Instrument Overview

Sat Sept 8 9:40 – 10:10

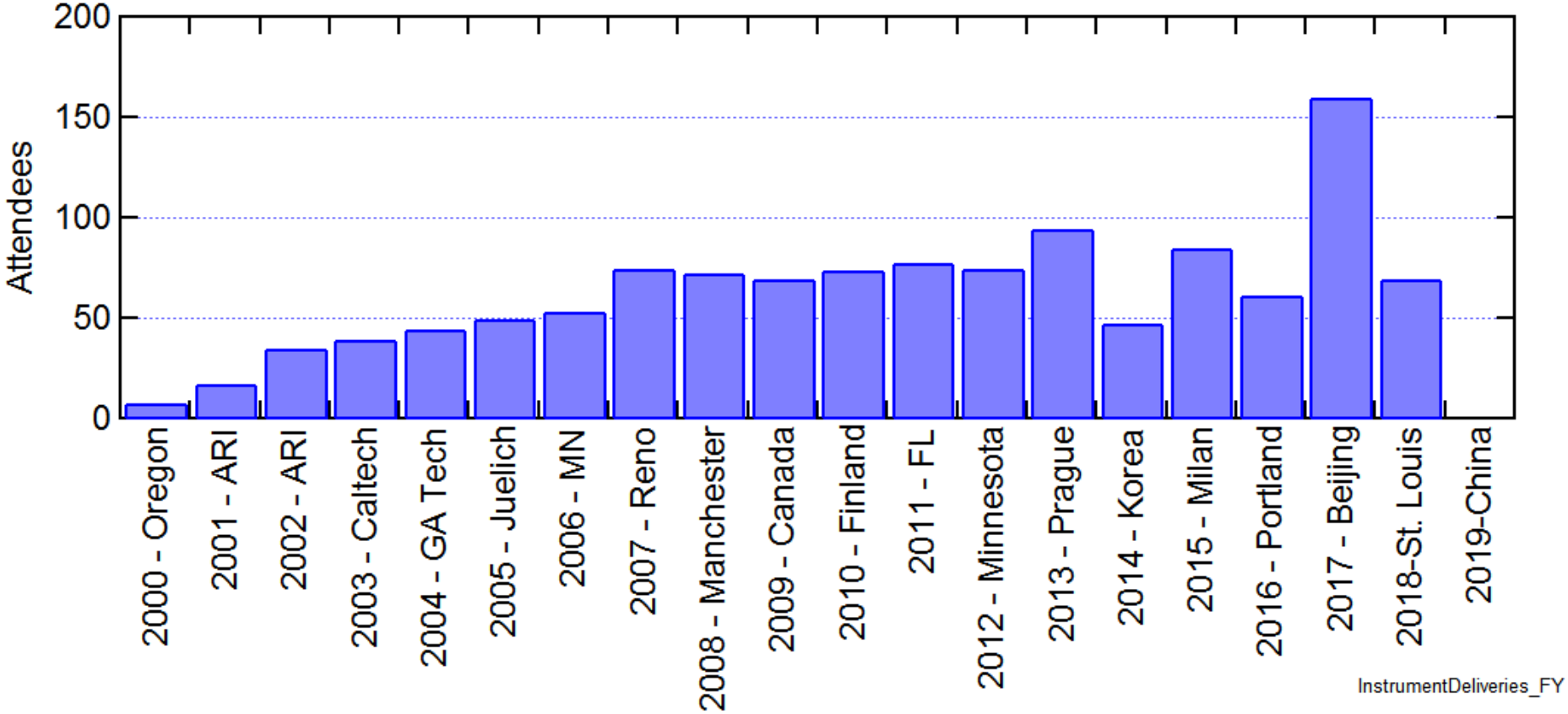
19th AMS Users Meeting
Washington University, St. Louis

Sept 2001 – AMS Users Meeting.

SN 001 to 004

Its been a while…

AMS Users Meeting Attendance



Aerodyne Mass Spectrometer Systems

Aerosol Instruments

~~QAMS~~
CTOF AMS
HTOF AMS
SP HTOF AMS
CTOF mini-AMS
LTOF AMS
QACSM
eTOF ACSM

TOFWERK Time-of-Flight MS

Tofwerk, AG Mass Spec Partner

Gas Phase Instruments

APi – TOF
IMS – TOF
EI-TOF
VOCUS PTR
Mini-GC (EI TOF, CIMS/VOCUS)

Most instruments available with C, H or L ToF MS

Sources

IMR (I^-, SF_6^-, H_3O^+, Acetate,…)
Nitrate (NO_3^-)
FIGAERO

AMS Components and Other Aerodyne Instruments

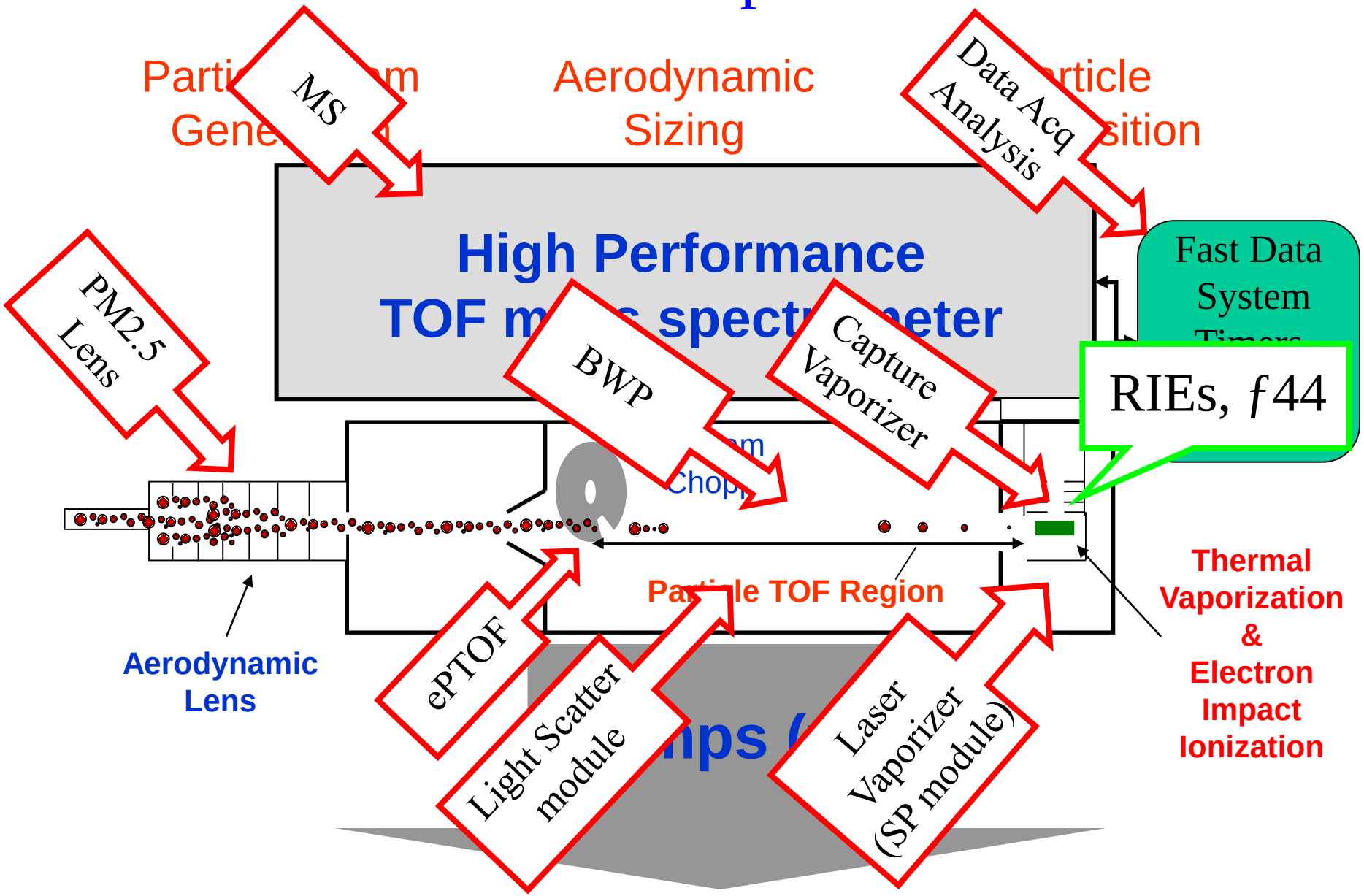
Components

SP – Soot Particle module
LS – Light Scattering module
Aerosol Dryer
Thermal Denuder
PAM – *OFR*
Pressure Controlled Inlet
EyeOn control system
Beam Width Probe
Auto Valve System

Instruments

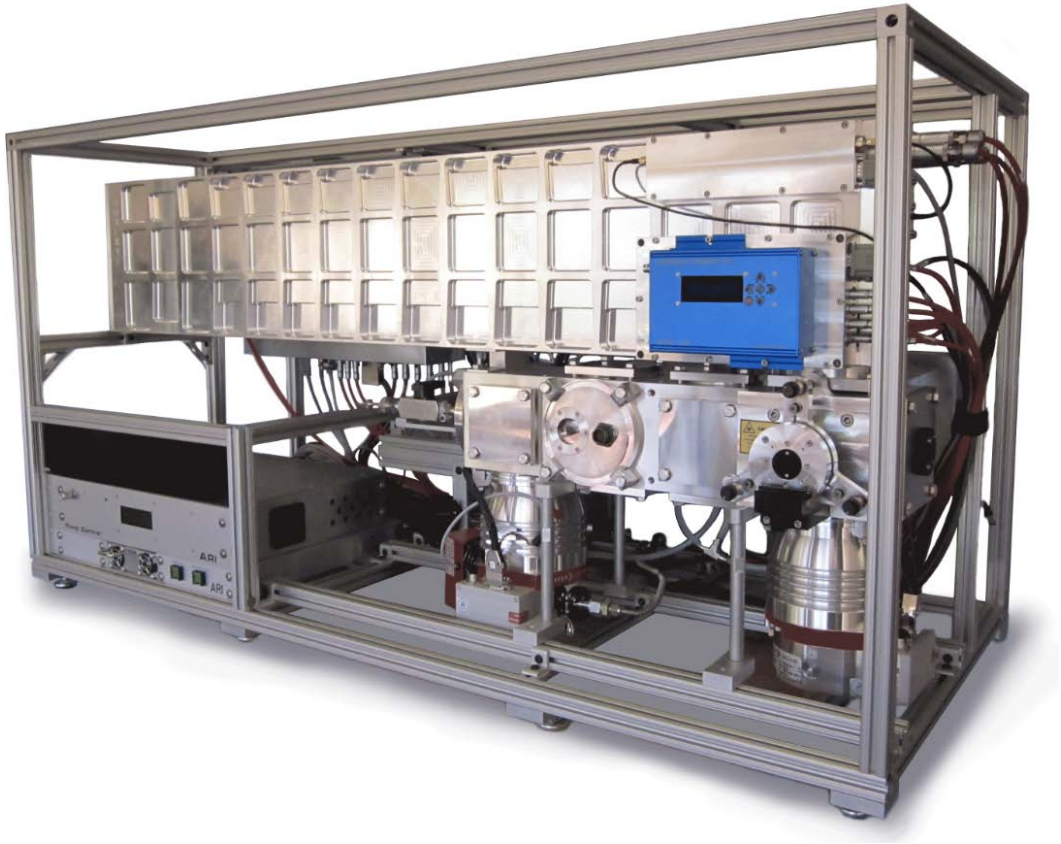
TILDAS (IR trace gas measurement)
CAPS (NO2, PMex, SSA)
TWST (Cloud optical depth)
DPAS (BC conc. *Zhenghong Yu)*
ARISense (Air quality monitoring package)

Aerosol Mass Spectrometer



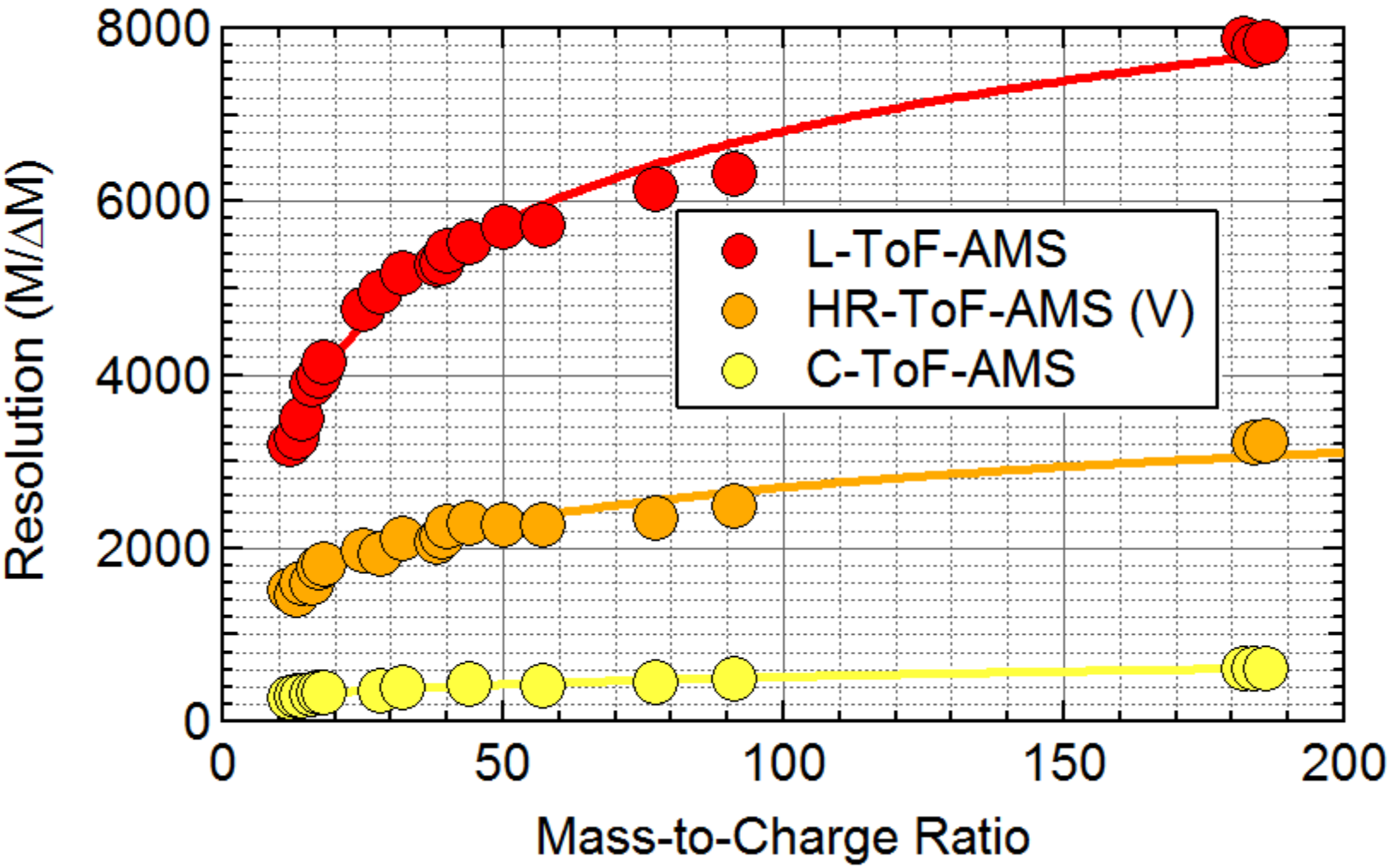
Long (L) TOF AMS

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



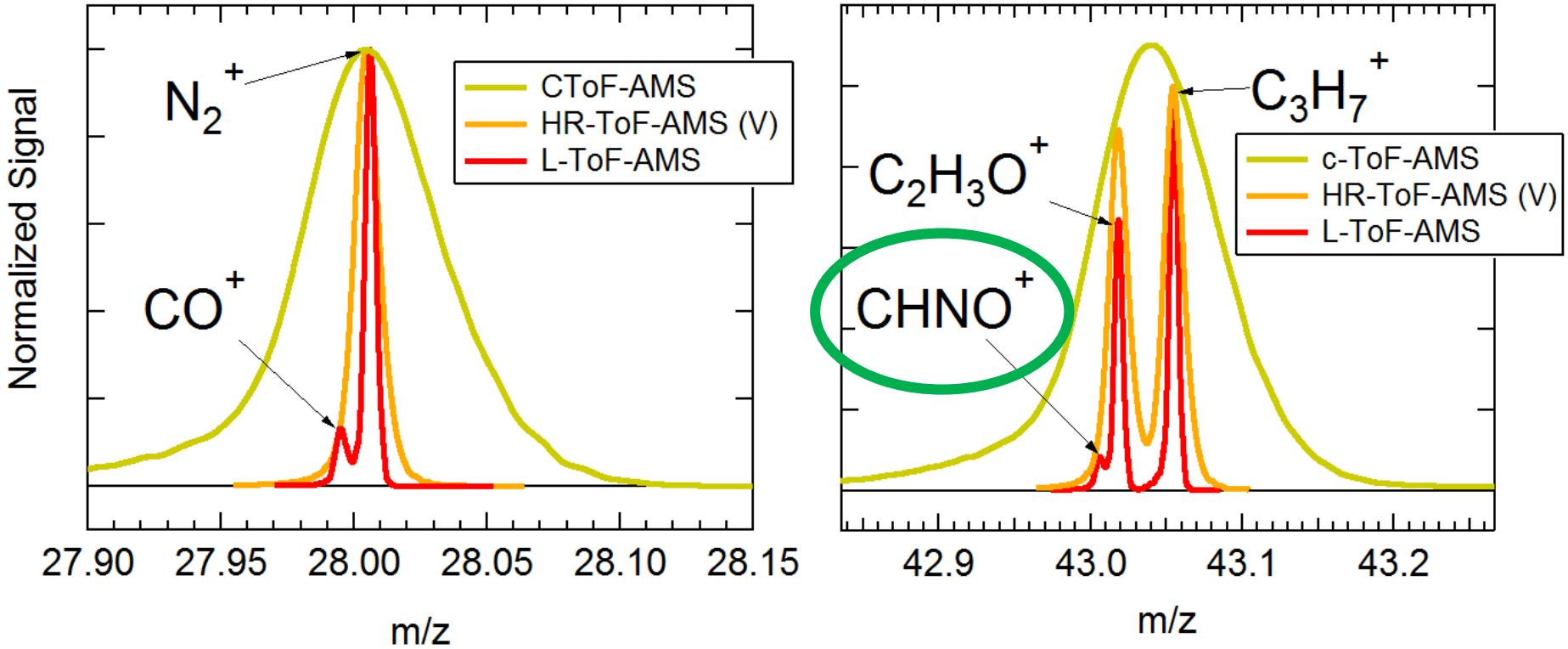
55” L x 24” D x 27” H, 275 lbs.
[139.7 cm x 60.9 cm x 68.6 cm, 124.7 kg]

Resolution of C-TOF, H-TOF and L-TOF



Andy Lambe

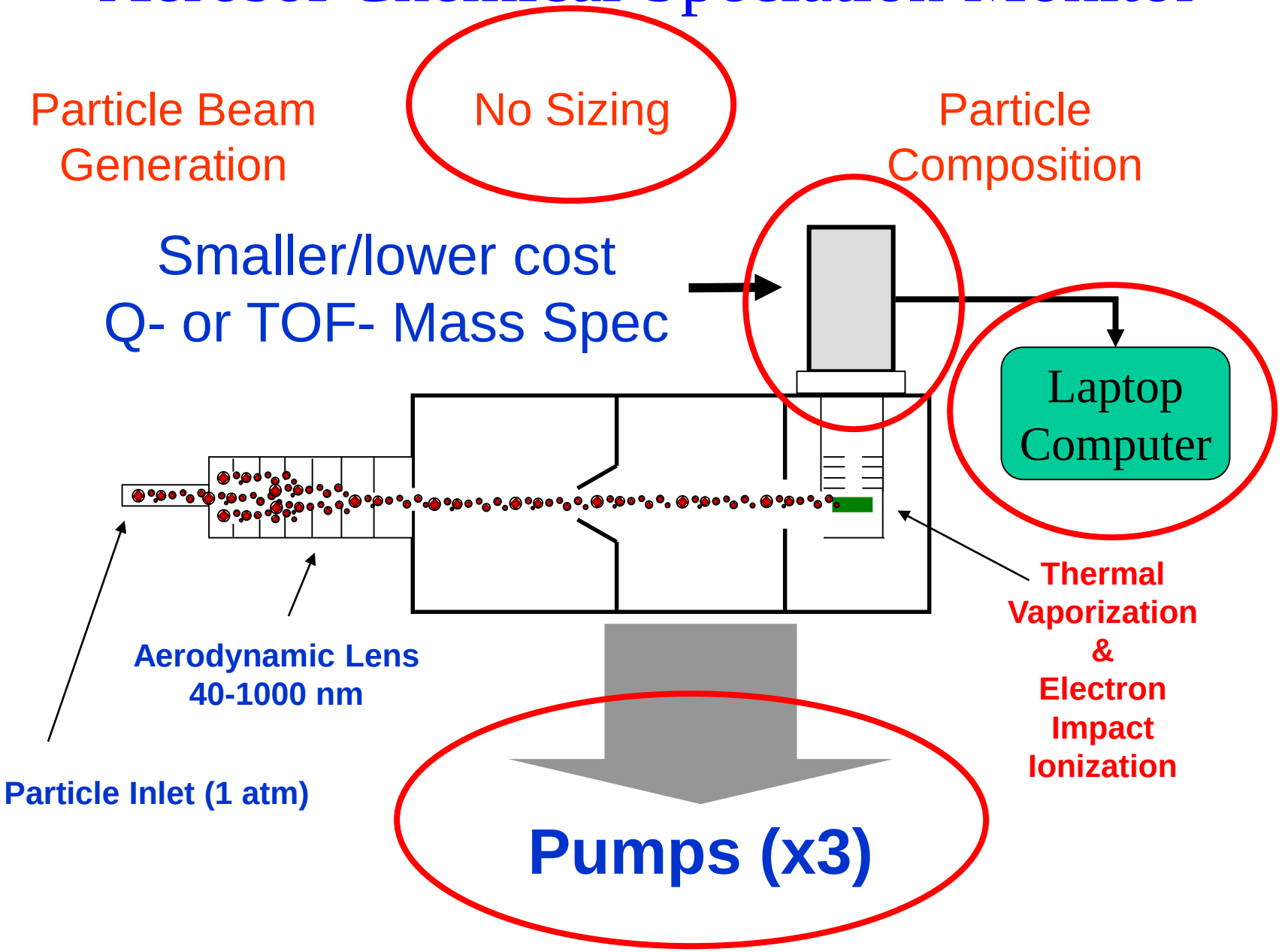
Qualitative Comparison of LTOF to C- and HTOF



Improved ability to report on elemental Nitrogen.

Andy Lambe

Aerosol Chemical Speciation Monitor

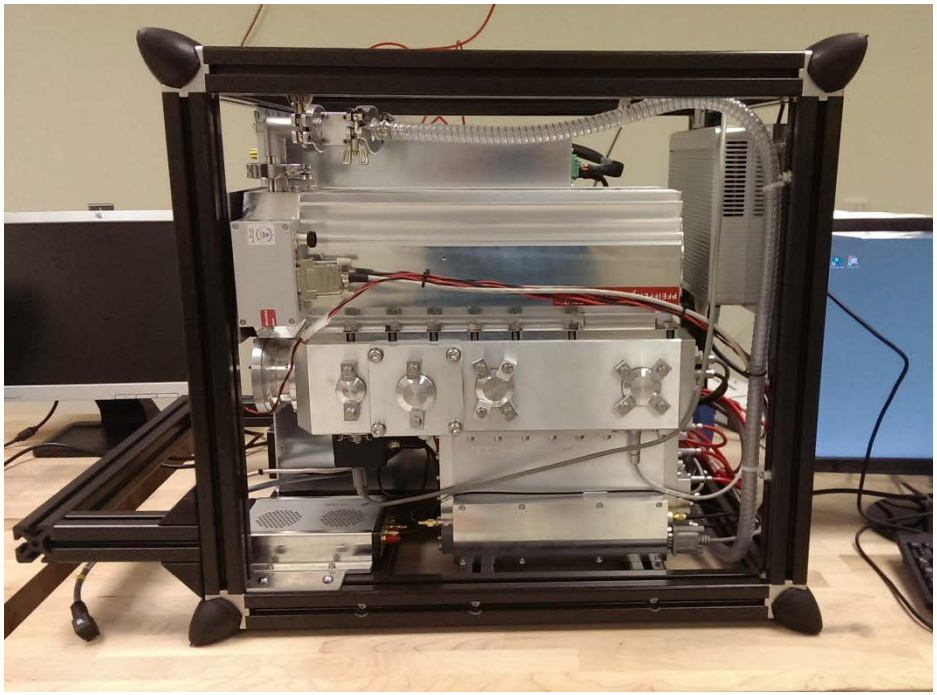


QACSM and ToF ACSM Systems

QACSM

For routine monitoring

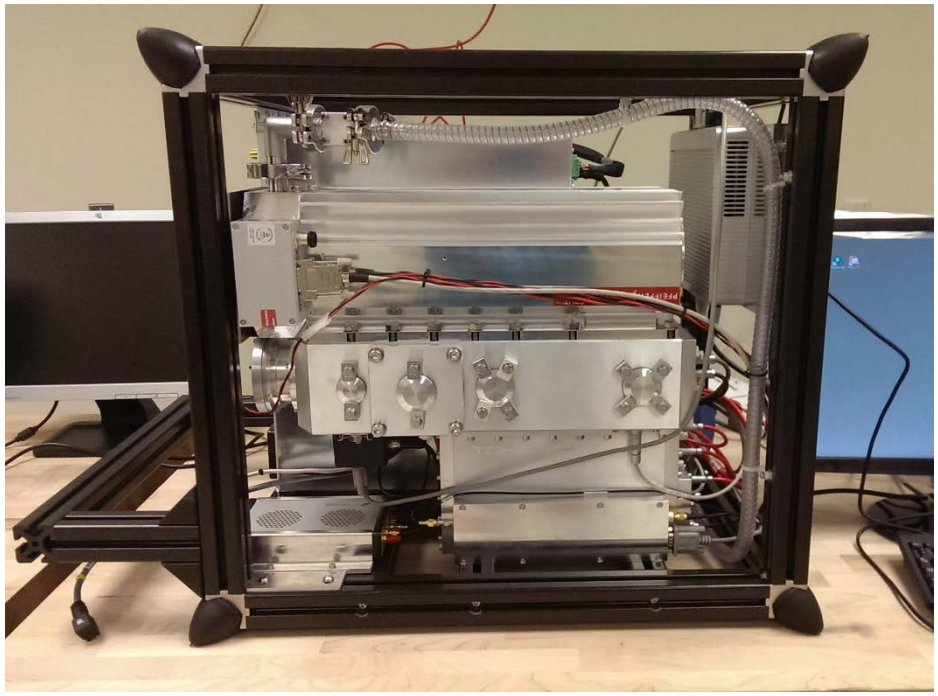
eTOF ACSM



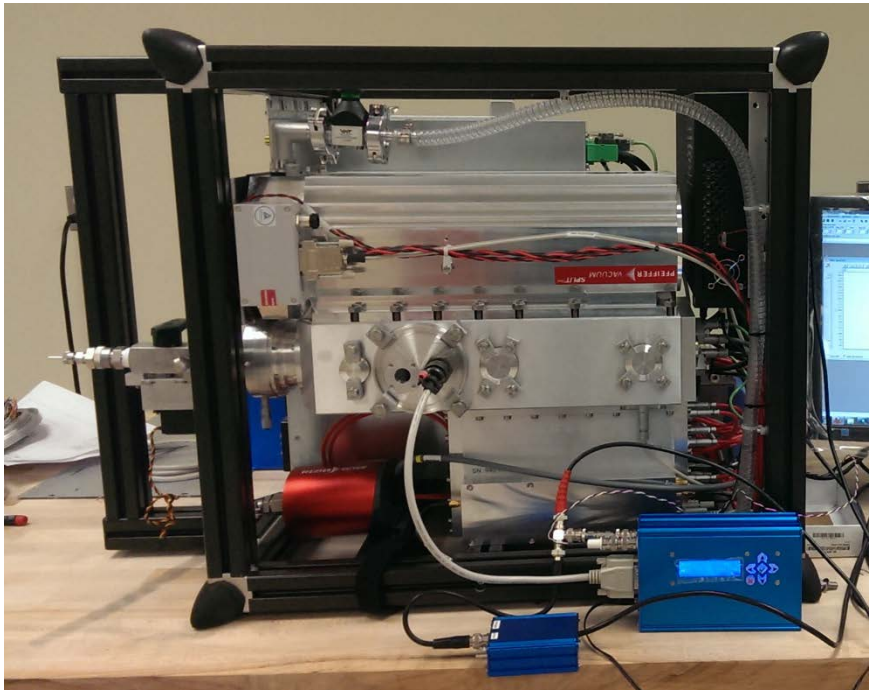
Higher performance version
Faster data rate (~1 min).

ToF ACSM and mini-AMS Systems

eTOF ACSM



cTOF mini-AMS



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

All AMS and ACSM Systems Share Some Common Features

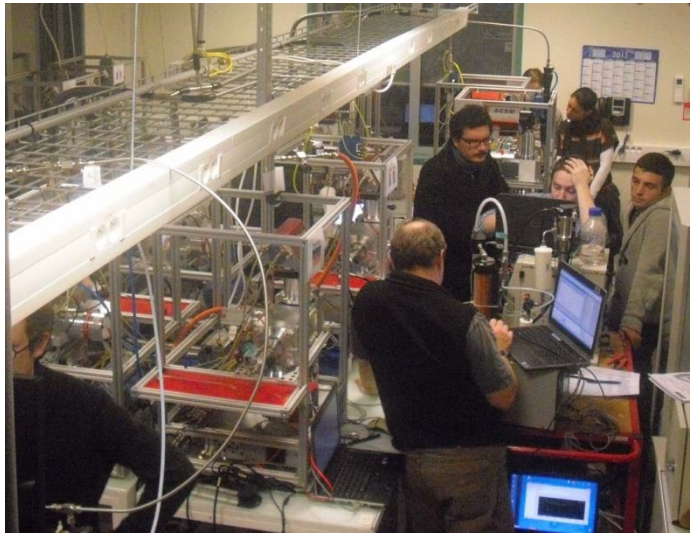
- Particle aerodynamic lens
- A differentially pumped high vacuum system, *efficient gas-particle separation*
- Particle vaporizer
- Electron impact ionization source
- Mass spectrometer ► performance/Cost

ACTRIS-ACSM intercomparison Studies in Paris 2013, 2016 and 2018

Aerosol Chemical Speciation Monitor Calibration Centre
(ACMCC at CNRS SIRTA Lab, France)

10 European countries

15 mass spectrometers
13 QACSM, TOF ACSM, HTOF AMS



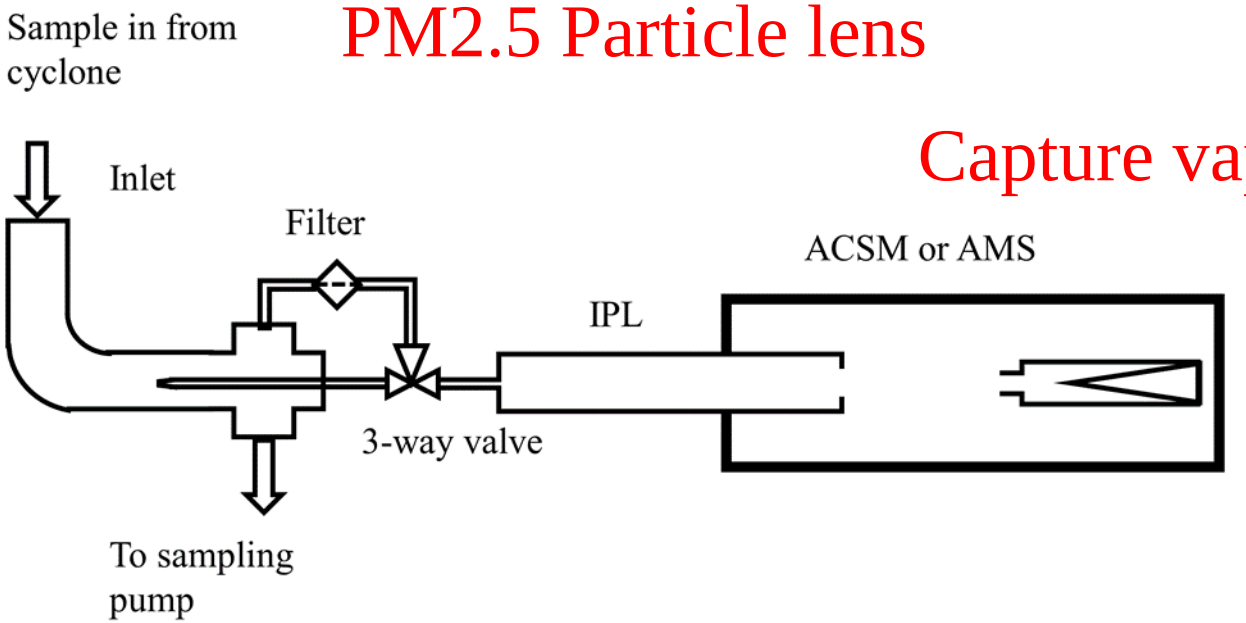
Now led by Evelyn Freney and Olivier Favez

PM2.5 Capability

Sampling system,
inlet plumbing

PM2.5 Particle lens

Capture vaporizer

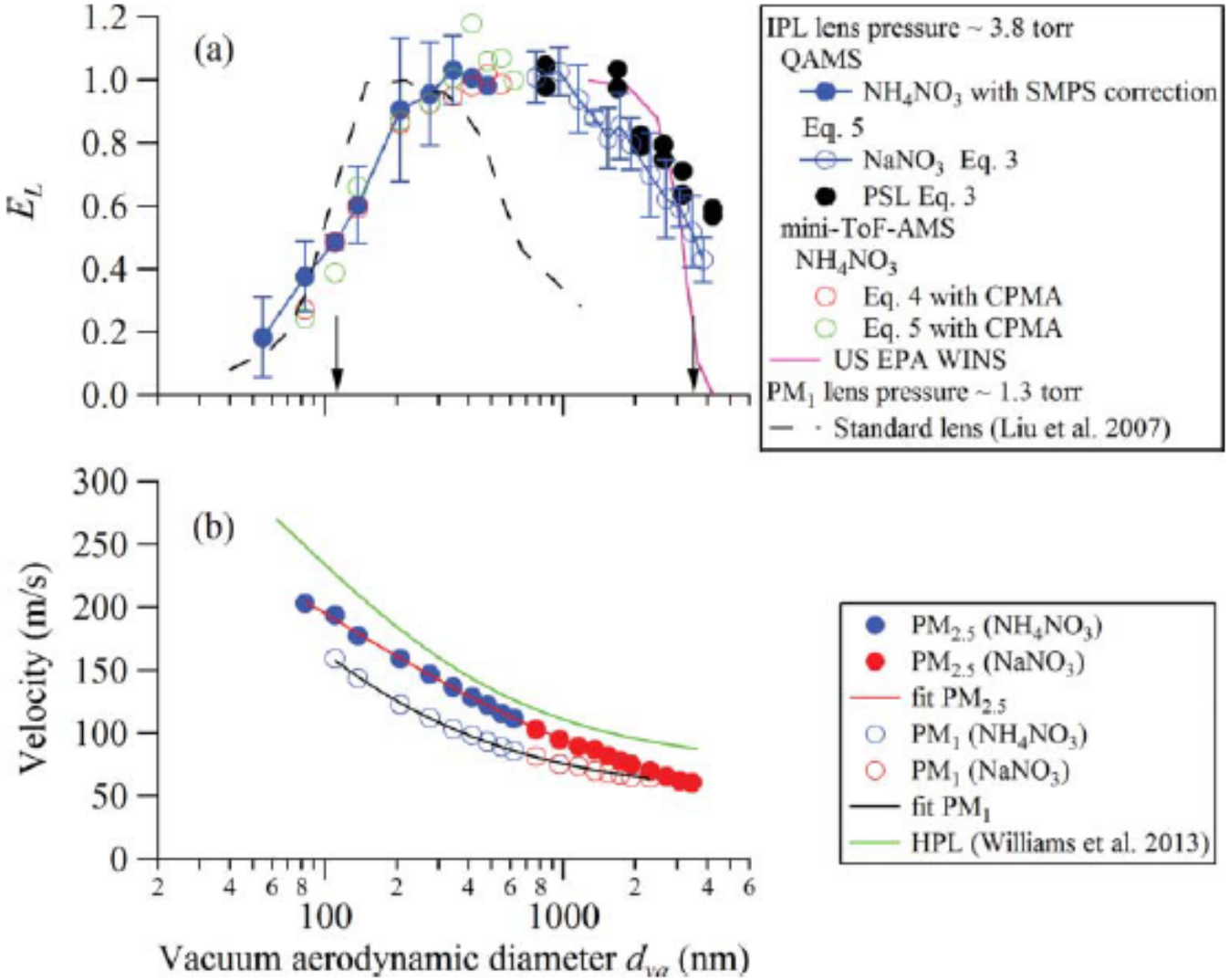


Xu et al, AS&T 2017
Yunjiang Zhang et al, ACP, 2017

Jian Zhao/Yele Sun - IAP

First PM2.5 QACSM instrument

PM2.5 Lens Transmission



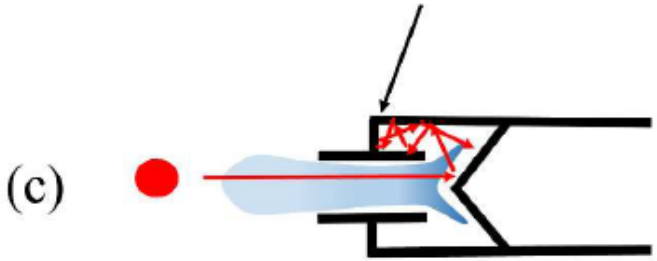
Xu et al, AS&T 2017

Particle Vaporizer Types

SV - Standard Vaporizer

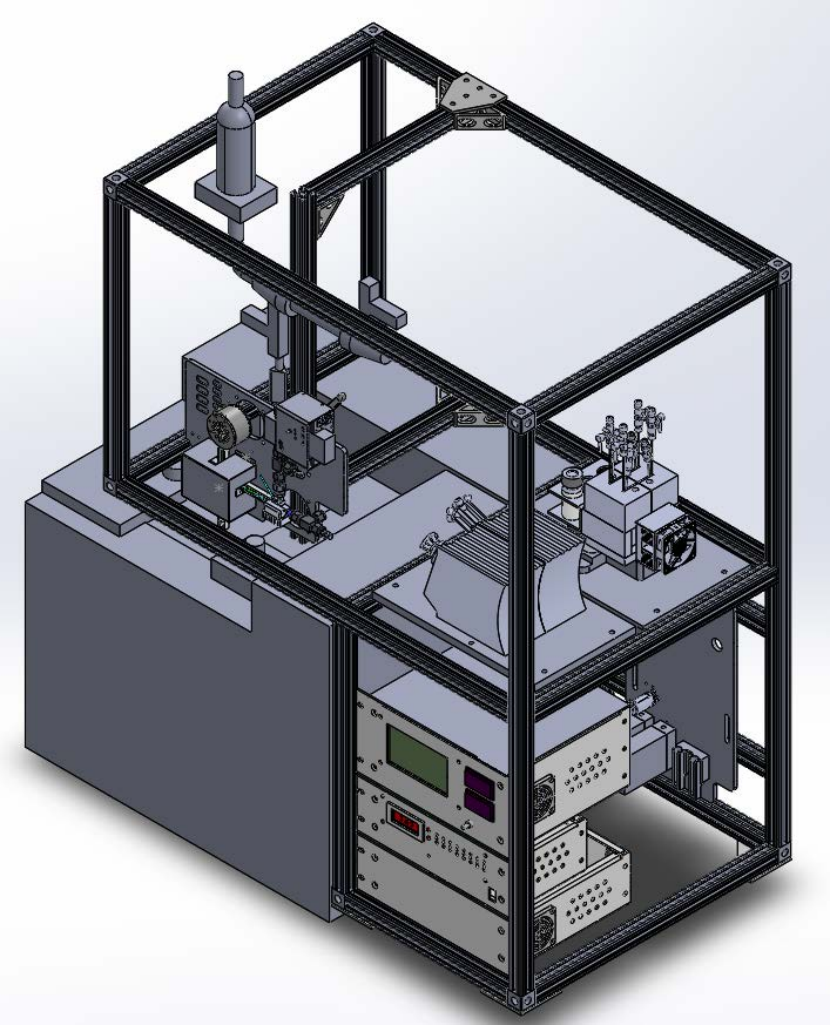
Xu et al, AS&T 2017

CV - capture Vaporizer



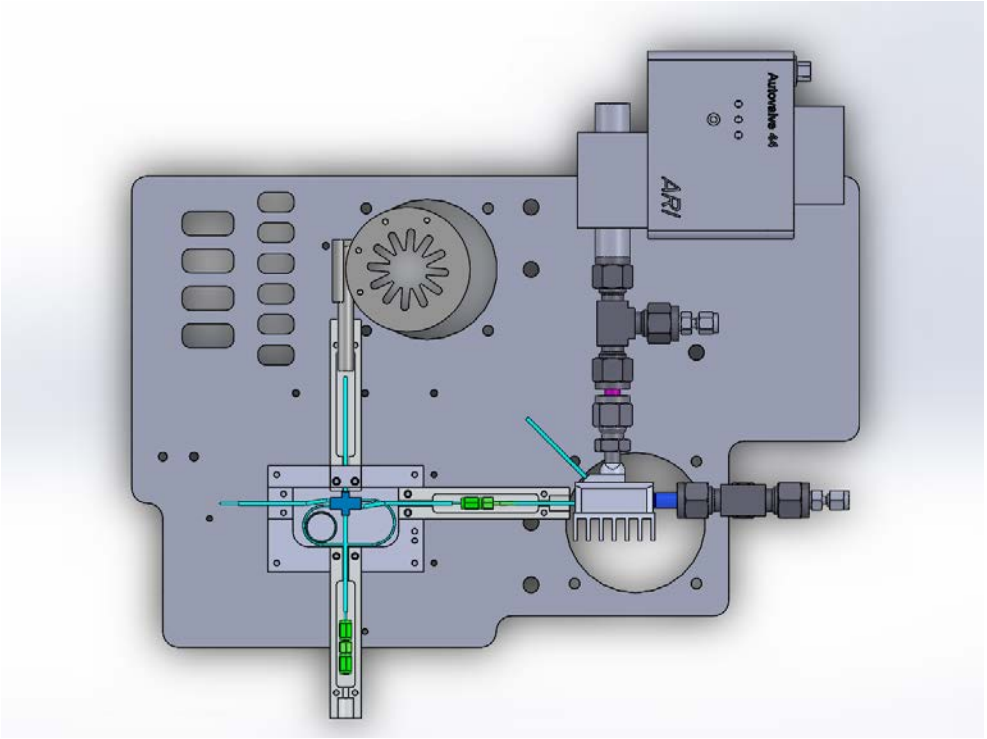
Hu et al,
AS&T (2017), AMT (2017), AS&T (2018),
ACS Earth and Space Chemistry (2018)

Stand-Alone TAG System for use with standard GCMS systems



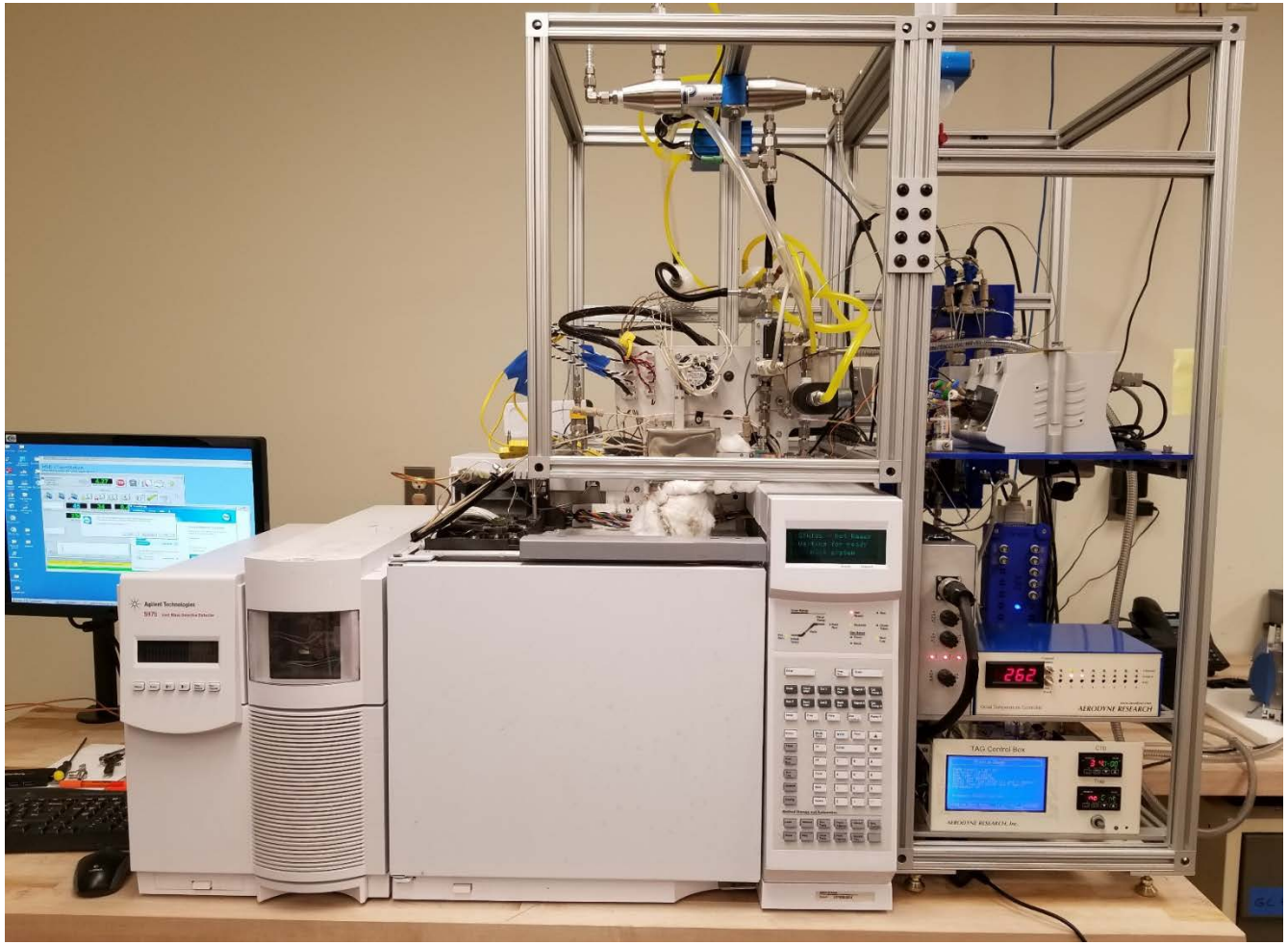
Wen Xu, Conor Mackinson, Aerodyne

Collection and Thermal Desorption cell (CTD) and valveless injector



Nathan Kreisberg, Aerosol Dynamics
Allen Goldstein, UC Berkeley

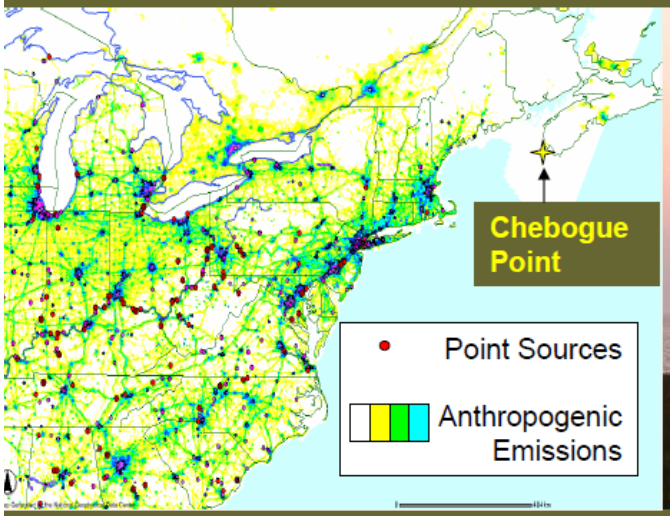
TAG System on Agilent GC-MS



Wen Xu, Nathan Kreisberg

Summer 2004
First TAG field deployment.
When TAG and AMS met

ICARTT Measurements at Chebogue Point



NOAA http://map.ngdc.noaa.gov/website/al/emissions/Run.htm

- ICARTT campaign at Chebogue Point during summer of 2004.
- Full range of meteorological, radiation, trace gas, and aerosol measurements
- TAG analysis focused on period of July 26 – Aug.15, 2004 (~3 weeks)
- Hourly data (750 chromatograms x 2 detectors)
- Manual calibration with directly applied standards
- Automated filtered and zero air blanks

Summer 2004
First TAG field deployment.
When TAG and AMS met

Aerosol Science and Technology, 40:627–638, 2006

ISSN: 0278-6826 print / 1521-7388 online
DOI: 10.1080/02786820600754631

An In-Situ Instrument for Speciated Organic Composition of Atmospheric Aerosols: Thermal Desorption Aerosol GC/MS-FID (TAG)

Brent J. Williams,[1] Allen H. Goldstein,[1] Nathan M. Kreisberg,[2] and Susanne V. Hering[2]
[1]*Department of Environmental Science, Policy, & Management, University of California, Berkeley, CA, USA*
[2]*Aerosol Dynamics Inc., Berkeley, California, USA*

Mini-GC for TOF MS

AERODYNE RESEARCH, Inc.

Brian Lerner, Megan Claflin

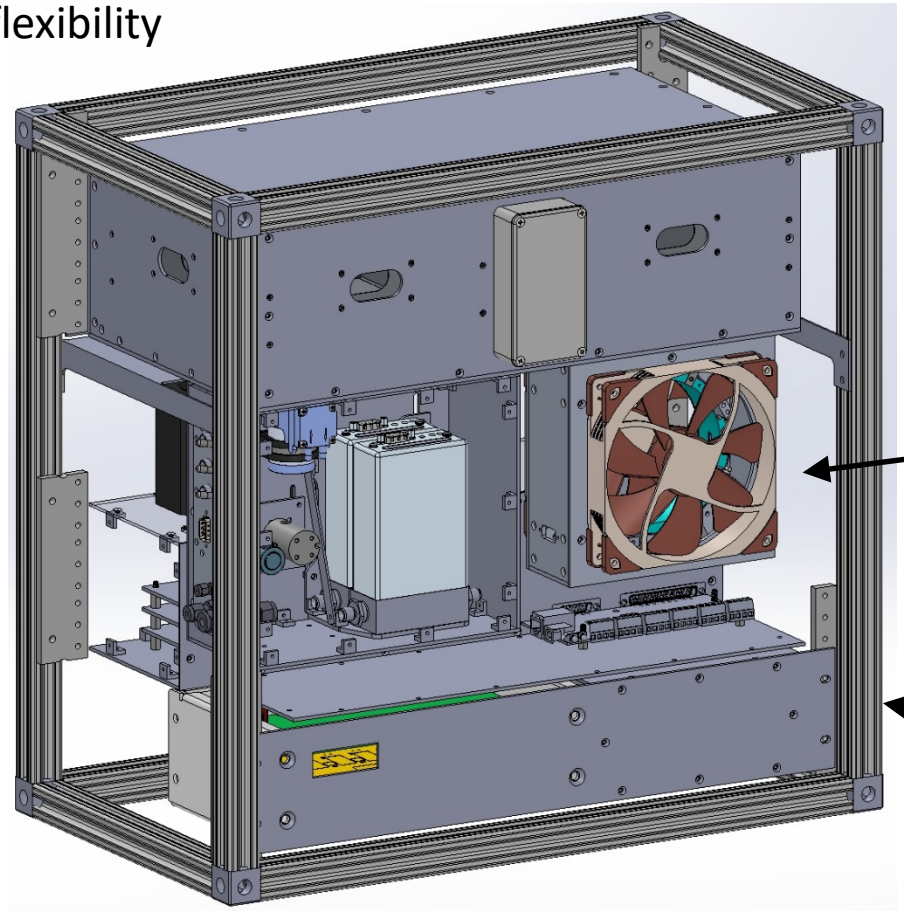
- Design a "proper" GC system for commercial sale
  - Couple seamlessly with EI- or Vocus- TOFMS
  - Modular design for flexibility
  - "Light and fast"

Valve oven
- 2-zone control
- Chromatography valves
- Sample loops

Gas deck
- MFCs
- Calibration valves

Data box

Octal temp controller



GC oven

Power supplies

Mini-GC mounted to EI-TOF MS

AERODYNE RESEARCH, Inc.

Brian Lerner, Megan Claflin

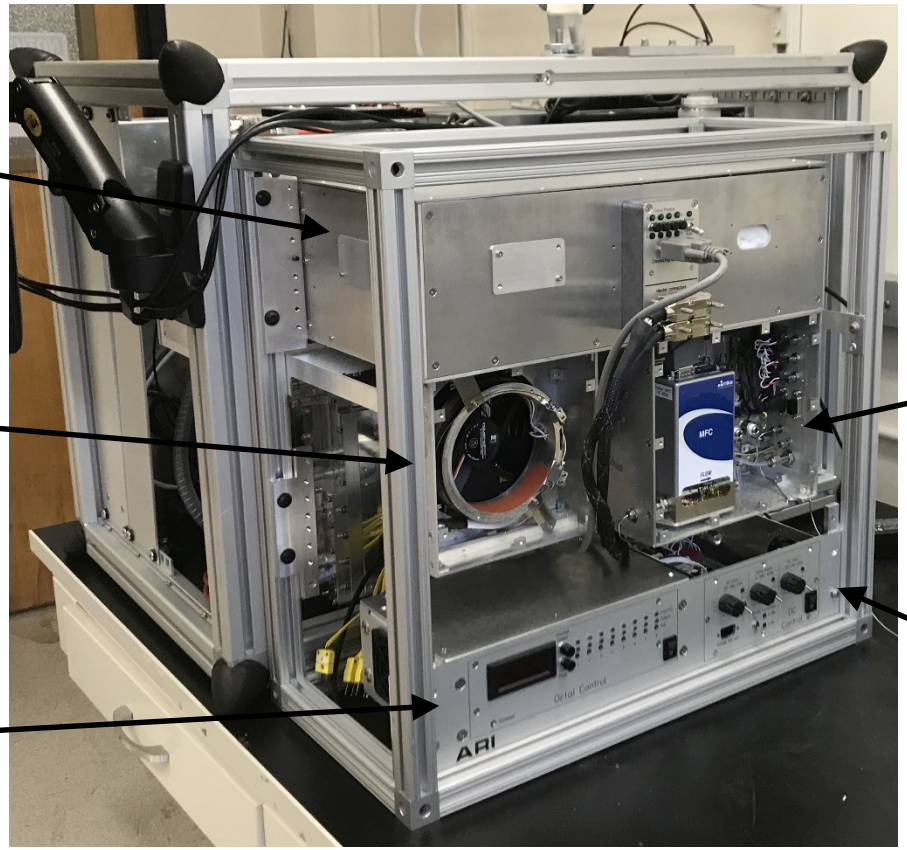
- Design a "proper" GC system for commercial sale
  - Shown mated to EI-TOFMS

Valve oven
- 2-zone control
- Chromatography valves
- Sample loops

GC oven

Data box

Octal temp controller



Gas deck
- MFCs
- Calibration valves

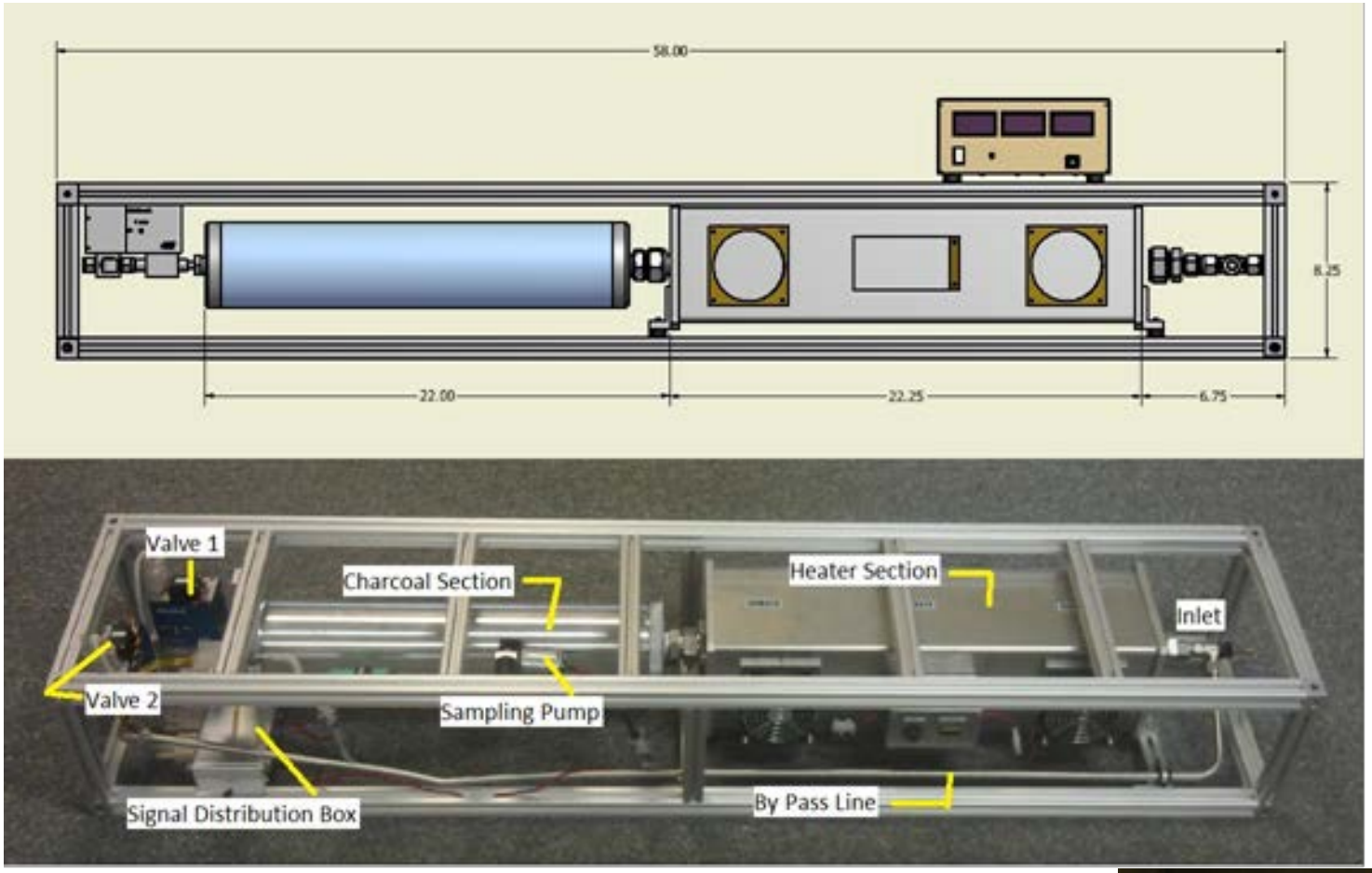
Power supplies

PAM Oxidation Flow Reactor

Radical Precursors + hv →→ Radicals
Radicals + Aerosol Precursors →→ Oxidation Products

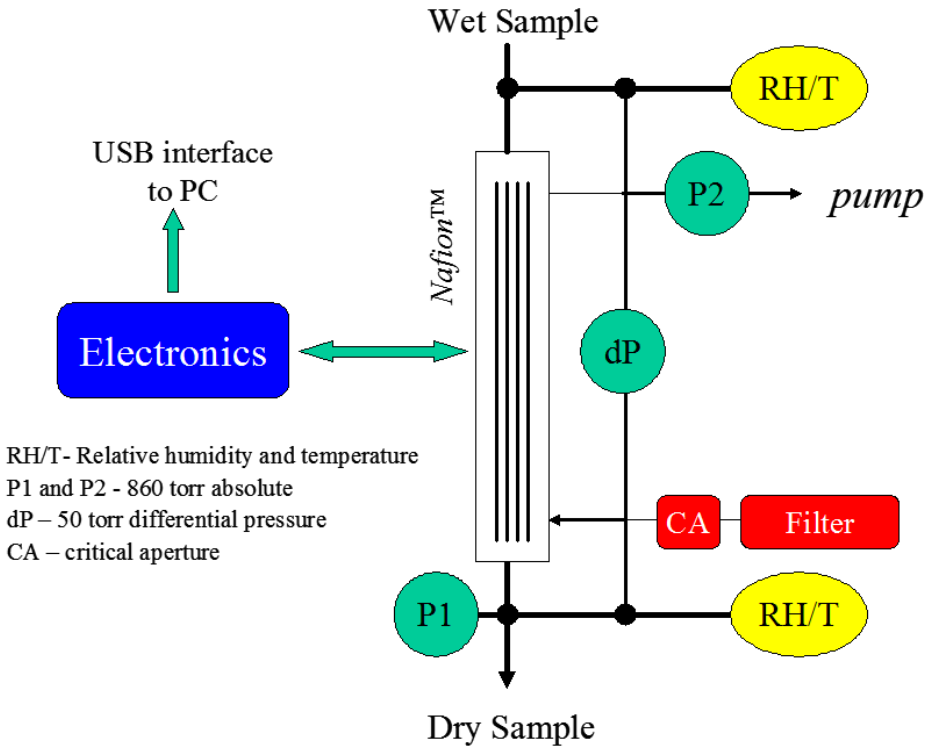
- Technique developed by Bill Brune (Kang et al., ACP, 2007)
- **Includes**: OFR, O_3 chamber, humidifier, autovalve, UV and RH/T sensors
- **Options**: MFCs, UV lamps (λ = 313 – 369 nm), syringe pump
- Remote control via PAMcontrols software

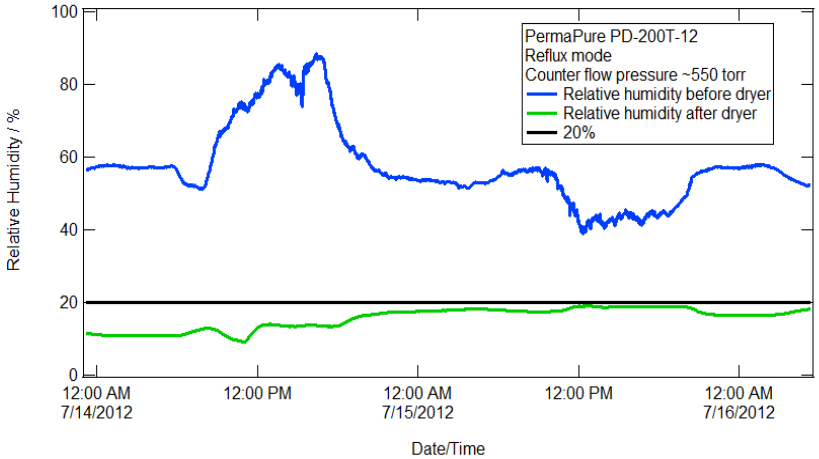
Thermal Denuder System



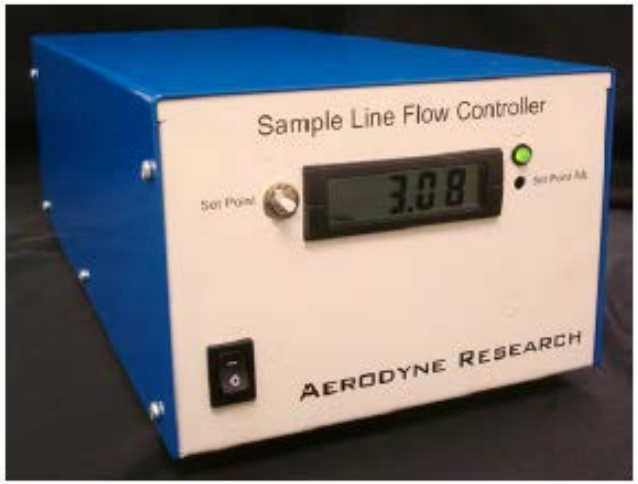
For aerosol volatility studies

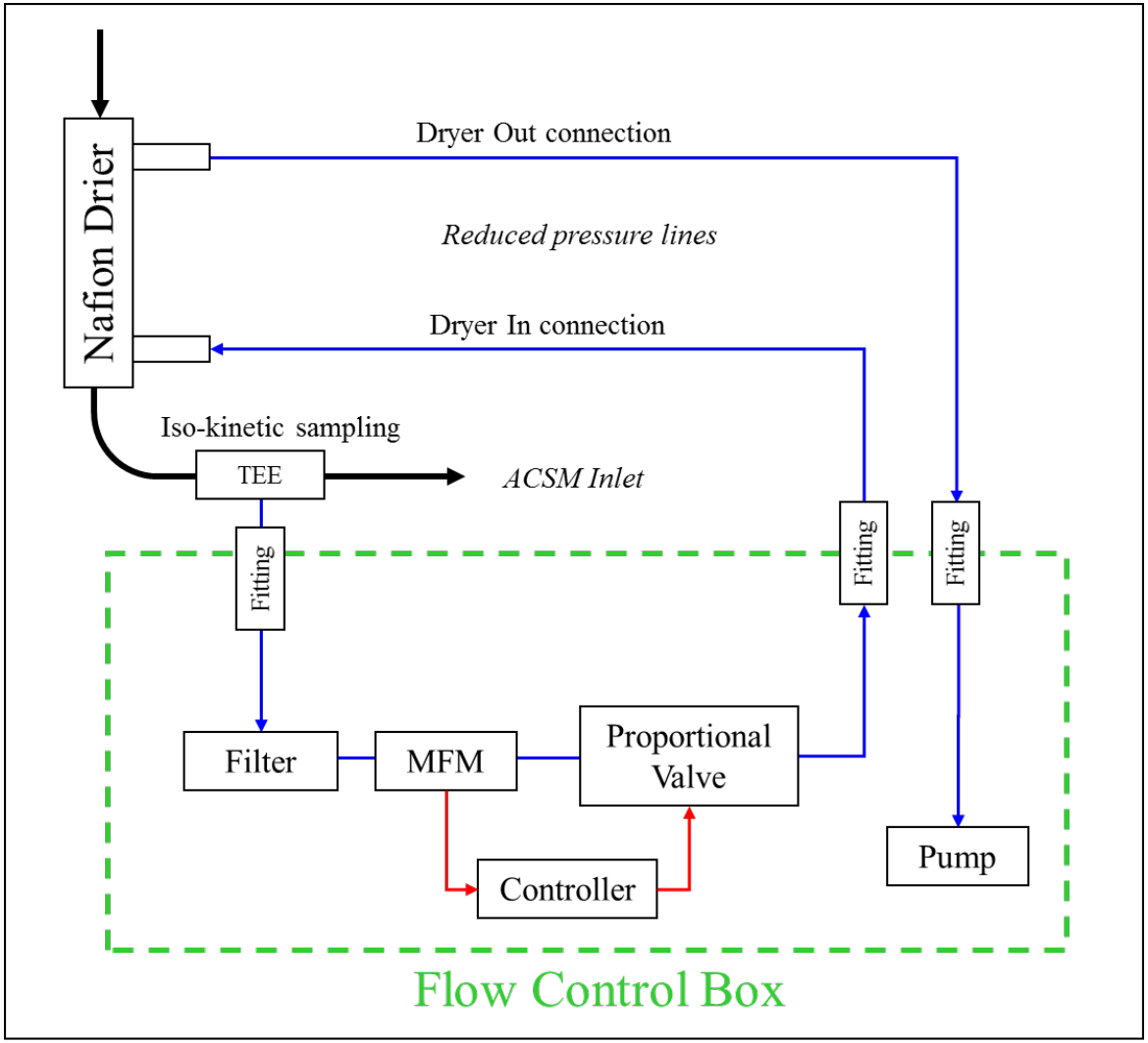
Aerosol Sample Dryer System





Sample Line Flow Controller System



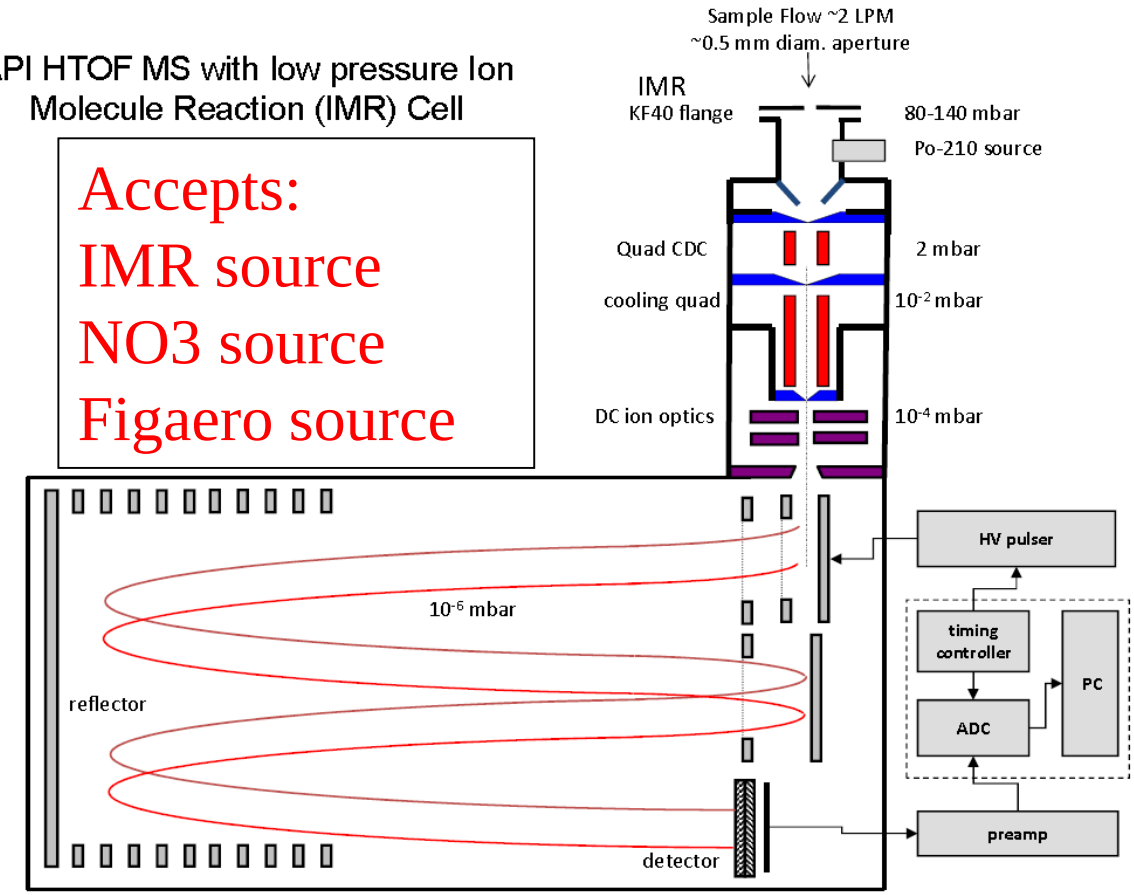


- Light weight, low power (24V)
- Up to 10 LPM
- Compatible with Dryer system

High Resolution Chemical Ionization Mass Spectrometer - CIMS

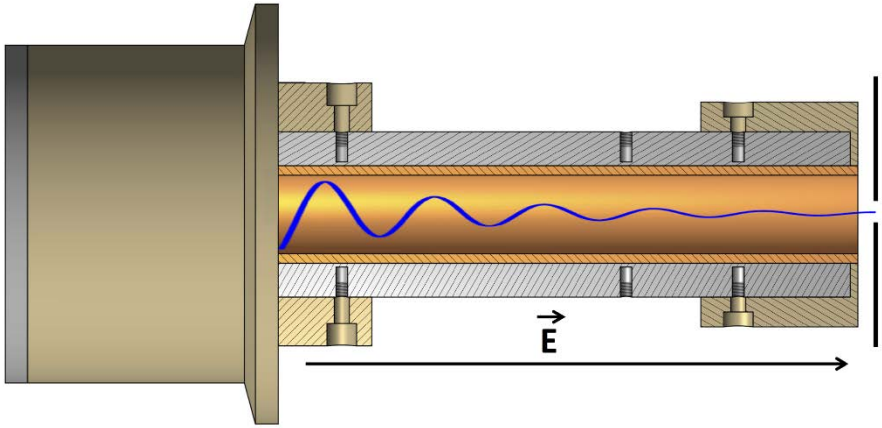
API HTOF MS with low pressure Ion Molecule Reaction (IMR) Cell

Accepts:
IMR source
NO3 source
Figaero source

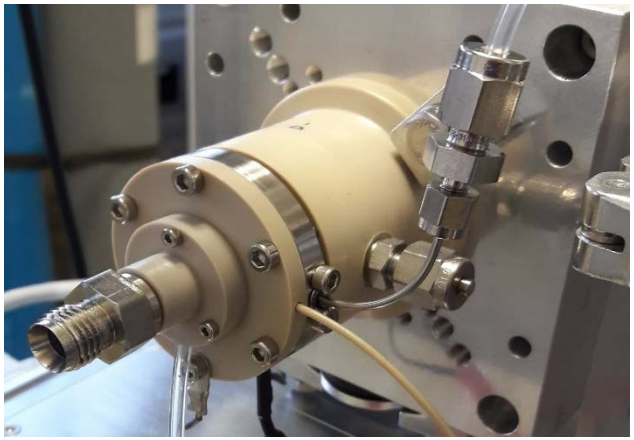


- Can be configured with various reagent ionization sources.
- Can also detect naturally occurring ambient ions - Api-TOF

VOCUS PTR LTOF MS



Reaction cell with RF focusing



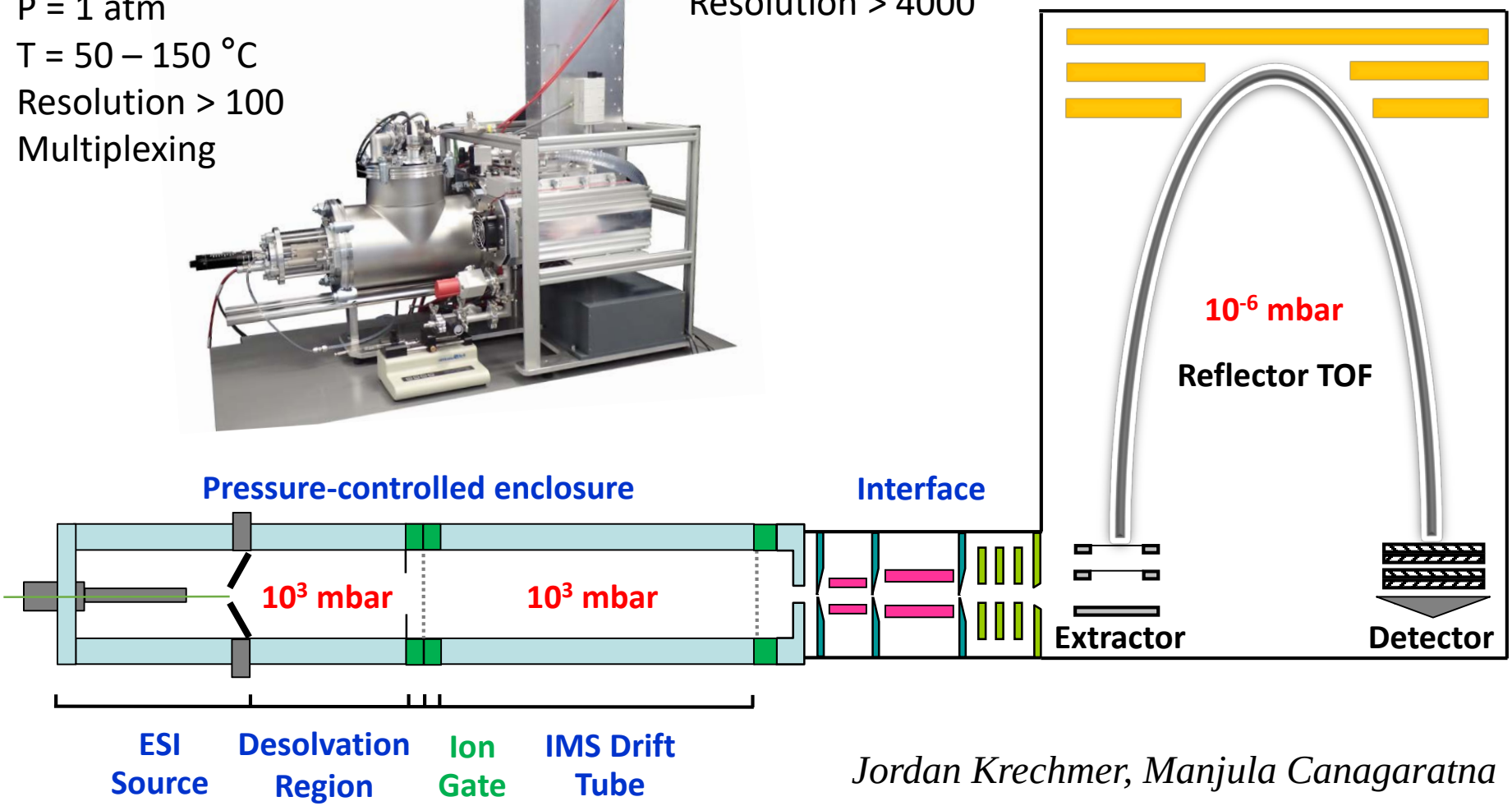
Evaluation of a New Vocus Reagent-Ion Source and Focusing Ion-Molecule Reactor for use in Proton-Transfer-Reaction Mass Spectrometry., Krechmer, et al. (2018): ChemRxiv. Preprint.

Ion Mobility Spectrometer TOF MS

Separation of structurally similar isobaric compounds.

Low field Drift Tube
P = 1 atm
T = 50 – 150 °C
Resolution > 100
Multiplexing

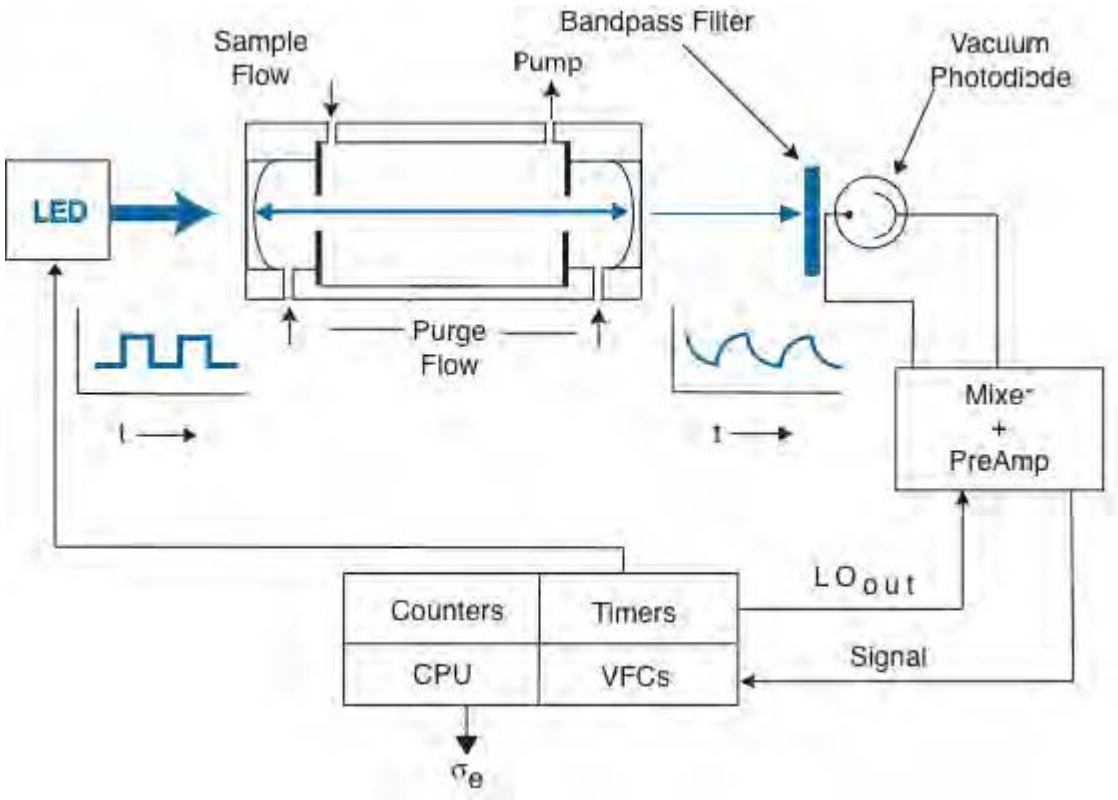
TOF-MS
Mass accuracy ~ 2-7 ppm
Resolution > 4000



Jordan Krechmer, Manjula Canagaratna

CAPS NO_2, PMex and SSA Monitors

Particle Extinction and Single Scattering Albedo

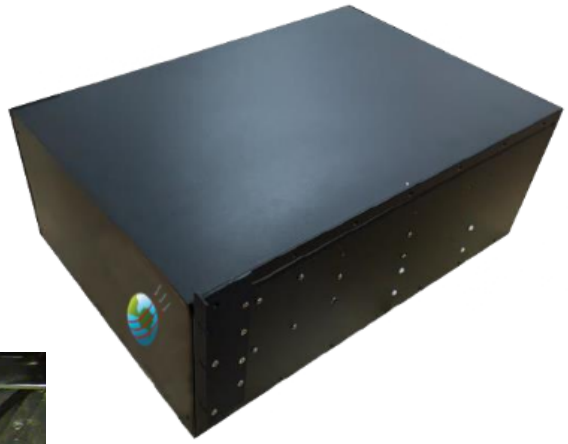


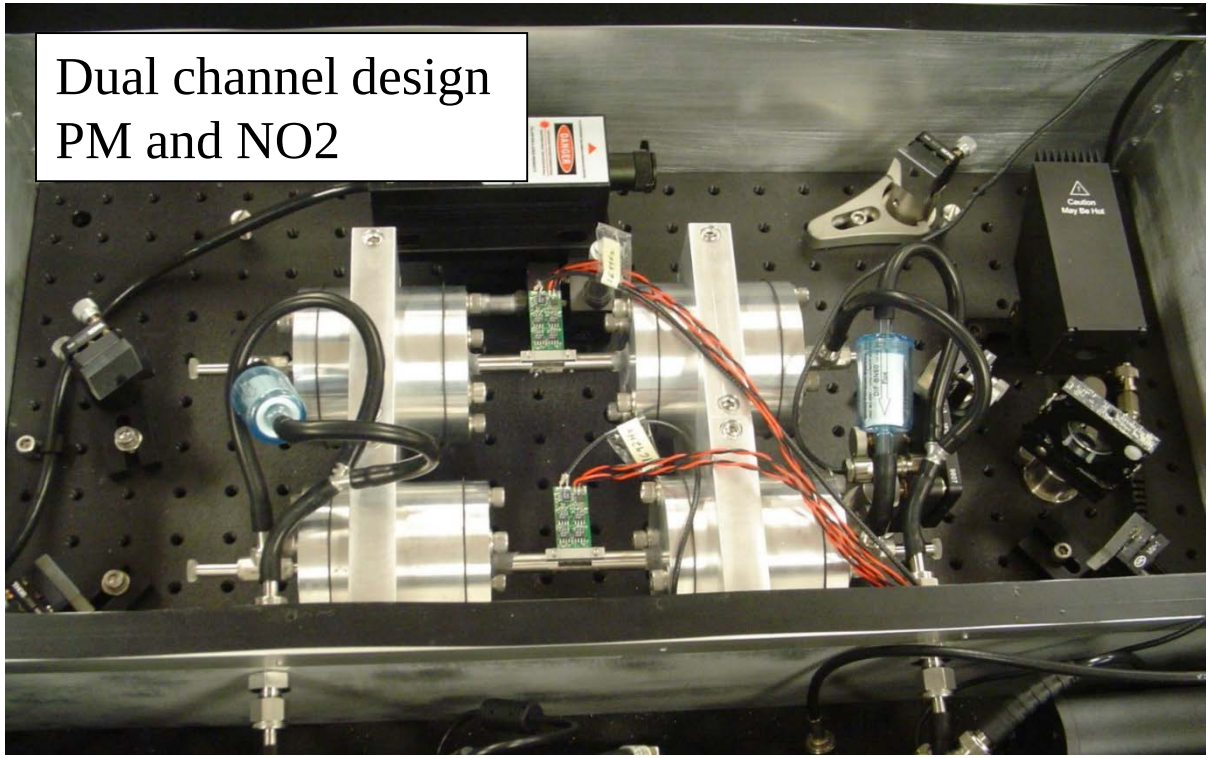
3-wavelength version now available

Andy Freedman/Tim Onasch/Phil Croteau

DPAS Aerosol Absorption Monitor

Real-time and continuous PM detection and quantification with high sensitivity





Differential Photoacoustic Absorption Monitor

Zhenhong Yu, Aerodyne

Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2017-138, 2017
Manuscript under review for journal Atmos. Meas. Tech.
Discussion started: 5 May 2017

ARISense

Use of electrochemical sensors for measurement of air pollution: correcting interference response and validating measurements

Eben S. Cross[1], David K. Lewis[1,2], Leah R. Williams[1], Gregory R. Magoon[1], Michael L. Kaminsky[3], Douglas R. Worsnop[1] and John T. Jayne[1]

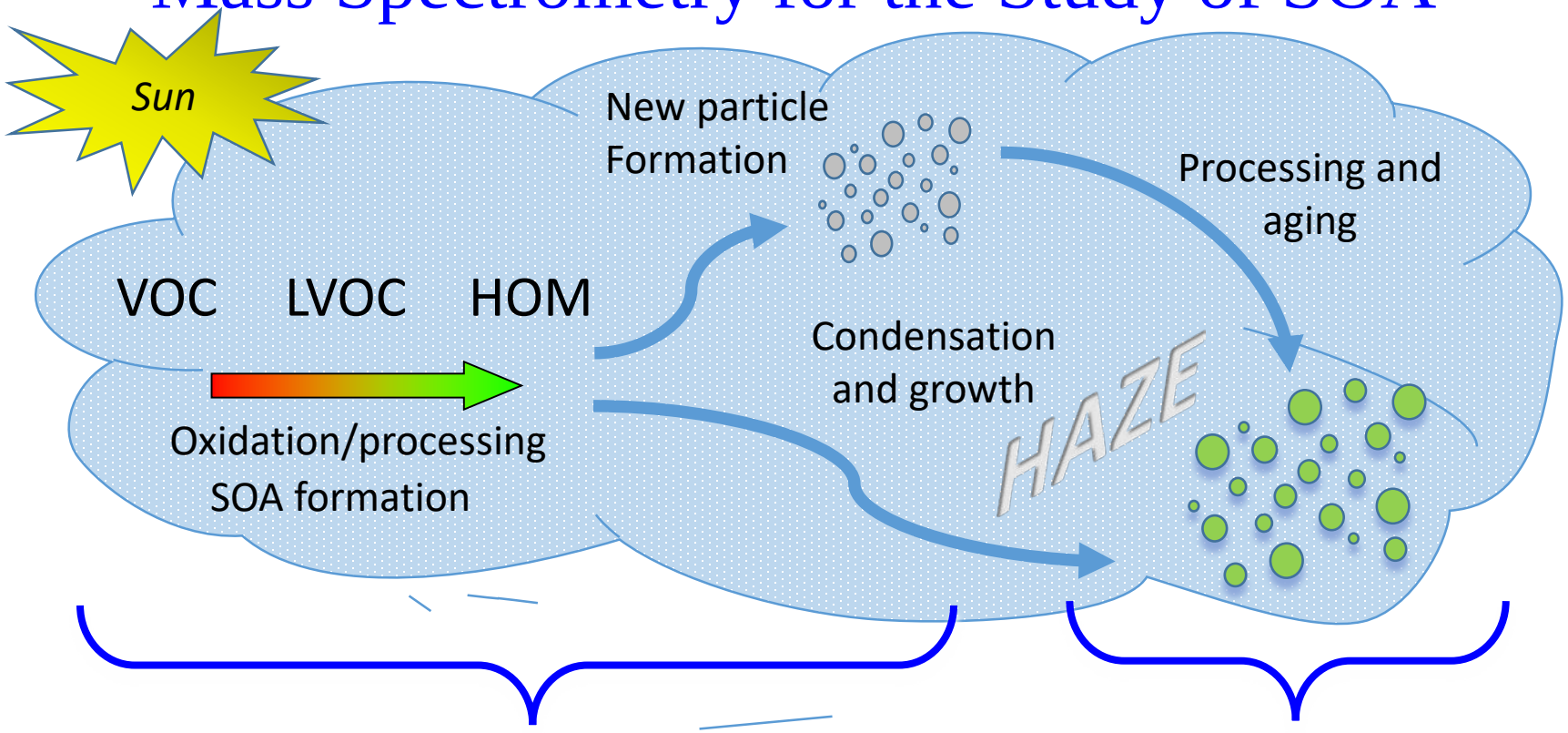
Air Quality Sensor System

Integrates 16 Measurements

- CO, NO, NO2, Ox, CO2
- Particle size ~(0.4 -17) um, 16 bins
- PM1, 2.5, 10
- Wind speed, Wind direction
- Solar
- Sound/noise
- Barometric pressure
- Relative Humidity
- Temperature

Eben Cross

CACC Research Group Focus
Mass Spectrometry for the Study of SOA



GC → PTR → CIMS (I^-, NO_3^-) → APi AMS

Decreasing Volatility →

Aerosol Composition
Chemical and physical properties

Compare observations from lab and field measurements to better understand gas to particle transformations