Quadrupole Ion Trap Mass Spectrometry for Space Shuttle Ground Support

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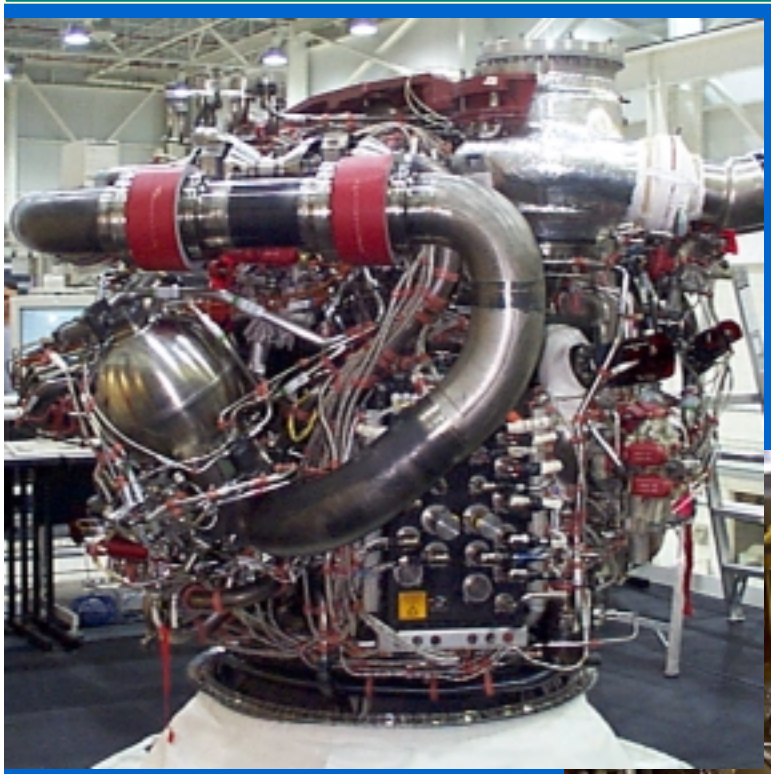
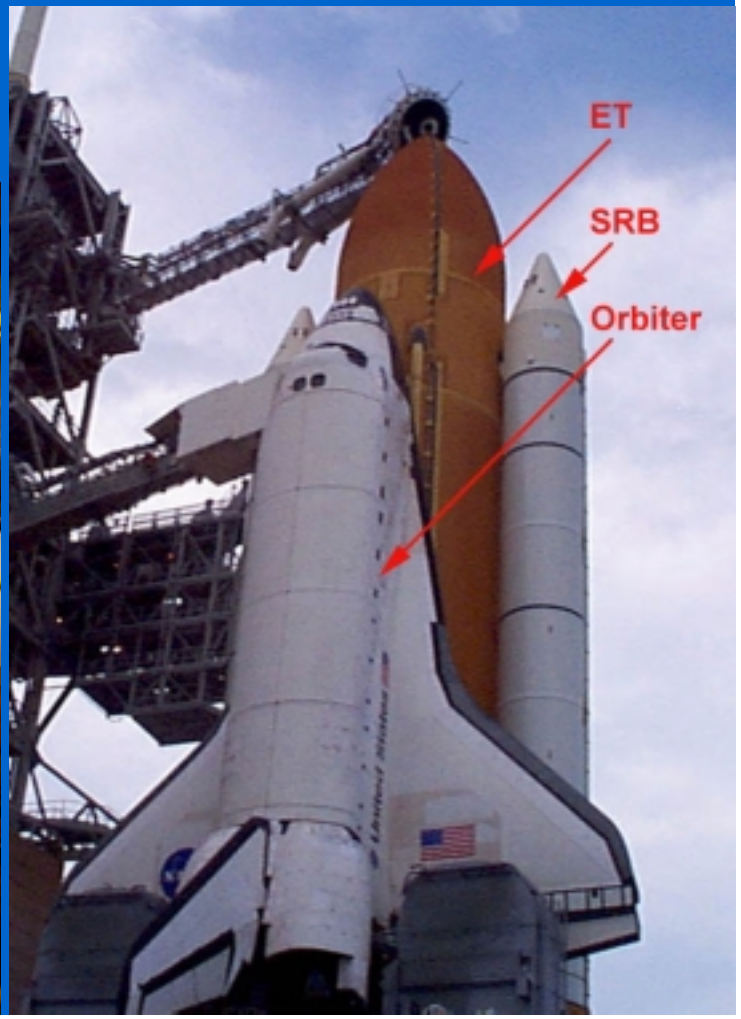
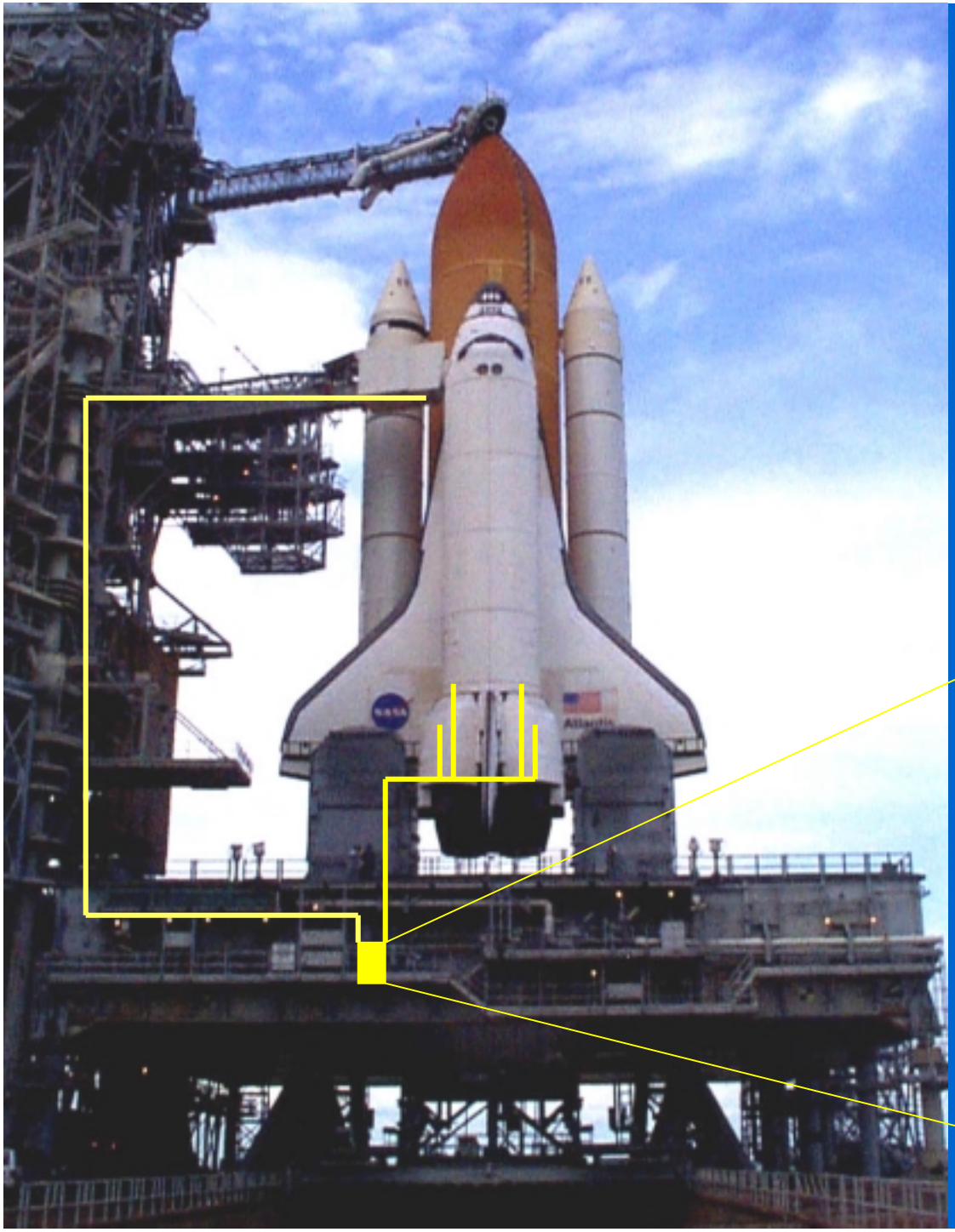
Cryogenic Fuel System

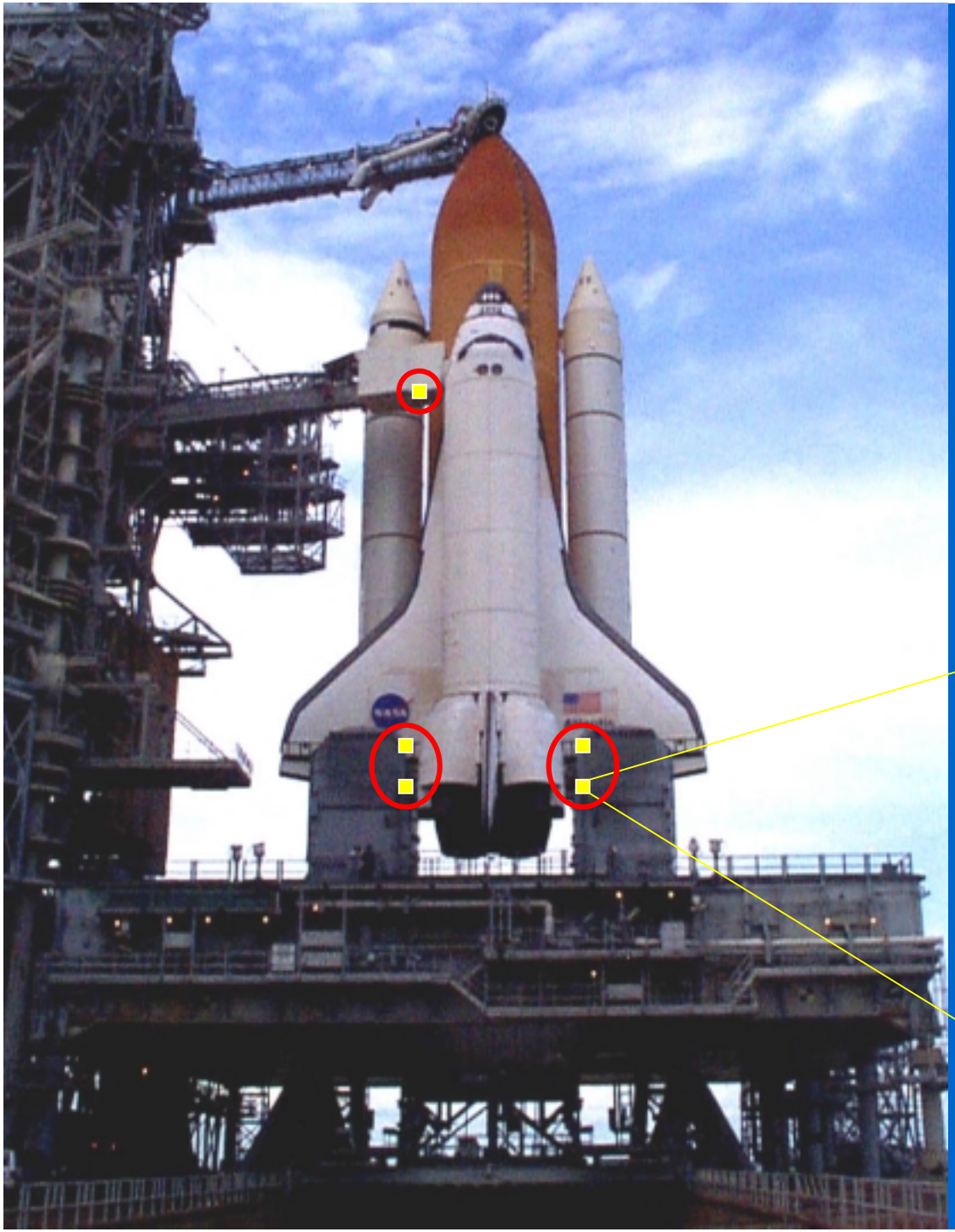
- 1,773,000 L LH_2
- 660,000 L LO_2





Current Leak Detection





Future

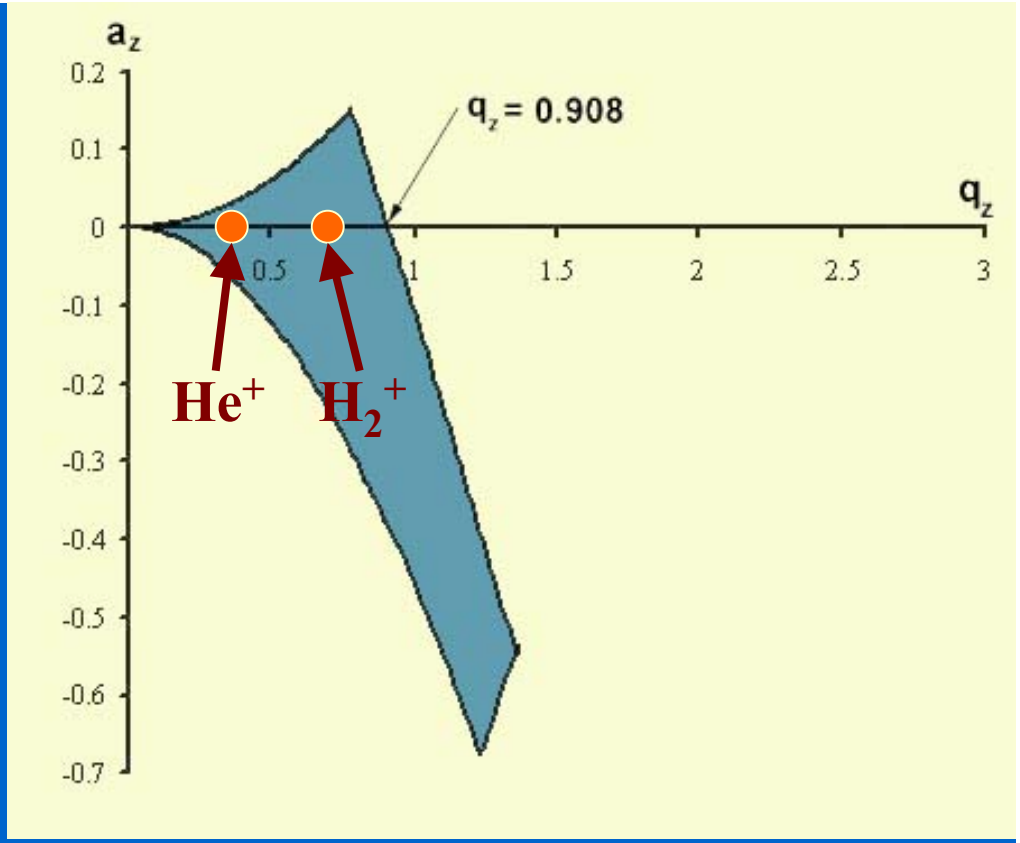
Leak Detection

QITMS

- 2 – 50 Da
- Fast Analysis
- Miniature & Rugged

Modify Mass Range

$$m/z\, q_z = \frac{8eV_{RF}}{(r_0^2 + 2z_0^2)\Omega^2}$$

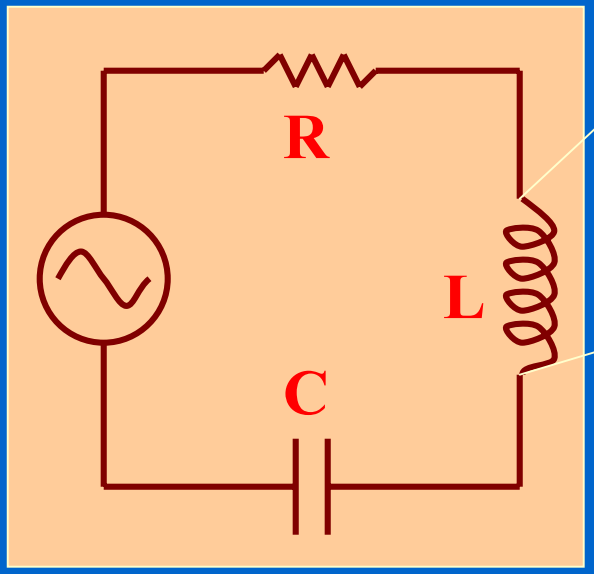


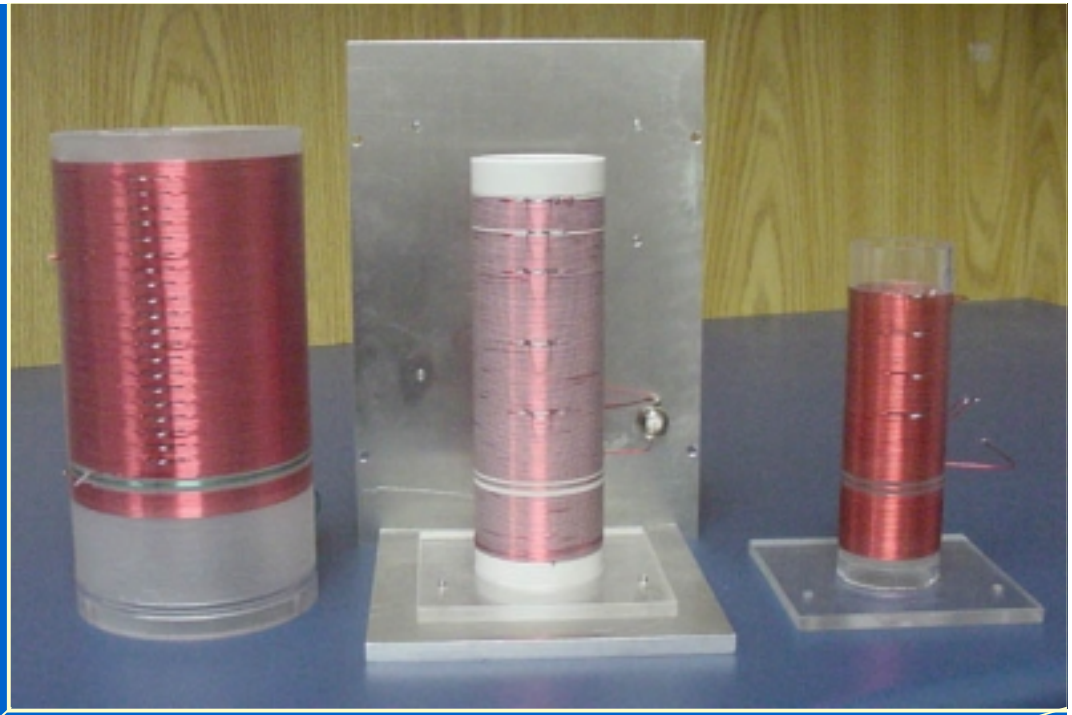
Increase Dimensions

Increase Frequency

RF Circuit

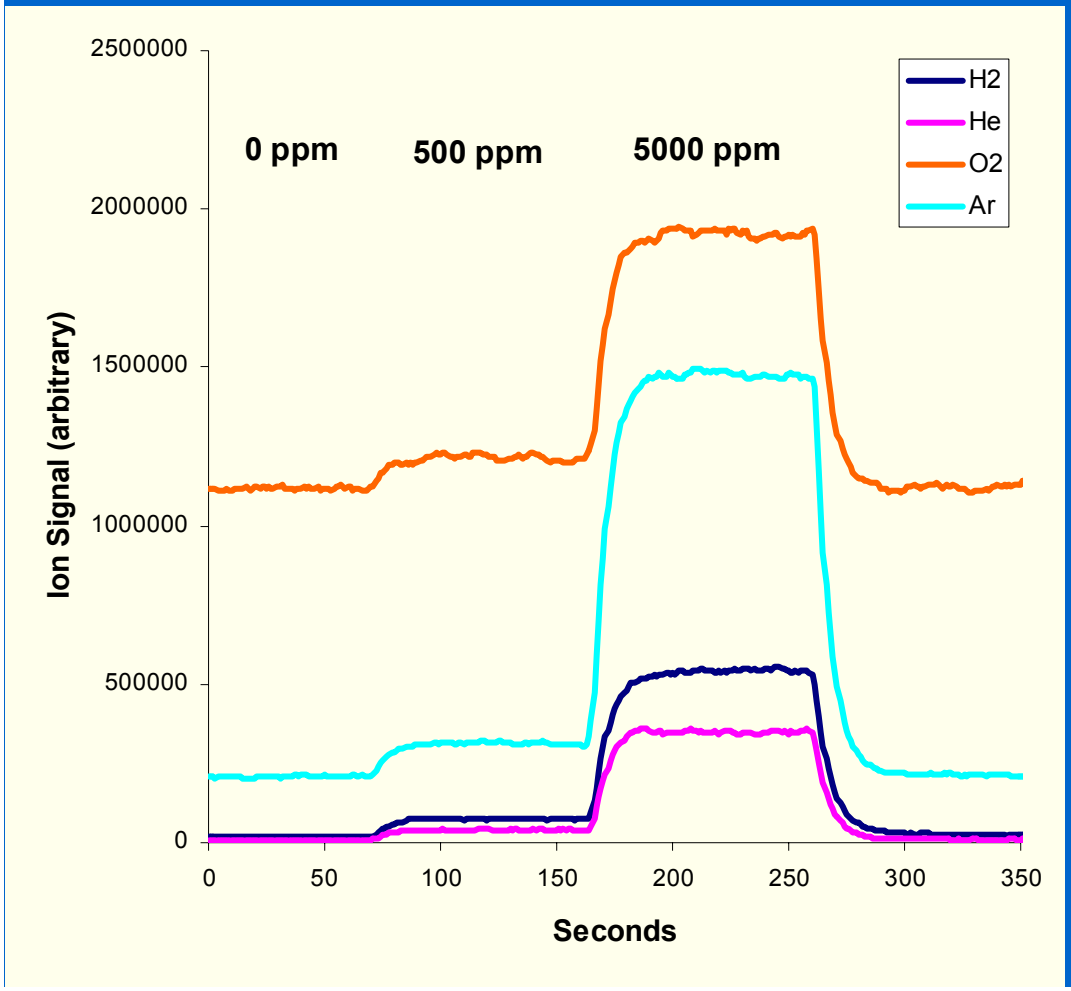
RLC Network

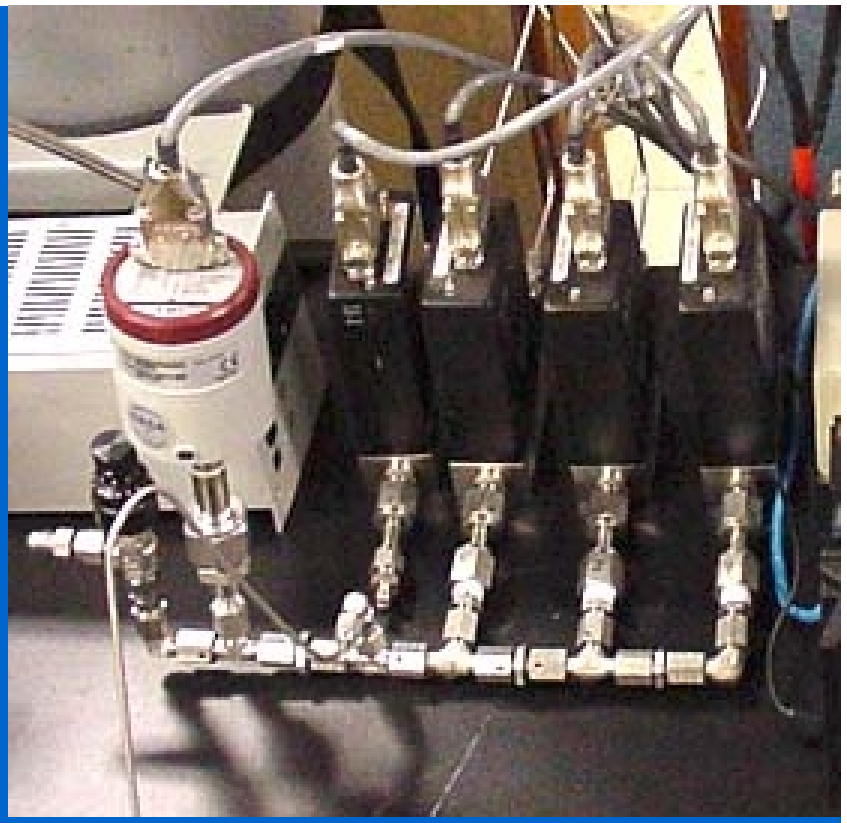




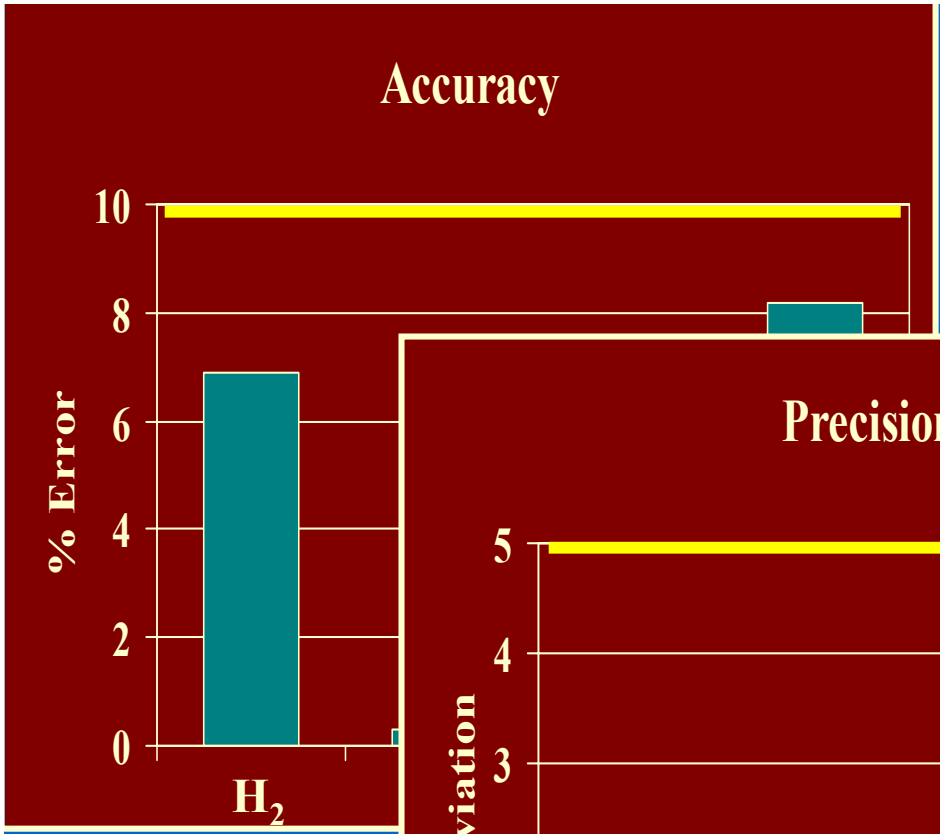
2.5 MHz ⟶ 2 to 60 Da

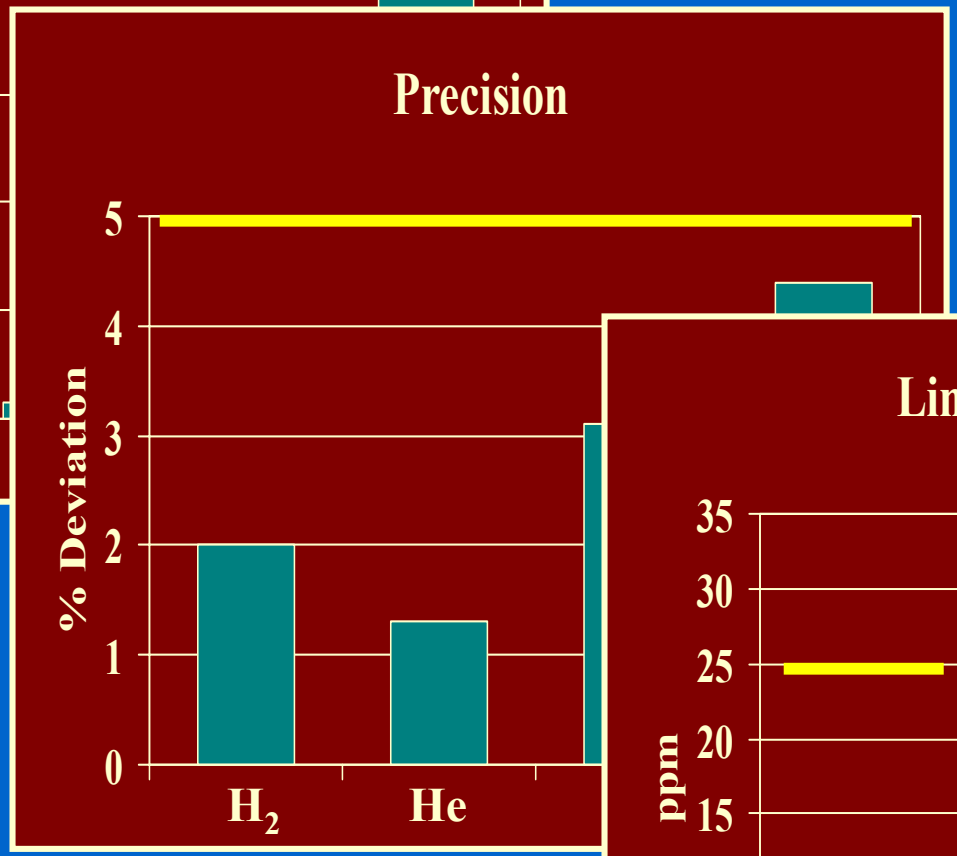
Testing

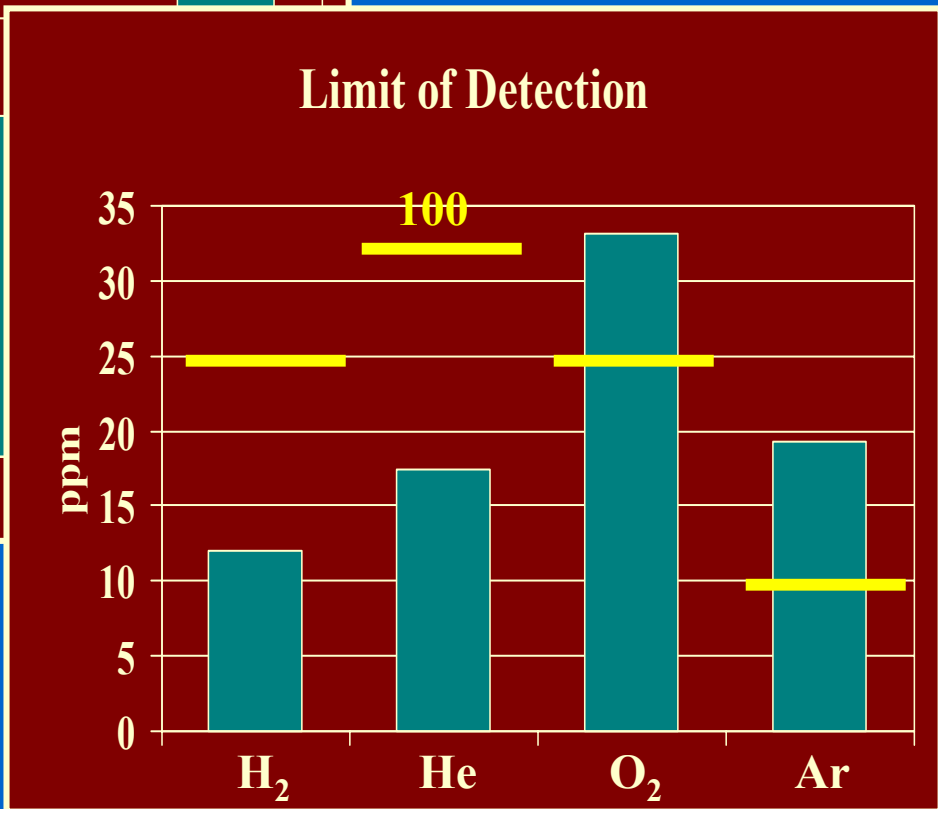

2500000
2000000
1500000
1000000
500000
0
Ion Signal (arbitrary)
0 ppm
500 ppm
5000 ppm
H2
He
O2
Ar
0
50
100
150
200
250
300
350
Seconds



Quantitative Results







Trapped Ions

More Ions = More Signal

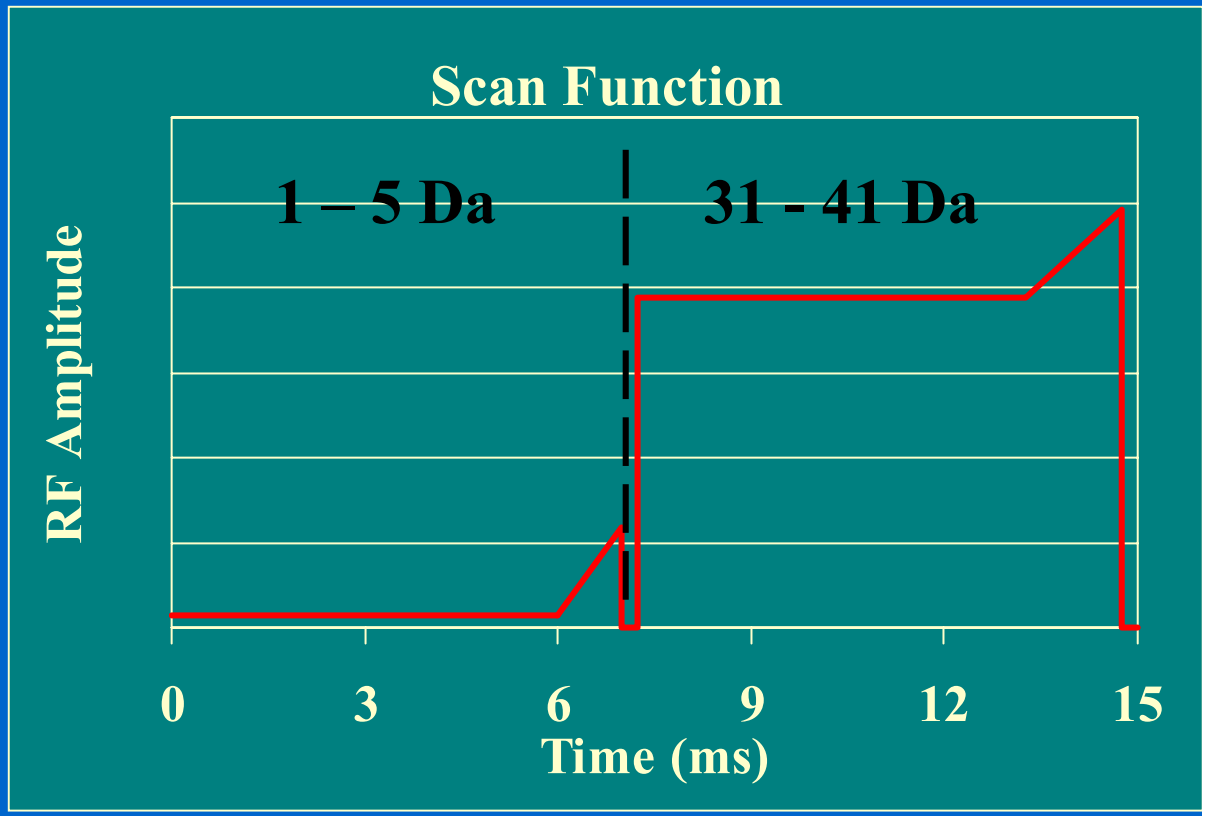
Or Not?

- **Space Charge**
- **Ion-Molecule Reactions**

Go Fast…

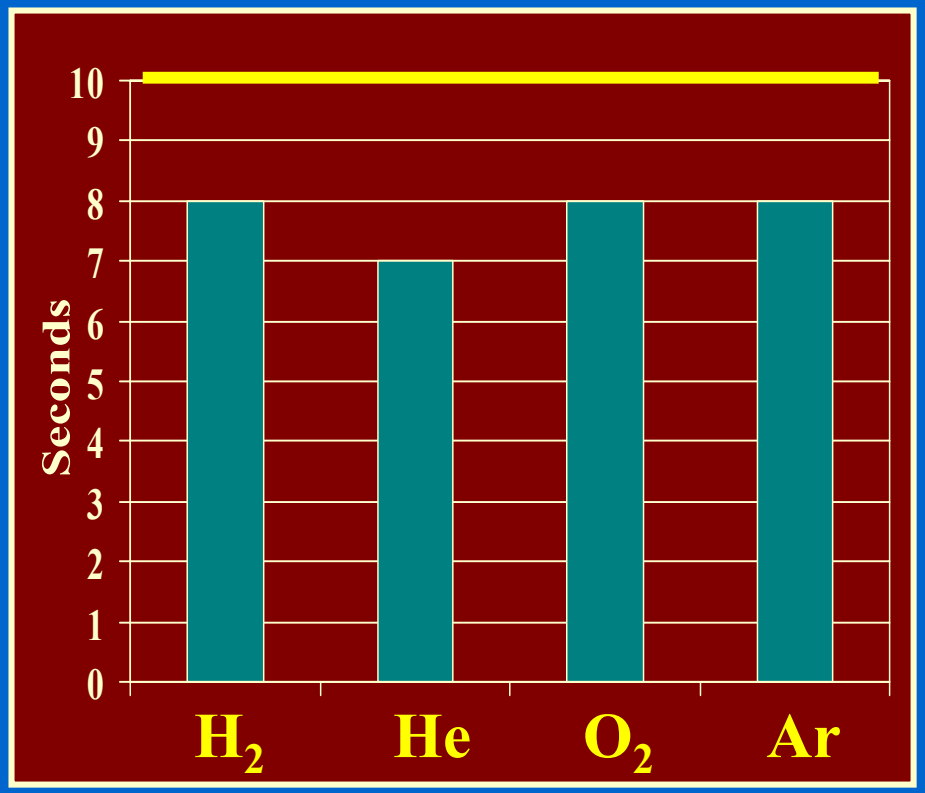
Maximize Signal

Minimize Noise

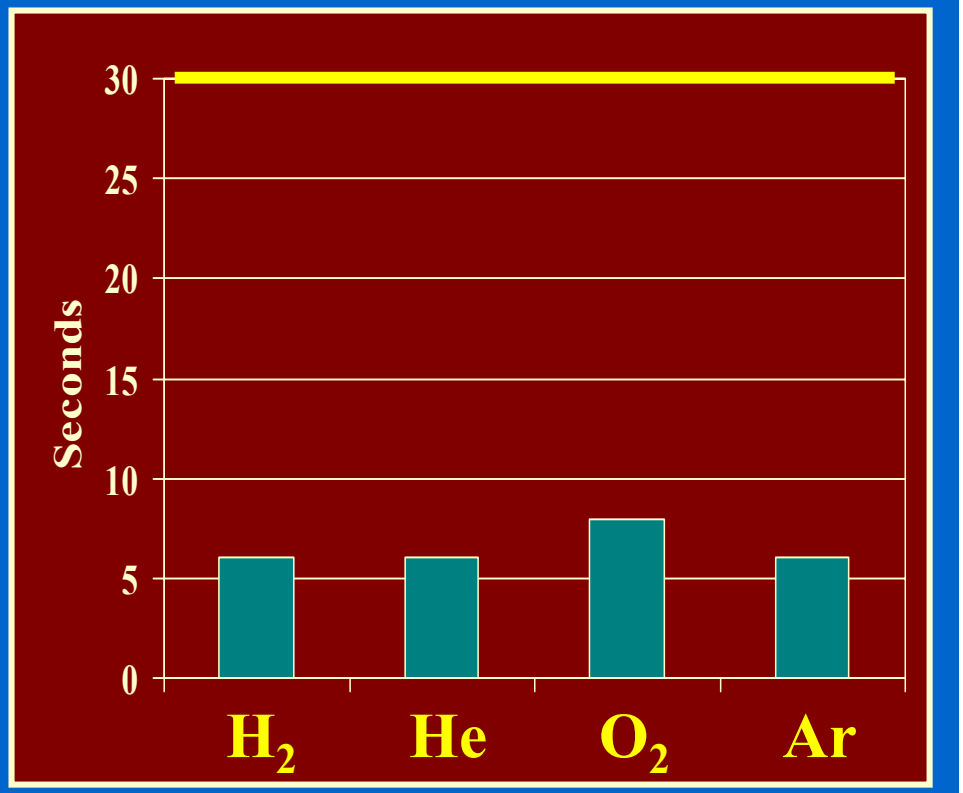


Quick Response

Response Time



Recovery Time



Miniature ?

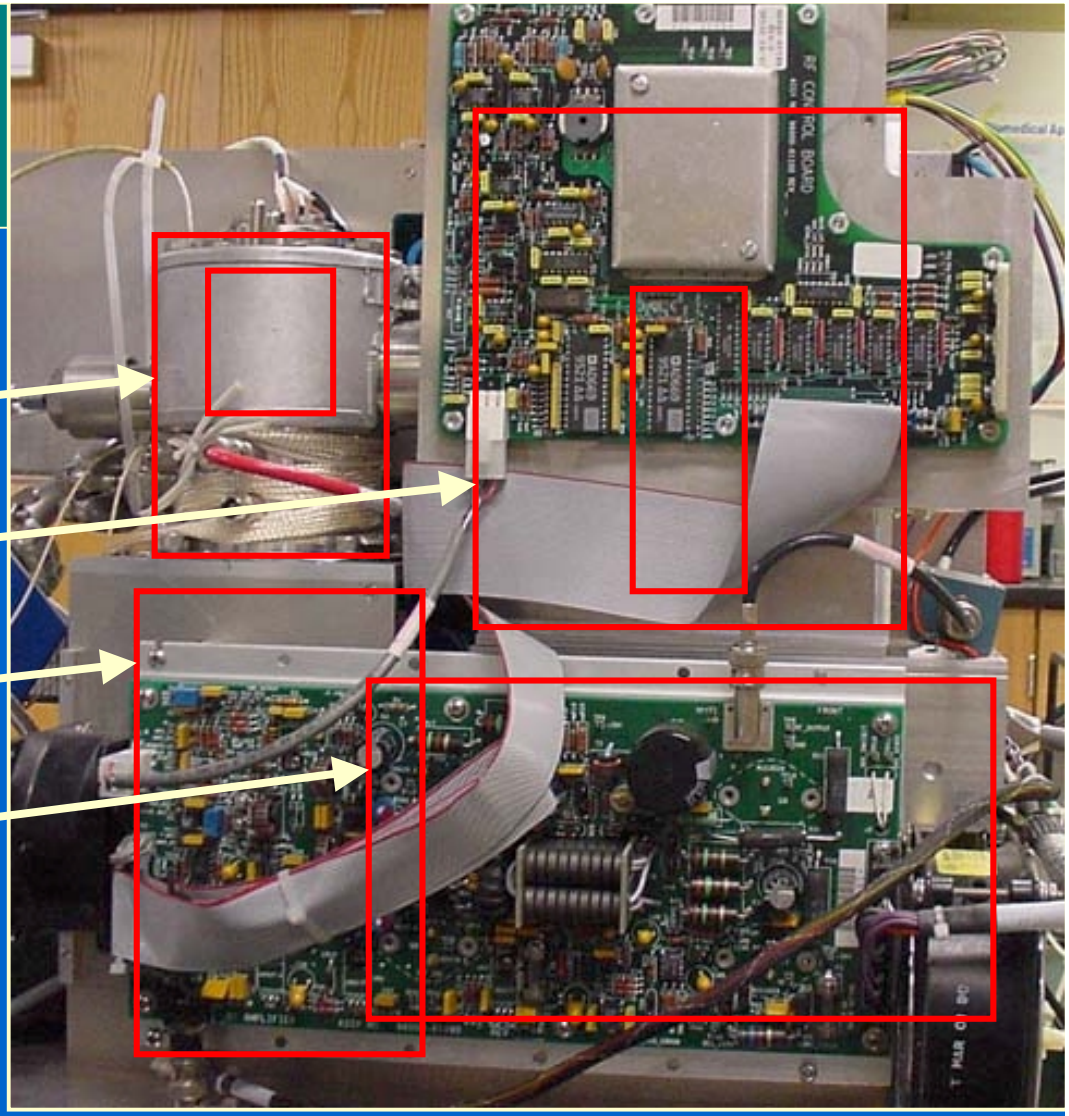
Volume

2 %

6.5 %

5 %

8 %



20 %

20 %

Other Electronics

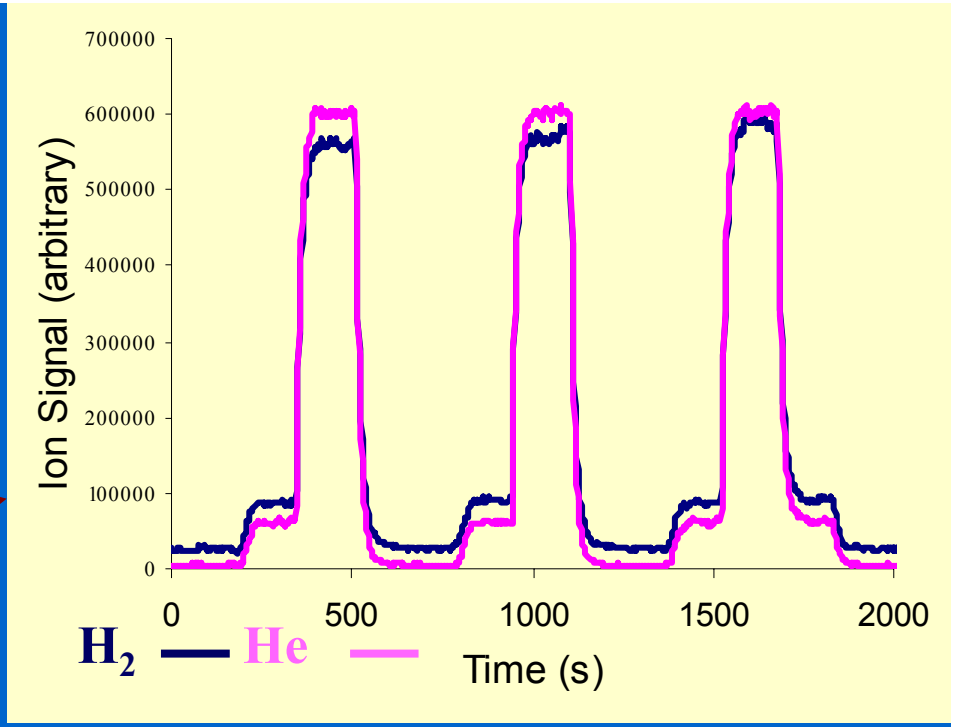
½ Size Trap

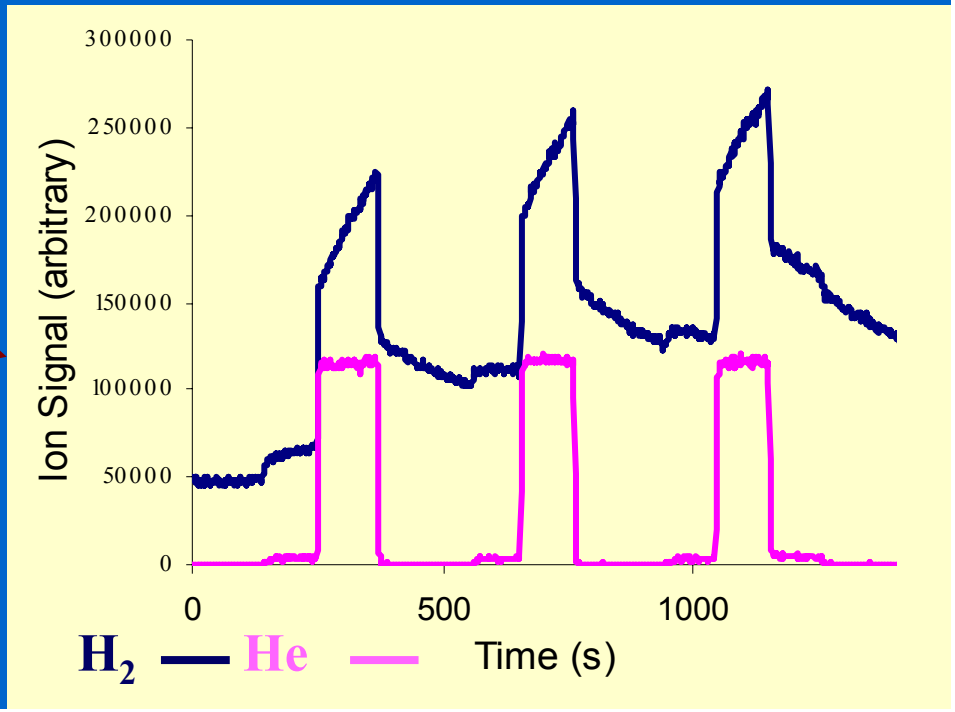
Reduce r_0 & z_0 by ½:

- **Trap volume reduced by ⅞**
- **Less Pumping**
- **Coil volume reduced by ½**
- **Less Power**

Will the Ions Fit?

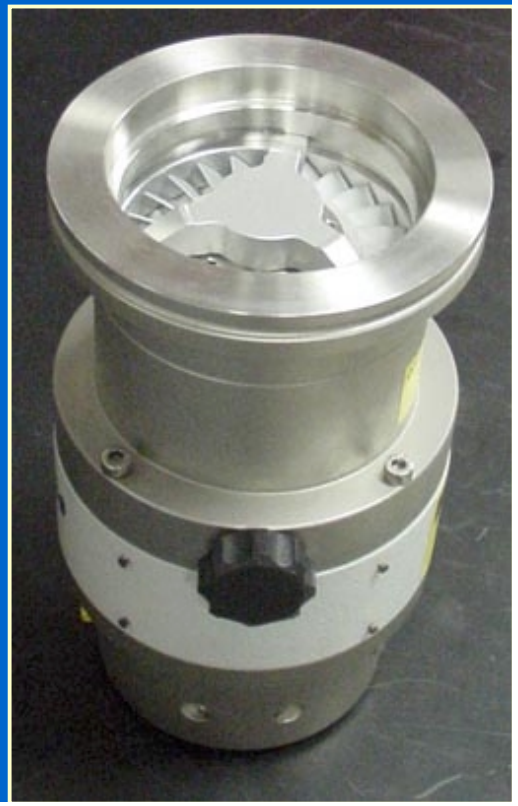
Pumps


700000
600000
500000
400000
300000
200000
100000
0
Ion Signal (arbitrary)
0
500
1000
1500
2000
H2
He
Time (s)


300000
250000
200000
150000
100000
50000
0
Ion Signal (arbitrary)
0
500
1000
H2
He
Time (s)

Rugged ?

- Solid State
- Source Filament
- Vacuum Pumps



Conclusions

QITMS

- Quantitative
- Fast Analysis

- Miniature
- Rugged

Acknowledgements

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