TNA User Report

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Project title	Calibration Workshop MPSS+CPC
Name of the accessed calibration center	World Calibration Centre for Aerosols (WCCAP)
Number of users in the project	2
Project objectives (max 100 words)	- TSI 3928 SMPS - Palas ENVI-CPC
Description of work (max 100 words):	Maintenance and calibration of TSI 3928 (MPSS-2019-5-2) and participation in Intercomparison with TSI 3775 and Palas ENVI-CPC (CPC-2019-5-6)

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User status[3]	RES & EXP
New user	Yes

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New user	No

[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

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: Christian Maier
Calibration center's name and location: ECAC
Campaign name and period: MPSS-2019-5-2 & CPC-2019-5-6

Introduction

In order to full fill the calibration and maintenance standards of GAW and ACTRIS the Sonnblick team participated in the WCCAP Workshop of Tropos in October 2019. The main goal was to compare and calibrate our Condensation Particle Counters (CPC) and our Mobility Particle Size Spectrometer (MPSS). This is necessary to verify the quality of the out coming data for scientific purposes.

Scientific Objects

The regular maintenance of Aerosol instruments is inevitable for providing suitable aerosol data. Hence we took part during the MPSS Workshop with following instrument:

TSI 3938 SMPS which consists of the following parts:

- Classifier (TSI 3082) Serial: 3082001549001
- Detector (TSI 3775) Serial: 3775155101
- DMA (TSI 3081) Serial: 3081A1550003

Beside the MPSS we participated in the CPC calibration workshop. The Detector from the SMPS and our second CPC were chosen for the Intercomparison:

- TSI 3775 Serial: 3775155101
- Palas ENVI CPC SN: 9532

Method and experimental set-up

Two main points were on the agenda for the calibration workshop. The first was to adapt the experimental setup for the MPSS and perform several runs with the instruments and a reference MPSS from TROPOS for evaluation. The second point was an Intercomparison of the CPC's participating in this workshop.

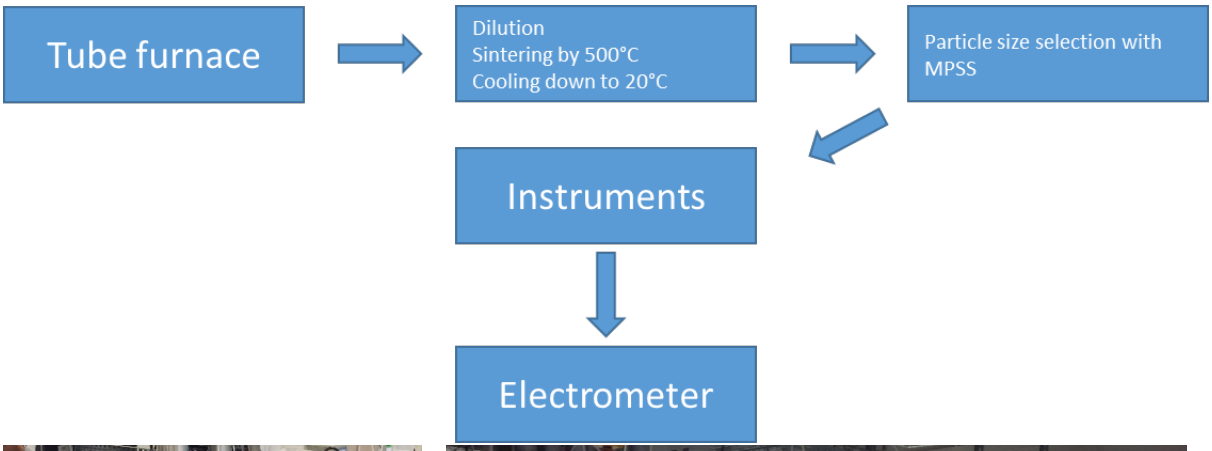
MPSS Intercomarison

The Laboratory setup was provided by TROPOS as follows. The ambient aerosol flow (15-20 l/min) with a relative humidity of less than 30% (realized by a dryer) was allocated through the instruments during the intercomparison. Additional equipment such as a flowmeter and Nanosphere Standard Size PSL (203 nm) was necessary.

Figure 1: Instrumentation setup of our TSI SMPS at the WCCAP-LAB.

CPC Intercomparison

By comparing CPC's we wanted to know the accuracy and sensibility of the instruments by different particle diameters. In this case an aerosol consisting of silver particles was generated by a tube furnace. Beside Zero-checks we made several runs with different particle diameters starting at 40 nm and going down to 5 nm. The particle size selection was made by a lab MPSS from TROPOS. The reference was an Electrometer TSI 3068B.



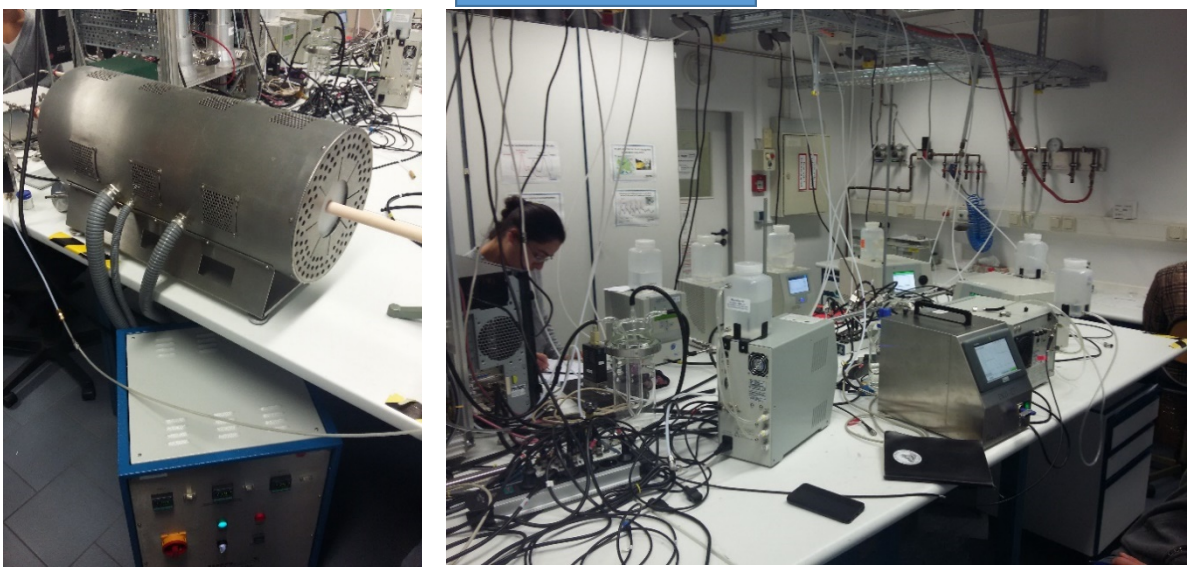


Figure 2: Laboratory setup for the CPC Intercomparison (top). Tube furnace (bottom left) and participating CPC's (bottom right).

Data description

The main purpose of Mobility particle size spectrometers is to measure the particle spectra of the air within a certain size range. Thus the TSI SMPS has two data outcomes. The first is the particle size distribution and the second one is the total number of particles over time. For measuring and exporting the data, the TSI software Aerosol Instrument Manager (AIM) is mandatory. As the TSI 3775 and PALAS ENVI CPC are both condensation particle counters they only detect the total number of particles within a specified range.

Preliminary results and conclusions

MPSS results

The first step was to run our instrument with the PSL 203 nm solution which is important to improve the instruments particle distribution performance. Hence our TSI SMPS should measure a peak at 209 nm particles.

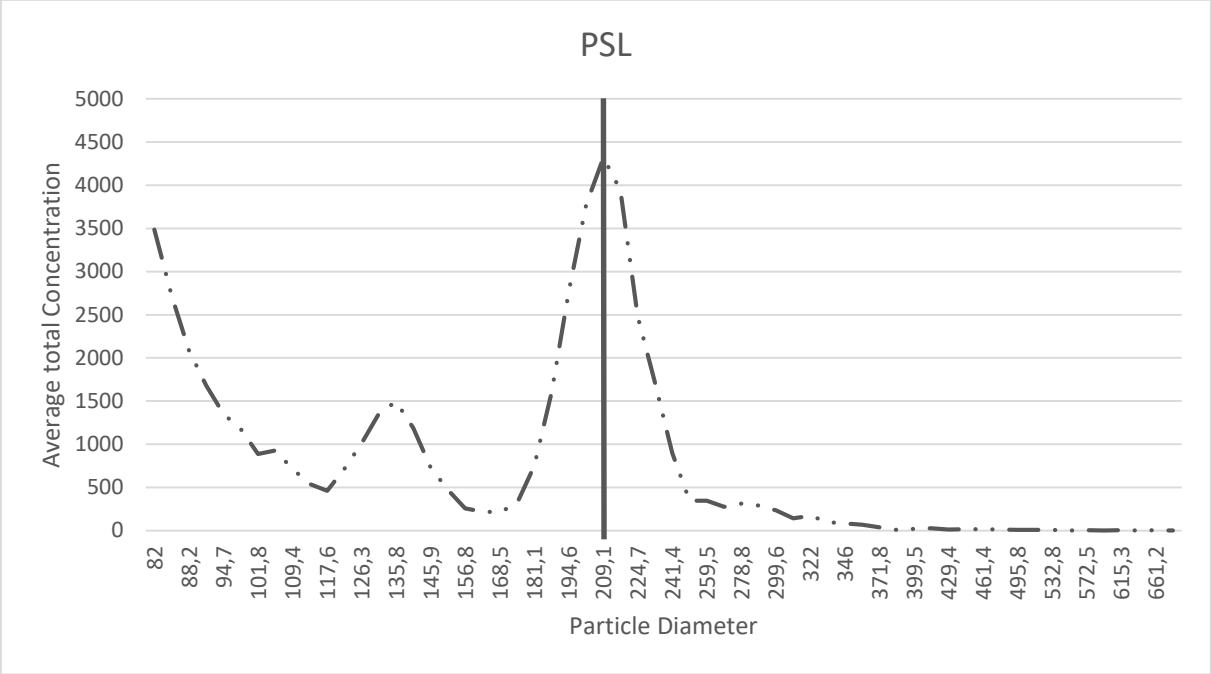


Figure 3: Particle distribution of PSL 203 nm run. Peak was at 209.1 nm. The setup was: Low Flow with impactor (0,071)

Apart from distribution comparisons we ran our instruments every night from 6 pm to 6 am. The data was averaged over the particle diameter to get a distribution of the period and a time series of the total concentration was made. The setup for the first night was our standard setup as we run our instrument at the station:

- Low/High flow change mode
- Without impactor

Results of the first night run show a significant deviation of our MPSS to the reference. Our TSI detected approx. 20 to 30 % less particles.

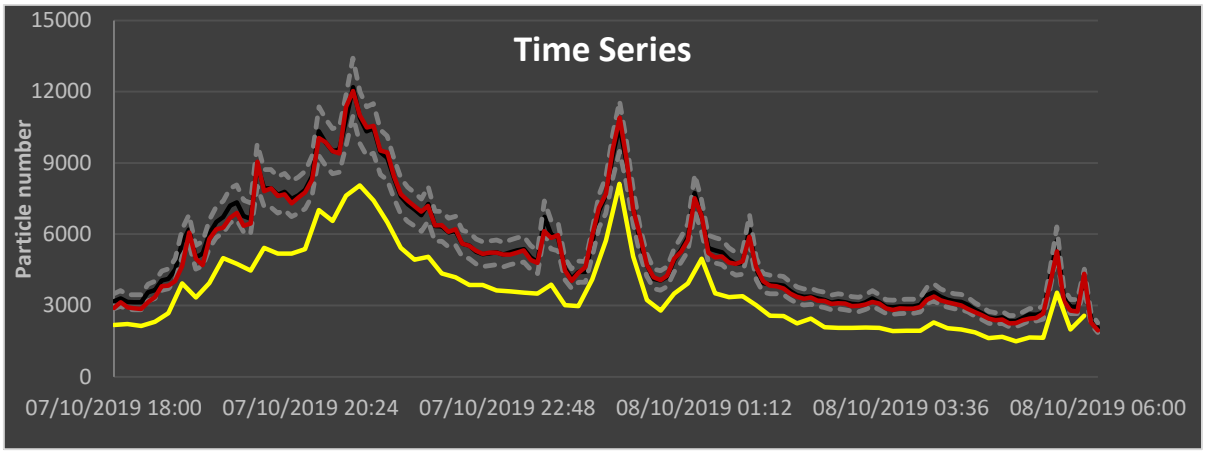


Figure 4: Time series of Night run 1. ZAMG TSI SMPS (yellow) with TROPOS TCPC (black) and TROPOS MPSS (red). Grey dashed lines are the +- 10% ranges.

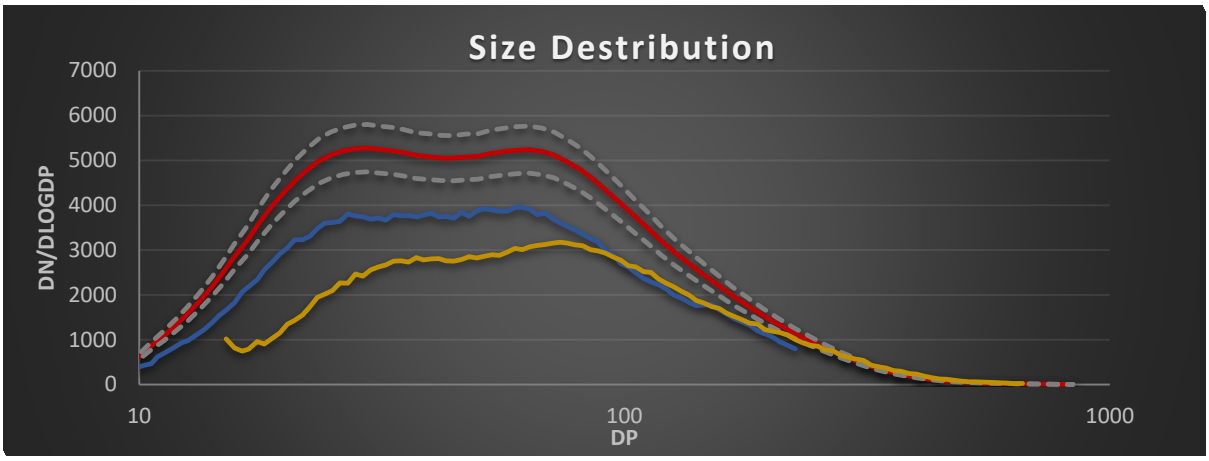


Figure 5: Mean Particle size distribution of night run 1. With Low Flow (yellow), High Flow (blue) and the TROPOS reference. Grey dashed lines are the +- 10% ranges.

During the week we could perform 4 night runs in total with almost the same results but with different Setups. Following table gives an overview of our Setups:

Run	Classifier	Detector	DMA	Scan Time	Sheath Flow	Aerosol Flow	Impactor
PSL	3082	3775	3081	120	1,4	0,281	0,071
Night 1	3082	3775	3081	120	2,5/13	0,3/1,5	None
Night 2	3082	3775	3081	120	15	1,5	None
Night 3	3082	3775	3081	280	5	1	None
Night 4	3082	3775	3081	120	2,5/13	0,3/1,5	None

We cleaned and maintained our DMA and had several test runs during the day to figure out the low particle detection problem of our SMPS. Night run 4 shows the final results of this workshop. We have significant underestimations of the particle number concentrations integrated over a certain size range (10-800 nm). Unfortunately, we couldn't solve the low detection problem. Undefined particle losses within the classifier could be one reason for the deviation of our instrument in comparison to the reference MPSS.

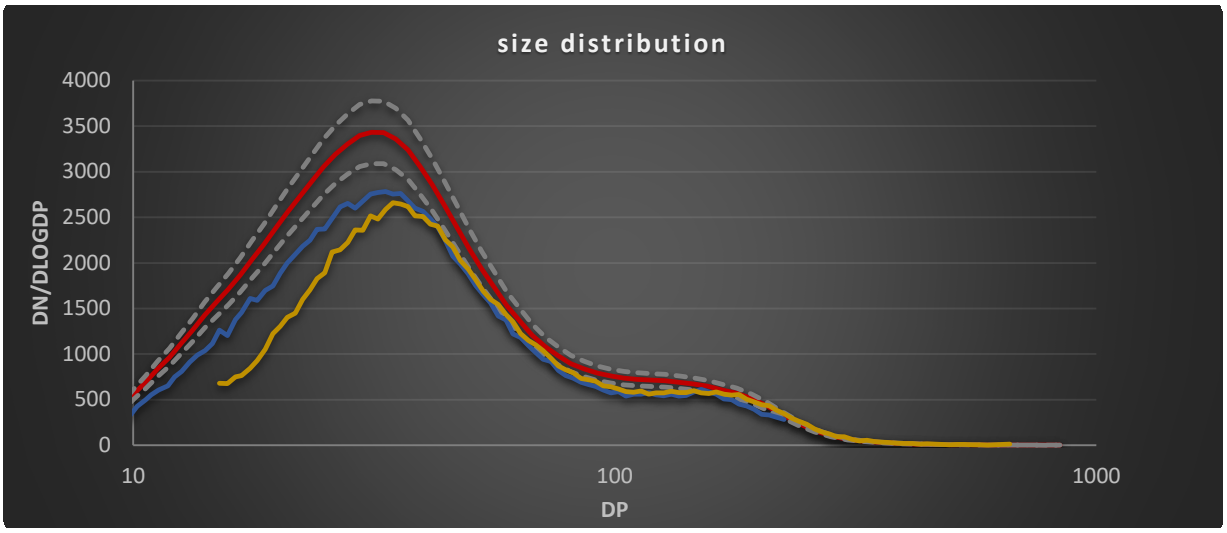


Figure 6: Mean Particle size distribution of night run 4. With Low Flow (yellow), High Flow (blue) and the TROPOS reference. Grey dashed lines are the +- 10% ranges.

CPC results

We participated in the WCCAP CPC Intercomparison with our TSI 3775 and Palas Envi CPC. Altogether eight CPC's took part. The final results of our instruments are shown below. The counting efficiency of the particle counters was determined by an aerosol electrometer. Zero measurements of both instruments showed 0 particles/cm³ within 5 minutes.

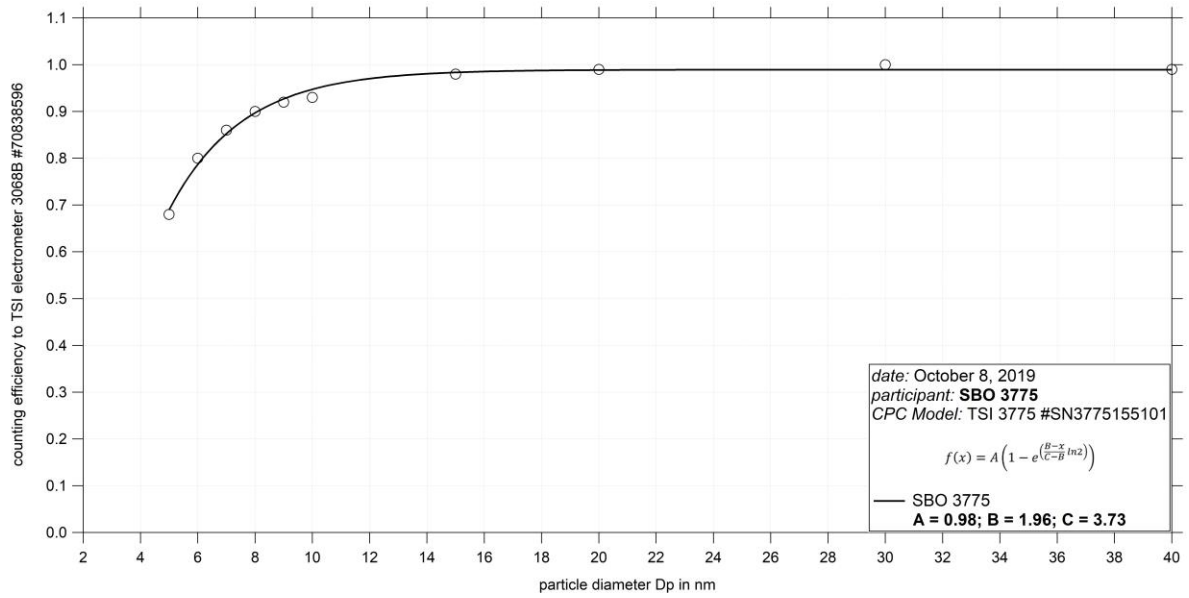


Figure 7: Counting efficiency of the TSI 3775.

The counting efficiencies of the TSI were within 0,9 until 8 nm particles. It declined by detecting smaller particles to a minimum of 0,68.

The Palas ENVI CPC had similar detection results for coarser particles (>= 15nm). Due to the lower detection range of the instrument the efficiency curve declined for particles smaller than 10 nm. The smallest particle size detected was 8 nm.

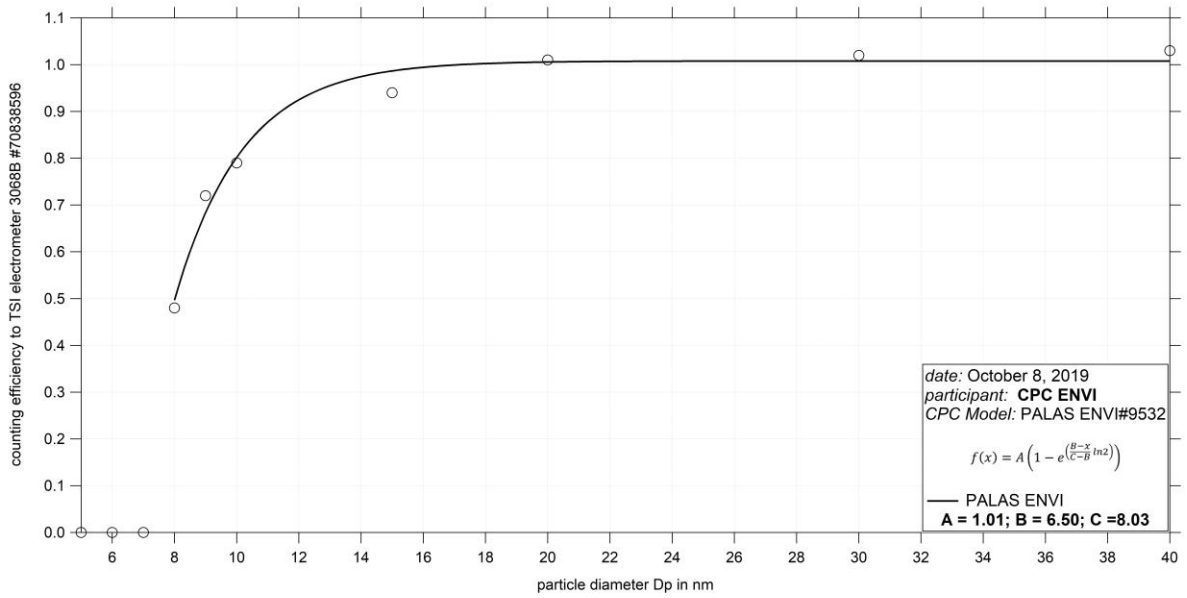


Figure 8: Counting efficiency of the Palas ENVI CPC.

Outcome and future studies

As a result of the detection problem of our TSI SMPS we decided to send it to the manufacturer for a repair service of our classifier. In a second step we will participate in a future calibration workshop with the instrument for verifying its performance.

Both CPC's passed the Actris and GAW conventions within the CPC intercomparison. Unfortunately, the Palas ENVI CPC showed significant deviations to the TSI CPC when running it at higher altitude. Hence additional investigations are mandatory to solve this problem.