Overview of AMS Hardware Development

• ePTOF - Efficient Particle Time-of-Flight
• ADQ1600, Custom data acquisition card
• AMS DAQ Software - Joel
• PM2.5 Lens
• Capture vaporizer
• Auto tuning software for mass spectrometer
• Pfeiffer pump system
Efficient Particle Time-of-Flight ePTOF

Application of a higher throughput chopper wheel

Performance enhancements in size resolved measurements with the AMS

ARI/Tofwerk
(J. Jayne, J. Kimmel, R. Knokumuss, M. Cubison, M. Gonin)

CU/Boulder
P. Campuzano Jost, D. Day & Weiwei Hu, Harald,
Donna, Jose
Size measurement in the AMS

Single slit chopper limits throughput to 2%
Typical AMS pTOF Size Distribution

![Graph showing typical AMS pTOF size distribution](030707_smps.pxp)
Multi-slit wheel for 50% aerosol throughput

Deconvolution procedure to obtain size information

- 3-phase brushless DC motor
- velocity regulated by closed loop control

Richard Knochenmuss - Tofwerk
ePTOF Hardware

6 systems in use

Next controller version will support remote control
ePTOF Controller Mounted on HTOF AMS
300 nm NH$_4$NO$_3$ Raw Data

Recorded with multi-slit wheel

One chopper rotational period, 381 TOF extractions
300 nm NH4NO3 Data De-Multiplexed

![Graph showing data de-multiplexed with different sharpness and denoise settings.]

- Blue line: sharpness=0, denoise=0
- Black line: sharpness=4, denoise=4

Data file: D:\aCIMS\Chopper_Sequence\PAM_Datxperiment2.pxp
PTOF & ePTOF resolution comparison on Mini-AMS (24.5cm flight path)

ePTOF has higher resolution - 127 bit sequence
→ 1/127 = 0.78% (effective slit width) vs 2%

Florian, Phil Dec 2013
Compares Single-slit (1%) to Multi-slit

\begin{figure}
\centering
\includegraphics[width=\textwidth]{m43_ion.png}
\caption{m43 ion}
\end{figure}

\begin{equation*}
a-\text{Pinene} + \text{OH}, \sim 10 \, \mu\text{g/m}^3, \, 2 \, \text{min data}
\end{equation*}
ePToF Summary

- Acquisition mode is implemented in DAQ5 and Squirrel
- Targeting acquisition that is ePTOF all the time (always get size, only a small reduction in net MS duty cycle).
- Evaluating de-noising and sharpness functions.
- Characterization paper this winter (CU), still improving timing.
New Data Acquisition Card
SP Devices ADQ1600

- Fast ADC with extended range, 14 bit, 1.6 GS/sec
- Replaces AP240 (8 bit, 1 GS/sec; now discontinued)
- Custom firmware (Tofwerk-SPD collaboration)
- PCIe and USB-3 versions (for all Tofwerk TOFs)
New Data Acquisition Card
SP Devices ADQ1600

• Supports ePTOF application.

• Single particle – Event Trigger mode (*no support for LS module*)

• With improved thresholding algorithm and extended dynamic range we expect better detection of SI and improved quality of PMF results

• Not recommended to run under Windows XP

• 10+ systems in use
PM2.5 Lens Transmission

We have a design, still learning how to make multiple copies
Capture Vaporizer and Particle Bounce
Particle Bounce

Ideal scenario
Vaporization on 1\textsuperscript{st} collision

Reduced ion production

Positive Ion Mass Spectrometry
Collection Efficiency

Standard Vaporizer 600C

$\text{NH}_4\text{NO}_3$

$\text{(NH}_4\text{)}_2\text{SO}_4$

“calibration”

$\text{CE} = 22\%$
Improved CE of AS with new capture vaporizer

76%
Capture Vaporizer pTOF Traces
300 nm SO4 and NO3

300 nm 620C
Particles entering Capture Vaporizer more m30 and broader than m46
SO4 is broadend as expected

- Orange: m64
- Red: m48
- Blue: Sig_p30_R15430
- Dark blue: Sig_p46_R1540

Ion Signal vs. pToF(s)

Sulfate is broadened as expected
SOAS Data  *Weiwei Hu et al*

**Time series of main species of AMS**

- **Preliminary data of capture vaporizer, CE=1**
- **Chemical composition based CE (~0.5) apply to standard vaporizer**
Similar PMF result are resolved in capture vaporizer

**Standard vap**

- OOA: 57%
- HOA: 22%
- COA: 20%

**Capture vap**

- OOA: 56%
- HOA: 23%
- COA: 21%

**Ambient**
Summary of Capture Vaporizer

• The device works, all the mass is recovered, CE=1
• Mostly applicable to ACSM since pTOF is distorted (as expected) but still provides some sizing info.
• Need to carefully evaluate fragmentation patterns.
• Field data from SOAS looks good. Side-by-side comparison of HTOF w/CV and HTOF w/standard vaporizer
New TOF Power Supply
TPS2 system

- Giraffe (2U)
- TPS2 (3U)
First Pfeiffer Turbo AMS

Replaces Agilent Turbos
Automatic TOF tuning by Thuner

One button simultaneous tuning of multiple TOF (and User) voltages.

- TOFWERK software package (.net, dll)
- Commercial algorithms (Umetrics MODDE)
- Compatible with any Tofwerk TOF

Tofwerk: Manuel Hutterli, Fredrik Östlund, Christian Tanner
Thuner - Simultaneous optimization of signal intensity and resolution

Quad 2 (BSQ) and Primary Beam Voltages

Sensitivity

Resolution

CIMS Clinic Boulder March 2013