Multibeam Patch Testing and the Importance of Good Positioning

By Joe Burnett

In my previous 2 articles, I have discussed how to collect and process your multibeam patch test data. Now, I am going to demonstrate the importance of the accuracy of your positioning system, specifically, GPS. It is well-known, that most DGPS systems have a horizontal accuracy of 2 meters or less, 95% of the time, and most, produce better than 2 meter accuracy. It is also known, that most RTK GPS systems have a horizontal accuracy of 2-7 centimeters, 95% of the time. Even if we were to consider a DGPS system to have sub-meter horizontal accuracy, there is still a considerable difference between that and an RTK GPS, as far as horizontal accuracy is concerned.

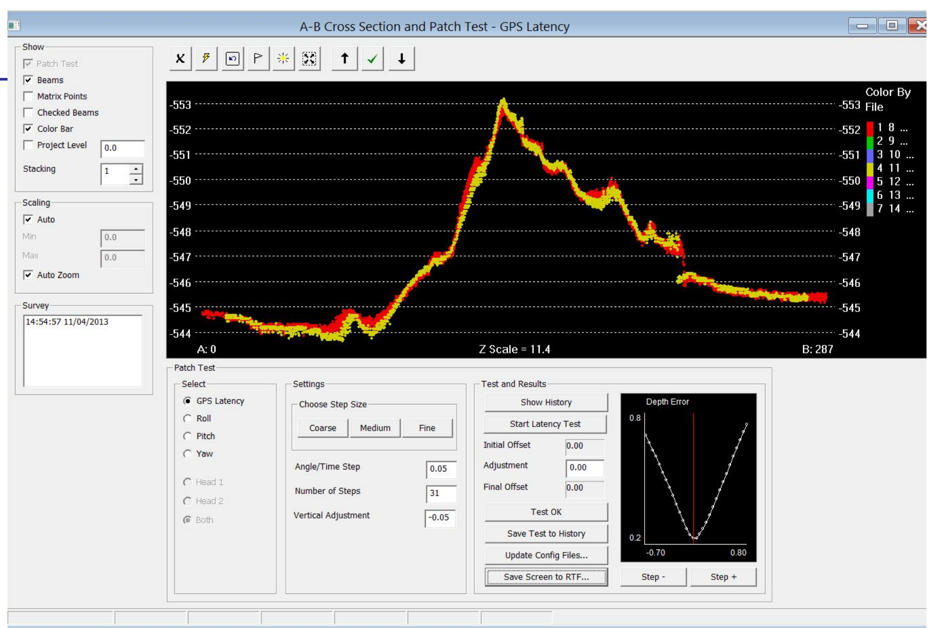
Recently, I was fortunate enough to be able to collect patch test data using both a differential GPS (DGPS) system, and a real-time kinematic GPS (RTK GPS) system. We are going to look at the results of these two patch tests and get an understanding of why their values differ.

Important: It is important to remember that the values produced from a patch test are statistical values. However, when you provide more consistent and higher accuracy data, you can expect to produce more accurate and repeatable values, statistically speaking.

DGPS Patch Test Results

Latency

FIGURE 1. Sample Latency Test



Notice that the data in the cross-section lines up fairly well, and produced a good V-pattern and the expected 0.00 latency value, since all of the data has been time-synchronized to the UTC time from the GPS.

Roll

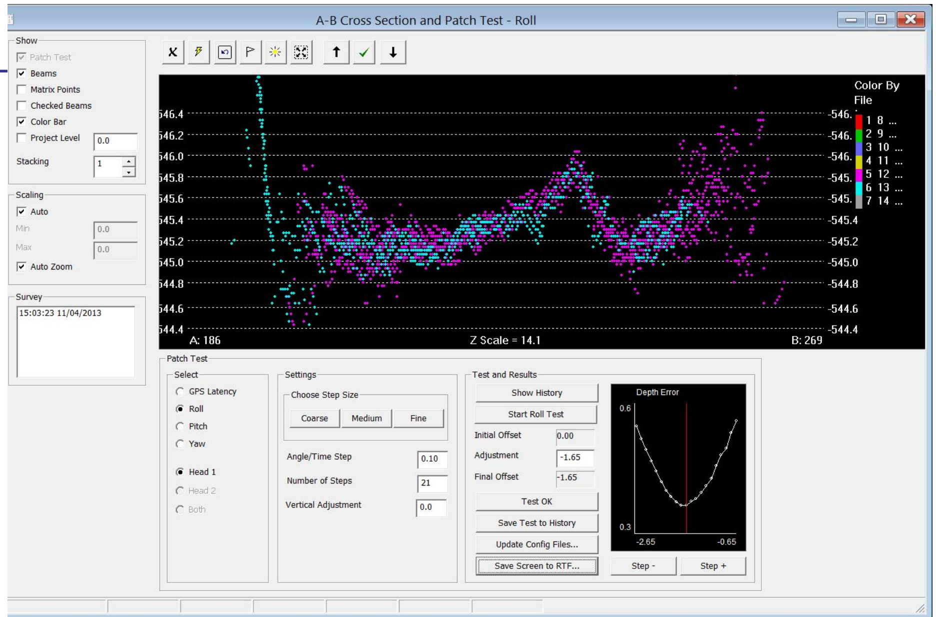


FIGURE 2. *Sample Roll Test*

Notice, again, that the data in the cross-section 'lines up' better here, disregarding the unedited outer beams, as the Roll Test is less susceptible to positional errors, like the other angular tests. The Roll Test also produced a very good V-Pattern, suggesting that the best result was obtained.

Pitch

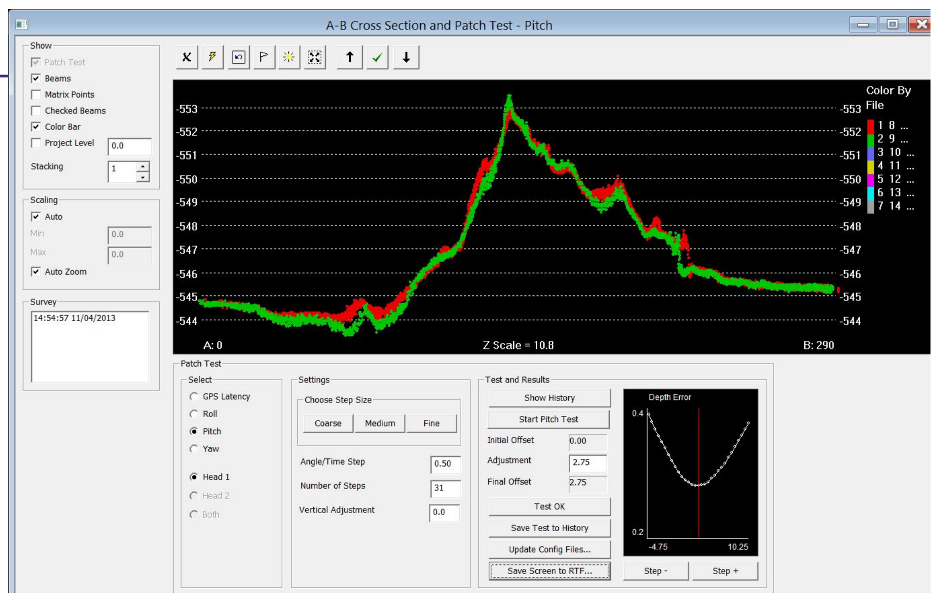


FIGURE 3. *Sample Pitch Test*

Notice the similarity to the latency test cross-section, and that the data lines up fairly well. It produced a good V-pattern suggesting that the best value was also obtained for the pitch test.

Yaw

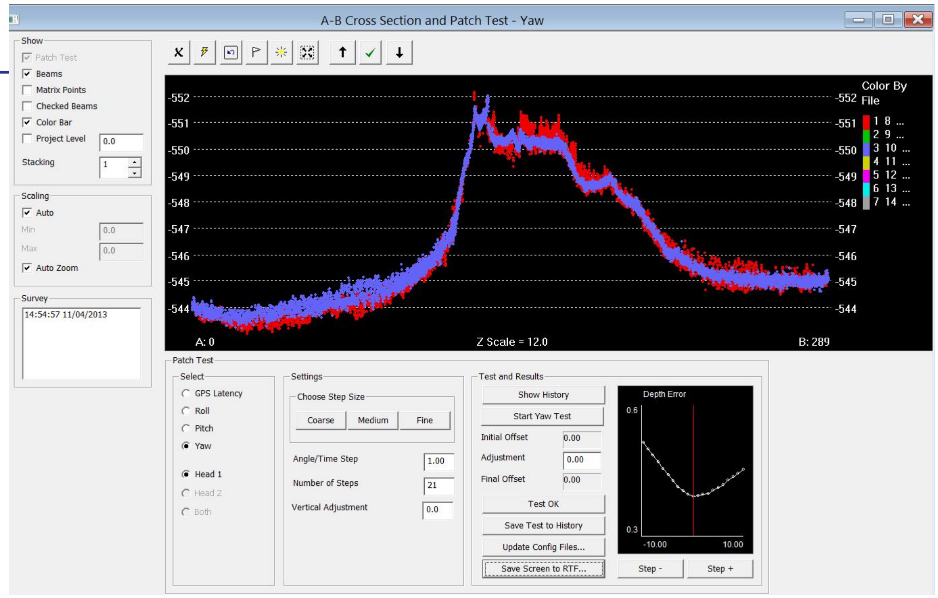


FIGURE 4. Sample Yaw Test

The overlap of the data in this cross-section, also lines up very well, and while the V-pattern wasn't as defined as the other tests, a distinct value was obtained for the yaw test.

RTK GPS Patch Test Results

In HYPACK® HARDWARE, the DGPS system was disabled and the RTK GPS system was enabled, then the same exact lines were run. Patch test data was collected using the RTK GPS as the positioning system. Here are the results from that set of data:

Latency

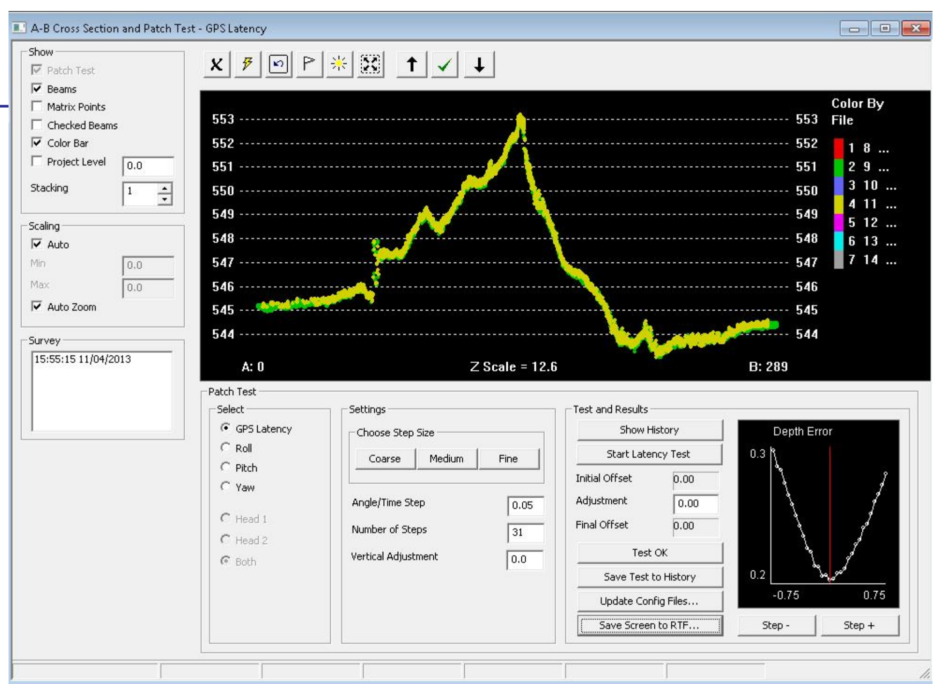


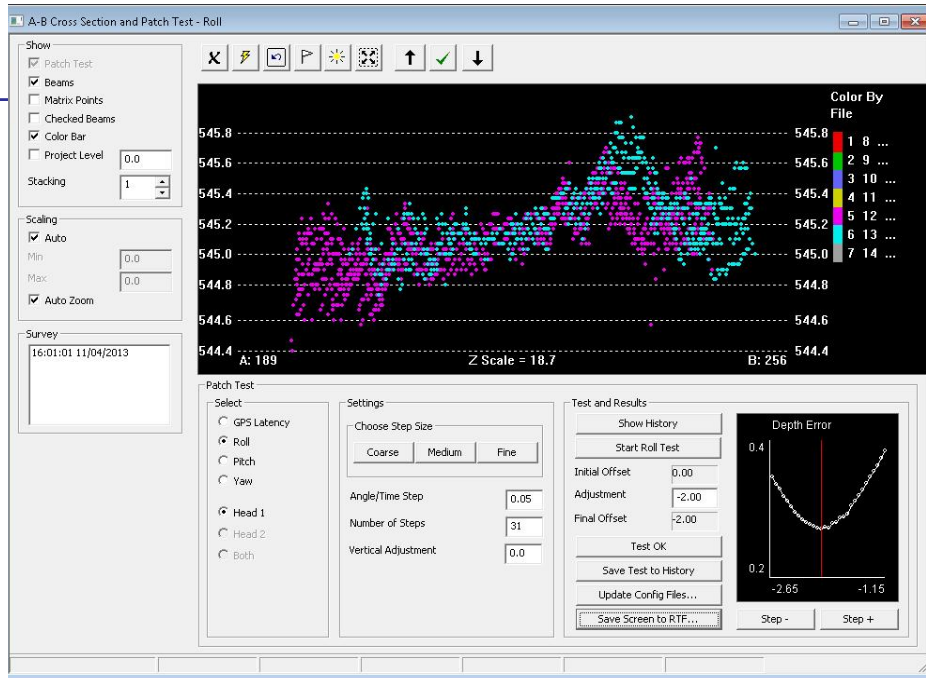
FIGURE 5. Sample Latency Test with RTK Data

Notice the overlap of the data in the cross-section here. It's almost a perfect overlay between the two files.

It also produced the expected 0.00 latency value and a good V-pattern.

Roll

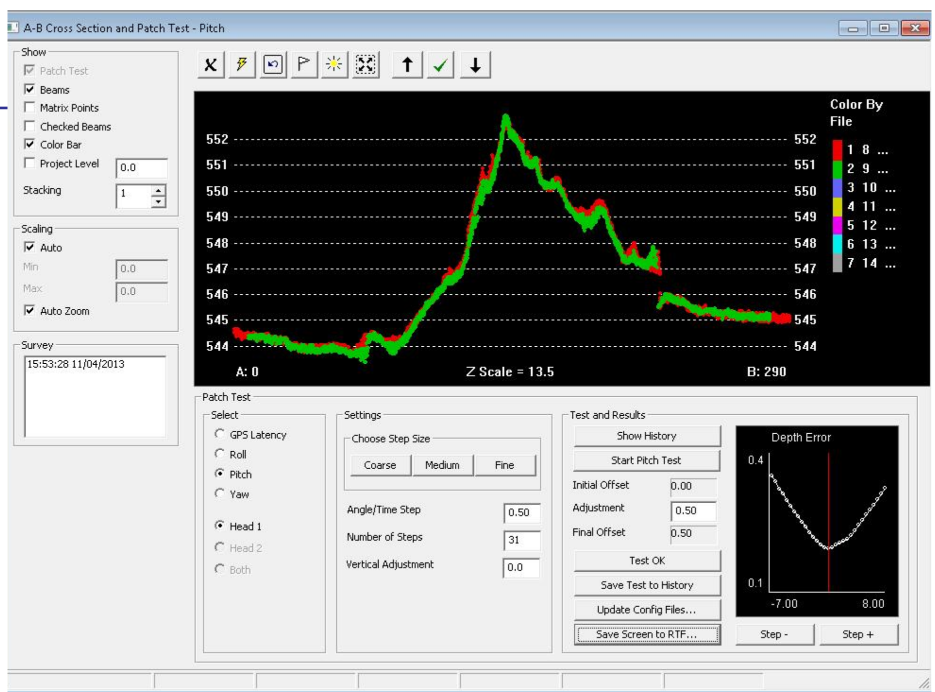
FIGURE 6. Sample Roll Test with RTK Data



The overlap between the two files line up very well here and a good V-pattern was also produced.

Pitch

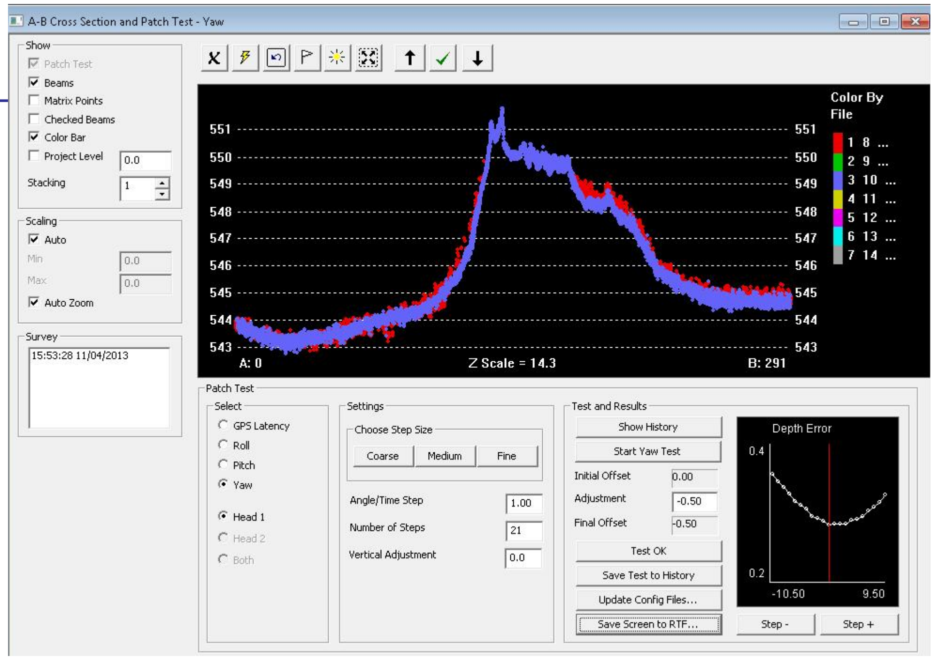
FIGURE 7. Sample Pitch Test with RTK Data



The overlap of the data in the cross-section here, is also, almost a perfect overlay. It also produced a very good V-pattern.

YAW

FIGURE 8. Sample Yaw Test with RTK Data



The overlap of the data in this cross-section, also lines up very well, and, again, the V-pattern wasn't as defined as the other tests, but a distinct value was obtained for the yaw test.

POSITIONING SYSTEM PATCH TEST COMPARISON

	DGPS	RTK GPS	Difference
Latency	0.00	0.00	0.00
Roll	-1.65	-2.00	-0.35
Pitch	2.75	0.50	-2.25
Yaw	0.00	-0.50	-0.50

As we can see, there are some significant differences in the angular test values. This is due to the level of accuracy of the positioning between the two tests.

TABLE 1. From a Slide in our Patch Test Training Notes:

AVOID PATCH TESTING WITH BAD POSITIONING

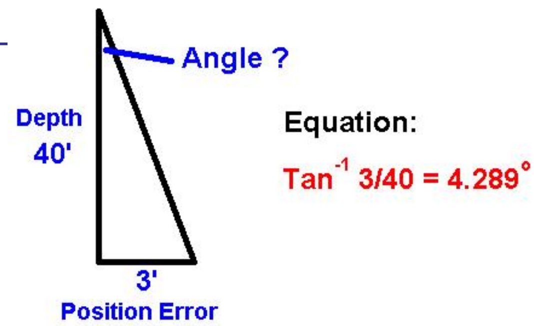
- Use RTK GPS whenever possible.
- Assuming 3' DGPS shift in 40' of water
    - Latency Test: +/- 0.4 seconds.
    - Pitch Test: +/- 4.4 degrees.
    - Yaw Test: +/- 4.3 degrees.

How are these differences calculated?

For the angular tests, it's simple geometry:

ArcTan of (Position Error/Depth) = Angle **(EQ 1)**

FIGURE 9. Calculating the Differences



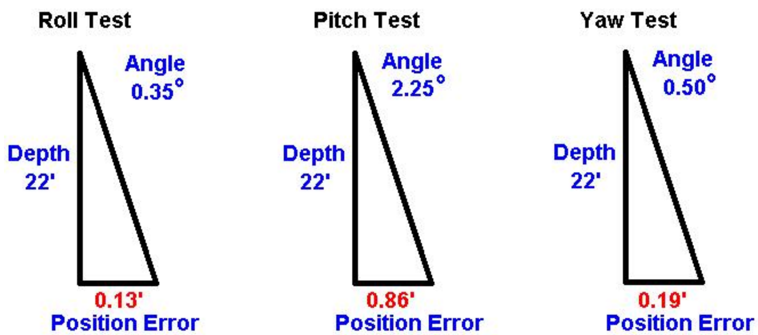
Now, if we look at the differences from the 2 tests, we can derive the position error between them that caused these differences.

In these patch tests, the depth of water was approximately 22 feet deep.

Working Equation 1 differently, we can find the position error between each test:

(Depth)x(Tan of the Angle) = Position Error (EQ 2)

TABLE 2. Calculating Position Error



- **Roll Test:**

22 x Tan(0.35) = 0.13’ (EQ 3)

- **Pitch Test:**

22 x Tan(2.25) = 0.86’ (EQ 4)

- **Yaw Test:**

22 x Tan(0.50) = 0.19’ (EQ 5)

Although these distances may seem insignificant, they can make very significant differences in the values produced in a patch test.

MORAL OF THE STORY

So, which test has the correct set of values to enter in HYSWEEP® HARDWARE for your Offsets?

BOTH !!

1) **If DGPS is the *only* positioning system** you have, there is nothing wrong with using these values.

2) **If you have both DGPS and RTK GPS**, use the RTK GPS derived values. Then, no matter which positioning system is used during your surveying efforts, *always use the RTK GPS derived values*. They were derived from more accurate and repeatable values, therefore, should be used for either positioning system.

In the data that we later collected for the survey, using DGPS as our positioning system, we used the RTK GPS derived values and found that the data blended more seamlessly than with the DGPS derived values.