Calibration workshop on Cloud Condensation Nucleus Counters

Project No.:

Principal Investigator: Pavel Moravec

Home Institution: *Czechia, ICPF*

Participant: Pavel Moravec

Candidate: **CCN-200**
Made by: DMT
Counter (SN): CCN-200, SN 1804-040
Software: DMT 5.0.6

Location of the quality assurance: TROPOS Leipzig, lab 118

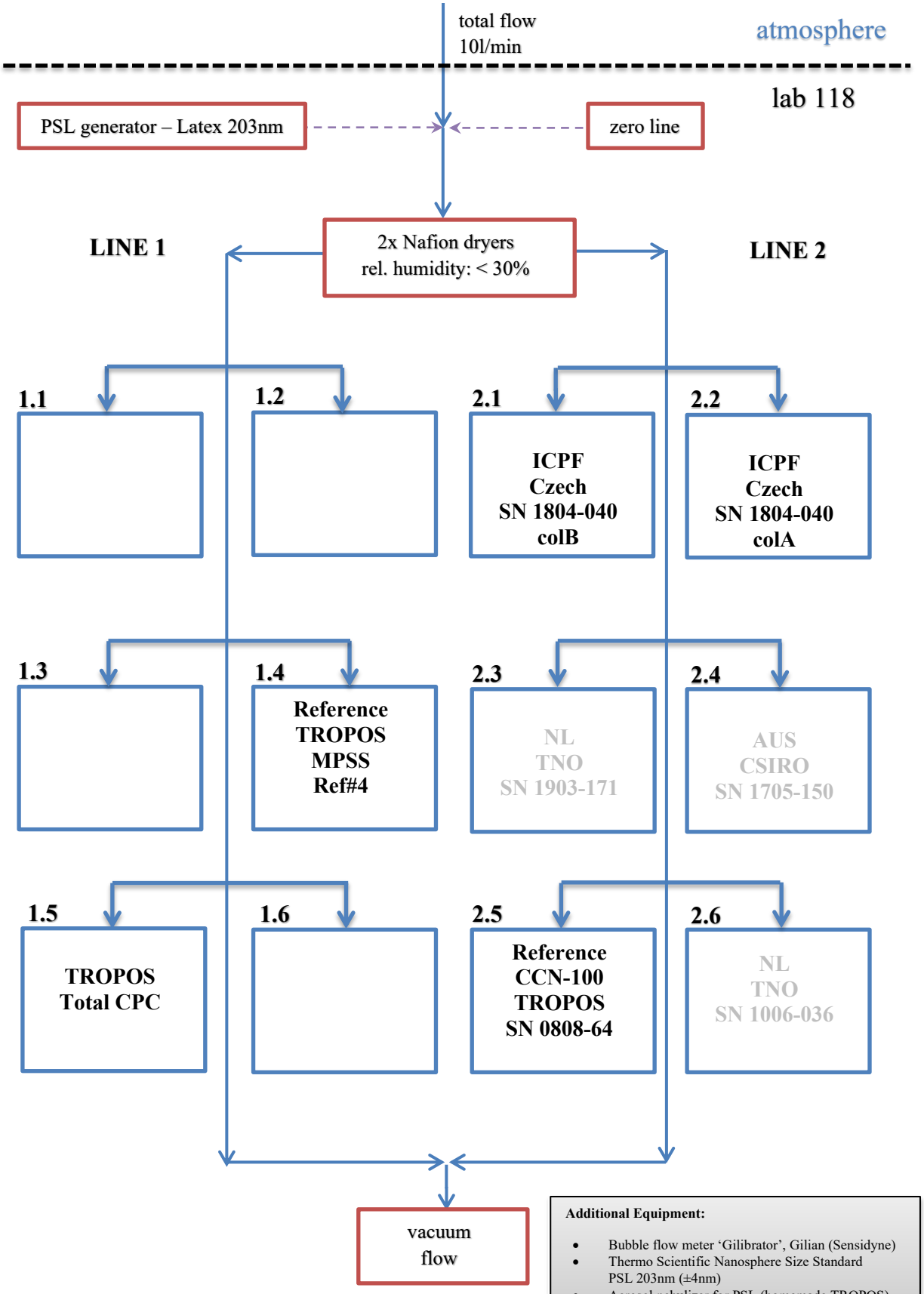
Comparison period: March 9, 2020 – March 12, 2019

Last Intercomparison (with Project No.):

Summary of Intercomparison

Pre-Status:
The instrument arrived with participant. Both columns were wetted and a pre-status measurement was done on ambient aerosol. During the pre-status, the performance of the system showed relative differences of +71% to +3% (col A) and +84% to +9% (col B) compared with the TROPOS Reference Instrument SN 0808-0064 for supersaturation between 0.1% and 1.0%. The system was operated with a flow of 500ml.
Final Status:
The new parameters for flow and supersaturation calibration were set. During the Final Status the performance of the system showed relative differences of -43% (@0.1% ss) to +1.3% (@ 1% ss) for col A and -13% (@0.1% ss) to +4.7% (@ 1% ss) for col B compared with the TROPOS Reference Instrument SN 0808-64. The candidate passed the quality standards of ACTRIS and GAW.

Laboratory setup:



Additional Equipment:

- Bubble flow meter 'Gilibrator', Gilian (Sensidyne)
- Thermo Scientific Nanosphere Size Standard PSL 203nm (±4nm)
- Aerosol nebulizer for PSL (homemade TROPOS)
- Voltcraft multimeter (0-1000V), Keysight Technologies

Supersaturation calibration protocol (Ammonium Sulfate Particle, size selected by TROPOS Reference MPSS "Wolken")

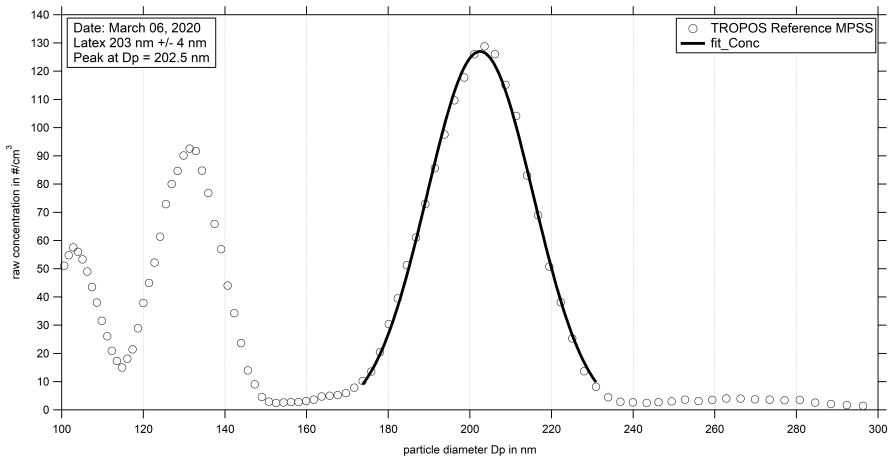


Figure 01: Measurement of latex 203 nm: Particle size distribution (raw concentration) for latex 203 nm on March 6, 2020

Pre-status settings:

Date of check: 10.03.2020

Calibration tab settings	SN 1804-040 Col A	SN 1804-040 Col B
Sample slope	58.47	58.84868
Sample y-intercept	-138.57	-131.362
Sheath slope	-931.72	-971.8554
Sheath y-intercept	2102.11	2179.8172
Temp gradiet slope	13.92	14.45
Temp gradient intercept	1.74	1.70

Zero-test with filter: passed (< 1 particles cm-3)

Candidate against Ref. CCN-100 SN 0808-64 during the pre-status: Time Series

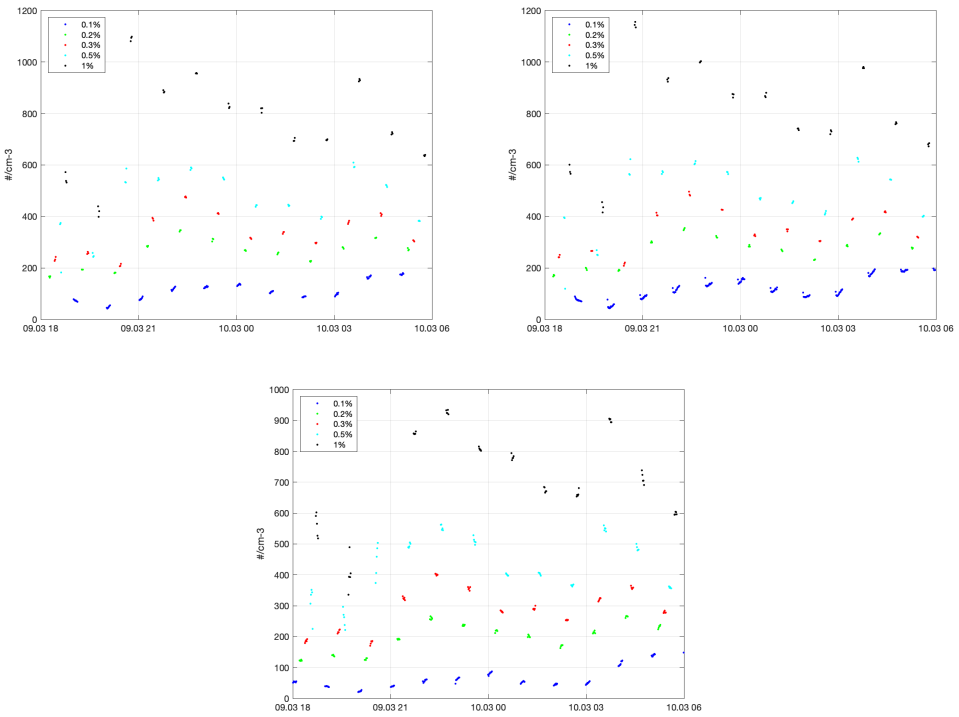


Figure 02: Time series (March 9, 2020 06:00 pm – March 10, 2020 06:00 am) of the candidate (upper row, col A (left) and col B (right)) vs. Ref. CCN-100 SN 0808-64 (lower row).

Candidate against Ref. CCN-100 SN 0808-64 during the pre-status: average over supersaturation

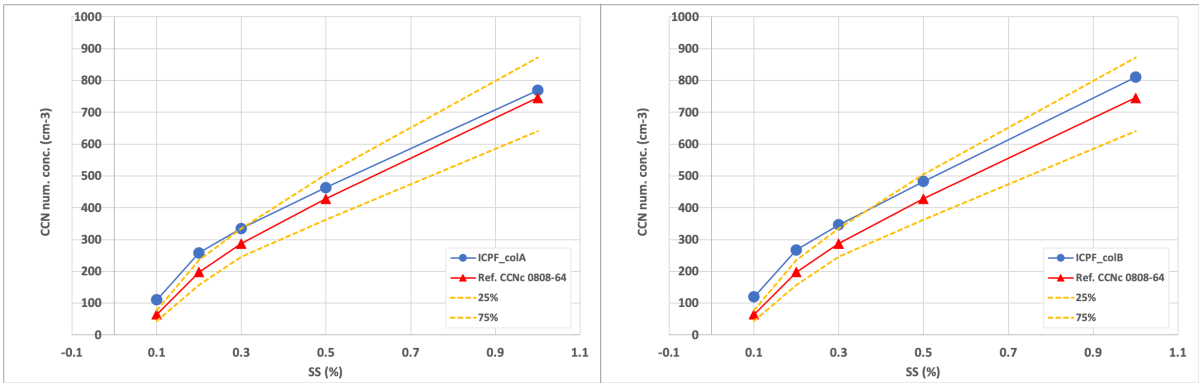


Figure 03: Average (March 9, 2020 06:00 pm – March 10, 2020 06:00 am) of the candidate col A (left) and col B (right) vs. Ref. CCN-100 SN-0808-64.

Flow calibration protocol (Bubble flow meter 'Gilibrator', Gilian (Sensidyne))

Col A

	Old	New		Old	New
Sample Slope	58.47	60.02	Sheath Slope	-931.72	-936.76
Sample intercept	-138.57	-141.49	Sheath intercept	2102.11	2105.5

Sample Calibration Without Sheath			
Valve Set (V)	Sample Volt (V)	Sheath Volt (V)	Measured Total Flow (mlpm)
2.45	2.72		21.09
2.49	2.9		32.39
2.53	3.1		45.53
2.58	3.45		66.54
2.61	3.68		78.28
2.56	3.3		56.68

Sheath Calibration					
Valve Set (V)	Sample Volt (V)	Sheath Volt (V)	Measured Total Flow (mlpm)	Sample Calcu (mlpm)	Sheath Flow (mlpm)
2.78		2.06	198.6	17	181.6
2.88		1.98	273.8	23	250.8
2.96		1.91	339.7	28	311.7
3.1		1.77	483	41	442
3.21		1.66	601.6	51.2	550.4
3.34		1.52	751.3	65.4	685.9

Col B

	Old	New		Old	New
Sample Slope	58.84868	61.569	Sheath Slope	-971.8554	-940.4603
Sample intercept	-131.362	-138.32	Sheath intercept	2179.8172	2122.966

Sample Calibration Without Sheath			
Valve Set (V)	Sample Volt (V)	Sheath Volt (V)	Measured Total Flow (mlpm)
	2.6		20.93
	2.74		30.6
	2.85		38.01
	3.1		52.5
	3.35		68.17
	3.49		76.1

Sheath Calibration					
Valve Set (V)	Sample Volt (V)	Sheath Volt (V)	Measured Total Flow (mlpm)	Sample flow (mlpm)	Sheath Flow (mlpm)
2.58		2.06	199.2	16.1	183.1
2.7		1.97	292.1	23	269.1
2.82		1.87	395.4	32.3	363.1
2.93		1.775	499.6	41.2	458.4
3.05		1.66	621.4	51.8	569.6
3.19		1.52	749.5	63.7	685.8

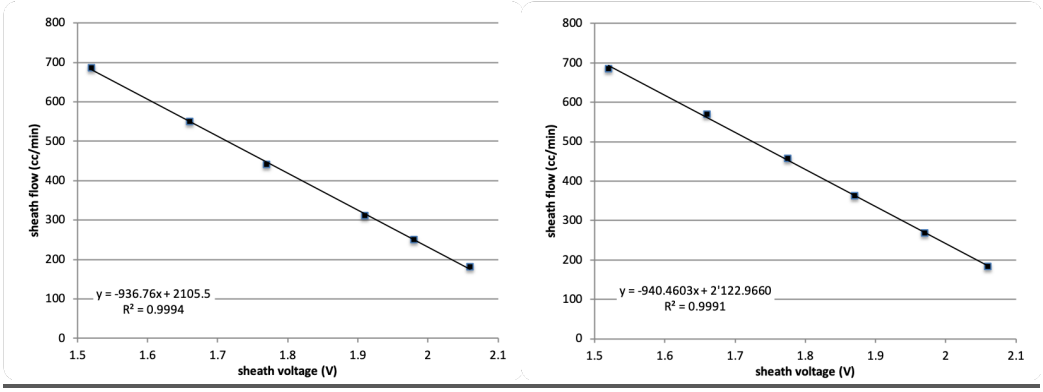


Figure 04: Sheath flow calibration col A (left) and col B (right)

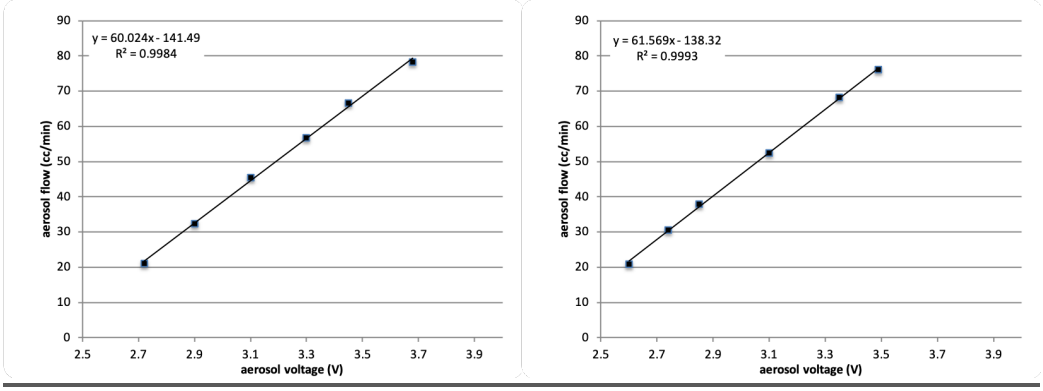
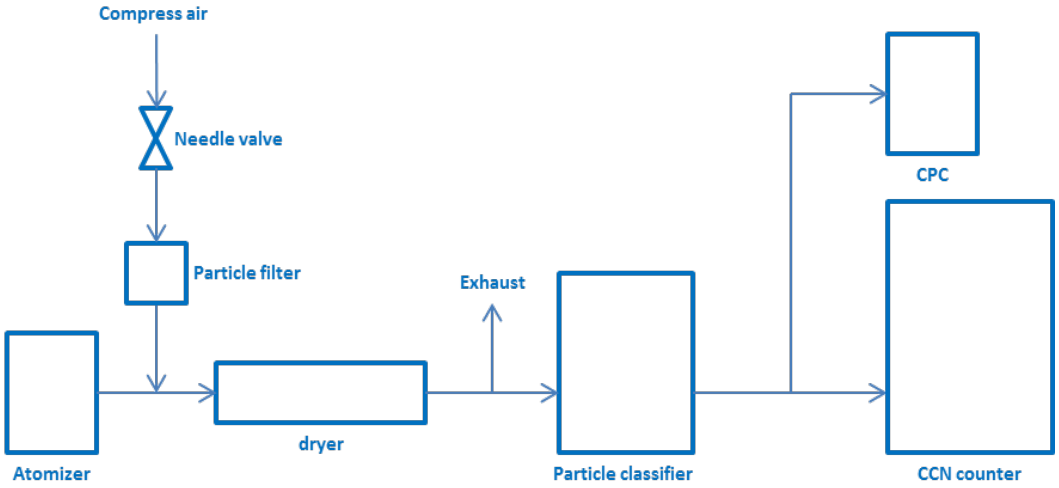


Figure 05: Aerosol flow calibration col A (left) and col B (right).

Calibration of Supersaturation-ΔT in CCN chamber

Experiment setup:



- Solution: ammonium sulfate 0.05 mol/L.
- Particle classifier was operated in diameter-scanning mode.
- Size-resolved activation ratio of ammonium sulfate particles was measured at 6 ΔT.
- Size-resolved activation ratio curves were fitted with 2 error functions, and critical diameter was taken as the center diameter of the second error function (Fig. 05).
- Equivalent supersaturation at each pre-selected ΔT was derived from the fitted critical diameter based on a lookup-table according to the Standardized protocol for CCN measurements WP3-NA3 / D3.11.
- Calibration parameters was derived by a linear fit of equivalent supersaturation and ΔT (Fig. 06).

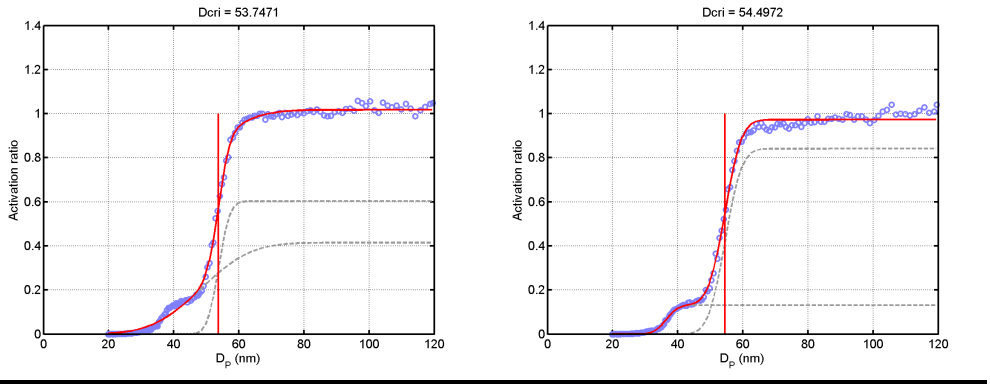


Figure 06: Example for activation curve of ammonium sulfate col A (left) and col B (right). Size selection was done with MPSS "Wolken" of WCCAP. The red line gives the sum of two sigmoid fits which are fitted to the measurements data. The grey lines give the fraction of doubly charged particles and the fit corrected for the doubly charged particles. The red vertical line gives the position of the determined critical diameter.

Table 01: Result of the supersaturation calibration col A (left) and col B (right).

col A					col B			
deltaT	SS	Dcrit	T		deltaT	SS	Dcrit	T
3.130	0.129	106.402	29.648		3.140	0.131	105.061	29.838
NaN	NaN	NaN	NaN		3.140	0.132	104.328	29.836
4.520	0.267	66.500	29.188		4.590	0.257	67.823	30.223
4.520	0.263	67.154	29.185		4.590	0.264	66.643	30.190
5.920	0.371	53.747	29.520		6.030	0.359	54.497	30.868
5.920	0.373	53.574	29.513		6.030	0.359	54.559	30.870
8.700	0.544	41.902	30.465		8.930	0.554	41.176	31.600
8.700	0.547	41.742	30.458		8.930	0.547	41.489	31.603
15.660	1.040	27.496	32.175		16.150	1.073	26.859	32.962
15.660	1.073	26.895	32.675		16.150	1.071	26.886	32.962
15.660	1.045	27.298	32.999		16.150	1.071	26.893	32.966
15.660	1.021	27.708	32.979					

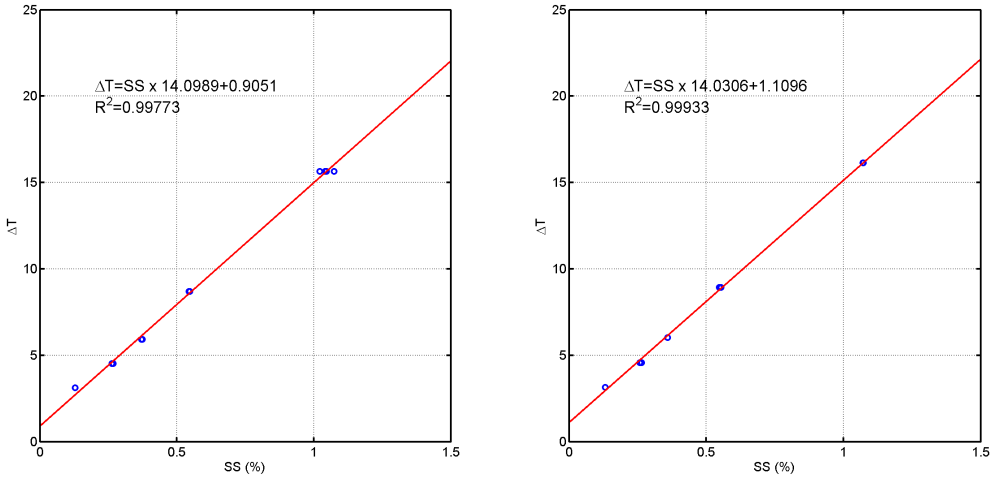


Figure 07: New supersaturation calibration coefficients col A (left) and col B (right).

Final Status of the Candidate: time series

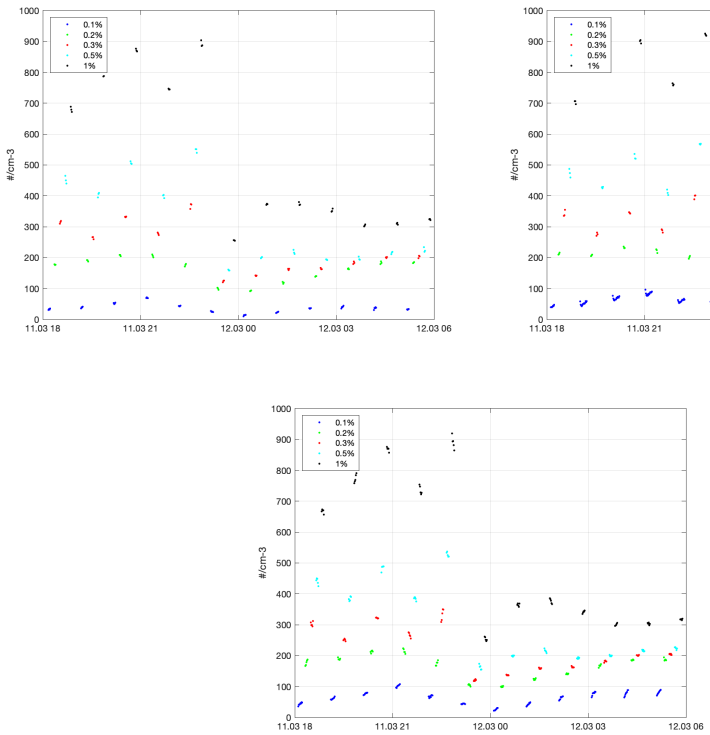


Figure 08: Time series (March 11, 2020 06:00 pm – March 12, 2020 06:00 am) of the Candidate (upper row, col A (left) and col B (right)) vs. Ref. CCN-100 SN 0808-64 (lower row).

Final Status of the Candidate: average over supersaturation

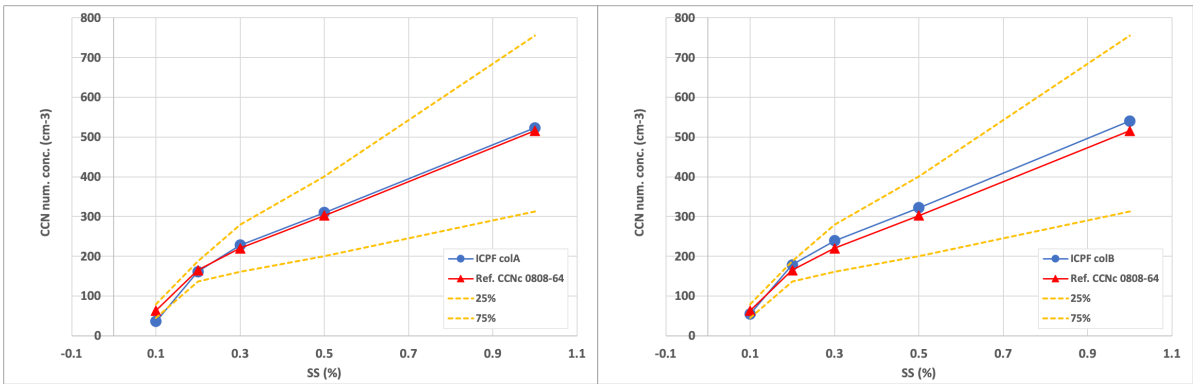


Figure 09: Average of activated particles vs. supersaturation (March 11, 2020 06:00 pm – March 12, 2020 06:00 am) of the Candidate (col A (left) and col B (right)) vs. Ref. CCN-100 SN 0808-64.