



Offsets for Systems with Inertial Positioning and Multibeam Sonar

By Joe Burnett

This article will describe the 'Preferred Method' that HYPACK recommends for entering the offsets for systems with INS positioning and multibeam sonar. This has been a long-debated topic on which we frequently get questions here at HYPACK Tech Support.

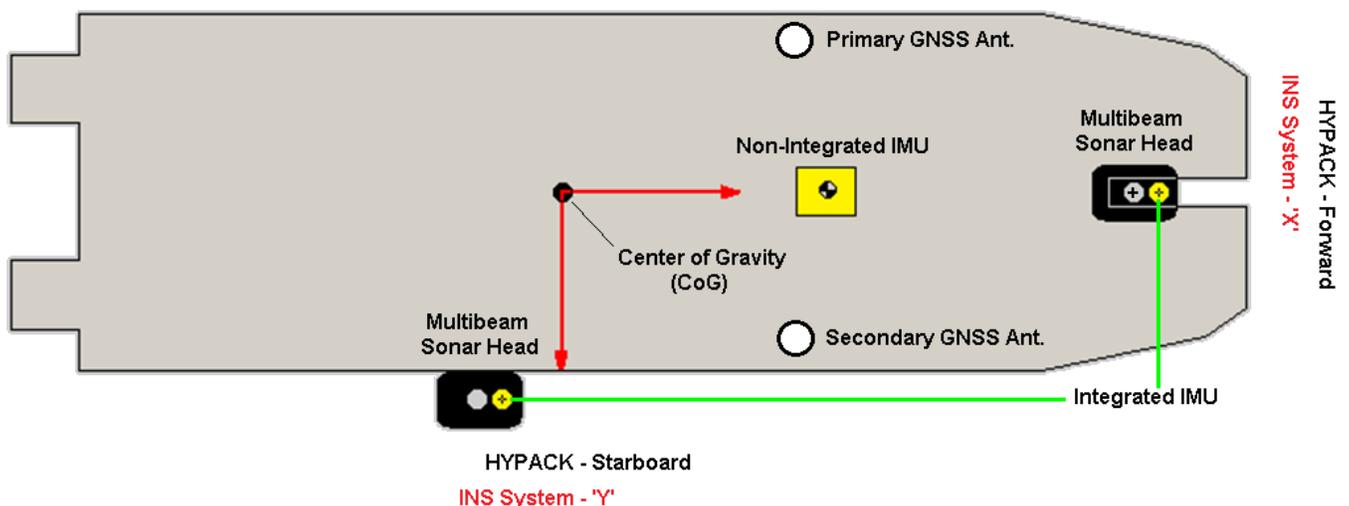
After a long discussion with Mike Brissette from R2Sonic, he suggested that we consider a method that he has been using for entering offsets in various INS systems with HYPACK® software.

To determine the overall best solution to this issue, I contacted Dave Andrews and Marvin Story at Teledyne Odom, and John Carss at Applanix, and we all agreed to meet in Baton Rouge and test several configurations, where offsets were put into either the inertial system firmware, the HYPACK®/HYSWEEP® software, or into both software systems, all in an attempt to determine the easiest offset configuration.

In the test, we had following configurations:

- Integrated Applanix POS MV IMU and Bow-mounted Teledyne-Odom MB2
- Non-Integrated Applanix POS MV IMU and Bow-mounted Teledyne-Odom MB2
- Integrated Applanix POS MV IMU and Side-mounted Teledyne-Odom MB2
- Non-Integrated Applanix POS MV IMU and Side-mounted Teledyne-Odom MB2

FIGURE 1. Test System Installation



For each of the 4 configurations, we had 3 different ways that Offsets for the position and motion data were entered in the different software packages:

- Enter offsets only in Applanix POSView software, where it outputs all data relative to the acoustic center of the multibeam ('Ref to Sensor 1' offset configuration).

Lever Arms & Mounting Angles		Lever Arms & Mounting Angles		Sensor Mounting	
Ref. to IMU Target		Ref. to Primary GNSS Lever Arm		Ref. to Centre of Rotation Lever Arm	
X (m)	2.15	X (m)	1.87	X (m)	0
Y (m)	0.00	Y (m)	-1.09	Y (m)	0
Z (m)	0.45	Z (m)	-2.64	Z (m)	0
				Ref. to Sensor 1 Lever Arm	
				X (m)	4.05
				Y (m)	0
				Z (m)	0.87

All offsets for *all* devices in HYPACK®/HYSWEEP® were set to 0.00.

- Enter offsets in the Applanix POSView software, where it outputs all at the location of the IMU Target ('Ref to Primary GNSS Antenna' and original 'HYPACK Preferred Method')

Lever Arms & Mounting Angles		
Lever Arms & Mounting Angles		
Ref. to IMU Target		
X (m)	0	
Y (m)	0	
Z (m)	0	
Ref. to Primary GNSS Lever Arm		
X (m)	1.87	
Y (m)	-1.09	
Z (m)	-2.64	
Ref. to Centre of Rotation Lever Arm		
X (m)	0	
Y (m)	0	
Z (m)	0	

FIGURE 2. Offsets in HYPACK for Vessel CoG to IMU and Teledyne-Odom MB2

Applanix POS M/V Network	Sonar Head 1
Position	Position
Enter Device Offset From Boat Reference Point (Center of Mass).	Enter Device Offset From Boat Reference Point (Center of Mass).
The Vertical Offset is Positive Downward and Measured From Waterline.	The Vertical Offset is Positive Downward and Measured From Waterline.
Starboard	Starboard
Forward	Forward
Vertical	Vertical
0.000	0.000
2.150	4.050
0.450	0.870

- Enter offsets in the Applanix POSView software, where it outputs ALL of it data at the Vessel's CoG ('Ref to IMU' and 'Ref to Primary GNSS' configuration, and new 'HYPACK Preferred Method).

Lever Arms & Mounting Angles		
Lever Arms & Mounting Angles		
Ref. to IMU Target		
X (m)	2.15	
Y (m)	0.00	
Z (m)	0.45	
Ref. to Primary GNSS Lever Arm		
X (m)	1.87	
Y (m)	-1.09	
Z (m)	-2.64	
Ref. to Centre of Rotation Lever Arm		
X (m)	0	
Y (m)	0	
Z (m)	0	

FIGURE 3. Offsets in HYPACK ONLY for Vessel CoG to Teledyne-Odom MB2

Applanix POS M/V Network		Sonar Head 1	
Position		Position	
Enter Device Offset From Boat Reference Point (Center of Mass).		Enter Device Offset From Boat Reference Point (Center of Mass).	
The Vertical Offset is Positive Downward and Measured From Waterline.		The Vertical Offset is Positive Downward and Measured From Waterline.	
Starboard	0.000	Starboard	0.000
Forward	0.000	Forward	4.050
Vertical	0.000	Vertical	0.870

So, a quick recap and some quick math, and we can see that 4 different mounting configurations and 3 different offset configurations for each setup, makes for 12 different data collection scenarios. It also meant that we had to perform a Patch Test for each setup.

A location on the Mississippi River was chosen and the data was collected and processed.

When it was all said and done, an XYZ file from each setup was created using a 0.5mX 0.5m grid, and all data sets were overlaid on each other to verify the validity of each setup.

Here are the results:

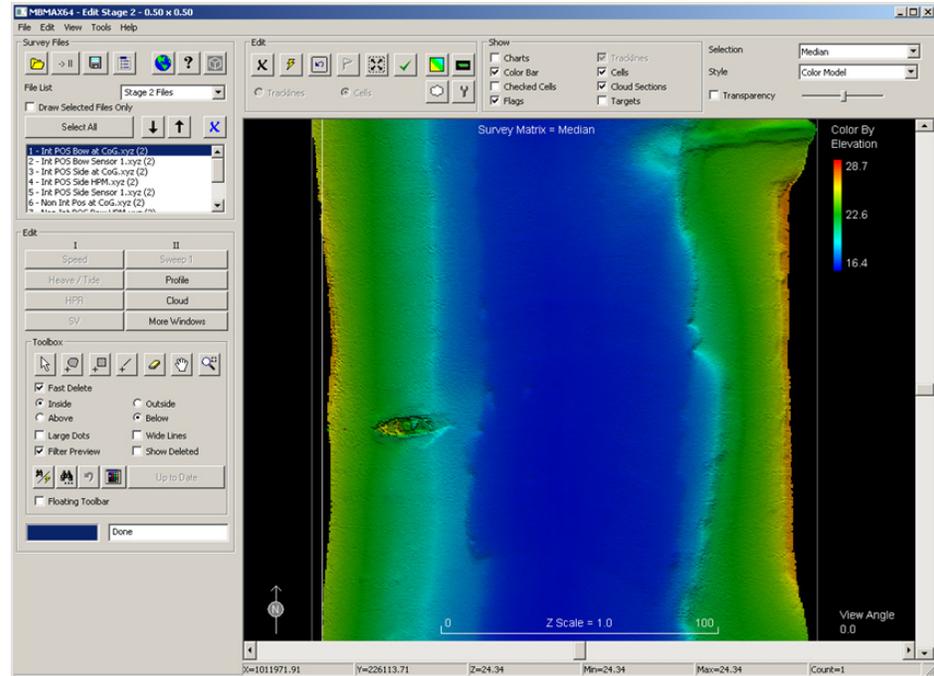


FIGURE 4. Test Results—Data from All Tests Overlaid

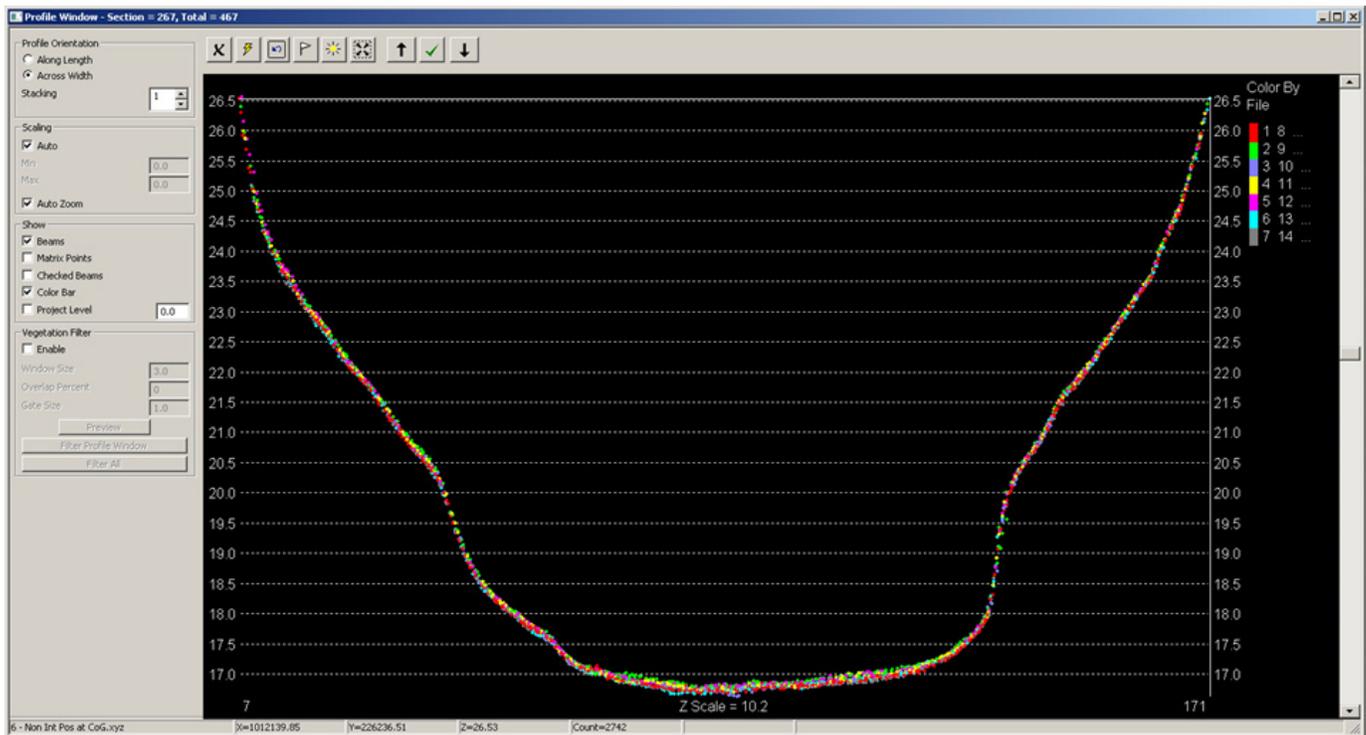
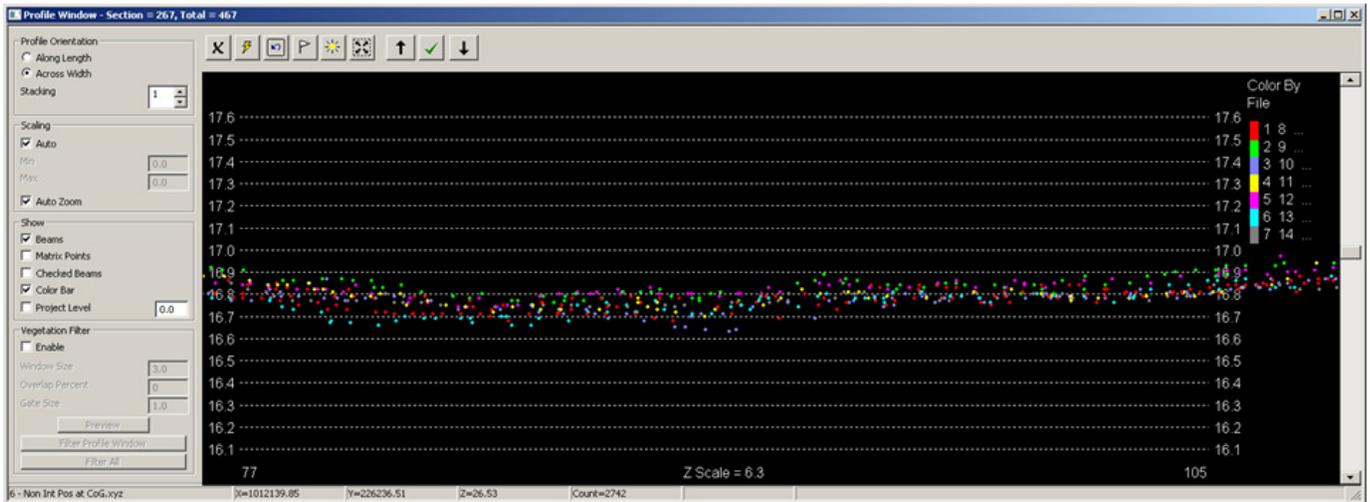


FIGURE 5. Zoomed in on the Same Data



MORAL OF THE STORY

After reviewing the data and consulting with those involved in the test, the one thing we noticed, was that the offsets entered for every setup, had to reference measurements from the vessel center of gravity (CoG or center of rotation); therefore, it only makes sense that we let the inertial system calculate and output all of its data from the CoG, no matter where it is physically located on the vessel. After all, that's what it was designed to do and it simplified where the offsets were entered.

So, it is the unanimous consensus of the group, to have the inertial system output its position, motion, and heading relative to the vessel CoG:

- Two sets of offsets in the Inertial System software:
 - CoG (Ref) to IMU Target
 - CoG (Ref) to Primary GNSS Antenna Phase Center

NOTE: CoG (Ref) is measured from the XY (Forward/Starboard) location on the vessel, and from the Waterline. This is an important measurement, because the INS will output the RTK tide water level, along with the position, motion, and heading data.

- One set of offsets in HYPACK®:
 - CoG to Multibeam Acoustic Phase Center
 - Everything else is 0.00

MEASURING AND ENTERING OFFSETS BASED ON THE HYPACK® PREFERRED METHOD

1. Find the Boat Reference Point.

- a. On the vessel, locate the fore-aft, port-starboard center point and mark it somehow. (Put a screw in the deck, permanent marker, whatever works.) This mark will now be your Boat Reference Point (BRP).
- b. From the BRP, measure its vertical offset to the waterline.

IMPORTANT! Remember that for *most* inertial systems, 'X' is their forward offset, 'Y' is their starboard offset, and 'Z' is their vertical offset. HYPACK® simply calls them starboard, forward, and vertical. The vertical offset is positive downward in both software packages.

NOTE: In this guide, the Applanix POSView program is used as an example. Most other inertial system software is very similar to this one.

2. In the POSView software, measure and enter the IMU and GNSS antenna offsets.

- a. Measure and record the IMU offsets:
 - Measure the distances forward and starboard from the BRP to the IMU target and enter these offsets in the Ref to IMU Target 'X' and 'Y' boxes.
 - Measure from the IMU Target to the waterline and enter the result in the 'Z' box
- b. Measure and record the offsets for the Primary Antenna Phase Center:
 - Measure the distances forward and starboard from the BRP to the Primary Antenna Phase Center. Enter these offsets in the Ref to Primary GNSS 'X' and 'Y' boxes.
 - Measure from the Primary GNSS Antenna Phase Center to the waterline and enter the result in the 'Z' box.

With the offsets entered for the IMU and GNSS Antenna, the POS MV (INS System) will now calculate and output all of its data relative to the BRP, at the waterline.

IMPORTANT! Do not enter any more offsets in POSView (Ins system) software.

3. In HYPACK® HARDWARE, measure and enter the multibeam offsets:

- Measure the distances forward and starboard from the BRP to the Acoustic Center of the Multibeam and enter these offsets for the Sonar Head in the Starboard and Forward boxes.
- Measure from the waterline to the Multibeam Acoustic Center and enter the result in the vertical box.

The offset configuration is now complete in both interfaces. Simple!!

WHAT!! I didn't tell you about entering any offsets for the POS MV in HYPACK?. Hmmmm, well, what were they to start with?...Right, they're all 0.00 because the POS MV is now set up to output all of its data referenced to the CoG at the waterline.

Yes, that includes everything: position data, motion data, heading data and, if you are receiving the right corrections, the RTK tide data relative to the waterline.

Again, because everything has been measured to the CoG at the waterline, there are *no offsets!*

FINAL THOUGHTS

Now, is this the *only* way to set up a system with Inertial positioning and Multibeam sonar? Absolutely not! I've already shown you 11 other ways, and there are several more. We just did not have the time to test them all. But, in our opinion, we have found what we believe to be the easiest, least complex way to enter the offsets for these types of systems.

This is the new "HYPACK Preferred Method", and what we recommend to our users.

Honestly, the hardest part to this setup, is determining the CoG location. It is going to be somewhat dynamic in nature, due to personnel, fuel and cargo loading, but, you should be able to pick a point that you believe to be close, and just stick with it.
