Characterisation of a Pumped Counterflow Virtual Impactor (PCVI)

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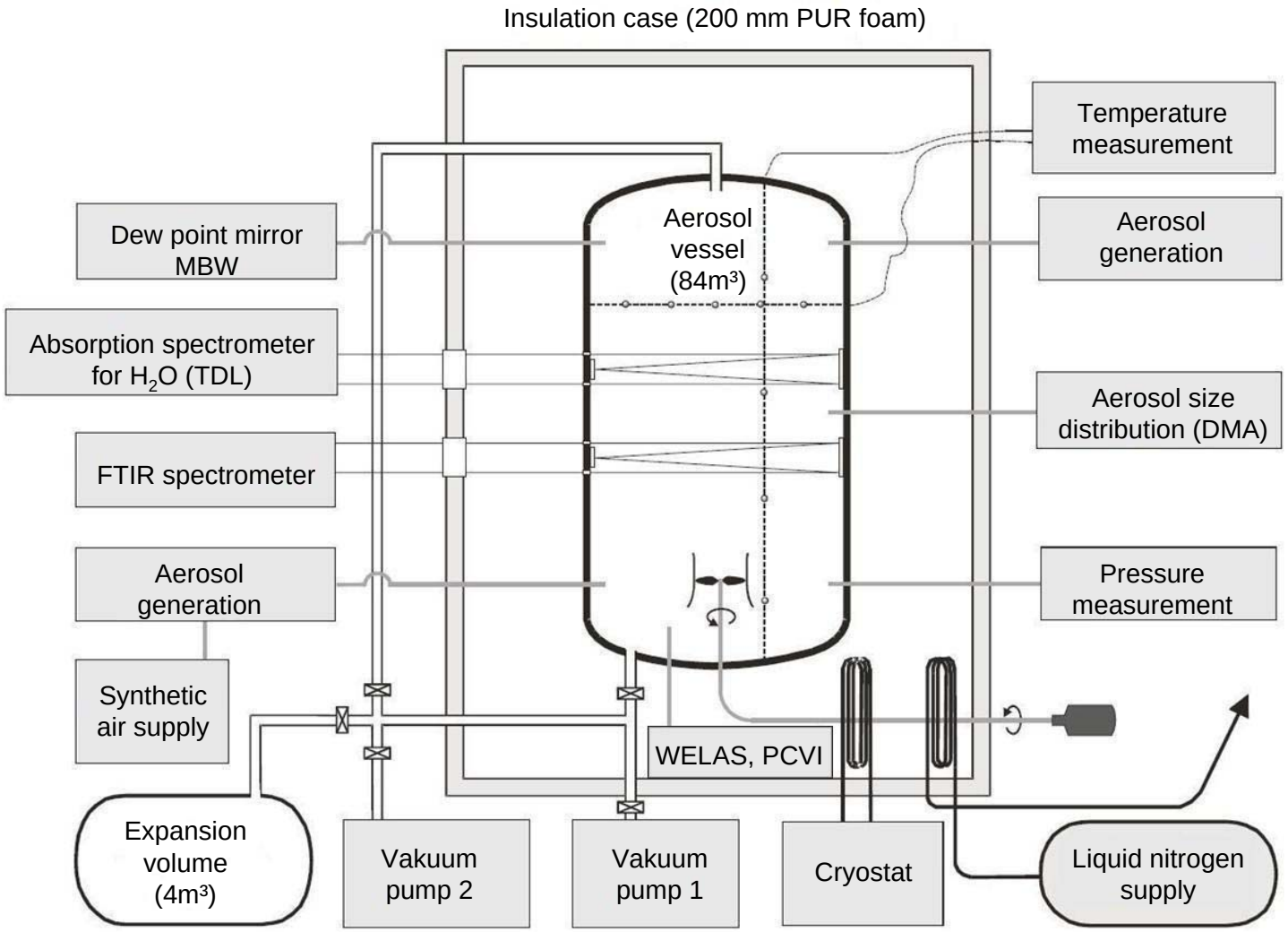
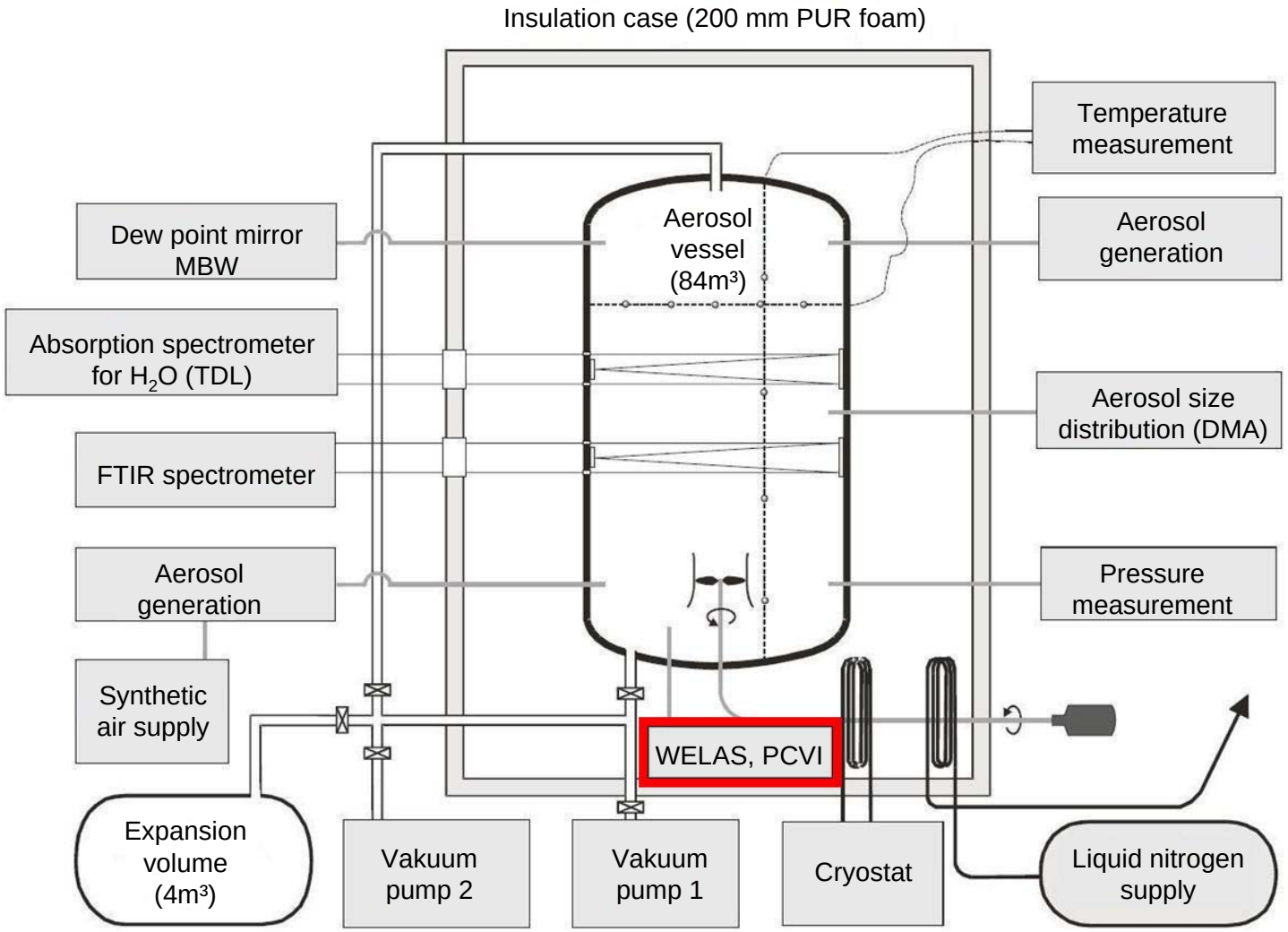
Schematic Sketch of the AIDA instrumentation

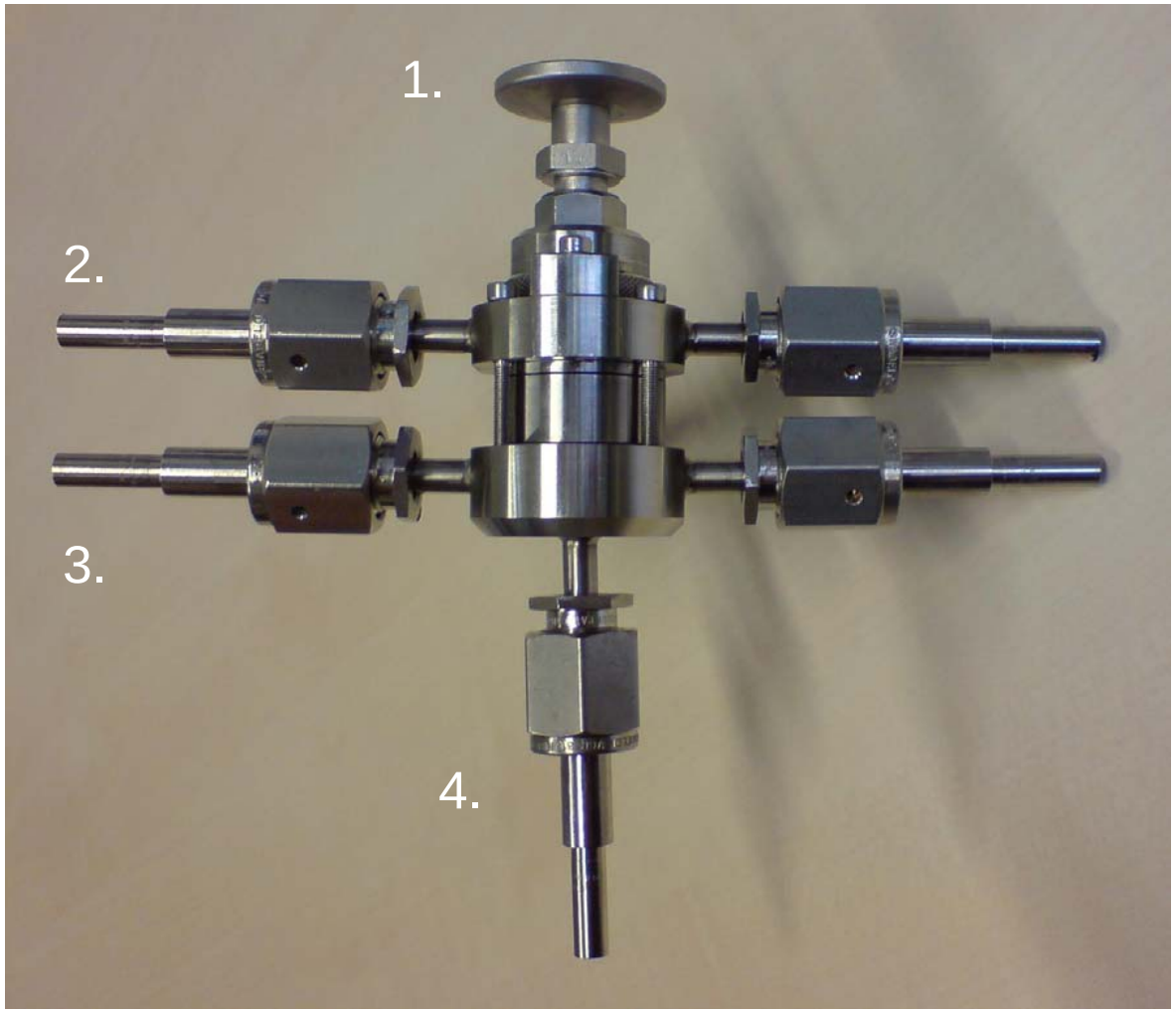


Schematic Sketch of the AIDA instrumentation



Pumped Counterflow Virtual Impactor (PCVI)

1. AIDA flow (input)
2. Pump flow
3. Synthetic air (counterflow)
4. Sample flow (output)



Pumped Counterflow Virtual Impactor (PCVI)

1. AIDA flow (input)
2. Pump flow
3. Synthetic air (counterflow)
4. Sample flow (output)
5. Pressure measurement
6. Input orifice
7. Collection orifice
8. Stagnation plane

- high inertia particle
- low inertia particle

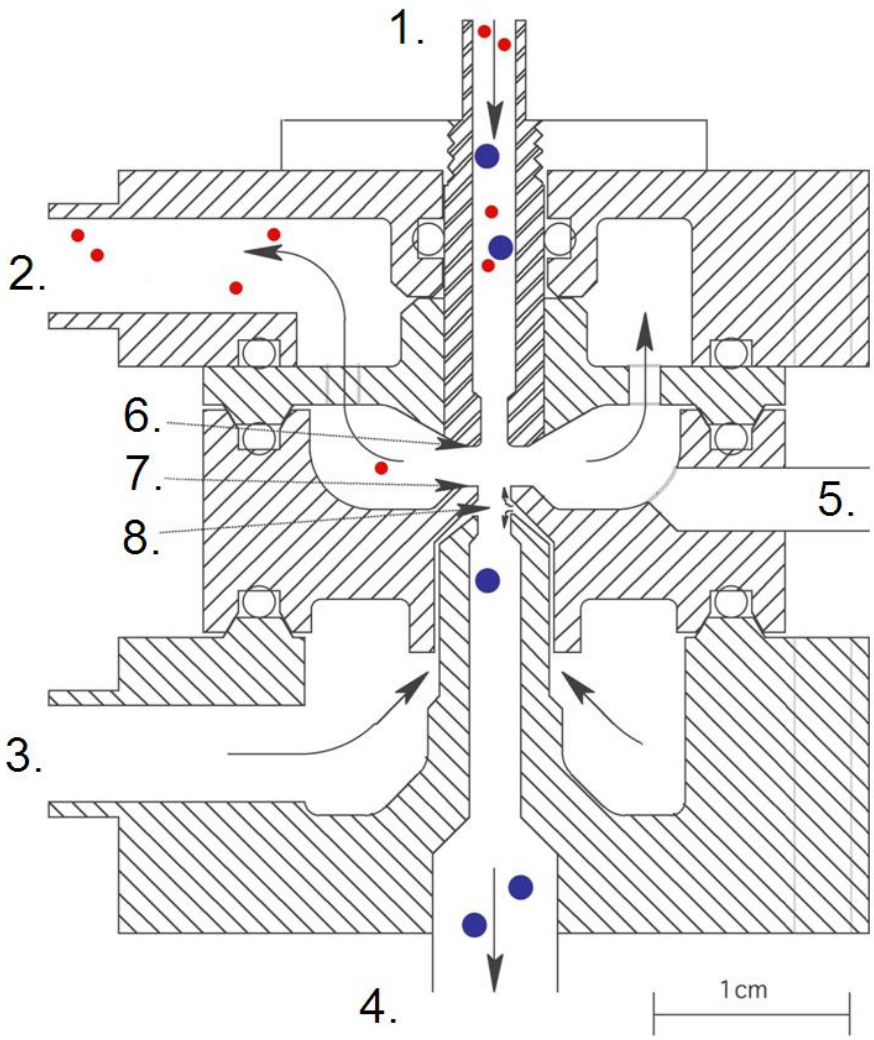
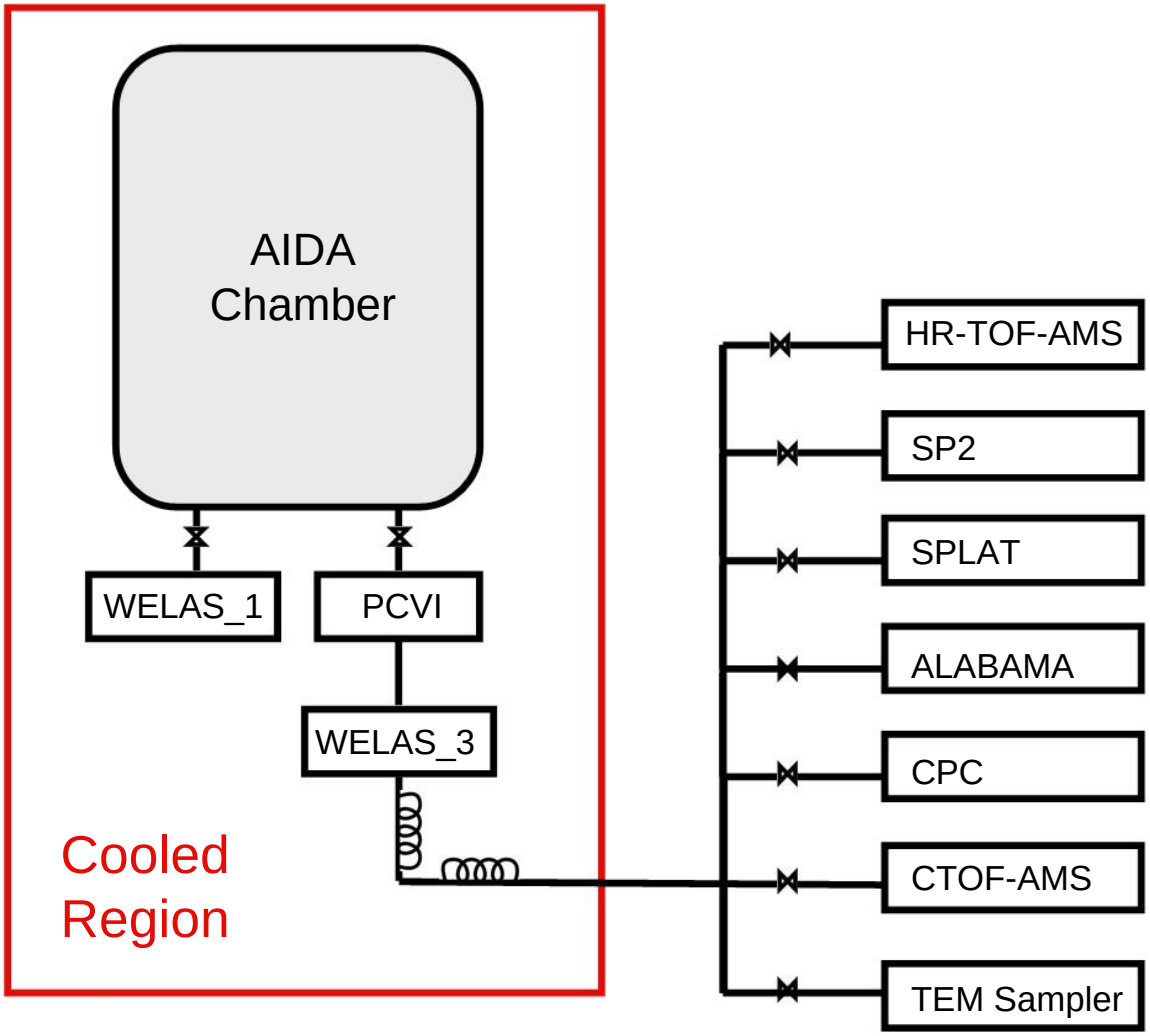


Figure: J. E. Boulter, D. J. Cziczo, A. M. Middlebrook, D. S. Thomson, and D. M. Murphy (2006). Design and Performance of a Pumped Counterflow Virtual Impactor, *Aerosol Science and Technology*, 40:969-976

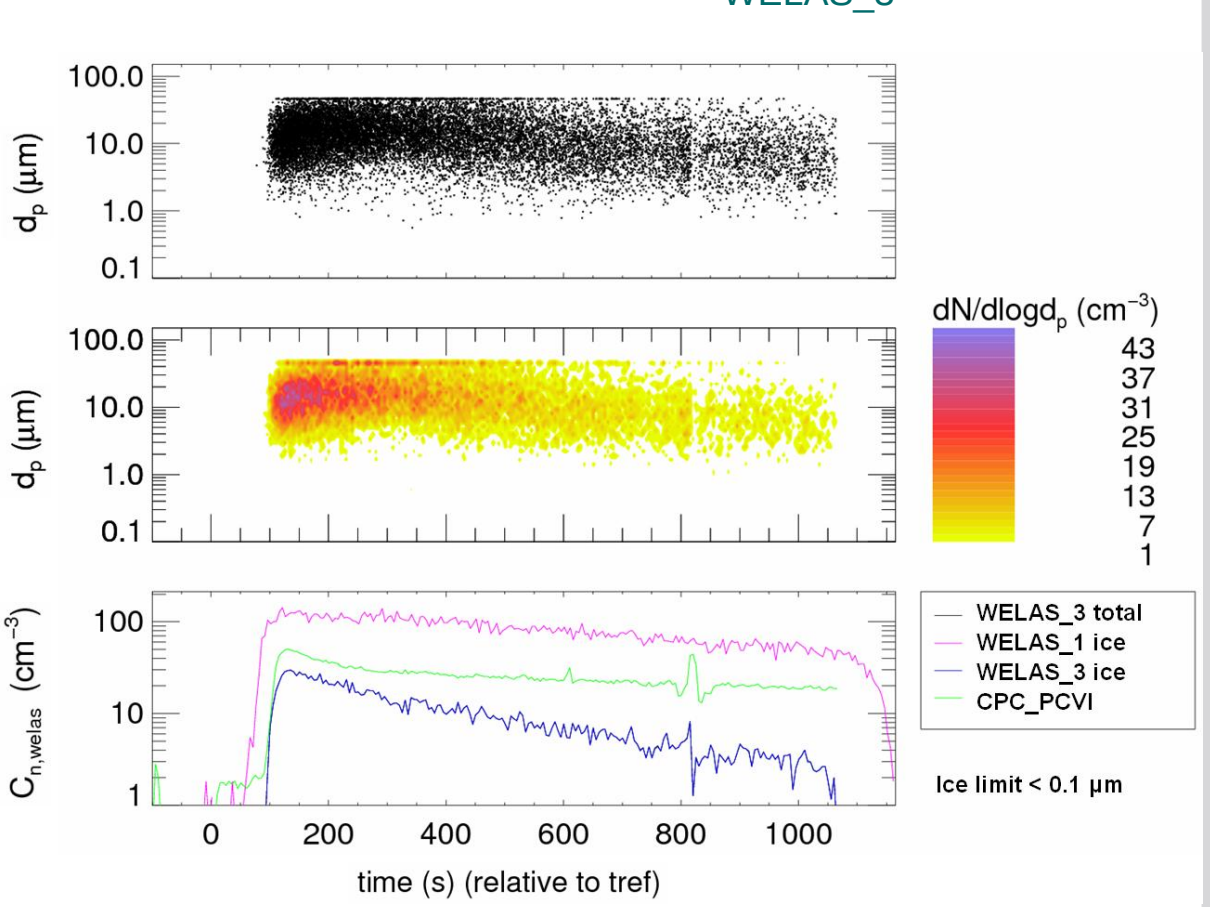
Improved Experimental Setup during ACI02



Particle size distribution of WELAS_3

Experiment conditions: Nr. 45
Gas temperature: 228K
Adiabatic cooling: 1000hPa to 850hPa
Nucleation start: at 927hPa (after 100s)
Aerosol: soot with SOA coating, argon as carrier gas

PCVI conditions:
F_{aida} = 6 l/min
F_{sample} = 3 l/min
$F_{counterflow}$ = 2.5 l/min



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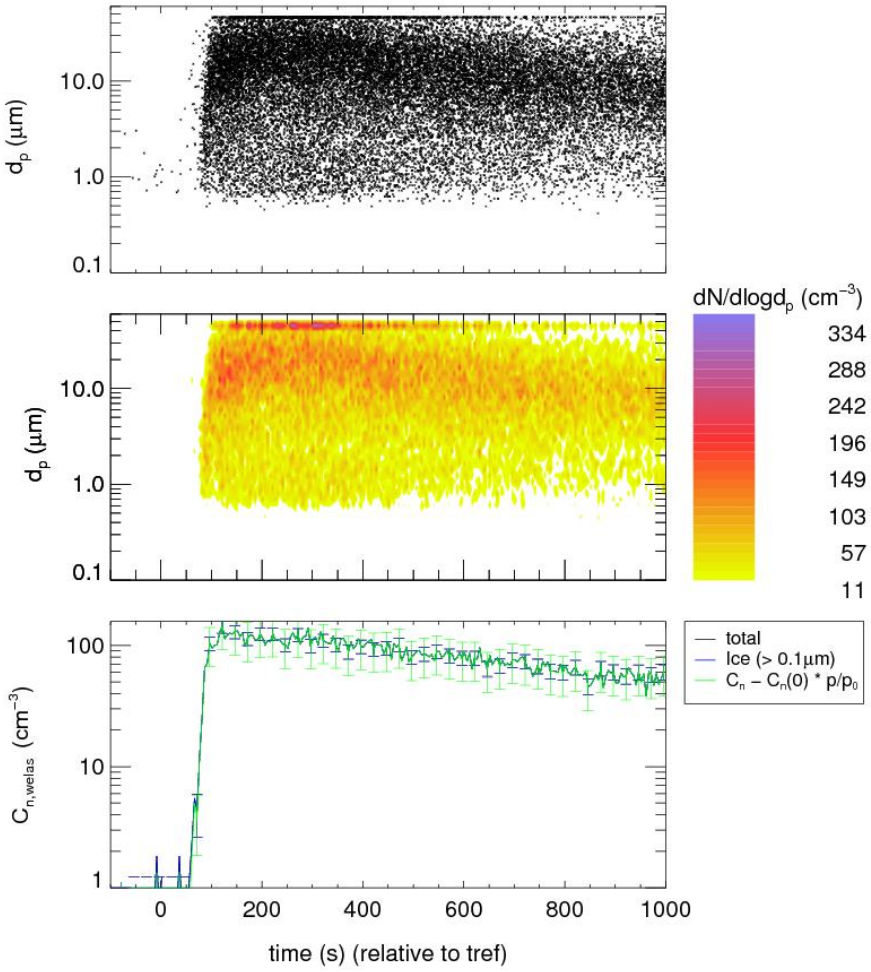
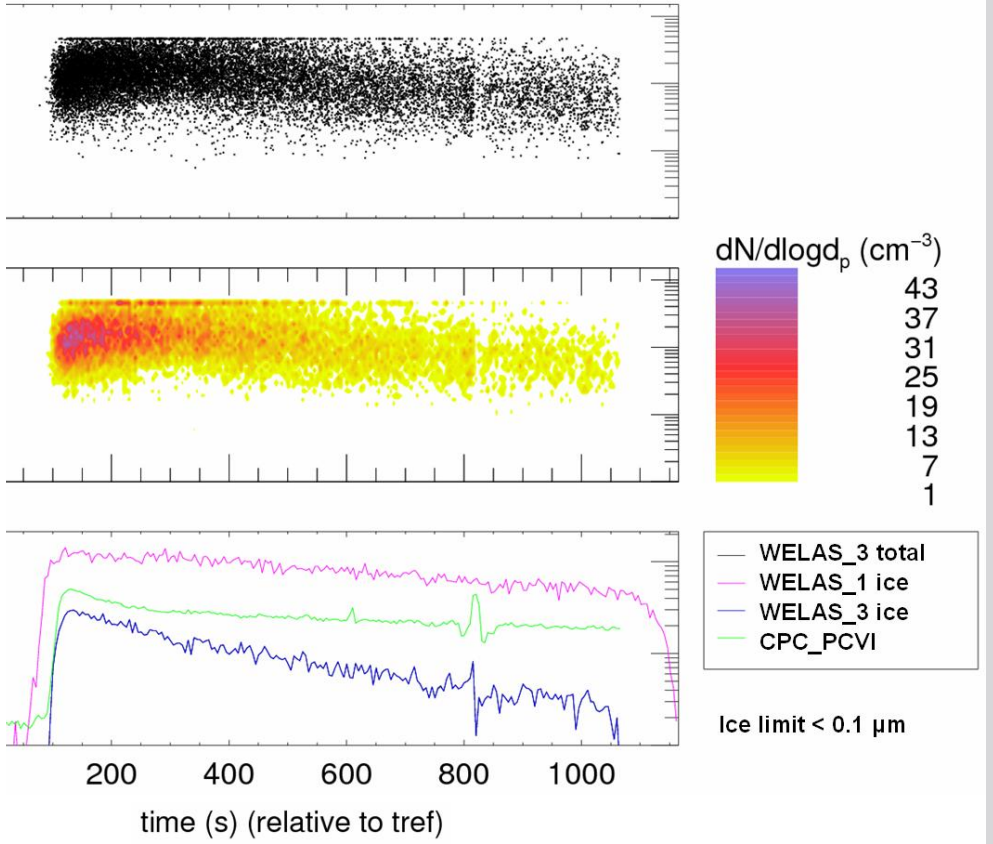
Particle size distribution of WELAS_3 and WELAS_1

WELAS_1



WELAS_3



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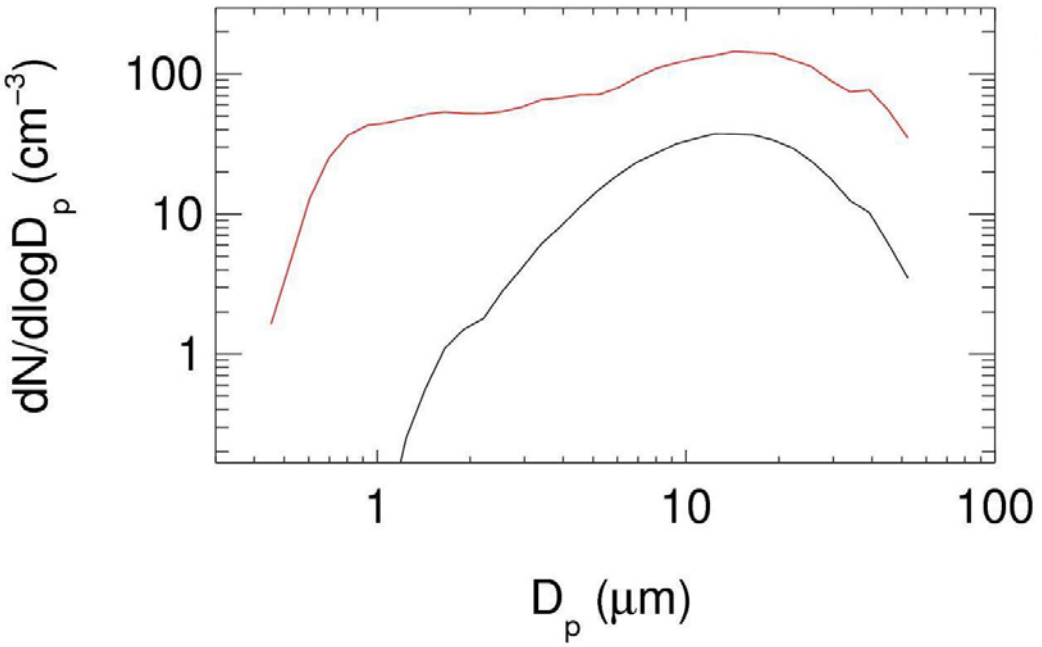
Particle size distribution of WELAS_3 and WELAS_1



Exp. Nr. 45

Time interval: 80s to 120s

$$\text{Collection Efficiency} = \frac{dN/d\log D_p\,[\text{WELAS\_3}]}{dN/d\log D_p\,[\text{WELAS\_1}]} \cdot \frac{1}{\text{Enh. Factor}}$$

$$\text{Enhancement Factor} = \frac{F_{aida}}{F_{sample}}$$

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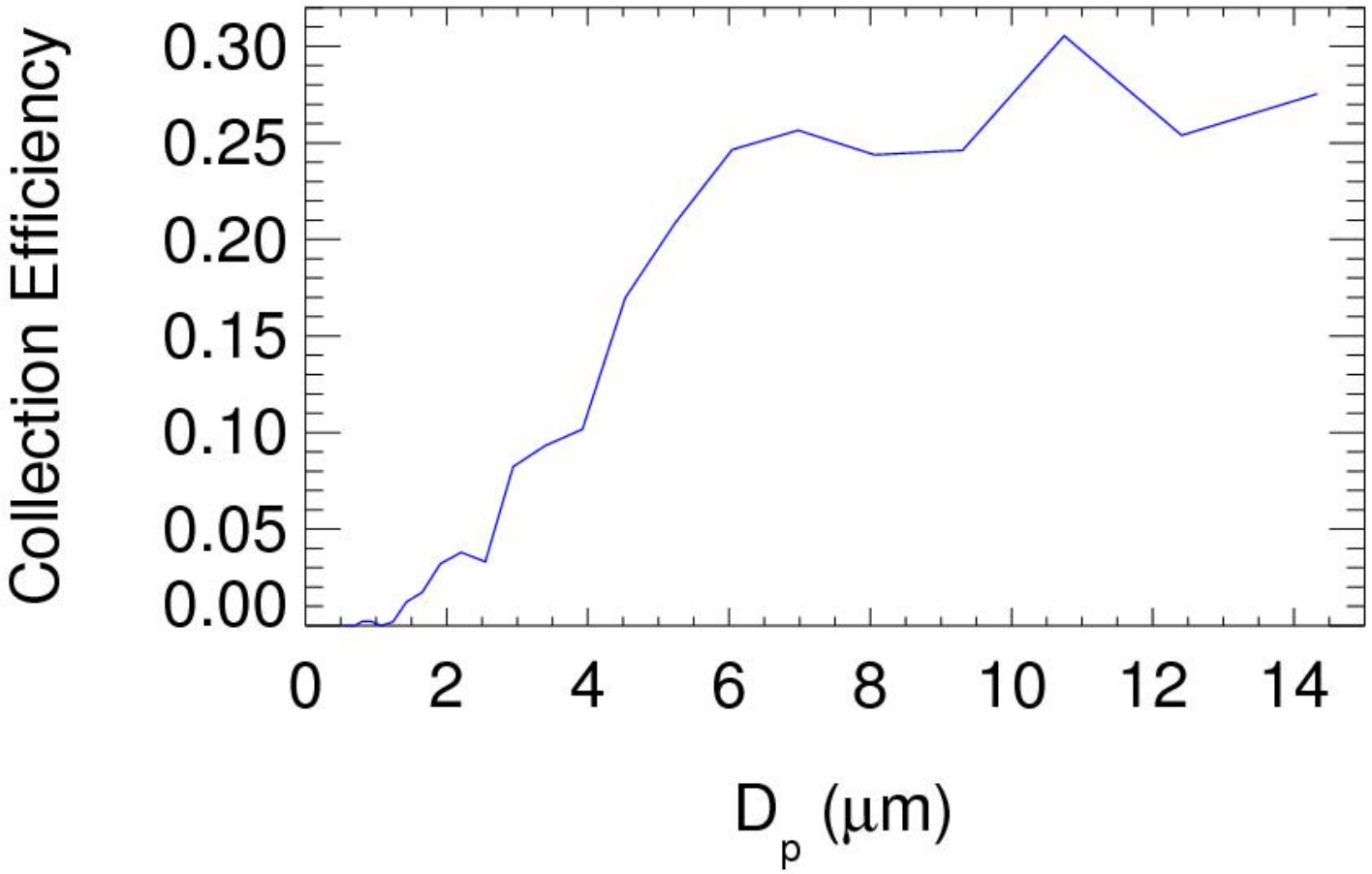
Cut-off curve of the PCVI



Exp. Nr. 45

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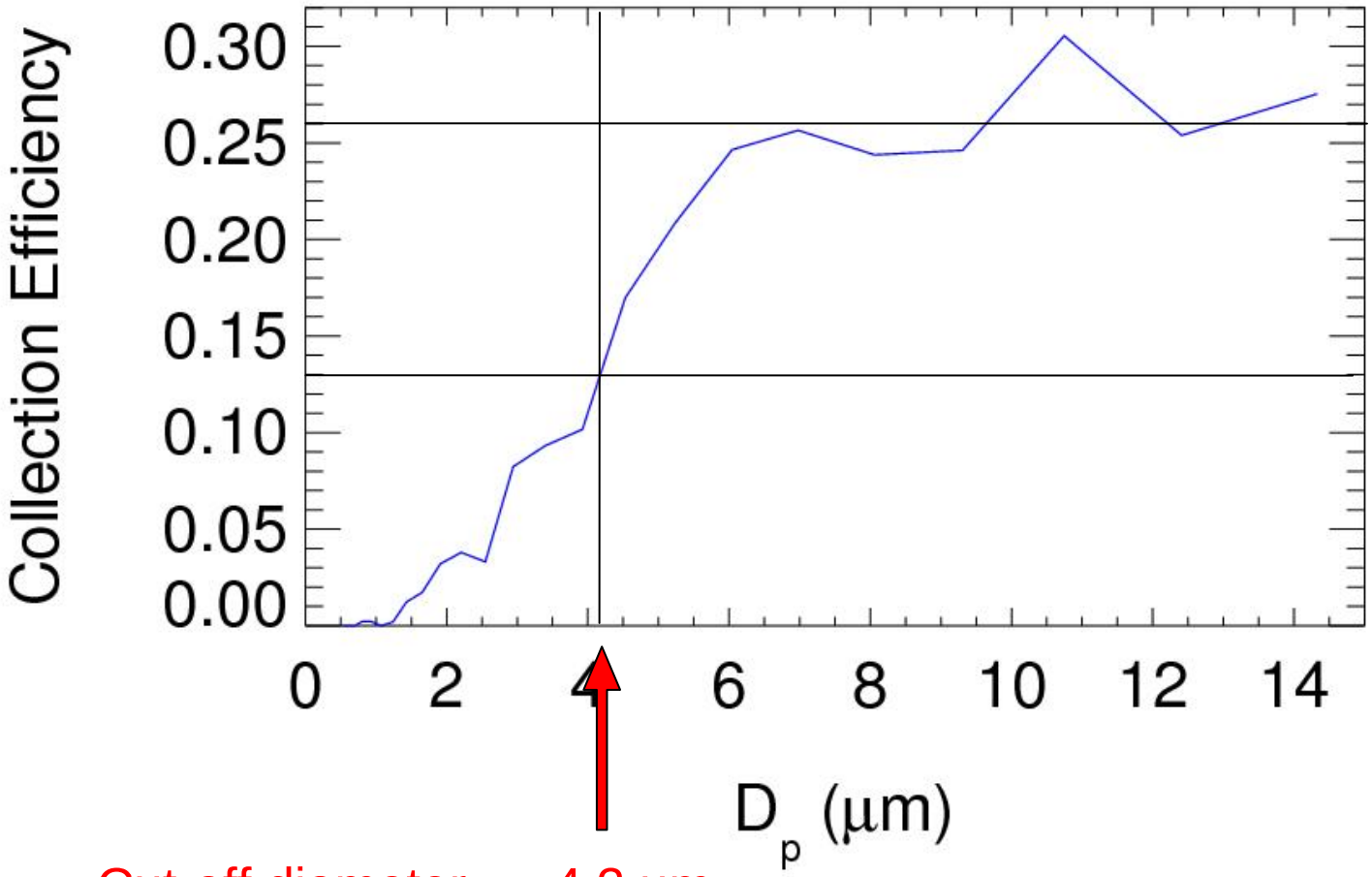
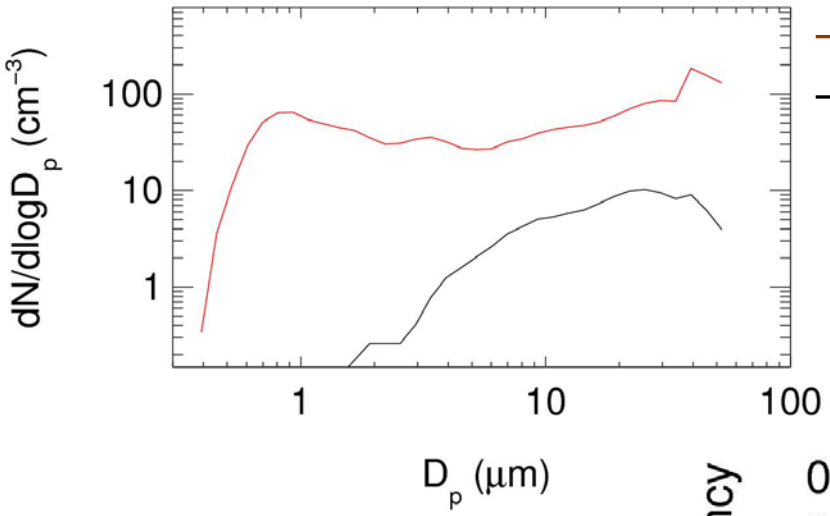
Cut-off curve of the PCVI



Exp. Nr. 45

Cut-off diameter = 4,2 µm

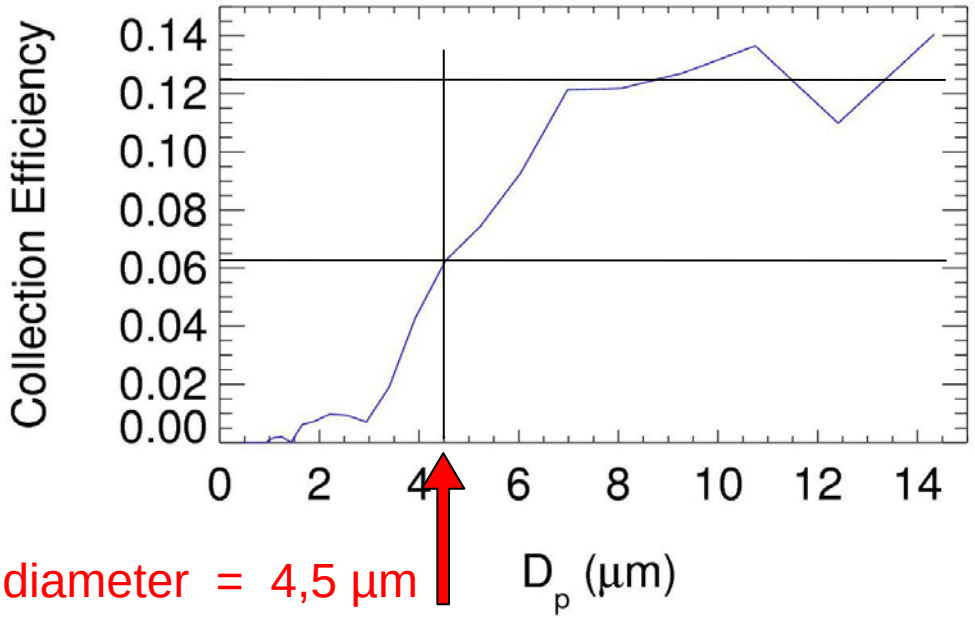
Cut-off curve of the PCVI



WELAS_1
WELAS_3

Exp. Nr. 50

Time interval: 110s to 135s



Cut-off diameter = 4,5 µm

Experiment conditions: Nr. 50
Gas temperature: 228K
Adiabatic cooling: 1000hPa to 800hPa
Nucleation start: at 935hPa (after 110s)
Aerosol: soot with SOA coating, nitrogen as carrier gas

PCVI conditions:
F_{aida} = 6 l/min
F_{sample} = 3 l/min
$F_{counterflow}$ = 2.5 l/min

Further improvement - Humid counterflow

Murphy and Koop, 2005:

$$\text{Log } p_i = 9.550426 - 5723.265/T_{ice} + 3.53068 \text{ Log}(T_{ice}) - 0.00728332\ T_{ice}$$

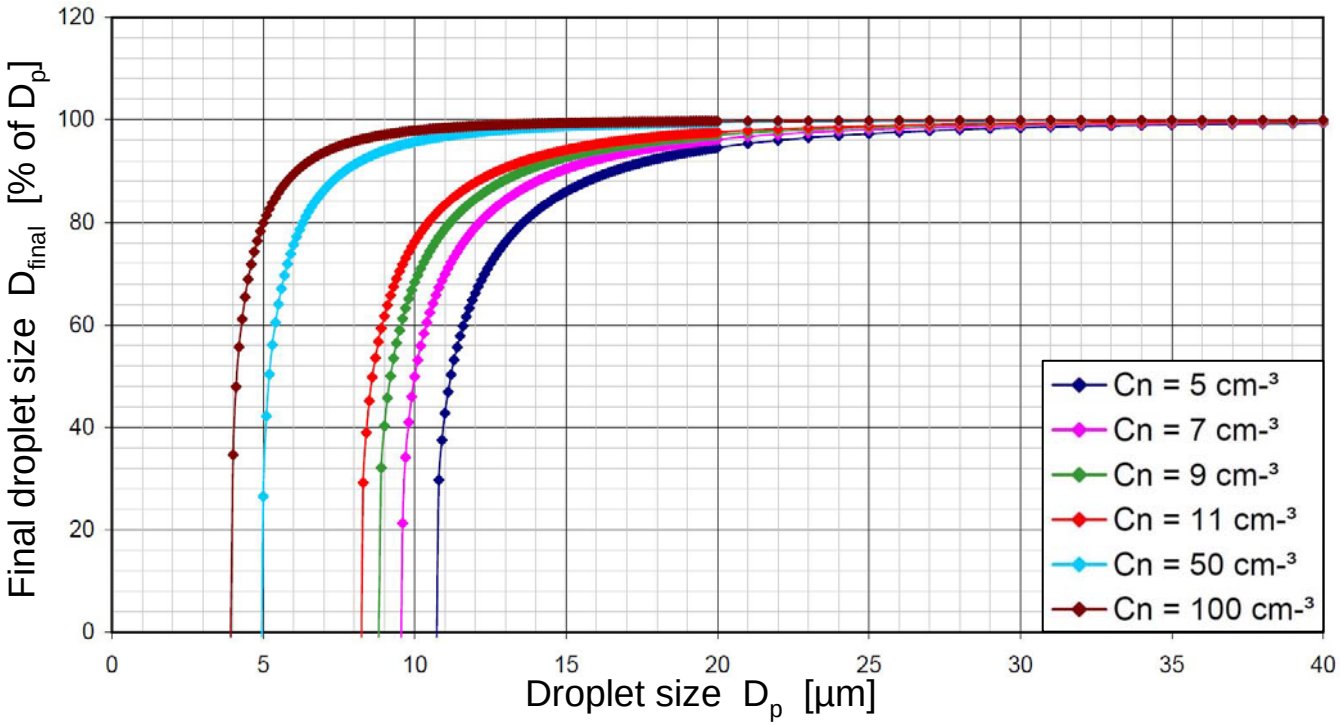
with: p_i = saturated vapour pressure over ice

T_{ice} = frost point temperature

Conditions:

- Maximum of evaporation
- Spherical ice particles
- Monodisperse Aerosol

Evaporation of ice particles in dry counterflows (T_{ice} = 237,15K)



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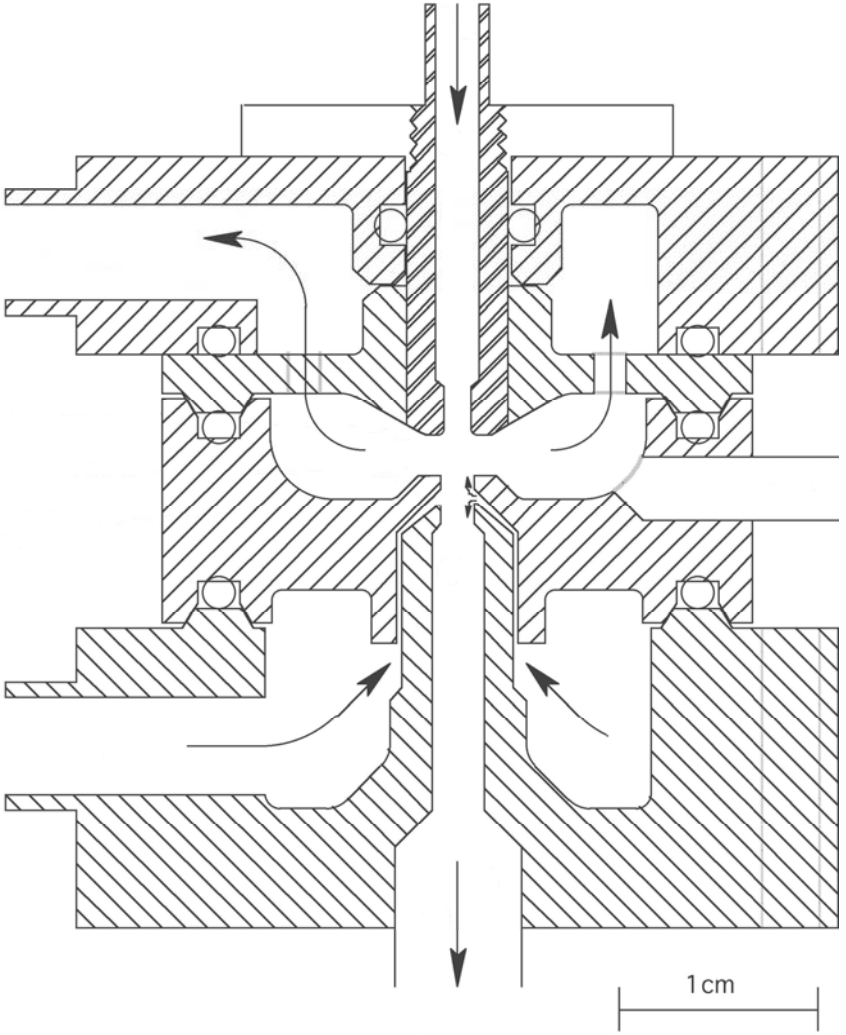

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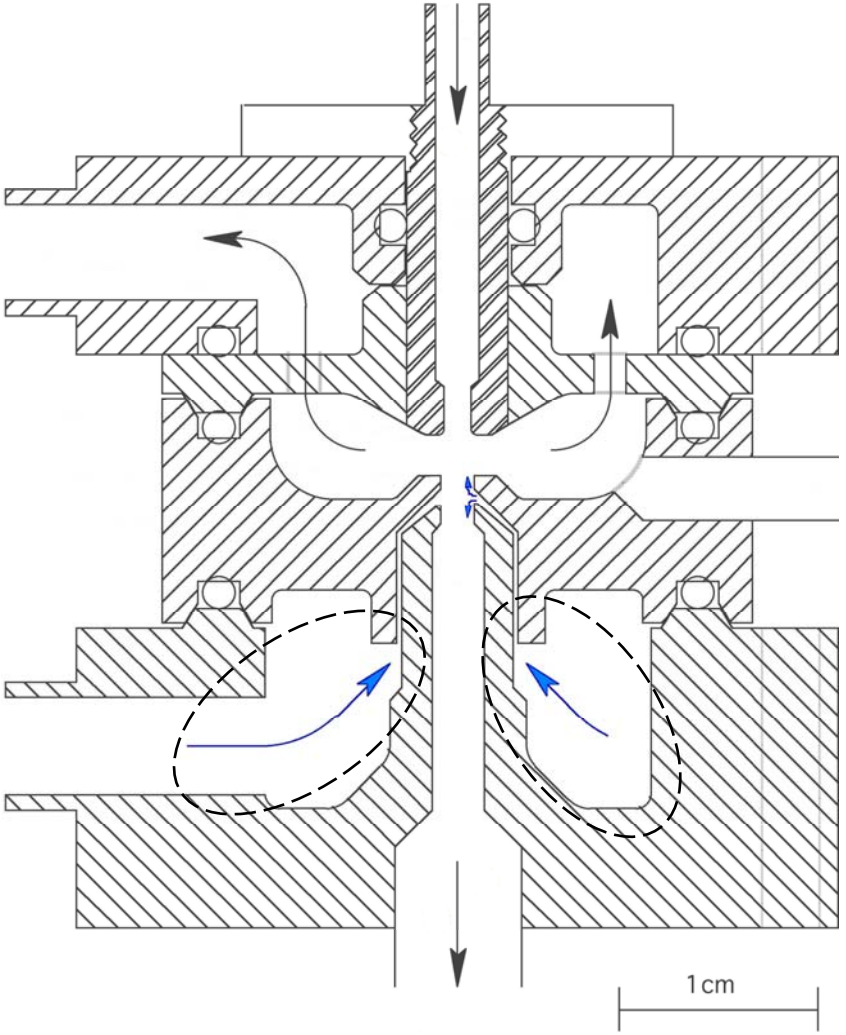
Further improvement - Humid counterflow

Still in testing!



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Thank you!