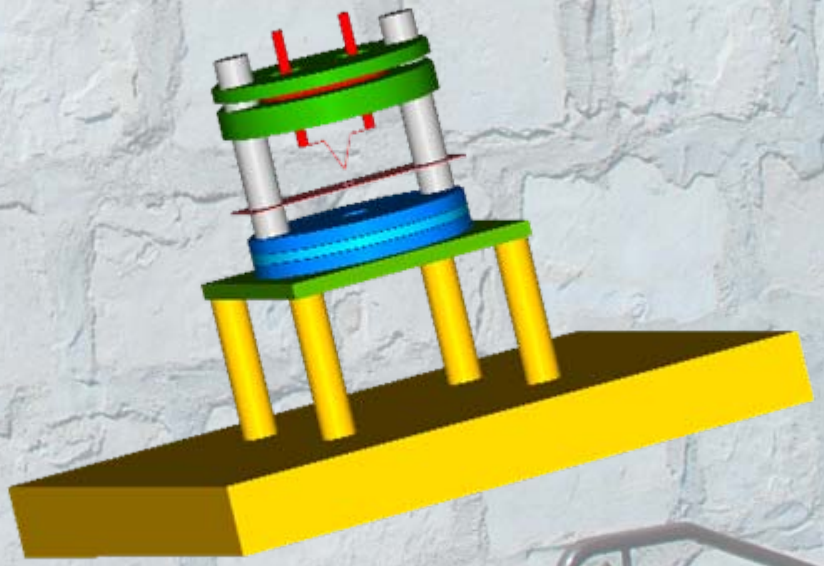
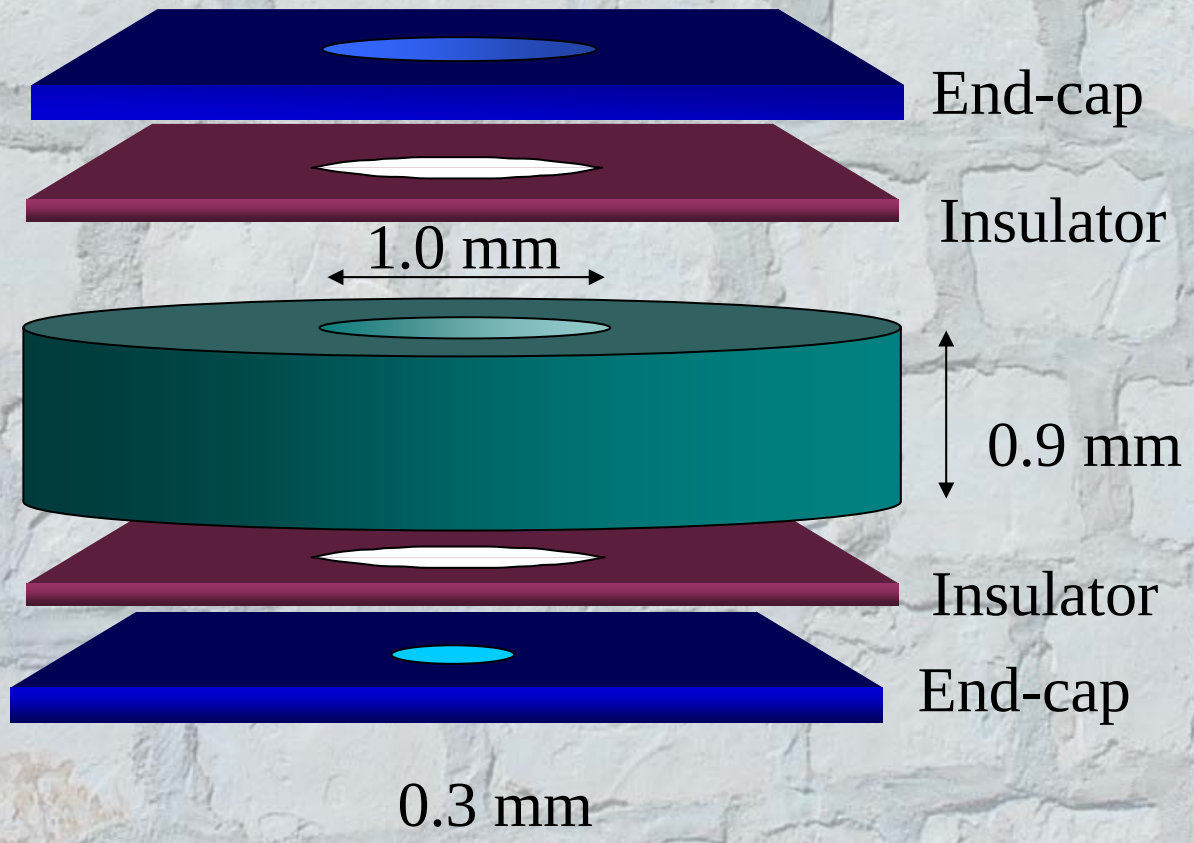
Achievable Resolution and Efficiency of Tandem Mass Spectrometry for Sub-mm Ion Traps

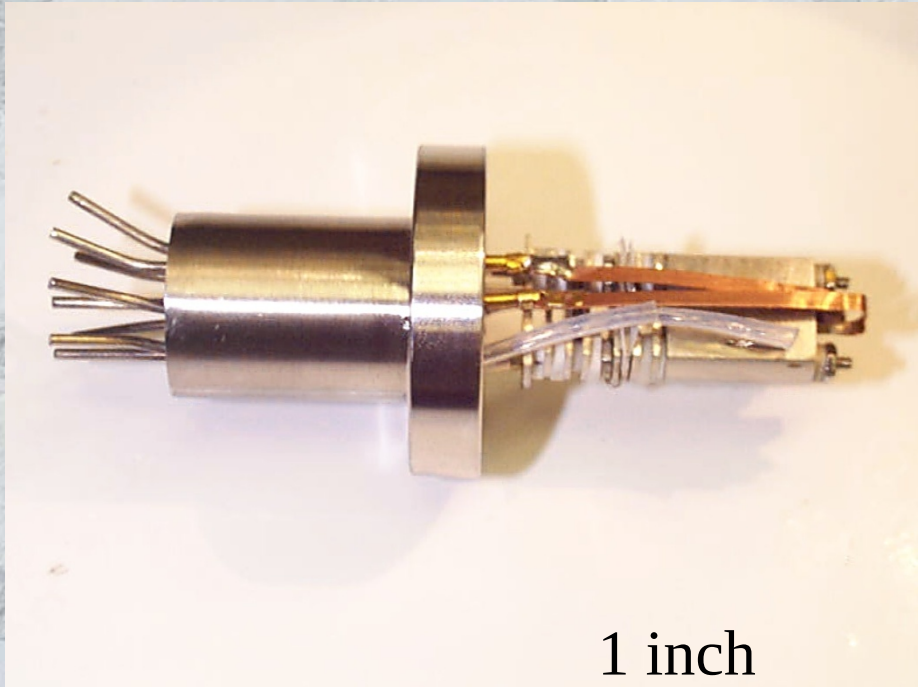
Guido Verbeck
University of North Texas



Ion trap geometry



1 mm dia. ITMS mounted on a mini-flange



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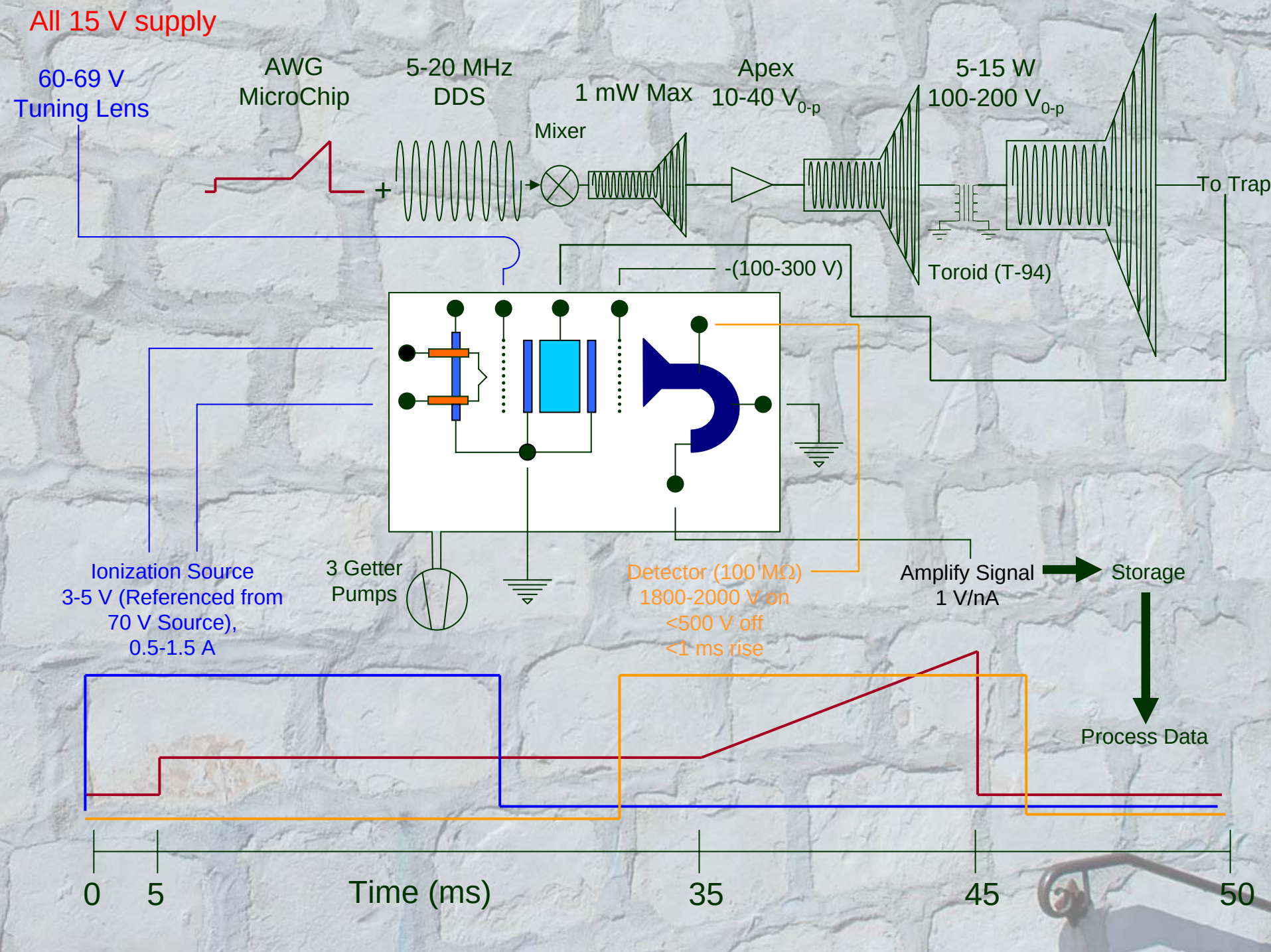
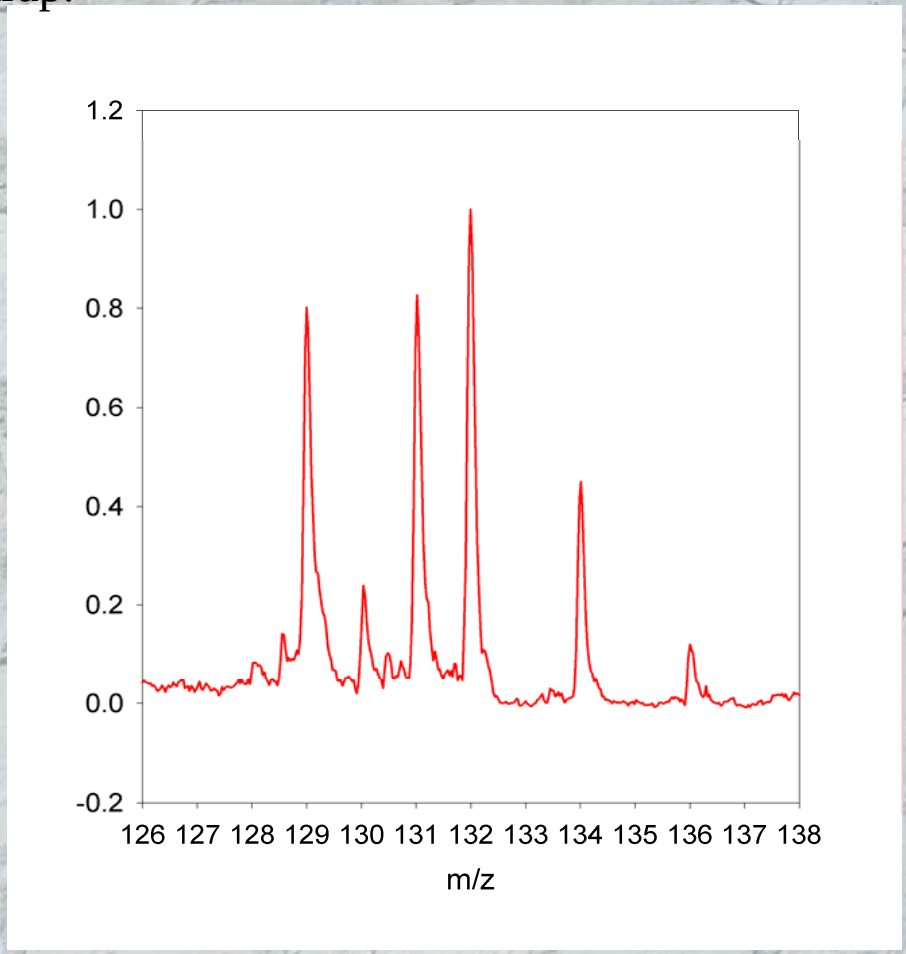

All 15 V supply
60-69 V
Tuning Lens
AWG
MicroChip
5-20 MHz
DDS
1 mW Max
Mixer
Apex
10-40 V_{0-p}
5-15 W
100-200 V_{0-p}
To Trap
Toroid (T-94)
-(100-300 V)
Ionization Source
3-5 V (Referenced from
70 V Source),
0.5-1.5 A
3 Getter
Pumps
Detector (100 MΩ)
1800-2000 V on
<500 V off
<1 ms rise
Amplify Signal
1 V/nA
Storage
Process Data
0
5
Time (ms)
35
45
50

Double Resonance Ejection from a Micro Ion Trap

Can get improved sensitivity and mass resolution when the ion secular frequency is doubly resonant with an axial modulation frequency and the frequency of a nonlinear resonance of the ion trap.

Mass spectrum of Xe isotopes
1-mm diameter ion trap
average of ~100 scans
Ω = 6.8 MHz
axial modulation at 1.75 MHz, applied to one end cap
(β_z = 1/2)



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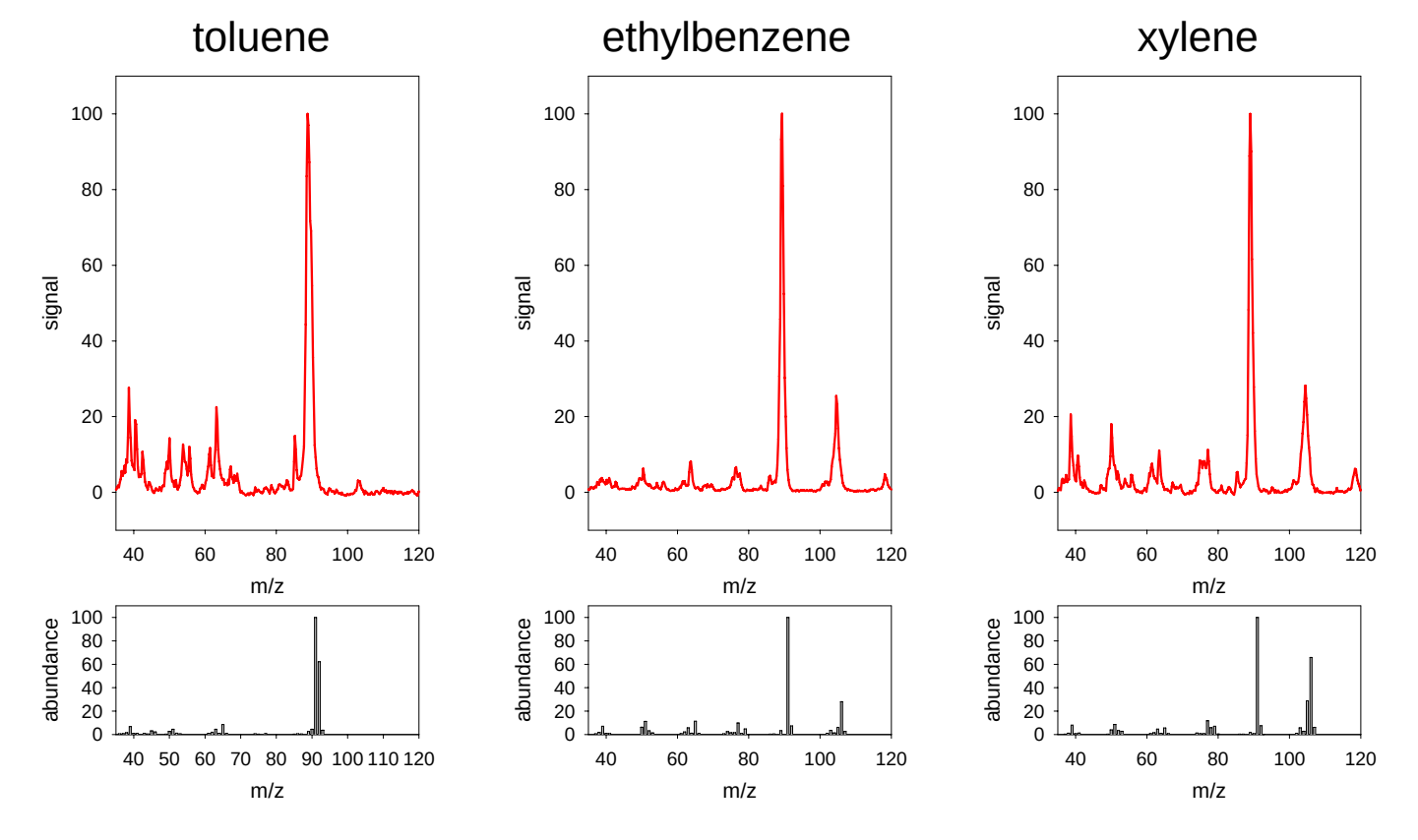
Membrane inlet mass specs



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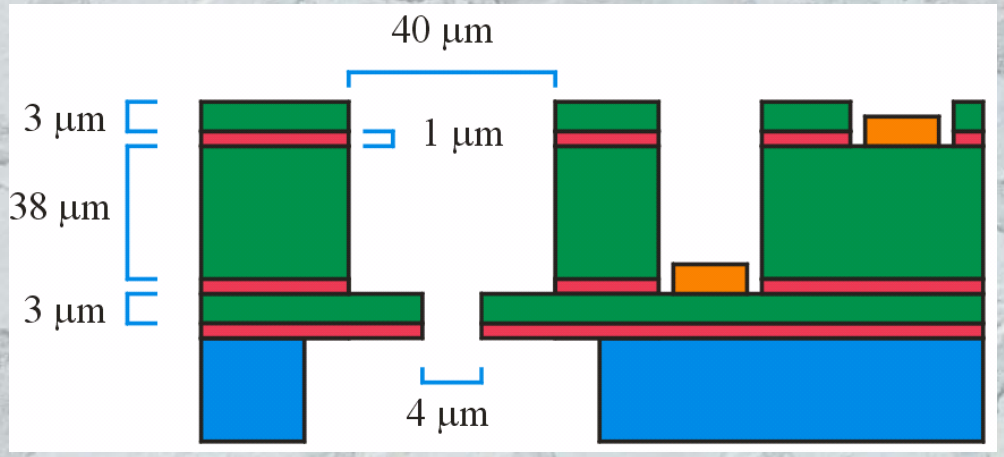
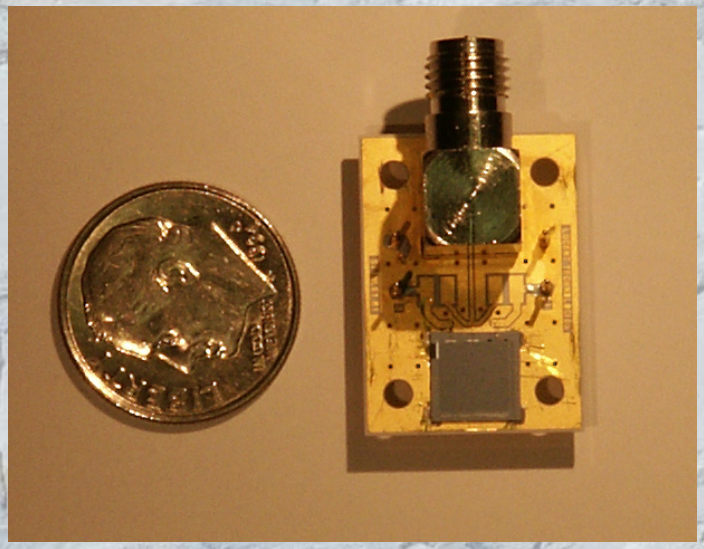
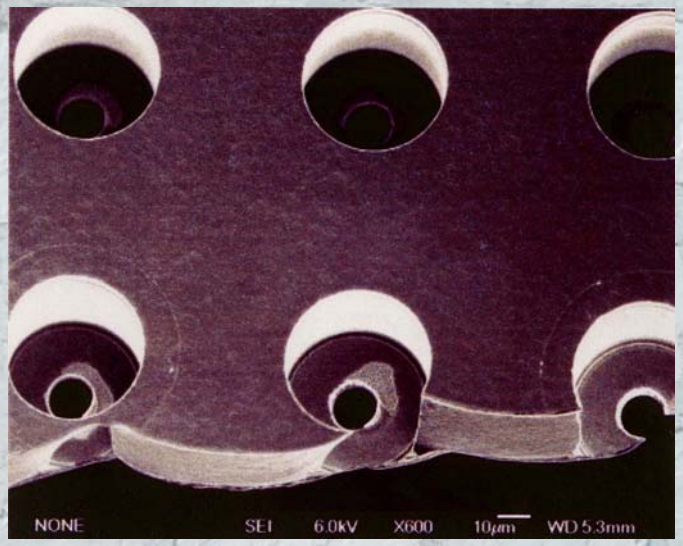
- **The first generation of 40-μm polysilicon ion traps fabricated by Bell Labs**

- **Rejects are being used in ionizer experiments**







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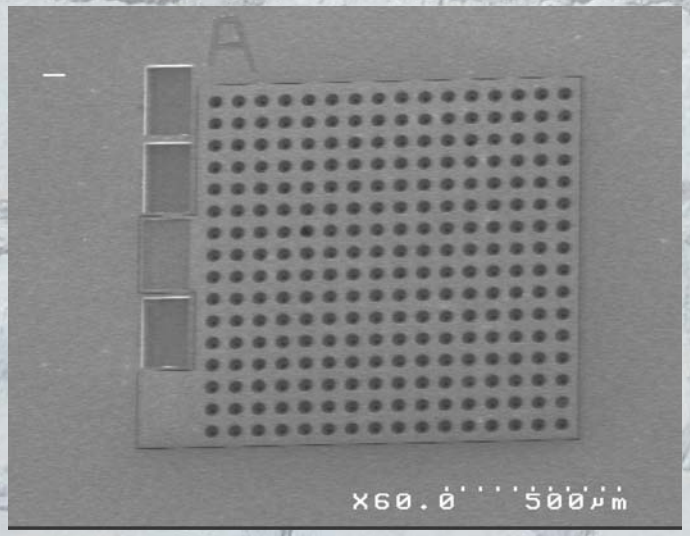
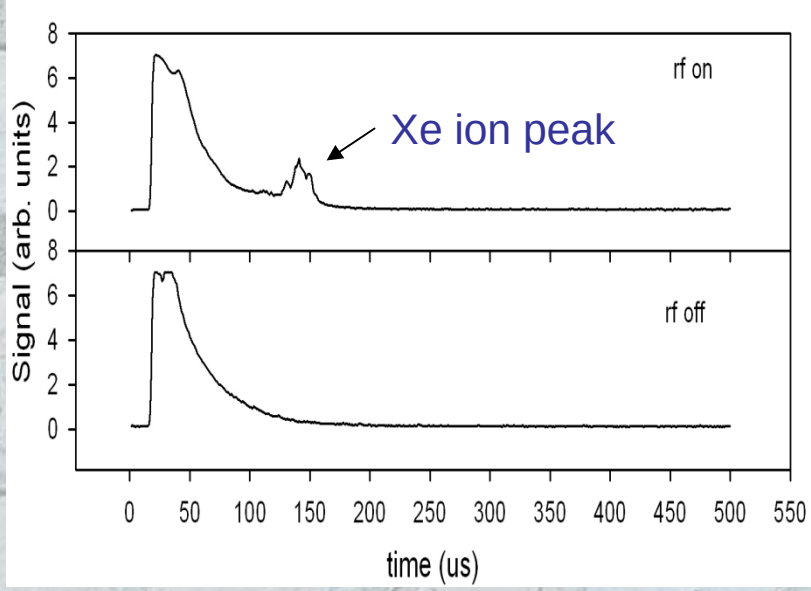
A second generation array of 40-micrometer traps has fewer traps, lower capacitance. We can now detect trapped xenon ions at low pressure.



SEM image of low-capacitance array fabricated by Bell Labs



Ion signal (xenon) obtained with array at left at low helium pressure (10^{-4} Torr)

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SOI Process Overview

Sputtered sidewall metal

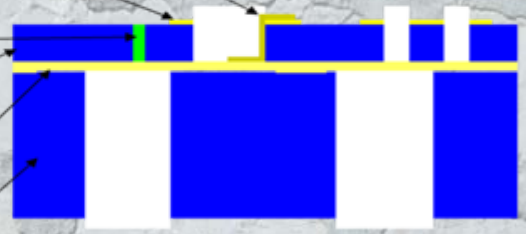
Top metal

Trench isolation

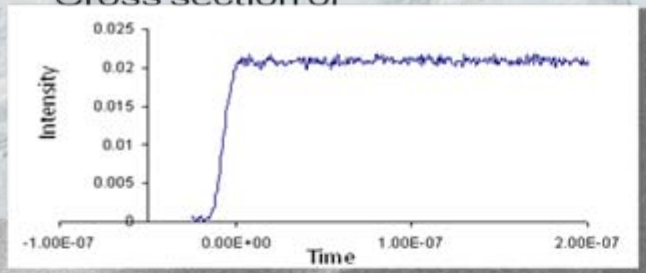
Device layer ~ 50 microns thick

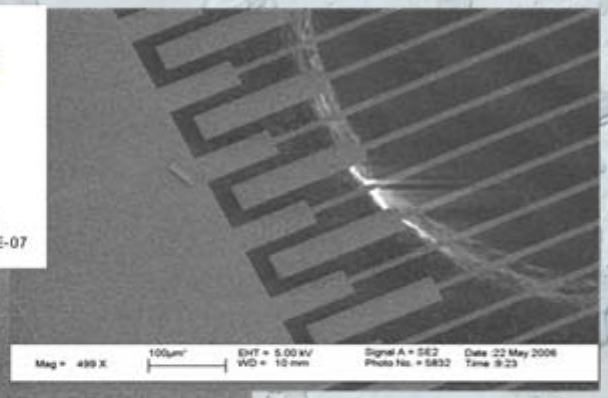
Buried oxide layer ~ 2 microns thick

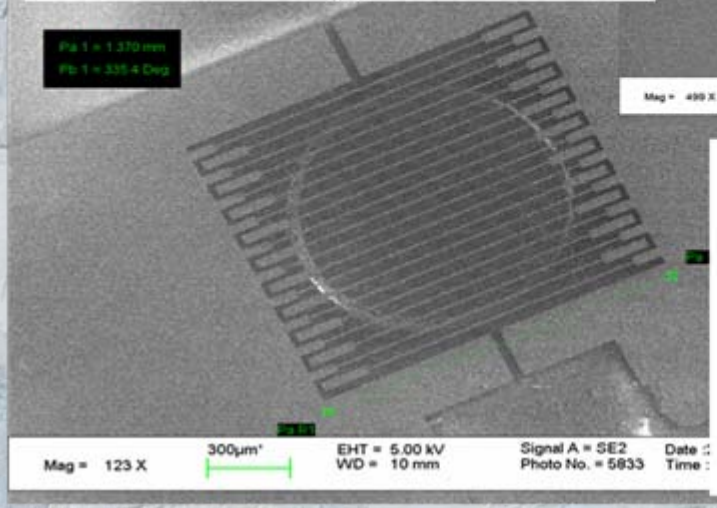
Silicon handle wafer ~ 550 microns thick

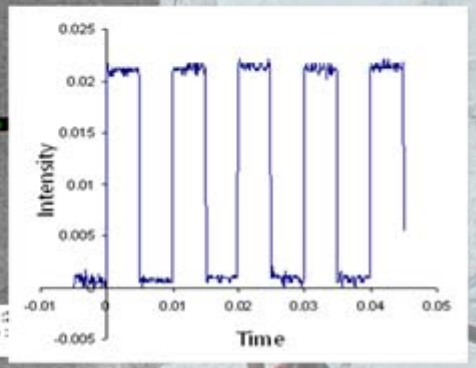


Cross section of









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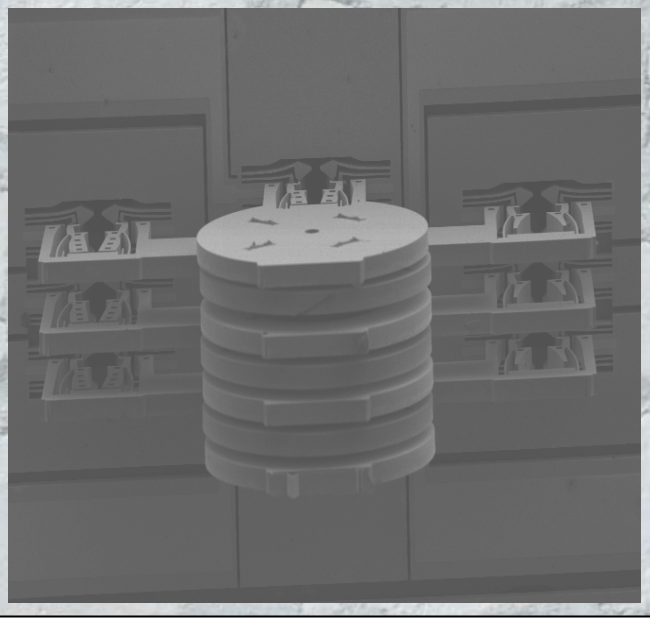
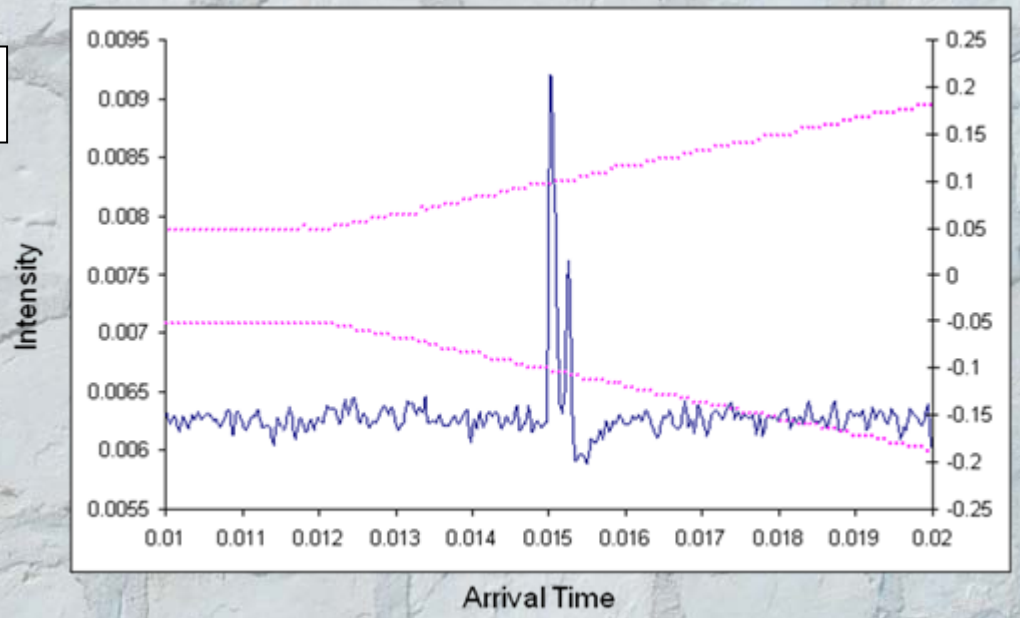


SEM image of the Coaxial Ring Ion Trap with 500um i.d.



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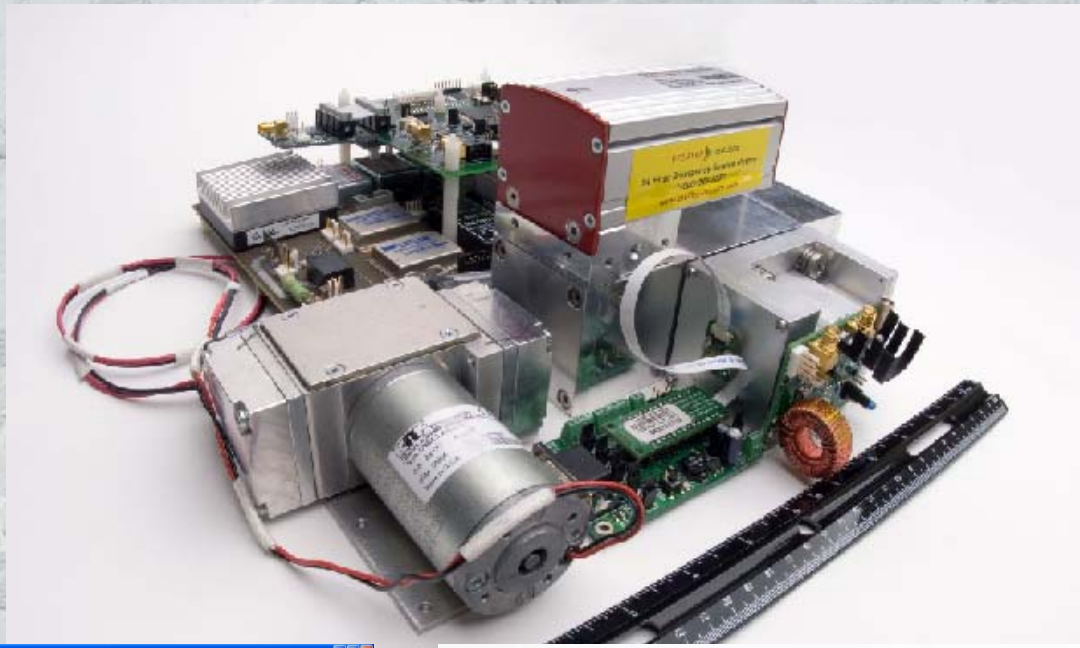
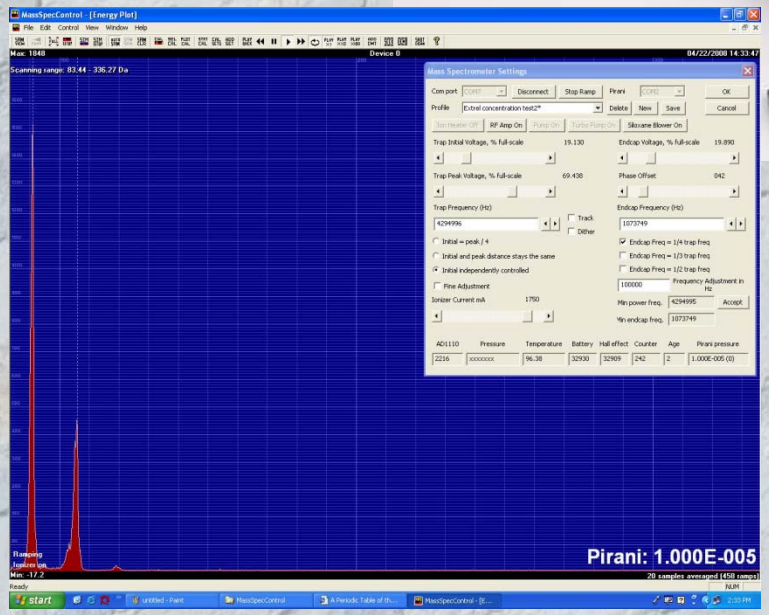
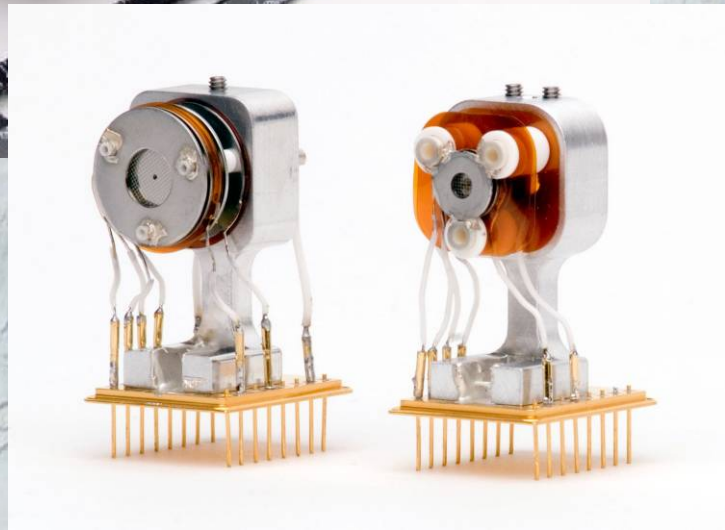
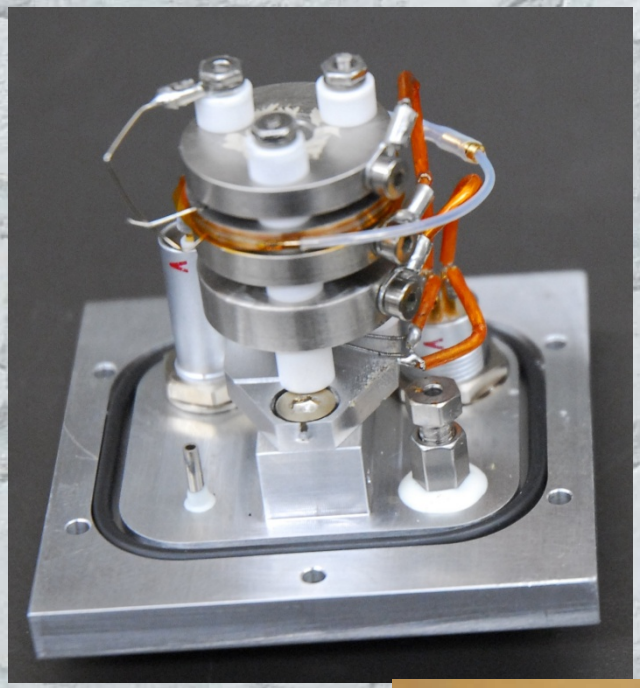
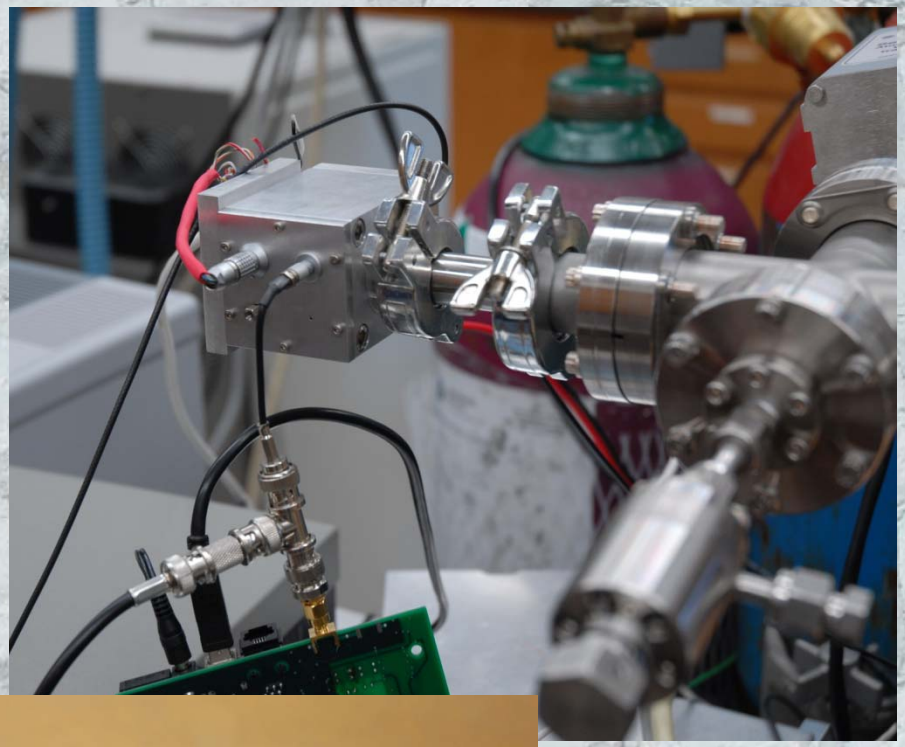
1st Detect (Formally SpaceHab)

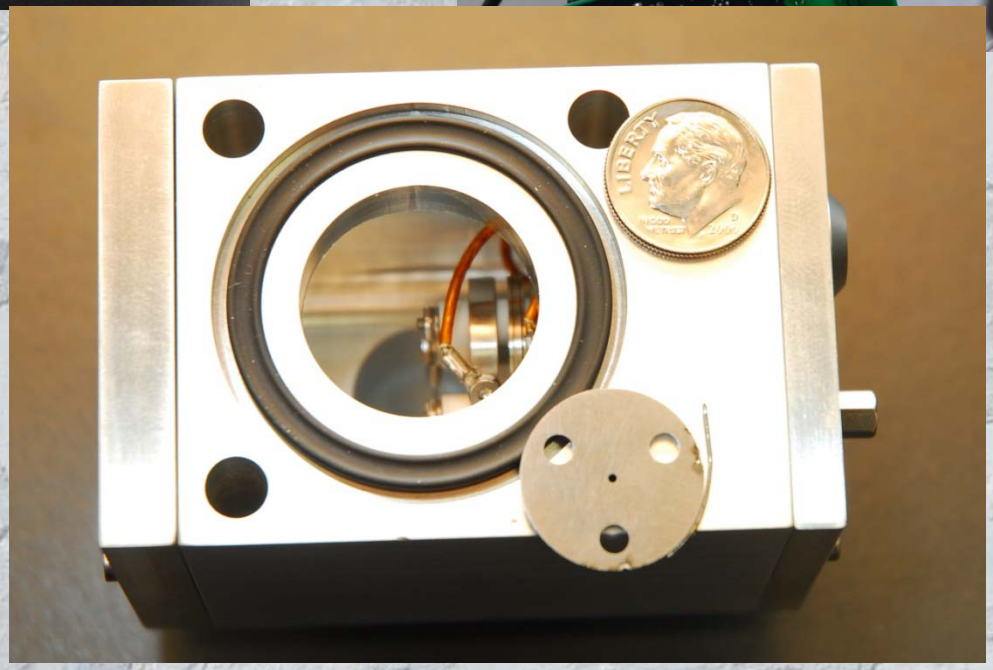








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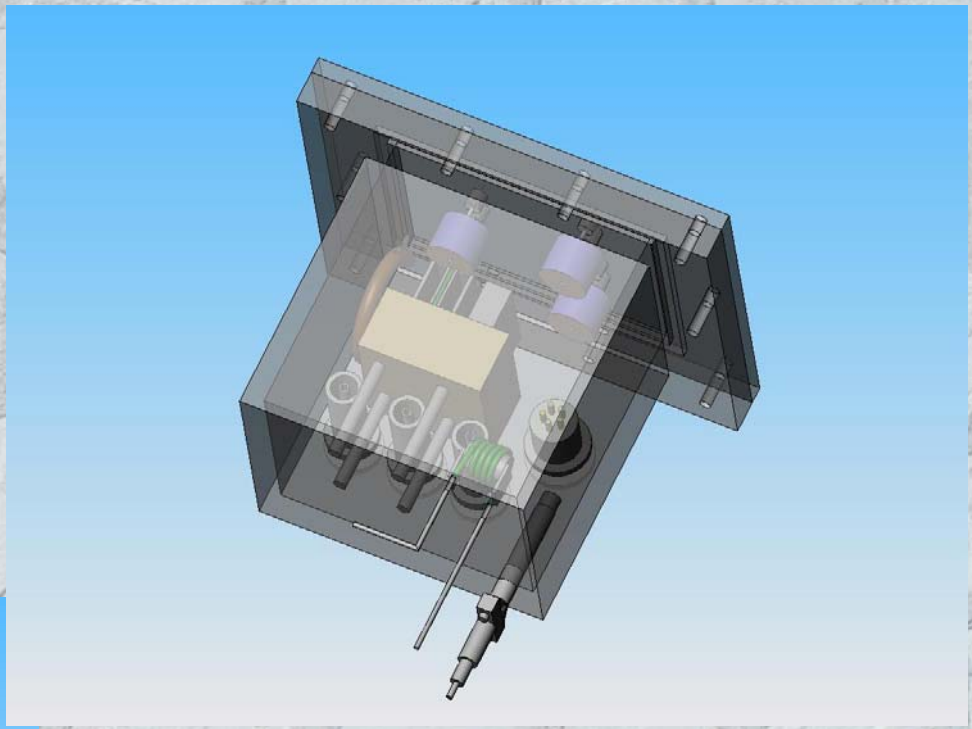

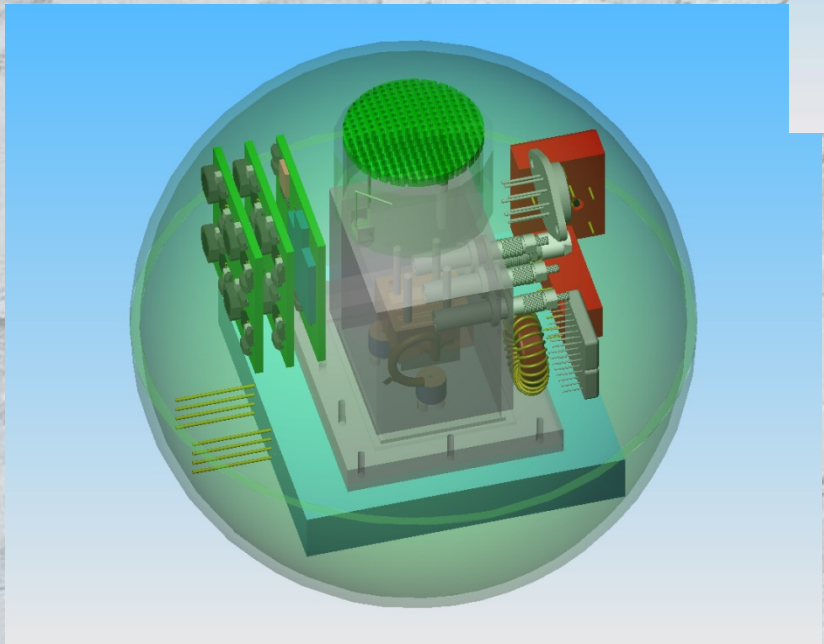

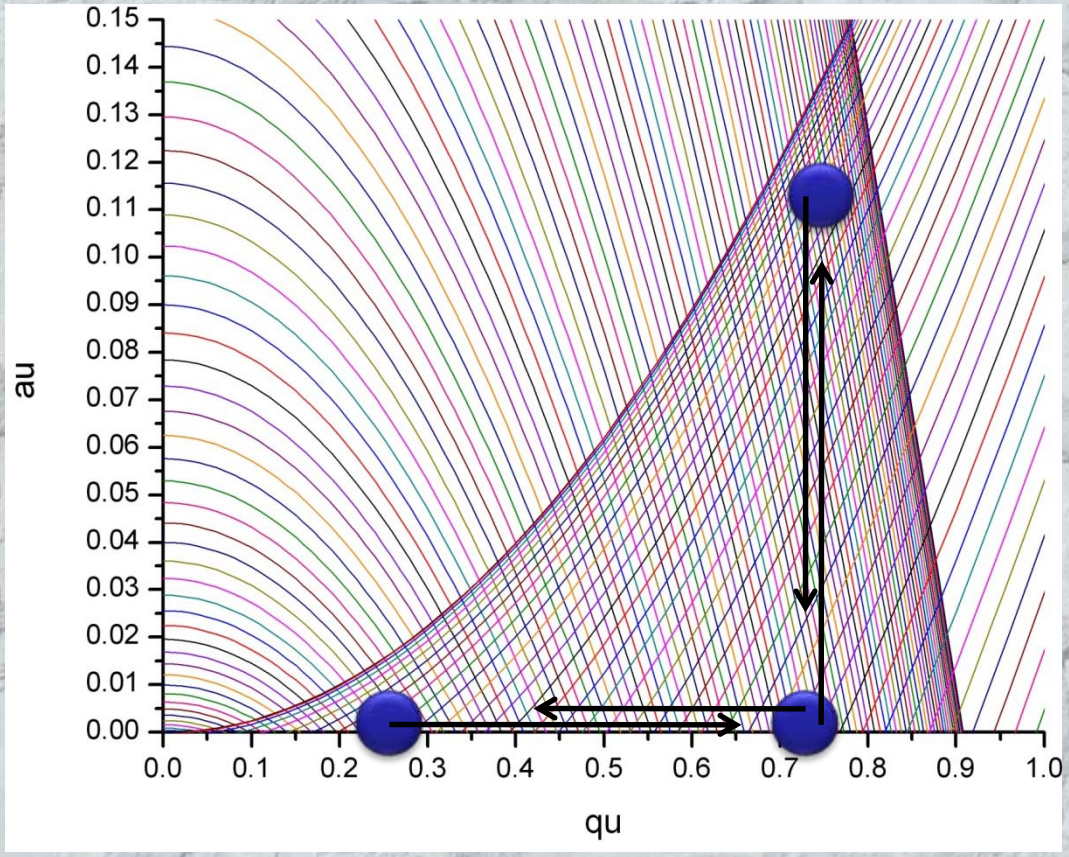
au
qu
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0.01
0.02
0.03
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0.06
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0.08
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0.11
0.12
0.13
0.14
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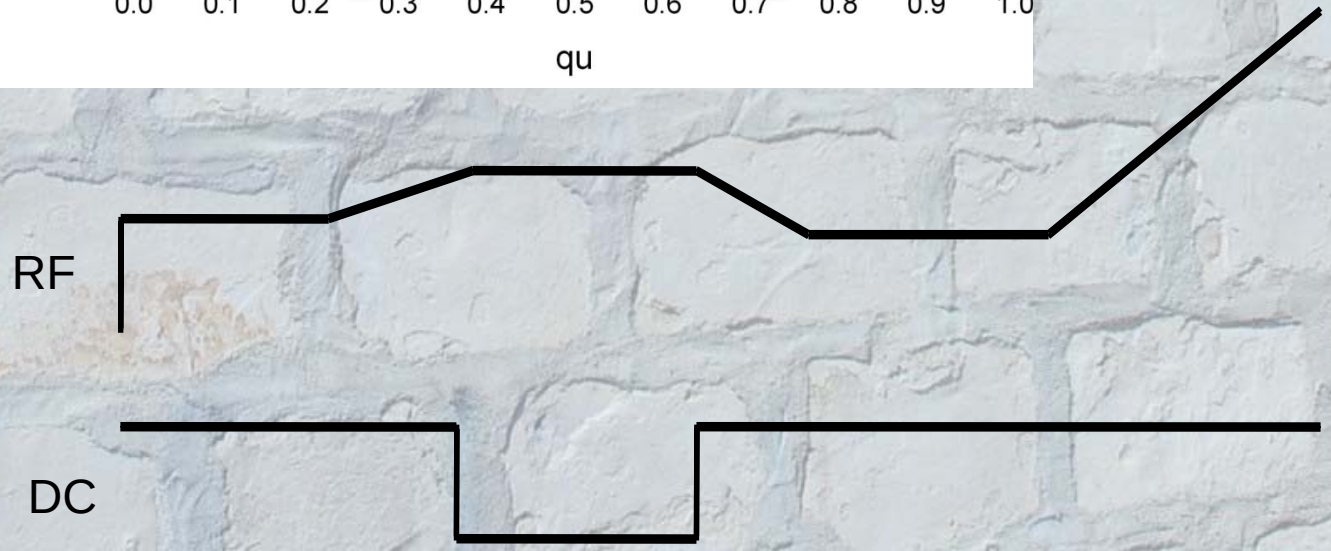
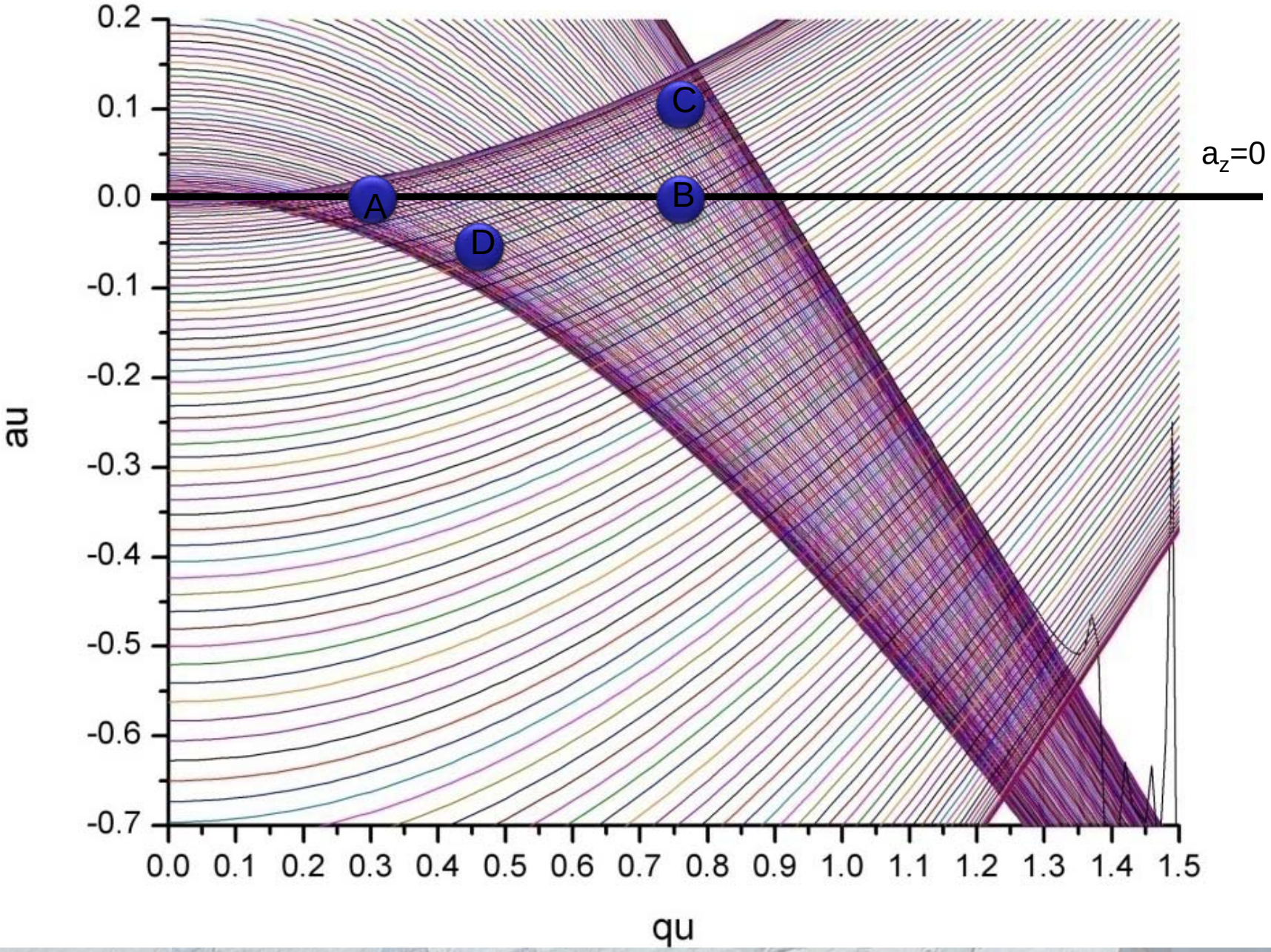
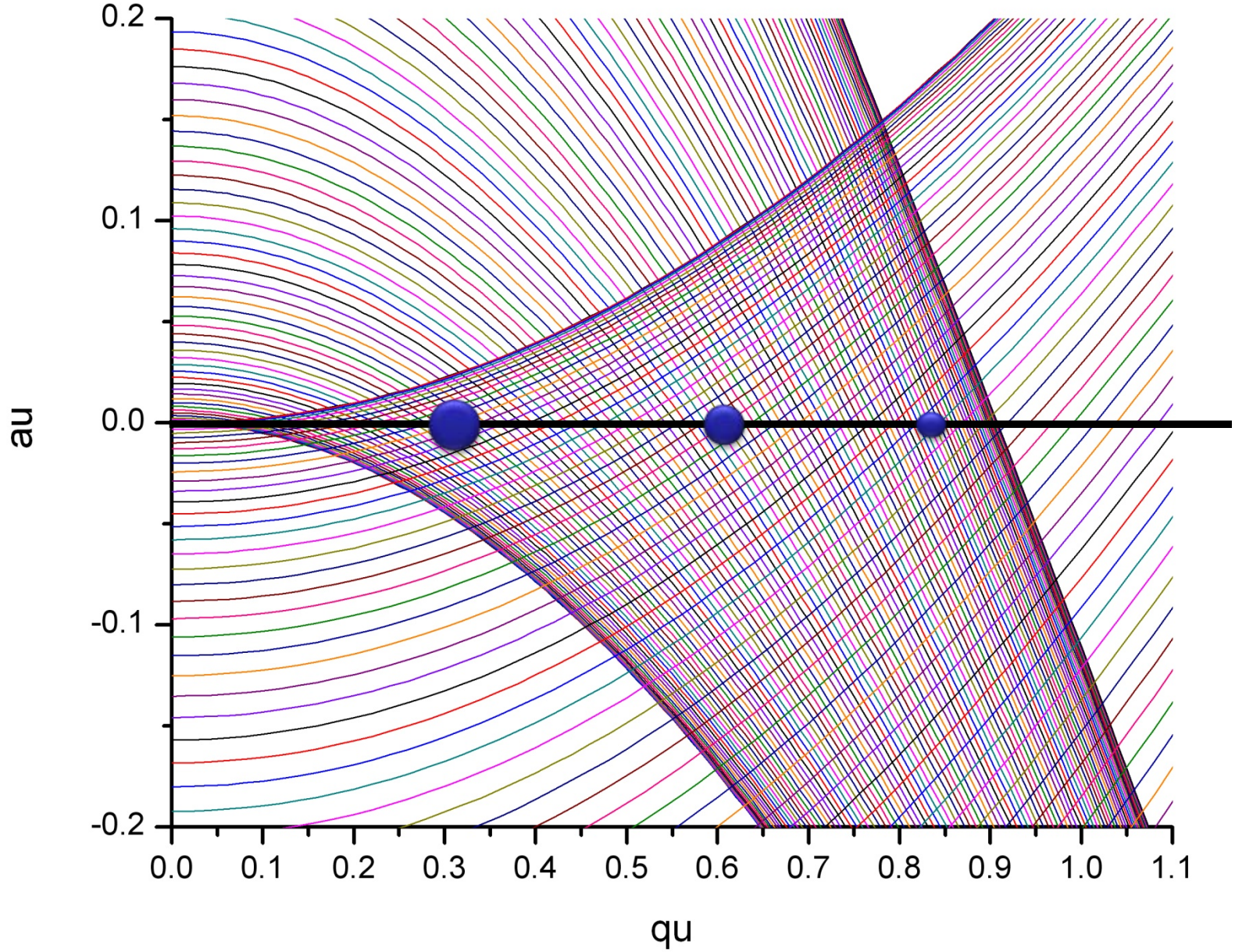

RF
DC


0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
au
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5
qu
A
B
C
D
a_z=0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0.1
0.0
-0.1
-0.2
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0.8
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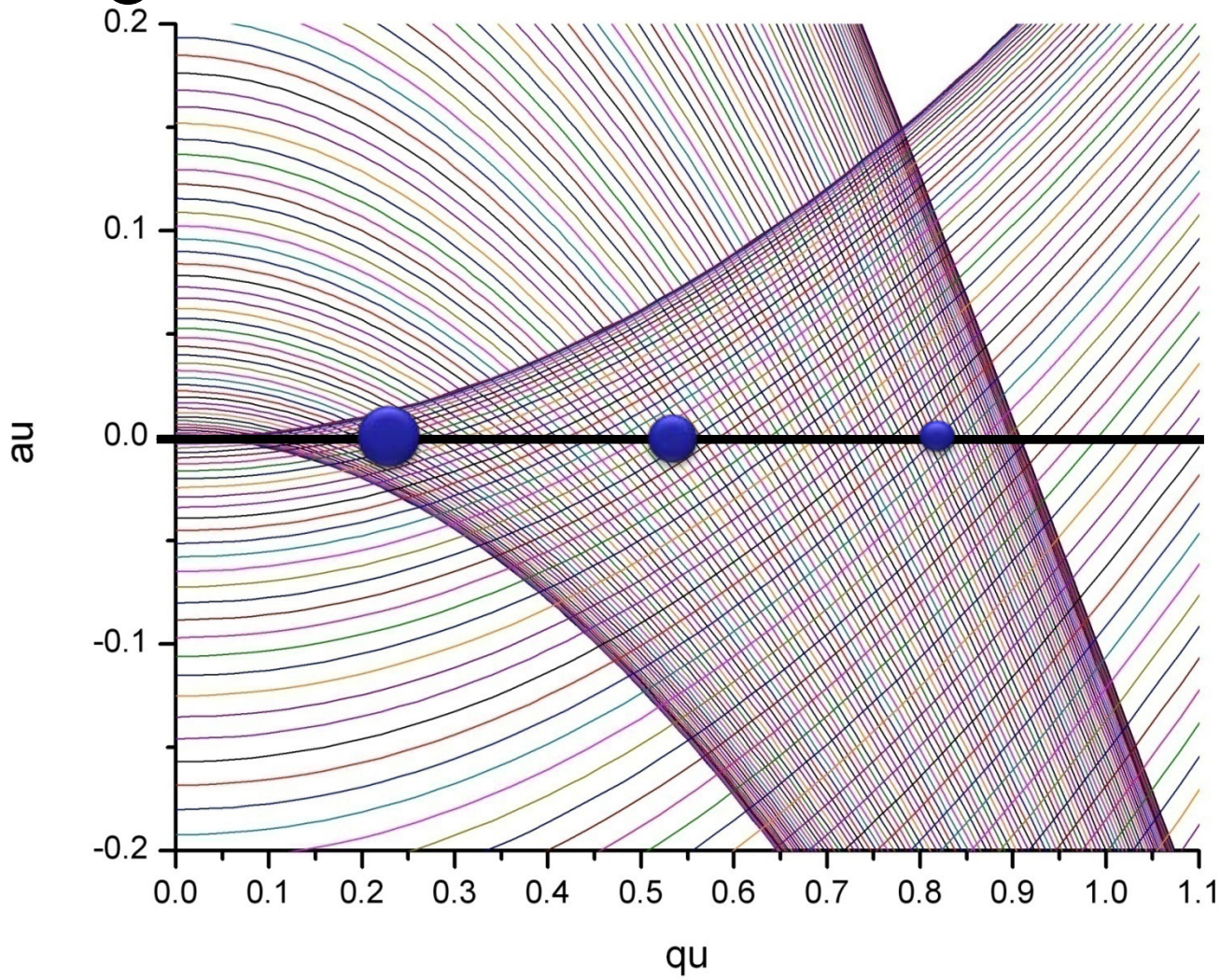
1.0
1.1
qu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-0.2
au
0.0
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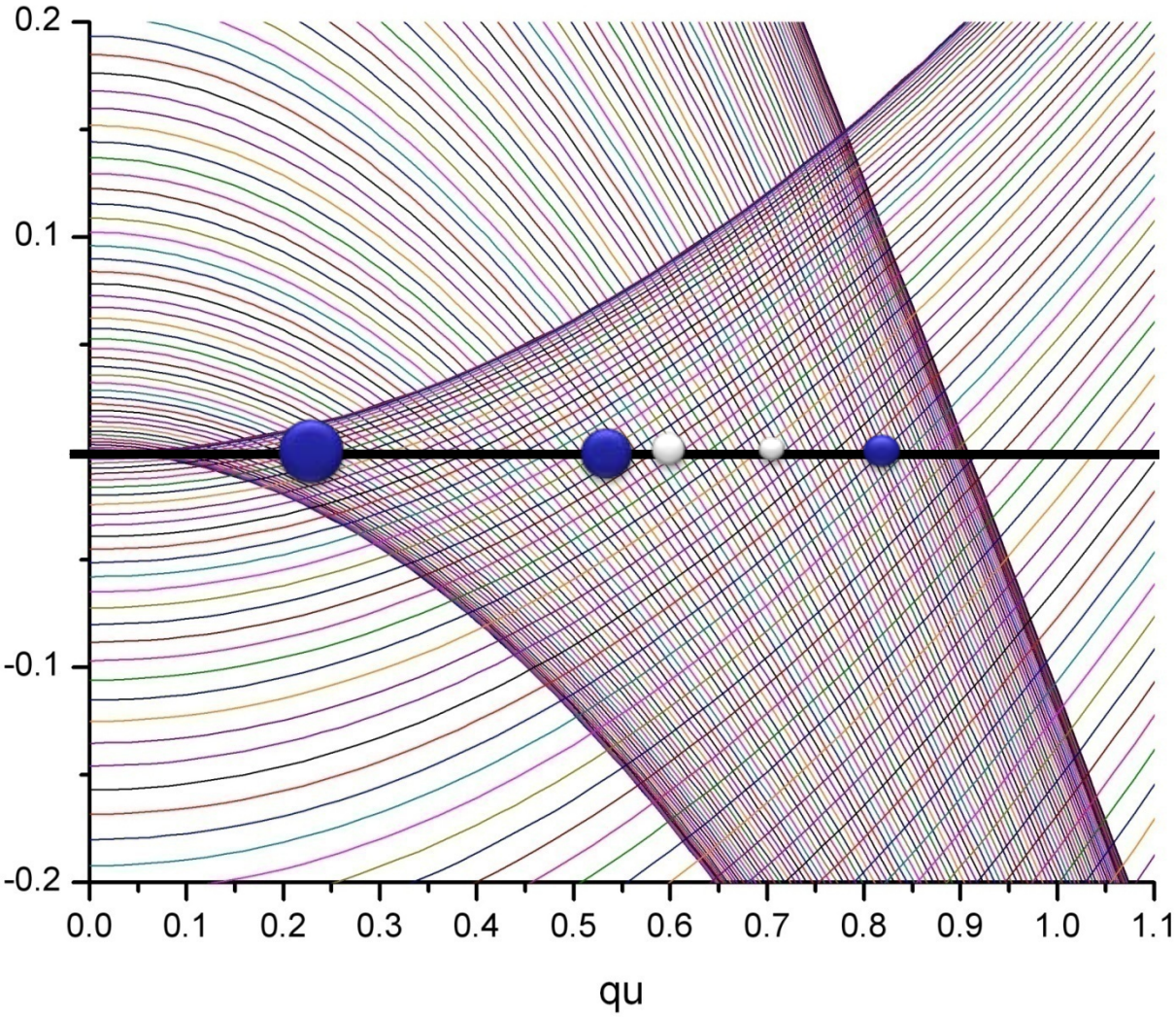
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-0.1
-0.2
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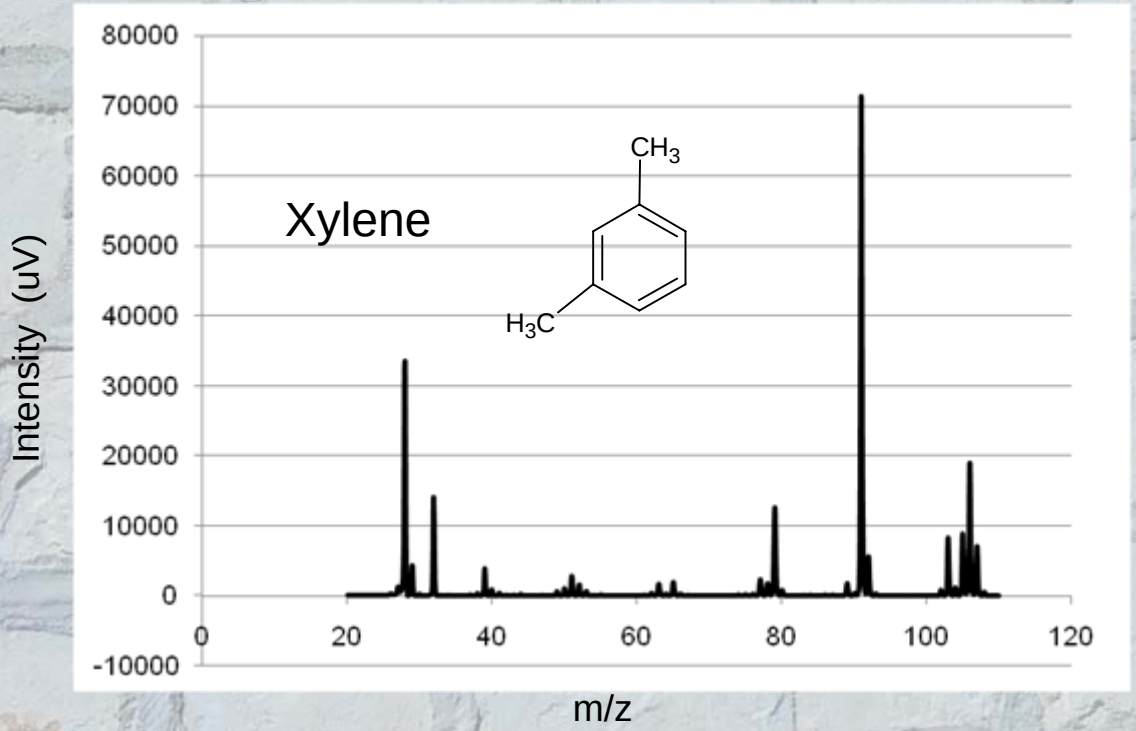
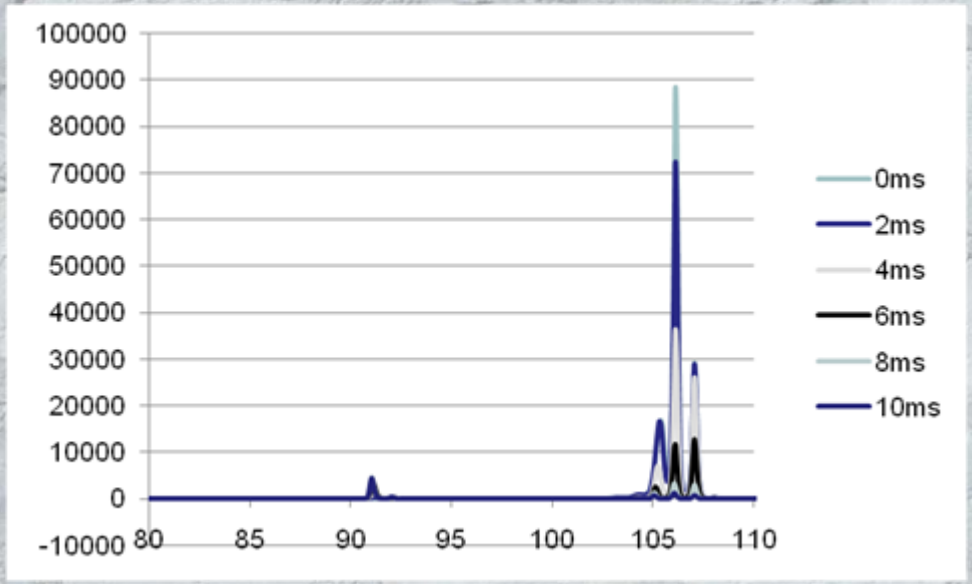
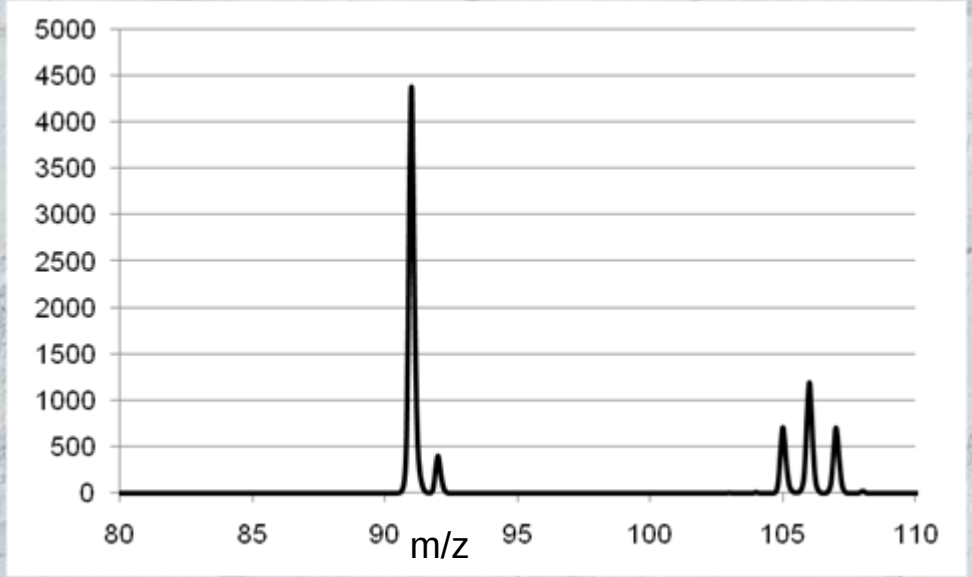

Xylene
CH_3
H_3C
Intensity (uV)
80000
70000
60000
50000
40000
30000
20000
10000
0
-10000
0
20
40
60
80
100
120
m/z


Intensity (uV)
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
-10000
80
85
90
95
100
105
110
0ms
2ms
4ms
6ms
8ms
10ms


Intensity (uV)
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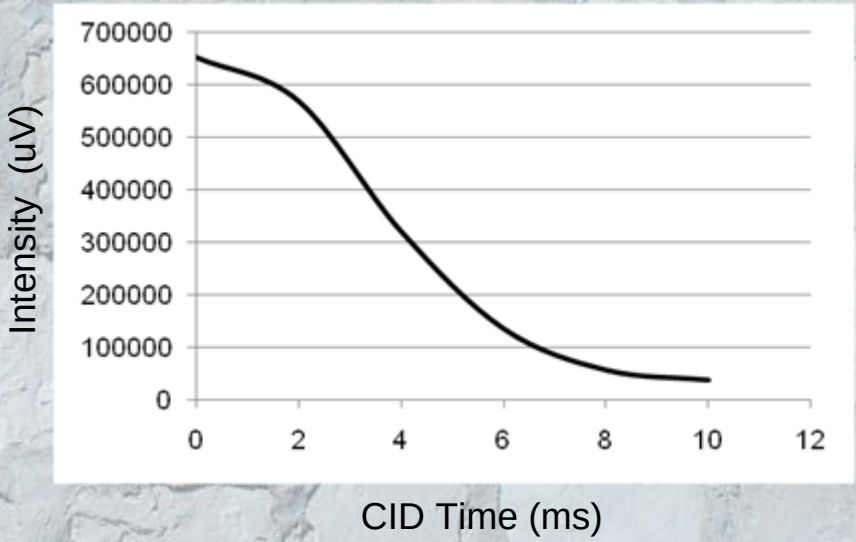
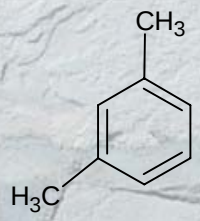
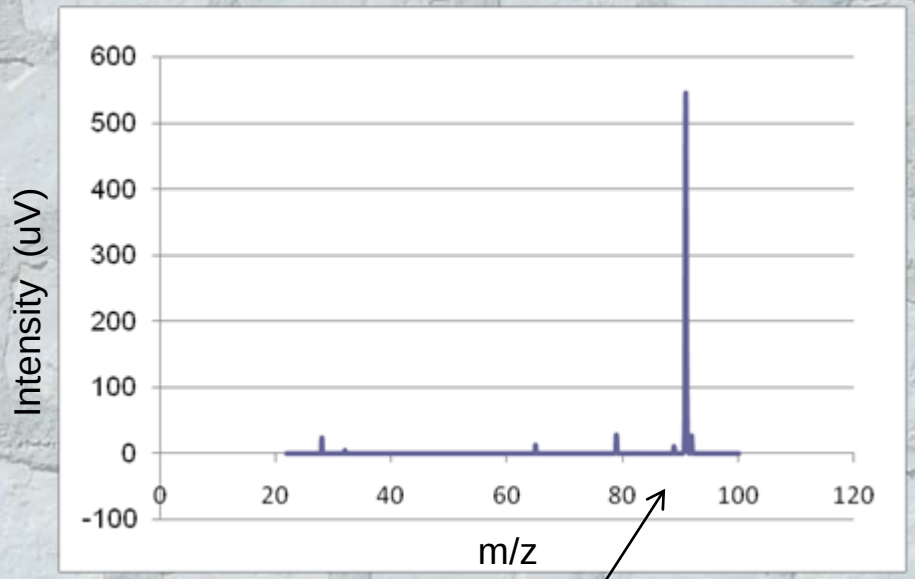
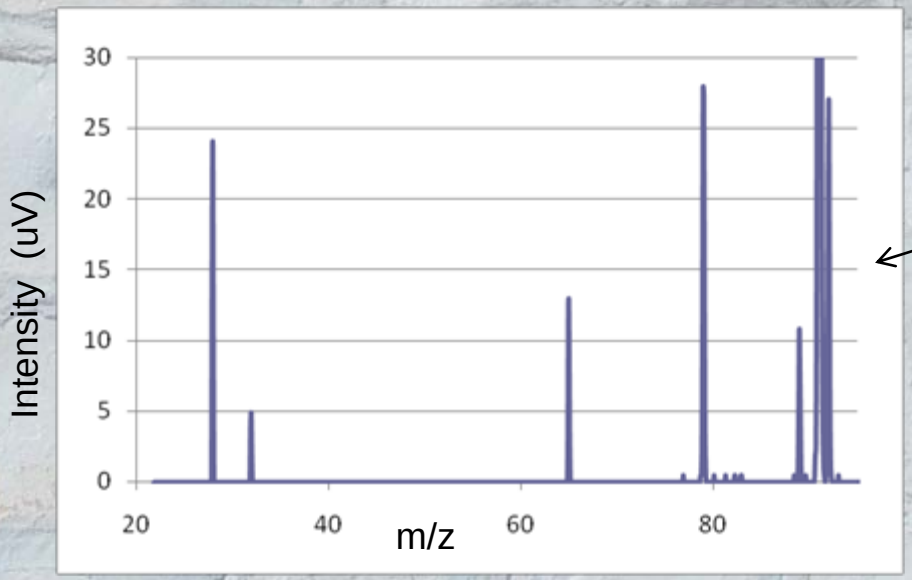
3500
3000
2500
2000
1500
1000
500
0
80
85
90
95
100
105
110
m/z

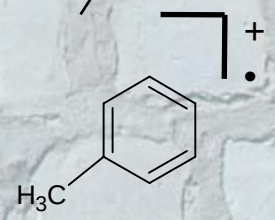

Intensity (uV)
700000
600000
500000
400000
300000
200000
100000
0
0
2
4
6
8
10
12
CID Time (ms)


CH3
H3C

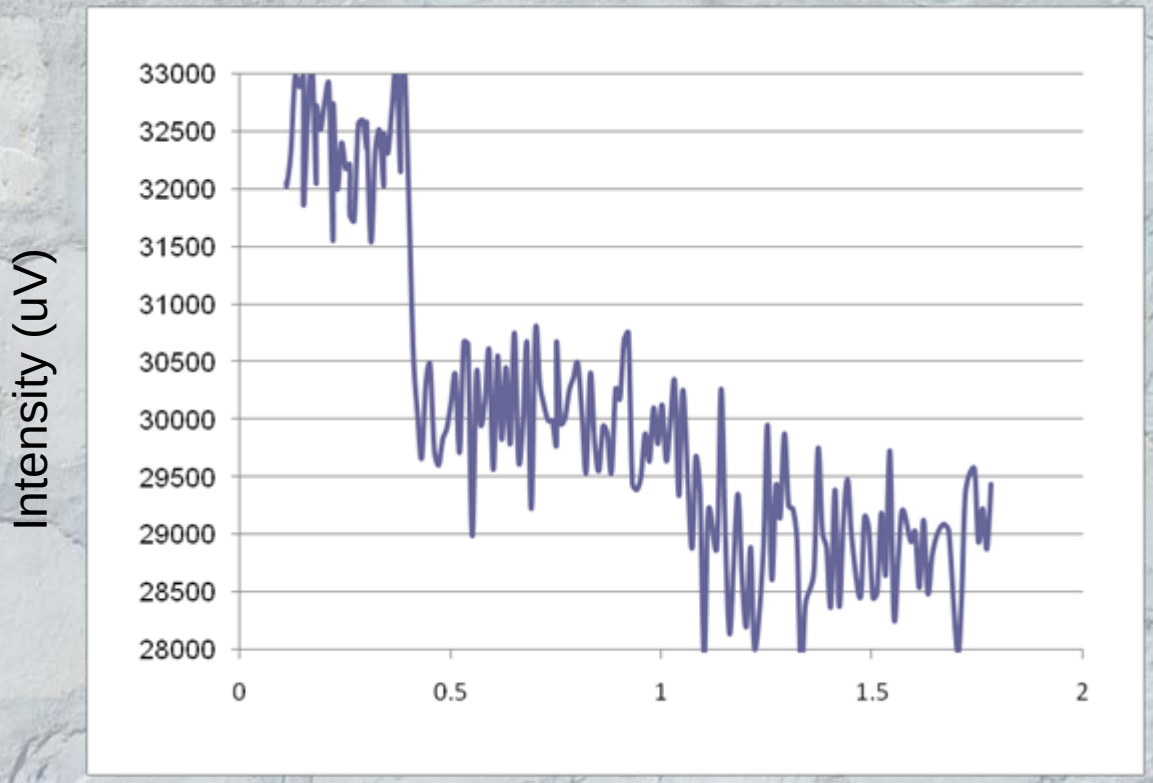
Xylene


Intensity (uV)
600
500
400
300
200
100
0
-100
0
20
40
60
80
100
120
m/z

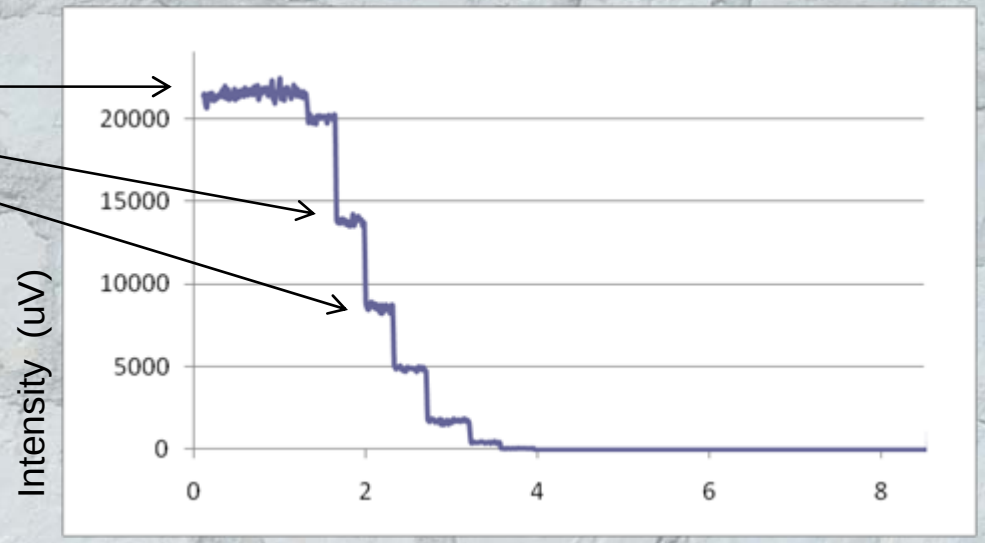

Intensity (uV)
30
25
20
15
10
5
0
20
40
60
80
m/z


+
H3C

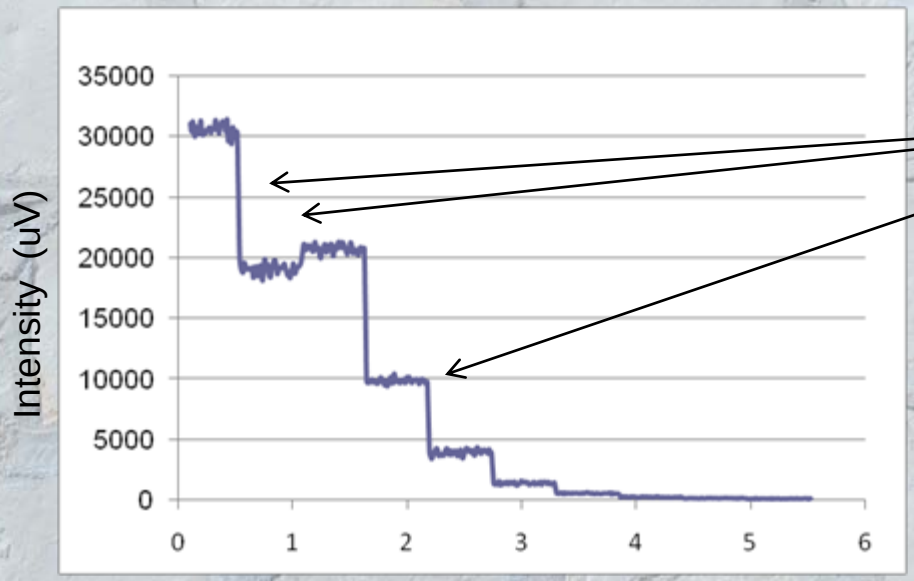
(Total Ion Count) TIC
Isolation of 91
~5amu window

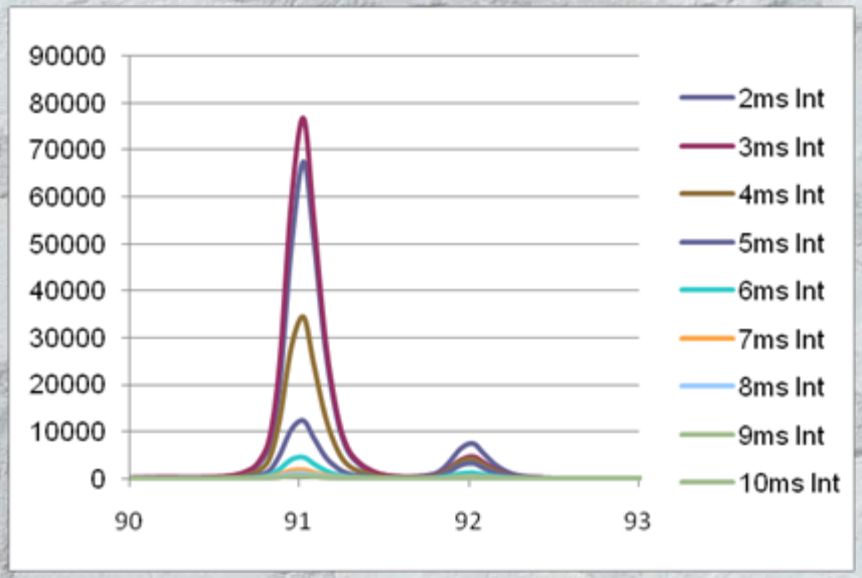


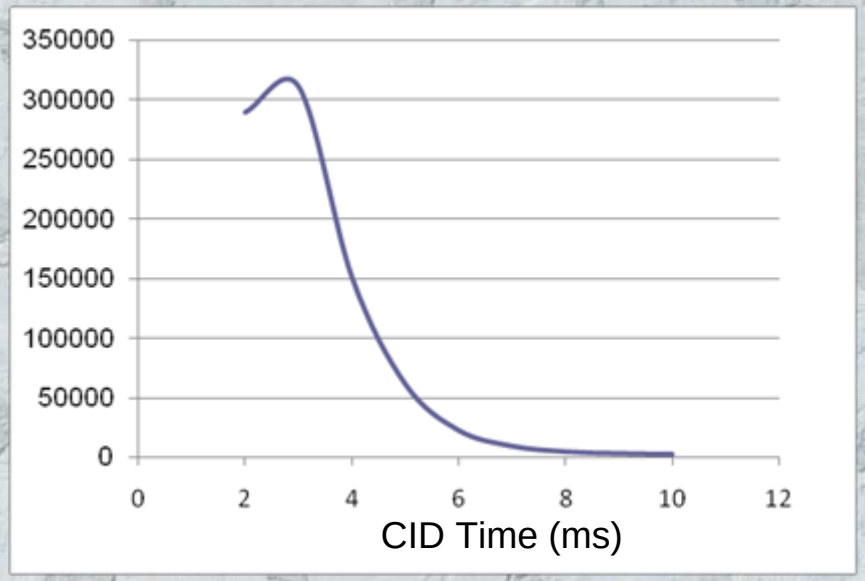
Increasing CID Voltage (100mV)

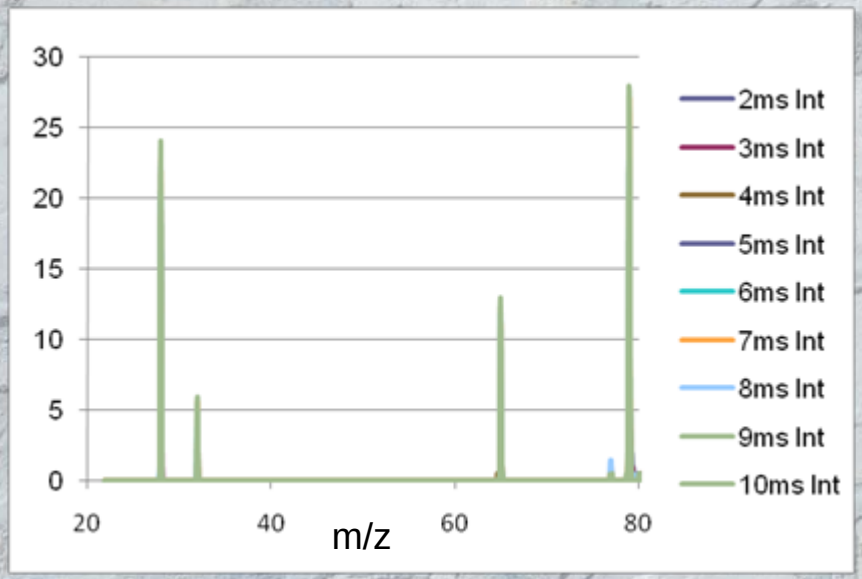


Increasing CID Time (ms)



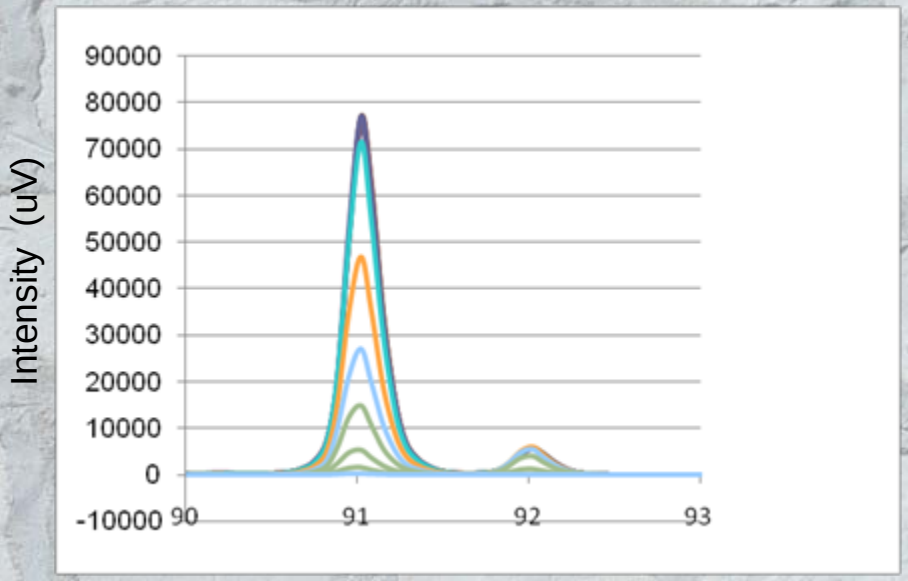


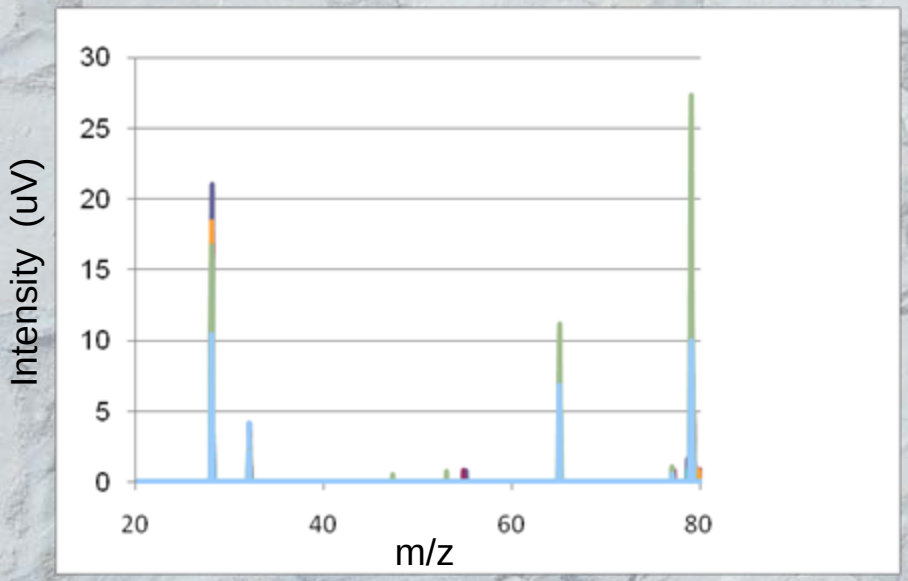


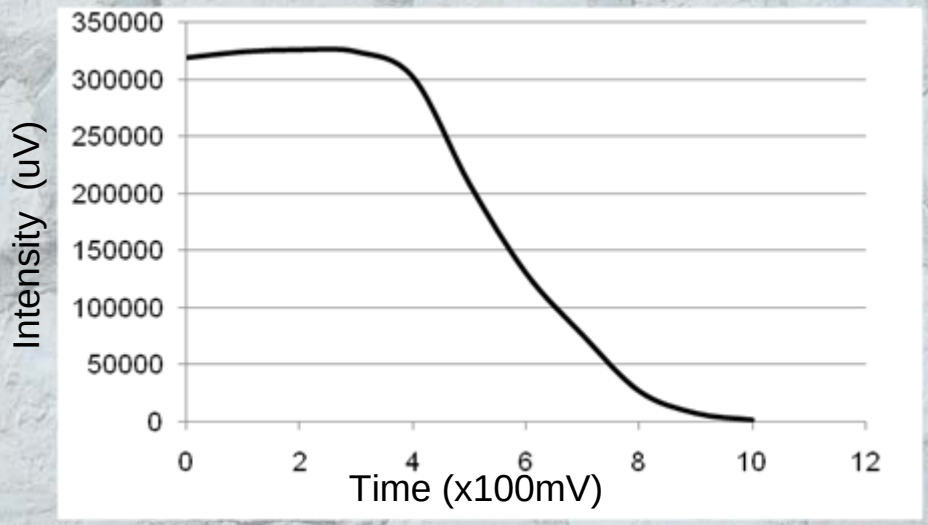


1V CID with Varying Time

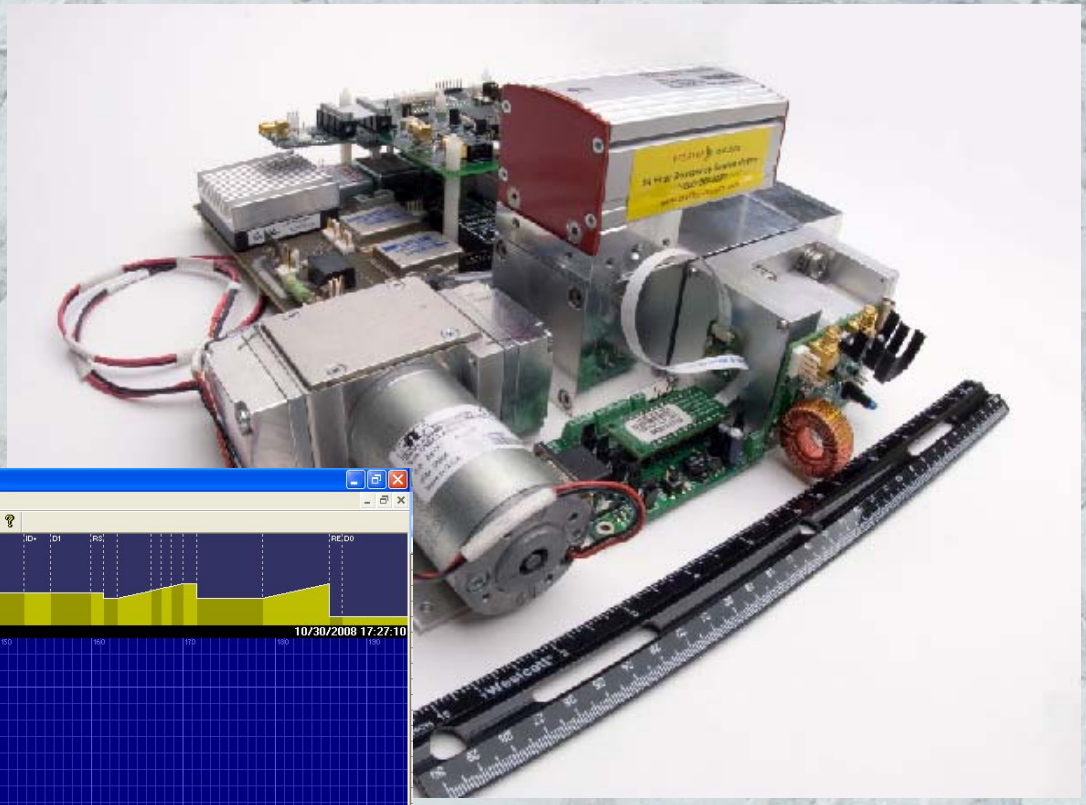
10ms CID with Varying Voltage

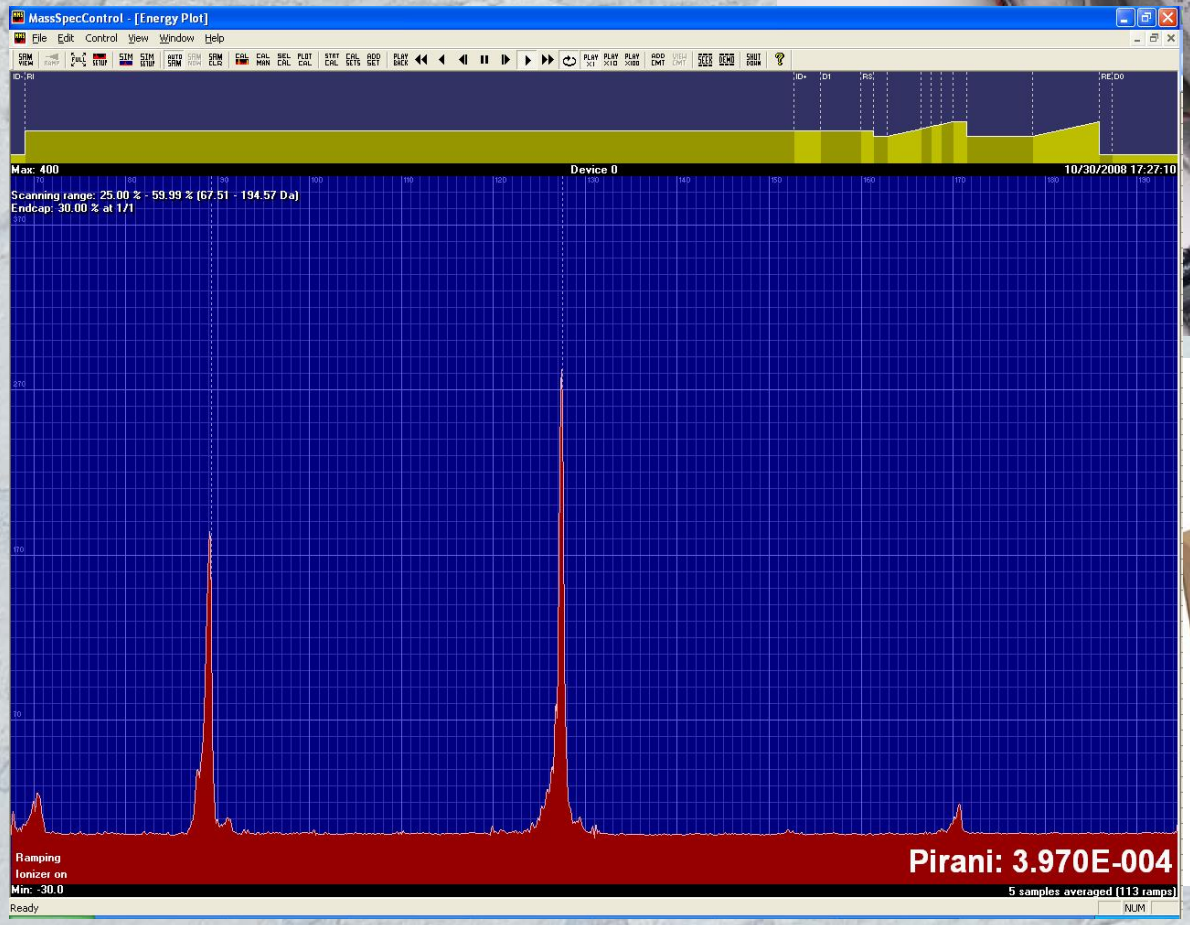






1st Detect
(MS/MS SF_6)





Thank you HEMS '09

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