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Particle Characterization during the VI-ACI FROST Campaigns using an Aerosol Mass Spectrometer

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Overview

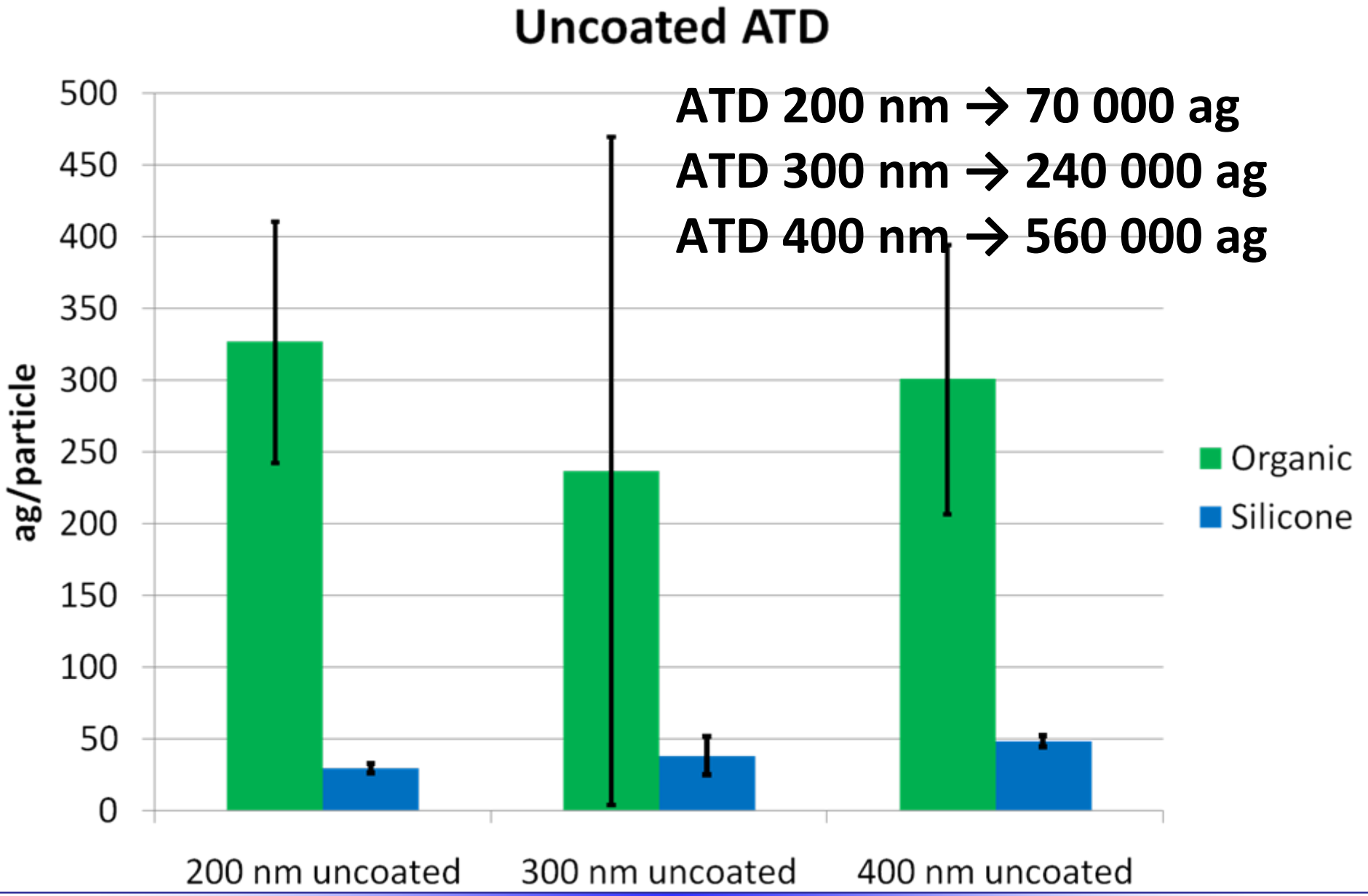
- FROST 1
  - Overview coatings
  - Size distributions
- FROST 2
  - Quicklook

FROST 1

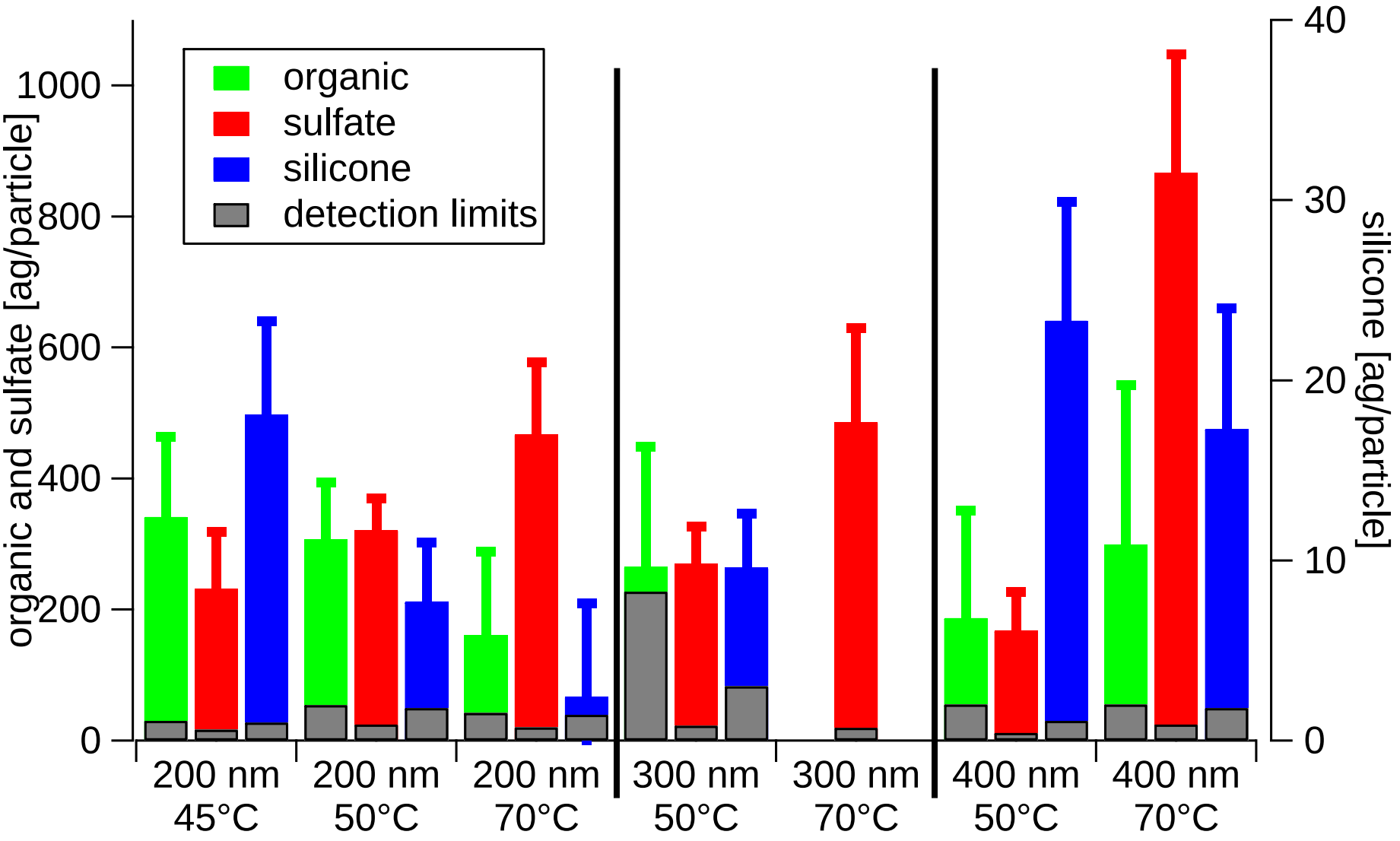
- Items from the outlook of last year's meeting:

- FROST campaign:
  - deliver µg per particle for all experiments
  - determine coating thickness, size resolved?
  - Merge IfT, MZ, FZJ data to a joint data set.

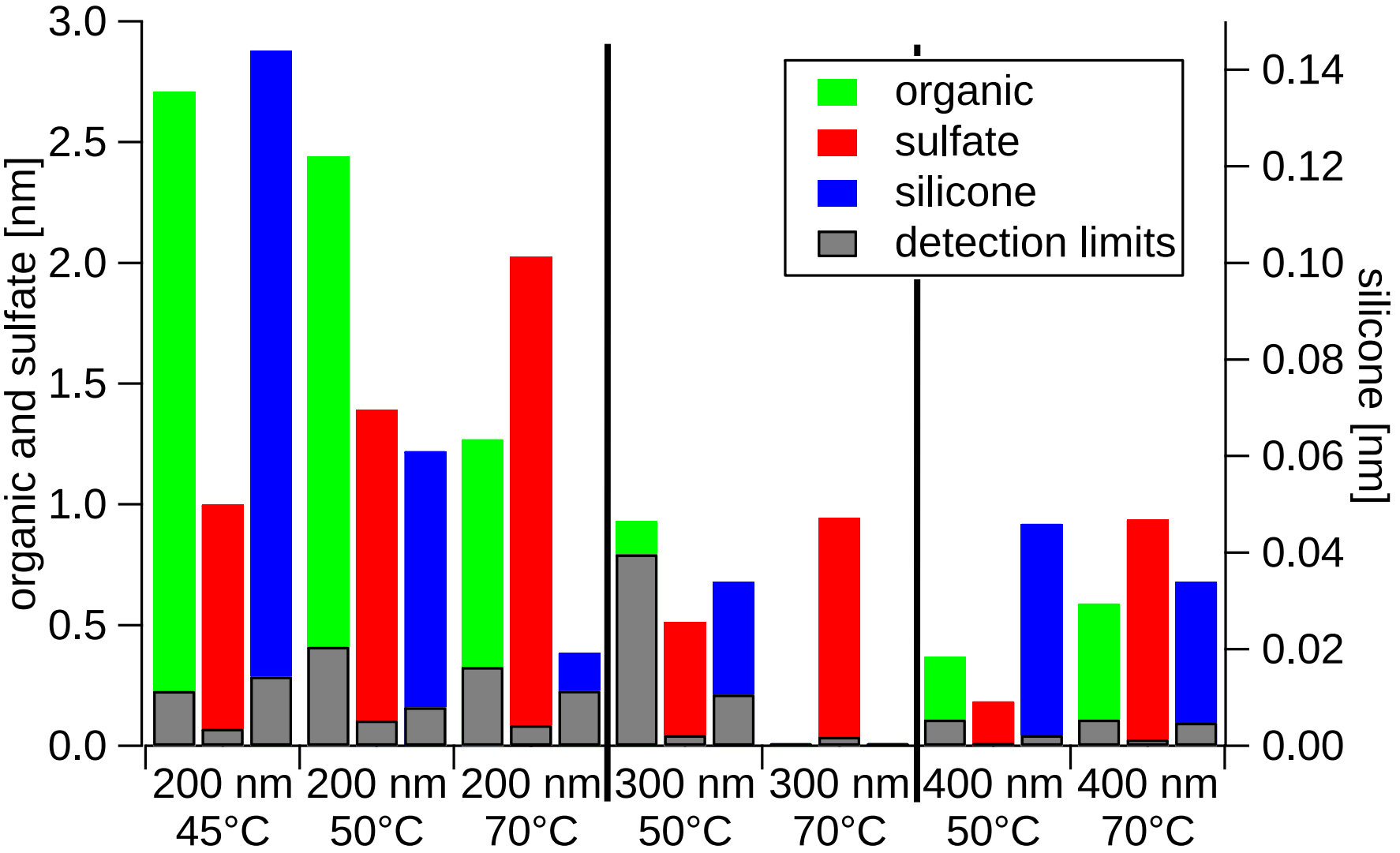
Chemical Composition



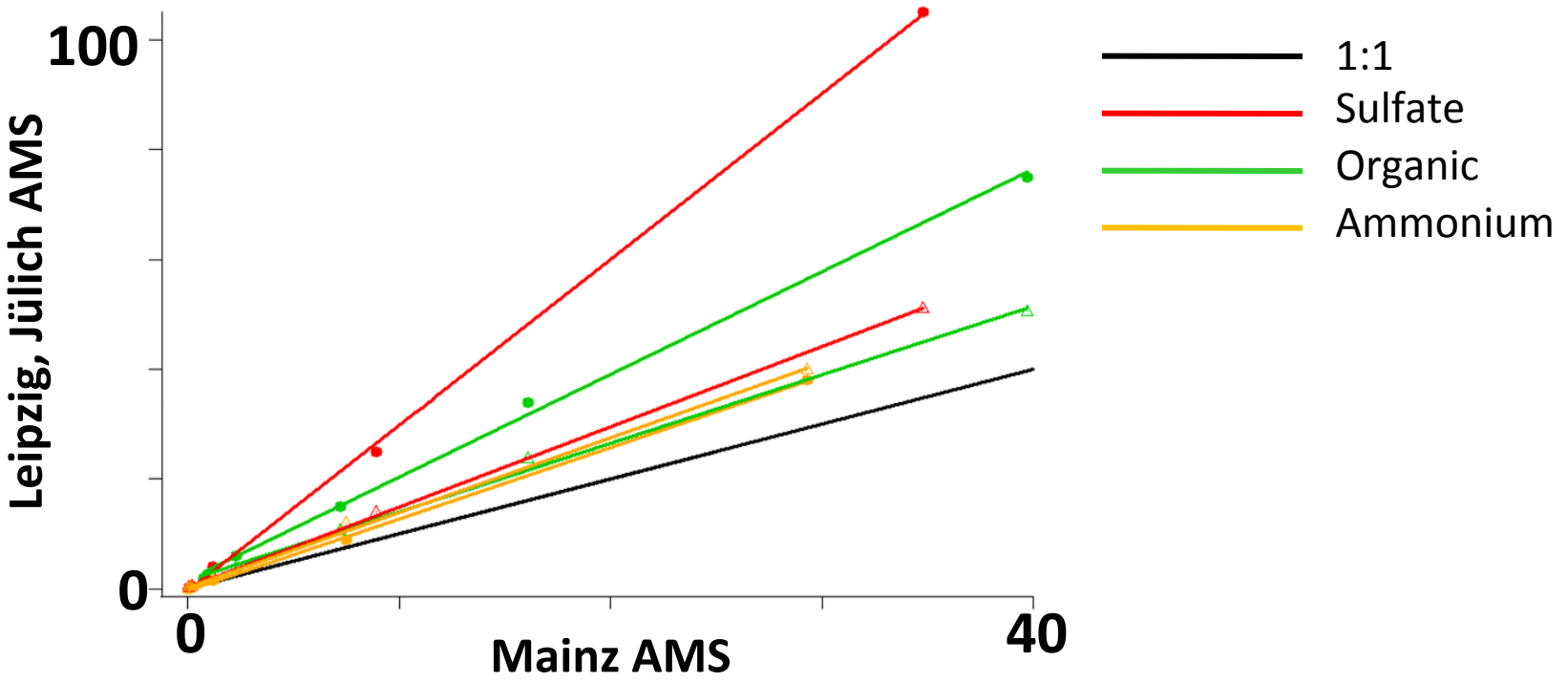
Chemical Composition



Chemical Composition

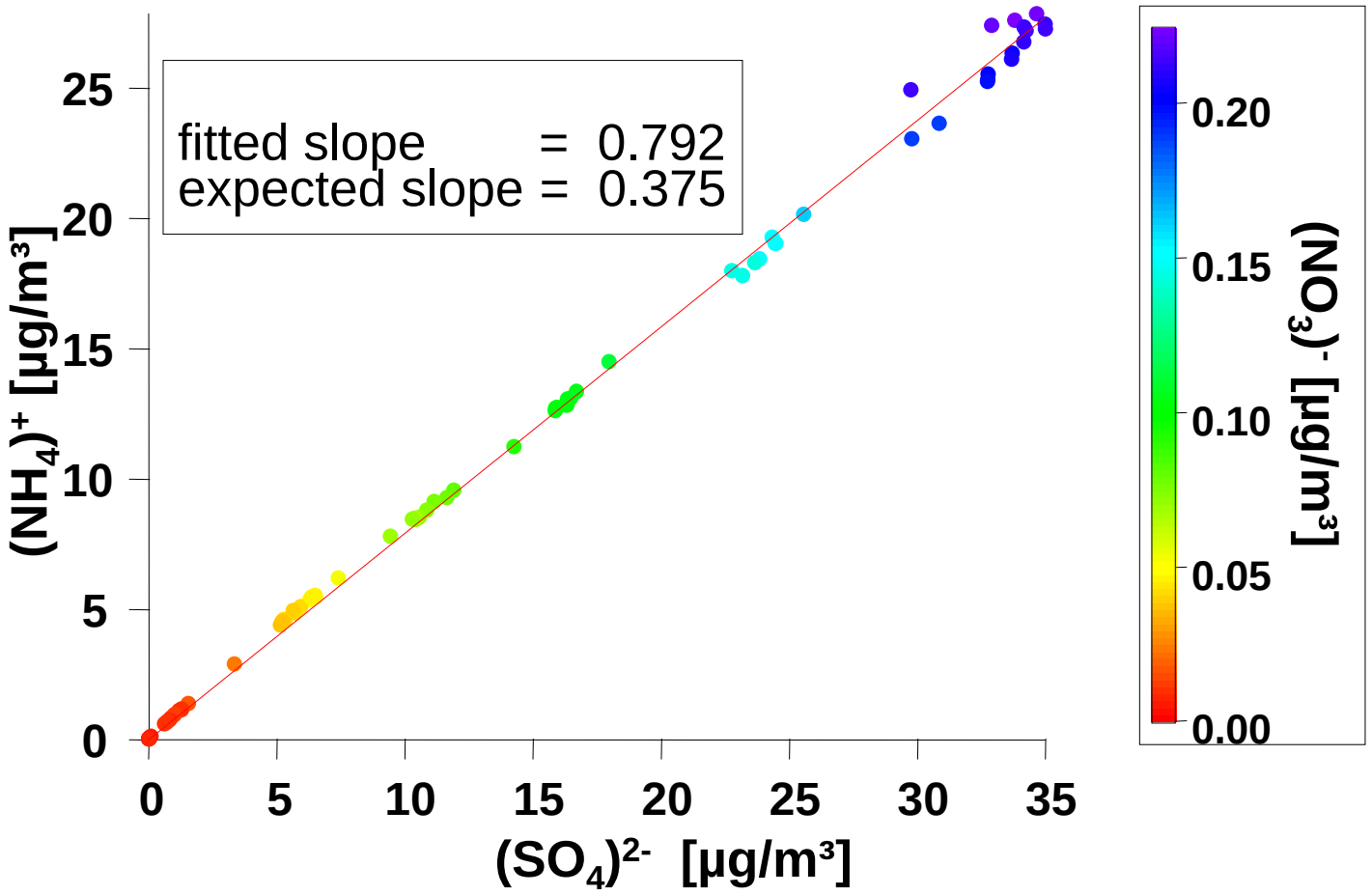


AMS intercomparison



Substance	Leipzig/Mainz	Jülich/Mainz
Succinic acid	1.87	1.25
Sulfate	3.01	1.36
Ammonium	1.30	1.46

Missing Sulfate?



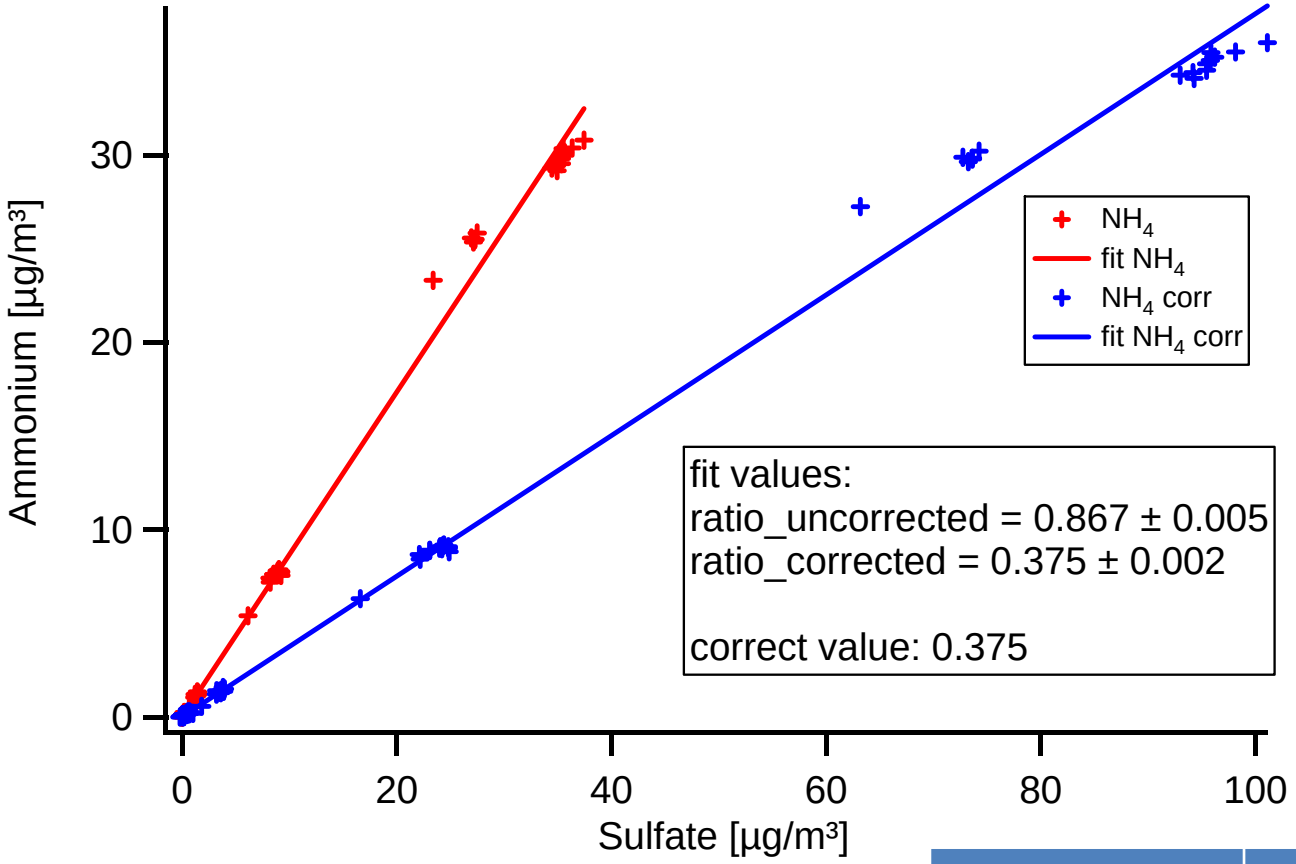
Correction

- Atomize mixed solution of NH_4NO_3 and $(NH_4)_2SO_4$ with known ratio
- Compare measured $(NH_4)^+$ and $(SO_4)^{2-}$ masses with the masses expected from the $(NO_3)^-$ signal which is used for calibration
- Use ratios between measured masses and expected masses as correction factors

Correction of the Leipzig $(NH_4)_2SO_4$ reference measurements yields the correct stoichiometric ratio between $(NH_4)^+$ and $(SO_4)^{2-}$ and provides nearly closure to the Leipzig data.

Missing Sulfate?

Use of correction factors on FROST data

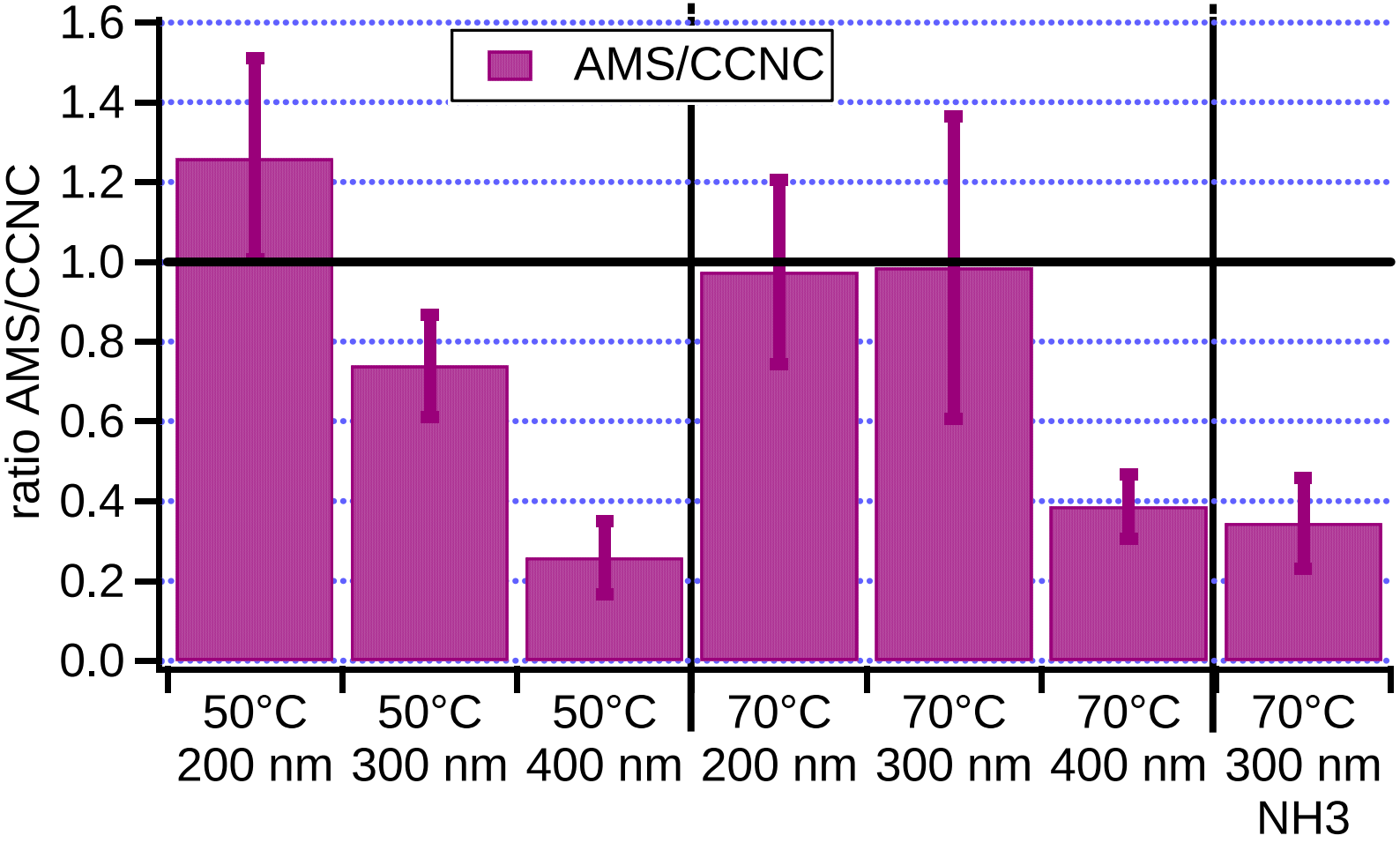


Stoichiometric ratio is now correct

Discrepancy to Leipzig AMS is now only a constant factor

Substance	Leipzig/Mainz	Jülich/Mainz
Sulfate	1.11	0.5
Ammonium	1.11	1.25

Comparison with CCNC



CCNC data from Heike Wex (IfT)

Comparison with CCNC

- Possible reasons for differences:
  - CCNC assumes spherical particles
  - CCNC assumes sulfuric acid
  - AMS cannot evaporate some sulfates produced on the particles
  - AMS correction factor has been determined for $(NH_4)_2SO_4$

Size distributions

Silicone,

a helpful contamination

Origin of the silicone

Silicone is part of particles with higher density:

Size selection trough DMA:

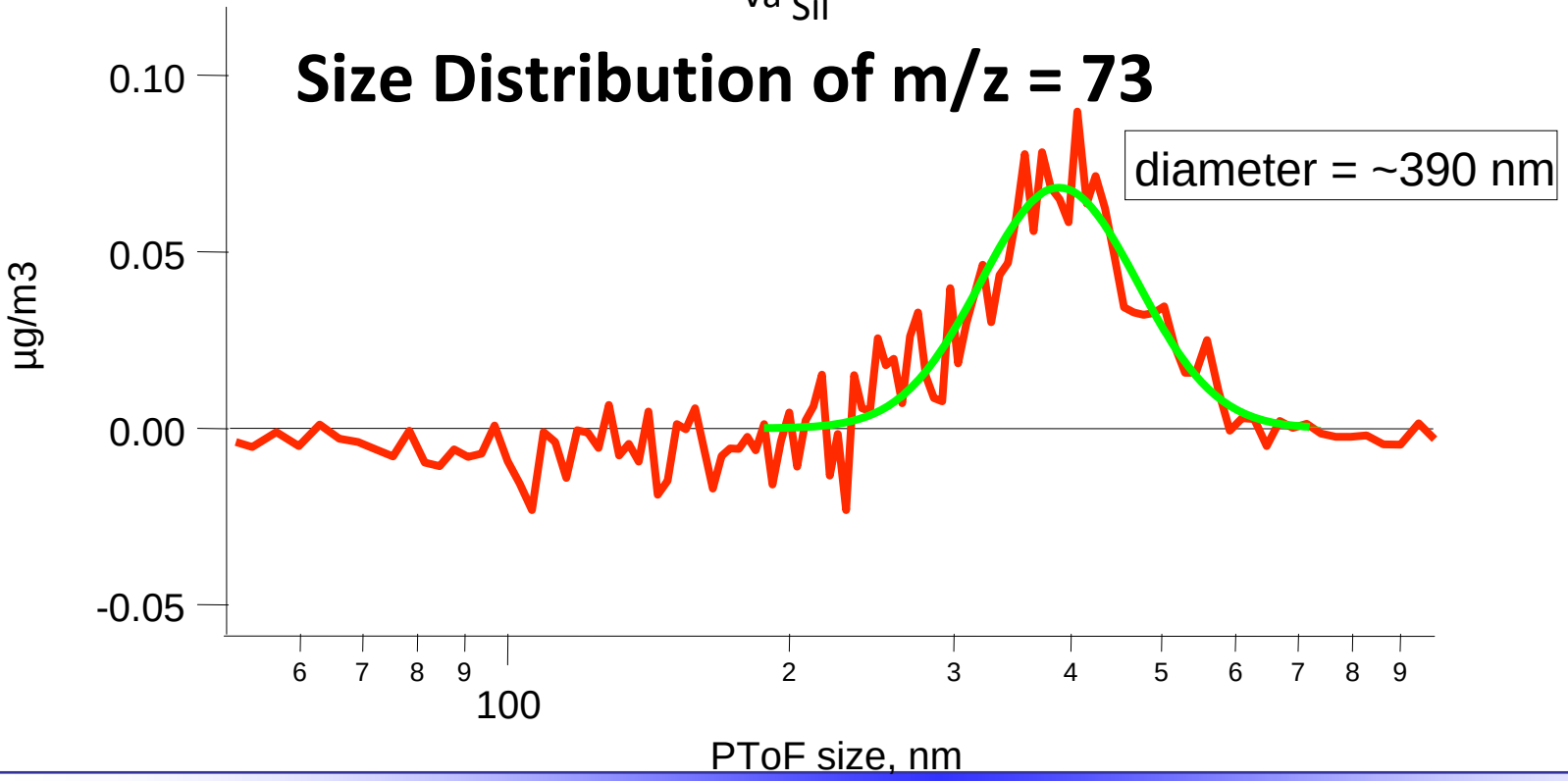
$\mathbf{d_{va} = d_{mob} \cdot \rho \cdot S}$

d_{mob} = 200 nm

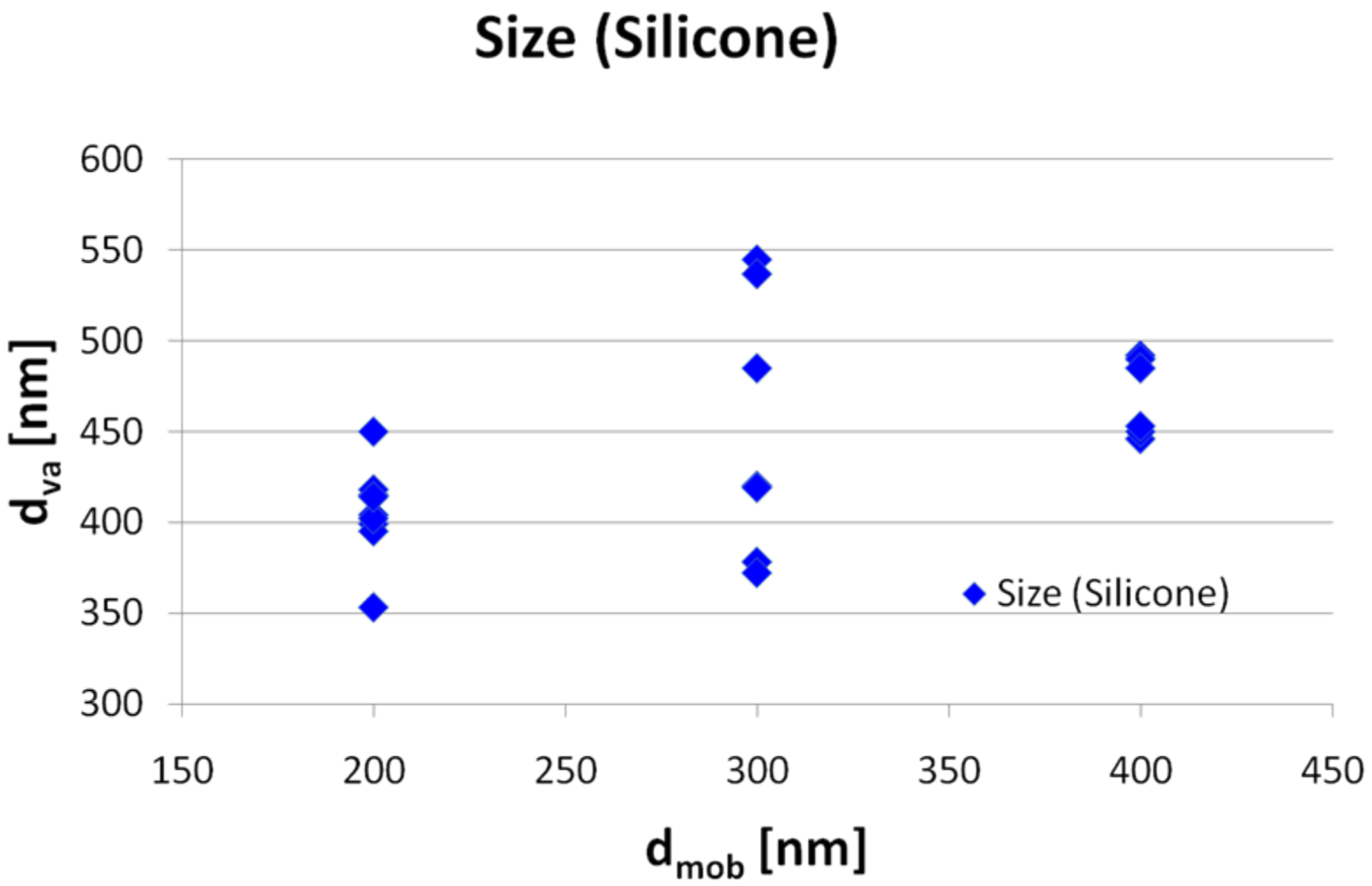
$\rho_{Sil} \approx 1 g/cm^3$

S:Jayne shape factor ≤ 1

$\Rightarrow d_{va\ Sil} \leq 200$ nm



Size Distributions



FROST 1

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Frost 2 quick look

- Differences to FROST 1
- Sulfuric acid vs. sulfates at different coating temperatures

Differences to FROST 1

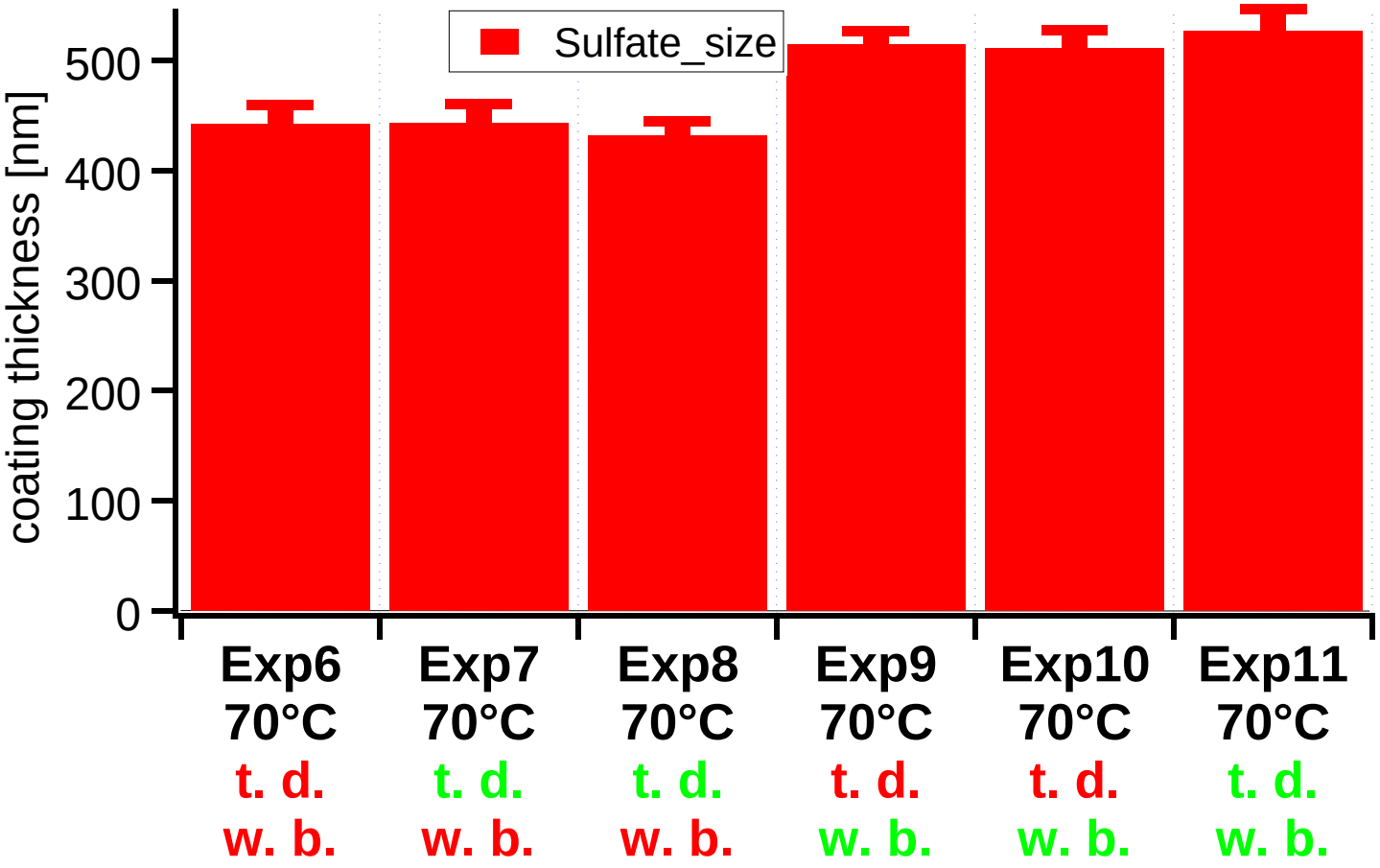
- A thermo denuder could be used after the coating
- Aerosol could be humidified and dried again before leaving the generator table

Size Overview

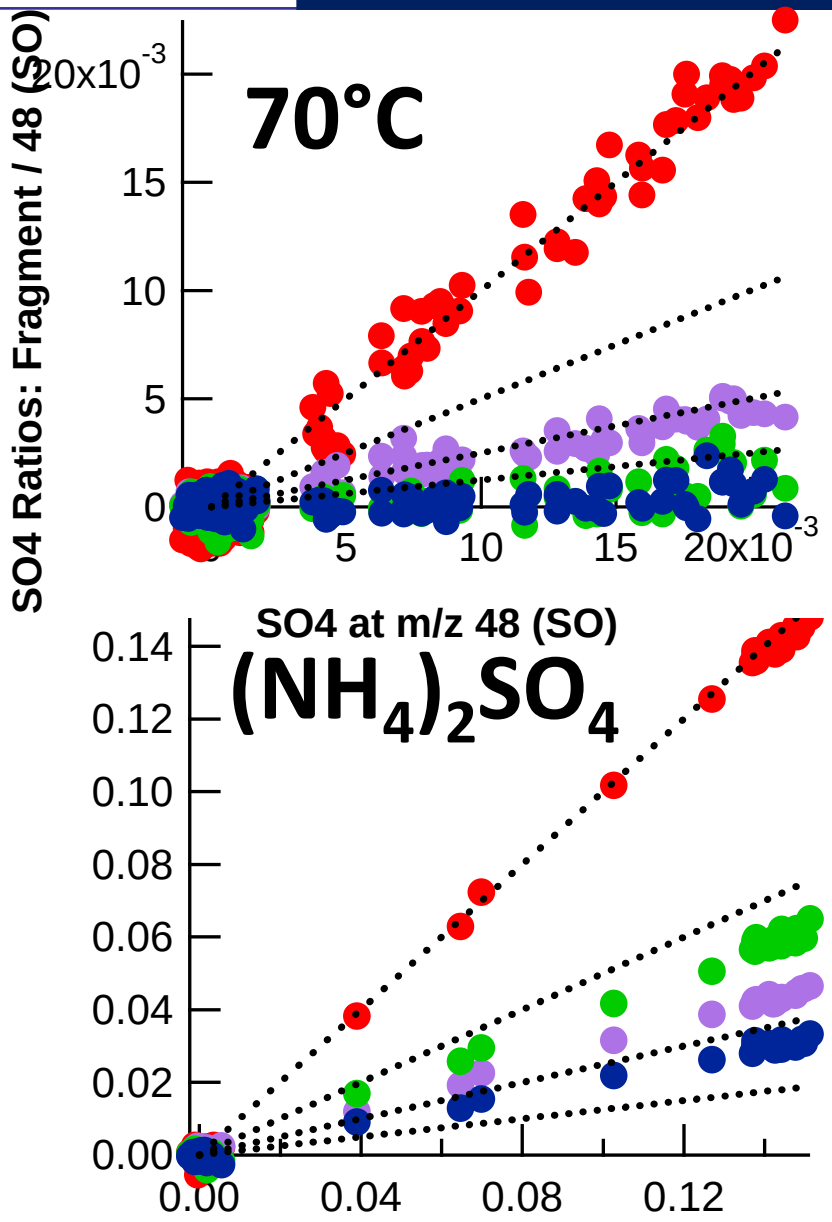
t.d. -> thermo denuder

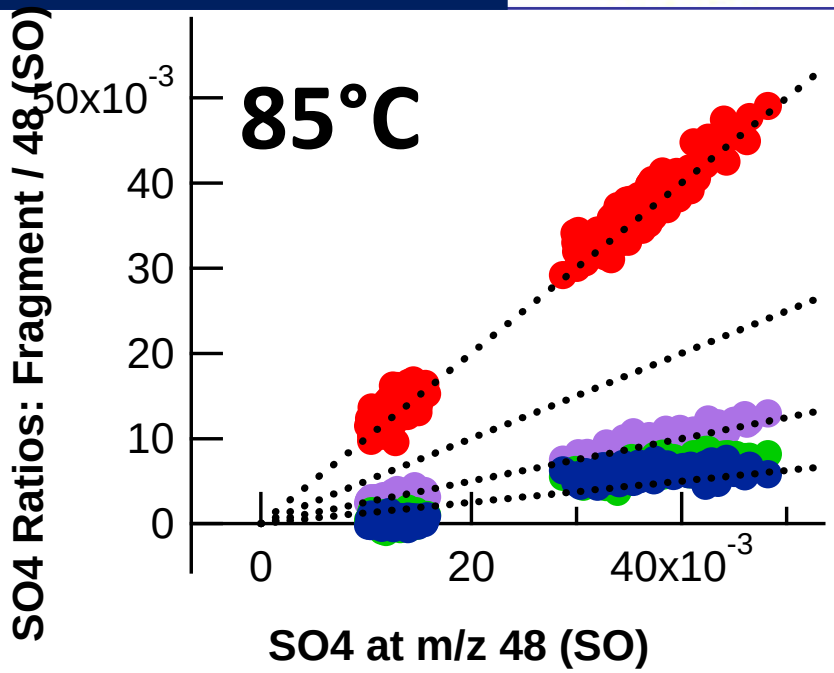
w.b. -> water bath

Green: in line red: not in line



$(NH_4)_2SO_4$ or H_2SO_4 or XSO_4





Sulfate fragment Ratios

m/z 64 (SO_2) / 48 (SO)

m/z 80 (SO_3) / 48 (SO)

m/z 81 (HSO_3) / 48 (SO)

m/z 98 (H_2SO_4) / 48 (SO)

No such data for FROST 1

Signal to noise was too bad

$(NH_4)_2SO_4$ or H_2SO_4 or XSO_4

- Linear correlation between the SO_4 fragments
- 70 °C: hydrogenated fragments $(HSO_3)^+$ and $(H_2SO_4)^+$ are not present
- 85 °C: hydrogenated fragments are present => H_2SO_4 or $(NH_4)_2SO_4$ are present

ACI02

- Single particle mass spectrometers SPLAT and ALABAMA participated
- Data from these instruments is being analyzed.
  - Evaluation software is currently being developed
  - No evaluation results up to now
- Outlook: Comparison of the single particle instruments data with the AMS data.

Outlook

- FROST campaigns:
  - Compare data with the different instruments of the campaign
  - Get size and chemical composition for all FROST 2 experiments
- Laboratory work:
  - Improve correction factors for sulfate using different standard substances (e.g.: $Fe_2(SO_4)_3$)
  - Find out about reasons for the need of correction factors