

## Intercomparison of Mobility Particle Size Spectrometers

Project No.: MPSS-2016-4-1

### Basic information:

Principal Investigator:	Eija Asmi
Home Institution:	Finnish Meteorological Institute Erik Palmenin aukio 1 00560 Helsinki FINLAND
Participant:	David Brus
Instrument No.1:	FI-FMI DMPSS TSI CPC Model 3010, SN: 11080
Location of the quality assurance:	TROPOS Leipzig, lab 118
Comparison period:	May 30, 2016 – June 03, 2016
Last Intercomparison (with Project No.):	

### Summary of Intercomparison:

#### Pre-Status:

The FI-FMI Homemade DMPS was not in a good condition. The system is out of the +/-10% range of the Reference MPSS No.1 from TROPOS.

#### Final Status:

The FI-FMI Homemade DMPS did not pass the quality standards of ACTRIS and GAW.

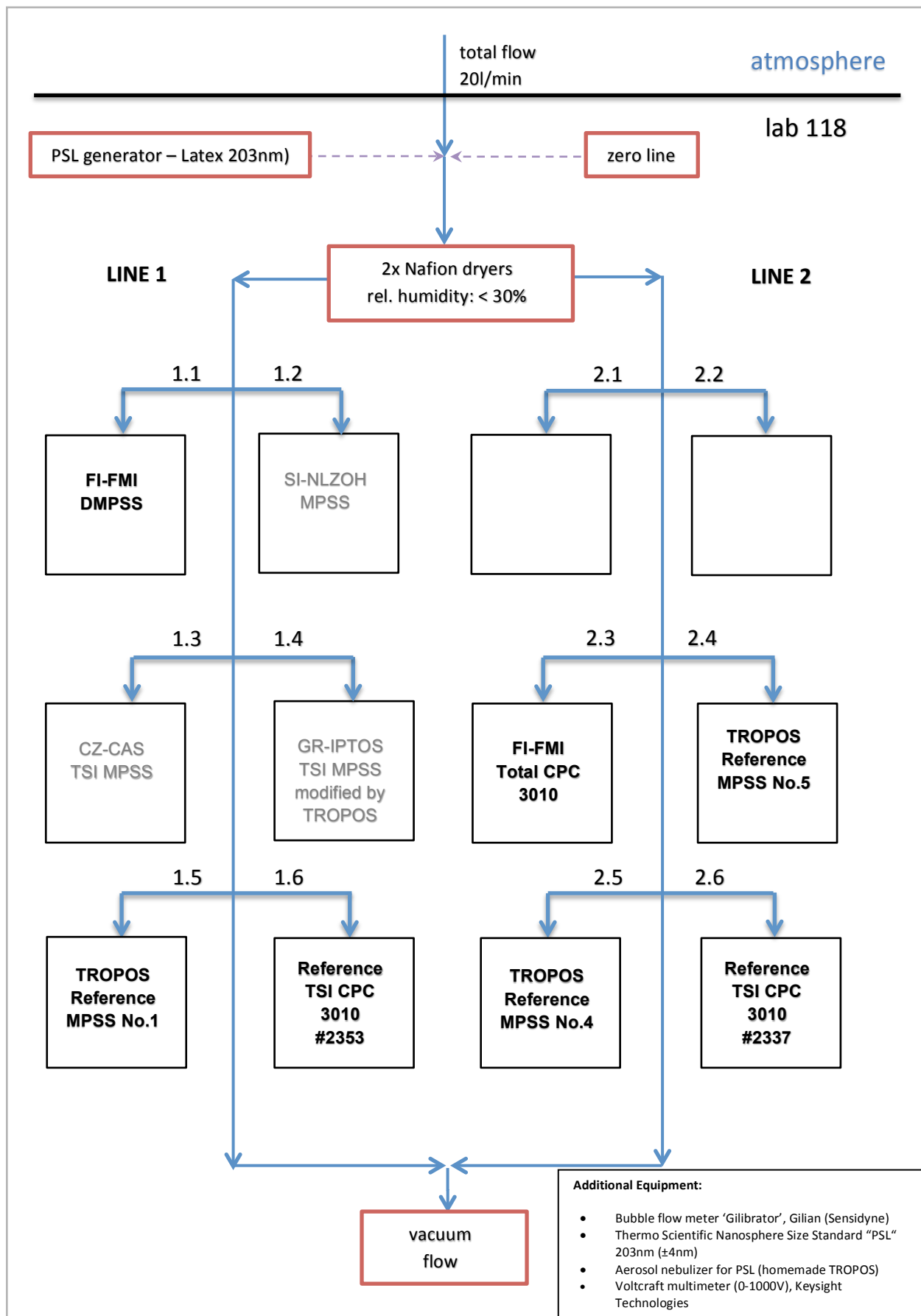
## List of Components:

	Specification	Reference MPSS No.1	FI-FMI DMPSS
Position (Line)		1.5	1.1
Company		TROPOS	FMI
Software		TROPOS 6.1	Home made
CPC		TSI CPC, Model 3772	Model 3010
Flow ratio		1.0 : 5.0	1.0 : 10.0
Source		Kr85	Ni 63
HV cassette		positive	positive
DMA		Hauke medium	Vienna type medium
Flow meas.	aerosol	✓	✓
Dryer		✓	
RH sensor		✓	✓
T sensor		✓	✓
RH sensor	Sheath air	✓	
T sensor		✓	
Dryer		✓	
p sensor		✓	

- 30.05.2016: System arrived in Leipzig. Setup in lab 118 including checks and calibrations.
- 30.05.2016: Pre-status overnight run from 30.05.2016, 6 pm to 31.05.2016 8 am.
- 31.05.2016: CPC Workshop in lab 130. More details in the ACTRIS CPC Workshop report. It was necessary to clean the CPC. Back to lab 118 for setup, checks, and calibrations.
- Information regarding the PSL measurements: The pre-status on Monday showed a large peak at 216 nm compared to the TROPOS DMA. We cleaned the DMA and changed the electrode inside due of scratches. We still had the same problem of the large peak at 216 nm. After changing the flow ratio in the software to 1:10 and calibrating the sheath air flow against PSL 203, we got a peak at 203.2 nm. But we still had the large size distribution compared to the TROPOS DMA. We changed the different parts (head, cylinder, and bottom parts) of the DMA one at a time, still there were no changes in the size distribution. But when we used a TROPOS DMA, we achieved good results. David will try other DMAs in Finland.
- Concentration Problem: In the pre-status run, the concentration was too high compared to the TROPOS Reference Instrument. We did several tests to check how the software is working. David wants to check the software when he is back in Finland. The raw-concentration is in the range of +/-10%. It looks like there is a problem with the inversion process. The DMPS concentrations for smaller particle (<30nm) is too high for both raw and inverted data.
- 31.05.2016: Overnight run from 31.05.2016, 6 pm to 01.06.2016 8 am.
- 01.06.2016: Checking and cleaning of the DMA.
- 01.06.2016: Overnight run from 01.06.2016, 6 pm to 02.06.2016 8 am.
- 02.06.2016: Final-status overnight run from 02.06.2016, 6 pm to 03.06.2016 8 am.

- 02.06.2016: Data check and backup. Finalize all for shipping.

## Laboratory setup:



**TROPOS Total CPC Status**

Instrument	Variable	Status
<b>TROPOS Total CPC 3010, #2337</b>	Power	good
	Laser	good
	Flow	good
	Liquid level	full

Institute	Variable	Status
<b>TROPOS Total CPC 3010, #2353</b>	Power	good
	Laser	good
	Flow	good
	Liquid level	full

**TROPOS Reference Instrument Status**

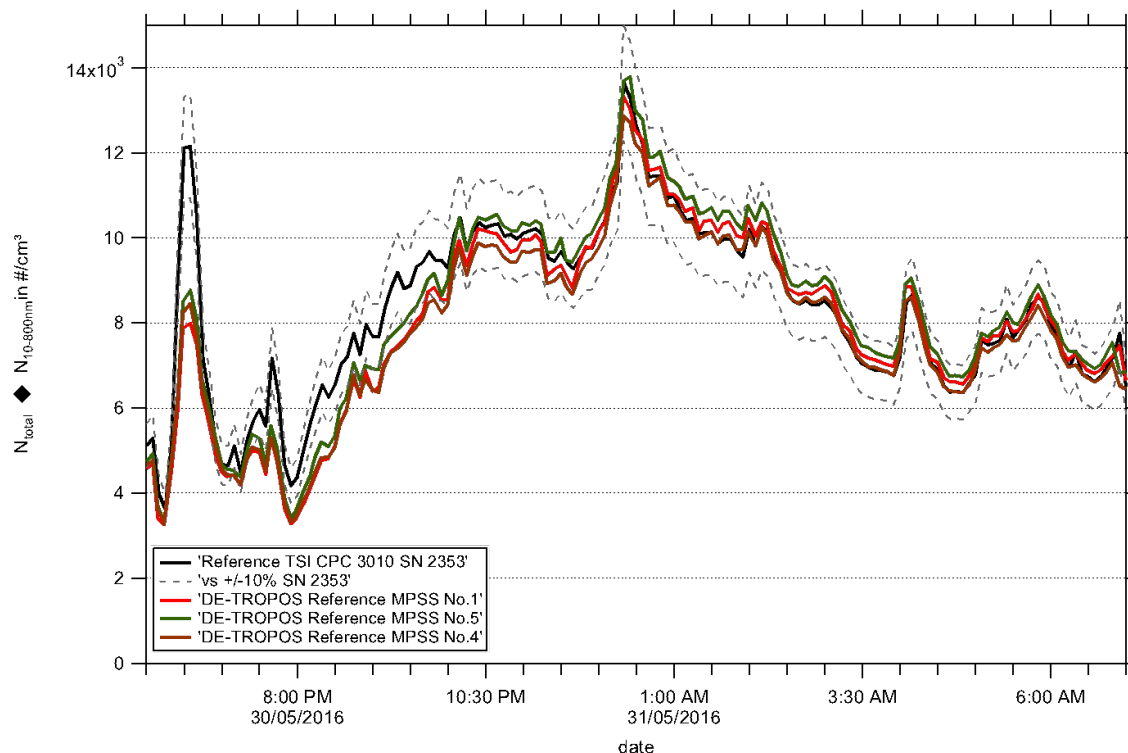
Instrument	Variable	Status
<b>TROPOS Reference Instrument No.1, TSI CPC 3772 #3772141701</b>	Saturator Temp	39.0°C
	Condenser Temp	22.0°C
	Optics Temp	40.0°C
	Cabinet Temp	32.8°C
	Ambient Pressure	98.7 kPa
	Orifice Pressure	69.8 kPa
	Nozzle Pressure	2.8 kPa
	Laser Current	50 mA

Instrument	Variable	Status
<b>TROPOS Reference Instrument No.5, TSI CPC 3772 #71011008</b>	Saturator Temp	38.9°C
	Condenser Temp	22.0°C
	Optics Temp	40.0°C
	Cabinet Temp	38.3°C
	Ambient Pressure	99.0 kPa
	Orifice Pressure	73.6 kPa
	Nozzle Pressure	2.5 kPa
	Laser Current	52 mA

Instrument	Variable	Status
<b>TROPOS Reference Instrument No.4, TSI CPC 3772 #71011009</b>	Saturator Temp	39.0°C
	Condenser Temp	22.0°C
	Optics Temp	39.9°C
	Cabinet Temp	33.3°C
	Ambient Pressure	99.2 kPa
	Orifice Pressure	78.7 kPa
	Nozzle Pressure	2.8 kPa
	Laser Current	46 mA

## TROPOS Reference Systems during the pre-status May 30-31<sup>st</sup>

### Time Series



**Figure 01:** Time series (May 30, 2016 06:00 pm – May 31, 2016 08:00 am) of the integrated particle number concentration ( $N_{10-800nm}$ ) of the TROPOS Reference MPSS and total number concentration ( $N_{total}$ ) of the Reference TSI CPC 3010. The inversion was performed using TROPOS software. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

## Pre- Status of the Candidate (May 30-31<sup>th</sup>)

### Components and zero check

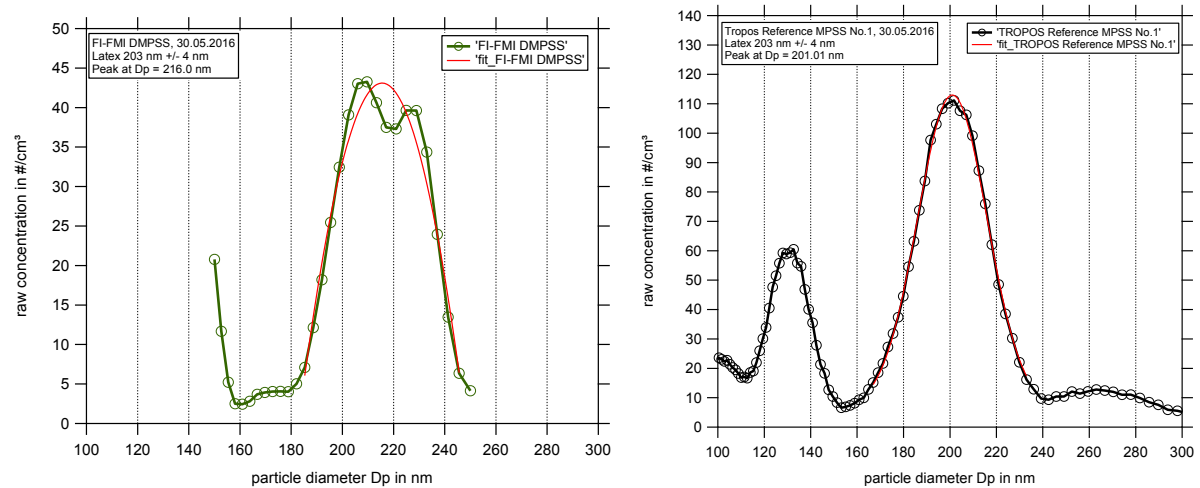
Instrument	Line	Flow		Zero	
TROPOS Reference MPSS No.1	1.5	1.026	l/min	0	# cm <sup>-3</sup>
TROPOS Total CPC 3010, #2337	1.6	1.015	l/min	0	# cm <sup>-3</sup>
FI-FMI DMPS	1.1	0.98	l/min	0	# cm <sup>-3</sup>
FI-FMI total CPC	2.3	0.902	l/min	0	# cm <sup>-3</sup>

### High voltage calibration

Instrument	[V]	0 V	4 mV	80 mV	800 mV
TROPOS Reference MPSS No.1	final	0.0	4.9	99.5	999.1
	[V]	0 V	5 mV	200 mV	800 mV
FI-FMI	final	-	Check	by	David

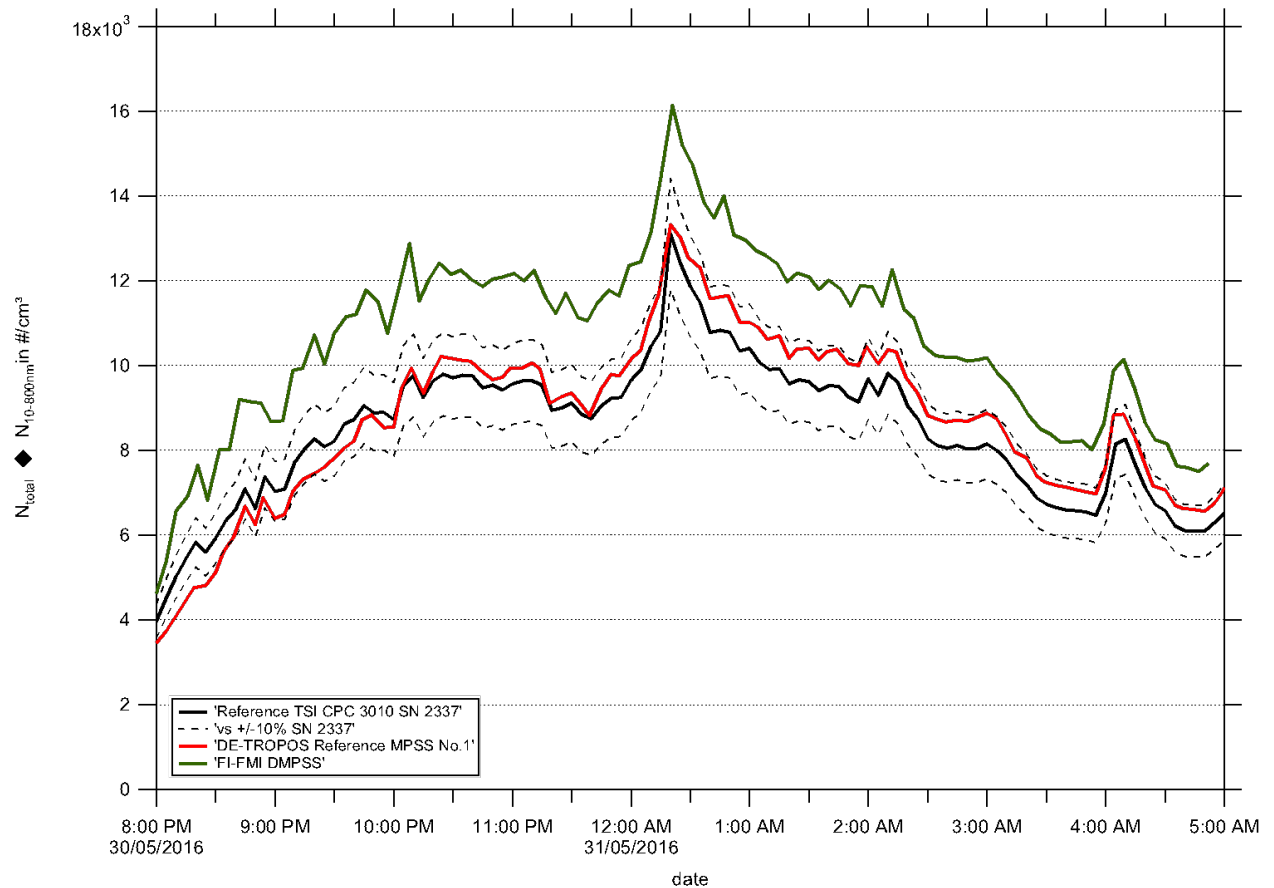
### Latex 203nm ±4nm (pressure 988 hPa, 23.0°C)

Instrument	Latex 203 [nm]	slope
TROPOS Reference MPSS No.1	201.01	5.27
FI-FMI	216.0	-



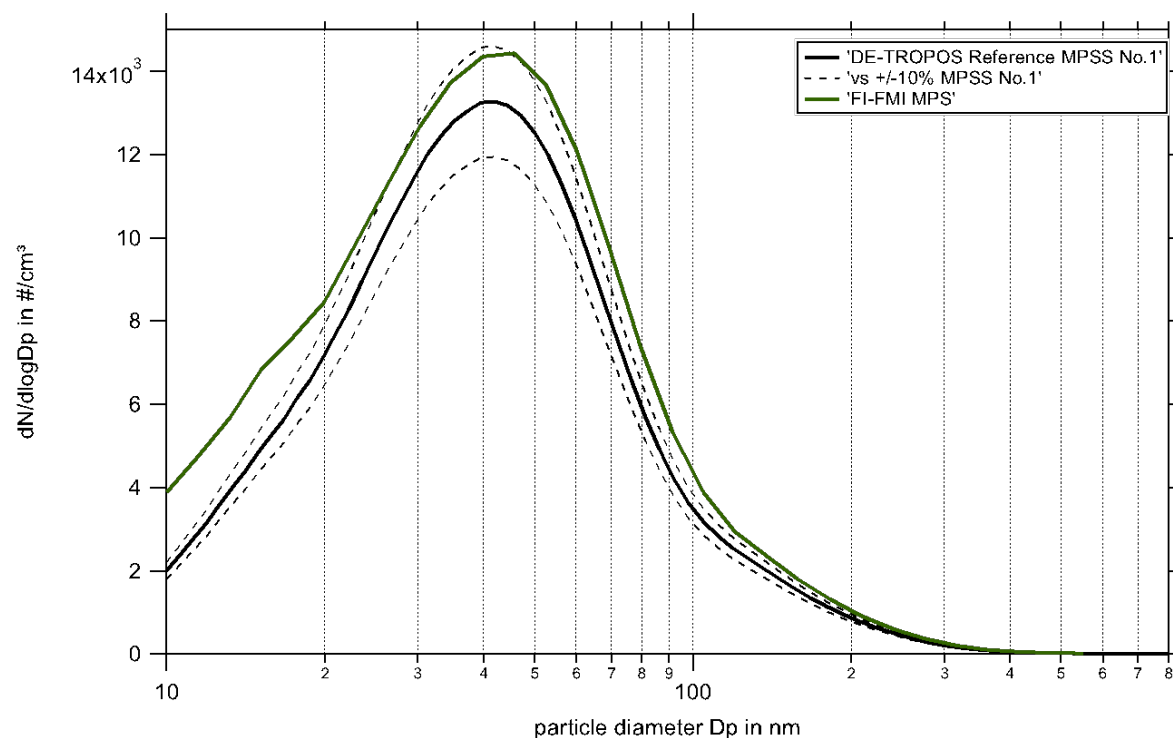
**Figure 02:** Measurement of latex 203 nm: Particle size distribution (raw concentration) for latex 203 nm on May 30<sup>th</sup>, 2016.

## Time Series



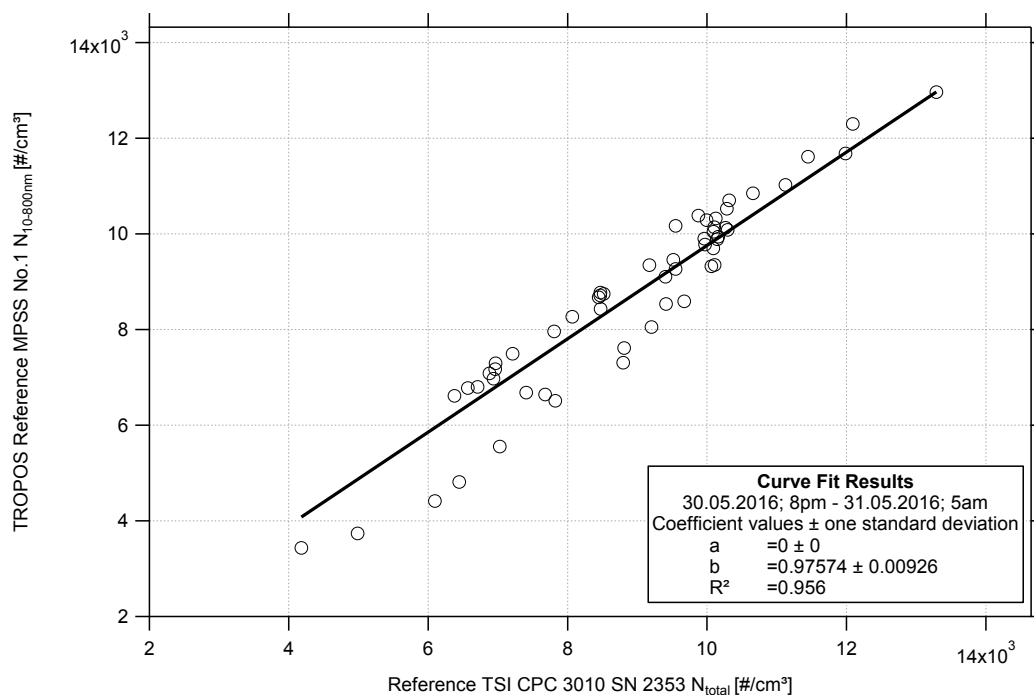
**Figure 03:** Time series (May 30, 2016 06:00 pm – May 31, 2016 08:00 am) of the integrated particle number concentration ( $N_{10-800nm}$ ) of the MPSS and total number concentration ( $N_{total}$ ) of the reference TSI-CPC Model 3010. The inversion was performed using TROPOS software. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

## Particle Number Size Distribution



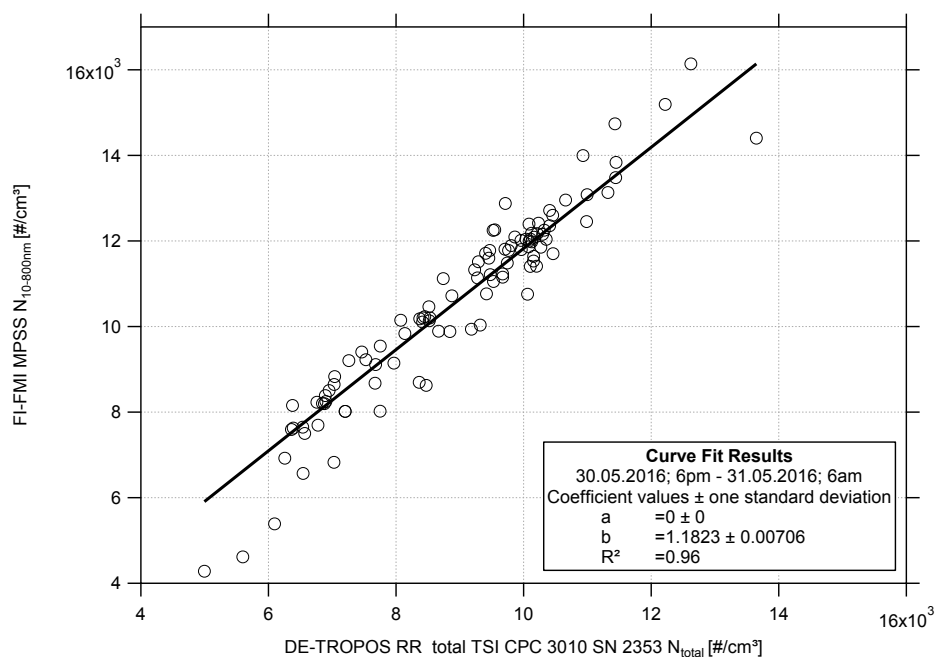
**Figure 04:** Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against FI-FMI from May 30, 2016 08:00 pm until May 31, 2016 05:00 am. Multiple charge correction, internal diffusion losses and CPC efficiency are included for both of the TROPOS Reference MPSS.

## Correlation

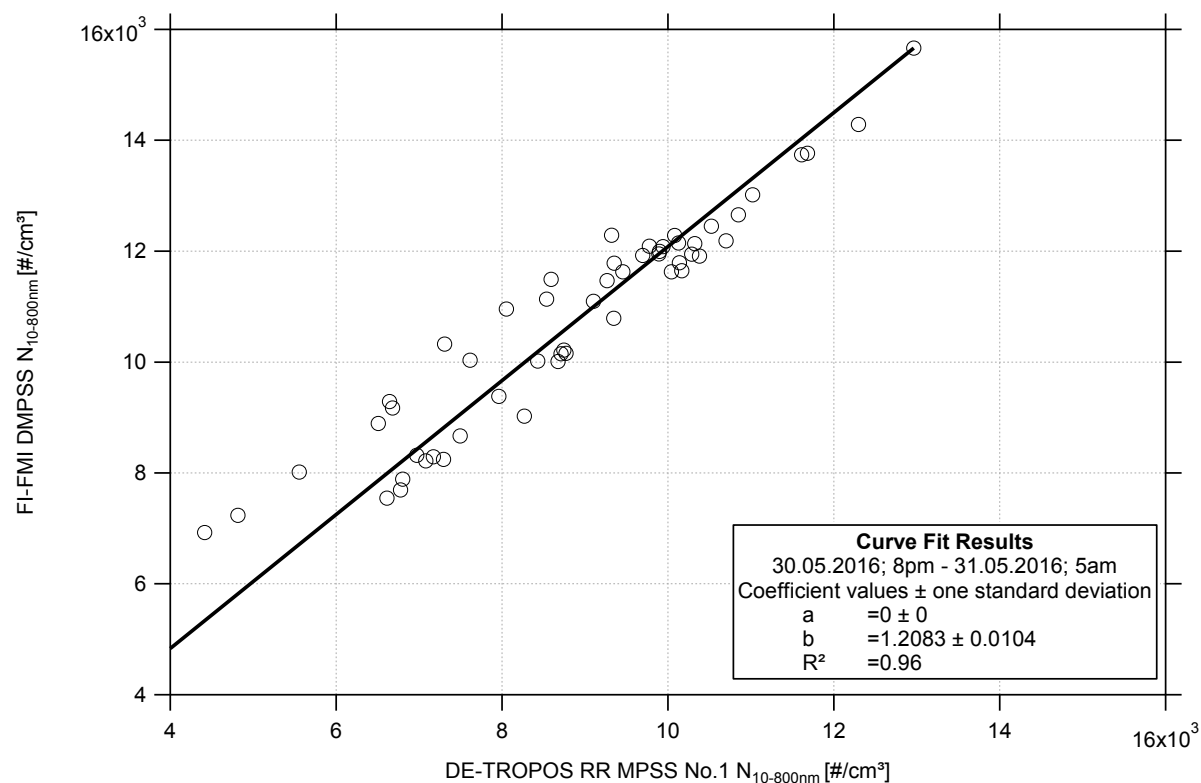


**Figure 05:** Linear regression between the number concentrations of the TROPOS Reference TSI CPC Model 3010 SN: 2353 and TROPOS Reference MPSS No.1. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.





**Figure 06:** Linear regression between the number concentrations of the TROPOS Reference TSI CPC Model 3010 SN: 2353 and FI-FMI. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.



**Figure 07:** Linear regression between the number concentrations of the TROPOS Reference MPSS No.1 and FI-FMI. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

## Final Status of the Candidate June 02-03<sup>st</sup>

### Components and zero check

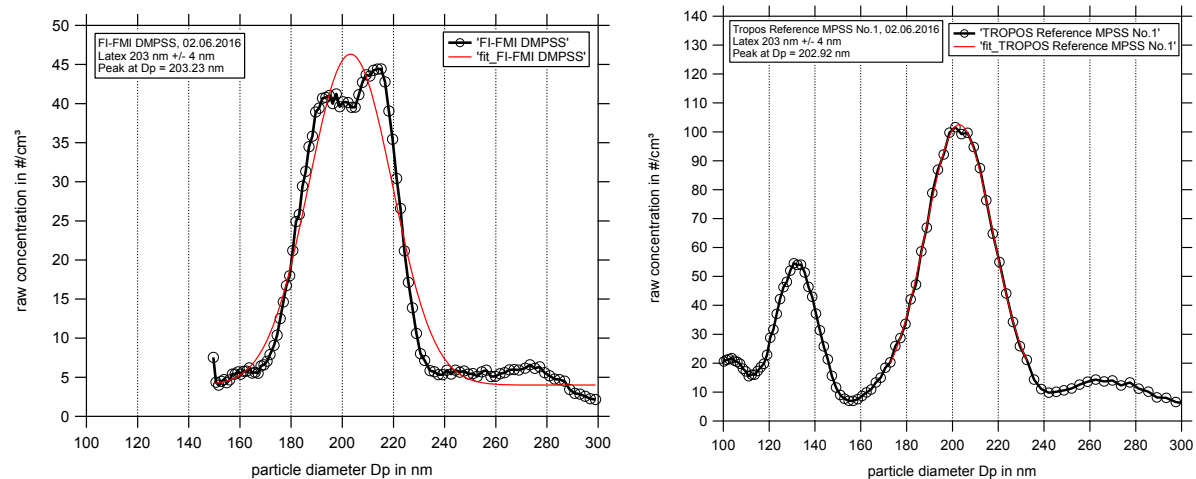
Instrument	Line	Flow		Zero	
TROPOS Reference MPSS No.1	1.5	1.026	l/min	0	# cm <sup>-3</sup>
TROPOS Total CPC 3010, #2337	1.6	1.015	l/min	0	# cm <sup>-3</sup>
FI-FMI DMPS	1.1	0.997	l/min	0	# cm <sup>-3</sup>
FI-FMI total CPC	2.3	1.011	l/min	0	# cm <sup>-3</sup>

### High voltage calibration

Instrument	[V]	0 V	4 mV	80 mV	800 mV
TROPOS Reference MPSS No.1	final	0.0	4.9	99.5	999.1
	[V]	0 V	5 mV	200 mV	1000 mV
FI-FMI	final		Check	by	David

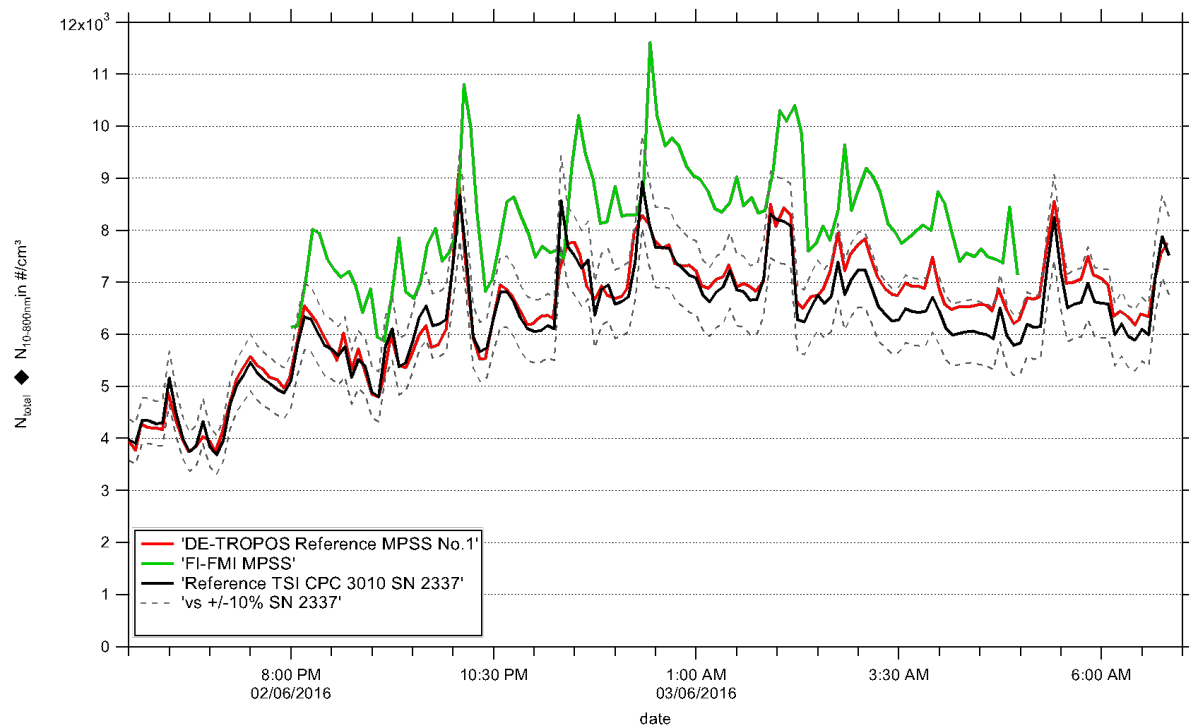
### Latex 203nm ±4nm (pressure 988 hPa, 23.0°C)

Instrument	Latex 203 [nm]	slope
TROPOS Reference MPSS No.1	202.92	5.27
FI-FMI	203.23	-



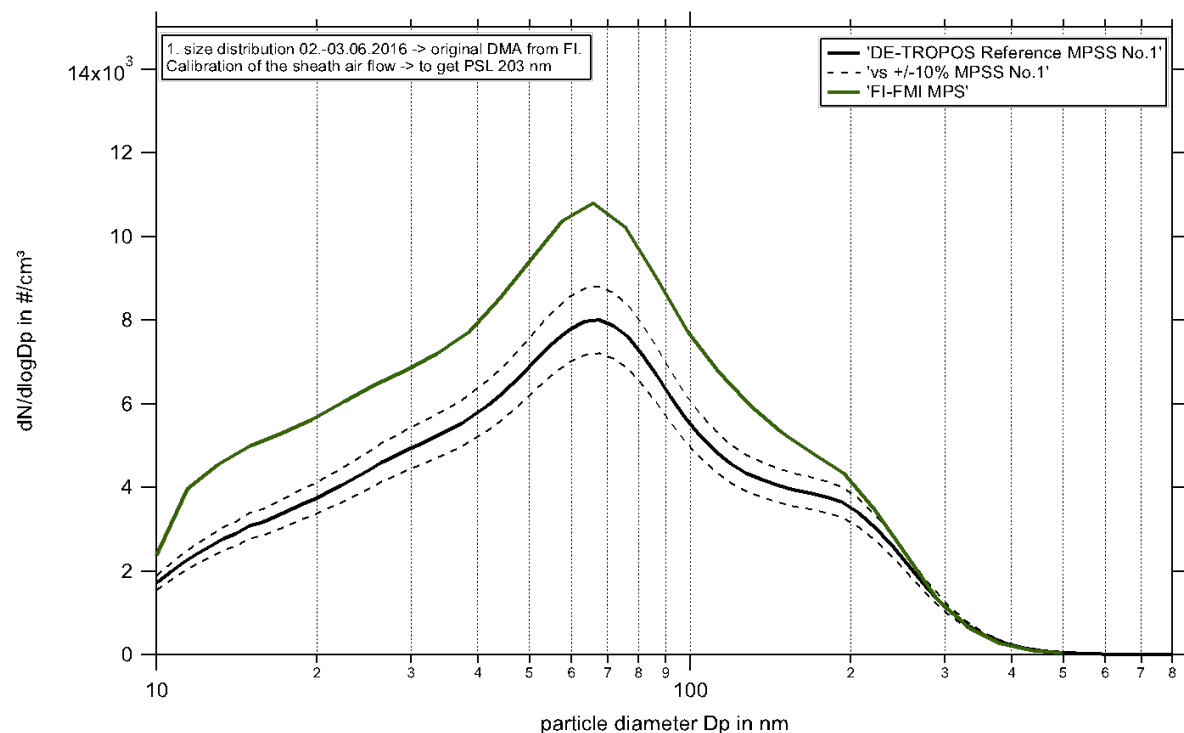
**Figure 08:** Measurement of latex 203 nm: Particle size distribution (raw concentration) for latex 203 nm on June 02<sup>th</sup>, 2016. FI-FMI showed the correct size at 203 nm, but there is still the same problem with the duple peak.

## Time Series

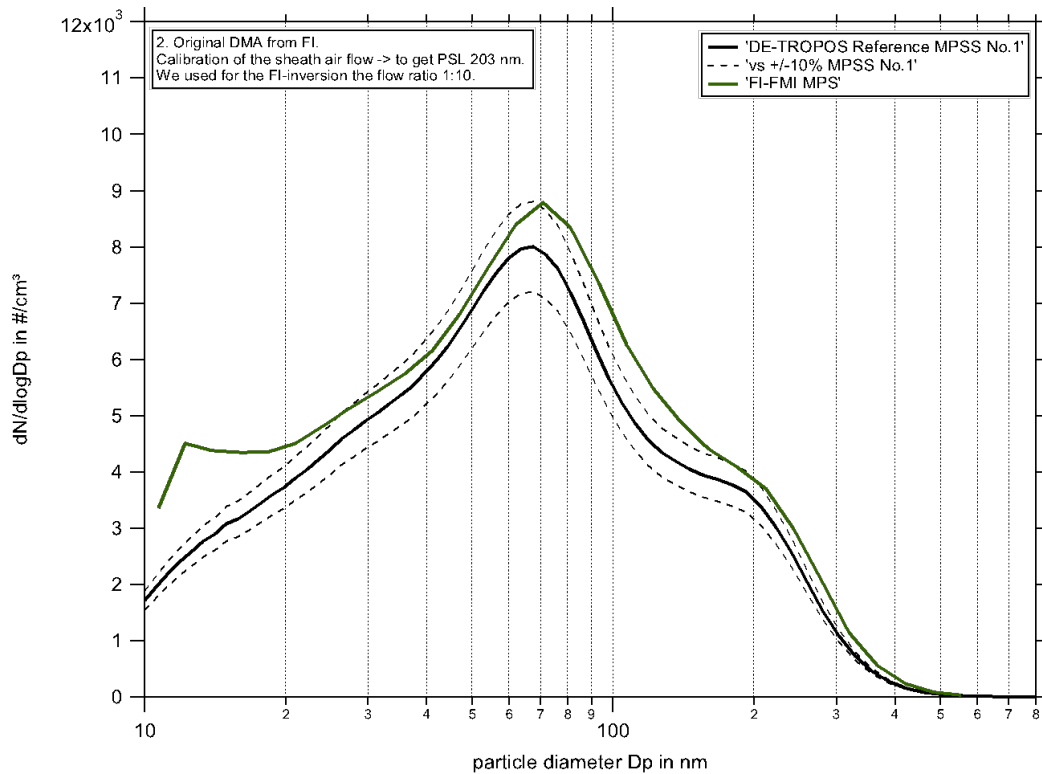


**Figure 09:** Time series (June 02, 2016 06:00 pm – June 03, 2016 08:00 am) of the integrated particle number concentration ( $N_{10-800nm}$ ) of the MPSS and total number concentration ( $N_{total}$ ) of the reference TSI-CPC Model 3010. The inversion was performed using TROPOS software. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.

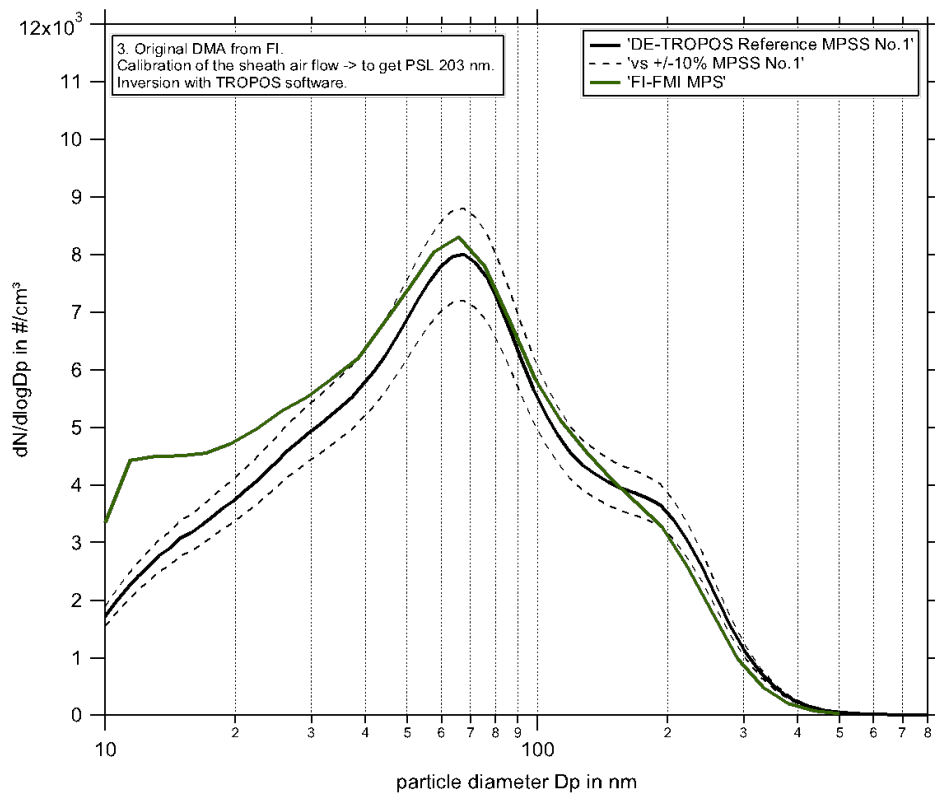
## Particle Number Size Distribution



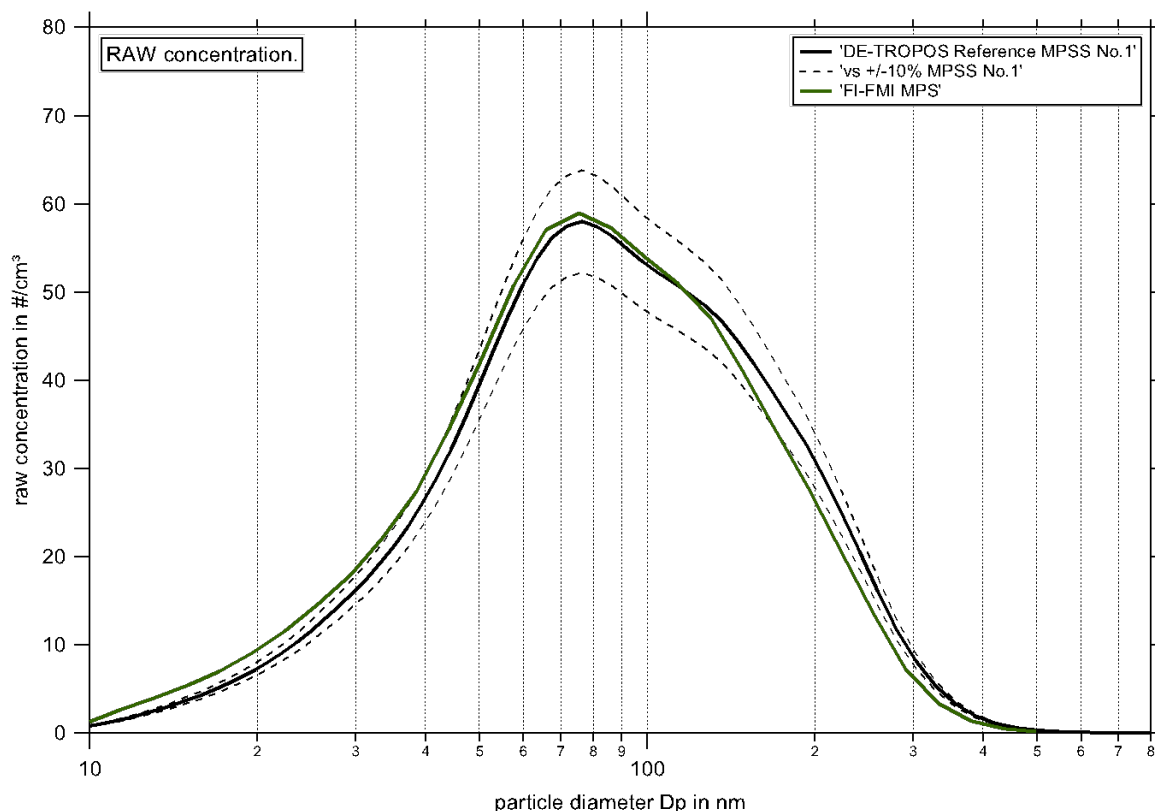
**Figure 10:** Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against FI-FMI from June 02, 2016 08:00 pm until June 03, 2016 05:00 am. The system was working with the original DMA from FI. The sheath air was calibrated to PSL 203 nm. David used the original FI- inversion.



**Figure 11:** Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against FI-FMI from June 02, 2016 08:00 pm until June 03, 2016 05:00 am. The system was working with the original DMA from FI. The sheath air was calibrated to PSL 203 nm. We used the inversion from FI with the flow ratio 1:10.

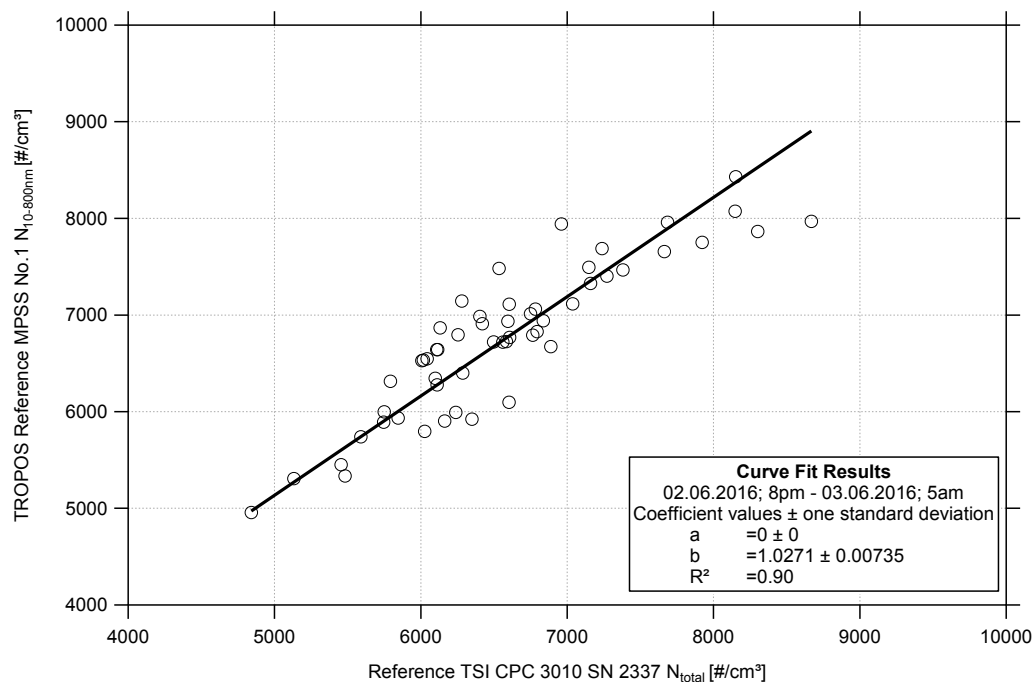


**Figure 12:** Comparison of mean particle number size distribution of TROPOS Reference MPSS No.1 against FI-FMI from June 02, 2016 08:00 pm until June 03, 2016 05:00 am. The system was working with the original DMA from FI. The sheath air was calibrated to PSL 203 nm. Inversion with TROPOS software.

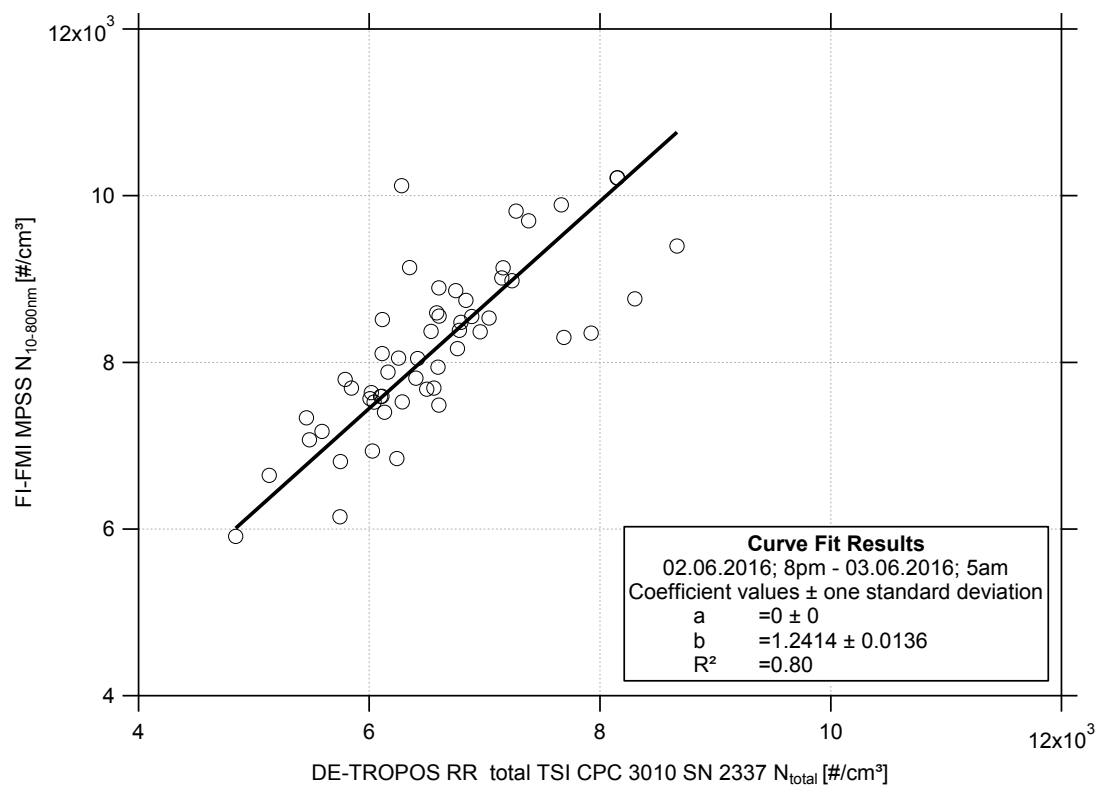


**Figure 13:** Comparison of mean particle number size distribution (raw concentration) of TROPOS Reference MPSS No.1 against FI-FMI from June 02, 2016 08:00 pm until June 03, 2016 05:00 am. The system was working with the original DMA from FI. The sheath air was calibrated to PSL 203 nm.

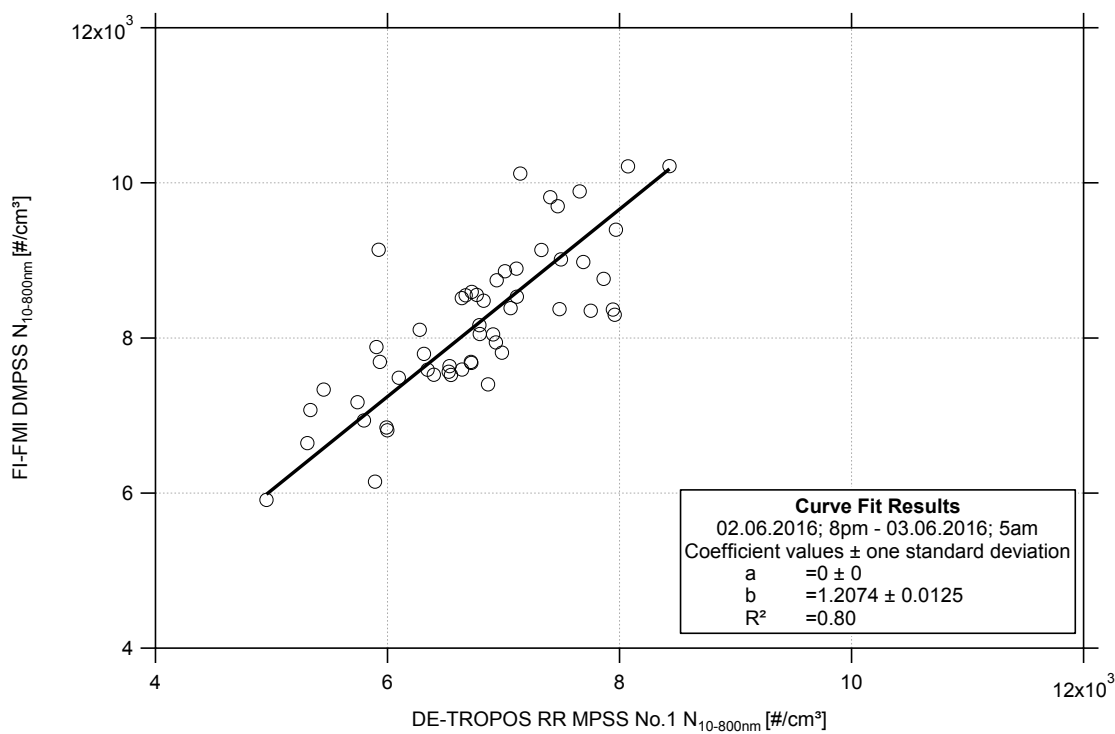
## Correlation



**Figure 14:** Linear regression between the number concentrations of the TROPOS Reference TSI CPC Model 3010 SN: 2337 and TROPOS Reference MPSS No.1. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.



**Figure 12:** Linear regression between the number concentrations of the TROPOS Reference TSI CPC Model 3010 SN: 2337 and FI-FMI. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.



**Figure 13:** Linear regression between the number concentrations of the TROPOS Reference MPSS No.1 and FI-FMI. Multiple charge correction, internal diffusion losses and CPC flow corrections are included.