

LIDAR PATCH TEST CALIBRATION

WITH CARLSON MERLIN LASER SCANNER

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1 Introduction

This manual will guide you through the patch test calibration procedure when using a **Merlin LiDAR** produced by Carlson.

The procedure can be used for other vessel mounted laser scanners.

The purpose of the patch test calibration for laser scanners is to determine the mount angles of the laser scanner, relative to the three axes of the local coordinate system of the vessel. These three figures are often referred to as the roll-, pitch- and heading mount angles.

Applying the angles in the software is crucial for a quality LiDAR survey in order to ensure proper overlap of consecutive surveys taken from different navigation lines.

This process needs to be done/redone each time the hardware (Merlin LiDAR or the IMU) mounting has been changed (eg moved at least one of them to a new location).

Once the calibration angles are calculated, the values can be re-used accordingly.

It is recommended that a patch test calibration should be done each time a different mounting angle and corresponding values are used.

This guide will follow the instructions from the Merlin System Calibration Manual, which is provided with the device, calibrating first the heading offset, then roll and pitch.

We recommend interfacing the laser scanner using PPS time synchronisation to account for latency.

2 Patch test calibration procedure and runline planning

For each offset there are specific criteria for choosing the calibration site and planning the runlines. Please choose a site with a good GNSS environment; with clearance as good as possible towards the horizon, no high buildings, or passing under bridges.

2.1 Heading calibration runline planning

The recommended approach is to survey lines on opposite sides of an identifiable feature (further one called **target**) in the same direction, with angular offsets (such as an A frame). The target should ideally be placed as close as possible to the height of the laser scanner.

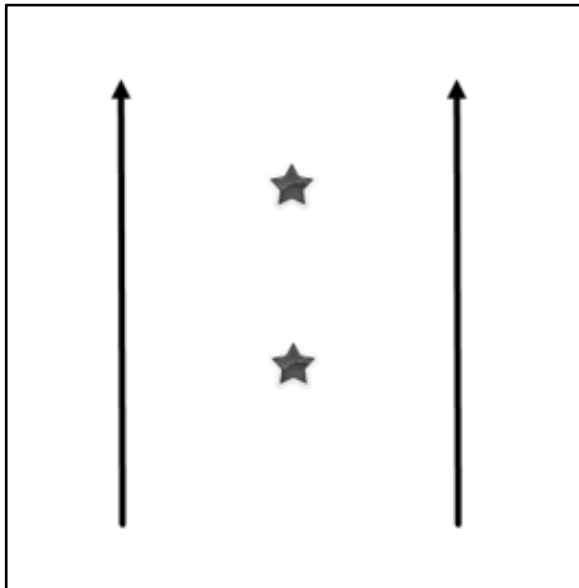


Figure 1 Ideal runline planning for heading calibration (stars representing targets)

However, this kind of feature may not be easy to find around a water environment, therefore the workaround is to survey two parallel lines in the same direction, but at different distances from the chosen object. The Merlin System Calibration Manual suggests that the spacing should be done with the closer line being 15-20 m away from object and the farther line at a distance of 30-40 m.

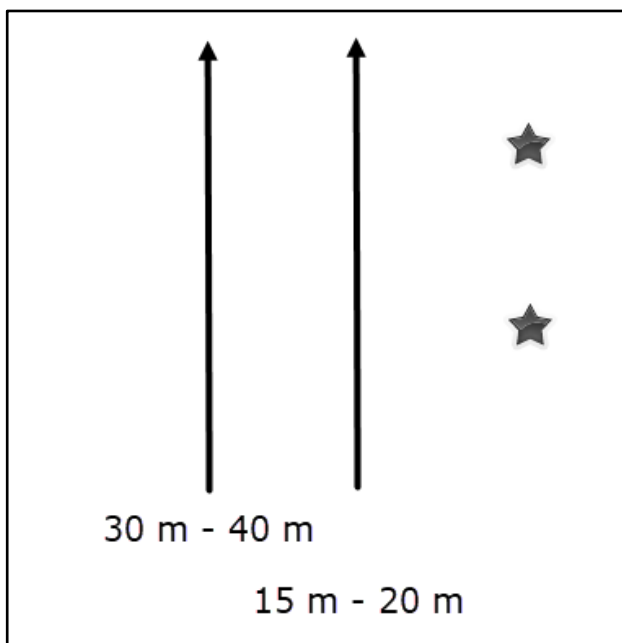


Figure 2 Heading runline planning if not possible to survey the target from both sides

2.2 Roll calibration runline planning

The best option is to survey a flat surface on land if the laser scanner is placed high enough on the vessel for land to be visible; another option is to use the edge of the quay wall.

Calibration survey lines should be done with the laser scanner on the same runline in opposite directions as far as possible from the feature. The Merlin Calibration Manual recommends them to be around 30 to 40 m away.

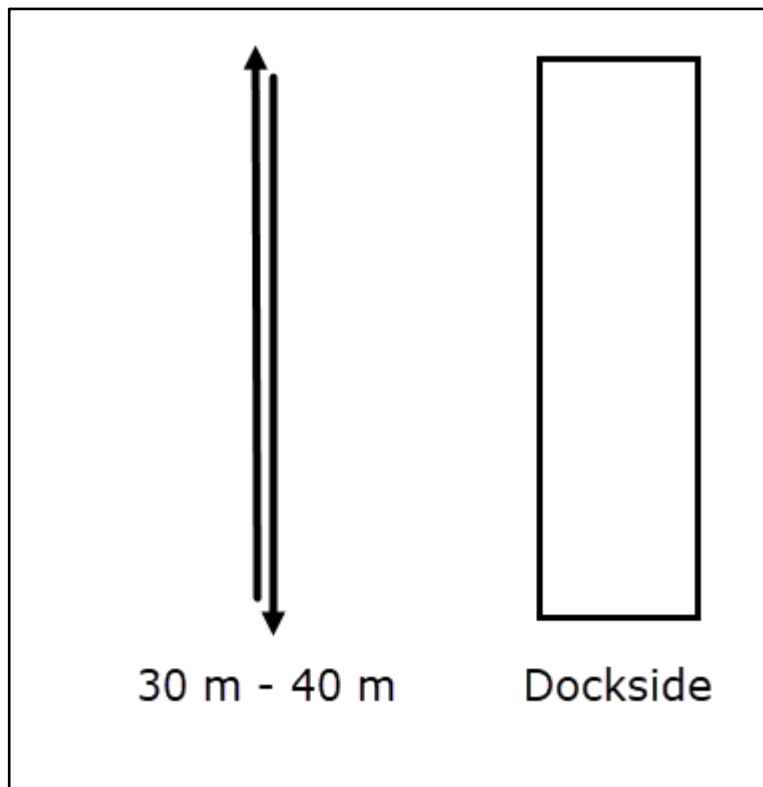


Figure 3 Runline planning for roll calibration

2.3 Pitch calibration runline planning

For pitch calibration, the tallest structures must be used. This can be a crane, tall building, or pole. Please do not pass under bridge structures and other overlying features, as this can cause GNSS outages that can provide unreliable data.

The survey lines should be run in pairs on the same runline in opposite directions.

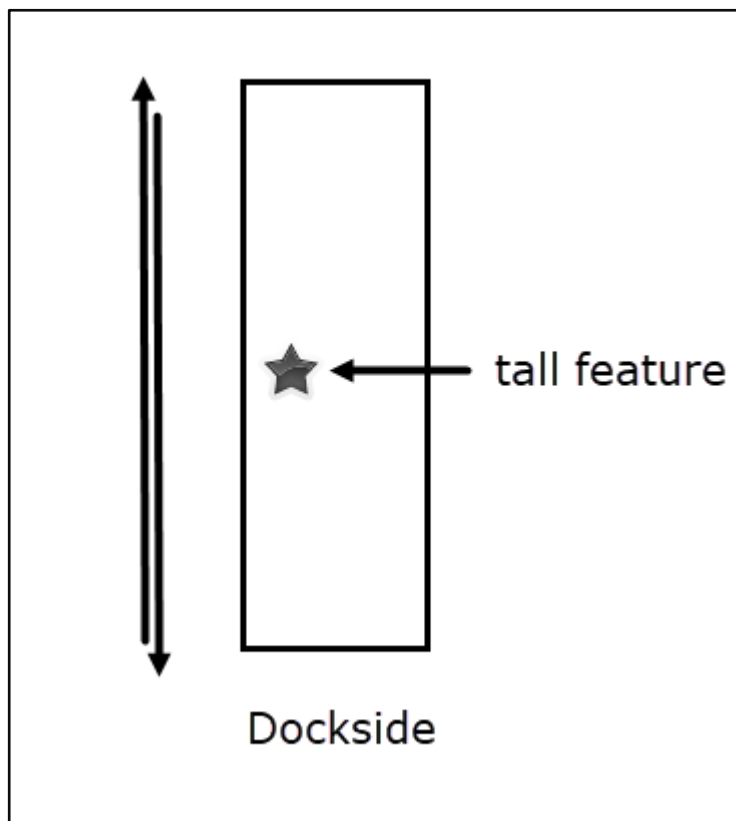


Figure 4 Runlines planning for pitch calibration

3 Calibrating in NaviSuite

3.1 NaviScan

The laser scanner is interfaced in NaviScan using the Dynascan driver.

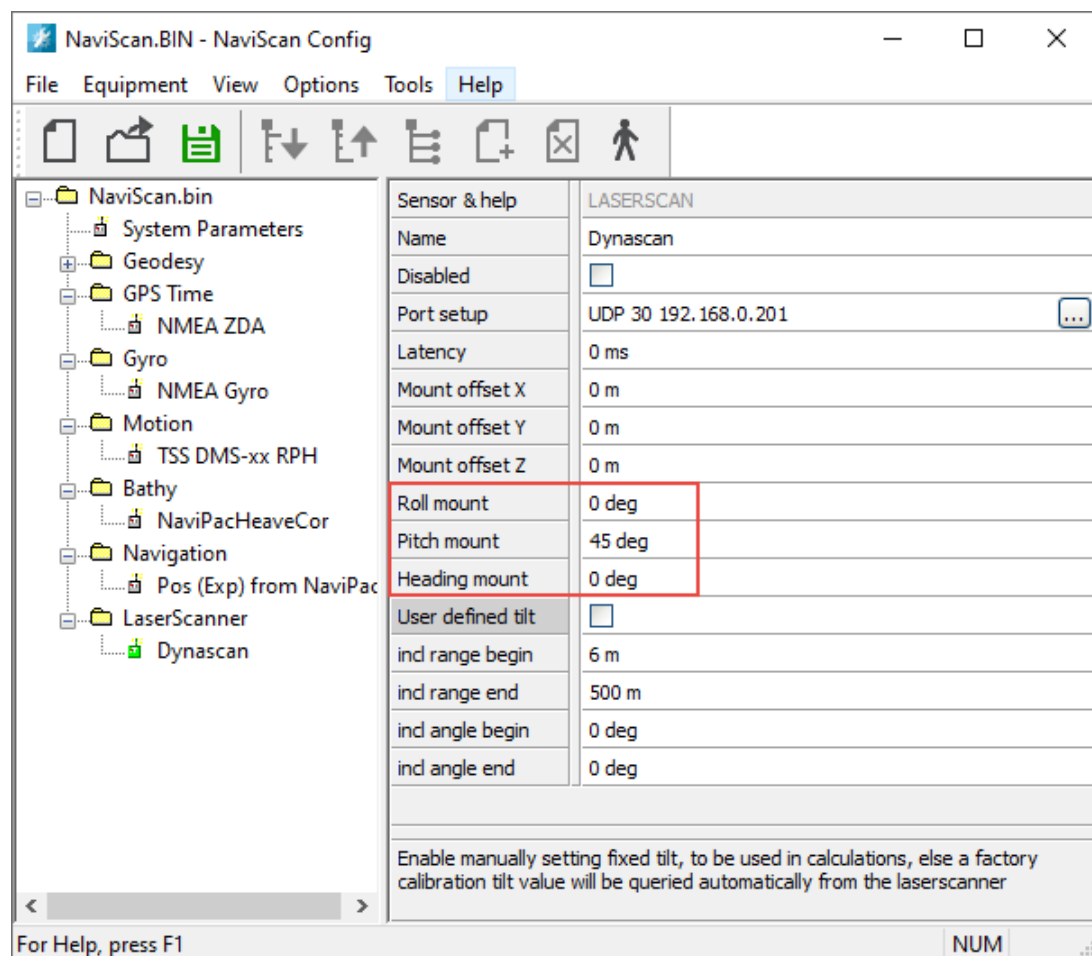


Figure 5 NaviScan configuration

The angular offsets are now, before calibration, as read from the Merlin mounting brackets. In this example, the laser scanner is pitched at 45 degrees and facing towards the front of the vessel (0 heading offset).

3.2 NaviEdit

After performing the survey, load your SBD files in NaviEdit via the **Import > NaviScan Files...** option. Open the Header Editor to find the mounting angles that were applied in NaviScan. They can be adjusted here.

Please make sure to import all files into the same NaviEdit folder, instead of individual files in order to ensure that the adjustments are performed on all data files. We will return to the Header Editor for each mounting angle adjustment.

1. Data folder
2. Open Header Editor > Instruments
3. Double click on Laser data values
4. Manually input mount angles

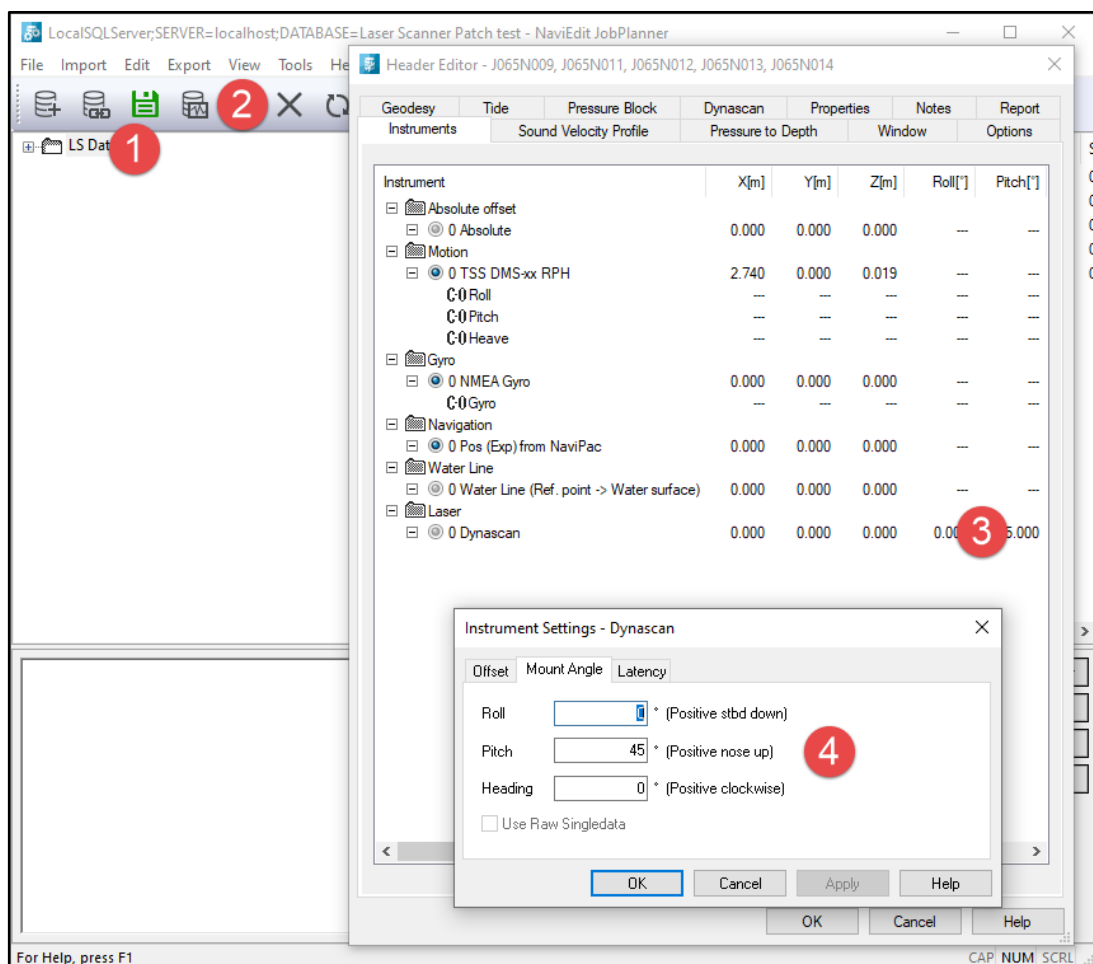


Figure 6 Mount angles in NaviEdit Header Editor

3.3 NaviModel

NaviModel is used for analysing and comparing the point clouds.

Go to the NaviEdit node in the NaviModel project tree and load the data with the option **Import points as Point Clouds**.

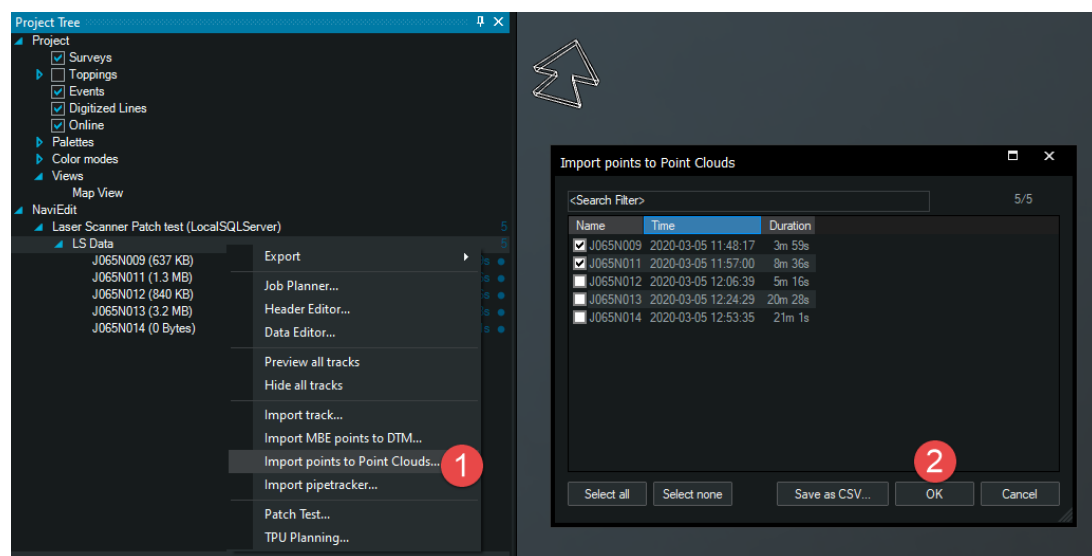


Figure 7 Import data from NaviEdit

Another useful tool will be the **Toggle Profile On/Off** tool. Open it from NaviModel's **View > Views > Views Toolbar**. This way you can control the profiles, where you can analyse the misalignments between point clouds.



Figure 8 The Toggle Profile On/Off

The profile can be moved and controlled based on 2 points.

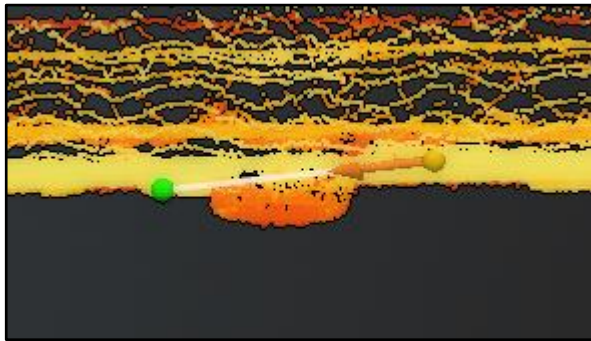


Figure 9 NaviModel with a profile line

Right-click in profile to find the **Measure** option. The given value is divided into its horizontal and vertical components.

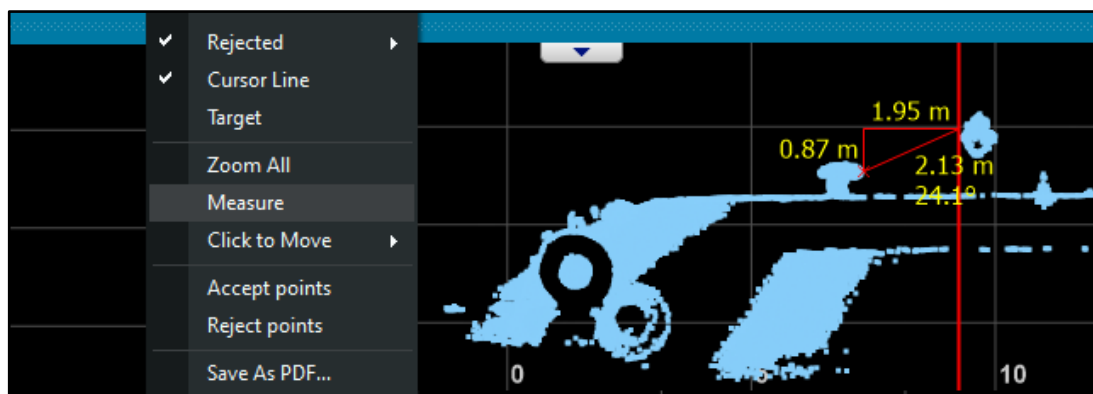


Figure 10 Measuring on the profile

The calibration works with iterations. The first one is rough and meant as a first set of corrections with supplementary iterations for better accuracy.

3.4 Determining the rough heading offset

- Create point clouds based on the datafiles recorded for the heading calibration
- Identify the same object on both scans and measure the horizontal difference

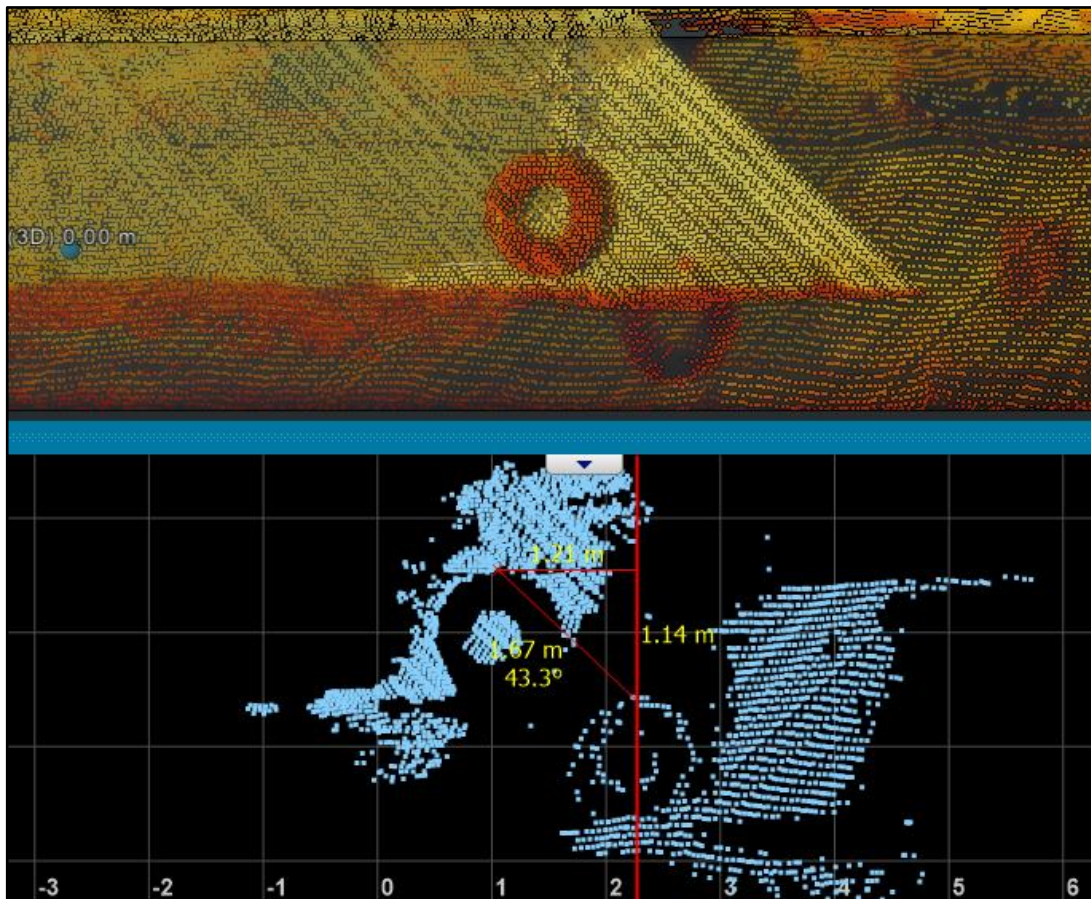


Figure 11 Measuring the horizontal misalignment value for the same object

- Go to the **NaviModel Project Tree > Toppings > Point Clouds** and select each individual point cloud to make them visible and find out which direction you need to adjust the heading mount angle
- Start adjusting your heading mount angle in the NaviEdit Header Editor

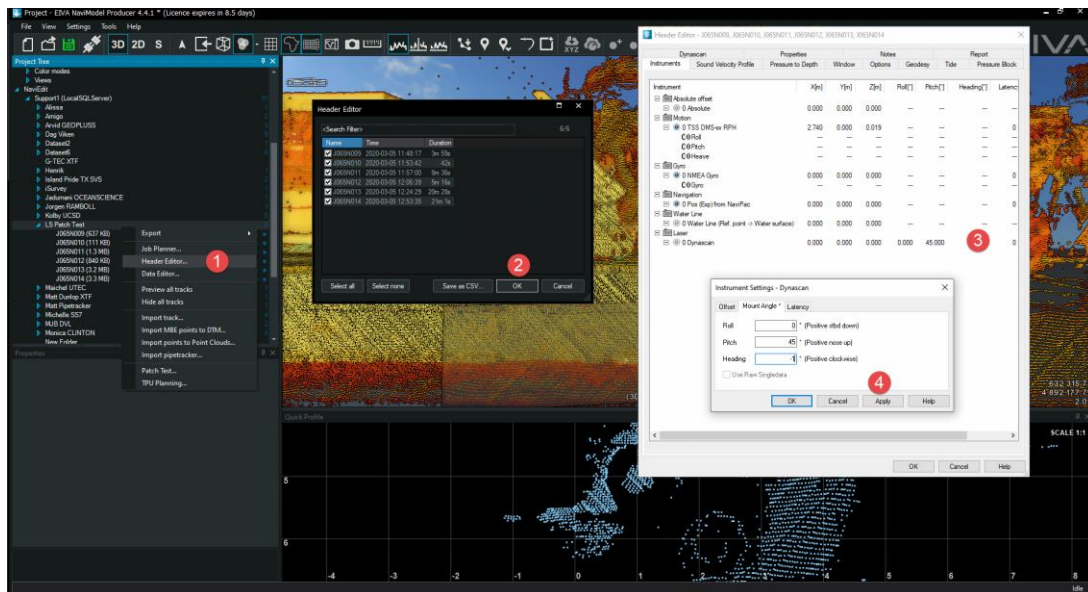


Figure 12 Adjusting mounting angles

- Do not close or move the profile

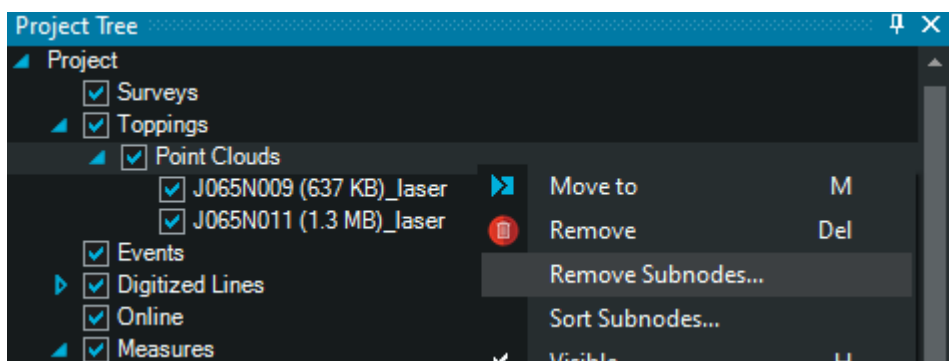


Figure 13 Remove Subnodes (point clouds) before making new ones to reduce the risk of confusion

- Create a new set of point clouds in NaviModel to apply NaviEdit changes
- Measure the horizontal distance again and see what effect it had
- Continue to adjust until you have the lowest horizontal distance

3.5 Determining the rough roll offset

- With rough heading compensated angles, the two point clouds from the two data files for roll should be created.
- Look for a flat area on shore (such as the dockside) or the quay wall edge and draw a profile. A scaling up can be done to vertically exaggerate the artefact's roll; note, the rotated V shape of the profile between the surfaces and aim to minimise the V, hence make them as parallel as possible.
- Pick a place where you can measure points from both surfaces on the profile.

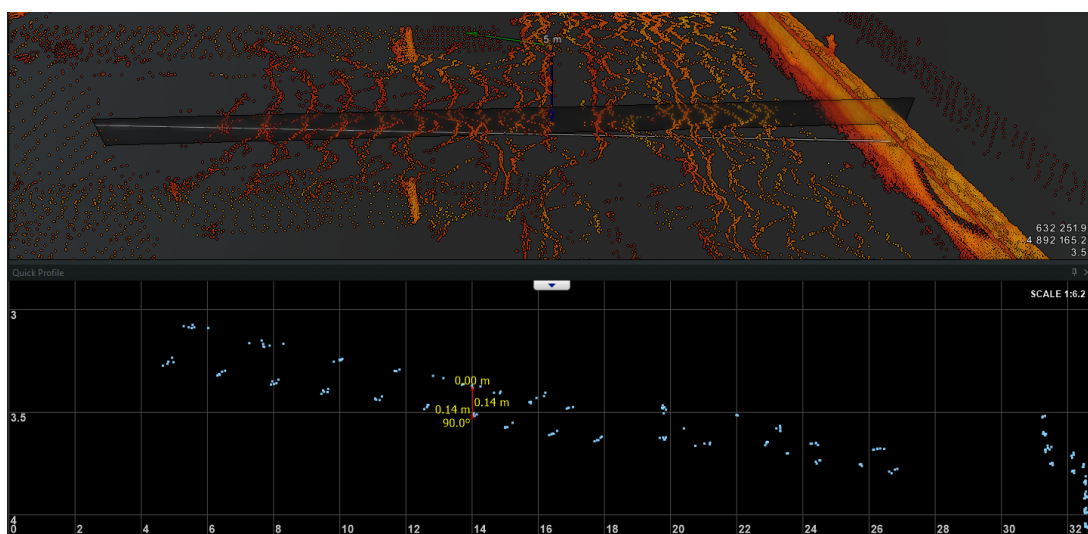


Figure 14 Measure the misalignment caused mainly by the roll angle values

- Toggle point clouds on/off to find out which is the top and bottom one and taking in account the vessel's movement, the sign of the correction can be deduced.
- Start applying corrections as in section 3.4 until you get the value which provides the best rough alignment.

Another option, in case the laser scanner was high enough on the vessel to survey more than the few meters of the dockside, is to use the Patch Test Tool and define an area with low noise. Please note this tool was developed for multi-beam calibration and therefore, taking into account the high concentration of data points from the Merlin laser, it can only be used on a small surface.

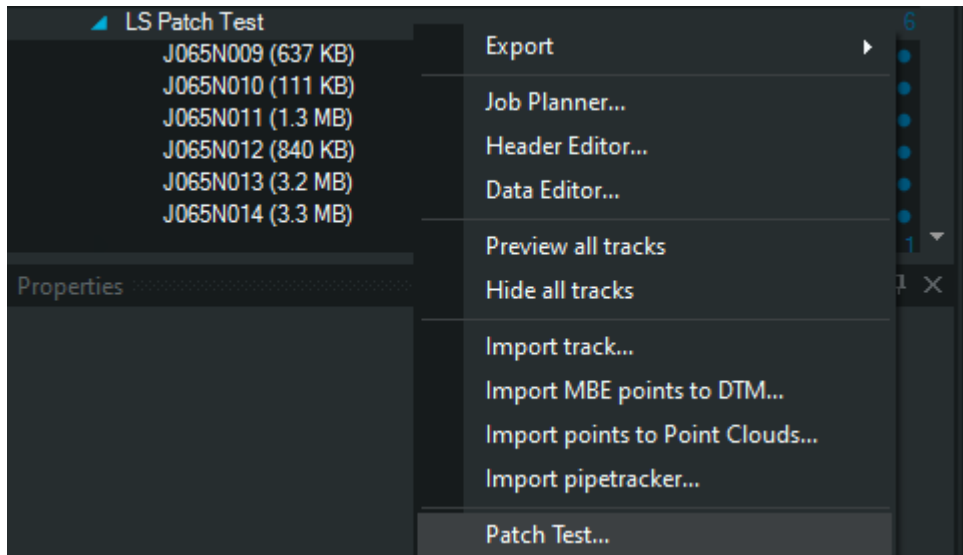


Figure 15 NaviEdit node with Patch Test... option

3.6 Determining the rough pitch offset

With heading and roll approximately calibrated, pitch is last. Choose a distinct, high target. The higher the target and closer on the horizontal plane to the laser scanner, the more it will be influenced by pitch misalignments.

- Measure the horizontal distance between the two measurements
- Toggle point clouds on/off to figure out the sign of the correction
- Apply adjustments in NaviEdit **Header Editor**, checking how this is reflected in the measurements by creating new point clouds in **NaviModel**.

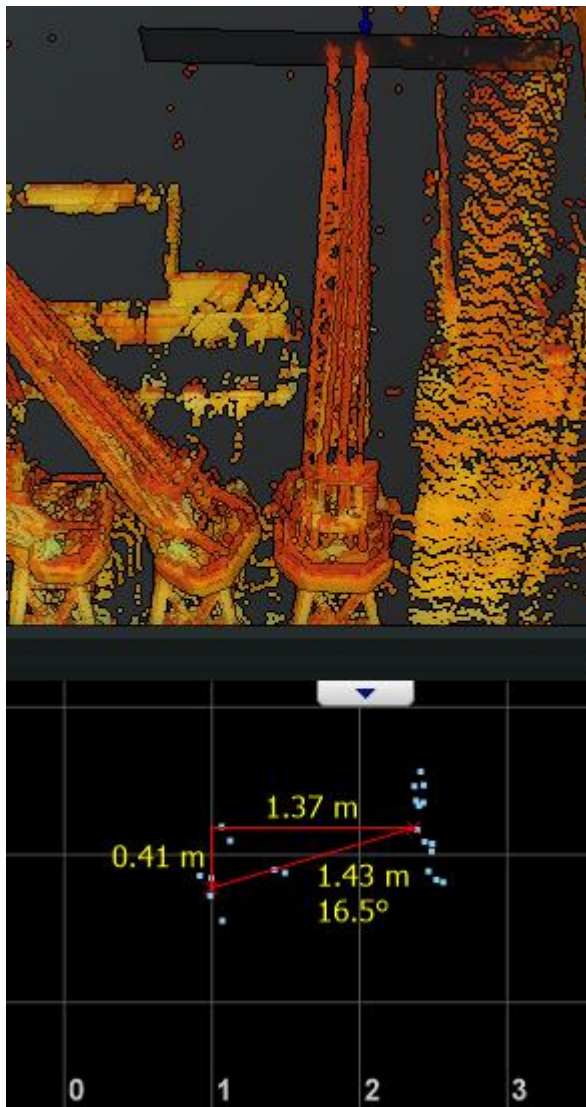


Figure 16 Measure the misalignment caused mainly by the pitch angle values

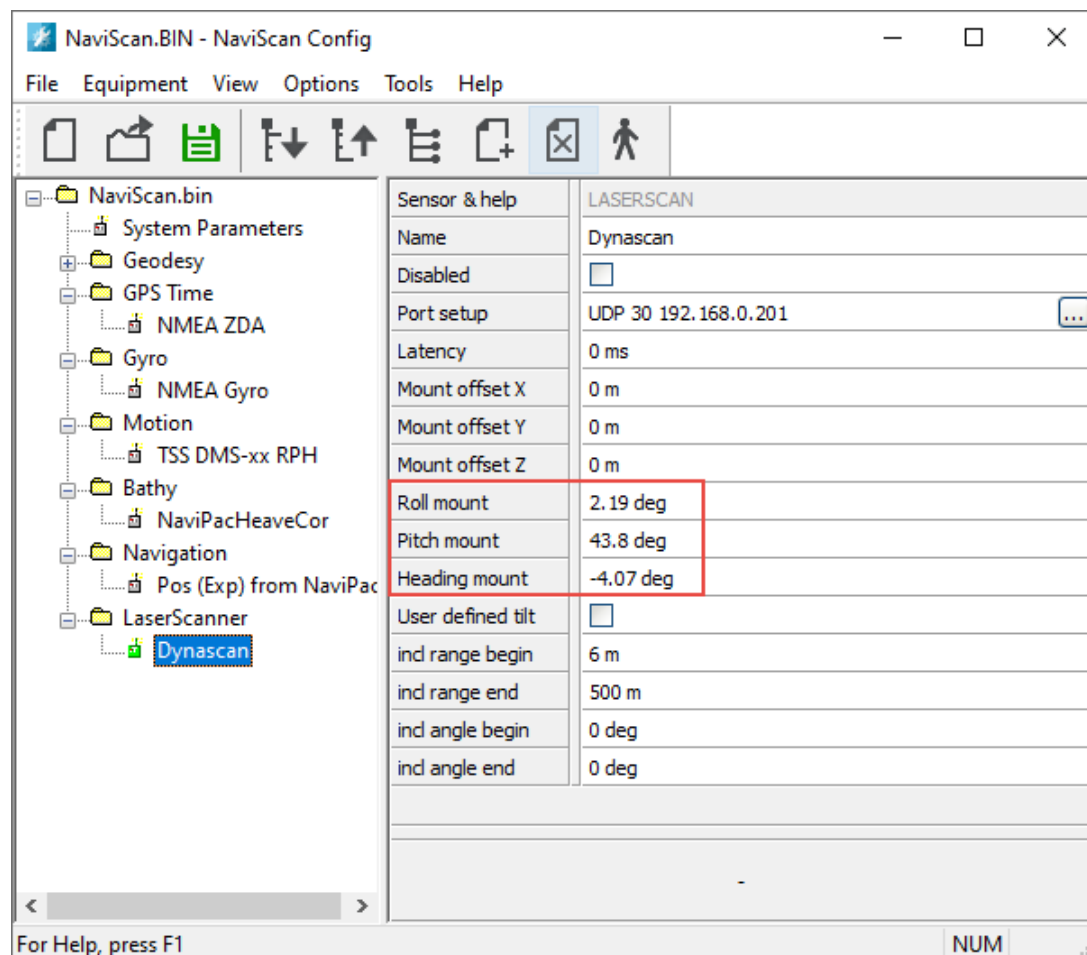
3.7 Iterations

Now that you got a rough calibration and alignment of your point clouds, continue by one or more iterations for fine tuning until you are satisfied with the result.

4 Applying the corrections

After the calibration is done, the values should be kept in the NaviEdit Header Editor.

We advise to add them to **NaviScan** before future surveys so that there will be no need to add them again for post-processing.



5 Version descriptions

Version	Date	Author	Description
4.4	17.03.2020	VLA	Initial version
4.4	17.09.2020	ZKA	Review