Dynamic cutpoint switching of nanoparticle detector for improved aerosol characterization

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Background

- Diffusion charger based aerosol detectors are generally simple to use, sensitive and low maintenance instruments.
- The size integrated response is proportional to the active surface area of the particle population, meaning proportional to the power 1 to 1.3 of the particle size. (See Figs. 1 and 2 and Rostedt et al., Järvinen et al.)
- To get particle number (PN) or other result, further analysis of the particle population is needed.

Partial trapping

- Particle trapping with known size response trap can be used to estimate particle population statistics.
- The signal response to trap is used to obtain approximate size information to improve particle number, mass or other signals. (Amanatidis et al., Fierz et al.)
- The trap response curve steepness gives a compromise between accuracy and size range

Dynamic trap

- Changing the trap response curve (Fig 5.) allows **wide range** and **optimal signal to noise ratio**.
- Response ratio is tracked with voltage to reach 0.5 (Fig. 3-4)
- Voltage calibration to approximate size is used to calculate factors to get number, mass and other signals.

Simulation

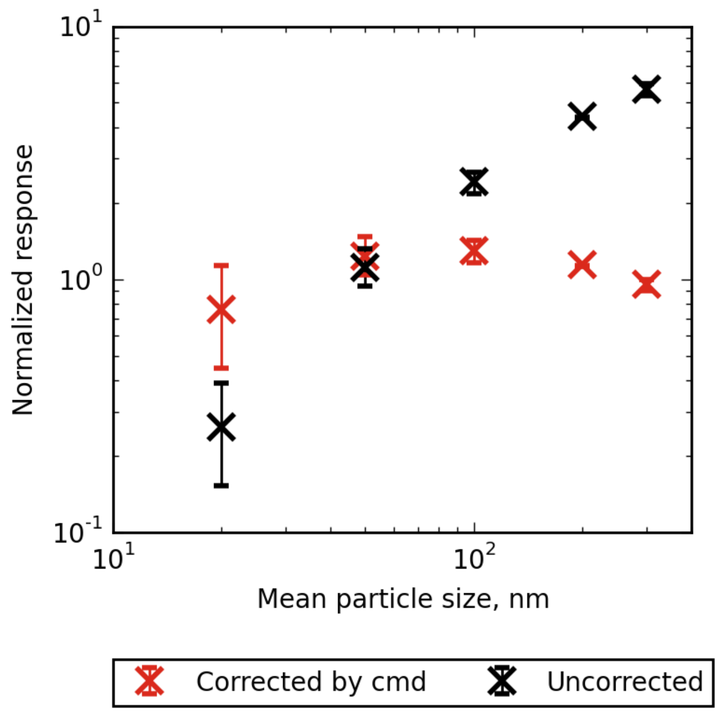

Fig. 1 Simulation of uncorrected and corrected response and limits for different number size distributions with widths between 1.3 to 2.3.

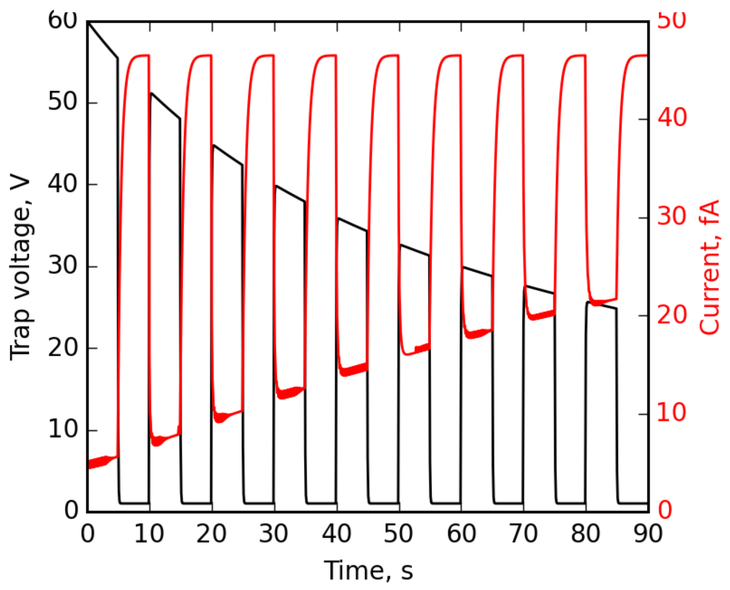

Fig. 3 Simulated current and trap voltage for step response of particle size change using dynamic trap change.

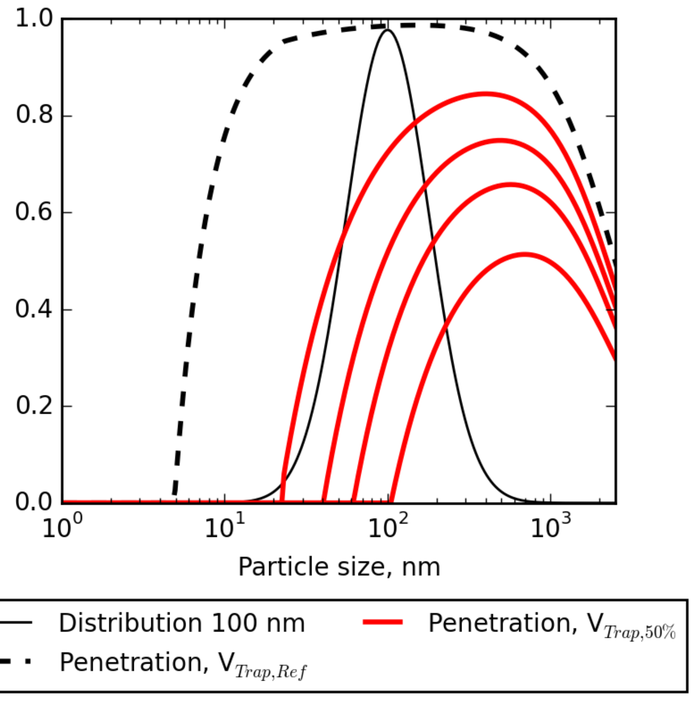

Fig. 5 Simulated trap penetration functions at the reference voltage and at different upper voltages.

Measurement

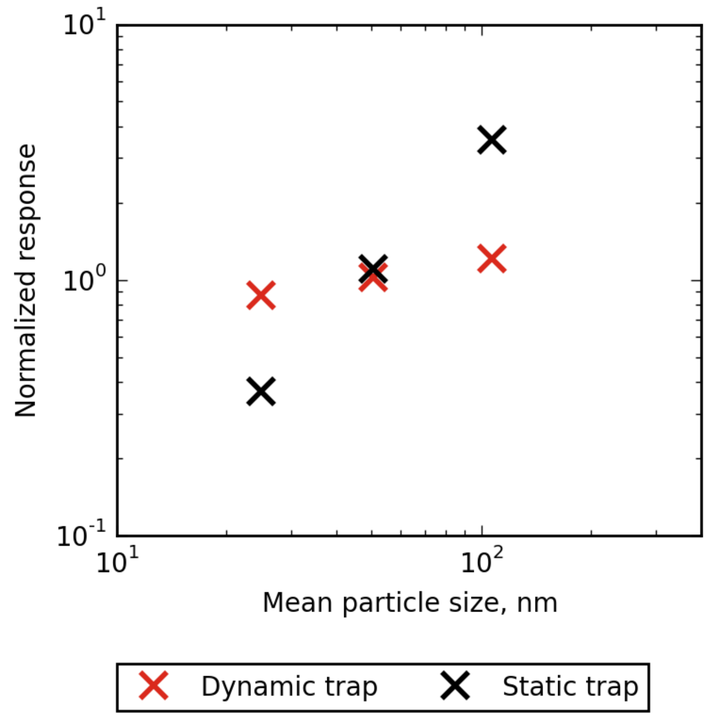

Fig. 2 Measured responses of two instruments using static or dynamic trap with transformation factors obtained from the signal.

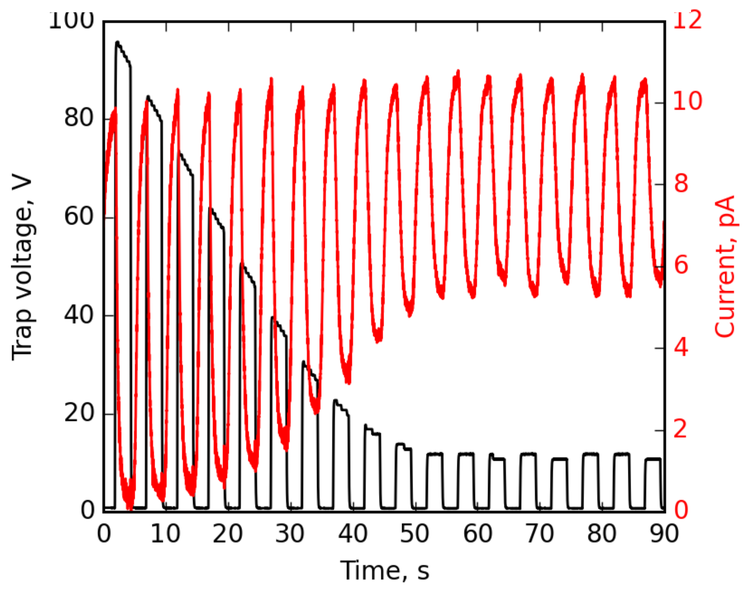

Fig. 4 Measured current and trap voltage for step response of particle size change using dynamic trap change.

References

Rostedt et al. 2014, Aerosol Science and Technology, 48(10), 1022-1030.
Järvinen et al. 2015, Urban Climate, 14, 441-456.
Amanatidis et al. 2016, Journal of Aerosol Science, 92, 1-15.
Fierz et al. 2011, Aerosol Science and Technology, 45(1), 1-10.

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