Aerosol Chemical Speciation Monitor (ACSM)

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In from cyclone

Aerosol Sampling

Filter

Out to sampling pump

3-way Valve

Particle Beam Generation

Aerodynamic lens

No Sizing

RGA

Laptop Computer

Turbo Pumps

Thermal Vaporization & Electron Impact Ionization

105 Instruments Around the World
PM2.5 Capable ACSM
Xu et al., Atmos. Meas. Tech., in press

Inlet System


Intermediate Pressure Lens

Capture Vaporizer

AMS Users Meeting 2016
Custom Mass Spec (CMS) Switching Mode – to investigate time-resolved behavior of m/z 44 (and others)

Can switch between an MID mode and standard ‘single scan mode’

# of Repeats is iterations of MID mode before moving to ‘single scan mode’

Generates new type of data file for the custom scan mode data which has is the average of all ‘Sets’
What data looks like

![Graph showing data](image_url)
PAM Generated Naphthalene SOA Data from ACTRIS Intercomparison II

Coefficient values ± one standard deviation

\[ y_0 = 1.8153e-010 \pm 5.12e-013 \]
\[ A = -1.0326e-011 \pm 6e-013 \]
\[ \tau = 2.7784 \pm 0.446 \]

Constant:
\[ X_0 = 0 \]
TOF-ACSM Detectors

- Implementing a new type of detector

Benefits
- Longer Life (factor of 8)

Drawbacks
- Somewhat lower resolution (~30%)
- Maybe lower sensitivity (still testing)
- Backwards compatibility requires swapping whole extractor flange
Q-to-TOF-ACSM Upgrade Possibility

• Can this be done?
  • Yes
  • System exists
  • Runs AMS DAQ
  • Uses Frankensteined AMS/ACSM electronics
  • Same footprint/crate

• Should this be done?
  • No
  • It’s too expensive.
Splitflow/SingleTurbos Comparison
Both equipped with eTOF-MS

Discrete/Single turbos

Split flow turbo

Nominal Pumping speeds (L/s)

300  80  300  80  40  170  135  160

5x10^-8 Torr

5x10^-7 Torr
Comparison between operating parameters for Single Turbos (ST) and SplitFlow (SF) ToF-ACSM Systems

<table>
<thead>
<tr>
<th></th>
<th>ST System</th>
<th>SF System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Ion Strength / mv*ns</td>
<td>1.98</td>
<td>1.98</td>
</tr>
<tr>
<td>Resolution at m/z 28 (from DAQ)</td>
<td>306</td>
<td>317</td>
</tr>
<tr>
<td>AB Open / Hz</td>
<td>4.38x10^5</td>
<td>6.58x10^5</td>
</tr>
<tr>
<td>AB Closed / Hz</td>
<td>6.65x10^4</td>
<td>2.48x10^4</td>
</tr>
<tr>
<td>AB Diff / Hz</td>
<td>3.72x10^5</td>
<td>6.33x10^5</td>
</tr>
<tr>
<td>IE / ions/pg</td>
<td>184</td>
<td>201</td>
</tr>
<tr>
<td>IE / AB Open</td>
<td>4.2x10^{-4}</td>
<td>3.1x10^{-4}</td>
</tr>
</tbody>
</table>

Adjusted detector gain to match single ion between systems prior to the following experiments to try to get as close to an ‘absolute’ comparison as possible.
40 second ambient data

SplitFlow Chamber
Single Turbos Chamber
(Filter – Filter) Allan Variance Experiment
40s Acquisition with total filter
### 10 minute 3σ Detection Limit / µg m⁻³

<table>
<thead>
<tr>
<th>Species</th>
<th>Org</th>
<th>m/q 44</th>
<th>NH4</th>
<th>NO3</th>
<th>SO4</th>
<th>Chl</th>
<th>&quot;Air&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ST</td>
<td>SF</td>
<td>ST</td>
<td>SF</td>
<td>ST</td>
<td>SF</td>
<td>ST</td>
</tr>
<tr>
<td>10 min, 3σ DL</td>
<td>0.084</td>
<td>0.122</td>
<td>0.022</td>
<td>0.039</td>
<td>0.033</td>
<td>0.067</td>
<td>0.008</td>
</tr>
</tbody>
</table>

**Organic (Org)**

**Mass/Charge 44 (m/q 44)**

**Ammonium (NH4)**

**Nitrate (NO3)**

**Sulfate (SO4)**

**Chlorophyll (Chl)**

**Ambient Air ("Air")**
Org Breakdown

The graph shows the 10 minute 3σ detection limit for different samples:
- **Org**
- **Org w/o 44**
- **m/z 44**

The graph compares two methods:
- **Single Turbos**
- **SplitFlow**

Bar heights indicate the detection limits for each method and sample combination.
NH₄ Breakdown
Signal-to-Noise Comparison Summary

- Overall comparison is quite similar
- For Organics and NH4, Single Turbos configuration has slightly enhanced detection limits compared to SplitFlow
  - This is likely due to lower ultimate pressure in detection region (lower water and CO2 background signals)
Lens Transmission Measuresments:
Size select NH$_4$NO$_3$ w/ DMA, Mass select w/ CPMA (no Q2s!), split between SF and ST systems.

Lens transmission is pretty much identical.