

**Rock Profiling**

**Cavity Monitoring**

**Blast Design**

**Lidar Scanning**

**Void Scanning**

**Stockpile  
Volumetrics**





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Carlson Software produces a complete suite of solutions for land development professionals, across the disciplines of data collection, surveying, engineering design and drafting. In addition, utilizing its expertise in data collection, Carlson also offers accident and crime reconstruction field and office software for law enforcement personnel or law consultants.

“ We at Carlson recognize the paramount importance of free choice to the professional consumer in the land industry. We are committed to providing consistent software interfaces across hardware and across disciplines. This is the mission of Carlson Software. ”

--R. Bruce Carlson  
 Founder and President  
 Carlson Software

Founded in 1983 and based in Maysville, Kentucky, U.S.A., Carlson has a branch office in Boston, Massachusetts, U.S.A., and local representatives in Australia, Russia, Germany, The Netherlands, Spain, Ireland, and El Salvador.



# C-ALS®

## Cavity Auto-scanning Laser System



CLASS 1  
LASER PRODUCT

The Carlson C-ALS laser system provides safe, quick, and reliable mapping capabilities for inaccessible underground cavities. Deployable via boreholes on cable or rods, via a boom, or on a zip-wire, the C-ALS system can be used from the surface to provide a detailed visual record of the subsurface environment in a wide range of applications. A C-ALS Gyro option now gives greater navigational capability, ensuring that the probe's position along the borehole can be determined without relying on the mechanical alignment of deployment rods or a magnetic compass.

### C-ALS supports successful projects

The Carlson C-ALS system enables laser scanning of air-filled voids to create geo-referenced 3D models of subsurface conditions as a cost-effective, comprehensive, and accurate alternative to systematic drilling, enabling users to:

- Protect worker safety
- Report to project stakeholders in greater detail
- Cost out planned works accurately
- Devise more efficient work programs
- Move new projects forward faster
- Design and engineer solutions based on accurate data
- Minimize disruption, drilling, and disturbance in populated areas

### The advantages of C-ALS laser scanning

- Ability to survey potentially dangerous underground voids safely
- Get precise and accurate cavity/void measurement in minutes, not days
- 360° spherical coverage for a full view from a single scan, with no blind spots
- Operation is remotely controlled
- Deployment methods are flexible
- Easily transported
- Rugged design for durability in extreme conditions -
  - IP67 rating (probe only)
  - Withstands submersion to a depth of 1 m (in case accidentally deployed in a flooded cavity)
  - Withstands extremes of temperature and high humidity

### How it works

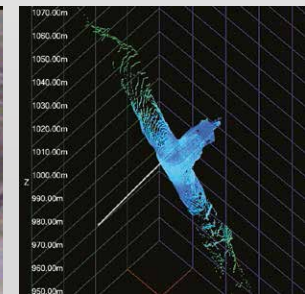
- With a diameter of just 50 mm, the Carlson C-ALS system is easily deployed through boreholes, downhole or uphole in order to survey inaccessible spaces.
- A system of hinged, lightweight, 1 m rods provide a fixed azimuth capability, as well as the ability to deploy the C-ALS down boreholes as long as 200 m.
- The C-ALS probe incorporates pitch-and-roll sensors. The sensors ensure C-ALS can be tracked both up and down the borehole and that the scan is automatically georeferenced to fit into existing 3D mine data.
- Alternatively, the C-ALS Gyro uses an internal MEMS IMU to establish the heading and inclination of the probe as it is deployed. An initial reference azimuth is determined on the surface and the survey is then relative to this heading. This gives the possibility of more flexible, cable-only deployments.
- A nosecone camera, embedded within the end of the C-ALS probe, provides onscreen video and a real-time view of the borehole as the probe is deployed. This allows operators to see any obstructions, and judge the point at which the C-ALS scanning head and rotating horizontal shaft breaks through into the void.
- Once in the void, a simple click from the operator commands the laser-scanning head to rotate on two axes, measuring the 3D shape of the void with full (horizontal axis) 360° coverage and no blind spots, and with a range up to 150 m.
- Operators control C-ALS from a distance, via the robust PC or tablet that may be optionally included in the package. PC or tablet is linked to the C-ALS system by Ethernet cable or a WiFi link. From a safe distance, the operator can view live data, analyse point clouds and create models.



The C-ALS system deployed downhole to survey an inaccessible underground void.



The nosecone camera provides a helpful view into the borehole during deployment.



The probe rotates on two axes to create full 360-degree scans of voids and cavities.

## Monitor excavations, assess risk, or design solutions

Utilize the Carlson C-ALS system when a complete picture of the situation underground is needed. Identify, measure, and map voids below construction or geotechnical projects to help avoid/prepare for differential settlement, sinkholes, or even catastrophic collapse of old mine workings or voids that may underlie residential and commercial properties. With the complete picture the C-ALS system provides, engineering solutions can then be put into place to counter the problems.

The C-ALS system can be used in a huge range of applications where an inaccessible void exists and accurate data is required.

### C-ALS Gyro option

C-ALS units are available with a fitted, miniaturised MEMS IMU. The IMU contains a 3-axis gyro which monitors the probe's heading and accelerometers which determine the inclination. In this case, the lightweight rods are not required for their original purpose of mechanically aligning the probe during a deployment. The rods may still be useful to push the probe along horizontal or uphole deployments, or to retain stability during free-hanging deployments. In other cases, with the gyro active, the C-ALS can be lowered just with its cable, or with the addition of a manual or powered winch.

Prior to a deployment, the C-ALS Gyro probe is set out in a stable position and its heading is established in relation to the mine's grid system. This forms the reference orientation for the rest of the deployment.

The software automatically identifies the gyro & offers controls appropriate to this variety of C-ALS.

### Support underground or surface mining projects

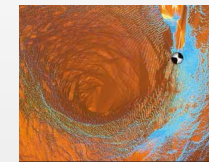
By using C-ALS to determine the size, extent, and status of inaccessible voids, mining customers get a complete picture of the situation underground before committing to projects or deploying workers. In addition, a full understanding of the layout of underground workings and their relation to surface operations is also essential for safe open-pit operations using heavy machinery, explosives, and personnel.

The C-ALS system provides a detailed visual record of the following:

- Excavation and infill of stopes
- Location of voids
- Geometry and condition of mine workings
- Inaccessible historic workings
- Collapsed areas, sinkholes, and troughs
- Erosion of ore passes
- Volumes of voids
- Position of cavities in relation to other underground workings and structures
- Size and location of remaining pillars
- Location of the voids/workings relative to surface features



The ruggedised PC enables you to carry out operations on site in extreme environments.

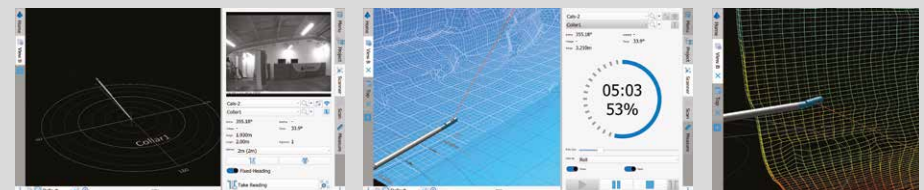


Laser cavity scans are easy to export into a large range of software packages.

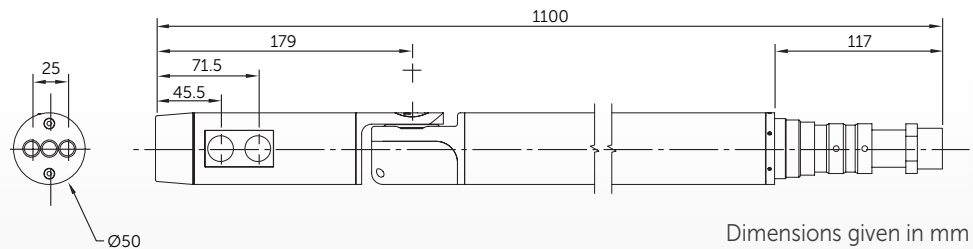
### Carlson Scan software

Carlson's software for C-ALS makes it easier and quicker for operators to use the system, to analyse collected data and to produce industry-standard deliverables.

- Quick navigation and intuitive design for both new and experienced operators.
- Smooth and efficient animation and point cloud rendering
- Optimised for ruggedised, touchscreen tablets for easy in-field use
- Desktop mode for reviewing data in the office.
- See the heading, inclination and activity of the animated C-ALS probe at all times
- Real-time surfacing and volume calculation from raw scan data for the production of closed 3D models and volumes
- Quickstart mode with single-click project setup up and instrument auto-detection
- Save live footage from the C-ALS camera
- Integration with third-party packages with the ability to import and export formats, such as LAS and DXF



## C-ALS Probe dimensions



### C-ALS

#### Laser module

**Laser classification (BS EN 60825-1 : 2014)**  
(21 CRF 1040.10 and 1040.11 except for deviations pursuant to Laser No 50, dated 24 June 2007)

**Class 1**

<b>Type</b>	InGaAs laser diode
<b>Wavelength (typical)</b>	905 nm
<b>Resolution</b>	1 cm
<b>Maximum range to a passive target*</b>	Up to 150 m
<b>Minimum range</b>	0.5 m

#### Angle measurement

<b>Type</b>	Opto-electronic encoder	
<b>Inertial Pitch-Roll Sensor</b>	± 0.2°	
<b>Angular Accuracy</b>	0.2°	
<b>Angular Resolution</b>	0.1°	
<b>Range</b>	Vertical	-90° to 90°
	Horizontal	0° to 360°
<b>Motion</b>	Servo-driven gear system in both axes with manual clutch override system	

#### Boretrak Sensors

<b>Type (standard system)</b>	Triaxial sensor
<b>Pitch-and-roll accuracy</b>	± 0.2°
<b>Pitch-and-roll range</b>	360°
<b>Compass (optinal) accuracy</b>	± 1.2°

#### Physical data

<b>Construction</b>	Machined aluminium and stainless steel	
<b>Water and dust resistant</b>	IP67	
<b>Operating temperature range</b>	Probe	-10 °C to +60 °C
	Surface Unit	0 °C to +50 °C
<b>Dimensions</b>	Probe	1100 mm × Ø50 mm
	Probe with extension piece	2179 mm × Ø50 mm
	Surface Unit	270 mm × 245 mm × 170 mm
<b>Weight</b>	Stainless steel probe	5.9 kg
	Single-section steel extension piece	3 kg
	Main C-ALS cable	0.18 kg/m
	1 m Boretrak rod	0.4 kg
	Surface Unit	4.1 kg
<b>External power input</b>	12-15 V dc and 110-240 V ac	
<b>Power consumption during scan</b>	0.8 to 2.0 A	

\* Max measuring ranges are recorded against Kodak white card (90% reflectivity).

For further information and the best possible application and performance support please contact Carlson at [lasermeasurement@carlsonsw.com](mailto:lasermeasurement@carlsonsw.com)

# Merlin

## Vessel-Based Laser Scanner



Merlin is the marine Lidar (Light Detection and Ranging) system developed specifically for cost-effective and safer coastal, offshore and inland waterway surveying. Extremely robust, portable, and well-engineered, Merlin provides eye-safe, long-range laser scanning that enables the capture, processing, and analysis of geospatial point cloud data quickly and accurately.

### Safer, faster, more efficient surveying with Merlin

Seamless integration with existing echosounder technology enables the fast and effective acquisition of time-tagged survey data above and below the water simultaneously.

### Map the full environment in a single survey

Information acquired by Carlson's time-tagged Merlin marine laser scanner combines seamlessly with bathymetric echosounder data for complete datasets that reveal the full landscape above and below the waterline in the same survey.

Obtaining a full 360° point cloud with Merlin quickly and safely:

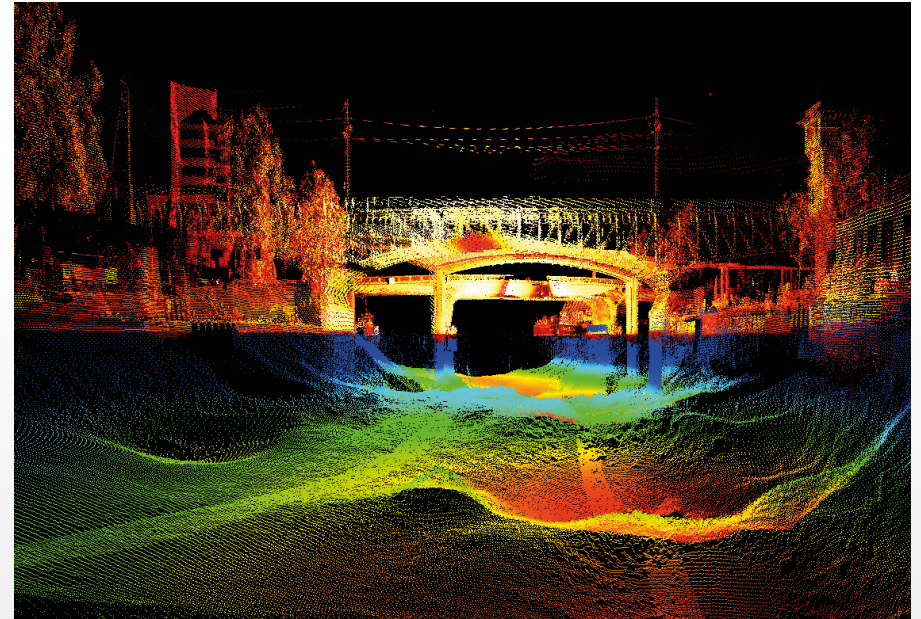
- Speeds up project timescales,
- Minimizes the amount of time crew spend in potentially hazardous areas, and
- Reduces the surveying costs associated with complex vessel-based surveying assignments.

### Key Features

- IP66 (EN 60945) water and dust resistance
- 250 m laser range (maximum)
- $\pm 1$  cm laser accuracy
- 360° field of view

### Key Benefits

- Saves on setup: Seamless integration with existing hardware and software means no need to duplicate equipment, infrastructure, or technologies already owned.
- Minimizes training costs: The low maintenance plug-and-play Merlin system is easy to install and operate, eliminating the need for specialist training. It is also compatible with industry-standard software packages.
- Improves worker safety: Fast installation, deployment, and speed of data capture reduce the amount of time spent in potentially hazardous marine environment.



**CLASS 1  
LASER PRODUCT**



The custom-made mounting plate ensures rapid installation and deployment



Accurately manage and monitor coastal erosion by comparing new and old data with ease.



The portable Merlin laser scanner can be deployed for offshore surveying in remote locations.



The marine surveying industry needs a dedicated marine laser scanner for high-performance data acquisition in extreme environments.



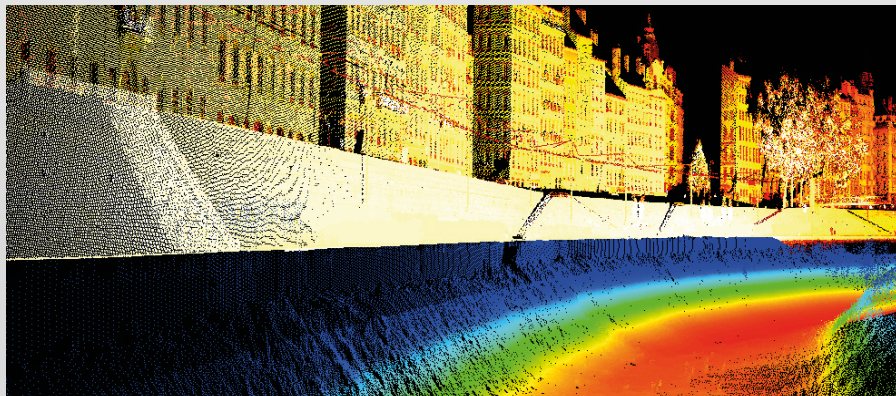
## Safe, flexible, and easy to operate for a wide range of applications

Merlin is ready to install out of the box with no customization required. The mounting plate can either be permanently welded into place or attached temporarily to a mast or cabin roof by three simple screws.

Merlin's 250 m range\* addresses the challenges of safely and accurately mapping the full landscape above the waterline - including the shoreline, coastal features, manmade structures, and more - as it enables accurate data acquisition from a safe distance. These challenges include avoiding hazardous natural features and dealing with unpredictable weather conditions.

Merlin also comes with its own diagnostic tool, which can be used to set up the system with existing infrastructure, such as port numbers and IP addresses. It also enables operators to select and test a timing source and troubleshoot.

\* Passive range limit is target (reflectivity) dependent (to a 90% reflective target where the entire laser spot falls upon the target).



Merlin supports faster and more accurate data collection, minimizing the amount of time operators need to spend in the field.

## Many uses for Merlin's high-quality 3D data

- Monitoring coastal change by comparing old and new information
- Creating navigation charts without venturing into hazardous coastal zones
- Updating risk management and flood models to predict future events by using historic data
- Assisting with urban planning with identification of key marine features
- Collecting detailed information safely and quickly from high traffic waterways

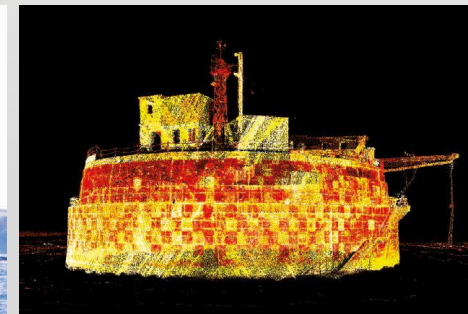
## Connect an additional sensor

The option to connect a second Merlin unit via a specialized top-side interface box further helps to reduce project timelines and improve point cloud density. Benefits of deploying two Merlin units on one vessel include:

- Reducing the amount of shadowing encountered during scanning
- Enabling the capture of more points per second for more detailed datasets in a shorter amount of time
- Increasing the quality and quantity of scan data that can be captured, for improved decision making



The Merlin marine laser scanner provides high-performance range accuracy and marine resistance.



With improved data you can better analyse the landscape for complex mapping projects with ease and confidence.

## Merlin: Compatible with all major software

The Merlin vessel-based Lidar system quickly measures and records time-tagged geo-referenced data points, which can then be calibrated and processed into a finished point cloud by the following packages:

- HYSWEEP® multibeam collection and editing software from HYPACK®
- NaviScan and Kuda sonar and laser data acquisition software from EIVA
- QINSy hydrographic data acquisition software from QPS
- Teledyne PDS software for hydrographic survey and dredging operations



The processed point cloud can then be exported in formats such as LAS or XYZ into a CAD package such as Carlson Point Cloud, to Carlson P3D Topo to produce a 3D model, create surfaces, or to export to other file formats including DXF or DWG.

Merlin's universal interface ensures operator familiarity and ease of use.

### Carlson Merlin Vessel-Based Laser Scanner

Laser module	
Type	InGaAs laser diode
Wavelength (typ)	905 nm
Accuracy*	± 1cm
Maximum energy per pulse	0.461 µJ
Beam divergence	2.25 × 1.5 mrad
Range resolution	1 cm
Maximum range to a passive target**	250 m
Minimum range	0.5 m
Lens aperture size and location	28 mm (location at front of module)
Scanner field of view	360°
Scanner angle resolution	Up to 0.01°
Scan rate	Up to 20 Hz
Beam footprint at 50 m	141 mm × 103 mm
Pulse measurement rate (points per second)	36000
Power	11 to 30 V dc 198 W
Physical data - Carlson Merlin	
Weight (Merlin unit excluding mount)	12.5 kg
Dimensions (L × W × H)	370.5 mm × 274 mm × 423 mm
Physical data - Carlson Merlin LT	
Weight (Merlin unit excluding mount)	8.4 kg
Dimensions (L × W × H)	285 mm × 273.6 mm × 310 mm

## Merlin vs Merlin LT

Two varieties of Merlin offer alternative configurations depending on your vessel setup.

The standard Merlin incorporates a GPS receiver which provides internal timing for the laser. This timing can also be exported to other equipment on the vessel.

The Merlin LT is a stripped down version of the Merlin. It is designed without the GPS receiver and also without the cabin-mounted interface box which provides a cabling interface and power management for the standard Merlin.

Lighter and more compact, the Merlin LT can be used on smaller, unmanned vessels and for installations where the timing is being imported from another part of the navigation system.

## Global support and training

Carlson provides expert training and support provided by our team of in-house surveyors and engineers at your location or at our offices in the UK, USA, Canada, and Australia. We also offer remote diagnostics support to perform instant software and hardware diagnostics from our offices to yours anywhere in the world. Please contact us at [lasermeasurement@carlsonsw.com](mailto:lasermeasurement@carlsonsw.com) for more information.

Environmental	
Water and dust resistant***	IP66 (marine grade)
Operating temperature	-10 °C to +50 °C
Storage temperature	-25 °C to +70 °C
Tests and approvals	
CE conformity	DoC available
Safety of laser products (Class 1)	BS EN 60825-1: 2007 (21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser No. 50, dated 24 June 2007)
EMC	BS EN 60945: 2002 section 9-11
FCC compliance	CFR47 Part 15.19, 15.21, 15.105
Photobiological safety of lamps and lamp systems	BS EN 62471: 2008
Safety of machinery	BS EN ISO 12100: 2010
Safety of electrical equipment	BS EN 61010-1: 2010

\* Max measuring accuracy recorded at 50 m against Kodak white card (90% reflectivity) to 1σ. Accuracy is defined as the degree of conformity of the measured sample mean range to its actual (true) value, measured with reference to a total station under Carlson test conditions.

\*\* Max measuring ranges are recorded against Kodak white card (90% reflectivity).

\*\*\* Environmental protection is tested in accordance with EN 60529: 1992 + A1: 2002 and EN 60945: 2002.



# Quarryman® Pro



*The Carlson Quarryman Pro is the 3D laser-scanning system of choice for quarries around the world. It is intuitive to use, portable and rugged, and carefully designed and tested to make it robust enough to operate in the toughest environments.*

## Improves safety. Increases profitability. Made for the demanding quarry environment.

- Safe, long-range reflectorless surveying for blast planning, stockpile measurement, and whole site mapping
- Easily operated by one person, with very little training needed to use the system or the associated intuitive software
- Durable and reliable in tough environments – certified water and dust resistance with operating capabilities from -20 °C to +45 °C
- Light and portable for easy, one-man operation that can quickly be moved around and between sites by operators
- Scans entire rock faces in minutes as it measures and records thousands of data points, which can be sent directly to a USB drive
- Provides a manual point-and-shoot mode and an automatic laser-scanning mode (250 points per second) and can be integrated with blast design software packages and with Lidar data collected from mobile mapping systems and UAVs
- Processes the collected data to create detailed 3D models, which can be edited, analyzed, and exported to specialist packages or other CAD software

## Blast design, optimization, and evaluation

Scan a full rock face quickly with the Quarryman Pro and then use the data to plan:

- More accurate blasts, which eliminates the costs associated with over-using explosives
- Safer blasts that keep workers safe
- Legally compliant blasts, which have less impact on the external environment by minimizing noise and vibration
- Blasts with optimal fragmentation, which cuts transport costs for quarried rock and minimizes the waste associated with over-fragmentation
- Improved floor control, minimizing wear on tires and heavy mobile equipment



## Detailed mapping

Use Quarryman Pro data to measure bench heights, level of crest and toe, slope angle, and maximum/minimum burden. This detailed mapping of a rock face increases safety as it enables the determination of actual burden across the face. This helps to avoid the problems associated with underestimating the burden, such as vibration and oversized rock, and overestimating the burden, which can result in flyrock and airblast.

## Plan blast layout

Determine the layout of the blast hole pattern using data from the Quarryman Pro, taking into account safety parameters, vibration limits, explosives to be used, and design floor elevations. The resultant blast design plan will specify the collar elevations, burden, spacing, drill hole diameter, type and quantity of explosives, and type and delay of detonations.

## Drilling

Utilize Carlson Boretrak® borehole deviation tool to check that drilling has been carried out correctly as per the blast design, verifying the hole depth, heading, and inclination, to increase safety and improve final results.

## Features and Applications

The must have on-site system for quarries for more than three decades, the Quarryman Pro has transformed on-site safety and improved post-blast workflow and minimized costs.

## 3D Map entire quarry or mine site

Fast, portable and rugged, the Quarryman Pro system provides scans that can be stitched together for a complete model of a site or for a quick and simple way to conduct necessary stockpile and volumetric surveys. The long range of the Quarryman Pro minimizes the number of instrument setups required and also reduces the operator time needed to complete surveys.

Utilize the Quarryman Pro to compile a complete 3D map of a constantly evolving, open-pit site to plan such operations as truck routes, siting of generators, crushers, or other equipment, and to report to local residents or other stakeholders at update meetings.

The Carlson Quarryman Pro offers the following features:

- A highly visible, full color sun-readable screen
- Data is saved to a USB for ease of data transfer, and enables holding many more files
- A GPS mount is built into the handle so that the Quarryman Pro can be geopositioned quickly, and easily maps point cloud data to other quarry surveys
- Minimal clicks for each operation greatly enhances work speed
- Auto date and time stamping helps users find files without needing to enter details.
- The battery issues a warning when low, but shuts down automatically if not recharged, retaining data for retrieval later
- The lightweight Li-ion battery provides at least four hours of scan time



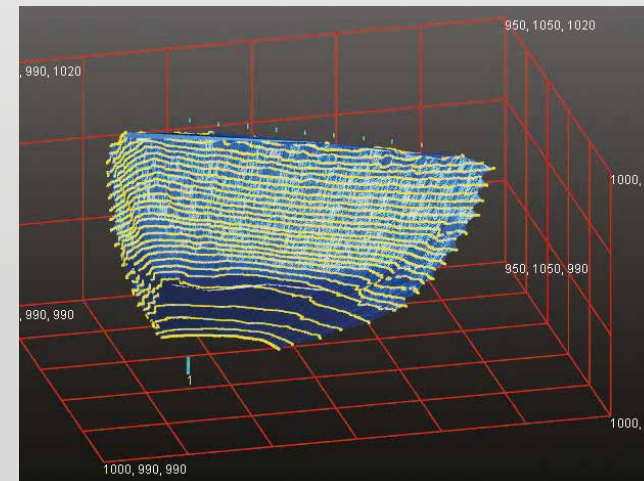
Quarries around the world rely on **Quarryman Pro** to plan safer, quieter, more effective blasting operations.

Perform safer, quieter, more effective blasting using data acquired from **Carlson** laser systems.



**Quarryman Pro** is dust-resistant and waterproof for performance even in extreme conditions

When used in combination with our **Boretrak** borehole deviation tool, **Quarryman Pro** enables the design of more productive blasts.

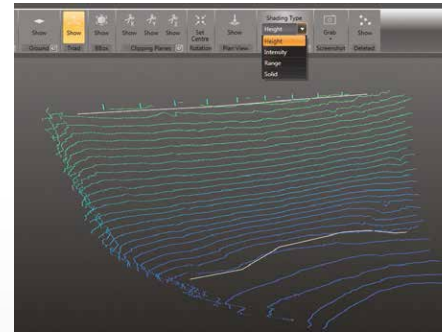


Rock faces that are mapped by **Quarryman Pro** allow users to plan effective operations.

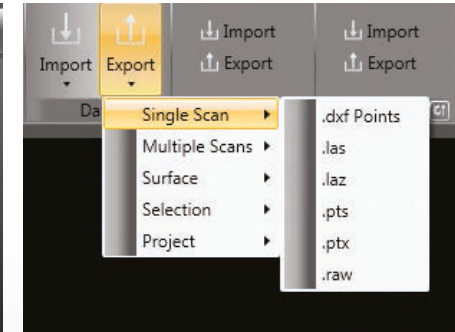
## Quarryman® Viewer Software

The intuitive Quarryman Viewer software offers increased flexibility and functionality as it speeds workflow:

- Clear, precise visuals enable quicker interpretation of data
- Automated point coding, traverse processing, and surfacing of single scans save time
- Ability to store most commonly completed functions makes it quick and easy to retrieve them for future projects
- Project tree gives easy access to, and control of, all data: scans, surfaces, observations, and stations
- Versatile import and export options together with user-preset filters reduce operator programming time



Quarryman software provides clear visuals for quicker interpretation of data.



Filters can be defined to obtain the data required. Data is then exported in multiple formats to all major CAD and point cloud packages.

	Quarryman Pro	Quarryman Pro LR (long range)
<b>Laser module</b>		
Laser classification (BS EN 60825-1: 2014) (21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser No. 50, dated 24 June 2007)	Class 2	Class 3R*
<b>Infrared laser module</b>		
Type	InGaAs laser diode	
Wavelength (typical)	905 nm	
Maximum energy per pulse	2.88 µJ	4.81 µJ
Beam divergence	2.25 x 0.15 mrad	
Resolution	1 cm	
Maximum range to a passive target **	Up to 750 m	Up to 1200 m
Minimum range	10 m	20 m
Lens aperture size and location	46 mm (location at front of module)	
<b>Visible laser module</b>		
Type	InGaAsP laser diode	
Wavelength (typical)	650 nm	
Maximum power	<0.6 mW (continuous wave)	
Lens aperture size and location	3 mm (location at front of module)	
<b>Angle measurement</b>		
Encoder type	Opto-electronic encoder	
Encoder accuracy	0.02°	
Encoder resolution	0.01°	
Range	Vertical	-45° to +90°
	Horizontal	0° to 360°
Motion	Stepper-driven worm and wheel drives in both axes with manual clutch override	

<b>Keyboard and display</b>	
Display	3.5-in, sun-readable TFT
Resolution	320 x 240
Keyboard	17-button keypad
<b>Data logging</b>	
Supplied logging media	8GB USB drive
Compatibility	USB 2.0 and 3.0
<b>Power</b>	
Supplied battery	14.4 V Lithium-ion
Capacity	6.2 Ah
Scan time (typical)	210 min
Alternative power	12 V dc lead acid
<b>Physical data</b>	
Construction	Machined aluminium
Water and dust resistant	IP66
Operating temperature range***	-20 °C to +45 °C
Weight Including tribrach	8 Kg
Including tribatch and battery pack	8.6 Kg
Including transit case and accessories	16.5 Kg

\* Visible and invisible laser radiation. Avoid direct eye exposure.

\*\* Max measuring ranges are recorded against Kodak white card (90% reflectivity).

\*\*\* Visible laser module operational -10°C to +60 °C

# Boretrak®

## Rodded and Cabled



*The Boretrak measurement system measures borehole deviation in a wide range of applications, including quarrying, mining, geotechnical, and engineering works.*

### Improve safety

Accurately measure the borehole data needed and effectively use the data to plan projects safely and in compliance with audit trail.



- Provides 3D data on drilling activity from ground level or underground site
- Ensures compliance with quarrying legislation
- Avoids the potential risks and costs associated with deviated or unsurveyed boreholes

### Increases work efficiency

Optimizes blasting and engineering works by easily creating detailed maps of drilling activity.



- Easy-to-use with minimal training, lessening the need for an expert surveyor
- Reduces the need for large teams with entire drilling sites able to be measured and modeled in hours
- Portable, lightweight and made to be transported, the easy-to-deploy system is designed to be used by a single operator
- Audits drilled holes and produces reports in minutes, making on-site drilling operations data-led, with no guesswork and data gaps

### Works reliably in extreme environments

The rugged, portable design, which is resistant to weather and environmental factors, make Boretrak a system for challenging projects.



- Provides a high degree of environmental protection to perform reliably and accurately in the toughest conditions
- Rodded Boretrak operates in areas of magnetic interference and in flooded holes

### Carlson LMD Blast Design Package

Widely used in mines, quarries, and in various engineering and geotechnical works, the Quarryman Pro laser scanner, Boretrak, and Blast Commander software make up the Carlson blast design package. The Boretrak system is used alongside the Carlson Quarryman Pro to provide detailed data at all stages of blast planning, thus providing quarry managers with a greater degree of control over final results.

### Get accurate data on site and make better decisions

- A ruggedized PDA interfaces with dedicated PC software so users can audit drilled holes and produce reports in minutes. Results can then be issued to drillers on site if needed. On-site drilling operations are then data-led, responsive and better integrated.
- Map entire sites. Boretrak data can easily be georeferenced and related to your local co-ordinate system helping users to map entire sites. This means current results can be compared with historical data and data viewed from a range of systems - notably Carlson's Quarryman Pro - in one place. There's no guesswork and no data gaps.
- Allows uphole and downhole borehole measurement with a single tool.





The Boretrak system enables faster yet safer rock face blasting.



Carlson's Cabled Boretrak system is supplied in a Peli-case that can be hand carried by a single operative.



The quick-to-deploy Boretrak is designed for use by a single operator.

## Cabled Boretrak

Compact, lightweight, rugged, and highly portable, Cabled Boretrak enables users to work quickly and move across large sites, covering vast areas, without the need to transport bulky surveying equipment.

- Designed to be deployed downhole on its integrated toughened cable to depths up to 65 meters (70+ yards)
- Contains a dual axis tilt sensor and digital compass to calculate borehole deviation from the collar position at fixed intervals
- Simple, robust CDU provides speedy job configuration, calibration, survey, and download

## Rodded Boretrak

The Rodded Boretrak system uses specially designed rods to deploy the probe: these maintain the orientation of the system without the need for a compass. This method offers accurate measurement for uphole deployments and areas that contain ferrous material, whether next to cabling or metalwork, or where there is magnetic interference.

The Rodded Boretrak system is ideal if needed to be deployed to great depths. Cabled probes limit users to the fixed cable length originally purchased. With Rodded Boretrak, additional stacks of rods can simply be added to be deployed down deeper holes.

### Recent Rodded Boretrak improvements include:

- Bluetooth communications between the probe and ruggedized PDA, negating the need for a hotshoe and enabling easy, on-site data download
- The ruggedized PDA provides the ability to communicate wirelessly with the probe and allows data to be sent to a PC via WiFi or Bluetooth
- The Boretrak Mobile Android app provides on-site viewing and troubleshooting, and enables users to output data directly into their own third-party packages
- Store and revisit multiple projects on one device
- Android capabilities and applications further complement the Rodded Boretrak system
- New smaller and lighter briefcase-style transit case

## Increase safety and efficiency

### Measuring borehole deviation

Drilled holes are employed in a wide variety of quarrying and mining projects and need to be drilled to a specified depth, inclination, and heading. Deviation from these specifications can pose real dangers and also increase costs due to unpredictable blast results. The Carlson Boretrak provides a reliable way of measuring borehole deviation by taking the actual results of drilling activity into account. When used as part of the blast design package, this ultimately saves mine and quarry owners on secondary breakage, transport, explosives, and fuel costs as well as increasing worker safety and that of others working or living near blast sites.



The benefit of a Cabled Boretrak is speed and portability.

### Work safely

- Deployed from ground level (or from underground sites), Boretrak keeps workers safe while providing 3D data on drilling activity
- Boretrak works with Quarryman to help ensure compliance with quarrying legislation, protecting local residents, employees, and property
- Measuring borehole deviation avoids the risks associated with incorrect borehole data: fly-rock caused by poorly designed blasts, or intersection with underground utilities in engineering works
- Safer, more efficient blasts also result in neater quarry faces and quarry floors, on which it is easier to operate machinery and vehicles

### Work reliably and efficiently in extreme environments

- A high degree of dust- and water-proofing is engineered into both the Rodded and Cabled Boretrak variants. Resistance to wet weather, water-logged ground, submersion, temperature extremes, sand and dust mean that Boretrak performs reliably and accurately in tough conditions.
- Portable, lightweight, and easy to transport across sites and between locations, the easy-to-deploy Boretrak is designed to be used by a single operator. The Cabled Boretrak system comes in a single 'Peli' case, with a total weight of less than 11 pounds (5 kg), and a soft case to carry the tripod and ballast rod when needed. The Rodded Boretrak probe and rods can also be hand carried by a single operator.



Rodded Boretrak's rods guide and locate the probe.

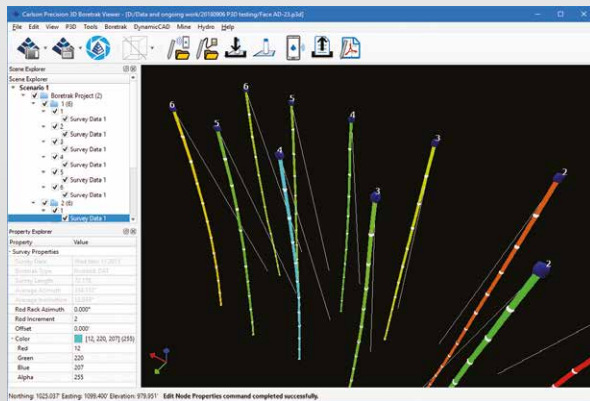
## P3D Boretrak plug-in

Carlson's P3D software is a point and surface modelling and processing package. Functionality for the Cabled and Rodded Boretraks is offered as a plug-in to P3D.

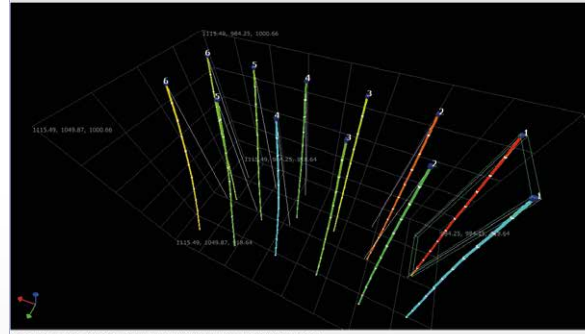
Available free of charge as part of all new Boretrak system purchases, the Boretrak P3D plug-in enables you to use the Boretrak 'out of the box' with no need to purchase additional third-party software. The package offers functionality for downloading, processing, editing, and viewing Boretrak data. The processed holes can then be exported in a wide range of data formats and comprehensive printed reports can be generated. The combination of Boretrak hardware and the P3D Boretrak plug-in provides operators with the control required to complete complex tasks.

P3D Boretrak plug-in works with all generations and models of Boretrak system, including seamless data transfer in DRL format with the 'Boretrak Mobile' Android application which is supplied with Carlson's latest Rodded Boretrak. DRL data can be transferred across Carlson's range of mining, quarrying and surveying software packages.

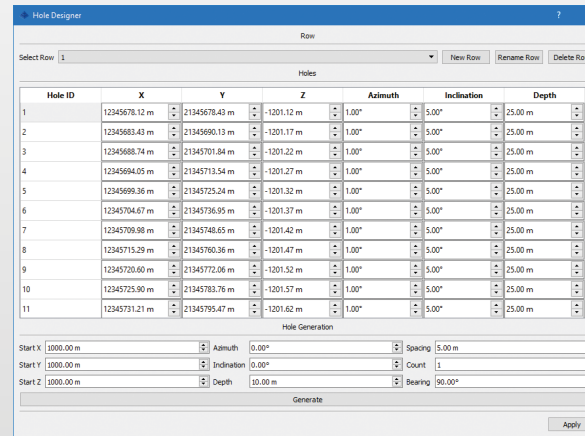
P3D's UI is very flexible and you can adapt the workspace to create a clear and simple interface for Boretrak operations.



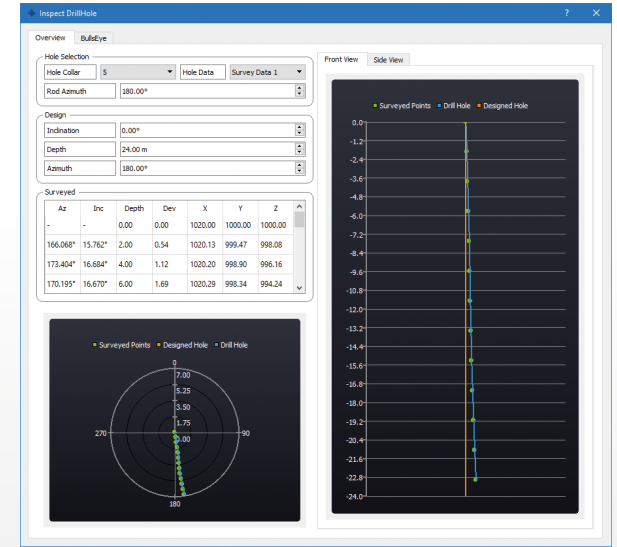
The powerful 3D graphics window shows all surveyed holes together with the relevant design data.



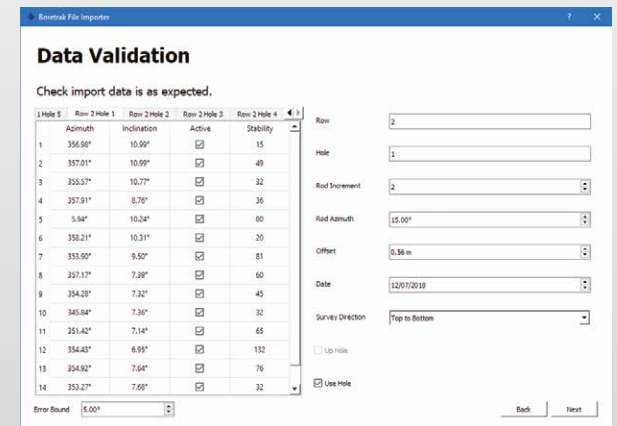
Each hole can be positioned on predefined coordinates. These can be automatically generated by default, or you can import surveyed or planned hole coordinates from a file. Alternatively, the Hole Designer allows you to manually create individual holes or rows of holes. Any hole coordinates can then be automatically matched to the surveyed holes on import of Boretrak data.



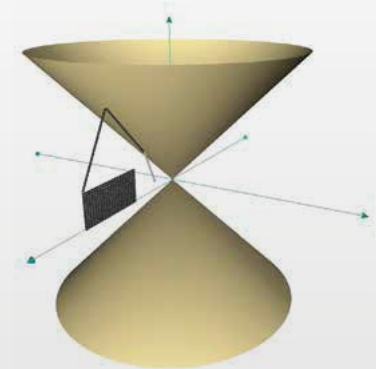
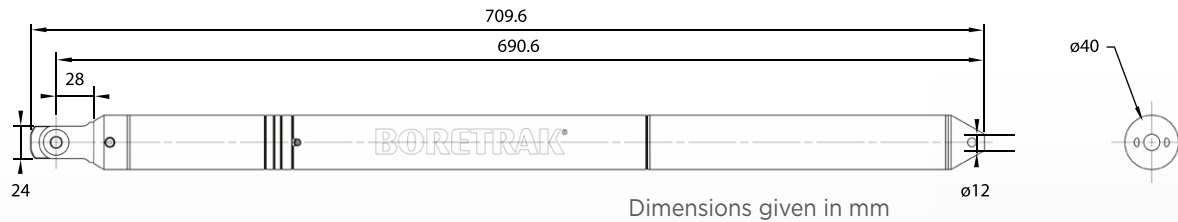
All data relating to each hole can be viewed on a single window showing design information, plan view, side views and each Boretrak reading in tabular form. Both the graphics and the table illustrate how the surveyed hole deviated from the design hole as the Boretrak was deployed.



You can create design holes in P3D Boretrak plug-in and then export these in DRL format to Boretrak Mobile. This will then form the basis of your Boretrak project in the field which, in turn, can then be downloaded back into P3D.



# Rodded Boretrak®



The measurement range is 45° from vertically up or down.

## Construction

Probe	Stainless steel
Rods	Glass fibre rods, acetal joints, and stainless steel quick release joints, nuts and bolts
Rack	Tubular aluminium

## Physical

Weight	Probe (inc batteries)	3.2 kg
	Rods (individual)	400 g
	PDA (inc battery)	225 g
Dim.	Probe	709.6 mm × 40 mm (L × Dia)
	Rods (individual)	1000 mm × 30 mm (L × Dia)
	PDA	152 mm × 81 mm × 17 mm

## Sensor

Angular range	0° to 45° and 135° to 180°
Accuracy	0.1°
Resolution	0.01°

## Power

Probe	3 × 1.5V D cells (LR20)
PDA	4500 mAh rechargeable Li-ion battery

## Environmental

IP degree of protection*	Probe	IP68 waterproof (pressure rated to 300 m)
	PDA	IP68
Operating temperature**	-10 °C to +60 °C	
Storage temperature**	-20 °C to +70 °C	

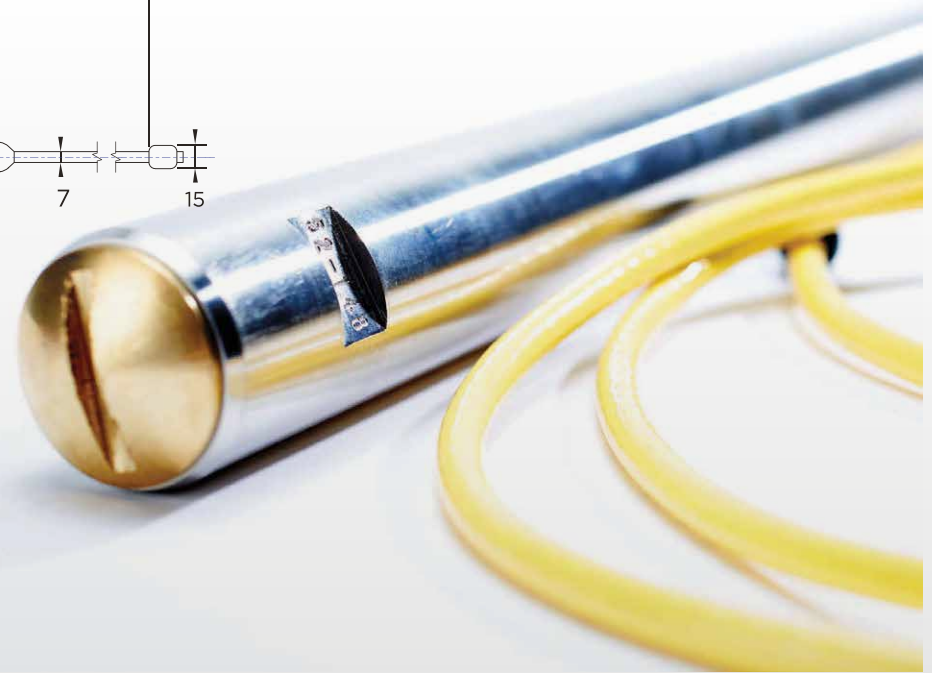
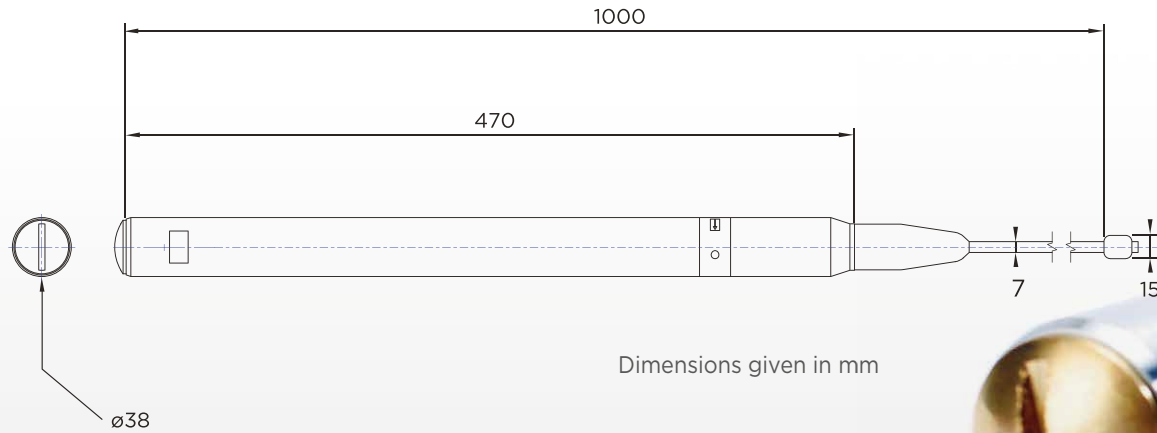
## Optional PDA

Model	CEDAR CT5
Display	4.7" high-definition (720 mm × 1280 mm) with Corning® Gorilla® Glass 3
Interface	Capacitive touchscreen and buttons
Data communications	Bluetooth (probe to PDA), Wi-Fi and USB (PDA to PC)

\* Environmental compatibility requirements of EN 60529:1992+A1:2002.

\*\* The probe operating and storage temperature may be limited by the choice of battery. The supplied Duracell has an operating temperature of -20 °C to +54 °C and a storage temperature of +5 °C to +30 °C

# Cabled Boretrak®



Construction		
Probe	316 stainless steel body and brass insert	
Ballast Rod	Glass fibre and stainless steel	
Cable	Kevlar-reinforced polyurethane	
CDU	Black acetal	
Physical	Weight	Dimensions
Probe	2.5 kg	480 x 38 mm (L x Dia)
Balast Rod	960 g	1000 x 38 mm (L x Dia)
Cable	50 g/m	N/A
CDU	800 g	210 mm x 102 mm x 41 mm
Sensor		
Dual axis inclinometer	Range: +/- 40° from the vertical Accuracy: 0.2° Resolution: 0.1°	
Compass	Range: 0 to 360° from the vertical Accuracy: +/- 1° typical (vertical and calibrated) Resolution: 0.1°	

CDU	
Display	128 x 64 graphic backlit
Keypad	4 x 4 plus dedicated Fire button
Memory	64 KB
Data download	RS232 (selectable baud rate)
Power system	
System	3 x 1.5V C (MN 1400, LR14) cells
Environmental	
Probe	Waterproof (pressure rated to 100 m)
CDU	IP66
Operating temperature	0 °C to +45 °C
Storage temperature	-10 °C to +50 °C



# Void Scanner

Laser-based cavity monitoring system



The affordable Carlson Void Scanner is a survey and inspection tool designed for use in extreme environments to work quickly, safely, and accurately. The specialized and ruggedized Void Scanner uses time-of-flight laser measurement to map the shape, position, and spatial location of cavities quickly, giving site managers the information needed to plan more profitable projects, improve operational efficiency, and, importantly, ensure high standards of safety in potentially hazardous locations.

## Applications for mining and civil engineering

Void Scanner solves a wide range of underground surveying challenges at a low cost, including the following:

- Gallery, void, and stope surveying
- Ore pass monitoring
- Mine design management
- End-of-shift extraction volume scanning
- Compliance, environmental, and safety management
- Underground blast planning
- Drive surveys
- Pre- and post-excavation mapping
- Storage silo volume measurement
- Project profitability/feasibility planning

## Benefits of use

Reach otherwise inaccessible or hazardous locations safely to determine the exact volume and position of air-filled underground spaces. This helps to provide:

- Enhanced safety - Ensure the safety and compliance of current operations and future projects with Void Scanner's detailed models of underground voids
- Increased profitability - Use Void Scanner to map the shape and dimensions of underground voids, thus helping to manage dilution and ore loss in the mine
- Better planning - Support new project planning with Void Scanner's full 3D images of sites that can be exported into CAD packages to plan for new extraction, installations, or mine workings



VISIBLE AND INVISIBLE  
LASER RADIATION  
DO NOT STARE INTO BEAM  
CLASS 2 LASER PRODUCT



## Engineered for precise, safe underground use

### How Void Scanner works

The Void Scanner laser sends out infrared pulses, which reflect off solid surfaces and are received back into the probe to provide quick, precise, and safe surveying of underground voids. Distance measurements are accurate to  $\pm 5$  cm and the encoders measuring the direction of the laser are accurate to  $0.2^\circ$ .

The scan information is corrected by internal pitch-and-roll sensors to produce real-time XYZ coordinates for each data point. This allows the data to be accurately geo-referenced in the mine's co-ordinate system and multiple scans can be stitched together. The output data can then be plotted against design drawings or as-built data to build a 3D representation of the project site.

### Specialized features

#### Ease of use

Quick set-up and simple operation – it takes 5 minutes to unpack the system, connect cables, mount to the boom, and ready the software – speeding regular stope volume calculations.

#### Speed of operation

Complete a full scan in  $1^\circ$  increments in less than 12 minutes with the 200 points-per-second scan rate,  $360^\circ$  horizontal scan, and vertical scan extent of  $270^\circ$ .

#### Flexible deployment

Mount the Void Scanner via tripod, boom, mast, and crane to enable safe operation where access is limited or dangerous.

#### Optional wireless connectivity

Control the Void Scanner wirelessly from a position of safety (up to 50 meters if needed) with the optional WiFi box that includes a rechargeable battery, a wireless module, two power options, and a ruggedized IP65 Peli™ case enclosure.

#### Multi-station project capabilities

Scan from multiple locations and view the resulting 3D data together in real time for a complete 3D representation of a mining or construction project site.

## VS Software - Intuitive design and navigation

Running on a rugged field PC or tablet, Carlson's Cavity Profiler – VS package controls the Void Scanner, guiding users through deployment and processing and enabling visualization of scans in real-time as data is collected. This saves time both in training of operators and when in use on-site.

The software's post processing tools enable operators to analyze, edit, and filter data as required. Geo-referenced point clouds or modeled surfaces can be exported in a number of industry-standard formats for easy integration with third-party processing software packages.

## Tested to guarantee high performance

Developed for use underground, Carlson's Void Scanner has been subjected to rigorous environmental testing to guarantee high performance operation within specified limits of temperature, pressure, humidity, mechanical stress, and other adverse environmental conditions. Testing includes IP65 dust and water protection and performance in extremes of temperature and humidity. Inspections also include:

- Shock testing
- Acceleration testing
- Vibration testing & drop testing

**Cavity Profiler – VS is the ideal choice for mining and construction projects where time is at a premium**

Reduce setup time with auto-connection to the probe.

Visualise scans in real time as data is collected. Software shows scanner inclination and position at all times.

Obtain a closed 3D model and volume within seconds of finishing a scan with one-click surfacing and volume calculation from raw scan data.

Calculate the width, height, and length of tunnels, as well as the volume, shape, position and spatial location of voids.

Rotate the data if orientation not known prior to scan commencing.

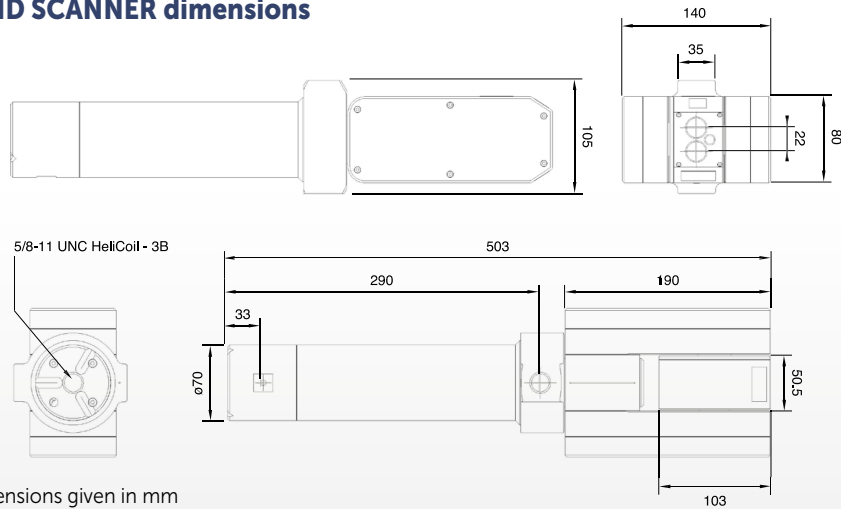
Conduct point cloud editing and visualisation on site to support swift operations.

Shift the dataset if collar co-ordinates not known prior to scan commencing.

Use 3D manipulation tools to visualise data.

Export to industry-standard formats, including LAS and DXF, allows easy integration with third-party processing software.

## VOID SCANNER dimensions



Dimensions given in mm

### Angle measurement

<b>Type</b>	Opto-electronic encoder	
<b>Accuracy</b>	0.2°	
<b>Resolution</b>	0.1°	
<b>Range</b>	<b>Vertical</b>	+ 135° to -135°
	<b>Horizontal</b>	0° to 360°
<b>Motion</b>	Servo-driven gear systems with manual clutches	

### Pitch-and-roll sensors

<b>Type</b>	Accelerometer based
<b>Pitch-and-roll accuracy</b>	± 0.2°
<b>Pitch-and-roll range</b>	360°

### Physical data

<b>Construction</b>	Machined aluminium and stainless steel
<b>IP degree of protection**</b>	IP65
<b>Operational temperature range</b>	-10 °C to 45 °C
<b>Transit case dimensions</b>	620 mm x 480 mm x 240 mm
<b>Weight</b>	Probe: 5 kg / System in transit case: 23 kg
<b>External power input</b>	10 to 15 V dc and 110 to 240 V ac
<b>Power consumption during scan (typical)</b>	9.6 W

\* Viewing laser output with optical instruments designed for use at a distance (e.g. binoculars) may pose an eye hazard.

\*\* Max measuring ranges are recorded against Kodak white card (90% reflectivity).

\*\*\* Environmental compatibility requirements of EN 60529:1992+Al:2002.

## Void Scanner

### Laser module

**Laser classification (BS EN 60825-1 : 2014)** Class 2\*  
(21 CRF 1040.10 and 1040.11 except for deviations pursuant to Laser No 50, dated 24 June 2007)

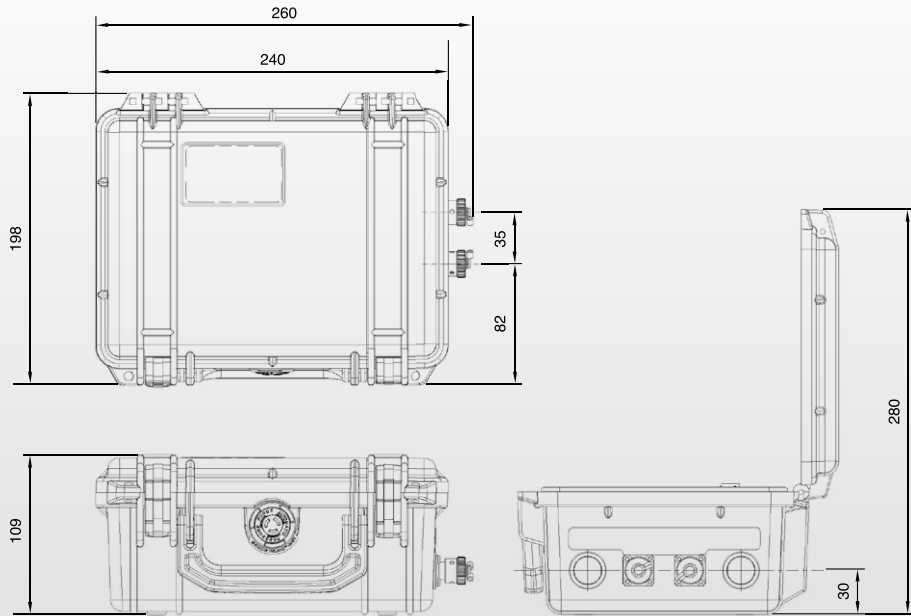
### Infrared laser module

<b>Type</b>	InGaAs laser diode
<b>Wavelength (typical)</b>	905 nm
<b>Maximum energy per pulse</b>	1.06 µJ
<b>Beam divergence</b>	2.76 x 1.5 mrad
<b>Resolution</b>	1 cm
<b>Maximum range to a passive target**</b>	Up to 150 m
<b>Minimum range</b>	0.5 m
<b>Lens aperture size and location</b>	18 mm location at front of module

### Visible laser module

<b>Type</b>	InGaAs laser diode
<b>Wavelength (typical)</b>	650 nm
<b>Maximum power</b>	<0.6 mW
<b>Lens aperture size and location</b>	3 mm location at front of module

# Void Scanner Wi-Fi Box



Dimensions given in mm



## Void Scanner Wi-Fi Box

### Physical data

IP degree of protection*	IP65 (when lid is closed and connector caps fitted)
Operational temperature range	-10 °C to +45 °C
Storage temperature range**	-20 °C to +50 °C for up to one month (thereafter -20 °C to +35 °C)
Dimensions	260 mm x 198 mm x 109 mm
Weight	2.0 kg

### Power

Internal battery	14.4 V dc, 6.8 Ah lithium-ion battery
External battery	Optional Carlson-supplied 14.4 V dc, 6.8 Ah lithium-ion battery pack
Max current	3.15 A
Max power rating	45.4 W
Fuse	T3.15 AH 250 V

### Operations

Connection to Void Scanner	Via power/data cable: supplied 1.5 m cable or standard 13.6 m cable
Data connections	Wi-Fi connection to PC or handheld tablet RS232 connection to Void Scanner probe
Continuous scanning time (typical***)	6 hours on internal battery
Wi-Fi range (limit)	>50 m line of sight
Charge time	3 hours (approx.)
Charging temperature	+10 °C to +45 °C

### Compatibility

Void Scanner probe	Mk3 onwards
Wi-Fi frequency range	2.412 GHz–2.484 GHz
Wi-Fi standard	802.11 b/g/n
Operating system	Windows versions 7, 8 and 10
Software	Cavity Profiler – VS: version 1.3 onwards

\* Environmental compatibility requirements of EN 60529:1992+A1:2002.

\*\* Storage at up to 50 °C permissible within guidelines. Prolonged storage at high temperatures will dramatically shorten life.

\*\*\* Under standard test conditions.

# FiX1

## Fixed Installation Scanner



The **Fixed Installation Scanner (FiX1)** from **Carlson** provides a simple, automated method for obtaining volumetric data of stockpiles in many different installation scenarios. The system can be scheduled to scan, process and deliver a result without any user intervention. With remote connectivity through Cellular and Wi-Fi networks, the **FiX1** can be permanently installed into inaccessible areas. It can be left to carry out volumetric scans which are triggered manually or by a user-defined schedule.

Several **FiX1** units can be configured into a single system. One unit acts as the master, with up to eight slaves connected to it. All the slaves are accessed and controlled through the master unit.

The **FiX1** is not limited to volumetric data. At its simplest it will output a volume at the end of any scan. However, it also stores a timestamped archive of the collected point clouds which can be downloaded via the numerous connection options. This allows the **FiX1** to be used as a standard laser scanner.

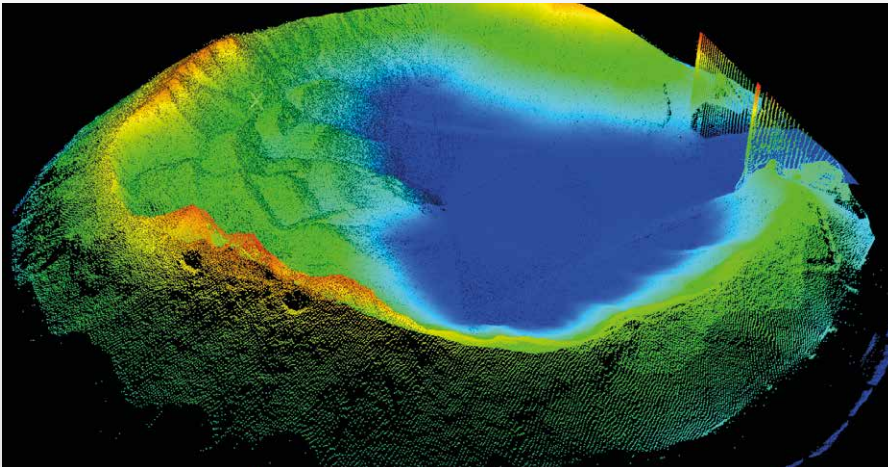
### Advantages of the FiX1

- **Automated delivery** of volumetric data
- Provides **stockpile volume information** or detailed scans in geographically remote areas without assigning man power and measurement tools.
- After installation, **no knowledge of surveying, data processing or point cloud manipulation** is required by users.
- **Improves safety** by removing the need for feet on the ground in potentially hazardous areas, such as quarries or open pit mining.
- **Identify trends** in material stockpiling or usage.
- Multiple units can be **connected in a network** to allow monitoring of large stockpiles or distinct unrelated locations within a site.
- **Web interface** accessible through cellular, Wi-Fi or ethernet.
- **Resolution of scans** can be adjusted to meet time requirements. A fast, low resolution scan can be completed in 5 mins. Slower, high resolution scans can take 25 mins.
- **Versatile mounting plate** supplied for easy installation.
- **Options to mount** the unit hanging down or sat upright.
- **Serial and USB ports** provide opportunities to interface with external sensors for more advanced configurations.
- **Rugged design** for durability in extreme conditions:
  - IP67
  - Temperature range of -40 °C to +50 °C.
- **GPS/GLONASS** for site location and identification.



## How it works – System

- A **common web interface** is provided across the three connectivity options, Cellular, Wi-Fi and Ethernet.
- The web interface presents a **complete history of scans and volumes** that the user can download, if required.
- **Scheduled scans** can report completion and volumetric data via email and SMS.
- The web interface provides **access to all settings and diagnostics** such as scheduling of scans, system performance, laser and motor configurations.
- **Fault reporting** can be accessed through the web interface and alerts sent to email.
- The software for the FiX1 is **remotely upgradeable** through the web interface.
- In a multiple system configuration, the master provides the **connection to all networked systems** so that they can be configured and accessed through a single interface.

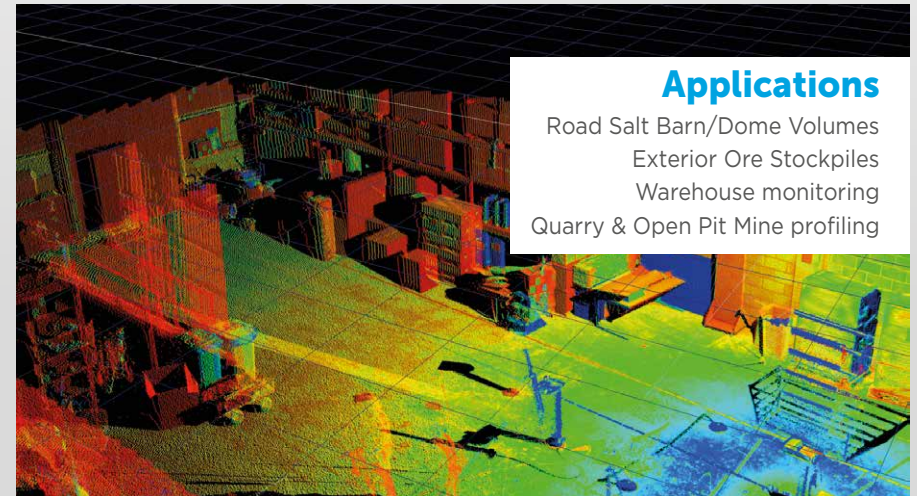
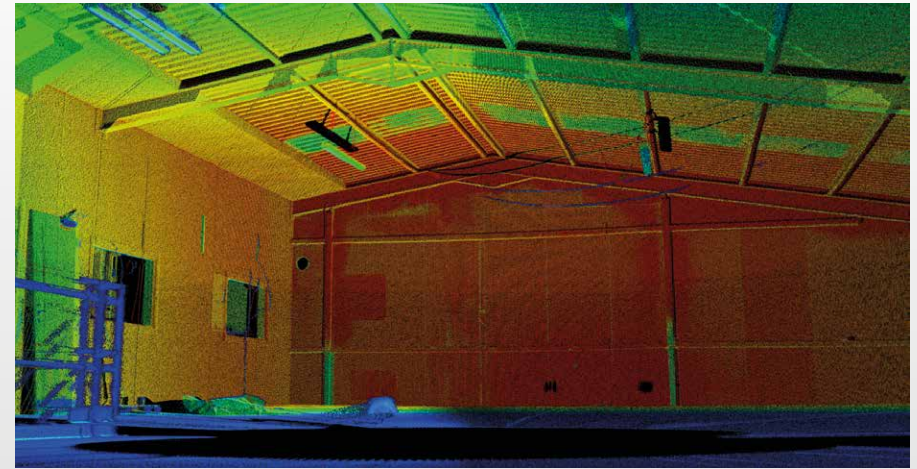


## How it works – Volumetric Data

- If a volumetric scan is activated the FiX1 will generate a point cloud, extract the region of interest and calculate the volume of material in that area. The volume is presented to the user through the web interface without any need for further manipulation.
- Volumes can be verified by examining the linked point cloud data for foreign objects and anomalies.
- Volumetric accuracy can be user-defined through the setting of laser and angle resolutions in the web interface.
- The web interface provides a graphical representation of how volumes have changed over time.
- Data for a multiple FiX1 system is automatically stitched together based on references created during installation and therefore a total volume can be calculated without the need for manual intervention.

## How it Works – Laser Scanning

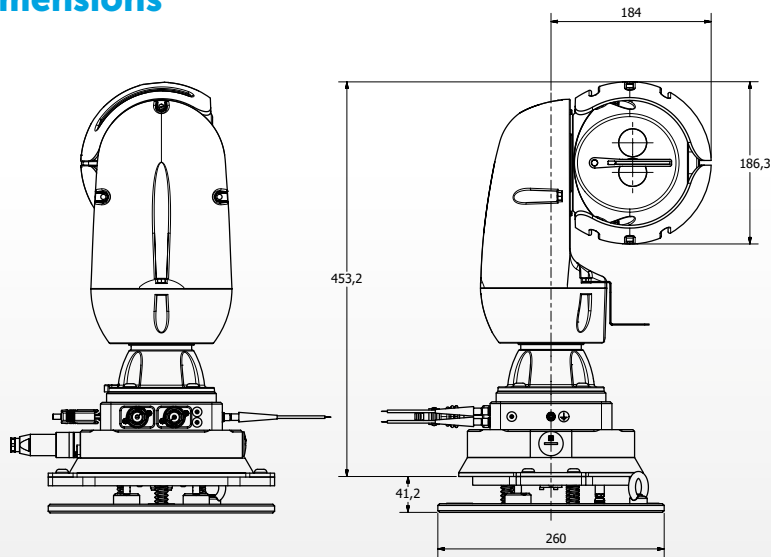
- By default, all **point cloud data is stored in the FiX1**. This information can be downloaded from the FiX1 in the common '.las' format.
- Like the volumetric calculations, **the resolution of point cloud data** can be configured through the web interface.
- **Automatic stitching** of the point clouds in a multiple scanner system is carried out by the referencing of each FiX1 during installation.
- **Point clouds** for distinct and isolated FiX1 systems in a multiple scanner setup can be downloaded in isolation through the FiX1 master.
- Point cloud **manipulation and processing** can remain 'invisible' to the user for regular operations.



### Applications

- Road Salt Barn/Dome Volumes
- Exterior Ore Stockpiles
- Warehouse monitoring
- Quarry & Open Pit Mine profiling

## Dimensions



### Laser Module

Type	InGaAs Laser Diode
Wavelength (typical)	905 nm
Accuracy*	±10 mm
Maximum Energy per Pulse	0.461 µJ
Beam Divergence	2.25 x 1.5 mrad
Range Resolution	10 mm
Maximum Range to Passive Target**	250 m
Minimum Range	0.5 m
Lens Aperture Size and Location	28 mm located in tilt head
Beam Footprint at 50m	141 mm x 103 mm
Maximum Measurement Rate (points per second)	15000 Hz

### Physical Data

Size	(H x W) 495 mm x 314 mm (rotational clearance 368 mm)
Weight	12.5 kg
Power	85 – 265 VAC, 80 W

### Environmental

Water & Dust Resistance	IP67
Operating Temperature	-40 °C to +50 °C
Storage Temperature	-40 °C to +85 °C

### Angle Measurement

Type	Opto-electronic Encoder
Angular Accuracy	0.0055°
Pan Angle Resolution	0.0055°
Tilt Angle Resolution	0.0055°
Pan Range	360°
Tilt Head Range	360°
Scanning Field of View (Pan)	360°
Scanning Filed of View (Tilt)	200°
Motion	Servo controlled Brushless DC Motor

### External Connections

Serial	Rugged 9-Pin D-Type
Ethernet	Rugged RJ45
USB	Rugged STD USB A Female
Antenna	3 x 50Ω SMA (IP67)
Power	4-pin Rugged Binder Connector
SIM Card	Access via IP67 threaded plug

### Connectivity

Serial	115200 baud, with 12 V, 1 A power. Isolated data and power.
USB	Full Speed USB2.0 with 5 V, 500 mA isolated power.
Ethernet	10/100 Base T
Wi-Fi	<ul style="list-style-type: none"> <li>• 802.11 b/g/n 1x1 (1-14, max channel width 20 MHz)</li> <li>• Up to 72.2 Mbps OTA throughput, 50 Mbps actual throughput</li> </ul>
Cellular	<p><b>2G:</b></p> <ul style="list-style-type: none"> <li>• GSM/GPRS/EDGE (multi-slot class 10) note: only EDGE RX mode supported</li> <li>• Quad band support (GSM850/E-GSM900/w DCS1800/PCS1900)</li> </ul> <p><b>3G:</b></p> <ul style="list-style-type: none"> <li>• WCDMA (HSDPA 21Mbps cat14 / HSUPA 5.76Mbps cat6)</li> <li>• Quad band support (band 1 / 2 / 5 / 8)</li> <li>• Class3 power class</li> </ul>
GNSS	<ul style="list-style-type: none"> <li>• GPS/GLONASS receiver</li> <li>• Assisted GNSS</li> <li>• SBAS: WAAS, EGNOS</li> </ul>



\* Max measuring accuracy recorded at 50 m against Kodak white card (90% reflectivity) to 1σ. Accuracy is defined as the degree of conformity of the measured sample mean range to its actual (true) value, measured with reference to a total station under Carlson test conditions.

\*\* Max measuring ranges are recorded against Kodak white card (90% reflectivity).  
Carlson Software maintains the right to change the specifications.

**By Surveyors, For Surveyors**  
**Carlson Works for You**



[www.carlsonsw.com](http://www.carlsonsw.com)



## The Complete Workflow

Offering powerful software, with comprehensive yet easy-to-use features, backed by dedicated customer service, Carlson is used world-wide by professionals in land surveying, civil engineering, construction, machine control, mining, crash/crime investigation, and agriculture.

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