

# SPLAT II

## *Interrogating Nanoparticles*

### SPLAT II Specifications

- **Multidimensional Characterization:**  
Simultaneously measures nanoparticle size, density, dynamic shape factor, fractal dimension, and composition
- **Particle Type:**  
Yields quantitative information about all particle types
- **Size Range:**  
Detects particles from 50 nm to 3  $\mu\text{m}$  in size
- **Analysis Rate:**  
Measures up to 50 particles/second
- **Sensitivity:**  
Detects 200 nm particles at a concentration as low as 1 particle/ $\text{cm}^3$  at a rate of 1 particle/second
- **Sizing Precision:**  
Better than 1 nm
- **Ion Formation:**  
IR-UV operation mode yields reproducible and quantitative particle mass spectra

SPLAT II is a second-generation Single Particle Laser Ablation Time-of-flight mass spectrometer housed in the Environmental Molecular Sciences Laboratory (EMSL), a national scientific user facility in Richland, Washington. A high-precision and unique instrument, it allows users to study the fundamental processes that govern the chemistry and physics of particles on the nano- and micro-scales. Under normal operating conditions, millions of particles per sample are detected by SPLAT II, then characterized using the dedicated data visualization software, SpectraMiner. SPLAT analysis applications include, but are not limited to, climate, air pollution, human health, bioterrorism, and emerging nanotechnologies.

Portability is a hallmark of SPLAT II—it is the first field-deployable instrument that provides, in real time, the size, density, shape, fractal dimension, and composition of individual particles down to 50 nm in diameter. It is also the first instrument operated in the field in an infrared-ultraviolet (IR-UV) mode; this operation mode yields reproducible and quantitative particle mass spectra. SPLAT II's high measurement rate permits rapid characterization of quickly changing samples, for example, fast chemical reactions, and its high sensitivity allows characterization of particles with low number concentrations.

SPLAT II's versatility allows characterization of any particle type, including volatile and non-volatile fractions of internally mixed aerosol particles commonly encountered in the atmosphere and engine exhaust. Its wide size range and low size limit are essential for characterizing nanoparticles, atmospheric aerosol, and engine emissions. In addition, its sizing precision allows researchers to follow physical and chemical transformation of particles with submonolayer resolution.

### SPLAT II is Designed for Field Research

The compact, portable, and aircraft-compatible SPLAT II is designed for bench and field use. It has been used to characterize the unique properties and behavior of nanoparticles in the laboratory and to characterize atmospheric particles and exhaust particulate emissions in the field.

SPLAT analysis has been applied to aerosol studies in Houston, Texas; Cheju Island, South Korea; New York City; National Transportation Research Center, Oak Ridge, Tennessee; and Cummins Inc., Columbus, Indiana.

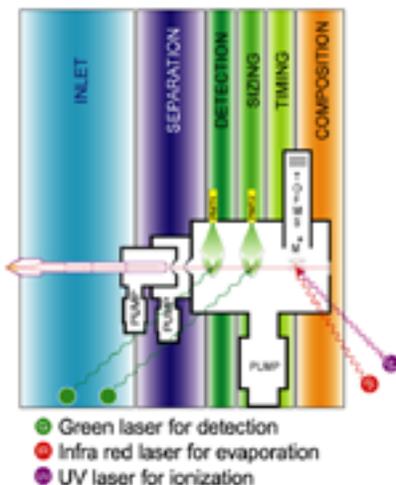


*SPLAT II offers users the versatility of laboratory studies and field campaigns.*



## How SPLAT II Works

SPLAT II uses an extremely efficient aerodynamic lens inlet to produce a narrow (250  $\mu\text{m}$ ) low divergent particle beam. Two stages of differential pumping separate particles and gas. Two stages of optical detection use light scattering to detect each particle twice and to measure its velocity, from which the particle aerodynamic diameter is obtained. Pulsed, synchronized IR evaporation followed by UV ionization of semi-volatile fractions and ablation of non-volatile fractions creates ions. From these ions, time-of-flight mass spectra are generated for compositional analysis.



*Schematic of how SPLAT II works.*

## SpectraMiner for High-Throughput Data Analysis

SpectraMiner is dedicated data mining and visualization software specifically designed to explore single-particle mass spectra. It helps researchers make use of the vast amounts of detailed data generated by SPLAT II. SpectraMiner puts the scientist at the center of the data mining process, providing intuitive controls that connect particle data with any other relevant events, thus pushing knowledge beyond simple statistical analysis.

## About EMSL

EMSL is a national scientific user facility operated by the Pacific Northwest National Laboratory for the U.S. Department of Energy's (DOE's) Office of Biological and Environmental Research. Located in Richland, Washington, EMSL provides users with integrated experimental and computational resources for discovery and technological innovation in the environmental molecular sciences to support the needs of DOE and the nation.

EMSL offers researchers worldwide a comprehensive array of leading-edge resources—at one location—that are

available on a peer-reviewed proposal basis. Proposals are encouraged to be submitted for research centered around EMSL's four science themes, which represent growing areas of research: Atmospheric Aerosol Chemistry, Biological Interactions and Dynamics, Geochemistry/Biogeochemistry and Subsurface Science, and Science of Interfacial Phenomena. Researchers may use EMSL's state-of-the-art instruments and world class experts at no cost if research results are shared in the open literature.

Since opening its doors to users in 1997, EMSL has hosted scientific users from academia, industry, and other national laboratories who represent all 50 states and nearly 30 countries. For information on EMSL's proposal process and the resources available to users, see the EMSL website at [www.emsl.pnl.gov](http://www.emsl.pnl.gov).

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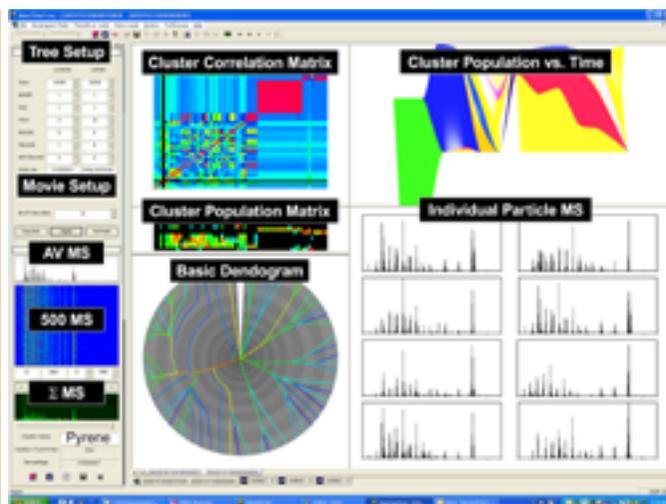
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### **SpectraMiner:**

- Organizes data in a hierarchical fashion
- Provides an interactive and intuitive interface to explore the data
- Makes viewing data easy at any level of detail
- Searches for and displays relationships between different observables
- Runs on a PC in real time driven by simple mouse clicks.



*SpectraMiner presents a multitude of views to the scientist.*