Third EUSAAR Spectrometer Workshop

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Motivation

The first spectrometer workshop in 2006 was carried out with non-modified or non-harmonized spectrometers. Modifications for nearly all spectrometers were recommended. The 2006 workshop was held to improve or to audit the spectrometers for a first overview. Interestingly, the results for mono-disperse 200 nm latex particles experiment showed a relative good agreement between the different systems with deviations ranging from -2.5 % to +5 %.

Comparison of each spectrometer with a total particle counter for ambient aerosol particle measurements showed similar good agreements of counting efficiencies. Despite the incomplete upgraded systems regarding EUSAAR standards, these nice results could be achieved due to the participation of well-experienced operators for each system who knew their spectrometers for more than few years.

These results are directly compared to those of second workshop conducted in 2008, where most systems had been modified and harmonized according to the EUSAAR standards. However, the spectrometer inter-comparison had not been improved during the 2nd workshop as expected. It even yielded worse results compared to the first workshop 2 years before. In general, we figured out some problems including results of both workshops, which have to be investigated and solved:

1. The absolute concentrations vary up to 50 % between individual systems, especially for second workshop. We would like to achieve an absolute counting accuracy in range of ± 10 %.
2. The sizing accuracy fluctuates too much and should be in range of ± 2.5 %.
3. In some cases we observed a shifting of particle number sizes distribution due to wrong sheath to aerosol air flow ratios.

The goal of third spectrometer workshop was to minimize well know existing problems (see above) of spectrometers for counting and sizing uncertainties of aerosol particles in the size range from 10-500 nm, especially below 20 nm.

Time schedule

08 - 12 June:

- Preparing of setup for calibration workshop, installing (see Fig 1) ift system for testing of setup

15 June:

- Kick of meeting for all participants

15 - 16 June:

- Unpacking of instruments
- Technical checks of instruments (leak test, etc…)
- Audits of spectrometers

17 - 18 June:

- First experiments with Latex Nanospheres at 200 nm and 350 nm
- Preliminary data evaluation

19 - 21 June:

- First experiments with ambient aerosols

22 - 23 June:

- Preliminary data evaluation and discussion of results, first quick looks
- Optimize setup and adjust spectrometer
- Repeat of experiment with Latex Nanospheres at 200 nm and 350 nm

23 - 24 June:

- Repeat of experiment with ambient aerosol
- Discussion of results and several data session, quick looks
- Developing a working strategy to optimize counting efficiency of spectrometers below 20 nm

25 June:

- Workshop end and packing of instruments

Experimental setup

The experimental setup for the spectrometer workshop was installed one week prior to the workshop at the IfT WCC Lab. The performance of the setup was checked with two homemade reference systems (SMPS and TDMPS). The SMPS system used for this purpose was the traveling standard for GAW and EUSAAR.

The setup consists of a high volume aerosol tank and homemade aerosol generator (see Fig 1). The aerosol tank was used as a buffer volume (0.42 m^3) to minimize fluctuations of the particle number concentration of the aerosol generators and to uniformly distribute the aerosol particles to different output ports.

All spectrometers in total 11 (2 TDMPS, 4 DMPS and 5 SMPS) and 2 CPCs were connected to the aerosol tank. Two different inlets allow switching between Latex Nanospheres and ambient aerosols.

In a first step all instruments were checked for proper functioning and correct sampling flow rates. Two instruments which were broken or contaminated and had to be repaired and cleaned at the institute's workshop. The measurements were performed mainly during the first four days and focused during night.

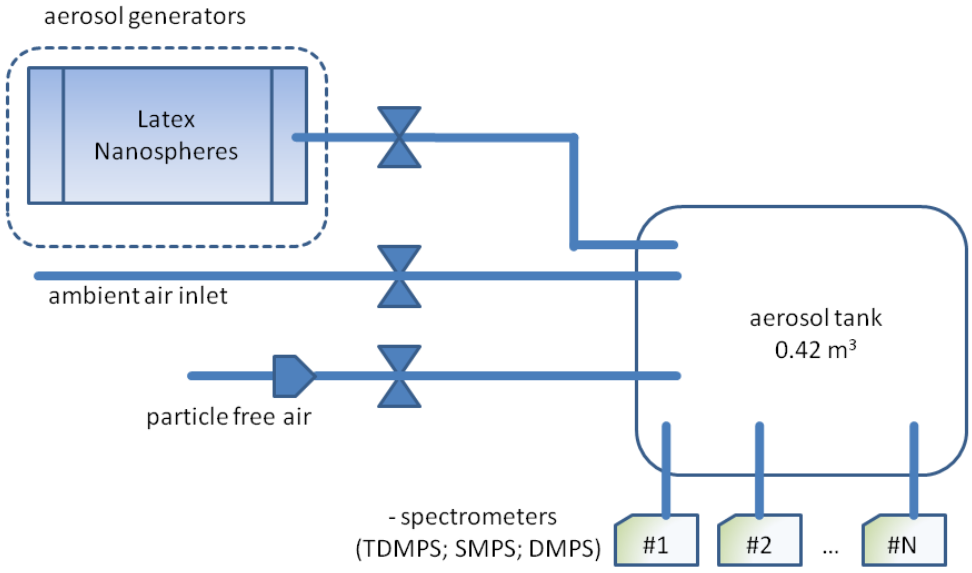

Fig 1: Schematic scheme of calibration setup for spectrometer workshop.

Data evaluation

A set of 11 DMPS/SMPS systems took part in the third workshop and their efficiency for sizing and counting were evaluated. The IFT-SMPS was chosen as reference system to improve counting and sizing efficiency of all participating systems.

We figure out the best results of all three workshops. We are within ± 10 % uncertainties of counting (see Fig 5 and Fig 6) and almost ± 3.5 % of sizing accuracy (see Fig 2 and Fig 3) for nearly all systems. Uncertainties of counting for particles below 20 nm are still too high, influenced by different CPC temperatures and different assumptions for losses correction. Community should be taken into account possibilities to extent systems for better counting efficiency below 20 nm.

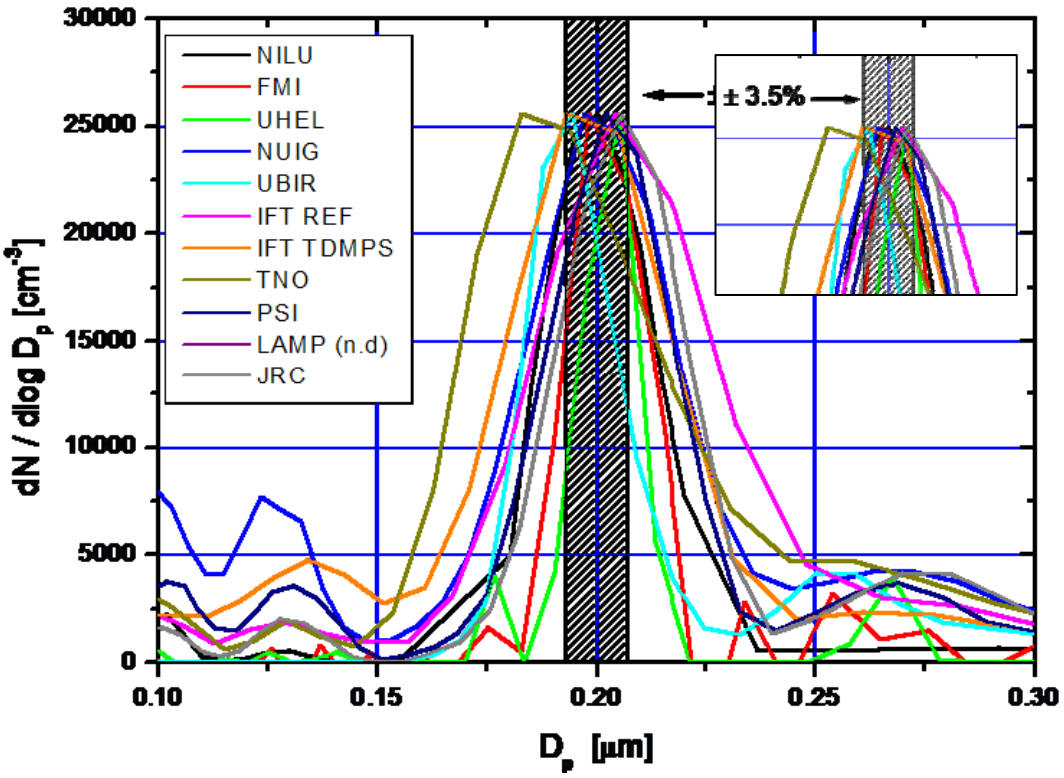

Fig 2: Latex Nanospheres at 200 nm, normalized to maximum of particle number of SMPS reference system, grey colored area shows ± 3.5 % variation of diameter shift of SMPS reference system

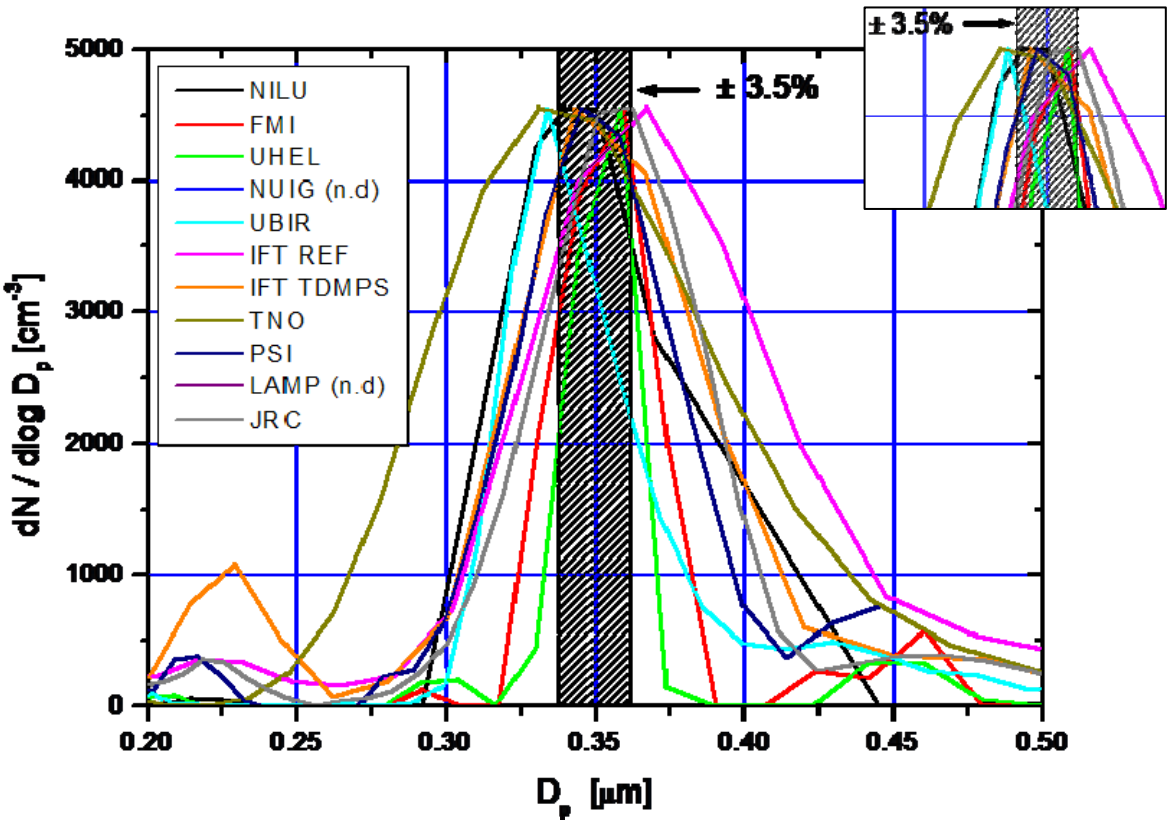

Fig 3: Latex Nanospheres at 350 nm, normalized to maximum of particle number of SMPS reference system, grey colored area shows ± 3.5 % variation of diameter shift of SMPS reference system

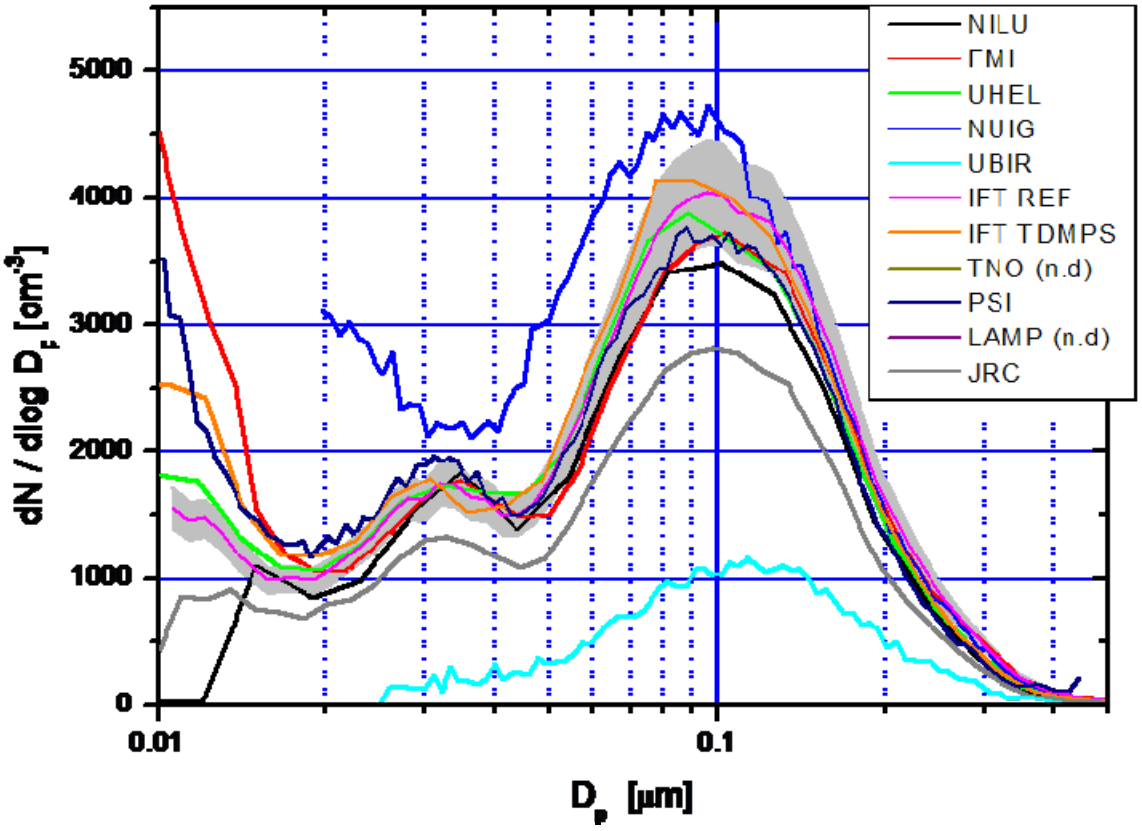

Fig 4: Particle number size distributions for an ambient aerosol, grey colored area shows ± 10 % variation of concentration of SMPS reference system.

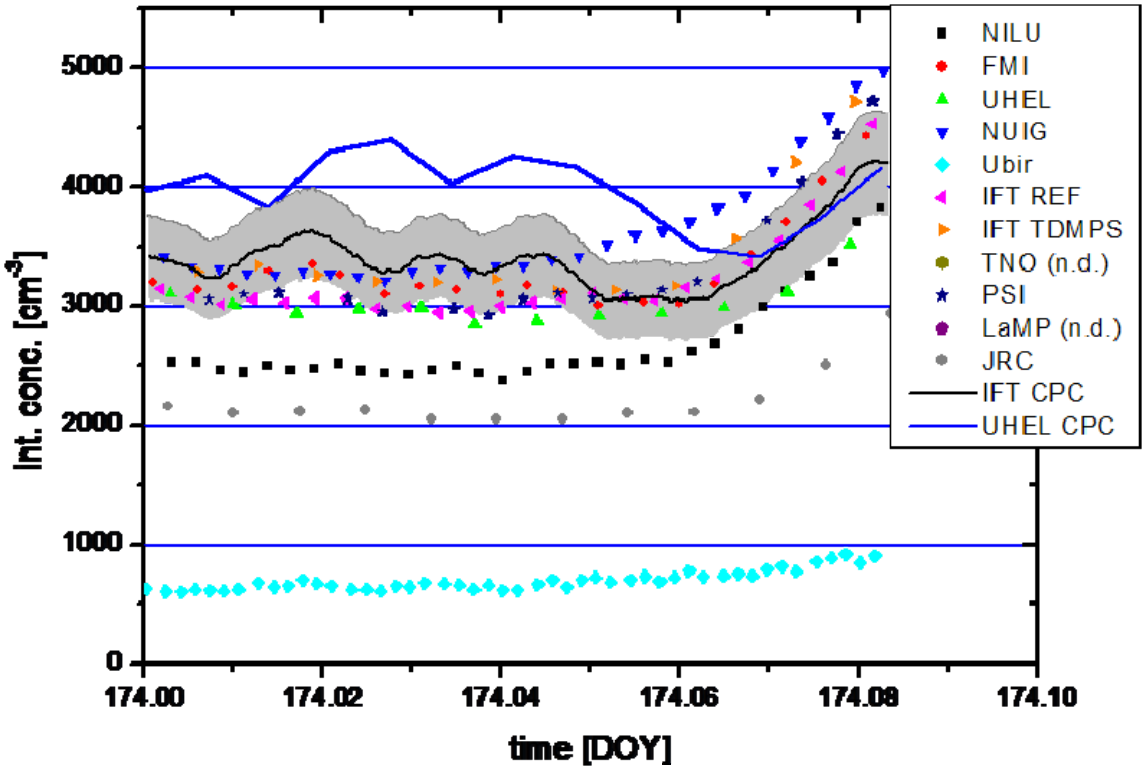

Fig 5: Absolute concentration for particle > 10nm, corrected for losses by each operator, grey colored area shows ± 10 % variation of concentration of SMPS reference system.

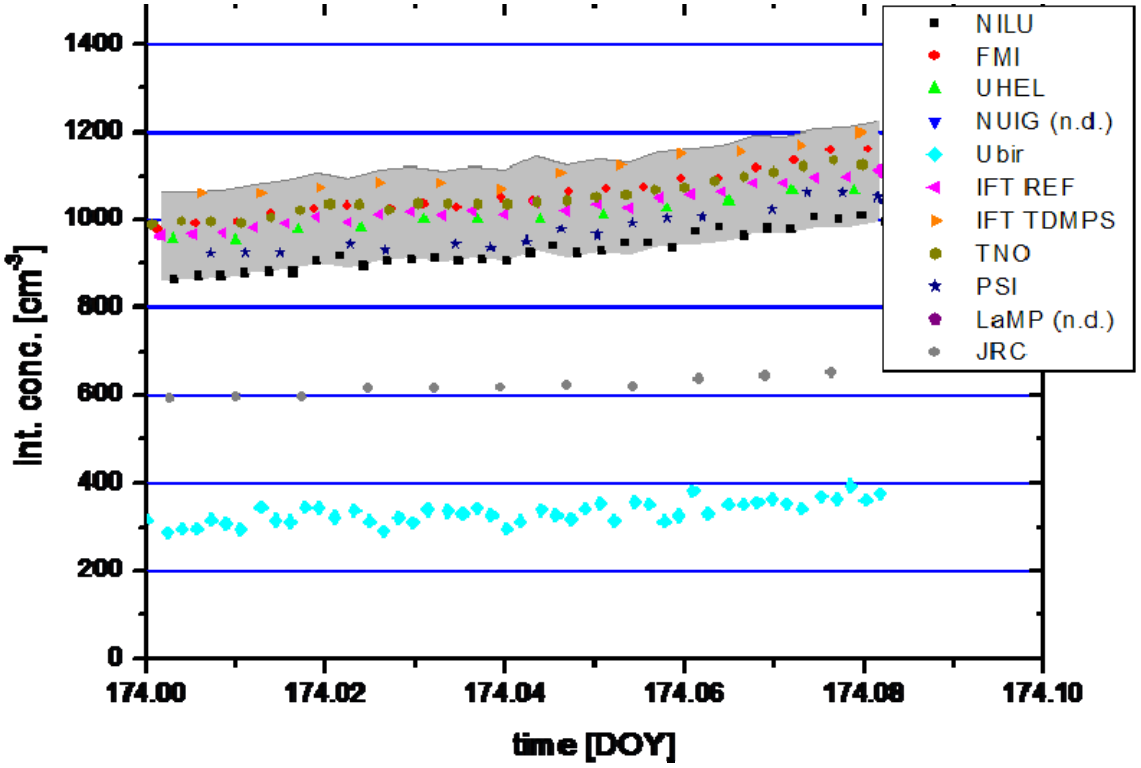

Fig 6: Absolute concentration > 100 nm, corrected for losses by each operator, grey colored area shows ± 10 % variation of concentration of SMPS reference system.

Appendix

List of participants of the EUSAAR Spectrometer workshop in June 2009

Andreas Nowak	Inst. for Tropospheric Research	Leipzig	Germany
Maik Merkel	Inst. for Tropospheric Research	Leipzig	Germany
Phillip Witzig	Inst. for Tropospheric Research	Leipzig	Germany
Alfred Wiedensohler	Inst. for Tropospheric Research	Leipzig	Germany
Kate Faloon	School of Geography, Earth & Environmental Sciences	Birmingham	United Kingdom
David Beddows	School of Geography, Earth & Environmental Sciences	Birmingham	United Kingdom
Aurelien Ustache	INERIS, Direction des Risques Chroniques, NOVA	Paris	France
Pasi Alto	University of Helsinki	Helsinki	Finnland
Ejia Asmi	Finish Meteorological Institute	Helsinki	Finnland
Francesco Riccobono	Paul Scherrer Institut	Villigen	Switzerland
Markus Fiebig	Norwegian Inst. for Air Research	Kjeller	Norway
Sebastio Santos	EU - Joint Research Centre	Ispra	Italy
Hervé Venzac	Université Blaise Pascal	Clermont-Ferrand	France
Marcel Moerman	TNO – Netherlands organisation for applied sciences	Utrecht	Netherlands
Ciarán Monahan	Centre for Climate & Air Pollution Studies	Galway	Ireland