Max-Planck-Institut für Chemie (Otto-Hahn-Institut)

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

VI-ACI Kampagne "FROST"
LACIS, IfT Leipzig, April 2008
First results from aerosol mass spectrometry

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VI-ACI Annual Meeting, Frankfurt, May 05-06, 2008

- FROST campaign, LACIS, IfT Leipzig, April 2008

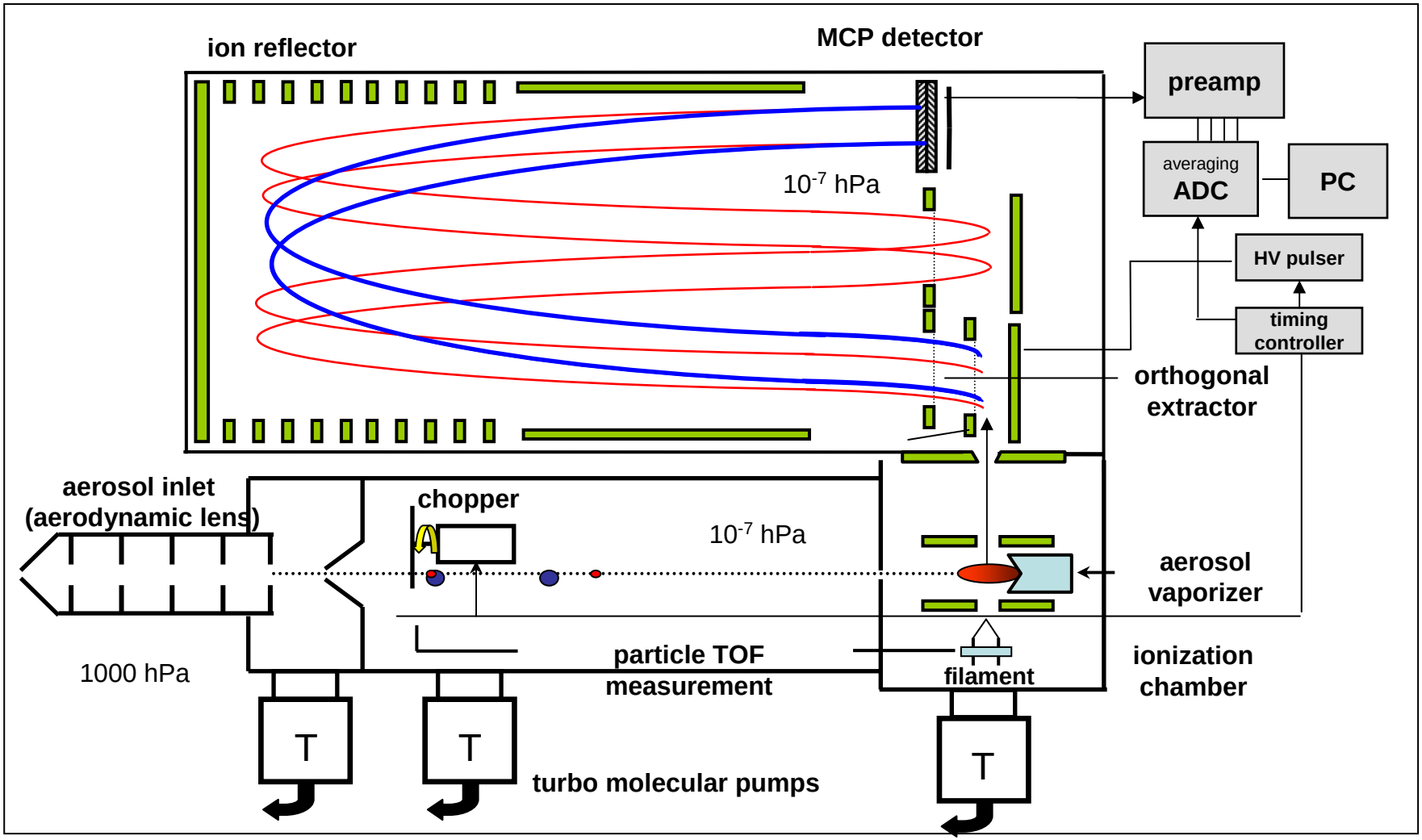
- Three Aerosol Mass Spectrometers:
  - IfT (HR-ToF), FZJ (HR-ToF), MPI-C/Uni-MZ (C-ToF)

- 2 CCN counters, 1 HTDMA, LACIS (freezing experiments)

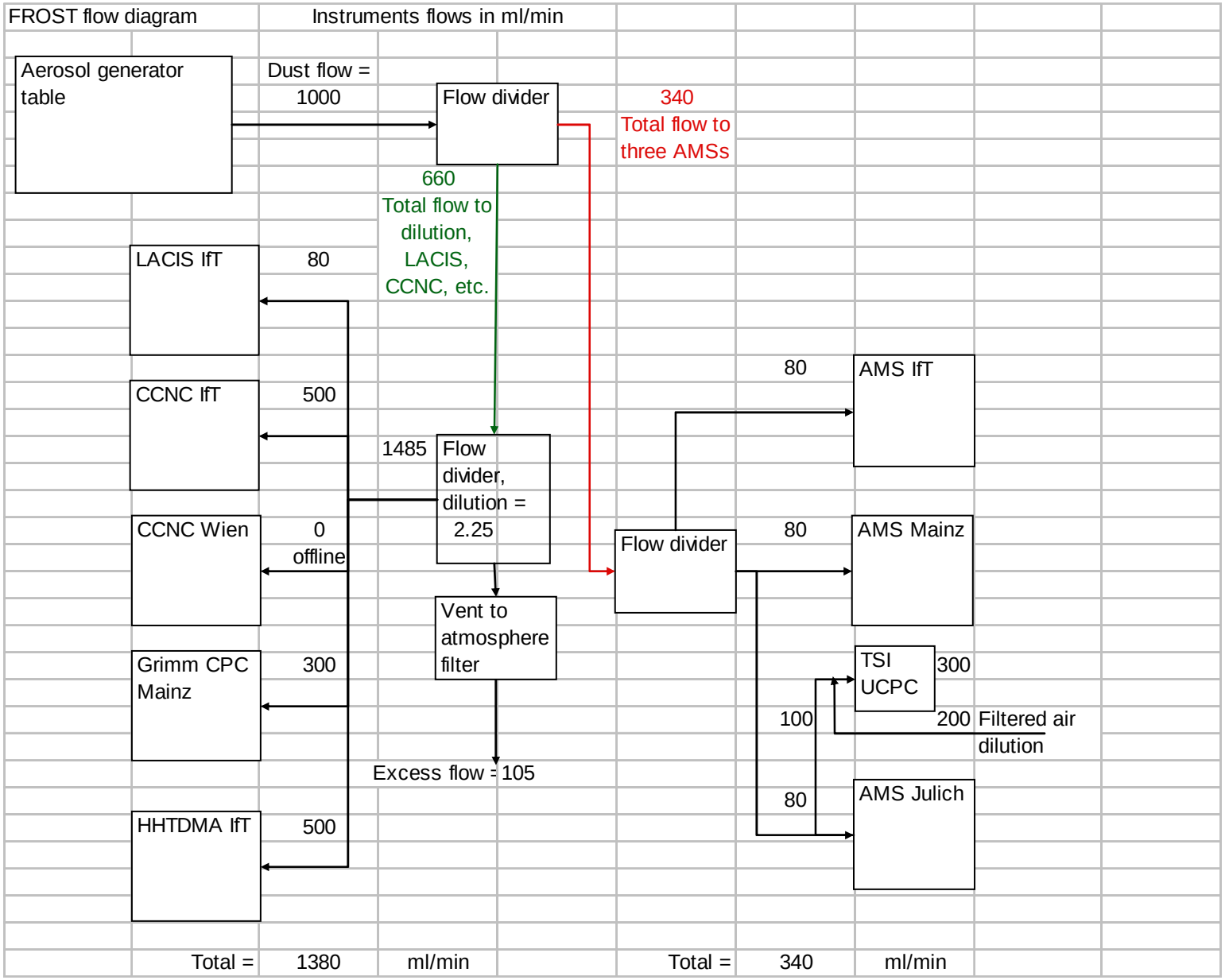
- Objectives:
  - Characterizing the input particles for LACIS:
    - Arizona Test Dust (ATD) uncoated
    - ATD coated wih H_2SO_4
    - ATD coated with $(NH_4)_2SO_4$
    - ATD coated with succinic acid

  - Mass per particle
  - Coating thickness
  - Particle aerodynamic size

Time-of-Flight AMS

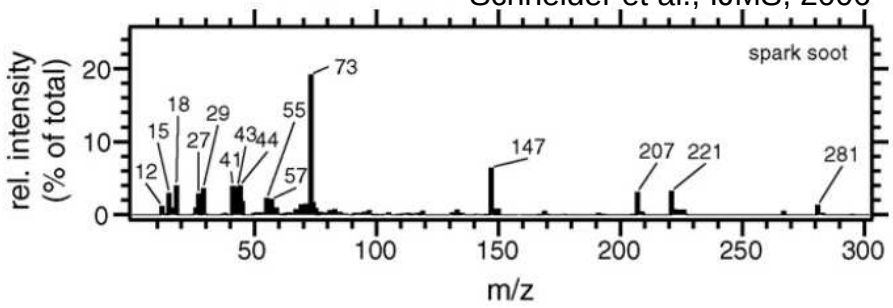


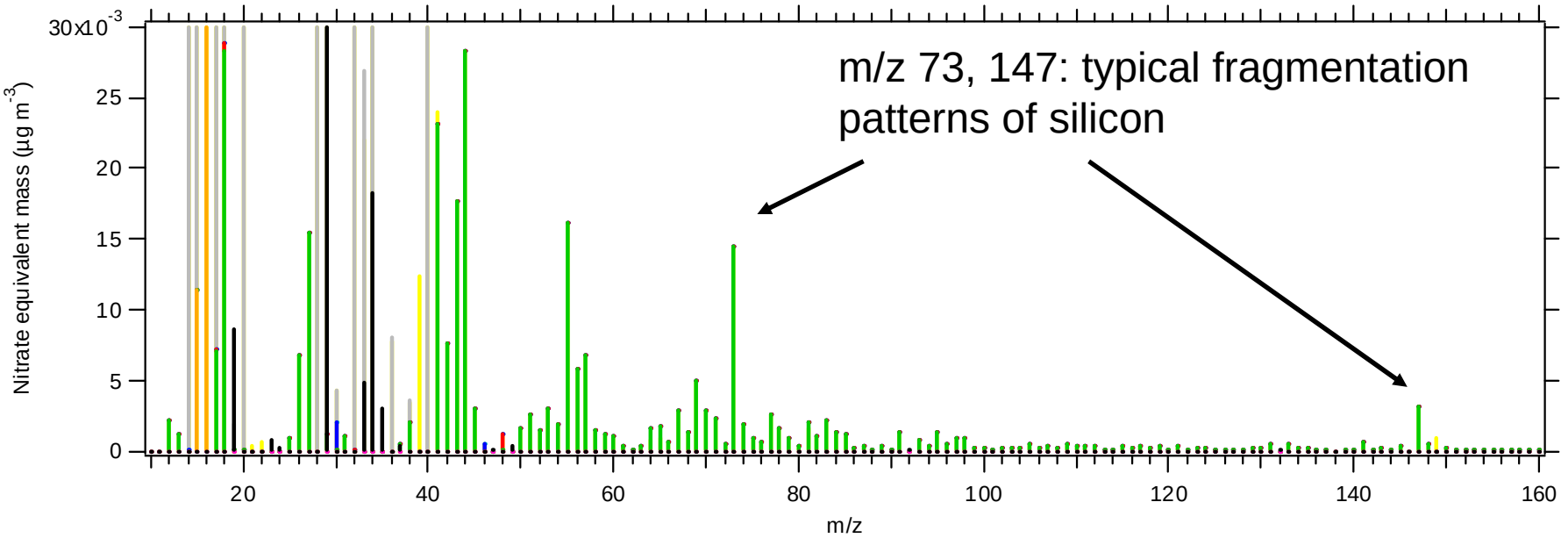
Setup


FROST flow diagram
Instruments flows in ml/min
Aerosol generator table
Dust flow = 1000
Flow divider
340
Total flow to three AMSs
660
Total flow to dilution, LACIS, CCNC, etc.
LACIS IfT
80
CCNC IfT
500
1485
Flow divider, dilution = 2.25
CCNC Wien
0
offline
Vent to atmosphere filter
Grimm CPC Mainz
300
Excess flow = 105
HHTDMA IfT
500
Total = 1380 ml/min
Flow divider
80
AMS IfT
80
AMS Mainz
TSI UCPC
300
100
200
Filtered air dilution
80
AMS Julich
Total = 340 ml/min

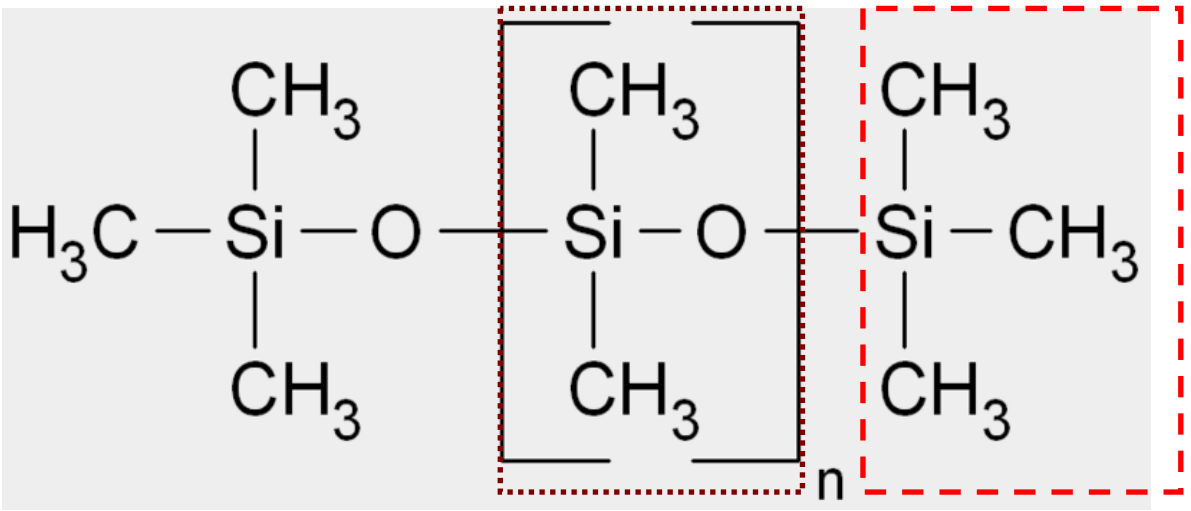
Uncoated Arizona Test dust:
Organic contamination:
Silicone? Others?

Schneider et al., IJMS, 2006



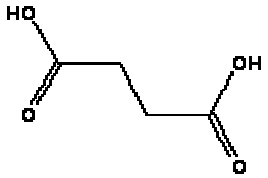


Silicone (Siloxane):

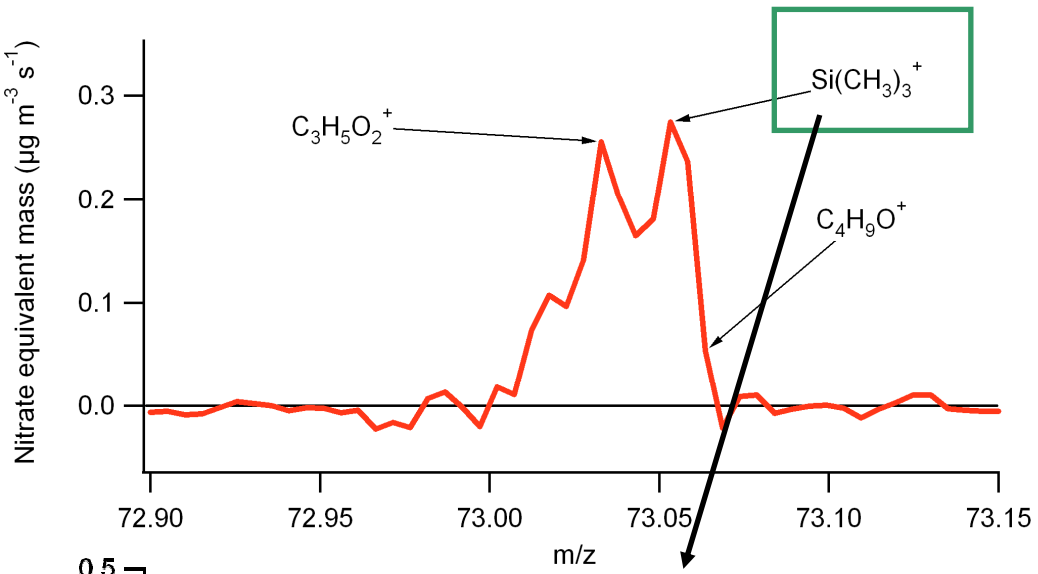


Silicone?

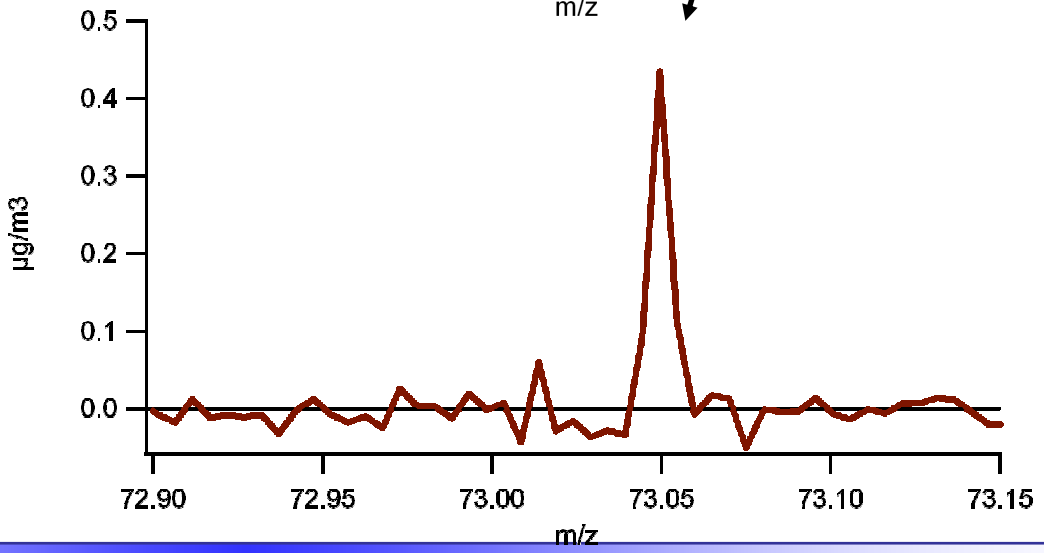
$C_4H_6O_4$



ATD with
succinic acid coating



ATD without
succinic acid

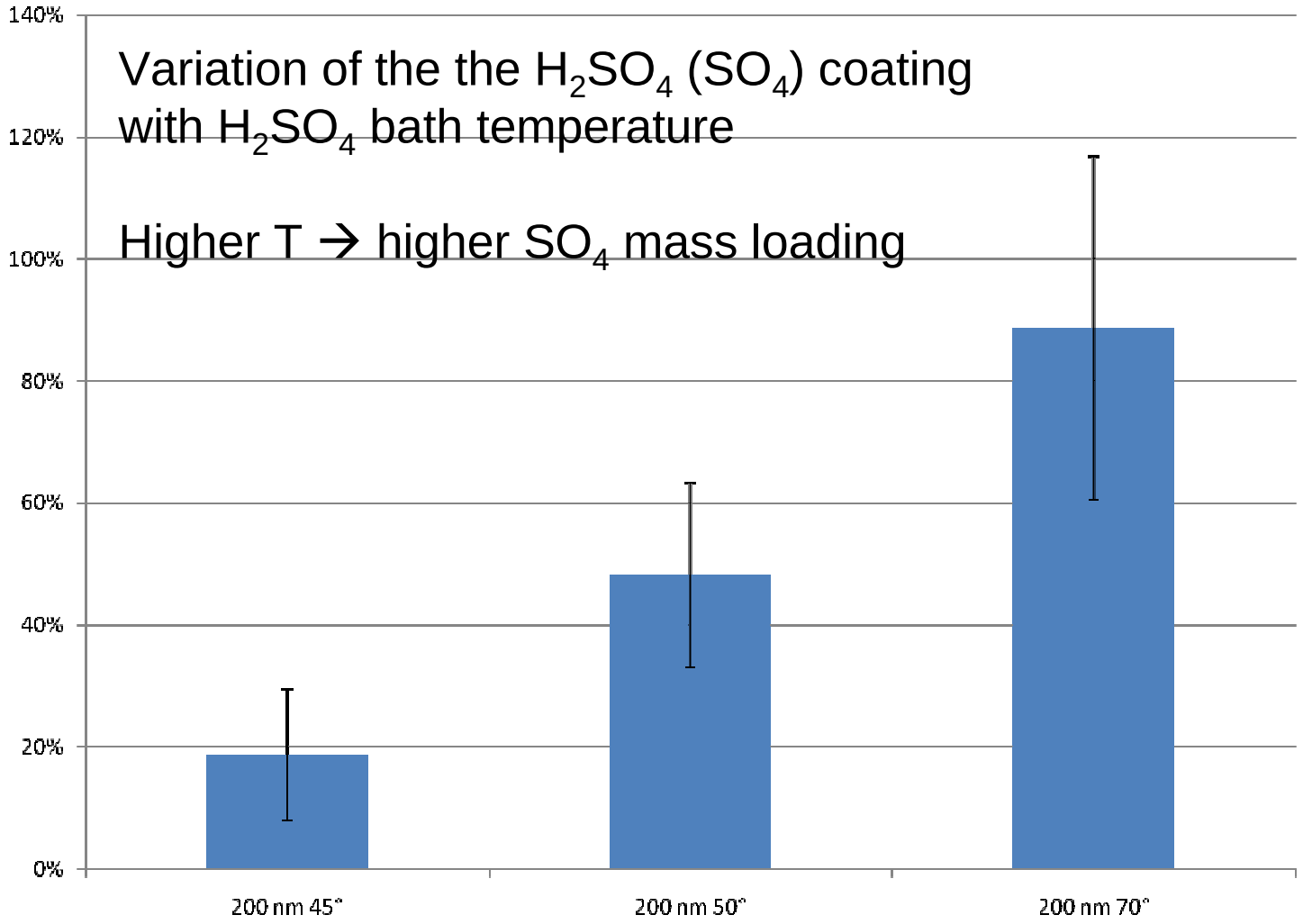


Results from HR-ToF-AMS
(Chr. Spindler)

- Coating with H_2SO_4

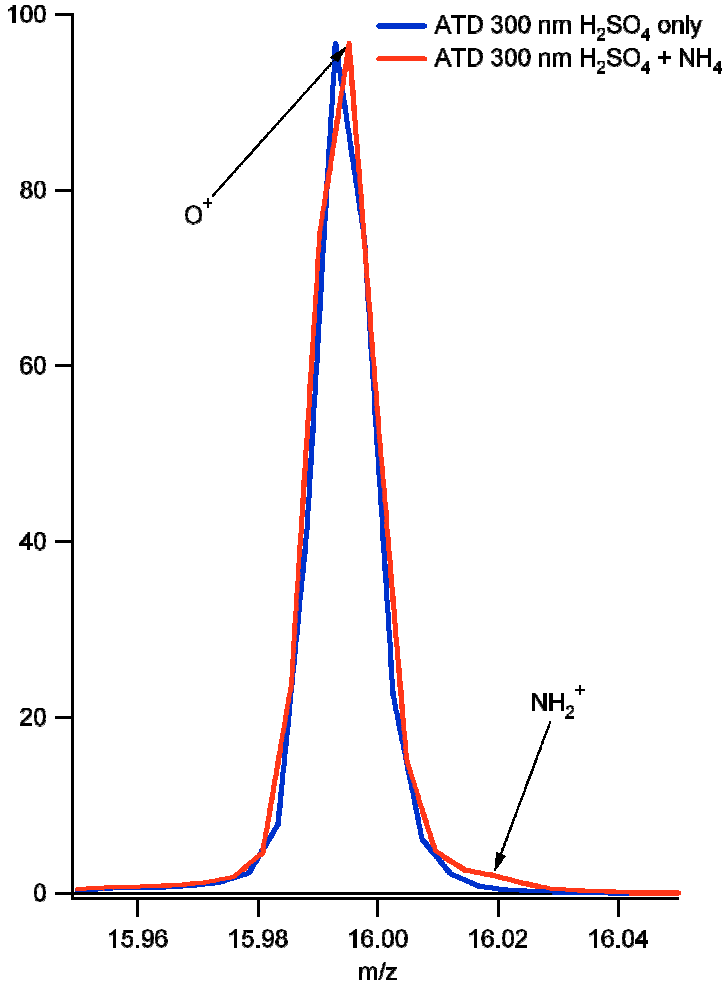
- Add NH_3 to produce $(NH_4)_2SO_4$

Sulfate/Organic Ratio in H2SO4 Coated ATD

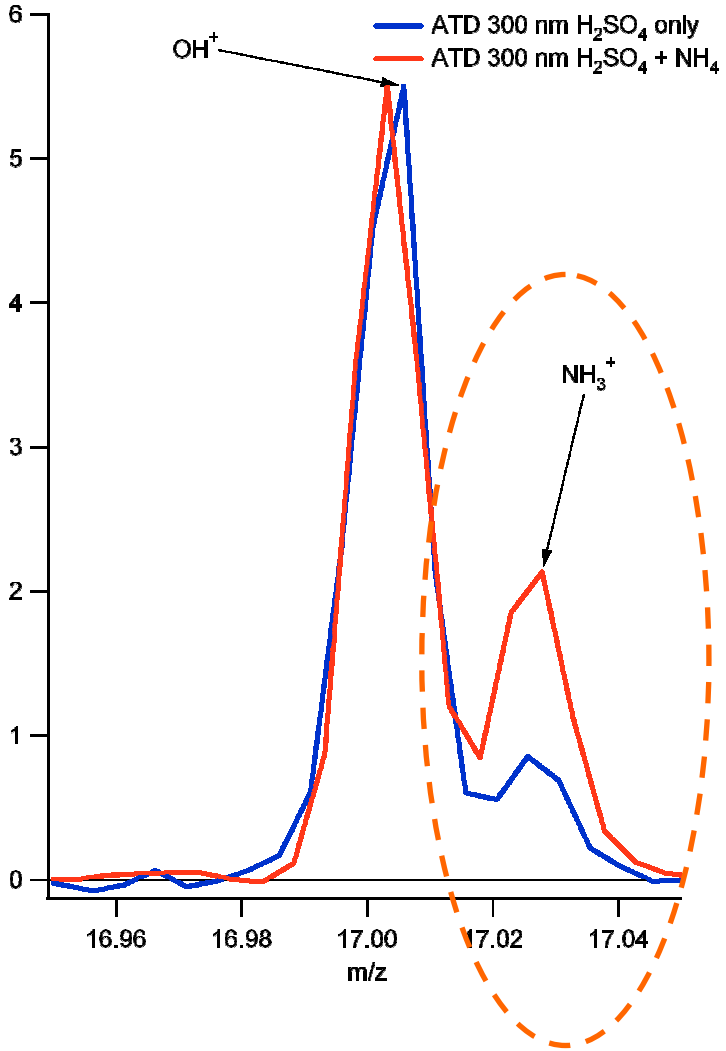


Coating with H_2SO_4 + NH_4

m/z 16



m/z 17



Chr. Spindler

Comparison of Organic and Sulfate mass loading

		200 nm coated 50℃		200 nm uncoated		Difference (coated, un-)	
Parameter	Unit	µg per 1.000 particles	% of total	µg per 1.000 particles	% of total	µg per 1.000 particles	%
Organics	µg/m³	1,39E-04	43,48%	1,40E-04	82,35%	-1,11E-06	-0,79%
Sulfate	µg/m³	6,94E-05	21,74%	0,00E+00	0,00%	6,94E-05	-
Total	µg/m³	3,19E-04		1,70E-04		1,49E-04	87,91%
not yet attributed	µg/m³	1,11E-04	34,78%	3,00E-05	17,65%		

↓

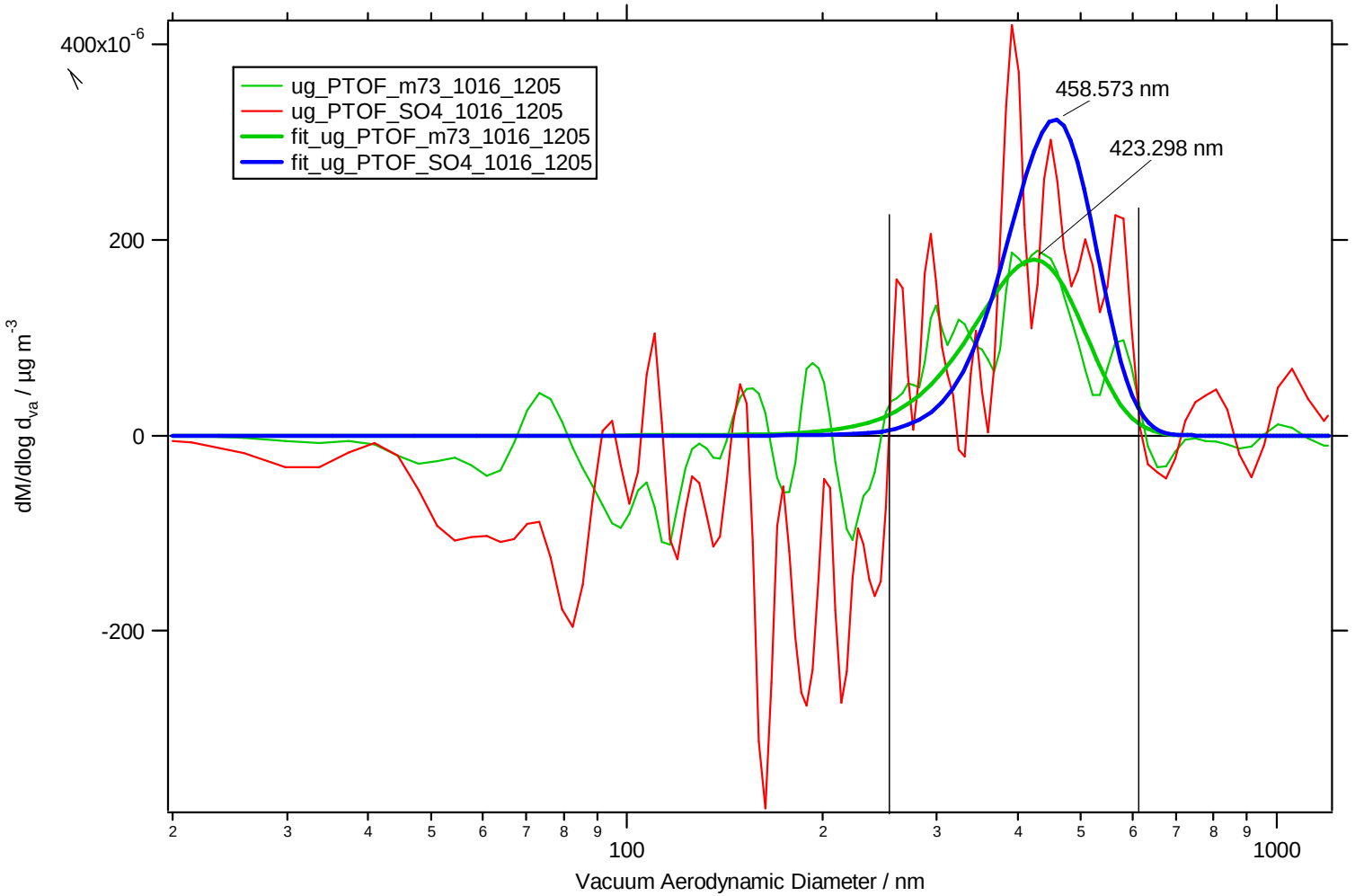
calculated weight of pure ATD particle

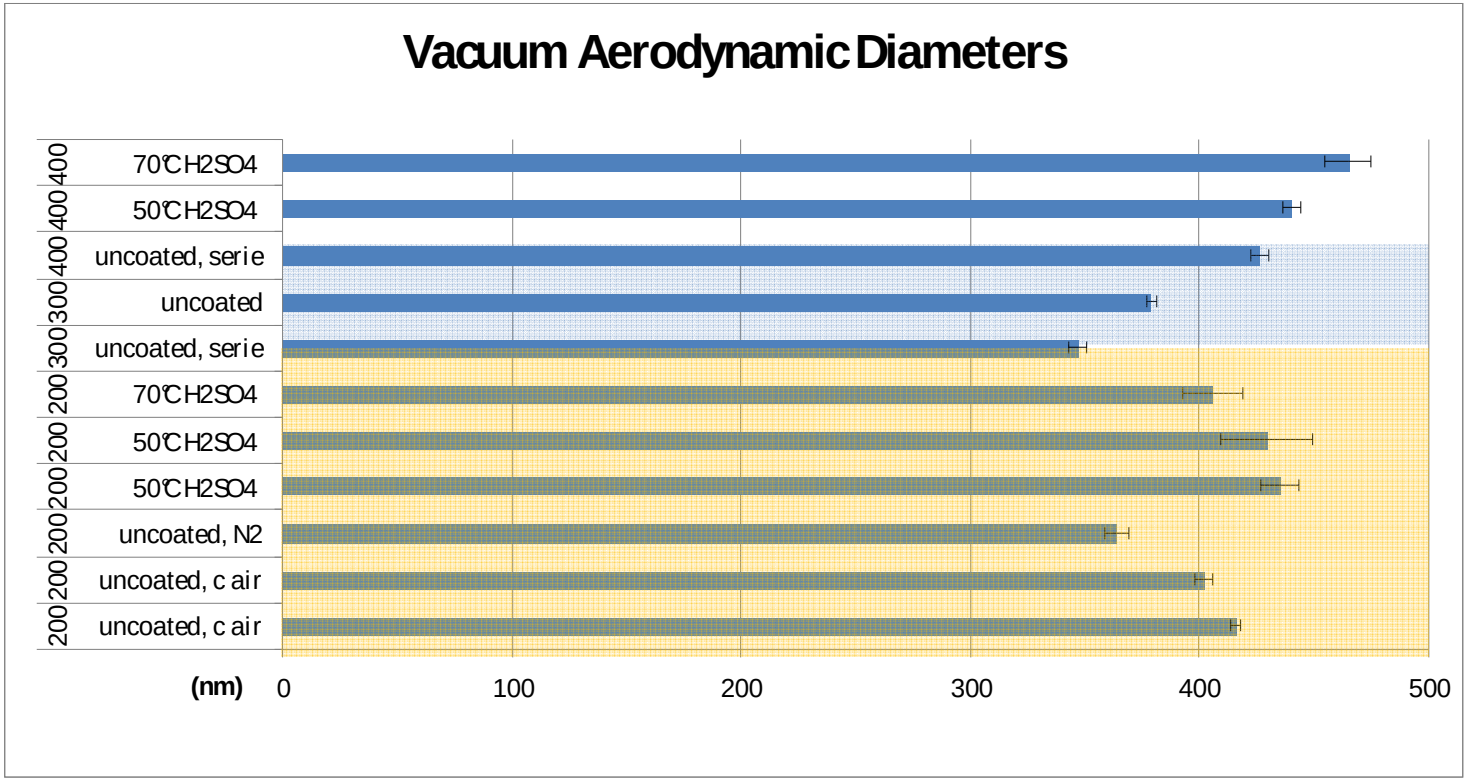
200 nm uncoated	7E-07	µg/particle
	22,97%	Organic mass loading
400 nm uncoated	6E-06	µg/particle
	5,40%	Organic mass loading

Size measurements with AMS

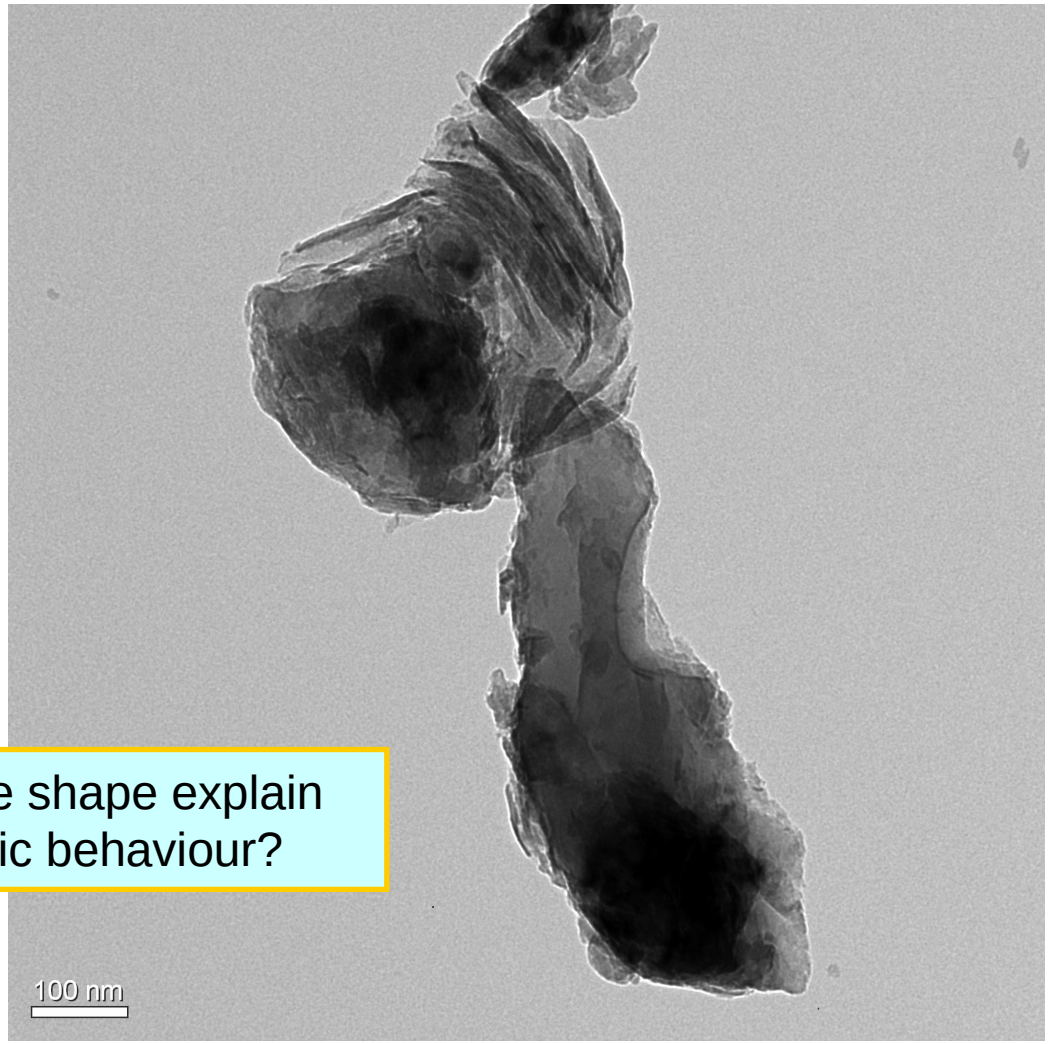
- **AMS does not detect dust, only the coating or the contamination → low signal intensity**

- **Different mobility diameters yield same vacuum aerodynamic diameter. Effect of particle shape?**


400x10^-6
200
0
-200
dM/dlog d_va / µg m^-3
ug_PTOF_m73_1016_1205
ug_PTOF_SO4_1016_1205
fit_ug_PTOF_m73_1016_1205
fit_ug_PTOF_SO4_1016_1205
458.573 nm
423.298 nm
2 3 4 5 6 7 8 9
100
2 3 4 5 6 7 8 9
1000
Vacuum Aerodynamic Diameter / nm


Vacuum Aerodynamic Diameters
400
70℃H2SO4
400
50℃H2SO4
400
uncoated, serie
300
uncoated
300
uncoated, serie
200
70℃H2SO4
200
50℃H2SO4
200
50℃H2SO4
200
uncoated, N2
200
uncoated, c air
200
uncoated, c air
(nm)
0
100
200
300
400
500

TEM pictures (A. Kiselev, IfT; I. Lieberwirth, MPI-P)



Can particle shape explain aerodynamic behaviour?

Outlook:

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

- Laboratory:
  - SiO_2 particles (does AMS always detect some "contamination"?),
  - coat SiO_2 with H_2SO_4,
  - ATD, pure and uncoated, check if contamination is always present in the ATD?