



Multibeam Calibration: Conducting a Patch Test

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What is a Patch Test?

A **patch test** is the systematic approach used for calibrating the various sensors used in multibeam data acquisition. There are three main sensors needed to map the bathymetry of the seafloor: the navigation sensor, attitude sensor and the echosounder (SONAR). The navigation sensor measures ship speed, heading and position. The attitude sensor measures the motion of the ship (i.e. pitch, roll, heave and yaw). The echosounder is used for transmitting and receiving sound to determine water depth and seafloor characteristics.

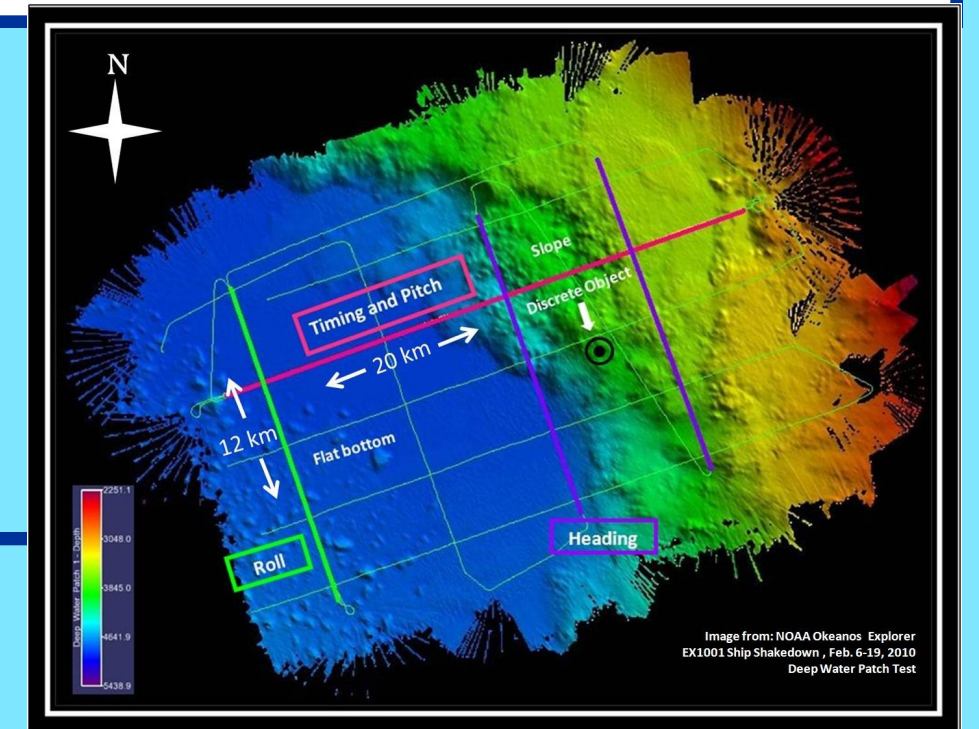
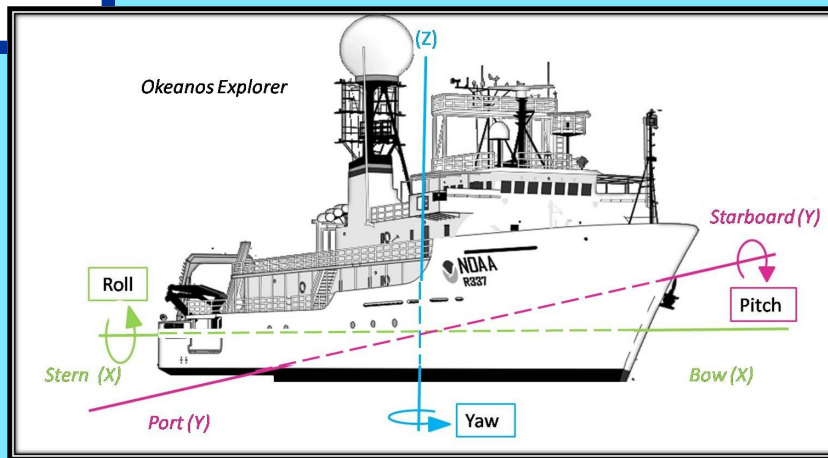
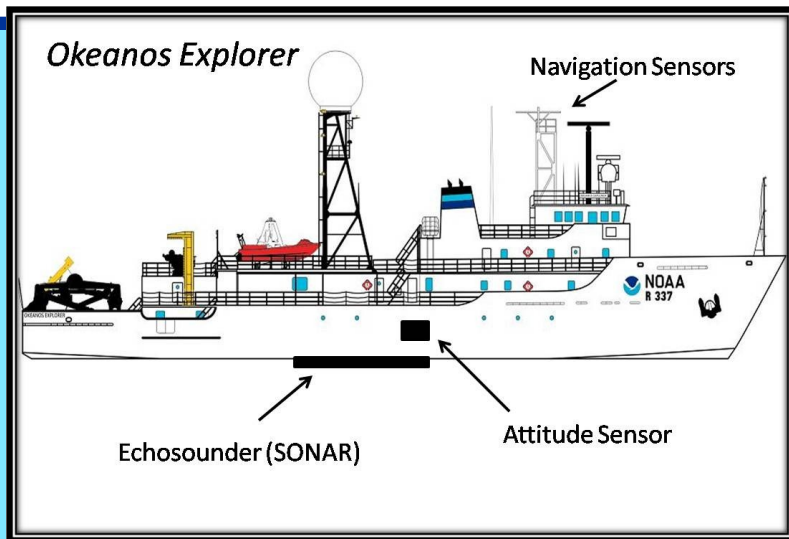
The purpose of calibration is to correct for systematic errors created by the positioning and mounting angles of the different sensors. A correctly calibrated system will show the same bathymetry in repeated tests, regardless of variables such as speed, direction and ship motion.

What a Patch Test Consists of:

A patch test is conducted in an area of known bathymetry. An EM302 transducer (used on the *Okeanos Explorer*) performs in a wide range of depths, therefore both a shallow (500–2500 meters) and a deep (2500–4500 meters) water patch test are run. For reliability, it is preferable that the same area be used annually. A specific line plan is created to measure offsets from slight misalignment of the sensors. The plan consists of pairs of lines, each pair designated to measure its own variable.

There are four variables that are typically measured for the calibration. These are **time delay**, **pitch**, **roll** and **heading**, which must be calculated in this order. A few seafloor features are needed in the measuring of the offsets between specific sensors, including a slope, flat bottom and a discrete object (i.e. a pipe, shipwreck or rock).

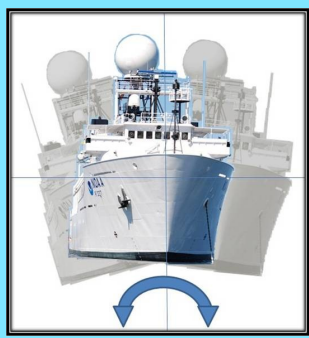
Note: When conducting a patch test, it is important to eliminate sound velocity as a source of error. Therefore, a current **sound velocity profile** (SVP) should be maintained throughout the patch test.



How to Measure Variables

Time Delay

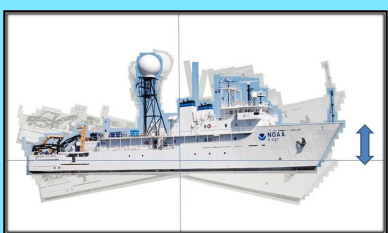
Roll



- Between navigation and SONAR sensors
- Time is the common factor among all sensors.
- Calibrate time first to eliminate it as a source of error while conducting the other tests.
- Must include a 10-20° slope with a flat surface on each side.

Pitch

Pitch



- Between attitude and SONAR sensors
- Pitch can use the same coincident lines as time delay.
- Must include a 10-20° slope with a flat surface on each side.

Roll

- Between attitude and SONAR sensors
- Must be conducted on a flat bottom in order to show the same offset in the port and starboard outer beams.

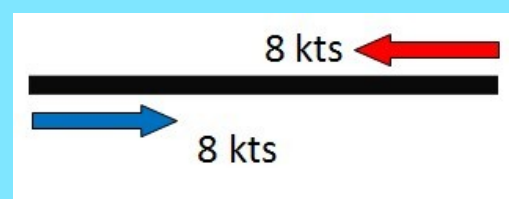
Heading

- Between navigation and SONAR sensors
- Requires a discrete object or slope (if no object available) in the outer beams of two separate lines.
- Object should be centered between the two lines, and half the distance of each line.

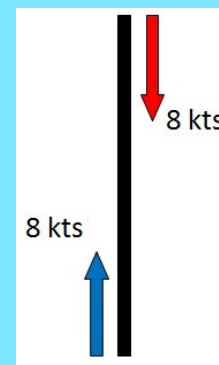
Setup:



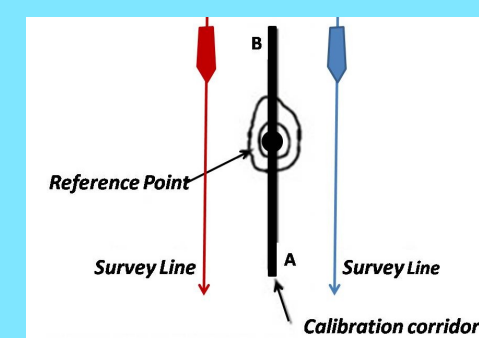
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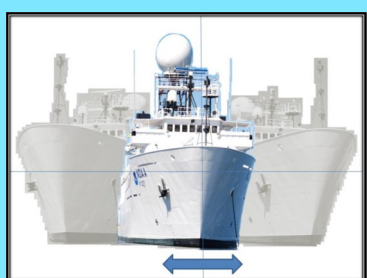
Setup:



Setup:



Yaw



- Run one line twice, same direction, two different speeds
- Run one line twice, same speed, opposite directions.
- Run one line twice, same speed, opposite directions.
- Two separate lines of equal length, same direction, same speed.

Results:

- If a time delay offset is present, the position of the soundings of the slope will shift laterally with a change in speed.

Results:

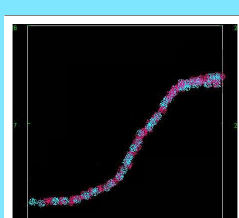
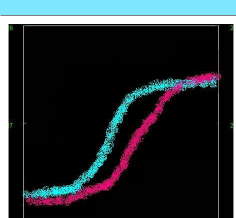
- If a pitch offset occurs, the soundings of the slope will shift for reciprocal directions.

Results:

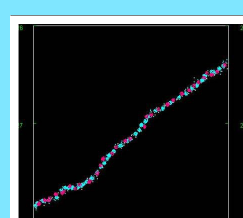
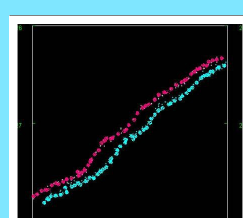
- A roll offset will be shown as a change in sounding height on the same side of the swath for each direction.

Results:

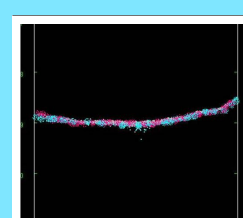
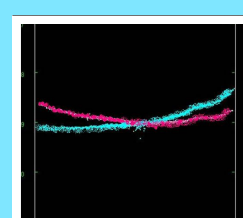
- If an offset is present, it will be shown as a shift in the object's position.



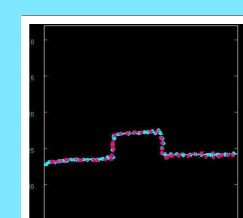
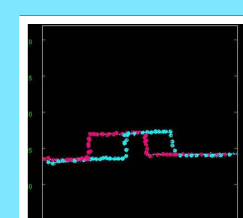
Incorrect Correct



Incorrect Correct



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Incorrect Correct

Sources:

- NOAA Hydro Training Course, Pacific Hydro Branch, *MBES Calibration Procedures*, 2009
- NOAA Ship *Okeanos Explorer*, Standard Operation Procedures, *Multibeam Patch Test SIS Calibration*, 2009
- CARIS HIPS 6.1 User guide (calibration tool)

*Offsets can be calculated using **CARIS** calibration tool or in **Seafloor Information Systems (SIS)** calibration tool*