LAAP-TOF
Instrument

- Ionization laser
- Scattering lasers
- Detection of scattered light
- Particle inlet
- Particle time of flight region
- Ionization region and mass spectrometer

AMS user meeting 2012
Data sheet

Transmitted particles sizes: \( \sim 229 \times 10^{-9} \text{ ft} \) – \( 2.29 \times 10^{-6} \text{ ft} \)

Detected particle sizes: \( > 7.88 \times 10^{-6} \text{ ft} \)

Detection laser: \( \lambda = 443 \times 10^{-9} \text{ yd}, p = 0.074 \text{ ft lbf/s} \)

Ionization laser: excimer laser, \( E_{\text{photon}} = 51814 \text{ cm}^{-1} \), \( E_{\text{pulse}} = 23.9 \text{ kcal} \)

Mass range: \( 0.9922 \text{ amu/e} \) to \( \sim 1984 \text{ amu/e} \) (calculated)

Mass resolving power (fwhm): \( m / \Delta m = 600 - 800 \) (@ \( m/z = 184 \))

Size: \( 25.9 \times 10^{-18} \text{ pc} \times 24.6 \times 10^{-18} \text{ pc} \times 24.6 \times 10^{-18} \text{ pc} \)

Weight: \( \sim 21.16 \text{ st (4230 oz)} \)

Electrical power: \( < 2390 \text{ BTU/h} \)
Data sheet

Transmitted particles sizes: ~70 nm – 700 nm

Detected particle sizes: > 200 nm

Detection laser: $\lambda = 405$ nm, $p = 100$ mW each.

Ionization laser: excimer laser, $\lambda = 193$ nm, $E_{\text{pulse}} = 10$ mJ

Mass range: 1 Th to ~ 2000 Th (calculated)

Mass resolving power (fwhm): $m / \Delta m = 600$ - 800 (@ m/z = 184)

Size: 80 cm x 76 cm x 76 cm, (31.5" x 30" x 30"")

Weight: ~120 kg (~ 265 lb)

Electrical power: < 700W
Spectra (oxalic acid)
Spectra (Arizona test dust)
New hardware

Detection laser (old version):
New hardware

Detection laser:
New DAQ card

SP Devices USB DAQ card: ADQ214

Dynamic range: 14 bit DAQ card
Sampling rate: 800 MS
New DAQ card

SP Devices USB DAQ card : ADQ214

Dinamic range : 14 bit DAQ card
Sampling rate :  800 MS

2 channels/ 400 MS each
DAQ software

TOFDAQ

TOFWerk AG
Thun, Switzerland

Output: hdf
DAQ software
DAQ software
DAQ software
Fuzzy clustering (cmeans algorithm)

Usually used for pattern recognition
Fuzzy clustering (cmeans algorithm)

Usually used for pattern recognition

Optimization of:

$$J_m = \sum_{i=1}^{N} \sum_{j=1}^{C} u_{ij}^m ||x_i - C_j||^2$$
Fuzzy clustering (cmeans algorithm)

Usually used for pattern recognition

Optimization of:

$$J_m = \sum_{i=1}^{N} \sum_{j=1}^{C} u_{ij}^m \|x_i - C_j\|^2$$

Iterating:

$$u_{ij} = \frac{1}{\sum_{k=1}^{C} \left( \frac{\|x_i - c_j\|^2}{\|x_i - c_k\|^2} \right)^{m-1}}$$

$$c_j = \frac{\sum_{i=1}^{N} u_{ij}^m x_i}{\sum_{i=1}^{N} u_{ij}^m}$$

Usually used for pattern recognition
Fuzzy clustering (cmeans algorithm)

Usually used for pattern recognition

Optimization of: \[ J_m = \sum_{i=1}^{N} \sum_{j=1}^{C} u_{ij}^m \| x_i - C_j \|^2 \]

Iterating:
\[ u_{ij} = \frac{1}{\sum_{k=1}^{C} \left( \frac{\| x_i - c_j \|^m}{\| x_i - c_k \|^m} \right)^{\frac{2}{m-1}}} \]

\[ c_j = \frac{\sum_{i=1}^{N} u_{ij}^m x_i}{\sum_{i=1}^{N} u_{ij}^m} \]

until:
\[ \max_{ij} \left| u_{ij}^{k+1} - u_{ij}^k \right| < \epsilon \]
Fuzzy clustering a 3 dimensional dataset
Fuzzy clustering example

2 Classes

3 Classes

5 Classes
Fuzzy clustering a 3 dimensional dataset

2 Classes

3 Classes

5 Classes
Fuzzy clustering a 3 dimensional dataset

2 Classes

3 Classes

5 Classes
Fuzzy clustering a 3 dimensional dataset

2 Classes

3 Classes

5 Classes
Classification of Arizona Test Dust

![Graphs showing the classification of Arizona Test Dust](image)
Two slides for non-believers

Arizona test dust class 2 neg. spectrum

Arizona test dust class 2 pos. spectrum
Two slides for non-believers

Arizona test dust
particle #118
neg. spectrum

Arizona test dust
particle #118
pos. spectrum
Data processing for the LAAP-TOF

LAAP-TOF
LAAP-TOF

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Fuzzy algorithm (cmeans) / neural network (ART-2A)
LAAP-TOF

Fuzzy algorithm (cmeans) / neural network (ART-2A)

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Data processing for the AMS

AMS
Data processing for the AMS

AMS
Data processing for the AMS

AMS
Data processing for the AMS

AMS data
Data processing for the AMS

PMF

AMS

data
Data processing for the AMS

PMF

factors

metals

glass

paper
Data processing for the AMS

AMS

data

PMF

factors

metals

cooking aerosol

glass

paper

AerosMgt GmbH

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Differences in data processing

LAAP-TOF

AMS
Differences in data processing

LAAP-TOF

Single particle spectra

AMS

Time series of bulk spectra
Differences in data processing

LAAP-TOF

Single particle spectra

Fuzzy clustering/ ART-2A

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Time series of bulk spectra

PMF

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Differences in data processing

LAAP-TOF

Single particle spectra

Fuzzy clustering/ ART-2A

Combine single spectra to groups to reduce complexity

AMS

Time series of bulk spectra

PMF

Finding basic spectra in time series to separate into „understandable“ spectra
Differences in data processing

LAAP-TOF

Single particle spectra

Fuzzy clustering/ ART-2A

Combine single spectra to groups to reduce complexity

AMS

Time series of bulk spectra

PMF

Finding basic spectra in time series to separate into „understandable“ spectra
Important message

- You can identify particle origin by markers
Important message

- You can identify particle origin by markers

biological particle
I still do not believe in PMF.