Mobile Laboratory Instruments -
Aerosol Measurements

Mobile laboratory equipped with online gas and particle measuring instruments

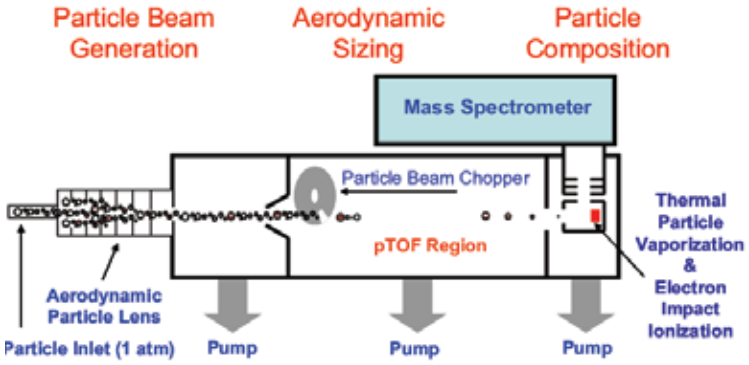
L-TOF-AMS
LTOF-CIMS
VOCUS 2R PTR
TILDAS NH3
TILDAS DUAL HCL & HNO3
CAPS PMex
PAM

CO_2,CH_4,H_2O
Ozone
NO-NO_2-NOx
SO_2
CO

Aethalometer
Xact 625i
APS
SEMS
Cloud ceilometer

AMS
Aerosol Mass Spectrometer Systems

Measure real-time, non-refractory, size-resolved particulate chemical composition and mass.



APPLICATIONS

- Climate change and air quality research.
- Organic aerosol quantification and analysis.
    - Separation and quantification of organic components including HOA (hydrocarbon-like organic aerosol, linked to primary combustion sources) and OOA (oxygenated organic aerosol, linked to secondary aerosol sources).
    - Elemental composition (O:C, H:C).
- Mobile measurements from ship, truck and aircraft platforms.
- Fast response plume studies up to 100 Hz.
- Aerosol chamber studies.
- Combustion exhaust monitoring and source characterization.

ADVANTAGES

- Particle beam source for efficient separation of gas and particle.
- Thermal particle vaporization with electron impact ionization source.
- Direct linear detection of sulfate, nitrate, ammonium, chloride and organic aerosol species.
- Fast response, up to 100 Hz mass spectra.
- Particle aerodynamic diameter determined from particle time-of-flight (velocity) measurements using a particle beam chopping technique.
- Several mass spectrometers to choose from: quadrupole, compact, and high resolution TOF systems.

AMS

SPECIFICATIONS:

Detection Limit (S/N =3) dependent on mass spectrometer option:

Mass Spectrometer System	Detection Limit* (ng/m^3)	Mass Resolving Power ($m/\Delta m$)	Mass Range (m/z)
C-ToF-AMS	1.2	800	1-1000
HR-ToF-AMS:(V-mode)	2.9	2500	1-1200
:(W-mode)	32	5000	1-1200

*Detection limits are for 1-minute integration, 3σ. Detection limits depend on chemical species. Typical values for nitrate are listed (organic DL is ~10x higher, sulfate DL is ~2x higher and ammonium DL is ~20x higher).

Particle Size Range:	40-1000 nm aerodynamic diameter standard or PM 2.5 option
Data Rate:	1-5 minute typical data reporting interval. Maximum mass spectra data rate 100 Hz (ToF MS systems only). Maximum size distribution data rate 150 Hz.
Data Format:	Custom acquisition and analysis software for mass loadings and size distributions. Specialized routines for high resolution data analysis (O:C ratios)
Sample Flow:	0.85 l min^{-1}
Available Options:	Black carbon detection module, PM 2.5 lens, beam width probe, efficient particle time-of-flight (ePTOF), aerosol dryer, sample line flow controller
Size/Weight:	41” x 24” x 53”, 385 lbs [104.14 cm x 83.82 cm x 134.62 cm, 175 kg]
Electric Power:	600 W; 110VAC/60Hz or 220VAC/50Hz

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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 Science and Technology, 33, 49-70, 2000.

Jimenez, J.L., J.T. Jayne, Q. Shi, C.E. Kolb, D.R. Worsnop, I. Yourshaw, J.H. Seinfeld, R.C. Flagan, X. Zhang, K.A. Smith, J. Morris, and P. Davidovits, Ambient Aerosol Sampling with an Aerosol Mass Spectrometer. Journal of Geophysical Research - Atmospheres, 108(D7), 8425, doi:10.1029/2001JD001213, 2003.

DeCarlo, P.F., J.R. Kimmel, A. Trimborn, M.J. Northway, J.T. Jayne, A.C. Aiken, M. Gonin, K. Fuhrer, T. Horvath, K. Docherty, D.R. Worsnop, and J.L. Jimenez, Field-Deployable, High-Resolution, Time-of-Flight Aerosol Mass Spectrometer, Analytical Chemistry, 78: 8281-8289, 2006.

Canagaratna, M.R., J.T. Jayne, J.L. Jimenez, J.D. Allan, M.R. Alfarra, Q. Zhang, T.B. Onasch, F. Drewnick, H. Coe, A. Middlebrook, A. Delia, L.R. Williams, A.M. Trimborn, M.J. Northway, P.F. DeCarlo, C.E. Kolb, P. Davidovits, D.R. Worsnop, Chemical and Microphysical Characterization of Ambient Aerosols with the Aerodyne Aerosol Mass Spectrometer, Mass Spectrometry Reviews, 26, 185– 222, 2007.

Drewnick, F., S.S. Hings, P.F. DeCarlo, J.T. Jayne, M. Gonin, K. Fuhrer, S. Weimer, J.L. Jimenez, K.L. Demerjian, S. Borrmann, D.R. Worsnop. A new Time-of-Flight Aerosol Mass Spectrometer (ToF-AMS) – Instrument Description and First Field Deployment, Aerosol Science and Technology, 39:637–658, 2005.

L-ToF AMS for Increased Chemical Resolution of Particulate Matter

Measure real-time, non-refractory, size-resolved particulate chemical composition and mass.

APPLICATIONS

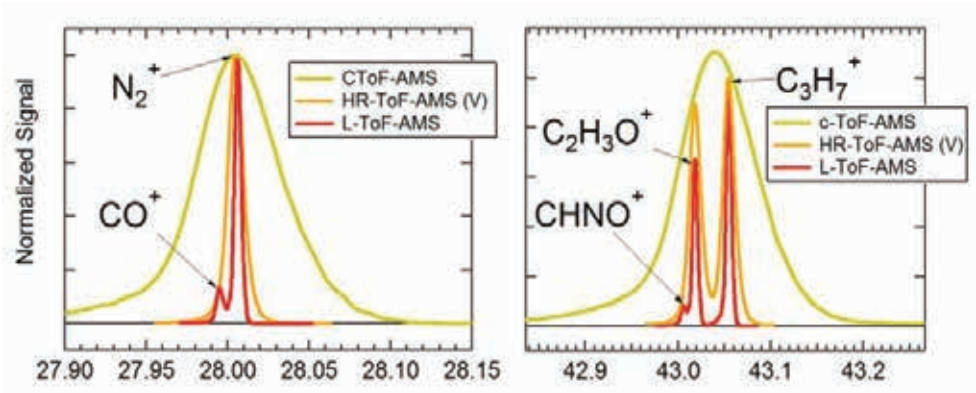
- Climate change and air quality research.
- Organic aerosol quantification and analysis.
    - Separation and quantification of organic components including HOA (hydrocarbon-like organic aerosol, linked to primary combustion sources) and OOA (oxygenated organic aerosol, linked to secondary aerosol sources).
    - Elemental composition (O:C, H:C, N:C).
- Fast response plume studies up to 100 Hz.
- Aerosol chamber studies.
- Combustion exhaust monitoring and source characterization.

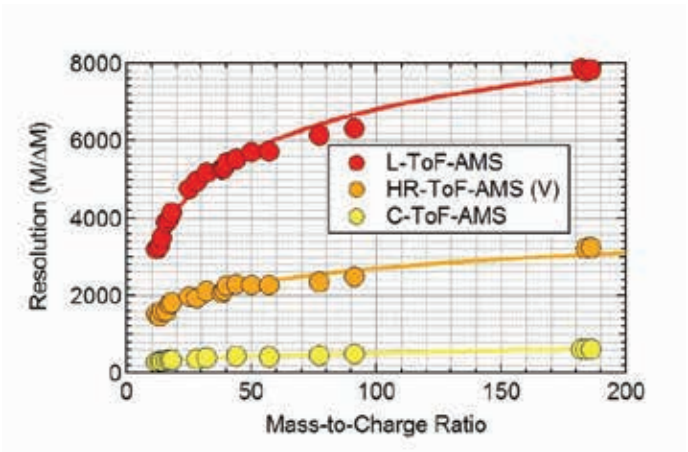
ADVANTAGES

- Particle beam source for efficient separation of gas and particle.
- Resolution approaching 8000 M/ΔM.
- Thermal particle vaporization with electron impact ionization source.
- Direct linear detection of sulfate, nitrate, ammonium, chloride and organic aerosol species.
- Fast response, up to 100 Hz mass spectra.
- Single particle spectra, event triggering.
- Particle aerodynamic diameter determined from particle time-of-flight (velocity) measurements using a particle beam chopping technique.
- Compatible with 1064 nm laser vaporization module.

L-ToF AMS

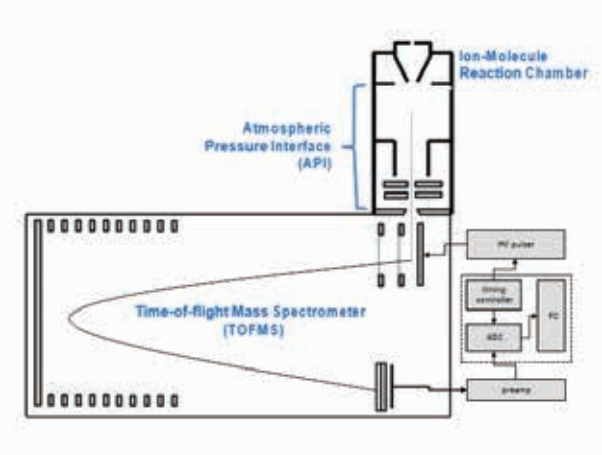
Particle Size Range:	40-1000 nm aerodynamic diameter standard or PM 2.5 option
Mass Range:	Greater than 1000 AMU
Data Rate:	1-5 minute typical data reporting interval Maximum mass spectra data rate 100 Hz (ToF MS systems only) Maximum size distribution data rate 150 Hz
Data System:	High speed acquisition of 1.6 Gs/s with custom firmware for single particle (eventtrigger) mode
Sample Flow:	0.085 l min^{-1}
Available Options:	Black carbon detection module, efficient particle time-of-flight (ePTOF), sample flow line controller, aerosol dryer, PM 2.5 capable, beam width probe
Size/Weight/Power:	55” L x 24” D x 27” H, 275 lbs [139.7 cm x 60.9 cm x 68.6 cm, 124.7 kg]r 600 Watts (24VDC vacuum system)





ToF-CIMS
Chemical Ionization
Time-of-Flight Mass

Real-time chemical analysis of trace gases, aerosols, or atmospheric ions



APPLICATIONS

- Online identification and quantification of trace gas- or particle-phase compounds
- Laboratory, field, or mobile platform based experiments
- Air quality and climate change research

ADVANTAGES

- Quantitative response with broad dynamic range
- Sub pptv gas-phase limits of detection
- Molecular identification and elemental speciation
- Interchangeable ionization sources for selective detection of different chemical classes
- High-speed data acquisition
- Low power, field portable assembly

INTERCHANGEABLE INLETS AND IONIZATION SOURCES

The ToF-CIMS is used with three different chemical ionization sources, which can be easily interchanged by the user.

- **Flow Tube Ion Molecule Reaction Chamber (IMR):** Reduced, tuneable pressure (30 to 500 mbar) reaction ionization chamber for use with acetate, iodide, and water cluster reagent ions. Compatible with Po or X-ray ionizer. The standard configuration uses a gas-phase inlet. The IMR can optionally be used with the **FIGAERO Inlet**, which enables real-time chemical analysis of gas and aerosols.
- **Atmospheric Pressure Drift Tube Reaction Chamber:** For use with nitrate reagent ion. Measurement of highly oxidized gas-phase organic compounds. Not compatible with FIGAERO.
- **Extractive Electrospray Ionization Source (EESI):** Ionization source for online molecular analysis of aerosols.

TOF Mass Analyzer

The ToF-CIMS is available in two models that differ in size and mass resolving power.

	Mass Resolving Power (M/ΔM)	Dimensions
HToF-CIMS	4000 - 6000	59 x 42 x 83 cm
LToF-CIMS	7000 - 9000	61 x 48 x 151 cm

Performance and Specifications

- **Gas-Phase LOD:** For example, 4 pptv formic acid (1 s, Bertram, 2011), 0.4 pptv malonic acid (15 s, Lee, 2014)
- **Aerosol LOD, FIGAERO**: For example,4 ng/m^3 formic acid and 2 ng/m^3 C_9pinene acid (Lopez-Hilfiker, 2014)
- **Aerosol LOD, EESI**: 1 ng/m^{3}dipentaerythritol and raffinose (Lopez-Hilfiker and Slowik, 2019)
- **Mass Range**: 0 to 1000 Th
- **Save Rate**: Up to 200 complete mass spectra/second
- **Detection polarity:** Bipolar TOF mass analyzer
- **Power:**
  - ToF-CIMS: <2 kW peak, <1.3 kW steady state
  - FIGAERO: < 0.5 kW
- **Sample Flow Rate:**
  - IMR: 2 lpm
  - FIGAERO: 2 lpm gas, 5 - 15 lpm aerosol
  - Atm Pressure Drift Tube: 10 lpm
  - EESI: 1 lpm

Software

Tofware is an Igor-based post processing software, with workflows for quantification and high-resolution peak fitting and identification.

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A field-deployable chemical ionization time-of-flight mass spectrometer Atmos. Meas. Tech., 4, 1471-1479. doi:10.5194/amt-4-1471-2011, 2011.

Particulate Organic Matter Detection Using a Micro-Orifice Volatilization Impactor Coupled to a Chemical Ionization Mass Spectrometer (MOVI-CIMS), Aerosol Sci. Technol., 44(1), 61–74, doi:10.1080/02786820903380233, 2010.

An iodide-adduct high-resolution time-of-flight chemical-ionization mass spectrometer: application to atmospheric inorganic and organic compounds, Environ. Sci. Technol., 48(11), 6309–6317, doi:10.1021/es500362a, 2014.

Atmospheric Pressure Nitrate Ionization Source

Measurement of the gas phase concentration of H2SO4 and methane sulfonic acid and estimates of H2SO4 production and loss in the atmosphere Geophys. Res., 98(D5), 9001–9010, doi:10.1029/93JD00031., 1993.

Atmospheric sulphuric acid and neutral cluster measurements using CI-APi-TOF Atmos. Chem. Phys., 12, 4117-4125, doi:10.5194/acp-12-4117-2012, 2012.

A large source of low-volatility secondary organic aerosol Nature 506, 476–479 doi:10.1038/nature13032

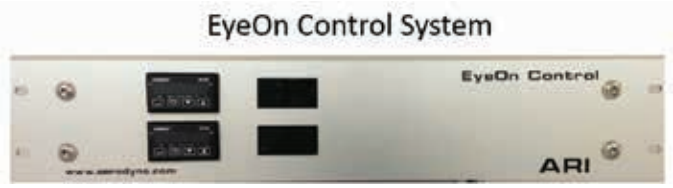
Real-time Aerosol Measurements (FIGAERO)

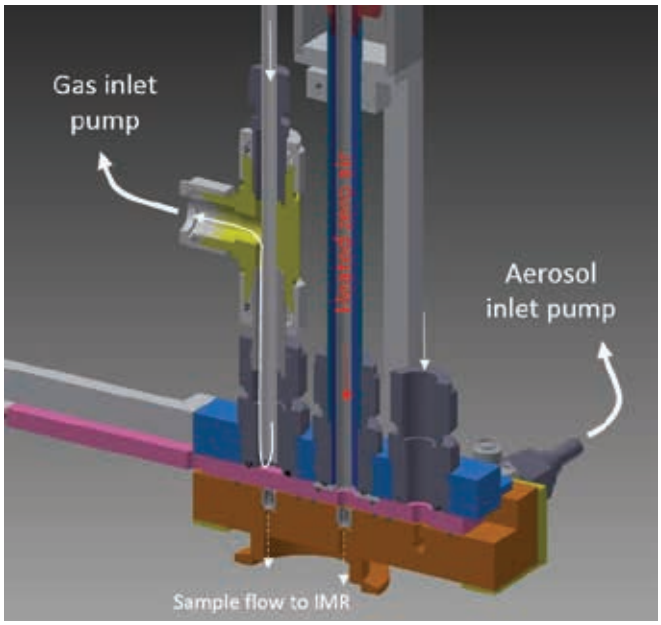
A novel method for online analysis of gas and particle composition: description and evaluation of a Filter Inlet for Gases and AEROsols (FIGAERO), Atmos. Meas. Tech., 7(4), 983–1001, doi:10.5194/amt-7-983-2014, 2014.

An Extractive Electrospray Ionization Time-of-Flight Mass Spectrometer (EESI-TOF) for online measurement of atmospheric aerosol particles, Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2019-45, in review, 2019.

FIGAERO
Filter Inlet for Gas and Aerosols

Custom Inlet for the Aerodyne ToF-CIMS enabling simultaneous real-time chemical analysis of trace gases and aerosols





APPLICATIONS

Inlet Hardware

- For direct mounting on ToF-CIMS.

EyeON Controller Box and Software

- Automated control of sampling valves and flows
- Programmable temperature ramp
- Synchronization with ToF-CIMS Data Acquisition
- Chemical characterization of gas and particle composition
- Laboratory or ambient sampling
- Characterization of SOA generated by smog chambers

ADVANTAGES

Aerosol Collection Efficiency

- Filter collects > 99.99% of aerosol particles, 0.1mm and larger

Limits of Detection

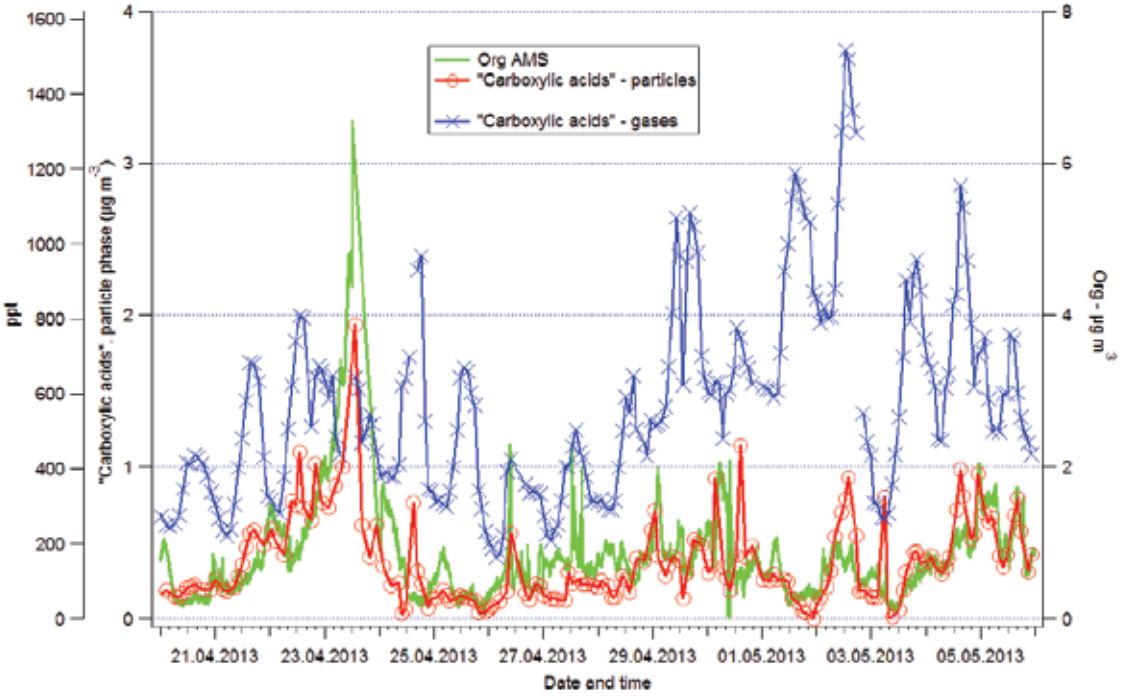
- Gas: <10 ppt for organic acids
- Aerosol: ~1 ng-m^{-3}

Time Resolution

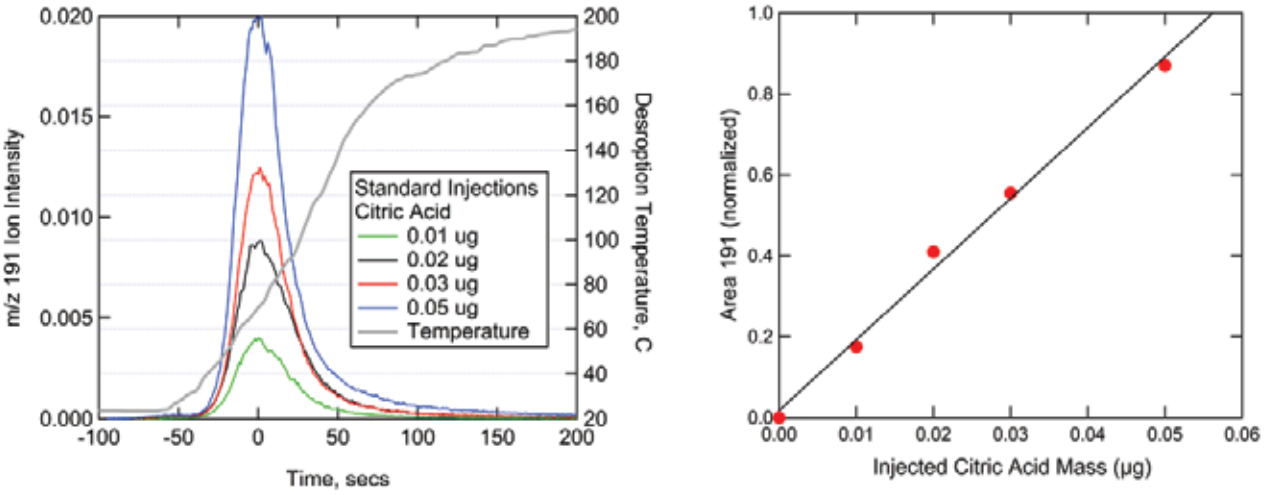
- Up to 10 mass spectra/s
- No limit on aerosol collection time
- Temperature ramps >5 minutes

Lopez-Hilfiker, F. D., Mohr, C., Ehn, M., Rubach, F., Kleist, E., Wildt, J., Mentel, Th. F., Lutz, A., Hallquist, M., Worsnop, D., Thornton, J. A. A novel method for online analysis of gas and particle composition: description and evaluation of a Filter Inlet for Gases and AEROsols (FIGAERO), Atmos. Meas. Tech., 7(4), 983 - 1001, 2014.

FILTER INLET For GAS AND AEROSOLS



Comparison of gas particles measured with FIGAERO - CIMS and AMS.



Calibration with standard injections of citric acid. Acetate ion chemistry.

Vocus PTR-TOF

Real-Time VOC Analysis
with Market Leading
Performance

Market Leading PTR-MS Performance

With sub-ppt limits of detection and mass resolving power up to 15,000 the Vocus PTR-TOF is taking Laboratory and field analysis of VOCs in exciting new directions.

Ultra-Low Limits of Detection

- Proprietary Vocus reaction cell reduces wall losses and focuses product ions
- Maximize analyte signals with combination of Vocus reaction cell, ion cooling interface, and sensitive TOF mass analyzer
- Up to 10x the sensitivity of other commercial PTR-MS
- Sub-ppt limits of detection in seconds

Highest Available PTR-MS Mass Resolving Power

- Mass resolving power up to 15000 enables identification of isobaric compounds in complex mixtures
- Identification of analytes and confirmation of peak assignments based on exact mass and isotope patterns

Select a Model to Meet Your Needs

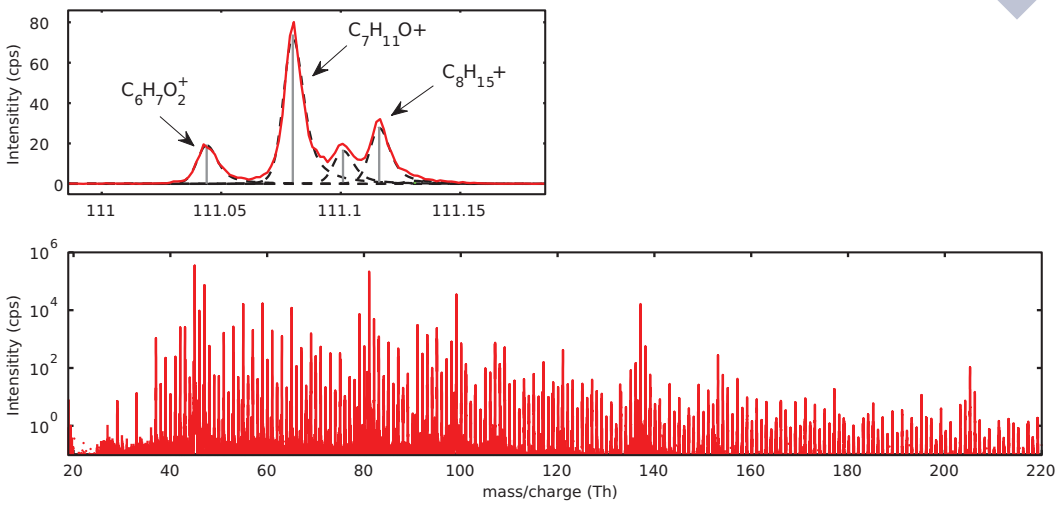
	Sensitivity cps/ppb benzene	**Limit of Detection (LOD)** 1-min, BTX	**Resolving Power at Specified Sensitivity**[a] M/ΔM
Vocus PTR-TOF standard	10000	< 1 ppt	5000
Vocus PTR-TOF C compact	Krechmer, J., Lopez-Hil□ker, F. et al. : Evaluation of a New Reagent-Ion Source and Focusing Ion–Molecule Reactor for Use in Proton-Transfer-Reaction Mass Spectrometry, Anal. Chem., 90(20), 12011–12018, doi:10.1021/acs.analchem.8b02641, 2018.		
Vocus PTR-TOF 2R high resolution	10000	< 1 ppt	10000

a. Each model can be operated with higher resolving power at reduced sensitivity.

Resolving Power up to 15000 with the Vocus PTR-TOF 2R

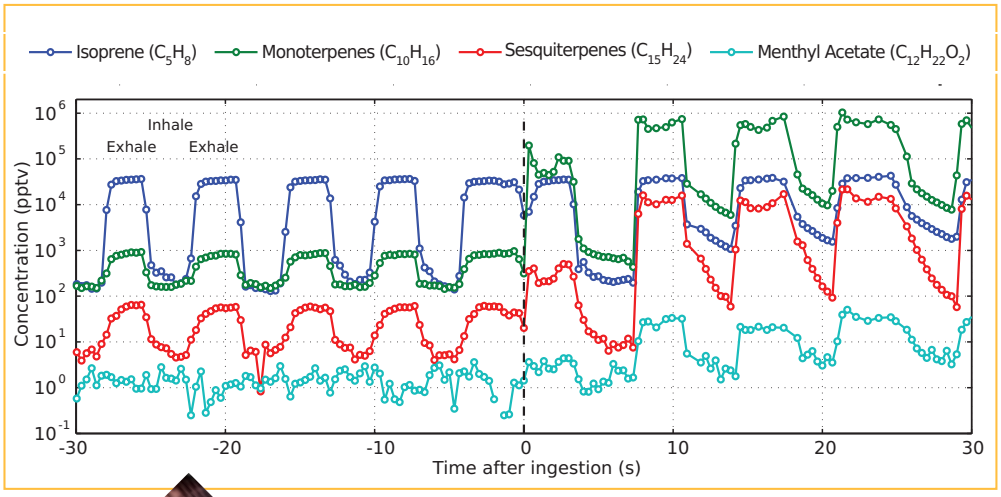
Confident analysis of complex mixtures often demands resolution of individual peaks

This mass spectrum shows the diverse collection of biogenic VOCs that was emitted when a single pine needle was cut in lab air in front of the inlet of the Vocus PTR-TOF 2R. The inset demonstrates the capability of the 2R to separate and identify isobars.



Real-Time Monitoring of VOCs with

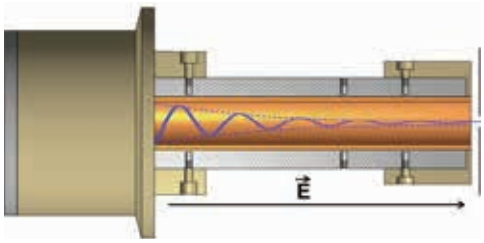
The Vocus PTR-TOF can quantify dynamic changes in even ultra-low concentration compounds.



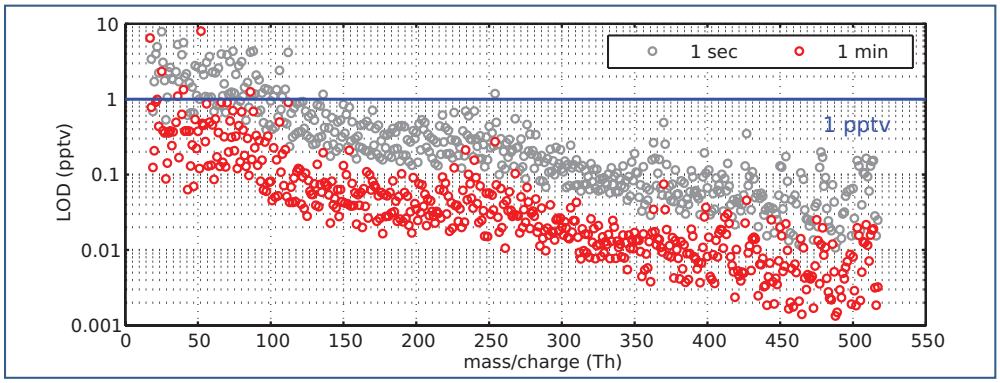
Human breath was monitored in real time at 3 Hz before and after the ingestion of a Ricola™ herb cough drop. Hundreds of compounds were present in the post-ingestion data, including monoterpenes, sesquiterpenes, and other compounds of herbal origin. A subset of detected compounds is shown in order to demonstrate the fast time response and broad dynamic range of the Vocus PTR-TOF.

Vocus™ is a Leap Forward in PTR Source Design

The RF focusing and uniform drift fields of the Vocus source enable real-time analysis organic compounds (VOCs) with unprecedented limits of detection and speed.



Sample Flow Rate	50 – 500 sccm typical 150 sccm
Operating Pressure	0.5 – 5 mbar typical 1-2 mbar
Axial Gradient	Uniform Linear Field 0-5 V/mm
Reagent Ions	$(H_20)_nH_3O^+$, NO^+, O_2^+



Sub-ppt limits of detection in seconds

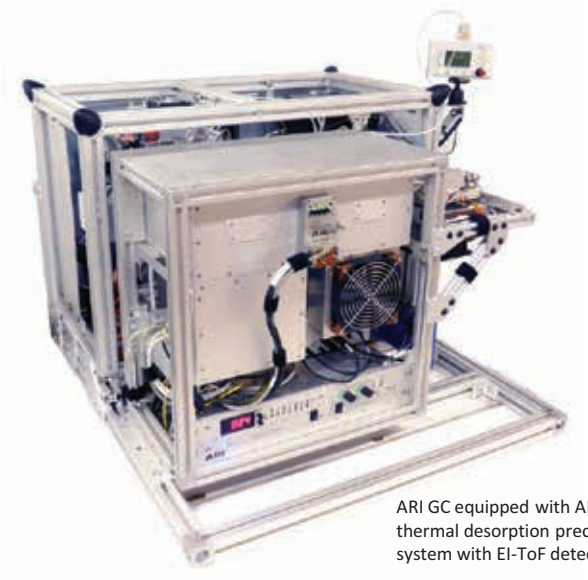
Calculated as 3 times the standard deviation of signal with ultra clean air and assuming the sensitivity of BTX.

Vocus PTR-TOF

The Vocus 2R
484 x 619 x 1484
160 kg
<1200 w

ARI Gas Chromatograph

A Field-deployable modular GC for time-of-flight mass Spectrometry (ToF-MS)



ARI GC equipped with ARI two-stage thermal desorption preconcetration system with EI-ToF detection

Features:

Flexibility – up to three GC columns depending on application, pre-concentration methods (e.g. thermal desorption vs cryo-mechanical), detector type(s)

Field deployable – ruggedized GC with small, light-weight, footprint for automated operation

Detector compatibility – true plug-and-play operation with all ARI ToF-MS systems (hardware and software, including Tofwerk Acquility)

Dual detectors – designed to operate automatically with two detectors for a more complete data set

Turn-Key – ready-to-run on delivery due to pre-installed analytical column(s) with custom pre-loaded method(s)

Speed – flow path allows user to perform multiple GC operations at once; the benefit of this parallel operation is a faster GC cycle (10 – 30 min) without loss of performance

GC Technology

Aerodyne Research, Inc. (ARI) offers a modular gas chromatograph (GC) that combines recent innovations in fast GC separation with highly selective and sensitive detection in a field-deployable package for the measurement of VOCs and OVOCs.

Aerodyne works with our customers to provide a GC system with a ***custom separation method*** appropriate for their analytical needs. The instrument delivers with the required capillary column installed and analytical methods pre-loaded into the Windows-based control software, for a true ***turn-key*** operation.

Data Analysis Software

Wavemetrics Igor Pro analysis software (TERN) allows for retention time correction, automated baseline and peak fitting. TERN provides de-convoluted peak fitting for overlapping chromatographic peaks. Compatible for analysis of both high resolution (HR) and unit mass resolution (UMR) data.

Compatible Accessories

Sample Preconcentrators

ARI Thermal Desorption (TDPC)

ARI Cryomechanical (CMPC)

Other commercial preconcentration systems

Direct Injection Methods

Passivated sample loop (0.005 – 1 mL)

Split/Splitless Injection Port

Commercial autosamplers

Detectors

Vocus PTR-ToF-MS

EI-ToF-MS

CIMS-ToF-MS

Other commercial detectors (q-MS, FID, ECD, etc.)

Performance Specifications:

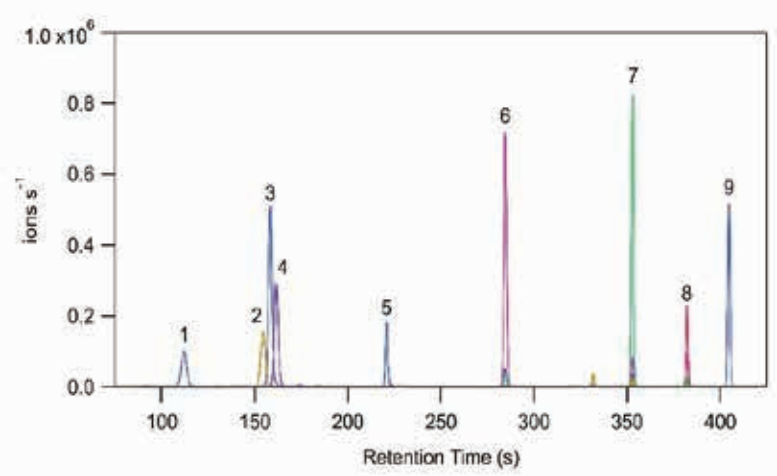
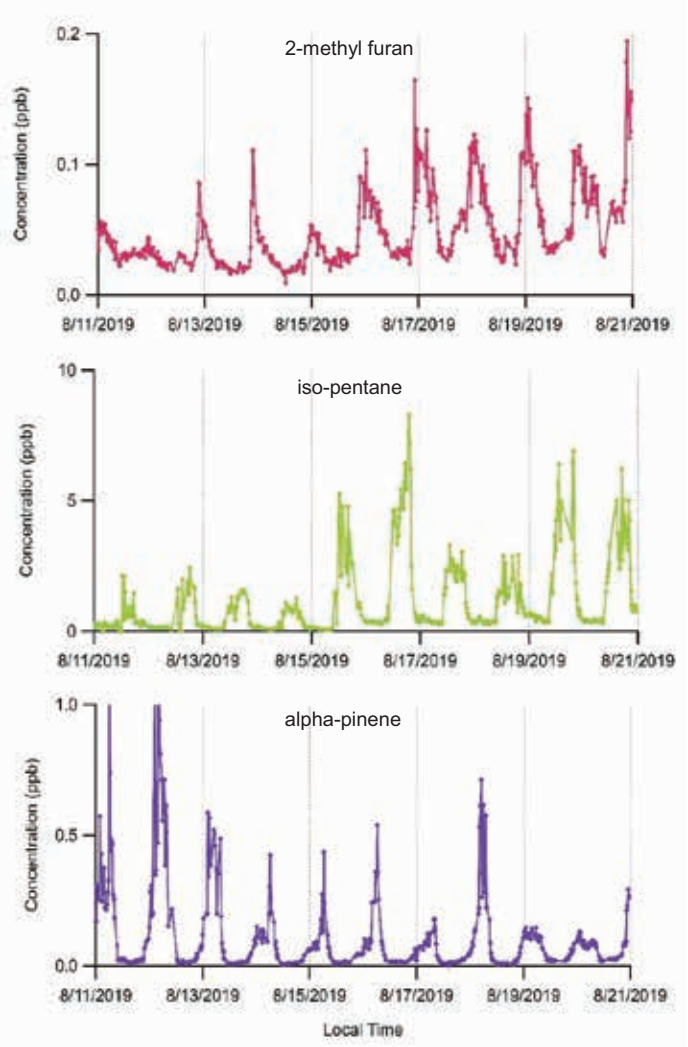


Figure 1. ARI GC equipped with ARI two-stage thermal desorption preconcetration system with EI-ToF detection (TD-GC-EI-ToF). Analysis of multi-component calibration mixture in nitrogen. 1000 mL sample of 0.75 ppb each (1) n-hexane, (2) carbon tetrachloride, (3) 2,2,4-trimethylpentane, (4) benzene, (5) n-octane, (6) ethyl benzene, (7) 1,3,5-trimethylbenzene, (8) limonene, (9) n-undecane.

Figure 2. Ambient data acquired with ARI GC equipped with ARI two-stage thermal desorption preconcetration system with EI-ToF detection (TD-GC-EI-ToF)



Column Oven Specifications

Max heating rate: 120 °C/min
Max cooling rate: 250 °C/min
Max temperature: 260 °C
Temperature accuracy: ± 0.5 °C (ramped);
± 0.25 °C (isothermal)
Column compatibility: all fused silica and metal columns (60m @ ≤0.32mm ID, 30m @ ≥0.53mm ID)
Capillary columns are swappable without venting detector

Sampling / Reagent Gas Specifications

3-inlet system for analysis of sample (ambient), zero, and calibration gases
Sample gas: -40 to 50 °C; 0-90% RH; 50-125 kPa
Carrier gas compatibility: helium, nitrogen, hydrogen
Sample flow rate: up to 200 sccm, ± 1% accuracy
Carrier gas flow rate: up to 10 sccm
Complete inert/passivated sample flow path
(DuPont PFA, SilcoTek Siltek/Sulfinert passivated stainless steel)

Data Outputs

USB

Weight, Size, Power

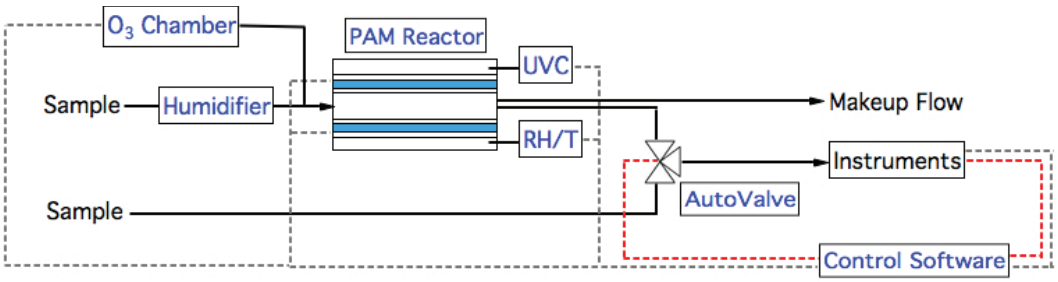
Weight: 24 kg
Dimensions: 55 cm x 55 cm x 30 cm
Max power: 600 W, 120/240 V, 50/60 Hz (start-up)
300 W (typical operation)

Aerodyne specializes in collaboration and custom design. Please contact us if you would like to discuss additional measurement options and applications.

REFERENCES:
Lerner, B. M., et al. (2017). Atmos. Meas. Tech. 10(1): 291-313. doi: 10.5194/amt-10-291-2017
Koss, A. R., et al. (2018). Atmos. Chem. Phys. 18(5): 3299-3319. doi: 10.5194/acp-18-3299-2018
Van Wertz et al. (2017) J Chromatogr A; 1529:81-92. doi: 10.1016/j.chroma.2017.11.005

Potential Aerosol Mass (PAM) Oxidation Flow

A highly oxidizing environment that simulates oxidation processes on timescales of days in the atmospherein minutes in real time.



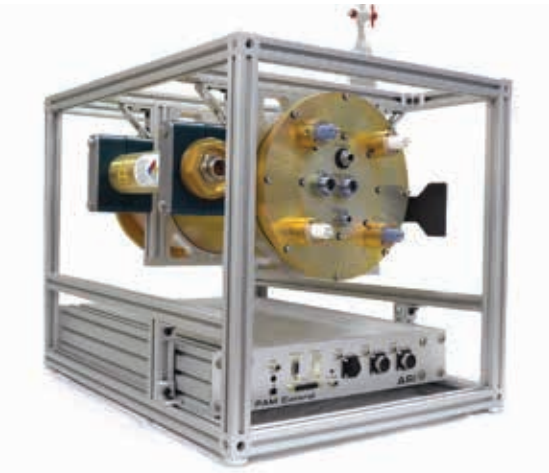
Typical setup for measurements incorporating PAM reactor. Control software facilitates data-logging at 1 Hz and automated control with event sequencing for unattended operation (dashed grey = analog input/output; dashed red = digital input/output)

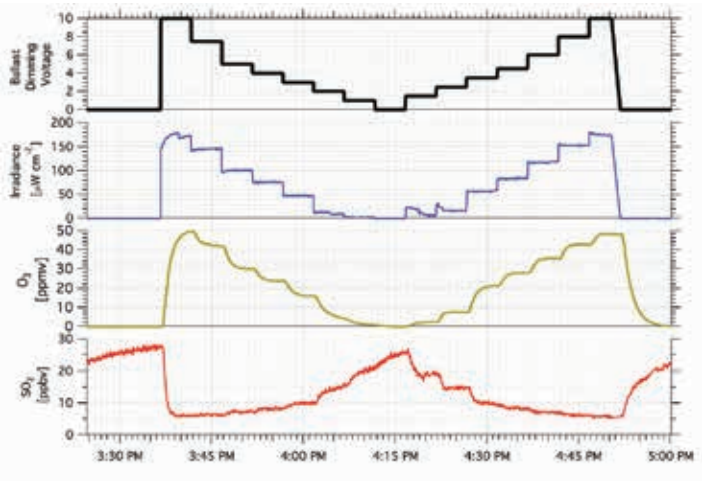
APPLICATIONS

- Laboratory or field studies of secondary aerosol generation via gas-phase hydroxyl (OH) radical or ozone (O_3) oxidation of gas-phase precursors.
- Heterogenous oxidation of primary aerosols.
- Compatible with gas and particle mass spectrometry techniques.
- Complement to laboratory smog chamber techniques commonly used to generate secondary organic aerosol (SOA).

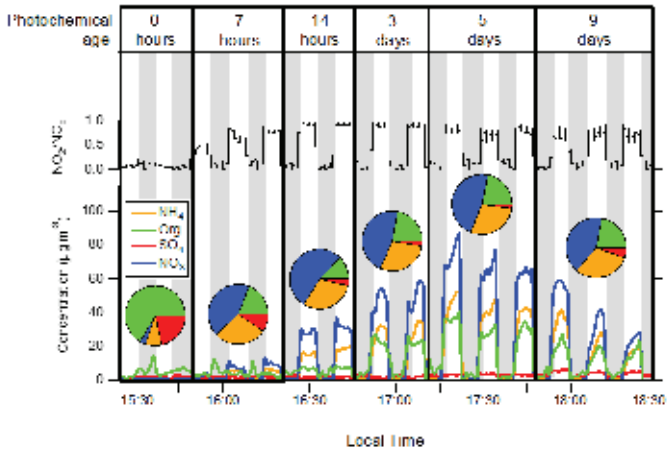
ADVANTAGES

- Based on Penn State flow reactor design introduced by Kang et al. (2007) and further evaluated by Lambe et al. (2011).
- Field deployable.
- Wide range of oxidant exposure times attainable with dimmable UV lamps (primary emission intensity at λ = 254 nm) at high measurement throughput/ resolution.
- OH/HO_2 and OH/O_3 ratios similar to tropospheric ratios. Amounts of OH, HO_2, and O_3 are 100 to 10,000 times larger than in the daytime troposphere, simulating days of atmospheric oxidation in minutes.





Time series from an example OH exposure calibration experiment using SO_2 as a reactive tracer species. The dimming voltage applied to UV lamp ballasts is stepped from 0-10 VDC, which varies the UV irradiance and the ozone mixing ratio in the PAM chamber.



Example measurements obtained with a PAM reactor. Secondary ammonium, sulfate, organic, and nitrate aerosols are generated from OH oxidation of gas-phase motor vehicle emissions inside the Fort Pitt Tunnel in Pittsburgh, Pennsylvania, USA (Tkacik et al., Environ Sci. Technol, 2014). Shaded periods are when the tunnel air bypassed the PAM reactor.

OH Exposure	2×10^{11} to 2×10^{12} molec cm^{-3} sec at 100 sec residence time
Size	26" x 16" x 30", 30 lbs [66.04 cm x 40.64 cm x 76.20 cm]
Electric Power	160 W max; 110VAC/60Hz or 220VAC/50Hz
Components	PAM reactor with ozone-free and ozone-producing UV lamps ; ozone chamber; UVC photodetector; Nafion humidifier; RH/T sensor; electronically actuated 3-way valve ("autovalve"); user interface for analog/digital controls; Windows PC control software; PAM_chem photochemical box model
Required Accessories	N_2 purge gas for UV lamps; carrier gas; instrument and makeup flows; Windows PC
Suggested Accessories	O_3 analyzer; flow controllers; ozone scrubbers; MATLAB license; SO_2 or CO analyzer for OH exposure calibrations if needed

E. Kang, M. J. Root, D. W. Toohey, and W. H. Brune, Introducing the concept of Potential Aerosol Mass (PAM), Atmos. Chem. Phys., 7, 5727–5744, **2007**.

A. T. Lambe, A. T. Ahern, L. R. Williams, J. G. Slowik, J. P. S. Wong, J. P. D. Abbatt, W. H. Brune, N. L. Ng, J. P. Wright, D. R. Croasdale, D. R. Worsnop, P. Davidovits, and T. B. Onasch, Characterization of aerosol photooxidation flow reactors: heterogeneous oxidation, secondary organic aerosol formation and cloud condensation nuclei activity measurements, Atmos. Meas. Tech., 4, 445–461, **2011**.

Additional references available at https://sites.google.com/site/pamwiki/

Aerosol Mini-TILDAS Ammonia Motitor

Unprecedented NH_3 accuracy, precision and time response in a compact. rugged package

Features:

- <50 ppt 1-s precision
- <10 ppt long term precision
- Fast time response (10 Hz)
- Option to correct for water dilution
- Inertial inlet provides filter-less partical separation
- Option to improve time response using active passivation

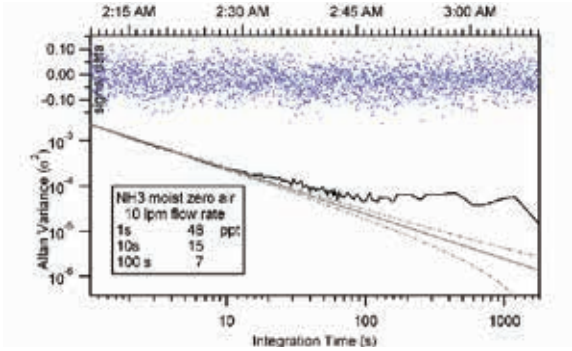
Rugged, field-ready instruments

Direct absorption spectroscopy allows for highly specific and accurate gas detection

Mid-IR detection enables maximum measurement sensitivity

TILDAS Technology

Aerodyne instruments use tunable infrared laser direct absorption spectroscopy (TILDAS) at mid-IR wavelengths to probe molecules at their strongest “finger-print” transition frequencies. We further enhance sensitivity by employing a patented multi-pass broad-band absorption cell that provides optical path lengths up to 76 m. Direct absorption spectroscopy allows for fast (<1 sec) absolute trace gas concentrations without need for elaborate calibration procedures. Moreover, TILDAS instruments are free of measurement interference from other molecular species, enabling extremely specific detection.



Applications

- Determination of atmospheric nitrogen sources, sinks, and transport.
- Agricultural and biosphere exchange
- Mobile measurements aboard aircraft, marine, and ground-based platforms
- Long-term unattended operation in remote field sites.
- Eddy covariance flux measurements to quantify nitrogen deposition

Aerodyne Ammonia Advantages

- Aerodyne inertial inlet provides particle separation with <1 s time response.
- Improved time response using active passivation
- Powerful TDLWintel software provides flexible instrument control and real-time data analysis.
- Valve control capable of complex scheduling and automatic background and calibrations.
- 19” rack mountable for easy installation aboard aerial and mobile platforms

Performance Specifications:

Precision

1 seconds	<50 ppt
10 seconds	<15 ppt
100 seconds	<10 ppt

Time response

1-10 Hz data rate
0.5 s minimum Rise/Fall time (1/e)
(using inertial inlet with active passivation)

Drift (peak-to-peak, 24 hrs)

< 0.5 %

Dynamic Range (air)

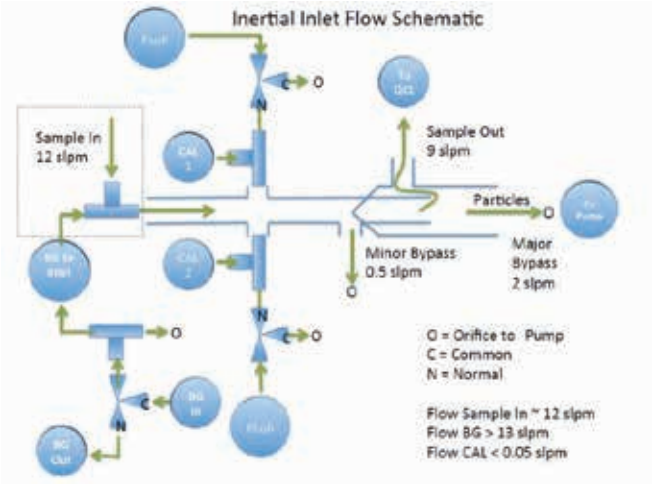
	min	max
NH_3	0 ppb	10 ppm

Enhanced Measurement Options

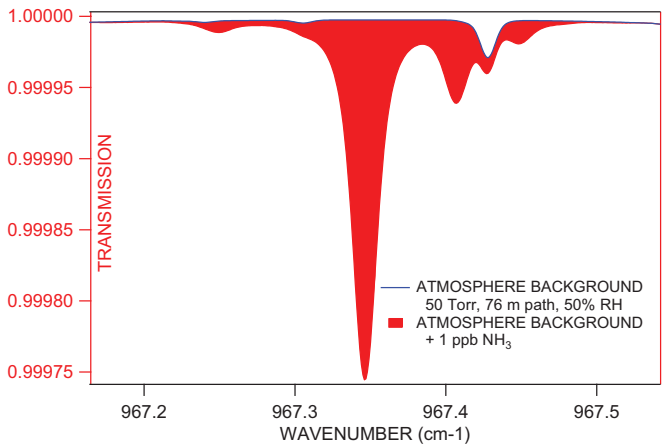
Inertial inlet for particle separation with fast time response (see below)

Multiple valve control for calibration/zeroing at inertial inlet

Active passivation to improve time response to <1 s



High-resolution spectrum of NH_3



Installation

19” rack mountable or benchtop

Sampling Conditions

Sample temperature: -20 to 50 °C
Sample pressure: 1 to 100 Torr
Sample flow rate: 0 to 20 slpm

Instrument components

Core instrument
Thermoelectric chiller
Keyboard, mouse, and monitor
Vacuum pump (customer specified)
Inlet sampling system (customizable)

Data Outputs

RS-232, USB, ethernet

Size, Weight, Power

Dimensions: 440 mm x 660 mm x 6U (267mm) (W x D x H)

Weight: 35 kg (core instrument) + 15 kg (chiller) + pump weight
Electrical Power: 250 W, 120/240 V, 50/60 Hz (without pump)

Aerodyne specializes in collaboration and custom design. Please contact us if you would like to discuss additional measurement options and applications.

REFERENCES:

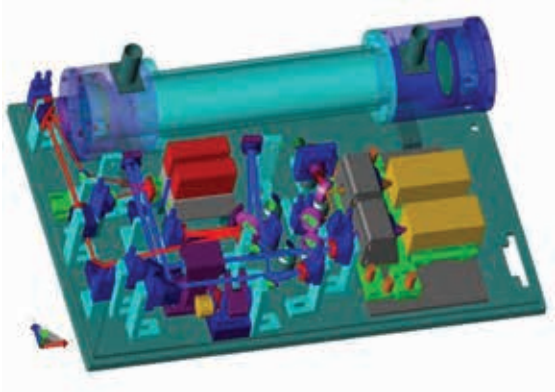
Ellis, R. A., et al. “Characterizing a Quantum Cascade Tunable Infrared Laser Differential Absorption Spectrometer (QC-TILDAS) for measurements of atmospheric ammonia”, *Atmos. Meas. Tech.,* 3 (2010), 397-406.

Herndon, S. C., et al. "Characterization of urban pollutant emission fluxes and ambient concentration distributions using a mobile laboratory with rapid response instrumentation", *Faraday Discuss.,* 130 (2005), 327-339

Roscioli, J. R., et al. "New Approaches to Measuring Sticky Molecules: Improvement of Instrumental Response Times Using Active Passivation", *J. Phys. Chem. A*, 120 (2016), 1347-1357

Dual Laser Trace Gas Monitor

Sensitive, rapid, highly specific and continuous measurements of multiple atmospheric trace



APPLICATIONS

- Extremely sensitive detection of a wide variety of atmospheric trace gases, such as: methane, nitrous oxide, nitric oxide, nitrogen dioxide, carbon monoxide, carbon dioxide, formaldehyde, formic acid, ethylene, acetylene, carbonyl sulfide, acrolein, ammonia and others.
- Combustion monitoring and characterization.
- Isotopic monitoring of CH_4 and N_2O for source/ sink characterization.
- Eddy Covariance measurements.
- Fast response plume studies.
- Air quality monitoring.
- Mobile measurements from ship, truck, and Aircraft platforms.

ADVANTAGES

- Absolute trace gas concentrations with out calibration gases.
- Fast time response.
- Free from interferences by other atmospheric gases or water vapor.
- Turnkey and unattended operation.
- Ready to be deployed in field measurements and on moving platforms.
- Two lasers allow simultaneous measurement of more species.
- Optical pathlength of either 76 meters or 210 meters.

POPULAR INSTRUMENTS

HIGHER PRECISION AND ACCURACY IS OBTAINABLE WITH MID-INFRARED LASERS

Clumped CO_2 Isotopes*

CH_4 Isotopes

CO_2, Water Isotopes

N_2O Isotopes

NO, NO_2

CH_4, N_2O, CO, CO_2, H_2O, C_2H_6

MECHANICAL SPECIFICATIONS FOR DUAL LASER TRACE GAS MONITOR:
Dimensions: 560 mm x 770 mm x 640 mm (W x D x H)
Weight: 75 kg
Electrical Power: 250-500 W, 120/240 V, 50/60 Hz (without pump)

MULTIPASS CELL:
Choice of 76 meter standard cell (V=0.5 liters) or 210 meter “Super Cell” (V=2liters)

REFERENCES:

Nelson, D.D. et al., Optics Let. 31, 2012-2014, 2006.
McManus, J.B. et al., Applied Physics B, DOI: 10.1007/s00340-006-2407-7 (2006).
McManus, J.B., M.S. Zahniser, D.D. Nelson, L.R. Williams, and C.E. Kolb, Infrared laser spectrometer with balanced absorption for measurements of isotopic ratios of carbon gases,, Spectrochim. Acta A, 58, 2465-2479, (2002).
McManus, J.B., D.D. Nelson, J.H. Shorter, R. Jiménez, S. Herndon, S. Saleska, and M.S. Zahniser, A high precision pulsed QCL spectrometer for measurements of stable isotopes of carbon dioxide, J. Modern Optics, 52, 2309-2321 (2005).
Saleska, SR; J. Shorter, S. Herndon, R. Jimenéz, B. McManus, D. Nelson, M. Zahniser, What are the instrumentation requirements for measuring the isotopic composition of net ecosystem exchange of CO2 using eddy covariance methods? Isotopes in Environmental and Health Studies, 42 (1), 117 (2006).
Nelson, D.D., J. B. McManus, S. C. Herndon, M. S. Zahniser, B. Tuzson and L. Emmenegger, New Method for Isotopic Ratio Measurements of Atmospheric Carbon Dioxide Using a 4.3 μm Pulsed Quantum Cascade Laser, Appl. Phys. B 90, 301–309 (2008).
Tuzson, B , J. Mohn, M. J. Zeeman, R. A. Werner, W. Eugster, M. S. Zahniser, D. D. Nelson,
J. B. McManus, L. Emmenegger, High precision and continuous field measurements of δ13C and
δ18O in carbon dioxide with a cryogen-free QCLAS, Appl. Phys. B 92, 451-458 (2008).

CAPS PM_{ex} Monitor

Accurate and precise
Continuous Monitoring of
Particle Optical Extintion.

APPLICATIONS

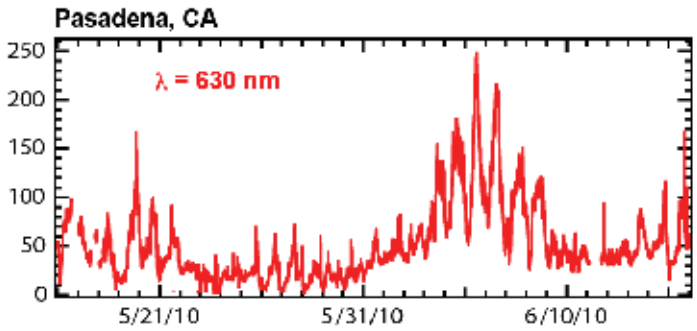
- Visible (red, green or blue) measurement of particle optical extinction using patented Cavity Attenuated Phase Shift technology.
- Measurement of ambient optical extinctions at the 1 Mm^{-1} level.
- Climate Change Research
  Optical Properties Closure.
- Roadside Monitoring.
- Combustion Plume Analysis.
- Aircraft Engine Exhaust Monitoring.

ADVANTAGES

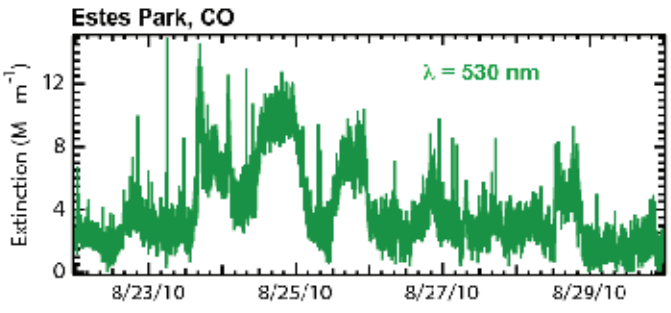
- Choice of 1 of 5 Wavelengths:

Far Blue	(405 nm)
Blue	(450 nm)
Green	(525 nm)
Red	(630 nm)
Far Red	(660 nm)
Near IR	(780 nm)

- No calibration required.
- Autonomous Operation:
  No Zero Air.
  Automated Background Subtraction.
- Linear Response (0 - 4000 Mm^{-1}).
- Maintenance-Free.



Measured particle extinction at 630 nm in Pasadena, CA during the CalNex campaign shown as 1 hour average values. Note the diurnal variation in extinction levels.

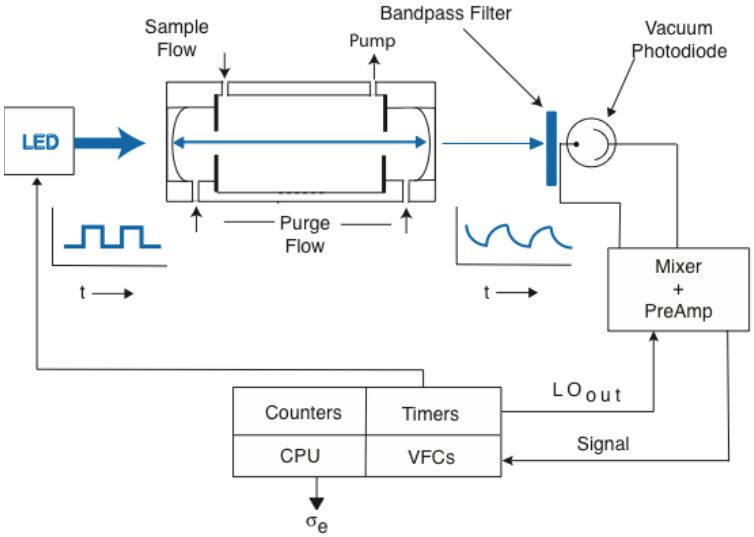


Measured particle extinction at 532 nm outside of Estes Park, CO shown as 1 minute averages. Note the low levels of ambient particle extinction. The spikes are particulate emissions from passing vehicles.

CAPS PM_{ex} Monitor

SPECIFICATIONS:

Sensitivity (S/N =3):	2.5 Mm^{-1} (1 s), 0.25 Mm^{-1} (60 s)
Response Time (10-90%):	< 2 s
Sample Flow:	0.85 l min^{-1} (volumetric flow)
Operating Pressure:	Ambient
Materials Exposed to Sample:	Conductive Urethane, Stainless Steel, Conductive Silicone, and Aluminum
Data Output:	RS-232, USB, Ethernet (Data Acquisition Program Included) On-board Data Storage (10 yrs) Front Panel Display
Size/Weight:	Rack mount, 19” x 24” x 9.06”, 25 lbs. [61 cm x 43 cm x 23 cm, 12 kg]
Electric Power:	50 W; 100-250 VAC (50-60 Hz)



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“Aerosol light extinction measurements by Cavity Attenuated Phase Shift Spectroscopy (CAPS): laboratory validation and field deployment of a compact aerosol extinction monitor,” P.Massoli, P. Kebabian, T. Onasch, F. Hills, and A. Freedman, Aerosol Sci. Technol., 44:428–435 (2010).

“System and method for trace species detection using cavity attenuated phase shift spectroscopy with an incoherent light source”, P.L. Kebabian and A. Freedman, U.S. Patent No. 7301639 (issued November 27, 2007).

“Optical Extinction Monitor Using CW Cavity Enhanced Detection”, P.L. Kebabian, W.A. Robinson and A. Freedman, Rev. Sci. Instrum., 78, 063102 (2007).

“Intercomparison of a Cavity Attenuated Phase Shift-based extinction monitor (CAPS PMex) with an integrating nephelometer and a filter-based absorption monitor”, A. Petzold, T. Onasch, P. Kebabian and A. Freedman, Atmos. Meas. Tech., 6:1141–1151 (2013).

Thermo Scientific 49iQ

Ozone Analyzer-UV Photometric

The Thermo Scientific™ 49iQ Ozone(O_3) Analyzer utilizes UV Photometric technology to measure the amount of ozone in the air from ppb levels up to 200ppm.

The Thermo Scientific 49iQ Analyzer is a dual cell photometer, the concept adopted by NIST for the national ozone standard. Because the instrument has both sample and reference flowing at the same time, a response time of 20 seconds can be achieved. Dual range, auto range, temperature correction and pressure correction are standard features.

Non-Stop Intelligence

- Predictive Diagnostics
- Proactive Communication
- Personal Device Connectivity

The Thermo Scientific iQ Series Gas Analyzer provides a smart environmental monitoring solution designed for reliability, easy operation and proactive maintenance. Get more control over your instrument's performance, costs, workflow and data availability.

The iQ companion app for the iQ Series Gas Analyzer delivers the ultimate in ease of use and smart engineering. The iQ app allows for remote monitoring of iQ gas analyzers, simplified ways of contacting us and instant access to product resources. Download the iQ app at **thermofisher.com/iQapp**

Thermo Scientific 49iQ Ozone Analyzer

Specifications	
Range	0-200 ppm 0-400 mg/m^3
Zero noise	0.25 ppb RMS (60 second averaging time)
Detection limit	0.50 ppb (60 second averaging time)
Zero drift	<1.0 ppb (24 hour) <2.0 ppb (7 day)
Span drift	<1% full scale (1 month)
Response time	20 seconds (10 second averaging time)
Linearity	±1% full scale
Flow rate	1-3 liters/min.
Operating temperature	0°-45°C.
Power requirements	100-240 VAC 50/60 Hz 275 Watts
Size and weight	16.75" (W) × 8.72" (H) × 24" (D), 31.7 lbs std; 35.6 lbs w/ozonator 425.45 mm (W) × 221.48 mm (H) × 609 mm (D), 14.4 kg std; 16.1 kg w/ozonator
Analog I/O	4 Isolated voltage Inputs 0–10 V 6 Isolated analog voltages outputs, with 4 selectable ranges 6 Isolated analog current outputs, with 2 selectable ranges
Digital I/O	16 Digital inputs (TTL) 8 Solenoid driver outputs 10 Digital reed relay contact outputs
Serial ports	1 RS-232/485 port; 1 RS-485 external accessory port
Other ports	3 Full speed USB ports (one in front, two in rear) 1 Gigabit ethernet port
Communications	MODBUS, streaming
Approvals and Certifications	CE, TUV-SUD Safety, US EPA: EQOA-0880-047

To maintain optimal product performance, you need immediate access to experts worldwide, as well as priority status when your air quality equipment needs repair or replacement. We offer comprehensive, flexible support solutions for all phases of the product life cycle. Through predictable, fixed-cost pricing, our services help protect the return on investment and total cost of ownership of your Thermo Scientific products. For more information on our comprehensive service solutions visit thermofisher.com/EMservice

Ordering information

49iQ Ozone Analyzer
Choose from the following configurations/options to customize your own 49iQ Analyzer
1. Power Cord
A = 100-120 VAC 50/60 Hz (NA)
B = 220 VAC 50/60 Hz (EU)
C = 220 VAC 50/60 Hz (CHN)
2. Communications
N = No I/O
A = Serial RS232/RS485
B = Analog and Digital
C = Serial, Analog and Digital
3. Internal Sample/Cal
N = No sample/Cal Valve
A = Internal Sample/Cal Valve
B = Internal Ozonator, Manifold, Sample/Cal Valve
C = Internal Ozonator, Sample/Cal & Zero/Ozone
4. Zero air source:
N = No Zero Air Source
A = Zero air source

Your Order Code: 49iQ –

☐ ☐ ☐ ☐

Thermo Scientific 42iQ

$NO-NO_2-NO_x$ Analyzer-chemiluminescent

The Thermo Scientific™ 42iQ $NO-NO_2-NO_x$ Analyzer utilizes chemiluminescence technology to measure the amount of nitrogen oxides in the air from sub-ppb levels up to 100ppm.

This analyzer is a single chamber, single photomultiplier tube design that cycles between the NO and NO_x modes.

The 42iQ Analyzer has independent outputs for NO, NO_2 and NO_x that can be calibrated separately. If required, the instrument can be operated continuously in either the NO or NO_x modes allowing for response times of less than five seconds. Dual range, auto range, temperature correction and pressure correction are standard features.

Non-Stop Intelligence

- Predictive Diagnostics
- Proactive Communication
- Personal Device Connectivity

The Thermo Scientific iQ Series Gas Analyzer provides a smart environmental monitoring solution designed for reliability, easy operation and proactive maintenance. Get more control over your instrument's performance, costs, workflow and data availability.

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Thermo Scientific 42iQ NO-NO_2-NO_X Analyzer

Specifications	
Range	0-20 ppm; 0-30 mg/m^3
Extended ranges	0-100 ppm; 0-150 mg/m^3
Zero noise	0.20 ppb RMS (60 second averaging time)
Detection limit	0.40 ppb (60 second averaging time)
Zero drift	< 0.40 ppb (24 hour)
Span drift	±1% full scale (24 hour)
Response time	40 seconds (10 second averaging time) 80 seconds (60 second averaging time) 300 seconds (300 second averaging time)
Linearity	±1% full scale
Flow rate	0.6-0.8 lpm
Operating temperature	0°-40°C
Power requirements	100-240 VAC 50/60 Hz, 275 Watts
Size and weight	24 in (D) x 16.75 in (W) x 8.72 in (H), 40lbs 609 mm (D) 425.45 mm (W) x 221.48 mm (H), 18kg
Analog I/O	4 Isolated voltage inputs 0–10 V 6 Isolated analog voltages outputs, with 4 selectable ranges 6 Isolated analog current outputs, with 2 selectable ranges
Digital I/O	16 digital inputs (TTL) 8 solenoid driver outputs 10 digital reed relay contact outputs
Serial ports	1 RS-232/485 port 1 RS-485 external accessory port
Other ports	3 Full speed USB ports (one in front, two in rear) 1 Gigabit ethernet port
Communication protocols	MODBUS, streaming
Approvals and certifications	CE, TUV-SUD Safety, US EPA: RFNA-1289-074

To maintain optimal product performance, you need immediate access to experts worldwide, as well as priority status when your air quality equipment needs repair or replacement. We offer comprehensive, flexible support solutions for all phases of the product life cycle. Through predictable, fixed-cost pricing, our services help protect the return on investment and total cost of ownership of your Thermo Scientific products. For more information on our comprehensive service solutions visit thermofisher.com/EMservice

Ordering information

42iQ NO-NO_2-NO_X Analyzer

Choose from the following configurations/options to customize your own 42iQ Analyzer

1. Power Cord	
A = 100-120 VAC 50/60 Hz (NA)	
B = 220 VAC 50/60 Hz (EU)	
C = 220 VAC 50/60 Hz (CHN)	
2. Communications	
N = No I/O	
A = Serial RS232/RS485	
B = Analog and Digital	
C = Serial, Analog and Digital	
3. Moly Converter Material	**3. SS Converter Material**
A = Molybdenum	B = Stainless Steel
4. Moly Zero/Span	**4. SS Internal Zero/ Span & Sample Conditioning**
N = No Zero/Span Assembly	NN = No Zero/Span Assembly
A = Internal Zero/Span Assembly	AN = Internal Zero/Spar Assembly
B = Internal Zero/Span Assembly, Internal Permeation Oven	
5. Moly Sample Conditioning	
N = None	
A = Ammonia Scrubber	
B = Sample Permeation Dryer	
C = Lag Volume with Sample Permeation Dryer	

Your Order Code: 42iQ -

☐ ☐ ☐ ☐ ☐

Thermo Scientific Model 43i

Sulfer Dioxide Analyzer- pulsed fluorescence gas analyzer

The Thermo Scientific™ Model 43*i* Sulfur Dioxide (SO_2) Analyzer utilizes pulsed fluorescence technology to measure the amount of sulfur dioxide in the air up to 100 ppm.

Features

- Ethernet connectivity for efficient remote access
- Enhanced user interface with one button programming and large display screen
- Flash memory for increased data storage and user downloadable software
- Enhanced electronics design optimizes product commonality

Introduction

The Thermo Scientific Model 43*i* Sulfur Dioxide (SO_2) Analyzer utilizes pulsed fluorescence technology to measure the amount of sulfur dioxide in the air up to 100 ppm.

The pulsing of the U.V. source lamp serves to increase the optical intensity whereby a greater U.V. energy throughput and lower detectable SO_2 concentration are realized.

Reflective bandpass filters, as compared to commonly used transmission filters, are less subject to photochemical degradation and more selective in wavelength isolation.

This results in both increased detection specificity and long term stability. The state-of-the-art gas analyzer offers features such as an Ethernet port as well as flash memory for increased data storage.

Ethernet connectivity provides efficient remote access, allowing the user to download measurement information directly from the instrument without having to be onsite.

Easily programmable short-cut keys allow you to jump directly to frequently accessed functions, menus or screens. The larger interface screen can display up to five lines of measurement information while the primary screen remains visible.

Thermo Scientific™ Model 43*i*
Sulfur Dioxide Analyzer

Thermo Scientific Model 43*i* Sulfur Dioxide Analyzer

Specifications	
Preset ranges	0-0.05, 0.1, 0.2, 0.5, 1, 2, 5, and 10 ppm, 0-0.2, 0.5, 1, 2, 5, 10, 20, and 25 mg/m^3
Extended ranges	0-0.05, 1, 2, 5, 10, 20, 50 and 100 ppm, 0-2, 5, 10, 20, 50, 100, 200, and 250 mg/m^3
Custom ranges	0-0.05 to 100 ppm, 0-0.2 to 250 mg/m^3
Zero noise	1.0 ppb RMS (10 second averaging time), 0.5 ppb RMS (60 second averaging time),0.25 ppb RMS (300 second averaging time)
Lower detectable limit	< 0.5 ppb
Zero drift (24 hour)	Less than 1 ppb
Span drift (24 hour)	+/-0.5%
Response time	< 20 seconds (lag time) (60 second or less averaging time) < 100 seconds (rise time) < 100 seconds (fall time)
Precision	1% of reading or 1 ppb (whichever is greater)
Linearity	+/-1% full scale < 100ppm
Sample flow rate	0.5 liters/min. (standard) 1 liter/min. (optional)
Interferences	< lower detectable limit except for the following: (EPA Levels) NO < 3 ppb, M-Xylene < 1 ppb, H2O < 3% of reading
Operating temperature	Performance specifications based on operation within 68°-86°F (20°C-30°C) range (per U.S. EPA guidelines). Instrument may be safely operated over the range of 32°-113°F (0°-45°C).
Power requirements	100 VAC, 115 VAC, 220-240 VAC +/-10% @ 165W
Size and weight	16.75" (W) × 8.62" (H) × 23" (D), 48 lbs. (21.8 kg)
Outputs	Selectable voltage, RS232/RS485, TCP/IP, 10 status relays, and power fail Indication (standard). 0-20 or 4-20 mA isolated current output (optional)
Inputs	16 digital inputs (standard), 8 0-10Vdc analog inputs (optional)
Approvals and certifications	US EPA Equivalent Method: EQSA-0486-060 MCERTS Certified: Sira MC070094/00 EN14212: TÜV 936/21203248/D Report

To maintain optimal product performance, you need immediate access to experts worldwide, as well as priority status when your air quality equipment needs repair or replacement. We offer comprehensive, flexible support solutions for all phases of the product life cycle. Through predictable, fixed-cost pricing, our services help protect the return on investment and total cost of ownership of your Thermo Scientific products.

Ordering information

Model 43*i* Sulfur Dioxide Analyzer
Choose from the following configurations/options to customize your own Model 43*i* Analyzer
1. Voltage options
A = 115 VAC 60 Hz
B = 220 VAC 50 Hz
J = 100 VAC 50/60 Hz
2. Internal zero/span
N = No zero/span assembly (standard)
Z = Internal zero span assembly
P = Internal permeation span source w/zero/span assembly
L = Oxygen sensor with no zero/span
K = Oxygen sensor with zero/span
3. Kicker type
S = Standard
H = Heated
4. Optional I/O
A = None (standard)
C = 0-20, 4-20mA current output – 6 channels, 0-10v analog input -8 channel
5. Mounting hardware
A = Bench mounting and ears/handles, EIA

Your Order Code: Model 43*i* –

☐ ☐ ☐ ☐ ☐

Thermo Scientific Model 48i

Gas filter correlation
Carbon Monoxide Analyzer

The Thermo Scientific™ Model 48*i* Carbon Monoxide (CO) Analyzer utilizes gas filter correlation technology to measures the amount of carbon monoxide in the air.

Features

- Approved to meet the following standards: U.S. EPA, UK Environmental Agency and the EU Environmental Agency
- Ethernet connectivity for efficient remote access
- Enhanced user interface with one button programming and large display screen
- Flash memory for increased data storage and user downloadable software

Introduction

The Model 48*i* Analyzer is based on the principle that carbon monoxide (CO) absorbs infrared radiation at a wavelength of 4.6 microns. Because infrared absorption is a nonlinear measurement technique, it is necessary for the instrument electronics to transform the basic analyzer signal into a linear output.

The Model 48*i* Analyzer uses an exact calibration curve to accurately linearize the instrument output over any range up to a concentration of 10,000ppm. This state-of-the-art gas analyzer offers features such as an Ethernet port as well as flash memory for increased data storage.

Ethernet connectivity provides efficient remote access, allowing the user to download measurement information directly from the instrument without having to be onsite.

Easily programmable short cut keys allow you to jump directly to frequently accessed functions, menus or screens. The larger interface screen can display up to five lines of measurement information while primary screen remains visible.

Thermo Scientific Model 48*i*
Carbon Monoxide Analyzer

Thermo Scientific Model 48*i* Carbon Monoxide Analyzer

Specifications	
Preset ranges	0-1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000 and 10000 ppm 0-1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000 and 10000 mg/m^3
Custom ranges	0-1 to 10000 ppm, 0-1 to 10000 mg/m^3
Zero noise	0.02 ppm RMS (30 second averaging time)
Lower detectable limit	0.04 ppm
Zero drift (24 hour)	< 0.1 ppm
Span drift (24 hour)	+/-1% full scale
Response time	60 seconds (30 second average time)
Precision	+/-0.1 ppm
Linearity	+/-1% full scale < 1000 ppm +/-2.5% full scale > 1000 ppm
Sample flow rate	0.5-2 liters/min.
Interferences	< lower detectable limit except for the following: (EPA Levels) NO < 3 ppb, M-Xylene < 1 ppb, H2O < 3% of reading
Operating temperature	Performance specifications based on operation within 20°-30°C range (per U.S. EPA Guidelines). Instrument may be safely operated over the range of 0°- 45°C.
Power requirements	100 VAC, 115 VAC, 220-240 VAC +/-10% @ 275W
Size and weight	116.75" (W) × 8.62" (H) × 23" (D), 49 lbs. (22.2 kg)
Outputs	Selectable voltage, RS232/RS485, TCP/IP, 10 status relays and power fail indication (standard) 0-20 or 4-20 mA isolated current output (optional)
Inputs	16 digital inputs (standard), 8 0-10Vdc analog inputs (optional)
Approvals and certifications	U.S. EPA Equivalent Method: RFCA-0981-054 MCERTS Certified: Sira MC070095/00 EN14626: TÜV 936/21203248/A Report

To maintain optimal product performance, you need immediate access to experts worldwide, as well as priority status when your air quality equipment needs repair or replacement. We offer comprehensive, flexible support solutions for all phases of the product life cycle. Through predictable, fixed-cost pricing, our services help protect the return on investment and total cost of ownership of your Thermo Scientific products. For more information on our comprehensive service solutions visit thermofisher.com/EMservice

Ordering information

Model 48*i* Carbon Monoxide Analyzer
Choose from the following configurations options to customize your own Model 48*i* Analyzer
1. Voltage options
A = 120 VAC 50/60 Hz (standard)
B = 220 VAC 50/60 Hz
J = 100 VAC 50/60 Hz
2. Internal zero / span and/or Oxygen Sensor
N = No zero/span valve assembly (standard)
A = No zero/span valve w/Zero Air Scrubber
Z = Internal zero/span valve assembly
C = Internal zero/span valve w/Zero Air Scrubber
G = Oxygen Sensor with NO zero/span
R = Oxygen Sensor with zero/span
3. Filter wheel purge
S = Standard plumbing (standard)
P = Filter wheel purge setup
4. Optional I/O
A = No optional I/O (standard)
C = 0-20, 4-20mA current output – 6 channels, 0-10v analog input -8 channel
5. Mounting hardware
A = Bench mounting and ears/handles, EIA

Your Order Code: Model 48*i* –

☐ ☐ ☐ ☐ ☐

Advanced Measurement of Aerosol Black Carbon

Aethalometer Model AE33

Key Features

- Full Spectrum 7-Wavelength analysis: UV – IR, 1 Hz data rate
- DualSpot™ Technology for compensation of “filter loading effect”
- Real-time source apportionment
- NIST-traceable Calibration/Validation by Neutral Density Optical kit
- Network ready for remote management and data transfer
- Integrates with Total Carbon Analyzer TCA08 for OC/EC analysis
- Integrates with CO_2 and meteorological sensors for additional data
- Integrates with an external pump for High altitude BC monitoring

*United States Patent 8,411,272, United States Patent 9,018,583, other patents pending

Applications

- Air Quality monitoring
- Real-time source apportionment
- Emissions testing
- Climate Change research
- Health Effects research
- Combustion research

¸Good decisions can only be based on good data

The **Aethalometer** provides real-time monitoring, quantitation and speciation of **Black (and 'Brown') Carbon** aerosols. This data is used to study:

- Public Health and Occupational Health
- Climate Change
- Visibility
- Stationary Source Emissions
- Vehicle and Engine Emissions
- Modification of Precipitation
- Impacts on Agricultural Yields
- Degradation of Cultural Heritage

*The Aethalometer® is the instrument most-used in the world for **real-time** monitoring and speciation of Black Carbon. Thousands of instruments have been installed world-wide since commercialization began in 1986, and are now operating on all 7 continents.*

The Aethalometer measurement principle

The Aethalometer draws the sample air stream through a filter tape with a flow rate from 2 to 5 liters per minute. Aerosols are collected on two spots on the tape, and are illuminated by a multi-wavelength light source. Detectors measure the attenuation of light by the absorbing components of the aerosols, relative to a reference through an un-exposed portion of the tape.

The filter tape advances on a time schedule, or when a pre-set loading limit is reached. The instrument operates completely automatically from power-up, and provides continuous real-time data with no operator attention.

DualSpot™
Patented automatic compensation for 'filter loading effect'

Sample collection and analysis is performed on two filter spots simultaneously at different flow rates. Mathematical combination of the data eliminates the "Filter Loading Effect" and provides continuously-corrected data in real time with **no discontinuities at filter advances**.[2]
This compensation depends critically on the aerosol composition and properties. It **must be determined in real time** from the measurement data, as it **cannot be predicted** in advance.
The parameters derived from this analysis also offer additional insights into **aerosol composition and aging.**

***DualSpot** enables Aethalometer to be used to be used under dynamically varying ambient conditions. It provides valid Black Carbon measurement data out-of-the-box, with no need for post-processing.*

1- United States patents US 8411272 and US 9018583; and European patent applications EP 2 151 679 A3 and EP 2 498 079 A2; cover aspects of the proprietary technology embodied in the Aethalometer®.

2- Drinovec et al.: The "dual-spot" Aethalometer: an improved measurement of aerosol black carbon with real-time loading compensation, Atmos. Meas. Tech., 8, 1965-1979, 2015.

Real-time source apportionment

The Aethalometer analyzes the sample at 7 optical wavelengths from UV (370 nm) to IR (950 nm). Optical absorption by different aerosol components may have different variations across the spectrum: most notably, the differences between diesel exhaust and emissions from biomass burning. The 7-wavelength data allows for a separation of these components, providing **a real-time speciation of the aerosol sources and a determination of their origins.**

A source-apportionment algorithm was verified[3] using C14 analysis based on several year's campaign dataset.

Calibration/Validation against NIST Standard Reference Materials

The performance of the Aethalometer may be validated by a 'Neutral Density Optical Filter Kit' (optional accessory), which uses NIST-traceable optical standards to verify the analysis and validate the data. This can be performed at the instrument site: it is not necessary to take the instrument out of service. This **maximizes up-time** and **minimizes expense**.

High time resolution (1Hz) analytical response

Sampling, analysis and all calculations are performed at a fundamental rate of 1 Hz. Standard reporting time bases of 1 second or 1 minute permit **the identification of temporal patterns** and **the study of direct emission sources** such as engines, stoves, etc. Data may be aggregated into averages of 1 hour (or other intervals) for air-quality reporting. All data and internal diagnostics are stored internally with an instrument capacity of many years.

Networking

The Aethalometer provides digital data outputs ('COM')for local logging and recording; and a network connection ('Ethernet'). Magee Scientific offers networking solutions for **remote access**, **remote operation**, **networking**, **status reporting**, **alerting** and **data management**.

Integrate with Total Carbon Analyser TCA08 for OC/EC Analysis

The AE33 Aethalometer may be integrated with the TCA08 Total Carbon Analyzer to provide a **complete characterization of the carbonaceous component of ambient aerosols in near-real time**. This provides TC, "EC/OC", BC and BrC data in a rugged instrument package suitable for laboratory and Air Quality monitoring applications.

3- Zotter et al.: Evaluation of the absorption Ångström exponents for traffic and wood burning in the Aethalometer-based source apportionment using radiocarbon measurements of ambient aerosol, *Atmos. Chem. Phys., 17, 4229-4249, 2017.*

Product Specifications

MEASUREMENT PRINCIPLE

Continuous collection of aerosol on filter with simultaneous measurement of attenuation of transmitted light at wavelengths of 370, 470, 520, 590, 660, 880 and 950 nm.
Black Carbon concentration measurement is defined by the absorption measurement at 880 nm.
Multiple wavelength analysis for source apportionment (identification of biomass smoke), studies of aerosol light absorption, radiative transfer, atmospheric optics.
High data rate capability for source and emissions testing.

DUALSPOT™ TECHNOLOGY

Simultaneous analysis of light absorption by aerosol deposits collected on 2 spots in parallel at different loading rates*. Mathematical combination of data yields Black Carbon result independent of ''spot loading effects'' and provides additional information about aerosol composition.

*United States Patent 8,411,272, United States Patent 9,018,583, other patents pending

SOURCE APPORTIONMENT

Discrimination of Black Carbon from fossil fuel versus biomass combustion possible with built-in analysis by a two-component model.

SENSITIVITY

Proportional to time-base and sample flow rate settings: approximately 0.03 µg/m^3 @ 1 min, 5 LPM.

DETECTION

Detection Limit (1 hour): <0.005 µg/m^3
Range: <0.01 to >100 µg/m^3 Black Carbon
Resolution: 0.001 µg/m^3 or 1 ng/m^3 (user-definable display units)

SAMPLING

Aerosol sample collected on reinforced glass-fiber/PTFE filter tape. Tape advances automatically on aerosol loading or at predefined times or intervals.
Size selective inlets (impactor, cyclone) may be attached.
• Time-base 1 second or 1 minute, post-processing to any time resolution.
• Flow-rate 2 to 5 LPM provided by internal pump. Flow measured by two mass flow sensors and stabilized by closed-loop control.

OPERATOR INTERFACE

Display
8.4'' color touch-screen with status indicator LED's.
Interface
Graphical User Interface with basic data display and control, advanced screens for detailed reporting and parameter setup.
Remote management
Network ready for remote management and data transfer.

EXTENDED RANGE OF OPERATION

Standard AE33 analyzer can be converted to High Altitude (HA) mode using an external pump. Operating range extends from basic 3000 m a.s.l. to 5000 m a.s.l.

DATA OUTPUT & STORAGE

Output
• Digital data via RS-232 COM port and Ethernet
• Analog output via AOM module
Storage
Data are written to internal memory once every time-base period. Stored data may be transferred over a network or to a manually inserted USB drive.

QUALITY CONTROL AND ASSURANCE

Automatic or manual sample flowrate calibration using an externally-attached calibrator.
Verification of optical performance using a set of NIST-traceable neutral density optical filters.
Automatic or manual "Dynamic Active Zero" and stability tests may be programmed to occur at specified time intervals.

PHYSICAL SPECIFICATIONS

• Dimensions (HxWxD): 28 x 43 x 33 cm
• Weight: 21 kg
• Electrical Power supply: 100-230VAC, 50/60Hz (auto-switching)
• Power consumption: 25 W average
• Internal Vacuum Pump: dual diaphragm, brushless motor
• Modular hardware, constructed in a fully-enclosed 19'' rack mount 6U chassis, hermetically sealed

RELATED PRODUCTS

Aerosol Inlet Dryer including external pump (PN 5610)
AEccessor remote access from PC, tablet, phone
AethAlerts status reporting and sytem alert service by email
AethNET networking solution that connects Aethalometers to a data center where the data is analyzed, stored and made available to users
Integrates with **Total Carbon Analyzer TCA08** for OC/EC analysis

ACCESSORIES

Neutral Density Optical Filter validation kit (PN 7662)
Ambient Meteorological Sensor, with 10-m cable (PN 5510)
PM2.5 inlet (2.5 µm @ 5 LPM) (PN 4110)
PM1 inlet (1 µm @ 5 LPM, 2.5 um @ 2 LPM) (PN 4114)
Mini PM Inlet configurable: PM1, PM2.5, PM4, PM10, TSP (PN 4121)
CO2 sensor, integrated with AE33 airflow & data acquisition (PN 5710)
Flow Calibrator, with cable for automatic/manual use (PN 7900)
Insect Screen Assembly with Water Trap (PN 9556)
Tape Sensor Calibration Disc kit (PN 3410)
Shockproof & waterproof transit case (PN 9610)
GPS Module (PN AE33-GPS)

Xact 625i Multi-metals Monitoring System

Ambient/Fence-Line Multi-Metals monitor (AMM)

ADAPT Screenshots

Description

Cooper Environmental's Xact® 625i is designed for high time resolution multi-metals monitoring of ambient air, with detection limits that rival those of laboratory analysis. The Xact® 625i comes standard with a solid-state meteorological sensor and Cooper Environmental's proprietary ADAPT analysis package, making the instrument one of the most powerful air pollution source detection offerings in the industry.

The system uses reel-to-reel filter tape sampling and nondestructive energy dispersive X-ray fluorescence (EDXRF) analysis. The air is sampled through a low volume (16.7 l/min) particulate matter (PM) size-selective inlet and drawn through a filter tape. The resulting PM deposit is then advanced into the analysis area where the sample is analyzed by EDXRF for selected metals while the next sample is collected.

Standard Features

- ADAPT data analysis software that enables immediate research-quality graphical reports to deliver unique insight on the temporal and variability trends of the metals measured
- Sampling and analysis methodology that has been validated by the US EPA ETV program
- Windows-based operating system with 10.1 inch touchscreen that may be ordered flat (shown) or tilted for lower placed instruments
- Sampling, analysis, and near real-time reporting (every 15, 30, 60, 120, 180, or 240 minutes in ng/m^3)
- Automatic quality assurance, alarms, & control features
- Incorporates an internal XRF quality assurance standard with every sample analyzed
- Provides automatic, daily XRF calibration drift checks
- Remote polling and remote system control
- Global power design does not require power conversion or conditioning
- Average detection limits improved by over 30% compared to previous generation Xact® 625

Benefits

- Adaptable to both stationary and mobile monitoring platforms
- Effective for fugitive emissions measurement
- Can be used to establish baseline levels for health-based standards
- Capable of identifying hazardous "hot spots" around the perimeter of a facility
- Enables effective source apportionment and chemical mass balance comparisons
- Highly sensitive and reliable (low pg/m^3 to µg/m^3 range)
- Nondestructive analysis allows for sample archiving
- Aids source identification by correlating metals concentrations to wind speed and direction
- Demonstrates metal concentration variability not observable with standard 24-hour methods
- Can be used to identify plant activities associated with high metals concentrations

Applications

The Xact® 625i monitoring system can simultaneously identify and measure multiple metals in ambient air to provide data for use in the following applications:

- Fence-line monitoring
- Source Apportionment
- Determination of background concentrations
- Spatial recognition of pollution sources
- Temporal recognition of pollution sources
- Resolve acute, short duration events
- Risk and emergency management

Specifications

Measurement method	Based on EPA Method IO 3.3: Determination of Metals in Ambient PM Using XRF
Key applicable elements	Sb, As, Ba, Cd, Ca Cr, Co, Cu, Fe, Pb, Hg, Mn, Ni, Se, Ag, Sn, Ti, Tl, V, Zn, and more available
Measurement range	Up to 60 µg/dscm and higher
Detection limits (IF, EPA IO - 3.3)[1]	Metal and sample time dependent; refer to the minimum detection limit (MDL) data
Sampling and analysis times	Every 15, 30, 60, 120, 180, or 240 minutes, user defined
Calibration stability check frequency	Automatically with each sample analyzed
Estimated recalibration frequency	Annually, when manufacturer's operating recommendations are followed
Sample flow rate	16.7 lpm
Linearity	Correlation coefficient >0.99
Size and weight	19" w x 20" d x 30" h 130 lbs 19 inch (483 mm) rack-mountable or tabletop
Required operating environment	Lab environment with temperature controlled to 20±5°C (68°F)
Power requirements	120 VAC/60 Hz @ 20 amp or 220 VAC/50 Hz 10 amp circuit
Outputs	RS232 Modbus protocol Reporting of all metals that the system is calibrated to measure
Options	Change or add elements Enclosures (NEMA 4, 4x, 12, or 12x) Inlets (PM10, PM2.5, PM1, low volume TSP)

Performance

Xact 625i Minimum Detection Limits (ng/m³) 68% Confidence Level (C1σ) per US EPA IO 3.3 and Currie *							
Element	Atomic Number	15	30	60	120	180	240
Al	13	840	290	100	35	19	12
Si	14	150	51	17.8	6.3	3.4	2.2
P	15	44	15	5.2	1.8	0.99	0.64
S	16	26	9.1	3.16	1.1	0.60	0.39
Cl	17	15	5.0	1.73	0.61	0.33	0.21
K	19	9.8	3.4	1.17	0.41	0.22	0.14
Ca	20	2.5	0.86	0.30	0.10	0.057	0.037
Ti	22	1.3	0.46	0.16	0.056	0.030	0.020
V	23	1.0	0.34	0.12	0.042	0.023	0.015
Cr	24	0.97	0.33	0.12	0.041	0.022	0.014
Mn	25	1.2	0.41	0.14	0.050	0.027	0.018
Fe	26	1.4	0.49	0.17	0.061	0.033	0.021
Co	27	1.1	0.39	0.14	0.049	0.026	0.017
Ni	28	0.78	0.27	0.10	0.034	0.018	0.012
Cu	29	0.65	0.23	0.079	0.028	0.015	0.010
Zn	30	0.55	0.19	0.067	0.023	0.013	0.008
As	33	0.52	0.18	0.063	0.022	0.012	0.008
Se	34	0.66	0.23	0.081	0.029	0.016	0.010
Br	35	0.85	0.30	0.10	0.037	0.020	0.013
Ag	47	16	5.5	1.9	0.68	0.37	0.24
Cd	48	21	7.2	2.5	0.89	0.48	0.31
In	49	26	8.9	3.1	1.1	0.60	0.39
Sn	50	33	12	4.1	1.4	0.78	0.51
Sb	51	42	15	5.2	1.8	0.99	0.64
Ba	56	3.3	1.1	0.39	0.14	0.074	0.048
Hg	80	0.99	0.35	0.12	0.043	0.023	0.015
Tl	81	0.95	0.33	0.12	0.041	0.022	0.014
Pb	82	1.0	0.36	0.13	0.045	0.024	0.016
Bi	83	1.1	0.37	0.13	0.046	0.025	0.016

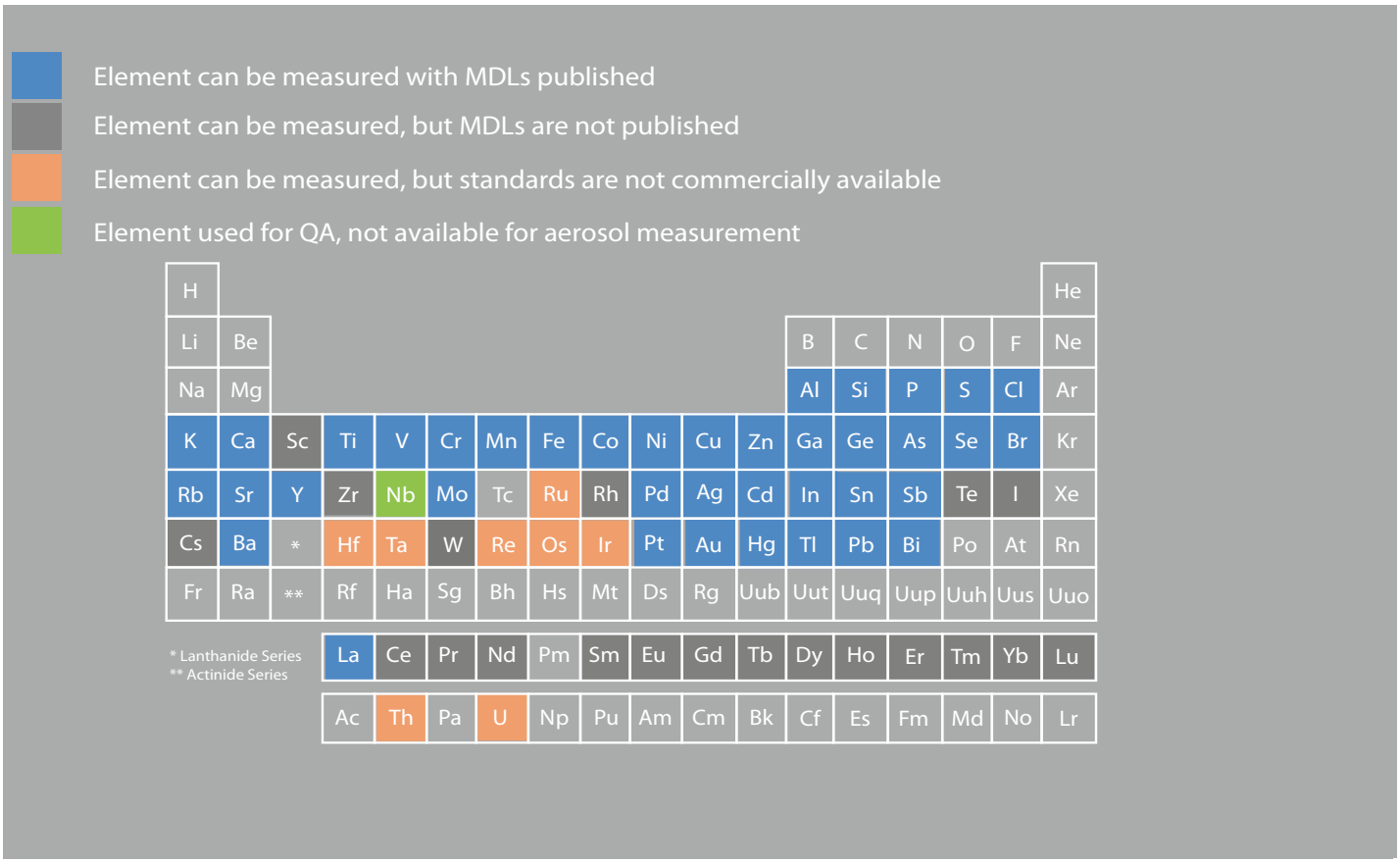
* - Interference free one sigma detection limits or "…net signal level (instrument response) above which an observed signal may be reliably recognized as "detected" (Currie, 1968). See www.cooperenvironmental.com for more details on detection limits.

US EPA Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air, June 1999: Method IO-3.3.

US EPA XRF Web Seminar, Module 2: Basic XRF Concepts, August 2008.

Currie, L. A., "Detection and Quantification in X-Ray Fluorescence Spectrometry" in T. G. Dzubay, X-ray Fluorescence Analysis of Environmental Samples, Ann Arbor Science, 1977; and L. A. Currie, Analytical Chemistry, 40, p586, March 1968.

Detection limits above are for 0.707 in^2 spot sample size



Elements Supported

Xact® 625i monitoring systems are capable of identifying and measuring the 67 elements highlighted in the table above. Minimum detection limits for the elements highlighted in blue can be found on the performance page of this data sheet. The Xact® 625i can measure elements highlighted in gray, but detection limit data has not been published for these elements. Please contact your Xact® representative for more information on your specific metals monitoring requirements.

As a "standard" set of elements of interest, the 625i will be equipped to report the following 44 elements - Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Rb, Sr, Y, Zr, Mo, Pd, Ag, Cd, In, Sn, Sb, Te, Cs, Ba, La, Ce, W, Pt, Au, Hg, Tl, Pb, and Bi. Of course, the elements can be tailored specifically to the user's needs as well.

Ordering Information

To place an order or for more information about the Xact® 625i continuous monitoring system, contact your regional CES representative or email us at info@cooperenvironmental.com

Solutions for your research challenges

SEMS
Scanning Electrical
Mobilty Spectrometer

Model 2100

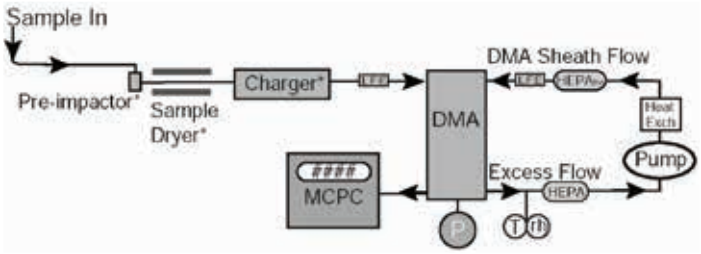
Real-time particle number size distribution measurement system and monodisperse particle generator

Features:

- Broadest available particle size range - select up to 2 micron diameter
- Recirculating DMA sheath flow eliminates external pumps
- Fast CPC response and DMA scan times down to a few seconds
- Precise volumetric airflow measurement with laminar flow elements
- Low pressure package for aircraft & other low pressure applications
- Easy to use software displays Number, Area & Volume size distributions
- Fully automated, long-term unattended operation
- Dry sizing package for low relative humidity operation
- High voltage design practically eliminates arcing problems
- Monodisperse particle selection and scanning software with inversion
- Real-time temperature, relative humidity and pressure measurements

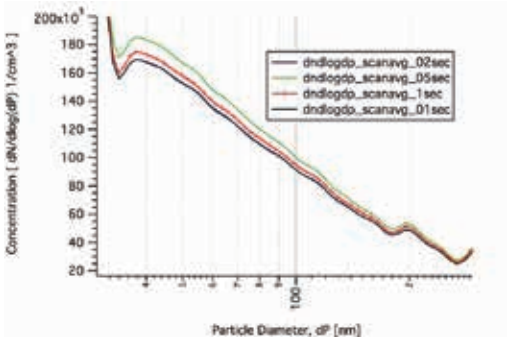
Providing Aerosol Measurement Solutions

Schematic of SEMS



*denotes optional equipment

Ambient size distribution measurements with 60 size bins for total scan times between 6 and 60 seconds



Specifications

Parameter	Value
Selectable particle diameter size range	0.005—1.0 or 0.01 – 2.0 µm NOTE1
Size resolution (set by Q_{aer}/Q_{sheath})	Variable (28:1 typical)
Scan time range	5 secs to > 1 hour
Sheath flow range	2.5-12 lpm
Aerosol sample flow range	0.1 to 2.0 lpm
Particle concentration range	1-10^8 /cm³
Range of high voltage	0-6,000 Volts
Pre-impactor cut size diameter	0.5 or 1.0 µm
Communications	Ethernet and RS-232
CPC working fluid	1-Butanol
Operating temperature	15-35°C
Operating pressure	200-1,000 mb NOTE2
Physical size	19 x 13 x 22 in/48 x 33 x 56 cm
Weight	35 lbs/16 kg
Power usage	80 watts (85 to 230 VAC)

Notes:
1. 2 micron sizing with SEMS--DMA-UG option.
2. Only with SEMS-ExP options.

*Some products may be shown with optional accessories, which are sold separately. Items shown may not be to scale.

Publications:

Xerxes F. Lopez-Yglesias, Ming Chee Yeung, Stephen E. Dey, Fred J. Brechtel and Chak K. Chan (2014), Performance evaluation of the Brechtel Mfg. Humidified Tandem Differential Mobility Analyzer (BMI HTDMA) for studying hygroscopic properties of aerosol particles, Aerosol Science and Technology, July 2014; DOI: 10.1080/02786826.2014.952366

Applications

- Continuous monitoring of ambient number size distributions
- Laboratory flow-tube reactor studies
- Cloud condensation nucleus studies
- Visibility reduction studies
- Aerosol health impacts
- Long-term climate and air quality monitoring
- Sampling conditions with highly transient aerosol concentrations
- Vertical profiles of number distributions from aircraft

How to Order

Part No.	Description
2100	Scanning Electrical Mobility Sizing (SEMS) System
8008	Round Jet Impactor with 0.5 micrometer cut size, 0.6 lpm flow
8009	Round Jet Impactor with 1.0 micrometer cut size, 0.6 lpm flow
9000	Aerosol charge neutralizer (Requires Polonium-210 sources)
9001	Non-radioactive charger (available 2018)
9002	Soft X-ray charger
9200	Aerosol Generation System
9202	Automated Aerosol Generation System: includes Model 9200 AGS plus Auto-3 way Valve Chassis
SEMS-DMA-UG	Upgrade DMA for 0.01 to 2µm diameter size selection range
SEMS-DrySize	Dry sizing package
SEMS-ExP115	External pump package, 115V
SEMS-ExP230	External pump package, 230V
SEMS-PPSoft	Post-processing software to allow off-line inversion
RackS	Rackmount kit for 2100 SEMS
SEMS-Kit	Maintenance kit for 2100 SEMS

Solutions for your research challenges

Soft X-Ray Charger

Model 9002

The Model 9002 is a Bipolar charger that uses Soft X-rays to charge particles instead of a radioactive source such as Am241 (Americium-241), Kr85 (Krypton-85), or Po210 (Polonium-210). Soft X-rays are easily absorbed by a thin layer of air and have been widely used for anti-static applications. The unit is safe, easy to use and requires minimal maintenance. It is also easy to import for use in scientific applications such as aerosol research.

Features:

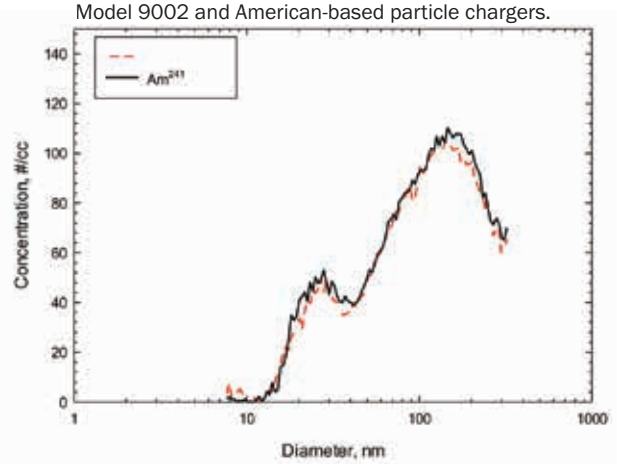
- Easy to operate, safe and simple
- No particle or ozone generation
- Environmentally safe non-radioactive source
- Low maintenance
- Compressed air not required
- Built-in controller
- No transportation restrictions; simplifies handling
- Compatible with Brechtel's SEMS Model 2100 and HTDMA Model 3100

Providing Aerosol Measurement Solutions

The Model 9002 charger is qualified as a fully protective type device. It can be safely used since a separate radiation shield is not required.

The charger has a useable “power-on” lifetime of 10,000 hours, its built-in yellow LED turns on when the operating lifespan is reached. Return the charger to Brechtel or its authorized representative for repair and calibration.

Particle size distribution measurements with Model 9002 and American-based particle chargers.



Specifications

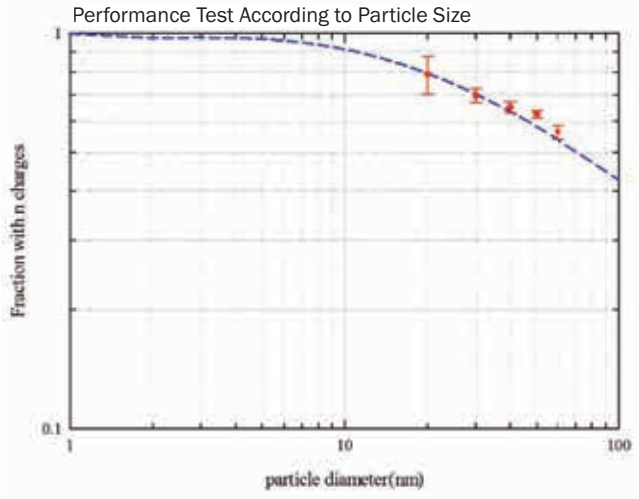
Parameter	Value
Ion Generation Method	Soft X-ray <9.5 keV
Source	Sort X-ray tube
Flow Rate Range	0.3-4.0 L/min
Equivalent X-ray Dose	<0.13 µSv/h at 10 cm distance
Aerosol Medium	Air or N2 only
Power Consumption	7.2W
Cooling Method	Natural cooling
Aerosol Ports	1/4 inch O.D.
Weight	1.11 kg/2.45 lbs
Input Power	AC100~240V, 50/60Hz (Adaptor input) DC 112V, 3.33A
Warranty	1 Year
Dimensions (LWH)	10.8 x 2.8 x 7.5 in/27.3 x 7.2 x 19.1 cm
Maximum Input Concentration	10^7 particles/cm^3

*Some products may be shown with optional accessories, which are sold separately. Items shown may not be to scale.

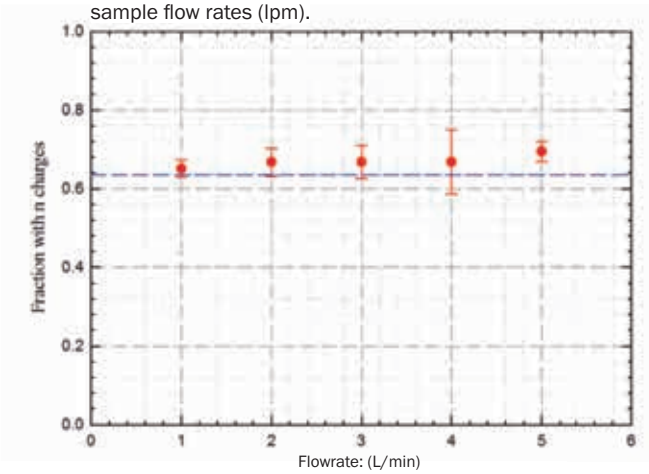
Applications

- Particle charging
- Particle generation
- Particle sizing

Performance Test According to Particle Size



Fraction of particles with one charge for various operating sample flow rates (lpm).



Flowrate: (L/min)
Particle concentration: 1,000#/cc
Particle diameter: 40nm

How to Order

Part No.	Description
9002	Soft X-Ray Charger

Aerodynamic Particle Sizer

High-resolution aerodynamic sizing Plus light-scattering intensity

The Aerodynamic Particle Sizer® (APS™) Model 3321 spectrometer provides high-resolution, real-time aerodynamic measurements of particles from 0.5 to 20 µm. This unique particle sizer also measures light-scattering intensity in the equivalent optical size range of 0.37 to 20 µm. By providing paired data for each particle, the APS spectrometer opens up exciting new possibilities for those interested in studying the makeup of an aerosol.

The APS spectrometer uses a patented*, double-crest optical system for unmatched sizing accuracy. It also includes a redesigned nozzle configuration and improved signal processing. The result is greater small-particle sizing efficiency, improved accuracy of mass-weighted distributions, and virtual elimination of false background counts. *US Patent # 5,561,515.

Applications:

+ Inhalation toxicology
+ Drug delivery studies
+ Atmospheric studies
+ Ambient air monitoring
+ Indoor air-quality monitoring
+ Filter and air-cleaner testing
+ Biohazard detection
+ Test aerosols characterization
+ Usable for particle instrument calibration
+ Spray technology
+ Performance evaluations of aerodynamic devices
+ Powder sizing
+ Basic research

Features and Benefits

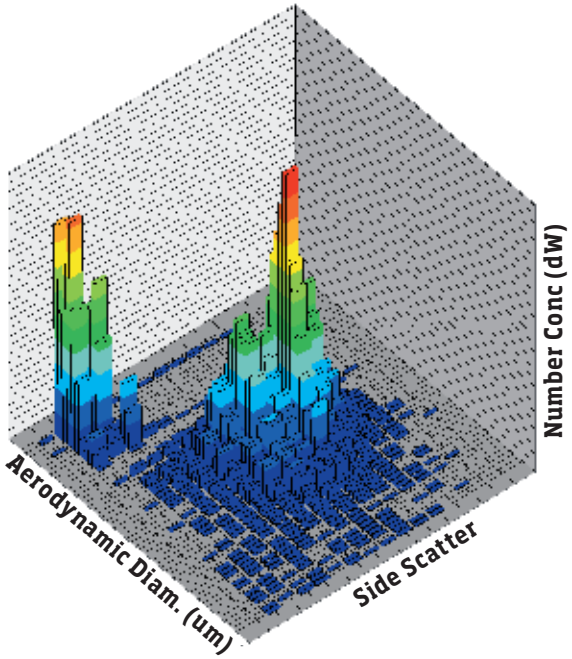
+ Double-crest optics produce high-quality measurements
+ Measures aerodynamic particle size from 0.5 to 20 µm
+ Measures light-scattering intensity from 0.37 to 20 µm
+ Real-time aerodynamic sizing
+ No need to wait for cascade impactor measurements
+ High size resolution - 52 size channels
+ Independent of optical properties of the particles and fluid

Why is Aerodynamic diameter imprtant?

Aerodynamic diameter is defined as the physical diameter of a unit density sphere that settles through the air with a velocity equal to that of the particle in question. It is the most significant aerosol size parameter because it determines the particle's behavior while airborne. Particles exhibiting the same airborne behavior have the same aerodynamic diameter, regardless of their physical size, shape, density, or composition.

Knowledge of a particle's aerodynamic diameter allows you to determine:

+ If and where the particle will be deposited in the human respiratory tract
+ How long the particle will remain airborne in the atmosphere or in an aerosol
+ Whether the particle will penetrate a filter, cyclone, or other particle-removing device
+ Whether the particle will enter a particle-sampling system
+ Whether the particle will penetrate a pipe, tube, duct, or channel



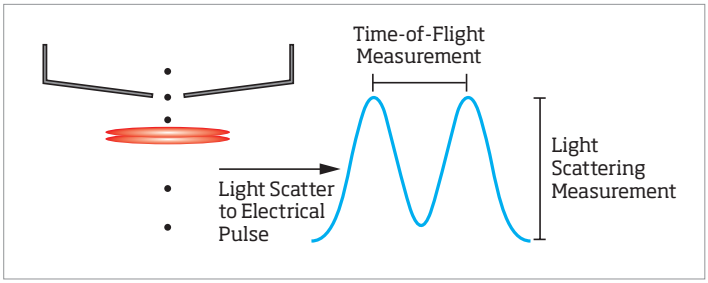
Why is the Model 3321 Superior?

Traditionally, TSI has designed its time-of-flight spectrometers to provide the truest high-resolution measurements of aerodynamic size. With the introduction of the Model 3320 in 1997, TSI produced the first aerosol spectrometer capable of detecting coincidence. The Model 3321 builds upon this accomplishment with a redesigned nozzle configuration and improved signal processing. These enhancements provide greater small-particle sizing efficiency, improved accuracy of mass-weighted distributions, and virtual elimination of false background counts. Coincidence affects all single-particle-counting instruments. It occurs when more than one particle is present in an instrument's measuring volume. This can distort sizing information and lead to underreporting of particle concentration.

The APS Model 3321 uses a patented optical system with two partially overlapping laser beams to detect coincidence. As a particle passes through these overlapping beams, it generates one signal with two crests. The time between the crests provides aerodynamic particle-size information. If more than one particle is in the viewing volume, more than two crests appear, and the APS spectrometer logs this separately as a coincidence event. While it does not eliminate the occurrence of coincidence, the instrument does effectively limit the effect of coincidence on particle-size distributions.

Why Include Light-Scattering Intensity?

Converting light-scattering intensity to geometric size often produces inaccuracies when sizing particles of different shapes and refraction indices. The APS spectrometer measures relative light-scattering intensity, but rather than use it to determine particle size, the APS spectrometer logs this measurement as a separate parameter. Light-scattering measurements can be made alone, in addition to aerodynamic diameter, or correlated to aerodynamic diameter on a particle-by-particle basis. Thus, researchers are able to gain additional insights into aerosol composition.



Accessories and Software

Accessories

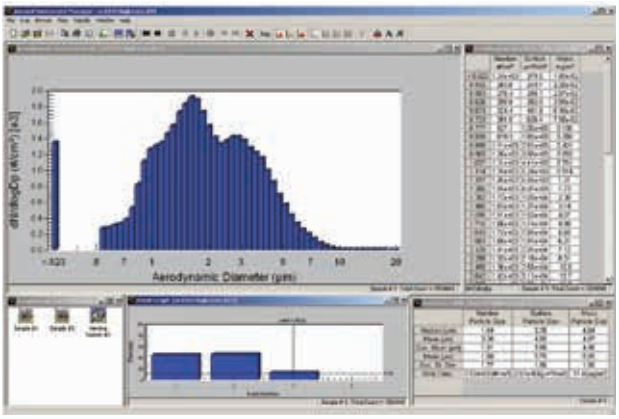
Optional Small Scale Powder Disperser for classifying bulk powders with accuracy. (See manual for setup requirements.)

APS spectrometer configured with optional Aerosol Diluter (Model 3302A) for conditioning high-concentration aerosols.

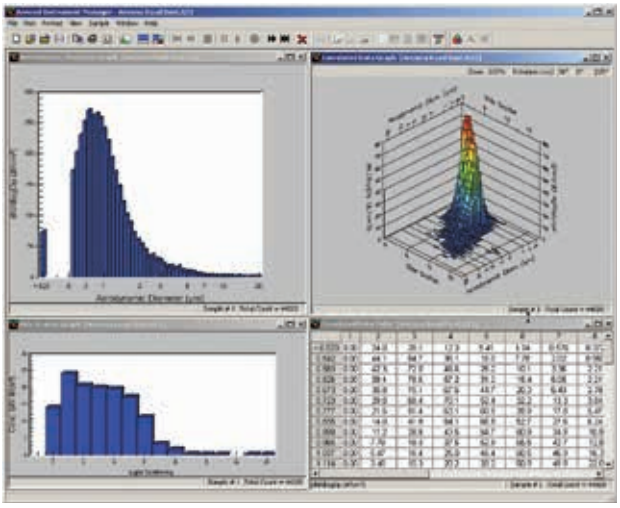
APS spectrometer with optional Impactor Inlet (Model 3306) for MDI/DPI aerosol analysis.

Software

For setup and initial sampling, you can operate the APS Model 3321 without a computer using the front panel control knob and built-in display. However, to save, interpret, or print data, you must use a computer or some other data collection system. The Model 3321 includes the Aerosol Instrument Manager® software, designed for use with Windows® operating systems. The Aerosol Instrument Manager software controls instrument operation, plus it provides impressive file management capabilities and numerous choices for data display. Graphs and tables make it easy to view channel data as well as raw data, giving you the highest resolution possible. You can view all data types–time-of-flight, light-scattering, or correlated data–with the Aerosol Instrument Manager software. An export function allows easy transport of data files to spreadsheet or other applications for customized data handling.



Three graphs showing aerodynamic diameter, side scatter, and correlated data



Aerodynamic diameter and events displayed simultaneously

Specifications

Aerodynamic Particle Sizer Model 3321

Measurement Technique
Time-of-flight of individual particles measured in an accelerating flow field with a single, high-speed timing processor; coincidence detection achieved using a patented, double-crest optical system; particle size binning based on internally stored calibration curve

Particle Size Range
0.5 to 20 µm aerodynamic sizing, 0.37 to 20 µm optical detection (PSL equivalent)

Aerodynamic Size Resolution
0.02 µm at 1.0 µm, 0.03 µm at 10 µm

Display Resolution

Particle Size	32 channels per decade of particle size (logarithmic), 52 channels total; 1,024 bins of raw time-of-flight data (4 nsec per bin) in uncorrelated mode

Light Scattering (log-compressed)

	16 channels of light-scattering intensity (displayed); 64 channels of raw light-scattering data

Particle Type
Airborne solids and nonvolatile liquids

Maximum Recommended Particle Concentration
1,000 particles/cm^3 at 0.5 µm with <5% coincidence; 1,000 particles/cm^3 at 10.0 µm with <10% coincidence; usable data up to 10,000 particles/cm^3

Minimum Particle Concentration
0.001 particle/cm^3

Concentration Range
±10% of reading plus variation from counting statistics

Maximum Processing Rate for Aerodynamic Sizing
>200,000 particles/sec

Sampling Time
Programmable and repeatable from 1 sec to 18 hr per sample; sampling schedules selected by user

Flow Rates*

Aerosol Sample	1.0 L/min ±0.1
Sheath Air	4.0 L/min ±0.1
Total	5.0 L/min ±0.2

Atmospheric Pressure Correction
Automatic correction between 400 and 1,030 mbar (full correction between 700 and 1,030 mbar)

Laser Source
30-mW, 655-nm laser diode

Detector
Avalanche photodetector (APD)

Front-panel Display
320 x 240 pixels

Operating Temperature
10 to 40°C (50 to 104°F)

Operating Humidity
10 to 90% R.H., non-condensing

Power
100 to 240 VAC, 50/60 Hz, 100 W, single phase or 24 VDC

Computer Requirements
Pentium® 4 processor with 2-GHz speed or better, at least 512 MB RAM

Operating System
Windows® 7 operating system or better

Communications
DSUB 9-pin RS-232

Outputs

Digital I/O	15-pin port (3 inputs, 3 outputs) for external device control and two analog inputs (0 to 10 V)
Configurable Analog	BNC (0 to 10 V)
Analog Pulse	BNC
Digital Time-of-flight	BNC

Dimensions

Aerosol Inlet	3/4 in. (O.D.)
Sensor (HWD)	18 cm x 30 cm x 38 cm (7 in. x 12 in. x 15 in.)
Weight	10 kg (22 lb.)

*Flow accuracy affects size and concentration measurements. Flow specifications are the minimum expected performance of a properly calibrated instrument at standard temperature and pressure.

TO ORDER

Aerodynamic Particle Sizer® Spectrometer

Specify	Description
3321	APS sensor with Aerosol Instrument Manager® software

Optional Accessories

Specify	Description
3302A	Aerosol Diluter
3306	Impactor Inlet
3433	Small-Scale Powder Disperser
390069	Data Merge Software Module

Please specify voltage requirements for Model 3433.

Cloud Ceilometer CBME80

General

The cloud ceilometer CBME 80 is a stand-alone instrument designed for fixed and mobile installations where accurate and reliable cloud height information is required. The design is based on the LIDAR principle. The light emitting component is a low power diode laser with the output power limited to an eye-safe level. Real time digitizing technique is employed in signal detection and the powerful 80C186 microprocessor is used in signal processing.

Data presentation

CBME 80 has outputs for different types of display and recording units. An RS-232C interface supports local control, test and data acquisition. For remote control and data acquisition there is an FSK modem.

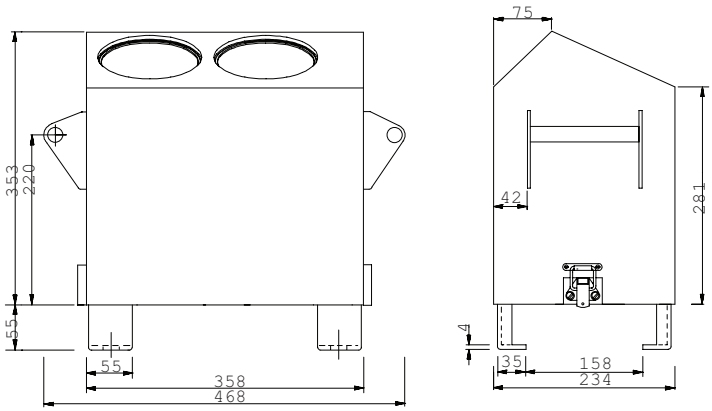
Maintenance

A built-in test system indicates failures in the event of a malfunction. The electronics are located in two easily replaceable subunits, i.e. a power supply module and printer circuit board. The subunits, as well as the laser diode which is placed on the printed circuit board, can be replaced by spare parts without adjustments or recalibration.

Features

- Reliable operation
- Easy installation and maintenance.
- Very long laser life (calc. 10 year)
- 25 000 feet measuring range capability.
- Low weight and low power consumption.

Dimensions



Technical data

Performance	
Range	0 — 7 500 m / 0 — 25 000 ft
Resolution	10 m / 30 ft
Accuracy	Greater of ±10 m / 30 ft or ±1% of height (against hard target)
Measuring interval	15, 30, 60, 120 s (selectable)
Laser safety	Eye safe Class 1M in accordance to IEC 60825-1
Environmental	
Operating temp	-40 — +55 °C / -40 — 130 °F
Weight	15 kg (standalone)
Electrical	
Power supply	115V alt 230V, 45-65 Hz
Power consumption	Electronics 30VA Heater 200VA
Output	
Interface	FSK/V23, RS232
Data	Cloud height (up to 3 layers) or vertical visibility Cloud amount / sky condition Status information Backscatter profile
Options and accessories	
Options	Window blower Solar shutter Mobile version with local display Power supply 12V DC Military green color
Accessories	Graphic software (PC) Cloud Presentation Suite Digital display Demodulator

LI-7810 $CH_4/CO_2/H_2O$ Trace Gas Analyser Specifications

The LI-7810 $CH_4/CO_2/H_2O$ Trace Gas Analyzer is a laser-based instrument that uses OF-CEAS in combination with numerous patented technologies to measure CH_4 in air with high precision and stability. This document describes the performance specifications of the LI-7810.

General

Measurement Technique: OF-CEAS (Optical Feedback – Cavity Enhanced Absorption Spectroscopy)
Measurement Rate: 1 sample per second
Optical Cavity Volume: 6.41 cm^3
Flow Rate: 250 sccm nominally
Total Weight: 11.4 kg (including batteries)
Case Dimensions: 51 cm L x 33 cm W x 18 cm H
Operating Temperature Range: -25 °C to 45 °C (without solar load, under normal operating conditions)
Operating Humidity Range: 0 to 85% RH (non-condensing, without solar load, under normal operating conditions)
Operating Pressure Range: 70 to 110 kPa
Connectivity: Ethernet and Wi-Fi (not available in some countries)
Wi-Fi Compatibility: 2.4 GHz, 802.11a/b/g/n/ac
Power Requirements:
  Pins 1 and 5: 24 VDC Input; 6 Amps
  Pins 3 and 4: 10.5 to 33 VDC Input; 8 Amps
Power Consumption:
  During Steady State Operation: 22 Watts
  During Warmup (10.5 to 33 VDC power supply, pins 3 and 4): Up to 90 Watts
  During Warmup (Universal power supply or 24VDC power supply, pins 1 and 5): Up to 140 Watts with batteries charging
Power Supply: Universal power adapter (Input: 100 to 240 VAC, 50 to 60 Hz; Output: 24 VDC)
Battery Life: 8 hours typical with 2 batteries
Response Time (T_{10}-T_{90}): $CH_4 \leq 2$ seconds from 0 to 2 ppm

CH_4 Measurements

Range: 0.1 to 100 ppm
Precision (1σ):
  0.25 ppb with 5 second averaging
  0.60 ppb with 1 second averaging
Maximum Drift: < 1 ppb per 24-hour period

CO_2 Measurements

Range: 1 to 10,000 ppm
Precision (1σ):
  1.5 ppm with 5 second averaging
  3.5 ppm with 1 second averaging

H_2O Measurements

Range: 100 to 60,000 ppm
Precision (1σ):
  20 ppm with 5 second averaging
  45 ppm with 1 second averaging

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