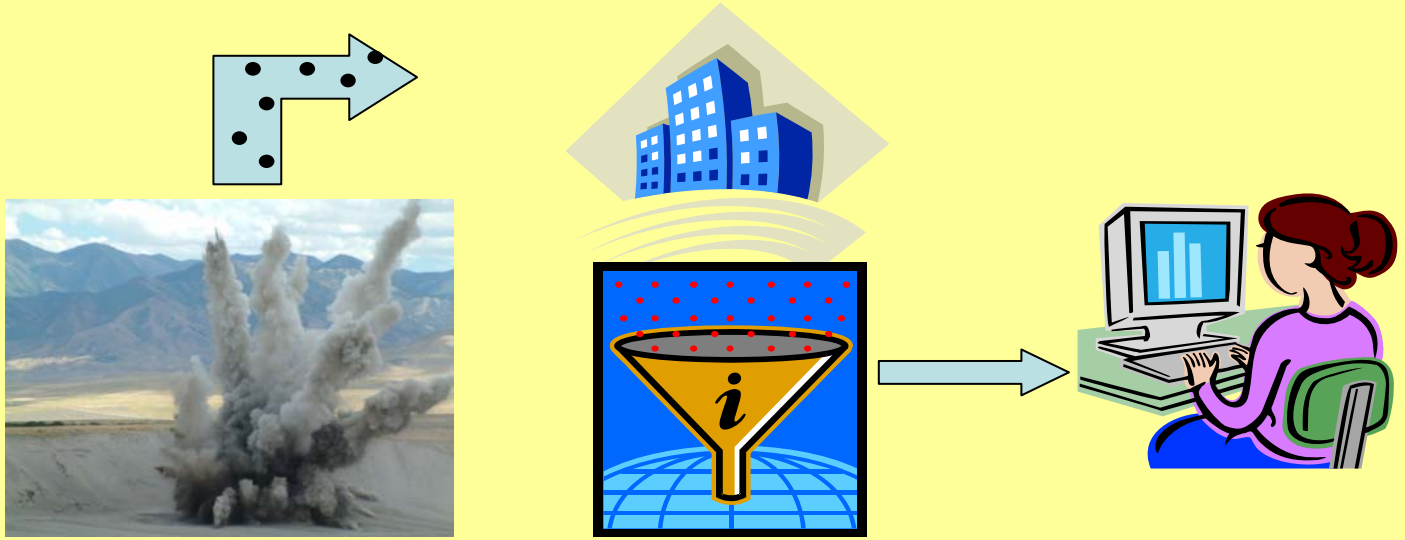


# Instantaneous Detection of Particles Liberated by Open Detonation Treatments

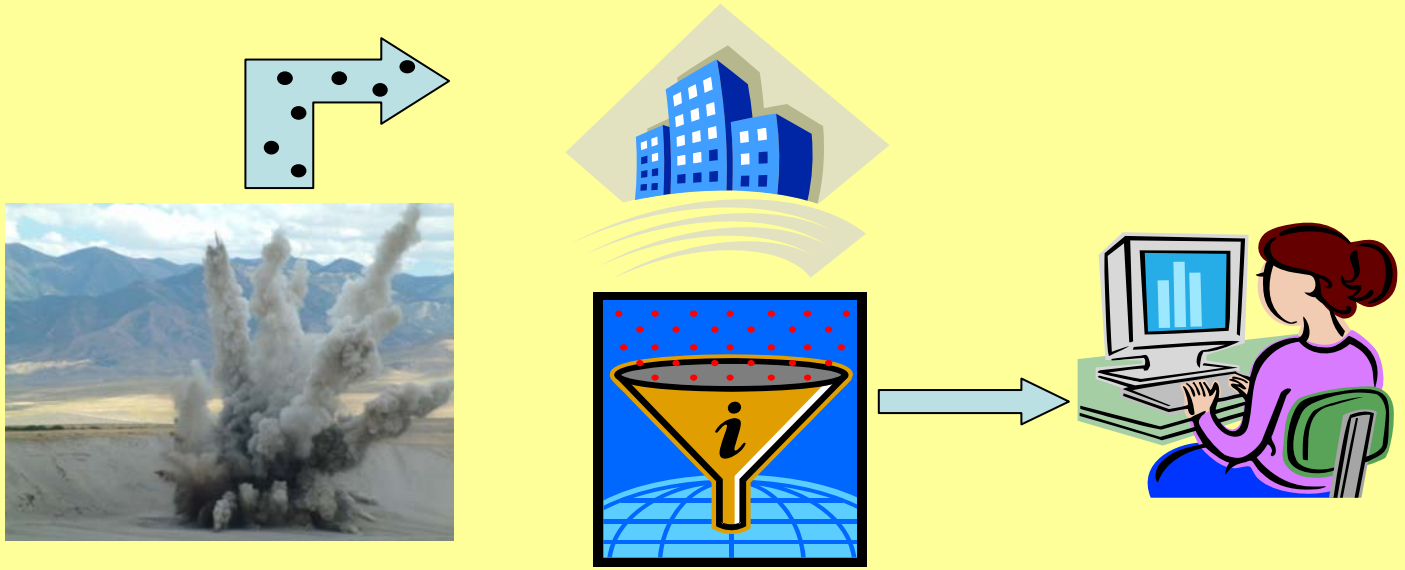
Dr. David P. Fergenson*, Dr. George R. Farquar, Dr. Keith R. Coffee and Mr. Vincent Riot

Lawrence Livermore National Laboratory

Correspondance to: fergenson1@llnl.gov, (925) 422-5530

# The Idea:

This project supports DAC's effort to increase efficiency of operations.

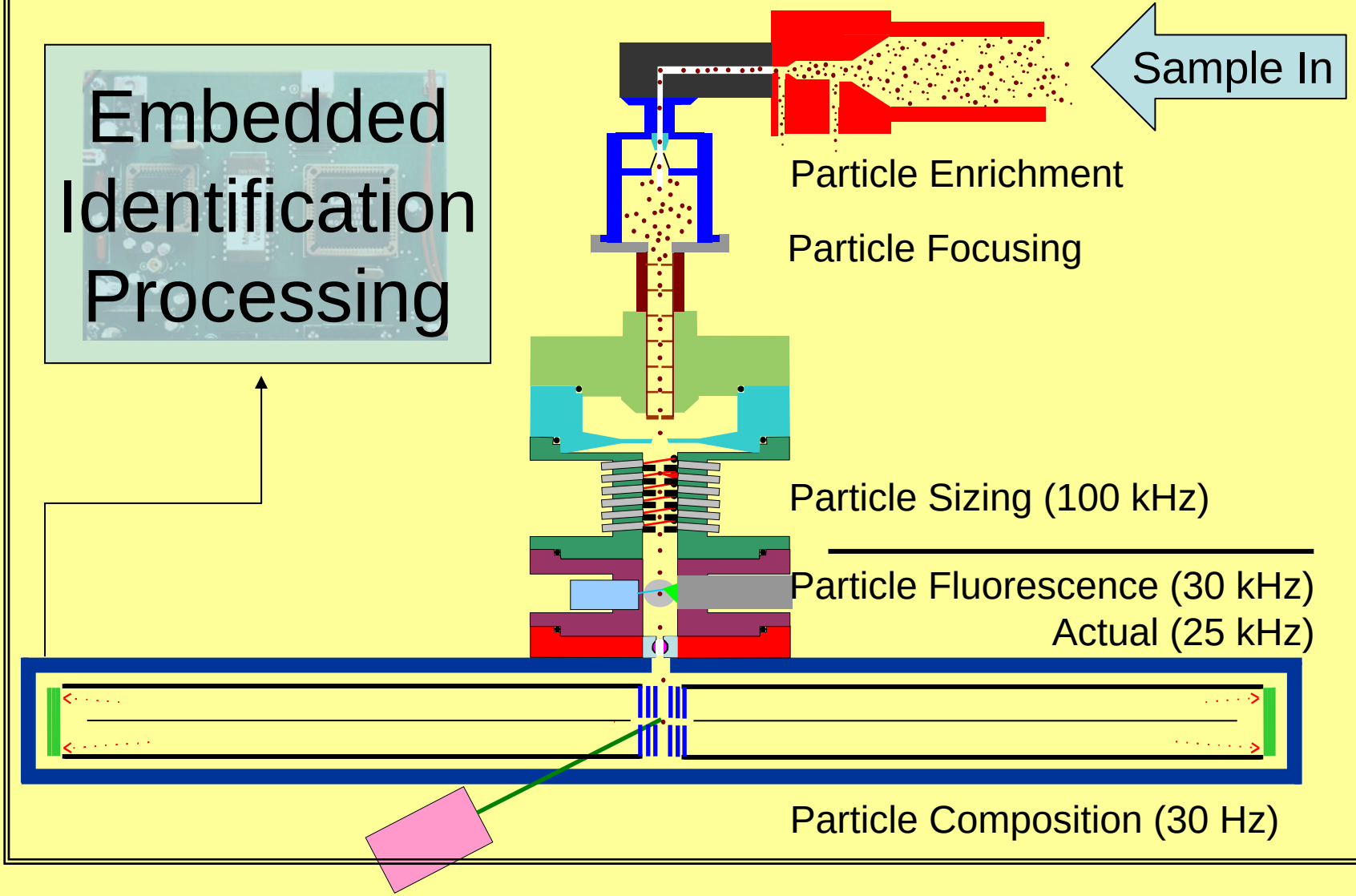


Open burn and detonation treatments release aerosol particles:

- Characterize the particles generated
- Track these particles in the environment
  - On range
  - Fencelines
  - Residential areas

# Particle Analysis by Mass Spectrometry (PAMS)

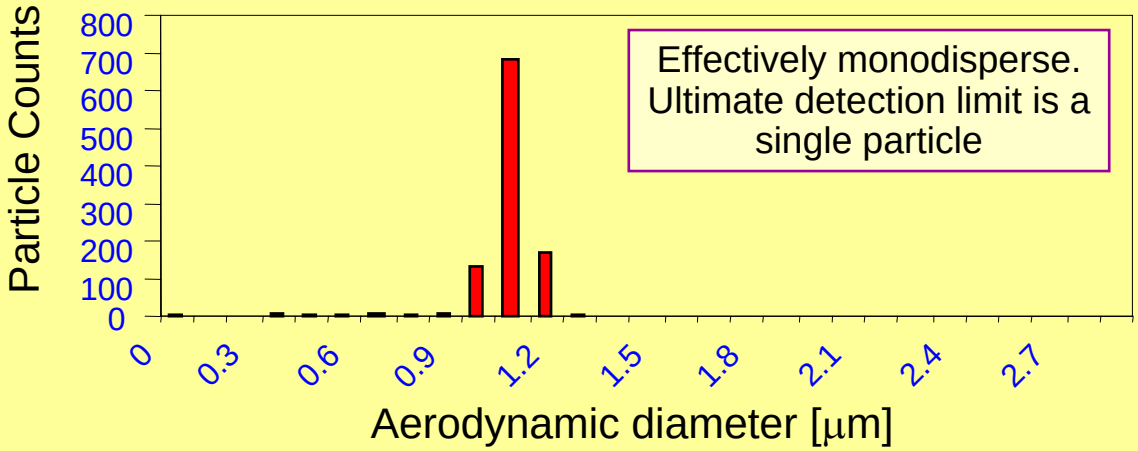
Embedded Identification Processing



# SPAMS Data

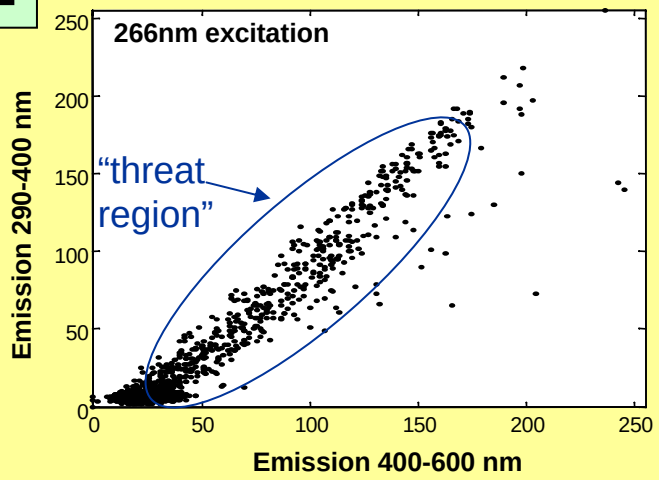
**1**

## *B. atrophaeus* spore size distribution



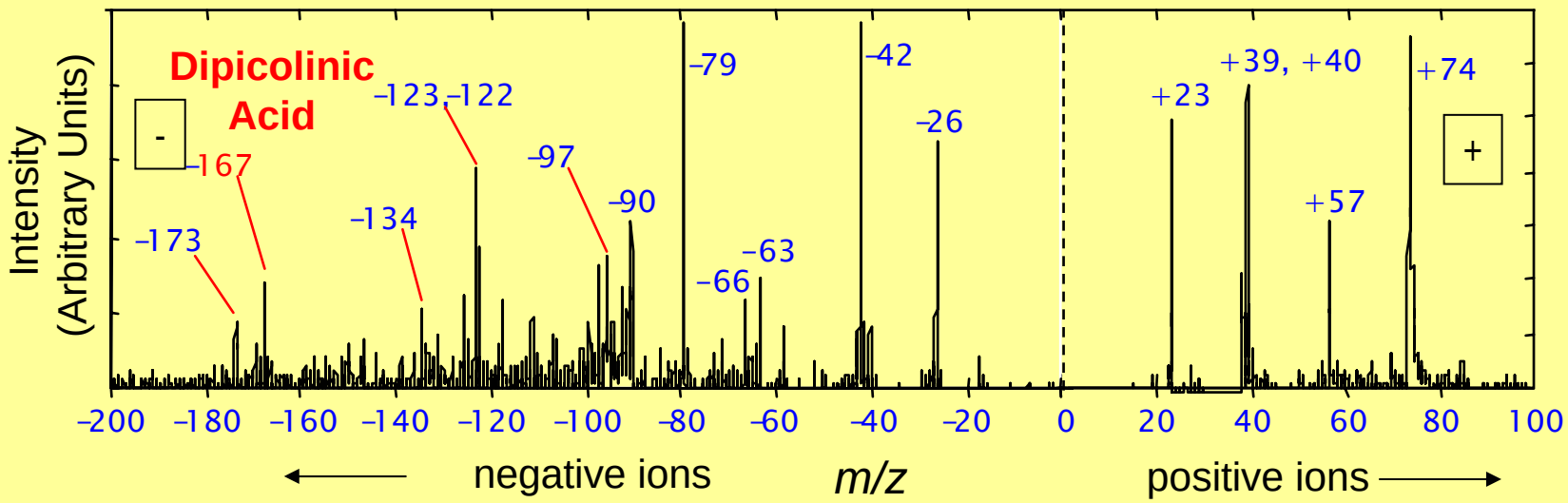

**2**

## UV-LIF *B. atrophaeus*




**3**

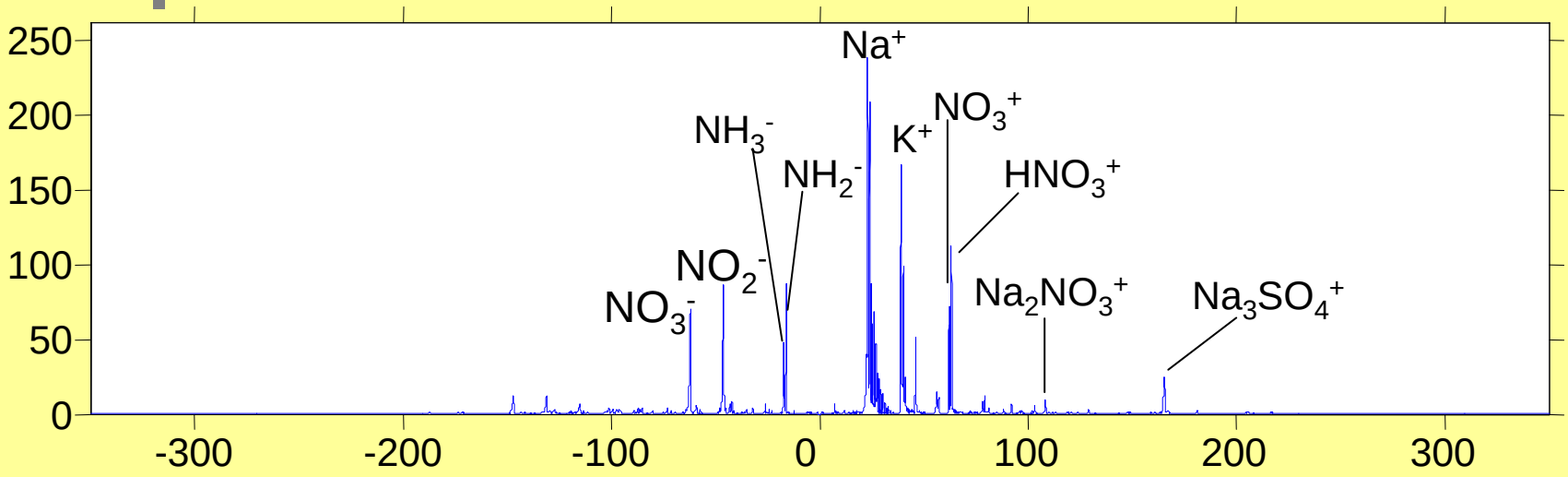
## Mass spectrum of single *B. atrophaeus (B. globigii)* spore

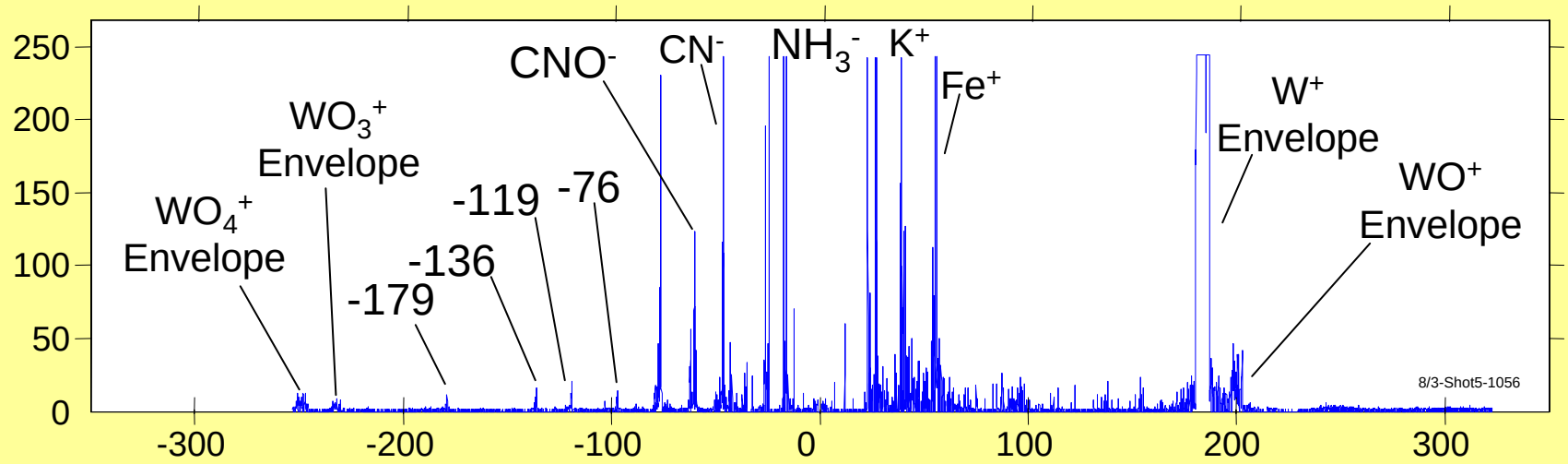


# Proving the Concept

LLNL Site 300, Bunker 850

# Site 300 Background/Post Shot

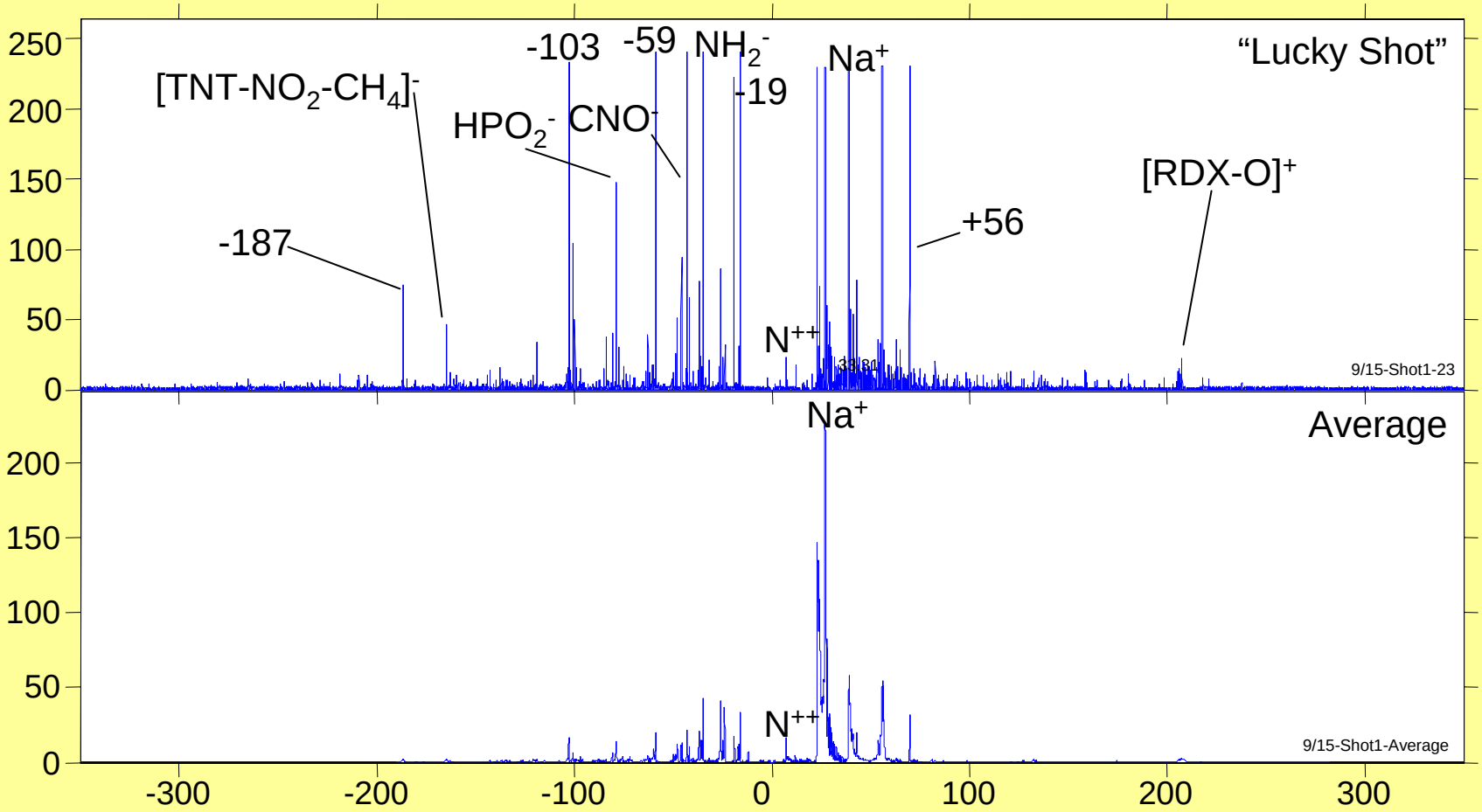


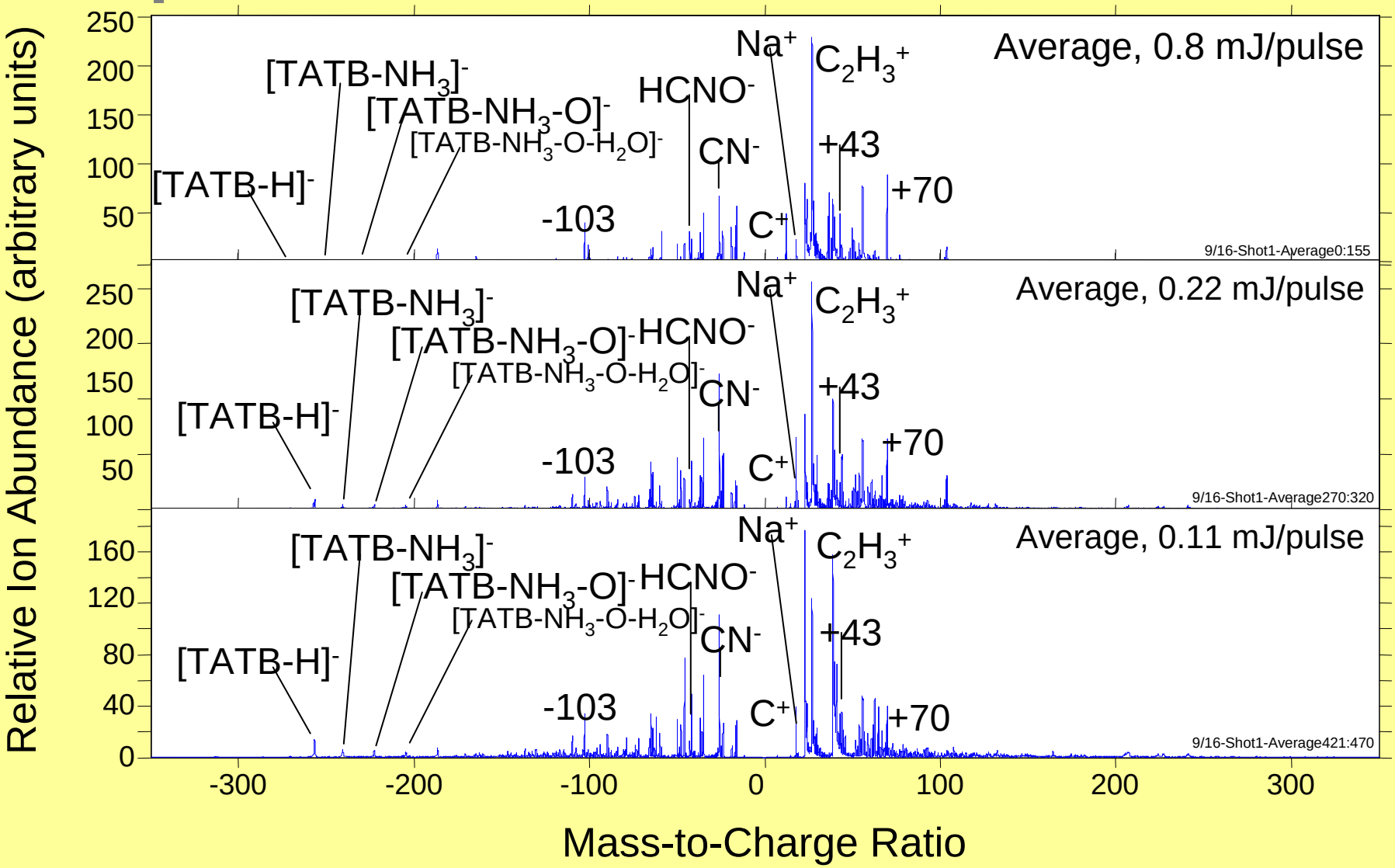
# The BAMS at HEAF


150 g TNT and LX-17 charges.

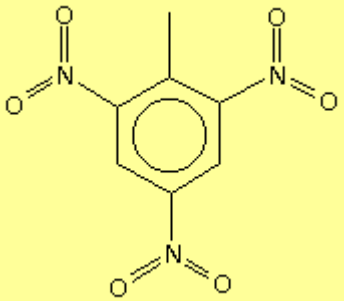
# Comp B, 0.9 mJ/Pulse



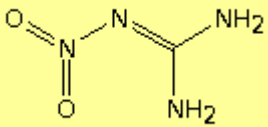
# LX-17, Decreasing Laser Power



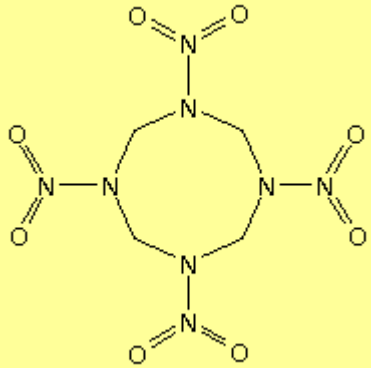
# Expanding the Library: Explosives



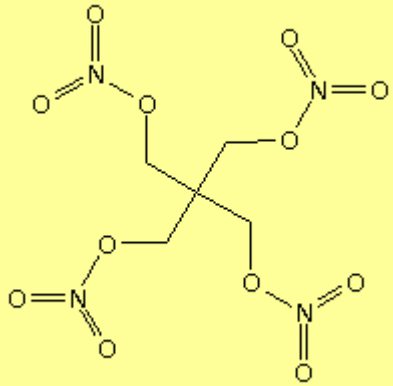
TNT



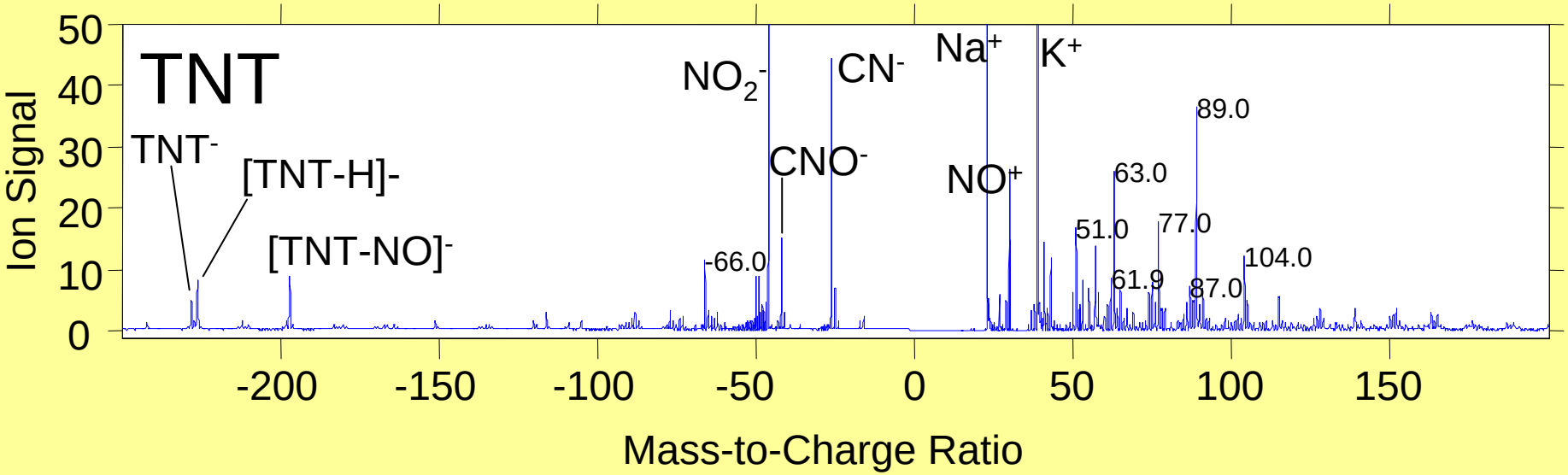
Nitro Guanidine (NQ)



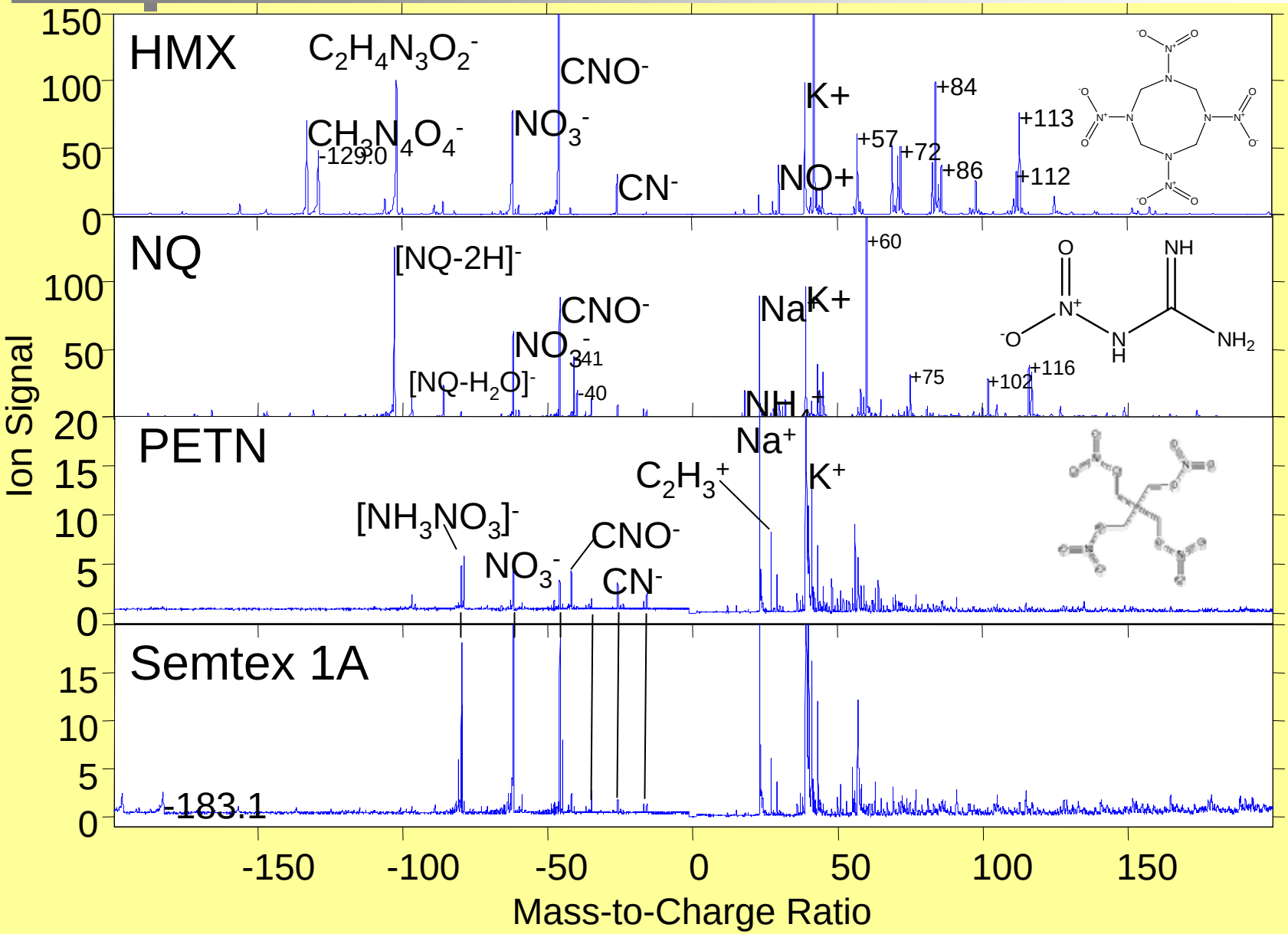
HMX



PETN



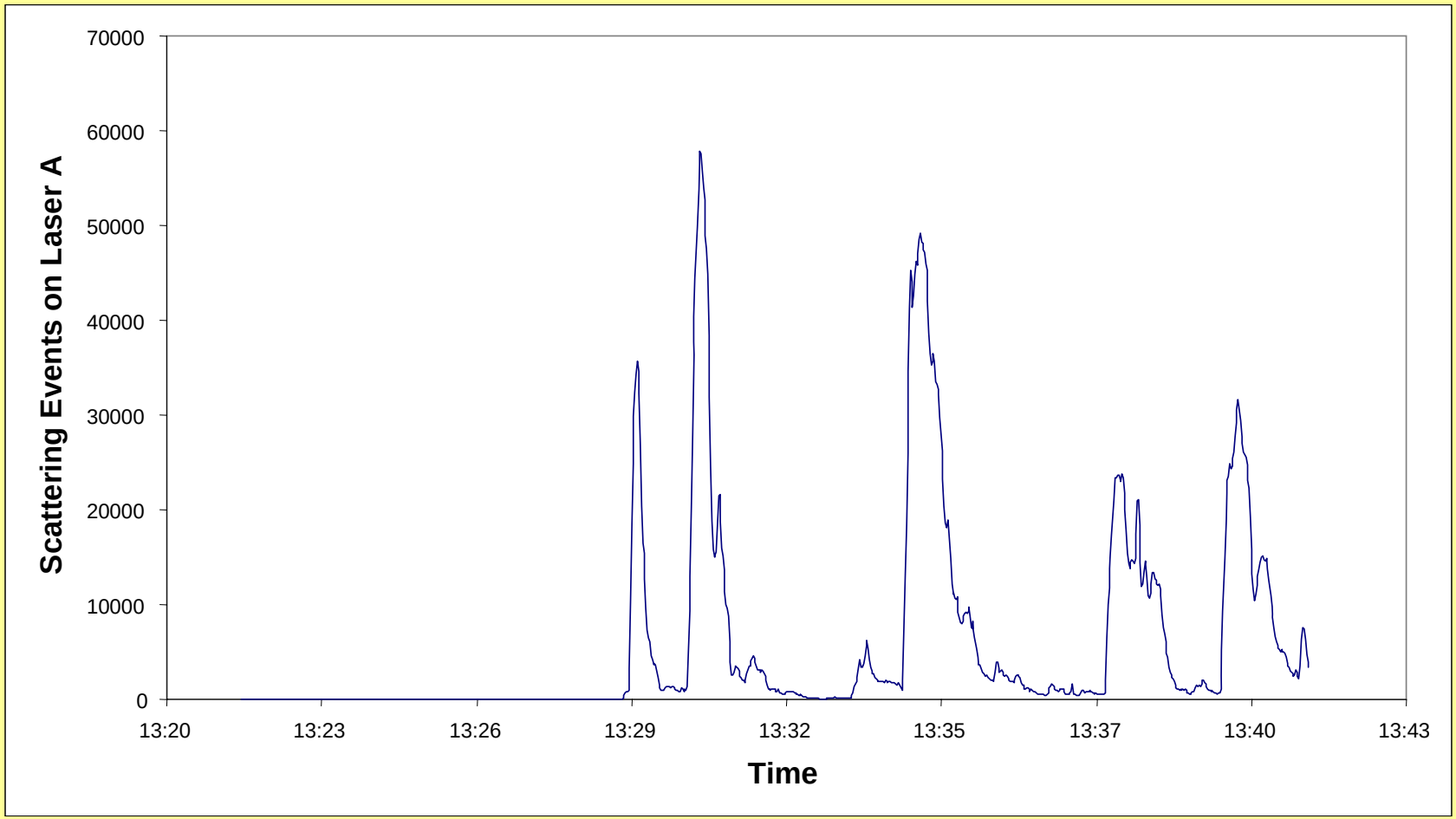
# Other High Explosives



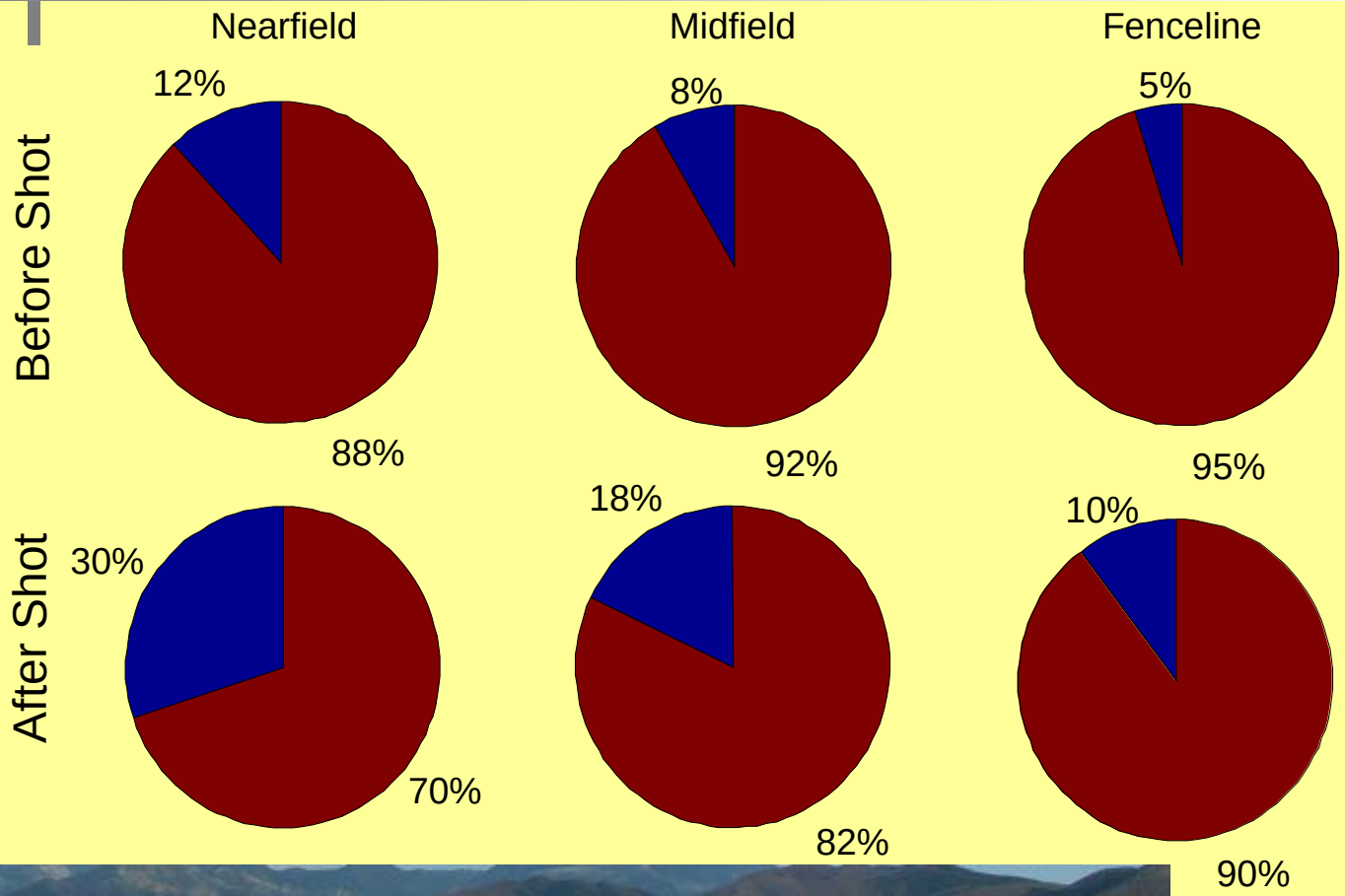
# Field Testing

- ONLY QUALITATIVE DATA
- TEAD
- 800 lbs NEW
- Comp B/TNT
- 3 distances
  - 70 M
  - ~200 M
  - Fenceline

# Plumes

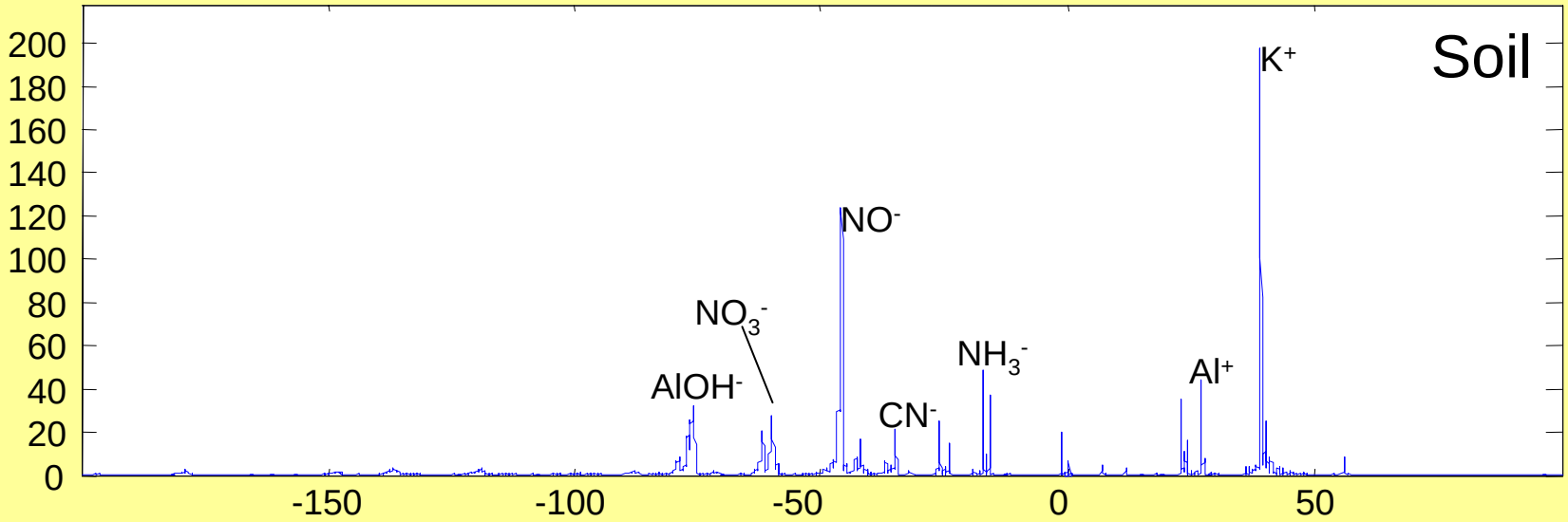

70000
60000
50000
40000
30000
20000
10000
0
Scattering Events on Laser A
13:20
13:23
13:26
13:29
13:32
13:35
13:37
13:40
13:43
Time

# Identified Soil Particles

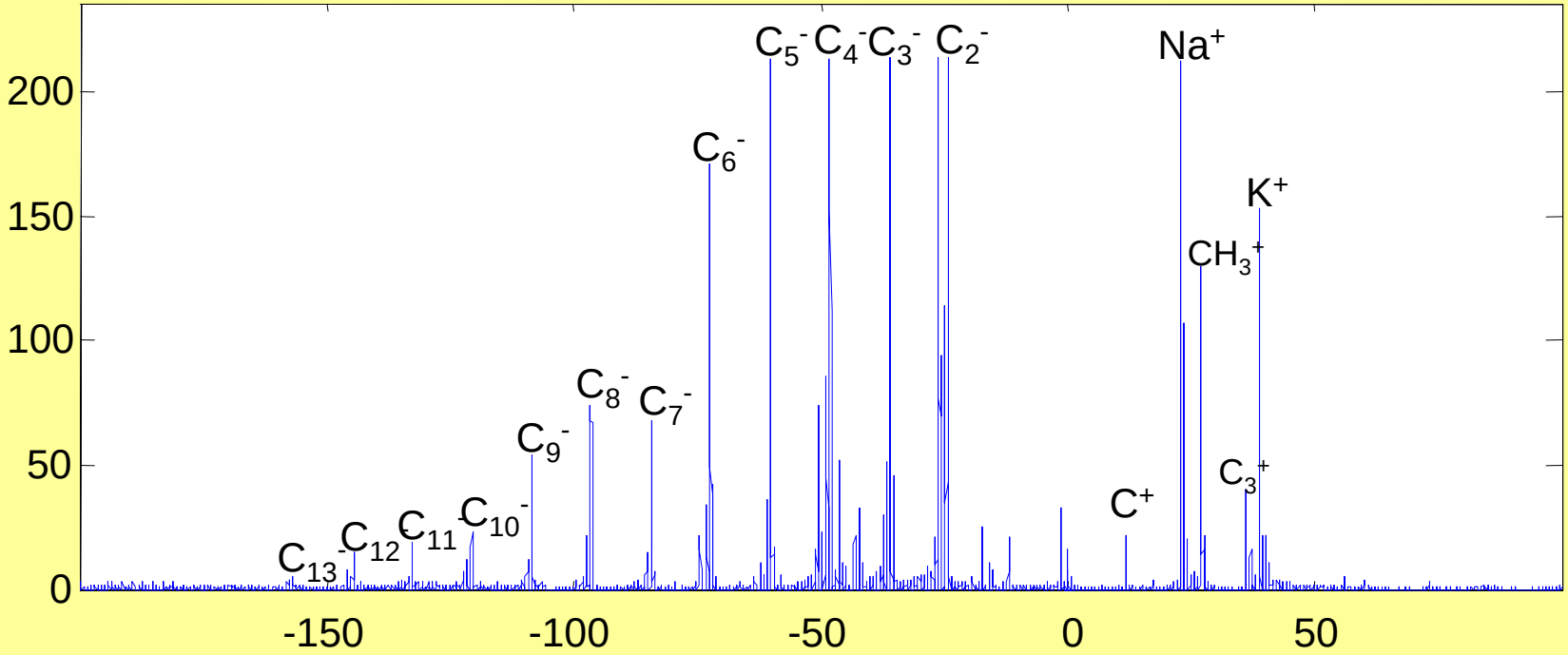



# Near Field Data: 70 Meters

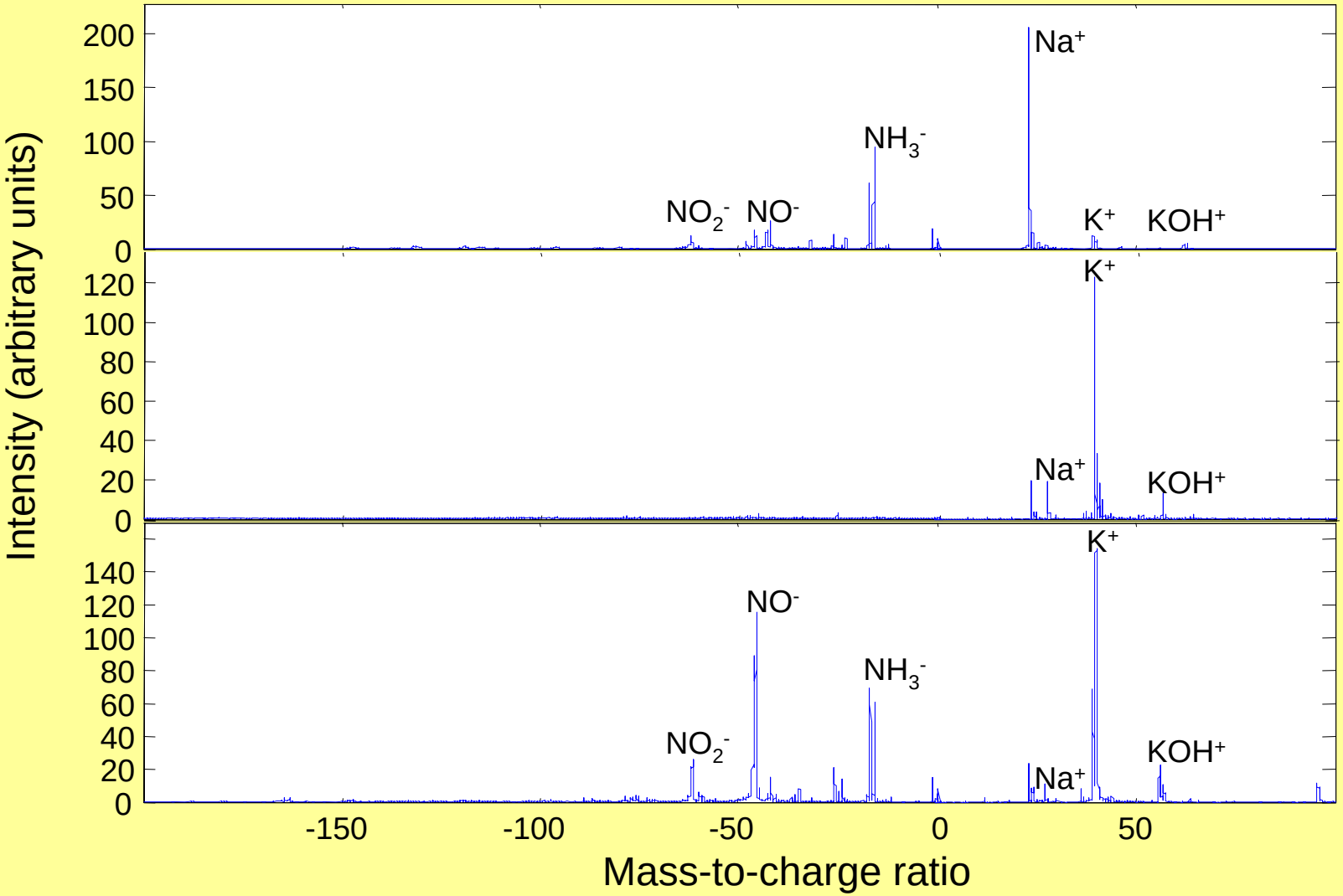
- Background: 1456 Spectra over 21 minutes
- Shot Spectra: 1365 Spectra over ~2 hours
  - Different sampling inlet
- Major Clusters Present:
  - Soil, Soot, Ammonium Nitrate with Salts



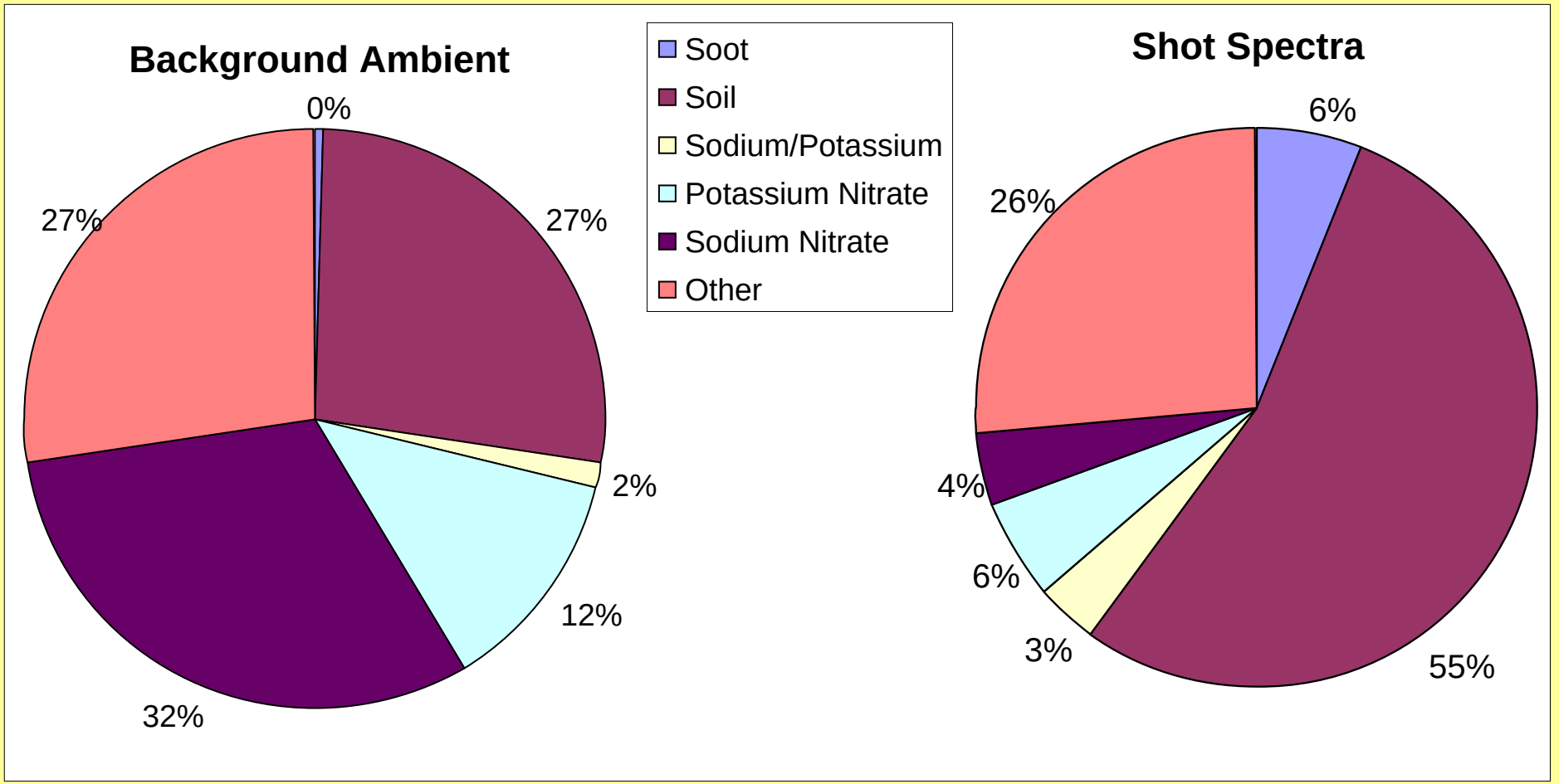
# Soot


200
150
100
50
0
-150
-100
-50
0
50
$C_{13}^-$
$C_{12}^-$
$C_{11}^-$
$C_{10}^-$
$C_9^-$
$C_8^-$
$C_7^-$
$C_6^-$
$C_5^-$
$C_4^-$
$C_3^-$
$C_2^-$
$C^+$
$Na^+$
$CH_3^+$
$K^+$
$C_3^+$

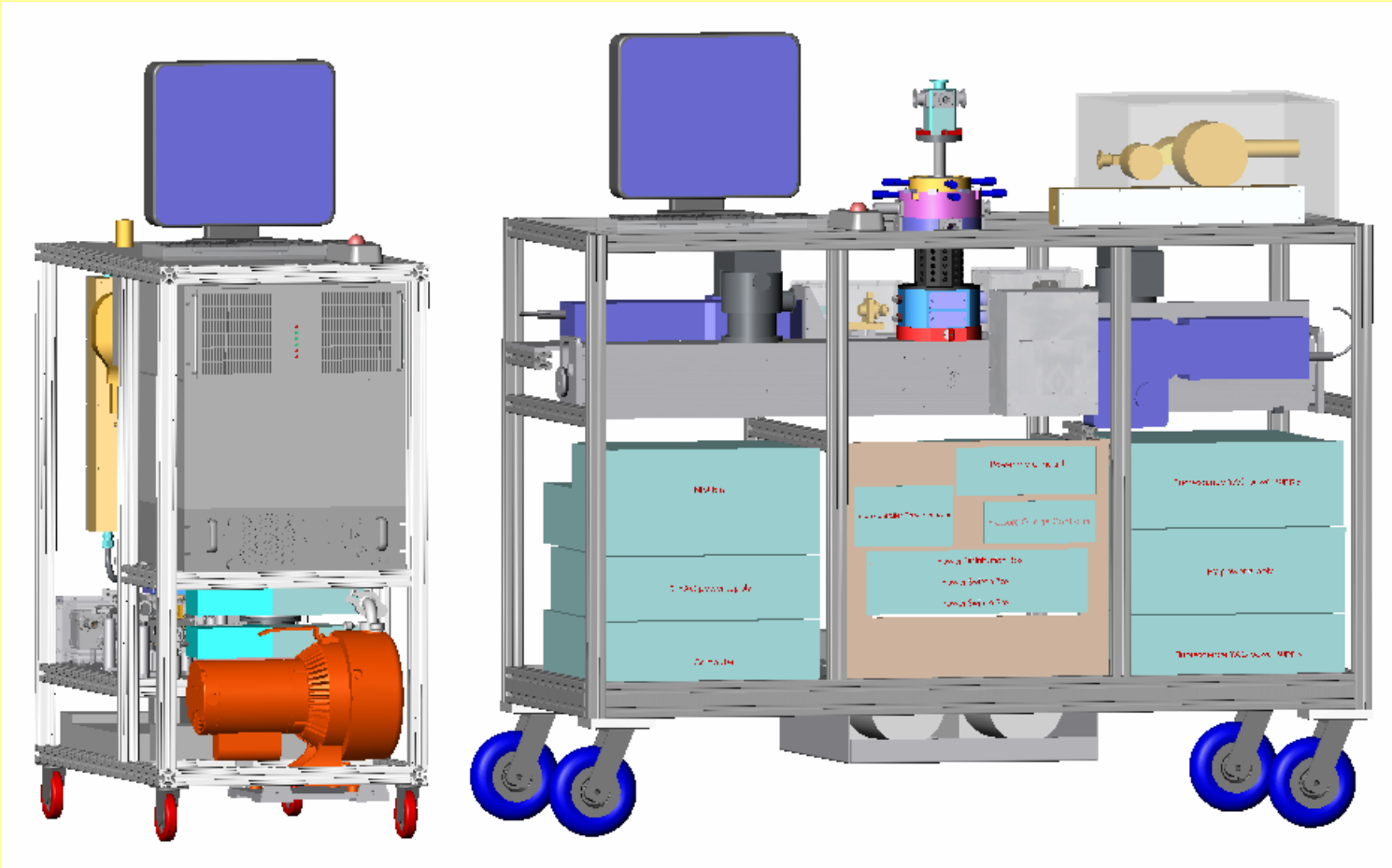
# Other Background Particle Classes



# Near Shot Data: Before and After



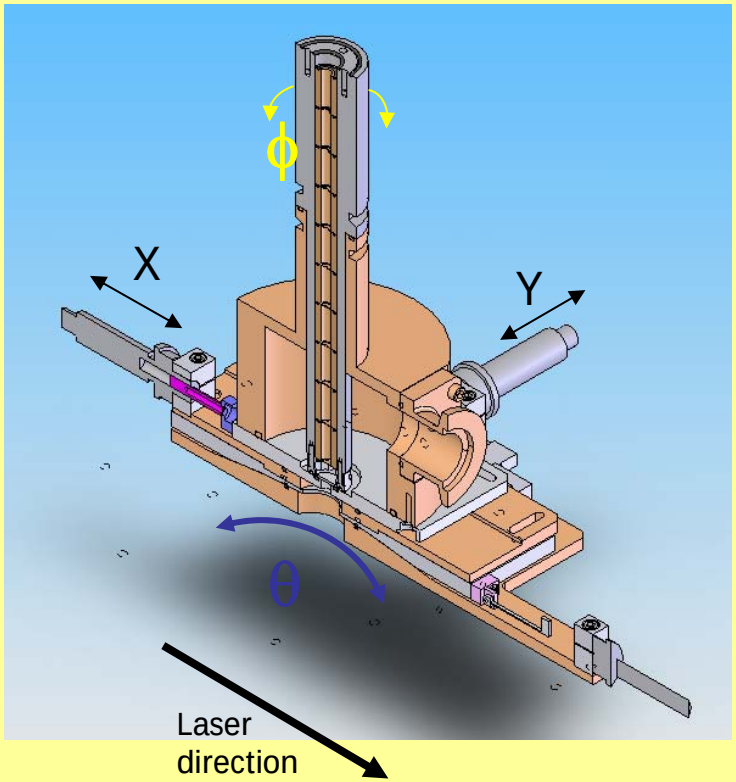
# PAMS/BAMS/SPAMS 2.0 (!)

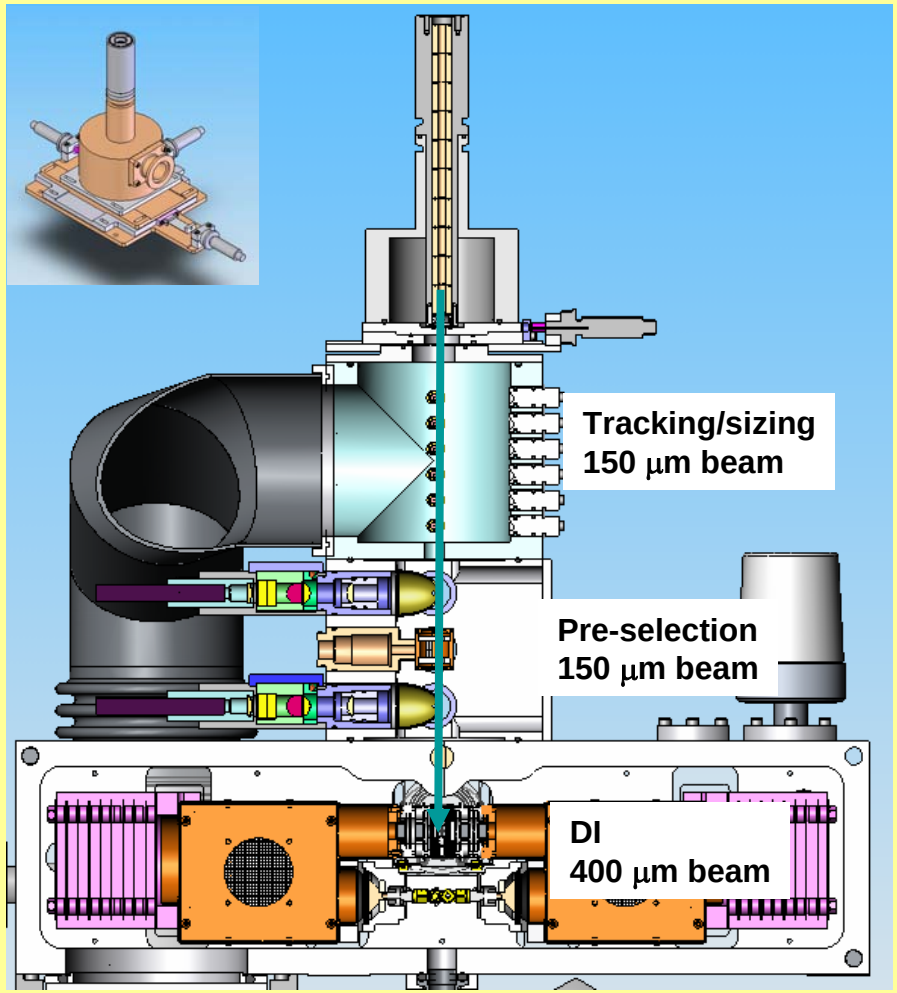


# SPAMS 2.0 Design Changes

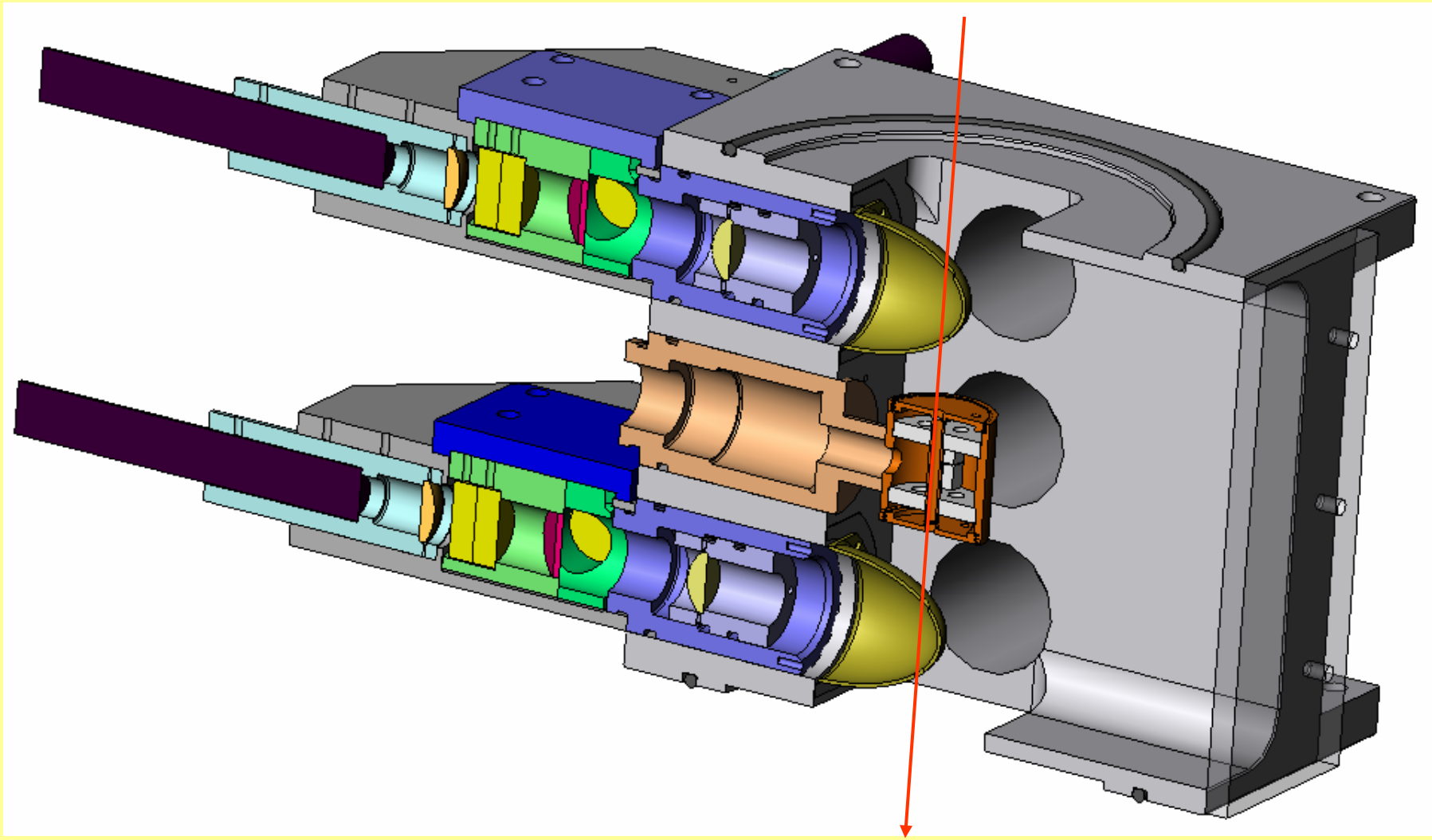
- Particle Focusing
- Two stages of fluorescence preselection
- Advanced Mass Spectrometer
- Improved Software
  - XML File Format
- Reduced footprint and weight!

# The Aerosol Beam Can Be Aimed

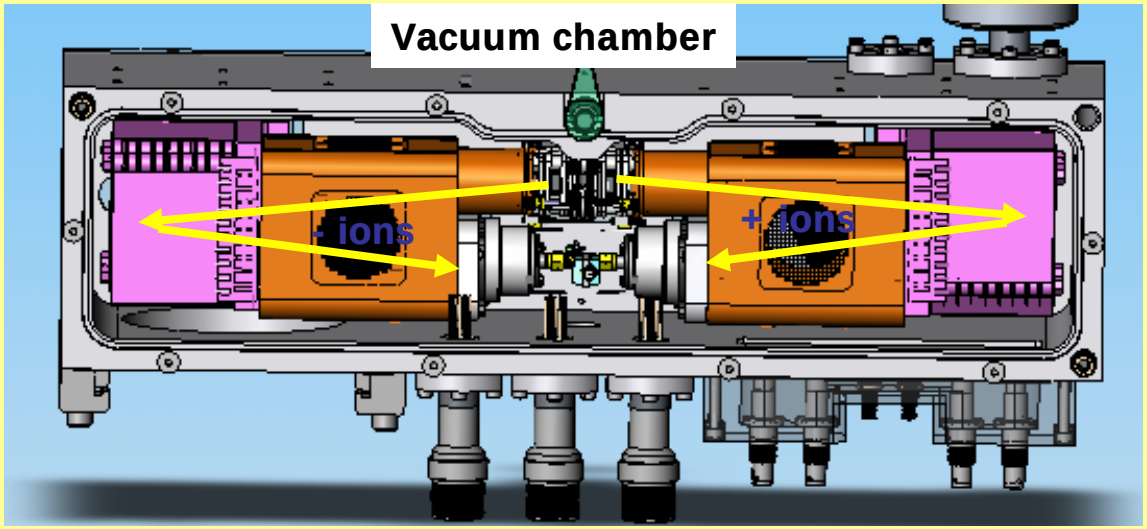


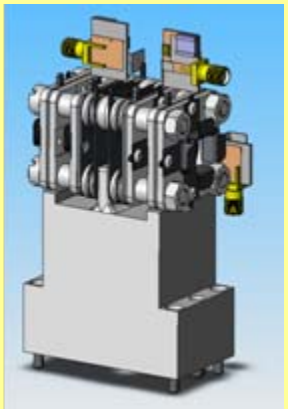



# Preselection Increases Sensitivity

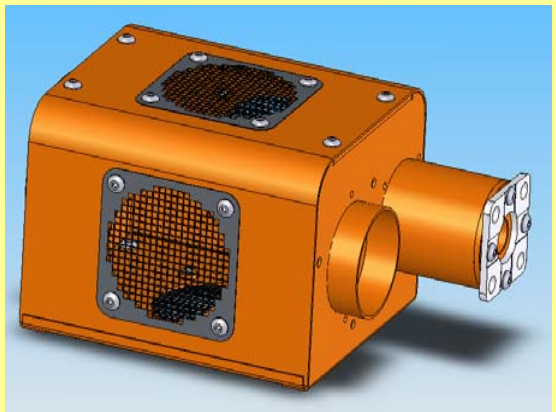


# The Mass Spectrometer is 4x smaller

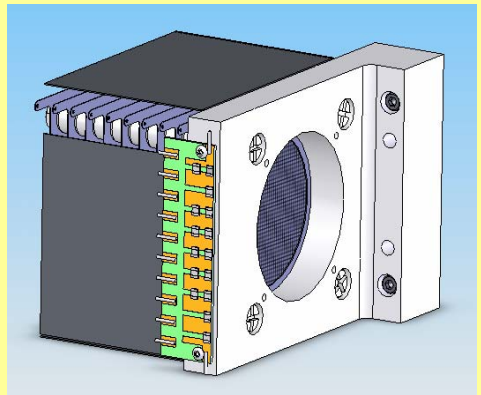


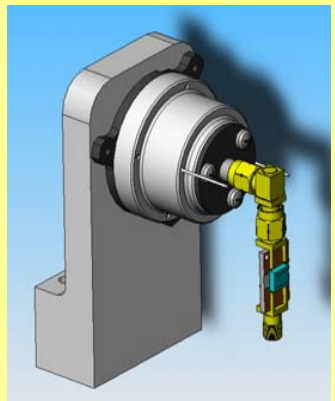
**Acceleration & steering**



**Drift**

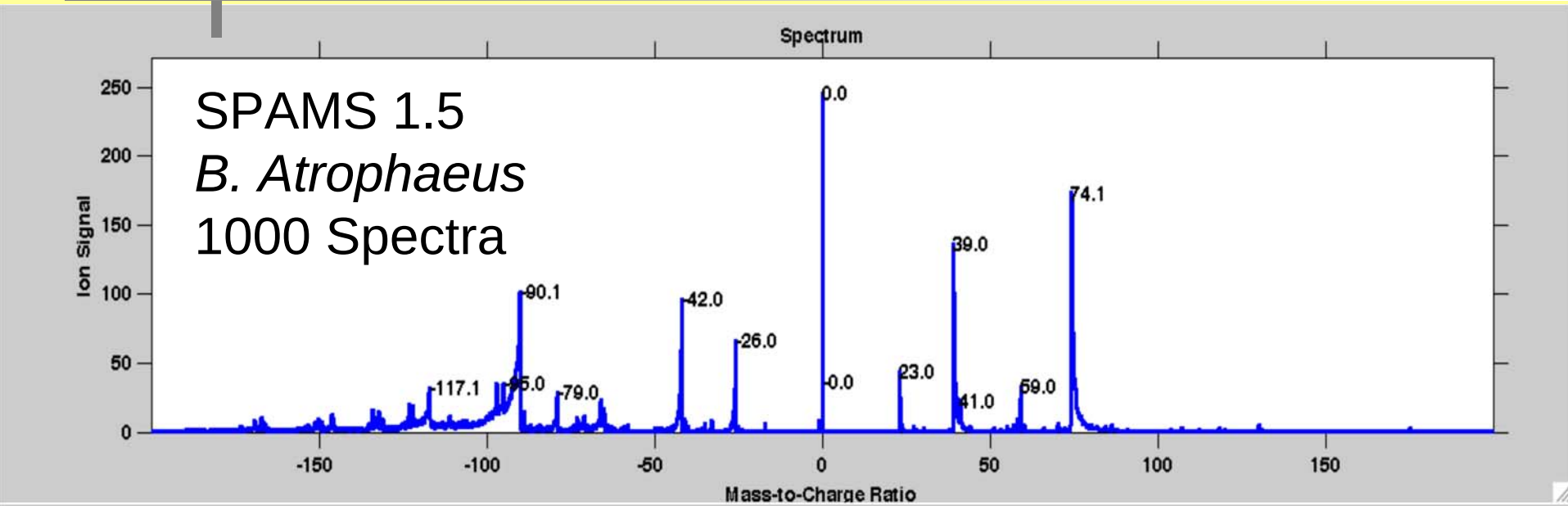


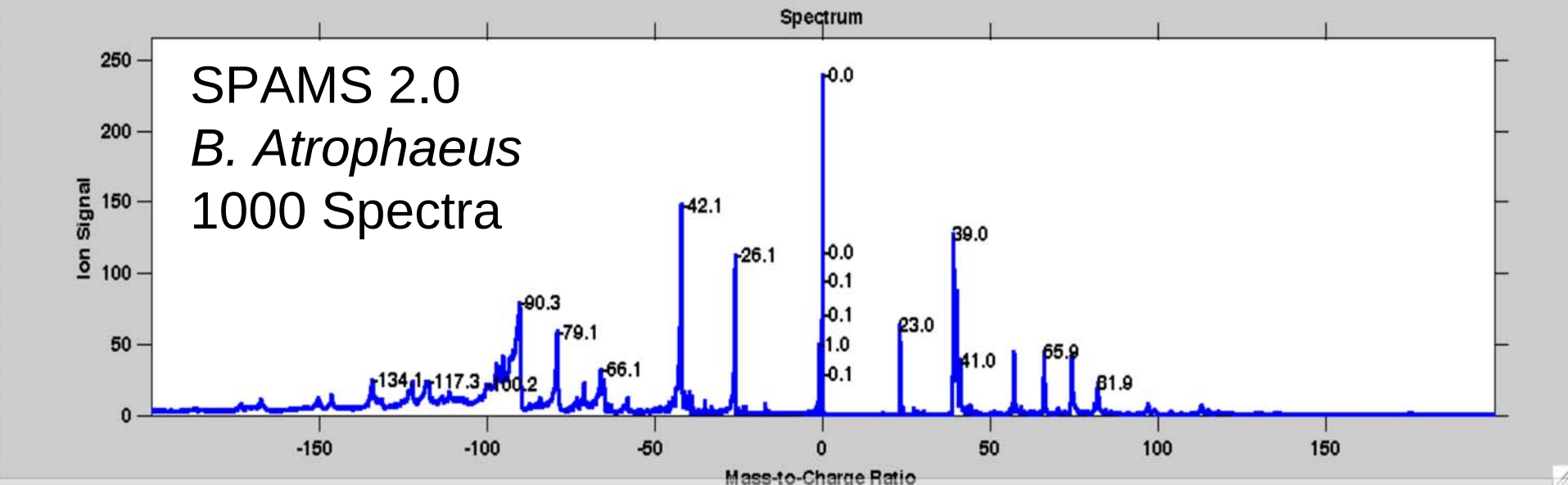
**Reflectron**



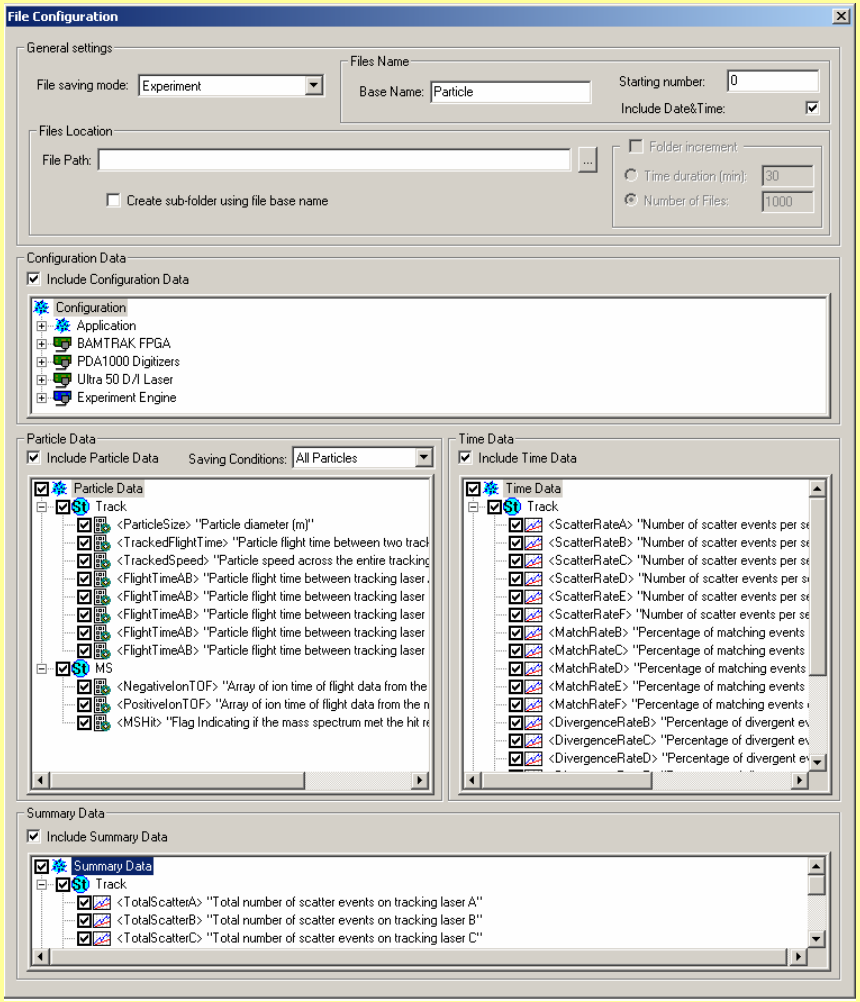
**MCP Detector**

# SPAMS 1.X vs. 2.0 Mass Spectra



# The Files are Now in XML




- Self-documenting.
- User can decide what data to save.
- Extensible if instrument is improved in the future.
- Openable in most web browsers.

**Performances:**

| Old | Speed | Size |
|---|---|---|
| Single File | 60 particles/sec | 70 Kbytes/particle |
| Zipped file | 6 particles/sec | 26 |
| **New** | **Speed** | **Size** |
| Single File | 60 particles/sec | 41 Kbytes/particle |
| Multiple file | 106 particles/sec | 41 Kbytes/particle |

# Conclusions/Future Research

- The concept of SPAMS for demil impact monitoring works.
- SPAMS 2.0 is at least comparable to SPAMS 1.X in all respects and better in most.

- Next Stop: Spartan Rocket Motor Demil Operation!
- We are seeking other applications for this technology. See me after the seminar!

# Acknowledgements


- The BAMS Group at LLNL
- Tooele Army Depot
  - Keith Siniscalchi
  - Dave Ayala
  - Spencer Chamberlain
- The funding agencies:
  - DoD Office Of Munitions TCG-IX
  - Defense Ammunition Center
  - DARPA
  - TSWG
  - LLNL LDRD
  - DHS

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