Sampling to Quantify Respirable Dust Generation

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Presentation topics

- Current respirable dust standards and sampling requirements

- Dust sampling instruments approved for use in underground US coal mines

- Sampling methods to quantify dust sources

Respirable dust standard for coal mining
(Federal Coal Mine Health and Safety Act of 1969)

$$2.0 \text{ mg/m}^3$$

If silica > 5%, reduced standard = 10 / (% silica)

Gravimetric dust sampler

- Provides time-weighted-average respirable dust concentration

- Dorr-Oliver cyclone separates respirable and oversize dust

- Pump operated at 2.0 liters per minute in coal mines

Sampling with gravimetric sampler

- Filter is pre- and post-weighed to determine mass gain and is used to calculate an <u>average</u> dust concentration over sampling period

- Filter processed using MSHA P7 infrared analytical technique for silica content

- Sufficient mass must be collected to have confidence in measurement

- NIOSH typically uses multiple gravimetric samplers and averages data

Personal DataRAM (pDR)

- Uses light scattering as measurement technology

- Instantaneous readings correlated with time and stored in internal memory

- Relative concentrations impacted by:
  - size distribution of dust
  - composition of dust
  - water mist in air

- PRL adjusts readings with ratio obtained from adjacent gravimetric samplers

pDR field calibration

- Divide average gravimetric concentration by average pDR concentration for same sampling period

- Multiply all individual pDR readings by ratio

- Example:

  gravimetric average = 1.4 mg/m^3

  pDR average = 1.1 mg/m^3

  grav/pDR ratio = 1.4/1.1 = 1.27

  pDR concentrations * 1.27 = adjusted pDR concentrations

pDR provides time record of dust levels
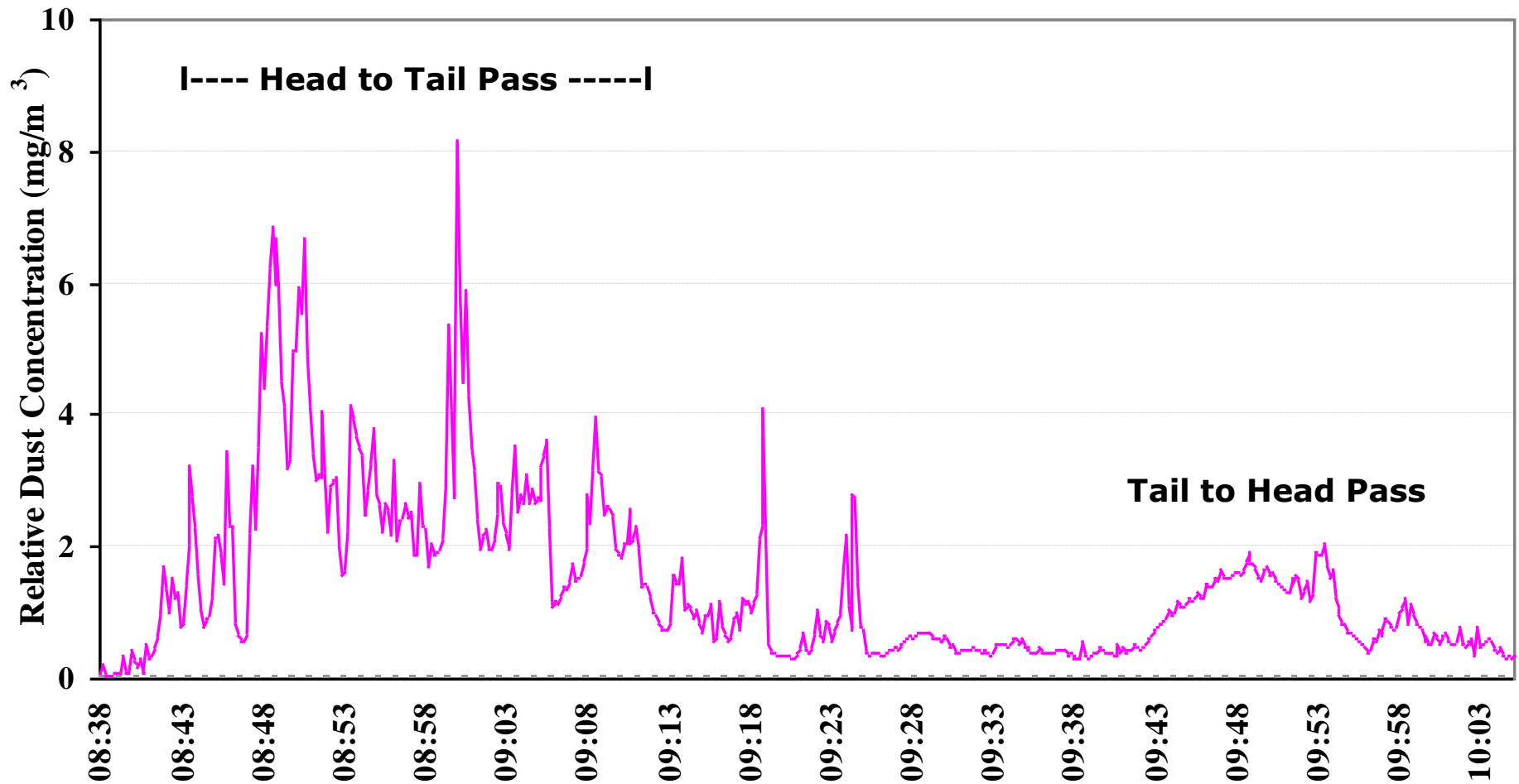
Personal Dust Monitor (PDM)

- Real-time measurement of respirable dust

- Combines dust sampler and cap lamp into one unit

- Sample inlet is mounted on cap lamp

- Utilizes mass-based measurement to quantify dust concentration (TEOM)

- Dust measurements are displayed on screen and stored internally for later analysis
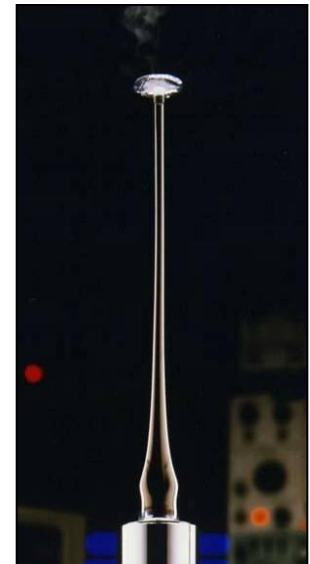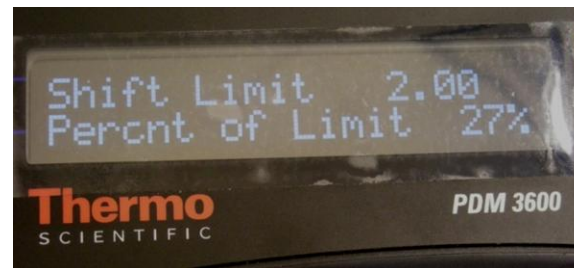
Principle of operation

- Exchangeable filter cartridge mounted on the end of the tapered element collects particles as sample stream flows through hollow tube

- Tapered element oscillates at its harmonic frequency -- like a tuning fork

- Frequency changes in *direct* relation to the mass collected on the filter

- Measurement principle does *not* respond to other particle characteristics such as size distribution or composition (heated circuit removes moisture)

Flow

Tapered element
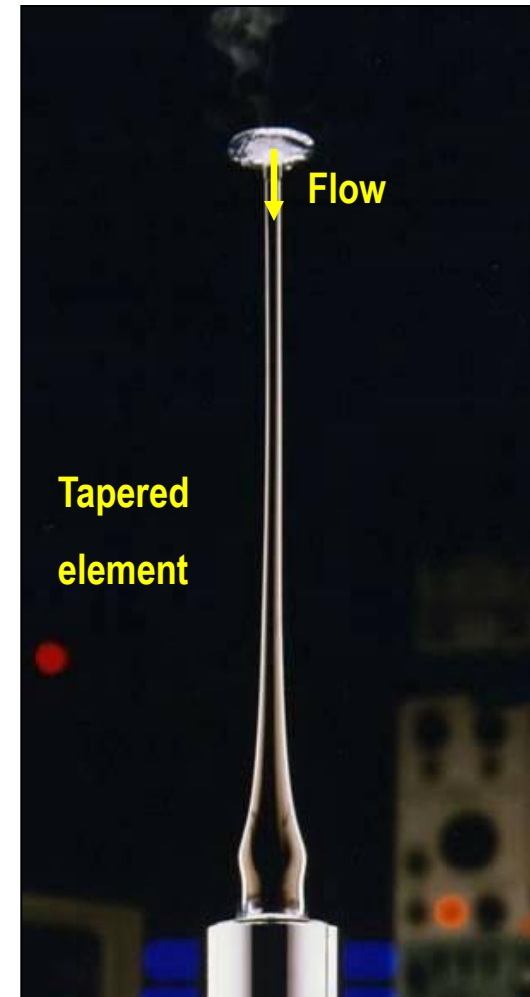
PDM status:

- Meets NIOSH sampling accuracy requirements (NIOSH RI 9669)

- Equivalency to CMPDSU (gravimetric sampler) published in peer-review journal

- MSHA IS approval granted for use in underground coal mines

- CFR 30, Part 74 modified rule published April 6, 2010

- Thermo Scientific began delivery of commercial units in July 2009

- Two ongoing NIOSH research efforts (software and silica)

PDM analytical software

- Compile output from PDM samplers
- Provide user-selected summaries for multiple samplers (foreman, mine superintendent, etc.) or engineering evaluations
- Provide graphing capabilities

CM operator changing positions per cut

Unit not used, lying on side.

PDM filter capsule for maintaining sample integrity for quartz analysis

- Place capsule over PDM filter when TEOM unit removed from PDM

- Use capsule as filter removal tool and to secure dust

- Send to lab, remove finger tab, ash capsule

- Plan to conduct mine surveys to complete side-by-side testing with current silica analysis method
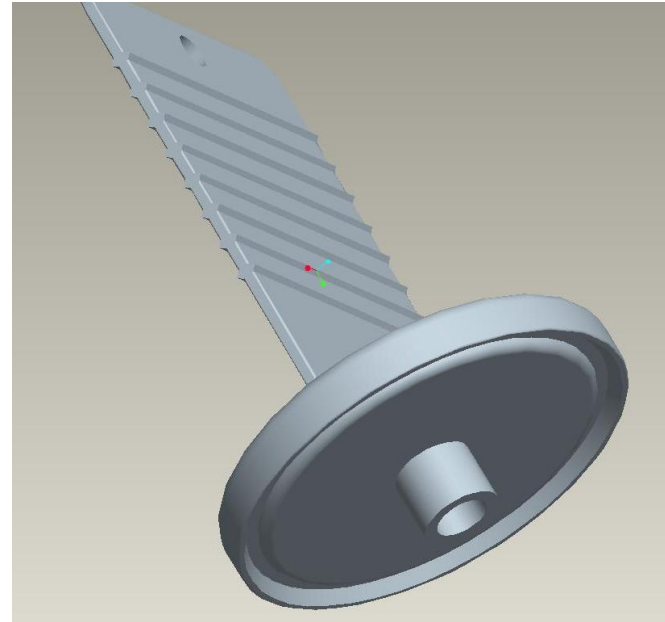
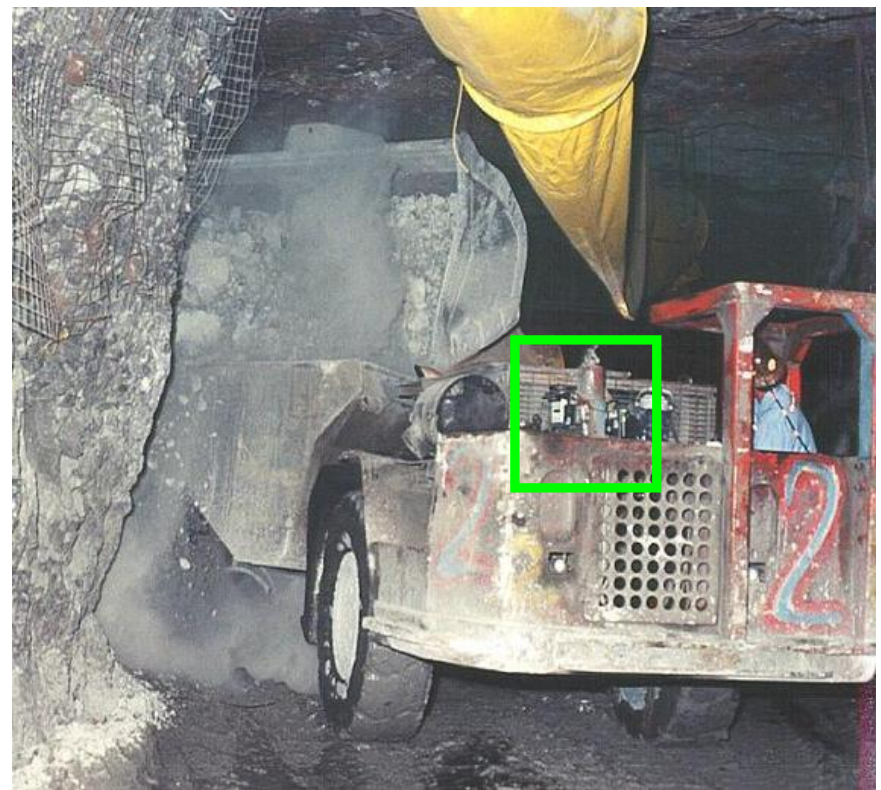# Sampling to isolate a fixed dust source

Continuous miner

Line brattice

Sampling locations

Return

Intake

Check curtain
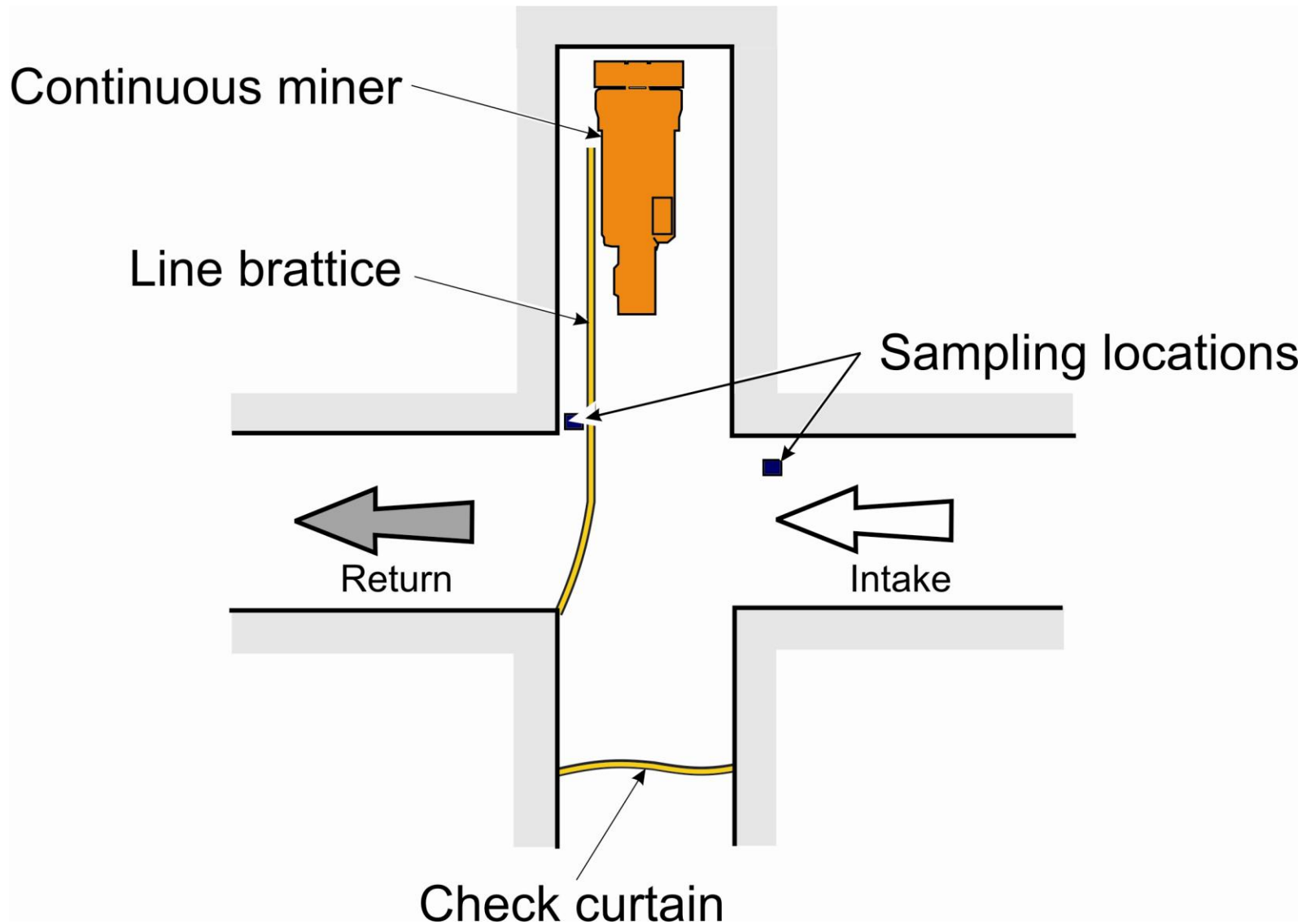
Sampling to isolate a mobile dust source
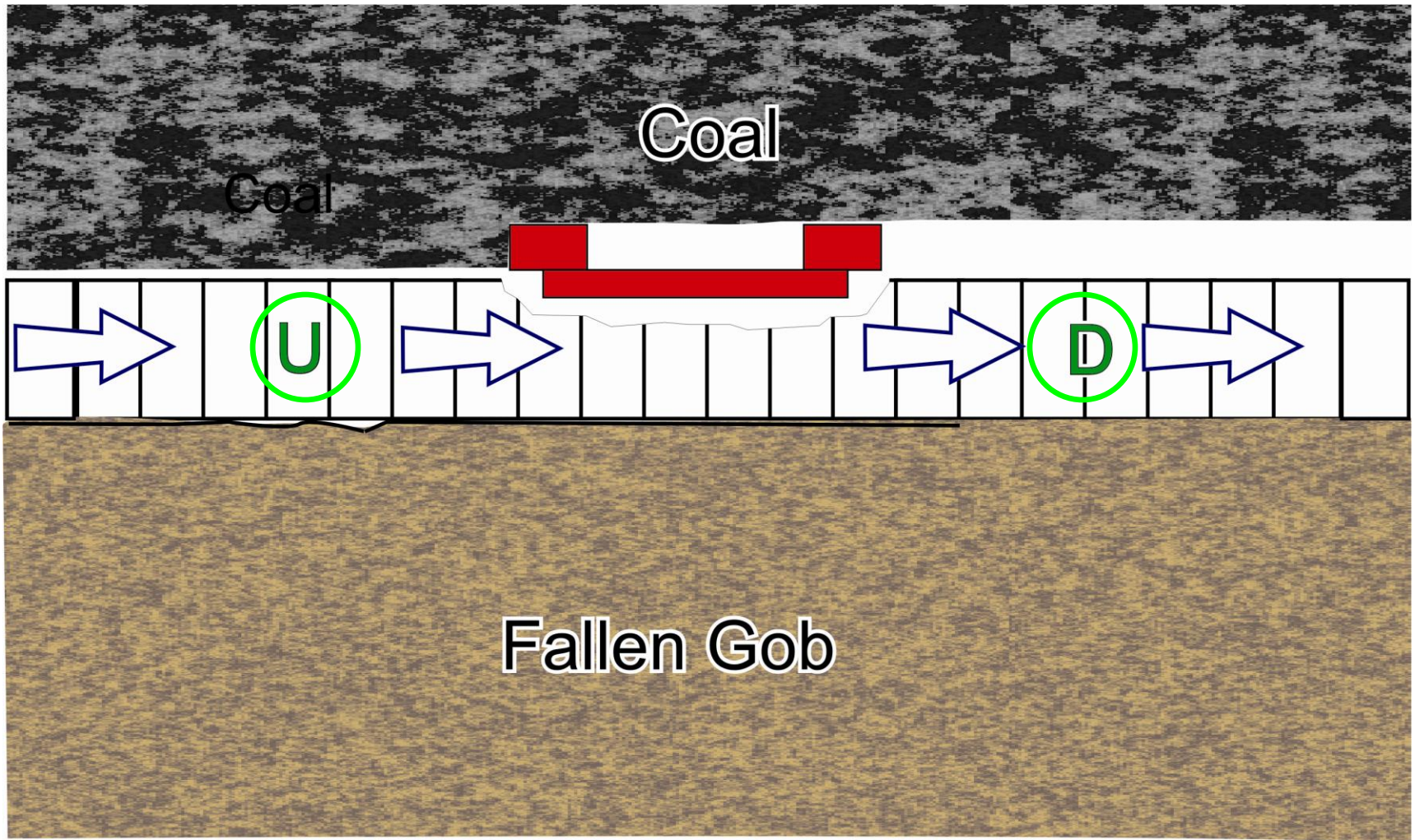
**U - Upwind location   D - Downwind location**

Using real-time data to quantify mobile dust sources

- Evaluate dust levels during truck haulage cycle at an underground gold mine

- Use pDR samplers and time study data to quantify dust generation for different parts of cycle
  - loading
  - hauling full
  - dumping
  - hauling empty

- Two researchers conducting time studies
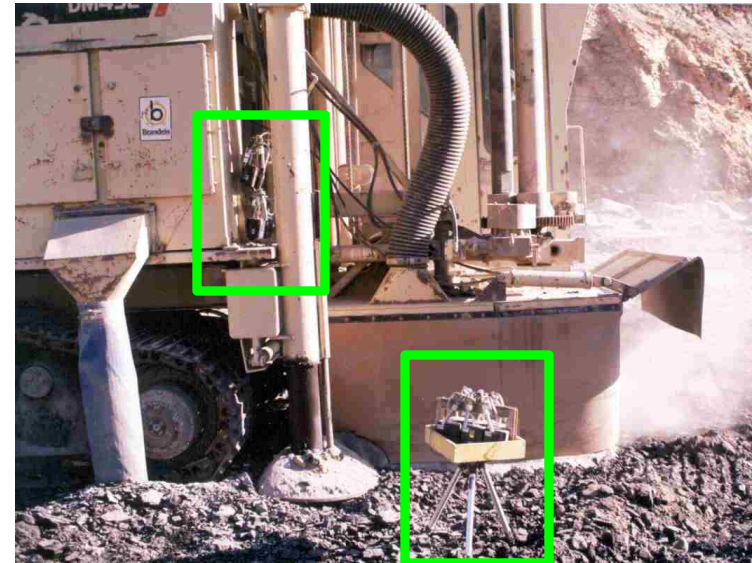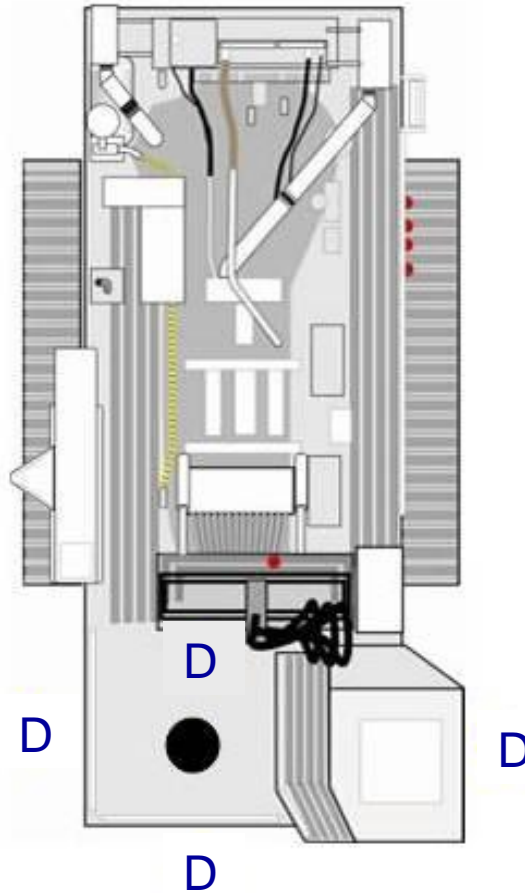
Time-weighted-average dust contributions

Dump location had highest dust contribution despite having the shortest duration… (14% time vs 34% dust)

Dump
34%
(3.7 mins)

Tram
Full
22%
(6.7 mins)

Tram
Empty
29%
(11.4 mins)

Loading
15%
(4.2 mins)
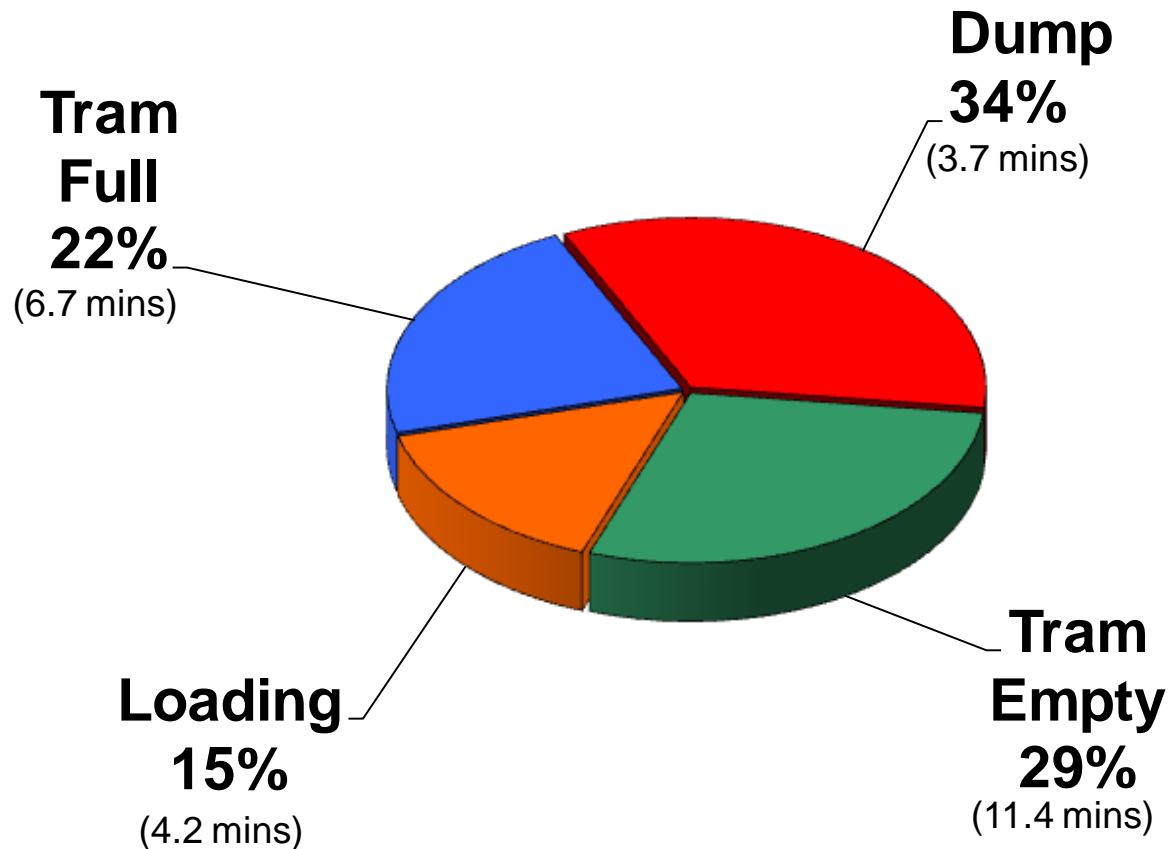
Sampling to isolate an unconfined dust source

A

Wind direction

D

D

D

D

A – Ambient sampling location

D – Drill sampling locations

Thank you!

Questions??

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