Overview of AMS Hardware Developments

Tues Aug 26 10:35 (25 min)

- ePTOF - Efficient Particle Time-of-Flight
- ADQ1600, Custom data acquisition card
- AMS DAQ Software
- 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

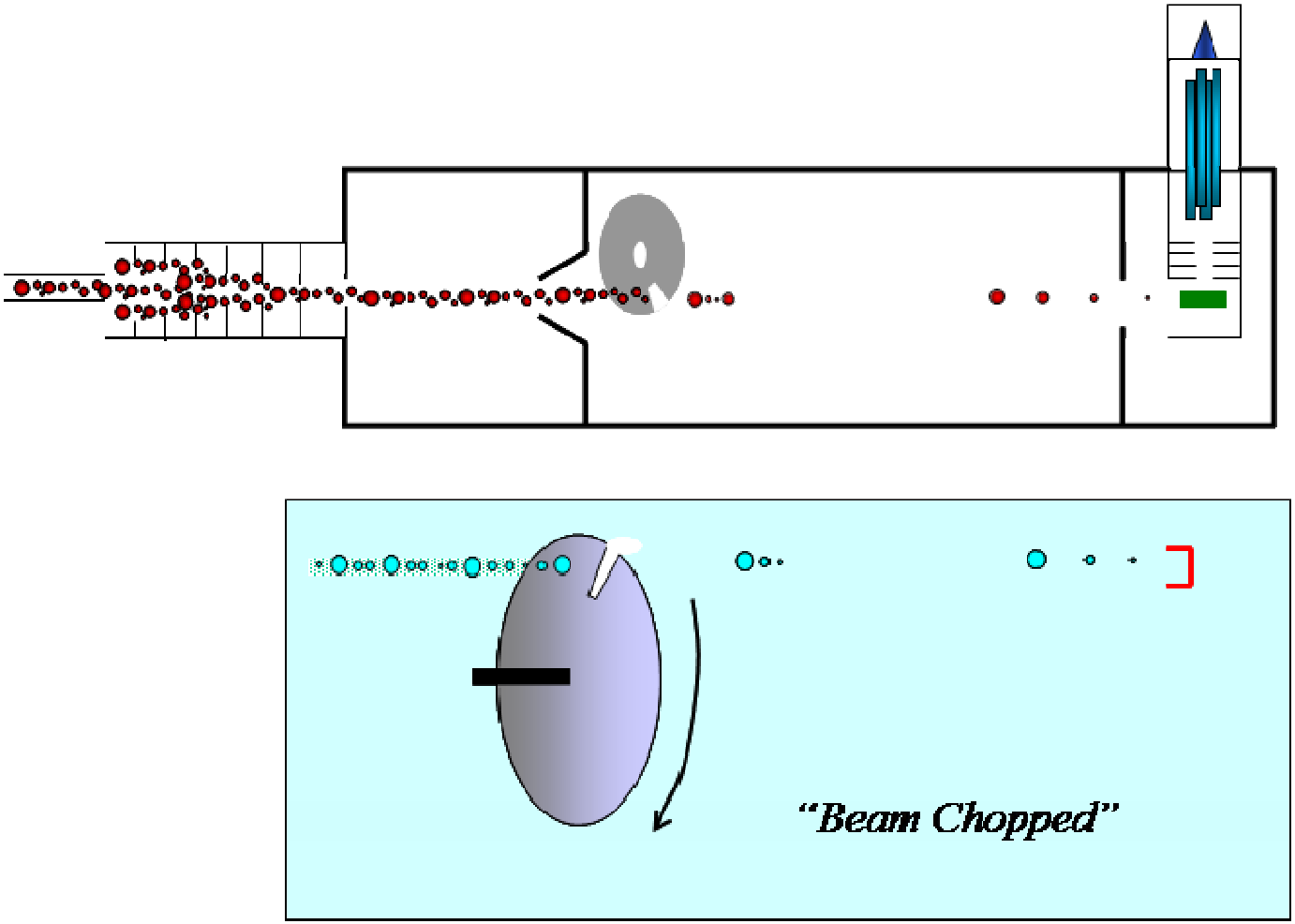
Performance enhancements in size resolved measurements with the AMS

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

CU/Boulder
P. Campuzano Jost, D. Day & Weiwei Hu, Harald,

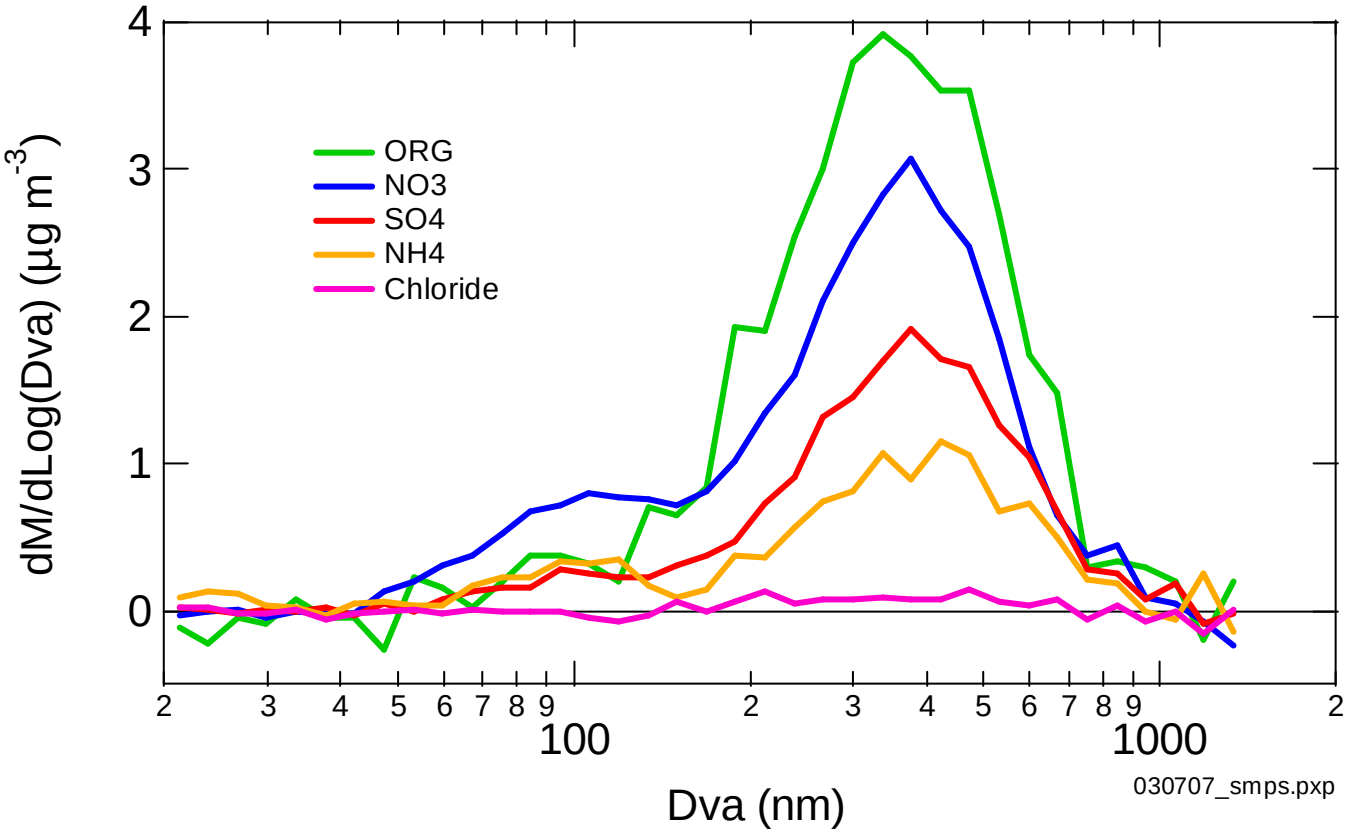
Donna, Jose

Size measurement in the AMS



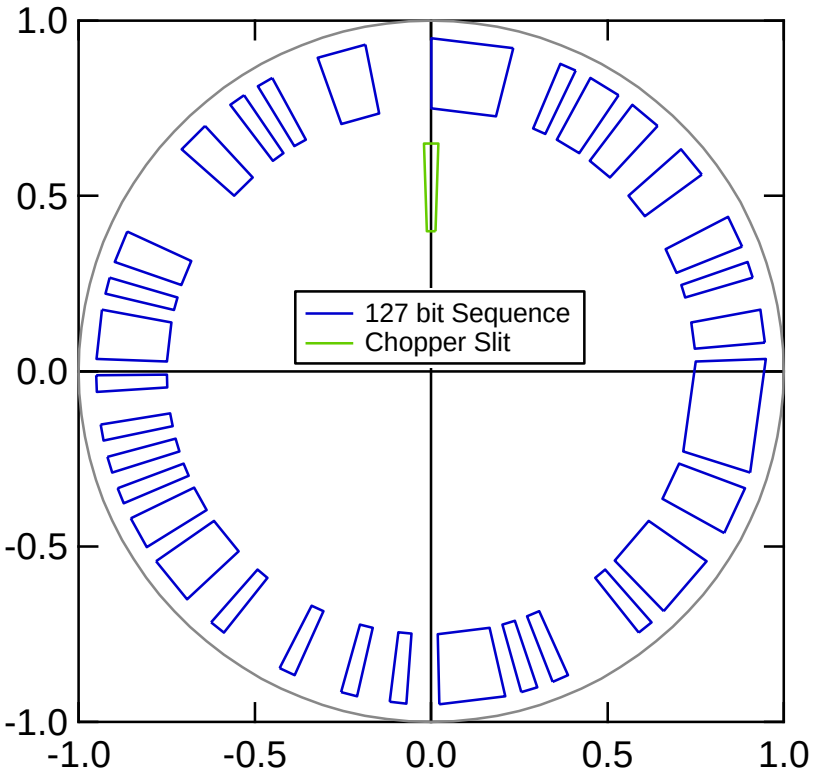
Single slit chopper limits throughput to 2%

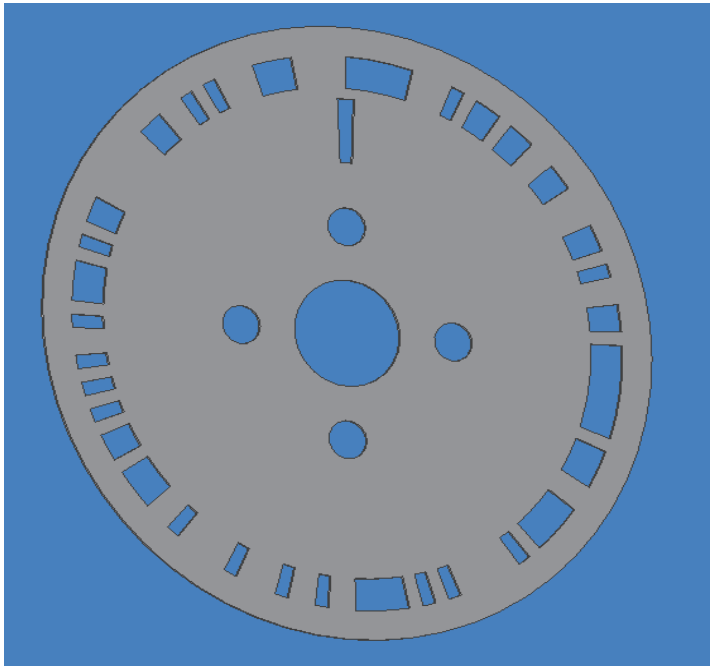
Typical AMS pTOF Size Distribution



Multi-slit wheel for 50% aerosol throughput

Deconvolution procedure to obtain size information





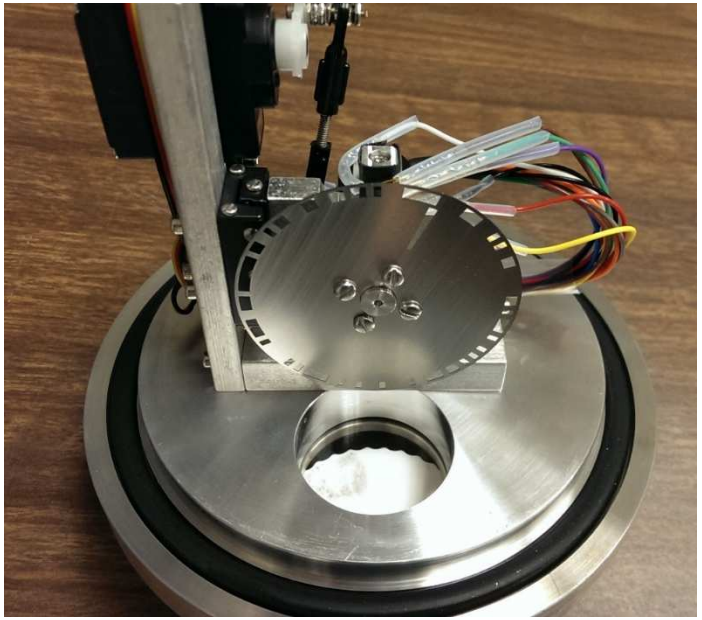
4-positions
open, closed, blocked, chop

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

Richard Knochenmuss - Tofwerk

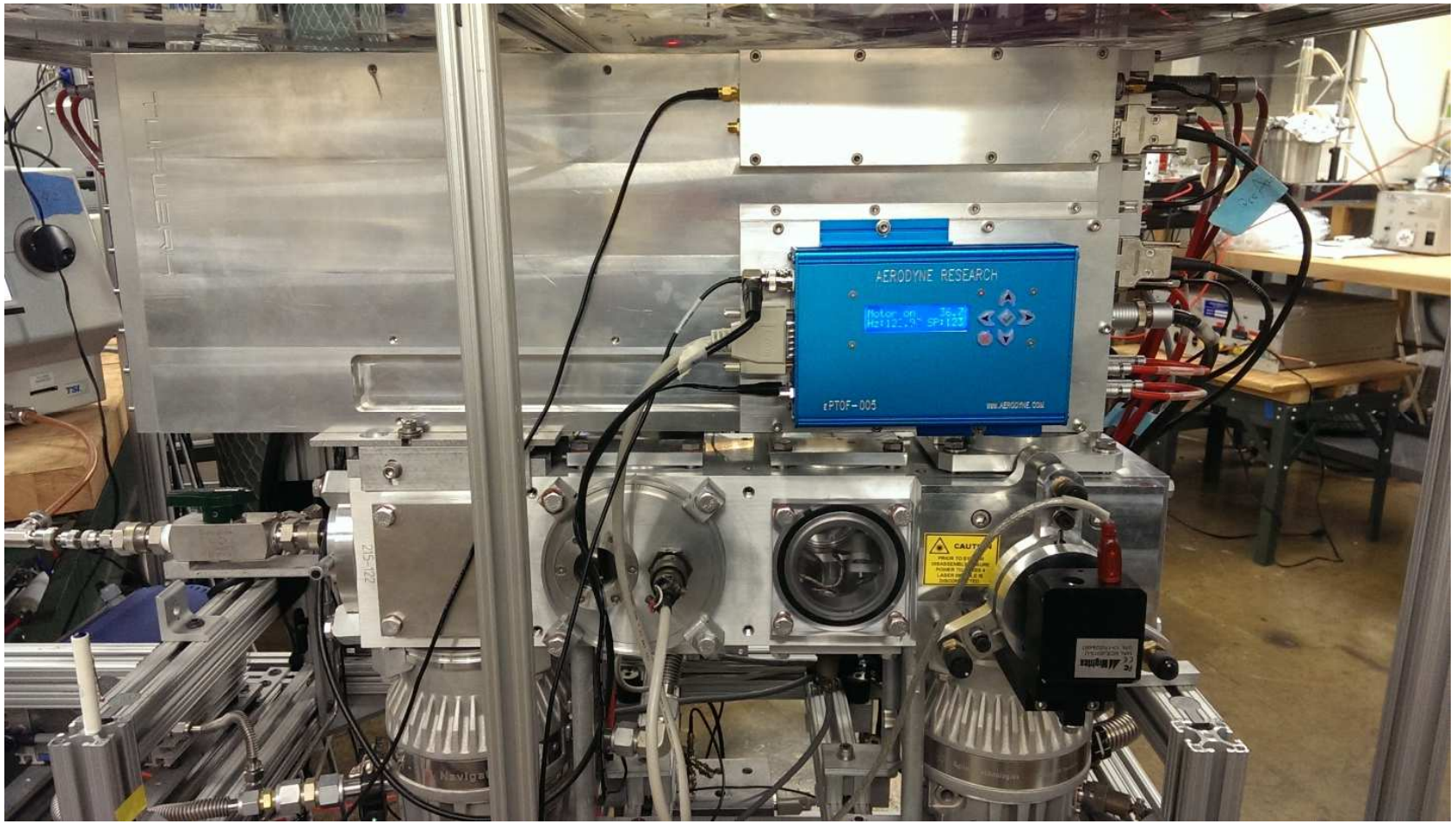
ePTOF Hardware

6 systems in use



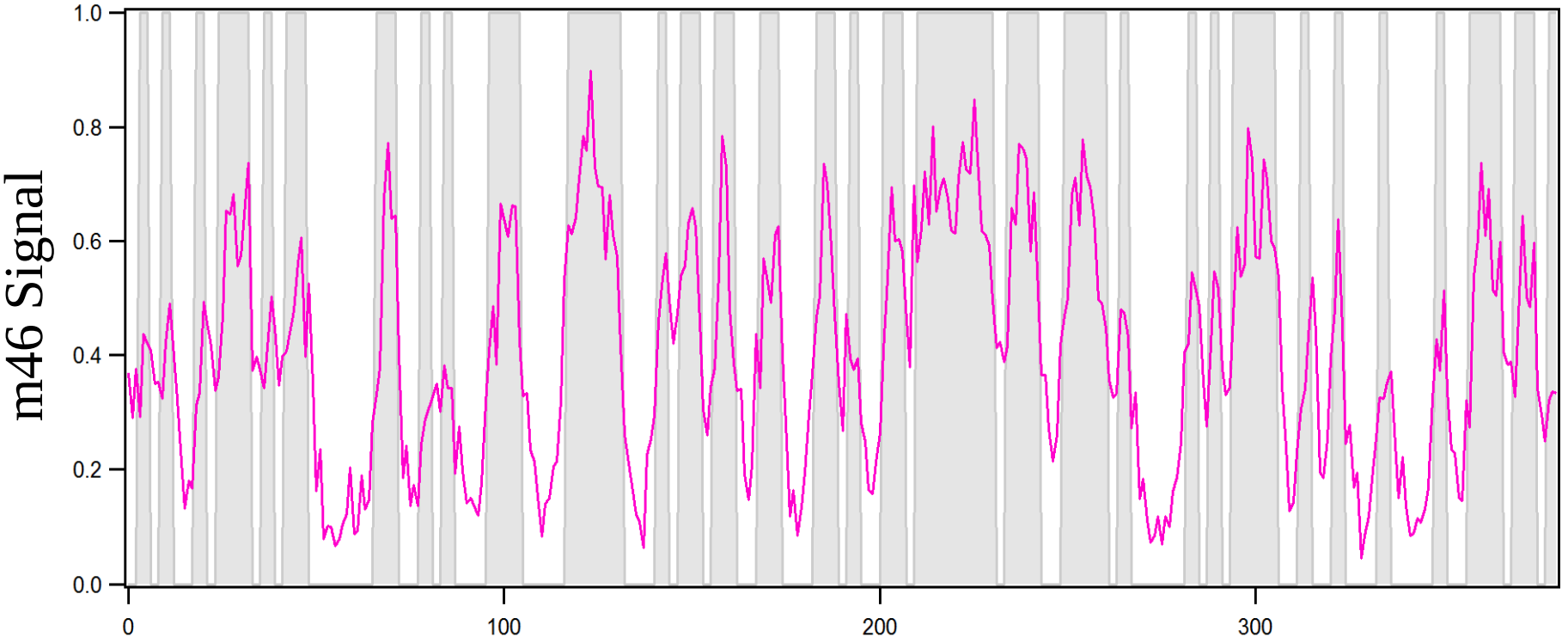
Next controller version will support remote control

ePTOF Controller Mounted on HTOF AMS



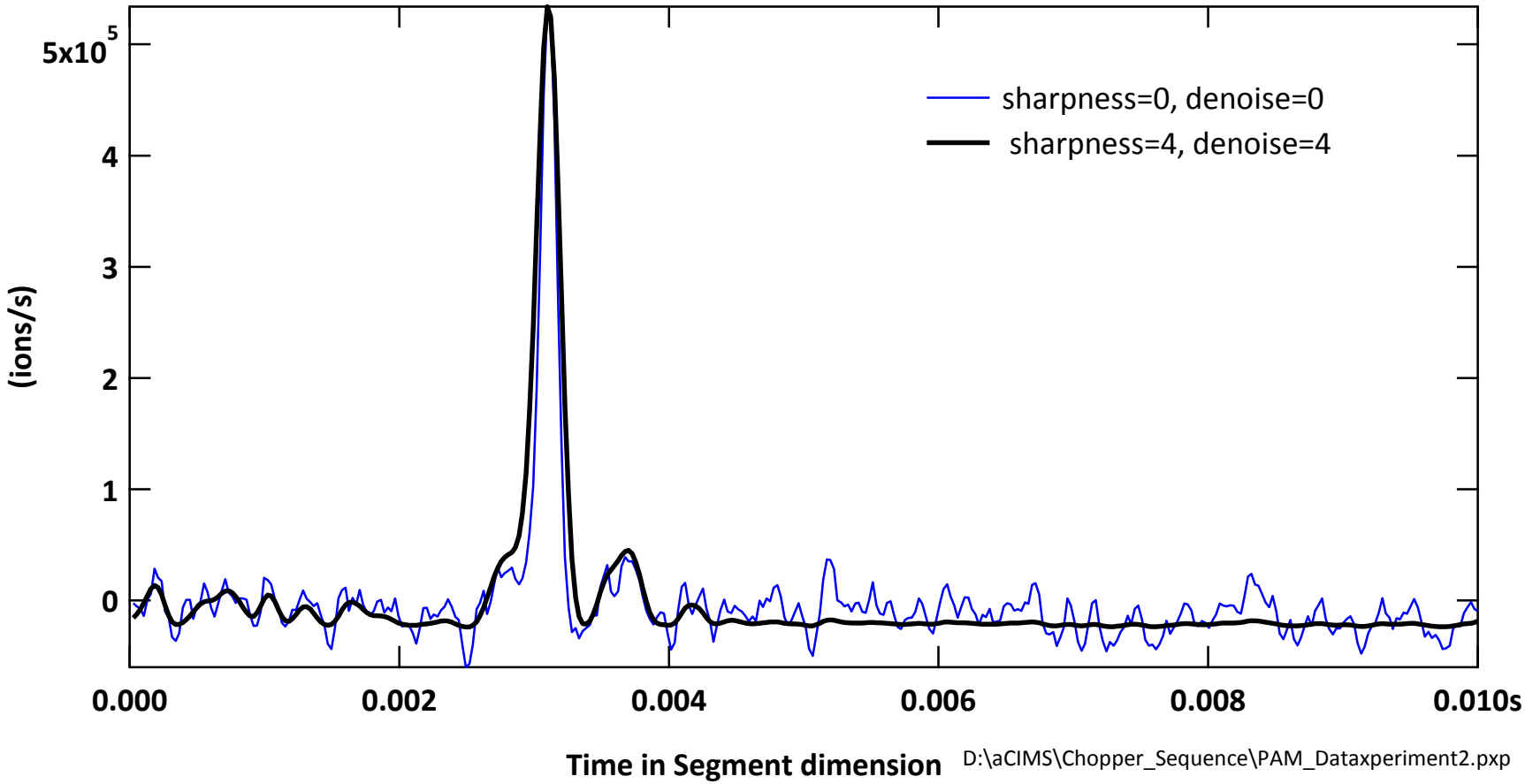
300 nm NH_4NO_3 Raw Data

Recorded with multi-slit wheel

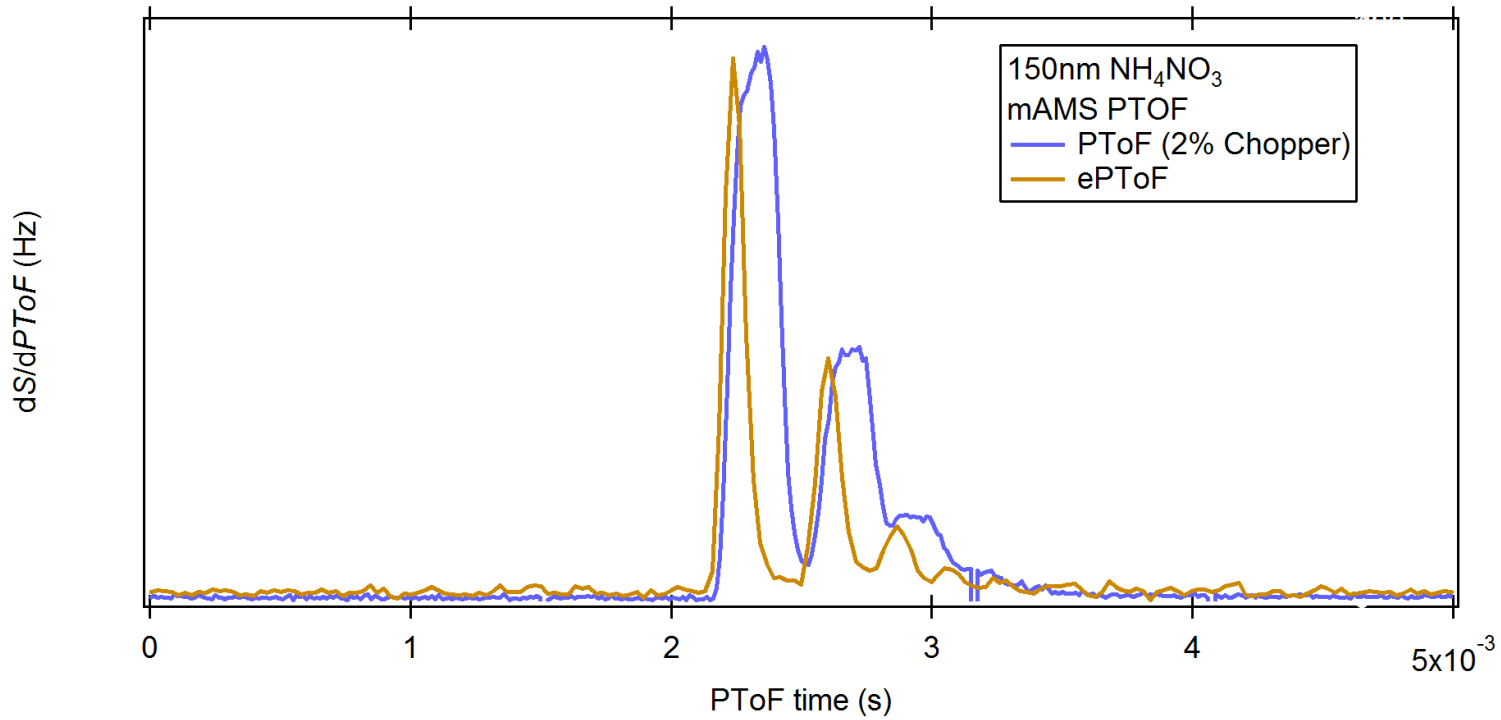


One chopper rotational period, 381 TOF extractions

300 nm NH4NO3 Data De-Multiplexed

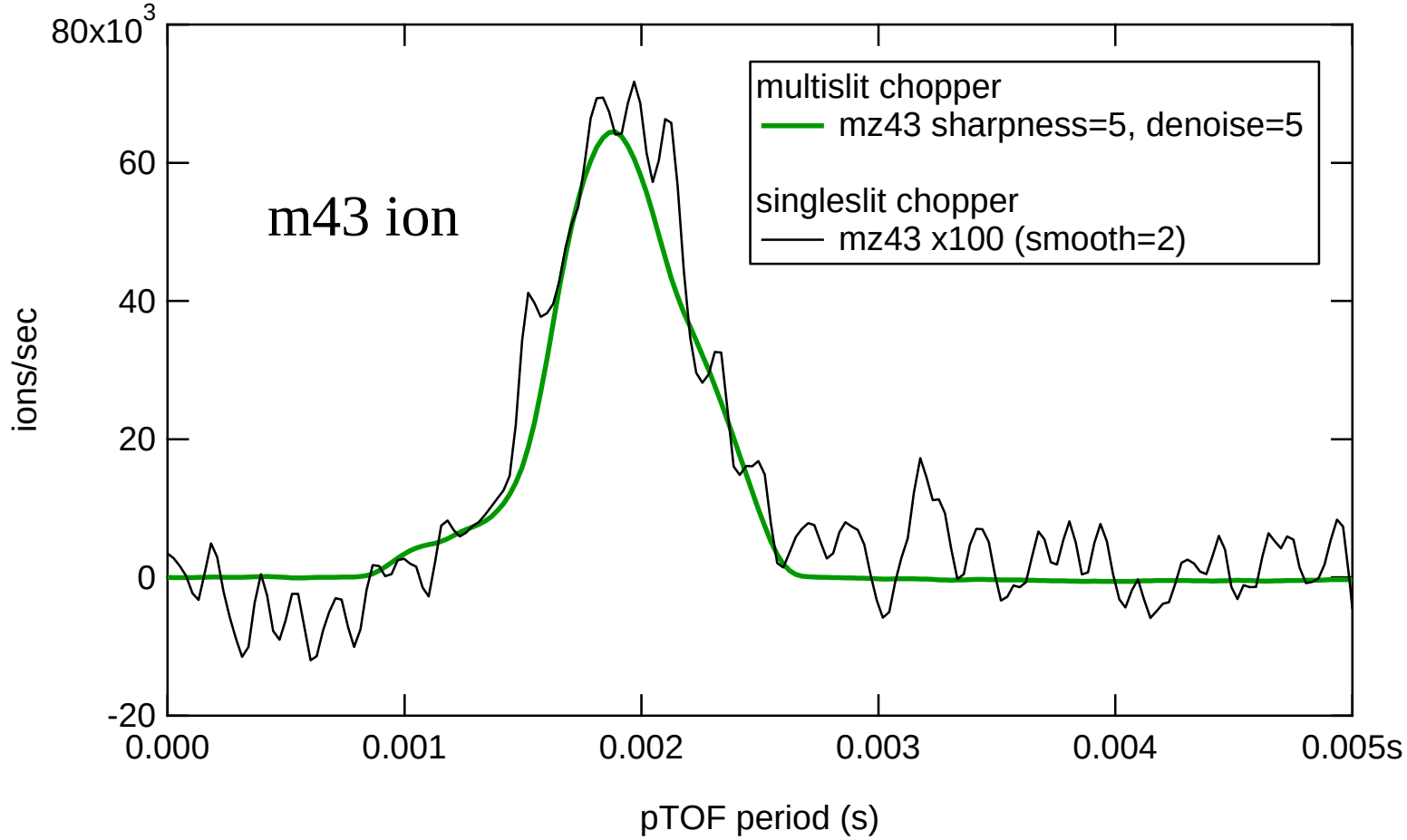


Mini-AMS PTOF& ePTOF resolution comparison (24.5cm flight path)



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

Compares Single-slit (1%) to Multi-slit



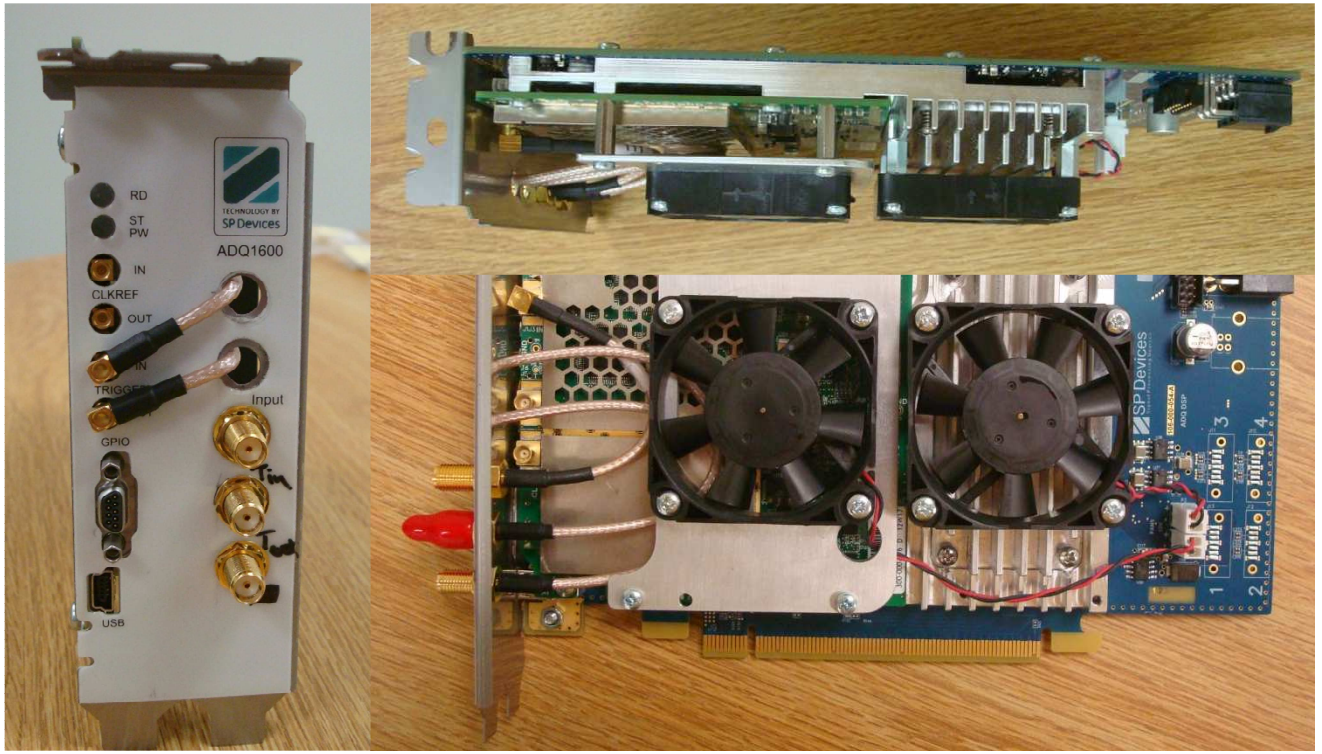
a-Pinene + OH, ~10 µg/m^3, 2 min data

ePToF Summary

- Acquisition mode is implemented in DAQ5 and Squirrel
- Still targeting acquisition that is ePTOF all the time (always get size, only a small reduction in net MS duty cycle).
- Still 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

ToF-AMS DAQ

Joel Kimmel

Aerodyne Research | TOFWERK AG

What is DAQ5?

Development of DAQ4 has ended

- Only DAQ 4.0.24 and .36 are supported. Anybody running earlier versions is encouraged to upgrade.

DAQ5 is a major overhaul to accommodate the many AMS configurations that are now possible and new modes of operation

- AP240/ADQ, TPS1/TPS2, mini-AMS
- ePToF , Event Trigger, auto-tuning software

Maintains much of DAQ4 structure and appearance to ease transition for users

- Menu file structure, major windows, HDF file structure

Now in use on 10 to 15 AMSs

- Most are mAMS, ADQ, or TPS2
- 2 or 3 are AP240 beta testers
- Expect broad release for all in next year

DAQ5

DAQ5 controls the new variety of hardware configurations

User interface adjusts based on combination of components in use

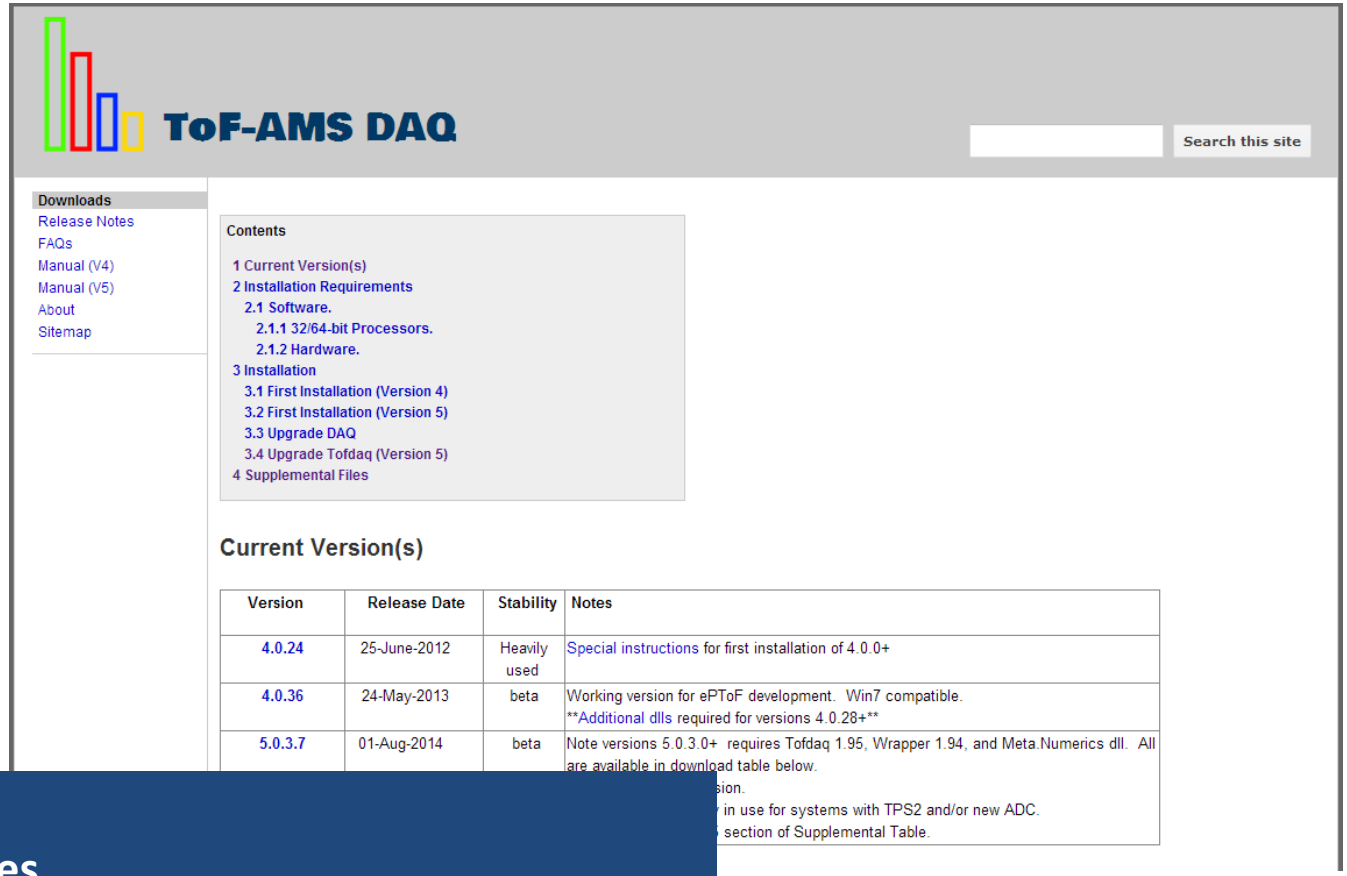
	DAQ4	DAQ5	
AP240	X	X	
Slow Board	X	X	
TPS1	X	X	
MS, PToF, FMS	X	X	
Light Scattering	X	?	*Delayed implementation*
New ADC		X	
ePToF		X	
mini-AMS		X	
TPS2		X	
Event Trigger Single Particle Mode		X	
Auto-tuning		X	*Can be used without AMS DAQ; DAQ5 will have dedicated interface*

ADQ1600

All new AMSs are delivering with the SP Devices ADQ1600. It is also available as an upgrade. 10-15 units now in use.

	AP240	ADQ	
Speed	1 GS/s	1.6 GS/s	
Resolution	8-bit (254)	14-bit (16384)	
Thresholding Algorithm	Record samples that are above threshold	Record samples that are above threshold and adjacent samples	For many single ions, this means AP240 records only the peak, while ADQ records peaks and edges
Event Trigger Mode	No	Yes	
ePToF Mode	No	Yes	

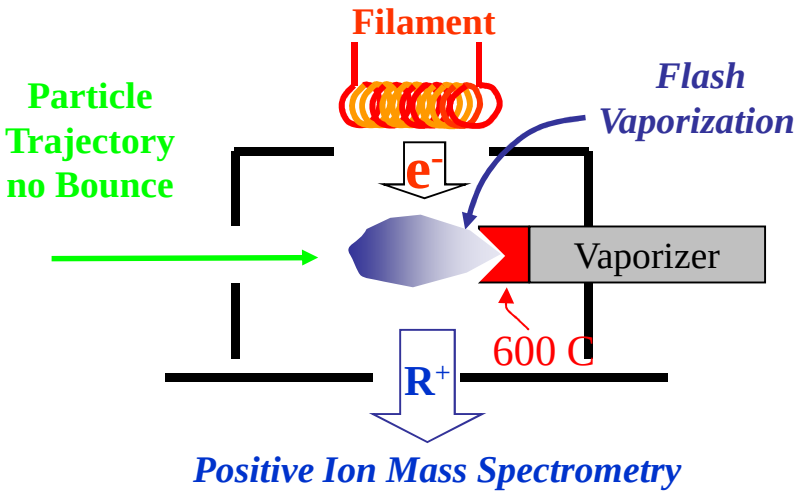
site.google.com/site/tofamsdaq

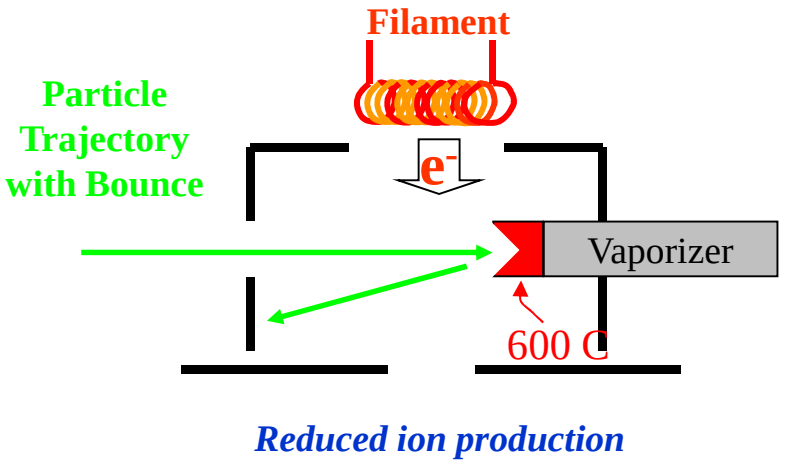


- Downloads
  - Release Notes
- Manual
- FAQs
  - Updated with real questions!
- jkimmel@aerodyne.com
  - Always available for questions and suggestions

Capture Vaporizer
and
Particle Bounce

Particle Bounce





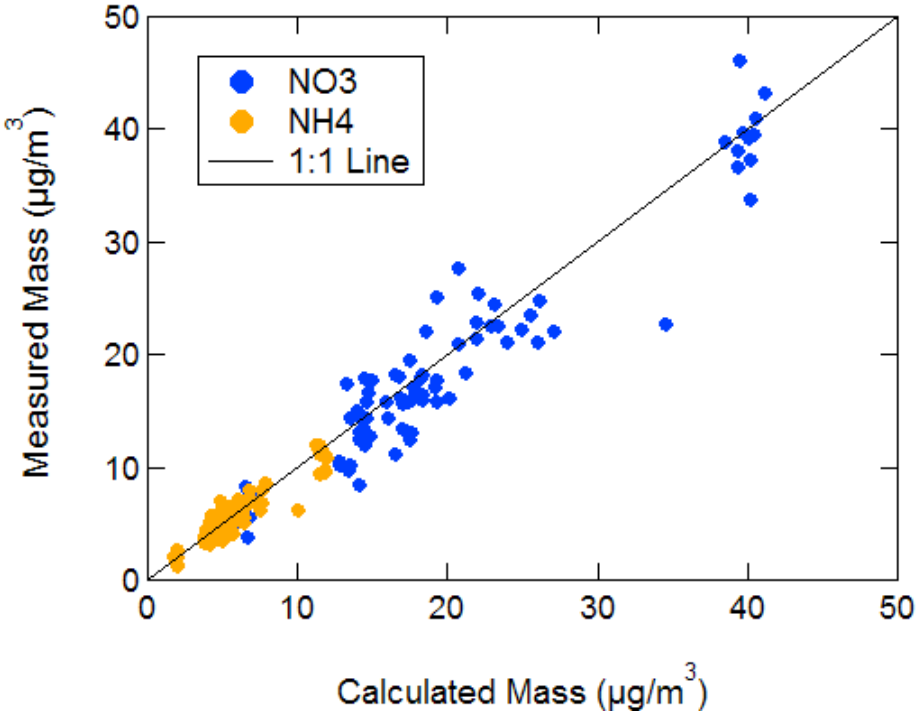
Ideal scenario
Vaporization on
1st collision

Particle Bounce

Collection Efficiency

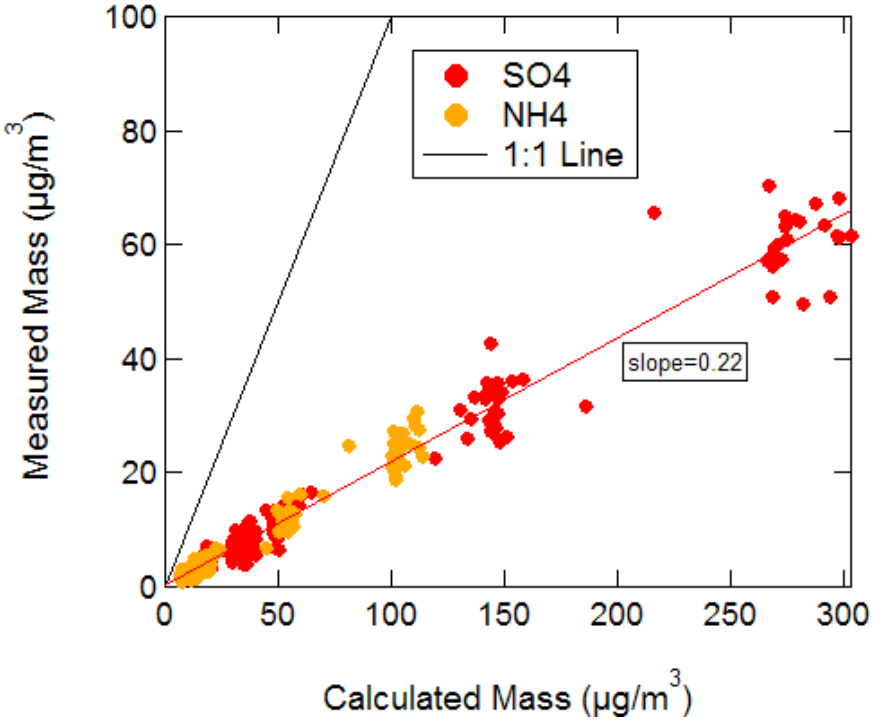
Standard Vaporizer 600C

NH_4NO_3



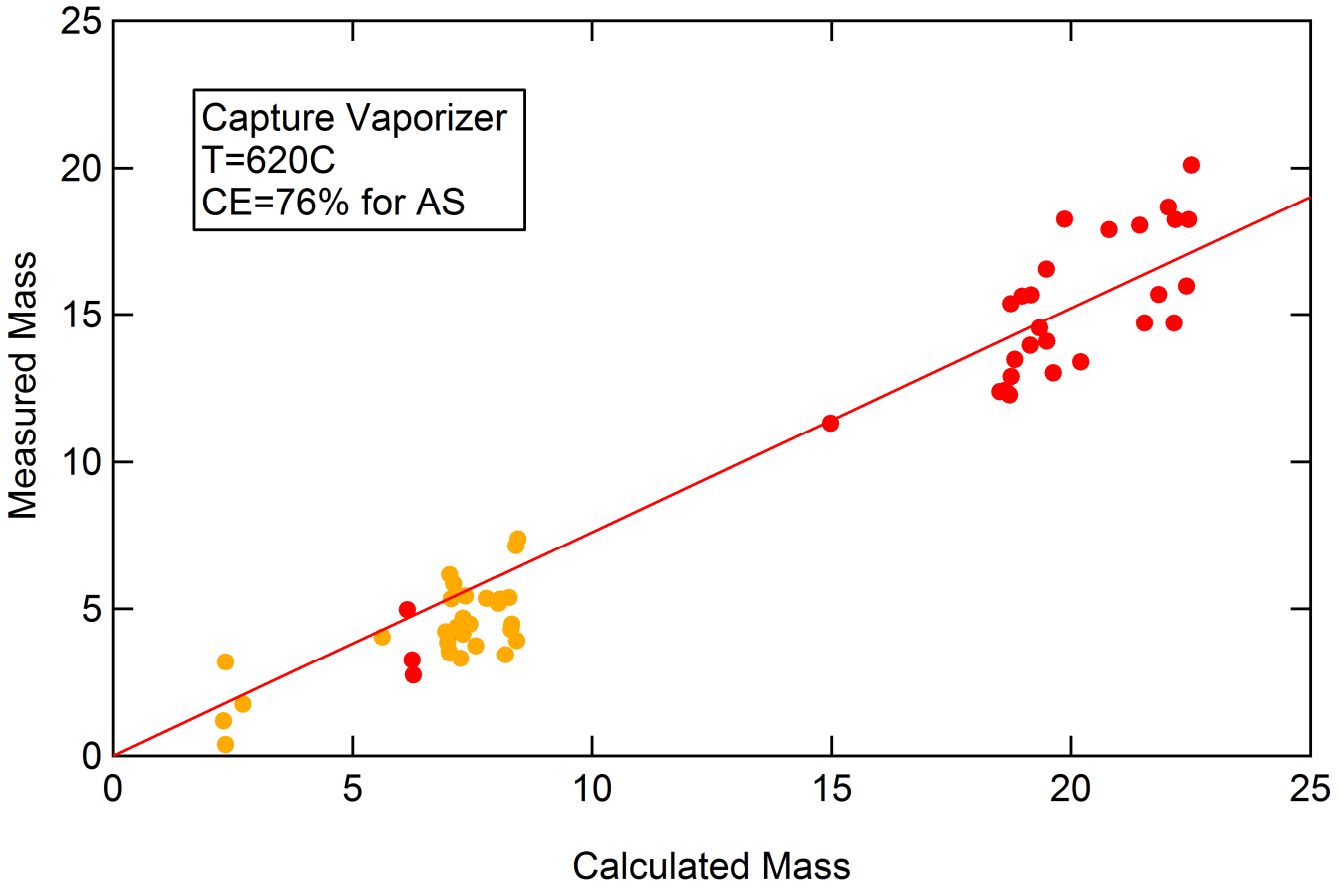
"calibration"

$(NH_4)_2SO_4$

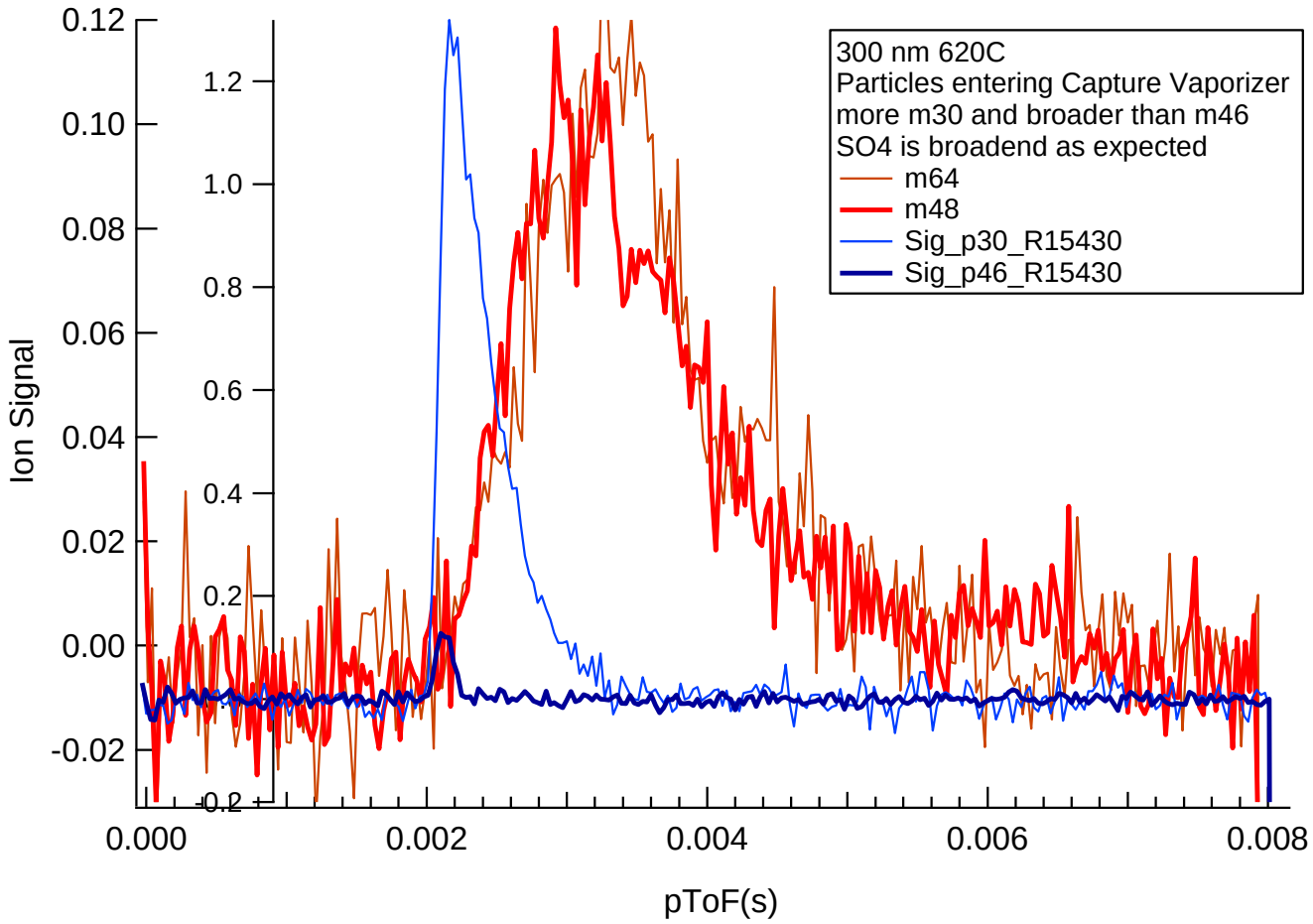


CE = 22%

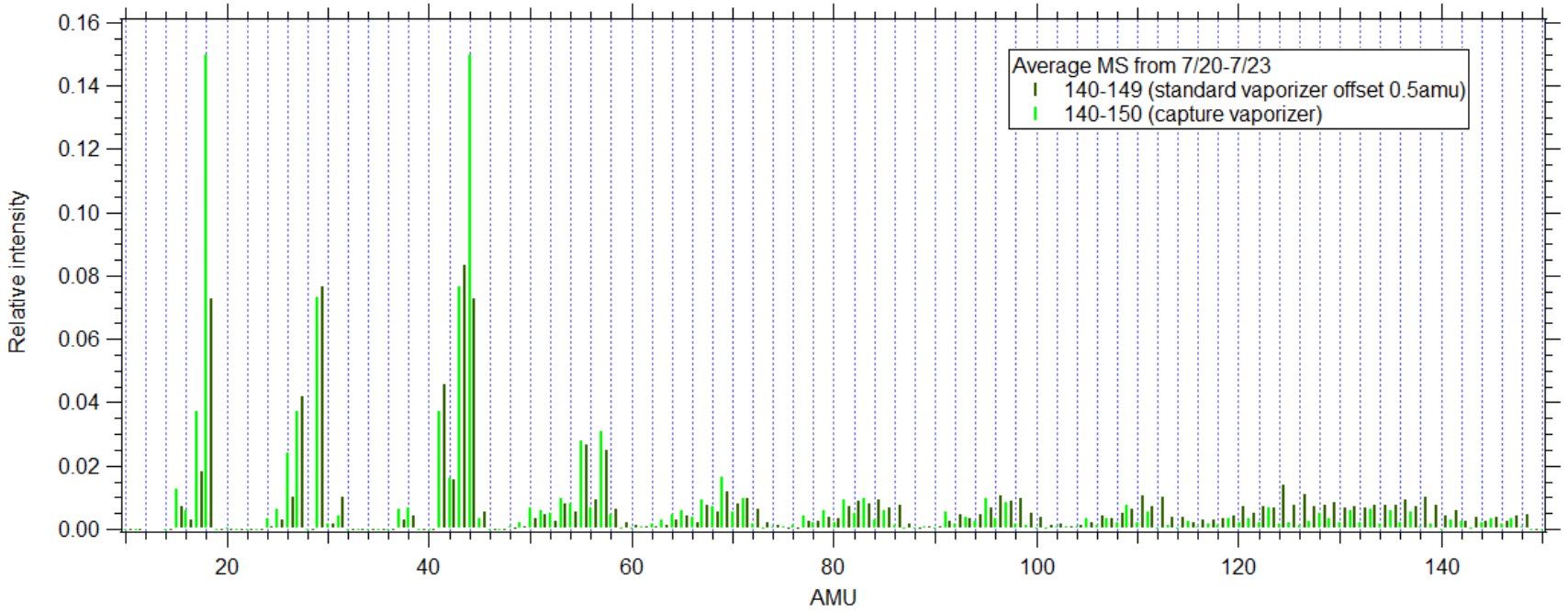
Improved CE of AS with new capture vaporizer 76%



Capture Vaporizer pTOF Traces SO4 and NO3
Sulfate is broadened as expected



Mass spectrum shows a larger fraction of Org is going into m/z 44



Two side-by-side QACSM systems sampling ambient aerosol

Summary of Capture Vaporizer

- Mostly applicable to ACSM since pTOF is distorted (as expected).
- The device works, all the mass is recovered, CE=1
- Need to carefully evaluate fragmentation patterns.
- Data set from SOAS to be presented (Weiwei, CU)
  - Side-by-side comparison of HTOF w/CV and HTOF w/standard vaporizer

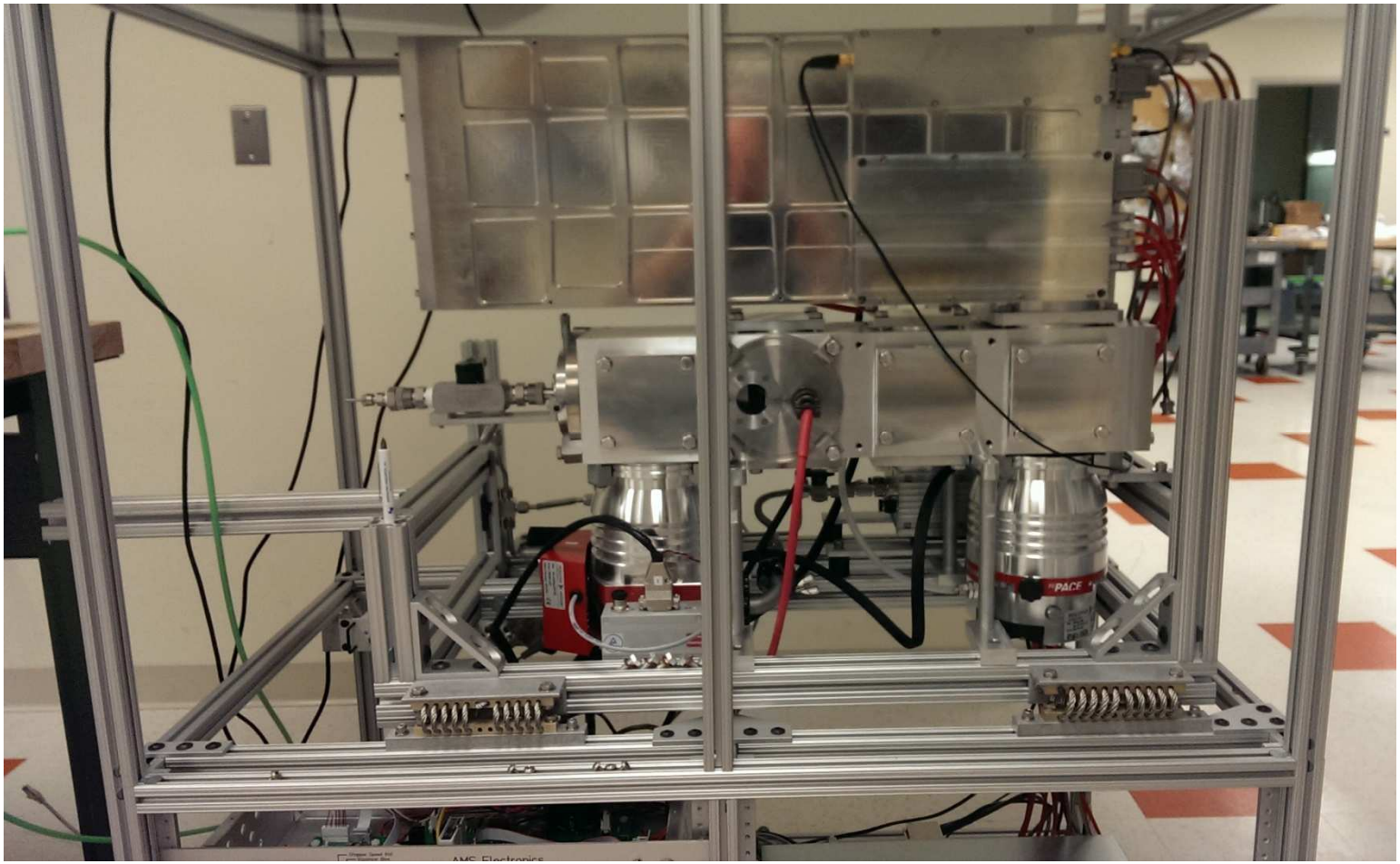
New TOF Power Supply

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.

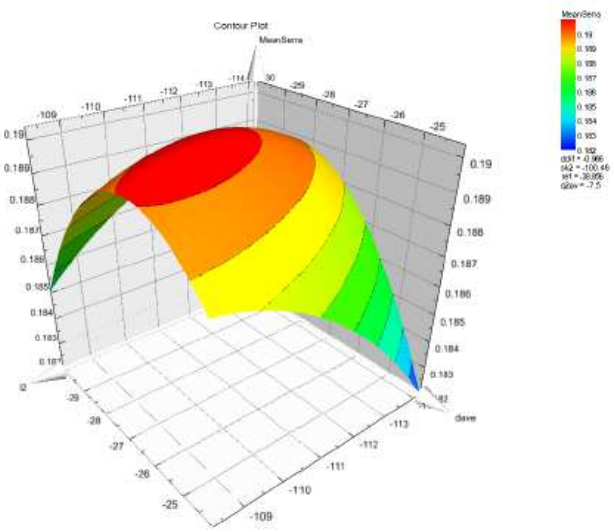
- TOFWERK software package (.net, dll)
- Commercial algorithms (Umetrics MODDE)
- Compatible with any Tofwerk TOF

Tofwerk: Manuel Hutterli, Fredrik Östlund, Christian Tanner

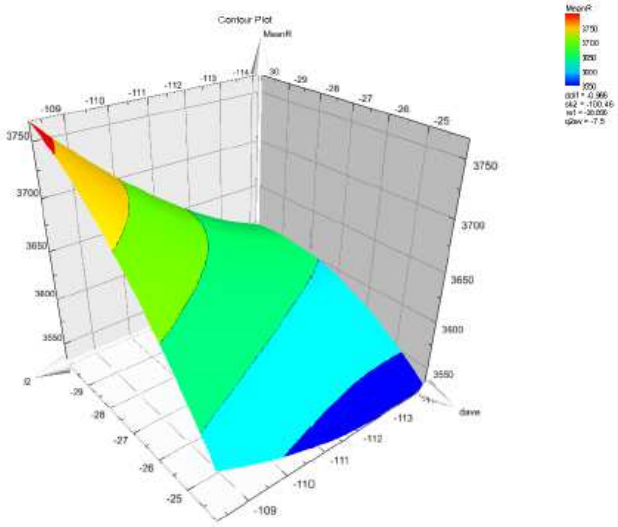
Thuner - Simultaneous optimization of signal intensity and resolution

Quad 2 (BSQ) and Primary Beam Voltages

TOFWERK
Time-of-Flight Mass Spectrometry

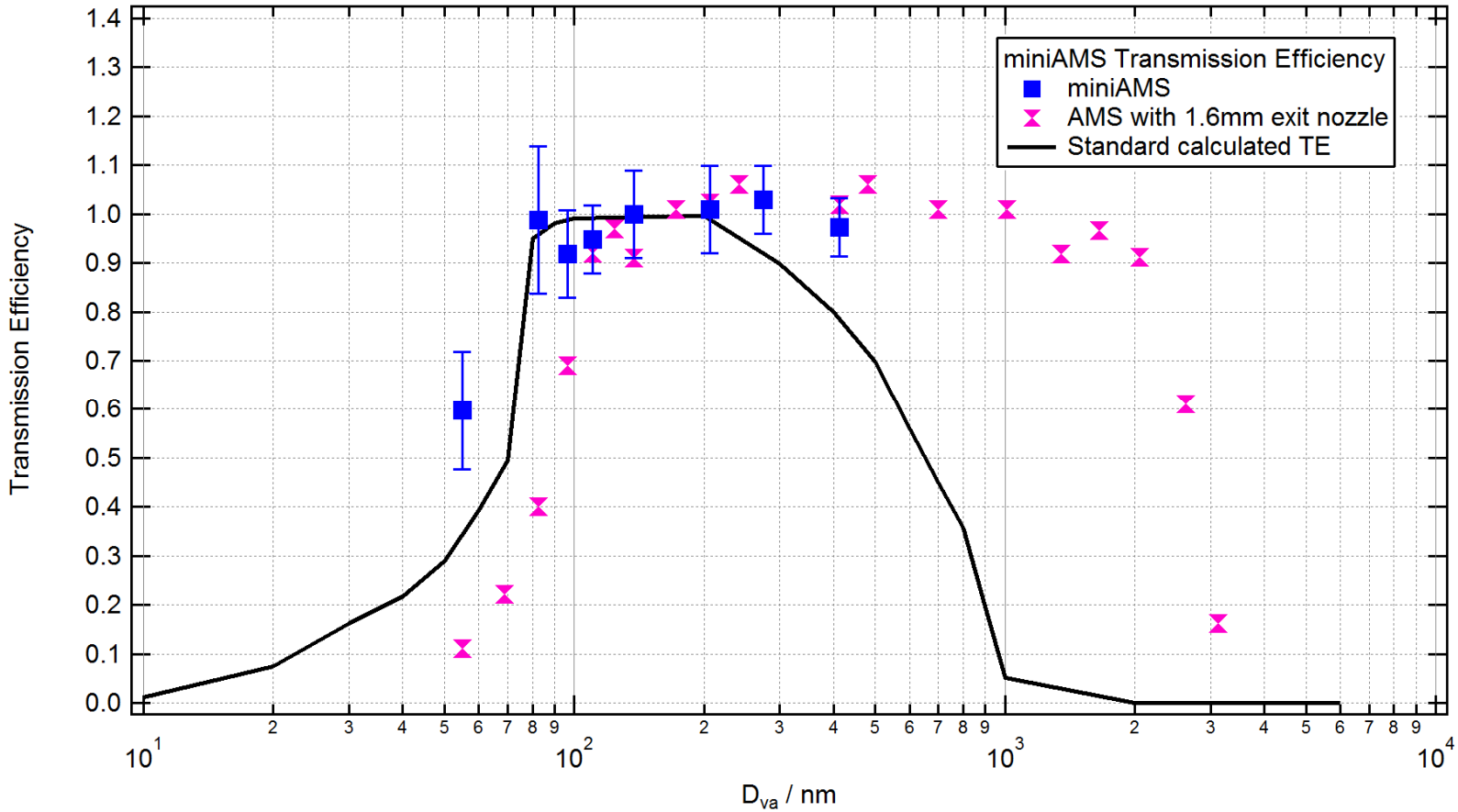


Sensitivity



Resolution

PM2.5 Lens Transmission



We have a design, still learning how to make multiple copies