

Online Characterization of Ultrafine Aerosol Particles

Challenges and Future Trends

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28 June 2019

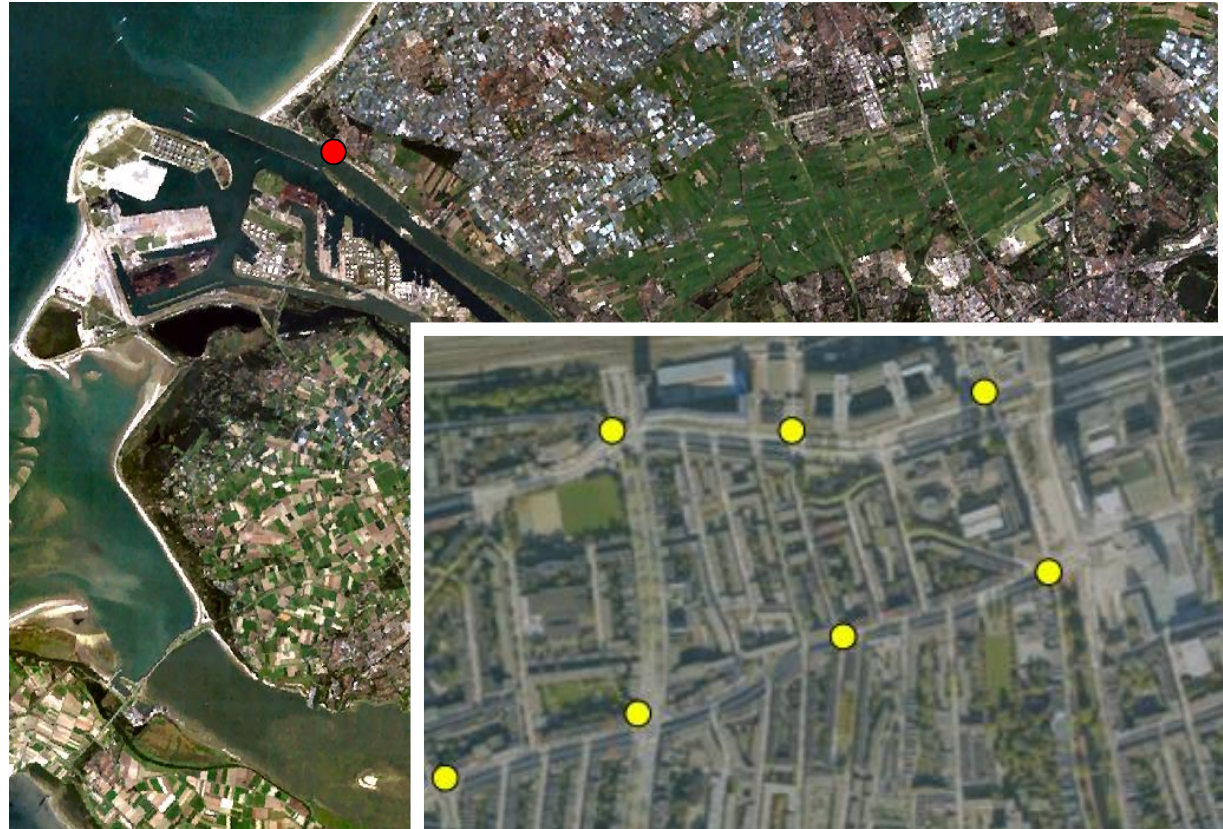


Brief History ...



Lower
Cost
Size &
Weight

Motivation 1: Instruments for Monitoring



Motivation 2: Compact Mobile Platforms

Present



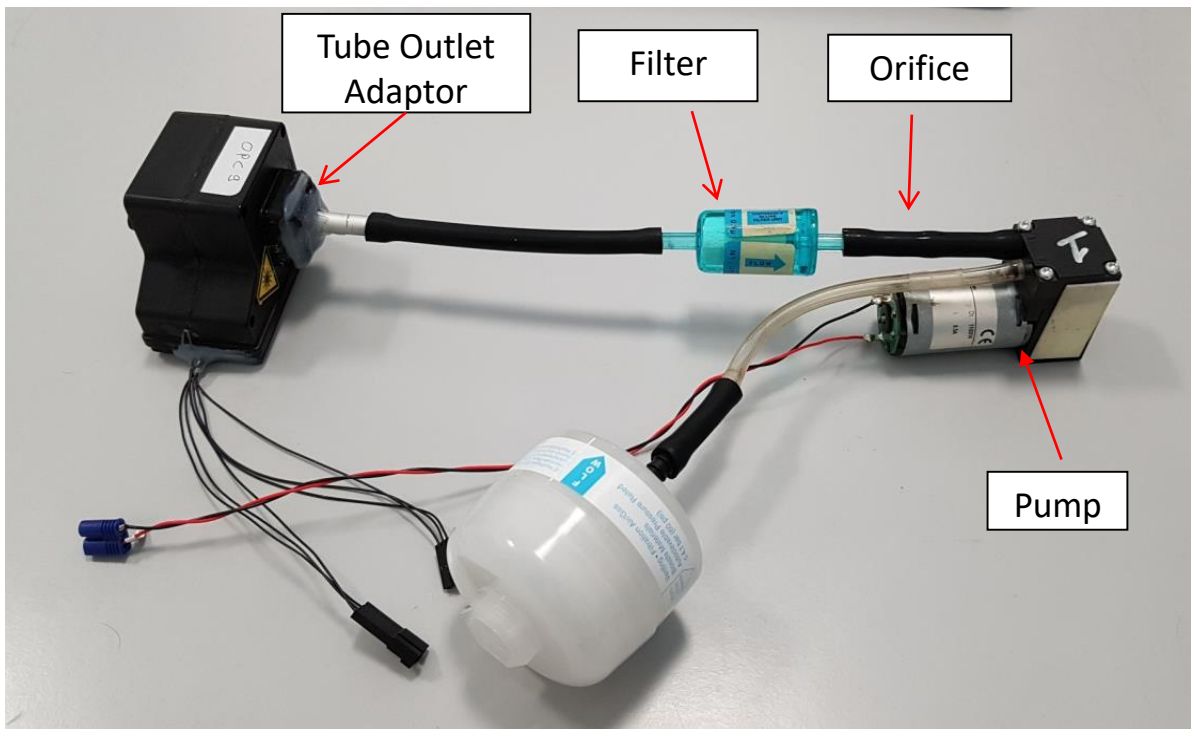
Future



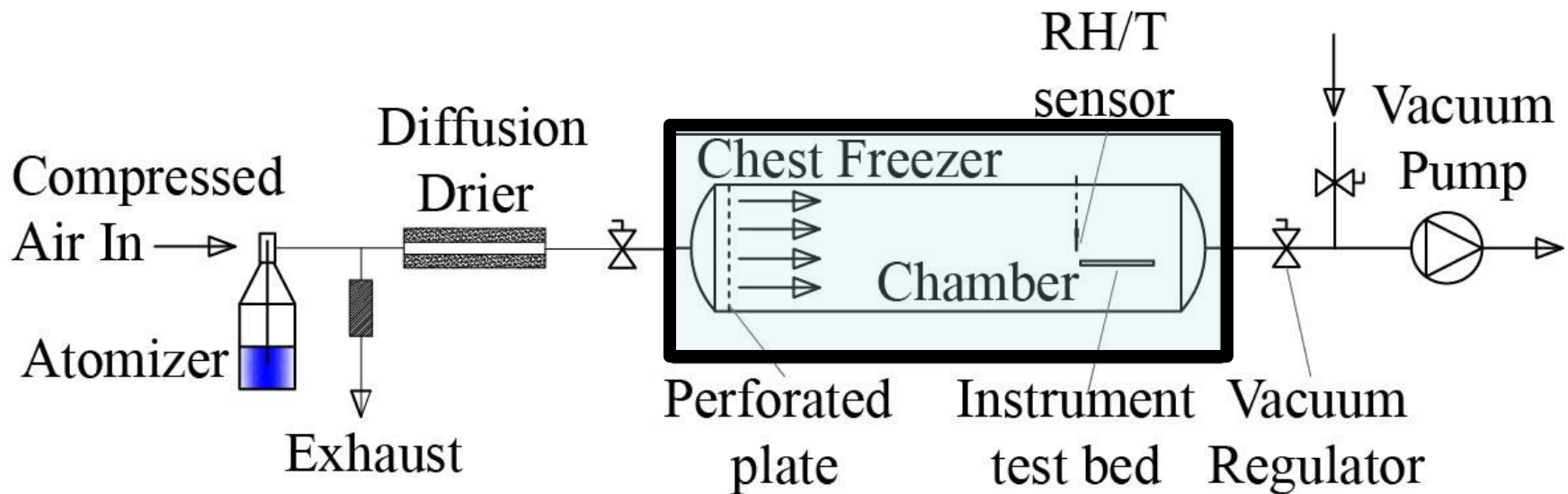
Low-cost Optical Particle Counter/Spectrometer



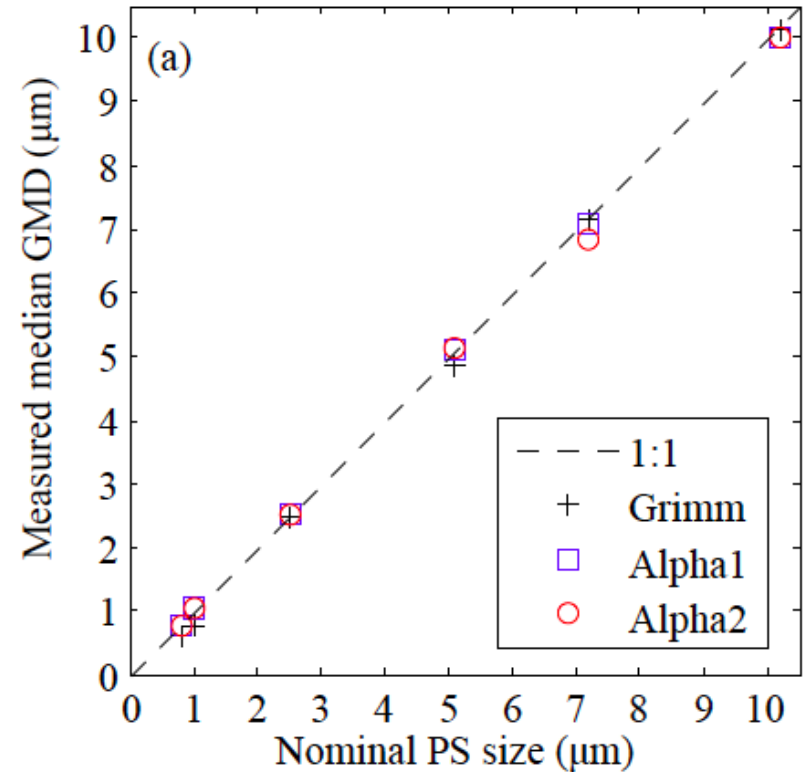
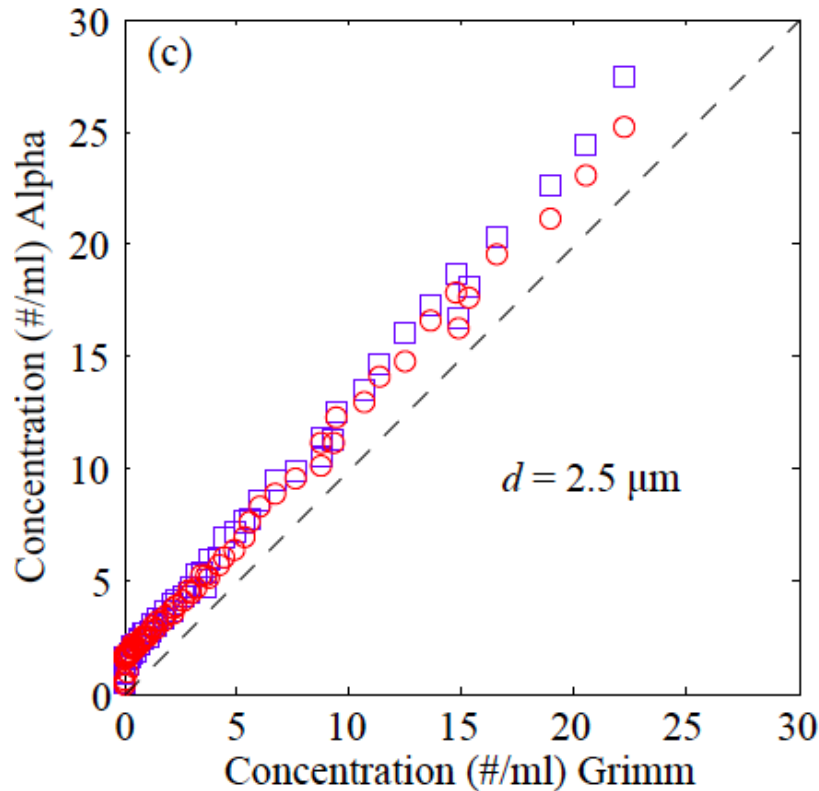
Modification



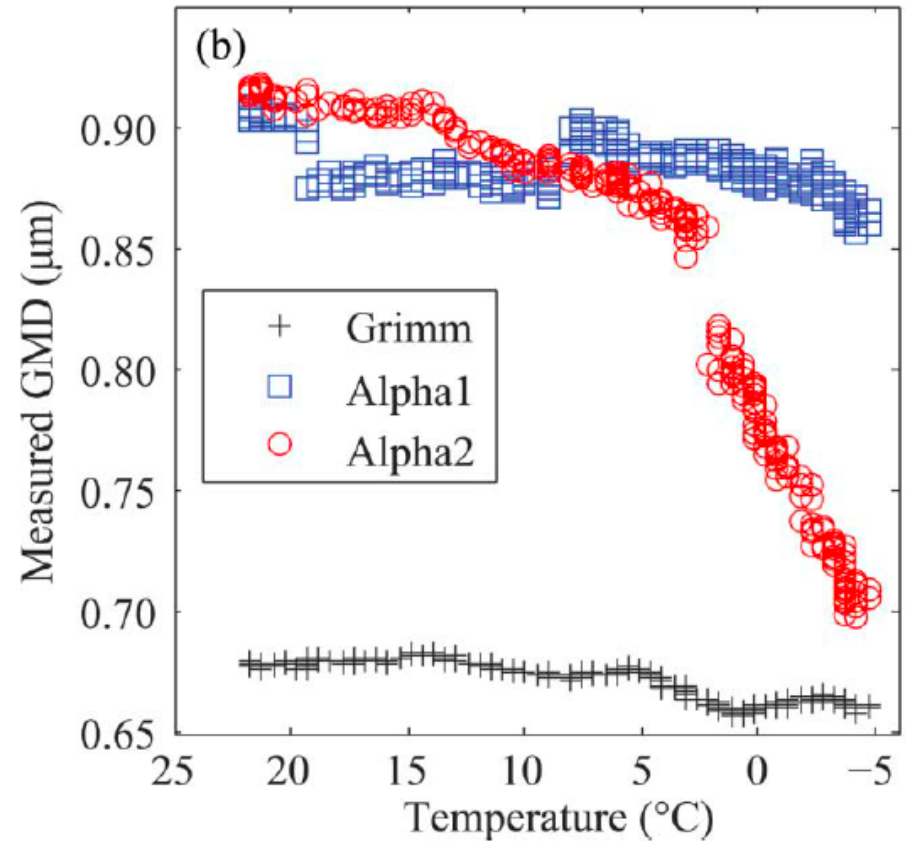
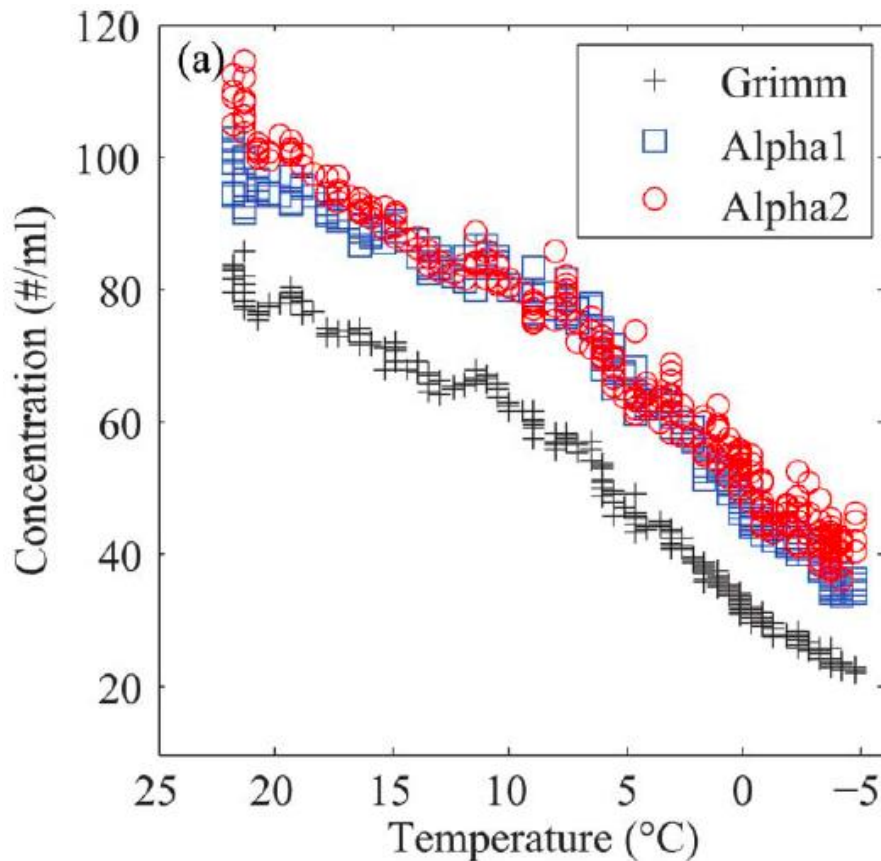
Instrument Performance at Low T/P Conditions



Counting and Sizing @ Atmospheric Conditions



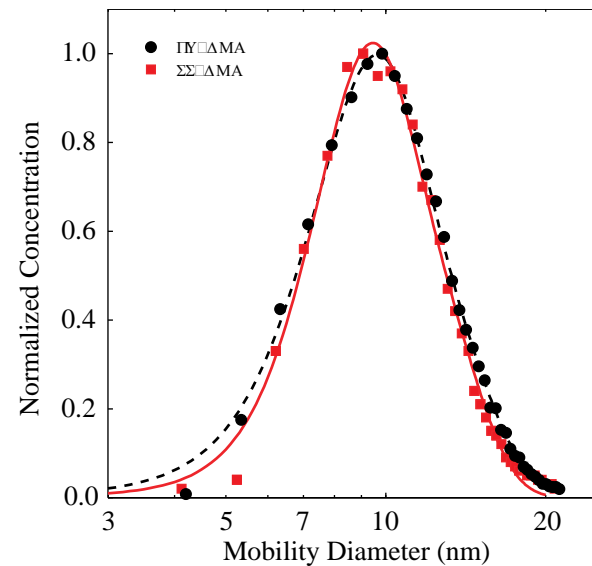
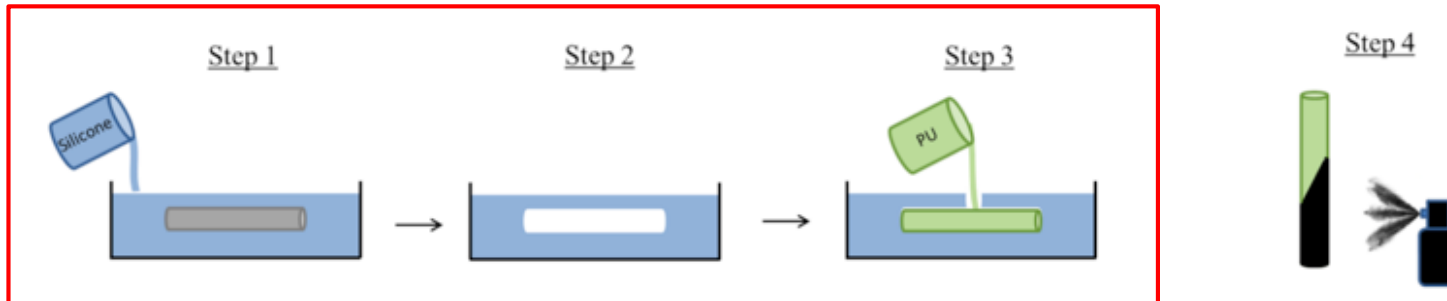
Counting and Sizing @ Low-Temperature Conditions



Lightweight differential mobility analyzers: Toward new and inexpensive manufacturing methods

K. Barmounis^a, A. Maisser^a, A. Schmidt-Ott^a, and G. Biskos^{a,b,c}

DMAs made of plastic!

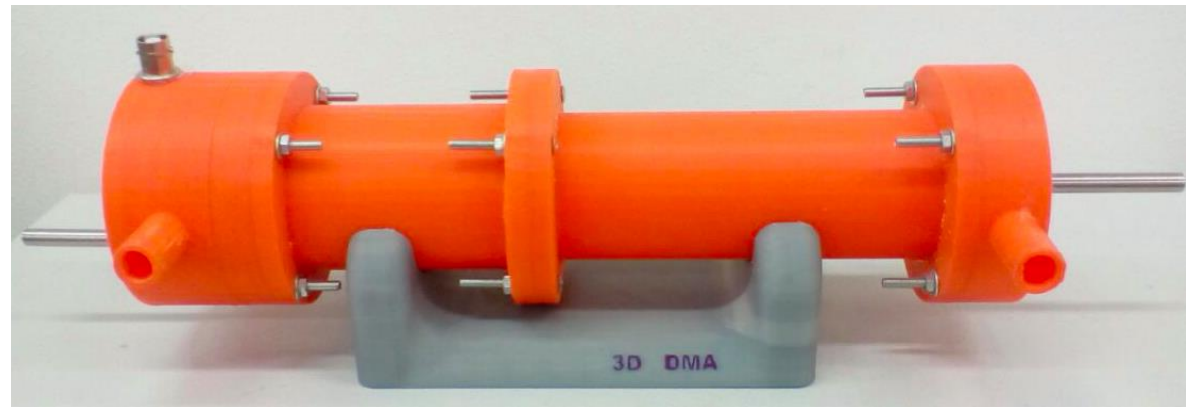


3D-printed Instruments

Lightweight & Inexpensive



**Konstantinos
Barmounis**

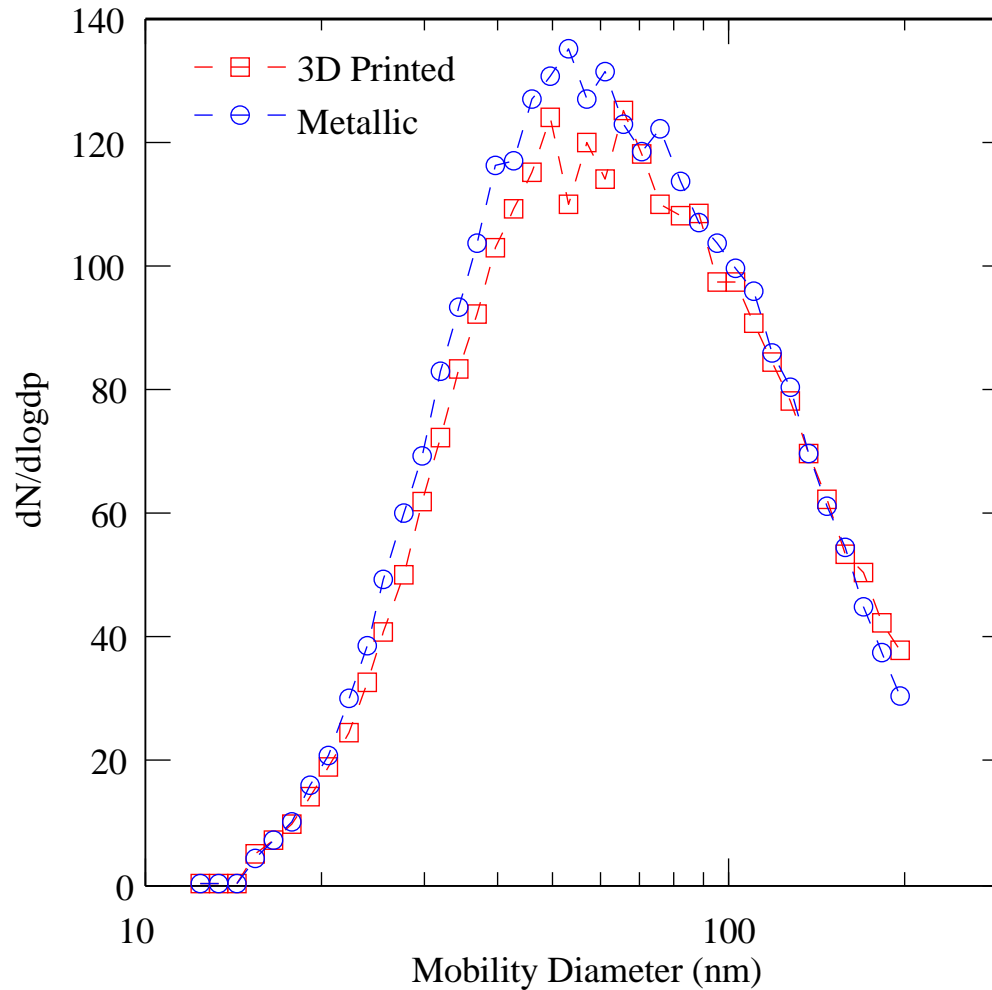


Cost: 50 €; Weight: 0.3 kg

Performance of the 3D-Printed DMA



Konstantinos
Barmponis



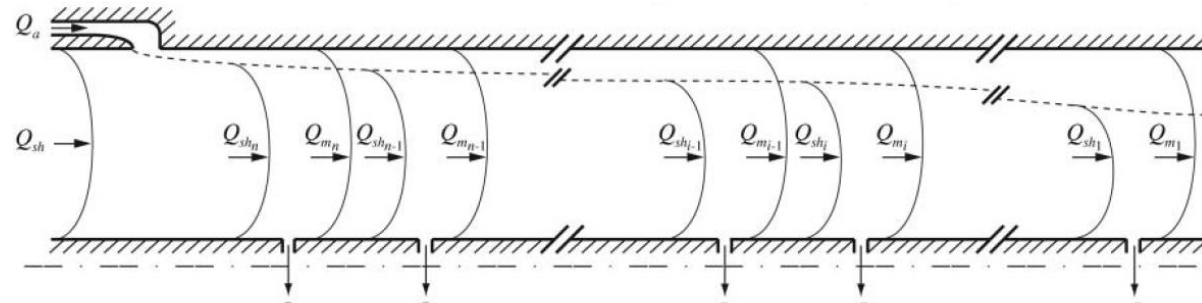


Mult.-Mon.- -Out. DMA

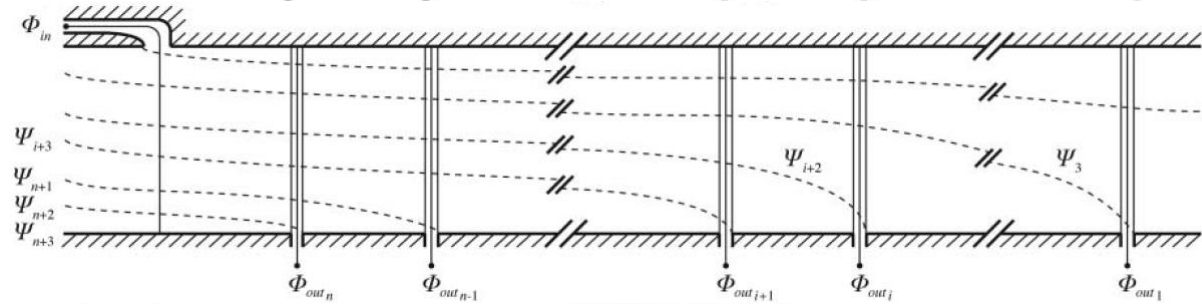
The Multiple Monodisperse Outlet Differential Mobility Analyzer: Derivation of Its Transfer Function and Resolution

M. Giamarelou,¹ M. Stolzenburg,² and G. Biskos^{1,3}

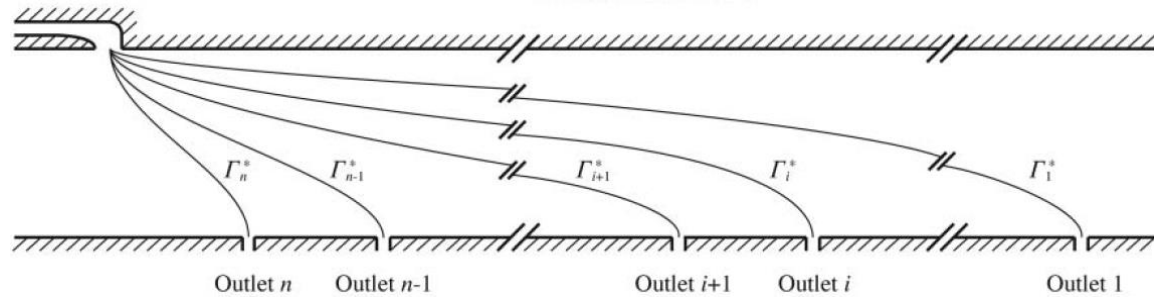
Flow Field



Electric Field



Particle Trajectories



The 3-MO DMA

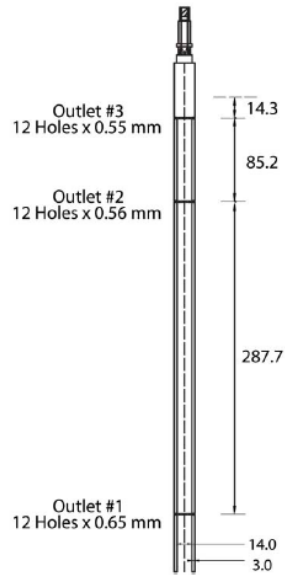
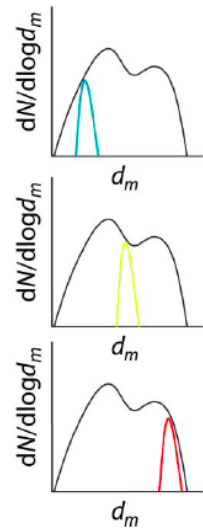
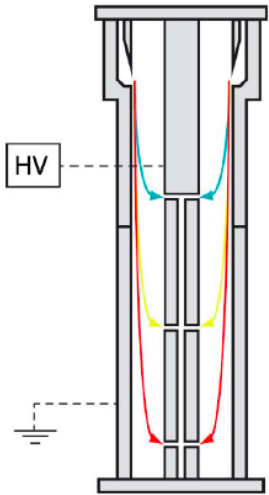
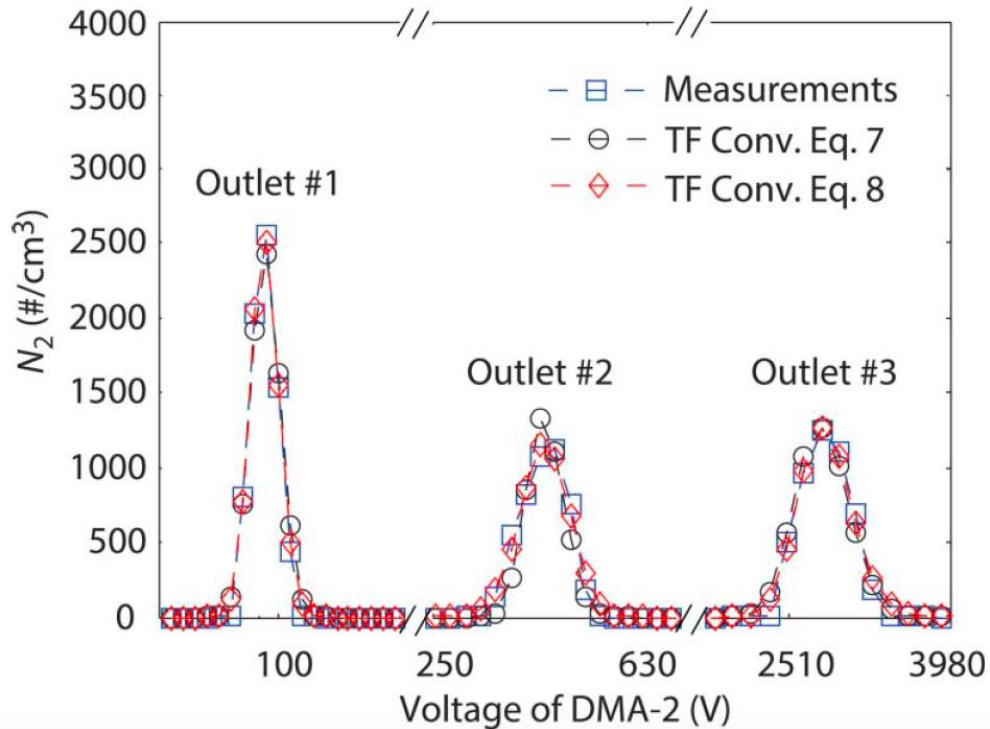
Modification of the TSI 3081 differential mobility analyzer to include three monodisperse outlets: Comparison between experimental and theoretical performance

S. Bezantakos^{a,b}, M. Giamarelou^a, L. Huang^c, J. Olfert^d, and G. Biskos^{b,c,e}

3MO-DMA

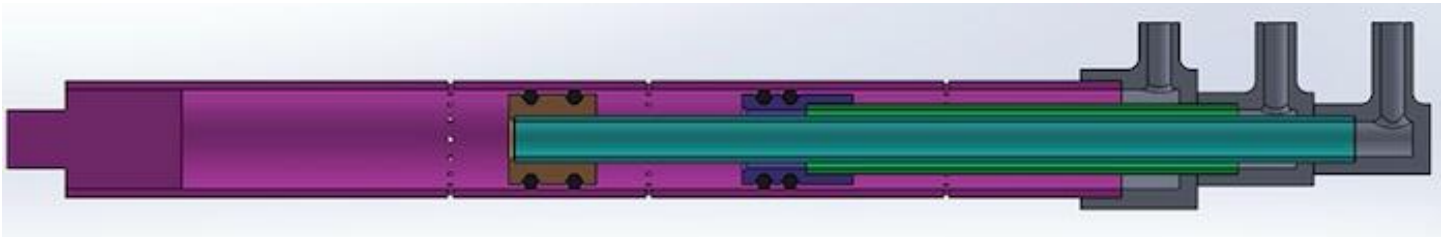
Distributions

Central Rod

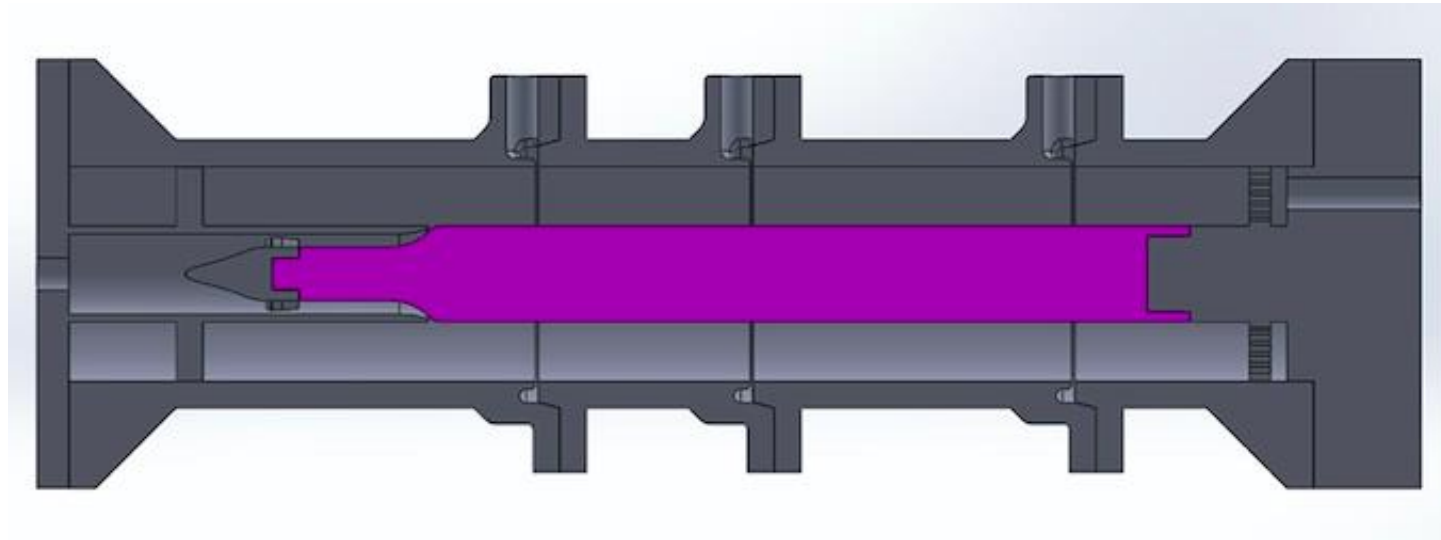


Current Manufacturing

Outside-in particle trajectories

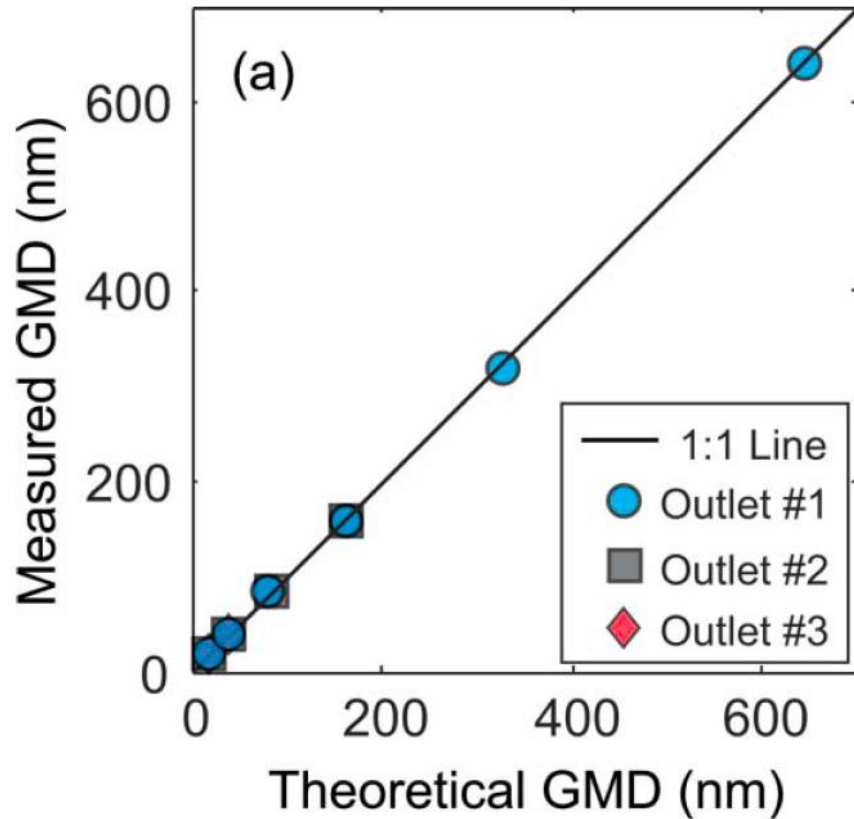


Inside-out particle trajectories

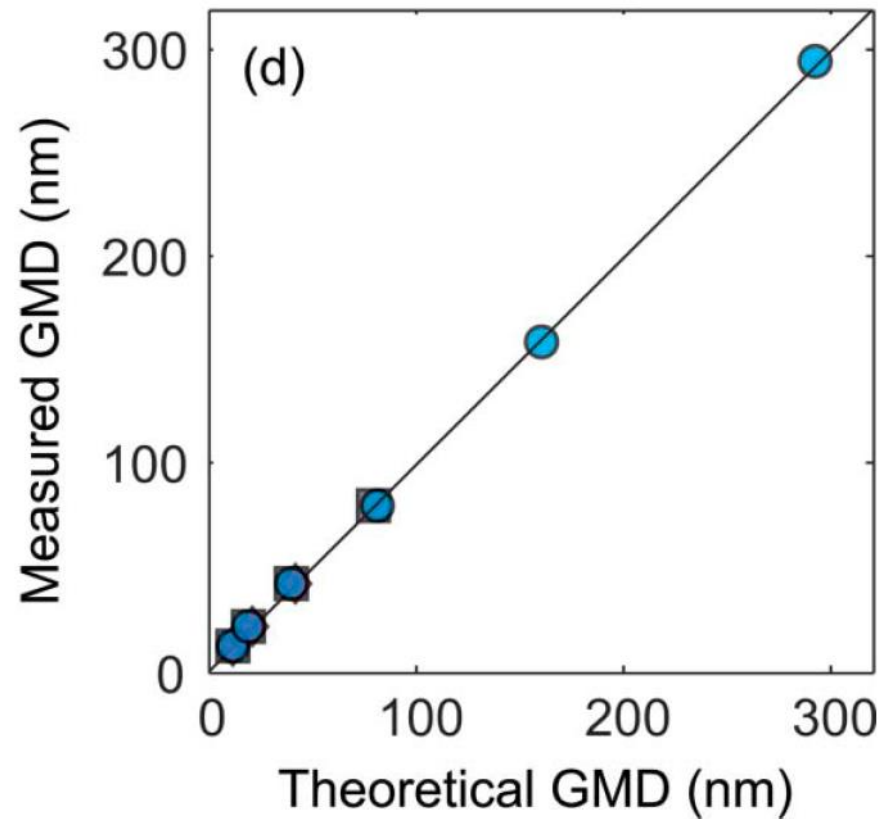


Sizing of the 3-MO DMA

$Q_a = 0.3 \text{ lpm}; Q_s = 3.0 \text{ lpm}$

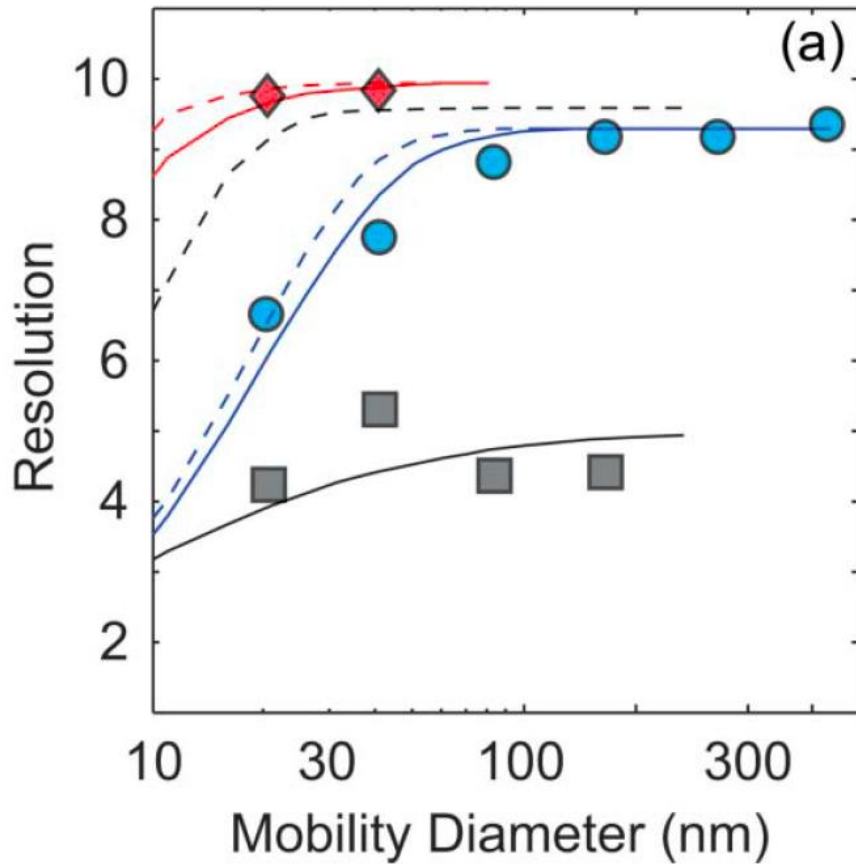


$Q_a = 1.5 \text{ lpm}; Q_s = 8.0 \text{ lpm}$

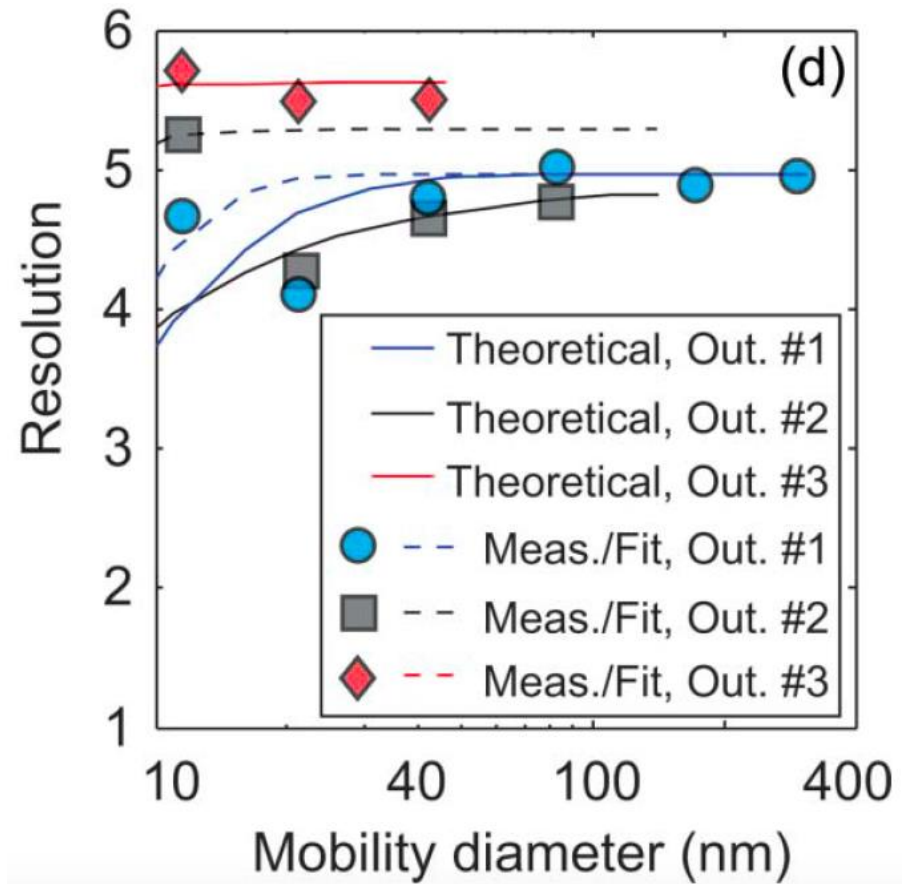


Resolution of the 3-MO DMA

$Q_a = 0.3 \text{ lpm}; Q_s = 3.0 \text{ lpm}$



$Q_a = 1.5 \text{ lpm}; Q_s = 8.0 \text{ lpm}$

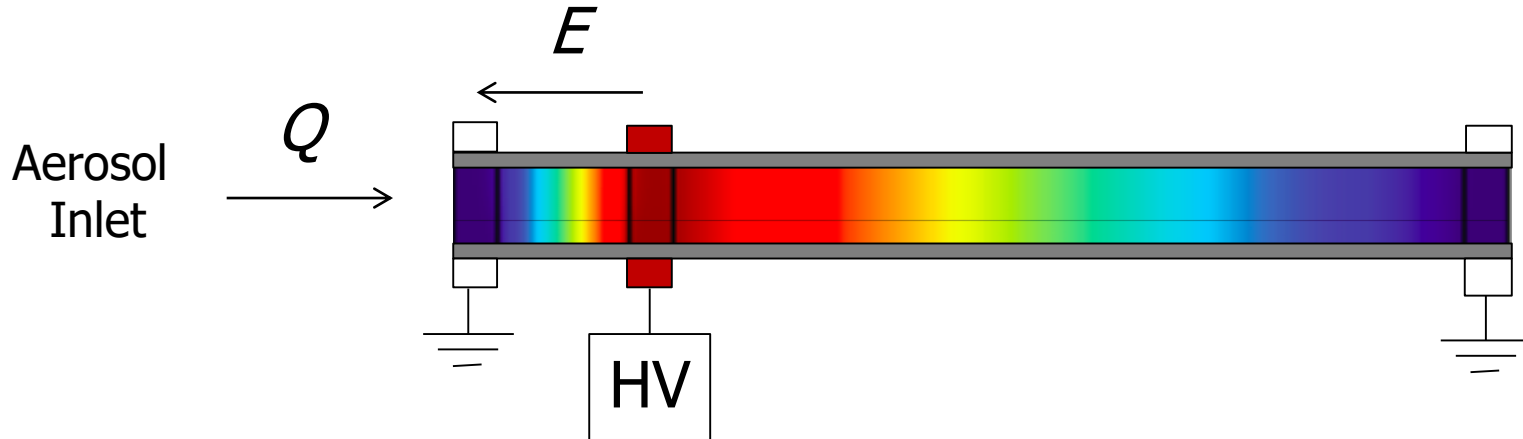


Single Tube Classifier

Aerosol Research Letter

A Cost-Effective Electrostatic Precipitator for Aerosol Nanoparticle Segregation

S. Bezantakos,^{1,2} L. Huang,³ K. Barmounis,³ M. Attoui,⁴ A. Schmidt-Ott,³ and G. Biskos^{1,3,5,6}

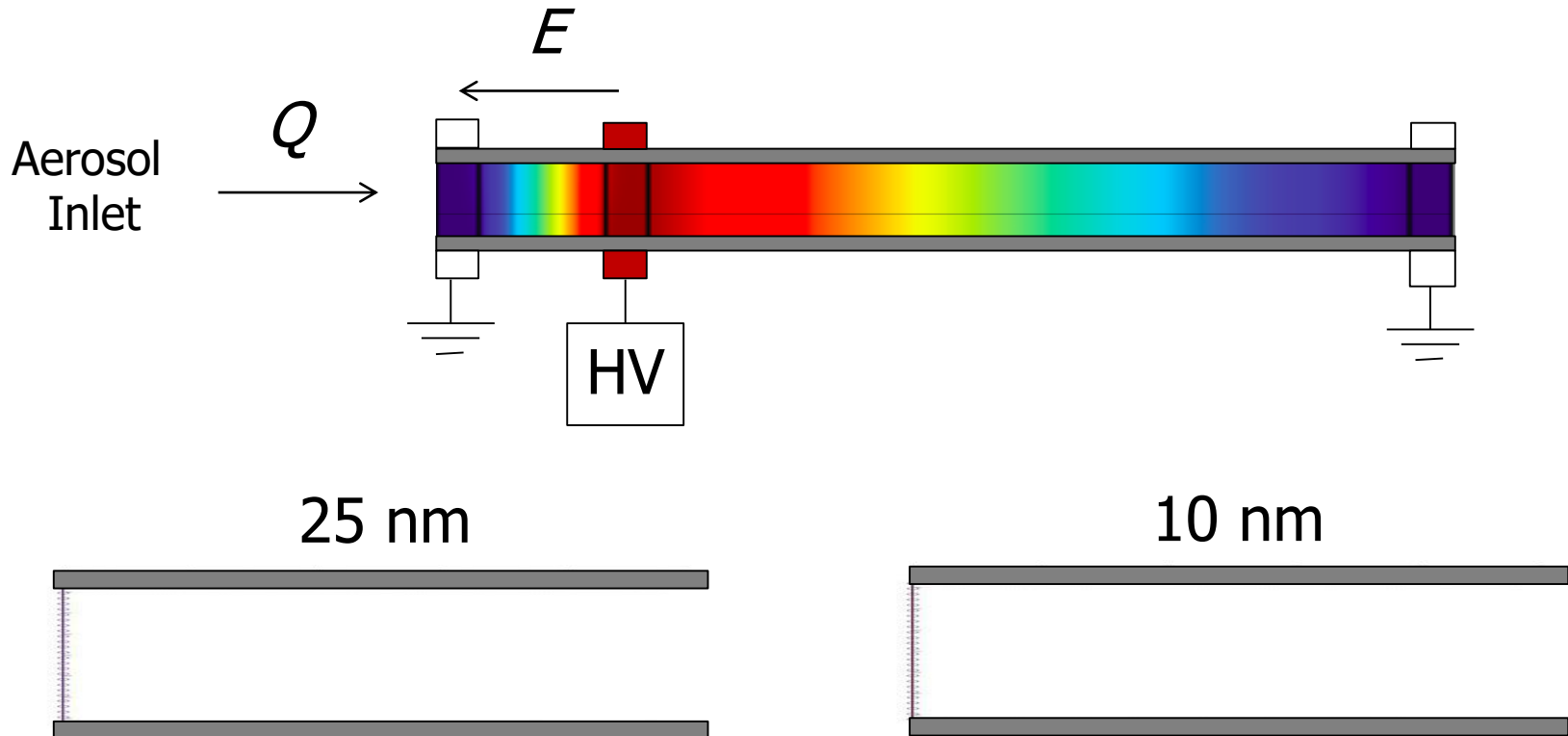


Single Tube Classifier

Aerosol Research Letter

A Cost-Effective Electrostatic Precipitator for Aerosol Nanoparticle Segregation

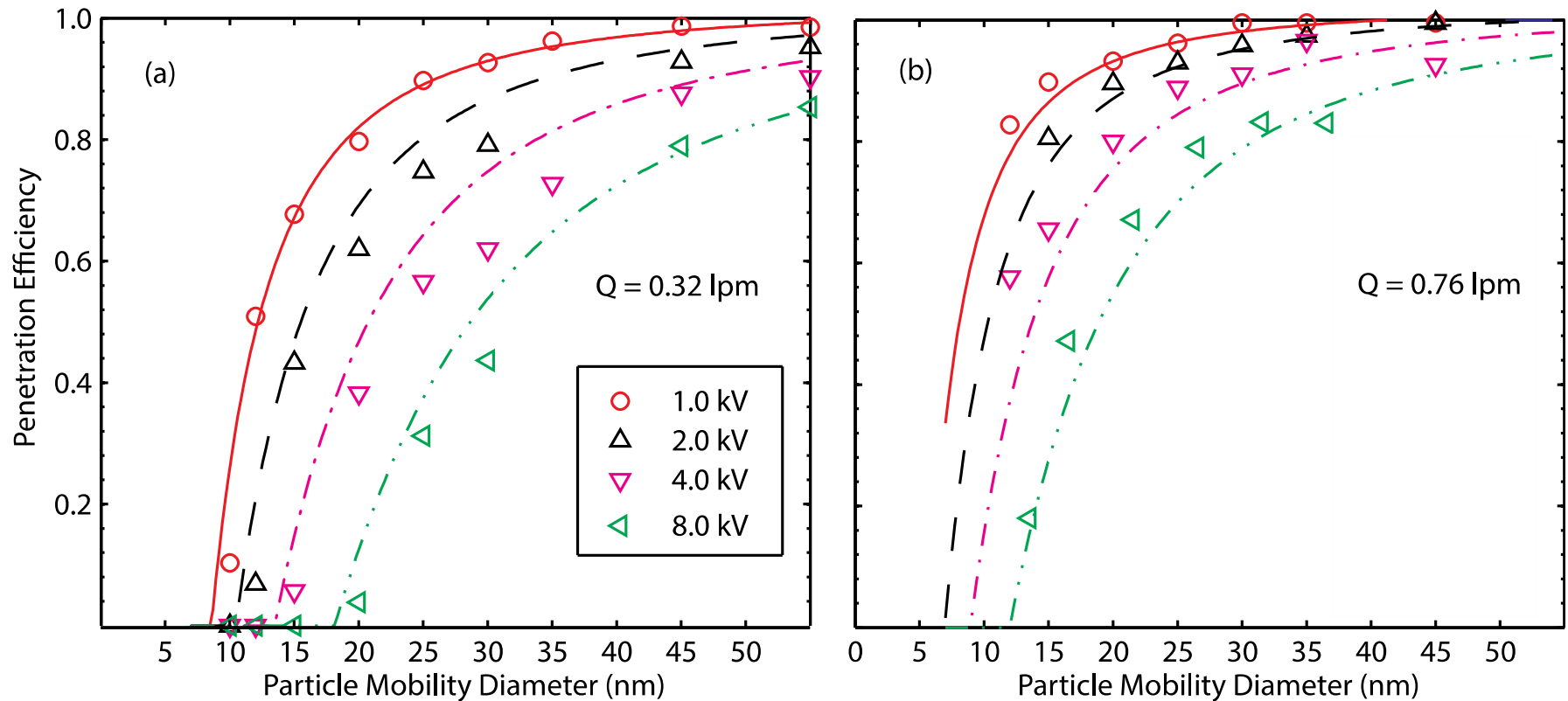
S. Bezantakos,^{1,2} L. Huang,³ K. Barmounis,³ M. Attoui,⁴ A. Schmidt-Ott,³ and G. Biskos^{1,3,5,6}



Penetration Efficiency Curves



Spyros
Bezantakos



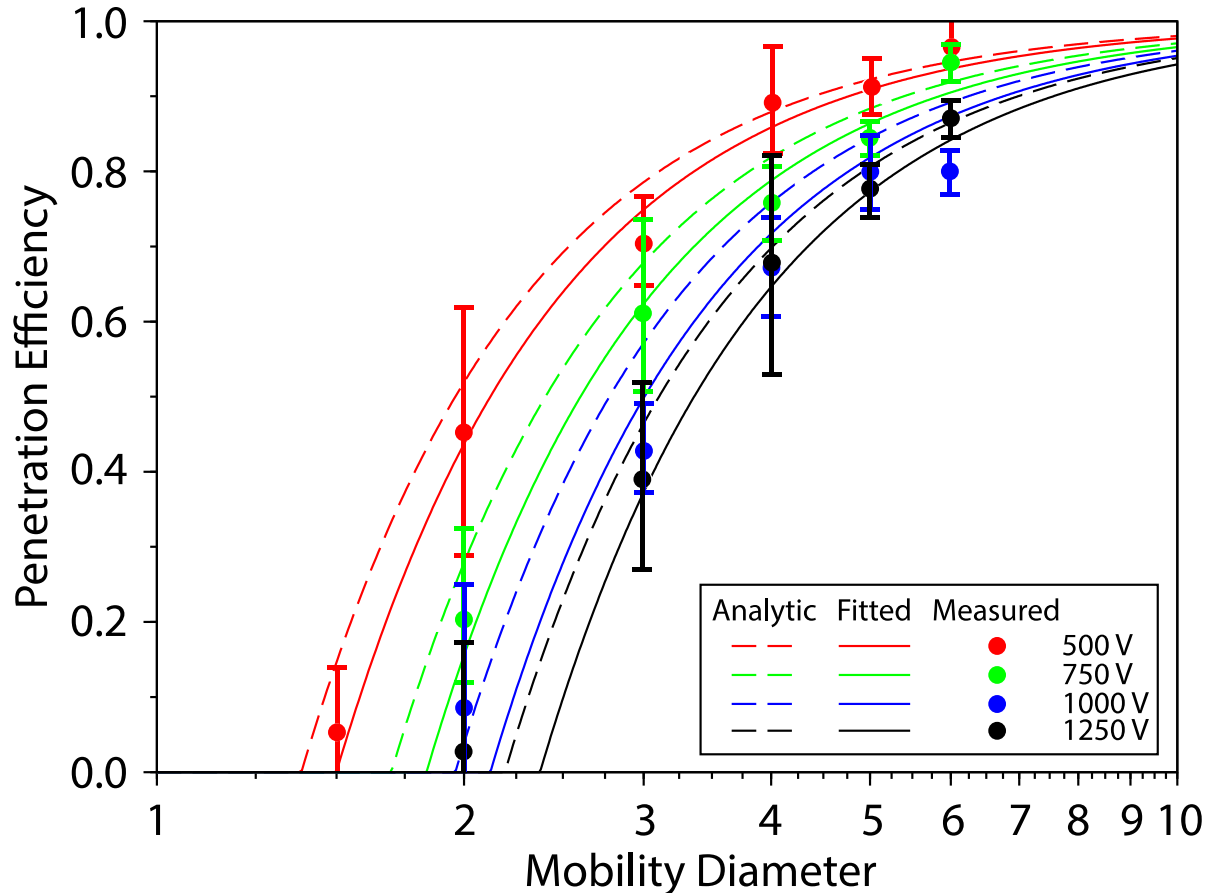
Bezantakos et al. (2015), AS&T, 49, vi-iv

Performance with sub-10-nm particles

OPEN A tunable high-pass filter for simple and inexpensive size-segregation of sub-10-nm nanoparticles

Received: 14 December 2016
Accepted: 28 February 2017

N. C. Surawski^{1,†}, S. Bezantakos¹, K. Barmounis^{1,2}, M. C. Dallaston³, A. Schmidt-Ott^{1,2} & G. Biskos¹

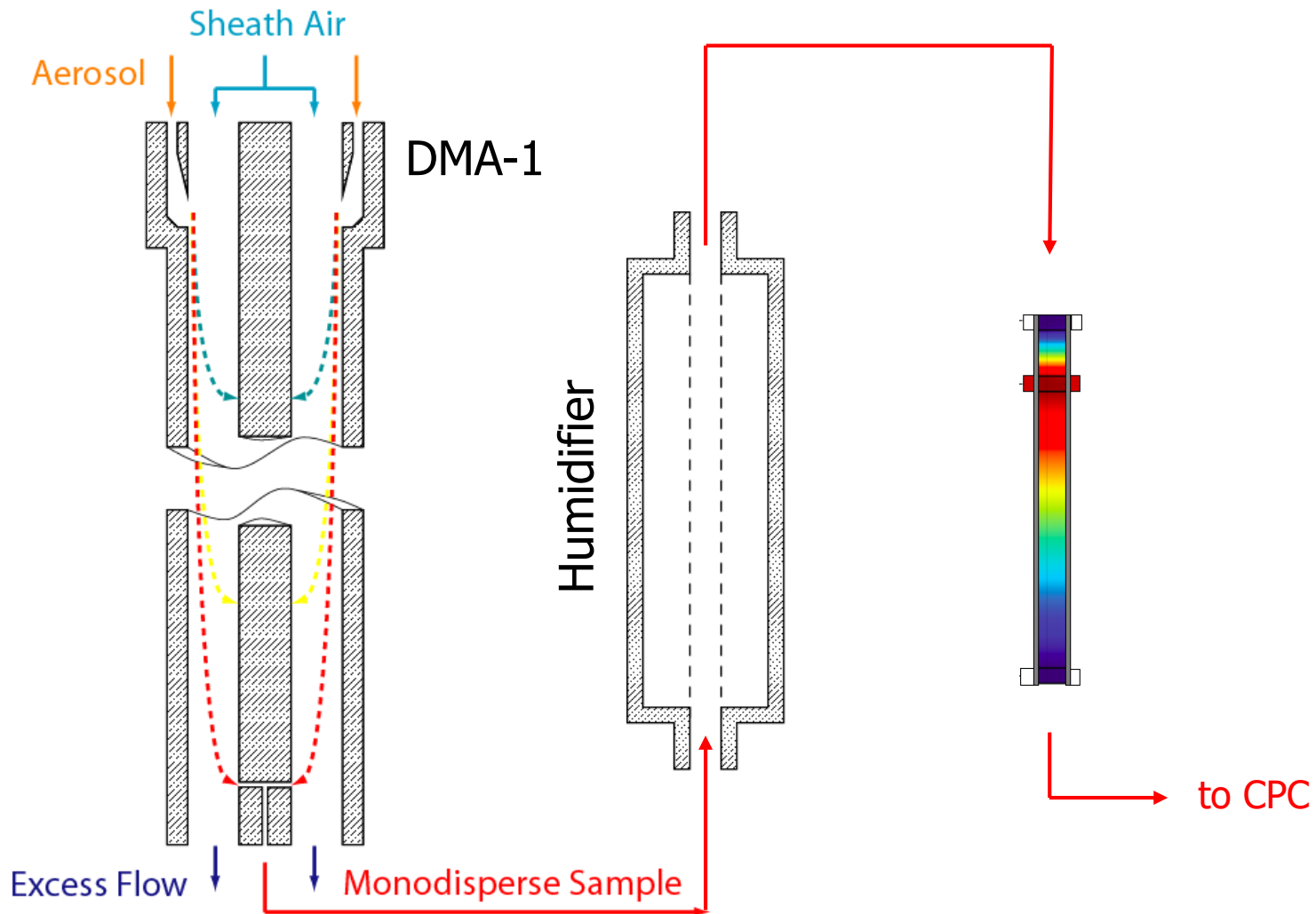


- Nucleation Studies
- Nanotechnology

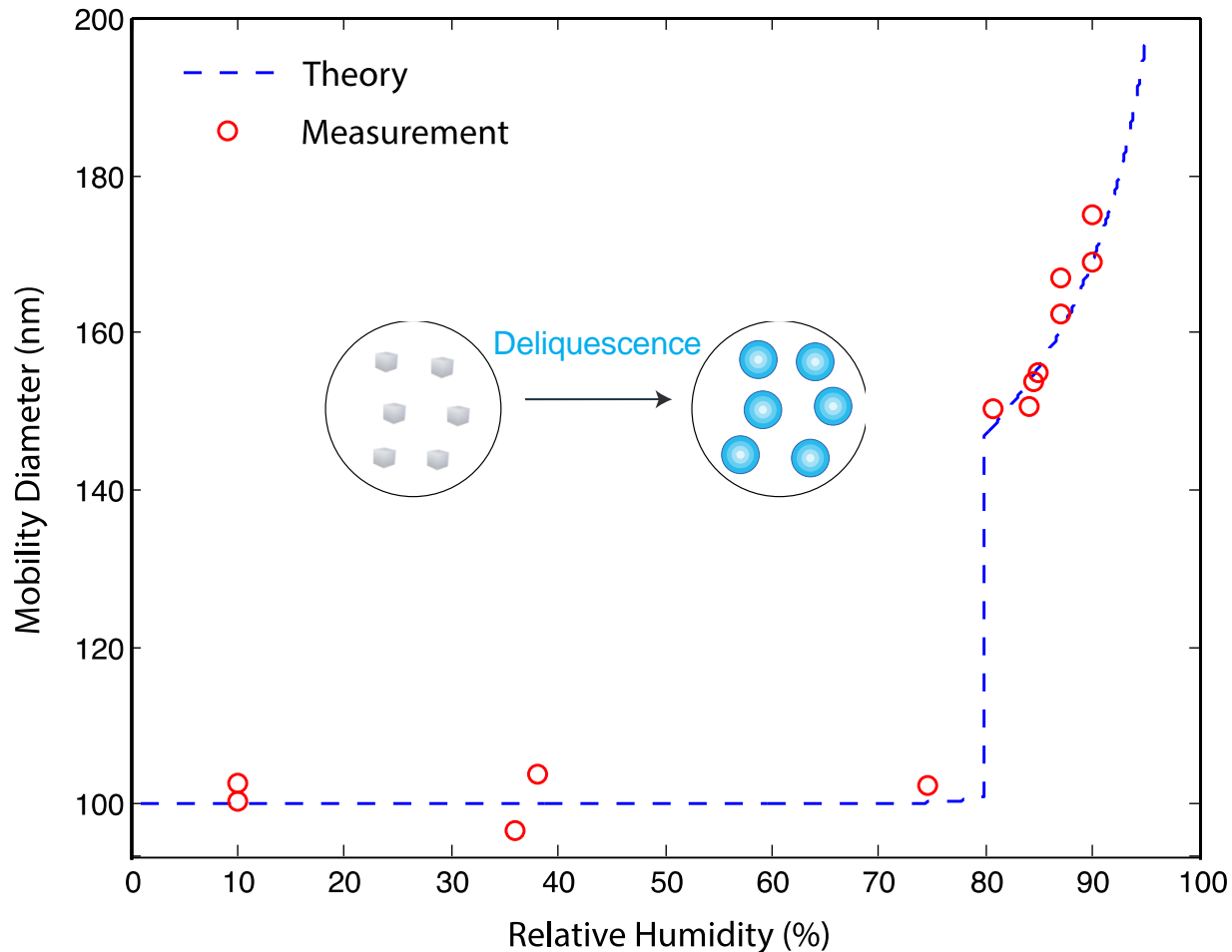
Simplified tandem DMA



Spyros
Bezantakos



Particle Hygroscopicity Measurements using the tandem 3Dp-DMA-precipitator setup

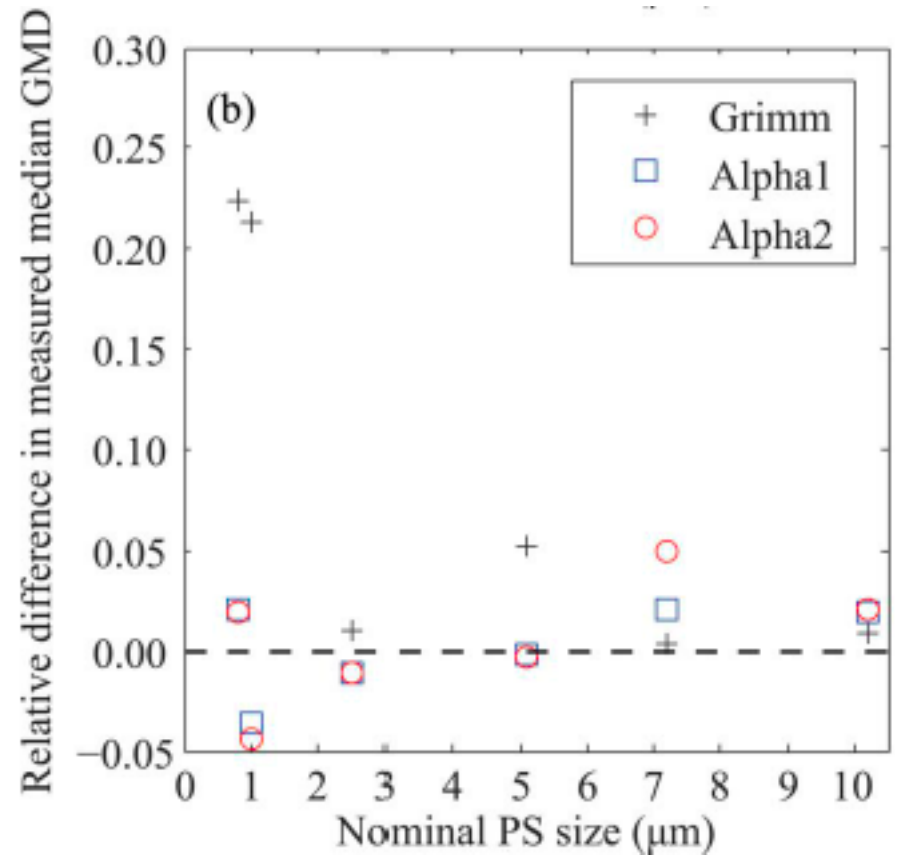
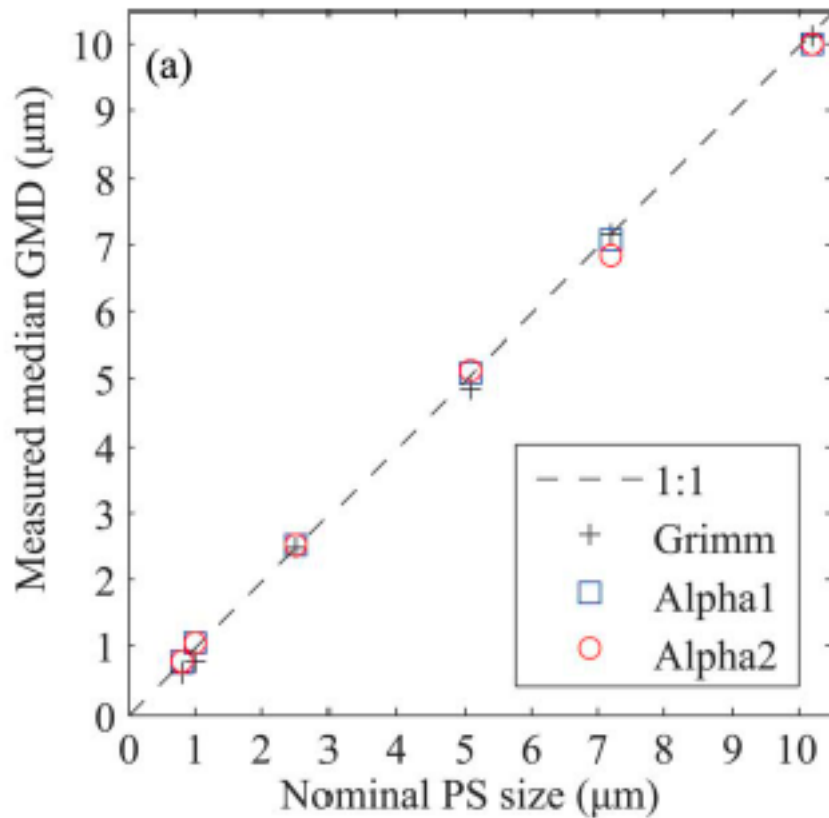


Instead of Summary...

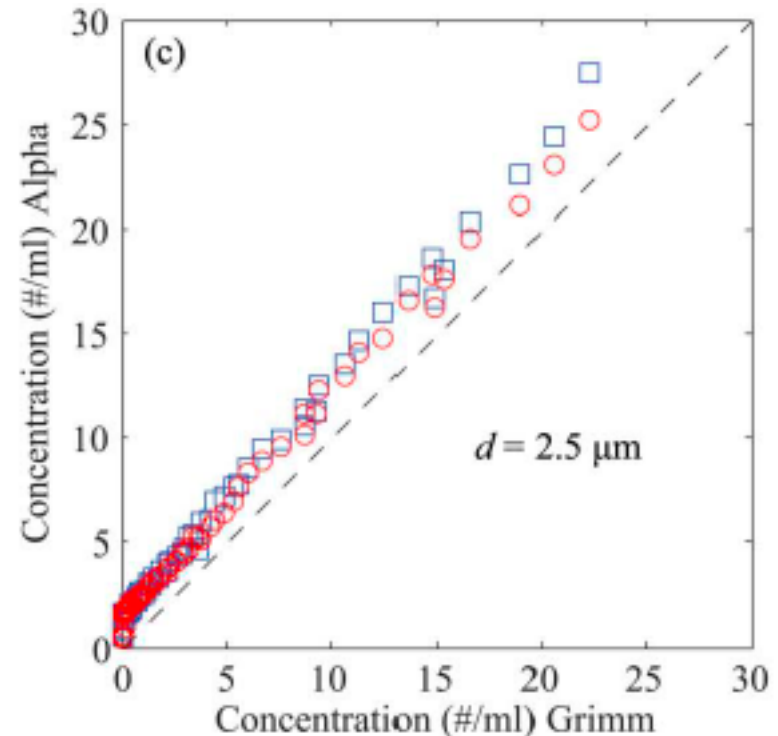
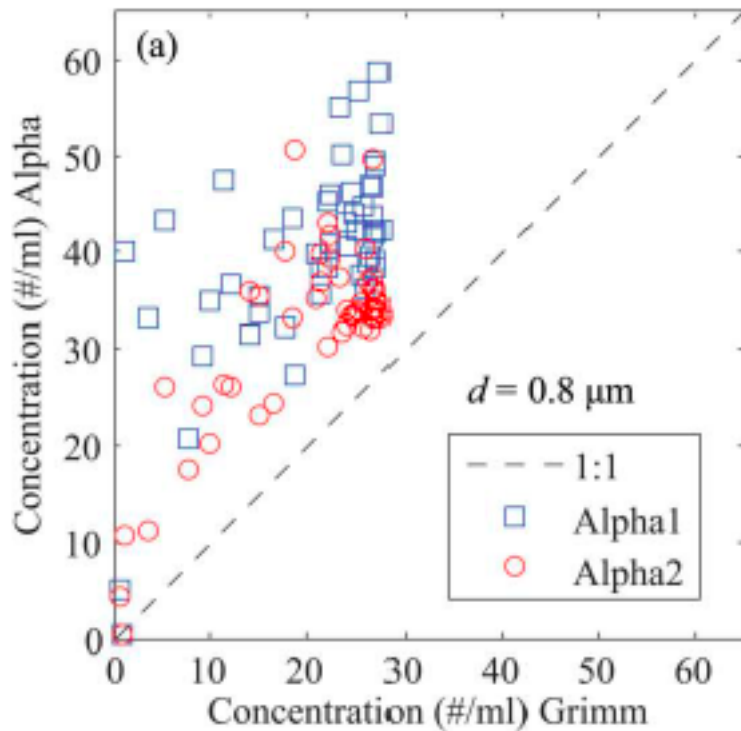
- New techniques for **manufacturing cost-effective** and **lightweight** aerosol instruments are here!
- They can be **used in different combinations** for measuring the concentration and size as well as other intrinsic particle properties
- Currently they (aerosol instruments) provide **a (much) better solutions** to gas sensors **for determining air quality!**

Thank You

Size (@ atm. cond.)



Concentration (@ atm. cond.)

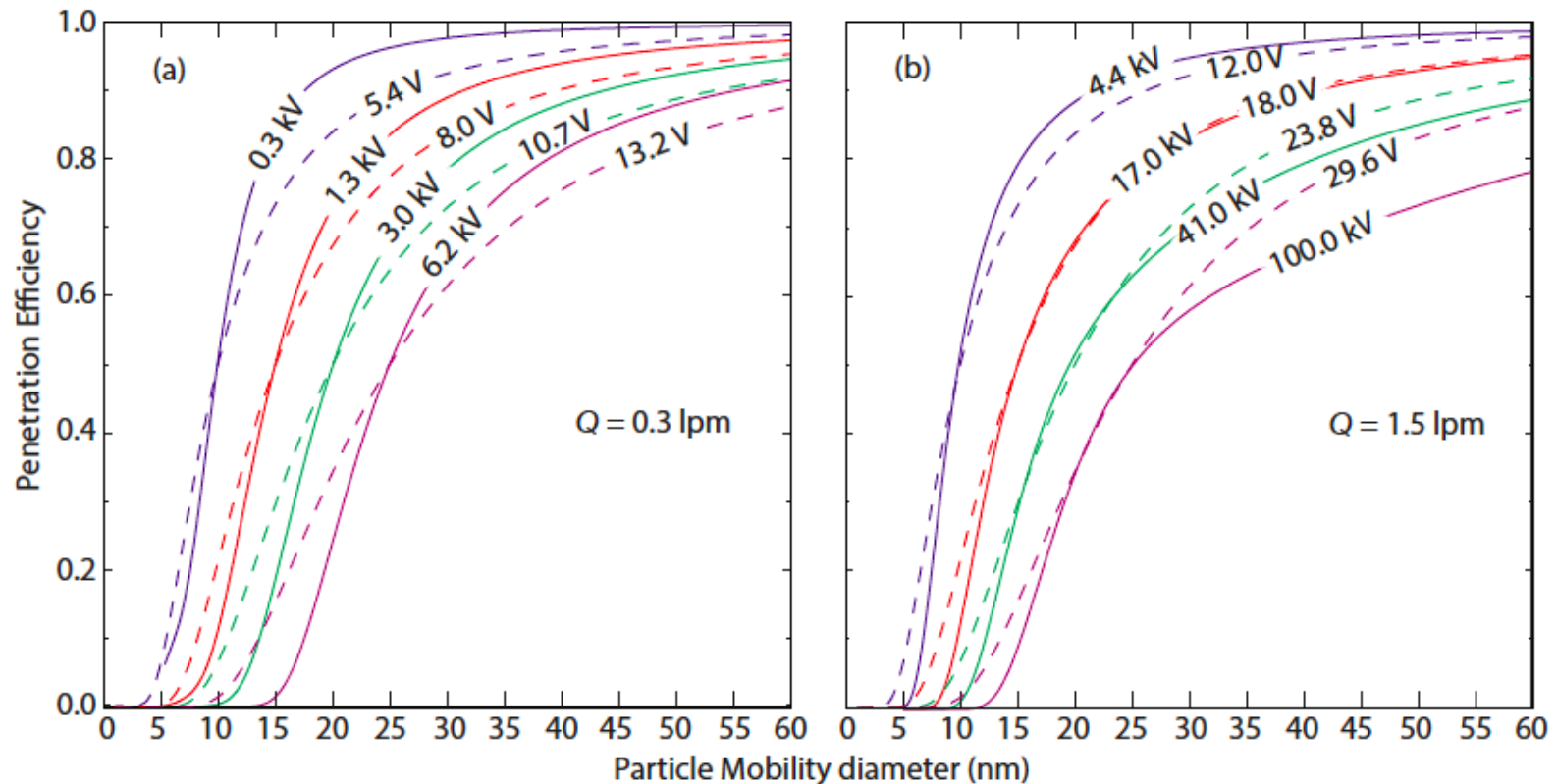


DMA sizing, resolution (Charis Results)

Penetration Efficiency Curves

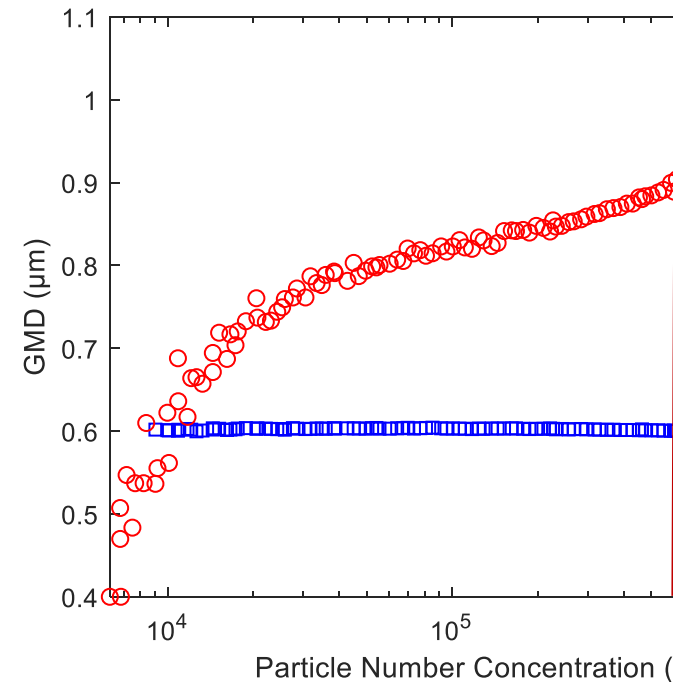
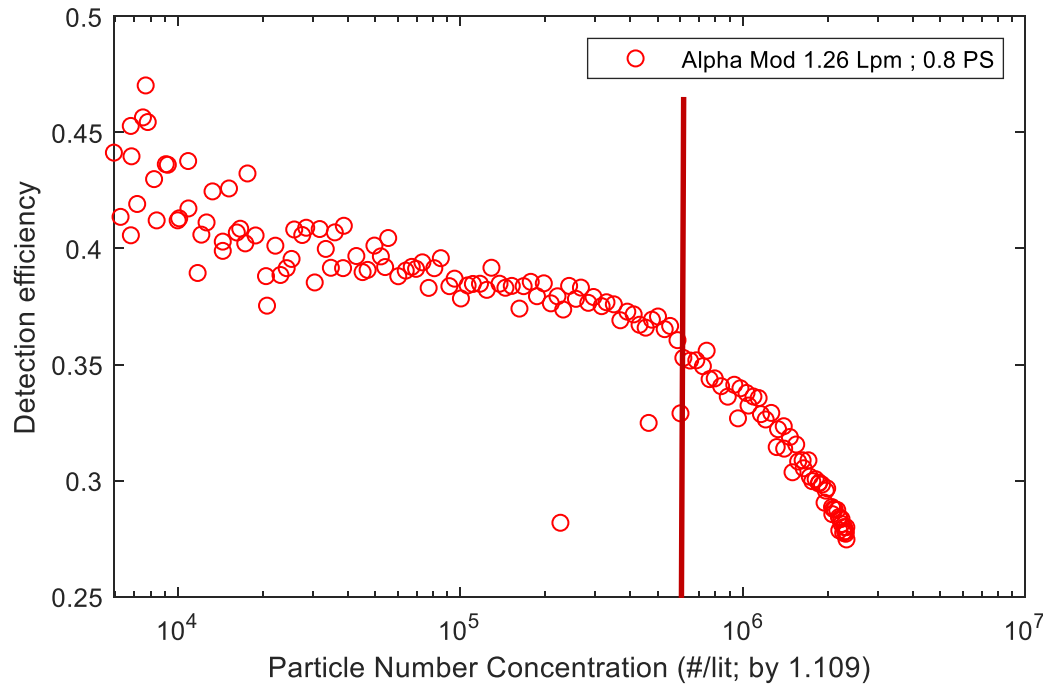


Spyros

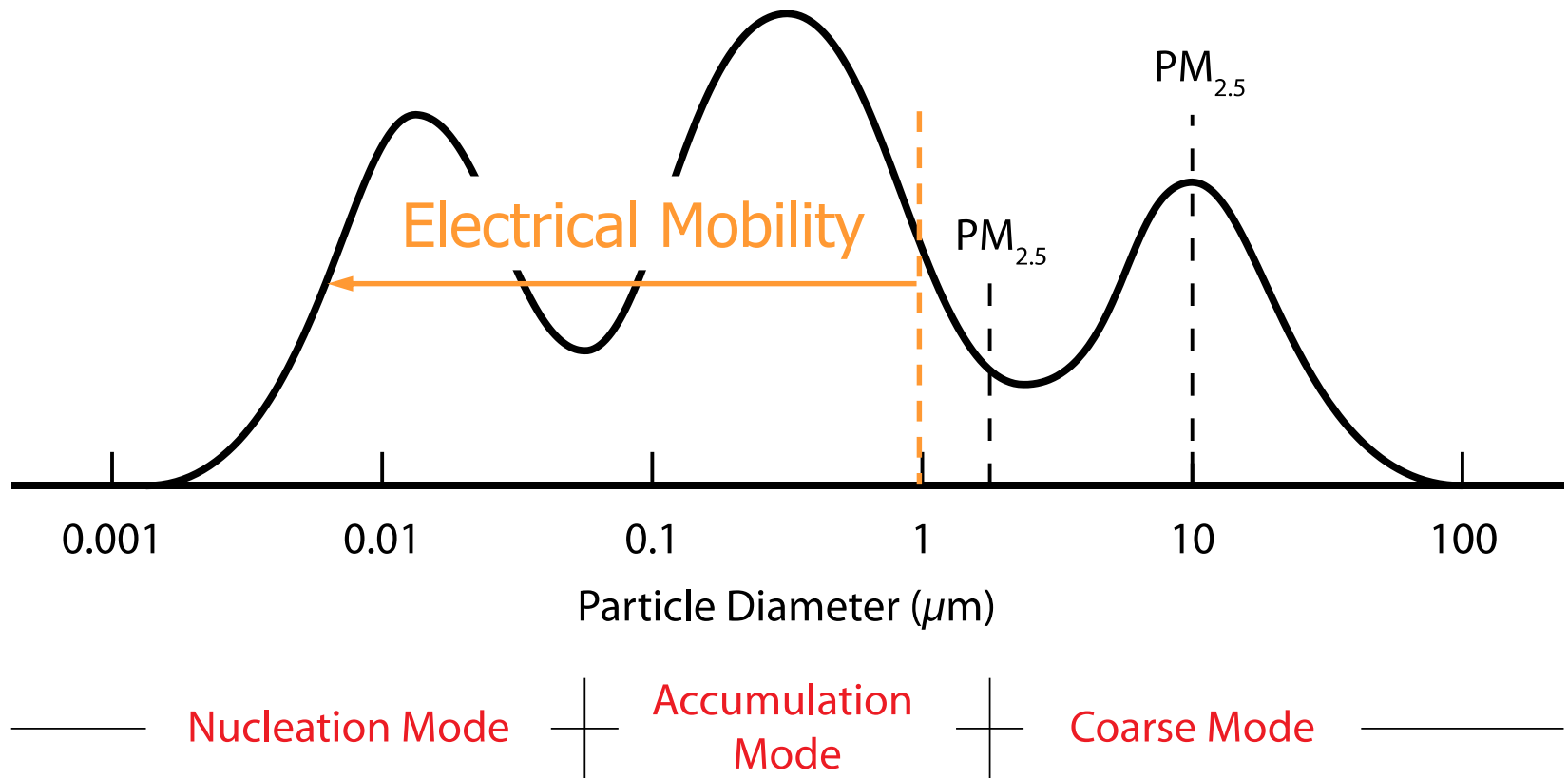


Bezantakos et al. (2015), AS&T, 49, vi-iv

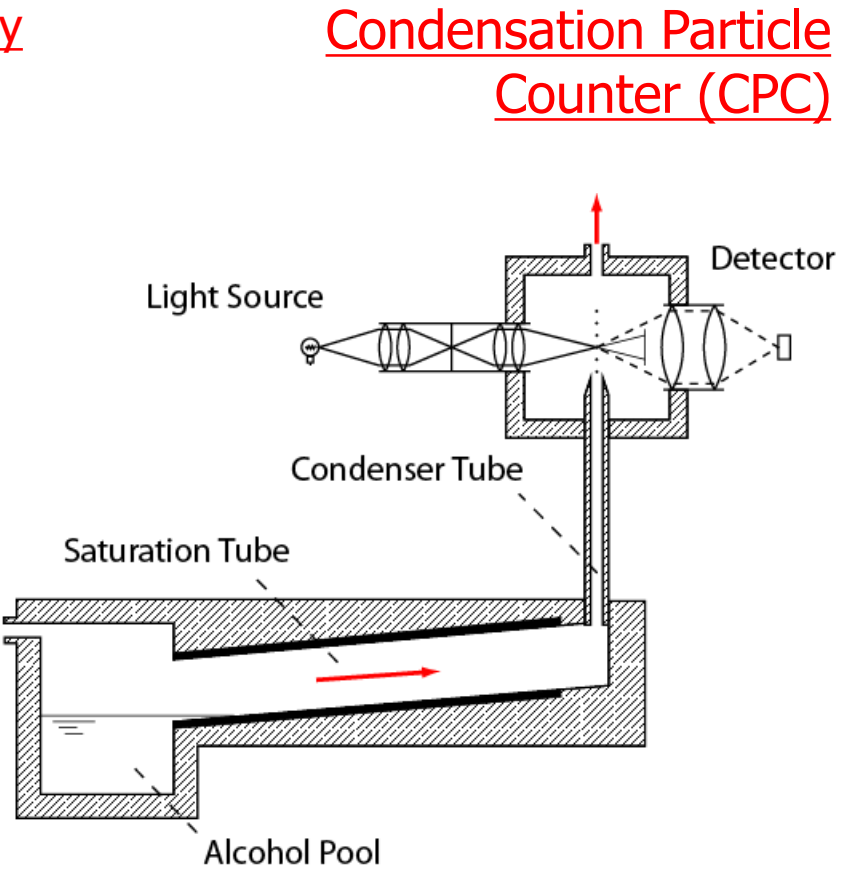
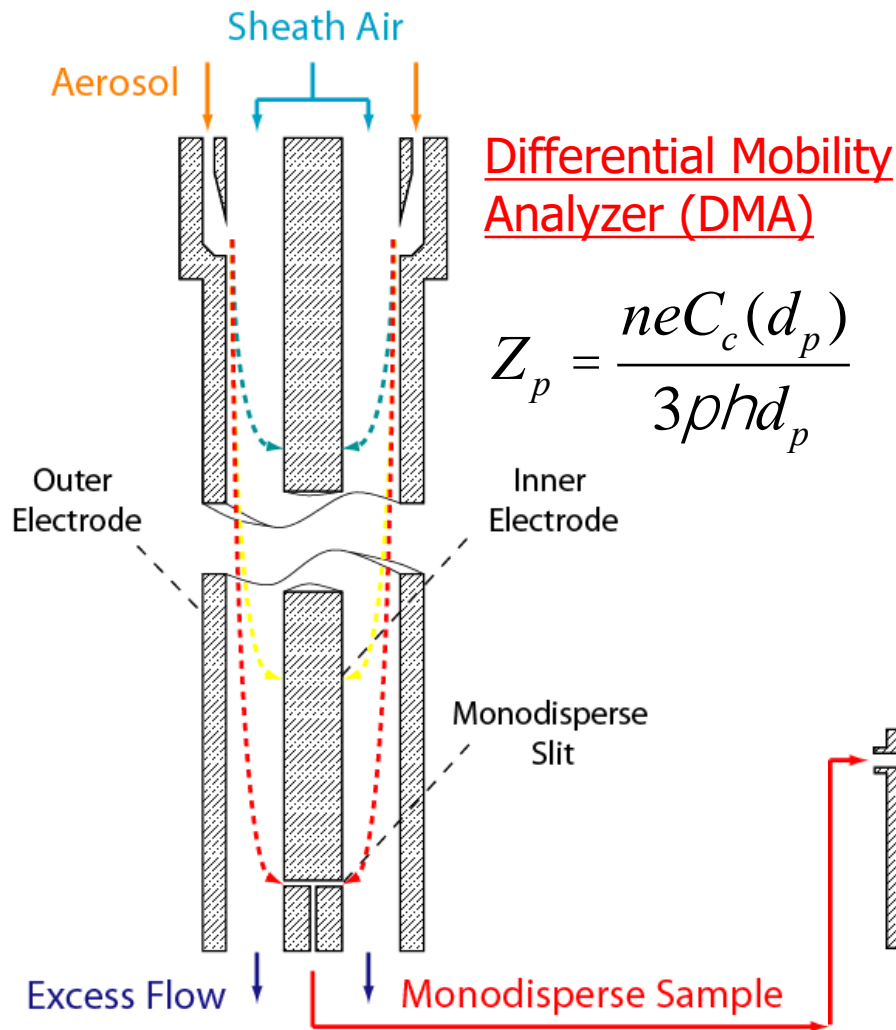
Characterization of the Alphasense OPC



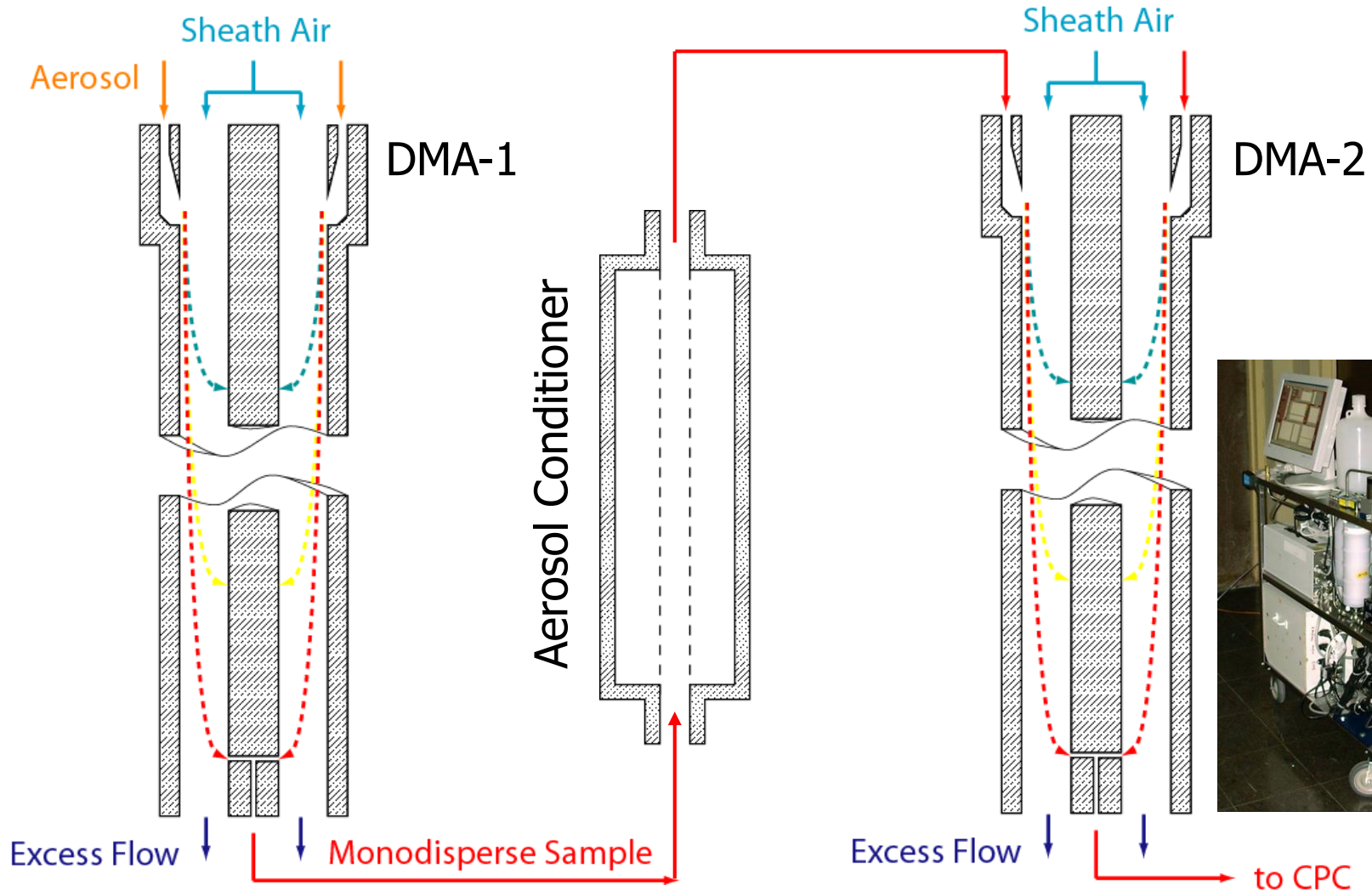
Measuring Particles Size and Size-dependent Properties



Measuring the Size of Sub-micron Particles



The Hygroscopic Tandem DMA (HTDMA)



Rader and McMurry (1986), *J. Aerosol Sci.*, 17, 771-787