Concept for a Miniaturized Confocal Plane Mass Spectrometer

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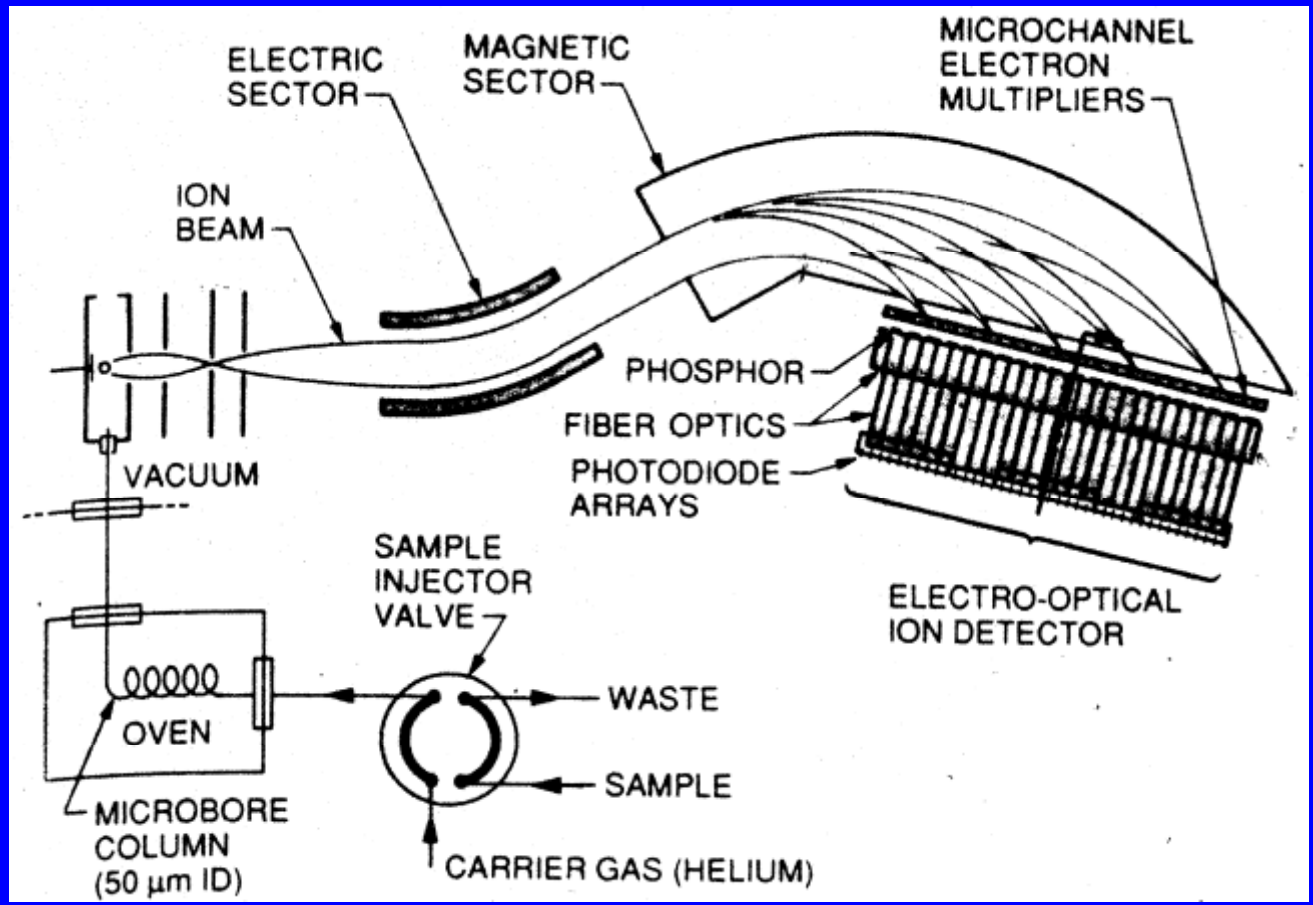
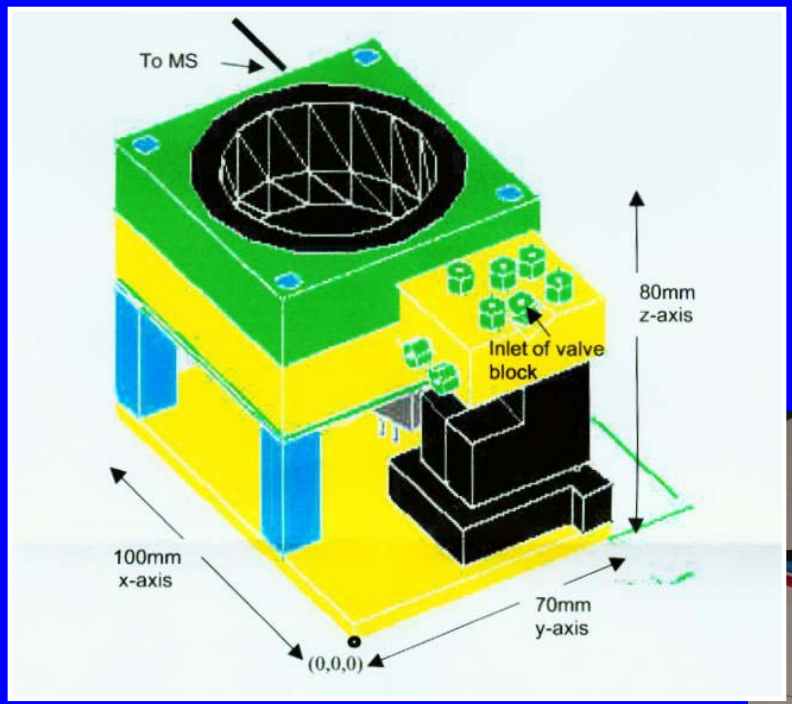
Goal:
Build a small, very fast GC/MS

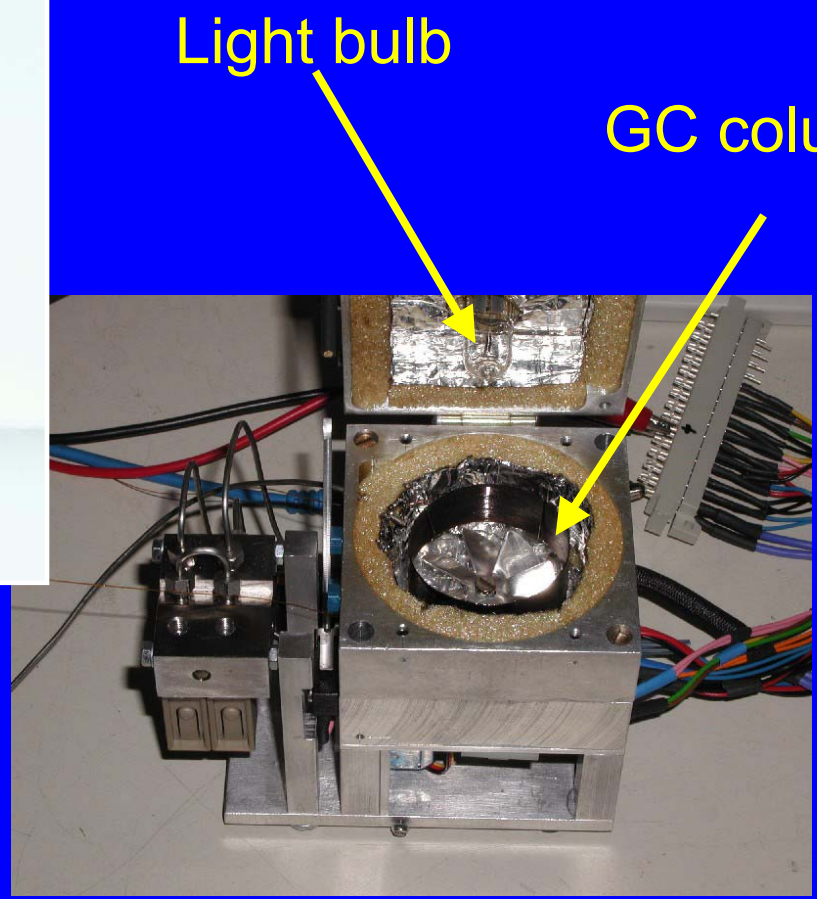


Gas chromatograph

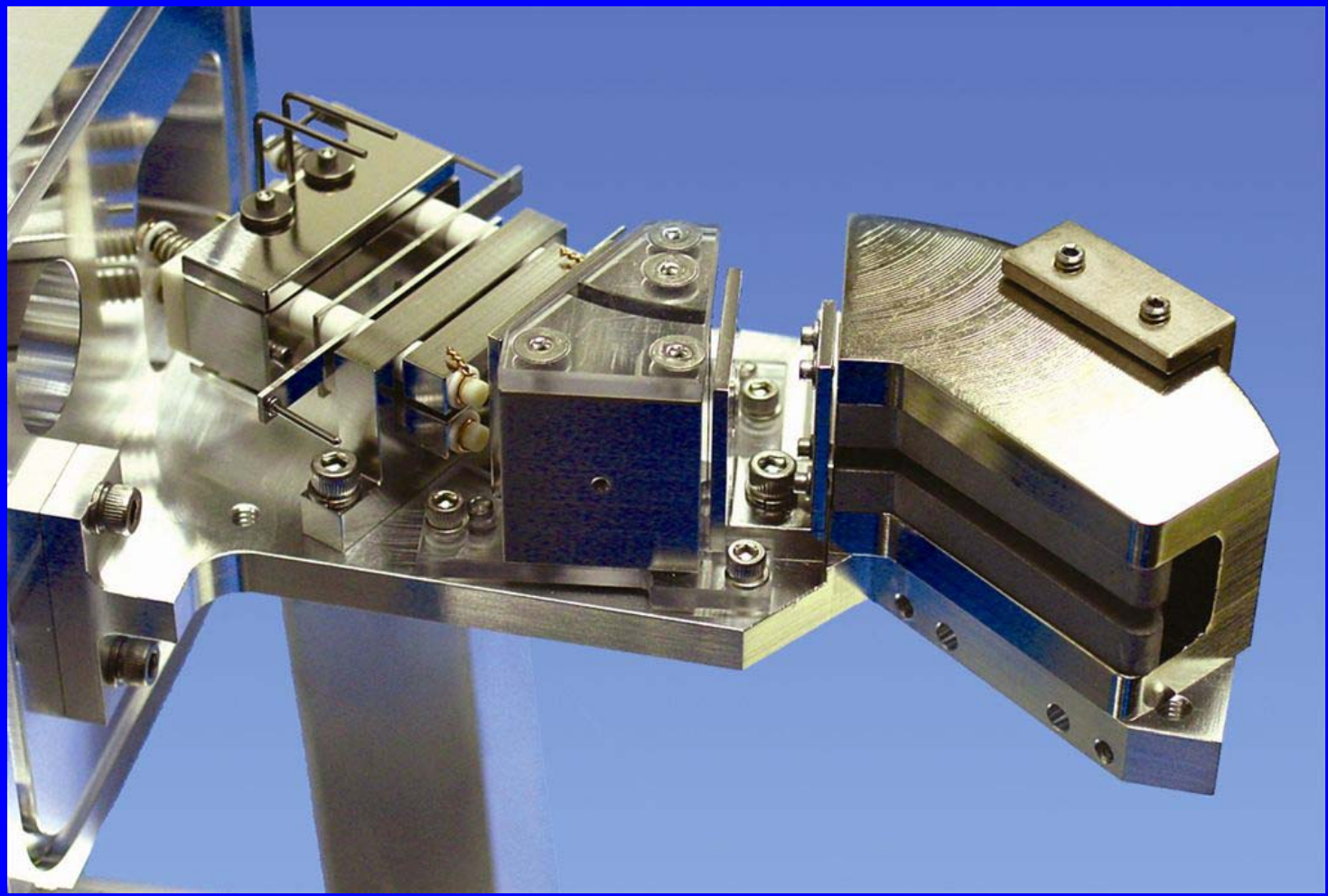
- Small and lightweight
- Steep temperature ramps
- Fast injector
- Low thermal capacity
- High analytical throughput
- Standard columns and parts

Flash-Gas-Chromatograph - MS





The 1” Focal Plane MS



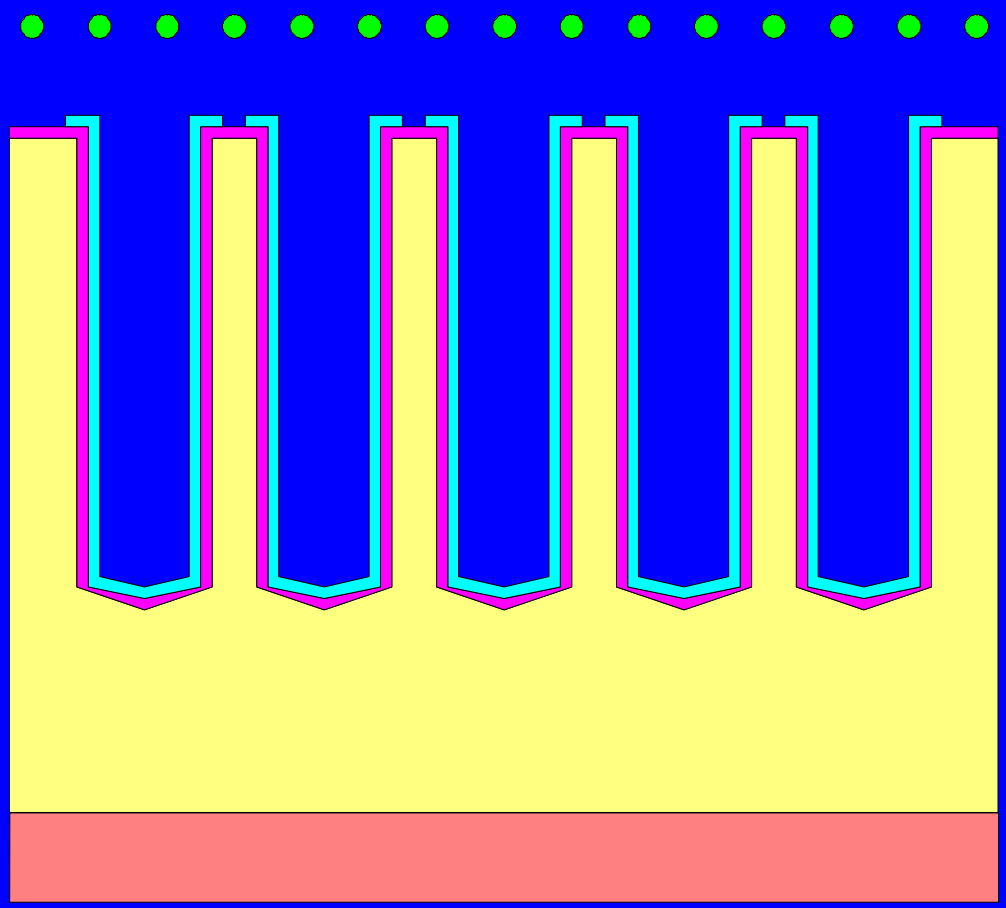
Detectors

1. Micromachined Faraday Cup Array (MFCA)
   University of Washington – A. Scheidemann

2. Electro-Optical Ion Detector (EOID)
   JPL- M. Sinha

3. Charge-Coupled Device (*CCD)*
   JPL – M. Wadsworth & M. Sinha

MFCA Construction Details



suppressor grid

conformally deposited
oxide and cup conductor

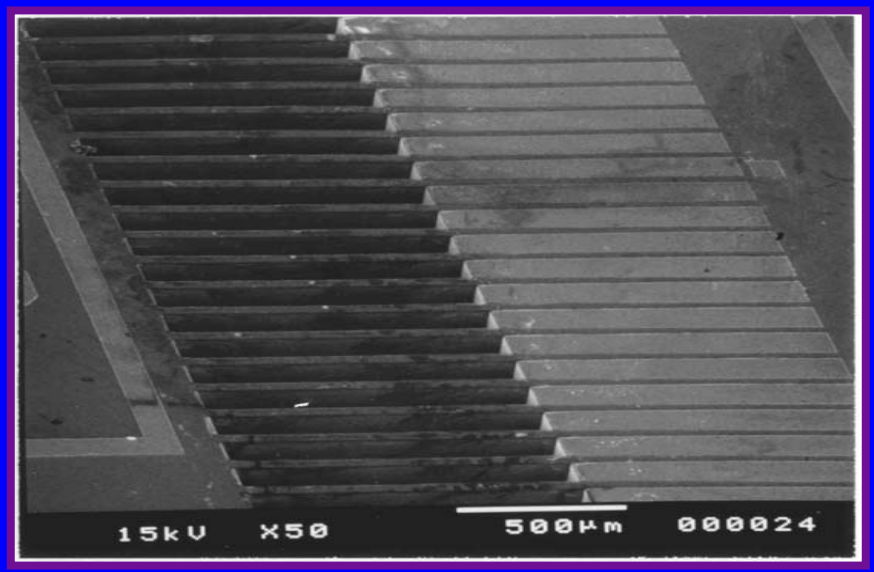
anisotropically etched
silicon trenches

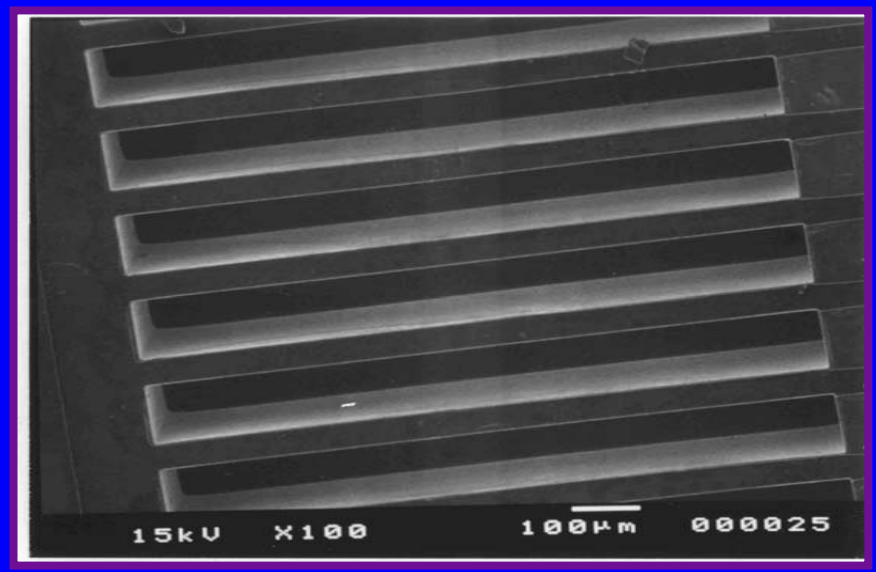
bakeout heater

MFCA in DRIE

1. Deep reactive ion etching to produce the Faraday cups.
2. Oxidation to produce an insulating film.
3. Deposition of polysilicon to produce the cup conductor.
4. Doping of the polysilicon with boron to increase the conductivity of the cup conductor.
5. Reactive ion etching of the polysilicon to pattern the cup conductors.
6. Metalization with aluminum to form contacts to the cup conductors.

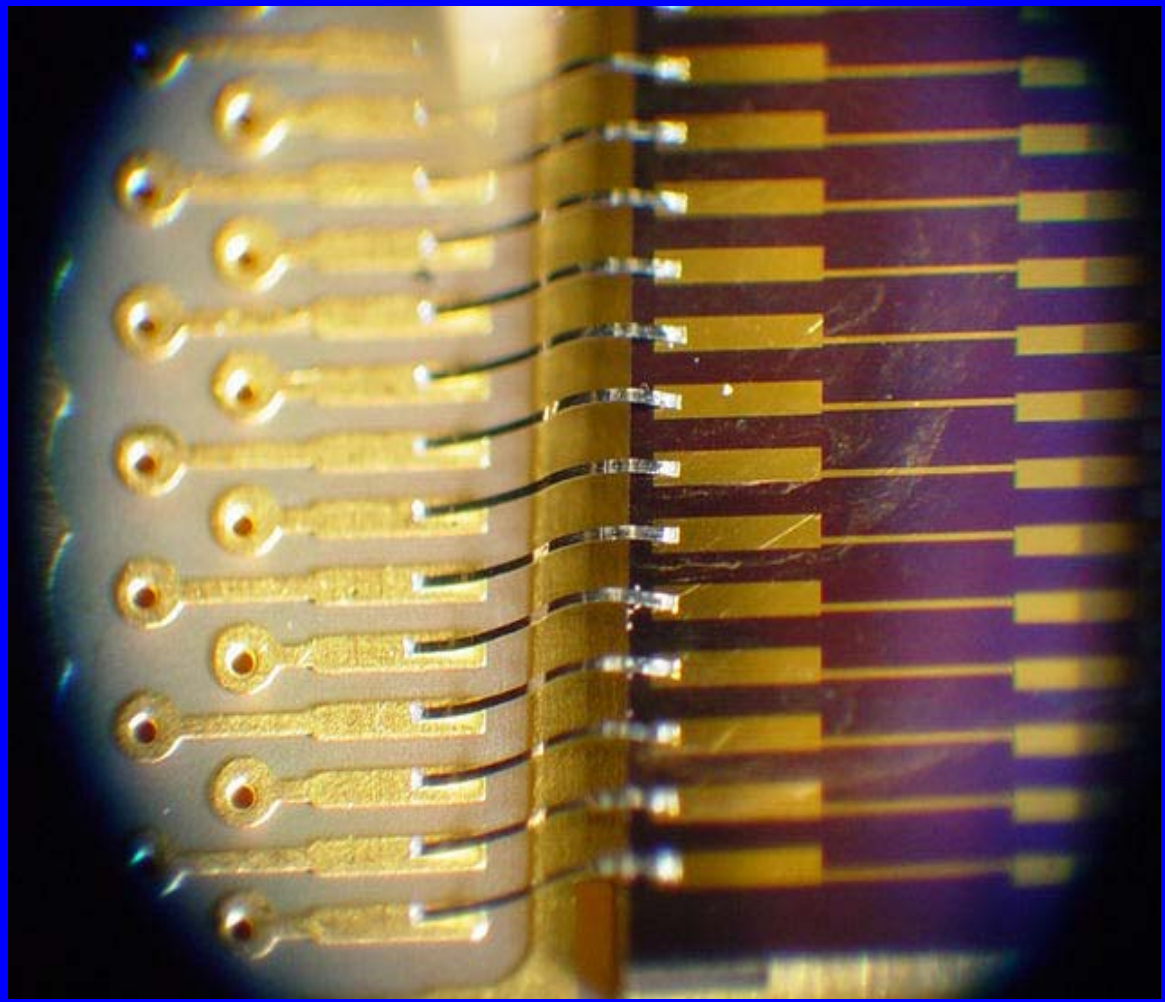
Micromachined Faraday Cup Array



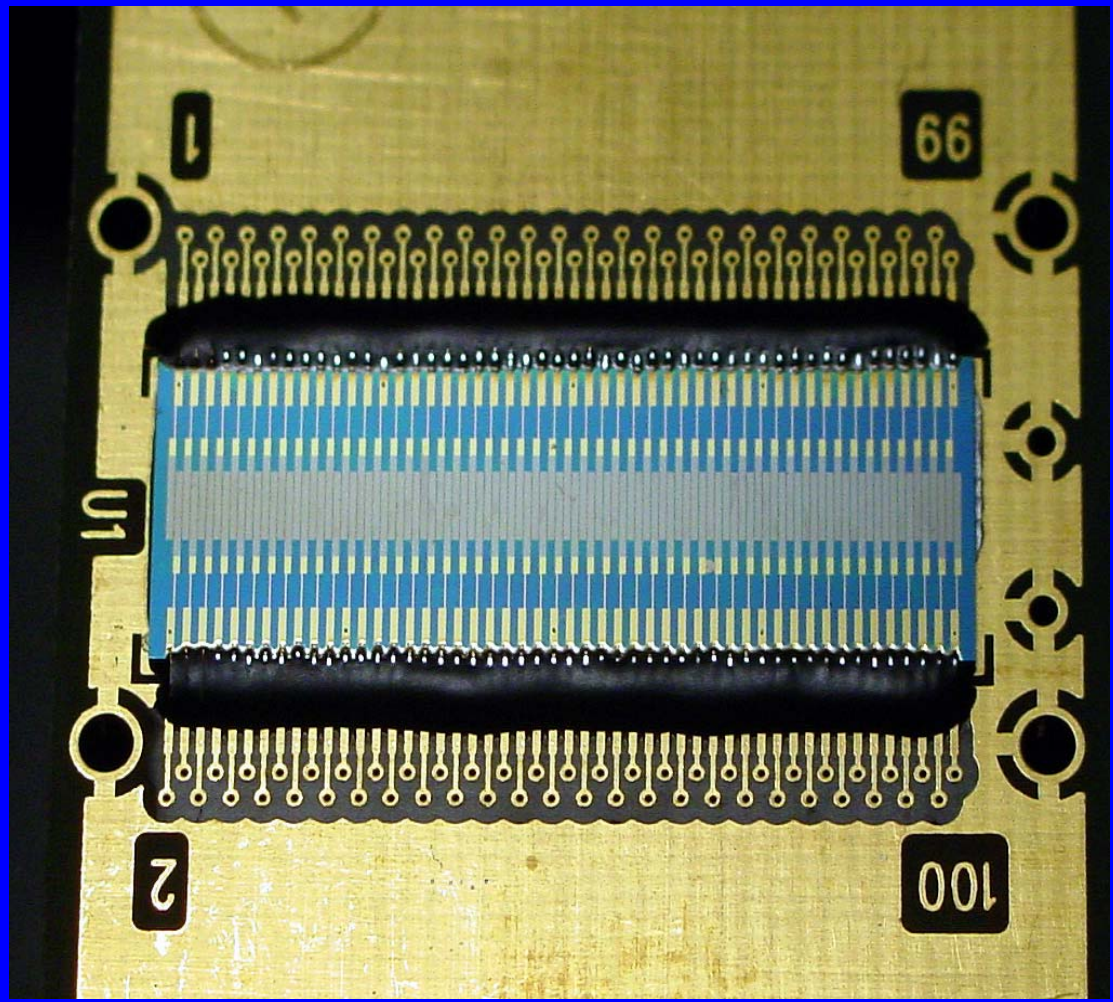


SEM views of MFCA showing sharp internal features

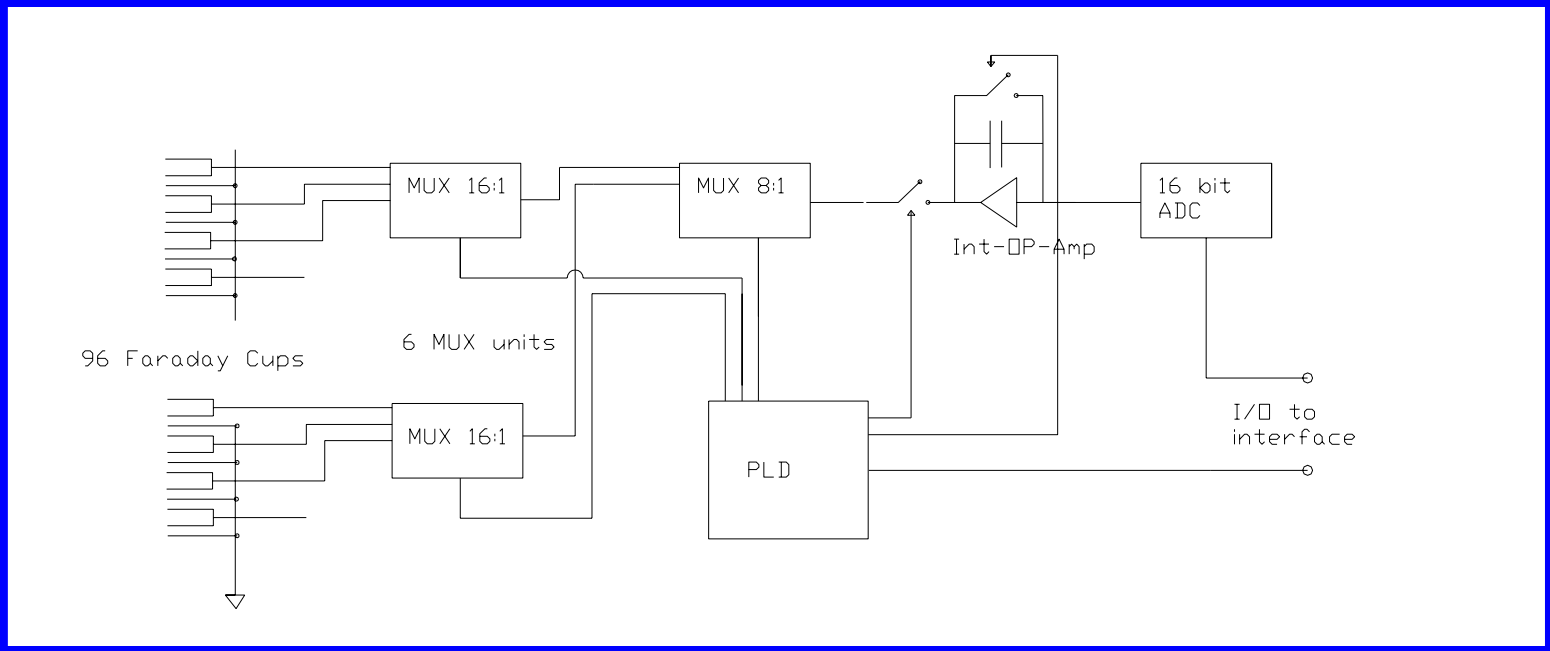
Wire Bonding to PCB



Faraday Detector / PC-Board Mounted

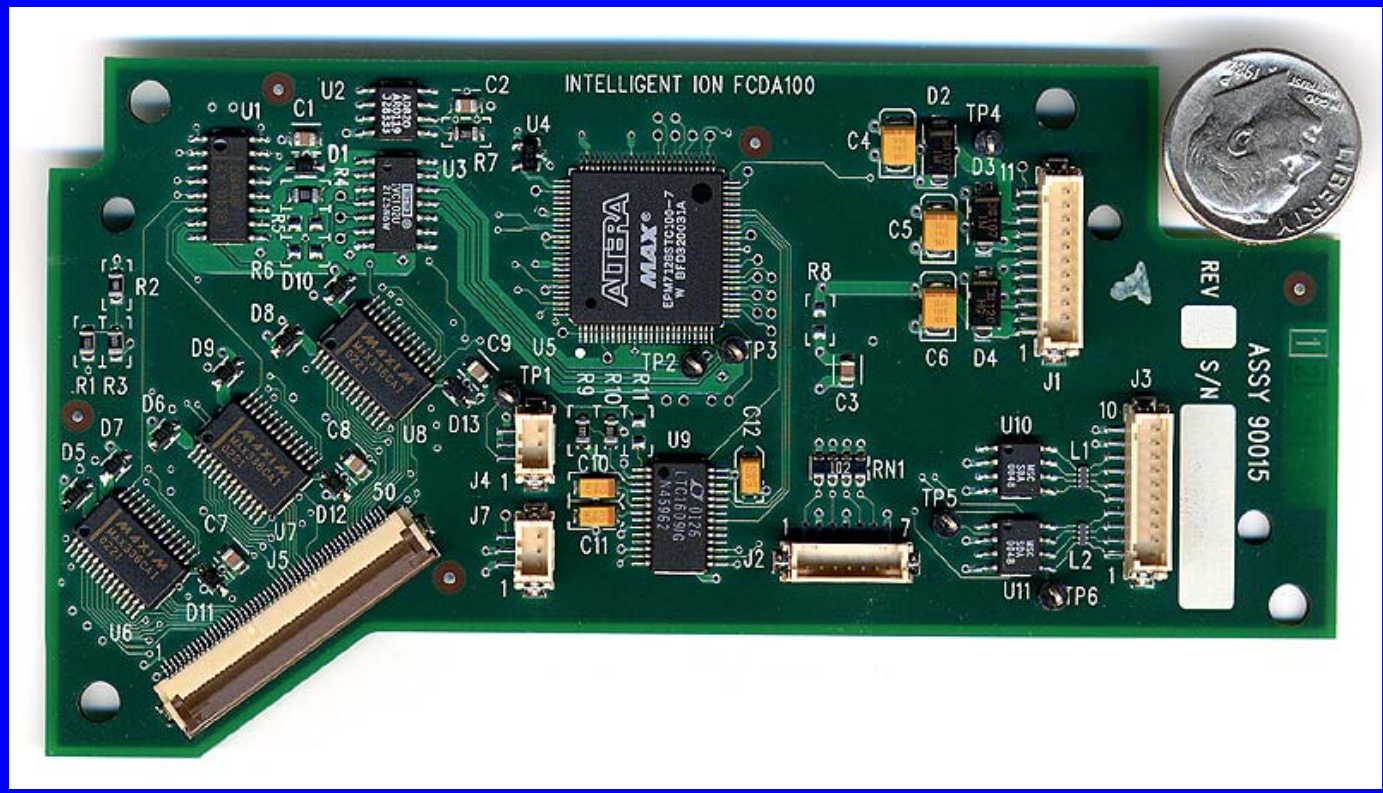


FCDA-MUX-Integrator Unit



Two stage multiplexing

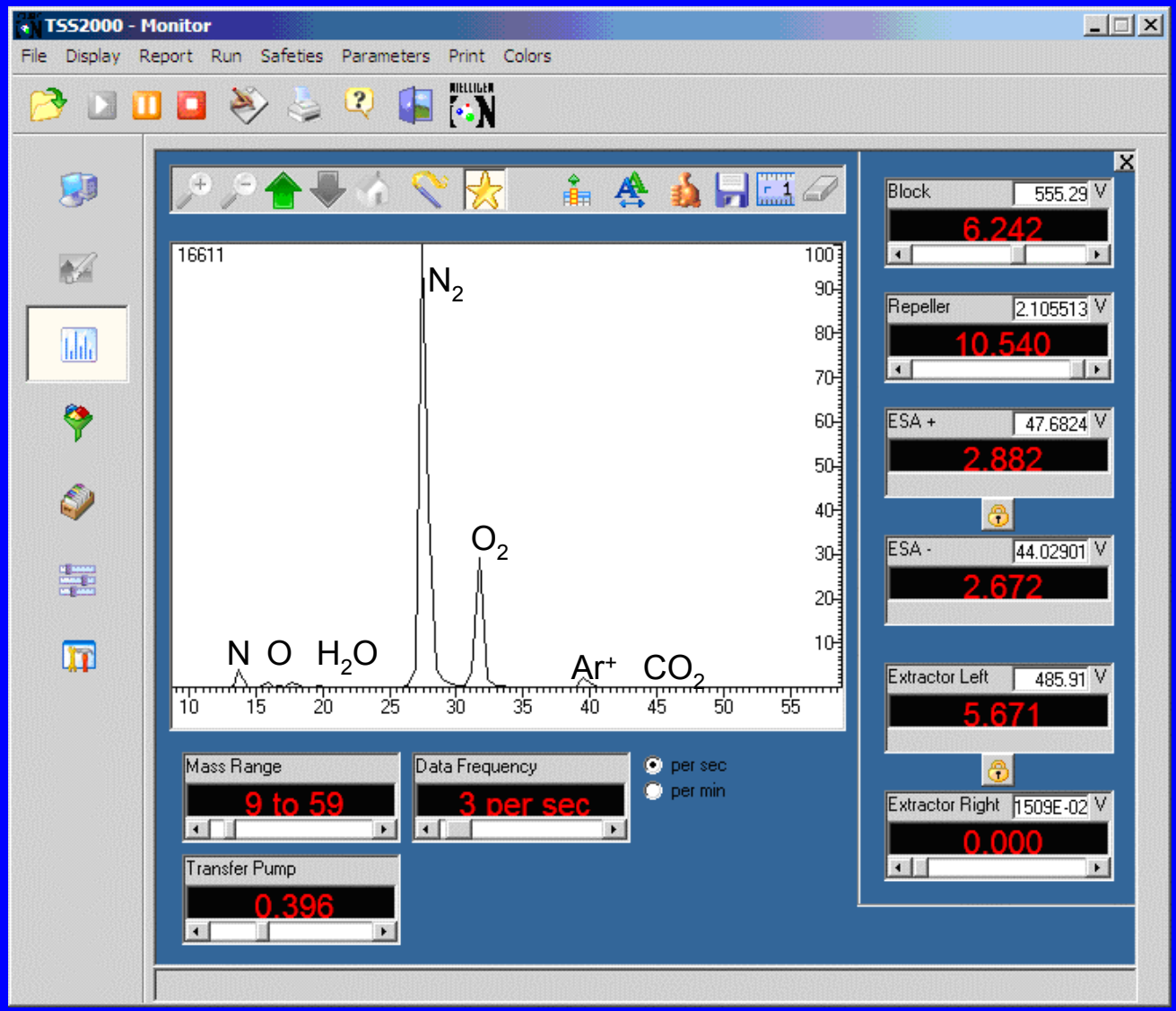
Multiplexer and Integrator Unit



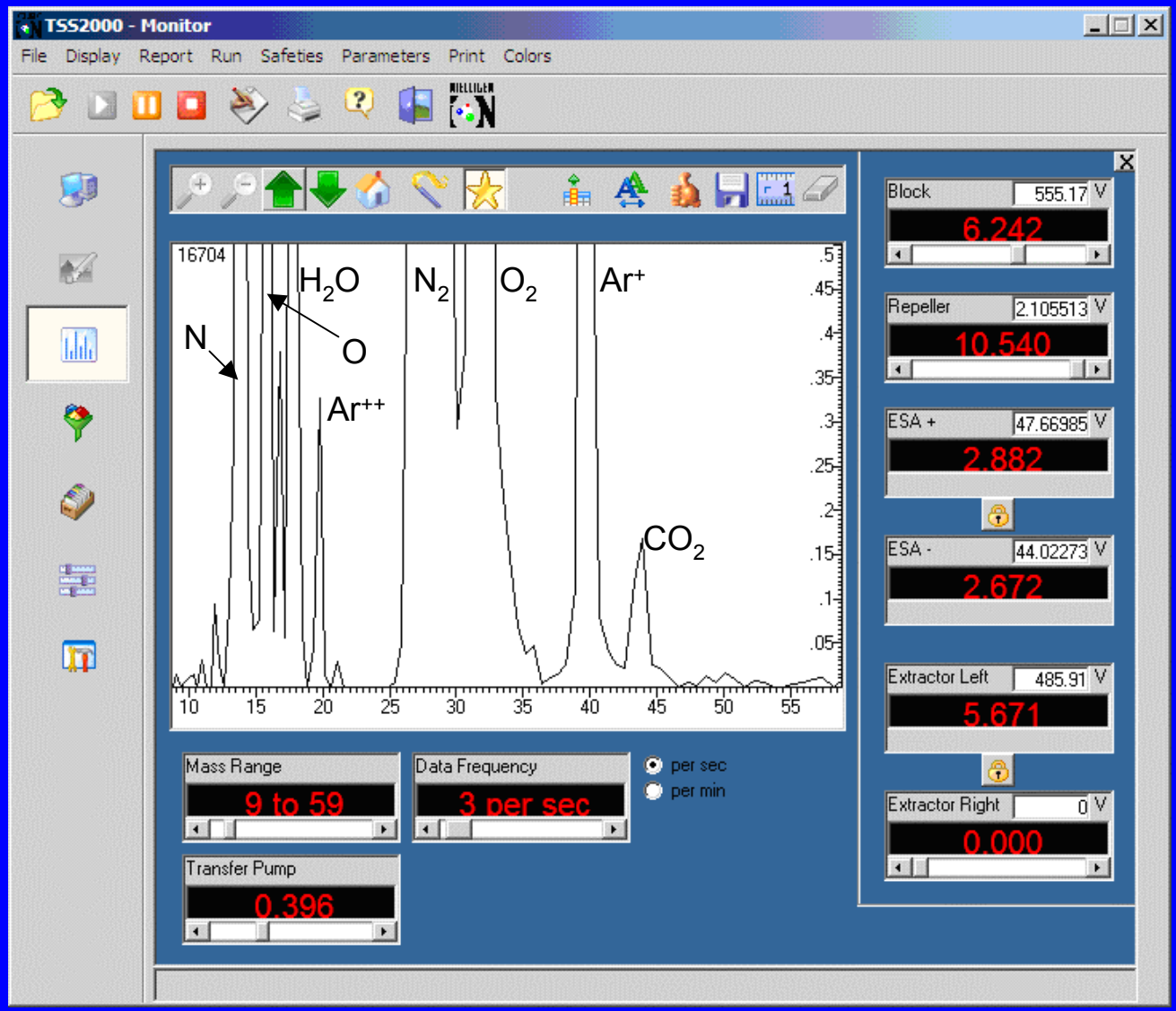
The multiplexing and integration board sits in the vacuum housing

Desktop Mattauch-Herzog Instrument

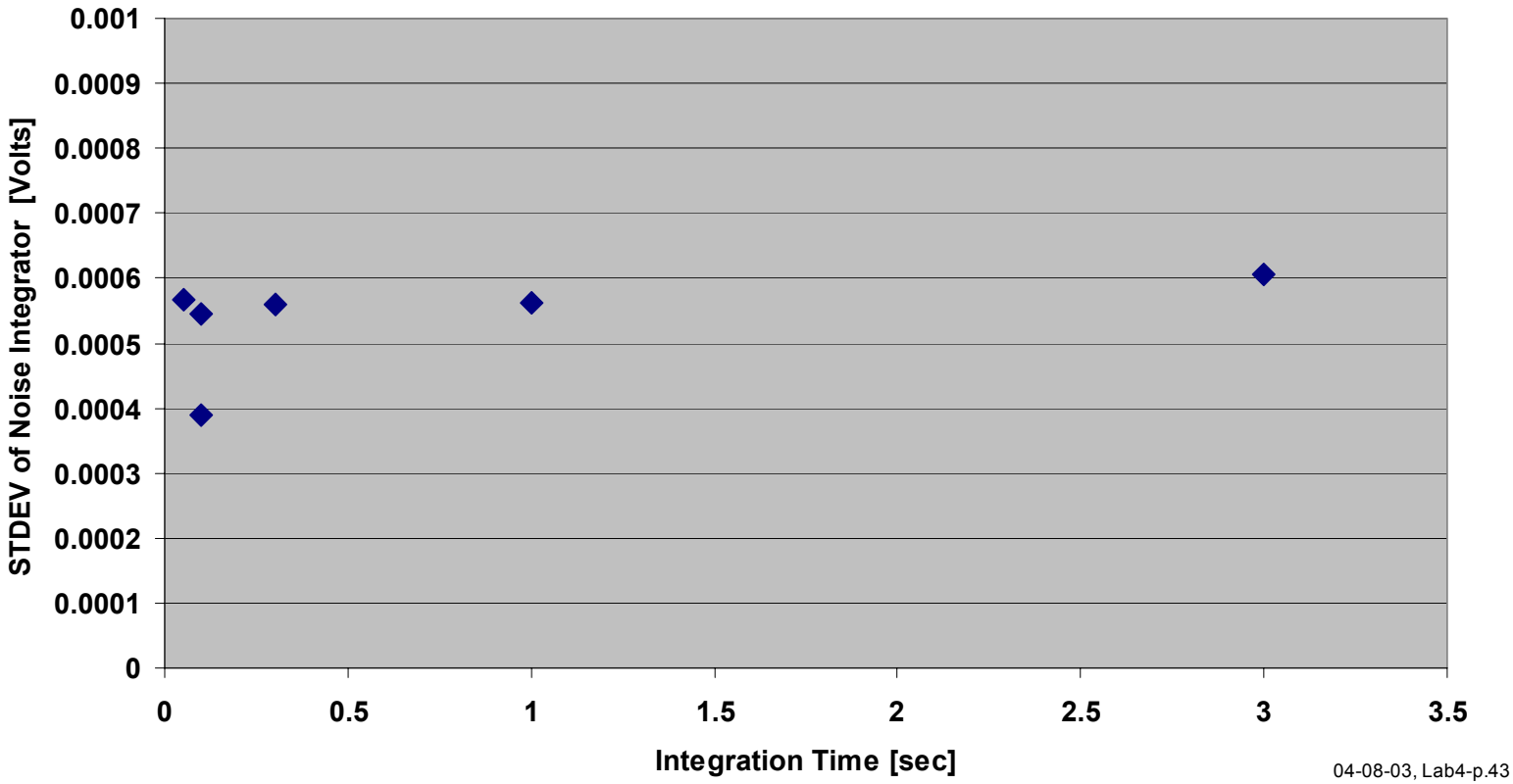
Sample Spectrum



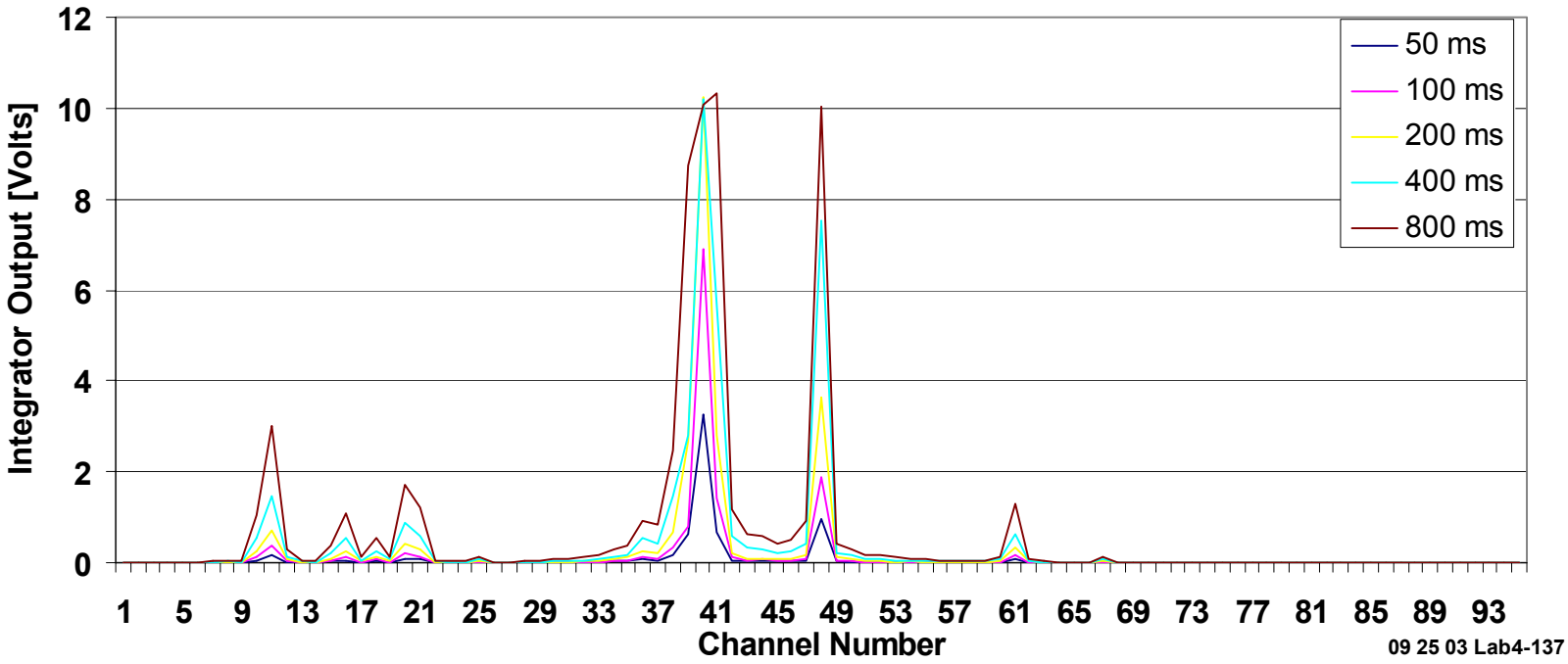
Sample Spectrum (2)



Noise as Function of Integration Time



New Results CO2 in Air



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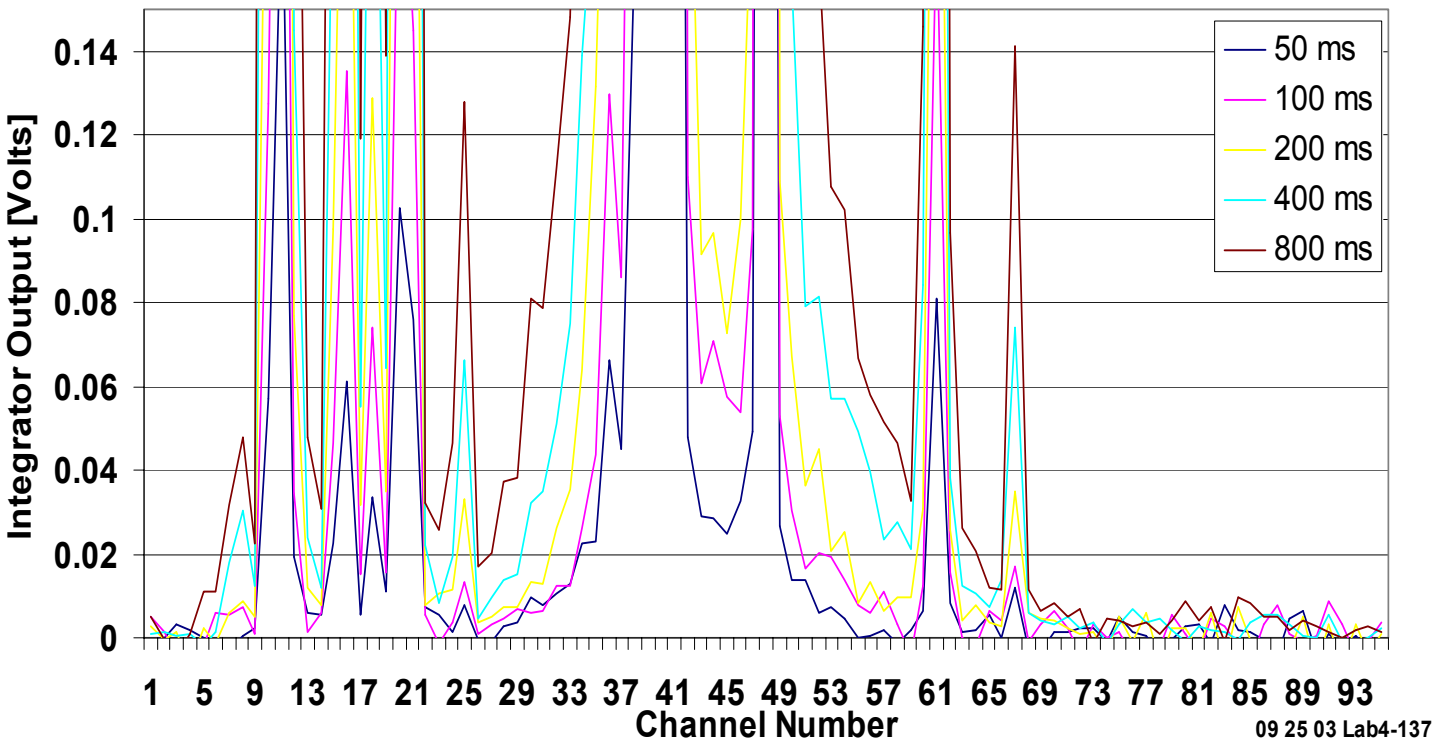
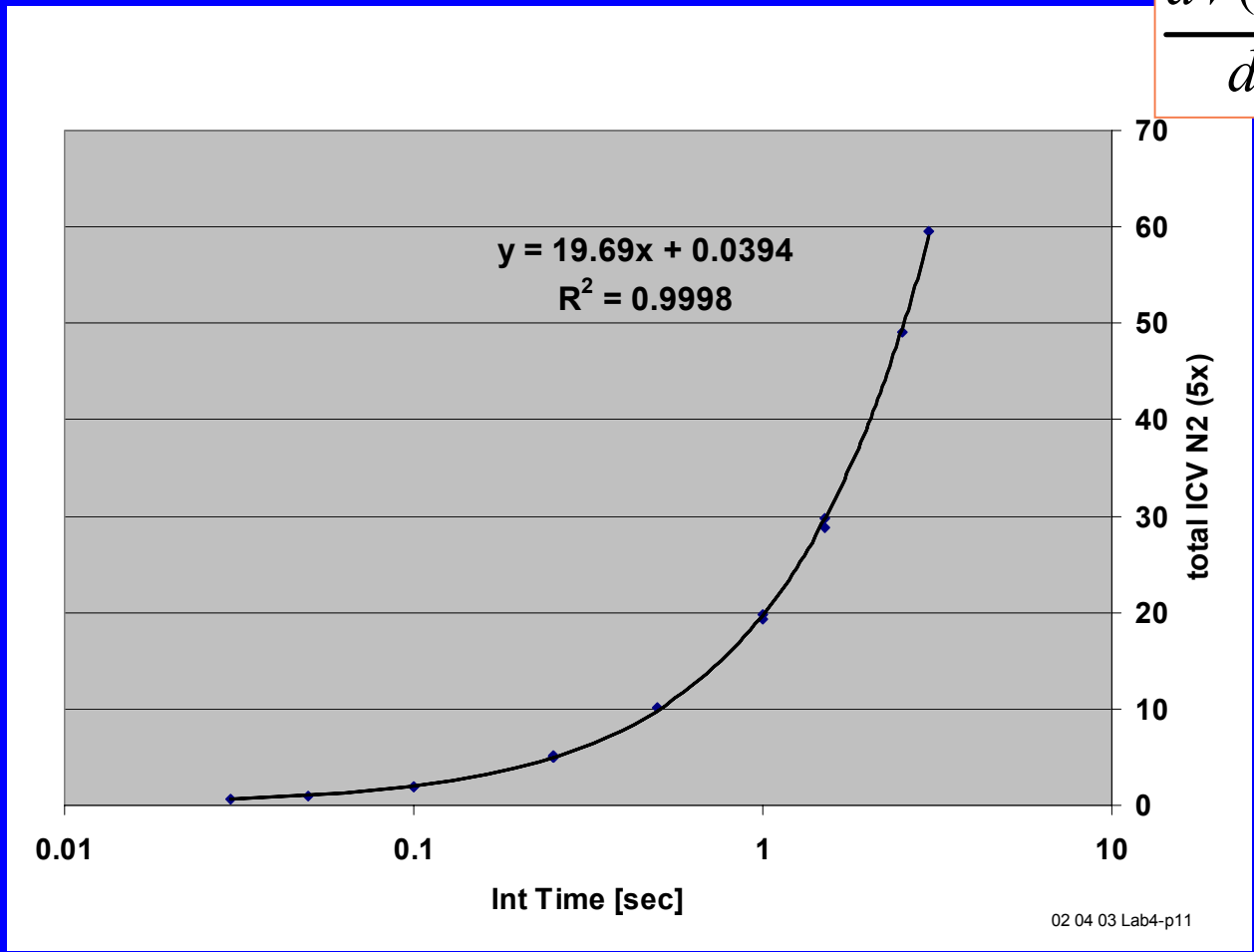


Signal as Function of Integration Time

$$\frac{dV(t_{clock})^{INT}}{dt_{clock}} = \frac{-I_{Ion}\ N}{C_{INT}}$$



High gain:
max. 10^{11} V/A

Read-out times
Linear:
30 msec to 3 sec

Significance/Conclusions

The development of a micromachined Faraday cup array in conjunction with a linear dispersion magnet in a confocal plane mass spectrometer enables the use of true multichannel mass spectrometry. This design is ideally suited for industrial process monitoring applications. Interfacing the LDMS system to a GC interface will allow to build a fast, low-cost GC/MS.

The Team

www.Intelligention.com

System Specifications

- Confocal plane Mattauch-Herzog layout
- DC-voltages and permanent magnet
- Ion Energy: 0.5-2.5 kV DC
- Mass Range:2-250 D, Window: 100%
- Baseline resolution for small molecules
- Xenon isotopes are well resolved
- EOID or Faraday Cup Detector Array
- Faraday Cup Detector Array with 250μm each
- Integrating operational amplifier with upto 10**11 gain
- Duty Cycle: > 99 %
- Read-Out Speed (FCDA): max 1.68 kHz