Gas-Phase Measurements Using ~~Aerosol~~ Aerodyne Mass Spectrometers (AMS)

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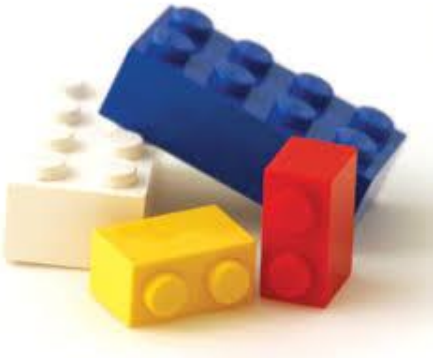
The ToF-CIMS is a story about re-using parts.

In the past 4 years we have

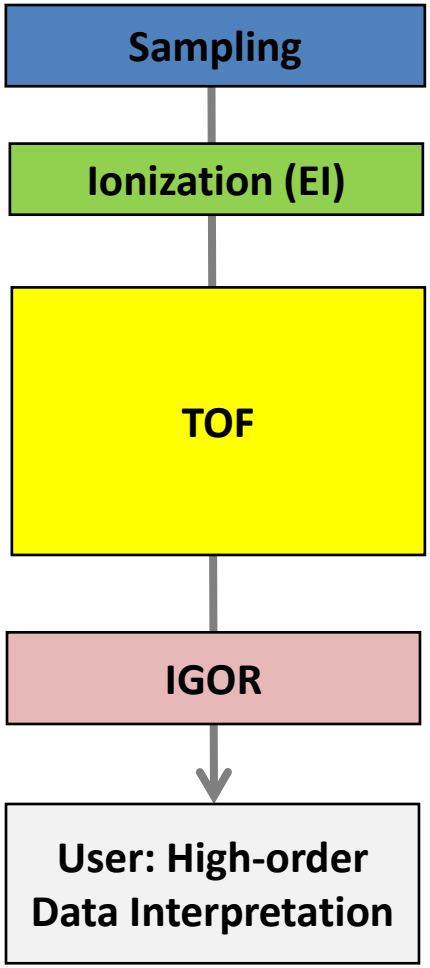
adapted our **TOFMS and analysis methods**

for use with well-known

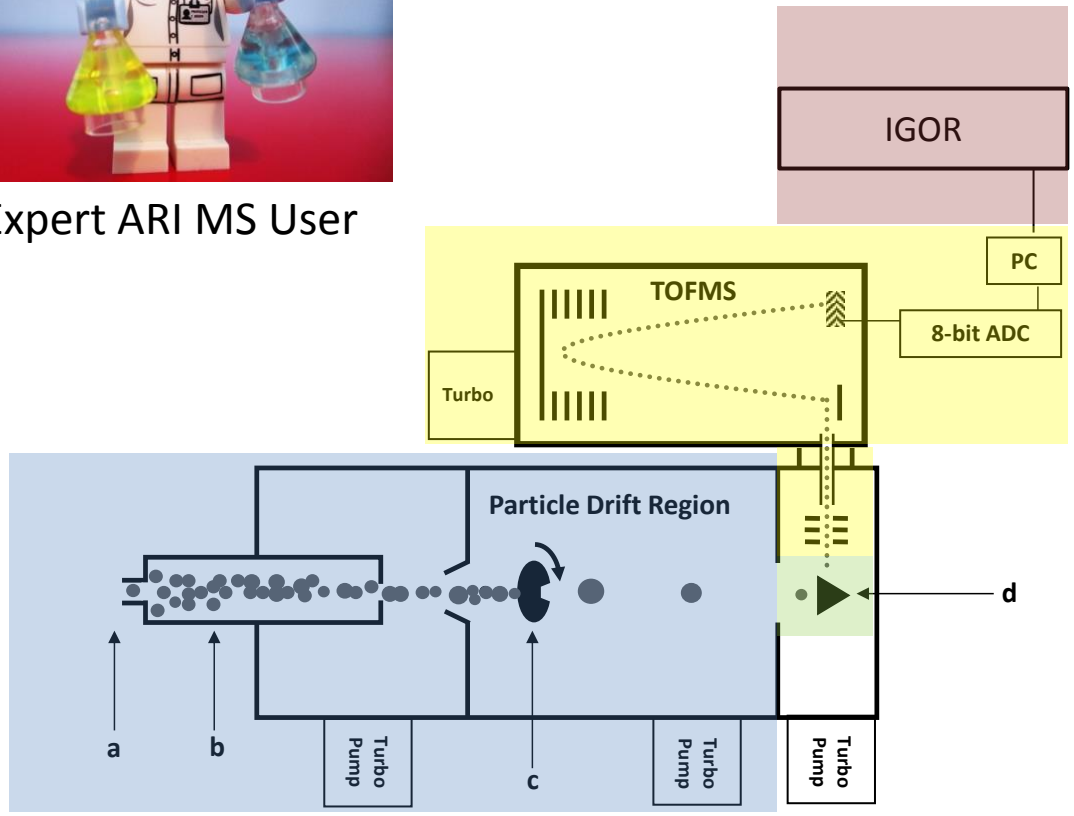
chemical ionization (CI) schemes



The Anatomy of an AMS Experiment

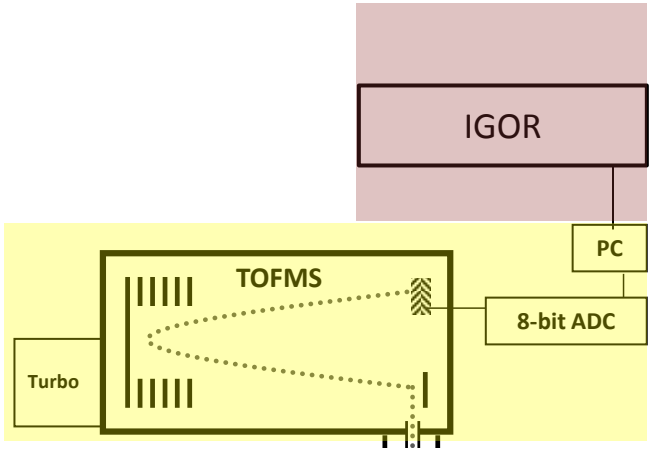


Expert ARI MS User



Changing the front end

Expert ARI MS User



Chemical Ionization

Chemical Ionization is widely used in atmospheric science. Hardware and ion chemistry well documented.

- We are not inventing this!

Bring advantages of TOF to field of chemical ionization

- Utilize instrumental and analytical expertise developed through the AMS.

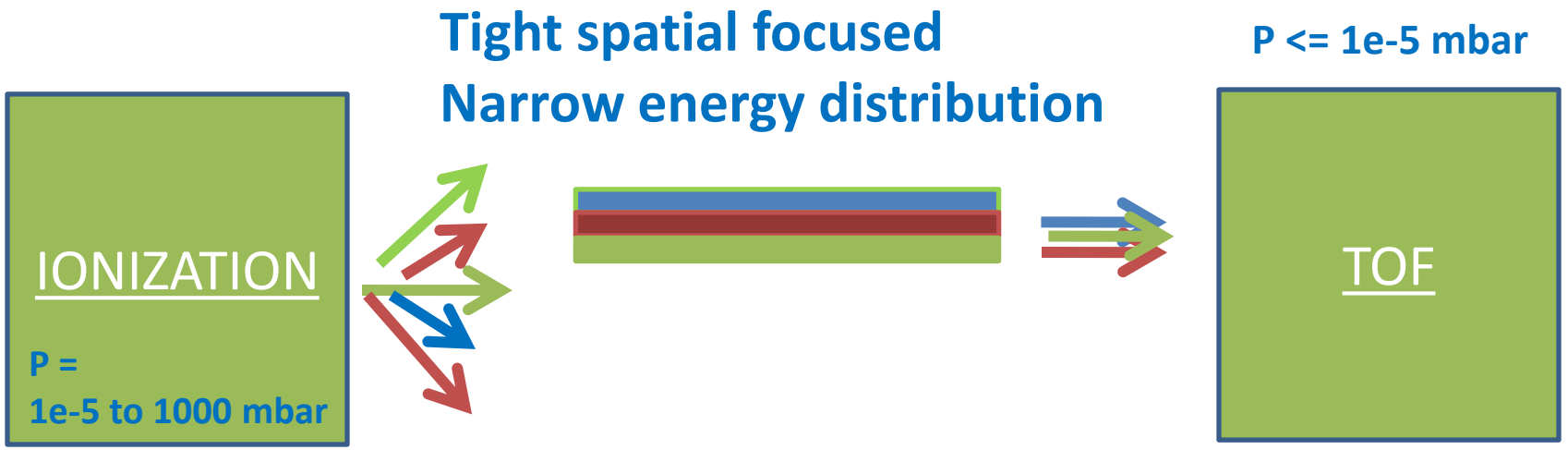
<u>AMS Users already know a lot about this instrument and the data!</u>

TOF “does not care” about origin of an ion.

The INTERFACE couples the ion source to the mass analyzer.

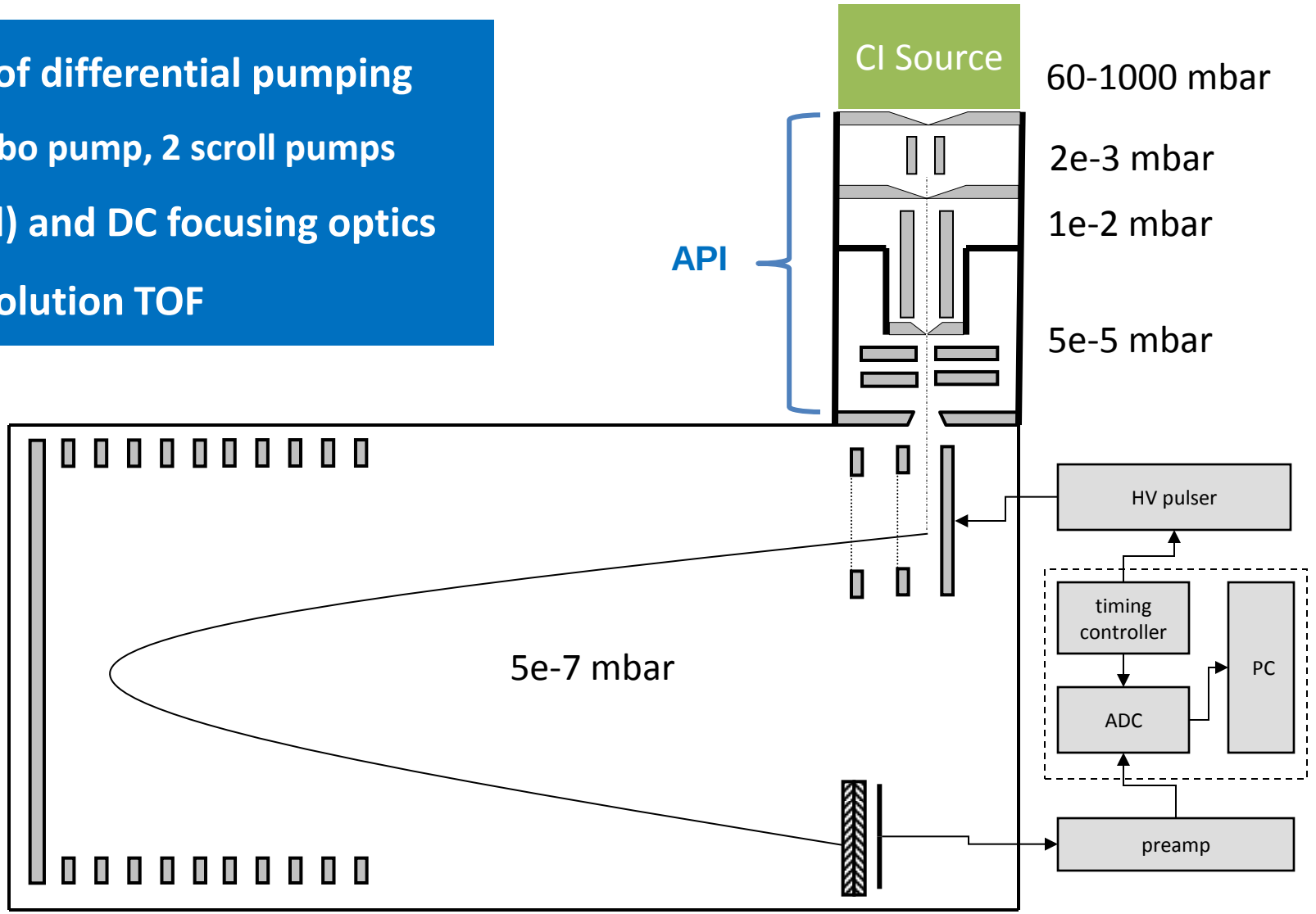
(1) Reconcile pressure difference between source and TOF

(2) Electrostatics devices for EFFICIENT transfer, cooling, and focus of ions



Atmospheric Pressure Interface (API)

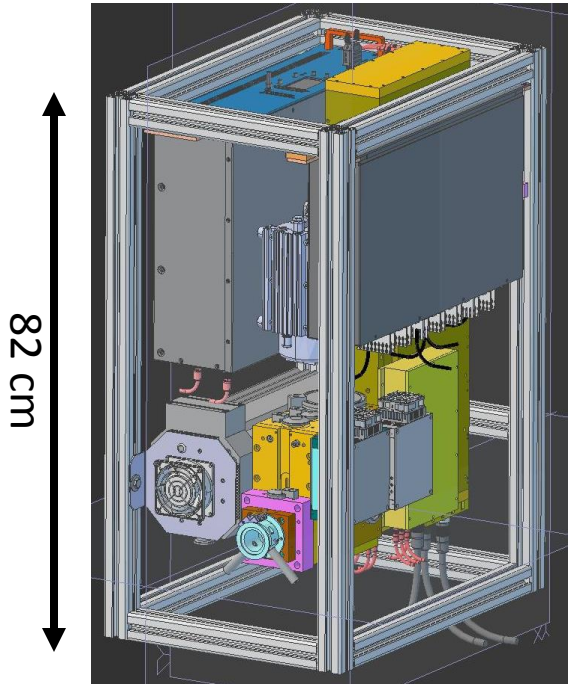
- 5 stages of differential pumping
  - 1 Turbo pump, 2 scroll pumps
- RF (Quad) and DC focusing optics
- High Resolution TOF



	AMS	CIMS
Lens + PTOF Chamber	X	
EI Source	X	
CI Source		X
AP Interface		X
“High Res” TOF	X	X
AP240 (ADC)	X	X
HDF Data Files	X	X
Igor HR Analysis	X	X

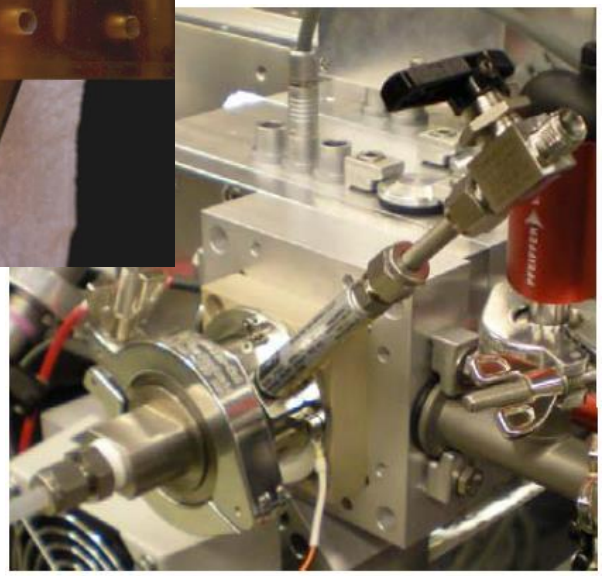
Mechanically, functionally and operationally: Much is the same between AMS and CIMS.

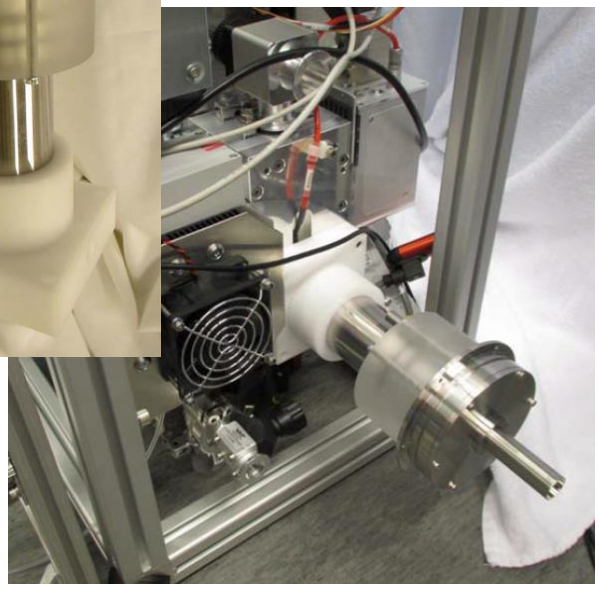
Aerodyne ToF-CIMS



- **Field-portable system (59x42x82 cm, 85 kg, 1.5 kW)**
  - **“Drop in” shipping container**
- **pptv sensitivity for individual gas-phase ions (eg Formic Acid)**
- **Adaptable for multiple ion sources and reagent ion chemistries**
  - **Reagent ions are selective, choice depends on analytes of interest (Harald’s talk)**

Two different ion sources, easily interchanged





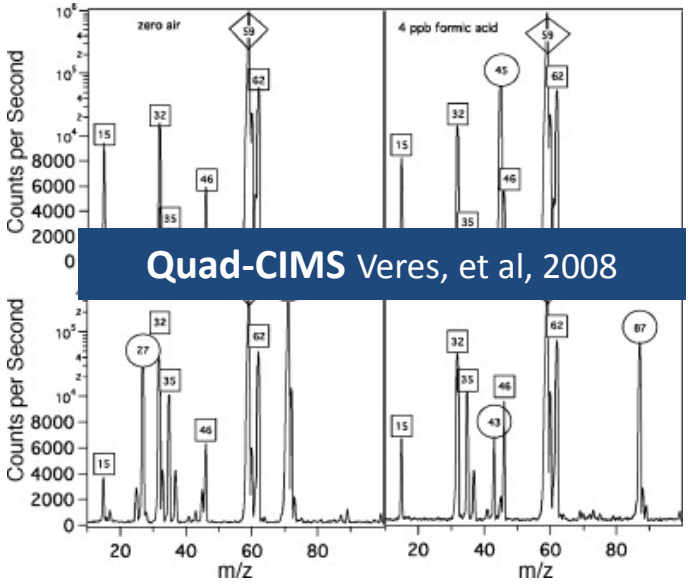
Low Pressure Flow Tube (IMR)

Source design has been widely used for 10+ years
Reagent: Acetate, I-, H30(H2O)n, …
Fast switching between reagent ions…
Compatible with FIGAERO aerosol inlet (Claudia's talk)

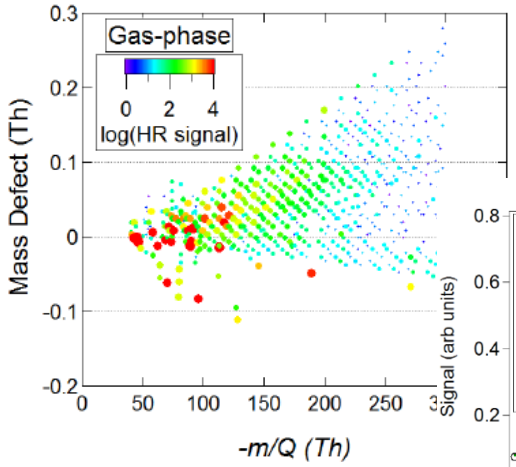
Atm Pressure Drift Tube

Reagent: Nitrate
Based on design from NCAR
Product of Airmodus (Helsinki)

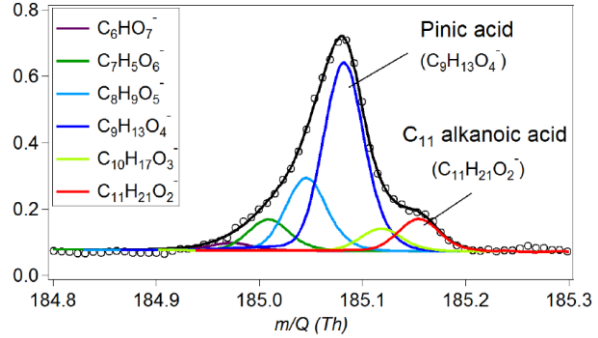
A new lens for CIMS data



Quad-CIMS Veres, et al, 2008



ToF-CIMS Yatavelli, 2013



Standard Quad-CIMS experiment monitors a few ions of interest, and carefully quantified these species.

For <u>identical</u> ion source, TOF brings a more complete (and complicated view):

Resolution: High resolution replaces UMR, enables exact mass analysis

Mass Range: No more scanning. Measure full spectrum across broad mass range. 1000s of peaks/spectrum

Continue to quantify single species. Now - also - able to pursue questions about bulk composition.
(Similar transition made in shift from Q-AMS to HR-AMS)

Following the AMS Model

20+ Instruments, 100+ Users
- Support Wiki and newsgroup

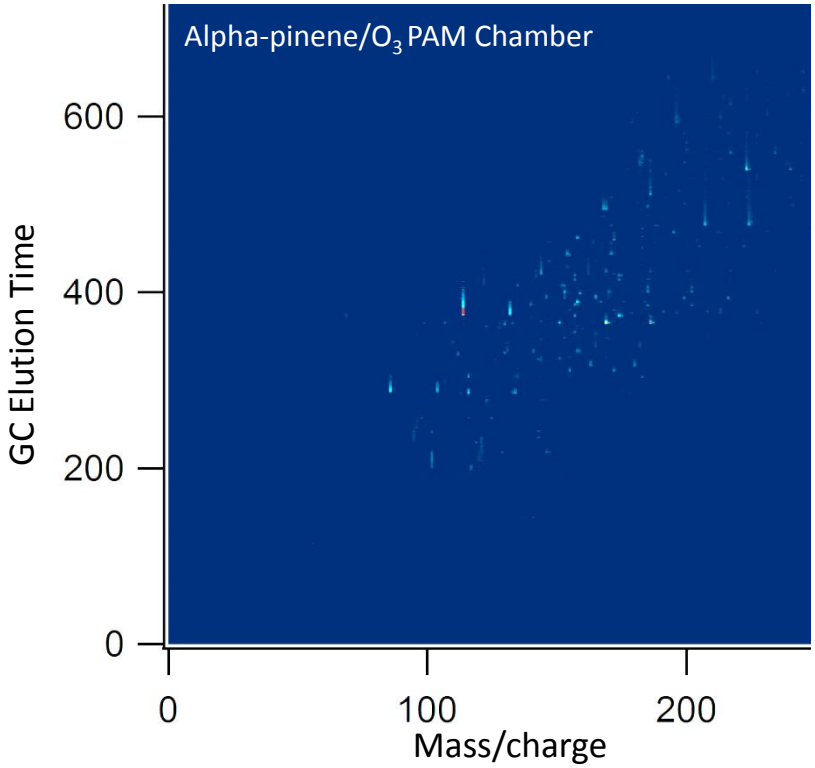
Annual Clinic

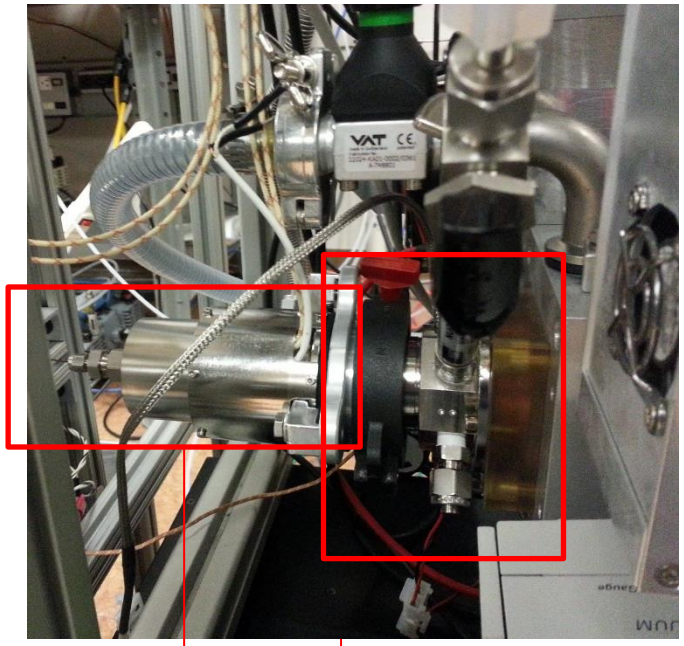
Dedicated Data Analysis Tools
- Tofware (The young cousin of Squirrel)

Varied Applications
- Urban and biogenic field campaigns
- Chamber studies
- Aircraft, ship

2nd Annual ToF-CIMS Users' Meeting, Boulder, CO, 2013

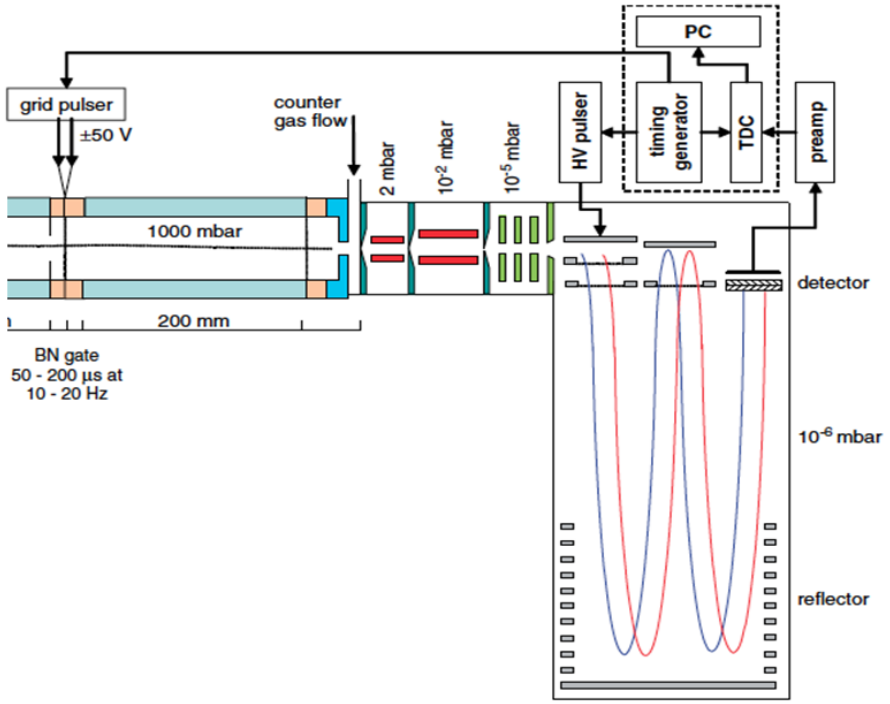
TAG ToF-CIMS

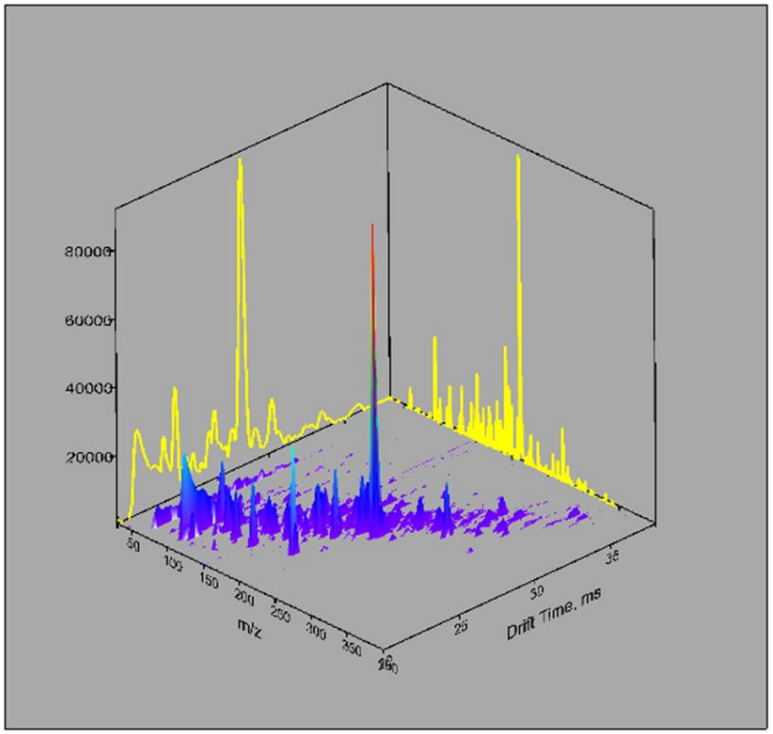




- **Heated GC Capillary inlet replaces air sampling inlet on ToF-CIMS.**
  - **2D: Retention Time vs HR-TOFMS**
- **Demonstrated with ARI TAG aerosol collection system (Talk later this morning)**
- **Proof of concept; development ongoing**

IMS-TOF





- Ion mobility spectrometer upstream of TOFMS. Measure mobility of ion in a buffer gas. Separation based on size, shape and charge.
- 2D data set
  - Mobility and mass-to-charge of all ions
  - Increased peak capacity (peak resolution)
  - Possible CID between IMS and MS (like MS/MS)
- Demonstrated with ESI of aerosol filter extracts (Surratt) and chemical ionization (Helsinki)
- *Manjula will discuss this morning*