HIDEN RC SYSTEMS

QUADRUPOLE MASS SPECTROMETERS FOR RGA, GAS ANALYSIS AND PROCESS MONITORING

The HAL RC systems are designed for RGA, gas analysis and process monitoring applications including leak detection, trend analysis and vacuum survey.

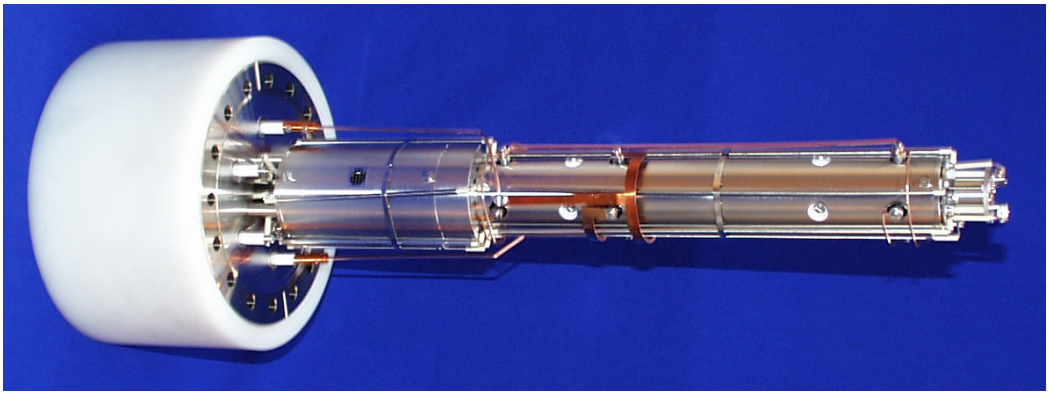
The quadrupole analyser is a precision assembly including a mass filter with machined radial ceramic supports, an electron impact ioniser with twin oxide coated iridium filament and a choice of either Faraday only, a dual Faraday and Channelplate electron multiplier detector or a dual Faraday and Channeltron electron multiplier detector. The analyser mounting flange is a DN-35-CF (2¾", 70mm OD) Conflat type flange. Mass range is 100 amu, 200 amu or 300 amu.

HAL RC systems are directly controlled from a PC compatible computer via RS232 or Ethernet link, providing simultaneous data acquisition from multiple systems. The RC interface unit is a 90mm high (2U), 19-inch rack-mounting unit. It is mains powered and includes power on and filament status indicators.

Windows™-MASsoft PC software provides for fast data acquisition through either user configured acquisition files or pre-set modes selected by icon.

Features:

- Fast access for Histogram, Trend Analysis and Analog peak displays
- Mixed mode scanning e.g. Trend Analysis, Histogram and Analog peaks in multiple-windows
- Real time background subtract
- Simultaneous real time display of graphical and tabular trend analysis data
- Data acquisition from multiple systems via Ethernet
- Automatic mass scale alignment
- Integral mass spectral library with full editing facilities
- Data export facility to ASCII format and to all Windows™ devices for printing / plotting
- Cursor for peak height identification under mouse control
- Dynamic Data Exchange, DDE facility for real time data transfer to other DDE client compatible Windows™ applications, Excel, SPC-IV statistical process control software or Origin, for example



HAL/3F RC TRIPLE FILTER SYSTEMS

QUADRUPOLE MASS SPECTROMETERS FOR GAS ANALYSIS IN HIGH PRECISION SCIENTIFIC AND PROCESS APPLICATIONS

The HAL/3F RC systems are designed for gas analysis in high precision scientific and process applications including trend analysis, broad mass scans and leak detection.

The quadrupole analyser is a precision assembled triple mass filter with RF- only secondary filter stages preceding and following the primary mass filter, independently driven for optimum beam transfer. A radially symmetric electron impact ioniser with twin oxide coated iridium filaments and a dual Faraday / single channel electron multiplier detector are included as standard.
Mass range options are 50, 300 and 510 amu.

HAL/3F RC systems are directly controlled from a PC compatible computer via RS232 or Ethernet link, providing simultaneous data acquisition from multiple systems. The RC interface unit is a 90mm high (2U), 19 inch rack mounting unit. It is mains powered and includes power on and filament status indicators.

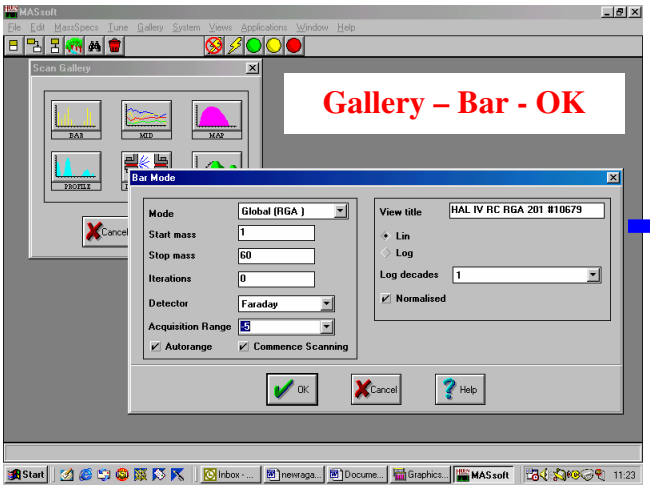
Operation through Windows™-MASsoft PC software with all the features and benefits of the Hiden RC RGA with:

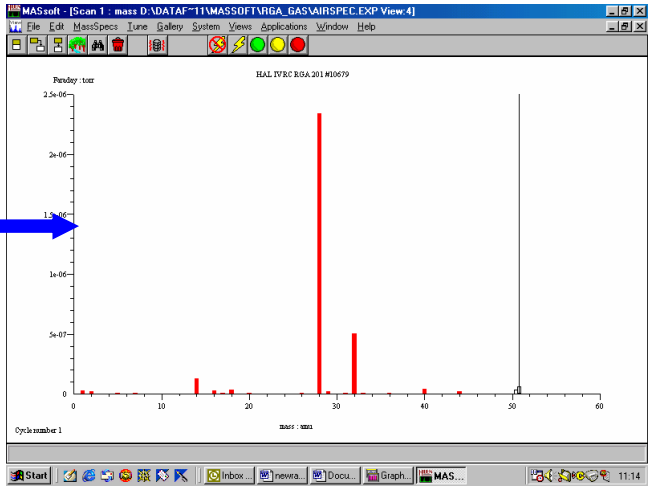
- Ion source control for **soft ionisation** and appearance potential mass spectrometry
- Enhanced detection capability from 100% to 5ppb
- Enhanced sensitivity for high mass transmission
- Enhanced long-term stability
- Enhanced contamination resistance via the RF-only pre-filter stage

RGA Applications ***BASE PRESSURE FINGERPRINT:***

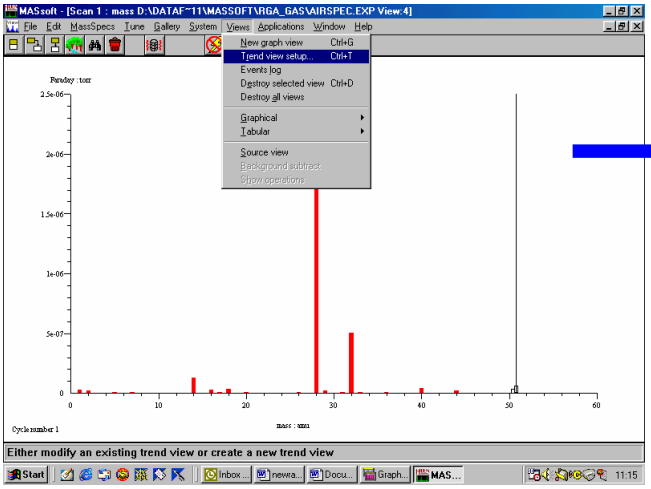
The speciation of the process / chamber contaminants using the residual gas analyser under the ultimate vacuum conditions or typical conditions of the process / chamber provides the user with a molecular 'Fingerprint' to help the user develop an understanding of the process occurring within the system as well identifying key variables and their affect on the process.

To generate a histogram fingerprint using Hiden's MASsoft operating system simply click:

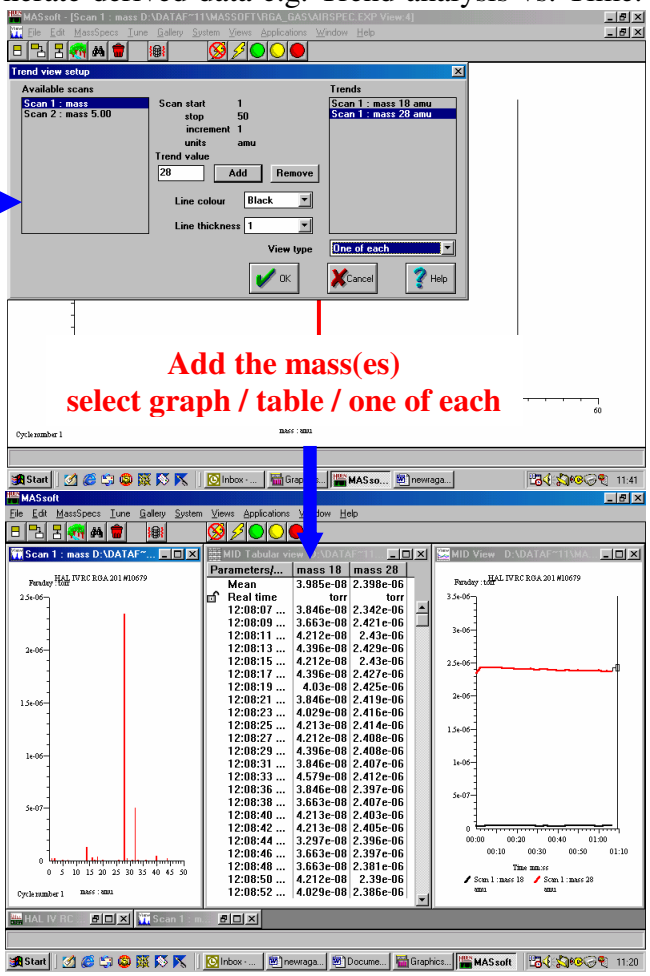




From this simple scan MASsoft allows the user to generate derived data e.g. Trend analysis vs. Time. To do this simply select:



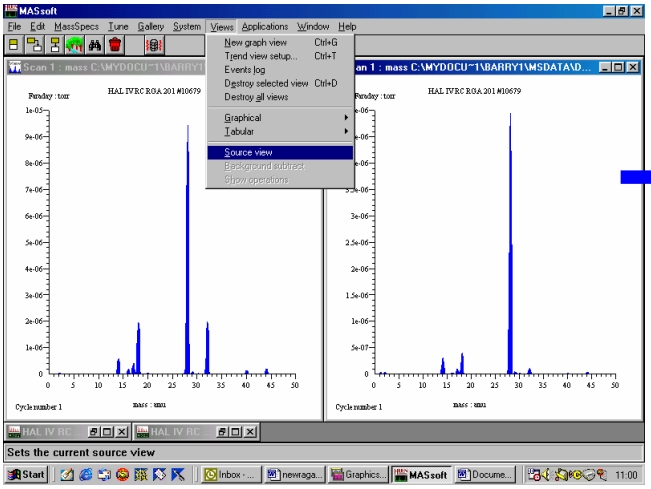
Views – Trend view set up



Note. This process does not affect the operation of the bar scan or alter any data acquired.

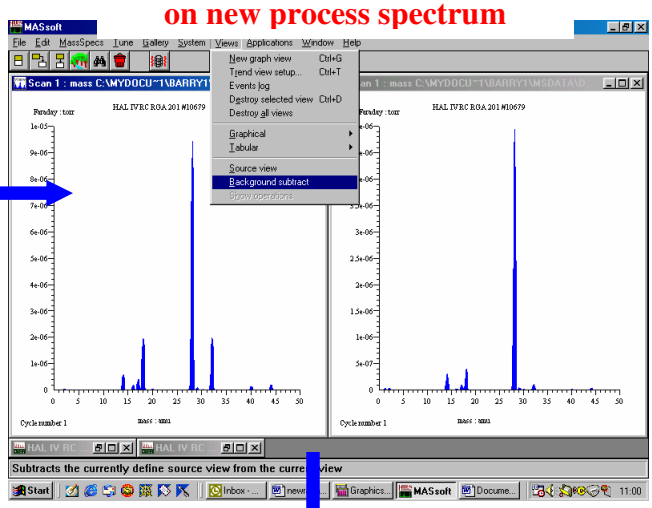
In addition MASsoft can use the source / background subtract software options to define a baseline 'Fingerprint' and automatically subtract the recorded signals from newly acquired data.

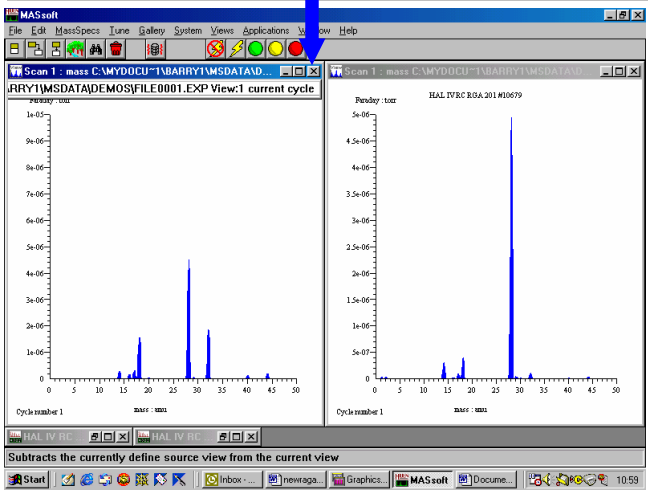
To do this select:



Views – Source View on Fingerprint spectrum

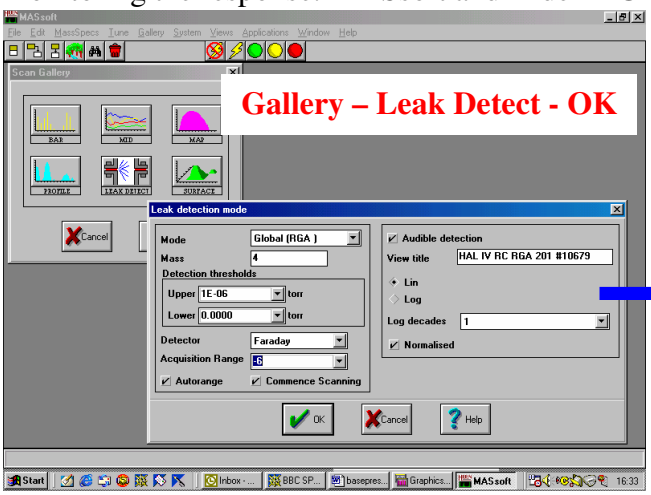
Views – Background subtract on new process spectrum

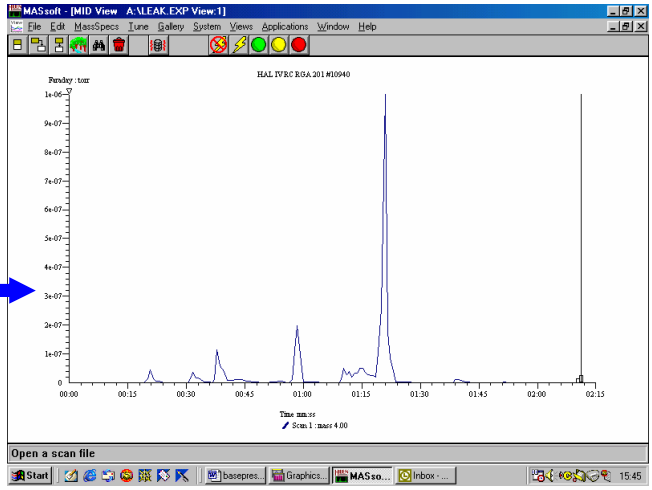




LEAK DETECTION:

In order to ensure integrity of the vacuum system RGA of process chambers using a Helium 'sniffer' to examine the seal at joints / flanges / welds etc. by passing Helium over the area under investigation and monitoring the response. MASsoft and Hiden RGA include Leak Detection mode as standard



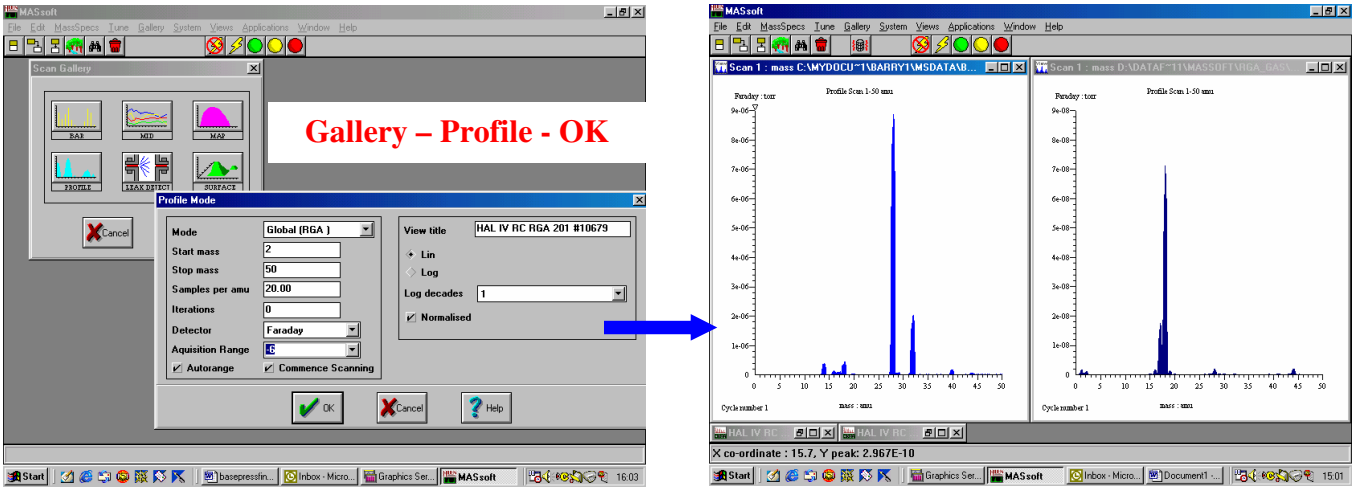


VIRTUAL LEAKS:

A virtual leak arises when gas or moisture is physically trapped in an environment of very low conductance to the UHV chamber proper such as internal tapped screw holes or weld cracks. Such features can result in the trapping of comparatively large volumes, e.g. a ¼'' diameter tapped hole with a $^{1}/_{16}$ '' clearance has a dead volume of 0.049 in^3 and can trap 0.6 litre of gas at STP which corresponds to 6 * 10^{-3} Torr in a 100 litre chamber. The evacuation of this volume is particularly difficult due to the low conductance through the screw thread resulting in great difficulties in achieving ultimate pressure. Given the nature of these sources of contaminants leak checking using He is of limited assistance. The characteristics of virtual leaks also differ from normal desorption / outgassing as they tend to manifest as intermittent pressure spikes resulting from the release of a trapped volume, as opposed to the gradual desorption / degassing processes. To reduce the impact of virtual leaks gentle heating of the affected area can promote gas release or alternatively filling the chamber with a dry, inert gas e.g. Argon to displace the trapped species as the slow release of Argon is generally less detrimental.

Bakeout Cycles:

The slow rate of desorption of some species e.g. permanent gases, water, cleaning fluid residues etc. from the inner walls of the process chamber can result in the need for extended pumping periods in order to obtain ultimate base pressure. However the rate of desorption of these species and their subsequent evacuation can be significantly enhanced by heating of the chamber, a process known as 'baking-out'. After the baking-out the pressure greatly improves as the system cools. As the temperatures involved can often be in excess of 150 °C Hiden provide a 'Thermal Extender' option to limit heat conduction to the sensitive electronic components of the RF head.



RGA Case Studies Using Hiden Residual Gas Analysers

Example 1. Process Chamber and Gas Purity Studies.

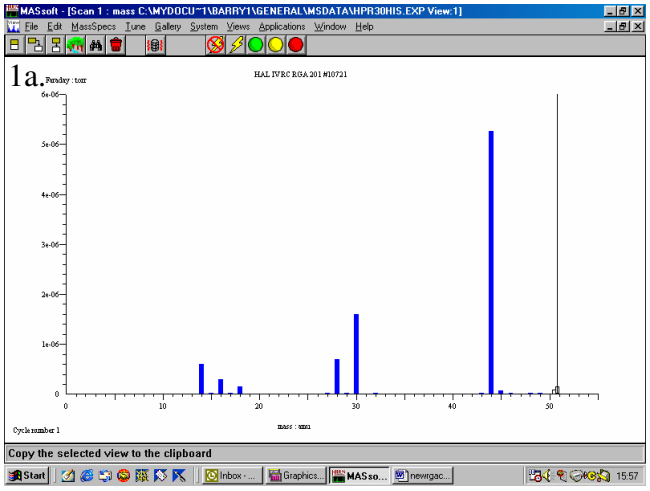
A plasma deposition process was found to suffer from inconsistency in the coverage quality- why?

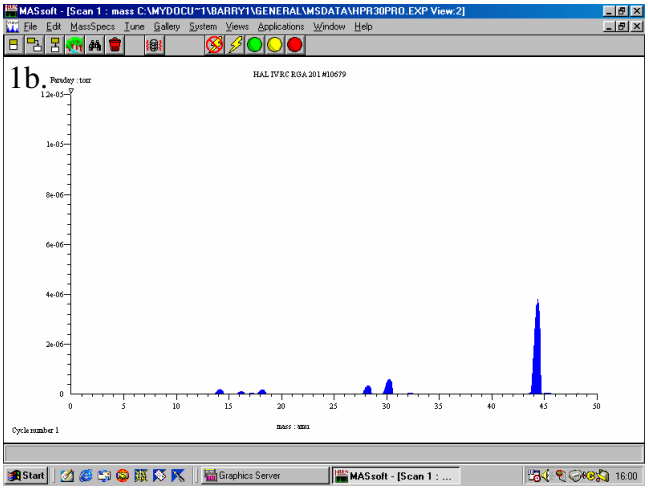
Chamber and N_2O Tool gas analysis showed (Figures 1a - Histogram and 1b Profile):

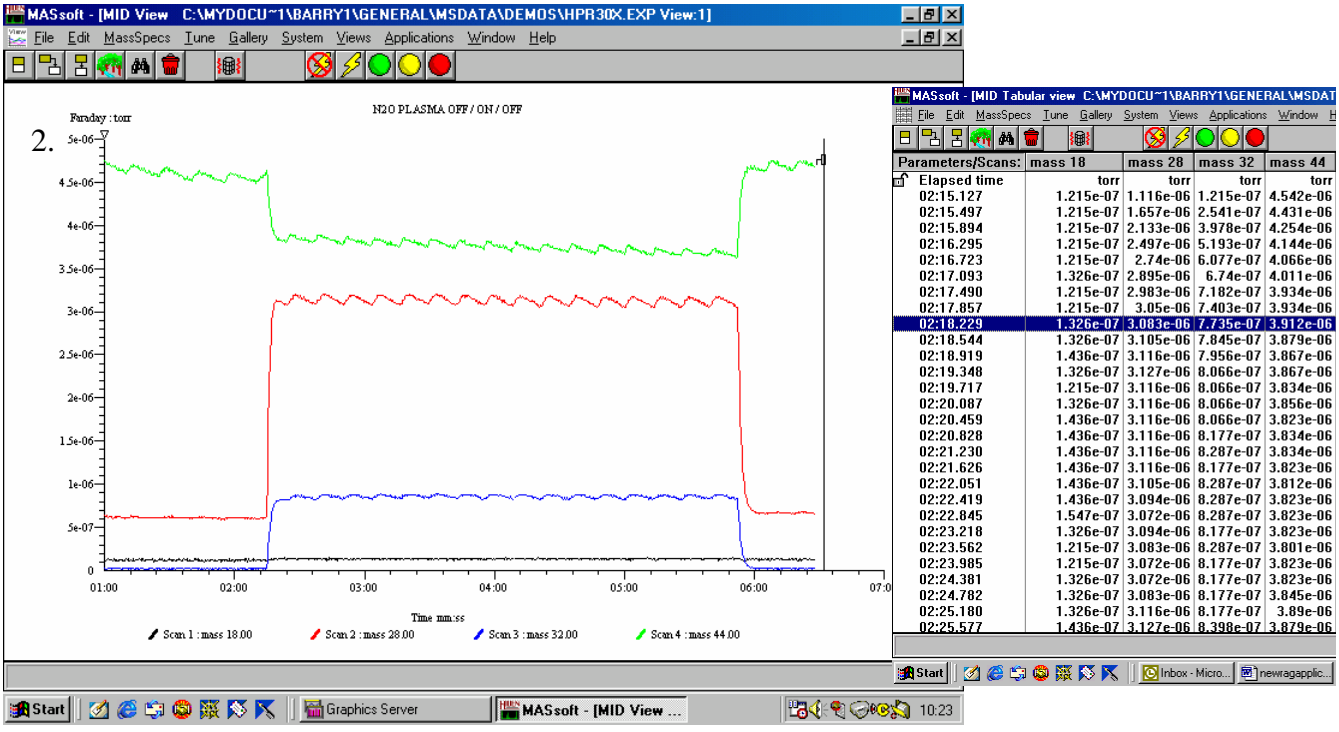
N_2 contamination of the N_2O

Water contamination (m/z 18) from desorption from the chamber walls under vacuum.

The latter was found to have a significant influence on the plasma chemistry and enabled process optimisation to address this issue. In addition trend RGA of the changes of species with time in plasma on / plasma off modes (Figure 2) indicated a problem in the gas delivery system due to a faulty / inappropriate valve which resulted in an uneven delivery of the N_2O (reflected in the saw-tooth aspect of the trends) and also an increase in water levels due to increased desorption from the walls.







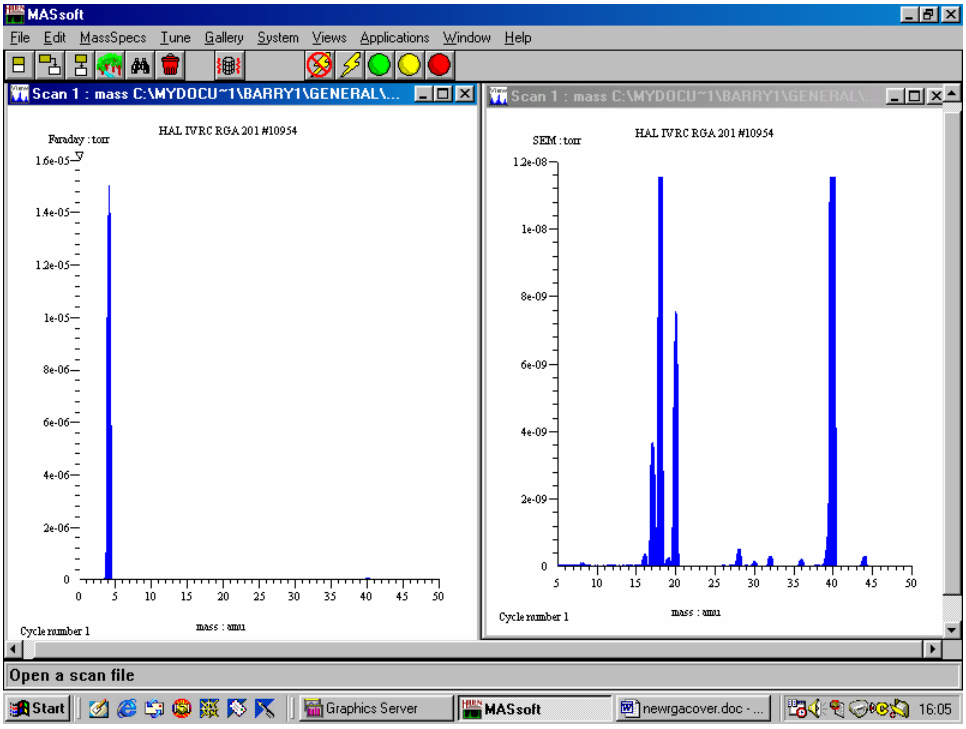
Parameters/Scans:	mass 18	mass 28	mass 32	mass 44
Elapsed time	torr	torr	torr	torr
02:15.127	1.215e-07	1.116e-06	1.215e-07	4.542e-06
02:15.497	1.215e-07	1.657e-06	2.541e-07	4.431e-06
02:15.894	1.215e-07	2.133e-06	3.978e-07	4.254e-06
02:16.295	1.215e-07	2.497e-06	5.193e-07	4.144e-06
02:16.723	1.215e-07	2.74e-06	6.077e-07	4.066e-06
02:17.093	1.326e-07	2.895e-06	6.74e-07	4.011e-06
02:17.490	1.215e-07	2.983e-06	7.182e-07	3.934e-06
02:17.857	1.215e-07	3.05e-06	7.403e-07	3.934e-06
02:18.229	1.326e-07	3.083e-06	7.735e-07	3.912e-06
02:18.544	1.326e-07	3.105e-06	7.845e-07	3.879e-06
02:18.919	1.436e-07	3.116e-06	7.956e-07	3.867e-06
02:19.348	1.326e-07	3.127e-06	8.066e-07	3.867e-06
02:19.717	1.215e-07	3.116e-06	8.066e-07	3.834e-06
02:20.087	1.326e-07	3.116e-06	8.066e-07	3.856e-06
02:20.459	1.436e-07	3.116e-06	8.066e-07	3.823e-06
02:20.828	1.436e-07	3.116e-06	8.177e-07	3.834e-06
02:21.230	1.436e-07	3.116e-06	8.287e-07	3.834e-06
02:21.626	1.436e-07	3.116e-06	8.177e-07	3.823e-06
02:22.051	1.436e-07	3.105e-06	8.287e-07	3.812e-06
02:22.419	1.436e-07	3.094e-06	8.287e-07	3.823e-06
02:22.845	1.547e-07	3.072e-06	8.287e-07	3.823e-06
02:23.218	1.326e-07	3.094e-06	8.177e-07	3.823e-06
02:23.562	1.215e-07	3.083e-06	8.287e-07	3.801e-06
02:23.985	1.215e-07	3.072e-06	8.177e-07	3.823e-06
02:24.381	1.326e-07	3.072e-06	8.177e-07	3.823e-06
02:24.782	1.326e-07	3.083e-06	8.177e-07	3.845e-06
02:25.180	1.326e-07	3.116e-06	8.177e-07	3.89e-06
02:25.577	1.436e-07	3.127e-06	8.398e-07	3.879e-06

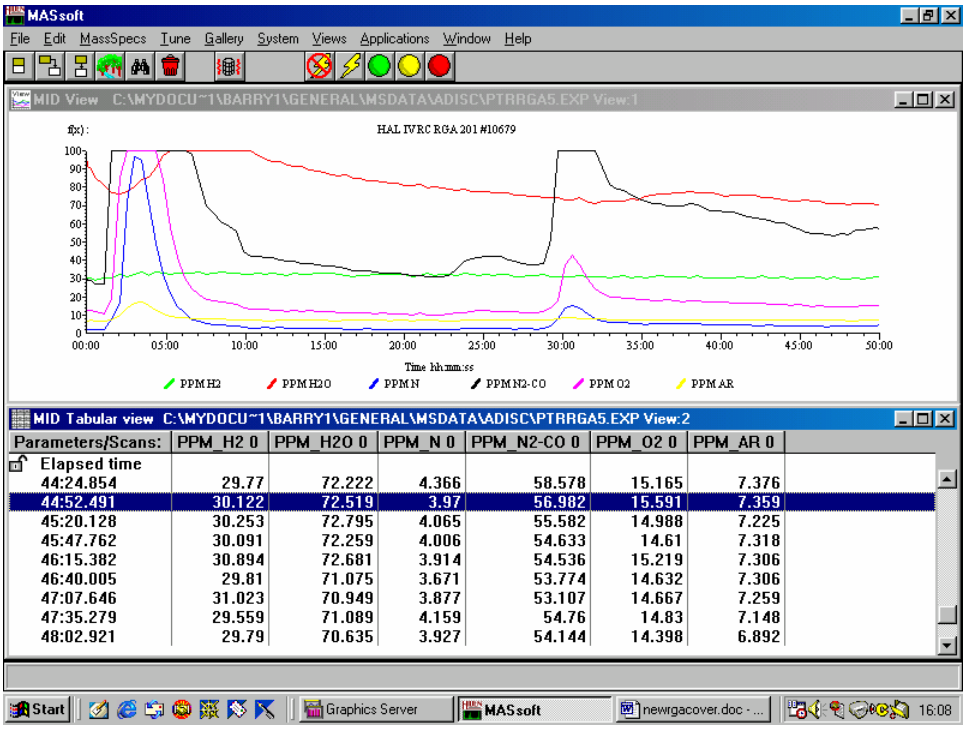
Example 2. Gas Purity Studies

The performance of liquid He-cooled super magnets were found to deteriorate with time – why?

RGA of the He showed ppm contaminants which increased with time.

As these effects are seen at ppm levels the highest levels of performance of the RGA were necessary to address this. Hiden RGA systems meet these exacting standards and provide quantitative determination of these species to aid the user develop and confirm methodologies for their removal.





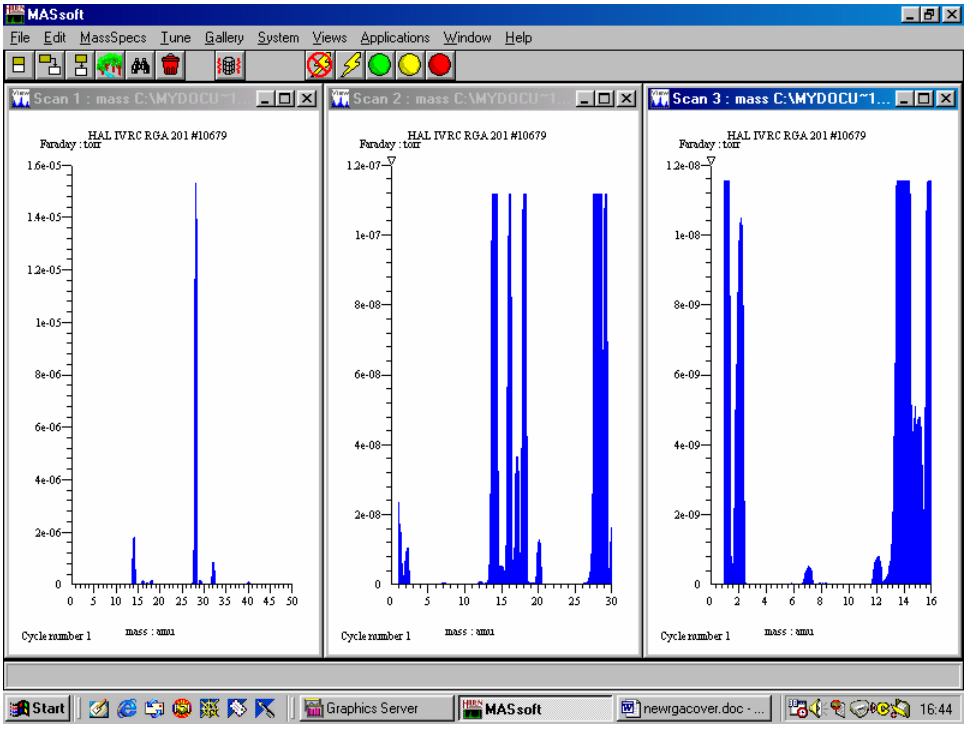
Parameters/Scans:	PPM_H2 0	PPM_H2O 0	PPM_N 0	PPM_N2-CO 0	PPM_O2 0	PPM_AR 0
Elapsed time						
44:24.854	29.77	72.222	4.366	58.578	15.165	7.376
44:52.491	30.122	72.519	3.97	56.982	15.591	7.359
45:20.128	30.253	72.795	4.065	55.582	14.988	7.225
45:47.762	30.091	72.259	4.006	54.633	14.61	7.318
46:15.382	30.894	72.681	3.914	54.536	15.219	7.306
46:40.005	29.81	71.075	3.671	53.774	14.632	7.306
47:07.646	31.023	70.949	3.877	53.107	14.667	7.259
47:35.279	29.559	71.089	4.159	54.76	14.83	7.148
48:02.921	29.79	70.635	3.927	54.144	14.398	6.892

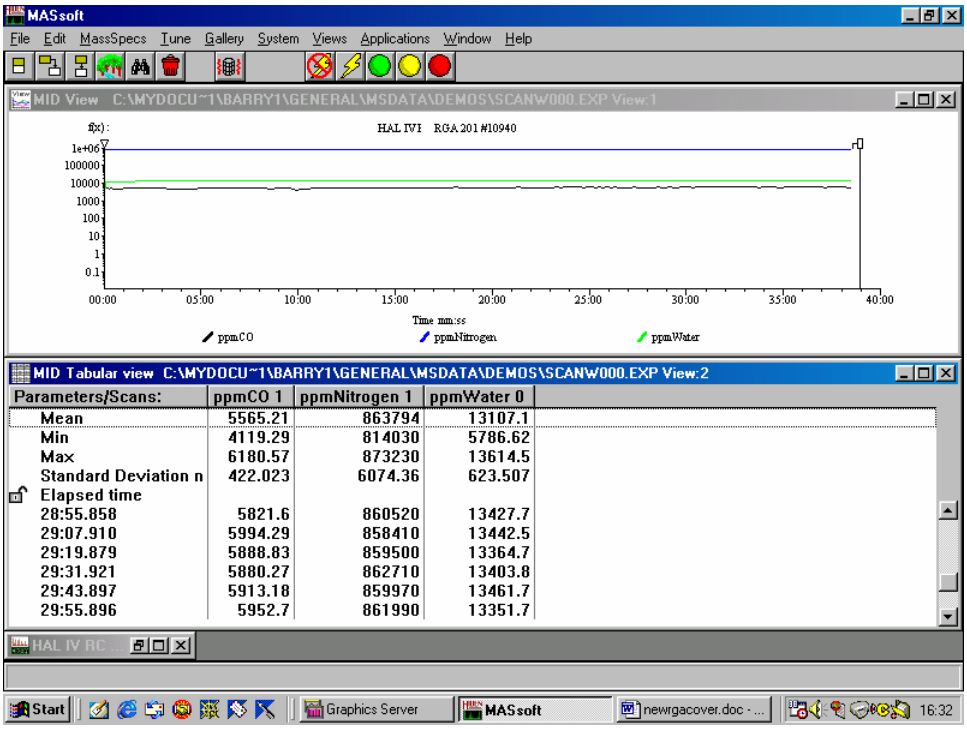
Example 3. In-Situ Monitoring / Diagnostics

High purity Silicon and Indium drawing processes were affected by contamination – why?

RGA of the process showed trace levels of CO from oxidation of the graphite furnace elements.

The CO was adsorbed into the wafer and led to formation of carbidic species and carbon inclusions. Hiden RGA provided the users with the ability to quantify the CO, despite spectral interference from N_2 at m/z 28, to provide an effective process diagnostic tool.





Parameters/Scans:	ppmCO 1	ppmNitrogen 1	ppmWater 0
Mean	5565.21	863794	13107.1
Min	4119.29	814030	5786.62
Max	6180.57	873230	13614.5
Standard Deviation n	422.023	6074.36	623.507
Elapsed time			
28:55.858	5821.6	860520	13427.7
29:07.910	5994.29	858410	13442.5
29:19.879	5888.83	859500	13364.7
29:31.921	5880.27	862710	13403.8
29:43.897	5913.18	859970	13461.7
29:55.896	5952.7	861990	13351.7