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Multichannel Laser Data

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INTRODUCTION

This article looks at beach replenishment surveyed by the HYPACK NEXUS drone. The point is to better understand how the individual channels (beams) of a multichannel laser scanner compare to one another.

MULTICHANNEL LASER SCANNER

The Velodyne VLP-16 laser scanner (figures 1 and 2) is used on the NEXUS drone. Figure 3 shows the drone itself with the scanner mounted front and center. The VLP-16 was chosen because it is small and has low power requirements.

FIGURE 1. *Side view of the Velodyne VLP-16 laser scanner. This is the topographic device used in HYPACK's NEXUS drone.*

The schematics of figure 2 show how the scanner provides data in three dimensions. A disk rotates within the housing and 16 beams (channels) are mounted on the spinning disk. Beam pointing angles (w in the side view) are precise from +15 to -15 degrees at 2 degree increments. The top view shows the rotation of the disk through 360 degrees. We get 300,000 points per second from this!

The scanner is rotated 90 degrees for NEXUS, to what we call a vertical mount. That's easy to see in figure 3. Schematic y becomes survey z and other axes change accordingly. With NEXUS rotation the individual channels scan forward and aft (+/- 15 degrees) and 360 degrees sideways.

FIGURE 2. *VLP-16 side and top view schematics. 16 separate channels span from +w to –w (side view) at two degree increments (+/- 15 degrees). One channel = one beam. The channels rotate through 360 degrees (top view).*

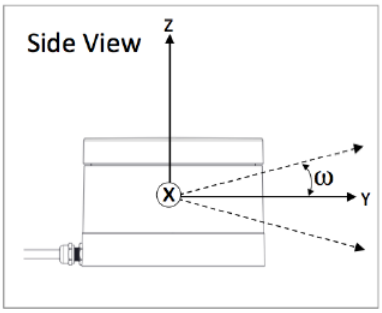
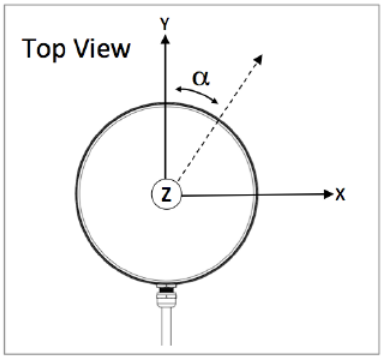


FIGURE 3. *NEXUS drone system with the VLP-16 scanner at front pointing downward. This orientation gives 360 degree coverage side to side and +/- 15 degree coverage fore and aft (16 beams at 2 degree spacing).*



THE SURVEY

We used a beach survey to test the VLP-16 channels. Figure 4 shows an area of active replenishment.

FIGURE 4. *Hammonasset Beach —an Area of Active Replenishment*

An interesting section of the Hammonasset beach replenishment survey shows dredge pipe leading to a distribution area. Done with four of the 16 laser channels, which provided plenty of data.

Further on we look at NEXUS performance using 4 vs 8 vs 16 channels.

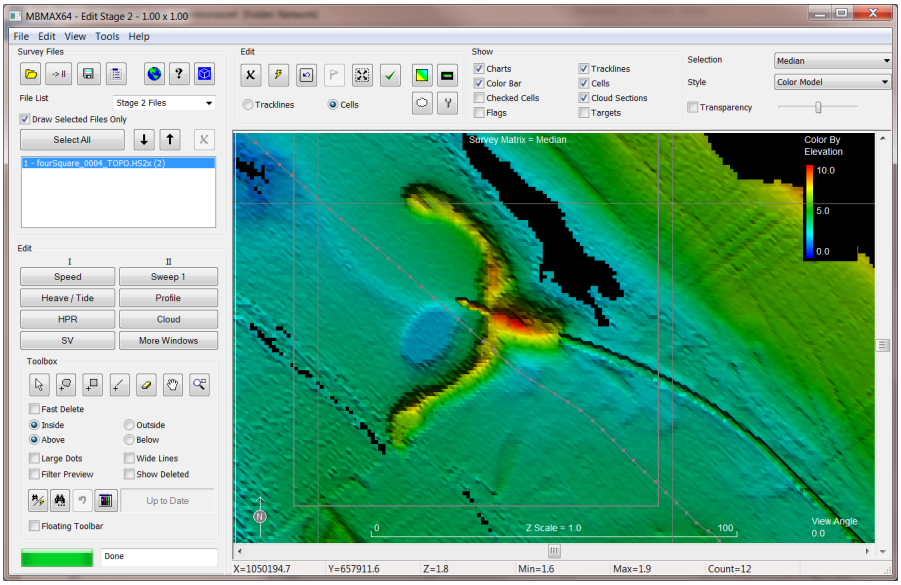
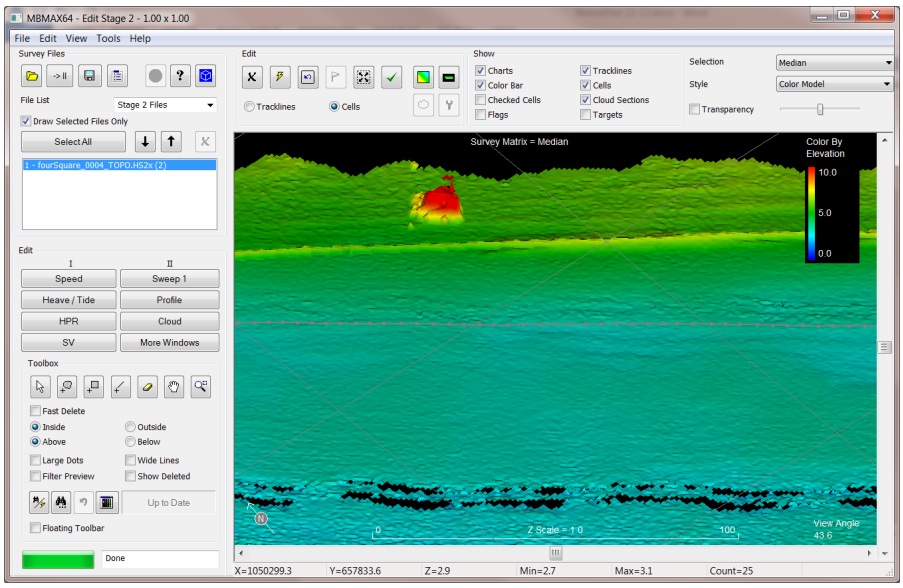


Figure 5 shows the statistical test site—relatively flat, perfect for performance testing!

FIGURE 5. *A less interesting area used for statistical calculations. Because of gridding, statistical results are more accurate over flat or gradually sloping terrain.*



TEST AND RESULTS

Statistical tests were done using HYPACK® MBMAX64 (64-bit HYSWEEP® EDITOR) multibeam processing program. Testing is not complex and involves only a few steps:

- Find an area of beach with gentle slope and survey it with all 16 channels enabled.
- Grid the best data 1 foot by 1 foot and save the average as the reference surface. In this case, the best data is the four inner channels, so channels 5-16 are discarded for the reference.
- Use MBMAX64 Check Line Statistics (in the Tools menu) to find the statistical difference between reference and the check lines. Check lines are (1) the four inner channels, (2) the eight inner channels, (3) all 16 channels and (4) four inner channels on a different day.

Figure 6 is an MBMAX64 screen shot showing one of the tests. Results from all four tests are shown in Table 1.

FIGURE 6. MBMAX64 check line statistics from one of the tests. Reference – check differences are quite small.

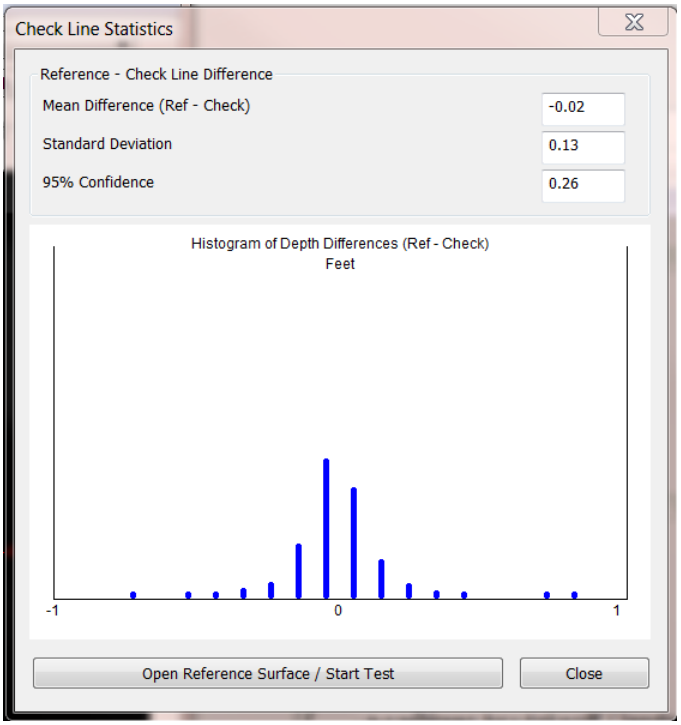


TABLE 1. The Results. The surprise (to me) is that uncertainty changes little using 4, 8 or 16 channels.

Number of VLP-16 Channels	Mean Difference (feet)	Standard Deviation vs Reference (feet)	95% Confidence vs Reference (feet)
4	-0.02	0.13	0.26
8	-0.01	0.17	0.32
16	-0.00	0.16	0.32

The uncertainty difference (one standard deviation) between 4 and 16 beams = 0.16 – 0.13 = 0.03 feet = 0.9 cm. That's not much considering data density is quadrupled.

CONCLUSIONS

This is a single test so we don't want to read much into it. A second test might give different results. We'll try it again next time out.

These results show that if you survey using all the channels there's only a small degradation in accuracy. Of course there's a tremendous increase in data size using all channels. If the inner four provide enough coverage (as in figure 4) stick with that!