Calibration workshop on Cloud Condensation Nucleus Counters

Project No.: CCNC-2020-1-2

Principal Investigator: Jason Ward

Home Institution: *Australia, CSIRO*

Participant:

Candidate: **CCN-100**
Made by: DMT
Counter (SN): CCN-100, SN 1705-150
Software: DMT 5.0.6

Location of the quality assurance: TROPOS Leipzig, lab 118

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

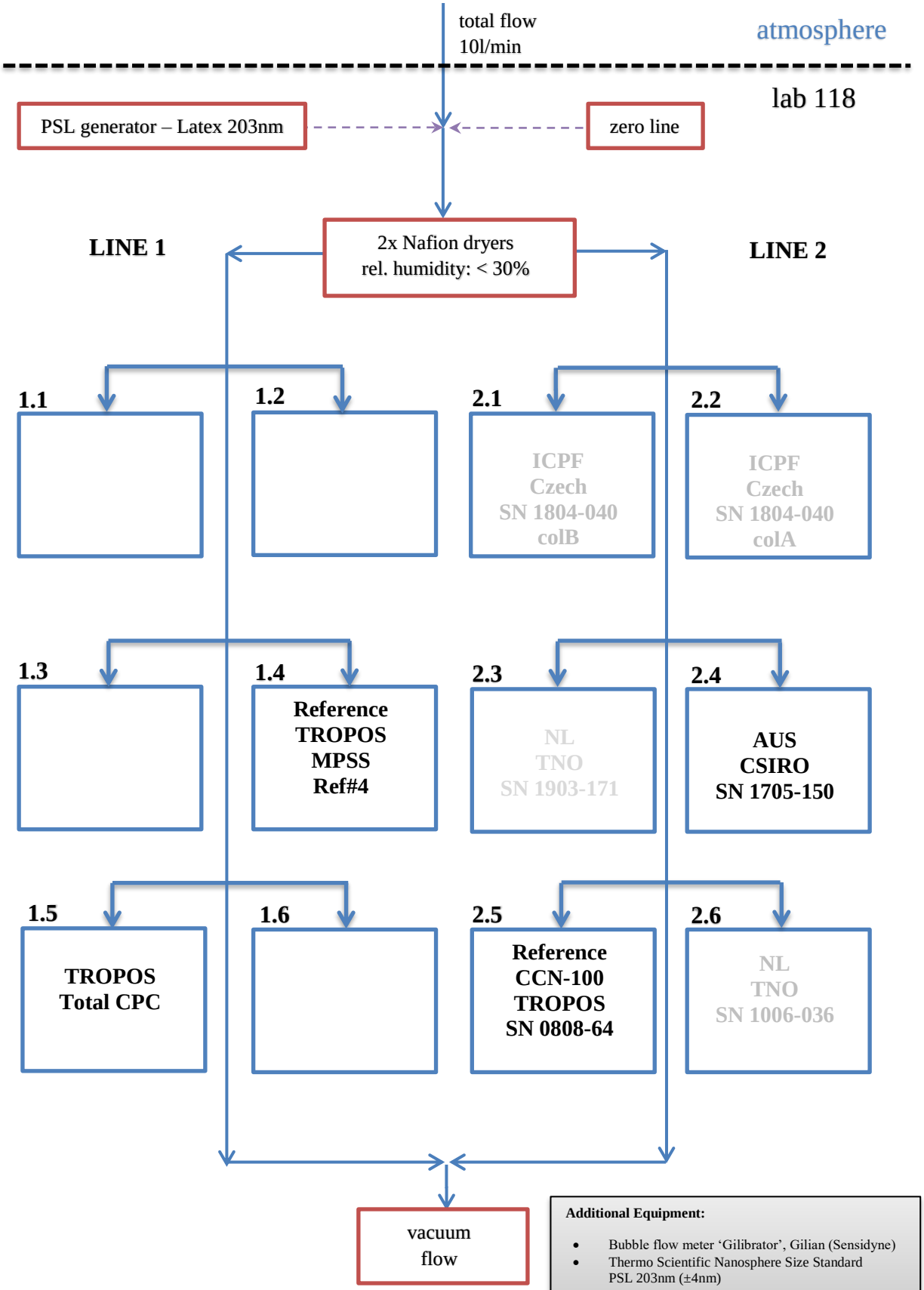
Last Intercomparison (with Project No.):

Summary of Intercomparison

Pre-Status:
The instrument arrived with participant. The column was wetted and a pre-status measurement was done on ambient aerosol. During the pre-status, the performance of the system showed relative differences of 43% to -3% 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 -26% (@0.1% ss) to 4.4% compared with the TROPOS Reference Instrument SN 0808-64 for supersaturation between 0.1% and 1.0%. 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")

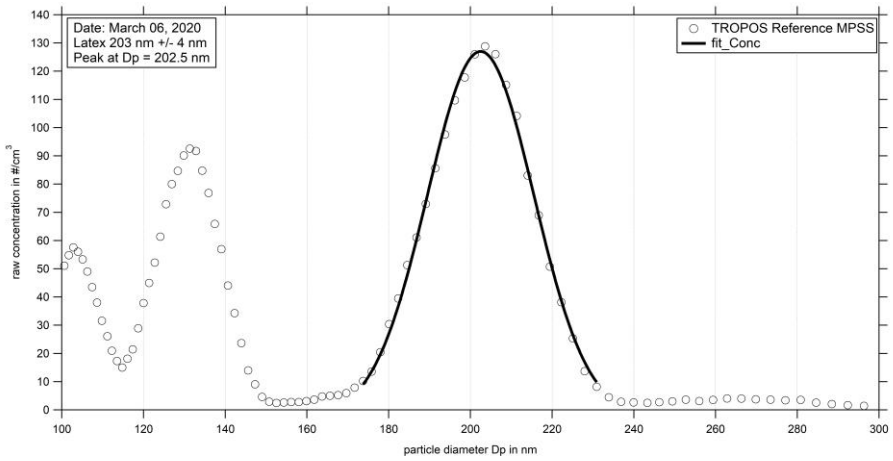


Figure 01: Measurement of latex 203 nm: Particle size distribution (raw concentration) for latex 203 nm on March 6, 2020

Pre-status settings:

Date of check: 10.03.2020

Calibration tab settings	CSIRO 1705-150 DMT-CCN-100
Sample slope	60.1942
Sample y-intercept	-135.354
Sheath slope	583.324
Sheath y-intercept	-1306.81
Temp gradiet slope	12.73
Temp gradient intercept	1.83

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

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

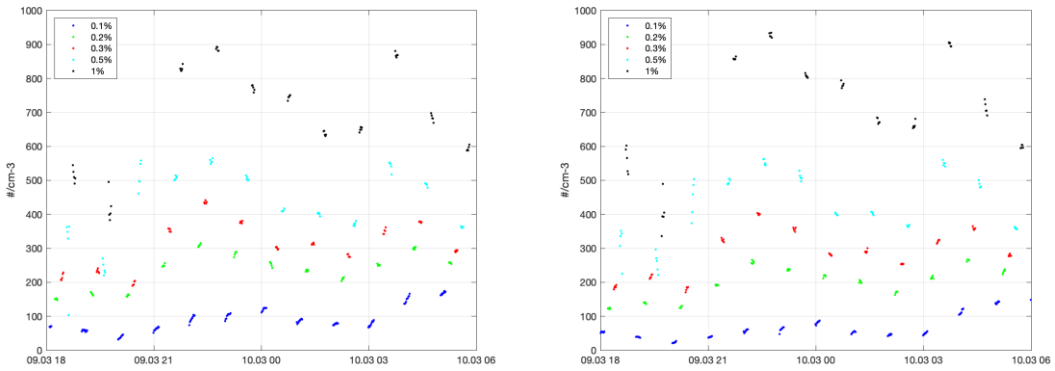


Figure 02: Time series (March 9, 2020 06:00 pm – March 10, 2020 06:00 am) of the candidate (left) vs. Ref. CCN-100 SN 0808-64 (right).

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

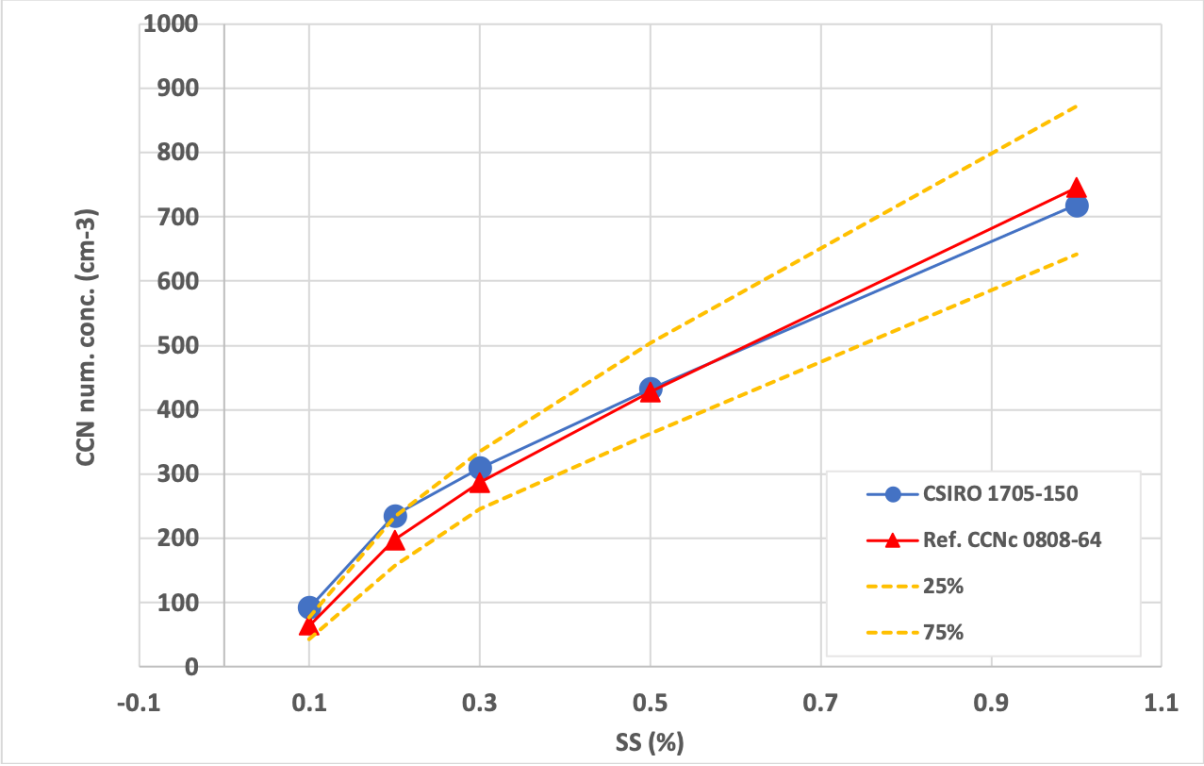


Figure 03: Average (March 9, 2020 06:00 pm – March 10, 2020 06:00 am) of the candidate vs. Ref. CCN-100 SN-0808-64.

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

	Old	New		Old	New
Sample Slope	60.1942	**58.081**	Sheath Slope	583.324	**563.318**
Sample intercept	-135.354	**-129.54**	Sheath intercept	-1306.81	**-1268.2**

Sample Calibration Without Sheath			
Valve Set (V)	Sample Volt (V)	Sheath Volt (V)	Measured Total Flow (mlpm)
2.5	2.8		34.25
2.48	2.5		14.92
2.52	2.68		25.72
2.6	3.3		62.2
2.63	3.58		77.74
2.57	2.94		41.2
2.6	3.16		54.55

Sheath Calibration					
Valve Set (V)	Sample Volt (V)	Sheath Volt (V)	Measured Total Flow (mlpm)	Sample measured (ml	Sheath Flow (mlpm)
3		3.1	521.8	45.3	476.5
2.6		2.43	111.2	10.8	100.4
2.75		2.65	246.9	21.6	225.3
3.2		3.5	774	70	704
2.9		2.93	419.5	36.45	383.05

total flow before
502.7
total flow after
500.9

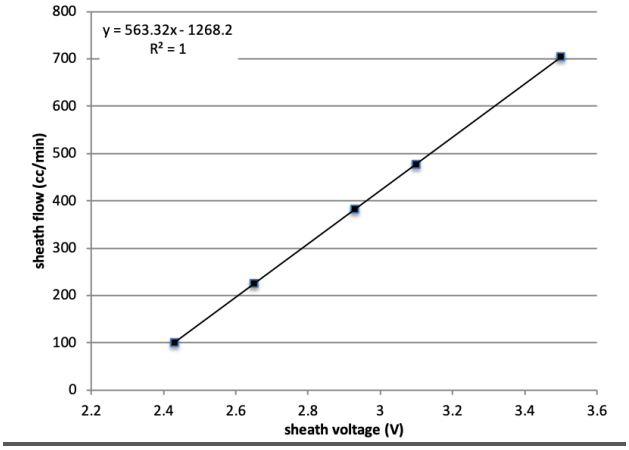


Figure 04: Sheath flow calibration

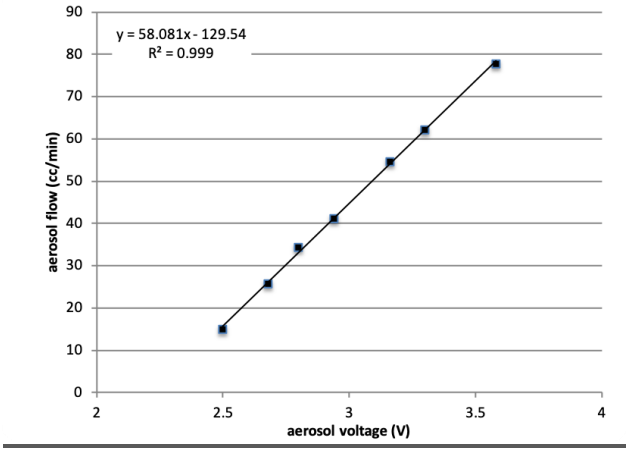
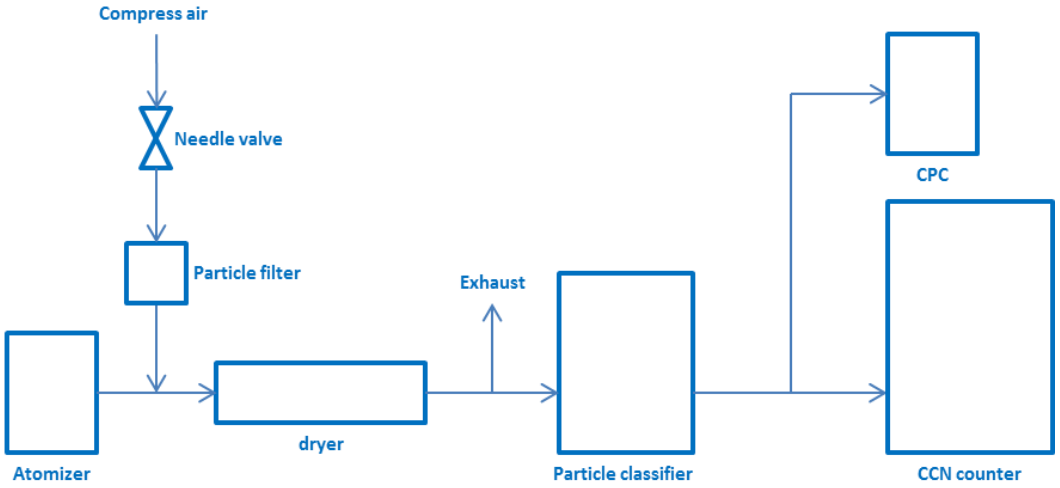


Figure 05: Aerosol flow calibration.

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).

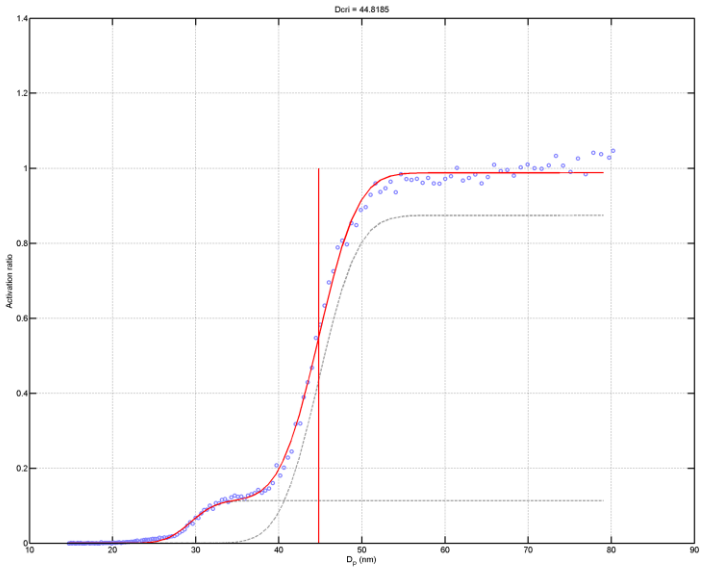


Figure 06: Example for activation curve of ammonium sulfate. Size selection was done with MPSS ”Wolken” of WCCAP. The red line gives the sum of two sigmoid fits which are fitted to the measurements data. The grey lines give the fraction of doubly charged particles and the fit corrected for the doubly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

Table 01: Result of the supersaturation calibration.

deltaT	SS	Dcrit	T
14.560	0.957	29.674	27.725
14.560	0.958	29.662	27.725
14.560	0.953	29.749	27.724
14.560	0.952	29.764	27.726
8.195	0.508	44.776	26.150
8.195	0.506	44.855	26.151
8.195	0.507	44.818	26.151
8.195	0.507	44.796	26.149
8.195	0.506	44.849	26.149
8.195	0.507	44.825	26.150
5.649	0.329	58.726	27.191
5.649	0.328	58.887	27.190
4.376	0.228	74.454	26.864
4.376	0.229	74.361	26.866
4.376	0.228	74.482	26.864
4.376	0.232	73.623	26.866
4.376	0.239	72.282	26.864
4.376	0.224	75.315	26.866
4.376	0.238	72.437	26.865
3.103	0.113	117.537	26.562
3.103	0.112	118.125	26.563
3.103	0.113	117.603	26.564

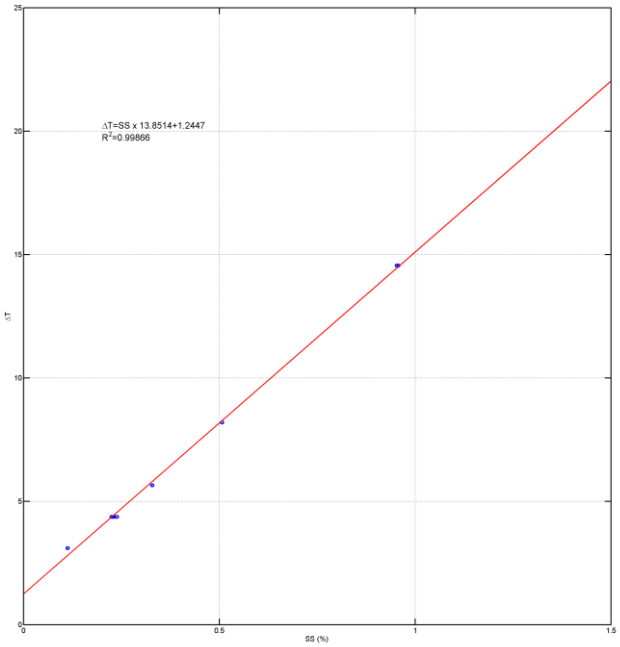


Figure 07: New supersaturation calibration coefficients: **slope 13.8514, intercept 1.2447**.

Final Status of the Candidate: time series

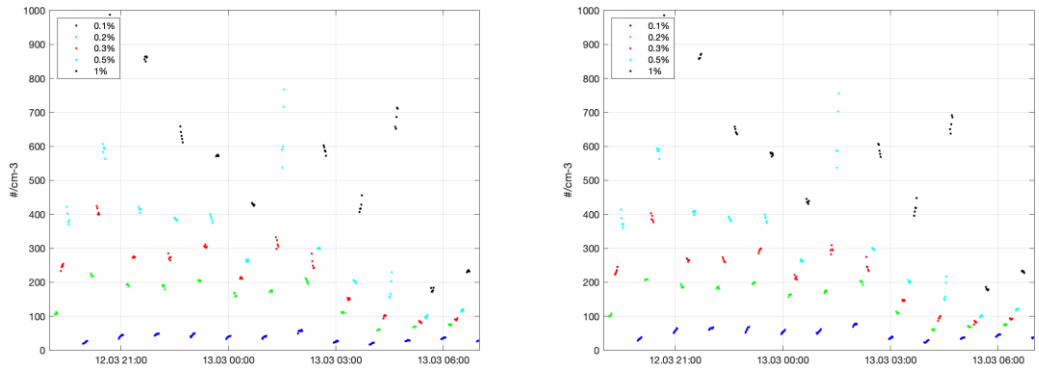


Figure 08: Time series (March 12, 2020 07:00 pm – March 13, 2020 07:00 am) of the Candidate (left) vs. Ref. CCN-100 SN 0808-64 (right).

Final Status of the Candidate: average over supersaturation

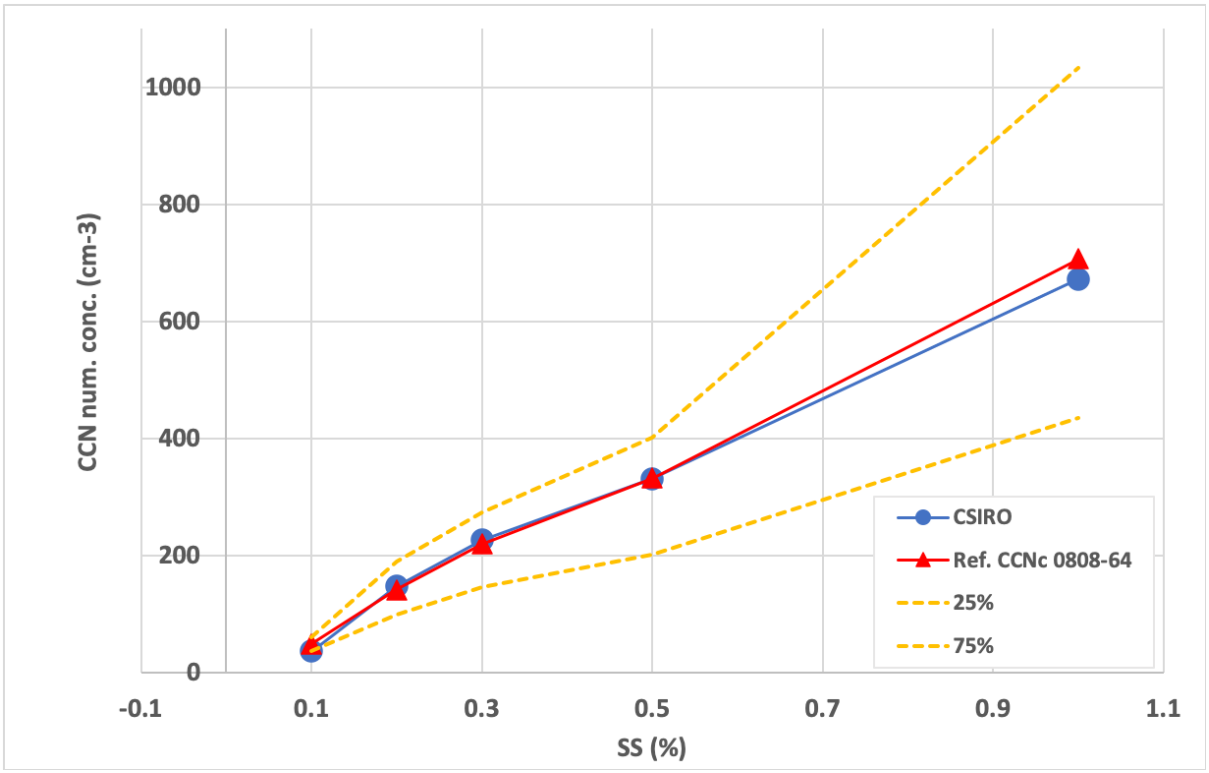


Figure 09: Average of activated particles vs. supersaturation (March 12, 2020 07:00 pm – March 13, 2020 07:00 am) of the Candidate vs. Ref. CCN-100 SN 0808-64.