

Tackling Silica Dust Health and Safety Challenges

Dr. Winnie Chu

Founder & CTO

Former Faculty at the University
of British Columbia

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Nanozen DustCount 9000
Industry-Leading Real-Time Aerosol Monitor

Real time Silica Detection...

Do we need it??

Stone Cutting

Young California workers in their 30s and 40s who made a living by cutting, polishing and installing countertops in and around Los Angeles County are dying of lung failure from inhaled crystalline silica.



1. [Jane C. Fazio, MD^{1,2,3}](#); [Sheiphali A. Gandhi, MD, MPH^{2,4}](#); [Jennifer Flattery, MPH²](#); [et al](#) [Amy Heinzerling, MD, MPH²](#); [Nader Kamangar, MD, MS^{1,3}](#); [Nawal Afif, DO³](#); [Kristin J. Cummings, MD, MPH²](#); [Robert J. Harrison, MD, MPH²](#)

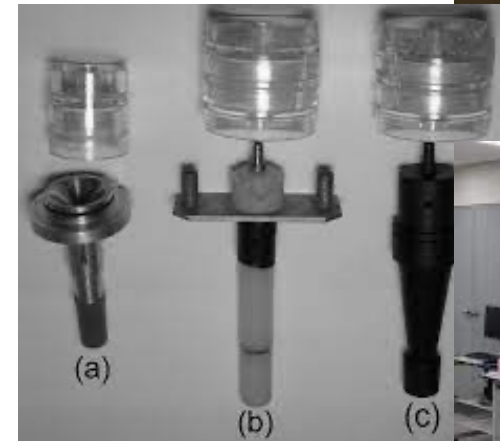
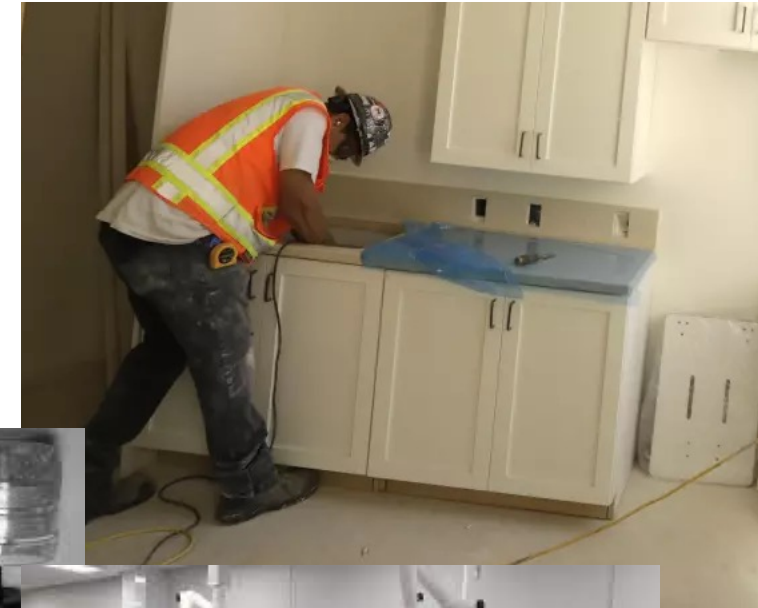
Author Affiliations

JAMA Intern Med. 2023;183(9):991-998. doi:10.1001/jamainternmed.2023.3295

Alarmed by Dr. Fazio a pulmonary critical care physician at Oliver View-UCLA Medical Center.

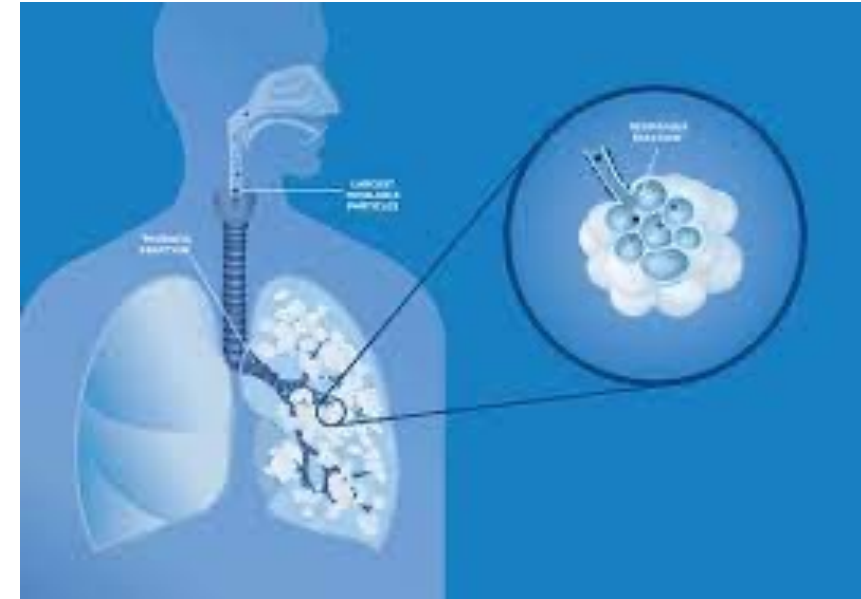
Industry Challenge – Exposure source identification and elimination

- Exposure to RCS – Lung Cancer
- Water filtration at treatment plants, foundry castings stone cuttings, metal production...etc.
- Exposure happen when materials containing silica are being aerosolized by grinding, cutting, drilling or chipping.



Regulatory Evolution

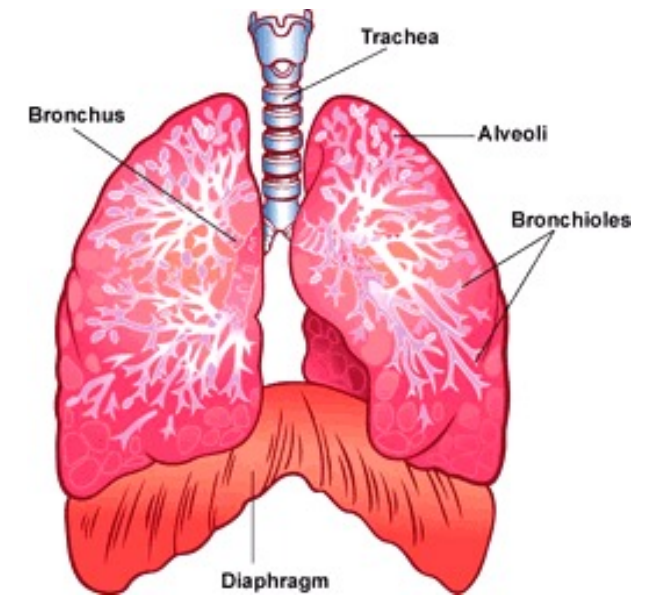
- **1994 and 1995** -- OSHA lists silica as a priority for rulemaking
- **1996** -- the World Health Organization – International Agency on Cancer Research (IARC) first classified silica as a known human carcinogen
- **March 24, 2016** -- OSHA announces [final rule](#) to protect workers from exposure to respirable crystalline silica.



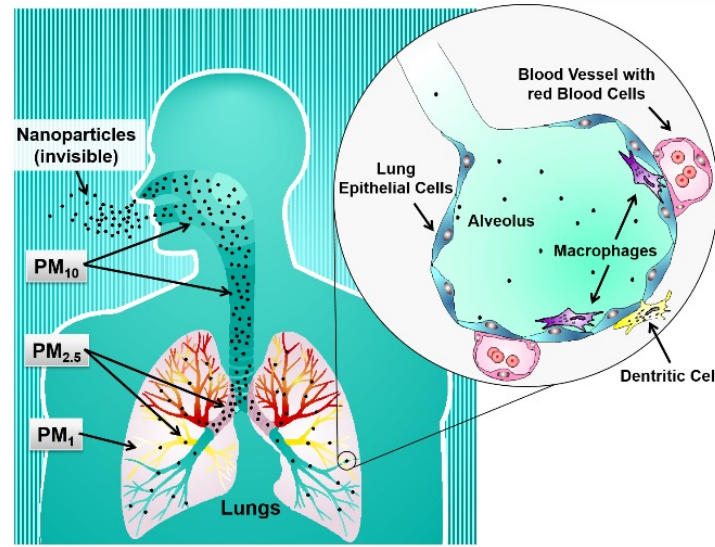
Australia – considering a national ban on engineered stone - no level of cancer-causing silica is “safe”.

Crystalline Silica in Canada Approximately 429,000 Canadians are exposed to silica at work

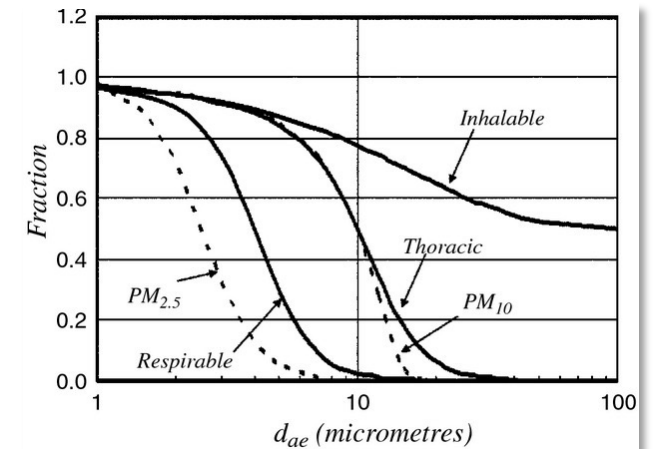
- In 2021, Canada export 376,034 t of silica sands and quartz sands, and import 5,128,722 t of silica sands and quartz sands
- Occupational Exposure Limits (OEL) in Canadian jurisdictions ranging from 0.025 mg/m³ on respirable crystalline silica in British Columbia to 0.1 mg/m³ in Quebec for respirable crystalline silica, quartz and Tripoli.
- Environmental Exposure limit in Ontario – 0.005 mg/m³ respirable cristobalite, quartz, or tridymite within 24 hour.



Occupational Air Sampling (Current Regulatory Approved Sampling Method)

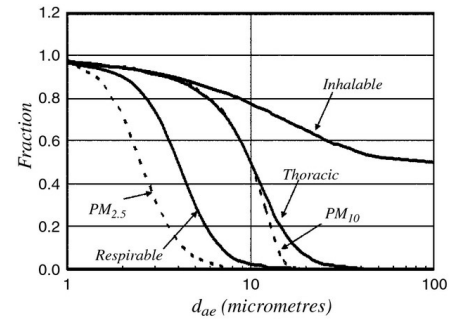
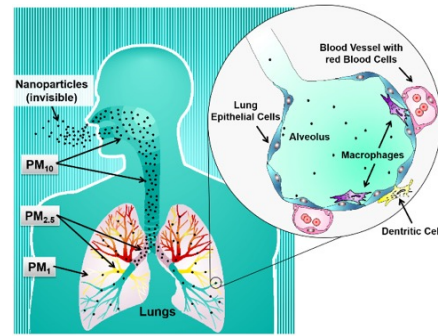


ISO/CEN/ACGIH sampling convention



Occupational Air Sampling

- Need for shortening the long wait time for the analysis results



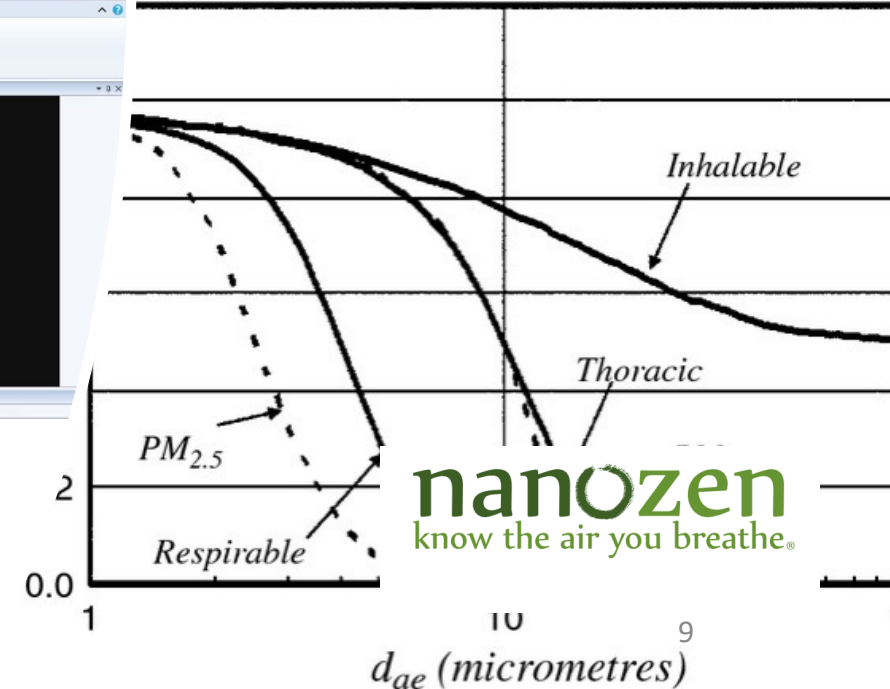
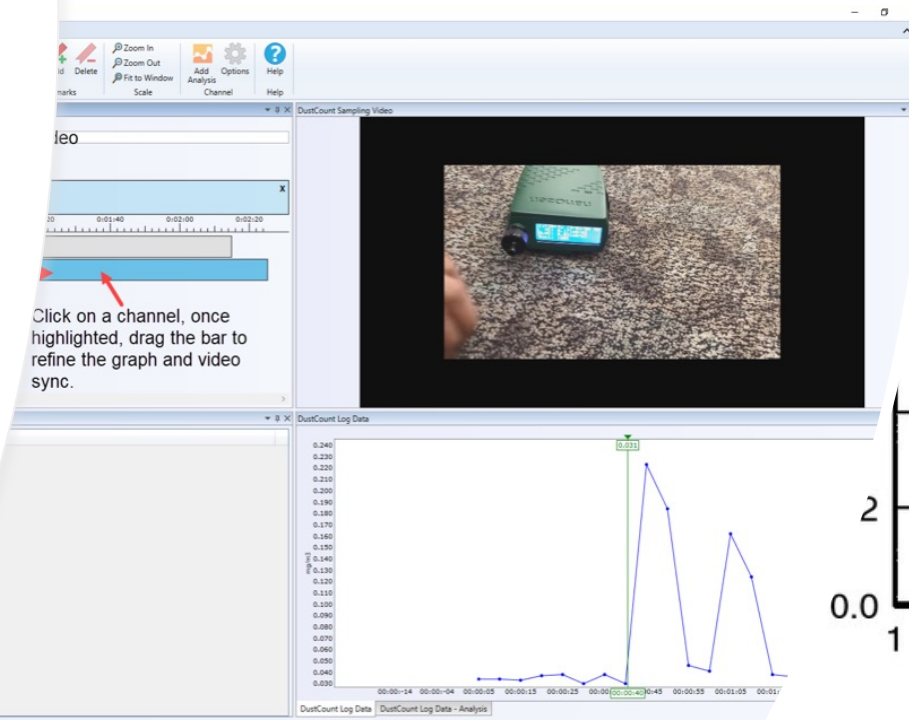
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PINPOINT SILICA EXPOSURE SOURCE

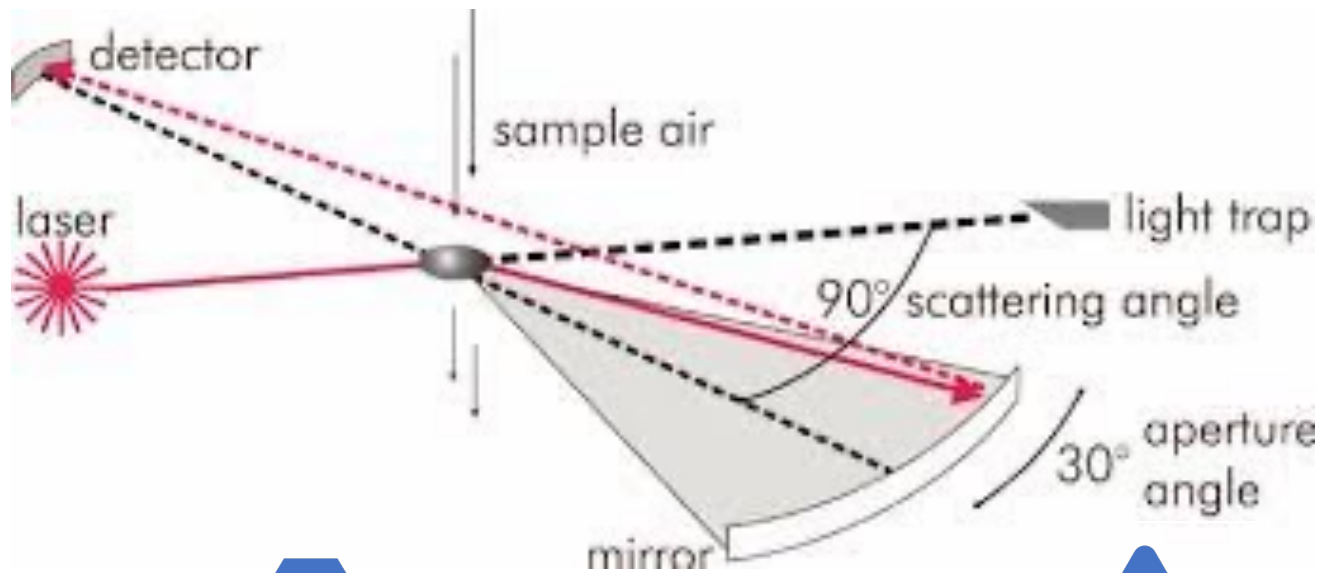


Nanozen and NIOSH Evade Software

VEM
Video Exposure Monitoring



Aerosol Spectrometer – Particle Size Distribution



Operation principle: Optical scattering method;



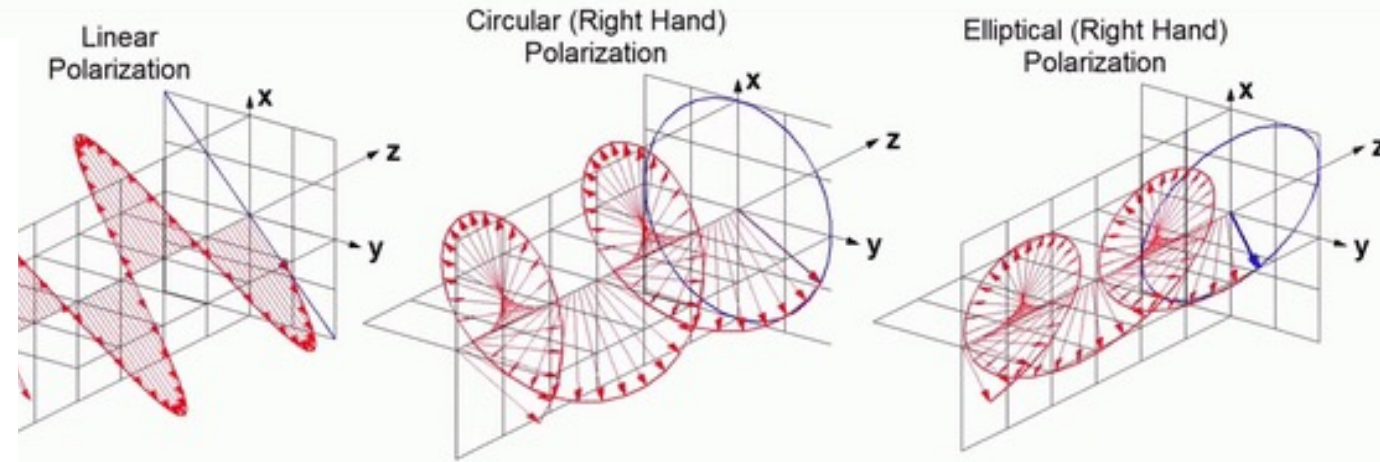
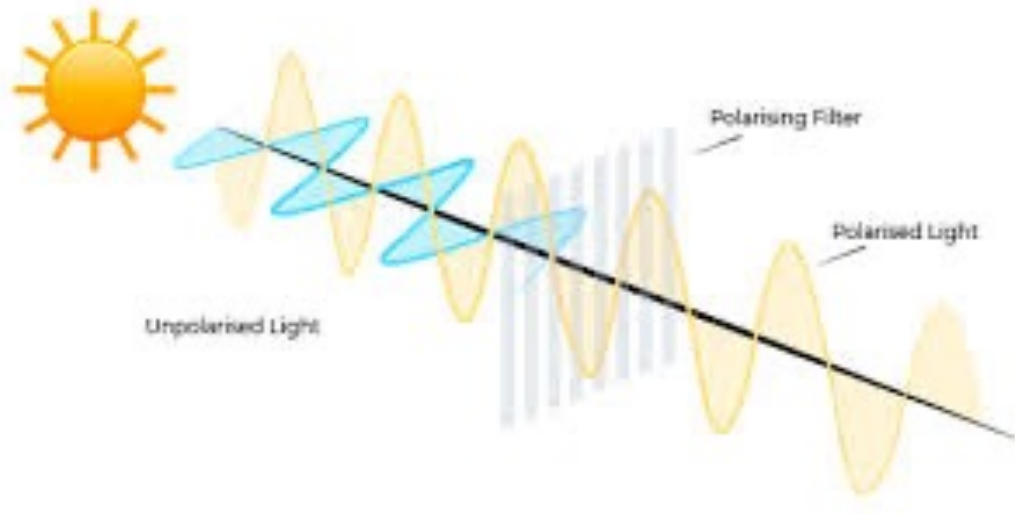
Provide particle counting, sizing and distribution statistics;



Limitations:

Scattering depends both on the particle size and refractive index (typically unknown). This introduces sizing ambiguity and prohibits the identification of particle composition.

Polarization concept

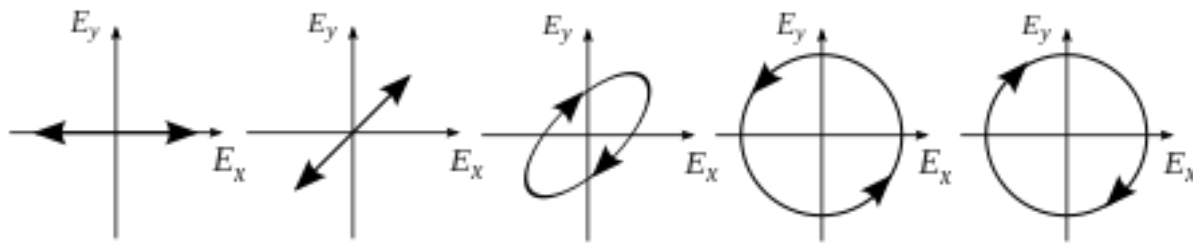


Light is naturally unpolarized - the direction of the electric field fluctuates randomly in time; such as Sunlight Halogen LED.

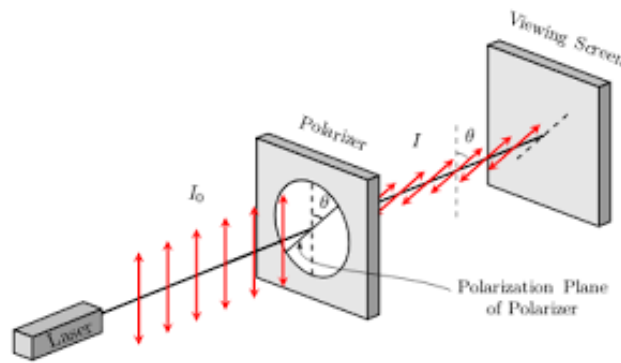
The polarization ratio is generally defined as the ratio of the two orthogonal components.

Polarization of laser

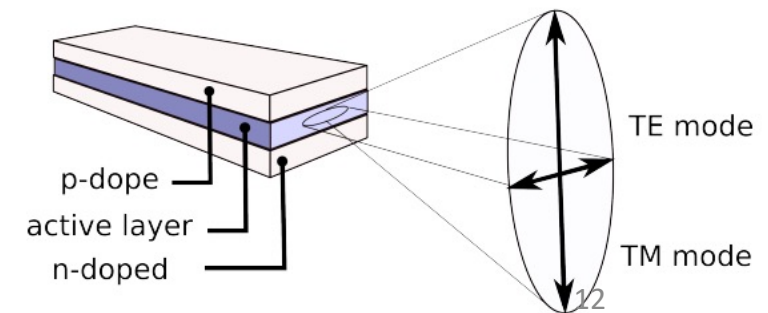
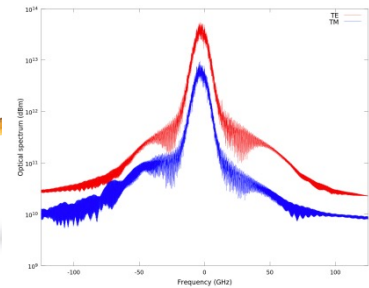
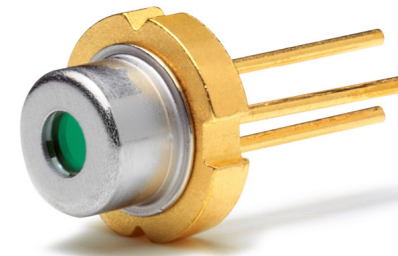
- ❖ Lasers are generally linearly polarized;
- ❖ The polarization state can be manipulated via polarization components (e.g., wave plate, polarizer, retarders, etc.).
- ❖ Degree of polarization (DOP) describes the portion of a wave which is polarized.
- ❖ Laser diodes are polarized parallel to the short axis for an elliptical beam (TE polarization or S polarization).



Electric field oscillation

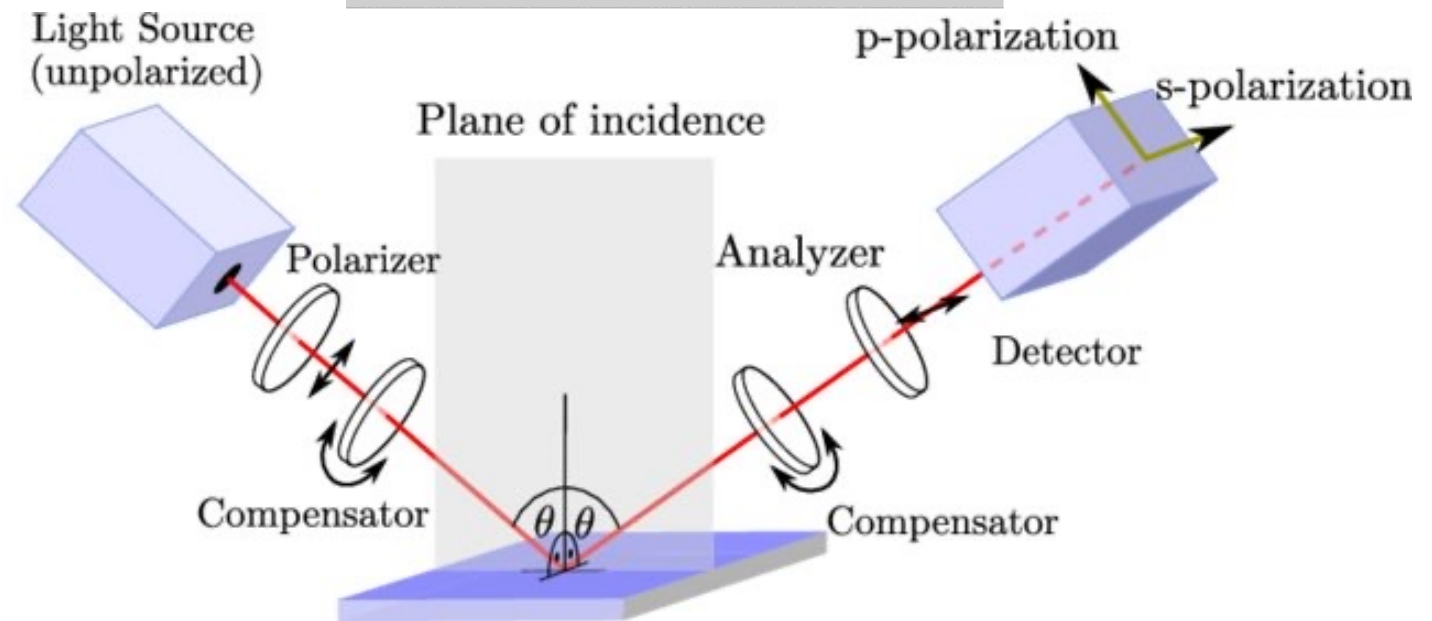
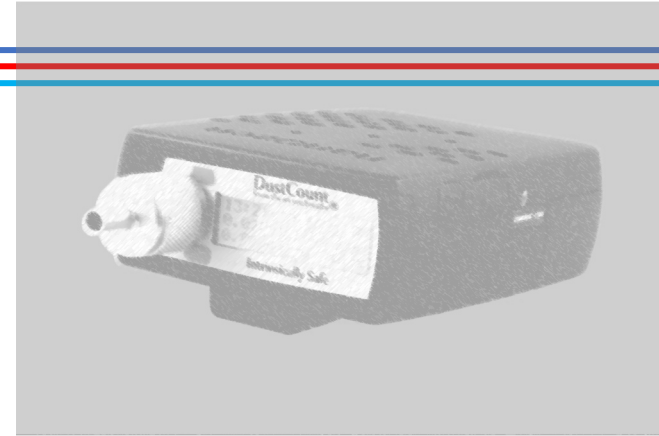


Change of polarization

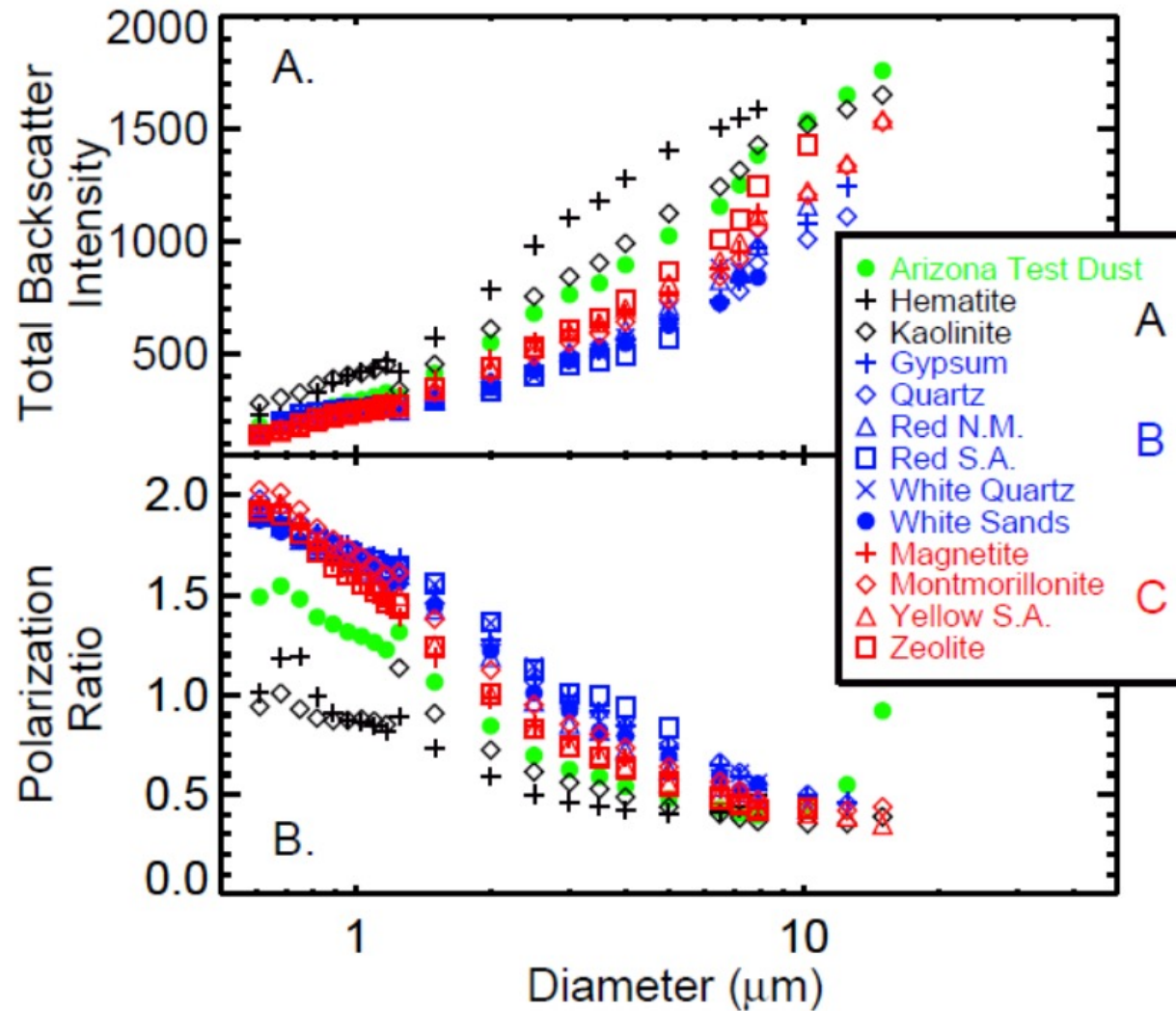


Added Polarization ratio for fingerprint identification

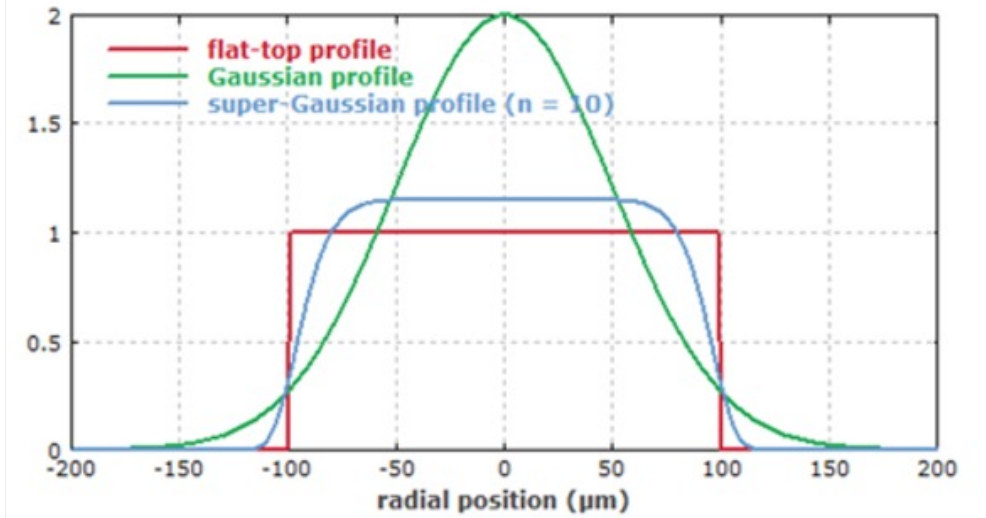
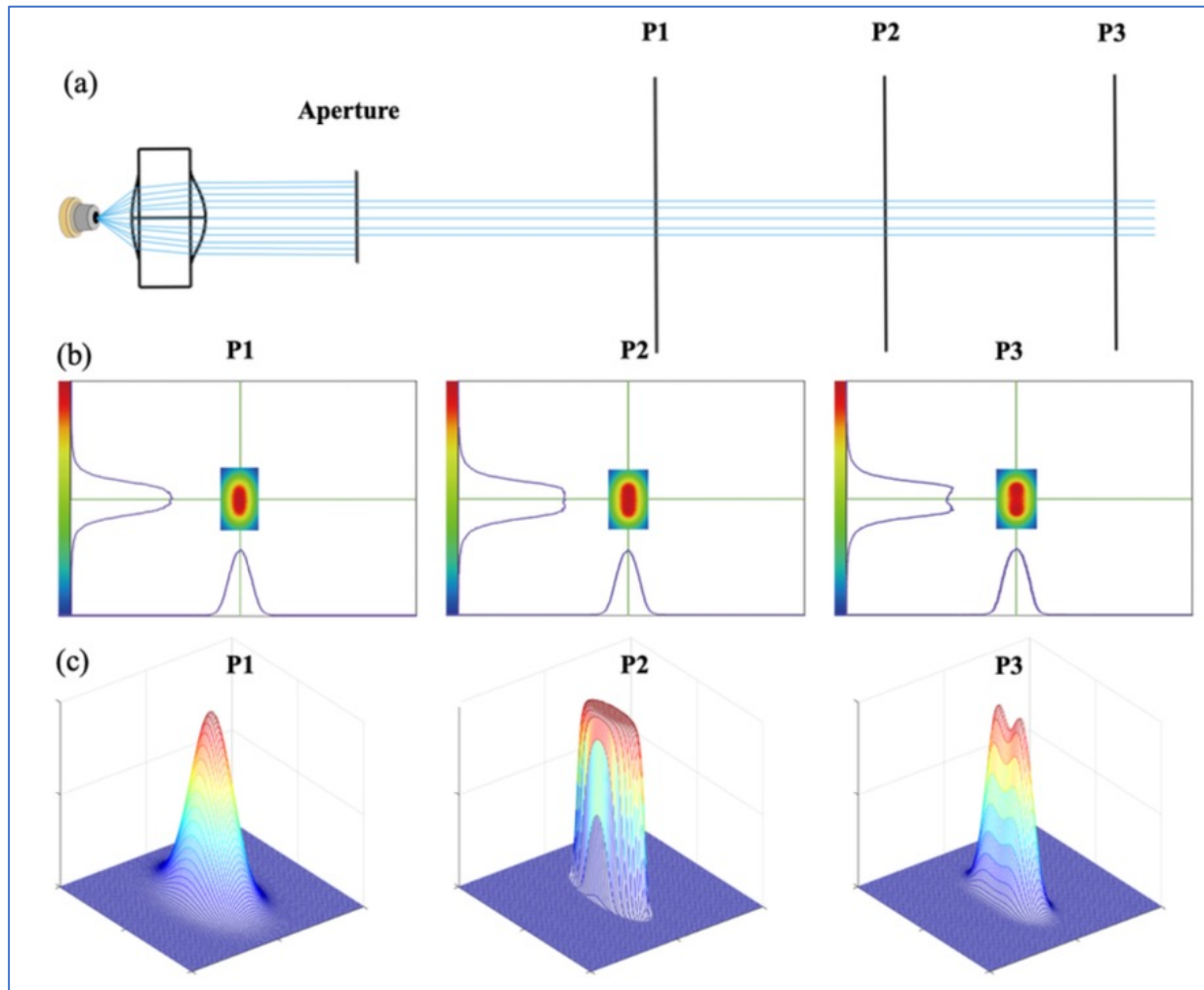
- ❖ The characterization polarization state of a beam is affected by the materials during interaction;
- ❖ By measuring the changes of polarization state after enables identification of interacted materials, and probe the complex refractive index of a material, which serves as a fingerprint parameter.



Polarization ratio for categorizing particles

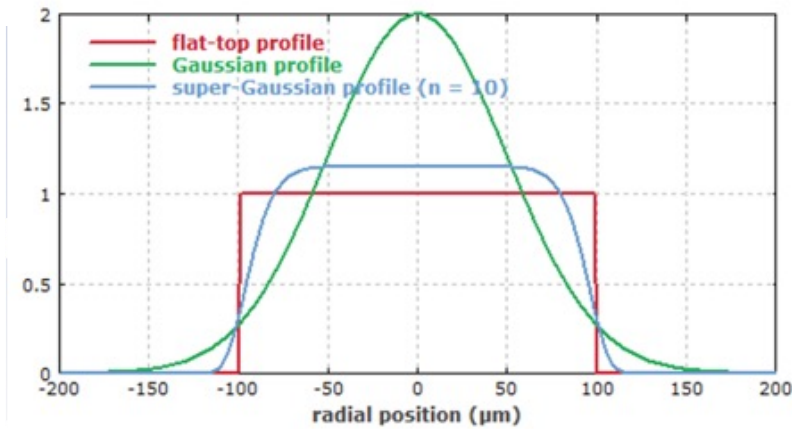
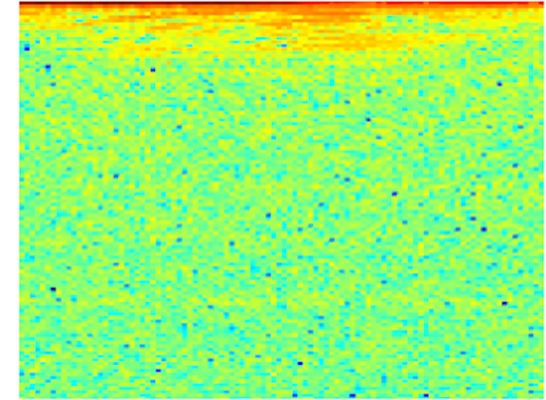
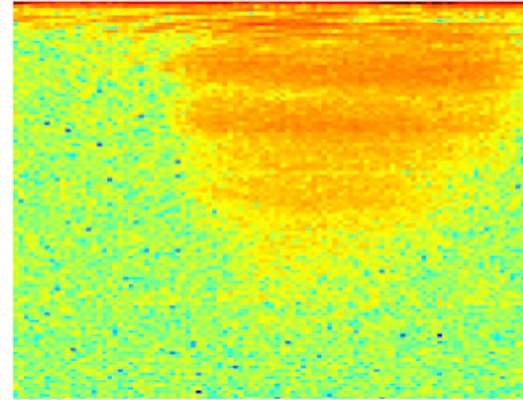
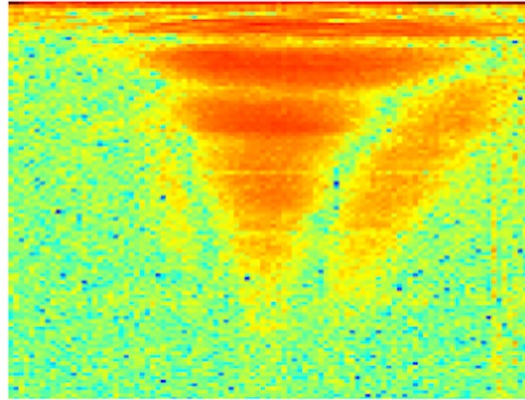


1D Flat Top Laser Profile

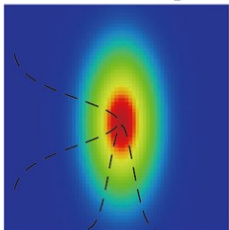


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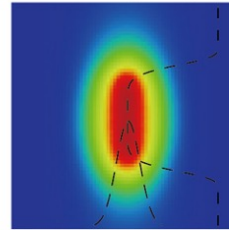
Nanozen Spectral Aerosol Sensor SAS to achieve specific chemical detection with PSD



Laser diode input

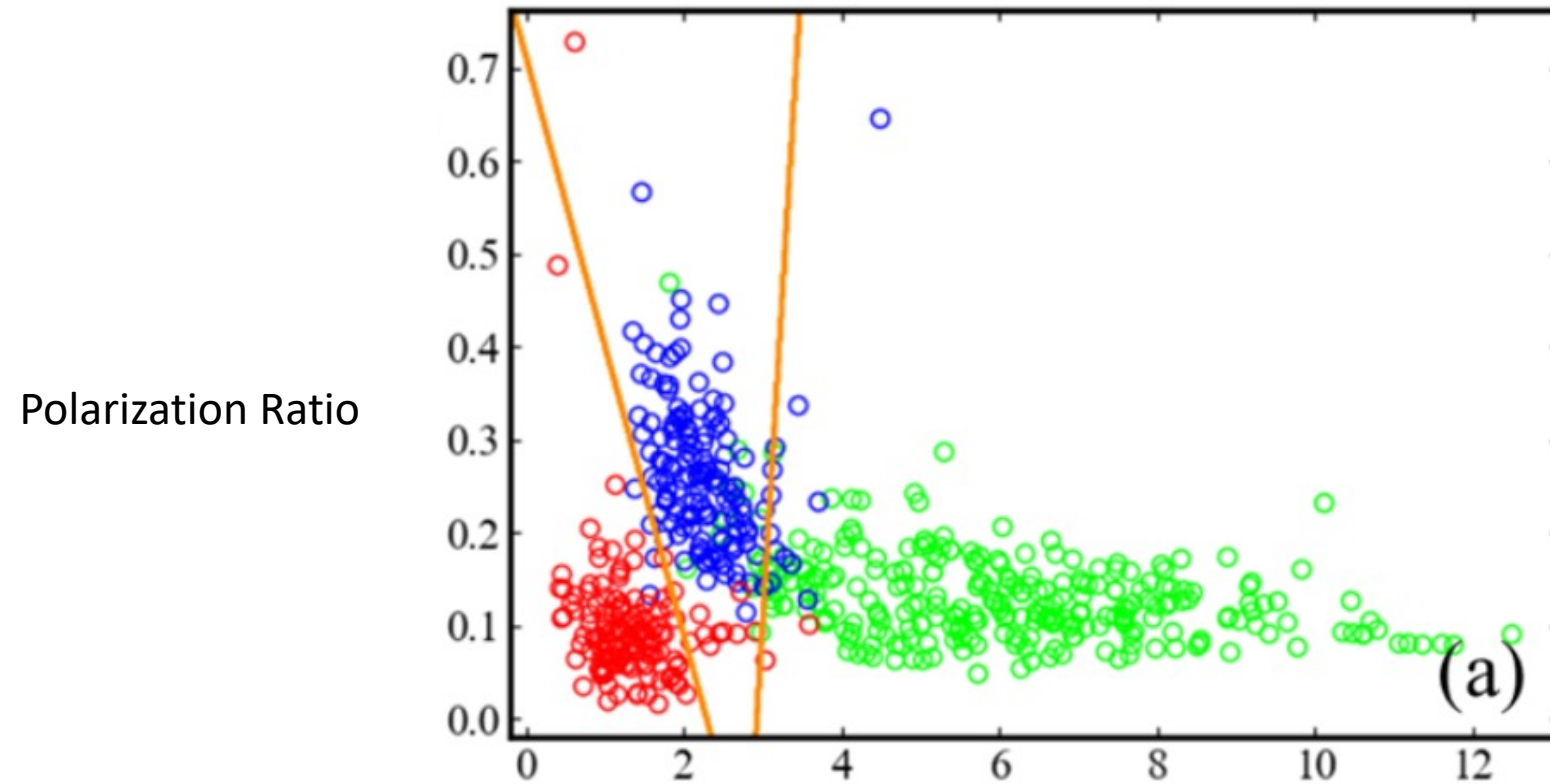


1D Flat top output



- Design and build 3 in 1 lens to guide laser to interact with the particle on the flat-top which greatly enhance the precision of PSD determination.
- Use time of flight with depolarization in a wearable package to decipher 3D chemical information.

Single Silica particle identification



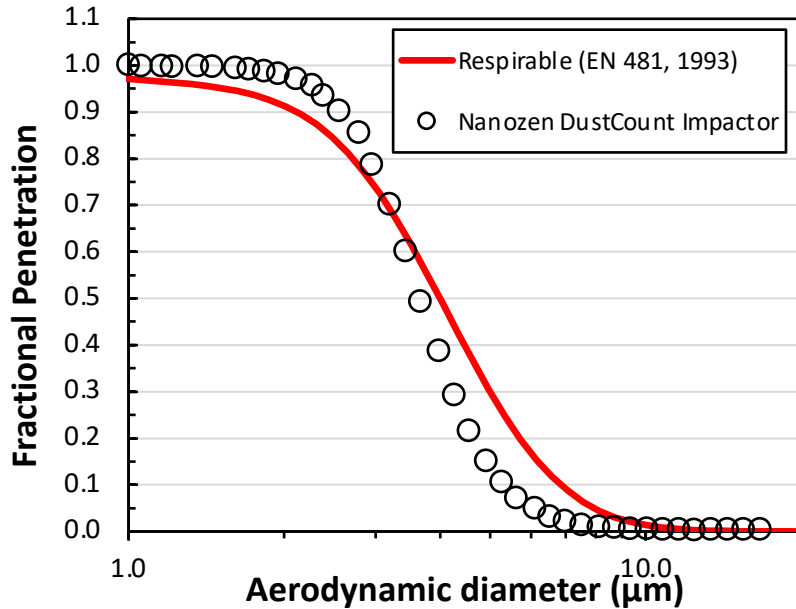
- Carbon
- Silica
- PSL

Nanozen DustCount Respirable Sampling Impactor

Tested at the HSE Science and Research Centre
 Harpur Hill, Buxton, SK17 9JN
www.hse.gov.uk

Report Date: December 2021

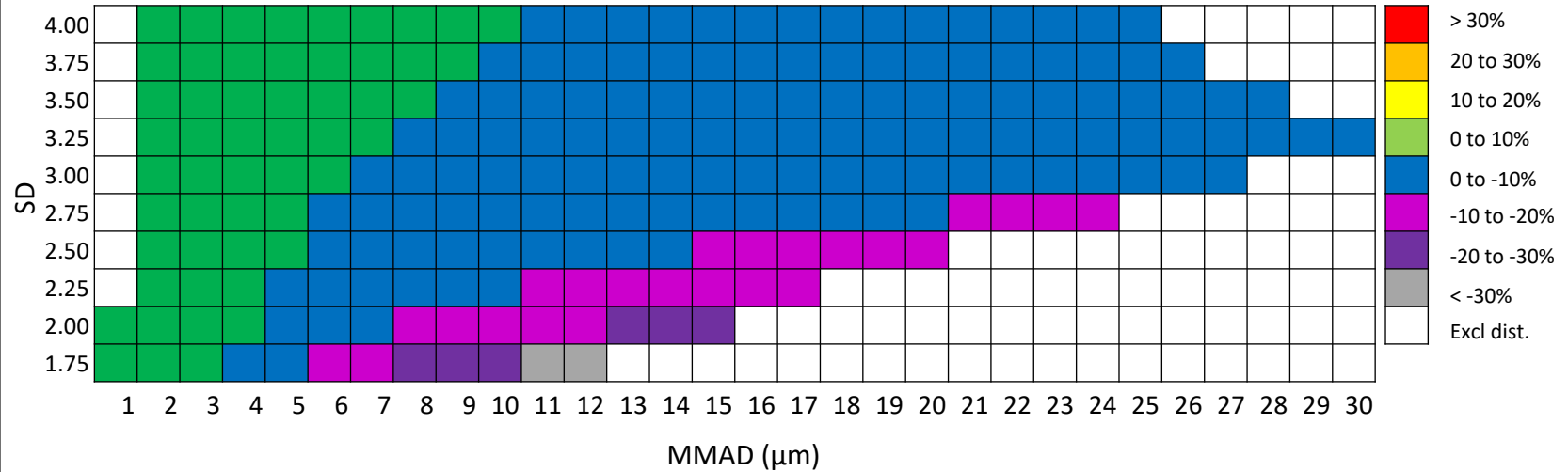
Measured Mean Penetration



The average D_{50} Cut off particle size for the six impactor samplers provided by Nanozen was $3.65 \mu\text{m}$: within 9 % of the target D_{50} value of $4.00 \mu\text{m}$ for respirable fraction (BSI, EN481, 1993).

A coefficient of variation of 2 % for the D_{50} of the six Nanozen impactor samplers indicated low intra-variability.

Bias Grid



The Nanozen impactor exhibited a negative bias relative to the sampling convention of -4 % for theoretical aerosol distributions with mass median aerodynamic diameters 1 – 30 µm and geometric standard deviations 1.75 – 4 µm.

A well-optimized sampler is expected to result in a bias between -10 % and 10 % relative to the sampling convention (BSI, 2014).

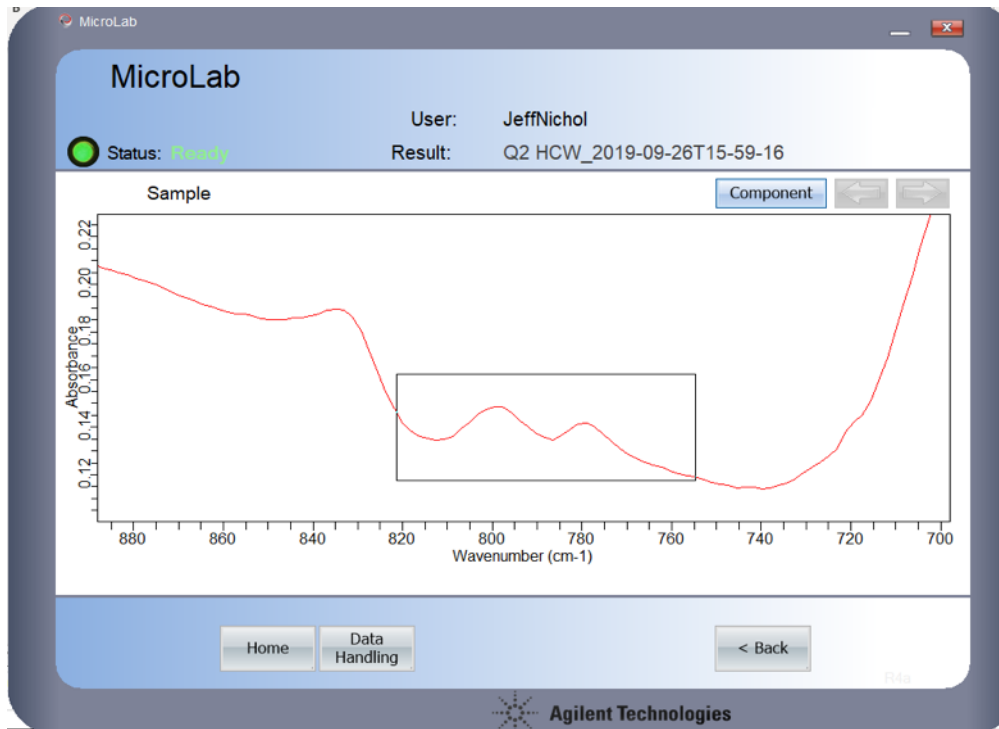
Nanozen Particle Calibration Complete Setup

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Assist Chemical sites to calibrate their specific airborne powders.

FTIR XRD and IR detection of RCS Detection

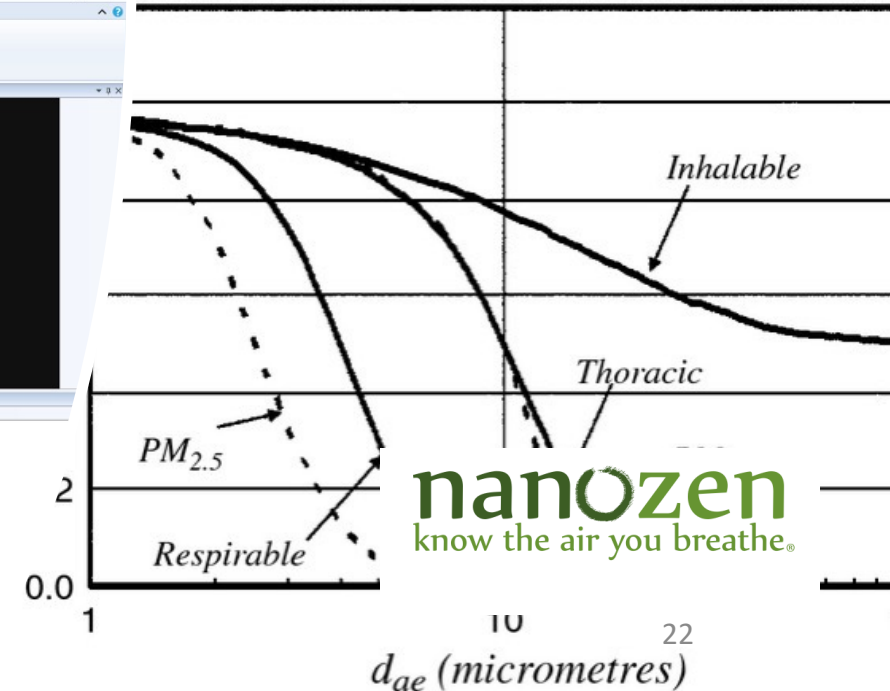
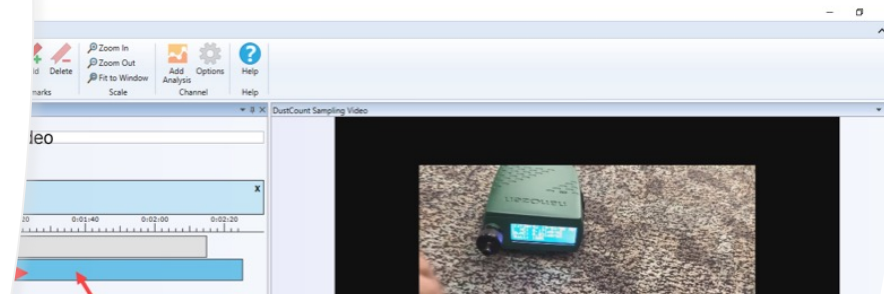


Calibrate Silica among various of minerals



PINPOINT SILICA EXPOSURE SOURCE

Real time Silica project appointment during AIOH 2023 (December 3-6)



FUTURE READY:
transformative, innovative, relevant

CONFERENCE PROGRAM



peterb@nanozen.com

nanozen

know the air you breathe.®

winnie.chu@nanozen.ca

 +1.844.626.6936

 moreinfo@nanozen.com

 www.nanozen.com

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