COMPOSITIONAL TRENDS OF MINERAL ICE NUCLEI:

A STUDY AT THE AIDA CHAMBER

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IUGG Perugia
Mineral Dust Workshop

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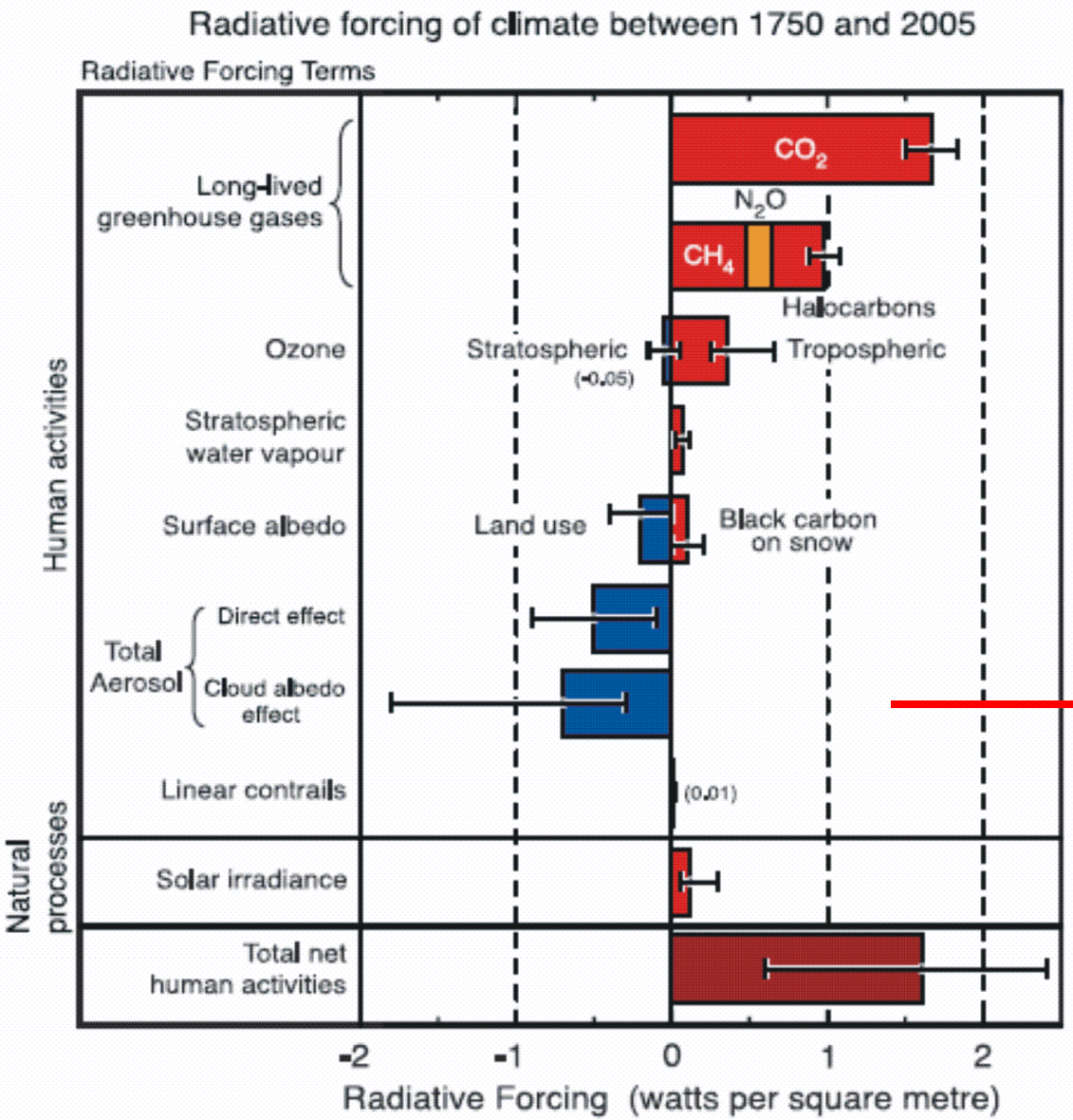
Why studying mineral dust as ice nucleus?



1st Indirect effect:

Ice crystal formation via heterogeneous nucleation
-38°C < T < -5°C

Mineral dusts are good ice nuclei
Pruppacher and Klett, 1997
DeMott et al. 2003

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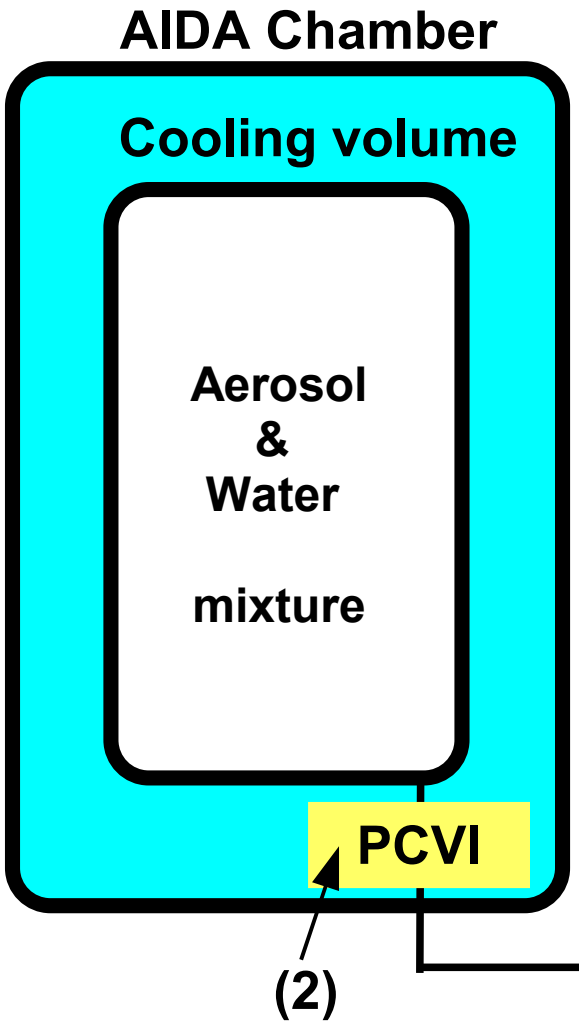
Overview of the instrumental setup



(1) → *Ice particle production*

(2) *Aerodynamic particle selection*

Ice particles only are sampled

(3) PALMS

1 - Ice nucleation
4 m diameter, 83 m^3

2 - Separation of ice crystals

3 - Characterization of single particles and ice residues

- *Laser ablation/ionization*
- *Mass spectrometry*
- Particle size
- Particle composition
- Single particle
- Refractory through volatile materials
- On-line

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Ice crystal formation by heterogeneous nucleation

Adiabatic expansion

↓

Cooling of air

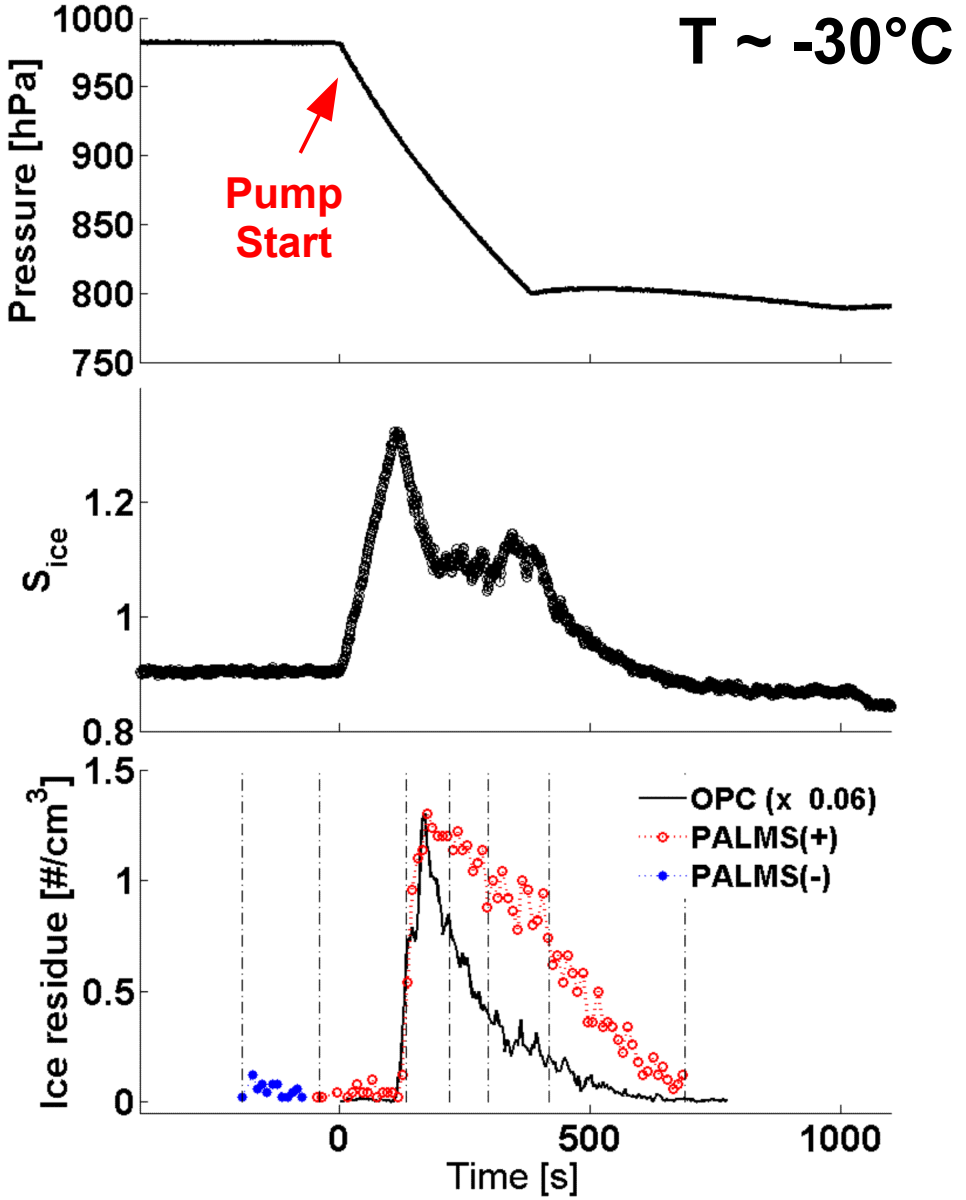
↓

Water supersaturation with respect to ice

↓

Ice particles formation by heterogeneous nucleation

Good ice nuclei detected first in time



Experiment cycle = **Pre-expansion** **Expansion** **Post-expansion**

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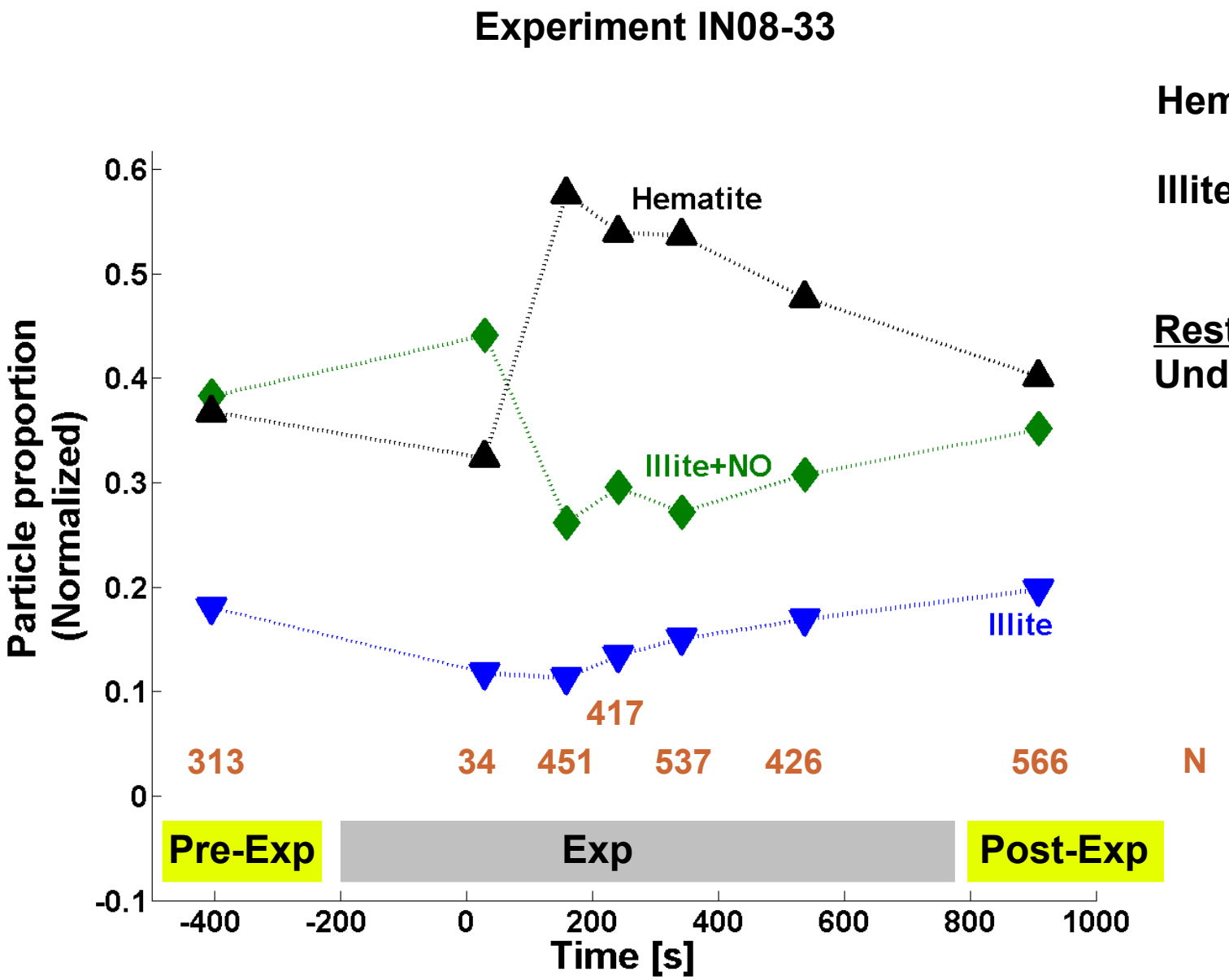
External mixture: Hematite + Illite (a)



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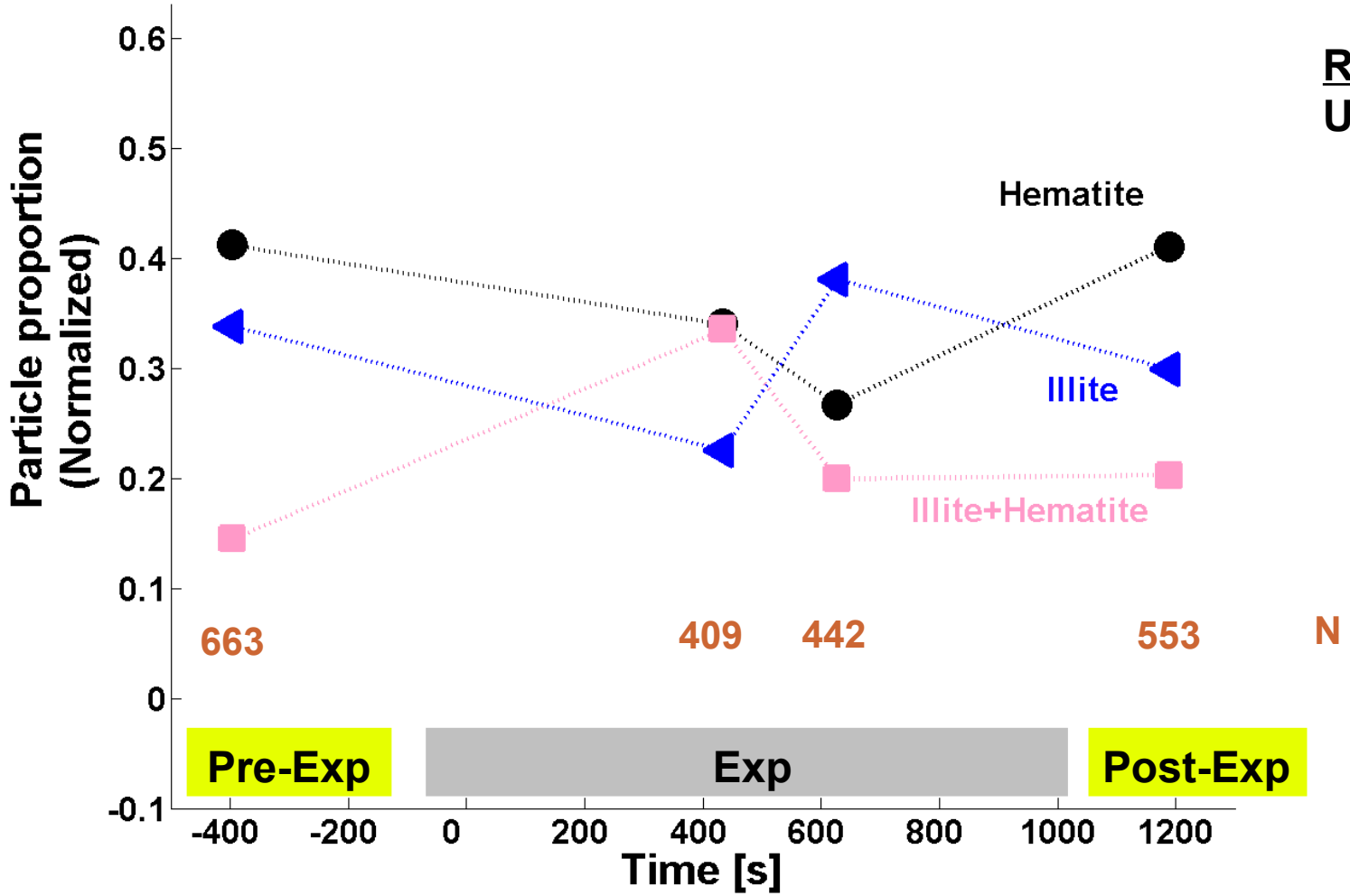
External mixture: Hematite + Illite (b)

Experiment IN08-34



Rest particles:
Undefined

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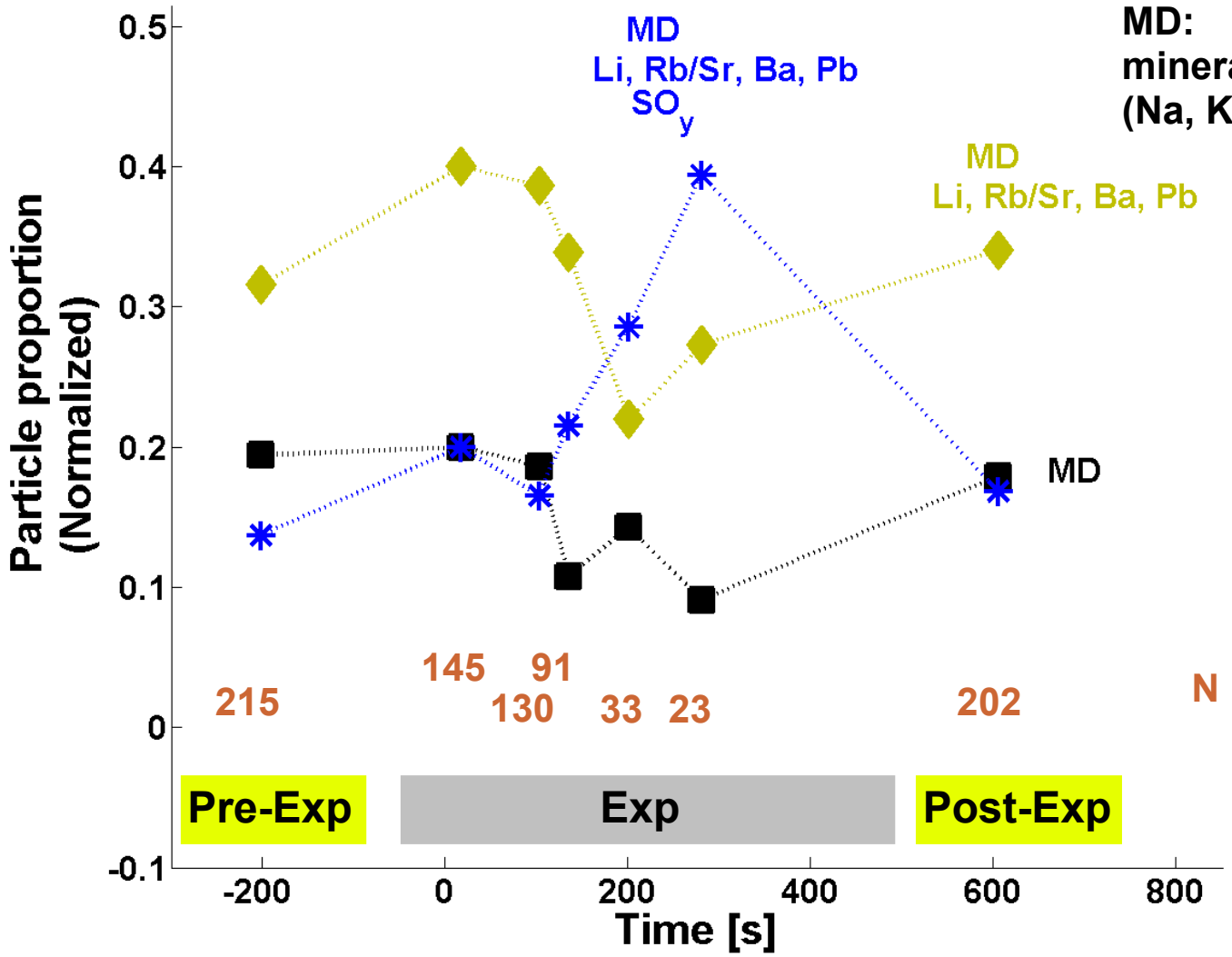
Arizona Test Dust (a)

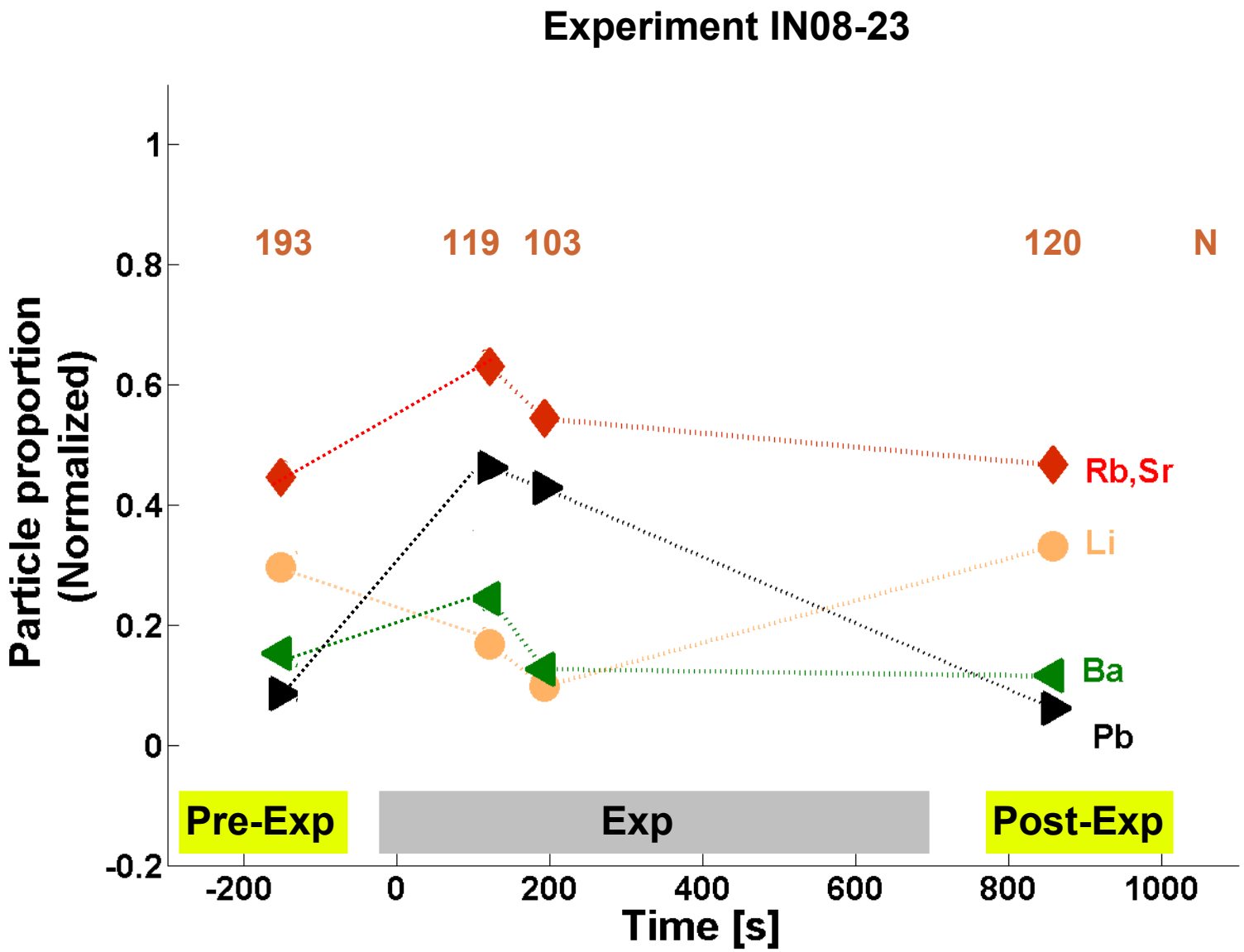
Experiment IN08-24



MD:
mineral dust elements (Na, K, Al, Si, Fe)

Rest particles:
Undefined

Arizona Test Dust (b)



Conclusion and Outlook

In these experiments:

- **Hematite is a better ice nucleus than illite. It is composition driven.**
- **Bare silicate particles are better ice nuclei than those populated with sulfates on their surface.**
- **Particles with a large signal for Rb/Sr, Ba, Pb were more frequently found in ice residues.**
- **The setup AIDA chamber + PALMS has a high potential to investigate the size & composition contribution to ice nucleation ability of particles**

Outlook:

- **Additional mineral particles will be tested with this method (e.g. ICIS2007 Workshop, September, Karlsruhe)**

Acknowledgments

Thank you for your attention !!!

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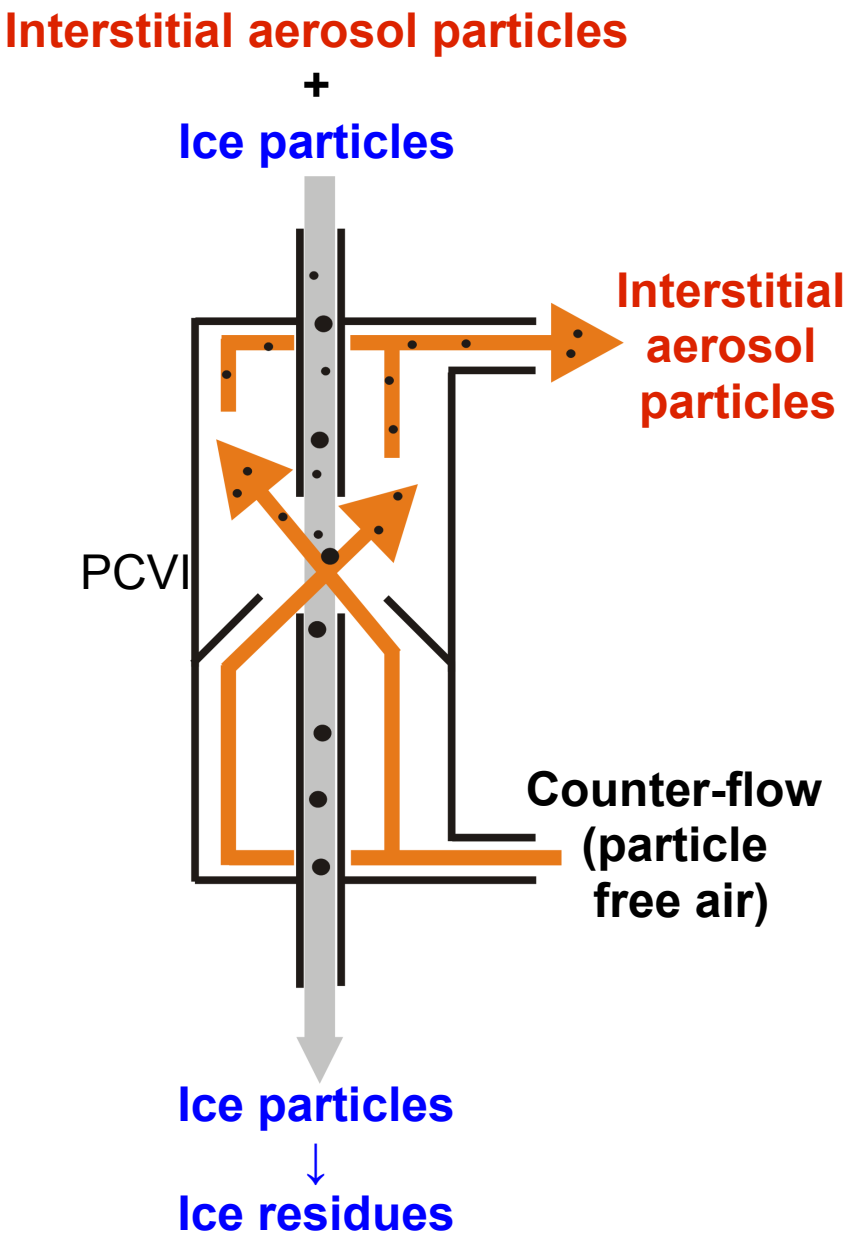
Ice particle selection

Ice particles should be differentiated from the interstitial aerosol particles

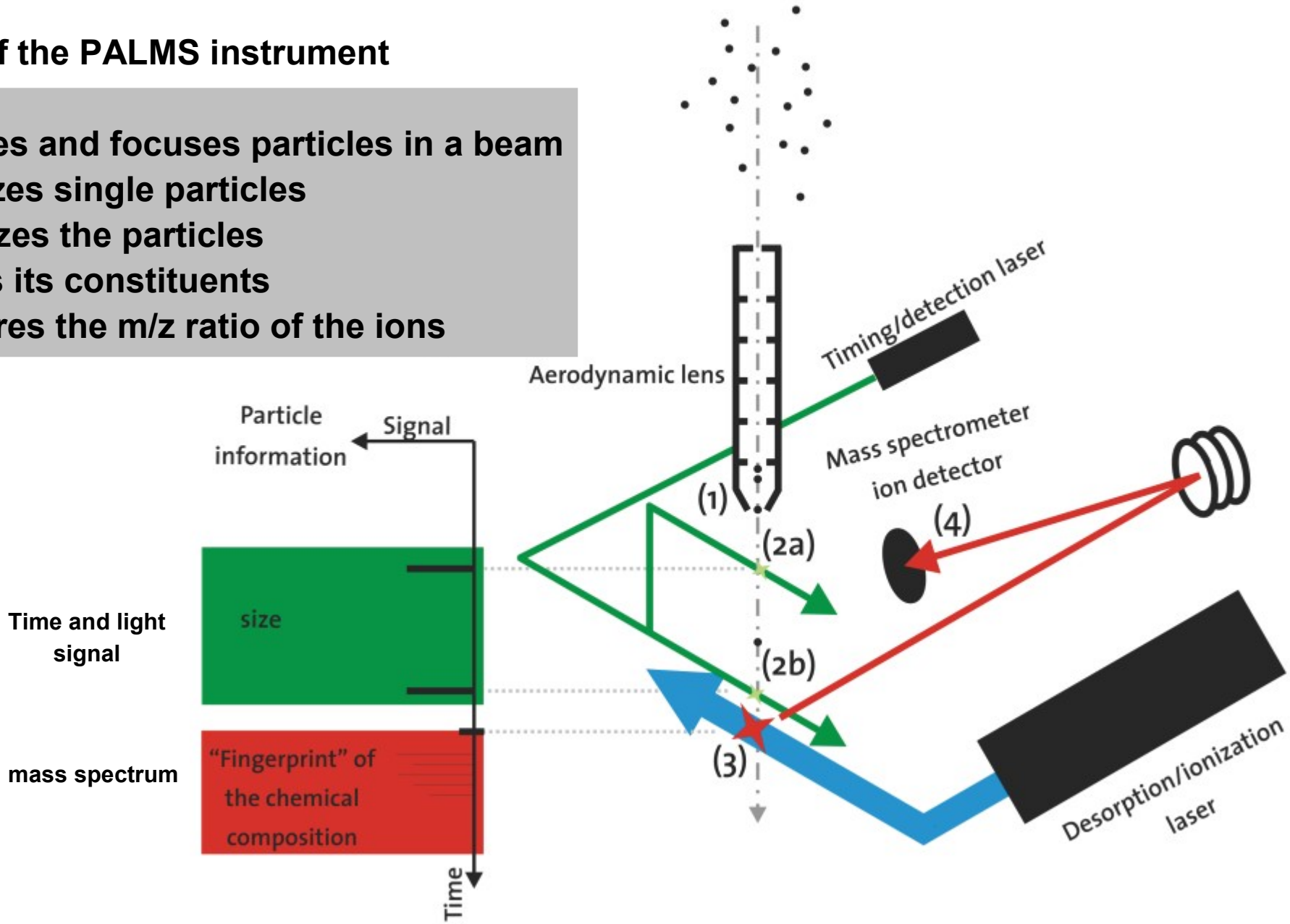
- **Particles bigger than 5 µm are considered to be ice crystals**
- **Ice particles are inertially selected with a Particle Counter-flow Virtual Impactor (PCVI)**
- **Ice particles are melted and water evaporated: an ice residue is formed**
- **Ice residues can be analyzed by PALMS**



Aerosol characterization

Operation of the PALMS instrument

- (1) Samples and focuses particles in a beam
- (2a,2b) Sizes single particles
- (3) Vaporizes the particles
- (3) Ionizes its constituents
- (4) Measures the m/z ratio of the ions



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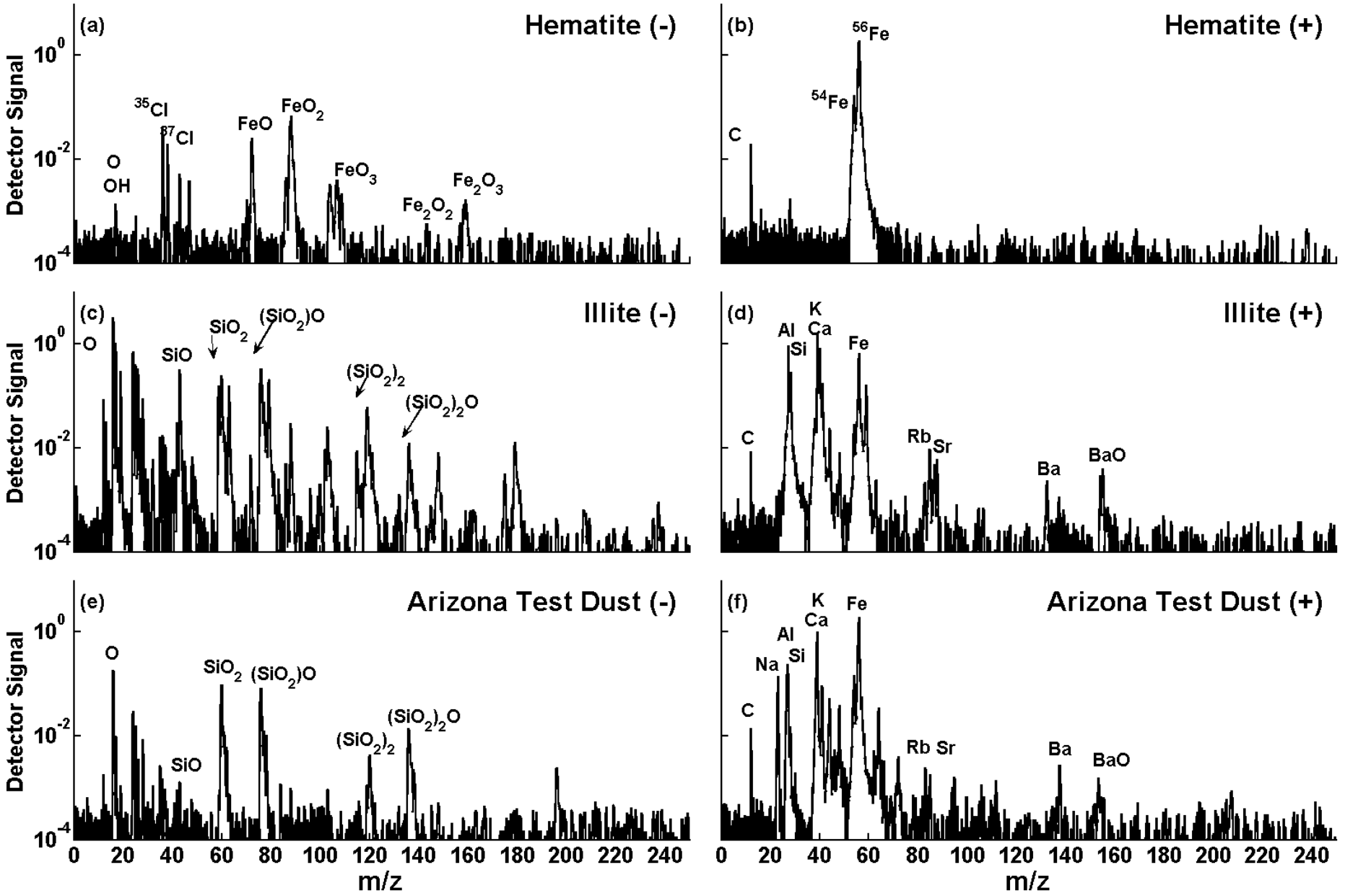
Example of mineral dust mass spectra



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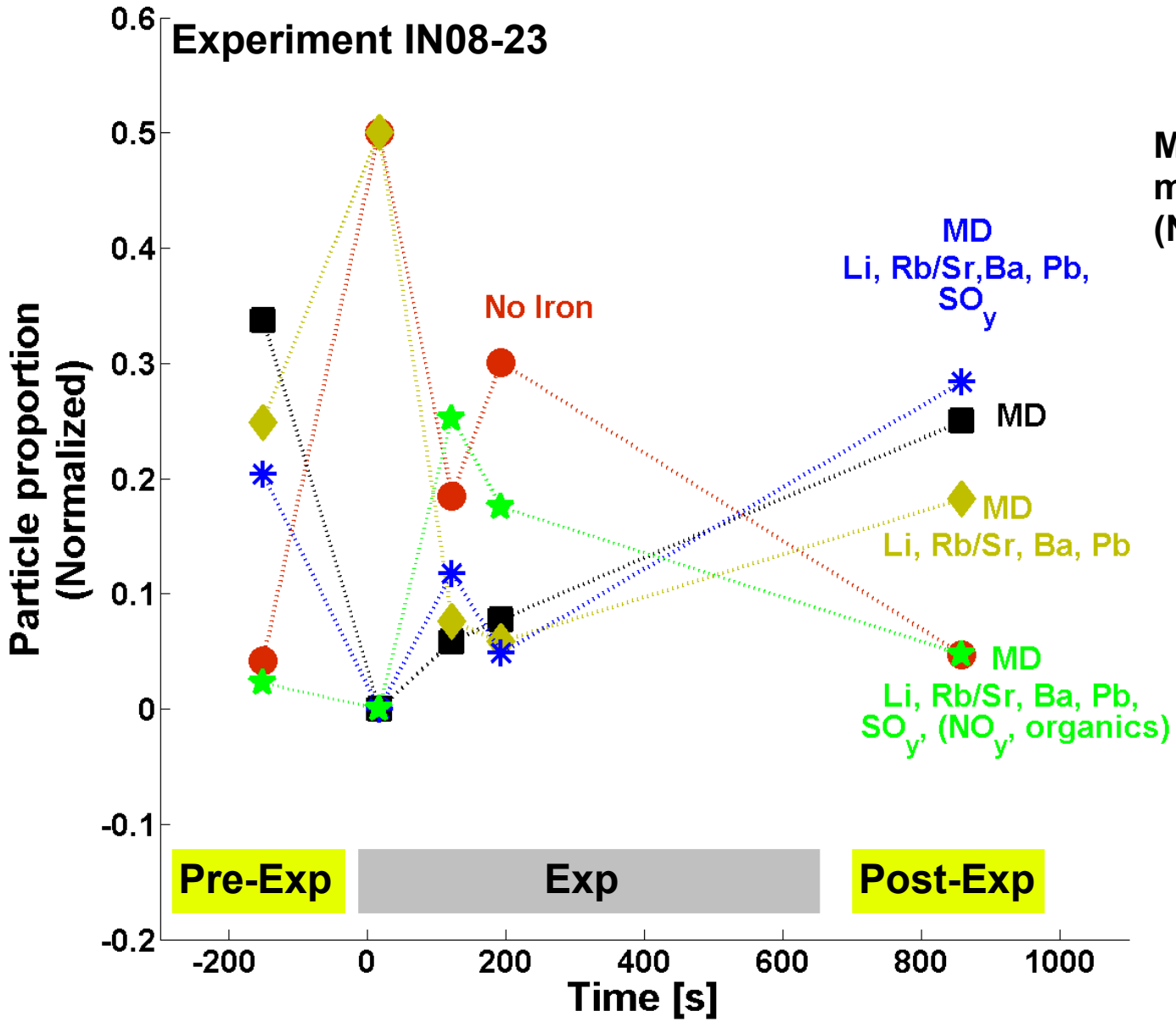
Arizona Test Dust (a)



MD:
mineral dust elements (Na, K, Al, Si, Fe)

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Poster Presentation (1)

Chemical differentiation of mineral dusts with single particle aerosol mass spectrometry

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Laser based aerosol mass spectrometry informs about:

- particle size
- chemical composition
- of single particles

It is
- universal
- on-line
- highly sensitive
- field deployable

This technique is:

- based on mass spectrometry with ionization by laser

- for all aerosol types such as (organics, soot, sea-salt, bio-aerosols) both natural and industrial origin

-never used for mineral particles

Our study focuses:

- usable for mineral dusts ?

- can similar chemical composition be differentiated ?

- indirect access to mineralogy ?

- alternative to EM - EDX ?

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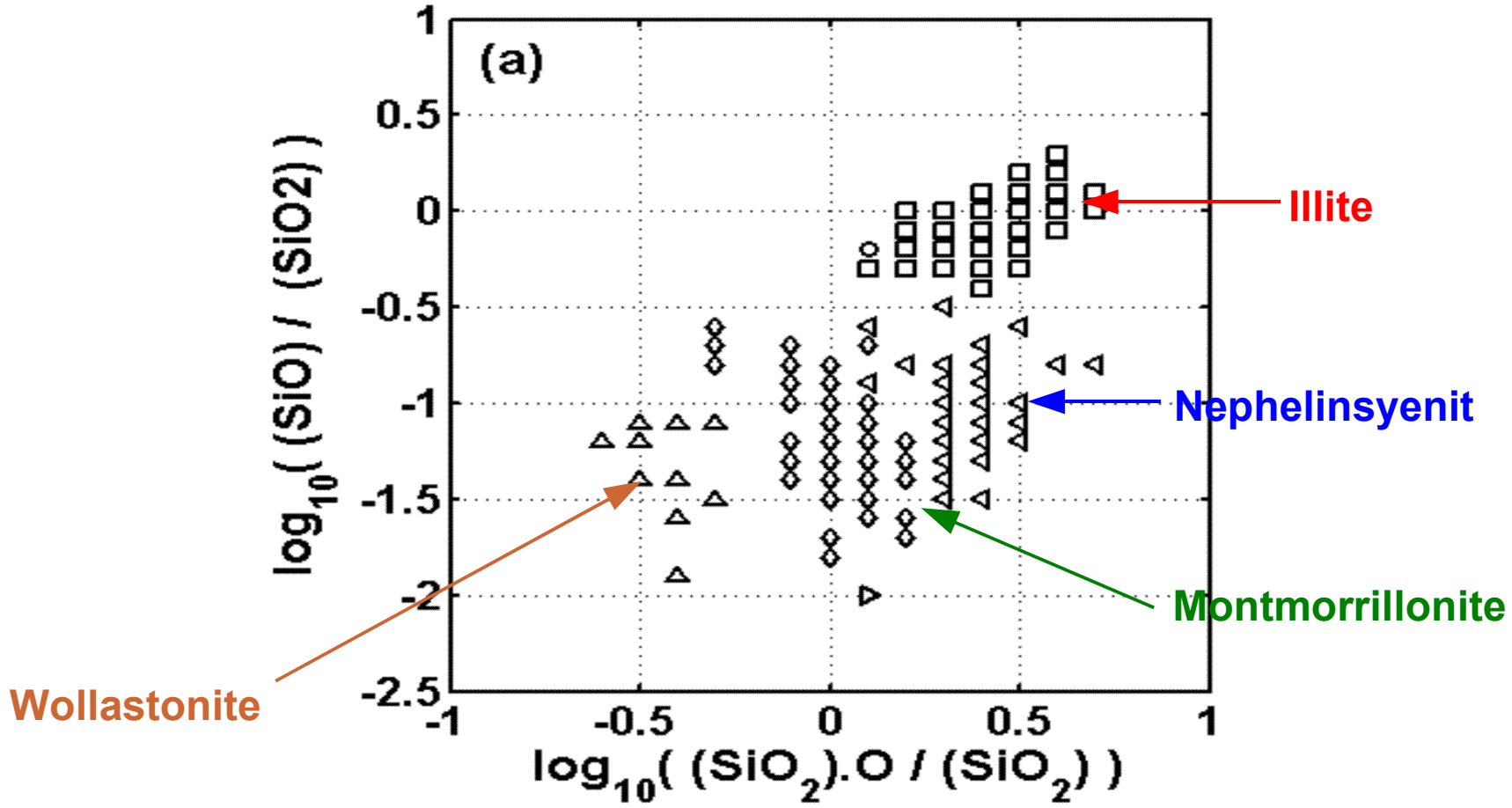
Poster Presentation (2)



Potential to differentiate silicates from each other