The concept of the particle concentration reduction factor (fr) has to be examined with respect to the thermal stability of the aerosol material used. Validation of the Condensation Particle Counter (CPC) are necessary. In a second step, the calibration of the volatile particle remover (VPR) using the aerosol material used. The thermal stability of the aerosols was checked by measuring the size distribution prior and after the evaporation tube of the VPR. The NaCl Aerosol generated via the Atomizer and diffusion dryer showed a broadening of the size distribution and a shift to larger particle sizes, after the evaporation tube of the VPR. The NaCl Aerosol generated via the Atomizer and diffusion dryer showed a broadening of the size distribution and a shift to larger particle sizes, after the evaporation tube of the VPR. The calibration of the VPR is on the one hand very sensitive to the aerosol material used. For the sake of comparability the calibration aerosol material should be as similar as possible to what is measured in reality. Because of that combustion soot particles are preferred. In the laboratory one way of generating soot particles is to use a CAST (Combustion Aerosol Standard, Matter Engineering AG) producing propane flame combustion soot particles in the desired particle number concentration regime.

### Step 1: PNC Calibration with Combustion Soot Particles

#### Experimental Setup
The calibration of the CPC shall be traceable to a standard calibration method by comparing the response of the CPC under calibration with that of a calibrated aerosol electrometer (AE) when simultaneously sampling electrostatically classified calibration particles by means of a Differential Mobility Analyzer (DMA).

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#### Results
At first, validation attempts supplied unsatisfactory results, which imply correlation coefficients (R²) at 0.998 but regression gradient in the range of 0.65 to 0.75. In order to reduce a potential multiple-charge-effect, the size distribution of the CAST-aerosol was optimized by shifting the particle size distribution towards smaller size (CMD = 28 nm). With this size distribution the regression gradient was raised up to 0.85. Figure 1 shows the development of the regression gradients by - the improvement of the aerosol (shifting the size distribution to smaller size), - the consideration of the multiple loads, and the "cross cut" phenomenon. Multiple charge effects: Multiple charged aerosol particles are assumed theoretically and exist in reality. It is difficult to determine the measured amount of multiple charges, a bigger difference as theoretically expected, which was shown by measuring multiple charges by means of t-DMA setup. However, measuring the multiple charges before calibration is necessary to ensure the calibration time consuming and complicated.

#### Solution: The cross cut
A way out of this cul-de-sac is to make sure that there are no multiple charged particles in the aerosol. We used the set up shown in figure 2. The raw CAST Aerosol was fed into the first DMA the radioactive source neutralizes the Aerosol and cuts the 55nm singly charged particles. With this setup the multiple charge effect can be minimized and the regression gradient could be reached as expected from the calibration certificate as delivered by the CPC manufacturer. With this technique it is possible to generate an Aerosol of single charged particles of the desired diameter. The advantage of this procedure is the independency from the raw Aerosol. In the laboratory one way of generating soot particles is to use a CAST (Combustion Aerosol Standard, Matter Engineering AG) producing propane flame combustion soot particles in the desired particle number concentration regime.

### Step 2: VPR calibration with Combustion Soot Particles

#### Procedure for the VPR calibration
- Aerosol with 100 nm particles is generated by means of a DMA.
- Number concentration is just below the detection limit of the CPC (maximum calibrated concentration).
- When number concentration is stable at the outlet of the generator the concentration is measured with the calibrated CPC (Nu100 = Cu100 = upstream concentration and uncertainty of VPR).
- The same aerosol is fed to the inlet upstream the VPR and the concentration is measured at the outlet of the VPR with the calibrated CPC (Nd100 = Ud100).
- Repeat the procedure with 50 nm particles (Nu50 and NuNd50) and 30nm particles (Nu50 and NuNd50).
- Calculate fr(100 nm), fr(50 nm), fr(30 nm) and fr = (Nu30 + Nu50+ Nu100 ) / (Nu50 + NuNd50 + NuNd100) and their uncertainties.

#### Results
The procedure for the VPR calibration was done with both the single and the double CPC calibration procedure with two different Aerosol materials (CAST with Thermodenduer; Atomizer with NaCl solution with diffusion dryer).

### Conclusion
The calibration of the VPR is on the one hand very sensitive to the aerosol material used. For the sake of comparability the calibration aerosol material should be as similar as possible to what is measured in reality. Because of that combustion soot particles are preferred. In the laboratory one way of generating soot particles is to use a CAST (Combustion Aerosol Standard, Matter Engineering AG) producing propane flame combustion soot particles in the desired particle number concentration regime.