



Ronin® Proprietary Products



A guide to understand the fundamentals of the

ART Inventory Management System

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Inventory Management

Good Inventory Management, Stock Control and Accountability is core to any income statement and balance sheet and is an often neglected, yet effective means of achieving efficiency and adding profitability to the business.

For almost 20 years Ronin has been supplying Inventory Management Solutions into almost every bulk handling industry and in all of these industries we have been successful in assisting with the implementation of global inventory management systems.

We call our system ART®



A successful Inventory Management system requires several components, including:

- *A clear business approach to inventory management, with defined structure, rules, and accountability.*
- *The accurate measurement of stores and stockpiles, coupled with user confidence in the data.*
- *Consistent measurement frequency and clearly defined periods between measurements.*
- *Efficient data correlation and report generation, ensuring timely and actionable information.*
- *High accuracy in data correlation, enabling reliable stock reporting and decision-making.*

In most bulk commodity businesses—whether dealing with hard or soft commodities—operational units often function efficiently within their own silos, yet these efficiencies rarely translate directly to the income statement or balance sheet.

Each operational unit typically has its own inventory reconciliation and accountability function, responsible for tracking monthly production, processing, and distribution. However, this function is frequently assigned to personnel whose primary responsibilities lie elsewhere, making inventory reconciliation a secondary or nonessential task. Consequently, limited effort and resources are applied to managing stock accurately.

This situation places stockpiled or stored products in a state of limbo. As products move between operational units or toward external customers, ownership and accountability become ambiguous, leaving the business exposed to potential discrepancies and risk.



Ronin®  ART®

A

A successful inventory management system must be operated as a

core business function. It should be managed by a dedicated, experienced team that is accountable to the entire organisation, rather than to an individual operational unit. This team must operate with a clear strategy, strong executive support, and well-defined Allowable Measurement Errors (AMEs).

As a solutions provider, Ronin does not focus on accuracy alone—we focus on trust. Our objective is for system users to have complete confidence in the information presented to them by ART®.

In this context, accuracy is a byproduct of trust, not the sole objective. The required level of accuracy is defined by the business's inventory management team, based on operational risk, material value, and reconciliation requirements. ART® is then configured to consistently meet those requirements.

When users trust the system, their focus shifts from verifying data integrity to resolving inventory issues identified by the system. This significantly reduces time spent validating measurements and increases time spent on corrective action and root-cause resolution.

To support this approach, ART® incorporates a range of diagnostic tools and configuration controls that assess measurement quality before data is

These include the following:

- Standard and bespoke configurations for the creation of any storage vessel or platform be they vertical or horizontal stores, to irregular outdoor stock & stack piles, to regulars silo complexes, to remote strategic stores, we've either got a standard configuration or can make one to suite.
- As part of this configuration we remove all unnecessary static structures like walls and roofs, conveyors and pillars, so that we don't confuse them as stock.
- Similarly we can separate stores virtually into separate stores within stores or alternatively separate and report dead stock or sacrificial beds as well as inactive stock.
- In order not to respond to temporary structures like vehicles or people in the loading area we
- operate a profile conformity and spike filter
- Finally we diagnose the resulting information to satisfy ourselves that it's sufficiently representative of product profile before we process it to the user.

This is all done automatically, on site, by the ART® system.



The ART System



Accuracy

Measurement accuracy is also directly influenced by the type and capability of the measuring instrument selected. Choosing the most appropriate instrument requires consideration of several key factors, including:

1. Whether the store is vertical or horizontal
2. The filling and discharge method of the store
3. Whether the store is under roof or in open air
4. The product or material being measured
5. The surface area covered by the store
6. The required scan density
7. The required scan frequency
8. The target scan duration
9. The number of instruments per store
10. Whether instruments can be shared across multiple stores

It is important to note that higher scan density results in a more representative surface profile and improved measurement accuracy. However, increased scan density also leads to longer scan times, which must be balanced against operational requirements and reporting timelines.

The ART® system supports this optimisation process by enabling instrument selection and configuration that balances accuracy, scan time, and operational efficiency, ensuring reliable results without compromising system performance.

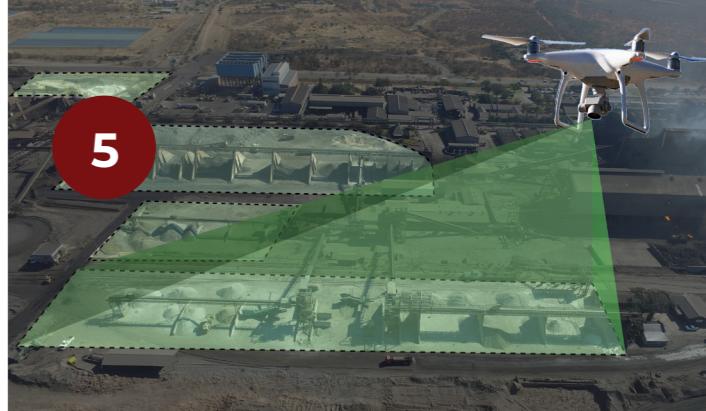
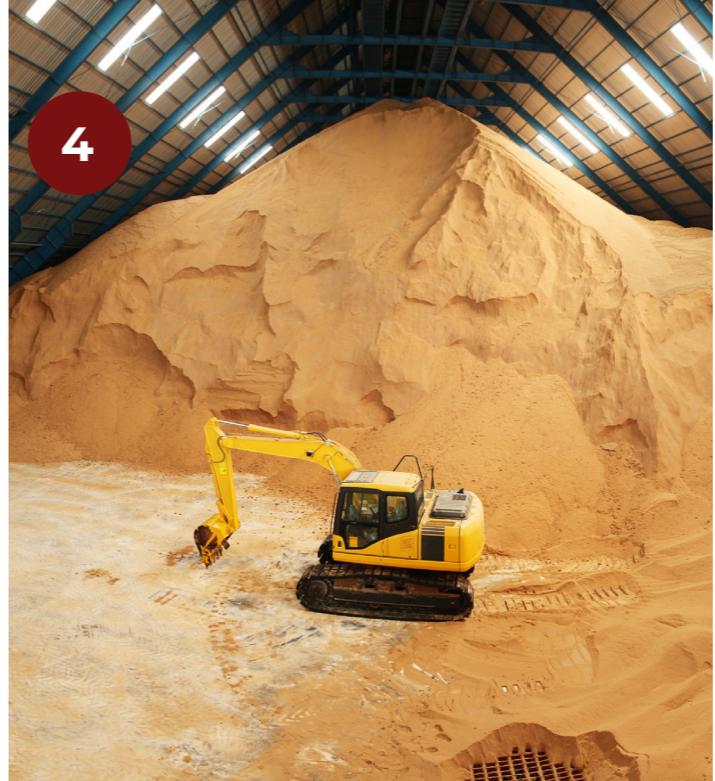


Image 1 Laser Scanner Manufacturing

Image 2 Silo Inventory Systems

Image 3 Mine Inventory Audits

Image 4 Warehouse Inventory Systems

Image 5 UAV Inventory Audits : Mines

Image 6 AIMS Lidar Audits : Ports

Experience



Silo



Warehouse



Dome



Stockpile



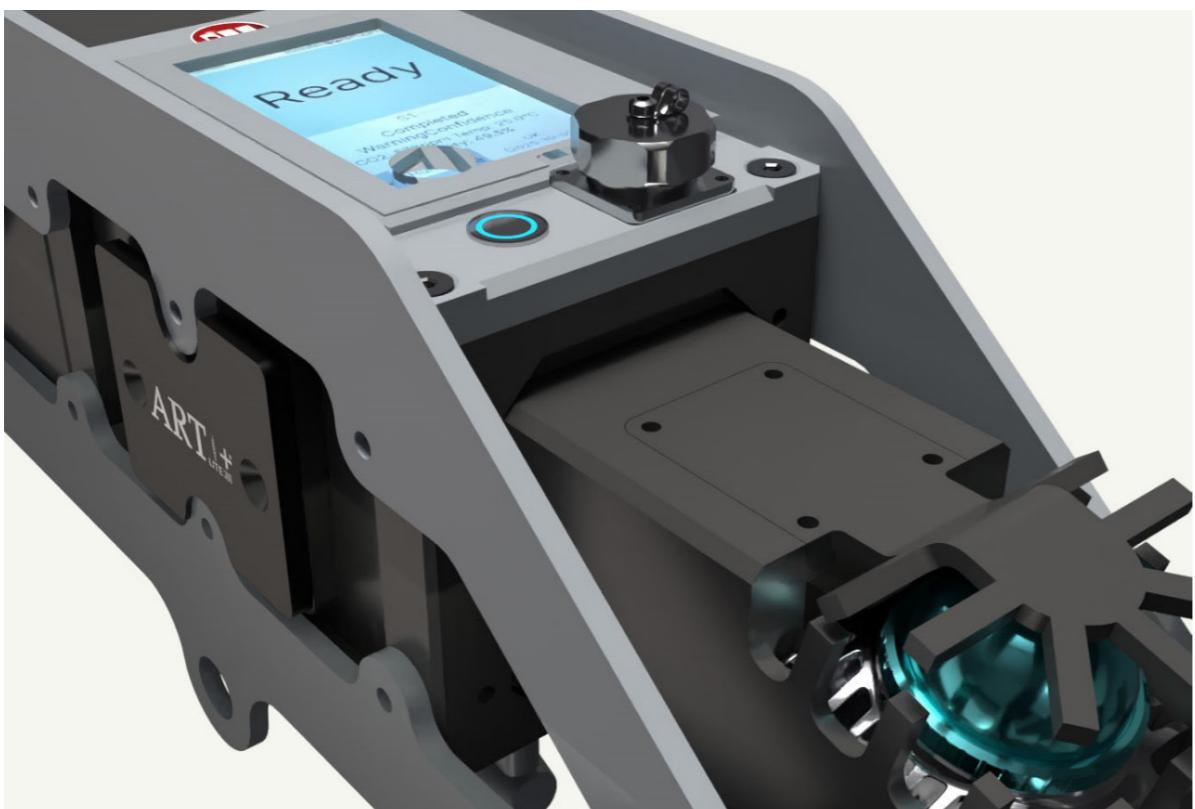
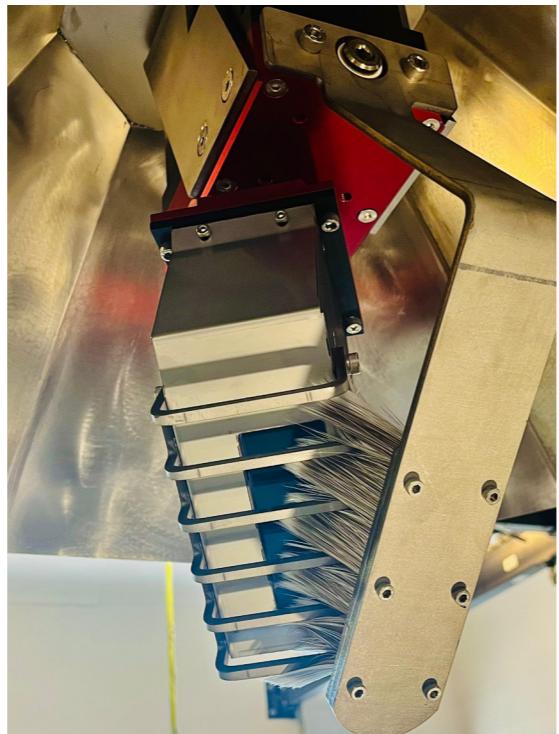
Survey

Ronin manufactures a range of laser scanners to complement the ART[®] system. These all-weather EX or ATEX certified scanners include:

- ART[®] single point,
- ART+[®] 2D (220° x 1° *)
- ART Lite+[®] portable 3D
- Artemis[®] J42 / 3D, (220° x 360° *)
- Artemis[®] Lidar HAP|LT15 3D
- AIMS[®] Rig Lidar 3D

* Plot pattern/scan density configurable.

Adaptation



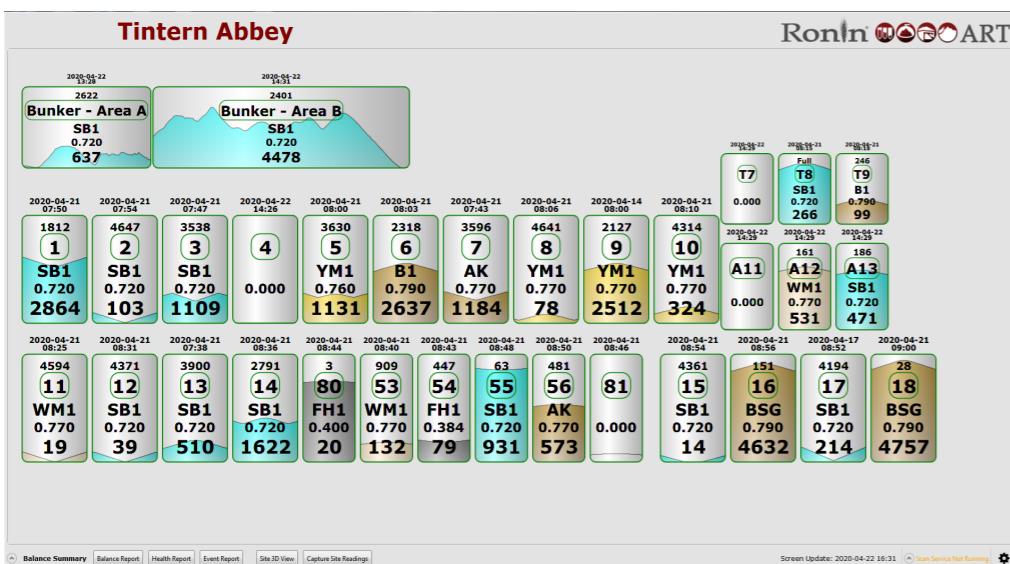
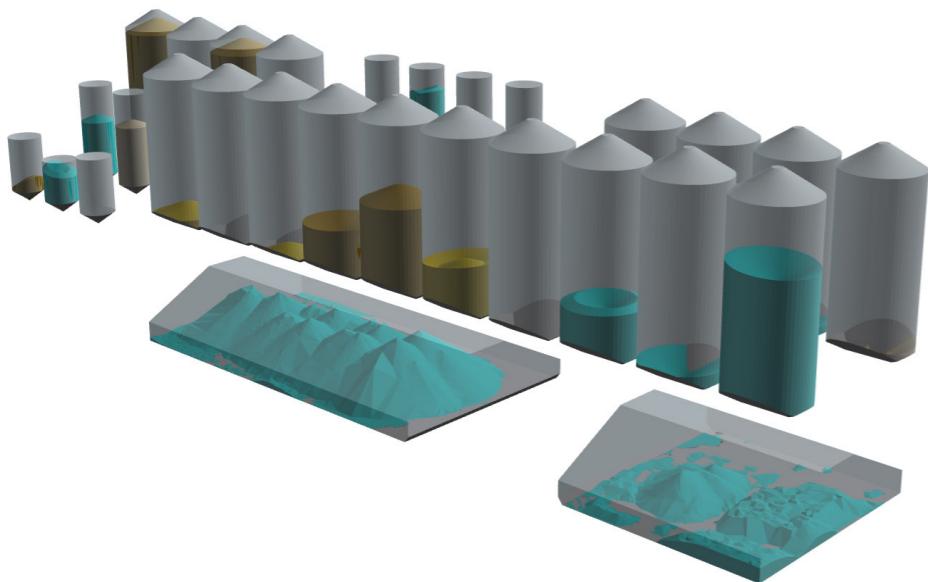
Depending on the application, the ART® system seamlessly integrates with a range of third-party measurement instruments, including ultrasound and radar-based sensors. In addition, ART® supports the ingestion of third-party survey data through an extensive library of data conversions, enabling the effective use of photogrammetry and LiDAR datasets alongside native ART® measurements.

Equally important to measurement accuracy are the measurement frequency and the reporting period. The reporting period is defined as the interval between formal stock reconciliations. When the ART® system is reconciled against a facility's receipt and dispatch tallies, and these tallies are available on a per-shift or daily basis, this interval becomes the reporting period. In practical terms, the reporting period represents the shortest interval between reconcilable inventory events.

At the conclusion of each reporting period, a stock report is automatically generated and distributed to designated stakeholders.

Each stock report provides the following:
A stock report details the following per store:

- *Date and time of last measurement.*
- *Measurement status.*
- *Commodity type & grade assigned to the store.*
- *Bulk density assigned to the commodity type & grade.*
- *Constituent values assigned to the commodity type & grade (if available).*
- *Tons per store & sub stores as per the commodity type & grade.*
- *Surplus/deficit of the store & sub stores (sub stores are either virtual stores, or stores defined as dead stock, sacrificial beds or inactive/unreachable stores)*
- *The stock report also details the following:*
 - *Total tons per commodity type & grade.*
 - *Surplus/deficit per commodity type & grade.*



Reporting

The measurement period is defined as the time interval between successive measurements for each store and can range from one minute to one day, depending on the measurement method and instrument deployed.

In large-scale facilities—for example, a 1.5 million m² site measured using drone-based surveying—operational constraints such as flight time, data processing, and site access typically limit measurements to one or two scans per day. Likewise, for fixed or mounted scanning instruments, the achievable measurement frequency is determined by the scan duration and system processing capabilities.

To ensure meaningful and actionable inventory data, the measurement period should align with the rate of material change within each store. As a guideline, the system is designed to detect changes within $\pm 1.5\%$ of total store capacity per unit of time. For instance, if an 8,000 m³ store is being filled or reclaimed at 80 m³ per hour, an hourly measurement interval provides optimal visibility and control.

The measurement period plays a critical role not only in tracking inventory movement but also in maintaining data integrity within ART[®]. If a measurement is rejected by ART[®] due to adverse environmental or meteorological conditions—such as excessive dust, rainfall, or reduced visibility—the measurement is excluded from reporting. In this scenario, ART[®] continues to report the most recent validated measurement, clearly time- and date-stamped, flags the store status as “out of date”, and automatically initiates the next scheduled measurement cycle.

During extended weather events or continuous high-rate filling operations, there may be limited opportunities to obtain valid scans—sometimes only one or two successful measurements within a reporting period. For this reason, ART[®] supports multiple measurement attempts per reporting period, ensuring continuity of reliable inventory data.

At the completion of each successful scan, the processed point cloud, derived store profile, calculated volume and mass, along with the exact date and time of measurement, are securely stored on a per-store basis.

All bulk storage facilities are inherently dynamic environments. Inventory levels at both facility and individual store level are continuously changing. Traditional reconciliation methods—often performed weekly or monthly—frequently delay the identification of discrepancies, increasing operational risk and financial exposure.

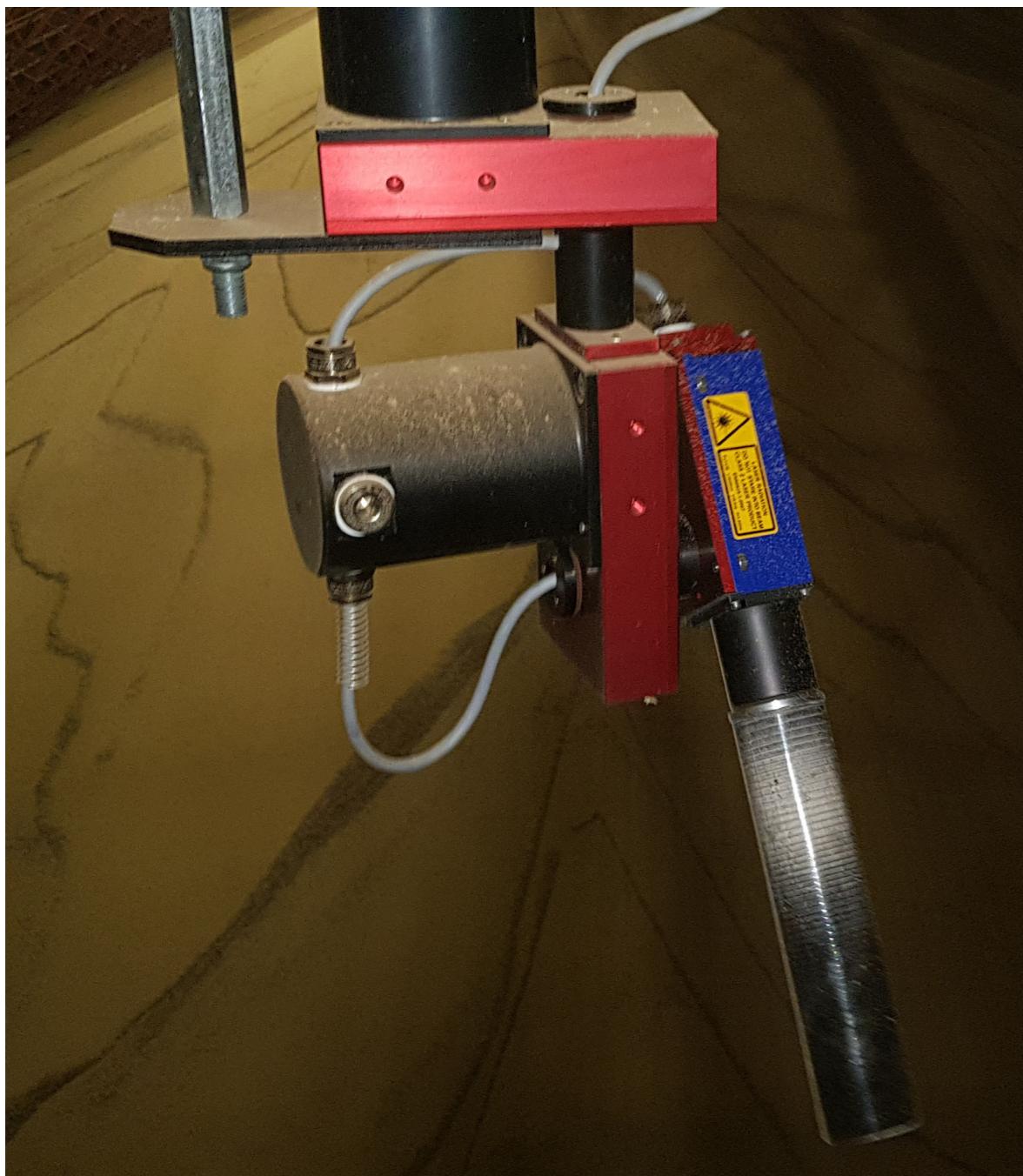
By combining a well-defined measurement period, an appropriate reporting period, and comprehensive stock reporting, ART[®]

When discrepancies exceed acceptable thresholds, ART[®] allows the inventory team to rapidly isolate:

- the affected store,
- the specific commodity type and grade,
- and the measurement event and time window during which the discrepancy occurred.

This level of visibility enables targeted investigation of material flow, rapid root-cause analysis, and timely resolution, significantly reducing inventory risk and improving operational confidence.

Correlation



Correlation provides both context and a point of reference to the stock report, the concept being that the stock reported by ART® and the stock reported by the facility should be within tolerance of each other in order for both reports to be correct, as such both data sets act as reference for the other and if different should both be interrogated for errors.

Therefore system accuracy, which can range from 95% to 99.5% is all dependent upon the design of the system as determined by the inventory management team, when selecting measuring instruments, deciding upon scan times, defining reporting period and establishing their AME's and SOP's.

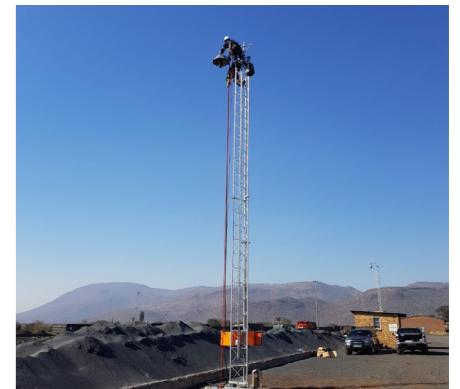
To assist in the reconciliation of data, ART® can automatically receive the tally outputs of the facilities receipts & dispatch scales and we can do this for a range of scales over several protocols.

However most of our customers have sophisticated stock accounting systems which provide a greater depth of information and with which we share data by means of a system generated .csv/.txt/.html file which is either pushed or pulled, depending on the customer, to and from their network and the ART® system.

ART® is installed on a dedicated PC located on the storage facility, all of our measuring devices require 24V DC, communicate via Ethernet over a TCP/IP network and are either EX or ATEX certified (depending on model specs)

The ART® system consists of AIMS® which is the core of the system and is our data acquisition, processing, configuration and archiving platform and is installed alongside ART® on the site PC.

All of measuring devices are operationally reliant upon AIMS® and cannot operate in a standalone capacity. AIMS® is the administrative interface with the system, through which all configurations support and diagnostics is conducted. AIMS® has an on-board diagnostic tool through which all remote/direct support can be rendered. Survey data can be uploaded /downloaded here and profiles can be edited by administrators.



ARTEMIS® J42

ART® Dashboard

The user interface is via an ART® dashboard which provides a simplified mimic panel of the site detailing each store on the facility. Each store is displayed in a size and shape relative to the store and details the following:

- Bin number/name
- Content type and grade
- Applied kg/hl
- Current stored tons
- Space available in tons
- Colour coded Content type and grade bar graph, with actual product profile
- Date and time of last measurement
- Store status. Each store has an individual store page, where all of the above plus the following is available:
- 3D display of store and profile for current and previous 10 measurements, with point cloud option.
- Histogram of store volume and mass with linear readout, with period selection and zoom (exportable)
- Change content type function (dependent on user level)
- Status explanation and diagnostics
- Profile cross section with linear margin of Y vs. Z

The dashboard also has pop up tables with the same format as the stock report but with current information as well as a scan status display (if applicable). Additionally dashboard has options to generate either a stock report, events reports or health report. The health report details specific system generated messages that assist in identifying potential weaknesses within the system and should be used for preventative maintenance purposes.

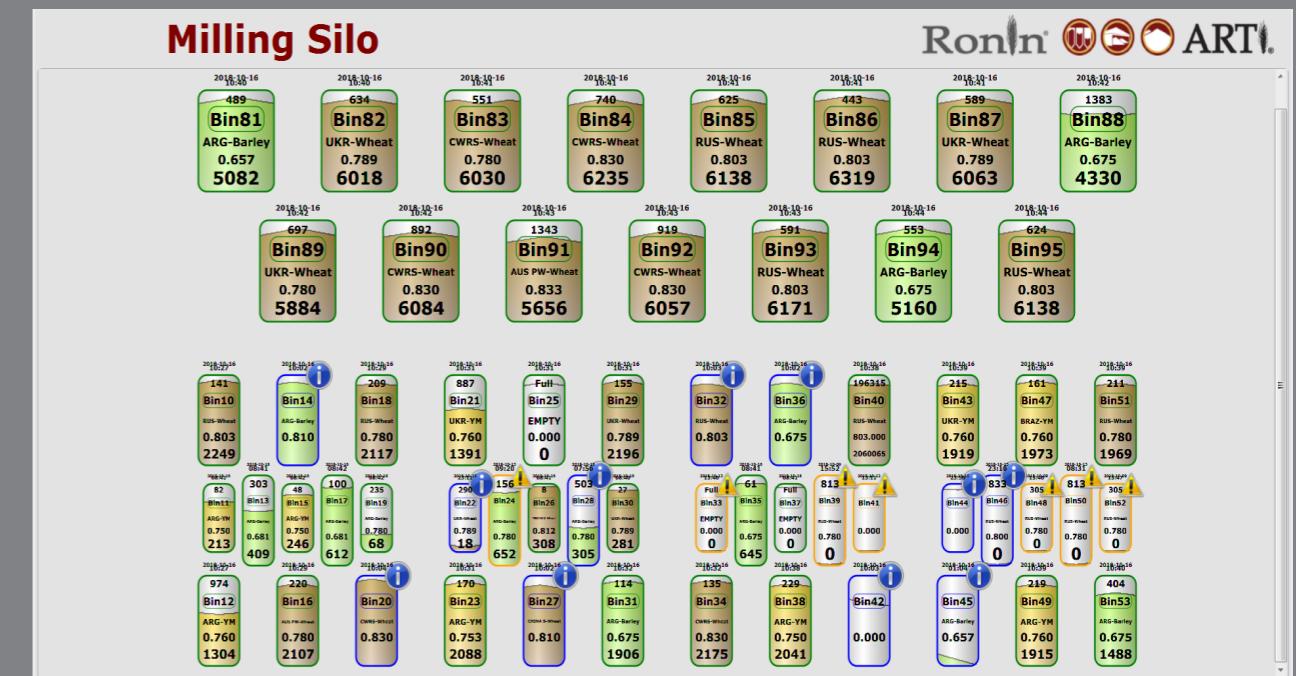


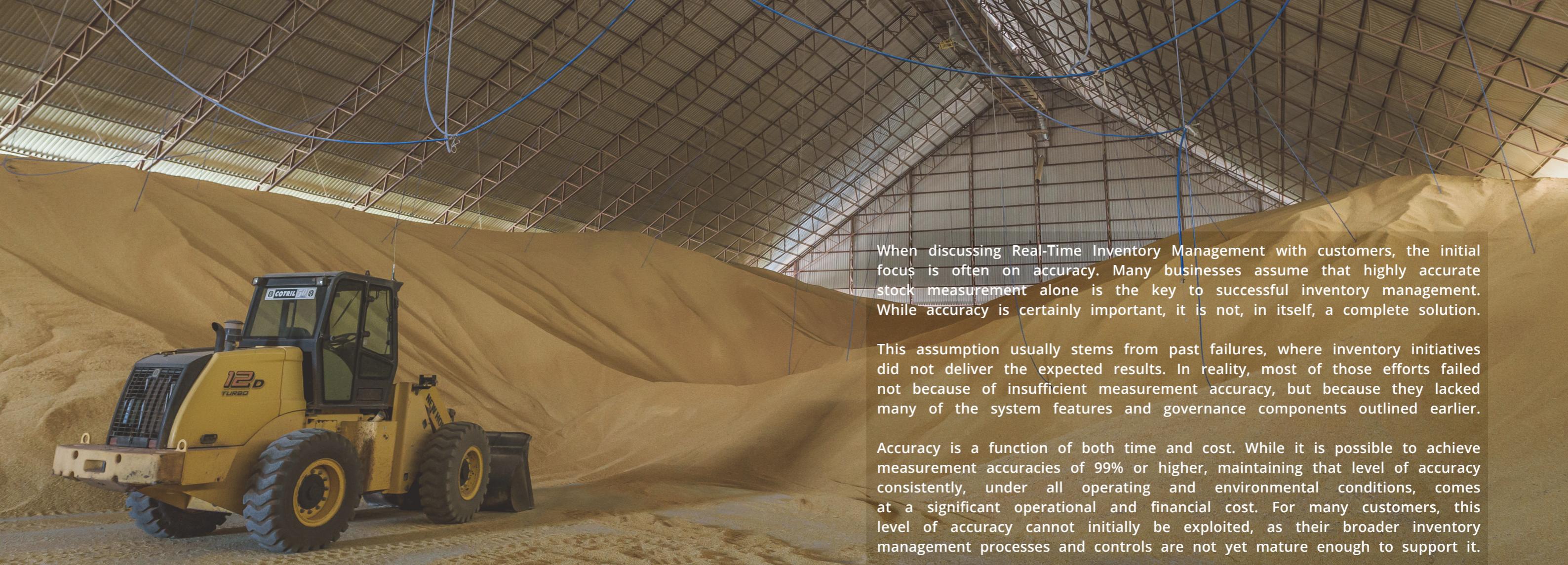
The store status provides a time-based indication of the accuracy and currency of the information displayed on the dashboard.

- A green border indicates normal operation and that the reported mass is current, based on the most recent accepted measurement.
- An orange border indicates a temporary system or environmental event preventing updates. The reported mass reflects the last accepted measurement and may be out of date. This status typically applies to events less than six hours old.
- A red border indicates the last reported mass is older than six hours, or that the issue has not resolved and support intervention is required.

Store statuses are included in the stock report, with configurable time thresholds.

ART® provides three access levels—Users, Managers, and Administrators. All system interactions are logged in event reports for transparency and accountability, with access managed through AIMS®. For each role are centrally configured and managed through AIMS®.





When discussing Real-Time Inventory Management with customers, the initial focus is often on accuracy. Many businesses assume that highly accurate stock measurement alone is the key to successful inventory management. While accuracy is certainly important, it is not, in itself, a complete solution.

This assumption usually stems from past failures, where inventory initiatives did not deliver the expected results. In reality, most of those efforts failed not because of insufficient measurement accuracy, but because they lacked many of the system features and governance components outlined earlier.

Accuracy is a function of both time and cost. While it is possible to achieve measurement accuracies of 99% or higher, maintaining that level of accuracy consistently, under all operating and environmental conditions, comes at a significant operational and financial cost. For many customers, this level of accuracy cannot initially be exploited, as their broader inventory management processes and controls are not yet mature enough to support it.

The ART® system is capable of delivering repeatable accuracies of up to 99.5%. In practical terms, this equates to 0.5 tons per 100 tons, which is negligible, or 500 tons per 100,000 tons, where the impact becomes more meaningful. However, the objective of ART® is not simply to report these numbers—it is to help customers manage them: reducing deficits, nurturing surpluses, identifying where and why discrepancies occur, and supporting effective corrective action.

Our approach to Real-Time Inventory Management is therefore holistic. We consider all variables within the customer's inventory environment and work with a small, dedicated team to develop a goal-oriented implementation plan. This plan defines the system's end objective and establishes initial Allowable Measurement Errors (AMEs) for ART®.

The team's mandate is to consistently achieve these AMEs and then progressively tighten them over time through improved operating procedures, enhanced management oversight, and disciplined execution—each improvement being clearly reflected as increased accuracy within ART®.

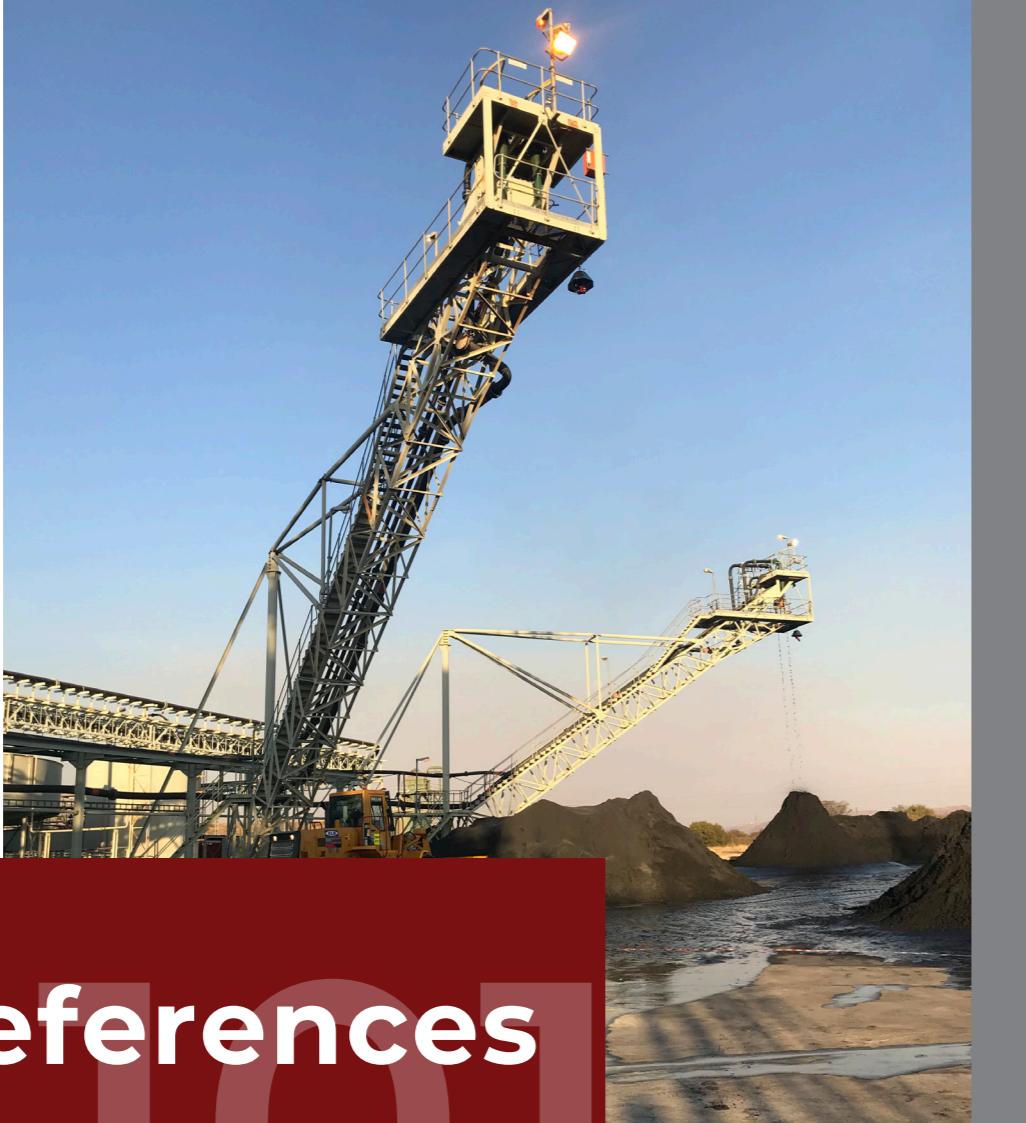
As such, we do not claim that ART® will solve your problems for you. What we do believe is that, when applied correctly, ART® enables you to solve your own inventory challenges and sustainably improve profitability.

Alignment

References

Over the past 20 years Ronin sold various ART® systems and audit services into the following international industries:

- *Grain Silo*
- *Grain Milling and Processing*
- *Sugar*
- *Fertiliser*
- *Mining (Iron | Coal | Manganese | Chrome | Sulphur | Copper | others)*
- *Ports*



Northam Platinum
Chrome Pad



Al Khaleej Sugar
1 Million Ton facility



EXXARO Coal
Discard Coal



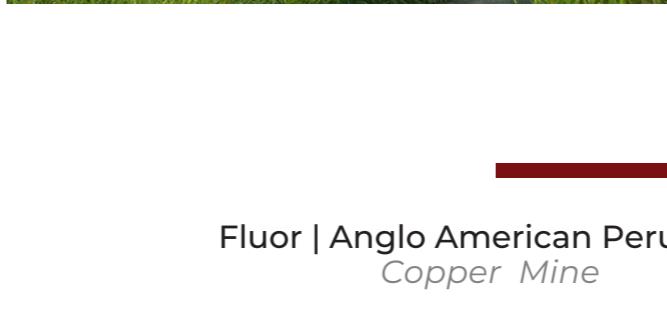
CGSS Egypt
23 Sites | 276 Silo Bins



AFGRI
71 Sites | 1472 Silo Bins
35 sites | 151 Bunkers



Illovo Sugar Noodsberg



Fluor | Anglo American Peru
Copper Mine



1D ART[®]
Single Point Measurement for Small silo bins.
Bin Shape Floor Type

2D ART⁺
2D Laser Measurement for Medium silo bins.
Bin Shape Floor Type

3D Artemis[®] Laser Scanning System
3D Laser Measurement for Small to Large silo bins.
Bin Shape Floor Type

3D Artemis[®] Laser Scanning System
3D Laser Measurement for Bulk stored in Warehouses

3D Artemis[®] Laser Scanning System
3D Laser Measurement for Bulk stored in Partitioned Bunker Warehouses

3D Artemis[®] Laser Scanning System
3D Laser Measurement for Mining Stockpiles

Solution Design

Ronin considers every project as a solution. No single facility is 100% the same. Our hardware design is tailored towards the storage area or silo bin dynamics which have a great influence on flow dynamics and general inventory housekeeping. Then there is product behaviour and its effect on the laser.

Considering any new project, the following forms part of the site and application evaluation.

- Do we have a similar project from the past that we could learn from?
- Is it a zoned environment?
- How dynamic is the floor | laydown area?
- Bin | Warehouse roof structure and /or other possible mounting areas.
- How dynamic is the fill and discharge process?
- Determine if it will be a 1D, 2D or 3D solution.
- Determine the laser type to go on the 1D, 2D or 3D measuring device.
- Identify power and network connectivity options.
- Software and PC requirements
- Data and report outputs required.
- Product data.

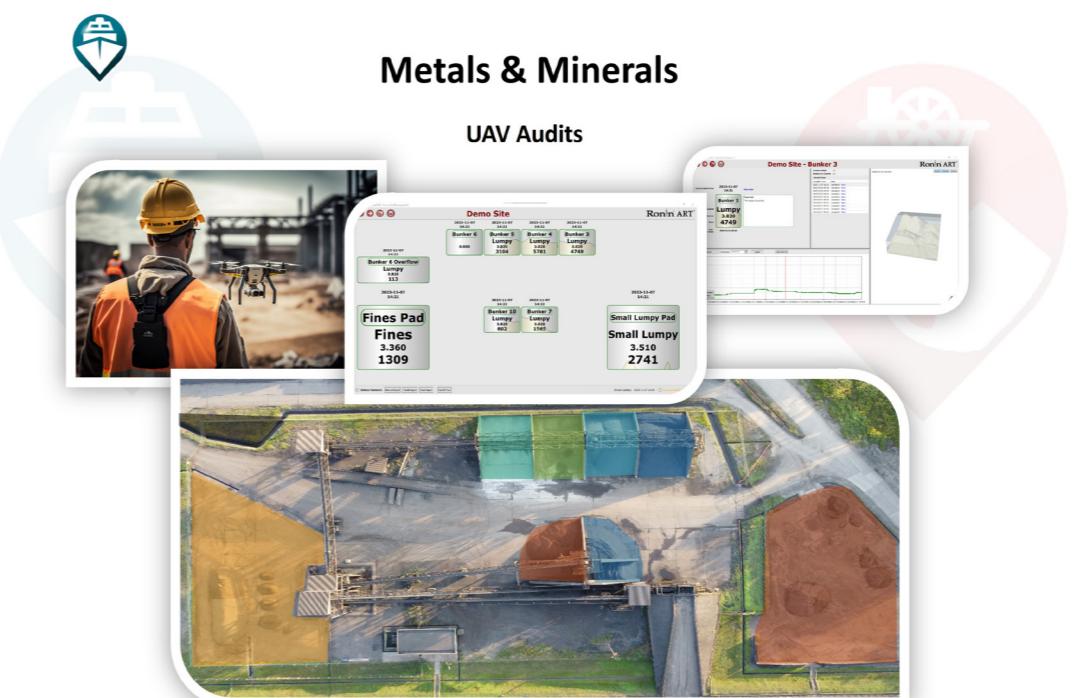
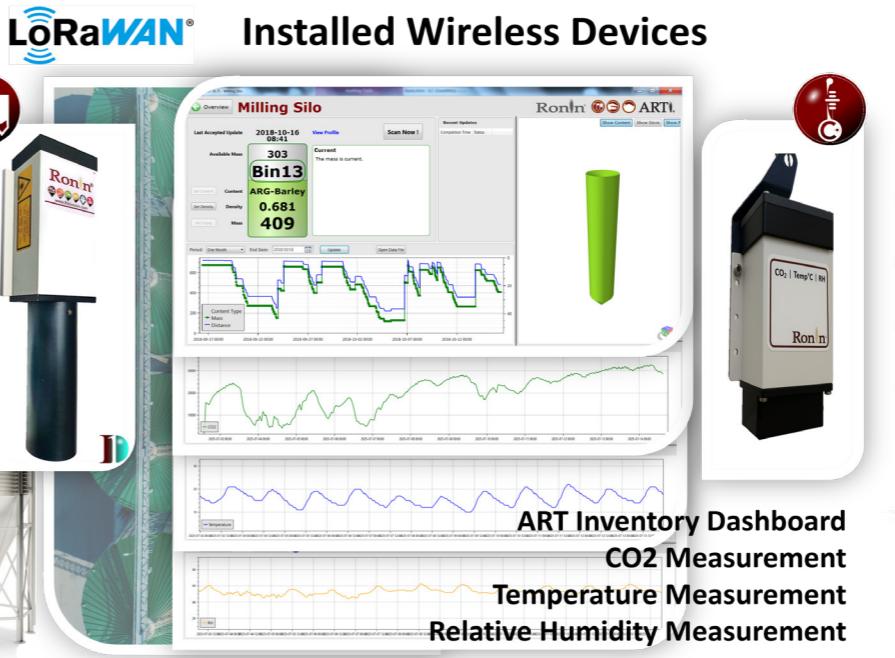


ALP360 Portable Lidar
with Temperature, Humidity & Co2 measurement

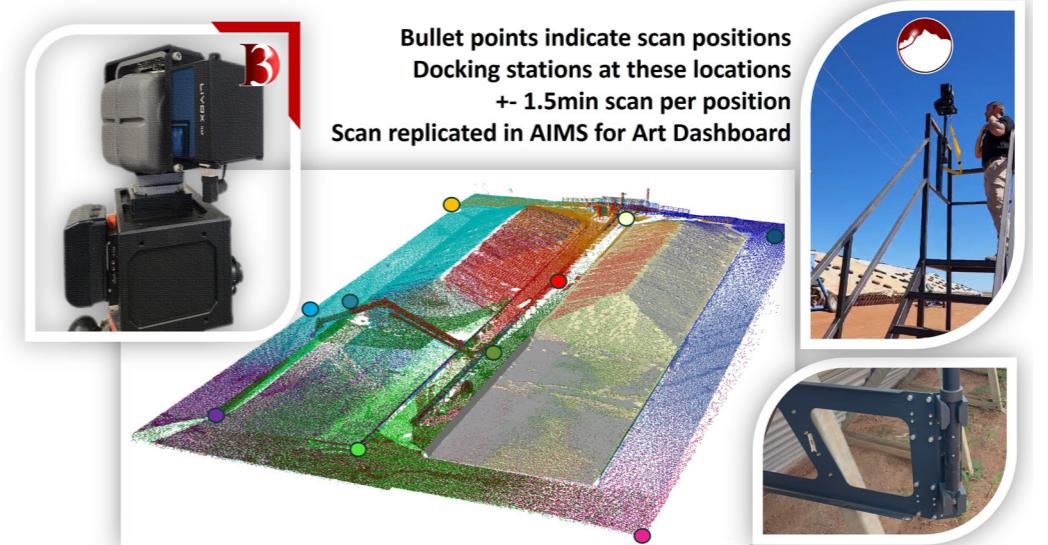


ART[®]+HAP

Product Enhancement



3D Scanning Systems for Australian Bunker Stockpiles





Control at ART
your **fingertips**

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Silo



Warehouse



Stockpile



Monitoring

