

Real-Time Assessment of Mining Vehicle In/Out-Cabin particulate matter (PM) concentration

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- Measurement methods and setup into vehicle
- Limitations of the study
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Introduction

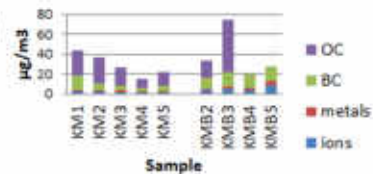
- Mines can potentially have particulate matter levels that are hazardous to health
- Fixed point AQ measurements do not necessarily represent the AQ at worker breathing area
- Particulate matter in mines emerges from a compilation of sources, which presents requirements for the measurement technology
- Aim of this study was to evaluate a PM sensor in real-life mining conditions to evaluate drill rig in/out cabin concentrations and see what we could learn about mining conditions

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Aerosols & challenges in mines

- Multiple particle sources (HIME)project
 - Oil droplets from machinery
 - DPM
 - Mineral dust
 - Metallic aerosols from machinery and mining activity
- High humidity and water droplets
- Conditions are challenging for optical instruments



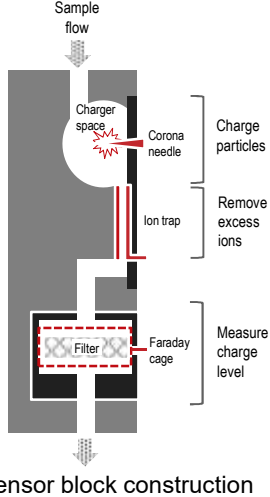
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DEKATI DePS™ - Dekati® electrical Particle Sensor



DePS™ - Go

- Diffusion charger and faraday cup electrometer
- Measurement result dependent **only** on particle surface area concentration



Sample flow

Charger space

Corona needle

Charge particles

Ion trap

Remove excess ions

Filter

Faraday cage

Measure charge level

Sensor block construction

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DEKATI DePS™ -Go: Main features






- Real-time particle mass, number and LDSA concentration
- Battery powered, light weight, portable, wearable
- Replaceable detector block → (almost) no maintenance
- New, more performant chip-set with readiness for wireless data communication & IoT architecture
 - Wifi-based bi-directional device communication
 - IoT cloud architecture: possibility for data collection, processing, visualization and storage via cloud based applications
- **eFilter instrument available for simultaneous collection on a 47mm gravimetric filter**

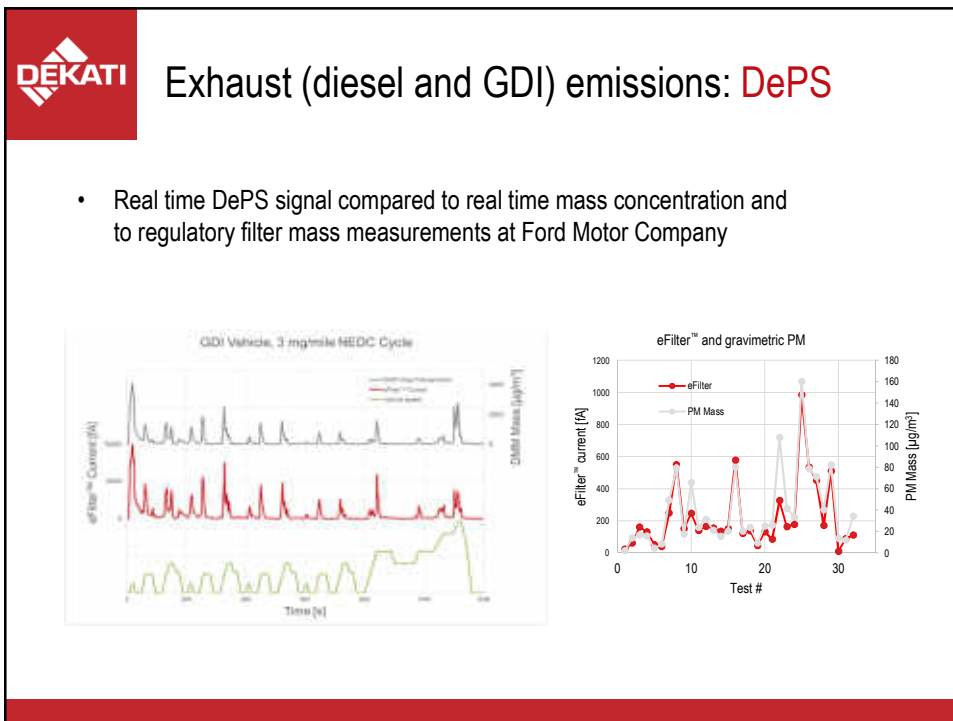
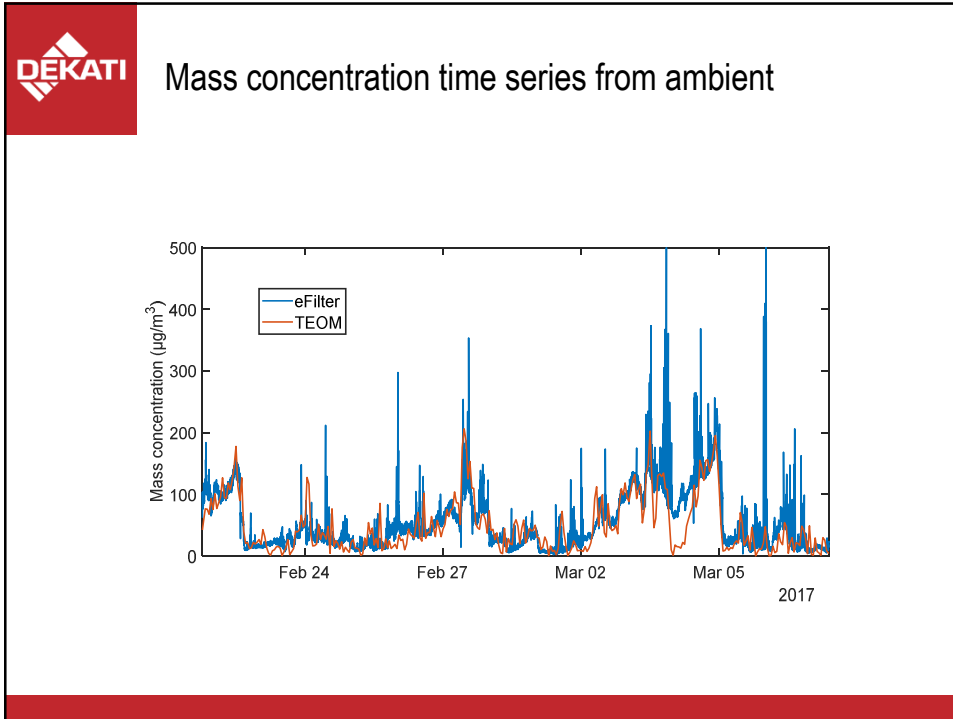
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 DePS™ – Technical specifications	
Electrical detection sensitivity	~3 fA electrical current With 70nm particles this corresponds to about 1000 #/cm ³ , 1 ug/m ³
Measurement frequency	1 Hz
Particle material & size	Total PM (Solid / semi-volatile / liquid) Min. size 4-13 nm (adjustable), max ~3 μm
Power	110V or 230V AC-to-USB adapter Up to 7 hours of battery-life
Detector block flow rate	0.50 lpm, automatically adjusted in docking station
Operating conditions	10-50 °C, RH 0-99 % (non-condensing)
Service & maintenance	No maintenance as detector block is physically separated from the control unit. Detector blocks can be exchanged refurbished

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 DePS™-Go vs. DePS™-OEM		
Share the same technology but		
<ul style="list-style-type: none"> • DePS™-Go is a stand-alone product • DePS™-OEM is a particle detection sensor element, for integration in OEM devices. Cannot be used as stand-alone product 		
	DePS-Go	DePS-OEM
Design	Stand-alone, ready-to-use, plug & play Integrated housing	Core consists of detector-block, CPU and integrated pump
UI	Touch-screen / wireless	USB / customized
Data storage & comms	Micro-SD USB / WiFi (Q4/2019)	USB / customized
Power supply	Battery / AC / USB	USB / customized

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Setup into vehicle

- Diesel powered drill rig in a hard rock mine
- Two DePS instruments placed inside the vehicle cabin
 - One measuring cabin indoor air directly (no sample conditioning)
 - One measuring mine "ambient" air pulled through a ~0.5m tygon line
 - No loss correction applied
 - Held in place with cable ties and powered from vehicle USB-outlets
- Instruments operated by mine personnel in semi-automatic mode
- Let's see what happens - type approach
 - No information on vibration, temperature, humidity etc.

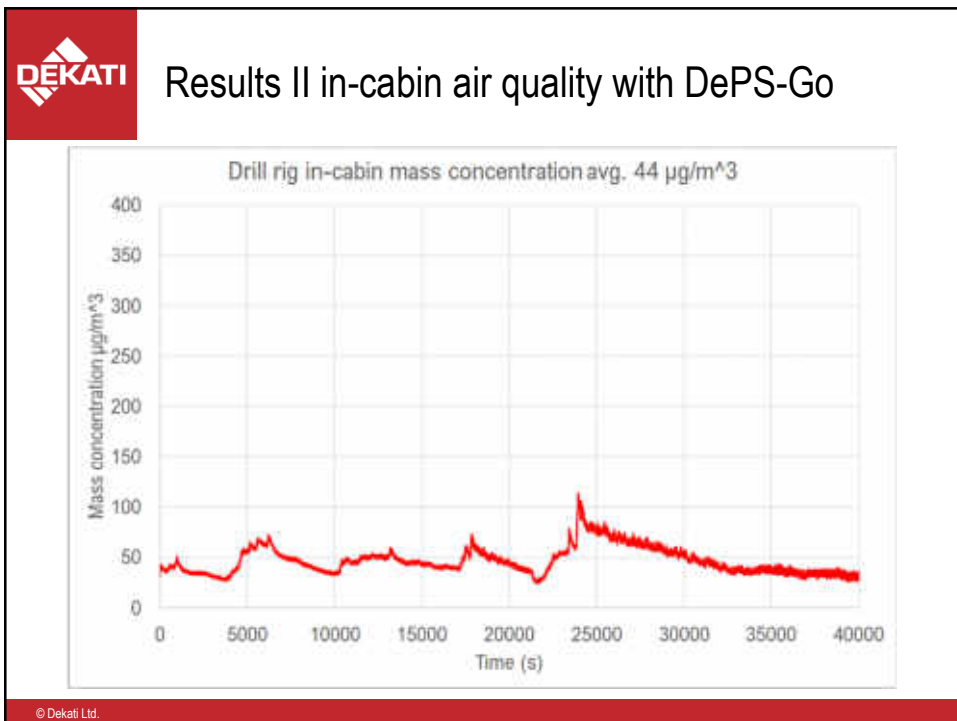
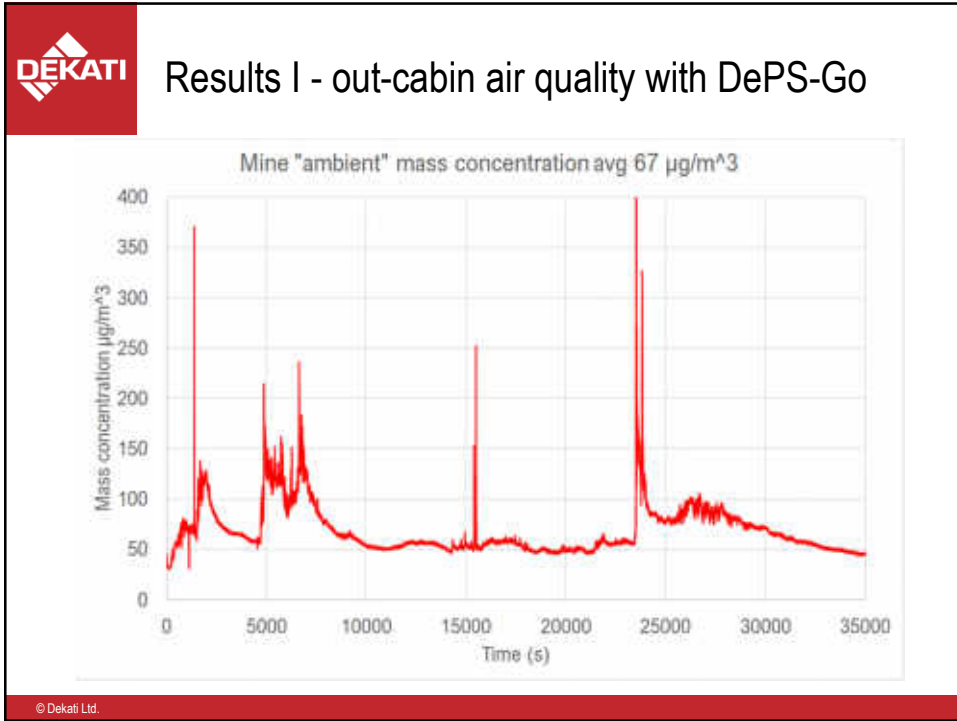
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Limitations of the study

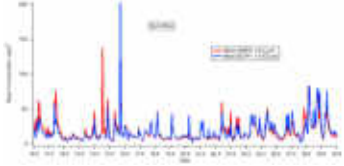
- No information of vehicle operational parameters or mine activity during measurements
- No simultaneous in/out vehicle data
 - Operational cycles similar for vehicle
 - Issues with data saving and ambient humidity
 - Solutions discussed later
- Scope too narrow to be representative, more of a feasibility study
 - More vehicles, more data
 - Study in ongoing at the moment

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Discussion



- Lower concentrations in vehicle cabin than mine "ambient" in studied vehicle
 - Ambient concentration in good agreement with HIME project results
 - Significant reduction of highest peaks
 - Average concentration ~30% lower
- Increase of CO2 levels with recirculation
 - Data from passenger vehicle cabin measurements shows increase in CO2 that will affect driver concentration
 - Effective filtration better than recirculation
- Humidity and data saving problems
 - Elevated temperature detector block (currently in use)
 - Don't be stupid
- Future studies
 - Vehicle operational data
 - More vehicles
 - Data with diesel and electric vehicles operating in the mine
- Measurement concept is feasible to evaluate operator exposure and vehicle filtration effectiveness

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Thank you!





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