Multibeam System Setup and Patch Test Data Collection

By Joe Burnett

With the increasing use of multibeam systems for Higher Resolution and Full-bottom Coverage Surveys, there also comes the demand to install and calibrate these systems, both properly and correctly. This article is going to focus on the Basics of performing both the installation of the equipment and the collection of the data necessary for performing a Patch Test, or calibration of your system.

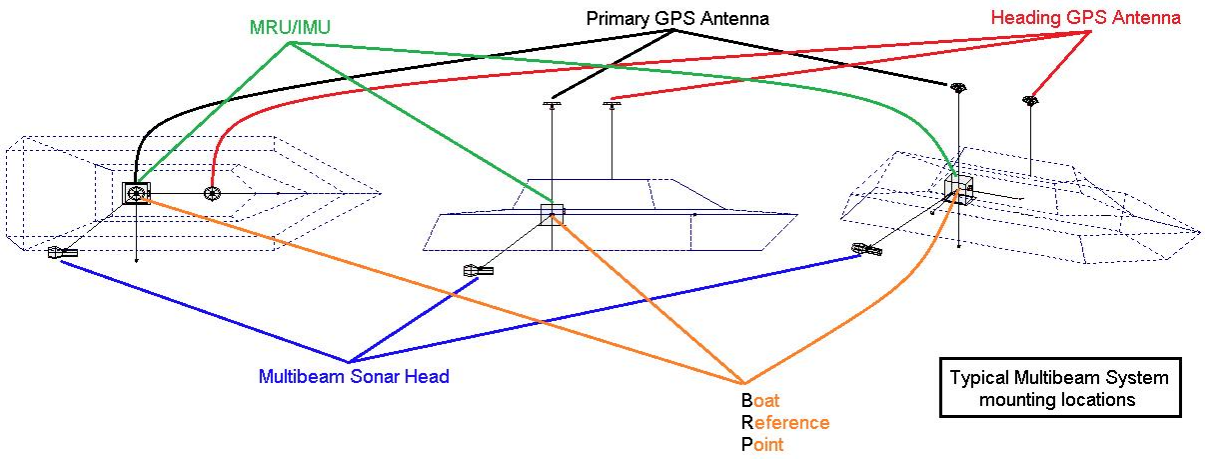
Caveat #1: Everything mentioned in this article is based upon what we call the 'HYPACK Preferred Method'. These procedures are what we consider to be the most logical and practical ways to set up and calibrate your multibeam system. We understand that there are other methods in which this can be accomplished, but this is the method with which it is easiest to resolve problems so it is the method we teach.

Caveat #2: These are only the basics for setting up the hardware. Depending on the equipment you have, there may be multiple ways to set up the hardware. Please contact the Tech. Support department at HYPACK for specific questions and always reference the 'HYSWEEP® Interfacing' Notes PDF file located in the C:\Hypack 201x\Help directory.

EQUIPMENT MOUNTING

Before putting a multibeam system into use, you must first mount all of the equipment on the vessel. In a perfect world, mounting all the pieces of equipment on the same planar surface, so that everything is conveniently and perfectly oriented to one another, would be nice, but it is rarely ever the case. Most systems have their equipment mounted in multiple locations on the boat, and there is no guarantee that they are in this perfect symmetry.

FIGURE 1. *Typical Multibeam System Mounting Locations*



Multibeam Sonar

Wherever possible on your vessel, mount the sonar and its bracket or pole where it will be at its most rigidly supported position and away from any electrical or mechanical noise interference.

The Sonar manufacturer may recommend a particular minimum depth to assure the sonar travels through ‘clean’ water, and that the sonar head and any fairing added to it, does not act like a hydrofoil, and cause the boat to change its planing characteristics.

Note: The dual-point connection of the pole to the boat is extremely important. It provides the necessary rigidity, in order that the sonar will not experience any movement in the water.

Motion Sensor

If at all possible, mount the MRU/IMU at the vessel’s center of gravity, or as near as possible. This will reduce the number of lever arm calculations that will be applied to the data during processing.

When mounting the MRU/IMU, pay careful attention to taken to orient the alignment marks on the sensor, to the alignment of the keel of the vessel. Improper alignment of the MRU/IMU with respect to the alignment of the keel will cause a ‘bleed-over’ of roll data in the pitch values, and pitch data in the roll values.

Heading Sensor

There is no requirement for the location of this sensor, but mounting it very rigidly is highly recommended. With any of the devices in this system, there can be *no* movement when a survey is being conducted.

GPS Antenna(s)

If at all possible, mount the GPS antenna directly over the boat's center of gravity. This can be particularly important if you are using a RTK GPS for vertical positioning.

Boat Center of Gravity

Prior to performing the patch test and after all of the equipment has been mounted, you must locate the boat's center of gravity, as closely as possible. This point is also known as the boat reference point (BRP). From the BRP, as accurately as possible, measure the forward, starboard and vertical distances to each of the above sensors.

Finding the boat's center of gravity is not an easy feat. The varying ways that the boat is loaded with fuel, supplies, and personnel each day, can cause this position to move, especially on smaller, more motionally dynamic vessels. Regardless, this location must be determined and all sensors measured from it.

Entering Offsets in the Software

Enter the above values into *both* the HYPACK® and HYSWEEP® HARDWARE programs. Offsets do *not* get duplicated during processing.

HYPACK® HARDWARE

- Positioning Device (GPS, Inertial System, etc.)

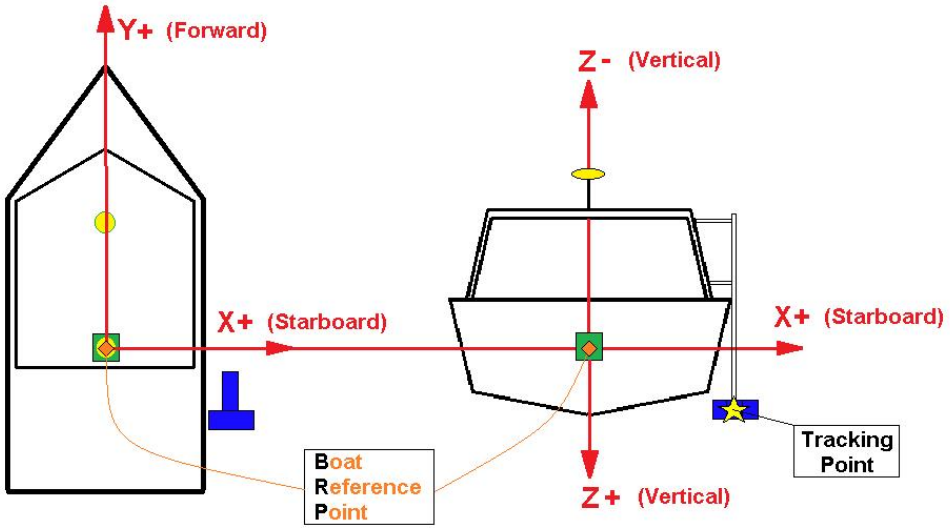
HYSWEEP® HARDWARE

- HYPACK Navigation
- Motion Sensor
- Heading Sensor
- Multibeam Sonar

Important: Each of your sensors (Sonar, MRU/IMU, and Heading) most likely has their own software which will allow you to configure that sensor, individually, with offsets and other settings. It is the 'HYPACK Preferred Method' that you enter or input as little as possible in these software programs, as you may be duplicating or negating any offsets or settings that you have already made in the HYPACK® and HYSWEEP® HARDWARE programs.

Pay close attention to the X-Y axes, as *they may be different between HYPACK® and the sensor's software*.

FIGURE 2. HYPACK® Convention for Offset Measurements



Minor inaccuracies in the offset measurements can have catastrophic effects on your Patch Test and any subsequent survey data that you collect.

Boat Tracking Point

the boat tracking point should be set to the same location (offsets) as the multibeam transducer. This is set in the HYPACK® HARDWARE program by clicking on 'Boat' and entering the Forward and Starboard offsets of the multibeam transducer from the BRP.

Important: The tracking point is used by SURVEY to position your transducer over your survey lines. (The distance off line is reflected in your left/right indicator display.) It is a crucial part of the patch test.

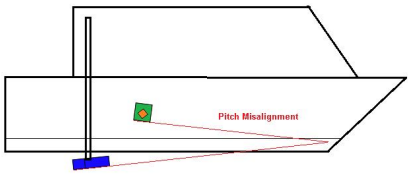
So… What is a Patch Test?

Once you have completed the setup, you are ready for the patch test.

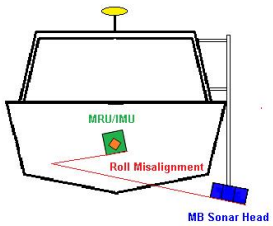
A patch test is a combination of hydrographic survey data collection procedures and the subsequent statistical analysis that is performed on this collected data to determine angular misalignments and timing differences in the multibeam system hardware.

Angular Tests

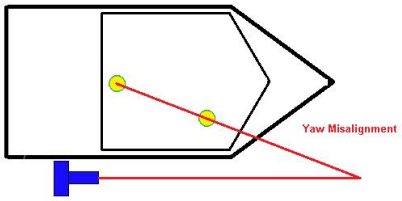
The **Pitch** test determines the offset or angular misalignment between the fore/aft orientation of the multibeam sonar head with respect to the motion reference unit (MRU) or inertial motion unit (IMU).



The **Roll** test determines the offset or angular misalignment between the port/starboard orientation of the multibeam sonar head with respect to the motion reference unit (MRU) or inertial motion unit (IMU).



The **Yaw** Test determines the offset or angular misalignment between the orientation of the multibeam sonar head with respect to the heading sensor.



Timing Test

The **Latency** Test determines any time-synchronization differences between the time-tagging of the multibeam soundings with respect to the time-tagging of the position records.

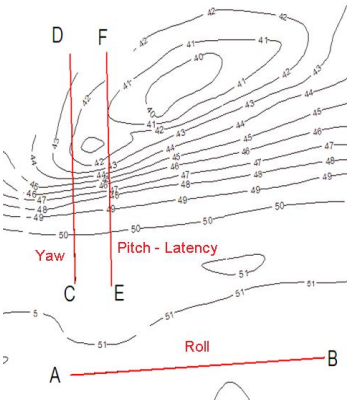
Take care that the time-tagging for the motion and heading data are also synchronized with the rest of the data collected.

Each test in a Patch Test is conducted over a specific bottom terrain, varying boat speeds and direction of the data collection.

Bottom Terrain

Finding the area for performing your patch test is probably going to be the most difficult part. You will need two different types of bottom terrain:

- Flat Bottom (Roll Test)
- Sloped Bottom with a quick and significant elevation change (latency, pitch, and yaw tests). The more abrupt or vertical the change in the bottom terrain, the better the test results.)



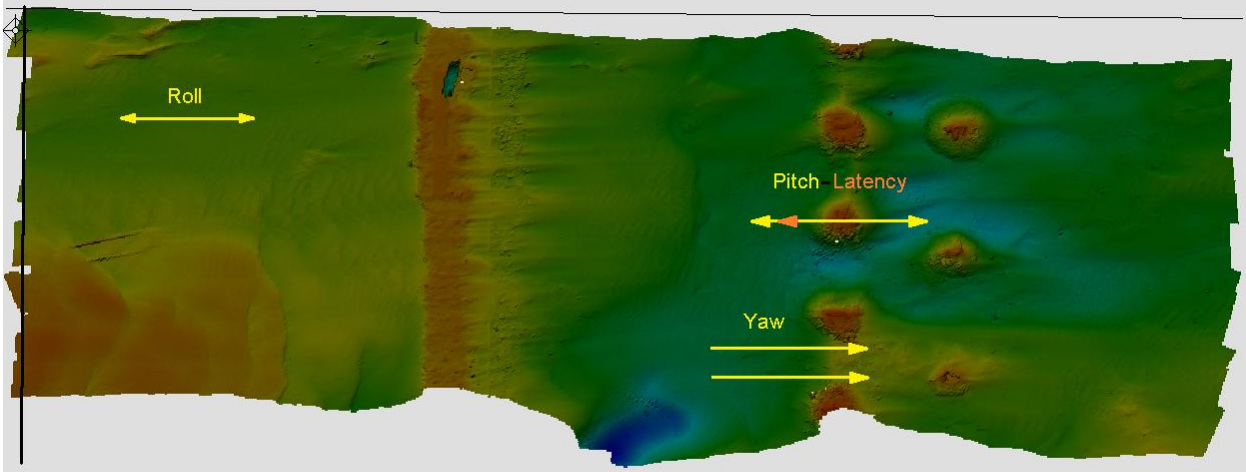
Locating the Patch Test Area

Understand that collecting and processing your patch test data before you start your actual survey, is *not necessary, but* it *is* necessary that you collect the patch test data before you finish your survey.

My recommendation: If you need to collect patch test data, whether it is for a new installation or to verify that your current values are still good, and you also need to perform an actual survey, go ahead and begin the data collection over the survey area. While you are collecting your survey data, you will likely come across the two types of bottom terrain that you need for a patch test.

Once you have located these two areas (flat and sloped), **STOP SURVEYING** and set up your run lines for your patch test. It will take you less than 30 minutes to collect your patch test data, then you can continue collecting survey data. By following this recommendation, you can 'kill two birds with one stone' and avoid wasting time trying to locate suitable areas in which to perform your Patch Test data collection.

FIGURE 3. *Patch Test Areas*



Areas located for collecting Patch Test data

Why suspend the survey to collect your patch test data? If you hit something with your sonar head before you have your patch test data, and it causes the current orientation and alignment of the sonar head to change, the survey data you have collected will be unusable. Once you collect the patch test data, if you damage the mounting orientation, you will have the patch test information to apply to the survey data. When you repair your system, you must then only collect more patch test data for the 'new' sensor alignment, and orientation.

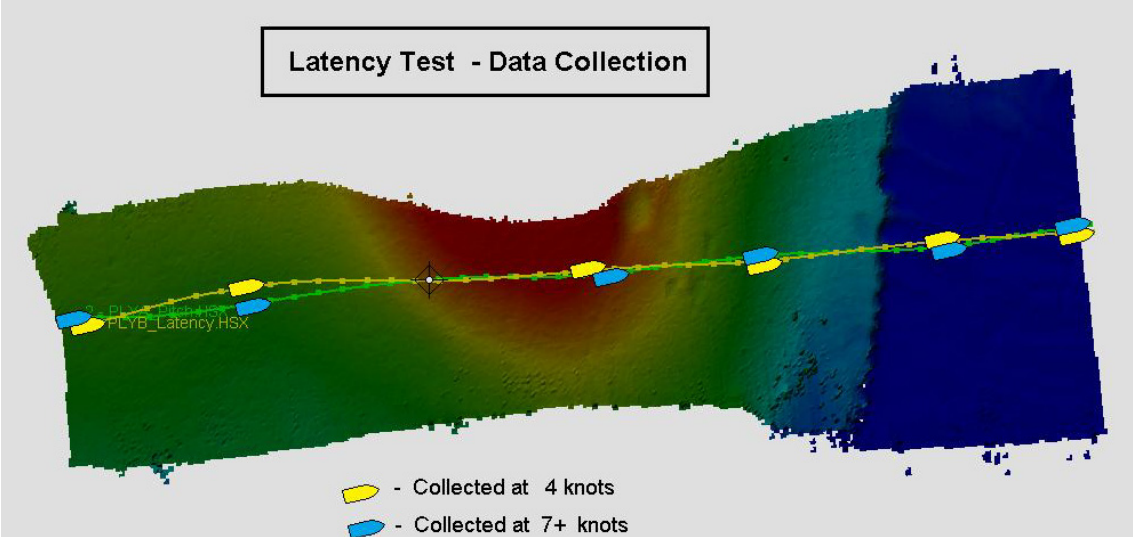
Setting up the Run Lines

Once you have located the bottom terrains necessary for performing the Patch Test:

- **Create run lines, at least 300 feet (100 meters) in length**, over these areas.
  That's right! *Only* 300 feet of collected data is necessary to perform the statistical analysis that determine the four patch test offsets.)
- **Orient the roll test run line** on the Flat Bottom or as parallel as possible to any contour it may have.
- **Orient the Latency, Pitch, and Yaw run lines** as perpendicular as possible to the sloped bottom. Here are the setups for each test:

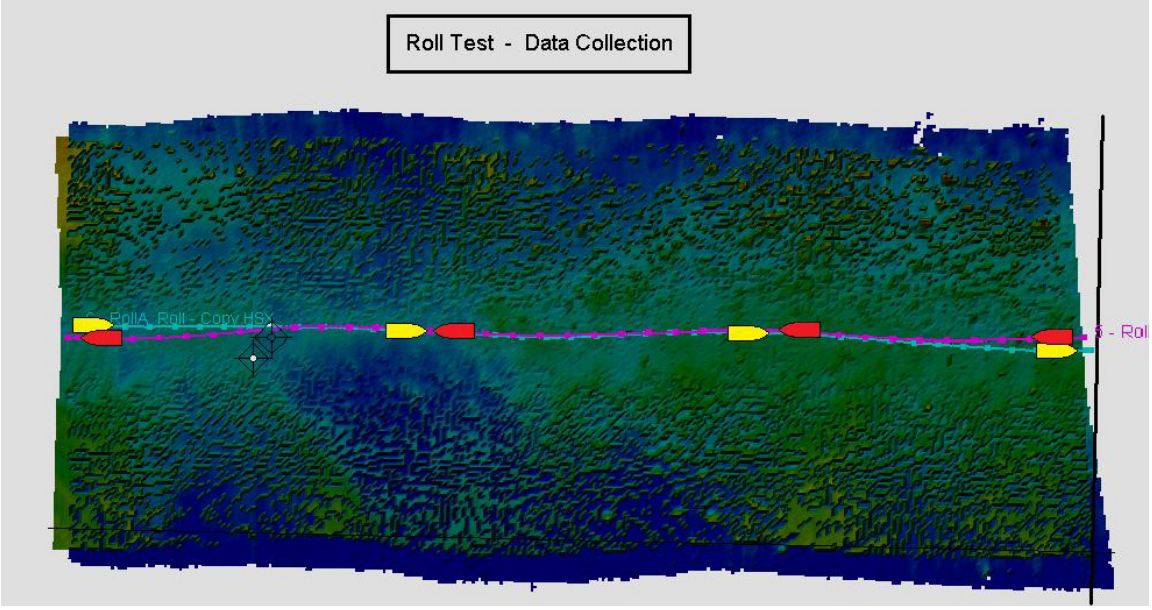
- **Latency Test:** Two passes, collected on the same line and in the same direction, at significantly different speeds, over a sloped bottom. The speeds should vary by more than 50% from one another (e.g. first pass at 4 knots, second pass at 7+ knots)

FIGURE 4. *Collecting Latency Test Data*



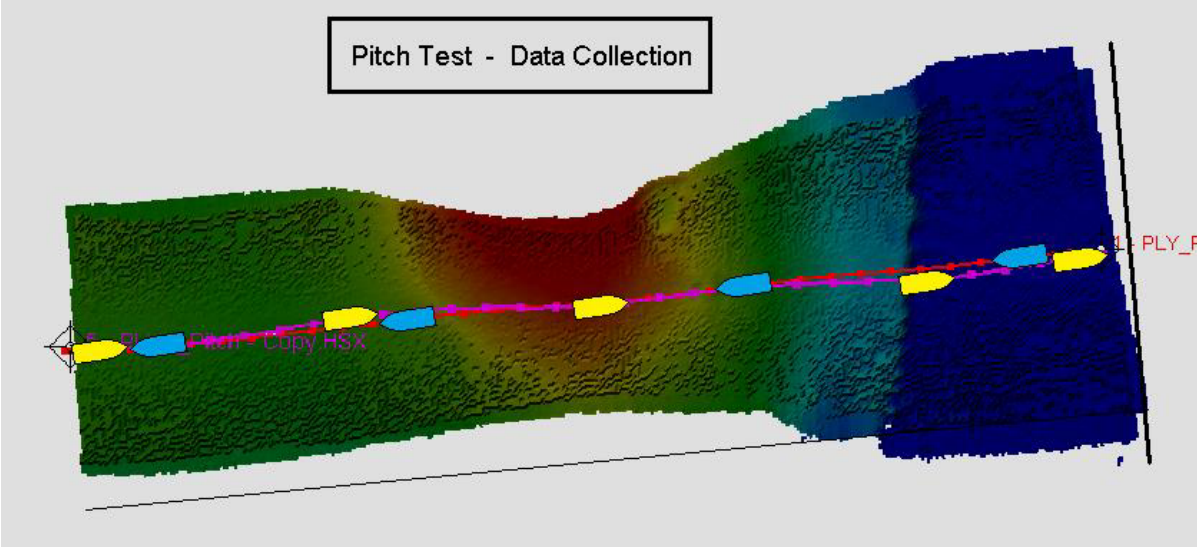
- **Roll Test:** Two passes, collected on the same line in opposite directions, at the same speed (typically your normal survey speed), over a flat bottom.

FIGURE 5. *Collecting Roll Test Data*



Pitch Test: Two passes, collected on the same line in opposite directions, at the same speed (typically your normal survey speed), over a sloped bottom.

FIGURE 6. Collecting Pitch Test Data



Yaw Test: Two passes, collected in the same direction, along parallel lines spaced by the depth of water, at the same speed (typically your normal survey speed), over a sloped bottom.

Note: For the best results, you need a 50% overlap in the data. it is best to run the first pass ‘straight’ while ‘painting’ the matrix cells. On the second pass, drive the boat down the outer-edge of where the matrix was painted by the first pass, steering the boat so that it runs as parallel as possible to the first pass. This will give you the 50% overlap needed to generate good results for the yaw test.

FIGURE 7. Collecting Yaw Test Data

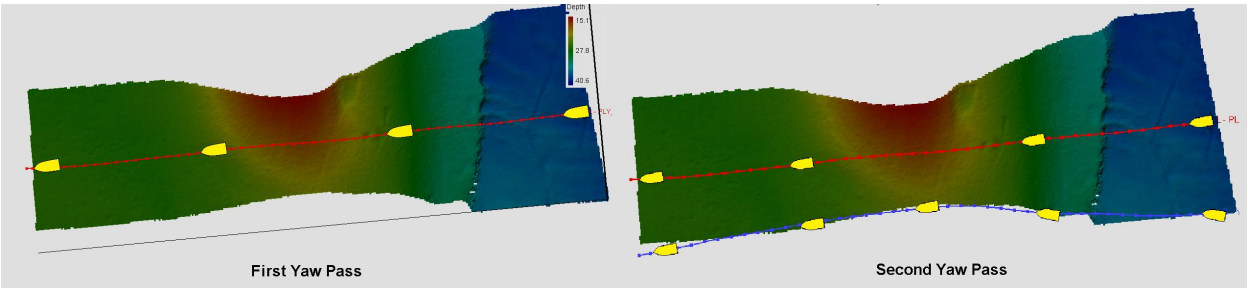
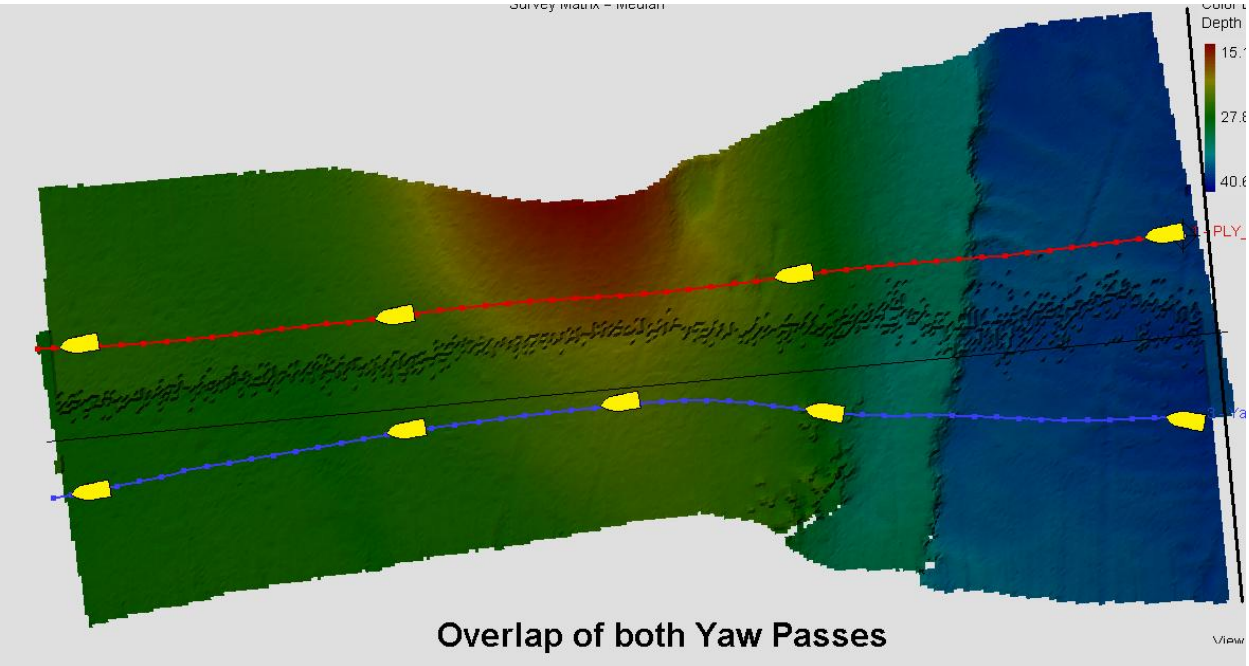
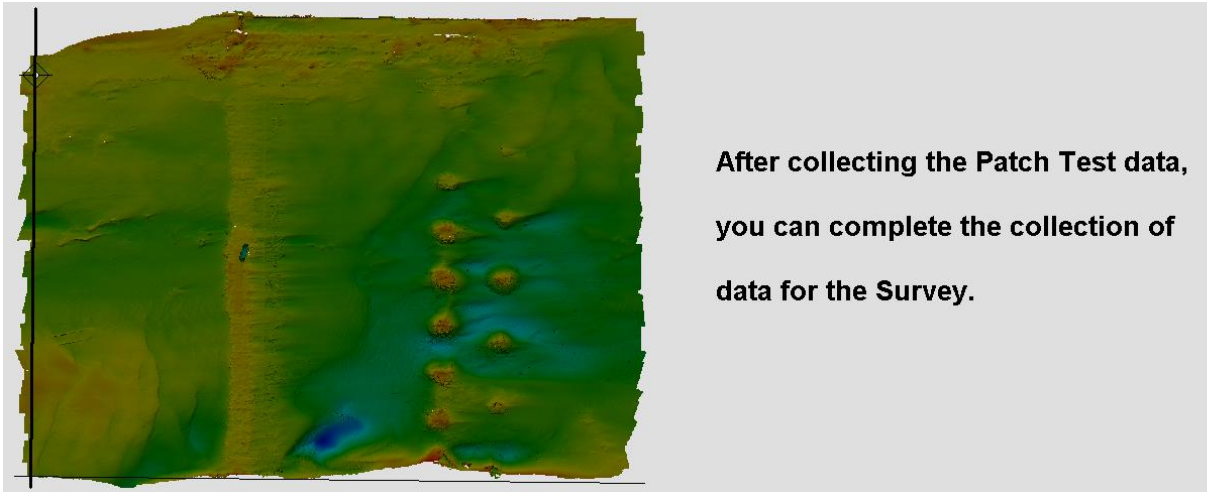


FIGURE 8. Overlapping Yaw Lines



You must collect, at least, one pair of run lines for each test. However, you may collect as many pairs of run lines for each test as you would like. You can enter all of these run line pairs into the Patch Test program simultaneously. This is not necessary, but more 'good' data points can help in producing better statistical values for each test.

FIGURE 9. Completing Your Survey.



Upon completion of the survey, process your patch test data so you can apply the proper offsets to your survey data.