Aerosol mass spectrometry

NOAA's Particle Analysis by Laser Mass Spectrometry instrument aboard the NASA WB-57 high-altitude research aircraft

https://en.wikipedia.org/wiki/Aerosol_mass_spectrometry#/media/File:WB-57_PALMS_Mount.jpg

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Introduction

Aerosols: Solid and liquid particles suspended in air usual size range of 3 nm to 100 microns.

- Produced from both anthropogenic sources and natural processes.
- They are major impact on the global climate and pollution.
- Due to their complexities due to the chemical composition, the instrumentation us also complex. The instrument needs to separate the particles based on their size and also provide the real-time information about their chemical composition

Aerosol mass spectrometry

Off-line

- Particles are separated based on their size
- Cascade impactors are generally used
- Pre-separation before chemical analysis

On-line

Aerosol mass spectrometer

Aerosol mass spectrometer

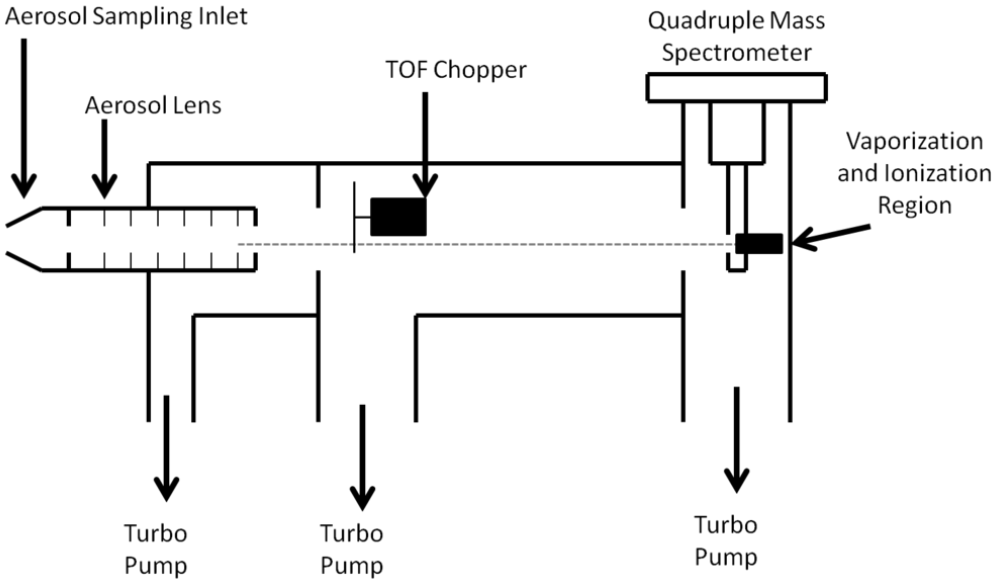
The Aerodyne AMS is made up of three sections; The aerosol inlet, the particle sizing chamber, and the particle detection chamber.

The aerosol inlet has a flow limiting orifice entrance that is around 100 micron in diameter.

Once in the chamber the sample goes through aerodynamic focusing lens system, which consist of several orifice lenses that are mount in sequence of decreasing inner diameter.

TOF chopper is used to determine the velocity of the particle and through which the diameter.

These particles are flash vaporized by the heated W element, (~600 ^{o}C).



Schematic of the Aerodyne aerosol mass spectrometer (AMS)

Ionization is done by electron impact ionization and the sample is then analyzed by:

1. quadruple
2. time-of-flight
3. high-resolution ToF mass analyzer

Only non-refractory compounds (organics, sulfates, nitrates and ammonium etc) can be analyzed. These species evaporate rapidly at 600 ^{o}C.

https://en.wikipedia.org/wiki/Aerosol_mass_spectrometry#/media/File:Aerosol_Mass_Spectrometer.png

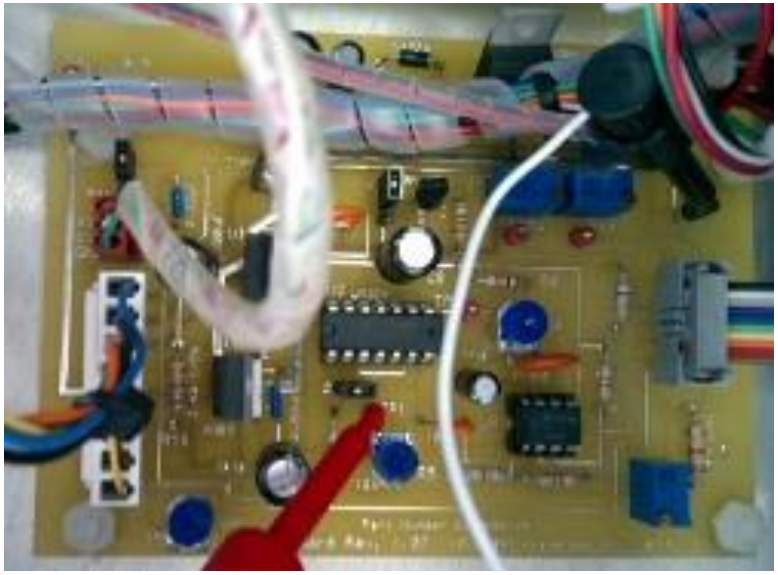
Aerosol time of flight mass spectrometer

http://www.cas.manchester.ac.uk/restools/instruments/aerosol/ams/tofrhamble/

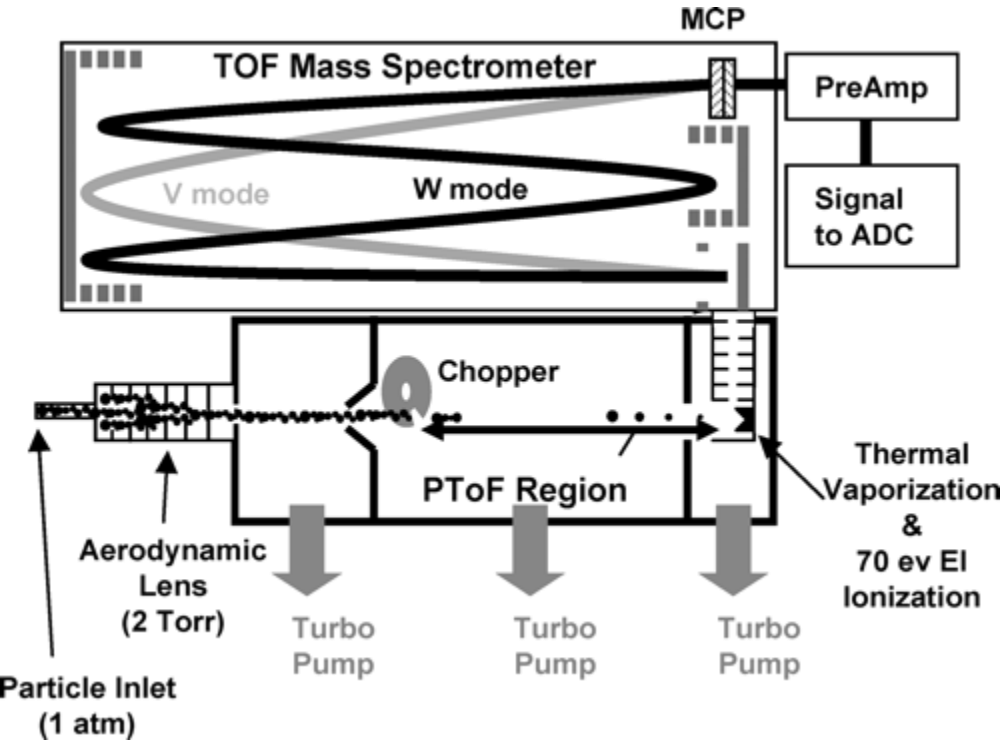
Chopper:

The chopper assembly contains three principal electronic parts:

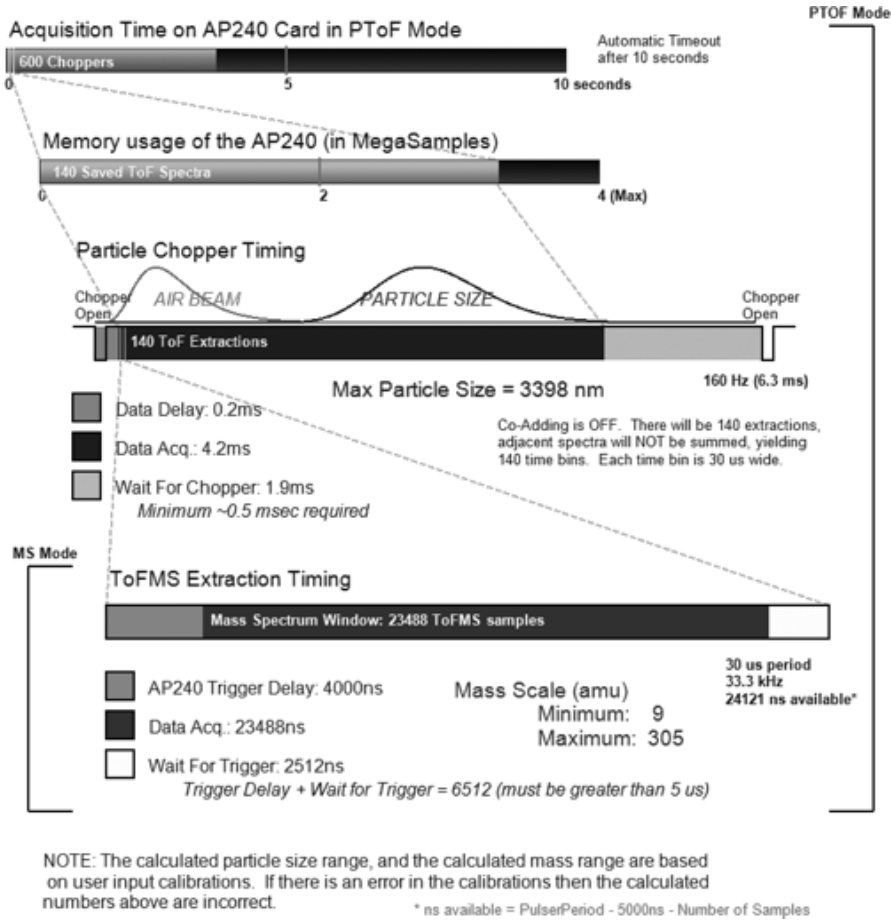
1. Motor to spin chopper wheel.
2. Servo motor to move chopper in and out of particle beam.
3. Honeywell opto sensor to return chopper wheel position signal to electronics.



http://cires1.colorado.edu/jimenez-group/wiki/images/a/ad/Chopper_TP1_Opto.jpg

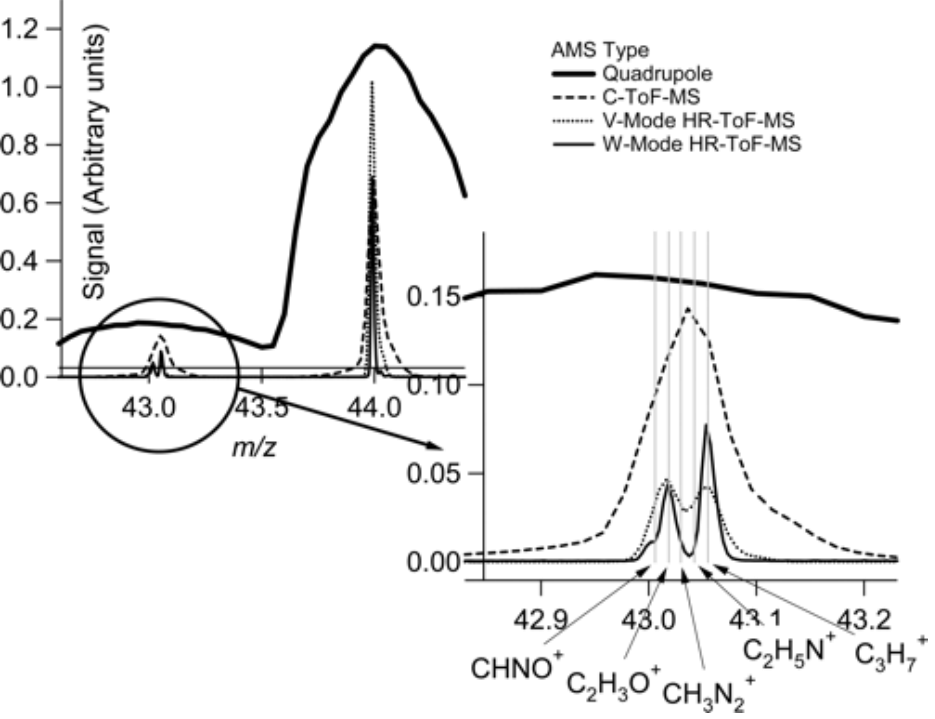


Schematic of the HR-ToF-AMS showing its two ion optical modes



Timing diagram for use of the HR-ToF-AMS in PTOF mode (whole diagram) and MS mode (marked portion on bottom) showing allocations of AP240 board memory, time spent averaging on the board, particle size range for the timing settings, and *m/z* range for each of the extractions. Delays for the chopper and TOFMS extraction are required for timer card reset

Anal. Chem. 2006, 78, 24, 8281-8289



Peak comparisons for the four versions of the AMS. Resolution improvements are obvious in the progression from Q-AMS to C-ToF-AMS to V-mode to W-mode of the HR-ToF-AMS

Thank you