Monitoring stockpiles with the Elios 3 vs TLS. Holcim Eclepens

How the Elios 3 drone compares to terrestrial laser scanners for measuring stockpile volumes at a cement plant.

Introduction

In 1951, the site of Eclépens was chosen to host the first cement plant in French-speaking Switzerland. The site alone combines three decisive advantages: the proximity of a large limestone reserve in Mormont and a marl reserve in Côtes de Vaux, land available with the possibility of connection to the railway, a central location in the canton of Vaud and French-speaking Switzerland.

At this site for Holcim Eclépens, there is a third-party surveying company that surveys material stockpiles.
These surveys are important as they help determine:

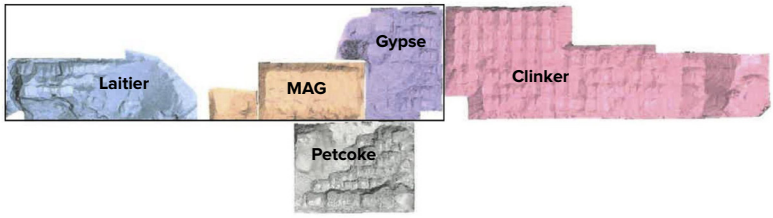
- How much of a material is present in stockpiles within a mine.
- How much of a material is present in storage.
- How much of another material will be needed for backfilling empty chambers from which the extracted material has been removed. This last use helps determine the amount of material needed to fill a chamber, and it also determines whether the initial volume calculation for how much material could be taken out matches how much material was actually taken out.

This stockpile inventory takes place on the last week of every month, where a series of material stockpile monitoring is done to keep track of the material in each stockpile, all of which is critical for concrete manufacturing. The material being measured includes Laitier, Magnesium, Gypsum, and Clinker.

The goal of this document is to compare stockpile measurements with the traditional method with the airborne LiDAR on the Flyability drone Elios 3. The comparisons will be judged in in terms of Speed, Efficiency, Accuracy, and Safety. An indoor stockpile was selected for this test and is part of the Holcim Eclépens plant. This location has a monthly stockpile assessment used for measuring inventories of Gypsum, Magnesium, and Slag.

Key Findings:

1. The Elios 3 is 92% more efficient than traditional methods with a laser scanner
2. Results from the Elios 3 are accurate within +/- 2cm of terrestrial laser scanners
3. The drone results had high precision, with an average volume of error +/- 1%



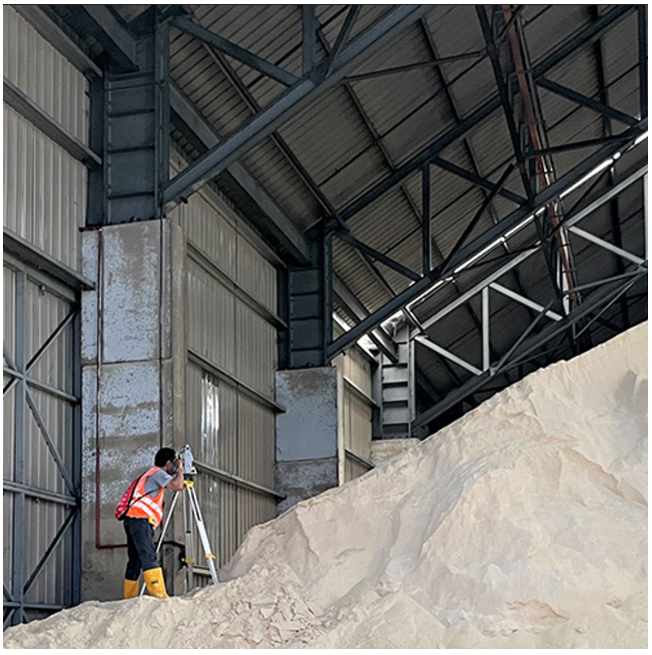
Traditional methods of measuring stockpiles

The traditional methods of stockpile measurements can vary, depending on the operation and material type. These types of measurements include manual measurements with measuring tapes or handheld tools, ultrasonic level measurements, theodolite or total station point measurements, and in some outdoor cases, the use of a GPS rover.

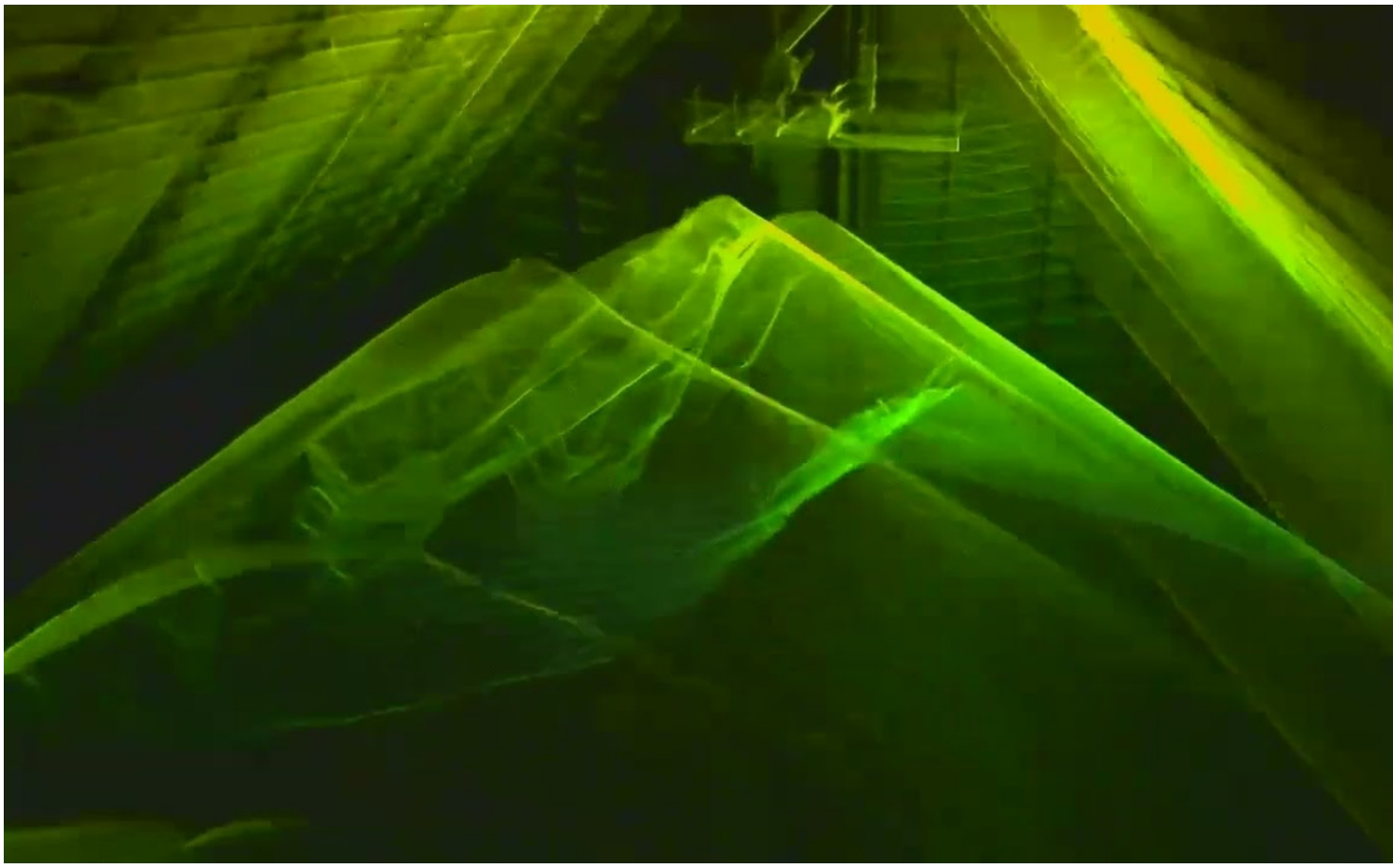
Today the most common method of stockpile inventory measurement is terrestrial laser scanning. Laser scanning, also known as LiDAR (Light Detection and Ranging), is a widely used technology for surveying and creating detailed 3D models of various objects and environments, including stockpiles. It utilizes laser beams to measure distances and capture data points, which are then used to create accurate representations of the scanned area in a point cloud.

Terrestrial laser scanning has been a popular choice as it provides exceptional accuracy in capturing detailed point cloud data. This accuracy is crucial for precise stockpile measurements, especially when dealing with valuable or critical materials where even small variations can have significant implications.

Stockpiles often have uneven surfaces, irregular shapes, or areas with obstructions. Terrestrial laser scanners are capable of capturing data from multiple angles and positions, making them effective at mapping the intricate features of stockpiles, including complex surfaces or areas with significant variations in height.



The captured point cloud data from terrestrial laser scanning can be processed and visualized with specialized software tools to generate accurate 3D models of the stockpile. These models enable detailed analysis, volumetric calculations, and measurements of the stockpile, providing valuable insights for inventory management and decision-making.



Using laser scanners to measure stockpiles comes with a range of benefits as well as obstacles.

Terrestrial laser scanners are a tool that can be repeatedly used, allowing for regular measurements to be made over time. By performing periodic scans, you can track changes in the stockpile's volume, shape, and surface characteristics, enabling better monitoring of stockpile inventories and identifying any discrepancies or variations.

In addition, terrestrial laser scanning (TLS) eliminates some of the need for surveyors to physically climb the stockpile, which can be very dangerous due to the unstable nature of the material. However, in a lot of cases, even when the stockpile topography is complex or there is poor access to traverse with the TLS, the surveyors are still required to climb the stockpile.

Finally, stockpile areas need to be shut down or locked out so the surveyor team can enter the area safely to conduct the survey. This adds to the complexity of the entire stockpile monitoring system and can slow down overall operations.

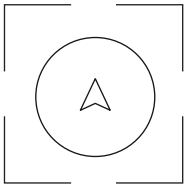
Data collection is more than ten time faster with Elios 3

The Flyability Elios 3 is a specialized indoor inspection drone designed for confined spaces and challenging environments. While it is primarily intended for indoor inspections, it can also be used for mapping applications from mining to industrial asset management, including stockpile measurements.

To collect the data, instead of surveyors climbing the stockpiles with terrestrial equipment or needing multiple setups due to the topography of the stockpile, the entire stockpile can be captured by one person using the remote controlled drone from a single location, out of the danger of dusty environments and machinery/plant infrastructure. This also means that the stockpile area does not have to be shut down or “ locked out” as the flights can be conducted when the stockpile area is in operation.

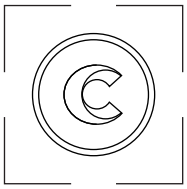
In addition to making the process faster, the Elios 3 gathers data that is used to create 3D models that provide greater accuracy regarding stockpile calculations than the calculations made using manual methods like handheld tools. This Elios 3 stockpile measurement method is also easily repeatable on a weekly or monthly basis and requires less training than terrestrial equipment.

Comparing the Elios 3 drone with Terrestrial Laser Scanners data capture



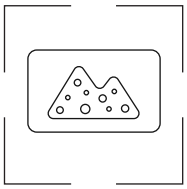
Setup and capture

Setup your site and capture your data quickly and easily quickly and easily with the Elios 3 and capture reflective targets as you fly.



Process

Transfer the data to a computer, and FARO Connect will process, align and clean the scan and place it in the listening folder for FARO's GeoSLAM Volumes.



View

The data can be viewed in the FARO's GeoSLAM Volumes viewer. The graph as well as the report is updated automatically.

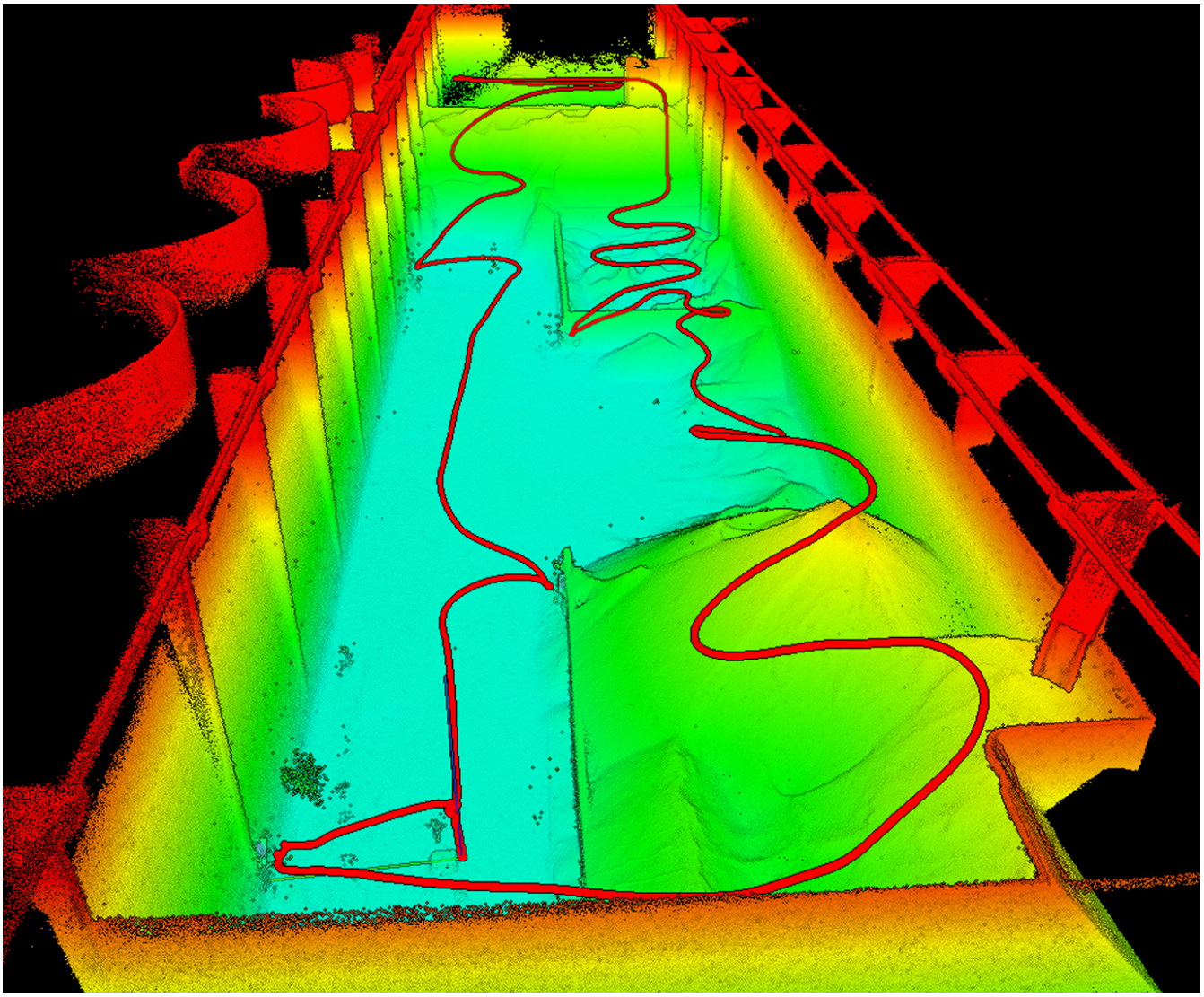
Create

You can now create a report or excel sheet for import to 3rd party systems such as SCADA.

When comparing the speed, efficiency, accuracy, and safety of the data collection over the same period of time, the stockpile area was laser scanned using a terrestrial laser scan and the Elios 3 was flown simultaneously, so a true comparison of the speed and accuracy of volumes could be made.

In terms of the Elios 3's flight, a very simple manual flight in assisted mode was made of the stockpile area. The flight took approximately 7 minutes and was conducted with personnel standing outside of the stockpile building, adding to the safety factor of not needing to be inside the building to complete the data capture.

The same area was laser scanned using terrestrial methods. A total of 6 individual scans were made so that the entire volume and topography of the stockpile building was thoroughly covered. This operation took approximately 1.5 hours and also involved the surveyor scaling the stockpile on foot to make sure that the terrestrial scanner was able to produce 100% coverage of the stockpile area.



Example of a flight made using the Elios 3 showing the trajectory.

Care was taken during the flight to make sure that the stockpile area was thoroughly covered. The Live Flyaware Cloud, produced by the onboard SLAM algorithm of the Elios 3 and displayed on the drone's remote controller's Cockpit, gave a perfect indication of the coverage which was achieved when flying the Elios 3 and also enabled the pilot to make sure that the entire area has been completely covered before returning to the pilot who could start processing the LiDAR data.

Elios 3 in flight showing the Flyaware live cloud

Processing data from the Elios 3 stockpile measurement flight

From drone to volume

FARO Connect (formerly GeoSLAM Connect & GeoSLAM Volumes) is a software platform that allows for 3D visualization of data and workflow automation. FARO Connect was used to process the flight data from the Elios 3 into a high dense point cloud. Data can automatically be processed, saved in a predesignated folder of choice, and prepared for the next step of a user's workflow.

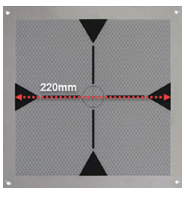
The data was uploaded to FARO Connect and the Indoor stockpile capture environment was used as a processing template. This capture environment will automatically filter and thin the dataset to maintain the coverage, but reduce the amount of LiDAR points, so the data set is less dense with reduced noise and more manageable to use in third party software.

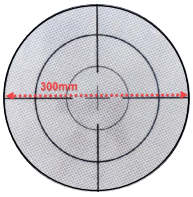
As this stockpile area will be surveyed every month, 4 retro-reflective targets were placed so that the FARO Connect Reflective target alignment workflow could be performed. These targets can align two or more point clouds, using common reflective targets captured within the scans. These targets can also be used to automatically georeference point clouds with known control points.

In this case, every time a new flight is performed, the flight data can be aligned to within 2cm of the previous flight using this automatic retro-reflective target alignment workflow. This increases the efficiency of producing replicable scan data and avoids the need to manually align and match each individual flight, which in turn, can increase the risk of accumulating errors in the stockpile volume data.

The specifications of the targets are as follows:

Material	Survey grade or 3M Diamond grade retroreflective targets
Size	300mm x 300mm (recommended) | 200mm x 200mm (minimum)
Shape	Circular or square
Number of targets	6x targets recommended | 4x targets required





Target geometry examples

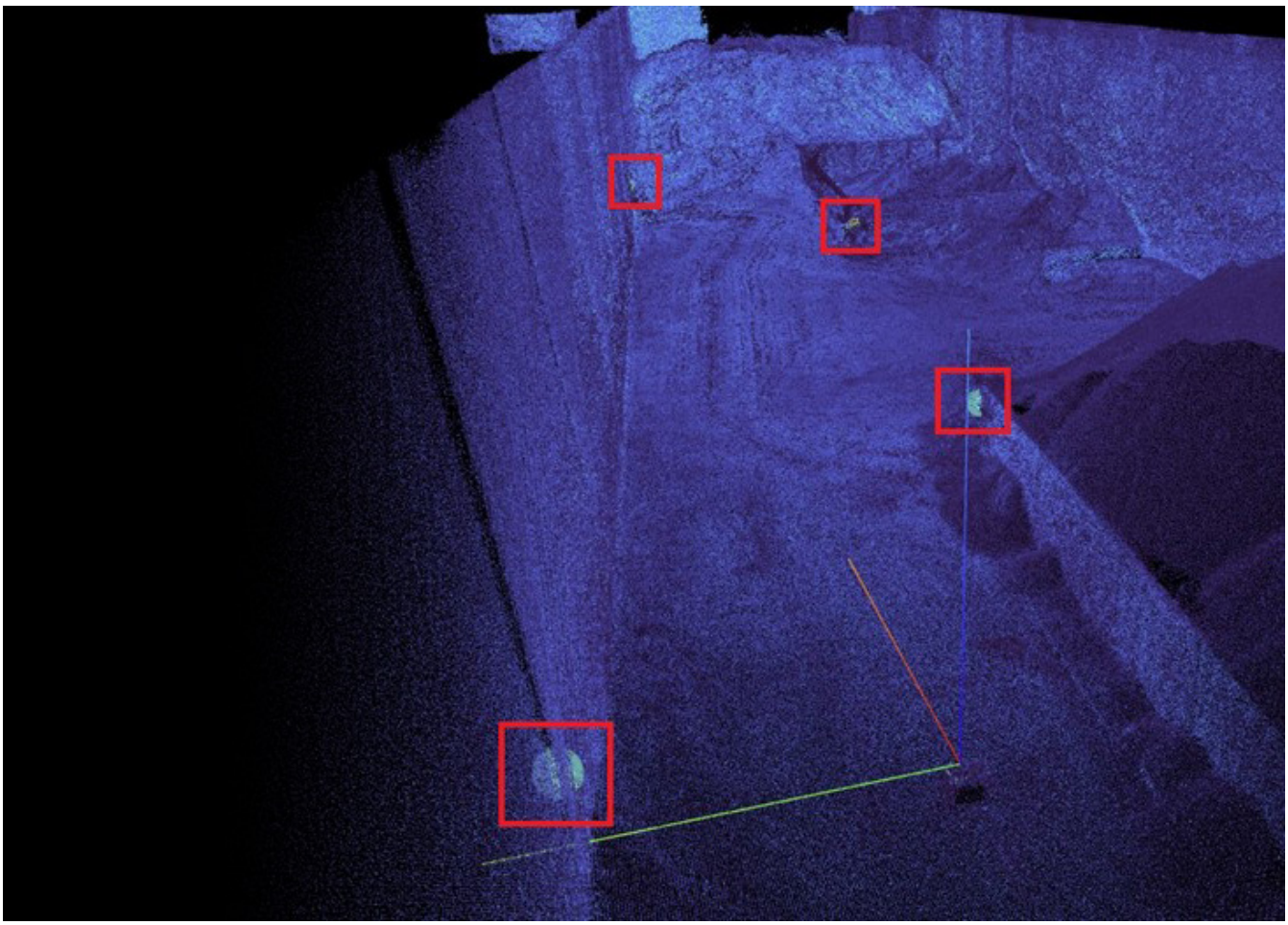
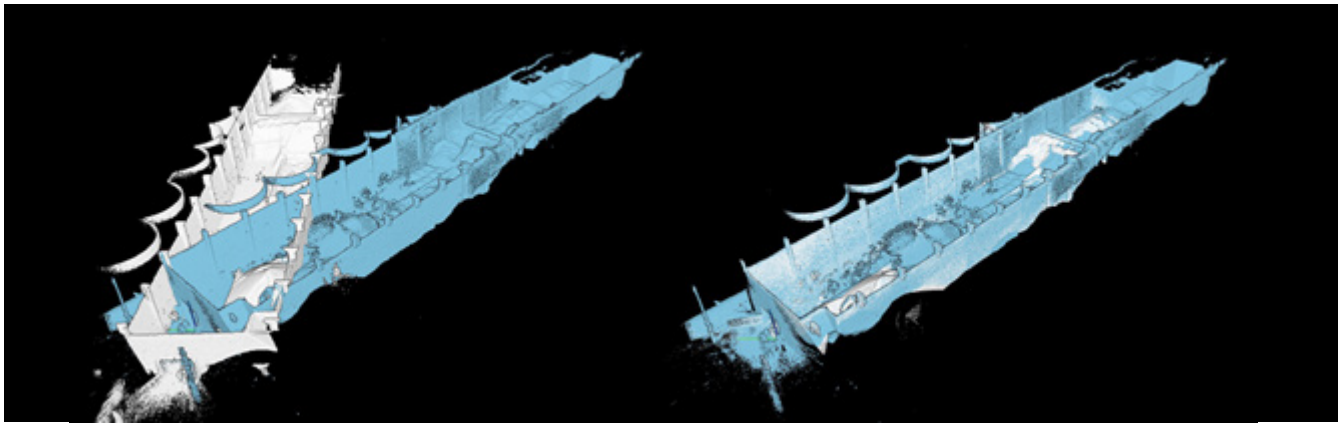


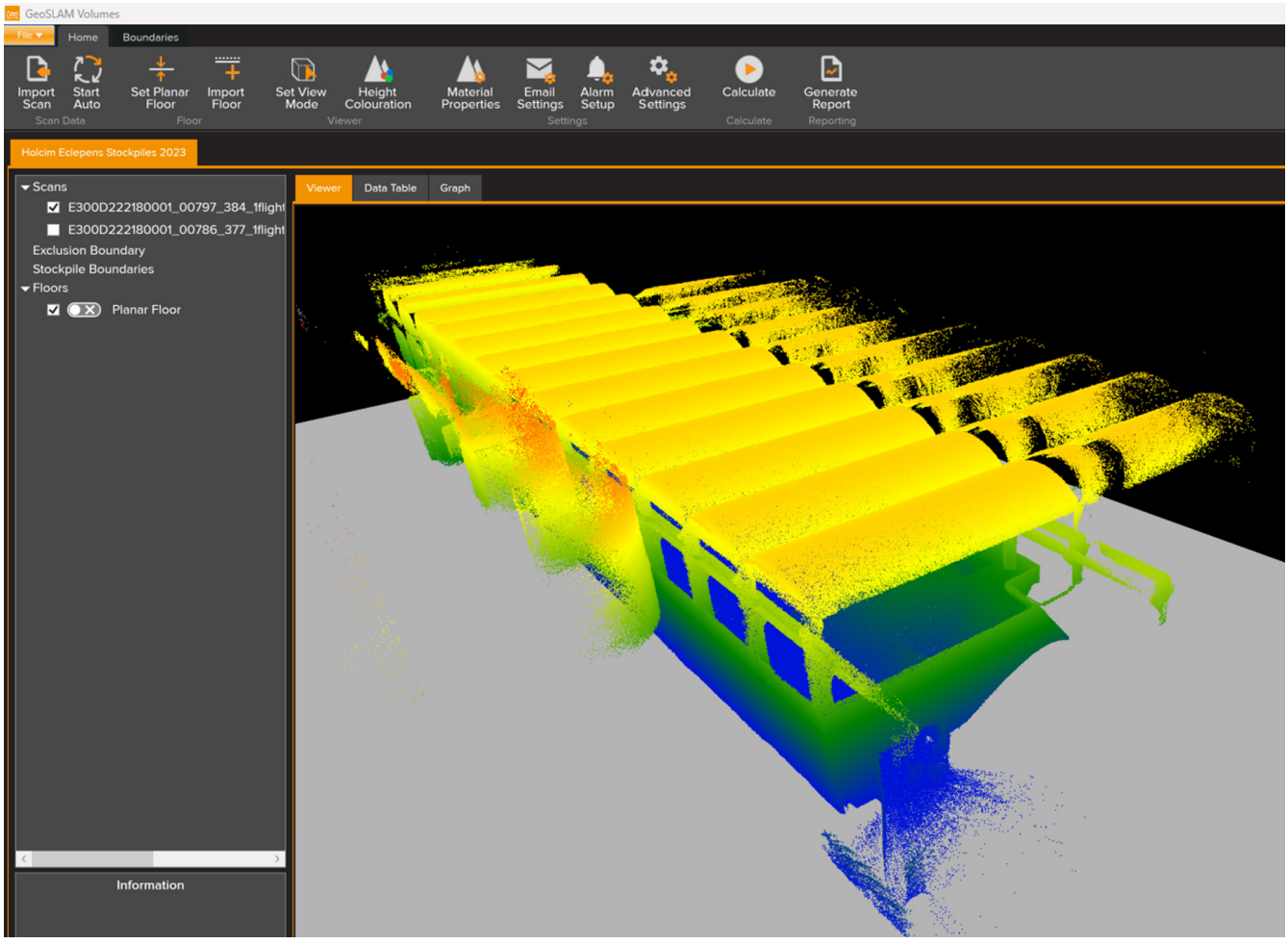
Image shows the automatically detected target centroids in FARO Connect



Automatic alignment of 2 scans

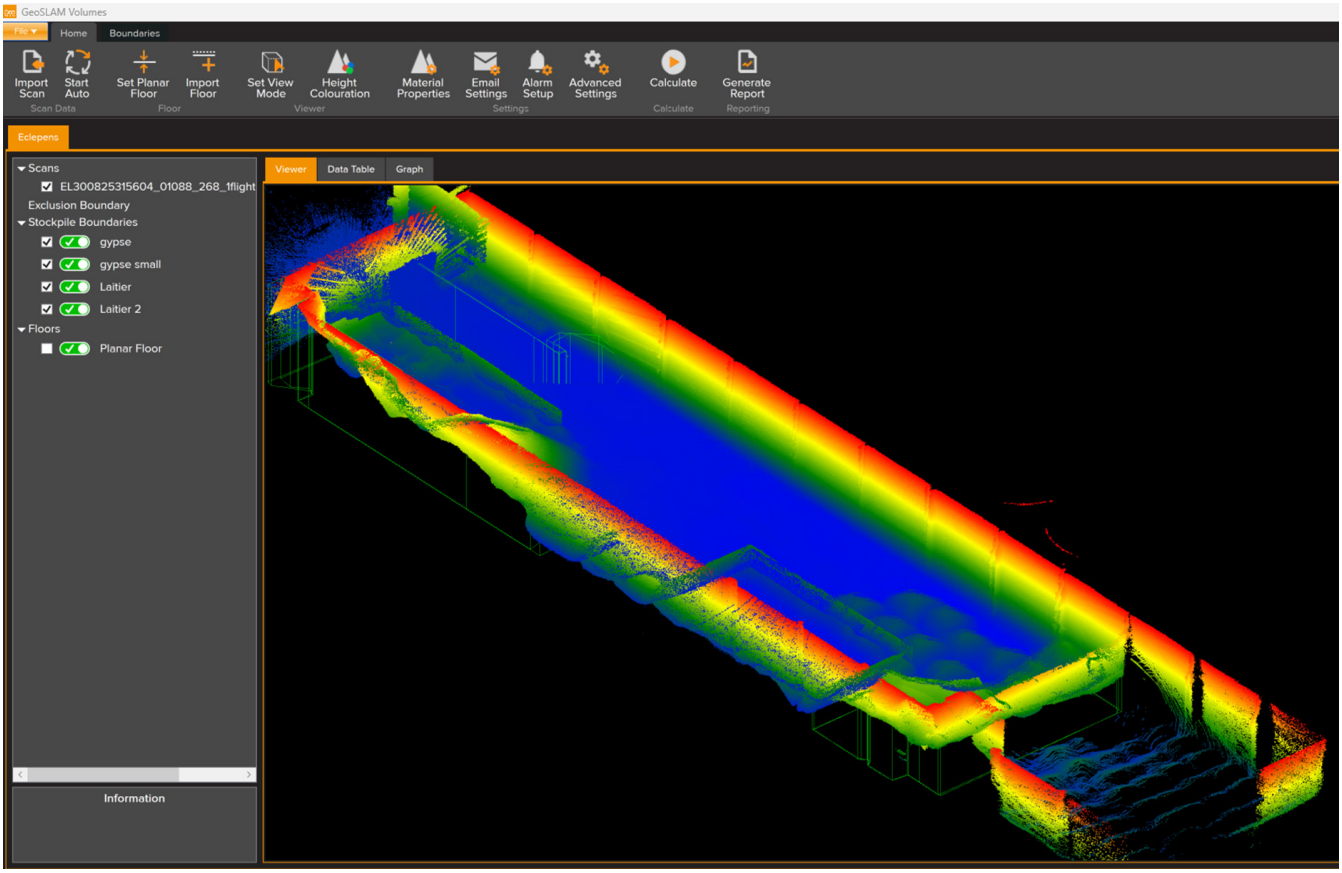
FARO Connect & Volume Measurements

FARO's GeoSLAM Volumes is specialized software that includes a dedicated inventory stockpile process that instantly turns data into actionable 3D information for rapid real-time decision making. Asset owners can confidently verify volumes at all stages of the supply chain as frequently as necessary, train staff in minutes, slash survey times, and drive down costs. With GeoSLAM Volumes, asset owners can calculate stockpile tonnage within a few minutes, and monitor changes over time, quickly and easily.



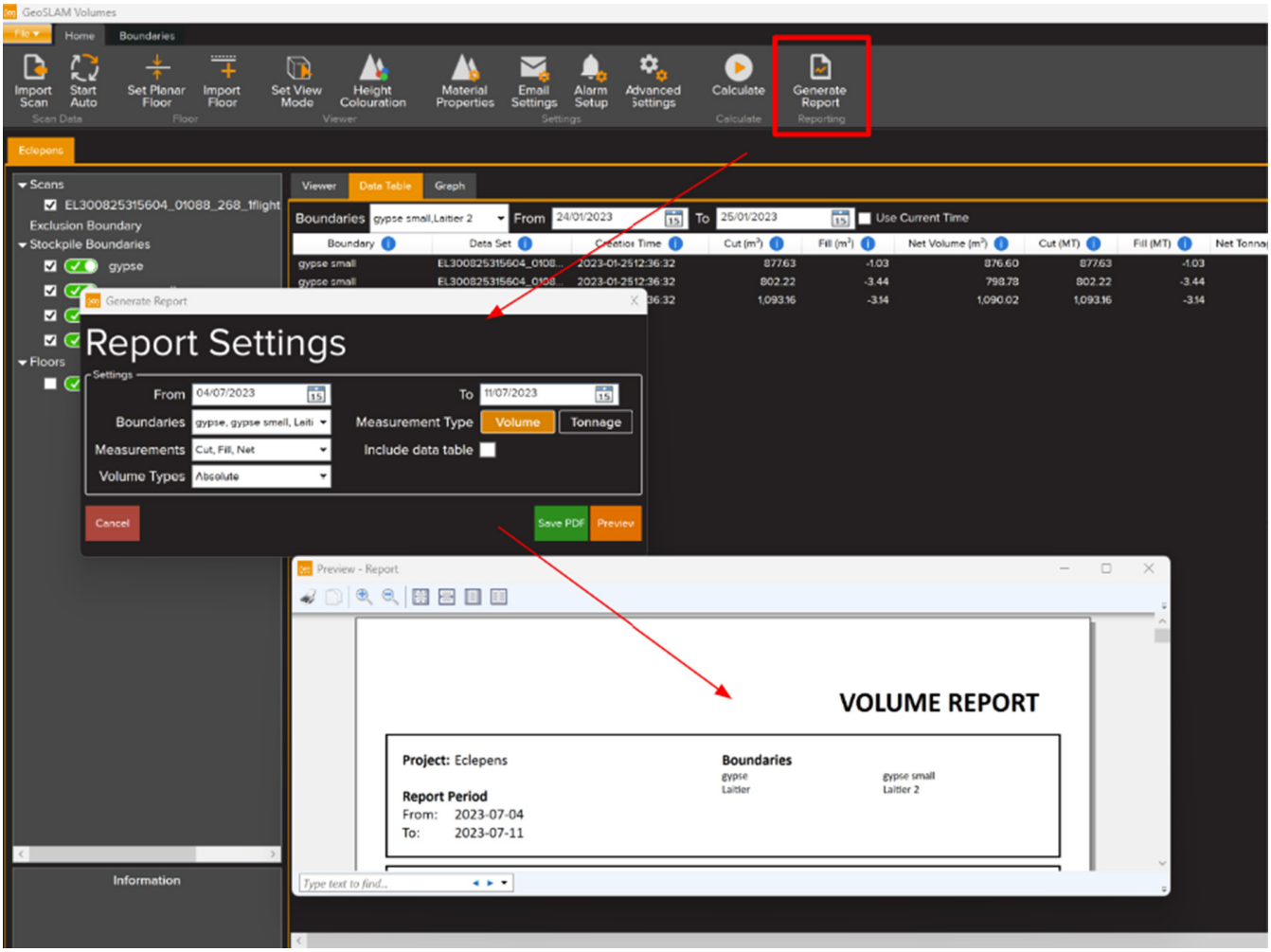
After the data was imported, the point cloud was edited to remove the top section roof of the plant infrastructure so as to cleanly reveal the stop pile volumes.

From there, each of the stockpiles was enclosed into a bound box and the material, specific gravity, cut and fill bulk factor was added so that the volume and tonnage could be accurately calculated.



After calculating the volumes, each stockpile volume is presented according to the Data table. A Report was generated automatically in GeoSlam Volumes which was then shared directly with the project stakeholders.

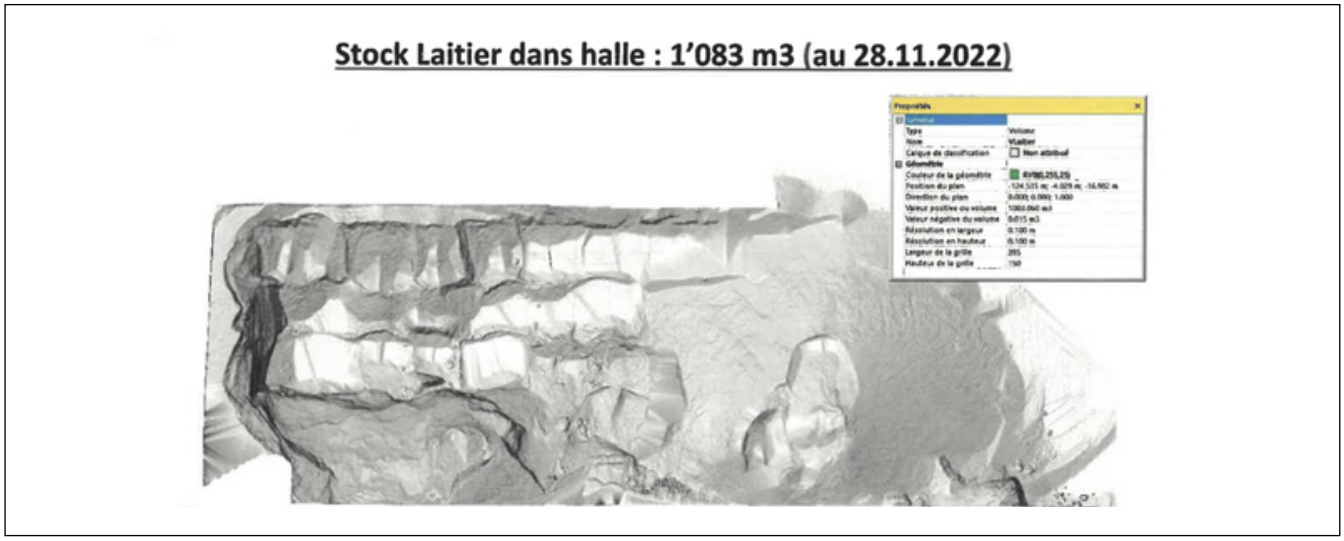
Report generation workflow in GeoSLAM

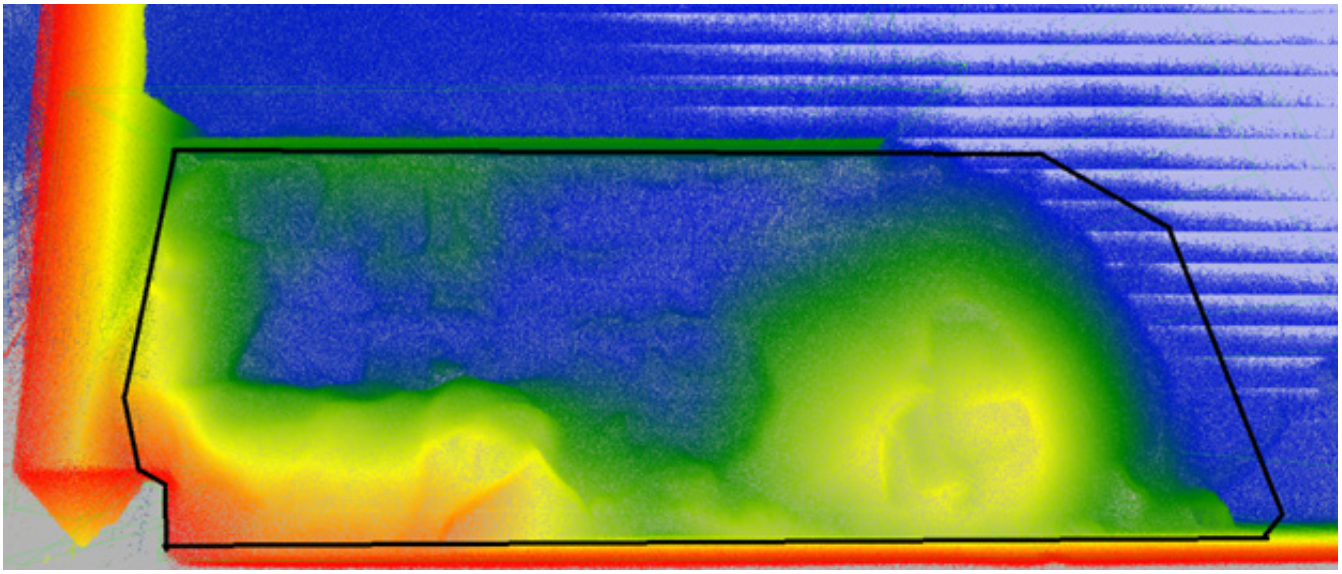


How did the Elios 3 compare to the terrestrial laser scanner?

The results of the different volumes were compared between the Elios 3 data and the terrestrial laser scan data are expressed through the following diagrams and descriptive captions.

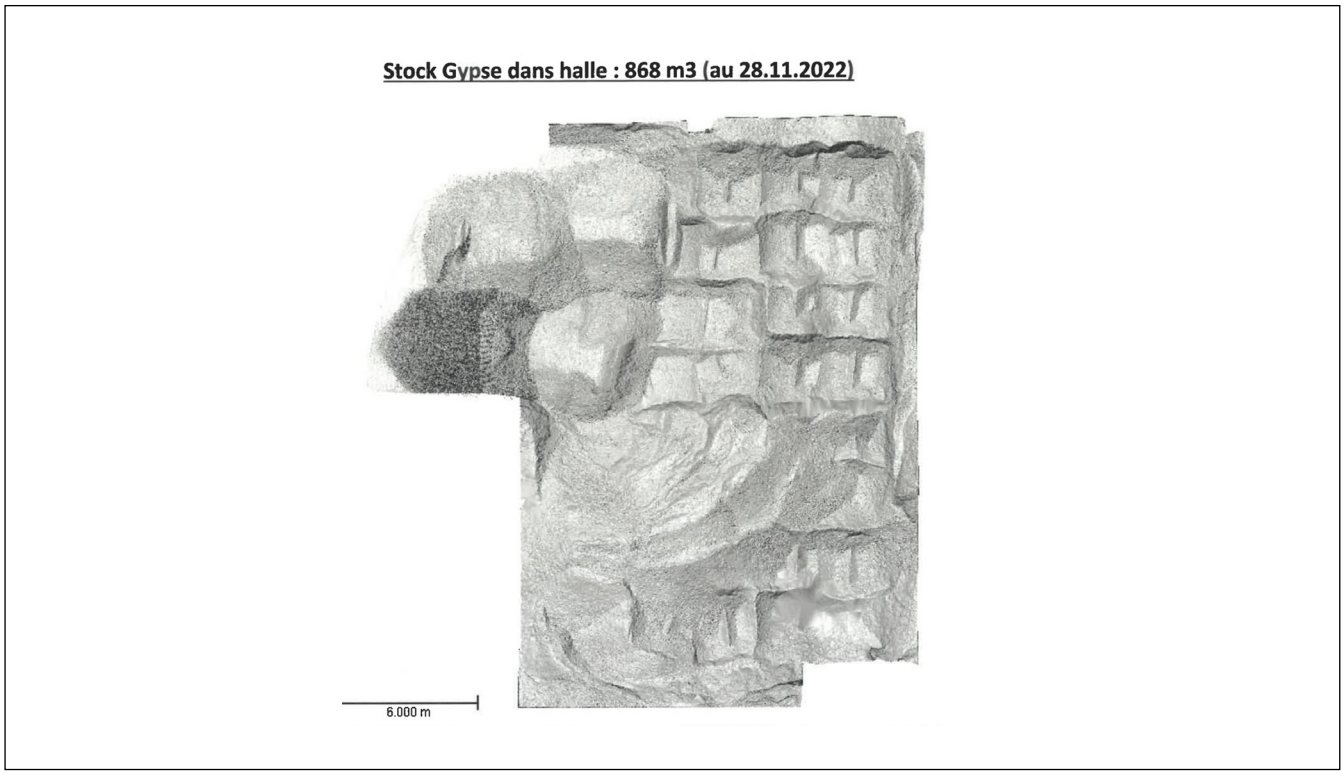
Laiter (Slag) Stockpile captured with the Elios 3

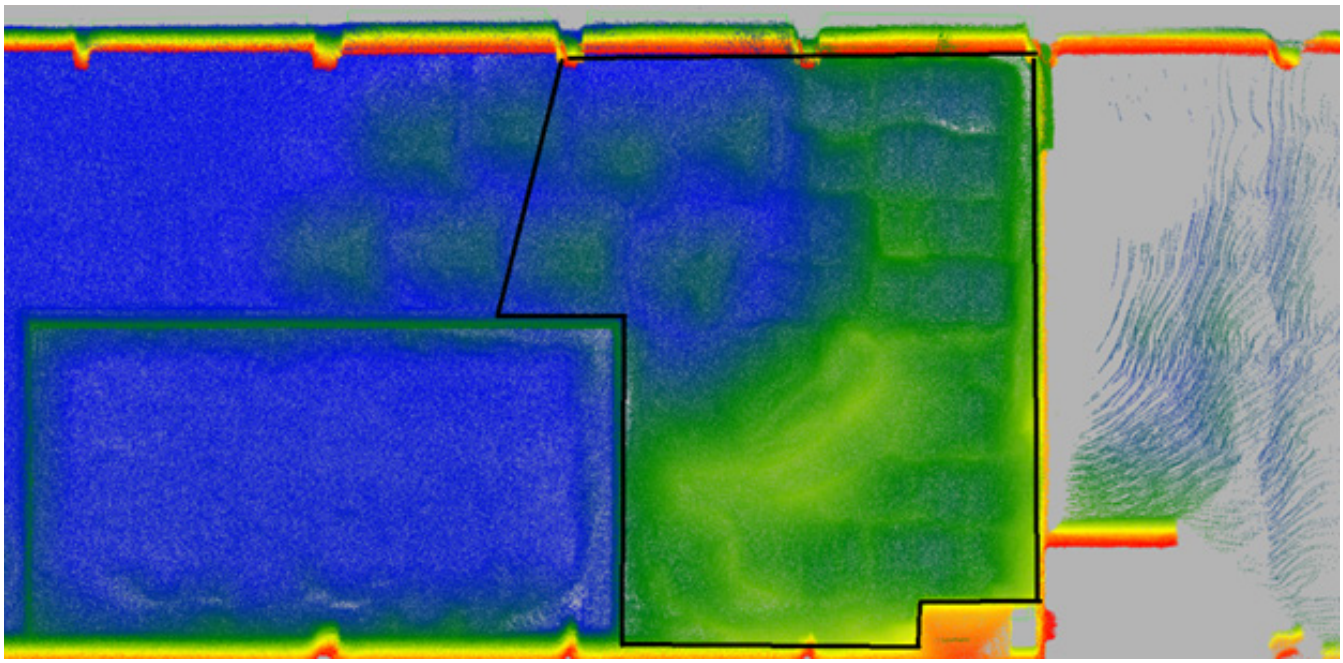




Volume 1,093 m³ = 0.9% difference between the Elios 3 Lidar data and terrestrial scan data

Gypsum Stockpile captured with the Elios 3





Volume 877 m³ = 1% difference between the Elios 3 LiDAR data and terrestrial scan data.

The Magnesium stockpile was empty at the time of testing.

Conclusion: A 92% boost to efficiency with the Elios 3 and accuracy to +/- 2 cm

The test results demonstrate that the Elios 3 can produce survey-grade 3D models which are within the accuracy tolerance (+/- 2cm) of the terrestrial laser scanners when comparing Volume to Volume computations.

Focusing on the speed and efficiency of data capture, the Elios 3 is significantly more efficient than the terrestrial laser scanning in direct comparison. Flying the Elios 3 is a one person operation, compared to Laser scanning which usually requires 1-2 surveyors to manage traversing the equipment around the scan environment. In terms of time-saving on-site for data capture, the Elios is 92% more efficient.

Data processing is also more efficient and simpler as there is only one scan to process, in comparison to 5 separate scans to process and align.

The Volume accuracy of the data was exceptionally good with an average of volume error of + or - 1% between the data captured using the drone and the terrestrial laser scan data.

From a safety perspective, calculating volumes manually with terrestrial equipment requires surveyors to climb the stockpiles, presenting dangers related to work at height. The Elios 3 removes the need for surveyors to do this climbing for data collection, allowing them to remain safely on the ground while collecting all the data they need.

Finally, there is a far better improvement in the ROI. Traditionally, a third-party surveying company has to be brought in to conduct the measurements at a scheduled date, whereas a drone pilot can work in-house on stockpile management and other asset inspection projects.

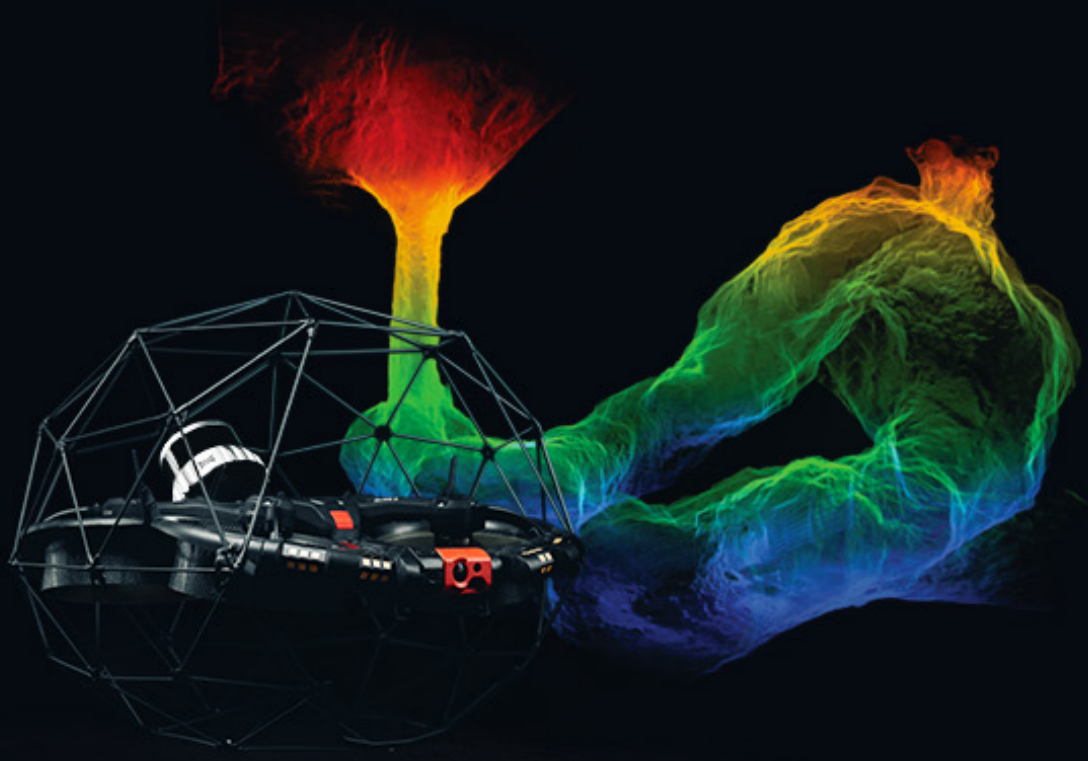
Conducting the stockpile assessment flights internally has benefits that include:

- More flexibility in when to conduct the stockpile flights.
- Data capture can be done when the stockpile area is in full operation.
- More control over and ownership of the stockpile data.
- Easy-to-use software and workflows to follow. Less expertise is required.
- Reduction of costs for the plant when conducted internally and not outsourced.
- Results can be computed within the hour instead of waiting days for the reports

Although the Elios 3 is a newer piece of equipment, it is clearly equal to the task of volume measurements for stockpiles compared to traditional laser scanning techniques. The results from this project were shared with the plant owners in a report and assisted in a streamlined operation that can be repeated without losing the safety improvements or cost and time savings.

ELIOS 3 SURVEYING PAYLOAD

Bring your volumetric surveys to the next level



For all applications where centimeter accuracy matters, mobile scanning is far more effective than traditional methods. With a range of 100 meters, a point density of 1.3 million pt/sec, the Elios 3 Surveying Payload can turn days of mapping into a 10-minute job.

For more information on the Surveying capabilities, get in touch with our team. Our specialists are available to assist you regardless of where you are in your drone adoption journey.

We look forward to speaking with you soon.

FLYABILITY | SAFE DRONES FOR INACCESSIBLE PLACES