TNA User Report

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Project title	Calibration workshop of CPC and DMPS instruments within the EUROCHAMP-2020 community
Name of the accessed calibration center	WCCAP (World Calibration Center for Aerosol Physics)
Number of users in the project	11
Project objectives (max 100 words)	The object of the intercomparison and calibration workshop was to see if the Condensation Particle Counter (CPC) and Mobility Particle Size Spectrometers (MPSS) meet the requirements for data quality within accepted uncertainty limit. The instruments were also cleaned and calibrated.
Description of work (max 100 words):	This project was an intercomparison and calibration workshop for Condensation Particle Counter (CPC) and Mobility Particle Size Spectrometers (MPSS) or differential mobility analyzer (DMA). The CPC were opened and checked and a calibration were performed with WCCAP reference instrument. The CPC passed the quality standards of ACTRIS and GAW. The SMPS (CPC + DMA) is in the range required by WCCAP for the particle size from 25 nm and larger. For smaller particles the instrument has significant losses which can be due to the DMA.

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[1] Physics; Chemistry, Earth Sciences & Environment; Engineering & Technology; Mathematics; Information & Communication Technologies; Material Sciences; Energy; Social sciences; Humanities.
[2] UNI= University and Other Higher Education Organisation;
RES= Public Research Organisation (including international research organisations and private research organisations controlled by public authority);
SME= Small and Medium Enterprise;
PRV= Other Industrial and/or Profit Private Organisation;
OTH= Other type of organization.
[3] UND= Undergraduate; PGR= Post graduate; PDOC= Post-doctoral researcher; RES= Researcher EXP= Engineer; ACA= Academic; TEC= Technician.
[4] Reproduce the table for each user who accessed the infrastructure
[5] Physics; Chemistry, Earth Sciences & Environment; Engineering & Technology; Mathematics; Information & Communication Technologies; Material Sciences; Energy; Social sciences; Humanities.
[6] UNI= University and Other Higher Education Organisation;
RES= Public Research Organisation (including international research organisations and private research organisations controlled by public authority);
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[7] UND= Undergraduate; PGR= Post graduate; PDOC= Post-doctoral researcher; RES= Researcher EXP= Engineer; ACA= Academic; TEC= Technician.

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Trans-National Access (TNA) Scientific Report

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Instructions

Please limit the report to max 5 pages, you can include tables and figures. Please make sure to address any comments made by the reviewers at the moment of the project evaluation (if applicable, in this case you were informed beforehand). Please do not alter the layout of the document and keep it in Word version. The report will be made available on the eurochamp.org website. Should any information be confidential or not be made public, please inform us accordingly (in this case it will only be accessible by the European Commission, the EUROCHAMP-2020 project partners, and the reviewers). Please include:

- Introduction and motivation
- Scientific objectives
- Reason for choosing the calibration facility
- Method and experimental set-up
- Data description
- Preliminary results and conclusions
- Outcome and future studies
- References

Name of the PI: Jean-François Doussin
Calibration center's name and location: WCCAP, Leipzig, Germany
Campaign name and period: CPC-2019-4-1, MPSS-2019-4-1, Sept. 16 – Oct. 11 2019
Text:

Introduction and motivation

This report presents the methods and results from CPC and MPSS intercomparison and calibration workshop held at the World Calibration Center for Aerosol Physics (WCCAP) in Leibniz Institute for Tropospheric Research (TROPOS).
The results are based on the WCCAP reports, which are published in webpage of European Center for Aerosol Calibration (ECAC; https://www.actris-ecac.eu/cpc-2019-4.html; https://www.actris-ecac.eu/mpss-2019-4.html)

Particle size distributions (from 10 to 500 nm or 20 to 850 nm) were measured with a scanning mobility particle sizer (SMPS) composed of a differential mobility analyzer (TSI, DMA 3080) and a condensation particle counter (TSI, CPC 3772), operating with 0.2 and 2 LPM for the sample and sheath flow, respectively. To assess aerosol mass concentrations, density was used. More detailed information about SMPS is presented by Wang et al. (2011).

Several EUROCHAMP partners participated in the workshop, all listed as follows:

- CNRS LISA

- Manufacturer: TSI
- Model: 3772
- Additional info: SMPS : Classifier TSI model 3080 + TSI DMA model 3081

LISA CNRS attended the workshop with one CPC (TSI CPC Model 3772 #3772134401) and one MPSS (**TSI MPSS 3080 SN: 8414)**. The instruments are deployed for measurements at CESAM chamber (http://www.cesam.cnrs.fr/, Wang et al. (2011)). Being awarded **"National Instrument of CNRS-INSU"**, CESAM is widely open to the international community. CESAM is part of the facilities of the European consortium Eurochamp (https://www.eurochamp.org/). Consequently, requires regular instrument calibration and intercomparison will be performed.

- FORTH
  - Manufacturer: TSI CPC:
  - Model: a butanol 3775

- Alexandru Ioan Cuza University
  - Model: 378700 with water
  - Manufacturer: TSI
  - Additional info: it is connected with a DMA: 308100 (long type). CPC has a selectable inlet flow rate of 1.5 or 0.6 L/min.

- CNRS IRCELyon
  - Manufacturer: TSI
  - Model: two types: 3776 et 3772, fines and ultrafines.

- CEAM
  - Manufacturer: TSI
  - Model: 3775
  - Additional information: Use 1-butanol. S/N 71043191

- University College Cork
  - Manufacturer: TSI
  - Model: Scanning mobility particle sizer (3938L50, with DMA 3081 and CPC 3750)

Scientific objectives

The aim of the absorption photometer intercomparison and calibration workshop was to verify that the instruments measure particle size distribution within the accepted uncertainty range. Comparison with a reference instrument reveals possible systematic errors and instrumental malfunctions.
The instruments were calibrated and cleaned during the workshop and therefore the workshop also gives some hands-on experience to the users about the maintenance of the instruments.

Reason for choosing the calibration facility

WCCAP provides regular calibration and intercomparison workshops for CPC and MPSS. They have a well-equipped laboratory and a lot of experience running these workshops.

Method and experimental set-up

In total, there were seven CPC verified in the workshop: CPC Model 3750 #3750180301 from UCC, CPC Model 3775 #71043191 from CEAM, CPC Model 3787 #3787123904 from UAIC-CERNESIM, CPC Model 3775 #71046188 from FORTH, as well as TSI CPC Model 3772 #3772134401 and one MPSS (TSI MPSS 3080 SN: 8414) from CNRS-LISA. In addition to these seven instruments, the experimental set-up included reference instruments, particle generators, and a flow reactor to which all the instruments were connected. The reference instruments at the WCCAP were: CPC WCCAP (Reference CPC #71011008) and Electrometer TSI 3068B (Serial number: 70838596). In particularly, the electrometer used as a reference has been certified at PTB Braunschweig in September 05, 2018. Silver particles between 6 and 40 nm were used for calibration. A tube furnace generator (945 °C – 1200 °C) were used to perform the calibration. The particle size selection was performed by a Bipolar diffusion charger (Kr.85), a Differential Mobility Analyzer (DMA) and a Turbulent diluter.

In total, there was two MPSS verified in the workshop: TSI MPSS 3082 #3082001803002 from UCC and a TSI MPSS from ZAMG**.** In addition to these instrument, the experimental set-up included reference instruments (Reference TCPC and Reference MPSS), PSL generators, and a flow reactor to which all the instruments were connected. Latex (at 203 nm) and ambient air were used for the calibration and a comparison will be performed with the reference instrument.

CNRS-LISA

Data description

Figure 1 shows the CPC efficiency curve from LISA-CNRS, i.e. the Counting efficiency for TSI CPC Model 3772 #3772134401 against aerosol electrometer 3068 S/N 70838596 in function of particle diameter (silver particles between 6 and 40 nm).

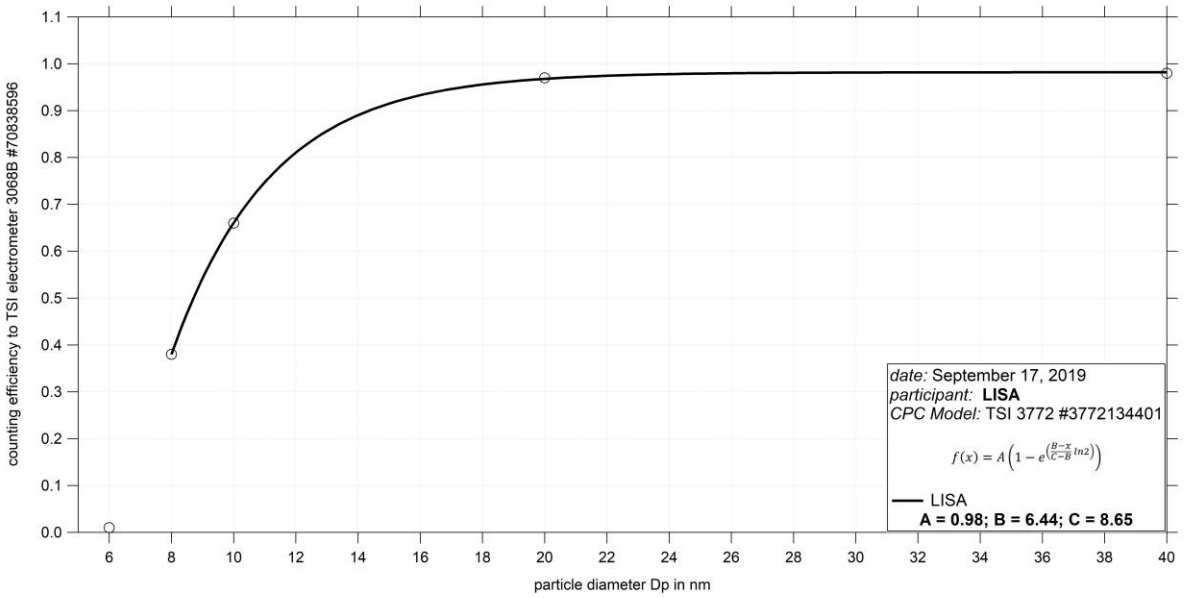

Figure 1 : Final-status: Counting efficiency for *TSI CPC Model 3772 #3772134401* against aerosol electrometer 3068 S/N 70838596; silver particles between 6 and 40 nm were used for calibration; the calculated Dp50 is 8.65 nm.

Figure 2 shows the particle size distribution of latex (203 nm) for CNRS-LISA (TSI CPC Model 3772 #3772134401, TSI MPSS 3080 SN: 8414)).

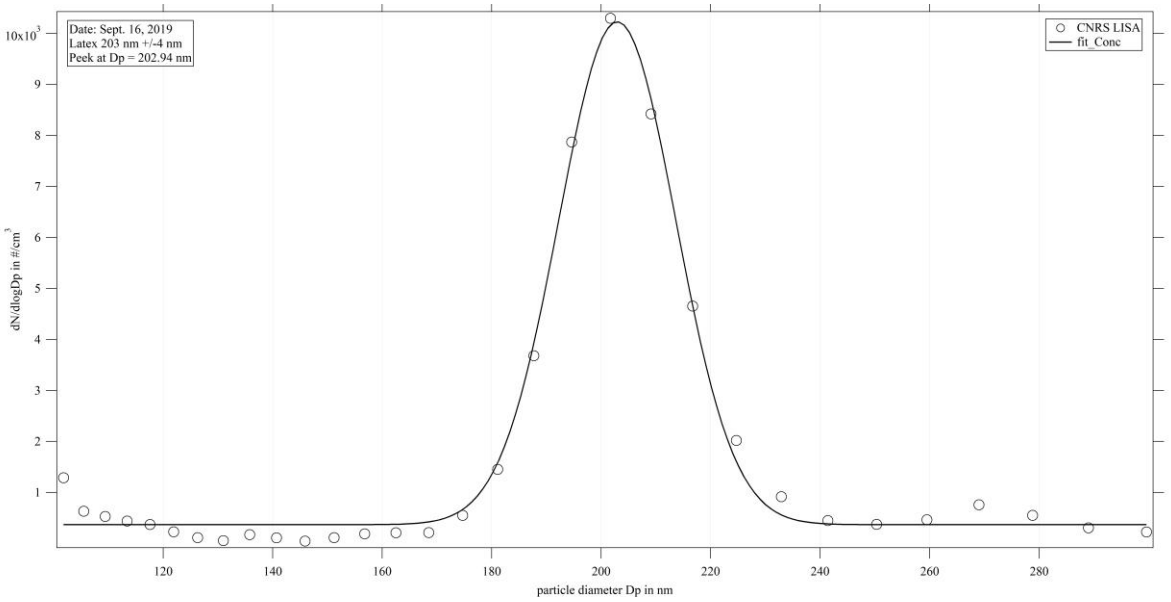

Figure2: Measurement of latex 203 nm – CNRS LISA: Particle size distribution of latex 203 nm on Sept. 16th 2019. The flow ratio was 0.2 L/min aerosol and 2.0 L/min sheath air.

Figure 3 shows a comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 (in blue) against CNRS LISA (in red and green) from Sept. 19, 2019 9:30 AM – Sept. 19, 2019 14:30 PM.

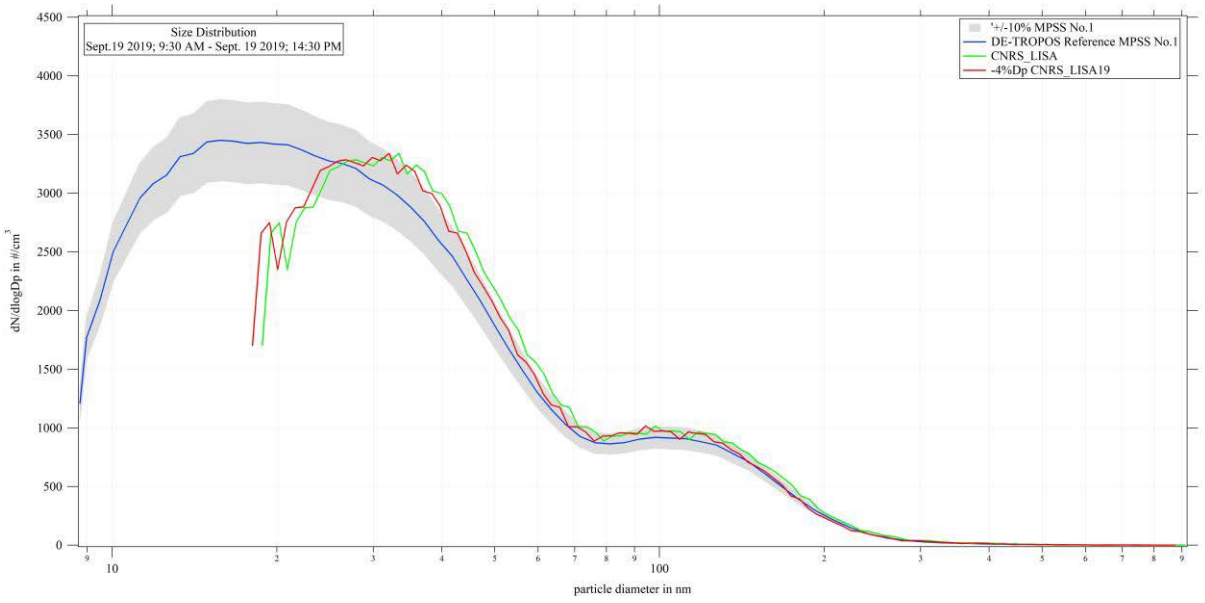

Figure 3: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against CNRS LISA from Sept. 19, 2019 9:30 AM – Sept. 19, 2019 14:30 PM. After fixing the DMA, the following PSL calibration (203 nm) of instrument showed a peak at 209 nm. The red line shows a 4% correction in the sizing.

Preliminary results and conclusions for LISA

The LISA CPC (TSI CPC Model 3772 #3772134401) passed the quality standards of ACTRIS and GAW. The candidate reached 98% efficiency at 40 nm. The Dp50 is at 8.65 nm in the final-status. To increase the performance, TROPOS opened the CPC and checked and cleaned it. It was not necessary to replace

or repair anything. The CPC efficiency curve corresponds to the standard of ACTRIS and GAW (Cf. figure 1). For more detailed information, see WCCAP-report-CPC-2019-4-1 report.

The pre-status of the TSI MPSS from LISA-CNRS was performed in the same setup like on CESAM chamber with a flow of 0.2 l/min (aerosol) and 2.0 l/min sheath air. Using a TSI 3772 counter with usually 1 l/min, the flow was decreased over a splitter with a total filter and needle valve. The candidate showed a PSL peak at 203 nm (cf. figure 2) and the particle number concentration integrated over the size range 20-800 nm is 10% higher than the Reference Instrument.
However, it was not possible to run the TSI MPSS from CNRS-LISA with a higher flow than 2.0 l/min in any setup cases and PSL performance. Consequently, the DMA was opened and cleaned it. World Calibration Center for Aerosol Physics found out that the laminarity net in the head of the DMA was broken. It was not possible to reach a laminar flow inside the DMA. WCCAP replaced the net and the participants cleaned the DMA. The classifier was check with a flow ratio 1.0: 5.0 l/min and without an impactor. An example of results is shown in figure 3. For other example of results and for more details information, see WCCAP report MPSS-2019-4-1 report.
The candidate showed with the TSI AIM software a slightly higher concentration against the Reference Instrument No.1. The software is overcorrecting the small particles with the internal corrections from TSI. Looking at the evaluation with the TROPOS software using the measured effective lengths and the measured CPC efficiency curve from 17.09.2019, the candidate is in the range required by WCCAP for the particle size from 25 nm and larger. For smaller particles the instrument has significant losses which can be due to the DMA.

Outcome and future studies
WCCAP recommends LISA-CNRS to change the laminarity net to a new one and polish the DMA.

UCC
UCC Data Description

Figure 1 shows the CPC efficiency curve from UCC for the TSI CPC model 3750 #3750180301 against Aerosol Electrometer 3068 #70838596. Silver particles between 5 and 40 nm were used for the calibration.

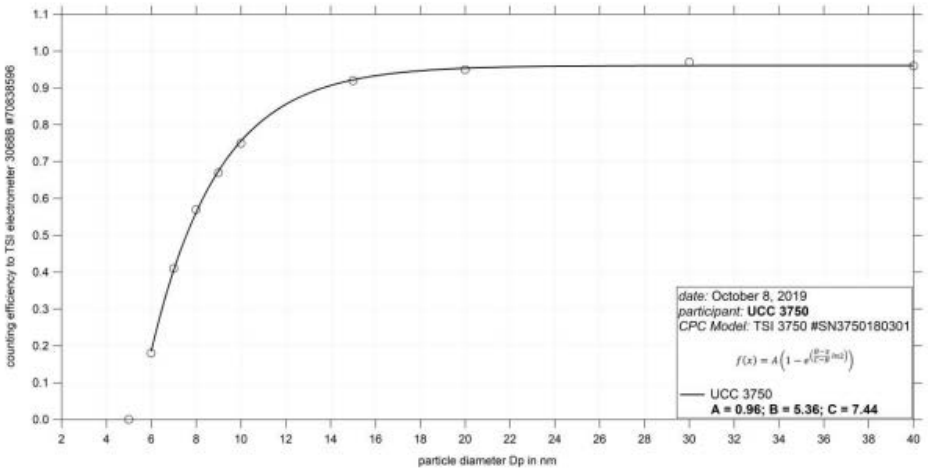

Figure 1: Counting efficiency for UCC CPC 3750 S/N 3750180301 against aerosol electrometer 3068 S/N 70838596; silver particles between 5 and 40 nm were used for calibration; the calculated Dp50 is 7.44 nm.

Figure 2 shows the particle size distribution of latex (203 nm) for UCC (TSI CPC Model 3750 #3750180301, TSI MPSS 3082 SN: 3082001803002).

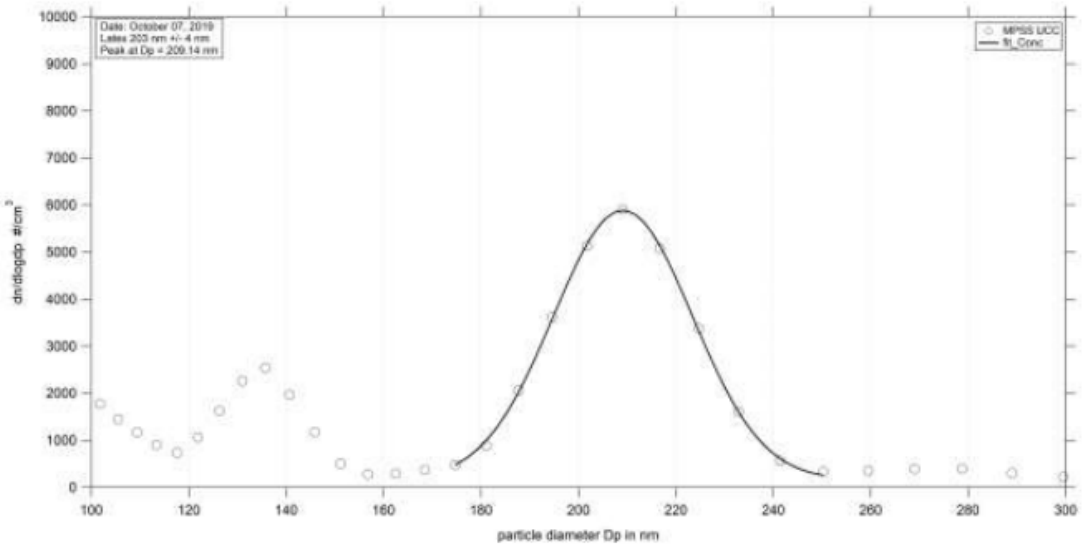

Figure 2: Measurement of latex 203 nm – MPSS UCC: Particle size distribution of latex 203 nm on Oct. 7 th 2019. The peak is at 209.14 nm.

Figure 3 shows a comparison of the UCC MPSS system (in blue) and the Tropos reference MPSS system (in green) for the mean particle number size distribution for an overnight measurement from 6 PM on October 10th 2019 to 6 AM on October 11th 2019.

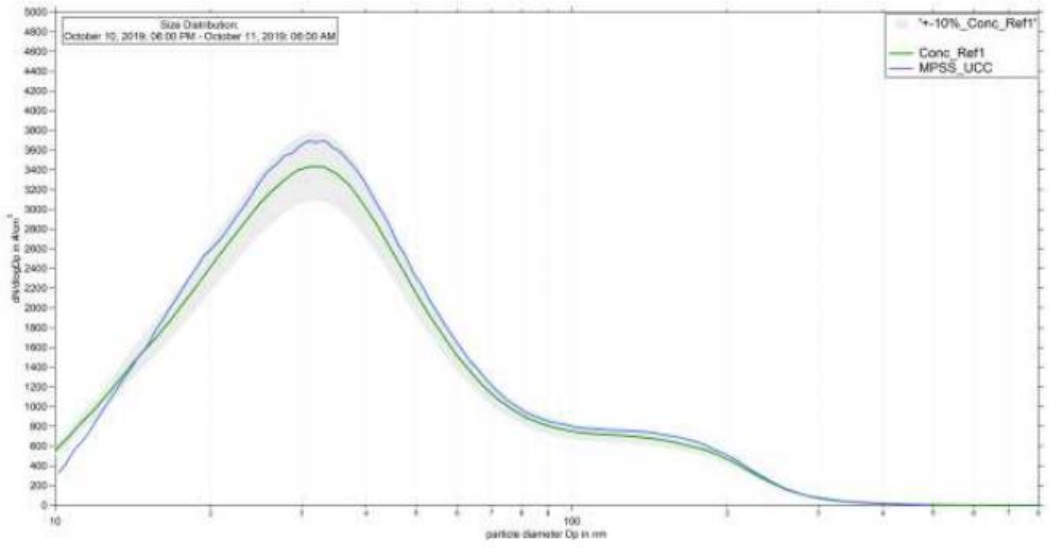

Figure 3: Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against MPSS UCC from Oct. 10, 2019 6 PM – Oct. 11, 2019 6 AM.

Preliminary Results and Conclusions

The UCC CPC model 3750 passed the quality standards of ACTRIS and GAW. The UCC system reached 96% efficiency at 40 nm and the Dp50 is at 7.44 nm. The CPC efficiency curve corresponds to the standard of ACTRIS and GAW. During the intercomparison, the CPC was opened for cleaning and also to check for any damage. For more detailed information, see WCCAP report CPC-2019-5-1.

The pre-status was performed in the same setup as used in the lab with a flow of 1.0 l/min (aerosol) and 5.0 l/min (sheath air). The candidate used a TSI 3750 counter with a flow rate of 1 l/min and butanol-based. The radioactive source was provided by TROPOS, because of transport issues. The candidate showed a PSL peak at 209.14 nm and the integrated particle number concentration over the size range 10-520 nm is 7% lower than the Reference Instrument No.1. Looking at the size distribution the candidate overestimates the accumulation mode and underestimates the Aitken mode.

There are problems in selecting particles over the DMA and undefined losses in the instrument. It is necessary to check and clean the whole instrument and run one experiment without the impactor, using a dummy. The instrument was cleaned and checked. The final run was performed from 10.-11.10.2019 using the TSI AMI software V10 is seen in Figure 3 above. For more results, see WCCAP report MPSS-2019-5-1.

The candidate showed, with the TSI AIM software, a slightly higher concentration against the Reference Instrument No.1. The candidate passed the standards of ACTRIS and GAW under the conditions: using the TROPOS Reference CPC No.1 as a counter and a radioactive source from TROPOS.

FORTH

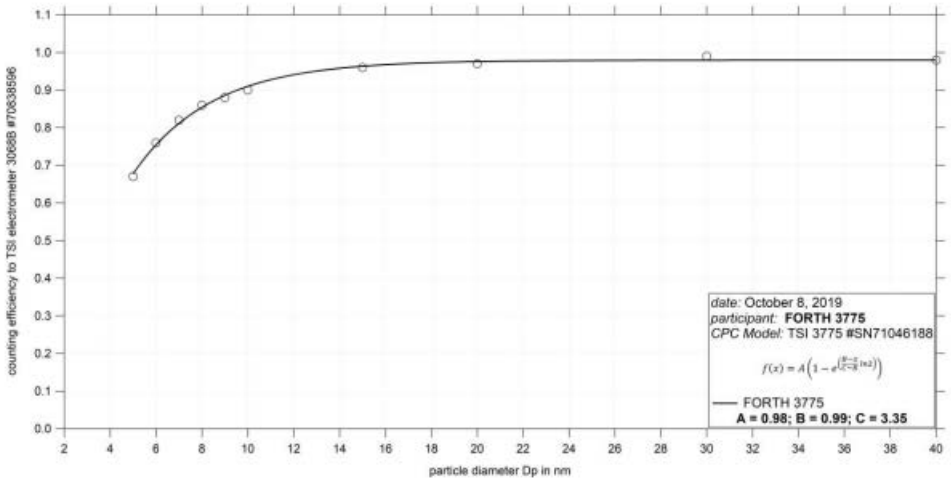

Figure 4: Final-status: Counting efficiency for TSI CPC Model 3775 #71046188 against aerosol electrometer 3068 S/N 70838596; the calculated Dp50 is 3.35 nm.

Figure 4 shows the CPC efficiency curve from FORTH i.e. the Counting efficiency for TSI CPC Model 3775 #71046188 against aerosol electrometer 3068 S/N . The FORTH CPC passed the quality standards of ACTRIS and GAW, reaching 98% efficiency at 40 nm. The Dp50 for this CPC is at 3.35 nm. The CPC efficiency curve corresponds to the standard of ACTRIS and GAW. Additional service on the instrument was not required.

UAIC

CERNESIM water CPC from TSI, model 3787 S/N 3787123904, is coupled to a 3080 model TSI Electrostatic Classifier and a long type TSI 3081 DMA. These instruments are usual used for measure the secondary organic aerosols formation during the gas phase oxidation of various VOCs into the ESC-Q-UAIC photoreactor. The CPC, model 3787, passes the quality standards of ACTRIS, showing a 93% efficiency at 40 nm and a DP50 at 9, 62 nm. Figure 5 shows the CPC efficiency curve of UAIC-CERMESIM water CPC versus TROPOS reference aerosol electrometer 3068 S/N 70838596.

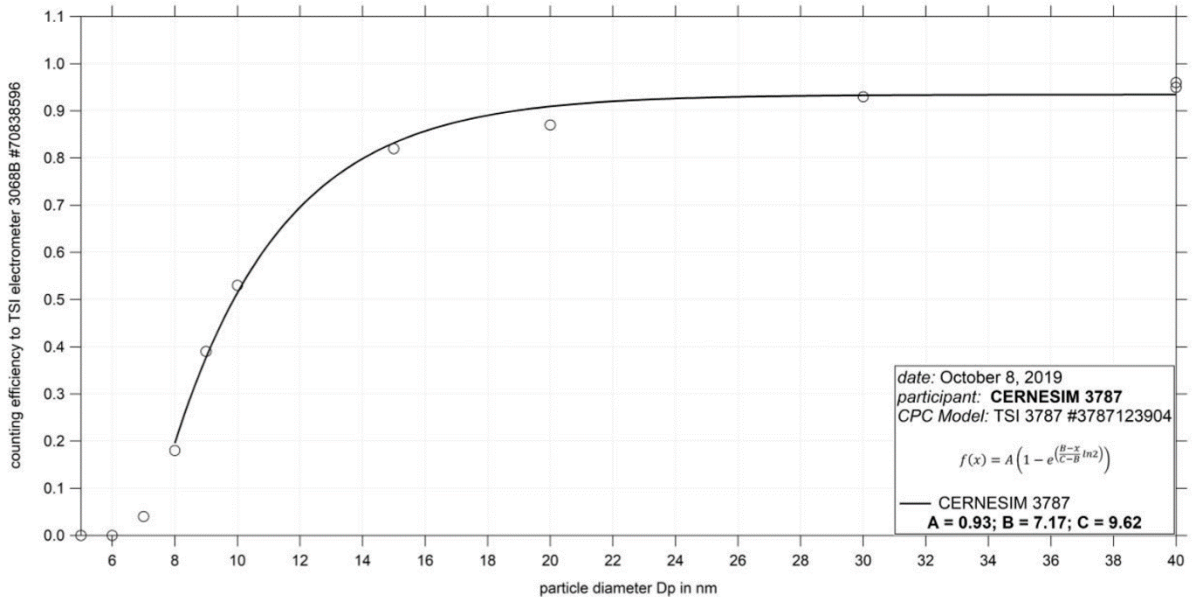

Figure 5: Counting efficiency for CERNESIM Water CPC 3787 S/N 3787123904 against aerosol electrometer 3068 S/N 70838596; silver particles between 5 and 40 nm were used for calibration; the calculated Dp50 is 9.62 nm.

References

Wang J., J. F. Doussin, S. Perrier, E. Perraudin, Y. Katrib, E. Pangui, and B. Picquet-Varrault (2011), Design of a new multi-phase experimental simulation chamber for atmospheric photosmog, aerosol and cloud chemistry research, *Atmospheric Measurement Techniques*, 4, 2465–2494.

WCCAP-report-CPC-2019-5-1 (2019): Intercomparison of Condensation Particle Counter Project No.: CPC-2019-5-1, published in https://www.actris-ecac.eu/cpc-2019-5.html.

WCCAP-report-CPC-2019-4-1 (2019): Intercomparison of Condensation Particle Counter Project No.: CPC-2019-4-1, published in https://www.actris-ecac.eu/cpc-2019-4.html.

WCCAP report MPSS-2019-4-1 (2019): Intercomparison of Mobility Particle Size Spectrometers Project No.: MPSS-2019-4-1, published in https://www.actris-ecac.eu/mpss-2019-4.html