Announcing…

PAX

PHOTOACOUSTICEXTINCTIOMETER

The new Photoacoustic Extinctiometer (PAX) is a sensitive, high-resolution, fast-response instrument for measuring aerosol optical properties relevant for climate change and carbon particle sensing. The instrument directly measures in-situ light absorption and scattering of aerosol particles, from which it derives extinction, single scattering albedo and black carbon (soot) mass concentration. With no filter collection required, and consequently no filter-media artifacts, the PAX provides a highly accurate measure of absorption from black carbon.

Advantages

- Direct in-situ measurement of light absorption and scattering in a single instrument
- Absorption measurement correlates to black carbon mass concentration
- Reciprocal nephelometry provides excellent scattering coefficient sensitivity
- Choice of wavelengths: 870 nm (standard); optional 405 nm or 532 nm
- Fast response, one-second resolution, real-time data display
- Wide dynamic range suitable for pristine regions to source sampling
- Continuous and autonomous operation
- High-resolution touch screen display for real-time data and instrument status
- No filter collection required - no filter data artifacts

Applications

- Air quality and visibility
- Atmosphere and climate
- Health effects
- Combustion source emissions
- Biomass burning

Suitable for fixed site, mobile or airborne sampling

DROPLET MEASUREMENT TECHNOLOGIES

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What are Scattering, Absorption, Extinction and Single Scattering Albedo?

The scattering coefficient is a measure of the efficiency of particles to scatter light photons, while the absorption coefficient is a measure of how many photons are absorbed. The coefficients are expressed as a number proportional to the amount of photons scattered or absorbed per unit distance.

The extinction coefficient is the sum of the scattering and absorption coefficients and in climate models is used to help determine the amount of solar radiation that is blocked from reaching the surface of the earth.

Single scattering albedo (SSA) is a measure of the reflectivity of a particle and is a key optical characteristic in assessing the radiative effects of aerosols. SSA is the dimensionless ratio of the scattering relative to extinction. Albedo is one for a perfectly white object and zero for a perfectly black object. SSA helps determine whether aerosols have a heating or cooling effect on climate in their interaction with solar radiation.

How the Instrument Operates

The PAX uses a modulated diode laser to simultaneously measure light scattering and absorption. The standard 870-nm wavelength has strong sensitivity to black carbon particles, and relatively little absorption from gases and other aerosol species.

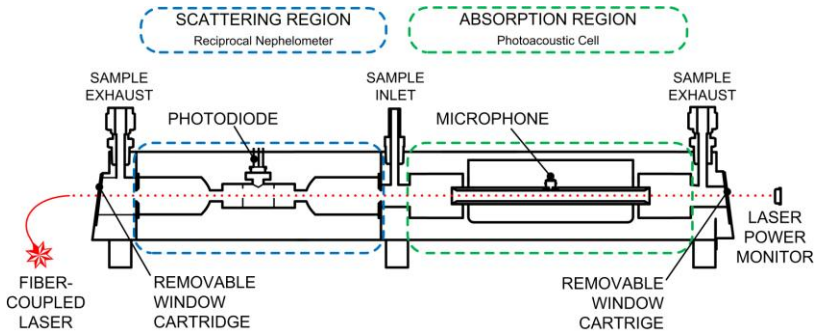
PAX laser wavelength options:

- Red (870 nm) – absorption is highly specific for black carbon (soot) particles; scattering best for large particles
- Green (532 nm) – measures in the visual range, typically what the human eye observes
- Blue (405 nm) – absorption correlates to the organic, or brown carbon content; efficient scattering for fine and ultrafine particles

A 1 L/min aerosol sample flow is drawn into the PAX using an internal vacuum pump controlled by two critical orifices. The flow is split between the nephelometer and photoacoustic resonator for simultaneous measurement of light scattering and absorption.

The absorption measurement uses in-situ photoacoustic technology. A laser beam directed through the aerosol stream is modulated at the resonant frequency of the acoustical resonator. Absorbing particles heat up and quickly transfer heat to the surrounding air. The periodic heating produces pressure waves that can be detected with a sensitive microphone. An integral speaker is used to determine the resonator quality factor and resonance frequency, which are needed to quantitatively determine aerosol light absorption. Phase-sensitive detection is used for all sensors.

The PAX uses a wide-angle integrating reciprocal nephelometer to measure the light scattering coefficient. The scattering measurement responds to all particle types regardless of chemical makeup, mixing state, or morphology.



PAX Software

The PAX is controlled by fully-integrated software that presents an intuitive user interface via either the front-panel touch-screen or a web browser on any networked computer. This interface provides real-time display of measured and calculated data and instrument status, and allows the configuration of the instrument's operating parameters. Access to this interface by web-browser is password-protected and allows full instrument operation and configuration from remote locations.

Data is written to an easy-to-read ASCII file. An external program which can be run on a network-connected computer can be used to download, archive, and display these data files. This program can also upload calibration information to the PAX and perform other maintenance functions.

What is Reciprocal Nephelometry?

A reciprocal nephelometer uses the same physics of light scattering from particles as a "standard" nephelometer, only the location of the light source and detectors are reversed. In a standard nephelometer with a broad-band incandescent light source, optical filters are used to select scattered light in a wavelength band, and expensive photomultiplier tubes are necessary to gain sensitivity. All of the light needs to pass through a cosine sensor to illuminate the particles. The cosine sensor can absorb some of the light and result in excessive heating. With a reciprocal nephelometer, the laser bandwidth is much narrower and more precisely defined, making the instrument response easier to quantify. The laser light is scattered along its path and simple photodiodes can be used for detection. Readily available, high-power diode-laser light sources are used in the PAX to increase instrument sensitivity.

Specifications

Measured Parameters	Absorption coefficient, B_{abs} Scattering coefficient, B_{scat}
Auxiliary Parameters	Temperature Pressure Relative Humidity
Derived Parameters	Extinction coefficient, B_{ext} Single scattering albedo, SSA Dew Point
Measurement Range – Absorption and Scattering	< 1 Mm^{-1} - 100,000 Mm^{-1} (870 nm, 60 sec. averaging)
Laser Modulation Frequency	870 nm (1.4 W) 1500 Hz nominal, square wave
Angular Integration for Scattering	6 to 174°
Sample Flow Flow Control Pump	1 L/min Critical orifice Diaphragm
Response Time	< 10 sec; one-second resolution
Data Averaging Time	1, 10 or 60 seconds; user selectable
Calibration Interval	Recommended every 6 months, or before and after critical projects.
Calibration Particles Absorption Scattering	 Strongly absorbing particles such as black smoke from a fuel-rich gas lamp, or glassy black carbon. Strongly scattering particles such as ammonium sulfate, or polystyrene latex (PSL) spheres, 200-260 nm diameter.

Zero Check and Acoustic Calibration	On demand, or automated at user selectable interval at 5, 15, 20, 30, or 60 minutes. Zero check with high-efficiency filtered air sample; acoustic calibration for resonance frequency and resonator quality factor.
Maintenance Schedule	• Flow checks as necessary • Window cartridge cleaning and replacement as necessary • Yearly replacement of consumable parts
Front Panel Features	Graphical color touch-panel display screen, two USB-A ports, Ethernet port, power switch; user interface via touch screen or standard keyboard and mouse
Rear Panel Connections	Sample inlet (compression fitting for ¼" tube), pump exhaust (compression fitting for ¼" tube), AC and DC power connections, Serial RS-232 jack, Ethernet port, two analog BNC inputs, four analog BNC outputs
Communications Output	Ethernet 100/10 Mbps, RS-232 Serial
Power Requirements	90 - 264 V, 47 - 63 Hz (AC Power) or 12 VDC
Dimensions, HWD	18 x 48 x 61 cm (7 x 19 x 24 inches); rack mountable
Weight	18 kg (40 lb)
Environmental Operating Conditions: Temp RH	 0 – 40°C (32 – 104°F) 0 – 90% RH non-condensing
PAX Maintenance Console (PMC) Software (included)	Executable program written in LabVIEW; external PMC software package for instrument maintenance, data playback and archiving. Computer and PMC software are not required to operate the instrument.
Computer Requirements for PMC Software	Windows XP, Vista, or Windows 7 Minimum 1GB RAM

Specifications are subject to change without notice. The PAX is a Class 1 Laser Product.

Accessories

- Deluxe hard-shell shipping case suitable for frequent travel
- PM 1.0 and PM 2.5 cyclone inlets, 1 liter/min, for particle size selection

How to Order

The Photoacoustic Extinctiometer (PAX) System includes analytical spectrometer with internal data storage, data playback and archiving software, operator manual and one-year warranty. The standard version features an 870 nm wavelength laser; wavelengths of 405 and 532 nm are also available.

Contact DMT for pricing or more information: +1.303.440.5576, customer-contact@dropletmeasurement.com.

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