

Instantaneous Detection of Particles Liberated by Open Detonation Treatments

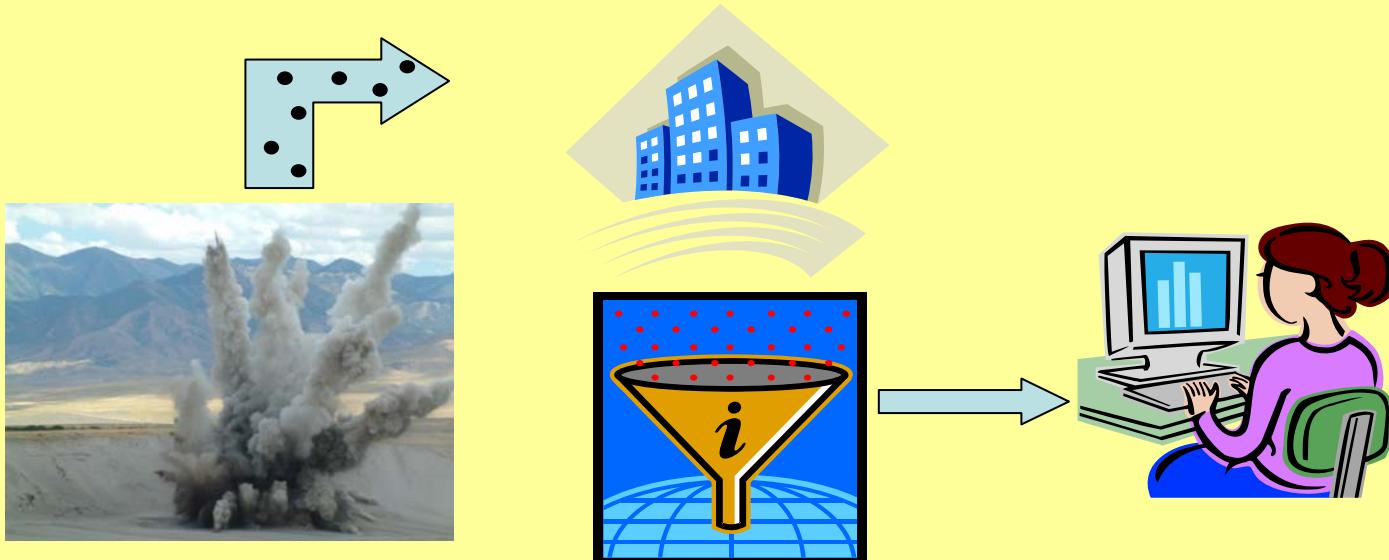
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Coffee and Mr. Vincent Riot
Lawrence Livermore National Laboratory

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



The Idea:

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



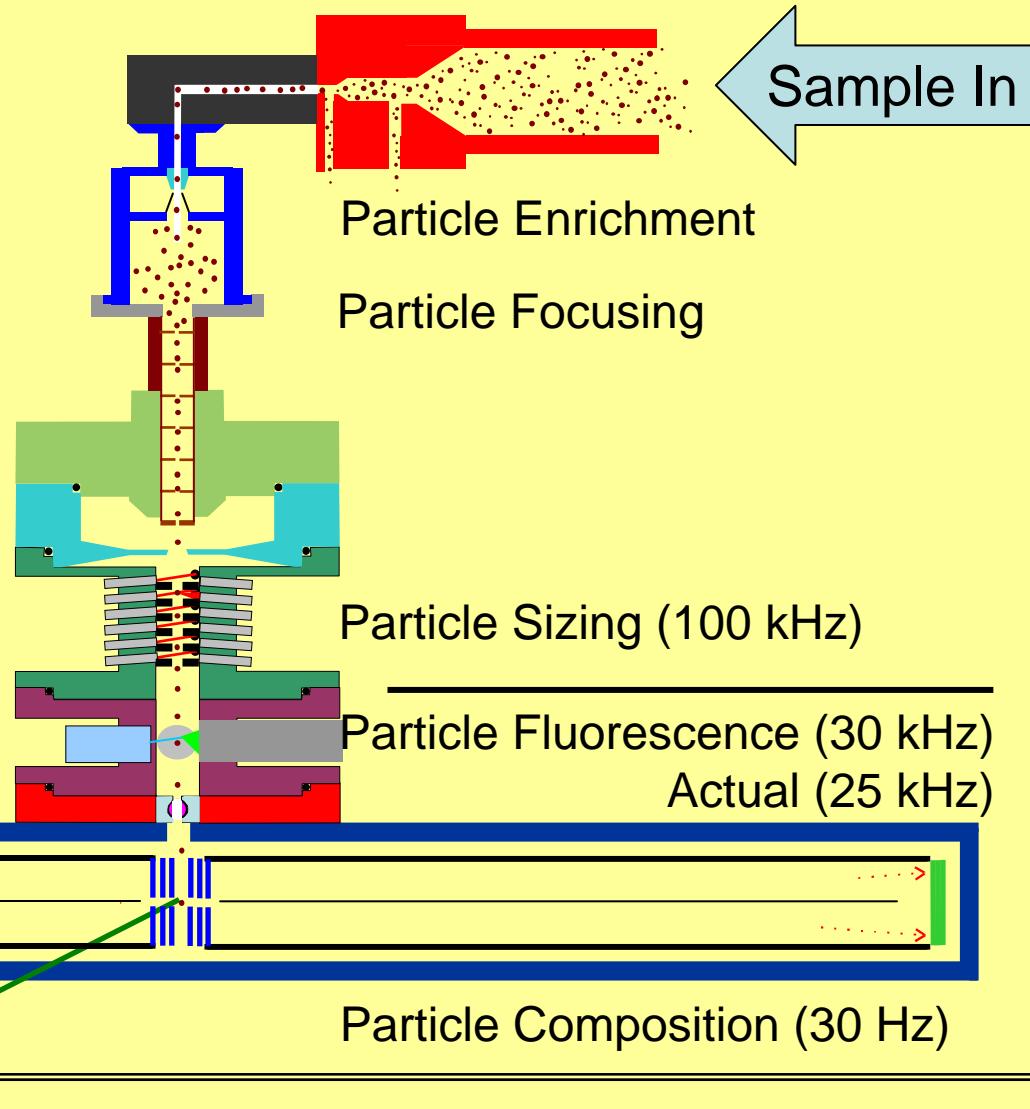
Open burn and detonation treatments release aerosol particles:

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



Particle Analysis by Mass Spectrometry (PAMS)

Embedded
Identification
Processing

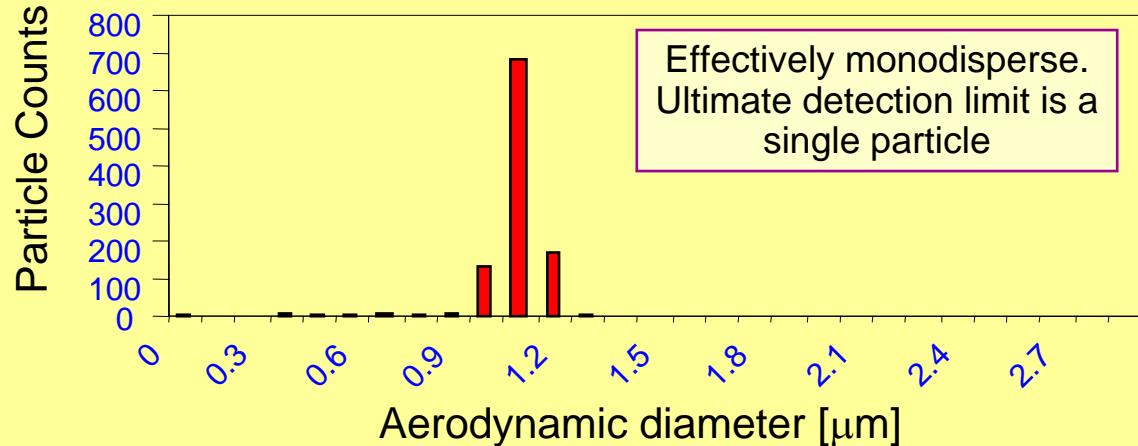




SPAMS Data

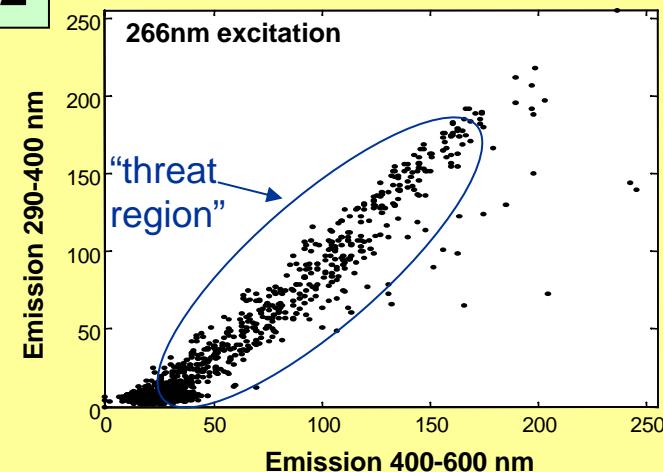
1

B. atrophaeus spore size distribution



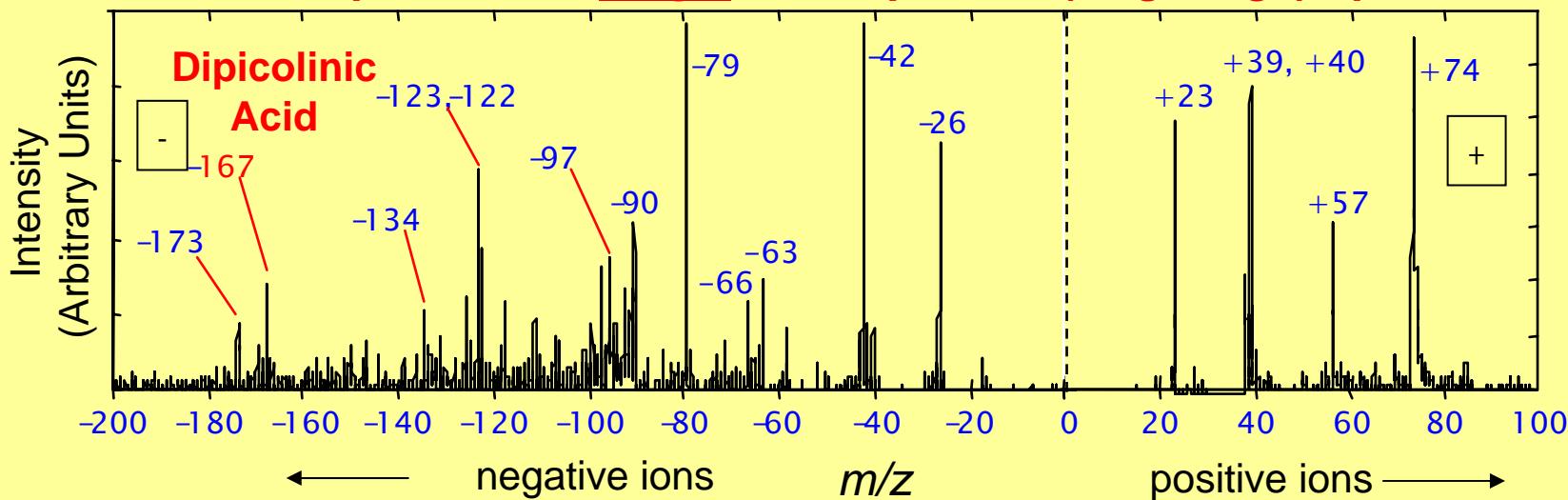
2

UV-LIF *B. atrophaeus*



3

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





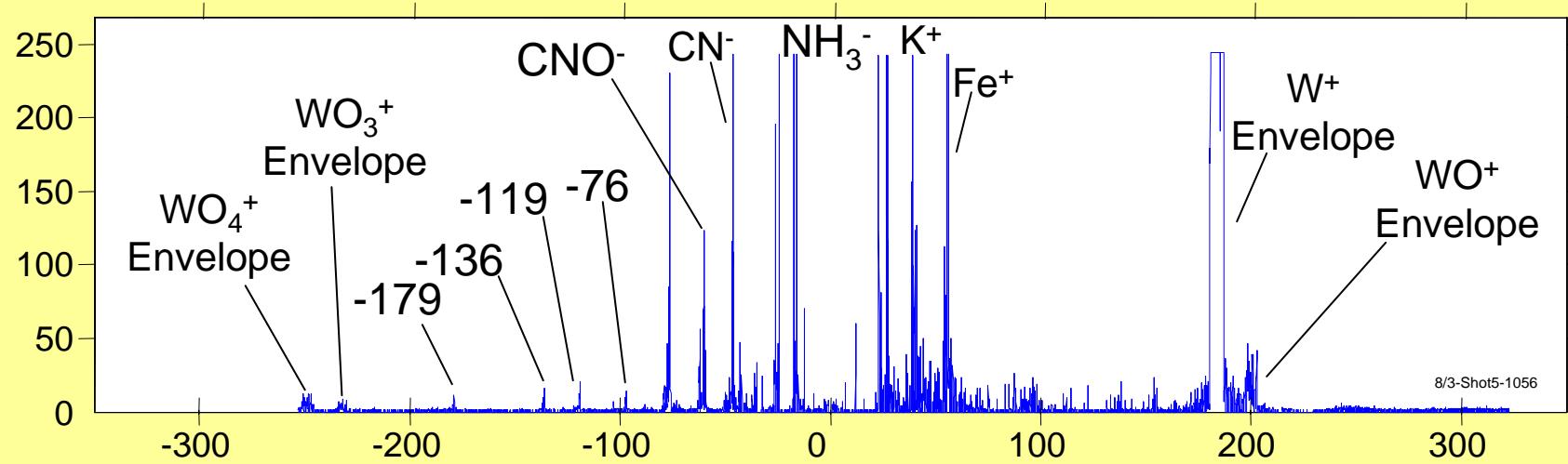
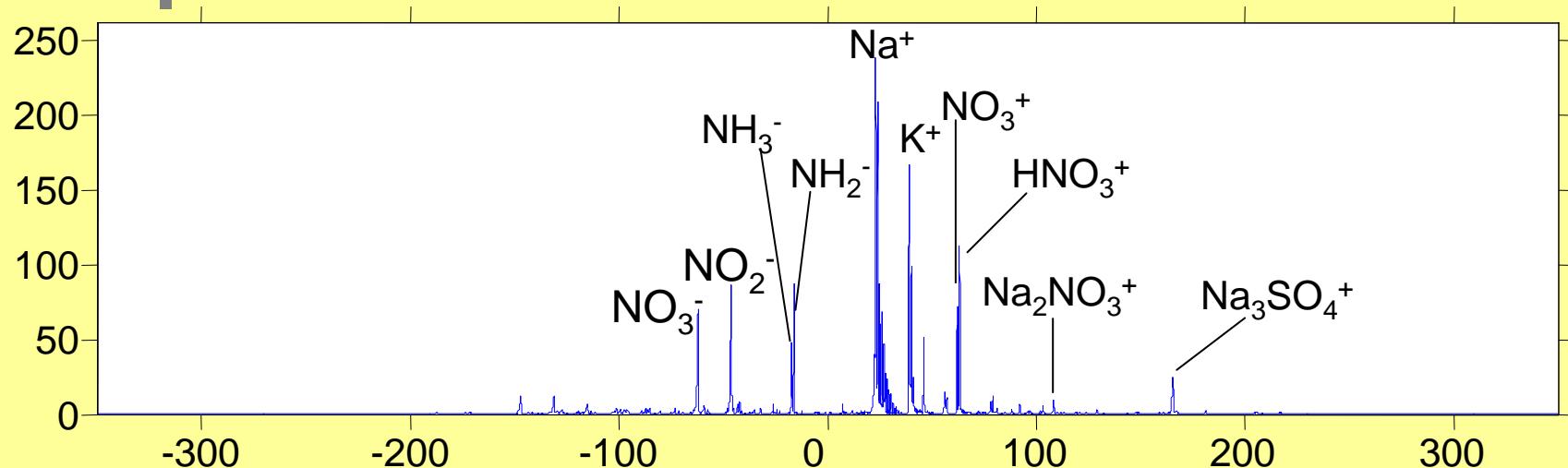
Proving the Concept



LLNL Site 300, Bunker 850



Site 300 Background/Post Shot





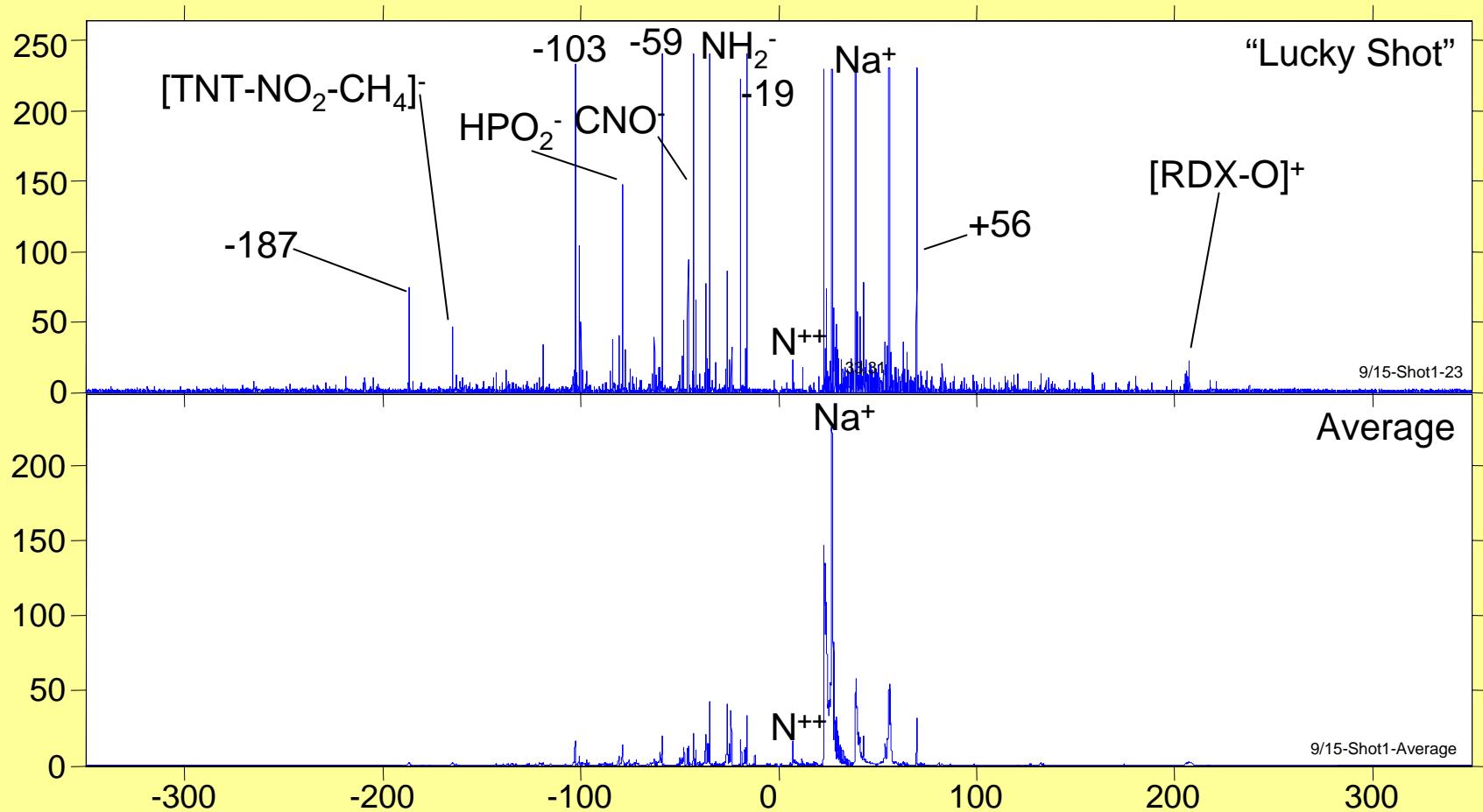
The BAMS at HEAF



150 g TNT and LX-17 charges.

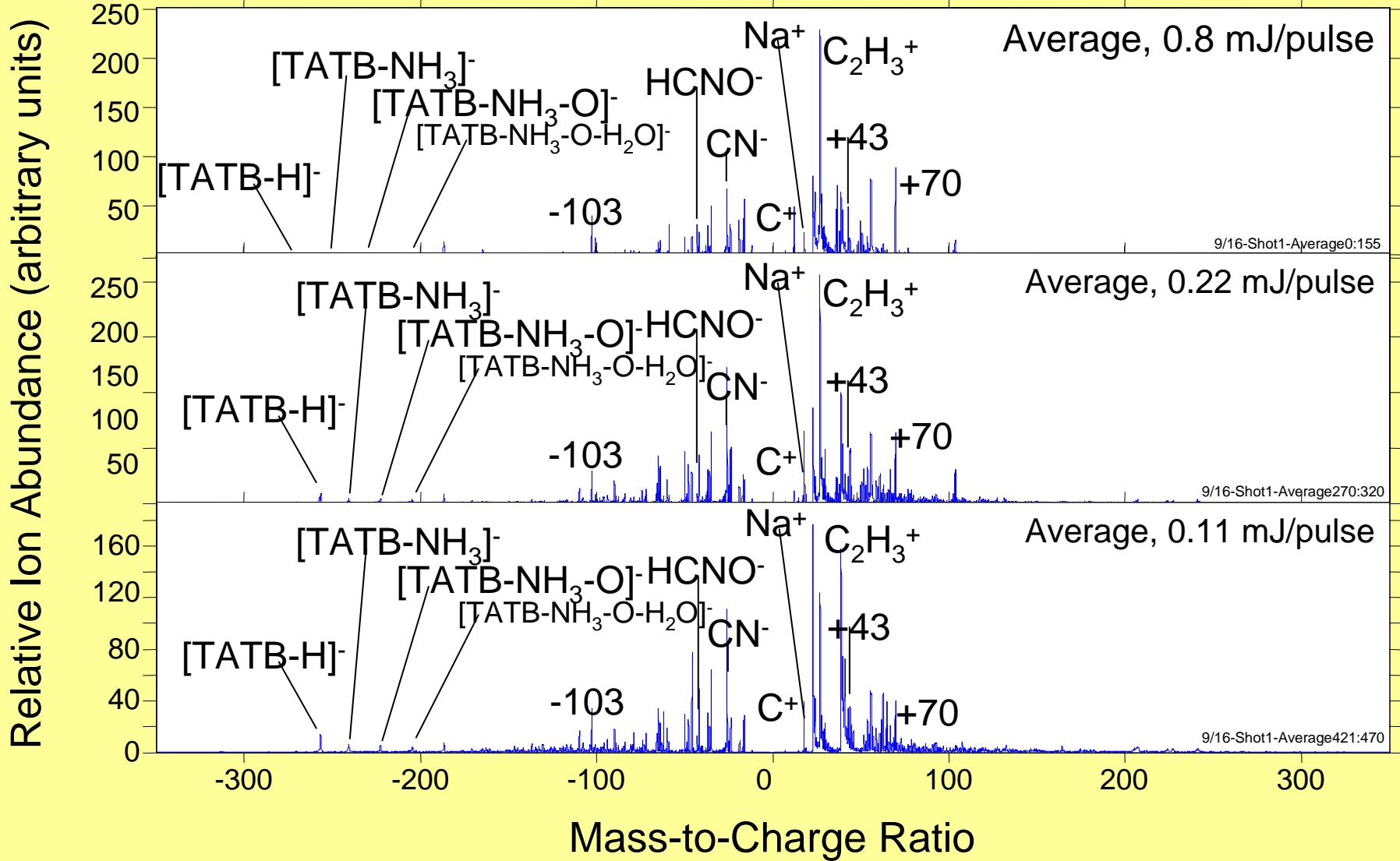


Comp B, 0.9 mJ/Pulse



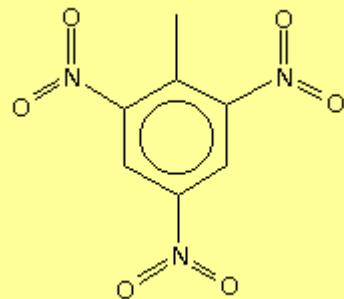


LX-17, Decreasing Laser Power

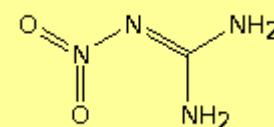




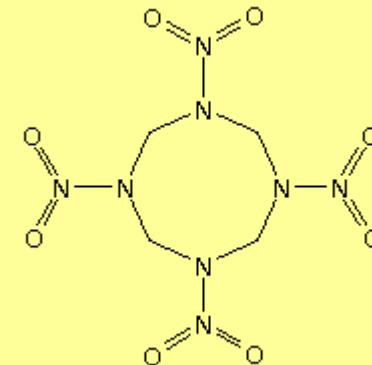
Expanding the Library: Explosives



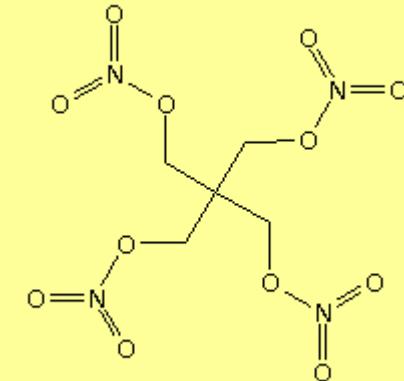
TNT



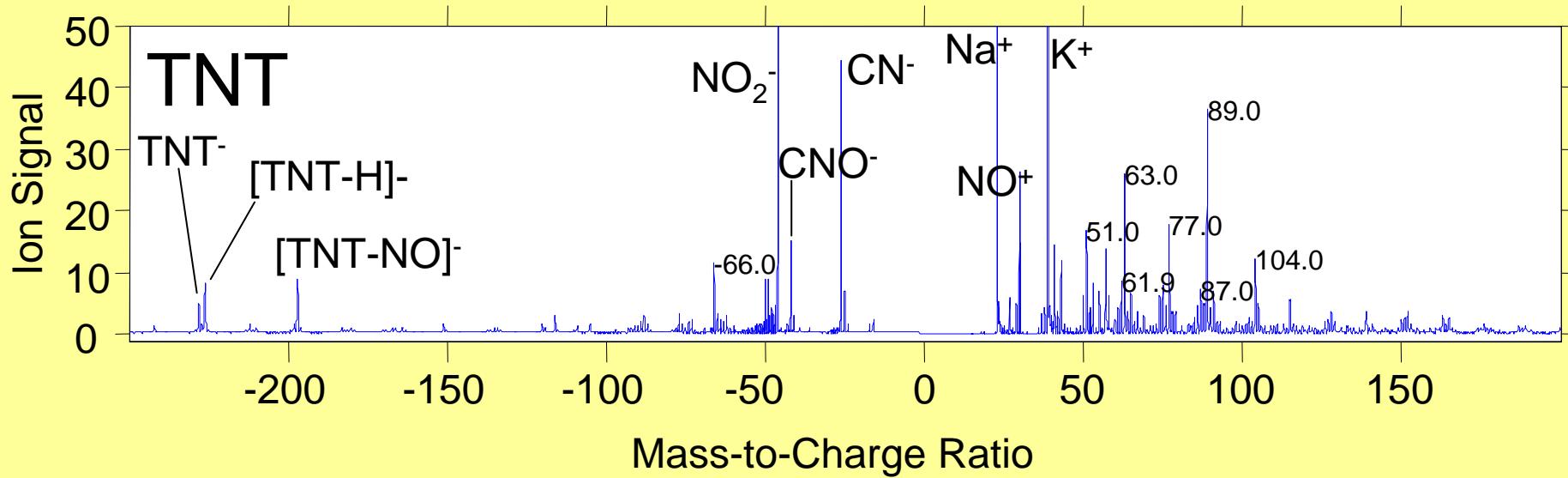
Nitro Guanidine (NQ)



HMX

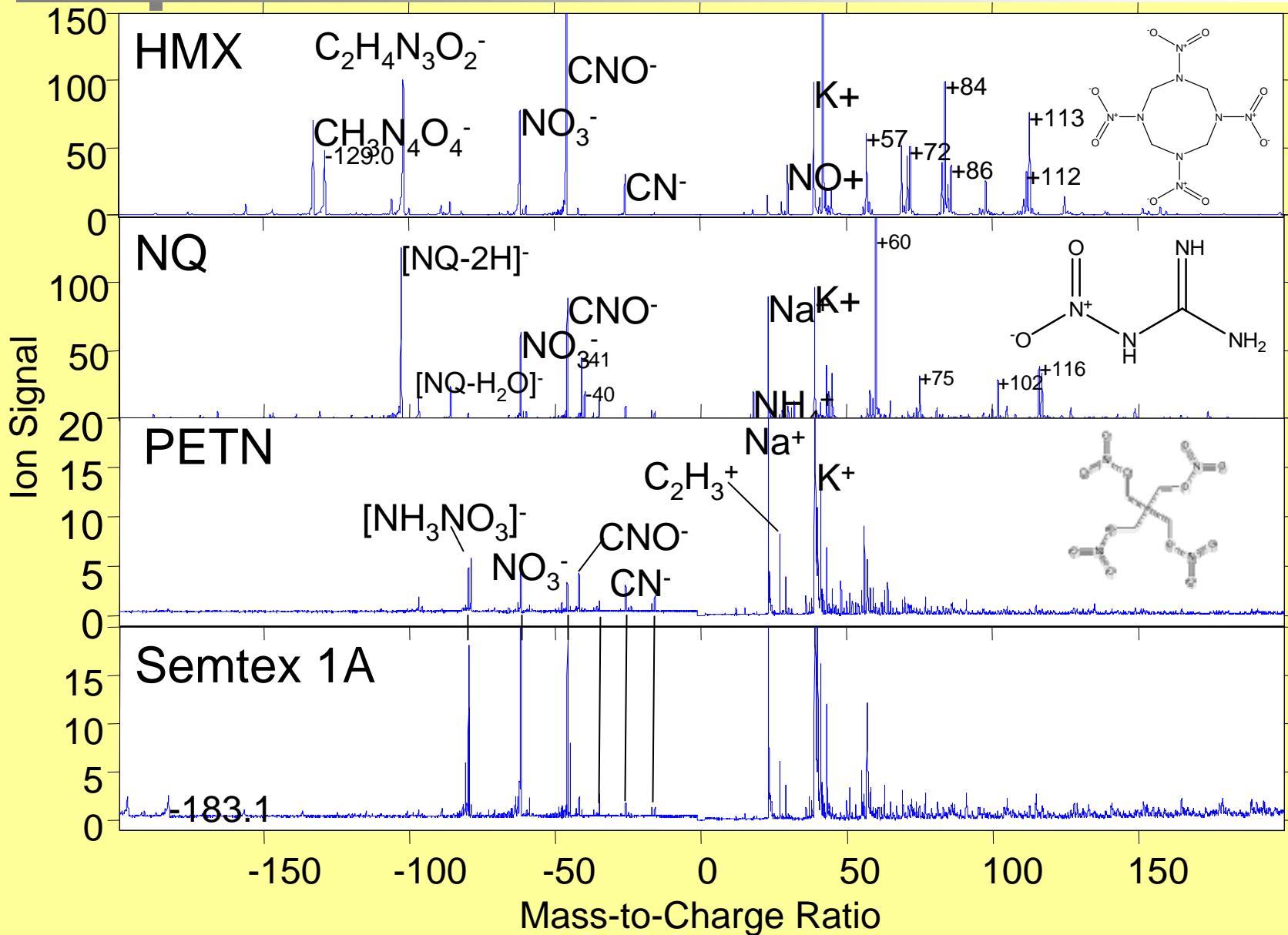


PETN





Other High Explosives





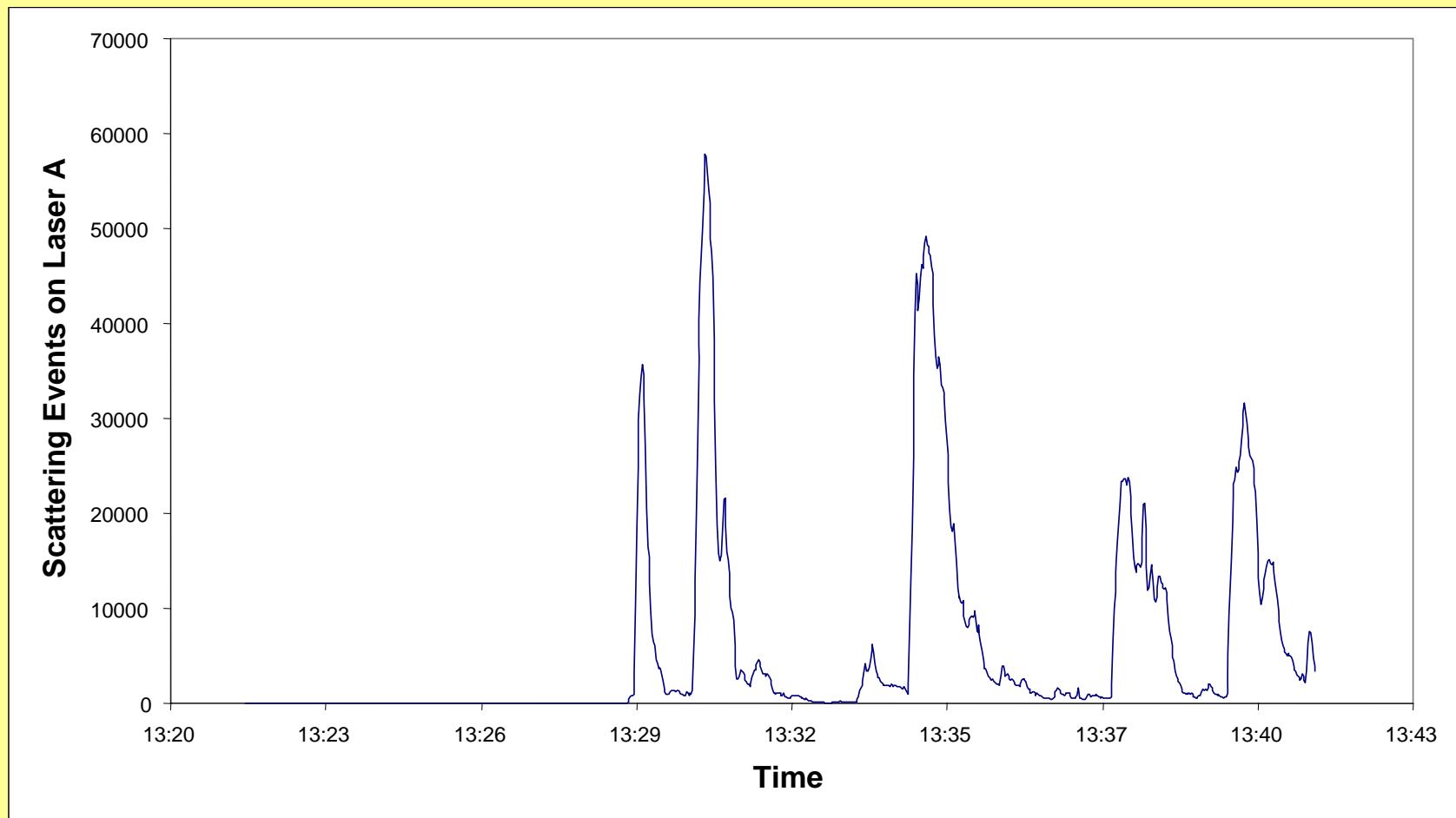
Field Testing

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



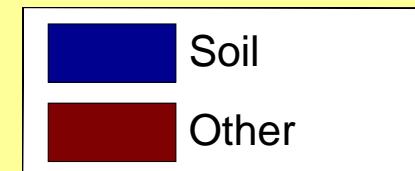
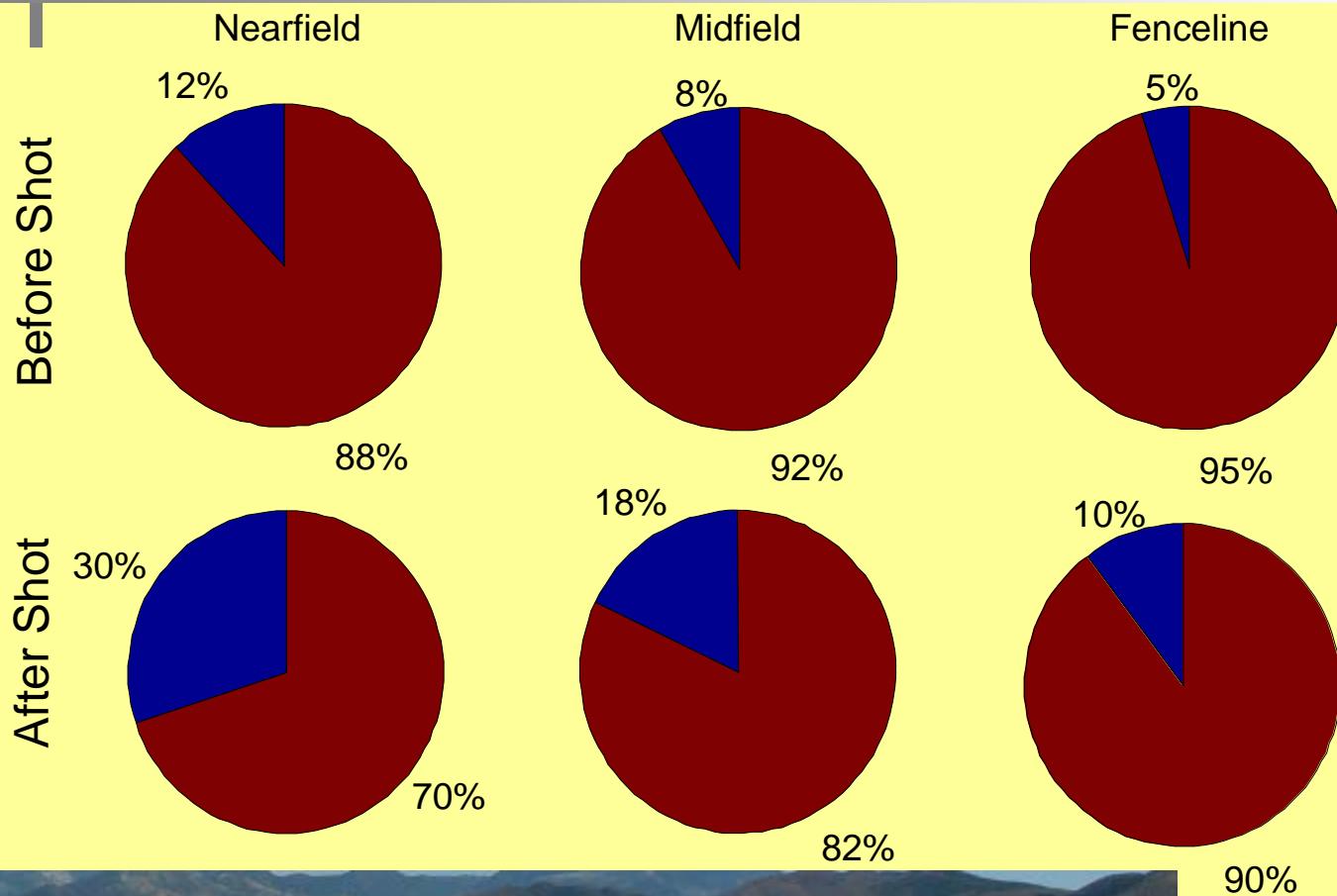


Plumes





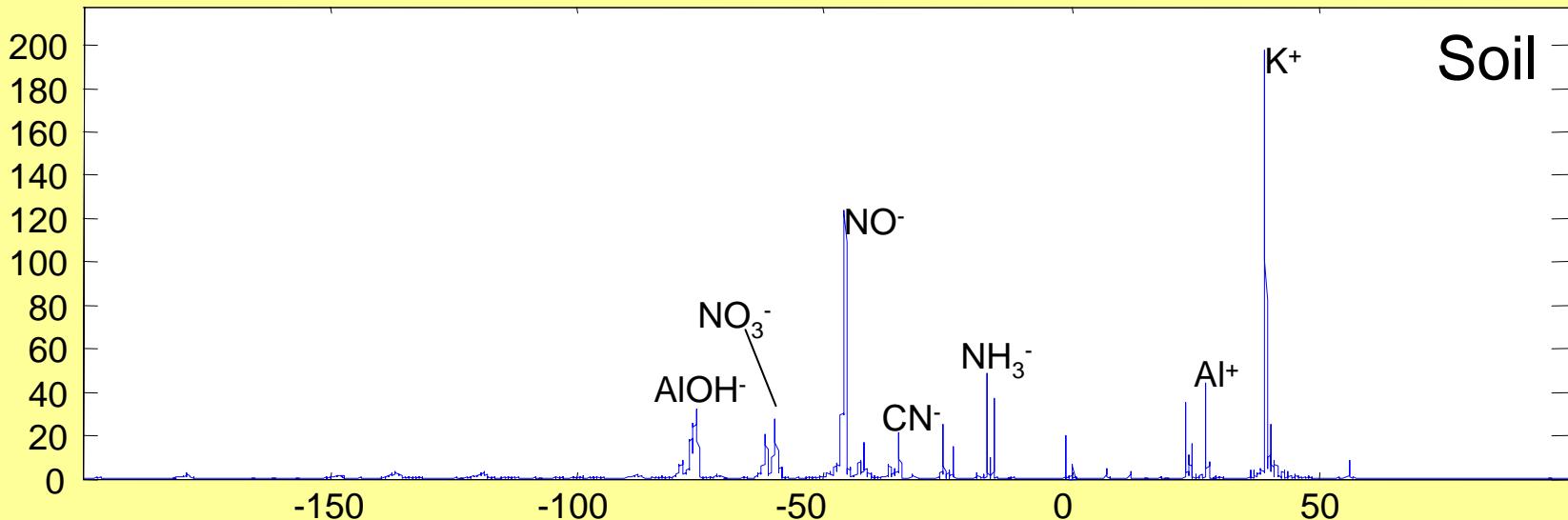
Identified Soil Particles





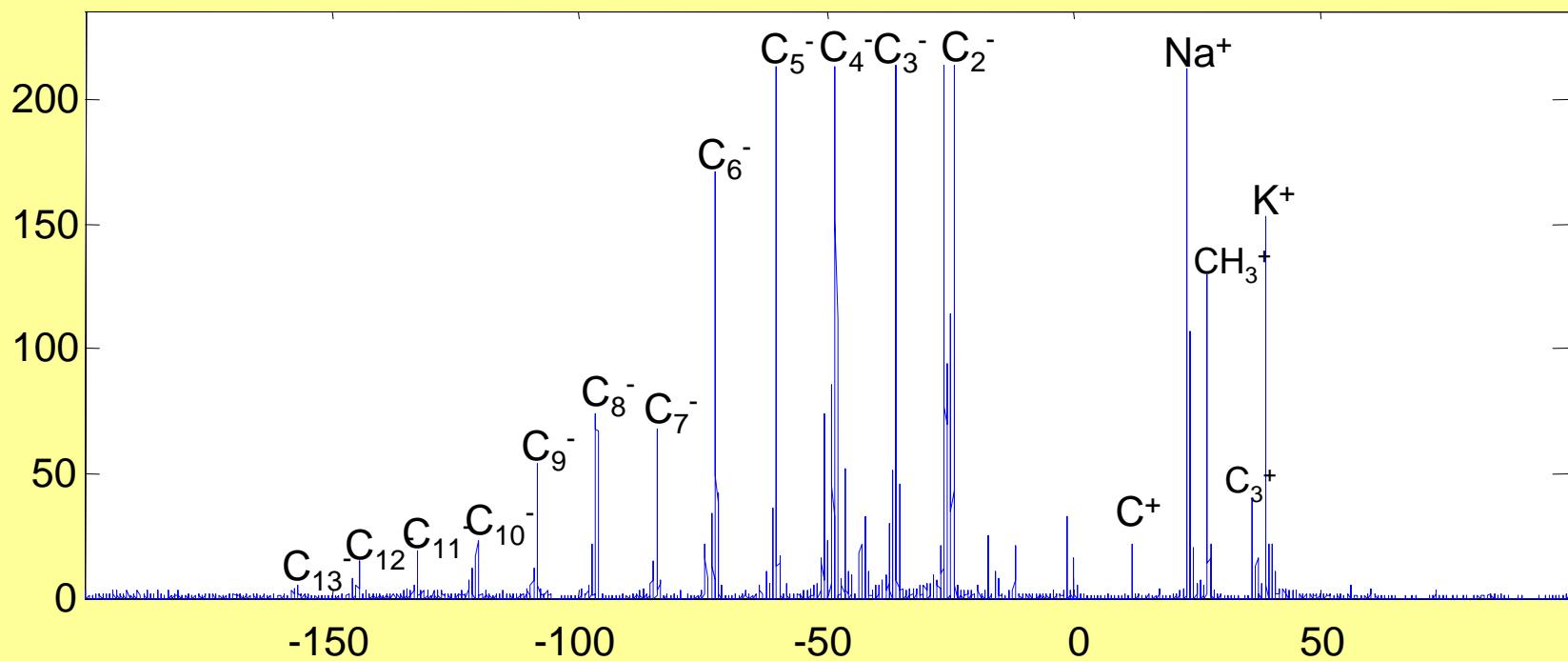
Near Field Data: 70 Meters

- 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



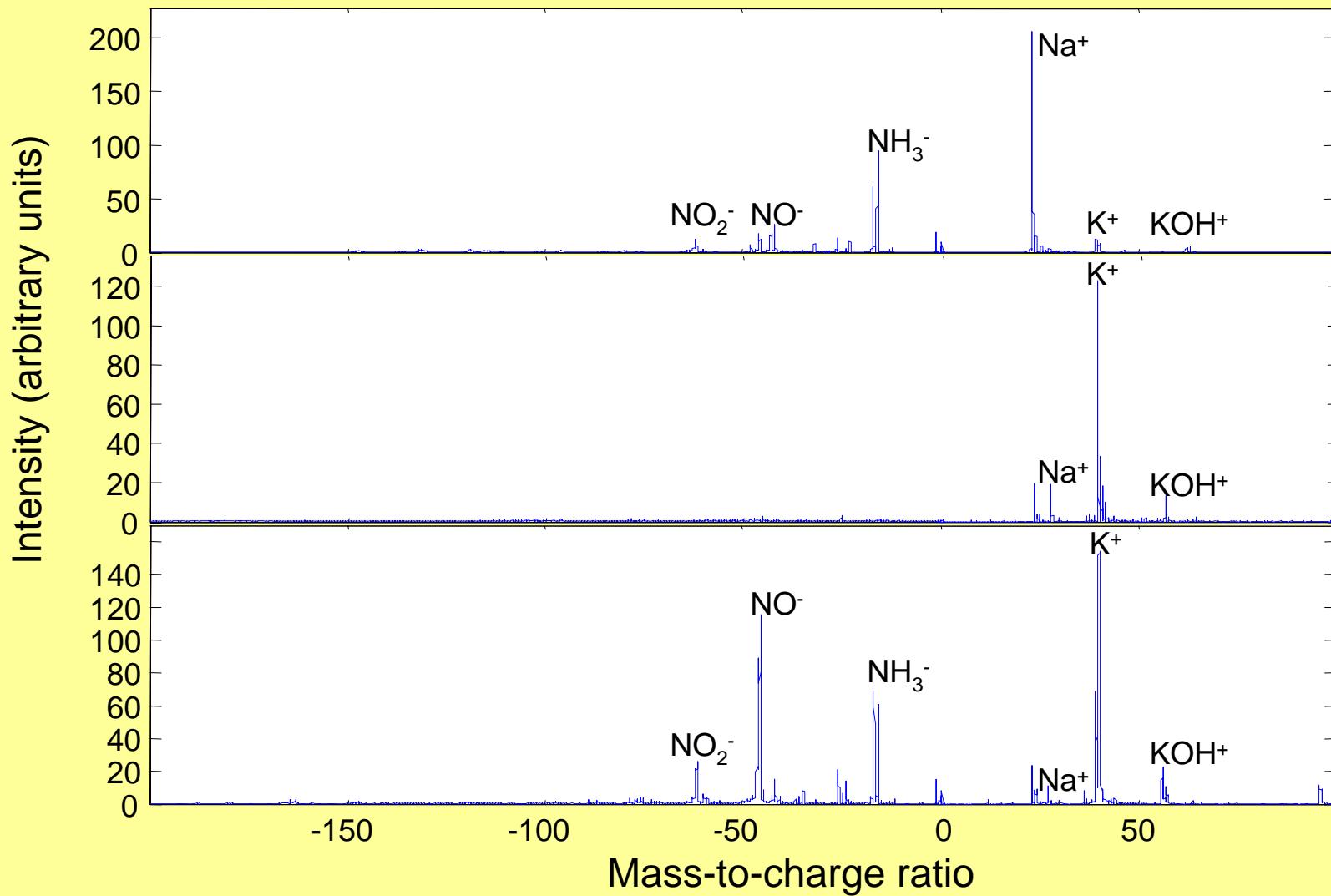


Soot





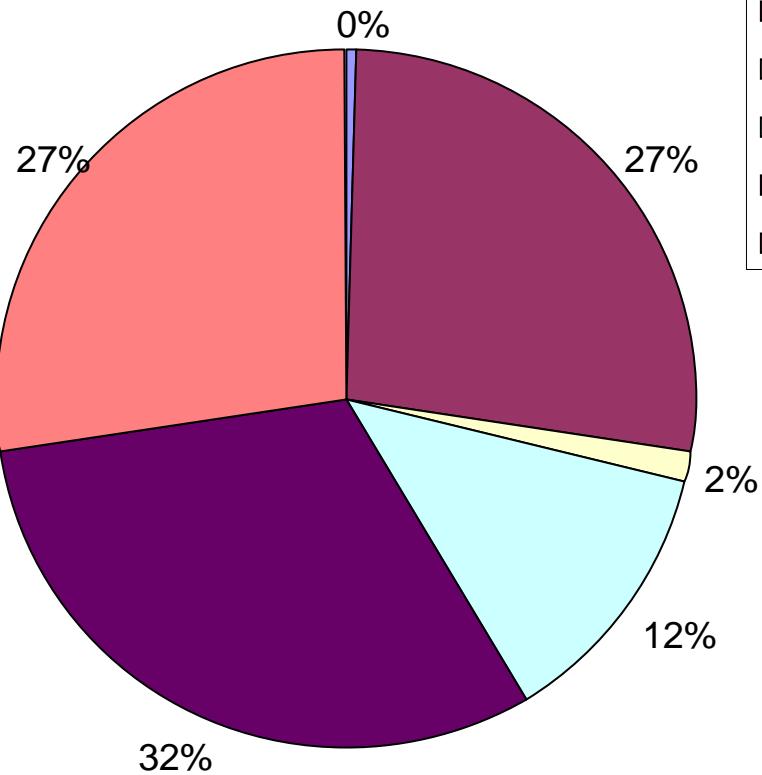
Other Background Particle Classes





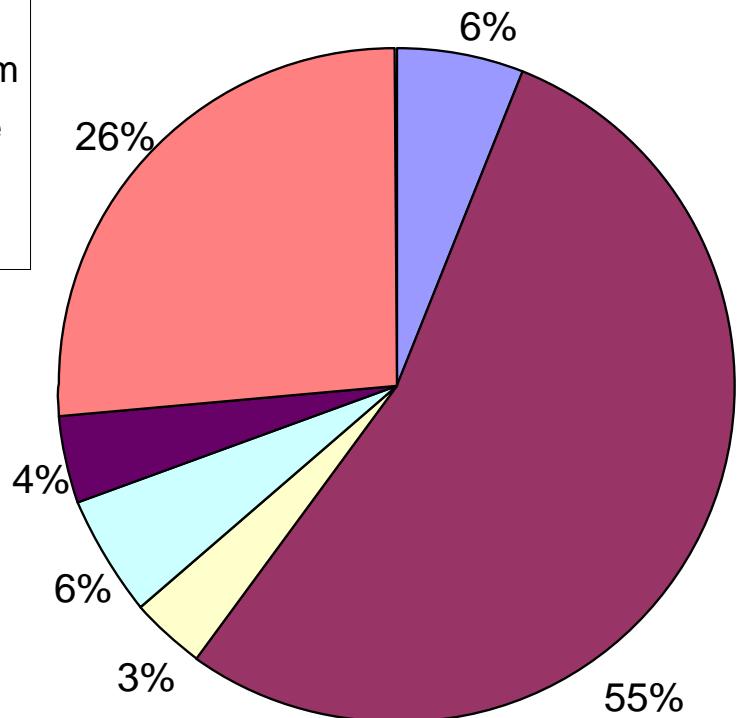
Near Shot Data: Before and After

Background Ambient



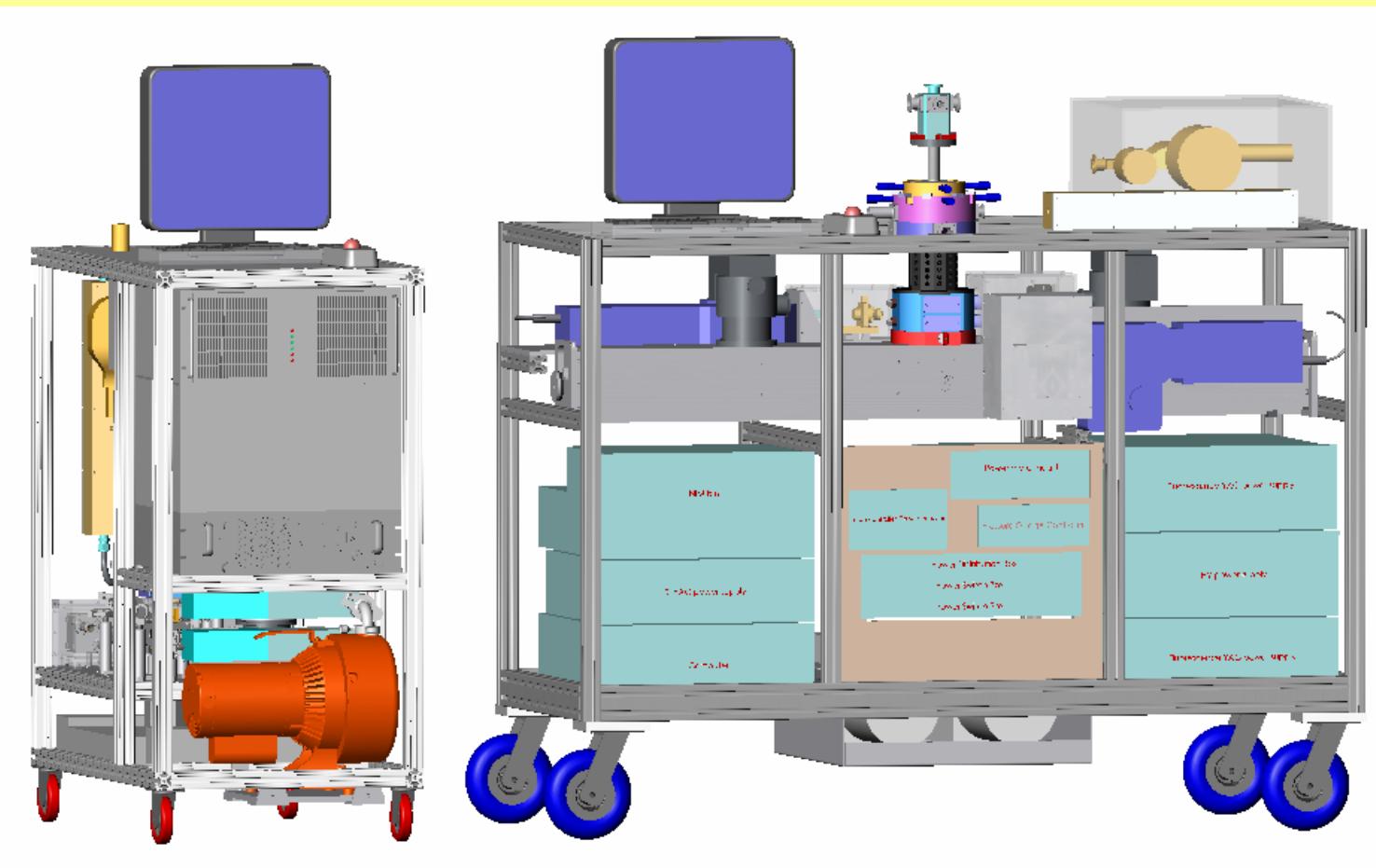
■ Soot
■ Soil
■ Sodium/Potassium
■ Potassium Nitrate
■ Sodium Nitrate
■ Other

Shot Spectra





PAMS/BAMS/SPAMS 2.0 (!)





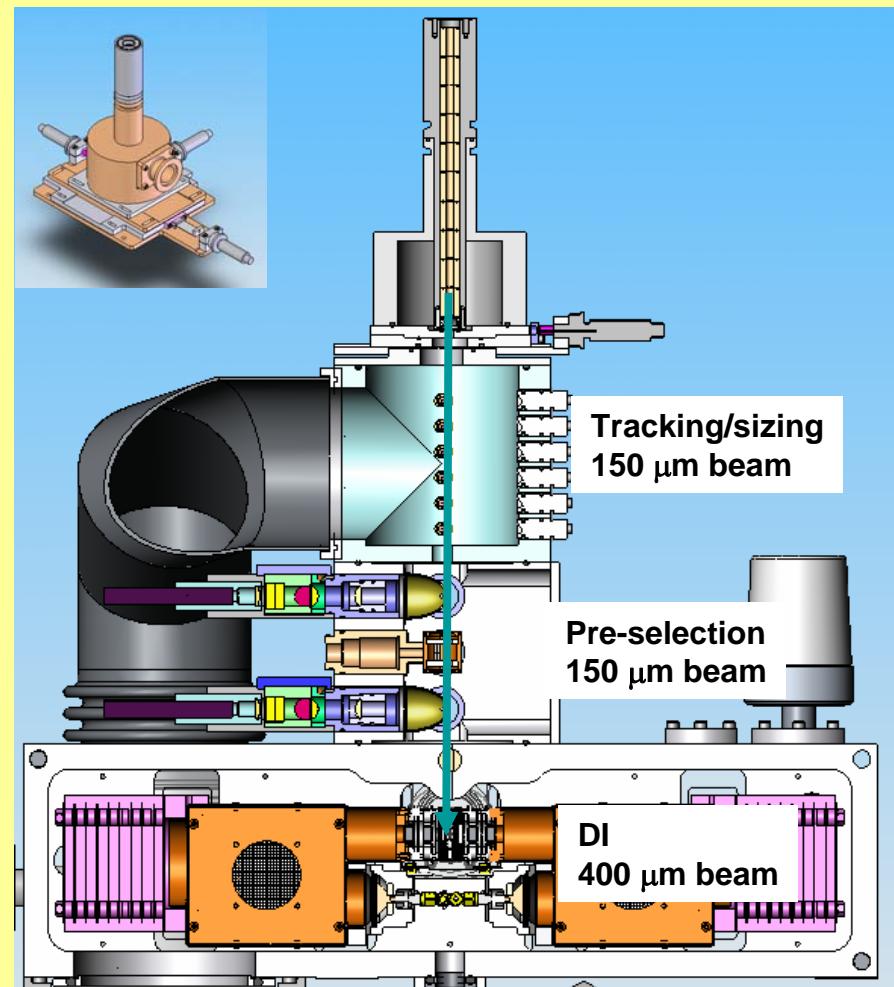
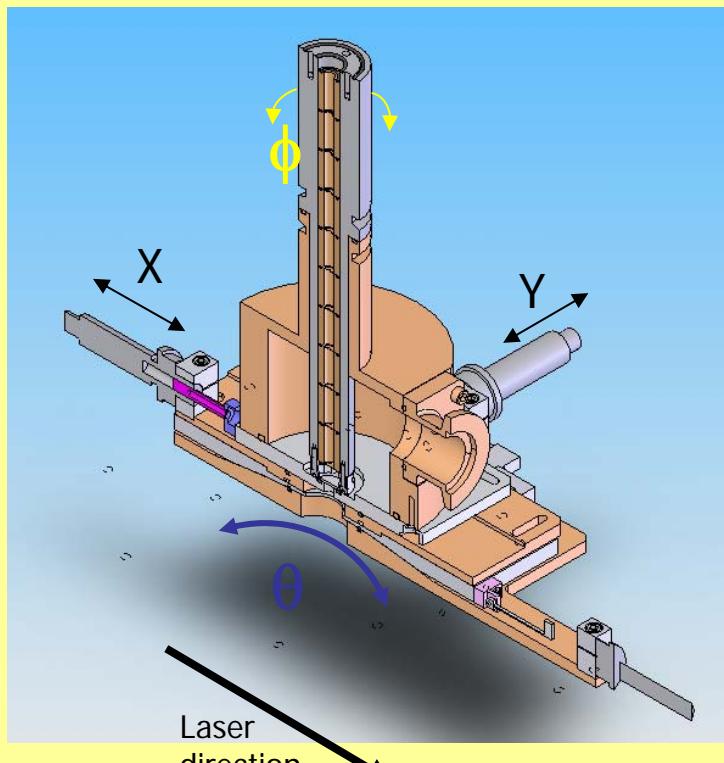
SPAMS 2.0 Design Changes

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



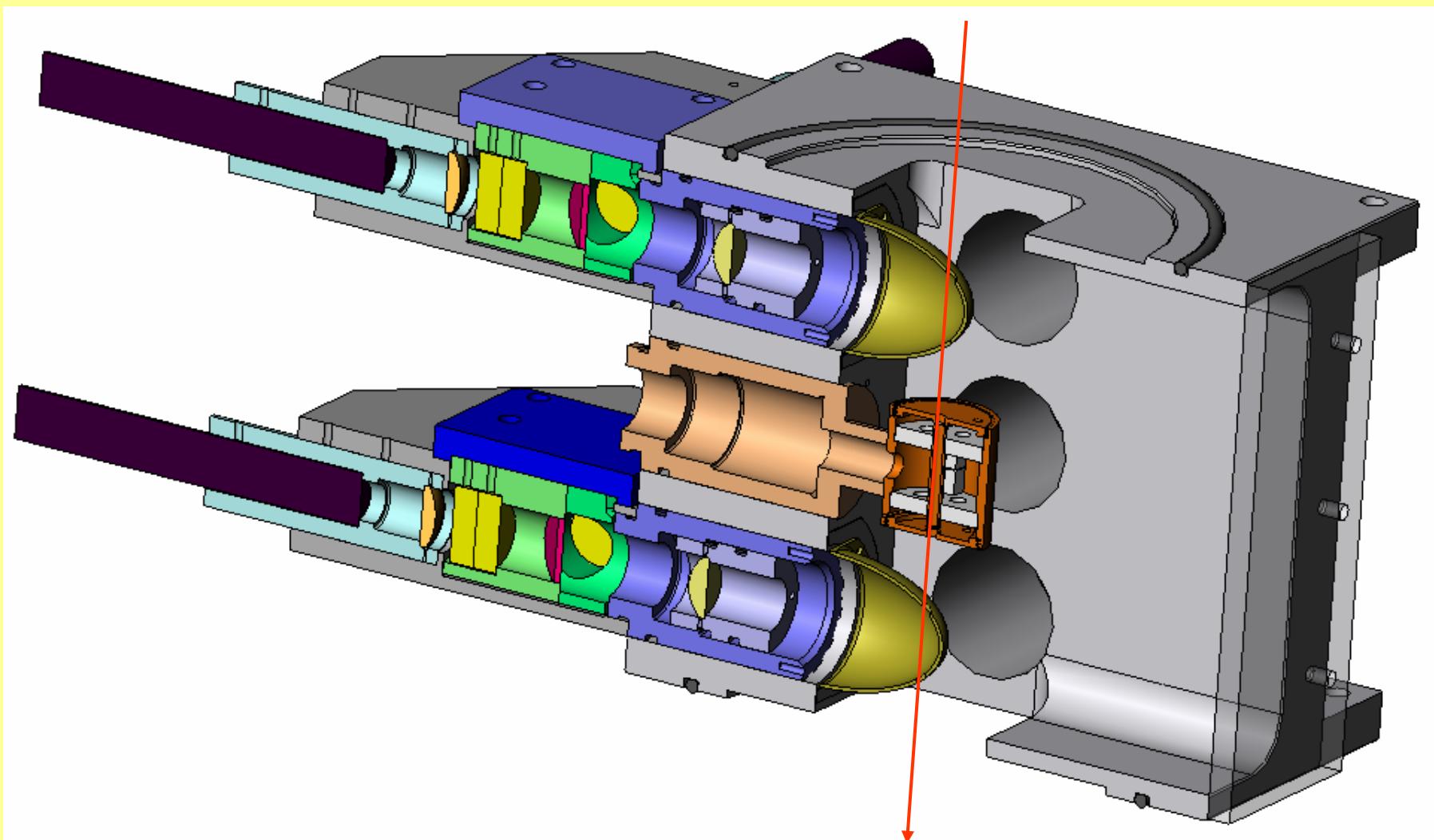


The Aerosol Beam Can Be Aimed



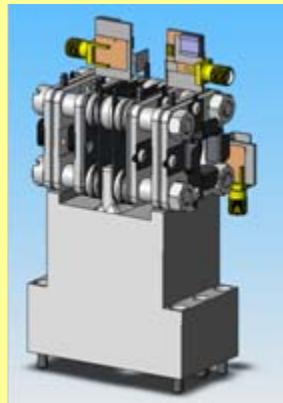
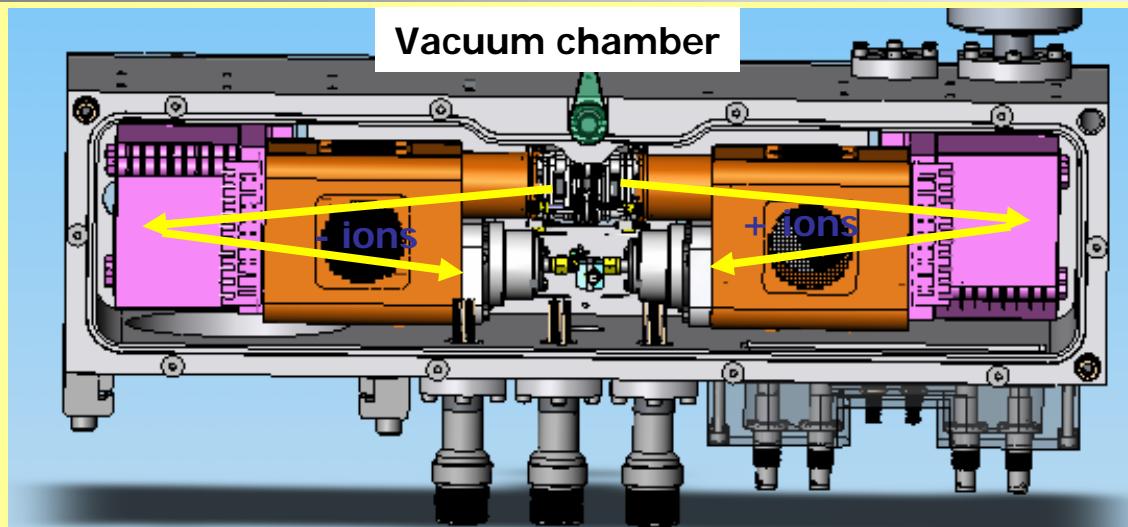


Preselection Increases Sensitivity

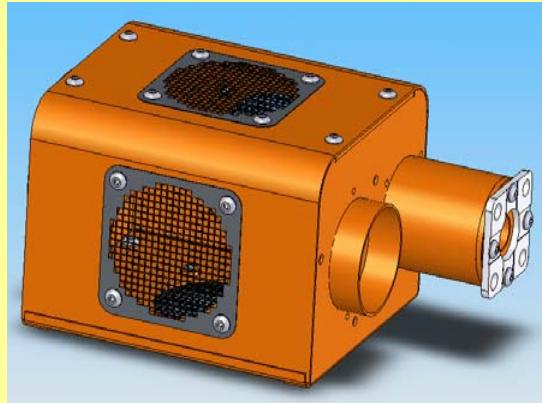




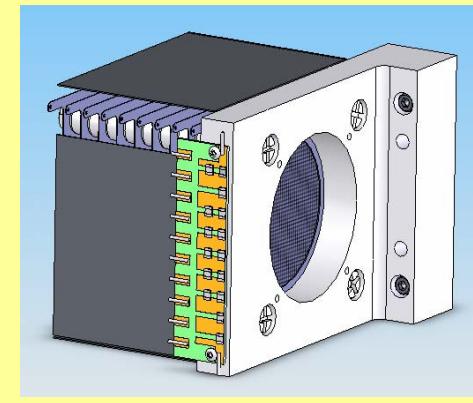
The Mass Spectrometer is 4x smaller



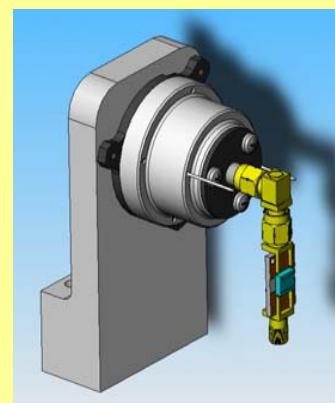
Acceleration
& steering



Drift



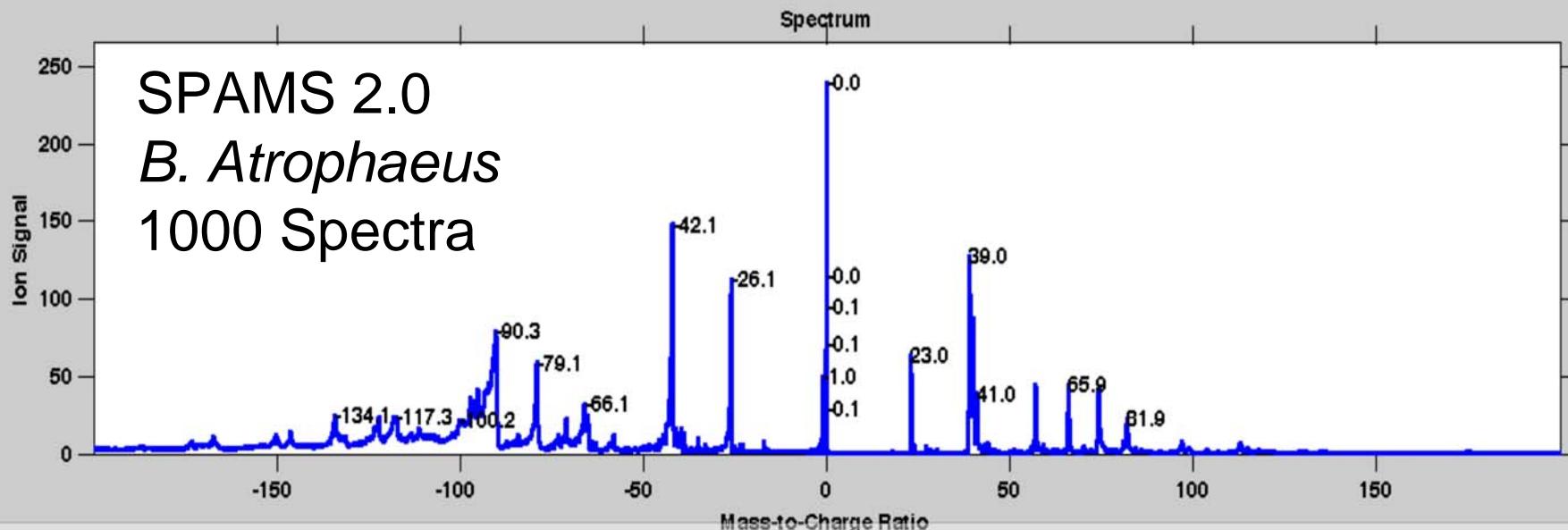
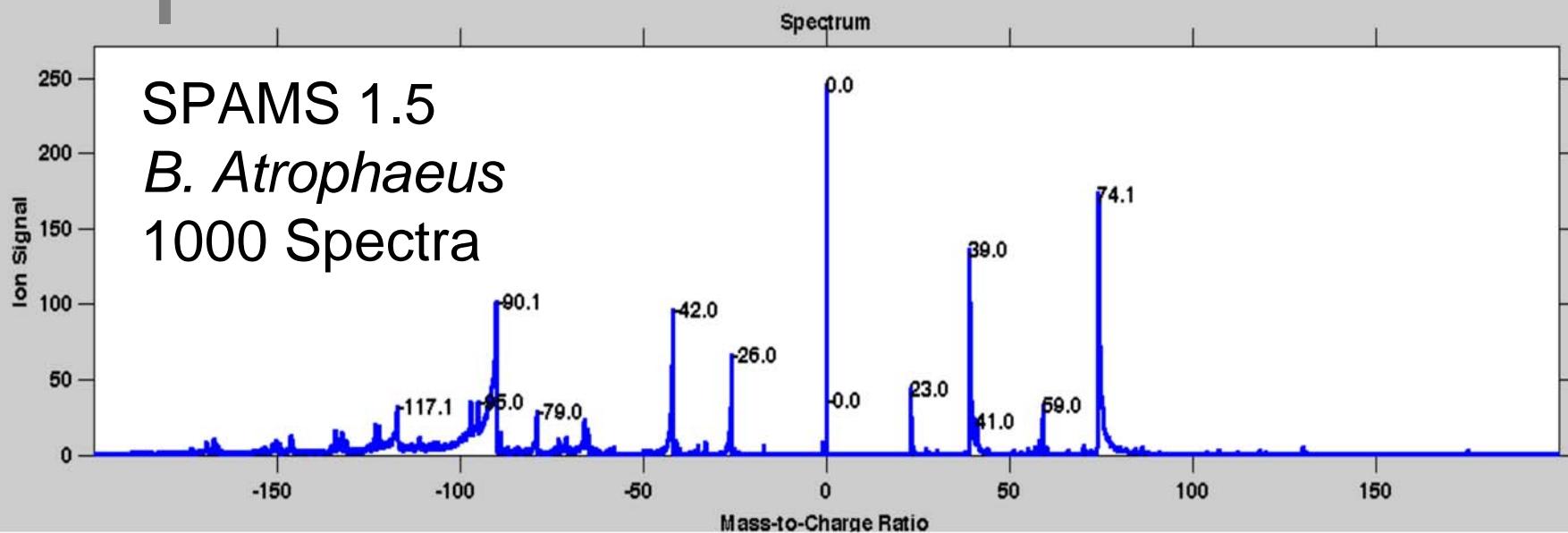
Reflectron



MCP Detector



SPAMS 1.X vs. 2.0 Mass Spectra





The Files are Now in XML

File Configuration

General settings

File saving mode: Experiment
Base Name: Particle
Starting number: 0
Include Date&Time:

Files Location

File Path:
 Create sub-folder using file base name

Time duration (min): 30
Number of Files: 1000

Configuration Data

Include Configuration Data

Configuration

- + Application
- + BAMTRAK FPGA
- + PDA1000 Digitizers
- + Ultra 50 D/I Laser
- + Experiment Engine

Particle Data

Include Particle Data Saving Conditions: All Particles

Time Data

Include Time Data

Time Data

- + Track
 - + ScatterRateA: "Number of scatter events per second on tracking laser A"
 - + ScatterRateB: "Number of scatter events per second on tracking laser B"
 - + ScatterRateC: "Number of scatter events per second on tracking laser C"
 - + ScatterRateD: "Number of scatter events per second on tracking laser D"
 - + ScatterRateE: "Number of scatter events per second on tracking laser E"
 - + ScatterRateF: "Number of scatter events per second on tracking laser F"
 - + MatchRateB: "Percentage of matching events between tracking laser B and tracking laser A"
 - + MatchRateC: "Percentage of matching events between tracking laser C and tracking laser A"
 - + MatchRateD: "Percentage of matching events between tracking laser D and tracking laser A"
 - + MatchRateE: "Percentage of matching events between tracking laser E and tracking laser A"
 - + MatchRateF: "Percentage of matching events between tracking laser F and tracking laser A"
 - + DivergenceRateB: "Percentage of divergent events between tracking laser B and tracking laser A"
 - + DivergenceRateC: "Percentage of divergent events between tracking laser C and tracking laser A"
 - + DivergenceRateD: "Percentage of divergent events between tracking laser D and tracking laser A"
 - + DivergenceRateE: "Percentage of divergent events between tracking laser E and tracking laser A"
 - + DivergenceRateF: "Percentage of divergent events between tracking laser F and tracking laser A"

MS

- + NegativelionTOF: "Array of ion time of flight data from the negative ion source"
- + PositivelionTOF: "Array of ion time of flight data from the positive ion source"
- + MSHit: "Flag Indicating if the mass spectrum met the hit requirement"

Summary Data

Include Summary Data

Summary Data

- + Track
 - + TotalScattererA: "Total number of scatter events on tracking laser A"
 - + TotalScattererB: "Total number of scatter events on tracking laser B"
 - + TotalScattererC: "Total number of scatter events on tracking laser C"

- 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
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