

# Technology Behind the Finnigan LTQ

ASMS Users Forum 2003



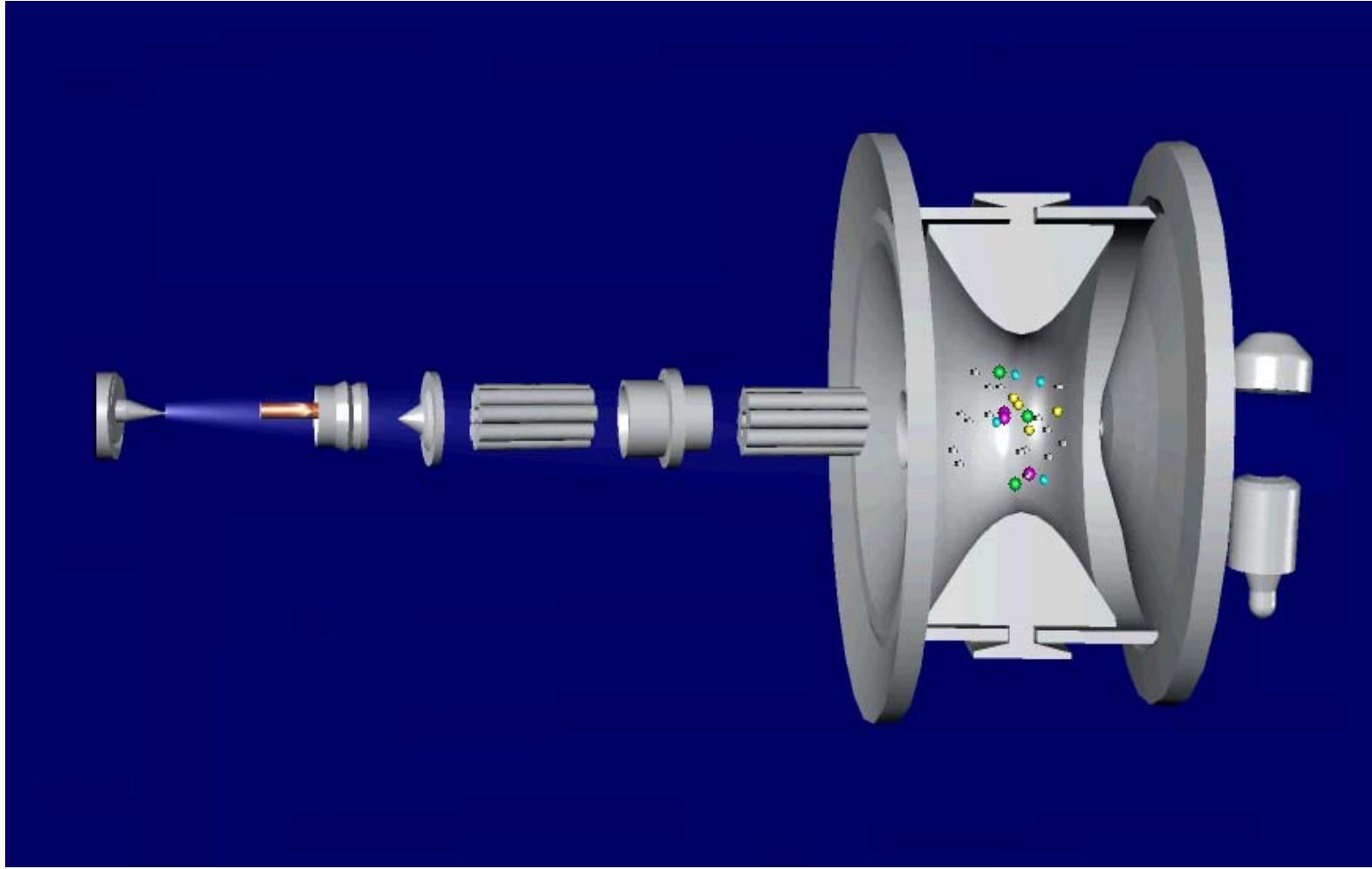
**Jae C. Schwartz**

# Outline

1. Fundamentals of Linear Trap Technology
2. Instrument Configuration
3. Instrument Performance

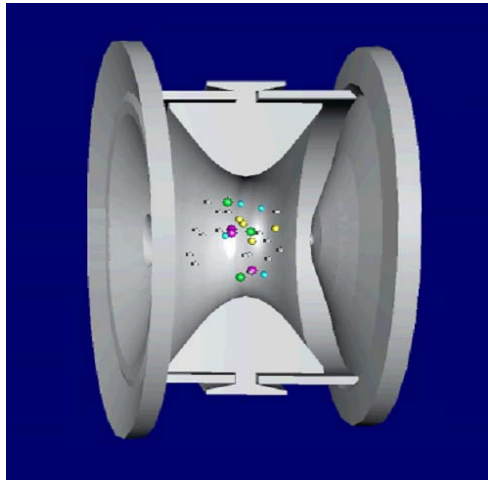


# 3D - Quadrupole Ion Trap

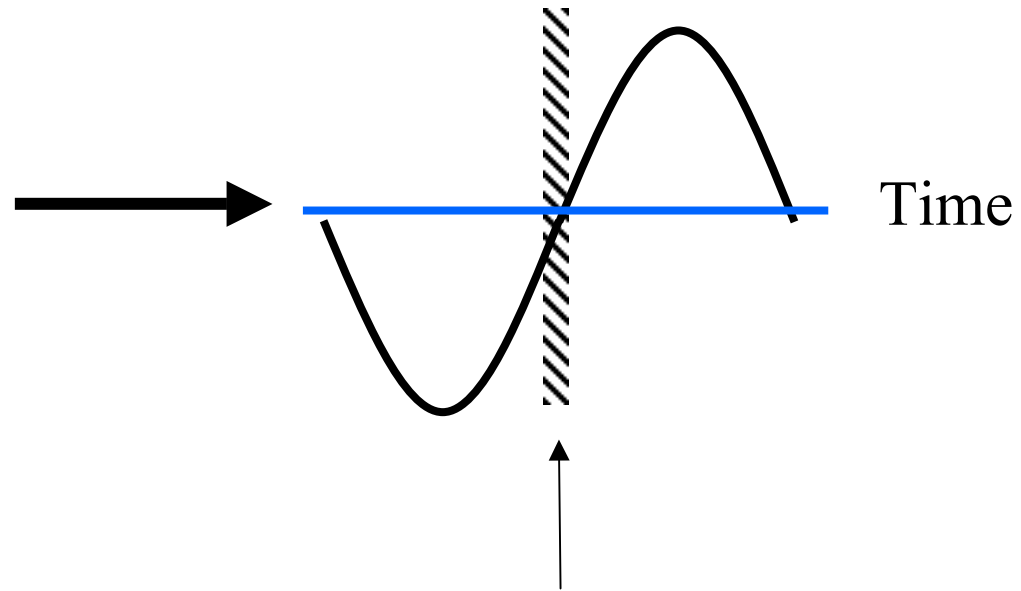


# Trapping of Injected Ions

3D Trap

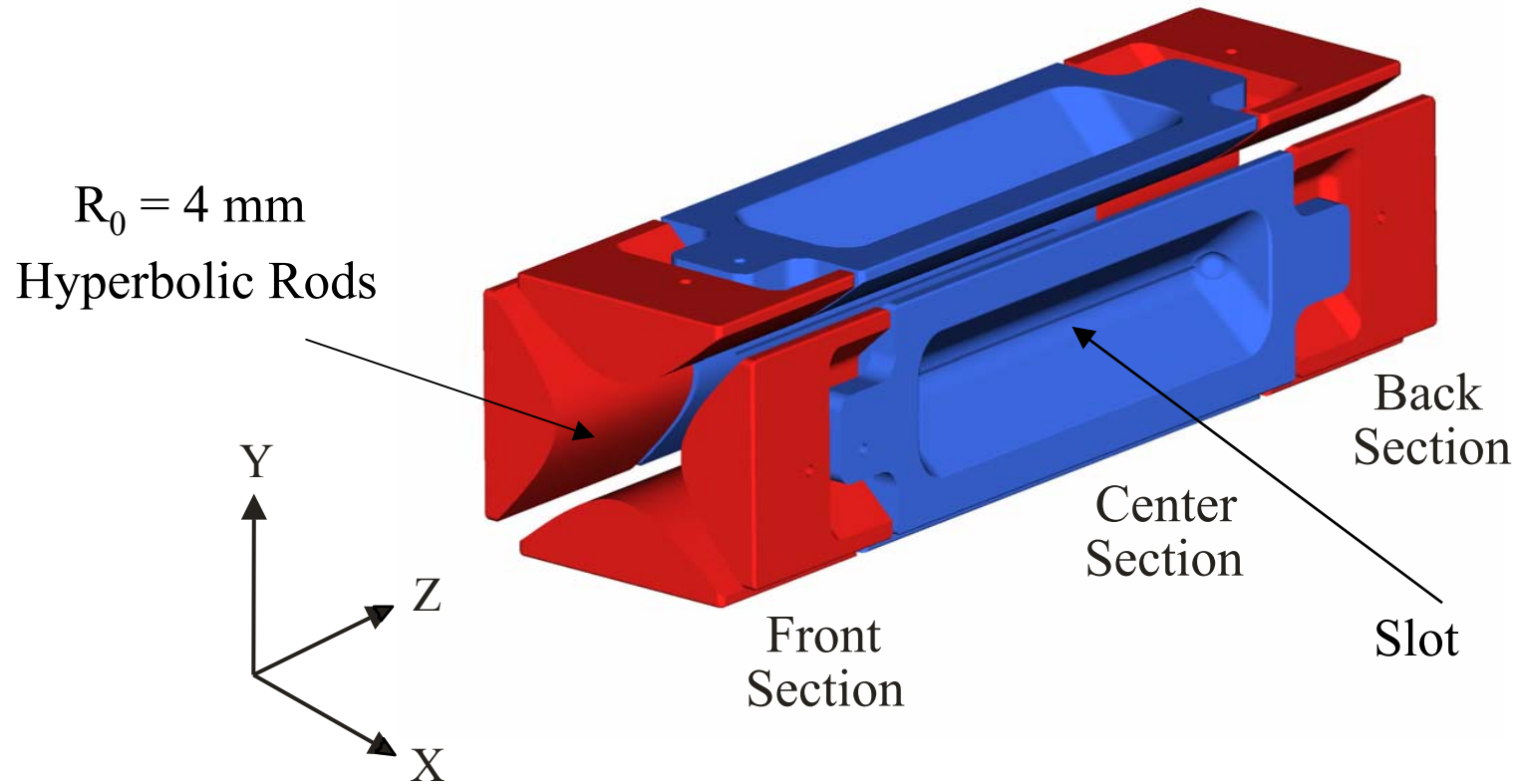


Rf Amplitude

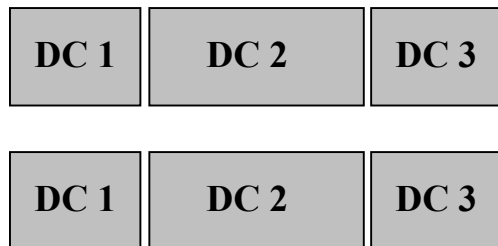


Phase Window for  
Successful Trapping of  
Injected Ions

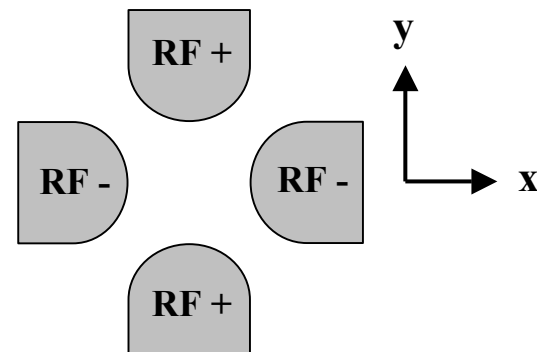
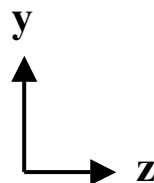
# Basic Linear Trap Structure



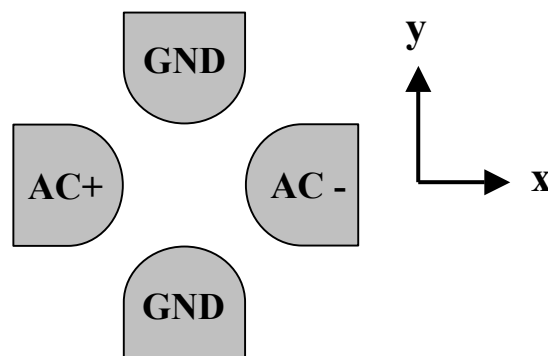
# RF/AC/DC Voltages Applied



**Axial Trapping**  
3-130 V DC

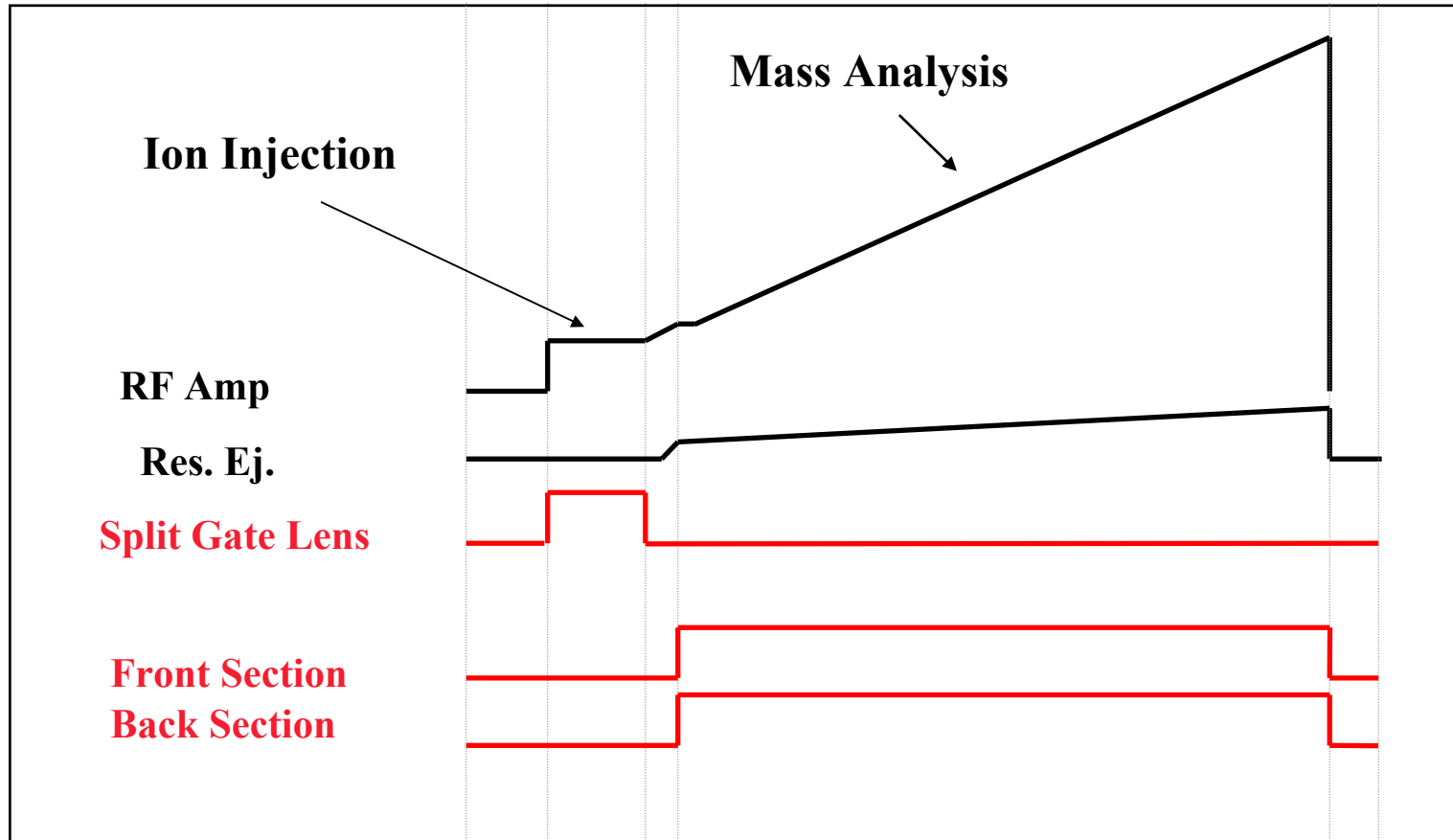


**Radial Quadrupolar Trapping**  
1.2 MHz 5KV<sub>0-P</sub>

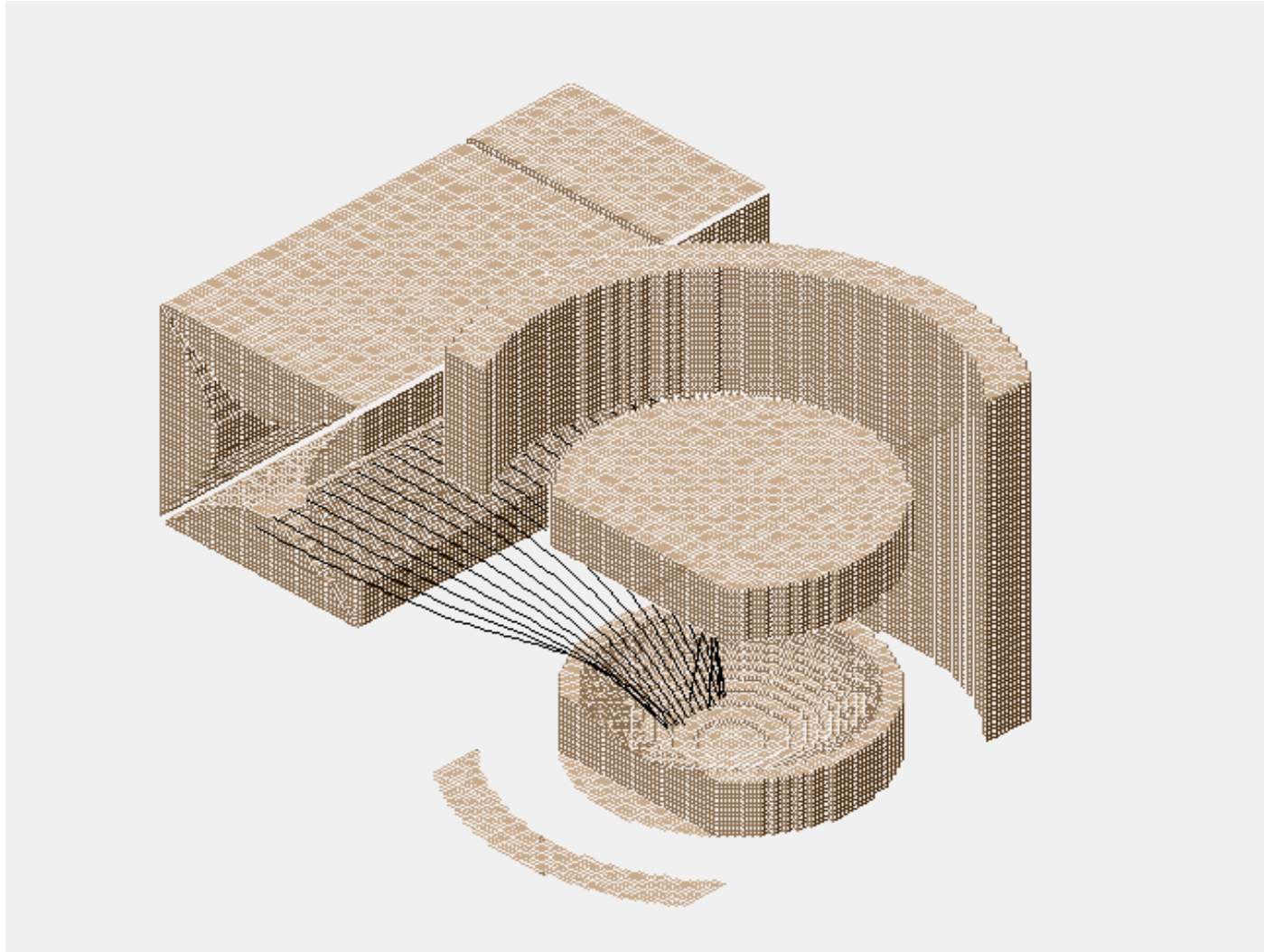


**Radial Dipolar Excitation and Ejection**  
5-600 KHz 0-400 V<sub>pp</sub>

# Basic Full Scan MS Scan Function

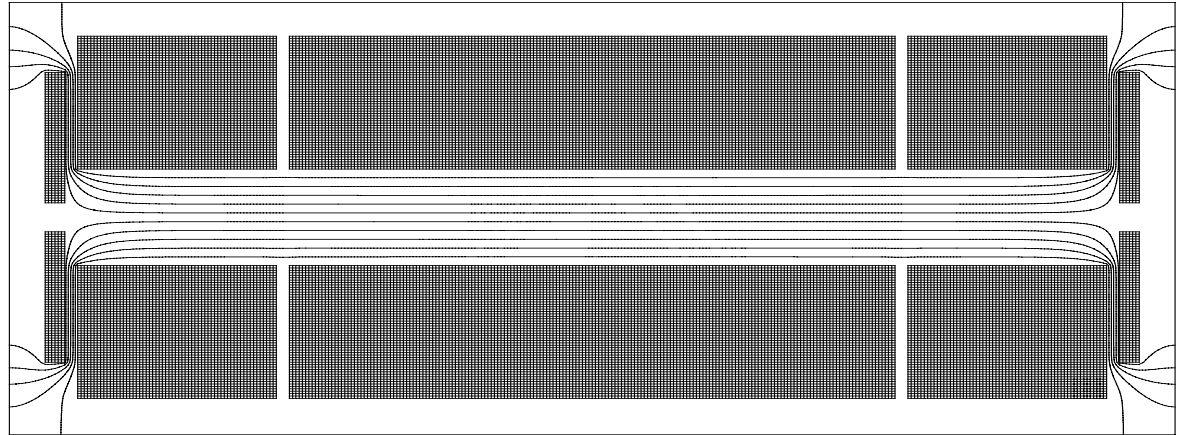


# SIMION 3D Version 7 Simulation

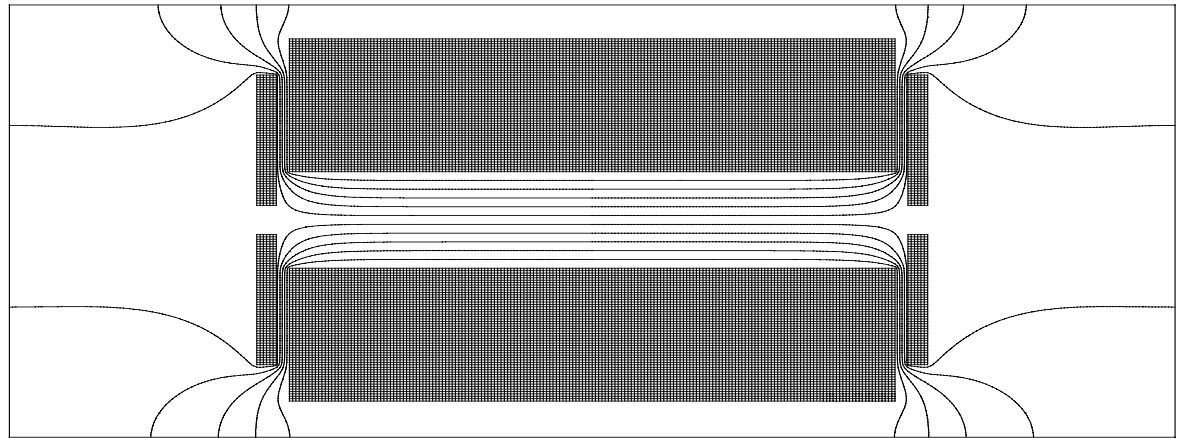


# Simion Simulation of Dipole Excitation Field

Segmented  
Trap



Unsegmented  
Trap



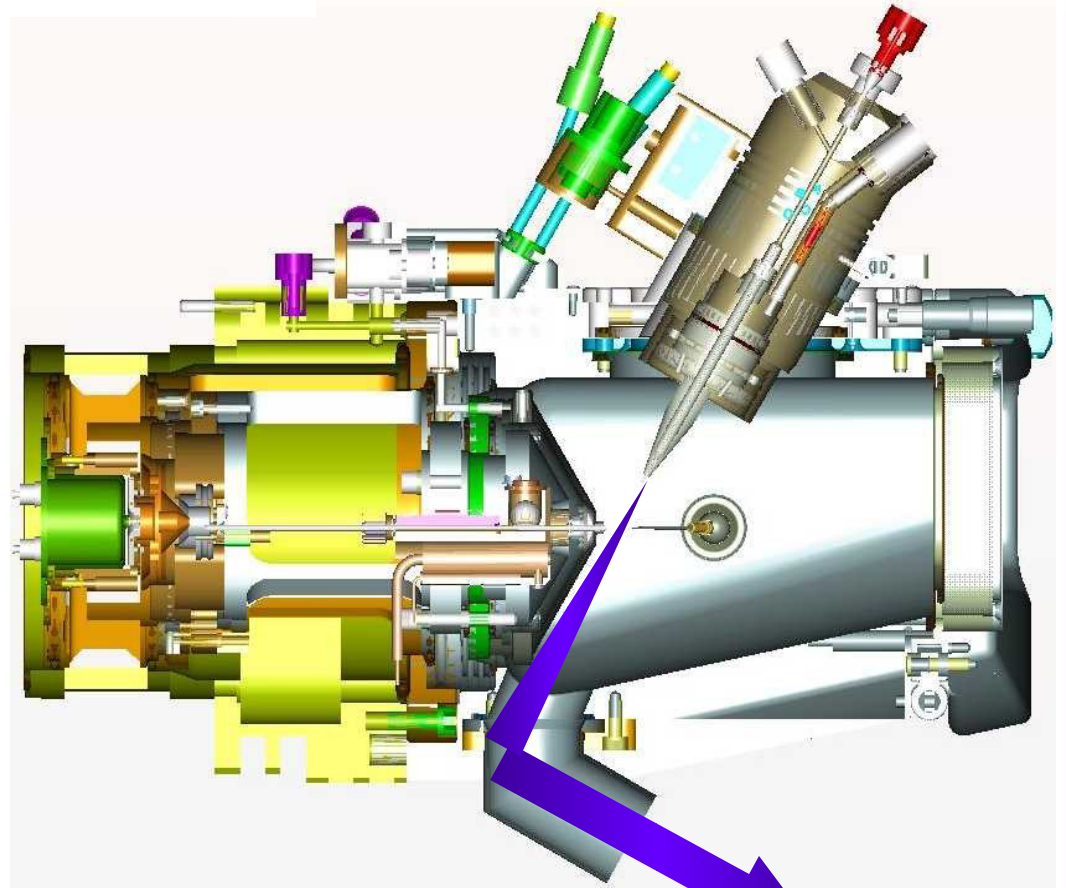
# LTQ Instrument Configuration

# The Finnigan LTQ



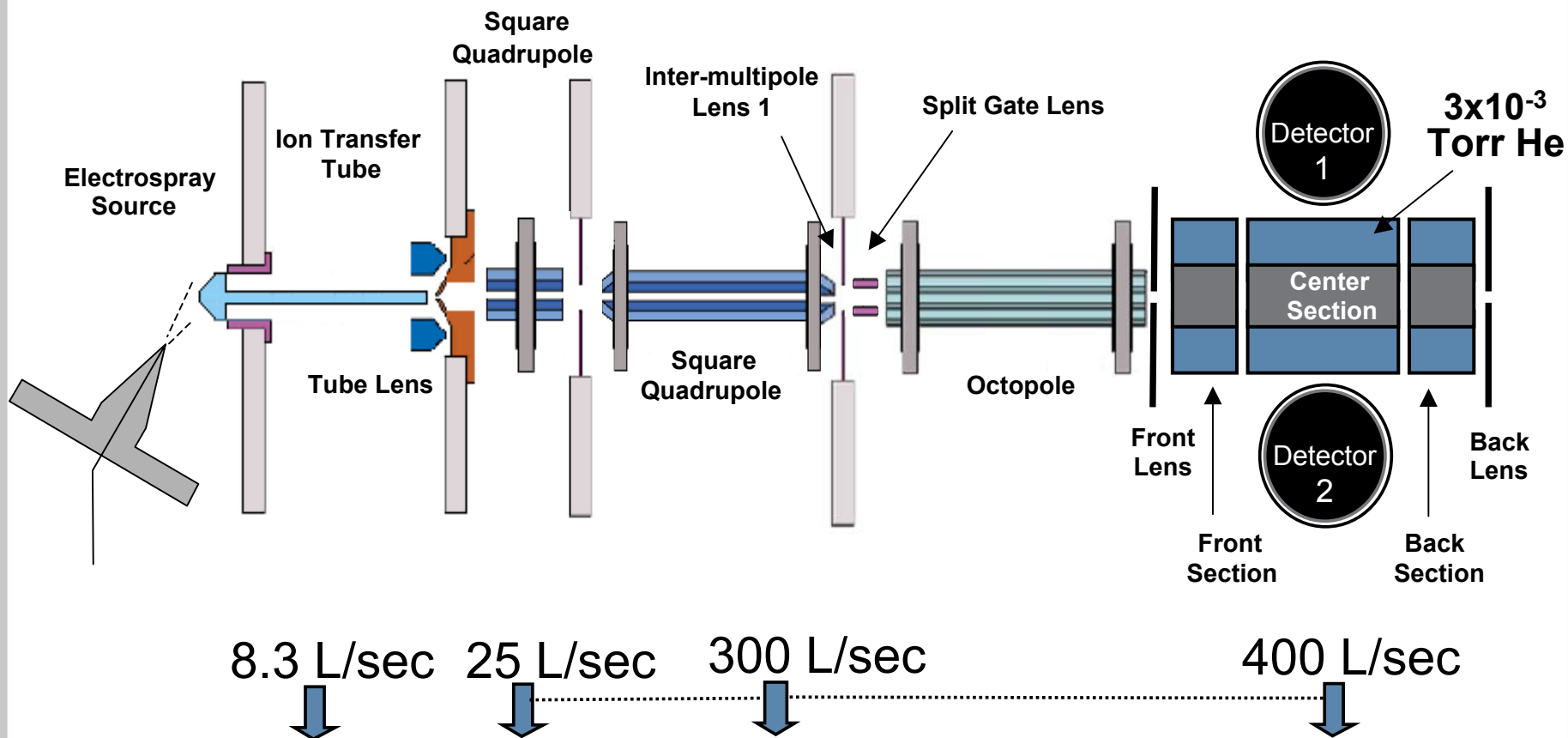
# Source Design Features

- New 60 deg design
- New Ion Sweep Design
- New Exhaust Design
- Titanium Skimmer
- New Tube lens design
- Q00 multipole
- Larger L0 Lens
- New Ion Transfer Tube Design
- Metal needle for low and high flow
- New ceramic heater for APCI
- APPI Ready



**Increased Sensitivity, Reduced Chemical  
Noise, and Increased Robustness**

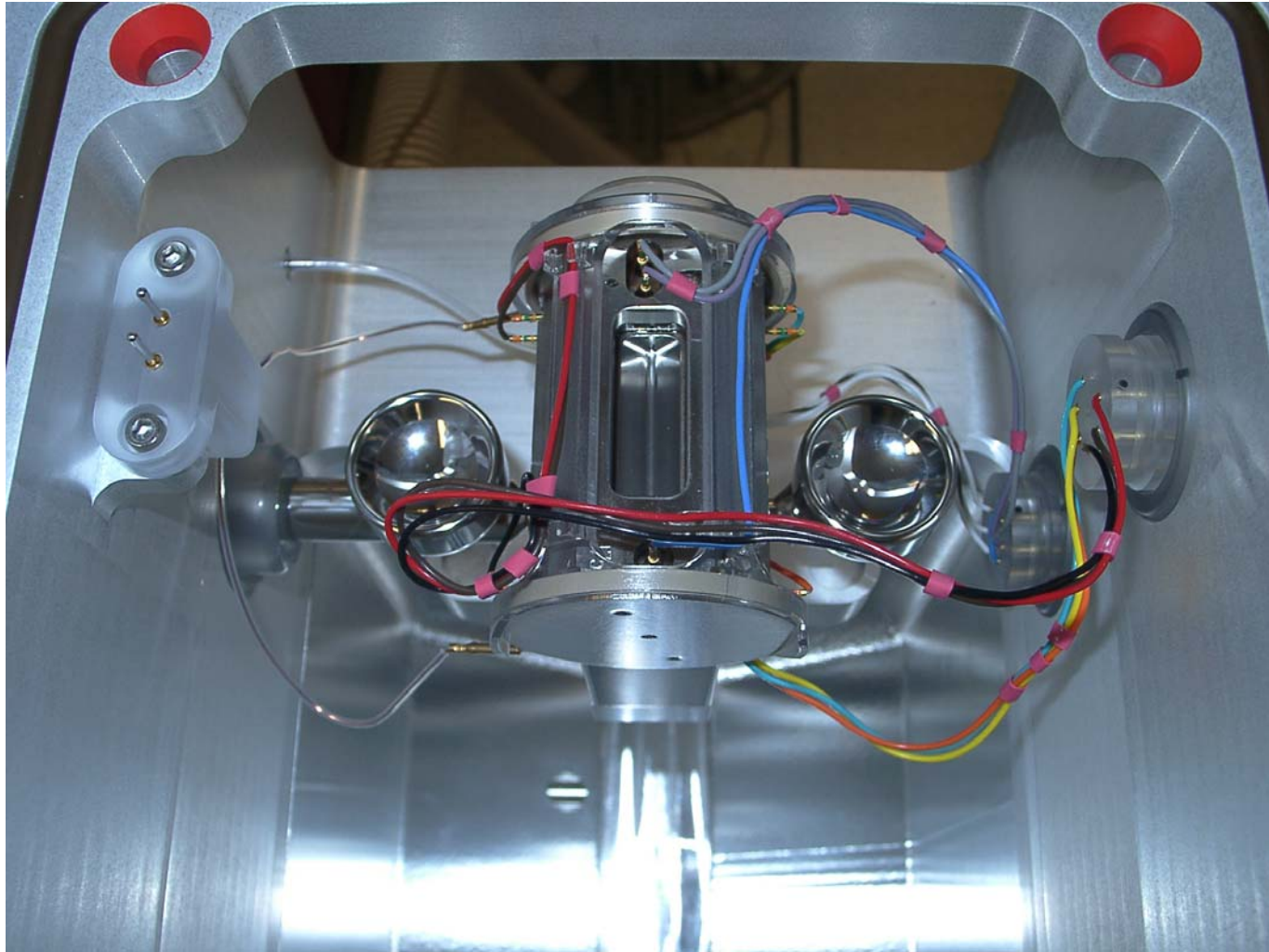
# LTQ Instrument Configuration



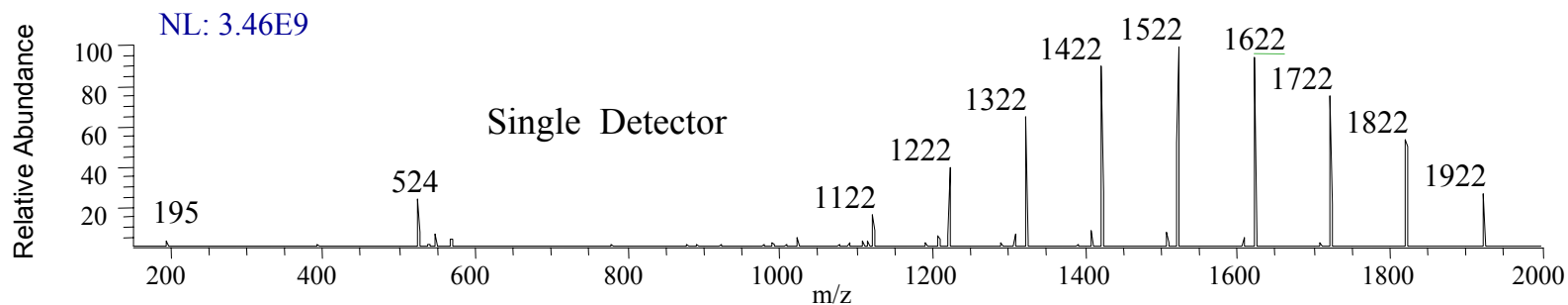
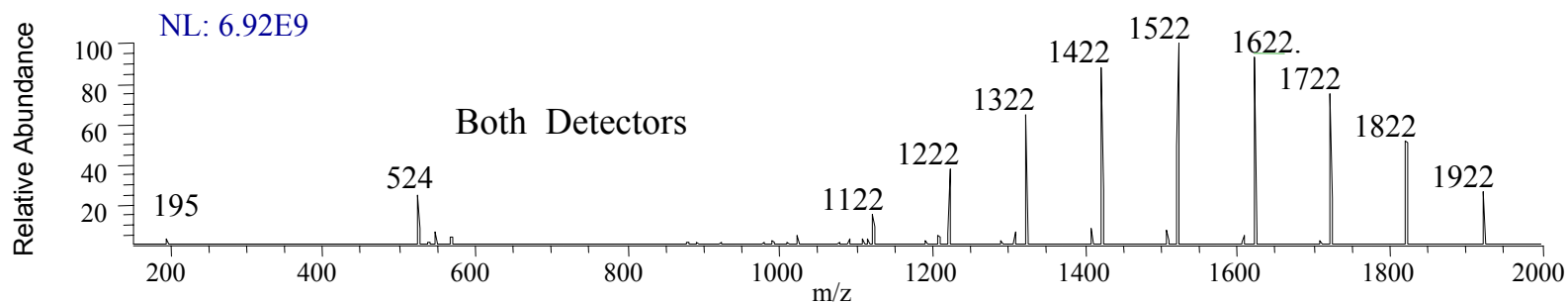
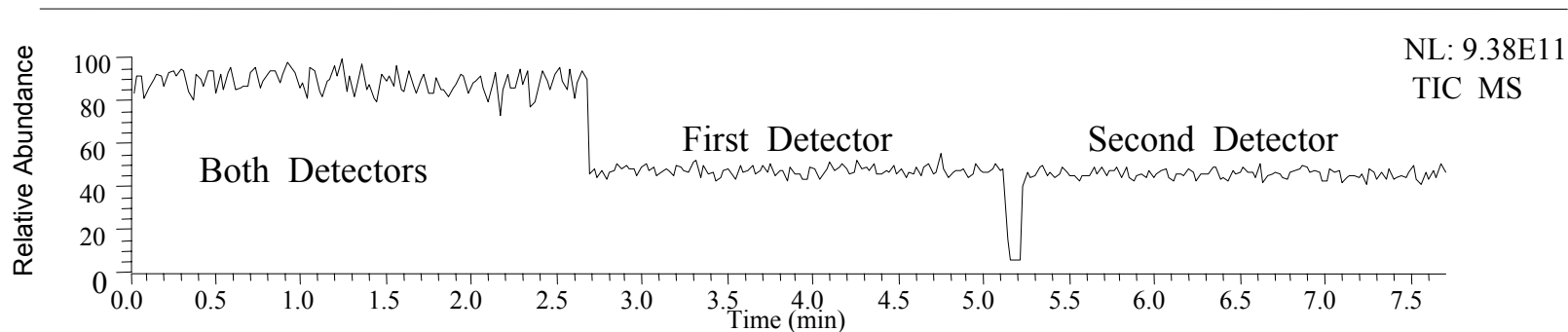
# LTQ Top Cover Plate – Ion Optics



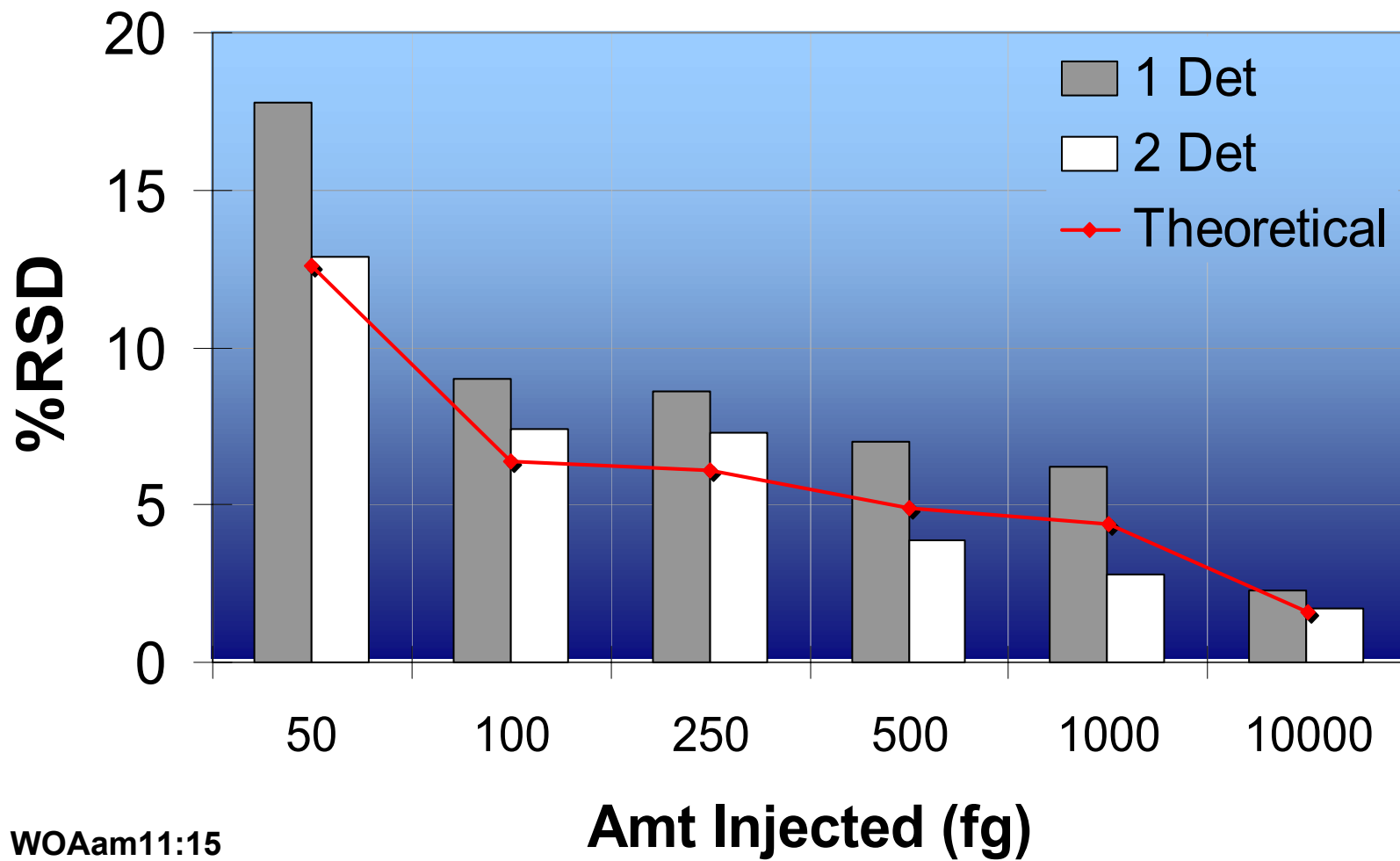
# LTQ Vacuum Chamber – Linear Trap and Dynodes



# Two Detectors - 2x Signal



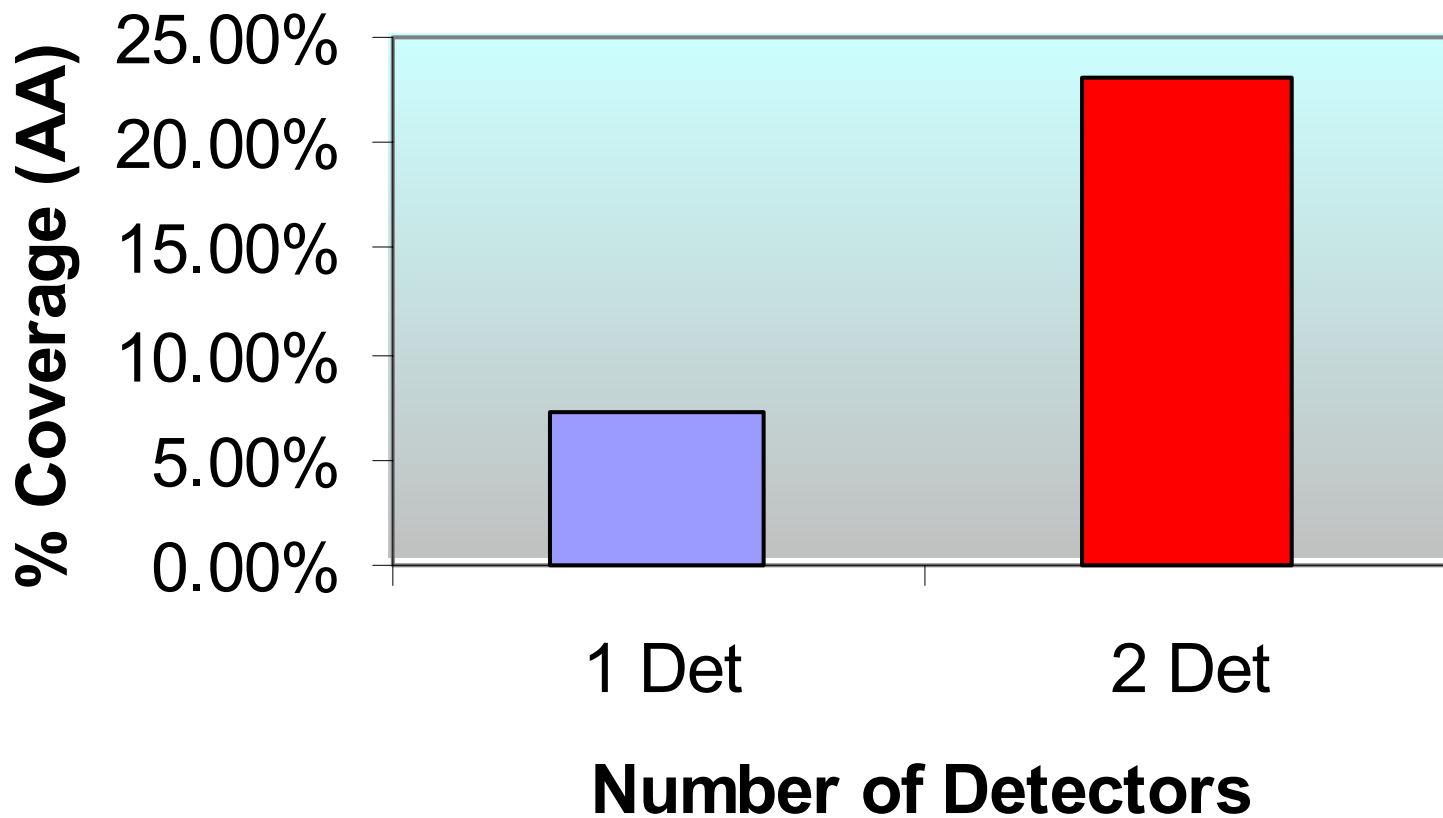
# 1 vs 2 Detectors: %RSD Improvement (Alprazolam Quantitation)



WOAm11:15

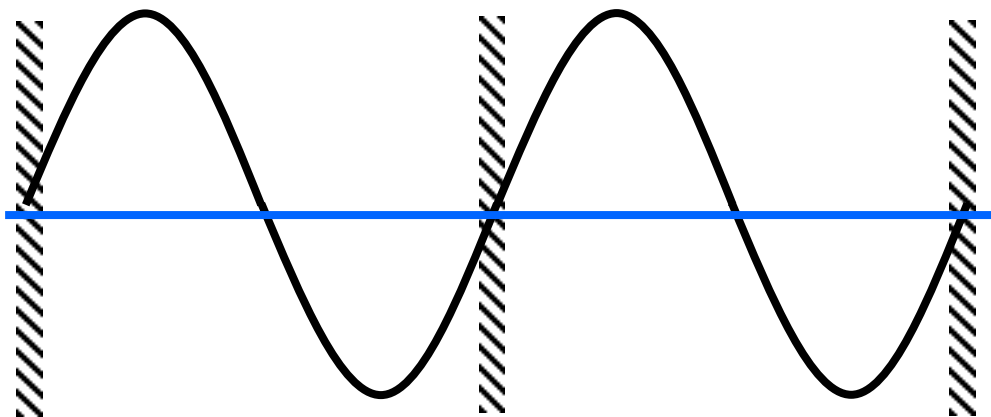
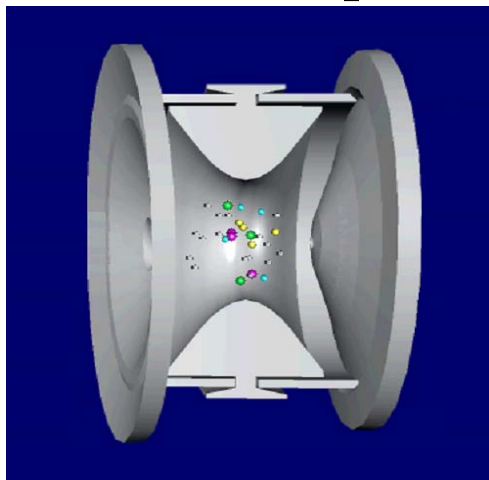
# 1 vs 2 Detectors – Qualitative Results

## 200 amols of Myoglobin Digest Injected

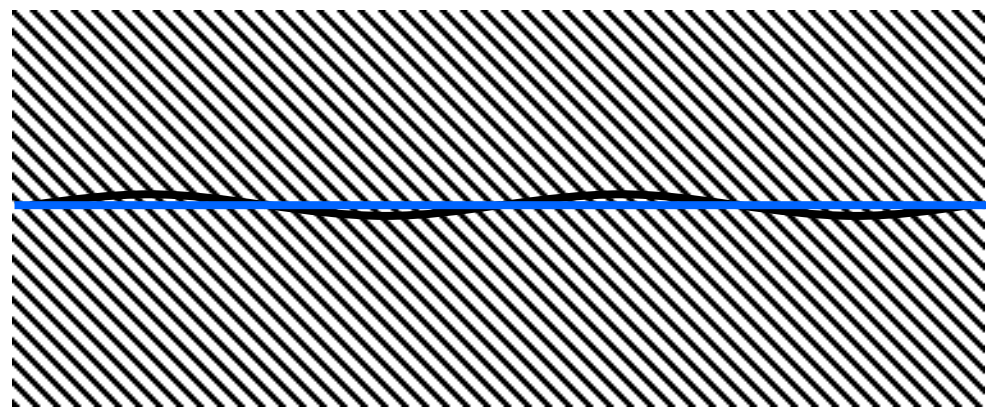
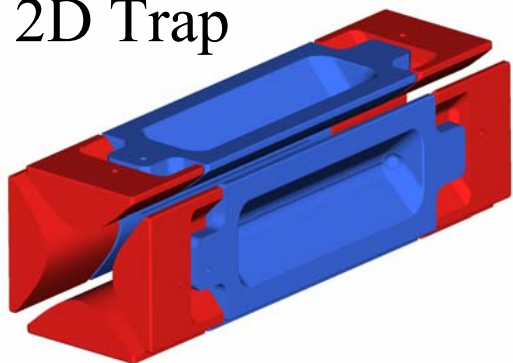


# Trapping of Injected Ions

3D Trap



2D Trap

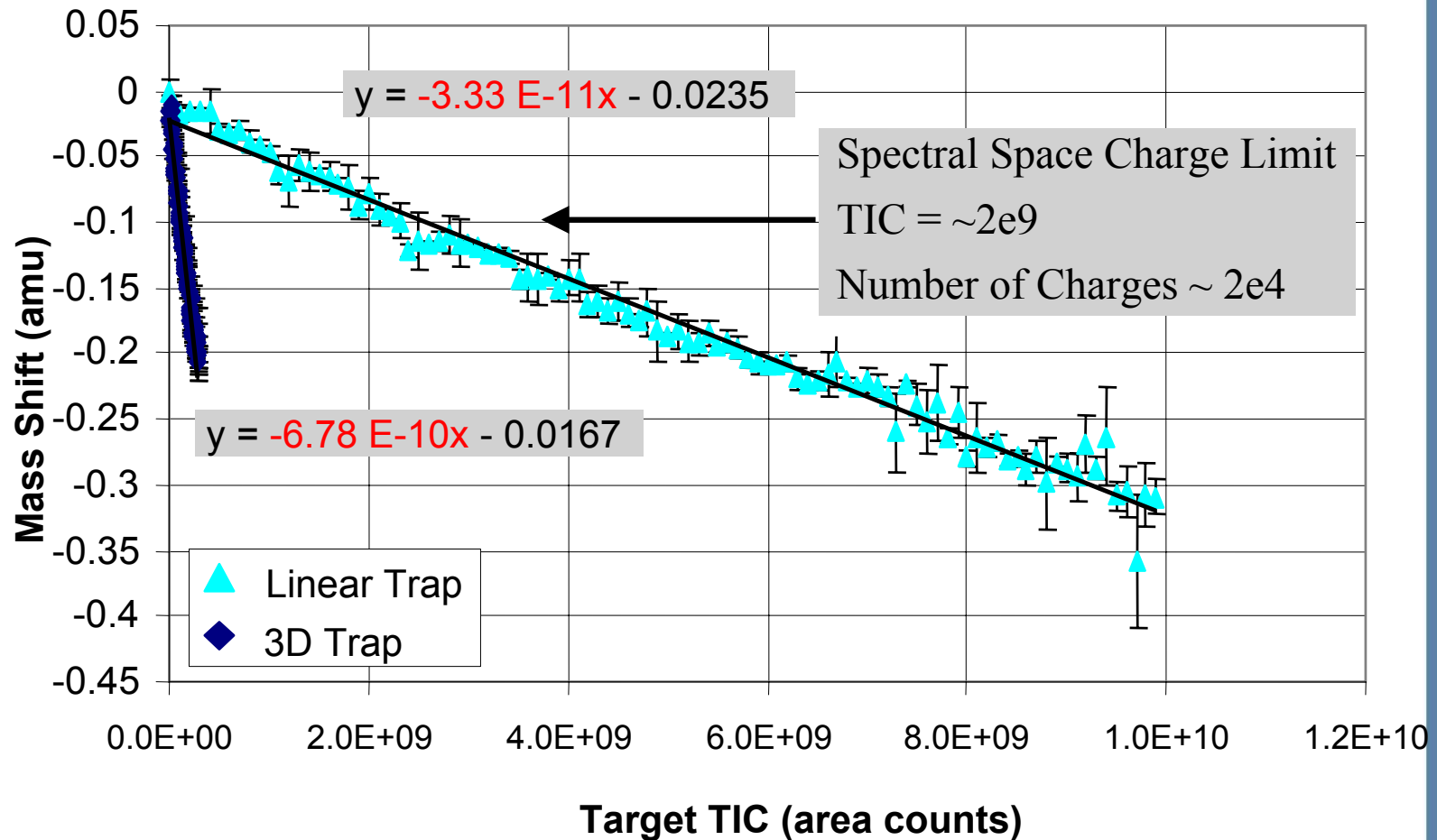


# Improvements to Trapping and Ejection Efficiencies

LTQ vs XP Increase

Overall Detection Efficiency: ~14-22x

# Spectral Space Charge Limit Comparison (SIM m/z 524.3 +/- 5)



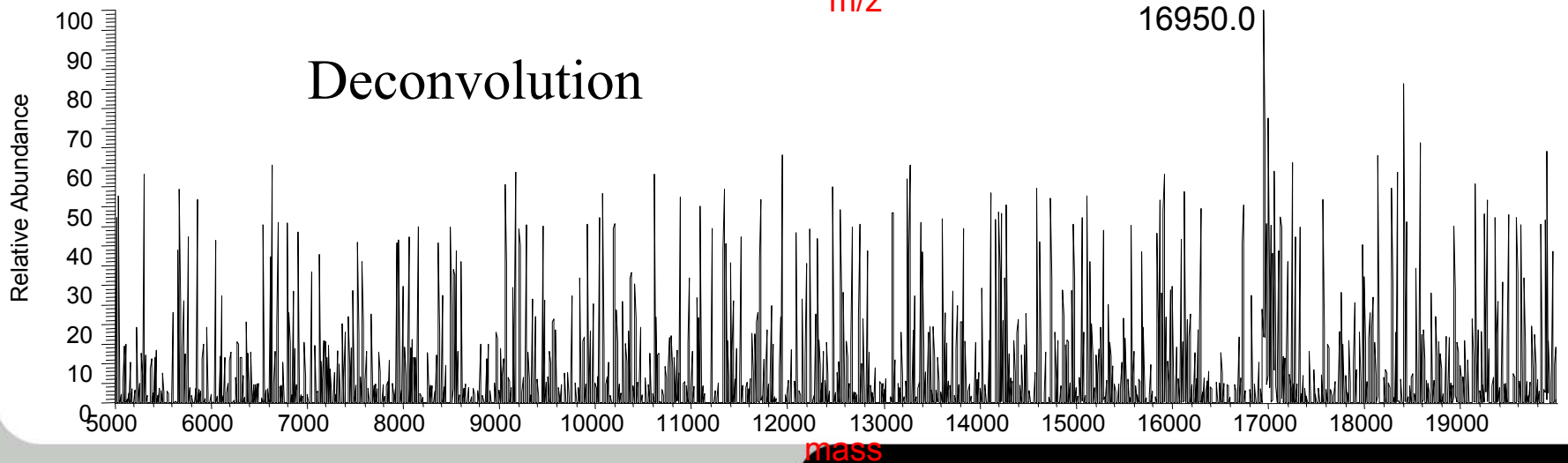
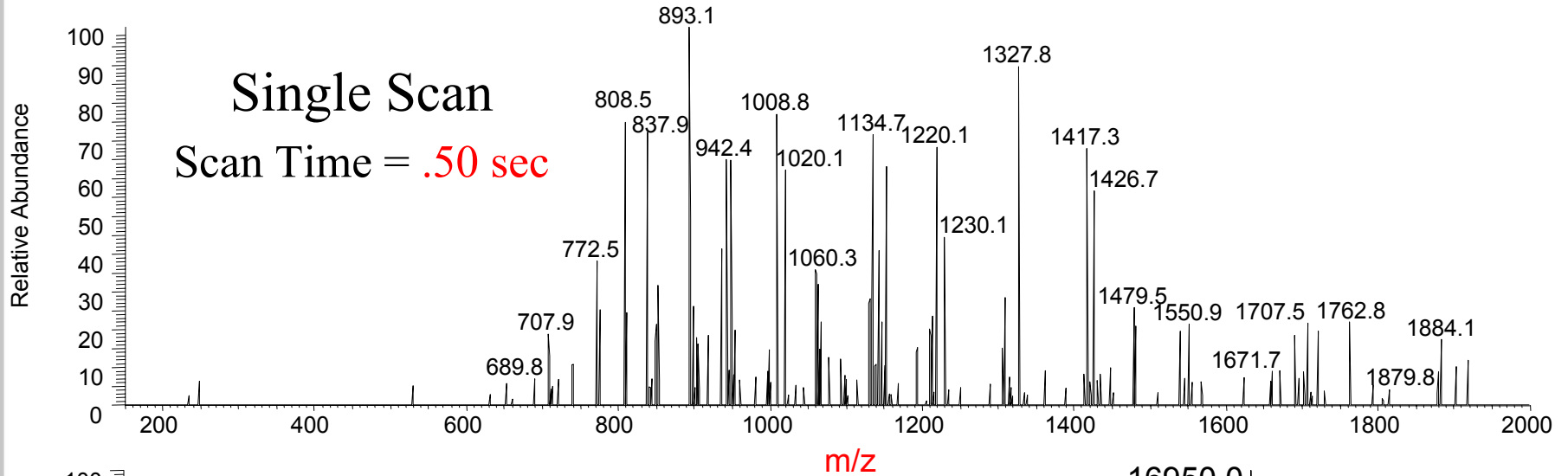
# Motivating Factors Realized

- Increased Trapping Efficiency
- Increased Trapping Capacity

Which means....

- Increased Sensitivity
- Increased Inherent Dynamic Range
  - Increased S/N for full Scan MS
  - Practical MS<sup>n</sup>
  - Faster Scan Times - no uscans (only one)

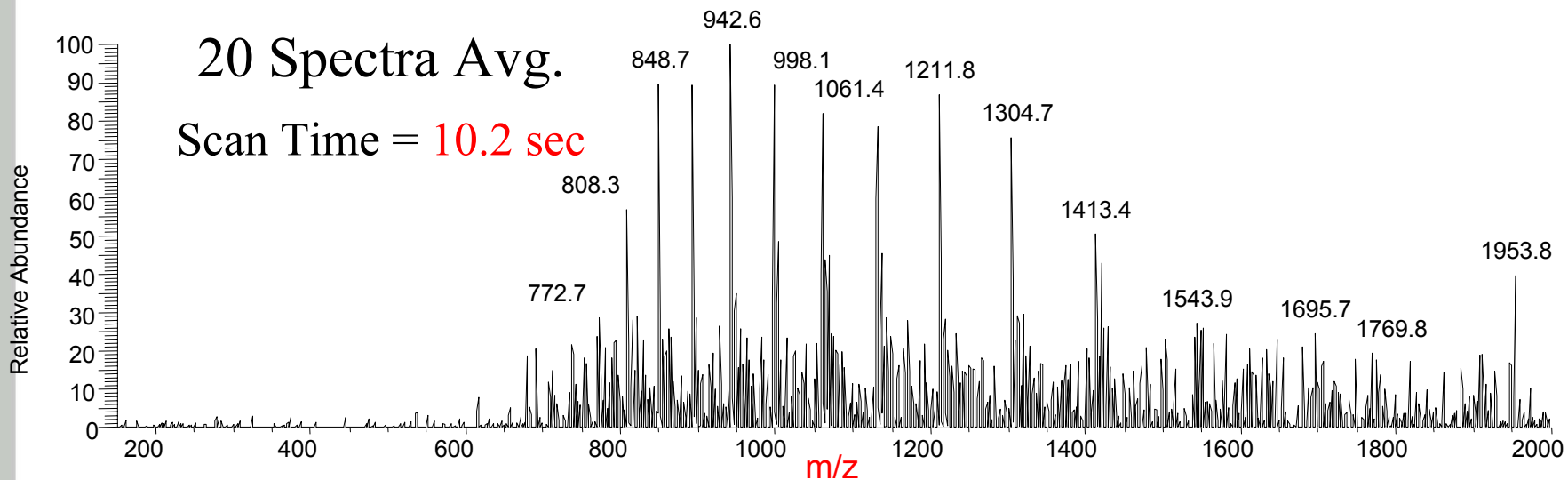
# 3D Trap - Myoglobin



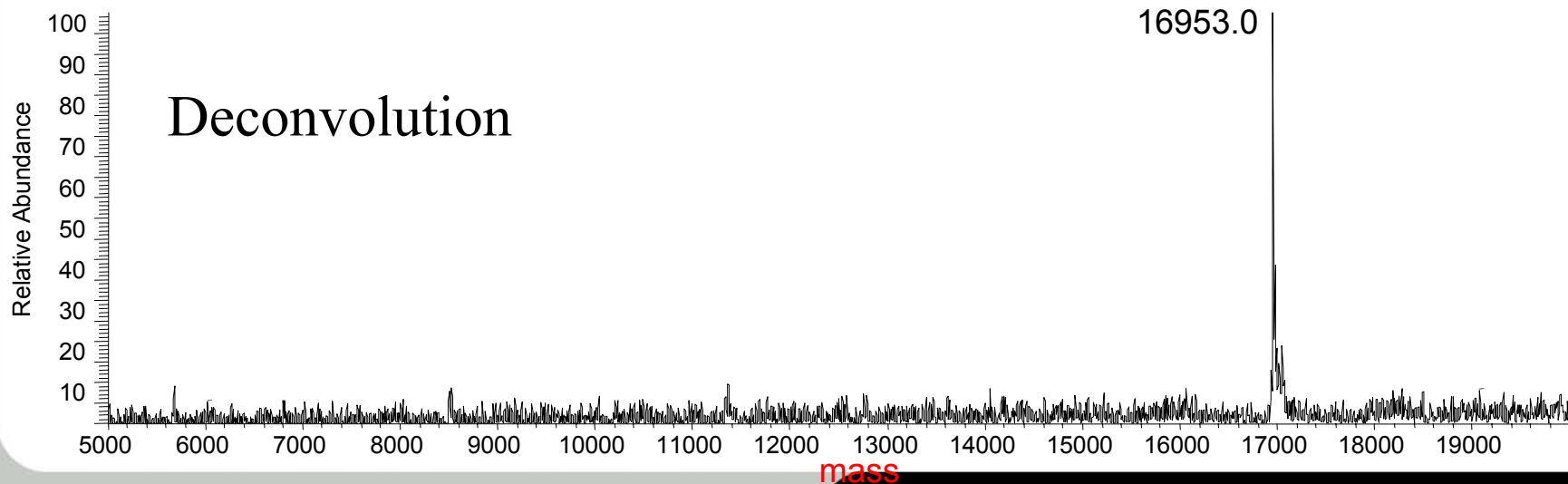
# 3D-Trap Myoglobin

20 Spectra Avg.

Scan Time = 10.2 sec



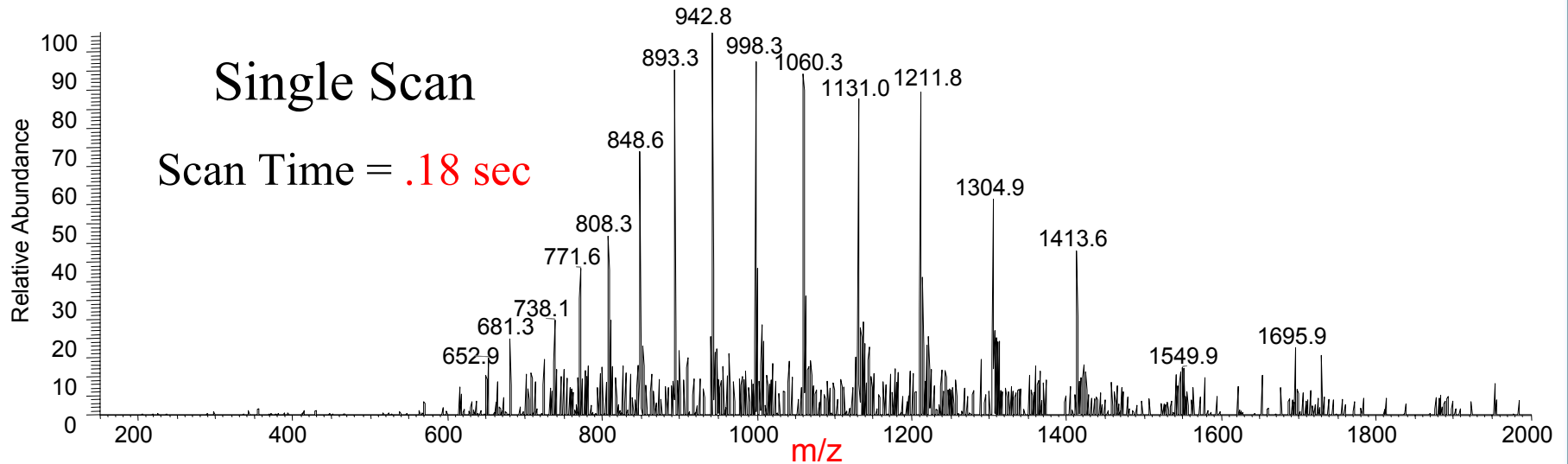
Deconvolution



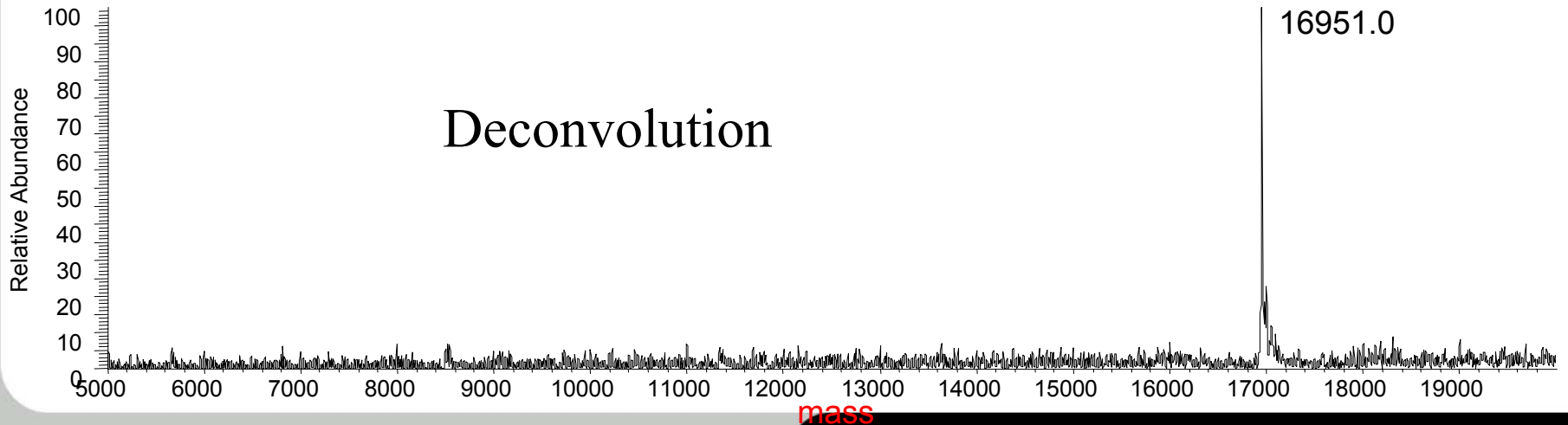
# LTQ - Myoglobin

Single Scan

Scan Time = .18 sec

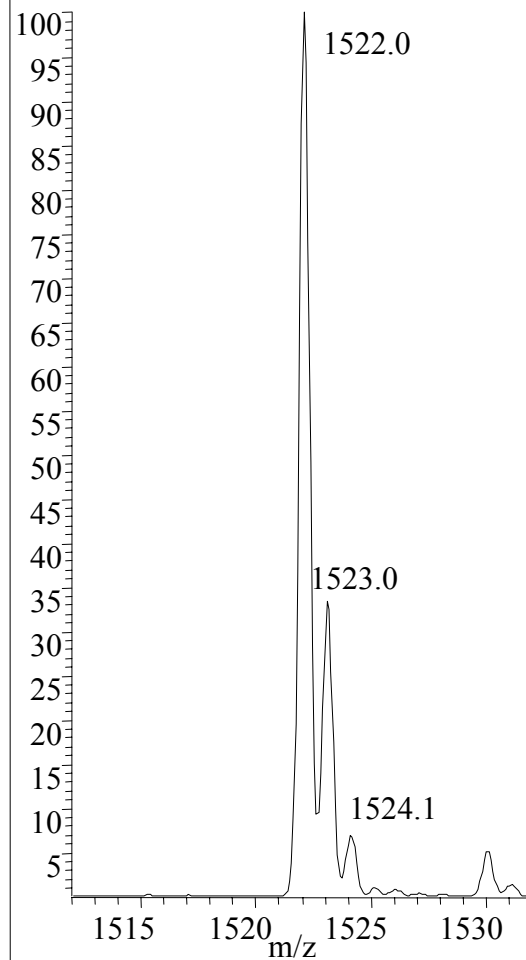
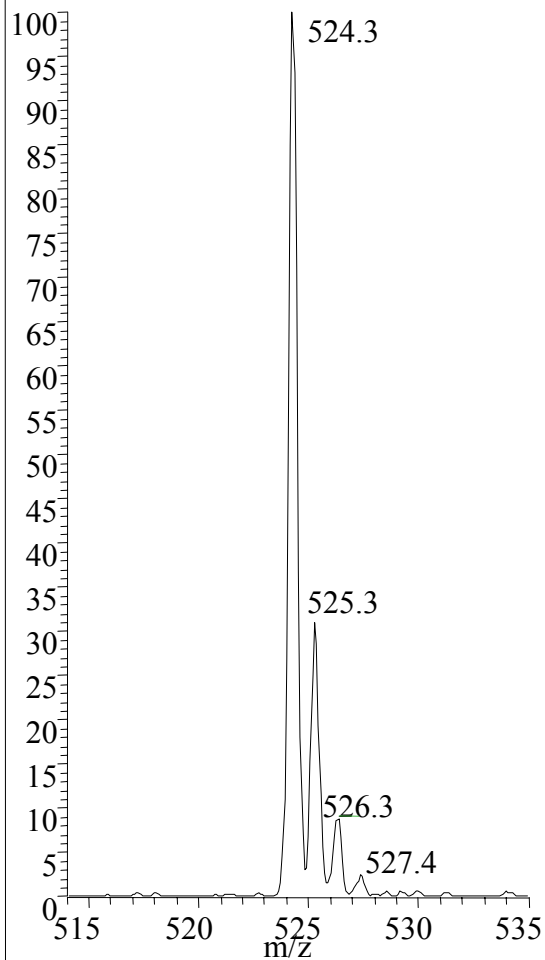
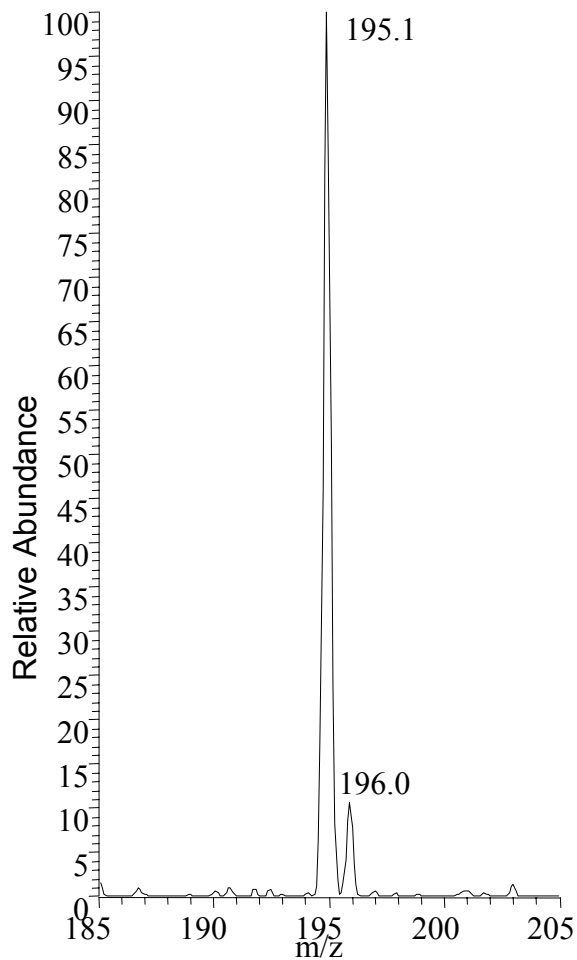


Deconvolution



# Improvements in Resolution/Scan Speed

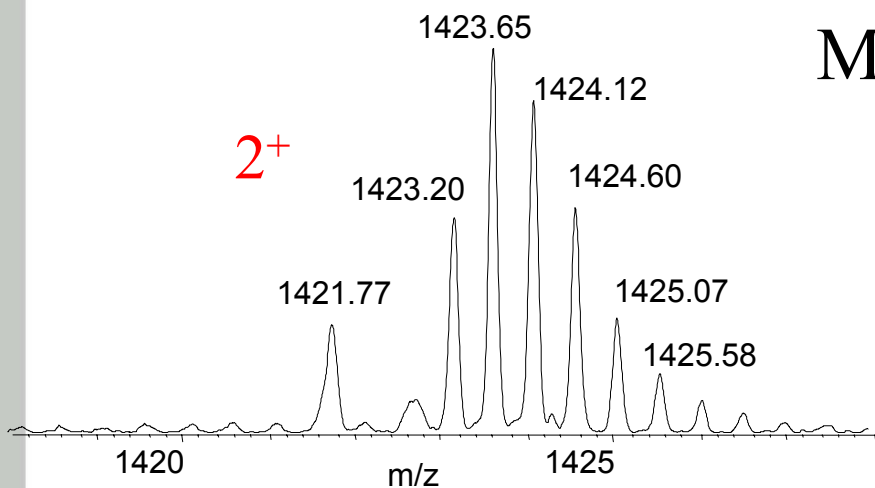
# Unit Resolution - Scan rate of 16700 amu/sec



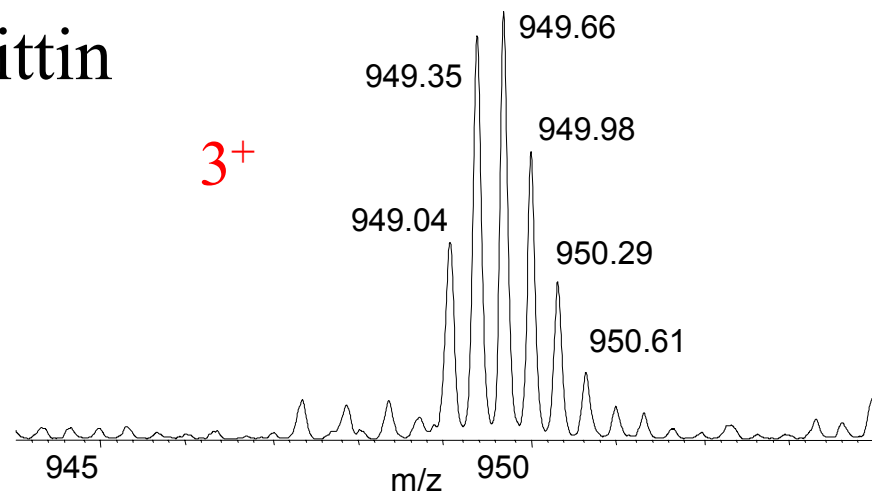
# Zoom Scan Resolution - Scan Rate of 1100 amu/sec

## Melittin

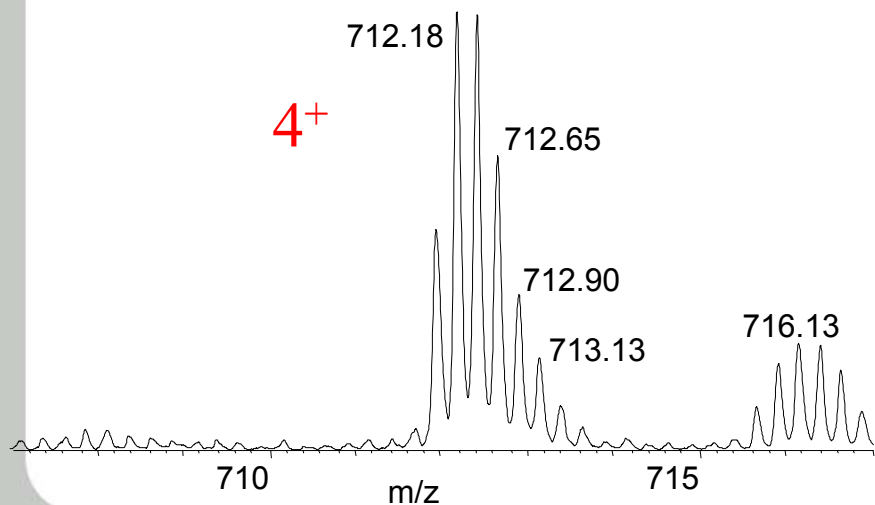
2<sup>+</sup>



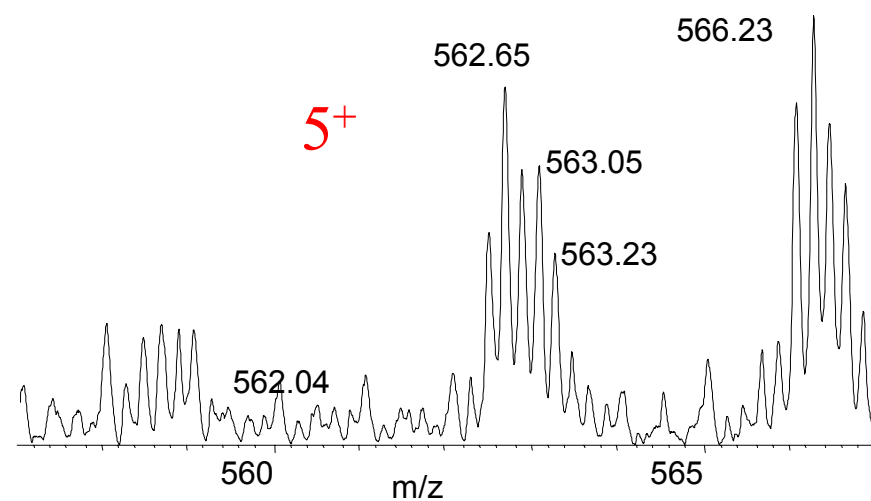
3<sup>+</sup>



4<sup>+</sup>

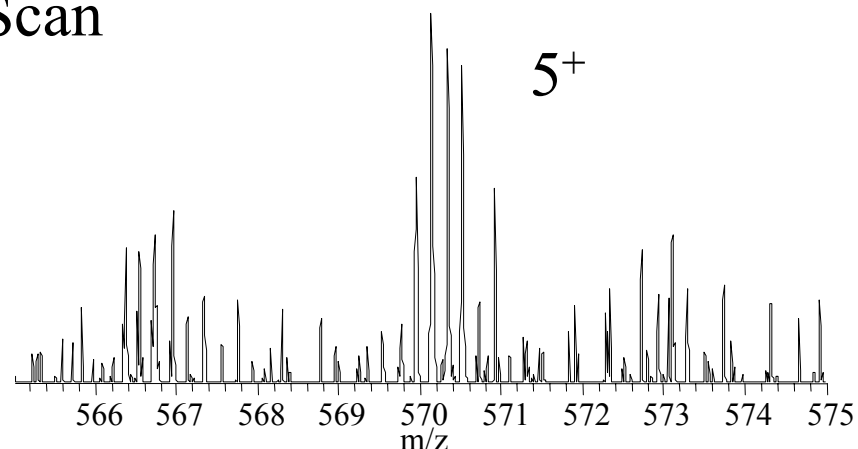
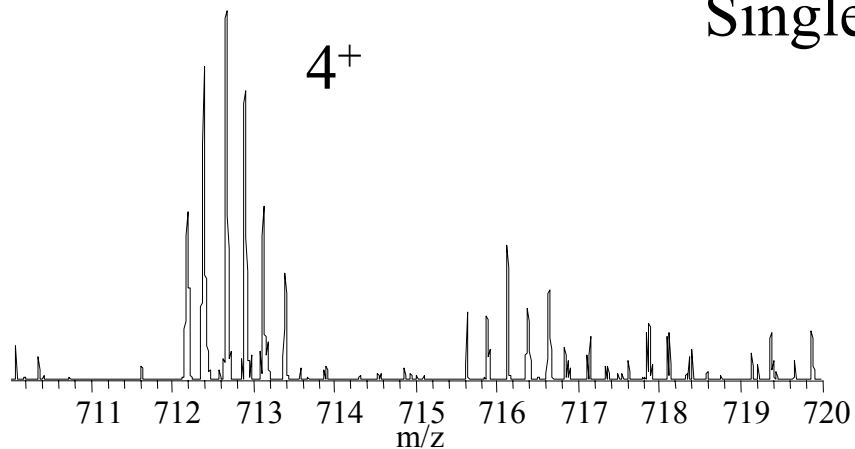


5<sup>+</sup>

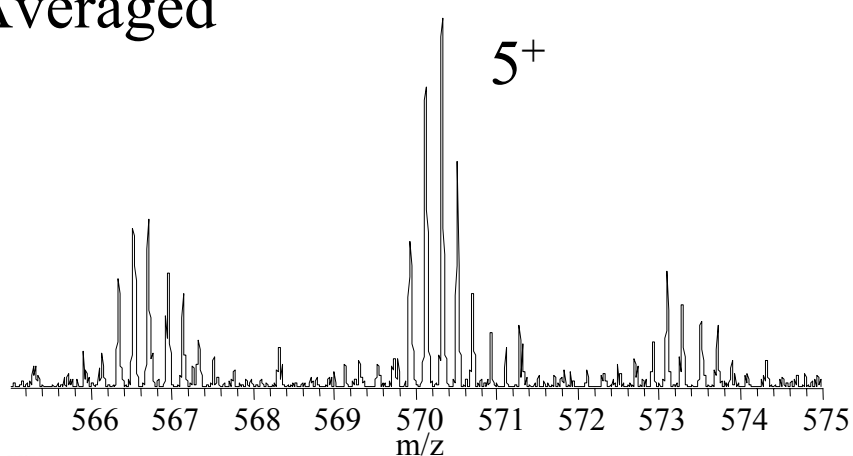
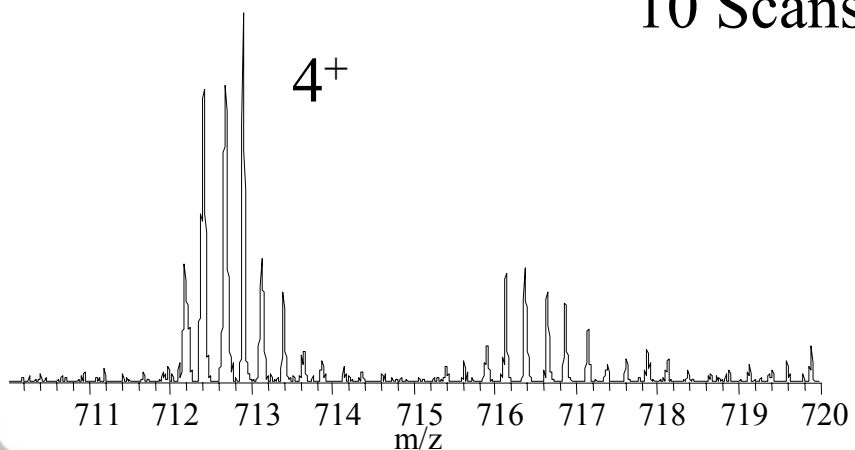


# Ultra Zoom Scan - 27 amu/sec

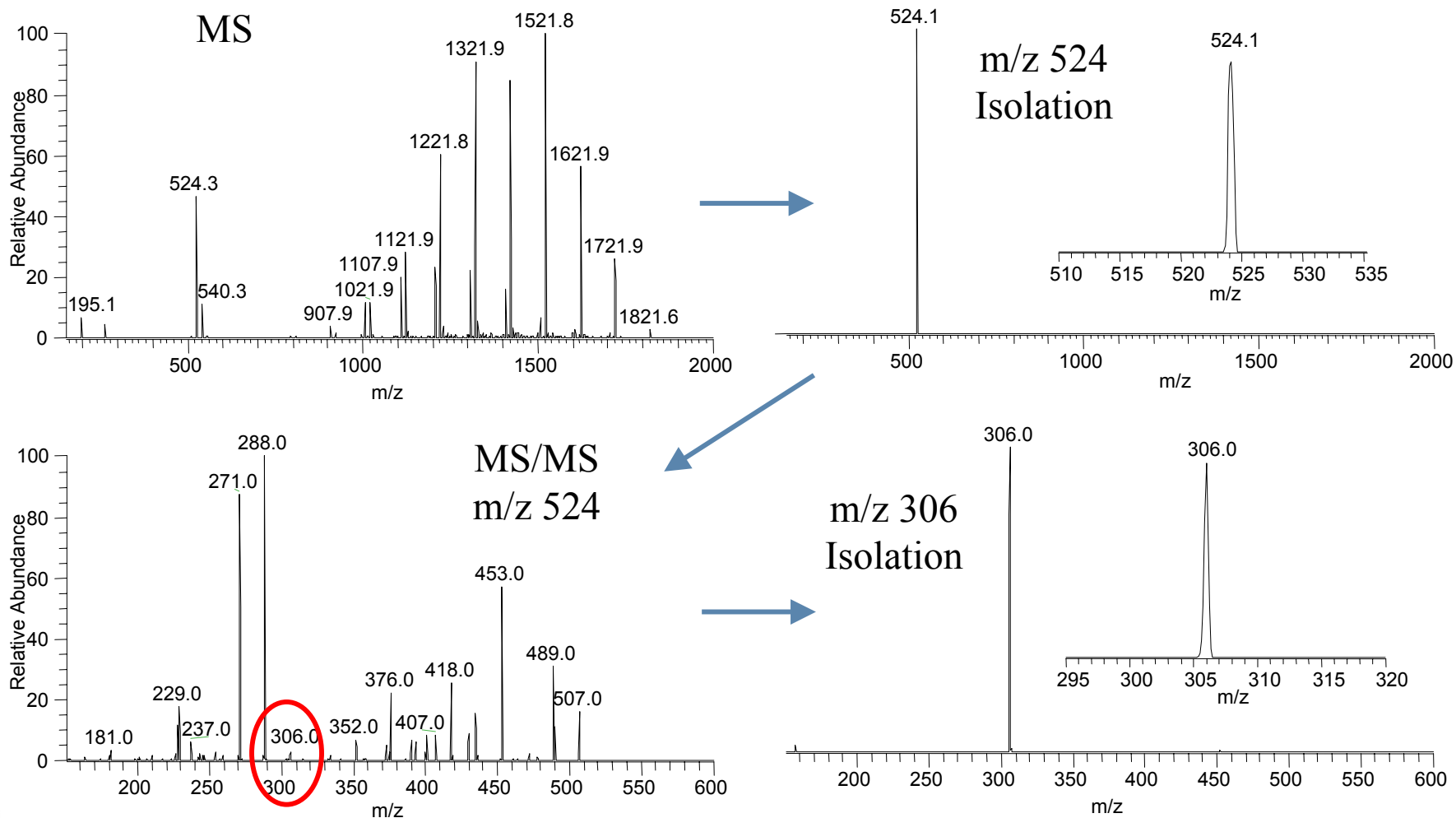
## Single Scan



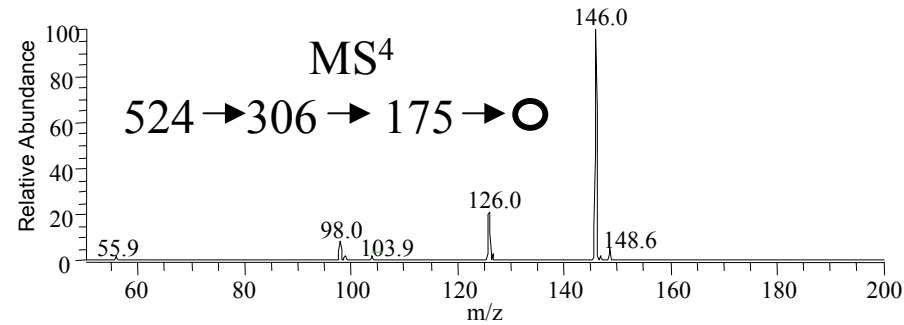
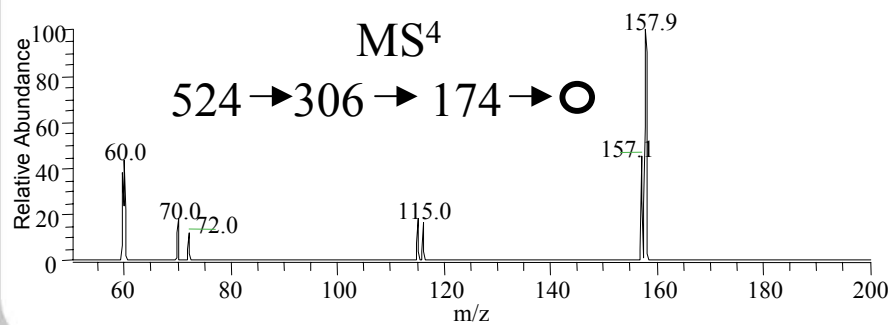
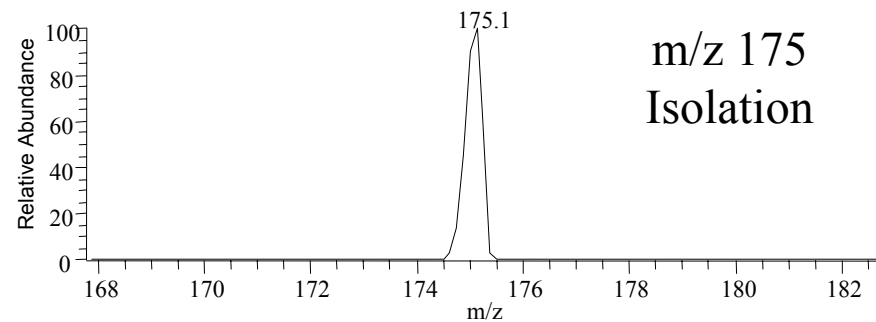
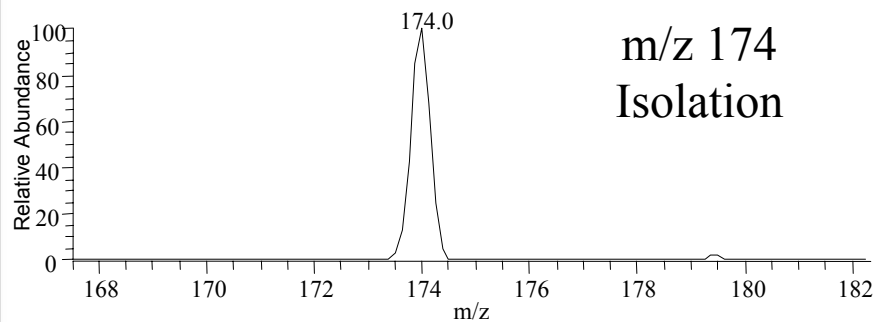
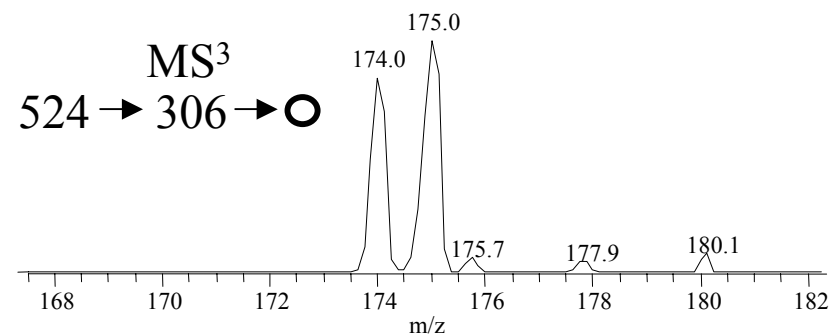
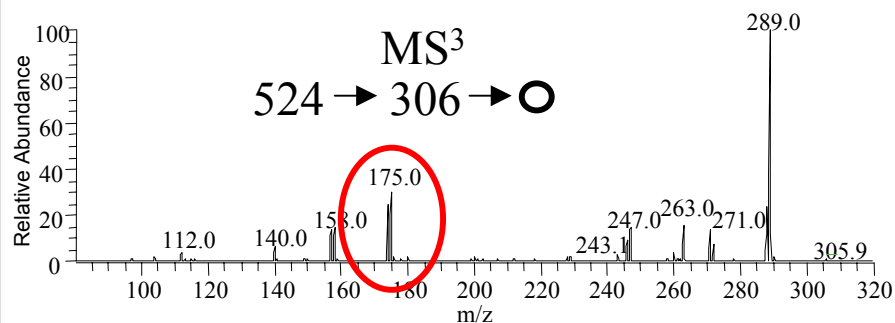
## 10 Scans Averaged



# MS<sup>n</sup> on Low Abundance Ions

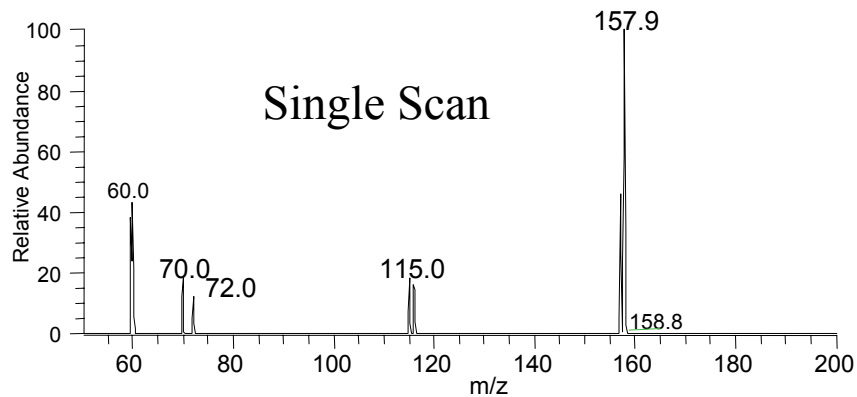


# MS<sup>n</sup> on Low Abundance Ions

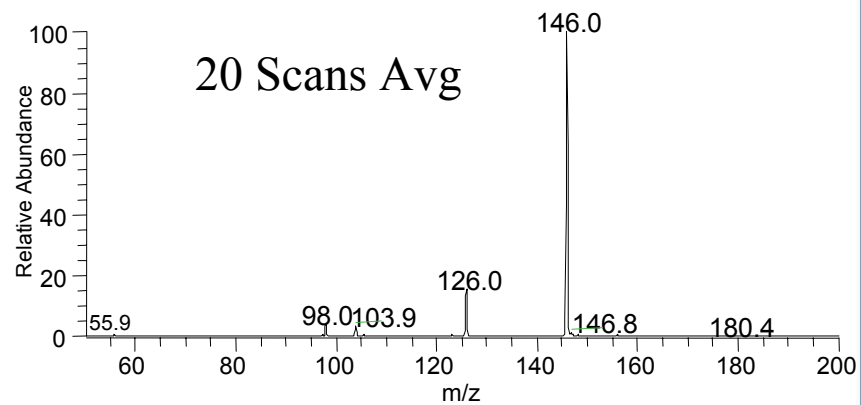
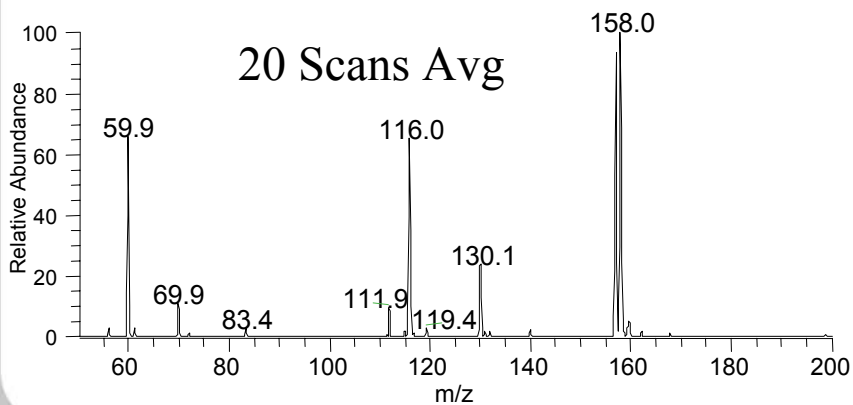
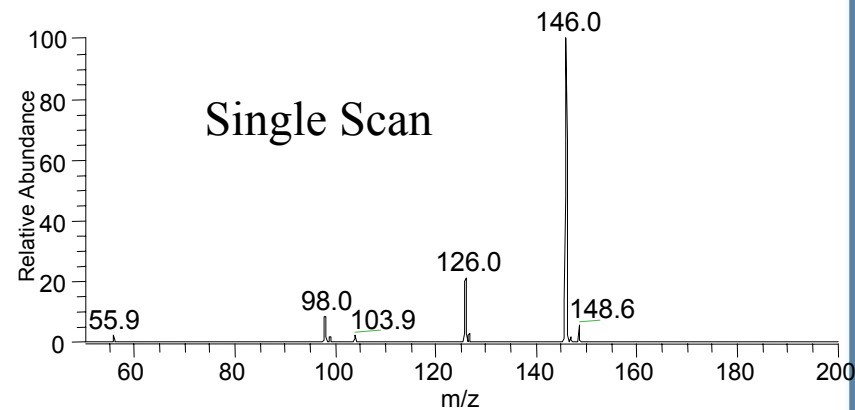


# MS<sup>n</sup> on Low Abundance Ions

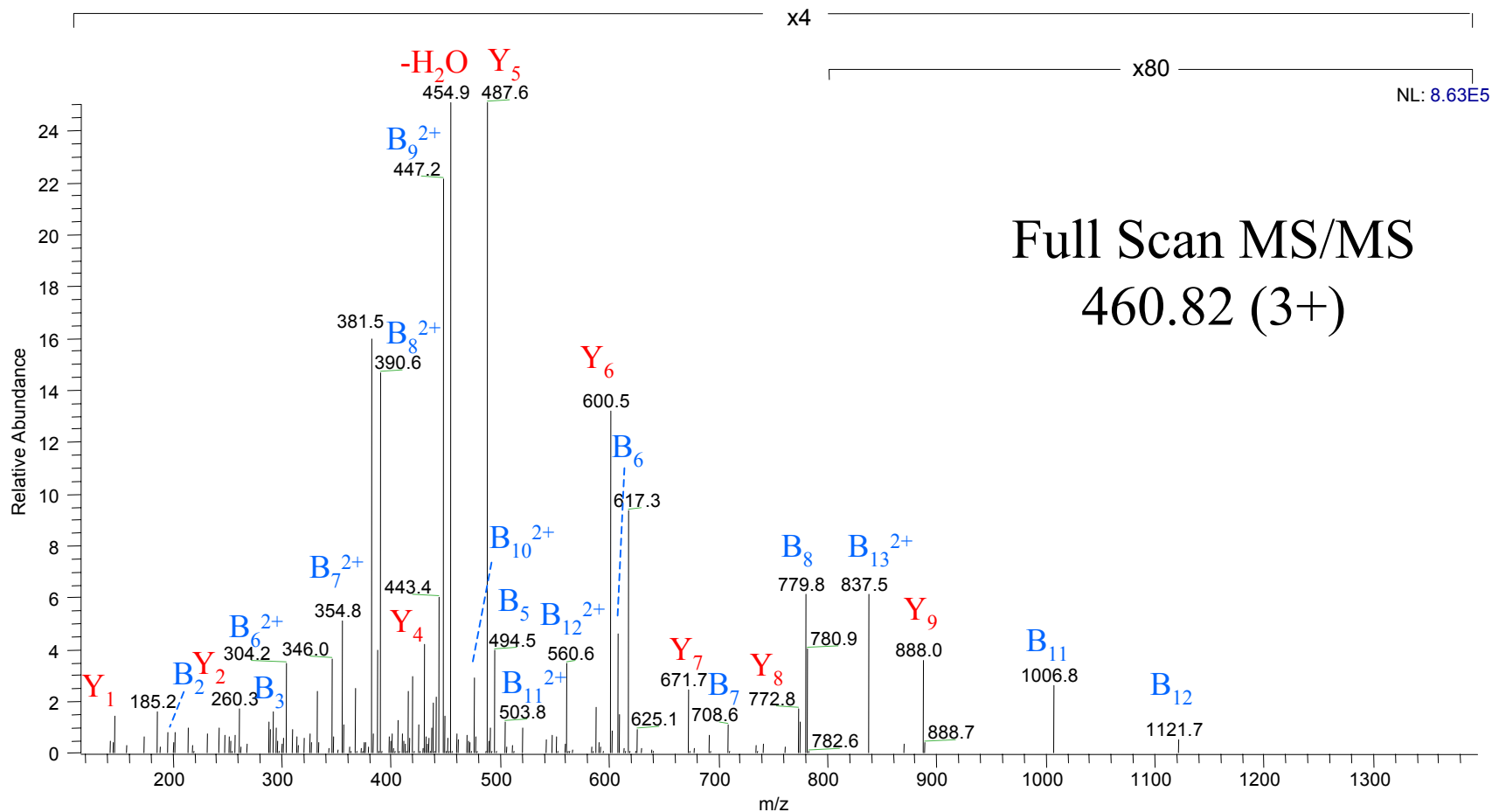
MS<sup>4</sup>  
524 → 306 → 174 → ○



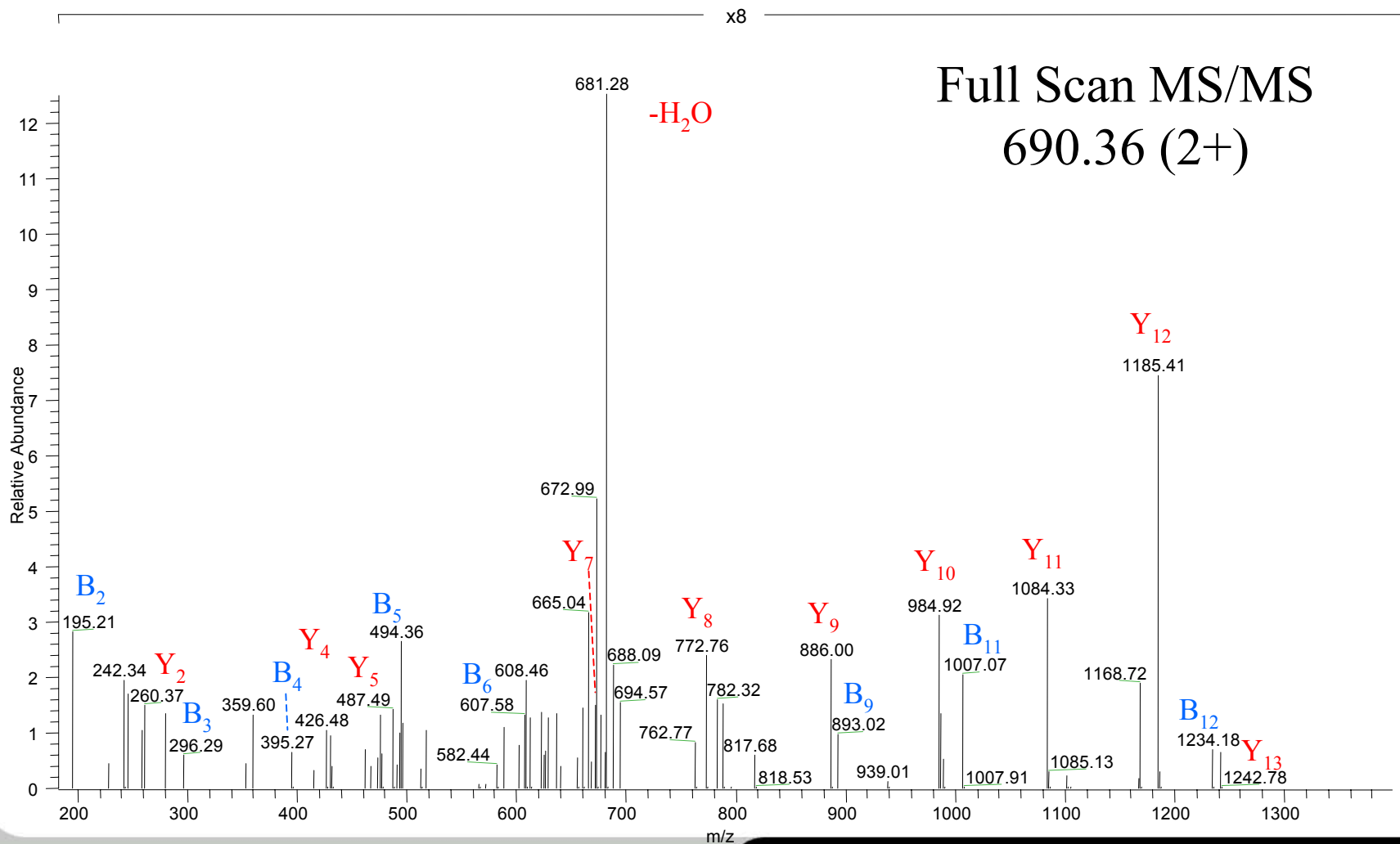
MS<sup>4</sup>  
524 → 306 → 175 → ○



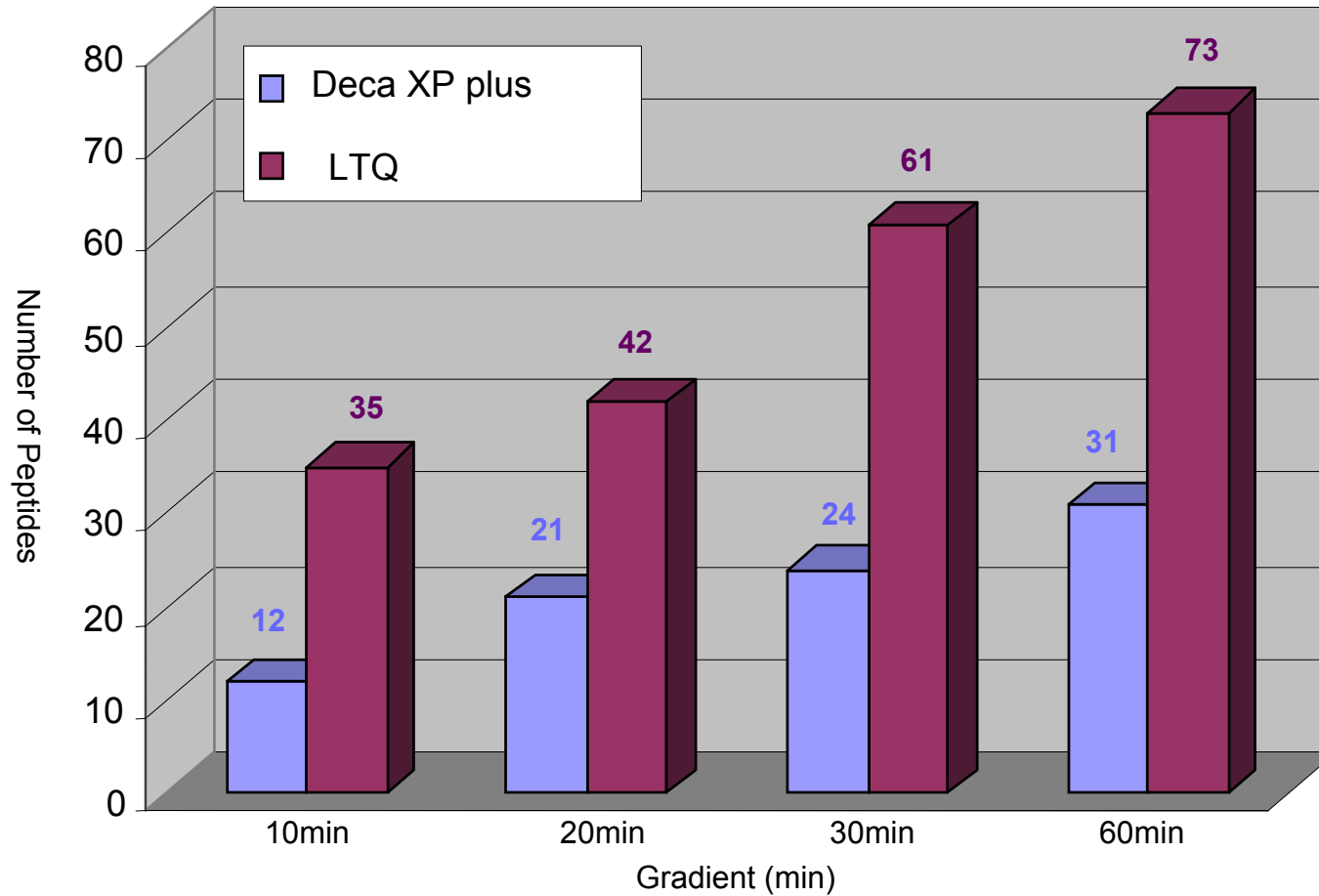
# Myoglobin Tryptic Digest - 40 Attomole



# Myoglobin Tryptic Digest - 40 Attomole



# 9 Protein Mixture Peptide Identification



# Summary – Analytical Improvements

- Increased Sensitivity
  - Improved Intact Protein Analysis
  - Improved MS/MS
    - MS3 and MS4 at same sensitivity as MS2 on 3D Traps
- Faster Overall Cycle Times / Scan Rates
  - Fast Data Dependant Analyses
- Increased Sequence Coverage
- Lower Limits of Quantitation (Better %RSD)

Do we think we have a winner?  
We'll let you be the judge.

