Cassini-Huygens Gas Chromatograph Mass Spectrometer

Dan Harpold
and the GCMS Team

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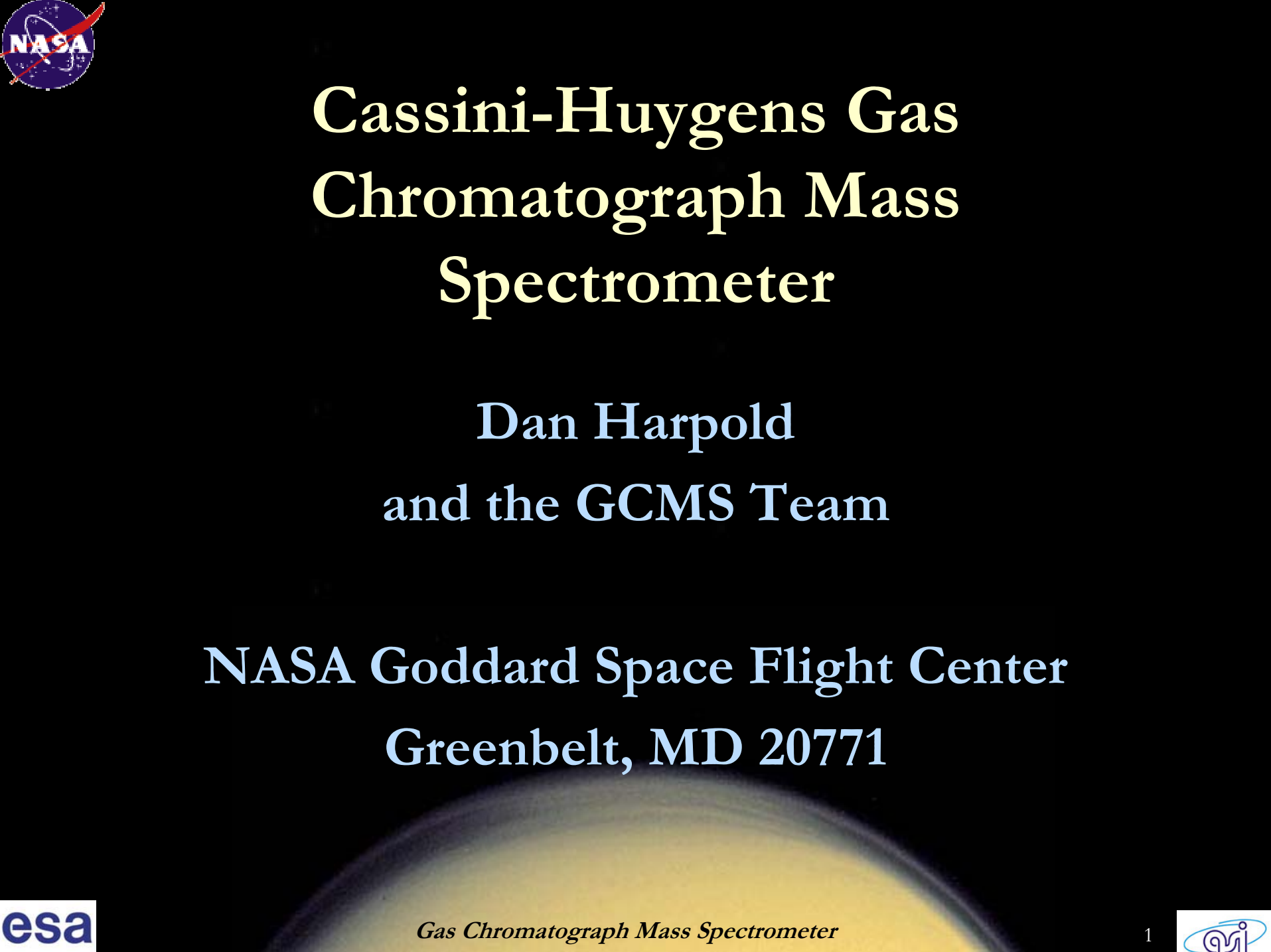
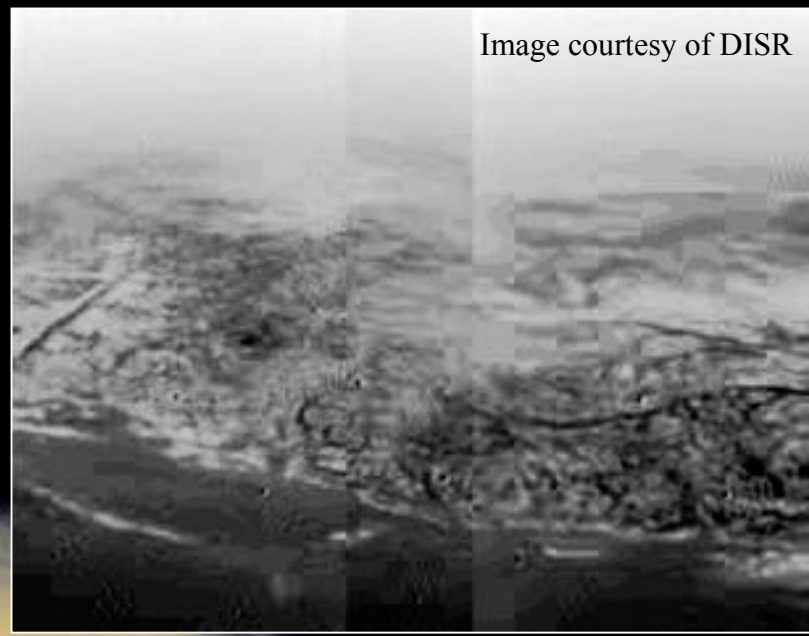


Cassini- Huygens Probe at Titan

- Launch: October 17, 1997
- Saturn Orbit Insertion: July 1, 2004
- Probe Release: December 25, 2004
- Entry and Landing: January 14, 2005
- Probe mass: 318 kg



- Heat shield and parachutes.
- 6 instruments on Probe.
- Probe and instruments survived impact and acquired data for over 1 hour on the surface.

The GCMS Team

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8. University of Hawaii
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10. Massachusetts Institute of Technology
11. Max Planck Institute

Huygens GCMS Characteristics

- Quadrupole mass spectrometer with a dual, secondary electron multiplier detection system; 5 electron impact ion sources; and 3 gas chromatographic columns
- Sample trapping and enrichment system
- 6 ion pumps and 8 getters
- 17.3 kg mass, 41 W average power
- Mass range 2-141 u
- Dynamic range $\geq 1 \times 10^{8}$
- Resolution 1×10^{-6} for adjacent half masses

  up to 60 u, less for higher masses
- Sensitivity limit: 1×10^{14} counts/s/mbar source pressure

Flight Configuration

Exhaust Tube

Pressurized Housing

Mounting Flange

Outlet Break off

Thermal Inlet Isolator

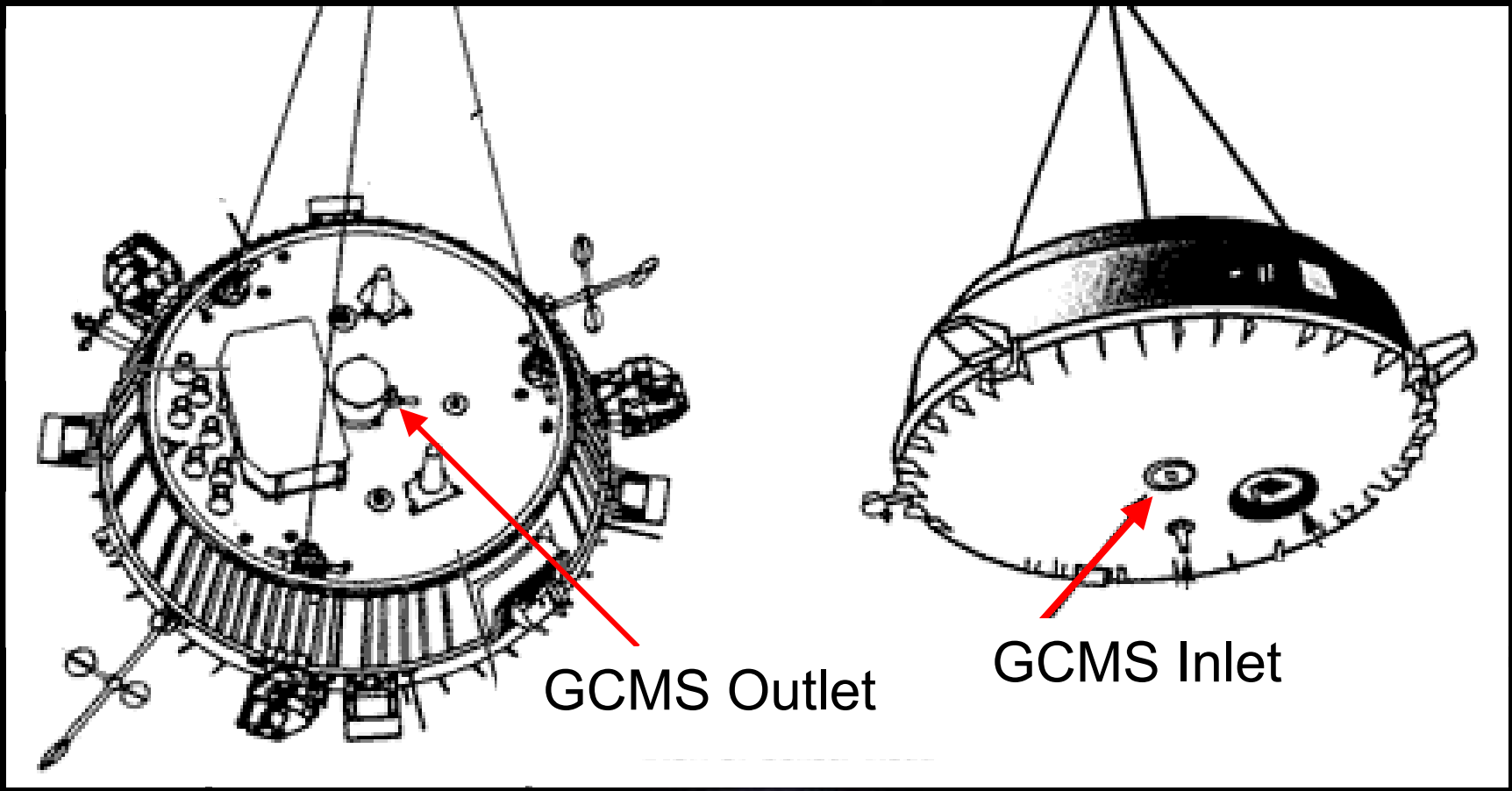
Inlet Break off

Ion Pump HV Supplies

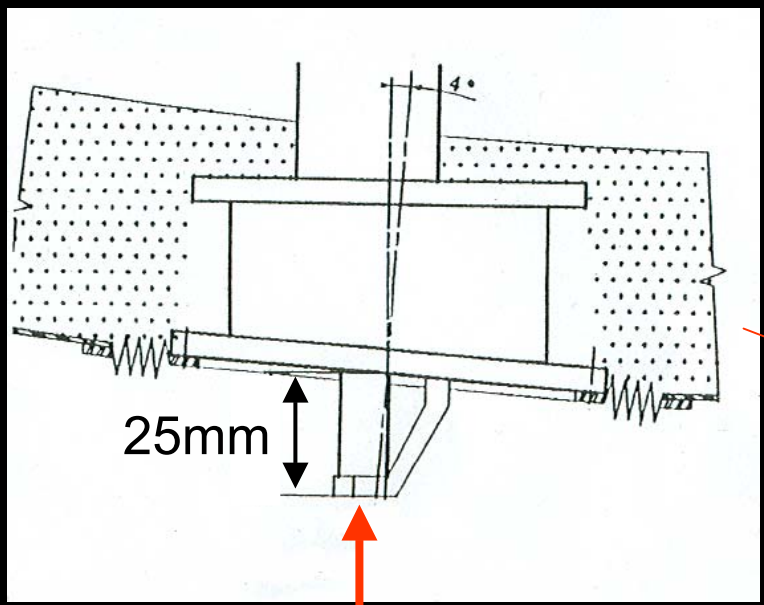
Center Section

Prom Board

GCMS Location in Probe

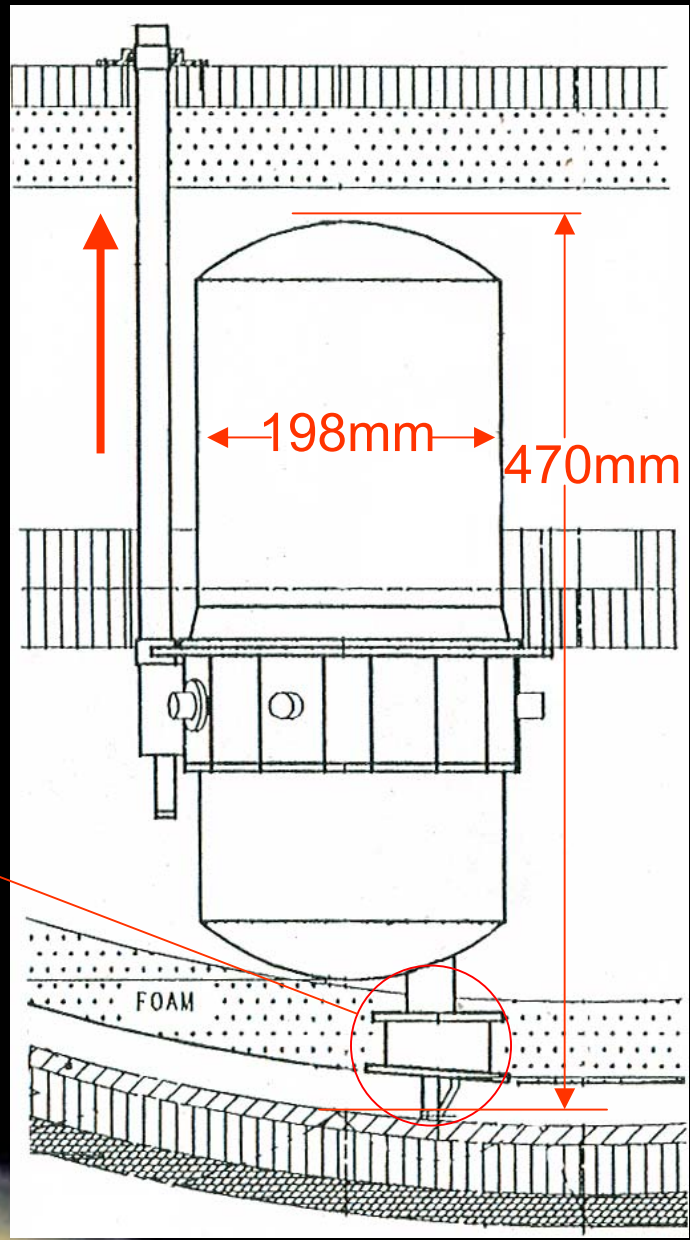


Heated Sample Inlet



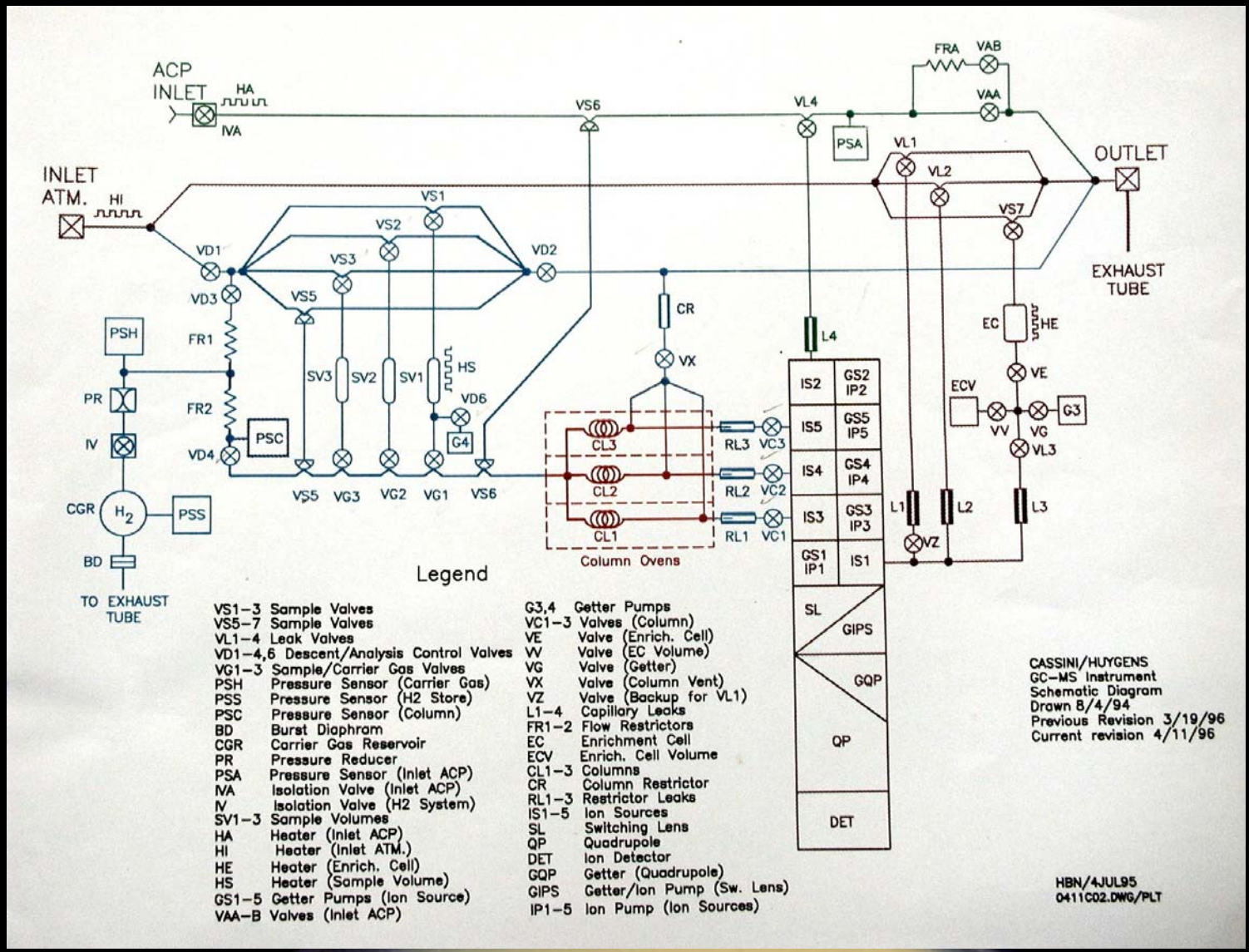
Atmospheric Inlet

Exhaust Outlet

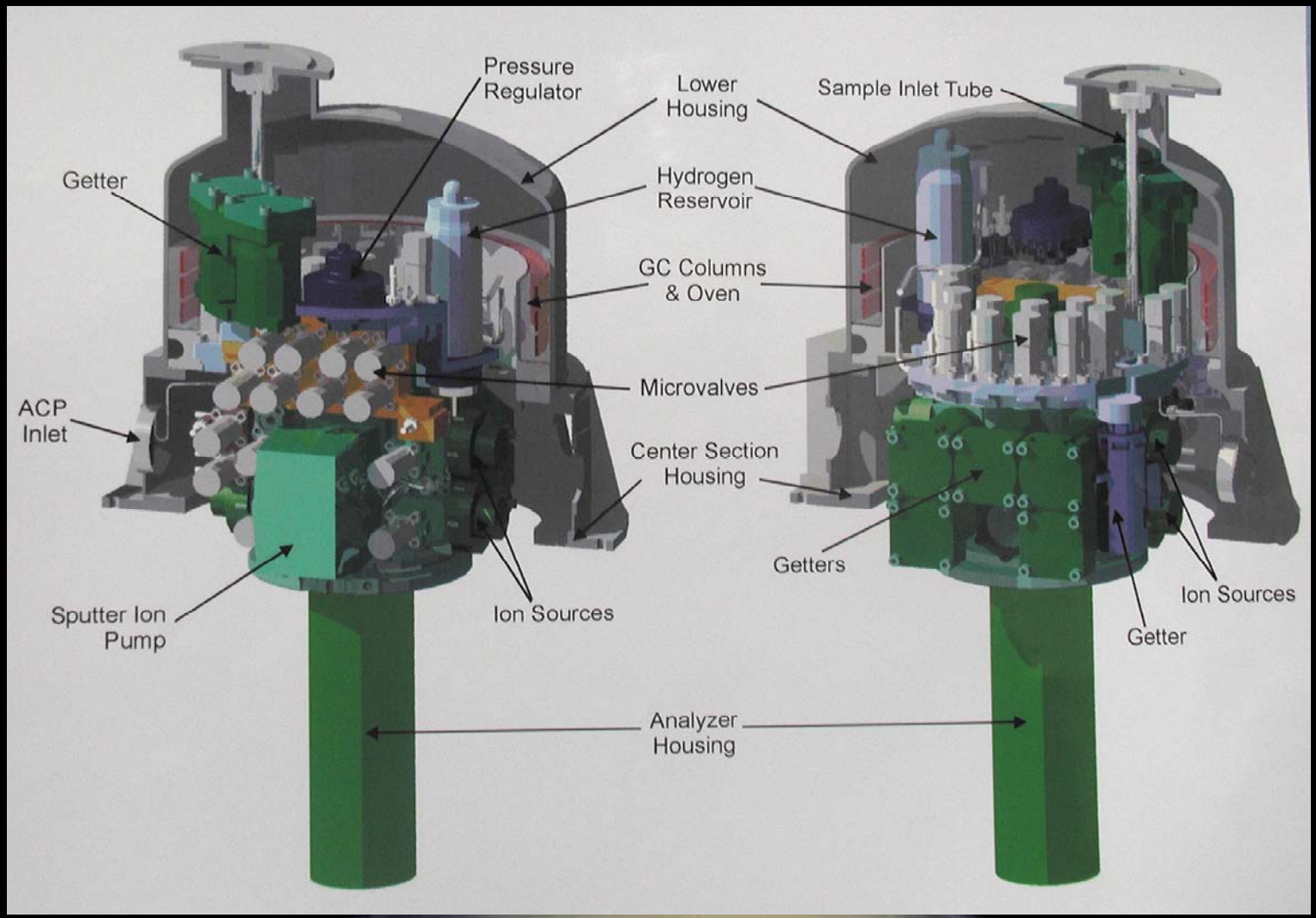


Front Shield

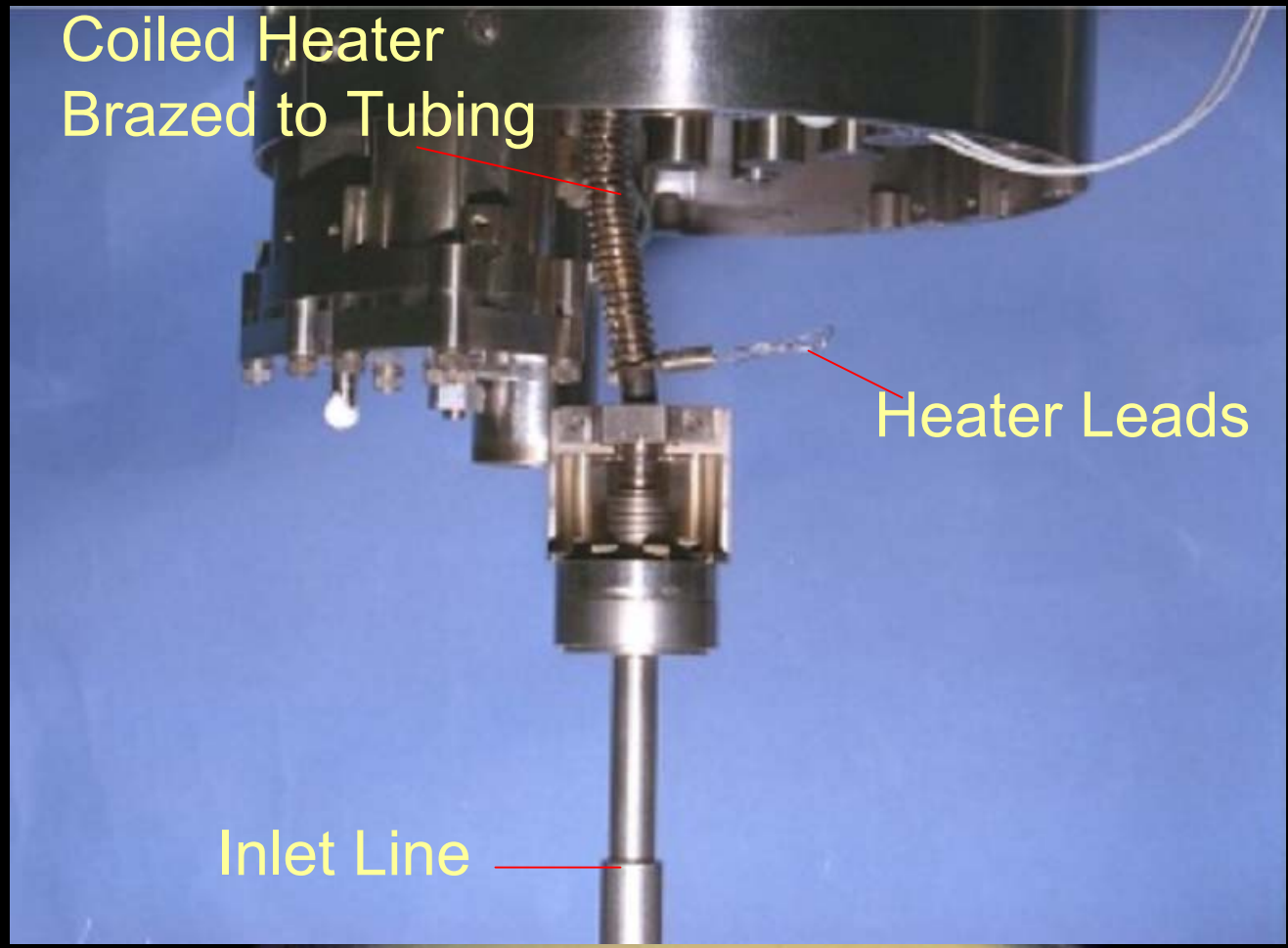
GCMS Gas Flow Diagram



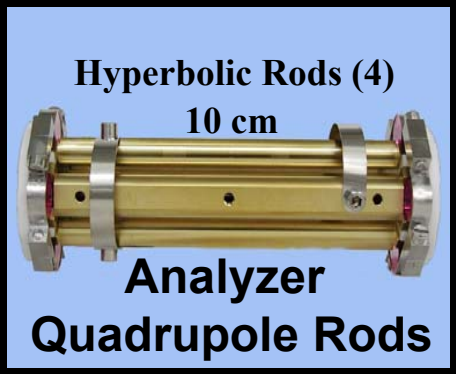
GCMS External View

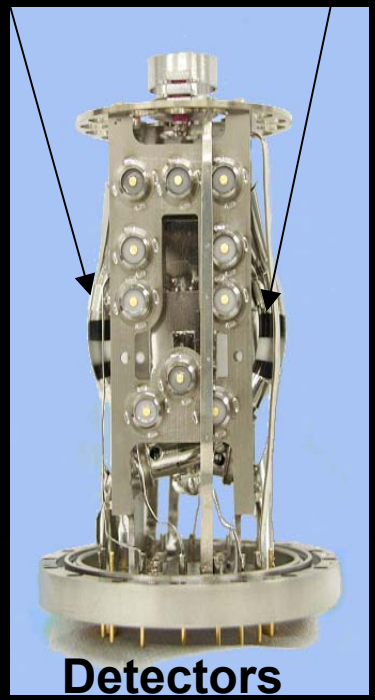


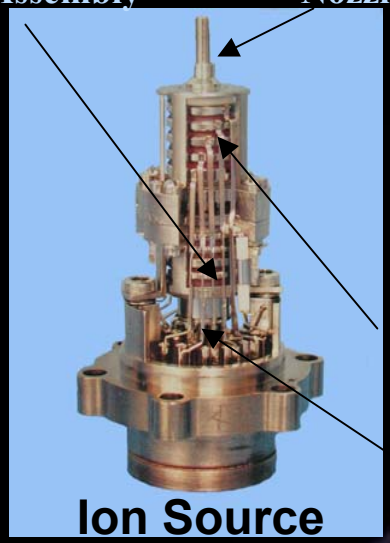
Inlet Tubing

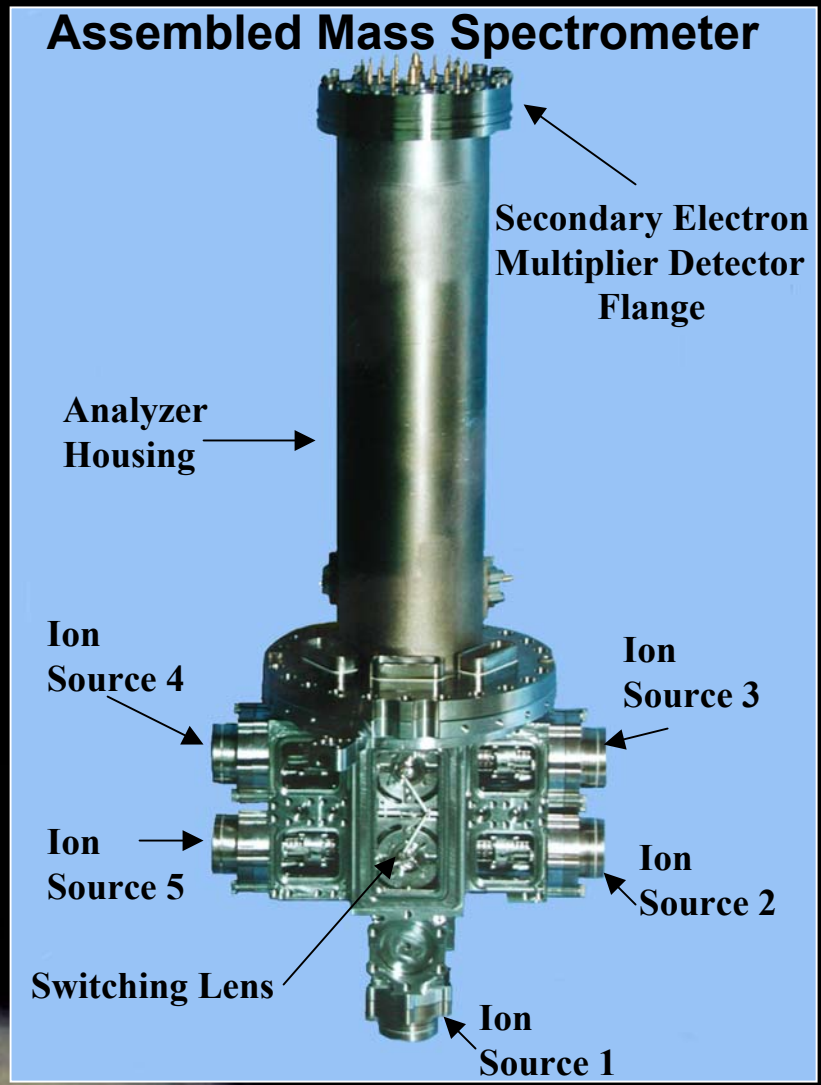


GCMS Internal Components









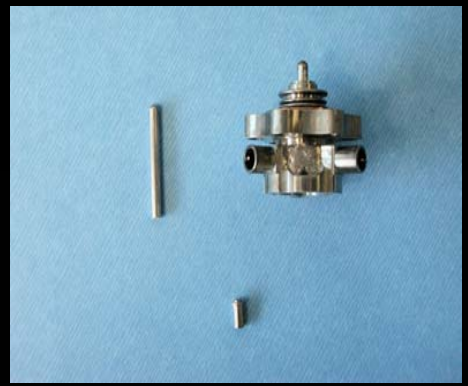
GCMS Inlet System Components

Manifolds

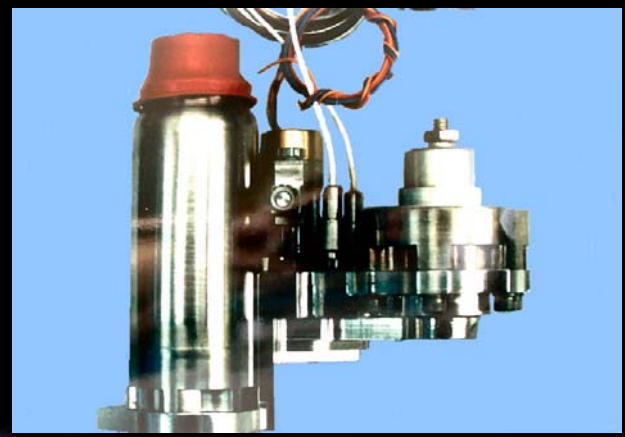
Microvalve

Getter Assembly

Enrichment Cell

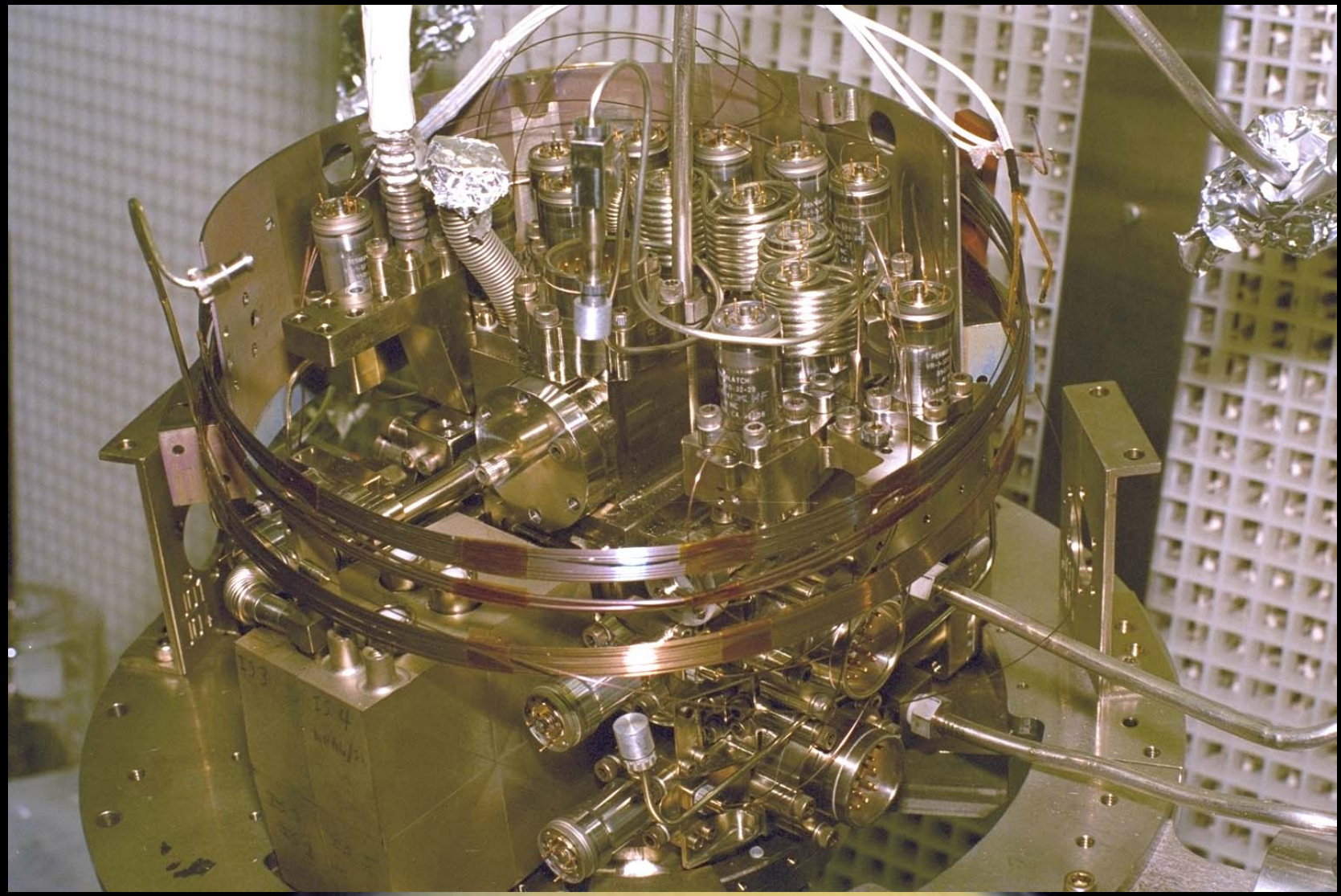


Capillary Leaks

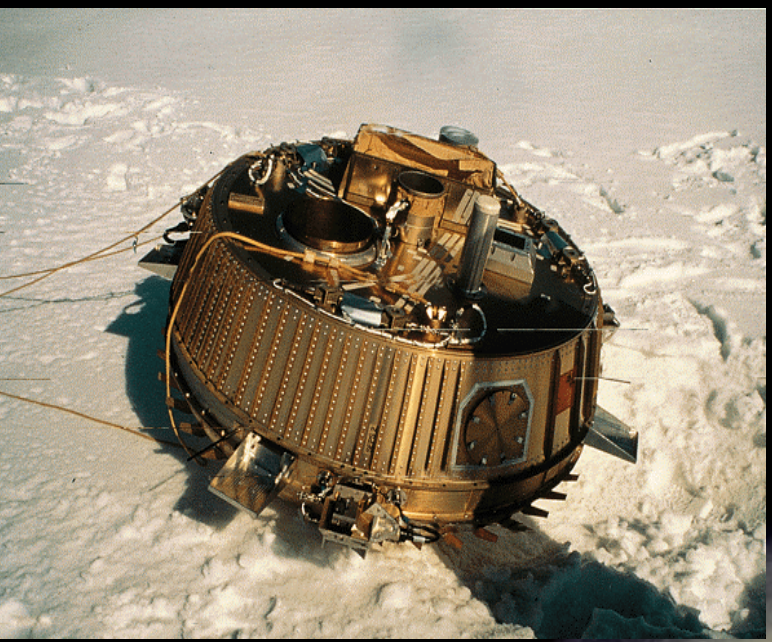


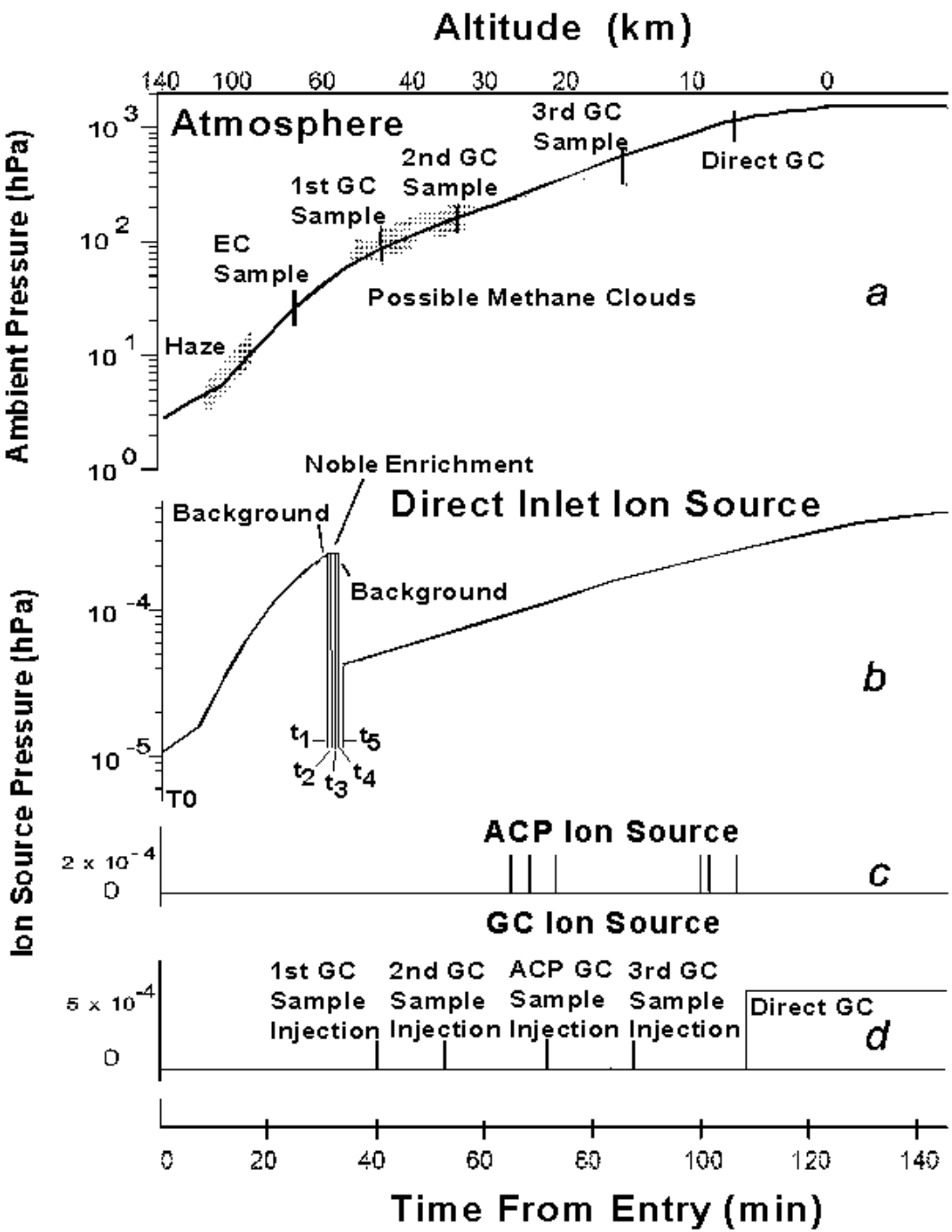
Hydrogen Manifold

GCMS During Assembly



Descent Sequence

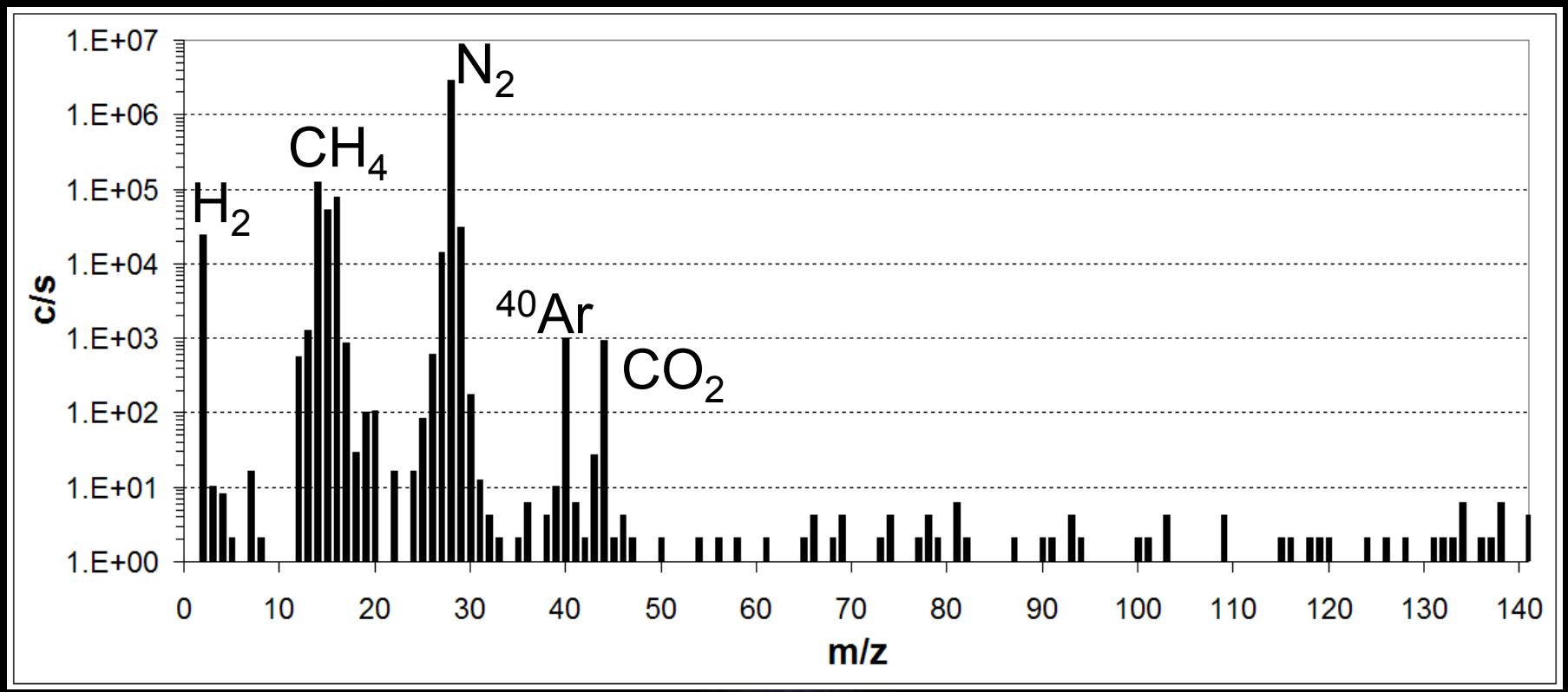




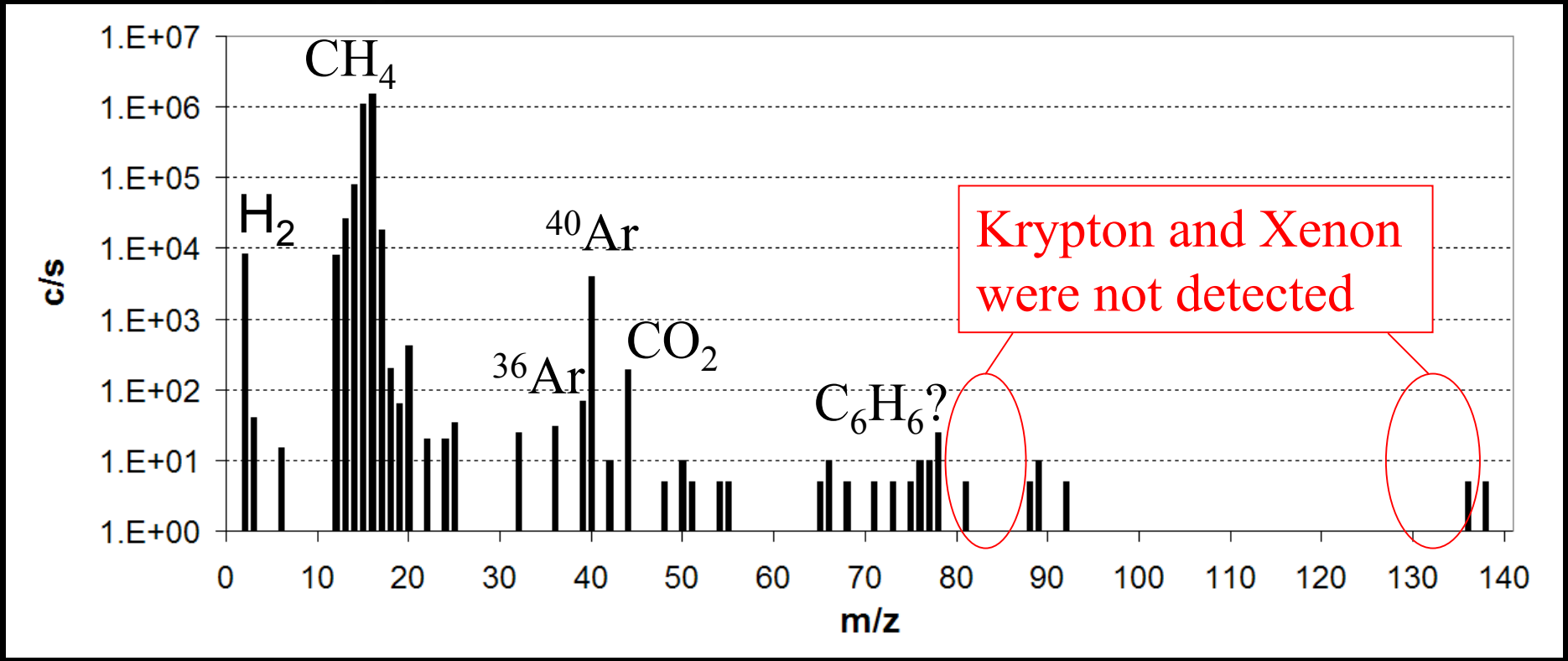
Instrument Performance

- The instrument executed the pre-programmed sequence as expected
- Data were taken from about 146 km altitude to the surface
- 2h27m descent operation yielding 5634 mass spectra
- 1h10m surface operation yielding 2692 mass spectra
- Ion source 5 failed to operate early in the descent
  - Loss of data from one gas chromatograph column which resolved CO and N_2
- Loss of channel A effected time resolution and signal statistics, no loss of essential data

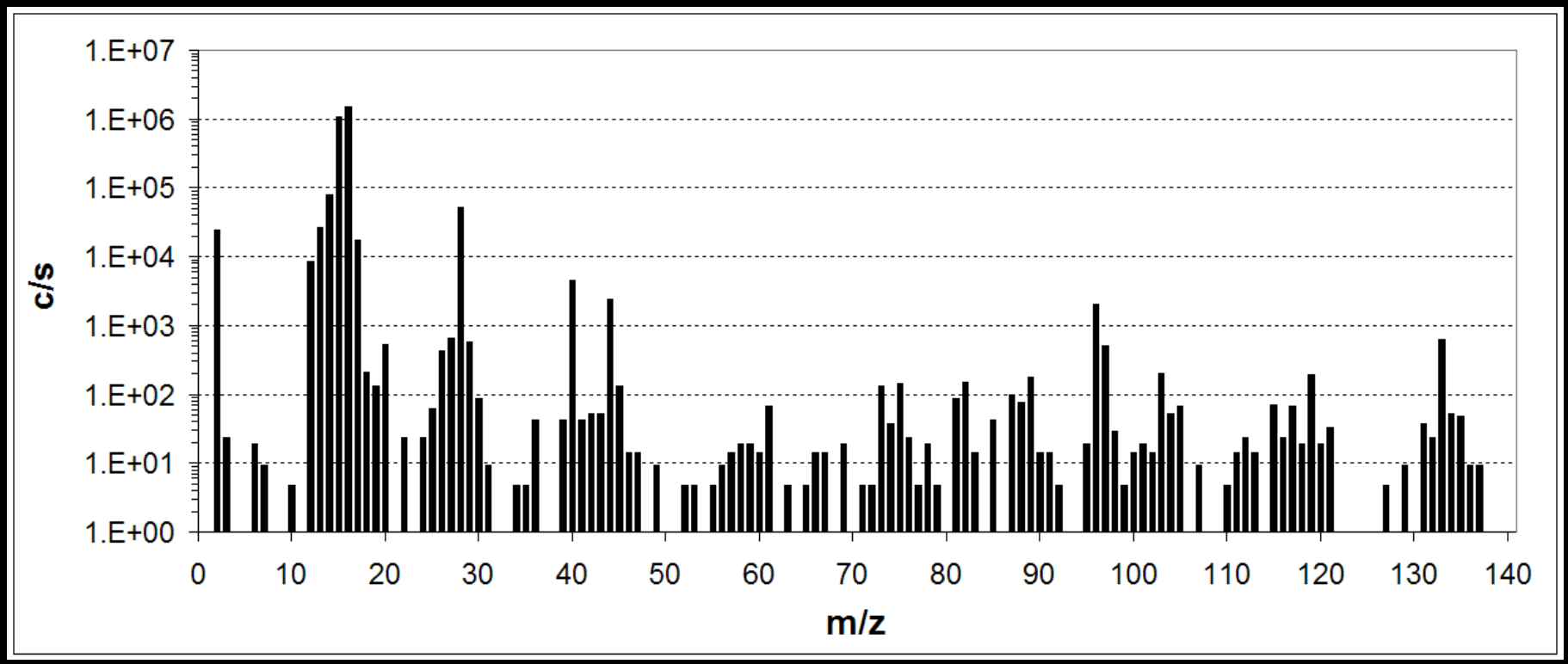
Upper Atmosphere Averaged Spectrum (130-120 km)



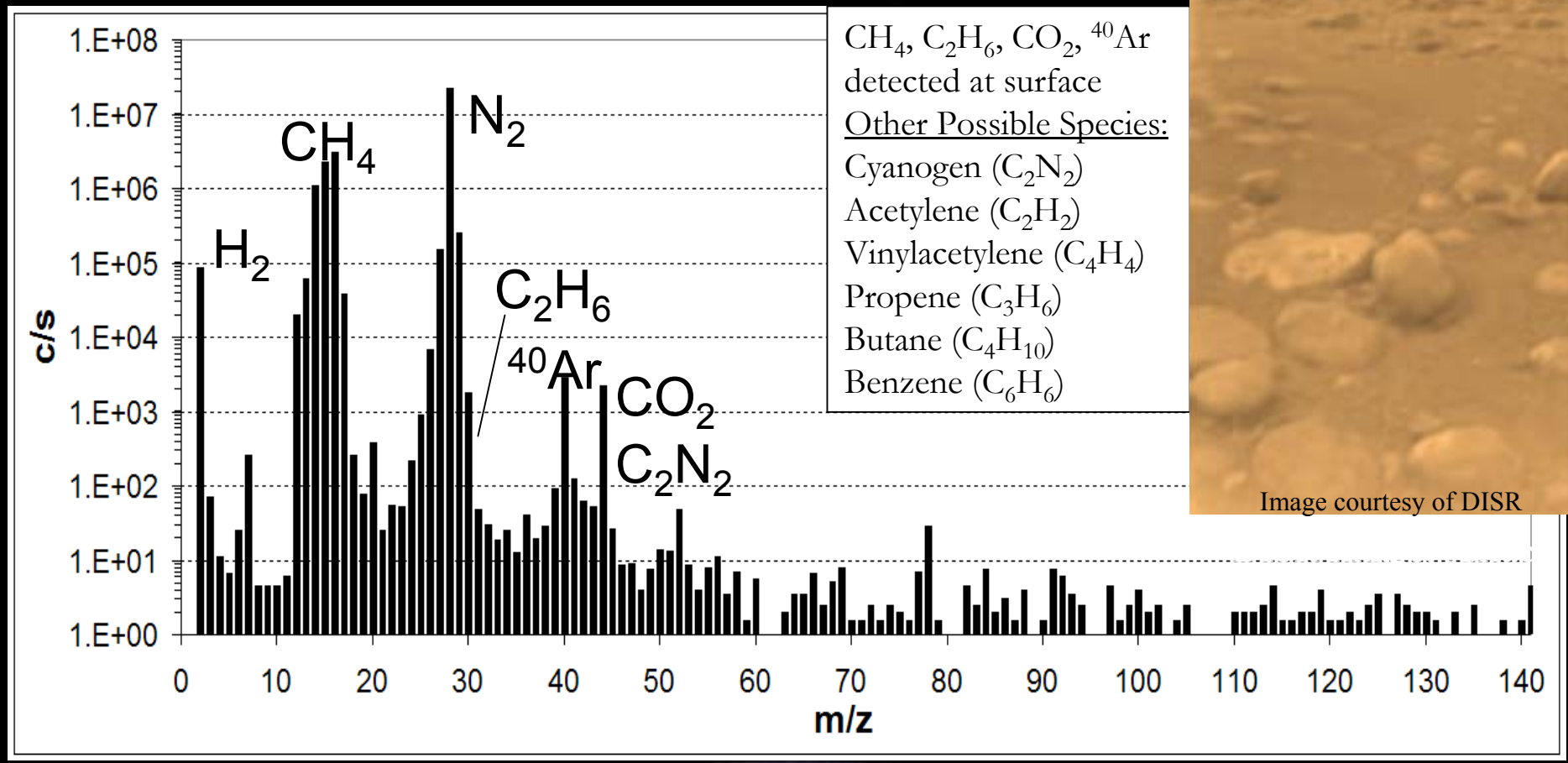
Rare Gas Experiment Averaged Spectrum (with Background Subtracted)



Enrichment Cell Averaged Spectrum



Averaged Surface Spectrum



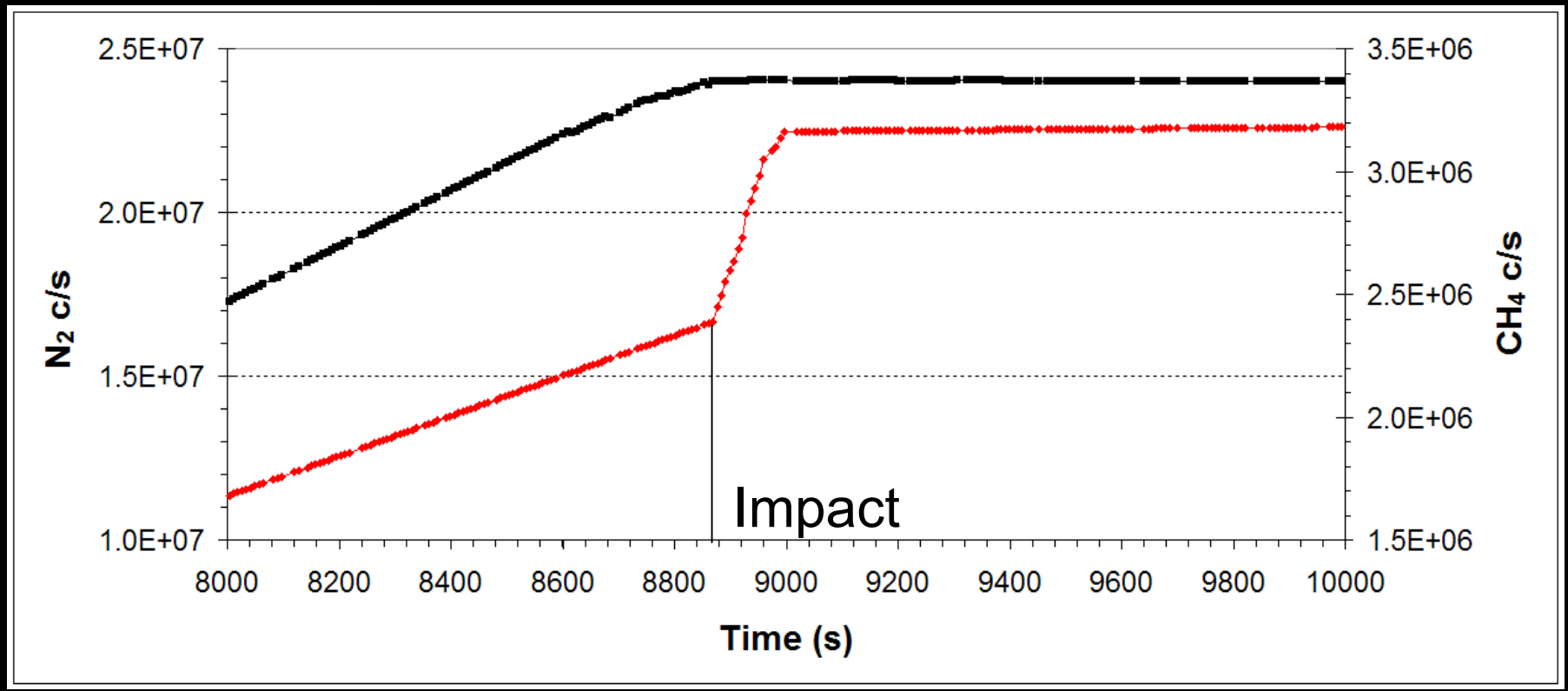
CH_4, C_2H_6, CO_2, ^{40}Ar detected at surface

Other Possible Species:

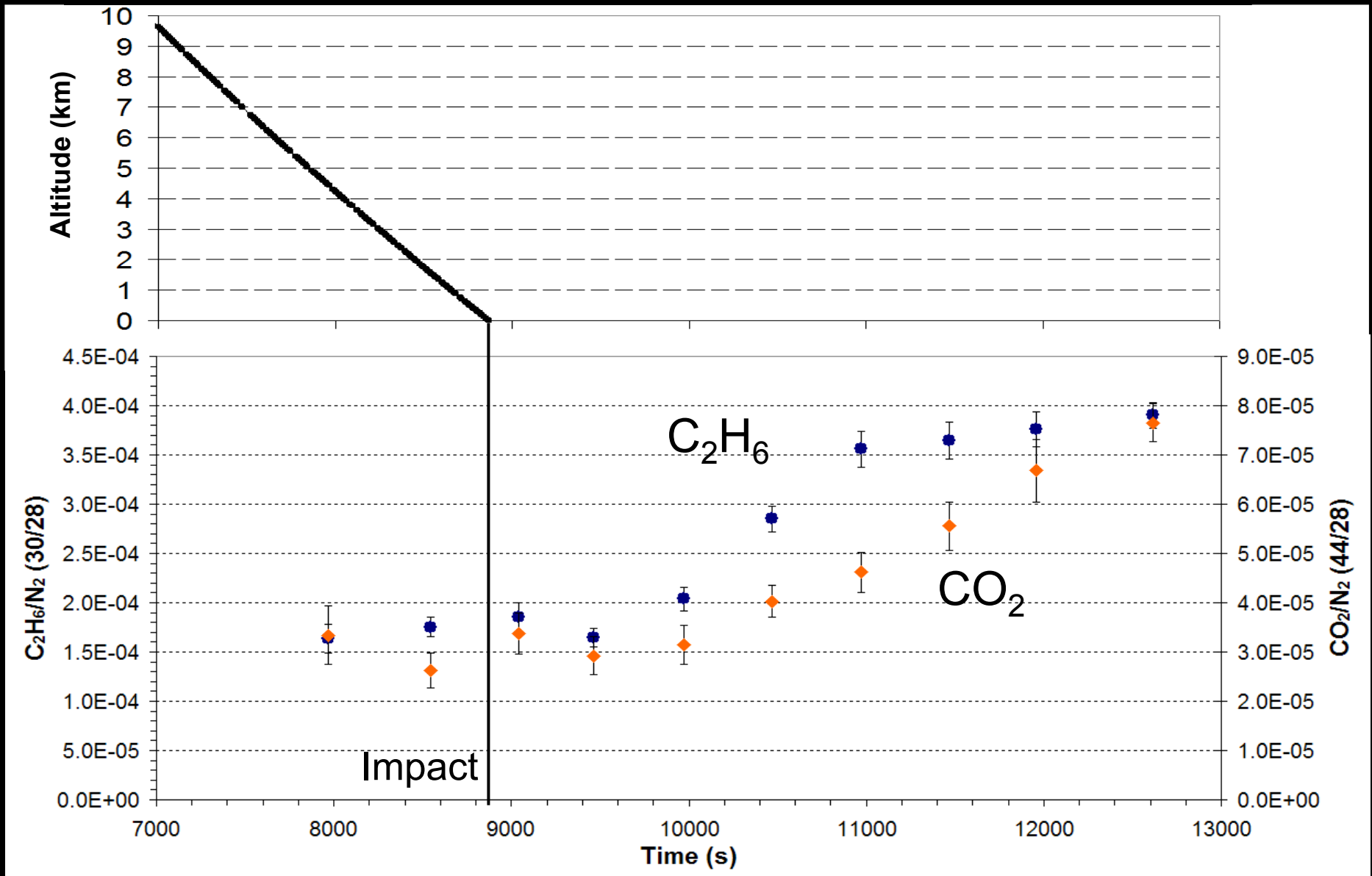
Cyanogen (C_2N_2)
Acetylene (C_2H_2)
Vinylacetylene (C_4H_4)
Propene (C_3H_6)
Butane (C_4H_{10})
Benzene (C_6H_6)

Image courtesy of DISR

Surface Response of N_2 and CH_4



Surface Response of C_2H_6 and CO_2



Last Image from Titan

No evidence for macroscopic life on Titan's surface except for this one image which is far from certain.

Companies Supplying Products or Services to the Huygens GCMS

Company	Product/Services
Aker Industries	Microvalves
Artech Industries	Ceramic to Metal Brazing
AutoFlow Products	Pressure Regulator
Collimated Holes	Capillary Leaks
Command Technology	Machining
EG&G Pressure Sciences	Vacuum/Pressure Seals
Electron Beam Engineering	Electron Beam Welding
Ergenics	Hydrogen Storage
F&M Machine	Machining
Form Grind	Hyperbolic Rod Manufacturing
Galileo Electro Optics	Secondary Electron Multipliers
Hermetic Seal	Vacuum/Pressure Feedthrus
Insaco	Ceramic Insulators
Kulite Semiconductor	Pressure Transducers
Laser Applications	Laser Welding
Micro Machining	Machining
Restek Corp.	GC Columns
Reynolds Industries	Ion Pump Feedthrus
Spiralock Corp.	Self-locking Taps
Summit Machining	Machining
Supelco	Adsorbent Material for Enrichment Cells
Teledyne Electronics	Hybrid Manufacturers
University of Michigan	Analog Electronics
Westport Development	Thin-walled Bellows