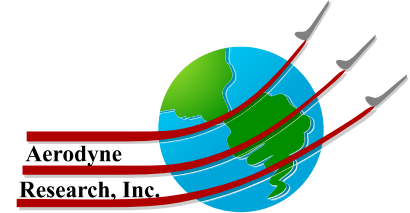
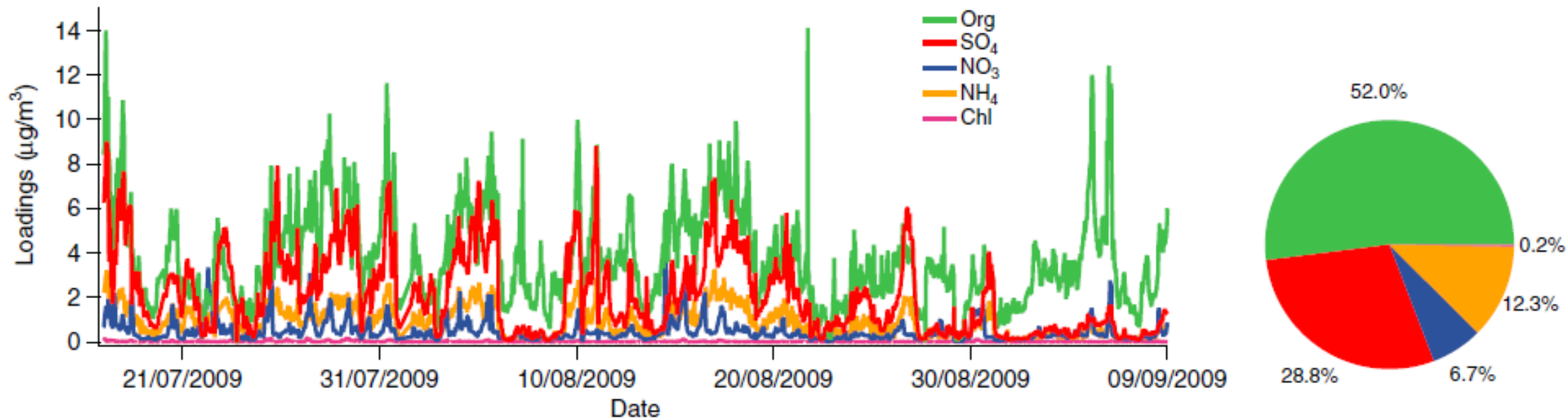


# Aerosol Chemical Speciation Monitor ACSM



Long-term unattended mass spectrometry-based measurements of aerosol chemical composition

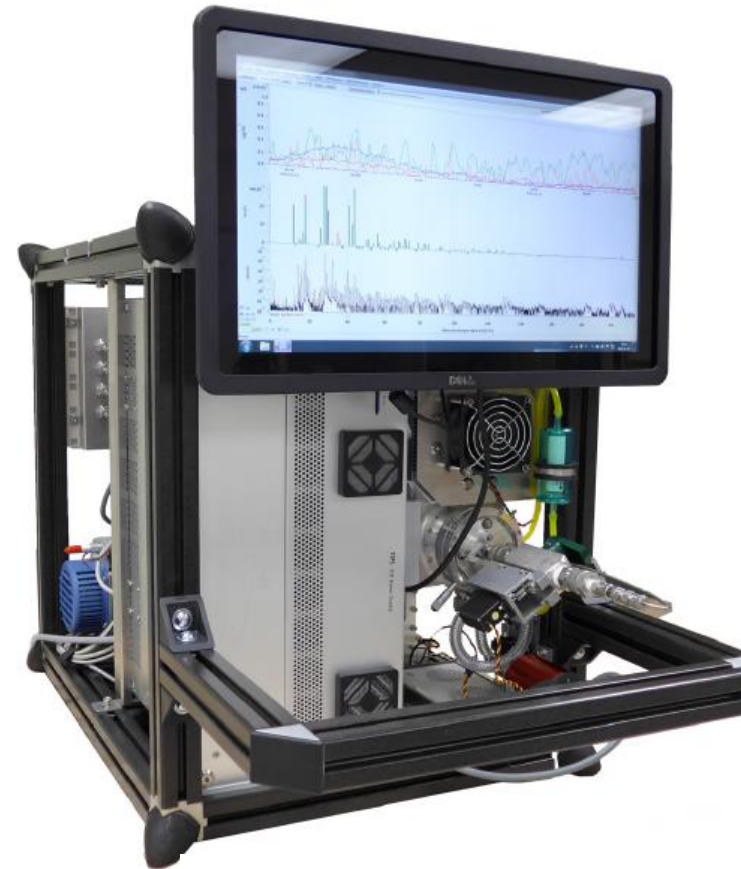


Philip Croteau – [croteau@aerodyne.com](mailto:croteau@aerodyne.com)

# Quadrupole, Q-ACSM



# Time-of-Flight, ToF-ACSM



## Aerosol Science and Technology

Publication details, including instructions for authors and subscription information:  
<http://www.informaworld.com/smpp/title~content=t713656376>

### An Aerosol Chemical Speciation Monitor (ACSM) for Routine Monitoring of the Composition and Mass Concentrations of Ambient Aerosol

N. L. Ng<sup>a</sup>; S. C. Hemdon<sup>a</sup>; A. Trimborn<sup>a</sup>; M. R. Canagaratna<sup>a</sup>; P. L. Croteau<sup>a</sup>; T. B. Onasch<sup>a</sup>; D. Sueper<sup>b</sup>; D. R. Worsnop<sup>a</sup>; Q. Zhang<sup>a</sup>; Y. L. Sun<sup>a</sup>; J. T. Jayne<sup>a</sup>


<sup>a</sup> Aerodyne Research, Inc., Billerica, Massachusetts, USA <sup>b</sup> CIRES, University of Colorado, Boulder, Colorado, USA <sup>c</sup> Department of Environmental Toxicology, University of California, Davis, California, USA

3/27/2018  
 First published on: 07 March 2011

Aerodyne Users Meeting PKU 2017

Atmos. Meas. Tech., 6, 3225–3241, 2013  
[www.atmos-meas-tech.net/6/3225/2013/](http://www.atmos-meas-tech.net/6/3225/2013/)  
 doi:10.5194/amt-6-3225-2013  
 © Author(s) 2013. CC Attribution 3.0 License.

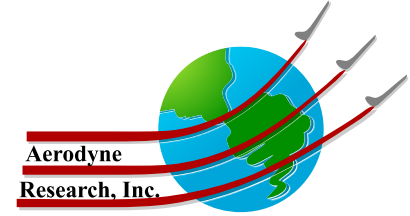


Atmospheric  
 Measurement  
 Techniques  


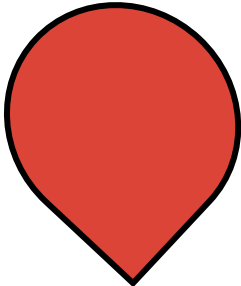
### The ToF-ACSM: a portable aerosol chemical speciation monitor with TOFMS detection

R. Fröhlich<sup>1</sup>, M. J. Cubison<sup>2</sup>, J. G. Slowik<sup>1</sup>, N. Bukowiecki<sup>1</sup>, A. S. H. Prévôt<sup>1</sup>, U. Baltensperger<sup>1</sup>, J. Schneider<sup>2</sup>, J. R. Kimmel<sup>3</sup>, M. Gonin<sup>3</sup>, U. Rohner<sup>3</sup>, D. R. Worsnop<sup>4</sup>, and J. T. Jayne<sup>1</sup>

# 112 ACSMs Around the World

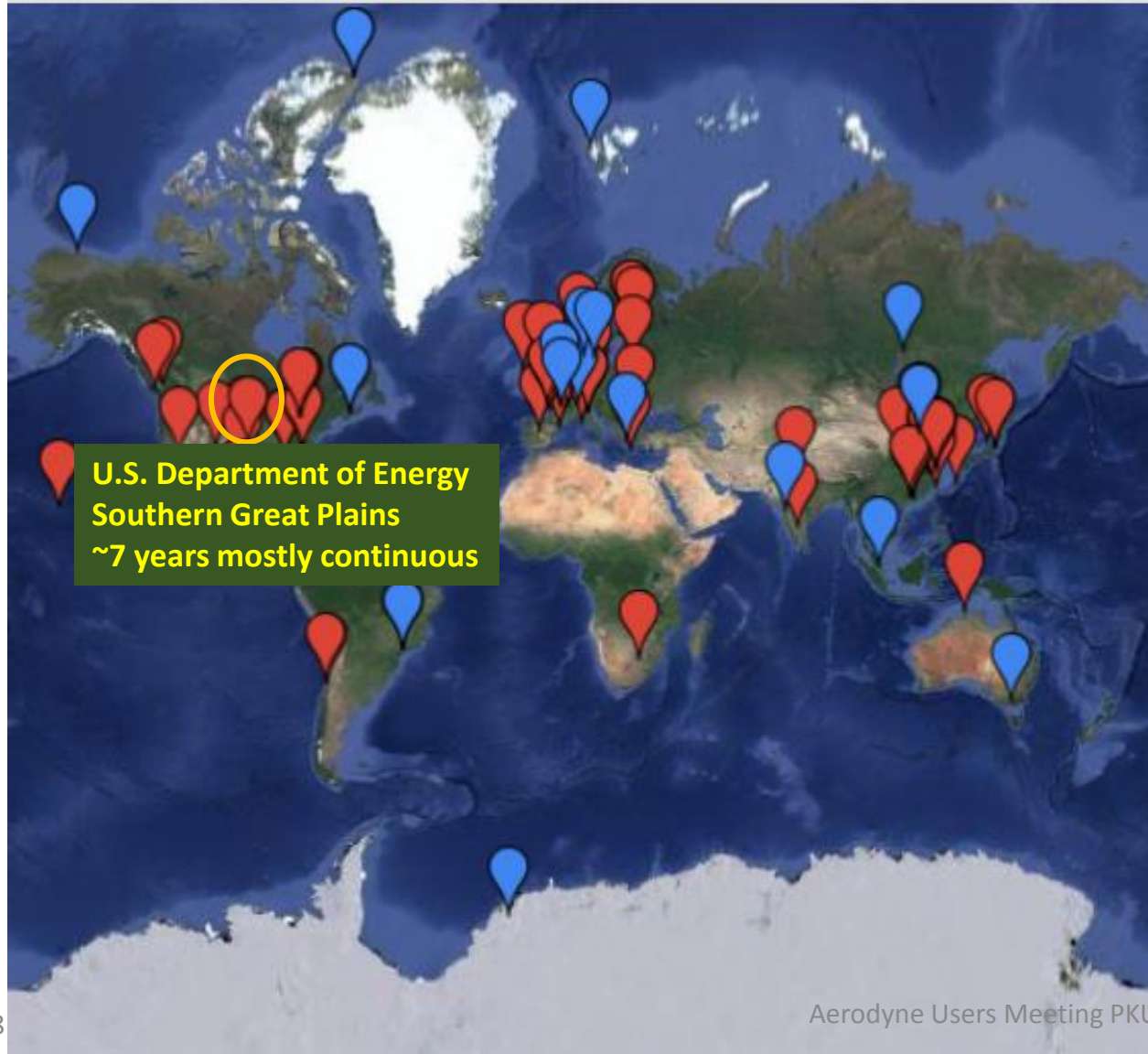


 ToF-ACSM  
x21

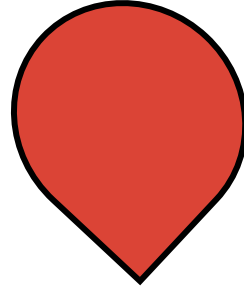
 Q-ACSM  
x91



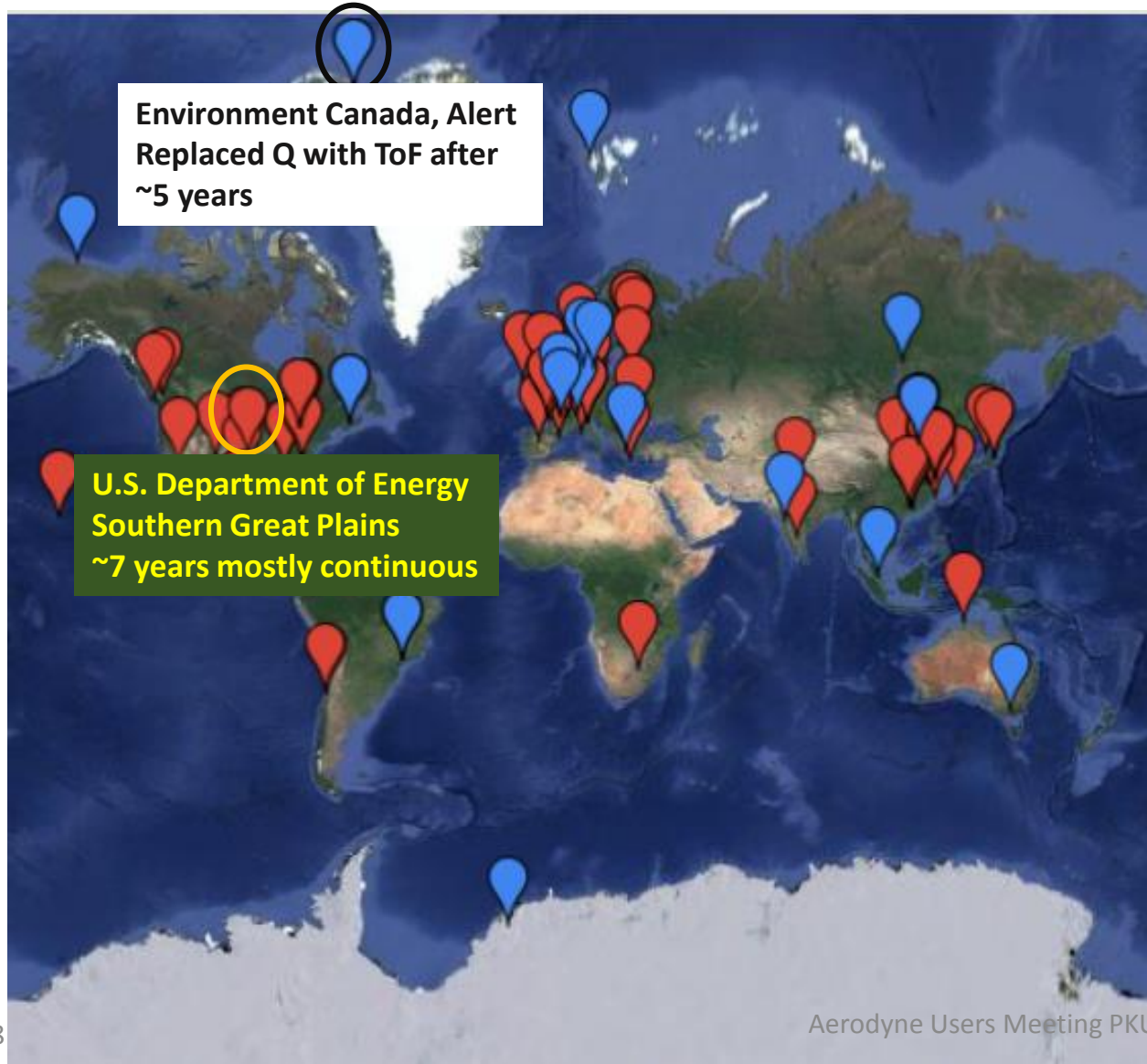
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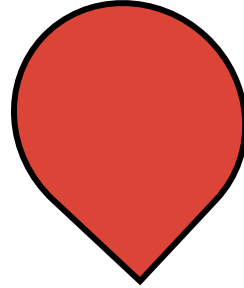
 ToF-ACSM  
x21

 Q-ACSM  
x91

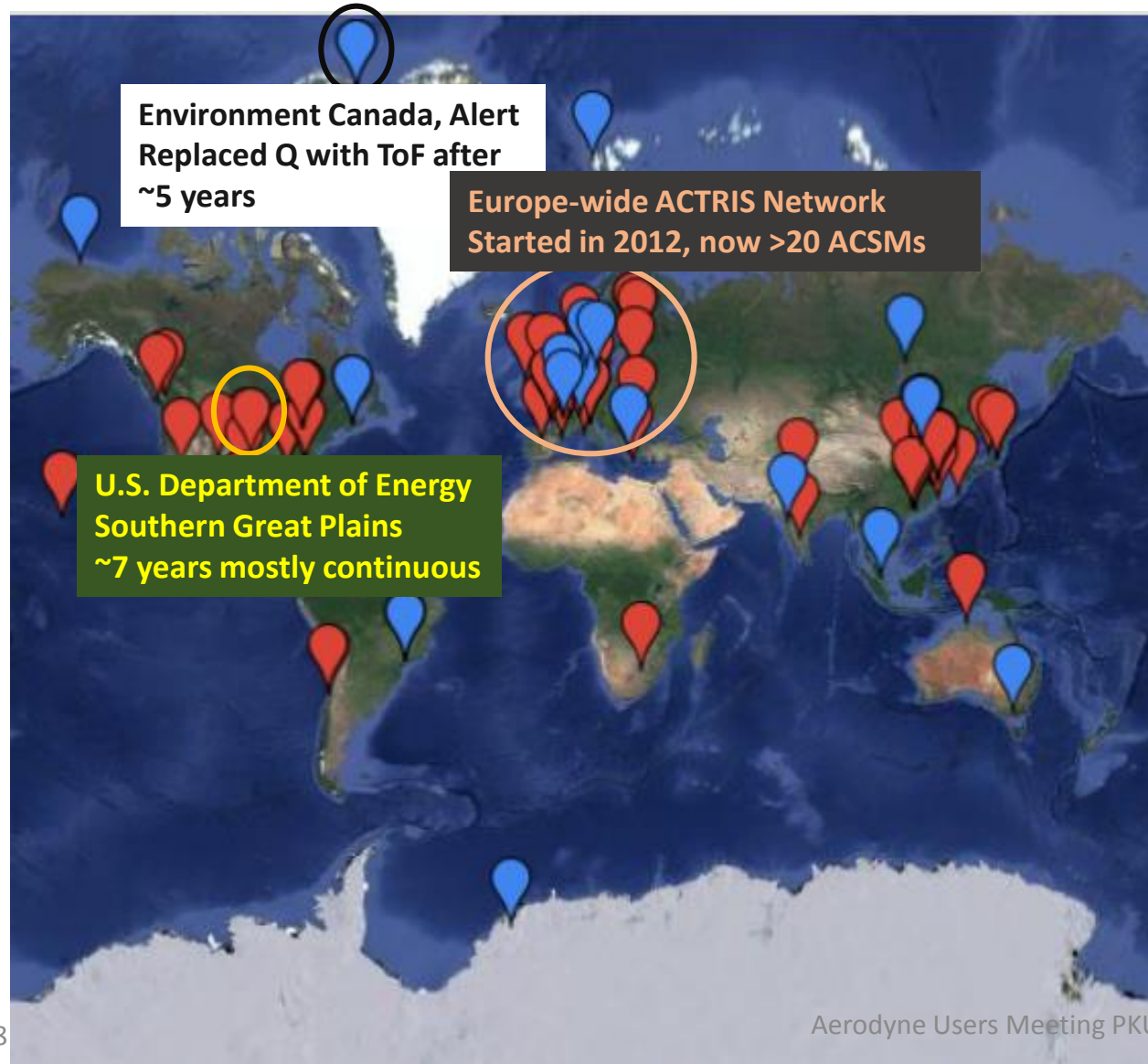
# 112 ACSMs Around the World



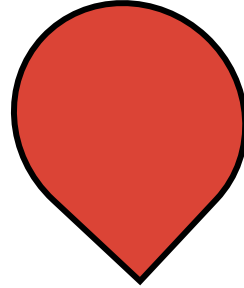
 ToF-ACSM  
x21

 Q-ACSM  
x91

# 112 ACSMs Around the World

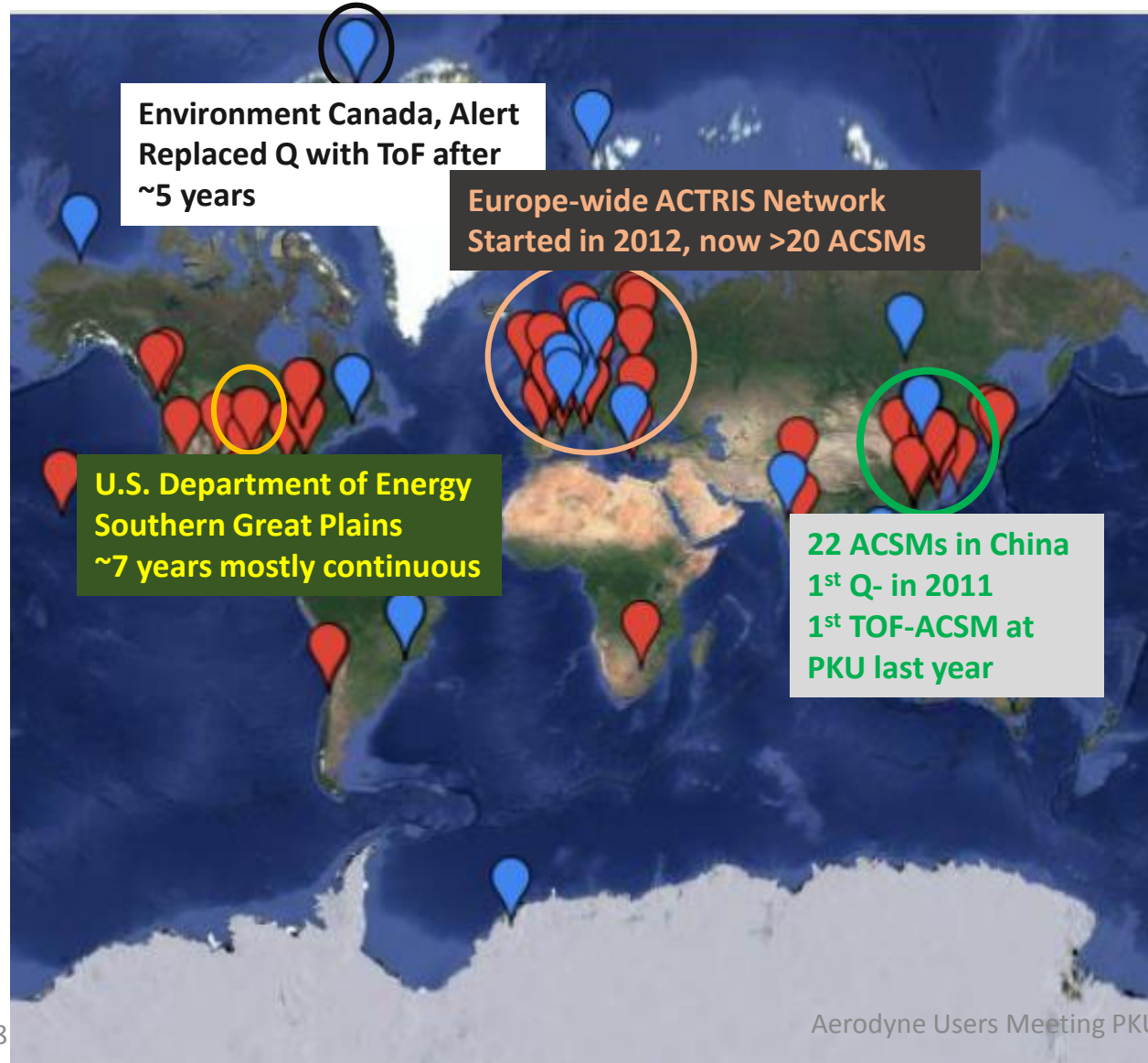


 ToF-ACSM  
x21

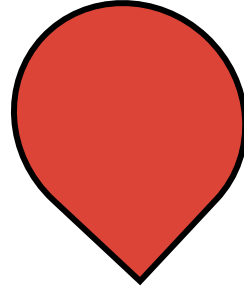
 Q-ACSM  
x91



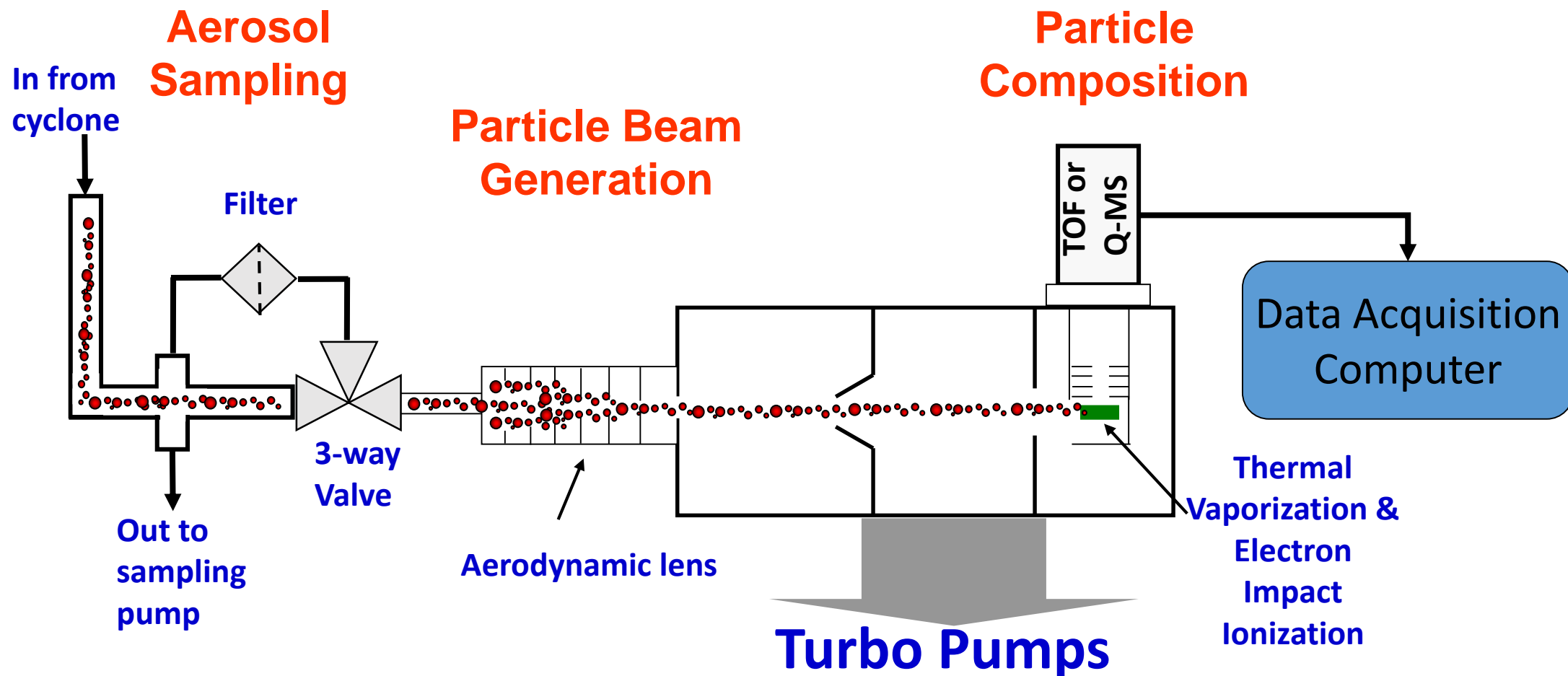
# 112 ACSMs Around the World



 ToF-ACSM  
x21

 Q-ACSM  
x91

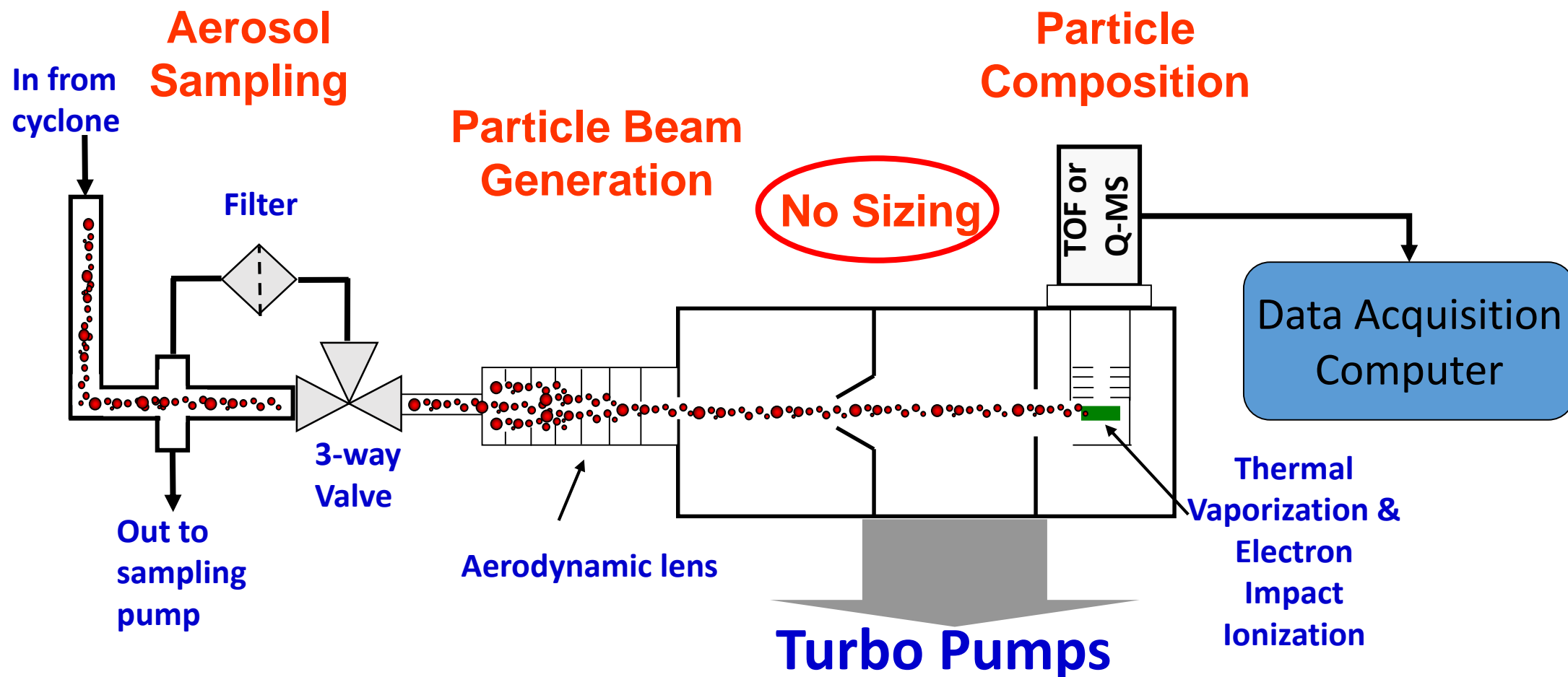
# Aerosol Chemical Speciation Monitor (ACSM)



Ng, et al., Aerosol Sci. Technol., 45:7, 770-784, 2011

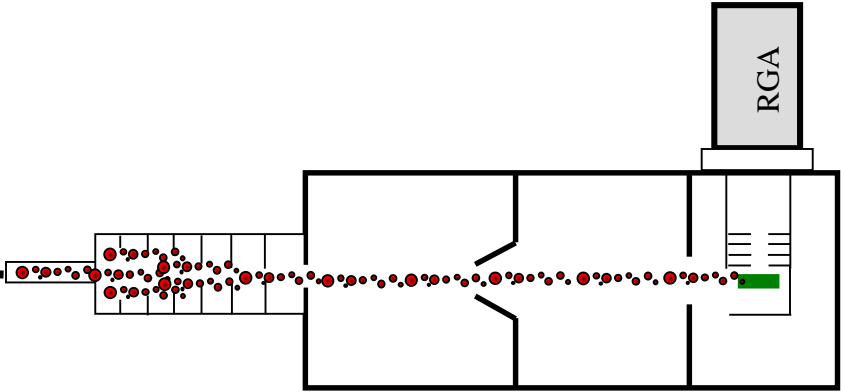
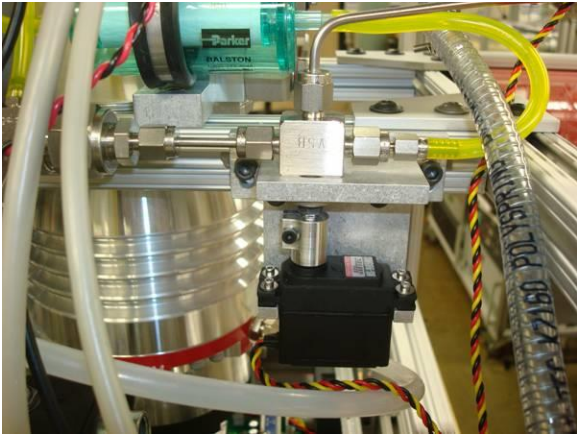
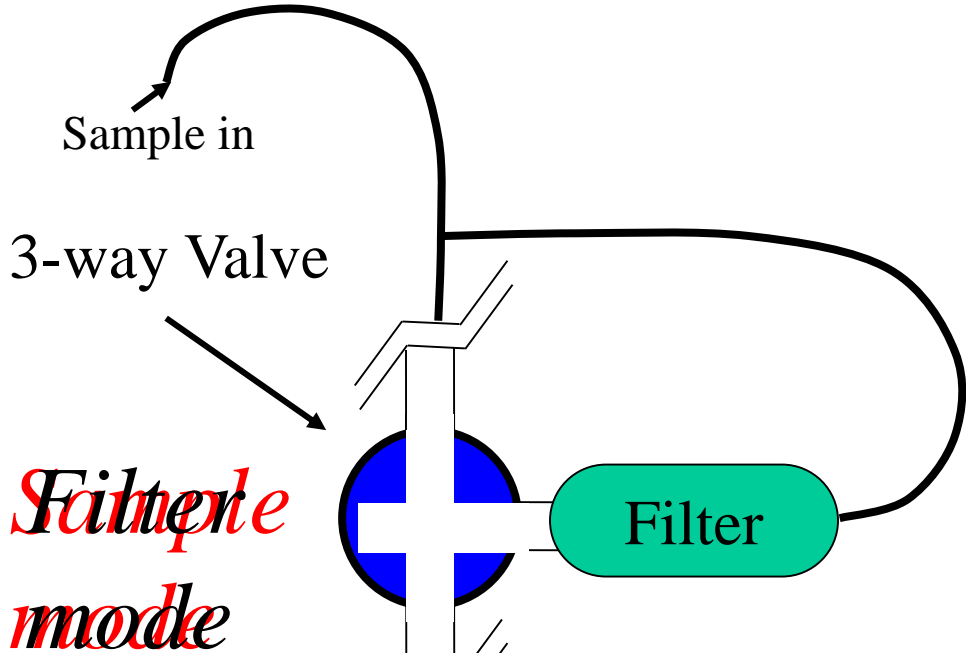


# Aerosol Chemical Speciation Monitor (ACSM)



Ng, et al., Aerosol Sci. Technol., 45:7, 770-784, 2011

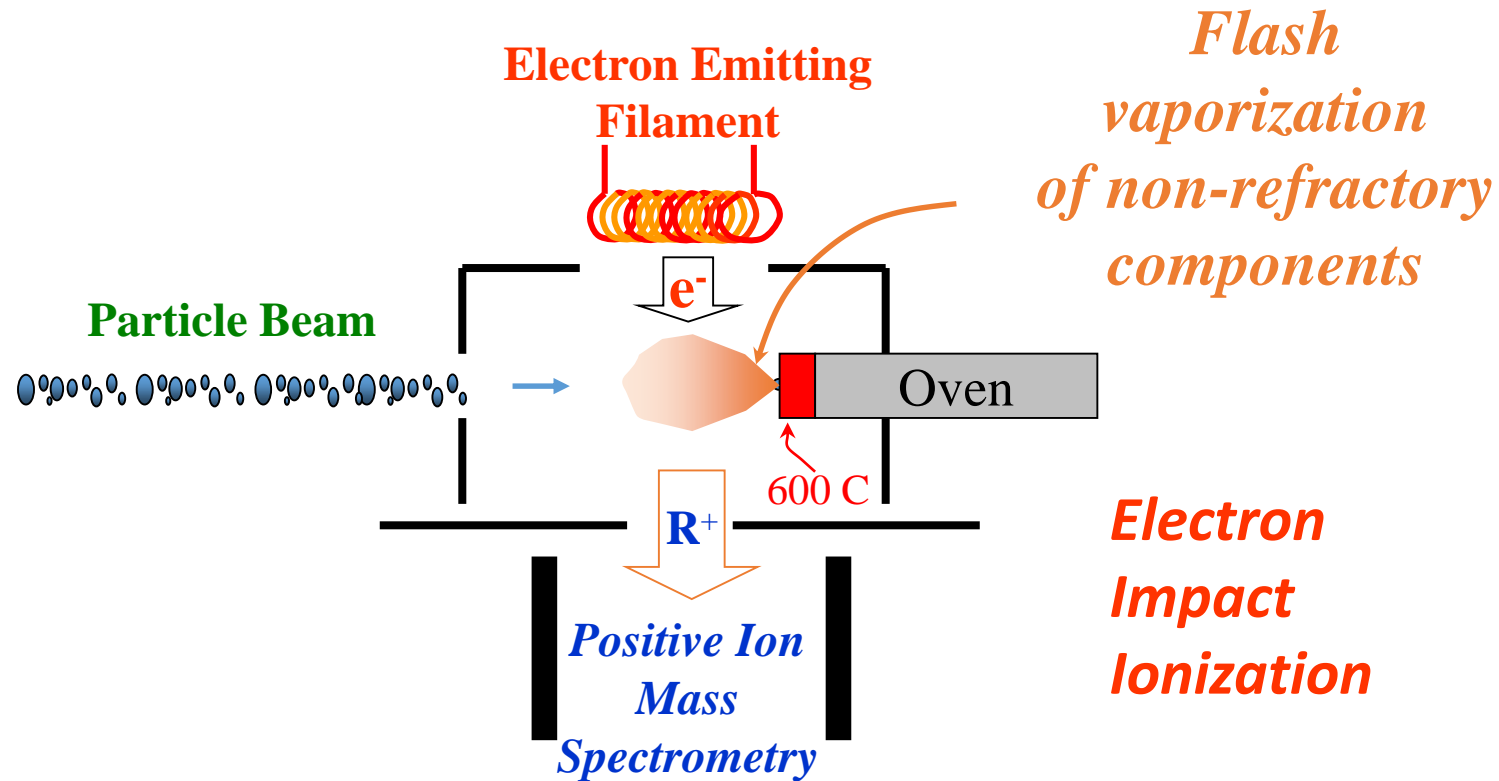
# Automated filter switching valve for instrument background



*Aerosol mass is determined from difference between Sample and Filter mass spectra*

# Detection Process:

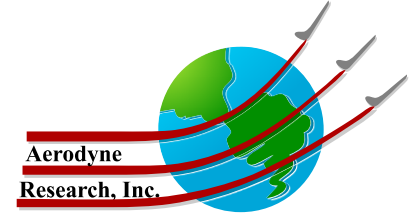
## Separation of vaporization and ionization



- Vaporization and analysis of most aerosol chemical constituents
- Crustal oxides and elemental carbon are not well detected.
  - Electron impact ionization is universal and quantifiable.

# Marker Peaks for Aerosol Species Identification

*color coded to match spectra*

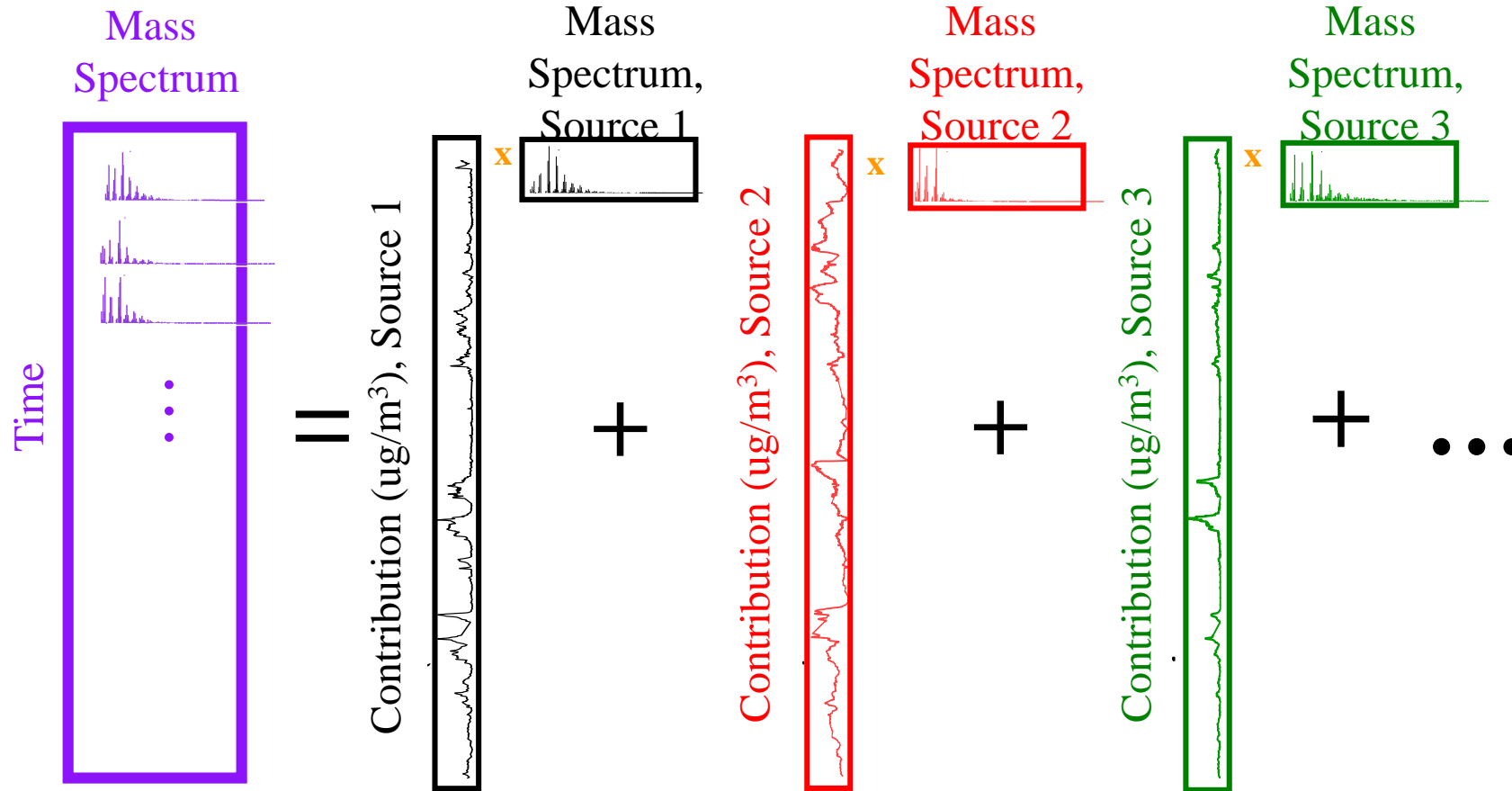
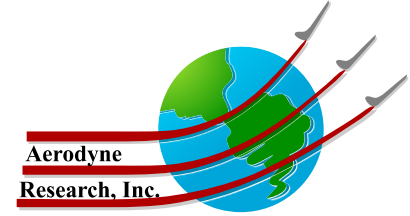


Group	Molecule/Species		Ion Fragments	Mass Fragments
Ammonium	$\text{NH}_3$	$\xrightarrow{e^-}$	$\text{NH}_3^+, \text{NH}_2^+, \text{NH}^+$	17, 16, 15
Nitrate	$\text{HNO}_3$	$\xrightarrow{e^-}$	$\text{HNO}_3^+, \text{NO}_2^+, \text{NO}^+$	63, 46, 30
Sulfate	$\text{H}_2\text{SO}_4$	$\xrightarrow{e^-}$	$\text{H}_2\text{SO}_4^+, \text{HSO}_3^+, \text{SO}_3^+$ $\text{SO}_2^+, \text{SO}^+$	98, 81, 80 64, 48
Organic (Oxygenated)	$\text{C}_n\text{H}_m\text{O}_y$	$\xrightarrow{e^-}$	$\text{CO}_2^+$ $\text{H}_3\text{C}_2\text{O}^+, \text{HCO}_2^+, \text{C}_n\text{H}_m^+$	44 43, 45, ...
Organic (hydrocarbon)	$\text{C}_n\text{H}_m$	$\xrightarrow{e^-}$	$\text{C}_n\text{H}_m^+$	27, 29, 41, 43, 55, 57, 69, 71...

*Standard electron impact ionization 70 eV*



# Deconvolution of AMS Spectra



**Chemical Mass Balance (CMB)** – e.g. Ng et al., 2010

**Positive Matrix Factorization (PMF)** - Paatero, Ingrid Ulbrich, Jose Jimenez (Univ. Colorado, Boulder) Ulbrich et al., 2009

**ME-2 Source Finder (SoFi)** – Paatero, Francesco Canonaco, Monica Crippa, Jay Slowik, Andre Prevot (PSI) Canonaco, et al., 2013

# PM2.5 Capable ACSM



Aerosol Science and Technology

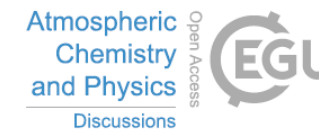


ISSN: 0278-6826 (Print) 1521-7388 (Online) Journal homepage: <http://www.tandfonline.com/loi/uast20>

## Laboratory characterization of an aerosol chemical speciation monitor with PM<sub>2.5</sub> measurement capability

Wen Xu, Philip Croteau, Leah Williams, Manjula Canagaratna, Timothy Onasch, Eben Cross, Xuan Zhang, Wade Robinson, Douglas Worsnop & John Jayne

Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2017-233, 2017  
Manuscript under review for journal Atmos. Chem. Phys.  
Discussion started: 5 May 2017  
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Aerosol Science and Technology



ISSN: 0278-6826 (Print) 1521-7388 (Online) Journal homepage: <http://www.tandfonline.com/loi/uast20>

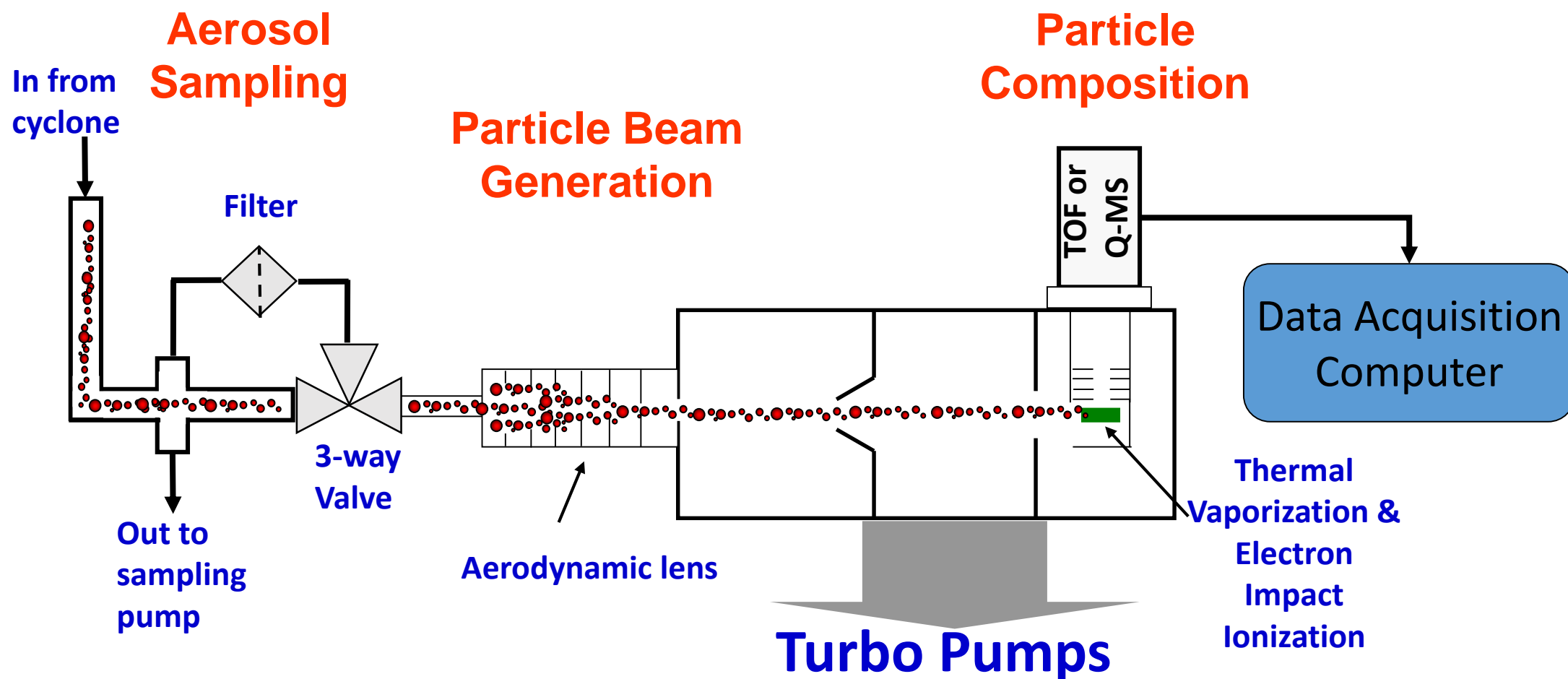
## Development of an aerosol mass spectrometer lens system for PM<sub>2.5</sub>

Jay Peck, Lino A. Gonzalez, Leah R. Williams, Wen Xu, Philip L. Croteau, Michael T. Timko, John T. Jayne, Douglas R. Worsnop, Richard C. Miake-Lye & Kenneth A. Smith

## Field characterization of the PM<sub>2.5</sub> Aerosol Chemical Speciation Monitor: insights into the composition, sources and processes of fine particles in Eastern China

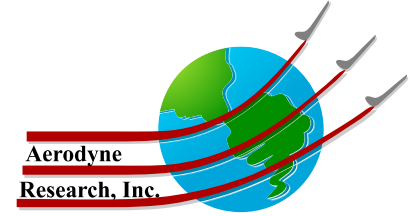
- 5 Yunjiang Zhang<sup>1-4</sup>, Lili Tang<sup>1,2</sup>, Philip L. Croteau<sup>5</sup>, Olivier Favez<sup>3</sup>, Yele Sun<sup>6</sup>, Manjula R. Canagaratna<sup>5</sup>, Zhuang Wang<sup>1</sup>, Florian Couvidat<sup>3</sup>, Alexandre Albinet<sup>3</sup>, Hongliang Zhang<sup>7</sup>, Jean Sciare<sup>8</sup>, André S. H. Prévôt<sup>9</sup>, John T. Jayne<sup>5</sup>, Douglas R. Worsnop<sup>5</sup>

# Aerosol Chemical Speciation Monitor (ACSM)

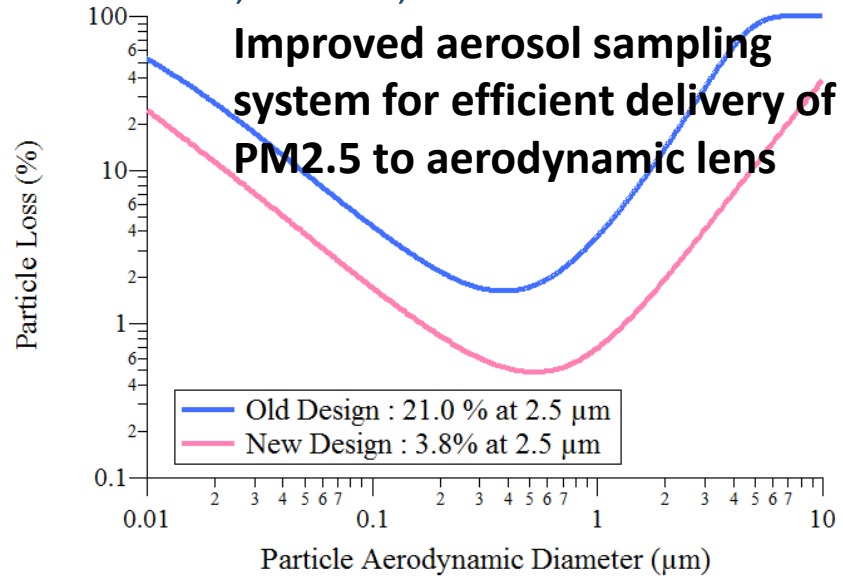


Ng, et al., Aerosol Sci. Technol., 45:7, 770-784, 2011

# PM2.5 Capable ACSM – Laboratory Characterization



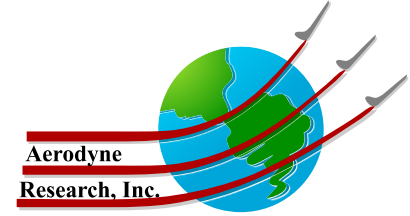
Xu et al., AS&T, 2016



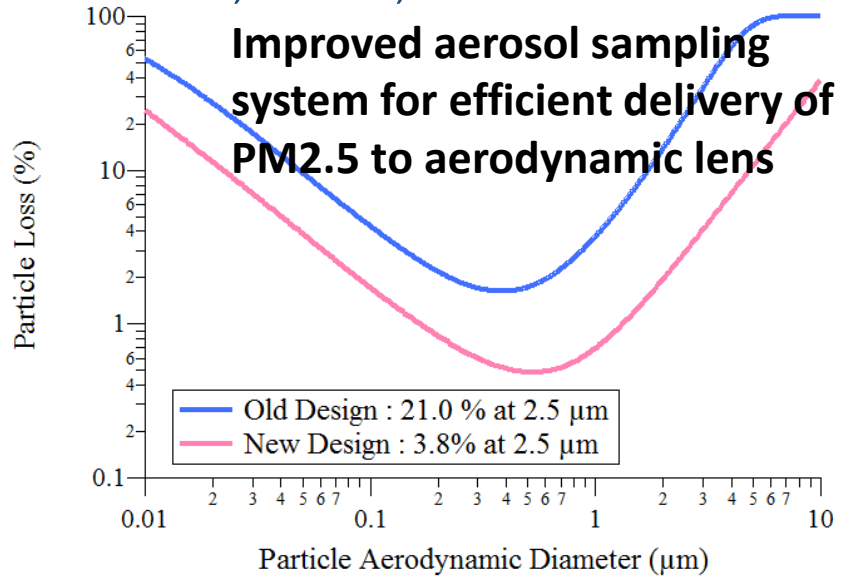
Von der Weiden et al., Atmos. Meas. Tech., 2, 479-494, 2009.



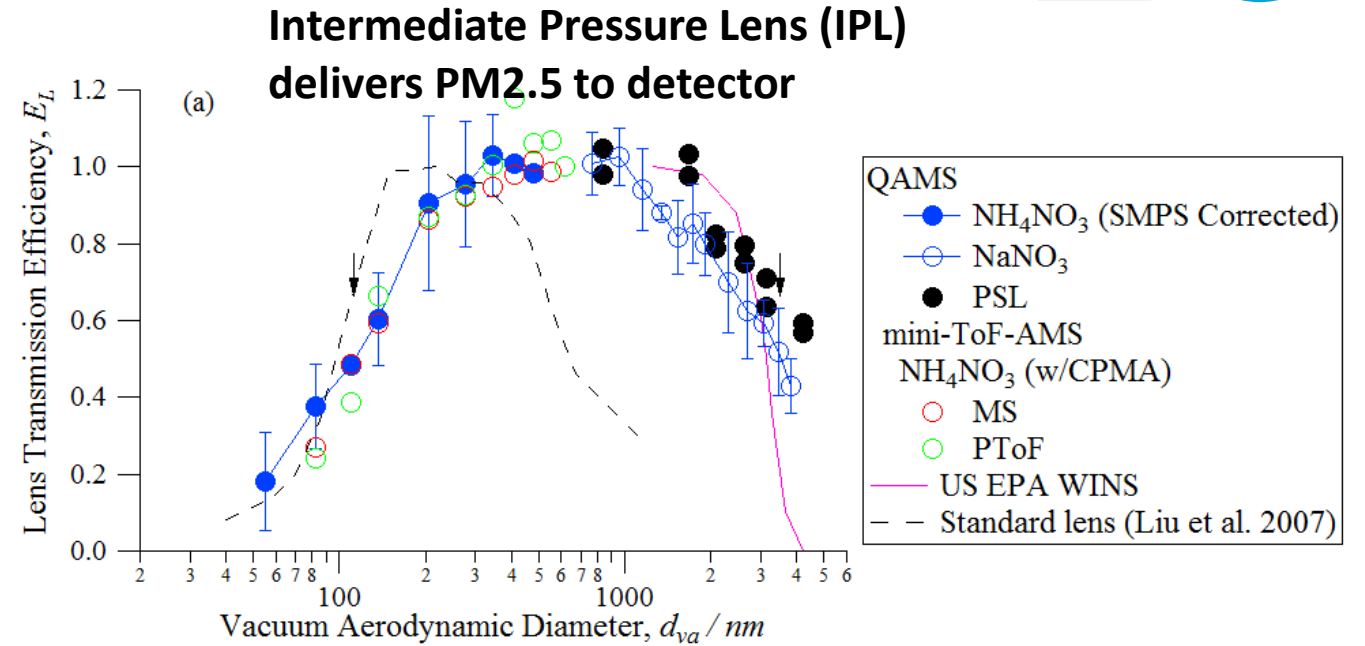
# PM2.5 Capable ACSM – Laboratory Characterization



Xu et al., AS&T, 2016

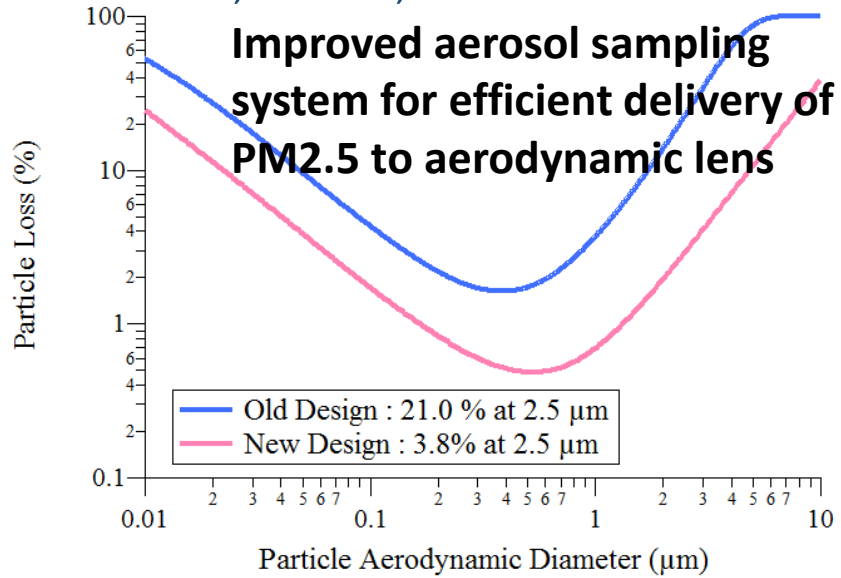
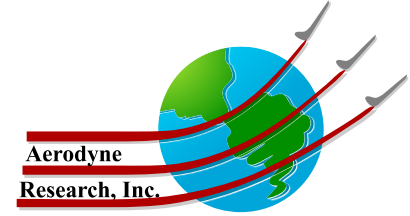


Von der Weiden et al., Atmos. Meas. Tech., 2, 479-494, 2009.

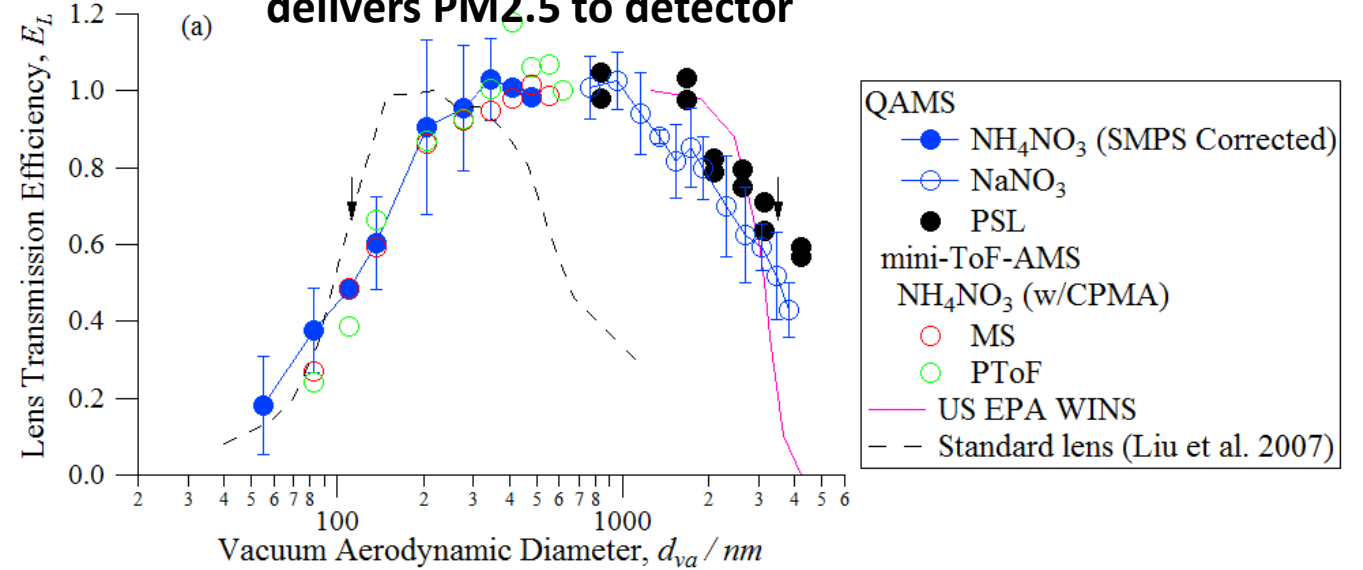


# PM2.5 Capable ACSM – Laboratory Characterization

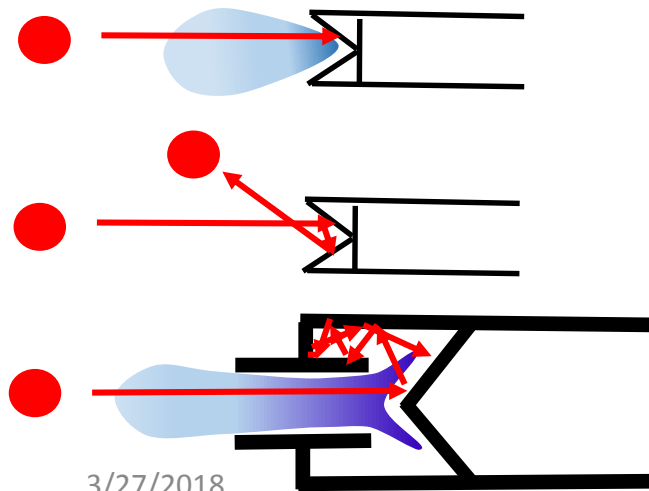
Xu et al., AS&T, 2016



## Intermediate Pressure Lens (IPL) delivers PM2.5 to detector

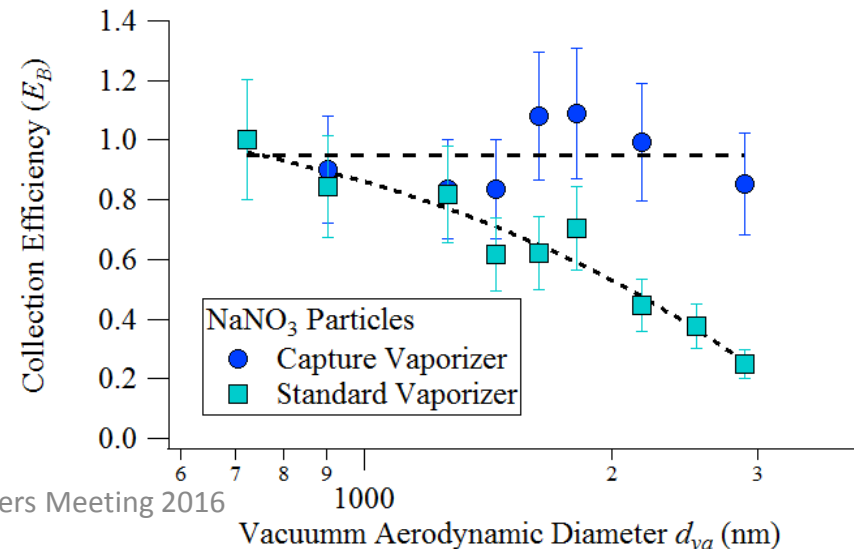


Von der Weiden et al., Atmos. Meas. Tech., 2, 479-494, 2009.



**Capture Vaporizer effectively vaporizes all large particles for complete detection of NR-PM2.5**

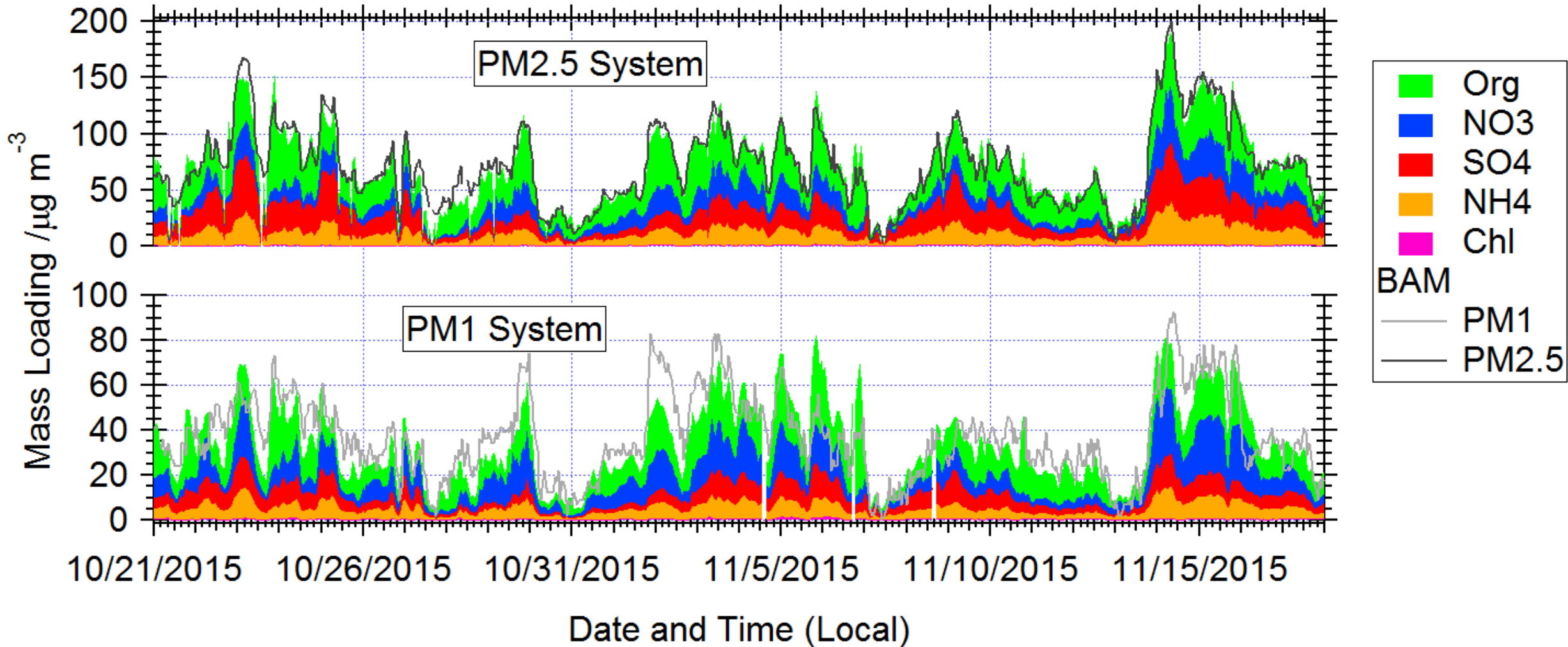
3/27/2018



AMS Users Meeting 2016

# PM2.5 Capable ACSM – Ambient Characterization

Zhang et al., ACPD, 2017



<https://sites.google.com/site/ariacsm/>



## ACSM - Aerosol Chemical Speciation Monitor

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attachment from Yele Sun

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[Untitled Post](#)

attachment from John Jayne



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This site has been divided into several sections:

1) **ARI Content** area is to be primarily managed by ARI. In this section you will find support material such as software updates, manuals, technical and application notes.



ACSM with Varian pumps  
S/N: 140-100  
Sept. 2009  
(serial numbers -107 and lower)



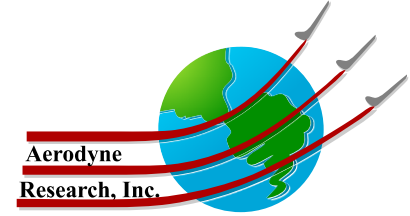
ACSM with the Pfeiffer pumps and integrated power supply  
S/N: 140-110  
Feb 2011



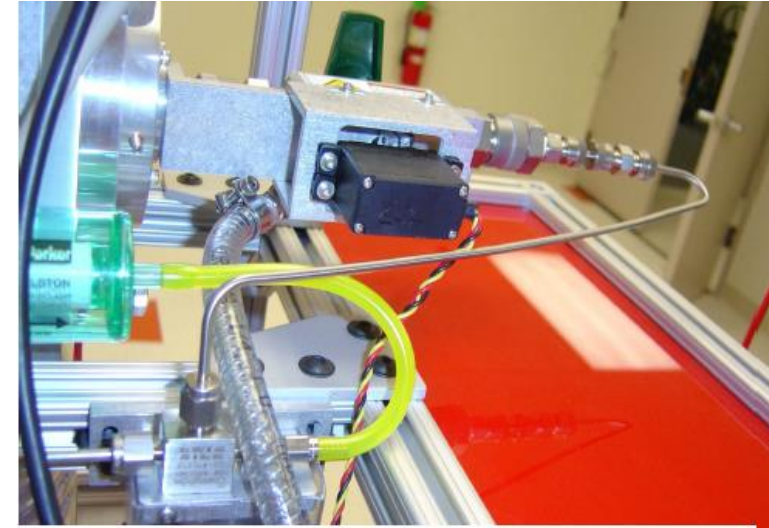
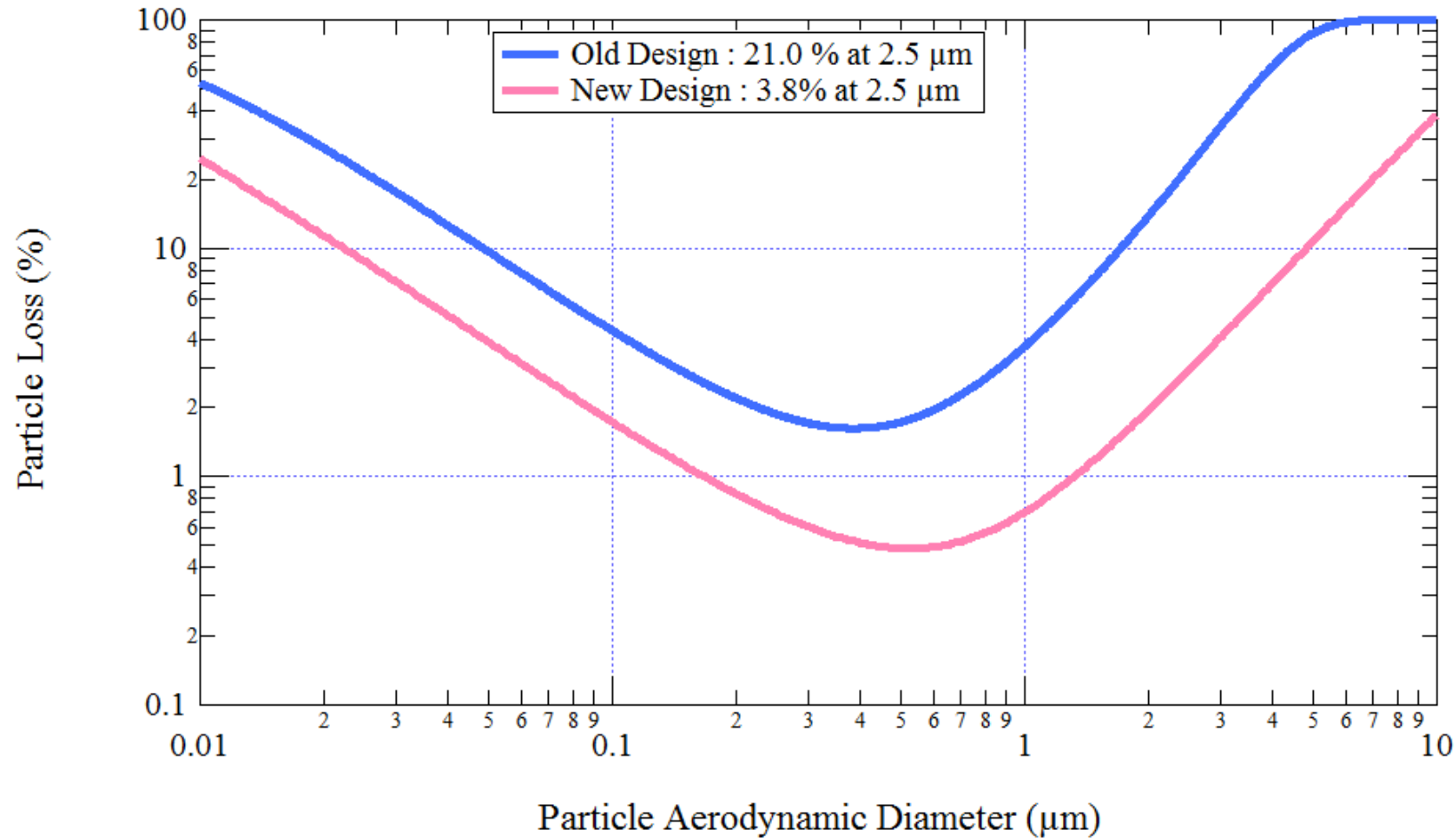
# Thanks!

- Questions: Come talk to me; I'm here until Friday.
- email: [croteau@aerodyne.com](mailto:croteau@aerodyne.com)
- [cacc-support@aerodyne.com](mailto:cacc-support@aerodyne.com)

END

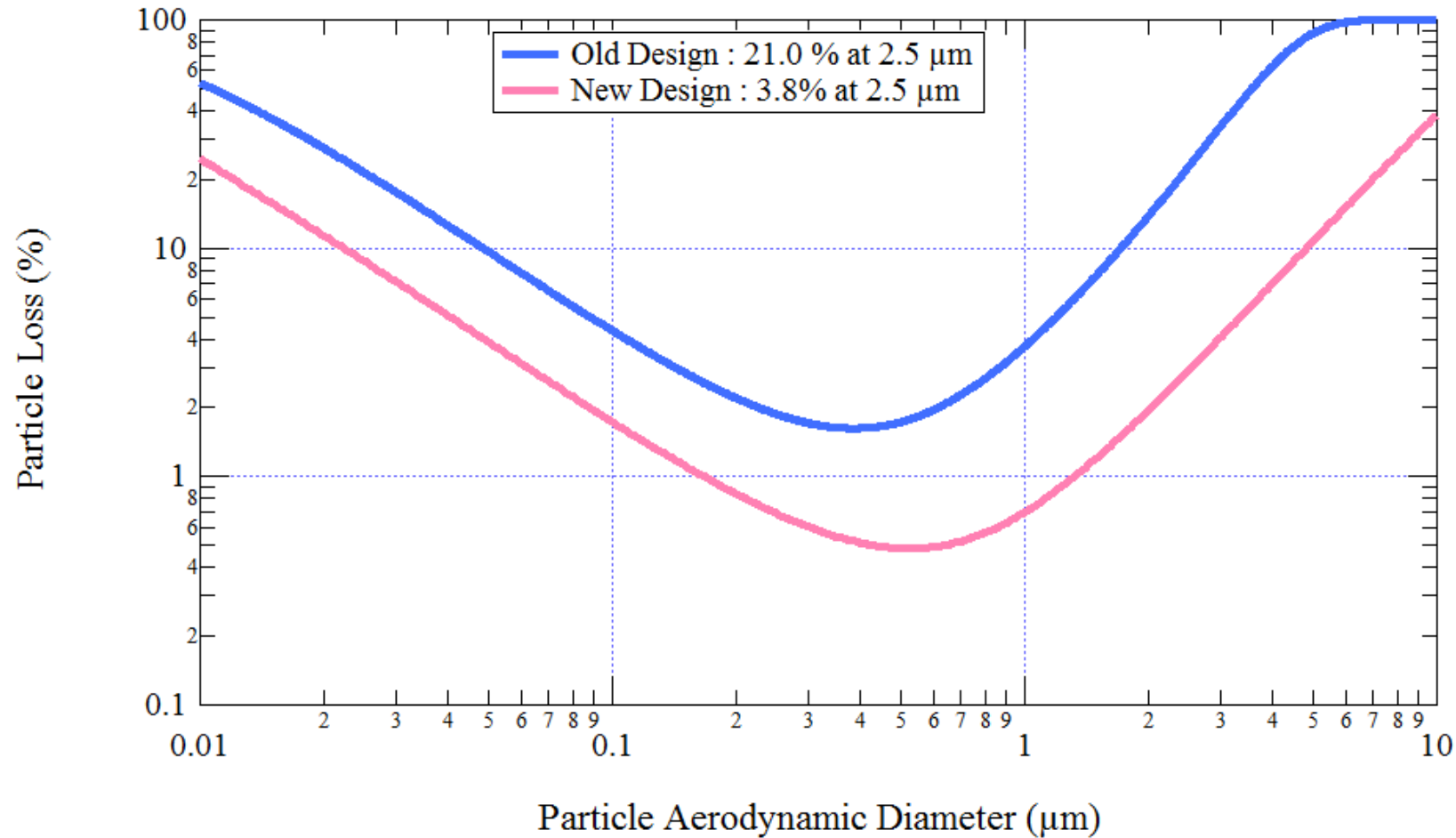


# Aerosol Sampling – Reduce Inlet Losses



Von der Weiden et al., Atmos. Meas. Tech., 2, 479-494, 2009.

# Aerosol Sampling – Reduce Inlet Losses



Straight path 3-way valve

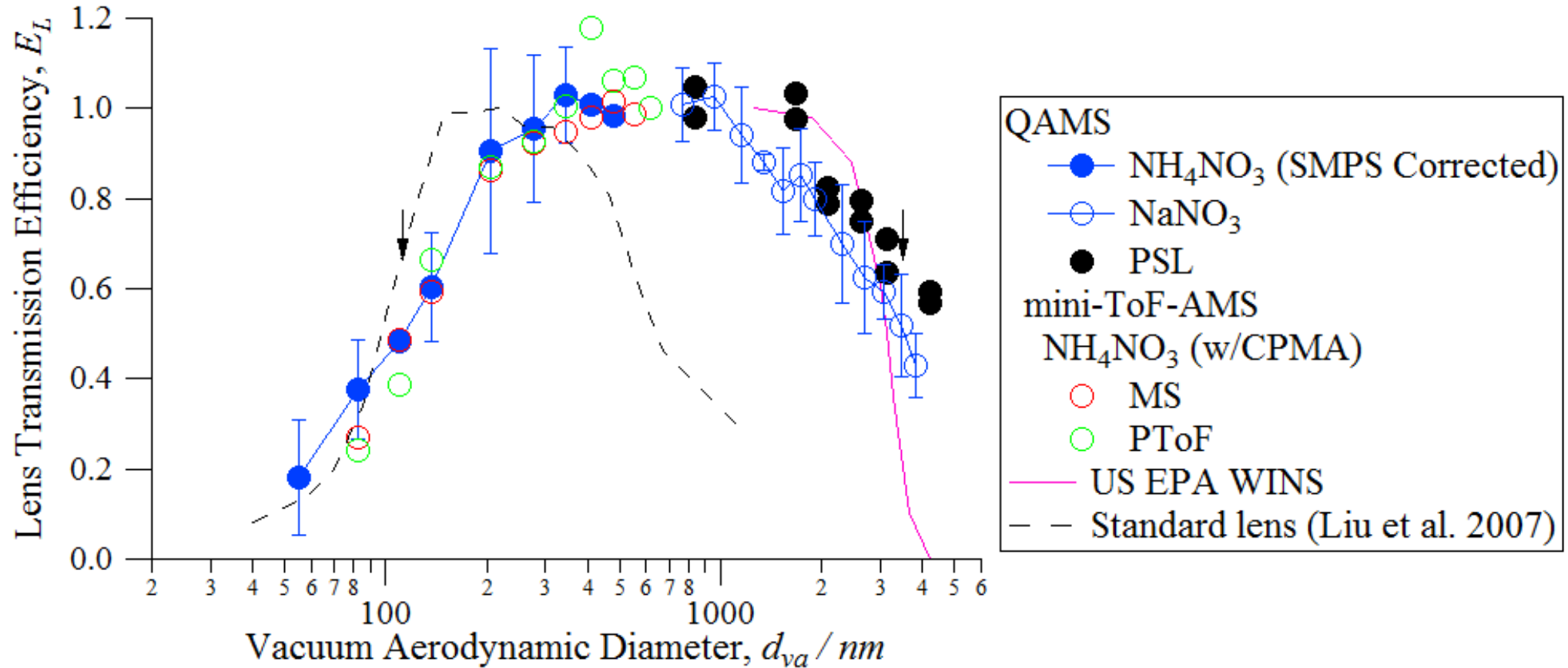
No bends in 1/8" tube



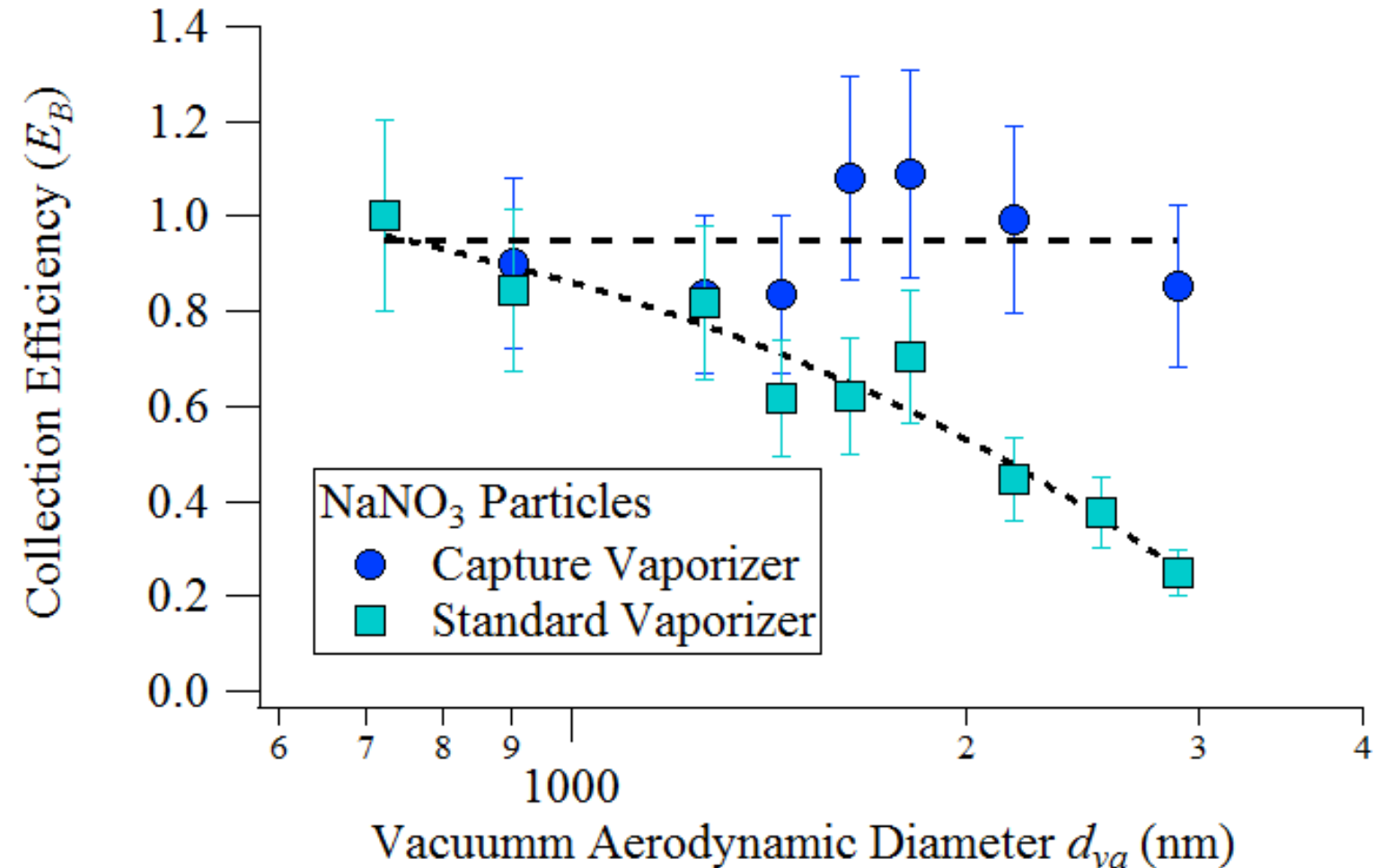
Von der Weiden et al., Atmos. Meas. Tech., 2, 479-494, 2009.



# Particle Beam Generation – Measured Losses

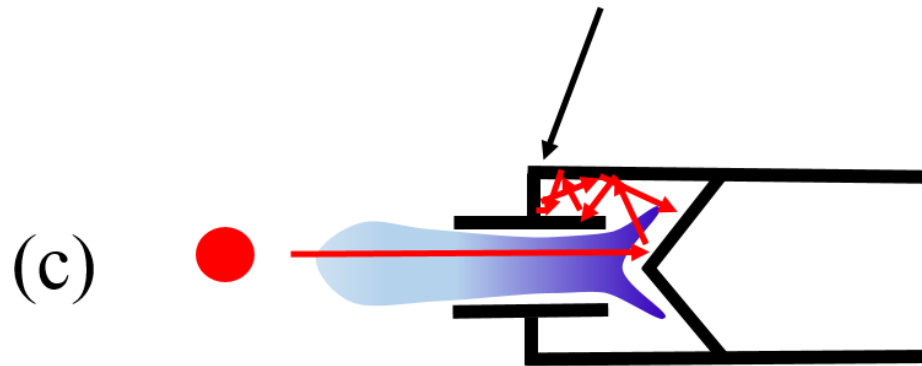
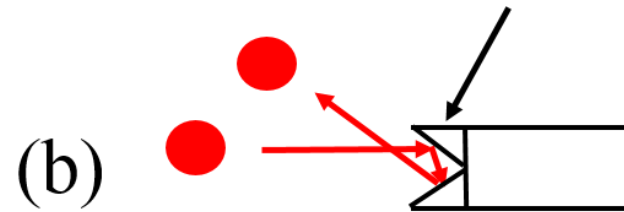
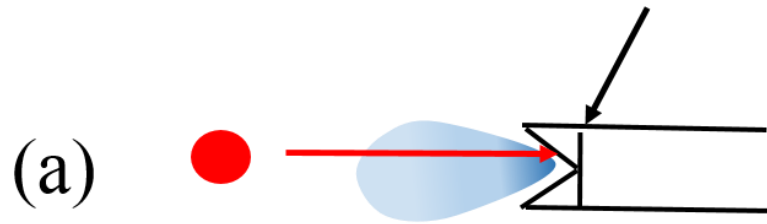


# Particle Composition - Bounce



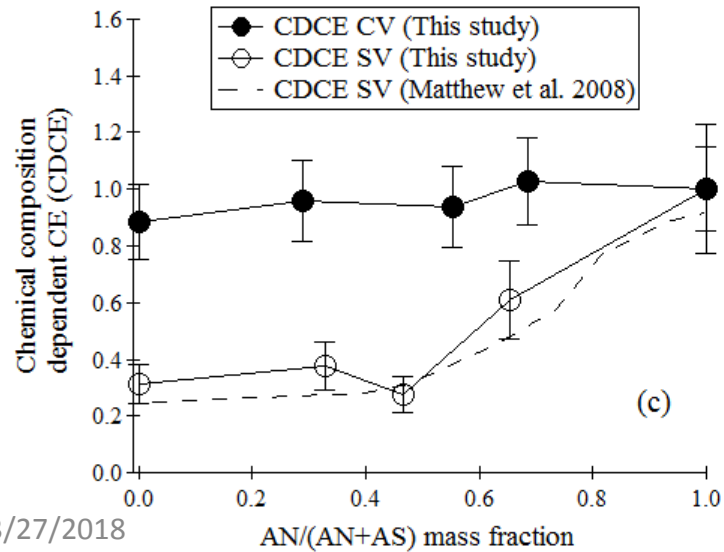
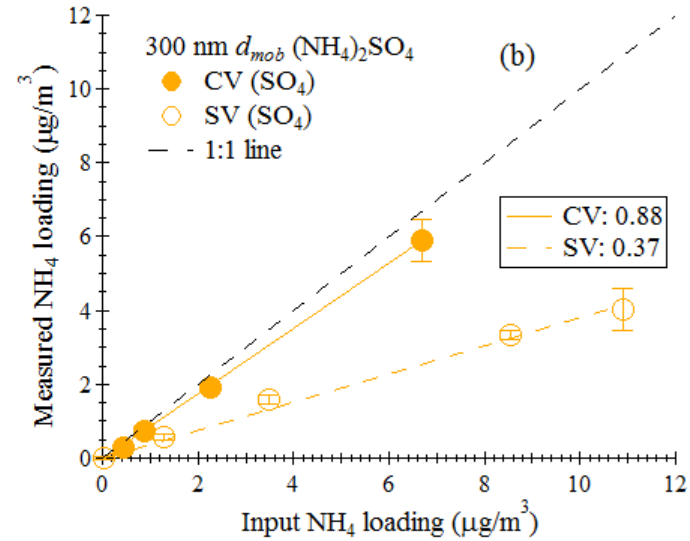
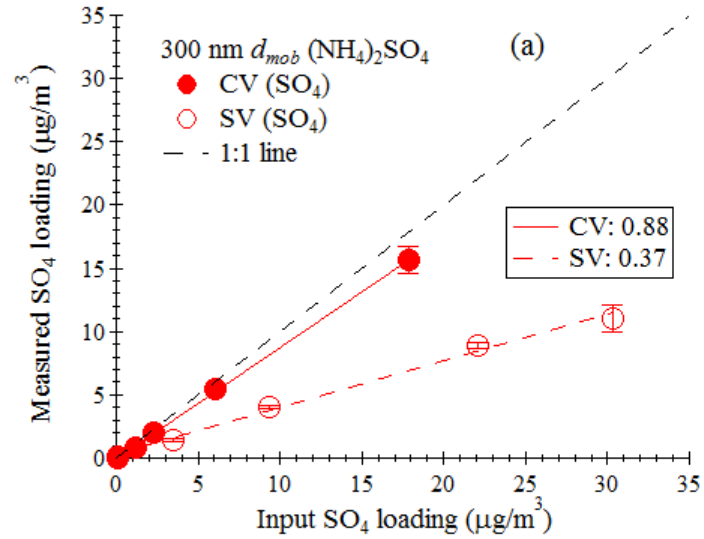
This is why we need to solve bounce to have a working PM2.5 system

# Particle Composition – Fixing Bounce

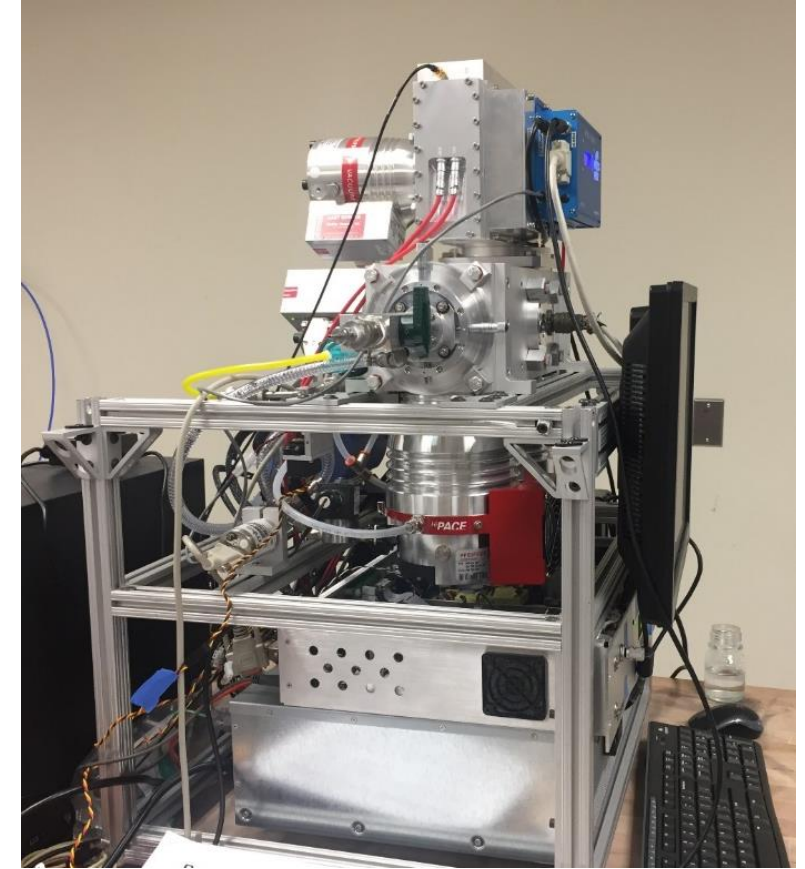
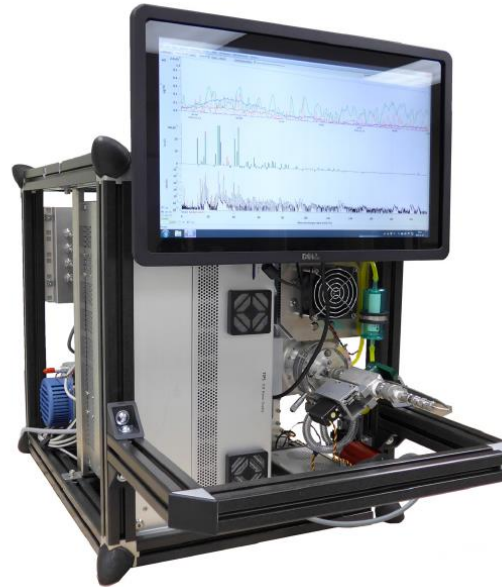


Black arrows denote T/C attach points

# Particle Composition – Bounce is fixed



# Q-to-TOF-ACSM Upgrade

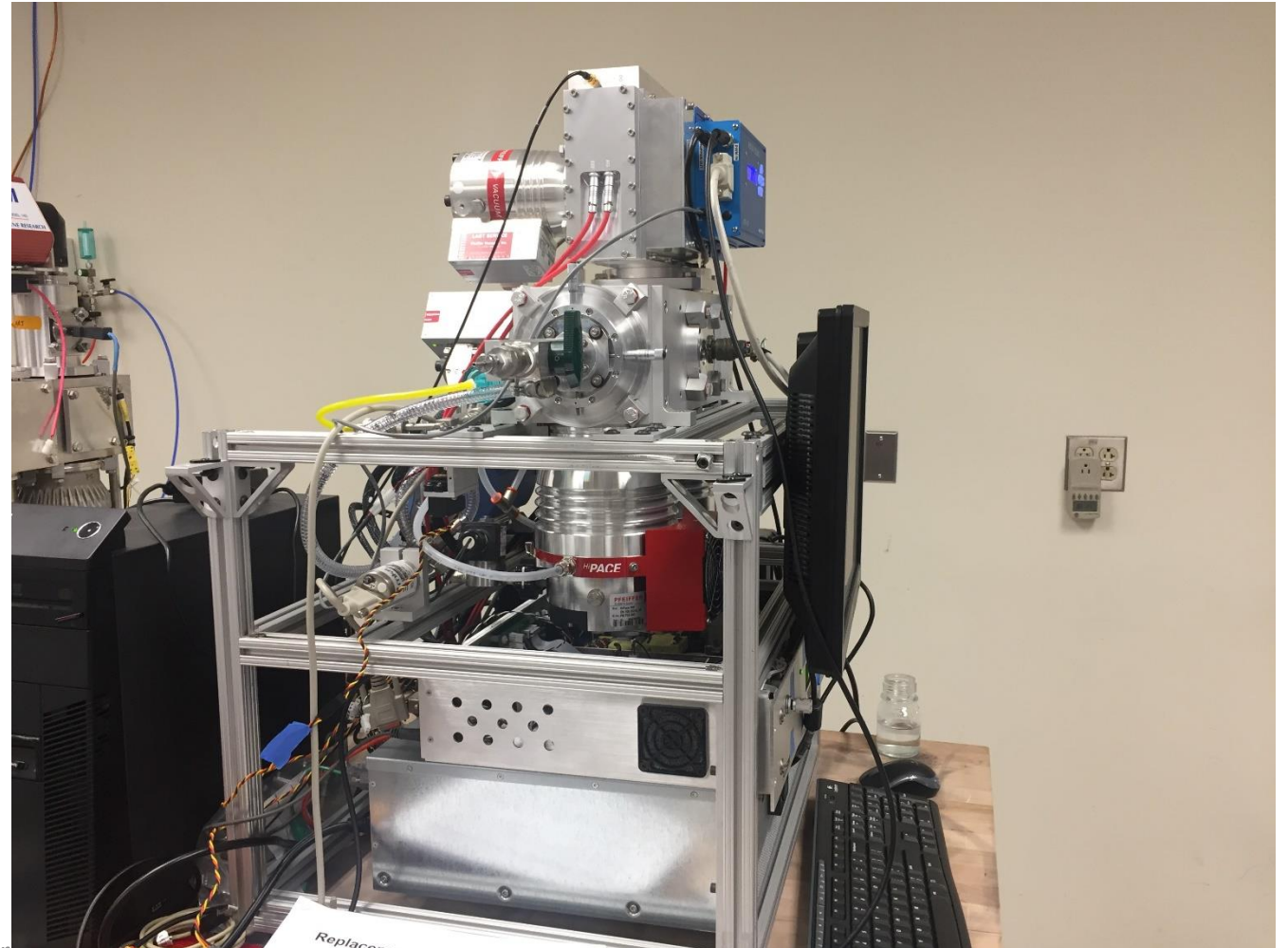


2



# Q-to-TOF-ACSM Upgrade Possibility

- Can this be done?
  - Yes
  - System exists
  - Runs AMS DAQ
  - Uses combination of AMS and ACSM electronics
  - Same footprint/crate



# Q-to-TOF-ACSM Upgrade Possibility

- Can this be done?
  - Yes
  - System exists
  - Runs AMS DAQ
  - Uses combination of AMS and ACSM electronics
  - Same footprint/crate
- Should this be done?
  - No
  - It's too expensive.

