ACSM Update

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AMS Users Meeting 2012

Aerosol Chemical Speciation Monitor

Size: 19”D x 21”W x 32”H

Weight: 140 lbs

Power: 300W

universal AC power; 85-264 VAC, 47-63 Hz

ACSM-011 SN 140-109

Shown with Pfeiffer Pumps and Integrated Power Supply

Aerosol Chemical Speciation Monitor

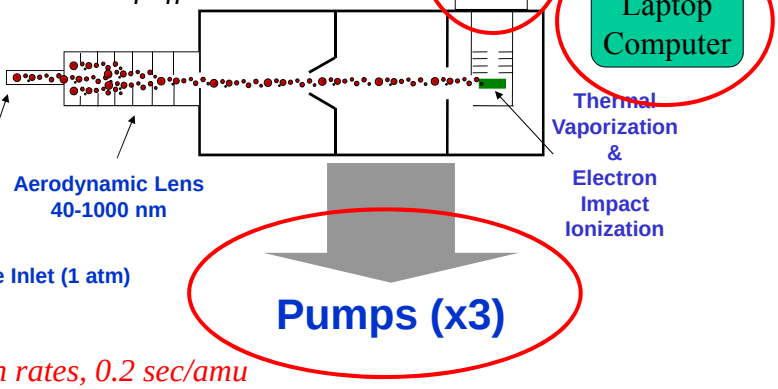
Particle Beam Generation

No Sizing

Particle Composition

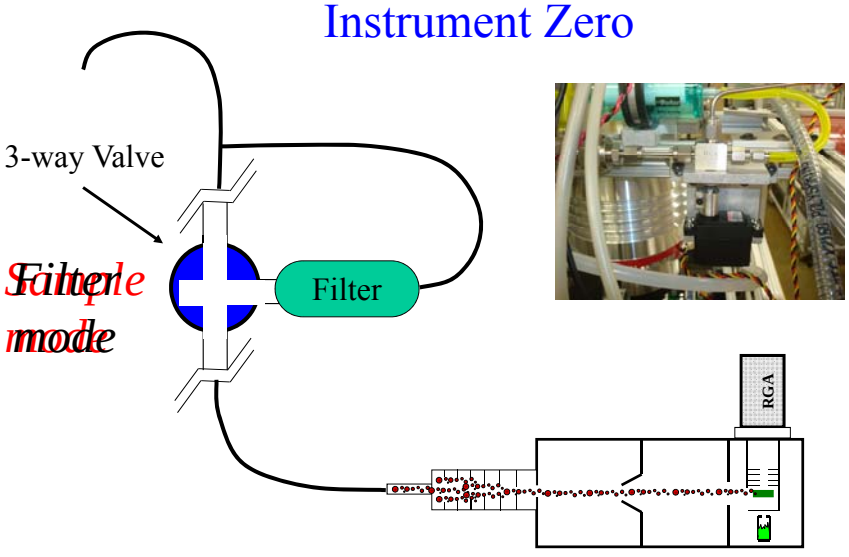
Commercial grade Mass Spectrometer

Pfeiffer Prisma



Slow scan rates, 0.2 sec/amu

Automated Valve System for Instrument Zero



Aerosol mass is determined from difference of 'Sample – Filter"

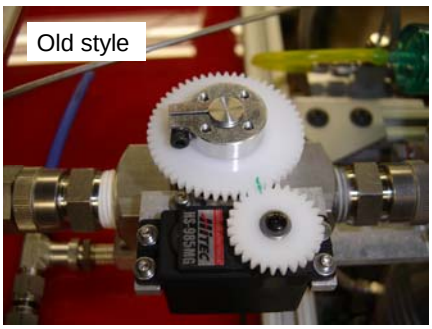
37 Delivered – 17 since last users meeting
ACSMs have been on 6/7 continents

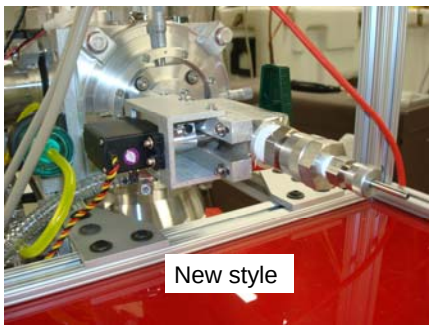
ACTRIS - Aerosols, Clouds, and Trace gases Research Infrastructure Network
15 ACSMs across Europe 1-year deployment started June 2012

Long term measurements

- UNC – at Jefferson St. in Atlanta
- PSI Zurich 1-year of data
- Outside Paris (Jean Sciare) – 1 year
- DoE – 3 instruments; SGP site > 2 years
- Environment Canada – Alert, Whistler > 2 years

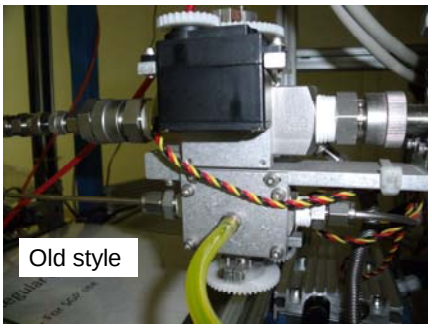
New Automated (Inlet) Valve

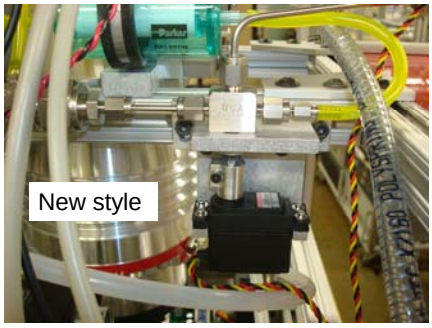




Changed from gear driven to direct drive.
Eliminates forces on plug valve and safer

New Automated Filter Switching Valve



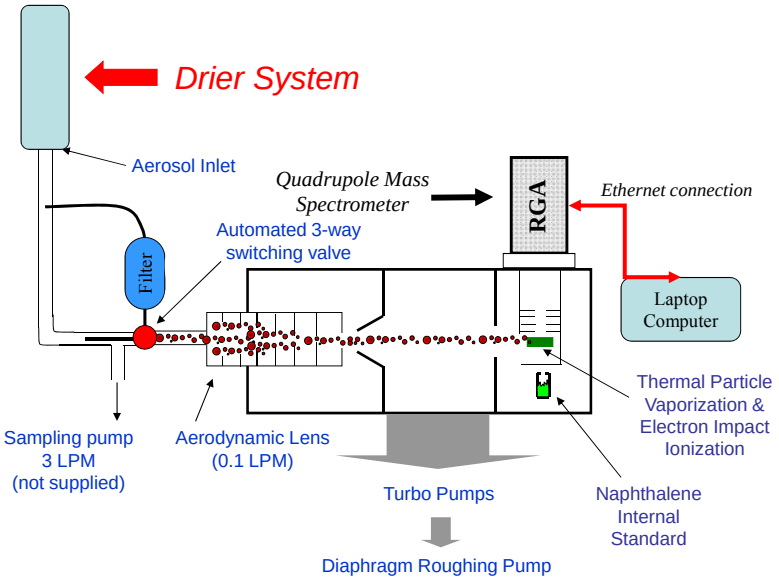


Changed from gear driven to direct drive.
Eliminates forces on plug valve and safer

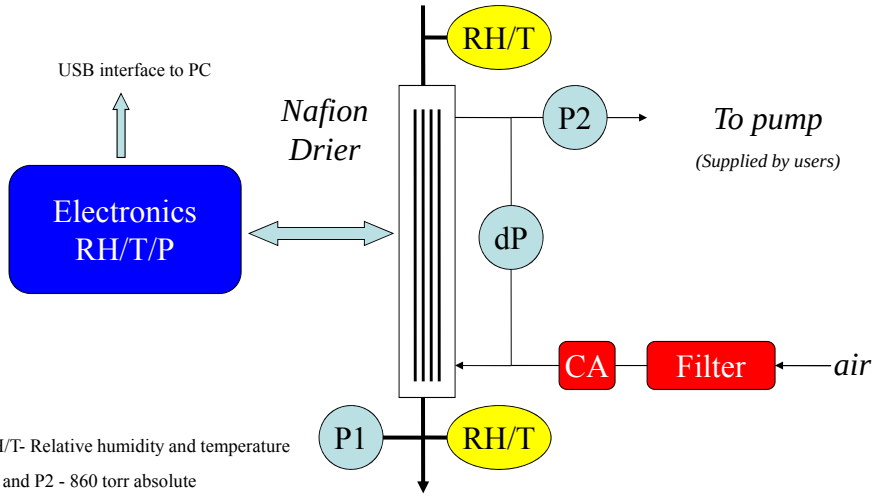
Sample Line Flow Controller

3-20 LPM, 25mBar
50W, 24VDC
14” x 4” x 6”
~2 lbs

Aerosol Drier System



Aerosol Drier System Schematic



RH/T- Relative humidity and temperature

P1 and P2 - 860 torr absolute

dP – 50 torr differential pressure

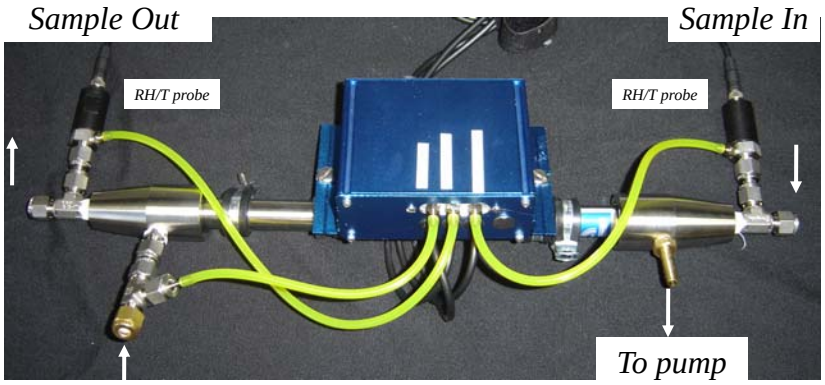
CA – critical aperture

April 2012

Aerodyne Research

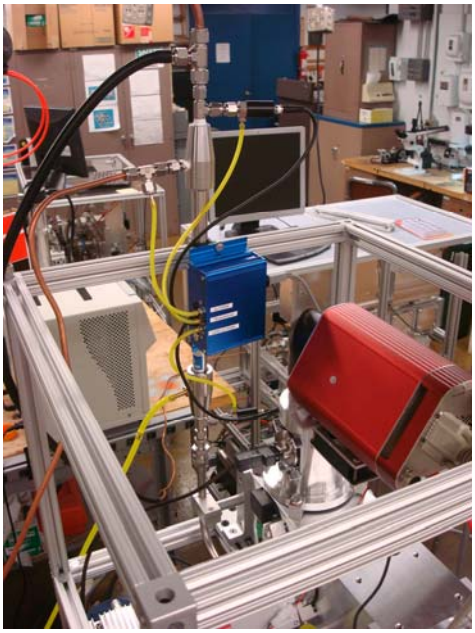
Aerosol Sample Line Drier System

(*50 tube Permapure shown*)



April 2012

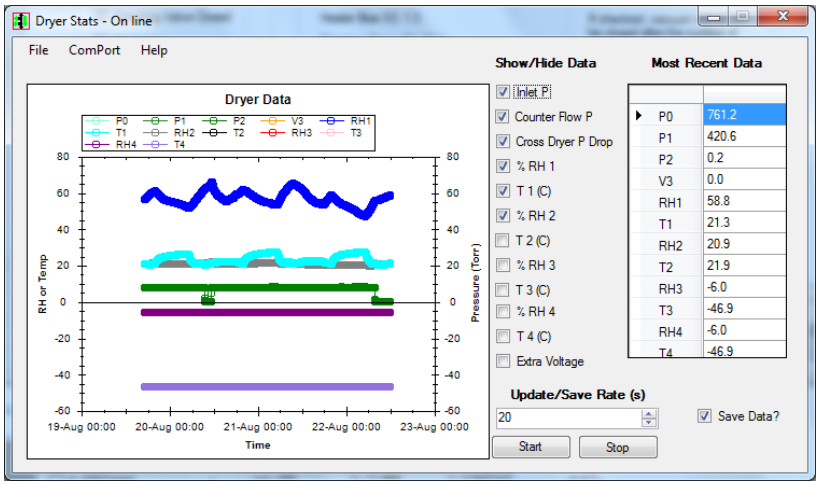
Aerodyne Research



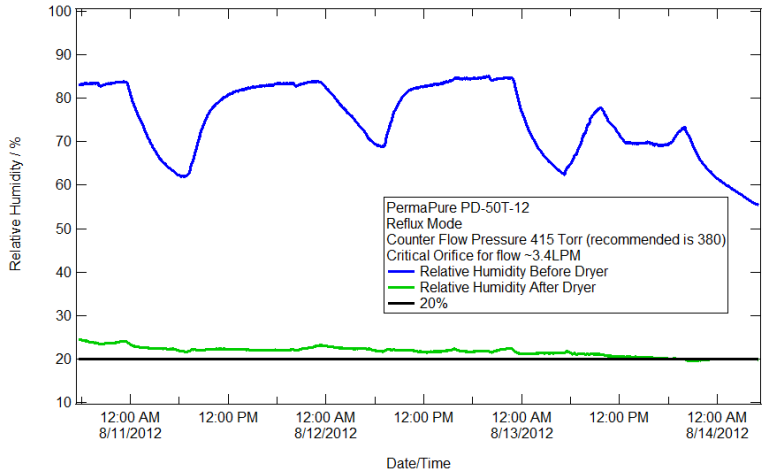
Aerosol drier adapted to ACSM sampling manifold

Evaluating 50 and 200 tube systems for aerosol loss and drier performance

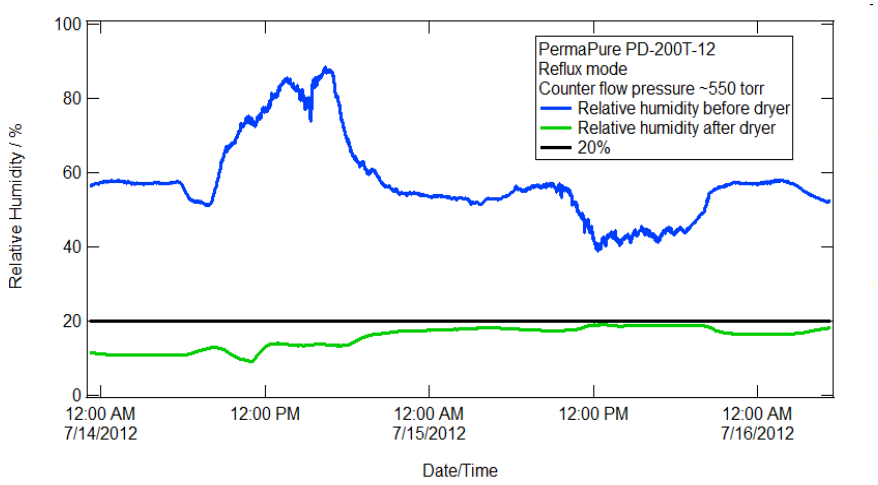
Dryer data logging software – plots and saves all of the RH/T/P data



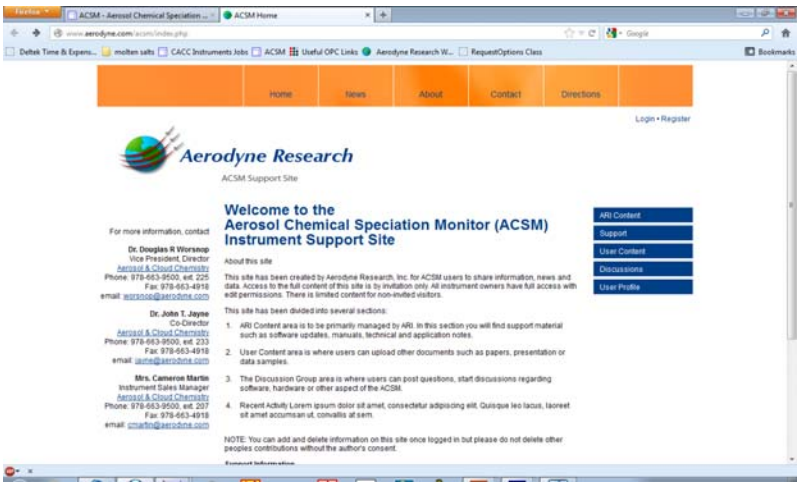
PD-50T-12 Performance



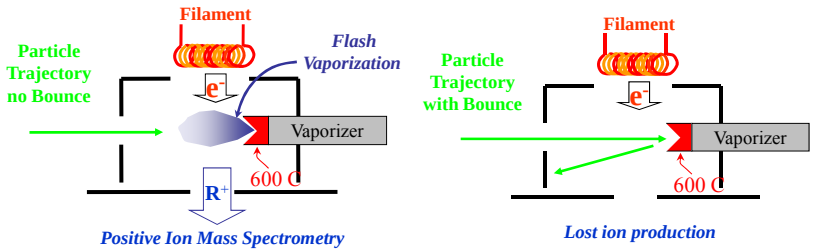
PD-200T-12 Performance



ACSM Users Site is migrating from google to Aerodyne – stay tuned



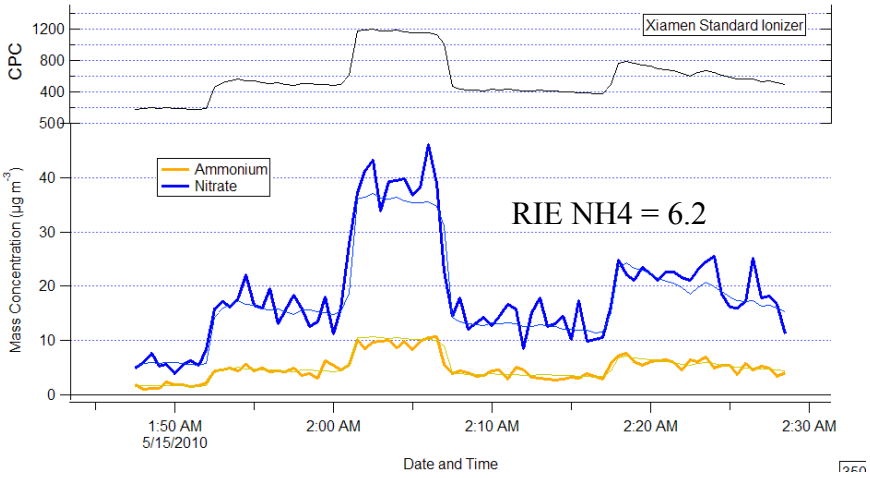
Particle Bounce Illustration.



Schematic representation of the bounce phenomena that is observed with the research grade AMS. The figure on the left illustrates efficient vaporization and ion production and on the right, the case of a particle trajectory with bounce which does not result in ion production.

CE Determination Method

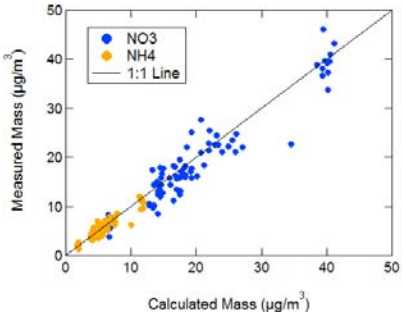
Standard Vaporizer, 590 C Ammonium Nitrate



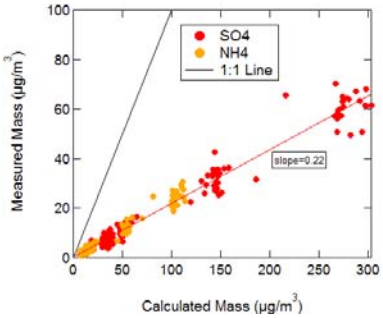
Sample DMA output aerosol and record CPC. Vary number concentration using an aerosol diluter. Compare measured and calculated mass loadings

Collection Efficiency Results

Standard Vaporizer Xiamen City QAMS 600C

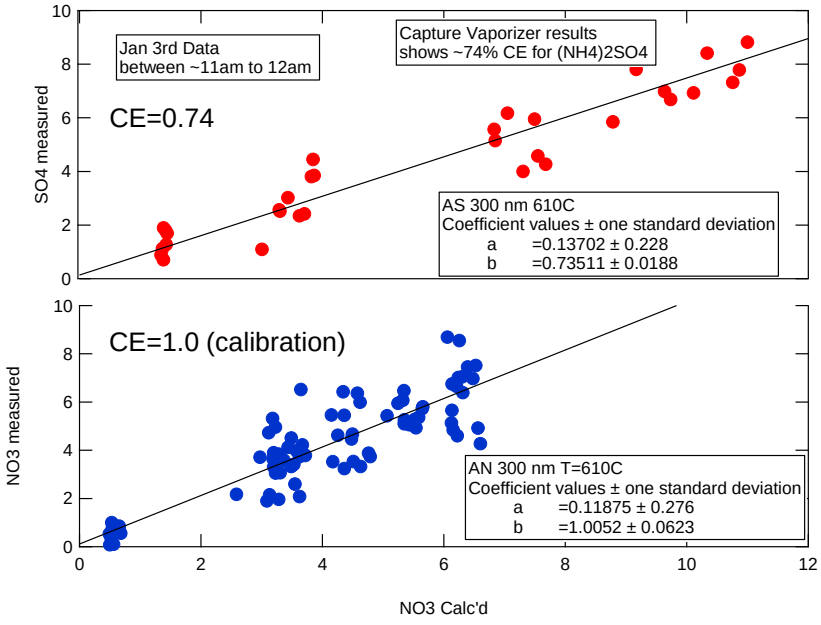


"calibration"



CE = 22%

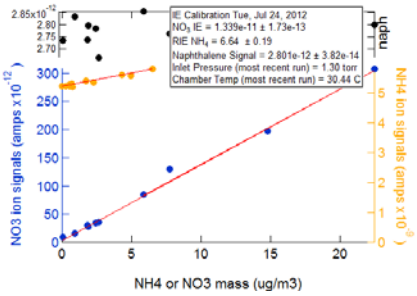
Improved CE of AS with new capture vaporizer

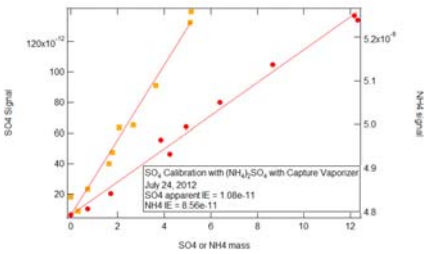


NH4NO3 and (NH4)2SO4 IE calibration with capture vaporizer on ACSM (mass based IE → sum of ions vs CPC calculated mass)

NO3 IE = 1.3×10^{-11}
NH4 IE = 8.9×10^{-11}

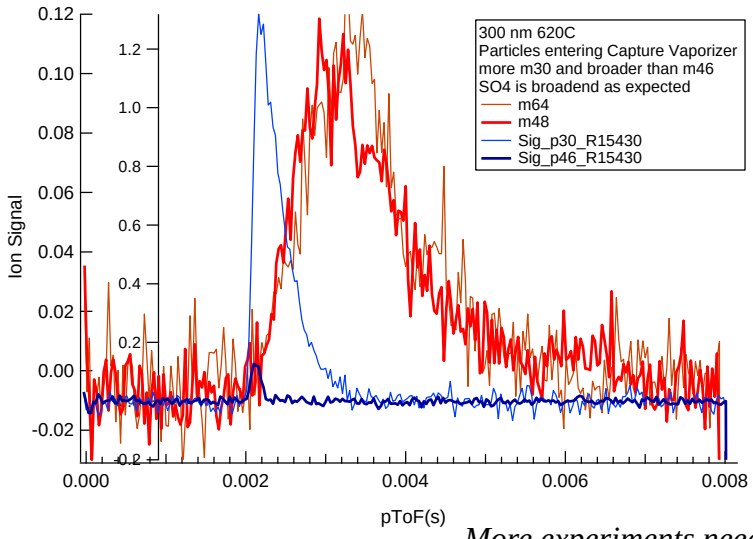
SO4 IE = 1.3×10^{-11}
NH4 IE = 8.6×10^{-11}





Suggests CE with $(NH_4)_2SO_4$ is approaching 100% - typically ~20% with dry laboratory generated particles

Capture Vaporizer pTOF Traces SO4 and NO3
Sulfate is broadened as expected

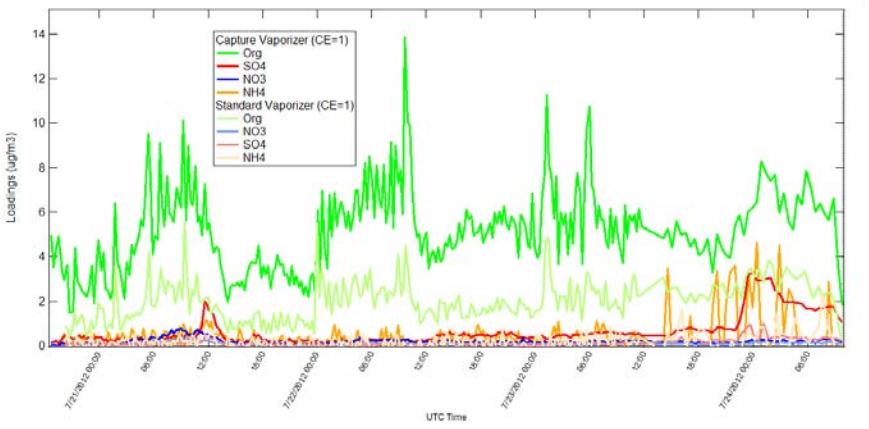


More experiments needed…

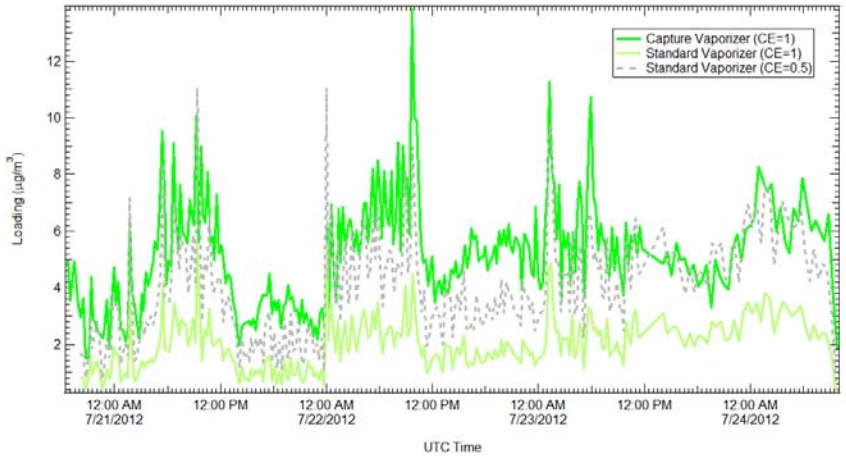
ACSM/ACSM Comparison

- ACSMs 140-149 with standard vaporizer and 140-150 with capture vaporizer were calibrated and run side-by-side sampling roof air at ARI 7/20-7/24.
- An airbeam correction was applied to each dataset relative to the conditions at the time of calibration.

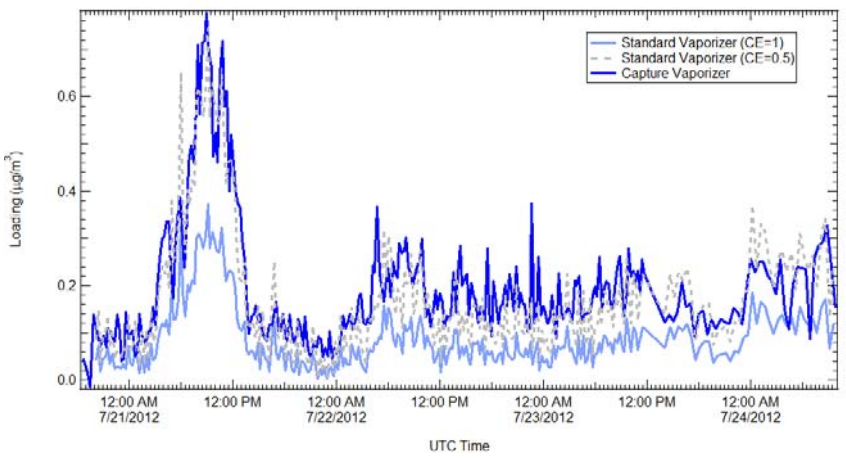
All Species



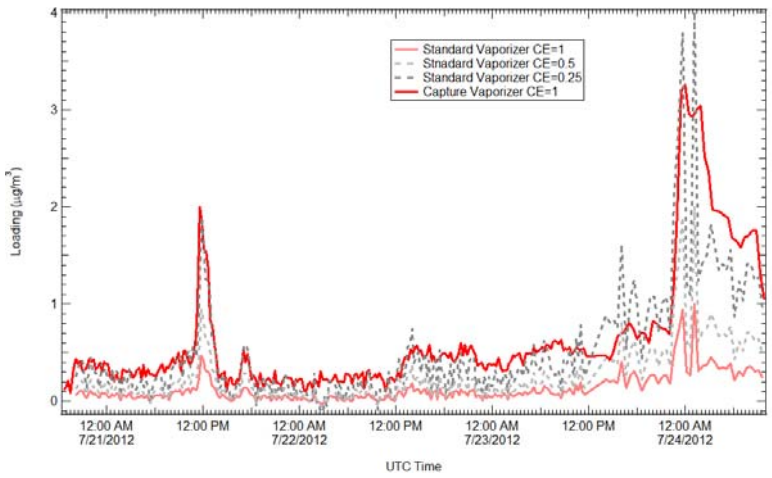
Org


Capture Vaporizer (CE=1)
Standard Vaporizer (CE=1)
Standard Vaporizer (CE=0.5)
Loading (µg/m³)
12
10
8
6
4
2
12:00 AM 7/21/2012
12:00 PM
12:00 AM 7/22/2012
12:00 PM
12:00 AM 7/23/2012
12:00 PM
12:00 AM 7/24/2012
UTC Time

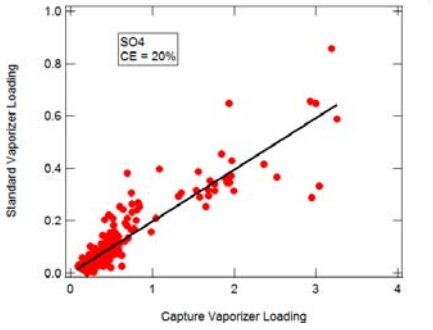
NO3

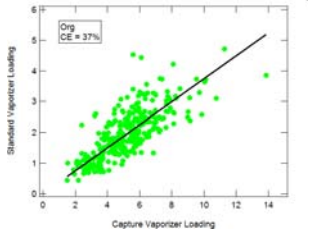

Standard Vaporizer (CE=1)
Standard Vaporizer (CE=0.5)
Capture Vaporizer
Loading (µg/m³)
0.6
0.4
0.2
0.0
12:00 AM 7/21/2012
12:00 PM
12:00 AM 7/22/2012
12:00 PM
12:00 AM 7/23/2012
12:00 PM
12:00 AM 7/24/2012
UTC Time

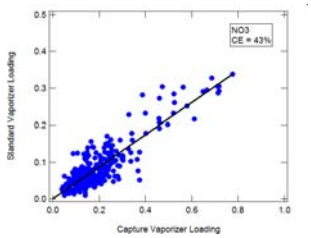
SO4



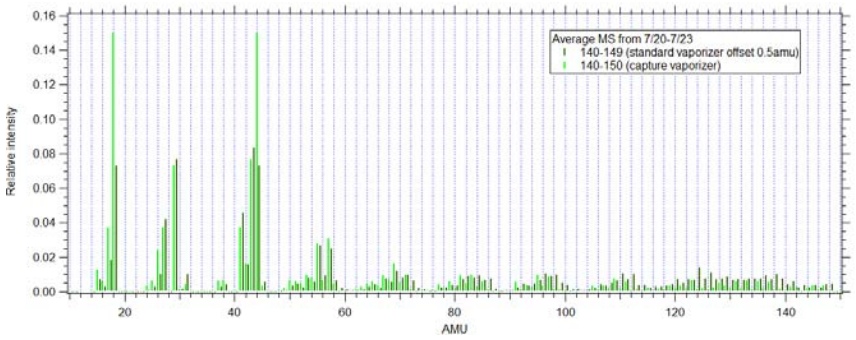
Org and NO3 are more or less as expected. SO4 is different



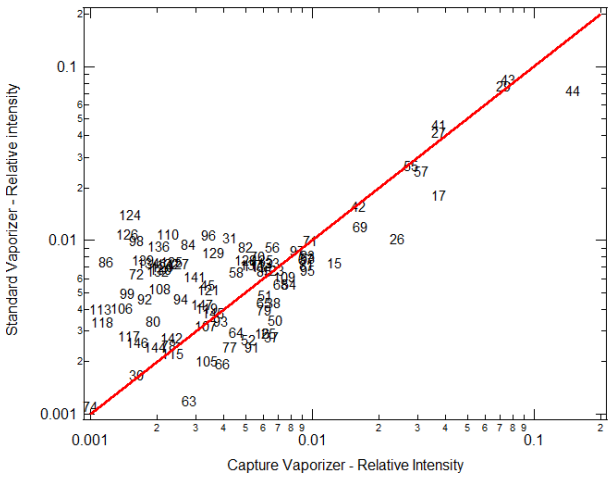




Increased decomposition with capture vaporizer



Another view of the fragmentation difference



Results are very encouraging but there's much still to figure out

- Things to figure out:
  - Why 4-5x SO4 in ACSM/ACSM comparison?
  - How much control do we have over fragmentation with temperature?
  - If we can do that do other species (i.e. SO4) still vaporize?
  - Put one in an HToF system - more to learn from pToF and high res. MS