Overview of Aerodyne Instruments

21st (and first virtual) AMS Users Meeting

J. Jayne

Jan 19, 2021
AMS Users Meeting Attendance

>280 Registered attendees for 2021 Virtual Meeting
### Aerodyne Mass Spectrometer Systems

**2000-to date**

**Aerosol Instruments**
- QAMS
- CTOF AMS
- HTOF AMS
- SP HTOF AMS
- mini-AMS
- LTOF AMS
- QACSM
- TOF ACSM
- TOF ACSM X

**Calibration System**

**2009-to date**

**Gas Phase Instruments**
- APi – TOF
- EI-TOF
- VOCUS PTR
- GC (EI TOF, CIMS, VOCUS)

**Sources**
- IMR ($I^-$, $SF_6^-$, $H_3O^+$, Acetate,…)
- Nitrate ($NO_3^-$)
- FIGAERO
- VIA

**Available with H or L ToF MS detectors**
Aerodyne Mass Spectrometry Development and Support Team

**Engineers**
- Bill Brooks
- Wade Robinson
- Dan Thompson
- Salvador Cartagena
- Stephen Prescott
- Adin Field
- Jason Curry

**AMS/ACSM Scientists**
- Phil Croteau
- Leah Williams
- Manjula Canagaratna
- Ed Fortner
- Ben Nault
- Anita Avery
- Donna Sueper
- Harald Stark
- Andy Lambe
- Penglin Ye (*in China*)

**CIMS/Vocus/GC Scientists**
- Manjula Canagaratna
- Jordan Krechmer
- Francesca Majluf
- Anita Avery
- Andy Lambe
- Megan Claflin
- Brian Lerner
- Donna Sueper
- Harald Stark
- Penglin Ye

Support email address: CACC-Support@aerodyne.com

New Aerodyne Knowledge Base
CACC Group Personnel: www.aerodyne.com/centers/aerosol-cloud-chemistry/
Aerodyne CACC

CACC-Support@aerodyne.com

Full bios at www.aerodyne.com/centers/aerosol-cloud-chemistry
High Performance TOF mass spectrometer

Thermal Vaporization & Electron Impact Ionization

Aerodynamic Lens

Capture Vaporizer

Light Scatter module

Laser Vaporizer (SP module)

PM2.5 Lens

Cal. Sys.

BWP

Data Acquisition Analysis

Pumps (x5)

Fast Data System Timers

RIEs, f44

Particle Beam Chopper

Aerosol Mass Spectrometer

Particle Beam Generation

Aerodynamic Sizing

Particle Composition

Aerodynamic Lens

ePTOF
## AMS Components and Other Aerodyne Instruments

<table>
<thead>
<tr>
<th>Components</th>
<th>Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP – Soot Particle module</td>
<td>TILDAS (high precision IR measurement for trace gases and isotopes)</td>
</tr>
<tr>
<td>LS – Light Scattering module</td>
<td>CAPS (NO2, PMex, SSA)</td>
</tr>
<tr>
<td>PAM – OFR</td>
<td>TWST-EN (Measures cloud optical depth and cloud droplet size and phase)</td>
</tr>
<tr>
<td>TAG Aerosol Collector</td>
<td></td>
</tr>
<tr>
<td>Thermal Denuder</td>
<td></td>
</tr>
<tr>
<td>Aerosol Dryer</td>
<td></td>
</tr>
<tr>
<td>Sample Line Flow Controller</td>
<td></td>
</tr>
<tr>
<td>Pressure Controlled Inlet</td>
<td></td>
</tr>
<tr>
<td><em>EyeOn</em> control system</td>
<td></td>
</tr>
<tr>
<td>Beam Width Probe</td>
<td></td>
</tr>
<tr>
<td>Auto Valve System</td>
<td></td>
</tr>
<tr>
<td>PM2.5 Lens and Capture Vaporizer</td>
<td></td>
</tr>
</tbody>
</table>
HTOF and LTOF AMS Systems

LTOF AMS ~2x the resolution of HTOF (Vmode) with the same sensitivity. Also, 2x the length of the HTOF
Resolution of C-TOF, H-TOF and L-TOF

Andy Lambe
Aerosol Chemical Speciation Monitor - ACSM

- Particle Beam Generation
- No Sizing
- Particle Composition

Smaller/lower cost Q- or TOF- Mass Spec

Laptop Computer

Thermal Vaporization & Electron Impact Ionization

Pumps (x3)

Aerodynamic Lens 40-1000 nm

Particle Inlet (1 atm)
QACSM and ToF ACSM Systems

QACSM

For routine monitoring

eTOF ACSM

Higher performance compared to Q ACSM
2-3x improved sensitivity with faster data rate (~1 min).
ToF ACSM X
New this Year

• ‘X’ for eXtra resolution
• ~2000 M/ΔM
• Provides O:C and H:C ratios
• Improved NH4 measurements
• Performance evaluation in progress

(Almost) Same size as TOF ACSM but uses a higher resolution TOF MS
ToF ACSM and mini-AMS Systems

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
TAG System for Organic Aerosol Molecular Speciation

Impactor Collection and Thermal Desorption cell (iCTD) and valveless injector Module

TAG collector show with Agilent GC MS detector, also compatible with EI TOF MS and CIMS detectors

Wen Xu, Aerodyne
Nathan Kreisberg, Aerosol Dynamics
Allen Goldstein, UC Berkeley
PAM – Potential Aerosol Mass Oxidation Flow Reactor

Front end to AMS/ACSM (and CIMS/Vocus) for lab and ambient experiments

- Technique developed by Bill Brune (Kang et al., ACP, 2007)
- **Includes**: OFR, \( \text{O}_3 \) chamber, humidifier, autovalve, UV and RH/T sensors
- **Options**: MFCs, UV lamps (\( \lambda = 313 – 369 \) nm), syringe pump for VOC injection
- Automated operation via PAM controls software

---

*Andy Lambe*
Thermal Denuder System

For aerosol volatility studies

Recent control SW updates
Aerosol Sample Dryer System

Nafion based dryer
Sample Line Flow Controller System

- Light weight, low power (24V)
- Up to 8 LPM
- Designed for compatibility with Dryer system
ARI Fast GC system

Adaptable to:
- EI-TOF MS
- Vocus PTR-TOF MS
- Cl-ToF-MS
- Other detectors

Supports two columns

Max. heating rate: 130 C/min
Max cooling rate: 190 C/min
Max column temp: 260 C

Size: 55H x 55W x 30D (cm)
Weight: 24 kg (52 lbs)
Power: ~250W

Claflin et al., Atmos. Meas. Tech., 14, 133–152 (2021)
Vocus mass spectrum at m/Q 69. The high-resolution MS shows four separate peaks.

Chromatographic retention time separates the isomeric compounds.
Aerosol Inlets for Gas Phase Mass Spectrometer Systems

**FIGAERO** - Filter Inlet for Gases and Aerosol
Filter based particle collection with programmable thermal desorption up to ~250°C

*Used with CIMS Instruments*

**VIA** - Vocus Inlet for Aerosol
Online thermal desorption of organic aerosols
Programmable temperature from 150 - 250°C

*Used with Vocus Instruments*
Aerodyne Suite of Mass Spec based Instruments for on-line Gas and Aerosol Chemical Characterization

Vocus
PTR-TOF

GC-EI-TOF

TOF-CIMS

SV-TAG

AMS and ACSM

Phil Croteau

Decreasing Volatility
CACC Research Group Focus
Mass Spectrometry for the Study of SOA

VOC  LVOC  HOM
Oxidation/processing
SOA formation

Sun

New particle Formation

Processing and aging

Condensation and growth

HAZE

GC  ➔  PTR  ➔  CIMS (I⁻, NO₃⁻)  ➔  APi  

AMS/ACSM

Decreasing Volatility

Aerosol Composition
Chemical and physical properties

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