University of Applied Sciences and Arts Northwestern Switzerland
School of Engineering

The organic coating unit, an all-in-one system for reproducible generation of secondary organic aerosol

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EMPIR 18HLT02 AeroTox project

EMPIR EURAMET

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

http://empir.npl.co.uk/aerotox/

Generation of «fresh» and «aged» soot aerosols

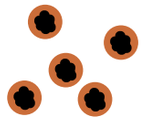
FIELD

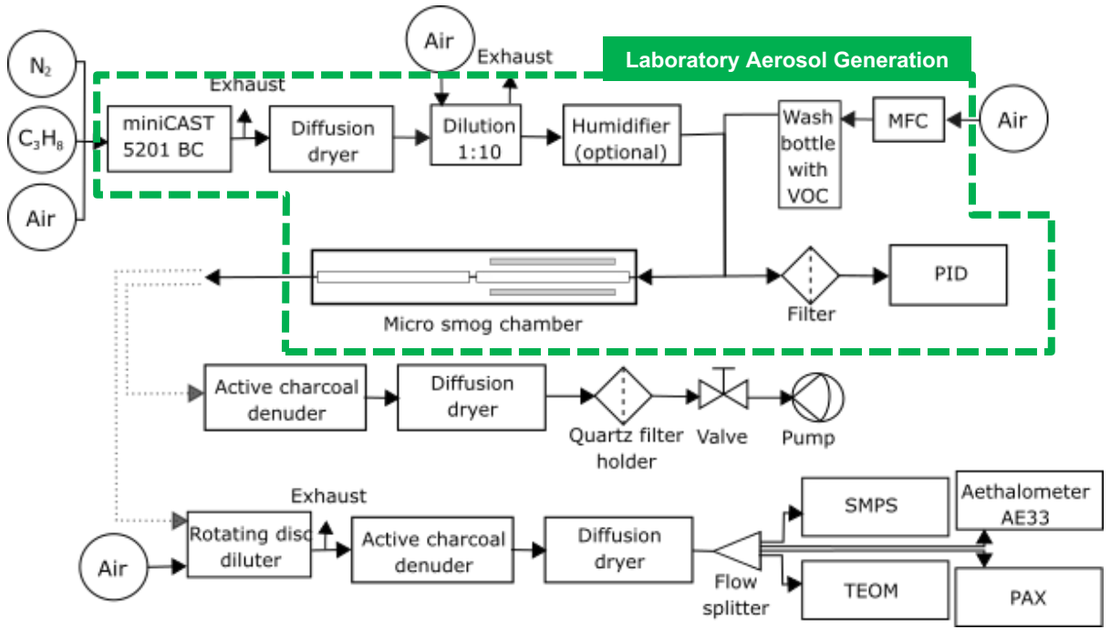
Fresh soot particles

ozone, NOX, OH
+ **organic vapours**

atmospheric ageing of soot
within a few hours or days

Aged soot particles





Setup works well but is time consuming!
- bulky
- not automated
- requires external units
- **manual adjument and permanent supervision**

- Ess et al, JAS (2021): https://doi.org/10.1016/j.jaerosci.2021.105820

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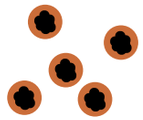
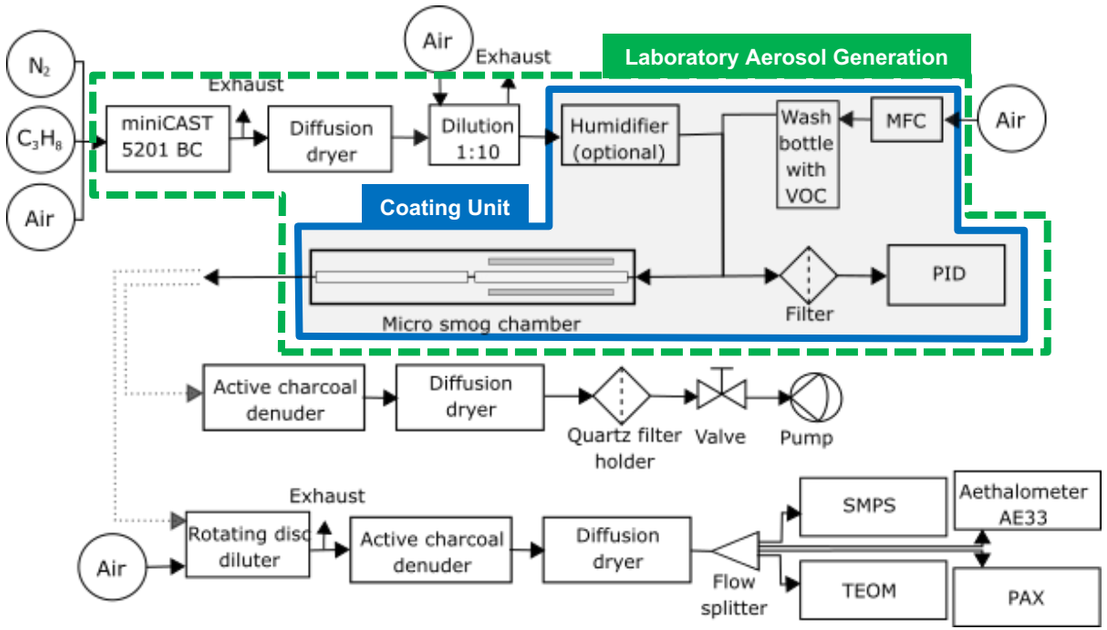
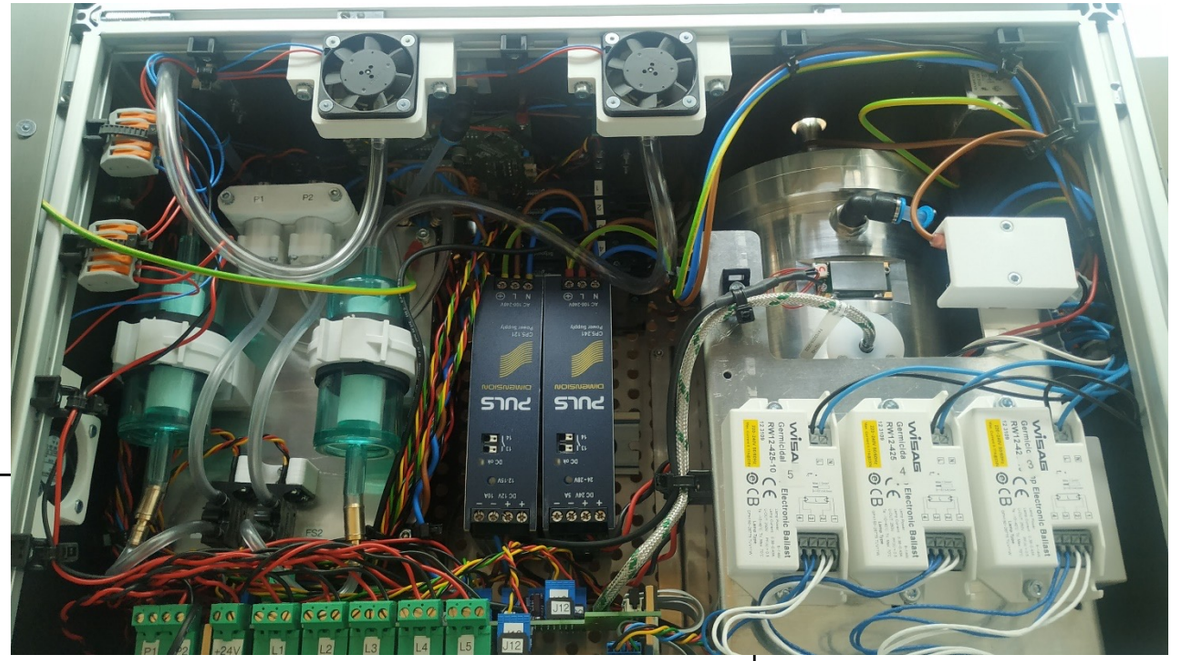
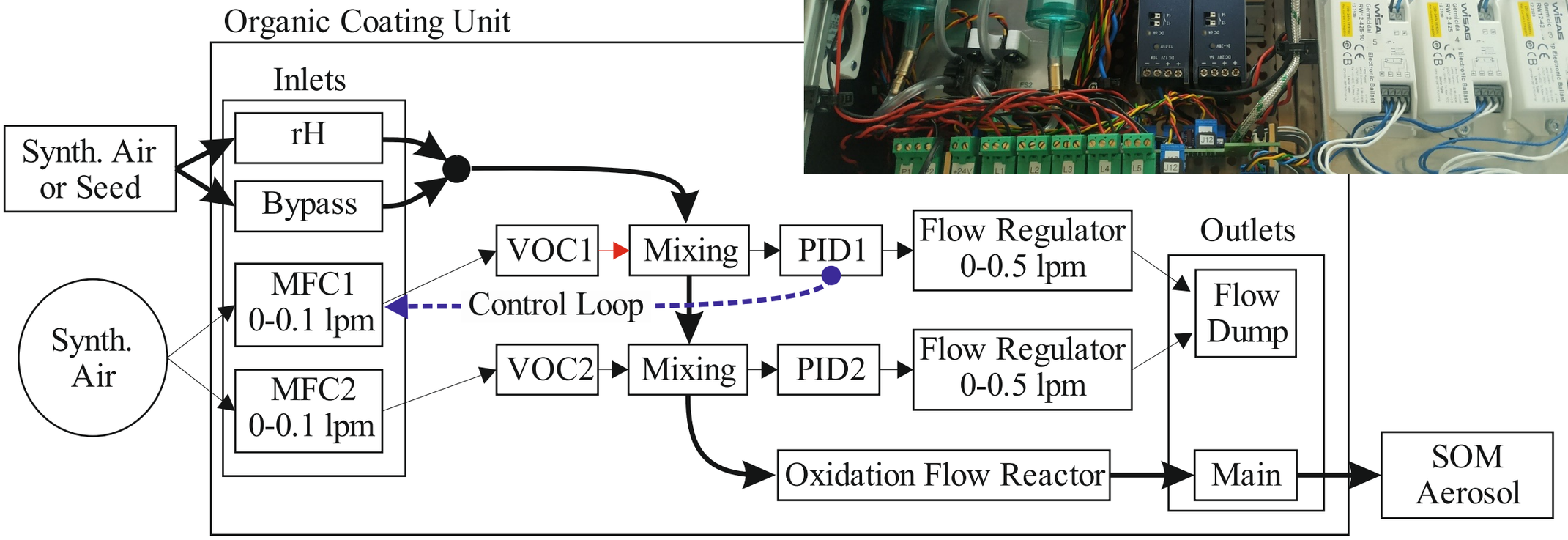




- Ess et al, JAS (2021): https://doi.org/10.1016/j.jaerosci.2021.105820

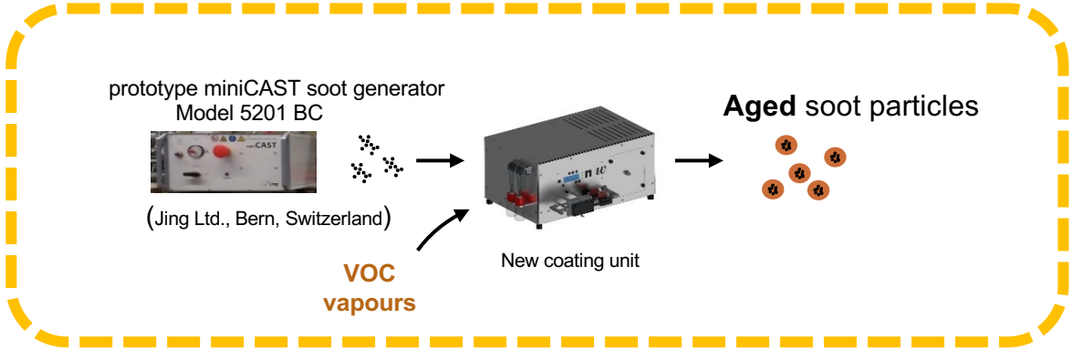
- MFC: mass flow controller
- PID: photo ionisation detector
- VOC1 and VOC2: containers for precursor substance
- SOM: secondary organic matter

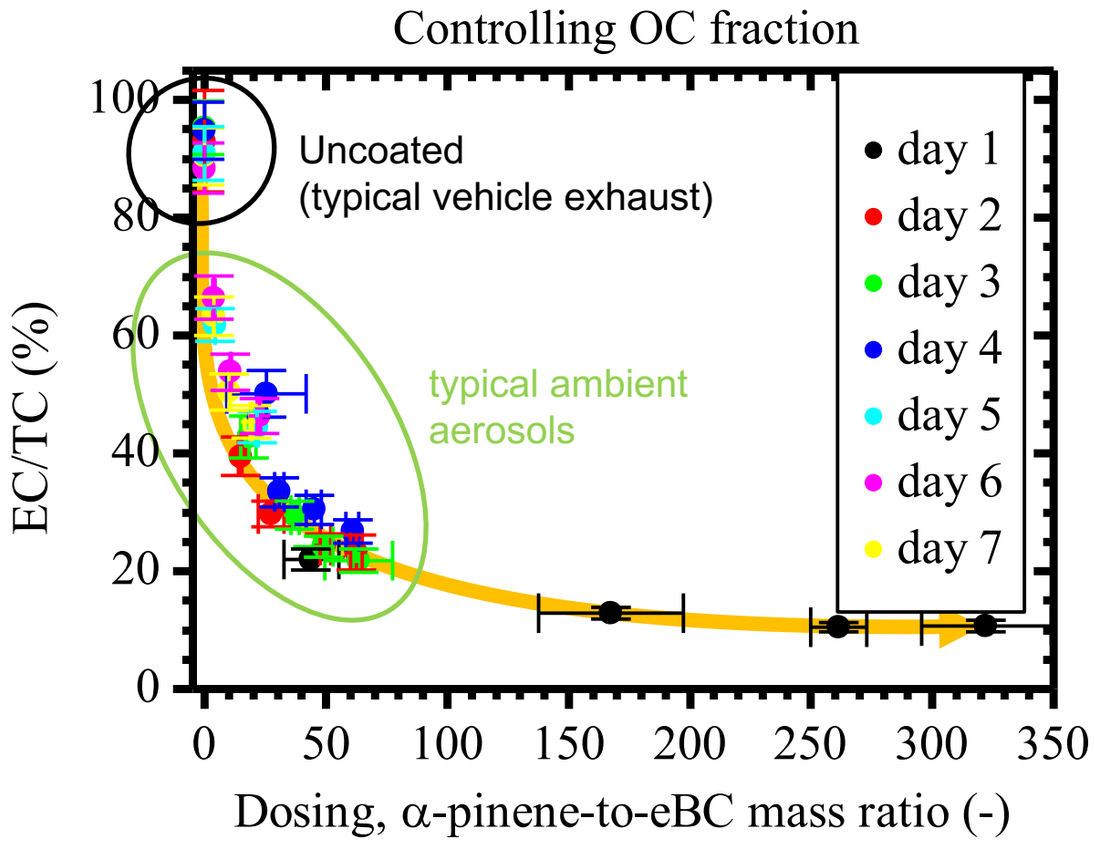


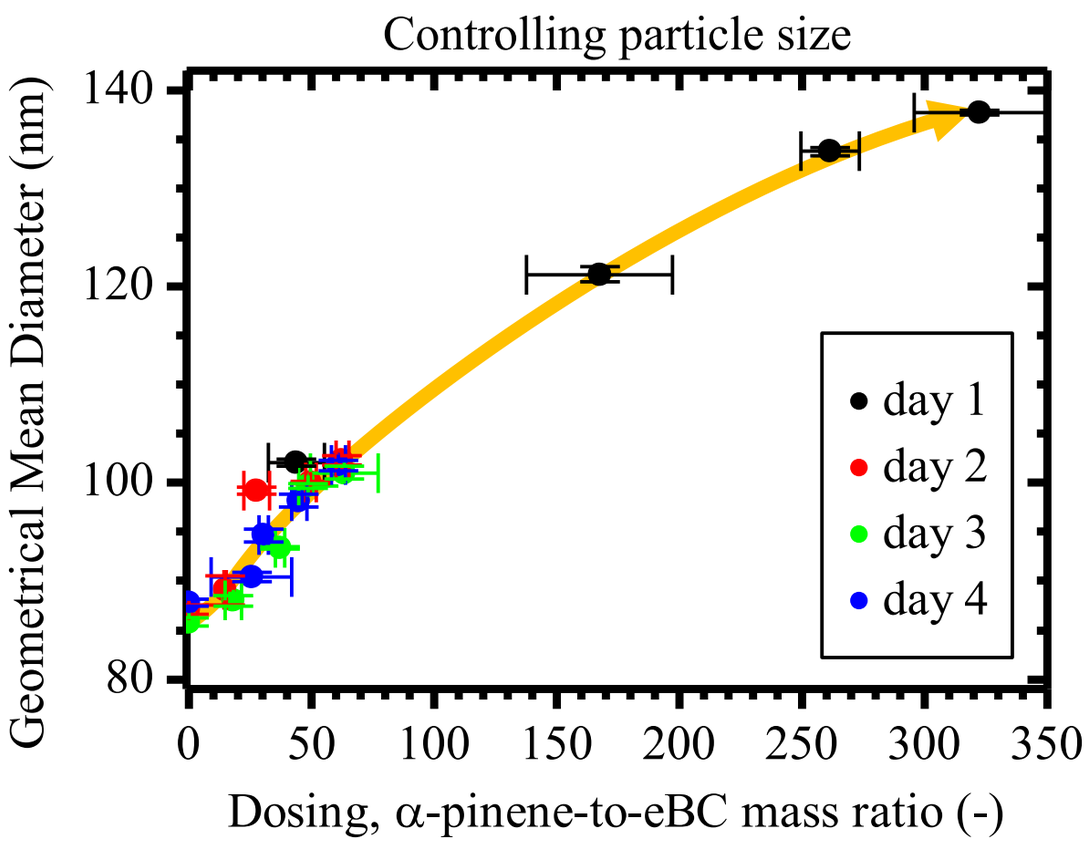


Producing Stable Model Aerosols

- EC=elemental carbon, OC=organic carbon
- TC=total carbon = EC+OC, eBC=Equivalent Black Carbon







Producing Stable Model Aerosols

- EC=elemental carbon, OC=organic carbon
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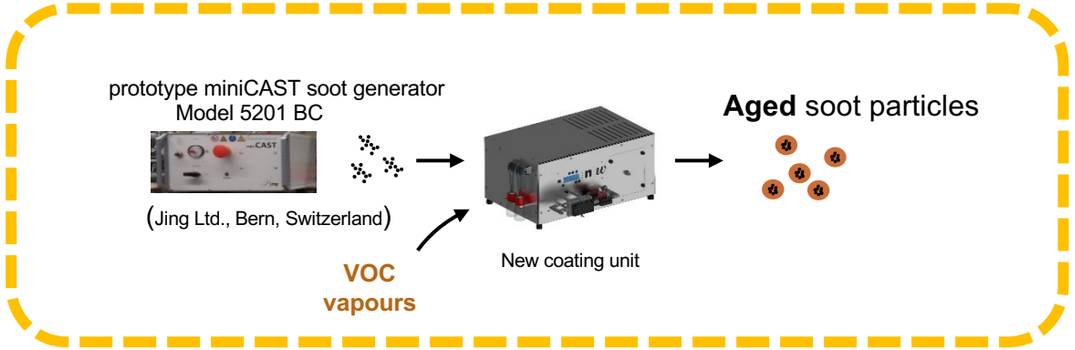
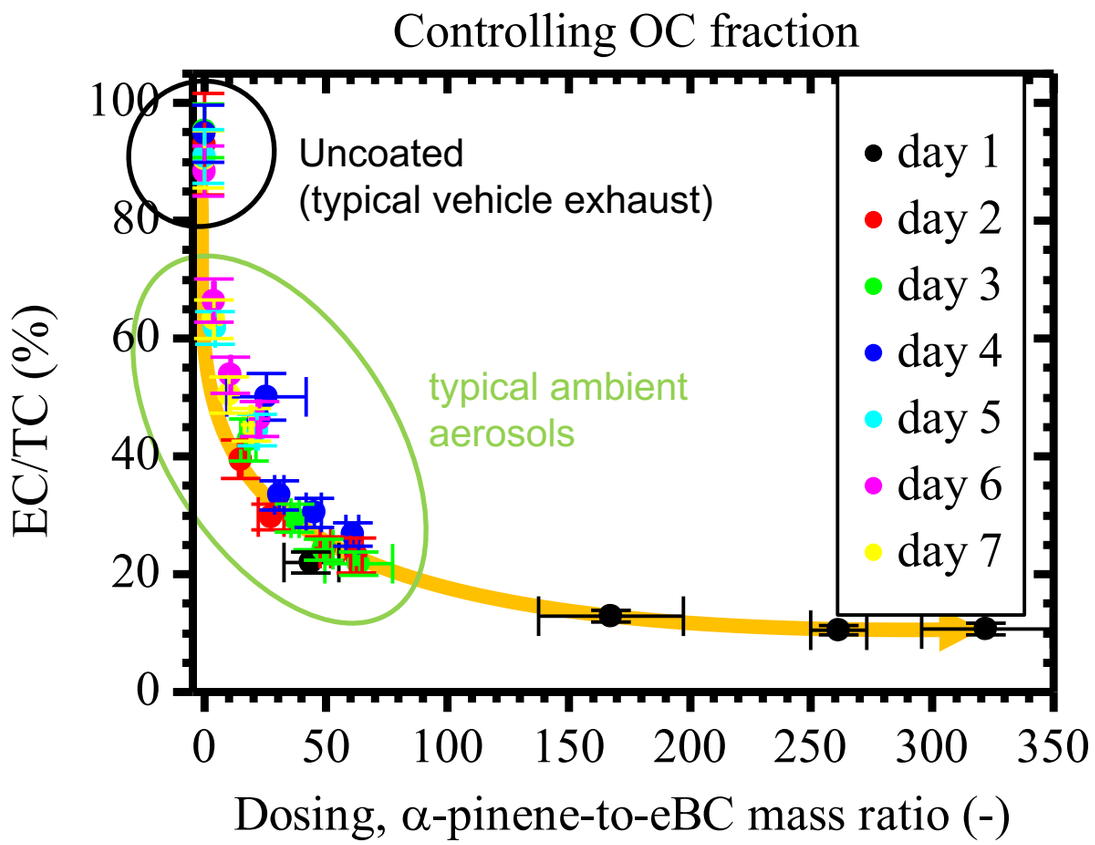
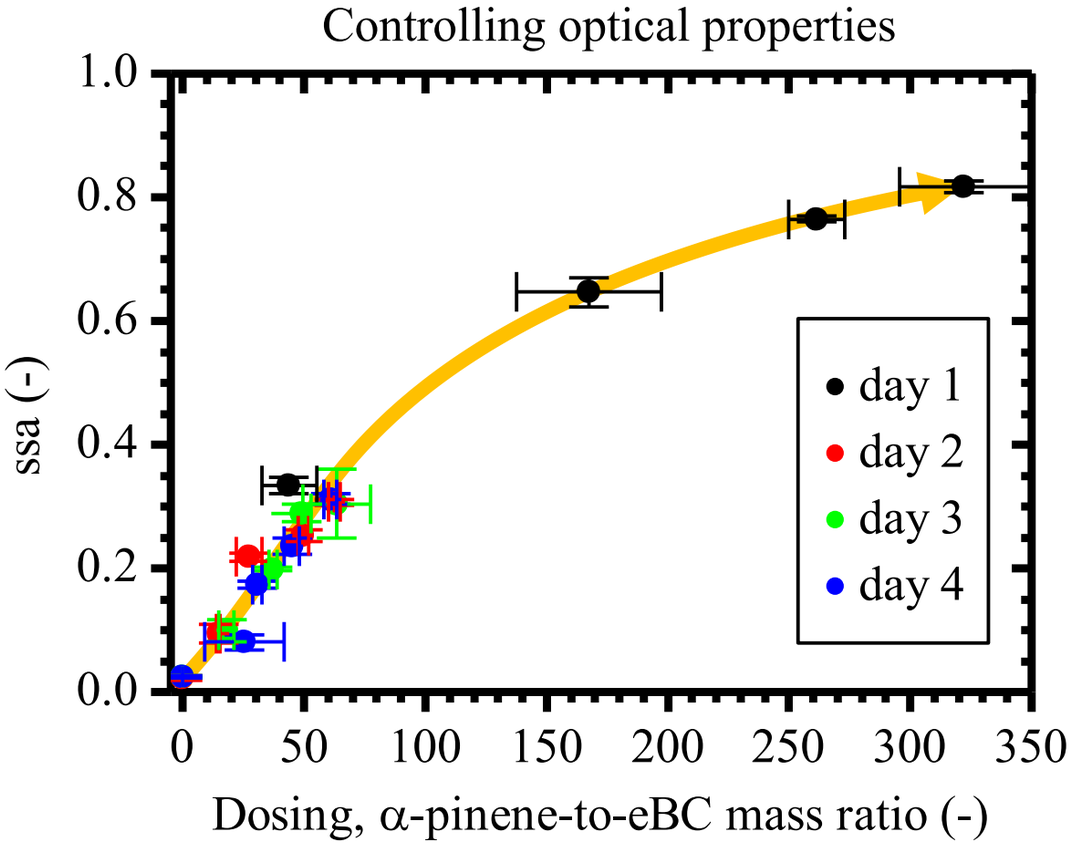
- SSA = single-scattering albedo







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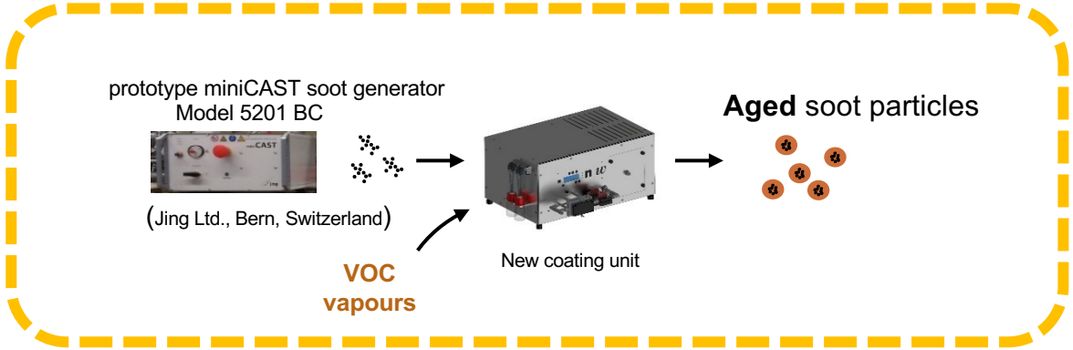
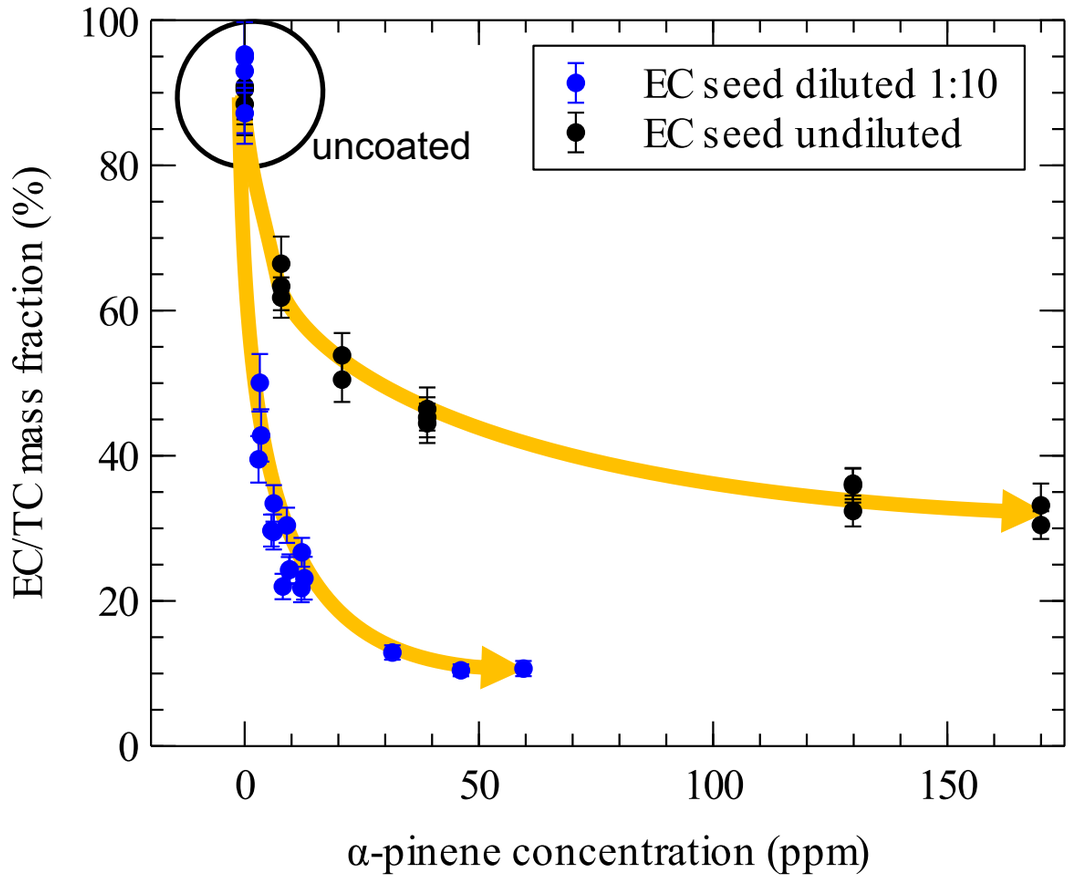
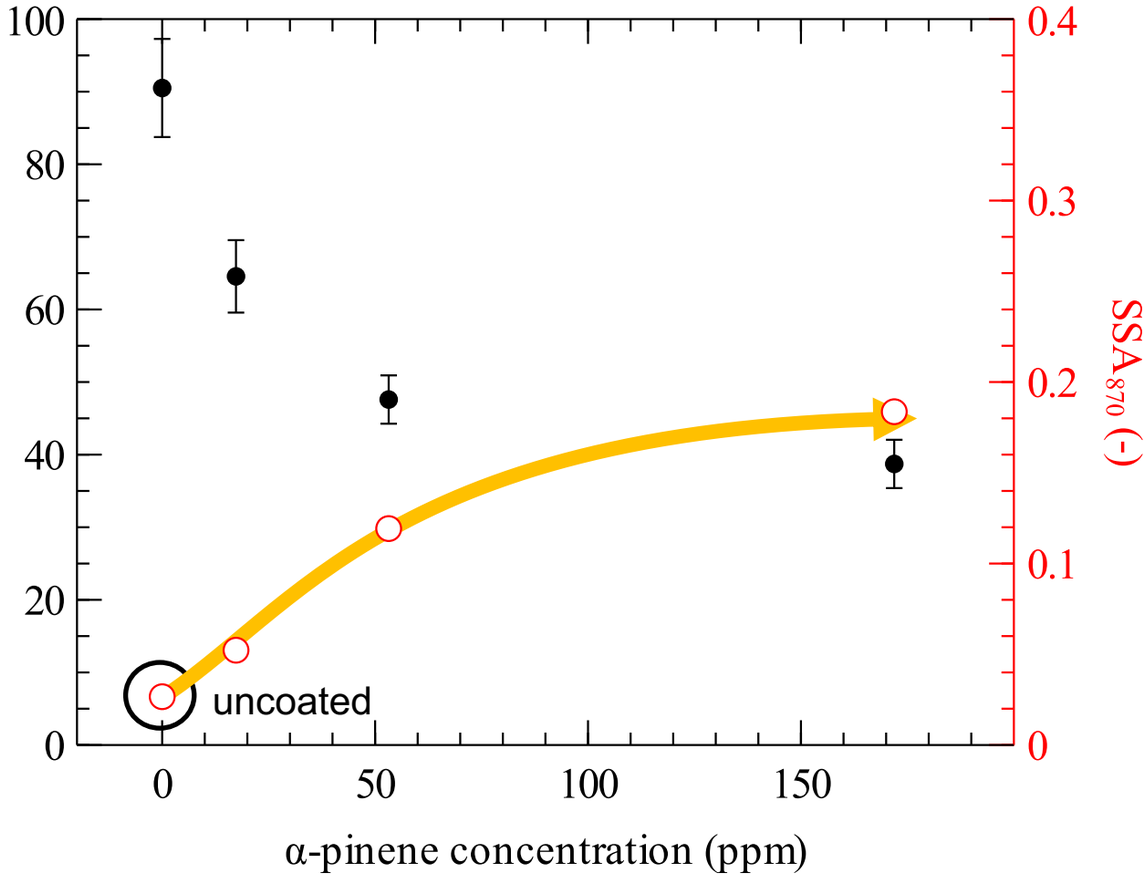
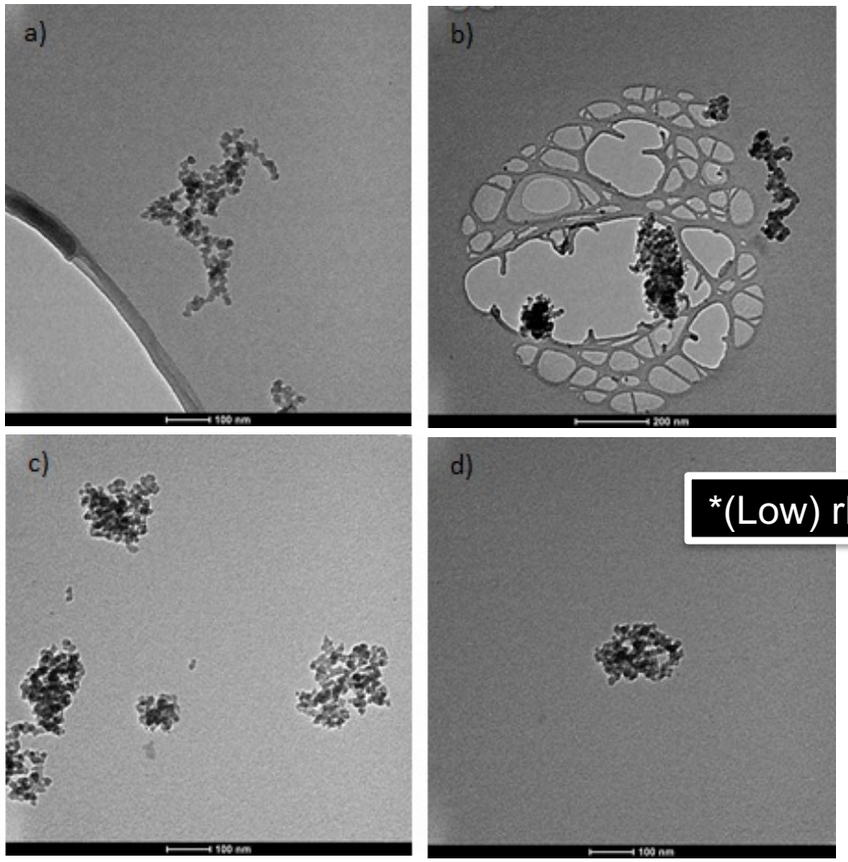




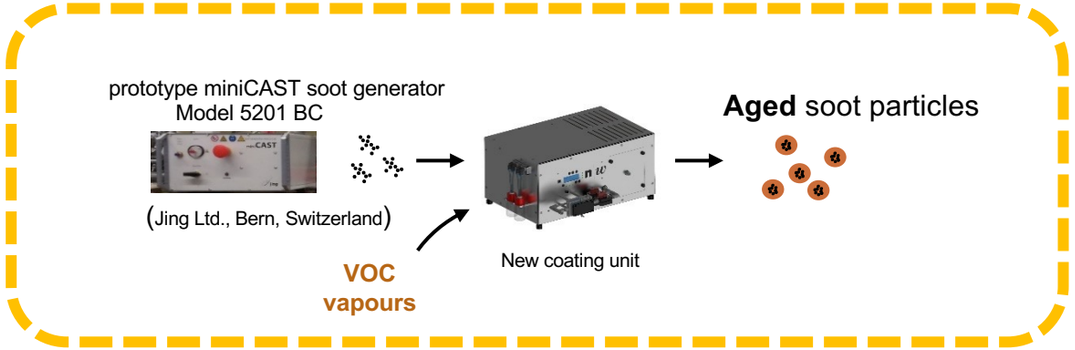


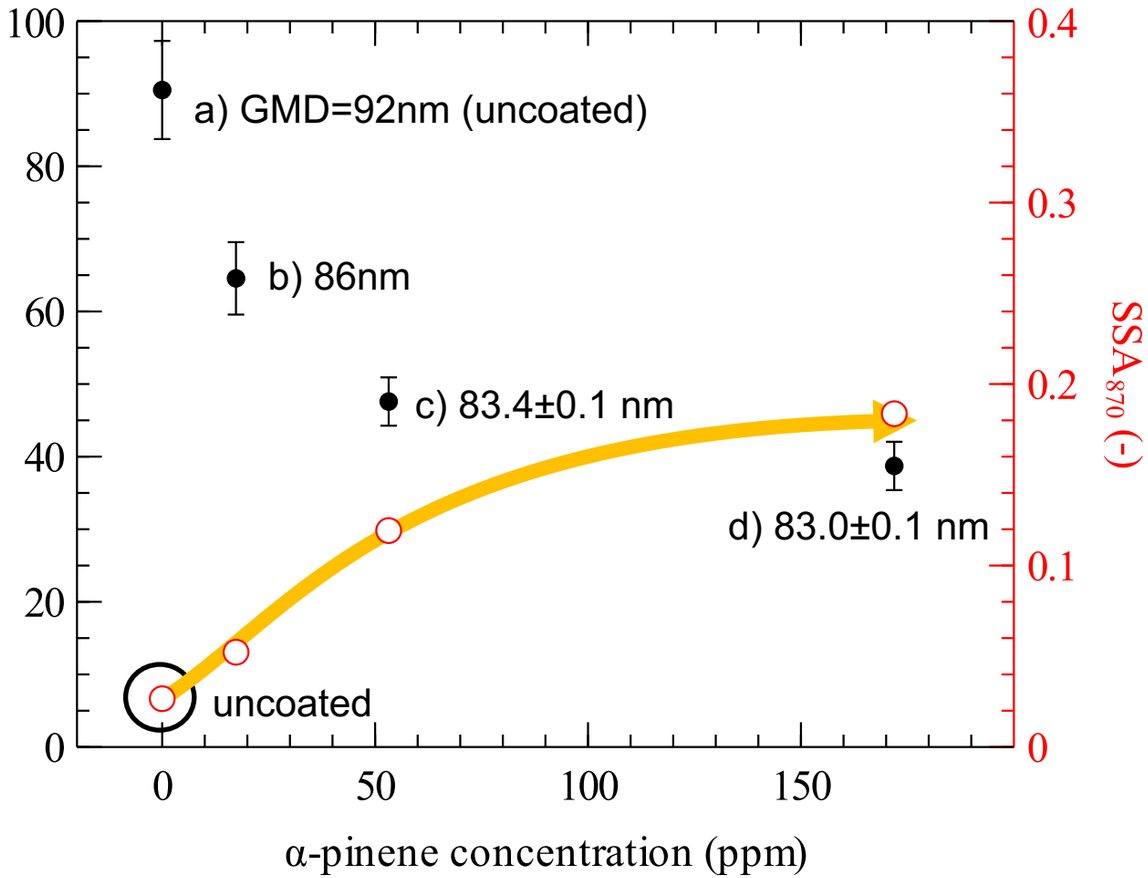
Producing Stable Model Aerosols

- EC=elemental carbon, OC=organic carbon
- TC=total carbon = EC+OC
- SSA=single-scattering albedo
- GMD=Geometrical mean diameter



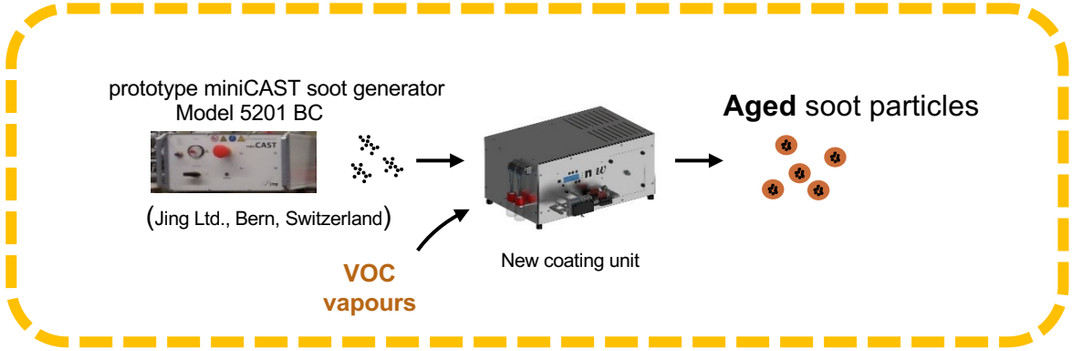
*(Low) rH=25%

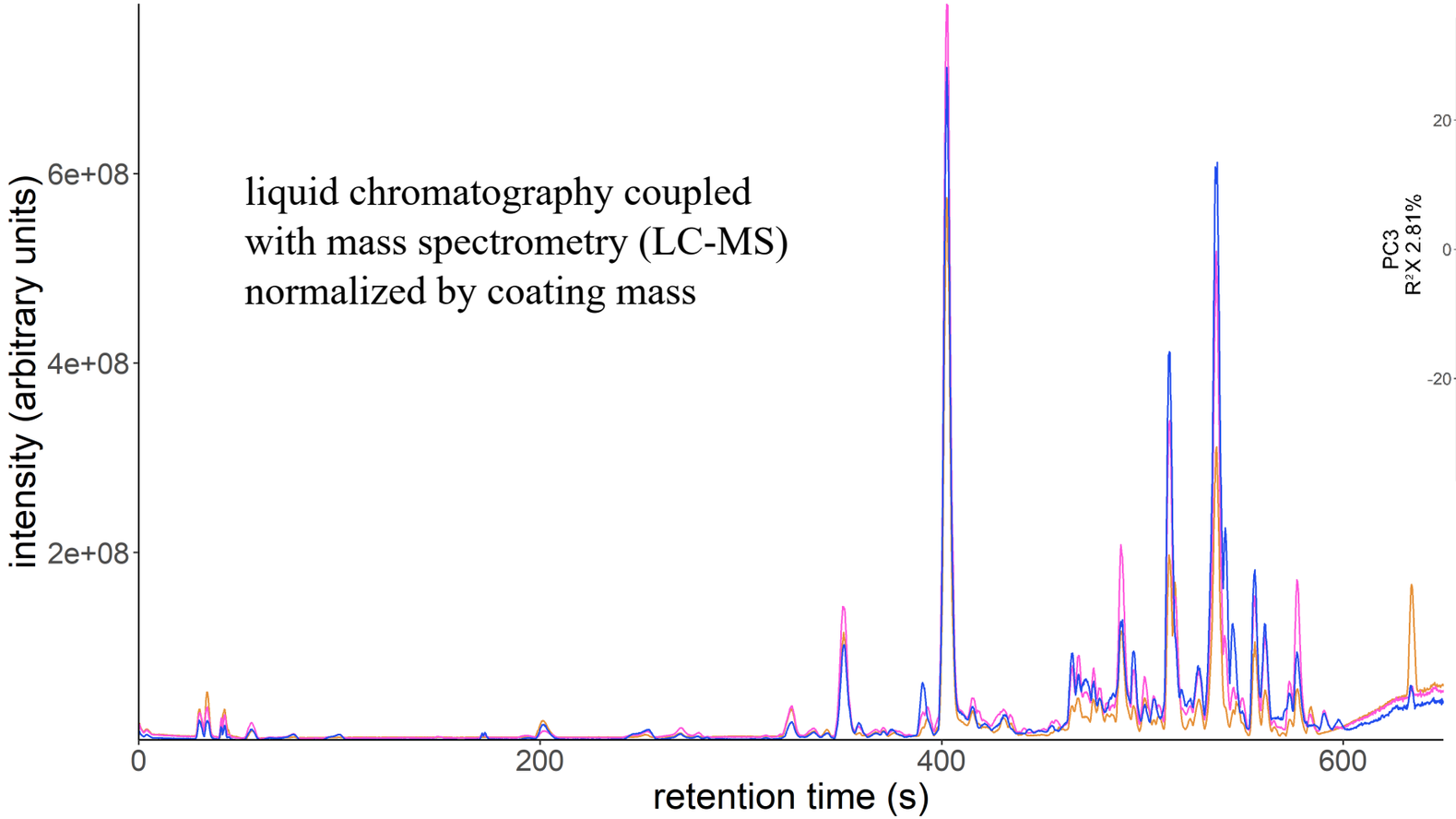


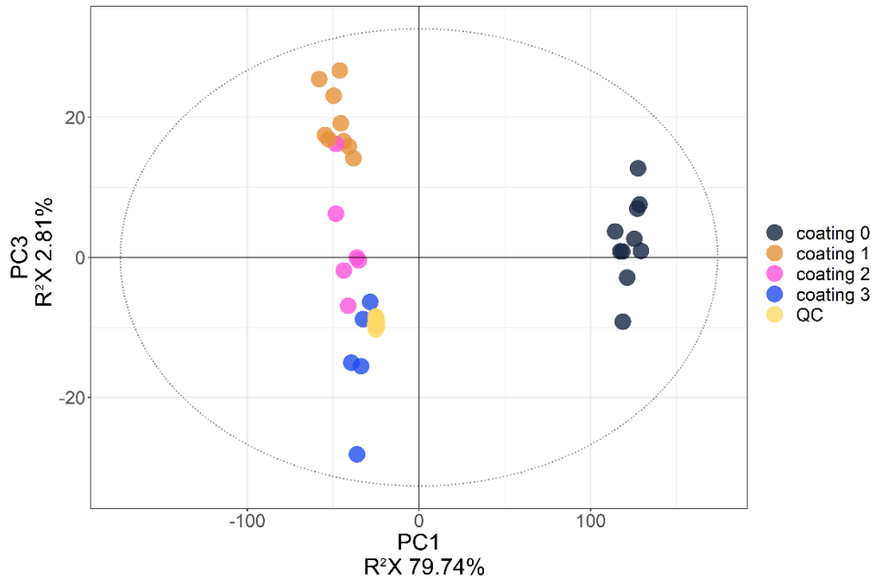


Producing Stable Model Aerosols

- Composition across coating thickness is very similar and reproducible.
- 4226 analyzed peaks; variation from fewer than 15 peaks



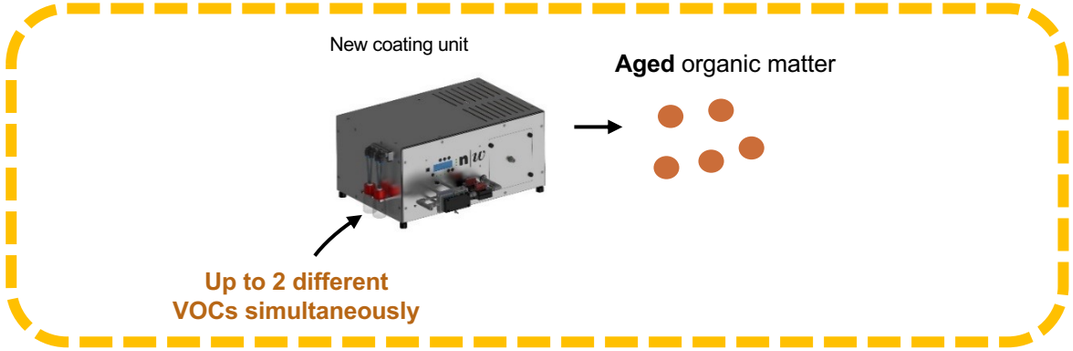


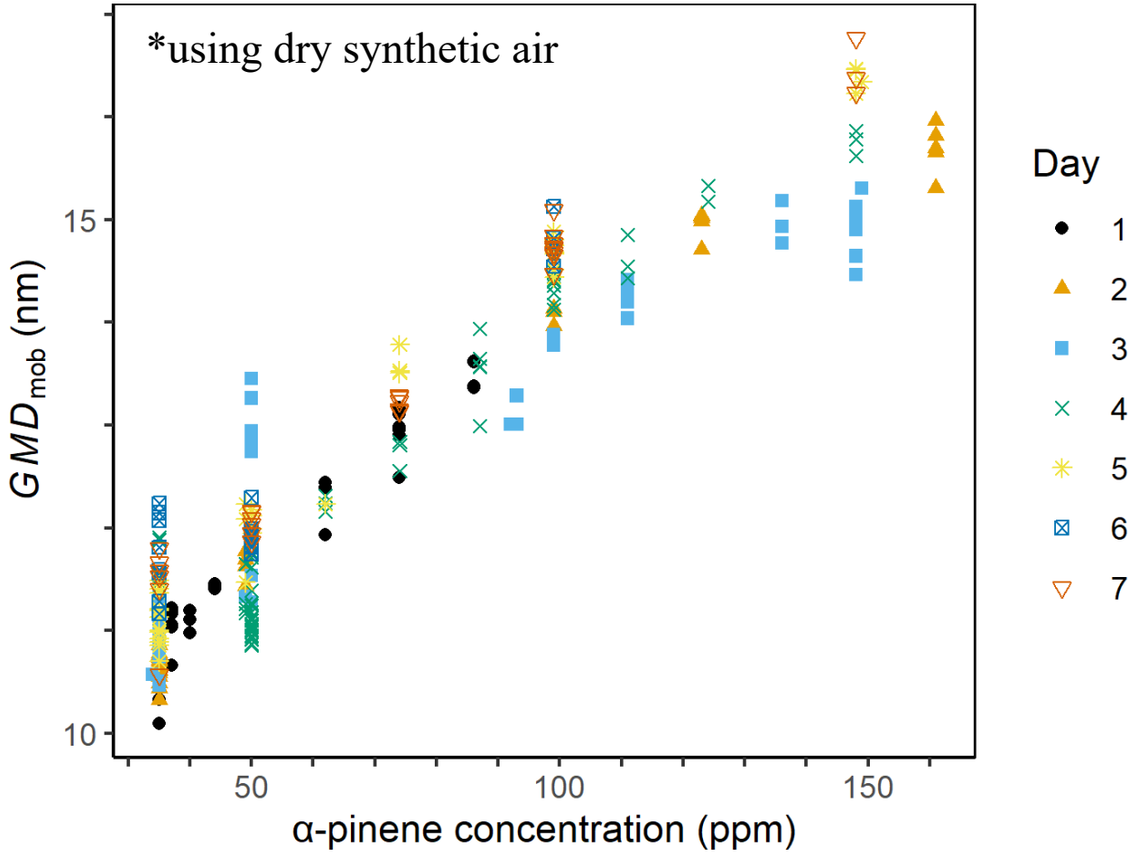


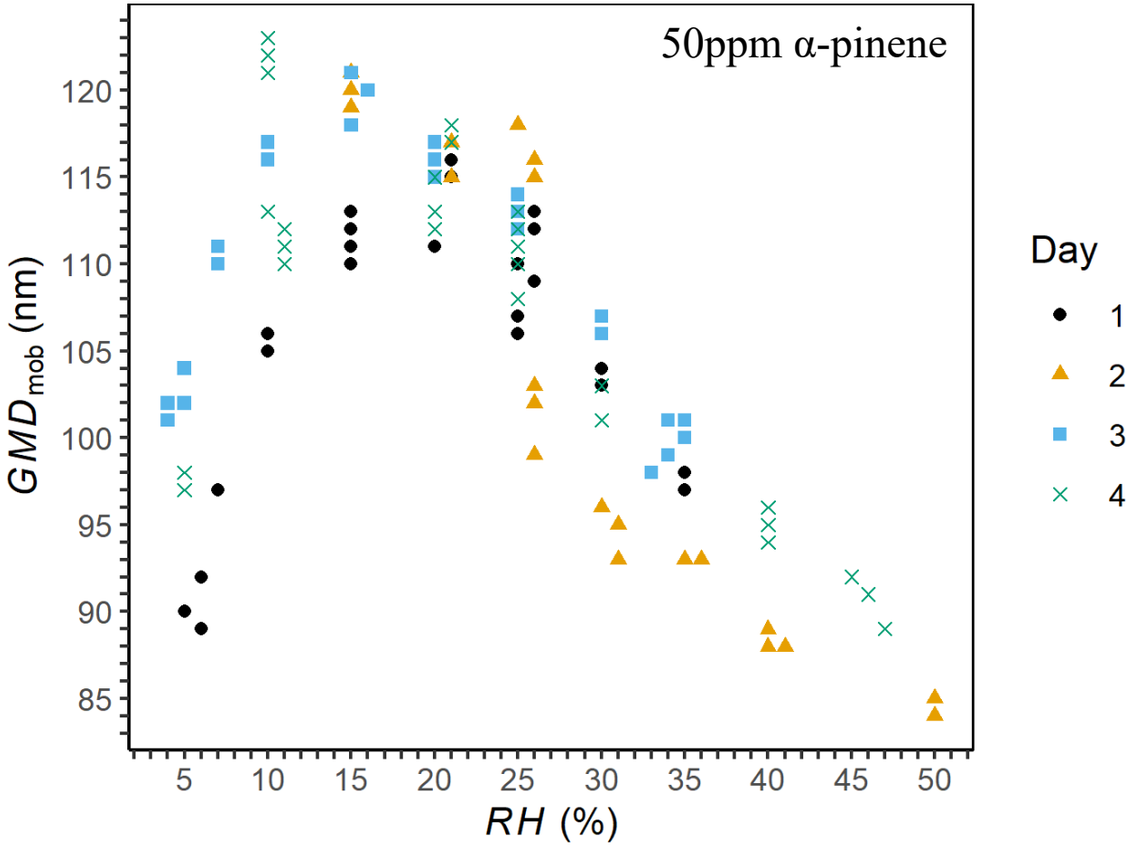
Principal component analysis

Producing Stable Model Aerosols

- GMD=Geometrical mean diameter
- RH=Relative humidity

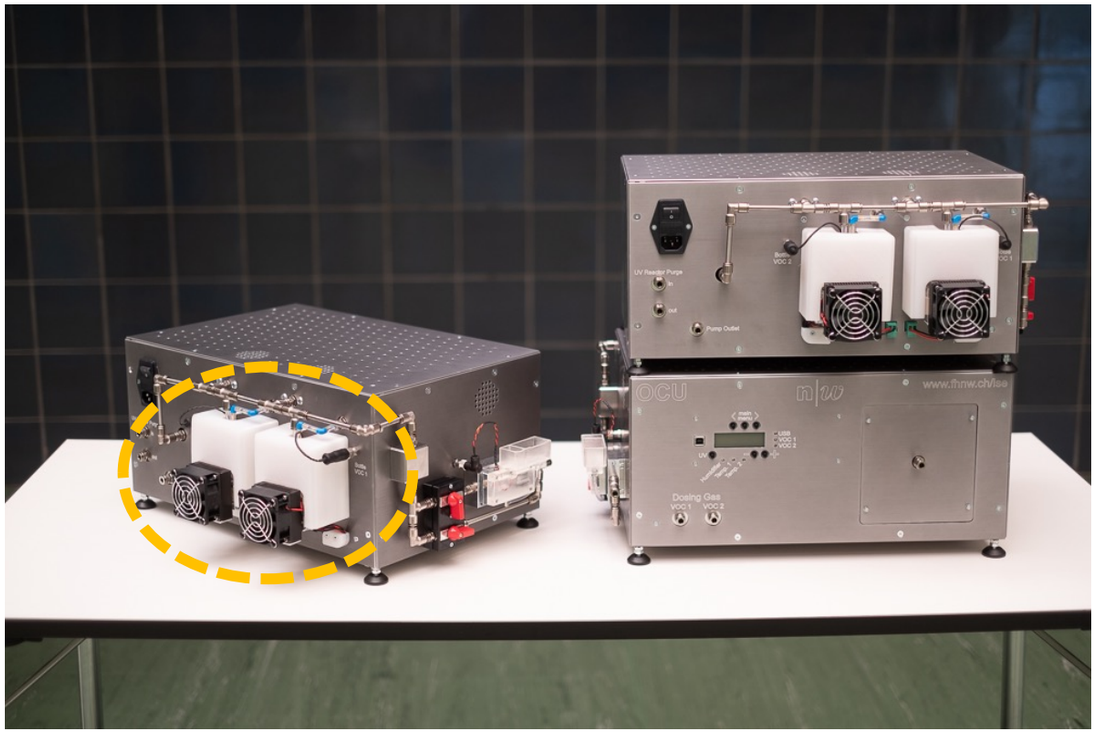


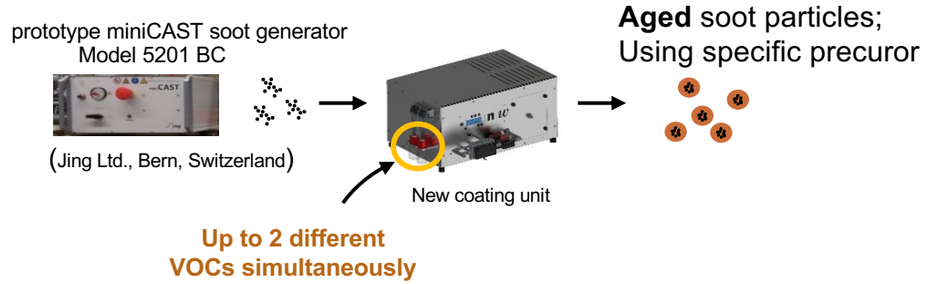


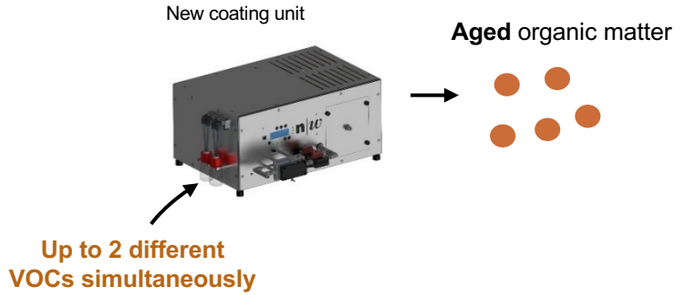


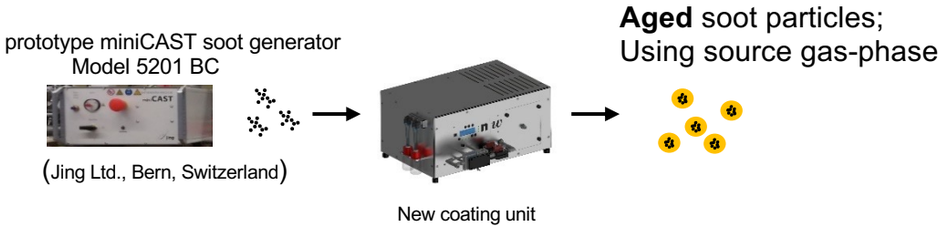
New generation of the instrument available (May 2022)

- 4 instruments from the first generation
- Used by groups in Switzerland, France, UK (and soon Sweden)
- 3 instruments of the second generation
- New generation has a temperature control for the VOC dosing (10 to 80°C)
- This extends the range of dosing and allows the use of substances with a wide range of volatility









Areas of application for the coating unit

- Simulation of atmospheric processes
- Lab-based study of the evolution of particle properties (e.g., potential climate impact)
- Lab-based study of health effects (Health)
- Lab-based calibration of, e.g., absorption photometers (Air quality)
- New test aerosols for, e.g., filter testing (Industry)

Excellent repeatability: day to day & unit to unit.

Publications

Description of the instrument:

- Keller et al., Aerosol Sci. & Tech, under review

Optical properties, absorption measurement instruments:

- Kalbermater et al., AMT, 2022 https://doi.org/10.5194/amt-15-561-2022

Healt effects:

- To be submitted

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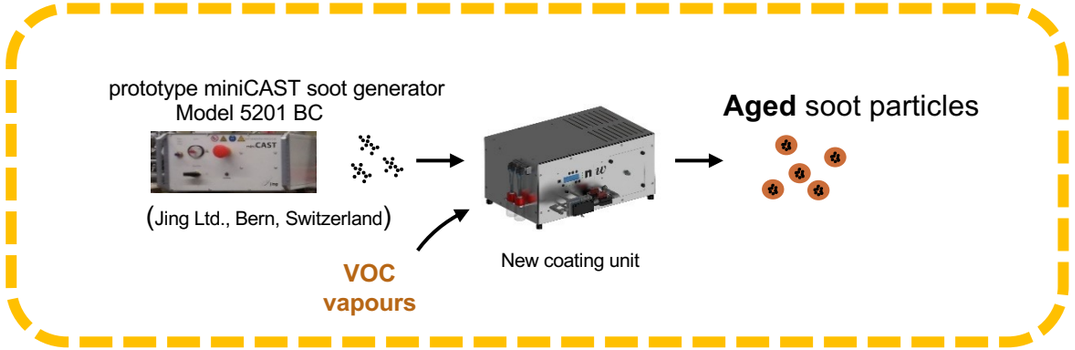
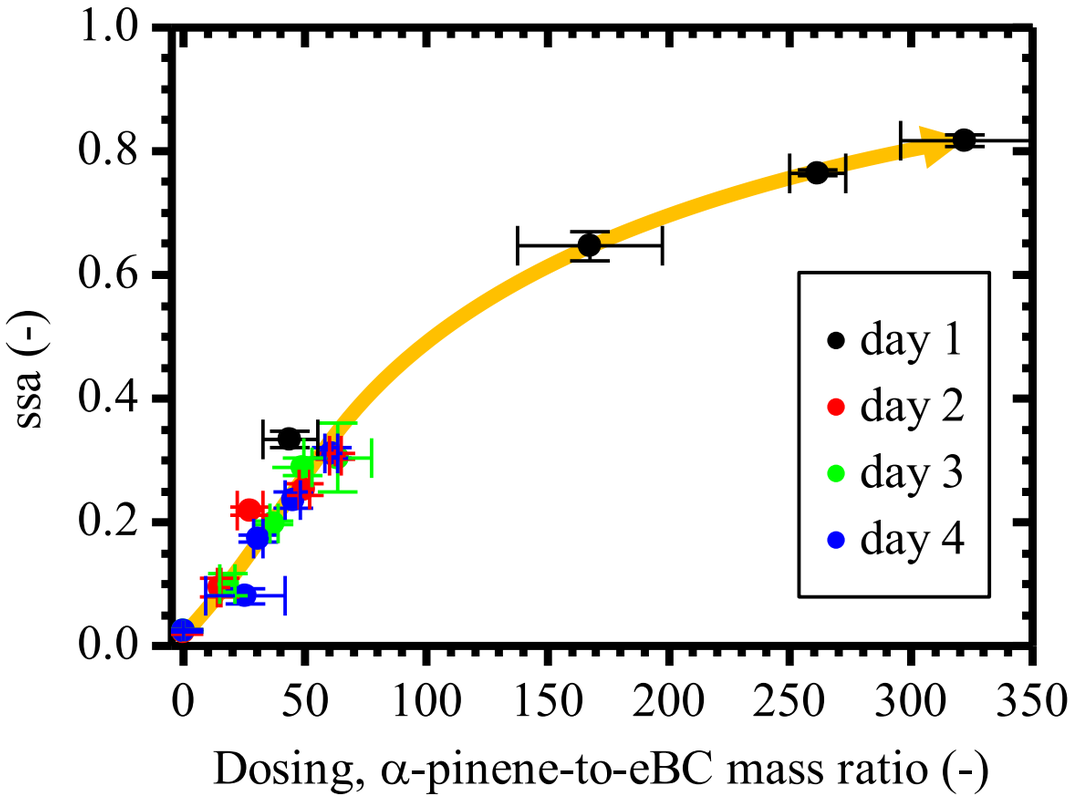
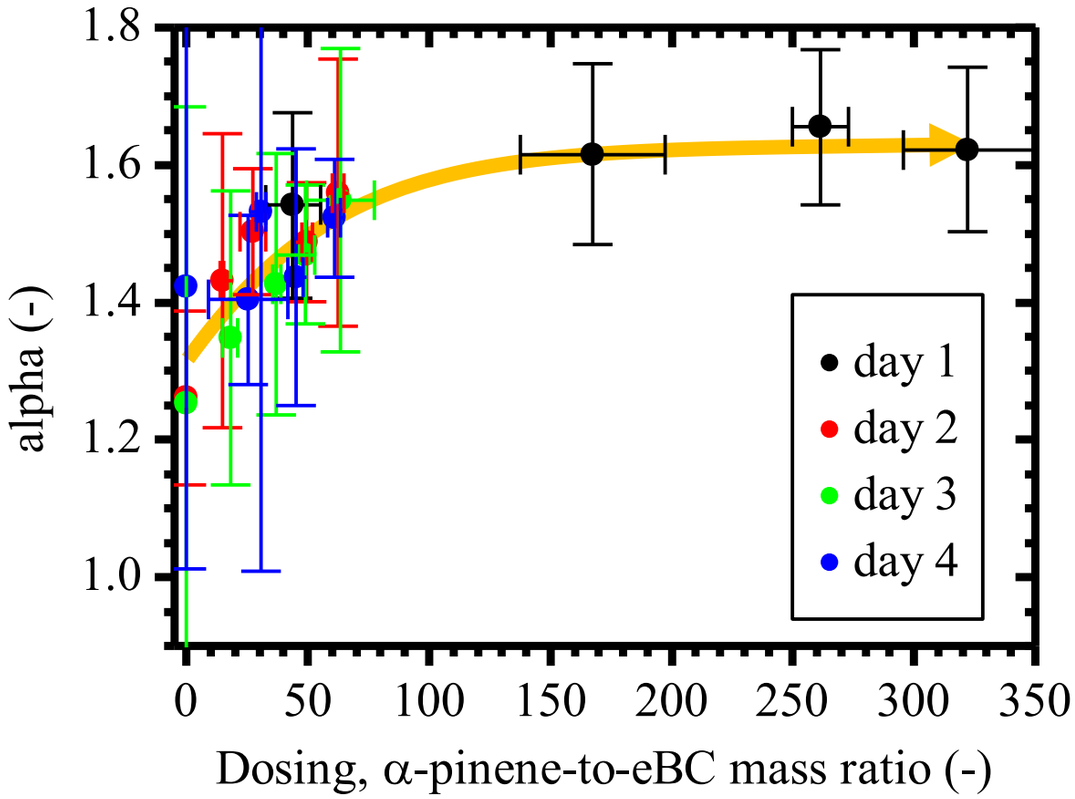
METAS

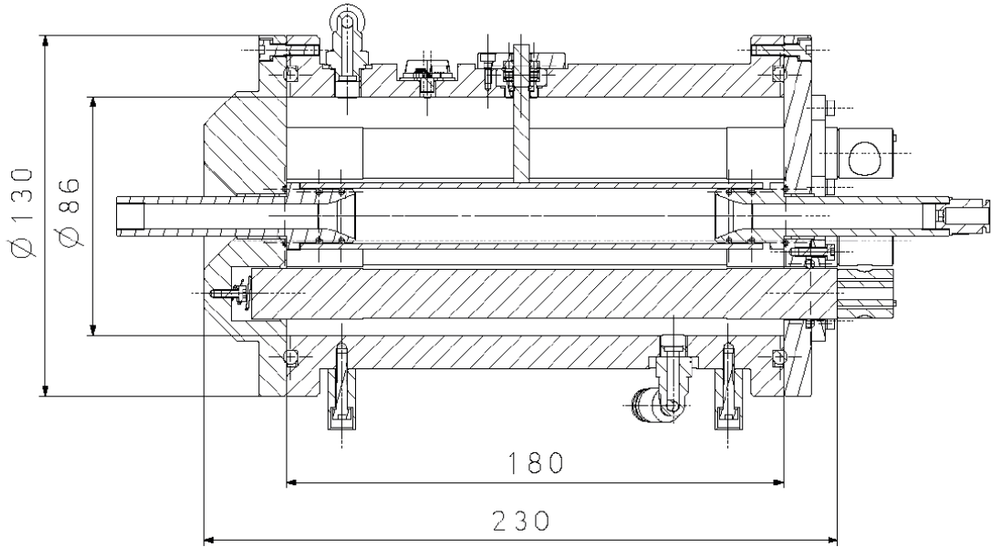
Modelling optical properties

- Relative humidity <5% (→ Ozonolysis of α-pinene)
- SSA = single-scattering albedo
- alpha= Ångström exponent





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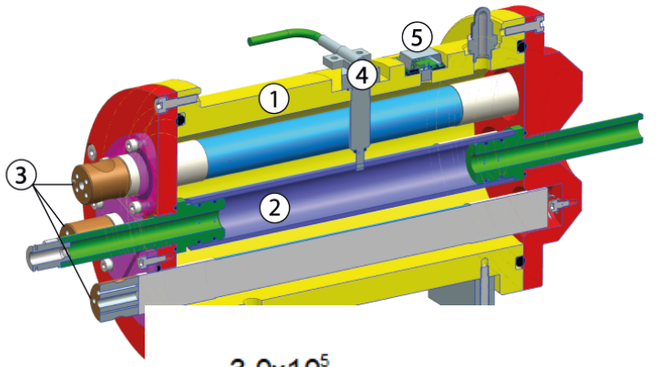
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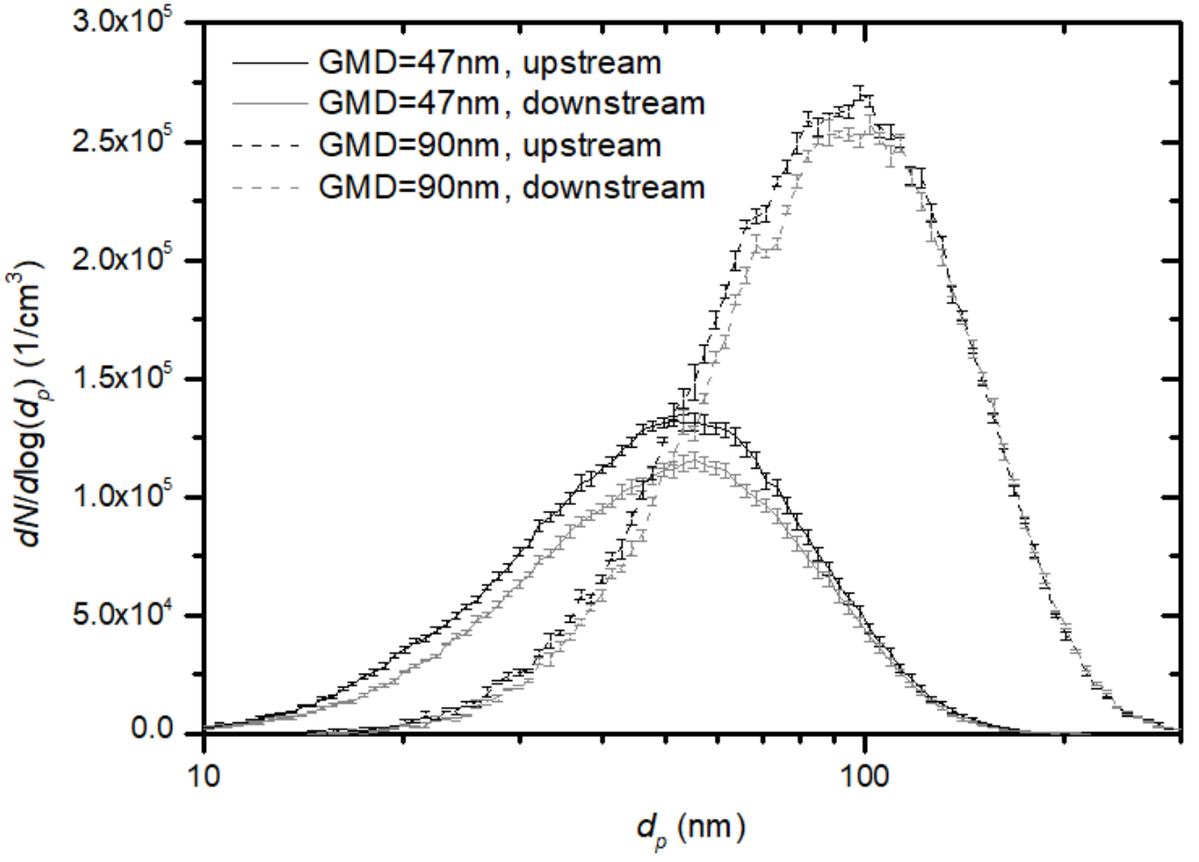
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GMD=90nm, upstream
GMD=90nm, downstream
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1.0x10^5
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10
100
d_p (nm)