Silica Research, Monitoring and Control Measures

CalCIMA Spring Thaw 2023

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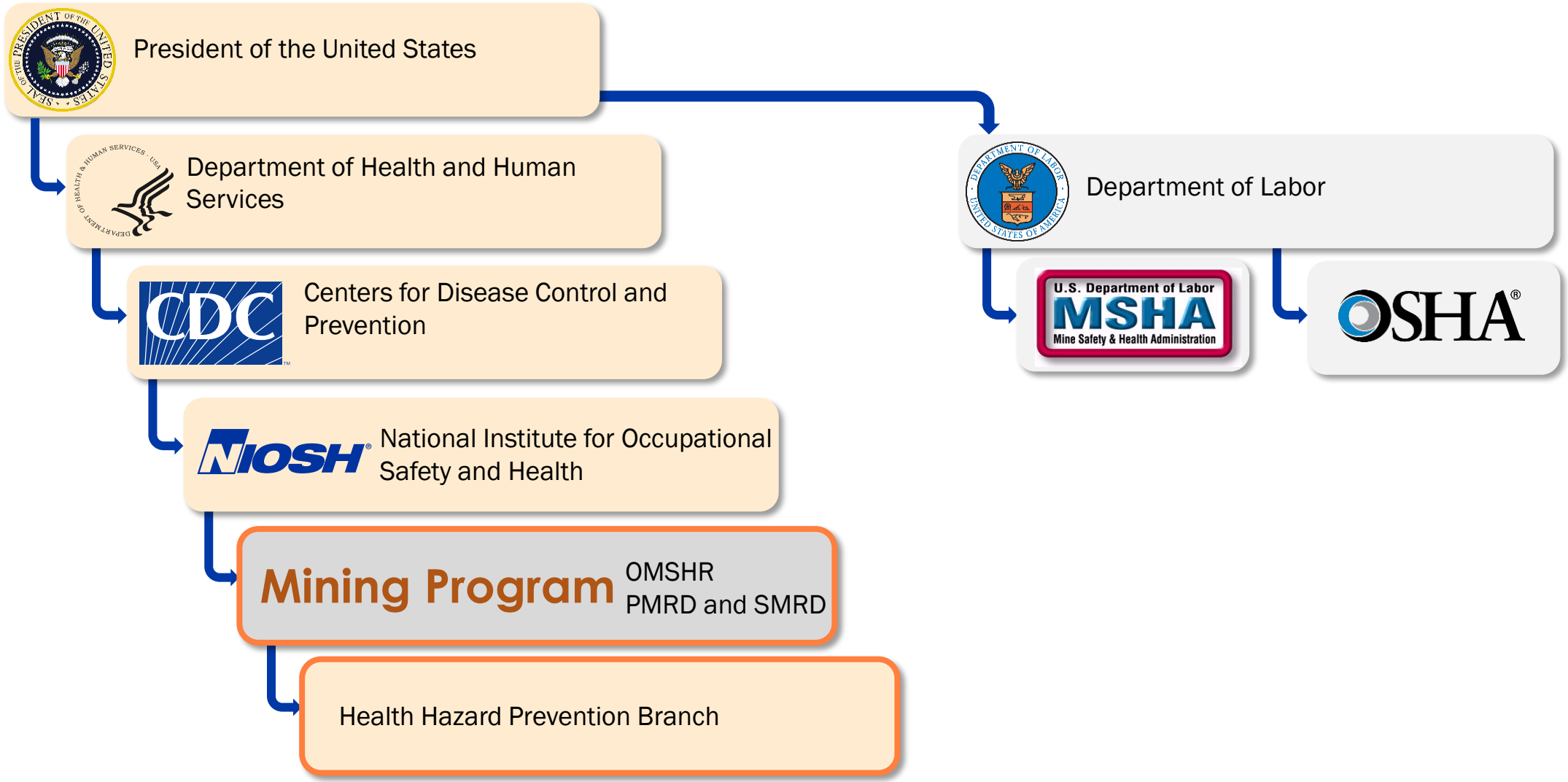
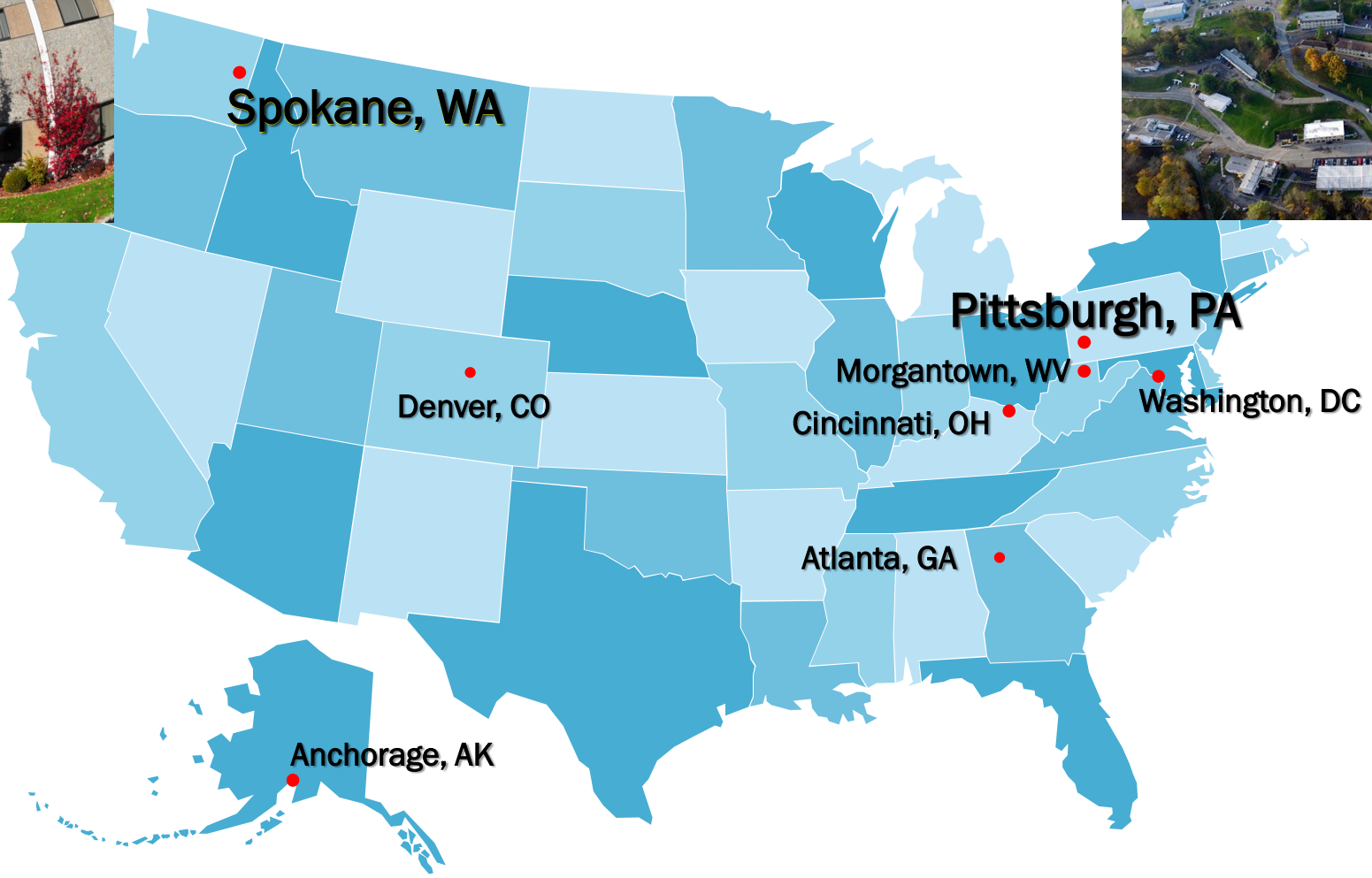
NIOSH / PMRD /Pittsburgh PA

Contributors: Cauda, Cecala, Vanderslice, Yekich & Wolf

The NIOSH Mining Program is a scientific (non-regulatory) program within NIOSH



Most NIOSH Mining research stems from divisions based in Spokane, WA and Pittsburgh, PA



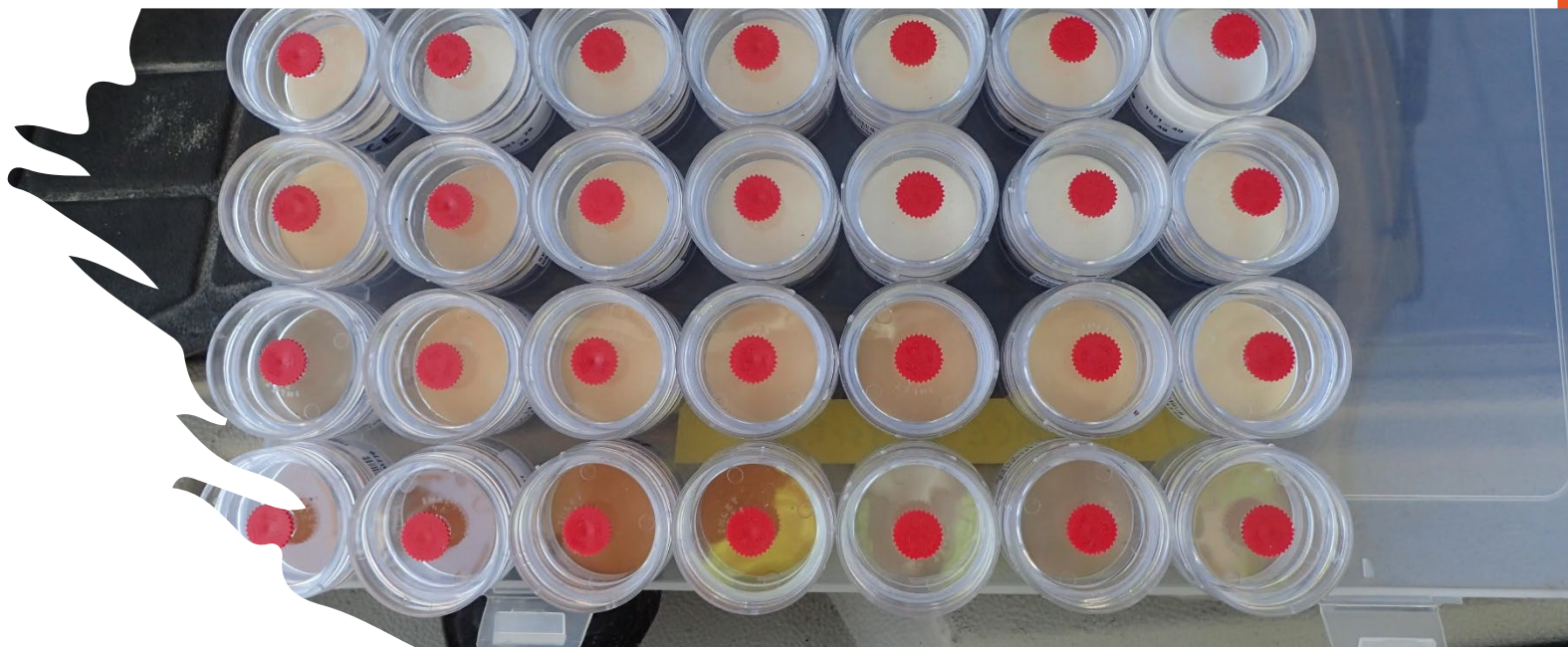
The Mining Program has three strategic goals

1. Reduce mine workers' risk of **occupational illness**

2. Reduce mine workers' risk of **traumatic injuries and fatalities**

3. Reduce the risk of **mine disasters** and **improve survivability** of mine workers

Exposure hazards vary with *time and space*. You cannot control what you cannot measure (in both those dimensions)



Project 9390DTJ Objectives

Low Cost Dust Sensors

To determine the suitability of low-cost dust sensors for the mining industry.

Smart Filtration Systems

To encourage major equipment manufacturers to incorporate state-of-the-art filtration and pressurization in their cabs to ensure that acceptable air quality is continuously maintained.

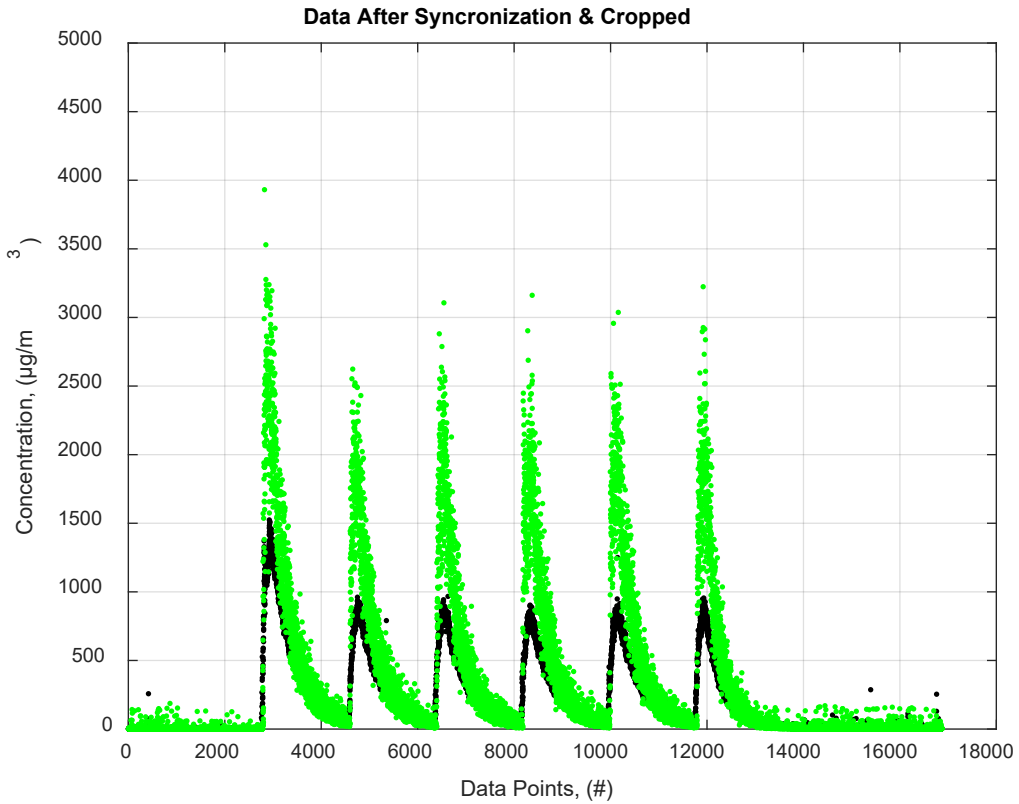
Emerging Controls

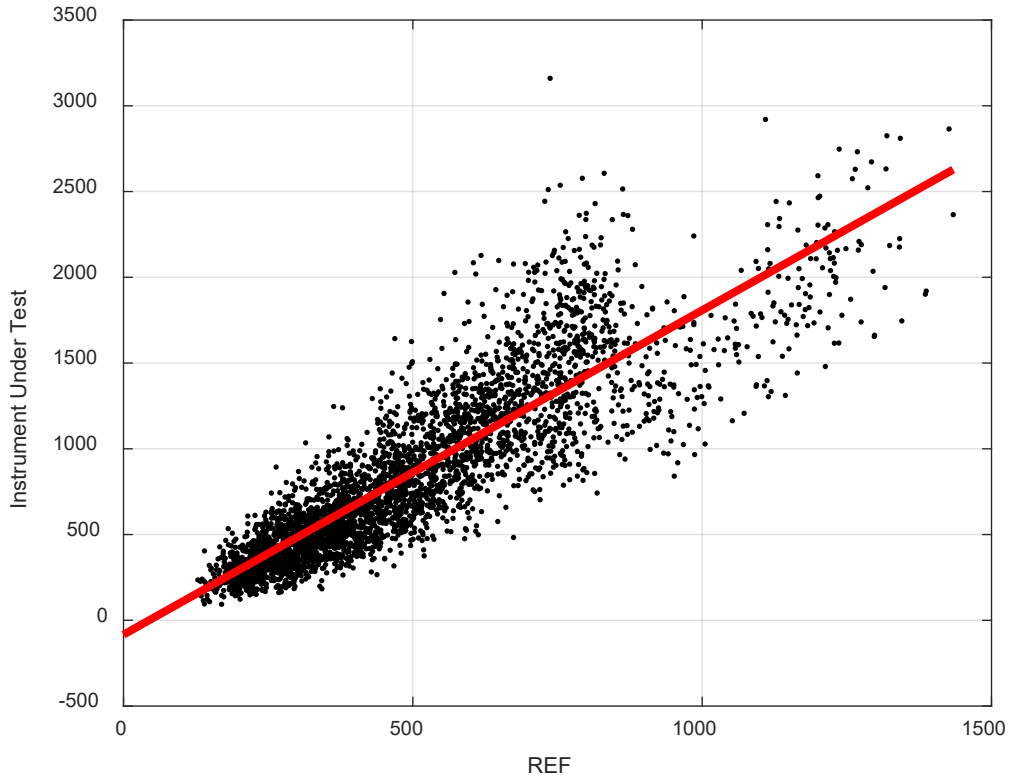
To provide the mining industry with an unbiased assessment of the efficacy of specific control technologies, particularly those that have been developed to address reduced exposure PELs.

Area & Personal Dust Monitors Exist but are Cost-Prohibitive for More than a Few Areas or Units

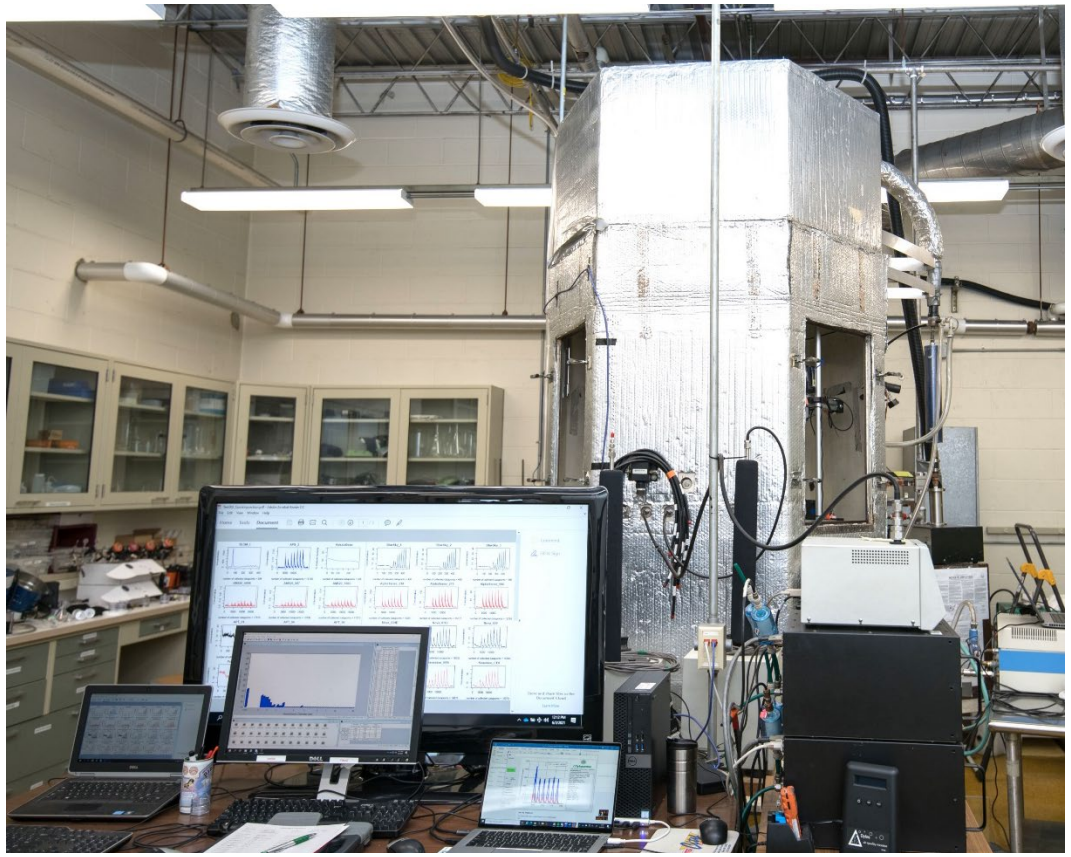
Instruments Under Test in Lab Environment

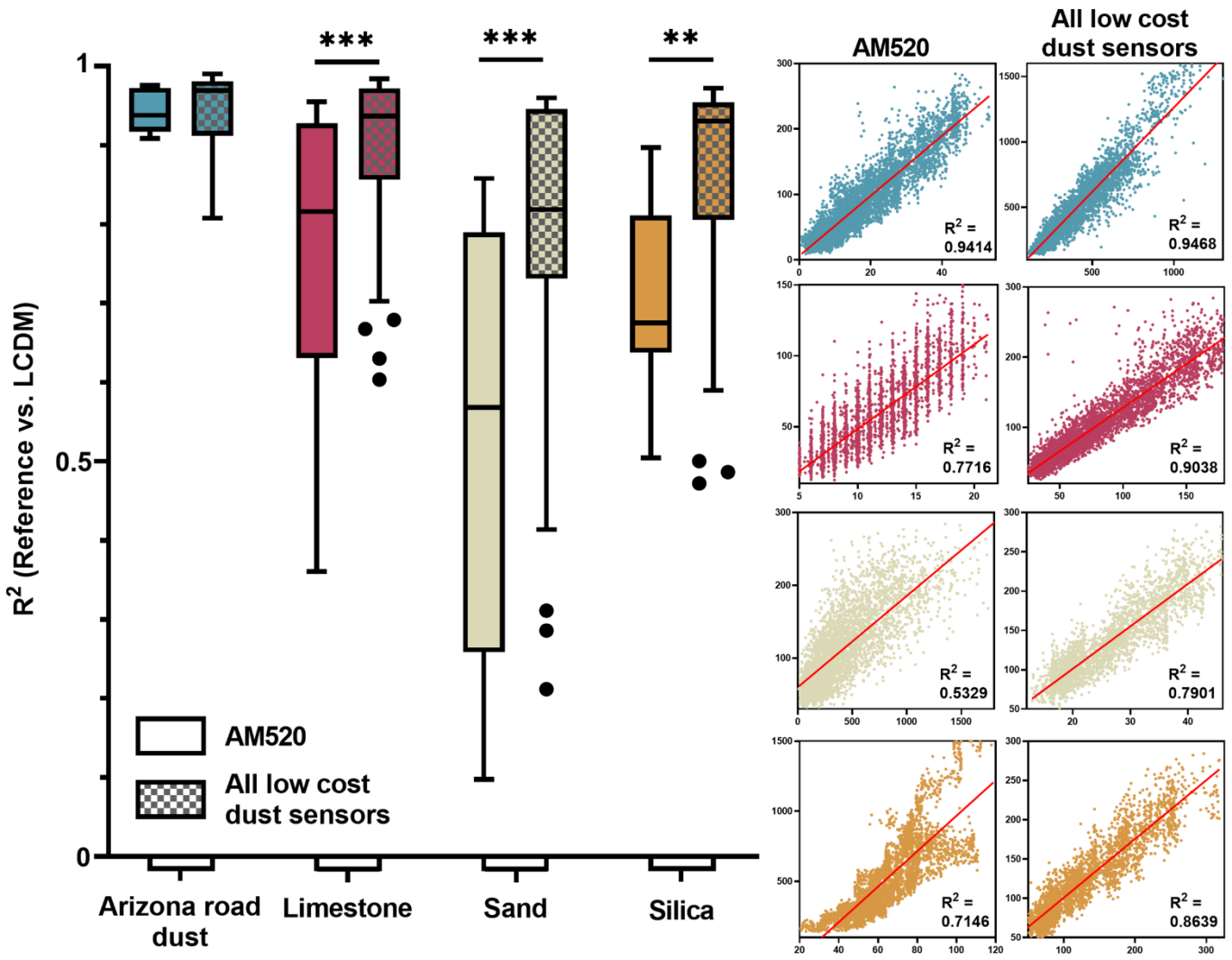
Lab Testing Compares LCDM to Reference Grade Instruments



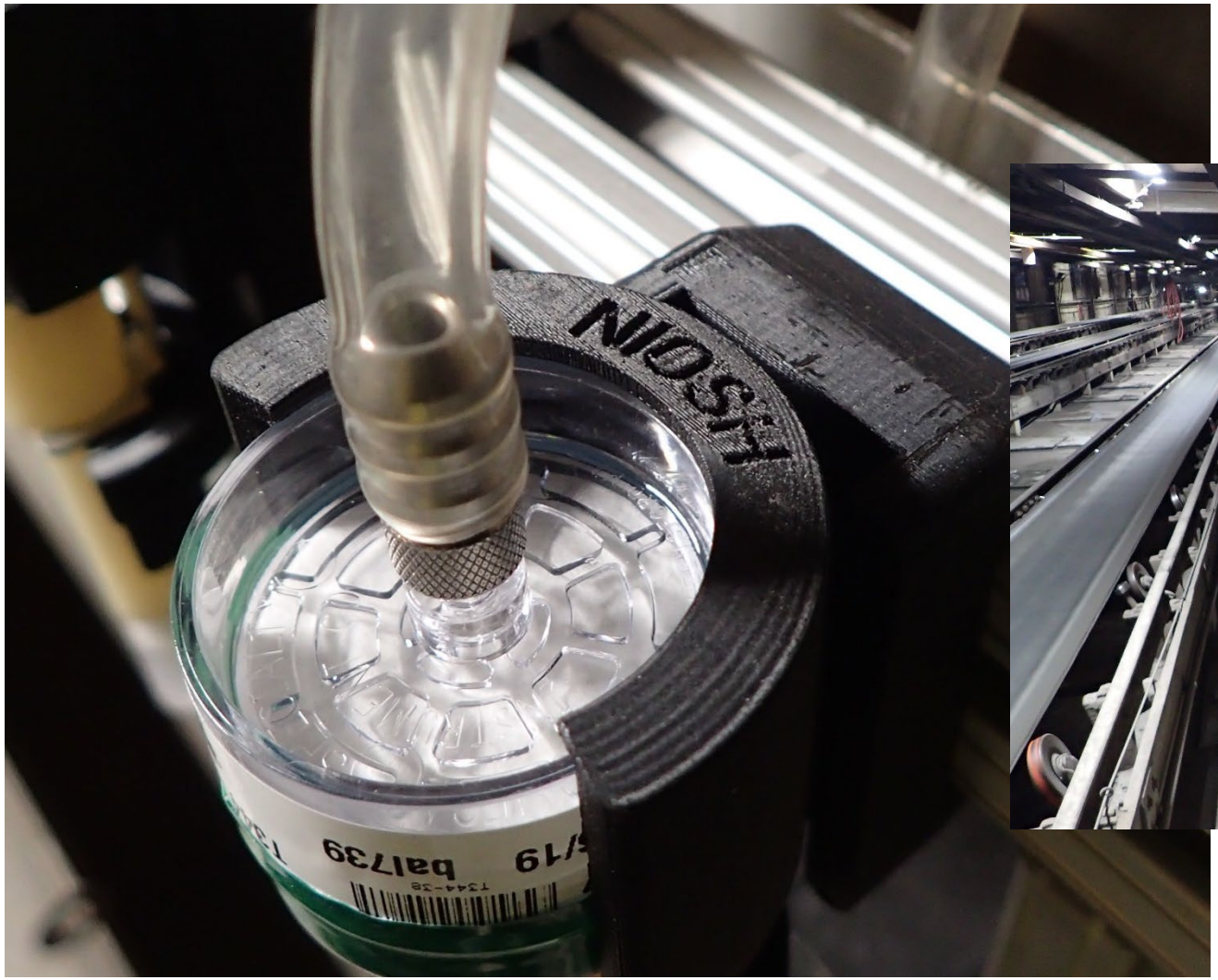


LCDM Laboratory Testing Completed, Performance is Compelling

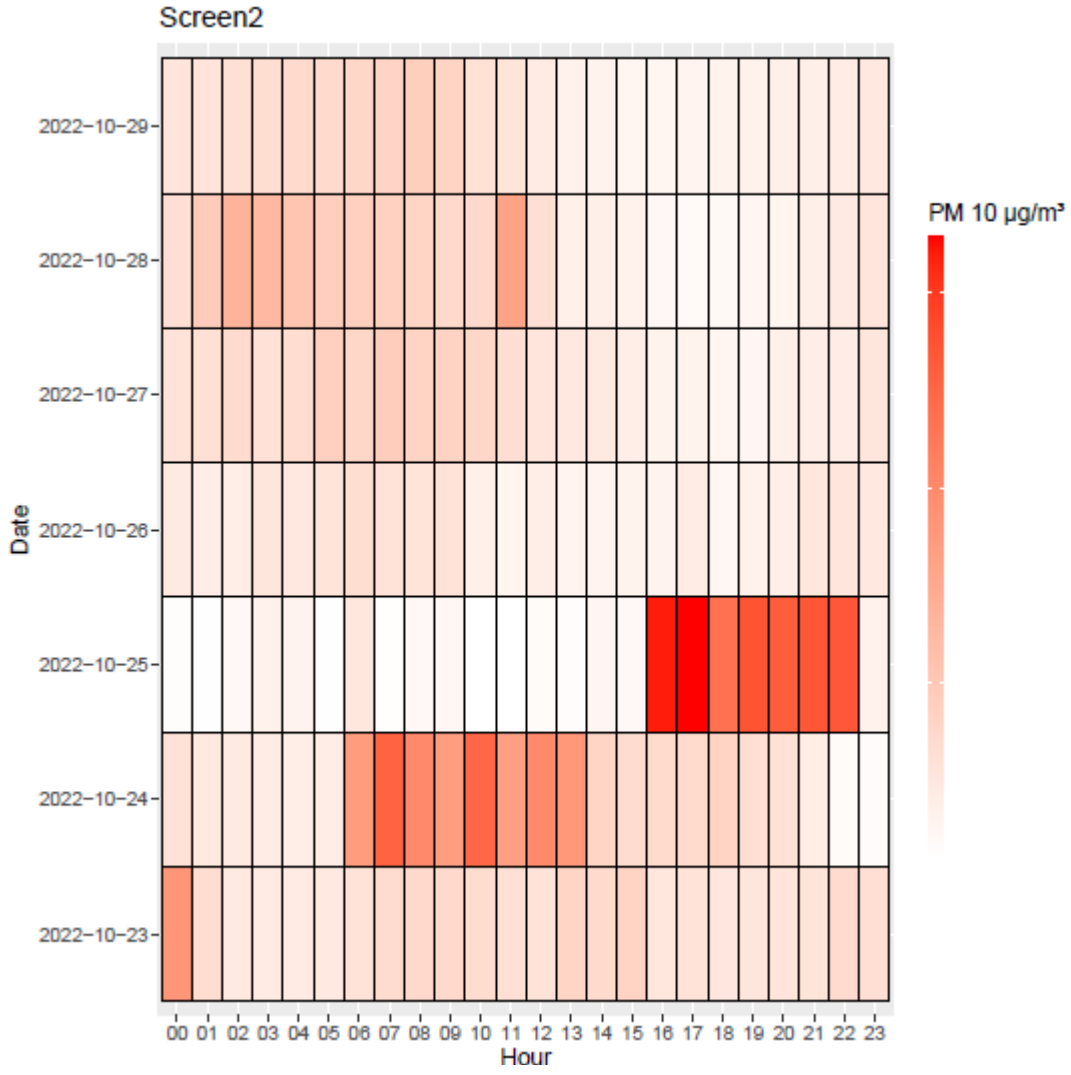




Parallel Gravimetric Sampling to Establish In-Field Calibration



LCDM Field Trials and Data Visualization Efforts



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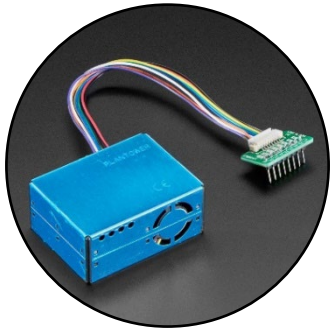
SmartCab Prototype Built, Shop Tested, Preparing for Field Test

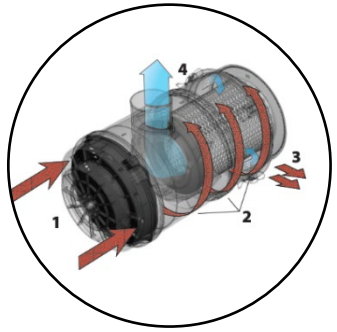


Measure

Dust levels

CO2

Cab Pressure



Improve

Adjust intake airflow

Change recirculation airflow

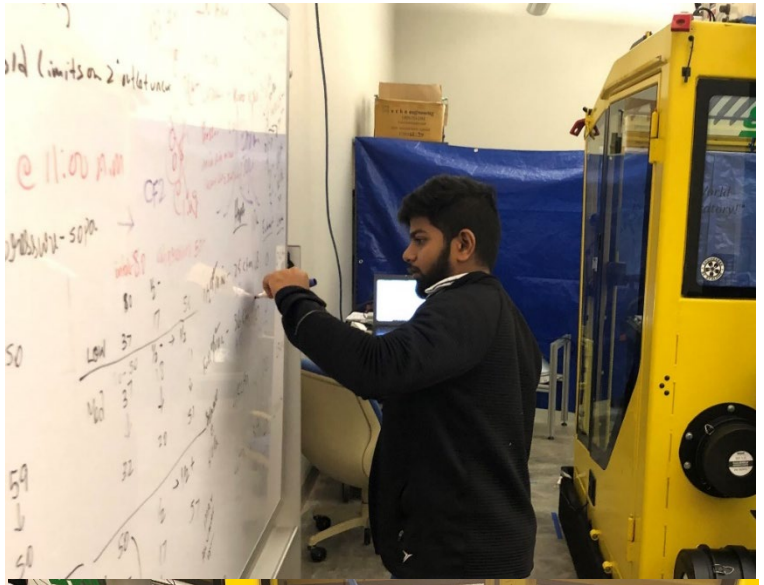
Inform

Display cab pressure

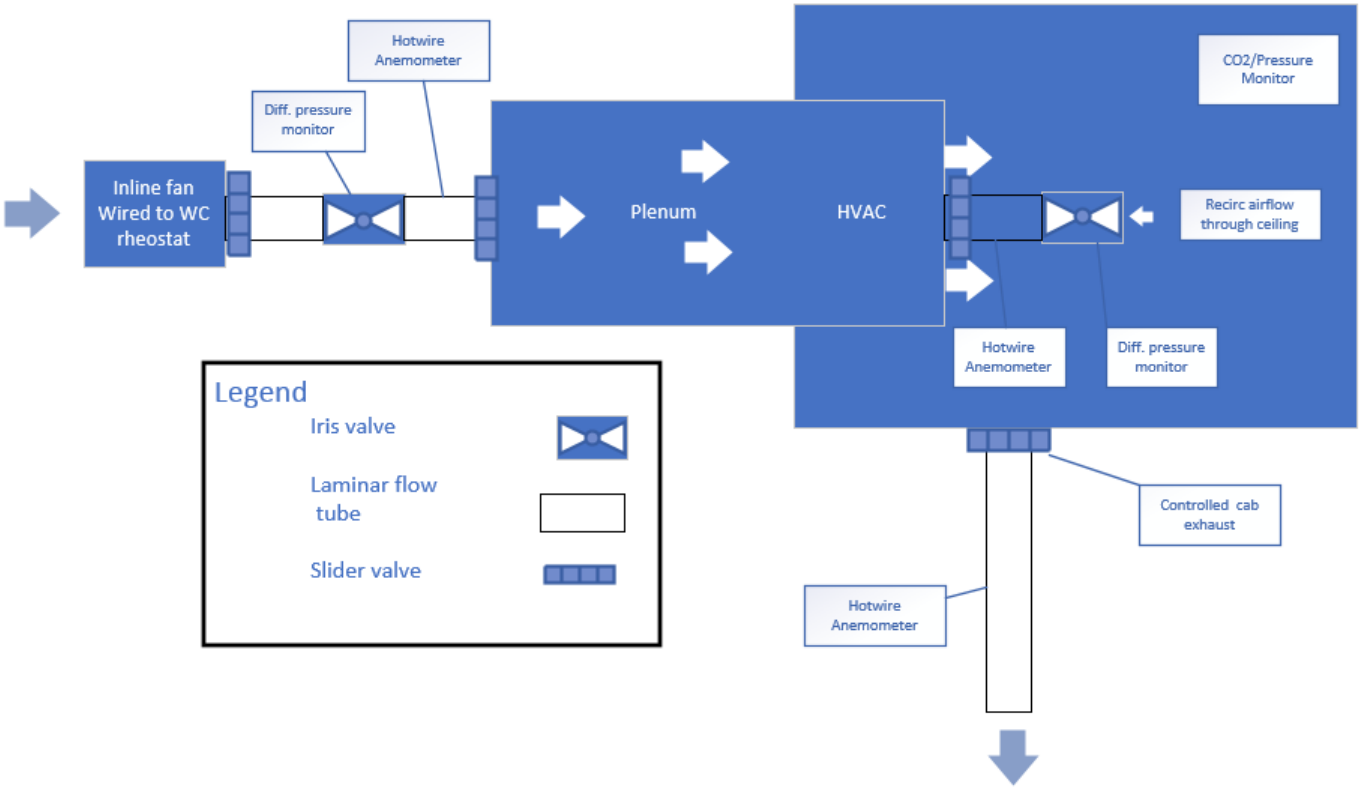
Suggest filter change

Log air quality

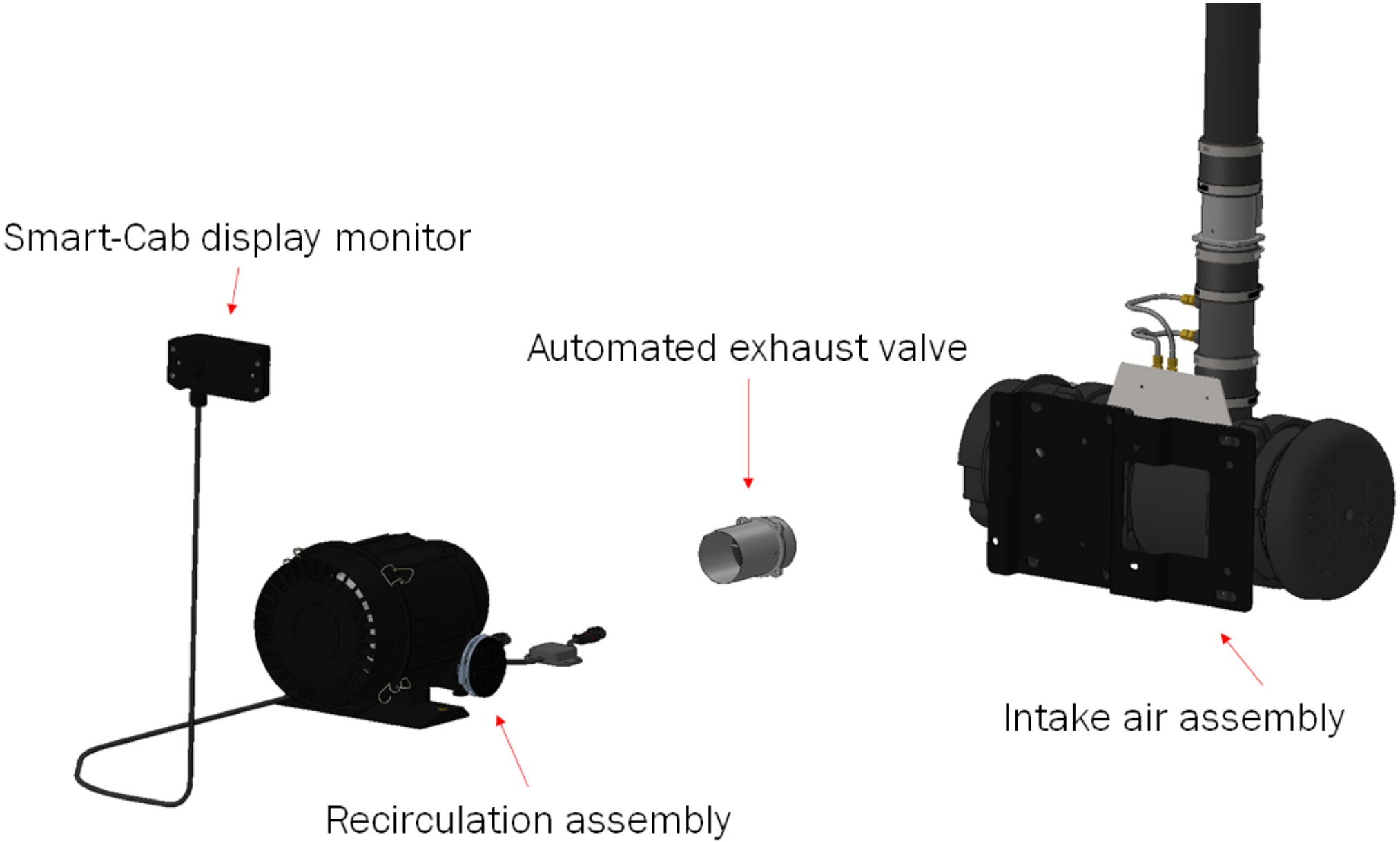
Integrate to Create SmartCab System



The SmartCab Prototype has Been Built and Shop-Tested



Major SmartCab Components Have Been Sourced and Prototyped



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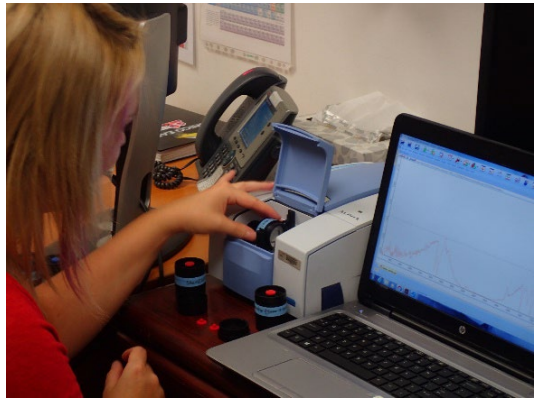
Efficacy Testing of Coated Sands and Welding Fume Capture Units

Research to Practice – Solutions will be Demonstrated at Mines

Field-Based Respirable Crystalline Monitoring Approach



Milan R. Yekich

Health Scientist

The Rapid Quartz Analysis is a 3-steps field-based approach

Collect samples using gravimetric dust samplers

Analyze samples with a portable FTIR unit

Process the FTIR data with NIOSH FAST software

(optional) Verify field analysis with laboratory tests

FAST
Field Analysis of Silica Tool

Cauda, E., A. Miller and P. Drake (2016). "Promoting early exposure monitoring for respirable crystalline silica: taking the laboratory to the mine site." Journal of Occupational and Environmental Hygiene 13(3): D39–D45.

All the components of the Rapid Quartz Analysis approach are available

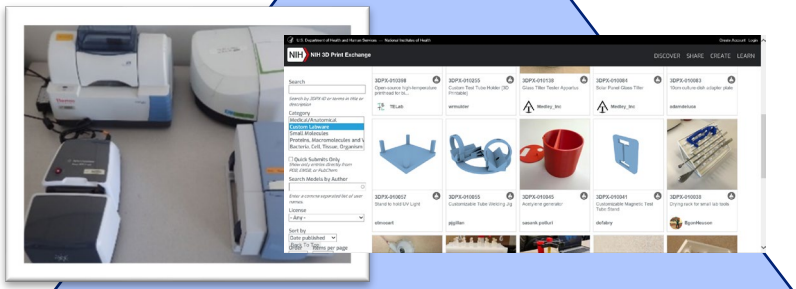
Multidisciplinary effort

Compatible with most respirable dust samplers
New dedicated dust sampling cassette (Zefon)

Chubb, L. G. and E. G. Cauda (2021). "A novel sampling cassette for field-based analysis of respirable crystalline silica." Journal of Occupational and Environmental Hygiene **18(3): 103-109.**

Industrial hygiene

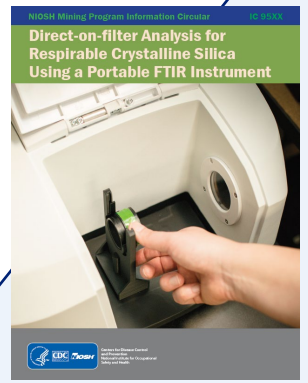
Commercially available instruments
New components - NIH 3D Exchange



Adapted spectroscopy

Ashley, E. L., E. Cauda, L. G. Chubb, D. P. Tuchman and E. N. Rubinstein (2020). "Performance Comparison of Four Portable FTIR Instruments for Direct-on-Filter Measurement of Respirable Crystalline Silica." Annals of Work Exposures and Health **64(5): 536-546.**

Dedicated NIOSH software
Comprehensive user guide



FAST
Field Analysis of Silica Tool

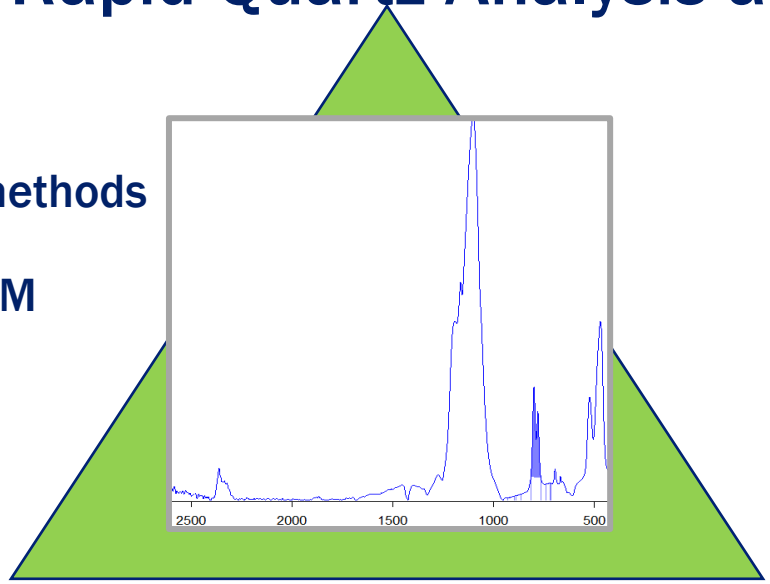
User experience

Chubb, Cauda, NIOSH (IC) 2021, "Direct-on-filter Analysis for Respirable Crystalline Silica Using a Portable FTIR Instrument"

All the components of the Rapid Quartz Analysis approach are available

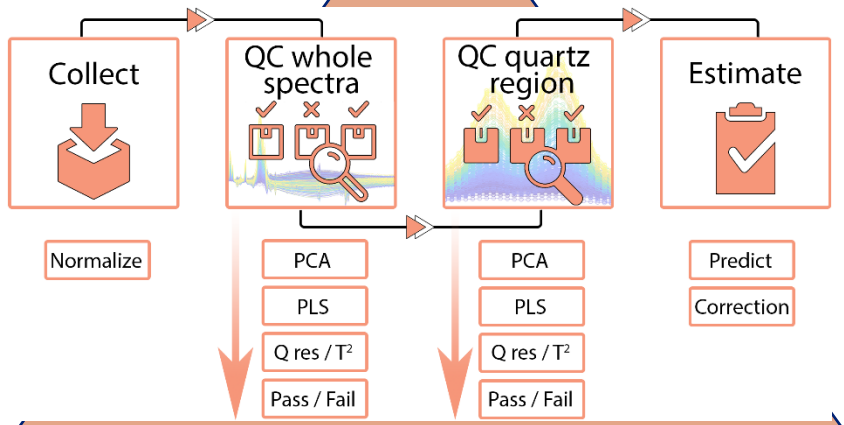
Multidisciplinary effort

Based on established analytical methods
- NIOSH,MSHA, HSE (UK).
- Interest of NMAM and ISO, ASTM



Acknowledging the complexity and variability of the respirable dust in mines

Implementing a chemometric-based pipeline for accurate quantification of complex samples



Geology

Chemometrics

Walker R, Cauda E, Chubb L, Krebs P, Stach R, Mizaikoff B, Johnston C. (2021) **Complexity of Respirable Dust Found in Mining Operations as Characterized by X-ray Diffraction and FTIR Analysis.** Minerals; 11: 383.

Wolfe C, Chubb L, Walker R, Yekich M, Cauda E. (2022) **Monitoring Worker Exposure to Respirable Crystalline Silica: Application for Data-driven Predictive Modeling for End-of-Shift Exposure Assessment.** Ann Work Expo Health; accepted

Good interest from the mining/non mining industry

Coal mines:

- Interest by the National Mining Association for implementation in coal mines
- Interest from major coal mine companies
- BHP (Australia coal) has adopted the methodology

Metal mines:

- Interest from Freeport McMoran for national and international use
- Interest from the International Council of Metal and Mining (ICMM)
- Teck Resources (Canada) invested $1M in H&S monitoring technologies including portable FTIRs
- Barrick in Tanzania

Aggregate mines:

- Collaboration with single operators and NSSGA on the creation of case studies for demonstration of the benefit of the field-based technologies

Outside mining:

- Department of Energy (SRS – Georgia) has been using it for a few years
- The entire industrial hygiene community – AIHA, IOHA, SAIOH (South Africa), BOHS (UK)
- Perkin Elmer SILICA analyzer – the complete package.

Interaction with mining operators is critical

Case study: New Enterprise – sandstone operation - Pennsylvania

- NIOSH conducted the case study in a typical quarry operation– open pit, plant, QC laboratory.
- Assessment of different tasks using the Rapid Quartz Analysis approach and Helmet-CAM
- The case study was showcased on NSSGA Magazine "*Stone and Sand & Gravel Review*"

Most significant outcomes

- New Enterprise used the material from the NIOSH report for training purposes.
- NIOSH got a better idea of the possible benefits and challenges connected with adoption of technologies.

Questions?