ARTIUM TECHNOLOGIES, INC.

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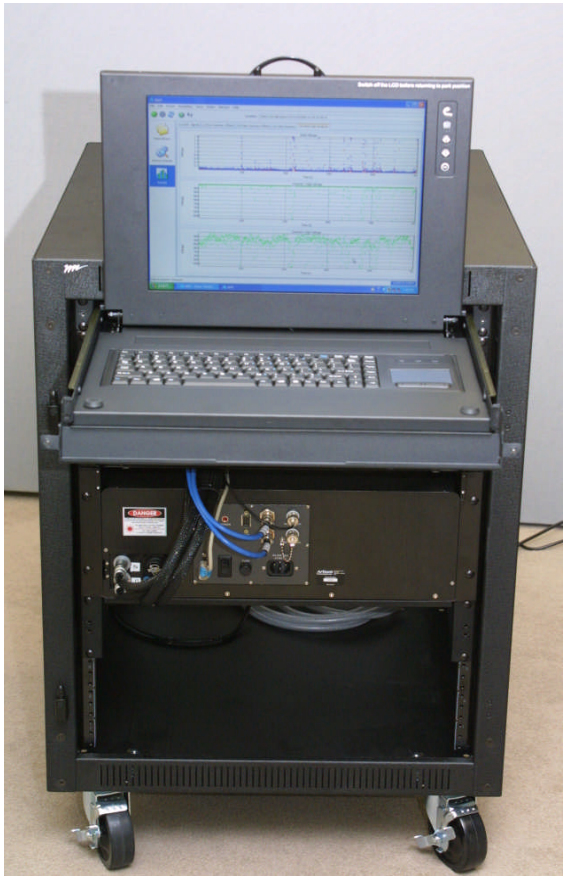
LII 200 Laser - Induced Incandescence Instrument for Soot Characterization

Measures Soot Volume Fraction, Specific Surface Area, and Primary Particle Size in Real-Time

- ***Fast, convenient, reliable and easy to use***
- ***Measures raw exhaust or from CVS***
- ***Measures elemental carbon (EC) independent of condensed material***
- ***Proprietary NIST Traceable Calibration method***
- ***Rugged system capable of extended operation without maintenance***



Artium Technologies, Inc. Introduces the **LII200** system, the most advanced laser-induced incandescence instrument available in the market today. Laser-induced incandescence is an optical technique for accurate, non-intrusive, and temporally resolved measurement of soot volume fraction, specific surface area, and primary particle size.

Artium Technologies, Inc. was founded in 1998 by a team of experts with extensive experience in Phase Doppler Interferometer (PDI) system development and other laser-based diagnostic systems for particle characterization.

Laser Induced Incandescence (LII) - A pulsed laser with light pulse duration below 20 nanoseconds is used to rapidly heat the soot particles from the local ambient temperature to just below the soot sublimation temperature (<4000 K) to avoid any material losses. Incandescence from the soot particles is detected by photodetectors, and the signals are recorded for subsequent analyses. Complex rigorous analysis involving the laser light energy absorption by the soot particles, and the subsequent cooling process, is used to calculate the soot volume fraction and primary particle size. The method is based on a solid scientific foundation and supported by an extensive scientific community (e.g. see http://www.liiscience.org).

LII has a well-defined, but complex, response to volatile particulate matter. It is totally insensitive to liquid particles and material other than elemental carbon (EC) because they absorb a negligible amount of laser energy compared to carbon. For carbon particles coated with volatile material, the volatile components are believed to vaporize early in the laser heating period. In general, it is reasonable to state that LII measures the volume fraction of elemental carbon particles in the exhaust. Although metallic ash may also be present at low concentrations, it has a low absorptivity and emissivity relative to carbon at the high temperatures, resulting in a negligible contribution to the incandescence.

The LII technique is capable of real-time measurements during transient vehicle operation, making it a valuable tool for optimizing gasoline and diesel engine soot emissions performance. The measurement frequency is only limited by the repetition rate of high-power pulsed lasers (typically 10-30 Hz, which corresponds to one measurement per engine cycle at 1200-3600 rpm). Therefore, ensemble-averaging for many engine cycles can be used to reconstruct cycle-resolved transient behavior. The real-time measurement frequency is adequate to observe engine and vehicle transients, such as those that occur in driving cycles.

The Artium LII 200 consists of a self-contained rugged optics enclosure which includes the laser and all components needed for operating the instrument. The optical system consists of a computer-controlled automated laser beam energy detection and adjustment system that maintains the laser light fluence through the sampling volume at optimum conditions. The system automatically maintains constant laser fluence over a wide range of environmental conditions.

The incandescence signal is collected at 90 degrees to the transmitted beam which helps form a well-defined measurement volume. The incandescence signal is detected by a pair of detectors that use light filters centered at wavelengths of approximately 400 nm and 780 nm. The innovative two-color pyrometry technique permits accurate measurement of soot temperature and concentration.

Besides measuring the soot volume fraction, the LII signal decay characteristics are also processed to infer the primary particle size and specific surface area.

Artium Integrated Management Software (AIMS) controls all aspects of the instrument setup and operation. The system software is designed around a client/server model that allows remote operation via the intranet or the Internet and is multi-user accessible. Dedicated algorithms are included for automated setup of the instrument functions and online adjustment to the prevailing measurement conditions. An external input feature allows tagging of the LII signals with external events such as engine RPM, throttle setting, pressure, temperature, etc. The software has the capability of accepting, processing, displaying, and storing data for extended periods of time without interruption. During long acquisition periods, the data can be broken into multiple files for greater manageability. The data analysis and display are easily extensible and may be modified as needed. The data can be easily exported to Microsoft Excel for analysis and plotting.

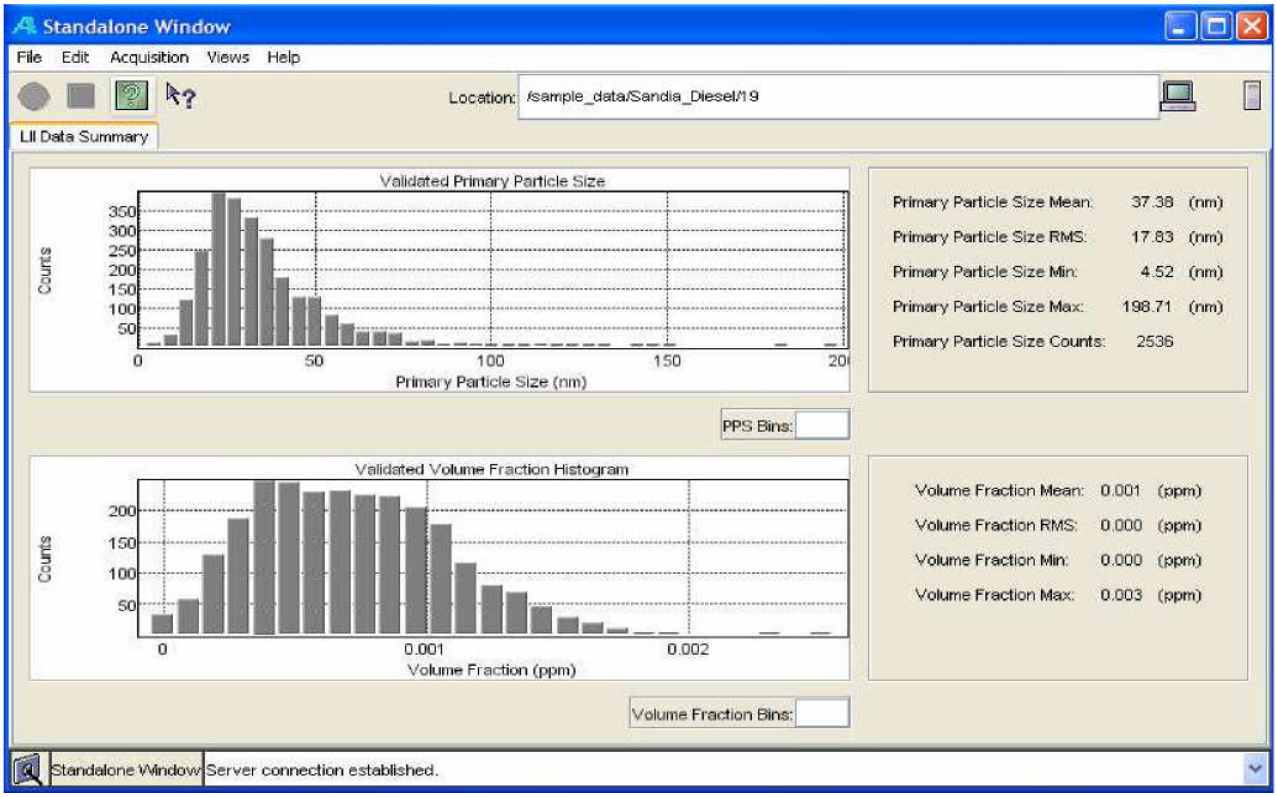
The instrument operation is essentially turnkey and requires little or no operator intervention.

Software Key Features

- Windows (2000/XP) or LINUX
- Remote operation
- Automated setup
- Online adjustment
- External input
- Uninterrupted data collection
- Multi-user capable
- Data is portable to Excel

LII 200 Key Features

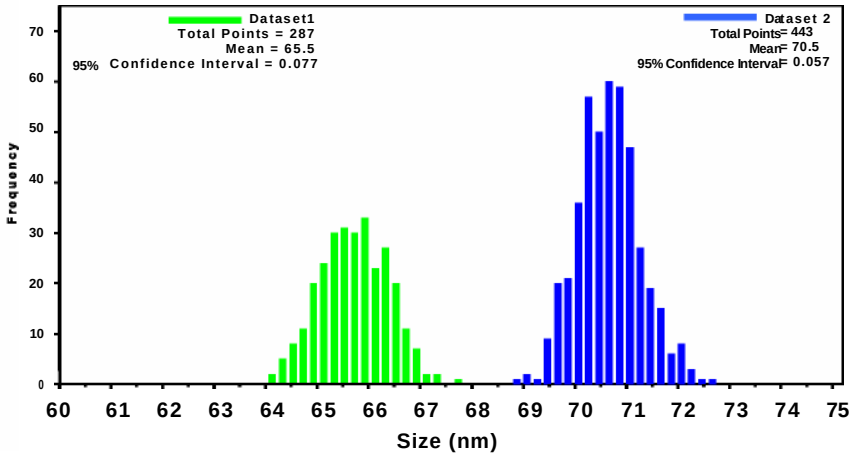
- Automated laser fluence control
- Top-hat laser beam profile
- Two-color pyrometry
- Self-calibrating
- Real-time measurements
- Vehicle onboard monitoring
- Rugged and turn-key operation
- Large dynamic range



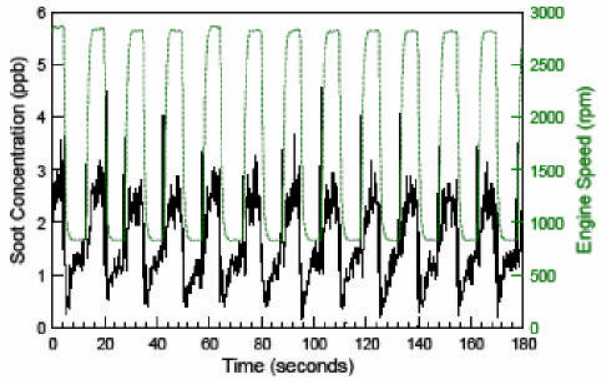
Typical Applications

- Diesel engine exhaust emissions R&D, roadside monitoring, and onboard monitoring
- SI Gasoline engine exhaust R&D and monitoring
- Carbon-black manufacture process

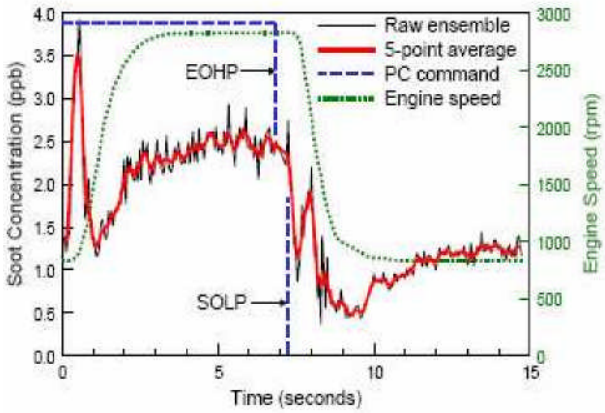
Carbon-black Manufacturing Process—Primary Particle Size



Engine Speed versus Soot Concentration



Ensemble Averaging



Specifications

Concentration:

Low end:	<1.0 parts per trillion
	<2 micrograms/cubic meter
High End:	10 parts per million
	20 grams/cubic meter
Range:	>1,000,000:1
Precision	+/- 2%

Primary Particle Size

Range:	10 – 100 nm
Precision	+/- 2% of max.

Specific Surface Area

Soot Surface Area / Primary Particle Diameter

US Patents: **6,154,277, Nov. 2000, 6,181,419, Jan. 2001**

Licensed from National Research Council (NRC), Canada

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