

## Aerosol Chemical Speciation Monitor

### ACSM

#### *Instrument description and sample data*

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AAAR Meeting Oct 27, 2009

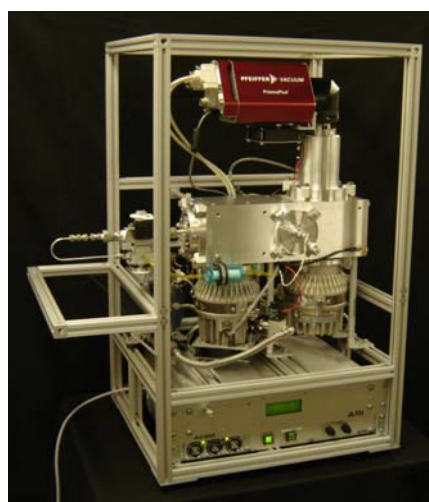
## Aerosol Chemical Speciation Monitor ACSM

Size: 19”D x 21”W x 33”H

Weight: 140 lbs (64 kg)

Power: 300W

Data acquisition via Ethernet  
connection – basic laptop is  
sufficient.



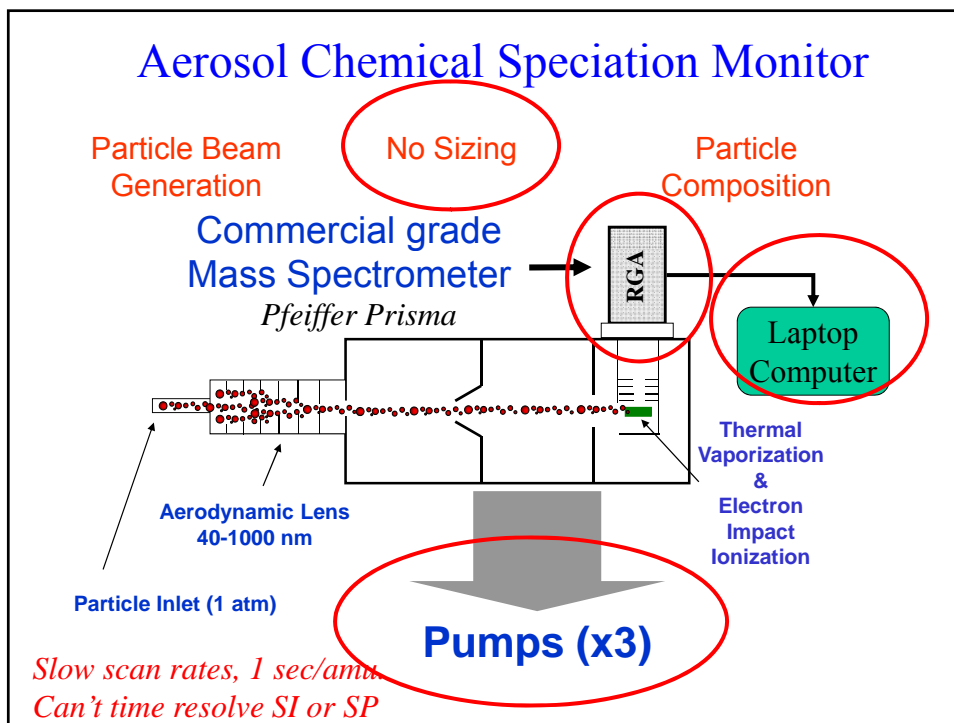
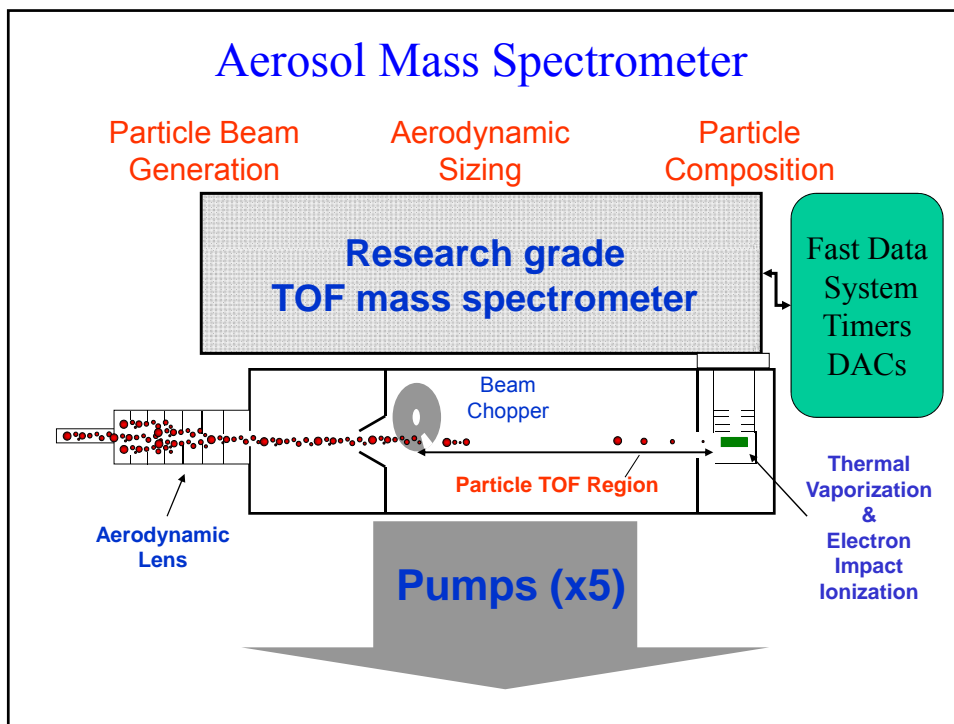
ACSM-002 SN 140-100

## ACSM, *aka...*

- Ehm-Eye-Ehn-Eye → MINI
- Mini-AMS
- Baby AMS
- AMS Light
- Cheap AMS
- Ponche
- Sammy

## Aerosol Chemical Speciation Monitor ACSM

- Continuous monitoring of non-refractory aerosol composition by thermal particle vaporization aerosol mass spectrometry.  
*Sulfate, Nitrate, Chloride, Ammonium, Organics*
- Builds on ARI Q and ToF AMS Hardware and analysis concepts.  
*lower cost, lower sensitivity.*
- Designed for monitoring, long term unattended operation.  
*Performance demonstrations in progress*



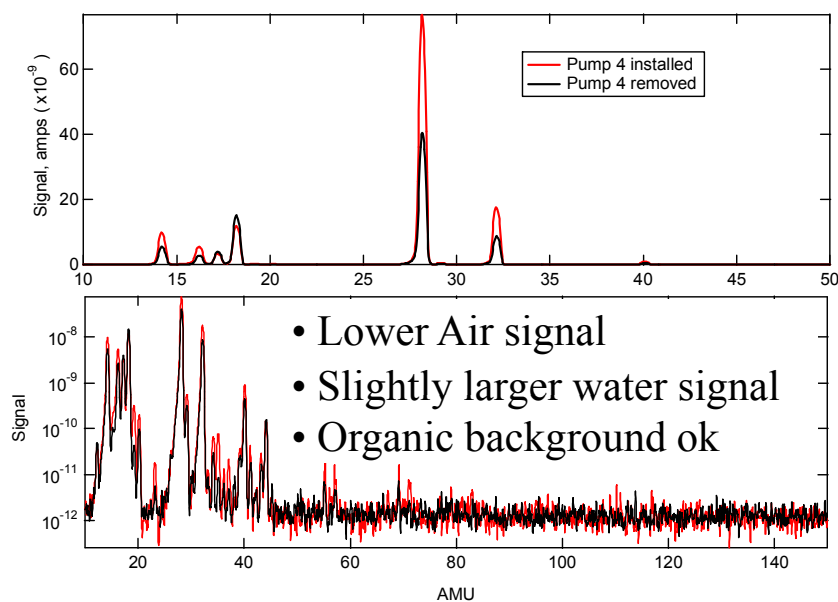
## ACSM Designed Around Pfeiffer Prisma RGA



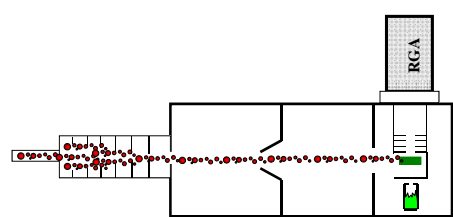
- Prisma electronics supports:
  - 6mm diameter rods, 200 amu range.
  - 1 mA/mbar sensitivity to Ar (200 amu head)
  - Ethernet connectivity with OPC<sup>1</sup> interface.
  - A Windows CE computer/OS.
  - Built-in digital and analog I/O.

<sup>1</sup>OPC is a standard software interface which enables data communication between applications of different manufacturers. OPC stands for Openness, Productivity, Collaboration (formerly OLE for Process Control).

### Removal of Pump4



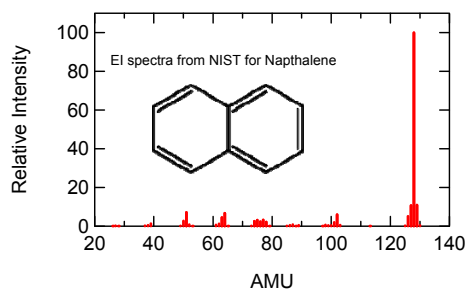
## Internal Standard Naphthalene Effusive Source



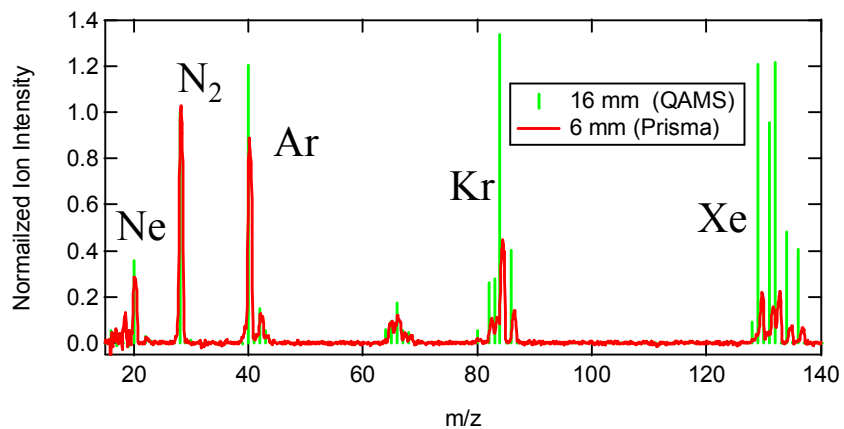
- *m/z* marker
- *Ion transmission*
- *Ionization efficiency reference*

1  $\mu\text{m}$  pin hole  
 $10^{11} \text{ s}^{-1}$

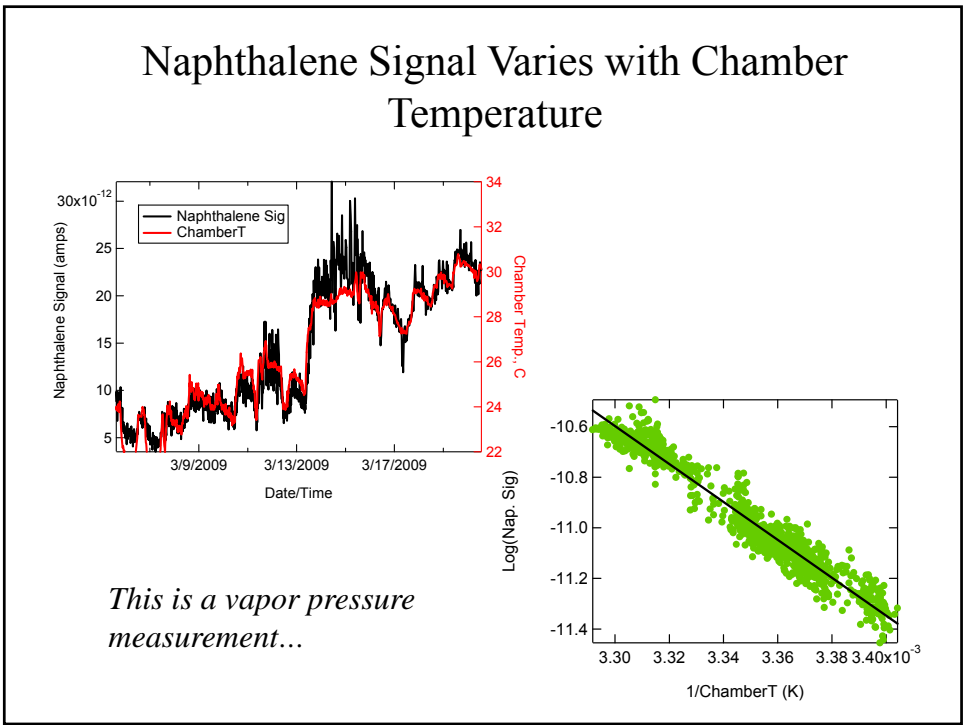
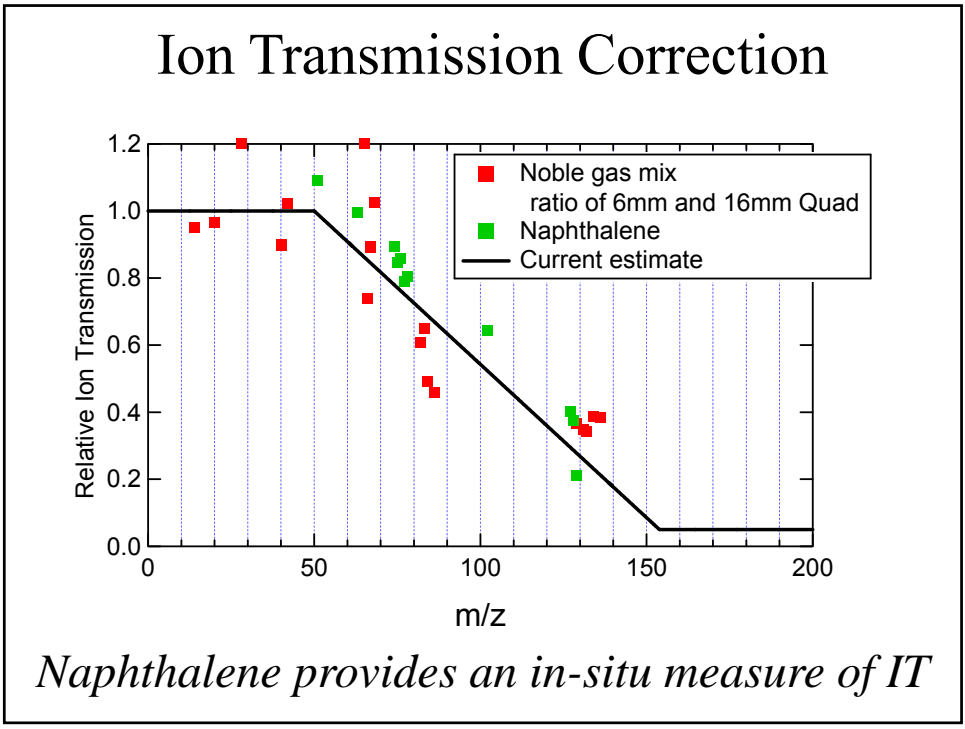
naphthalene molecules

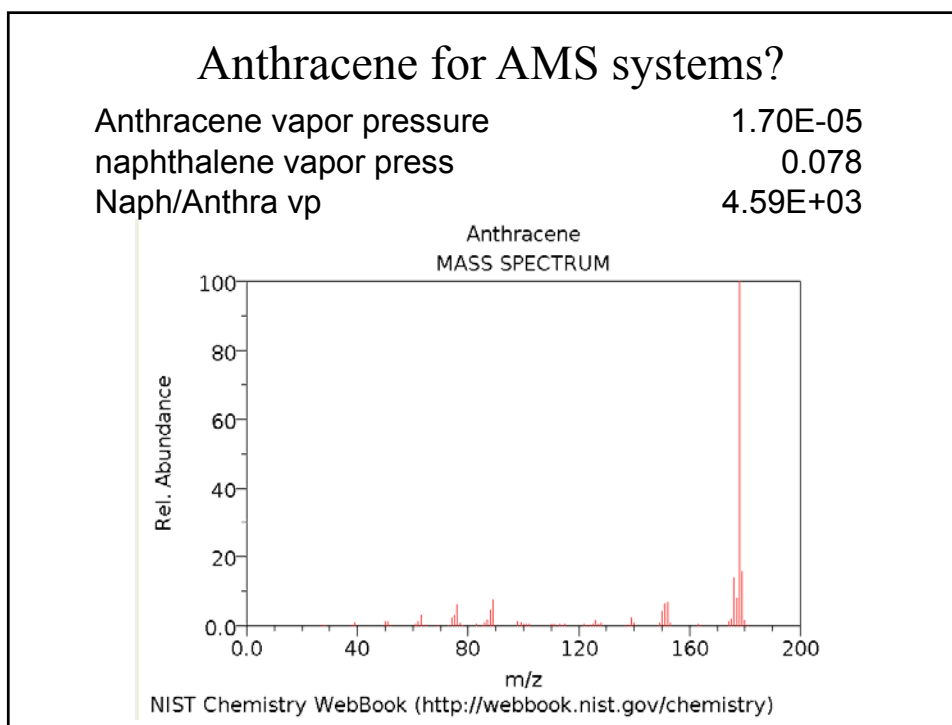
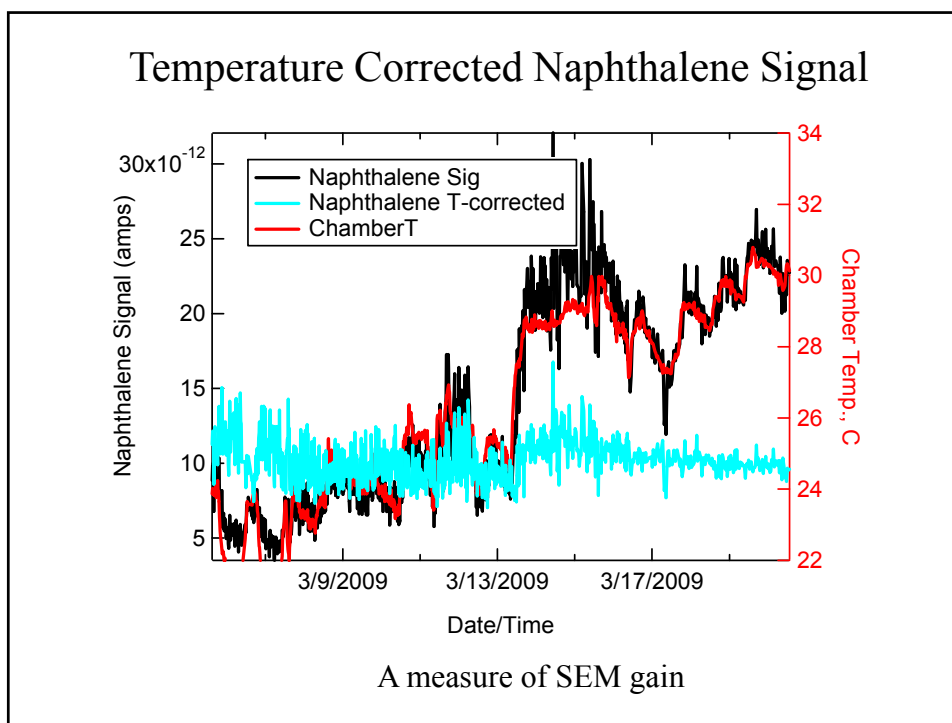


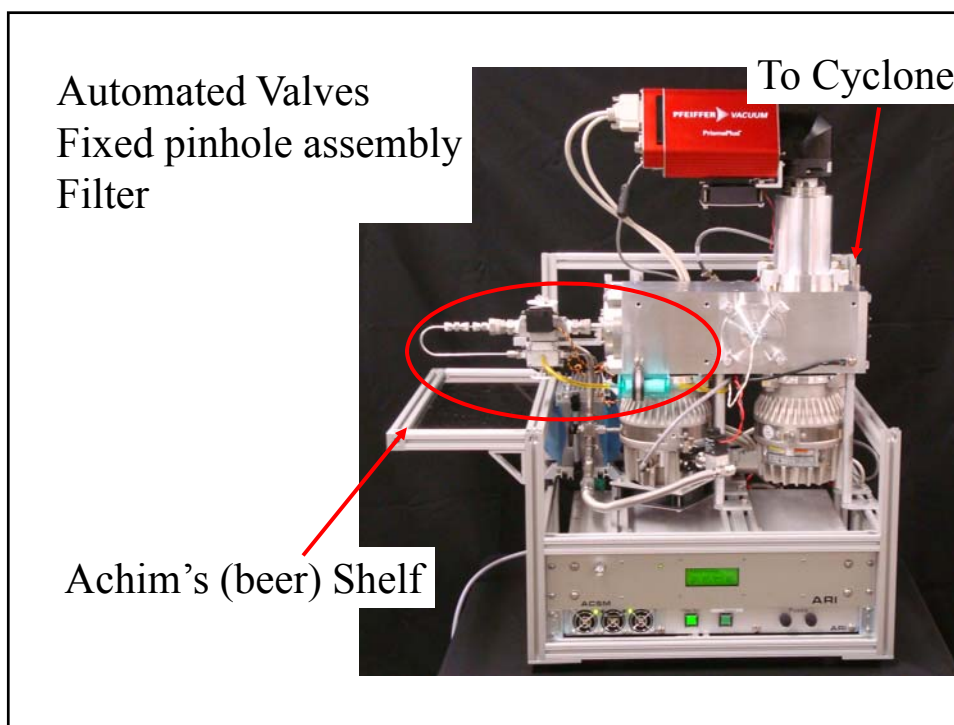
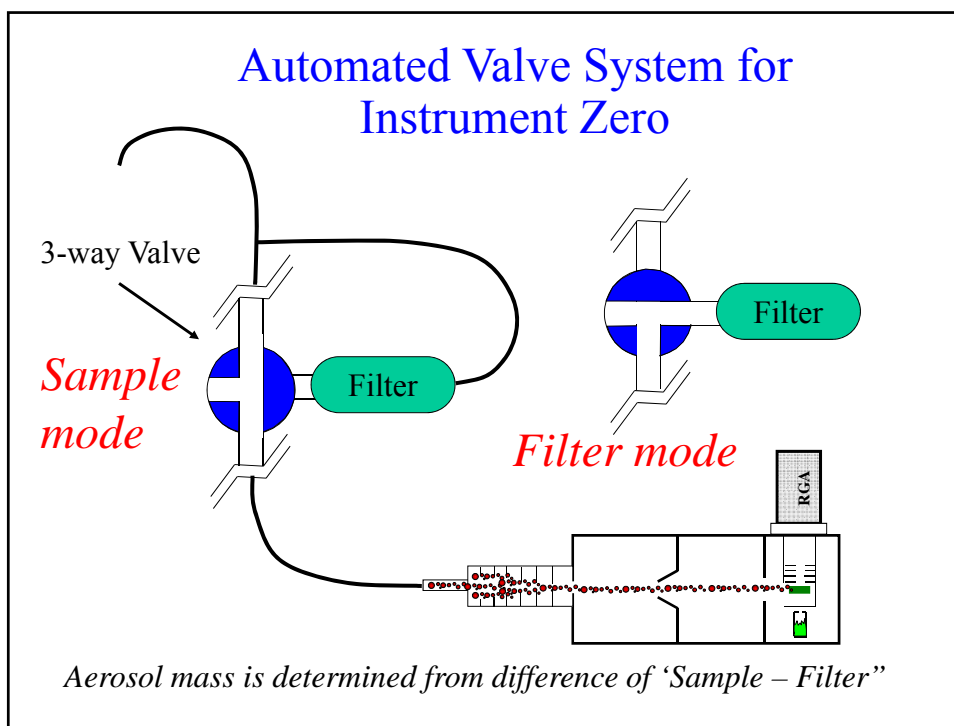
## Ion Transmission



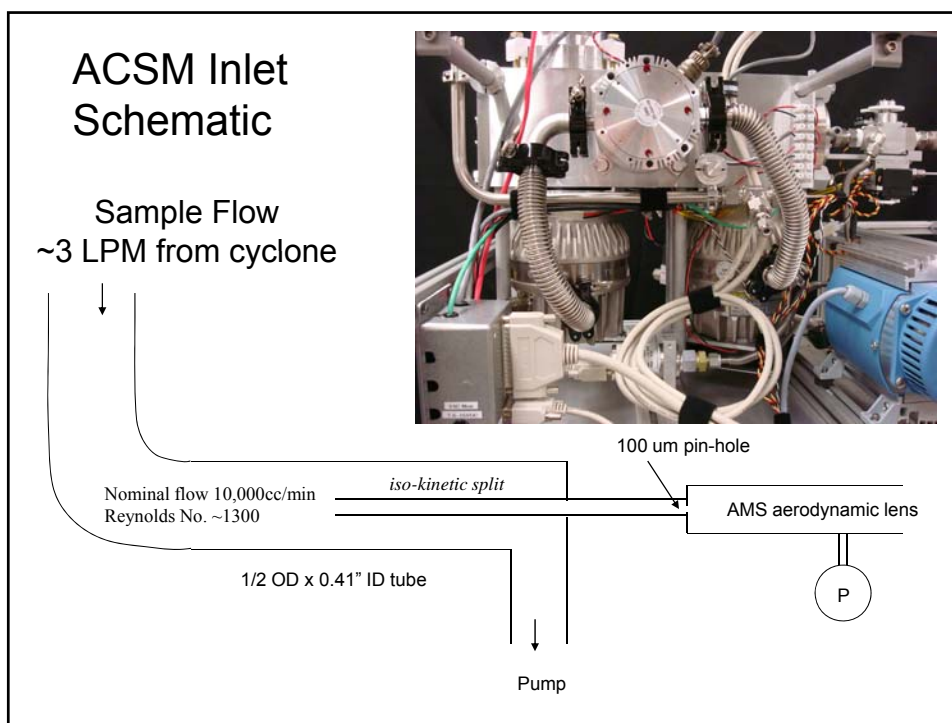
*Compares 16mm (QAMS) to 6mm (ACSM)*



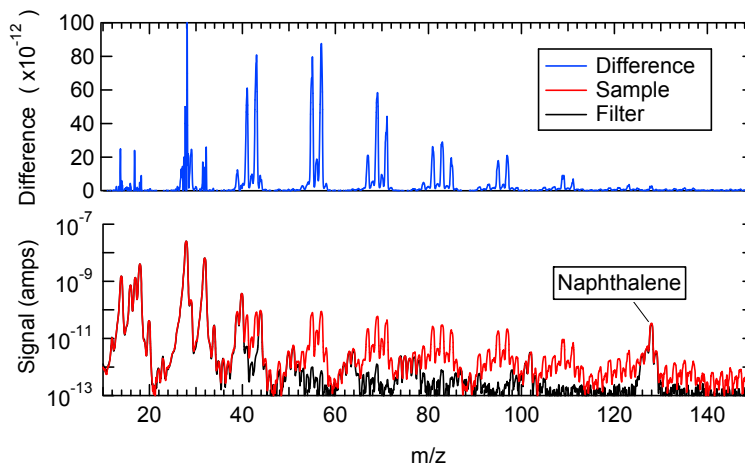








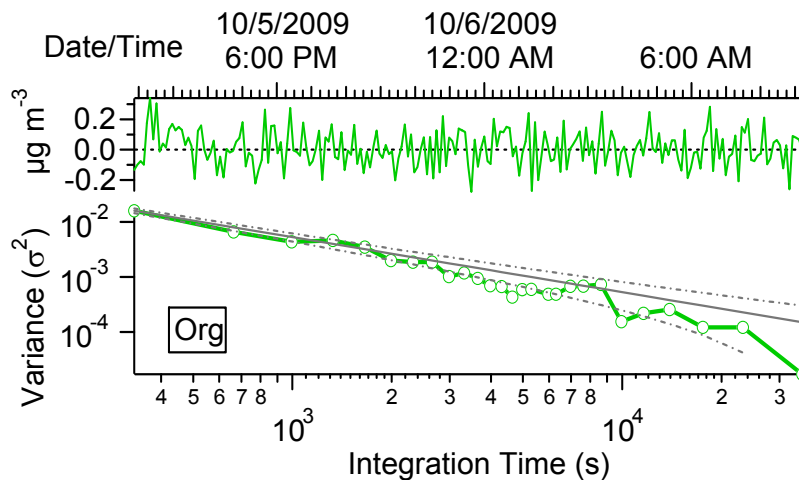
Aerosol mass is determined from difference of  
‘Sample – Filter’ mass spectra



Chemical species are determined following Allan et al, 2003

**Sulfate**, **Nitrate**, **Chloride**, **Ammonium**, **Organics**

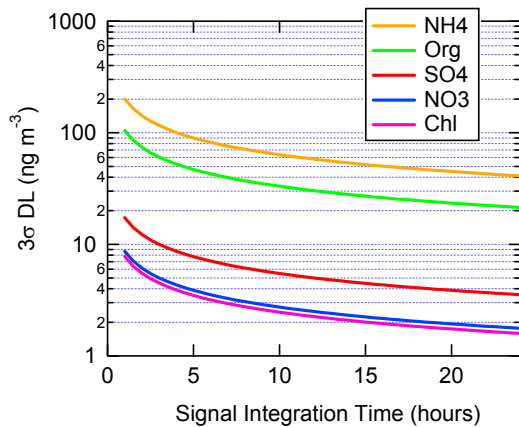
### Instrument Stability - Allan Variance



*Measured under (ideal) laboratory conditions*

5 min

### Estimated $3\sigma$ Detection Limits



- 1 hr DLs are  $< 0.2 \mu\text{g m}^{-3}$
- 24 hr DLs are  $< 0.05 \mu\text{g m}^{-3}$

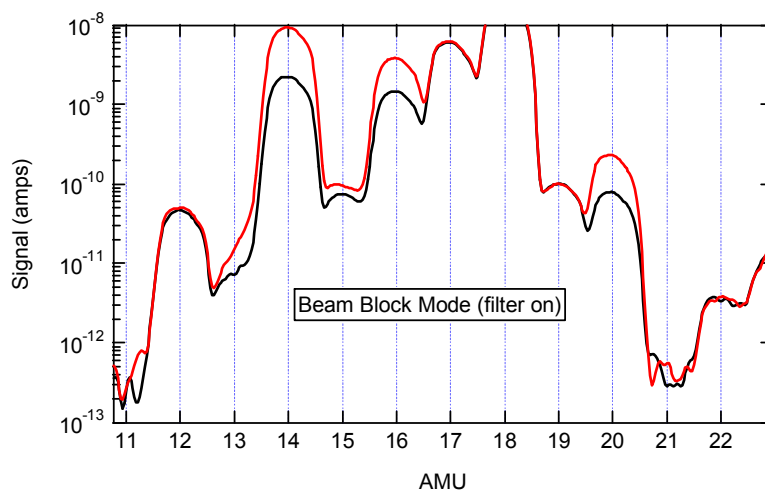
*Detection limits depend on background signal levels in the spectrum*

## Ratio of xAMS / ACSM Detection Limits Values are 30 min $3\sigma$

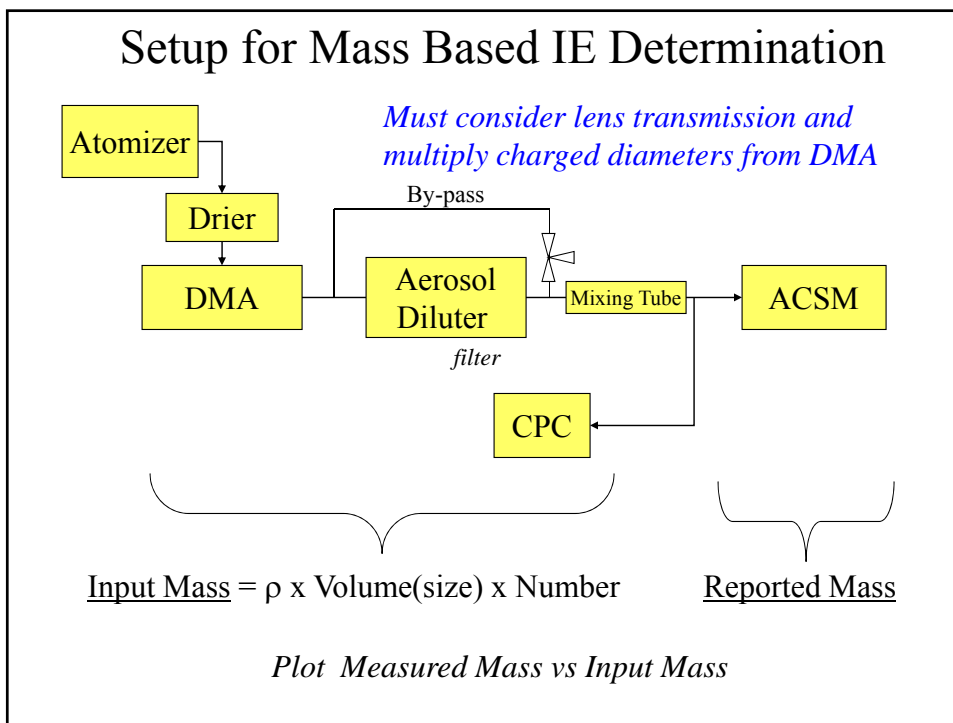
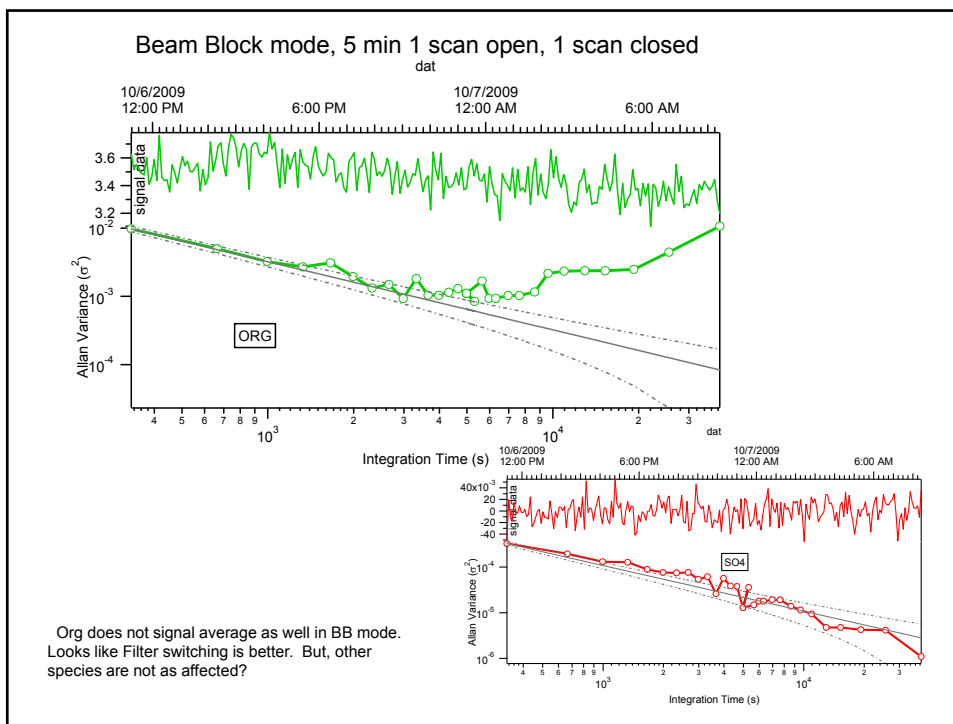
	HTOF-w	HTOF-v	Ctof	QAMS
Org	3.9	63.7	73.8	3.0
SO <sub>4</sub>	2.1	45.3	107.1	1.5
NO <sub>3</sub>	3.3	35.9	86.7	3.3
NH <sub>4</sub>	18.0	70.9	168.4	7.7
Chl	1.9	8.2	24.6	3.1

*DeCarlo et al, 2006 Anal. Chem, 78, 8281-8289*

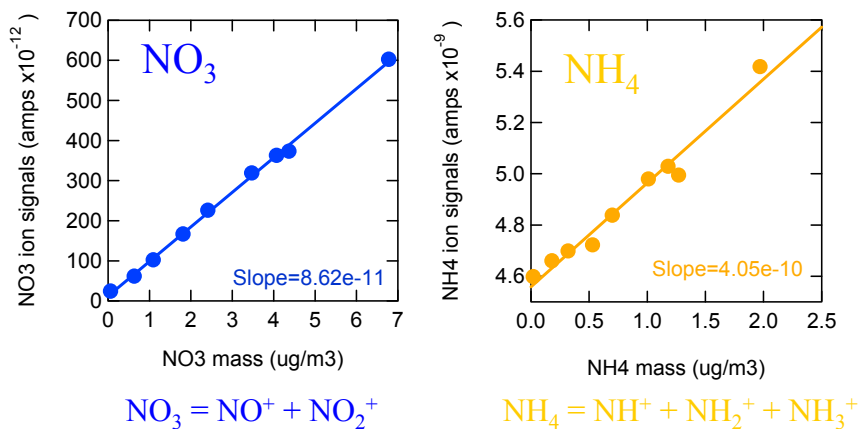
## MS Difference in Beam Block mode



*A consequence of a shorter chamber is a more intense  
molecular beam*

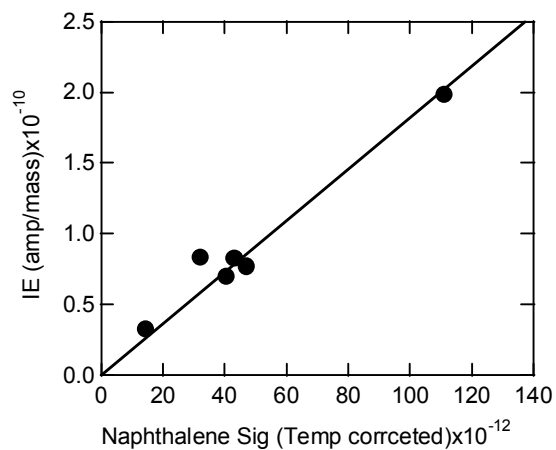


## NH<sub>4</sub>NO<sub>3</sub> Ionization Efficiency Calibration



*Calibration based on calculated mass  
delivered from atomizer/DMA/CPC system*

## Correlation of AN-IE with naphthalene Signal



Want to demonstrate that naphthalene signal is  
an effective measure of IE

## Recent Field Deployments of the ACSM

- Spain, March 2009 – 3 weeks
- Houston, May 2009 – 6 weeks
- Queens, NY June 2009 – 8 weeks

Queens College II Ambient Air Monitoring Station  
Queens College II: CUNY - Queens College Campus

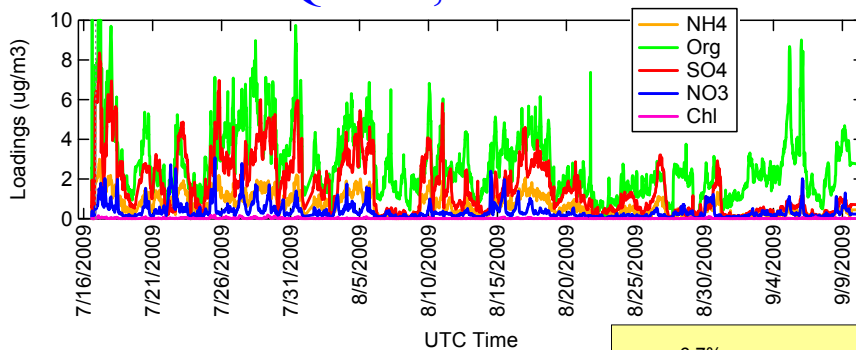


NYSDEC

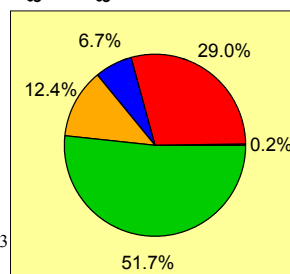


<http://www.dec.ny.gov/chemical/54360.html>

## ACSM Data Sample Queens, NY 2009

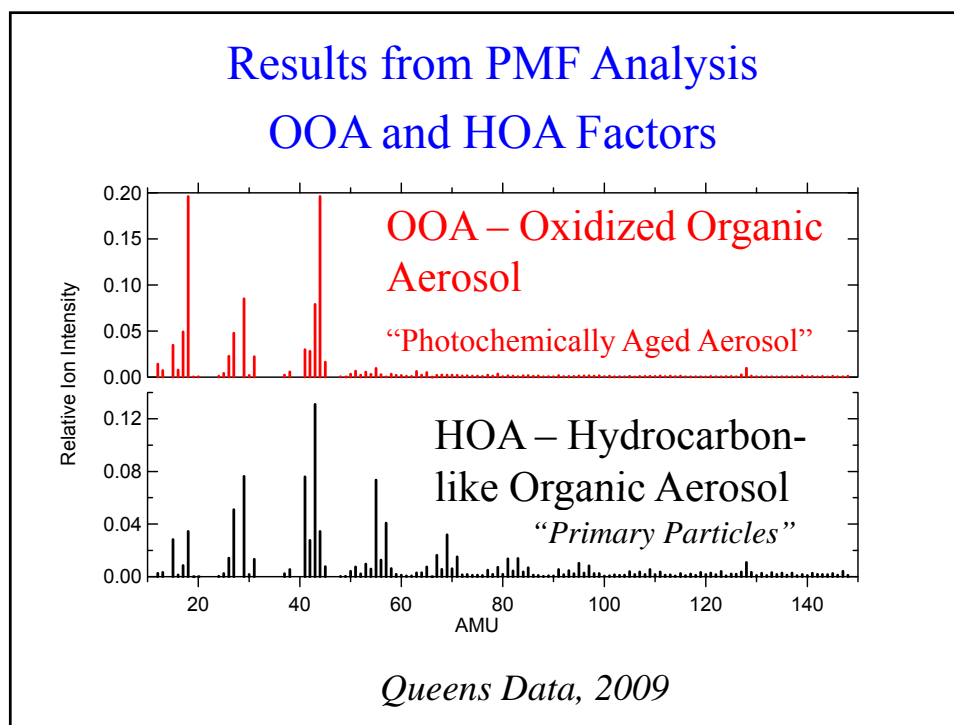
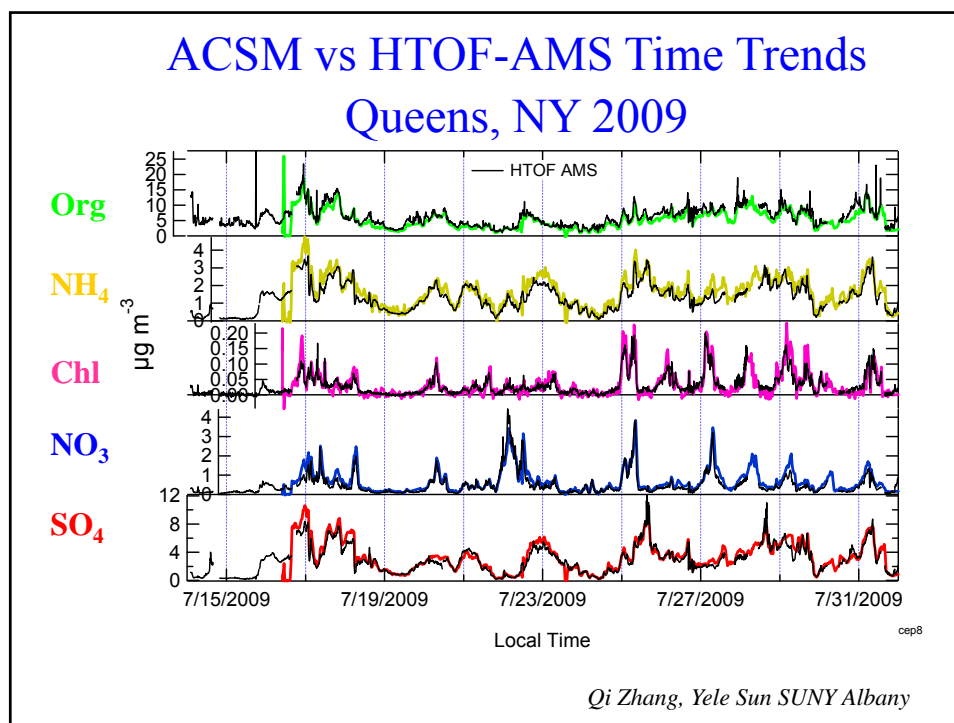


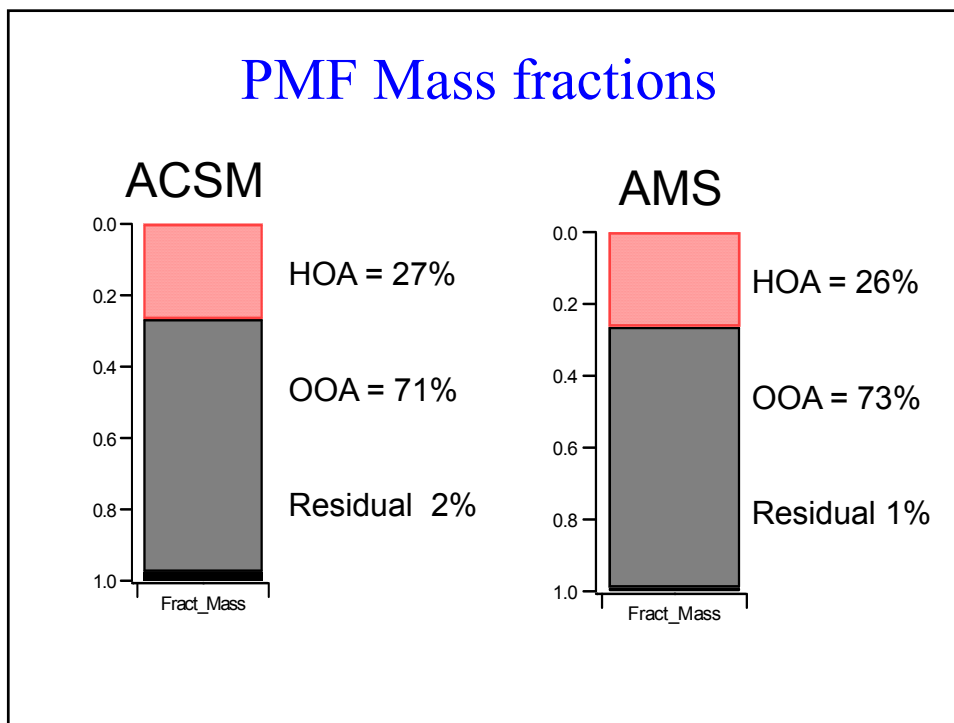
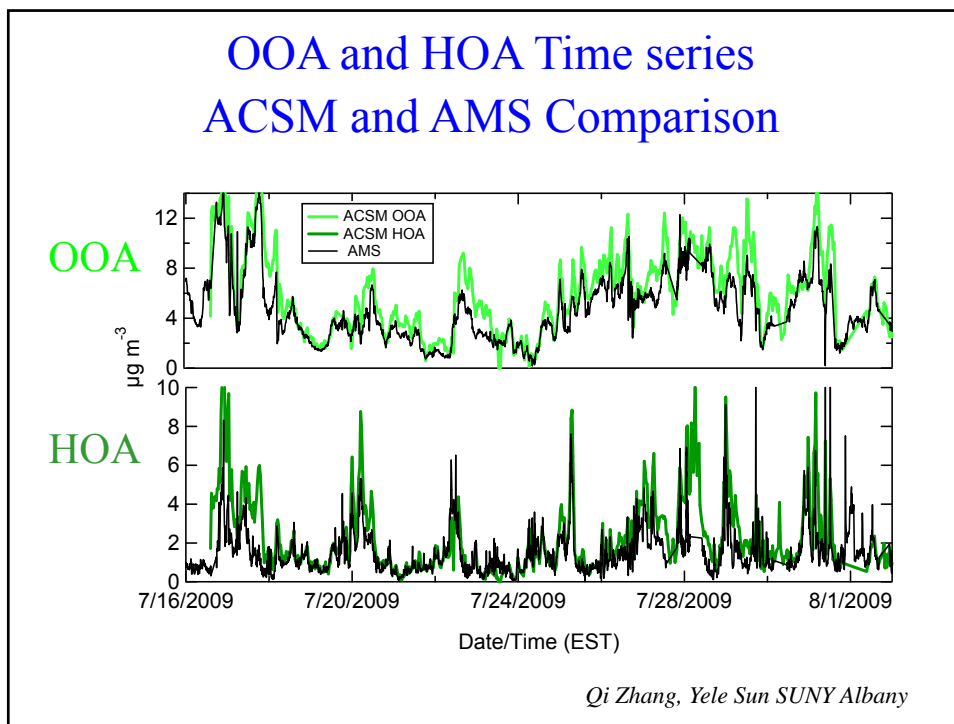
- 8 weeks unattended continuous measurements
- Data upload to a FTP site



15.9  $\mu\text{g m}^{-3}$   
average

cp5

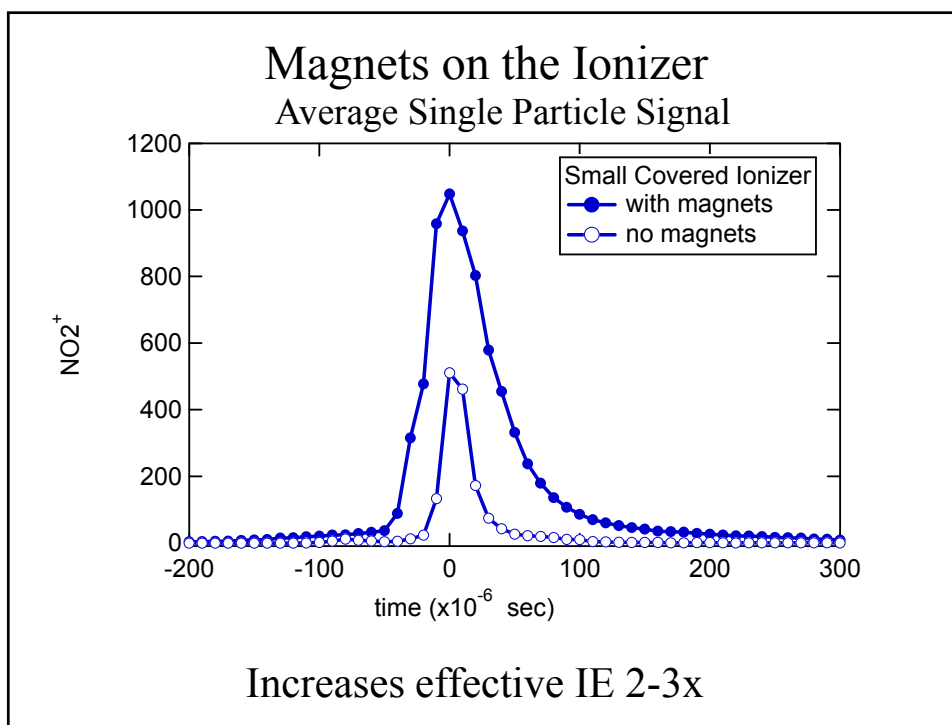


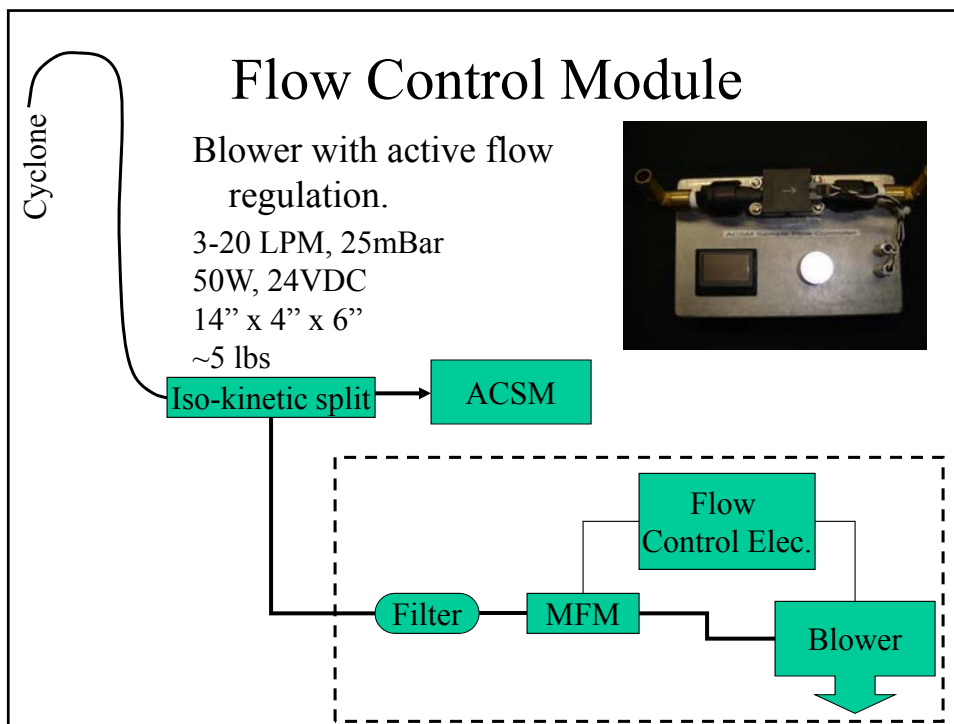




## Future Work for ACSM

- Vaporization cage to capture and sample “bounced” particles.
- PM2.5 lens.
- Particle sizing module.
- Integrated aerosol drier for RH treatment.
- Continued sw development.
- Continue field demonstrations.
- Magnets







## Portable Met Monitor

### *Portamon*

- RH 10-90%
- Temp
- Barometric Pressure, 30-100 kPa, resolution of 1.5Pa, ~12 cm air.
- Wind Speed, spinning cup ~0.2 m/s/pulse
- Wind Direction, 10 bit=360degree
- Solar
- RTC
- GPS
- Data logging to USB thumb drive or RS232
- Data rates: 1, 2, 5, 10, 15, 30, 60 secs

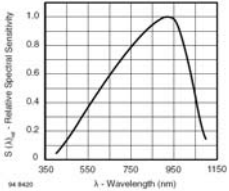


Fig. 7 - Relative Spectral Sensitivity vs. Wavelength

The graph shows the relative spectral sensitivity of the sensor across a range of wavelengths from 350 nm to 1150 nm. The sensitivity peaks at approximately 0.95 around 950 nm and drops to near zero at 350 nm and 1150 nm.