Implementation of a field-based respirable dust and crystalline silica monitoring program

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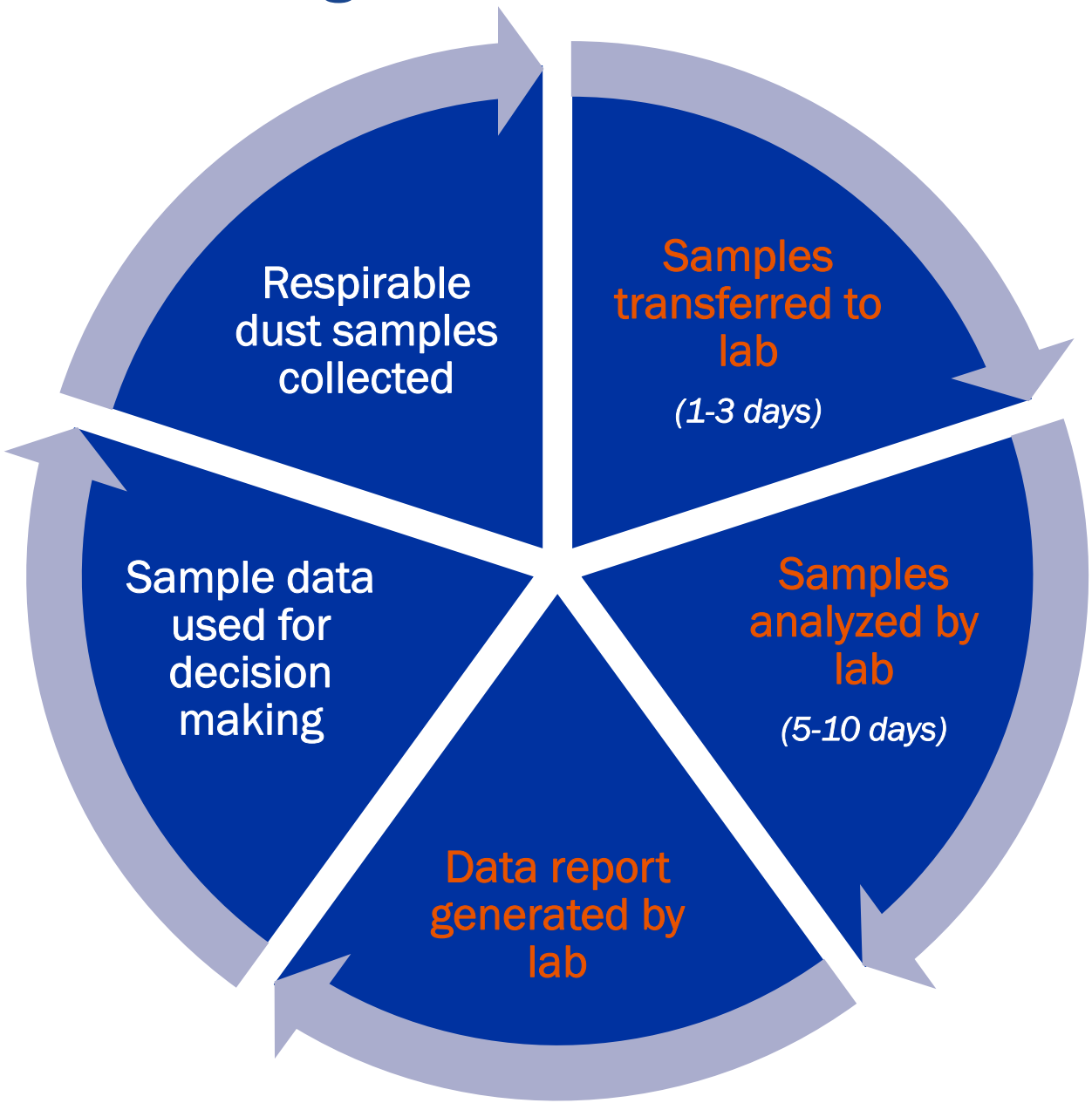
Traditional exposure monitoring

Challenges

- Changing conditions can move faster than results are available
- Much of the process is outside direct control
- Additional samples → additional costs



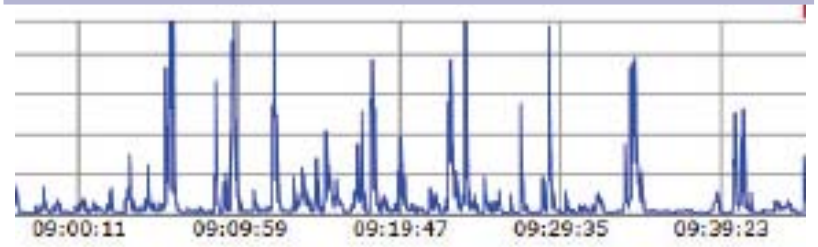
“direct-reading”

vs.

“field-based”

Helmet-CAM: overview

Real-time exposure monitoring



Video recording of surroundings and activities

Connection between

exposure source

exposure level

Helmet-CAM components

Helmet-CAM options (*not an exhaustive list*)

housing

Backpack

Miner's Safety Belts

Safety Vest

video

dust monitoring

NIOSH's EVADE software simplifies Helmet-CAM analysis

With the interactive and intuitive interface:

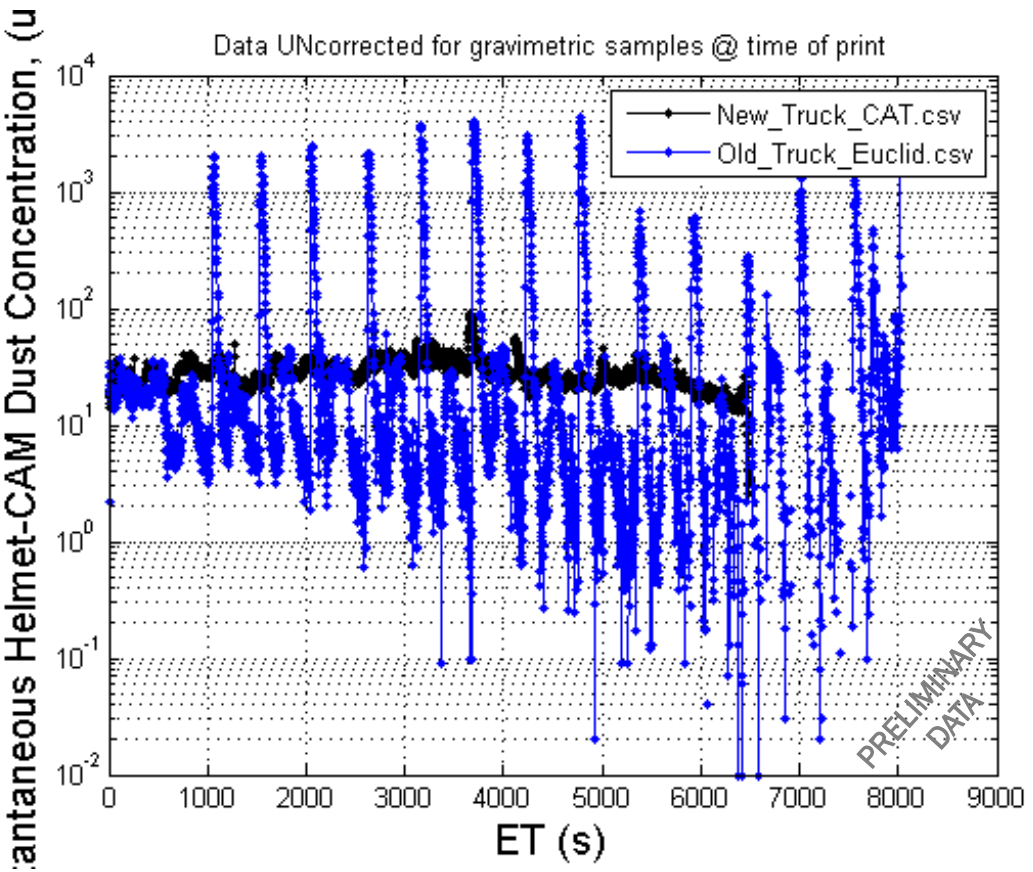
Point to location of video and exposure concentration

Merge data by time (automatically)

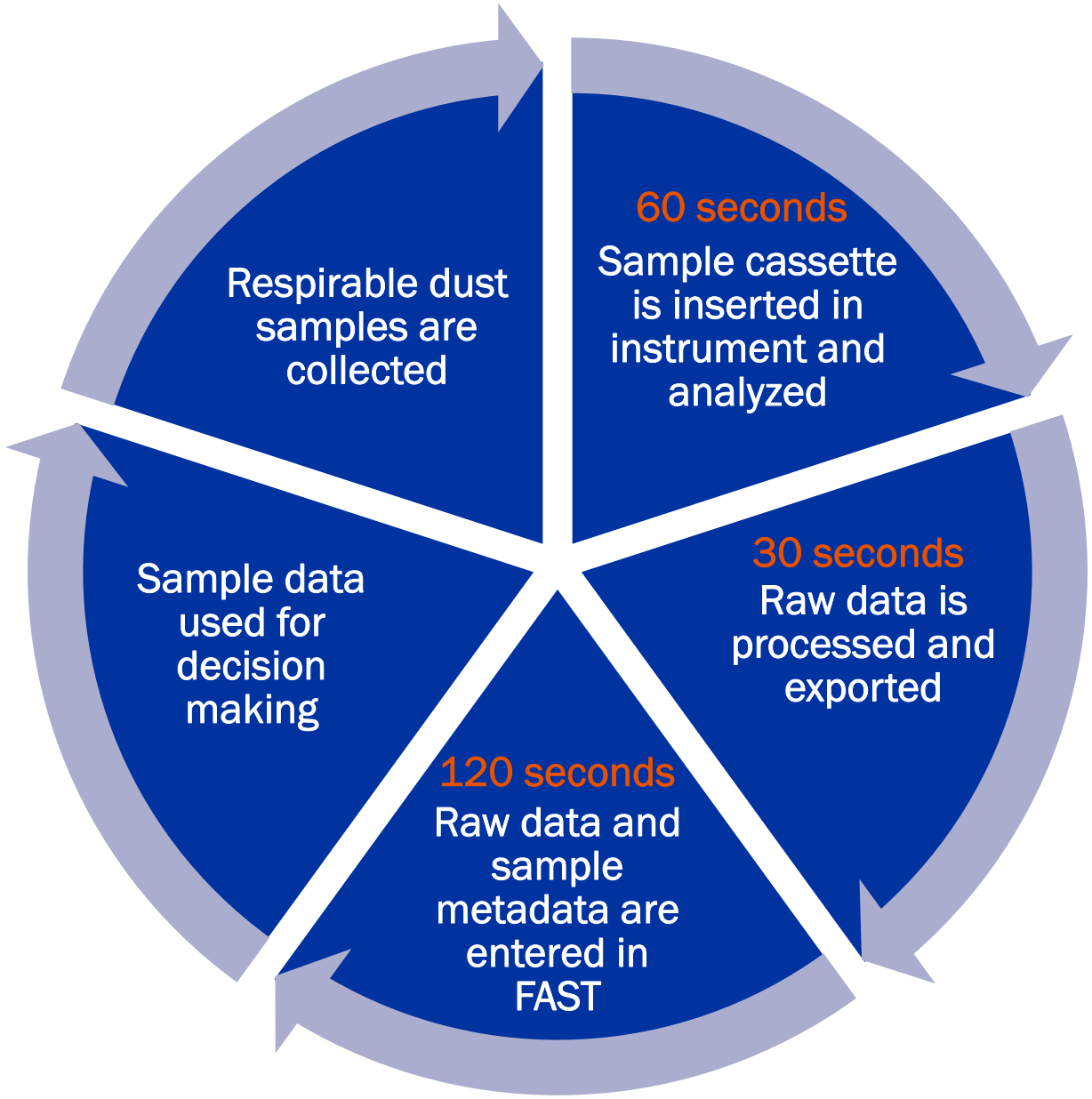
Identify peak exposures easily from visual display

https://www.cdc.gov/niosh/mining/Works/coversheet1867.html

Helmet-CAM allows for fast evaluation of engineering controls



Field-based silica monitoring: overview



Field-based silica monitoring components

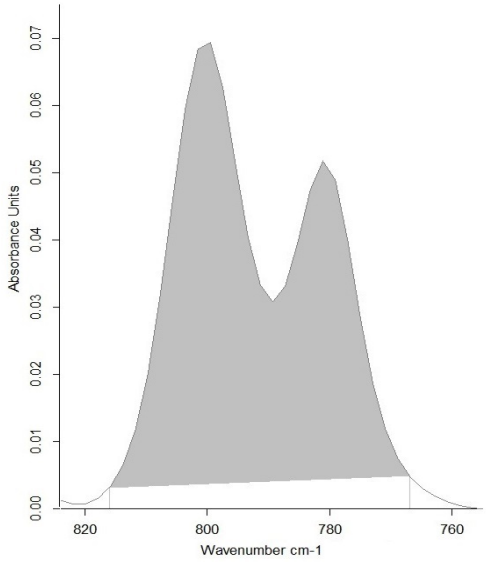
respirable cyclone

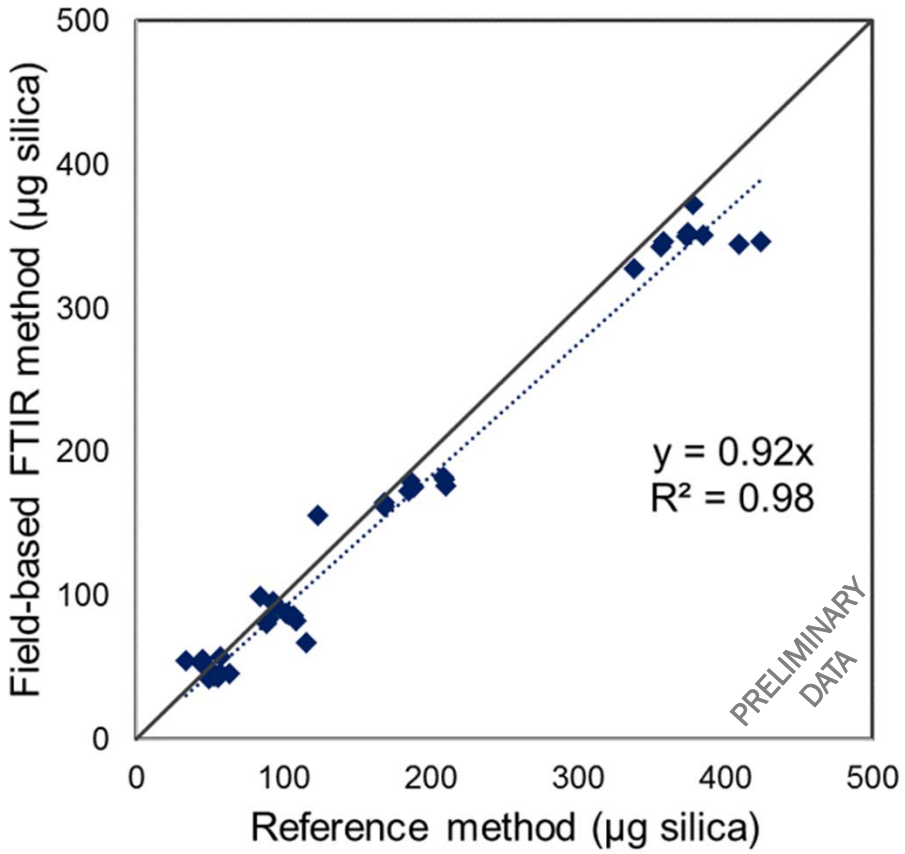
compatible cassette / cradle

FAST
Field Analysis of Silica Tool

The science behind field-based silica monitoring

- FTIR already used in the U.S. to measure quartz in samples from coal mines
- Sample analysis produces a broad spectrum; a specific region is used to quantify quartz





Field-based silica monitoring options (*not an exhaustive list*)

instruments


samplers



& more samplers to be added in coming FAST updates!

cassette




FAST Field Analysis of Silica Tool facilitates the field-based analysis process

	A	B	C	D	E	F
1	**Sample Name**	**q**	**k**	**m**	**d**	**c**
2	d1_1.SPA_2	0.586811	0.006651	0.009559	0.02339	0.04847
3	D2_510.SPA_2	0.854991	0.412392	0.18293	0.24728	-0.0166
4	D7_124.SPA_2	0.350641	-0.06148	0.569191	0.595799	2.0558
5	d9_181.SPA_2	0.671479	-0.12221	1.23489	1.35087	3.8605
6	d12_225.SPA_2	0.579531	-0.03156	0.480433	0.519085	1.2331
7	d15_324.SPA_2	1.69646	-0.03751	-0.06087	-0.03212	0.01205

RAW OUTPUT FROM FTIR (EXAMPLE DATA)

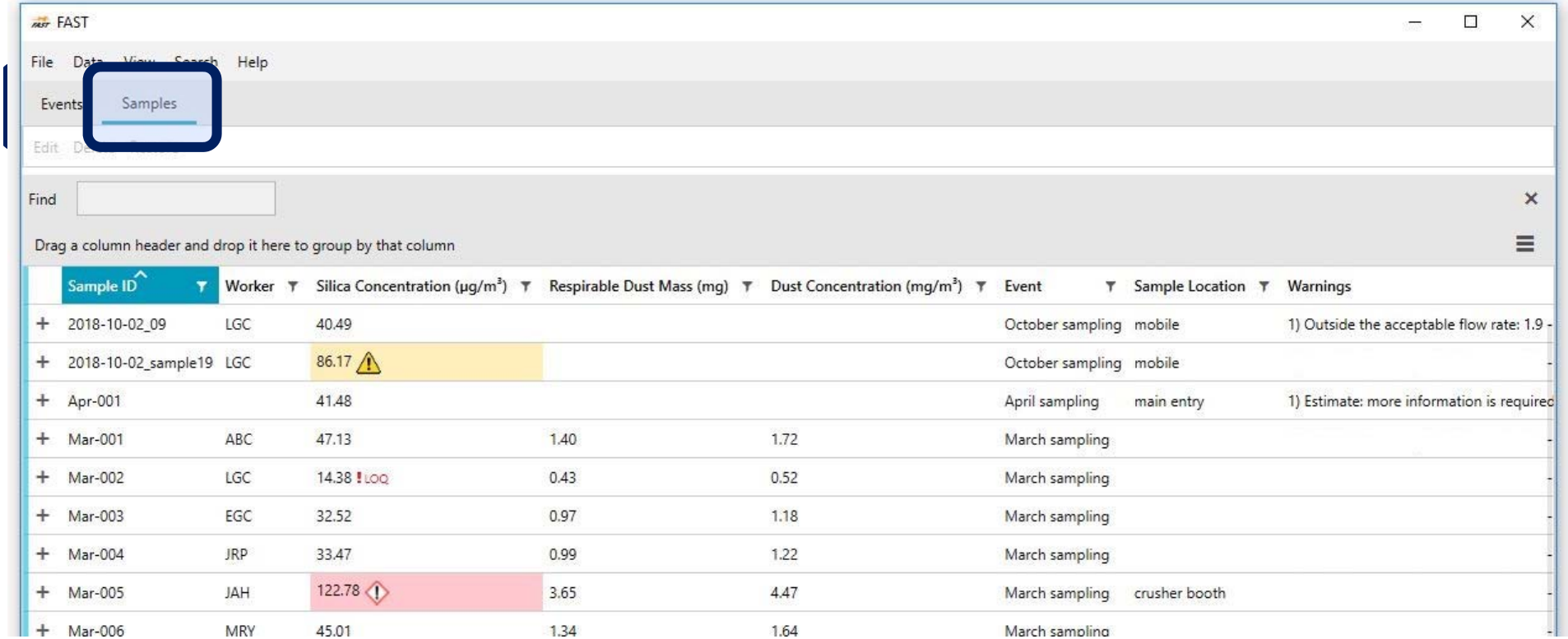
Translate the raw output from the FTIR software, using information that you provide to calculate mass and concentration

Store data in a database which can be shared or synced

Organize data by sampling event … and more

FAST: Data out

EXAMPLE DATA



Sample ID	Worker	Silica Concentration (µg/m³)	Respirable Dust Mass (mg)	Dust Concentration (mg/m³)	Event	Sample Location	Warnings
2018-10-02_09	LGC	40.49			October sampling	mobile	1) Outside the acceptable flow rate: 1.9 -
2018-10-02_sample19	LGC	86.17 ⚠			October sampling	mobile	-
Apr-001		41.48			April sampling	main entry	1) Estimate: more information is required
Mar-001	ABC	47.13	1.40	1.72	March sampling		-
Mar-002	LGC	14.38 ! LOQ	0.43	0.52	March sampling		-
Mar-003	EGC	32.52	0.97	1.18	March sampling		-
Mar-004	JRP	33.47	0.99	1.22	March sampling		-
Mar-005	JAH	122.78 ⚠	3.65	4.47	March sampling	crusher booth	-
Mar-006	MRY	45.01	1.34	1.64	March sampling		-

FAST: Data out

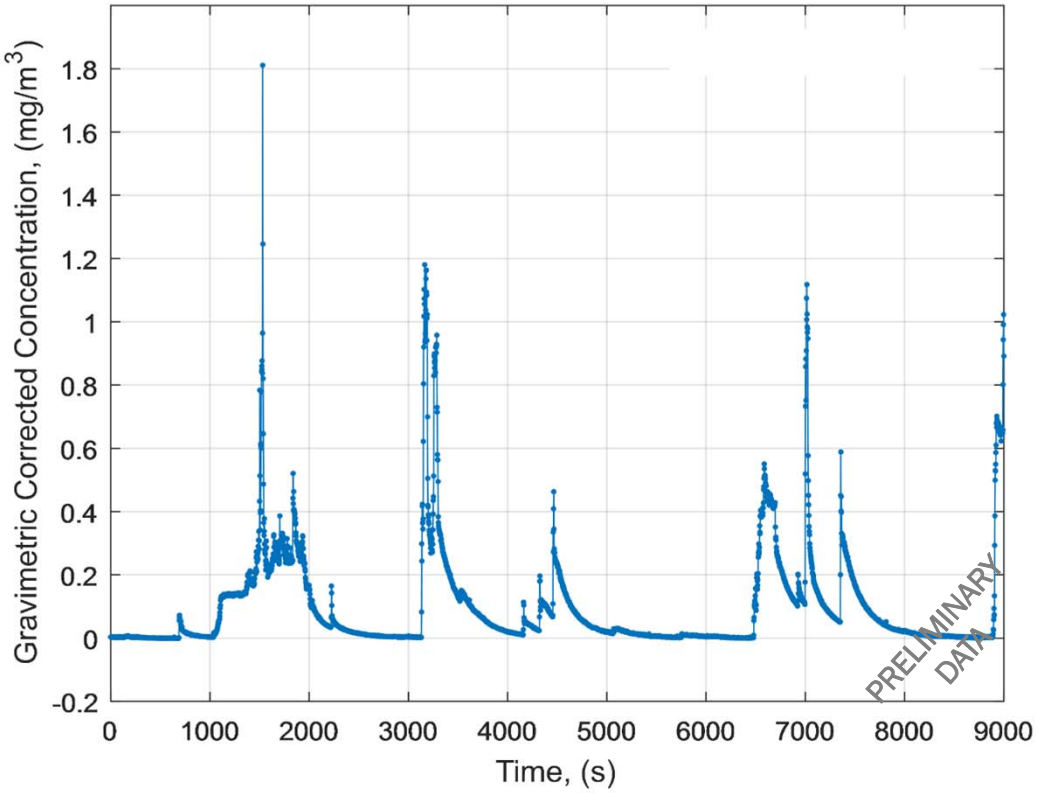
EXAMPLE DATA

Silica Concentration (µg/m³)	Warnings
40.49	
86.1 ⚠	1) Outside the acceptable flow rate: 1.9 - 2.1
41.48	1) Estimate: more information is required for a more accurate quantification
47.13	
14.3 ! LOQ	
32.52	
33.47	
122.7 ⚠	
45.01	

Case-study: Helmet-CAM / field-based monitoring combined

Two workers experience the same respirable dust concentration

Worker 1



Total sampling time:
2 hours 44 minutes

Average silica concentration:
0.053 mg/m^3 *(FTIR estimate)*

Silica content of sample:
16.9% *(FTIR estimate)*

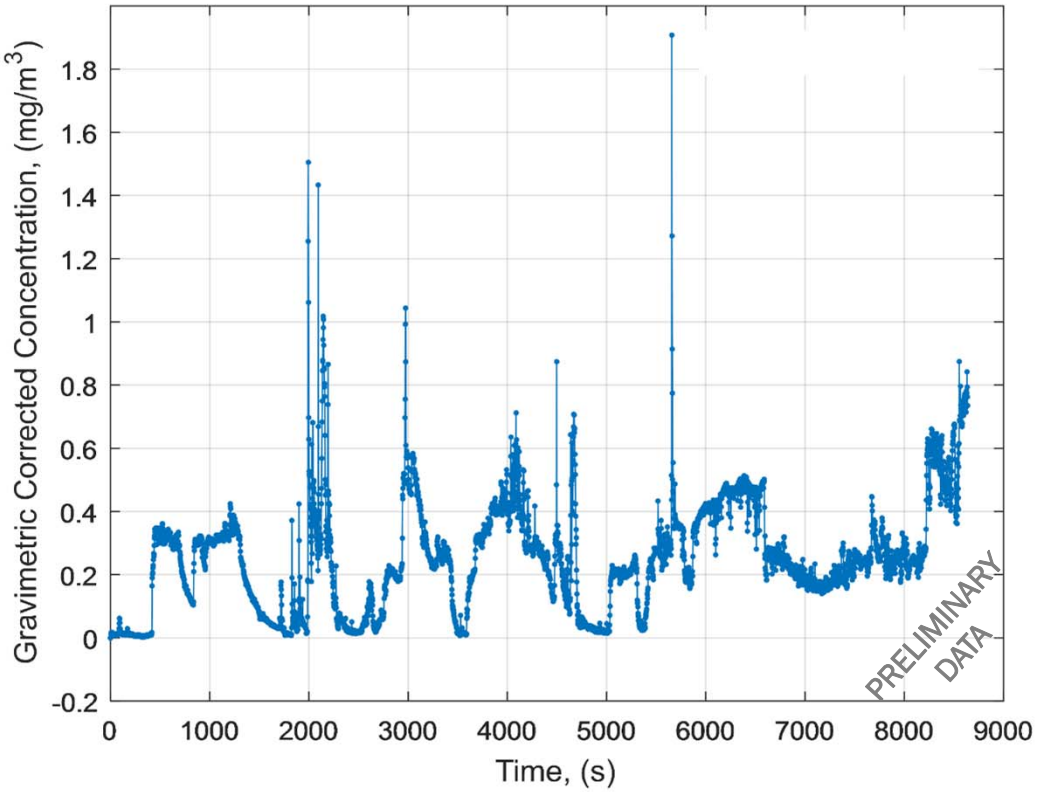
Spikes attributed to:

- marking rib with aerosol can
- changing bits
- work outside the cab

Case-study: Helmet-CAM / field-based monitoring combined

Two workers experience the same respirable dust concentration

Worker 2



Total sampling time:
2 hours 24 minutes

Average silica concentration:
0.095 mg/m^3 *(FTIR estimate)*

x 2

Silica content of sample:
26.5% *(FTIR estimate)*

Spikes attributed to:
Not attributed to specific events

What does this comparison tell us?

Silica content (% silica) is variable throughout the mine – 16.9% vs. 26.5%

Specific sources can be addressed to reduce Worker 1's exposure

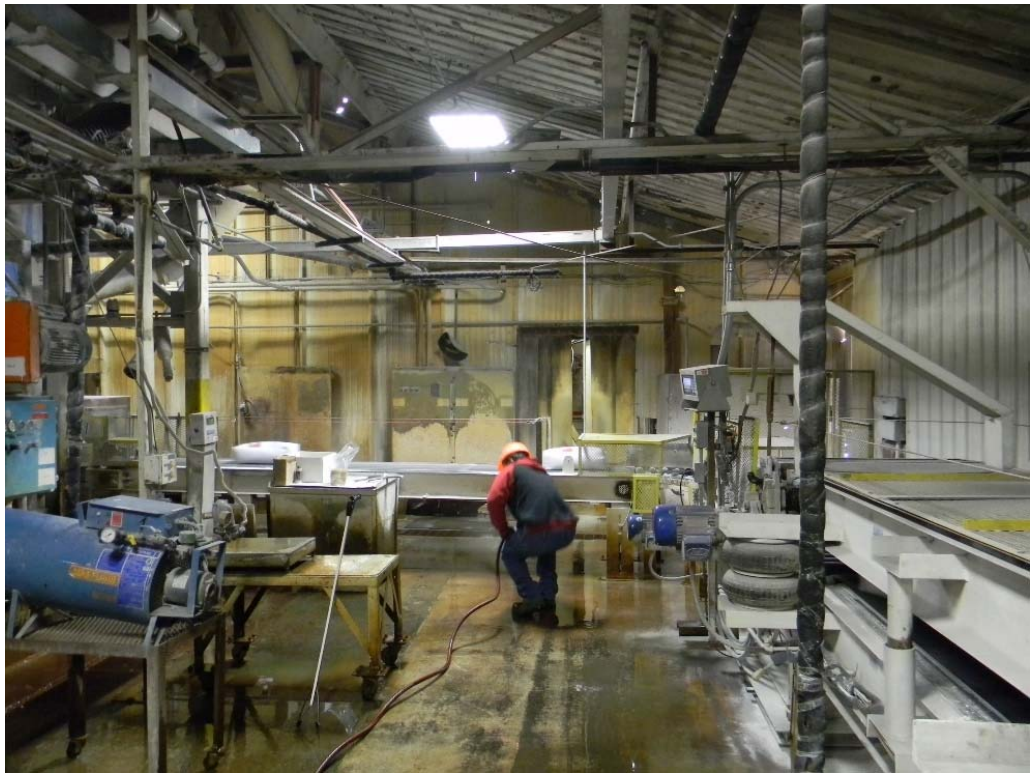
- Worker 1 can modify how he performs those three tasks
  - to move his breathing zone away from the source
  - to produce less dust as he performs the tasks
  - to spend less time in those areas
- Worker 1 may want to wear a respirator, and this data will show him where that will be most beneficial

No specific sources are associated with Worker 2's overall exposure

- More generalized control strategies may reduce his exposure
- Can the roadways be watered more often?
- Can ventilation in this area be increased or optimized?
- Can Worker 2 reduce the amount of time he needs to spend in this area?

Integrating what is learned through Helmet-CAM / field-based monitoring into company health and safety management systems

NIOSH dissemination and mine implementation of information

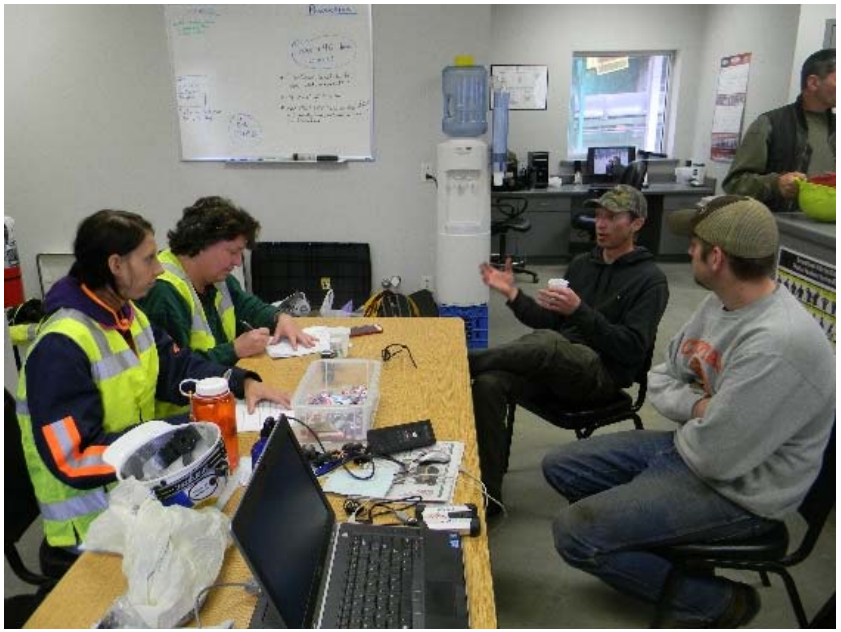


During Helmet-CAM interventions managers and workers talked about what occurs [or not] on mine sites to promote health and safety processes and practices

56 managers – various levels of mine

48 workers – all hourly employees

Results showed conflicting information about leaders' communication



- Visibility of organizational support
- Consistency of supervisor support and communication
- Worker engagement to obtain consensus

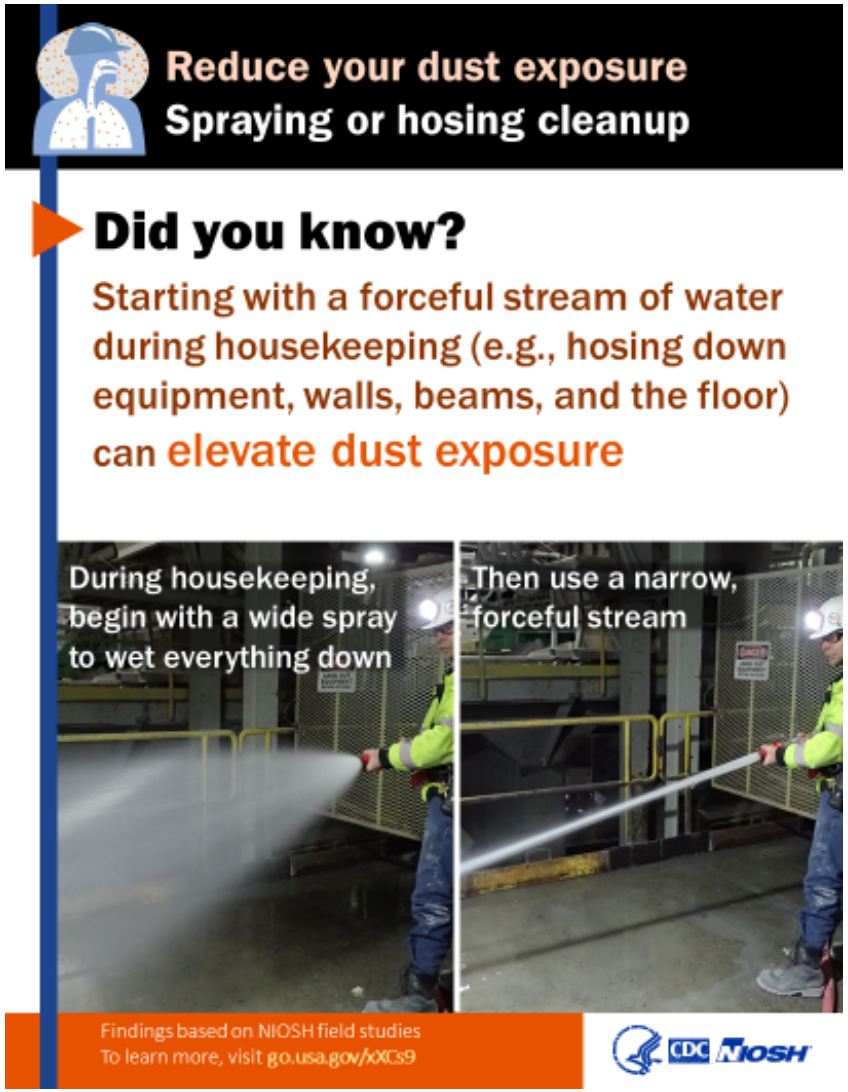
NIOSH studied the progress of management's H&S practices through the use of Helmet-CAM.

Visibility → Management action is critical

- What management says versus what they do
- Quality of responses and follow up
- Site-specific messages about critical hazards

*Supervisor support * Compliance*

Besides encouraging protective practices, management should be willing to engage in small pilot studies to determine what may help reduce exposure



Consistency

Balancing positive and negative reinforcements and maintaining the same consequences

- What, why, and how messages are communicated
- How mistakes are used and responded to among the workforce – can mistakes be made?
- How accomplishments are used and responded to among the workforce
- Consistent rules for everyone to follow

*Supervisor Communication * Risk Tolerance*

To help maintenance of a new behavior, management must encourage and provide positive consequences for health protective practices.

Consensus → Engaging workers in HSMS implementation

- Methods to encourage joint decision making (peer to peer interventions, committees, etc.)
- Methods to enhance worker responsibility and accountability

*Engagement * Performance*

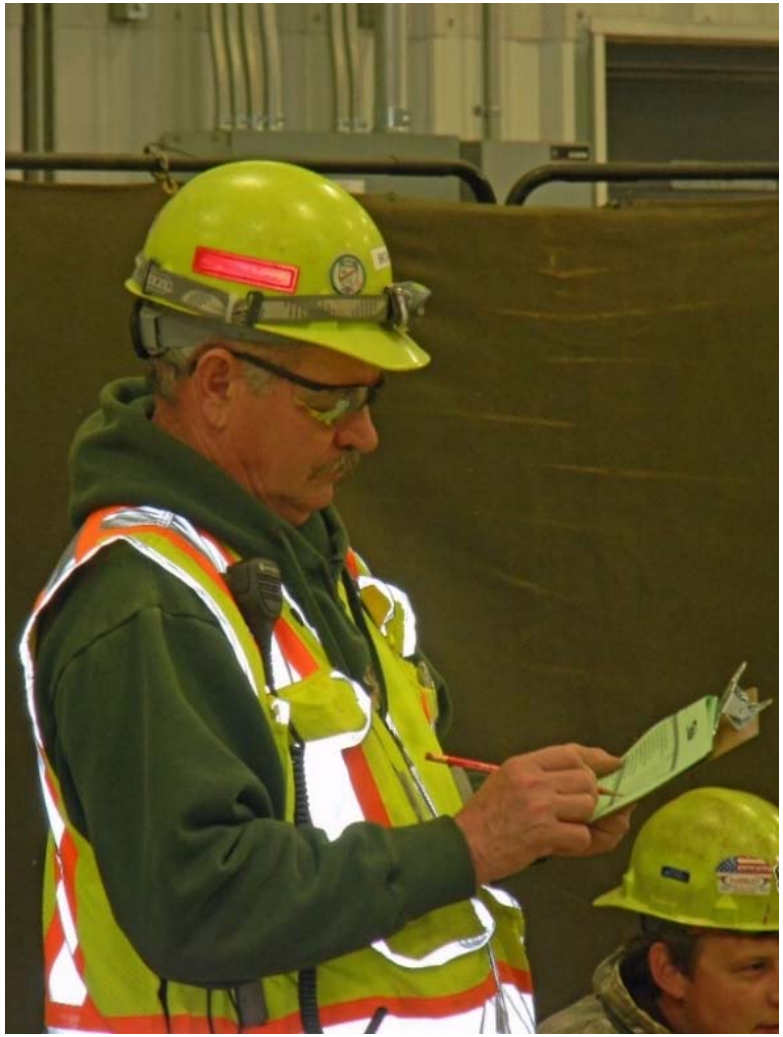
Using this information to improve the entire system, not just the use of one technology or program

System: Engineering is integrated within risk management and clothes cleaning technology becomes recognized as a H&S process in mining.

Leadership: Organizations provide health protective technology and support its use.

Culture: Workers buy into and use the technology to protect their health as a part of their normal, daily work practices.

But does this have an impact on worker perceptions and performance?



What management says versus what they do directly impacts workers' perceptions of H&S priorities and their subsequent actions

Initial HSMS assessment(X)

Manager perceptions and performance:

- You need things to be visible to them. Take action. I'm pretty sure the guys respect me, I try to be visible on site, talk to them.

Worker perceptions and performance:

- Pre assessment survey
- "You can bring up issues but no changes are made. The chain of command makes it difficult to implement any changes."

Intervention Activities

$Activity_1$:

Dust data vantage points, feedback, and interviews

$Activity_2$:

Management Communication Practices, Support, and Engagement

Observable changes (Y)

Worker change in perception – increase in supervisor support:

- After learning how much the dust booth helps us they [mgmt.] moved it in the shack so even in 30 degree below weather you can use it – so the booth was moved and we have less hassle.

Worker change in behavior:

- use of clothes cleaning booth @ 6 weeks and 6 months.

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