

Low Cost Dust Sensors in Mining:

Initial Results and Future Research

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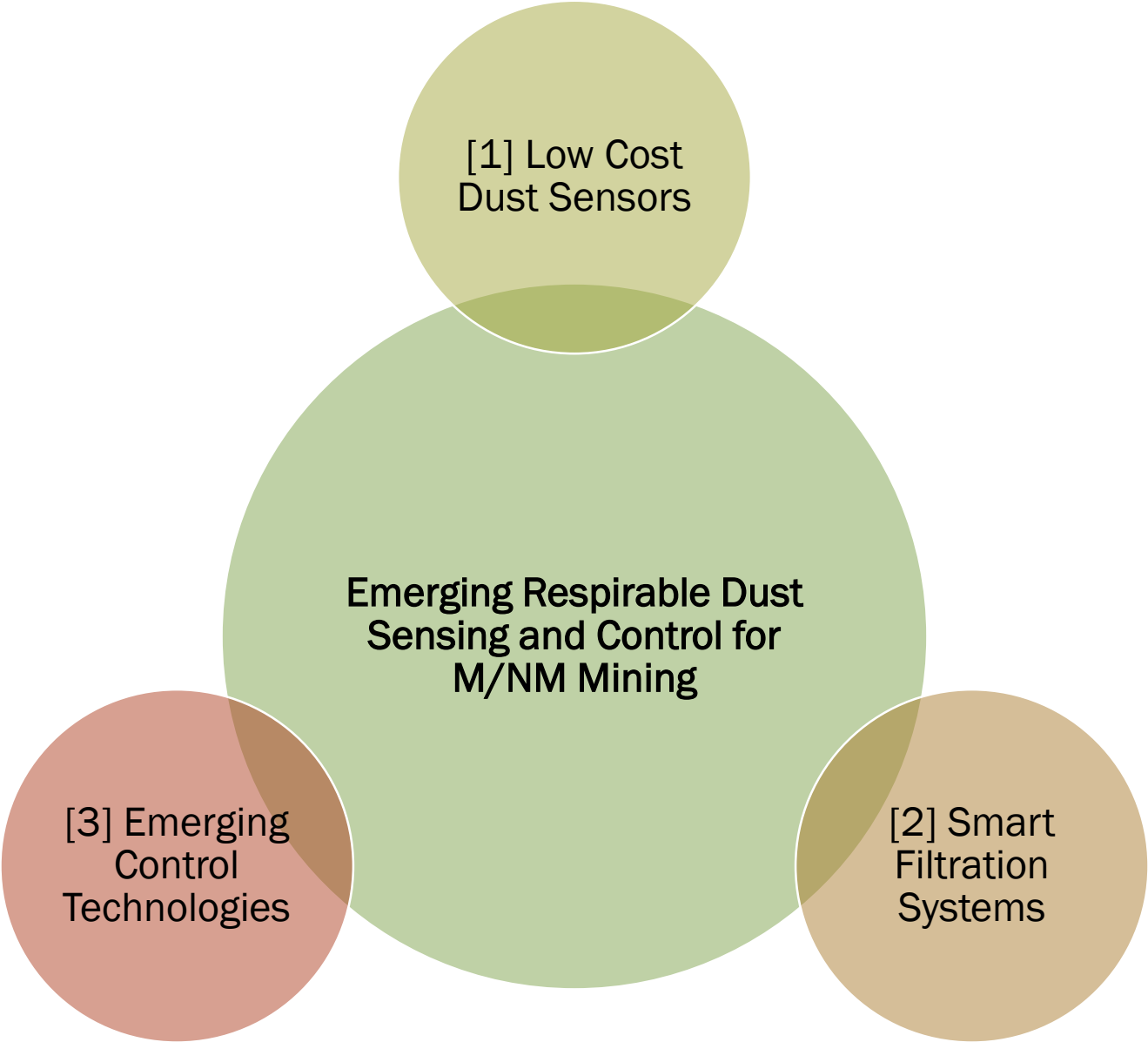


https://www.cdc.gov/niosh/mining/researchprogram/projects/project_DustSensing.html

Emerging Respirable Dust Sensing and Control for M/NM Mining



NIOSH project 9390DTJ: three aims with one goal



Many controls exist – how to encourage increased adoption?

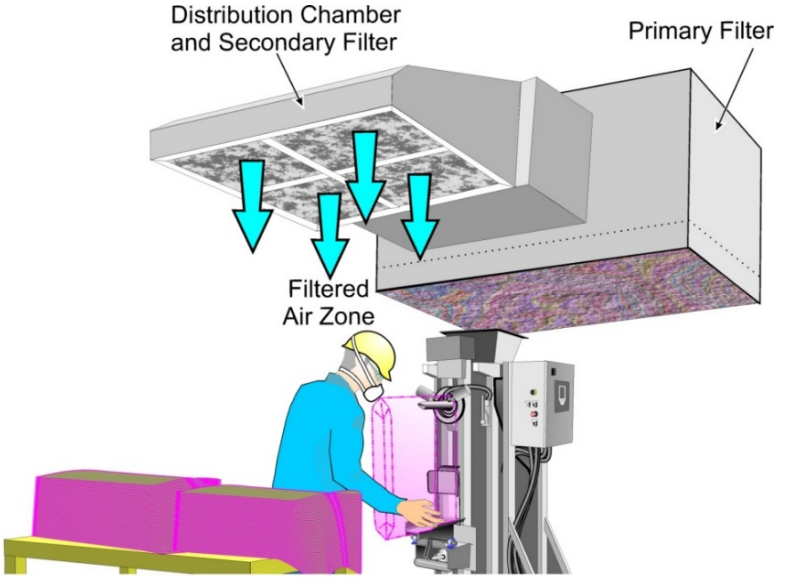
NIOSH Mining Program Report of Investigations R1XXXX

Dust Control Handbook for Industrial Minerals Mining and Processing

Second Edition

Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

IMA-NA
Industrial Minerals Association
North America



NIOSH Mining Program Information Circular IC 9531

Design, Testing, and Modeling of Environmental Enclosures for Controlling Worker Exposure to Airborne Contaminants

Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

Compliance sampling captures snapshot of exposures; area monitoring networks may guide engineering controls

3%

Of workers in M/NM had a (compliance) respirable dust sample collected between 2000-2017

10%

Of Respirable Quartz Samples > MSHA PEL

31%

Of Respirable Quartz Samples > OSHA PEL

Source: <https://arlweb.msha.gov/OpenGovernmentData/OGIMSHA.asp>



“The next era of exposure assessment may involve continuous sensing of the working environment”

- Dr. John Howard, 2014

Mining leaders also see the benefit of real time dust sensing...

“Over the next three years, 4/5 mining companies will increase spending on 4IR technologies including automation, robotics, mobile technology and the “Internet of Things”...It’s all about efficiencies, cost savings and increased productivity, all of which will combine to make miners more nimble and profitable.

Fourth Industrial Revolution Technology is Changing the Mining Game”;
energy and resource digest.com

“Smart building ventilation systems? We need that yesterday.” – Major US Sand Producer, 2019

When asked what is a smart building ventilation system... *“Something that tells us in real-time that we have a dust problem, that a filter needs changed, etc. Not waiting until a health audit reveals this.”* – Major US Mining Co., 2018

Area & personal dust monitors exist but are cost-prohibitive for more than a few areas or units



Sensor classifications; benefits and limitations

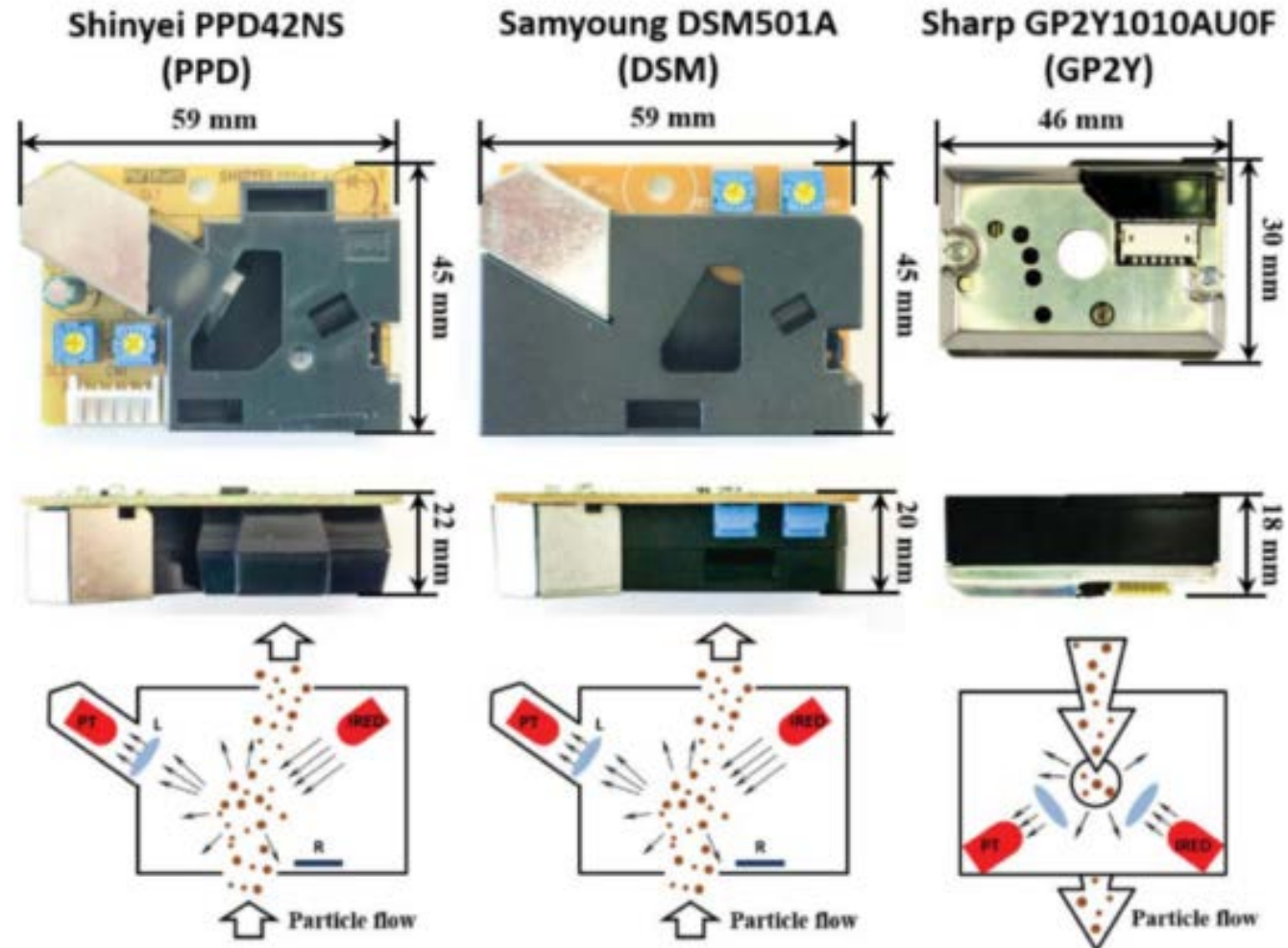


DECREASING COST, DECREASING CONFIDENCE BUT INCREASING ACCESSIBILITY

Sources:

TSI (left and middle), Plantower (Right)

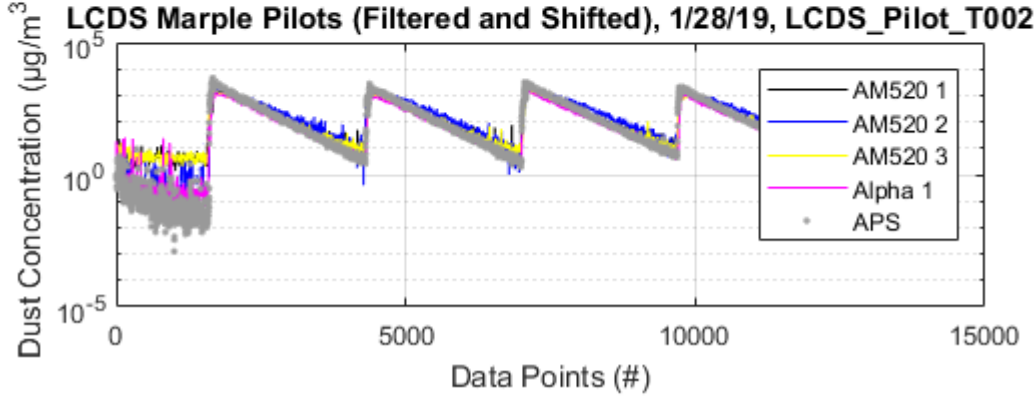
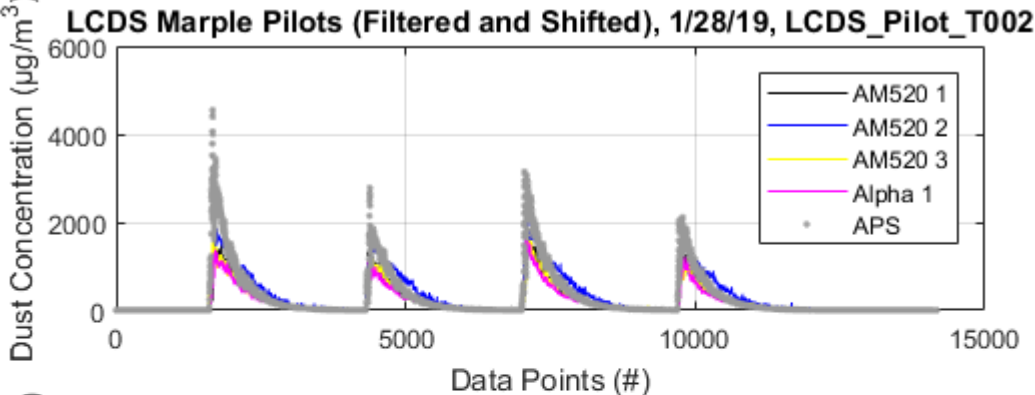
Inner workings of common low-cost dust sensors (LCDM)



Source:

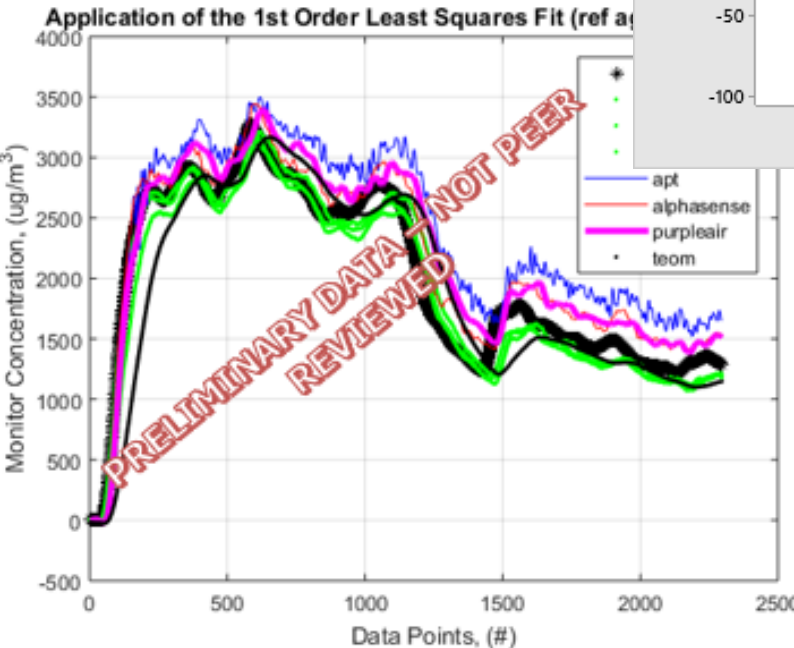
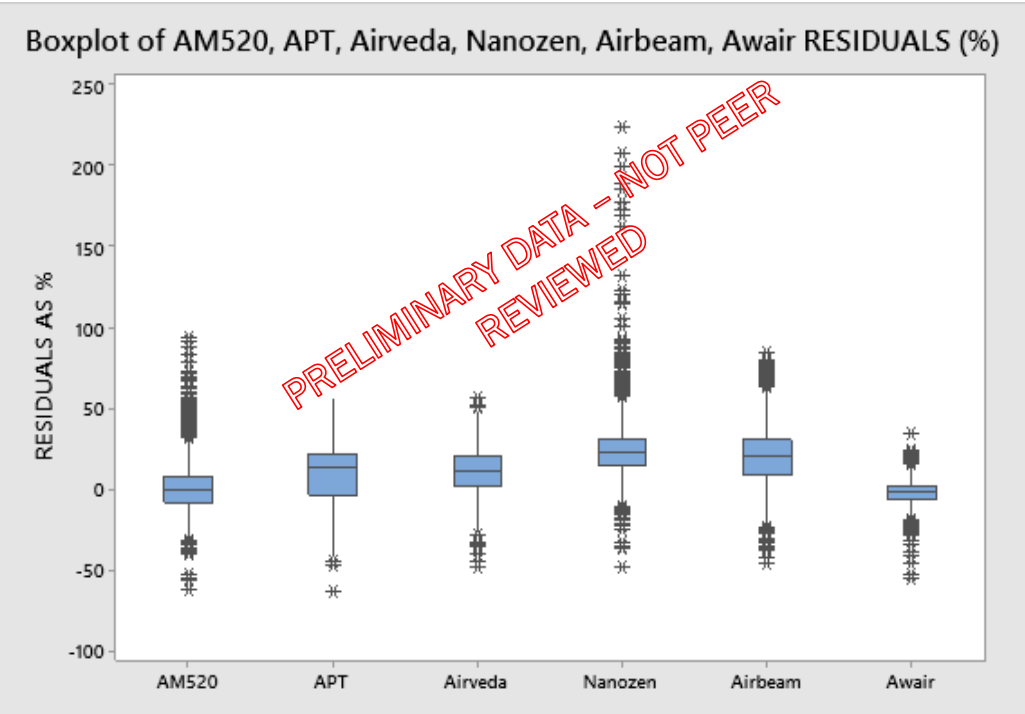
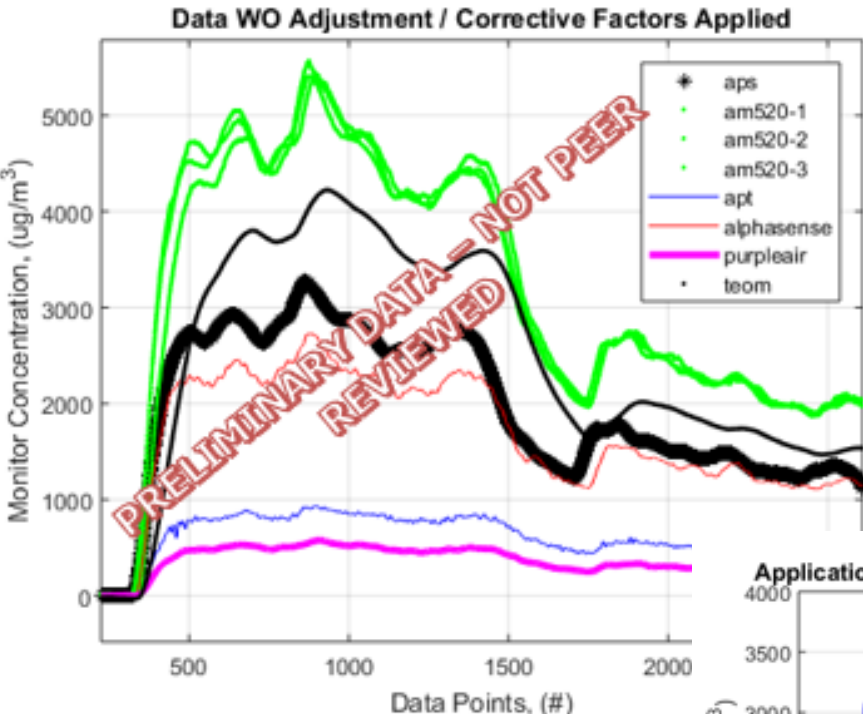
(Wang Y, Li J, Jing H, Zhang Q, Jiang J, Biswas P [2015]. Laboratory evaluation and calibration of three low-cost particle sensors for particulate matter measurement. *Aerosol Science and Technology*, Vol. 49, No. 11, pp. 1063-1077)

Can low-cost dust sensors be useful in mining applications?




\$20 Sensor; \$250 package

Example of LCDM aerosol chamber processing



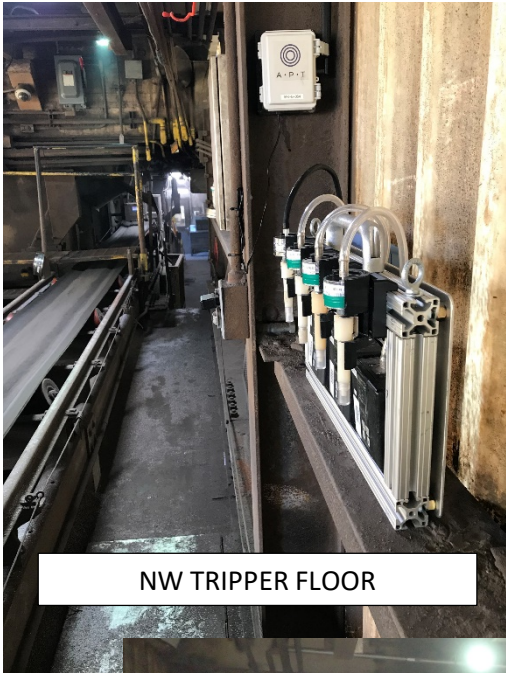
NIOSH wants to lower dust exposures with low-cost dust monitors

Research Goal: Characterize the performance of low-cost dust sensors and evaluate their use in operational environments.

An aerial photograph of an industrial site, likely a chemical or manufacturing plant. The central focus is a large, multi-story building with a dark roof. To the left, there is a complex structure of pipes and scaffolding. In the foreground, several large cylindrical tanks are visible. The surrounding area includes paved roads, parking lots with several vehicles, and some greenery. The overall scene depicts a busy industrial environment.

**NIOSH has installed or
assisted in the setup of ~20
LCDM in CA, IL and AR**

Examples of installed sensor locations



NW TRIPPER FLOOR



N CENTER TRIPPER FLOOR



NE TRIPPER FLOOR



SW TRIPPER FLOOR

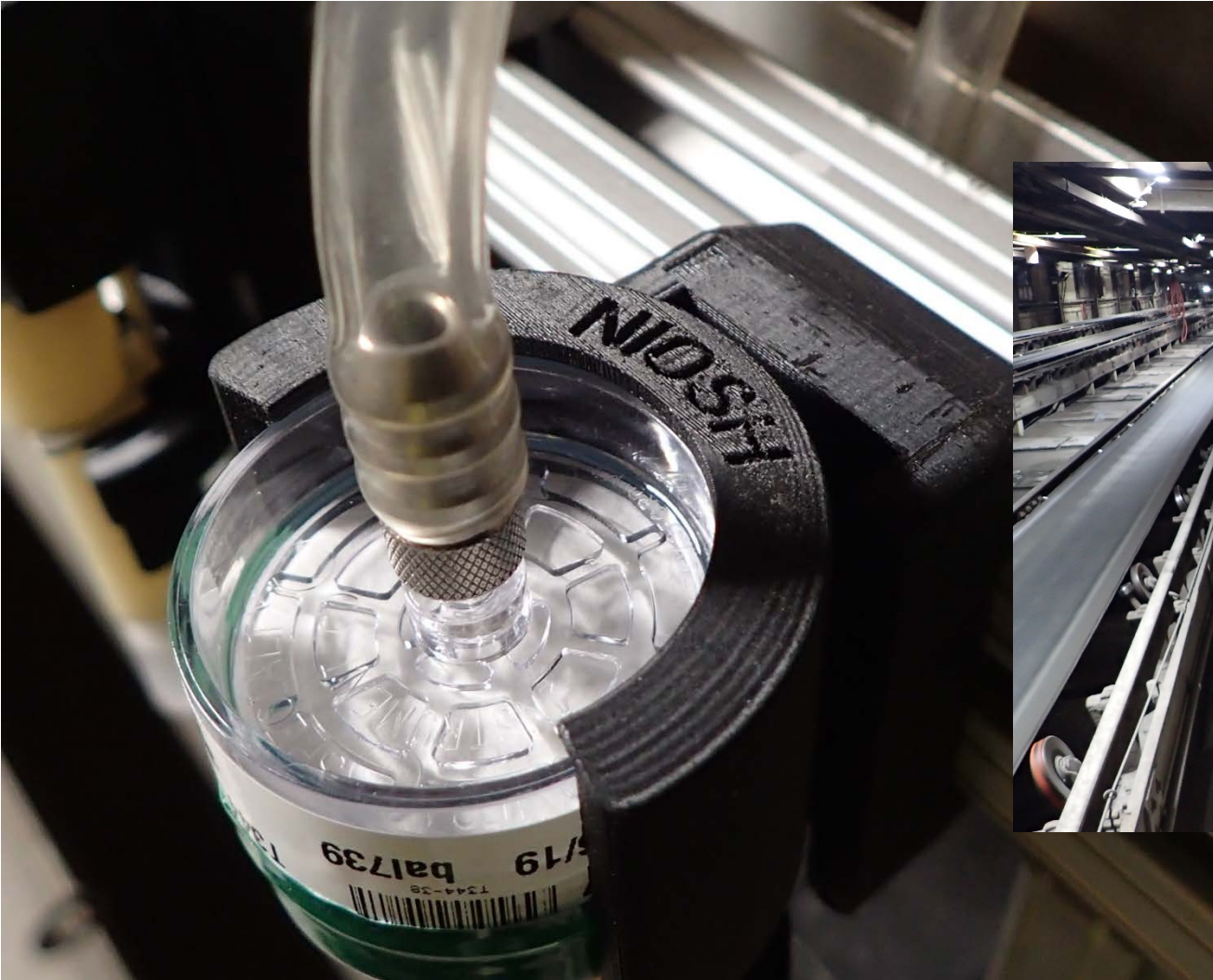


SE TRIPPER FLOOR

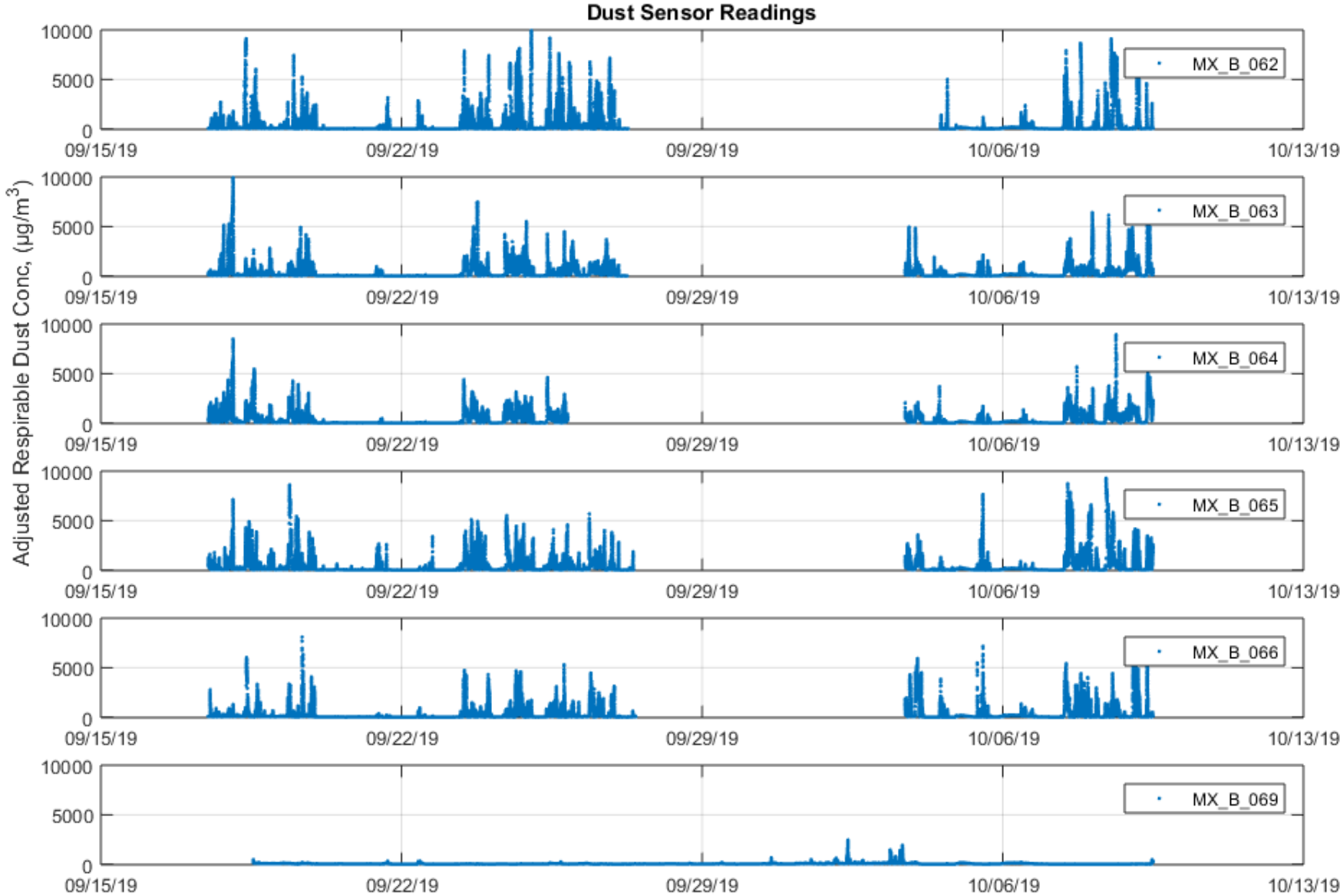


NEW CONTROL ROOM

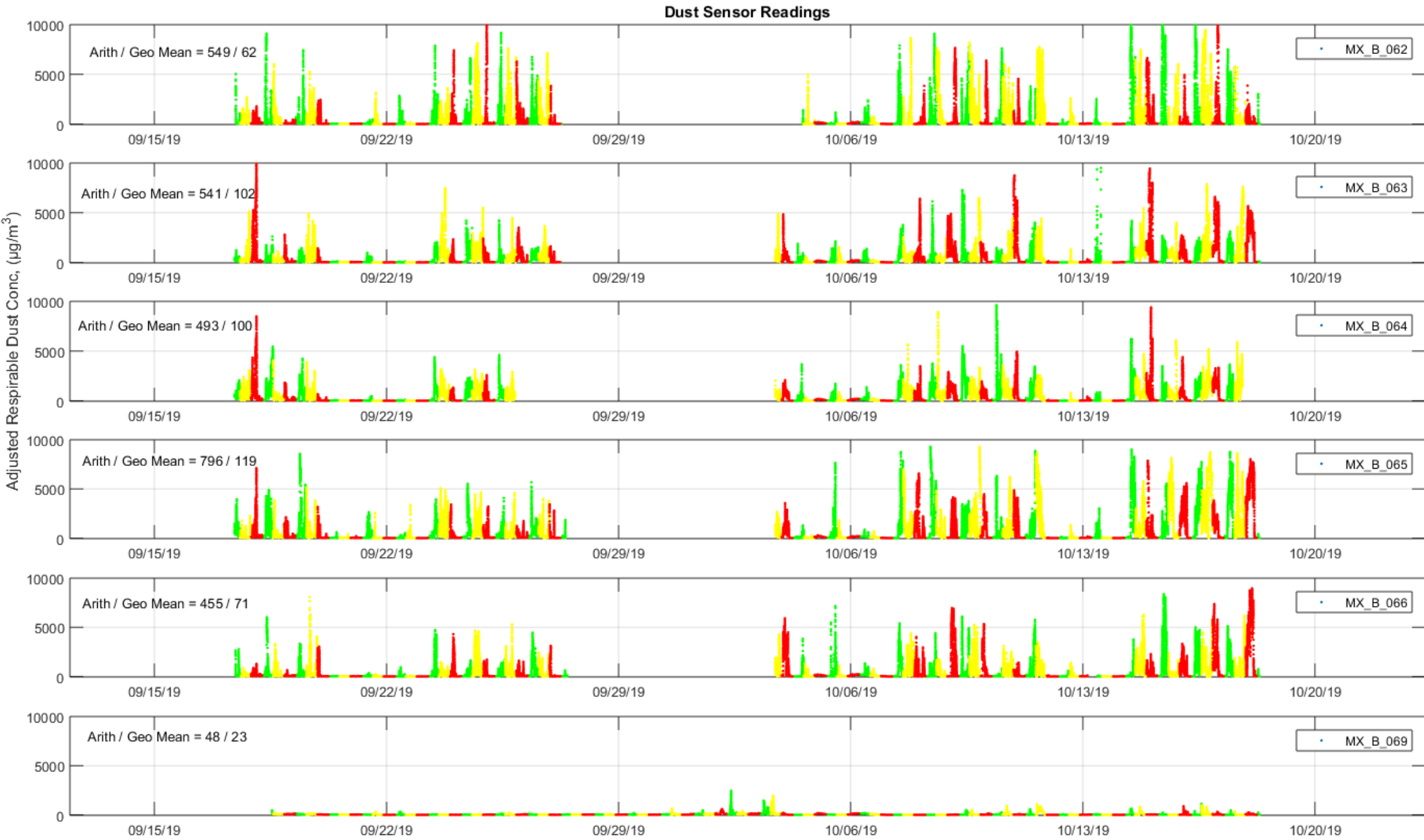
Parallel gravimetric sampling to establish in-field calibration



LCDM data is real-time; transferred to cloud by WiFi

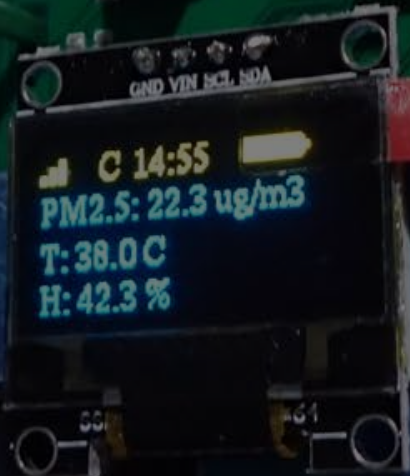


Data can be separated into shifts...1st, 2nd, 3rd



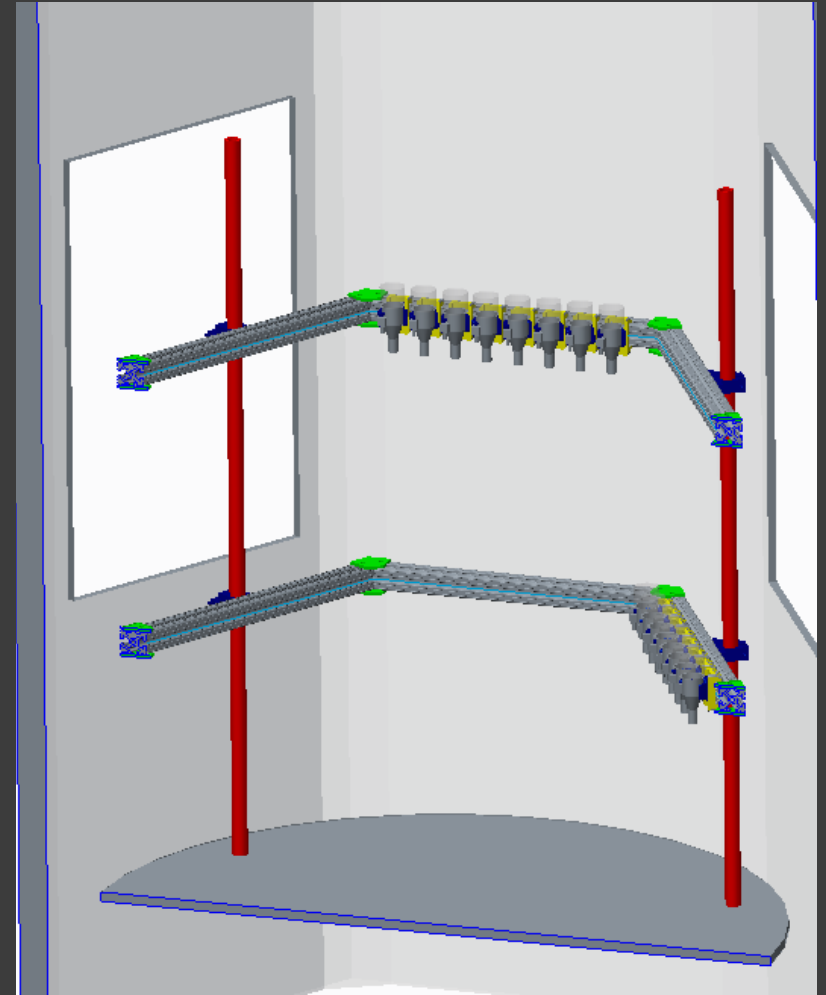


BRC 18650 600mAh
3.7V Li-ion



GND VIN VCC SDA
C 14:55
PM2.5: 22.3 ug/m³
T: 38.0 C
H: 42.3 %

*The reason to collect continuous dust data is to **drive change** – justifying the targeted installation of dust controls.*

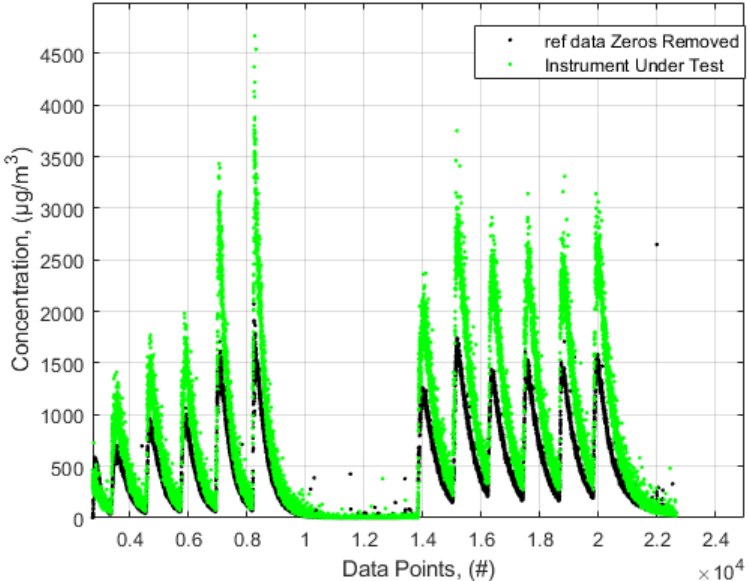


Aerosol Chamber

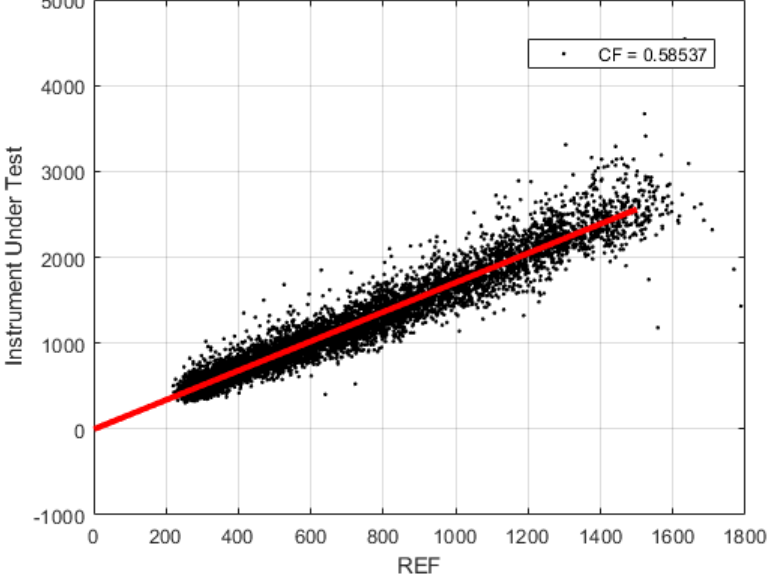
Upcoming lab testing



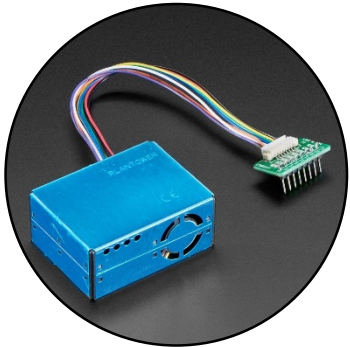
Data After Synchronization & Cropped



Cropped Data, Decreasing Conc Only

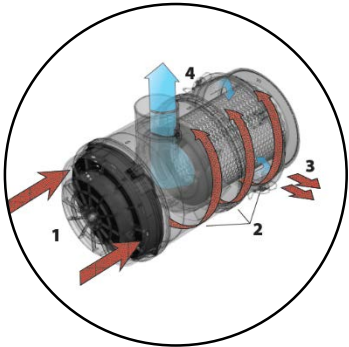


What level of operator protection is possible with a “SmartCab”?



Measure

- Dust levels
- CO2
- Cab Pressure



Improve

- Adjust intake airflow
- Change recirculation airflow



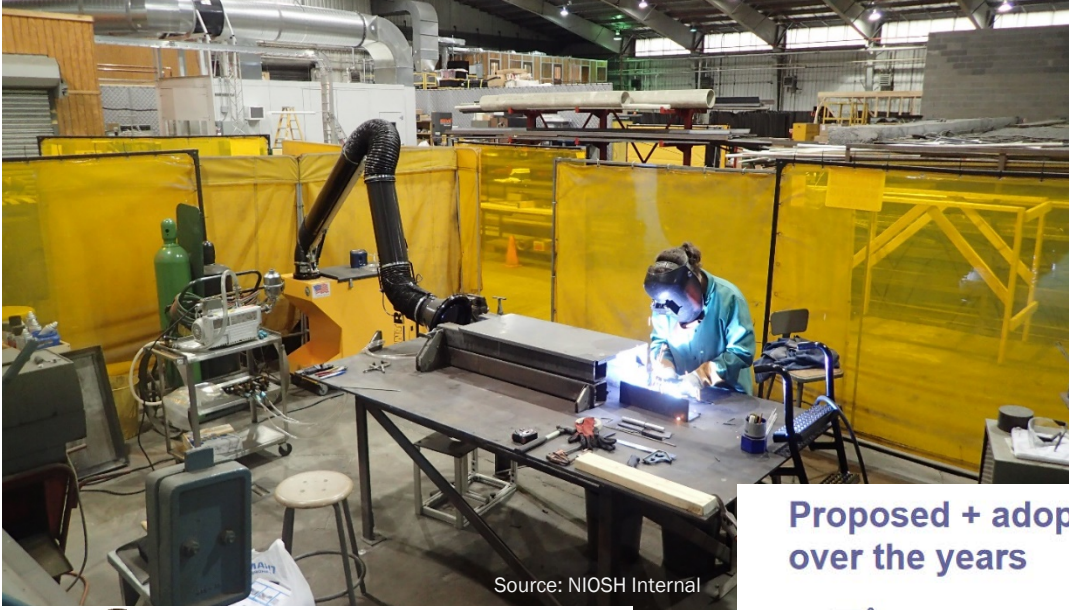
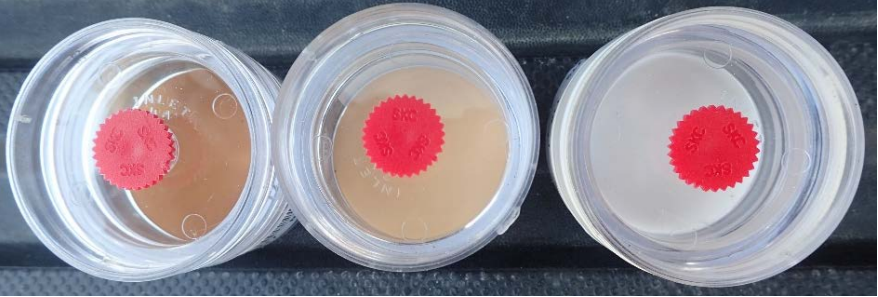
Inform

- Display cab pressure
- Suggest filter change
- Log air quality



[Link to Smart Cab Notice of Intent @ Sam.gov](#)

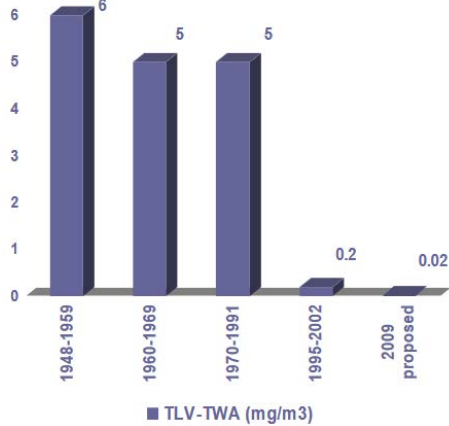
How effective are portable welding fume capture units?

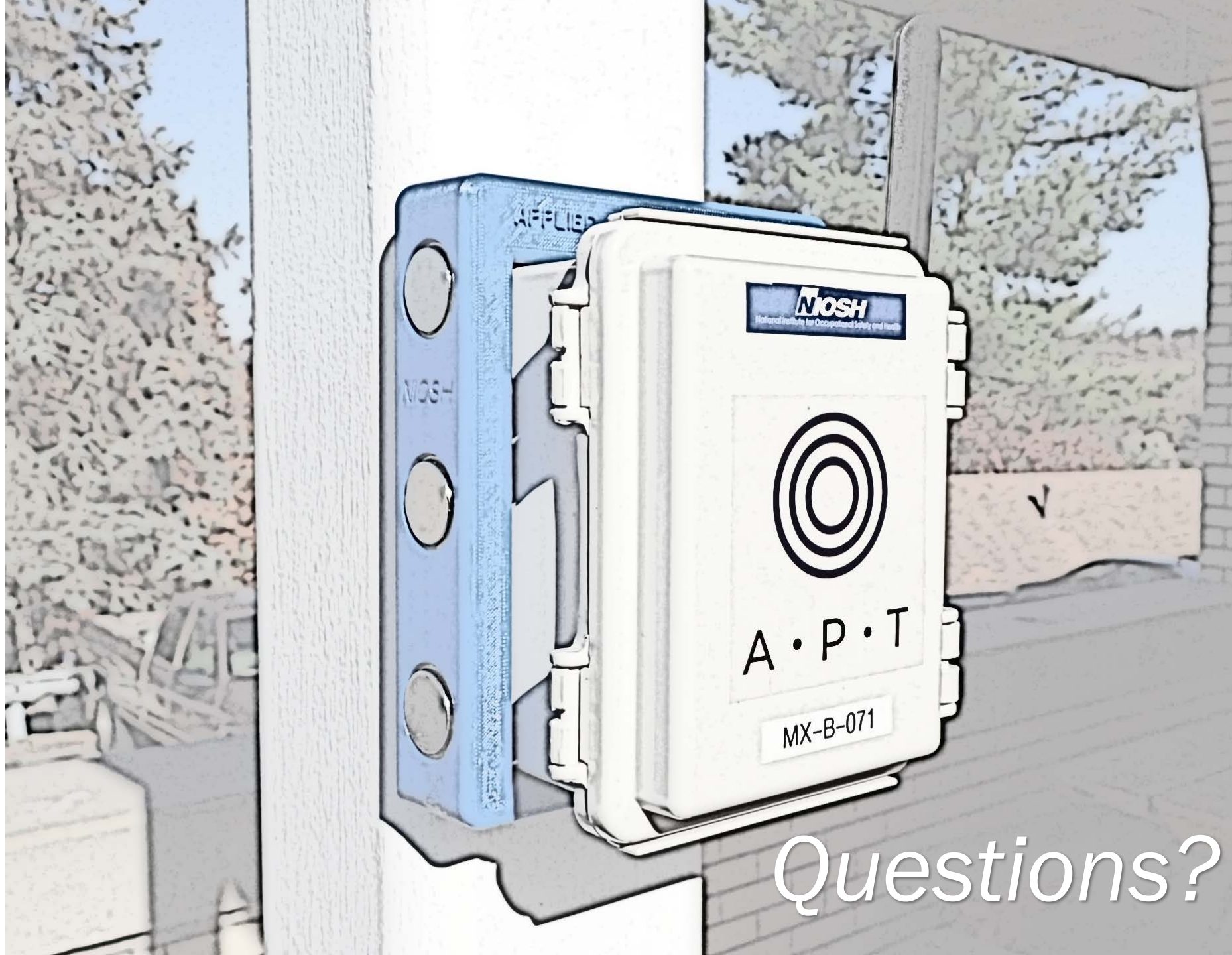


Source: NIOSH Internal



Proposed + adopted values over the years





Questions?