPS and inertial reference system supplies attitude, heading, heave, and position. The system consists of an IMU (used as the reference point for the ship), computer system, and two GPS antennas.

*Issues affecting GAMS*

The POS MV GPS Azimuth Measurement Subsystem (GAMS) provides heading aiding to the system. A successful GAMS calibration was not achieved during W00269. In addition, the heading accuracy was routinely degraded during survey operations (Figure 2).



Status

POS Mode Nav: Aligned

IMU Status OK

Nav Status Aux. DGPS

GAMS Not Ready

Accuracy

- ● Attitude
- ● Heading
- ● Position
- ● Velocity
- ● Heave

Attitude

| | | Accuracy (deg) |
|---|---|---|
| Roll (deg) | 0.987 | 0.020 |
| Pitch (deg) | 0.076 | 0.020 |
| Heading (deg) | 168.868 | 0.600 |

Speed (knots) 7.313 Track (deg) 169.187

Position

| | | Accuracy (m) |
|---|---|---|
| Latitude | 28°12'22.9471" N | 0.430 |
| Longitude | 80°07'47.9665" W | 0.469 |
| Altitude (m) | -33.945 | 0.630 |

Velocity

| | | Accuracy (m/s) |
|---|---|---|
| North (m/s) | -3.695 | 0.040 |
| East (m/s) | 0.706 | 0.051 |
| Down (m/s) | 0.425 | 0.025 |

Dynamics

| | Angular Rate (deg/s) | Accel. (m/s²) |
|---|---|---|
| Longitudinal | -0.434 | 0.024 |
| Transverse | -0.087 | 0.034 |
| Vertical | -0.217 | -0.012 |

Events

Event 1

Event 2

PPS

POS Ethernet Logging Status

| | |
|---|---|
| Total Log Time | 5:59:44 |
| Bytes Logged (Bytes) | 503447704 |
| Free Disk Space (Bytes) | 14654046208 |

6/26/2013 6:42:19 UTC 6:42:19 UTC Monitor

Figure 2. Degraded Heading Accuracy observed during survey data acquisition (highlighted)

Last year, while underway for cruise PC-12-04, the GAMS calibration was also unsuccessful. The only recorded history of a successful GAMS calibration was in September of 2008, when the system was first installed. The original POS MV 320 Installation Report for NOAA Ship *Pisces* is included in Appendix II: Vessel Documents. However, note the original configuration for the POS MV had the ship's granite block as the reference point, so the offsets listed in this document do not correlate with the current POS MV configuration. The POS MV IMU was designated as the reference point in 2012 (prior to cruise PC-12-04), and all offsets were updated accordingly.

Contrary to the convention commonly used on hydrographic survey platforms, the POS MV was configured such that the starboard antenna was primary. This configuration is fine, so long as the lever arm offsets in POSView are set accordingly. However, a 3D offset display in Applanix POSView did not make intuitive sense, and post-processing of logged POS MV data in Applanix POSPAC showed a very large error in the IMU to Primary antenna lever arm. On July 24th, 2013, it was confirmed that the port antenna was actually designated as primary, thus making the lever arm offsets (particularly in the Y direction) incorrect. The lever arm offsets in POSView were updated (see Appendix II: Vessel Documents), and another GAMS calibration attempted; unfortunately, this too was not successful.

The POS MV user's manual specifies that it is necessary for the antennas to have clear view of the sky from horizon to horizon, which currently is not the case on NOAA Ship *Pisces*. Interference from superstructures (see Figure 3) on the flying bridge of the ship could be the cause of the intermittent degraded heading accuracy as well as the inability for the system to calibrate the GAMS. It was strongly recommended to the ship to have the POS MV antennas moved higher and away from other structures such that the requirements listed in the POS MV user manual are adhered to.

Figure 3. POS MV antenna position relative to ship superstructures.

Logged motion data from the POS MV on NOAA Ship *Pisces* was transmitted to Applanix on occasion, during both survey legs, as part of continued troubleshooting efforts.

Initially, Applanix also had concern regarding the antenna separation; however, this distance was measured again and the value of 2.942 m verified within a few mm (the closest precision possible with a tape measure).

Applanix reported an excessive number of cycle slips in both frequencies, particularly the L2, and this was attributed to environmental interference. Another concern from Applanix was that the Z gyro scale of the raw IMU readings far exceeded the maximum allowable tolerance, which could be the reason for the GAMS calibration failures. Applanix recommends the IMU be sent in for calibration, which would allow for comparison of the IMU data to the results of the manufacturer specifications. Correspondence with Applanix, including the screen captures of their observations upon analysis of the POS MV data, are included within Appendix II: Correspondence.

### *Post-processed POS MV data*

The application of the logged POS MV files (.000) for the Trueheave correction in post-processing using CARIS HIPS had no noticeable effect to the data, so this step was not regularly performed.

The POS files were regularly post-processed in Applanix POSPAC to create Smoothed Best Estimates of Trajectory (SBET). The SBETs can be used in CARIS HIPS to overwrite the real-time attitude and navigation with a more accurate solution, and also for the computation of GPS tides for use in ellipsoid referenced techniques. Neither SBET application was performed regularly, as the SBETs generally failed standard procedures for quality control and were thus considered unusable.

An example of an unusable SBET is shown below in Figure 4. The noise in the altitude during lines of acquisition initially is on the order of meters, and then settles to 0.5-1m. During these times such noise is considered too high for applications in post-processing. Applanix commented that the SBET failure is likely related to antenna interference and/or the high Z gyro scale error, both discussed above (also see Appendix II: Correspondence).

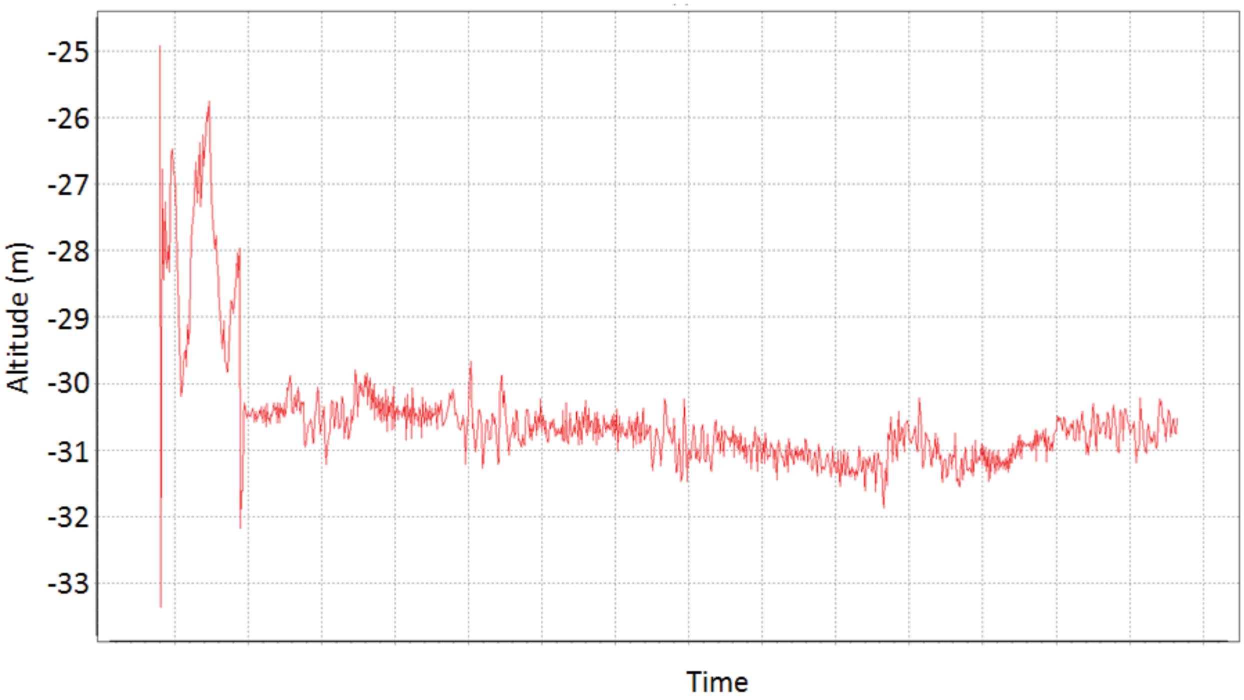


Figure 4. Unusable ellipsoid altitudes during lines of acquisition.

### B1d. Sound speed equipment

*Real-time transducer sound speed*

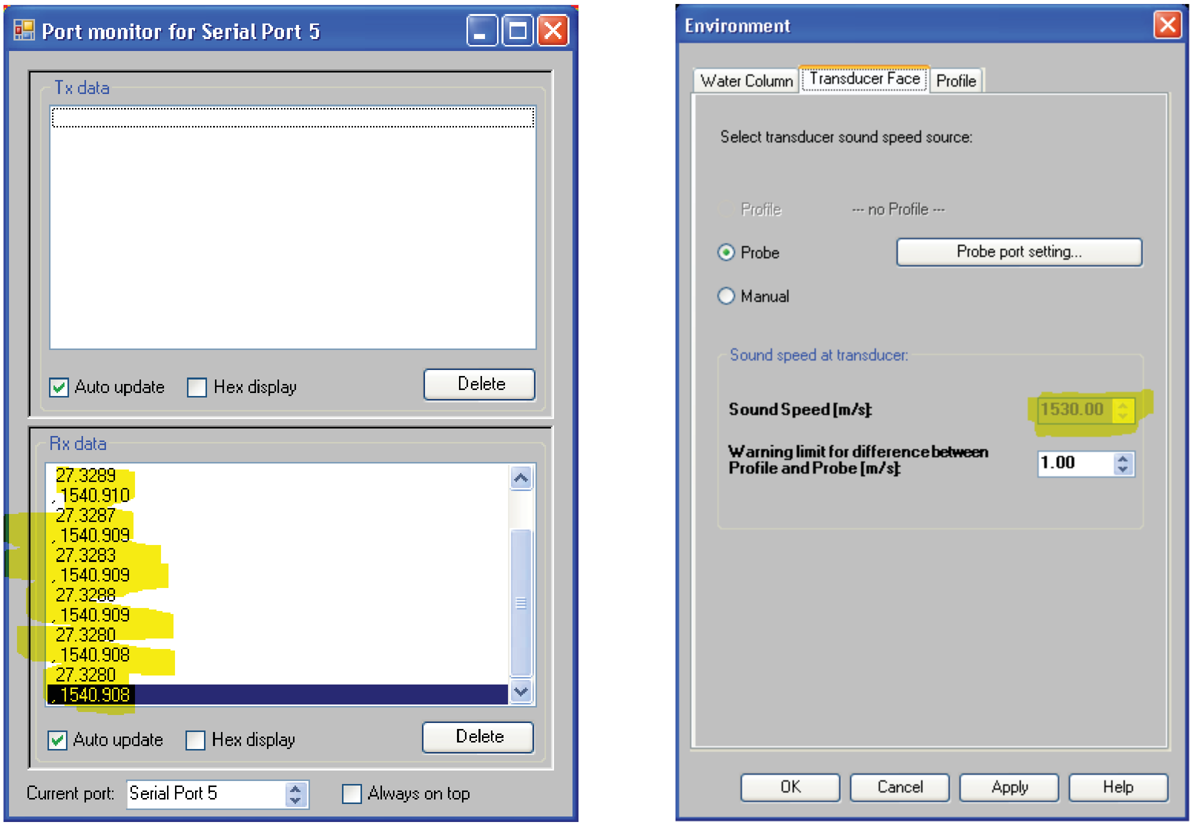
The ship has two thermosalinographs (SBE45 and SBE21) that supply seawater temperatures and sound speed in real-time. The SBE45 supplies the real-time sound speed to the ME70 for beam steering.

There was concern about the SBE45 in that it appears to not have been calibrated since its installation (see Table 2), and this is the sensor used for the ME70 real-time beamforming. Accurate sound speed measurements at the transducer face are critical, because any errors in these measurements are propagated through the entire ray trace and would introduce systematic error into raw data files.

Table 2. Sound speed sensor calibration dates

| Sensor | Date of last calibration |
|---|---|
| SBE 03 Plus | 4/2/2013 |
| SBE45 | 6/15/2008 |
| SBE21 | 12/6/2012 |

In addition, it became apparent during the course of survey operations that, while the ME70 was indeed receiving the real-time feed from the SBE45 (see Figure 5, left), the data were not being applied due to a syntax issue. The ME70 was then defaulting to a static value (see Figure 5, right), outdated and inapplicable to the current oceanography.



```
27.3289
, 1540.910
27.3287
, 1540.909
27.3283
, 1540.909
27.3288
, 1540.909
27.3280
, 1540.908
27.3280
, 1540.908
```

☑ Auto update ☐ Hex display

Current port: Serial Port 5 ☐ Always on top

Select transducer sound speed source:

○ Profile --- no Profile ---
● Probe Probe port setting...
○ Manual

Sound speed at transducer:

**Sound Speed [m/s]:** 1530.00

**Warning limit for difference between Profile and Probe [m/s]:** 1.00

Figure 5. The real-time feed from the SBE45 updating at a 1 Hz frequency (left). The transducer face environment settings are set to Probe, serial comport 5 (right). If set correctly, the “greyed out” number (highlighted here) should update. If not updating, the remnant value residing in that manual input box will be used for beamforming, and the ME70 will not provide the user an alert to this undesired outcome.

Adjusting the static value significantly affected data quality, as shown in Figure 6, even though the real-time value was observed streaming into the system. There was speculation that the ME70 onboard NOAA Ship *Pisces* has never been utilizing a real-time sound speed for beamforming, and has always unintentionally defaulted to this static value.

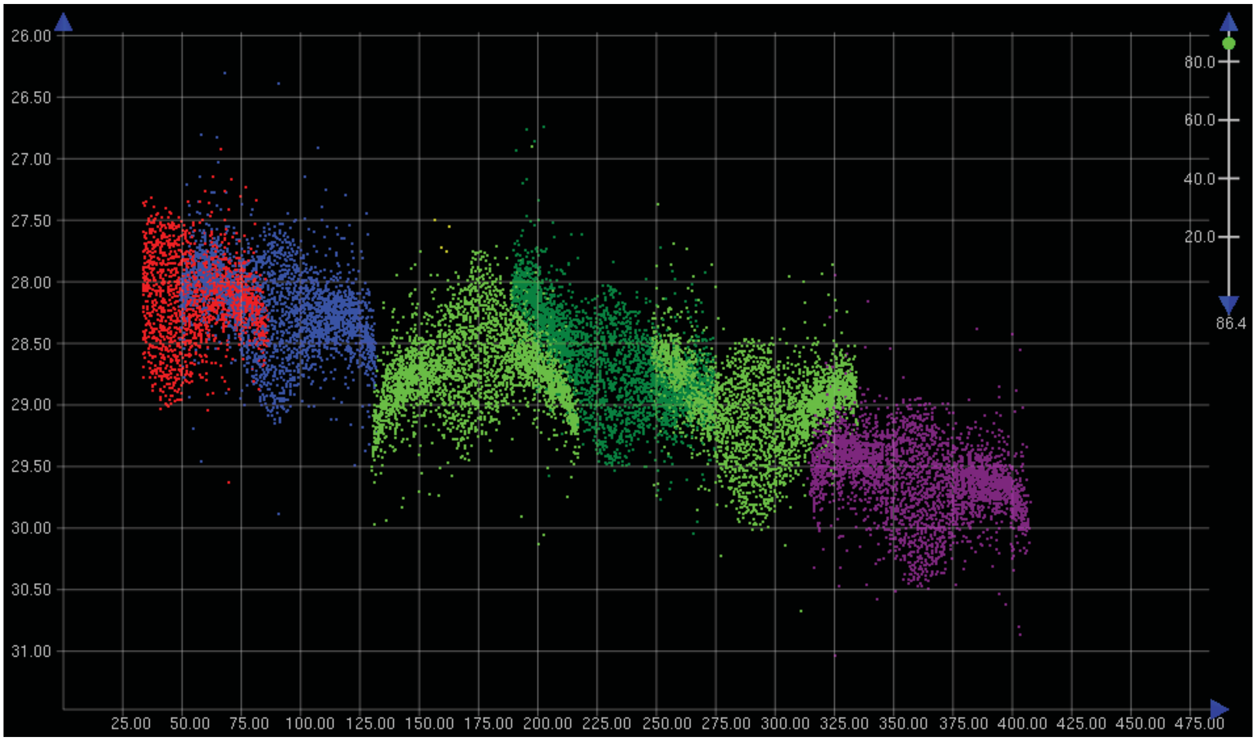


Figure 6. Lines of across-track vertically-exaggerated multibeam swaths, acquired while varying the “manual” transducer face environment sound speed value: red, blue, and purple lines used 1530 m/s, light green (left) used 1540 m/s; dark green and light green (right) used 1519 m/s. The significant effect to the multibeam swaths observed above served as confirmation to the users that the real-time sound speed was not being applied, and instead the ME70 was defaulting to that manual value.

The ship’s survey technician during the first leg of W00269, ST Kathy Hough, had prior experience with these systems onboard the NOAA Ship *Oscar Dyson* that was invaluable during the identification and troubleshooting of data quality issues. She also established an eventual workaround to the issue by routing the data feed from the SBE21 (not the SBE45) into the ship SCS (Scientific Computer Systems). Then, from SCS, a correctly formatted data feed was sent to the ME70, where it was finally accepted by the system (confirmed by the changing manual value). This issue was resolved on the last day of the first cruise leg, after the ship had reached port (June 27, 2013). For the in-depth details regarding the troubleshooting efforts, ST Hough’s reports are included in Appendix II: Field Reports.

The SBE21 may actually be a preferred data feed to the ME70 since it has been calibrated much more recently than the SBE45. Comparisons of the data feeds from both sensors were performed by ST Hough, and are submitted in Appendix II: Field Reports. She concludes that the SBE21, if provided full flow, would likely provide the most reliable sound speed data to the ME70.

Despite the improvements to the system applied during the second cruise leg, refraction error still persists in the data (see Section B2d).

*Water-column sound speed*

Full water-column temperature and salinity profiles are obtained via SBE 03 Plus CTD, from which sound speed is derived. The SEFIS program also purchased XBT's for use during nighttime mapping operations, which measure temperature as a function of elapsed time. Sound speed is derived from XBT data and used in the post-processing of the bathymetric data, if it were to compare favorably to the CTD casts.

On the first leg, the XBTs were initially failing, reporting unrealistic temperature values. Comparisons taken with concurrent CTD data verified their failure, and for the first few days of survey, additional CTD casts were taken in the evenings and early mornings and used in the post-processing of bathymetric data. Eventually, a wire failure was discovered 8 feet down from the launcher, and fixed by the ship's ET Patrick Bergin. Ensuing comparisons with CTD casts were deemed acceptable. ST Hough performed XBT comparisons with the CTD casts, both before and after fixing the wire, and these are included in Appendix II: Field Reports. Also included is a ray tracing uncertainty analysis between concurrent XBT and CTD data (after the wire fix). At the transducer depth of the ME70, a maximum outer beam depth sounding uncertainty of 1.5 cm was observed between the CTD and XBT casts, well within allowable HSSD tolerance levels. This analysis helps justify the use of the XBTs after the repair.

During the second leg, the wire just below the XBT launcher failed, and was again fixed by ET Bergin. Ensuing comparisons of the XBT to a concurrent CTD proved favorable and justified their continued use.

### B1e. Software inventory

The name, version, and purpose of each software used during W00269 is give below in Table 3.

Table 3. Software List

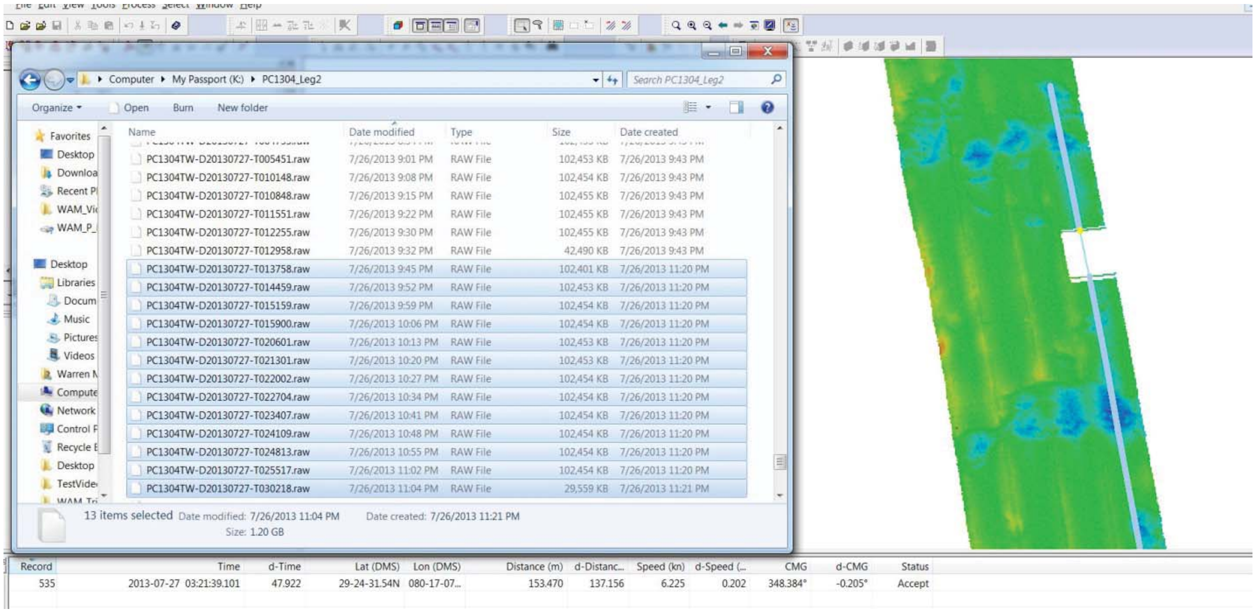
| | | |
|---|---|---|
| Hypack | v13.0.0.6 | Line planning |
| GPS Utility | v5.17 | Line plan format conversion |
| Rose Point ECS | v2.0.11159.1751 | Navigation |
| Simrad ME70 | v1.1.1 | Acquisition |
| MATLAB | v7.12.0.365 | Extract soundings, convert *.raw to *.gsf |
| POSView | v3.3.0.0 | Interface with POS MV |
| CARIS HIPS | v7.1.2 SP2 | Process bathymetry |
| FMGT | v7.3.4 | Process backscatter |
| POSPac MMS | vX.X | Process vessel drafts and SBETs |
| CARIS Base Editor | v4.0.4 | GIS applications, create soundings |
| Pydro | v13.2 | Fetch tides, Velocipy |

## B2. Quality Control

Nighttime surveyors maintained careful watch over the Simrad ME70, monitoring for any issues affecting data quality during acquisition, such as interference from other sounders, errors, warnings, or screen freezes. The range gates on the ME70 were monitored carefully to ensure bottom detections were retained, also to ensure the reception of incoming position, motion, and sound speed data feeds. Alarms were set within Rose Point ECS to alert the start and end of survey lines.

On a few occasions, the ME70 had to be shut down and restarted in order to resolve frozen screens or errors from the transceiver boards, and the ship turned back around in order to maintain a seamless coverage. The ME70 system shutdowns were minimized by ensuring pinging was halted prior to changing any sonar settings, and also by replacing the degraded transceiver boards on 6/18/2013.

On the second leg, it was also found that connecting and removing portable hard drives to migrate data from the ME70 to processing machines was detrimental to survey operations, causing the system to crash on one occasion, and on multiple occasions causing data gaps. Initially the cause of the data gaps was unknown, but then it was realized that the time stamps of the data gaps as reported by the HDCS data were the same as the times that files were copied from the ME70 to a portable hard drive (see Figure 7). Subsequent data transfers were performed during turns, while not recording. It was strongly recommended to the ship for network data transmission capabilities, such that the transfer could occur without the need for portable hard drives, and this issue circumvented entirely.



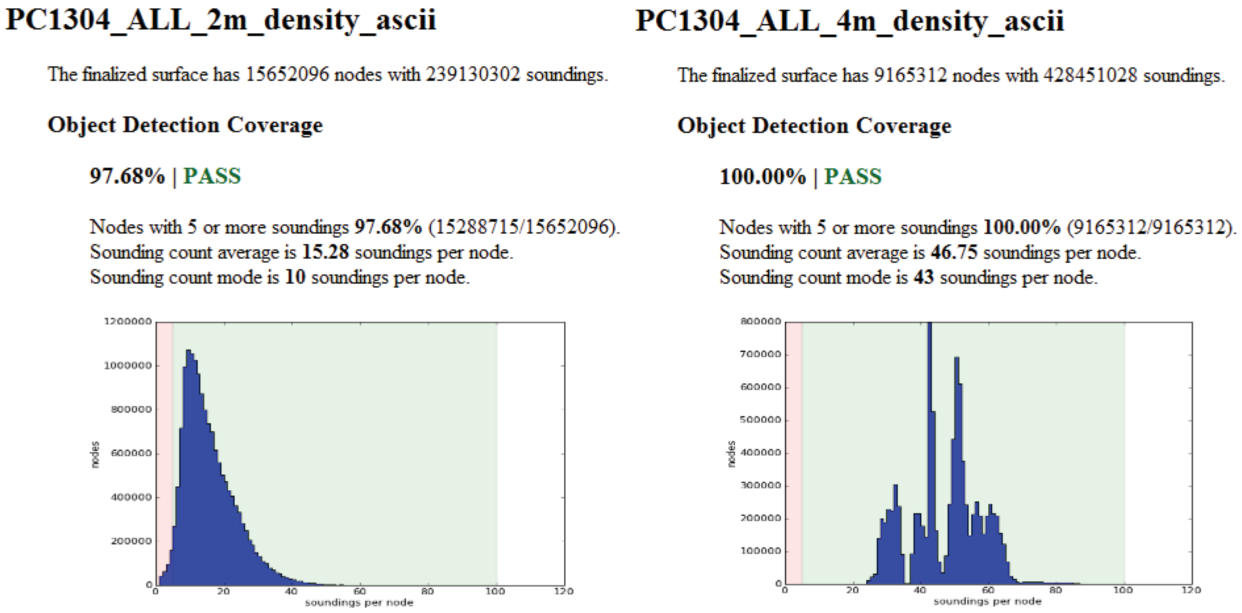
| Name | Date modified | Type | Size | Date created |
|---|---|---|---|---|
| PC1304TW-D20130727-T005451.raw | 7/26/2013 9:01 PM | RAW File | 102,453 KB | 7/26/2013 9:43 PM |
| PC1304TW-D20130727-T010148.raw | 7/26/2013 9:08 PM | RAW File | 102,454 KB | 7/26/2013 9:43 PM |
| PC1304TW-D20130727-T010848.raw | 7/26/2013 9:15 PM | RAW File | 102,455 KB | 7/26/2013 9:43 PM |
| PC1304TW-D20130727-T011551.raw | 7/26/2013 9:22 PM | RAW File | 102,455 KB | 7/26/2013 9:43 PM |
| PC1304TW-D20130727-T012255.raw | 7/26/2013 9:30 PM | RAW File | 102,455 KB | 7/26/2013 9:43 PM |
| PC1304TW-D20130727-T012958.raw | 7/26/2013 9:32 PM | RAW File | 42,490 KB | 7/26/2013 9:43 PM |
| PC1304TW-D20130727-T013758.raw | 7/26/2013 9:45 PM | RAW File | 102,401 KB | 7/26/2013 11:20 PM |
| PC1304TW-D20130727-T014459.raw | 7/26/2013 9:52 PM | RAW File | 102,453 KB | 7/26/2013 11:20 PM |
| PC1304TW-D20130727-T015159.raw | 7/26/2013 9:59 PM | RAW File | 102,454 KB | 7/26/2013 11:20 PM |
| PC1304TW-D20130727-T015900.raw | 7/26/2013 10:06 PM | RAW File | 102,454 KB | 7/26/2013 11:20 PM |
| PC1304TW-D20130727-T020601.raw | 7/26/2013 10:13 PM | RAW File | 102,453 KB | 7/26/2013 11:20 PM |
| PC1304TW-D20130727-T021301.raw | 7/26/2013 10:20 PM | RAW File | 102,453 KB | 7/26/2013 11:20 PM |
| PC1304TW-D20130727-T022002.raw | 7/26/2013 10:27 PM | RAW File | 102,454 KB | 7/26/2013 11:20 PM |
| PC1304TW-D20130727-T022704.raw | 7/26/2013 10:34 PM | RAW File | 102,454 KB | 7/26/2013 11:20 PM |
| PC1304TW-D20130727-T023407.raw | 7/26/2013 10:41 PM | RAW File | 102,454 KB | 7/26/2013 11:20 PM |
| PC1304TW-D20130727-T024109.raw | 7/26/2013 10:48 PM | RAW File | 102,454 KB | 7/26/2013 11:20 PM |
| PC1304TW-D20130727-T024813.raw | 7/26/2013 10:55 PM | RAW File | 102,454 KB | 7/26/2013 11:20 PM |
| PC1304TW-D20130727-T025517.raw | 7/26/2013 11:02 PM | RAW File | 102,454 KB | 7/26/2013 11:20 PM |
| PC1304TW-D20130727-T030218.raw | 7/26/2013 11:04 PM | RAW File | 29,559 KB | 7/26/2013 11:21 PM |

13 items selected Date modified: 7/26/2013 11:04 PM Date created: 7/26/2013 11:21 PM
Size: 1.20 GB

| Record | Time | d-Time | Lat (DMS) | Lon (DMS) | Distance (m) | d-Distanc... | Speed (kn) | d-Speed (... | CMG | d-CMG | Status |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 535 | 2013-07-27 03:21:39.101 | 47.922 | 29-24-31.54N | 080-17-07... | 153.470 | 137.156 | 6.225 | 0.202 | 348.384° | -0.205° | Accept |

Figure 7. The error received when .raw files were copied onto the portable hard drive at 11:20-11:21PM (local time), or 3:20-3:21AM (GMT), which coincides with the data gap occurrence ending at 3:21AM (GMT). Thereafter, data were only moved during turns, while not recording.

Survey line plans were generated in Hypack with line spacing ranging 50-140 m (dependent on depth), to ensure overlap sufficient to maintain complete coverage.  The lines were then converted into a format usable by Rose Point ECS, which the bridge could access for line steering.  Survey speeds were maintained at 6-8 knots in efforts to conform to HSSD requirements for data density that stipulates 95% of all grid nodes need contain 5 or more soundings.  Two combined grids were created, one which encompasses all the boxes created at a 2m resolution, and another that includes all of the 4m resolution.  The resulting 2m and 4m resolution grids were analyzed via a Python script to determine whether or not a grid conforms to HSSD data density requirements, and the results are shown in Figure 8.



**PC1304_ALL_2m_density_ascii**

The finalized surface has 15652096 nodes with 239130302 soundings.

**Object Detection Coverage**

**97.68%** | **PASS**

Nodes with 5 or more soundings **97.68%** (15288715/15652096).
Sounding count average is **15.28** soundings per node.
Sounding count mode is **10** soundings per node.

**PC1304_ALL_4m_density_ascii**

The finalized surface has 9165312 nodes with 428451028 soundings.

**Object Detection Coverage**

**100.00%** | **PASS**

Nodes with 5 or more soundings **100.00%** (9165312/9165312).
Sounding count average is **46.75** soundings per node.
Sounding count mode is **43** soundings per node.

Figure 8. W00269 data density of the 2m resolution combined grid (left), and the 4m resolution grid (right).

Data density was much higher in outer beams because of the overlap of adjacent swaths, and also because of phase detection allowance for multiple soundings per beam.  The data are sparser at nadir, where amplitude detections allow for only one sounding per beam.  Despite the favorable results indicated by Figure 8, there are holes in the 2m resolution grids (see Figure 9) that are approximately the size of a grid node that the Python script is likely not taking into account. Therefore, complete coverage at nadir was not always possible at a 2m resolution when maintaining survey speeds of 6-7 knots.  To achieve SEFIS objectives, the holes in the grid at nadir were deemed preferable to decreased overall coverage resulting from slowing down the vessel.

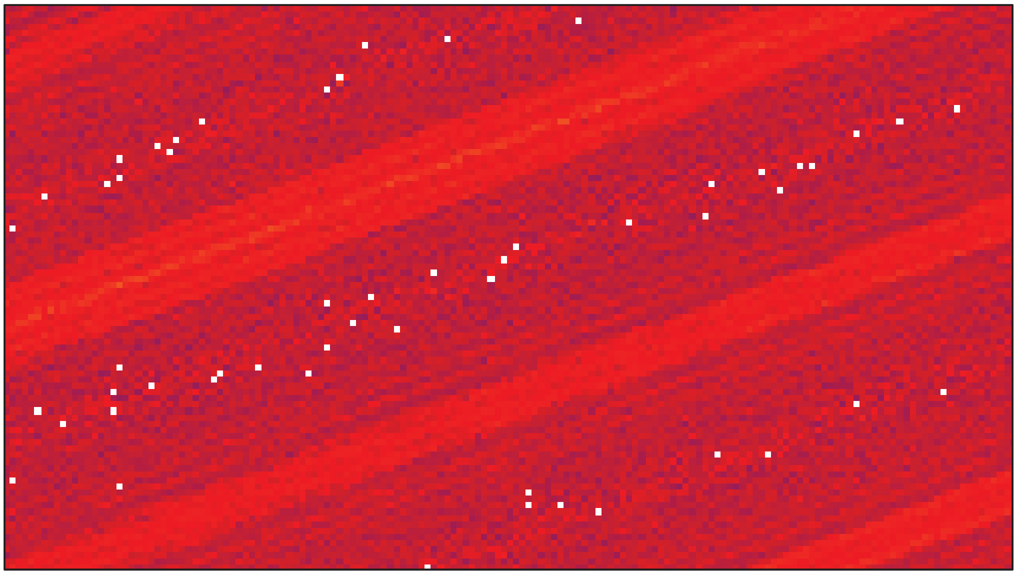
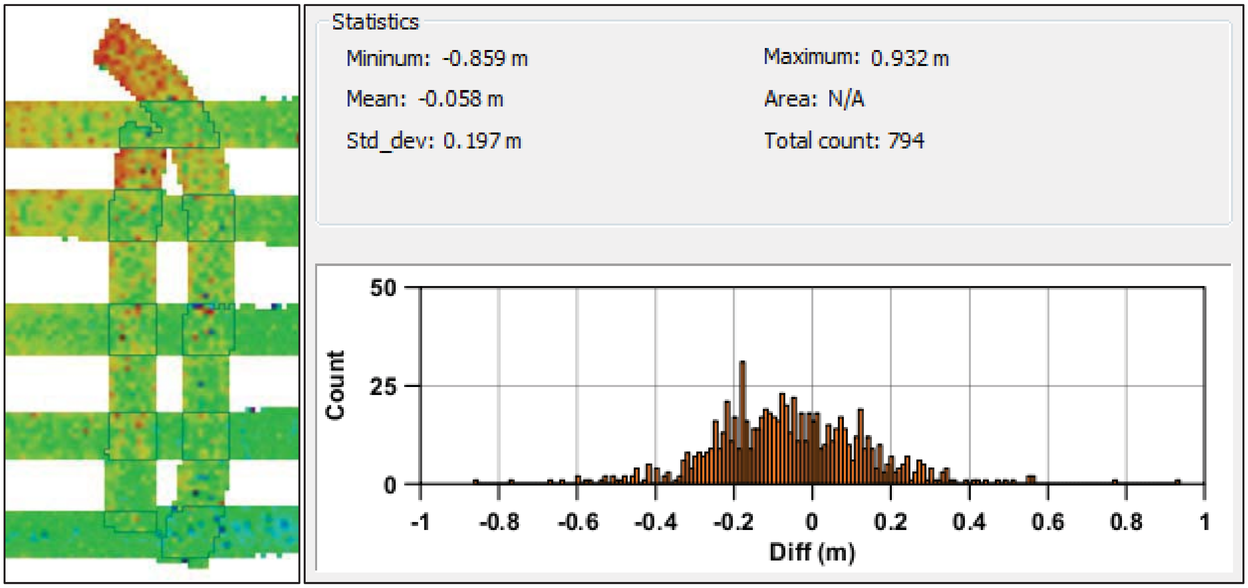


Figure 9. 2m resolution bathymetric grid colored by density. Areas of swath overlap are colored by the light red (~15-20 soundings/node), whereas under nadir are colored by the darker red (~5-15 soundings/node), black (<5 soundings/node), and areas with no data are white.

In addition, there were occasional holidays in the grids greater than 3 nodes across, the result of imperfect line steering. On most nights, SEFIS deemed the greater overall coverage preferable to backfilling holidays.

### B2a. Crosslines

Crosslines were not a requirement for the support to SEFIS, and a greater overall coverage was of higher priority than data redundancy checks. However, there was one instance in which ship logistics allowed for acquisition of two short crosslines over mainscheme acquired 9-13 hours earlier (see Figure 10, left side). Two bathymetric grids were created, one to encompass the mainscheme, and another the crosslines. Prior to their creation, the sounding data were filtered to retain data 30° to either side of nadir, such that the effect of refraction in the crossline analysis was removed, and any remaining system biases might be revealed. The filtered grids were differenced, and the mean difference found to be 0.058m +/-0.197, as shown on the right side of Figure 10.



Statistics

Mininum: -0.859 m

Mean: -0.058 m

Std_dev: 0.197 m

Maximum: 0.932 m

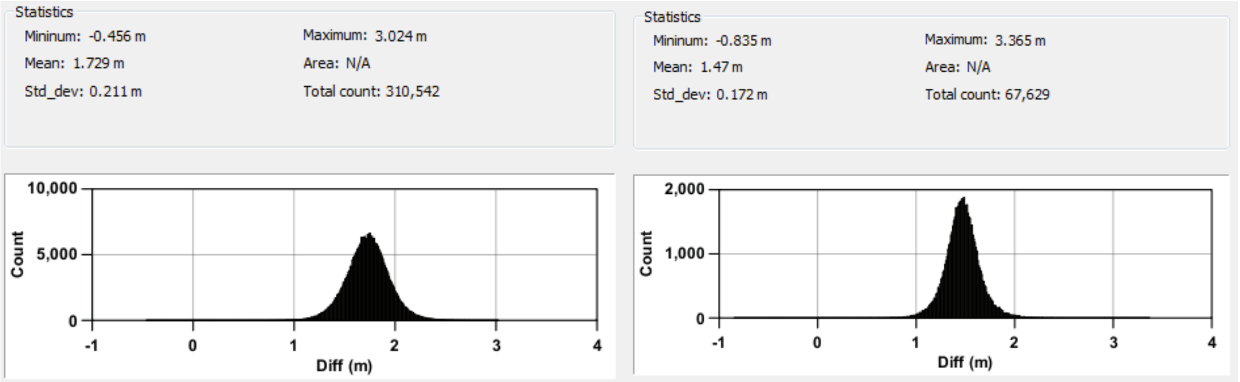
Area: N/A

Total count: 794

Figure 10. Bathymetric grid depicting the intersection of mainscheme and crossline bathymetry used in this analysis (left), and the resulting statistics of the comparison (right).

### B2b. Junctions

During the first leg of W00269, the ship had opportunity to acquire data over NOAA Ship *Thomas Jefferson* survey H11821 in 2008, and SAIC survey H12099 in 2009. Surface differencing revealed a consistent, deep vertical offset in NOAA Ship *Pisces* ME70 data (see Figure 11; a mean difference of 1.729m with NOAA Ship *Thomas Jefferson*, and a mean difference of 1.47m with a NOAA contractor vessel).



Statistics

Mininum: -0.456 m

Mean: 1.729 m

Std_dev: 0.211 m

Maximum: 3.024 m

Area: N/A

Total count: 310,542

Statistics

Mininum: -0.835 m

Mean: 1.47 m

Std_dev: 0.172 m

Maximum: 3.365 m

Area: N/A

Total count: 67,629

Figure 11. Surface difference between NOAA Ship *Pisces* and reference surfaces: between NOAA Ship *Pisces* and NOAA Ship *Thomas Jefferson* survey H11821 in 2008 (left), and surface difference between NOAA Ship *Pisces* and a contractor survey H12099 in 2009 (right).

Note that the *Pisces* data were filtered to retain only 30° to either side of nadir prior to the differencing, in an effort to compare the depths under keel and not those affected by refraction. The deep bias of the *Pisces* system has been observed on other ME70 platforms (Rice 2011a;

W00265, 2009; DY1103, 2011; Malik, Burkitt, and Mitchell, 2012; Wilson and Wolfskehl, 2013) to various magnitudes, and its origin may be related in part to error in the ship offsets (see Section B3b), bottom detection methods inherent in the *.raw-to-*.gsf file conversion step in Matlab, or is perhaps an issue inherent to the ME70 and not currently understood (see Section B2d).

### B2c. Uncertainty

The software tool to derive the ME70 bottom detections can be run from a MATLAB command line, or as a standalone executable, if no MATLAB license is available. The standalone executable includes the computation of uncertainty. Generally, the software was run from the command line, as the uncertainty calculations were not necessary for SEFIS objectives, and time consuming enough such that real-time data processing could not keep up with data acquisition. This would ultimately result in a backlog, and prevent the timely delivery of products each morning to SEFIS, which was the primary objective of the nightly mapping operations. For these reasons, computations of uncertainty were not included as part of the standard processing pipeline during cruise W00269.

Calculations of Total Propagated Uncertainty (TPU) were performed during the final processing of the data, as part of the final assessment of the ME70 data and its potential usage towards other applications. A CARIS HIPS device model was created for the beam configuration written by Dr. Tom Weber and used in a HVF with estimates for each of the uncertainty components given in Table 4. The elements specific to tides and sound speed were entered into CARIS HIPS and are shown in Table 5.

Table 4. TPU standard deviation values

| | |
|---|---|
| Motion Gyro (deg) | 0.02 |
| Heave % | 5.00 |
| Heave (m) | 0.05 |
| Roll (deg) | 0.02 |
| Position Nav (m) | 0.02 |
| Timing Trans (s) | 0.001 |
| Nav Timing (s) | 0.01 |
| Gyro Timing (s) | 0.01 |
| Heave Timing (s) | 0.01 |
| Pitch Timing (s) | 0.01 |
| Roll Timing (s) | 0.01 |
| Offset X (m) | 0.20 |
| Offset Y (m) | 0.20 |
| Offset Z (m) | 0.20 |
| Vessel Speed (m/s) | 0.058 |
| Loading (m) | 0.30 |
| Draft (m) | 0.025 |
| Delta Draft (m) | 0.02 |
| MRU Align StdDev gyro | 0.10 |
| MRU Align StdDev Roll/Pitch | 0.10 |

Table 5. TPU values of tides and sound speed

|  |  |  |
|---|---|---|
| Tide | Measured: 0.0250 m | Zoning: 0.200 m |
| Sound speed | Measured: 4 m/s | Surface: 1.00 m/s |

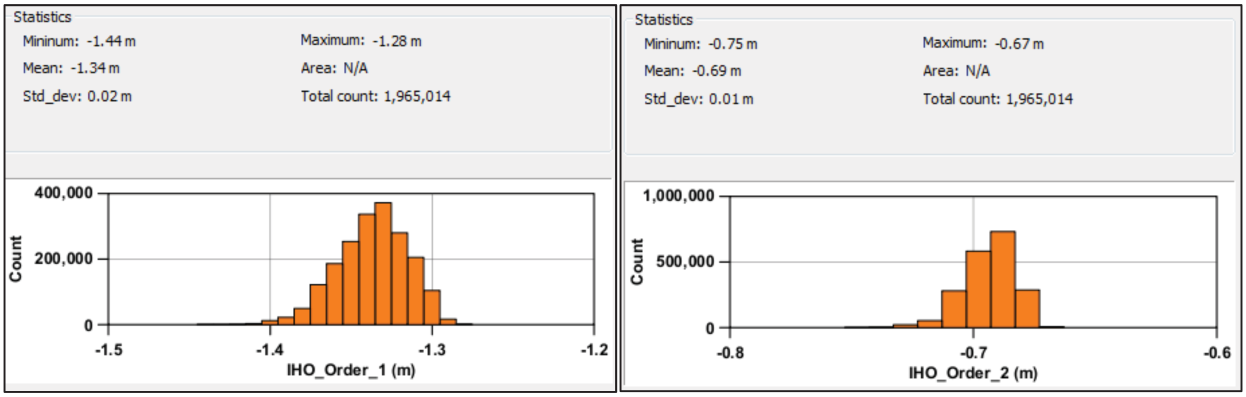
Additional surfaces were created for data to cover the depth range of the cruise; specifically, Box 106 (23-31m), Box 49 (35-43), and the vicinity of the first patch test (49-90m). The surfaces were created using the Combined Uncertainty and Bathymetry Estimator (CUBE) algorithm. Additional layers were added to each surface that compute a ratio of the uncertainties to the allowable Total Vertical Uncertainty (TVU), per IHO Order 1 and Order 2 specifications:

$$(\text{-Uncertainty}) / ( ( a^2 + ( b * \text{depth})^2 )^{0.5} )$$

where a = 0.5m and b = 0.013m for Order 1, and a = 1.0m and b = 0.023m for Order 2. The resulting layers can be used for quality control purposes. Each grid node displays what percentage of the allowable TVU has been consumed (0 meaning there was essentially no uncertainty, and -1.0 meaning that 100% was consumed), and which nodes have exceeded the specification altogether. Any grid node with a value of -1.0 or of greater negative magnitude indicates that the allowable TVU has been exceeded, and therefore warrants further examination.

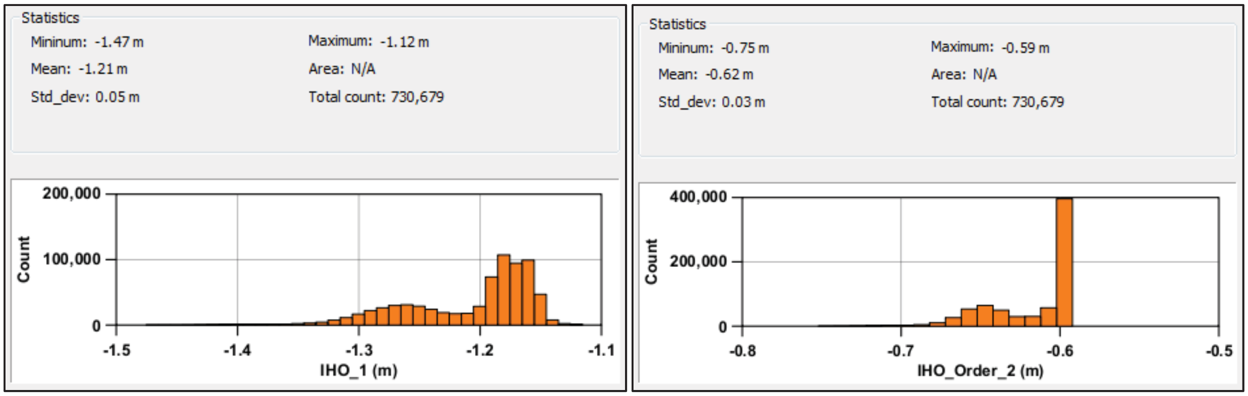
According to the IHO S-44, Order 1 is often required for areas less than 100m where there are features that may be of concern to surface shipping, and Order 2 is often recommended for areas deeper than 100m, where any features large enough to impact surface shipping and still remain undetected is highly unlikely.

The statistics of the Order 1 and Order 2 quality control layers are shown for Box 106, Box 49, and in the vicinity of the first patch test (Figures 12-14).


Statistics
Mininum: -1.44 m
Maximum: -1.28 m
Mean: -1.34 m
Area: N/A
Std_dev: 0.02 m
Total count: 1,965,014

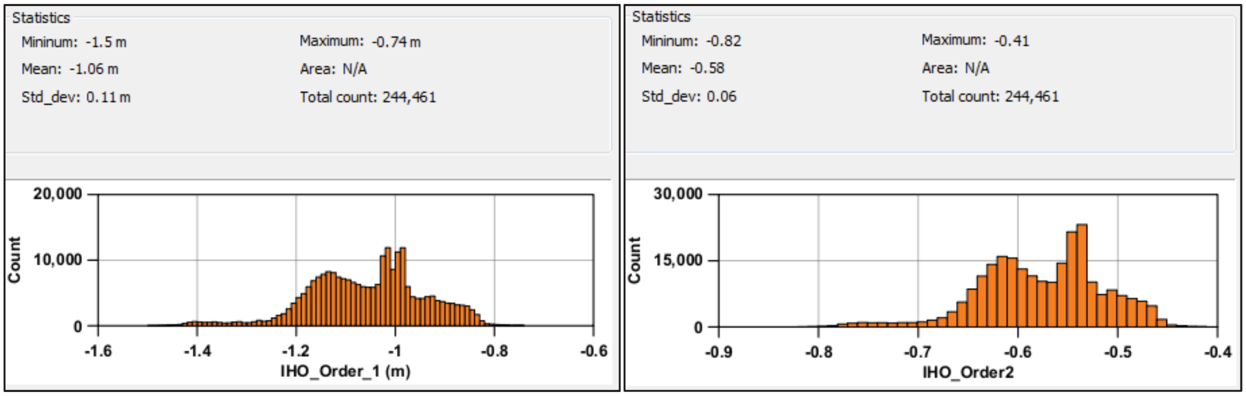
Statistics
Mininum: -0.75 m
Maximum: -0.67 m
Mean: -0.69 m
Area: N/A
Std_dev: 0.01 m
Total count: 1,965,014

Figure 12. The ratio of grid node uncertainty to allowable TVU in Box 106 (23-31m depths) indicates the entire surface has exceeded Order 1 (left) specifications; however, is within Order 2 (right).


Statistics
Mininum: -1.47 m
Maximum: -1.12 m
Mean: -1.21 m
Area: N/A
Std_dev: 0.05 m
Total count: 730,679

Statistics
Mininum: -0.75 m
Maximum: -0.59 m
Mean: -0.62 m
Area: N/A
Std_dev: 0.03 m
Total count: 730,679

Figure 13. The ratio of grid node uncertainty to allowable TVU in Box 49 (35-43m depths) indicates the entire surface has exceeded Order 1 (left) specifications; however, is within Order 2 (right).


Statistics
Mininum: -1.5 m
Maximum: -0.74 m
Mean: -1.06 m
Area: N/A
Std_dev: 0.11 m
Total count: 244,461

Statistics
Mininum: -0.82
Maximum: -0.41
Mean: -0.58
Area: N/A
Std_dev: 0.06
Total count: 244,461

Figure 14. The ratio of grid node uncertainty to allowable TVU in the vicinity of the first patch test (49-90m depths) indicates that a variable section of the swath is within Order 1 (left) specifications; the entire swath is within Order 2.

For this TPU model, it is estimated that in depths 55m and less, the ME70 generally does not meet IHO Order 1 criteria. In depths of approximately 60m, of a full swath of 120°, a swath width of +/-40° to either side of nadir meets Order 1, and this width increases with depth. In depths of approximately 85-90m, a swath width of +/-48° to either side of nadir meets Order 1.

## B2d. Issues affecting data quality

*Heave*

Real-time heave from the POS MV is logged in the raw ME70 data during acquisition and applied in post-processing; however, during times of increased sea state, the gridded bathymetry revealed a heave artifact up to 0.5m in magnitude (see Figure 15). The artifact is also a function ship’s heading, which is why the artifact is generally only observed on every other line in the grids. Application of True Heave in post-processing did not alleviate the artifact.

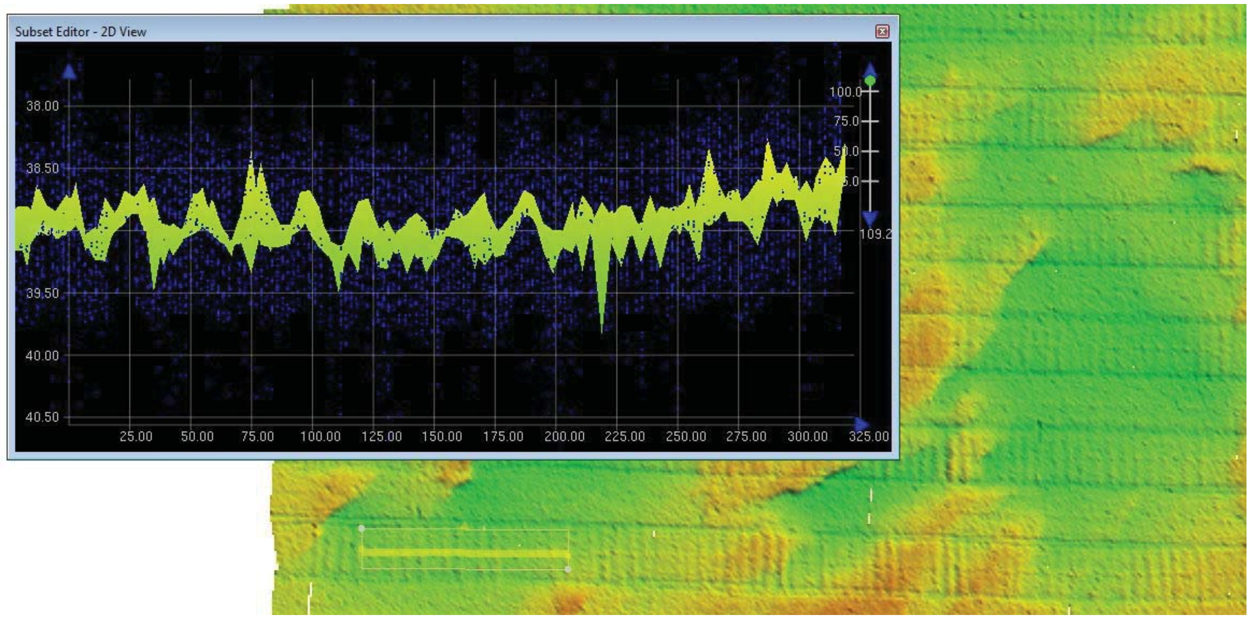


Figure 15. The heave artifact observed in Box 49 is up to 0.5m in magnitude and only evident in the 91° heading.

### *Refraction*

The most significant issue affecting data quality is refraction. XBT data compared favorably to CTD casts, so it is believed that the refraction error was occurring at the transducer face, where a real-time sound speed input is used to adjust the initial launch angle of the beams. Errors in this adjustment will propagate throughout the entire ray trace and could potentially cause the refraction observed in Figures 16 and 17.

During the first leg, it was believed that the refraction was due an inaccurate sound speed value being applied at the transducer face, because the real-time feed was not updating (see Section B1d). An example of the refraction observed during the first leg, and how it affects the gridded bathymetry, is shown in Figure 16.

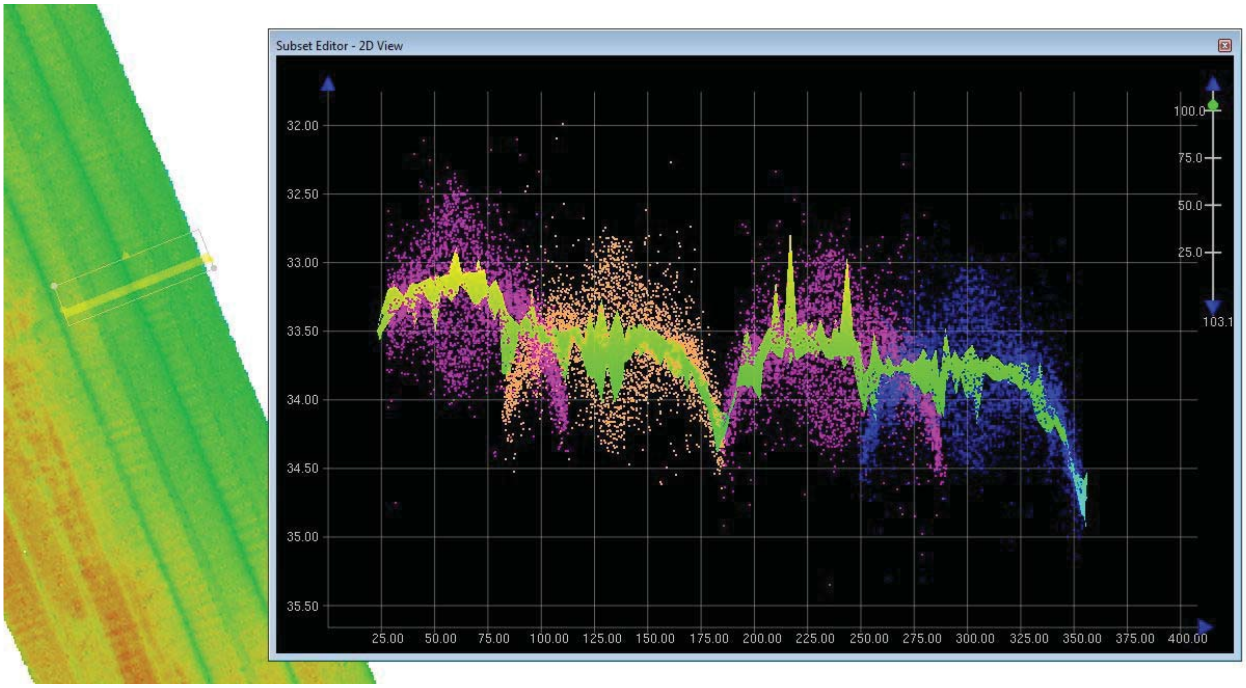


Figure 16. An example of refraction observed during the first leg of W00269 (prior to fixing the real-time sound speed input), and the resulting gridded bathymetry. Note that when the outer beams have sufficient overlap, the effect to the grid is minimized; however, when the overlap is not there, artificial trenches were often observed in the grid, up to 1m in magnitude.

The real-time sound speed input into the ME70 was restored at the end of the first leg, and the resulting effects to the data were significant. The “frowning” generally observed (Figure 16) prior to the fix were not flattened as hoped; instead, a refraction “smile” became the predominant observation (Figure 17). Effectively, the direction of the refraction was reversed, but the magnitude of the error remained approximately the same.

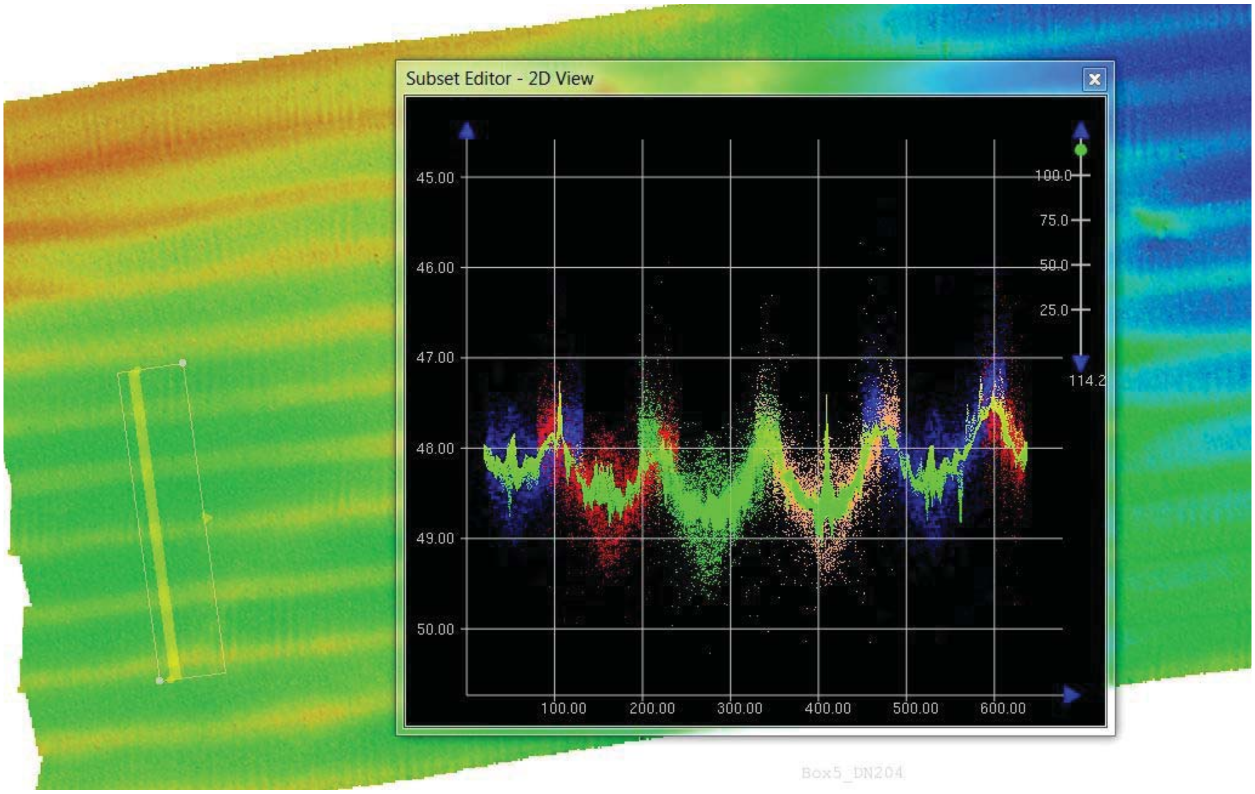


Figure 17. An example of refraction observed during the second leg of W00269 (after having fixed the real-time sound speed input), and the resulting gridded bathymetry. The refraction "smiles" are up to 1m in magnitude.

The real-time surface sound speed value was routinely checked against the sound speed value as reported by XBT data at the commensurate depth. The values were usually within 0.1-0.2 m/s, and always within 0.5 m/s, thus there was confidence in the values reported by the SBE21 thermosalinograph. Thus, the cause of the refraction as observed in Figure 17 remains unknown. If the error source is related it is likely related to the real-time surface sound speed input, and not related to the full water-column correction performed in post-processing. Although the real-time feed is observed to be streaming into the ME70, there is speculation that it is nevertheless not being applied. To exacerbate the problem, the sound speed value that is actually used to point the beams is never logged in the raw ME70 data, thus there is no record of it to examine for troubleshooting purposes.

The error is significant enough such that the HSSD allowable tolerance for refraction is often exceeded. To facilitate any potential charting applications with the data, a filter was applied to only retain 30° to either side of nadir. The resulting swaths then do not overlap, and create what is essentially a de facto "skunk stripe" multibeam survey; however, the refraction error is almost entirely mitigated. The sounding data and the bathymetric grid are shown both prior to and after filtering in Figure 18.

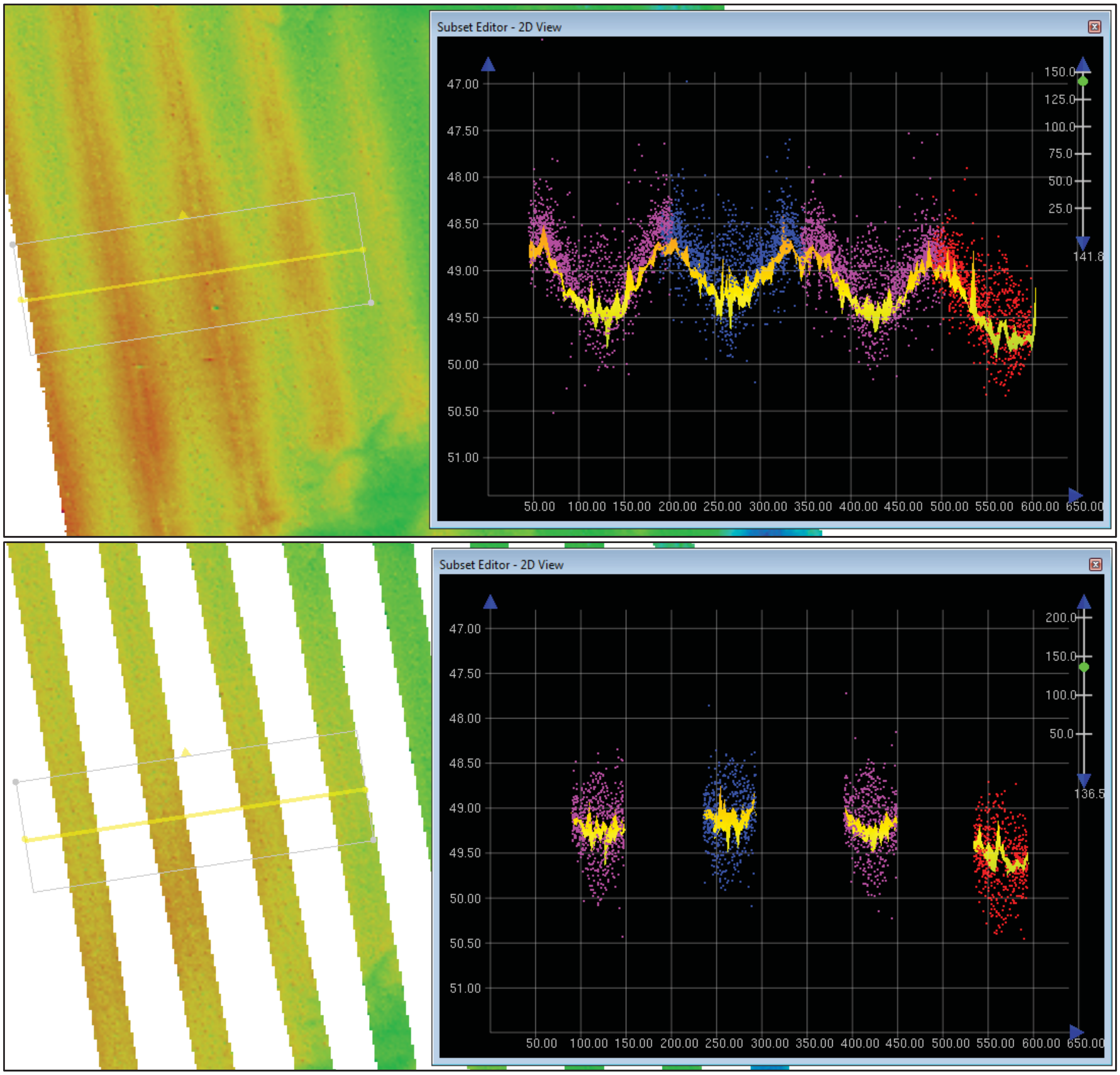


Figure 18. ME70 sounding data and the resulting bathymetric surfaces, for a 120° swath prior to filtering (top), and for the 60° swath after filtering (bottom).

On some days, the refraction error was not as pronounced, and within allowable tolerance levels. However, the filtering was still performed regardless, such that all the data fell into the same processing pipeline in preparation for submission to OCS. The only exception was portions of Box 106, acquired on 6/25/2013. The outer beams of the adjacent swaths aligned well, and of greatest importance was preserving the shoalest depths of the dynamic seafloor in this region. For those lines that acquired data over these formations, the data were left unfiltered, as shown in Figure 19.

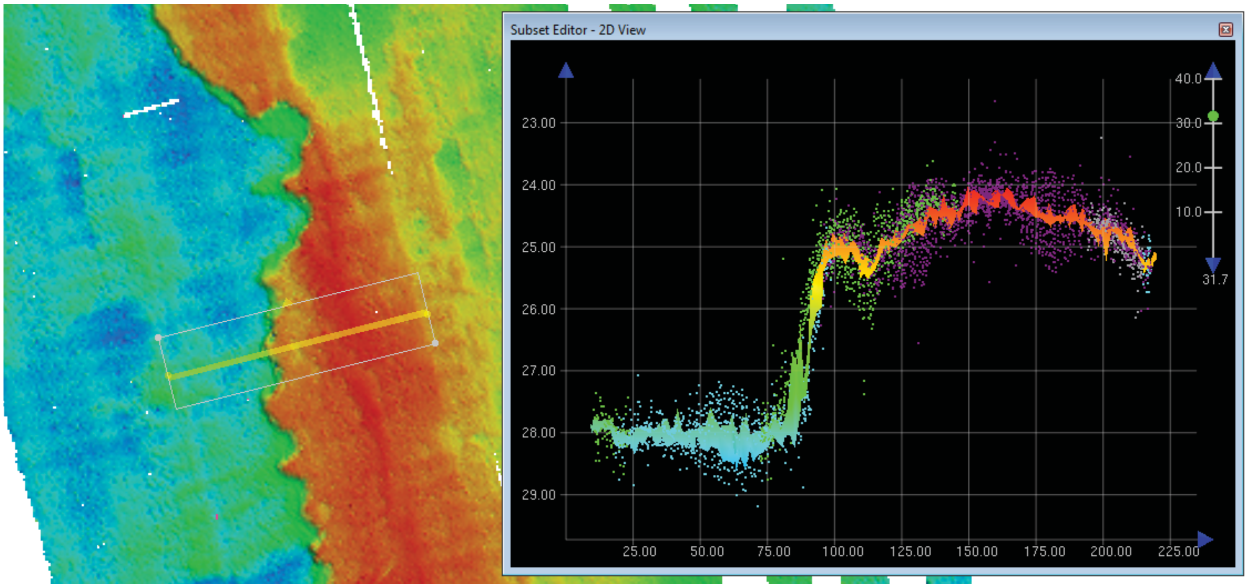


Figure 19. The lines acquired over the areas of dynamic relief in Box 106 were left unfiltered as to preserve the shoalest depths. Shown here is the bathymetric grid in plan view, with a 2D subset of the sounding data and surface.

*Vertical offset*

A vertical offset is evident in the junction analysis (see Section B2b) when comparing the sounding data to reference data from other survey platforms. The ME70 data are between 1.5-1.7m deeper than the reference data sets. The vertical offset was initially believed to be due to incorrect vessel survey offsets, but re-measuring and validation techniques in post-processing (see Section B3a) provides confidence in the vessel survey offsets in use, or at least assurance that there is unlikely an error on the order of 1.5m.

Other ME70 platforms (W00265, 2009; DY1103, 2011; HB1204, 2012) have shown a similar deep bias when compared to platforms that employ a hydrographic multibeam, so there is speculation that the offset may be inherent to the ME70 in some manner not yet understood. This vertical offset issue with the ME70 is the subject of continuing research and investigation and UNH-CCOM, and until it is fully understood, further applications with the ME70 data are limited.

## B3. Corrections to Echo Soundings

### B3a. Vessel offsets

Vessel offsets were measured by Raymond C. Impastato (Professional Land Surveyor, Slidell, LA) in 2007. The ship provided a document with the offsets listed in tabular format, as well as a series of hand drawn diagrams and calculations (submitted in Appendix II: Vessel Documents). All of the Impastato offsets are referenced to the ship's granite block. For the purposes of this hydrographic survey, the POS MV IMU was designated as the reference point, which sets the lever arm and rotation from vessel to IMU to zero (see Appendix II: Vessel Documents for the POS offsets was they were left). The Impastato offsets, now referenced to the POS MV rather than the granite block, are shown in Figures 20 (vertical offsets) and 21 (horizontal offsets). Note the waterline-IMU value is included in Figure 20 as well (discussed in Section B3b).

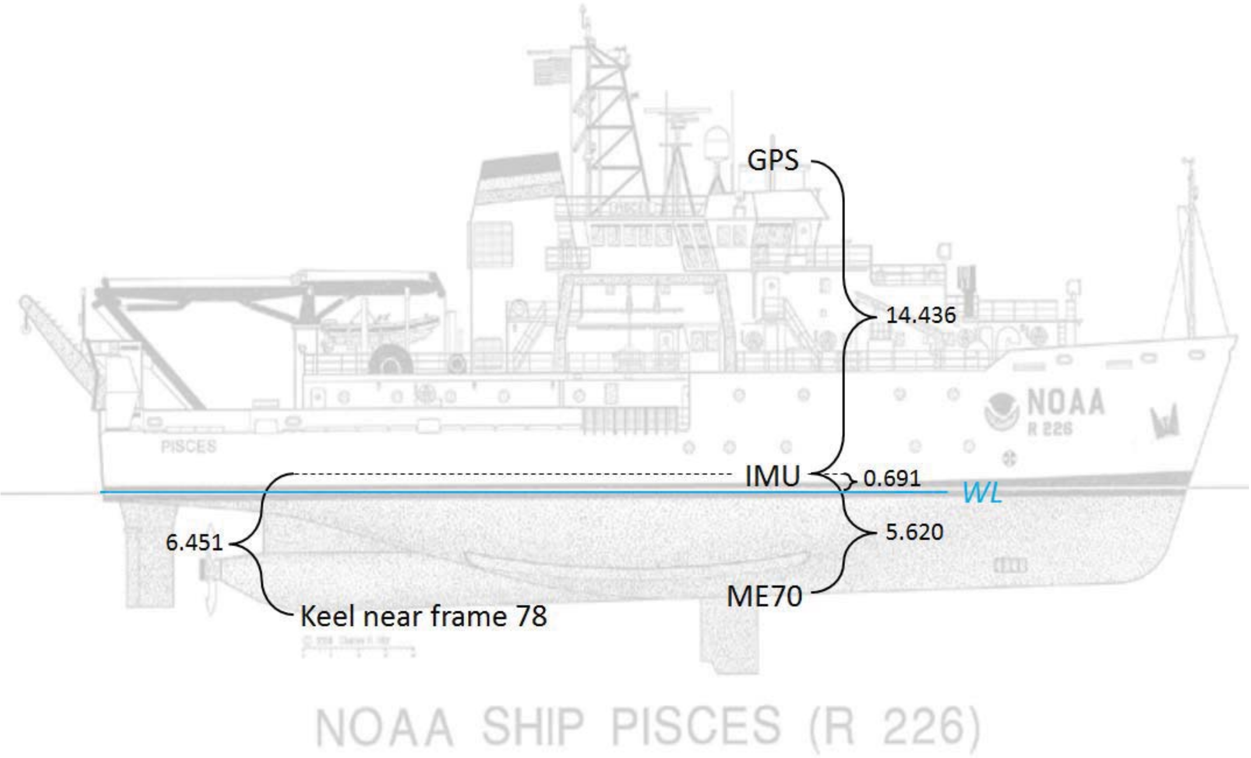


Figure 20. Vertical offsets referenced to the POS MV IMU (not to scale).

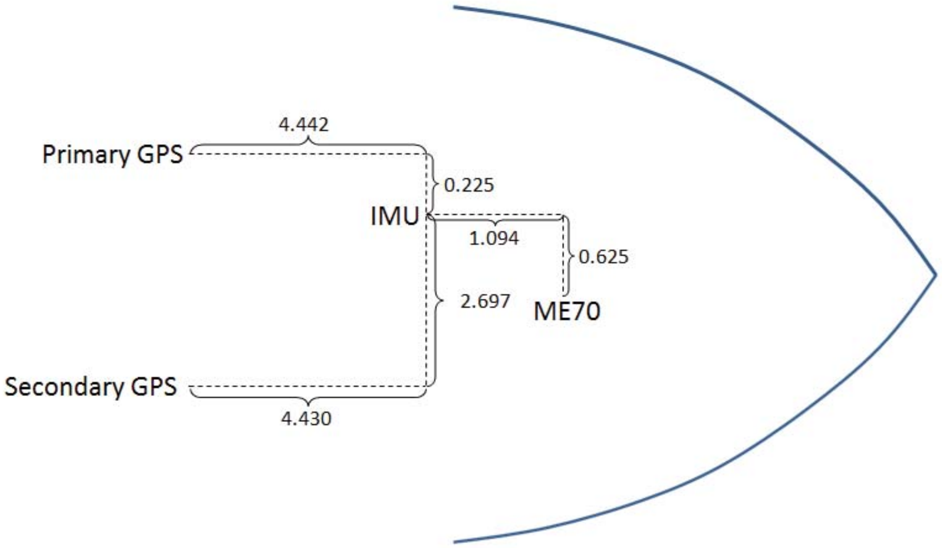


Figure 21. Horizontal offsets referenced to the POS MV IMU (not to scale).

The Impastato documentation did not describe where exactly the IMU to ME70 5.620m vertical offset is measured to. Simrad (see Appendix II: Correspondence) suggested using the transducer front surface as the acoustic center. The vertical offset from IMU to ME70 was measured via tape measure, a method unlikely to achieve high accuracy, but adequate to verify a particular offset on the order of decimeters. The measurement from the top of the IMU to the hull beside the ME70 was approximately 5.54m; an additional 8 cm to account for the hull and ME70 transducer face thickness was plausible to achieve the 5.620m reported in the Impastato survey.

The IMU to POS MV antenna offset can be verified by the post-processing of POS MV data in Applanix POSPAC. The estimated errors for the X, Y, and Z IMU to primary POS MV antenna offsets are 5cm, 17cm, and 22cm (see Appendix II: Field Reports).

To alleviate the questions about the ship's offsets, and due to the consistent vertical offset observed in the junction analysis (see Section B2b), an updated NGS offset survey is recommended for the ship.

## B3b. Waterline

The IMU to waterline offset was measured by three separate, independent methods; results obtained were all each within 3.4cm.

The first technique uses the vessel draft marks and ship offsets. Vessel draft marks reported from the bridge when leaving port on 6/12/2013 were 5.45 m (forward) and 6.13 m (aft). The average value (5.79 m) is an assumed measurement up from the keel near frame 78 mark (see Figure 20), which is the lowest surveyed offset on the ship according to the Impastato offsets (see Appendix II: Vessel Documents). The draft mark is then differenced from the offset from IMU to keel near frame 78 (6.451 m). The result is the offset from IMU to waterline, 0.661m.

The second technique, courtesy of Charles Thompson (see Appendix II: Correspondence), was measurement via lead line. The top of the IMU to the deck surface was 0.479 m, and from the deck surface to the waterline was 0.178 m. The result is the offset from IMU to waterline, 0.657 m.

The third technique uses ellipsoid reference methods in a procedure established by Glen Rice (2011b), who also supplied the Python script. A time series of vessel ellipsoid heights (generated using Applanix POSPac from post-processed POS MV data to create an SBET) is differenced from a time series of a nearby water level gauge ellipsoid heights (see Figure 22, left side). Remaining offsets were a time series of IMU to waterline values (see Figure 22, right side), from which the mean provides the final estimate of 0.691m. The estimate uncertainty is high, 0.457m, a result of the high noise in the ellipsoid heights of the SBET, as noted in Section B1c, and observed in Figure 22.

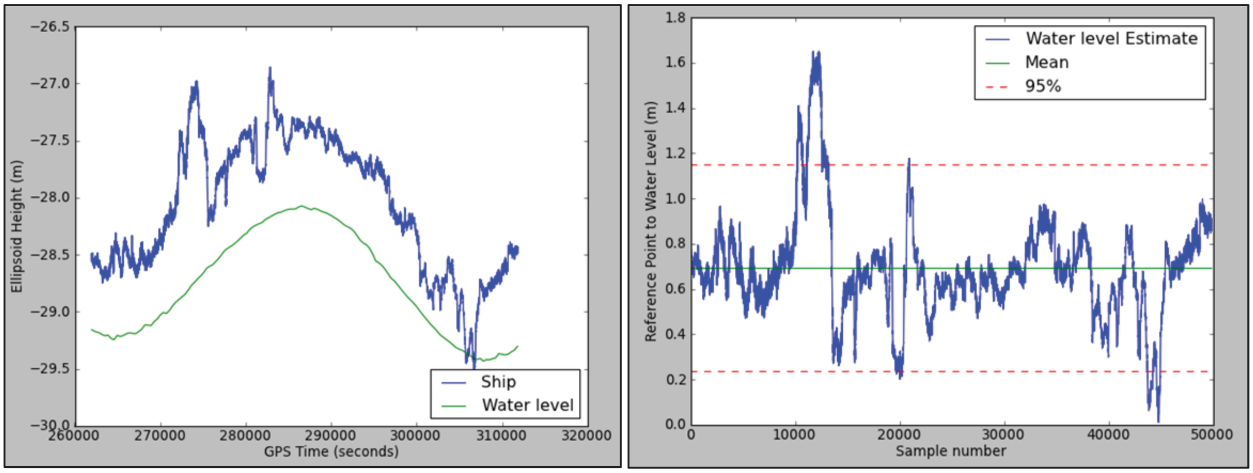


Figure 22. Vertical offset from ship reference point to waterline. The vessel and water level gauge ellipsoid heights (left) are differenced (right) to obtain an estimate.

The estimate of 0.691m was utilized as the waterline offset in the CARIS HVF and applied in post-processing.

### B3c. Dynamic draft

The high uncertainty in the post-processed SBET ellipsoid heights (as discussed in Section B1c) prevented use of the ellipsoid referenced dynamic draft measurement technique, thus soundings from the ship's Simrad ME70 were used to perform the measurements.

During the data acquisition, the lowest speed possible while maintaining heading was 3.124 knots, thus this speed is considered the baseline reference with negligible dynamic draft. Additional passes along this same line were performed, each with the same heading but at a different speed. Each line was then processed, filtered to exclude all beams more than 30° outside of nadir, and gridded. Grid node depths were plotted in a histogram (see Figure 23). The mean depth value of each grid was differenced from the reference grid to produce the values shown in Table 6, which is the same dynamic draft table entered into the CARIS HVF and applied in post-processing.

If the ship's POS MV is serviced and usable SBETs able to be generated, it is recommended that determination of the ship's dynamic draft be performed again using ellipsoid referenced techniques.

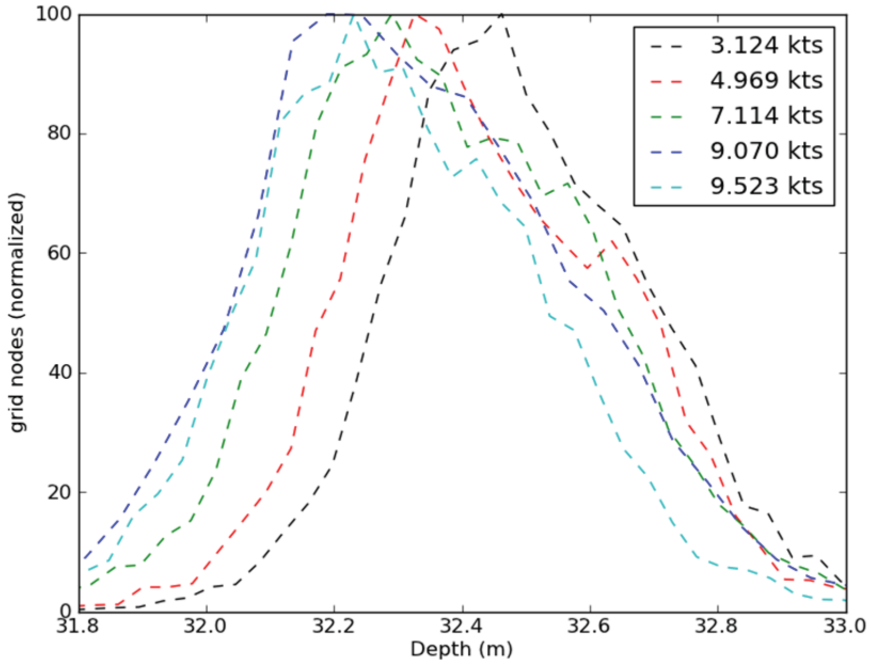


Figure 23. Depth node histogram of gridded bathymetry for five vessel speeds. The dashed lines connect the histogram bin centers for optimal display purposes. The number of grid nodes has been normalized to facilitate direct comparison. Over the same 1 km stretch of seafloor, the depth becomes progressively shallower as the vessel settles with increasing speed.

Table 6. Dynamic draft values

| Draft | Speed |
|---|---|
| 0.000 | 3.124 |
| 0.060 | 4.969 |
| 0.120 | 7.114 |
| 0.170 | 9.070 |
| 0.200 | 9.523 |

### B3d. Patch test

Two patch tests were conducted on the first full acquisition shift of the cruise (6/13/2013), and another after the transceiver boards were replaced (6/20/2013). A ledge, with a sharp 7+ m vertical (see Figure 24), was identified on the shelf break, and was suitable for the latency, pitch, and yaw calibrations. West of the shelf break was primarily flat seafloor and suitable for the roll calibration.

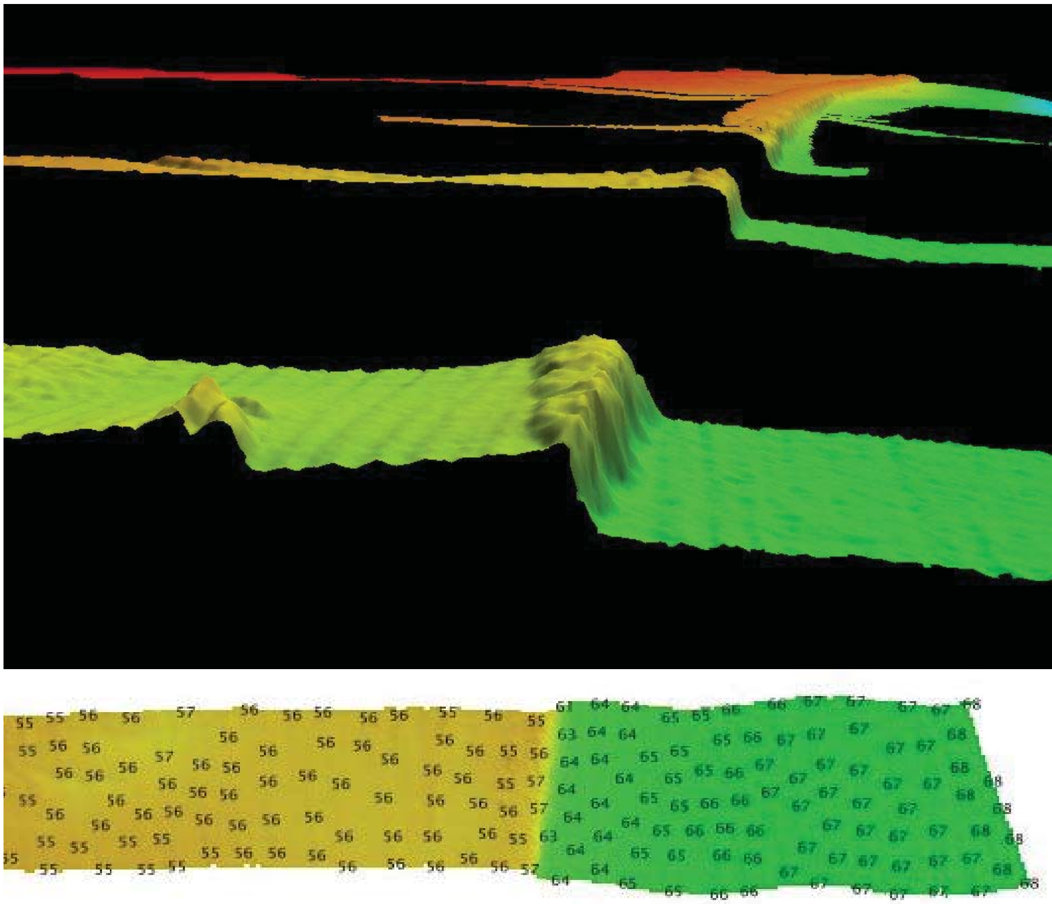


Figure 24. Patch test bathymetry displaying (top) a 7-m ledge as depicted in 3D view, and (bottom) comparable gridded bathymetry from NOAA Ship Nancy Foster, overlaid with a sounding selection (units in meters).

All nighttime surveyors derived timing and misalignment values. The average values are shown in Table 7, and were entered into the POS MV settings for Sensor 1 Frame with respect to Reference Frame (not the CARIS HVF). This is because the ME70 is roll and pitch compensated. Entering the roll, pitch, and heading values in the POS MV ensures the real-time motion provided to the ME70 is in the correct frame. However, the real-time heading logged in the raw data remains in the IMU reference frame, so it must be applied in CARIS. This is why the HVF contains only the heading correction. The configuration as explained here was provided by Glen Rice (see Appendix II: Correspondence).

Table 7. First Leg Patch Test values

| | |
|---|---|
| **Pitch** | 2.70° |
| **Roll** | 1.32° |
| **Heading** | 3.00° |
| **Timing** | 0 seconds |

For regular operation, the ME70 is roll and pitch compensated. However, for the patch test, both roll and pitch compensation are switched off in ME70 user settings, because both roll and pitch misalignment between vessel and echo sounder reference frames are objectives of the patch test. It is believed that the real-time heave is only logged, and then applied later in post-processing.

For each patch test conducted, the heave artifact observed in the resultant gridded data (see Figure 25) was particularly pronounced, suggesting that turning off the real-time roll and pitch compensation also prevented the real-time heave from being applied in post-processing. This made it difficult to distinguish heave from other errors, and the patch test values were difficult to derive, particularly the roll value. A third patch test, conducted after replacing the transceiver boards, was deemed ultimately unusable, due to this issue, but also because the feature was not conspicuous enough (see right side of Figure 25).

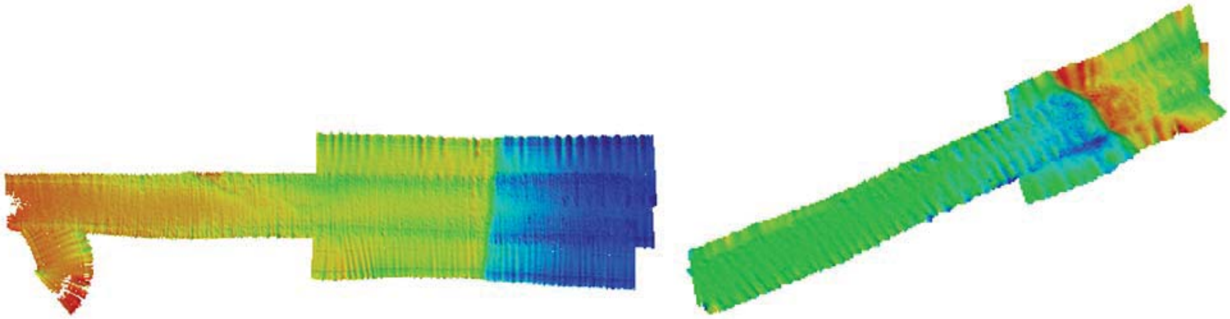


Figure 25. Gridded bathymetry that shows artifacts visible at patch test sites: the heave artifact for the second patch test conducted on 6/13/2013 (left), and for the patch test on 6/20/2013 (right), conducted after tranceiver board replacement .

On 07/24/2013, during the second leg, a patch test was performed over a charted wreck located at approximately 30.373N, 80.900W, shown in Figure 26. The heave artifact was problematic, but the wreck had good height off the bottom, and misalignment values were successfully derived (Table 8).

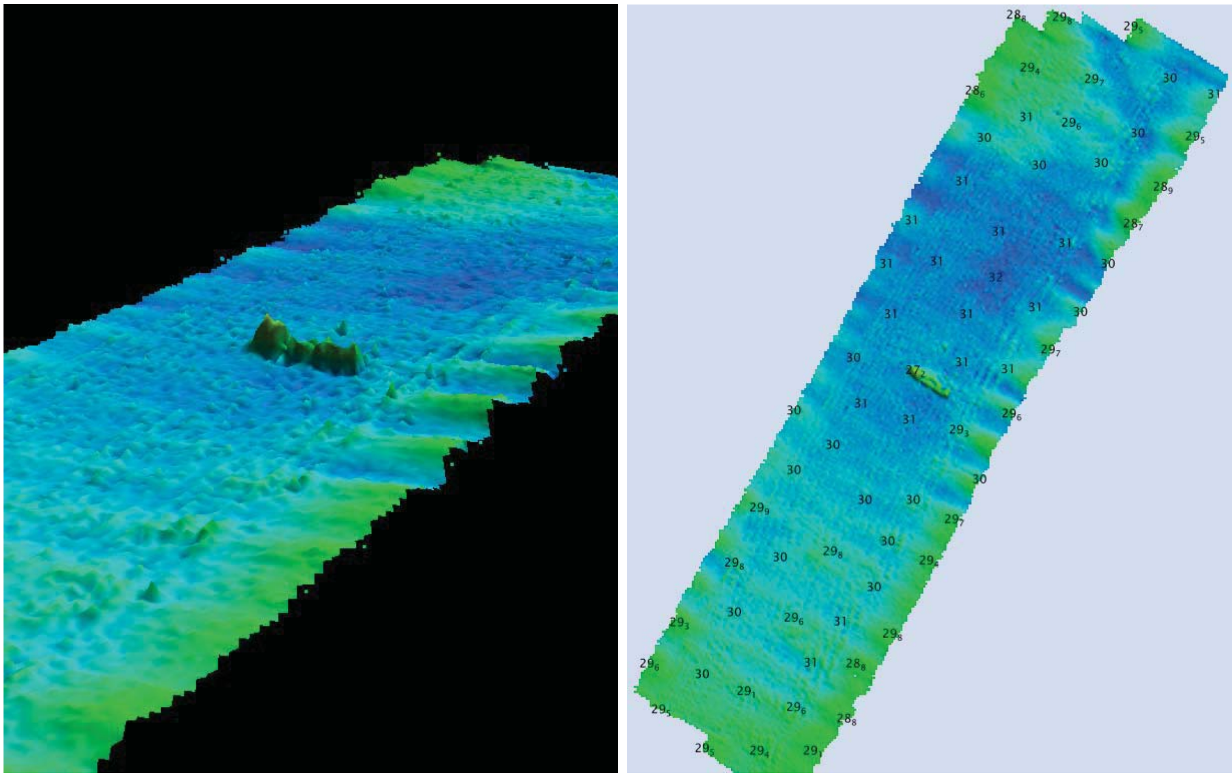


Figure 26. Patch test on the second leg utilizing a charted wreck, shown in 3D (left), and plan view (right) with soundings in meters.

Table 8. Second Leg Patch Test values

| | |
|---|---|
| **Pitch** | 3.326° |
| **Roll** | 1.32° |
| **Heading** | 2.492° |
| **Timing** | 0 seconds |

## B3e. Sound speed corrections

Sound speed profiles were acquired via CTD sensor (SBE 03 Plus) for the first few days of the first leg, until the XBT wire was fixed (see Section B1d and the XBT casts were in agreement with those from the CTD taken concurrently (see Appendix II: Field Reports).

The profiles acquired over both legs (Figure 27) were acquired over a large area and therefore have considerable variability, a function of depth, latitude, sea state, and proximity to the Gulf Stream. The variability is related to temperature. The upper portion of the water-column has a mixed layer of 10-15 m thick, above a thermocline of varying depth and gradient.

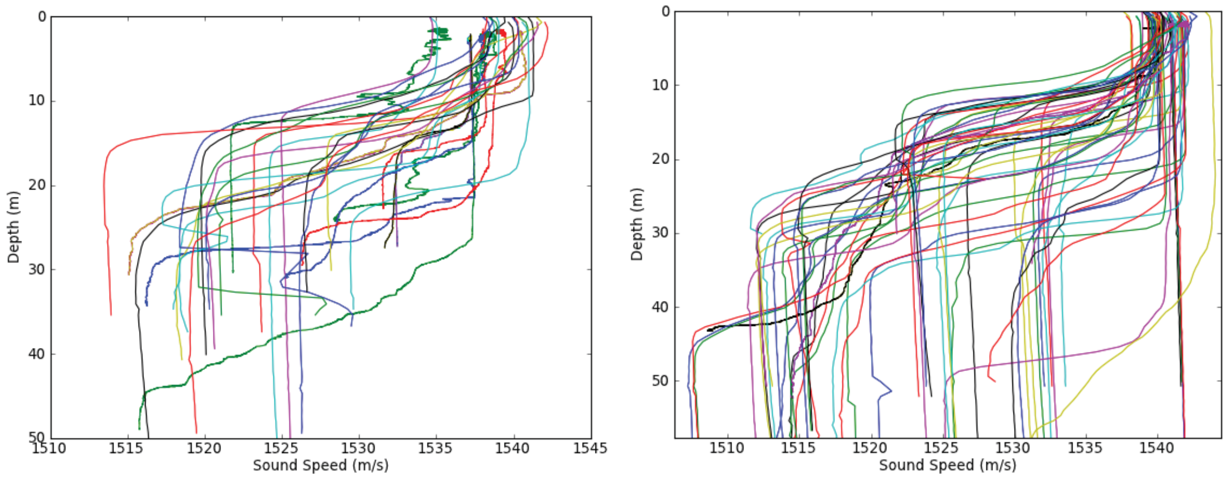


Figure 27. Sound speed profiles acquired by CTD and XBT during W00269 first (left) and second (right) legs.

The casts were converted to .svp file format in Velocipy and applied during post-processing with nearest in time for most boxes, and nearest in distance within 2 hours on occasion. The XBT supply allotted for four casts per shift, and these were dropped such as to maximize the spatial and depth extents of the survey areas.

### B3f. Tides and water levels

Soundings were reduced to MLLW using the predicted data from National Water Level Observation Network (NWLON) stations 8665530 (Charleston, Cooper River Entrance), 8670870 (Fort Pulaski, Savannah River), 8720030 (Fernandina Beach, Amelia River), 8720218 (Mayport Bar Pilots Dock, St. John's River), and 8721604 (Trident Pier, Port Canaveral). The stations are zoned by CCMABioGeo2012COR_rev.zdf, a zoning file that encompasses the entire area of operations. The zoning file was originally created for the Biogeography Branch, Center for Coastal Monitoring and Assessment, in 2012, and is included in Appendix I: Tides and Water Levels.

### B4. Backscatter

The backscatter collected along each beam of the ME70 was retained in the raw data and the GSF output from MATLAB. After corrections were applied in CARIS HIPS, the data were exported from HIPS once more into GSF. The GSFs were imported into Fledermaus Geocoder Toolbox, and the mosaics created.

While the bathymetry will reveal areas of structure and relief, one cannot necessarily infer hardbottom, as it may not have any depth variation. This is why multibeam backscatter is essential, as hardbottom can be inferred from areas of strong returns of acoustic intensity. Thus when used together, the backscatter is an effective complement to the bathymetry. An example is shown in Figure 28.

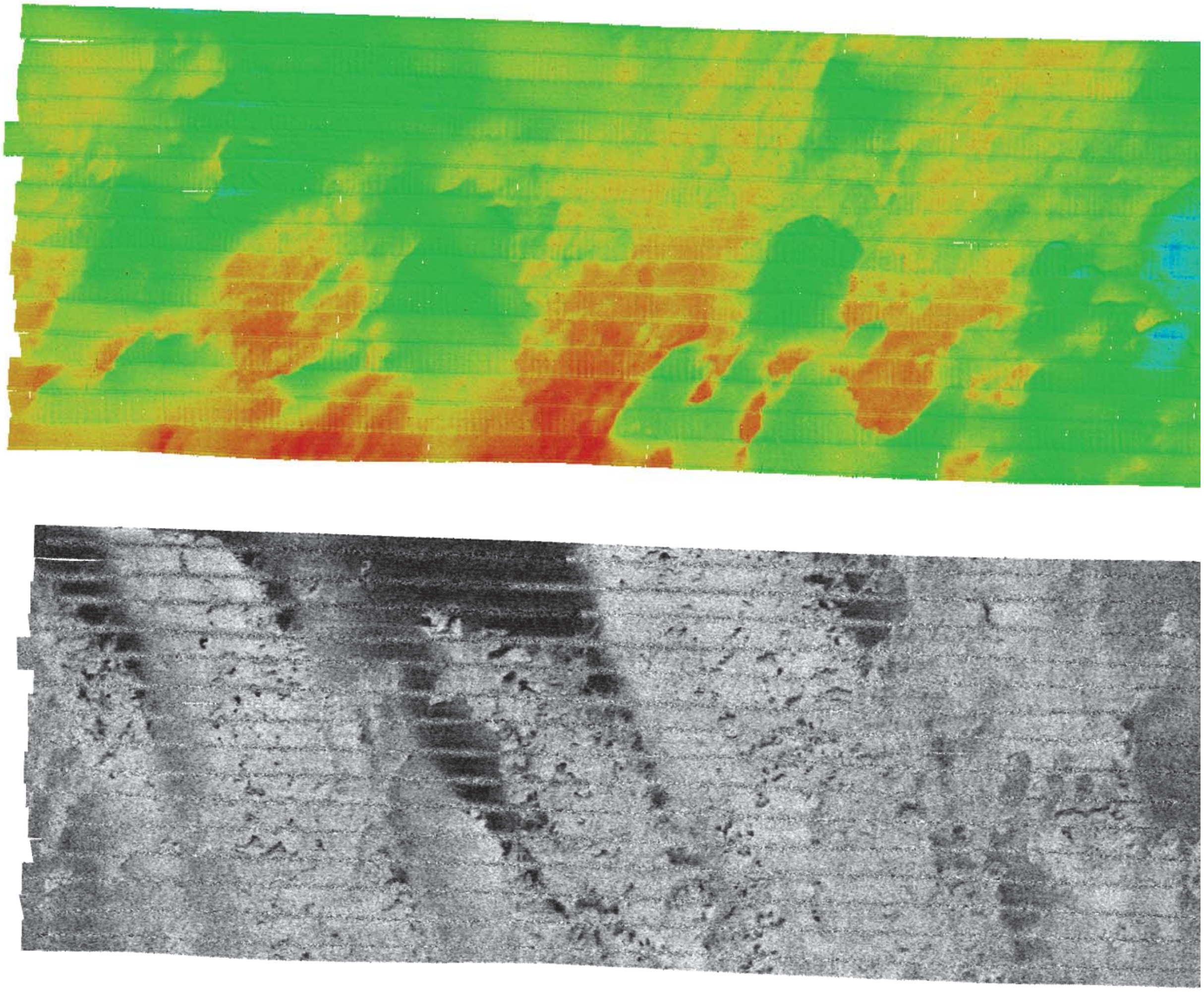


Figure 28. Multibeam bathymetry and backscatter showing ledges and habitat suitable for the deployment of fish sampling gears (e.g., traps, camera arrays). Note there is little or no correlation between areas of hard bottom revealed by bathymetry (top) and backscatter (below); backscatter is equally important when considering optimal reef fish sampling locations.

## B5. Data Processing

The work flow from data acquisition to the delivery of both daily products to SEFIS, and the final product to OCS, is given below in Figure 29.

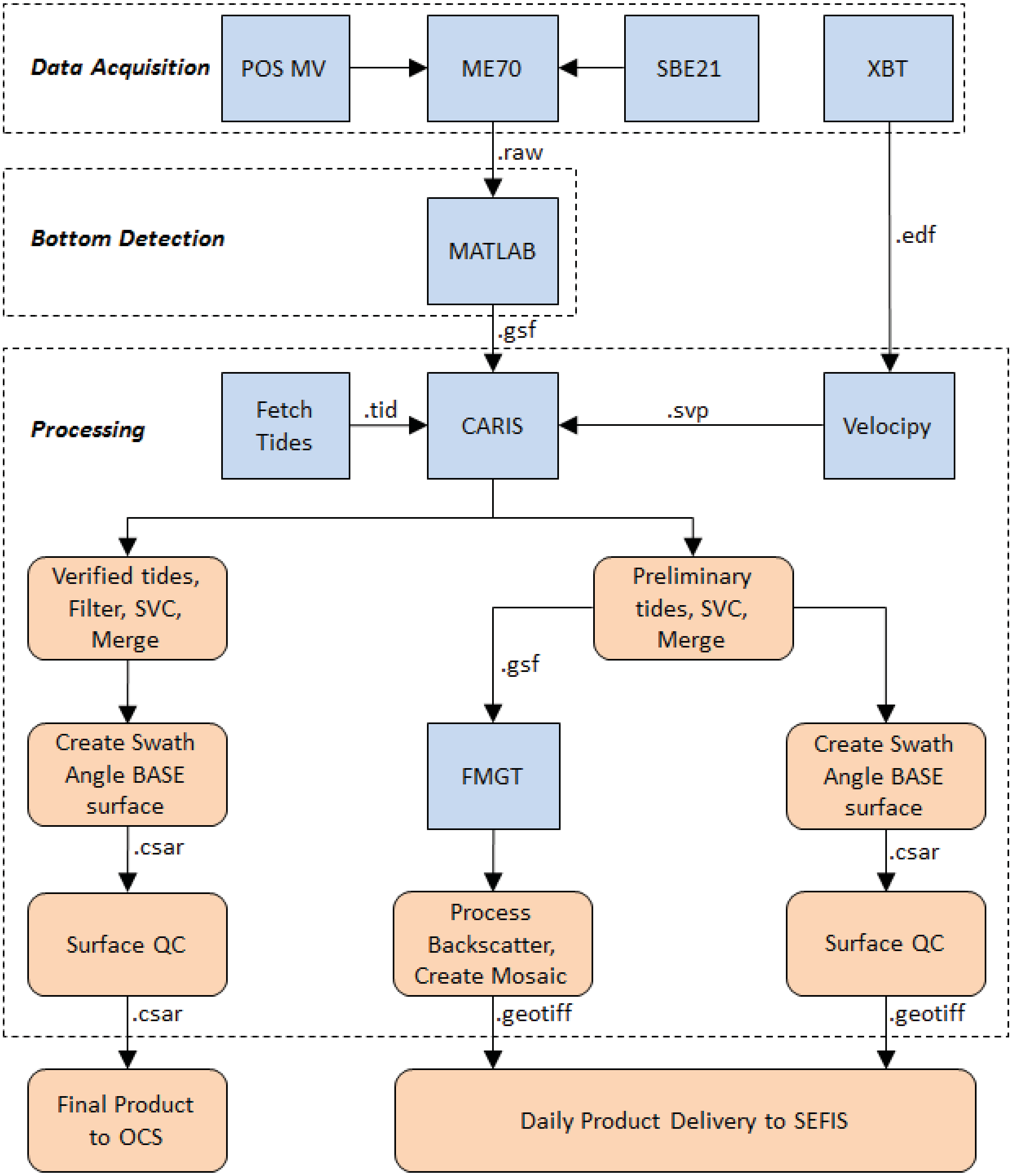


Figure 29. The W00269 work flow from data acquisition to product delivery. Note that the logged POS MV data (.000) was not used, either in the Trueheave correction, or for any SBET application, due to ineffectiveness, or to the issues discussed in Section B1c. The real-time output from the POS MV is shown in more detail in Appendix II: Vessel Documents.

### B5a. Bottom detections

As a fisheries multibeam echo sounder, the ME70 is not designed to derive bottom detections. However, the acoustic intensity returns are collected and stored for each beam in the raw data, thus depth soundings can be extracted in post-processing. A MATLAB software package written by Dr. Tom Weber derives bottom detections from raw ME70 data. The output of this package is a Generic Sensor Format (GSF) that can then be readily converted into CARIS HIPS.

A minimum and maximum depth gates must be set in the MATLAB, with which the program will use to focus the bottom detection algorithm. Narrower depth gates noticeably improved the performance of the algorithm; however, it required a close watch by the users to ensure actual depths never surpassed the gate bounds. The output from MATLAB is in GSF, a format readily ingested into CARIS HIPS.

### B5b. CARIS HIPS workflow

*Vessel file*

- The CARIS HIPS Vessel File was entitled “ME70_Pisces_2013.hvf”.
- Linear offsets between the IMU and the ME70 are entered into the Swath1 X,Y,Z field.
- The motion data are shifted to the correct reference frame in the POSView, this is why the roll and pitch misalignment values of Swath1 are set to zero. The exception is the yaw, as explained in Section B3d.
- An additional roll correction was added on DN166 due to an observed roll artifact. Thereafter, the roll value was adjusted in the POSView, and then the roll once again was set to zero in the HVF on DN168.
- Linear offsets between the IMU and the primary GPS antenna were entered into POSView, thus the Navigation X,Y,Z fields are set to zero in the HVF.
- The X,Y,Z offset values are entered into the heave to shift the heave data to the ME70 because it is not actually applied in real-time.
- The dynamic and static drafts are applied in post-processing via the Draft and Waterline Height fields in the HVF.
- The SVP corrections are shifted to the ME70 via the X,Y,Z offsets in the SVP1 field.

*Data conversion and correctors*

- The GSF output from MATLAB was converted into CARIS HDCS format using the CARIS Conversion Wizard. Geographic coordinates were selected, and no filters were applied during the conversion.

- After the conversion, the lines were opened within HIPS, and the predicted, zoned tide data (see Section B3g) was applied to reduce all sounding data to MLLW.

- The lines were often filtered to remove all soundings outside of +/-50 or +/-60 degrees of nadir. This was necessary due to refraction error (see Section B2d).

- Sound speed corrections were applied predominantly with nearest in time, though in some instances nearest in distance within 2 hours was used (see Section B3e).

- The merge operation in CARIS was then performed, without applying smoothing to sensors.

- Prior to submission to OCS, the soundings were reduced to MLLW using verified water levels and a more aggressive filter applied (+/-30 degrees of nadir) to mitigate the refraction error.

*Data cleaning*

- Lines were spot-checked in HIPS navigation and attitude editors.

- Field sheets were created to encompass the survey areas and used for creating surfaces, gridded to either a 2m or a 4m resolution.

- The depth and statistical layers of the grid were used find anomalous data points, which were removed using CARIS Subset Editor.

### B5c. Fledermaus Geocoder Toolbox

Data were exported from CARIS HIPS to a GSF and imported into a FMGT Project. The sonar default values were set to “Custom Override All”; Sonar Type was “Simrad ME70”; source files were added, and a mosaic created. The greyscale bar of the resulting mosaic was adjusted to maximize the contrast of the backscatter strength.

## C. VERTICAL AND HORIZONTAL CONTROL

### C1. Vertical Control

The vertical datum for this project is MLLW. Soundings were reduced to MLLW using verified tides from the National Water Level Observation Network primary water level stations listed in Table 9, in conjunction with the zoning file CCMABioGeo2012COR_rev.zdf (originally created for the Biogeography Branch, Center for Coastal Monitoring and Assessment in 2012). The zoning file encompasses the entire area of operations for W00269. A plan view of the zoning file extents is given in Appendix I: Tides and Water Levels.

Table 9. NWLON Stations used in W00269

| Station ID | Location | Lat/Lon | Established | Present Installation | NOAA Chart |
|---|---|---|---|---|---|
| **8665530** | Charleston, SC | 32-46.9 N, 79-55.5 W | 9/13/1899 | 4/25/1990 | 11524 |
| **8670870** | Fort Pulaski, GA | 32-2 N, 80-54.1 W | 7/1/1935 | 5/14/1990 | 11513 |
| **8720030** | Fernandina Beach, FL | 30-40.3 N, 81-27.9 W | 5/18/1898 | 2/5/1997 | 11502 |
| **8720218** | Mayport, FL | 30-23.8 N, 81-25.8 W | 8/1/1995 | 6/29/1995 | 11490 |
| **8721604** | Trident Pier, FL | 28-24.9 N, 80-35.5 W | 10/13/1994 | 10/18/1994 | 11478 |

### C2. Horizontal Control

The horizontal datum for this survey is NAD83, and all projections to UTM Zone 17N.

DGPS corrections were supplied to the POS MV positioning via Leica MX-420 DGPS receiver and coupled with attitude from the IMU to establish horizontal control.

## D. RESULTS AND RECOMMENDATIONS

### D1. Chart Comparison

The chart comparison was performed with the largest scale rasters charts that contain the survey areas. The charts used in the comparison are listed in Table 10.

Table 10. Raster charts used for comparison

| Chart | Scale | Edition | Edition Date | Latest LNM | Latest NTM |
|---|---|---|---|---|---|
| 11476 | 1:80,000 | 22 | 2/1/2010 | 4/2/2013 | 4/6/2013 |
| 11484 | 1:80,000 | 24 | 7/1/2011 | 4/2/2013 | 4/6/2013 |
| 11486 | 1:80,000 | 16 | 11/1/2010 | 4/2/2013 | 4/6/2013 |
| 11480 | 1:449,659 | 41 | 11/1/2010 | 4/2/2013 | 4/6/2013 |

Due to the significant refraction error observed in the data (see Section B2d), the soundings were filtered prior to comparison to retain only those data within 30° to either side of nadir. Filtration created a de facto multibeam “skunk stripe” survey, wherein the adjacent swaths share no overlap.  The bathymetric grids were recomputed and the refraction error was almost entirely mitigated.

From the filtered, bathymetric grids, a shoal-biased sounding selection was created to facilitate chart comparison.  However, due to the vertical offset issue (see Sections B2b and B2d), the derived soundings are not recommended for a full chart update, which involves superseding all charted soundings in common areas with the surveyed soundings.  Instead, a more limited application is recommended, which involves superseding chart soundings on a case by case basis, for the benefit of the chart, to reveal dangers to navigation and/or areas of shoaling otherwise not represented.  It is important to also consider the origin of the charted soundings in the area of acquisition for W00269, most of which was partial bottom coverage, acquired sometime between 1940-1969.

Considering the vertical offset, it is not prudent to supersede charted soundings with surveyed soundings that are deeper.  In this case, water would be added that may not exist.  If the charted soundings are consistent with the survey soundings, no action is taken, because there is no benefit to the chart in this case.  However, in the event that the surveyed soundings are shoaler than the charted soundings, it is recommended to update the chart accordingly.  In this case, we are removing water that almost surely does not exist, in fact (considering the vertical offset) there may be considerably less water than the chart indicated.  In this scenario, the chart is improved.

Using this methodology, a total of 18 soundings were identified as candidates to improve the chart, and are recommended to be added in a limited chart update.  The soundings, and their relation to the currently charted soundings, are shown in Figures 30-33, and are included in the survey submission in a CARIS HOB file.

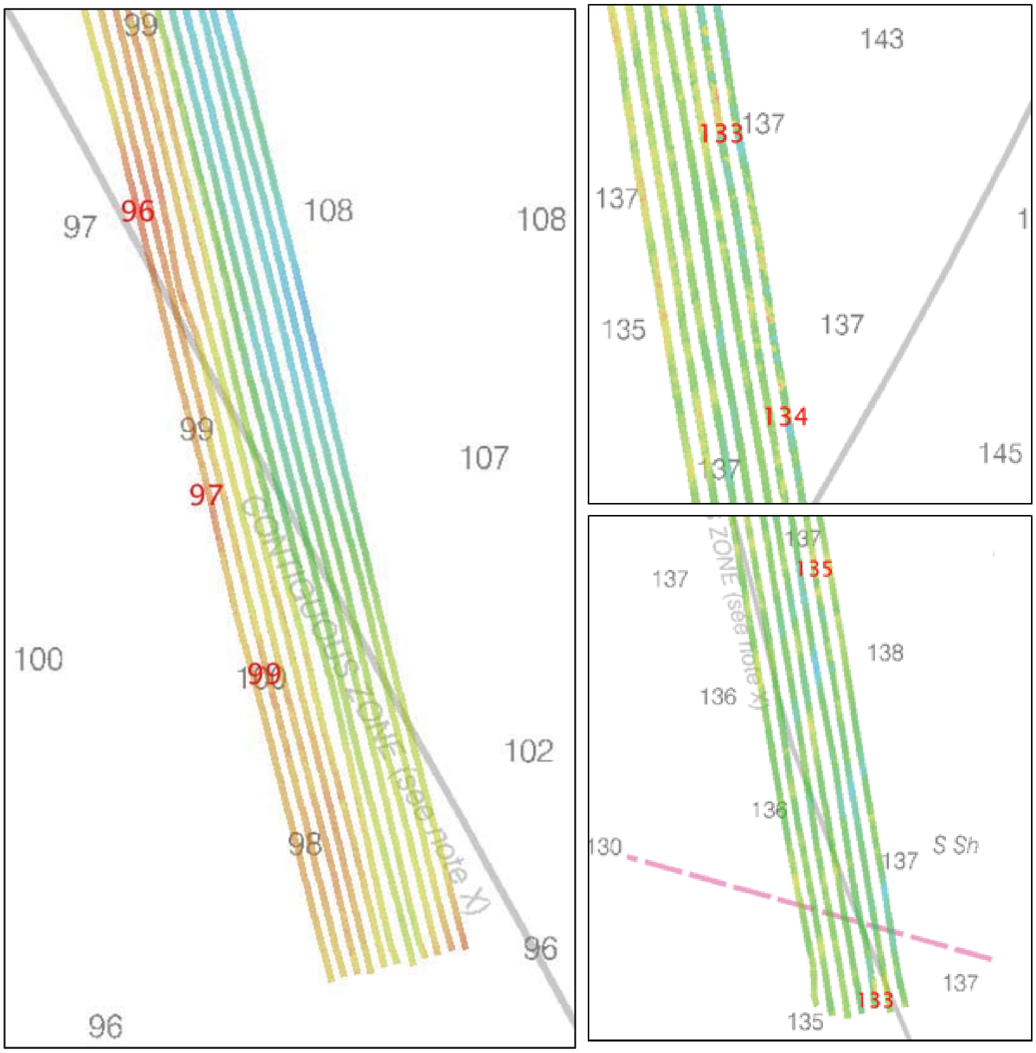


Figure 30. Filtered bathymetry and recommended soundings (red) from Box 91 (left), and Box 105 (top and bottom right). Charted soundings (grey) from Charts 11484 (left) and 11476 (top and bottom right). All soundings are in feet.

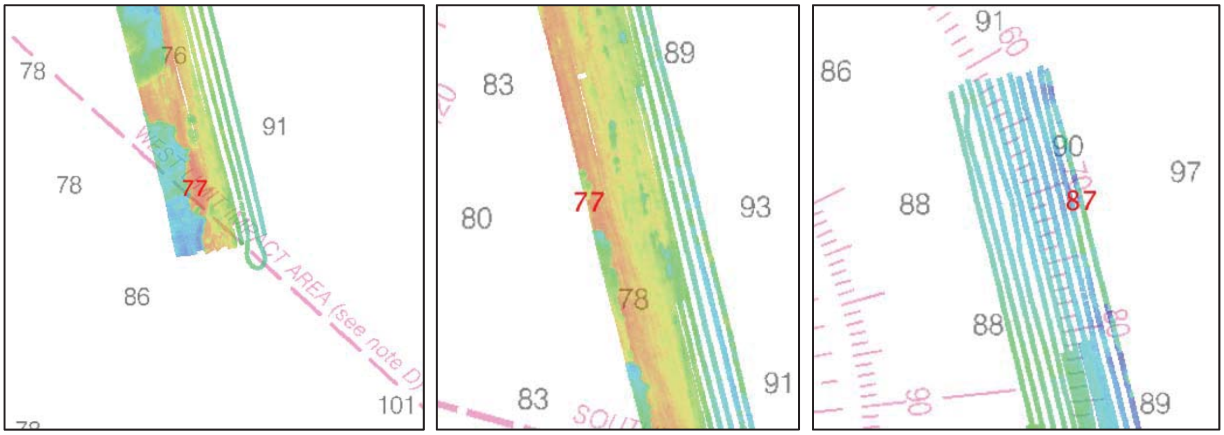


Figure 31. Filtered bathymetry and recommended soundings (red) from Box 106, and charted soundings (grey) from Chart 11476. All soundings are in feet.

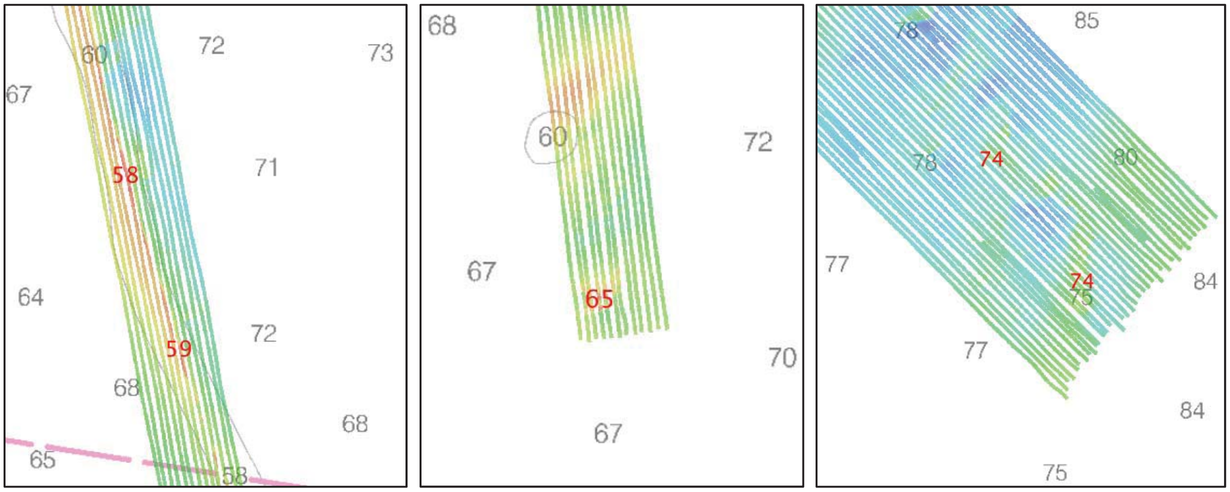


Figure 32. Filtered bathymetry and recommended soundings (red) from Box 108 (left), Box 97 (middle), and Box 92 (right). Charted soundings (grey) from Chart 11484. All soundings are in feet.

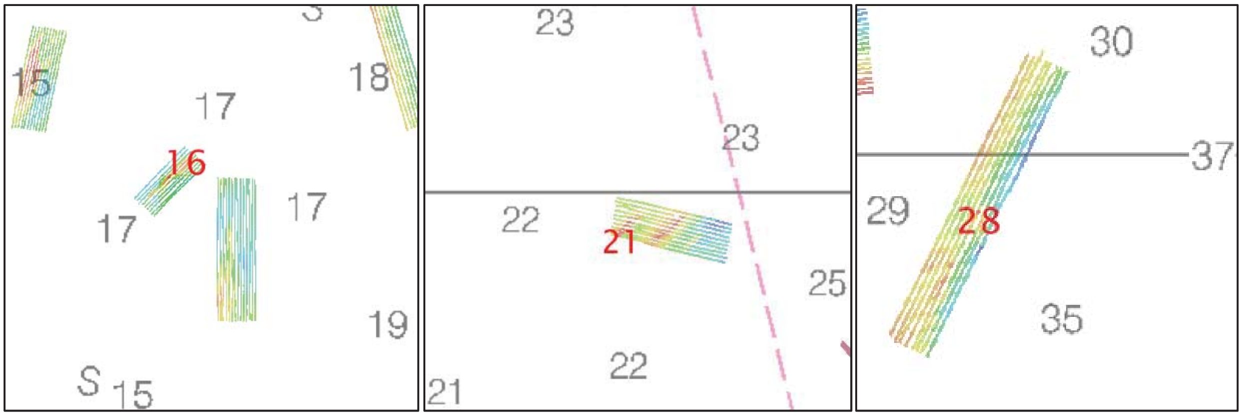


Figure 33. Filtered bathymetry and recommended soundings (red) from Box 87 (left), Box 13 (middle), and Box 6 (right). Charted soundings (grey) from Chart 11480. All soundings are in fathoms.

### D2. Additional Results

There was no shoreline, bridges, overhead cables, pipelines, platforms, unusual submarine features, present or planned construction within this survey.

## D3. Summary and Recommendations

Ship time is limited and valuable. More specifically, where NOAA hydrographic surveys are concerned, it is a NOAA IOCM objective to further “intra- and inter-agency coordination with a focus on streamlining operations, reducing redundancies, improving efficiencies, developing common standards, and stimulating innovation and technological development” (i.e., Map once, use many times). During this 32-day survey, 40 areas were mapped in continental shelf and shelf-break waters off the southeastern U.S., totaling approximately 258 $km^2$ between 28.2°N and 32.1 °N. Maps were comprehensively useful for fisheries science purposes; a total of 399 paired fish trap catches and underwater video recordings were collected from previously-unmapped and -unsampled reef fish habitats. Additionally, ME70 data acquired during fisheries research can add value to OCS nautical charts.

The calculations of total propagated uncertainty show that the ME70 data generally did not meet IHO Order 1 specifications in shallower depths, which indicates that the ME70 may not be suitable for object detection, feature disproval, or for areas of critical underkeel clearance. However, it is important to consider the areas that the ship may be working in, and the source of the charted soundings. Deeper areas further offshore where the ship may be operating often have not received a chart update in several decades. For example, the survey areas as part of cruise PC-13-04 were last updated between 1940-1969, in which case the application of suggested shoal soundings from this cruise is easily justified, and are of great benefit to the nautical chart.

Throughout PC-13-04, daily habitat maps were prepared for a rapid turnaround and delivery to SEFIS, while data were being simultaneously processed as part of a deliverables package to OCS. Throughout this process, there was opportunity to assess and build the capacity for acoustic mapping on the NOAA Ship *Pisces.* The following is a list of substantial accomplishments during PC-13-04:

- Ellipsoid-referenced techniques were used to accurately determine the ship’s waterline, and this value is recommended for use over any previous estimations.
- The ship’s static and dynamic draft measurements were measured and implemented into the post-processing routine, in order to properly reference echo soundings to the true waterline.
- Continued examination of the POS MV system and communication with Applanix has resulted in recommendations for improved performance (see Appendix II: Correspondence, and below).
- Several patch tests were conducted and the motion data was properly rotated into the multibeam reference frame in real-time.
- A processing workflow was established to correct derived bottom detections for vessel offsets, tides, and sound speed.
- ME70 system biases have been discovered and analyzed, and are pending inquiry from HSTP and UNH-CCOM.
- Conducted training with SEFIS personnel and undergraduate students, building knowledge and hydrographic capacity for future mapping work, as well as shared tools and best practices.

The following is a list of recommendations provided to NOAA Ship *Pisces* in order to further build capacity for acoustic mapping, listed in the order of priority, such that the first item on the list is deemed most urgent.

1. Resolve the issues that lead to a degraded POS MV performance and GAMS calibration failures. Based on examination of the data from PC-13-04 and correspondence with Applanix, it is recommended that:
    a. The POS MV antennas to be positioned higher and away from the other structures on the ship, such that a clear view from horizon to horizon is achieved.
    b. The IMU is sent to Applanix for evaluation and "tumble test".
2. An updated vessel offset survey by NGS, using the top of the POS MV IMU as the ship's reference point, and to include the following:
    a. The exact point on the ME70 to which is measured should be clearly defined.
    b. The offsets to the auxiliary GPS antenna should also be included, as these have only been estimated in the past and not surveyed.
    c. An estimate for the vessel's center of rotation should also be attained, as this is a necessary input into the POS MV.
3. Calibration of all sound speed sensors, including the SBE45.
4. Software and hardware updates to POS MV POSView and ME70 systems.
    a. POSView and ME70 software updates are available.
    b. Defective ME70 transducer elements should be evaluated.
5. It is recommended that *Pisces* obtain resident software licenses (e.g., CARIS HIPS, FMGT) that will facilitate ME70 data processing.
6. Network data transmission capabilities to circumvent the usage of portable hard drives for data transfer, which was found to be detrimental to survey operations.
7. Increased support for the XBT system, including a PC update, software update, and backup cables and launcher.
8. Hull cleaning to include removal of bio-fouling on all sonar transducer faces.
9. Ability for ME70 data acquisition with Hypack, to include line steering and real-time swath display. Discussions are ongoing between HSTP and Hypack regarding this potential capability.

## D4. References

Applanix, 2009. POS MV V4 User Guide.

Greenaway, M., 2013. Total Vertical Uncertainty Quality Check.

International Hydrographic Organization, 2008. IHO Standards for Hydrographic Surveys Special Publication No. 44.

Malik, M., Burkitt, J., and Mitchell, N., 2012. NOAA Ship *Henry Bigelow* ME70 troubleshooting and system performance checks.

NOAA Ship Oscar Dyson, 2009. Descriptive Report to Accompany Survey W00265.

Rice, G., 2011a. Descriptive Report to Accompany Survey DY1103.

Rice, G., 2011b. Estimating Vessel Static Waterline Using Vessel Ellipsoid Height.

Trenkel, V. M., Mazauric, V., and Berger, L. 2008. The new fisheries multibeam echosounder ME70: description and expected contribution to fisheries research. ICES Journal of Marine Science 65: 645–655.

Wilson, M., Wolfskehl, S., 2013. NOAA Ship *Henry Bigelow* Patch Test and Assessment.

## E. LETTER OF APPROVAL

Efforts were made in the field to adhere to NOS Hydrographic Specifications and Deliverables (2013), though because it was collected for non-hydrographic purposes, this was not always possible, as detailed in the report. The data are submitted as outside source data, for use by the NOAA Office of Coast Survey, should it be deemed beneficial.

This report and the accompanying data are respectfully submitted.

Digitally signed by
WILSON.MATTHEW.JAMES.1075678645
DN: c=US, o=U.S. Government, ou=DoD,
ou=PKI, ou=OTHER,
cn=WILSON.MATTHEW.JAMES.1075678645
Date: 2013.09.24 10:56:12 -04'00'

Matthew J. Wilson
Physical Scientist, Office of Coast Survey
Lead Hydrographer

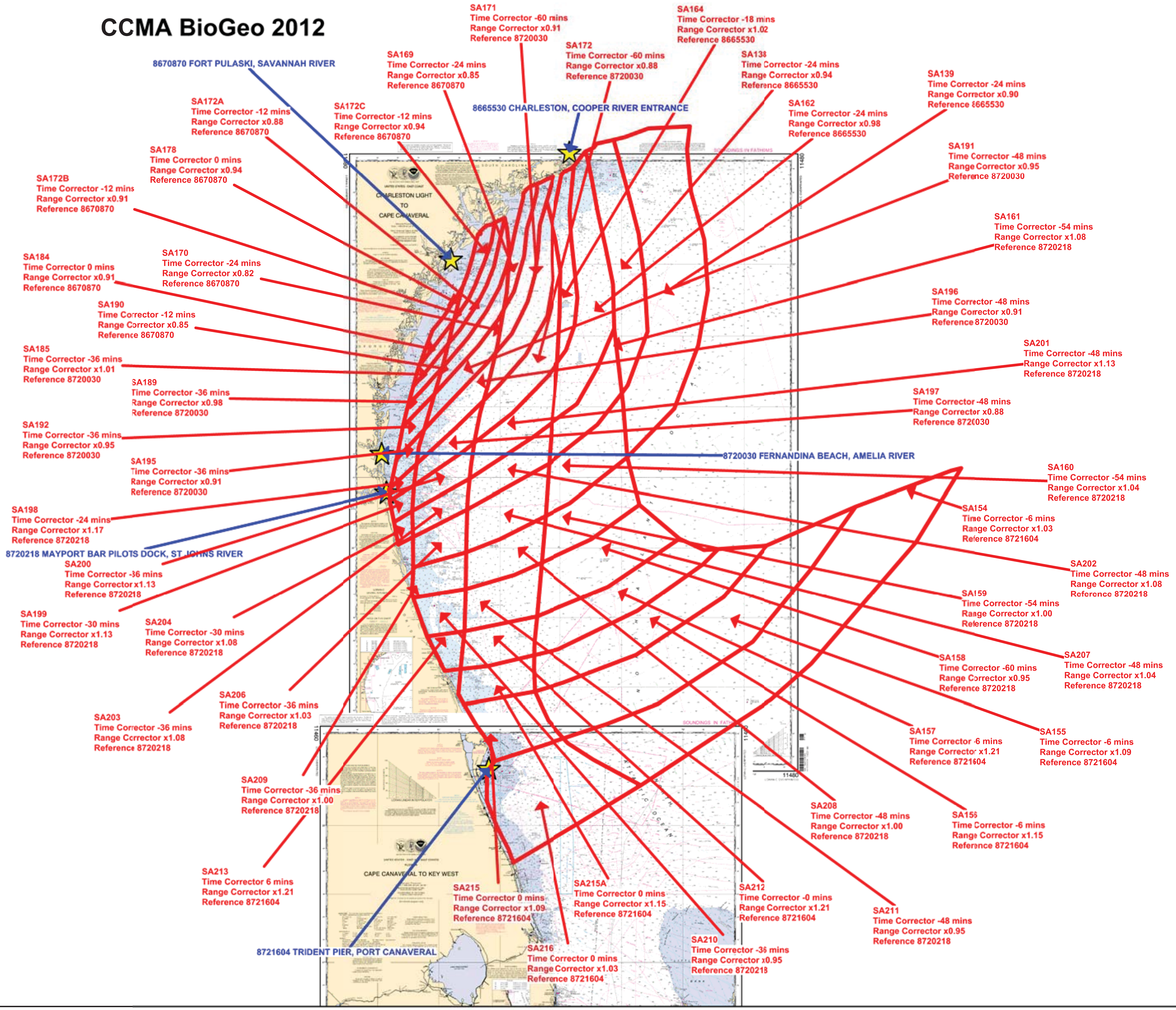
Warren A. Mitchell

Warren Mitchell
JHT Contract Fisheries Biologist, Southeast Fishery-Independent Survey
Habitat Mapping Lead

# APPENDIX I

# TIDE NOTE AND GRAPHICS

# CCMA BioGeo 2012



# Appendix II:  Supplemental Survey Records and Correspondence

# ME70 Beam Configurations

A. B31_sec120deg_XmitByDecreaseSteering (Tom Weber, UNH-CCOM)

B. Grc0525_x3_pulse1536 (Randy Cutter, NMFS)

**Beam Configuration, Dr. Tom Weber (UNH-CCOM), "b31_sec120deg_XmitByDecreaseSteering"**

| Beam # | Minor-axis beam steering angle(degrees) | Major-axis beam steering angle(degrees) | Absorption Coefficient | EK60 SaCorrection | EK60 Transducer Gain | Frequency | Major Axis 3db Beam Angle | Major Axis Angle Offset |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | -65.886 | 0.205355 | -1.509 | 16.5114 | 73.23 | 11.29 | 0 |
| 1 | 0 | -56.749 | 0.0219545 | -1.5024 | 21.4327 | 76.09 | 8.09 | 0 |
| 2 | 0 | -49.698 | 0.0234011 | -1.5332 | 23.9341 | 78.95 | 6.61 | 0 |
| 3 | 0 | -43.76 | 0.024873 | -1.5435 | 26.2886 | 81.81 | 5.72 | 0 |
| 4 | 0 | -38.541 | 0.0263682 | -1.5525 | 28.126 | 84.66 | 5.1 | 0 |
| 5 | 0 | -33.833 | 0.0278844 | -1.549 | 29.8321 | 87.52 | 4.64 | 0 |
| 6 | 0 | -29.513 | 0.0294197 | -1.5548 | 31.0714 | 90.38 | 4.29 | 0 |
| 7 | 0 | -25.496 | 0.0309721 | -1.5589 | 31.6415 | 93.24 | 4.01 | 0 |
| 8 | 0 | -21.726 | 0.0325395 | -1.5582 | 32.1157 | 96.1 | 3.78 | 0 |
| 9 | 0 | -18.158 | 0.0341201 | -1.5562 | 32.5372 | 98.95 | 3.59 | 0 |
| 10 | 0 | -14.761 | 0.035712 | -1.5499 | 33.182 | 101.81 | 3.43 | 0 |
| 11 | 0 | -11.509 | 0.0373136 | -1.5753 | 33.6903 | 104.67 | 3.29 | 0 |
| 12 | 0 | -8.38 | 0.038923 | -1.5739 | 34.1049 | 107.53 | 3.17 | 0 |
| 13 | 0 | -5.357 | 0.0405387 | -1.5698 | 34.8434 | 110.39 | 3.07 | 0 |
| 14 | 0 | -2.425 | 0.0421591 | -1.5531 | 34.9524 | 113.24 | 2.98 | 0 |
| 15 | 0 | 0.419 | 0.044161 | -1.573 | 34.6922 | 116.77 | 2.89 | 0 |
| 16 | 0 | 3.246 | 0.0429706 | -1.5421 | 34.8525 | 114.67 | 2.95 | 0 |
| 17 | 0 | 6.143 | 0.0413485 | -1.5606 | 34.8145 | 111.82 | 3.04 | 0 |
| 18 | 0 | 9.132 | 0.0397302 | -1.5602 | 34.3404 | 108.96 | 3.14 | 0 |
| 19 | 0 | 12.227 | 0.0381174 | -1.5649 | 34.0878 | 106.1 | 3.26 | 0 |
| 20 | 0 | 15.444 | 0.0365117 | -1.5489 | 33.3743 | 103.24 | 3.39 | 0 |
| 21 | 0 | 18.805 | 0.0349147 | -1.548 | 32.8707 | 100.38 | 3.55 | 0 |
| 22 | 0 | 22.335 | 0.0333282 | -1.5563 | 32.5383 | 97.53 | 3.74 | 0 |
| 23 | 0 | 26.067 | 0.031754 | -1.5547 | 32.0085 | 94.67 | 3.97 | 0 |
| 24 | 0 | 30.042 | 0.0301939 | -1.5554 | 31.3318 | 91.81 | 4.25 | 0 |
| 25 | 0 | 34.317 | 0.0286498 | -1.53 | 30.3649 | 88.95 | 4.6 | 0 |
| 26 | 0 | 38.975 | 0.0271238 | -1.5081 | 28.8346 | 86.09 | 5.05 | 0 |
| 27 | 0 | 44.139 | 0.0256178 | -1.5158 | 26.8605 | 83.24 | 5.65 | 0 |
| 28 | 0 | 50.011 | 0.024134 | -1.5072 | 24.88 | 80.38 | 6.54 | 0 |
| 29 | 0 | 56.978 | 0.0226745 | -1.5107 | 21.9911 | 77.52 | 7.99 | 0 |
| 30 | 0 | 65.99 | 0.0212414 | -1.4759 | 17.6196 | 74.66 | 11.12 | 0 |

For display purposes, beam characteristics were read directly from example ME70 *.raw files, via Myriax Echoview fisheries acoustics software.

| Beam # | Major Axis Angle Sensitivity | Minor Axis 3db Beam Angle | Minor Axis Angle Offset | Minor Axis Angle Sensitivity | Sound Speed | Transmitted Power | Transmitted Pulse Length | Tvg Range Correction | Two Way Beam Angle |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 21.27 | 4.63 | 0 | 51.86 | 1542.5 | 81.47754 | 1.536 | SimradEx60 | -20.450947 |
| 1 | 29.65 | 4.45 | 0 | 53.89 | 1542.5 | 85.23 | 1.536 | SimradEx60 | -22.6061117 |
| 2 | 36.29 | 4.29 | 0 | 55.91 | 1542.5 | 85.98632 | 1.536 | SimradEx60 | 23.09897 |
| 3 | 41.99 | 4.14 | 0 | 57.94 | 1542.5 | 83.3707 | 1.536 | SimradEx60 | -23.886911 |
| 4 | 47.07 | 4 | 0 | 59.96 | 1542.5 | 80.09018 | 1.536 | SimradEx60 | -24.531351 |
| 5 | 51.67 | 3.87 | 0 | 61.99 | 1542.5 | 76.15279 | 1.536 | SimradEx60 | -25.080978 |
| 6 | 55.9 | 3.75 | 0 | 64.01 | 1542.5 | 74.11713 | 1.536 | SimradEx60 | -25.562269 |
| 7 | 59.82 | 3.63 | 0 | 66.03 | 1542.5 | 73.25302 | 1.536 | SimradEx60 | -25.991278 |
| 8 | 63.45 | 3.53 | 0 | 68.06 | 1542.5 | 73.75516 | 1.536 | SimradEx60 | -26.378506 |
| 9 | 66.83 | 3.42 | 0 | 70.08 | 1542.5 | 74.99984 | 1.536 | SimradEx60 | -26.731215 |
| 10 | 69.98 | 3.33 | 0 | 72.11 | 1542.5 | 77.11973 | 1.536 | SimradEx60 | -27.054628 |
| 11 | 72.9 | 3.24 | 0 | 74.13 | 1542.5 | 74.28594 | 1.536 | SimradEx60 | -27.352652 |
| 12 | 75.61 | 3.15 | 0 | 76.15 | 1542.5 | 68.12886 | 1.536 | SimradEx60 | -27.628239 |
| 13 | 78.12 | 3.07 | 0 | 78.18 | 1542.5 | 58.948 | 1.536 | SimradEx60 | -27.883692 |
| 14 | 80.42 | 2.99 | 0 | 80.2 | 1542.5 | 51.04043 | 1.536 | SimradEx60 | -28.120838 |
| 15 | 82.99 | 2.9 | 0 | 82.7 | 1542.5 | 44.5407 | 1.536 | SimradEx60 | -28.390734 |
| 16 | 81.37 | 2.96 | 0 | 81.21 | 1542.5 | 48.95229 | 1.536 | SimradEx60 | -28.226677 |
| 17 | 79.02 | 3.03 | 0 | 79.19 | 1542.5 | 55.53407 | 1.536 | SimradEx60 | -27.989418 |
| 18 | 76.46 | 3.11 | 0 | 77.17 | 1542.5 | 64.60277 | 1.536 | SimradEx60 | -27.734127 |
| 19 | 73.7 | 3.19 | 0 | 75.14 | 1542.5 | 70.35807 | 1.536 | SimradEx60 | -27.458996 |
| 20 | 70.73 | 3.28 | 0 | 73.12 | 1542.5 | 76.19363 | 1.536 | SimradEx60 | -27.161732 |
| 21 | 67.54 | 3.38 | 0 | 71.09 | 1542.5 | 76.00295 | 1.536 | SimradEx60 | -26.839361 |
| 22 | 64.12 | 3.47 | 0 | 69.07 | 1542.5 | 73.84613 | 1.536 | SimradEx60 | -26.488024 |
| 23 | 60.44 | 3.58 | 0 | 67.05 | 1542.5 | 73.06338 | 1.536 | SimradEx60 | -26.102505 |
| 24 | 56.49 | 3.69 | 0 | 65.02 | 1542.5 | 73.10033 | 1.536 | SimradEx60 | -25.675587 |
| 25 | 52.22 | 3.81 | 0 | 63 | 1542.5 | 75.12555 | 1.536 | SimradEx60 | -25.196833 |
| 26 | 47.57 | 3.94 | 0 | 60.97 | 1542.5 | 77.64481 | 1.536 | SimradEx60 | -24.650288 |
| 27 | 42.46 | 4.07 | 0 | 58.95 | 1542.5 | 80.8847 | 1.536 | SimradEx60 | -24.009666 |
| 28 | 36.71 | 4.22 | 0 | 56.93 | 1542.5 | 84.16721 | 1.536 | SimradEx60 | -23.226706 |
| 29 | 30.03 | 4.37 | 0 | 54.9 | 1542.5 | 85.56769 | 1.536 | SimradEx60 | -22.196171 |
| 30 | 21.59 | 4.54 | 0 | 52.88 | 1542.5 | 82.8196 | 1.536 | SimradEx60 | -20.601021 |

**Beam Configuration, Randy Cutter (NOAA NMFS), "Grc0525_x3_pulse"**

| Beam # | Minor-axis beam steering angle(degrees) | Major-axis beam steering angle(degrees) | Absorption Coefficient | EK60 SaCorrection | EK60 Transducer Gain | Frequency | Major Axis 3db Beam Angle | Major Axis Angle Offset | Major Axis Angle Sensitivity |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | -69.943 | 0.0196011 | -1.5938 | 20.4378 | 71.32 | 17.1 | 0 | 14.04 |
| 1 | 0 | -57.969 | 0.0210978 | -1.5938 | 23.8597 | 74.37 | 10.6 | 0 | 22.64 |
| 2 | 0 | -49.372 | 0.0226274 | -1.5938 | 25.812 | 77.43 | 8.3 | 0 | 28.93 |
| 3 | 0 | -42.28 | 0.0241874 | -1.5938 | 27.2927 | 80.48 | 7.02 | 0 | 34.17 |
| 4 | 0 | -36.088 | 0.025775 | -1.5938 | 28.4859 | 83.54 | 6.2 | 0 | 38.74 |
| 5 | 0 | -30.506 | 0.0273876 | -1.5938 | 29.4703 | 86.59 | 5.61 | 0 | 42.81 |
| 6 | 0 | -25.367 | 0.0290228 | -1.5938 | 30.2792 | 89.64 | 5.16 | 0 | 46.49 |
| 7 | 0 | -20.567 | 0.030678 | -1.5938 | 30.956 | 92.7 | 4.82 | 0 | 49.81 |
| 8 | 0 | -16.031 | 0.0323508 | -1.5938 | 31.4542 | 95.75 | 4.54 | 0 | 52.82 |
| 9 | 0 | -11.706 | 0.034039 | -1.5938 | 31.626 | 98.81 | 4.32 | 0 | 55.53 |
| 10 | 0 | -7.552 | 0.0357403 | -1.5938 | 31.7425 | 101.86 | 4.14 | 0 | 57.95 |
| 11 | 0 | -3.534 | 0.0374524 | -1.5938 | 31.7996 | 104.92 | 3.99 | 0 | 60.1 |
| 12 | 0 | 0.373 | 0.0395751 | -1.5938 | 31.7719 | 108.68 | 3.85 | 0 | 62.37 |
| 13 | 0 | 4.258 | 0.038312 | -1.5938 | 31.7707 | 106.44 | 3.94 | 0 | 60.92 |
| 14 | 0 | 8.233 | 0.0365951 | -1.5938 | 31.7148 | 103.39 | 4.09 | 0 | 58.72 |
| 15 | 0 | 12.346 | 0.0348882 | -1.5938 | 31.6002 | 100.34 | 4.27 | 0 | 56.25 |
| 16 | 0 | 16.629 | 0.0331932 | -1.5938 | 31.4312 | 97.28 | 4.49 | 0 | 53.49 |
| 17 | 0 | 21.123 | 0.0315124 | -1.5938 | 31.1092 | 94.23 | 4.76 | 0 | 50.44 |
| 18 | 0 | 25.88 | 0.029848 | -1.5938 | 30.4362 | 91.17 | 5.1 | 0 | 47.08 |
| 19 | 0 | 30.973 | 0.0282025 | -1.5938 | 29.6315 | 88.12 | 5.54 | 0 | 43.36 |
| 20 | 0 | 36.507 | 0.0265783 | -1.5938 | 28.6526 | 85.06 | 6.12 | 0 | 39.24 |
| 21 | 0 | 42.646 | 0.0249779 | -1.5938 | 27.4596 | 82.01 | 6.93 | 0 | 34.62 |
| 22 | 0 | 49.678 | 0.0234038 | -1.5938 | 25.999 | 78.95 | 8.19 | 0 | 29.32 |
| 23 | 0 | 58.201 | 0.0218586 | -1.5938 | 24.1066 | 75.9 | 10.46 | 0 | 22.95 |
| 24 | 0 | 70.064 | 0.0203451 | -1.5938 | 20.854 | 72.84 | 16.84 | 0 | 14.25 |

For display purposes, beam characteristics were read directly from example ME70 *.raw files, via Myriax Echoview fisheries acoustics software.

| Beam # | Minor Axis 3db Beam Angle | Minor Axis Angle Offset | Minor Axis Angle Sensitivity | Sound Speed | Transmitted Power | Transmitted Pulse Length | Tvg Range Correction | Two Way Beam Angle |
|---|---|---|---|---|---|---|---|---|
| 0 | 5.91 | 0 | 40.61 | 1542.5 | 11.45083 | 1.536 | SimradEx60 | -17.573374 |
| 1 | 5.67 | 0 | 42.35 | 1542.5 | 12.21411 | 1.536 | SimradEx60 | -19.83103 |
| 2 | 5.44 | 0 | 44.09 | 1542.5 | 12.61939 | 1.536 | SimradEx60 | -21.071596 |
| 3 | 5.24 | 0 | 45.83 | 1542.5 | 12.41285 | 1.536 | SimradEx60 | -21.962429 |
| 4 | 5.04 | 0 | 47.57 | 1542.5 | 11.92875 | 1.536 | SimradEx60 | -22.669216 |
| 5 | 4.87 | 0 | 49.31 | 1542.5 | 11.45094 | 1.536 | SimradEx60 | -23.259399 |
| 6 | 4.7 | 0 | 51.05 | 1542.5 | 10.98186 | 1.536 | SimradEx60 | -23.767244 |
| 7 | 4.55 | 0 | 52.79 | 1542.5 | 10.77434 | 1.536 | SimradEx60 | -24.212597 |
| 8 | 4.4 | 0 | 54.53 | 1542.5 | 10.77669 | 1.536 | SimradEx60 | -24.607964 |
| 9 | 4.27 | 0 | 56.27 | 1542.5 | 11.06086 | 1.536 | SimradEx60 | -24.961697 |
| 10 | 4.14 | 0 | 58.01 | 1542.5 | 11.3735 | 1.536 | SimradEx60 | -25.279606 |
| 11 | 4.02 | 0 | 59.75 | 1542.5 | 10.95558 | 1.536 | SimradEx60 | -25.565807 |
| 12 | 3.88 | 0 | 61.89 | 1542.5 | 9.52752 | 1.536 | SimradEx60 | -25.880264 |
| 13 | 3.96 | 0 | 60.62 | 1542.5 | 10.3763 | 1.536 | SimradEx60 | -25.687599 |
| 14 | 4.08 | 0 | 58.88 | 1542.5 | 11.23692 | 1.536 | SimradEx60 | -25.401711 |
| 15 | 4.2 | 0 | 57.14 | 1542.5 | 11.2088 | 1.536 | SimradEx60 | -25.084602 |
| 16 | 4.33 | 0 | 55.4 | 1542.5 | 10.89072 | 1.536 | SimradEx60 | -24.732132 |
| 17 | 4.47 | 0 | 53.66 | 1542.5 | 10.77528 | 1.536 | SimradEx60 | -24.338499 |
| 18 | 4.62 | 0 | 51.92 | 1542.5 | 10.78073 | 1.536 | SimradEx60 | -23.895355 |
| 19 | 4.78 | 0 | 50.18 | 1542.5 | 11.0794 | 1.536 | SimradEx60 | -23.390213 |
| 20 | 4.95 | 0 | 48.44 | 1542.5 | 11.55779 | 1.536 | SimradEx60 | -22.80327 |
| 21 | 5.14 | 0 | 46.7 | 1542.5 | 12.16986 | 1.536 | SimradEx60 | -22.100334 |
| 22 | 5.34 | 0 | 44.96 | 1542.5 | 12.68113 | 1.536 | SimradEx60 | -21.214121 |
| 23 | 5.55 | 0 | 43.22 | 1542.5 | 12.45283 | 1.536 | SimradEx60 | -19.979422 |
| 24 | 5.79 | 0 | 41.48 | 1542.5 | 11.8402 | 1.536 | SimradEx60 | -17.732065 |

# Field Reports

A. Pisces Sound Velocity Data into ME70

B. Data Issues (Update June 28, 2013)

C. SBE21-SBE45 Comparisons

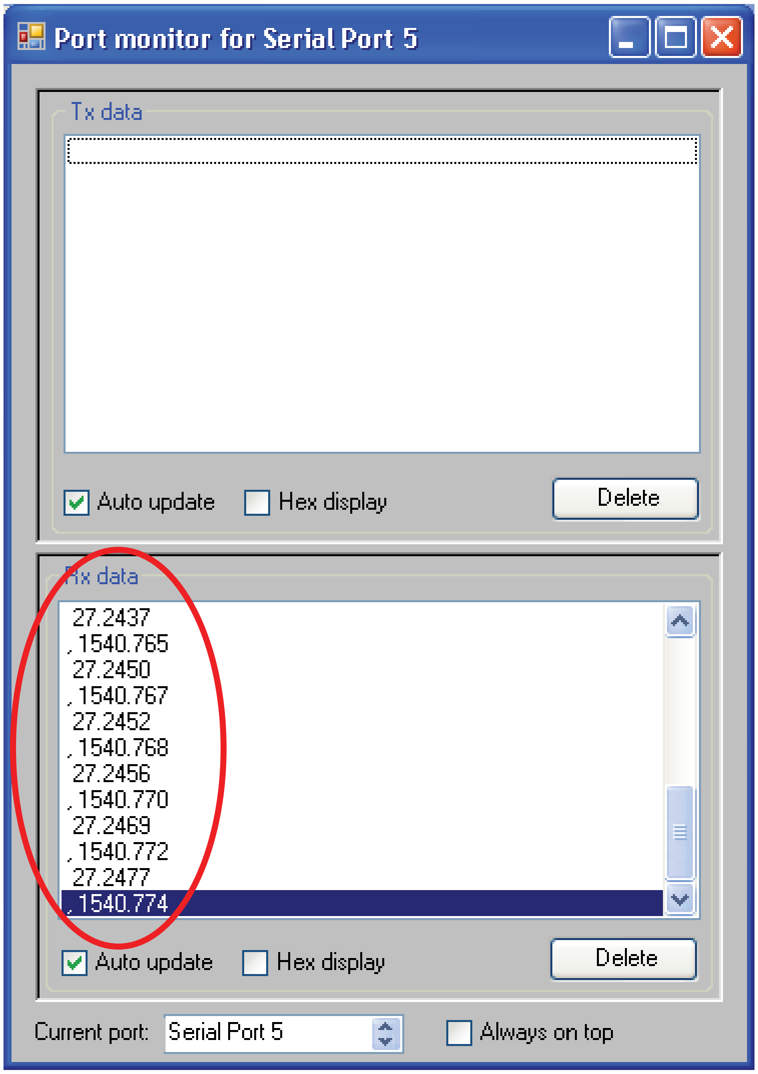
D. XBT-CTD Comparisons

E. IMU to POS MV Lever Arm Errors

# Pisces Sound Velocity Data into ME70
## PC1304, Leg 1 Summary by Kathy Hough

**Problem:** Mappers indicate there is a Sound Velocity error(s) in processed data.

1) Initially, there was an issue with XBTs failing. XBT data is used in post-processing; not in real-time. XBT issue has been fixed. It was a wire failure approximately 8 feet down from the launcher. The problem existed during at least PC1302. XBT data dating back only to May 28, 2013 could be found for evaluation. It indicated the problem already existed. The actual start of the problem is unknown.
2) Second, the SBE45 output rate was set to Interval=10 instead of Interval=1. Fixed 6/23/2013. Assumption at the time was that the ME70 was using the incoming SBE45 sound velocity data. Mappers evaluated over a night of survey. This increase in data rate did not remedy the issue.
3) Suspect ME70 is not actually using the SBE45 sound velocity data for beam forming. Data format is in question given comma between temperature and sound velocity, precision, and spaces. Mappers report, and demonstrated with a screen capture from SEFIS 2012, that this format is what has been sent to the ME70 for at least the past year, and potentially for the history of the Pisces.

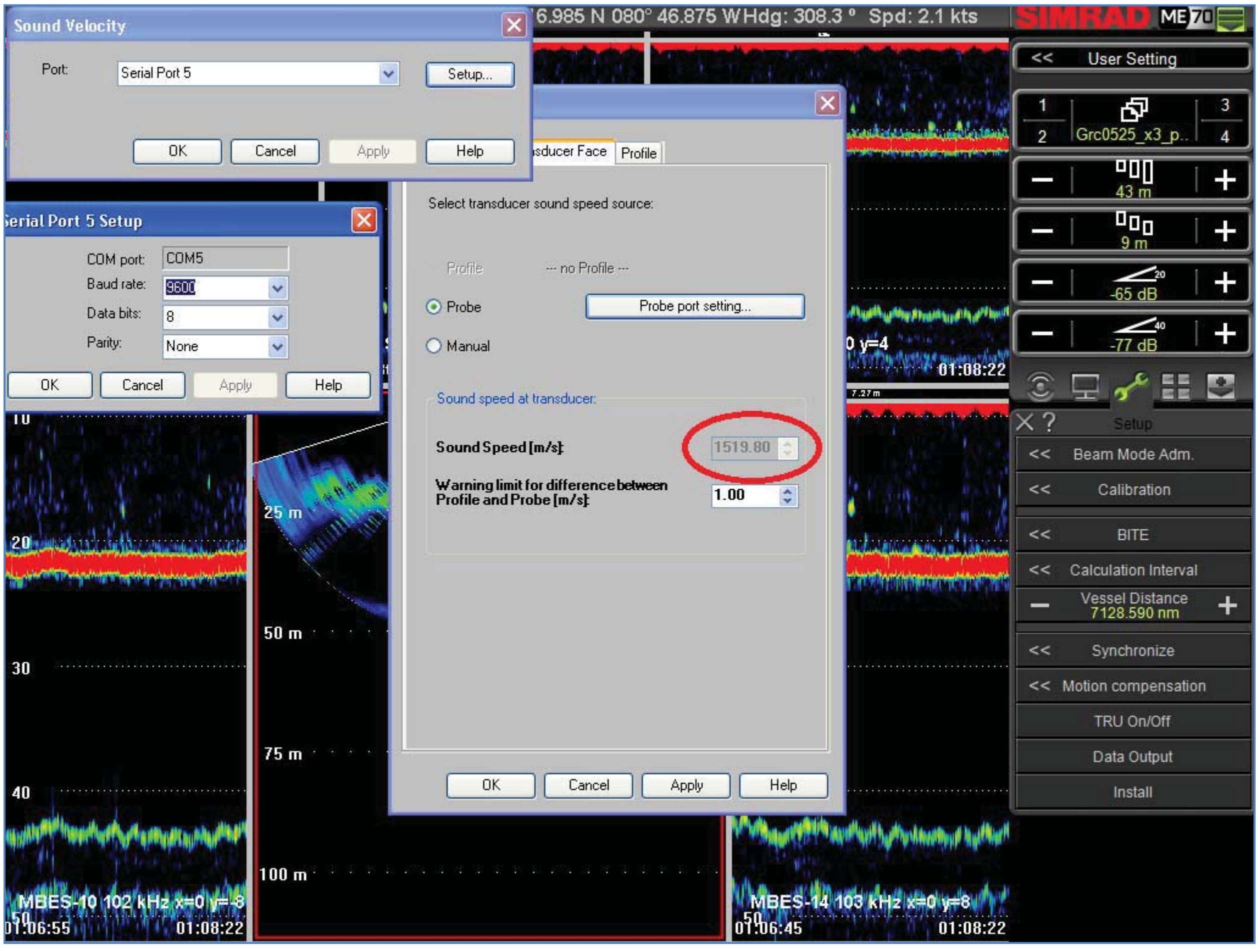


```
27.2437
, 1540.765
27.2450
, 1540.767
27.2452
, 1540.768
27.2456
, 1540.770
27.2469
, 1540.772
27.2477
, 1540.774
```

Current port: Serial Port 5

4) Several tests indicate the incoming SBE45 sound velocity data is NOT being utilized by the ME70. The most convenient indicator of the ME70 successfully using incoming data is the below circled value in the Install/Environment/Transducer Face tab. It should update/change to incoming data values each time the menu is closed out and re-opened, even though it is grayed out. Trials indicate this value is what is used by the ME70, regardless of whether or not Probe or Manual is selected. If Probe is selected, and the ME70 is

properly ingesting incoming sound velocity data, then the Sound Speed value will change. If the value does not change, then use Manual and set accordingly (use TSG Sound Velocity data via a SCS Real-Time Display, CTD, or XBT data).



6.985 N 080° 46.875 W Hdg: 308.3 ° Spd: 2.1 kts

Sound Velocity
Port: Serial Port 5

Serial Port 5 Setup
COM port: COM5
Baud rate: 9600
Data bits: 8
Parity: None

Select transducer sound speed source:
Profile --- no Profile ---
● Probe
○ Manual

Sound speed at transducer:
Sound Speed [m/s]: 1519.80
Warning limit for difference between Profile and Probe [m/s]: 1.00

**SBE45 Details:**

a) Direct SBE45 data path to ME70: SBE45 -> SCS gray cable -> SBE45 Idec/Wego block -> gray cable on bottom row directly to Port 3 on MOXA box (located on top of ME70 computer) -> Serial Port 5 in ME70 computer.
b) Format of SBE45 data going into ME70 Port 5 (confirmed via Hyperterminal on a laptop):

```
_27.8263,_1542.015
_27.8275,_1542.018
_27.8280,_1542.019
```

Note, the SBE45 format appears to be re-arranged in the ME70 (see first graphic, *Port monitor for Serial Port 5*). The required format for temperature and sound velocity input into the ME70, per the ME70 manual, is:

```
_TT.TTT_ _VVVV.V_CRLF
```

There are several differences between the SBE45 output and the required format for proper input into the ME70. In the SBE45, there is a single space (denoted by "_") before temperature, a single space after a comma, and high precision values.

The ME70 required format "resembles" a SBE45 data output option; however, that option requires input of a SBE38 into the SBE45 Interface Box. There is no SBE38 available for installation. It is not known whether this SBE45 Interface Box output option will actually work with the ME70; the Kongsberg EM300 is specified in the Interface Box manual. See Page

9 of the SBE45 Interface Box manual for setup details. The SBE21 manual has to be consulted to determine if this is an output option for it too.

There is a ME70 option to just receive sound velocity (Format: _VVVV.V_CRLF). Attempts were made to do this via the SCS Send Message Utility using SBE21 Sound Velocity data (as a test). Numerous COM and network options were tried with no success. Once communication is established with one of these options, sound velocity data can be sent to the ME70.

The SBE45 has apparently never been connected to SCS in the past. SBE45 sound velocity data, corrected with SBE38 temperature, is likely the best data **(See Note 1)** to send to the ME70 for beam forming. It can provide a 1-second data rate whereas the SBE21 can only provide a 3-second data rate. The SBE45 also requires less water flow than the SBE21. It has been established, on 2 other FSVs, that their SBE21s are not getting the recommended 16 gpm flow rate. The convoluted plumbing system, piping size, etc. disallow this flow rate.

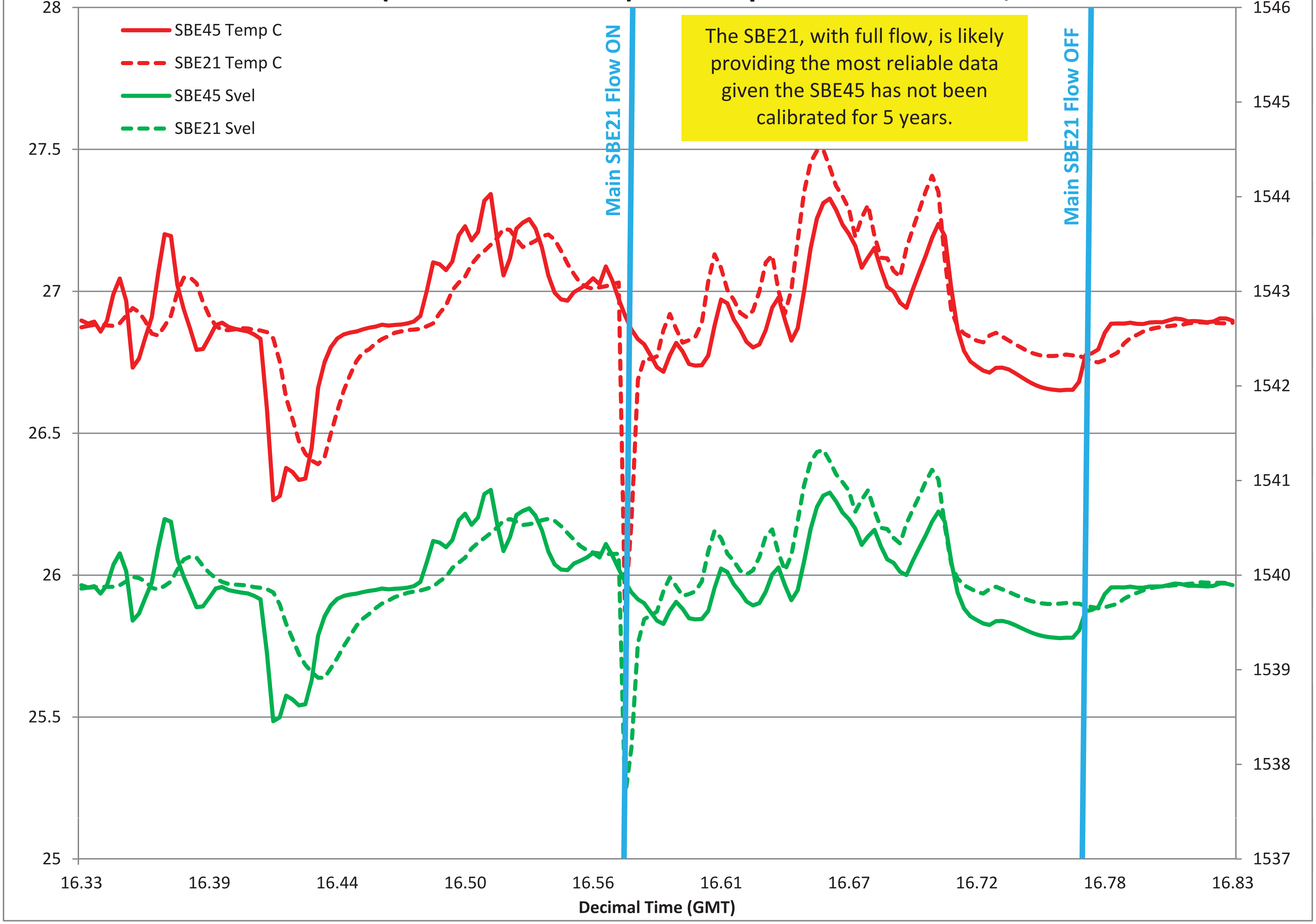
Connection of SBE45 data to SCS is now established (short yellow cable between SBE45 Idec/Wego block and Digi COM11), while maintaining the historic SBE45 -> ME70 serial connection. SCS sensors for the SBE45 have been created and will receive data upon restarting SCS ACQ for the next cruise. At this time, conductivity and salinity output is turned OFF at the SBE45. The historical format of just Temperature and Sound Velocity, depicted above, has been maintained until appropriate data input into the ME70 can be established. See Comments sections in the SCS Sensor Configuration File Editor for more details and instructions regarding potential future SBE45 SCS sensor changes.

**Note 1**: The SBE45 currently installed aboard the Pisces has not been calibrated since June 15, 2008. The SBE21 was calibrated December 6, 2012. The below graph is a preliminary analysis of SBE21 and SBE45 data. The SBE21, with both Fluorometer/SBE45 and primary saltwater flow inputs, appears to have the same detail as the SBE45. The current assumption is the SBE21 actually may provide more reliable data at this time given, 1) when flow was substantially increased, its data pattern matched the SBE45, 2) the SBE45 is likely out of calibration to an unknown extent. To confirm this assumption, more SBE45/SBE21 comparisons are needed, and CTD data needs to be used to decide which sensor is providing the most accurate data. Also, with full SBE21 in-flow, careful evaluation for back flushing of the SBE45 and fluorometer needs to be done. Ideally, all 3 instruments would have separate in-flows and discharges, and each would have dedicated flowmeters. The existing flowmeter, located at the beginning of the water intake line in the bowthruster room, cannot be used to determine how much water is going through each instrument. Flow rate is critical for data evaluation AND instrument preservation. The SBE45 and Turner fluorometer can be damaged by too much pressure.

**Conclusions:**

1) **The ideal sound velocity value to send to the ME70 is from a calibrated SBE45, corrected by a calibrated SBE38 temperature probe. The SBE38 is located at the hull intake for the underway Scientific Seawater System. The SBE45 and SBE21 are located in the Chem Lab, 2 decks up and aft; thus, the water warms by the time it reaches these instruments.**
2) **At present, the SBE21 may be providing more accurate data than the SBE45 **as long as** it is receiving flow from both the Fluorometer/SBE45 and primary salt water intakes. Currently, neither TSG unit can be corrected with a SBE38.**
3) **The ideal set-up for sound velocity data transmission to the ME70 is via a SCS Send Message. This way, all SBE45 and SBE21 variables, not just temperature and sound velocity, can be logged in SCS and used for other applications. Communication between SCS and the ME70 software needs to be established via a SCS Digi COM port or through a network option. A SCS Send Message, via the TCP option, could be viewed on the ME70 computer in a DOS window; however, would not appear in the ME70 Data Monitor window via a LAN port. It is possible the ME70 will only accept sound velocity data via a serial port. This needs to be confirmed with Simrad. If input is possible via a LAN port, then details as to proper set-up need to be obtained from Simrad.**

## Pisces TSG (SBE45 and SBE21) Flow Experiment. June 24, 2013



The SBE21, with full flow, is likely providing the most reliable data given the SBE45 has not been calibrated for 5 years.

# NOAA Ship Pisces
# Survey Department
# June 2013 Data Issues

Update June 28, 2013
Kathy Hough

See the following documents for background information from last cruise. They are located at **Netshares\Survey\PC1304, Leg 1**:

1) **\ME70 and TSG Issues\Pisces Sound Velocity Data into ME70.pdf** (ET Pat has a printed copy)
2) **PC Survey Tech to-do list.txt** (copy also on Survey computer desktop)
3) **\PC1302 and PC1304 (Leg 1) XBT Review\PC1304\June 18, 2013\061813 XBT-CTD Comparison.pdf** (direct CTD-XBT comparisons from last cruise).

Some issues, documented in the above files, were resolved the morning of June 27. The following is an update to these documents.

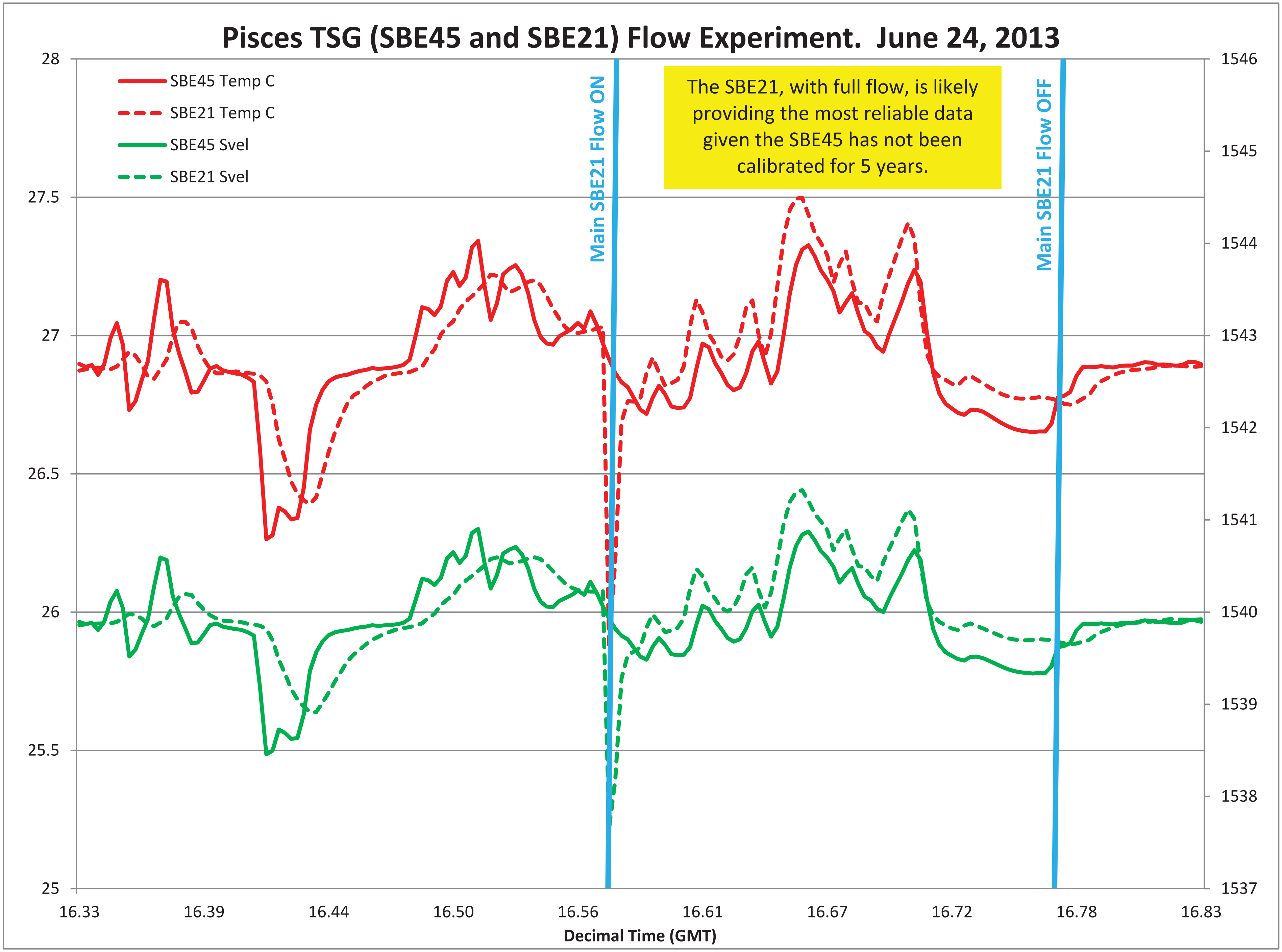
1) The ME70 is now receiving and recognizing SBE<u>21</u> Sound Velocity data being sent via a SCS Send Message.
    a. After SCS was shut-down yesterday, the SCS Digi COMs were reset. Pin-out of a shipboard-made wire was re-evaluated and corrected. Both of these steps were required for successful data output from a SCS Digi COM via the Send Message utility.
    b. The Send Message template currently utilizes SBE21 Sound Velocity and COM27. Note: COM27 exists in the SCS Sensor Configuration; however, no cable was attached to the COM port for data input to SCS. This is the same case for COM28 and the FS70; SCS sensor exists and is enabled, but there is no wire connection to COM28. As a result, the CTD SCS sensor is now disabled, and COM27 is currently utilized for the Sound Velocity output to the ME70. This can easily be changed if desired.
    c. Trouble-shooting/testing before yesterday included the 3rd rack of SCS Digi COMS. They did not work before yesterday, but now that all COMs have been reset, they may be available for use. Testing required.
2) Current ME70 settings: Within Install > Environment, there is a XBT file loaded. The ***Warning limit for difference between Profile and Probe (m/s)*** is set to 1.00. If this tolerance is met, as it is sitting at the dock, the ME70 produces a red flashing error. The error occurs even when Probe is selected. I did not see an option to “unload” that XBT file, so I am not sure how to “unload” it from the setup. Manuals are in the top drawer in AFT Acoustics Lab.
3) TSG items:
    a. The SBE21 output interval needs to be changed from 10 to 3. See if it accepts an interval of 1, but according to the Sea-Bird Training Guide, 3-second is the fastest rate. Increasing the sampling/output rate will improve the quality of data being logged by SCS, and being used by other instruments/applications such as the ME70. It will also provide more direct comparisons with the SBE45 (Interval now = 1 versus 10).
    b. Sea-Bird Electronics, Inc. has confirmed that the existing SBE45 unit has never been calibrated since its original calibration 5 years ago.
    c. SBE45 internal temperature and sound velocity successfully logged to SCS yesterday.

        i. Sound Velocity was the only value enabled historically (internal temp is always output), hypothetically due to direct wire connection to the ME70. None of the acceptable ME70 Probe data formats include Conductivity or Salinity.
        ii. Now that sound velocity data can be sent to the ME70 via SCS Send Message,
            1. The SBE45 Conductivity and Salinity values can be turned ON at the unit to allow logging by SCS.
            2. SBE45 Conductivity and Salinity sensors will need to be added back into SCS. I had them built, but got a lot of errors due to dummy values upon restarting SCS yesterday, so deleted them.
            3. The Sound Velocity character values will need to be updated if Conductivity and Salinity data is turned on at the SBE45, and SCS sensors are created. Set Start Char to actual column for first number in Sound Velocity data (i.e. the 1). This is due to the ME70 acceptable format having very specific space specs (for if and when SBE45 SVel is sent to ME70).

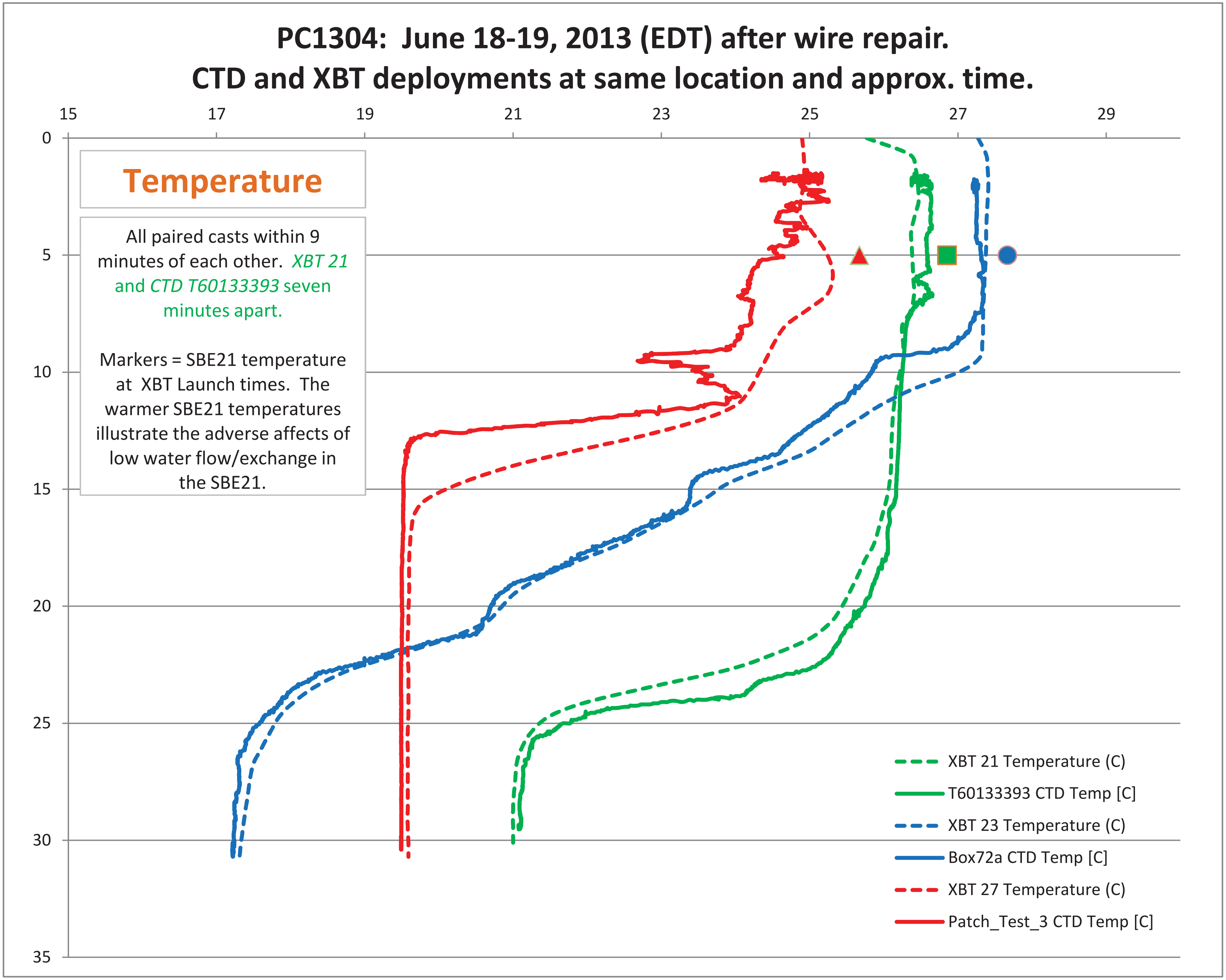
d. **Netshares\Survey\PC1304, Leg 1\PC1302 and PC1304 (Leg 1) XBT Review\PC1304\June 18, 2013\ 061813 XBT-CTD Comparison.pdf** should not be used for evaluation of the SBE21 data as the unit had very low flow at the sampling times.

e. Now that SBE45 data is going into SCS, direct comparison of both the SBE21 and SBE45 data to CTD data can easily be performed to determine/confirm which TSG is providing the most accurate Sound Velocity data (currently without a SBE38). I would recommend having both flows to the SBE21 ON; however, further monitoring for backflow effects (water going from SBE21 -> SBE45 -> Turner Fluorometer) needs to be done, and actual instrument specific flow-rates need to be measured to ensure the SBE45 and Fluorometer are not under too much water pressure. Eventually, the entire flow/drain system for the underway Scientific Seawater Systems needs to be reconfigured.


28
27.8
27.6
27.4
27.2
27
26.8
26.6
26.4
26.2
26
1546
1545
1544
1543
1542
1541
1540
1539
22:13:20
22:14:20
22:15:20
22:16:20
22:17:20
22:18:20
SBE45 Temp C
SBE21 Temp C
SBE45 Svel
SBE21 Svel



The SBE21, with full flow, is likely providing the most reliable data given the SBE45 has not been calibrated for 5 years.

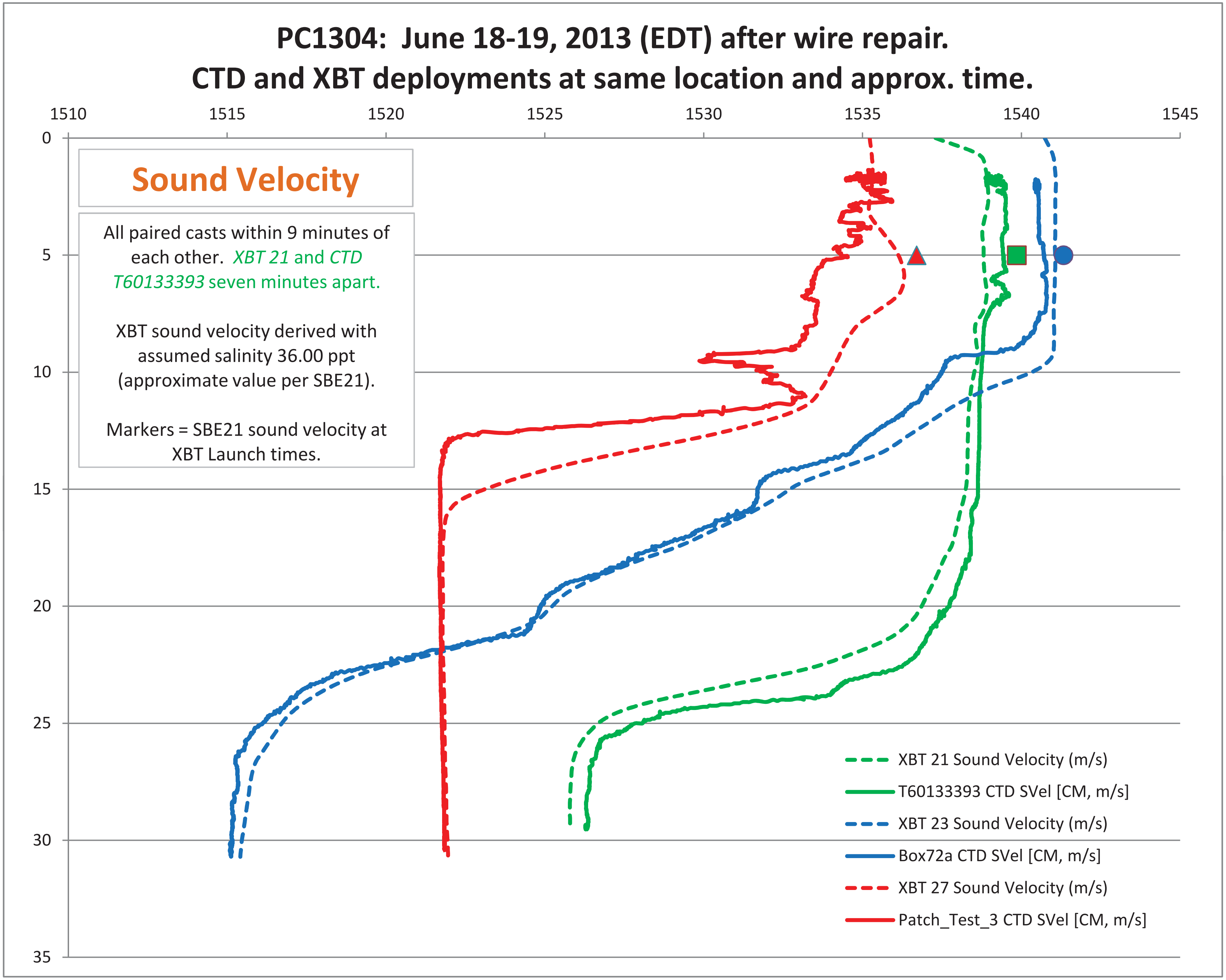


PC1304:  June 18-19, 2013 (EDT) after wire repair.
CTD and XBT deployments at same location and approx. time.

**Temperature**

All paired casts within 9 minutes of each other.  *XBT 21 and CTD T60133393* seven minutes apart.

Markers = SBE21 temperature at  XBT Launch times.  The warmer SBE21 temperatures illustrate the adverse affects of low water flow/exchange in the SBE21.



PC1304: June 18-19, 2013 (EDT) after wire repair.
CTD and XBT deployments at same location and approx. time.

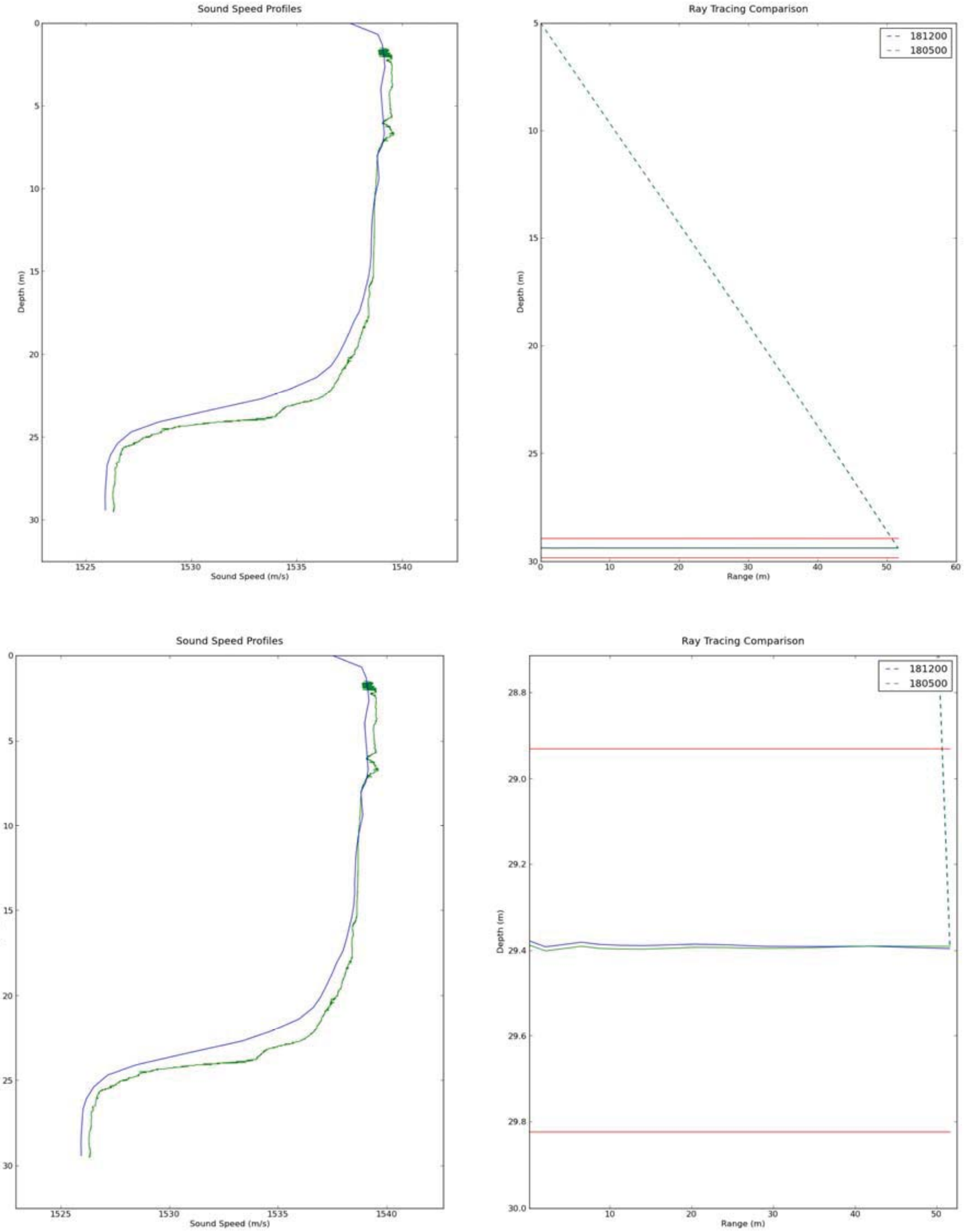
Sound Velocity

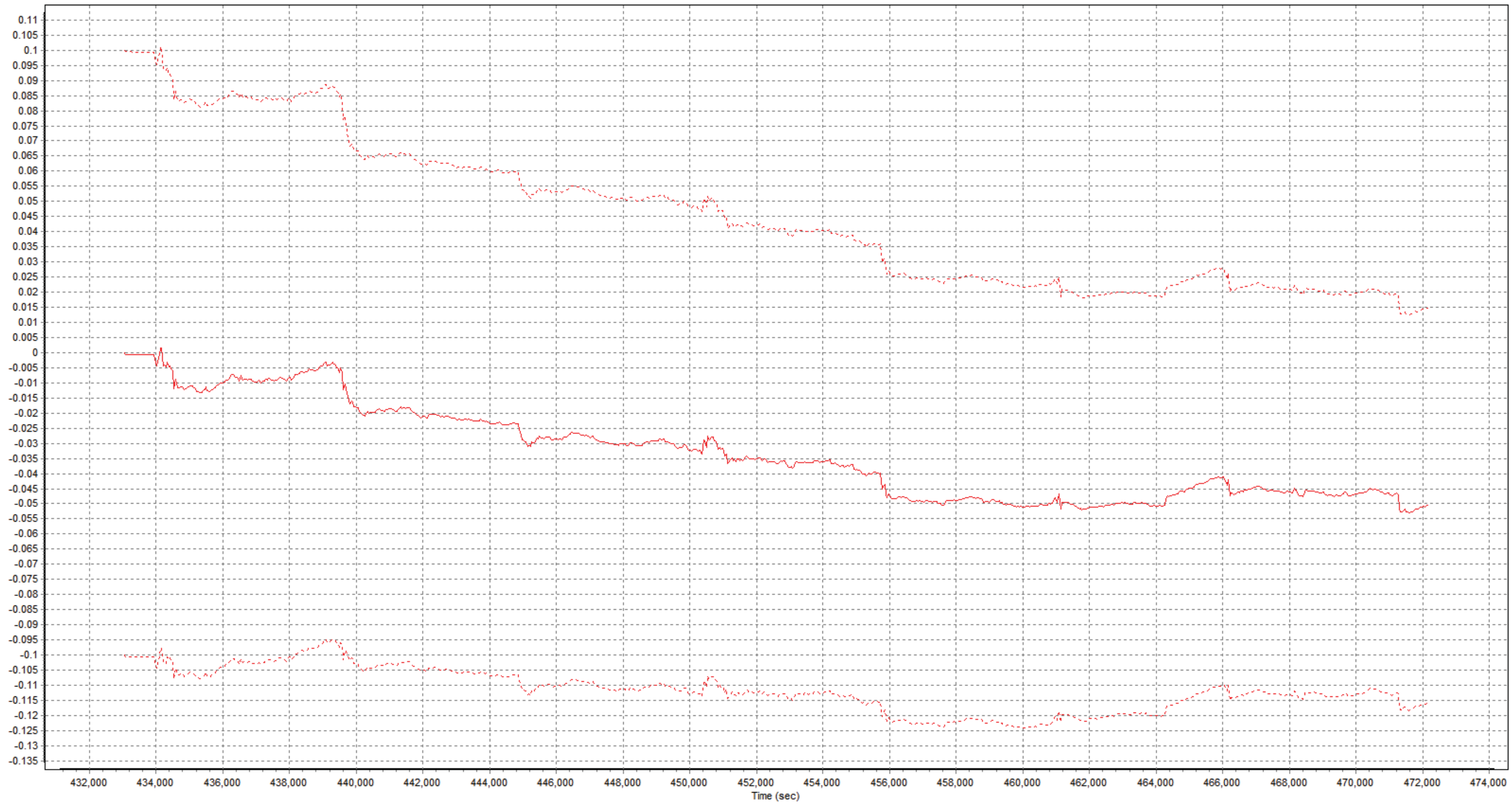
All paired casts within 9 minutes of each other. *XBT 21 and CTD T60133393 seven minutes apart.*

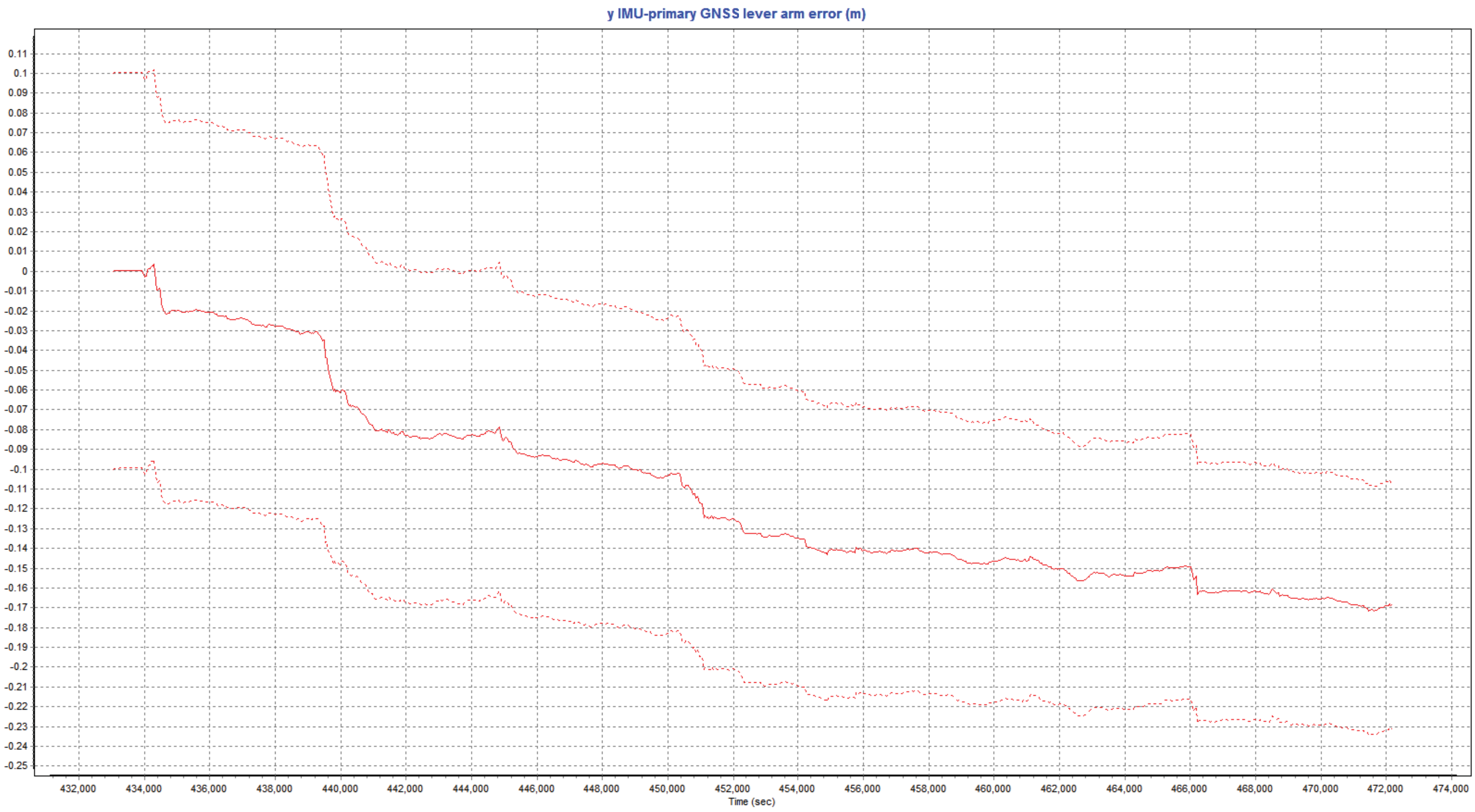
XBT sound velocity derived with assumed salinity 36.00 ppt (approximate value per SBE21).

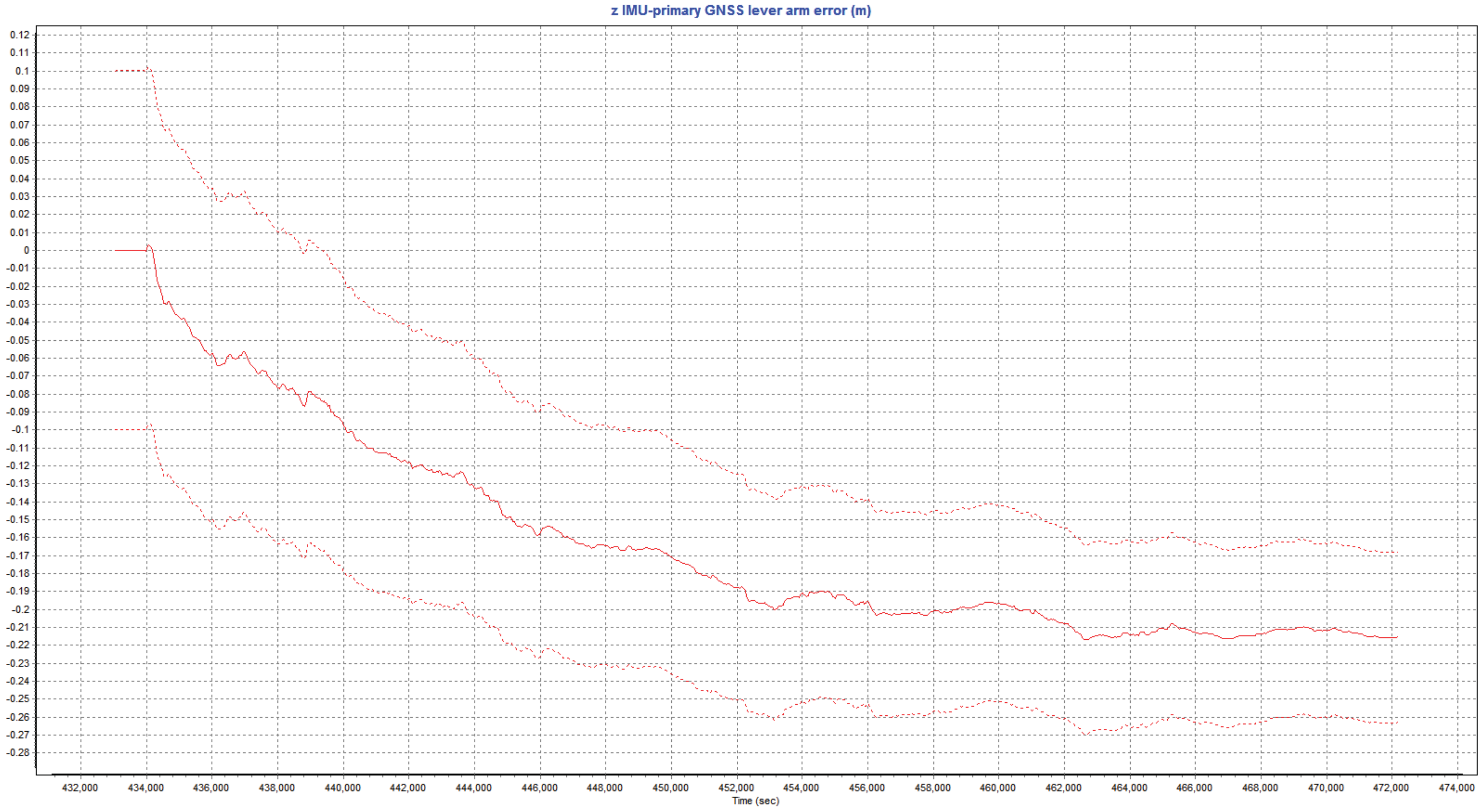
Markers = SBE21 sound velocity at XBT Launch times.

Comparison between an XBT (blue) and CTD (green) taken at approximately the same time, for the full depth (top) and zoomed into the simulated seafloor (bottom). Analysis involves ray tracing across a 70 degree multibeam swath to estimate depth sounding uncertainty across the swath. Across the swath, the highest magnitude of depth sounding uncertainty due to refraction is 1.5cm, well within allowable limits. This analysis increases confidence in the XBTs and helps to justify their usage (after wire fix).




x IMU-primary GNSS lever arm error (m)


y IMU-primary GNSS lever arm error (m)
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.1
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19
-0.2
-0.21
-0.22
-0.23
-0.24
-0.25
432,000
434,000
436,000
438,000
440,000
442,000
444,000
446,000
448,000
450,000
452,000
454,000
456,000
458,000
460,000
462,000
464,000
466,000
468,000
470,000
472,000
474,000
Time (sec)


z IMU-primary GNSS lever arm error (m)
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.1
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-0.17
-0.18
-0.19
-0.2
-0.21
-0.22
-0.23
-0.24
-0.25
-0.26
-0.27
-0.28
432,000
434,000
436,000
438,000
440,000
442,000
444,000
446,000
448,000
450,000
452,000
454,000
456,000
458,000
460,000
462,000
464,000
466,000
468,000
470,000
472,000
474,000
Time (sec)

# Vessel Documents

A. Vessel Offsets Report

B. Original POS MV Installation Report

**C.** Current POS MV and ME70 Configuration

D. Pisces POS MV Heading and Motion Data Flow

# SURVEY REPORT

## SHIP: FRV40/3
## Pisces

## LOCATION: PASCAGOULA, MS

## DATE: 9/17-9/21, 2007

## PURPOSE:

Determine the ship's centerline, roll, and pitch. Install benchmarks above decks, in the transducer room, and IMU room. Install the master reference plane in the same planes as the measured roll, pitch, and azimuth of the ship. Assist the shipyard to install the IMU parallel to the centerline, and in the same plane as the ship's roll and pitch.

## PERSONNEL:

Eric Kostelak
Raymond Impastado

## EQUIPMENT LIST:

WILD T2 THEODALITE SN: 73083E CAL EXPIRATION DATE 7/14/08
WILD T2 THEODALITE SN: 129697 CAL EXPIRATION DATE 7/14/08
WARREN KNIGHT 23-2252 CLINOMETER SN: 24297 CAL EXPIRATION DATE 8/18/08
Lietz SDM3E10 TOTAL STATION: SN 77485 CAL EXPIRATION DATE 9/06/08
WILD NA1 AUTO LEVEL: SN 472810 CAL EXPIRATION DATE 9/06/08

## PROCEDURES:

Step 1: Generate a closed traverse including points on the vessel
Step 2: Determine the ships pitch by taking elevations on the keel and Comparing them to the engineering information on elevations of the keel above the Base line.
Step 3: Determine the roll and centerline from points shot in the closed traverse
Step 4: Transfer centerline into the transducer room, place bench marks, and set The Master reference plane in place in agreement to the ship's roll, pitch, and Centerline
Step 5: Transfer the centerline into the ship via a hole cut into the side, and then Transfer it to the IMU space and trunk area
Step 6: Place benchmarks in the trunk space

Step 7: Place benchmarks by, and assist the shipyard in placing the IMU foundation
Step 8: Measure the transducer trunk deviation as it is placed in the fully deployed And fully retracted positions
Step 9: install benchmarks on decks
Step 10: Shoot azimuths from known points to each bearing repeater, then set each Each one to be parallel to the centerline
Step 11: Place marks on the hull defining centerline for future use
Step 12: Confirm all transducer mounts are level with the keel

## RESULTS

Roll was determined to be 9 min, 3 sec, starboard high
Pitch was determined to be 2 min, 56 sec, bow low

The IMU was found to be 32min, 54sec lower in the bow than the MRP, and 39 min,42 sec higher on the starboard side than the MRP

The center board had 28mm of side to side motion, and 7.5mm of fore/aft motion between the fully extended and fully retracted positions.

The ADCP LEVEL from the MRP is; roll 34 min, 12 sec port high,
Pitch 5 min, 27 sec bow low

The Multibeam LEVEL from the MRP is; Roll 14 min, 10 sec port high
Pitch is zero

For future reference, the bearings from the two top bearing repeaters to the center bench mark on the same deck are:
Port repeater to bench mark=74.8 deg
Starboard repeater to bench mark= 283.75 deg

For the lower bearing repeaters to the forward mast bench mark;
Port repeater to bench mark=14.5 deg
Starboard repeater to bench mark=345.25 deg

The bearing repeater stands are parallel to the centerline with no readable errors, limited by the accuracy of the azimuth circles

The master reference plane is .045M starboard of the centerline and over frame 26

Attached is the X,Y,Z address of each survey point, and the field notes
All measurements are in meters

RAYMOND C. IMPASTATO
PROFESSIONAL LAND SURVEYOR

139 RANCH ROAD
SLIDELL, LA 70460
(985) 774-1955

# PISCES

## X Y Z SURVEY

**September 25, 2007**

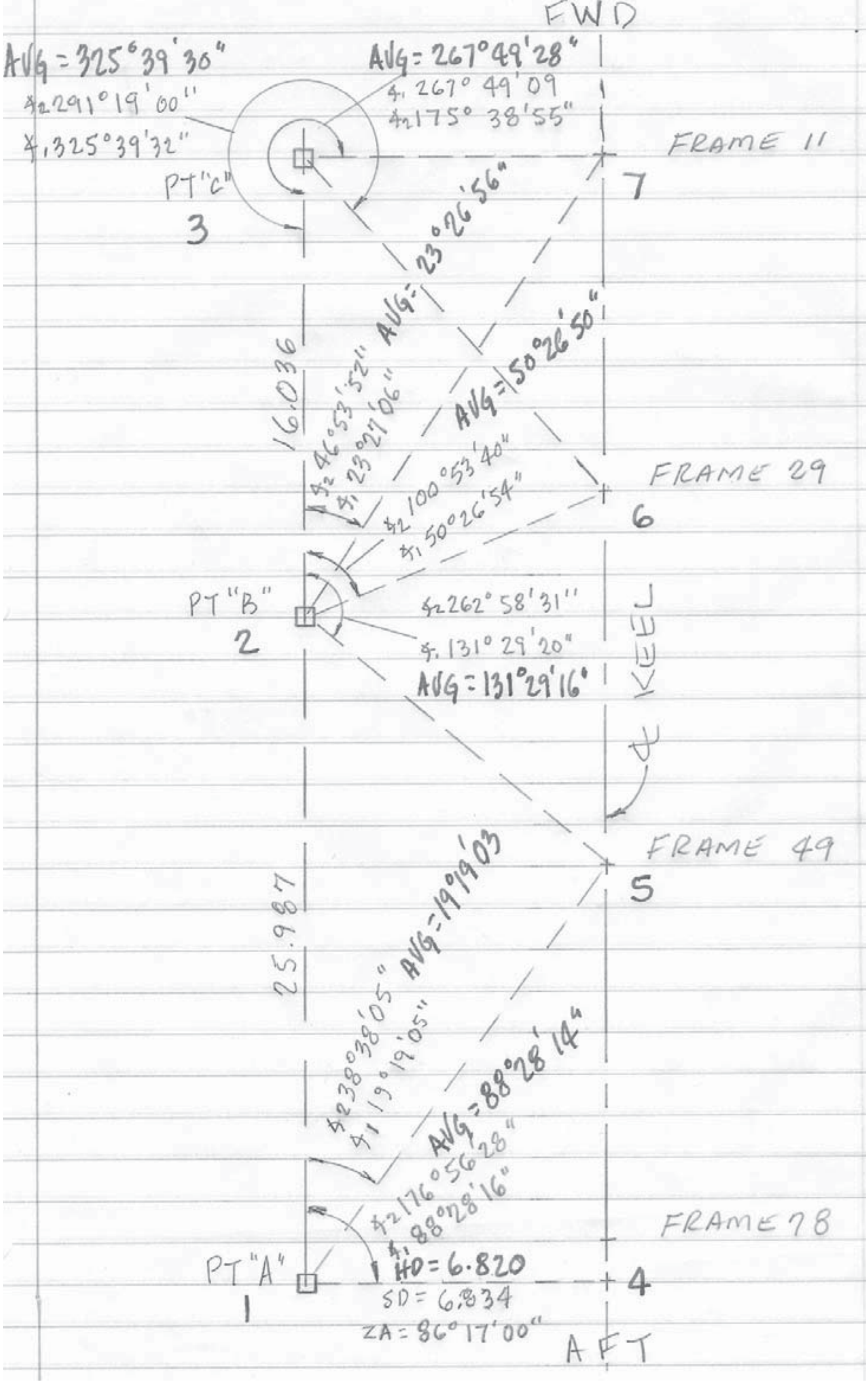
**Revised October 30, 2007**
**Revised December 1, 2007**

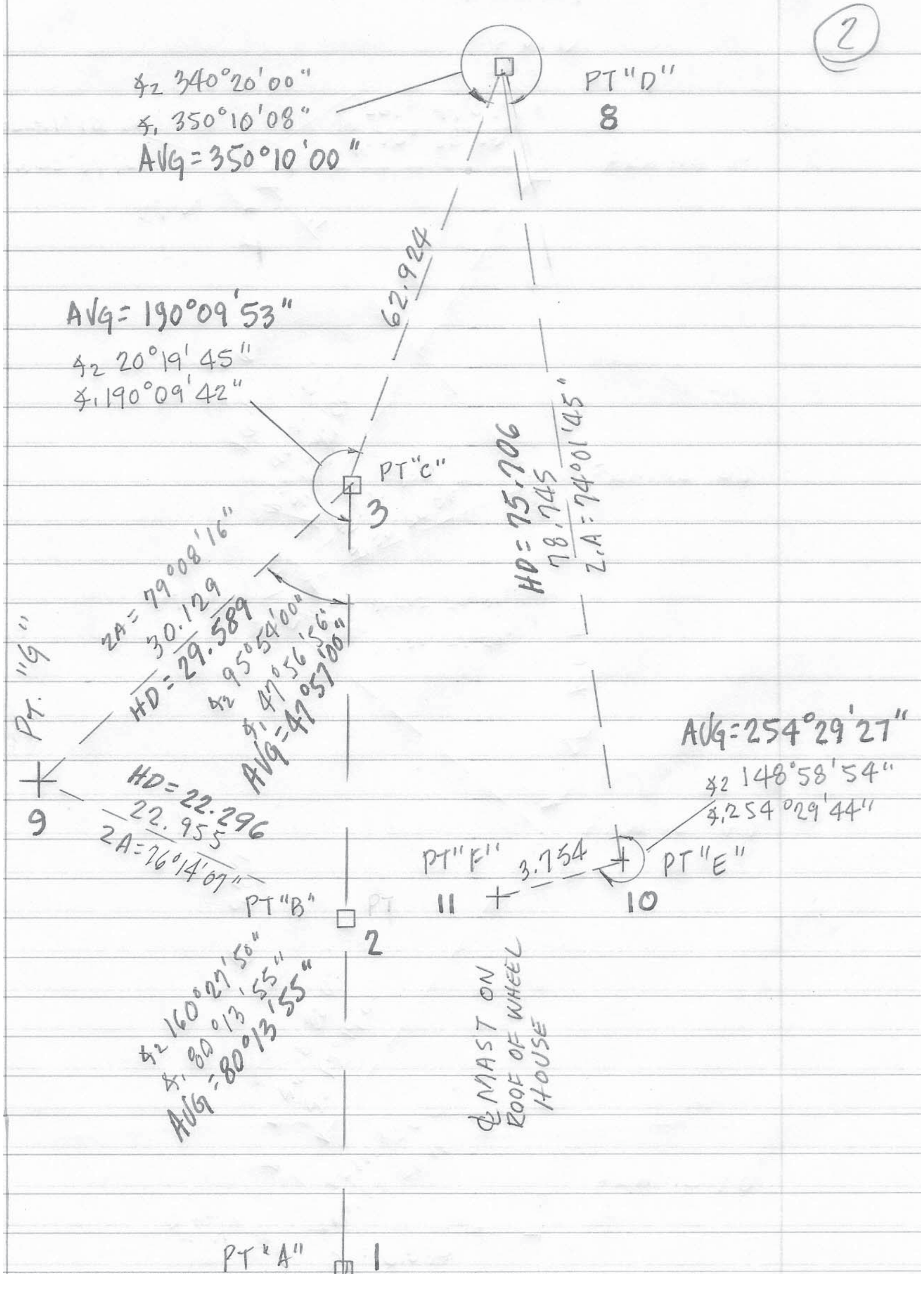
| POINT | X-AXIS | Y-AXIS | Z-AXIS | DESCRIPTION |
|---|---|---|---|---|
| 4 | -33.411 | -0.053 | +2.017 | KEEL NEAR FRAME 78 |
| 7 | 8.698 | -0.052 | +0.934 | KEEL FRAME 11 |
| 10 | -5.953 | 3.564 | -17.243 | STARBOARD BENCH MARK ON PILOT HOUSE |
| 14 | 0.000 | 0.000 | 0.000 | MASTER REFERENCE PLATE |
| 17 | -31.777 | -0.102 | -6.618 | FORWARD BENCH MARK ON BACK DECK |
| 18 | -36.261 | -0.102 | -6.640 | AFT BENCH MARK ON BACK DECK |
| 19 | 0.277 | -1.687 | +1.074 | AFT WELD BEAD NEAR TRANSDUCER |
| 20 | 1.411 | -1.680 | +1.033 | FORWARD WELD BEAD NEAR TRANSDUCER |
| 23 | -0.400 | -1.341 | -4.434 | IMU |
| 24 | -0.400 | -0.890 | -3.945 | STARBOARD BENCH MARK NEAR IMU |
| 25 | -5.953 | -0.053 | -17.244 | CENTERLINE BENCH MARK ON PILOT HOUSE |
| 26 | -5.953 | -3.670 | -17.242 | PORT BENCH MARK ON PILOT HOUSE |
| 27 | -0.400 | -0.388 | -3.945 | PORT BENCH MARK NEAR IMU |
| 28 | 0.726 | -1.805 | +0.995 | ADCP |
| 29 | 0.694 | -0.716 | +1.186 | MULTI BEAM |
| 30 | -4.830 | 1.356 | -18.870 | STARBOARD GPS (CENTERLINE TOP OF PLATE) |
| 31 | -4.842 | -1.566 | -18.870 | PORT GPS (CENTERLINE TOP OF PLATE |

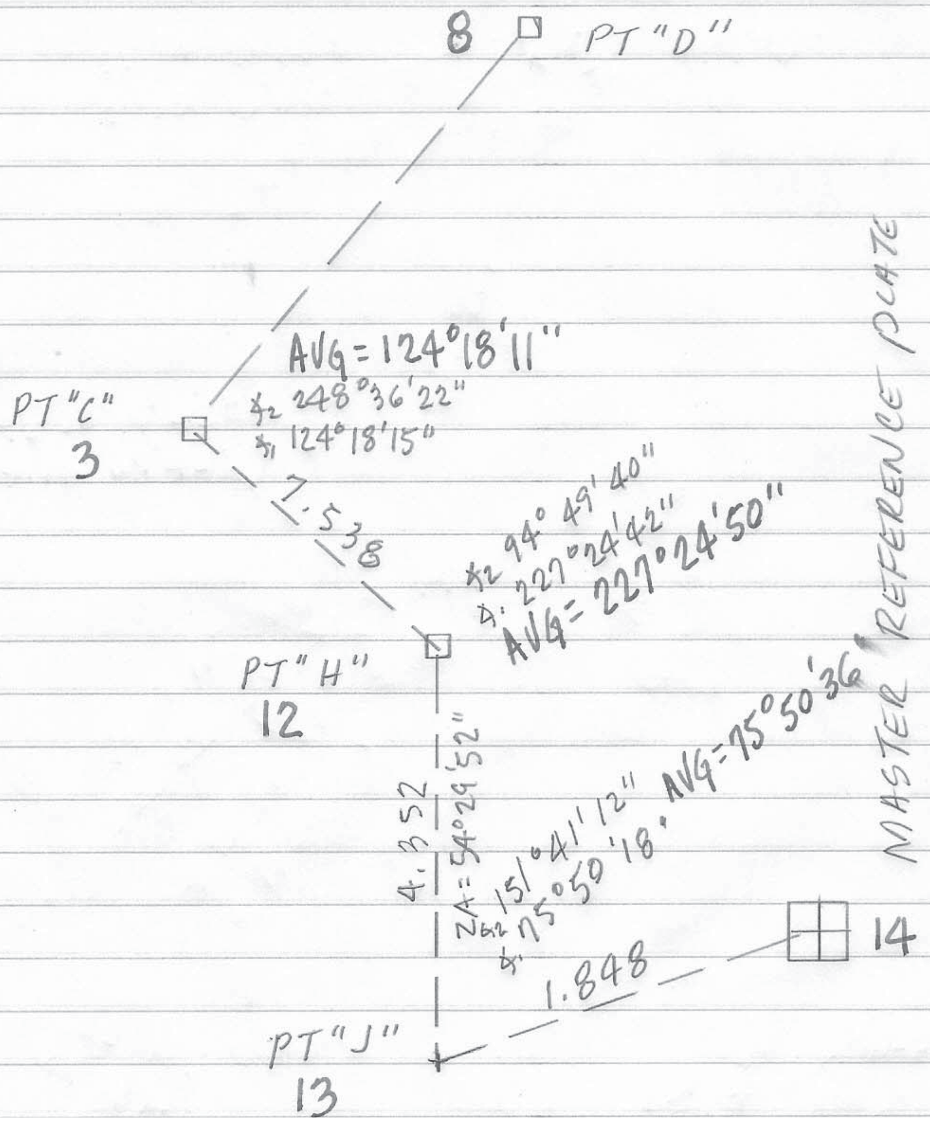
THE FOLLOWING ARE THE FIELD NOTES

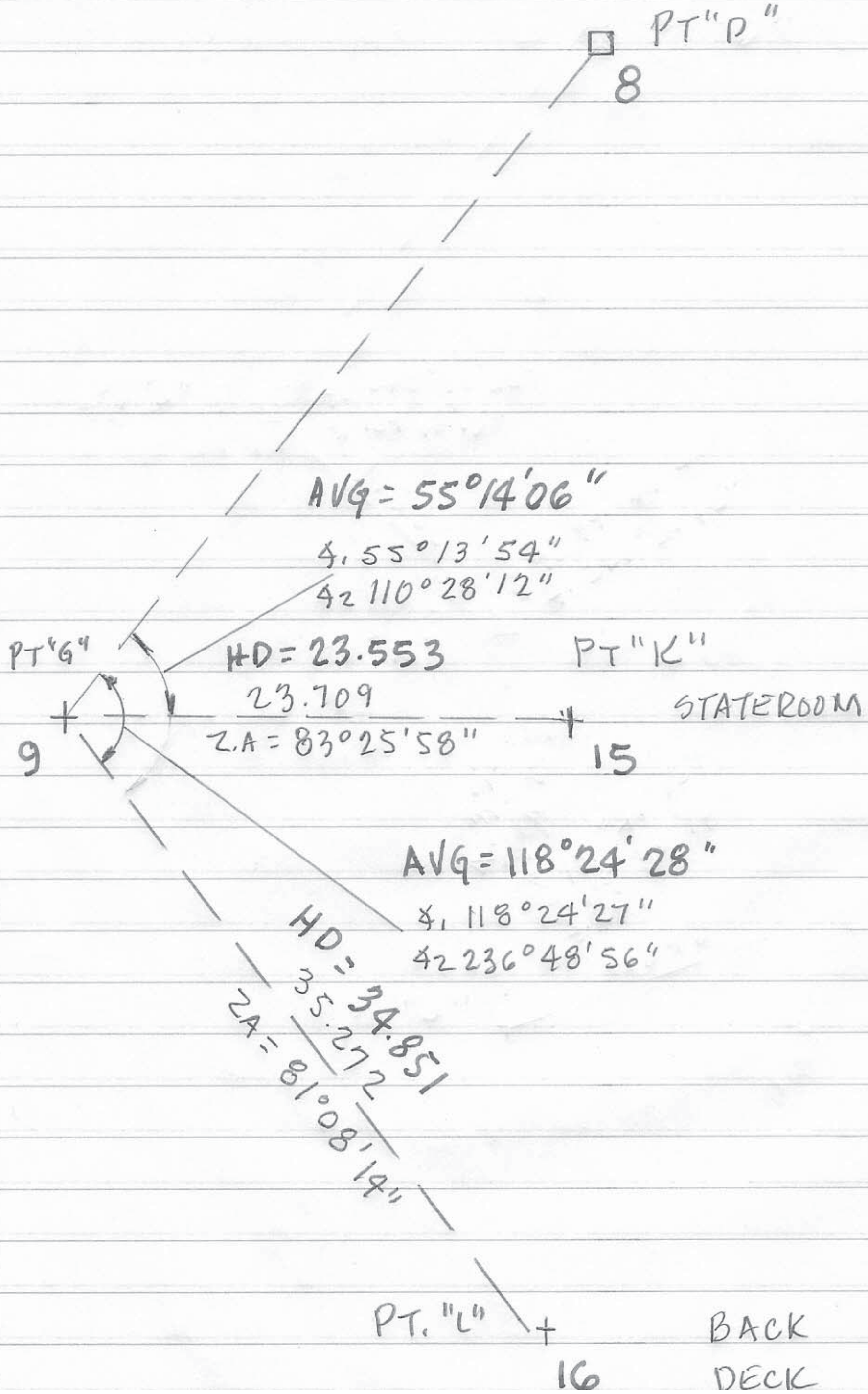
PISCES XYZ SURVEY
RAYMOND IMPASTATO
9-17-07 THRU 9-21-07

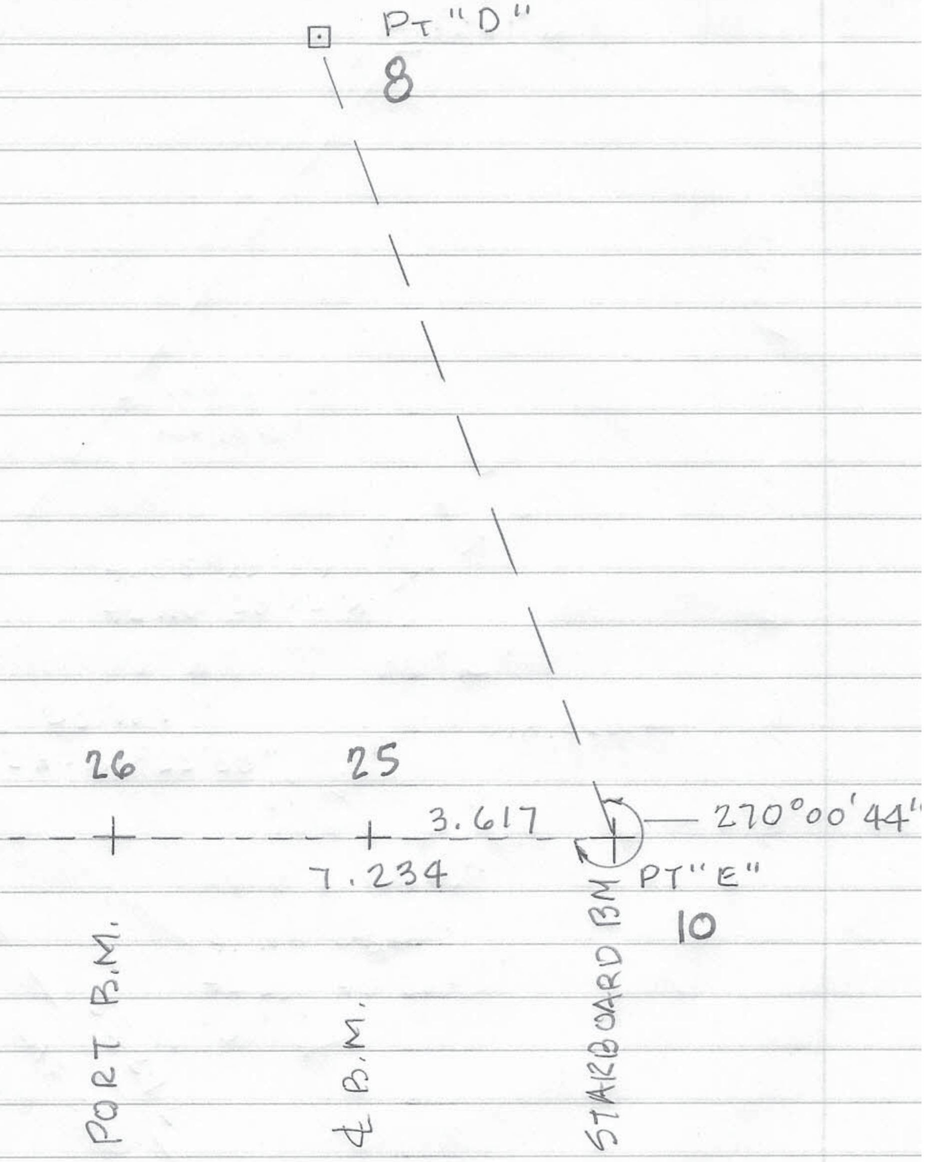
①



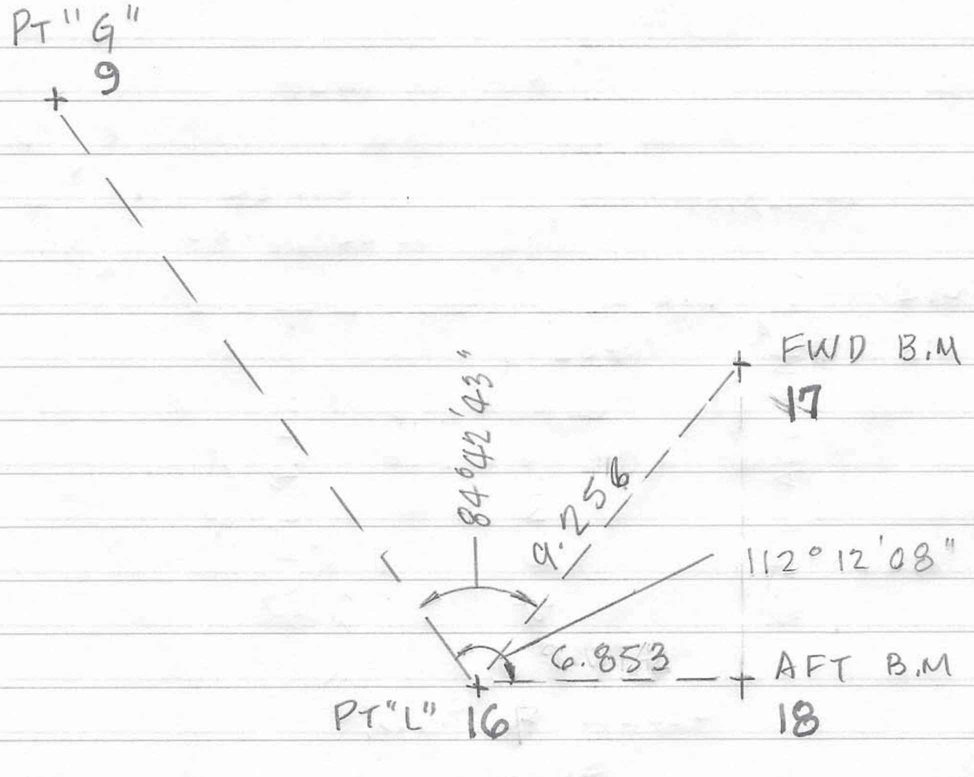

∡2 340°20'00"
∡1 350°10'08"
AVG=350°10'00"
PT"D"
8
62.924
AVG=190°09'53"
∡2 20°19'45"
∡1 190°09'42"
PT"C"
3
HD=75.706
78.745
Z.A=74°01'45"
ZA=79°08'16"
30.129
HD=29.589
∡2 95°54'00"
∡1 47°56'56"
AVG=47°57'00"
PT. "G"
9
HD=22.296
22.955
ZA=76°14'07"
AVG=254°29'27"
∡2 148°58'54"
∡1 254°29'44"
PT"F"
3.754
PT"E"
11
10
PT"B"
PT
2
∡2 160°27'50"
∡1 80°13'55"
AVG=80°13'55"
℄ MAST ON
ROOF OF WHEEL
HOUSE
PT"A"
1


8
PT "D"
AVG = 124°18'11"
PT "C"
3
∡2 248°36'22"
∡1 124°18'15"
7.538
∡2 94°49'40"
∡1 227°24'42"
AVG = 227°24'50"
PT "H"
12
4.352
ZA = 54°29'52"
Z∡2 151°41'12"
∡1 75°50'18"
AVG = 75°50'36"
MASTER REFERENCE PLATE
14
1.848
PT "J"
13

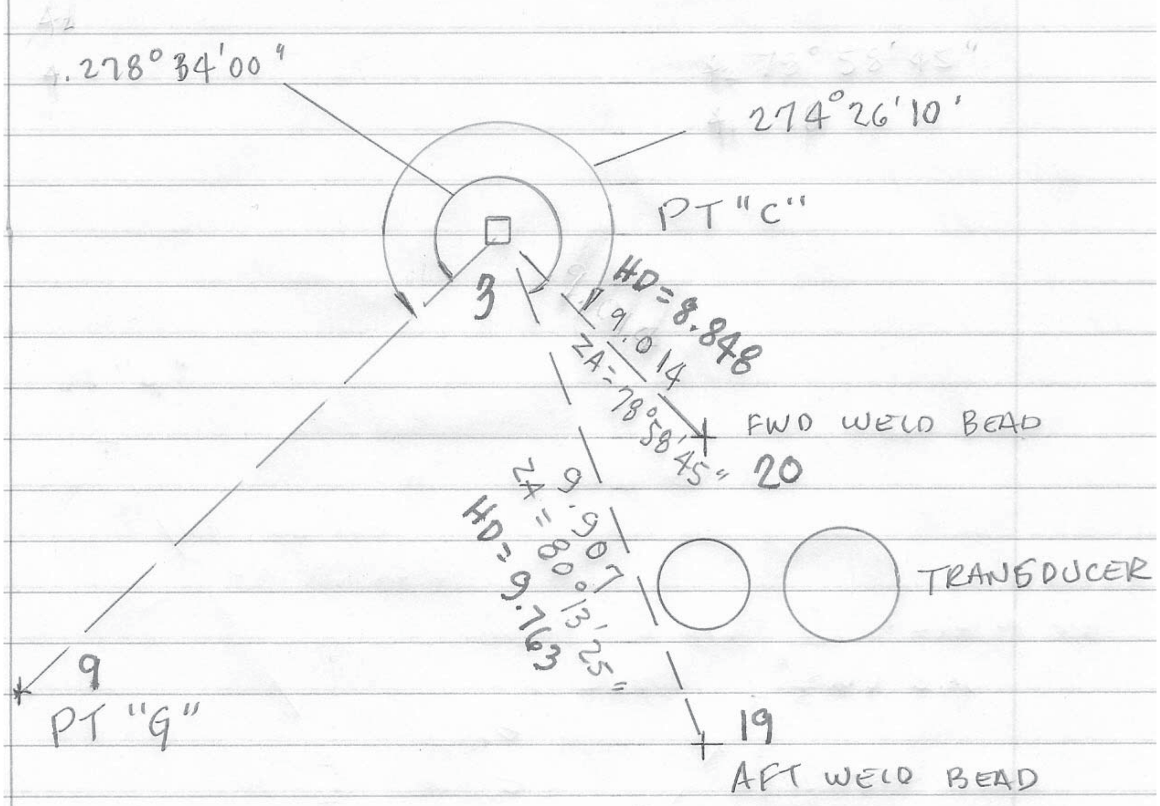

PT"D"
8
AVG = 55°14'06"
∡1 55°13'54"
∡2 110°28'12"
PT"G"
9
HD = 23.553
23.709
Z.A = 83°25'58"
PT"K"
15
STATEROOM
AVG = 118°24'28"
∡1 118°24'27"
∡2 236°48'56"
HD = 34.851
35.272
ZA = 81°08'14"
PT. "L"
16
BACK
DECK

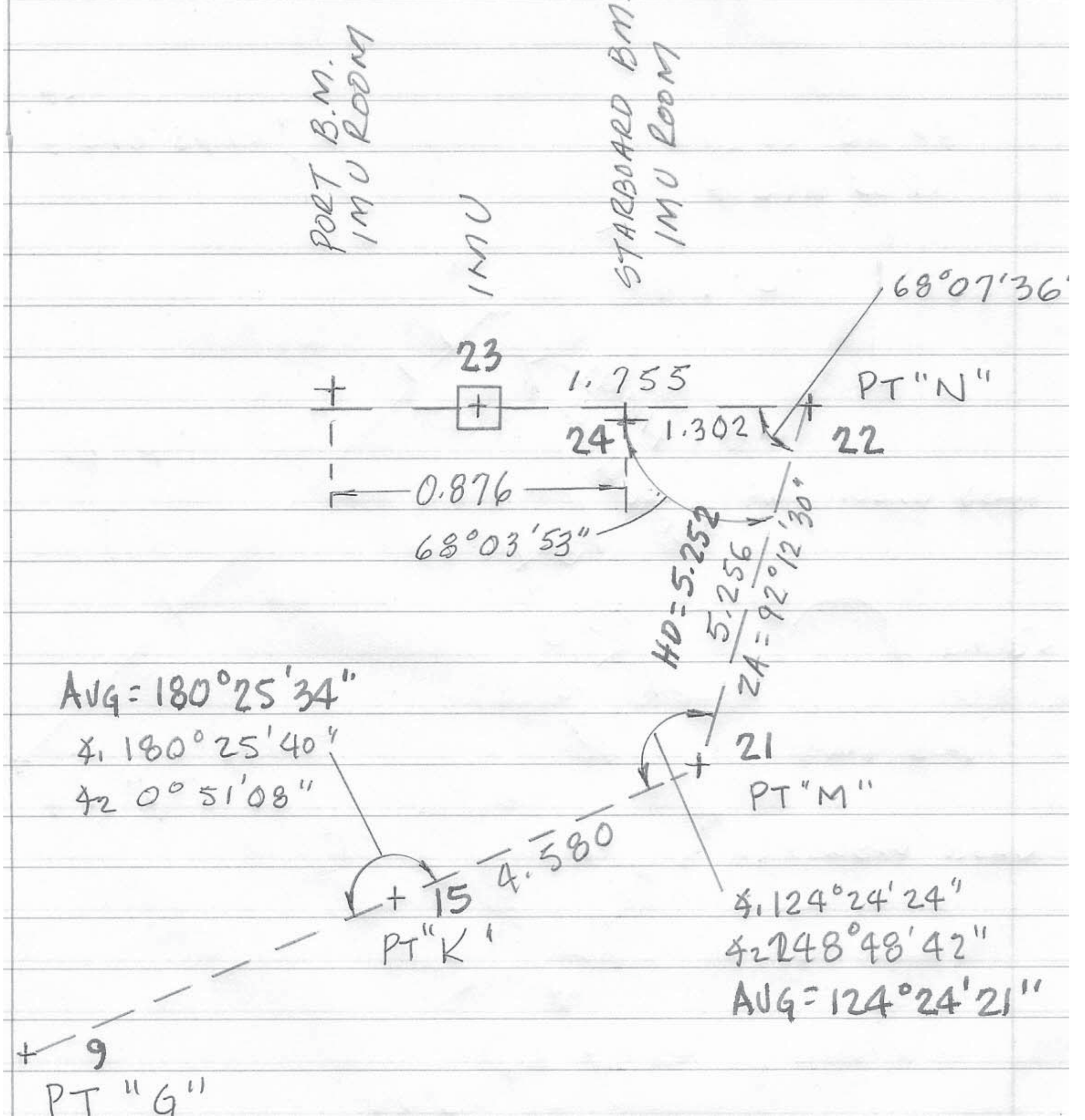


ROOF OF WHEEL
HOUSE



BACK DECK


Az
278°34'00"
274°26'10'
PT "C"
3
HD=8.848
9.014
ZA=78°58'45"
FWD WELD BEAD
20
9.907
ZA=80°13'25"
HD=9.763
TRANSDUCER
9
PT "G"
19
AFT WELD BEAD


PORT B.M.
IMU ROOM
IMU
STARBOARD B.M.
IMU ROOM
68°07'36"
23
1.755
PT "N"
24
1.302
22
0.876
68°03'53"
HD=5.252
5.256
ZA=92°12'30"
AVG=180°25'34"
∡1 180°25'40"
∡2 0°51'08"
21
PT "M"
4.580
15
PT "K"
∡1 124°24'24"
∡2 248°48'42"
AVG=124°24'21"
9
PT "G"

| ⑨ | B.S | H I | F.S | ELEV | DESCRIPTION |
|---|---|---|---|---|---|
| | | | | 10.00* | FRAME 78 |
| | -0.607 | 9.393 | | | |
| | | | -1.047 | 10.440 | FRAME 49 |
| | | | -1.378 | 10.771 | FRAME 29 |
| | | | -1.655 | 11.048 | FRAME 11 |
| | -1.692 | 9.356 | | | |
| | | | -1.414 | 10.770 | FRAME 29 |
| | | | -1.083 | 10.439 | FRAME 49 |
| | | | -0.643 | 9.999 | FRAME 78 |

* ASSUMED ELEVATION TO DETERMINE DIFFERENCE IN ELEVATIONS OF FRAMES AND ELEVATION OF ℄@ MAST.

| | | | | | |
|---|---|---|---|---|---|
| | | | | 10.00* | FRAME 78 |
| | -0.591 | 9.409 | | | |
| | | | 1.548 | 7.861 | PT "C" |
| | 1.353 | 9.214 | | | |
| T.P. "1" | | | 0.485 | 8.729 | CROSS BAR ON HOPPER |
| | 0.405 | 9.134 | | | |
| | | | 1.272 | 7.862 | |
| | 1.527 | 9.389 | | | |
| | | | -0.612 | 10.001 | FRAME 78 |
| | | | | | |
| T.P. "1" | | | | 8.729 | CROSS BAR ON HOPPER |
| | 0.512 | 9.241 | | | |
| S.D=78.145 | | ZA.=74°01'45 | | 9.241 | |
| | H.D= | 75.706 | | +21.667 | |
| | V.D= | 21.667 | | 30.908 | |
| | | -30.908 | -1.680 | 29.228 | PT "E" |
| | 1.614 | 30.842 | | | |
| | | | -1.623 | 29.219 | ℄ MAST ON-WHEEL HOUSE ROOF |

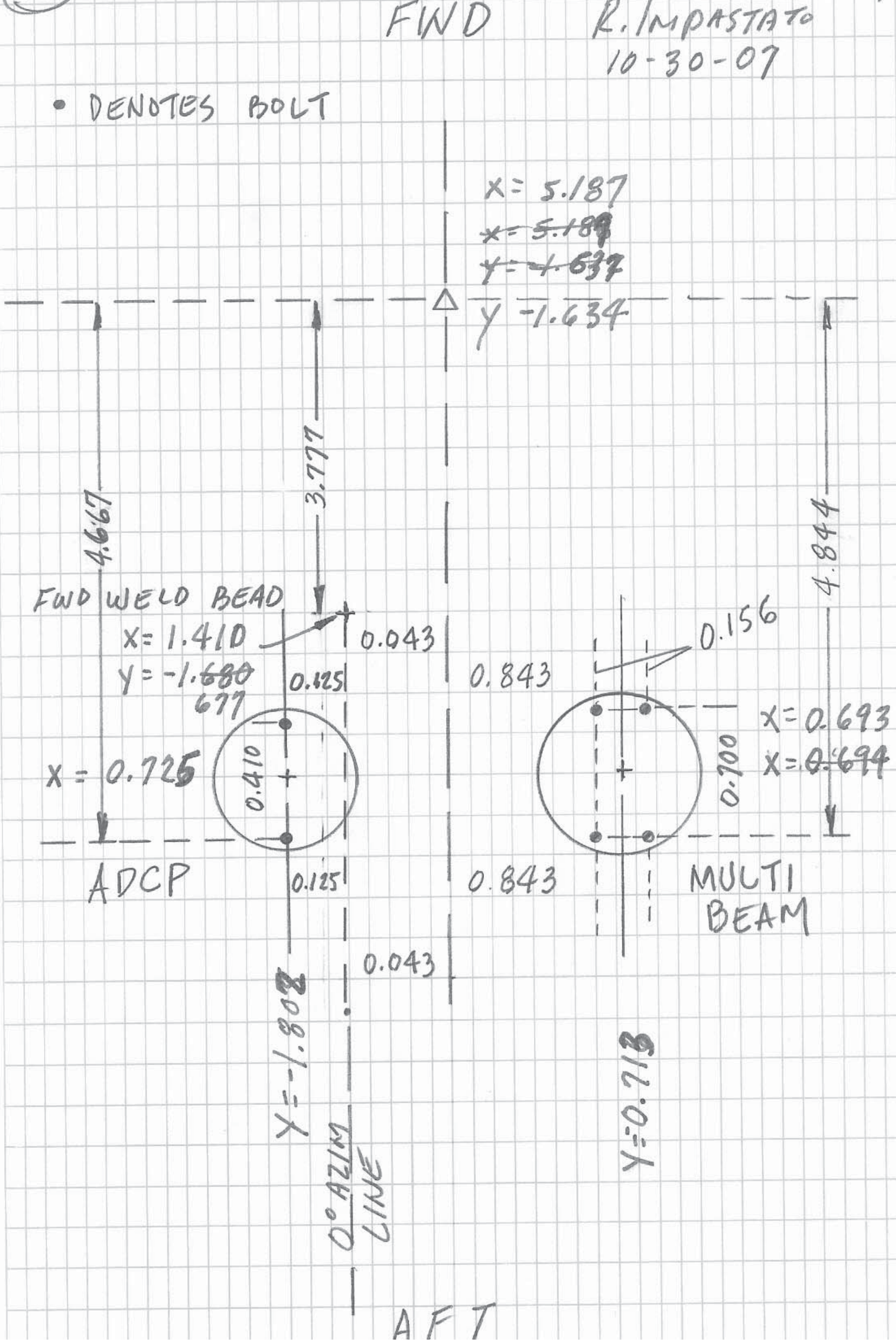
| B.S. | H.I | F.S | ELEV | DESCRIPTION |
|---|---|---|---|---|
| | | | | |
| | | | 17.239 | PT "E" |
| 1.614 | 18.853 | | | |
| | | 1.623 | 17.230 | BASE OF MAST ℄ |
| 1.584 | 18.814 | | | |
| | | 1.575 | 17.239 | PT "E" |
| | | | | |
| | | | | |
| | | | 17.239 | BASE OF MAST ℄ |
| 1.609 | 18.839 | | | |
| | | 1.582 | 17.251 | STARB B.M ON WHEEL HOUSE |
| | | 1.590 | 17.249 | ℄ B.M ON WHEEL HOUSE |
| | | 1.597 | 17.242 | PORT B.M. ON WHEEL HOUSE |
| | | 1.600 | 17.239 | |
| | | | | |
| | | | | |
| | | | -1.989 | BOTTOM KEEL "FRAME 78" |
| -0.477 | -2.466 | | | |
| | | -10.106 | 7.640 | TOP RAIL BACK DECK |
| -10.144 | -2.504 | | | |
| | | -0.514 | -1.990 | |
| | | | | |
| | | | 7.640 | TOP RAIL BACK DECK |
| 0.558 | 8.198 | | | |
| | | 1.528 | 6.670 | AFT B.M BACK DECK |
| | | 1.554 | 6.644 | FWD BM BACK DECK |
| 1.460 | 8.104 | | | |
| | | 1.434 | 6.670 | AFT B.M. BACK DECK |
| | | 0.464 | 7.640 | TOP RAIL BACK DECK |

| ⑫ | B.S. | H.I. | F.S. | ELEV. | DESCRIPTION |
|---|---|---|---|---|---|
| | | | | -4.128 | PT "C" |
| | 1.437 | -2.691 | | | |
| | | | -1.652 | -1.039 | WELD BEAD * (FWD) |
| | | | -1.612 | -1.079 | WELD BEAD * (AFT) |
| | -1.663 | -2.742 | | | |
| | | | -1.702 | -1.040 | WELD BEAD * (FWD) |
| | | | 1.387 | -4.129 | PT "C" |
| | | | | -1.989 | BOTTOM KEEL FRAME 78 |
| | -0.607 | -2.596 | | | |
| | | | -1.655 | -0.941 | BOTTOM KEEL FRAME 11 |
| | -1.692 | -2.633 | | | |
| | | | -0.643 | -1.990 | |
| | | | | 0.00 | MASTER REFERENCE PLATE |
| | 0.438 | 0.438 | | | |
| T.P. 4 | | | 1.038 | -0.600 | |
| | 1.007 | 0.407 | | | |
| | | | 0.407 | 0.00 | M.R.P. |
| T.P. 4 | | | | -0.600 | |
| | 6.027 | 5.427 | | | |
| | | | 1.483 | 3.944 | PORT BENCH MARK IMU |
| | | | 0.996 | 4.431 | TOP OF IMU |
| | | | 1.484 | 3.943 | STARBOARD BENCH MARK IMU |
| | 1.437 | 5.380 | | | |
| | | | 1.436 | 3.944 | PORT B.M |
| | | | 0.949 | 4.431 | TOP OF IMU |
| T.P. 4 | | | 5.979 | -0.599 | |

⑬

PISCES XYZ SURVEY
R. IMPASTATO
10-30-07

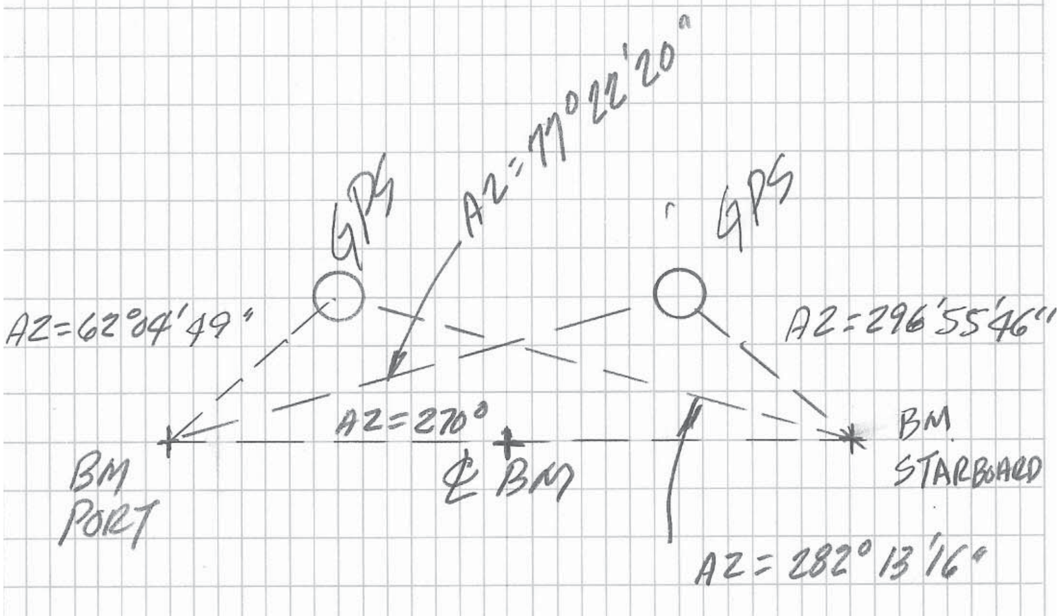
• DENOTES BOLT



④

| STA | B.S. | H I | F.S | ELEV | |
|---|---|---|---|---|---|
| TBM | | | | -1.039 | FWD WELD BEAD |
| | -1.585 | -2.624 | | | |
| | | | -1.624 | -1.000 | FWD RIM ADCP |
| | | | -1.625 | -0.999 | AFT RIM ADCP |
| | | | -1.626 | -0.998 | PORT RIM ADCP |
| | | | -1.623 | -1.001 | STB. RIM ADCP |
| | | | | | |
| | | | -1.435 | -1.189 | FWD RIM MB |
| | | | -1.435 | -1.189 | AFT RIM MB |
| | | | -1.435 | -1.189 | PORT RIM MB |
| | | | -1.434 | -1.190 | STB. RIM MB |
| | | | | | |
| T.BM | | | -1.585 | -1.039 | |

FWD



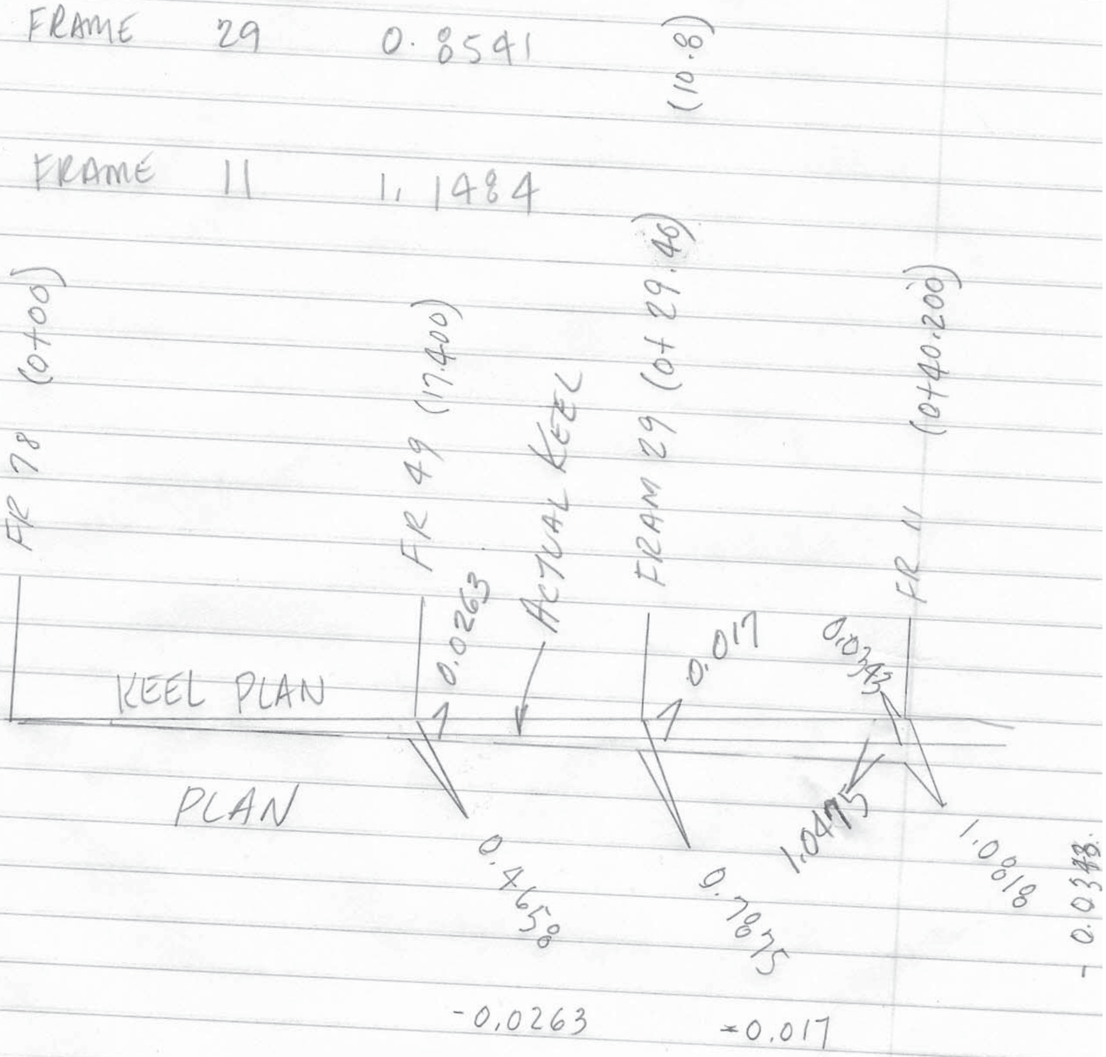
TOP OF WHEEL HOUSE

| STA | B.S | HI | F.S | ELEV | DESCRIPTION |
|---|---|---|---|---|---|
| | | | | 17.239 | POINT "E" |
| | 1.621 | 18.860 | | | |
| | | | -0.012 | 18.872 | GPS PLATE STAR |
| | | | -0.010 | 18.870 | GPS PLATE PORT |
| ⑭ | | | | | |
| | | | 1.621 | 17.239 | |

# PITCH CALCULATIONS
# PISCES

DIMENSIONS FROM ℄ TO KEEL ON DRAWING

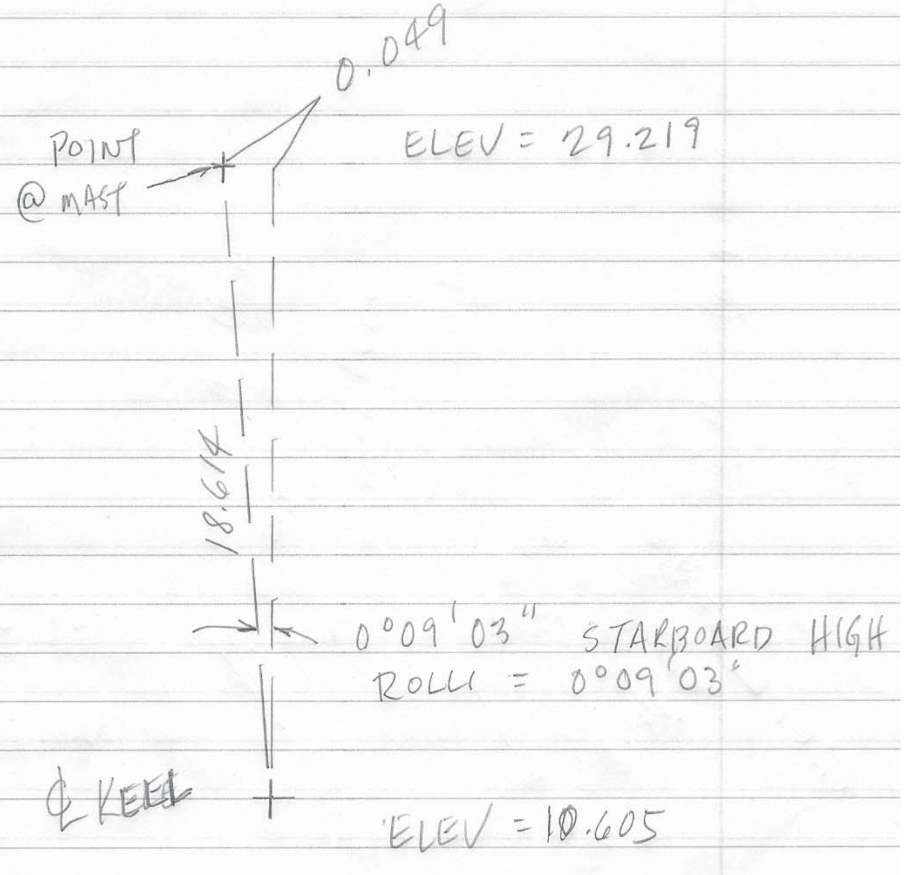
| | | |
|---|---|---|
| FRAME | 78 | 0.0666 |
| FRAME | 49 | 0.5324 |
| FRAME | 29 | 0.8541 |
| FRAME | 11 | 1.1484 |



PITCH

| | | |
|---|---|---|
| FR 78 - FR 11 | 0° 02' 56" | BOW LOW |
| FR 78 - FR 29 | 0° 01' 59" | BOW LOW |
| FR 78 - FR 49 | 0° 05' 12" | BOW LOW |

# PISCES
# ROLL CALCULATIONS



# POSMV 320
# INSTALLATION REPORT

Prepared for NOAA
FRV *Pisces*
November, 2008
By

Bruce A. Francis
Applanix LLC
Houston, TX

Bruce A. Francis
Applanix Corporation.
17461 Village Green Drive
Houston TX 77040
USA
Tel: (713) 896-9900
Fax: (713) 896-9919
bfrancis@applanix.com
http://www.applanix.com

**Company:** **Seacoast Electronics**

**Attention of:** **Art Thomas Jr.**

**Email:** Art.ThomasJr@seacoast-rhg.com

**From:** Bruce A. Francis

**Date:** 9 November, 2008

**Ref.:** **POSMV Installation aboard *Pisces***

---

During the period of Sept 8th to Sept 25th, 2008 a POSMV system commissioning was conducted aboard NOAA vessel *Pieces*. The following is a summary of the events and final observations.

**Chronology:**
Sept 8th-Sept 11th-

Travel from Houston TX to Mobile AL. Installation and initial checkout of equipment. Vessel departure for Pascagoula yard was delayed and as a result the final system calibration could not be completed.

Sept 21st- Sept 25th-

Return to complete final at sea testing and calibration of system.

**Calibration and testing results:**

1. The GAMS calibration was completed on Sept 24th and checked against the calculations derived from the survey report, tied very well.

**Notes:**

**Recommendations:**

Enter in the center of rotation (COR) lever arm when this information has been determined.

Should you have any questions or can be of further assistance, please do not hesitate to contact me.

Bruce A Francis

Submitted By:
Bruce A. Francis
Customer Support Engineer
Marine Products
713-896-9900
bfrancis@applanix.com

| | | |
|---|---|---|
| **Vessel Name** | Pisces |  |
| **PCS System** | POSMV 320 | |
| **PCS Serial number** | 2252 | |
| **IMU Serial number**<br>**Top Hat** | 408518<br>456 | |
| **Hardware version** | 2.7-7 | |
| **Firmware version** | 3.42 | |
| **POS IP Address**<br>**Subnet mask** | 129.100.1.231<br>255.255.0.0 | |
| **PC IP Address**<br>**Subnet mask** | 129.100.1.XXX<br>255.255.0.0 | |
| **Survey software** | ? | |
| **Multibeam system** | Simrad ME-70 | |
| **Single Beam system** | | |

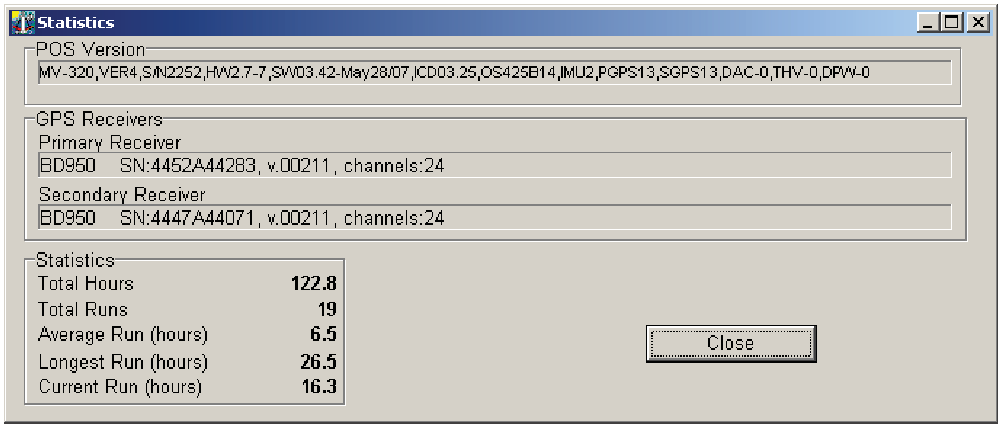
**Lever Arms: (Units are in Meters)**

| **Point** | **X Axis** | **Y Axis** | **Z Axis** | **Notes** |
|---|---|---|---|---|
| Reference point | 0.0 | 0.0 | 0.0 | Granite block |
| Ref to IMU | -0.400 | -1.341 | -4.434 | |
| Ref to Primary GPS | -4.830 | 1.356 | -18.870 | Starboard antenna |
| Ref to Secondary GPS | -4.842 | -1.566 | -18.870 | Port antenna |
| Ref to AUX GPS | -17.250 | -1.675 | -26.194 | Not surveyed-Estimated |
| Ref to Vessel | 0.0 | 0.0 | 0.0 | POS NMEA, message point of validity at target on IMU. |
| IMU frame w.r.t Ref frame | -0.662 | -0.548 | 0.0 | Rotation of IMU frame in comparison to ships frame. |
| Ref to Heave (COR) | 0.0 | 0.0 | 0.0 | Center of gravity (rotation) Information not available. |
| Ref to Sensor 1 | 0.0 | 0.0 | 0.0 | Point of validity of HPR +Posn-Valid at IMU |
| Ref to Sensor 2 | 0.0 | 0.0 | 0.0 | Point of validity-HPR +Posn-Valid at IMU |

**Connection Table**

| **FROM** | **TO** | **SIGNAL** | **COMMENT** |
|---|---|---|---|
| POSMV Com 1 | NMEA buffer | NMEA Output<br>4800, 8,N,1 @1 HZ | $INGGA, $INHDT |
| POSMV Com 2 | TO EK-60 | Binary<br>115200, 8,N,1@ 100HZ | Roll, pitch and heave data<br>Simrad EM3000 (Tate Bryant) |
| POSMV Com 3 | Leica DGPS receiver | AUX input<br>19200, 8,N,1 @ 1 HZ | AUX input- GGA, GST, GSV and GSA messages |
| POSMV Com 4 | Heading repeaters | NMEA Output<br>4800, 8,N,1 @ 1 HZ | $INHDT, heading data to shipboard repeaters. |
| POSMV Com 5 | ME-70 | Binary, 115200, 8,N, @100 HZ | Roll, pitch, heave data.<br>Simrad EM3000 (Tate Bryant) |
| POSMV PPS Out | N/C | TTL- Active low | Using master time clock in rack. |
| Ethernet | POSMV PC | POS data | For control/display of POS |

**General System information:**
**Options included- True Heave; DAC; (DPW-0) Password protection Disabled**



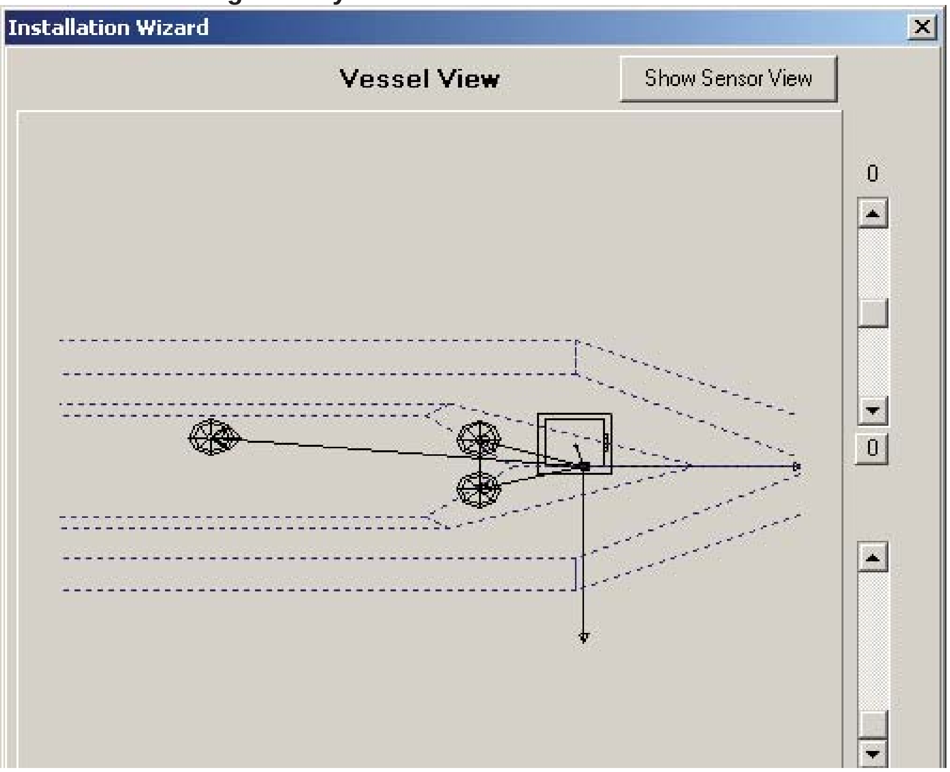
POS Version
MV-320,VER4,S/N2252,HW2.7-7,SW03.42-May28/07,ICD03.25,OS425B14,IMU2,PGPS13,SGPS13,DAC-0,THV-0,DPW-0

GPS Receivers
Primary Receiver
BD950 SN:4452A44283, v.00211, channels:24
Secondary Receiver
BD950 SN:4447A44071, v.00211, channels:24

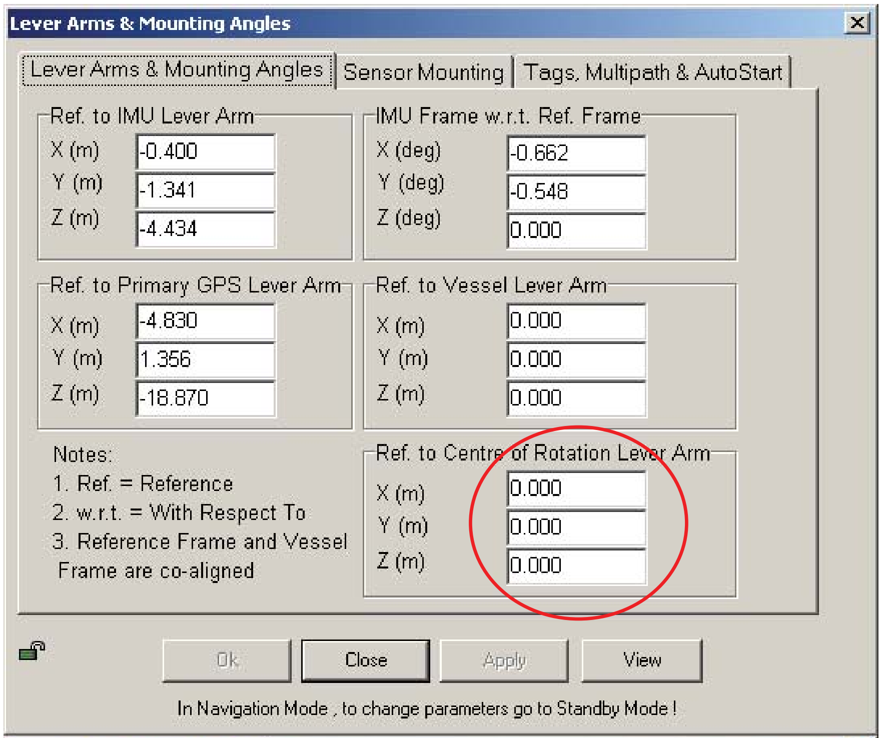
Statistics

| | |
|---|---|
| Total Hours | 122.8 |
| Total Runs | 19 |
| Average Run (hours) | 6.5 |
| Longest Run (hours) | 26.5 |
| Current Run (hours) | 16.3 |

**Basic installation geometry:**



**Lever Arm installation page on POSMV controller: Starboard antenna is Primary. Note: ref to COR value was not available and should be entered before use and Should be available from ships stability tables.**



Ref. to IMU Lever Arm
X (m) -0.400
Y (m) -1.341
Z (m) -4.434

IMU Frame w.r.t. Ref. Frame
X (deg) -0.662
Y (deg) -0.548
Z (deg) 0.000

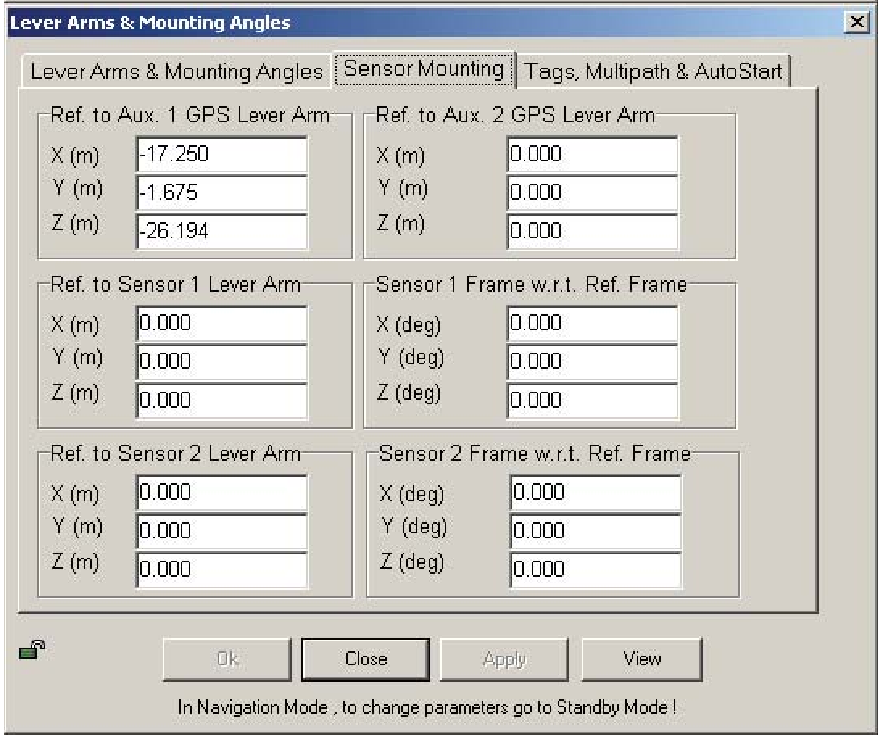
Ref. to Primary GPS Lever Arm
X (m) -4.830
Y (m) 1.356
Z (m) -18.870

Ref. to Vessel Lever Arm
X (m) 0.000
Y (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

Ref. to Centre of Rotation Lever Arm
X (m) 0.000
Y (m) 0.000
Z (m) 0.000

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



Ref. to Aux. 1 GPS Lever Arm
X (m) -17.250
Y (m) -1.675
Z (m) -26.194

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

Ref. to Sensor 1 Lever Arm
X (m) 0.000
Y (m) 0.000
Z (m) 0.000

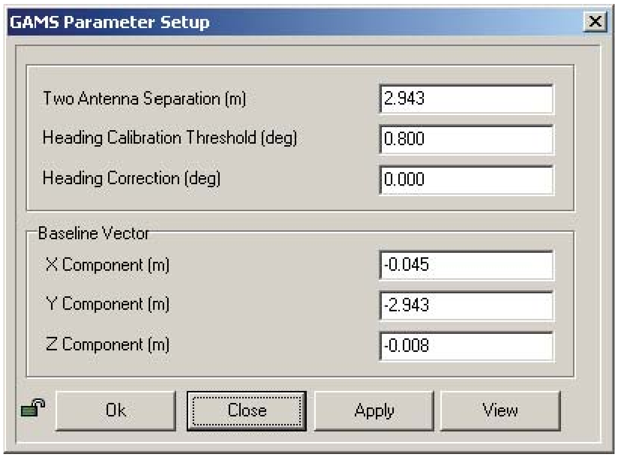
Sensor 1 Frame w.r.t. Ref. Frame
X (deg) 0.000
Y (deg) 0.000
Z (deg) 0.000

Ref. to Sensor 2 Lever Arm
X (m) 0.000
Y (m) 0.000
Z (m) 0.000

Sensor 2 Frame w.r.t. Ref. Frame
X (deg) 0.000
Y (deg) 0.000
Z (deg) 0.000

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

**Observed GAMS values derived from the field calibration:**



GAMS Parameter Setup

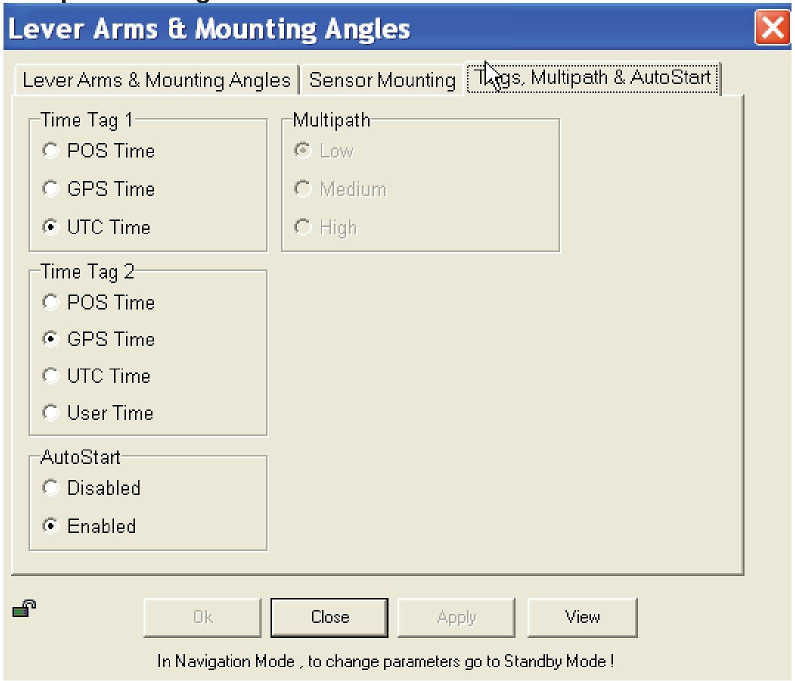
Two Antenna Separation (m) 2.943
Heading Calibration Threshold (deg) 0.800
Heading Correction (deg) 0.000

Baseline Vector
X Component (m) -0.045
Y Component (m) -2.943
Z Component (m) -0.008

GAMS
Calculated (vessel survey) vs. observed (field calibration) values:

| | Calculated | Observed | C-O |
|---|---|---|---|
| Two Ant Separation | 2.922 | 2.943 | -0.021m |
| X vector | -0.012 | -0.045 | -0.033m |
| Y vector | -2.922 | -2.943 | -0.021m |
| Z vector | 0.0 | -0.008 | -0.008m |
| Results of two GAMS calibrations | | | |
| | GAMS #1 | GAMS #2 | C-O |
| Two Ant Separation | 2.944 | 2.943 | -0.001 |
| X vector | -0.049 | -0.045 | +0.004 |
| Y vector | -2.943 | -2.942 | -0.001 |
| Z vector | -0.017 | -0.008 | +0.009 |

**Multi-path setting is fixed at LOW as this was deemed to be the most effective.**



Lever Arms & Mounting Angles

Time Tag 1
○ POS Time
○ GPS Time
● UTC Time

Multipath
● Low
○ Medium
○ High

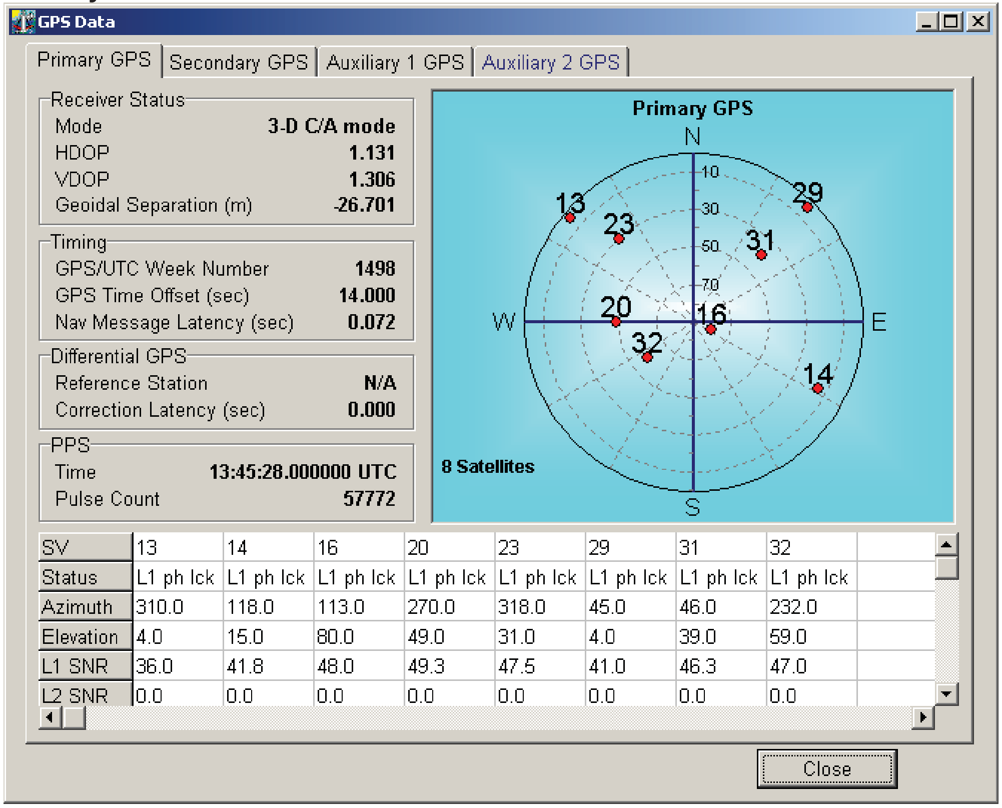
Time Tag 2
○ POS Time
● GPS Time
○ UTC Time
○ User Time

AutoStart
○ Disabled
● Enabled

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

.

**Primary GPS data observed from internal Trimble BD950 receivers.**



Receiver Status

| | |
|---|---|
| Mode | 3-D C/A mode |
| HDOP | 1.131 |
| VDOP | 1.306 |
| Geoidal Separation (m) | -26.701 |

Timing

| | |
|---|---|
| GPS/UTC Week Number | 1498 |
| GPS Time Offset (sec) | 14.000 |
| Nav Message Latency (sec) | 0.072 |

Differential GPS

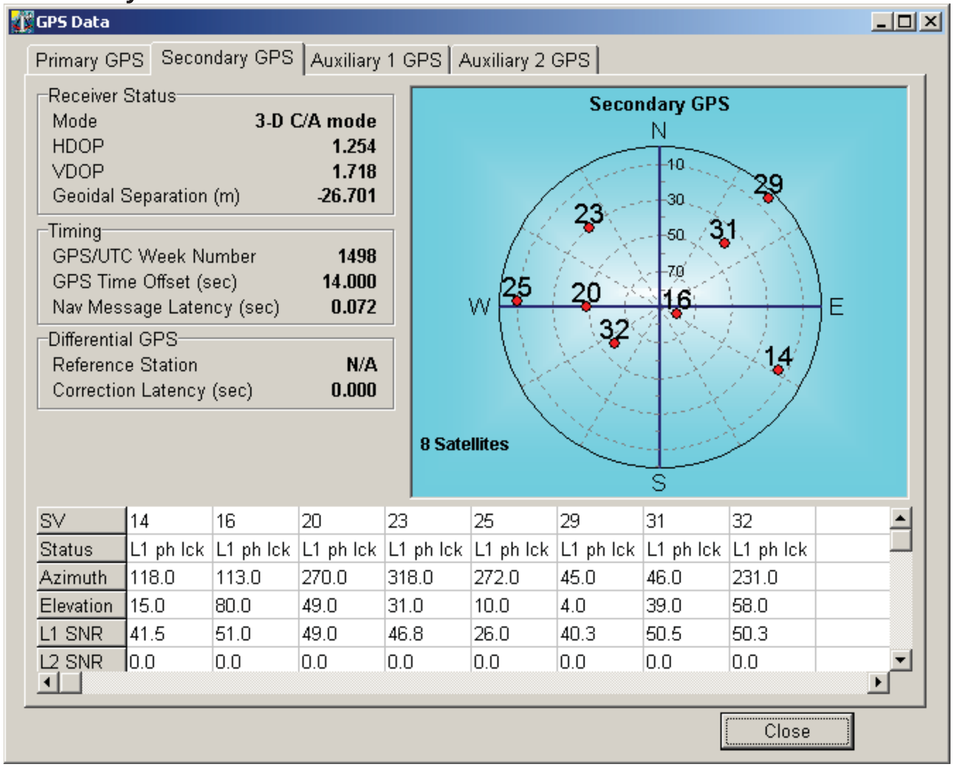
| | |
|---|---|
| Reference Station | N/A |
| Correction Latency (sec) | 0.000 |

PPS

| | |
|---|---|
| Time | 13:45:28.000000 UTC |
| Pulse Count | 57772 |

| SV | 13 | 14 | 16 | 20 | 23 | 29 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|
| Status | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck |
| Azimuth | 310.0 | 118.0 | 113.0 | 270.0 | 318.0 | 45.0 | 46.0 | 232.0 |
| Elevation | 4.0 | 15.0 | 80.0 | 49.0 | 31.0 | 4.0 | 39.0 | 59.0 |
| L1 SNR | 36.0 | 41.8 | 48.0 | 49.3 | 47.5 | 41.0 | 46.3 | 47.0 |
| L2 SNR | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Secondary embedded GPS data:**



Receiver Status

| | |
|---|---|
| Mode | 3-D C/A mode |
| HDOP | 1.254 |
| VDOP | 1.718 |
| Geoidal Separation (m) | -26.701 |

Timing

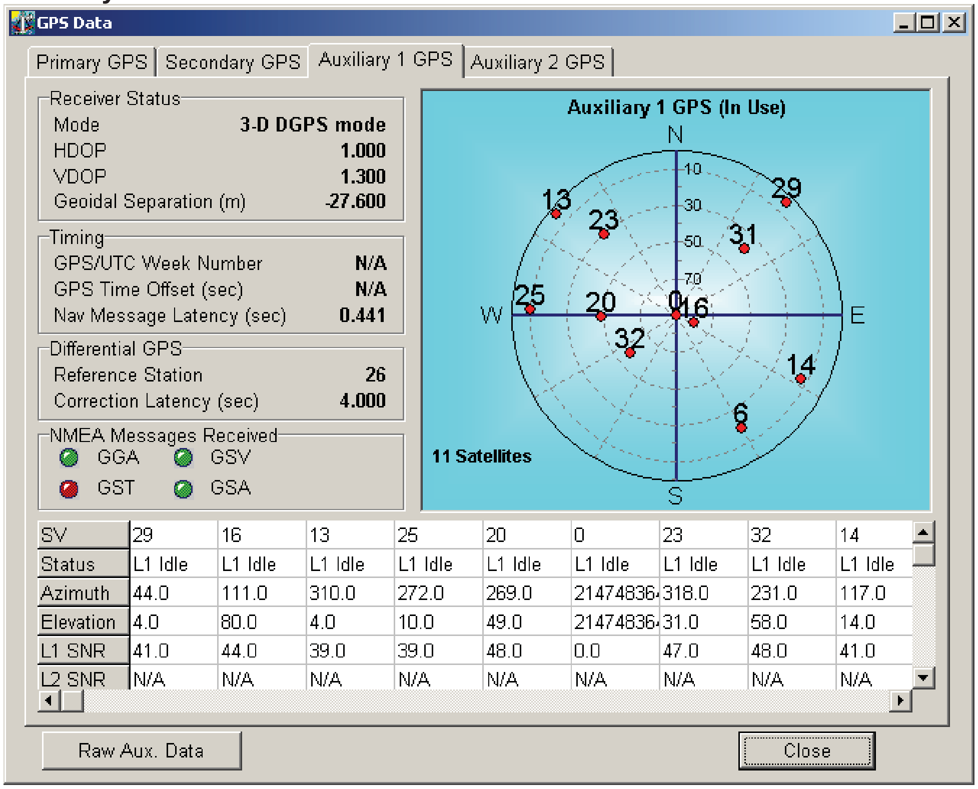
| | |
|---|---|
| GPS/UTC Week Number | 1498 |
| GPS Time Offset (sec) | 14.000 |
| Nav Message Latency (sec) | 0.072 |

Differential GPS

| | |
|---|---|
| Reference Station | N/A |
| Correction Latency (sec) | 0.000 |

| SV | 14 | 16 | 20 | 23 | 25 | 29 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|
| Status | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck |
| Azimuth | 118.0 | 113.0 | 270.0 | 318.0 | 272.0 | 45.0 | 46.0 | 231.0 |
| Elevation | 15.0 | 80.0 | 49.0 | 31.0 | 10.0 | 4.0 | 39.0 | 58.0 |
| L1 SNR | 41.5 | 51.0 | 49.0 | 46.8 | 26.0 | 40.3 | 50.5 | 50.3 |
| L2 SNR | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

## Auxiliary GPS Data from Leica Receiver:



Receiver Status

| | |
|---|---|
| Mode | 3-D DGPS mode |
| HDOP | 1.000 |
| VDOP | 1.300 |
| Geoidal Separation (m) | -27.600 |

Timing

| | |
|---|---|
| GPS/UTC Week Number | N/A |
| GPS Time Offset (sec) | N/A |
| Nav Message Latency (sec) | 0.441 |

Differential GPS

| | |
|---|---|
| Reference Station | 26 |
| Correction Latency (sec) | 4.000 |

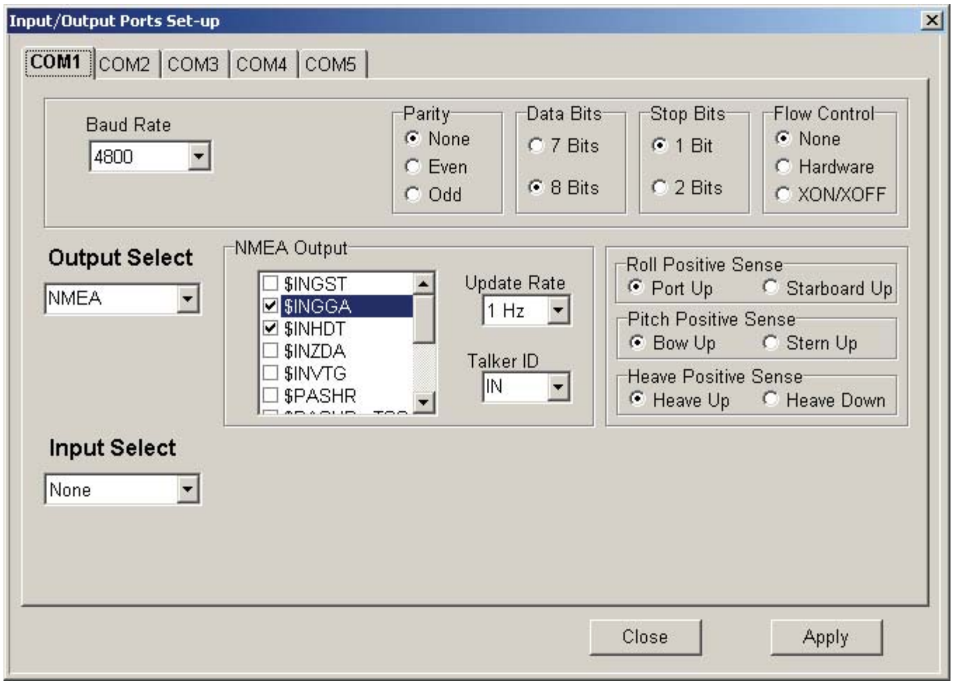
NMEA Messages Received

🟢 GGA 🟢 GSV
🔴 GST 🟢 GSA

11 Satellites

| SV | 29 | 16 | 13 | 25 | 20 | 0 | 23 | 32 | 14 |
|---|---|---|---|---|---|---|---|---|---|
| Status | L1 Idle | L1 Idle | L1 Idle | L1 Idle | L1 Idle | L1 Idle | L1 Idle | L1 Idle | L1 Idle |
| Azimuth | 44.0 | 111.0 | 310.0 | 272.0 | 269.0 | 21474836 | 318.0 | 231.0 | 117.0 |
| Elevation | 4.0 | 80.0 | 4.0 | 10.0 | 49.0 | 21474836 | 31.0 | 58.0 | 14.0 |
| L1 SNR | 41.0 | 44.0 | 39.0 | 39.0 | 48.0 | 0.0 | 47.0 | 48.0 | 41.0 |
| L2 SNR | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

## Com port #1 settings as installed: GGA and HDT to NMEA buffer.



Baud Rate: 4800

Parity: ● None ○ Even ○ Odd

Data Bits: ○ 7 Bits ● 8 Bits

Stop Bits: ● 1 Bit ○ 2 Bits

Flow Control: ● None ○ Hardware ○ XON/XOFF

Output Select: NMEA

NMEA Output:
☐ $INGST
☑ $INGGA
☑ $INHDT
☐ $INZDA
☐ $INVTG
☐ $PASHR

Update Rate: 1 Hz

Talker ID: IN

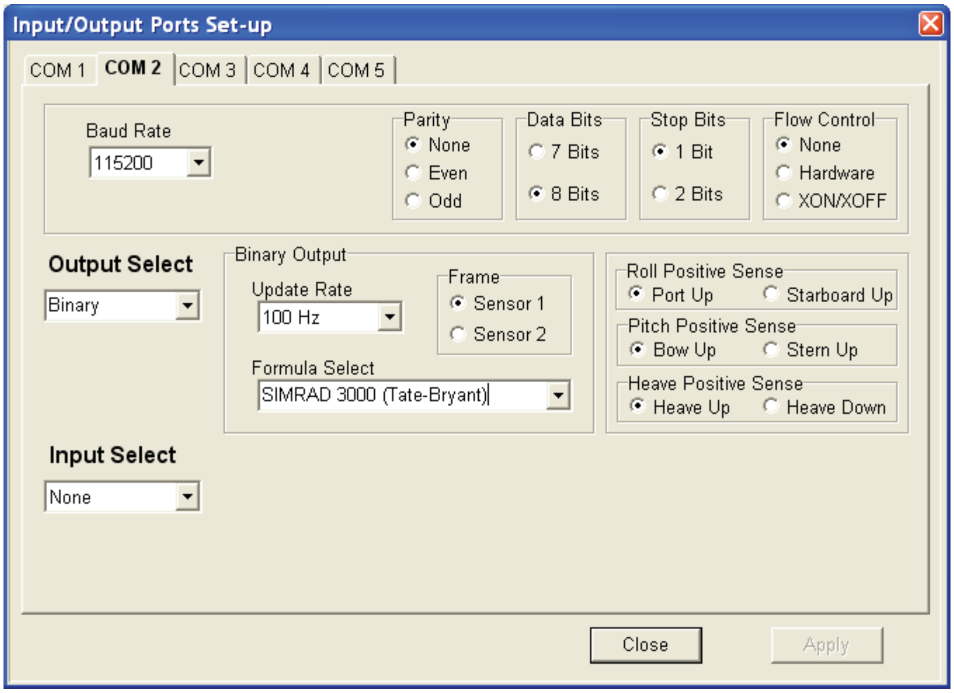
Roll Positive Sense: ● Port Up ○ Starboard Up

Pitch Positive Sense: ● Bow Up ○ Stern Up

Heave Positive Sense: ● Heave Up ○ Heave Down

Input Select: None

**Com port #2 settings as installed: H.P.R. Data to EK-60.**



Baud Rate: 115200

Parity: ● None ○ Even ○ Odd

Data Bits: ○ 7 Bits ● 8 Bits

Stop Bits: ● 1 Bit ○ 2 Bits

Flow Control: ● None ○ Hardware ○ XON/XOFF

Output Select: Binary

Binary Output

Update Rate: 100 Hz

Frame: ● Sensor 1 ○ Sensor 2

Formula Select: SIMRAD 3000 (Tate-Bryant)

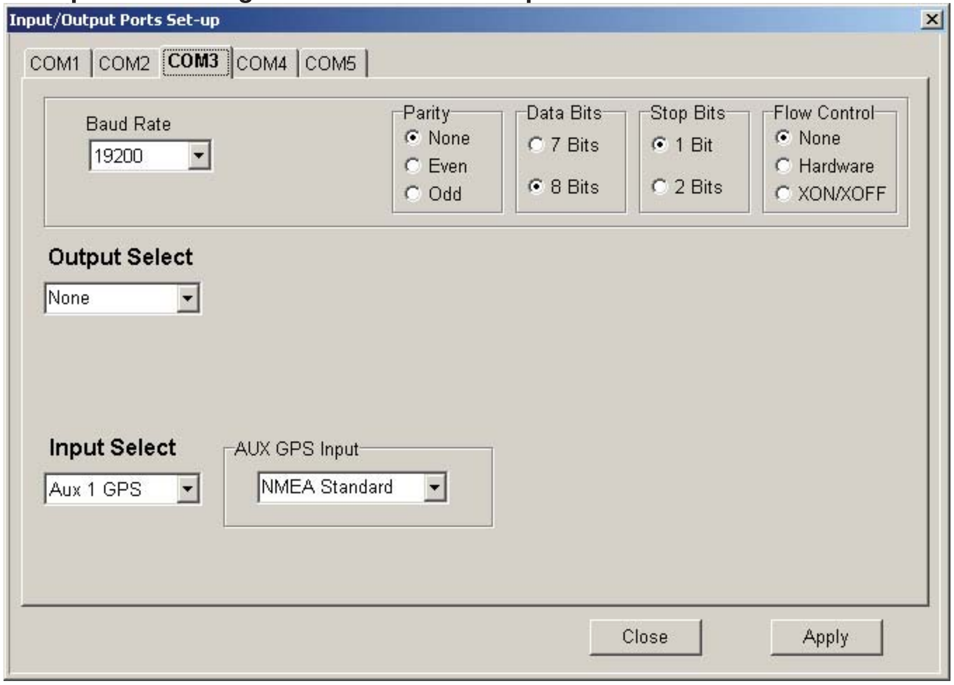
Roll Positive Sense: ● Port Up ○ Starboard Up

Pitch Positive Sense: ● Bow Up ○ Stern Up

Heave Positive Sense: ● Heave Up ○ Heave Down

Input Select: None

**Com port #3 settings as installed: AUX input from Leica receiver.**



Baud Rate: 19200

Parity: ● None ○ Even ○ Odd

Data Bits: ○ 7 Bits ● 8 Bits

Stop Bits: ● 1 Bit ○ 2 Bits

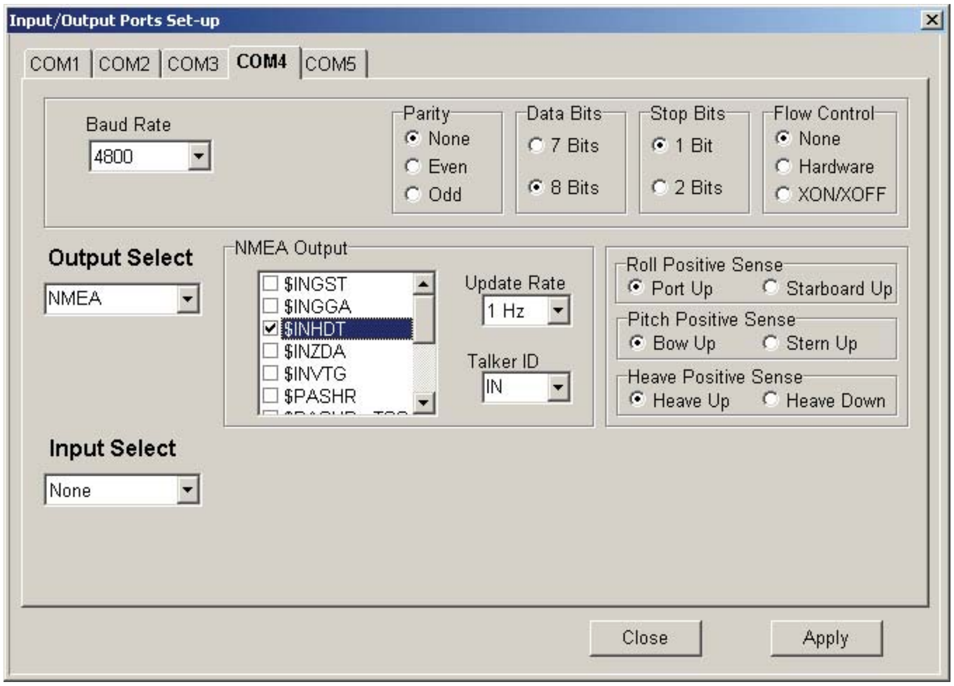
Flow Control: ● None ○ Hardware ○ XON/XOFF

Output Select: None

Input Select: Aux 1 GPS

AUX GPS Input: NMEA Standard

**Com port #4 settings as installed: NMEA HDT to ship heading repeaters.**



Input/Output Ports Set-up

COM1 | COM2 | COM3 | **COM4** | COM5

Baud Rate: 4800

Parity: ● None ○ Even ○ Odd

Data Bits: ○ 7 Bits ● 8 Bits

Stop Bits: ● 1 Bit ○ 2 Bits

Flow Control: ● None ○ Hardware ○ XON/XOFF

Output Select: NMEA

NMEA Output:
- ☐ $INGST
- ☐ $INGGA
- ☑ $INHDT
- ☐ $INZDA
- ☐ $INVTG
- ☐ $PASHR

Update Rate: 1 Hz

Talker ID: IN

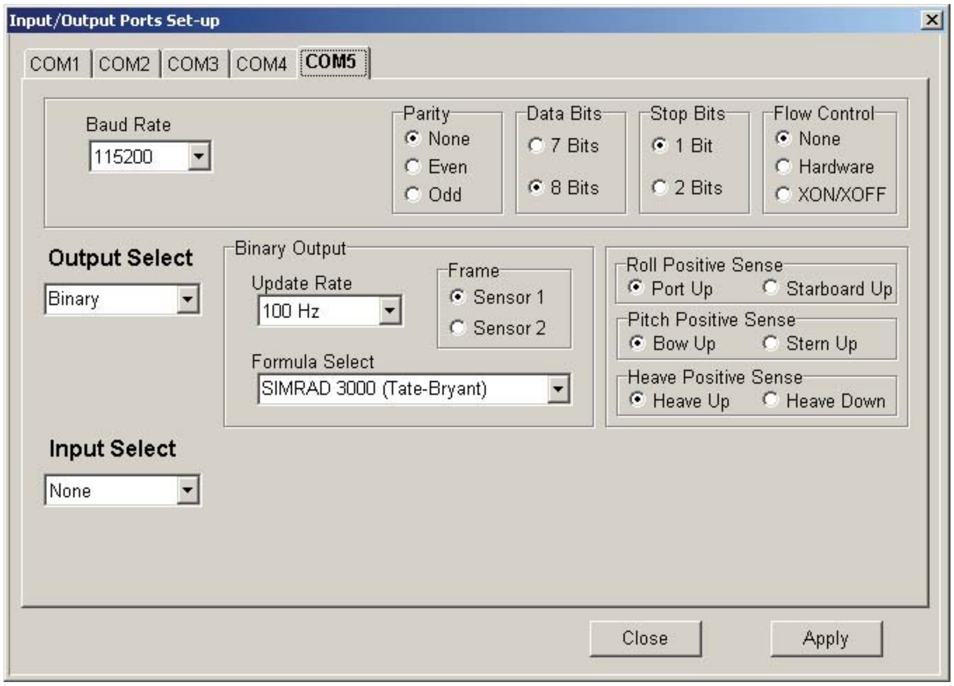
Roll Positive Sense: ● Port Up ○ Starboard Up

Pitch Positive Sense: ● Bow Up ○ Stern Up

Heave Positive Sense: ● Heave Up ○ Heave Down

Input Select: None

**Com port #5 settings as installed: H.R.P. To Simrad ME-70 sonar**



Input/Output Ports Set-up

COM1 | COM2 | COM3 | COM4 | **COM5**

Baud Rate: 115200

Parity: ● None ○ Even ○ Odd

Data Bits: ○ 7 Bits ● 8 Bits

Stop Bits: ● 1 Bit ○ 2 Bits

Flow Control: ● None ○ Hardware ○ XON/XOFF

Output Select: Binary

Binary Output:

Update Rate: 100 Hz

Frame: ● Sensor 1 ○ Sensor 2

Formula Select: SIMRAD 3000 (Tate-Bryant)

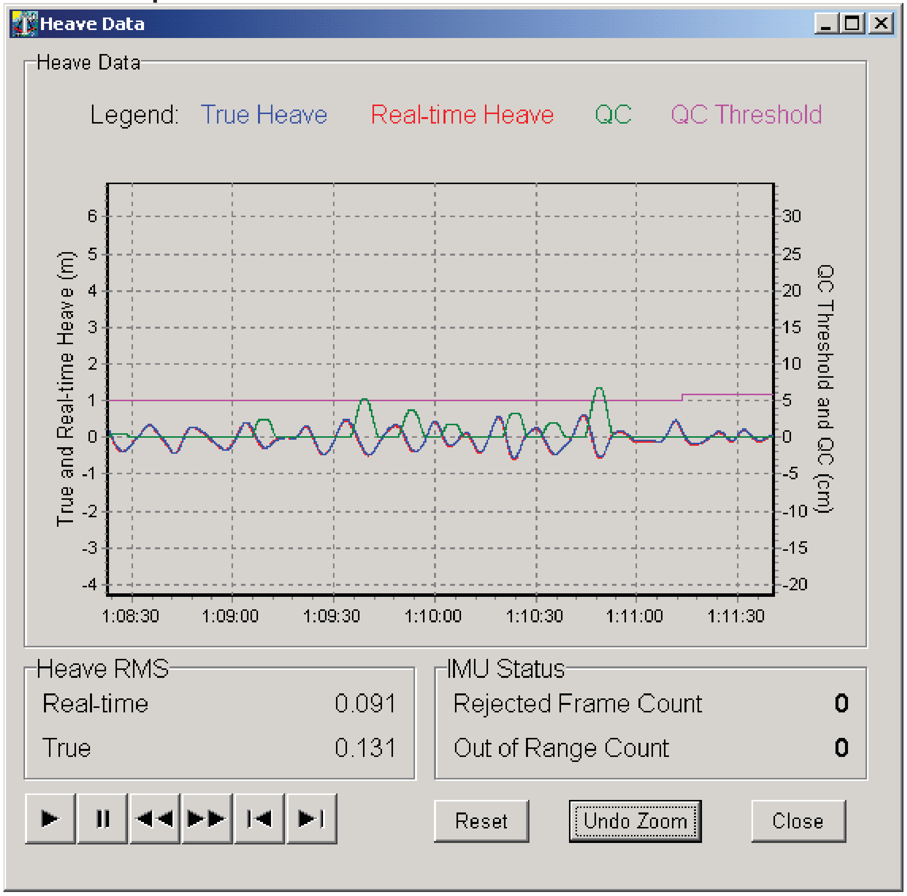
Roll Positive Sense: ● Port Up ○ Starboard Up

Pitch Positive Sense: ● Bow Up ○ Stern Up

Heave Positive Sense: ● Heave Up ○ Heave Down

Input Select: None

**Heave data plot:**

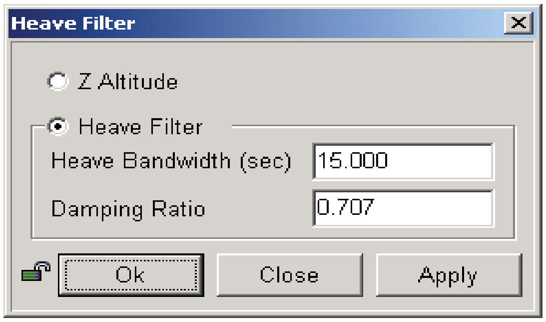


Heave RMS
Real-time 0.091
True 0.131

IMU Status
Rejected Frame Count 0
Out of Range Count 0

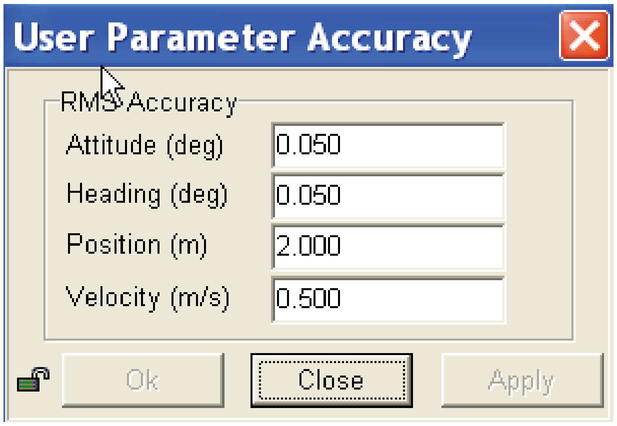
The heave plot above shows the relationship between the Real-time (RT) heave and the True (or delayed TH) heave measurements. The green line relates to quality control (QC) and represents the difference between the two values. When the delta between the RT and TH exceeds 5cm or 5% of total heave (pink line) then the radio light on the main controller screen will turn from green to red but does not affect the real-time heave data being collected. Quite often this occurs after the vessel makes a turn or an abrupt change in speed and is not necessarily cause for alarm. The heave filter has a 105 second buffer so the event which may have caused the impulse happened in the past. A red light merely calls the users attention to the difference and may also suggest that the filter settings need to be refined if the QC value is continually out of bounds.

Note: The TrueHeave data filter is delayed about 3 minutes from the TH value. Also, Group 111 & 113 must be enabled in the Ethernet Real-time logging page. In addition, this filter should be adjusted as required for changes in the local swell conditions.



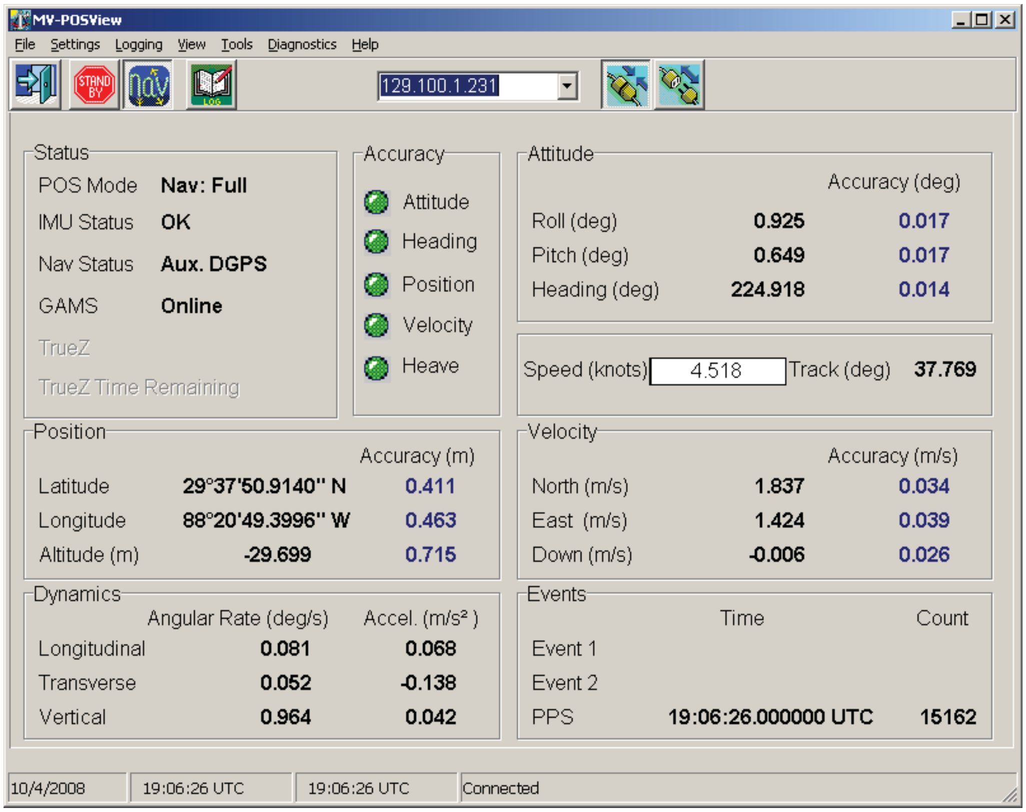
○ Z Altitude
● Heave Filter
Heave Bandwidth (sec) 15.000
Damping Ratio 0.707

**The main controller screen below shows normal POSMV operation. POS Mode is FULL indicating that all user accuracy settings have been satisfied. Note, when using RTK the position threshold should be set to a smaller value i.e. 0.100m or whatever is specified in the survey parameters. Exceeding any of the limits below will cause one of the radio lights to turn red and the POS mode will no longer report “Full Navigation” This however only affects the flag in the GGA or GGK message and not the performance.**



RMS Accuracy

| | |
|---|---|
| Attitude (deg) | 0.050 |
| Heading (deg) | 0.050 |
| Position (m) | 2.000 |
| Velocity (m/s) | 0.500 |



129.100.1.231

Status

| | |
|---|---|
| POS Mode | Nav: Full |
| IMU Status | OK |
| Nav Status | Aux. DGPS |
| GAMS | Online |
| TrueZ | |
| TrueZ Time Remaining | |

Accuracy

- ● Attitude
- ● Heading
- ● Position
- ● Velocity
- ● Heave

Attitude

| | | Accuracy (deg) |
|---|---|---|
| Roll (deg) | 0.925 | 0.017 |
| Pitch (deg) | 0.649 | 0.017 |
| Heading (deg) | 224.918 | 0.014 |

Speed (knots) 4.518 Track (deg) 37.769

Position

| | | Accuracy (m) |
|---|---|---|
| Latitude | 29°37'50.9140" N | 0.411 |
| Longitude | 88°20'49.3996" W | 0.463 |
| Altitude (m) | -29.699 | 0.715 |

Velocity

| | | Accuracy (m/s) |
|---|---|---|
| North (m/s) | 1.837 | 0.034 |
| East (m/s) | 1.424 | 0.039 |
| Down (m/s) | -0.006 | 0.026 |

Dynamics

| | Angular Rate (deg/s) | Accel. (m/s² ) |
|---|---|---|
| Longitudinal | 0.081 | 0.068 |
| Transverse | 0.052 | -0.138 |
| Vertical | 0.964 | 0.042 |

Events

| | Time | Count |
|---|---|---|
| Event 1 | | |
| Event 2 | | |
| PPS | 19:06:26.000000 UTC | 15162 |

10/4/2008 | 19:06:26 UTC | 19:06:26 UTC | Connected

Antenna mounting: In an effort to make the antenna mount bit more rigid, Trimble have developed and specified that the add-on support pictured below should be used in all high vibration environments. Whether this will improve the longevity of the antenna remains to be seen but certainly can't hurt.

# ME70 and POSMV instrument setup during PC1304

This documents the ME70 and POSMV instrument setup on NOAA ship Pices during cruise PC1304

Reporting format follows and includes portions of “*Pisces set-up for PC_12_03*” by Laura Kracker (LK), NOAA/NOS

The Pisces POSMV setup is based on a general approach described in the document “*POSMV Setup for the ME70*” by Glen Rice (GR) NOAA/OCS, spring 2012

1 Aug 2013
Questions: contact warren. mitchell@noaa.gov

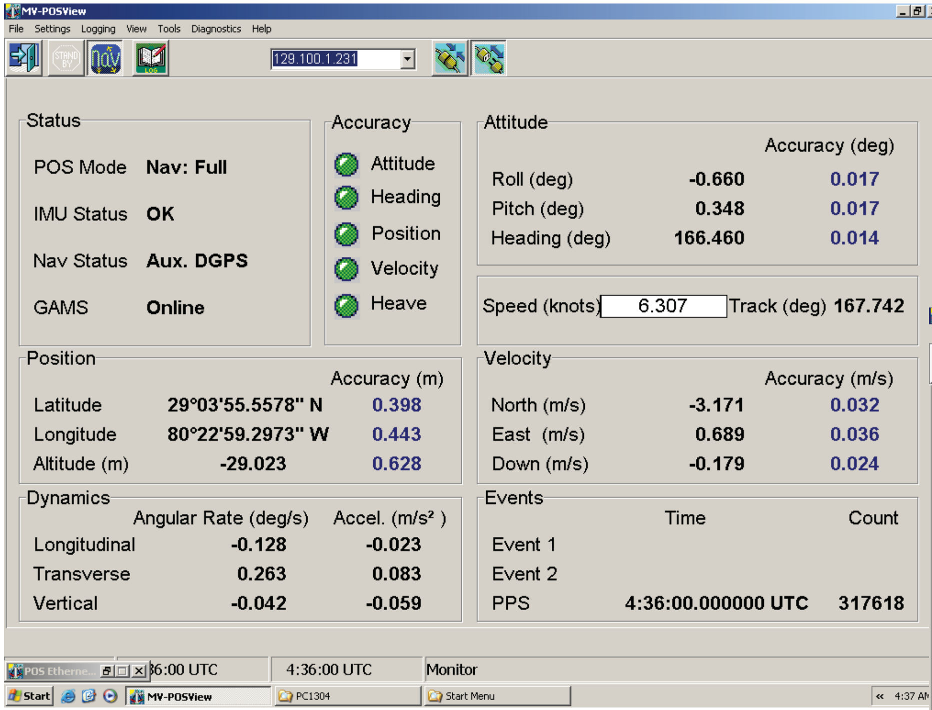
# ME70 and POSMV instrument setup during PC1304

Leg I: *R. Banner, D. Berrane, E. Ebert, W. Mitchell, M. Wilson*

Leg II: *N. Baechler, D. Berrane, D. Glasgow, W. Mitchell, M. WIlson*

- PC1304 Leg I was 12 June to 27 June; Leg II was 17 July to 1 Aug.
- As first presented in the PC1203 report, this document references a general approach designating the **Pos M/V IMU as the primary reference point; sensor 1 is the ME70 transducer.**
- Screen grabs were gathered by N. Baechler on 29 July.
- PC1304 actions and updated comments are noted in *blue italics.*
- Beam configs by Randy Cutter NOAA/SWFSC and Tom Weber Univ. of New Hampshire were used during the cruise.
- A hard copy of this document was left in the white, ME70 notes binder in the Pisces Acoustics Lab.

# PC1304



Status

POS Mode Nav: Full

IMU Status OK

Nav Status Aux. DGPS

GAMS Online

Accuracy

● Attitude
● Heading
● Position
● Velocity
● Heave

Attitude

| | | Accuracy (deg) |
|---|---|---|
| Roll (deg) | -0.660 | 0.017 |
| Pitch (deg) | 0.348 | 0.017 |
| Heading (deg) | 166.460 | 0.014 |

Speed (knots) 6.307 Track (deg) 167.742

Position

| | | Accuracy (m) |
|---|---|---|
| Latitude | 29°03'55.5578" N | 0.398 |
| Longitude | 80°22'59.2973" W | 0.443 |
| Altitude (m) | -29.023 | 0.628 |

Velocity

| | | Accuracy (m/s) |
|---|---|---|
| North (m/s) | -3.171 | 0.032 |
| East (m/s) | 0.689 | 0.036 |
| Down (m/s) | -0.179 | 0.024 |

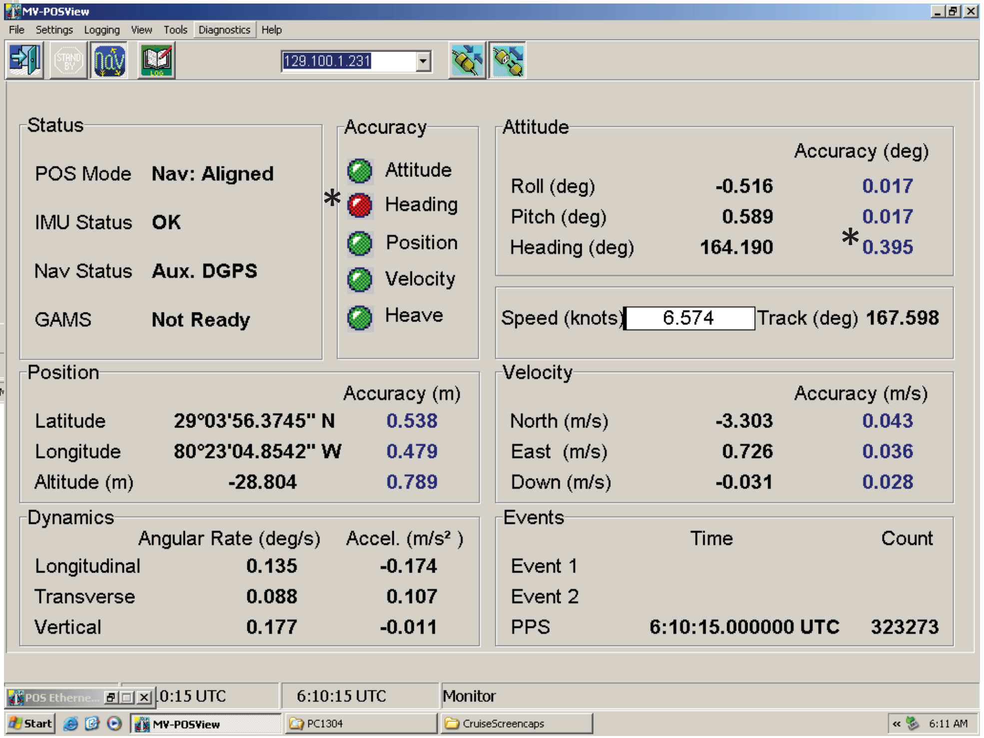
Dynamics

| | Angular Rate (deg/s) | Accel. (m/s²) |
|---|---|---|
| Longitudinal | -0.128 | -0.023 |
| Transverse | 0.263 | 0.083 |
| Vertical | -0.042 | -0.059 |

Events

| | Time | Count |
|---|---|---|
| Event 1 | | |
| Event 2 | | |
| PPS | 4:36:00.000000 UTC | 317618 |

36:00 UTC 4:36:00 UTC Monitor



Status

POS Mode Nav: Aligned

IMU Status OK

Nav Status Aux. DGPS

GAMS Not Ready

Accuracy

● Attitude
* ● Heading
● Position
● Velocity
● Heave

Attitude

| | | Accuracy (deg) |
|---|---|---|
| Roll (deg) | -0.516 | 0.017 |
| Pitch (deg) | 0.589 | 0.017 |
| Heading (deg) | 164.190 | * 0.395 |

Speed (knots) 6.574 Track (deg) 167.598

Position

| | | Accuracy (m) |
|---|---|---|
| Latitude | 29°03'56.3745" N | 0.538 |
| Longitude | 80°23'04.8542" W | 0.479 |
| Altitude (m) | -28.804 | 0.789 |

Velocity

| | | Accuracy (m/s) |
|---|---|---|
| North (m/s) | -3.303 | 0.043 |
| East (m/s) | 0.726 | 0.036 |
| Down (m/s) | -0.031 | 0.028 |

Dynamics

| | Angular Rate (deg/s) | Accel. (m/s²) |
|---|---|---|
| Longitudinal | 0.135 | -0.174 |
| Transverse | 0.088 | 0.107 |
| Vertical | 0.177 | -0.011 |

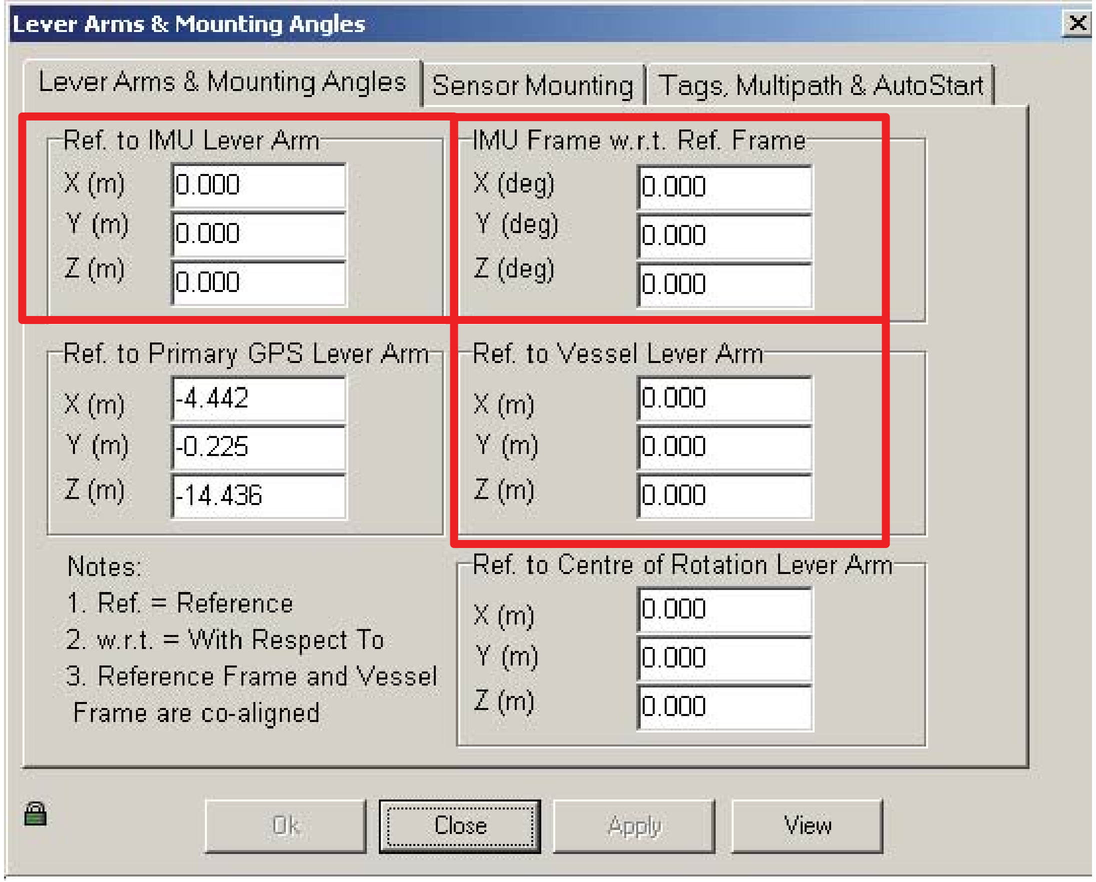
Events

| | Time | Count |
|---|---|---|
| Event 1 | | |
| Event 2 | | |
| PPS | 6:10:15.000000 UTC | 323273 |

0:15 UTC 6:10:15 UTC Monitor

**Note: Heading intermittently failed accuracy acceptance (approx. once per hour) during PC1304. Instances appeared more common when the vessel steered a heading directed generally north, or steered lines ≥8 km (i.e., held COG for long periods of time).*

# PC1304



Ref. to IMU Lever Arm
X (m) 0.000
Y (m) 0.000
Z (m) 0.000

IMU Frame w.r.t. Ref. Frame
X (deg) 0.000
Y (deg) 0.000
Z (deg) 0.000

Ref. to Primary GPS Lever Arm
X (m) -4.442
Y (m) -0.225
Z (m) -14.436

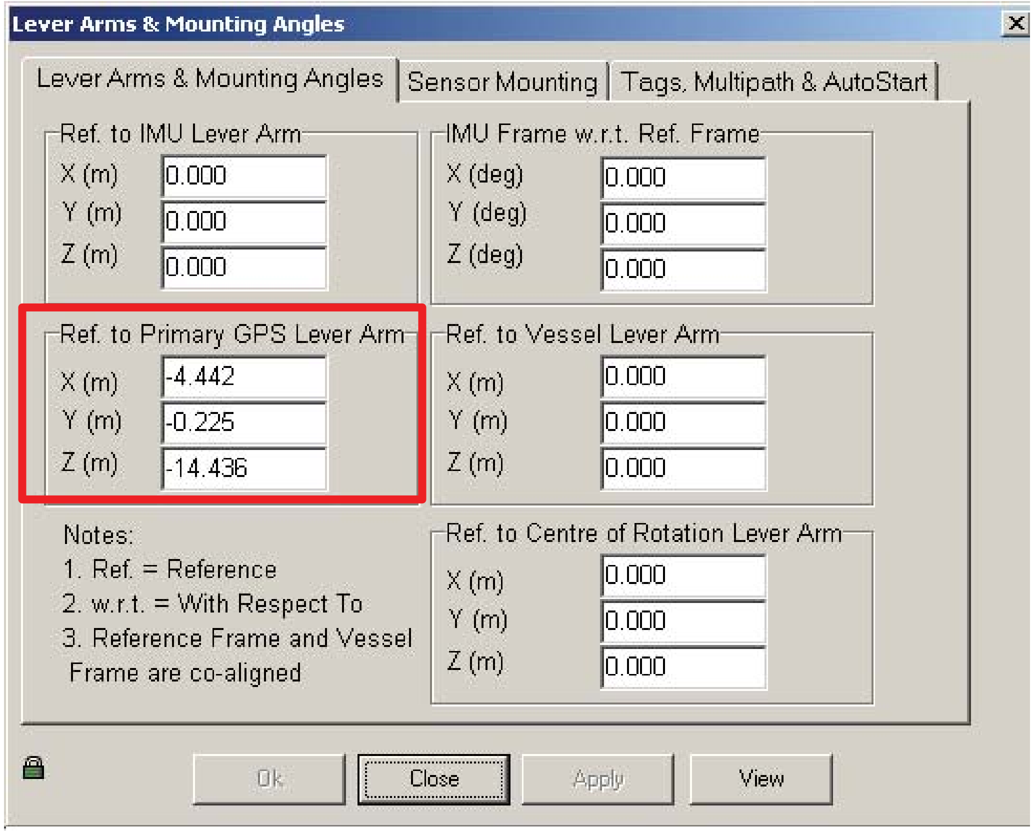
Ref. to Vessel Lever Arm
X (m) 0.000
Y (m) 0.000
Z (m) 0.000

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

Ref. to Centre of Rotation Lever Arm
X (m) 0.000
Y (m) 0.000
Z (m) 0.000

(LK) Glen_RiceME70_config.pdf indicates these should all be set to 0.0 .

*As during 2012 cruises, settings shown in red boxes remain at zero. All IMU to vessel reference frame offsets are zero here because the top of the IMU is considered the 0,0,0 reference point.*



Ref. to IMU Lever Arm
X (m) 0.000
Y (m) 0.000
Z (m) 0.000

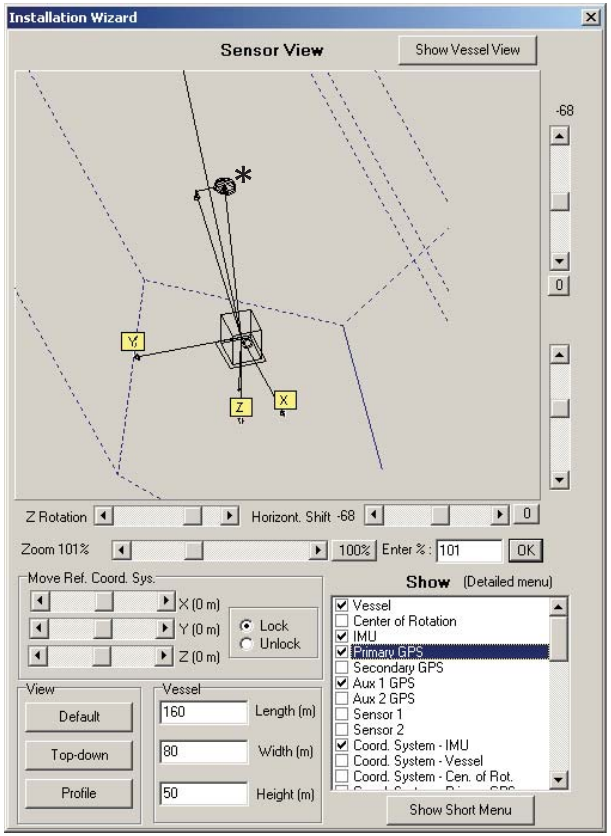
IMU Frame w.r.t. Ref. Frame
X (deg) 0.000
Y (deg) 0.000
Z (deg) 0.000

Ref. to Primary GPS Lever Arm
X (m) -4.442
Y (m) -0.225
Z (m) -14.436

Ref. to Vessel Lever Arm
X (m) 0.000
Y (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

Ref. to Centre of Rotation Lever Arm
X (m) 0.000
Y (m) 0.000
Z (m) 0.000



Z Rotation
Horizont. Shift -68
Zoom 101% 100% Enter % : 101 OK
X (0 m)
Y (0 m)
Z (0 m)
● Lock
○ Unlock

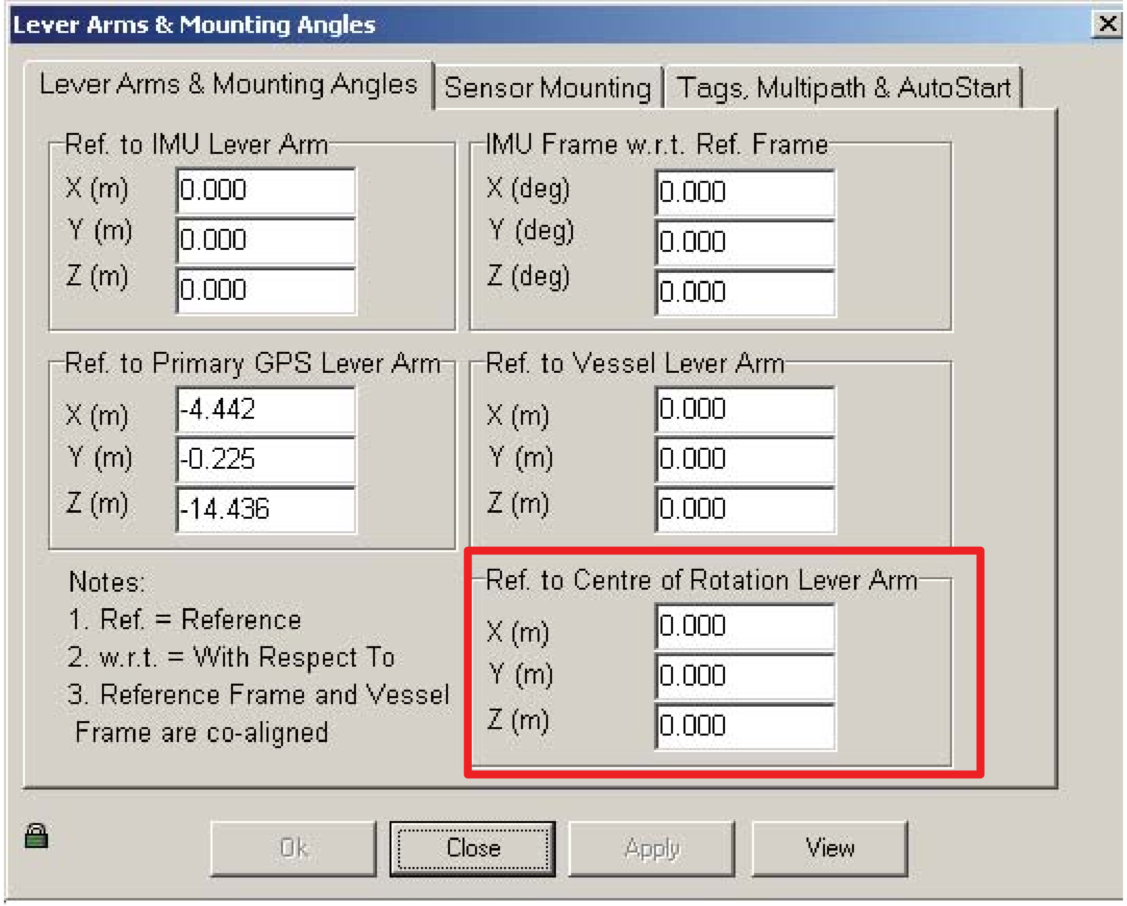
Vessel
Length (m) 160
Width (m) 80
Height (m) 50

Show (Detailed menu)
☑ Vessel
☐ Center of Rotation
☑ IMU
☑ Primary GPS
☐ Secondary GPS
☑ Aux 1 GPS
☐ Aux 2 GPS
☐ Sensor 1
☐ Sensor 2
☑ Coord. System - IMU
☐ Coord. System - Vessel
☐ Coord. System - Cen. of Rot.

GR: "Ref. to Primary GPS Lever Arm" is the offset from the IMU to the primary GPS antenna and needs to be provided for the POS M/V to work properly.

*During PC1304 Leg II, values in the red box were changed to the above values (02:08 GMT 24 July 2013), based on a discovery and verification that the POSMV deck unit-to-antenna cable arrangement designated the **port** antenna as 'primary antenna'*. The installation report stated the opposite:*
*N:\Public\Manuals and Drawing\Pisces Survey Report\NOAA PosMV Ship Pisces Installation Report.pdf*
*The port antenna remains the primary. The above offset figures were based on Impastato survey calculations of granite block-to-IMU and granite block-to-port GPS antenna. Previous to PC1304 Leg II, "Ref. to Primary GPS Lever Arm" measurements referenced Impastato survey measurements from IMU to the starboard antenna (most recently: x = -4.430, y = 2.697, y = -14.436, during Leg I).*

# PC1304



Ref. to IMU Lever Arm
X (m) 0.000
Y (m) 0.000
Z (m) 0.000

IMU Frame w.r.t. Ref. Frame
X (deg) 0.000
Y (deg) 0.000
Z (deg) 0.000

Ref. to Primary GPS Lever Arm
X (m) -4.442
Y (m) -0.225
Z (m) -14.436

Ref. to Vessel Lever Arm
X (m) 0.000
Y (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

Ref. to Centre of Rotation Lever Arm
X (m) 0.000
Y (m) 0.000
Z (m) 0.000

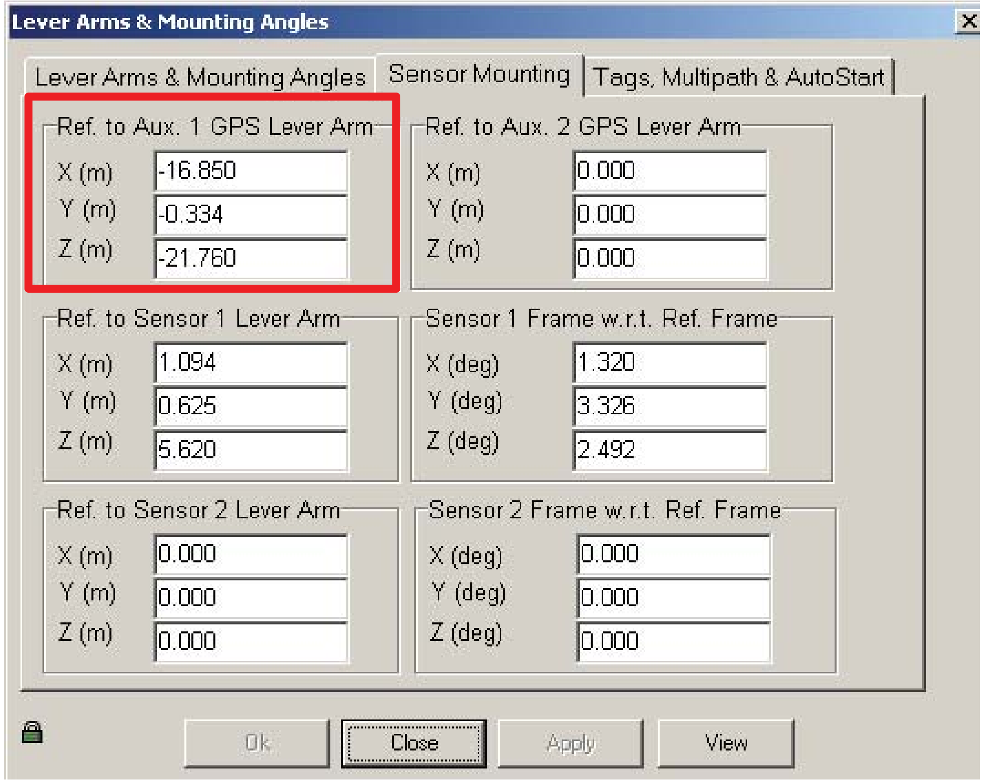
LK: And center of rotation should be estimated – but is not known at this point – so set to 0.0 -- correct?

GR: Yes.  Leave it at zero. … The bridge should have a stability booklet that might indicate something like this, but no promises.

LK: Left at 0.0. At this point, no attempt has been made to track this down.

*Near the end of PC1304, ST Laurie Roy located a Pisces 'Trip and Stability Booklet' document,*
*N:\Public\Manuals and Drawing\Drawings\Bigelow As Built Drawings\FC12-001-01-Trim & Stability Booklet.pdf*
*It may be possible to calculate "Ref. to Center of Rotation Lever Arm" from this document.*

# PC1304



Ref. to Aux. 1 GPS Lever Arm
X (m) -16.850
Y (m) -0.334
Z (m) -21.760

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

Ref. to Sensor 1 Lever Arm
X (m) 1.094
Y (m) 0.625
Z (m) 5.620

Sensor 1 Frame w.r.t. Ref. Frame
X (deg) 1.320
Y (deg) 3.326
Z (deg) 2.492

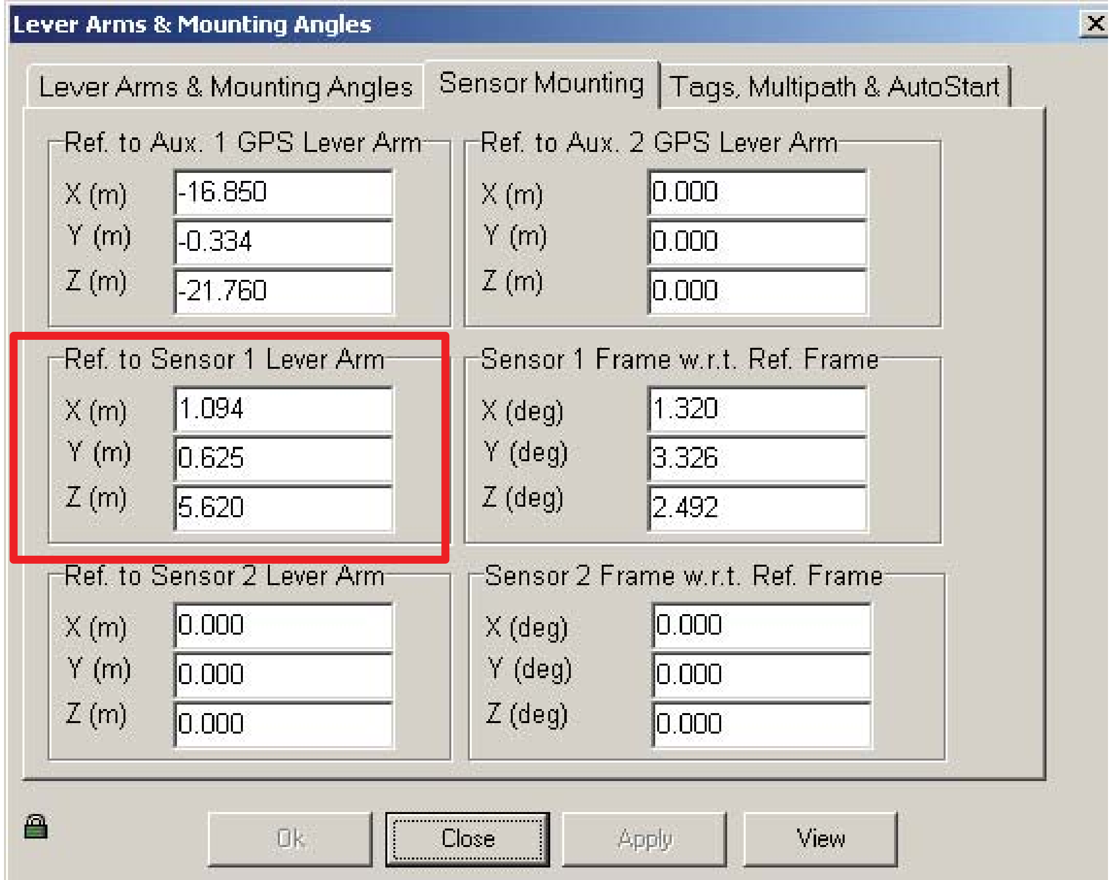
Ref. to Sensor 2 Lever Arm
X (m) 0.000
Y (m) 0.000
Z (m) 0.000

Sensor 2 Frame w.r.t. Ref. Frame
X (deg) 0.000
Y (deg) 0.000
Z (deg) 0.000

LK: The notes say this should be surveyed in - there is some confidence in these numbers. Should this be left in as is?
GR: These should not make difference since we are not using the GGA from the aux GPS. Leave as is.
LK: Left as is. However, the GGA data stream to the ME 70 should still be investigated?

*Even though GGA sentences from the auxiliary GPS (Leica MX420) apply here only for DGPS corrections, instrument offset values were calculated to reflect a best-available Aux GPS antenna-to-IMU reference. "POS MV 320 installation report" offsets used Impastato granite block-as-reference-point measurements; offsets above reference the IMU. Note, however, that "Ref to AUX GPS" measurement was "Not Surveyed-Estimated". The Aux GPS should be measured into any future vessels surveys.*

# PC1304



Ref. to Aux. 1 GPS Lever Arm
X (m) -16.850
Y (m) -0.334
Z (m) -21.760

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

Ref. to Sensor 1 Lever Arm
X (m) 1.094
Y (m) 0.625
Z (m) 5.620

Sensor 1 Frame w.r.t. Ref. Frame
X (deg) 1.320
Y (deg) 3.326
Z (deg) 2.492

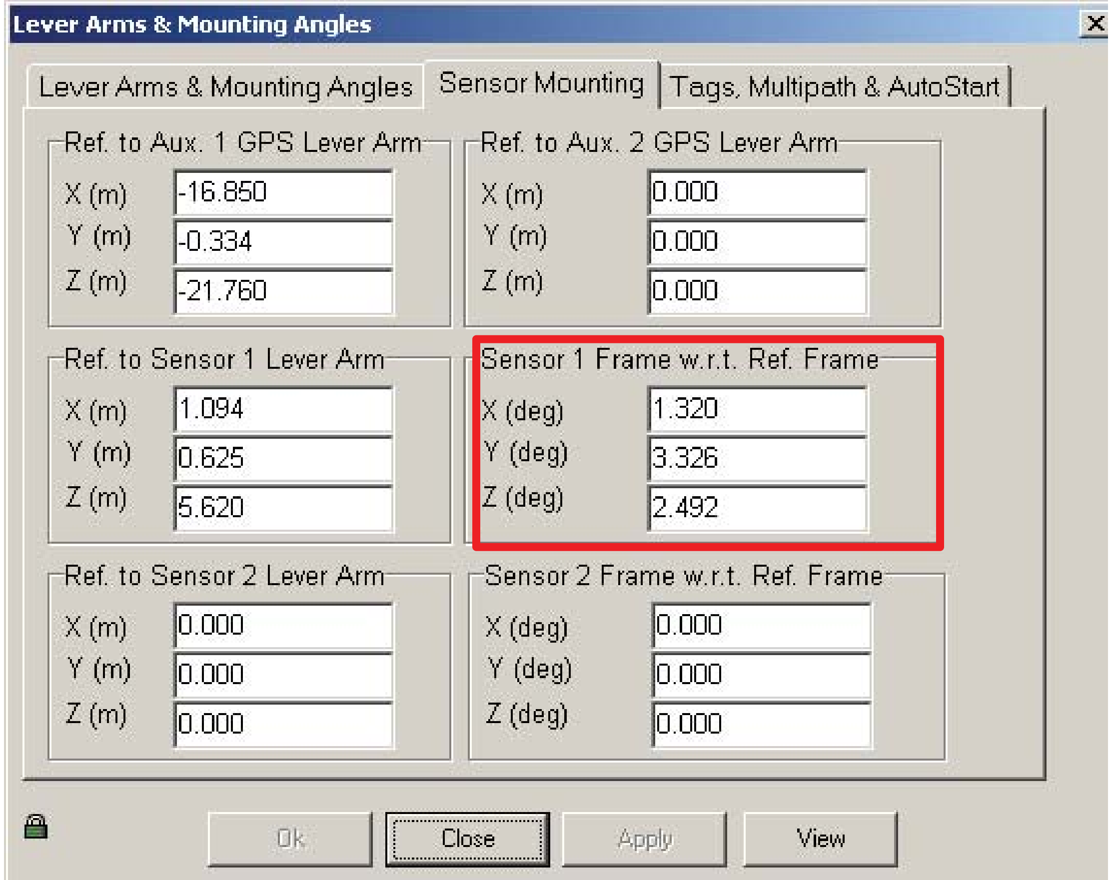
Ref. to Sensor 2 Lever Arm
X (m) 0.000
Y (m) 0.000
Z (m) 0.000

Sensor 2 Frame w.r.t. Ref. Frame
X (deg) 0.000
Y (deg) 0.000
Z (deg) 0.000

*No changes made during PC1304, above.*

*Reference to Sensor 1 (i.e., ME70) lever arm is based on Impastato survey calculations of IMU-to-granite block and granite block-to-ME70 transducer. These values are also entered into in HIPS vessel files.*

# PC1304



Ref. to Aux. 1 GPS Lever Arm
X (m) -16.850
Y (m) -0.334
Z (m) -21.760

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

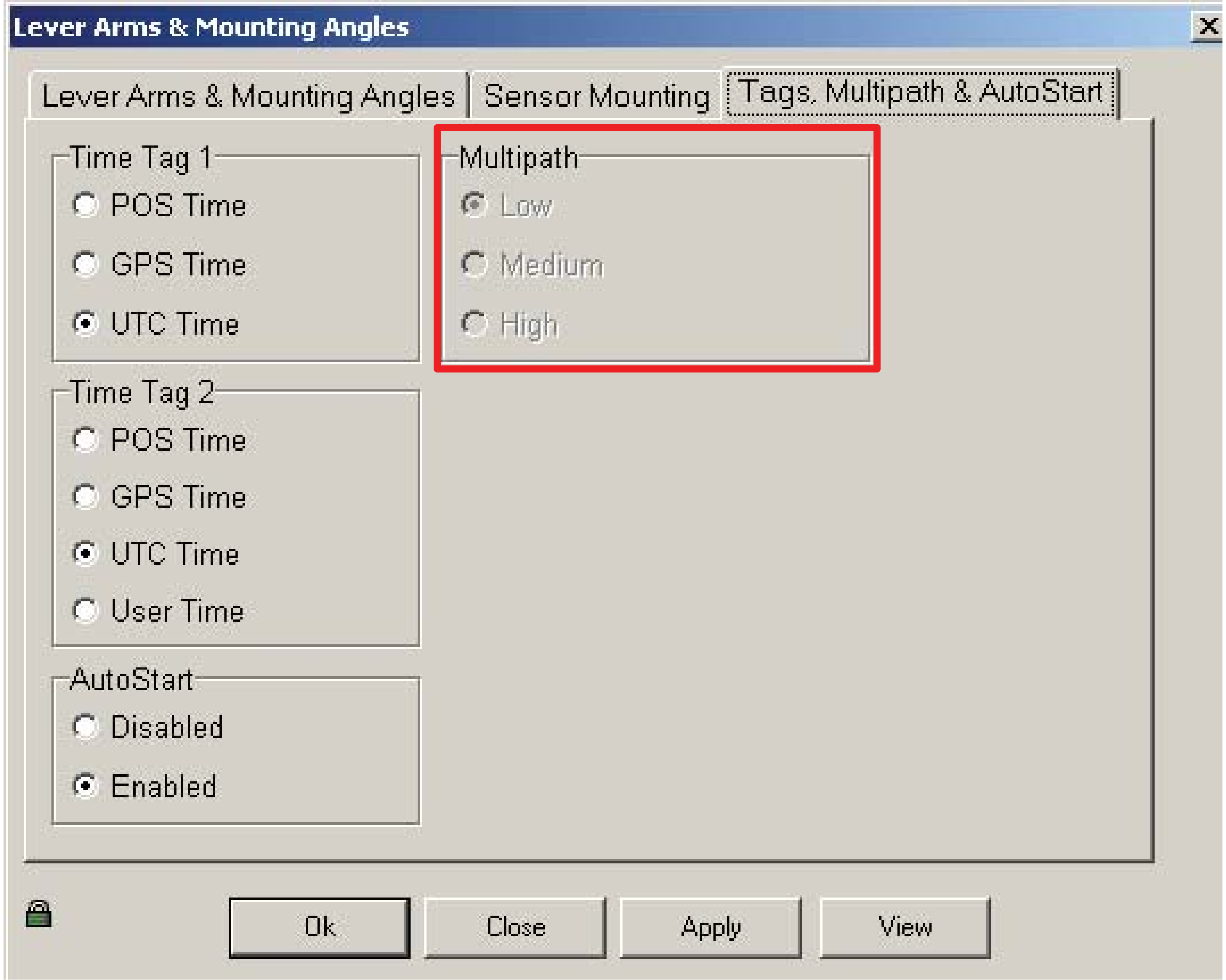
Ref. to Sensor 1 Lever Arm
X (m) 1.094
Y (m) 0.625
Z (m) 5.620

Sensor 1 Frame w.r.t. Ref. Frame
X (deg) 1.320
Y (deg) 3.326
Z (deg) 2.492

Ref. to Sensor 2 Lever Arm
X (m) 0.000
Y (m) 0.000
Z (m) 0.000

Sensor 2 Frame w.r.t. Ref. Frame
X (deg) 0.000
Y (deg) 0.000
Z (deg) 0.000

*"Sensor 1 Frame w.r.t Ref. Frame" values were derived from a patch test run on 25 July 2013, calculated in CARIS HIPS (independently by 5 science staff, then averaged). Note the roll value (x) was not altered from 2012 values. The pitch (y) value was increased from 2.700 to 3.326 degrees. The yaw/heading (z) value was decreased from 3.000 to 2.492 degrees.*



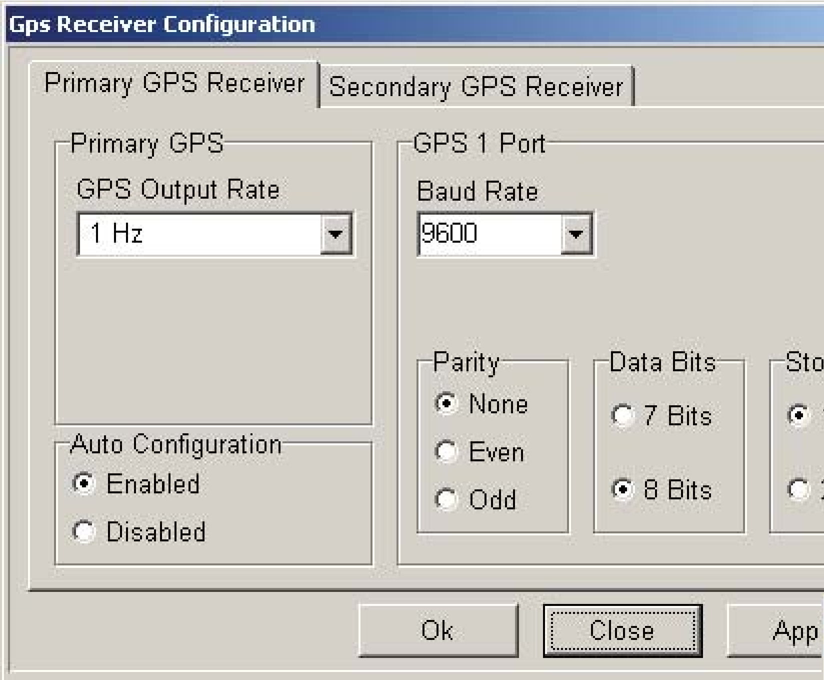
Time Tag 1
○ POS Time
○ GPS Time
● UTC Time

Time Tag 2
○ POS Time
○ GPS Time
● UTC Time
○ User Time

AutoStart
○ Disabled
● Enabled

Multipath
● Low
○ Medium
○ High

*No changes made during PC1304, above. Note: Science staff failed to attempt a change to the multipath environment – values remained grayed out at all times.*


**Gps Receiver Configuration**

Primary GPS
GPS Output Rate: 1 Hz

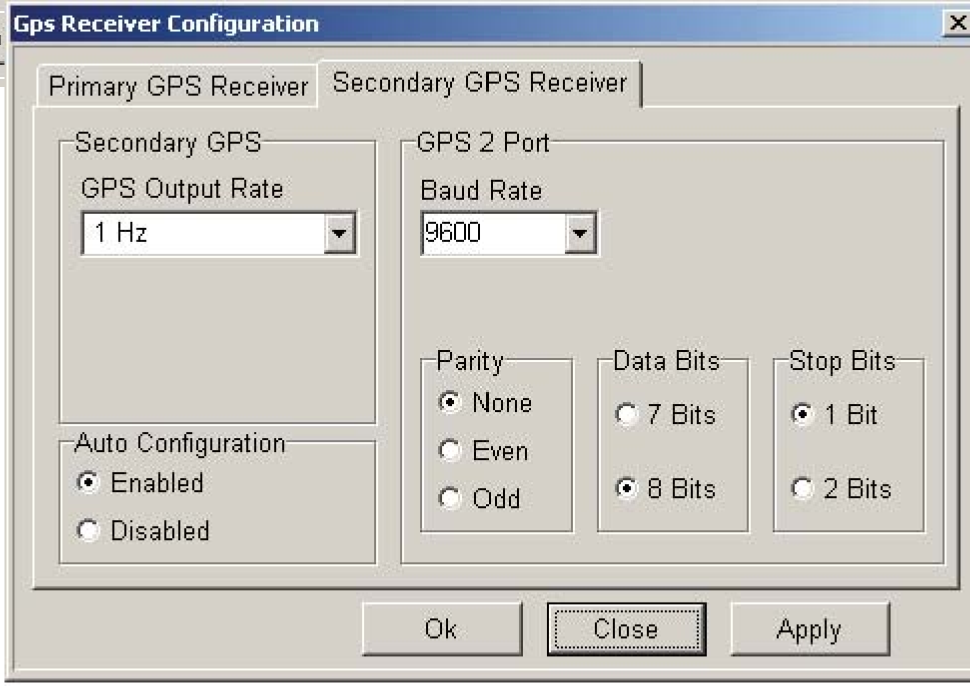
Auto Configuration
● Enabled
○ Disabled

GPS 1 Port
Baud Rate: 9600

Parity
● None
○ Even
○ Odd

Data Bits
○ 7 Bits
● 8 Bits

Stop Bits
● 1 Bit
○ 2 Bits


**Gps Receiver Configuration**

Secondary GPS
GPS Output Rate: 1 Hz

Auto Configuration
● Enabled
○ Disabled

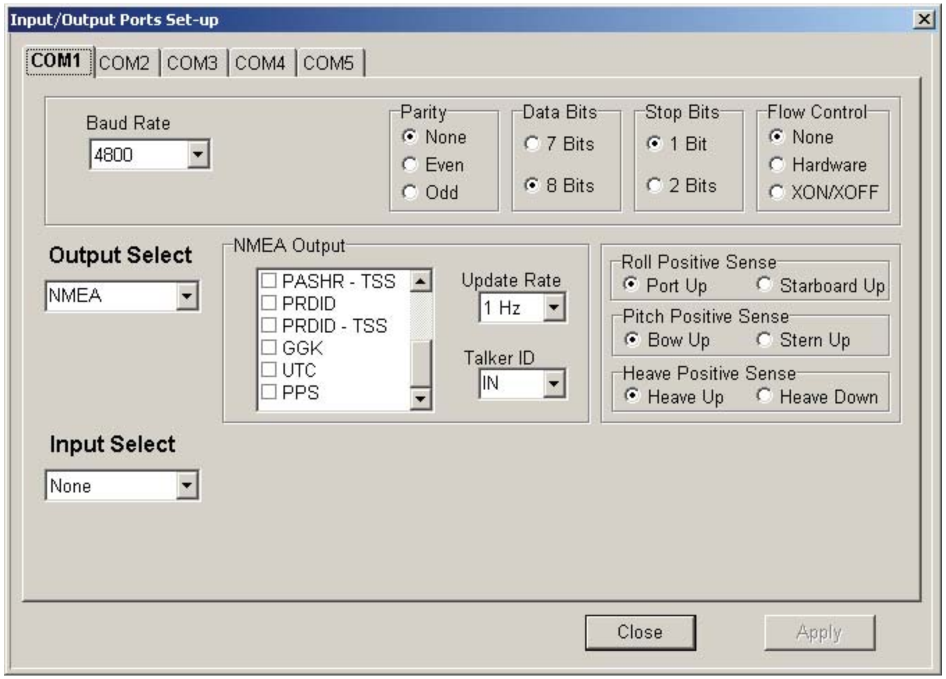
GPS 2 Port
Baud Rate: 9600

Parity
● None
○ Even
○ Odd

Data Bits
○ 7 Bits
● 8 Bits

Stop Bits
● 1 Bit
○ 2 Bits

*No changes made during PC1304.*



Baud Rate: 4800

Parity: ● None ○ Even ○ Odd

Data Bits: ○ 7 Bits ● 8 Bits

Stop Bits: ● 1 Bit ○ 2 Bits

Flow Control: ● None ○ Hardware ○ XON/XOFF

Output Select: NMEA

NMEA Output:
- ☐ PASHR - TSS
- ☐ PRDID
- ☐ PRDID - TSS
- ☐ GGK
- ☐ UTC
- ☐ PPS

Update Rate: 1 Hz

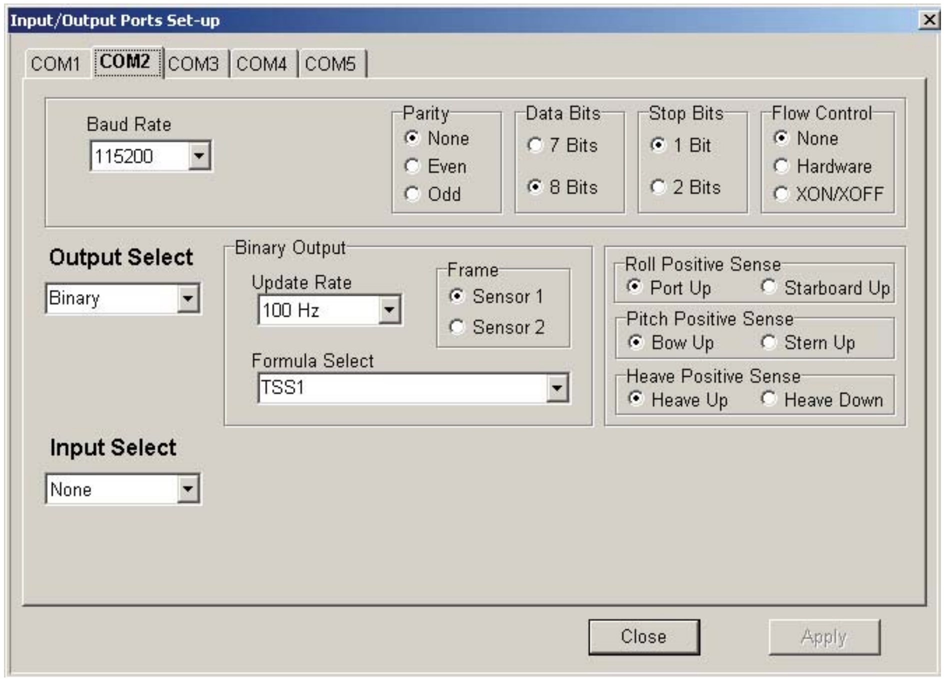
Talker ID: IN

Roll Positive Sense: ● Port Up ○ Starboard Up

Pitch Positive Sense: ● Bow Up ○ Stern Up

Heave Positive Sense: ● Heave Up ○ Heave Down

Input Select: None



Baud Rate: 115200

Parity: ● None ○ Even ○ Odd

Data Bits: ○ 7 Bits ● 8 Bits

Stop Bits: ● 1 Bit ○ 2 Bits

Flow Control: ● None ○ Hardware ○ XON/XOFF

Output Select: Binary

Binary Output:

Update Rate: 100 Hz

Frame: ● Sensor 1 ○ Sensor 2

Formula Select: TSS1

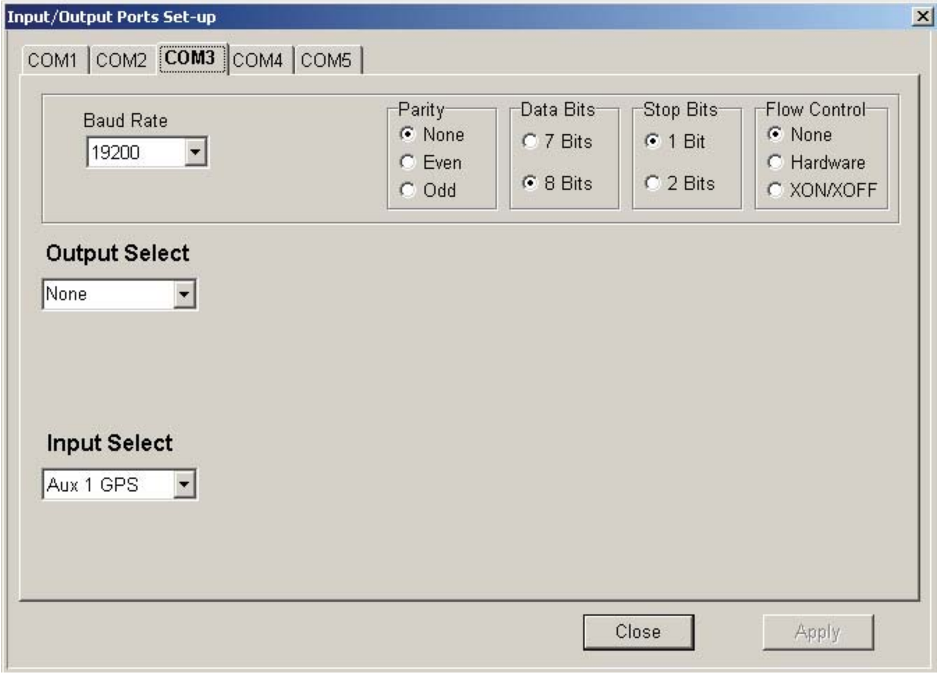
Roll Positive Sense: ● Port Up ○ Starboard Up

Pitch Positive Sense: ● Bow Up ○ Stern Up

Heave Positive Sense: ● Heave Up ○ Heave Down

Input Select: None

*No changes made during PC1304.*



Baud Rate: 19200

Parity: ● None ○ Even ○ Odd

Data Bits: ○ 7 Bits ● 8 Bits

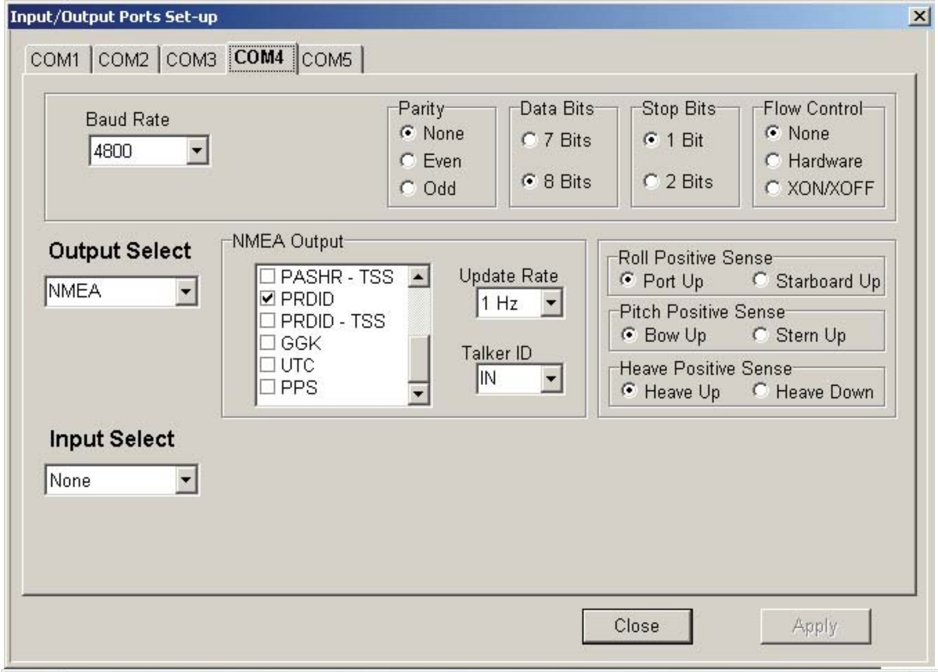
Stop Bits: ● 1 Bit ○ 2 Bits

Flow Control: ● None ○ Hardware ○ XON/XOFF

Output Select: None

Input Select: Aux 1 GPS

*No changes made during PC1304.*



Baud Rate: 4800

Parity: ● None ○ Even ○ Odd

Data Bits: ○ 7 Bits ● 8 Bits

Stop Bits: ● 1 Bit ○ 2 Bits

Flow Control: ● None ○ Hardware ○ XON/XOFF

Output Select: NMEA

NMEA Output:
- ☐ PASHR - TSS
- ☑ PRDID
- ☐ PRDID - TSS
- ☐ GGK
- ☐ UTC
- ☐ PPS

Update Rate: 1 Hz

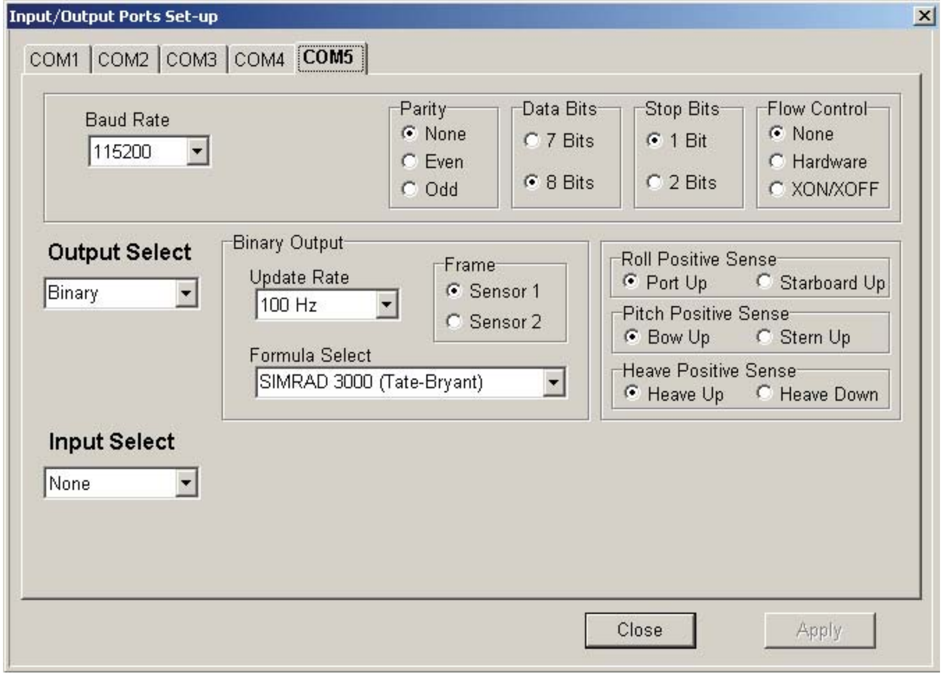
Talker ID: IN

Roll Positive Sense: ● Port Up ○ Starboard Up

Pitch Positive Sense: ● Bow Up ○ Stern Up

Heave Positive Sense: ● Heave Up ○ Heave Down

Input Select: None



Baud Rate: 115200

Parity: ● None ○ Even ○ Odd

Data Bits: ○ 7 Bits ● 8 Bits

Stop Bits: ● 1 Bit ○ 2 Bits

Flow Control: ● None ○ Hardware ○ XON/XOFF

Output Select: Binary

Binary Output:

Update Rate: 100 Hz

Frame: ● Sensor 1 ○ Sensor 2

Formula Select: SIMRAD 3000 (Tate-Bryant)

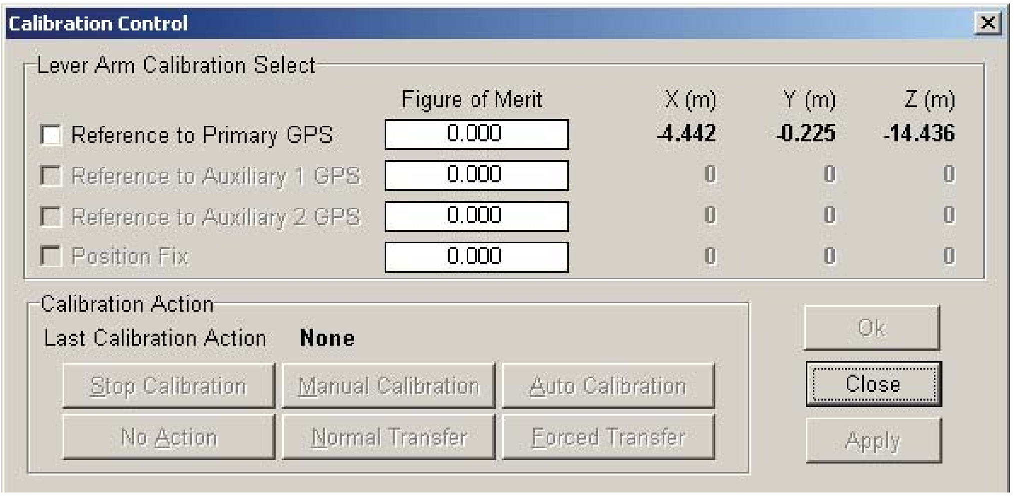
Roll Positive Sense: ● Port Up ○ Starboard Up

Pitch Positive Sense: ● Bow Up ○ Stern Up

Heave Positive Sense: ● Heave Up ○ Heave Down

Input Select: None

# PC1304



**Calibration Control**

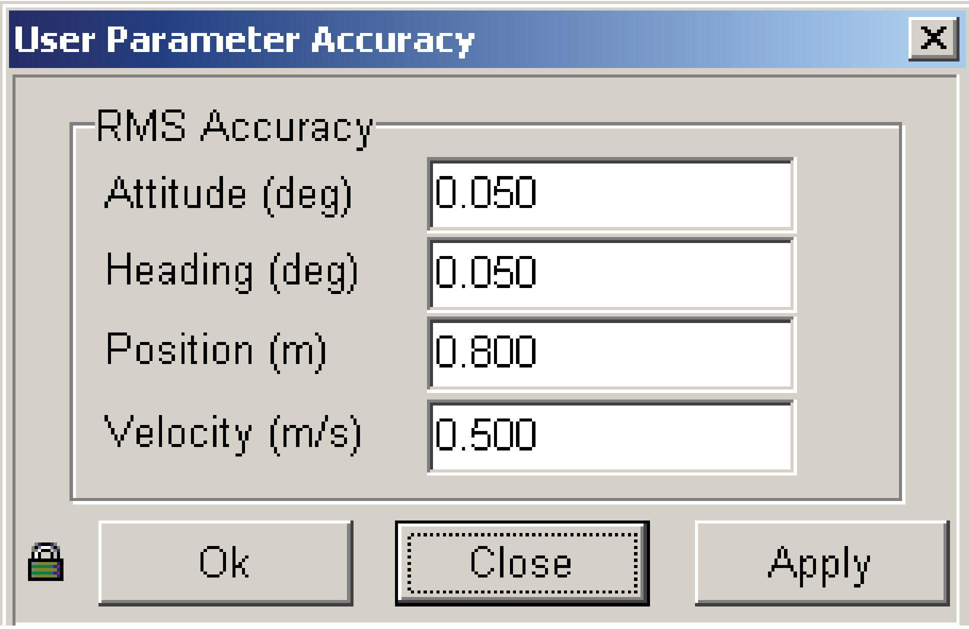
Lever Arm Calibration Select

| | Figure of Merit | X (m) | Y (m) | Z (m) |
|---|---|---|---|---|
| ☐ Reference to Primary GPS | 0.000 | -4.442 | -0.225 | -14.436 |
| ☐ Reference to Auxiliary 1 GPS | 0.000 | 0 | 0 | 0 |
| ☐ Reference to Auxiliary 2 GPS | 0.000 | 0 | 0 | 0 |
| ☐ Position Fix | 0.000 | 0 | 0 | 0 |

Calibration Action

Last Calibration Action **None**

Values at left reflect values re: the primary, port GPS antenna; see slide 5.



**User Parameter Accuracy**

RMS Accuracy

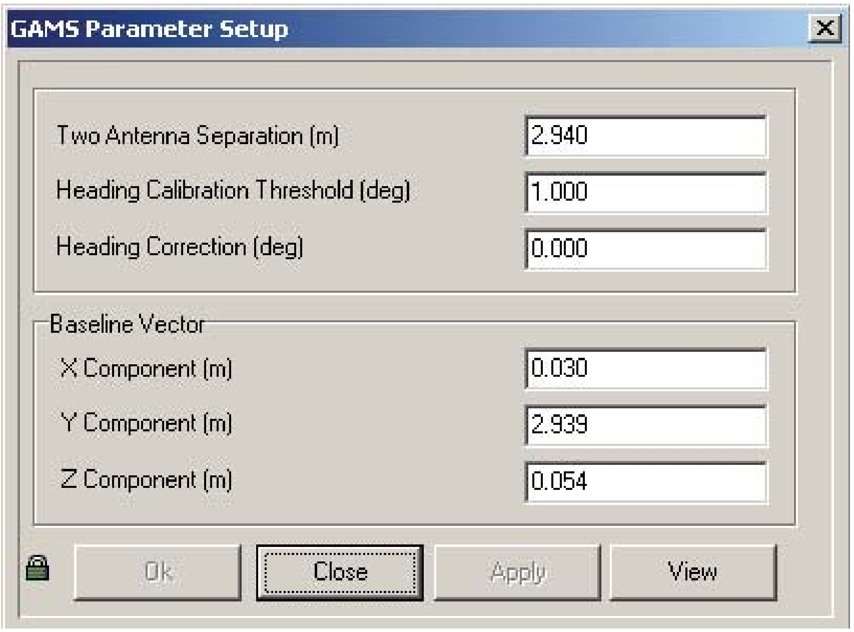
Attitude (deg) 0.050

Heading (deg) 0.050

Position (m) 0.800

Velocity (m/s) 0.500

*Image above unchanged.*



**GAMS Parameter Setup**

Two Antenna Separation (m) 2.940

Heading Calibration Threshold (deg) 1.000

Heading Correction (deg) 0.000

Baseline Vector

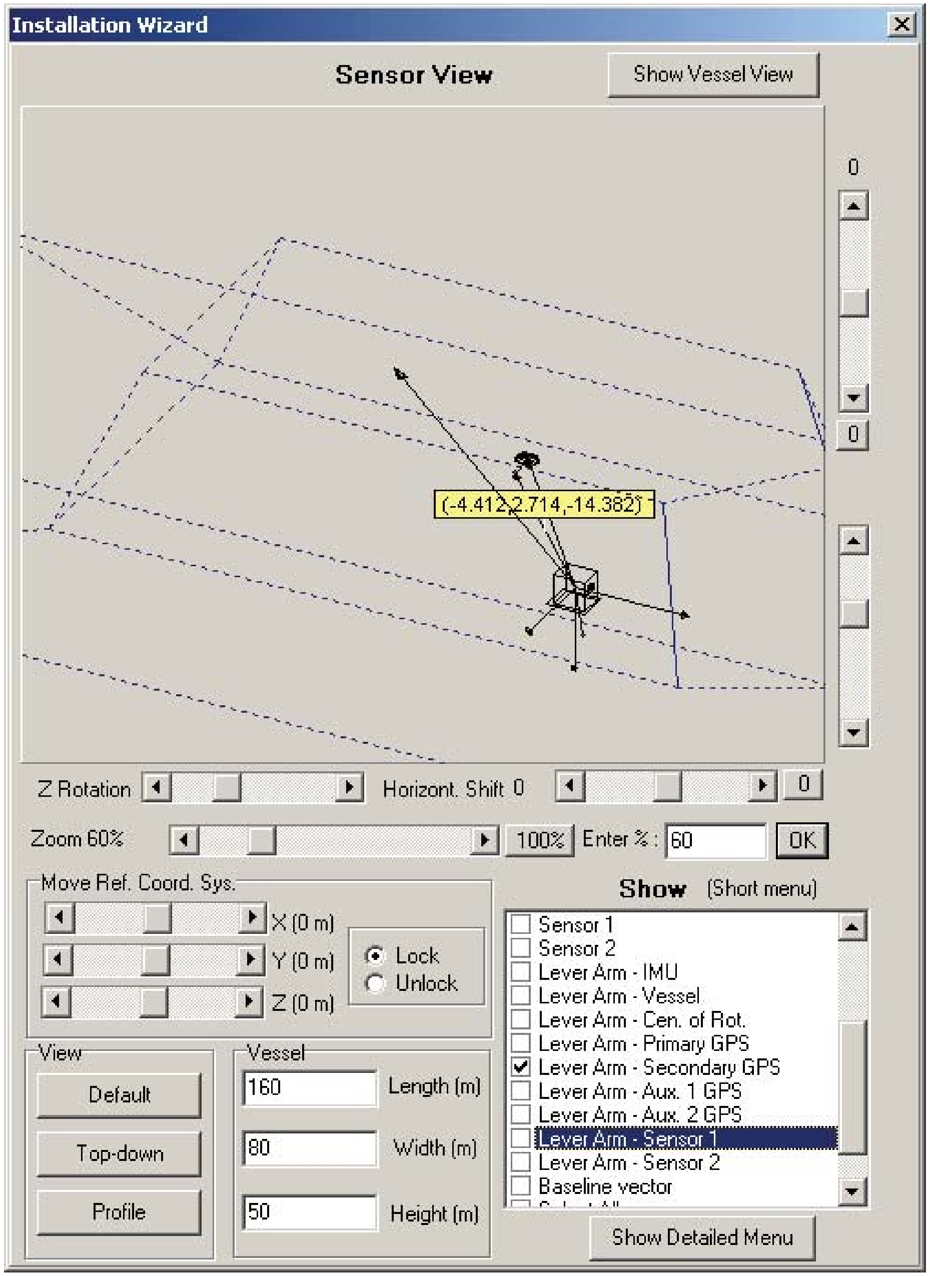
X Component (m) 0.030

Y Component (m) 2.939

Z Component (m) 0.054

*Values above were not changed during PC1304, but are different than during PC1204. Values were perhaps changed during or after previous GAMS test attempts?*

# PC1304



(-4.412,2.714,-14.382)

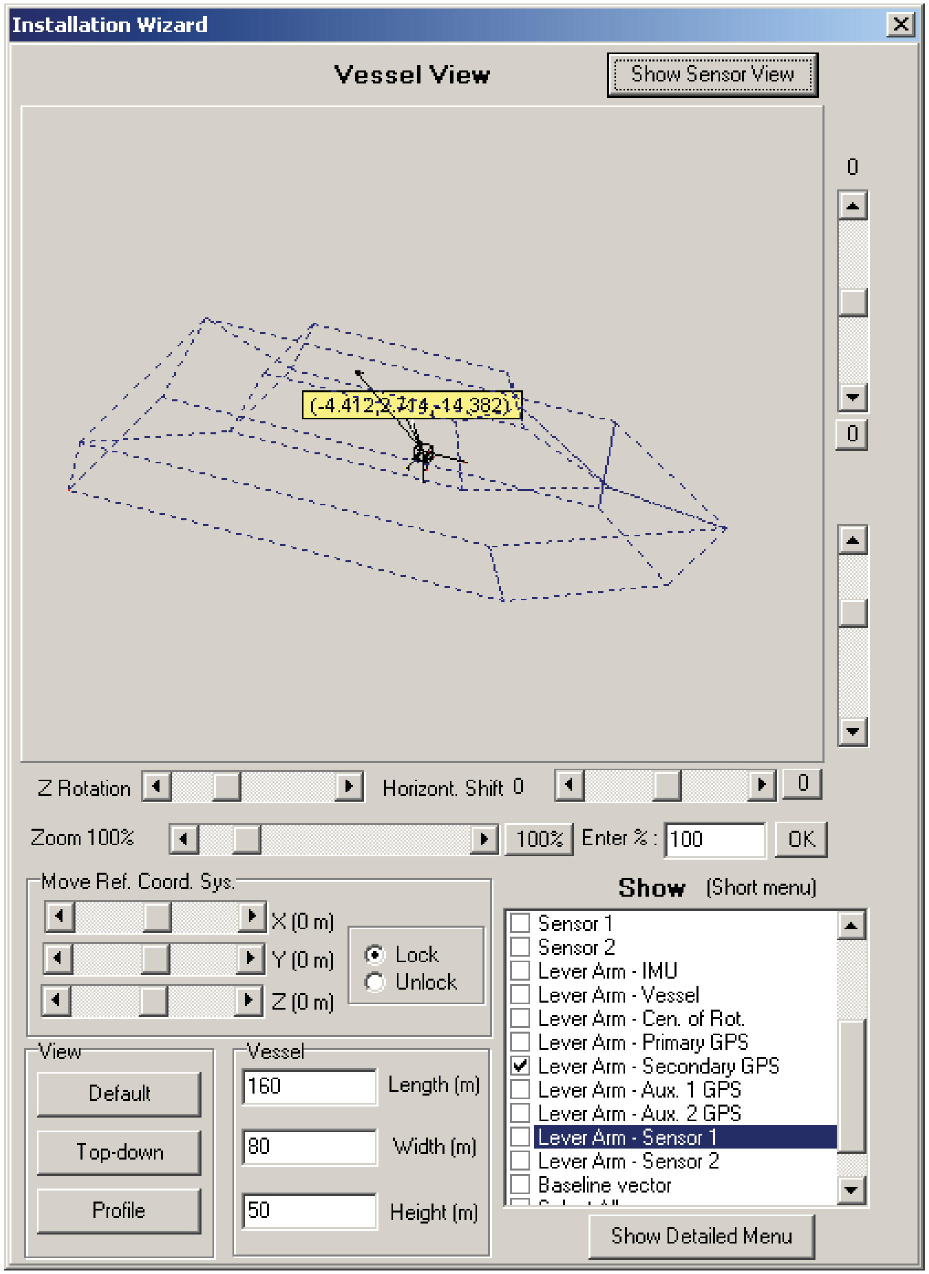
Enter % : 60

X (0 m)
Y (0 m)
Z (0 m)

● Lock
○ Unlock

160 Length (m)
80 Width (m)
50 Height (m)

☐ Sensor 1
☐ Sensor 2
☐ Lever Arm - IMU
☐ Lever Arm - Vessel
☐ Lever Arm - Cen. of Rot.
☐ Lever Arm - Primary GPS
☑ Lever Arm - Secondary GPS
☐ Lever Arm - Aux. 1 GPS
☐ Lever Arm - Aux. 2 GPS
☐ Lever Arm - Sensor 1
☐ Lever Arm - Sensor 2
☐ Baseline vector



(-4.412,2.714,-14.382)

Enter % : 100

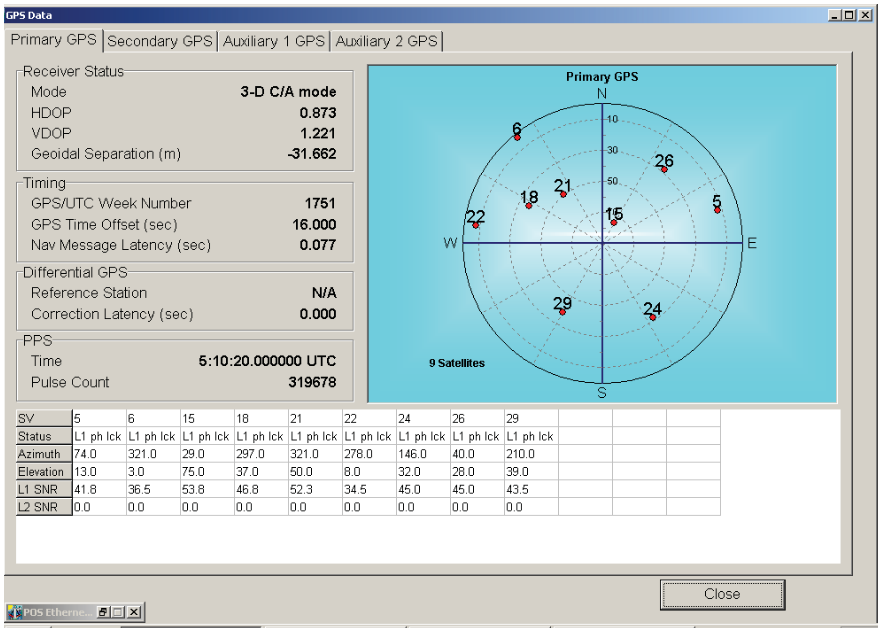
X (0 m)
Y (0 m)
Z (0 m)

● Lock
○ Unlock

160 Length (m)
80 Width (m)
50 Height (m)

☐ Sensor 1
☐ Sensor 2
☐ Lever Arm - IMU
☐ Lever Arm - Vessel
☐ Lever Arm - Cen. of Rot.
☐ Lever Arm - Primary GPS
☑ Lever Arm - Secondary GPS
☐ Lever Arm - Aux. 1 GPS
☐ Lever Arm - Aux. 2 GPS
☐ Lever Arm - Sensor 1
☐ Lever Arm - Sensor 2
☐ Baseline vector

PC1304



Receiver Status
Mode 3-D C/A mode
HDOP 0.873
VDOP 1.221
Geoidal Separation (m) -31.662

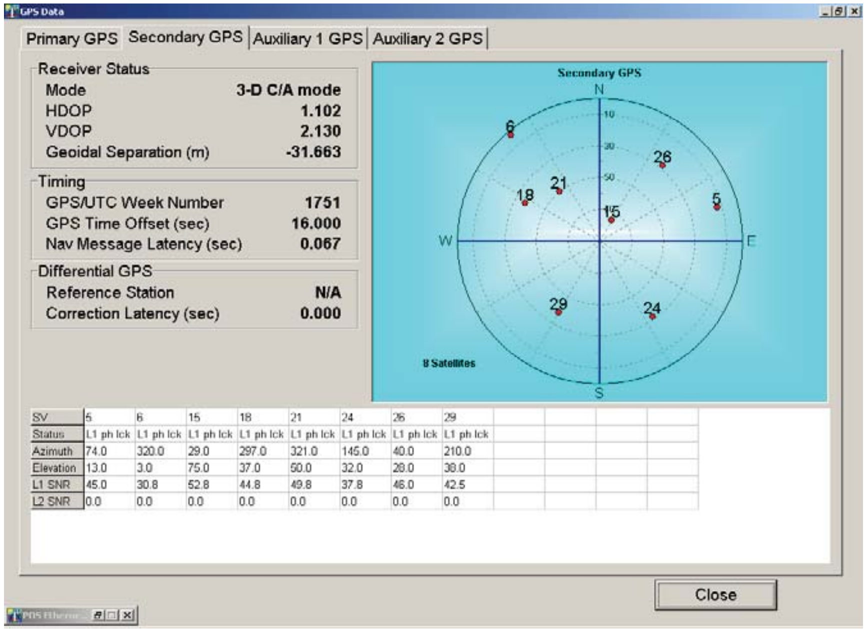
Timing
GPS/UTC Week Number 1751
GPS Time Offset (sec) 16.000
Nav Message Latency (sec) 0.077

Differential GPS
Reference Station N/A
Correction Latency (sec) 0.000

PPS
Time 5:10:20.000000 UTC
Pulse Count 319678

9 Satellites

| SV | 5 | 6 | 15 | 18 | 21 | 22 | 24 | 26 | 29 |
|---|---|---|---|---|---|---|---|---|---|
| Status | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck |
| Azimuth | 74.0 | 321.0 | 29.0 | 297.0 | 321.0 | 278.0 | 146.0 | 40.0 | 210.0 |
| Elevation | 13.0 | 3.0 | 75.0 | 37.0 | 50.0 | 8.0 | 32.0 | 28.0 | 39.0 |
| L1 SNR | 41.8 | 36.5 | 53.8 | 46.8 | 52.3 | 34.5 | 45.0 | 45.0 | 43.5 |
| L2 SNR | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |



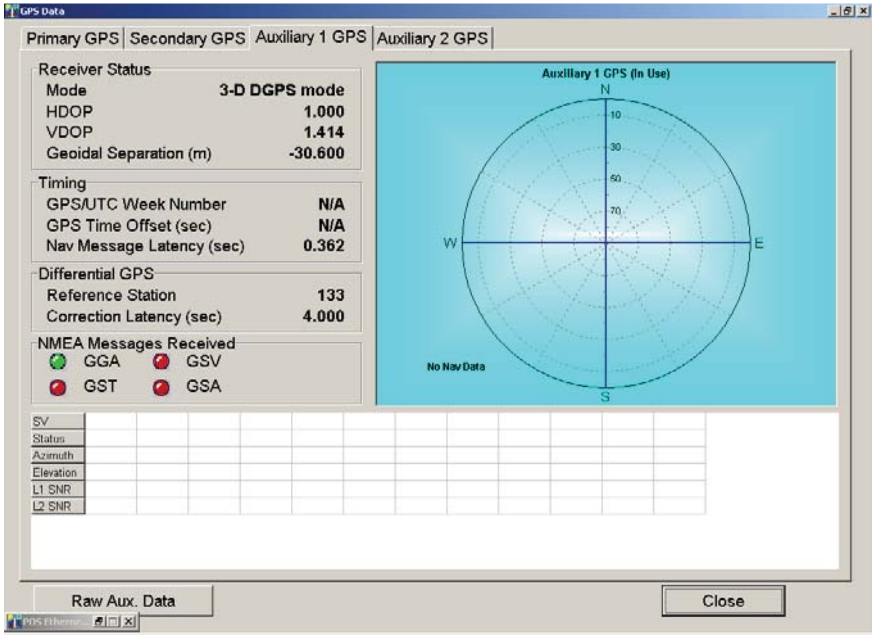
Receiver Status
Mode 3-D C/A mode
HDOP 1.102
VDOP 2.130
Geoidal Separation (m) -31.663

Timing
GPS/UTC Week Number 1751
GPS Time Offset (sec) 16.000
Nav Message Latency (sec) 0.067

Differential GPS
Reference Station N/A
Correction Latency (sec) 0.000

8 Satellites

| SV | 5 | 6 | 15 | 18 | 21 | 24 | 26 | 29 |
|---|---|---|---|---|---|---|---|---|
| Status | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck | L1 ph lck |
| Azimuth | 74.0 | 320.0 | 29.0 | 297.0 | 321.0 | 145.0 | 40.0 | 210.0 |
| Elevation | 13.0 | 3.0 | 75.0 | 37.0 | 50.0 | 32.0 | 28.0 | 38.0 |
| L1 SNR | 45.0 | 30.8 | 52.8 | 44.8 | 49.8 | 37.8 | 46.0 | 42.5 |
| L2 SNR | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |



Receiver Status
Mode 3-D DGPS mode
HDOP 1.000
VDOP 1.414
Geoidal Separation (m) -30.600

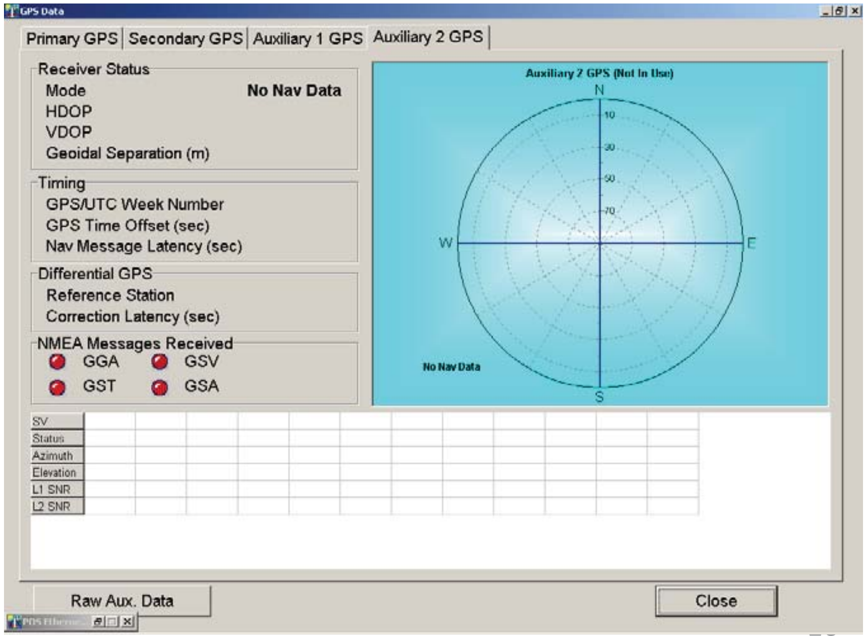
Timing
GPS/UTC Week Number N/A
GPS Time Offset (sec) N/A
Nav Message Latency (sec) 0.362

Differential GPS
Reference Station 133
Correction Latency (sec) 4.000

NMEA Messages Received
● GGA ● GSV
● GST ● GSA

No Nav Data

| | |
|---|---|
| SV | |
| Status | |
| Azimuth | |
| Elevation | |
| L1 SNR | |
| L2 SNR | |



Receiver Status
Mode No Nav Data
HDOP
VDOP
Geoidal Separation (m)

Timing
GPS/UTC Week Number
GPS Time Offset (sec)
Nav Message Latency (sec)

Differential GPS
Reference Station
Correction Latency (sec)

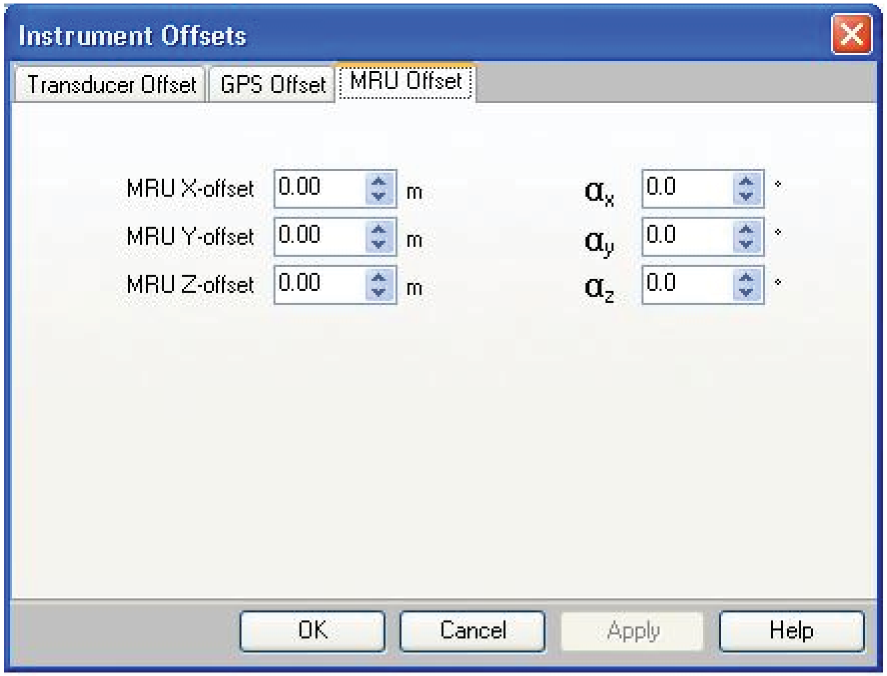
NMEA Messages Received
● GGA ● GSV
● GST ● GSA

No Nav Data

| | |
|---|---|
| SV | |
| Status | |
| Azimuth | |
| Elevation | |
| L1 SNR | |
| L2 SNR | |

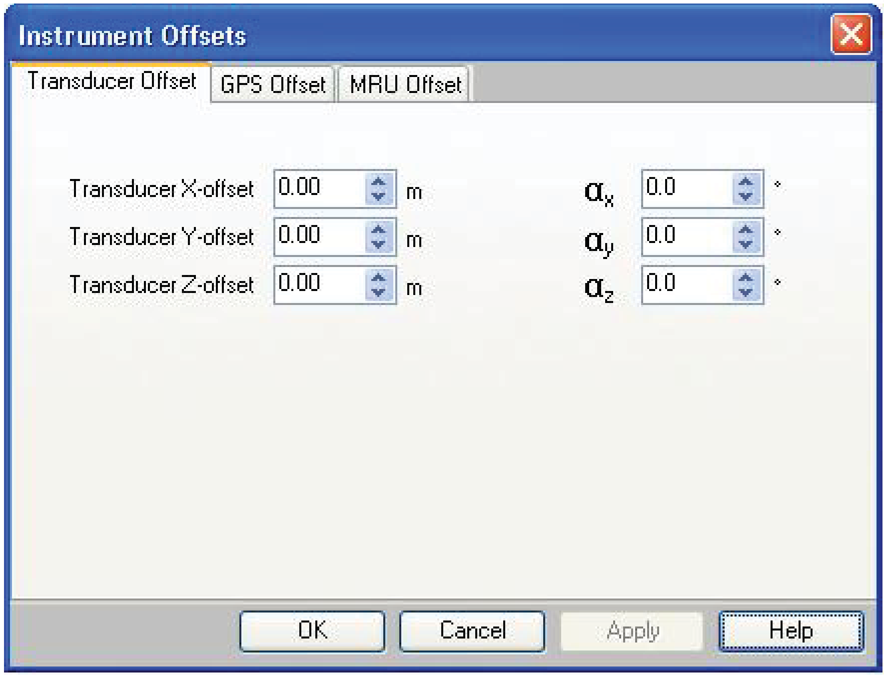
LK: ME 70 software. These offsets were changed to 0.0 in all cases on July 7, 2012 08:59 UTC

*Unchanged during PC1304*



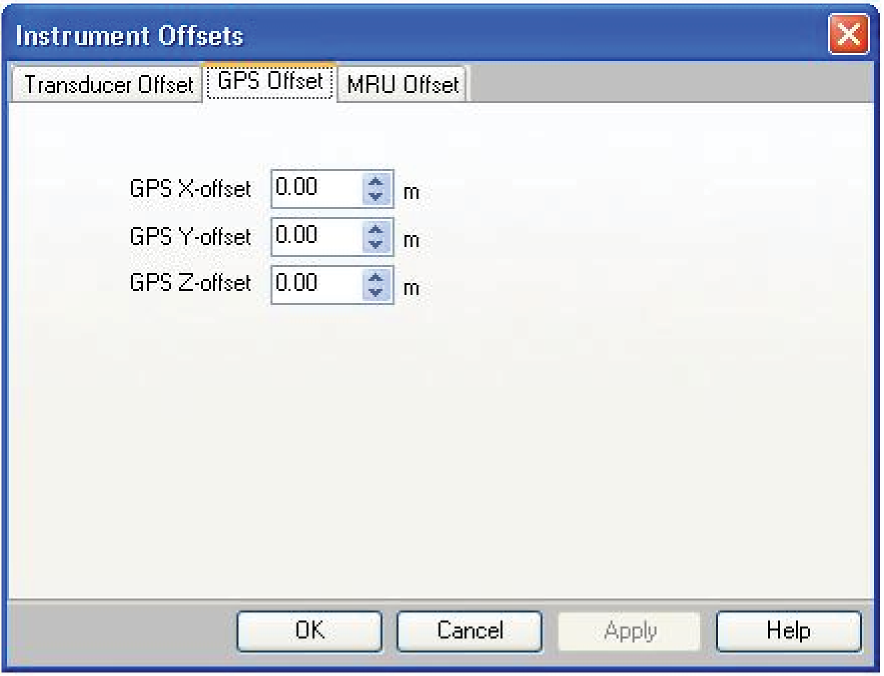
MRU X-offset 0.00 m
MRU Y-offset 0.00 m
MRU Z-offset 0.00 m

$\alpha_x$ 0.0 °
$\alpha_y$ 0.0 °
$\alpha_z$ 0.0 °



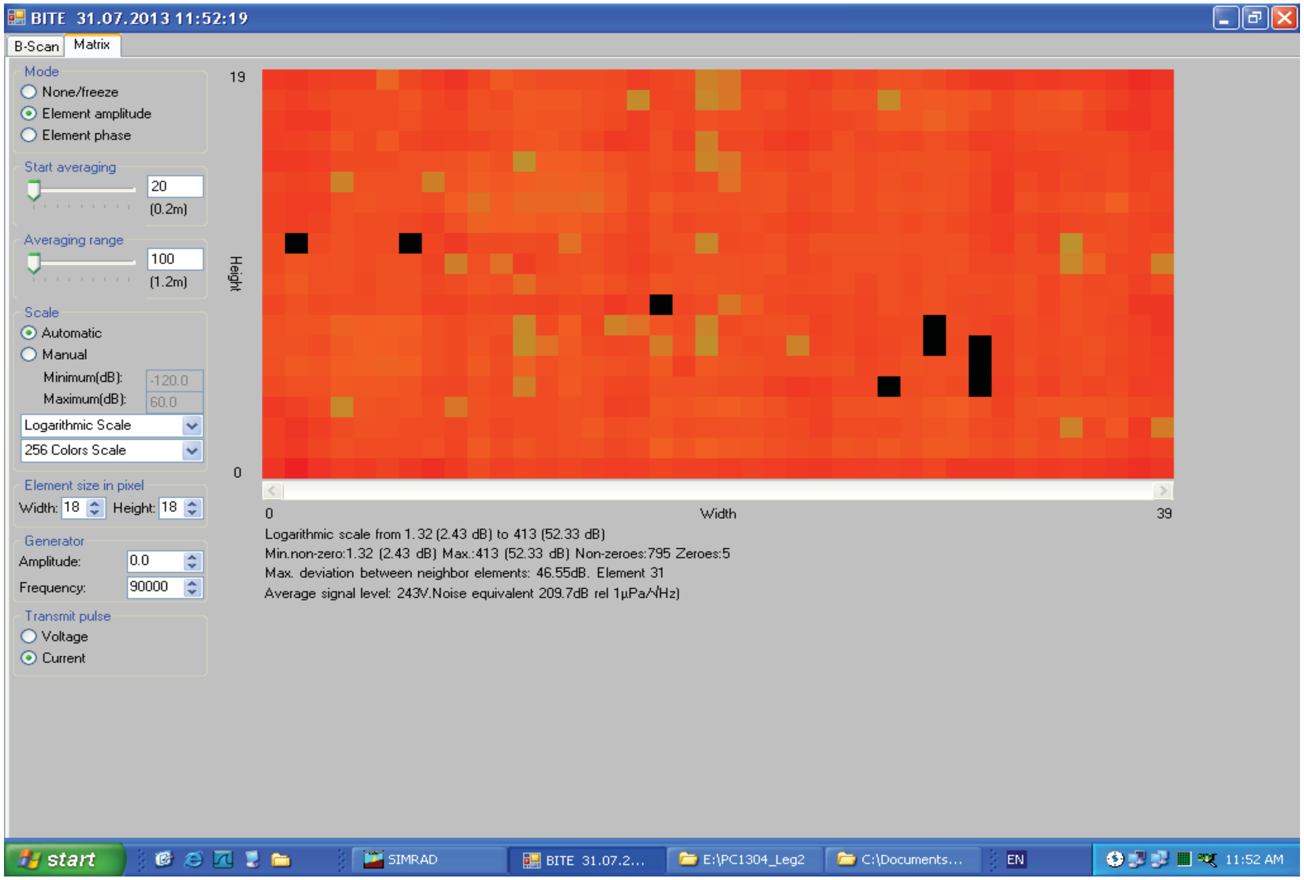
Transducer X-offset 0.00 m
Transducer Y-offset 0.00 m
Transducer Z-offset 0.00 m

$\alpha_x$ 0.0 °
$\alpha_y$ 0.0 °
$\alpha_z$ 0.0 °



GPS X-offset 0.00 m
GPS Y-offset 0.00 m
GPS Z-offset 0.00 m

# PC1304



Mode
○ None/freeze
● Element amplitude
○ Element phase

Start averaging: 20 (0.2m)

Averaging range: 100 (1.2m)

Scale
● Automatic
○ Manual
Minimum(dB): -120.0
Maximum(dB): 60.0
Logarithmic Scale
256 Colors Scale

Element size in pixel
Width: 18 Height: 18

Generator
Amplitude: 0.0
Frequency: 90000

Transmit pulse
○ Voltage
● Current

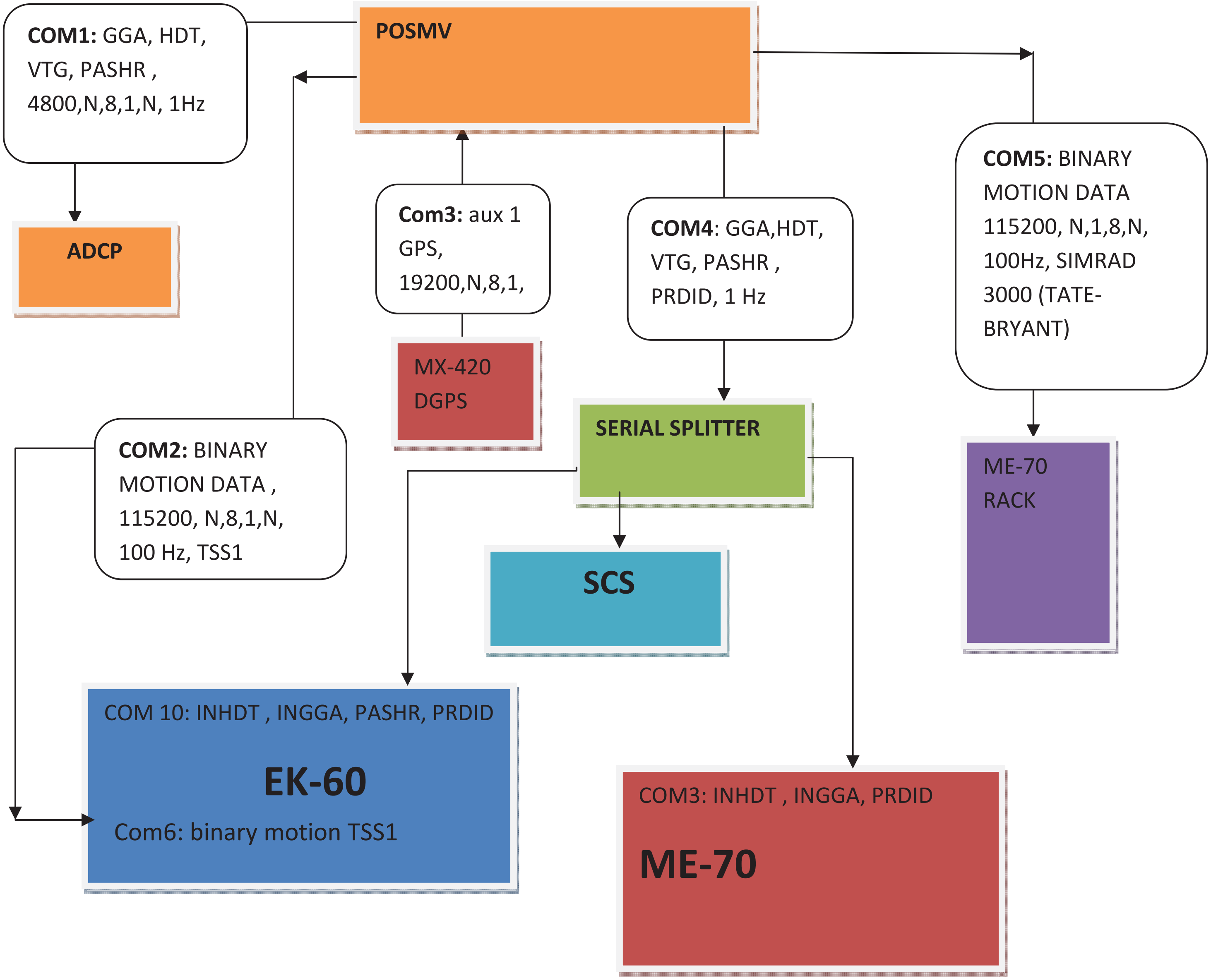
```
Logarithmic scale from 1.32 (2.43 dB) to 413 (52.33 dB)
Min.non-zero:1.32 (2.43 dB) Max.:413 (52.33 dB) Non-zeroes:795 Zeroes:5
Max. deviation between neighbor elements: 46.55dB. Element 31
Average signal level: 243V.Noise equivalent 209.7dB rel 1µPa/√Hz)
```

*BITE transmitter test run on 31 July 2013. Elemental transmissions were equal per methods described on page 46 of the ME70 Operator Manual. Elements(card #) showing aberrant transmission are 31(2), 131(2), 348(12), 544(16), 586(16), 587(16), 624(16), 625(16), and 626(16).*

# PC1304

| | | | | | |
|---|---|---|---|---|---|
| Table. Software used during PC1304 habitat mapping | | | | | |
| Current through August 2013 | | | | | |
| | | | | | |
| *Data processing* | | | | | |
| Name | Version | Purpose | Install location | software license needed? | Software source |
| ME70_RAW2GSF.m | Update received July 2012 | Proprietary code written to convert ME70 .raw files to .gsf format | NOAA Beaufort Lab laptop | No | Dr. Tom Weber, UNH CCOM |
| Matlab | 7.12.0.635 (R2011a) | Apply the file conversion code | NOAA Beaufort Lab laptop | Yes, license file | NOAA NMFS Beaufort Lab, Todd Kellison |
| Caris HIPS and SIPS | 7.1.2, Service Pack 2 | Process and export ME70 bathymetry data, export as geotiff and ascii text files | NOAA Beaufort Lab laptop | Yes, USB license key | University of New Hampshire; College of Charleston; SEFIS |
| Fledermaus, Geocoder Toolbox (i.e., FMGT) | 7.3.4, Build 3, 64 bit edition | Process and export ME70 backscatter data, export as geotiff | NOAA Beaufort Lab laptop | Yes, license file and USB key | NOAA NMFS Beaufort Lab, Todd Kellison |
| Python | 2.6.5, r265:79096 | Platform for running script codes SVP Editor, FetchTides and Mashpy | ACOUSTICLABAFT; SCSLAB4 | No | https://inside.nos.noaa.gov/hydrosoft/welcome.html |
| SVP Editor | 1.0.2 | Convert XBT temperature and sound speed file (.edf) to .svp Caris format | SCSLAB4 | No | Dr. Jonathan Beaudoin, UNH CCOM |
| Pydro, Velocipy | 13.2 r4239 | Convert XBT temperature and sound speed file (.edf) to .svp Caris format | ACOUSTICLABAFT; SCSLAB4 | No | https://inside.nos.noaa.gov/hydrosoft/welcome.html |
| Pydro, FetchTides | 13.2 | A component of Pydro, FetchTides compiles .tid files for local tide corrections | ACOUSTICLABAFT; SCSLAB4 | No | https://inside.nos.noaa.gov/hydrosoft/welcome.html |
| | | | | | |
| *Line planning method 1* | | | | | |
| Hypack | 13.0 13.0.0.6 | Hypack outputs .lnw survey line files, can also be output as .kml format | ACOUSTICLABAFT | Yes, USB license key | NOAA NOS Beaufort Lab, Chris Taylor |
| GPS Utility | 5.17 Licensed June 2013 | Convert .kml file from Hypack to .gpx file, importable to Rose Point | ACOUSTICLABAFT, licensed | Yes, for full functionality | gpsu.co.uk/download.html |
| Rose Point ECS 2009 | 2.0.111.159.1751 | Navigation software, separate copies on bridge and in Acoustics Lab | ACOUSTICLABAFT | Yes | Resident Pisces software |
| | | | | | |
| Questions/comments: warren.mitchell@noaa.gov | | | | | |

# PISCES POSMV HEADING AND MOTION DATA FLOW



**NOTES: COM 3 input on ME-70 was originally fed from GYRO. COM4 was originally fed from MX-420 GPS. NOTE: This document says ME-70 GGA AND HDT MUST BE INPUT ON DIFFERENT COM PORTS; however, as of July 2013 they are on the same com port, and we question whether HPR are being applied.**

**COM 10 input on EK-60 was originally from MX-420 GPS. Motion was coming in on COM 5, 4800 ,N, but specified as Simrad3000 so the system was reading it correctly.**

**NOTE: Roll positive: port up; Pitch positive: bow up; Heave Positive: heave up**

Document originally written by Mike Allen, Spring 2012. Provided by Warren Mitchell for update during PC1304, L2. ST L.Roy

# Correspondence

A. Applanix, re: POS MV

B. Simrad, re: ME70 acoustic center

C. Charles Thompson, re: waterline offset

D. Glen Rice, re: various issues

Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov>

# Fwd: Applanix

**Mike Stasko** <MStasko@applanix.com> Mon, Jul 8, 2013 at 3:06 PM
To: Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov>
Cc: Jon Andvick - NOAA Federal <jon.andvick@noaa.gov>, Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov>, Bruce Francis <BFrancis@applanix.com>, Donald Jones - NOAA Federal <donald.e.jones@noaa.gov>, Eric Younkin - NOAA Federal <eric.g.younkin@noaa.gov>, Olivia Hauser - NOAA Federal <olivia.hauser@noaa.gov>

Mathew,

Hello there good sir, sorry for the late response as our office was closed all last week. I have had a chance to look at the data you uploaded and it looks as if your offsets and lever arms are ok, however the antenna separation for the GAMS calibration is off. I would suggest performing another GAMS calibration in accordance to the routine outlined in the manual.

I do have another concern however; if you take a look at the attached jpg you will see a screen capture of the raw IMU readings for the Z gyro scale error. This is a direct reading of the gyro in the IMU and the maximum allowable tolerance is +- 200ppm. In the attached you will find data at the -750ppm levels which is considerably out of the usable specifications and may be the root of the GAMS issues. This being said there are a few things that I would expect to see in the logs associated with this IMU that I am not. Do you know if the navigators on the vessel are seeing any IMU warnings, failures or anything unexpected in the faults page?

Ideally it would be best to send this IMU in to Houston for a tumble test as this will test the raw IMU data produced by the IMU and will allow us to compare the results to the manufacturer specifications. I know sometimes this is not possible, however I would strongly recommend this route as this would be the best step forward.

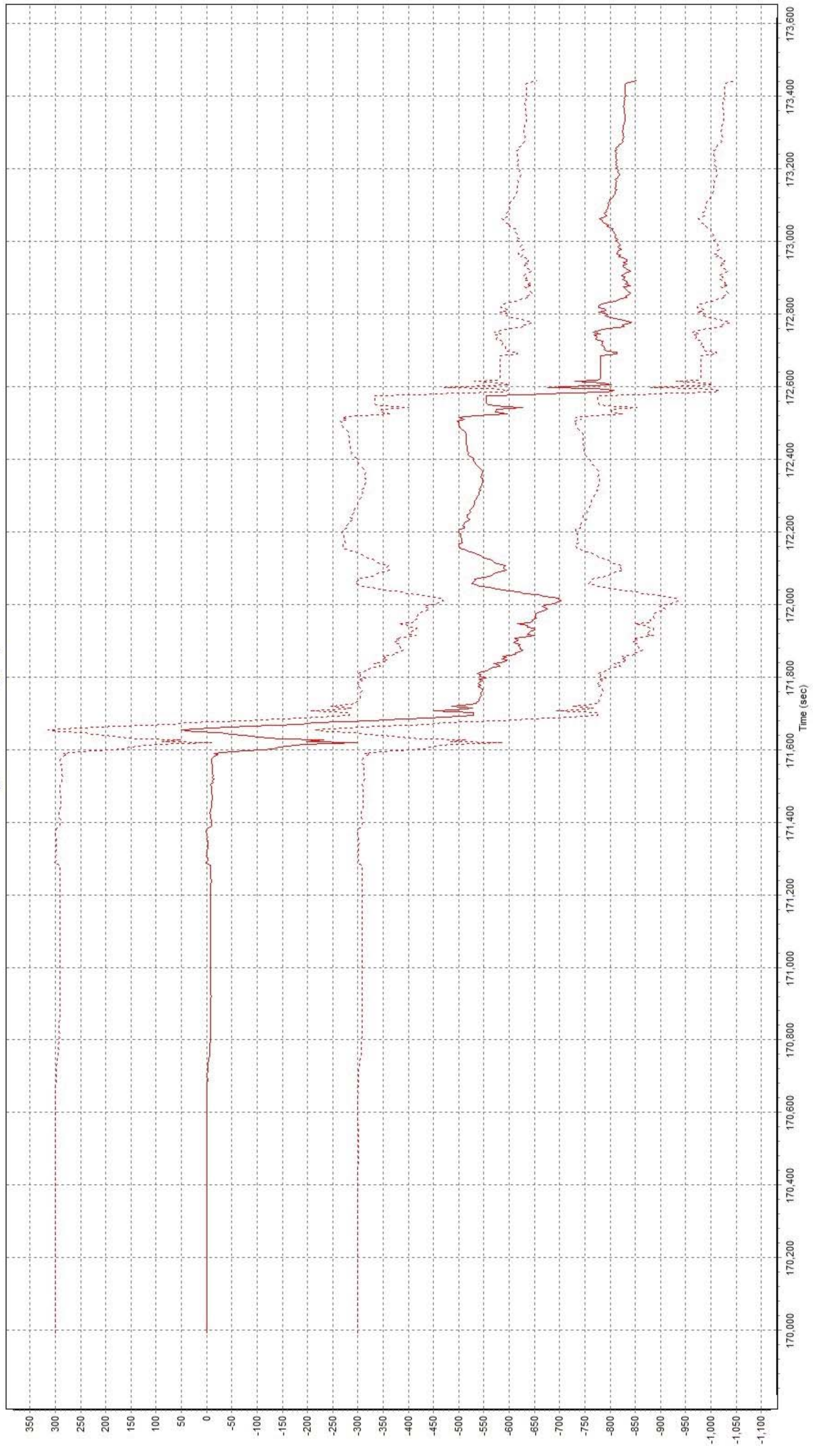
As always please let me know if you have any questions or concerns.

Thank you kindly,

Michael Stasko

Applanix (Houston)

Direct (713) 896 - 9900



z gyro scale error (ppm)

# Fwd: Applanix

**Mike Stasko** <MStasko@applanix.com> Wed, Jul 3, 2013 at 1:26 PM
To: Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov>, Jon Andvick - NOAA Federal <jon.andvick@noaa.gov>
Cc: Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov>, Bruce Francis <BFrancis@applanix.com>, Donald Jones - NOAA Federal <donald.e.jones@noaa.gov>, Eric Younkin - NOAA Federal <eric.g.younkin@noaa.gov>, Olivia Hauser - NOAA Federal <olivia.hauser@noaa.gov>

Mathew,

Hello there good sir and thank you for your input, I would like to address your observations as they seem to lead to a change in the setup from the original configuration.

1. You will never see a Cal Complete status unless you perform a GAMS calibration and it completes the GAMS calibration routine correctly.

2. Your screen captures and the fact that the system goes online occasional points towards another GAMS calibration needing to be performed after all the lever arms are checked. If all the lever arms are re-measured and the data matches what you have in the POSVIew software then you might have an issue with your IMU, however I highly suspects this is a lever arm issue and not a hardware issue.

3. The issues you are having with POSPac SBETS failing writing I don't think is related to the real time heading issue as a GAMS Calibration would not fail a SBET creation. Would it be possible to upload a trouble dataset to our ftp (directions attached)? This will allow us to witness the errors and trouble shoot hand in hand with our software team.

4. The superstructure may be a cause of the GAMS loss as well and is certainly well worth investigating. I should be able to see what is going on with the satellite reception from the POSPAC data file you upload as well. This being said I don't forsee this causing a SBET failure though….

> Please let me know when you have completed the data upload so we can take a look at it and see if we progress forward with solving this issue

Thank you kindly,

Michael Stasko

Applanix (Houston)

Direct (713) 896 - 9900

Cell (281) 813 - 6444

**From:** Matthew Wilson - NOAA Federal [mailto:matthew.wilson@noaa.gov]
**Sent:** Wednesday, July 03, 2013 11:03 AM
**To:** Jon Andvick - NOAA Federal
**Cc:** Warren Mitchell - NOAA Affiliate; Mike Stasko; Bruce Francis; Donald Jones - NOAA Federal; Eric Younkin - NOAA Federal; Olivia Hauser - NOAA Federal
**Subject:** Re: Applanix

Hello All:

Just wanted to add into this email thread my observations regarding the POS/MV on Pisces:

1. As Warren said, our GAMS calibration never appeared to achieve the heading accuracy required, and I never saw a status of "Cal Complete". When surveying thereafter, I did see instances of GAMS "Online".

2. Often times during surveying, there appeared to be heading issues. During one such occasion, I took 3 quick screen captures (see attached).

3. I had a POSPAC key with me and attempted to create SBETs. Most of these SBETs terminated with fatal errors during processing. A few of them finished, however did not pass our SBET quality control procedures (see screen captures in the attached zip file). I applied one of these SBETs in Caris, and computed and applied GPS tides; however the resulting bathymetric surface had noticeably poor internal data consistency.

4. There is a superstructure for a marine mammal shade in relatively close proximity to the POS antennas. Speculation is that this superstructure interferes with the antennas and perhaps causes the heading issues, ultimately may be sabotaging the SBETs as well, but again that is all our speculation.

I very much appreciate any guidance, advice, comments related to these issues. Thanks very much!

Matt Wilson

On Thu, Jun 27, 2013 at 2:23 PM, Jon Andvick - NOAA Federal <jon.andvick@noaa.gov> wrote:

Adding Olivia, Eric and Don to this email thread. Don is working on POS MV 320 V4 warranty reinstatement for the NOAA fleet with Applanix but this is still in the initial stages.

Very respectfully,
Jon

On Wed, Jun 26, 2013 at 9:19 AM, Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov> wrote:

Hello all: Mike, thank you for your quick respons. I'm very grateful. And greetings again to Jon Andvick, whom I met in Newport, OR this winter.

These documents are very helpful; I'll hope to study up and attempt testing again during the period 17-19 July. Some vessel set up has indeed changed since installation. I'm very glad a receive a fresh copy of the Installation Report so we may proceed accurately with care. I completely understand a limited support situation.

Good luck to all in your work on support contracts. Kind regards, - Warren

--

**Warren Mitchell**

*JHT Contract Fisheries Biologist*

*Habitat Mapping Lead* Fisheries Ecosystems Branch - SEFIS Group

NOAA Fisheries, Beaufort Laboratory
warren.mitchell@noaa.gov
252.728.8755 Note: Voicemail is currently inoperable at the Beaufort Lab http://www.sefsc.noaa.gov/labs/beaufort/ecosystems/sefis/

www.nmfs.noaa.gov

On Wed, Jun 26, 2013 at 10:35 AM, Mike Stasko <MStasko@applanix.com> wrote:

[Quoted text hidden]
[Quoted text hidden]

On Thu, Jun 20, 2013 at 10:22 AM, Mike Stasko <MStasko@applanix.com> wrote:

Warren,

Sorry for the late response good sir, as I was in the field for the last few days.

I am sorry to hear that you are having trouble with your POSMV system, however I believe I can help you. Can you forward me the screen shot you sent Angie so I can send you the correct manual? Also there is a very good walk through for the gams calibration routine in the manual as well.

Thank you kindly,

Michael Stasko

Applanix (Houston)

Direct (713) 896 - 9900

Cell (281) 813 - 6444

--

Respectfully,

Matthew J. Wilson

Physical Scientist, NOAA Office of Coast Survey

Atlantic Hydrographic Branch

matthew.wilson@noaa.gov

office (757) 441-6746 x101

cell (703) 638-3608

---

**Data upload to Applanix FTP Instructions.pdf**
32K

# Pisces DN178 POS and Sbet

**Mike Stasko** <MStasko@applanix.com> Wed, Jul 24, 2013 at 12:08 PM
To: Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov>

Matthew,

Looking at the data you provided recently (DN178.000) it looks like there is a very large error in the IMU-Primary GNSS lever arm, please see the attached screenshots labeled Y IMU-Pri and Y lever arm.jpg. I have reprocessed the data with what POSPac stated should be the new lever arm (only a 50% figure of merit) and the new offsets come out pretty close. This new offset seemed to have settled down the data quite a bit, however I am still seeing some very peculiar things here.

Next I would like to address the Zgyro scale error.jpg. It looks like we still have a high reading hear and noise throughout the complete dataset, I would say that this would definitely be affecting your sbet and may be part of the overall issue. I would highly recommend sending this to Applanix for evaluation and tumble testing.

Last I would like to address the final issue, that is the excessive cycle slips. There are so many cycle in both the L1 and L2, however there are many more in L2…..usually when we see this kind of issue in both the primary and secondary L1 and L2 data it can be attributed to environmental interference. Has there been any new equipment installed in the vicinity of the antennas or has anything at all changed? This is very important to note with the bridge and be cautious as if you ask the bridge about this 9 times out of 10 the answer is no nothing has changed and it has. One way to test this would be to shut off everything on the birds nest or watch area and log data. You should see the cycle slips near nothing. Again one must be very careful that EVERYTHING is actually off as the little things are often forgotten in these instances.

As always please let me know if you have any questions or concerns.

Thank you kindly,

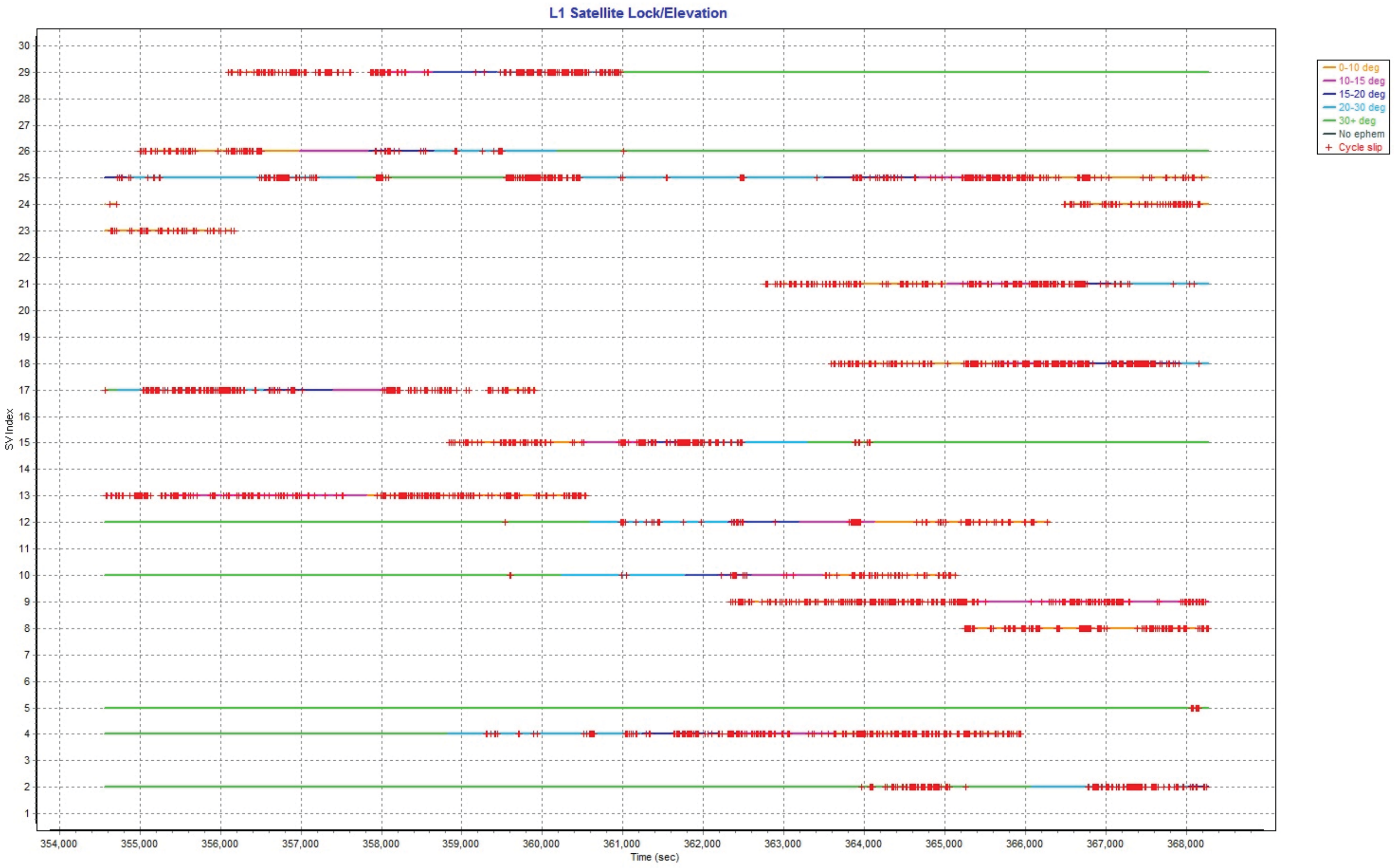
Michael Stasko

Applanix (Houston)

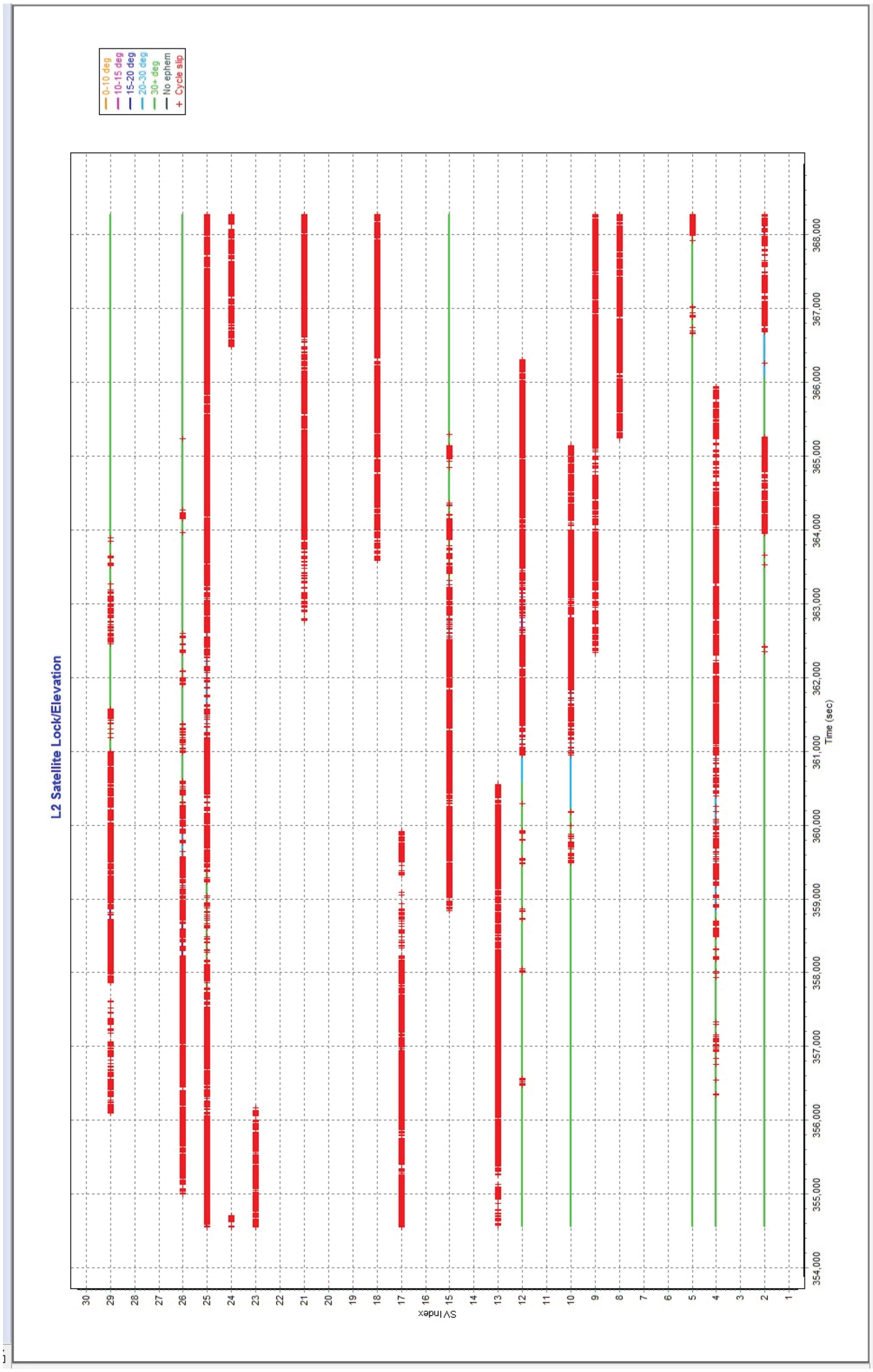
Direct (713) 896 - 9900

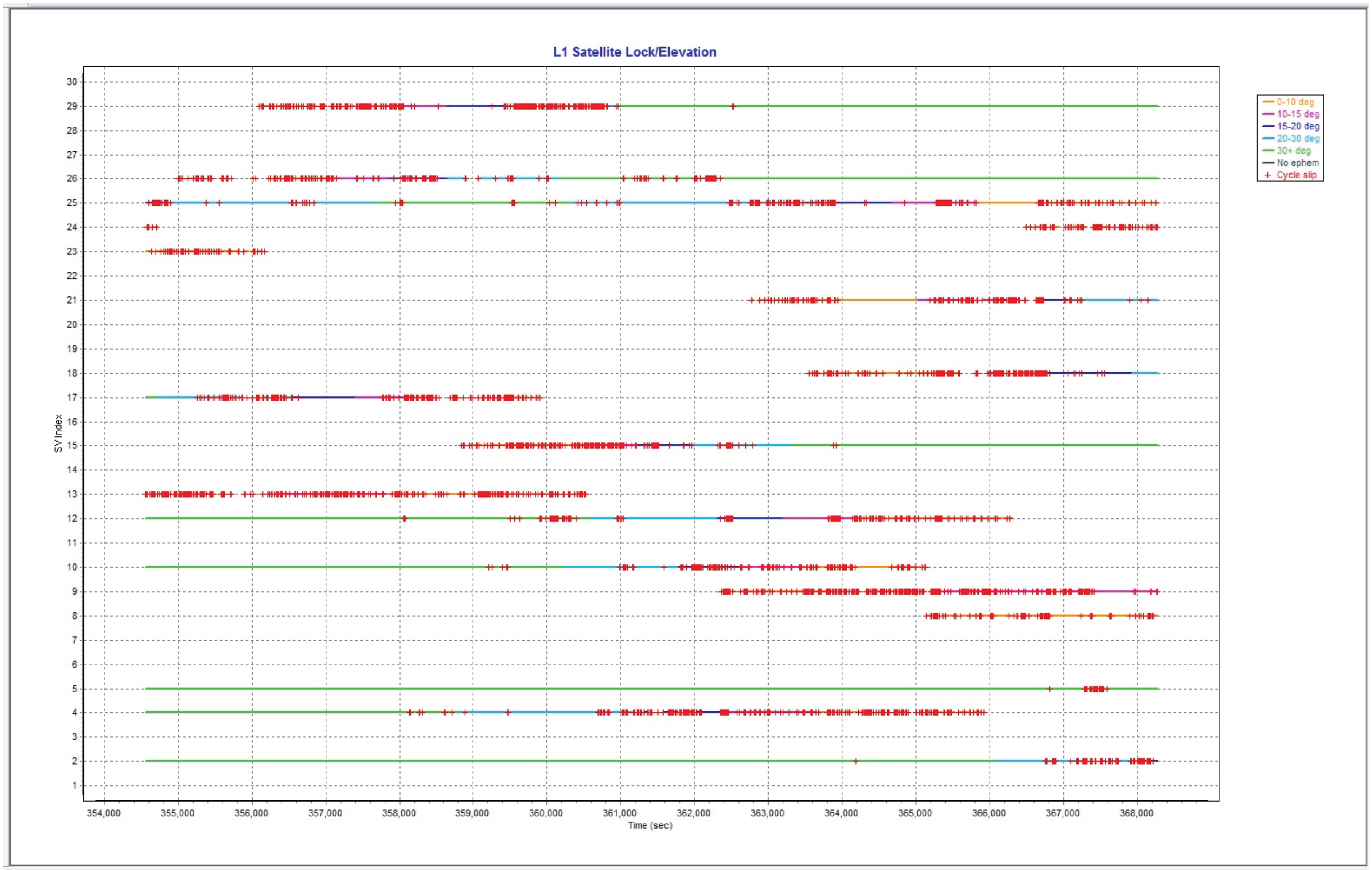
Cell (281) 813 - 6444

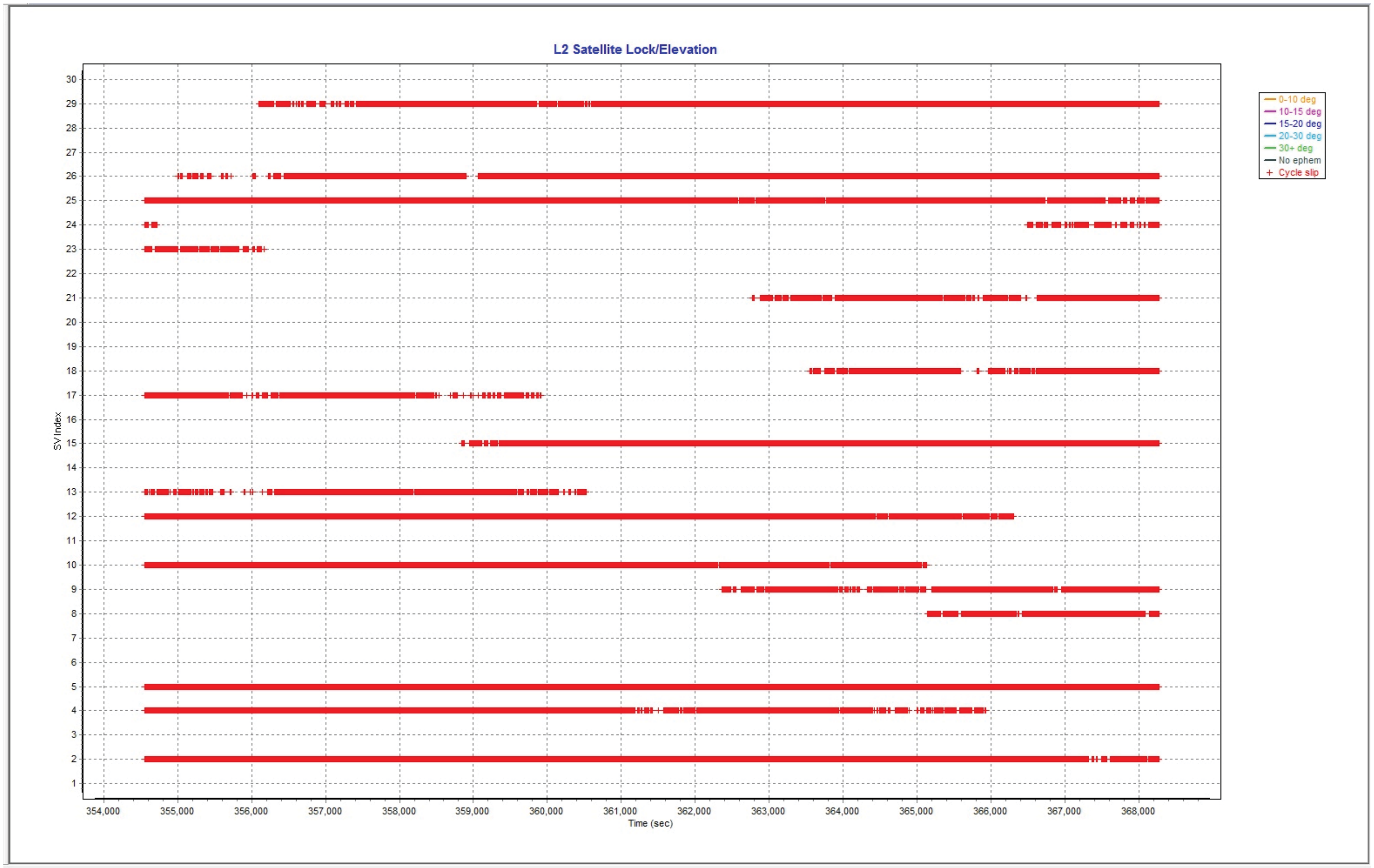
**From:** Matthew Wilson - NOAA Federal [mailto:matthew.wilson@noaa.gov]



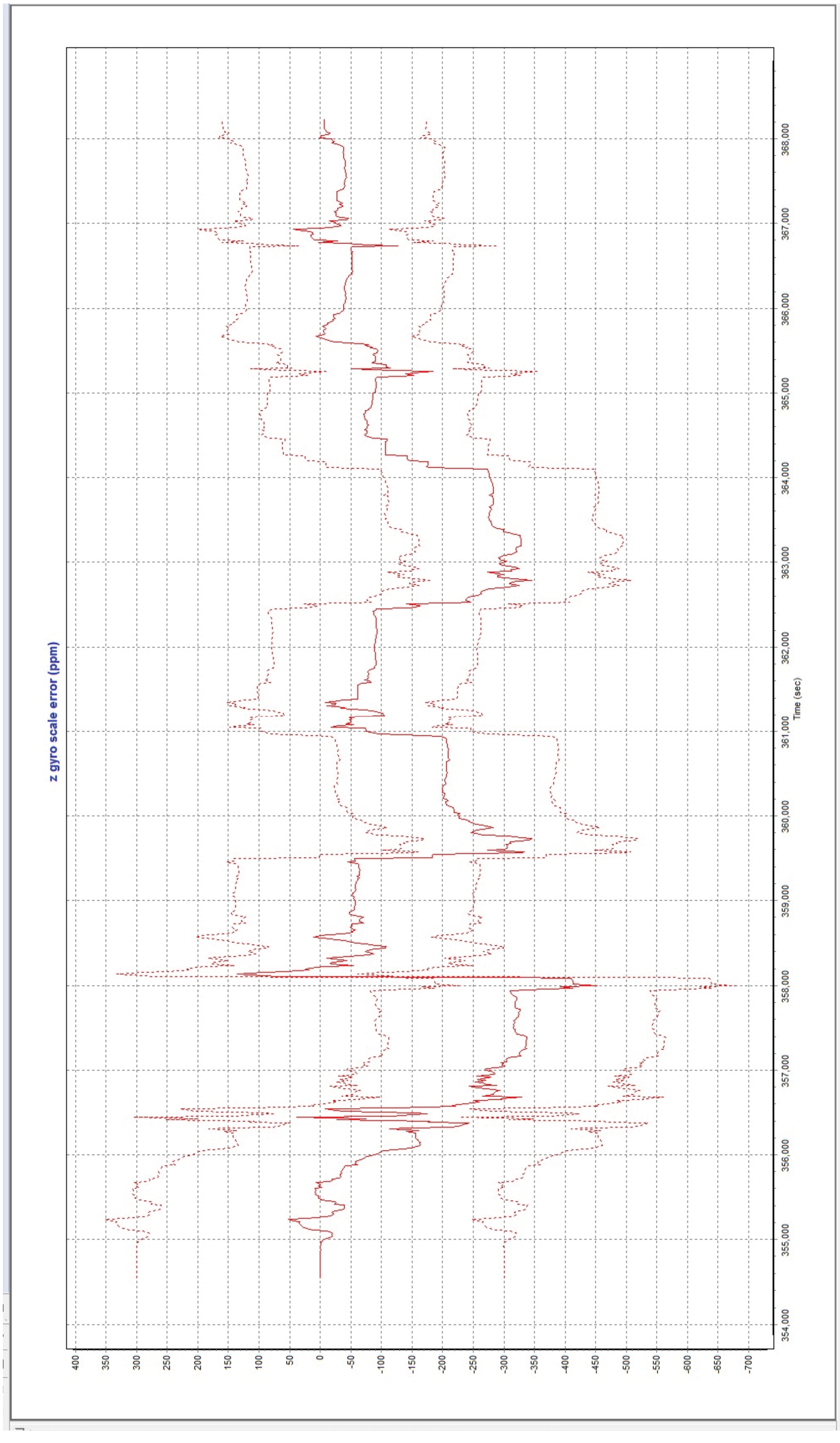
L1 Satellite Lock/Elevation


L2 Satellite Lock/Elevation
0-10 deg
10-15 deg
15-20 deg
20-30 deg
30+ deg
No ephem
+ Cycle slip
SV Index
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Time (sec)
354,000
355,000
356,000
357,000
358,000
359,000
360,000
361,000
362,000
363,000
364,000
365,000
366,000
367,000
368,000


L1 Satellite Lock/Elevation
SV Index
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
354,000
355,000
356,000
357,000
358,000
359,000
360,000
361,000
362,000
363,000
364,000
365,000
366,000
367,000
368,000
Time (sec)
0-10 deg
10-15 deg
15-20 deg
20-30 deg
30+ deg
No ephem
+ Cycle slip



L2 Satellite Lock/Elevation


z gyro scale error (ppm)
400
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
-500
-550
-600
-650
-700
354,000
355,000
356,000
357,000
358,000
359,000
360,000
361,000
362,000
363,000
364,000
365,000
366,000
367,000
368,000
Time (sec)

Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov>

# Re: ME70 Acoustic Center

**fish_research@simrad.com** <fish_research@simrad.com> Fri, Jul 5, 2013 at 3:45 AM
To: Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov>
Cc: Morten Helgesen <Morten.Helgesen@kongsberg.com>, Simrad Support Fish <simrad.support@simrad.com>, Gregg Juergens <gregg.juergens@simrad.com>

Hi Matt,

I suggest you use the transducer front surface as the acoustic center for ME70.

With Regards
Lars Nonboe Andersen
Fishery Research
Simrad
Horten

Direct tel: +47 33 03 44 62
Office: +47 33 03 40 00
Fax : +47 33 04 44 24
e-mail: lars.nonboe.andersen@simrad.com

http://www.simrad.com

From:
From: Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov>
To: contact@simrad.com,
Date: 03.07.2013 18:30
Subject: ME70 Acoustic Center

---

Hello,

I've been working recently with the Simrad ME70 on the NOAA Ship Pisces.

I'm searching for an offset to the "acoustic center" of the Simrad ME70. Our vessel offset survey appears to be measured to a topside bolt on the transducer, and I need the additional offset to the acoustic center. Perusing the ME70 user's manual, I see the transducer vertical height is 313mm, which is helpful, but there is no mention about the additional offset necessary to reach the acoustic center.

This is all in an attempt to properly reference ME70 data back to the ship and water line.

Thanks in advance for your assistance,
Matt

--

# Fwd: Caris Vessel Configuration File for Pisces

**Warren Mitchell - NOAA Affiliate** <warren.mitchell@noaa.gov> Thu, Jun 6, 2013 at 2:53 PM
To: Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov>

For thought, some plumb line measurements on Pisces waterline have been made in the past (fall 2011). The message below may be helpful for hvf troubleshooting.

--
**Warren Mitchell**
*JHT Contract Fisheries Biologist*
*Habitat Mapping Lead*
Fisheries Ecosystems Branch - SEFIS Group
NOAA Fisheries, Beaufort Laboratory
warren.mitchell@noaa.gov
252.728.8755 Note: Voicemail is currently inoperable at the Beaufort Lab
http://www.sefsc.noaa.gov/labs/beaufort/ecosystems/sefis/
www.nmfs.noaa.gov

NOAA FISHERIES

---------- Forwarded message ----------
From: **Charles H. Thompson** <charles.h.thompson@noaa.gov>
Date: Mon, Mar 25, 2013 at 5:45 PM
Subject: Re: Caris Vessel Configuration File for Pisces
To: Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov>
Cc: Charles Thompson - NOAA Federal <charles.h.thompson@noaa.gov>, David.Dodd@usm.edu

Warren,
Thanks greatly for the .hvf.

I went back to the notes I made at the end of the workshop when you, me, Karen, Chris, and Vince were on the Pisces. Chris and I made some measurements with a lead line to get the following.

Top of IMU down to deck surface: 18.875" = 0.479m
Deck surface to water (in the centerboard trunk): 7" = 0.178m
Deck surface to inner hull surface at ME70 xdcr: 16'7.25" = 5.061m

So the IMU is 0.657m above the waterline. And the transducer is 5.234m below the waterline. If I understand correctly (not at all certain) the value -3.21 m should be replaced by +0.66 m. Does this make more sense?

Charles

On 3/19/2013 4:33 PM, Warren Mitchell - NOAA Affiliate wrote:

> Greetings Charles and David.
>
> Things are well, thanks; hoping for the same down your way.
>
> Totally willing and encouraged by supervisors to share, .hvf is attached. I also attached the casual "configuration" documentation for the Pisces ME70, started by Laura Kracker (NOAA NOS, Charleston) and Glen Rice (then-NOAA Corps; IOCM @ UNH) during PC1203. The config document was updated during PC1204 with help from folks listed just below. If needed, the document should contribute context on where sensor offsets were applied. I believe a hard copy exists in the acoustics lab - perhaps folks like Mike Jech have made contributions since August.
>
> That's great news on help from Fairweather, and here's to good luck on the cruise. All the best with getting Matlab and Caris; we (Nate Bacheler) are working on getting Caris this spring and the going is slow, - Warren
>
> Some additional comments from cruise notes; may be helpful:
>
> The offsets and corrections in the configuration file were set up during the beginning of PC1204 cruise time (approx 24 26 July 2012), with Glen Rice , Matt Wilson (UNH; NOAA Atlantic Hydro Branch), and Jon Beaudoin (UNH).
>
> Those men drove the calculation and Caris work; I was learning. I recall they weren't completely happy with offset figures, in part due to lack of confidence in the vessel survey.
>
> The x, y, and z offsets seen in a few places within the .hvf (e.g., swath 1, SVP 1; x=0.625, y=1.094, z=5.620) will match what is on page 8 of the attached pdf config. There's text on page 8 about why the numbers changed a smidge from what Glen had originally provided to Laura for PC1203 (Matt caught a small math mistake by Glen during PC1204). Note that the PosMV and Caris fundamentally swap x and y as alongship and athwartship. I can confirm the x and y were transposed on purpose.
>
> In my humble opinion, I think a value to confirm in its application is the /waterline height/ -3.21 m. I have a suspicion from watching different sounders
>
> and depth charts while on board that there may be a systematic mistake present.
>
> On Tue, Mar 19, 2013 at 5:00 PM, Charles H. Thompson <charles.h.thompson@noaa.gov <mailto:charles.h.thompson@noaa.gov>> wrote:
>
> > Warren,
> >
> > Hope you're doing well.
> >
> > In a recent phone conversation, I think you said that you had created a Caris Vessel Configuration File for the Pisces. Would you be willing to share it? If so please send it to me and to David.Dodd@usm.edu <mailto:David.Dodd@usm.edu>.
> >
> > I think you are probably aware that the FAIRWEATHER is going to put a survey

> tech on the PISCES for the first half of the upcoming reef fish survey in
> the Gulf. I'm hoping to get a computer with Matlab and Caris onboard that he
> can use to do some processing.
>
> Best Regards,
> Charles
>
> --
> *Warren Mitchell*
> *JHT Contract Fisheries Biologist Fisheries Ecosystems Branch - SEFIS Group
> NOAA Fisheries, Beaufort Laboratory
> warren.mitchell@noaa.gov <mailto:email@noaa.gov>
> 252.728.8755 <tel:252.728.8755> Note: Voicemail is currently inoperable at the
> Beaufort Lab*http://www.sefsc.noaa.gov/labs/beaufort/ecosystems/sefis/
> *www.nmfs.noaa.gov <http://www.nmfs.noaa.gov/>
>
> *

**Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov>**

# On Pisces

**Glen Rice - NOAA Federal** <glen.rice@noaa.gov> Fri, Jun 14, 2013 at 3:32 PM
To: Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov>
Cc: Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov>

Hey Matt,

I recall heave being a problem, but we were also in pretty heavy conditions... How is your HVF setup? If I remember correctly, heave in the raw and GSF files are reported at the multibeam (see the PASHR data description), while True Heave is reported at the reference point (IMU). This makes it difficult for Caris to unapply and then reapply heave because of how your HVF should be setup depends on which stage of the process you are in...

All that said, I don't think that heave is applied real time... since all we have is range/angle, the vertical offset cannot be applied before Caris. The application of heave in real time is just for the reported display, not the logged data. If that is the case you should configure the HVF to put heave at the sonar if you are going to just apply real time heave. If you are going to apply True Heave you might want to do some testing, but I think you can put heave as reported at the IMU. In this case the real time heave will be applied in the wrong position, but then unapplied at the same place making it okay, and then True Heave will be applied. You might also try setting the heave to apply=no, and then applying True Heave. I think you can still apply True Heave even if the HVF says no, but you would need to check.

Those are my best guesses. Good luck,
Glen

On Fri, Jun 14, 2013 at 3:55 AM, Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov> wrote:

> Glen,
>
> We collected our patch test data with roll and pitch compensation off. Heave compensation was not turned off, however no heave data came through in the data,and we see a bad heave artifact. We noticed that our patch test data from last year also has no roll, pitch, and heave, and also has the bad heave artifact. Confused about this -- if heave should be coming through, and if so, we don't know why it didn't.
>
> Should we have set the misalignment values to zero in the POS? Or it doesn't matter if roll and pitch compensation is switched off in the ME70, right?
>
> We have time tomorrow to do GAMS, dynamic draft, and re-patch if we're not happy with the values. Right now we are all taking attempts at calibration, but the results are underwhelming because of the heave artifact.
>
> Thanks for any clarification you can provide.
> Matt
>
> On Fri, Jun 14, 2013 at 4:12 AM, Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov> wrote:
>
>> Yes, thank you Glen. Patch test data collected this afternoon, and processing is underway for comparisons with last year. I like to think we're collecting good data... one incremental improvement at a time, - WAM
>>
>> --
>> **Warren Mitchell**

>> *JHT Contract Fisheries Biologist*  
>> *Habitat Mapping Lead* Fisheries Ecosystems Branch - SEFIS Group  
>> NOAA Fisheries, Beaufort Laboratory  
>> warren.mitchell@noaa.gov  
>> 252.728.8755 Note: Voicemail is currently inoperable at the Beaufort Lab http://www.sefsc.noaa.gov/labs/beaufort/ecosystems/sefis/  
>> www.nmfs.noaa.gov
>>
>> On Thu, Jun 13, 2013 at 4:28 PM, Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov> wrote:
>>
>>> Glen -  
>>> Internet was down all day, just now able to send (hopefully)  
>>> 1. Copy, we will go with the 0.661m waterline value.  
>>> 2. Thanks for explaining this, your roll and pitch explanation makes perfect sense, will consult POS M/V manual further for the yaw. No reason to think any issues based on what we've seen in the data, just wanting to verify everything.  
>>> 3. Will update x,y,z offset TPU values for Pisces IMU to ME70 offsets in the user_variables.txt. Will also tinker with sigmaDRMS and stdTide values as you suggested to see if the sounding uncertainties make more sense.
>>>
>>> Thanks,  
>>> Matt
>>>
>>> On Thu, Jun 13, 2013 at 2:04 PM, Glen Rice - NOAA Federal <glen.rice@noaa.gov> wrote:
>>>
>>>> Hey Matt,
>>>>
>>>> Glad you guy are out working through stuff.
>>>>
>>>> 1. Your waterline value should be about right. The -3.2 value was a hold over from Dyson which references to their granite block rather than the IMU. I got that value using the method in the attached document. It had been my intention of doing this same thing for Pisces, but since the POSMV was not POSPac capable it got canned and forgotten about.
>>>>
>>>> 2. The ME70 is roll and pitch compensated, so applying roll and pitch are off in the HVF. Roll, pitch and heading are in the POS MV sensor 1 field so that the real time motion provided to the ME70 is in the correct reference frame, preventing cross talk between pitch and roll. Since roll and pitch are provided in the correct reference frame there should be no further need to account for these offsets. Heading is applied in Caris, and the logged heading value in the raw file (and therefore the GSF, and therefore used in Caris) is from the INHDT NMEA string. This string is in the IMU reference frame, so does not contain the Yaw offset. Therefore, the heading patch test value needs to be applied in Caris. You should look in the POS MV manual convince yourself of this.
>>>>
>>>> 3. The X/Y/Z values are the offsets between the POS MV (where nav and attitude are calculated) and the ME70 if I remember correctly, so those numbers should be larger (I think they were set for Dyson, but from the granite block to the ME70 for some reason). Uncertainty in the ME70 is large because the beam widths are so huge (5 degree along track). You might be able to improve the horizontal uncertainty some by dropping the sigmaDRMS value. I think the numbers that are in there are for a system without DGPS (Dyson). For the vertical (which does seem high) try adjusting the stdTide value. It might have been set large for AK. Feel free to play with those values to see how they effect the result.

> > > Fair winds and collect good data.
> > > Glen
> > >
> > > On Thu, Jun 13, 2013 at 1:40 AM, Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov> wrote:
> > >
> > > > Glen,
> > > >
> > > > Hey how are you? Fighting through our first shift here on Pisces. A few things to run by you:
> > > >
> > > > 1. Waterline value we used previously was -3.21. I cannot explain nor can I reproduce this. Do you remember how we got that value?
> > > >
> > > > Here are Charles Thompson's measurements / calculations:
> > > > "Top of IMU down to deck surface: 18.875" = 0.479m
> > > > Deck surface to water (in the centerboard trunk): 7" = 0.178m
> > > > Deck surface to inner hull surface at ME70 xdcr: 16'7.25" = 5.061m
> > > > So the IMU is 0.657m above the waterline. And the transducer is 5.234m below the waterline. If I understand correctly (not at all certain) the value -3.21 m should be replaced by +0.66 m. Does this make more sense?"
> > > >
> > > > Here are my calculations:
> > > >
> > > > 6/12/2013 fwd and aft draft marks: 5.45m / 6.13m, average = 5.79m
> > > > Granite Block to Keel Near Frame 78 z value= 2.017m (Impastato)
> > > > Granite Block to IMU z value = -4.434m (Impastato)
> > > > 4.434 + 2.017 - 5.79 = 0.661m (almost exactly the same as Charles Thompson)
> > > >
> > > > I'm thinking we will go with the 0.66m value, unless you see blatant errors in what we've done.
> > > >
> > > > 2. The HVF we used last year lists Pitch and Roll values in Swath 1 for the patch test data; thereafter, data collection uses "0" for Pitch and Roll. However the Yaw value is always populated. The POS MV Sensor Mounting tab, Sensor 1 Frame w.r.t. Ref. Frame lists Roll, Pitch, and Yaw values. Why were Roll and Pitch switched off in the HVF? Is it b/c of the ME70 Roll and Pitch compensation? Why is Yaw seemingly applied twice then, in HVF and POS?
> > > >
> > > > 3. Transceiver boards were not ordered due to breakdown in communication. Nevertheless we are sailing and pinging and recorded a quick line which I've gone ahead and processed without issue, using the matlab .exe. Regarding the user_variable.txt -- are those all TPU values (after the reject_outerbeams value)? why are the x,y,z offset values so high? (currently set to 0.961, -1.736, and 1.338, respectively). Resulting soundings have Hz and Dp Tpu of 10m, and 3m (approx).
> > > >
> > > > 4. So far ME70 is behaving, though there are cryptic warnings about those transceiver boards, from personnel onboard, that they could fail at any time. We are having them ordered, hopefully to be replaced this weekend, is the word I'm getting from the CO.
> > > >
> > > > Thanks Glen,
> > > >
> > > > Matt
> > > >
> > > > --
> > > > Respectfully,
> > > >
> > > > Matthew J. Wilson
> > > > Physical Scientist, NOAA Office of Coast Survey
> > > > Atlantic Hydrographic Branch
> > > > matthew.wilson@noaa.gov

# Simrad ME70 on Pisces - latest notes

**Glen Rice - NOAA Federal** <glen.rice@noaa.gov> Thu, Aug 15, 2013 at 11:08 AM
To: Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov>

Hey Matt,

The beams are not repointed in Matlab and there is no user setting for surface sound speed. The Matlab code is doing a bottom detection by beam, and then putting the angle information from the RAW file into the GSF without messing with it. Caris is handing any refraction stuff.

From what I understand the surface sound speed value in the RAW file is always what was provided by the user on the ME70, so it should not be used for repointing if the system was set to use the real time TSG information. What I was saying was that if the value in the RAW file contains the user value and not the real time value, maybe there is a bug such that the real time value is never being used by the ME70. While the value is displayed real time (thanks to your efforts), perhaps it is never actually used for beam pointing. I wanted to check that by drastically changing the value coming in from the TSG (by putting fresh water in it) and seeing if there was an observable change in the ME70 bathymetry. If the ME70 does not change, it would seem that it only ever uses the user supplied value, even when set to use real time information.

Regards,
Glen

On Thu, Aug 15, 2013 at 10:37 AM, Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov> wrote:

> Glen,
>
> Is the user set value you are referring to the value in the MATLAB code? Might we have potentially been pointing our beams in ME70 and then re-pointing them in MATLAB?
>
> There is a user set value in the ME70 acquisition software that we adjusted, which caused a very significant effect to the data. We finally got that value to auto-adjust based on the TSG feed.
>
> It will go on the list for next year to adjust the MATLAB sound speed value -- I didn't guess it would supersede the real-time value from the TSG.
>
> thanks,
> Matt
>
> On Thu, Aug 1, 2013 at 8:53 AM, Glen Rice - NOAA Federal <glen.rice@noaa.gov> wrote:
>
> > Sorry for the last minute suggestion. Only after the last email did it occur to me that a bug in the software might cause the real time feed to never be used and would cause a lot of the problems we see. The times that it is good would only be because the user set value happened to be close enough to being good values. Another way to check this would be to set the user value to something stupid and then switch to the real time feed. If there is not an improvement the system would have been stuck on the user value.
> >
> > You guys have earned your rest. Sleep well.
> > Glen
> >
> > On Wed, Jul 31, 2013 at 11:48 PM, Warren Mitchell - NOAA Affiliate <warren.mitchell@noaa.gov> wrote:
> >
> > > Winner, Glen Rice. Your fresh ideas have finally outpaced our drive and determination. Matt and I are heading to the rack here soon. Thanks as ever for your support during the cruise. Talk to you soon, - WAM
> > >
> > > --
> > > **Warren Mitchell**
> > > *JHT Contract Fisheries Biologist*
> > > *Habitat Mapping Lead*
> > > Fisheries Ecosystems Branch - SEFIS Group
> > > NOAA Fisheries, Beaufort Laboratory
> > > warren.mitchell@noaa.gov
> > > 252.728.8755 Note: Voicemail is currently inoperable at the Beaufort Lab
> > > http://www.sefsc.noaa.gov/labs/beaufort/ecosystems/sefis/
> > > www.nmfs.noaa.gov

> On Wed, Jul 31, 2013 at 3:54 PM, Glen Rice - NOAA Federal <glen.rice@noaa.gov> wrote:
>
>> Matt,
>>
>> Can you dump some fresh water in the TSG to see if it effects the ME70 when using the real time feed? Seems like that would confirm that the system is actually using the real time feed at all. That might be a worth while check while you are on board.
>>
>> Glen
>>
>> On Tue, Jul 30, 2013 at 7:18 PM, Matthew Wilson - NOAA Federal <matthew.wilson@noaa.gov> wrote:
>>
>>> Glen - I've been writing my report in the DR template but it basically contains all elements of the DAPR and could be transitioned easily. Please do send a copy of the DR you've been producing for a reference, I'd appreciate that and draw mine up in a similar manner.
>>> As for the temperature feed to the ME70, at the moment it comes from the SBE 21 that is not near the hull. Normally there is a SBE38 that supplies the hull-corrected temperature to the TSG45 as I understand however this is not currently functional. All that being said, the sound speed we see coming into the ME70 matches the transducer-level sound speed we see in the XBT and CTD casts.
>>>
>>> Jonathan - prior to fixing the real-time feed, there was a manual value field we could enter in at the transducer face, and experimenting/adjusting that value drastically altered the smiles/frowns observed in post-processing. We see that field updating now that the real-time feed is fixed.
>>>
>>> Thanks all,
>>> Matt
>>>
>>> On Tue, Jul 30, 2013 at 1:41 PM, Jonathan Beaudoin <jbeaudoin@ccom.unh.edu> wrote:
>>>
>>>> Perhaps the surface sound speed is only being used to scale the travel-times into ranges on the graphical display and is not used at all in the beam forming/steering?
>>>>
>>>> jb
>>>>
>>>> On 7/30/13 9:10 AM, Glen Rice - NOAA Federal wrote:
>>>>
>>>> Hey Matt,
>>>> See inline.
>>>>
>>>>> Hope you all are well. ME70 performance on Pisces is always meeting SEFIS objectives for trap deploments well enough, and I'm also writing an OCS-style Descriptive Report for the cruise, hopefully useful in future cruises.
>>>>
>>>> Awesome possum. From the most recent HTD it seems like HSD is looking for DAPRs more than full DRs, but this is something we have not done yet. Are you constructing this kind of document too? Would you be interested in a copy of the DRs we have been producing for reference? There has been some discussion about trying to fit FSVs into the XML DR process...
>>>>
>>>>> - uncertainty. We've normally been running the MATLAB scripts without uncertainty because the TPU calculations were slow enough such that we could not keep up with real-time processing and therefore would prevent timely delivery of products to SEFIS. However, for reporting purposes, as a side project I've ran the MATLAB executable that calculates uncertainty and the results must be incorrect (see first screen capture), up to 4.5m vertical uncertainty, and up to 65m horizontal uncertainty. Also, I believe I know each of the TPU components in the User_Variables.txt, except the last three (sigmaDeltaT, sigmaSOG, and sigmaDRMS). What are these and what might be a reasonable value? Anything else look fishy, or any advice otherwise?
>>>>
>>>> If memory serves, sigmaDeltaT is the uncertainty in timing, sigmaSOG is the uncertainty in the speed over ground, and sigmaDRMS is the positioning uncertainty.
>>>>
>>>>> - refraction. See the second screen capture. This is what we've normally been seeing. The TSG is functional now and supplies the ME70 with the real-time feed, however has not been calibrated in 5 years. That said, it is matching both the XBT and CTD values at transducer level (within 0.4 m/s). The XBT's have been matching the CTD well enough not to be a concern (~2cm outerbeam depth sounding uncertainty in the comparison). The CTD has been calibrated recently. So I don't know the cause of the persistent refraction. We have generally 4 XBT's a night, and have had some challenging areas near the Gulf Stream, so it could be just that, but still it seems like we see "smiles" of this magnitude no matter what, like its a given.
>>>>
>>>> We see problems with Dyson periodically too, but since we were not on board for the collection we cannot verify that things were working properly (it would be really nice if the system recorded the USED sound speed uncertainty for beam steering).
>>>> Can you confirm the temperature being used is from the hull and not the TSG?
>>>>
>>>>> Best Regards,
>>>>> Matt
>>>>
>>>> This is good stuff. Thanks for your thoughts and good work.
>>>> Glen
>>>>
>>>>> --
>>>>> Respectfully,
>>>>>
>>>>> Matthew J. Wilson
>>>>> Physical Scientist, NOAA Office of Coast Survey

# APPENDIX III

# FEATURES REPORT

## (NO AWOIS ITEMS, DTONS, WRECKS, OR MARITIME BOUNDARIES)

# APPROVAL PAGE

# W00269

Data meet or exceed current specifications as certified by the OCS survey acceptance review process. Descriptive Report and survey data except where noted are adequate to supersede prior surveys and nautical charts in the common area.

The following products will be sent to NGDC for archive

- W00269_DR.pdf
- Collection of depth varied resolution BAGS
- Processed survey data and records

The survey evaluation and verification has been conducted according to current OCS Specifications, and the survey has been approved for dissemination and usage of updating NOAA's suite of nautical charts.

Approved: Matthew Jaskoski

**Lieutenant Matthew Jaskoski, NOAA**
Chief, Atlantic Hydrographic Branch