Progress in coupling a differential mobility analyzer to the source end of a mass spectrometer for IMS-MS studies

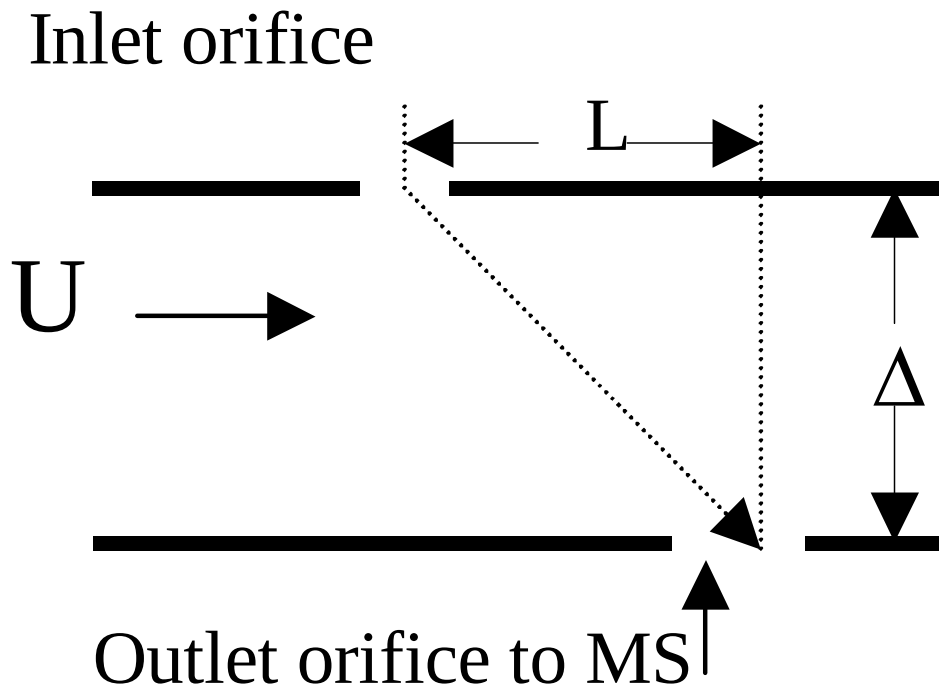
ThOF 03:50 pm

Juan Fernandez de la Mora[2]; Juan Rus[1]; Francisco Estevez[1]; Juan Antonio Sillero

[2] Yale University, Mechanical Engineering Department
[1] SEADM, Boecillo, Valladolid, Spain

The Differential Mobility Analyzer (DMA)

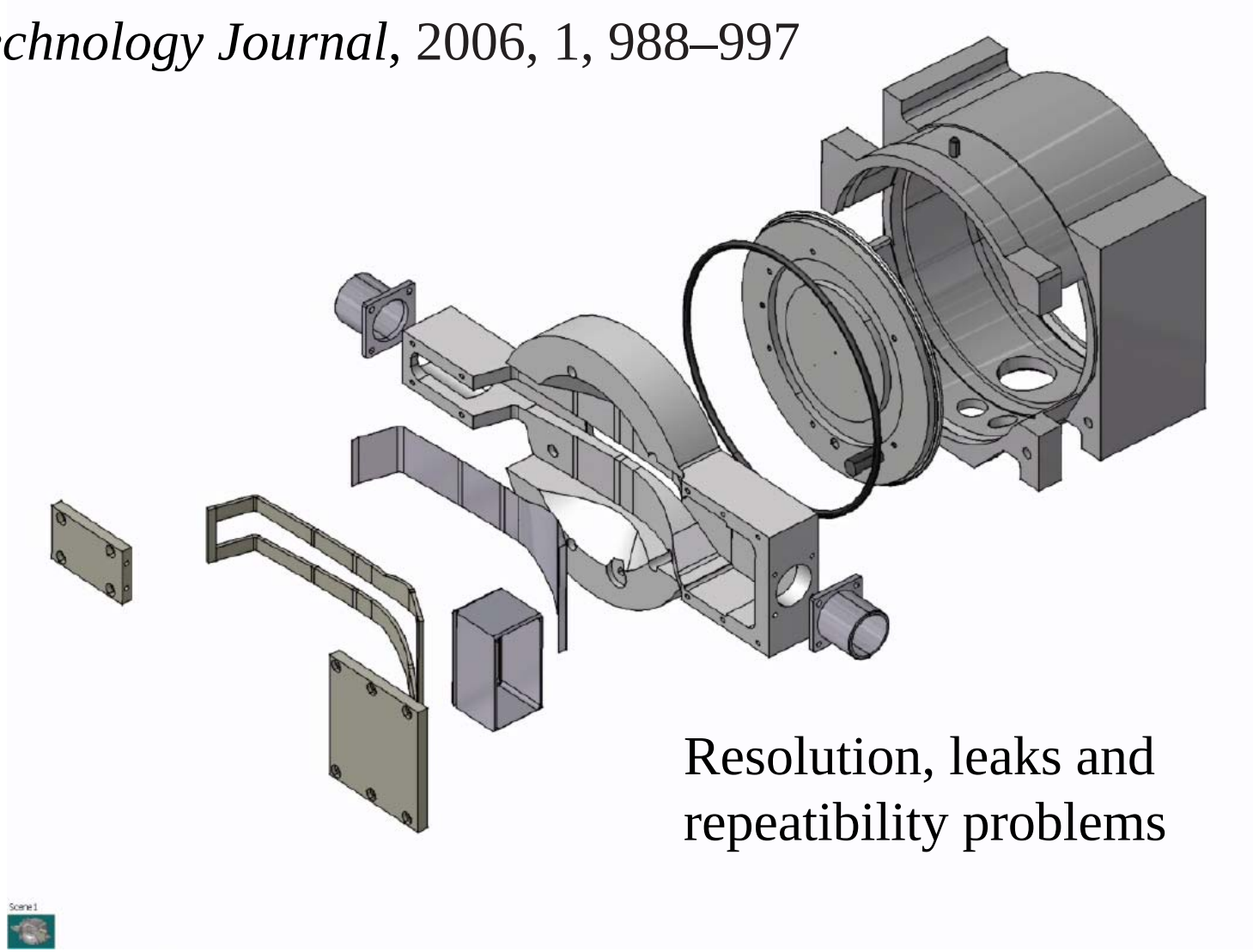
Mobility separation in space



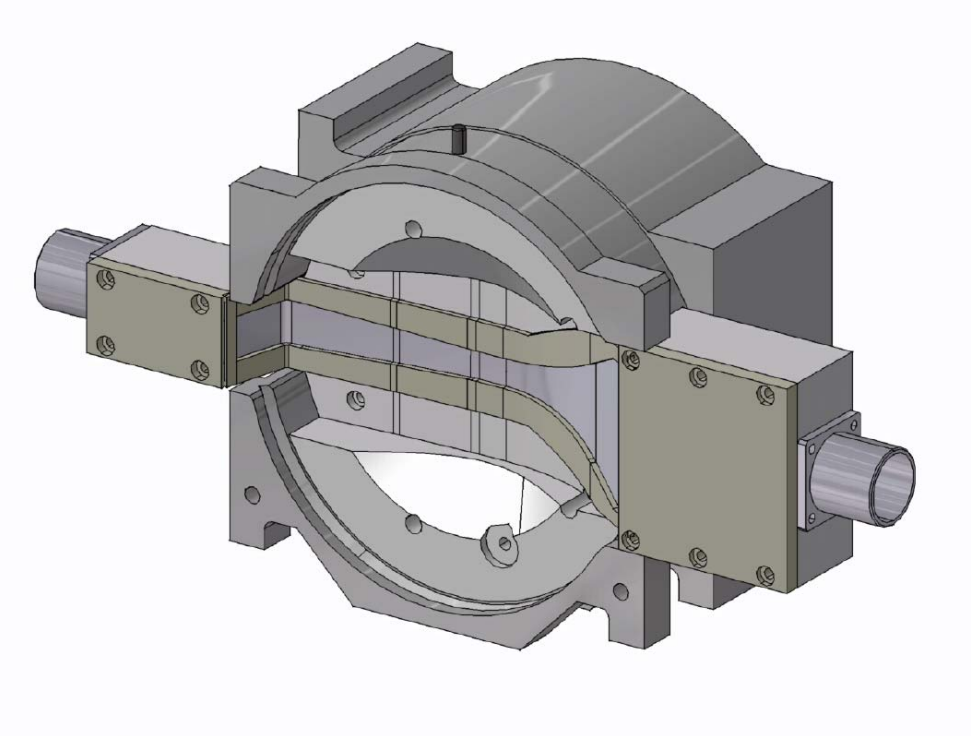
Simple front end to fit any MS with high pressure inlet
Steady mobility-selected signal (as long as one wants)
High transmission (~100%), fair resolution (50-100)

Prior work with Bruce Thomson (Sciex) and S. Ude: Coupling a DMA with Sciex's API-365

Biotechnology Journal, 2006, 1, 988–997



Resolution, leaks and repeatibility problems

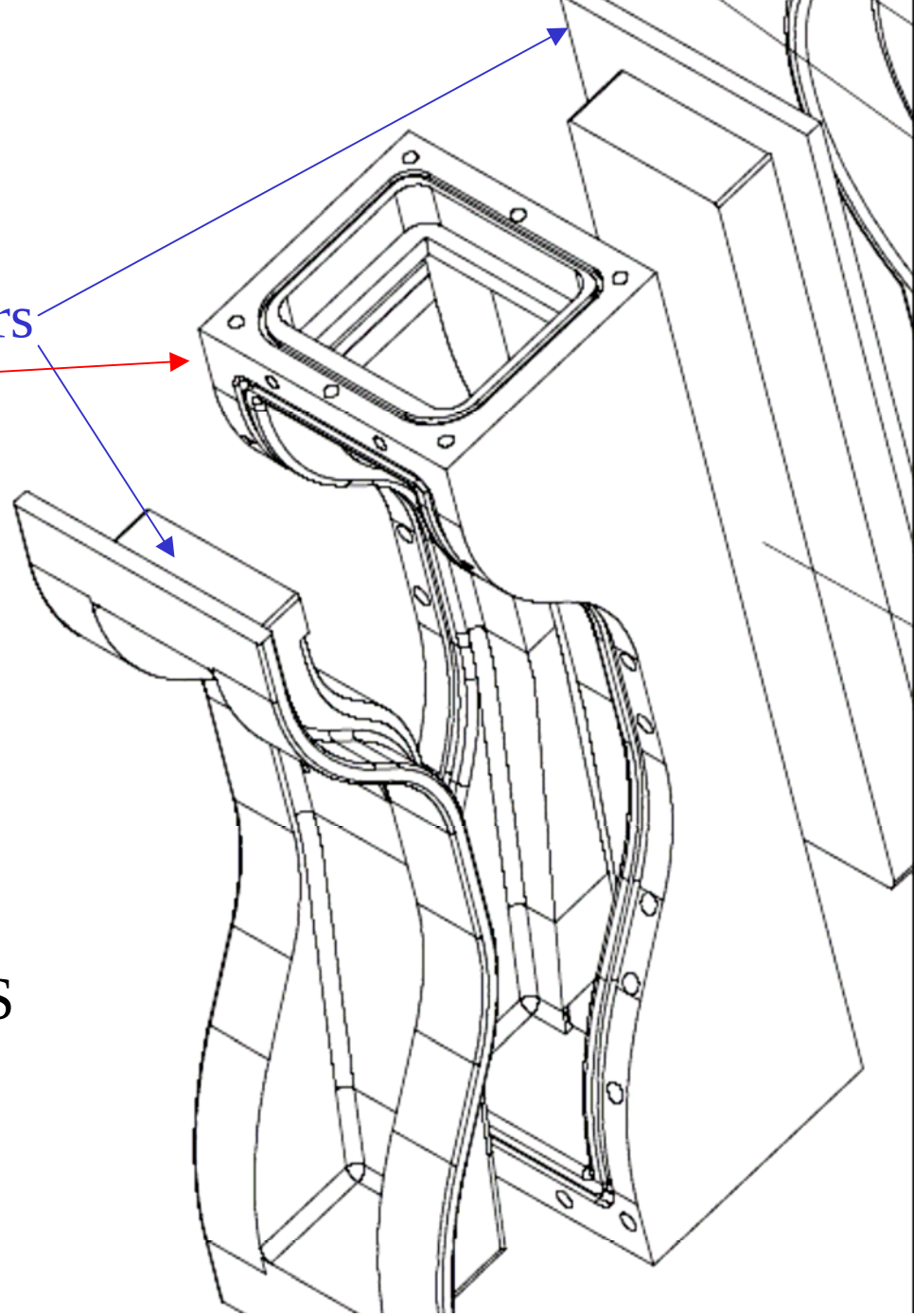


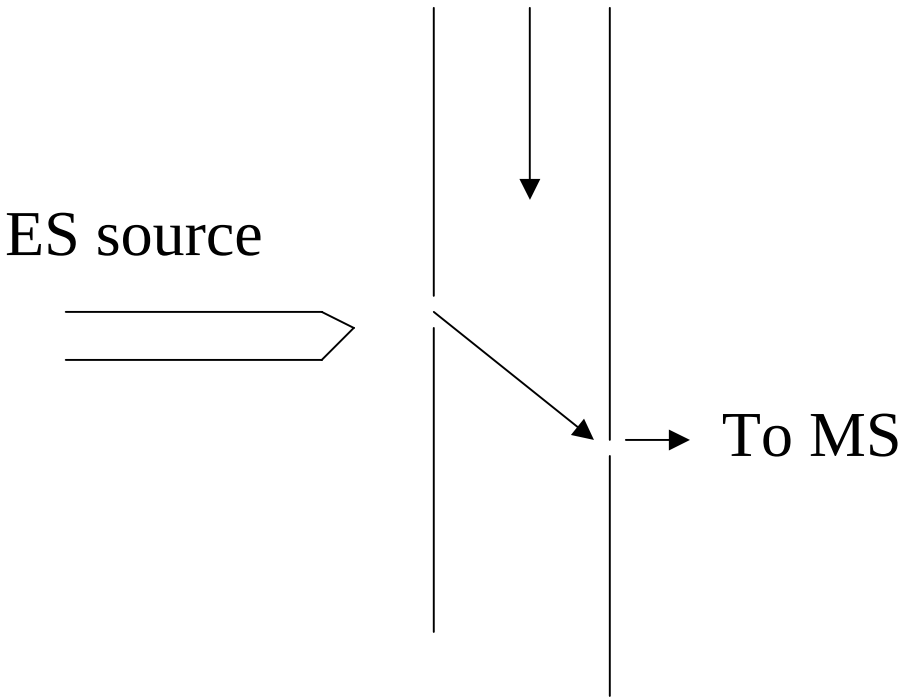
Other than that, the DMA provides a simple front-end mobility separator similar to FAIMS, but with two advantages

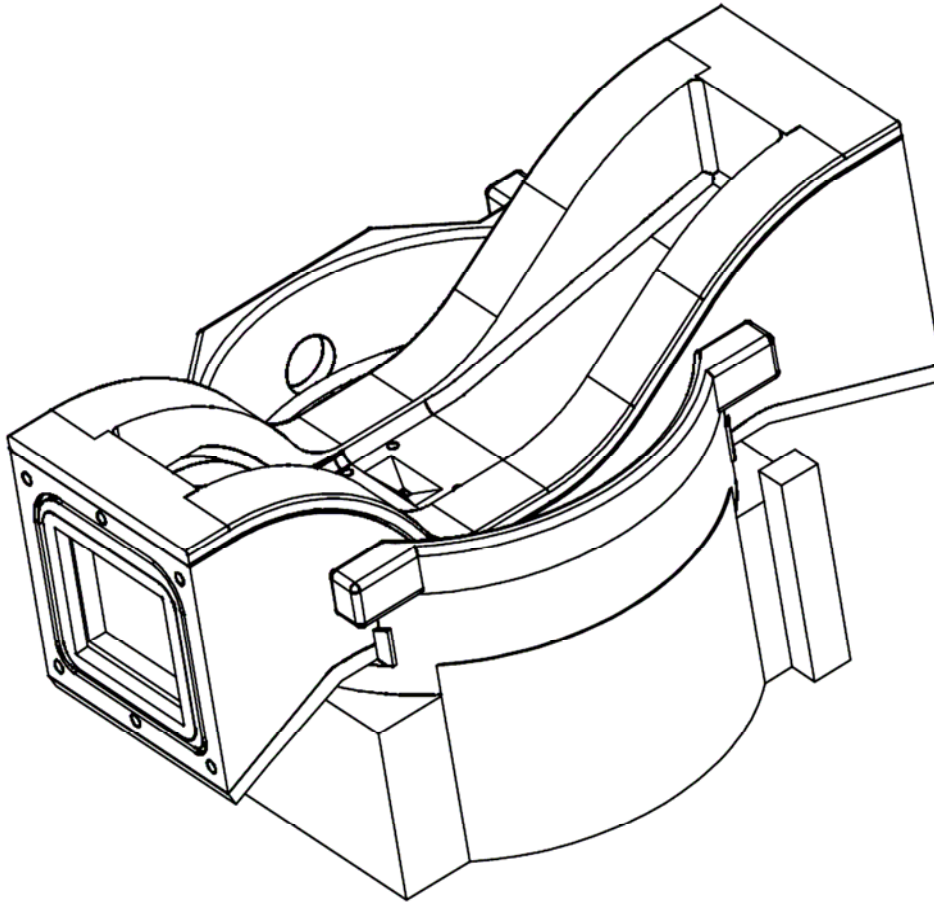
1) Measures true mobility (Weak-field limit)
2) High transmission (> 50%)
3) High resolution (50-90)

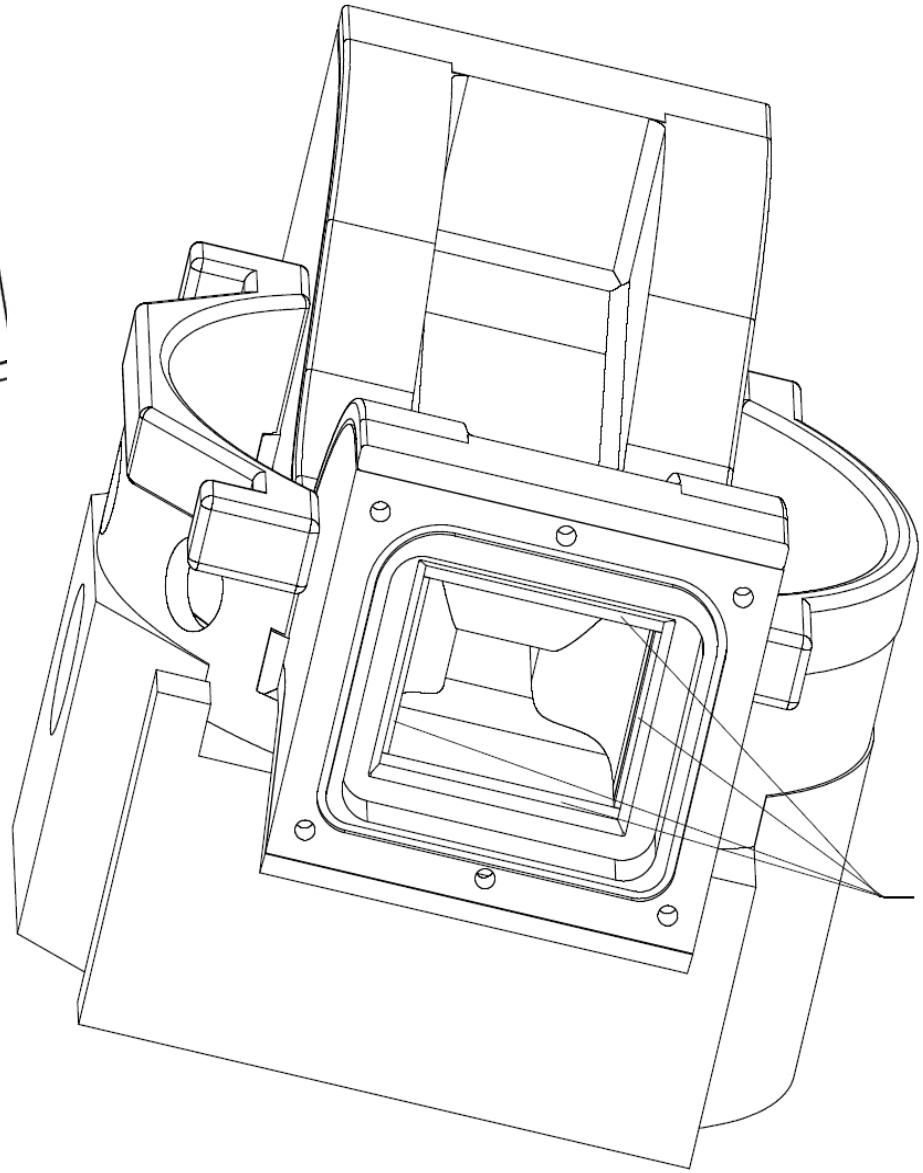
SEADM DMA: Coupled to Sciex's API-365 and q-Star

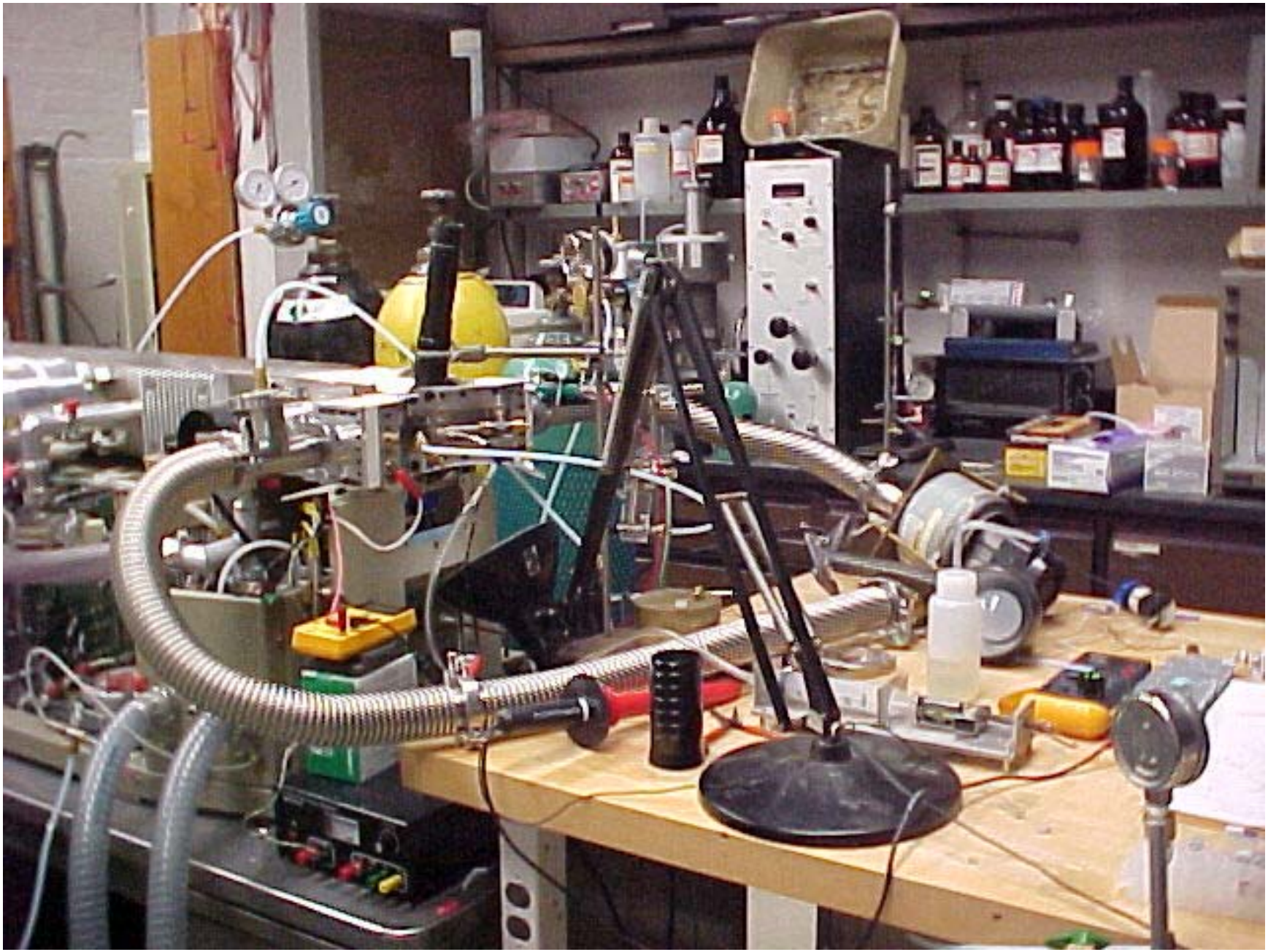
Design based on two electrode covers and an insulating box

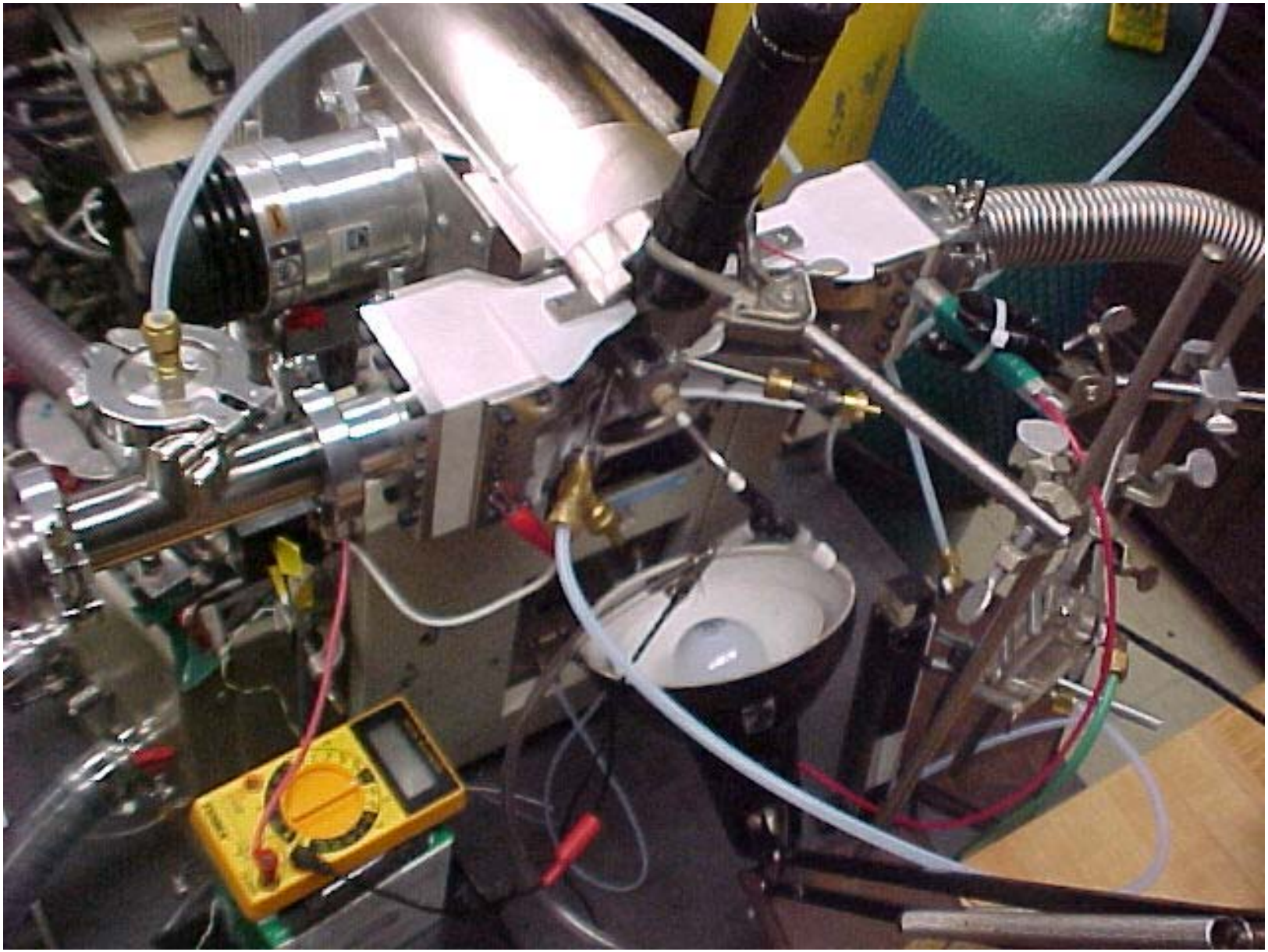


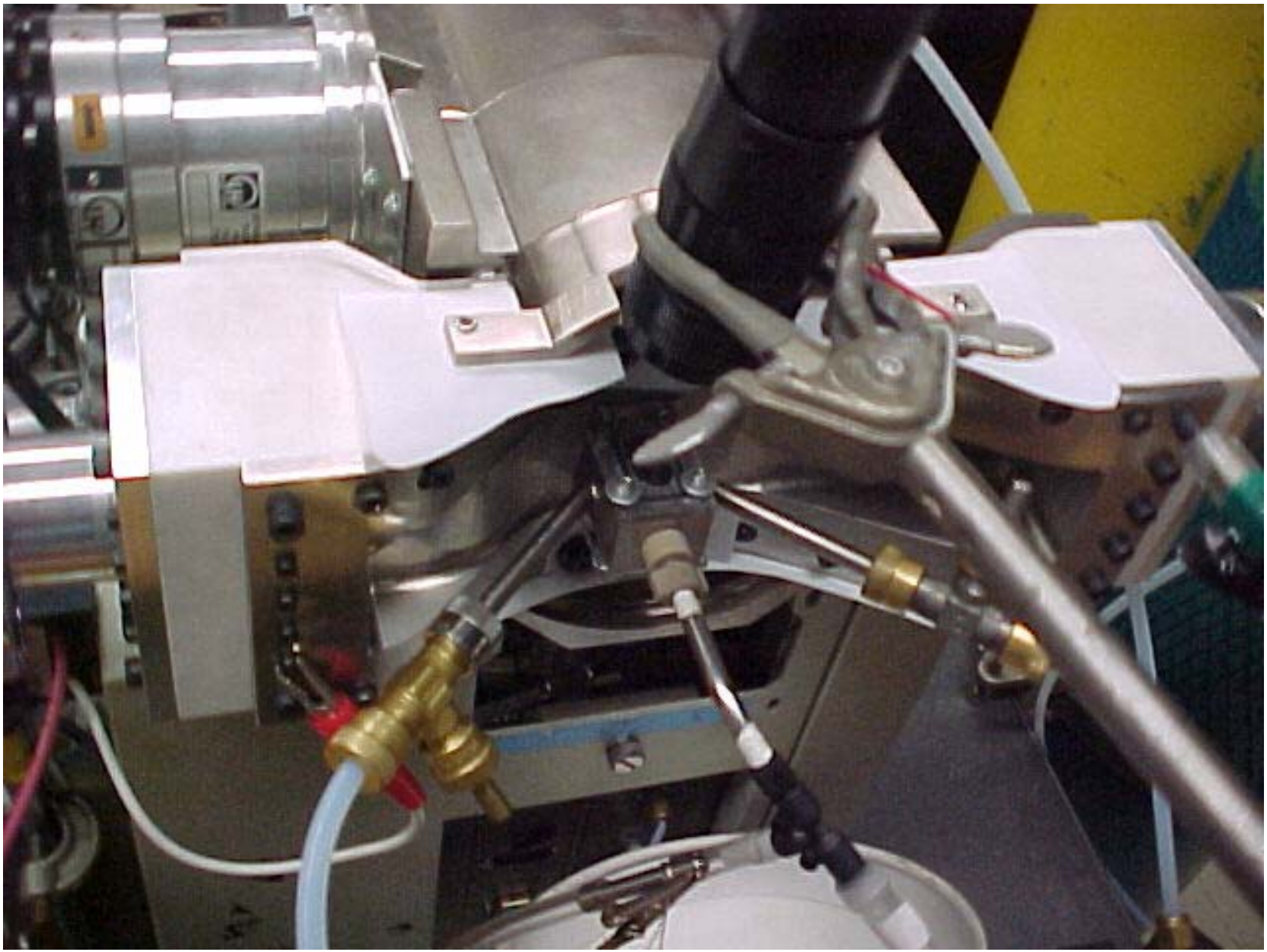












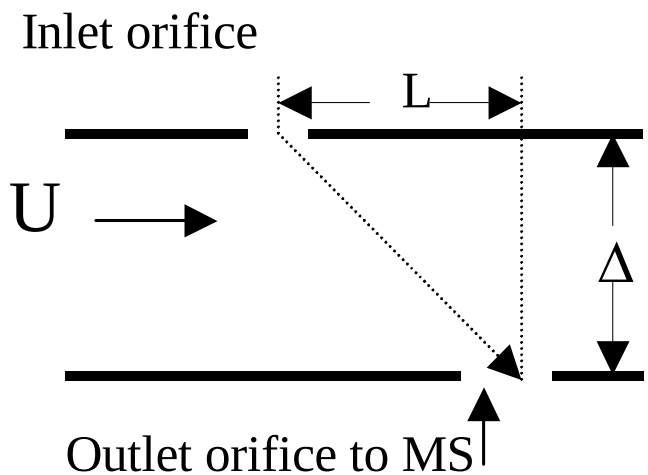
Resolution Limitations:

Resolution = $U\Delta/(\frac{1}{2}\, c\, \Delta_s) = 2\ \text{Mach}\ \Delta/\Delta_s$

If Mach = 1; $\Delta/\Delta_s = 40$ (10 mm/0.25 mm), then

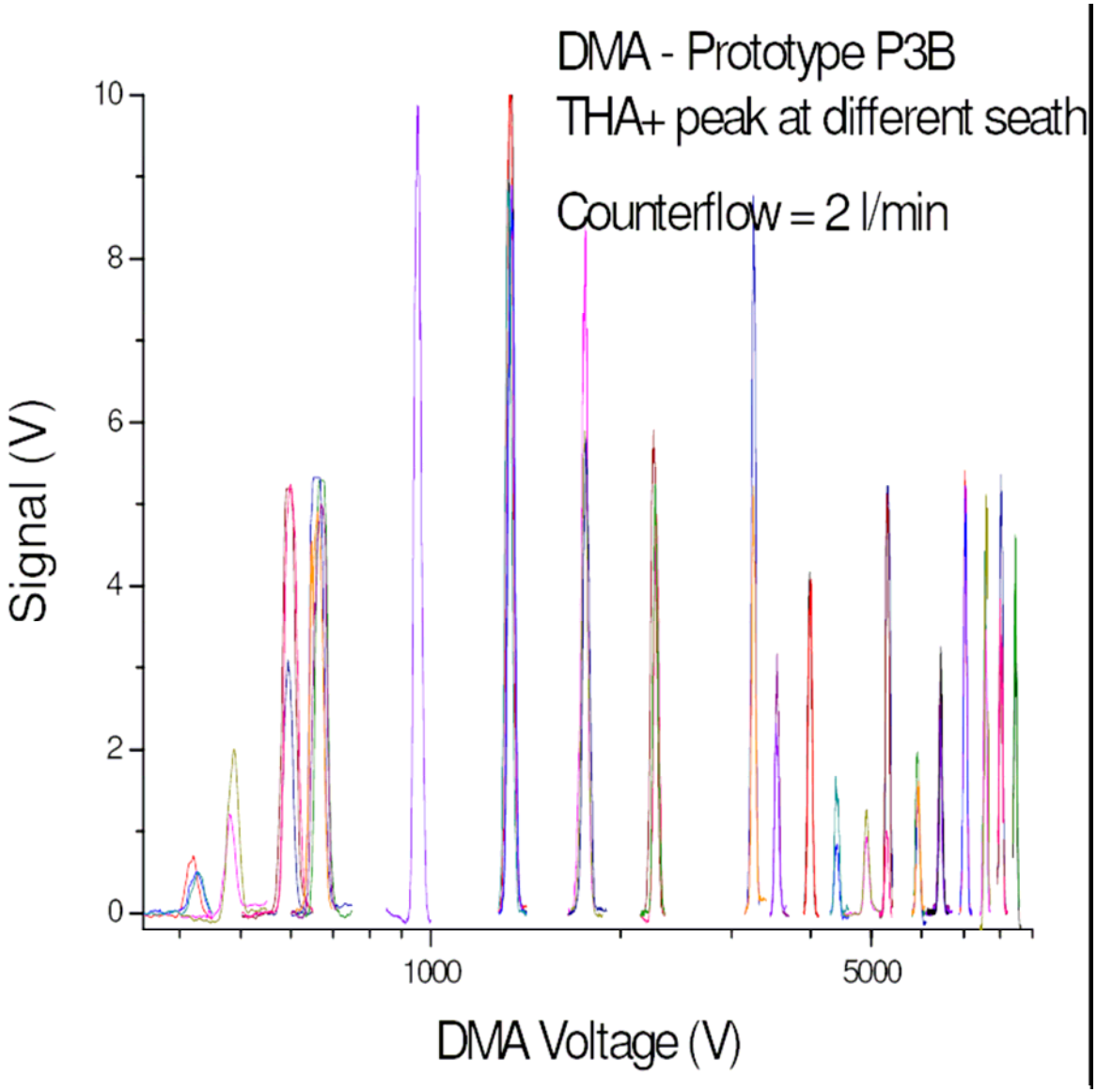
Resolution = 80.

Similar values achievable by reduction of Δ_s below MS inlet orifice diameter.



Resolution with tetraheptyl ammonium bromide ions (ES)

Q-Star prototype; Rus et al. (IMS Session; WPF; Poster Number: 106



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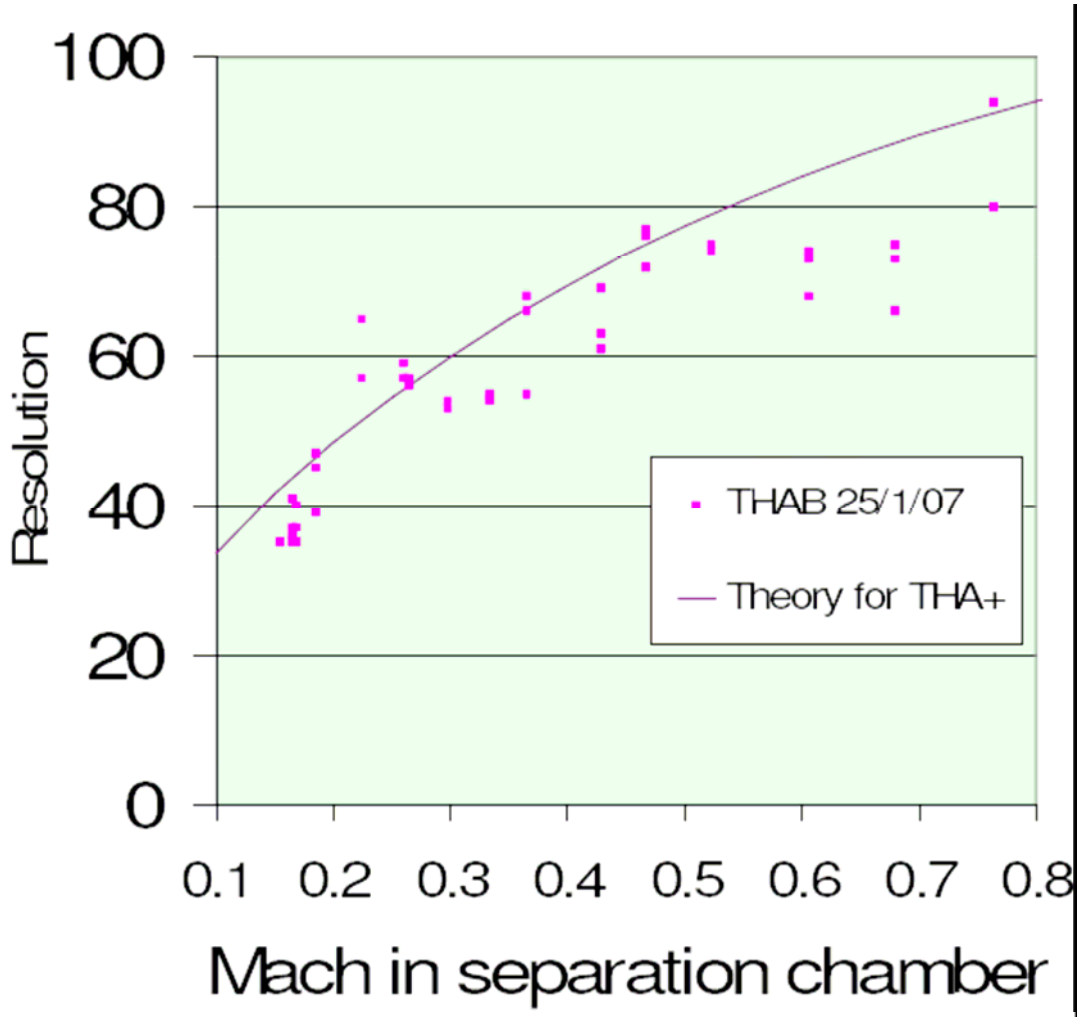
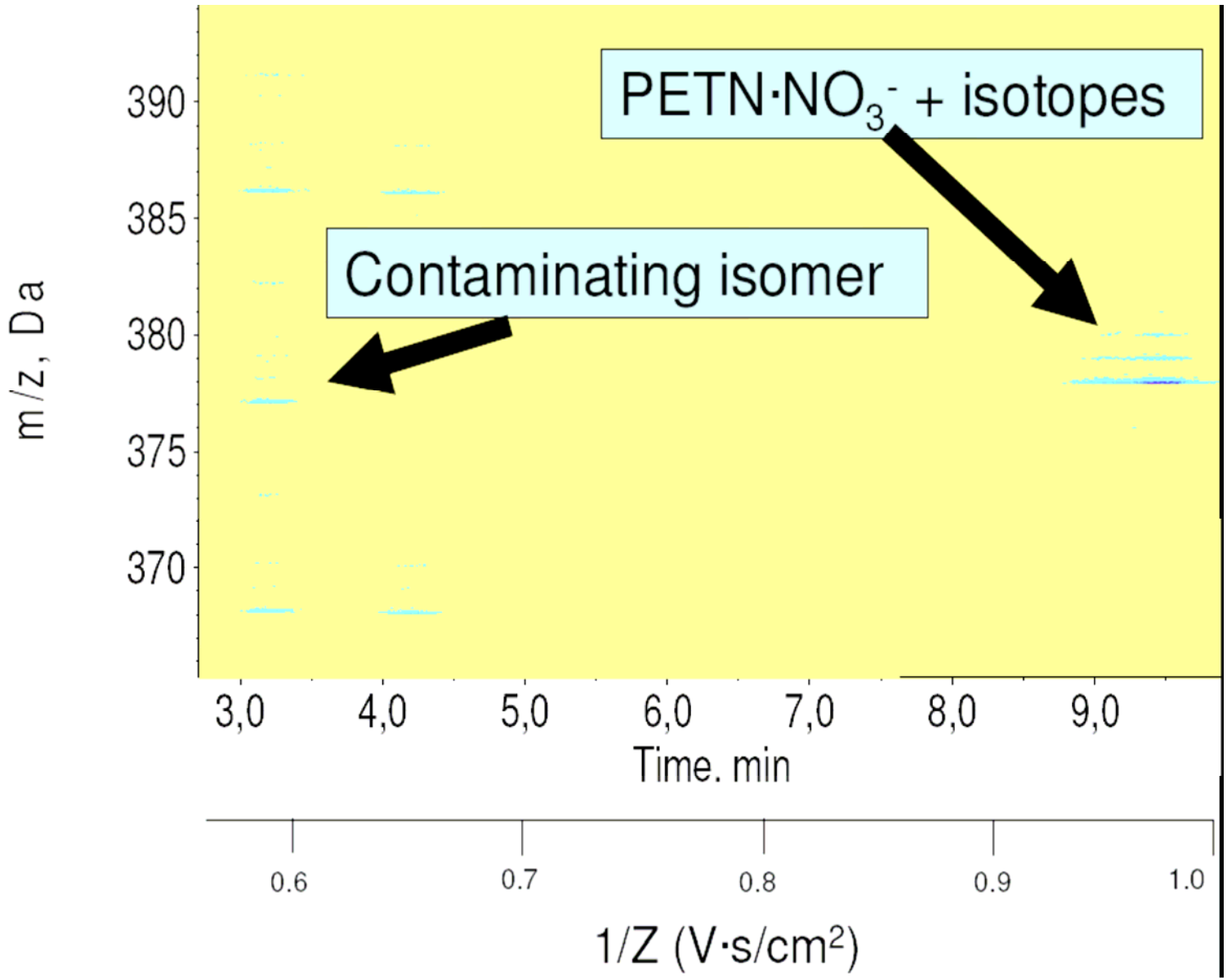


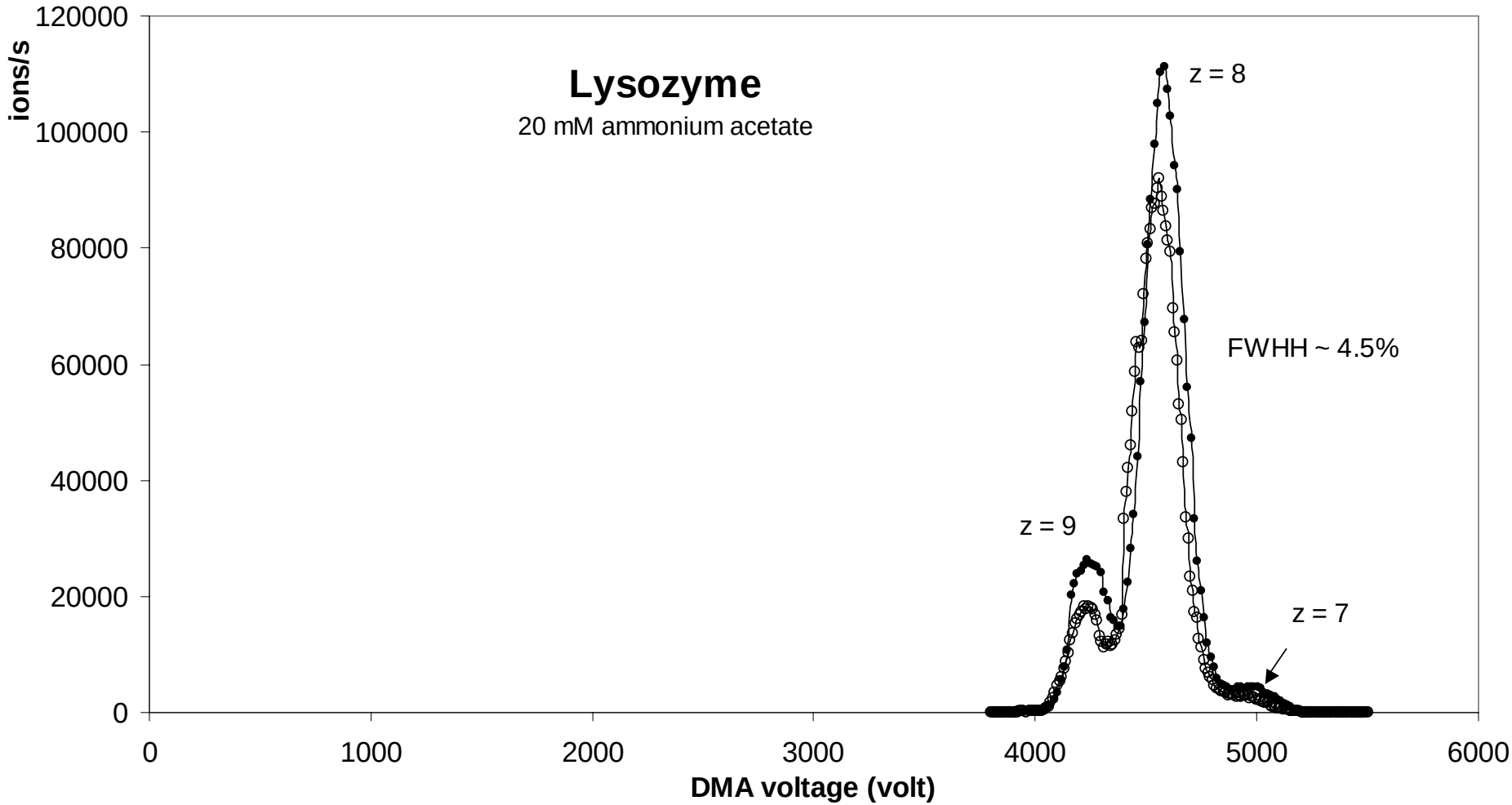
Noise reduction

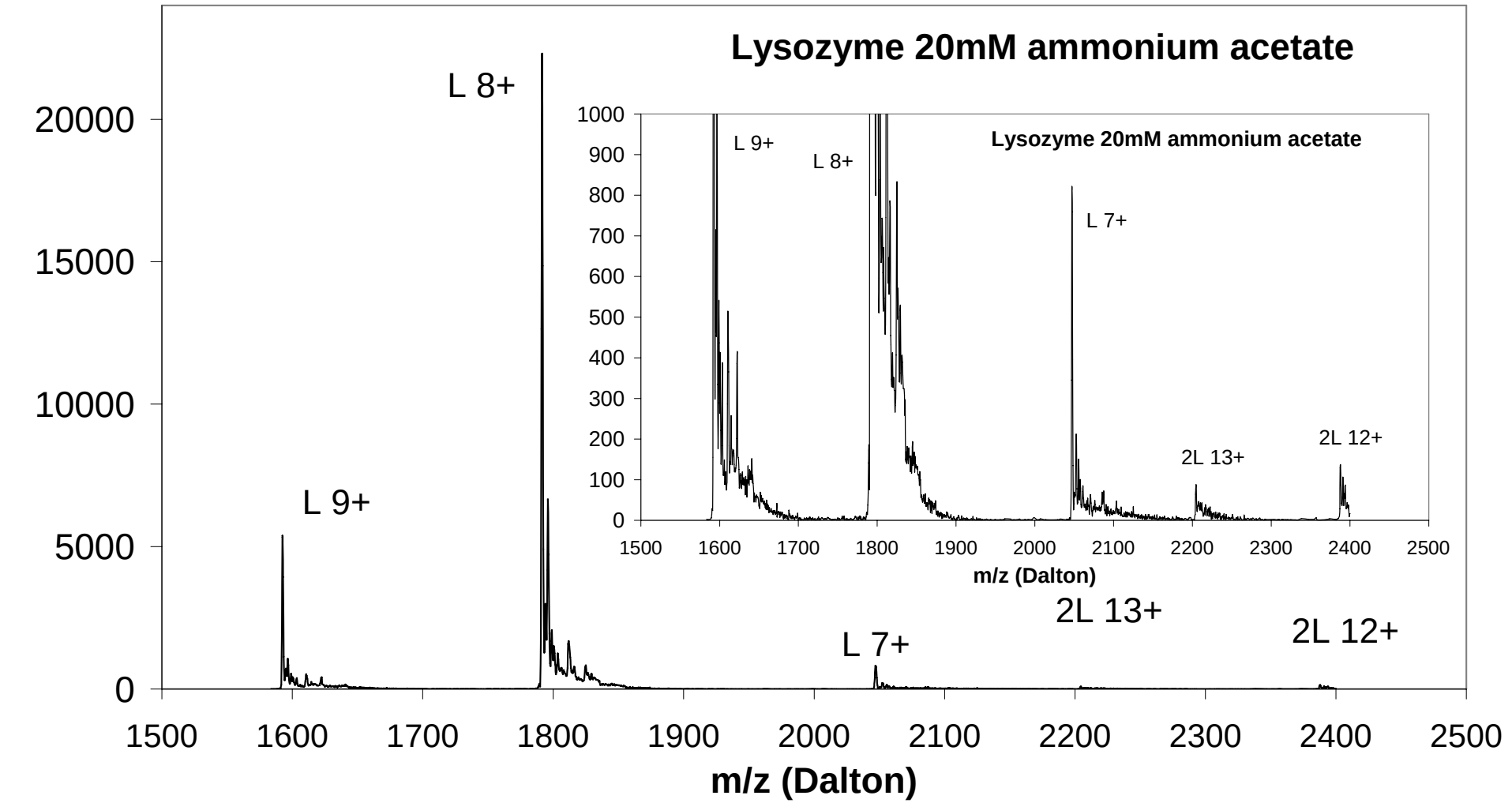
Q-Star prototype; Rus et al. (IMS Session; WPF; Poster Number: 106)

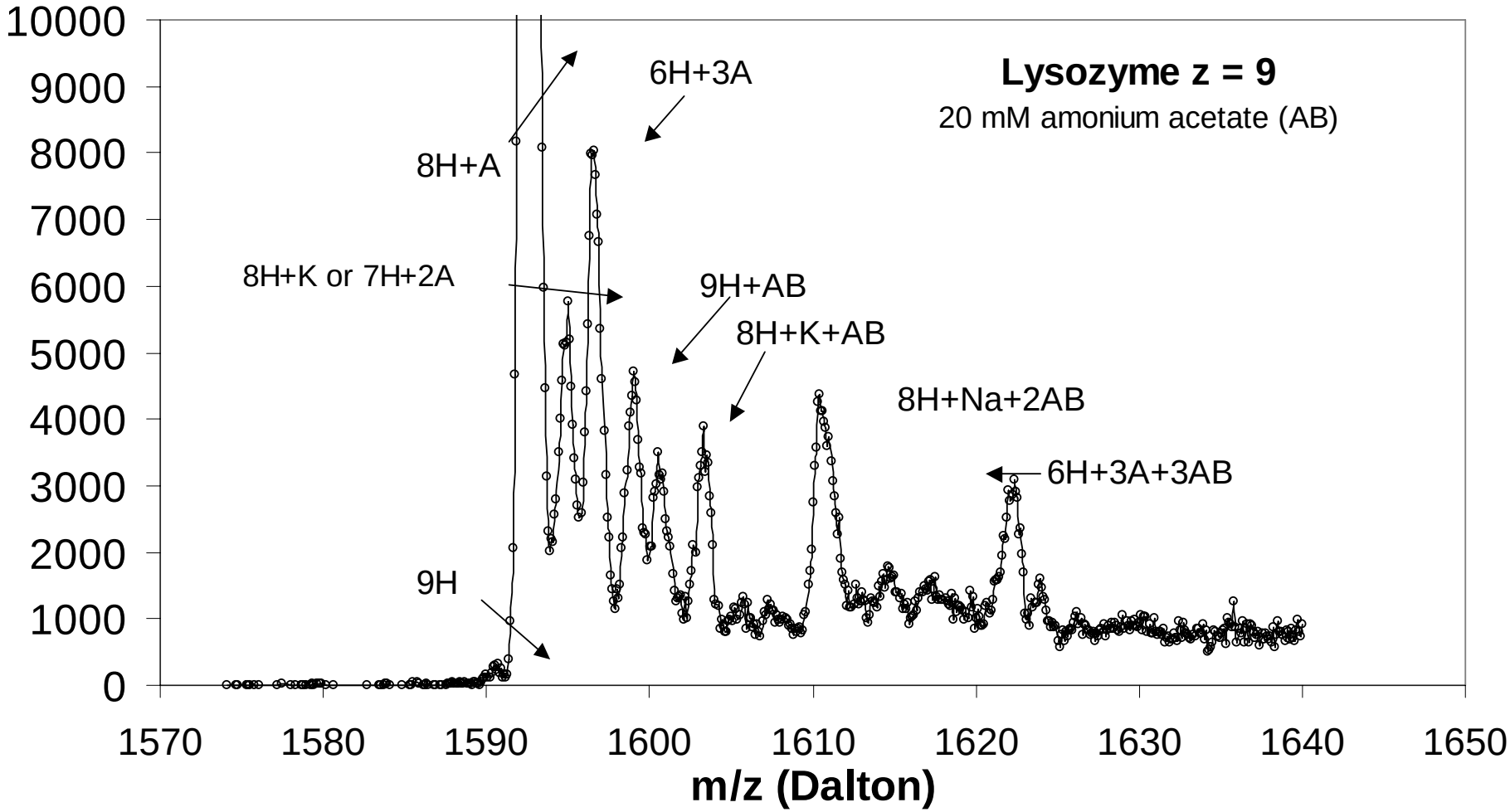


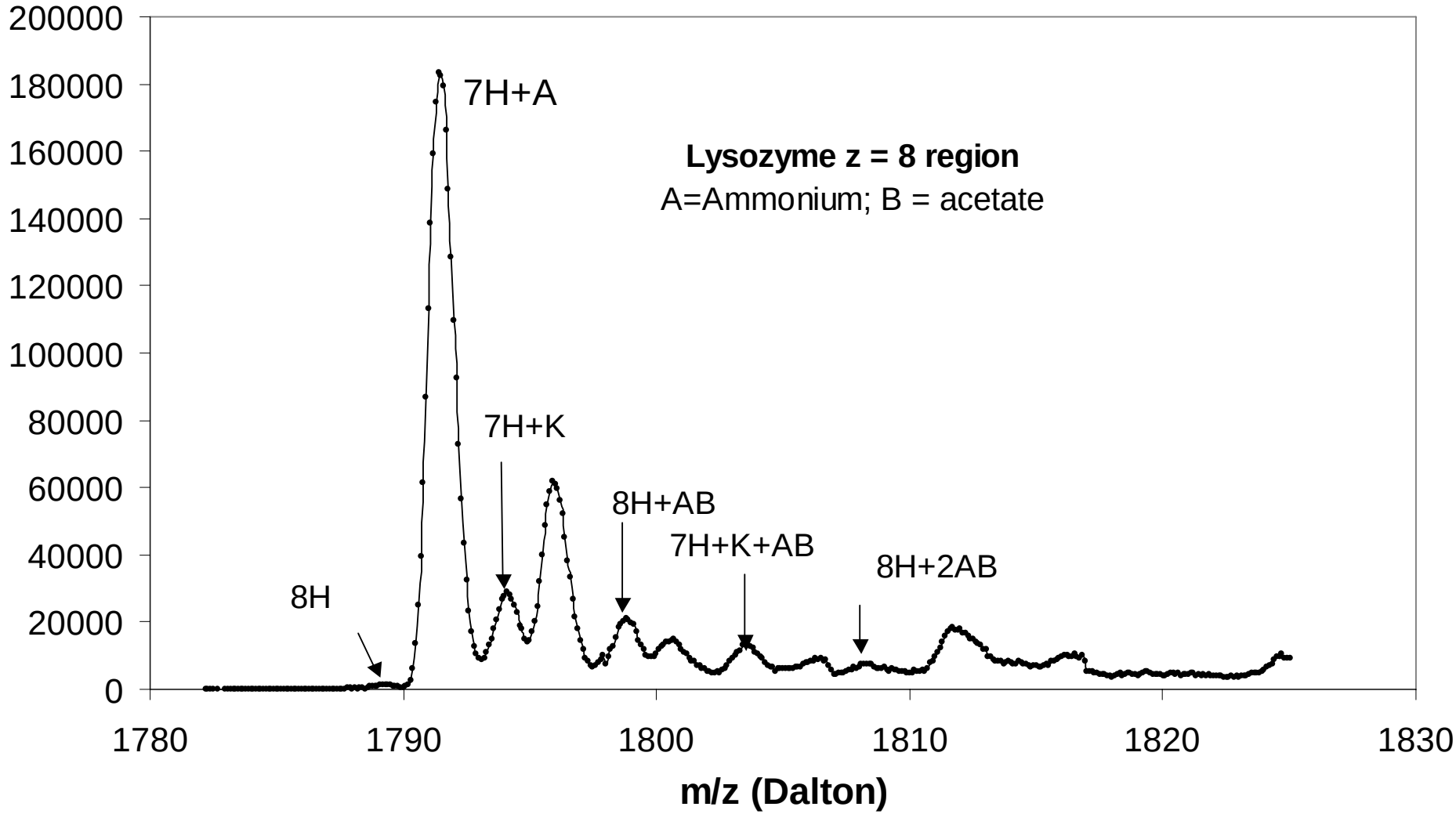
API-365 prototype:

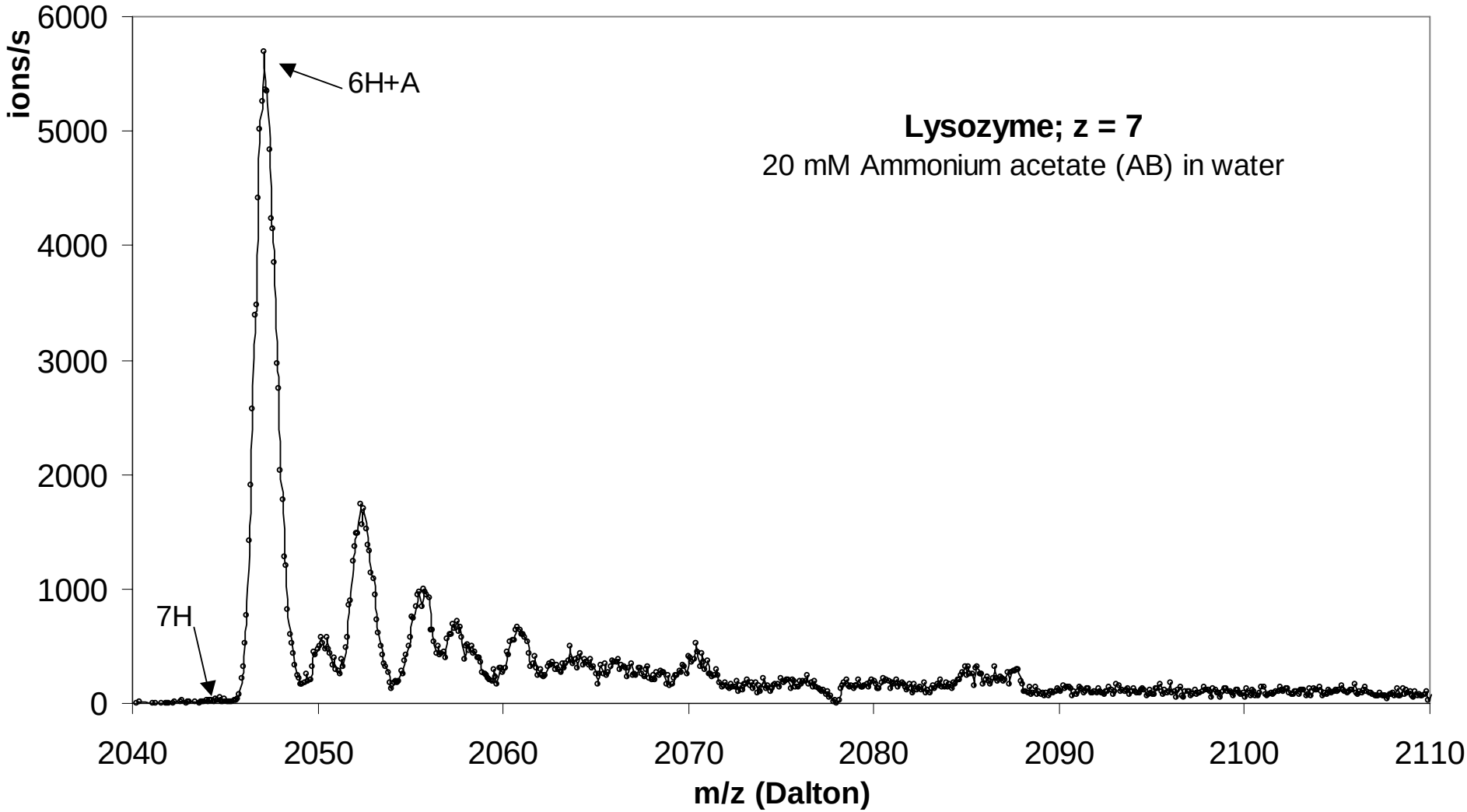
DMA-MS of lysozyme/water/20 mM Ammonium acetate




Lysozyme 20mM ammonium acetate
L 8+
L 9+
L 7+
2L 13+
2L 12+
20000
15000
10000
5000
0
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
2500
m/z (Dalton)
Lysozyme 20mM ammonium acetate
L 9+
L 8+
L 7+
2L 13+
2L 12+
1000
900
800
700
600
500
400
300
200
100
0
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
2500
m/z (Dalton)


Lysozyme z = 9
20 mM amonium acetate (AB)
6H+3A
8H+A
8H+K or 7H+2A
9H+AB
8H+K+AB
8H+Na+2AB
6H+3A+3AB
9H
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1570
1580
1590
1600
1610
1620
1630
1640
1650
m/z (Dalton)


200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
1780
1790
1800
1810
1820
1830
m/z (Dalton)
7H+A
7H+K
8H+AB
7H+K+AB
8H+2AB
8H
Lysozyme z = 8 region
A=Ammonium; B = acetate


ions/s
6000
5000
4000
3000
2000
1000
0
6H+A
7H
Lysozyme; z = 7
20 mM Ammonium acetate (AB) in water
2040
2050
2060
2070
2080
2090
2100
2110
m/z (Dalton)

Conclusions:

Practical problems of coupling a planar DMA to a MS with high DMA transmission (~1/2) and resolution (> 60) solved.

DMA achieves transonic speeds with inexpensive vacuum cleaner pump

Uses counterflow gas to avoid MS contamination (since MS curtain gas is eliminated)