GCMS Sensor Characterization

22 laboratory notebooks
3300 written pages of text
2500 data files
260 Megabytes of data
71 pages of notebook index listings
750 hours of instrument operation

Ion Source Characterization

After assembly, cleaning, installation on an ultra-high vacuum test stand, and bakeout, new filaments were “burned in” prior to operation:

> Using a DC power supply, each filament was exposed to slowly increasing current until emission was observed, and then the current was slowly lowered again. Filament current was stepped up at a rate of 50 mA every 7.5 minutes. When emission was observed, emission was increased up to 50 uA at a rate of 10 uA every 7.5 minutes. Rates during current step-down were twice as fast.
>
> During this procedure, the filament bias was 0 V, and all other elements close to the filament were set to +50 V. Emission was measured as the current on these other elements.
>
> Voltage across the filament was measured, as well as filament current, chamber pressure, and filament emission. All of these parameters were compared to expected values during a burn-in in order to ensure proper filament operation.

Then a detailed characterization of the ion source was performed:

> Using various combinations of focussing voltages, lens currents were monitored at a series of emission voltages. These measurements served to identify the particular characteristics of that assembly.
>
> A multiplier assembly was used to monitor the output of the ion source when in this configuration, and the ion beam was quantitatively measured at particular nitrogen pressures to identify those combinations of voltages which maximized sensitivity.
>
> In-house analytical software was used to generate these voltage combinations by computer monitoring of the multiplier current and D/A control of the filament voltages.

All of these focussing lens currents, filament currents, and focussing lens voltage combinations were monitored during ion source operation on the flight sensor.

Multiplier Assembly Characterization

After assembly, cleaning, installation on an ultra-high vacuum test stand, and bakeout, new multipliers were slowly turned on by ramping up their high voltage at ~100 V every two minutes.

Then a detailed characterization was taken of the multipliers themselves and of the assembly:

> "Bleeder current" was measured, which is the hot resistance of each multiplier at operating voltage.
>
> "Dark counts" were measured at length, to detect any extraneous multiplier output with the multtipliers at operating voltage and no ion beam present.
>
> Output counts and current for each multiplier were measured at various levels of ion beam input. This allowed calculation of the gain of each multiplier at various input levels.
>
> Each multiplier may be operated as the primary multiplier, depending on which one the incoming ion beam is focussed. The other multiplier acts as the secondary multiplier, sensing some set fraction of the counts that are seen on the primary multiplier. In characterization, output counts and current for each multiplier were measured in every combination of multiplier operation. This allowed the ratio of counts between the primary and secondary multiplier to be characterized.
>
> Pulse height distributions, or PHDs, of each multiplier at various operating voltages and ion beam inputs were taken. The shape of the PHD scan indicates the degree to which the multiplier is reliably producing detectable output for each ion coming into the multiplier.

An extended lifetime test was performed on a pair of multipliers from the lot obtained for the GCMS instrument. After XXX days of XXX hours a day of XXX ion beam flux being shot into the multipliers, no signifigant deterioration in performance of the multipliers was seen.

Gain, primary-secondary operation ratio, and PHDs for the multipliers were monitored during the course of operation on the flight sensor.

Experiments Performed

Leak Characterization:

Leak sizes:

Leak 1	$1.8*10^{-4}$ atm*cc/sec for He
Leak 2	$3.0*10^{-7}$ atm*cc/sec for He
Leak 3	$1.3*10^{-3}$ atm*cc/sec for He
Leak 4	$1.7*10^{-6}$ atm*cc/sec for He
VX	$1.2*10^{-3}$ atm*cc/sec for He

Leak, sample inlet pressure, gas mixture

Enrichment Cell Characterization

GCMS Characterization

Columns:

IS-3	Glassy column	15 m
IS-4	Packed column	2 m
IS-5	MXT column: MXT-1701	10 m

Column, sample volume, sample inlet pressure, gas mixture, squirt time on injection valve

Descent Sequence Characterization

Gas Mixtures Used in GCMS Sensor Characterization

1. Nitrogen mixture with trace amounts of various light hydrocarbons and other components:
~100 ppm each of--

methane	methane	ethene	acetylene
propane	propylene	n-butane	cis-2-butene
1-butene	trans-2-butene	1,3-butadiene	pentane
carbon dioxide		carbon monoxide	

2. Nitrogen mixture with trace amounts of various heavy hydrocarbons:
~100 ppm each of--

isobutane	isopentane	isohexane	benzene
toluene	o-xylene	3-methyl,1-butene	
2,2-dimethyl propane			

3. Nitrogen mixture with trace amounts of various noble gases:
~50 ppm each of xenon, krypton, argon
~250 ppm neon ~575 ppm helium

4. Nitrogen with 10% Argon

5. Helium with ~1000 ppm CO

6. Helium mixture with trace amounts of various light hydrocarbons:
~150 ppm each of--

methane	ethane	ethylene	isobutane
1-hexene	acetylene	propylene	propane
benzene			

7. Helium mixture with large amounts of various noble gases:
~5% each of xenon and krypton
~8% argon ~25% neon

8. Pure nitrogen

9. Pure hydrogen