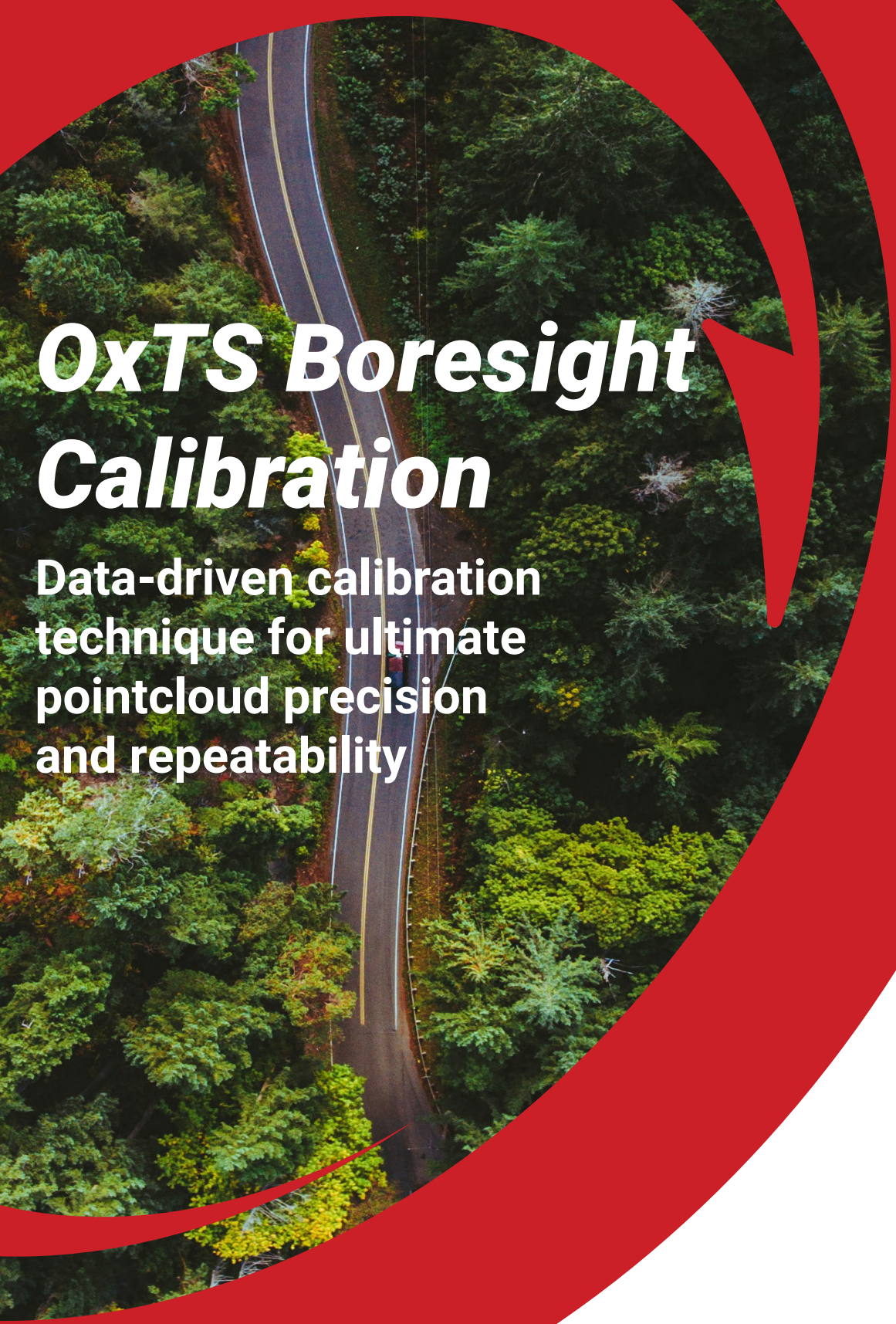


OxTS Boresight Calibration

Data-driven calibration technique for ultimate pointcloud precision and repeatability

OXTS Survey

www.oxts.com

OxTS Boresight Calibration

The OxTS Boresight Calibration feature allows you to get the very best data out of an INS-LiDAR system - precision that is not possible without a data-driven approach.

The calibration procedure can be added onto a survey run, without hassle, in under 10 minutes and the hard work is done by the OxTS Georeferencer software.

This data-driven approach to boresight calibrating angles in your setup will give users of OxTS' Inertial Navigation Systems maximum flexibility in how you set up equipment whilst also improving precision and repeatability.

OxTS Survey+ v3

The Challenge: Boresight Misalignment

What is boresight misalignment?

A boresight misalignment occurs when there is an imprecision in the angles measured between your tracking device (INS) and your surveying device (LiDAR). It is similar to aligning sights on a gun barrel.

Small errors in your heading, pitch and roll angles are often unimportant when you are only considering your own position, but when you are surveying objects some 10-100 metres away a tiny angular imprecision causes significant, if not fatal, distortions in your data.

It is therefore crucial to measure these angles as precisely as possible (to around 0.1°) and this is often impossible by eye or using physical measuring devices.

What is needed is a **data-driven calibration technique**.

"Boresight misalignment can cause major issues for businesses when conducting survey runs. By taking a data-driven approach to rectifying the problem we have saved our customers a tremendous amount of time and effort, as well as getting a level of precision that isn't possible otherwise"

Jacob Amacker, Product Engineer, OxTS

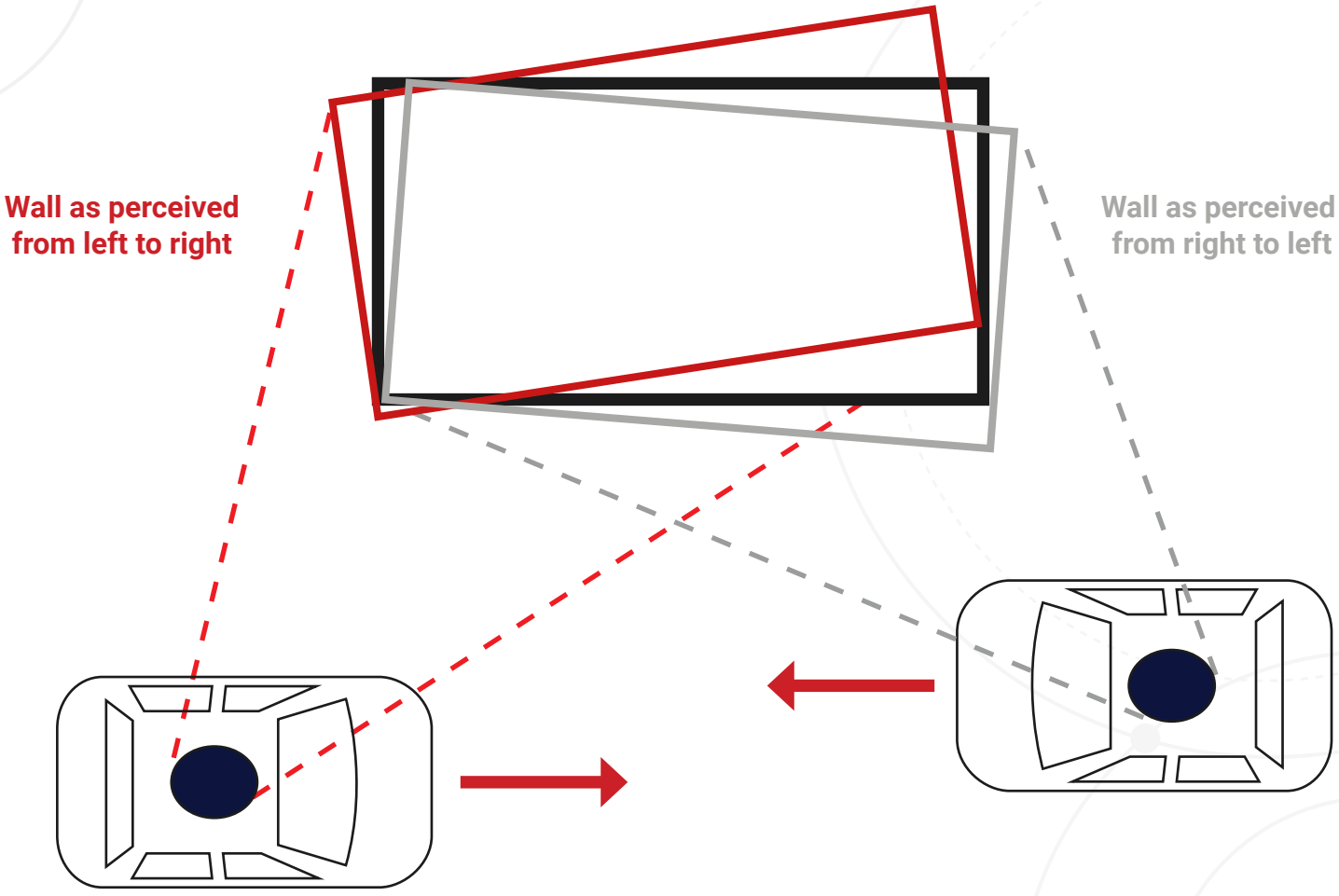
Boresight Misalignment

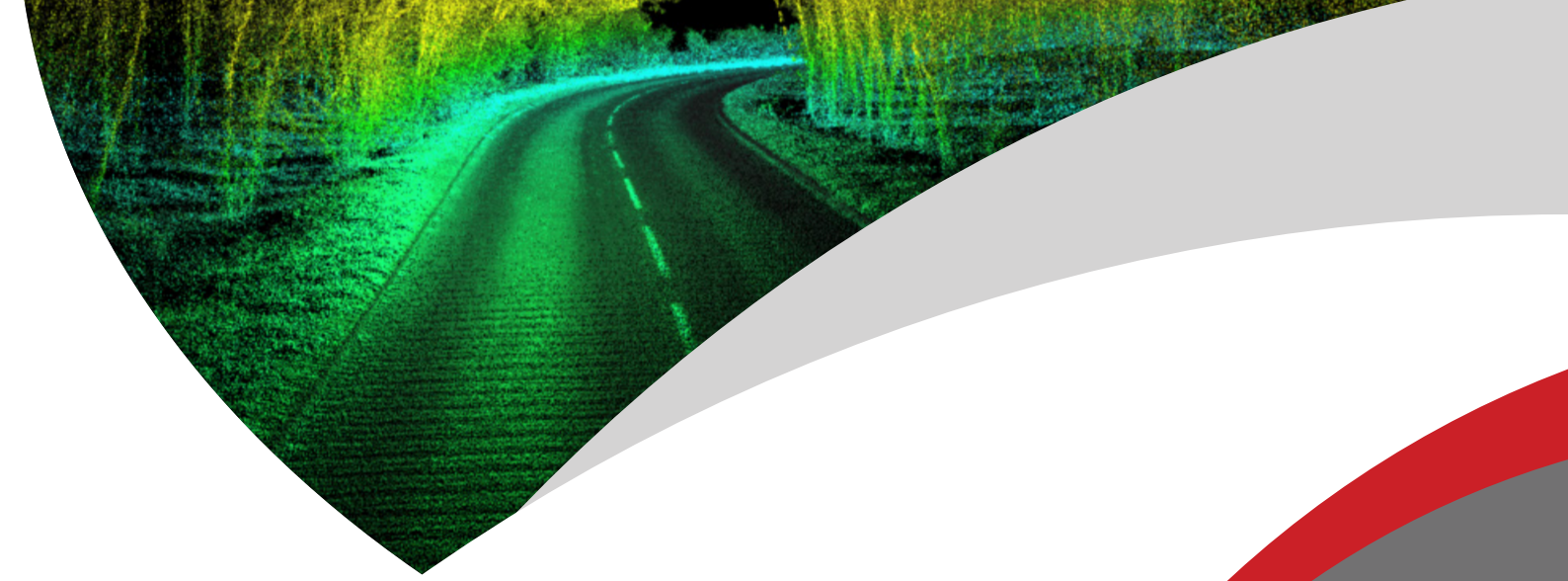
Why is it a challenge?

A boresight misalignment will give a position and orientation distortion to an object when you try to view it dependent on from where you are viewing it.

When you survey the same object from several directions you get a blurring effect. This will make distance and volume measurments inaccurate and, in the worst case, impossible. Object recognition also becomes challenging.

As a quick calculation, if you have an error in one axis of just **0.2°** then for a point 10 m away there will be a position error of approximately (0.2 *2)/360×2π×10 ≈ **7 cm**.





The Solution: Boresight Calibration

How can I fix a boresight misalignment?

OxTS Georeferencer software includes a boresight calibration tool to align your set-up perfectly. This tool automatically aligns the LiDAR and INS reference frames using a proprietary algorithm analysing returns from two planar targets to find the precise alignment.

As well as **saving time** and **reducing user work-load**, the target-based system has been designed from the outset to be **portable and simple to use** in real-world applications.

All the data required for boresight alignment is captured by arbitrarily placing two retro-reflective targets on the ground (with no surveying required) and driving your vehicle around these.

Benefits of Boresight Calibration

- No need for extensive survey-run pre-planning
- Short procedure and fast set-up time
- Calibrate your set-up to the highest precision
- Retrieve the best possible data
- Survey repeatedly with confidence
- Can be added onto any survey-run

Example Data

Three before and after boresight calibration examples

Each example below demonstrates empirical improvement in final output further to the boresight calibration of the targets.

The targets all become clearer, and much easier to recognise.

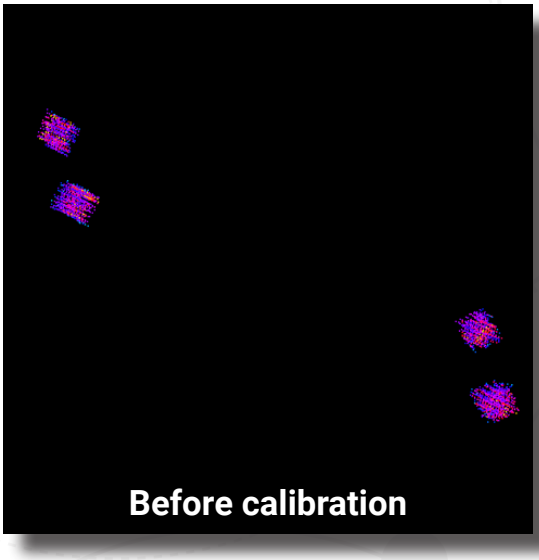
It is this data-driven approach to calibration that gives customers a vastly improved pointcloud.

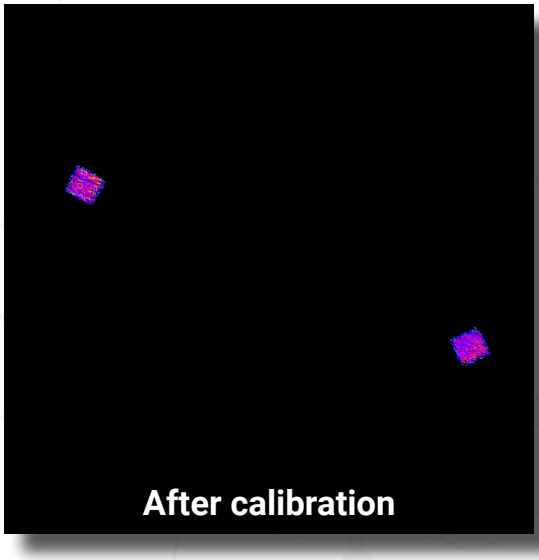
"We have seen from customer data sets the incredible difference boresight calibration makes to the end result and we're excited to see where our development plans for this feature take us"

Paris Austin, Head of Product - New Technology, OxTS

Dataset One: Target Only

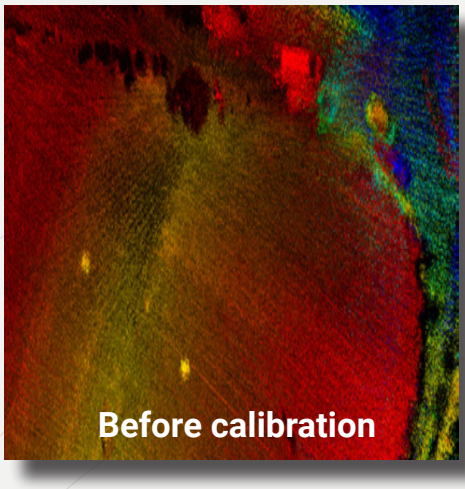
Without performing the calibration, the targets below appeared twice in the same pointcloud. After calibration the targets are clearer, as they should be, and there is no double-vision. This makes object recognition applications easier and gives you confidence when surveying the same area more than once.

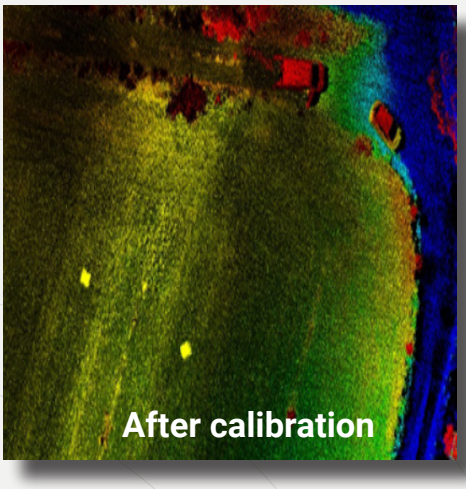




Dataset two: Full Pointcloud

Below is the same data but with the full pointcloud, not just the targets. The data becomes much more clear and usable and double-vision (see the car top right) has been eliminated.



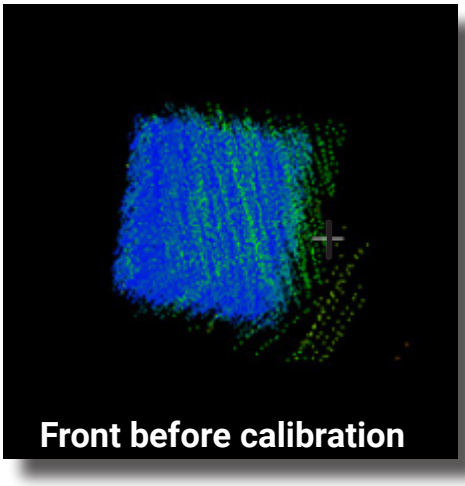


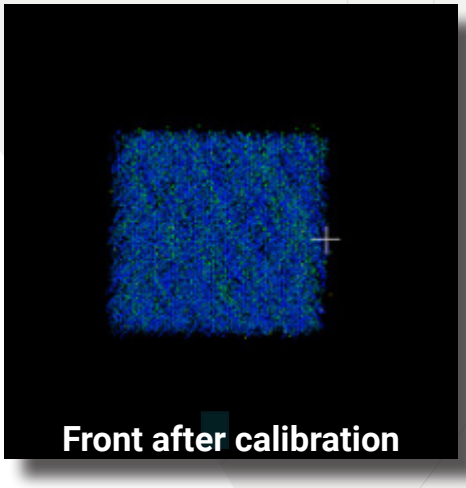
Dataset three: Square Targets - Front and Side

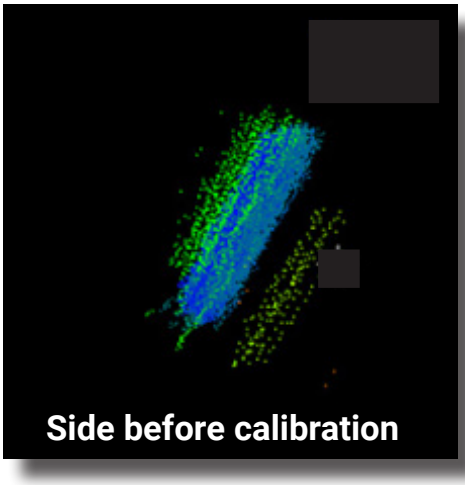
The targets in this third example have been shifted by about 80 cm giving a very inaccurate pointcloud before calibrating. Afterwards however the data is perfect.

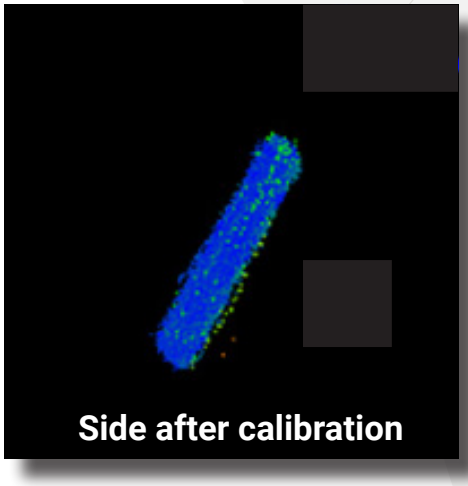
The angles were measured by eye to begin with to 90°, 0°, and 55° on the three axes. The boresight calibration corrected these to 88.74°, -0.43° and 54.86°. Meaning that this ~1 degrees difference causes the severe distortion seen.

These small angle corrections have made a significant impact and they can only be made using a data calibration technique.









The procedure

Simple and easily repeatable set-up

1. Set up reflective targets (2 mins)

Set up some flat, square retroreflective targets (contact OxTS for advice on creating these). Set up your LiDAR and INS device and configure them to start surveying, measuring the position and orientation of the LiDAR relative to the INS.

2. Have the LiDAR view the targets from all angles and distances (5-10 mins)

Manoeuvre your vehicle in such a way that the LiDAR device sees the targets from as many distances and angles as possible. This shouldn't take more than 5-10 minutes, after which you can immediately begin your survey without restarting any systems.

3. Use OxTS Georeferencer to calibrate the LiDAR orientation (3 mins)

When you are processing your data, follow the simple boresighting instructions in the OxTS Georeferencer software and your data will be calibrated.

The OxTS boresighting calibration feature will allow you to get the best data possible out of your setup and it will only have to be done once if you do not change your setup.

About OxTS

Leaders in Inertial Navigation Technology

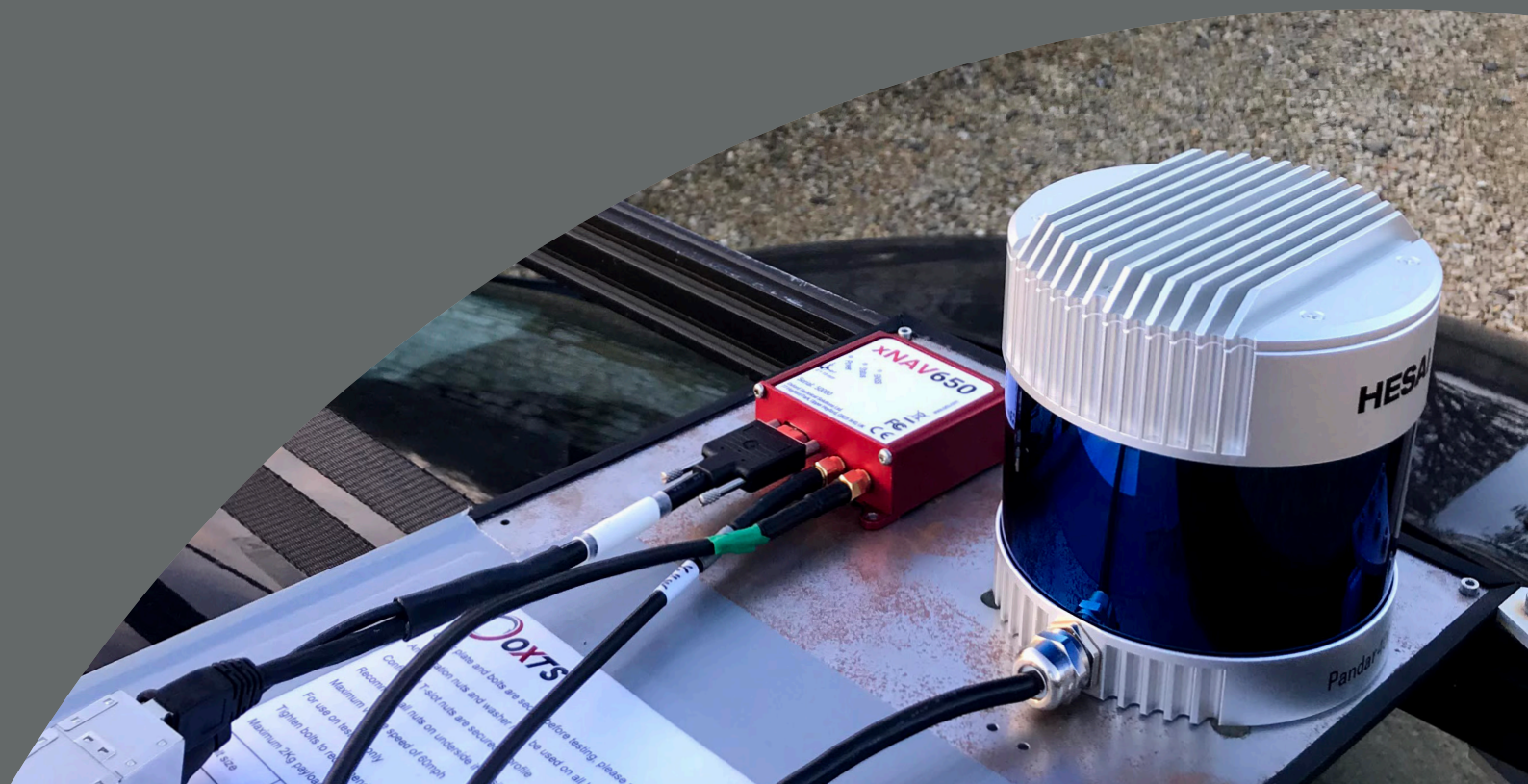
At OxTS we're passionate about inertial navigation and how we can help our customers with our technology. With over two decades of experience in combining the best of high precision GNSS receivers and world-class inertial navigation expertise, OxTS' products have become the industry standard for automotive testing and are widely used in other industries.

Our products provide position, roll, pitch, heading and other measurements of vehicles on land, sea and in the air. Our highly accurate Survey+ Inertial Navigation System (INS) is used in many mobile mapping applications, whilst our minature xNAV range of products are used to help many businesses map vast areas using Unmanned Aerial Vehicles (UAVs) because of their reduced size and weight.

For those applications that require a board set to be integrated tightly into a payload, the OxTS xOEM board set gives users a lightweight product whilst still providing the high-performance INS measurements you would expect from an OxTS system.

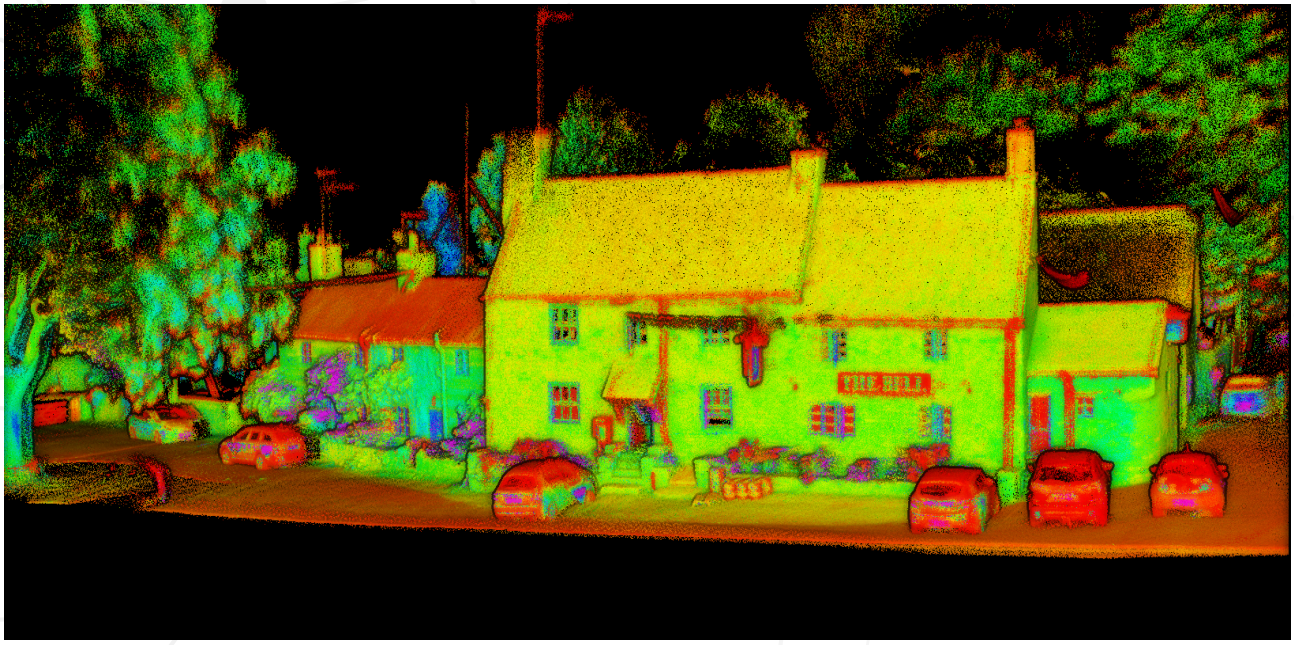
All OxTS systems come with free software that allows you to easily configure, monitor, analyse and post process your data.

OxTS Georeferencer is another software tool from OxTS that allows it's users to produce highly accurate, georeferenced, boresighted 3D pointclouds.



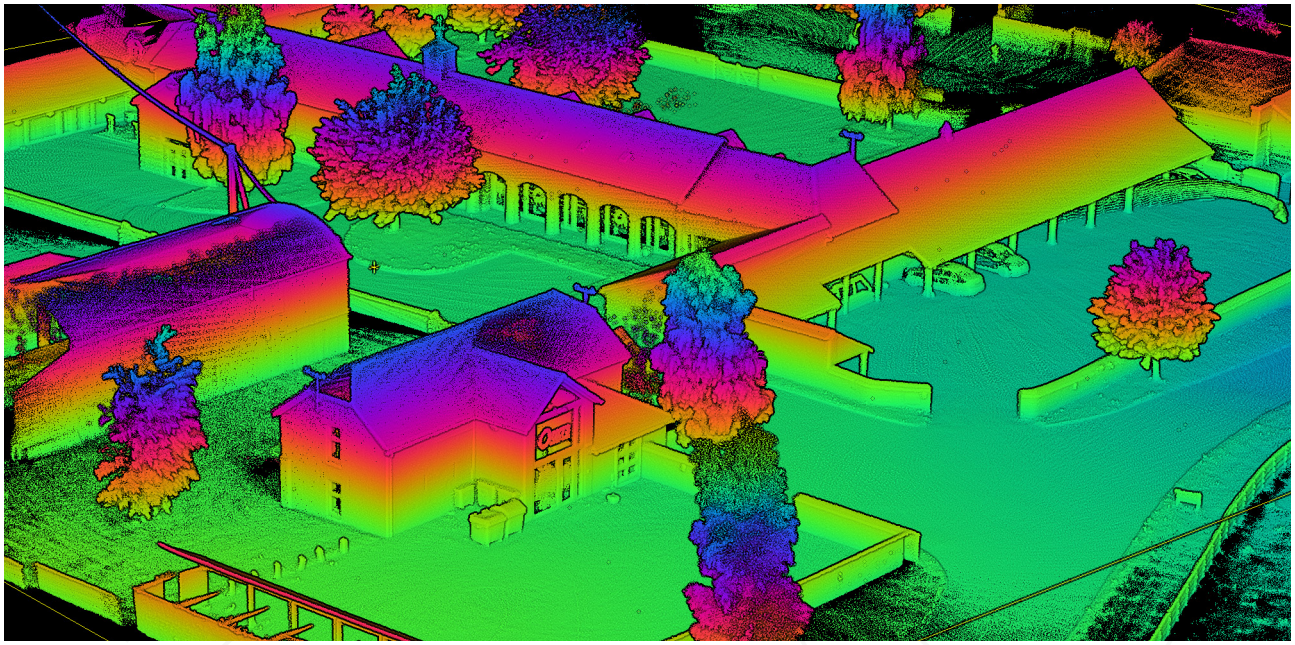
Example data

The coordinate frames of the devices used to create the following pointclouds, have been calibrated using the OxTS boresight calibraction process.

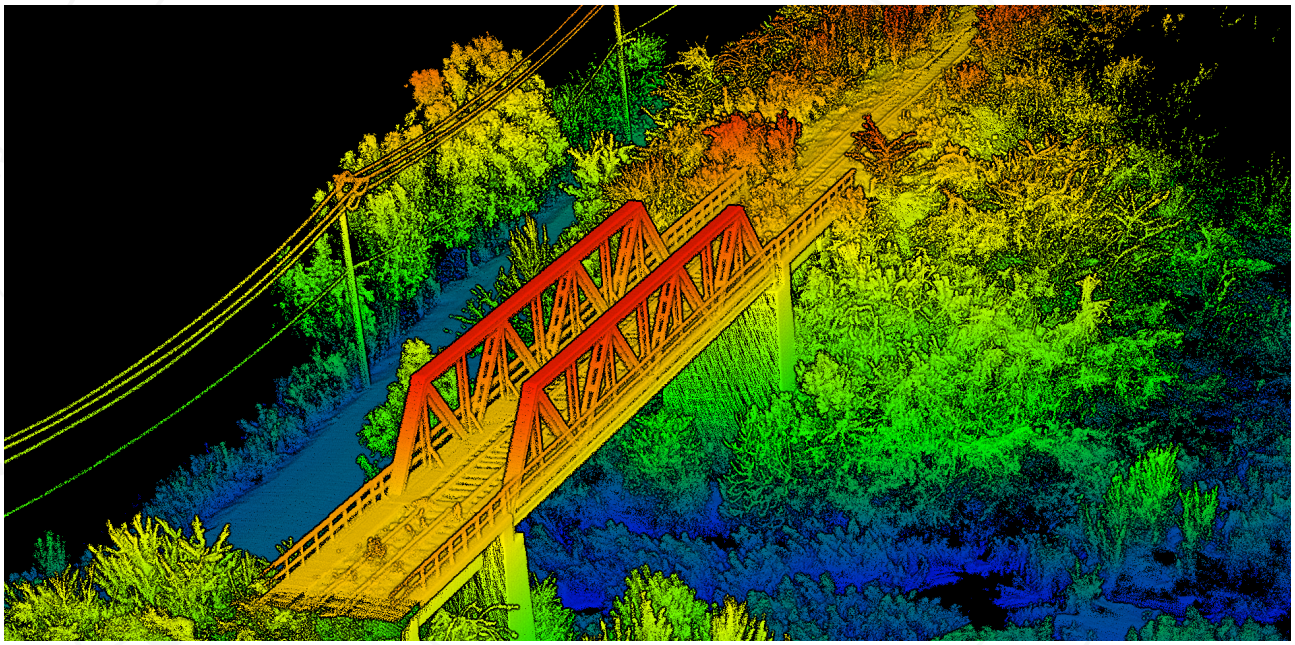


Building survey - pointcloud created using the xNAV650 INS and Livox Avia LiDAR sensor.

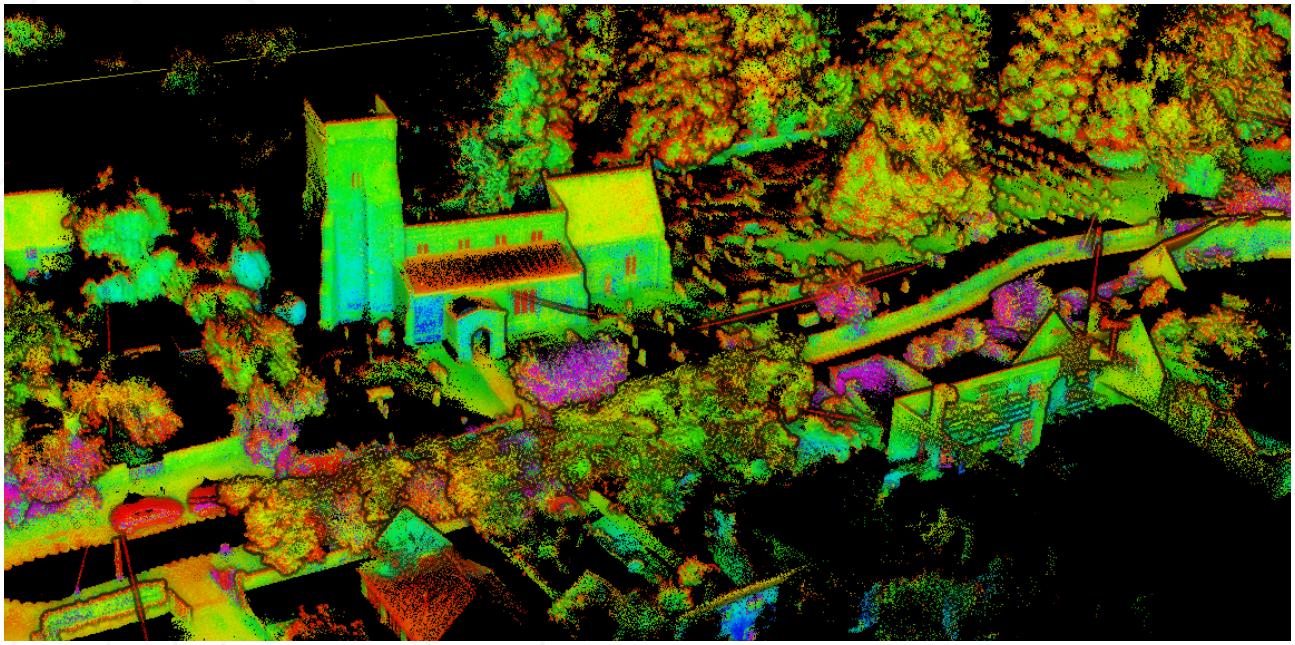
Road survey - pointcloud created using the Survey+ INS and Velodyne VLP-16 LiDAR sensor.



Building survey - pointcloud created using the xNAV650 INS and Hesai XT-32 LiDAR sensor.



Bridge survey - pointcloud created using the xNAV650 INS and Velodyne VLP-16 LiDAR sensor.



Building survey - pointcloud created using the xNAV650 INS and Livox Avia LiDAR sensor.

OxTS Inertial Navigation Experts since 1998

Global Headquarters

Park Farm Business Centre, Middleton Stoney, OX25 4AL

UK

For sales assistance
call +44 (0) 1869 814 250

For technical support
call +44 (0) 1869 814 251

For all other enquiries
call +44 (0) 1869 814 253

China

Suite 2808
Building 1 Grand Gateway
1 Hongqiao Road
Shanghai, 200030

US

OxTS inc.
Office 304, Regus Business Center
41000 Woodward Avenue
Suite 350 East
Bloomfield Hills
Michigan 48304

For technical support
call +1 248 260 1981

OXTS Survey