Particle Collection Efficiency

$CE$

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AMS Users Meeting
Caltech

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DEFINITION of NON-REFRACTORY (NR) Components

T > 150°C  \textit{MS Analysis of organics}

T > 350°C  Organics, NH$_4$NO$_3$, NH$_4$Cl

T ~ 550°C  NH$_4$SO$_4$

T ~ 620°C  NaNO$_3$, NaSO$_4$, Hg

T > 850°C  NaCl, ZnSO$_4$, Pb, …

T > 1500°C  BC, oxides \textit{refractory}

Flash Vaporization of Non-Refractory Components (NR)

Electron Emitting Filament

Focused Particle Beam

F vaporized

Positive Ion Mass Spectrometry

Electron Impact Ionization
NaNO₃ Vaporization as function of Vaporizer T

NaNO₃ Vaporization as function of Vaporizer T

Optimum T: ~620°C

NaNO₃  JCAP 1/03

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Current (amp)</th>
<th>Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>0.92</td>
<td>2.47</td>
</tr>
<tr>
<td>550</td>
<td>0.98</td>
<td>2.81</td>
</tr>
<tr>
<td>604</td>
<td>1.04</td>
<td>3.19</td>
</tr>
<tr>
<td>650</td>
<td>1.10</td>
<td>3.58</td>
</tr>
<tr>
<td>700</td>
<td>1.15</td>
<td>3.97</td>
</tr>
</tbody>
</table>

--- > ~615  1.05 amp
AMS – PILS Comparison (PM1.0@IMPACT2)

CE = 0.5
IE/AB measured at Langley during Pacific 2001
Ammonium Nitrate calibration at Langley, Vancouver, Canada

EI versus Air Beam

$10^{-6}$

$0.1$

$0.0$

Old EI (6.93e-7, AB = 3.37E6)

New IE used for ARI instrument

$V_{Pr} = 0.877222$;

$b = 2.7368e-13 \pm 8.37e-15$
Check NH4NO43 particle size

Ammonium Nitrate Calibration During pacific 2001

- t=0.00404
- t=0.00406
- t=0.004055
Measure PSLs

To check velocity calibration

New Velocity calibration

\[ p_0 = 528 \pm 0 \]
\[ p_1 = 12.777 \pm 0.645 \]
\[ p_2 = 0.70674 \pm 0.0115 \]
\[ p_3 = 65 \pm 0 \]
Total Inorganic:  AMS vs Moudi  

Pacific 2001  
C.E = 0.83
Langley Time Trends

Mass Concentration (µg m\(^{-3}\))

Date and Time

C.E = 0.83 for all species  

Pacific 2001

Organic_mass_to_Organic_carbon = 1
C.E. = 0.83 for all species

- sulfates
- nitrates
- organics
- ammonium
AMS vs Moudi  SO4 from Langley, PACIFIC 2001

AMS: \[ D_{va} = \rho \ D \]

MOUDI: \[ D_a = \sqrt{\rho} \ D \]
Mass loading = ion rate(Hz) * MW\textsubscript{NO}_3 / IE\textsubscript{NO}_3 / RIE\textsubscript{ion} / CE

IE\textsubscript{NO}_3 ≡ NH4NO3 calibration

RIE\textsubscript{ion} ≡ relative IE for ion type (e.g. SO4, org, …)

CE ≡ particle collection efficiency

**Particle Beam Width?**

Electron Emitting Filament

Focused Particle Beam

Vaporizer

Flash Vaporization of Non-Refractory Components (NR)

Positive Ion Mass Spectrometry

Electron Impact Ionization
Calibration factor $= 1 / \text{RIE}_{\text{ion}} / \text{CE}$

```
<table>
<thead>
<tr>
<th>Species</th>
<th>Displayed Name</th>
<th>Fragments</th>
<th>TOF Channels</th>
<th>Calibration Factor</th>
<th>Relative IE</th>
<th>Collection Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>Air</td>
<td>frag_air</td>
<td>28</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>water_RH</td>
<td>Water (RH)</td>
<td>frag_RH</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Oplus16</td>
<td>\texttt{\textbackslash S16\textbackslash MO\textbackslash S+\textbackslash M}</td>
<td>frag_O16</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>CO2_air</td>
<td>CO\texttt{\textbackslash B2\textbackslash M (air)}</td>
<td>frag_CO2</td>
<td>44</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Water</td>
<td>Water</td>
<td>frag_water</td>
<td>17,18</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>NH4</td>
<td>Ammonium</td>
<td>frag_NH4</td>
<td>16</td>
<td>0.285714</td>
<td>3.5</td>
<td>1</td>
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<td>NO3</td>
<td>Nitrate</td>
<td>frag_nitrate</td>
<td>30,46</td>
<td>0.909091</td>
<td>1.1</td>
<td>1</td>
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<tr>
<td>SO4</td>
<td>Sulphate</td>
<td>frag_sulphate</td>
<td>48.64</td>
<td>0.833333</td>
<td>1.2</td>
<td>1</td>
</tr>
<tr>
<td>SO3</td>
<td>SO\texttt{\textbackslash B3\textbackslash M}</td>
<td>frag_SO3</td>
<td></td>
<td>0.833333</td>
<td>1.2</td>
<td>1</td>
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<tr>
<td>H2SO4</td>
<td>H\texttt{\textbackslash B2\textbackslash MS\textbackslash O\textbackslash B4\textbackslash M}</td>
<td>frag_H2SO4</td>
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<td>0.833333</td>
<td>1.2</td>
<td>1</td>
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<tr>
<td>Org</td>
<td>Organics</td>
<td>frag_organic</td>
<td>43,53,55,57,67,79</td>
<td>0.714286</td>
<td>1.4</td>
<td>1</td>
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<td>Cl</td>
<td>Chloride</td>
<td>frag_chloride</td>
<td>36</td>
<td>0.769231</td>
<td>1.3</td>
<td>1</td>
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<tr>
<td>Total</td>
<td>Total</td>
<td>$\text{$Water,$NH4,$NC}$</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
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Batch File (James’ program)

Lab
In-situ (wire, RH, ....)
Inlet temperature experiment (lens focusing)

**Dry and Wet Conditions**

- **Dry**: Inlet temperature, Mass Concentration (µg m^{-3}), Temperature (°C)
- **Wet**: Inlet temperature, Mass Concentration (µg m^{-3}), Water, Sulfate, Nitrate, Org, Temperature (°C)

**Graphs**

- Mass Concentration vs. Date and Time
- Temperature vs. Date and Time
- dM/dlogD vs. Da (nm)

**Date and Time**

- 03/06/13
Sulfate and Nitrate: Dry/wet ratio ~ 0.5 (collection efficiency)
Organics: Dry/wet ratio ~ 0.5 for larger diameters
Dry/wet ratio ~ 1.0 for smaller diameters (hydrophobic?)
AMS – PILS Comparison (PM1.0@IMPACT2)

\[ CE = 0.5 \]
<table>
<thead>
<tr>
<th>Collection Efficiency</th>
<th>Langley</th>
<th>Tokyo</th>
</tr>
</thead>
<tbody>
<tr>
<td>external comparison</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Langley</th>
<th>Tokyo</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO3</td>
<td>1.06</td>
<td>0.5</td>
</tr>
<tr>
<td>SO4</td>
<td>0.75</td>
<td>0.5</td>
</tr>
</tbody>
</table>

RH: relatively high (no orifice temp measure) controlled

**NO3/SO4 ratio:**
- Quadrupole: “small” “large”
- Ionizer: “large” “small”

**CE:**
- Lens: “Michigan” “Mainz”
- Coarse Particles: few seasalt
AMS vs Moudi   SO4 from Langley, PACIFIC 2001

AMS:  \[ D_{va} = \rho \ D \]

MOUDI:  \[ D_{a} = \sqrt{\rho} \ D \]