

## C-ALS® Cavity Auto-scanning Laser System



### Plan new projects

Assess risk, design solutions based on accurate data, add C-ALS data to your existing maps and devise new programmes of work.



### Increase productivity

With accurate maps of voids and stopes, you can design plans that allow for efficient mining or construction projects.



### Improve safety

Map inaccessible underground areas to ensure that operations are risk-assessed to keep your workers safe.



## Key benefits of the C-ALS system

### C-ALS supports successful projects

C-ALS is a unique laser system that gives you new underground mapping capabilities. You can safely, quickly and reliably scan inaccessible underground workings, and upload the scan data to your existing mapping software. This gives you the information you need to:

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

Voids and abandoned mines can pose a serious potential threat to worker and public safety due to the possibility of failure and collapse. Traditionally, investigations of inaccessible voids were impossible, or involved vast numbers of exploratory boreholes. The Renishaw C-ALS system enables laser scanning of air-filled voids in order to create geo-referenced 3D models of subsurface conditions as a cost-effective, comprehensive and accurate alternative to systematic drilling.

In a wide range of applications – including underground and open-cast mining, construction, subsidence investigations and subterranean excavations – the C-ALS system ensures that vital work is neither delayed nor prevented due to a lack of data. It also avoids putting workers and the public at risk. With low cost of ownership and minimal operator training required (C-ALS does not need to be operated by a surveyor), C-ALS opens up new possibilities for safe, profitable operations.

### The advantages of C-ALS laser scanning

- The C-ALS system's unique 50 mm diameter allows deployment into cost-effective narrow boreholes
- Survey potentially dangerous underground voids safely
- View results in minutes not days
- Remotely controlled operation
- Flexible deployment methods
- Easily transported
- Precise and accurate cavity/void measurement
- Rugged design and construction ensures durability in extreme environments
- 360° spherical coverage gives you a full view from a single scan, with no blind spots
- The IP67 rating gives you the confidence that the Renishaw C-ALS system can withstand submersion to a depth of 1 m, reducing the risk of damage if accidentally deployed into a flooded cavity. C-ALS can also withstand extremes of temperature and high humidity



## C-ALS applications

### Unique ability to scan through even the narrowest boreholes

The Renishaw C-ALS system can be used in a huge range of applications where an inaccessible void exists and accurate data is required in order to monitor excavations, assess risk or design solutions, including:

- Subsurface voids and cavities
- Undercrofts
- Underground chambers and tanks
- Duct surveys
- Inaccessible roof spaces
- Subsidence investigations
- Slope surveys
- Ore passes
- Collapsed mine workings
- Culverts
- Shafts and bunkers
- Underground caverns
- Industrial production facilities with limited or unsafe access

Once deployed, C-ALS provides more detailed, accurate data than alternative technologies, such as ground-penetrating radar, and is the only borehole-deployable laser-scanning solution on the market.

The C-ALS system can also be used to enhance safety in areas where visibility is low or the entrance to a void is unstable. It can be deployed long distances into stopes on a cable or rods, as well as on a boom and/or remote-controlled vehicle from a safe and secure area. Once C-ALS has entered the unsafe void, data can be collected.

### Cavity surveys to support underground or surface mining projects

The existence of an underground void does not necessarily represent a significant subsidence hazard. However, by using C-ALS to determine the size and extent of openings, spacing and size of pillars, mining customers have been able to evaluate and accurately assess risks. In many cases this knowledge can be used to prepare for a range of ambitious new mining programmes.

Mine managers need a complete picture of the situation underground before committing to projects or deploying workers, and the C-ALS system supports them by providing data on the following:

- Excavation and infill of stopes
- Accurate location of voids
- Geometry and condition of mine workings
- Inaccessible historic workings
- Collapsed areas
- Erosion of ore-passes
- Volumes of voids
- The position of cavities in relation to other underground workings and structures
- Size of remaining pillars
- Failure mechanisms (sinkholes/troughing)
- Location of the workings relative to surface features

C-ALS is ideal for providing 3D data on inaccessible underground cavities. Mine managers can assess the stability of mine works and judge whether or not a cavity needs to be filled, whether work can proceed, and what project plans should be put in place to maximise productivity and safety.

Open-pit operations taking place over historic underground workings can pose serious threats to worker safety. The old mines will frequently be poorly mapped or will have shifted over the years due to collapse, void migration, flooding and seismic activity. A full understanding of the layout of underground workings and their relation to surface operations is essential to safe open-pit operations using heavy machinery, explosives and personnel. Traditionally, it has been very difficult or dangerous to collect this information. The Renishaw C-ALS system can be used from the surface to map out the network of old voids and to provide detailed visual record of the subsurface environment.



## Void surveys in construction and geo-technical projects

Many different construction and geotechnical projects may need to identify, measure and map voids below the project site. Where such voids cannot be easily or safely accessed, various technologies, such as ground-penetrating radar may be used to detect the void, but results can be limited by depth and geology, and can be difficult to interpret.

C-ALS is ideal for such applications. After locating the approximate position and extent of the void/cavity from GPR or previously held data, a borehole is drilled into the void or cavity and the C-ALS system is deployed via the borehole or other small access point. Once inside the void, the laser head opens out to measure the 3D shape of the entire void. The scan data can then be analysed visually, measurements can be taken, and a volume calculated.

## Pre- and post-construction subsidence surveys

The presence of old mine workings or voids underlying residential and commercial properties, transportation and infrastructure facilities can cause differential settlement, sinkholes or even catastrophic collapse.

While historic mine maps can help determine the geometry of voids, their depth, and the nature of overlying strata, they do not help identify the results of retreat mining, pillar theft, spontaneous collapse or other subterranean movements.

Engineering solutions can be put into place to counter problems caused by old underground workings, but designing these solutions requires a complete picture of the situation underground. By deploying the C-ALS system into these otherwise inaccessible areas, the required data can be collected and the area comprehensively mapped.

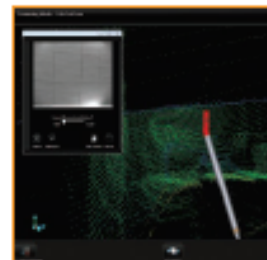
## User-friendly software

Renishaw's new software for C-ALS makes it easier and quicker for operators to use the system, by guiding them through the process of deploying and scanning.

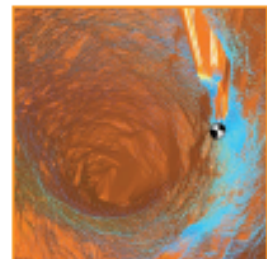
- Quicker navigation and intuitive design supports new operators
- Software, viewable on the connected PC, shows the scanner's inclination and heading at all times
- One-click surfacing and volume calculation from raw scan data enables you to obtain a closed 3D model and volume within seconds of finishing a scan
- Point cloud editing and visualisation can be conducted on site to support swift operations
- Auto-connection to the C-ALS probe reduces setup time
- Live recording from the C-ALS camera into WMV makes it easy to save and share video footage
- Live viewing of incoming point cloud data as a scan is in progress gives operators peace of mind or allows for a new deployment
- Guided workflow reduces training needs and improves efficiency
- A 3D scanner icon models the heading and inclination of the C-ALS probe so that operators can 'see' the probe, even when it is underground
- Export to a number of industry-standard formats, including LAS and DXF, allows easy integration with third-party processing software packages



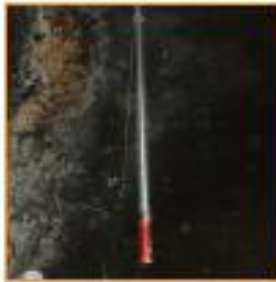
The ruggedised PC enables you to carry out operations on site in extreme environments.



C-ALS provides accurate point cloud data in a matter of minutes not days.



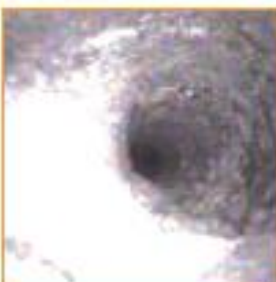
Laser cavity scans are easy to export into a large range of software packages.



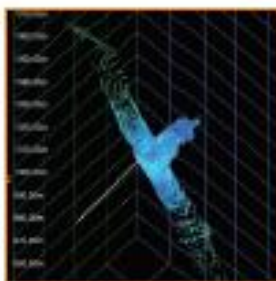
The C-ALS system deployed downhole to survey an inaccessible underground void.



C-ALS can be deployed by methods including ziplines, booms and remotely controlled vehicles.



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.

- With a diameter of just 50 mm, the Renishaw 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. C-ALS can also be deployed by boom or by remote-controlled vehicle.
- A nosecone camera sits on the end of the C-ALS probe and provides an on-screen video and a real-time view of the borehole as the probe is deployed, so operators can see any obstructions, and judge the point at which C-ALS enters the void.
- The C-ALS probe incorporates pitch-and-roll sensors and has the option of an internal compass. The sensors ensure C-ALS can be tracked down the borehole and that the scan is automatically geo-referenced to fit into existing 3D mine data.
- Once in the void, a simple click from the operator tells the laser-scanning head to rotate on two axes, measuring the three-dimensional shape of the void, with full 360-degree coverage and no blind spots, and with a range up to 150 m.
- Operators control C-ALS from a distance, via the robust, rugged PC that is included in the package. Built to work in tough conditions, this PC is linked to the C-ALS system by Ethernet cable or a WiFi link. From a safe distance, they can view live data, analyse point clouds and create models.
- The use of the remote PC keeps operators safe while offering broad visibility of the probe's location and what is happening underground.

