

A Study to Measure the Chemical Characteristics of Particle Emissions from Biomass Burning Stoves

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Direct Emissions of Particulate Matter



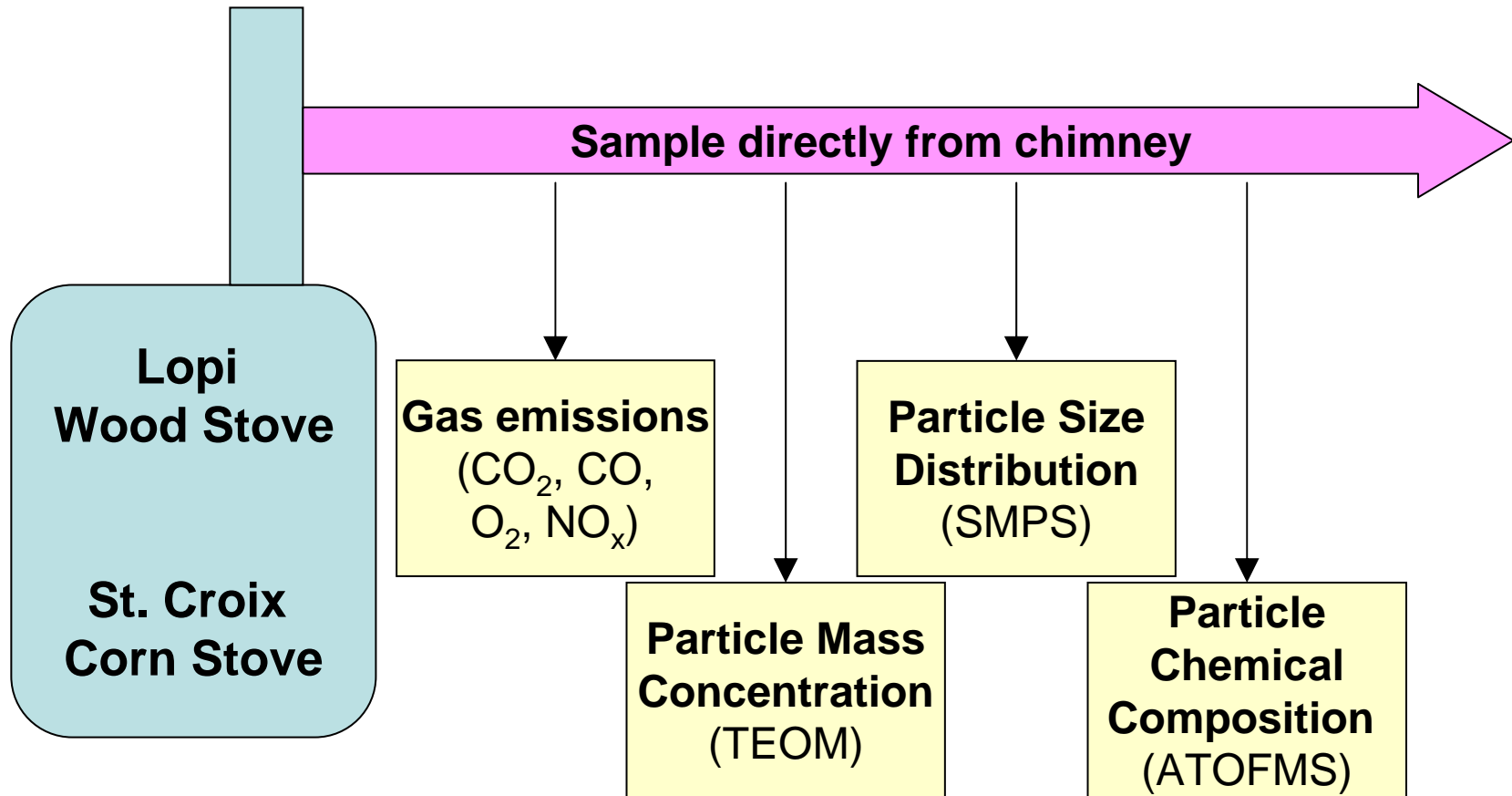
Goals of the Study

- **Goal 1**: Measure chemical composition and associated parameters (size distribution and mass) of the particles emitted from wood and corn combustion.
- **Goal 2**: Compare chemical composition, size distribution and mass emissions from various types of fuel combusted :
 - Hard wood: Oak, Birch
 - Soft wood: Pine
 - Corn
- **Goal 3**: Compare emissions characteristics.

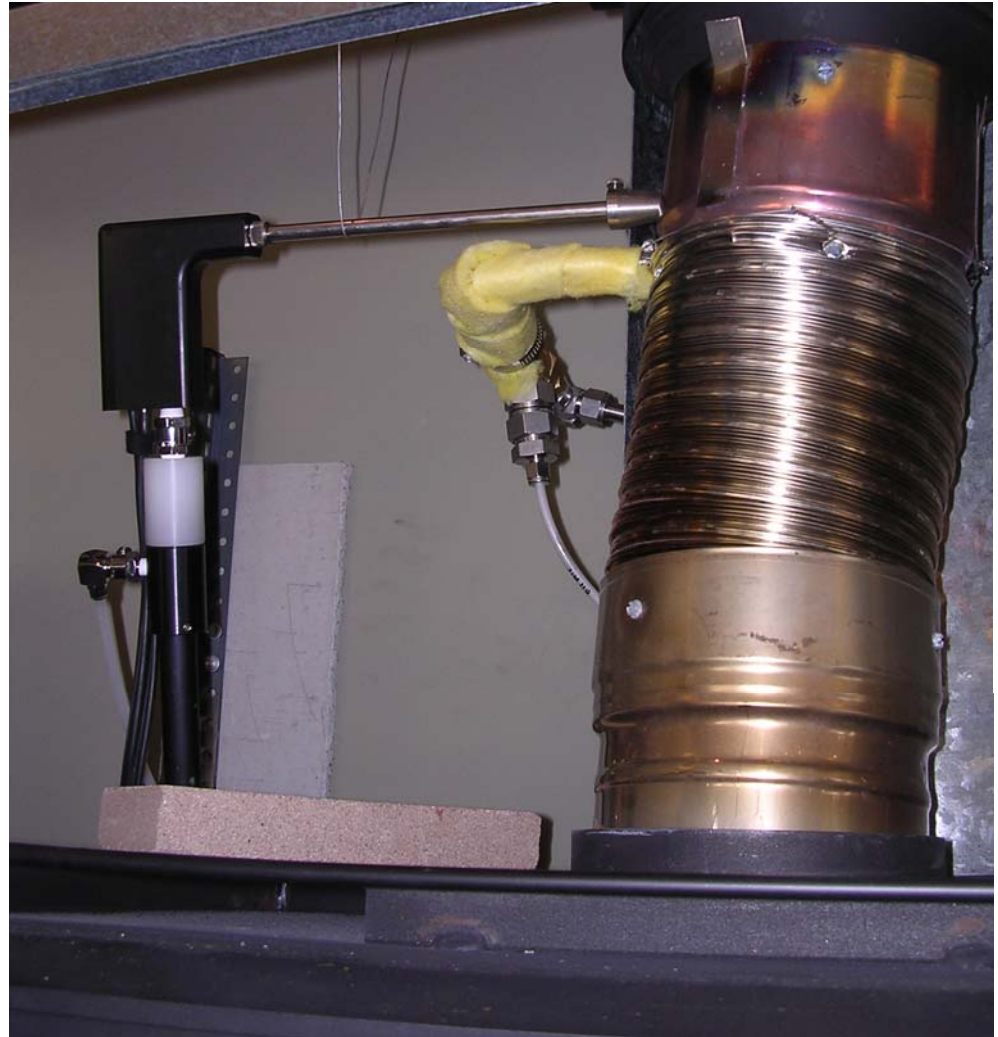
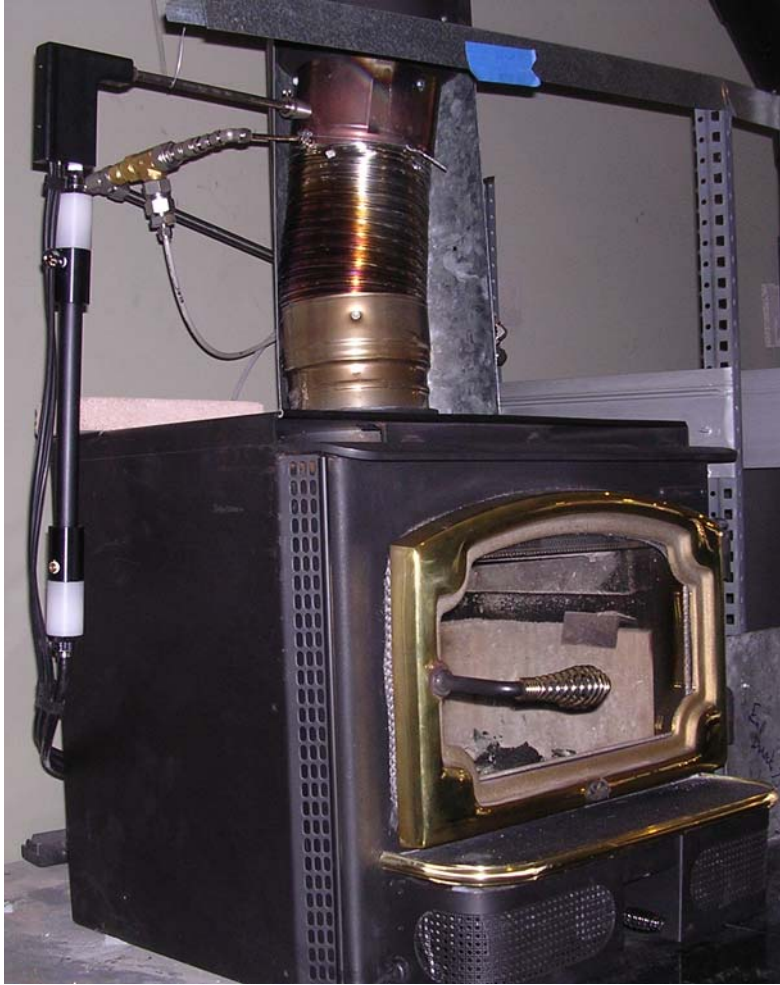
It is of interest to characterize sources of particles in the atmosphere

- Aerosol particles are of critical importance in the atmosphere because of their effect on:
 - Human Health
 - Visibility
 - Climate Change
- We need to understand contributions from various emission sources, eg:
 - Anthropogenic, eg: combustion (gasoline, diesel, biomass, etc.)
 - Natural, eg: sea-spray.

Schematic of Our Measurements



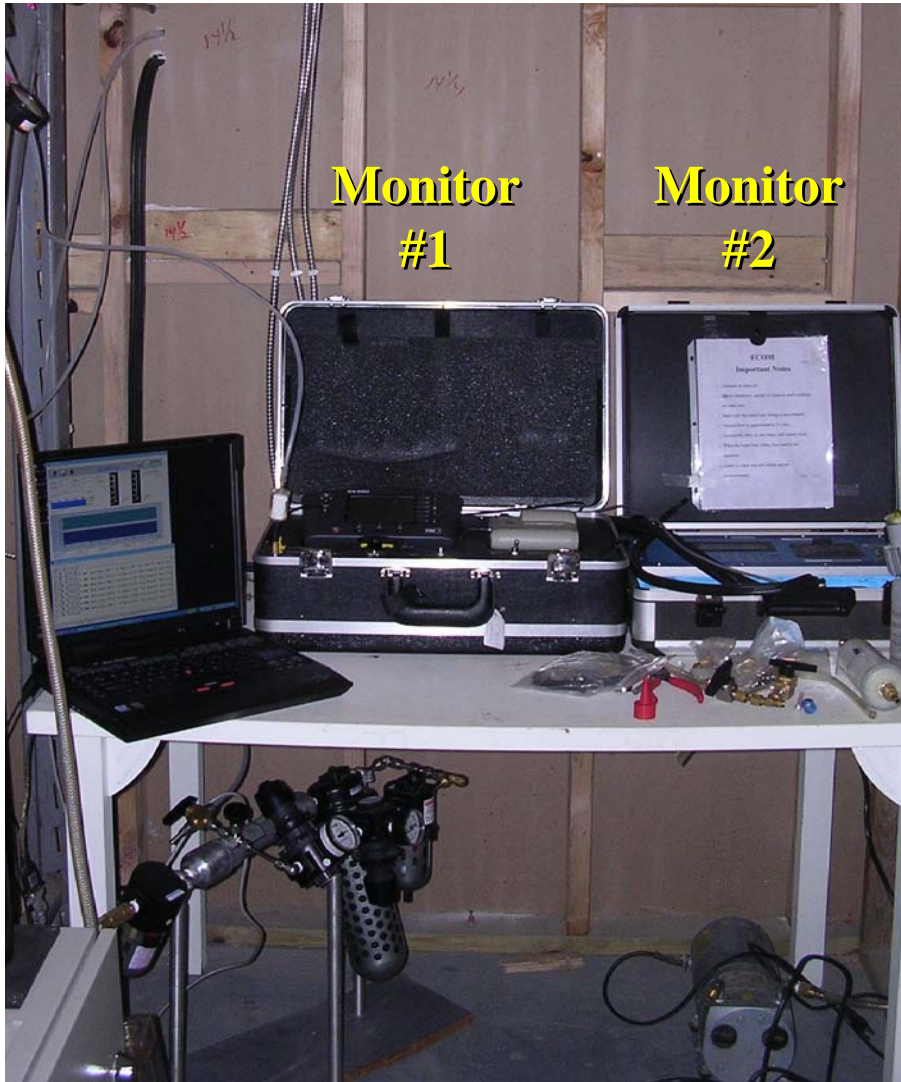
Sampling from the Wood Stove



The Corn Stove



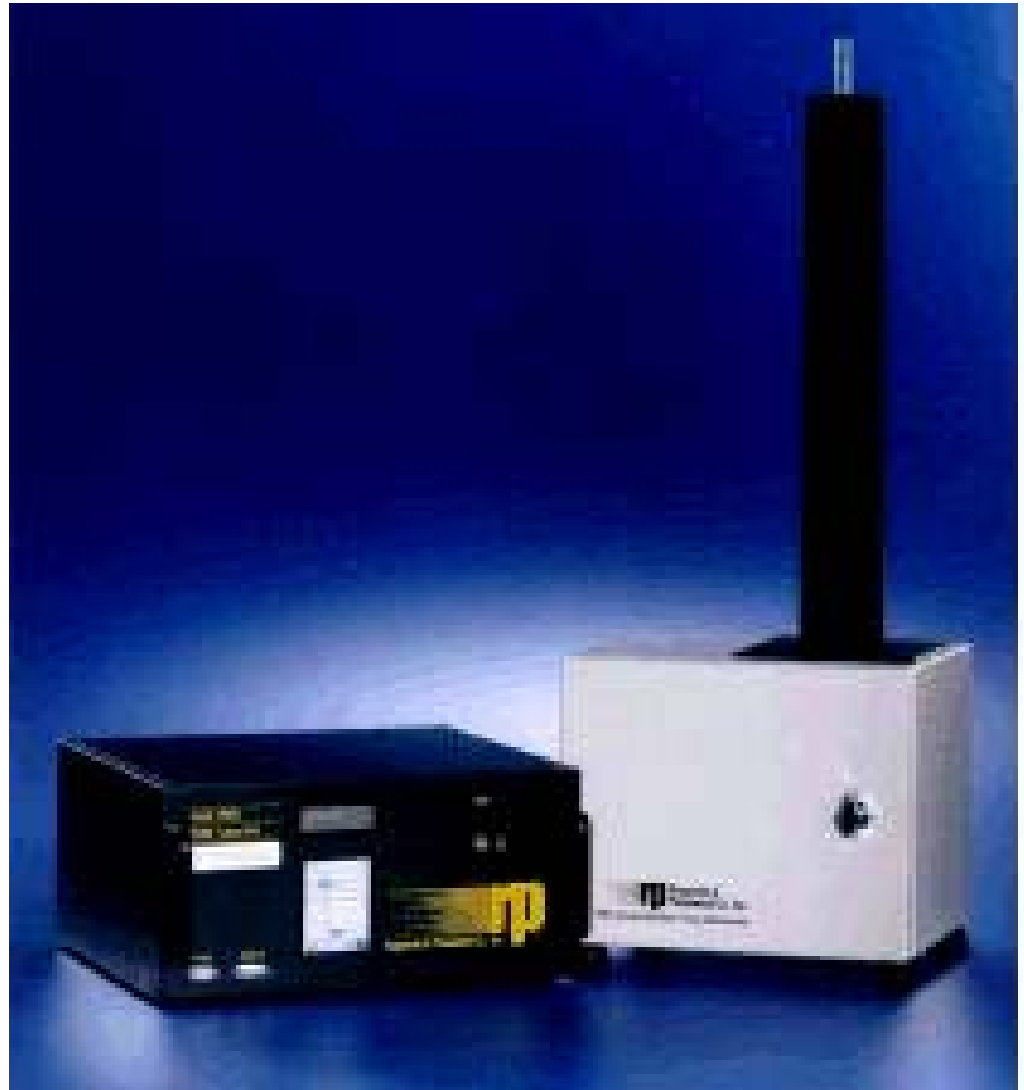
Gas Measurements



- Characterize combustion conditions
- Concentrations of: CO₂, CO, O₂, NO, NO₂
- Two gas monitors to determine the dilution ratio
 - Monitor #1 (TSI CA-Calc) measured raw emissions
 - Monitor #2 (ECOM-AC) measured diluted emissions

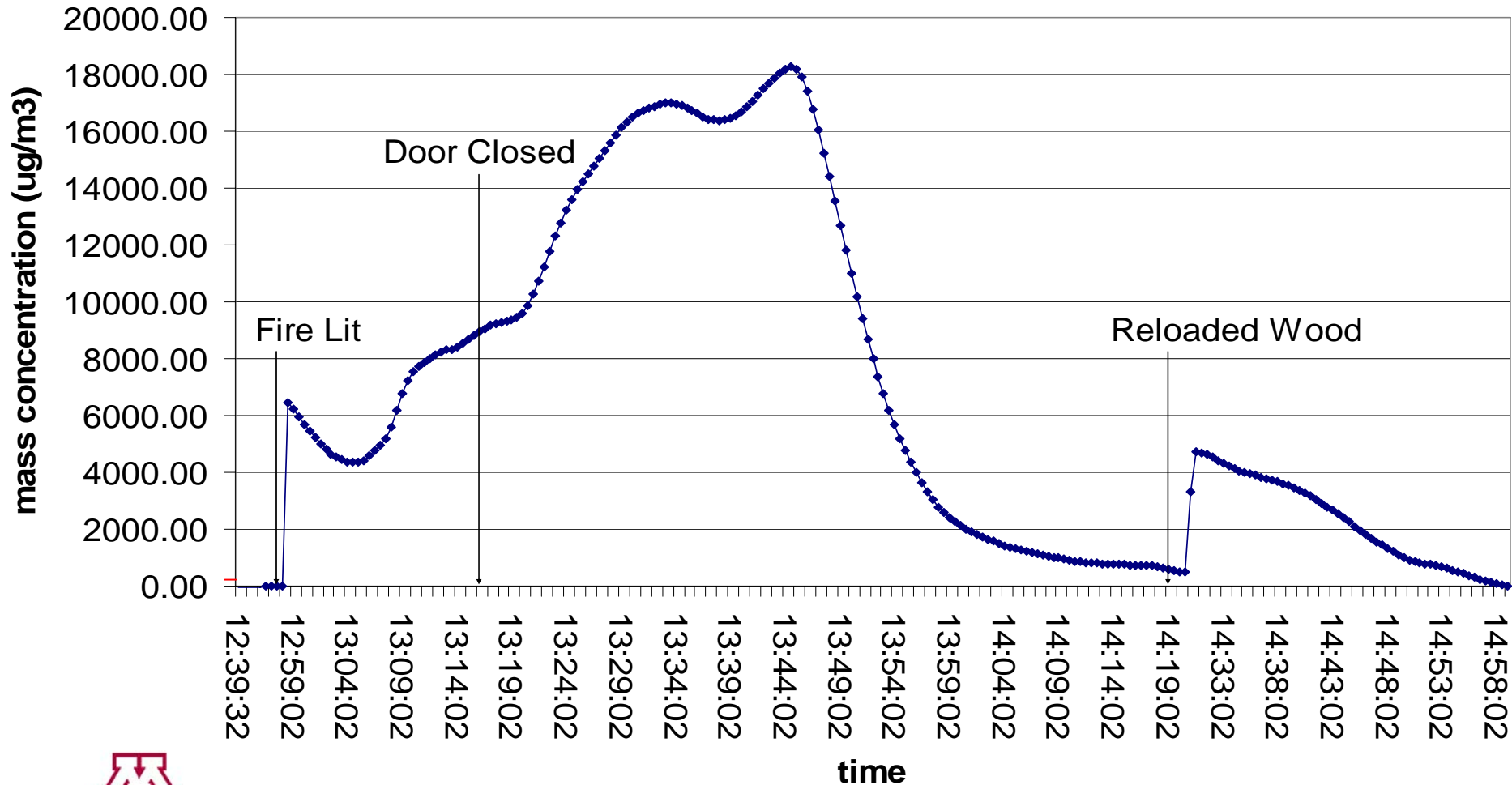
Particle Mass Concentration

- TEOM: Thermal Electric Oscillating Microbalance
- PM_{2.5} mass emissions (mg/m³ of exhaust sampled)
- Mass emission is a useful measure when comparing emissions from different sources



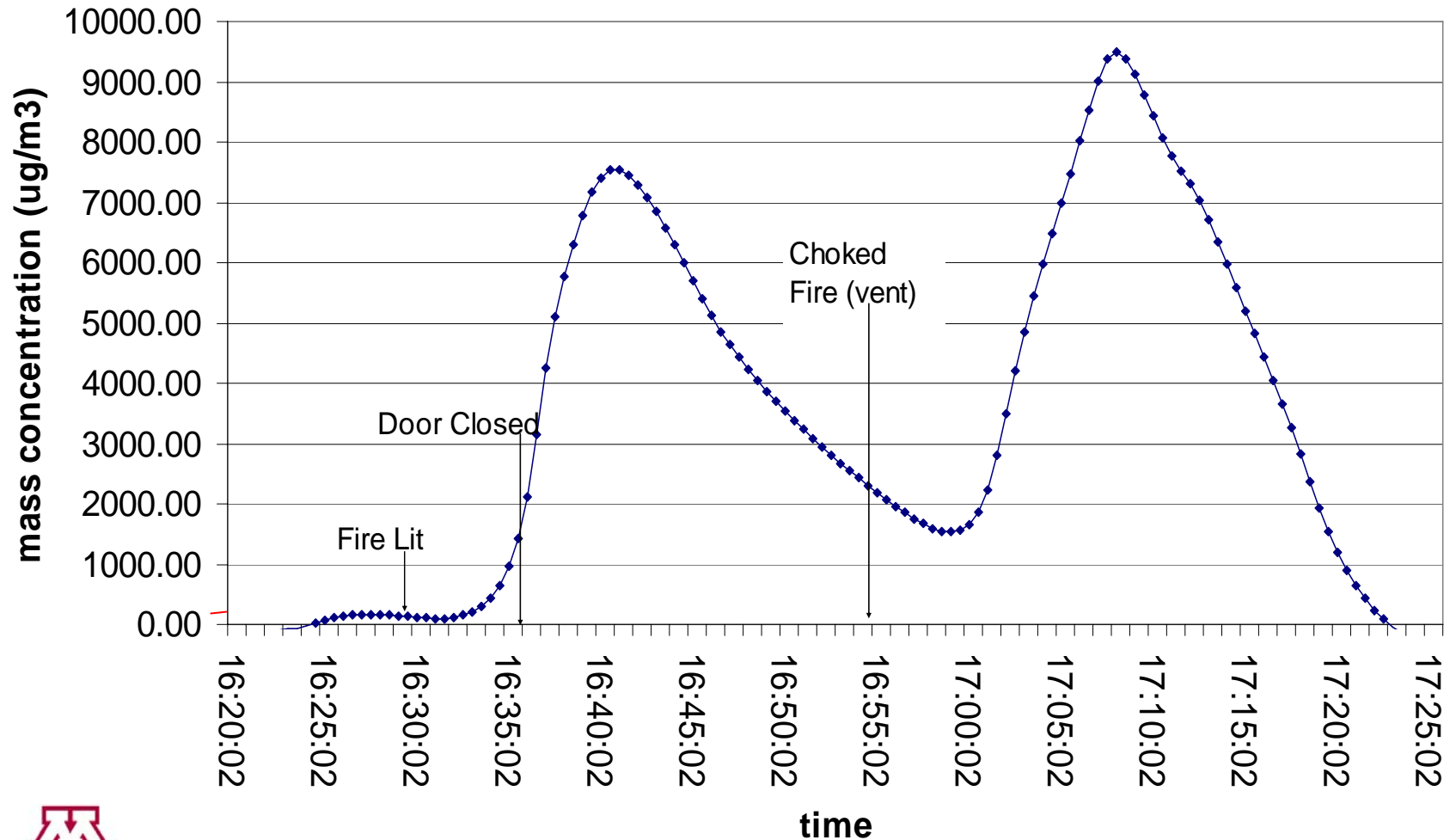
Particle Mass Concentration

Oak



Particle Mass Concentration

Birch

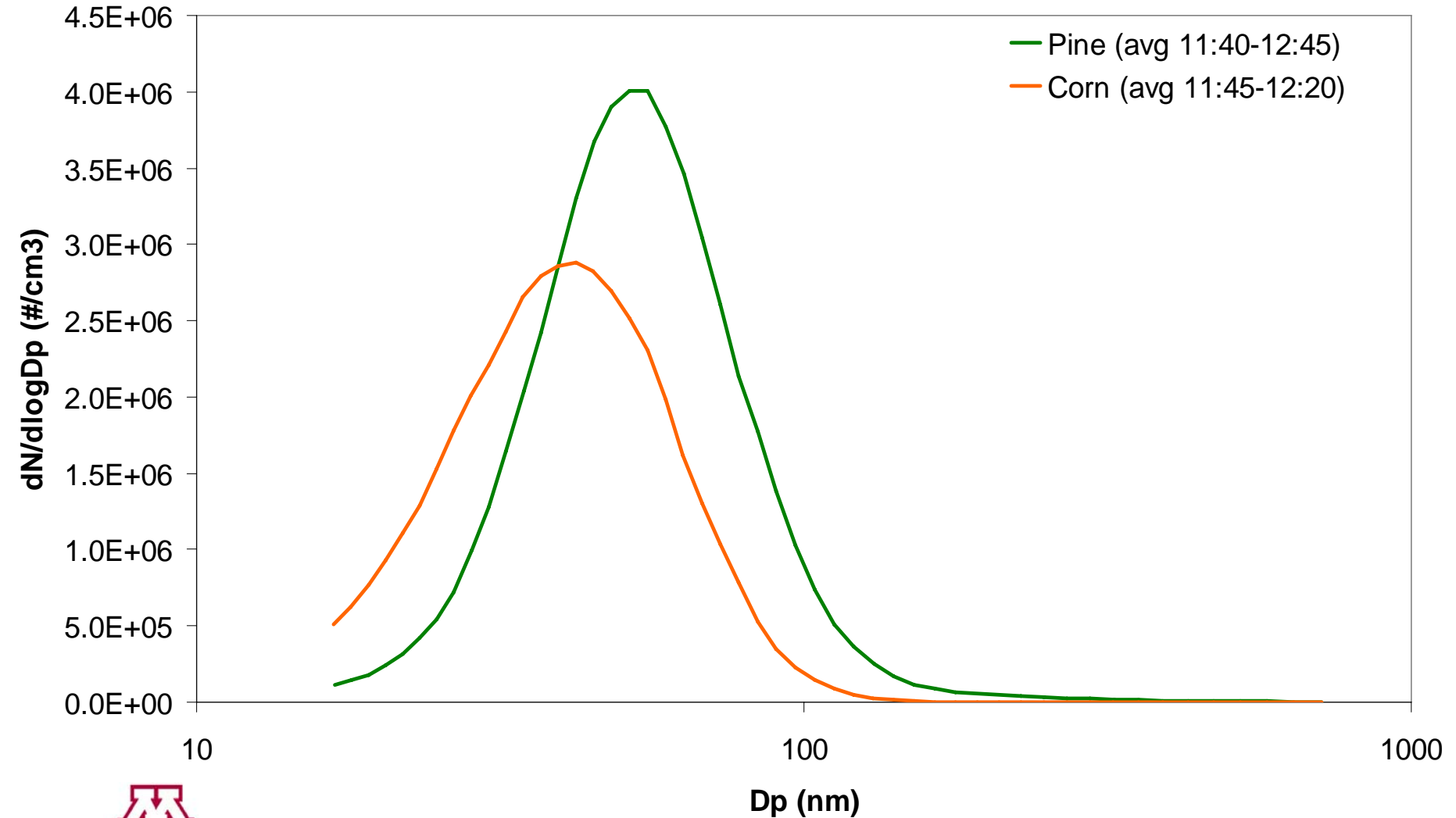


Particle Size Distribution

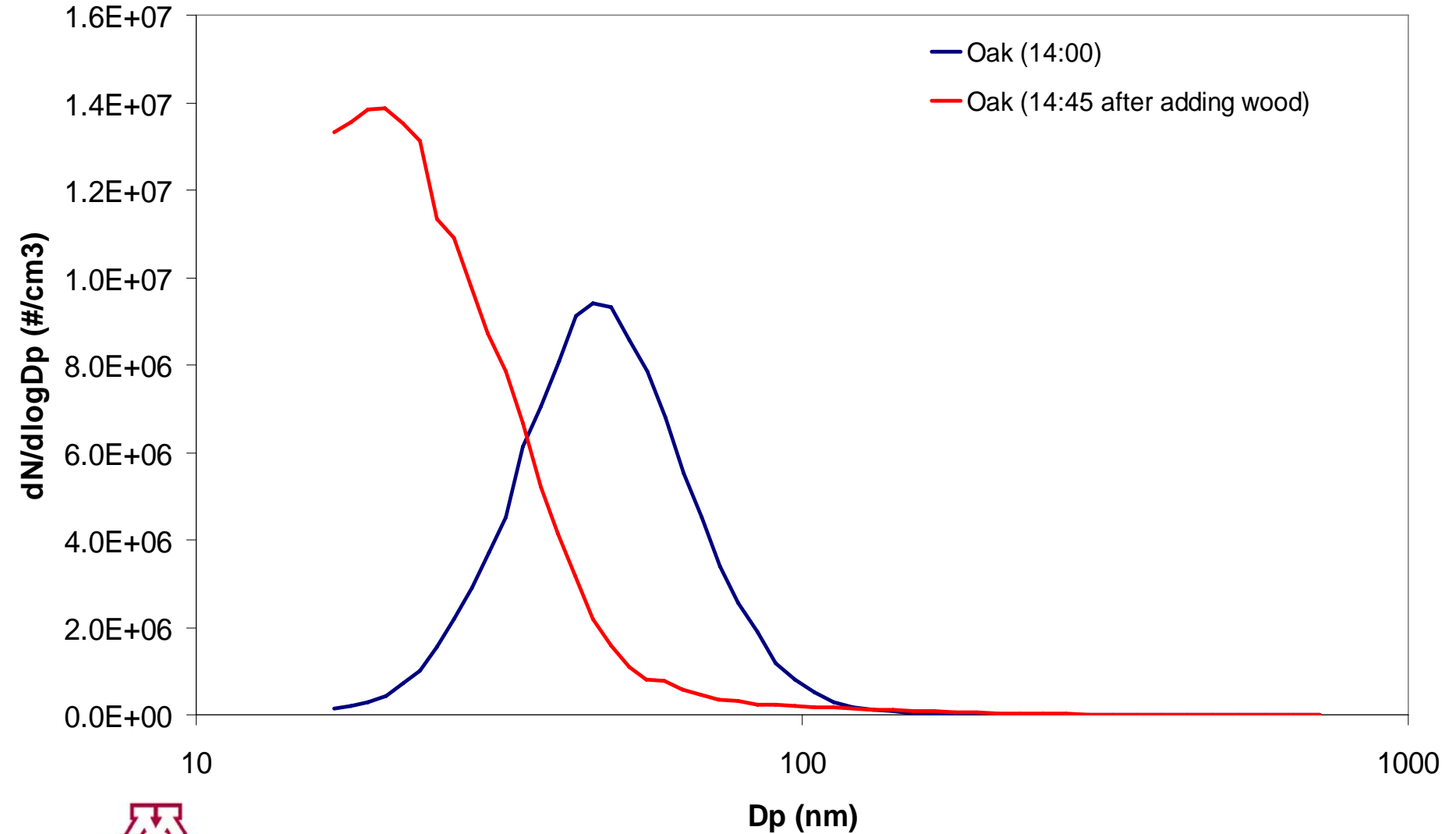
- SMPS: Scanning Mobility Particle Sizer
- Number of particles as a function of particle size
 - 10 – 700 nanometers
(1 nanometer = 10^{-9} meters)
 - Size distribution measured every 2.5 minutes
- Particle size determines many atmospheric and health effects



Particle Size Distribution



Particle Size Distribution

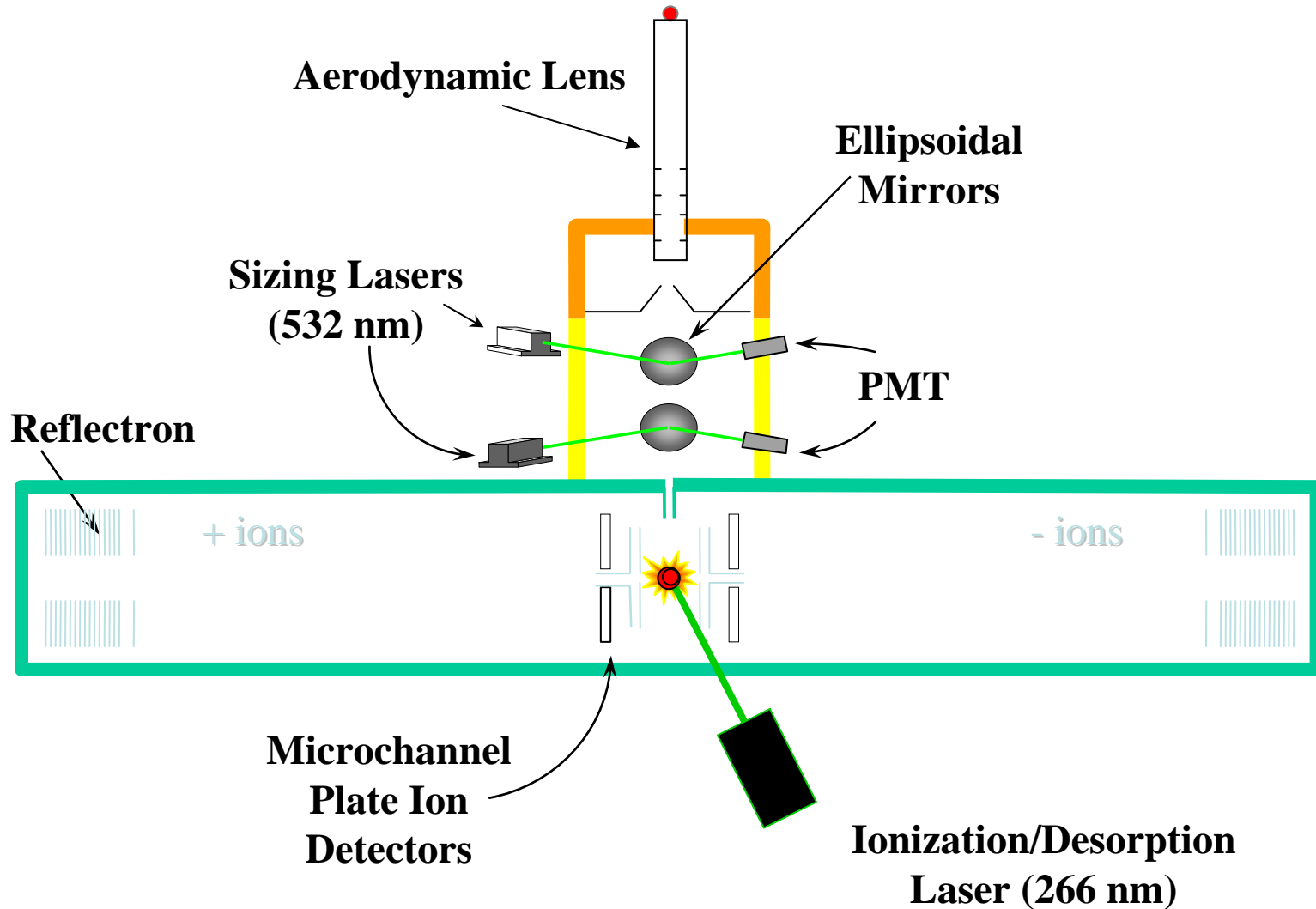


Particle Chemical Composition

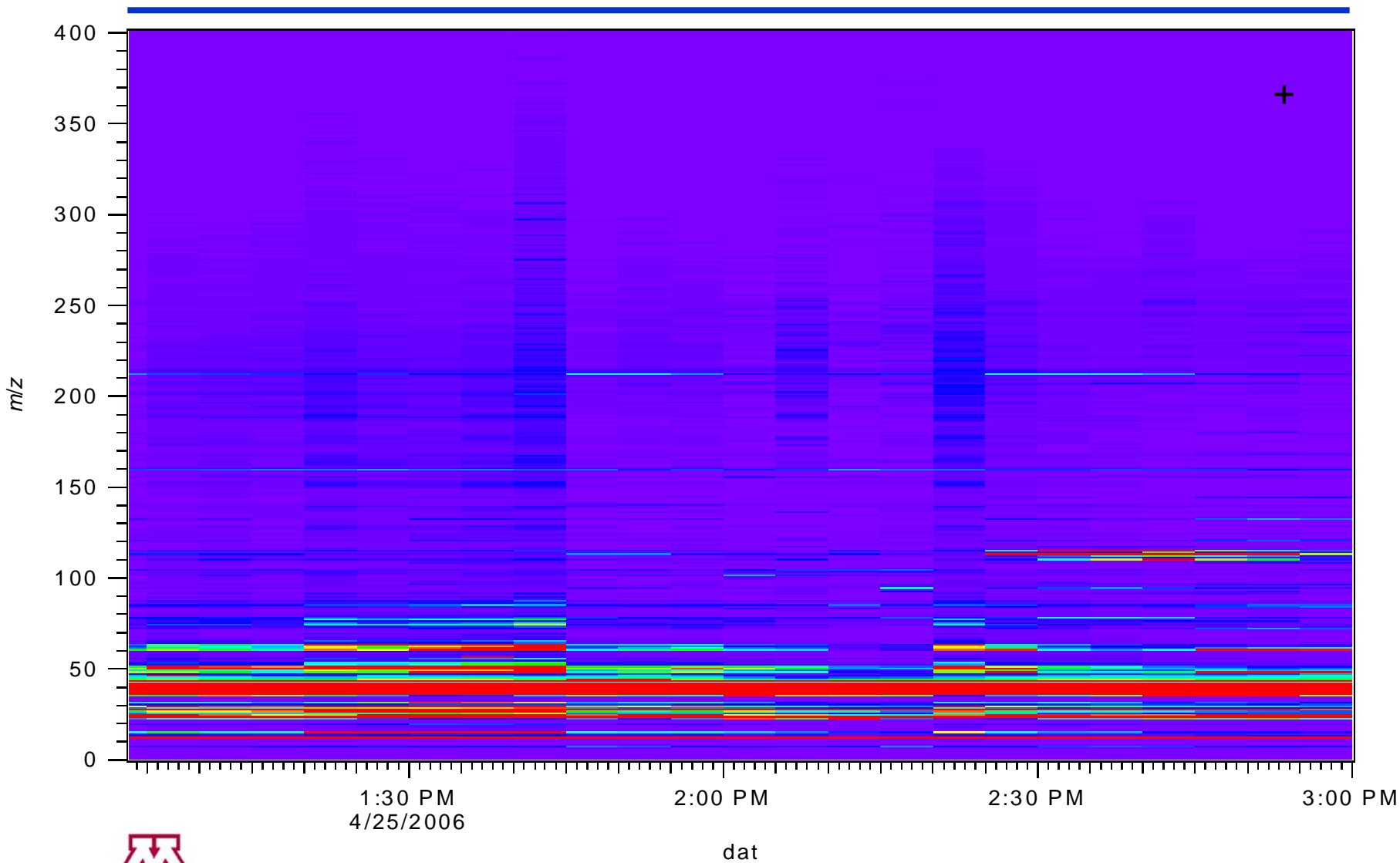


- ATOFMS: Aerosol Time-of-Flight Mass Spectrometer
- Size and chemical composition of individual particles, in real time
 - Ash
 - Soot
 - Organic compounds

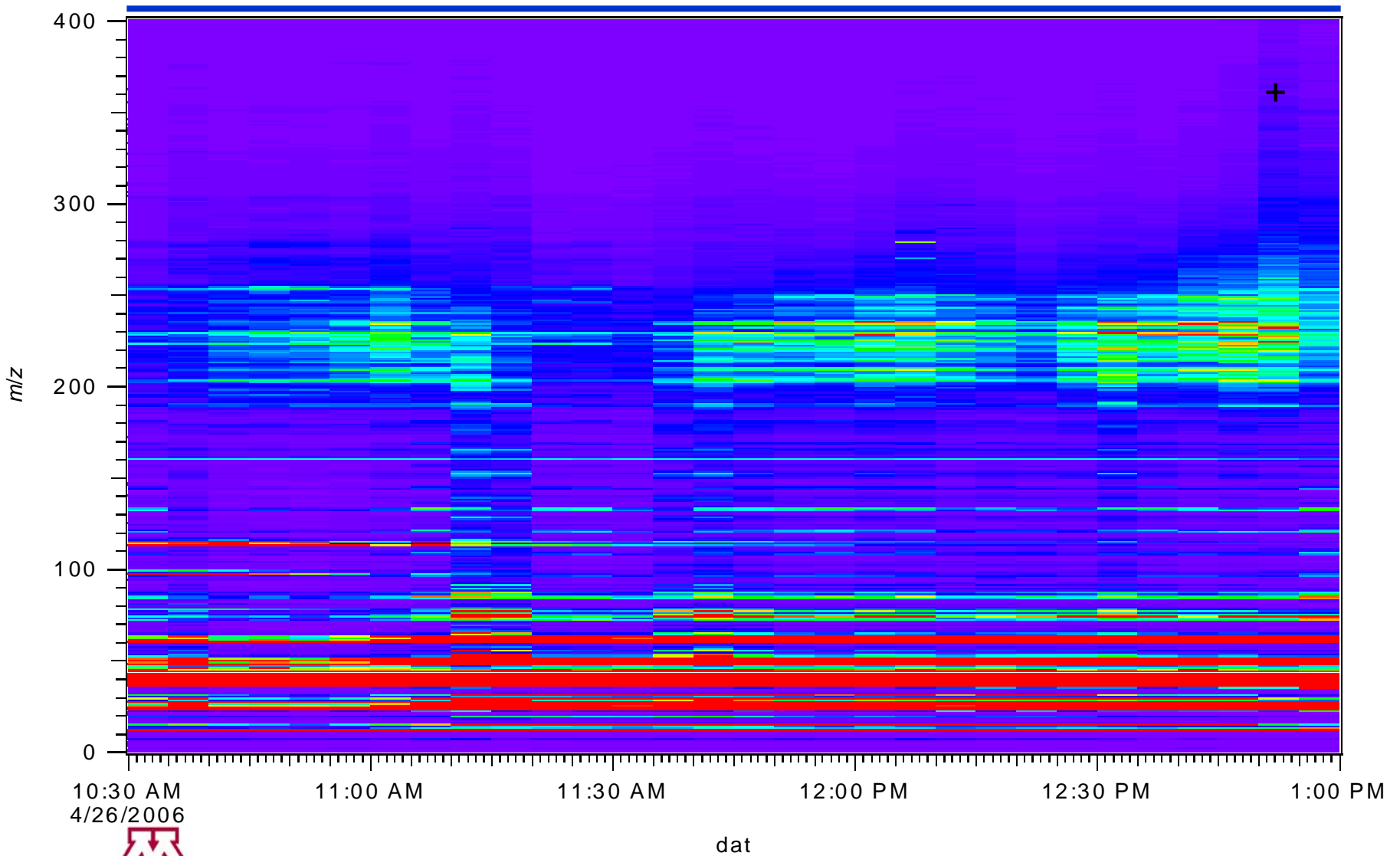
TSI 3800: Aerosol Time of Flight Mass Spectrometer - AKA Wallace



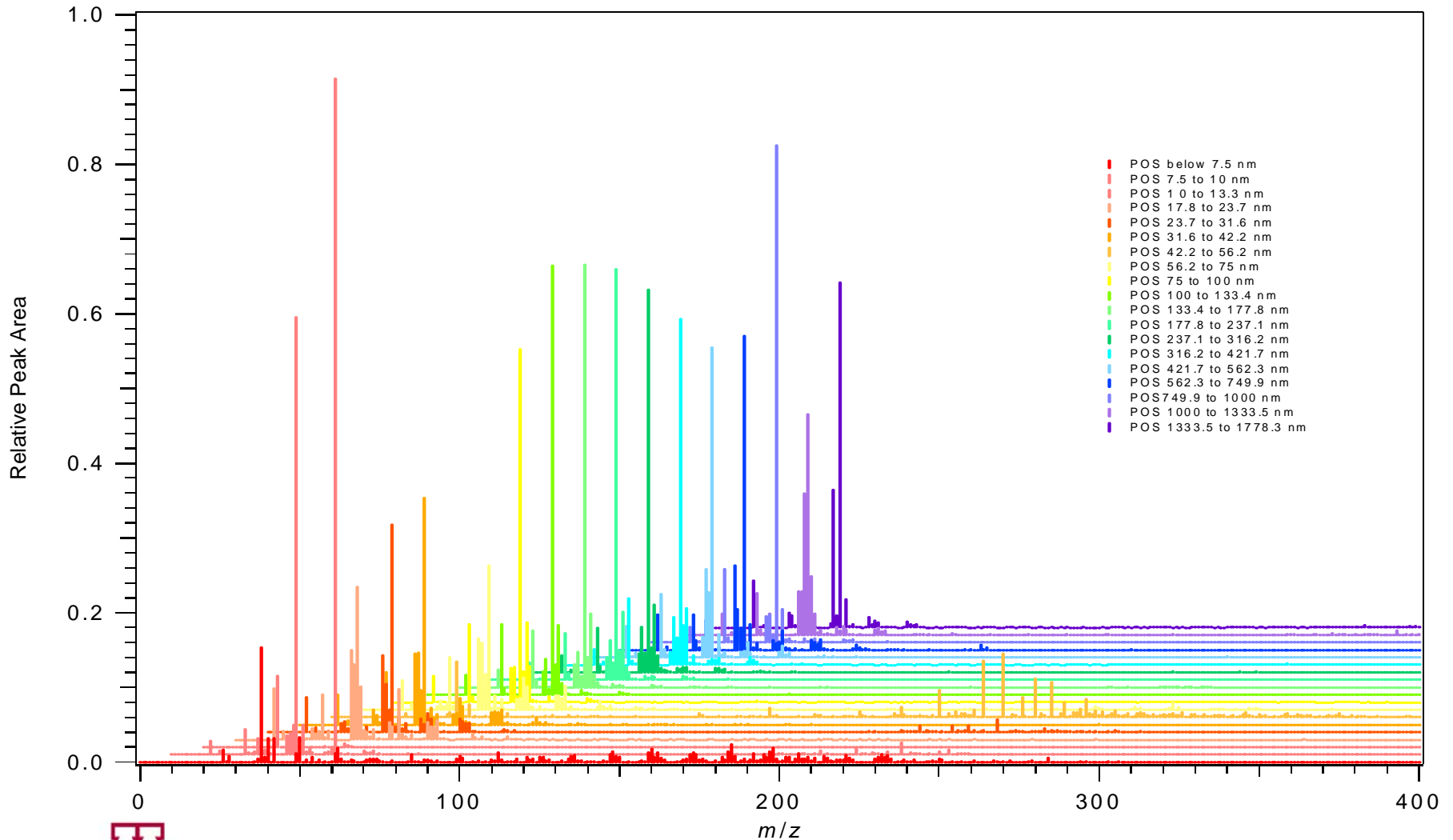
ATOFMS - Oak



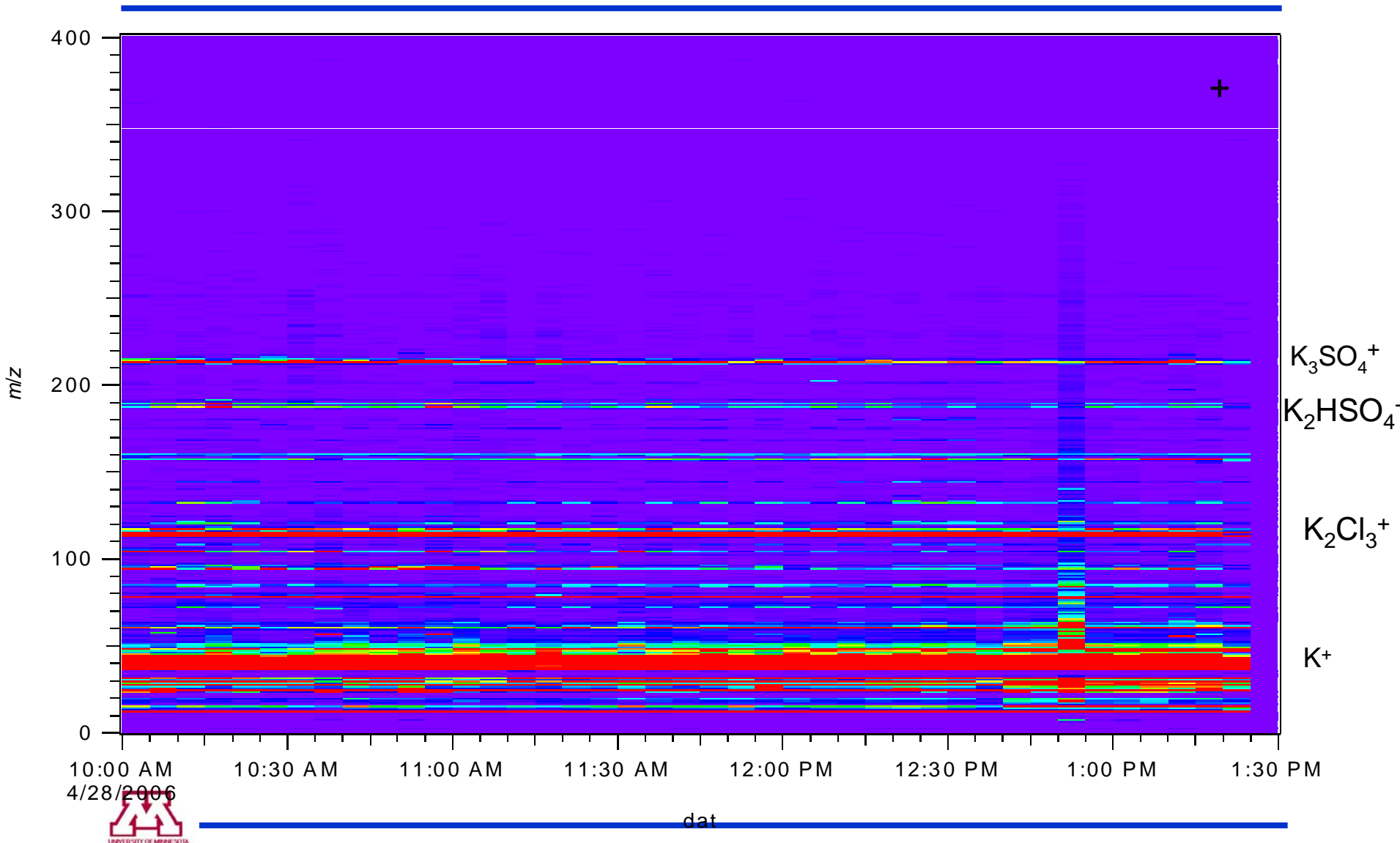
ATOFMS - Pine



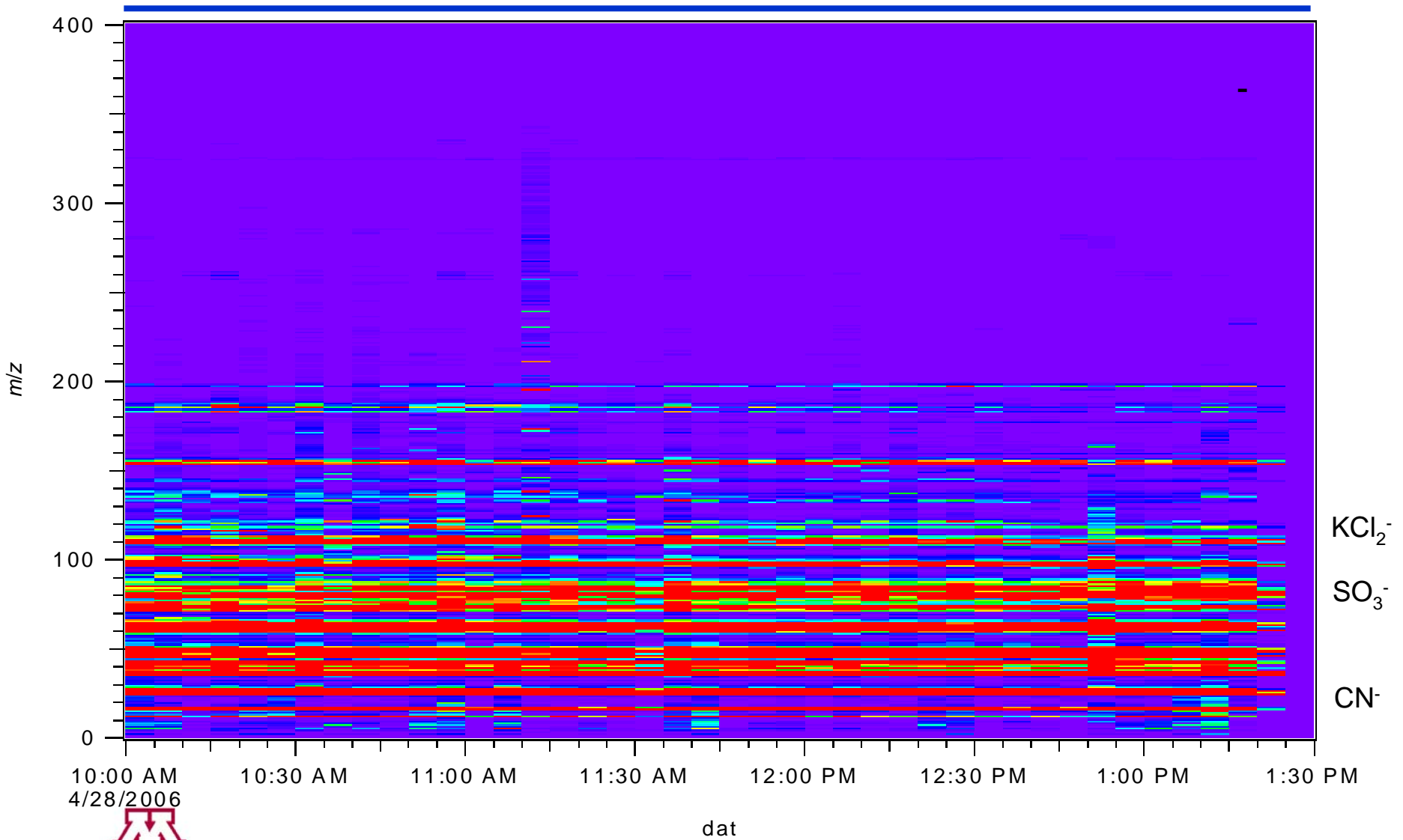
ATOFMS – Pine (sorted by particle size)



ATOFMS - Corn



ATOFMS - Corn



10:00 AM
4/28/2006



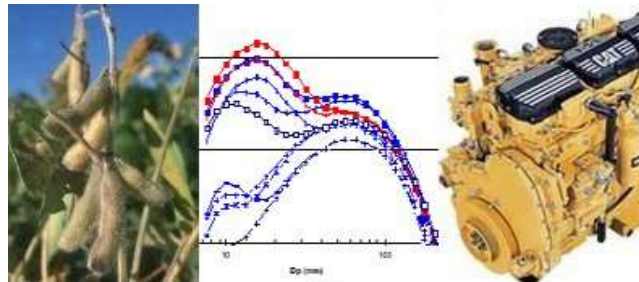
Results?

- A great deal of good data was acquired
- Data analysis is underway and will require integration of the results from all of the instruments used

Acknowledgements

- Jeff and Milt, GREF for funding
- Deborah Gross, Joakim Pagels, Mark Stolzenburg, Peter McMurry
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 - Peter Solac, Ted Palmer and coworkers
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- University of Minnesota Center for Diesel Research (for loan of ECOM-AC)

Center for Diesel Research



Fuels

Emissions

Engines

