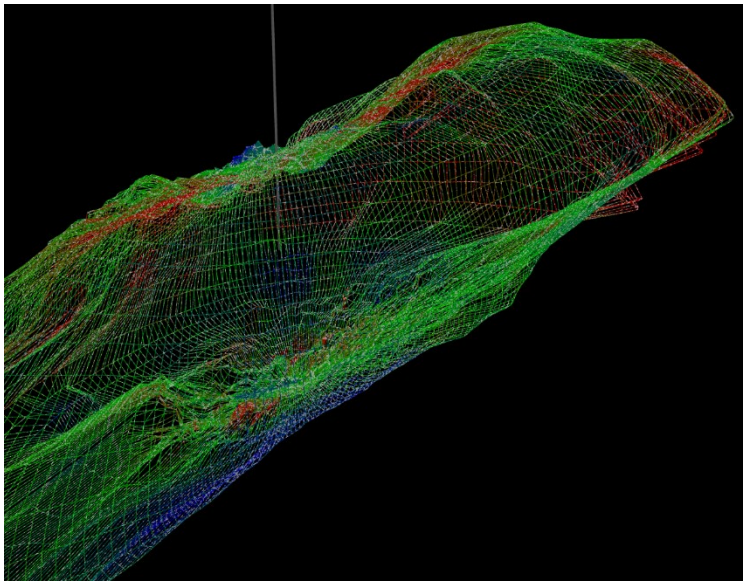
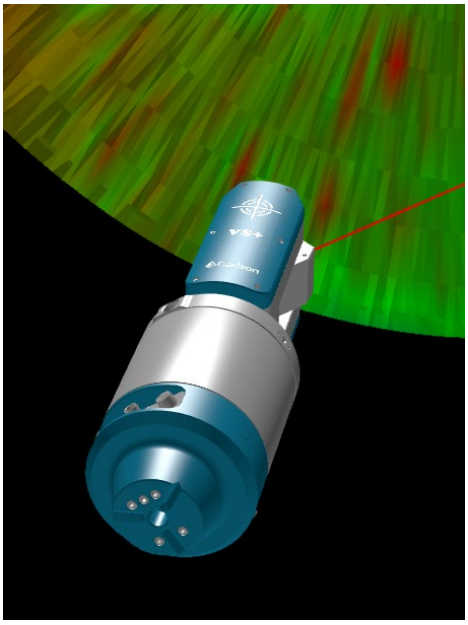
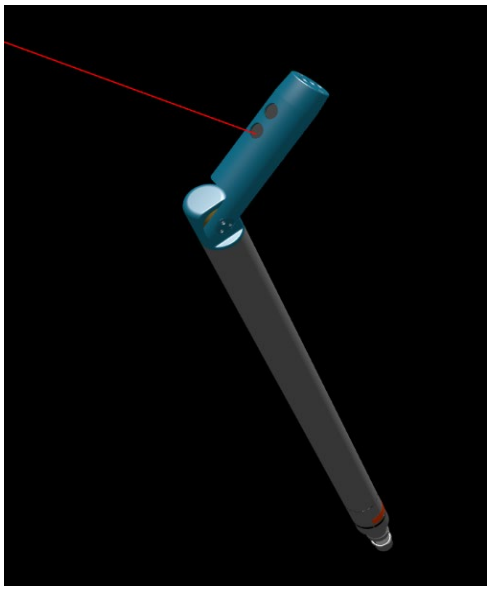
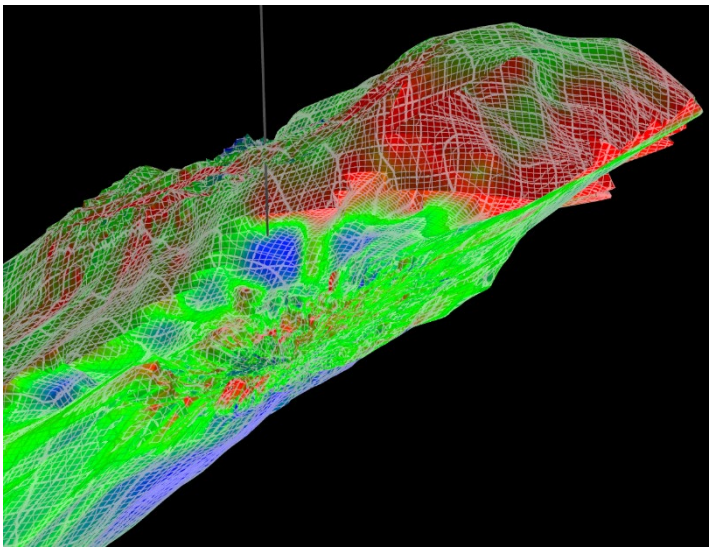
Carlson Software Inc.
33 E Second Street
Maysville, KY USA 41056
(p) +1-606-564-5028
www.carlsonsw.com

Carlson Scan software
User manual
For the C-ALS and VS+









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INTRODUCTION

1 Customer information

1.1 Carlson Software

Congratulations on purchasing a laser scanning system from Carlson Software.

Founded in 1983, Carlson Software specializes in CAD design software, surveying hardware, and machine control products for the land surveying, civil engineering, construction, and mining industries worldwide, providing one-source technology solutions from data collection to design to construction.

The C-ALS and VS+ are designed and built with Carlson's world-class levels of detail, quality and innovation.

Carlson's renowned dedication to customer service is unique in the industry.

For any technical support issues related to your hardware or software contact us directly or, alternatively, contact your local Carlson-approved service and support centre. Details of all contacts are on our website: www.carlsonsw.com.

1.2 About this manual

This manual is concerned with **Carlson Scan** software. **Carlson Scan** is designed to connect directly to Carlson's C-ALS and VS+ instruments.

Since the software is so integral to the use of both scanners, sections 15 to 18 of this manual detail typical, in-field deployment procedures together with a discussion of the navigational abilities and limitations of the C-ALS and VS+.

There are companion manuals dedicated to the C-ALS and VS+ hardware. These hardware manuals detail the system components, accessories and safety and certification information. It is important that both the hardware and software manuals are read carefully before deploying one of Carlson's scanners on site.

This **Carlson Scan** manual has been compiled with care. However, should you discover any errors, we would be grateful if you could contact Carlson directly.

For any feedback or comments, or if there are questions about the software which are beyond the scope of this manual, contact Carlson support. Contact details can be found on the back cover of this manual.

Alternatively, for information on your local Carlson approved dealer, visit our website www.carlsonsw.com.

Carlson has made considerable efforts to ensure the content of this document is correct at the date of publication but makes no warranties or representations regarding the content. Carlson excludes liability arising from any inaccuracies in this document.

1.2.1 Manual version

The document number of this manual is 3.5. Compiled in September 2025.

The manual is based on **Carlson Scan** software version 1.9.83.

Updates for manual version 3.5:

- *Alignment window changed.*
- *Settings windows updated.*
- *Cable counter setup and operation added.*

- *Mark feature added (see section 11.8.3).*
- *UI changes throughout.*

Updates for manual version 3.2:

- *Tidy of formatting and references throughout.*
- *'Calibration' changed to 'Alignment' throughout to match software terminology changes.*
- *Added joystick control panel and explanation (see section 11.6).*
- *Updated screenshots to reflect UI changes.*
- *Removed licensing information.*

1.2.2 Trademarks

Carlson and the symbol used in the Carlson logo are registered trademarks of Carlson in the USA and other countries. Break new ground and names and designations of other Carlson products and technologies are trademarks of Carlson or its subsidiaries.

Any other brand names and product names used in this document are trade names, trademarks, or registered trademarks of their respective owners.

2 Hardware and software

2.1 VS+

The VS+ is optimized for scanning underground stopes. The VS+ can be mounted on booms, tripods or customised deployment devices.

Prior to scanning, the VS+ is secured in place inside the stope. Prims mounted on the unit and on the back of the boom are surveyed using traditional survey techniques. This defines the position and heading of the instrument. This information is combined with data from inclinometers inside the VS+ to ensure all scanned data is correctly orientated and positioned.

The VS+ laser moves automatically, driven by **Carlson Scan** software, to survey the void.

2.2 C-ALS

Carlson's C-ALS is tubular in design and has a diameter of just 50 mm. This allows the instrument to be deployable into voids via drilled boreholes. The C-ALS can be deployed up to 200m before being secured in place to scan a void it has entered.

A motorised 2-axis scanning head ensures a complete 360° scan covering the entire scene, even looking back to where the C-ALS has entered the void.

This manual is focused on variants of C-ALS probes which incorporate an IMU: either a C-ALS Gyro or a C-ALS HD. The IMU incorporates a triaxial gyro and accelerometers. Data from these sensors is collected at regular intervals as the probe is being deployed. This ensures that an accurate model of the deployment route can be created and also that the C-ALS is correctly positioned and orientated when it is scanning.

If the borehole collar coordinates are known, this anchors all the collected data in a real-world location and each point in the resulting 'point cloud' can be correctly geo-referenced.

A borehole camera is integrated into the nose of the C-ALS. A feed from this camera aids deployment and helps to determine the optimum position of the scanner as it protrudes form the borehole, ready to scan.

2.3 Carlson Scan software

Both the C-ALS and the VS+ are operated remotely which ensures that personnel can remain in safe locations away from unsafe areas.

The scanners are controlled from a tablet PC or laptop running **Carlson Scan** software. **Carlson Scan** recognizes whichever instrument is plugged into the tablet and customizes the user interface and functionality accordingly.

Carlson Scan allows you to manage the deployment and georeferencing of the scanner and to initiate scans. All data from the instrument – from the navigation sensors, the borehole camera and from the laser – is visualised on screen in real-time, ensuring that immediate assessments can be made of the deployment, the data quality and of the area being scanned.

Different modes of **Carlson Scan** optimize the software for data collection and for data analysis. The collected data can be edited, transformed, combined with other datasets and exported to third-party software.

2.3.1 Changes to Carlson hardware and software

Carlson reserves the right to improve, change or modify its products and documentation without incurring any obligation to make changes to equipment previously sold or distributed.

CARLSON SCAN

SOFTWARE

3 Getting started

3.1 Equipment compatibility

Carlson Scan software is designed to work with C-ALS and VS+ instruments supplied by Carlson.

The exact compatibility is as follows:

- All C-ALS Gyro units are compatible (**excluding** C-ALS Gyro units produced by Renishaw).
- All C-ALS HD units are compatible.
- C-ALS Mk3 units are **not** supported beyond **Carlson Scan** version 1.3.6.
- All VS+ units produced by Carlson.
- Void Scanner units are **not** supported beyond **Carlson Scan** version 1.3.6.

If you have any doubts as to the compatibility of **Carlson Scan** with your instrument, please contact Carlson for further details.

3.2 Tablet requirements and compatibility

Carlson can supply VS+ and C-ALS systems packaged together with a recommended field tablet computer. The tablet is pre-installed with **Carlson Scan** software and pre-configured to optimize performance.

Alternatively, if you are independently selecting a Windows-based tablet or laptop to run **Carlson Scan**, consider the following points when making your choice.

Carlson Scan Tablet mode is optimized for use on a touch screen tablet with a screen size of around 10.1", although it will run on smaller screen sizes if required.

Carlson Scan Desktop mode is designed to be used in an office environment in conjunction with a standard mouse and keyboard.

Any tablet used in the field should be highly ruggedised to withstand the harsh conditions that are typical for the applications in which the scanning hardware is used.

For field use, the battery life of the tablet should also be considered to avoid the tablet running out of power during a deployment. Taking an inverter into the field can allow the tablet to be plugged into a battery or a vehicle 12V supply via its standard mains power supply adaptor.

Carlson Scan runs on 64-bit Windows PCs from Windows 7 upwards.

300 MB free space is required on your tablet's hard disk to install the software.

2 GB is the minimum recommendation for RAM installed in your tablet.

The main compatibility requirement for **Carlson Scan** to run is that the processor / GPU should be able to support Vulkan API. A list of processors and GPUs compatible with Vulkan in Windows, is shown here: https://en.wikipedia.org/wiki/Vulkan_(API)#Compatibility.

Carlson recommends that you ensure that all Windows updates are current and that the latest drivers for your graphics card are installed. Failure to update components may result in video or driver errors.

To connect to the C-ALS, an Ethernet port and/or a Wi-Fi card is required in your tablet.

To connect to the VS+ you require a Wi-Fi card in your tablet.

Both the C-ALS surface unit and the VS+ communicate wirelessly via a 2.4 GHz connection. Later models also offer a 5 GHz link. If your tablet hardware supports 5Ghz Wi-Fi, you may use this frequency to counter any interference or connectivity issues you may experience with the default 2.4 GHz connection.

3.3 Software installation

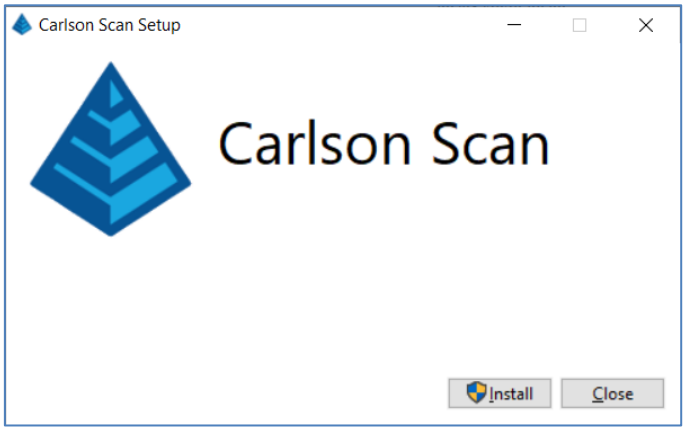
Carlson Scan has a non-restrictive distribution license, so it may be installed on as many tablets as required.

If you ordered a rugged tablet from Carlson as part of a C-ALS purchase, **Carlson Scan** is already loaded on the tablet.

If you are supplying your own tablet, you must install the software before using your scanner for the first time.

The **Carlson Scan** installer is loaded onto the USB drive packaged with all C-ALS systems. Updates are made available online.

The installer is supplied in the form of an *.exe file or, optionally, an MSI file. Double-click on the file to run the installer.



Carlson Scan installer

Click **Install, Next** and then accept the license after a careful review.

Click **Install**. The software and all necessary dependencies are loaded onto your tablet.

By default, **Carlson Scan** is installed at: **C:\Program Files\NDEVR\Carlson Scan**.

An icon is loaded onto your desktop. Double-click to open **Carlson Scan**.

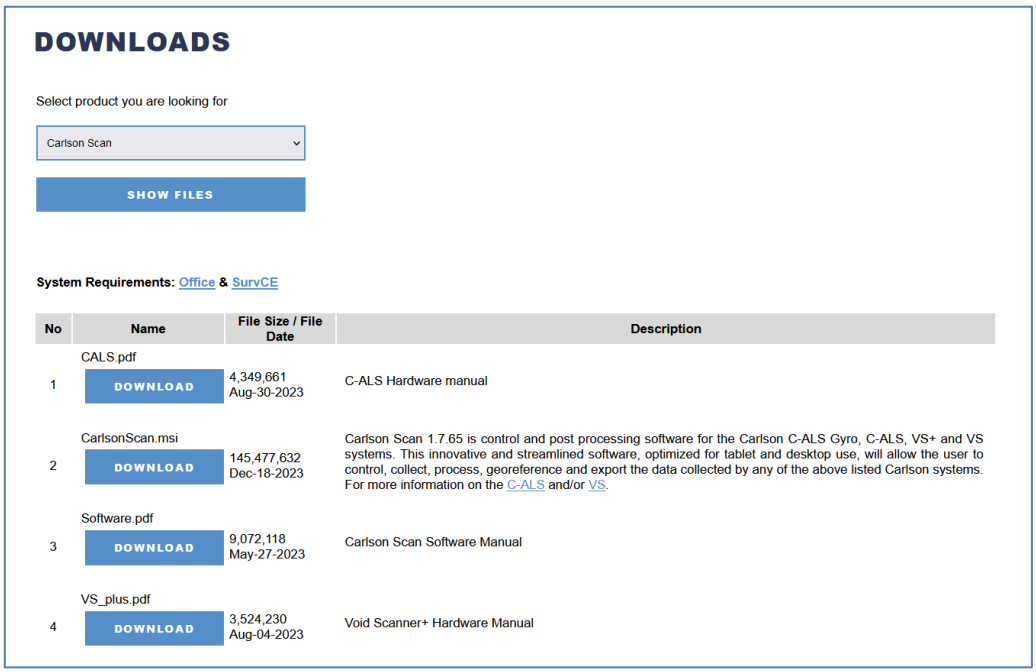
Carlson Scan desktop icon

3.4 Software updates

Always use the most recent released version of **Carlson Scan**. This is available from Carlson website downloads page here:

https://web.carlsonsw.com/files/updates/updates05.php?ss_email=&product=CarlsonScan

The latest version of the software is available at this location, together with the relevant software and hardware manuals.



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Carlson Scan

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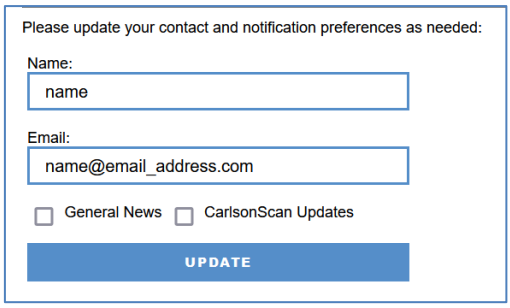
System Requirements: Office & SurvCE

No	Name	File Size / File Date	Description
1	CALS.pdf DOWNLOAD	4,349,661 Aug-30-2023	C-ALS Hardware manual
2	CarlsonScan.msi DOWNLOAD	145,477,632 Dec-18-2023	Carlson Scan 1.7.65 is control and post processing software for the Carlson C-ALS Gyro, C-ALS, VS+ and VS systems. This innovative and streamlined software, optimized for tablet and desktop use, will allow the user to control, collect, process, georeference and export the data collected by any of the above listed Carlson systems. For more information on the C-ALS and/or VS.
3	Software.pdf DOWNLOAD	9,072,118 May-27-2023	Carlson Scan Software Manual
4	VS_plus.pdf DOWNLOAD	3,524,230 Aug-04-2023	Void Scanner+ Hardware Manual

Carlson downloads page

Note that the legacy version 1.3.6 is also available from this page. Carlson Scan version 1.3.6 is the last version that works with C-ALS Mk3 and Void Scanner units.

At the bottom of the download page enter your name and email address and click **Update**. You will be sent an email notification whenever a new version of **Carlson Scan** is released.



Please update your contact and notification preferences as needed:

Name:

name

Email:

name@email_address.com

☐ General News ☐ CarlsonScan Updates

UPDATE

Enter details for update notifications

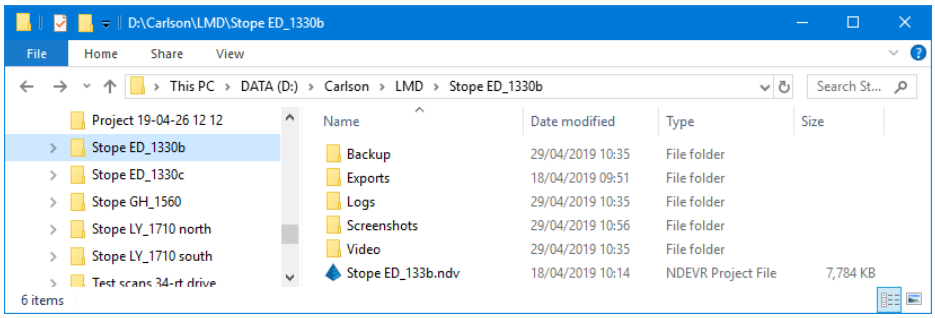
The first step of any troubleshooting process is to ensure that you are using the current release of **Carlson Scan** software.

3.5 Data storage and file formats

A **Carlson Scan** project is saved as an *.NDV file. You can open this file from within **Carlson Scan** by using the **Open** function. Alternatively, double-click on the file in Windows Explorer to automatically open the selected project inside **Carlson Scan**.

By default, projects created in **Carlson Scan** are saved in the location:

C:\Users\<username>\Documents\Carlson Scan\<projectname>.



A Carlson Scan project in Windows Explorer

The default location can be changed through the **Settings** window (see section 4.3.6).

Note that before you manually save the project, it is automatically saved in the temporary location:

C:\Users\<username>\Documents\Carlson Scan\Unsaved Projects\<projectname>.

Once you have manually saved the project, it is moved to the default **Carlson Scan** directory.

Other files are stored in sub-folders underneath the **Carlson Scan\<projectname>** directory:

- **Backup**: while a project is active, a backup file is stored here and continually updated. This ensures all data is secure and allows recovery in case of a hardware or software failure. Files in this folder are time/date stamped with *<most_recent.ndv>* being the last recorded backup.
- **Exports**: by default, any exports generated from a project are stored here.
- **Logs**: during data collection operations, detailed logs are kept of communications with the scanner. These may be used for support and troubleshooting.
- **Screenshots**: snapshots taken with the C-ALS borehole camera are stored here.
- **Video**: videos taken with the C-ALS borehole camera are stored here.

If problems are encountered with the hardware, software or any collected datasets, then it may be necessary to contact Carlson for support. In this case you may be requested to send the *.NDV file for further analysis and troubleshooting. This will help to ensure the highest level of support.

Access the project location from within **Carlson Scan** by tapping **Browse** in the **Menu** tab (see section 6.7). Windows File Explorer opens at the address of the active project.

3.6 Viewing modes

Carlson Scan is designed to be used with a choice of two viewing modes: **Tablet** and **Desktop**.

The mode can be selected when starting up the software. A **Desktop** button is available on the **Tablet** mode **Home** screen (section 4.9). A **Tablet** button is available in the **Desktop** tool bar when first starting the software (section 13).

Unless specified, screenshots in this manual show **Carlson Scan** being used in **Tablet** mode.

3.6.1 Tablet mode

Tablet mode is optimised to be used on a touch-screen tablet. It is recommended that **Tablet** mode be used when collecting data in the field. The relevant controls for connecting to, and controlling, the scanner are made easily accessible through large format buttons. Features less used in the field are kept clear from the main interface. Some functionality such as editing is not available in **Tablet** mode.

In **Tablet** mode, dedicated on-screen keyboards and number pads appear at any time manual data entry is required.

The keypads include buttons to progress to the next field or to go back to the previous field. The number pad can also be used as a calculator if required.

3.6.2 Desktop mode

When a project has been completed, the data is usually viewed and analysed back in the office. In this case, if you are using a larger format laptop or desktop computer then select **Desktop** mode.

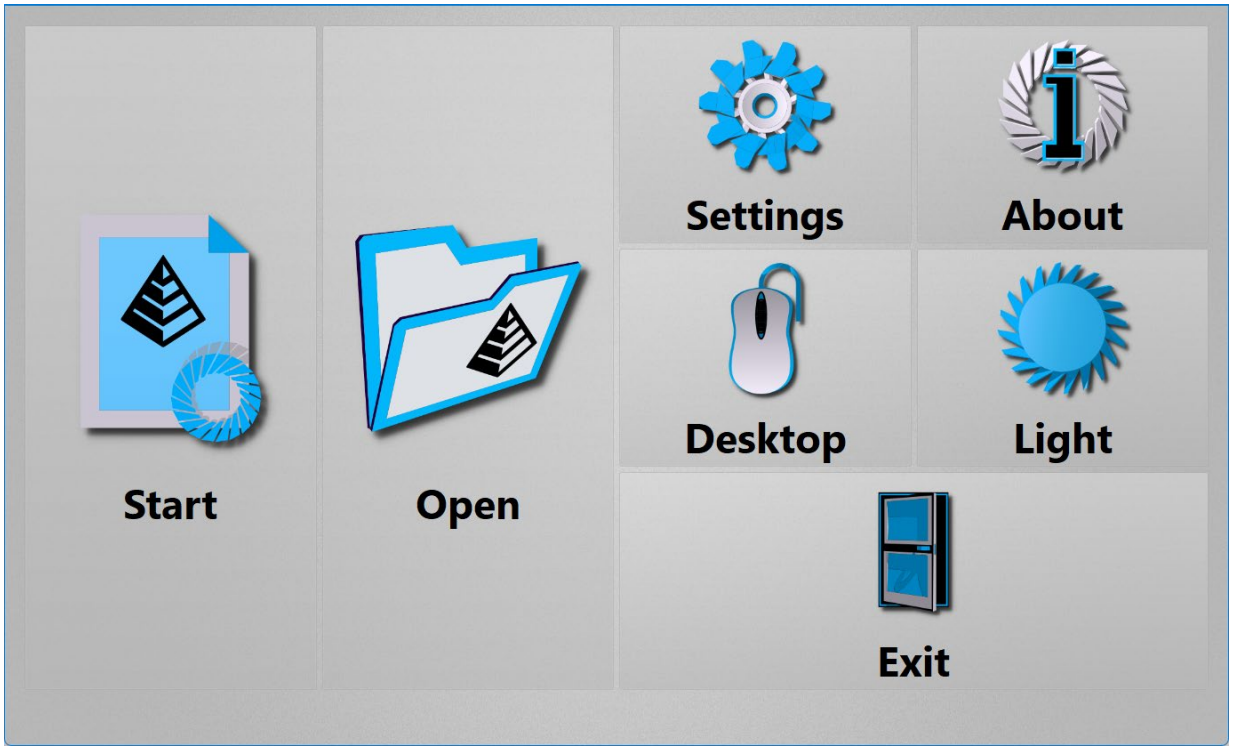
Desktop mode has a more traditional interface and is intended for use with a standard keyboard and mouse.

Desktop mode makes use of extra screen space by making more information available on-screen, and by allowing multiple viewing windows to be shown simultaneously.

More functionality for editing the data is accessible through the **Desktop** mode (see section 13).

4 Tablet mode – Home screen

When **Carlson Scan** is first opened in **Tablet** mode, the **Home** screen appears.



Tablet mode Home screen

4.1 Start

Tap **Start** to create a new, **Carlson Scan** project.

The **Project** window opens (see section 7.1). Edit the details as required. You can enter hole positions in advance, give the project an appropriate name and change the default folder location.

Tap **Create** to accept the entered details and create a new project.

Carlson Scan immediately runs an auto-detect process to identify a C-ALS or VS+ scanner which has been paired to the tablet and which is currently powered ON.

When a scanner is identified, the connection is made.

The **Station Details** window appears (see section 7.2.1). Enter your station coordinates, or just accept the default values. Tap **Finish**.

The main **Tablet** mode interface appears with the **3D View** on the left-hand side of the screen and the **Control** tab on the right-hand side.

The scanner is displayed graphically on screen, located at the newly generated station. The deployment is now ready to begin

See section 10.1 for further information on controlling the VS+ and section 11.1 for controlling the C-ALS.

To import existing data into the project, open the **Menu** tab and select **Import** (see section 6.3).

4.2 Open

From the **Home** screen, tap **Open** to open an existing **Carlson Scan** project. An **Open** dialog appears.

Select the appropriate project from the recent files list. Alternatively, tap **Browse Files** to open an **Open File** windows dialog. Browse to the project location and select the *.NDV file to open the project in **Carlson Scan**.

On opening a project, you can reconnect to a scanner via the **Find Scanners** button on the **Control** tab (see sections 10 and 11).

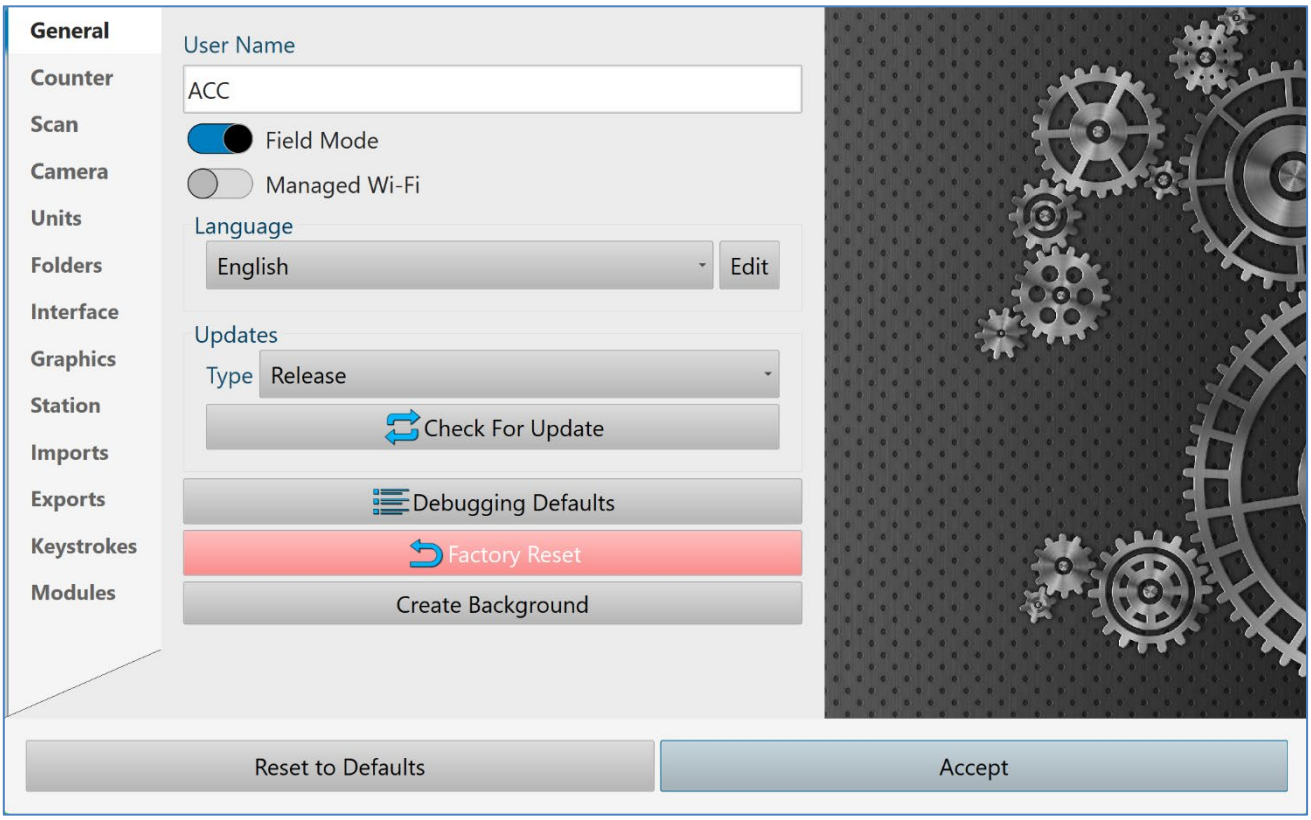
4.3 Settings

Tap **Settings** to view or edit software configuration settings. The **Settings** window appears.

There are tabs along the side of the screen which group together different categories of controls.

4.3.1 General

The **General** tab collects together settings affecting the general operation of **Carlson Scan** software.



Settings window > General tab

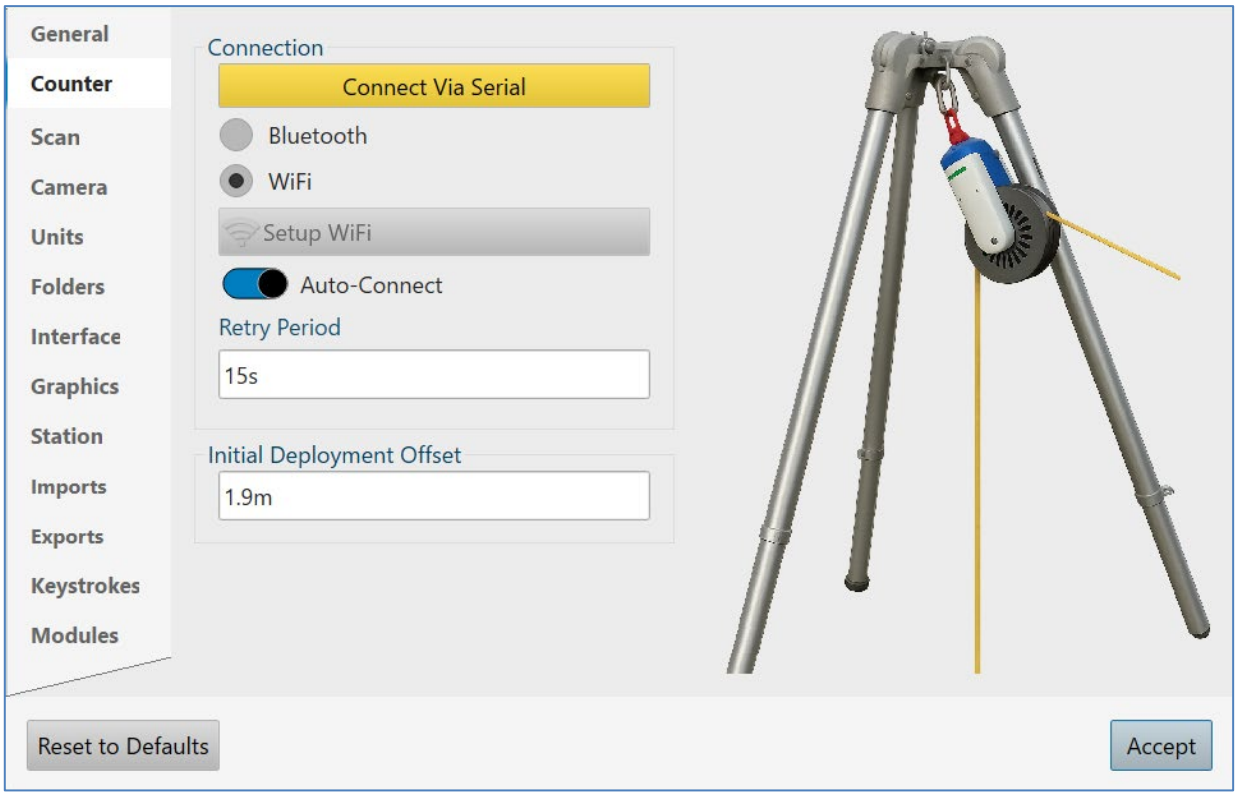
- **User name**: enter the name of the operator. This appears on reports and saved project information.
- **Field mode:** Toggle ON to optimise Desktop mode for data acquisition in the field. This ensures appropriate defaults are set for sounds, auto-connect to devices, full screen mode etc. Alternatively, if using Desktop mode for post-processing data in the office, switch **Field mode** OFF.
- **Language**: select from the list of available language options. If you would like to see additional language

options in the list, please contact Carlson to make a request.

- **Check for update:** automatically checks for new versions when the tablet is connected to a network. If a new version is available, hit the update button to download and update the software version.
- **Debugging defaults:** for troubleshooting purposes only.
- **Factory Reset**: restores **Carlson Scan** software to the state of a fresh installation.
- **Create Background**: creates a 'Carlson' desktop wallpaper for your device.

4.3.2 Counter

The **Counter** tab allows you to configure the cable counter to work with a specific surface unit. Once the cable counter has been configured, its interaction with **Carlson Scan** is fully automatic. Thereafter, the tools in the **Counter** tab are only required if a different surface unit or cable counter is to be used.



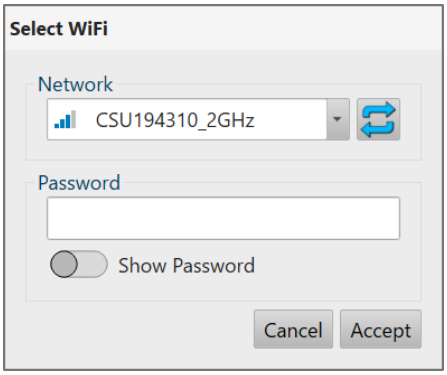
Settings window > Counter tab

If a new pairing is required between a counter and a surface unit, run a USB cable from your tablet to the USB C port in the cable counter.

Turn the cable counter ON. Turn the surface unit ON.

Tap **Connect via serial** to connect to the cable counter. If the connection is successful, the button changes to a green **Connected** button.

Tap on the **Setup Wi-Fi** button.



Select Wi-Fi button

From the **Network** drop down list, select the name of the 2 GHz Wi-Fi channel from the surface box to which the counter will be connected. Note that a surface unit has two Wi-Fi channels – 2 GHz and 5 GHz – but the cable counter will only connect to the one broadcasting at 2 GHz.

If the surface box Wi-Fi requires a password for connection, enter this in the **Password** data entry box.

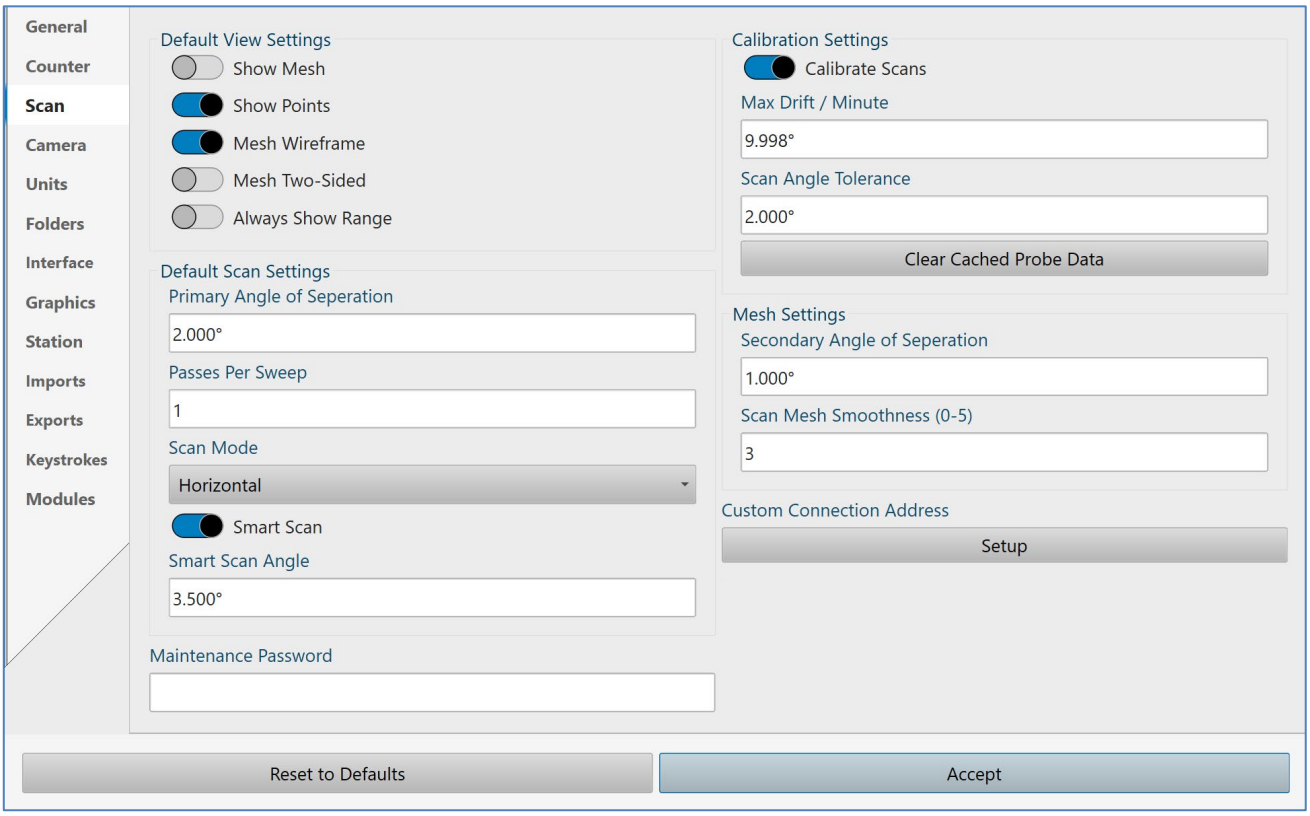
Tap **Accept**. The cable counter is automatically restarted to save the new configuration.

The **Initial deployment offset** is the distance that the C-ALS probe is deployed before the cable counter deployment is started (ie before the **Start Encoder Deployment** button is tapped in the **Scanner** tab). The entered distance will be added on to the deployment length as soon as the cable counter deployment is started.

By default this value is set at 2 m. This means that the C-ALS probe and extension piece would be deployed as far as the rod adaptor on the extension piece before the cable counter deployment is started. As soon as the deployment is started, 2 m is displayed.

4.3.3 Scan

The **Scan** tab allows you to configure some default settings for scanning operations.



Settings Window > Scan tab

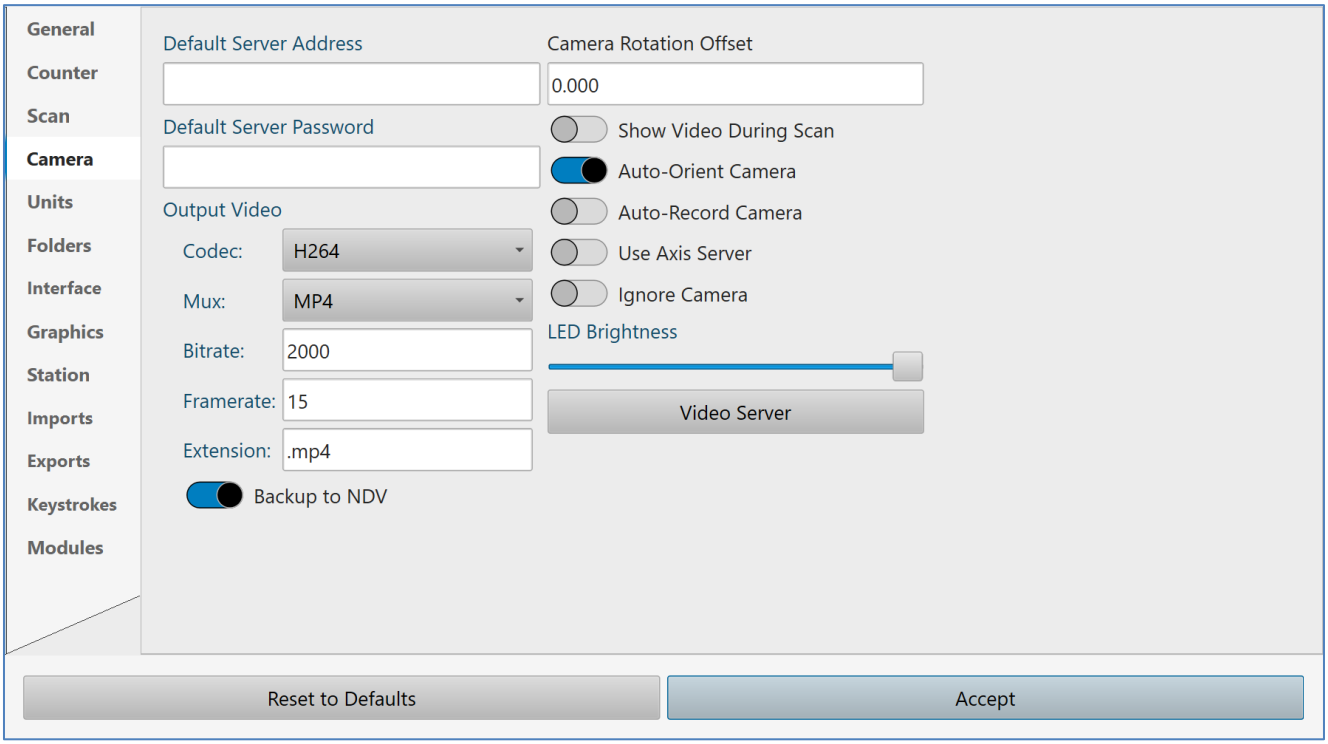
- **Show mesh:** set as default whether the mesh is visible or invisible when a scan is running.
- **Show points:** set as default whether the points are visible or invisible when a scan is running.
- **Mesh wireframe:** set as default whether the mesh is visible as a wireframe, or as a solid surface.
- **Mesh two-sided:** set as default whether the mesh is visible as a two-sided surface, or with the near side invisible.
- **Always show range:** set as default whether a range from the laser is displayed during a deployment.
- **Primary angle of separation:** set the default **Scan angle** in the **Control** tab.
- **Passes per sweep:** sets the number of times the scan head rotates at each given horizontal/vertical angle combination.
- **Scan mode:** set the default mode of scanning in the **Control** tab.
- **Smart scan:** set as default whether each scan is 'smart'. A smart scan attempts to optimise the point coverage by reducing scan lines where the laser is pointing at surfaces which are very close and which would normally be over-saturated with points. By default this is turned ON.
- **Maintenance password**: used for troubleshooting in conjunction with Carlson support personnel.
- **Calibrate scans:** set as default to use the gyro information captured during a scan to calibrate the orientation and alignment of the scan, after it is complete.

- **Max drift / minute**: calibration setting for troubleshooting use.
- **Scan angle tolerance**: calibration setting for troubleshooting use.
- **Clear cached probe data:** resets probe-specific data which is used for calibrating scans.

- **Secondary angle of separation:** sets how dense the mesh triangulation should be when it is created during a scan.
- **Scan mesh smoothness:** sets the default value which governs a local averaging algorithm which smooths the mesh over the point cloud. This can be adjusted to increase or reduce the smoothing. Reducing the value can help fill gaps in the mesh.
- **Custom connection address**: used for a custom instrument setup with a non-standard IP address.

4.3.4 Camera

The **Camera Settings** tab contains settings related to the on-screen C-ALS video window. It is not usually necessary to adjust these values.



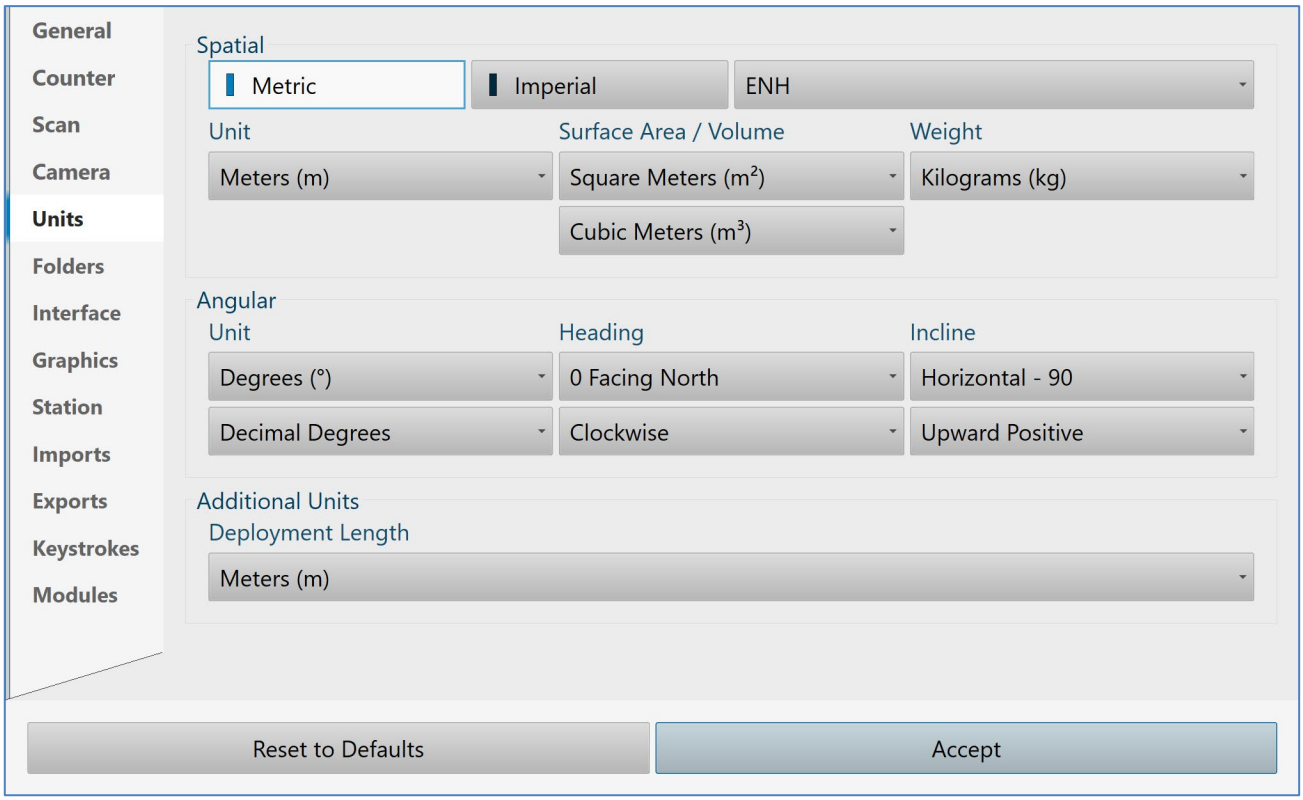
Settings > Camera tab

- **Backup to NDV:** compresses all recorded video and snapshots into the NDV project file. Irrespective of this setting, all recorded video and snapshots are separately saved to the tablet.
- **Show video during scan: to**ggle the switch ON to enable the on-screen C-ALS video window to display during a scan. If this option is OFF, the video window disappears during a scan.
- **Auto-orientate camera:** if toggled ON, the camera is kept orientated while the scan head rotates.
- **Auto-record camera:** if toggled ON, the camera image is always recorded while visible on screen.
- **Use Axis server:** allows the use of different video servers.
- **Ignore camera:** ignores the camera while the C-ALS is connected. The camera image will not be displayed.

  Note that if the C-ALS is being deployed down a borehole, the camera should always be used to detect obstructions and to identify the point at which the C-ALS probe enters the void.
- **LED Brightness:** use the slider to adjust the brightness of the LED on the nose of the C-ALS.
- **Video server:** opens a browser to view the video server's web UI. This allows direct adjustment of the video settings.

4.3.5 Units

The **Units** tab allows you to set the units of measurement for your project.



Settings window > Units tab

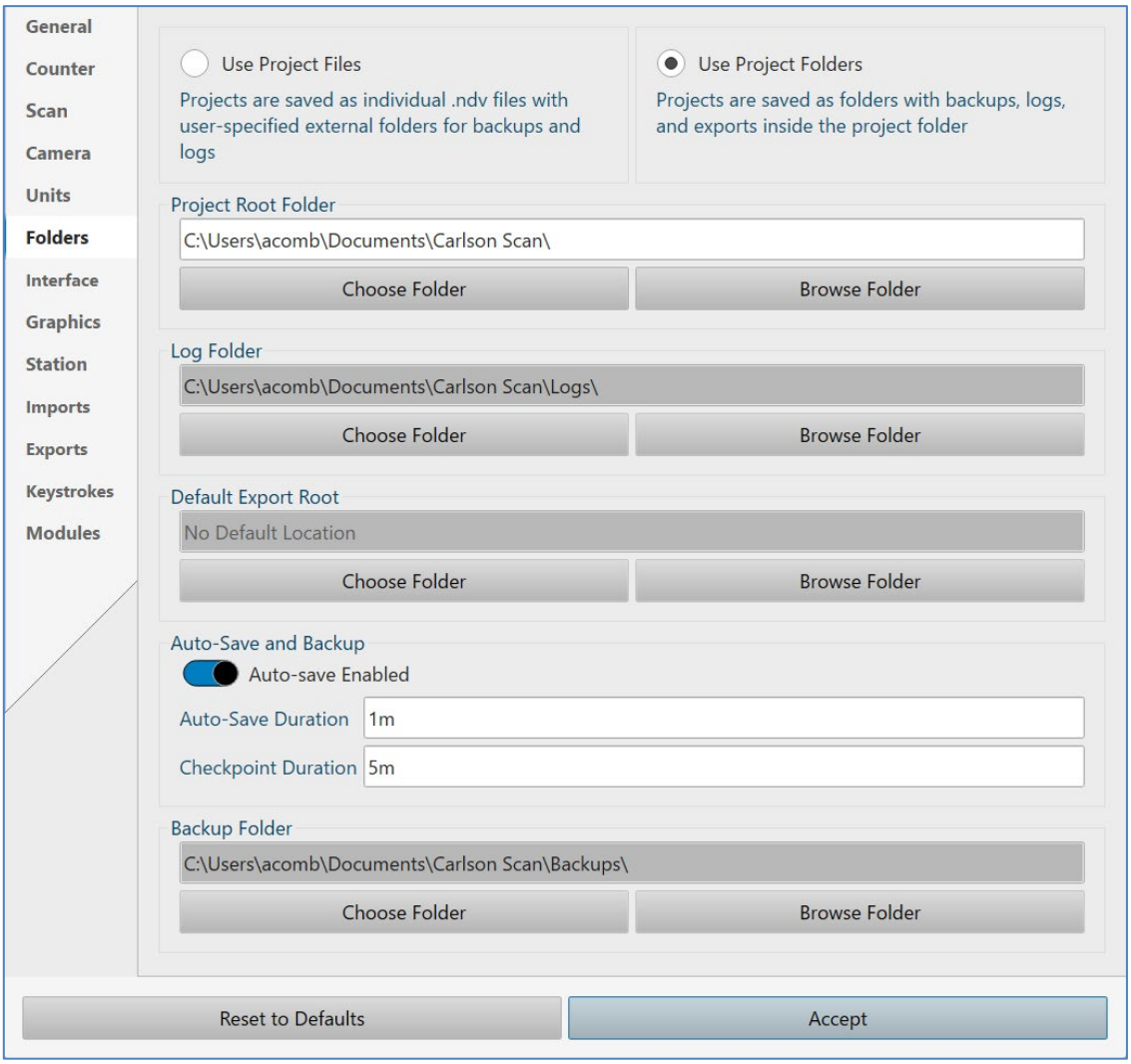
- **Metric**: tap to set all units to default metric measurement units.
- **Imperial**: tap to set all units to default imperial measurement units.
- Select the coordinate system from:
    - **ENH**: Easting, Northing, Height (x, y, z)
    - **NEH**: Northing, Easting, Height (y, x, z)
    - **WSH**: Westing, Southing, Height (x, y, z)
    - **XYZ:** Easting, Northing, Height (x, y, z)
    - **YXZ:** Northing, Easting, Height (y, x, z)
- **Unit**: select from:
    - **Metres**
    - **Feet**
    - **US Survey Feet**
    - **Inches**
    - **Centimetres**

- **Surface area unit**
    - **Square Feet**
    - **Square Metres**
    - **Square Yards**
    - **Square Inches**
    - **Square Kilometres**
- **Volume Unit**
    - **Cubic Feet**
    - **Cubic Metres**
    - **Cubic Yards**
    - **Cubic Inches**
    - **Litres**
    - **US Gallons**
- **Angular unit**:
    - **Decimal degrees**
    - **Degrees minutes**
    - **Degrees, minutes, seconds**
    - **Radians**
    - **Gradians (gons**)
- **Heading**: define the 0° reference direction:
    - **North**
    - **East**
    - **South**
    - **West**
- Define the direction of horizontal angle measurement:
    - **Clockwise**
    - **Anti-clockwise**
- **Inclination Unit:** define the angle define by a horizontal inclination:
    - **Horizontal = 90°**
    - **Horizontal = 0°**
- Define the direction of vertical angle measurement:
    - **Upward positive**

    - **Downwards positive**
- **Deployment Length**: define the units used to deploy the C-ALS:
    - **Meters**
    - **Feet**
    - **US Survey Feet**
    - **Inches**
    - **Centimeters**

4.3.6 Folders

The **Folders** tab defines the storage location of **Carlson Scan** projects on your tablet.



Settings window > Folders

By default, **Carlson Scan** uses project folders, as described in section 3.5. The **Use Project Folders** radio button is selected by default.

To change the default location in which projects, logs, exports or backups are stored, tap the appropriate **Choose Folder** button under **Project Root Folder**.

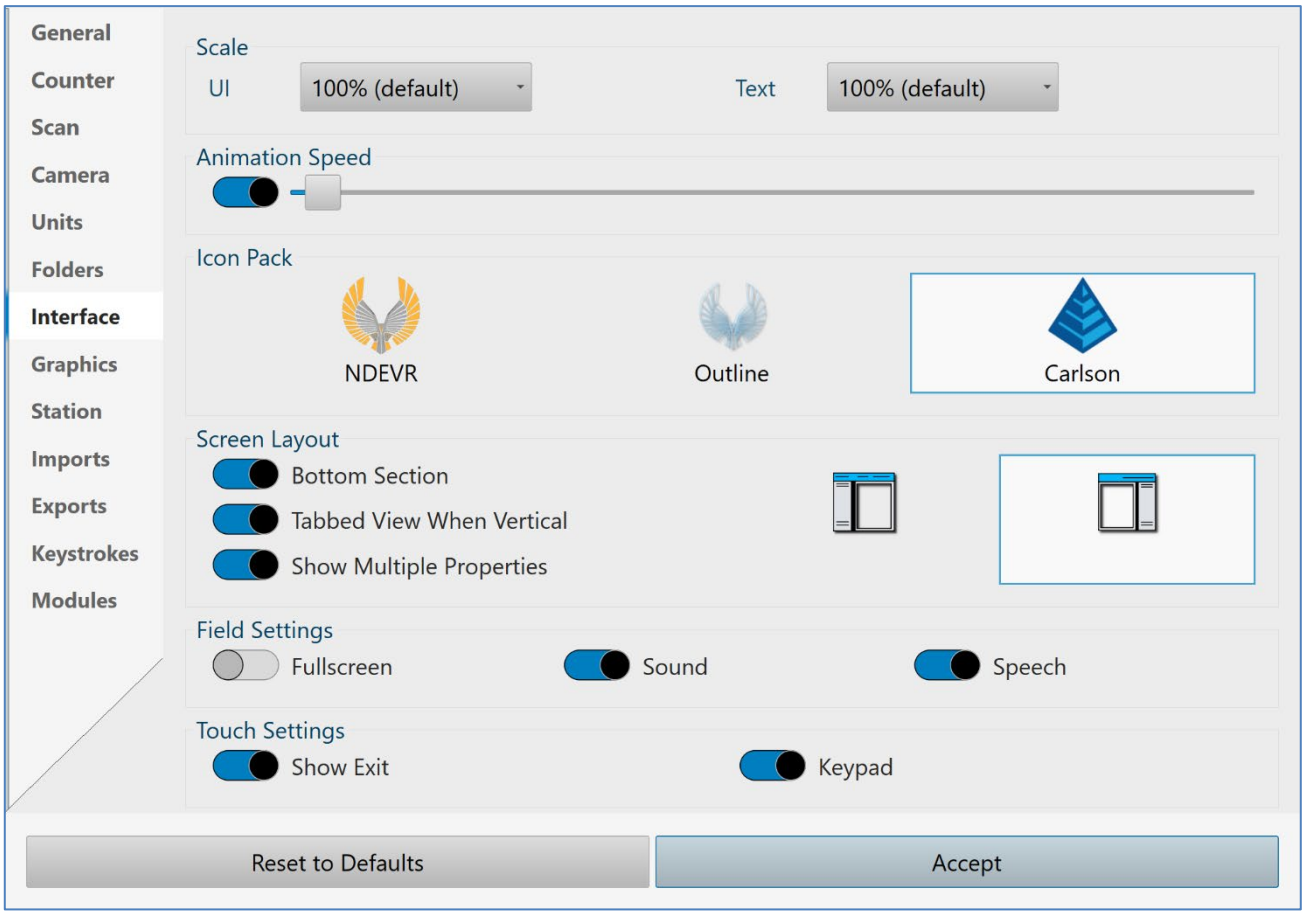
Alternatively, select **Use Project Files** to store each project and associated files in separate folders. In this case, by default, files are stored in the folder listed below, but can be changed.

- **Project Root Folder**: stores the main NDV project file.
- **Log Folder**: stores the log files for troubleshooting & diagnostics.
- **Default Export Root**: stores data files exported from the main project.
- **Backup Folder**: stores ongoing backup files which ensure that no data is ever lost.

Use the value in the **Auto Save Duration** text box to define how often the current project is automatically saved. By default, the project is auto-saved every five minutes.

4.3.7 Interface

The **Interface** tab collects settings which determine the appearance of **Carlson Scan** on your tablet.



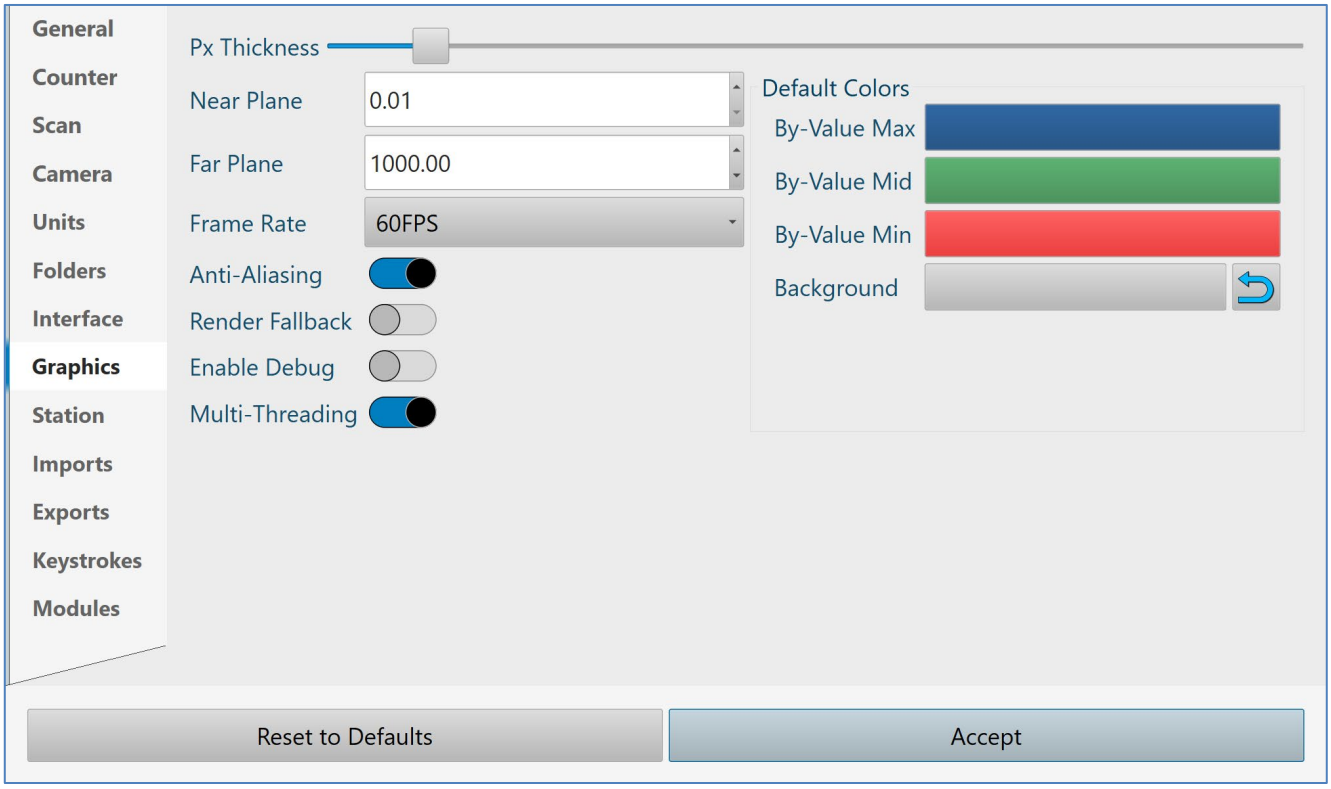
Settings window > Interface

- **UI scale**: select a scale to ensure a best fit for **Carlson Scan** on your tablet.
- **Text scale**: select a scale to ensure a best fit for **Carlson Scan** on your tablet.
- **Animation Speed**: control the appearance of transitions between various tabs, controls, and windows.
- **Icon pack**: change the appearance of all icons though out **Carlson Scan**.
- **Screen layout – Bottom section**: (Windows only) in Desktop mode, activates a frame at the bottom of the screen for scan information.
- **Tabbed view when vertical**: when using **Carlson Scan** in portrait mode, switch between displaying the 3D view as a tabbed screen, or a split screen.
- **Show multiple properties**: (Windows only) allow multiple properties windows to be opened at the same time.
- **Screen layout – tabs on left**: position tabs on the left-hand side of the screen.
- **Screen layout – tabs on right**: position tabs on the right-hand side of the screen.
- **Field settings – Fullscreen**: toggle between full screen mode and window mode.

- **Field settings – Sound**: toggle sound affects ON and OFF.
- **Field settings – Speech**: toggle spoken reports during a deployment ON and OFF.
- **Touch settings – Keypad**: activate the onscreen keypad for data entry.
- **Touch settings** – **Show exit**: enable or disable the **Exit** button in the **Menu** tab and the **Home** screen.

4.3.8 Graphics

The Graphics tab defines default settings for the visualisation of data in the **3D View**.

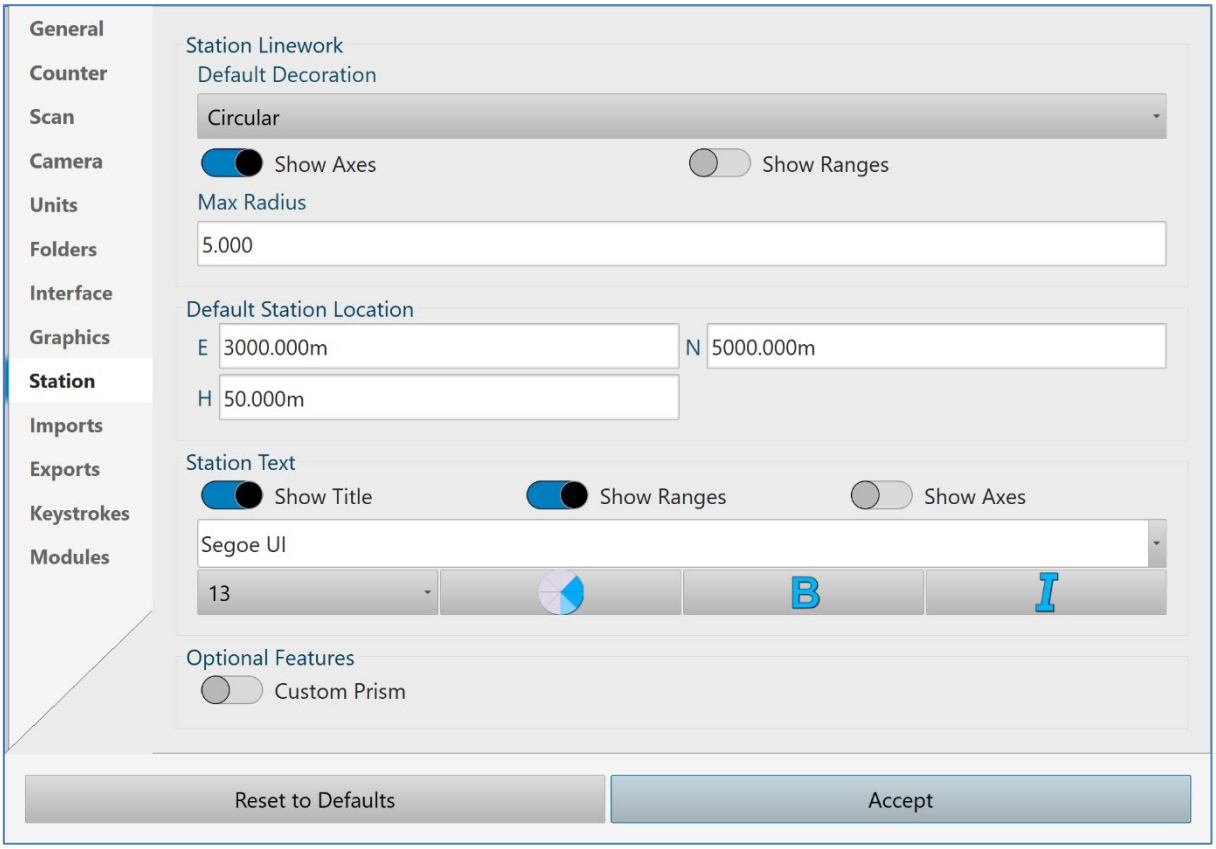


Settings window > Graphics tab

- **Pixel thickness**: change the thickness of lines displayed in the **3D View**.
- **Near plane**: the closest distance from your viewpoint that is rendered in the **3D View**.
- **Far plane**: the furthest distance from your viewpoint that is rendered in the **3D View**. Large distances can be displayed but may be at the expense of the rendered resolution.
- **Frame rate**: the number of frames to be displayed in the **3D View** per unit of time is expressed in frames per second (fps).
- **Anti-aliasing / Render Fallback / Enable debug / Multi-threading**: for troubleshooting purposes only. These options can be changed in response to graphics display issues on your mobile device.
- **Default colours**: select the colours which are used to shade the survey data and models in the project. Background selects the background colour for the **3D View.** The **Max, Mid** and **Min** values refer to different qualities depending on the colour scheme selected.

4.3.9 Station

The **Station** tab deals with default settings for station creation. A **Station** is a hole collar from which the C-ALS is deployed, or a surveyed position of the VS+. All settings can also be configured on an individual hole-by-hole basis through the **Station Details** window (see section 7.2.1).



Settings > Station

- **Station linework**: controls the default appearance of stations created in Carlson Scan.
  - **Show ranges:** display range circles / grids around the station in the **3D View**.
  - **Show axes:** display axes centred on the station.
  - **Max radius:** the maximum size of the Station in the **3D View**.
- **Default station coordinates**: sets the coordinates which are used when a station is automatically generated by **Carlson Scan**. These can be changed at any time before or after a survey. You may find it convenient to enter default station coordinates which are close to those on your project coordinate system.
- **Station text:** controls the default appearance of stations created in **Carlson Scan**.
  - **Show title:** display the station name in the **3D View**.
  - **Show ranges:** display range label on the range circles / grids around the station.
  - **Show axes:** display labels on axes centred on the station.
- **Optional features**:
  - **Custom prism**: toggle ON to use a non-standard prism position when using a VS+.

4.3.10 Imports

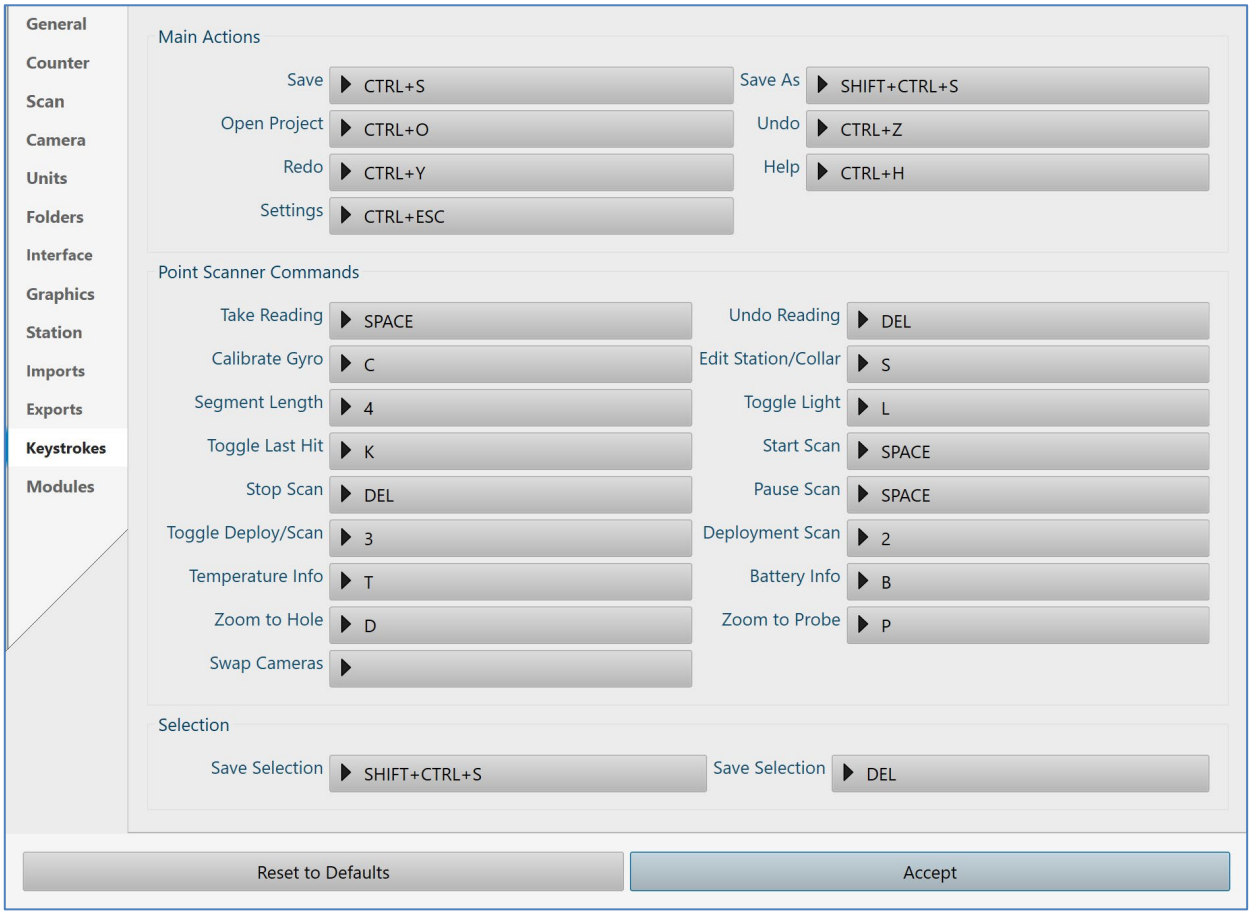
The **Imports** tab lists all file formats which can be imported into **Carlson Scan**. Tap on any import to define default options for each format. These settings can also be altered during each individual import.

4.3.11 Exports

The **Exports** tab lists all file formats which can be exported from **Carlson Scan**. Tap on any export to define default options for each format. These settings can also be altered during each individual export.

4.3.12 Keystrokes

The Keystrokes tab lists common actions in **Carlson Scan** and allows you to assign shortcut keys to each of these actions. This enables you to utilise hardware buttons on your mobile device to activate actions such as taking a reading or finishing a hole.



Settings > Keystrokes

To assign a shortcut key, tap on any of the existing shortcut buttons in the **Keystroke** tab. Press the button or combination of buttons you would like to use for the associated action. This shortcut now replaces the previous shortcut key.

You can assign the same button to actions which are encountered at different stages of a deployment operation. For example, a Function key may be assigned to 'Take Reading' and also to 'Download Data' as these actions are never offered as onscreen options at the same time.

4.3.13 Modules

The **Modules** tab lists the software modules present in your version of **Carlson Scan**.

4.4 About

Tap the **About** button to access help documentation and program information. There are three tabs along the top of the window.

4.4.1 About

The **About** tab displays details of **Carlson Scan** including the version number which should be quoted during any support query to Carlson.

About window > About tab

The version number of the software is shown in the **About** screen and should be quoted during any support call with Carlson.

If your tablet is connected to the internet, use the **Check for update** button to check whether you are using the most recent version of **Carlson Scan**.

4.4.2 Manuals

The **Manuals** tab provides access to this **Carlson Scan** software manual, as well as to the hardware manuals of all products supported by the software.

4.4.3 License

The **License** tab displays the end-user license agreement.

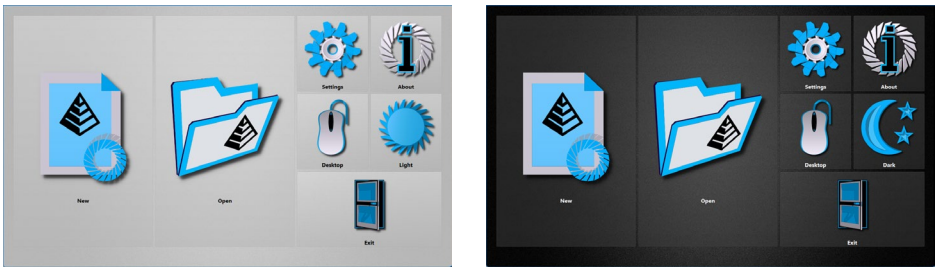
4.4.4 Modules

The **Modules** tab lists the software modules present in your version of **Carlson Scan**.

4.5 Light / Dark

Tap **Dark** / **Light** to toggle between two colour themes. During in-field operations, whether it be underground or in bright sunlight, one particular theme may give a clearer view of the screen.

You may also need to change the background colour to improve visibility in certain lighting conditions (see section 4.3.7).



Light mode, dark mode

4.6 Desktop

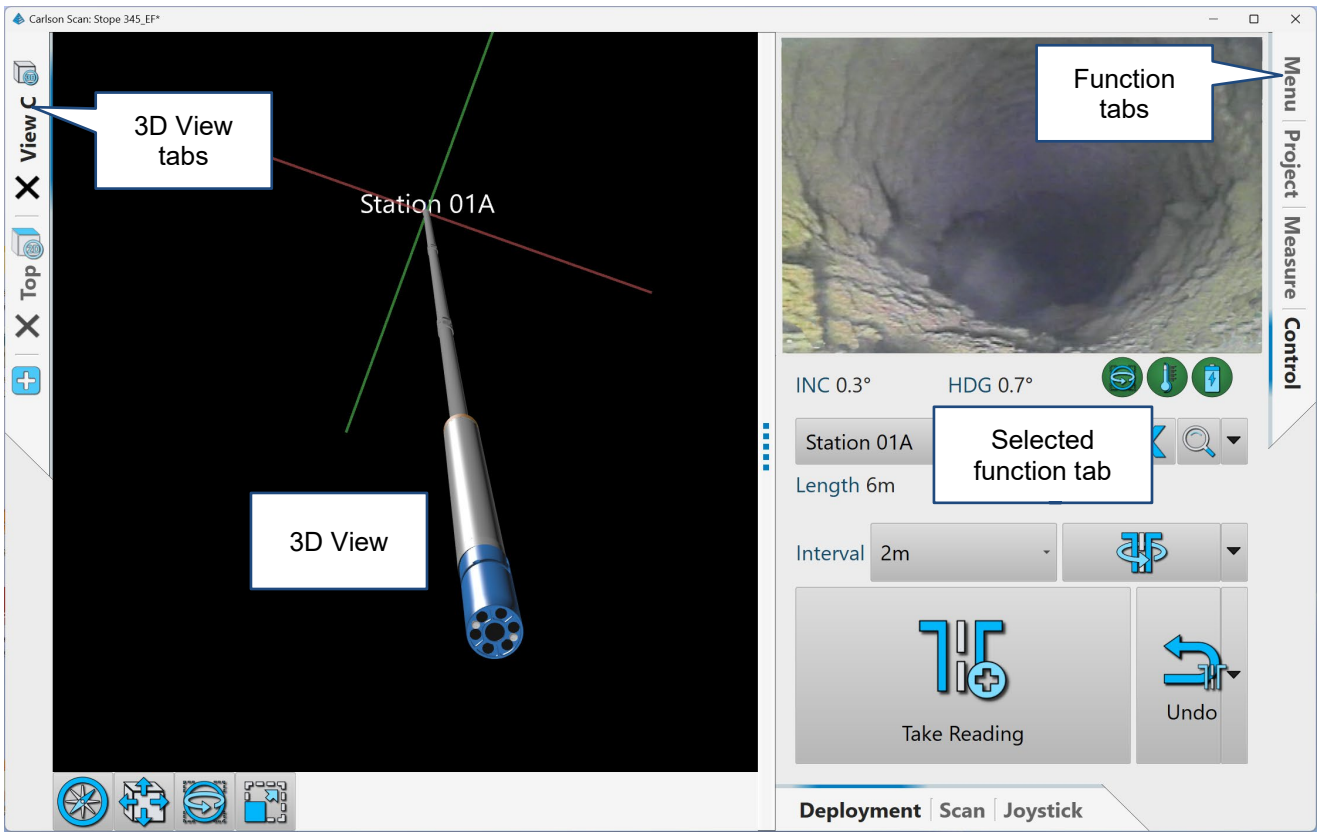
Tap the **Desktop** button to change to **Desktop** mode. **Carlson Scan** automatically restarts and opens in **Desktop** mode (see section 13).

When in **Desktop** mode, there is a corresponding **Tablet** mode button in the tool bar.

4.7 Exit

Tap the **Exit** button to close **Carlson Scan**.

5 Tablet mode – screen layout



Tablet mode - screen layout

In **Tablet mode**, a standard screen layout is composed of the elements outlined below.

Note that you may use the options in the **Settings** window to modify the appearance from the default layout shown in this manual (see section 4.3).

Also note that the screen will look different depending on which instrument is connected to the software. In the image above, **Carlson Scan** is connected to a C-ALS.

5.1 3D View

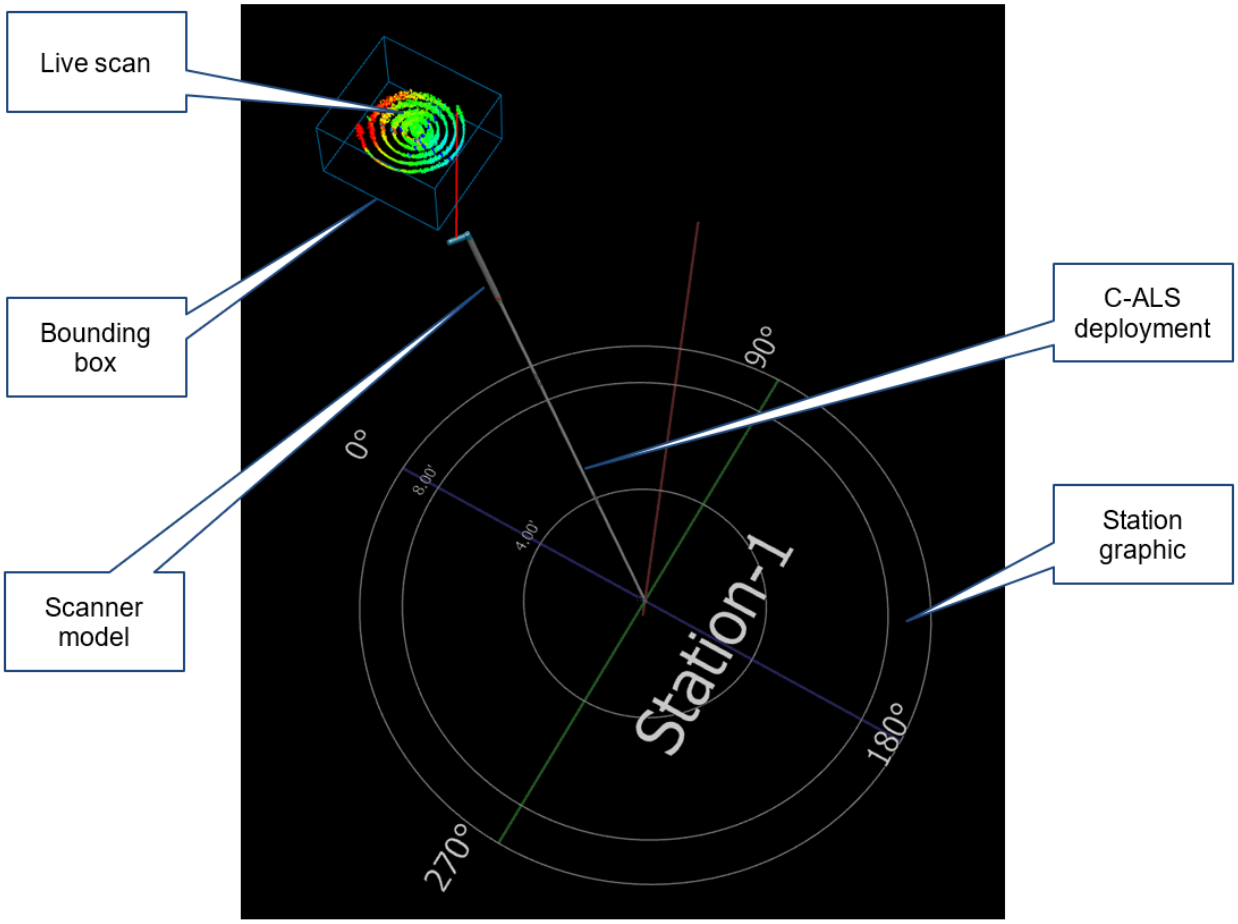
The main **3D View** window shows all data graphically as it collected in real-time. This includes scanned point clouds and, for the C-ALS, deployment trails.

Initially the **3D View** shares the screen space with one of the function tabs. Retract the active function tab to switch the **3D View** to full screen (see section 5.4).

Navigation in the **3D View** is by intuitive dragging and tapping or, alternatively, by using a mouse.

- **Zoom in / out**: pinch / expand gestures with two fingers; roll the scroll wheel on a mouse.
- **Rotate**: drag with a finger; click and drag with a mouse.
- **Pan**: hold and drag with a finger; click and drag with the right button on a mouse.

Elements visible in the **3D View** are outlined below.



Graphic elements in the 3D View

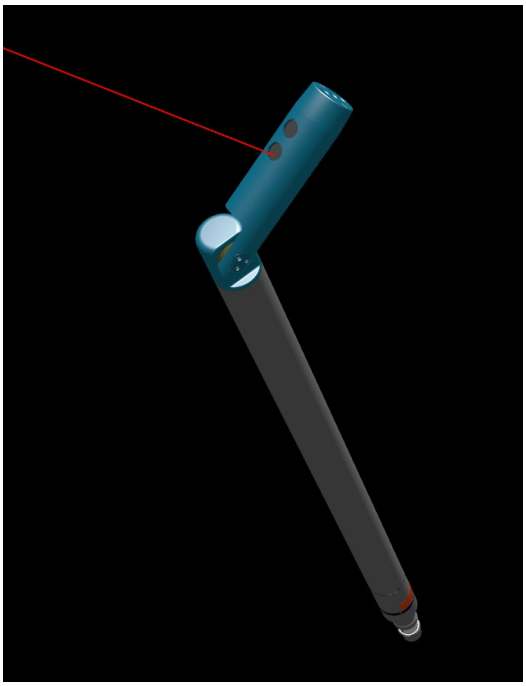
5.1.1 Background colour

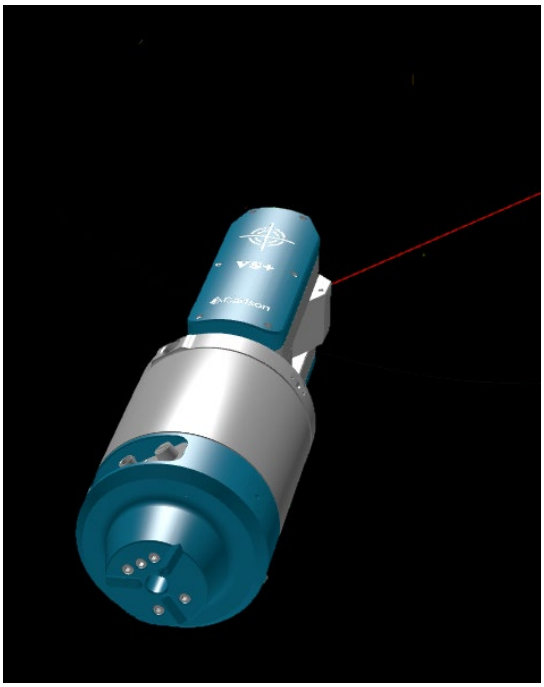
The background colour is black by default. Change the background colour in the **Settings** window (see section 4.3.8).

5.1.2 Scanner model

A model of the C-ALS or VS+ is shown on screen. The internal sensors allow the model to be correctly positioned in real-time, showing the inclination and roll of the scanner. As the scanner head moves, this is also replicated on screen.

When the instrument is scanning, a red laser line is displayed to illustrate the direction that the laser is firing.





C-ALS and VS+ models

5.1.3 Point clouds and meshes

The point cloud being generated by the scanner appears in real-time in the **3D View** window.

As the points are collected, **Carlson Scan** uses the points to create a mesh in real-time.

The **Scan** tab contains controls to change the appearance of the point cloud and the mesh (see section 8).

All scans completed in a project can be displayed on screen simultaneously.

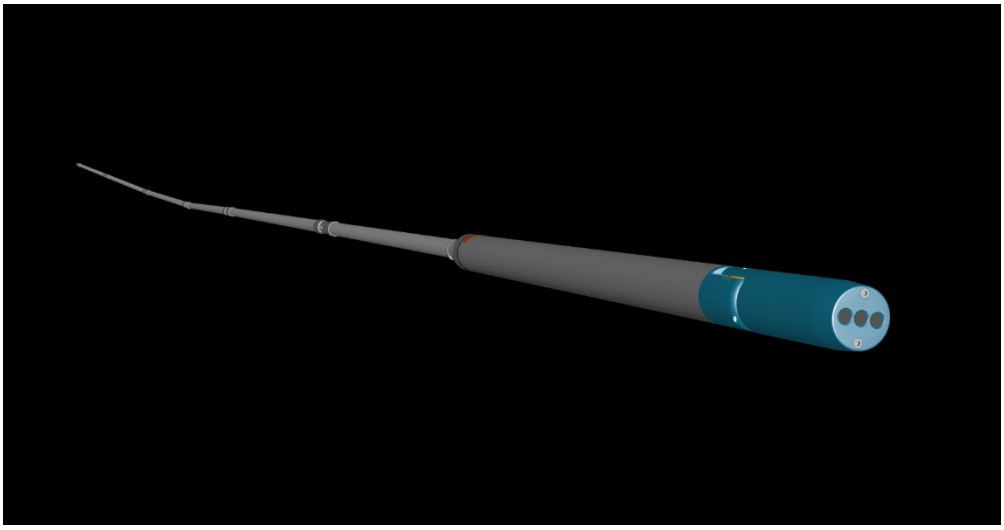
The **Project** tab contains controls to turn the scans and meshes on and off in the **3D View** window (see section 7).

5.1.4 Deployment data

As the C-ALS is deployed, Boretrak readings are taken and are visible on-screen as they are recorded.

You can thus trace the deployment of the C-ALS from the collar to the scan location and visually see any deviation in the borehole.

The **Deployment Details** window shows further information on the deployment and contains controls to turn the deployments on and off in the **3D View** window (see section 7.3).



The C-ALS with a trail of deployment data

5.1.5 Station graphics

Station coordinates are entered in the **Station Details** window. In the **3D View**, the location of these coordinates is marked by a station graphic.

- For C-ALS operations, these coordinates represent the collar location – the point at which the deployment begins. By default, these are represented in the **3D View** by concentric circles which expand as the deployment progresses.
- For VS+ operations, the coordinates represent the surveyed prism position and, taking into account prism offsets, the instrument position. By default, this location is marked in the **3D View** with a rectangular grid.

The station graphic includes text identifiers, grid lines or concentric circles, and an X (green), Y (blue), Z (red) axis.

The station graphic can be reconfigured or toggled on and off using options in **Settings** > **Station** tab (see section 4.3.9).

5.1.6 Bounding box

A bounding box appears around the active scan or deployment. The bounding box shows the geographic limits of the data.

Which dataset is ‘active’ at any given time is determined by:

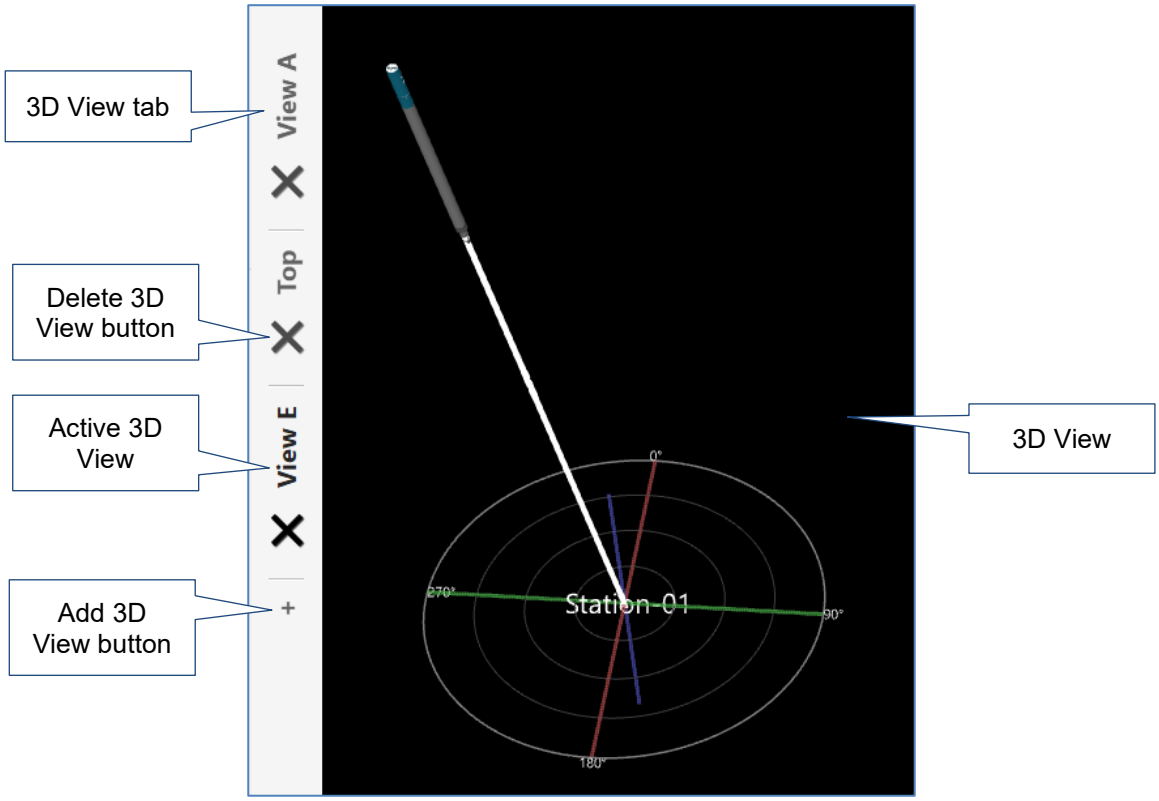
- The deployment or scan which is currently in progress.
- Tapping on a dataset in the **3D View**.
- Selecting a dataset in the **Project** tab.

5.1.7 Imported data

Any pre-existing data imported into the project can be viewed alongside data generated by the scanners within a project.

The **Project** tab contains controls to turn imported data on and off in the **3D View** window (see section 7.11).

5.2 3D View tabs



Multiple **3D Views** can be open but only one is 'active' and displayed in the **3D View** window at any time. Each **3D View** is contained within a tab which is arranged, by default, along the left-hand side of the screen. For example, you may wish to have one view set as a top down, orthographic view, and another a perspective view for free rotation.

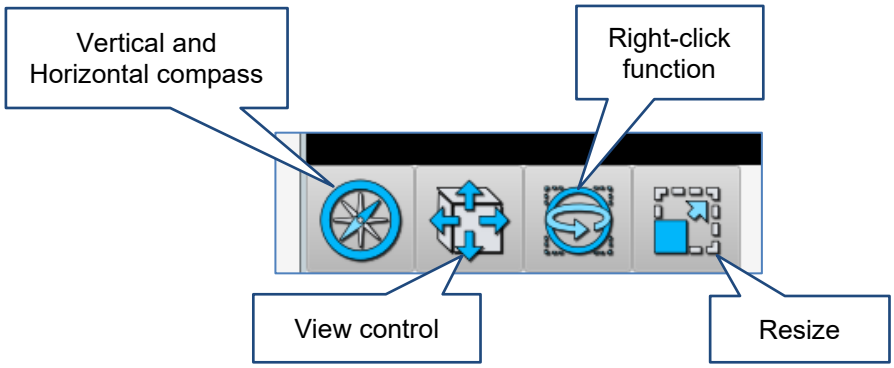
The active **3D View** tab is identified by bold text.

Tap the tab **Delete 3D View** button to delete a **3D View** tab.

Tap the **Add 3D View** button to add a new **3D View** tab.

5.3 3D View buttons

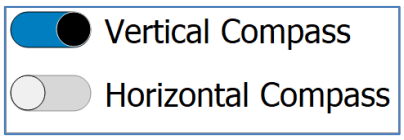
Buttons along the bottom of the **3D View** window provide options for viewing data.



3D View buttons

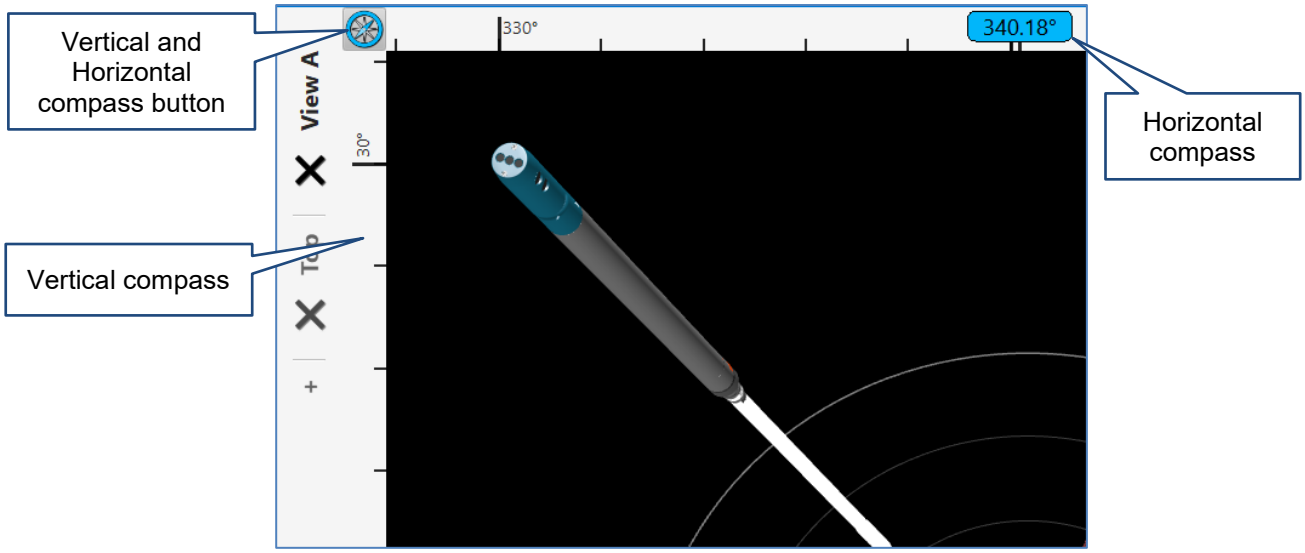
5.3.1 Vertical and horizontal compass

The vertical compass and horizontal compass are side bars in the **3D View** which can be give a live readout of the direction and inclination in which you are viewing the data. Tap **Vertical and horizonal compass** to open a dialog.



Vertical and horizonal compass dialog

Use the **Vertical Compass** and **Horizontal Compass** switches to turn on the side bars in the **3D View**. If one of the compasses is switched on, the **Vertical** and **horizonal compass** button moves to the top right of the **3D View**.



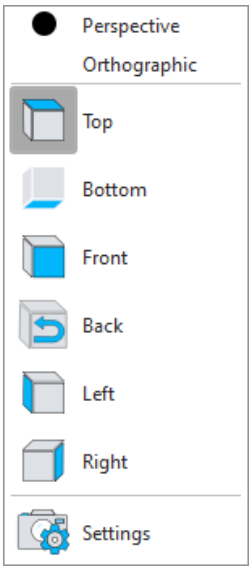
Vertical and horizontal compasses switched on

The **Vertical Compass** and **Horizontal Compass** are only available when using the **Perspective** display option (see section 5.3.2).

5.3.2 View control

The **View** control provides pre-defined view of all data currently active in the **3D View**. To zoom to pre-defined views of specific scans, deployments, or stations, use other zoom buttons in the **Control** tab or in the **Project** tab.

Tap **View** to open the **View** dialog.



View dialog

A choice of **Perspective** or **Orthographic** view is available.

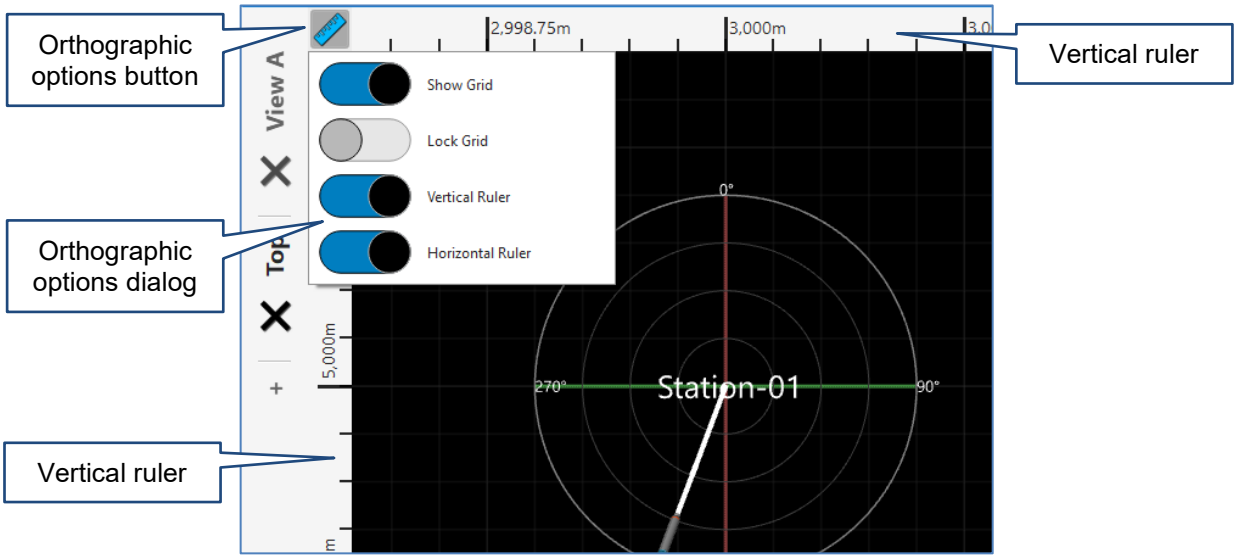
- In **Perspective** view, the data can be freely rotated. Objects which are far away are smaller than those nearby. A perspective viewpoint gives more information about relative distances and is often easier to view as it is familiar from our real-life view of the world.

- In **Orthographic** view, the data is viewed from a fixed perspective. All edges perpendicular to the view direction appear in proportion, at the same scale. Uniform perspective is very useful when analysing data to see the floor level or the shape of a void from fixed viewpoints.

  You cannot rotate data when **Orthographic** view is selected. The default rotating action will pan the data instead.

  When the **Orthographic** view is selected, gridlines are projected onto the **3D View**. The **Vertical Ruler** and **Horizontal Ruler** are displayed along the side and top of the screen respectively.

  An **Orthographic options** button appears in the top left of the **3D View**. Tap the **Orthographic options** button to open the **Orthographic options** dialog.



Orthographic view options

- **Show Grid**: toggles the background grid off and on.
- **Lock Grid**: holds the grid squares constant as you zoom in and out of the **3D View**. With **Lock Grid** switched off, the grid resizes depending on the zoom level.
- **Vertical Ruler**: shows a bar along the side of the **3D View.** This displays grid coordinates if you are viewing from the top of the data, or the height if you are using a side view.
- **Horizontal Ruler**: shows a bar along the top of the **3D View** which displays grid coordinates.

The **View** dialog offers six pre-defined views. Tap a pre-defined view to all active data from this angle. If you are using **Perspective** view, you can immediately rotate the data from the selected, pre-defined view.

5.3.3 Drag action

Determines the effect of dragging your finger, stylus or mouse on the **3D View**.

- **Orbit**: rotates data in the **3D View**. This is the default action when using **Perspective** view.
- **Pan**: pans data in the **3D View**. This is the default action when using **Orthographic** view.
- **Look**: sets the centre of rotation to be your current viewpoint, so you can look around the scene from a fixed location.
- **Zoom**: zooms in when you drag up the screen and zooms out when you drag down the screen.

5.3.4 Resize

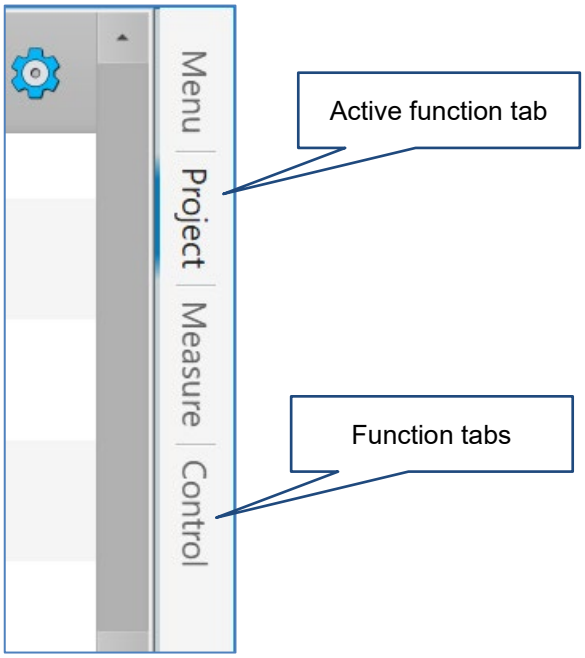
If a C-ALS is connected to **Carlson Scan**, the **Resize** button is available. Tap **Resize** to swap the active **3D View** with the video window in the **Control** tab (see section 11.2). This provides a larger format view of the borehole camera image. It is recommended that you use this window arrangement during a deployment. This helps to ensure that you are in the best position to see the entrance to the void and any obstructions in the hole during a deployment.

When you tap **Resize**, the video controls also swap position so that they always remain under the video window.

A **Resize** button is also present underneath the **Video** window in the **Control** tab (see section 11.2).

5.4 Function tabs

By default, on the right-hand side of the screen, are up to five function tabs which allow control of the scanner, provide data viewing and analysis tools, and enable management of the project.



Function tabs

Tap the required tab to make it active.

The active function tab is identified by bold text and a blue highlight.

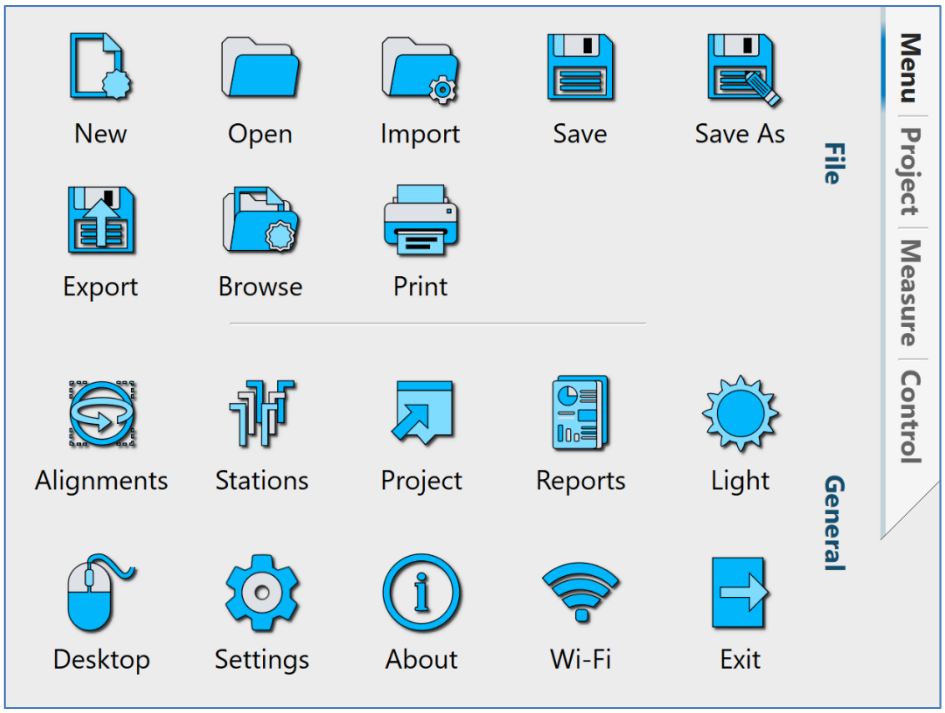
Tap the active function tab to retract it and switch the **3D View** to a full screen display.

The function tabs are each outlined in the following sections.

- **Menu tab:** see section 6.
- **Project tab**: see section 7.
- **Scan tab**: see section 8.
- **Measure tab**: see section 9.
- **Control tab**: see section 10 for use with the VS+, and sections 11 and 12 for use with a C-ALS.

6 Menu tab

The **Menu** tab contains buttons which offer project level and software level functions.



Menu tab

6.1 New

Tap **New** to start a new **Carlson Scan** project.

A message window opens: 'Do you want to save changes? All unsaved edits will be lost'.

- Tap **Save** to save all changes in your existing project and continue to create a new project.
- Tap **Discard** to reject any changes in your existing project and continue to create a new project.
- Tap **Cancel** to cancel the new project operation and remain in your current project.

After tapping **Save** or **Discard**, the **Project Details** window opens. Enter the required details for your new project and tap **Accept** to create the project (see section 7.1).

To connect to a scanner, open the **Control** tab and click **Find Scanners** (see section 10.1 for a VS+, and section 11.1 for a C-ALS).

6.2 Open

6.2.1 Open Carlson Scan projects

Tap **Open** to open an existing **Carlson Scan** project. An **Open** dialog appears.

Select the appropriate project from the recent files list. Alternatively, tap **Browse Files** to open an **Open File**

windows dialog. Browse to the project location and select the *.NDV file to open the project in **Carlson Scan**.

On opening a project, you can reconnect to a scanner via the **Find Scanner** button on the **Control** tab (see section 10.1 for a VS+ and section 11.1 for a C-ALS) or through the **Project Details** window (see section 7.1).

6.3 Import

6.3.1 Import existing survey data

Tap **Import** to import other files into your active **Carlson Scan** project. These files may contain pre-existing data such as surveyed points, solids or linework. This data can be used as a backdrop to data collected with the C-ALS and VS+.

Currently supported file types are:

- **E57:** Lidar point cloud data
- **LAS:** LAS scan data file
- **LAZ:** LAZ compressed scan data file
- **DXF:** Autodesk DXF
- **DXF:** Deswick DXF
- **DWG:** AutoCAD drawing file
- **DRL:** Carlson borehole data format
- **XML**: LandXML
- **OMF:** Open Mining Format
- **NDV:** Carlson Boretrak project. Merge data from an existing project with the data in your current project.
- **TIN:** Carlson triangulation format
- **OBJ:** Wavefront Object
- **PLY:** Polygon library
- **STL:** Stereolithography
- **DAE:** Collada
- **CSV:** Hole ASCII. Imports hole collar information in a user-defined ASCII format.
- ***.*:** Hole ASCII. Import hole collar information in a user-defined ASCII format.
- ***.*** Point ASCII. Import survey points in a user-defined ASCII format.

6.4 Save

Tap **Save** to save all changes in your existing **Carlson Scan** project.

Note that a backup project is continually saved in the Backup sub-directory in the project folder (see section 3.5).

If you have not yet manually saved a project, the project is automatically saved in the **_Unsaved Projects** folder

(see section 3.5).

6.5 Save As

Tap **Save As** to save the project under a different name or in a different location on your tablet.

6.6 Export

Tap **Export** to export data from the active project. A file dialog opens. Select the location where you wish to save the data, the file name and the file type.

Tap **Save**. Depending on the file type selected, an appropriate export dialog opens. Confirm the specific data within the project that you wish to export and configure any export options as required.

After accepting all settings, tap **Export** to generate the export.

6.7 Browse

Tap **Browse** to open Windows File Explorer at the location where the active project is stored (see section 4.3.6).

6.8 Print

Tap **Print** to print a screenshot of the current **3D View**.

6.9 Alignments

Tap **Alignments** to open the **Alignments** window. All alignments in a project are listed and can be examined and edited (see section 7.1.5).

6.10 Stations

Tap **Stations** to open a list of all the **Stations** in the active project (see section 7.1.2).

6.11 Project

Tap **Project** to open the **Project Details** window. The **Project Details** window contains information about the project, holes, and deployments that have been carried out within the current project (see section 7.1).

6.12 Reports

Tap **Reports** to open the **Generate Reports** window.

6.13 Light / Dark / Black

Tap **Dark** / **Light** / **Black** to toggle between the three themes. During in-field operations, whether it be underground or in bright sunlight, one particular theme may give a clearer view of the screen.

You may also need to change the background colour to improve visibility in certain lighting conditions (see section 4.3.7).

6.14 Desktop

Tap **Desktop** to switch to the **Desktop** display mode (see section 3.6).

6.15 Settings

Tap **Settings** to view or edit software configuration settings. The **Settings** window appears (see section 4.3).

6.16 About

Tap **About** to access help documentation and program information.

The version number of the software is shown in the **About** screen and should be quoted during any support call with Carlson.

6.17 Wi-Fi

Tap the **Wi-Fi** button to manage Wi-Fi connections between the tablet and your scanner.

The **Managed Wi-Fi** option in the **Settings** window > **General** tab (see section 4.3.1) determines whether the Wi-Fi is managed though **Carlson Scan**'s own Wi-Fi manager or through the standard Windows Wi-Fi manager.

6.18 Exit

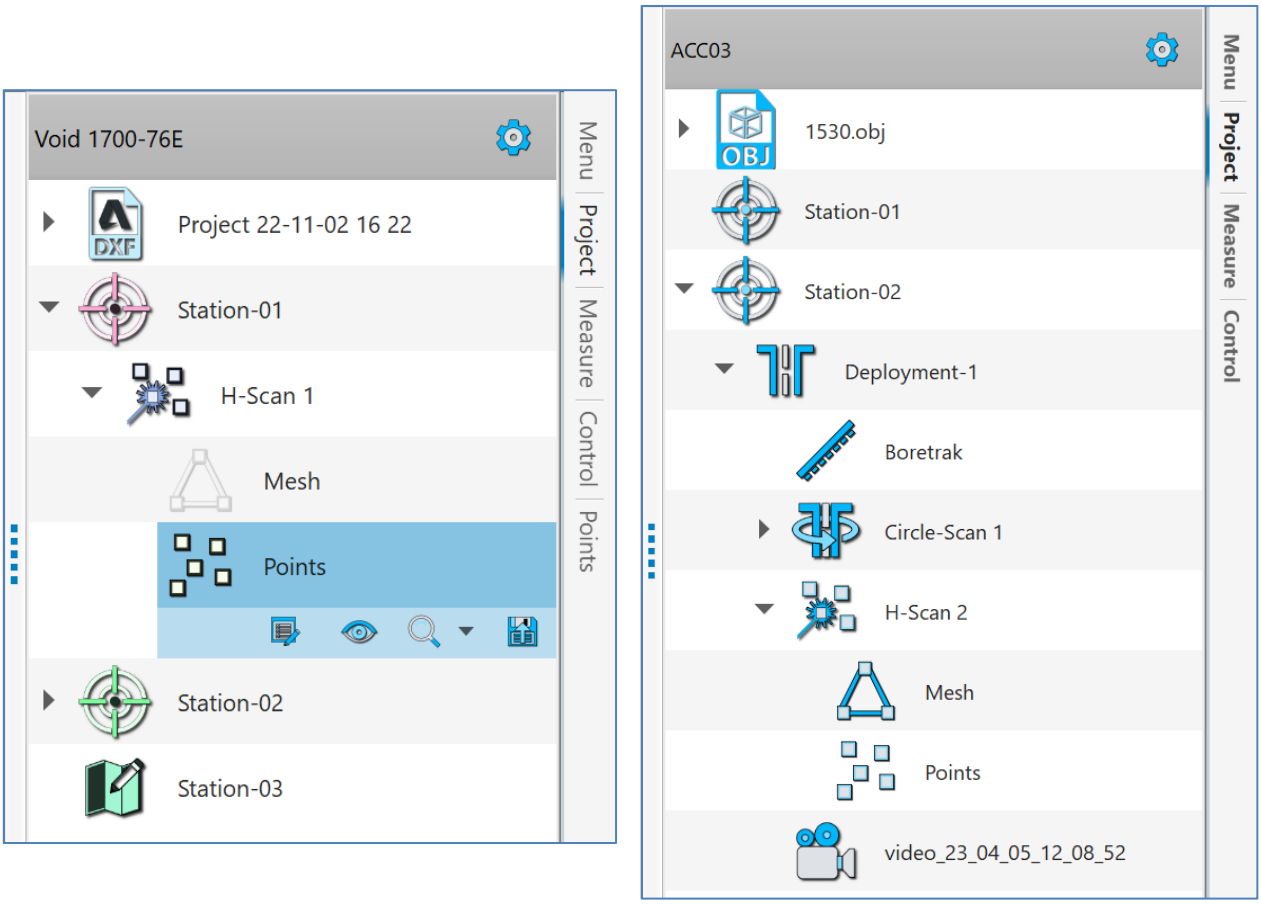
Tap **Exit** to exit **Carlson Scan**.

A message window opens: 'Do you want to save changes? All unsaved edits will be lost'.

- Tap **Save** to save all changes in your existing project and exit **Carlson Scan**.
- Tap **Discard** to reject any changes in your existing project and exit **Carlson Scan**.
- Tap **Cancel** to cancel the new project operation and remain in your current project.

7 Project tab

The **Project** tab contains a record of all data collected or imported within the active **Carlson Scan** project.



Project tabs for a VS+ project (left) and C-ALS project (right)

The list of elements in the **Project** tab expand indefinitely as more stations are added, scans are recorded, and data imported.

Each element in the **Project** tab can be selected and acted upon using buttons which appear directly underneath the element.

Details, Visible/Invisible, Zoom and Export buttons

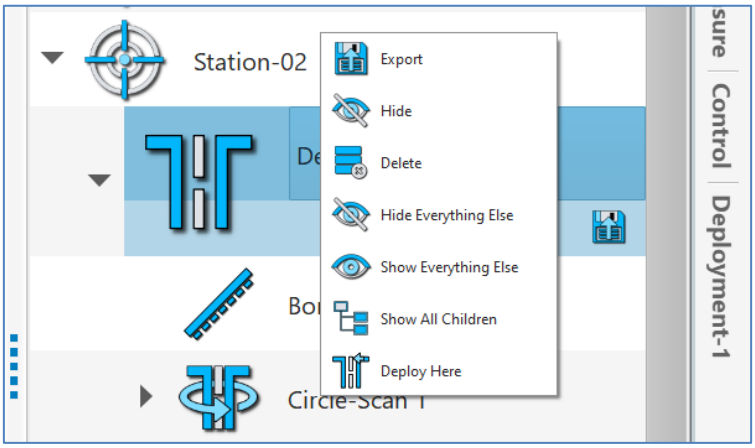
The buttons which appear are:

- **Details**: opens a relevant window or tab, which shows information about the selected element and, where appropriate, offers functionality to configure or analyse the element.
- **Visible / invisible**: toggles the selected element, and all elements nested beneath it in the **Project** tab, on and off in the **3D View**.
- **Zoom**: zooms in to the extents of the selected element, and all elements nested beneath it in the **Project** tab. Use the drop-down list to select a pre-set view.

- **Export**: exports the selected element and, by default, all elements nested beneath it in the **Project** tab. Individual elements can be switched on or off during the export process.

The elements in the **Project** tab are slightly different depending on whether you are using a C-ALS or VS+.

Each element in the **Project** tab has a context menu, accessed by right-clicking the element.



Project tab context menu

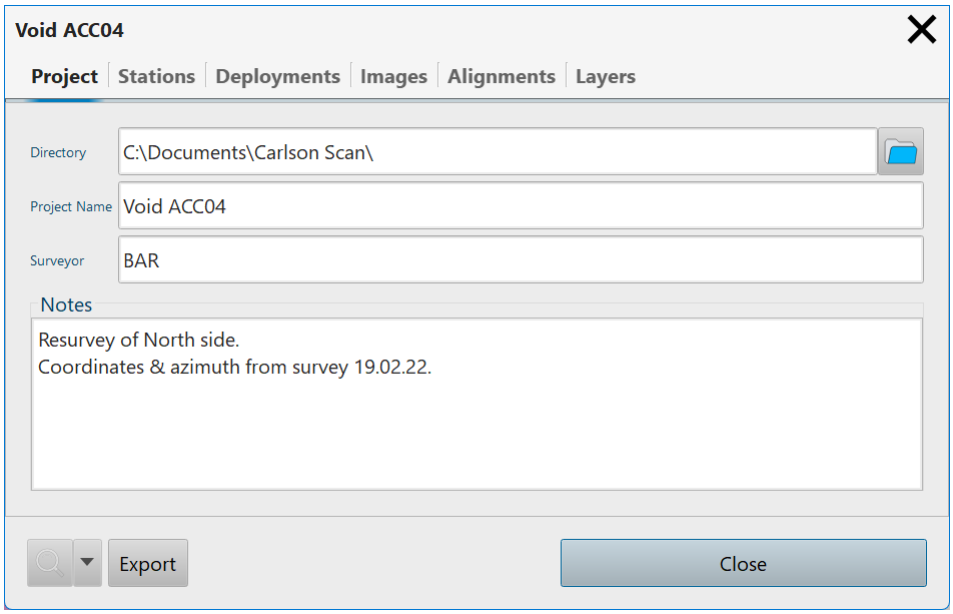
The list of items that may appear in the **Project** tab are listed below.

7.1 Project

At the top of the **Project** tab is the **Project** element.

Project element

Tap the **Project** element to open the **Project Details** window.



Project Details window

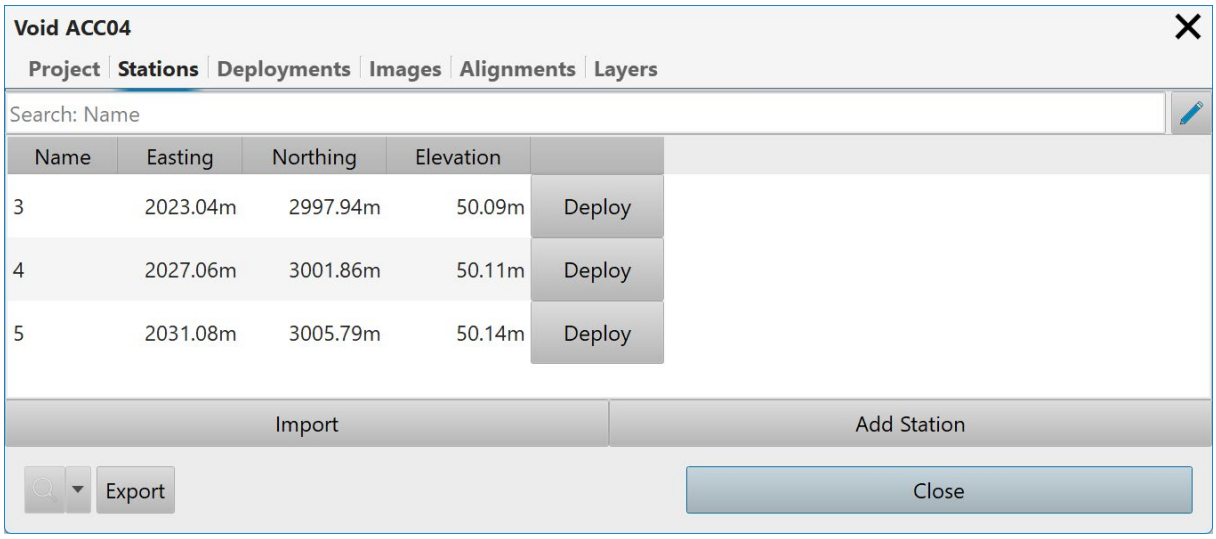
The **Project Details** window contains six tabs.

7.1.1 Project tab

- **Directory**: displays the current location of the project. If required, edit the directory path in the text entry box, or tap the Browse button to the right to select a different address in which to save the project.
- **Project Name**: displays the name of the project. If required, edit the project name in the text entry box. The project name will also be the name of the *.NDV project file and the project directory.
- **Surveyor**: enter the name of the surveyor responsible for the project.
- **Notes**: enter any project notes.

7.1.2 Stations tab

The **Station** tab provides tools for managing the stations in a project.



Project window > Stations tab

- For C-ALS operations the station defines starting point from which the scanner is deployed. Most commonly, this will be a collar location which marks the start of a deployment along a borehole.
- For VS+ operations, the station defines the position of the surveyed prism which is mounted on the instrument.

A list of all stations in the active project is displayed. The list shows the station name followed by the station coordinates and a **Deploy** button.

To edit a station in the list, tap on the appropriate station to open the **Station Details** window (see section 7.2).

To start a survey from a specific station, tap the **Deploy** button next to the appropriate station.

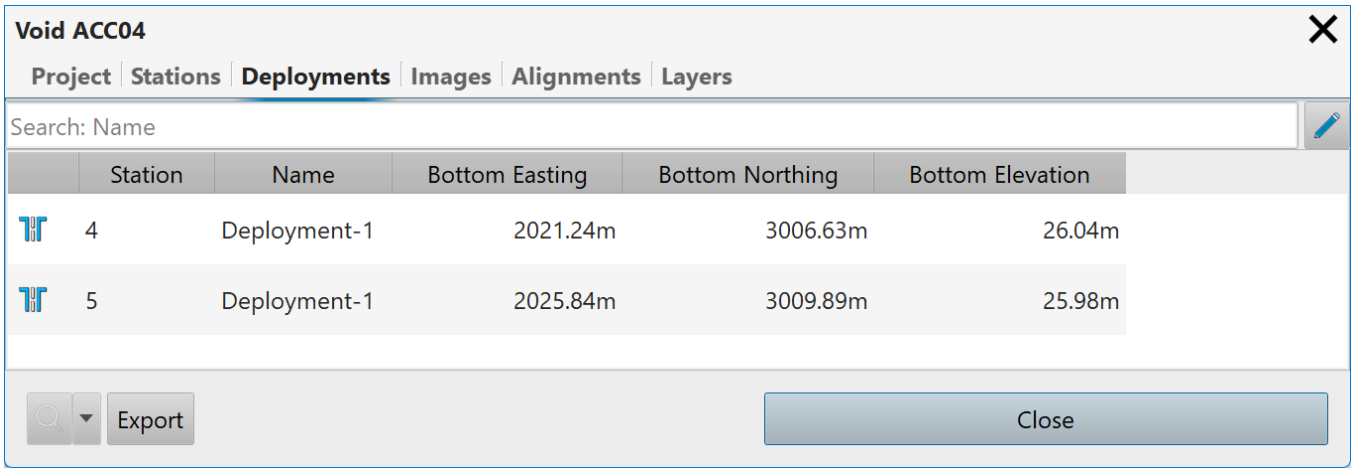
In the **3D View**, the location of these coordinates is marked by a station graphic.

To add a new station to the project, tap the **Add New** button. The **Station Details** window appears (see section 7.2).

Tap **Import** to add holes to the project from a text file. The text file may contain hole name, row name, coordinates, and design information. Select a file and the **Station ASCII Import Properties** window opens. Define the columns in the file and tap **Import**. The stations are added to the list in the **Project** window > **Station** tab.

7.1.3 Deployments tab

The **Deployments** tab lists the C-ALS deployments which have been carried out in the active project. **Deployments** are only relevant to C-ALS operations. No deployments are listed if the project is used solely for VS+ operations.



Project window > Deployments tab

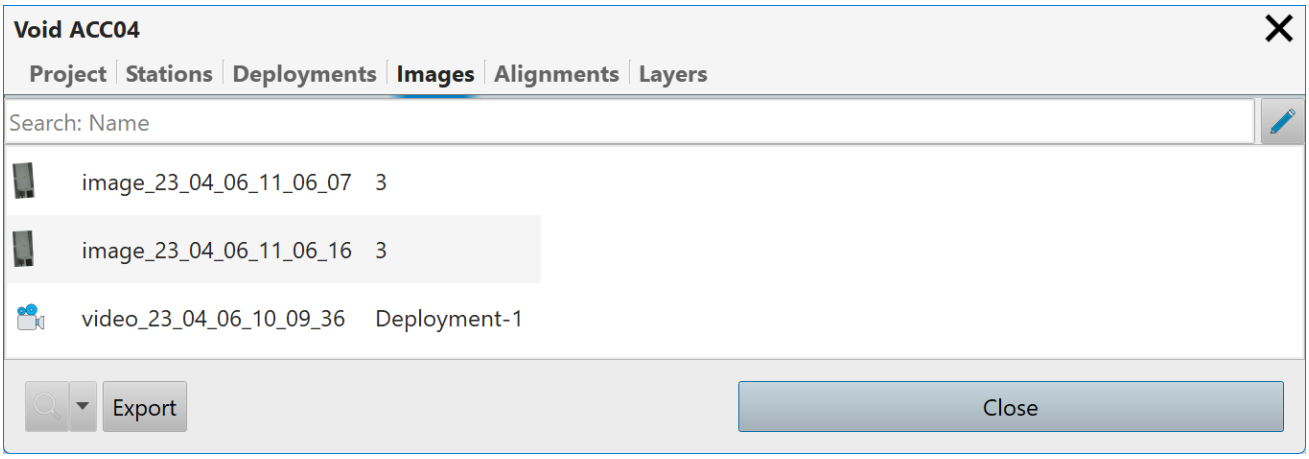
A list of all deployments in the active project is displayed. Each row in the list of deployments displays the **Station** from which the deployment was made, the **Name** of the deployment and the coordinates of the end of the deployment.

To view details of a deployment in the list, tap on the appropriate deployment to open the **Deployment Details** window (see section 7.3).

In the **3D View**, the deployment is marked by a deployment graphic (see section 7.3.1).

7.1.4 Images tab

The **Images** tab displays the images and videos which have been captured by the C-ALS camera during a project.

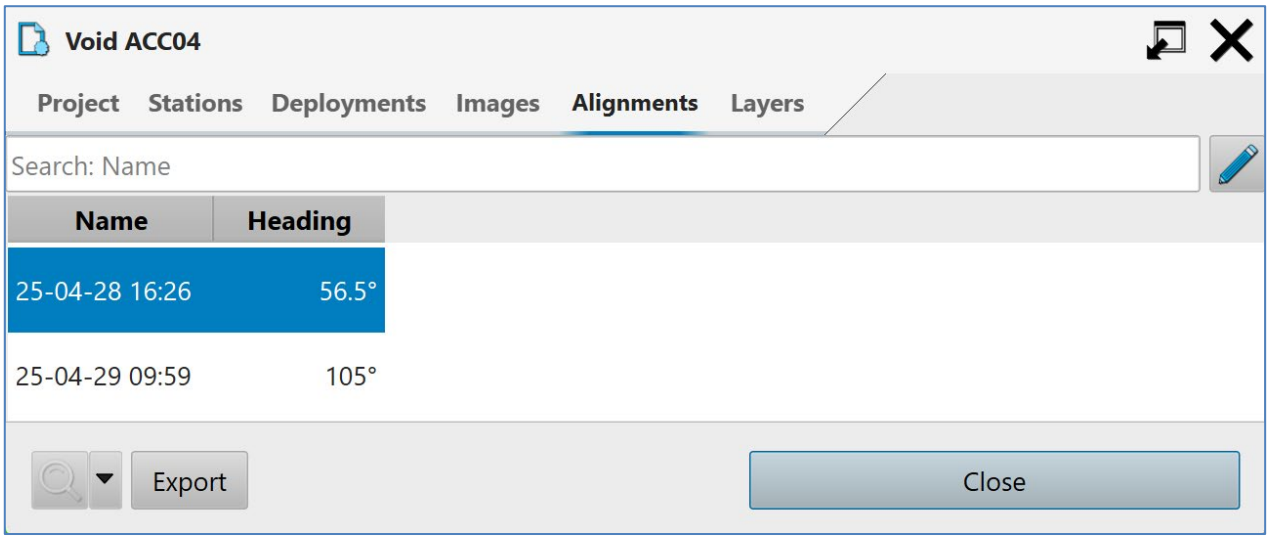


Project window > Images tab

Click on an entry in the list to view and export the snapshots and videos.

7.1.5 Alignment tab

The Alignment tab lists all the C-ALS alignments which have taken place during a project.



Project window > Alignments tab

An **Alignment** marks an alignment event carried out during field operations.

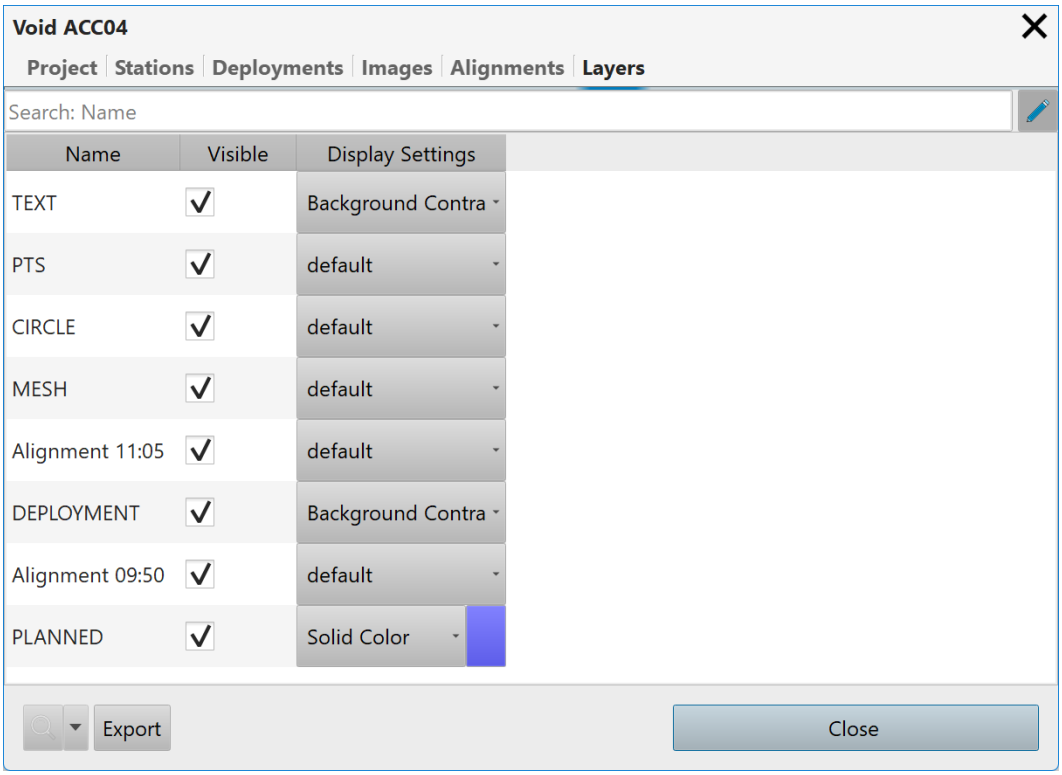
The list shows the **Name** of the alignment, followed by the **Heading** that has been manually input or computed.

To edit an alignment in the list, tap on the appropriate alignment to open the **Alignment Details** window (see section 11.5.1). Edit the details as required.

Note that if the heading of an alignment is edited, all data collected using the selected alignment will be affected by this edit. Each deployment will rotate around its collar position by the number of degrees by which the heading has changed.

7.1.6 Layer tab

The **Layers** tab displays the layers into which the data in the **3D View** is divided.



Project window > Layer tab

The **Layers** in the list group together different categories of items in the project. For example, all deployments which followed a specific alignment, all text or all planned holes. These are listed in the **Name** column.

Tick or untick the **Visible** checkbox to make the selected layers visible or invisible in the **3D View**.

Select a colouring option from the **Display Settings** drop down list. This selection overrides any colour settings for individual entities within the layer.

Restore colour settings for individual entities within a layer by selecting the blank entry from the **Display Settings**. drop down list.

7.2 Station

Each **Station** in a project has its own element in the **Project** tab. There may be multiple **Stations** in a **Project** and they may be setup in advance of field operations.

The **Station** may have **Deployment** (C-ALS only) and **Scan** elements nested beneath it.

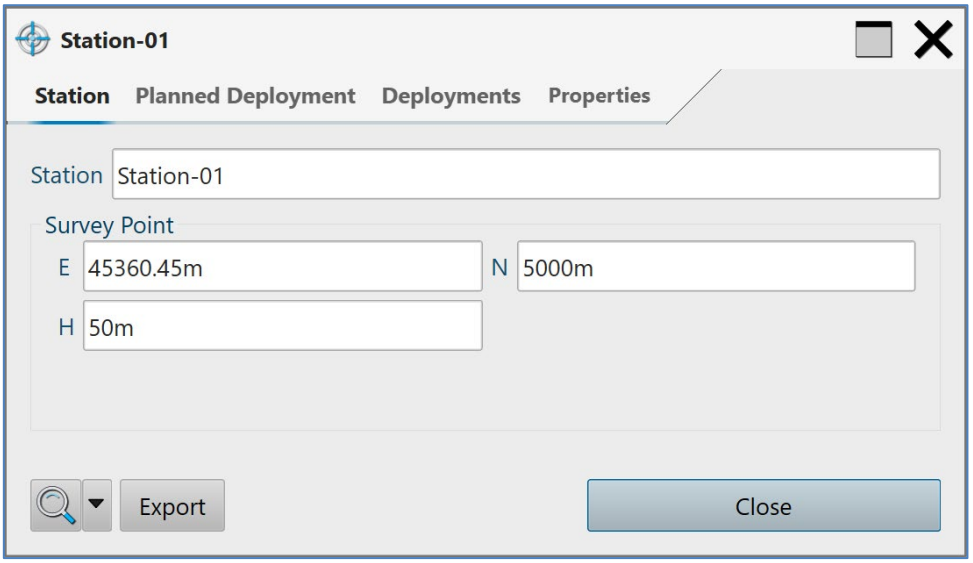
- The **Station Visible** / **invisible** button toggles all these elements on and off in the **3D View**
- The **Station Zoom** button positions the extents of all these elements within the **3D View**.
- The **Station Export** button exports data from all these elements.

7.2.1 Station Details

Tap the **Station Details** button to open the **Station Details** window. Depending on whether a C-ALS or a VS+ has been run from the selected station, the **Station** tab appears slightly differently.

7.2.2 Station Setup tab – C-ALS

The **Station** element represents fixed, starting coordinates for a survey. For C-ALS operations the station defines the starting point from which the scanner is deployed. Most commonly, this will be a collar location which marks the start of a deployment along a borehole.

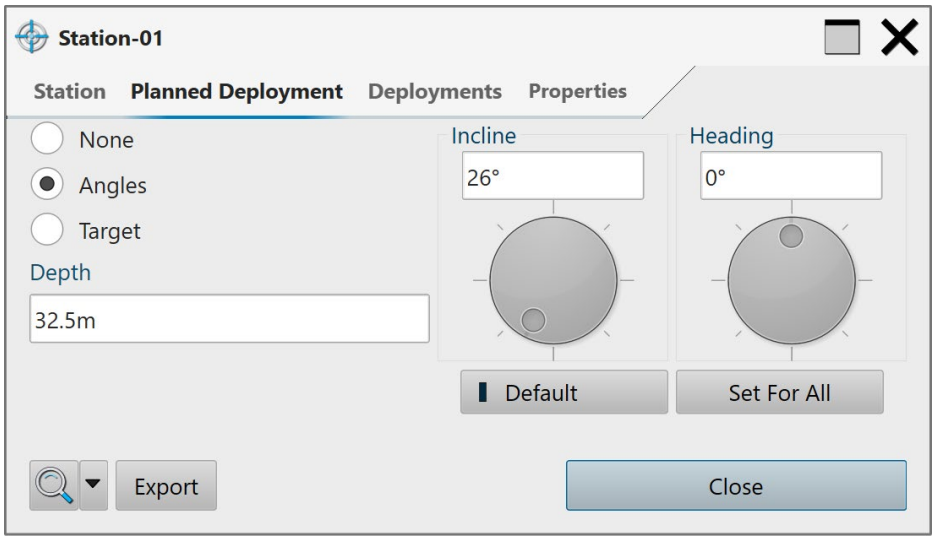


Station window > Collar Setup tab - C-ALS operations

The **Station Name** text entry field displays the name of the station. Edit the name as required.

The **Survey Point** frame displays the coordinates of the collar or start of the deployment. Edit the coordinates as required.

The **Planned Deployment** tab enables the setup of 'planned' or 'design' hole properties. A deployment carried out with a C-ALS can be compared with the planned hole to establish the measured deviation along the length of the surveyed hole.



One **Planned Deployment** can be set up for each **Station** in a project.

The **Planned Deployment** can be set up using manually entered angles, or by entering coordinates for the end of the hole. Use the radio buttons to select between these options.

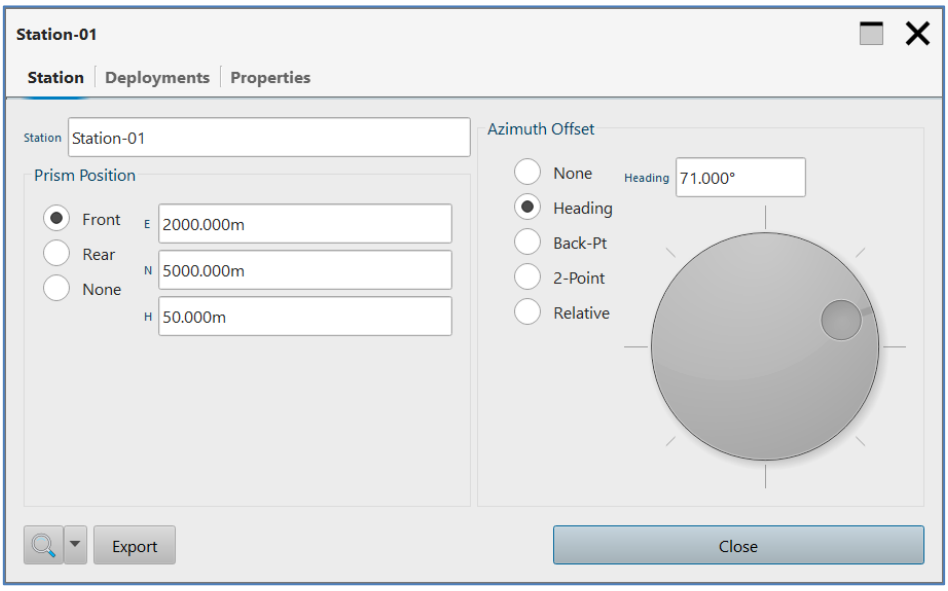
- **None**: no **Planned Hole** is attached to the selected **Hole**.
- **Angles**: enter a **Depth,** a **Heading** angle, and an **Incline** angle to establish the **Planned Hole**.
- **Target**: enter the X,Y,Z coordinates of the end of the hole to establish the **Planned Hole**. The Depth is adjusted automatically.

To use the same **Planned Deployment** values for holes which are created subsequently within the active project, tap **Default**. If a new hole is created, these planned hole values are applied when the **Angles** or **Target** radio buttons are selected.

To apply the same planned hole values to all holes which already exist in the active project, tap **Set for All**.

7.2.3 Station Setup tab – VS+

The **Station** element represents fixed, starting coordinates for a survey. For VS+ operations, the station defines the position of the surveyed prism position and, after taking into account the prism offsets and survey orientation, the position of the 'scan origin' which is at the centre of the trunnion axis of the VS+.



Station window > Station tab – VS+ operations

The **Station Name** text entry field displays the name of the station. Edit the name as required.

The **Prism Position** frame assists positioning of the VS+ when survey observations are being taken to the supplied 360° prism mounted on the VS+. There are two M6 × 1 threads on the horizontal housing of the VS+ into which the prism can be secured. Select either the **Front** or **Rear** position as required. Select **None** if you are not using a prism.

VS+ prism mounting locations - front (top) and rear (bottom)

The **Prism position** frame displays the coordinates of the surveyed prism. Edit the coordinates as required.

The **Azimuth offset** frame gives a choice for entering a heading for the VS+ deployment. This is usually the azimuth of the boom: from the back end of the boom towards the VS+.

- **None**: by default, the station has no user-defined azimuth. Leave the **Reference Azimuth** set to **None** and the survey is given an 0.00° azimuth by default.

- **Heading**: select **Heading** and a text entry box and dial appear. Enter the surveyed heading or rotate the dial to re-orientate all data underneath the selected **Station** element.

- **Back-Point**: if you have observed a secondary point to orientate the survey towards the **Prism position** (for example you may have observed to another prism on the back end of the boom) select **Back-Point**.

  Orientation Prism text entry boxes appear. Enter the coordinates of the secondary prism. A heading is computed from the **Orientation Prism** to the **Prism position**.

- **2-Point azimuth**: if you have established an azimuth with reference to two points separate from the **Prism position**, select **2-Point azimuth. Front location** and **Orientation Prism** text entry boxes appear.

  Enter the coordinates of the rear position as the **Orientation Prism**. Enter the coordinates of the front position as the **Front location**. The azimuth is computed from the **Orientation Prism** to the **Front location**.

  In this case, the main **Prism Position** is independent of the computed azimuth.

- **Relative**: if you have multiple surveyed stations in your Carlson Scan project, you can visually align the VS+ between two of these stations. Select existing stations in the **From** and **To** drop down lists. A heading is computed between the two.

When a scan is started from a station, the scan origin is derived by combining the **Prism Mount** selection, the **Prism Position**, the **Reference Azimuth**, and the inclination and roll values of the VS+.

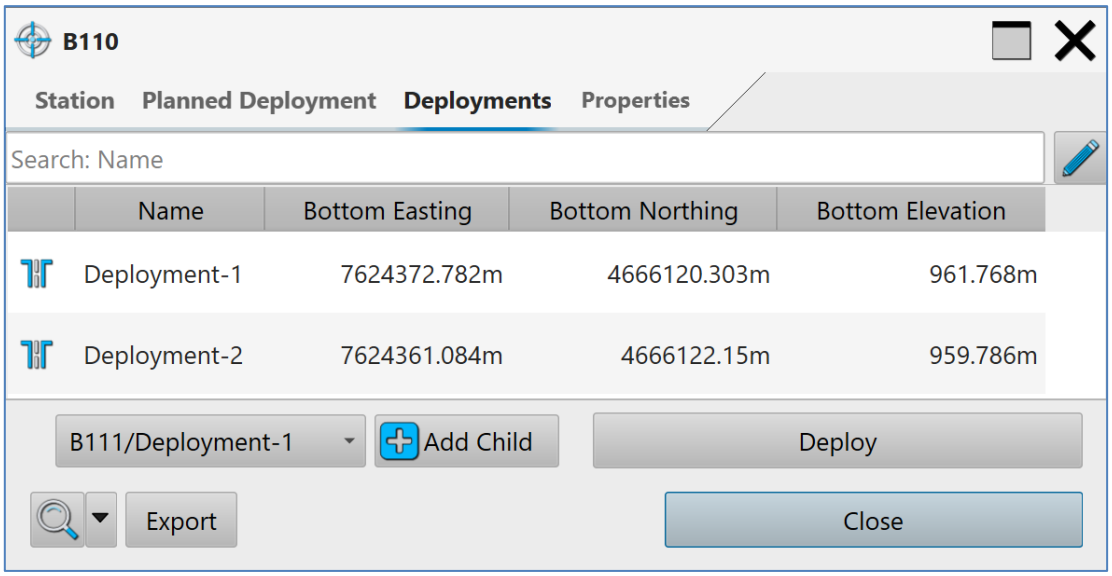
The scan origin or 'Head location' can be seen in the **Scan Information** window (see section 8.1.1).

Once the scan origin has been established, it only changes if you edit the **Prism Mount**, **Prism Position** or the **Reference Azimuth**.

You should create a new station whenever the VS+ is physically moved.

7.2.4 Deployments tab

The **Deployments** tab lists the C-ALS deployments which have been carried out from the selected station. **Deployments** are only relevant to C-ALS operations. No deployments are listed if the station has been used for VS+ operations.



Station window > Deployments tab

To view details of a deployment in the list, tap on the appropriate deployment to open the **Deployment Details** window (see section 7.3).

Each row in the list of deployments displays the **Name** of the deployment, the coordinates of the end of the deployment and a **Deploy** button.

To start another survey from this hole, tap the **Deploy** button.

In the **3D View**, the location of the deployment is marked by a deployment graphic (see section 7.3).

In case a deployment has been recorded from the wrong hole, it is possible to swap the hole to which a deployment is attached.

The **Deployments** drop-down list displays all deployments in the project. To move a deployment from another hole into the currently selected hole, select that deployment from the list. Tap **Add child**. The deployment is moved to the selected hole.

In the screenshot above, the currently selected hole is hole B110. Deployment 1 from hole B111 is selected from the **Deployments** drop-down list. After tapping **Add child**, deployment 1 from hole B111 will be moved to hole B110.

7.3 Deployment

Each **Deployment** in a project has its own element in the **Project** tab. There may be multiple deployments from underneath a single **Station**. **Deployments** only relate to C-ALS operations. There are no **Deployment** elements created during VS+ operations.

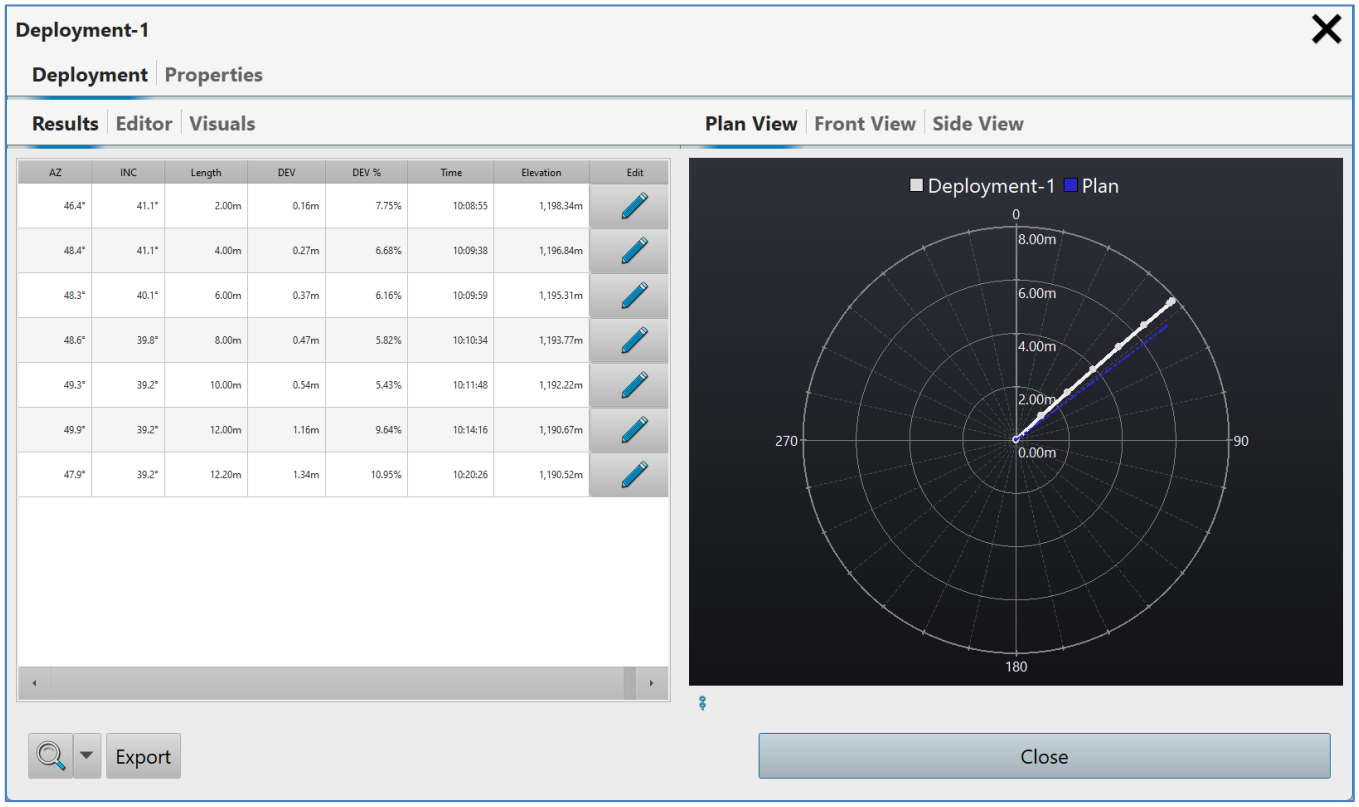
The **Deployment** may have **Boretrak** and **Scan** elements nested beneath it.

- The **Deployment Visible** / **invisible** button toggles all these elements on and off in the **3D View**

- The **Deployment Zoom** button positions the extents of all these elements within the **3D View**.
- The **Deployment Export** button exports data from all these elements.

7.3.1 Deployment Details

Tap the **Deployment Details** button to open the **Deployment Details** window.



Deployment details window

The **Deployment** tab > **Results** tab displays the sequence of Boretrak readings in tabular and graphical form.

In the table, the top row represents the collar coordinate, and each subsequent row in the table is a Boretrak reading recorded during the deployment. Columns in the table display:

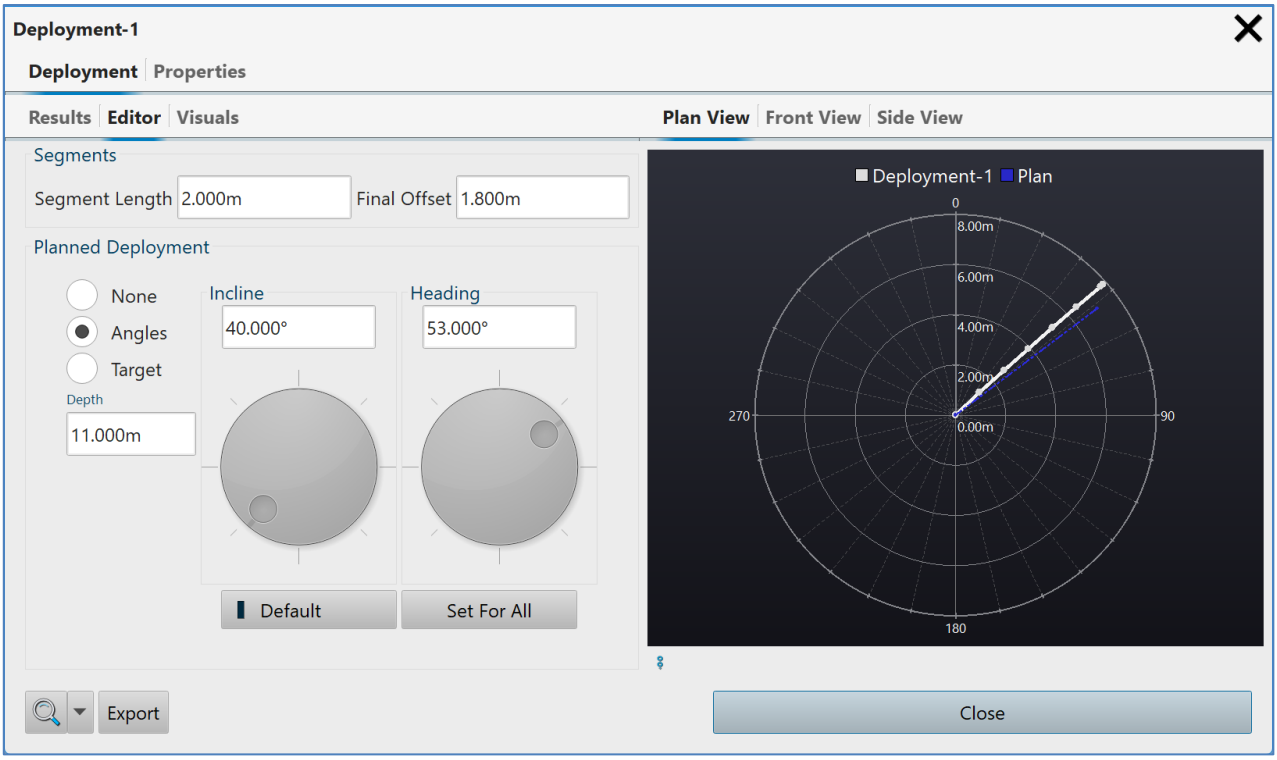
- **Az**: the azimuth of the C-ALS at each reading.
- **Inc**: the inclination of the C-ALS at each reading.
- **Length**: the depth of the C-ALS at each reading.
- **Dev**: The distance the surveyed hole has deviated from the planned holed (if a planned deployment is activated).
- **Dev%**: The percent of hole length by which the surveyed hole has deviated from the planned hole (if a planned deployment is activated).
- **Time**: the time at which the reading was taken.
- **E, N, Elevation**: the coordinates of the C-ALS at each reading (the reference point is inside the probe at the vertical pivot point).

The graphics show the deployment trail (in white) and the individual readings (displayed as dots).

There are three tabbed views:

- **Plan view**: displays a plan view 'bullseye display'
- **Front view** (tabbed view to the right of the deployment table). With **Heading: Hole Azimuth** selected, the **Front View** displays a perspective along the heading of the deployment – ie the deployment hole is heading directly into the screen. With **Heading: North/East** selected, the view is looking North.
- **Side view** (tabbed view to the right of the deployment table). Shows a view perpendicular to that of the **Front View**.

The **Deployment** tab > **Editor** tab provides tools to adjust the **Deployment** and the **Planned Deployment.**

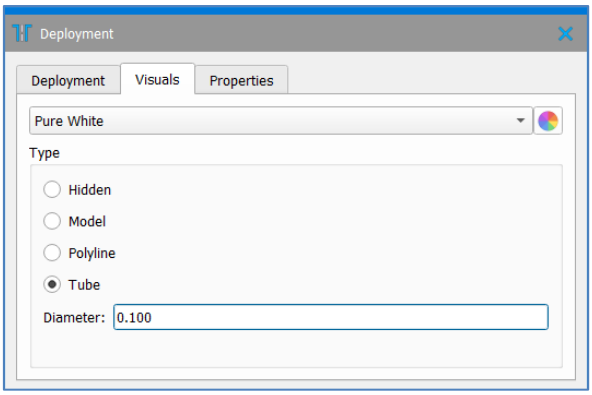


Deployment window > Editor tab

The **Segments** frame provides controls which allow editing of the **Deployment**. Use these controls with caution.

- **Segment Length**: edit the deployment interval that was used for the deployment.
- **Final Offset**: edit the offset that was entered after the last reading taken during the deployment.

The **Visuals** tab provides options for visualising the Boretrak deployment in the **3D View**.



Deployment window > Visuals tab

Select a colour theme for the Boretrak data from the drop-down list, or a solid colour from the **Colour** button to the right.

Options for visualising the Boretrak data are:

- **Hidden**: turns off the Boretrak data in the **3D View**.
- **Model**: displays the Boretrak data as modelled Boretrak rods.
- **Polyline**: displays the Boretrak data as a simple polyline.
- **Tube**: displays the Boretrak data as a tube. The diameter of the tube can be entered into the **Diameter** text entry box, if you wish to represent the true borehole size.

7.4 Boretrak

The **Boretrak** element relates solely to the Boretrak trail that is created during a deployment. There are no other elements nested underneath the **Boretrak** element.

- The **Boretrak Visible** / **invisible** button toggles the **Boretrak** data on and off in the **3D View**
- The **Boretrak Zoom** button positions the extents of the **Boretrak** data within the **3D View**.
- The **Boretrak Export** button exports the **Boretrak** data.

7.4.1 Boretrak Details

Tap the **Boretrak Details** button to open the **Boretrak Details** window. The **Deployment** tab is displayed, and the **Results** tab is displayed underneath.

The **Deployment** tab > **Results** tab displays the sequence of Boretrak readings in tabular and graphical form.

The display and other tabs are identical to the **Deployment Details** window (see section 7.3.1).

7.5 Scan

Each scan carried out within a project generates a **Scan** element in the **Project** tab.

Each **Scan** element has a **Mesh** and **Point**s element nested underneath it.

- The **Scan Visible** / **invisible** button toggles all these elements on and off in the **3D View**
- The **Scan Zoom** button positions the extents of all these elements within the **3D View**.
- The **Scan Export** button exports data from all these elements.

Click on any scan in the **Project** tab and the appropriate **Scan** tab becomes available (see section 8).

7.6 Mesh

A **Mesh** element is nested underneath every **Scan** element.

- The **Mesh Visible** / **invisible** button toggles the **Mesh** on and off in the **3D View**. The **Mesh** is invisible by default.
- The **Mesh Zoom** button positions the extents of the **Mesh** within the **3D View**.
- The **Mesh Export** button exports the **Mesh**.

7.7 Points

A **Points** element is nested underneath every **Scan** element.

- The **Points Visible** / **invisible** button toggles the **Points** on and off in the **3D View.** The **Points** are visible by default.
- The **Points Zoom** button positions the extents of the **Points** within the **3D View**.
- The **Points Export** button exports the **Points**.

7.8 Circle Scan

A **Circle Scan** is a limited, single sweep scan carried out by a C-ALS (see section 11.7.4). There are no **Circle Scan** elements created during VS+ operations.

Each **Circle Scan** element has a **Mesh** and **Point**s element nested underneath it.

- The **Circle Scan Visible** / **invisible** button toggles the **Circle Scan** on and off in the **3D View**
- The **Circle Scan Zoom** button positions the extents of the **Circle Scan** within the **3D View**.
- The **Circle Scan Export** button exports data from all these elements.

7.8.1 Circle Scan Details

Tap the **Circle Scan Details** button to open a **Properties** window which lists details of the **Circle Scan**, including the nearest and furthest points recorded during the scan.

7.9 Mesh (circle scan)

A **Mesh** element is nested underneath every **Scan** element. For a **Circle Scan**, the **Mesh** is a simple polyline which joins all points collected during the scan. The polyline is coloured according to the distance from the scanner: red is the closest and blue is the furthest.

- The **Mesh Visible** / **invisible** button toggles the **Mesh** on and off in the **3D View**. The Mesh is visible by default.
- The **Mesh Zoom** button positions the extents of the **Mesh** within the **3D View**.
- The **Mesh Export** button exports the **Mesh**.

7.9.1 Mesh Details

Tap the **Mesh Details** button to open a **Properties** window which lists details of the **Circle Scan**, including the nearest and furthest points recorded during the scan.

7.10 Points (circle scan)

A **Points** element is nested underneath every **Scan** element. For a **Circle Scan**, the **Points** are coloured according to the distance from the scanner: red is the closest and blue is the furthest.

- The **Points Visible** / **invisible** button toggles the **Points** on and off in the **3D View.** The **Points** are invisible by default.
- The **Points Zoom** button positions the extents of the **Points** within the **3D View**.
- The **Points Export** button exports the **Points**.

7.10.1 Points Details

Tap the **Points Details** button to open a **Properties** window which lists details of the **Circle Scan**, including the nearest and furthest points recorded during the scan.

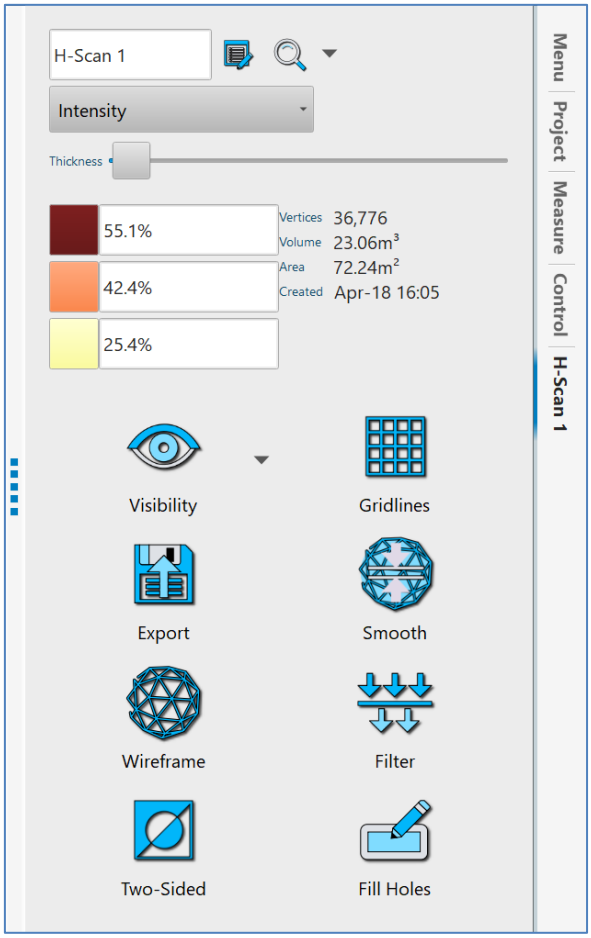
7.11 Imported data

Datasets which have been imported into the **Carlson Scan** project are listed at the bottom of the **Project** tab.

- The **Imported data Visible** / **invisible** button toggles the **Imported data** on and off in the **3D View.**
- The **Imported data Zoom** button positions the extents of the **Imported data** within the **3D View**.
- The **Imported data Export** button exports the **Imported data**.

8 Scan tab

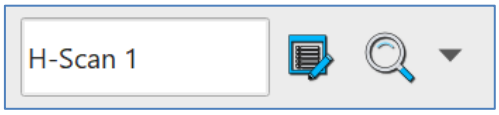
The **Scan** tab contains controls to change the appearance of the active point cloud and the mesh. The tab itself is labelled according to the active scan. In the image below, the active scan is H-Scan 1, and so the tab is shown as the H-Scan 1 tab.



Scan tab

8.1 Active scan

The active scan is displayed at the top of the **Scan** tab.



Active scan, Scan information button and Zoom button

The tools in the **Scan** tab only act on the active scan.

Which dataset is 'active' at any given time is determined by:

- The deployment or scan which is currently in progress.
- Tapping on a dataset in the **3D View**.

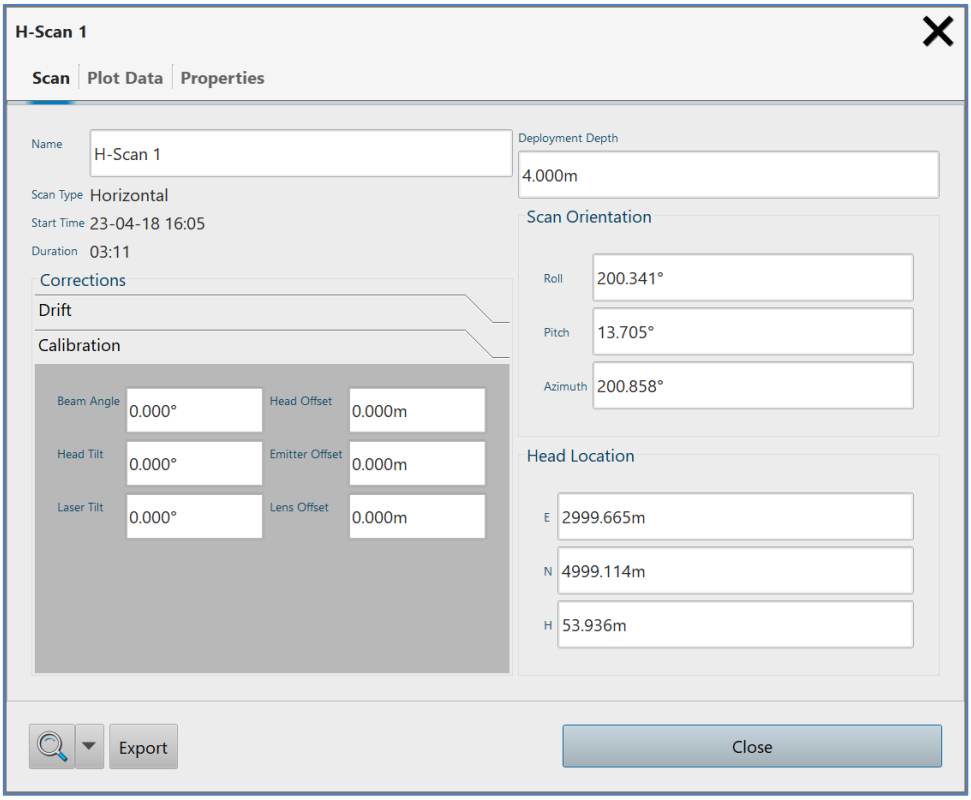
- Selecting a dataset in the **Project** tab.

Use the **Active scan** text box to edit the name of the scan, if required.

8.1.1 Scan information

To the right of the **Active scan** text box is the **Scan information** button. Tap the **Scan information** button to access more technical information on the positioning of the scan data, and statistics relating to the finished scan.

The **Scan** tab displays information relating to the positioning of the C-ALS or VS+ during the scan.



Scan information window > Scan tab

- **Details**: displays the scan name, selected scan pattern, the starting time of the scan and the duration of the scan.

- **Corrections / Drift / Calibration**: the amount of correction that was applied to the orientation of the scanner during the active scan. This applies primarily to C-ALS 'cable-only' deployments where the scanner may have rotated, or the gyro drifted, during the course of the scan. These values are editable but extreme caution should be taken before any edits are carried out.

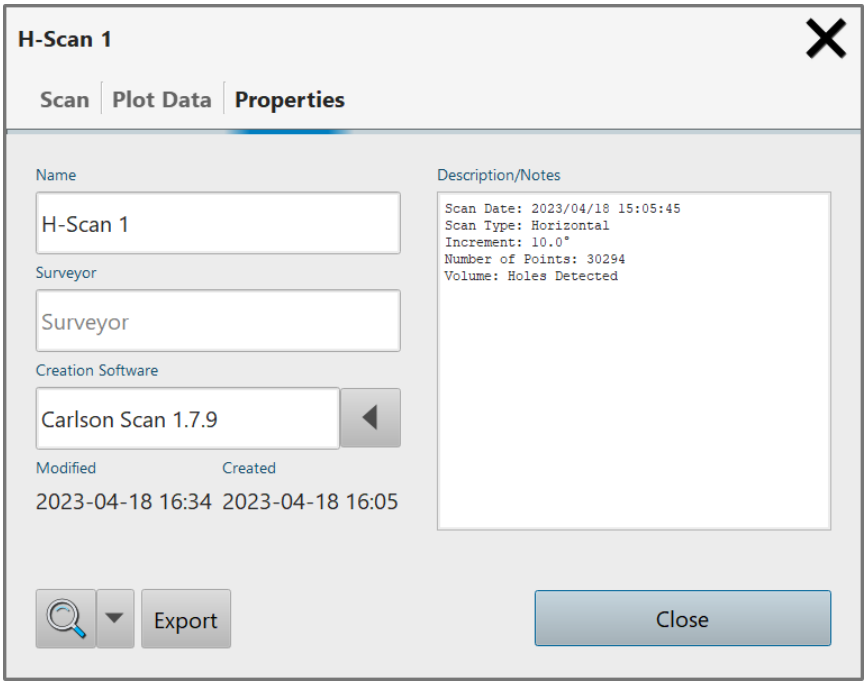
- **Scan Orientation**: displays the pitch, roll and azimuth of the scanner when the scan was started. These values are derived from the onboard accelerometers and from surveyed azimuth information from the gyro or information entered into the Station window. These values are editable but extreme caution should be taken before any edits are carried out.

- **Head location:** displays the 'scan origin' for the selected scan. This is the position to which all raw scan data is derived. For both the VS+ and the C-ALS, this point is at the centre of the instrument's vertical pivot. This value will be correct if the deployment of the VS+ or C-ALS probe has been carried out correctly. However, in some specific cases you may wish to fine-tune this position to fit in with other data surveyed to a higher accuracy. Caution should be taken before any edits are carried out.

The **Properties** tab displays statistics relating to the finished scan.

Information includes:

- Scan date
- Scan pattern
- Scan increment
- Number of points captured
- Volume computed



Scan information window > Properties tab

The information listed may be useful during troubleshooting or support enquiries.

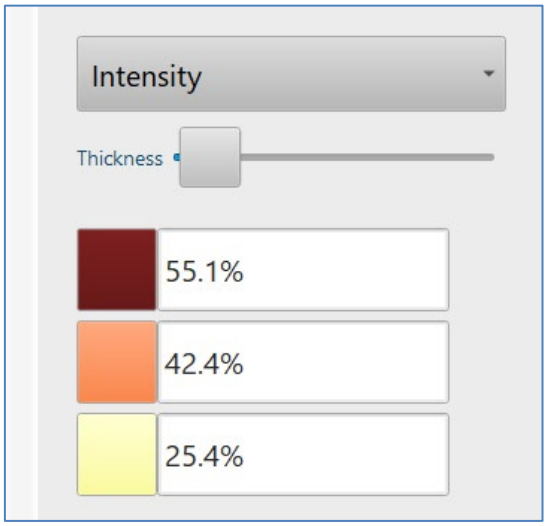
8.1.2 Zoom to scan

To the right of the **Scan information** button is the **Zoom to scan** button.

The **Zoom to scan** button positions the extents of the scan within the **3D View**. Use the drop-down list to select a pre-set view.

8.2 Visualisation tools

The visualisation tools control the appearance of the data collected in the active scan.



Visualisation tools

- Select a **Colour Scheme** from the drop-down list to change the value which is used to determine the colouring of the scan. Options include:
    - **Solid colour**: select a single colour for the scan.
    - **Intensity**: scan is coloured according to the signal strength recorded for each data point.
    - **Distance**: scan is coloured according to the distance from the scanner.
    - **Elevation**: scan is coloured according to its relative height.
- Use the **Thickness** slider to change the size of the points and the wireframe outline.
- The **Min**, **Mid** and **Max** colour choices determine the colour range used to display the selected **Colour Scheme**. The **Max, Mid** and **Min** values will refer to different qualities depending on the colour scheme selected.

8.3 Scan data

The **Scan data** panel gives live information about the active scan.

Vertices:	104,180
Volume:	162.65m³*
Area:	261.40m²*
Created:	2019-04-01 13:42

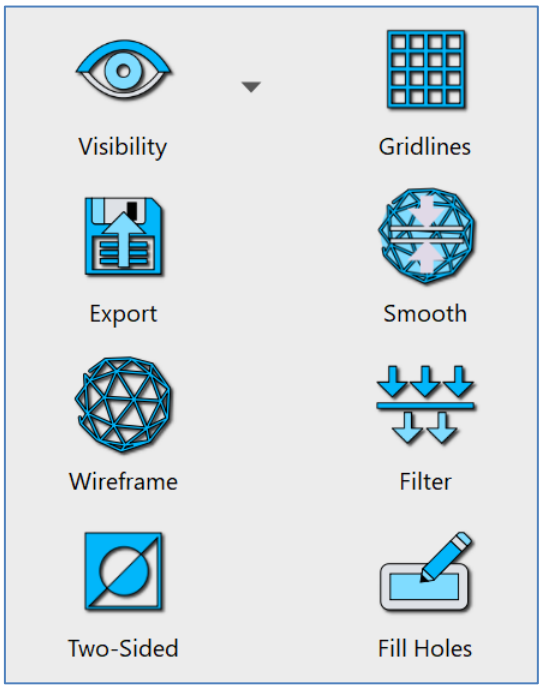
Scan tab live data

- **Vertices**: The number of computed data points used to create the mesh.
- **Volume**: the computed volume inside the mesh. The volume is calculated in real time. An asterisk after the value indicates that the scan, or the computation, is ongoing. If no volume is shown, tap the **Fill Holes** button to ensure that the mesh is closed and that a volume can thus be calculated (see section 8.4). An asterisk after the value indicates that the scan, or the computation, is ongoing.

- **Area**: the footprint of the volume. An asterisk after the value indicates that the scan, or the computation, is ongoing.
- **Created**: the time and date that the data was collected.

8.4 Mesh tools

The mesh tools offer functionality related to the properties of the scan and the appearance and construction of the surface model. Some of the mesh tools are only activated if the **Mesh** switch is toggled on in the Control tab (for live scans) or in the **Project** tab.



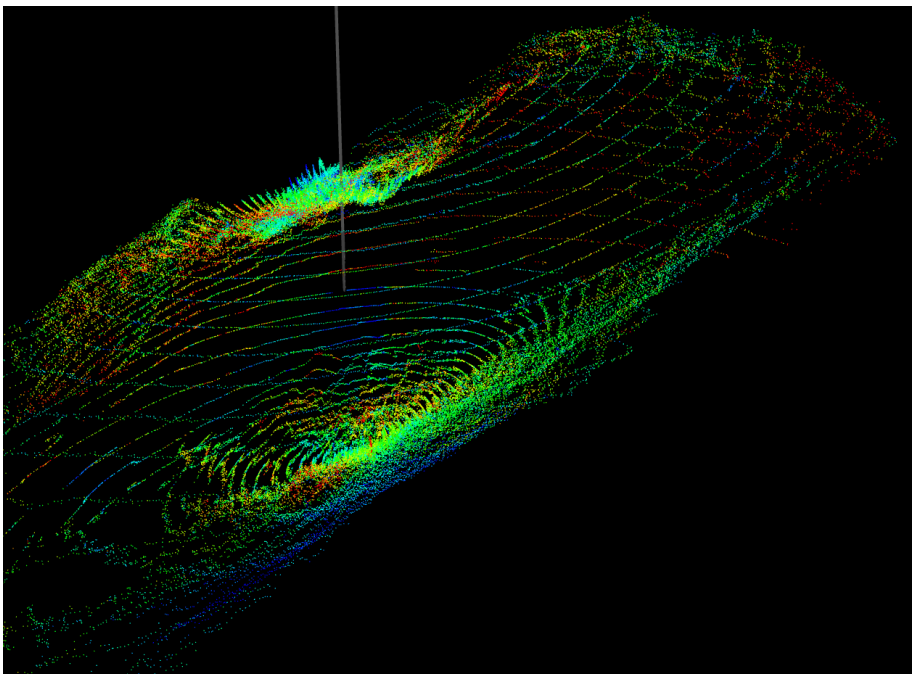
Mesh tools

8.4.1 Visibility

Toggles the active scan on and off in the **3D View.**

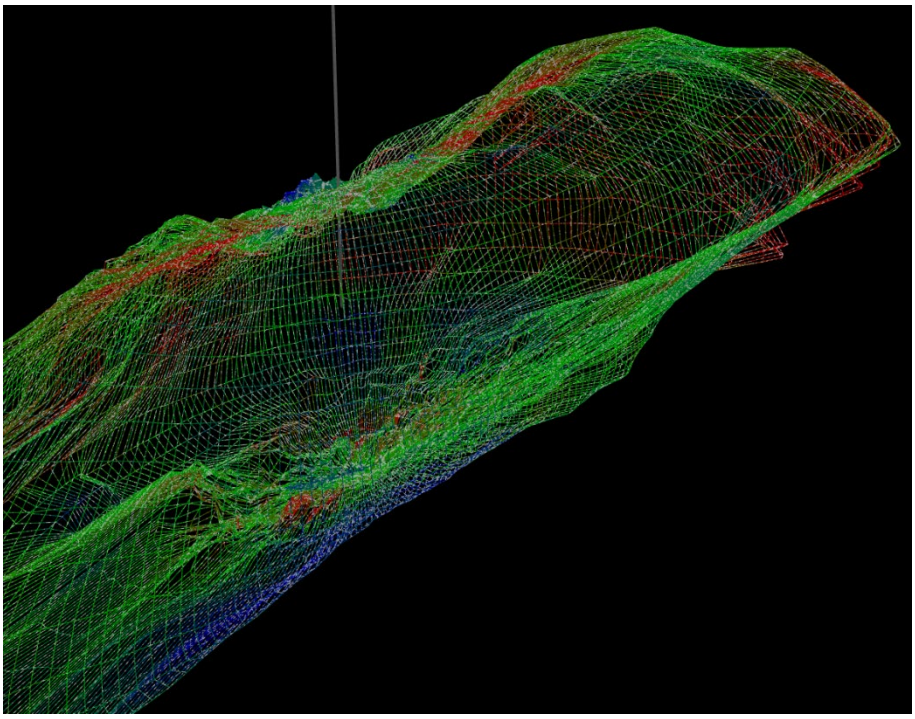
Tap the **Visibility** drop-down menu to differentiate between turning the points and the mesh on and off in the **3D View**.

- Tap the **Points** switch to toggle the points on and off in the **3D View**.



Points visible

- Tap the **Mesh** switch to toggle the real-time mesh on and off in the **3D View**.

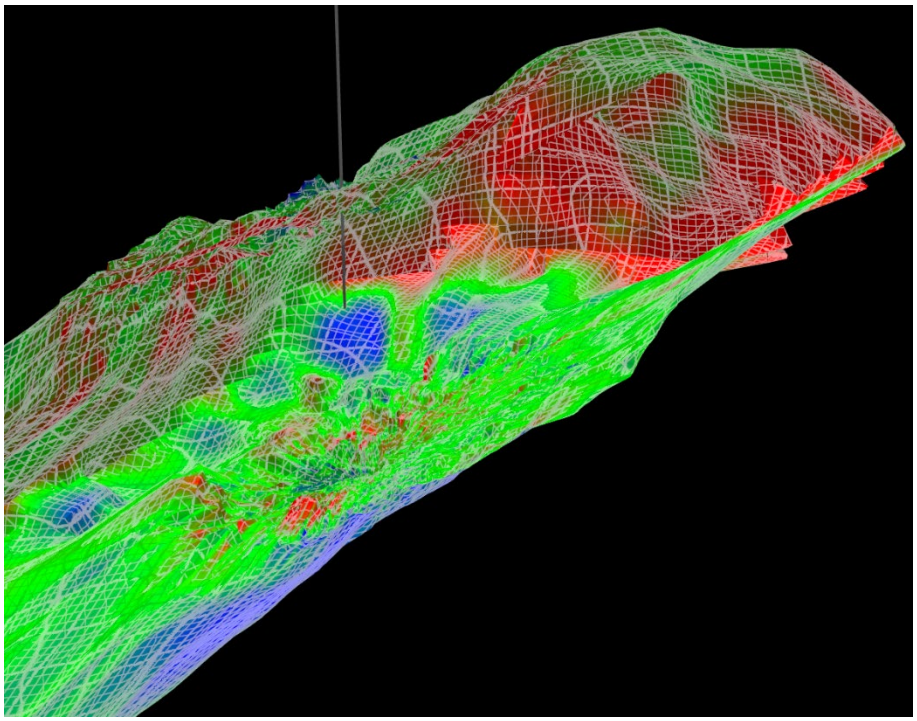


Mesh visible (as a wireframe)

If the **Mesh** switch is on, more mesh tools are activated.

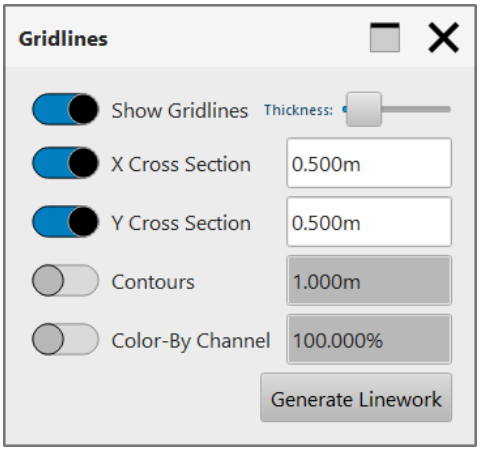
8.4.2 Gridlines

Tap **Gridlines** to toggle gridlines on and off. Gridlines are projected onto the model to help you judge scale and gradient.



Gridlines on (Two-sided off)

A **Gridlines** window opens.



Toggle and adjust the options as required.

- Use the **Thickness** slider to adjust the weight of the gridlines in the **3D View**.
- **X-cross section**: enter the required spacing between gridlines.
- **Y-cross section**: enter the required spacing between gridlines.
- **Contours**: enter the required spacing between contours.

To save the generated linework, tap **Generate linework**. An entry containing the linework is created in the **Project** tab.

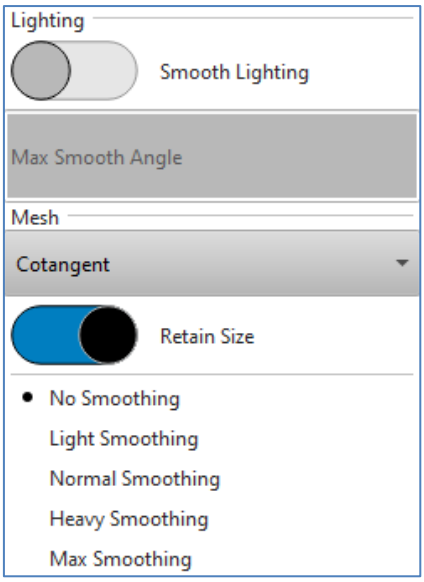
8.4.3 Export

Tap to export data from the active scan. A file dialog opens. Select the location where you wish to save the data, the file name and the file type. Tap **Save**.

Depending on the file type selected, an export dialog opens. Confirm the data you wish to export and configure any export options before accepting all settings and generating the export.

8.4.4 Smooth

Provides options to smooth the mesh created. You may wish to leave these settings untouched and to use the automatically generated surface. However, the tools are available if you wish to optimise a specific scan surface.

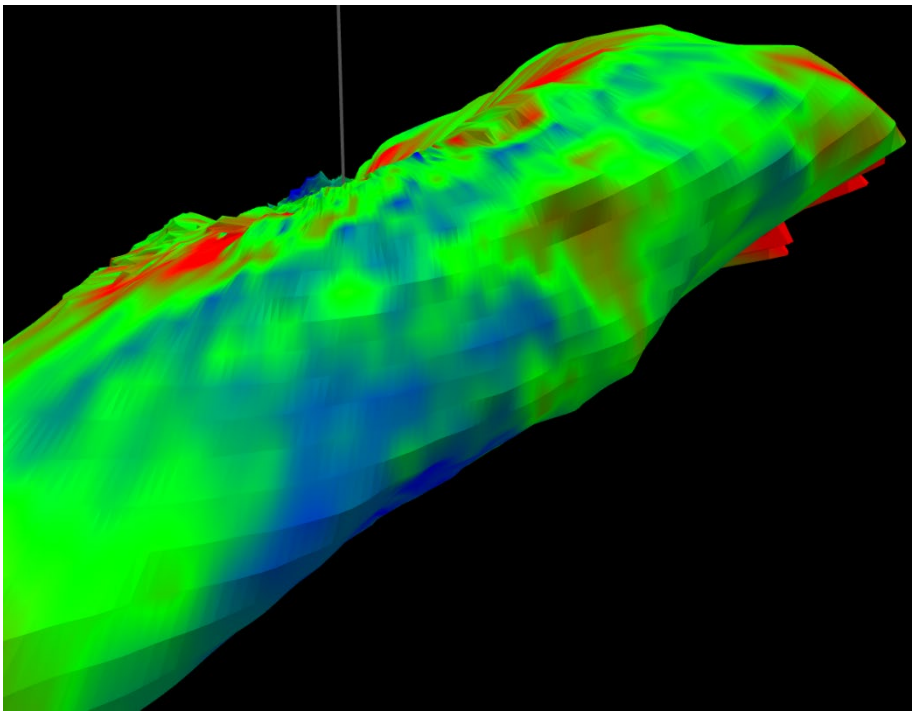


Smoothing options

- **Lighting**: tap the **Smooth Lighting** switch to adjust how the solid model is lighted. When the **Smooth Lighting** switch is on, tap **Max Smooth Angle** to adjust the lighting angle.
- **Mesh**: select **Cotangent** or **Laplacian** surfacing routines from the **Mesh** drop down list. The **Cotangent** option is better at preserving artefacts in a scan, but consequently will not smooth as well as the **Laplacian** routine.
- **Retain size:** tap the **Retain Size** switch to toggle the **Retain Size** option on and off. If **Retain Size** is on and changes are made to the smoothing, the volume of the surface is forced to stay constant and the level of smoothing is restricted.
- **Smoothing level:** select a level of smoothing from the list, from **No Smoothing** to **Max Smoothing**. No Smoothing is the routine which is most faithful to the collected points. The level of smoothing should correspond to the density of the active scan: the denser the scan, the higher the level of smoothing which can be used.

8.4.5 Wireframe

Toggle the **Wireframe** switch to view the mesh as a wireframe model or as a smoothed surface model.



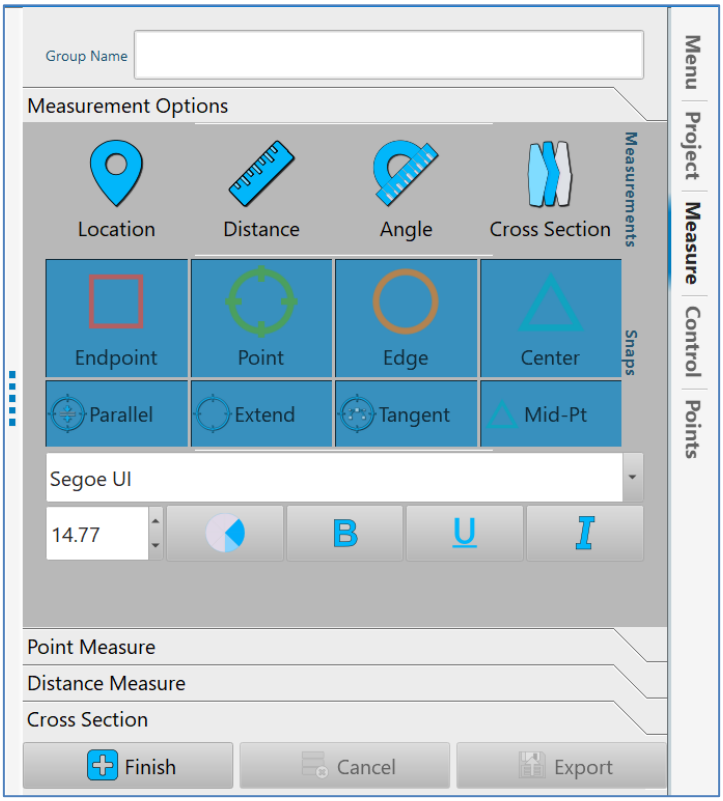
Smoothed surface model

8.4.6 Fill Holes

In order for the volume of a scanned void to be computed, the surface model must be completely closed, without any holes. If no volume result is shown in the live data (see section 8.2), tap the **Fill Holes** button to ensure that the mesh is closed and that a volume can thus be calculated.

9 Measurement tab

The **Measurement** tab provides tools for taking measurements from data within the active project.



Measurement tab

The measurement tools can be used with any data in the **3D View**, including points, meshes and linework.

9.1 Group name

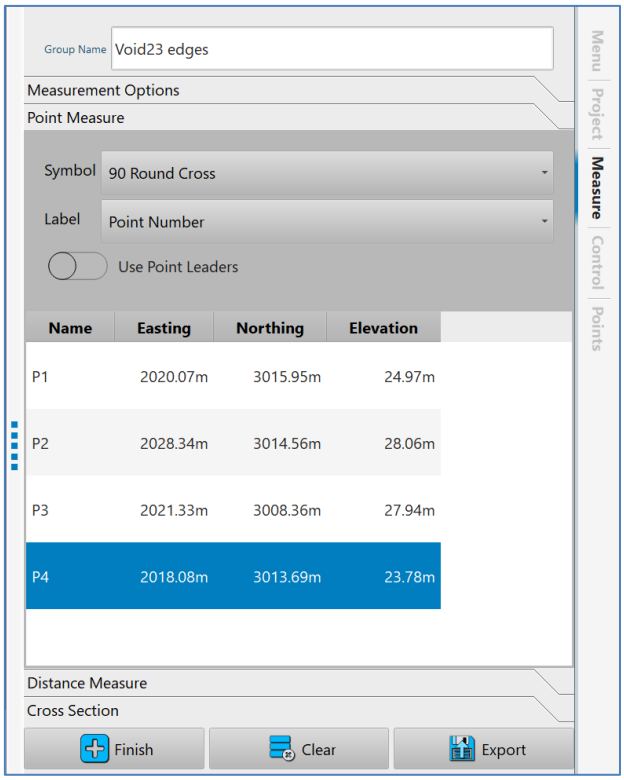
Name a group of measurements. If you save measurements, they are listed in the **Project** tab under this name. If you export measurements, the export file is named using the **Group Name**.

9.2 Measurements

Select the type of measurement you wish to carry out.

9.2.1 Location

Tap **Location** to investigate the coordinates of individual entities in the **3D View**.



Taking Locations

Tap on any entity in the **3D View** to generate the coordinates of the selected point. The coordinates appear in the **Measurement** tab.

Tap **Finish** to end the measurement session. The collected locations are added to the **Project** tab.

Tap **Clear** to cancel the collected locations.

Tap **Export** to export the collected locations in a user-defined file format.

9.2.2 Distance

Tap **Distance** to measure the distance between two items in the **3D View**.

Tap on any entity in the **3D View** to start the distance measurement. Tap on a second point to complete the measurement. A table in the **Measurements** tab displays for each distance:

- Slope distance
- Horizontal distance
- Vertical distance
- Inclination

Tap **Finish** to end the measurement session. The collected measurements are added to the **Project** tab.

Tap **Clear** to cancel the collected locations.

Tap **Export** to export the collected locations in a user-defined file format.

9.2.3 Angle

Tap **Angle** to measure the distances and direction between items in the **3D View**.

Tap on any entity in the **3D View** to start the angle measurement. After clicking on a second entity, a dynamic angle readout appears showing the angle between the line which has been created and the cursor.

Tap **Finish** to end the measurement session. The collected measurements are added to the **Project** tab.

Tap **Clear** to cancel the collected locations.

Tap **Export** to export the collected locations in a user-defined file format.

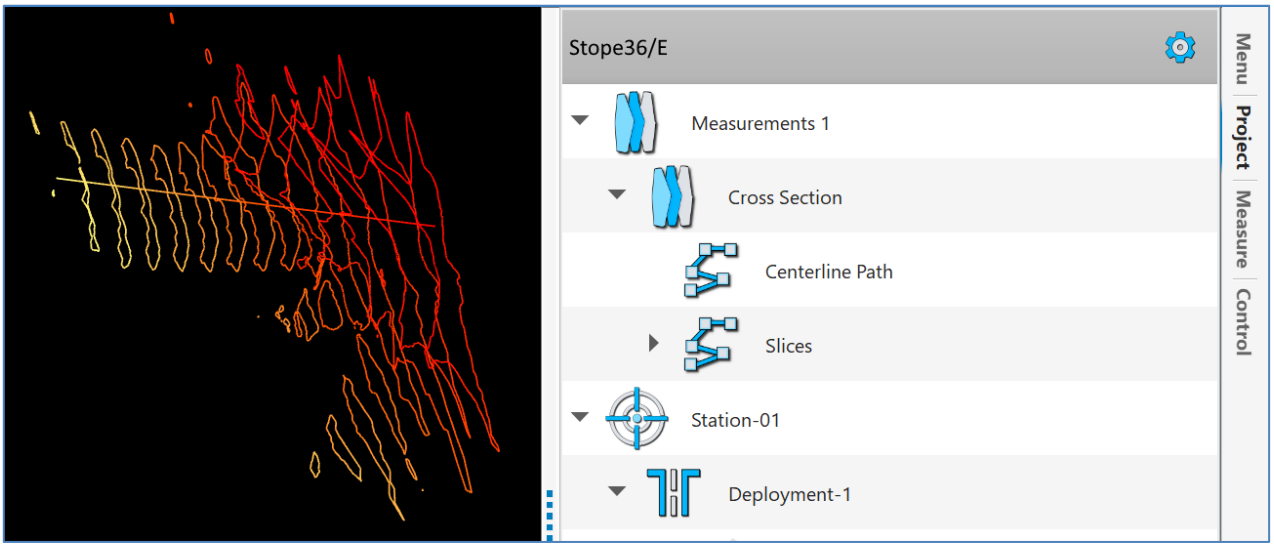
9.2.4 Cross Section

Tap **Cross Section** to generate a series of cross sections along a user-defined centre line.

A mesh must be visible in the **3D View** for the cross sections to be generated.

Create a centre line by clicking on two points. Hit Enter to accept the centre line. A series of cross sections is created perpendicular to the centre line.

The **Cross Sections** are added to the **Project** tab.



Cross sections in the 3D View and in the Project tab

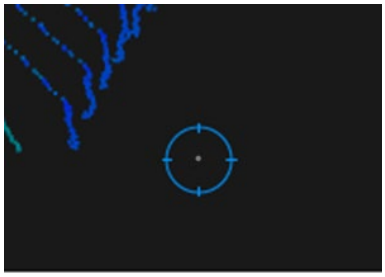
Tap **Finish** to end the measurement session. The cross sections are added to the **Project** tab.

Tap **Clear** to cancel the generated cross sections.

Tap **Export** to export the cross sections in a user-defined file format.

9.3 Snap settings

After a measurement function is selected, the cursor in the **3D View** changes appearance to a grey dot surrounded by a blue circle.



Cursor in measurement mode

The measurement tool attempts to 'snap to' items in the **3D View** that are within the blue circle. The items that measurement tool searches for within the blue circle for are determined by the **Snap** settings. Turn the snap switches on or off depending on which items you wish to measure.

For example, if you only wish to measure between single data points, turn off all switches except **Points**. In this case, the measurement tool only snaps to individual data points within the blue circle. It will ignore all other items such as edges and centre points of solid shapes.

As the cursor snaps to items in the **3D View**, it changes appearance again depending on which item it has snapped to. For example, if it has snapped to a single data point, it changes to a green circle.

Cursor snapped to a single data point

10 Control Tab – VS+

The **Control** tab provides direct control of the connected scanner. The **Control** tab is configured according to whether a C-ALS or VS+ is connected to **Carlson Scan**. This section outlines the **Control** tab functions and layout when a VS+ is connected.

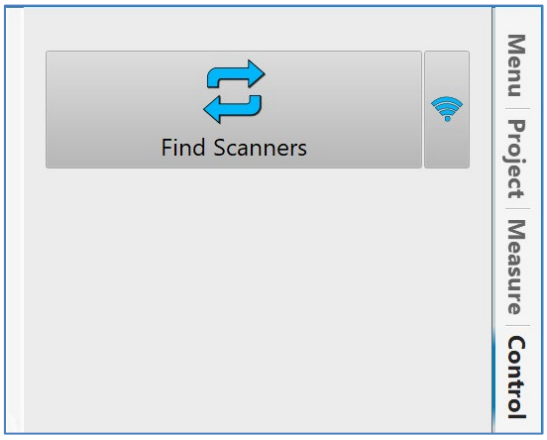
10.1 Connection to a VS+

10.1.1 Autodetect routine

Carlson Scan has an autodetect routine to establish if there are any scanners connected to the tablet. Once the routine is initiated, any scanner which is powered on and correctly interfaced with the tablet is detected. **Carlson Scan** first identifies that a VS+ is connected (or a C-ALS if that is the scanner you are using – see section 11.1) and then establishes the serial number, firmware and internal sensors within the instrument.

The autodetect routine can be started automatically by tapping the **New** button from the **Tablet** mode **Home** screen. This is the quickest way to get started with scanner operations.

Alternatively, tap the **Find Scanners** button in the **Control** tab to initiate the autodetect routine.

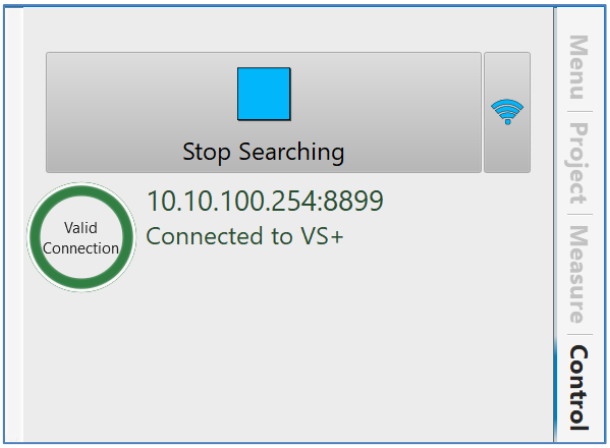


Find Scanners button and Wi-Fi button

The **Find Scanners** button is present on the **Control** tab in the following situations:

- If you have opened **Carlson Scan** in **Tablet** mode, from the **Home** screen tap **New** to start a new project. Enter any required details in the **Project Details** window and tap **Accept**.
- If you have opened an existing project and are viewing data without a connection to a scanner.
- If you are in an existing project and have lost connection with a scanner or have tapped the **Disconnect Device** button.

Once the autodetect routine has been initiated, the **Find Scanners** button changes to a **Stop Searching** button. Tap the **Stop Searching** button to end the autodetect routine.



Stop Searching button and Wi-Fi button

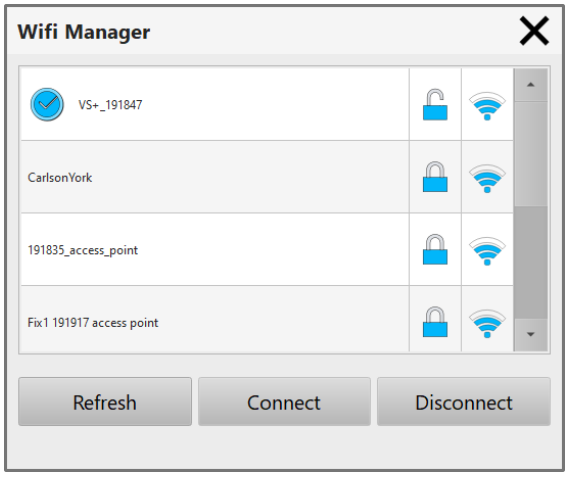
While the autodetect routine continues, **Carlson Scan** searches through all available COM ports and IP connections for scanners connected to the tablet.

10.1.2 Wi-Fi connection

Prior to initiating the autodetect routine, you may have used the standard Windows tools to connect to a Wi-Fi device such as the VS+. This allows the autodetect routine to find the scanner.

However, you can also connect to a Wi-Fi device from within **Carlson Scan**. Prior to using the **Find Scanners** button, tap the **Wi-Fi** button.

Depending on whether the **Managed Wi-Fi** switch in the **Settings** window is toggled ON or OFF (see section 4.3.1), either the Windows Wi-Fi manager or the **Carlson Scan Wi-Fi Manager** window appears. In the case below, the **Managed Wi-Fi** is toggled ON, so the **Carlson Scan Wi-Fi Manager** appears.



Carlson Scan Wi-Fi Manager

All Wi-Fi networks are displayed in a list.

Tap **Refresh** to refresh the list of Wi-Fi networks.

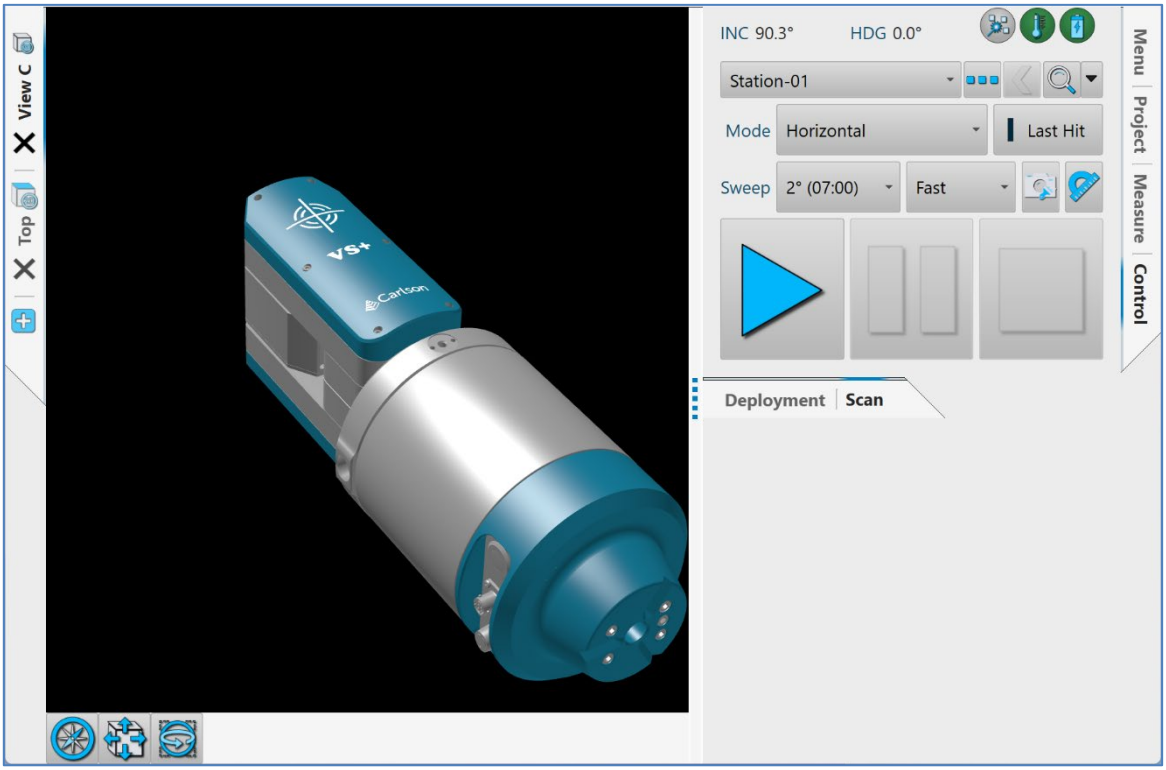
When you see your scanner listed in the **Wi-Fi Manager**, tap the appropriate entry in the list, then tap **Connect**. **Carlson Scan** runs the autodetect routine to identify a scanner on the selected Wi-Fi network.

10.1.3 Connected

On detection of a scanner, **Carlson Scan** runs through checks to establish that comms with the scanner are sound and to read information from the scanner.

With all checks complete, a graphic of the VS+ appears in the **3D View**.

The **Control** tab is active, displaying VS+-specific controls. These controls are outlined below.



Control tab active - connected to a VS+

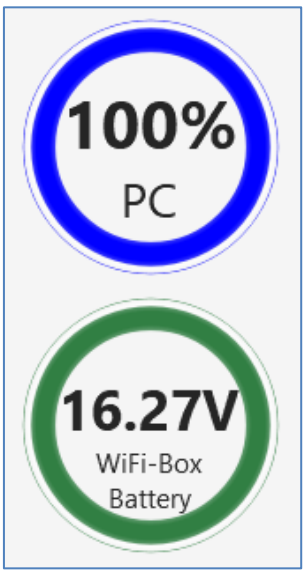
10.2 Live data

VS+ live data

The live data text displays real-time information on the VS+.

- **Incline**: the current inclination of the VS+ with respect to gravity. 0° is vertically down.
- **HDG**: the current heading of the VS+, as manually entered in the **Station Details** window (see section 7.2.3).
- **Red Dot**: Tap the **Red Dot** switch to toggle the VS+'s red dot pointer on and off.

- **Voltage**: The voltage level received from the VS+ and from the tablet running Carlson Scan. Tap on the Voltage icon to view the current battery status.



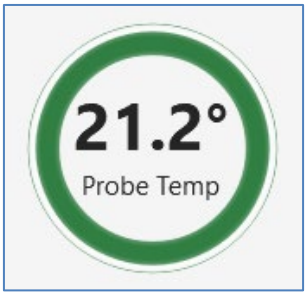
Battery status of the tablet and VS+

If you are connected via a VS+ a lithium-ion battery is being used to power the system. The **Voltage** display turns red if a voltage is returned below 11.5 V. A warning message appears the first time this occurs during a session connected to the VS+. If the voltage drops below 11.2 V, **Carlson Scan** software carries out a controlled shut-down of the current scan. In this case, the **Carlson Scan** project is automatically saved, along with any terminated scans.

Note that the VS+ power button changes from constant illumination to flashing when the battery voltage drops below 13.6 V. The VS+ shuts down automatically when the internal battery voltage drops below 10.8 V.

The VS+ probe automatically powers itself down if the voltage falls to voltage of 10.5 V or below is returned.

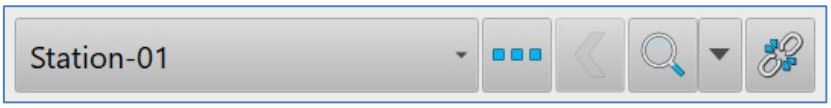
- **Temp**: the current temperature received from the VS+. Tap on the Temperature icon to view the current temperature status.



Temperature status of the VS+

The temperature limits of the VS+ are -10° C to +45° C. If the temperature of the probe approaches within 5° of these limits, the temperature value will display in red.

10.3 Active station controls



Station controls

- The active station is displayed in the **Station** drop-down list.

  Tap the **Station** drop-down list to see all stations in the active project. From the list, tap **New Station** to create a new VS+ station. The **Station Details** window appears from where you can configure the new station (see section 7.2.3).

- Tap the **Station Details** button to open the **Station Details** window. Edit details of the active station including name, coordinates and view options.

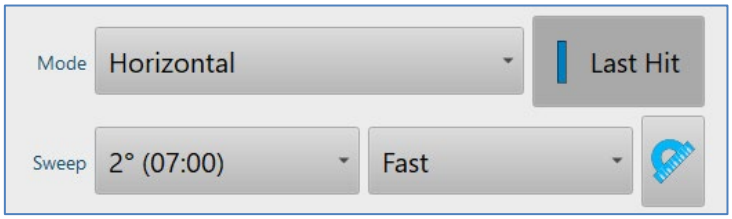
- Tap the **Zoom** button to zoom to a view of the active station and all data that has been collected from that station. Tap the **Zoom** drop-down list to access pre-defined views of the station.

- Tap the **Disconnect** button to disconnect **Carlson Scan** from the connected VS+. A message box appears: *'Are you sure you want to disconnect? All commands will finish and the device will move to the stow position'*.

  Tap **Yes** to continue. **Carlson Scan** disconnects from the VS+. The **Find Scanners** button is activated on the **Control** tab.

  Tap **Cancel** to remain connected to the scanner.

10.4 VS+ scan configuration



VS+ scan configuration

The scanning configuration tools offer functionality for configuring a scan.

- **Mode**: determines the pattern of the scan. From the drop-down list, select from:
  - **Horizontal**: the scanner completes a series of horizontal scan sweeps, separated by a stepped vertical increment
  - **Vertical**: the scanner completes a series of vertical scan sweeps, separated by a stepped horizontal increment
  - **Horiz+Vert**: the scanner completes a horizontal scan followed by a vertical scan. **Carlson Scan** treats the two scans as a single element for the purposes of display, colouring, meshing and exporting.
- **Sweep**: determines the size of the vertical increment (if a horizontal scan is selected) or horizontal increment (if a vertical scan is selected). The smaller the increment, the more scan sweeps the VS+

completes, the denser the resulting point cloud, and the longer the duration of the scan.

From the **Increment** drop-down list, select the required increment. The entries in the drop-down list show the increment in degrees followed by (in brackets) the approximate time to run the scan.

To enter a user-defined increment, select **Custom** from the drop-down list. The number pad opens. Enter your required increment and tap **Accept**. The smallest definable scan increment is 0.3 degrees.

Note that due to the mechanics of the scanner, the actual increment and scan time may differ slightly from the selected values.

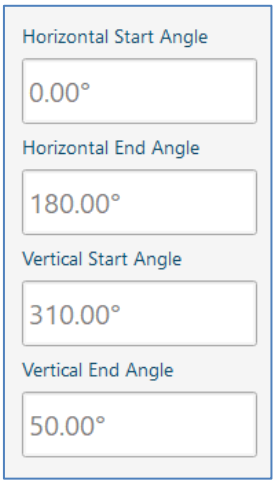
- **Speed**: select **Fast** or **Dense** from the drop-down list, to determine the speed of the scan. For most operations, leave the speed set to **Fast**. Alternatively, select **Dense** and each scan will run approximately 70% slower, with approximately 70% more points along each scan sweep. The **Dense** option is mainly intended for very large voids where the spacing between each point on a scan line can become very large on the most distance surfaces.

  Note that the **Sweep** control defines the density of scan sweeps whereas the **Speed** control defines the density of points *along* each scan sweep.

- **Last Hit**: Tap the **Last Hit** switch to toggle **Last Hit** mode on and off. The **Last Hit** option can be used if there are particles between the instrument and the target which are partially blocking the path of the laser. The particles may be water vapour or dust in the air which may cause the laser pulse to reflect back to the instrument before it hits the intended target. Activating this mode will instruct the VS+ to attempt to ignore any interference from the particles in the air and instead to concentrate on returns from the true target.

  The **Last Hit** option should not be used to shoot to reflective targets, as incorrect results may be returned.

- **Scan Limits**: Tap to set limits on the vertical or horizontal scan sweeps.



Scan Limits window

In order to save time and to concentrate the scan in certain directions, the scan can be limited vertically (most appropriate for horizontal scans) or horizontally (for vertical scans).

For a VS+, the default 'full scan' range values are:

- **Horizontal**: -180° to 180°.
- **Vertical**: 180° to 50°.

10.5 Scan controls

The scan controls enable scans to be started using the settings determined with the scan configuration tools.

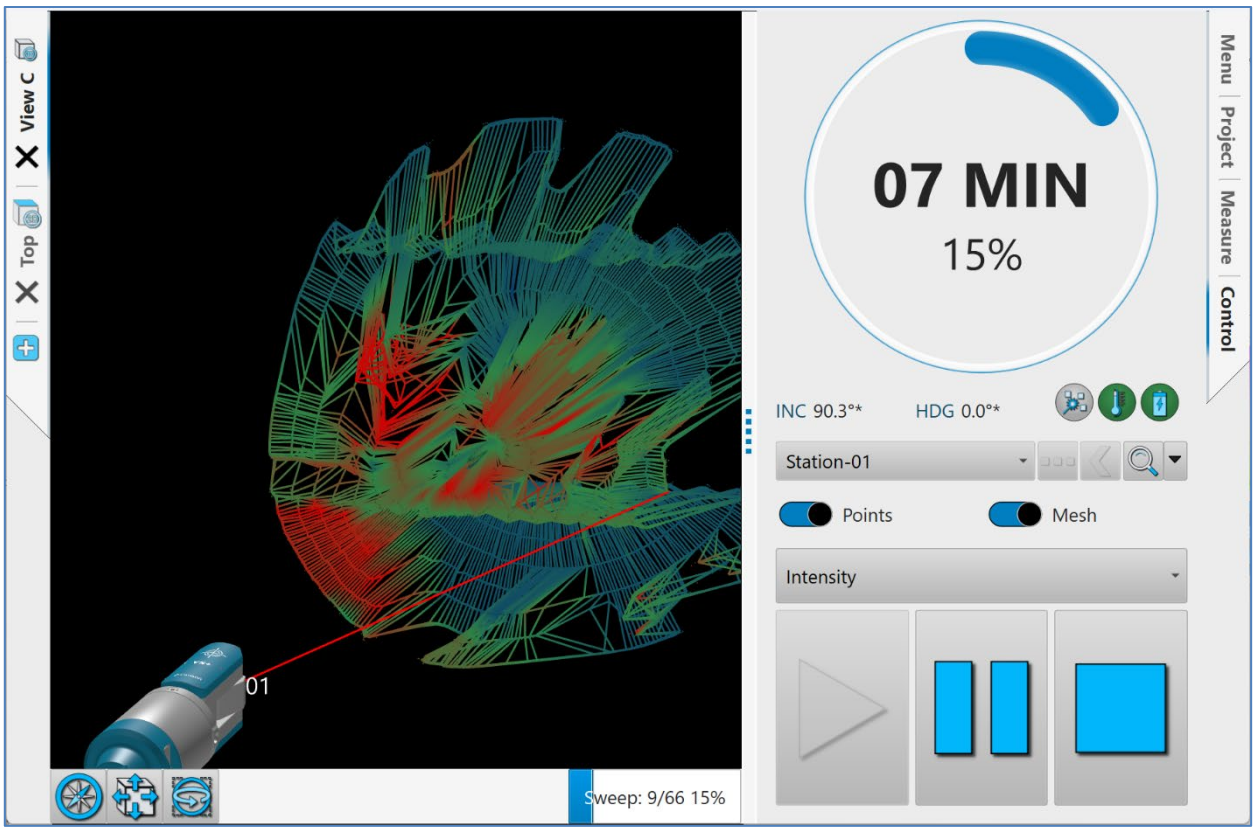
Scan, Pause and Stop buttons

- **Scan**: With the scan configured, tap **Scan** to begin the scan. The **Scan** button is greyed out until the scan is complete or cancelled.
- **Pause**: during a scan, tap **Pause** to interrupt a scan that is in progress. The VS+ completes the current scan sweep before pausing.

  While the scan is paused, tap **Scan** to continue the scan or tap **Stop** to abort the scan and park the VS+.
- **Stop**: during a scan, or while a scan is paused, tap **Stop** to end the scan. The VS+ parks and **Carlson Scan** displays a summary of the completed scan.

10.6 During a scan

Once a scan has been started, no further user intervention is required. The VS+ will progress through the scan according to the configuration selected.

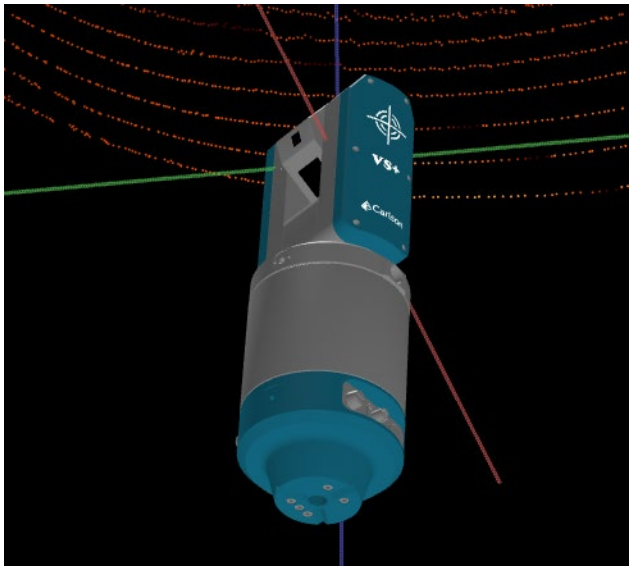


During a VS+ scan

During a scan, some controls are disabled and others change to become more relevant for the duration of the scan.

10.6.1 3D View

While a scan is in progress, the graphical model of the scanner replicates the mechanical movement of the laser head. The laser is displayed as a red line while it is firing (although in reality the measuring laser is invisible).



VS+ laser during a scan

All points collected are displayed in real time in the **3D View**.

Set different views in the **3D View** tabs to make it easy to switch between pre-defined views or between orthographic and perspective views.

Standard controls can be used to pan, rotate and zoom the data for visual analysis during the scan (see section 5.1).

To display the **3D View** in full screen mode, retract the **Control** tab or any other active function tab.

10.6.2 Progress dial

Progress dial during a scan

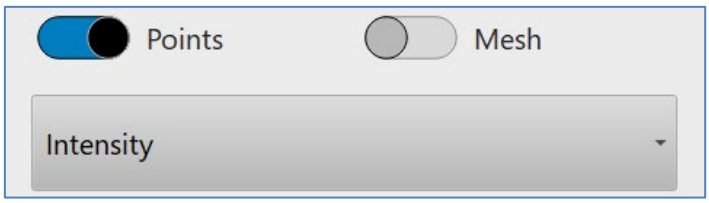
A live progress dial shows the scan progress including:

- Approximate time remaining
- Percentage of the scan completed
- A blue progress bar around the dial

When the **Control** tab is not active, the progress information is displayed in the status bar at the bottom of the screen.

10.6.3 Visualisation tools

The visualisation tools control the appearance of the data collected in the active scan.



Visualisation tools

- Tap the **Points** switch to toggle the points on and off in the **3D View**.
- Tap the **Mesh** switch to toggle the real-time mesh on and off in the **3D View**.
- Select a colour scheme from the drop-down list to change the colouring of the scan. Options are:
    - **Solid colour**: select a single colour for the scan.
    - **Intensity**: scan is coloured according to the signal strength recorded for each data point.
    - **Distance**: scan is coloured according to the distance from the scanner.
    - **Elevation**: scan is coloured according to its relative height.

Note you can open the **Scan** tab to further modify the view of the active scan and the real-time mesh (see section 8). The datasets in the **3D View** can also be toggled on and off in the **Project** tab (see section 7).

10.6.4 Scan controls

During a scan, the scan controls enable scans to be paused, restarted or stopped.

Scan, Pause and Stop buttons

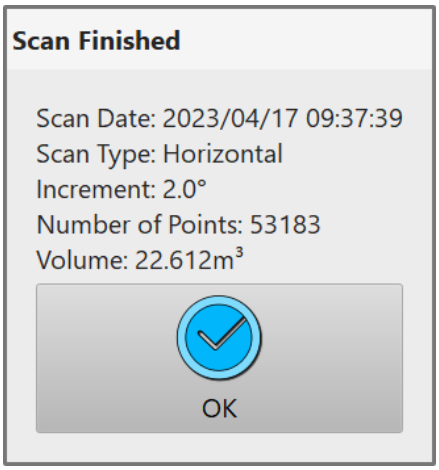
- **Pause**: during a scan, tap **Pause** to interrupt a scan that is in progress. The VS+ completes the current scan sweep before pausing.

  While the scan is paused, tap **Scan** to continue the scan or tap **Stop** to abort the scan and park the VS+.
- **Stop**: during a scan, or while a scan is paused, tap **Stop** to end the scan. The VS+ parks and **Carlson Scan** displays a summary of the completed scan.

10.6.5 Scan completion

When a scan has completed, or been cancelled, the VS+ laser head will park in its original position.

A summary of the scan appears in a message box.



Scan summary

You can conduct further scans from the same station if the VS+ has not physically moved. However, you must create a new station whenever the VS+ has been moved, as only one set of inclination and roll values apply to any given station.

11 Control Tab – C-ALS deployment

The **Control** tab provides direct control of the connected scanner. The **Control** tab is configured according to whether a C-ALS or VS+ is connected to **Carlson Scan**. This section outlines the **Control** tab functions and layout when a C-ALS is connected and a C-ALS deployment is being prepared, or is in progress.

Tap the **Scan** button at the bottom of the **Control** tab (see section 11.7.8) and the **Control** tab will again change configuration (see section 12) so that it is appropriate for scanning operations. Tap **Deployment** to return to the **Deployment** controls. Switch between the **Deployment** controls and **Scan** controls as required for your project.

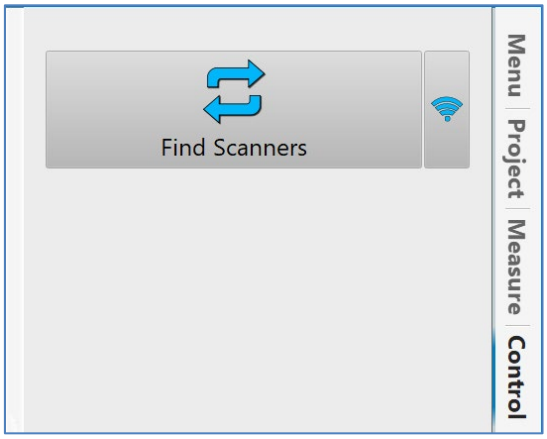
11.1 Connection to a C-ALS

11.1.1 Autodetect routine

Carlson Scan has an autodetect routine to establish if there are any scanners connected to the tablet. Once the routine is initiated, any scanner which is powered on and correctly interfaced with the tablet is detected. **Carlson Scan** first identifies that a C-ALS is connected (or a VS+ if that is the scanner you are using – see section 10.1) and then establishes the serial number, firmware and internal sensors within the instrument.

The autodetect routine can be started automatically by tapping the **New** button from the **Tablet** mode **Home** screen. This is the quickest way to get started with scanner operations.

Alternatively, tap the **Find Scanners** button in the **Control** tab to initiate the autodetect routine.

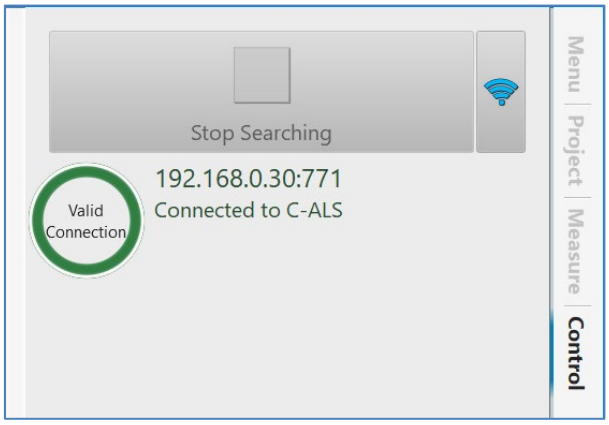


Find Scanners button and Wi-Fi button

The **Find Scanners** button is present on the **Control** tab in the following situations:

- If you have opened **Carlson Scan** in **Tablet** mode, from the **Home** screen tap **New** to start a new project. Enter any required details in the **Project Details** window and tap **Accept**.
- If you have opened an existing project and are viewing data without a connection to a scanner.
- If you are in an existing project and have lost connection with a scanner or have tapped the **Disconnect Device** button.

Once the autodetect routine has been initiated, the **Find Scanners** button changes to a **Stop Searching** button. Tap the **Stop Searching** button to end the autodetect routine.



Connecting to a C-ALS

While the autodetect routine continues, **Carlson Scan** searches through all available COM ports and IP connections for scanners connected to the tablet. If you are using a C-ALS, then **Carlson Scan** checks for:

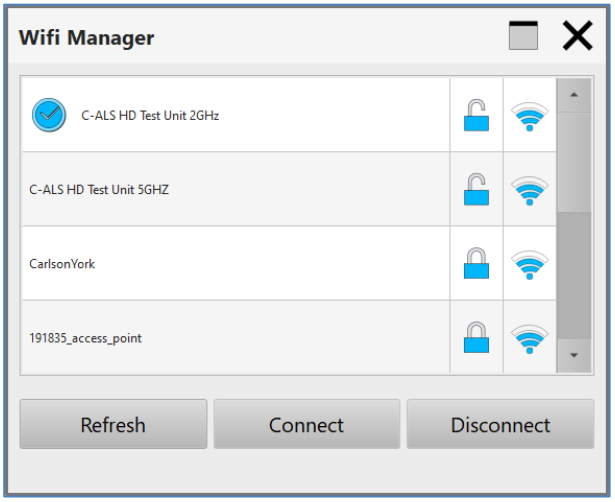
- A C-ALS connected via an Ethernet cable
- A C-ALS connected via a Wi-Fi link

11.1.2 Wi-Fi connection

Prior to initiating the autodetect routine, you may have used the standard Windows tools to connect to a Wi-Fi device such as the C-ALS surface unit. This allows the autodetect routine to find the scanner.

However, you can also connect to a Wi-Fi device from within **Carlson Scan**. Prior to using the **Find Scanners** button, tap the **Wi-Fi** button.

Depending on whether the **Managed Wi-Fi** switch in the **Settings** window is toggled ON or OFF (see section 4.3.1), either the Windows Wi-Fi manager or the **Carlson Scan Wi-Fi Manager** window appears. In the case below, the **Managed Wi-Fi** is toggled ON, so the **Carlson Scan Wi-Fi Manager** appears.



Carlson Scan Wi-Fi Manager

All Wi-Fi networks are displayed in a list.

Tap **Refresh** to refresh the list of Wi-Fi networks.

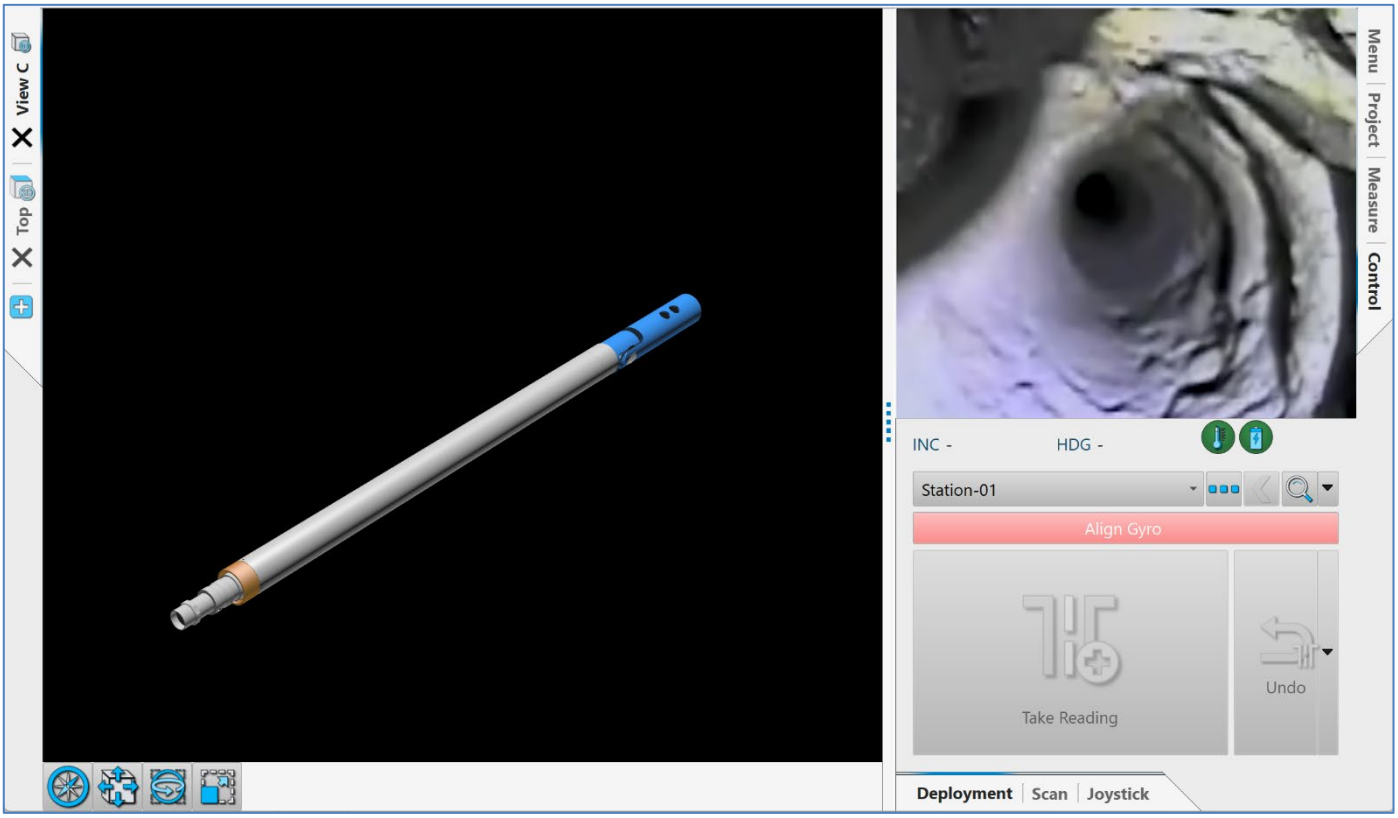
When you see the scanner to which you wish to connect listed in the Wi-Fi Manager, tap the appropriate entry, then tap **Connect**. **Carlson Scan** runs the autodetect routine to identify a scanner on the selected Wi-Fi network.

11.1.3 Connected

On detection of a scanner, **Carlson Scan** runs through checks to establish that comms with the scanner are sound and to read information from the scanner.

With all checks complete, a graphic of the C-ALS appears in the **3D View**.

The **Control** tab is active, displaying C-ALS-specific controls. These controls are outlined below.



Control tab active - connected to a C-ALS

11.2 Video

C-ALS video window

The C-ALS video window displays a real-time video feed from the borehole camera in the C-ALS. It is usually essential to monitor the video during deployment.

On connection with a C-ALS, **Carlson Scan** automatically displays the video feed. A 'Connecting' message appears in the video window until the connection to the video stream is ready.

Connecting to the C-ALS video stream

Once connected, the video stream is always visible during a deployment.

In the event that **Carlson Scan** cannot recognise a video stream, a warning icon is displayed in the video window.

Video stream not available

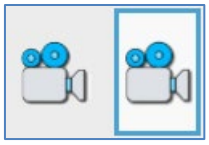
In this case, tap the **Reset** button (see section 11.2.1). If this does not produce a video display, reboot the C-ALS surface unit.

11.2.1 Video Controls

Tap on the video window to access video controls.

Video controls

- **Reset:** resets the video stream. Tap **Reset** if you are experiencing video issues.
- **Record snapshot**: takes an image of the current borehole camera view. The image is saved as a *.jpg file and saved in the Screenshot folder of the project.
- **Lighting**: controls the LEDs around the camera. By default, the LEDs are on during a deployment and off during a scan.
- **Record video**: toggles video recording on and off. The video is recorded as an *.mp4 file. The video is saved in the Video folder of the project. The button colour indicates the current status of the recording.



Video recording OFF (left) and ON (right)

- **Invert**: inverts the shading in the video image. This can make some images easier to analyse.
- **Orientation**: reorientates the camera image in real-time as the C-ALS head rotates.
- **Zoom in / zoom out**: allows digital zooming in and out of the live camera image.
- **Resize**: swaps the video window in the **Control** tab with the active **3D View**. This allows a larger format view of the borehole camera image. By default, the camera view is swapped to the main **3D View** during a deployment. This helps to ensure that you are in the best position to see the entrance to the void and any obstructions in the hole during a deployment.

  When you tap **Resize**, the video controls also swap position so that they remain under the video window at all times.

  A resize button is also present underneath the **3D View** window (see section 5.3.4).

11.3 Active station controls

Active station controls

- The active station is displayed in the **Station** drop-down list.

  Tap the **Station** drop-down list to see all stations in the active project. From the list, tap **New Station** to create a new C-ALS station. The **Station Details** window appears from where you can configure the new station (see section 7.2.2).

- Tap the **Station Details** button to open the **Station Details** window. Edit details of the active station including name, coordinates and view options (see section 7.2.2).

- Once a deployment is in progress, the **Finish deployment** button is active. Tap the **Finish deployment** button if you wish to end the current deployment and retrieve the C-ALS probe.

- Tap the **Zoom** button to zoom in to the active station. Tap the **Zoom** drop-down list to access pre-defined views of the scanner.

- Tap the **Disconnect** button to disconnect **Carlson Scan** from the connected C-ALS. A message box appears: '*Are you sure you want to disconnect? All commands will finish and the device will move to the stow position*'.

  Tap **Yes** to continue. **Carlson Scan** disconnects from the C-ALS. The **Find Scanners** button is activated on the **Control** tab.

  Tap **Cancel** to remain connected to the scanner.

11.4 Live data

C-ALS live data

The live data text displays real-time information on the C-ALS.

- **Incline**: the current inclination of the C-ALS with respect to gravity. 0° is vertically down.

- **HDG**: the current heading of the C-ALS. The heading is taken directly from the gyro, with reference to the entered alignment heading. The figure refers to the direction that the nose of the C-ALS probe is pointing, as seen from a plan view. When the probe is pointing directly vertical down or up, the displayed HDG value may be seen to fluctuate rapidly as the direction is less distinct. This will not affect stability or accuracy of the end results.

- **Temp**: the current temperature received from the C-ALS. If the **Gyro** deployment mode has been selected, the temperature is taken from the gyro's own internal sensor.

  The temperature limits of the C-ALS are -10° C to +60° C. If the temperature of the probe approaches within 5° of these limits, the temperature value will display in red.

- **Voltage**: the voltage level received from the C-ALS surface unit.

  The Voltage display turns red if a voltage is returned below 11.0 V. A warning message, shown below, appears the first time this occurs during a session connected to the C-ALS. If the voltage falls below 10.7 V, the software will carry out a controlled shut-down of the scan.

  The C-ALS probe automatically powers down if a voltage of 10.5 V or below is returned

- **Length**: The distance that the C-ALS has been deployed from the collar during the active deployment. The **Length** is computed by the number of **Segments** recorded multiplied by the **Increment** used for each segment.

  Note that the counting of the segments is a purely manual exercise: if you mistakenly forget to take a reading or take multiple readings at any stage of the deployment, then the **Length** will be incorrect.

- **Segments**: the total number of Boretrak readings taken, irrespective of the **Increment** set for each reading.

11.5 Gyro control

The gyro is used to monitor the changing heading of the C-ALS probe during the deployment. The gyro is integrated into an IMU (inertial measurement unit) which also includes accelerometers. The IMU ensures that the pitch, roll and yaw of the C-ALS probe can be tracked through all inclinations and headings.

Since the gyro in the C-ALS probe is not a north-seeking gyro, an initial, starting heading must be entered. Once the probe has been calibrated in alignment along the entered heading, the gyro then tracks the heading as it changes during handling and deployment.

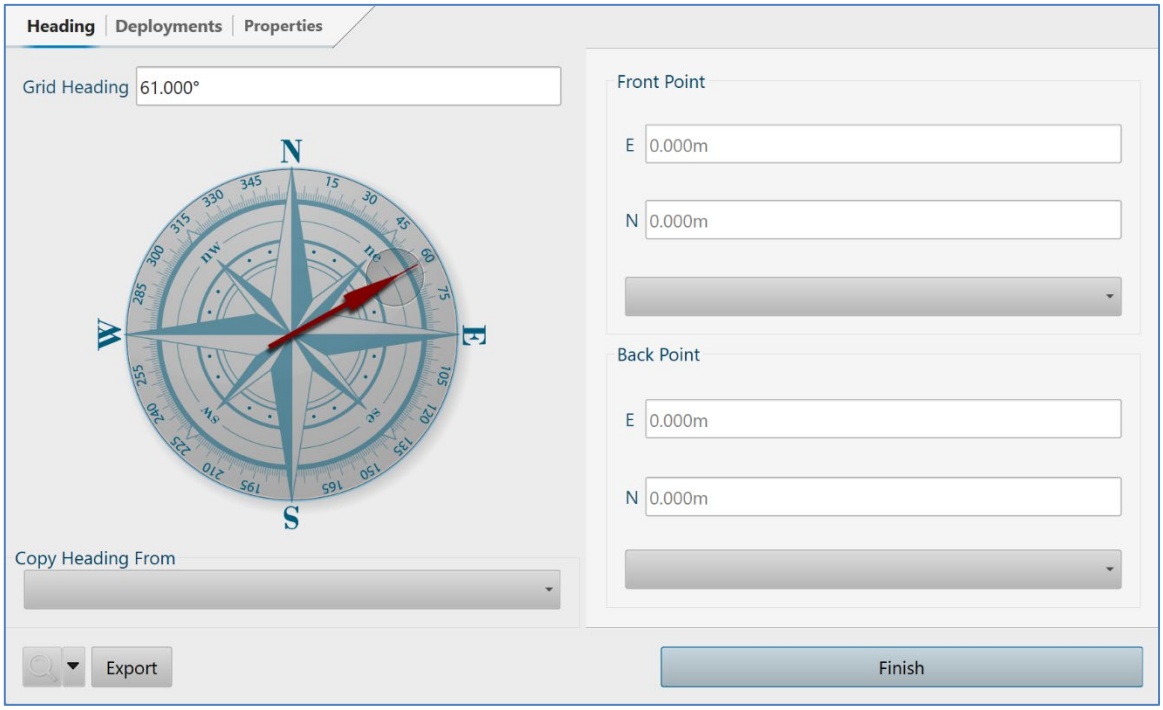
The **Gyro** button in the **Control** tab interface contains live information about the status of the gyro. The various states that the button can display are:

11.5.1 Unaligned

When the C-ALS probe is first powered up and connected to **Carlson Scan**, the gyro will be unaligned. At this stage the **Align Gyro** button is red and reads **Align Gyro**. The gyro must be aligned before a deployment can commence.

Gyro - unaligned

Tap the **Align Gyro** button to carry out an alignment.



Alignment window

By default the name of the alignment is *Alignment YY-MM-DD hh:mm*.

11.5.1.1 Manual heading entry

If the heading of the alignment jig is known, you can manually enter this value.

Enter the known heading in the **Grid heading** text box on the left of the window.

None: a default value of 0.00 degrees is used for the heading.

To accept the manually entered alignment grid heading, tap **Finish**.

11.5.1.2 Heading between known coordinates

The alignment can also be established by aligning the C-ALS probe between two holes of known coordinates. **Carlson Scan** will compute the heading between them and use this as the alignment value.

On the right are two drop-down lists.

Select the hole you are pointing *towards* from the **Front Point** drop-down list.

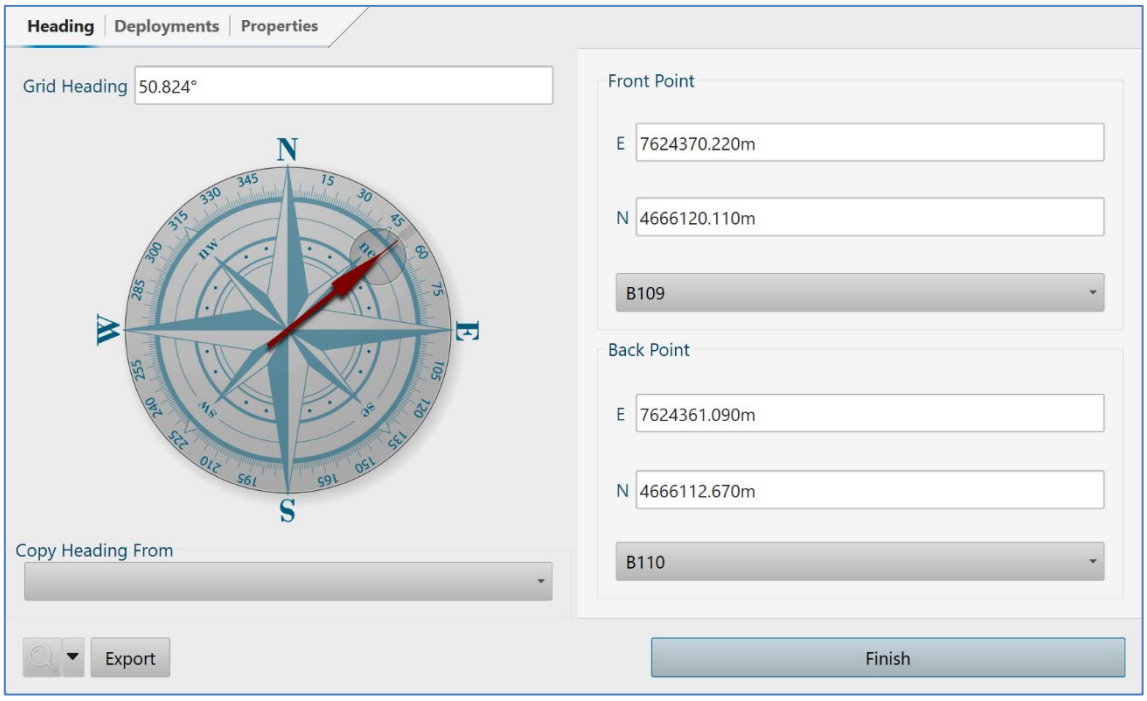
Select the hole you are pointing *away from,* from the **Back Point** drop-down list.

The coordinates of the selected holes are displayed.

On the left, the heading between the two selected holes is displayed as the **Grid heading**.

In the example below, the alignment jig is lined up between Hole B110 and Hole B109. Ensure the jig is on solid ground and reasonably close to level (i.e.: within 20 degrees).

Position the C-ALS probe in the jig. The C-ALS probe can be rolled around its axis in any rotation, but it must be pointing point towards the hole selected under **Front Point**: in the case below, Hole B109.



Alignment window

11.5.1.3 Using a pre-measured heading

If you have previously carried out an alignment from a jig and, if the jig has not been moved since that alignment, then you can return the C-ALS probe to the jig and select a previous alignment.

Use the **Copy heading from** drop down list to select a previous alignment. The **Grid heading** field is populated with the previously used heading value.

Tap **Finish** to close the **Alignment** window.

11.5.2 Aligning

Whilst aligning, the **Align Gyro** button is yellow, with a green progress bar, and reads **Aligning Gyro**.

Gyro - aligning

During this stage, the probe must be absolutely stable and free from movement and vibration. The probe must also be positioned in a known heading. The alignment takes approximately five seconds.

11.5.3 Verifying alignment

Immediately after an alignment, **Carlson Scan** monitors the gyro drift to ensure that a clean alignment has occurred. Again, the **Align Gyro** button is yellow, with a green progress bar. It now reads: **Verifying Alignment**.

Gyro - verifying alignment

The probe must remain static. The verification takes approximately five seconds.

11.5.4 Aligned – deployment not started

When an alignment is successfully completed, the **Align Gyro** button is green. A display of the time since the alignment is shown on the **Align Gyro** button. The deployment can proceed.

Gyro – aligned

The button to the right of the **Align Gyro** button opens the **Alignment setup** window. Edit the alignment as required.

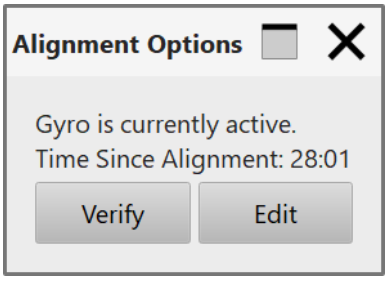
11.5.5 Aligned – deployment started

Once the first deployment reading has been taken, the **Align Gyro** button disappears and is replaced by an **Alignment** icon.

Alignment icon

Tap the **Alignment** icon to check the alignment.

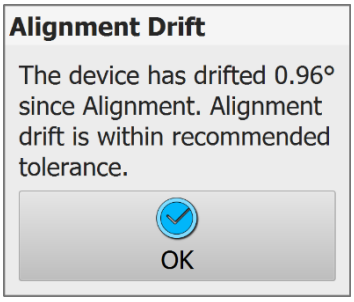
An **Alignments Options** dialog opens displaying the time since last alignment.



Alignment Options

Tap **Verify** to check how much the gyro has drifted since the last alignment. Place the probe back on the jig, in the same orientation. The jig must not have been moved since the last alignment.

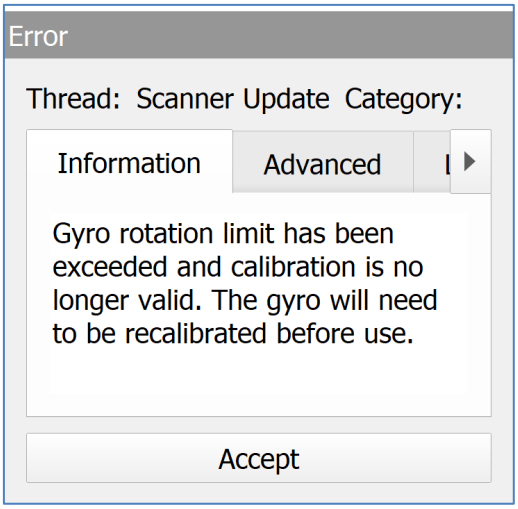
The current heading is compared to the user-defined alignment heading from the last alignment.



Alignment drift check

11.5.6 Losing alignment

If, during the survey, the probe is moved beyond the limitations of the gyro (i.e. a faster than the 400°/second maximum rotation rate) then an error message appears, and the **Gyro** button reverts to the **Align Gyro** state.

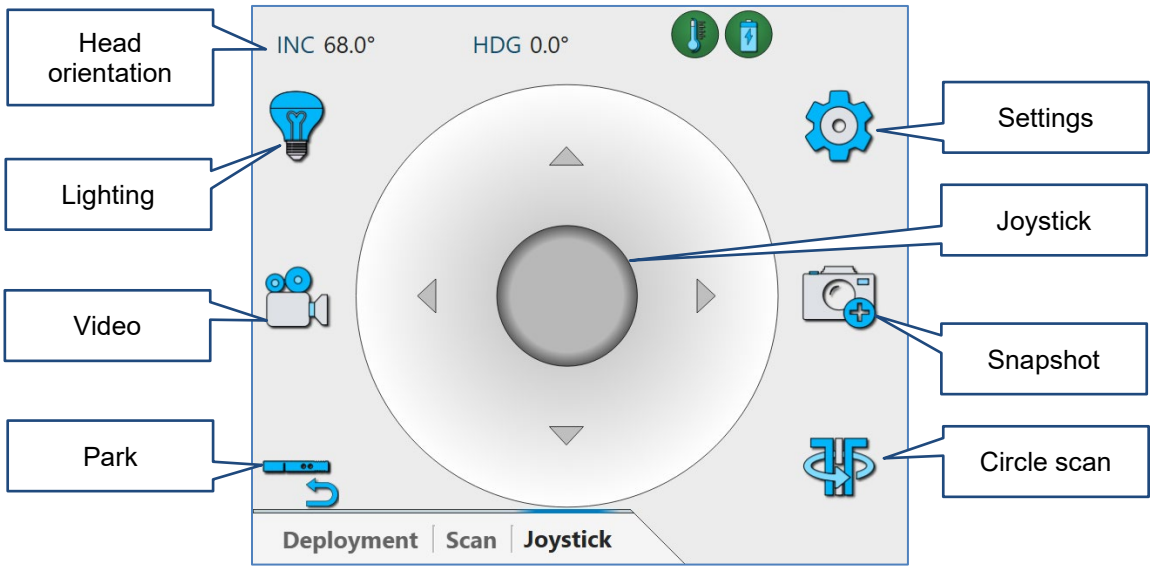


Gyro exceeded rotational speed limit

Full details of the C-ALS operations and procedures are outlined in section 16.

11.6 Joystick controls

The joystick controls help the operator to use the C-ALS borehole camera to inspect a void. While the joystick controls are active, the camera image is shown in the main **3D View**.



C-ALS joystick controls

11.6.1 Joystick

Move the joystick to manipulate the C-ALS scan head and thus to change the camera view. The scan head moves at two speeds. Pull the joystick further from the central position to increase the speed.

11.6.2 Head orientation

While the joystick is in use, the displayed **INC** (inclination) and **HDG** (heading) show the orientation of the scan head as it is moved.

11.6.3 Lighting

Controls the brightness of the LEDs which surround the C-ALS borehole camera. A vertical slider bar appears.

Drag the slider up to brighten the LEDs.

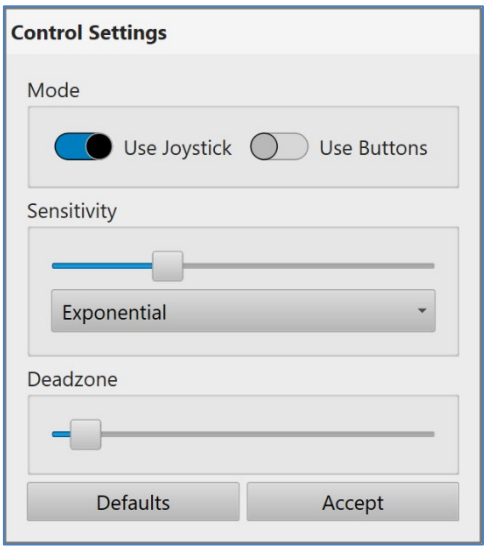
Drag the slider down to dim and turn OFF the LEDs.

11.6.4 Park

Return the scan head to the default 'parked' position in line with the body of the C-ALS.

11.6.5 Settings

Open a **Settings** window to change the default operation of the joystick controls.



Joystick Control settings

11.6.6 Snapshot

Takes an image of the current borehole camera view. The image is saved as a *.jpg file and saved in the Screenshot folder of the project.

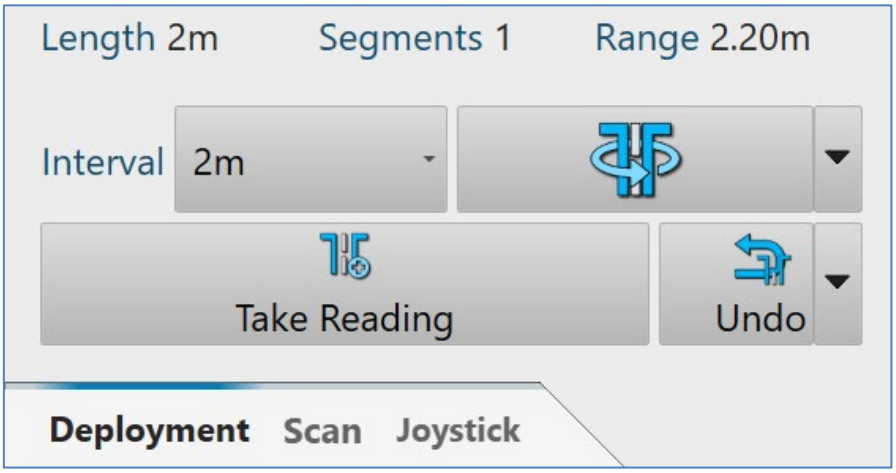
11.6.7 Circle scan

Carries out a circle scan whilst retaining the current vertical angle of the scan head. This allows a 360° view around the probe with the borehole camera.

11.7 Deployment Controls – manual deployment

During standard C-ALS deployments, the C-ALS probe is manually lowered or pushed along the borehole at fixed intervals. At each interval, the C-ALS is held steady while a Boretrak reading is taken.

If a cable counter is in use and connected to the surface unit, then the C-ALS probe is lowered continuously, without requiring regular stops. In this case, the deployment controls appear slightly different (see section 11.8).



C-ALS deployment controls – manual deployment

11.7.1 Length

The **Length** display shows the distance the probe has been deployed from the collar during the active deployment. This value is computed from the number of readings taken, multiplied by the selected **Interval**.

Note that the counting of the segments and the choice of **Interval** are purely manual. If you mistakenly forget to take a reading or take multiple readings at any stage of the deployment, then the **Length** will be incorrect.

11.7.2 Segments

Segments displays the total number of readings taken, irrespective of the **Interval** set for each reading.

11.7.3 Range

Shows a regular range from the C-ALS laser. During deployment the laser is pointing perpendicular to the direction of deployment. A range can help with understanding when the probe breaks out into a void. Toggle the range ON and OFF using the **Always show range** option in the **Settings** window > **Scan** tab (see section 4.3.3).

11.7.4 Interval

Use the **Interval** drop-down to define the physical increment between each Boretrak reading. In the drop-down list are three options

- **1 m**.
- **2 m**: this is the default for the first reading taken in a deployment – i.e. it is expected that the probe and extension piece will both be deployed into the hole before the first reading is taken.
- **Custom**: this activates the number-pad so that you can enter a user-defined distance. This is often required, particularly for a final Boretrak reading when adjusting the probe to be in the correct position to scan.

Negative values can be entered if the probe is being pulled back to the collar between scans rather than being lowered away from the collar.

The selected option can be changed at any point during the deployment.

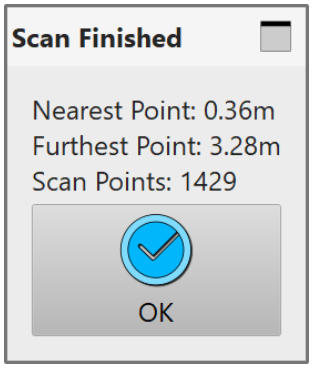
11.7.5 Circle scan

Tap **Circle scan** to carry out a circle scan.

A circle scan involves the laser head rotating around the horizontal axis to produce a single, circular scan.

A circle scan is particularly useful during a deployment to check whether the probe has been deployed far enough into a void. The results from the circle scan help to establish if there is enough space around the laser head for the C-ALS to conduct a full scan with the full range of vertical rotation. It is safer to use a circle scan to perform this check as the head will not move vertically and thus, even if the probe is still in the borehole and has not yet emerged into the void, it will not jam against the adjacent rock.

When the circle scan is complete, a scan summary appears. The distances to the nearest and furthest points recorded are displayed.



Circle scan summary

If any distance less than 25 cm is observed during the circle scan, a warning appears: '*Warning: surfaces detected very close to the laser. The C-ALS scan head may be physically obstructed if you run a scan from the probe's current location*'.

In this case, if practical, consider deploying the C-ALS further into the void and retrying the circle scan. However, always ensure that sufficient length of the probe/extension piece is left in the borehole to avoid the whole length of the C-ALS dropping into the void. If in doubt, retrieve the C-ALS. If the C-ALS is deployed further, take another Boretrak reading with the correct custom increment value.

11.7.6 Take reading

Tap **Take Reading** to take one Boretrak reading each time that the C-ALS reaches the pre-defined deployment interval.

Only take a Boretrak reading when the sensors are steady, so allow a few seconds for the probe to stabilise after it is lowered.

After each reading, the **Segments** display increases by one and the **Length** display increases by the value selected in **Increments** drop-down.

Each Boretrak reading is also registered in the **3D View** and as an additional entry in the **Deployment** window (see section 7.3).

Take care to synchronise the physical deployment of the C-ALS probe with the recording of the related deployment increment in **Carlson Scan**. It is easy to lose concentration during an operation and to mistakenly miss a reading or to take an extra reading before the probe has moved to the next interval.

11.7.7 Undo

If you have mistakenly taken a Boretrak reading, tap **Undo** reading to clear the last reading from **Carlson Scan**.

A warning message appears. Tap **Accept** to continue and deleted the last Boretrak reading.

After removing a Boretrak reading, the **Segments** display and the **Length** display revert to their previous values.

11.7.8 Switch to scan controls

When a deployment is complete and the C-ALS probe is secured in position to carry out a scan, tap **Scan**. The deployment controls are replaced by scan controls (see section 12)

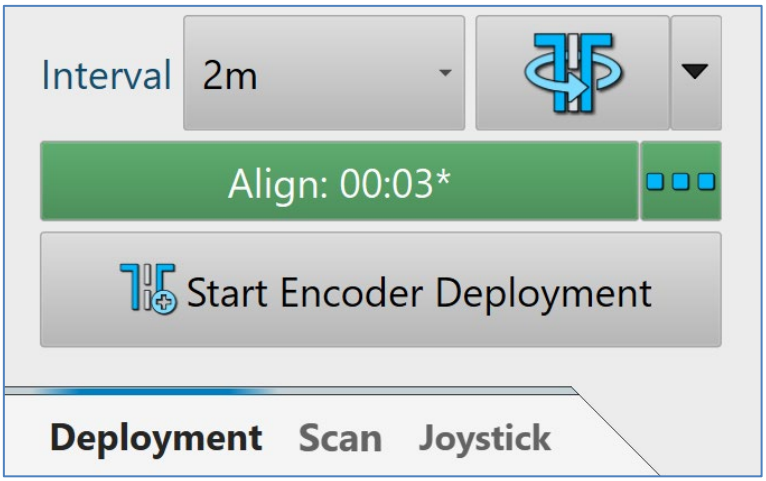
11.8 Deployment Controls – using a cable counter

If a cable counter is in use and connected to the surface unit, then the C-ALS probe can be lowered continuously, without requiring regular stops.

The deployment controls are similar to those outlined above, with a few differences.

11.8.1 Start encoder deployment

When the alignment is complete, the **Start encoder deployment** button appears.



C-ALS deployment controls - using a cable counter

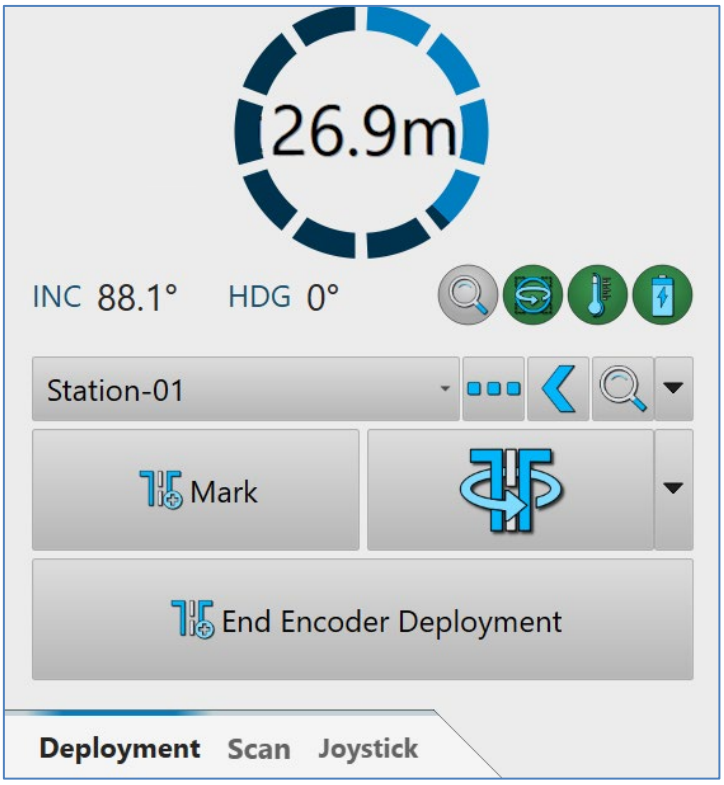
When the C-ALS probe is deployed 2 m past the hole collar (ie the end of the extension piece is at the hole collar) tap the **Start encoder button** to commence the deployment.

Note that if the **Initial deployment offset** in **Menu** > **Counter** window is changed from the 2 m default, then the distance that the probe is inserted into the hole should change accordingly (see section 4.3.2).

11.8.2 Length

As the probe is lowered, the cable counter keeps track of the deployed distance. This deployed distance is displayed in the **Scanner** tab. As the cable counter rotates, the progress circle around the deployed depth also rotates.

The cable counter also keeps track of the cable as it is retracted. Therefore if back and forth adjustments are made to the position of the C-ALS, at any stage of the operation, the correct deployment distance is always maintained.

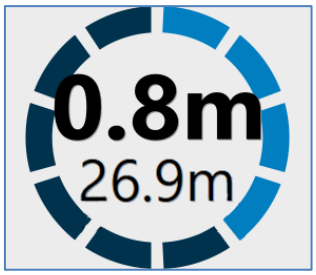


C-ALS deployment controls using a cable counter - deployment started

11.8.3 Mark

The **Mark** feature helps to monitor the distance the that probe is deployed out of the borehole and into a void.

Tap **Mark** to record the point at which the nose of the C-ALS probe enters the void (as seen in the camera image). A secondary distance measurement appears above the deployed depth display. This displays the distance deployed since the **Mark** button was tapped.



The deployed distance showing a secondary distance since a Mark was registered

Consider that the C-ALS probe plus extension piece is 2 m long. It is vital to always retain a section of this length within the borehole, to stabilise the probe and to make sure it does not entirely enter the void. Use the secondary distance to help gauge the extra length deployed into the void.

11.9 End encoder deployment

If the deployment and scanning operations are complete, tap **End encoder deployment**.

A message box appears: **Are you sure you want to finish the deployment and return to surface?**

Tap **Yes** to end the deployment.

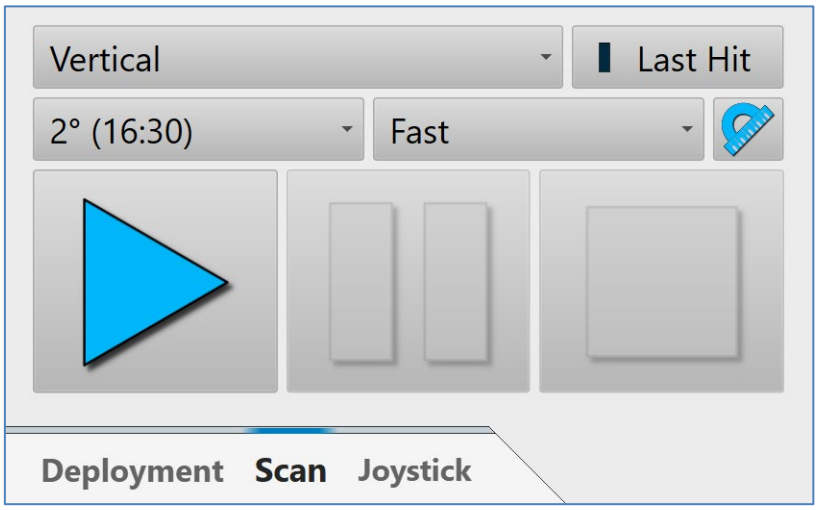
12 Control Tab – C-ALS scan

The **Control** tab provides direct control of the connected scanner. The previous section outlined the controls used during a deployment. After completing a deployment, tap the **Scan** button. Tools related to scanning operations appear in the **Control** tab.

Tap **Deployment** to return to the **Deployment** controls. Switch between the **Deployment** controls and **Scan** controls as required for your project.

12.1 Scan Controls

The scanning configuration tools offer functionality for configuring and initiating a scan.



Scan controls

12.1.1 Mode

The **Mode** selection determines the pattern of the scan. From the drop-down list, select from:

- **Horizontal**: the scanner completes a series of horizontal scan sweeps, separated by a stepped vertical increment
- **Vertical**: the scanner completes a series of vertical scan sweeps, separated by a stepped horizontal increment
- **Horiz + Vert**: the scanner completes a horizontal scan followed by a vertical scan. **Carlson Scan** treats the two scans as a single element for the purposes of display, colouring, meshing and exporting.
- **Video scan**: the scan head moves vertically by 90° and then rotates horizontally 360°. During these movements, a video is recorded, giving a view around the probe. No scan data is recorded.

12.1.2 Last Hit

Tap the **Last Hit** switch to toggle **Last Hit** mode on and off.

The **Last Hit** option can be used if there are particles between the instrument and the target which are partially blocking the path of the laser. The particles may be water vapour or dust in the air which may cause the laser pulse to reflect back to the instrument before it hits the intended target. Activating this mode will instruct the C-ALS to attempt to ignore any interference from the particles in the air and instead to concentrate on returns from the true target.

The **Last Hit** option should not be used to shoot to reflective targets, as incorrect results may be returned.

12.1.3 Sweep

The **Sweep** selection determines the size of the vertical increment (if a horizontal scan is selected) or horizontal increment (if a vertical scan is selected). The smaller the increment, the more scan sweeps the C-ALS completes, the denser the resulting point cloud, and the longer the duration of the scan.

From the **Sweep** drop-down list, select the required increment.

To enter a user-defined increment, select **Custom** from the drop-down list. The number-pad opens. Enter your required increment and tap **Accept**. The smallest definable scan increment is 0.3 degrees.

The entries in the drop-down list show the increment in degrees followed by (in brackets) the approximate time to run the scan.

Note that due to the mechanics of the scanner, the actual increment and scan time may differ slightly from the selected value.

12.1.4 Speed

Select **Fast** or **Dense** from the drop-down list, to determine the speed of the scan.

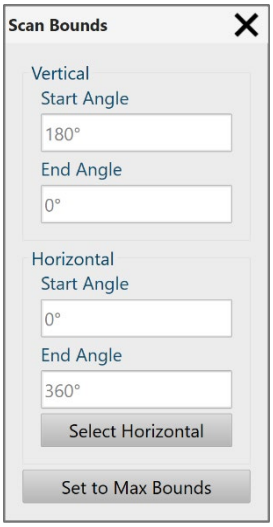
For most operations, leave the speed set to **Fast**. Alternatively, select **Dense** and each scan will run approximately 70% slower, with approximately 70% more points along each scan sweep.

The **Dense** option is mainly intended for very large voids where the spacing between each point on a scan line can become very large on the most distance surfaces.

Note that the **Sweep** control defines the density of scan sweeps whereas the **Speed** control defines the density of points *along* each scan sweep.

12.1.5 Custom scan

If a Verticl scan is selected, **Custom scan** controls allow you to limit the range of a scan. By default, horizontal and vertical scans provide a full 360° coverage of the area around the scan head. Sometimes, the full coverage is not required and, due to time constraints, it is desirable to physically limit the range of a scan.



Custom scan controls

Limit the angular range of a scan scan using the vertical and / or horizontal start and end angles.

Tap **Select Horizontal** to graphically mark the horizontal limits of the scan in the **3D View** .

Tap Set to max bounds to restore the scan to the default 'full scan' range values:

- **Vertical**: 180° to 0°.
- **Horizontal**: 0° to 360°.

12.1.1 Scan controls

The **Scan controls** enable scans to be started using the settings determined using the scan configuration tools.

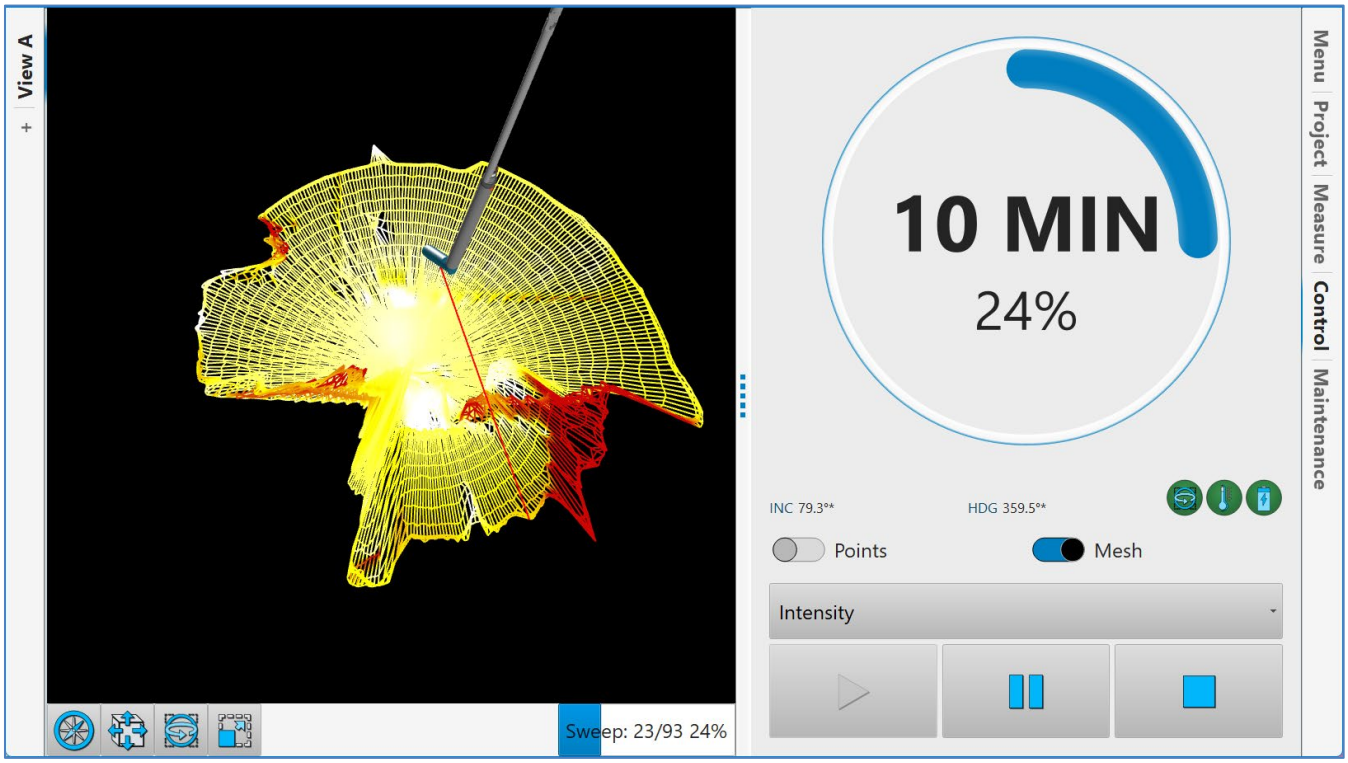
Scan, Pause and Stop buttons

- **Scan**: With the scan configured, tap **Scan** to begin the scan. The **Scan** button is greyed out until the scan is complete or cancelled.
- **Pause**: during a scan, tap the **Pause** button to interrupt a scan that is in progress. The C-ALS completes the current scan sweep before pausing.
- While the scan is paused, tap **Scan** to continue the scan or tap **Stop** to abort the scan and park the C-ALS.
- **Stop:** during a scan, or while a scan is paused, tap Stop to end the scan. The C-ALS and Carlson Scan displays a summary of the part of the completed scan.

12.2 During a scan

Once a scan has been started, no further user intervention is required. The C-ALS will progress through the scan according to the configuration selected.

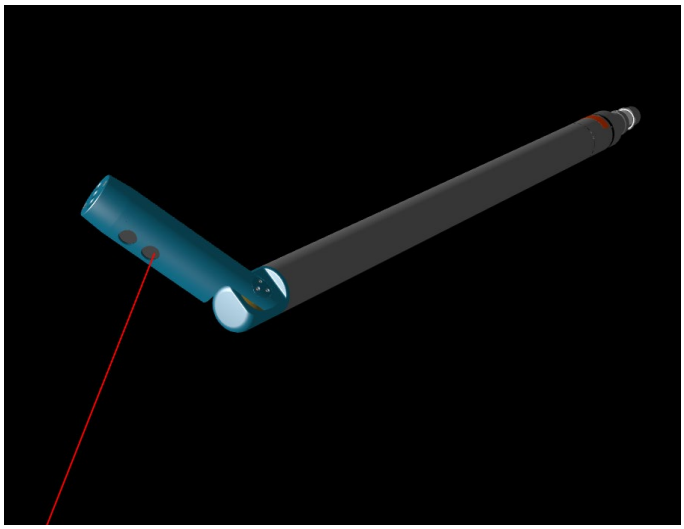
During a scan, some controls are disabled, and others change to become more relevant for the duration of the scan.



During a C-ALS scan

12.2.1 3D View

While a scan is in progress, the graphical model of the scanner replicates the mechanical movement of the laser head. The laser is displayed as a red line while it is firing (although in reality the measuring laser is invisible).



C-ALS model during a scan

All points collected are displayed in real time in the **3D View**.

Set different views in the **3D View** tabs to make it easy to switch between fixed views or between orthographic and perspective views.

Standard controls can be used to pan, rotate and zoom the data for visual analysis during the scan (see section 5.1).

To display the **3D View** in full screen mode, retract the **Control** tab or any other active function tab.

12.2.2 Progress dial

Progress dial during a scan

- A live progress dial shows the scan progress including:
  - Approximate time remaining
  - Percentage of the scan completed
  - A blue progress bar around the dial

When the **Control** tab is not active, the progress information is displayed in the status bar at the bottom of the screen.

12.2.3 Visualisation tools

The visualisation tools control the appearance of the data collected in the active scan.

Visualisation tools

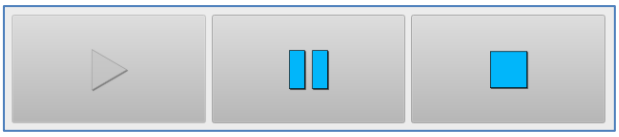
- Tap the **Points** switch to toggle the points on and off in the **3D View**.
- Tap the **Mesh** switch to toggle the real-time mesh on and off in the **3D View**.
- Select a colour scheme from the drop-down list to change the colouring of the scan. Options are:
  - **Solid colour**: select a single colour for the scan.

- **Intensity**: scan is coloured according to the signal strength recorded for each data point.
- **Distance**: scan is coloured according to the distance from the scanner.
- **Elevation**: scan is coloured according to its relative height.

Note you can open the **Scan** tab to further modify the view of the active scan and the real-time mesh (see section 8). The datasets in the **3D View** can also be toggled on and off in the **Project** tab (see section 7).

12.2.4 Scan controls

During a scan, the scan controls enable scans to be paused, restarted or stopped.



Scan, Pause and Stop buttons

- **Pause**: during a scan, tap **Pause** to interrupt a scan that is in progress. The C-ALS completes the current scan sweep before pausing.

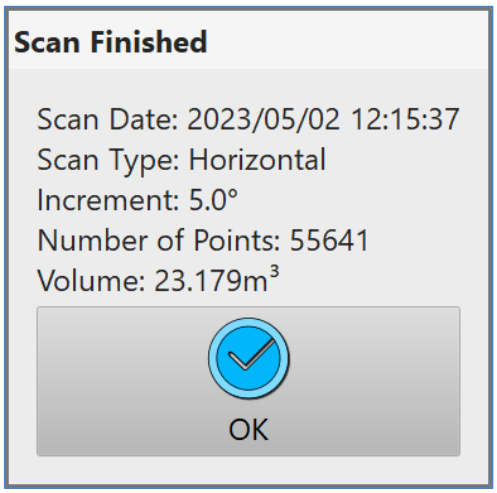
  While the scan is paused, tap **Scan** to continue the scan or tap **Stop** to abort the scan and park the C-ALS.

- **Stop**: during a scan, or while a scan is paused, tap **Stop** to end the scan. The C-ALS parks and **Carlson Scan** displays a summary of the completed scan.

12.2.5 Scan completion

When a scan has completed, or been cancelled, the C-ALS laser head will park in its original position.

A summary of the scan appears in a message box.



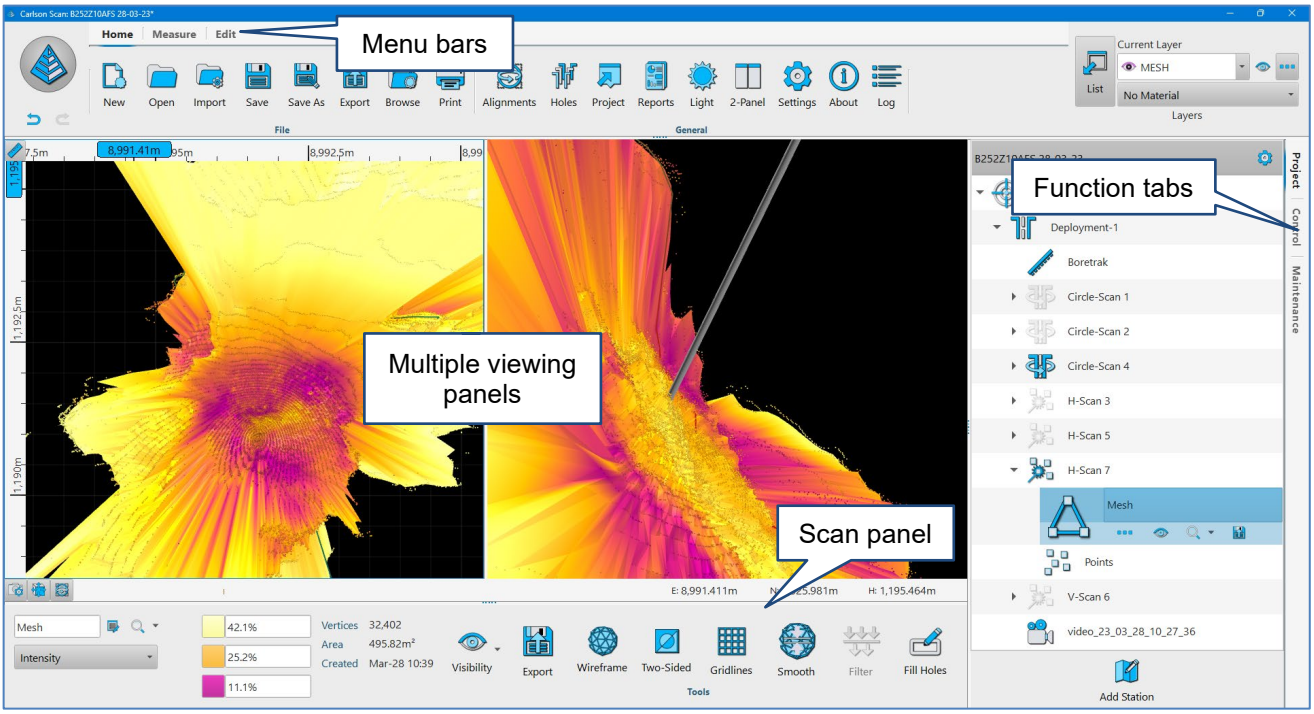
Scan summary

You can conduct further scans from the same station. However, if the C-ALS has been moved, a new Boretrak reading may need to be taken, with the appropriate value entered into the **Increment** drop down in the deployment controls.

13 Desktop Mode – screen layout

When a project has been completed, the data is usually viewed and analysed back in the office. In this case, if you are using a larger format laptop or desktop computer then select **Desktop** mode.

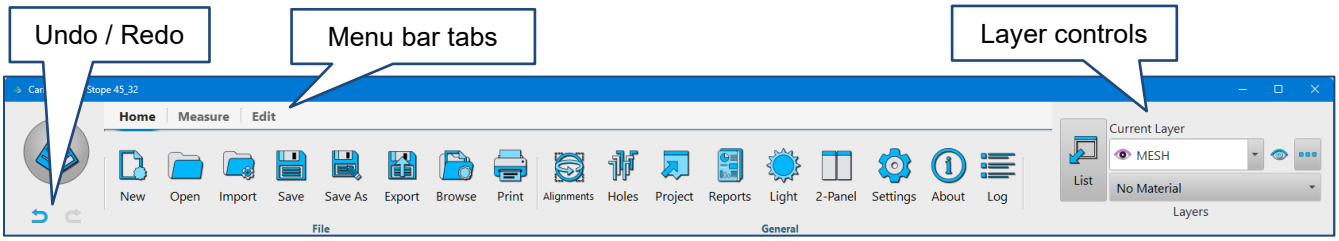
Desktop mode has a more traditional interface and is intended for use with a standard keyboard and mouse.



Desktop mode

All the same functionality is present in the **Desktop** mode, although the UI is arranged slightly differently. There are also some additional features which are useful for the processing stage.

13.1 Menu bars



Home menu bar

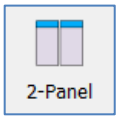
Many of the controls in **Desktop** mode are arranged into buttons in the menu bars. There are three menu bars which can be selected by clicking the menu bar tabs.

13.1.1 Home

The **Home** menu bar includes all the controls which are present in the **Menu** tab in **Tablet** mode (see section 6). In addition to these controls are:

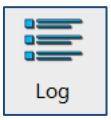
Tablet button

- **Tablet button**: swaps the viewing mode from **Desktop** to **Tablet**.



Panel button

- **Panel button**: changes the arrangement of **3D View** windows in the interface. Click the panel button to be offered a choice of:
    - 1 Panel
    - 2 Panel
    - 3 Panel left
    - 3 Panel right
    - 4 Panel



- **Log**: opens a series of logs which catalogue all interactions between the C-ALS or VS+ probe and Carlson Scan. These logs are used for troubleshooting and are not required for normal operations.

13.1.2 Measure

The **Measure** menu bar replicates the tools in the **Measure** tab in **Tablet** mode (see section 9). When using these measure tools in **Desktop** mode, the results from all measuring operations are displayed in the **Measure** tab, on the right-hand side of the screen.

13.1.3 Edit

The **Edit** menu bar contains editing tools for erasing and masking data.

The **Undo**/**Redo** buttons are used in conjunction with the editing tools. Details of the editing tools are in section 14.

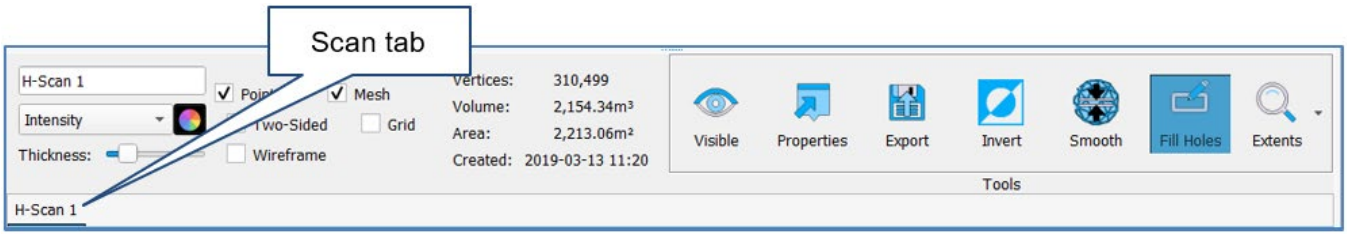
13.2 Function tabs

As in **Tablet** mode, on the right-hand side of the screen are function tabs which allow control of the scanner, provide data viewing and analysis tools, and enables management of the project.

- The **Project** tab contains a record of all data collected or imported within the active **Carlson Scan** project (see section 7).

- The **Control** tab provides direct control of the connected scanner. The **Control** tab is configured according to whether a C-ALS or VS+ is connected to **Carlson Scan** (see sections 10, 11 and 12).

- The **Scan** tab contains controls to change the appearance of the active point cloud and the mesh (see section 8). In the **Settings** window > **General** tab, if the **Bottom Section** check box is unticked, the **Scan** tab appears on the right-hand side with the other tabs. If the **Bottom Section** check box is ticked, all the tools in the **Scan** tab appear instead in the **Scan** panel at the bottom of the screen.

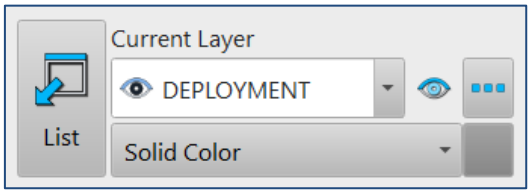


Scan panel

The **Measure** tab appears when the **Measure** toolbar has been selected at the top of the screen. All data resulting from measurement functions is displayed in the **Measure** tab.

13.3 Layer controls

The **Layer** controls provide tools to manage the layers into which the data in the **3D View** is divided.



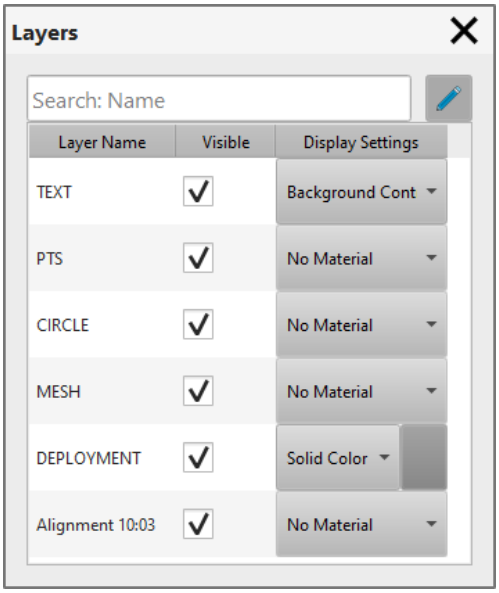
Layer controls

Select a layer from the drop down list and use the visible/invisible button to toggle the layer on and off in the **3D View**.

Select a layer from the drop down list and use the colour drop down list to configure the colour option of the layer in the **3D View**.

If you select a colour option for a layer, this overrides any colour settings for individual entities within the layer.

Click the **List** button to open the **Layers** tab in the **Project** window.



Layer tab

The colour option of each layer can be changed in the **Layers** tab. Select a colouring option from the **Display Settings** drop down list.

14 Editing functionality

In **Desktop** mode, **Carlson Scan** provides tools to edit the collected data. The intention is to help data analysis within **Carlson Scan**, and also to help smooth integration with third party packages by cleaning and preparing collected data before it is exported.

The **Undo**/**Redo** buttons are used in conjunction with the editing tools.

Edit menu bar #1

The buttons shown initially in the **Edit** menu bar are **Erase** and **Mask**.

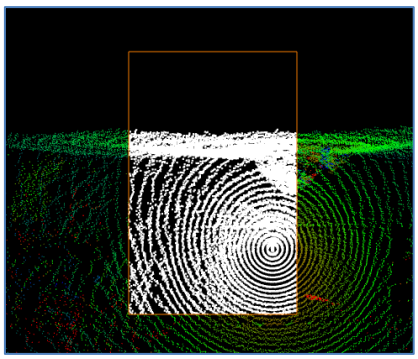
14.1 Erase

Click **Erase** to delete points from the project. The **Edit** menu bar changes to display additional tools.

Edit menu bar #2

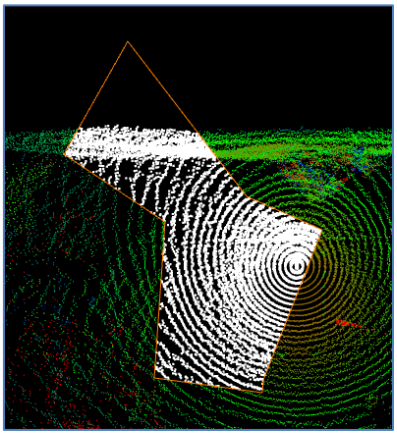
Define the manner in which points to erase are selected.

- **Rectangle**: select points by drawing a rectangle. Click in one corner of the rectangle and then drag out to click in the opposite corner to define the selected area.



Rectangle select

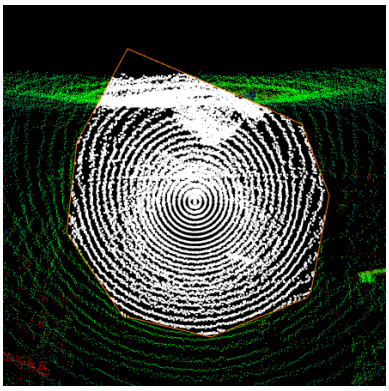
- **Polygon**: select points by clicking in the **3D View** to create a polygon.



Polygon select

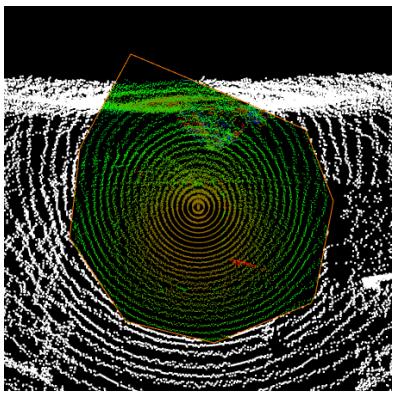
Define the selection of points.

- **Inside**: select the points inside the user-defined rectangle or polygon.



Inside select

- **Outside**: select the points outside the user-defined rectangle or polygon.



Outside select

Press ESC to cancel the selection.

Press **Enter** to complete the erase action. The selected points are deleted from the **3D View**.

Use the **Undo**/**Redo** buttons to retrieve or re-delete the points. The points are deleted from the **Carlson Scan** project when the project is closed and saved.

14.2 Mask

Click **Mask** to hide points within the **Carlson Scan** project. A mask is a temporary way to make points invisible to help analysis and editing. For example, you may mask the top and bottom of a scan so that you can see and edit stray points inside a void.

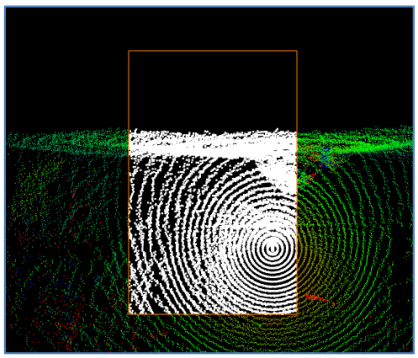
Click **Mask** to mask points from the project. The **Edit** menu bar changes to display additional tools.

Edit menu bar #2

14.2.1 Creating a mask

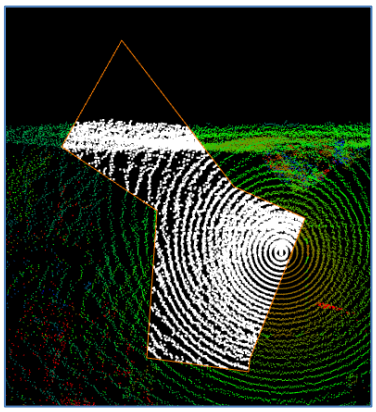
Define the manner in which points to erase are selected.

- **Rectangle**: select points by drawing a rectangle. Click in one corner of the rectangle and then drag out to click in the opposite corner to define the selected area.



Rectangle select

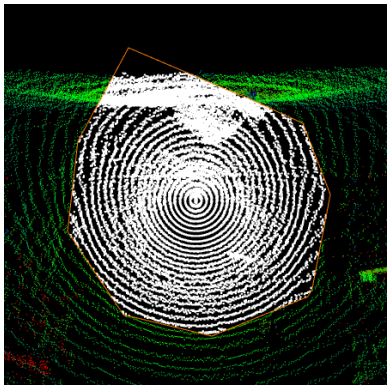
- **Polygon**: select points by clicking in the **3D View** to create a polygon.



Polygon select

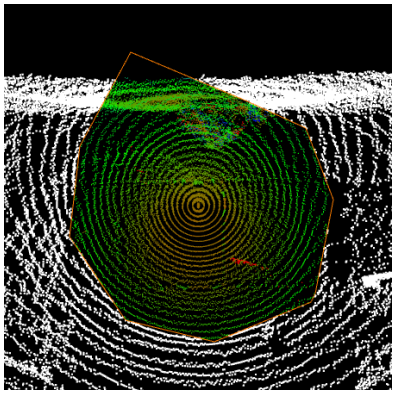
Define the selection of points.

- **Inside**: select the points inside the user-defined rectangle or polygon.



Inside select

- **Outside**: select the points outside the user-defined rectangle or polygon.



Outside select

Press ESC to cancel the selection.

Press **Enter** to accept the selection. A **Mask** is created. The **Edit** menu bar changes to display additional tools.

Edit menu bar #3

14.2.2 Working with a mask

The new mask is listed on the **Edit** menu bar as **Mask 1** button. This mask comprises selected points which can be analysed and edited in isolation from the rest of the data in the **Carlson Scan** project.

If required, create more masks to use in conjunction with each other. Each additional mask is added to the **Edit**

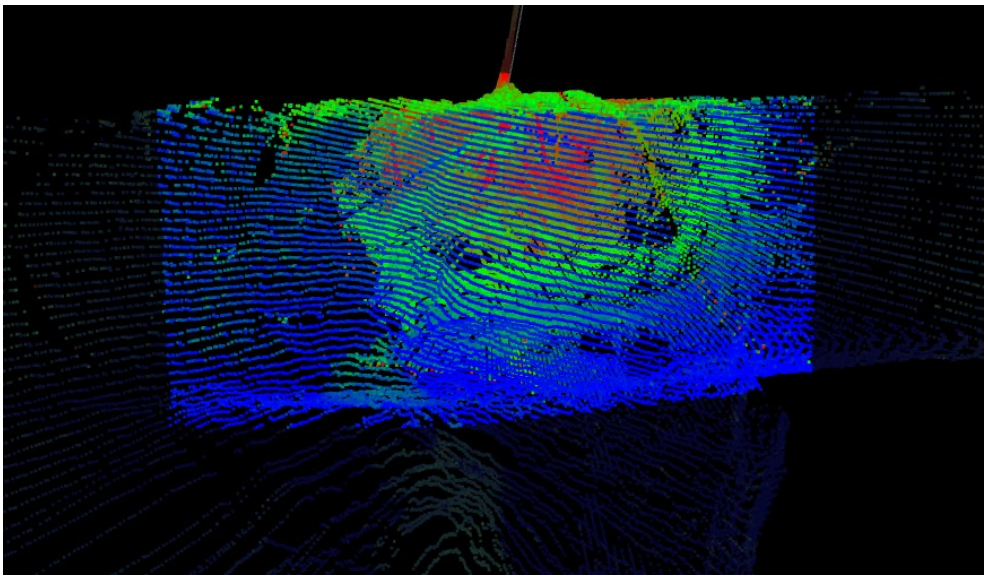
menu bar.

A mask can be active or inactive. Click **Mask 1** to toggle between active and inactive status.

The **Mask 1** button is highlighted when it is active.

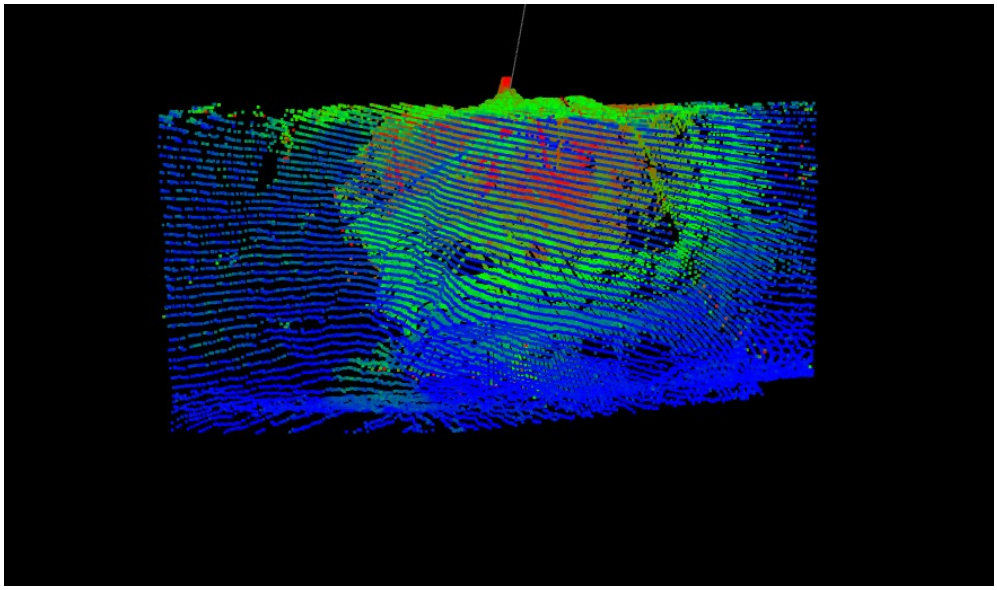
Any erase operations carried out while a mask is active only affects the points selected with the active mask.

Click **Highlight** to darken/lighten all unmasked points in the **3D View**.



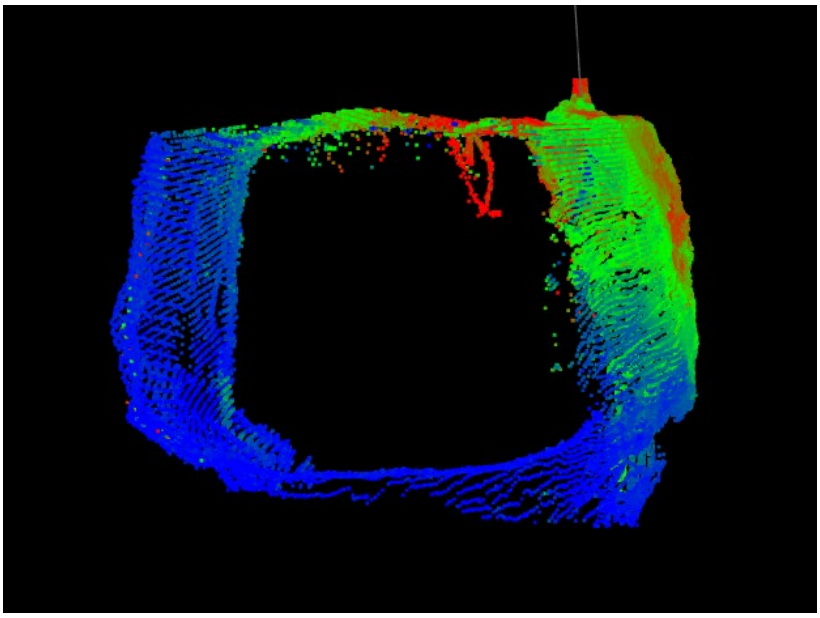
All unmasked points darkened

Click **Visible** to turn off/on all unmasked points in the 3D View.



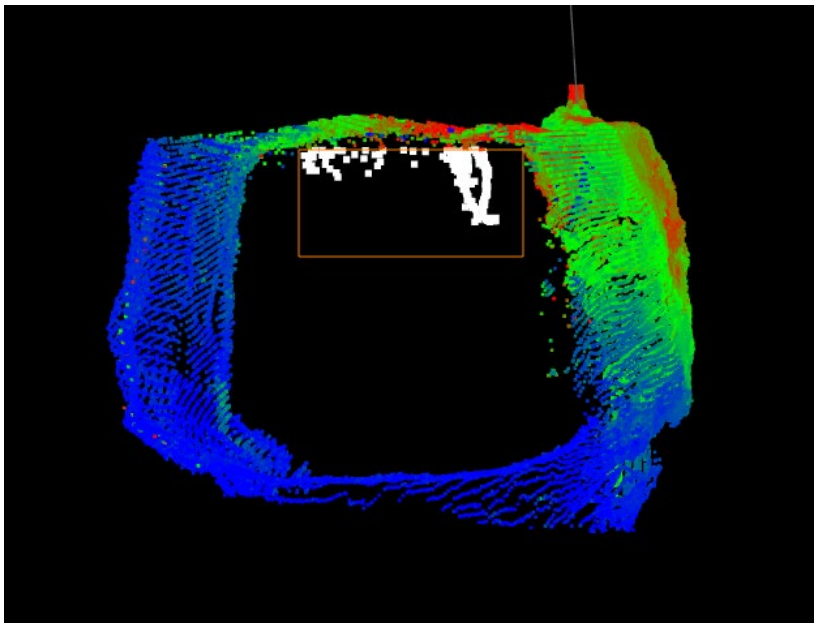
All unmasked points invisible

With a mask applied, analysis of the data can be clearer.



Viewing inside a masked dataset

Use erase tools or additional masks to carry out more advanced editing.



Erasing data inside a masked dataset

Click **Clear** to clear any masks from **Carlson Scan**. Masks are temporary viewing and editing aids so are cleared automatically when you exit a **Carlson Scan** project.

A TYPICAL C-ALS DEPLOYMENT

15 C-ALS deployment - introduction

The considerations and procedures for a typical C-ALS operation are outlined below. These include the limits of the system, project preparation, deployment and a basic software run-though.

This operations guide is focused on C-ALS units which incorporate an IMU: either a C-ALS Gyro or a C-ALS HD.

Depending on your specific site and project requirements, you may need to take a very different approach to your deployment. However, most of the information below is relevant to all operations, so please familiarise yourself with the basic best practices recommended by Carlson prior to using your system in the field and consider this to be a template for basic operations.

15.1 Gyro introduction

The C-ALS is fitted with an Inertial Measurement Unit (IMU) which incorporates a 3-axis MEMS-based gyro and a 3-axis accelerometer.

The IMU integrates information from both the gyro and the accelerometer and the output orientation is determined by fusing the outputs of both these sensors through a software-based Kalman filter model.

The advanced IMU solution ensures that the attitude and orientation of the C-ALS probe can always be tracked as it is deployed along a borehole, whether it is pointing up, down or horizontal.

A gyro provides more accuracy than a compass, as the gyro is not reliant on, or sensitive to, magnetic fields.

There are various properties of the gyro which affect the methodology we use when deploying a C-ALS system. Some notes about these properties are outlined below. You should make yourself familiar with this information and with the performance and operation of the gyro, prior to deploying the C-ALS system.

15.1.1 Gyro drift

The results from a gyro drift with time. If you lay a gyro flat and absolutely still, it will output a heading. If you leave the gyro in exactly the same position, the heading that it outputs will gradually change, even though the gyro is not changing position or rotating. This is ‘drift’ and it is effectively an error that will affect data output from the gyro.

In effect, from the moment the C-ALS is first aligned, the accuracy of the gyro is deteriorating due to an accumulating angular error. This means that the deployment operation should be as prompt and efficient as possible.

The results from a gyro also drift with temperature, with severe temperature changes causing greater drift in the gyro output.

However, processing in the C-ALS firmware and **Carlson Scan** software helps to mitigate these effects. Drift over a given time is kept to a minimum and checks on the drift throughout the deployment ensure that temperature changes are mostly accounted for.

However, there may be situations where you are deploying in extreme temperatures or in situations where the temperature of the C-ALS probe on power up is completely different to that of the ambient temperature in the deployment area. In this case, for optimum results, you may wish to leave the C-ALS switched on for a period of 10 to 20 minutes prior to a deployment to allow the internal temperature to stabilise.

We cannot predict severe temperature changes down the borehole, but the gyro is insulated within the probe to some extent. As long as the deployment is as speedy as possible, any effects are dampened.

In ideal circumstances, the drift of the gyro will be <1.0° per 30 minutes.

15.1.2 Drift alignment

If we leave a gyro absolutely still for a period of time, we can monitor the drift and then create a model of this error. Each time the system is turned on, a slightly different 'bias' effect is exhibited in the gyro where the drift is experienced strongly in certain directions. Modelling these biases helps to counteract the drift so that we obtain a much more stable heading value from the gyro during a deployment.

This process of modelling the biases is the 'drift alignment' which we carry out with the C-ALS prior to each deployment.

Note that although the alignment mitigates the worst effects of drift, it does not eradicate it entirely. There are some random, unpredictable elements of drift which we cannot account for.

After the C-ALS is switched on, the unit must undergo this drift alignment. The drift alignment is incorporated into the alignment process which is outlined below.

During the alignment the probe should be located within the operations area, ready for the deployment to commence. The probe should be laid out horizontally (roughly +/- 10° from horizontal) on a solid, stable surface. A alignment jig is supplied to provide an easy mounting point for the probe.

It is also possible to align the probe vertically and the alignment jig can be adapted for this purpose. In this case, the probe should be roughly +/-10° from vertical. However, horizontal alignments are usually preferable as, when set out horizontally, the alignment jig can be left in position for repeatable alignments at the same heading.

The alignment lasts approximately 5 seconds. During this period, the C-ALS probe must be absolutely motionless. Site the probe away from areas where knocks or excessive vibration may occur. Any movement creates 'noise' for the gyro and renders the alignment computations less effective. If vibration is detected, the alignment may automatically restart multiple times before tit is successfully completed.

If it is suspected that the device has moved during the alignment, or that the readings from the device seem to be unstable immediately after the alignment, then it is essential to re-align the device.

15.1.3 Reference azimuth

The gyro in the C-ALS does not output an azimuth with respect to true north. The gyro can measure the angle that it is rotated through as it is deployed or as it is moved around on the surface, but it cannot determine which direction it is pointing in when it is switched on.

For this reason, we must define the starting, 'reference' azimuth of the C-ALS at the beginning of an operation. Once we have determined this starting orientation, the gyro can then keep track of the changing heading as it is moved around and deployed.

For the purposes of a C-ALS survey, this reference azimuth is defined by surveying the orientation of the probe while it is in position for the alignment.

The alignment jig includes mounting points for survey prisms. Using traditional survey techniques, establish the orientation of the alignment jig in which the probe is sat, with respect to your site coordinate system.

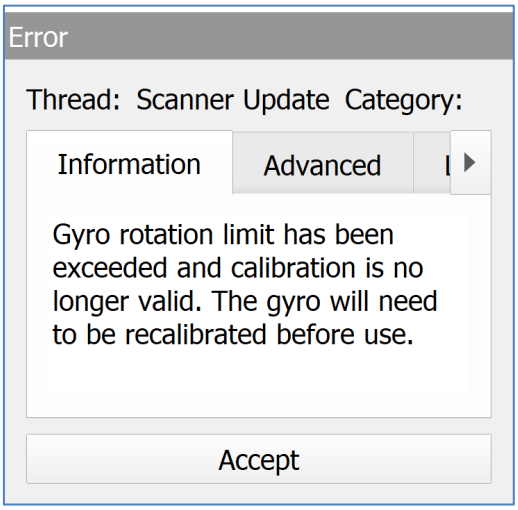
The surveyed, starting azimuth is entered into **Carlson Scan** software in the **Station Details** window (see section 16.11). This value can be entered before, during or after a C-ALS survey.

15.1.4 Gyro limits

The gyro is limited to measuring rates of rotation of up to 400°/sec in each axis. In practice this should not be a limiting factor providing no sudden rotational accelerations are encountered or constant rotations of greater than ~1.1Hz are not encountered. Deploy the C-ALS probe in such a manner that minimizes rotation speeds and ensure that no sudden 'jerks' in rotation occur.

If the gyro does rotate at >400°/sec in any axis, an out-of-range error will be displayed. In this case it is advised to

retrieve and re-align the C-ALS before starting the deployment again.



Gyro exceeded rotational speed limit

To avoid exceeding this rotational speed limit, once the C-ALS is aligned, handle the C-ALS probe carefully as it is being moved into the hole. During the deployment, lower the probe carefully and steadily. Using rods to deploy the C-ALS helps to ensure that the probe cannot twist at all. If you do deploy on the cable alone, try to ensure as little rotation as possible is introduced through twist in the cable.

15.1.5 Summary

Taking into account the points above, there are essentially six phases of a C-ALS operation:

- Preparation of all equipment on-site next to the deployment location.
- An ‘alignment’’ period of approximately 5 seconds where the C-ALS probe is mounted on the alignment jig. During this period, the gyro biases are modelled.
- Use traditional survey techniques to survey the reference azimuth: the heading of the probe while it is undergoing the alignment (this can be carried out at any stage of the operation).
- Deployment.
- Scan.
- Retrieval.

15.2 General C-ALS System limitations

As well as the limitations of the internal gyro, also consider the general C-ALS system limitations and take these points into account when preparing and carrying out all C-ALS operations.

The C-ALS is waterproof up to a depth of 1 m. It can move mechanically in waterlogged environments, but will not produce data in these circumstances.

The surface unit is not watertight when its lid is open. It is thus advisable that the lid should be closed once the unit has been switched on.

If the probe is being deployed through a borehole, it is recommended that the hole should be lined to reduce wear and tear on the unit and to reduce any flow of water over the unit.

The laser ranges up to a limit of 150 m. However, the maximum achievable range at any given time or location will depend on a number of factors. The following factors will limit the range to some degree and in some circumstances may prevent any readings from being taken:

- Dark, light-absorbent surfaces such as coal.
- Very dusty environments.
- Wet, slick, shiny or very smooth surfaces.
- An acute angle between the laser and the surface.

The minimum range of the laser is around 0.5 m. At shorter distances, readings may still be recorded, but their precision will be severely diminished.

If the C-ALS is deployed down a borehole, then the scan head and the rotating horizontal shaft must be free of the hole to allow unrestricted motion. However, the probe must not be deployed so far that its full length flops out of the borehole. If this occurs, it may be impossible to retrieve the unit.

Always monitor the borehole camera during the entire deployment. This is to gauge exactly the distance from the collar to the ‘breakout’ point, as well as to check the condition of the borehole. Failure to monitor the camera image may result in the C-ALS being damaged or lost in the borehole. In some cases, a separate borehole camera may be deployed first before the C-ALS is used, to check whether the conditions in the hole are suitable for the C-ALS.

16 C-ALS deployment - preparation

16.1 General considerations

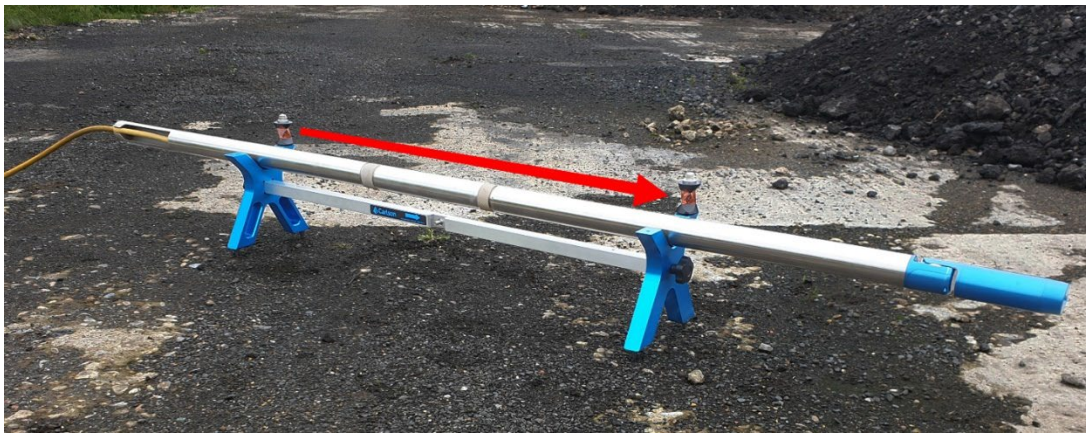
When using the C-ALS system, allow adequate time before the survey to plan out the logistics of the project and to prepare the equipment for the deployment.

Prior to deployment of the C-ALS, check the area in which the deployment will take place. Consider:

- What is the level of accessibility at the site for personnel and vehicles?
- Is there space to unspool and lay out the main C-ALS cable if required?
- Are there secure points for strapping a winch or tripod in position, if required?
- Is there any potential for interference from passing traffic that may disturb the equipment mid-scan?
- Is there a suitable location for setting up a base for the tablet?
- Which power supply will you use: supplied battery, other 12 V battery, or ac power?
- Will the power source last for the intended operations?
- Are there any requirements for backup power for the tablet? For example, a spare battery or an invertor.
- What is the size of void: can this be scanned from one location? Are all areas of interest visible and in range from the proposed instrument location?
- What are the atmospheric conditions? Thick dust clouds, mist or high humidity, very bright lights pointing straight at the proposed laser location: these can all affect the data quality.
- Is there a convenient way of stabilising and securing the C-ALS system when it is scanning?
- Where will any winches and tripods being used to assist the deployment be positioned?

16.2 Alignment jig

In addition to these standard considerations, when using a C-ALS you must determine an appropriate location for the alignment to be carried out. This is either a location for the horizontal jig to be set out, or a location (most likely the top of the borehole) for the probe to be suspended on the jig vertically.



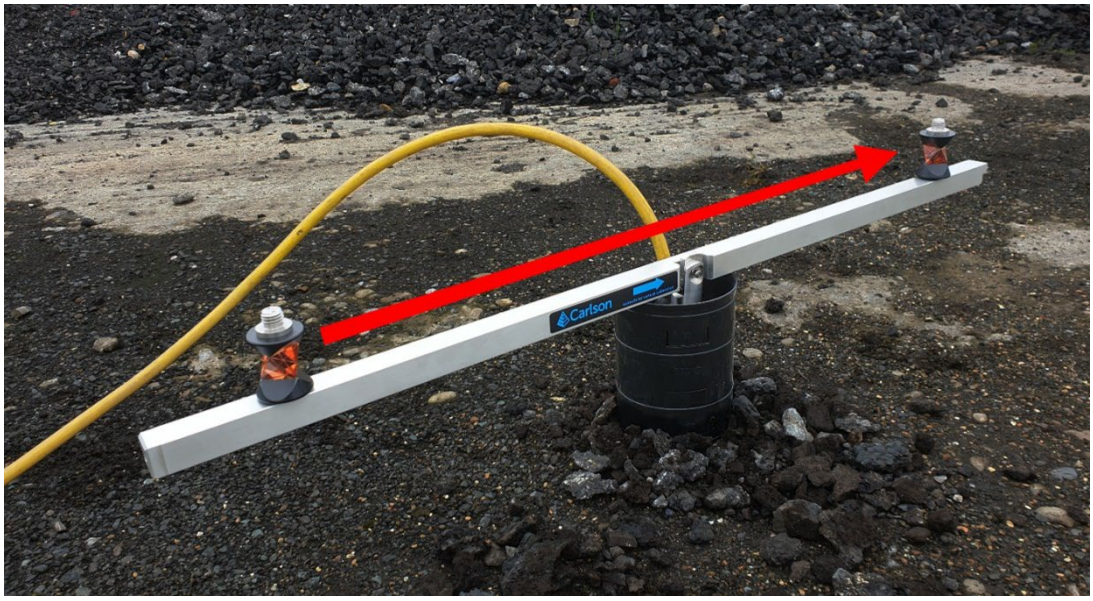
C-ALS mounted horizontally on a gyro jig

The location must be close enough to the project site so that the C-ALS can be promptly deployed when the alignment is complete. Take care that the cable run is not going to obstruct an access route or cause a trip hazard.

The location should be solid and not subject to movement or vibrations.

The survey to establish the reference azimuth can take place at any time. If convenient, you can set out the alignment jig well before the C-ALS deployment takes place, or leave it set up after the deployment is completed. As long as the alignment jig is not moved, the surveyor can then use the total station to establish the reference azimuth when the C-ALS survey is not in progress.

However, if the alignment jig is being used for a vertical alignment at the top of the borehole, the reference azimuth must be established at the time of the C-ALS alignment, as the alignment jig must be moved as soon as the deployment commences.



C-ALS mounted vertically on a gyro jig

16.3 Deployment method preparation

For quick, short deployments, it is possible to deploy the C-ALS directly into a borehole on a cable alone.

However, for longer deployments, a winch and tripod will be required to take the weight of the C-ALS probe and cable.

Boretrak rods are required if the borehole is horizontal or uphole. In this case the probe must be pushed with the rods. There may also be some downhole deployments where it is still advisable to use Boretrak rods to help to stabilize the probe during deployment and during the scanning process.

Using rods with a C-ALS system ensures that the probe cannot exceed the 400°/sec maximum rotation rate during a deployment.

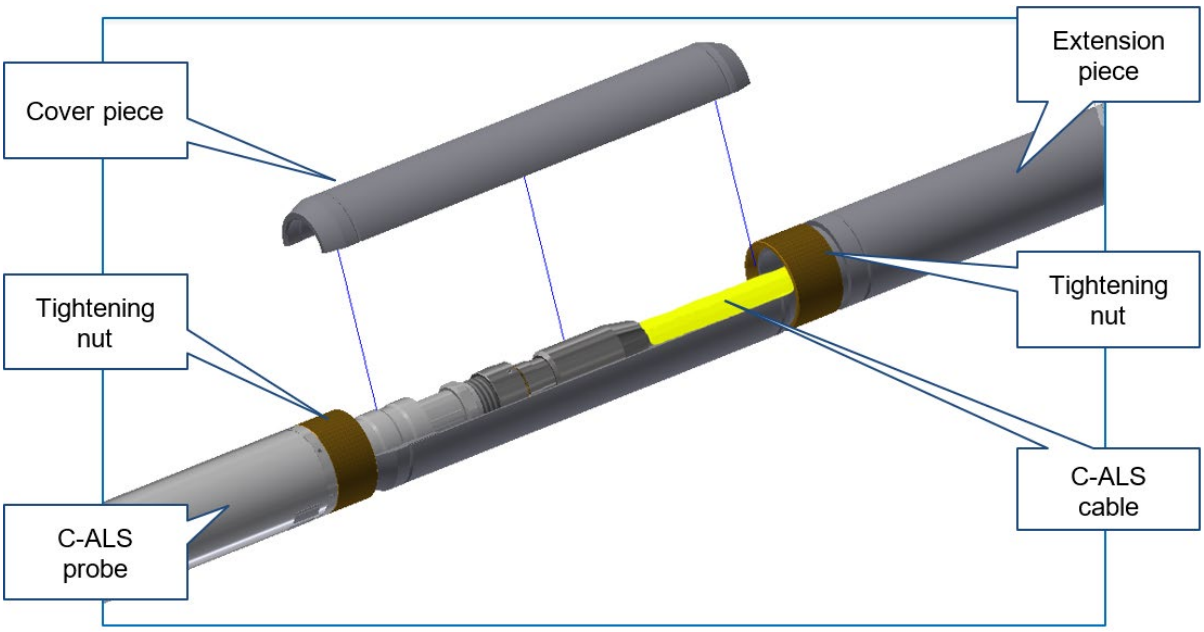
If using a winch and tripod it may be necessary to use straps to secure the system to anchor points in order to prevent the equipment over-balancing.

17 C-ALS deployment – in the field

17.1 Setting up the equipment

If a slip ring cable drum is NOT being used, unspool the length of cable that is required for the deployment. Lay out the cable neatly in such a way that it can be fed into the borehole without tangling or disrupting the deployment.

Thread the strained connector through the extension piece and screw firmly onto the C-ALS probe. Connect the extension piece to the C-ALS probe by mating the alignment pins and screwing the brass tightening screws around the cover piece.



Connecting the C-ALS probe to the extension piece

Connect the other end of the main cable to the surface unit.

If a slip ring drum is used, connect the short 5m extension cable to the side of the drum, then connect the other end to the surface unit.

Connect the surface unit to the selected power supply. Power the surface unit on. As soon as the surface unit is powered up, the probe initialises by rotating the scan head to register the encoders' zero index marks. Therefore, be sure that the horizontal and vertical axes of the probe are free to rotate for this start-up procedure.

17.2 Warm-up period

For most operations, you may skip this stage. However, there may be situations where you are deploying in extreme temperatures or in situations where the temperature of the C-ALS probe on power up is completely different to that of the ambient temperature in the deployment area. For example, if the C-ALS has been inside in a heated environment and the deployment is in freezing conditions, or if the C-ALS has been kept in an air-conditioned environment and the probe is cold to the touch, but the deployment is in extreme heat. In these cases case, for optimum results, you may wish to leave the C-ALS switched on for a period of 10 to 20 minutes prior to a deployment to allow the internal temperature to stabilise.

In this case, when setting up the equipment, try to get to the stage where the probe is powered on as soon as possible. This ensures that the warm-up period is started promptly while some of the other equipment setup is still continuing. This makes the most efficient use of your time in the field.

Do not switch the C-ALS system off between starting the warm-up period and starting the deployment. When the C-ALS is first switched on, and when it is located in position to carry out the alignment, the C-ALS should be in a state that is ready to deploy without powering down.

Note that during the warm-up period the C-ALS probe must switched on, but it does not have to be located ready to align, nor does it need to be held stable. However, it is probably most convenient and efficient if, while warming up, the probe is in position ready for the alignment.

The tablet does not have to be connected to the C-ALS system during this warm-up period.

17.3 Setting up Carlson Scan

Connect the surface unit to your tablet using the Ethernet cable, or via a Wi-Fi connection.

Open **Carlson Scan** and begin a new project.

From the **Tablet** mode **Home** screen, tap **Start**.

The **Project** window opens. Edit the details as required. If required, enter hole collar positions in advance.

Tap **Create** to accept the entered details and create a new project.

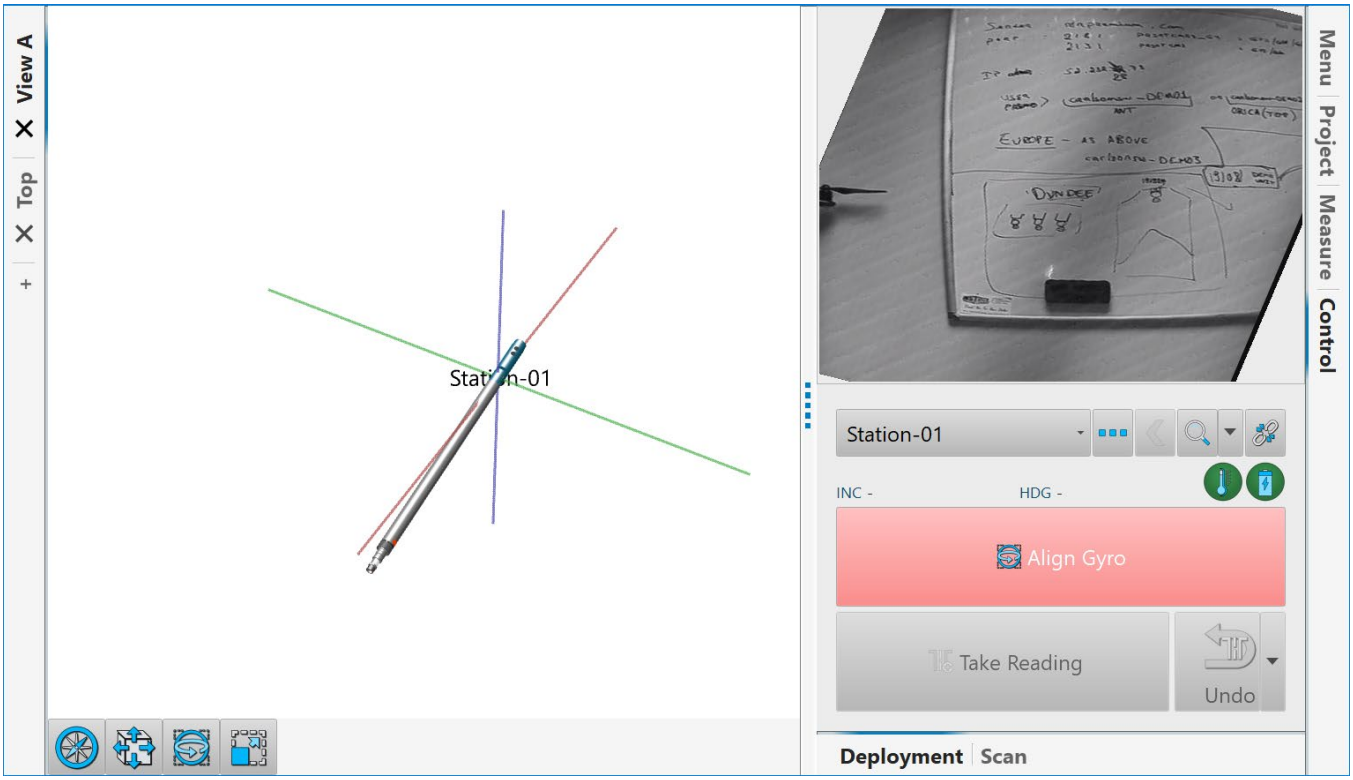
Carlson Scan immediately runs an auto-detect process to identify the C-ALS.

When a scanner is identified, the connection is made.

The **Station Details** window appears (see section 7.2.1). Enter your station coordinates, or just accept the default values. Tap **Finish**.

With all checks complete, a graphic of the C-ALS appears in the **3D View**.

The **Control** tab is active, displaying C-ALS-specific controls. The video window displays a video feed from the borehole camera.



Connected to a C-ALS

The **Align Gyro** button is red. The gyro requires alignment before you can proceed.

Gyro - unaligned

17.4 Alignment

During the alignment, the C-ALS probe must be absolutely stable: free from any vibrations, shocks and movement. If any movement is detected, the alignment will fail.

The heading in which the probe is positioned during the alignment is used to define the starting orientation of the C-ALS deployment. Whichever way the probe is positioned, the heading of the probe should be established by surveying the alignment jig. All gyro readings thereafter will be related back to this aligned heading.

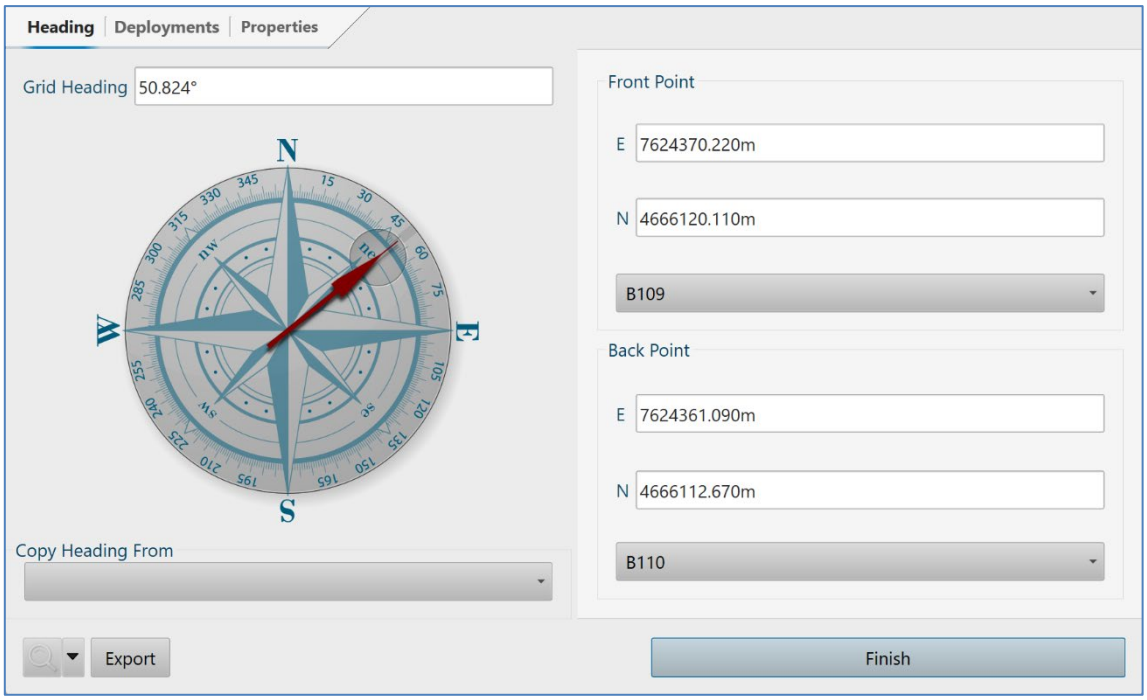
If you are aligning the C-ALS probe horizontally, survey the heading of the probe from the end of the extension piece to the laser head. If appropriate, the jig can be left in place for the duration of an operation and, once the heading has been surveyed, and as long as the jig is not moved, the same heading value can be used for multiple deployments. The heading of the jig can be established – and entered into **Carlson Scan** – before, during or after the alignment and C-ALS deployment.

For vertical alignments, the jig's horizontal crossbar provides the reference heading for the survey. A sticker on the crossbar illustrates the direction to survey.

When the probe is in position, tap the **Align Gyro** button to carry out the gyro alignment.

A message appears: "Are you sure you want to align the Gyro?" Tap **Yes**.

The **Alignment** window appears.



Alignment window

Enter the heading of the alignment jig, if known at this stage.

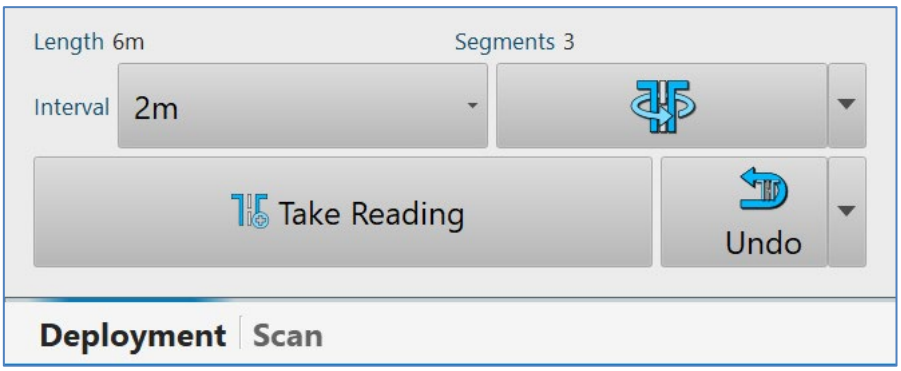
The gyro button progresses through its various states: **Aligning Gyro, Verifying Alignment,** and then **Aligned**

Gyro – aligned

The deployment can now proceed.

17.5 Deployment (manual)

Assuming that a cable counter is not being used, from the deployment controls, select your required **Interval**, usually 2m.



C-ALS deployment controls

At the start of the deployment, transfer the C-ALS into the borehole. The whole probe should be deployed, plus the extension piece up to the rod connector at the end of the extension piece. It is exactly 2 m from the centre of the rod connector back to the reference point at the centre of the vertical pivot.

Sufficient time should be left before each Boretrak reading, and before a scan is started, to allow the probe and its internal sensors to stabilise.

Tap the **Take Reading** button to record the first Boretrak reading.

The **Length** and **Segments** text increase accordingly after each reading.

Each stage of the deployment is displayed graphically in the **3D View**.

At each interval, steady the probe, take a reading and, as soon as the information on-screen has updated, continue the deployment.

The deployment interval can be changed at any time.

Monitor the video window at all times during the deployment. To make the video image clearer, use the **Resize** button to swap the **3D View** with the video window.

You must note the point at which the nose of the probe leaves the borehole and enters the void. Take great care from this point onwards not to push the C-ALS so far into the void that the whole length flops out of the borehole and becomes impossible to retrieve. However, the C-ALS must be far enough out of the borehole that the vertical and horizontal pivots are free to move mechanically, and that the laser head has enough room to turn through its full range of motion.

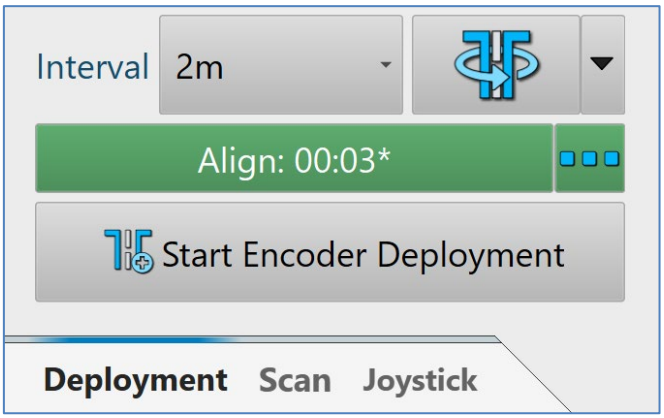
When the probe reaches the final scanning position it is likely that, for the last Boretrak reading, the probe cannot be deployed by exactly the distance previously specified. For example, although a 2 m interval may have been in use, the final deployment may need to be just 0.5 m to achieve the best position for the probe to take the scan, or to avoid the probe dropping out of the end of the borehole. Thus, before the final Boretrak reading is taken, change the **Interval** to **Custom** and then enter the actual deployment distance before taking the reading.

If the exit from the borehole into the void is not clear-cut, it is often advisable to run a **Circle scan** to check whether the probe has completely broken clear of the borehole. The circle scan does not involve any vertical movement of the laser head, so if the probe is still within the borehole, there is no risk of it being caught against a rockface. However, the observed ring of points will allow you to determine whether the C-ALS probe is clear to carry out a full scan.

17.6 Deployment (cable counter)

When a cable counter is connected to the C-ALS surface unit, the status LED shows solid orange.

When the alignment is complete, the **Start encoder deployment** button appears.



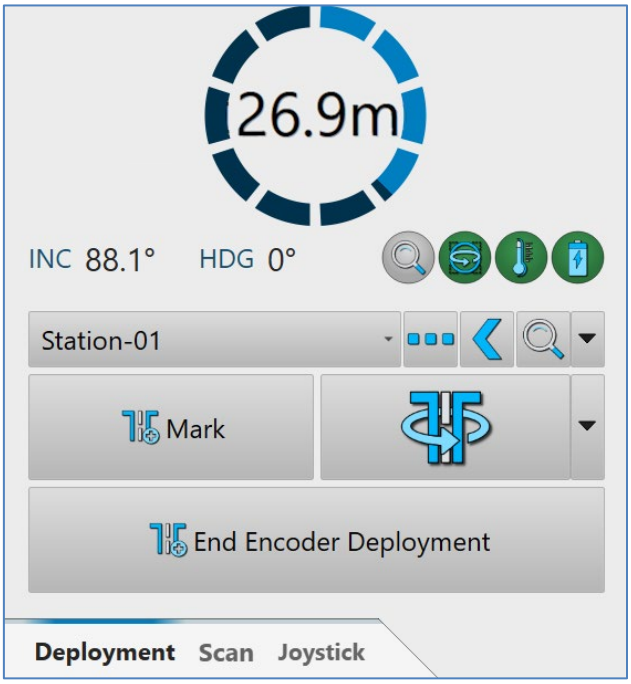
C-ALS deployment controls - using a cable counter

Lower the C-ALS probe and extension piece into the hole so that rod adaptor is level with the hole collar.

Tap the **Start encoder button** to commence the deployment. The Status LED on the cable counter turn solid green.

Lower the C-ALS using the manual handle of the slip ring drum with winch. Make sure the gear is set to 4:1.

As the probe is lowered, the cable counter keeps track of the deployed distance. This deployed distance is displayed in the **Scanner** tab. As the cable counter rotates, the progress circle around the deployed depth also rotates.



C-ALS deployment controls using a cable counter - deployment started

No regular stops are required during the deployment as all depth and IMU data are collected automatically.

Monitor the video window at all times during the deployment. To make the video image clearer, use the **Resize**

button to swap the **3D View** with the video window.

Tap **Mark** to record the point at which the nose of the C-ALS probe enters the void (as seen in the camera image). A secondary distance measurement appears above the deployed depth display. This displays the distance deployed since the **Mark** button was tapped.

The deployed distance showing a secondary distance since a Mark was registered

Consider that the C-ALS probe plus extension piece is 2 m long. It is vital to always retain a section of this length within the borehole, to stabilise the probe and to make sure it does not entirely enter the void. Use the secondary distance to help gauge the extra length deployed into the void.

If the exit from the borehole into the void is not clear-cut, it is often advisable to run a **Circle scan** to check whether the probe has completely broken clear of the borehole. The circle scan does not involve any vertical movement of the laser head, so if the probe is still within the borehole, there is no risk of it being caught against a rockface. However, the observed ring of points will allow you to determine whether the C-ALS probe is clear to carry out a full scan.

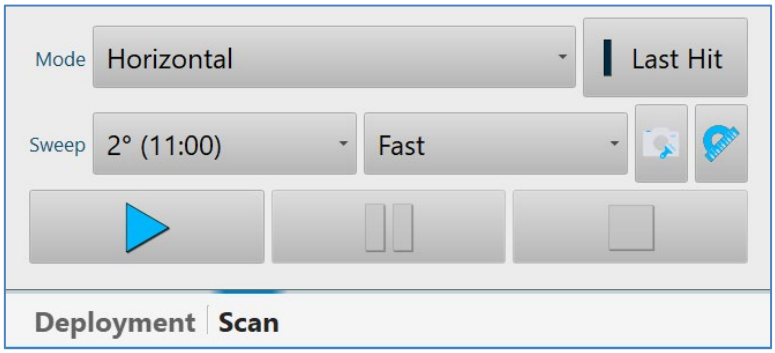
17.7 Final position

If the system is going to be tied and secured into place for a long scan, it is advisable to do this prior to taking the last reading. Failure to do this could lead to the probe moving before the scan commences, resulting in incorrectly positioned data.

The data recorded at the final Boretrak reading informs **Carlson Scan** of the attitude of the probe when the scan starts. It is assumed the probe will not move during the scan, therefore the unit must not be moved after the last Boretrak reading until the end of the scan.

Switch to the **Scan** controls. The deployment controls are replaced by scan controls.

Setup a scan using the C-ALS scan configuration tools.



Scan controls

Set the **Active Scan** pattern and the **Sweep**.

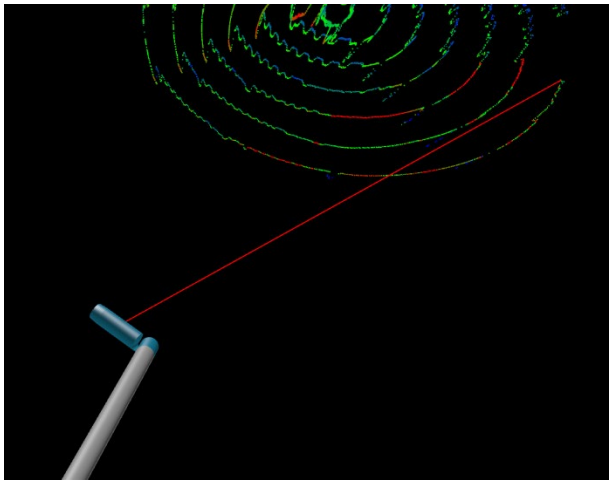
Tap **Scan** to begin the scan.

Scan, Pause and Stop buttons

17.8 During a scan

Once a scan has been started, no further user intervention is required. The C-ALS progresses through the scan according to the configuration selected.

All points collected are displayed in real time in the **3D View**. Retract the active function tab to switch the **3D View** to full screen



C-ALS in the 3D View during a scan

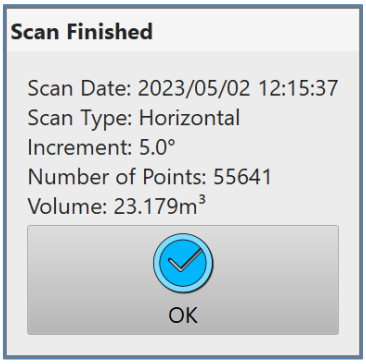
A live progress dial shows the scan progress.

Progress dial during a scan

17.9 After the scan

When a scan has completed, or been cancelled, the C-ALS laser head parks in its original position.

A summary of the scan appears in a message box.



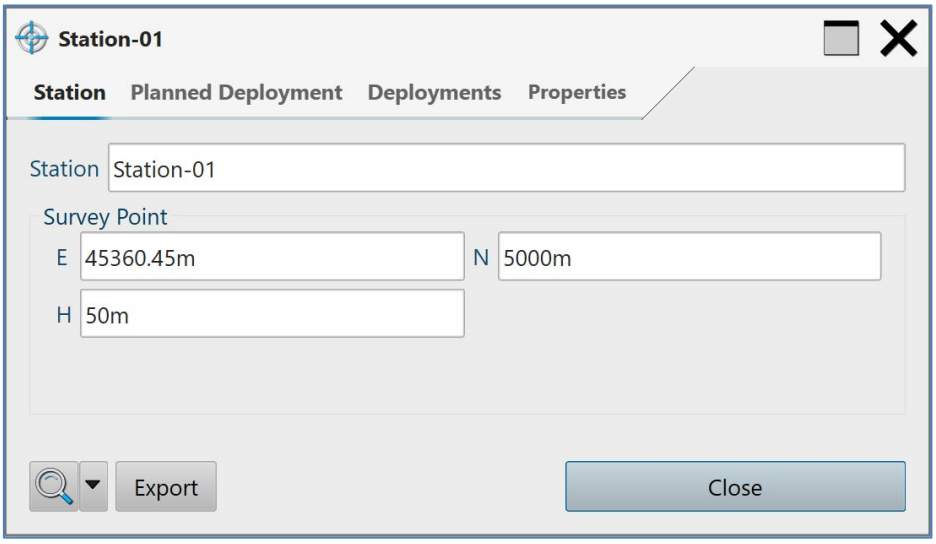
Scan summary

You can conduct further scans from the same station if the C-ALS has not physically moved.

To ensure the scan is correctly geo-referenced, tap the **Station Details** button.

Active station controls

The **Station Details** window opens.



Station window - C-ALS operations

Enter the surveyed **Collar location**: the position from where the deployment was started.

Tap **Accept**.

In the **Menu** tab, tap **Save**.

Tap **Exit** to close **Carlson Scan**.

A TYPICAL VS+ DEPLOYMENT

18 VS+ deployment – introduction

The considerations and procedures for a typical boom-mounted VS+ operation to scan a stope are outlined below. These include the limits of the system, project preparation, deployment and a basic software run-though.

Depending on your specific site and project requirements, you may need to take a very different approach to your deployment. However, most of the information below is relevant to all VS+ operations, so please familiarise yourself with the basic best practices recommended by Carlson prior to using your system in the field and consider this to be a template for basic operations.

18.1 System limitations

Note the limitations of the VS+ below and take these points into consideration when preparing and carrying out operations with the system.

The VS+ is water-resistant (IP65) but should not be submerged.

Sensors are incorporated into the VS+ to monitor the position of the instrument during its deployment and to correct the data when the unit is inclined during a scan. The unit can produce scan data while positioned at any angle. However, readings should not be taken if the probe itself is moving, swinging or unstable in any way. If the probe does move during a scan, no account of this is taken in the collected data. A warning message will appear once the scan is complete, noting that the VS+ has moved. You should then make a judgement as to whether the scan needs to be restarted.

The internal sensors measure the inclination and roll of the VS+. When the instrument is within 1° of being vertical, the roll value becomes impossible to calculate due to the sensor's position in relation to gravity. In this case, the roll value will be forced to 0°. Scans will still be accurately levelled, but the orientation of the scan will be difficult to measure correctly. For this reason, we recommend that, where possible, the instrument should be used at inclinations of greater than 1°.

The laser ranges up to a limit of 150 m to 90% reflective material. However, the maximum achievable range at any given time or location will depend on a number of factors. The following factors will limit the range to some degree and in some circumstances may prevent any readings from being taken:

- Dark, light-absorbent surfaces such as coal
- Very dusty environments
- Wet, slick, shiny or very smooth surfaces
- An acute angle between the laser and the surface

The minimum, calibrated range of the laser is 0.5 m. At shorter distances, readings may still be recorded, but their precision will be severely diminished.

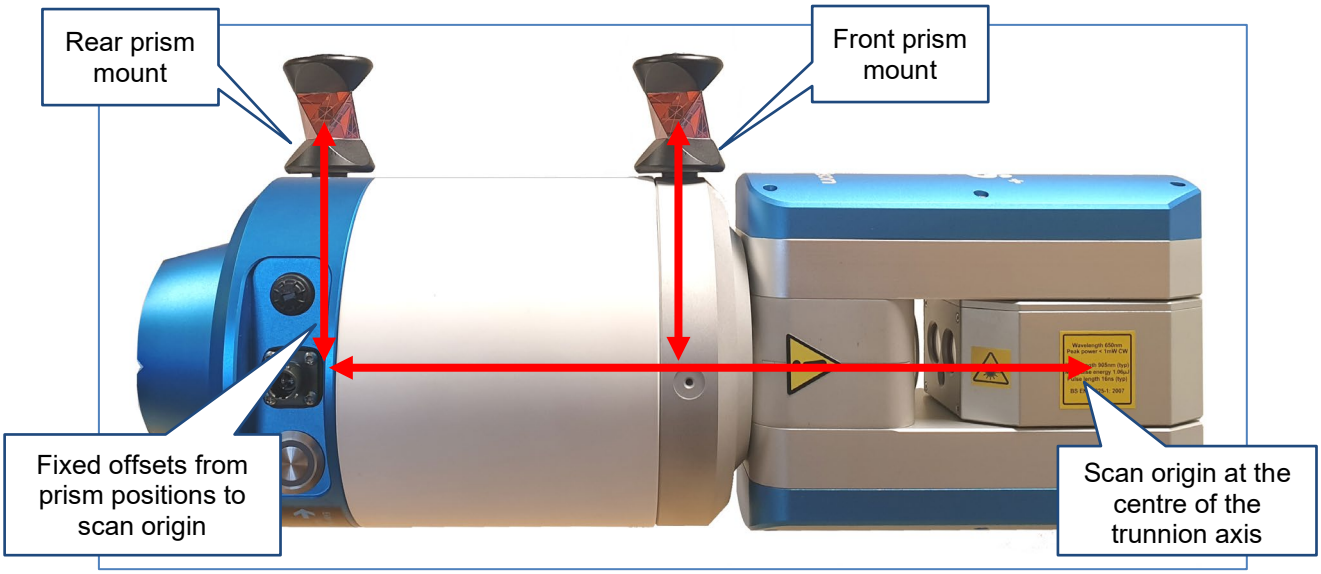
18.2 Geo-referencing VS+ data

A number of values are required to ensure that all data collected with a VS+ can be fully geo-referenced into the local site coordinate system.

The 'scan origin' in the VS+, to which all measurements are made and referenced, is a point inside the unit in the centre of the trunnion axis. This point needs to be computed by **Carlson Scan** to establish the true position on the VS+.

The VS+ incorporates two threads for mounting a prism at fixed locations on the instrument. With a prism screwed onto either one of these mounting points, use traditional survey techniques to establish the position of the prism

within your local site coordinate system. The offsets from both prism locations to the scan origin are hard-coded into **Carlson Scan**.



Prism mounting locations

Another prism is required to take another survey observation to the back of the boom on which the VS+ is mounted. The heading from this second prism to the prism on the VS+ gives the reference azimuth for the VS+ survey.

The last required values are gathered automatically by the accelerometers mounted in the VS+. These accelerometers establish the probe's inclination and roll when it is deployed and ready to scan.

With the all these values determined, the position of each of the observed points in the scan can be calculated from the individual range and bearing measurements. As long as all coordinates that are used are on the same datum, multiple scans from different stations can be combined together in **Carlson Scan** or exported into third-party software.

In **Carlson Scan**, a VS+ **Station** incorporates all these values and displays the scan origin (see section 7.2.3). The prism mounting point, prism coordinates and reference azimuth can all be edited post-survey. However, the inclination and roll are fixed as soon as the first scan from a given station is started. Therefore, once the VS+ has shifted position, a new **Station** should be created, and subsequent scans run from this new location.

19 VS+ deployment - preparation

Prior to deployment of the VS+, check the area in which the deployment will take place. Consider:

- What is the level of accessibility at the site for personnel and vehicles?
- Is there space to unfold the boom and lay out any cables and accessories?
- Is there any potential for interference from passing traffic that may disturb the equipment mid-scan?
- Is there a suitable location for setting up a base for the tablet?
- Which power supply will you use: will you require an external battery to supplement the internal battery?
- Will the power source last for the intended operations?
- Are there any requirements for backup power for the tablet? For example, a spare battery or an invertor.
- What is the size of void: can this be scanned from one location? Are all areas of interest visible and in range from the proposed instrument location?
- What are the atmospheric conditions? Thick dust clouds, mist or high humidity, very bright lights pointing straight at the proposed laser location: these can all affect the data quality.
- Is there a convenient point to act as a rest for the boom?
- Is there a convenient way of stabilising and securing the boom?

20 VS+ deployment – in the field

20.1 Setting up the equipment

Assemble the boom.

Attach the VS+ securely to the boom. Attach the prism to a prism mount location on the VS+.

Connect the main cable to the VS+. Where appropriate, secure the cable to the side of the boom.

Deploy the boom into the void, ensuring that the instrument's sight lines within the void are optimised and that the instrument is as far clear of the sidewalls as possible. Unspool the cable along the boom.

Attach a second prism to the back end of the boom. The azimuth that defines the orientation of the survey is that from the prism on the boom to the prism on the instrument.

Note that the prism on the boom should be aligned with the prism on the probe. As far as possible, ensure the probe is upright so that the attached prism is pointing directly upwards. The prism on the end of the boom should then also be directly on top of the boom. Any misalignment between the prisms will cause the calculation of azimuth to be incorrect.

Use a total station to shoot in both prisms within the mine's co-ordinate system. Note that to make the most efficient use of your time in the field, this stage can be completed while the VS+ scan is in progress.

Turn on the VS+. Establish a connection between the VS+ and the tablet.

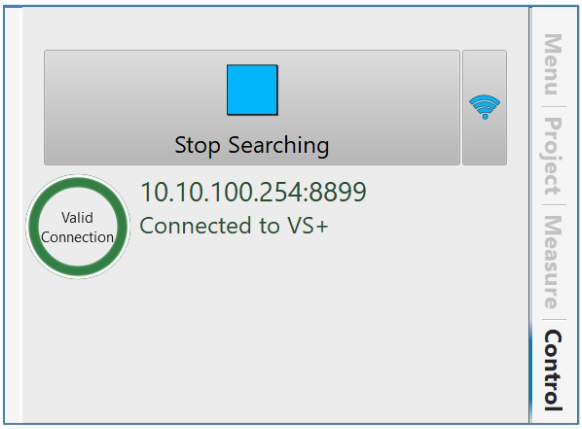
When powered up, the VS+'s horizontal and vertical motors will turn, and the laser head will park in its home position.

Start **Carlson Scan** software.

20.2 Setting up Carlson Scan

From the **Tablet** mode **Home** screen, tap **Quickstart**.

Carlson Scan searches through all available COM ports and IP connections for scanners connected to the tablet.



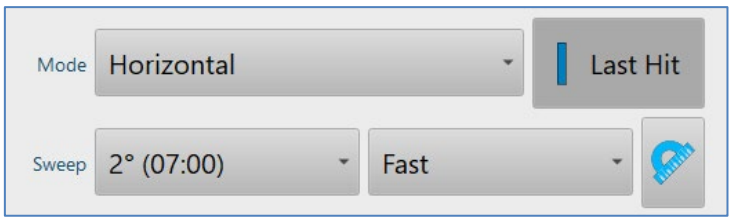
Connecting to a scanner

On detection of a scanner, **Carlson Scan** runs through checks to establish that comms with the scanner are sound.

With all checks complete, a graphic of the VS+ appears in the **3D View**.

The **Control** tab is active, displaying VS+-specific controls.

Setup a scan using the VS+ scan configuration tools.



Scan configuration tools

Set the **Active Scan** pattern and the **Increment**.

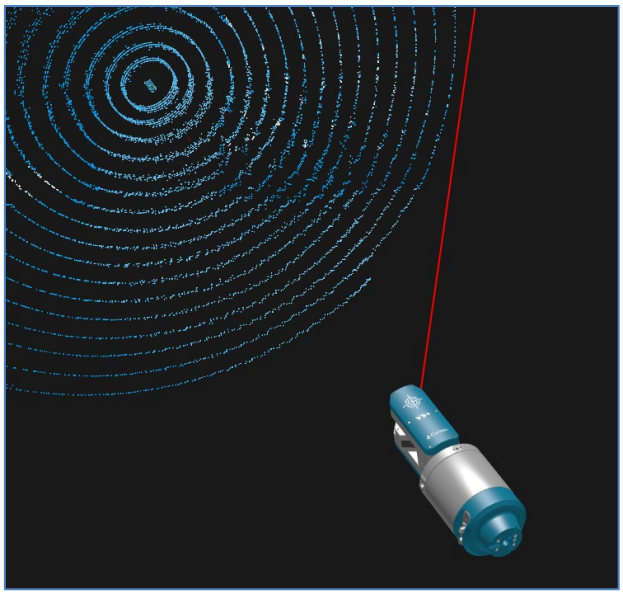
Tap **Scan** to begin the scan.

Scan controls

20.3 During a scan

Once a scan has been started, no further user intervention is required. The VS+ progresses through the scan according to the configuration selected.

All points collected are displayed in real time in the **3D View**. Retract the active function tab to switch the **3D View** to full screen.



VS+ in the 3D View during a scan

A live progress dial shows the scan progress.

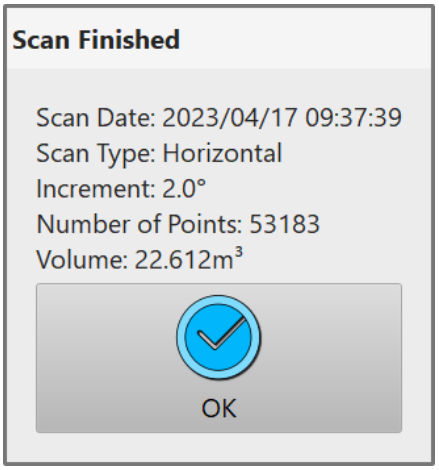
Progress dial during a scan

Open the **Scan** tab to modify the view of the active scan and the real-time mesh.

20.4 After the scan

When a scan has completed, or been cancelled, the VS+ laser head parks in its original position.

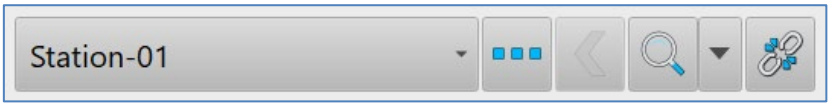
A summary of the scan appears in a message box.



Scan summary

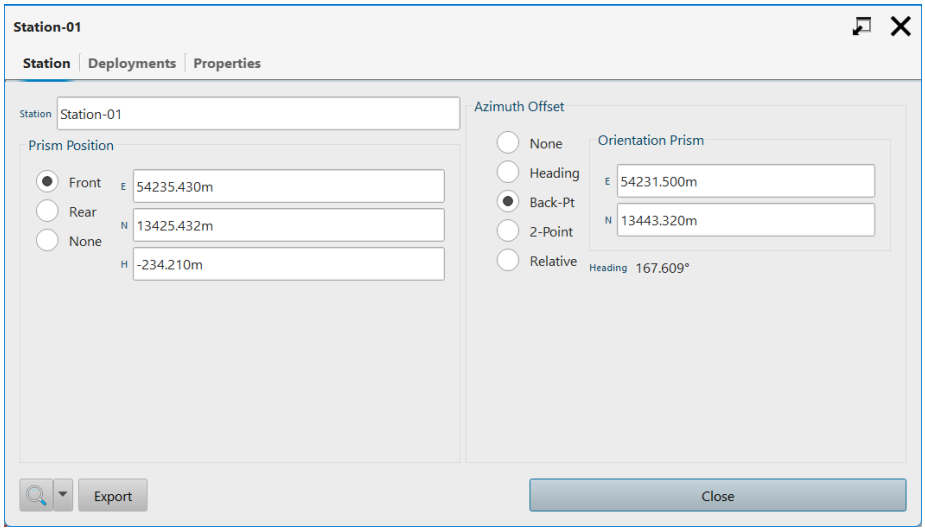
You can conduct further scans from the same station if the VS+ has not physically moved. However, you must create a new station whenever the VS+ has been moved, as only one set of inclination and roll values apply to any given station.

To ensure the scan is correctly geo-referenced, tap the **Station Details** button.



Station controls

The **Station Details** window opens.



Station window – VS+ operations

Select the **Prism position** as **Front** or **Rear,** which is the position on the VS+ where the prism was mounted.

Enter the **Prism position** coordinates which were surveyed with the total station.

Enter the **Azimuth Offset** which is the surveyed heading of the boom.

Tap **Accept**.

In the **Menu** tab, tap **Save**.

Tap **Exit** to close **Carlson Scan**.

TROUBLESHOOTING

21 Troubleshooting guides

Some of the most common support questions relating to equipment deployments and to **Carlson Scan** software are outlined below. These are divided into sections concentrating on VS+ operations, C-ALS operations, point clouds and **Carlson Scan** software operations.

If you experience any problems with your hardware, software or with the results of field operations, check the list to find the cause and action, and also a reference to the relevant section in this manual.

It is strongly advised that, should any fault occur which is not listed, or if the recommended action does not rectify the fault, you should contact Carlson.

22 VS+ deployments

Instrument does not power up when connected to power		
Cause	**Remedy**	**Reference in manual**
Cables not connected.	Cables not connected Ensure all connections are in good condition and plugged in.	See VS+ hardware manual.
Battery not charged.	Ensure the battery is charged prior to scanning operations.	See VS+ hardware manual.

Scan incorrectly tilted		
Cause	**Remedy**	**Reference in manual**
Pitch-and-roll sensors out of calibration.	Check the unit by scanning a flat, square room. Check the floor is level. If not, contact Carlson to arrange recalibration.	1.1 Dear customer.
VS+ moved during a scan or between two scans taken from the same station in Carlson Scan.	Start a new station and rescan. Ensure VS+ is stable throughout the scan.	10.7 During a scan.
Using an unsupported instrument.	Carlson Scan supports VS+ units, but not Void Scanner units from Renishaw or MDL.	3.1 Equipment compatibility.

Scan incorrectly orientated		
Cause	**Remedy**	**Reference in manual**
Azimuth calculated incorrectly.	Measure the azimuth from a target on the rear of the boom towards the target on the VS+. Keep the instrument as up-right as possible, with the prism on top.	17.2 Geo-referencing VS+ data. 7.2.3 Station Setup tab - VS+.
Boom moved between scan and azimuth observations.	The boom and the VS+ must be stationary while the scan is taking place and observations are made to prisms.	17.2 Geo-referencing VS+ data. 7.2.3 Station Setup tab - VS+.

23 C-ALS deployments

Instrument does not power up when connected to power		
Cause	**Remedy**	**Reference in manual**
Cables not connected.	Cables not connected Ensure all connections are in good condition and plugged in.	See C-ALS hardware manual.
Battery not charged.	Ensure the battery is charged prior to scanning operations.	See C-ALS hardware manual.
Main cable or power cables damaged.	Check all pins, connectors and cables for signs of damage.	See C-ALS hardware manual.

Cannot connect your tablet to the surface unit		
Cause	**Remedy**	**Reference in manual**
Ethernet cable not connected.	Ensure all connections are in good condition and plugged in.	See C-ALS hardware manual.
Tablet Wi-Fi not switched on.	Use standard Windows controls to activate your tablet's Wi-Fi function.	
Not connected to surface unit Wi-Fi.	Use standard Windows controls to ensure that the tablet's Wi-Fi is connected to the correct network. Alternatively use Carlson Scan Wi-Fi manager.	11.1.2 Wi-Fi connection.

Connected to surface unit, but cannot communicate with C-ALS probe		
Cause	**Remedy**	**Reference in manual**
'Empty firmware' message in Carlson Scan Tablet indicates no comms to probe. Faulty cable between surface unit and C-ALS probe.	Check, test or replace the cable between surface unit and C-ALS probe.	See C-ALS hardware manual.
C-ALS probe faulty. Check whether probe scan head is initialising when power is applied.	Contact Carlson for support.	1.1 Dear customer.

Cable counter is not recognised by Carlson Scan		
Cause	**Remedy**	**Reference in manual**
Cable counter not paired to the surface unit correctly.	Connect to the cable counter with a USB cable and set (precisely) the correct Wi-Fi SSID.	4.3.2 Counter.
Cable counter is giving the incorrect distance.	Check the Initial deployment offset value is 2 m and the deployment is starting with the probe 2 m past the hole collar.	4.3.2 Counter.

Scan incorrectly tilted		
Cause	**Remedy**	**Reference in manual**
Sensors out of calibration.	Check the unit by scanning a flat, square room. Check the floor is level. If not, contact Carlson to arrange recalibration.	1.1 Dear customer.
C-ALS moved during scan.	Check text report for indication that pitch-and-roll have changed during scan. Try rescanning same location. Ensure unit is stable throughout the scan.	12.3 During a scan.
Using an unsupported C-ALS.	Carlson Scan supports C-ALSs running firmware version 6.1 and above.	3.1 Equipment compatibility.

Scan orientated incorrectly		
Cause	**Remedy**	**Reference in manual**
Gyro deployment - azimuth measured the wrong way.	Horizontal alignment - measure along the probe from the rod adaptor to the laser head. Vertical alignment - measure the alignment bar as indicated on the attached sticker.	16.2 Alignment jig
Gyro lost alignment before scanning.	Handle the probe carefully after an alignment.	15.1 Gyro introduction
Too long since last alignment. Gyro has suffered drift.	Minimise the time between an alignment and a deployment. Align before every deployment.	15.1 Gyro introduction

Gyro errors		
Cause	**Remedy**	**Reference in manual**
Gyro will not calibrate	Probe is moving or vibrating during the alignment. Probe must be completely stable.	15.1.2 Drift
Gyro rotation error message.	Maximum rotational speed of the C-ALS probe body during gyro deployments is 400° per second.	15.1.4 Gyro limits
'Align Gyro' button does not appear on Control tab.	Electronic fault. Contact Carlson for support.	1.1 Dear customer
Viewing live scan, the data appears distorted and tilted.	Carlson Scan corrects gyro scans for drift and rotation of the probe during a cable-only deployment. Allow the scan to complete and the data is corrected automatically.	

Scan in wrong location		
Cause	**Remedy**	**Reference in manual**
Manual deployment - Boretrak readings missed out. C-ALS appears to be not deployed far enough.	Ensure the correct number of Boretrak readings are taken during the deployment.	17.5 Deployment
Manual deployment - extra Boretrak readings taken. C-ALS appears to be deployed too far.	Ensure the correct number of Boretrak readings are taken during the deployment.	17.5 Deployment
Manual deployment - incorrect Interval value used.	Ensure the correct Interval value is used, and that it is updated if you use different intervals during the deployment.	17.5 Deployment
Cable counter deployment - Initial deployment offset incorrect.	The Initial deployment offset value is usually 2 m. Thus the C-ALS probe and extension piece are inside the hole when the deployment is started.	4.3.2 Counter.
Collar coordinates incorrect.	Enter the correct collar coordinates, before or after the deployment.	17.2 Station

24 Point clouds

No points being displayed during a scan		
Cause	Remedy	Reference in manual
Zoomed in or out too far in 3D View.	Use the mouse wheel or shortcut keys to zoom in or out.	5.1 3D View
Different entities in the project have coordinates separated by a huge distance.	Check all station coordinates and coordinates of any imported data.	
Laser windows are dirty and no scan data is being collected.	Clean laser windows carefully.	See C-ALS hardware manual.
Laser electronics faulty.	Contact Carlson to arrange for service.	1.1 Dear customer

'Holes' in the point cloud		
Cause	Remedy	Reference in manual
Standing water or very unreflective surfaces such as coal are present.	None. Laser ranging to wet or very dark surfaces is unpredictable.	17.1 System limitations
Some surfaces in the void are beyond the range of the laser.	Redeploy the VS+ from another location if possible and combine scans to overcome range limitations.	17.1 System limitations
Line-of-sight blocked by rocks, pillars, debris etc.	Redeploy the VS+ from another location if possible and combine the scans to overcome shadowing.	17.1 System limitations

Point cloud is ill-defined and 'fuzzy'		
Cause	Remedy	Reference in manual
Dust or moisture in the void is interfering with the laser.	Switch on the 'last-hit' option.	10.5 VS+ scan configuration. 12.1.2 C-ALS scan configuration.
Standing water, running water or wet surfaces present in the void.	None. Laser ranging to wet surfaces is unpredictable.	17.1 System limitations

Point cloud spherical either wholly or in part		
Cause	Remedy	Reference in manual
Thick dust or moisture clouds in the void are interfering with the laser.	Switch on 'last-hit' option. If the problem persists, wait for dust or moisture to clear, if feasible.	10.5 VS+ scan configuration. 12.1.2 C-ALS scan configuration.

CARLSON SCAN EULA

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End User shall obtain all LICENSOR authorized product materials through LICENSOR or LICENSOR'S authorized representative and no other source. LICENSOR authorized product materials include, but are not limited to, manuals, license agreements and media upon which LICENSOR's proprietary computer programs are recorded. End User shall make no copies of any kind of any of the materials furnished by LICENSOR or LICENSOR's authorized representative, except as specifically authorized to do so in this EULA. End User is not entitled to make archival copies of those portions of LICENSOR's product(s) that are provided on a machine-readable media.

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End User agrees that LICENSOR retains exclusive ownership of the trademarks and service marks represented by its company name and logo and all of the documentation and computer recorded data related thereto. End User also agrees that all techniques, algorithms, and processes contained in LICENSOR's computer program

products or any modification or extraction thereof constitute TRADE SECRETS OF LICENSOR and will be safeguarded by End User, but in no event shall End User exercise less than due diligence and care in accordance with the laws of the country of purchase and International Law, whichever operates to best protect the interests of LICENSOR. End User shall not copy, reproduce, re-manufacture or in any way duplicate all or any part of LICENSOR products WHETHER MODIFIED OR TRANSLATED INTO ANOTHER LANGUAGE OR NOT, or in any documentation, or in any other material provided by LICENSOR in association with LICENSOR's computer program products regardless of what manner of storage and retrieval the product exists, except as specified in this Agreement and in accordance with the terms and conditions of this Agreement which remain in force. End User agrees that in the event End User breaches this EULA, End User will be liable for damages as may be determined by a court of competent jurisdiction.

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End User's rights and obligations under this EULA are nonexclusive and personal in nature, and the intellectual property Licensor grants to End User is subject to applicable law other than bankruptcy law. End User may not transfer or assign the SOFTWARE, rights under this EULA or accompanying user documentation, or any updates of the SOFTWARE which may be provided under this EULA, to a third party unless End User receives written consent from Licensor at least 30 days prior to the completion of transfer. Licensor reserves the right to deny transfer or assignment if, in its sole discretion, Licensor determines the transfer not to be a necessity. Whether or not a transfer or assignment is allowed shall be determined in Licensor's sole discretion after taking into consideration certain factors to find the existence of a necessity including, but not limited to, merger or acquisition of an entity, complete asset acquisition, change of control, severe economic hardship, severe loss of human resources or significant loss in business divisions, or winding down of entity affairs.

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Audit Rights

End User agrees that LICENSOR has the right to require an audit (electronic or otherwise) of the LICENSOR Materials and the Installation thereof and access thereto. As part of any such audit, LICENSOR or its authorized representative will have the right, on fifteen (15) days' prior notice to End User, to inspect End User's records, systems and facilities, including machine IDs, serial numbers and related information, to verify that the use of any and all LICENSOR Materials is in conformance with this Agreement. End User will provide full cooperation to enable any such audit. If LICENSOR determines that End User's use is not in conformity with this EULA, End User will obtain immediately and pay for a valid license to bring End User's use into compliance with this EULA and other applicable terms and pay the reasonable costs of the audit. In addition to such payment rights, LICENSOR reserves the right to seek any other remedies available at law or in equity, whether under this Agreement or otherwise.

Warranty

THE PRODUCT IS PROVIDED "AS IS" WITH ALL FAULTS. TO THE MAXIMUM EXTENT PERMITTED BY LAW, LICENSOR HEREBY DISCLAIMS ALL WARRANTIES, WHETHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANITIBILITY, FITNESS FOR A PARTICULAR PURPOSE, AND WARRANTIES THAT THE PRODUCT IS FREE OF DEFECTS AND NON-INFRINGING, WITH REGARD TO THE SOFTWARE, AND THE ACCOMPANYING WRITTEN MATERIALS. YOU BEAR ENTIRE RISK AS TO SELECTING THE PRODUCT FOR YOUR PURPOSES AND AS TO THE QUALITY AND PERFORMANCE OF THE PRODUCT. THIS LIMITATION WILL APPLY NOTWITHSTANDING THE FAILURE OF ESSENTIAL PURPOSE OF ANY REMEDY. In any event, LICENSOR will not honor any warranty shown to exist for which inaccurate or incorrect identifying data has been provided to LICENSOR. The product(s) provided are intended for commercial use only and should not be utilized as the sole data source in clinical decisions as to levels of care.

Furthermore, the Software Product may contain certain Cloud technology based features, such as messaging and crew view, where data can be passed freely between End Users using the Software Product. These features will generally be password protected, with no other built security for Software Product usage. Carlson accepts no responsibility for compromised data or loss due to unauthorized messaging or communication through Cloud technology provided in the Software Product.

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LICENSOR may, from time to time, revise the performance of its product(s) and in doing so, incur NO obligation to furnish such revisions to any End User nor shall it warrant or guarantee that any revision to the SOFTWARE will perform as expected by the End User on End User's equipment. At LICENSOR's option, LICENSOR may provide such revisions to the End User.

Customer Service

Although it is the LICENSOR's customary practice to provide reasonable assistance and support in the use of its products to its customers, LICENSOR shall not be obligated to any End User to provide technical assistance or support through this Agreement and may at LICENSOR's sole election charge a fee for customer support.

Termination of End User License

If any one or more of the provisions of this Agreement is breached, the license granted by this Agreement is hereby terminated. In the event of such termination, all rights of the LICENSOR shall remain in force and effect. Any protected health information data of End User maintained on LICENSOR'S data base shall upon reasonable notice to End User and at the discretion of LICENSOR may be destroyed.

Copyright

The SOFTWARE (including, but not limited to, any images, photographs, animations, video, audio, music and or text incorporated into the SOFTWARE), and all intellectual property rights associated with it, whether exists in a tangible media or in an electronic image media is owned by LICENSOR and is protected by United States copyright laws and international treaty provisions and all other commonwealth or national laws. LICENSOR reserves all intellectual property rights in the Products, except for the rights expressly granted in this Agreement. You may not remove or alter any trademark, logo, copyright or other proprietary notice in or on the Product. This license does not grant you any right to use the trademarks, service marks or logos of LICENSOR or its licensors. You may not copy any user documentation accompanying the SOFTWARE.

Injunctive Relief

It is understood and agreed that, notwithstanding any other provision of this Agreement, LICENSOR has the unequivocal right to obtain timely injunctive relief to protect the proprietary rights of LICENSOR.

Entire Agreement

This EULA constitutes the entire agreement between the parties and supersedes any prior agreements. This EULA may only be changed by mutual written consent.

End User Agreement Acknowledgment

The End User hereby accepts all the terms and conditions of this Agreement without exception, deletion, alteration. End User acknowledges they are authorized to enter this agreement on behalf of any organization for which the license is sought. Any unauthorized use of LICENSOR products will be considered a breach of this Agreement, subject to liquidated damages and otherwise unlawful and wilful infringement of LICENSOR's trade secrets and/or proprietary products.

Payment and Refund Policy

The use of the SOFTWARE herein is deemed a commercial use and under the terms of this license agreement End User shall not be entitled to any refund of purchase price. End User agrees to pay all user fees promptly. LICENSOR is authorized by End User to suspend any further access to SOFTWARE in the event fees are not fully paid. End user entity shall promptly pay any and all access and use charges incurred regardless of the end user. End user is responsible for protecting any pass word and user identity supplied to End User.

Loss/Theft/Misuse

End user shall promptly report to LICENSOR the theft or other loss of any password and/or user identity required to access SOFTWARE. LICENSOR shall not be responsible for maintaining the integrity of End User data in the event that end user's data base is accessed and/or altered by an unauthorized end user due to the failure of licensed End User to protect its password or user identity. End User shall be responsible for any costs incurred by LICENSOR due to the negligence or reckless disregard of End User's failure to protect its password or user identity.

Civil/Criminal Investigation

End user shall fully cooperate with LICENSOR and or any person authorized by LICENSOR (including local, state, or federal law enforcement officials) to investigate any alleged theft, misuse or unauthorized use of SOFTWARE or data related thereto.

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Governing Law

This EULA shall be governed and construed in accordance with the laws of the Commonwealth of Kentucky, USA.