Selection of quasi-monodisperse super-micron aerosol particles

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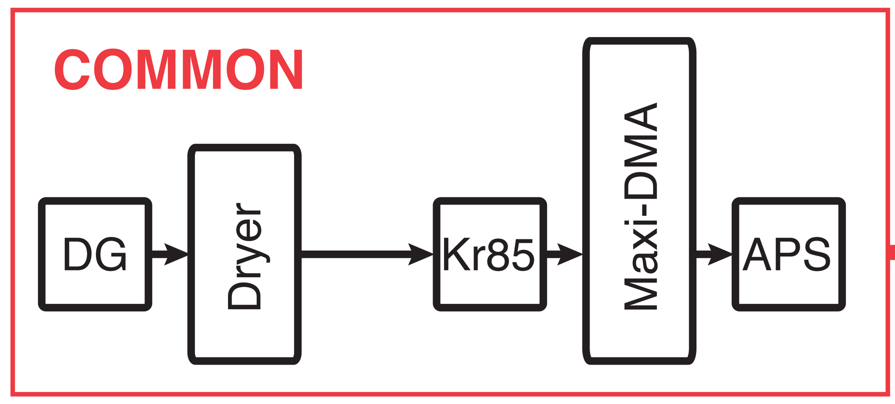
Objectives

- Size-segregated super-micron monodisperse particles are essential for e.g. fundamental research concerning cloud microphysical processes [1], as well as climate [2] or human health related issues [3].
- Commonly a Differential Mobility Analyzer (DMA) is used to select quasi-monodisperse particles [4].
- The resulting particle size distributions (SD), contain singly charged particles as well as undesired multiply charged larger particles (MCLP).
  - ***These larger particles need to be removed from the generated aerosol!***
- This becomes even more important when considering super-micron particles.
- We will present two different techniques to provide quasi-monodisperse super-micron aerosol particles.

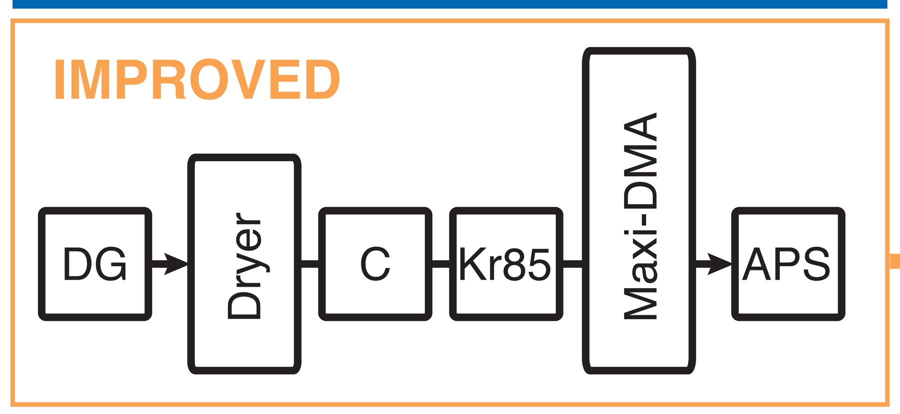
Methods

- First a combination of a cyclone (C) with adjustable aerodynamic cut-off diameter and our custom-built Maxi-DMA [5] was used to select particles, generated by a droplet generator (DG) named LADroP.
- The cyclone removes particles larger than the desired ones prior to bipolar charging by a neutralizer (Kr85) and mobility selection with the Maxi-DMA.
- Second we utilize a *NEW* combination of cyclone and Pumped Counterflow Virtual Impactor (PCVI)
  - *Based on purely inertial separation* › *Selection is independent of particle charging state!*
- The PCVI instrument was previously described by Boulter et al. [6] and Kulkarni et al. [7]
- The Aerodynamic Particle Sizer (APS, model 3321, TSI) was used as detector for both techniques.

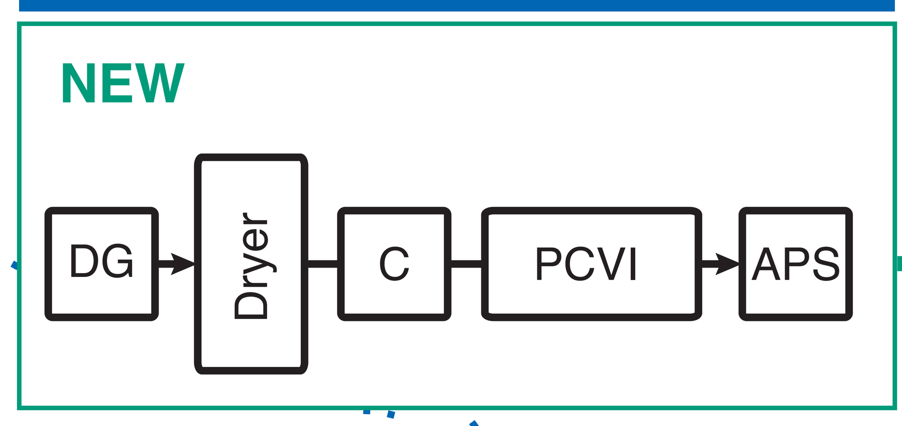
Maxi-DMA Setup



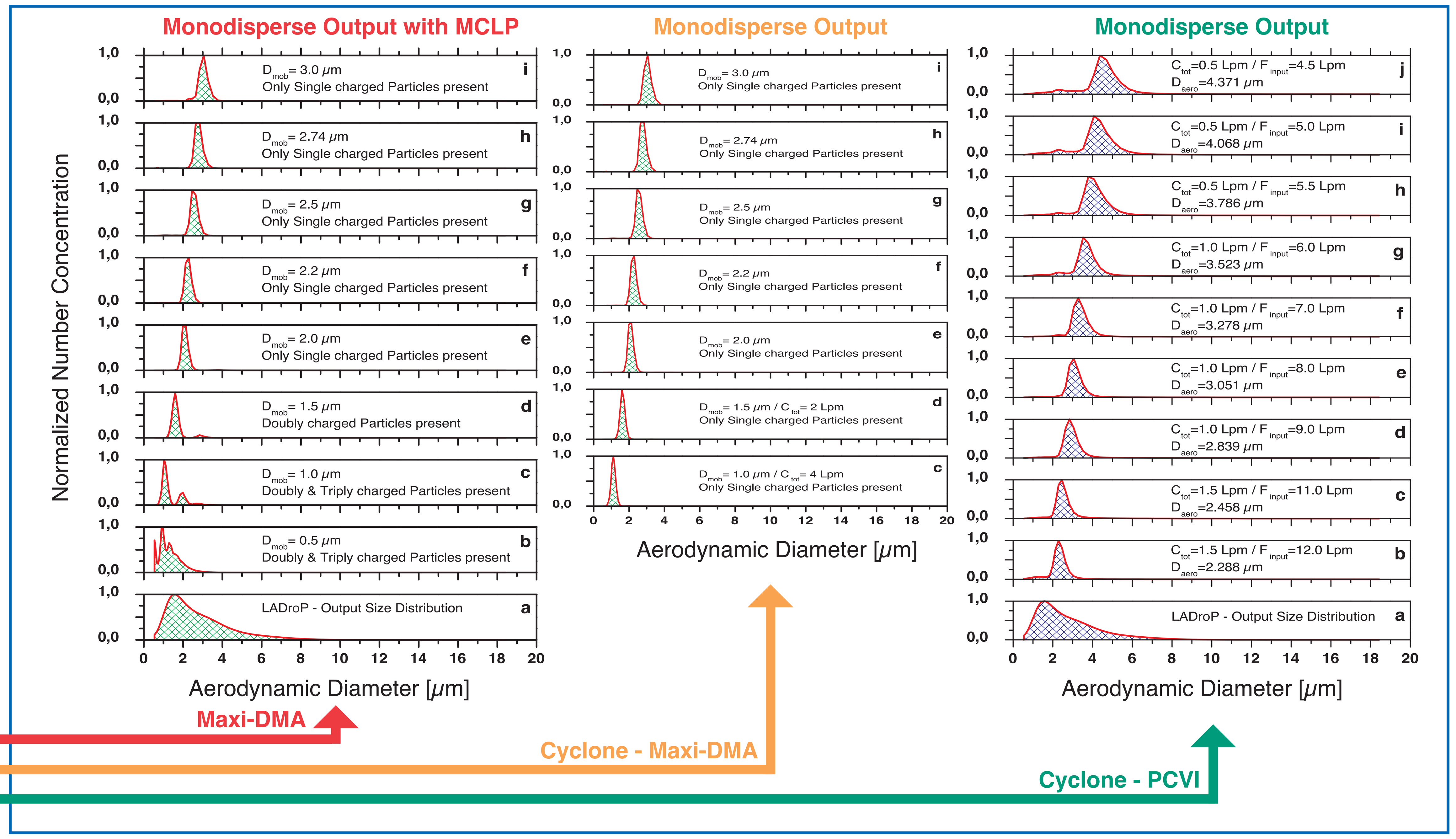
Cyclone - Maxi-DMA Setup



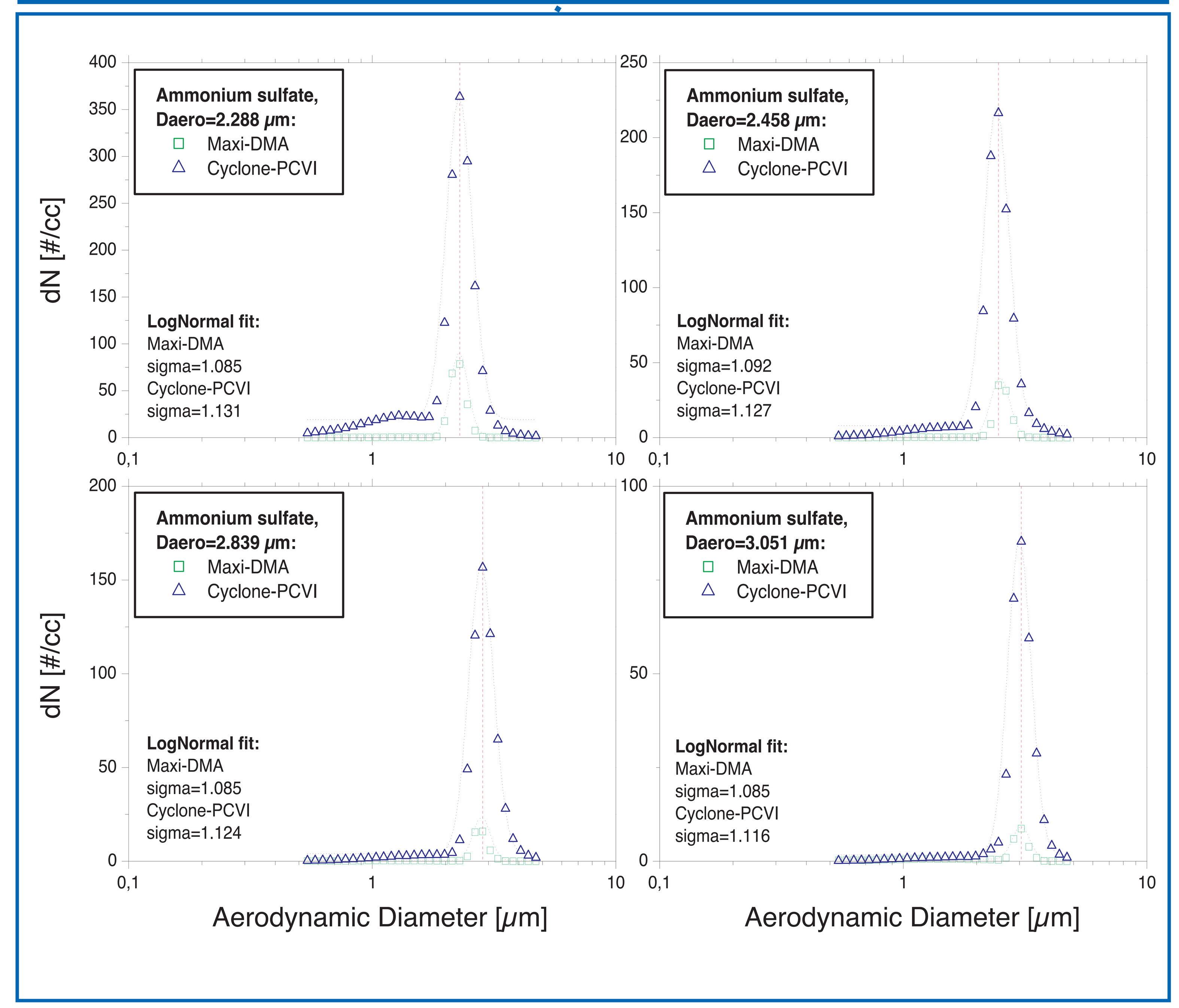
Cyclone - PCVI Setup



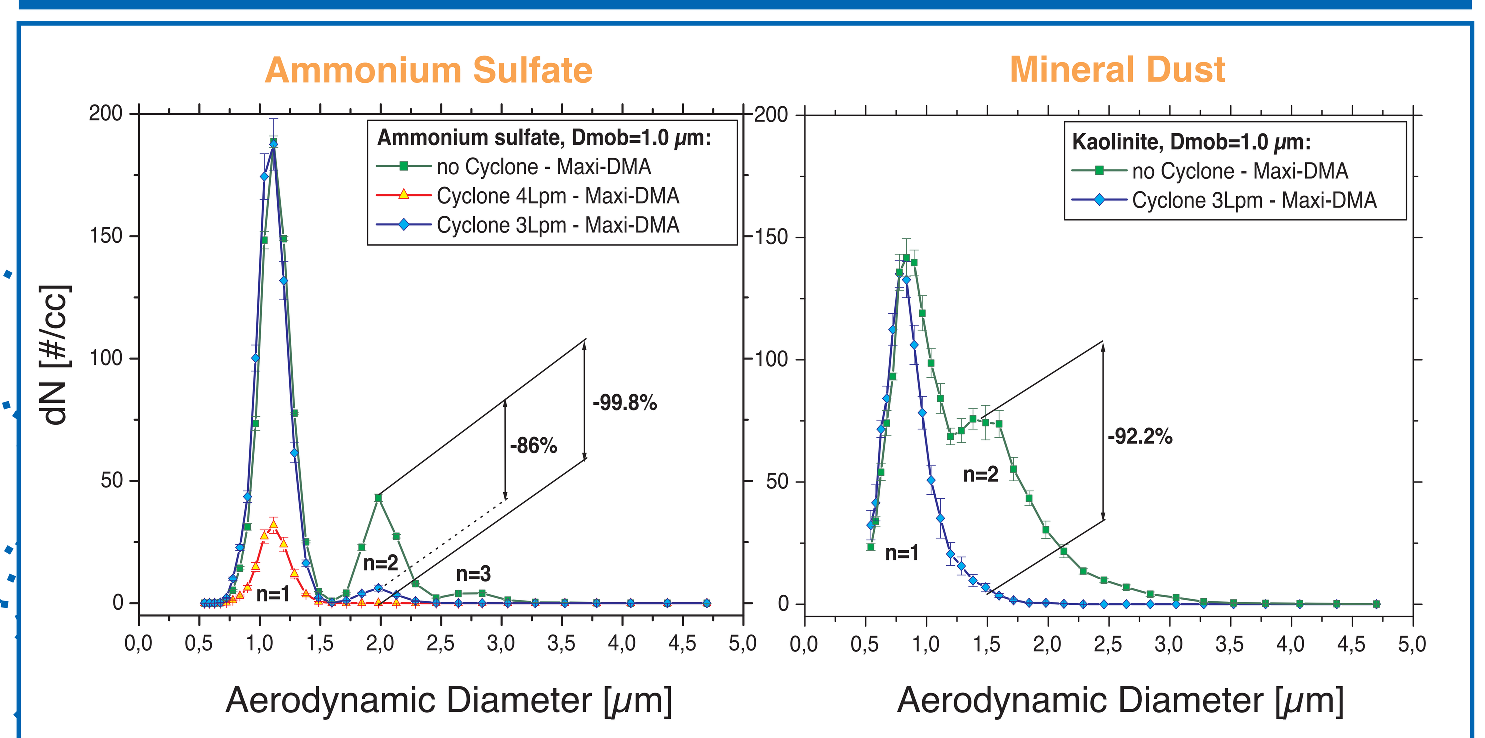
Particle Number Size Disitributions



Comparison Maxi-DMA vs. Cyclone - PCVI



Selected Monodisperse 1.0 µm Particles



Setup	Size Range [µm]	Selection Method	No Multiple Charges	Monodisperse Output	Mean Sigma Values of LogNormal Fit
Maxi-DMA	0.5 - 3.0	el. mob.	> 2µm ✓	> 2µm ✓	1.087
Cyclone - Maxi-DMA	1.0 - 3.0	aerodyn. + el. mob.	✓	✓	1.087
Cyclone -. PCVI	2.2 - 4.4	aerodyn.	✓	✓	1.125

References:
[1] Niedermeier et al., ACP, 10(8):3601–3614, 2010.
[2] DeMott et al.,PNAS, 107(25):11217–11222, 2010.
[3] Heyder et al., Journal of Aerosol Science, 6:311–328, 1974.
[4] Knutson and Whitby, Aerosol Science, 6:443–451, 1975.
[5] Raddatz et al., AIP Conf Proc,1527:457-460, 2013.
[6] Boulter et al., Aerosol Sci. Tech., 40(11): 969-976, 2006
[7] Kulkarni et al.,. Aerosol Sci. Tech., 45:382-392, 2011

Conclusions and Outlook

- Cyclone - Maxi-DMA and the *new* Cyclone - PCVI combination were applied to provide quasi-monodisperse super-micron particles.
- Aerosol output of both setups was found to be quasi-monodisperse
- Application of cyclone results in a reduction of multiple charged larger particles of up to 99.8%!
- The *number concentration of the PCVI setup was 4 to 7 times higher* than the Maxi-DMA output in the compared size range.
- The combination of *cyclone and PCVI* is applicable to *produce* quasi-monodisperse super-micron aerosol particles!
- Other cyclones in combination with the PCVI will be tested to shift the selection range down to the sub-micron region.

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