Silica Monitoring for Increased Worker Safety

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What is Silica?

Silica compounds are literally everywhere:
95% of known rocks contain it.

It’s in glass, stone, cement, bricks, asphalt, mortar, sand, tile, drywall, concrete and much, much more.

“Silicosis is the world's most prevalent occupational lung disease and is characterized by irreversible, progressive pulmonary fibrosis leading to restrictive lung disease. Silicosis is a preventable disease with significant morbidity and mortality that has no cure.”

NIH – **Silicosis,** Lauren Baum; Thomas C. Arnold.
August 6, 2023

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Estimated number of workers exposed to silica dust in the workplace

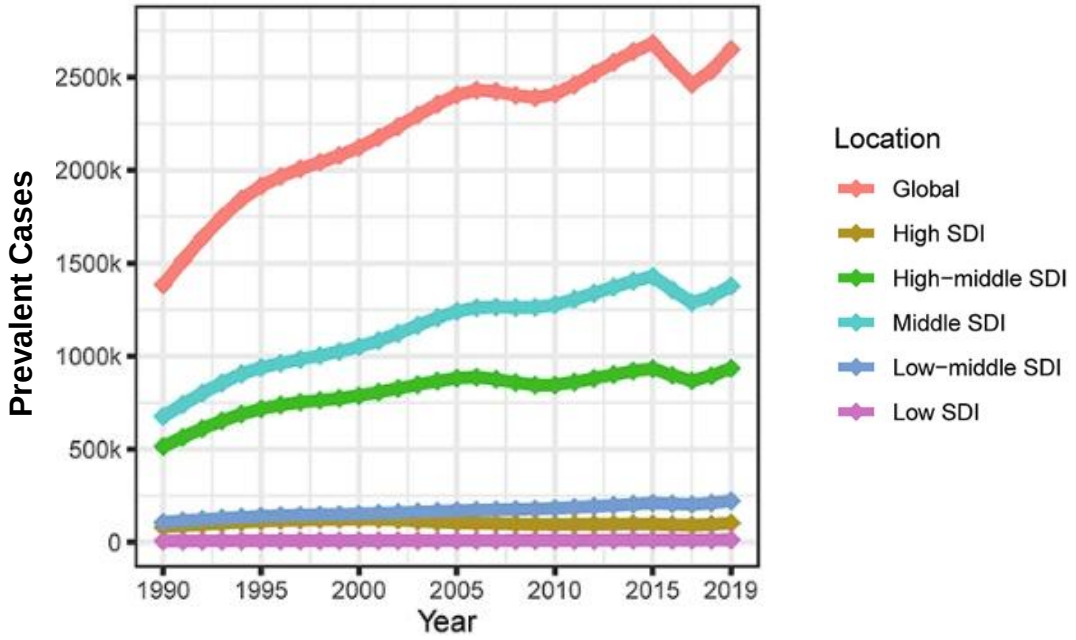
USA	7 million
Europe	7 million
UK	700,000
Australia	600,000
Global	40-50 million

Silica isn't *just* the new asbestos. It has the potential to be far, far worse.

Global Prevalence and Disease Burden of Silicosis

Cases of silicosis are increasing year-on-year in many major economies as mechanisation increases and large-scale infrastructure projects drive construction and materials production growth.

Inhalation of silica contributes to increased incidences of other diseases, too, including kidney disease, skin cancer, COPD, and brain cancer (NIOSH).



Liu, X., Jiang, Q., Wu, P. *et al.* Global incidence, prevalence and disease burden of silicosis: 30 years' overview and forecasted trends. *BMC Public Health* **23**, 1366 (2023). https://doi.org/10.1186/s12889-023-16295-2

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Applications in Silica Monitoring

2016 - OSHA Requirement statement 1910.1503, 1926.1153

Permissible Exposure Limit (PEL)

"The employer shall ensure that no employee is exposed to an airborne concentration of respirable crystalline silica in excess of 50 µg/m^3, calculated as an 8-hour TWA."

(Action Level 25 µg/m^3)

OSHA – Silica Standards

EMPLOYER REQUIREMENTS

General Industry: 1910.1153 – Exposure to Respirable Silica
Construction: 1926.1153 - Respirable Crystalline Silica

- Determine the amount of silica that workers are exposed to.
- Action level of 25 µg/m3 averaged over an 8-hour day.
- Protect workers from respirable crystalline silica exposures above the PEL of 50 µg/m3, averaged over an 8-hour day.
- Use dust controls and safer work methods to protect workers from silica exposures above the PEL.
- Provide respirators to workers when dust controls and safer work methods cannot limit exposures to the PEL.
- Establish a written Exposure Control Plan.
- Train workers, Competent Person & Awareness.

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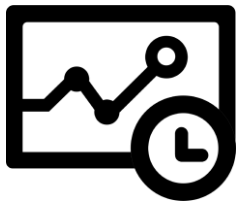
One key to avoiding this growing crisis?

Real-time detection of RCS.

Benefits of Utilizing New Technology - Methods

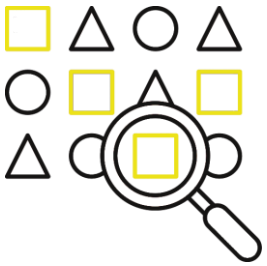


- Real time all the time

- Samples every second

- Tracks changing concentrations of silica

- Alarms as user-selectable thresholds



- Differentiates silica in complex mixtures

- Reports in user-selectable intervals of 15 minutes to 12 hours

- Results on-screen or through the dedicated Breathe XS software

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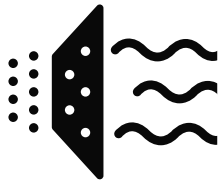
What will you do with real-time results?

- Use RPE only when necessary.

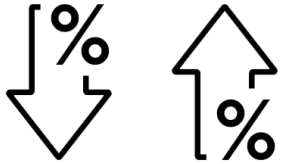


- Create smart dust ventilation, suppression, extraction or exclusion systems.

- Improve your processes and workflows to minimise product loss or dust creation.

- Protect your business from litigation and a PR crisis.

- Reduce the costs of workplace exposure surveys and legislative compliance.



- Reduce sickness, absenteeism, long-term health issues, early retirement and improve worker retention.

- Improve culture, working relations and deliver on your corporate responsibility.

- Save lives by ensuring workplace exposure limits are adhered to and reported on.

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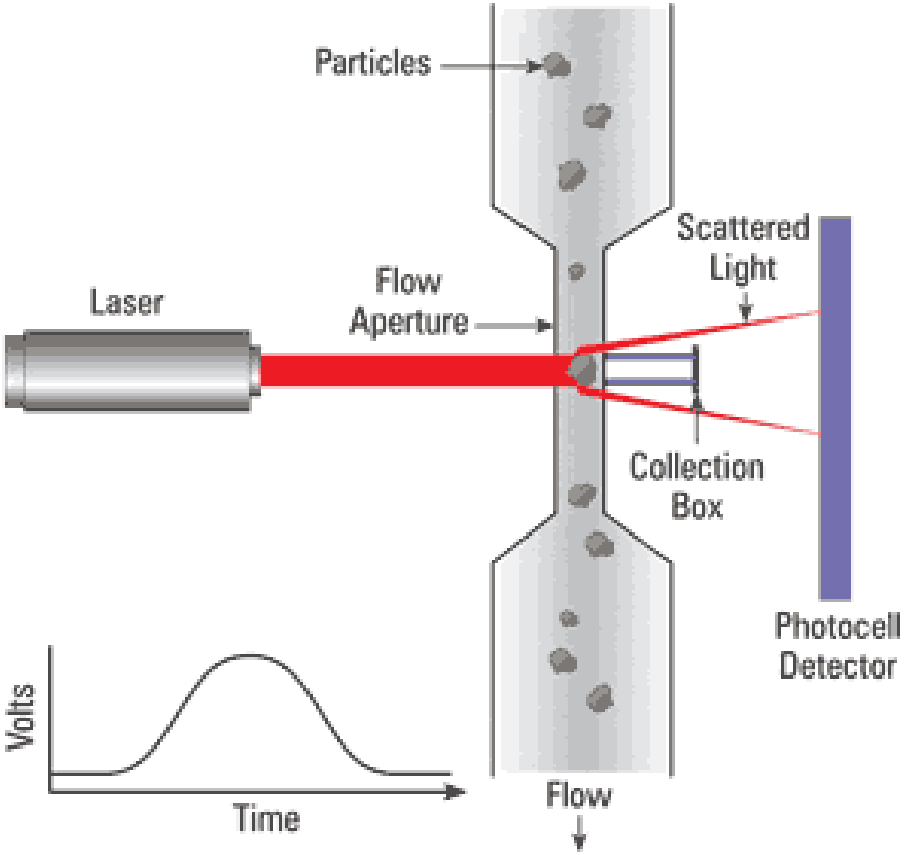
Technology Overview

How are particles counted?

Lasers at Work – Particle Counter



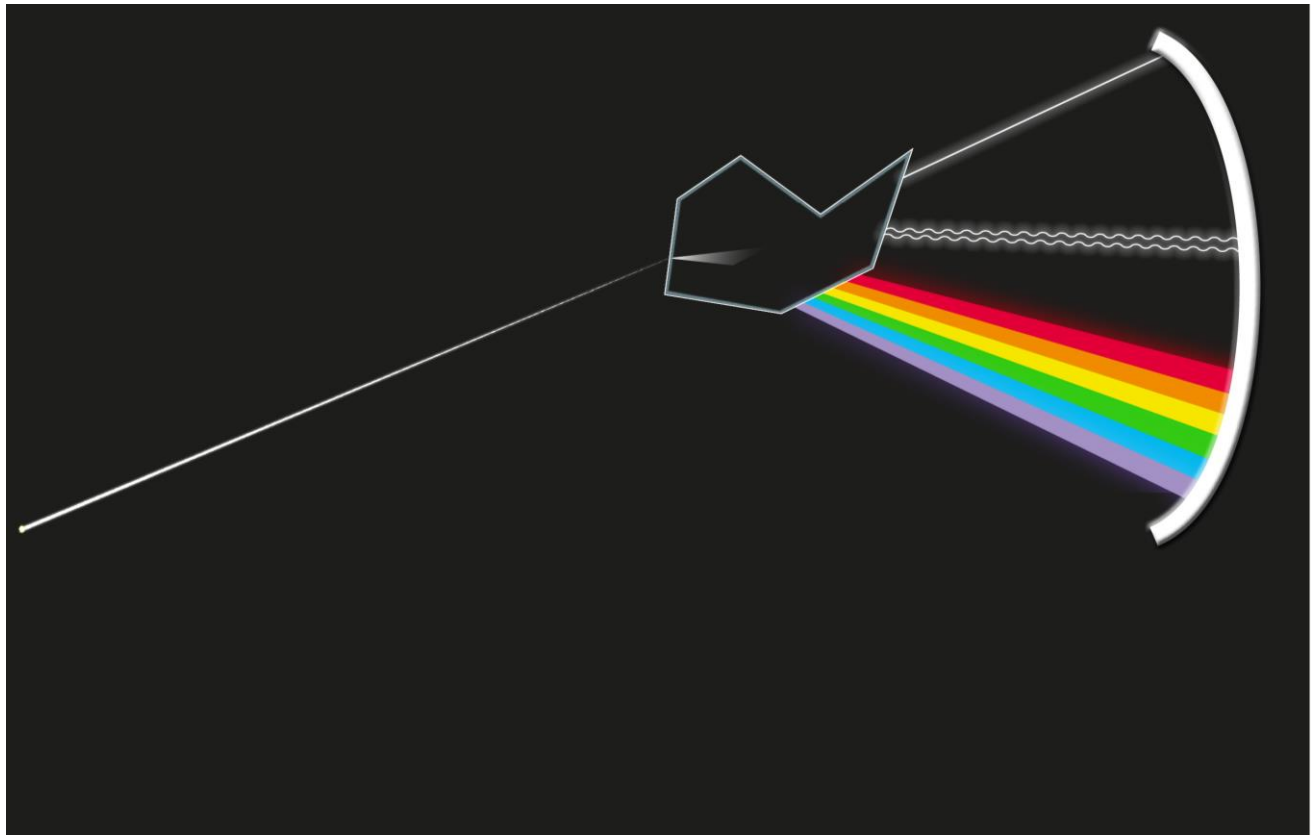
Key Innovation – What Makes This Work?

Deploying Optical Refraction Technology alongside Optical Particle Counting, Air XS examines every sampled particle and immediately identifies RCS through its optical properties.

Size, symmetry and a series of refractive qualities are analysed in real time, triggering a triple-voting system that positively identifies silica particulates.

This means that Air XS detects all forms of RCS including both alpha and beta quartz, cristobalite and tridymite.

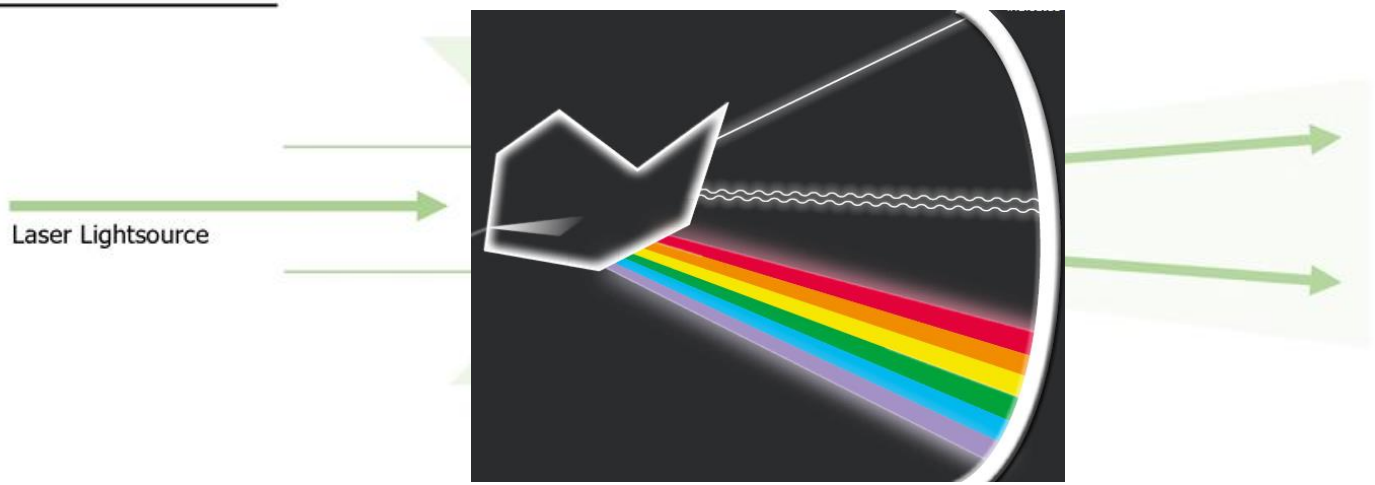
Air XS differentiates silica in dust mixtures and responds in real time to changing RCS concentrations.



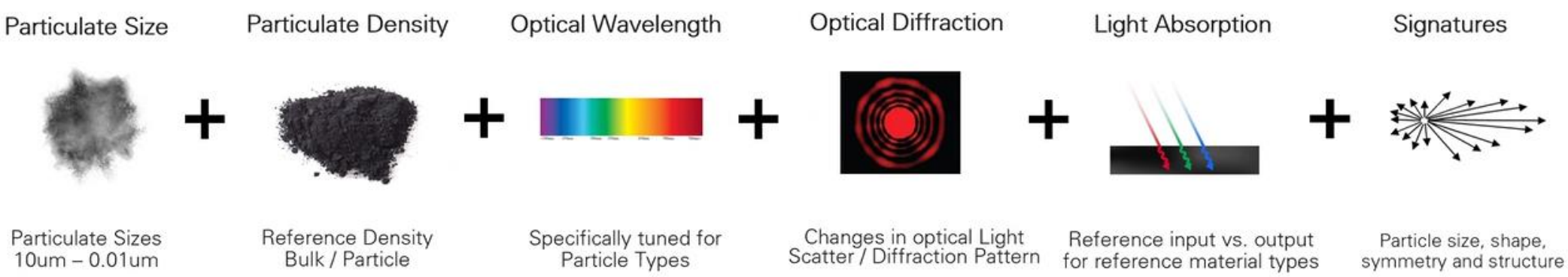
Lasers = Real Time Silica Counter

Real-Time RCS Detection

Optical Refraction Technology



- Refractive vs Reflective Technology, High-Speed Scatter
- Algorithm to converts the concentration of crystalline particles to µg/m3.
- Harmful SILICA is detected and reported in real-time.
- Optical sensing is robust and reduces maintenance.



Lasers = Real Time Silica Counter

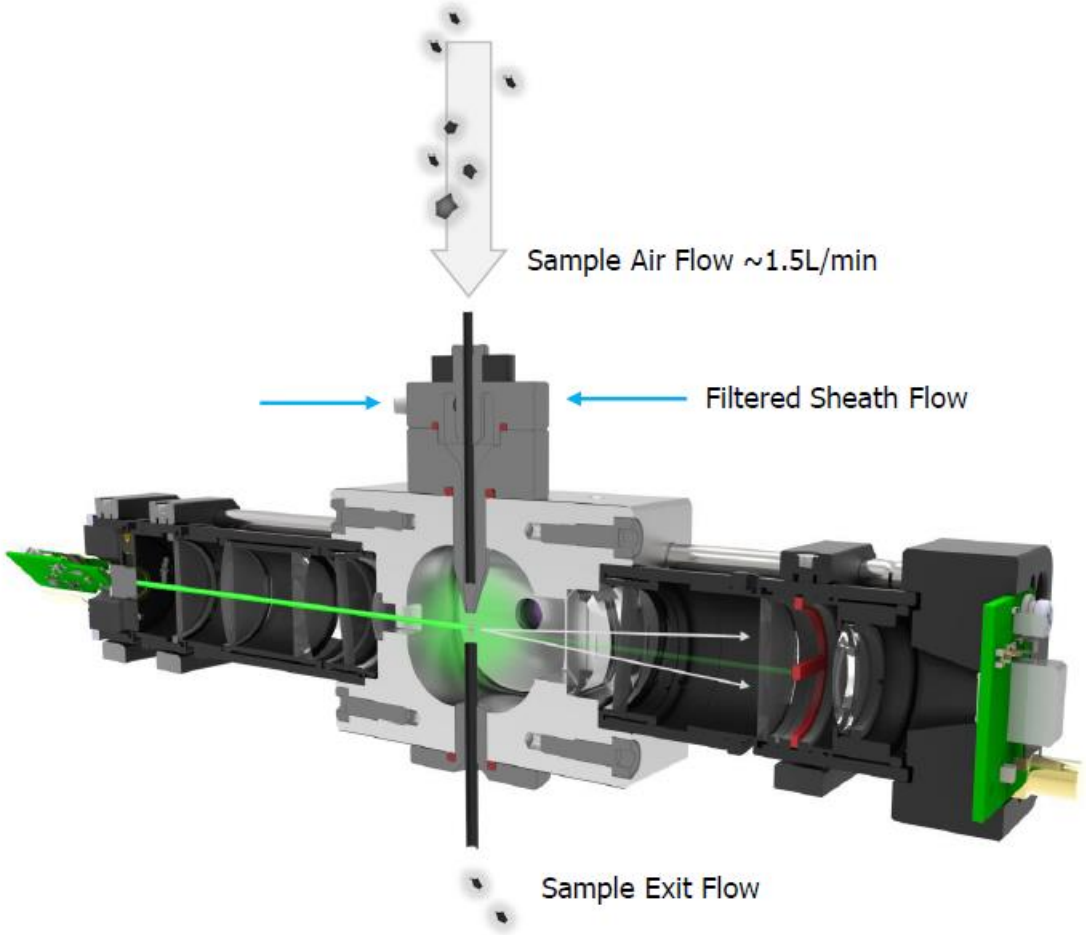
Real-Time RCS Detection

The Technology

Dedicated RCS sensor, designed around Trolex patented optical refraction technology.

- Mie Theory (Particulate Sizing)
- Scatter Asymmetry (Particle Shape)
- Light Polarisation (Characterisation)
- Specific Algorithm

Lasers = Real Time Silica Counter



Real-Time RCS Detection

The Method

From the sampled airflow the Air XS Sensor determines the following to support the identification of RCS particles

- Airflow Per Litre (Dynamic)
- ~10,000 triggers per second
- Particle count per second
- Particle Density
- Positive RCS count over general dust
- RCS content in mg/m^3

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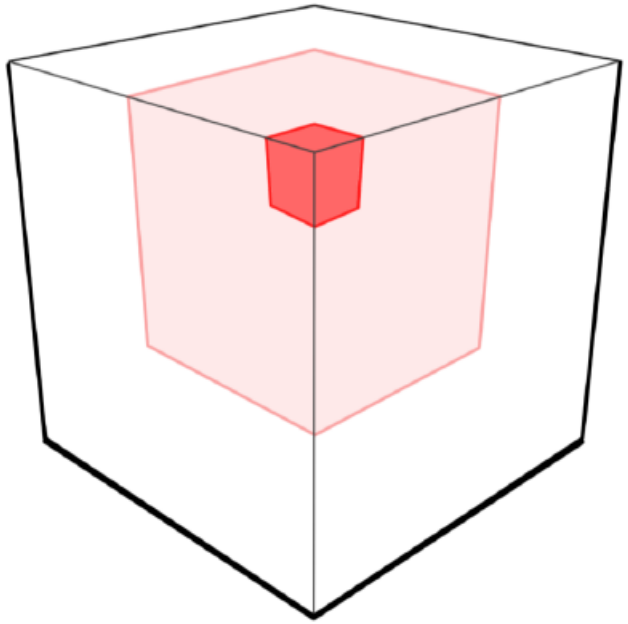
Air XS – Measurement Methods

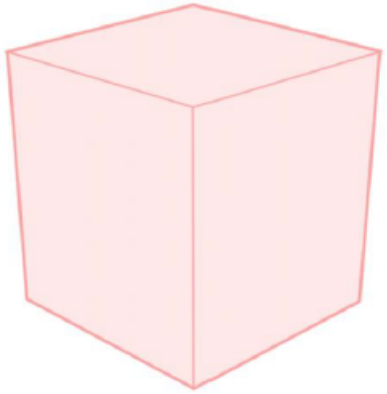
Real-Time RCS Detection

Device Measurement



Sample Concentration

Total volume of Air (Litres) sampled over a given time



Mixed Particulates

Volume of Particles sampled from 1 – 40µm in counts

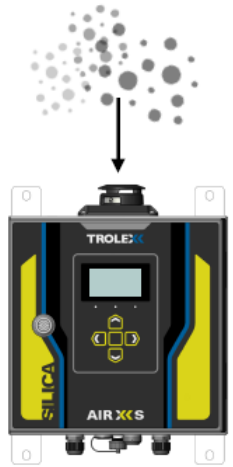
Silica Content

Volume of Silica Particles sampled from 1 – 10µm in counts and $mg.m^{-3}$

Air XS – Particle Sizing

Real-Time RCS Detection

Particle Sizing and Sorting



Particle Count (per second)	453	212	101	157	123	82	78	65	56	53	45	41
Particle Size	0 – 1um	1 – 2um	2 – 3um	3 – 4um	4 – 6um	6 – 8um	8 – 10um	10 – 14um	14 – 18um	18 – 22um	22 – 24um	24 – 28um

Note: This information is used for mass reporting and calculations, but is not available to the customer.

Air XS – Active Sampling Area

Real-Time RCS Detection

Active Sampling Area

Sampling Zone

- Airborne particulates drawn into device relative to the dust inlet port situated on the top of the device.
- Active sampling area typically draws from a ~1m radius in calm air conditions.
- Devices should be positioned relative to particle generation sources or areas of interest
- Sampling can be influenced by environmental conditions such as airflow, local extraction and ambient surroundings.

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Air XS - Tech Specs

Particulate sensing parameters

Sensing technology	Optical refraction technology (ORT) Light-scatter photometer (OPC)
Particulate measurement	Target RCS identification range 1 to 10 µm
Max. typical dust loading*	150 mg/m^3
Continuous range	25 mg/m^3
Displayed data	RCS mg/m^3 Total particles/litre over the selected averaging period
Resolution	1 µg (1,000th of a mg)
Averaging period	15 minutes, 1, 4, 8 and 12 hours
Sampling interval	1 second to 60 seconds
Particle count	> 600 particles/second
Total airflow rate	~ 1.5 L/m (nominal)
Typical RCS accuracy	± 25%

*The instrument can define particulate measurement peak trends up to the quantity specified.

Note: Sustained exposure to dust quantities above 25 mg/m^3 will be logged but they may affect the operating life of the Air XS sensor.

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TROLEX – Real Time Silica Monitoring

The AIR XD Packages

Mounted on a high-quality tripod and powered by dual lithium-ion batteries with a typical run cycle of 30 hours per battery. The standard Air XS can be converted into transportable mode in about 20 minutes.

Contains the Trolex-approved Compliance Audit dust samples, along with the particulate delivery system with hood, and swap-out filters for 12 compliance audits.

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Simple to use. Easy to maintain.

- Designed not to need calibration.

- Starts up automatically and is monitoring for RCS within a few seconds.
- Just 5 minutes every month* will give you the comfort your Air XS is functioning as it did when it left the factory.

***frequency dependant on environment.**

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Case Studies

Case Study – Aggregate Processor

Company Operations:

Blending and mixing, bulk tanker loading, contract bagging, contract drying screening and sieving.

Problem Statement:

“How can we determine the amount of dangerous dust in each process at the plants, while the business is growing and processes are changing?”

Case Study – The Approach

- Utilize “real-time” crystalline particle monitoring to:
  - Determine effectiveness of the dust suppression systems.
  - Reduce cost and turnaround time for lab analysis.
  - Increase worker engagement with transparency to readings.

Case Study – The Data

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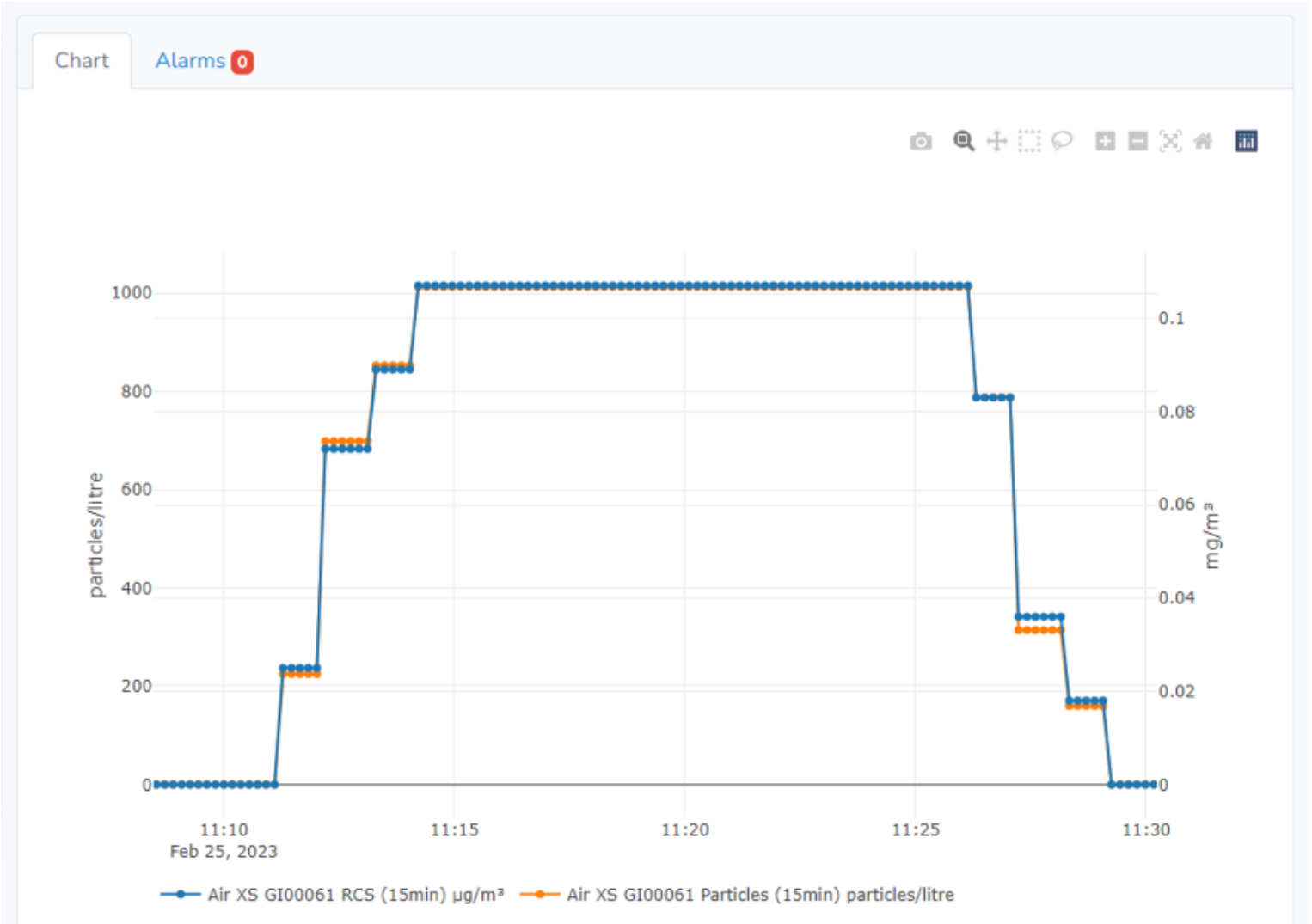

Case Study - Results

- The equipment and processes were verified for total dust suppression. Where necessary, adjustments made to the systems.
- A unit was mounted in the most dangerous areas to alert to high concentration operations and keep workers from entering.
- Company reduced the time and cost of analysis with less frequent sampling.
- Confidence grew across the organization.

Production Manager - *"For the first time the guys on the equipment were asking me to tell them about what the business was doing to protect them. And that was great as staff retention is quite high on our agenda right now."*

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Case Study – SIBELCO

Company Operations:

A multinational business with operations in 31 countries and an extensive multi-mineral portfolio. Working across a broad range of industries, products help to build homes, cities and vehicles; to support the supply of renewable energy, food and clean water; to create technologies such as smartphone display screens, printed circuit boards and semiconductors.

Problem Statement:

“How can we increase worker health, production efficiency and the lifespan of our equipment operations?”

Case Study – Equipment Evaluated

Sintrol: Total particles

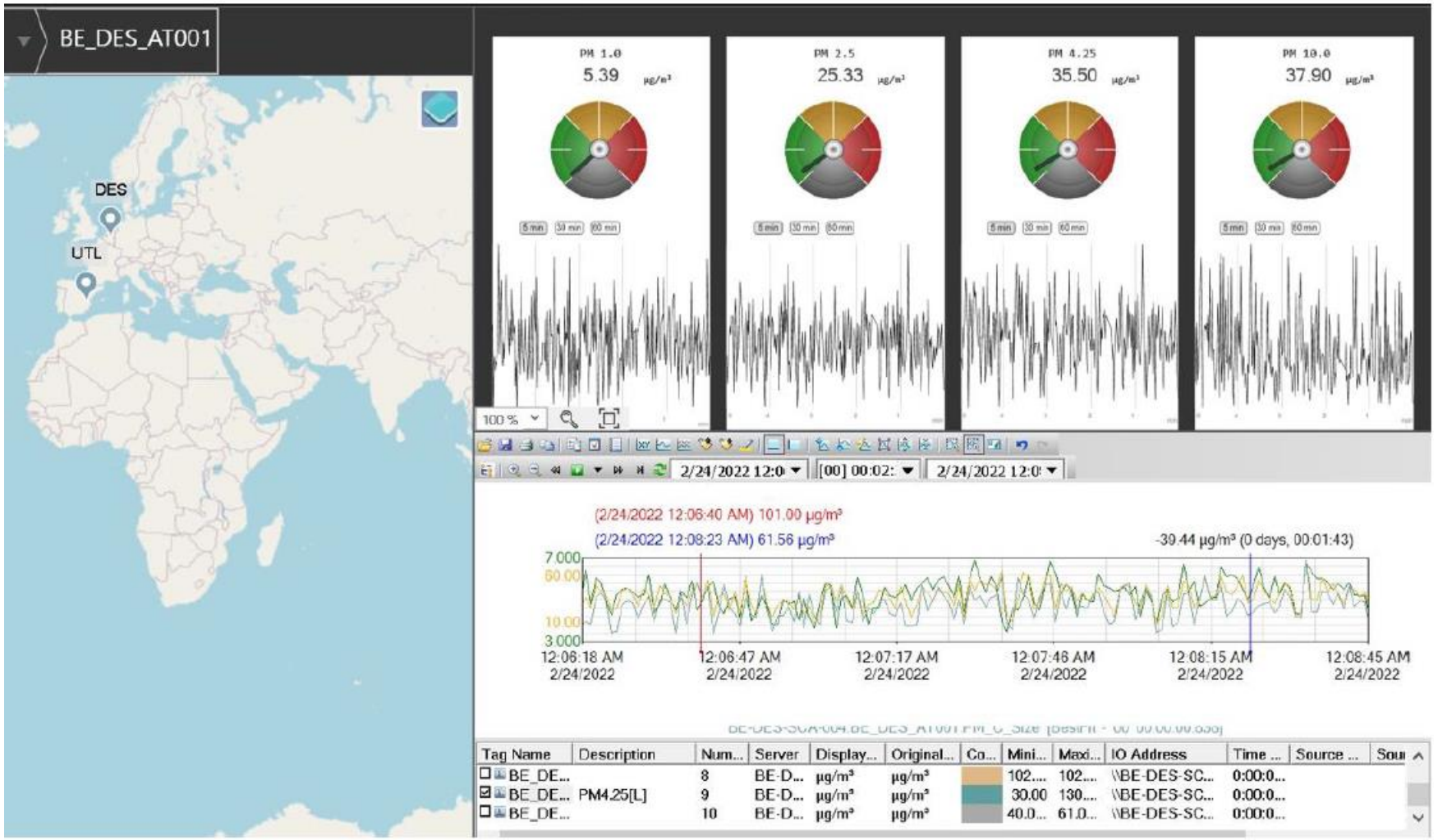
Mitrion: PM2.5

Trolex: PM4.25 and RCS

Case Study – Control System Integration

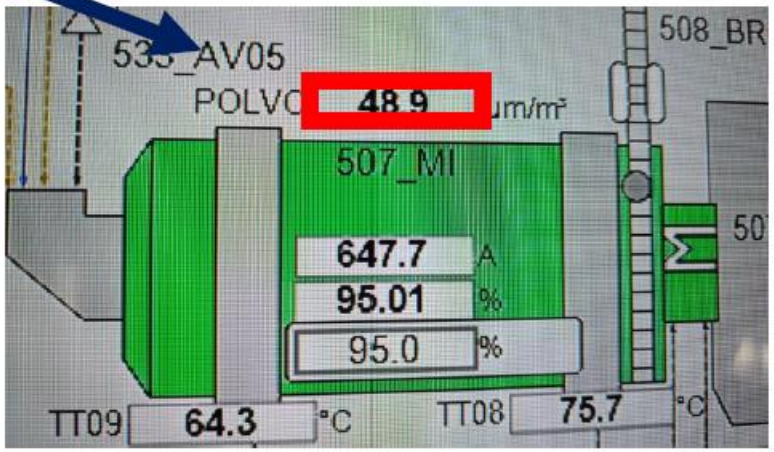
Trolex installed in Scada in multiple Plants:
Utiel, Arcos and Dessel:

Software developed internally by Sibelco



Case Study – Operator Visibility

The operator can see what the dust levels are in the different points of the plant



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Case Study – Monitoring Peak Readings

Dust peaks every time the operator takes a sample

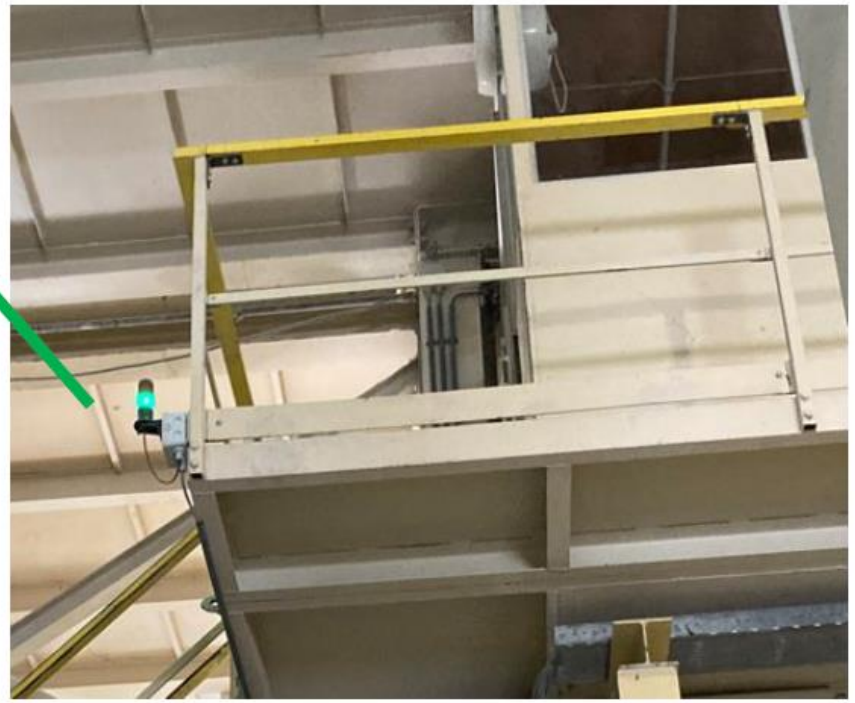
Case Study – Safer Work Spaces

Installation of more detectors to identify faster where the dust leak has occurred

Case Study – Safer Work Spaces

Installation of detectors in close areas that contain dust leaks, for example packaging stations

Pilot in green means that the dust values are low so you can enter inside



Case Study - Results

- Devices were used throughout the plant to alert employees to the most dangerous areas and timing, to alert to high concentration operations and keep workers from entering the spaces.
- Operators were able to control the frequency of maintenance and prolong equipment performance.
- Company follows through on employee commitment, “healthy minds, happy lives”.

Is This The Future of Silica Monitoring?

- Units are Portable and Transportable
- Get closer to the source
- Real Time Results in the Field with Alarm Settings
- Provides Total Particle Measurement & Real - Time Silica Concentration
- Will Lead to Smaller and Personal Style Monitors

Increased safety for personnel and decreased downtime waiting on analysis.

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Conclusions

PRO's

- Real-time monitoring can provide early warning system.
- Real-time monitoring can be used in permanently monitoring applications for high-risk processes.
- Real-time monitoring can be used for fence line monitoring during construction activities.

CON's

- Technology is still proving out in various industries.
- Unit is large and can be tough to move into a proper position.
- Large device does not allow for direct worker monitoring.
- Correlating results to the lab analysis can be inconclusive and not approved as a current analytical method.

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