American Filtration and Separations Society

THE GALT HOUSE
LOUISVILLE, KY
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Cambustion instruments for gas filtration R&D

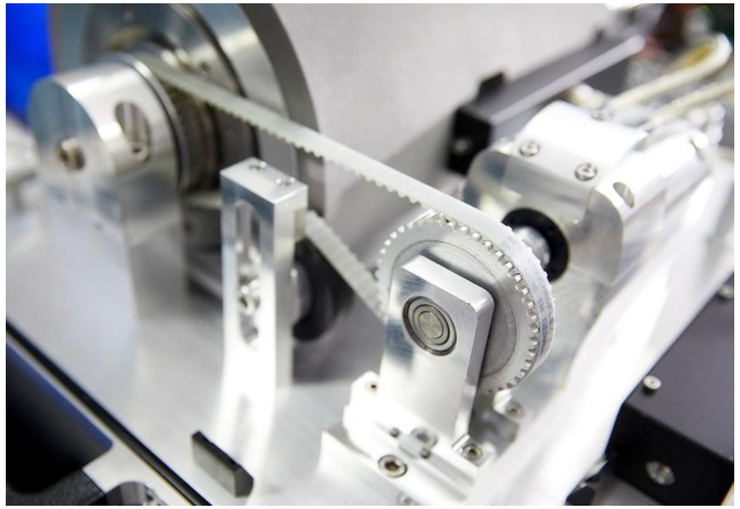
Ensuring the highest accuracy measurements of the most penetrating particle size

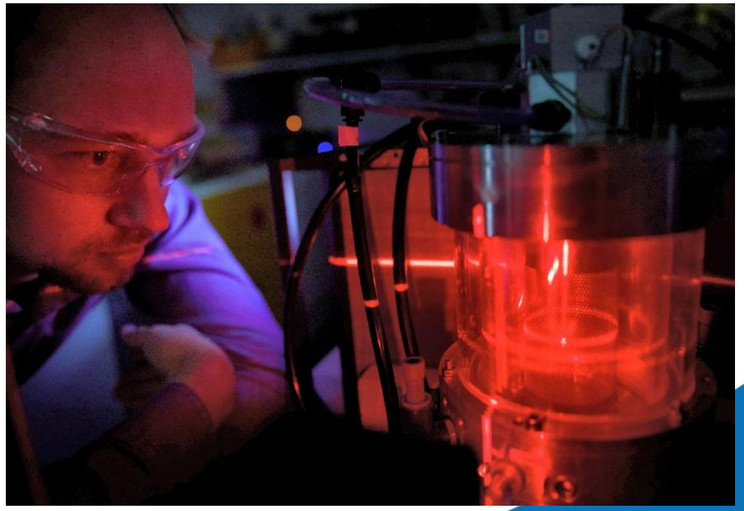
Presented by Yixin Zou

Cambustion

Cambustion Ltd, Cambridge, UK

- Founded in 1987 by a research group from the Cambridge University.
- We develop and support instruments for many gas and particle applications (including indoor air quality, climate science, metrology and nanoparticle characterisation).
- We also offer consultancy services on aerosol and filtration measurements.





Aerosol instruments for gas-particle filtration R&D and filter media testing

Aerodynamic Aerosol Classifier (AAC)

Established technique for selecting monodisperse particles by aerodynamic diameter

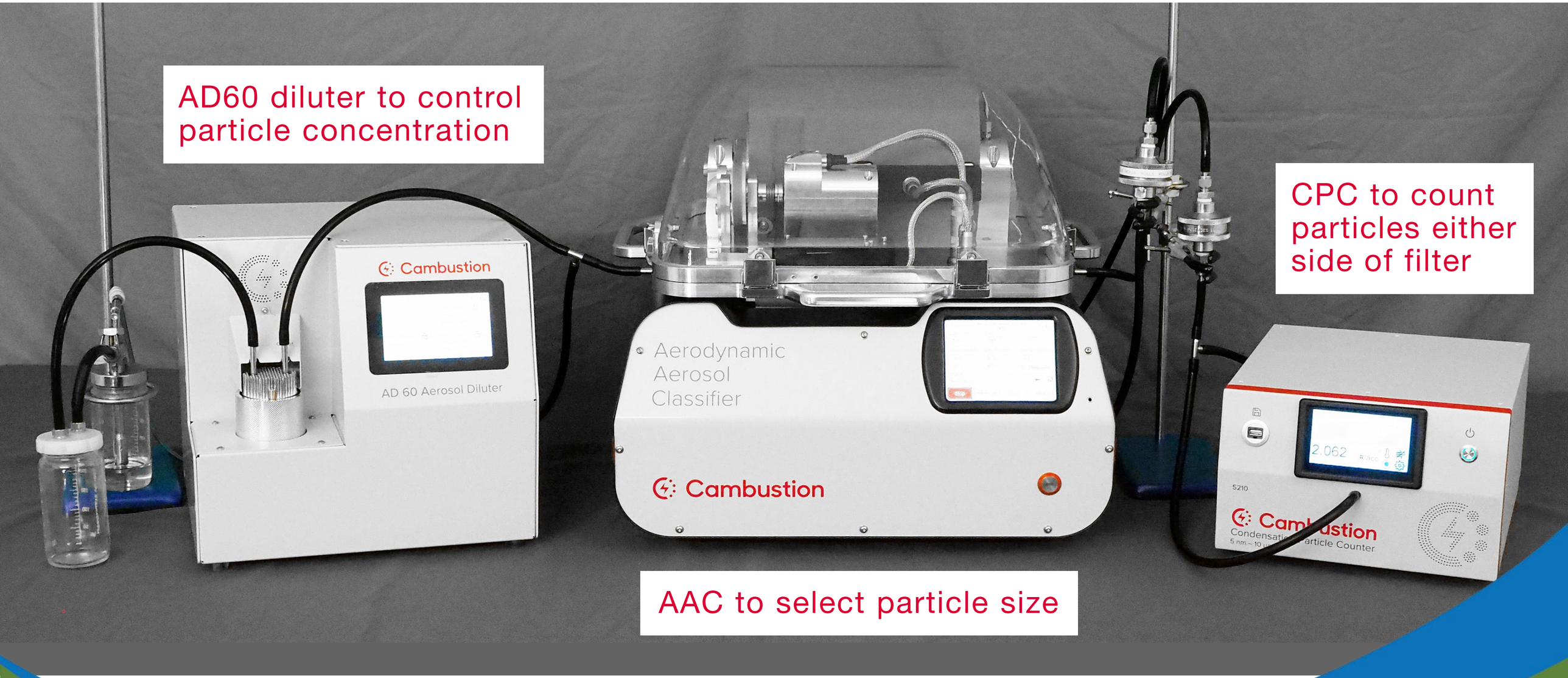
NEW Condensation Particle Counter (CPC) 5210

Fast-response detection of aerosol particles from 5 nm to 10 micrometers.

NEW Aerosol Diluter AD60

Flexible diluter offering a wide range of dilution factors.

Complete benchtop setup for testing filter media samples



The old technique for classifying particles

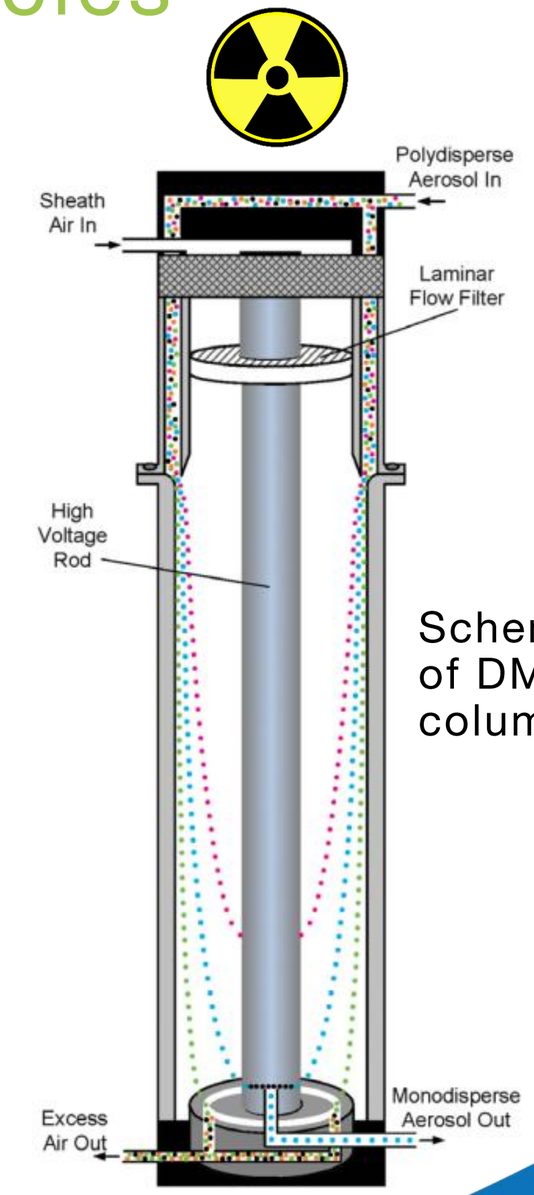
Most common aerosol classifier is the **Differential Mobility Analyser (DMA)**

- Used since the 1970s, and specified in international standards for filter testing (e.g. ISO 29463)
- Particles must be charged by a radioactive (or X-ray) neutraliser before entering the column, where they move across a sheath flow in an electric field

The DMA is intended to transmit singly-charged particles:

- This significantly limits transmission efficiency
- Larger, multiply-charged particles with the same electrical mobility may also pass

Particles are not truly monodisperse, which may affect accuracy of filter penetration measurements…



Schematic of DMA column

A better technique for classifying particles

Aerodynamic Aerosol Classifier

Commercially available since 2016

Select particles by size *without* a charge conditioner

Wide size range: 25 nm to >5 µm aerodynamic diameter

Advantages for filtration studies:

- **Aerosol flow is *truly* monodisperse, not dependent on the particle charge state**
- High transmission efficiency reduces uncertainty in filter penetration measurements
- Aerodynamic diameter is the most relevant particle metric when studying aerosol flow through filter media and deposition of particles in respiratory system

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5210 CPC

New!

Condensation Particle Counter

Nanoparticle concentration measurement
from **5** nanometers **to 10** microns

- **Wide detection range:**
  d50,min 5 nm
  d50,max > 10 µm
  up to 10^5 /cc
- **Fast time response:**
  T10-90% ~ 40 ms
  up to 50Hz data rate
- Automatic conversion of temperature and pressure conditions
- Touchscreen, web, ethernet, RS232, USB, analogue interfaces
- **Wickless mixing design** for low maintenance, calibration stability and portability

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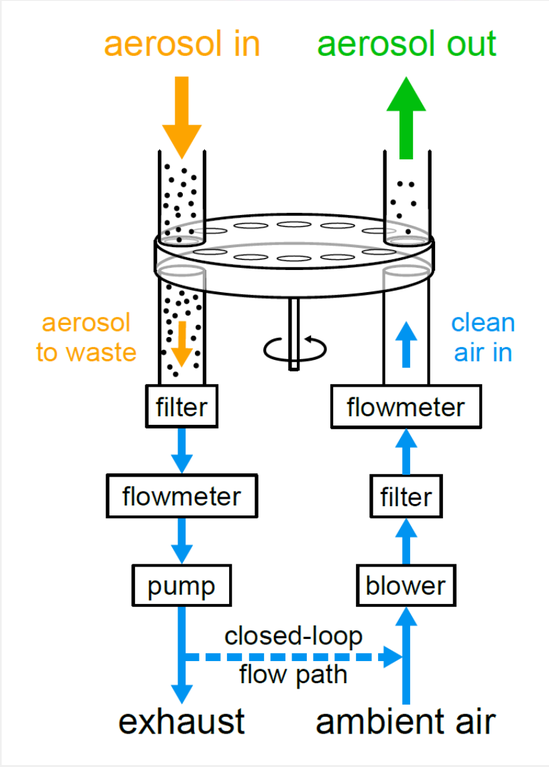
Aerosol Diluter AD60

New!

- Controllable dilution over more than two orders of magnitude
- Feedback control and monitoring for accuracy and stability with logging.
- Compatible with solid and/or liquid aerosols



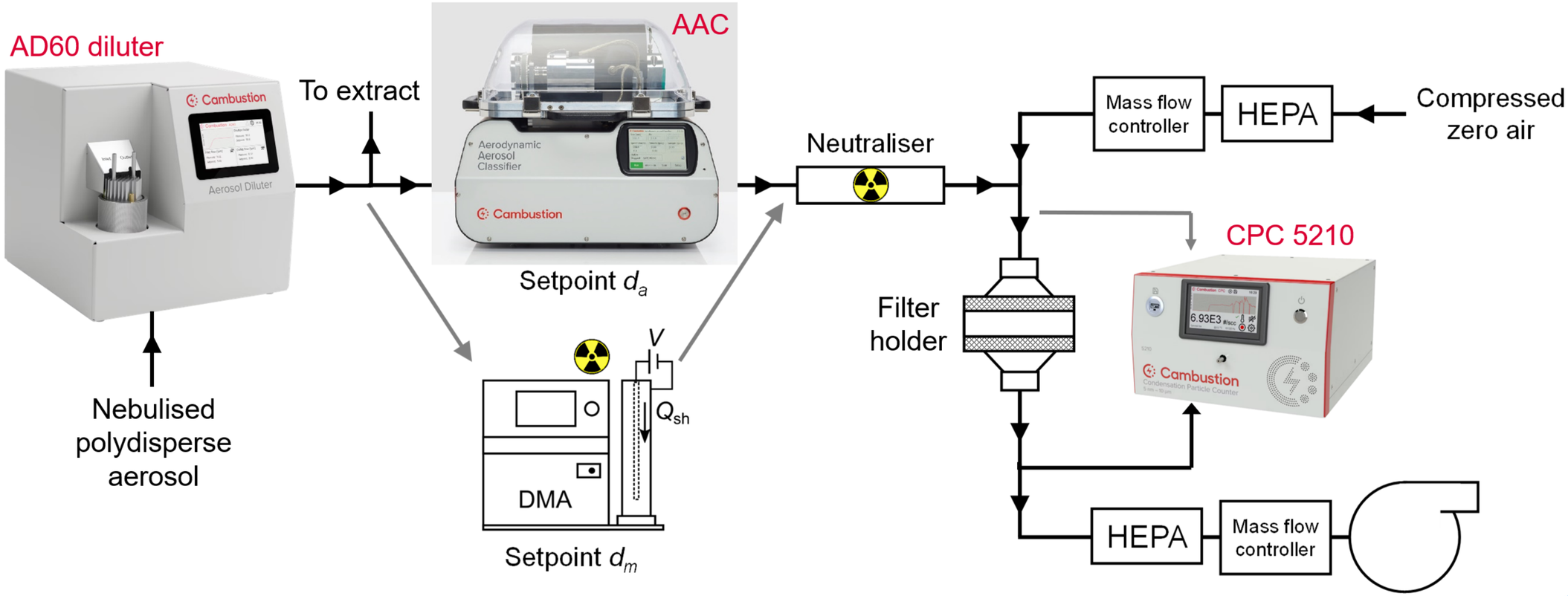
Aerosol Rotating Disc Diluter

Variable diluter for general-purpose lab applications

FILTCON25 | THE GALT HOUSE HOTEL | LOUISVILLE, KY

Filter penetration measurements using two different classifiers

- Samples from **face masks** and **air filter media** sealed in filter holder
- Both AAC and DMA operated at 10:1 sheath:sample flow ratio (aerodynamic diameter setpoints converted to electrical mobility equivalent for DMA)

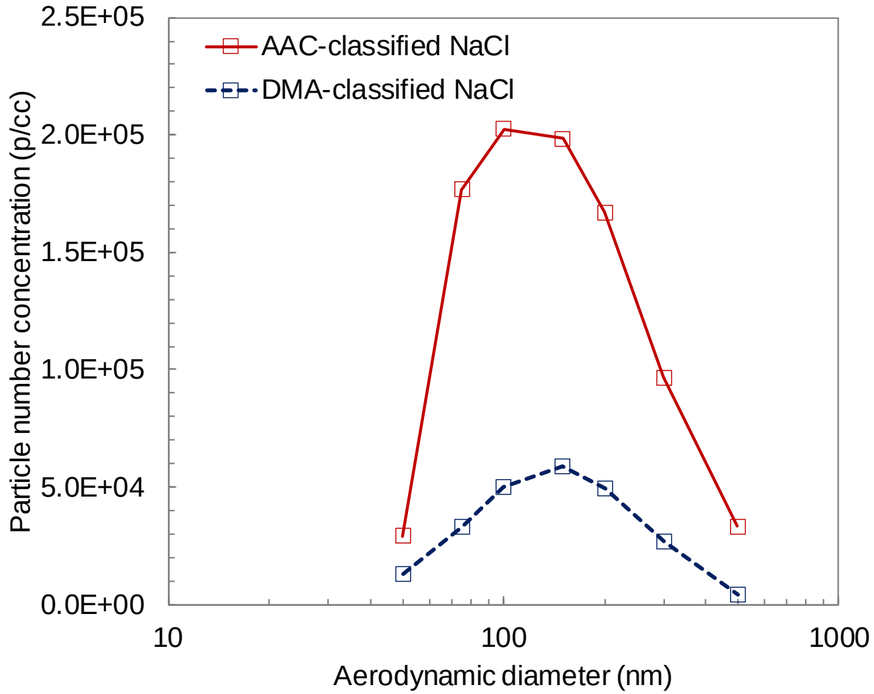


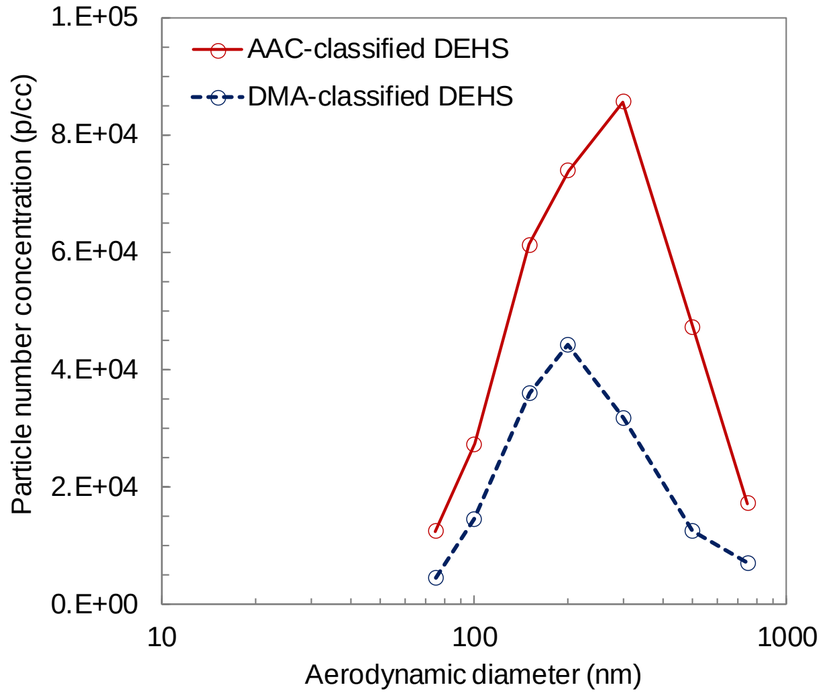
Payne et al., "A New Methodology for Measuring Filtration Efficiency as a Function of Aerodynamic Diameter Using a Monodisperse Aerosol Source", FILTECH 2018

Classifier transmission efficiency: AAC v DMA

- Two test aerosols from international standards:
  - **NaCl** (sodium chloride, solid particles) for face masks
  - **DEHS** (dioctyl sebacate, oil particles) for air filters
- AAC transmission efficiency is 1.5 to 5.5 times higher than the DMA across particle sizes tested from both aerosols:

DMA



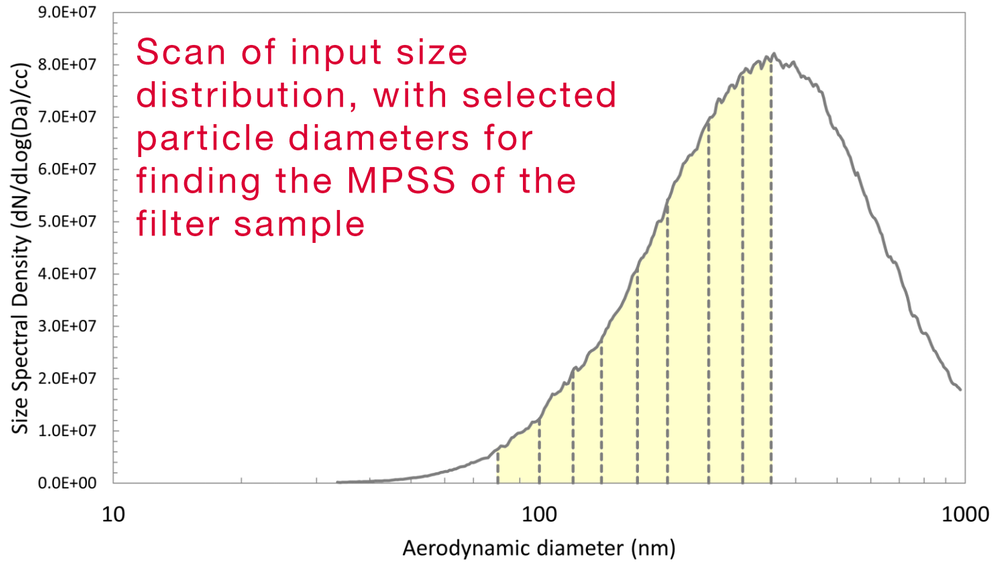


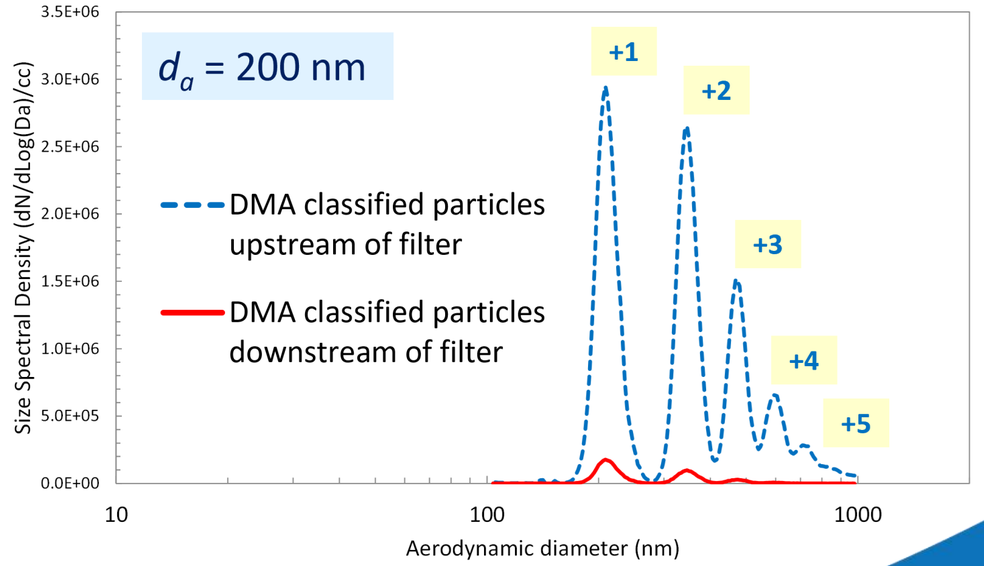
AAC

Multiple charging worst case scenario

What happens if particles are selected from the left side of the distribution from the aerosol generator?

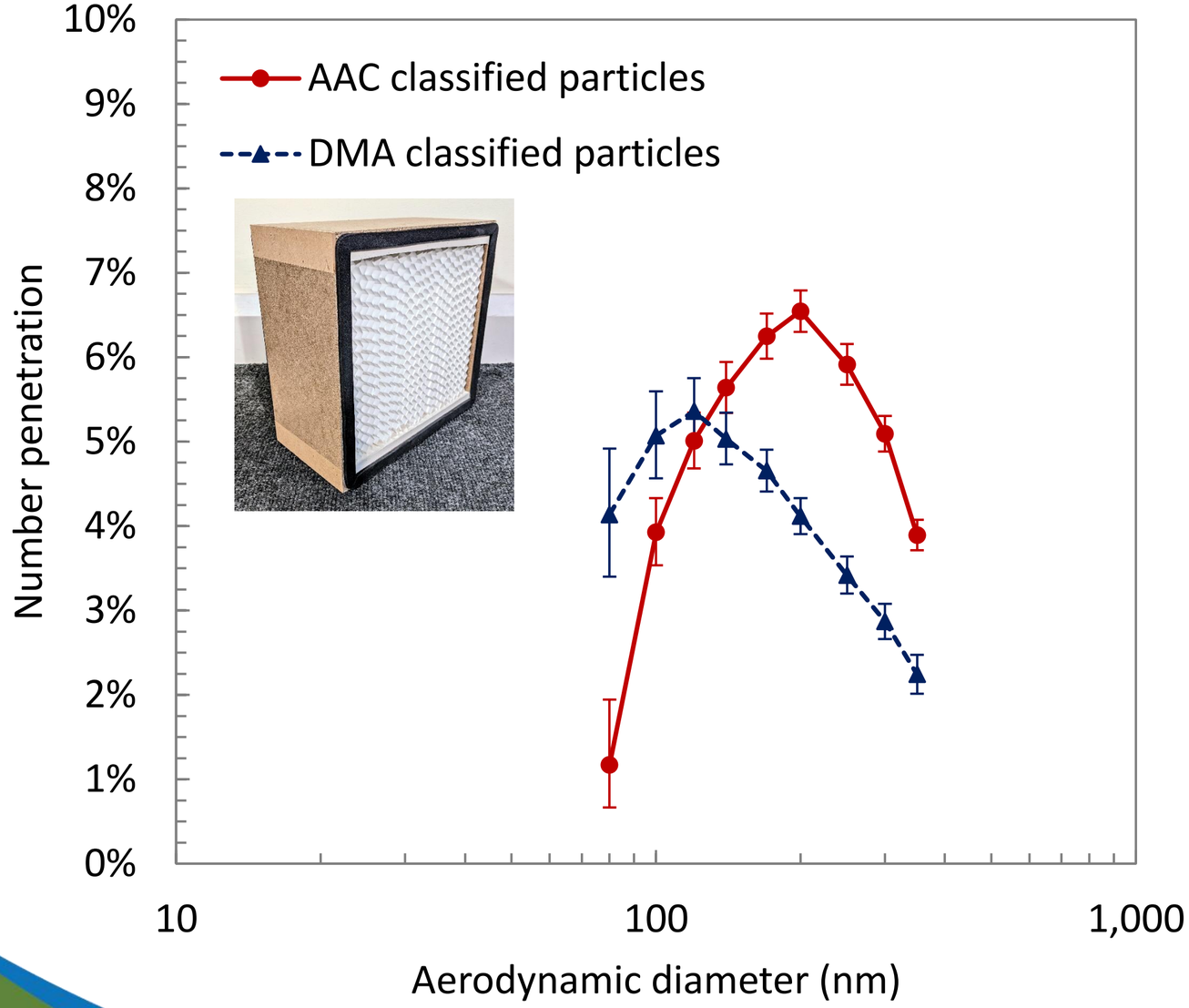
- DMA: Particles of different sizes emerge because a significant amount of larger, multiply charged ones are selected
- AAC: Concern is eliminated and **only one particle size emerges**





Air filter penetration results: AAC v DMA

Here are the consequences for filtration results:



- AAC reveals artefacts in MPPS measured with DMA.
- Although, artefacts can be eliminated if:
  - Impactor is fitted on the DMA inlet to remove some larger particles
  - Only particle sizes on the right side of the distribution are selected, requiring multiple aerosol generators
- **None of these measures are necessary if using an AAC instead**

Why is this effect of concern?

Beyond the regulations:

- The measurement of MPPS can depend on the challenge aerosol size distribution
  - Data taken with different aerosol sources may indicate apparently inconsistent filter performance

- May lead to misleading outcomes when using data derived from DMA testing to:
  - Predict real world performance
  - Guide selection/design criteria for applications

- **The Aerodynamic Aerosol Classifier offers an alternative**
  - **Without the artefacts**
  - **Without particle charging**

Summary

Cambustion AAC

- Can select truly monodisperse particles for testing.
- No potential charging artefacts that occur with the DMA
- Higher transmission efficiency
- Enables correct measurement of the filter MPPS.

5210 CPC

- Precisely measures number concentrations of particles from 5 nm to 10 micrometers.
- Optimized for fast response, ease of use, calibration stability and portability.

AD60 Diluter

- Achieves over two orders of magnitude of dilution
- Offers maximum flexibility and stability in test particle concentration

AFS FILTCON25

Cambustion

Thank You!

Come find us at our exhibition booth for more detailed information.