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Mounting Strategies for LiDAR Scanners

By Dave Maddock

Every year the list of LiDAR scanners that are supported in HYPACK® grows larger. Whether it's mounted on a traditional survey vessel alongside a sonar, on a truck for a mobile land survey, or deployed on a drone, a laser scanner can be a useful addition to your toolkit. However, when you first integrate one of these sensors into your workflow, you will inevitably stumble over a few "gotchas" with acquiring and processing laser data—such as how best to mount it, how to run a patch test, and how to deal with the resulting high density cloud of points. Patch testing and data cleaning are covered by our standard training materials already. This article will focus on how best to mount your LiDAR, which can vary by manufacturer, model, and your survey goals.

Supported Devices

As of the HYPACK® 2017 release, HYPACK® supports almost a dozen models:

- RIEGL LMS and V Series products
- Leica ScanStation P-20
- Renishaw SLM (also used with the MDL Dynascan and Trimble MX2)
- Optech ILRIS
- 2G Robotics ULS-500
- Velodyne HDL-32E and VLP-16

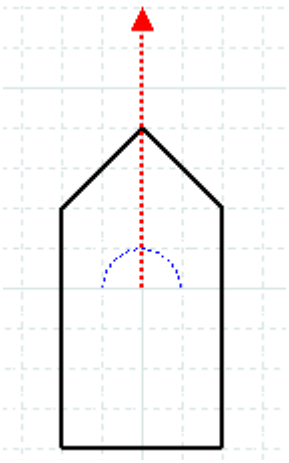
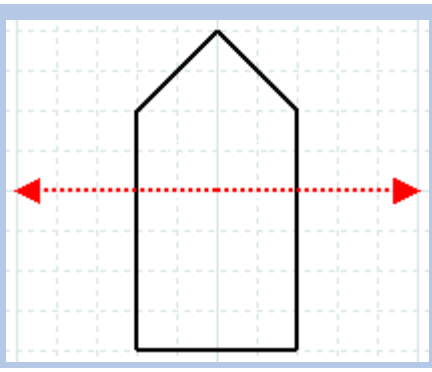
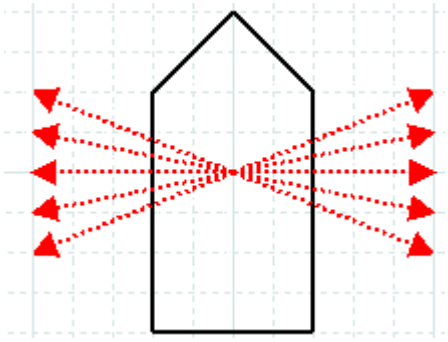
This list includes fixed 2D line scanners, line scanners with rotating heads or sector scanning capability, dual-head systems, and single-head systems with multiple beams. Each of these methodologies comes with its own mounting considerations.

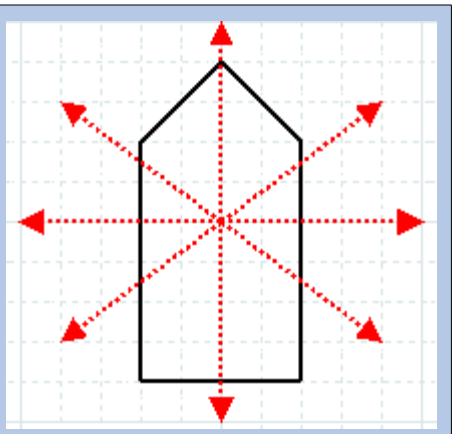
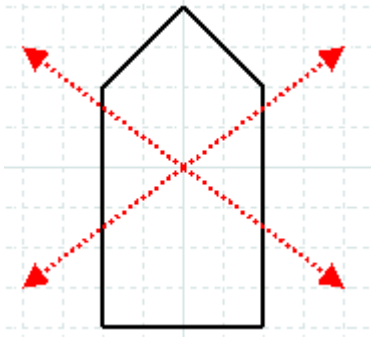
Default Orientations

The first step in integrating a laser in HYPACK® is to understand the default orientation when the offsets are all set to zero. All LiDAR drivers assume that the XYZ axes of the sensor's reference frame are aligned with the XYZ reference frame of the vessel when the HYPACK® offsets are zero.

The following table diagrams each type of LiDAR and what the default orientation looks like in 2D space. The red arrows indicate the path of the laser beam; the blue arcs indicate possible yaw offsets. Only when the physical mounting position deviates from the default, as outlined below, will an offset need to be applied in HYPACK®.

TABLE 1. *Default Orientations of Each LiDAR Type*

"Single Beam" Line Scanners These systems scan a 2D sector along the plane of the forward axis. Because the 3rd dimension is created by the movement of the vessel, collecting data with the laser oriented in this manner is not recommended. Mount these systems pointed off the port or starboard side and apply a +/- 90° yaw offset to tell HYPACK® which way you chose. The REIGL V series has the ability to apply a yaw rotation in the software controller. Mount this device with the 0° mark aligned forward and apply the desired yaw in the setup form. In this way, you can change the yaw offset without physically moving the device or modifying your HYPACK® offsets.	
360° Line Scanners, Single-head The Renishaw-based single-head products have a rotating head that scans a full 360° around the forward axis. The default orientation expects the head to be scanning port and starboard simultaneously.	
Velodyne "Multi-beam" Scanners, Vertical Mode There are vertical and horizontal versions of the Velodyne drivers. The vertical mode expects the sensor's bottom to be pointing forward and the zero mark to be pointing upward. This orients the "swath" of beams to the across-track of the vessel, rotating around the forward axis.	

Velodyne "Multi-beam" Scanners, Horizontal Mode In horizontal mode, the Velodyne sweep is rotating around the Z axis. The zero mark of the device is pointed forward. (Think of this as "self-driving car mode.") This orientation is not recommended because the angular gaps between beams are not reliably filled by the forward motion of the vessel. This mode is more effective with a 45° pitch offset. (More on this later.)	
360° Line Scanners, Dual-head The Renishaw dual-head systems mount the heads in an X pattern. (What I like to call the Princess Leia mount…) Each head has 45° offset for pitch and yaw in HYPACK®. Of course, the 2nd head has a negative yaw rotation.	

MINIMIZING SHADOWS

One advantage to the "multi-beam" and dual-head modes is that they are better at filling in areas that a single beam, which is perpendicular to the vessel, can't see because the oddly angled beams hit targets obliquely before and after the vessel passes by. If you have a "single-beam" line scanner, using a yaw offset other than +/- 90° doesn't buy you much.

ADDING A 45° PITCH ROTATION

All of the configurations above can be improved by adding a pitch rotation. (The dual-head systems already have this, no need to add "extra.") Orienting the laser beam diagonally insures that tall, thin targets (like light poles) are well-covered because they are less likely to fall between line scans. Mount the device in this manner and add the appropriate pitch angle to your HYPACK® HARDWARE settings. Because the laser beam is no longer near vertical, small offset errors are more noticeable in your dataset; it is critical to have a solid patch test in this case.

Finally, if your setup requires a significant yaw and pitch offset combined (as in the dual-head case above), you must use HYPACK® 2017 or later. Earlier versions of the package did not support this mode.