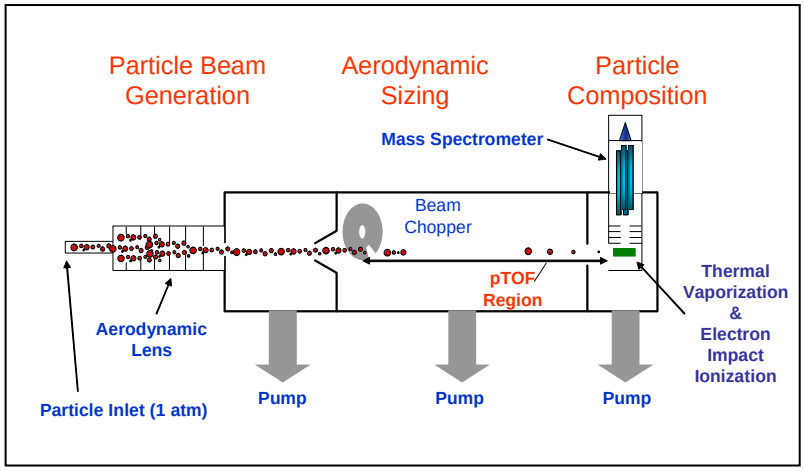
AERODYNE RESEARCH, Inc.

Aerosol Mass Spectrometer

Description

The Aerodyne AMS provides quantitative real-time, size-resolved composition analysis of non-refractory particulate matter. Aerosol particles in the size range 0.04 to ~1.0 micrometers are sampled into a high vacuum system where they are aerodynamically focused into a narrow beam (~1 mm diameter). The particle beam is directed onto a resistively heated surface where volatile and semivolatile chemical components are thermally vaporized and detected via standard 70 eV electron impact ionization quadrupole mass spectrometry. Particle aerodynamic diameter is determined from particle time-of-flight (velocity) measurements using a beam chopping technique.



This approach provides universal detection of chemical species that vaporize (in <1 sec) at 200 to 900 C (typically 600 C). This non-refractory fraction includes the majority of atmospheric components, with the notable exception of elemental carbon and crustal oxides (dust). Some inorganic components (e.g., sea-salt) require vaporization at higher temperature (900 C).

The combination of quantitative size and chemical analysis of sub-micron aerosol mass loadings with fast time resolution makes the Aerodyne AMS unique. Other aerosol instrumentation can provide complementary information. For example, differential mobility analyzers count and size ultrafine particles (no chemical analysis), which often have too little mass for effective AMS detection. Laser based time-of-flight particle mass spectrometer systems obtain mass spectra of individual (> 0.2 μm) particles, enabling separation of internal vs. external chemical mixing, but lack quantitative analysis due to non-linearities in the laser-ablation/ionization process.

The latest version of the AMS utilizes a time-of-flight mass spectrometer (ToF-AMS) which increases sensitivity, while enabling complete single particle analysis. The high resolution HR-ToF-AMS has high mass resolving power (up to 4000), enabling elemental analysis (C, H, O, N) for m/z < 100 and the potential to resolve other chemical components such as metals (e.g., Fe, Zn, Pb, Hg) and PAHs. Other options include an optical light scattering module that enables simultaneous optical, aerodynamic and chemical particle analysis (for d > 200 nm).

The AMS has been successfully deployed on mobile platforms (including sampling exhaust plumes from on-street vehicles), research vessels, and aircraft. The Aerodyne AMS is the only currently available instrument capable of providing quantitative size and chemical mass loading information in real-time for non-refractory sub-micron aerosols.

For more information see the two websites below

http://www.aerodyne.com/products/aerosol_mass_spectrometer.htm

http://cires.colorado.edu/~jjose/ams.html

ARI Aerosol Mass Spectrometer Models

Quadrupole-AMS **Compact-ToF-AMS** **High Resolution-ToF-AMS**



Three versions of the AMS are available: Quadrupole-AMS (Q-AMS), Compact-ToF-AMS (C-ToF-AMS) and High Resolution-ToF-AMS (HR-ToF-AMS). Attributes are summarized below:

	Detection Limit* ($\mu g/m^3$)	Mass Resolving Power ($m/\Delta m$)	Mass Range (m/z)
Q-AMS	0.01	300	1-300
C-ToF-AMS	0.002	800	1-1000
HR-ToF-AMS (V-mode)	0.003	2000	1-1200
HR-ToF-AMS (W-mode)	0.05	4000	1-1200

* Detection limits depend on chemical species. Typical values for nitrate are listed.

Call to discuss custom applications and components under development, such as, alternate soft ionization schemes, particle lenses for larger and smaller sizes, and light scattering modules:

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AERODYNE RESEARCH, Inc.

AMS Instrument Specifications

April, 2008

Performance

- Size resolved mass analysis of non-refractory aerosol components.
- Chemical analysis by thermal vaporization and electron impact ionization mass spectrometry
- Q-MS: unit mass resolution to 300 amu, scan rate 1 msec/amu.
- ToF-MS – mass range up to m/z 1200, mass resolving power (m/Δm) up to 4000.
- Real-time mass spectral analysis of inorganic (nitrate, sulfate, ammonium) and organic mass (OM).
- Particle vaporization temperature adjustable from 200 C to 900 C
- Single particle detection diameter approximately 200 nm.
- Sensitivity of ~0.002 to 0.05 $\mu g/m^3$ in a minute – depends on chemical species and MS option.
- Sampling flow rate 85 cc min^{-1}.
- Aerodynamic particle size measurement in the range of 40 nm to ~1 um. Size resolution of 5 to 10 ($D_{aero}/\Delta D_{aero}$, FWHM) over that size range.
- Fast time resolution of seconds. Maximum data rate ~100 Hz.
- Data output format; ASCII, HDF. Wavemetrics© Igor program license supplied.
- Acquisition and analysis software included (free upgrades).

Physical

Size	Approximately 41"W x 24"D x 53"H.
Weight	Approximately 170 kg.
Power	Approximately 600 Watts. Universal power 110VAC/60Hz or 220VAC/50Hz. Vacuum system fully operational on 24 VDC.
Computer	Current systems are shipped with rack a mounted computer, PIII 3GHz, Intel Core™ 2 Duo Processor, 512M SDRAM, 160G hard drive, CD-RW, floppy, 10/100 Ethernet port, 8 USB ports, 1 serial port. Flat screen monitor 17" XGA.
Packaging	Shipped in one reusable container. Total shipping weight ~280 kg. Approx. outside dimensions of container 30"W x 51"L x 63"H on fork lift skids, for Q-AMS, and 30"W x 51"L x 58" H for C- and HR-ToF-AMS.

AMS OPTIONS

Light Scattering Module provides additional information for larger particles (>200nm), particularly for large refractory (dust) particles with low non-refractory coatings. Light scattering analysis also can provide information on particle density and distinguish internal/external mixtures.

Negative Ion Detection Option for ToF-AMS (via electron attachment) selectively detects stable anion species, such as sulfate, nitrate and carboxylic acids. Sensitivity is 1000 lower than electron impact (EI). Switchable with standard EI.

Relative Humidity/Temperature/Pressure probes allow the user to measure ambient relative humidity, temperature and pressure at sampling inlet, with all measurements fully integrated into the data acquisition system.

Beam Width Probe allows measurement of particle shape by measuring the divergence of the particle beam.

Service/Support Contract (3 years) includes spare parts (extra filaments and electron multiplier) and up to two weeks of on-site support. Parts and support are interchangeable, as needed, based on advance payment of fee. Parts will usually be shipped overnight.

AMS COMPONENTS UNDER DEVELOPMENT

Soft Ionization Schemes provide less molecular fragmentation than electron impact ionization. Li+ ion attachment, VUV photo-ionization, and low energy electron attachment with negative ion mode detection are under development.

Black Carbon Detection Module relies on laser-induced incandescence vaporization for black carbon containing aerosol particles. This allows simultaneous quantification of the organic, inorganic and black carbon components of aerosol particles.

Aerodynamic Lens development is ongoing. A PM2.5 lens with a transmission range from 200 nm to 2.5 μm has been tested, as has a nanolens with transmission from 30 nm to 300 nm

LIST OF SELECTED AMS PUBLICATIONS

A complete list of publications related to the AMS and electronic files are available at http://cires.colorado.edu/jimenez/ams-papers.html.

Jayne, J.T., D.C. Leard, X. Zhang, P. Davidovits, K.A. Smith, C.E. Kolb, and D.R. Worsnop, Development of an aerosol mass spectrometer for size and composition analysis of submicron particles, *Aerosol Sci. Technol.*, 33, 49-70, 2000.

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