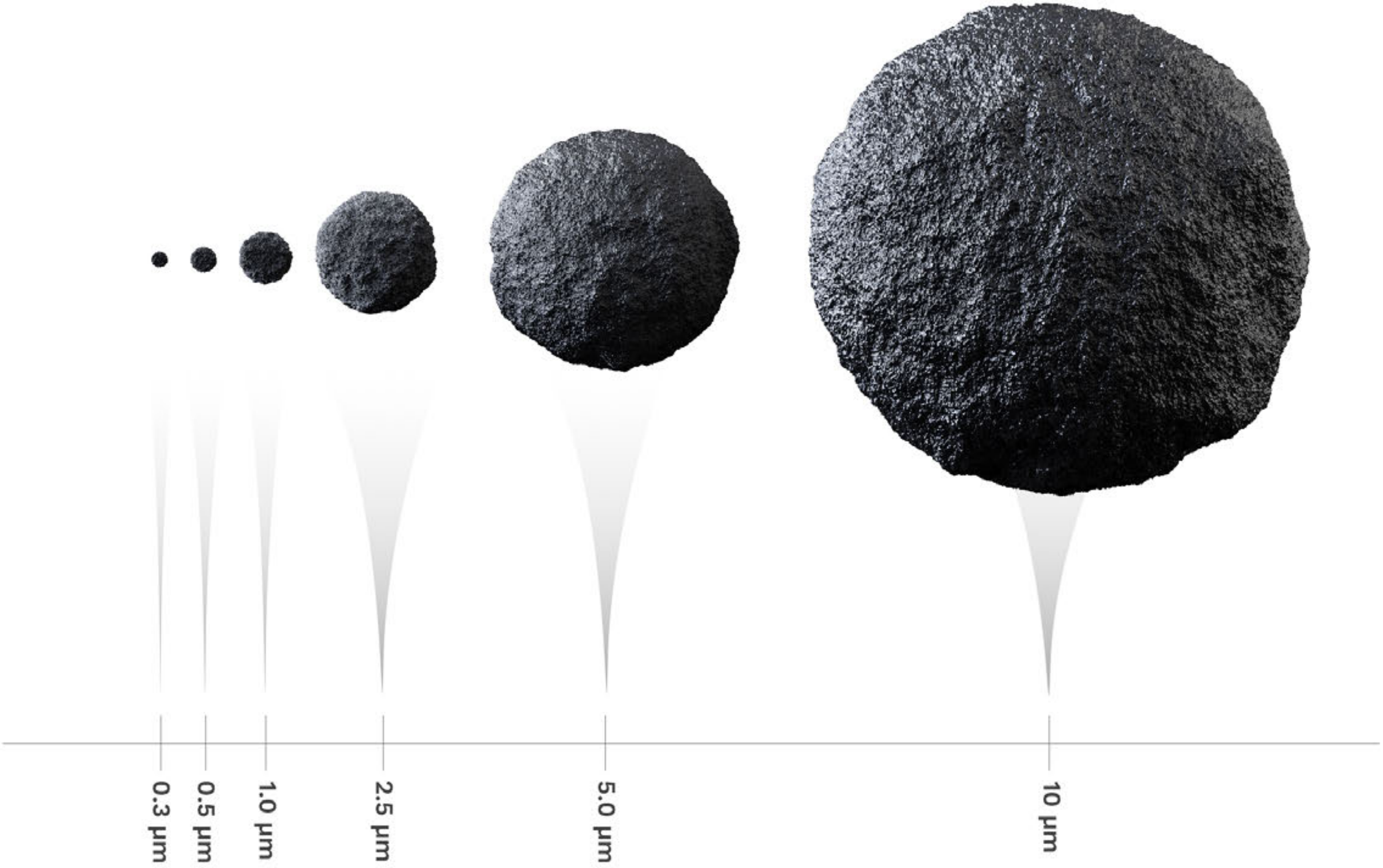
SIZE
MATTERS™

PARTICLES PLUS®

Agenda

- Particle Size Distribution
- What is Particulate Matter
- The Problem (Part 1 - $PM_{2.5}$ Values)
- Estimate the size distribution?
- Particle Pollution and Health
- The Problem (Part 2 - Technology)
- Solution
- Conclusion
- Q&A

Particle Size Distribution



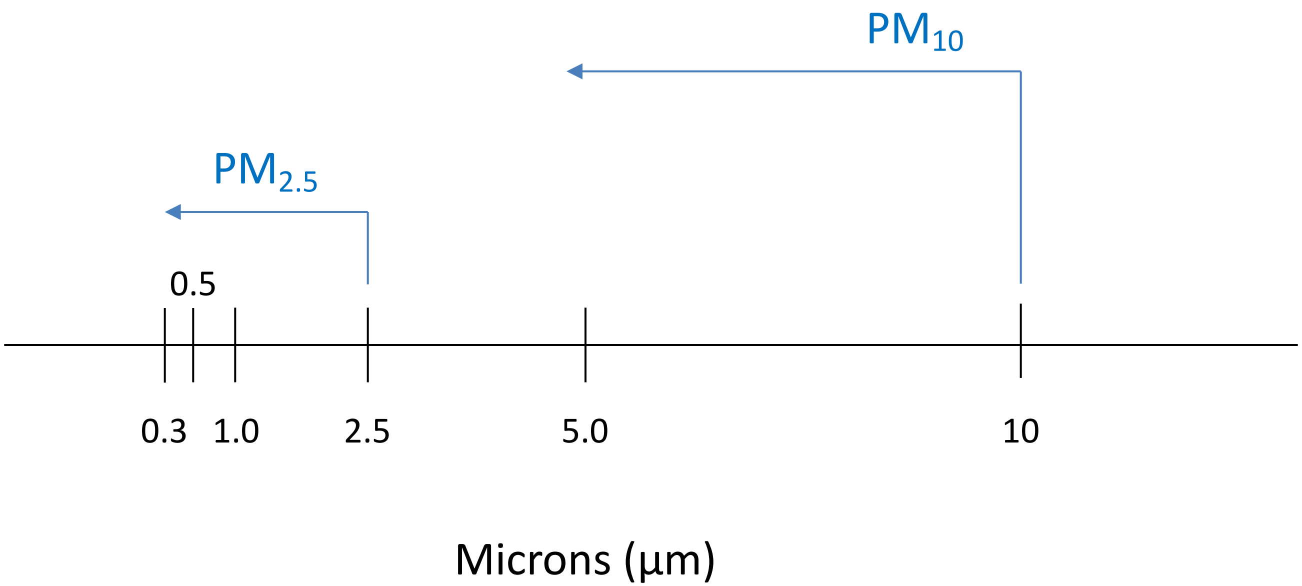
What is Particulate Matter

- Particulate matter (PM) is a mixture of solid particles and/or liquid droplets found in the breathable air. Particulates can also be described by size as in, fine, ultra-fine or nanoparticles. *Common terms such as dust, dirt, soot, aerosols, black carbon, or smoke may be used to describe particulate matter.*

- **$PM_{2.5}$** refers to particulates with a size smaller than 2.5 micrometers (microns). Technical definitions for this can be involved. *For example, the European Directive 2008/50/EC defines $PM_{2.5}$ as the mass of particulate matter which passes through a size-selective inlet (as defined in the reference method for the sampling and measurement of $PM_{2.5}$, EN 14907) with a 50 % efficiency cut-off at 2.5 μm aerodynamic diameter.*

The Problem (Part 1 - $PM_{2.5}$ Values)

- Unfortunately, any value of $PM_{2.5}$ can represent a wide variety of particulate distributions, and although it has helped researchers in the past to identify the relationship between air pollution and health issues, nowadays, it falls short as it doesn't reveal in detail the make up of air pollution.



The Problem (Part 1 - $PM_{2.5}$ Values)

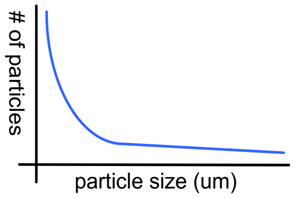
250 particles ⌀0.3~0.4

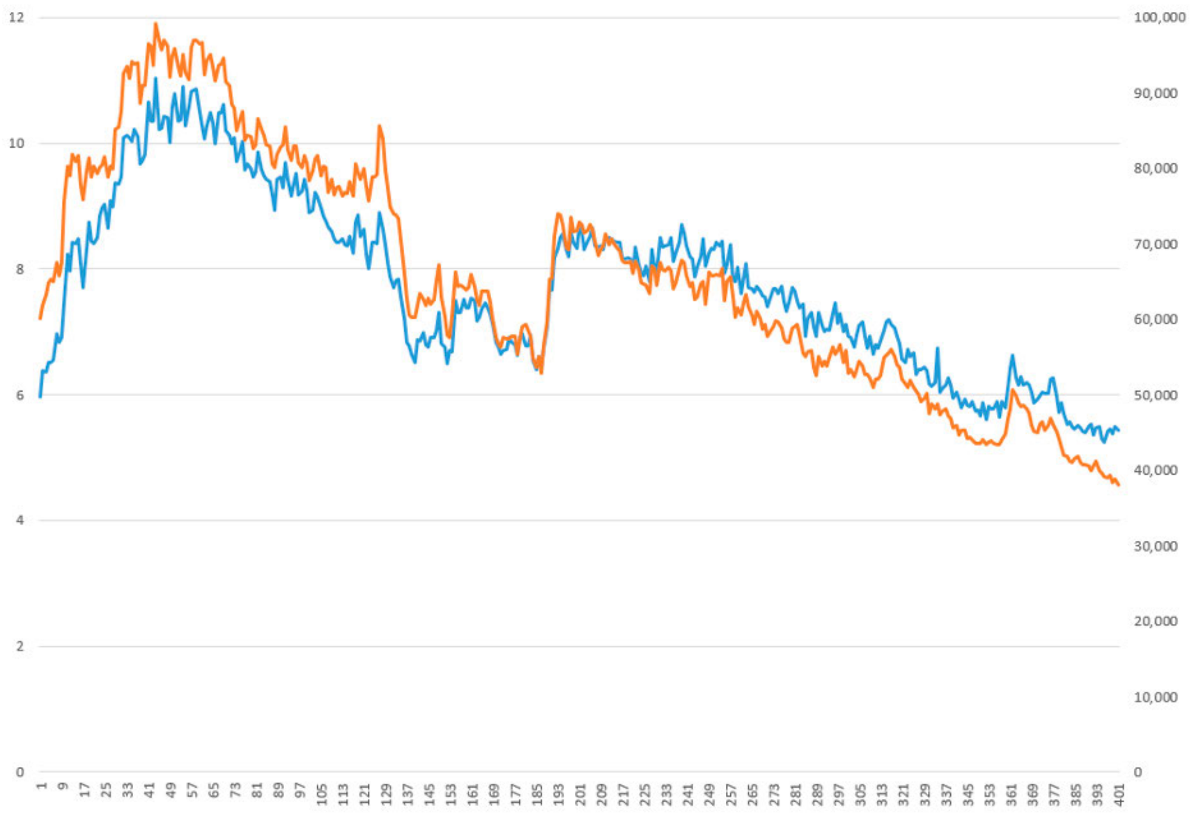
1 particle ⌀2.5

Both of these have the SAME $PM_{2.5}$ value, but which one(s) can travel deeper inside us?

Estimate the size distribution?

- Isn’t the size distribution in air a constant function?
- If so isn’t mass a reasonable estimation of air quality?

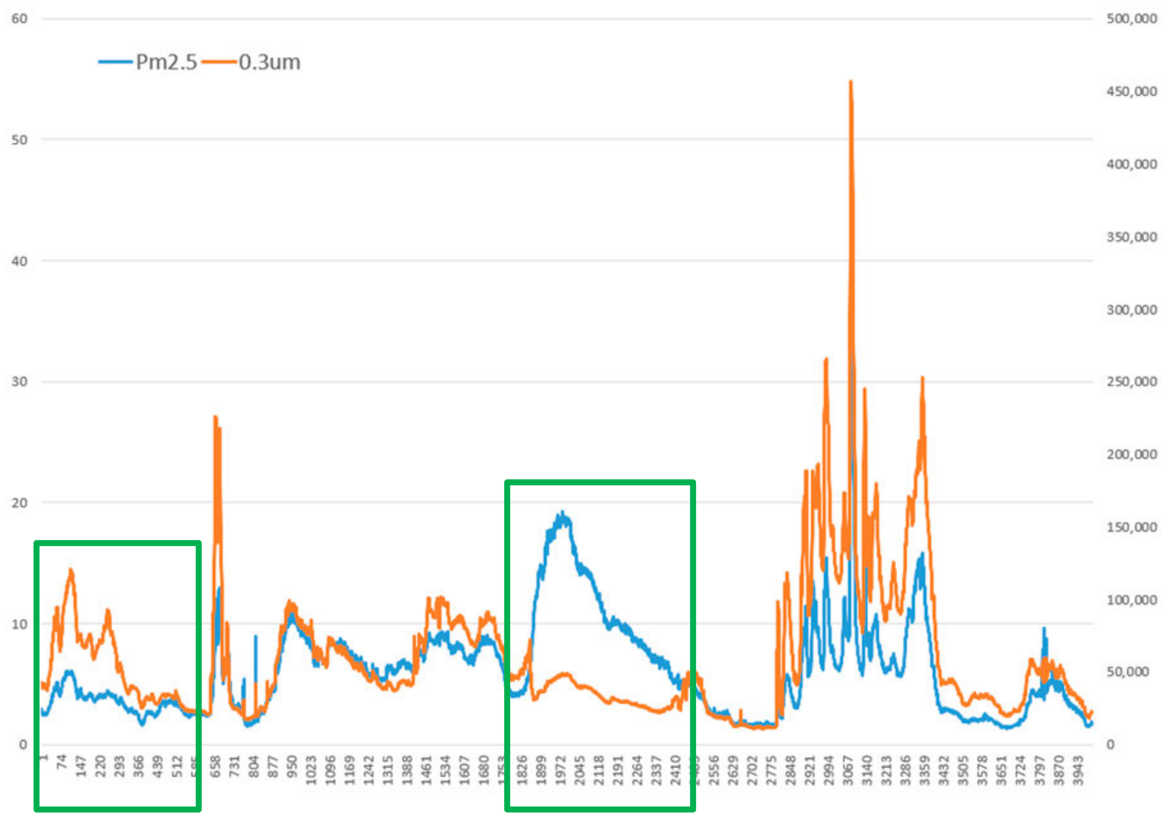




Narrow sample of 0.3µm vs. $PM_{2.5}$

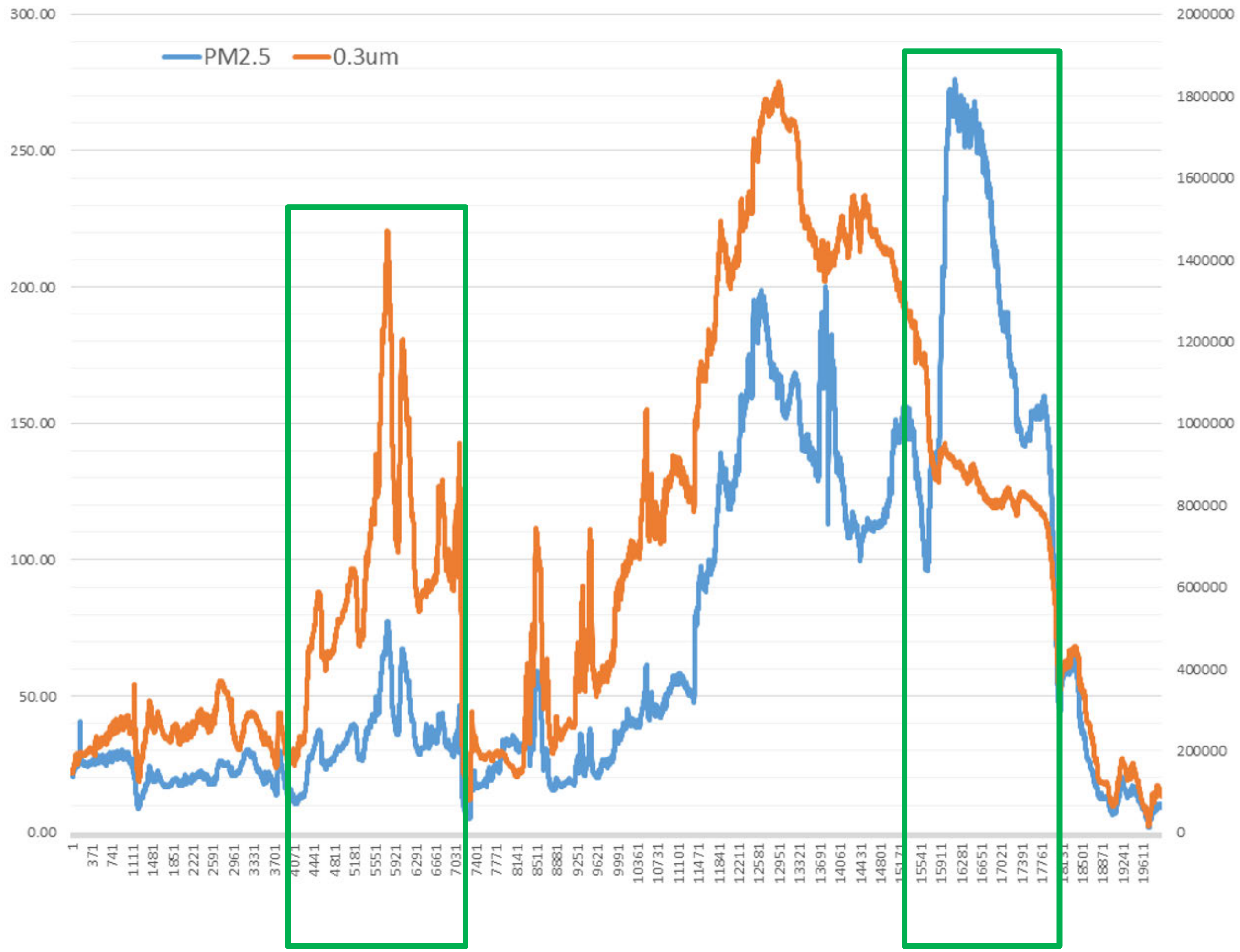
Estimate the size distribution?

- Isn't the size distribution in air a constant function?
- If so isn't mass a reasonable estimation of air quality?



Broad sample of 0.3µm vs. $PM_{2.5}$

Estimate the size distribution?



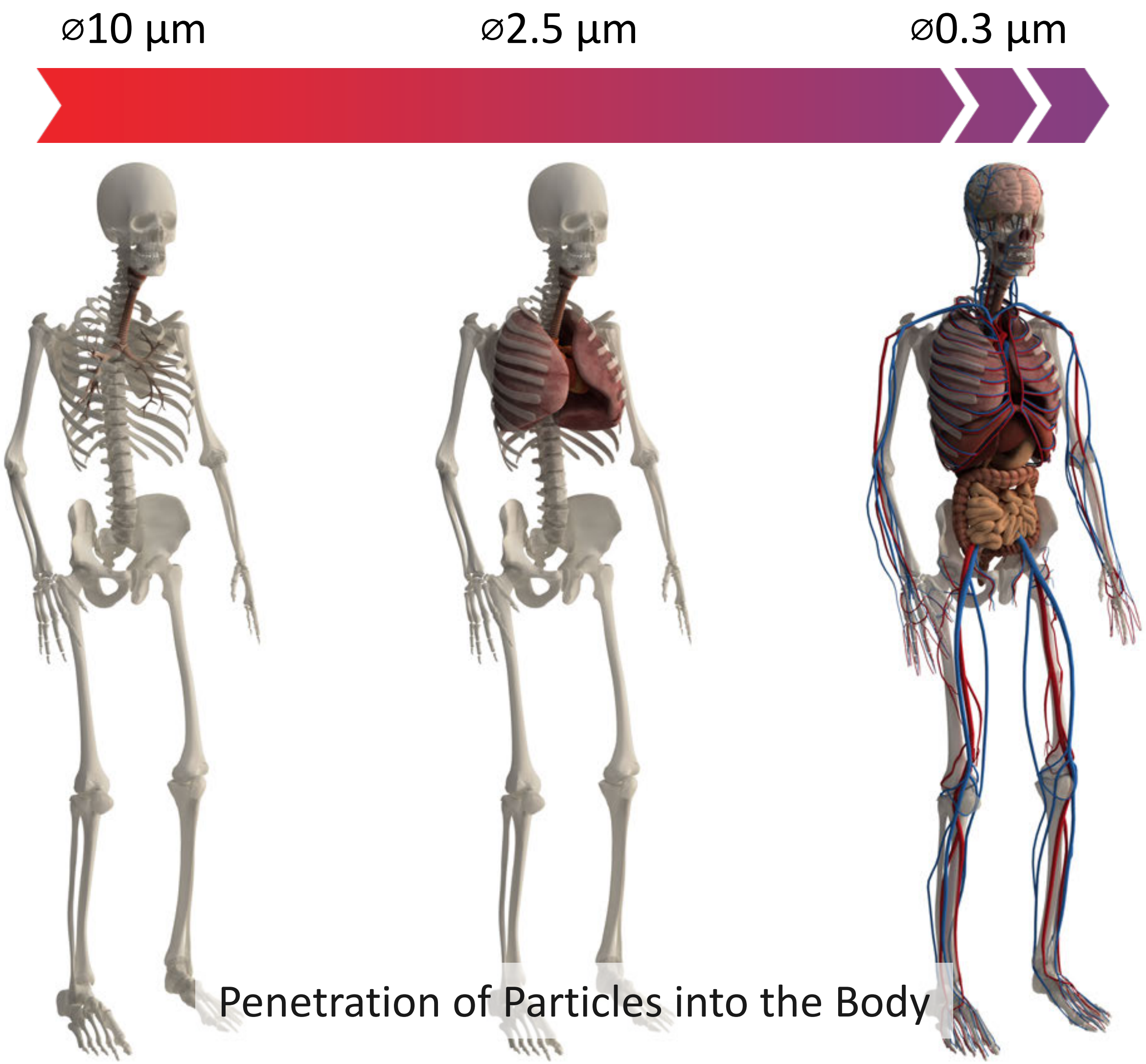
0.3µm vs. $PM_{2.5}$ during wildfires in California

Estimate the size distribution?

- A single mass figure like $PM_{2.5}$ isn’t sufficient to provide an accurate measure of air quality.
- Providing multiple PM values helps but is rarely used and can be confusing (lack of instrument details).
- Mass ($\mu g/m^3$) isn’t a good measure of smaller particles, especially submicron particles and ultra-fines.
- There are already studies that take advantage of the size distribution of the particles to identify the pollution source

    e.g. Namdeo et al. (2020) published a study Investigating the levels of indoor and outdoor particulate matter in six Southeast Asian cities.

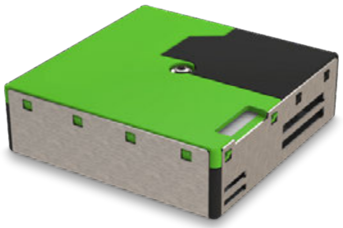
Particle Pollution & Health



The Problem (Part 2 - Technology)

PARTICLES PLUS

- Most off-the-shelf indoor and outdoor air quality monitors don’t comply to standards.
- Most indoor and outdoor air quality monitors “calibrate” their sensors to one channel and then they extrapolate data for the rest of the channels, commonly for $PM_{1.0}$ and PM_{10}.
- Most indoor and outdoor air quality monitors use nephelometers (aka photometers) that measure a cloud of particles.
- Most indoor and outdoor air quality monitors don’t measure the size distribution of the particles and they only give $PM_{2.5}$ and PM_{10} values.

The Problem (Part 2 - Technology)

PARTICLES PLUS

High-Cost

Gravimetric sampling
(Actual mass)
Capture sampled air, weight it to determine mass of sample

Pros:
Best known measurement of total mass for a sample
Potential to analyze the material make-up

Cons:
Not real-time, time lag between sample & results
Requires consumables and lab fees
No measurement of particulate size distribution

Low-Cost

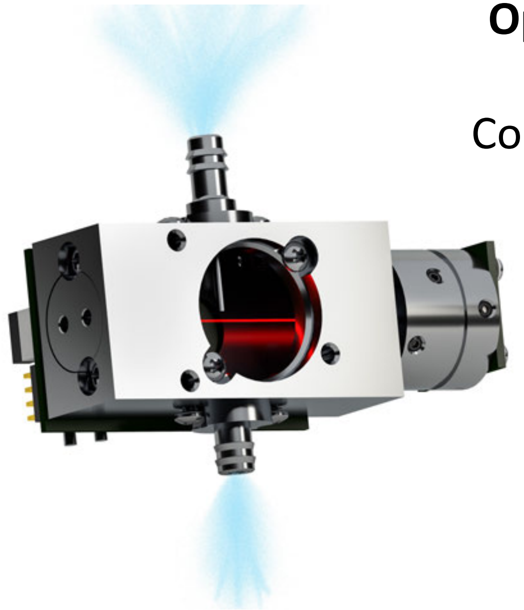
Photometers & Mass Market "Particle Counters"
(Estimated mass)
Estimate mass from a cloud

Pros:
Lowest cost
Real-time measurements

Cons:
Can't accurately convert aggregate light to mass (velocity, beam, surface vs. volume, etc.)
Correlation to a reference standard is very poor
Offset drifts with flow, temperature, time
No calibration standard

Solution

Mid-Range Cost



Optical Particle Counters – with Standards

(Very good estimated mass)

Collect light from every particle, bin them by size, estimate the mass of each size bin

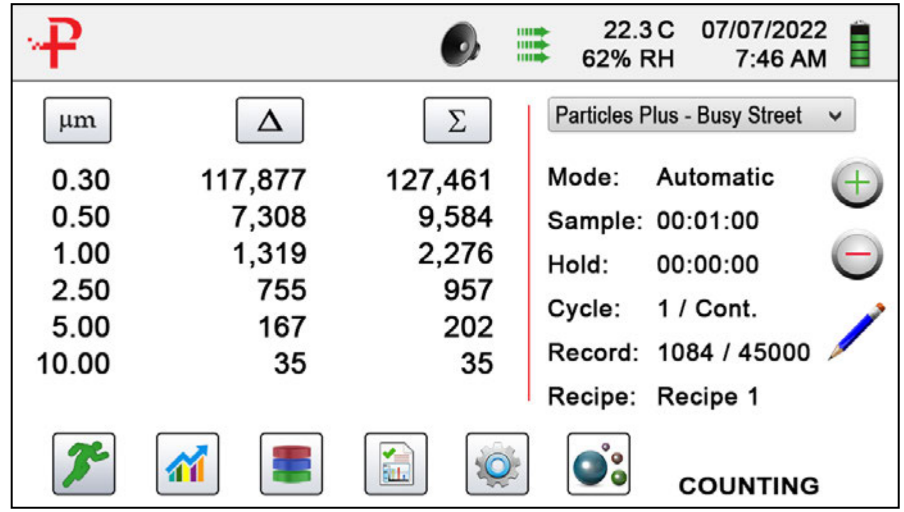
Pros:

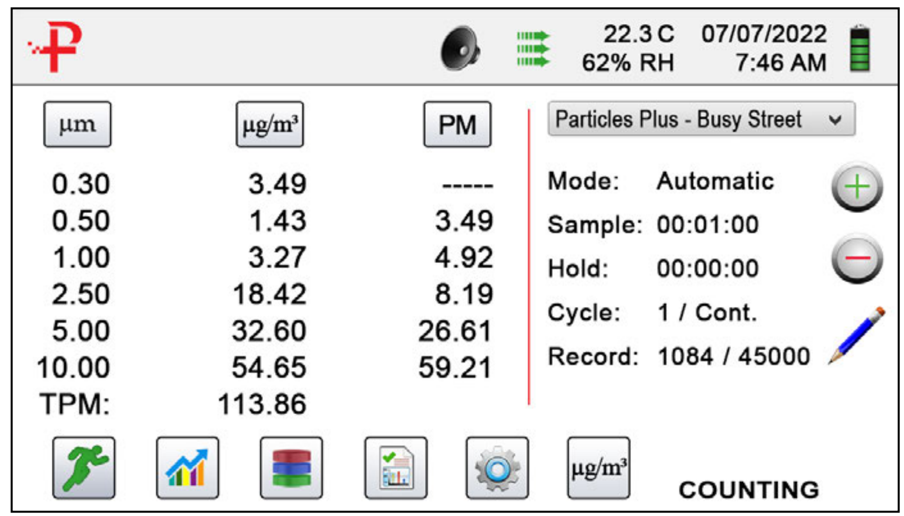
Very good mass estimation
Real-time measurements
Accurate, sensitive and reliable
Fully calibrated to an industry standard
Correlation to a reference standard is superb

Cons:

Higher cost

Solution - Particles Plus





All channels are calibrated according to ISO 21501-4 & JIS B9921 standards

Solution - Particles Plus

Indoor AQ Monitors

Ambient AQ Monitors

Handheld AQ Monitors

Conclusion

- With the pandemic, wildfires, cooking without proper ventilation, and studies showing links between air quality and numerous diseases or health conditions, air quality is increasingly important to everyone.

- Particle size distribution offers more in-depth, illuminating and descriptive AQ information, often adding context and clarity behind those numbers.

- Standardization is necessary for instrumentation in order to ensure the quality and accuracy of the information being provided.

- We should consider how we might augment mass estimates (especially for submicron particles) to provide a more complete picture of air quality.

Q&A

The questions which aren’t answered during the webinar will be answered via email.

PARTICLES
PLUS®

www.particlesplus.com

Thank you