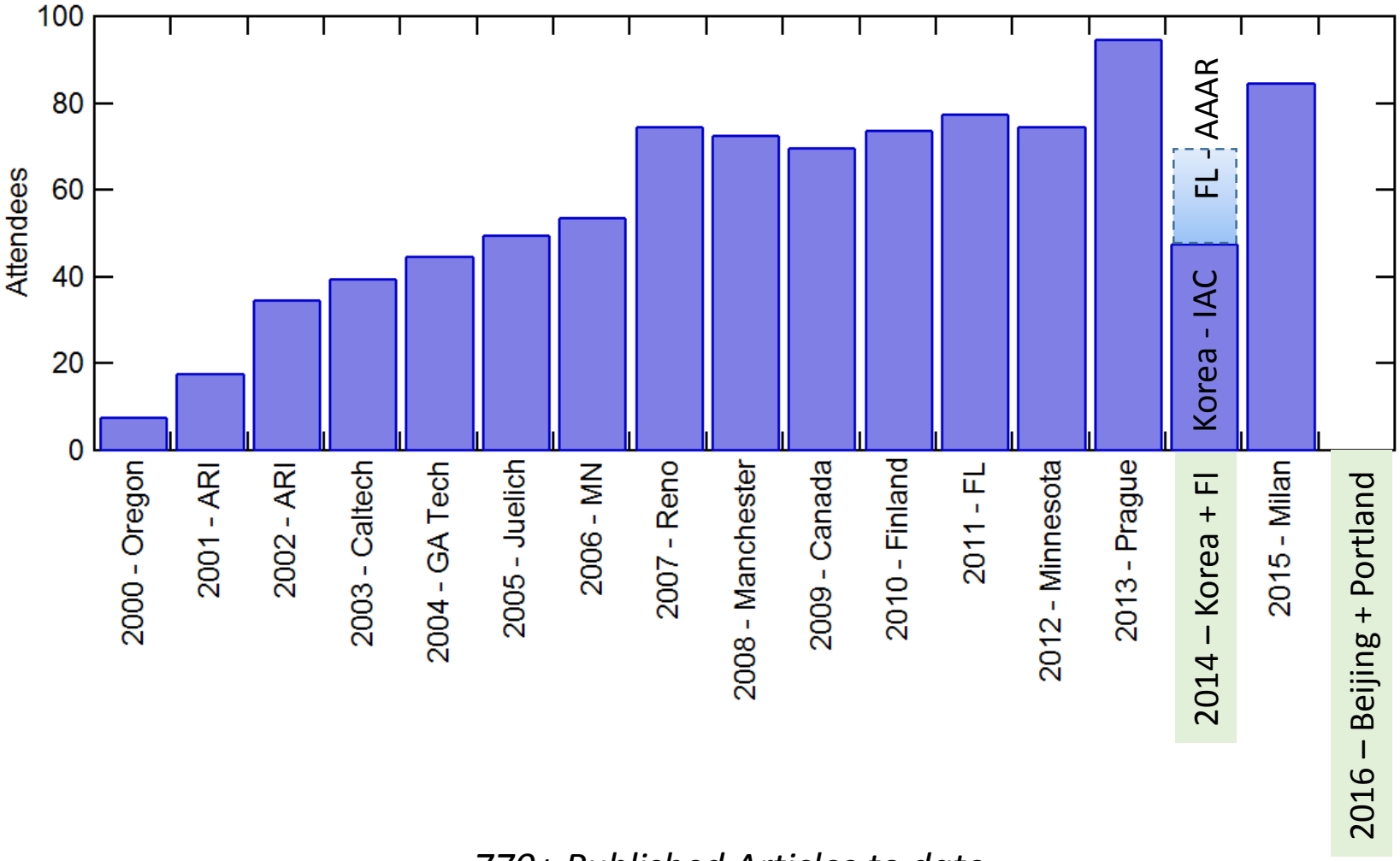
Friday 15:40
Instruments Overview

16th Users Meeting
Milan Sept 11, 2016

AMS Users Community
Annual Meeting Attendance



770+ Published Articles to date

Instruments and Developments

AMS, SP AMS, mini AMS
QACSM, ToF ACSM
CIMS and FIGAERO CIMS
TAG AMS, TAG CIMS
IMS TOF

Capture Vaporizer
ePTOF Multiplex chopper, PM2.5 lens
Data Acquisition

Thermal Denuder, PAM Reactor, Aerosol Dryer and Sampling System

Chronology of AMS systems

~~QAMS~~	~~1995 – 2000+~~
CTOF AMS	2001
HTOF AMS	2002
QACSM	2004 – 2009+
SP HTOF AMS	2007
eTOF ACSM	2010
CTOF mAMS	2011
HTOF mAMS	*TBD*
HTOF ACSM	*TBD*
LTOF AMS	***2015***

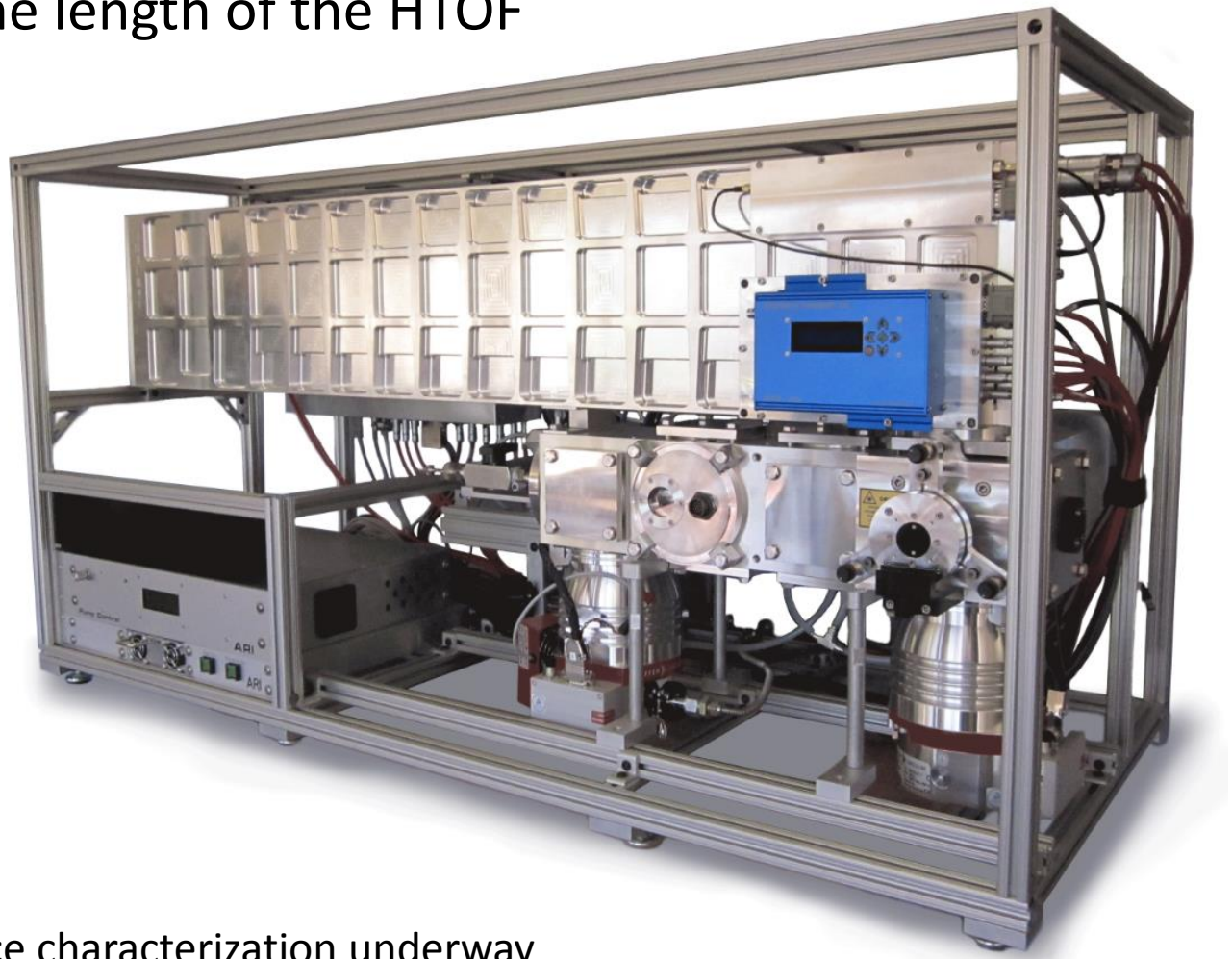
1st Api TOF

Different colors are different vacuum systems

Long (L) TOF AMS

2x the resolution of HTOF (Vmode) with the same sensitivity.

2x the length of the HTOF

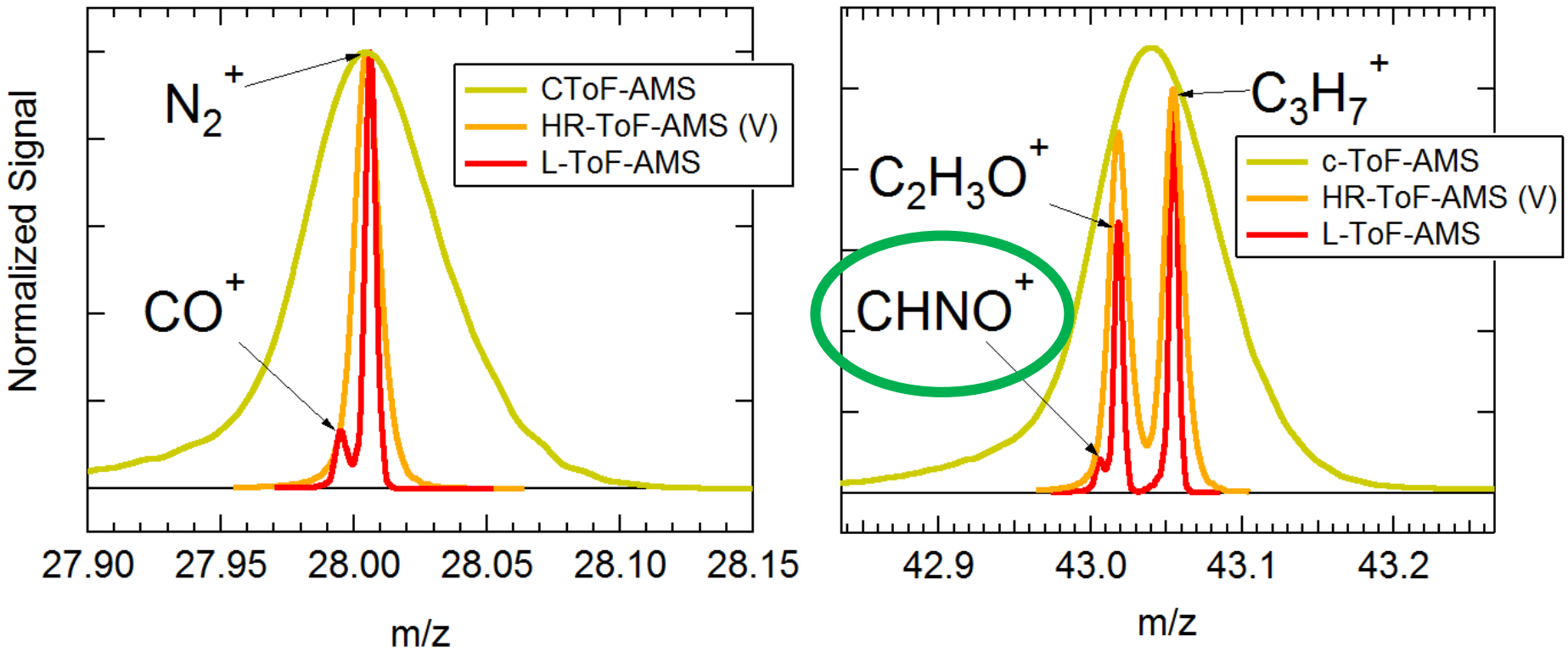


Performance characterization underway

Note use of Pfeiffer turbo pumps

55” L x 24” D x 27” H, 275 lbs.
[139.7 cm x 60.9 cm x 68.6 cm, 124.7 kg]

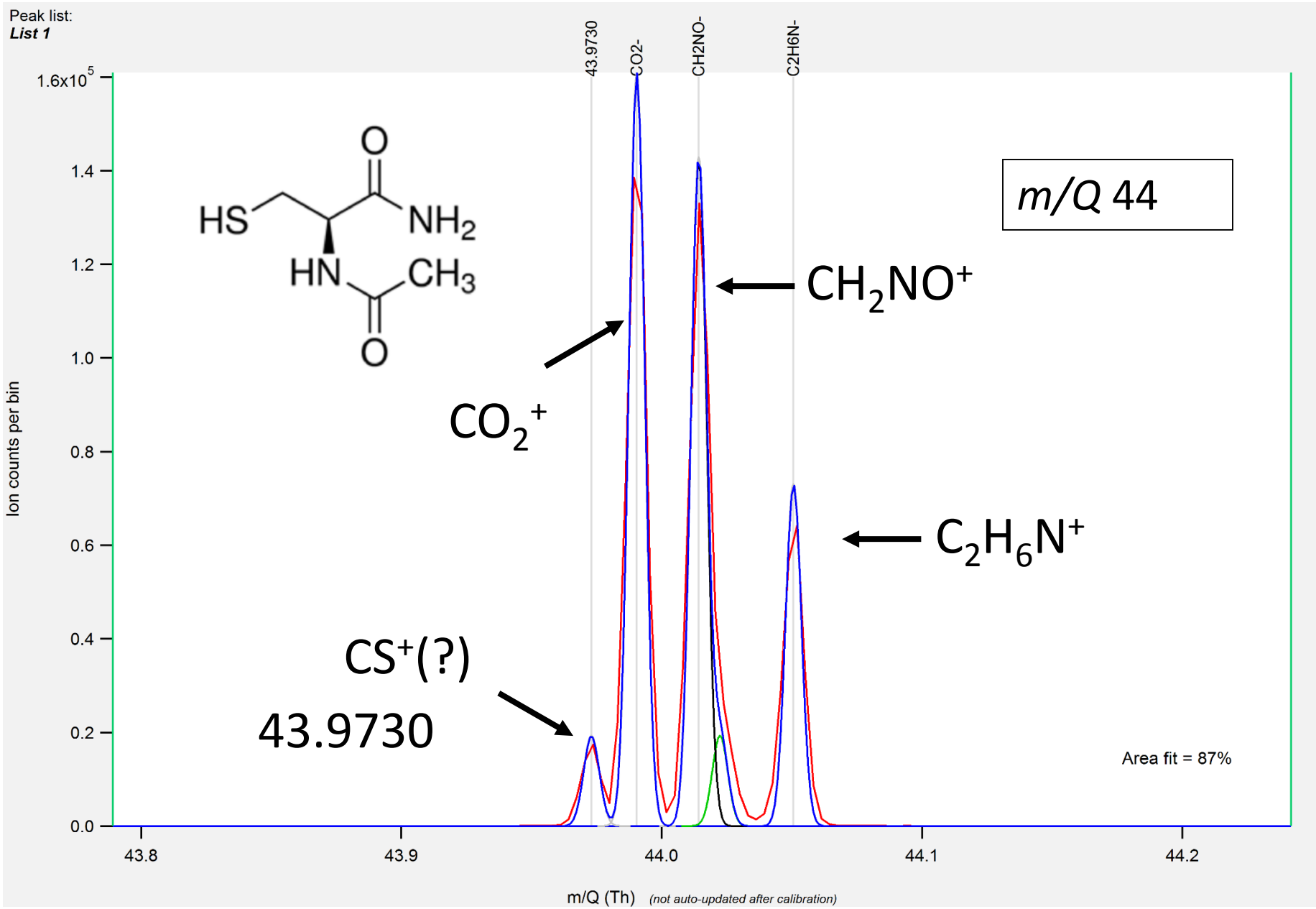
LTOF Qualitative Comparison to C- and HTOF



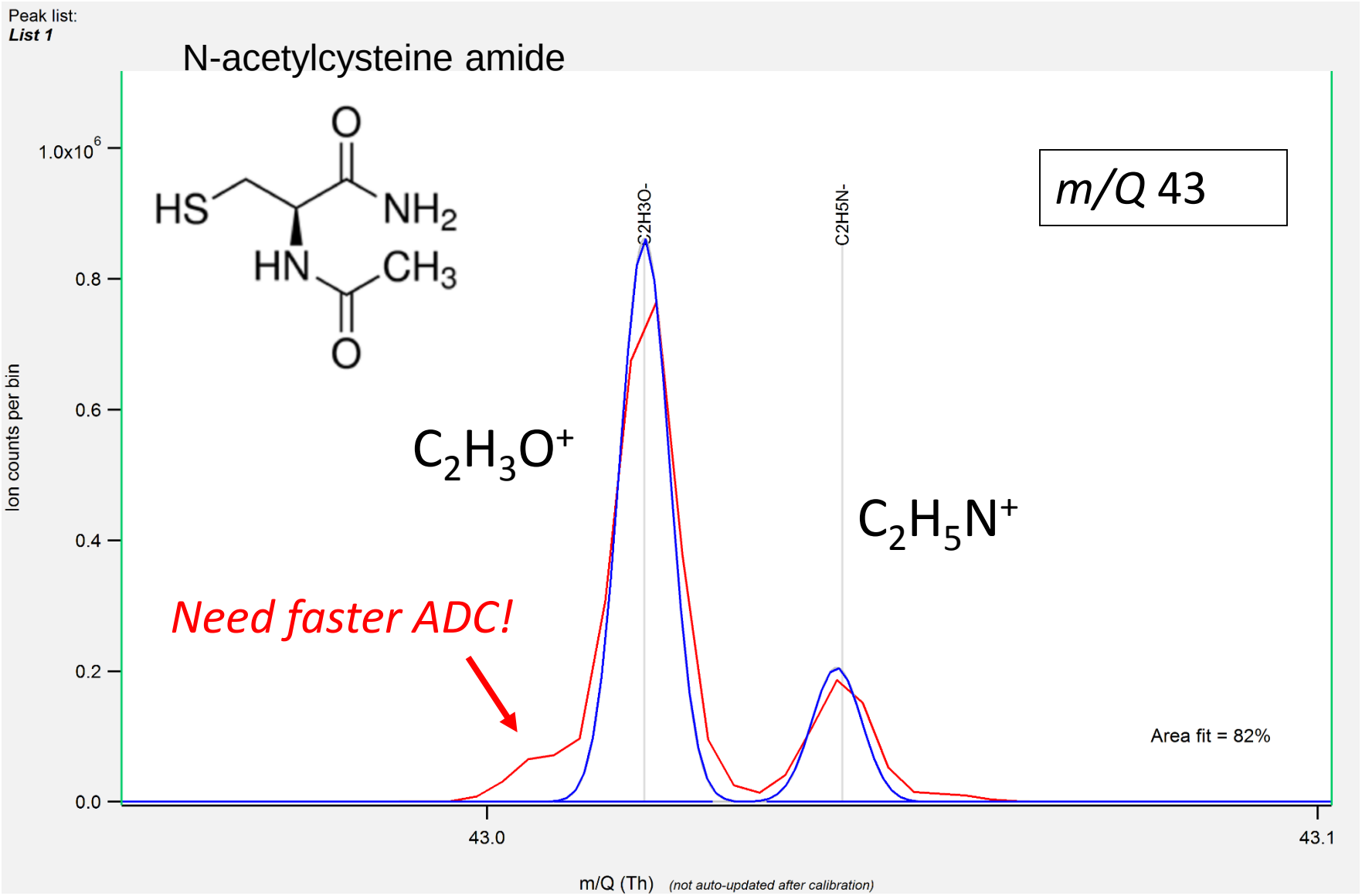
Improved ability to report on elemental Nitrogen.

Andy Lambe

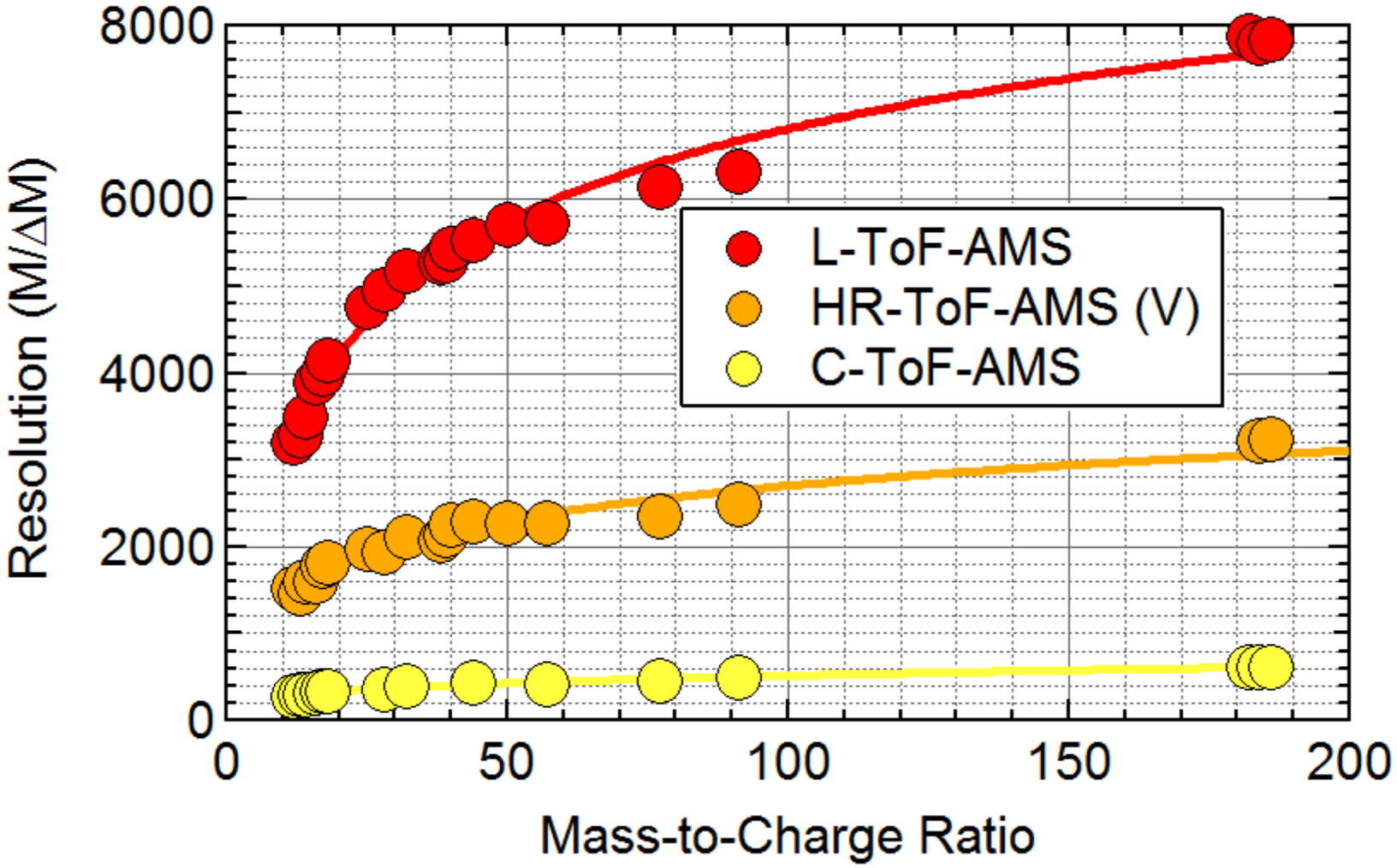
L-TOF: High Resolution separation of N containing ions



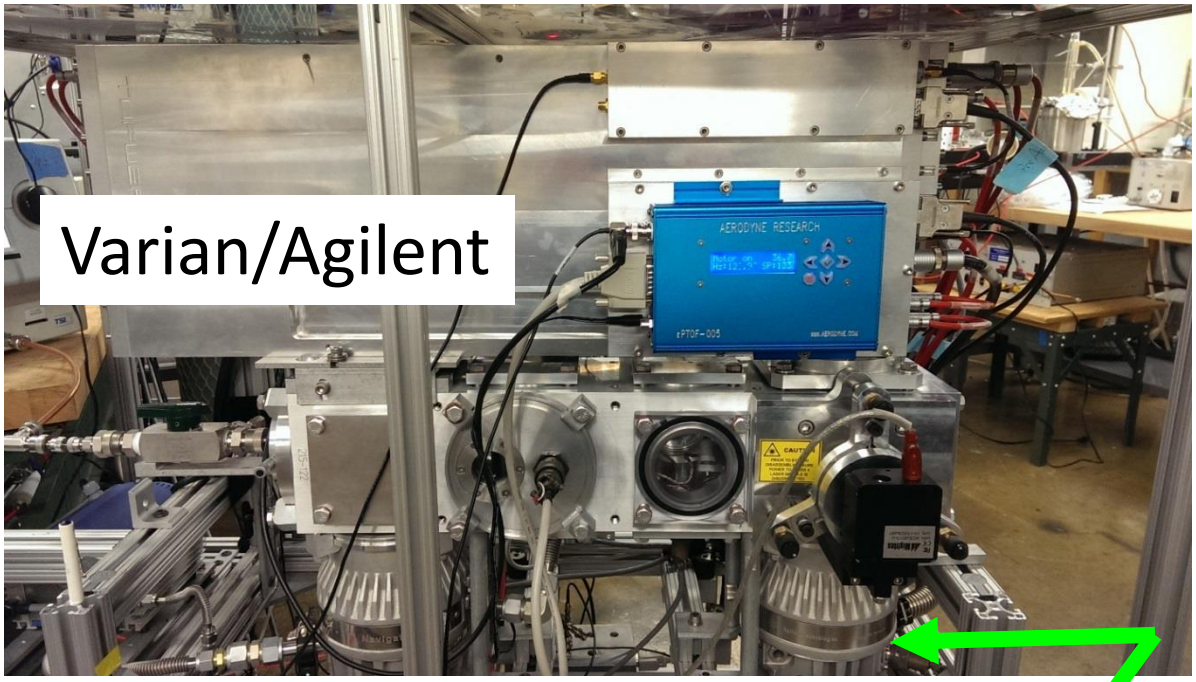
L-TOF: High Resolution separation of N containing ions

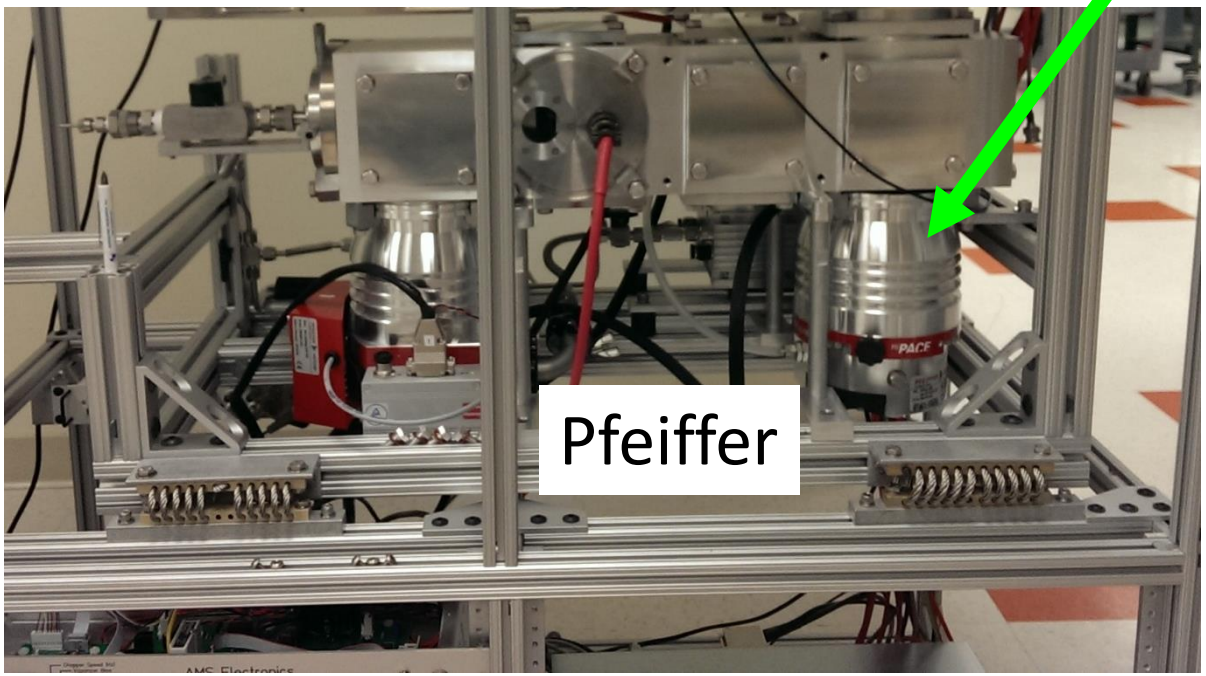


LTOF Resolution Compared to C- and HTOF



Andy Lambe





New systems are being built with Pfeiffer turbo pumps

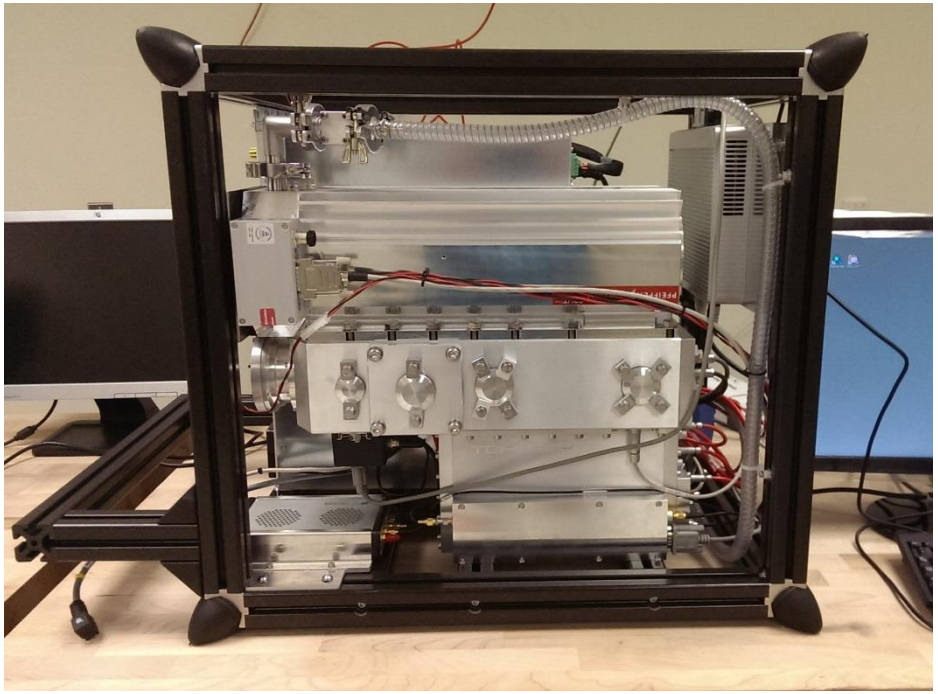
Will soon be evaluating HP300E high throughput pump at first stage.

Discussion and evaluation of new Agilent pumps presented during Hardware Session.

QACSM and ToF ACSM Systems

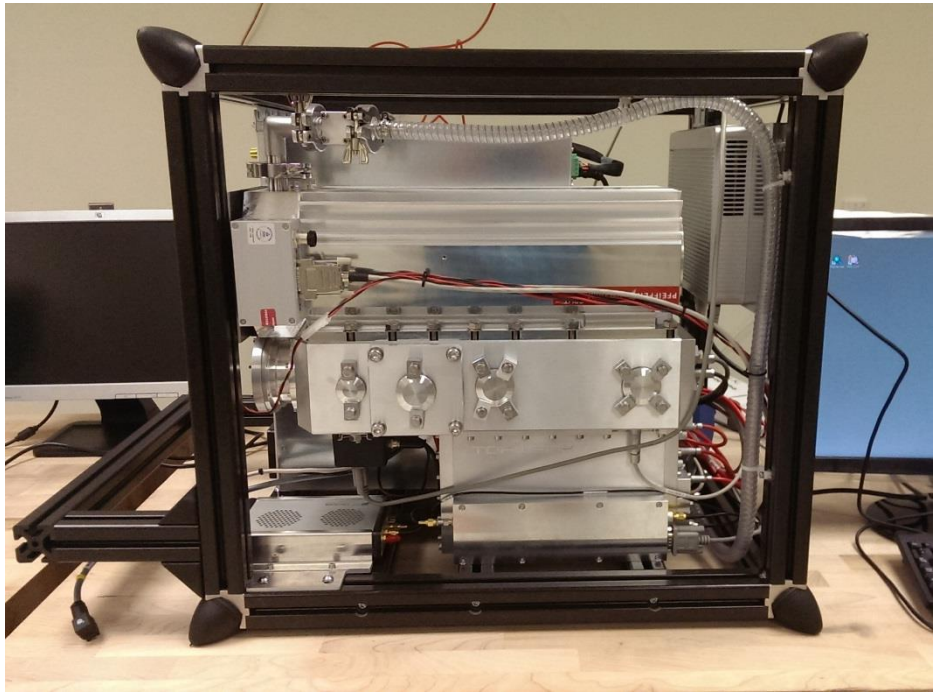
QACSM

TOF ACSM

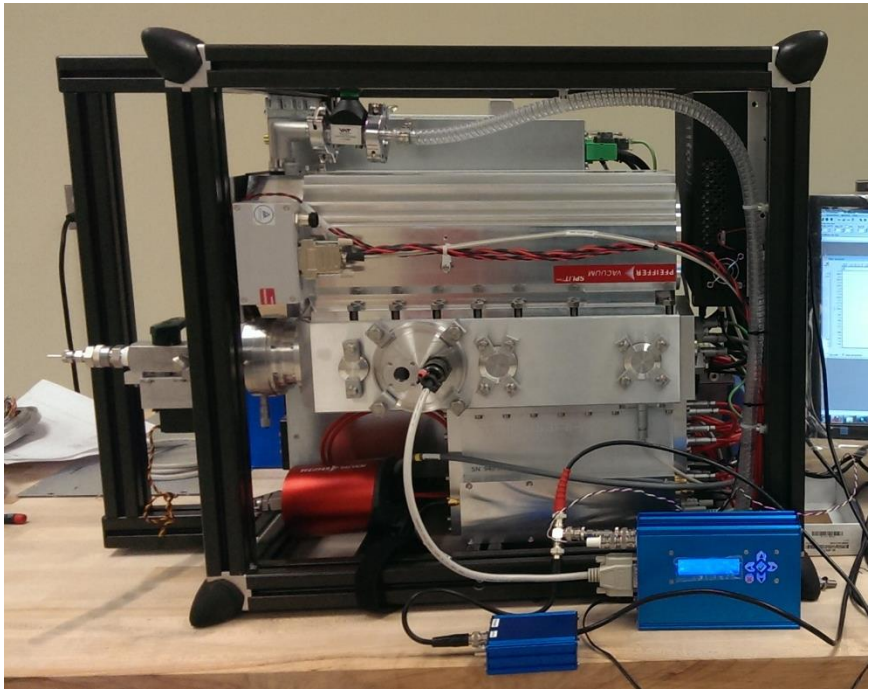


mini-AMS and ToF ACSM Systems

eTOF ACSM

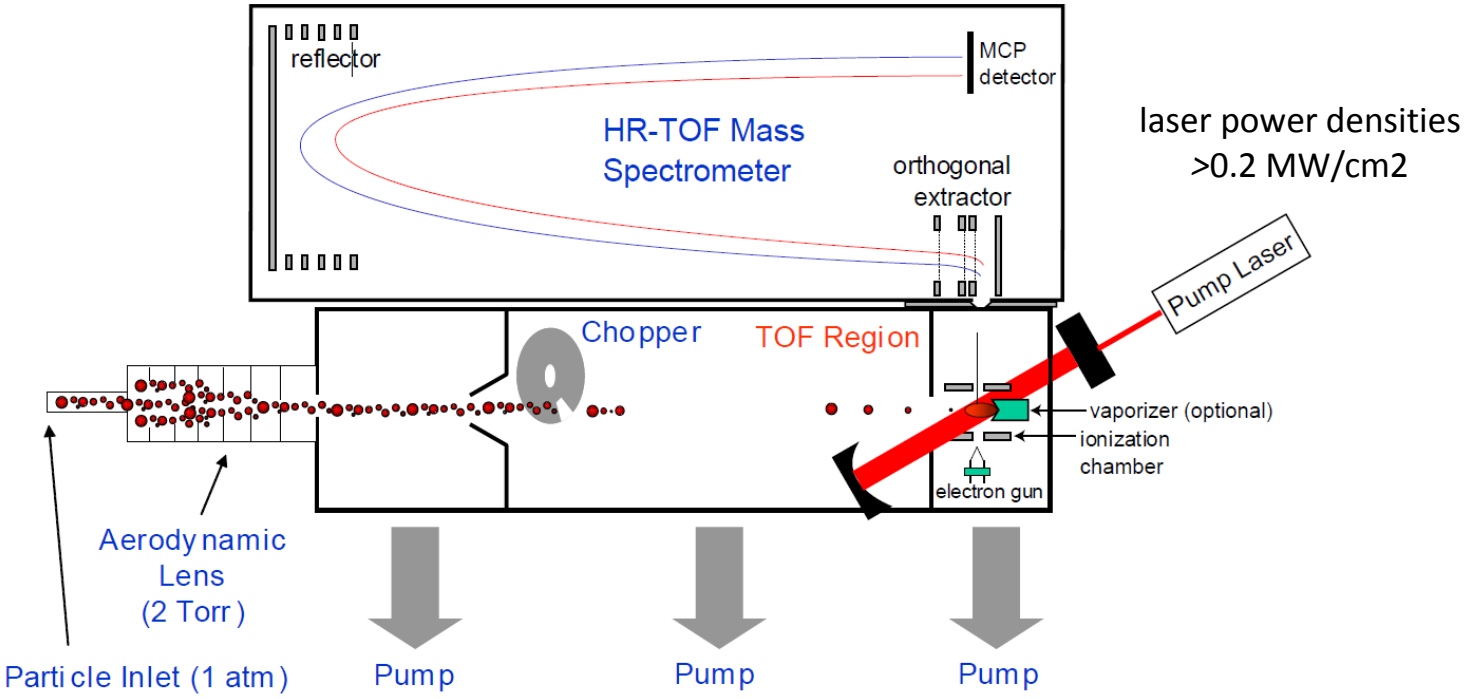


cTOF mAMS



Differences between ACSM and mAMS are the chopper and the DAQ system

Soot Particle (SP) AMS

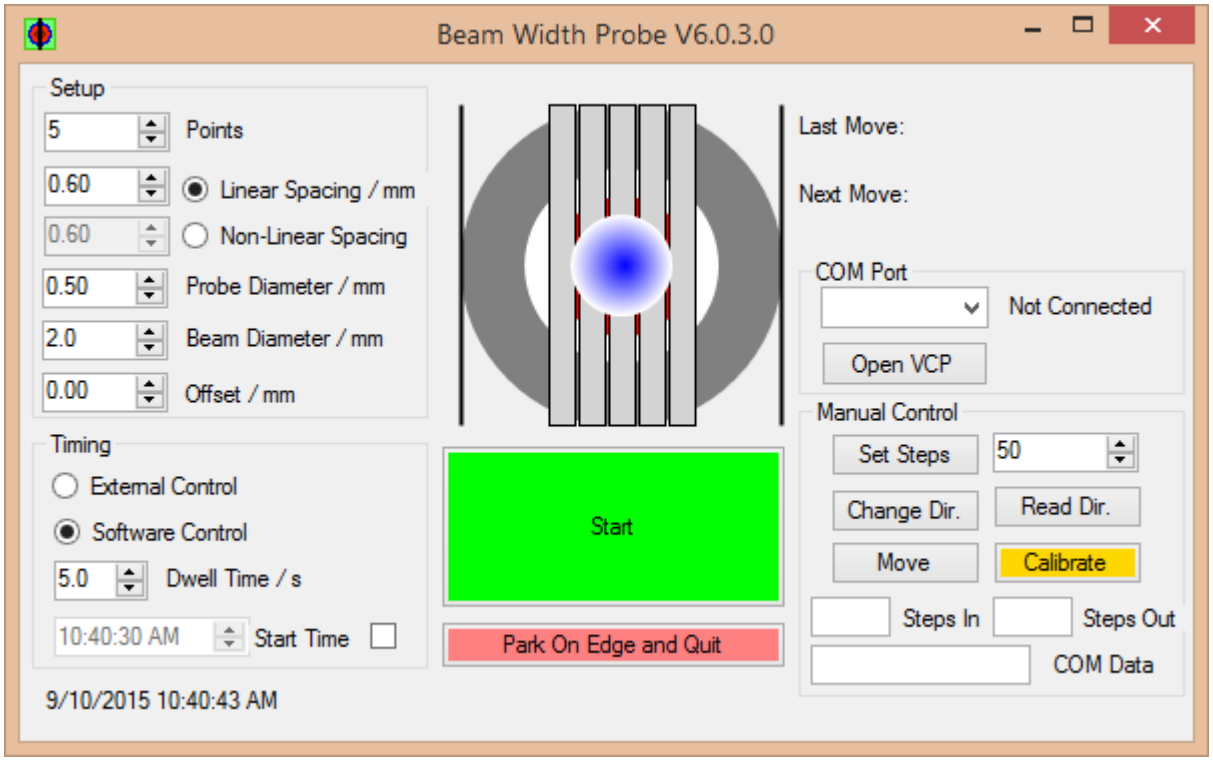


Addition of intra-cavity laser (1064 nm) to the AMS allows vaporization and detection of **black carbon** containing particles.

Work is focused on ability to quantify BC signals.

Onasch et al. AS&T 2012

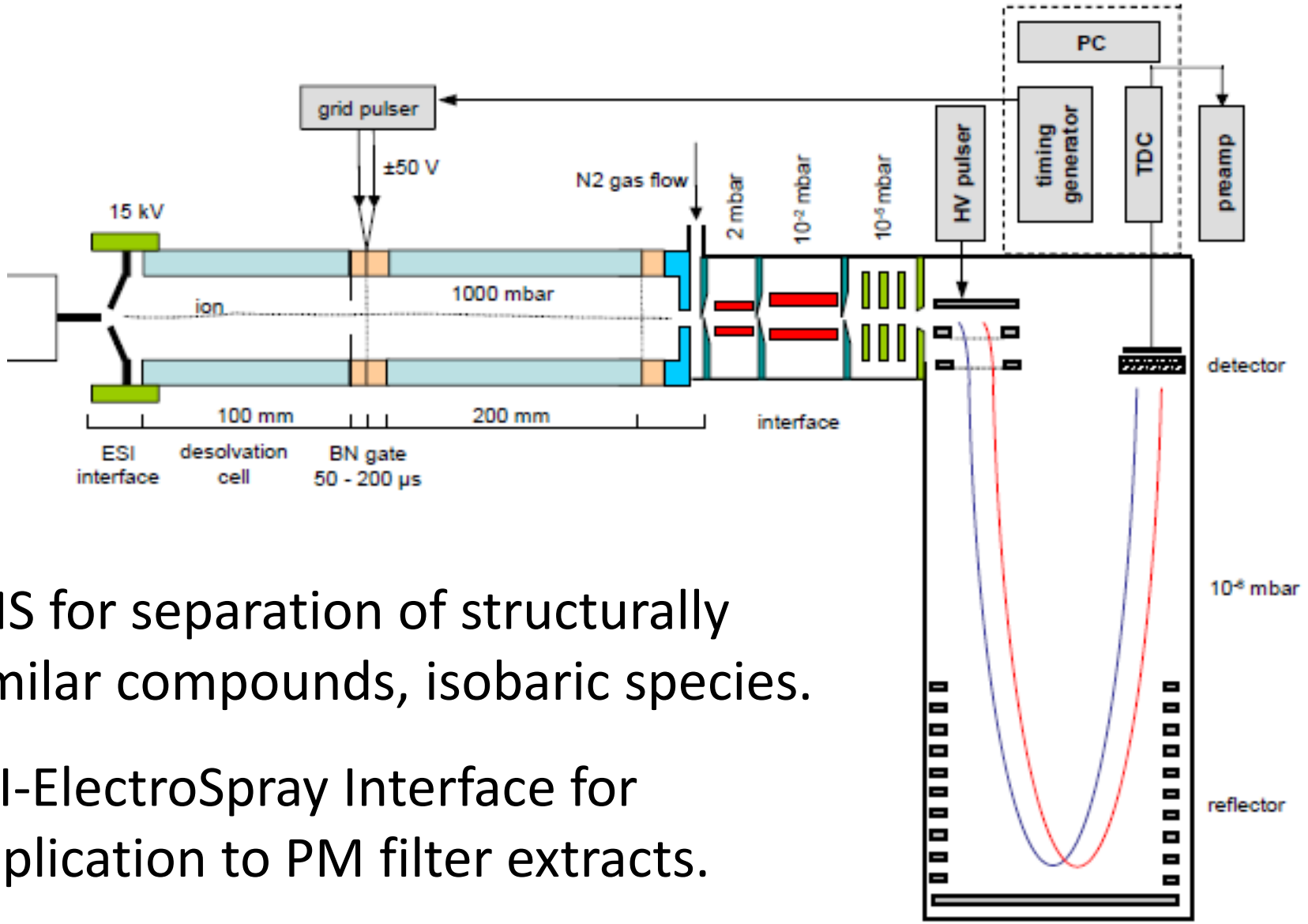
Beam Width Probe Revived



- Updated electronics to USB virtual COM Port connectivity
- Software rewritten for new hardware
- Hardware and software testing in process

Phil Croteau, Bill Brooks, Tim Onasch

Ion Mobilty Spectrometer TOF MS

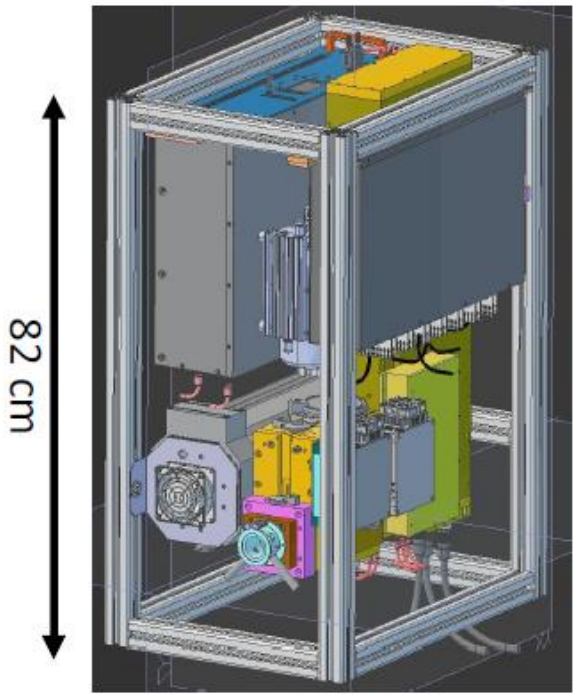


IMS for separation of structurally similar compounds, isobaric species.

ESI-ElectroSpray Interface for application to PM filter extracts.

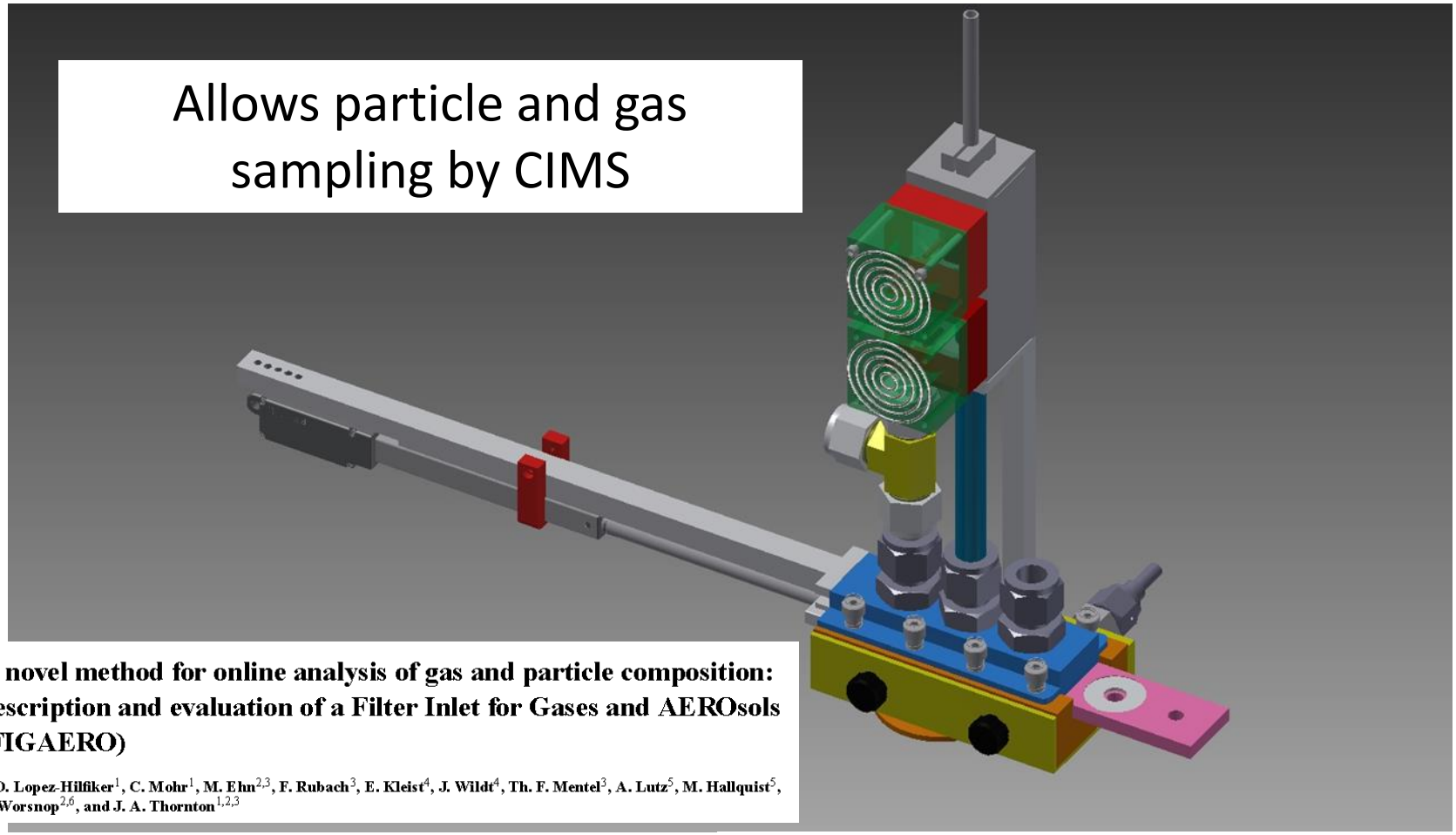
Manjula, Joel

Aerodyne ToF-CIMS



- Field-portable system (59x42x82 cm, 85 kg, 1.5 kW)
  - "Drop in" shipping container
- pptv sensitivity for individual gas-phase ions (eg Formic Acid)
- Adaptable for multiple ion sources and reagent ion chemistries
  - Reagent ions are selective, choice depends on analytes of interest (Harald's talk)

FIGAERO
Jointly developed with Thornton Group UW
Modelled after Lopez-Hilfiger et al, 2014



A novel method for online analysis of gas and particle composition: description and evaluation of a Filter Inlet for Gases and AEROsols (FIGAERO)

F. D. Lopez-Hilfiker[1], C. Mohr[1], M. Ehn[2,3], F. Rubach[3], E. Kleist[4], J. Wildt[4], Th. F. Mentel[3], A. Lutz[5], M. Hallquist[5], D. Worsnop[2,6], and J. A. Thornton[1,2,3]

Atmos. Meas. Tech., 7, 983–1001, 2014
www.atmos-meas-tech.net/7/983/2014/
doi:10.5194/amt-7-983-2014

Atmospheric Measurement Techniques
Open Access

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Atmospheric Measurement Techniques Open Access

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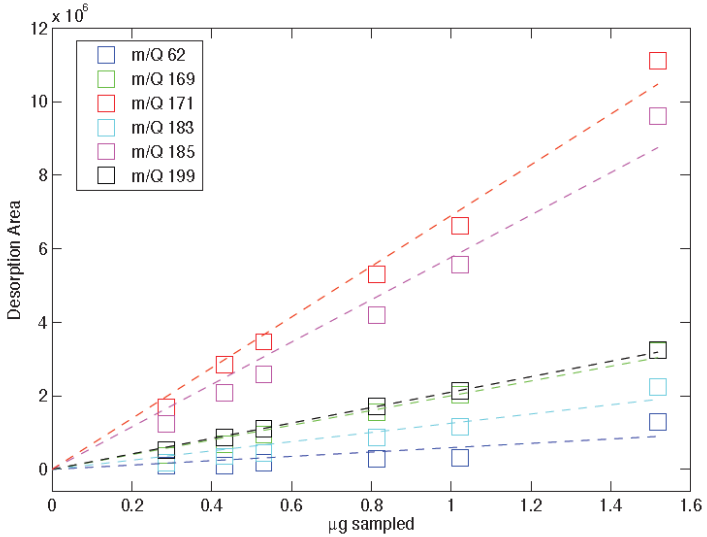
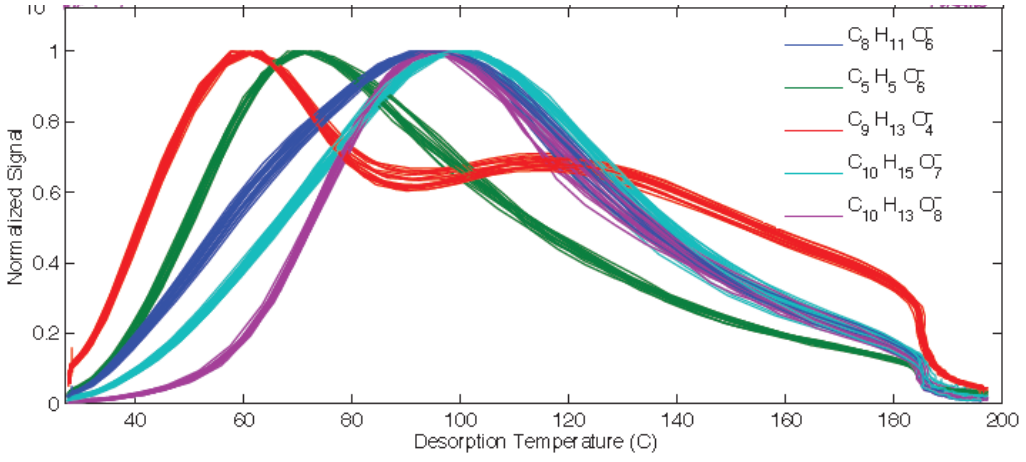
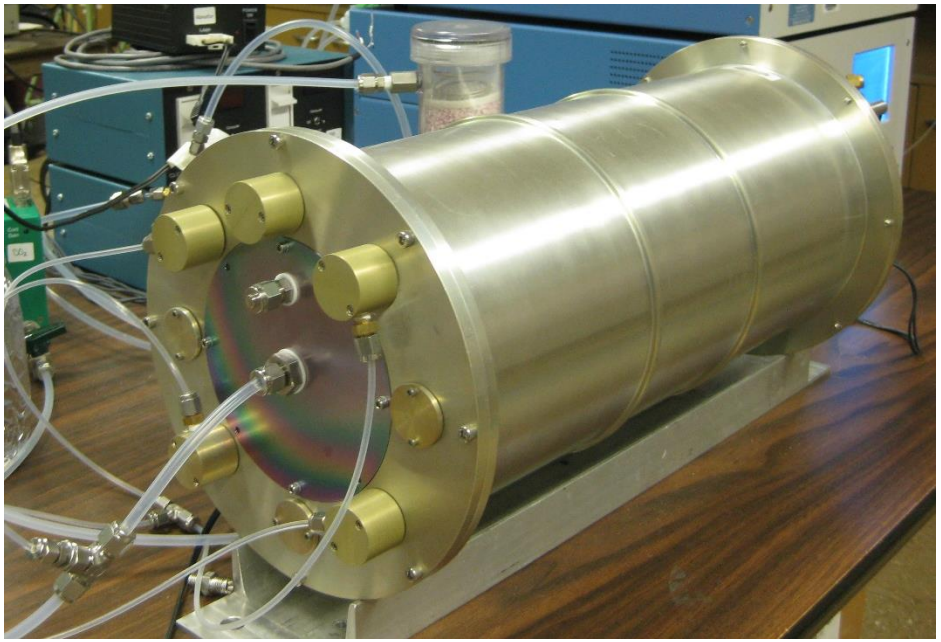
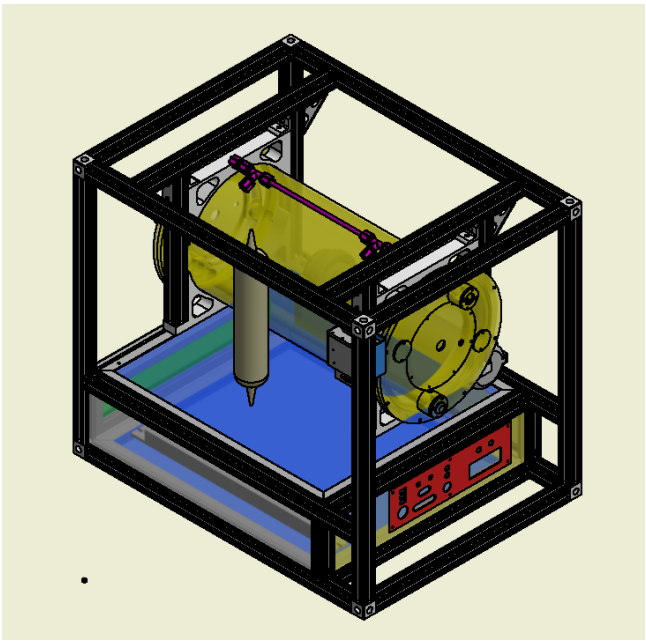




Collaboration with Joel Thornton, U. Washington; Jose Jimenez, CU

Development of Potential Aerosol Mass (PAM) Oxidation Flow Reactor





A. Lambe, J. Jayne, W. Robinson, X. Cabral, S. Prescott
Aerodyne Research, Inc.
Bill Brune, Pennsylvania State University

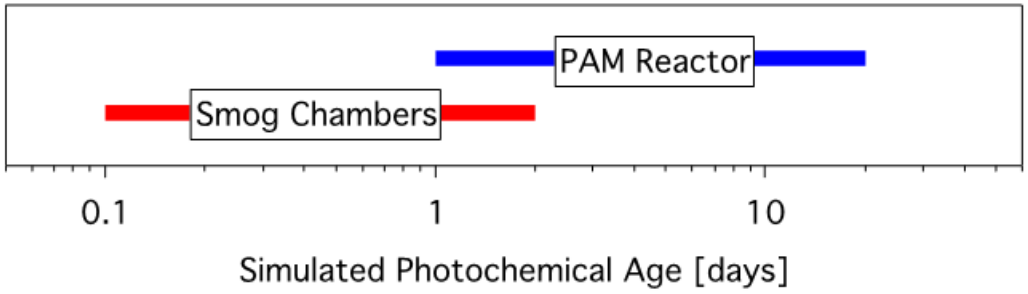
PAM overview

- Field-deployable oxidation flow reactor developed by Bill Brune [Kang et al., ACP, 2007] and further evaluated by Lambe et al. (2011)
- Production of secondary aerosol, oxidized primary aerosol

$$O_2 + h\nu_{185} \rightarrow 2O(^3P)$$
$$O(^3P) + O_2 \rightarrow O_3$$

$$O_3 + h\nu_{254} \rightarrow O(^1D) + O_2$$
$$O(^1D) + H_2O \rightarrow 2OH$$

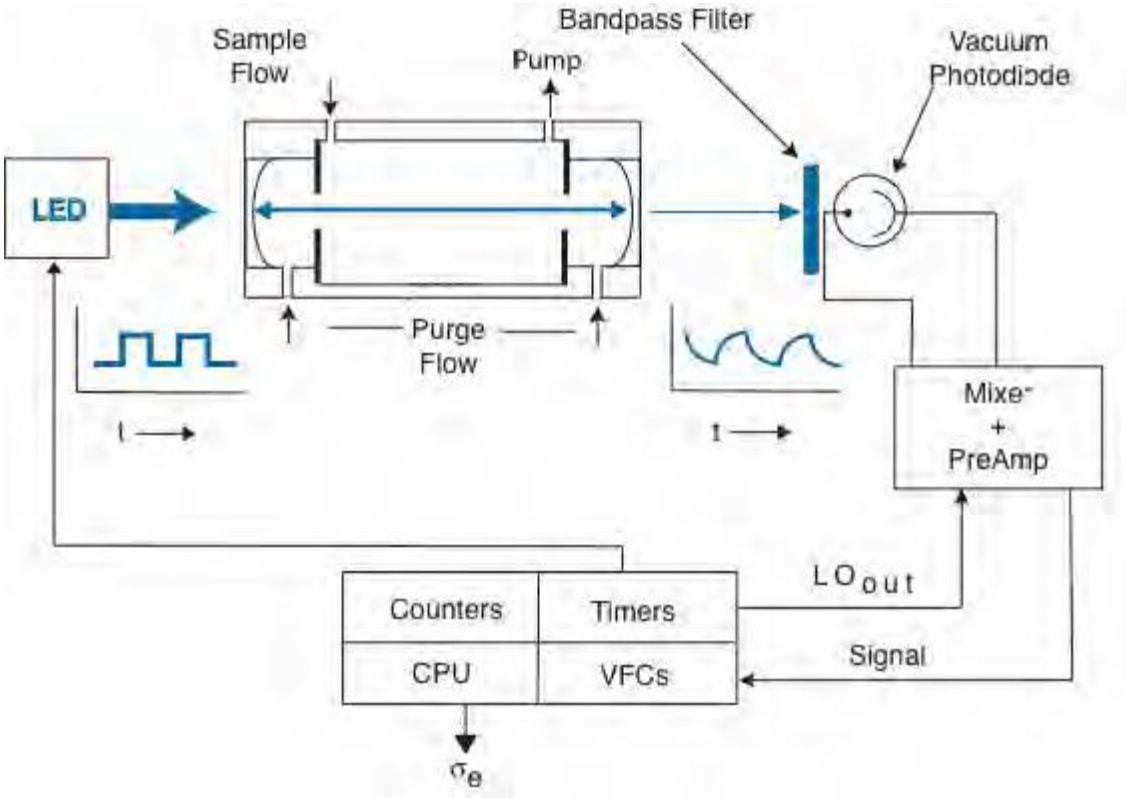
$$H_2O + h\nu_{185} \rightarrow OH + H$$
$$H + O_2 \rightarrow HO_2$$



- https://sites.google.com/site/pamwiki/publications [search 'PAMwiki']

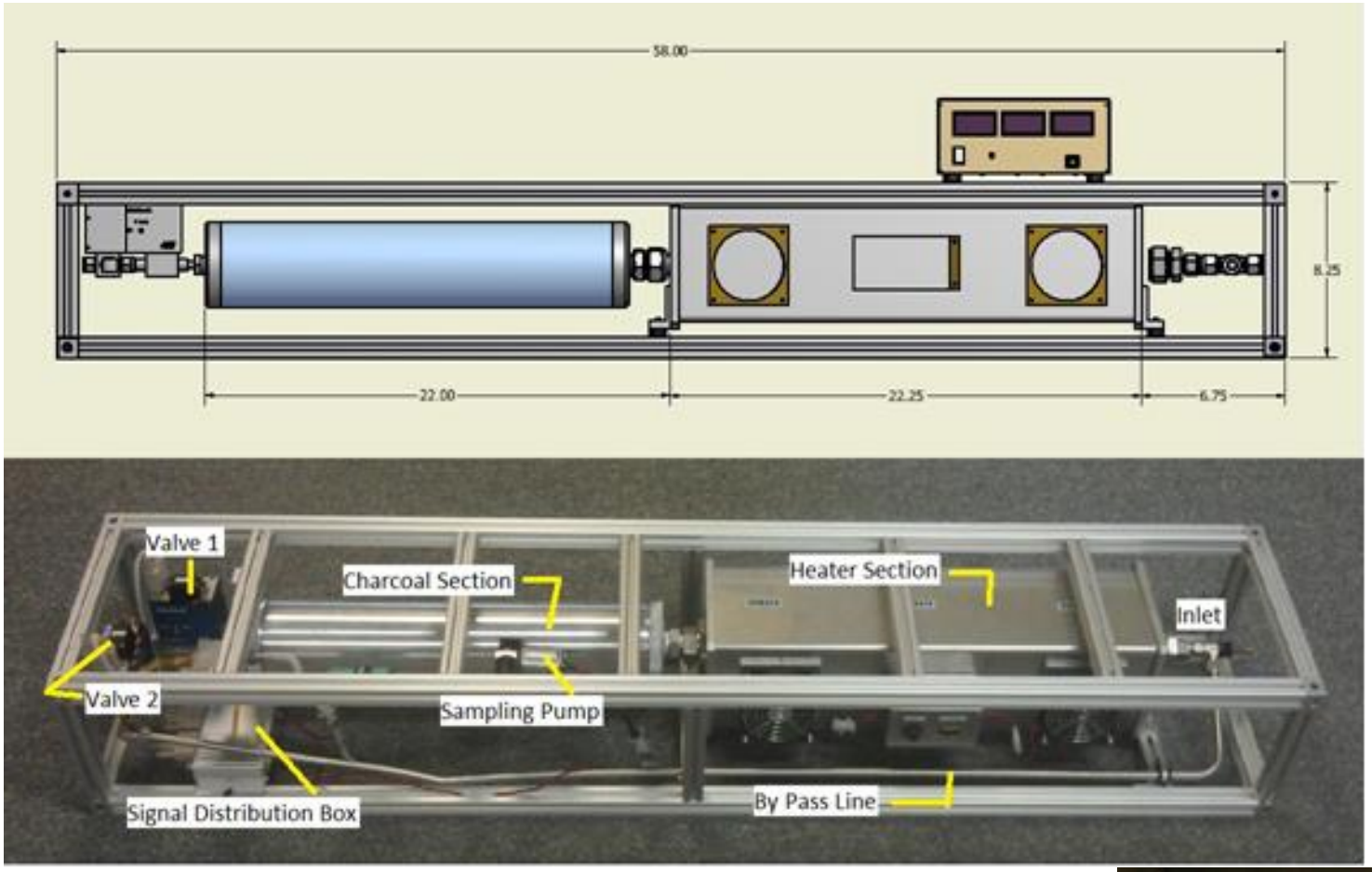
CAPS Pmex and SSA Monitors

Particle Extinction and Single Scattering Albedo



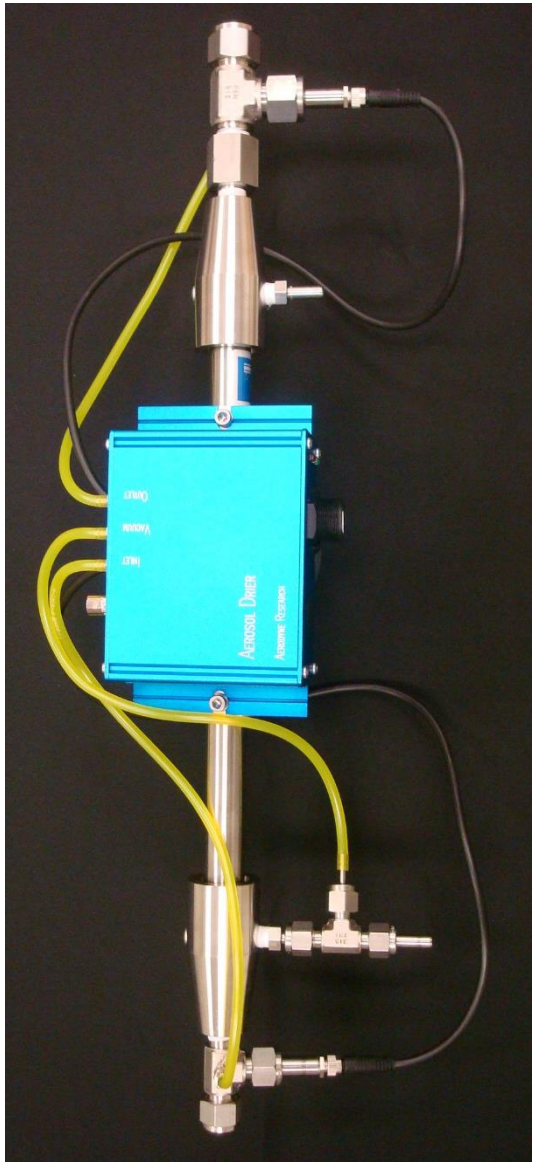
Andy Freedman

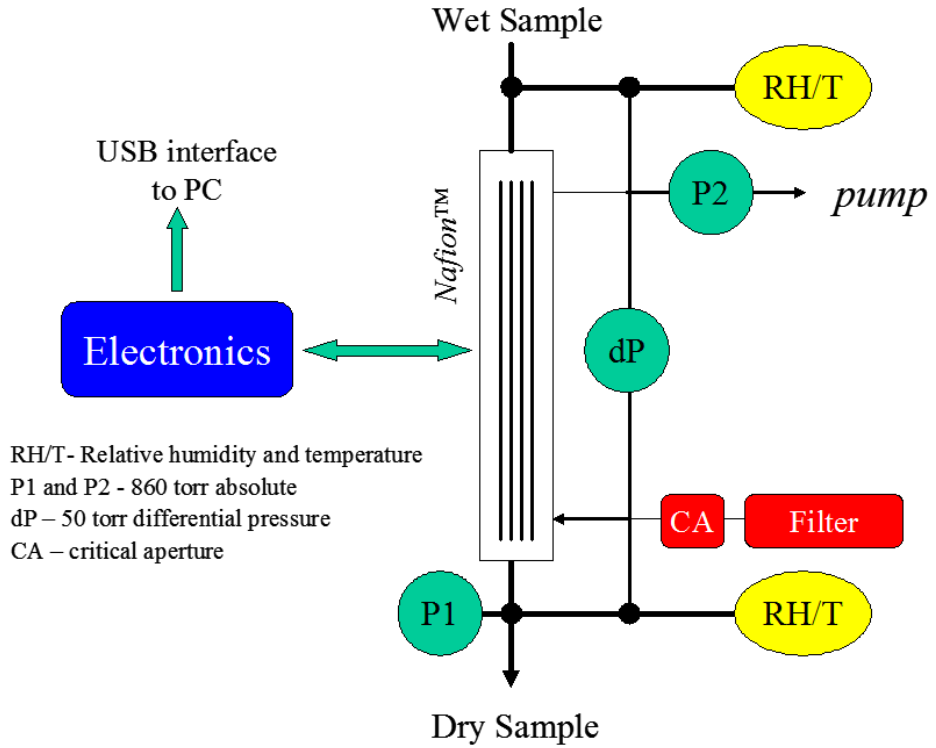
Thermal Denuder System

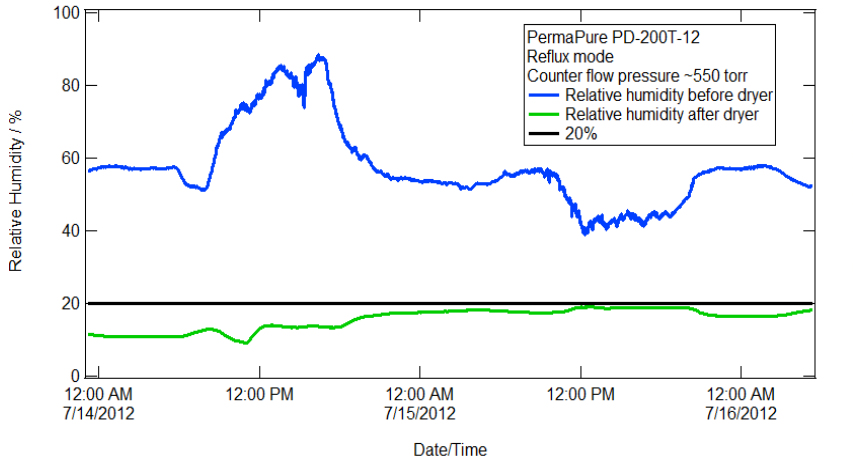


For aerosol volatility studies

Aerosol Sample Dryer System

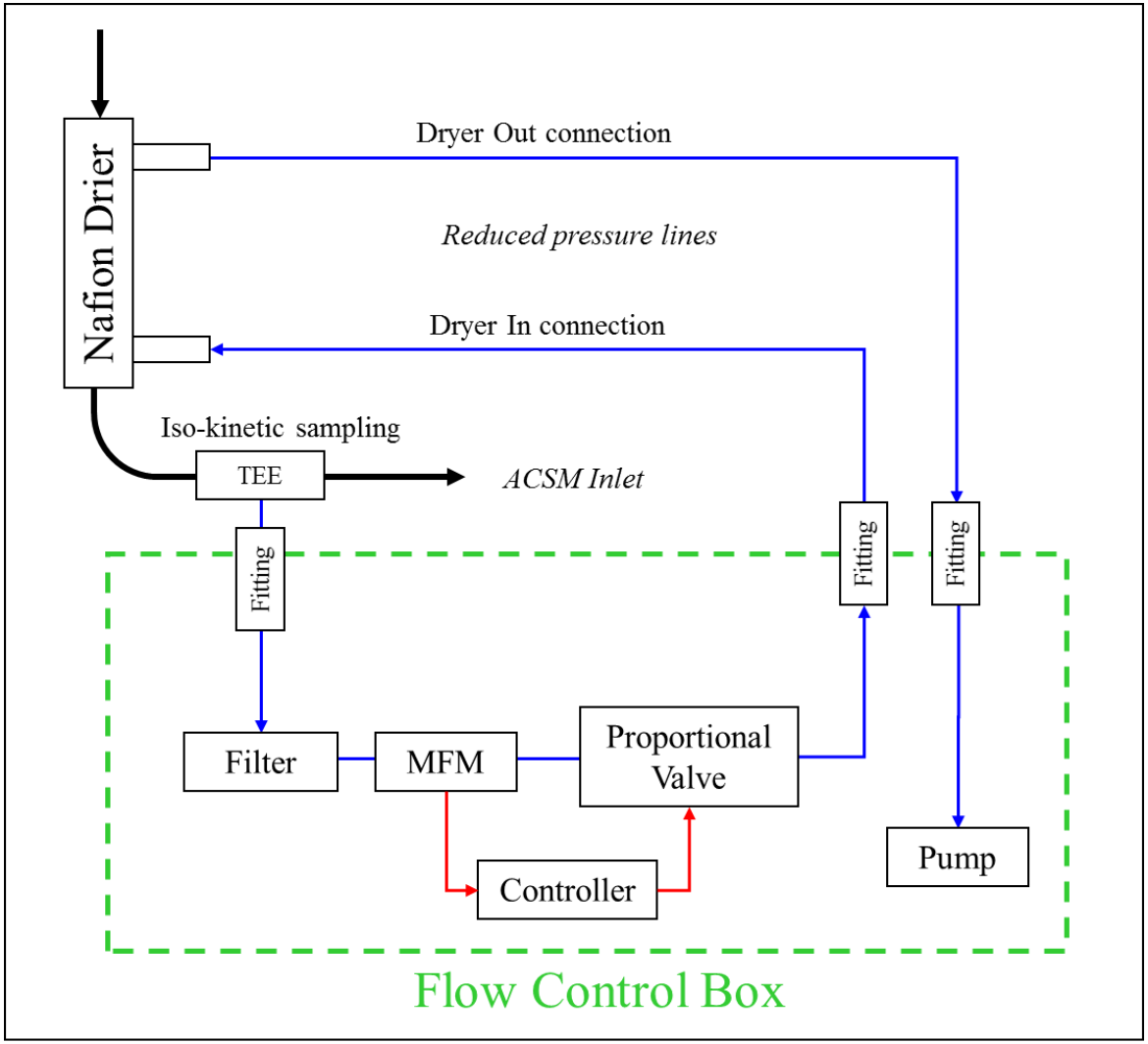






Sample Line Flow Controller System

- Light weight, low power (24V)
- Up to 10 LPM
- Compatible with Dryer system



Efficient Particle Time-of-Flight
ePTOF

Application of a higher throughput chopper wheel

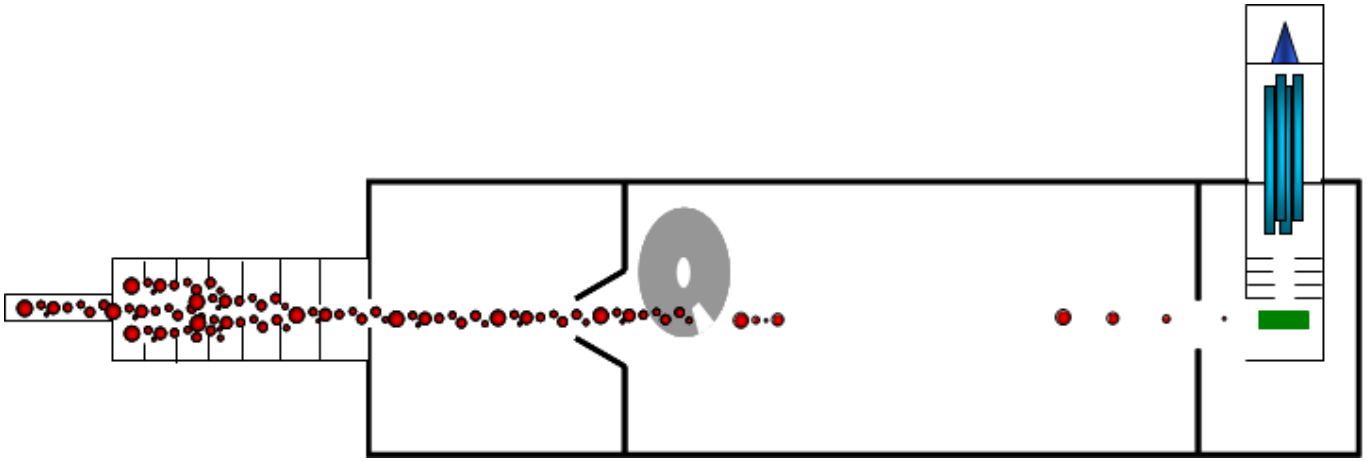
Performance enhancements in size resolved measurements with the AMS

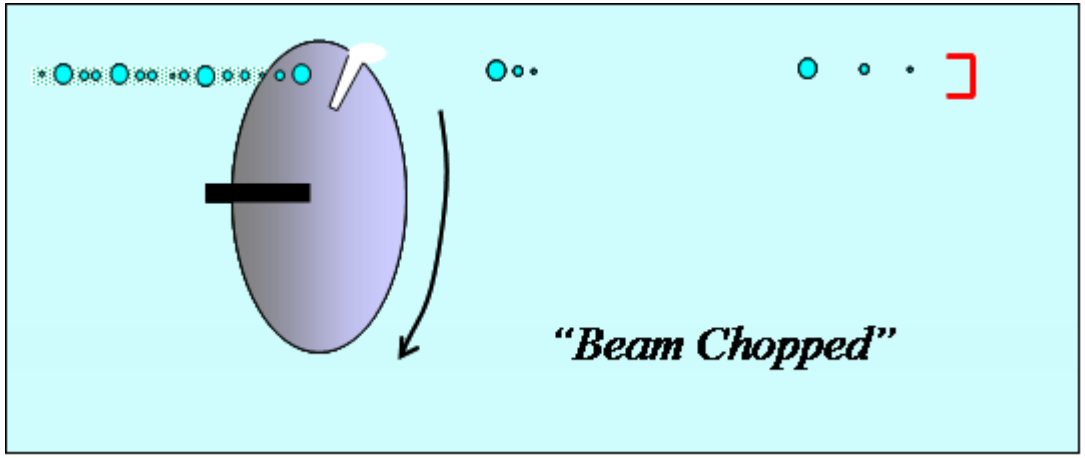
ARI/Tofwerk
J. Jayne, J. Kimmel, R. Knokumuss, M. Cubison, M. Gonin

CU/Boulder
P. Campuzano Jost, D. Day & Weiwei Hu, Harald, Donna, Jose

Florian Rubach, Mainz (mAMS)

Size measurement in the AMS

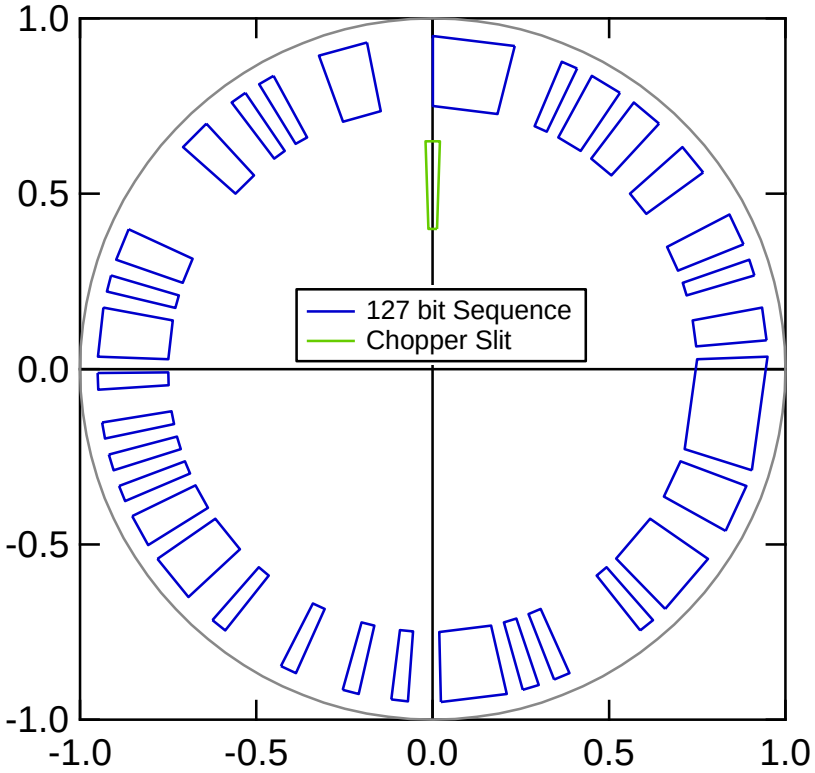


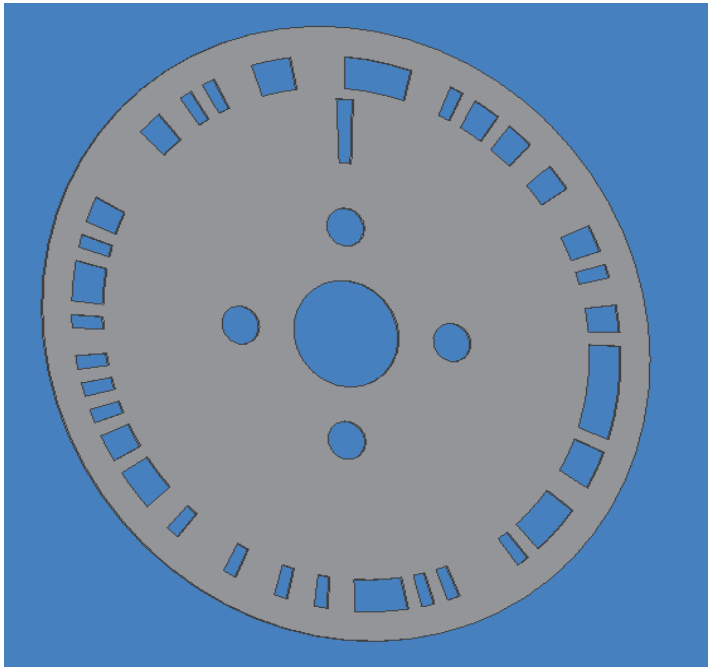


Single slit chopper limits throughput to 2%

Multi-slit wheel for 50% aerosol throughput

Deconvolution procedure to obtain size information





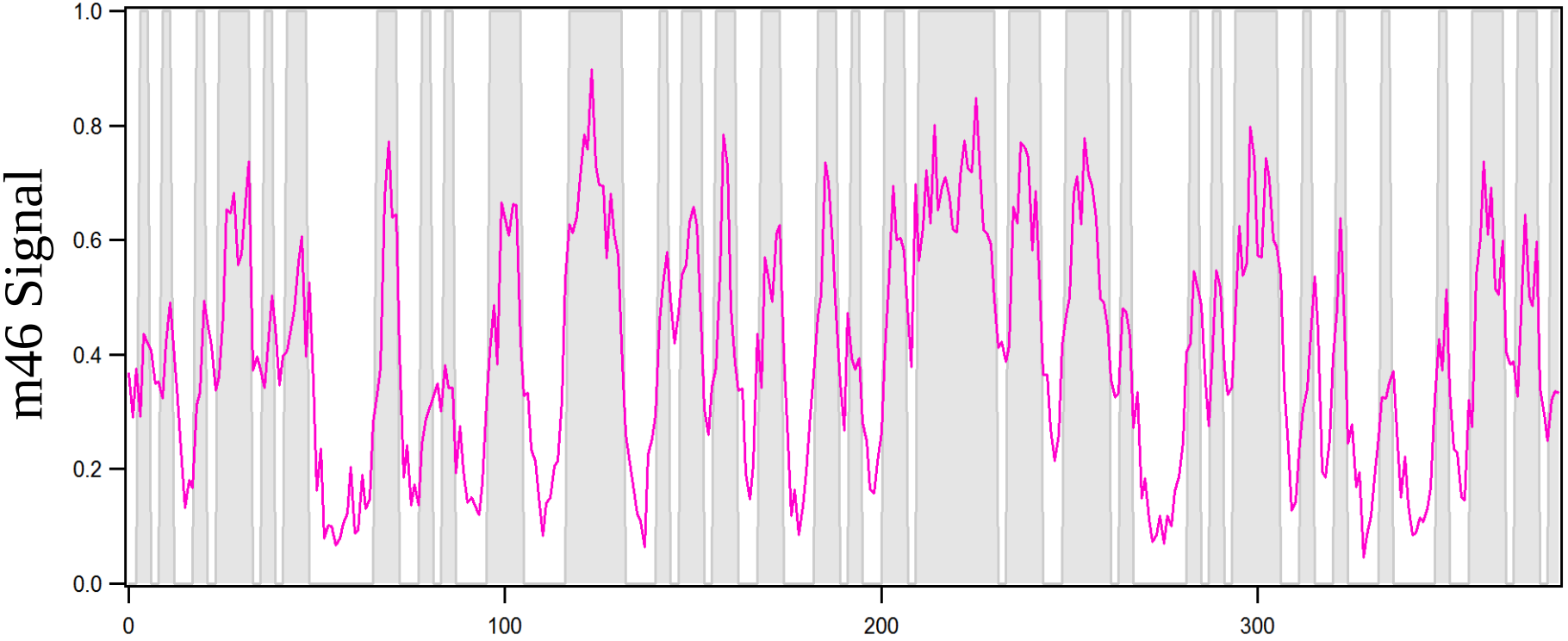
4-positions
open, closed, blocked, chop

- 3-phase brushless DC motor
- velocity regulated by closed loop control

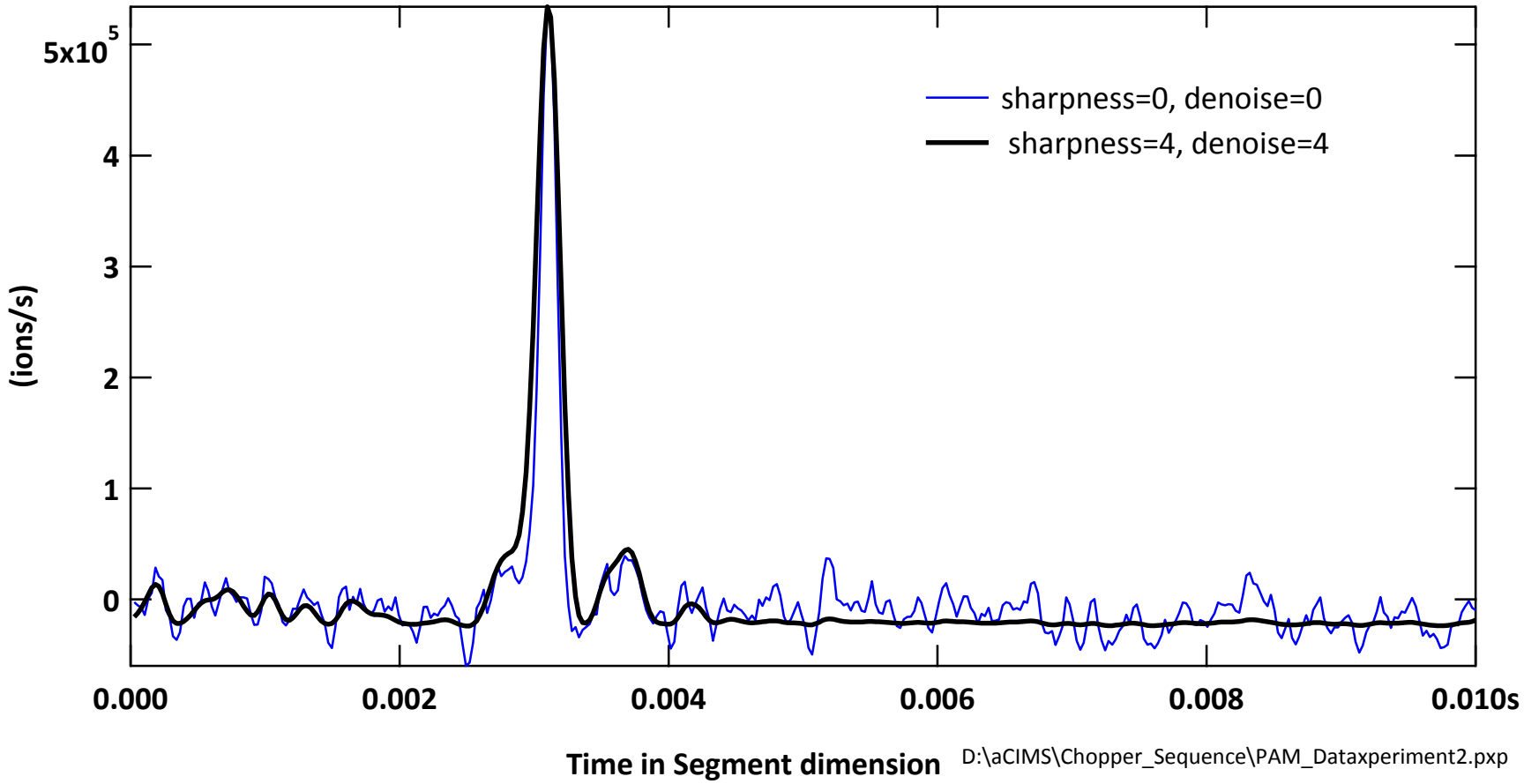
Richard Knochenmuss - Tofwerk

300 nm NH_4NO_3 Raw Data

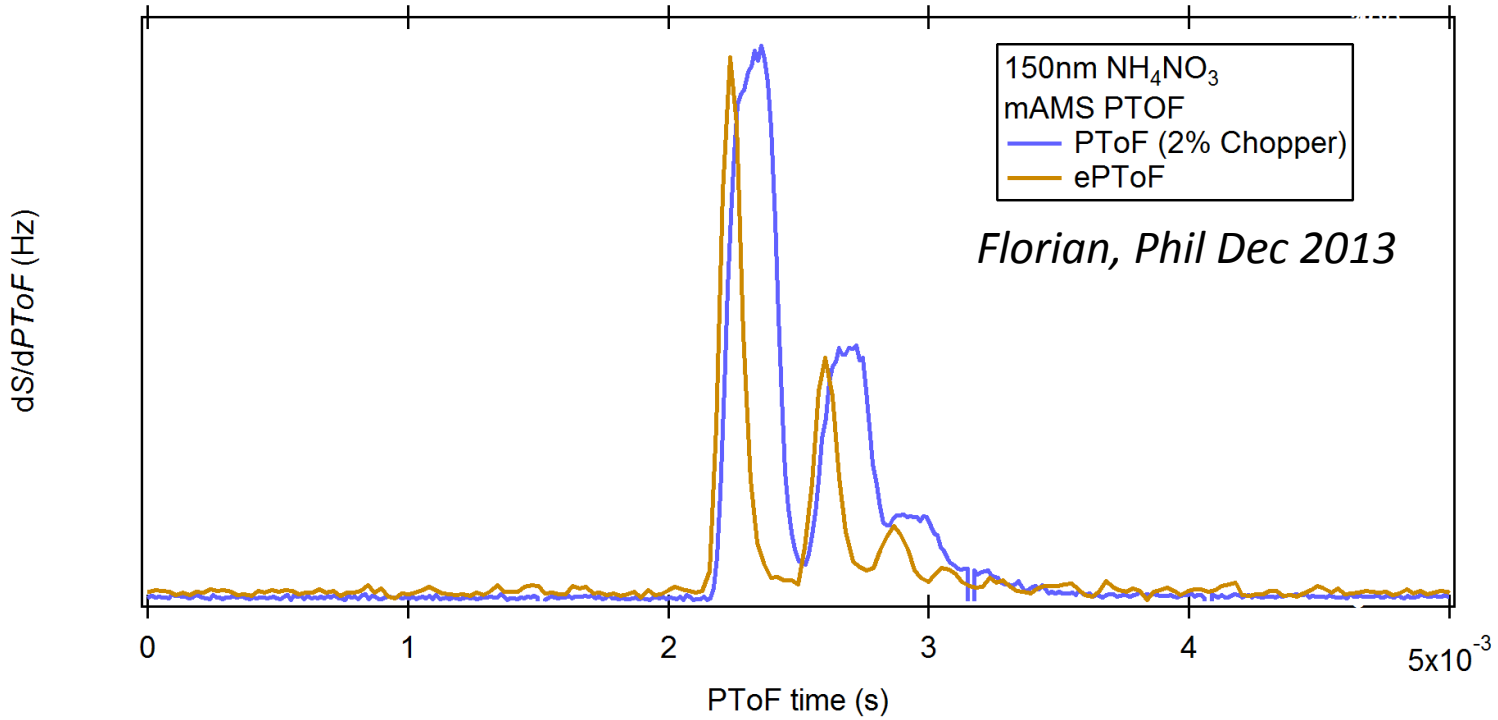
Recorded with multi-slit wheel



300 nm NH4NO3 Data De-Multiplexed



PTOF & ePTOF resolution comparison on Mini-AMS (24.5cm flight path)



ePTOF has higher resolution - 127 bit sequence → 1/127 = 0.78% (effective slit width) vs 2%

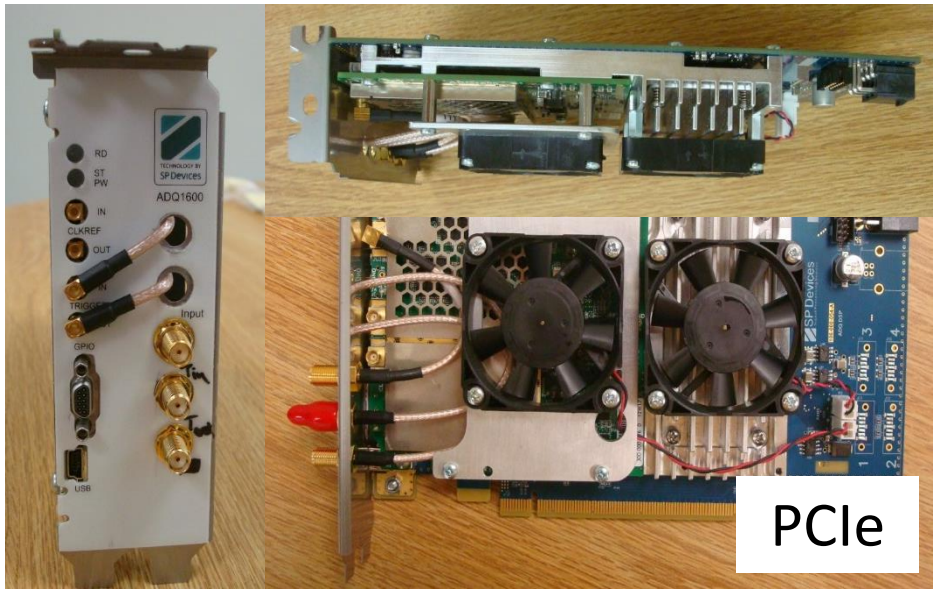
ePTOF Hardware

- *Plans are underway for communication with AMS DAQ*
- *Improvements to speed regulation*
- *Updates from Florian, Pedro/ Donna/Joel*

Can be built on NW63 and NW100 flanges (AMS, mAMS compatible). 17 systems delivered.

New Data Acquisition Card

SP Devices ADQ1600



- Replaces AP240 (8 bit, 1 GS/sec; now discontinued)
- Fast with extended ADC range, 1.6 GS/sec,14 bit
- Custom firmware for AMS, ePTOF, event trigger modes.
- PCIe version replaced by USB-3 version → Can use smaller PC

New Data Acquisition Card

SP Devices ADQ1600

- Supports ePTOF acquisition mode.
- Single particle – Event Trigger mode
- Requires AMS DAQ V5, strategic break point for AMS software. Joel will provide update on new AMS DAQ V5

Automatic TOF tuning by Thuner

One button simultaneous tuning of multiple TOF (and User) voltages.

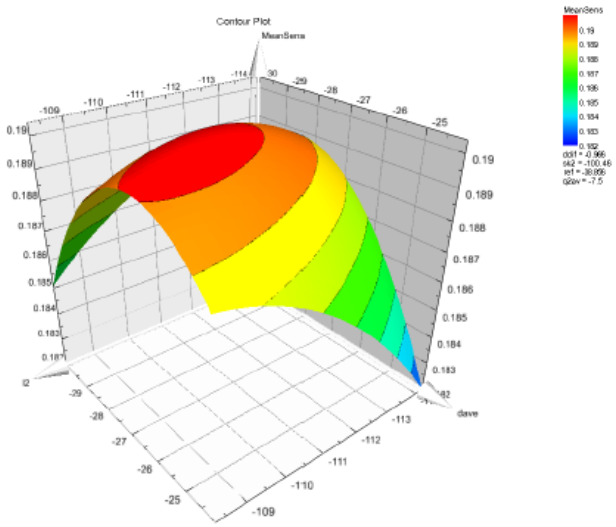
- TOFWERK software package (.net, dll)
- Commercial algorithms (Umetrics MODDE)
- Compatible with any Tofwerk TOF

Tofwerk: Manuel Hutterli, Fredrik Östlund, Christian Tanner

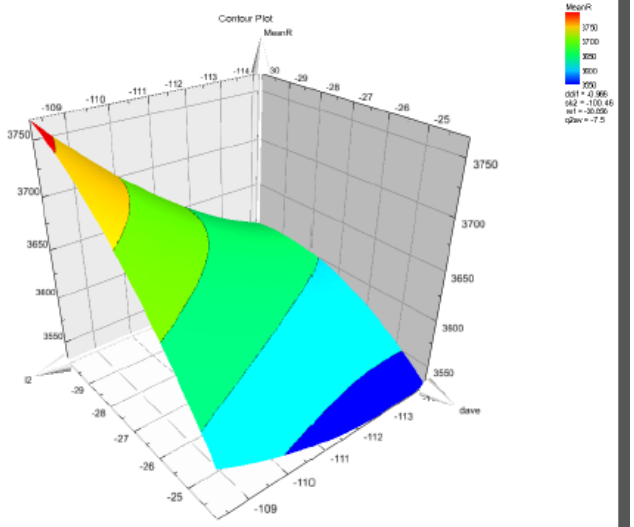
Thuner - Simultaneous optimization of signal intensity and resolution

Quad 2 (BSQ) and Primary Beam Voltages

TOFWERK
Time-of-Flight Mass Spectrometry



Sensitivity



Resolution

Updates on AMS Control System

-Ebox eliminated.
-Rack mount PC replaced with small form factor PC.
-Simplified cabling

Pump Controller now also manages:
-Heater power
-Heater temperature display
-Communication/control with AMS DAQ

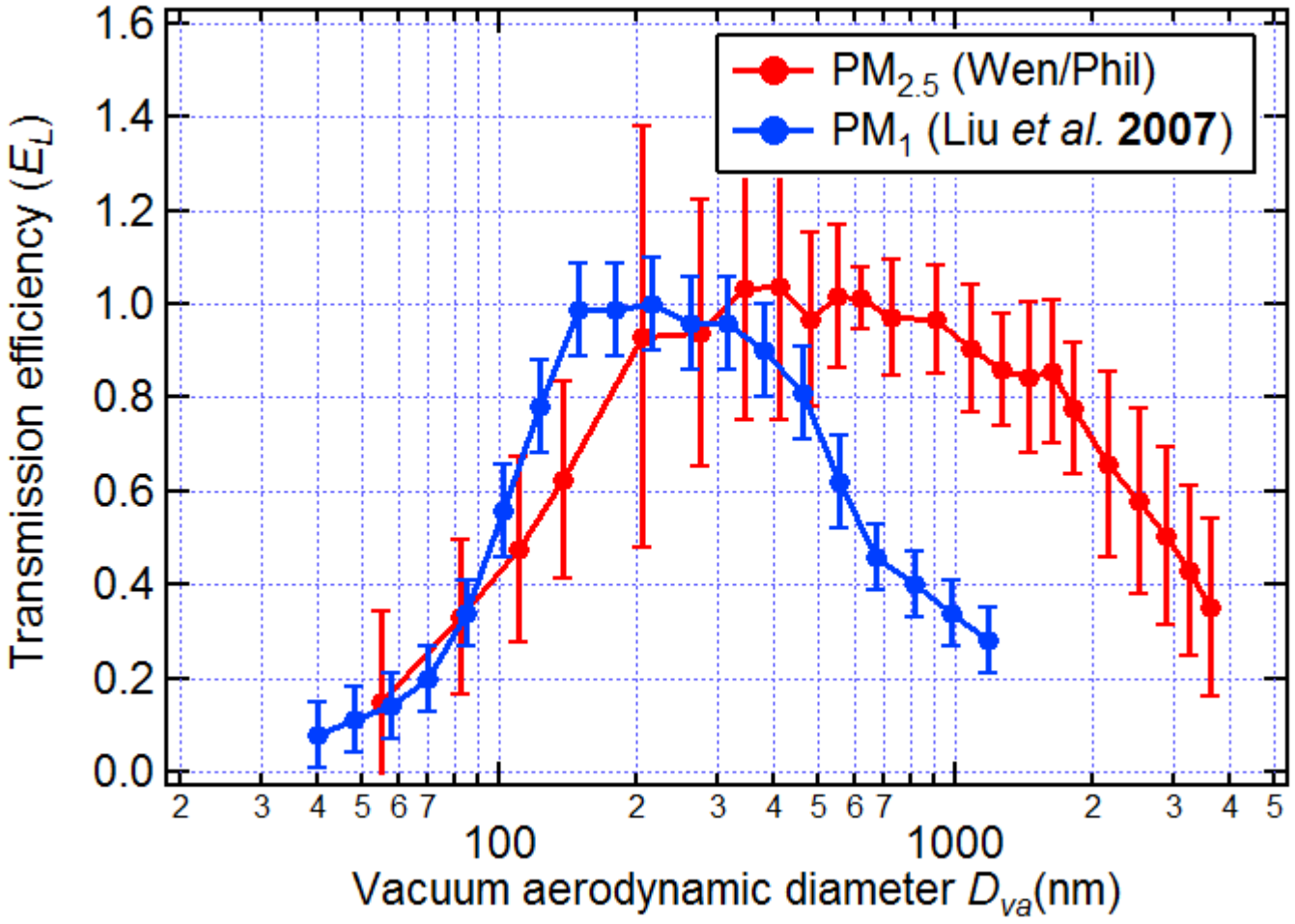
Coming:
-Add control for AutoInlet valve
-Backing pump isolation valve

PM2.5 Capability

- Particle lens
- Sampling system, inlet plumbing
- Capture vaporizer

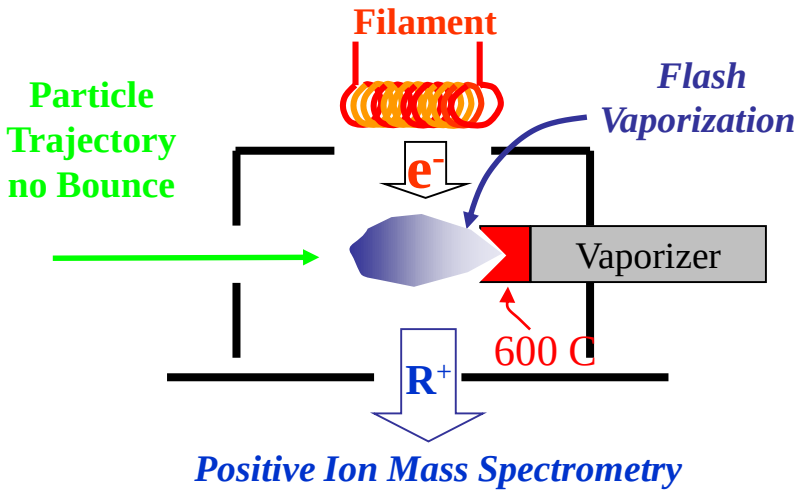
A first PM2.5 ACSM demo instrument is currently deployed in China (updates from Phil during ACSM session).

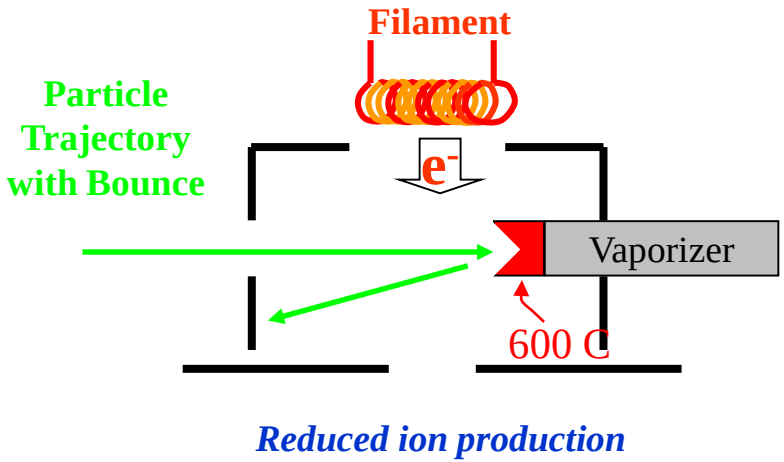
PM2.5 Lens Transmission



We have a design, making copies

Particle Bounce



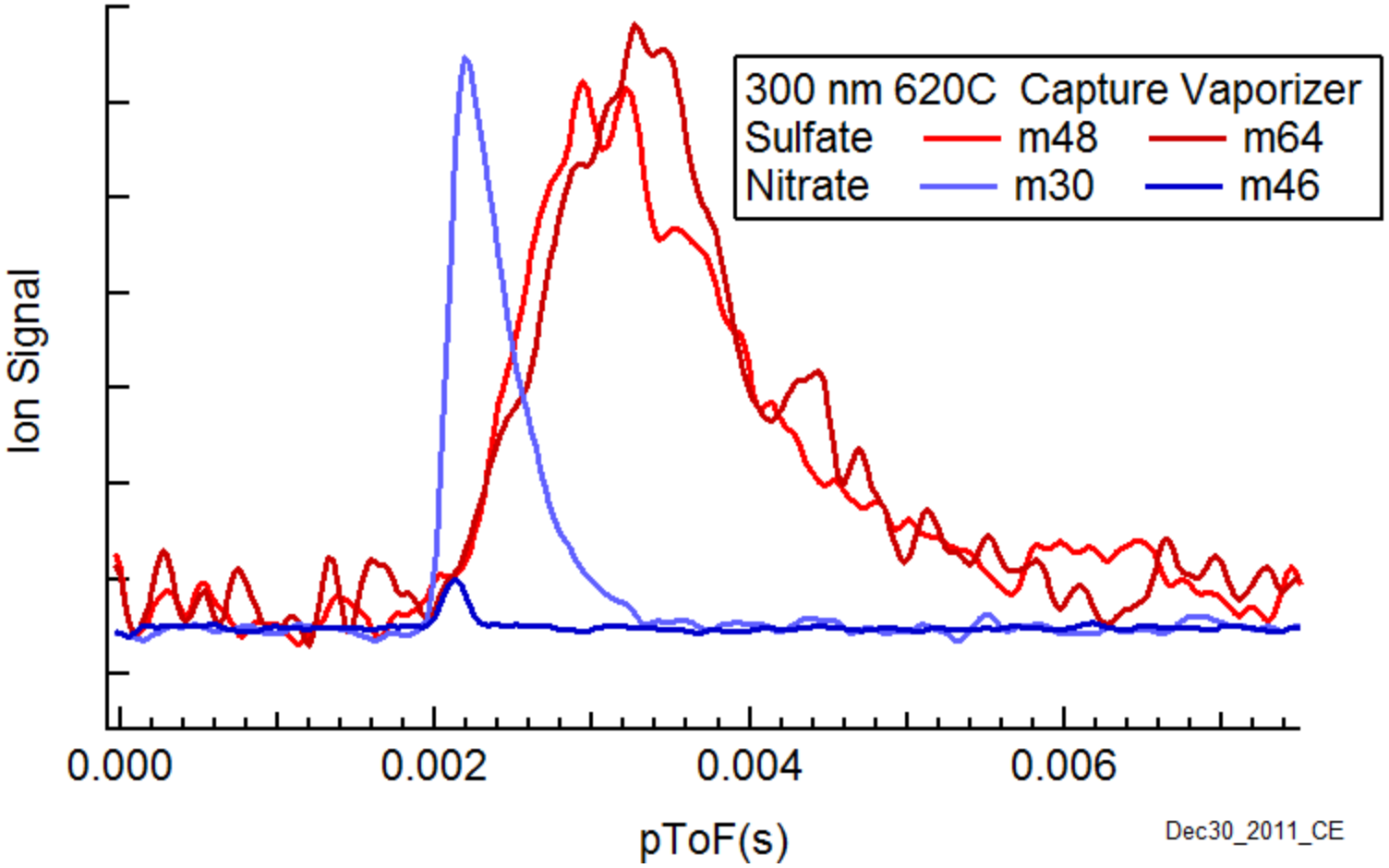


Ideal scenario
Vaporization on
1st collision

Particle Bounce

Slide of CV

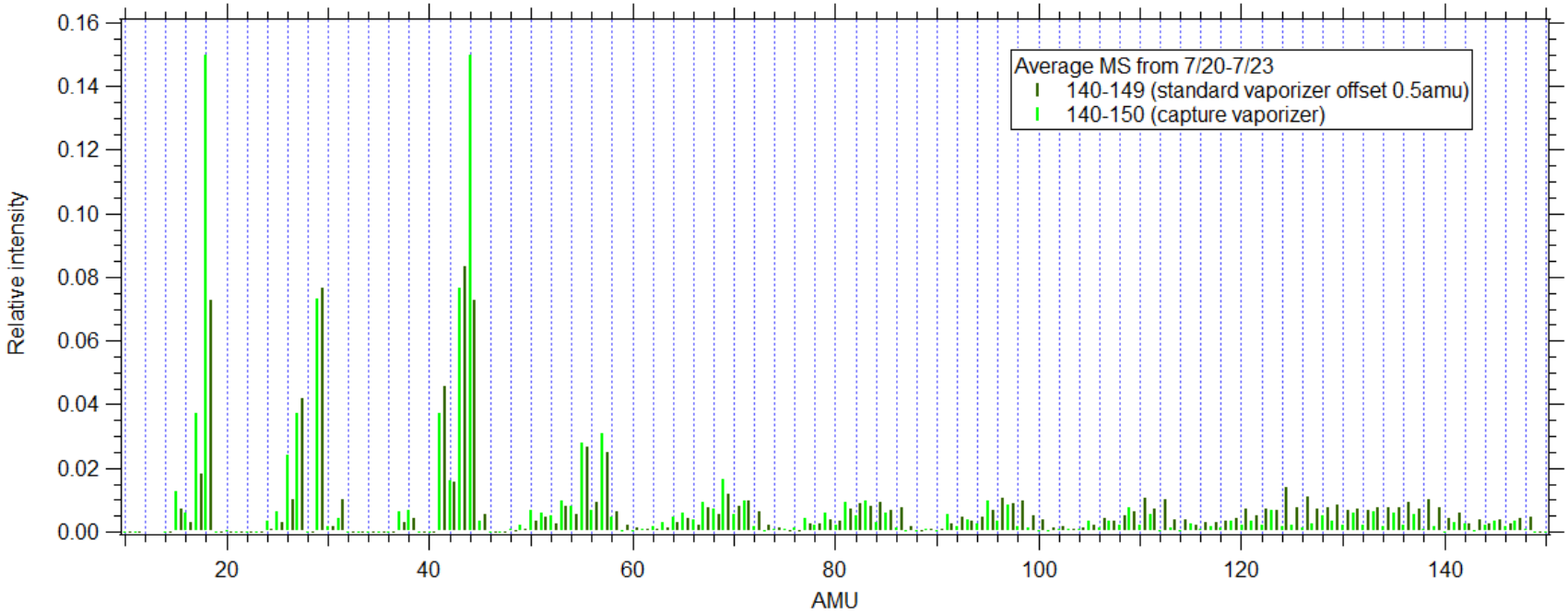
Capture Vaporizer pTOF Traces
300 nm SO4 and NO3



Sulfate is broadened (as expected)

More 30 than 46 for Nitrate

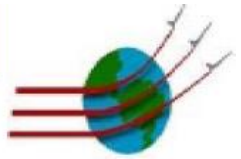
Mass spectrum shows a larger fraction of Org is going into m/z 44



Two side-by-side QACSM systems sampling ambient aerosol

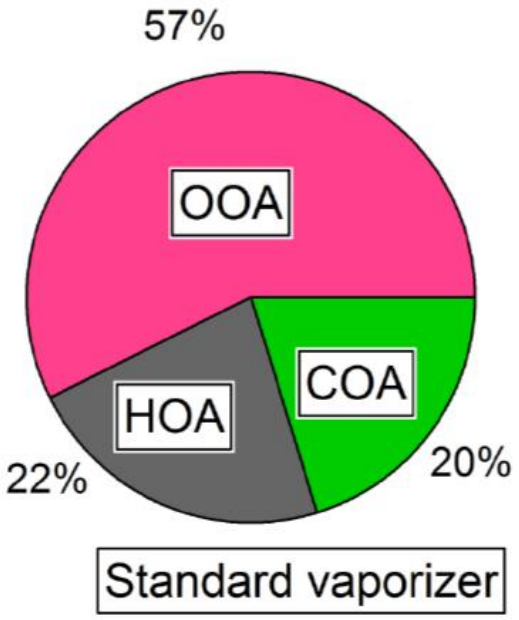
University of Colorado Boulder

Ambient

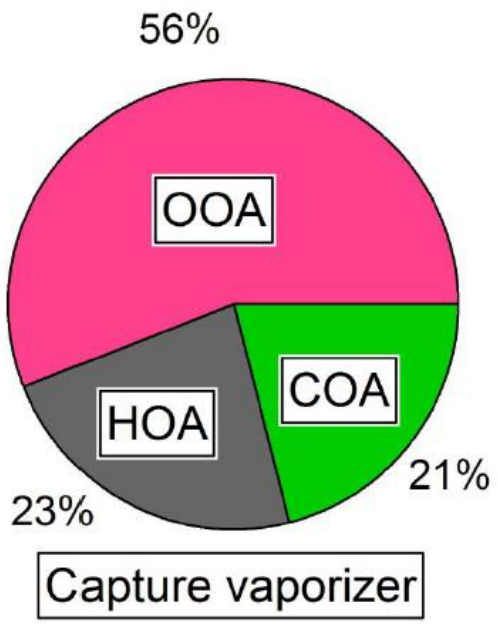


Similar PMF result are resolved in capture vaporizer

Standard vap



Capture vap

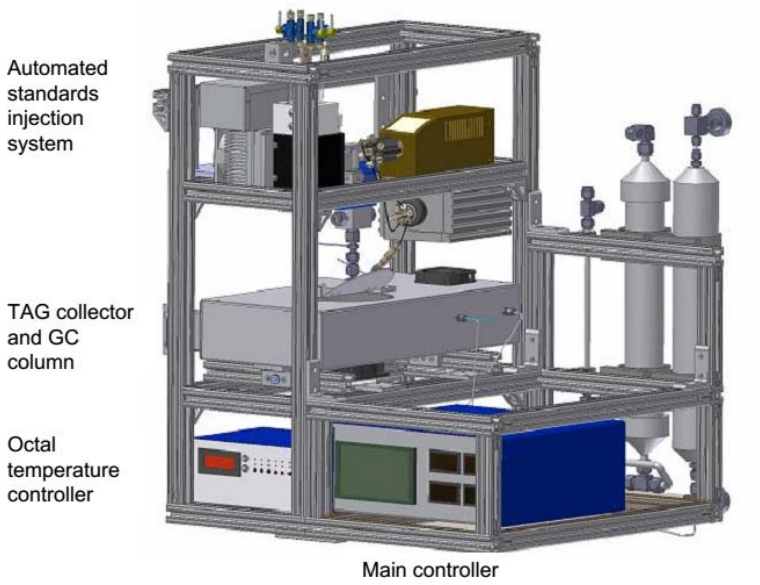


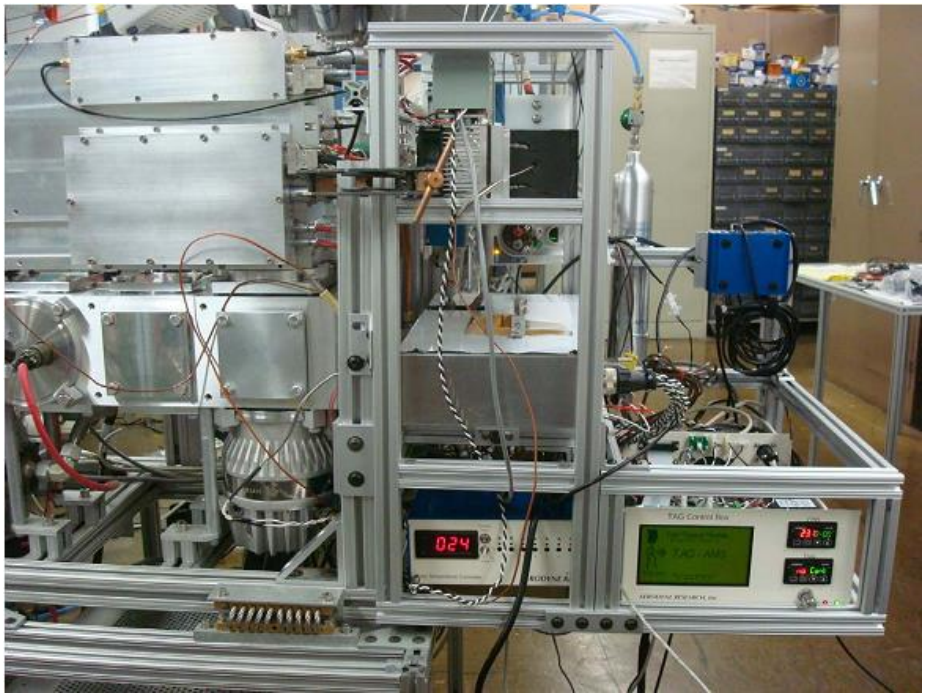
Two HTOF AMS Systems side-by-side comparison, SV and CV
SOAS Alabama 2013

TAG-AMS Updates

Thermal Desorption Aerosol GC/MS

Molecular identification for organic aerosol constituents





Collaboration with UC Berkeley.

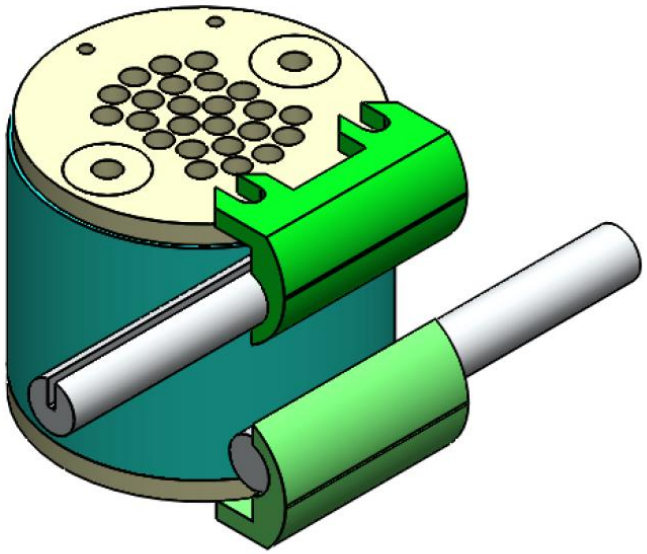
U. Provence, France Nicolas Marchand, Amelie Bertrand

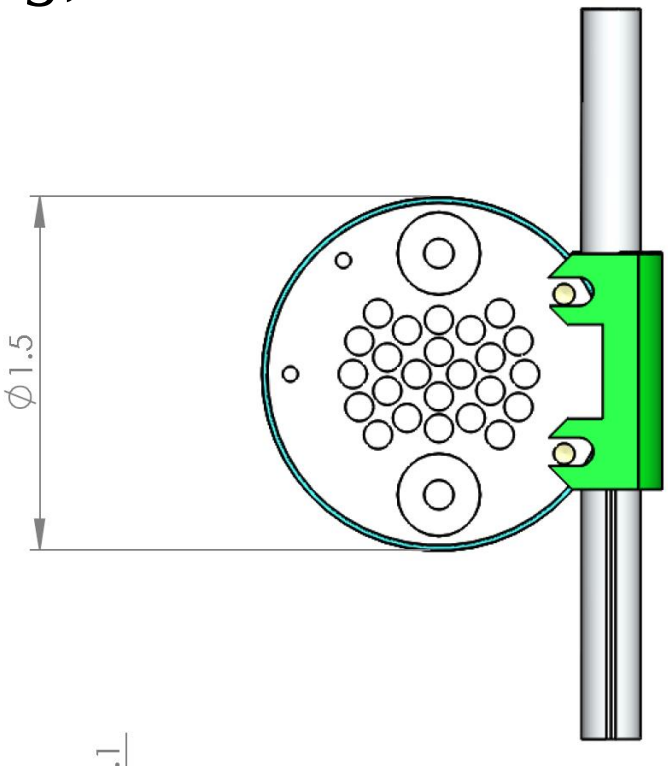
Julich, Thorsten Hohaus, Arthur Chan U. Toronto

Mini GC “Oven”

Nathan Kreisberg, ADI

1.5” diameter

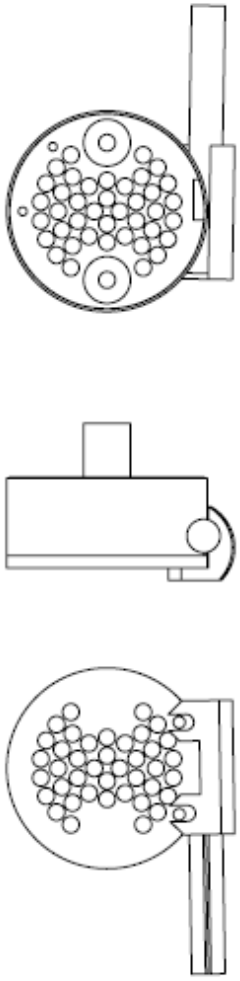


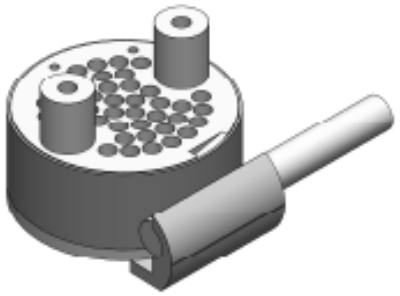


Replaces the Vici coated column which previously replaced the ‘conventional’ GC Oven box

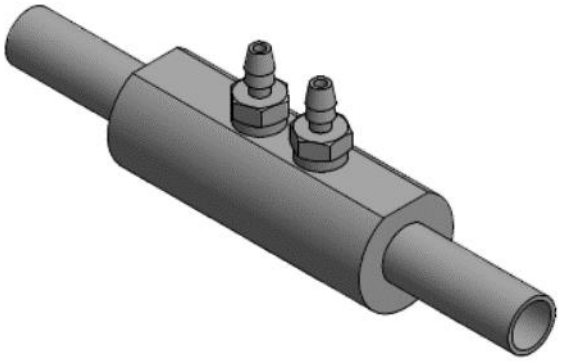
Focusing Trap
(current version in DTAG)

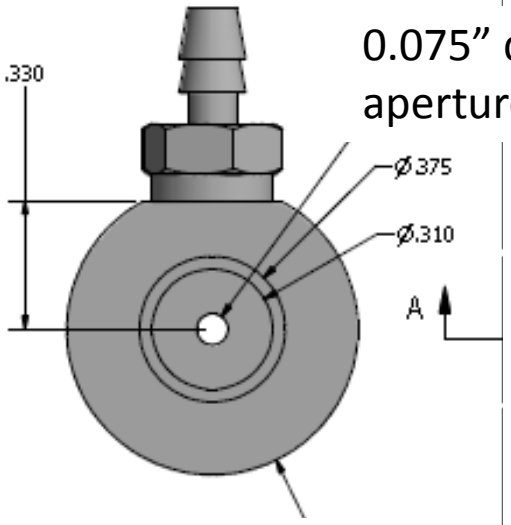
- Metal column winds around hub
- Continuous heating up to exit
- 30→330 C in 2 min (2x50W heaters)





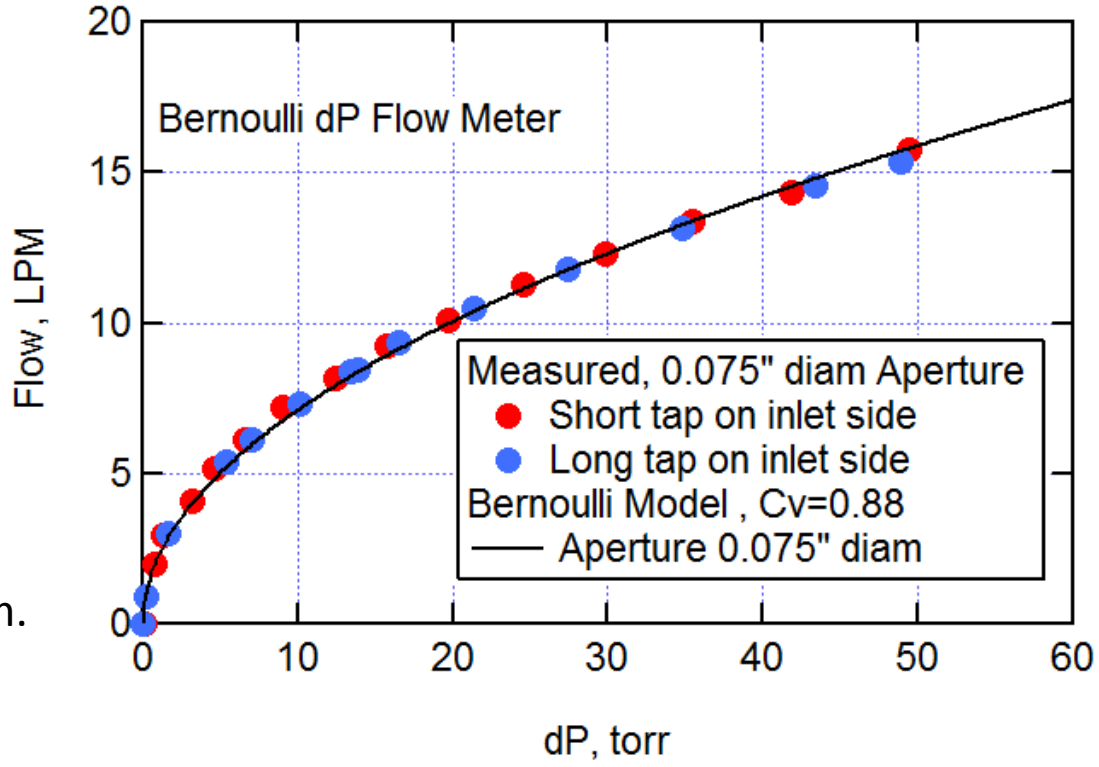
Total Flow measurement for TAG (or other) Systems



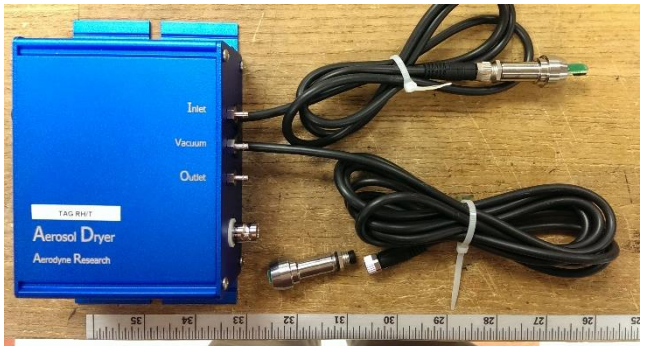


0.075” diam. aperture

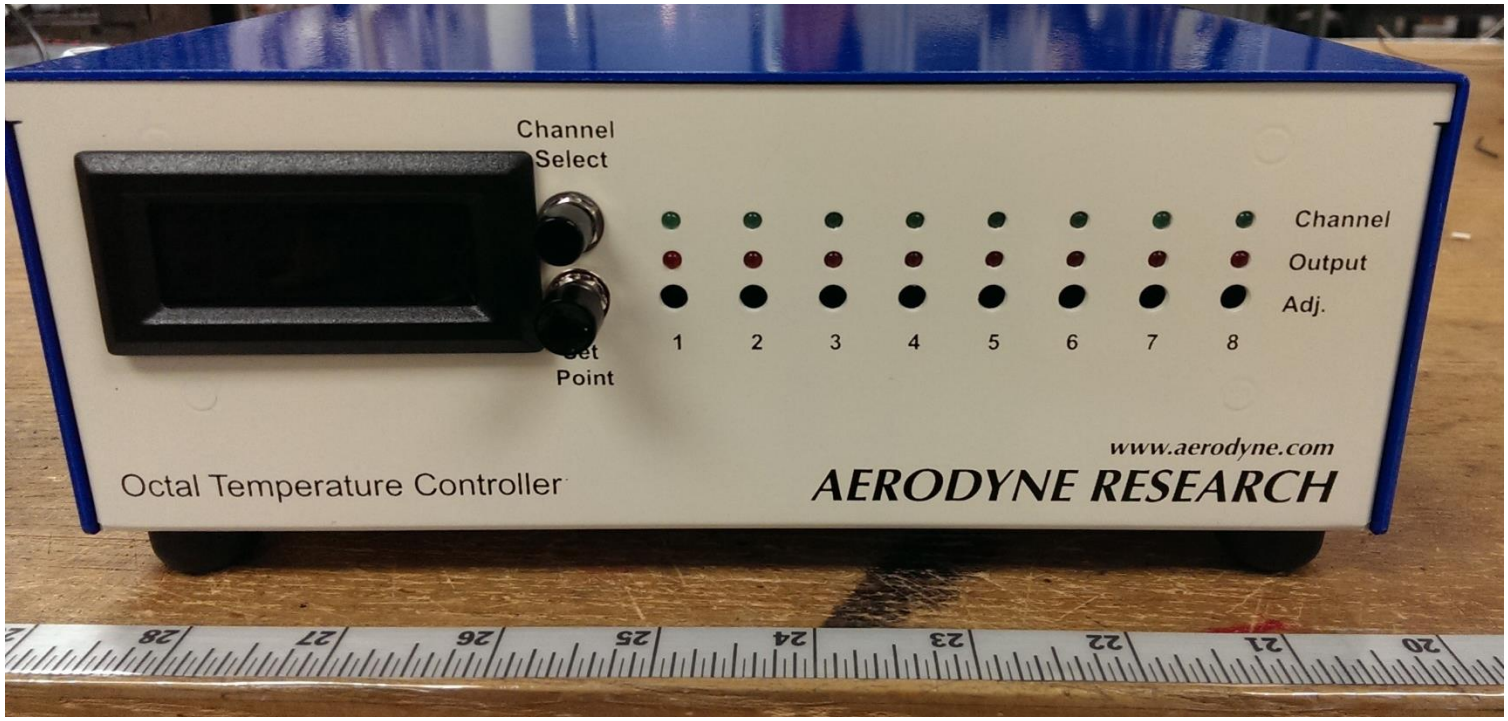
3/8” diam.



Connects with RH/T/P electronics



TAG Octal Temperature Controller Updates



- Set Points for two of the 8 channels can now be programmed.
- Channel 8 is dedicated for thermoelectric cooler for standards.

END