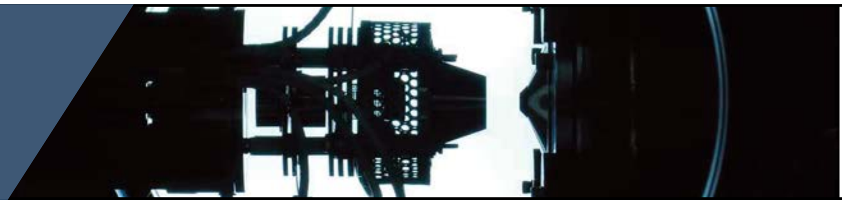
Discover the Advantage of High Resolution Quadrupole Mass Spectrometry



Extrel's MAX 50™ flange mounted quadrupole mass spectrometer and VeraSpec™HRQ turnkey system combines a 19mm tri-filter quadrupole and 2.9MHz Quadrupole Power Supply (QPS) to provide users with the tools to deliver fast, sensitive, and stable analysis. Achieving this level of performance using quadrupole mass spectrometry is an effective addition to high resolution analysis.

Product Advantages:

- High Resolution >4000 (M/ΔM – FWHM)
    - High Resolution Can Be Achieved While Scanning Entire Mass Range
- Variable Resolution
    - User Selectable Resolution Across Entire (50 amu) Mass Range
- High Abundance Sensitivity
- Fast, High Resolution Scans
    - Up to 5000 Data Points per amu in Scans
- Excellent High Resolution Mass Stability
- Low Detection Limits
    - Approximately 10 ppm Under High Resolution Conditions

Figure 1. VeraSpec HRQ High Resolution Quadrupole Mass Spectrometer.

Figure 2. MAX 50 Flange Mounted Quadrupole Probe and Control System.

High Resolution

The resolution capabilities are >4000 (M/ΔM – FWHM), measured with Argon at m/z 40. This allows for separation of species such as helium and deuterium, 4.002 and 4.028 amu, respectively. An example spectrum is shown in Figure 3. This spectrum was collected using a scan speed of approximately 1 second per scan.

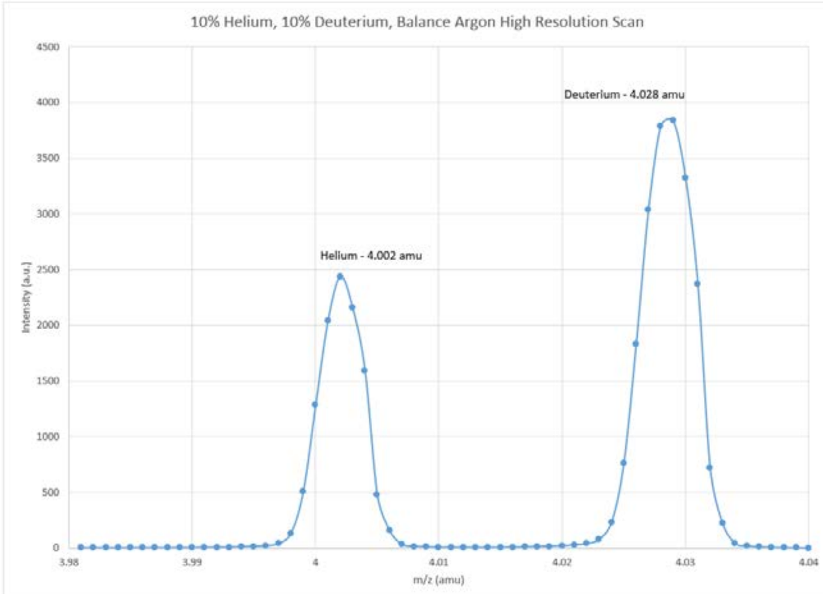


Figure 3. 3.98 – 4.04 amu Scan of 10% Helium, 10% Deuterium, Balance Argon.

Variable Resolution – User Selected Over Entire Mass Range

Typical use of a quadrupole mass spectrometer requires a nominal resolution setting at 1 amu across the mass range, or unit-mass resolution. Extrel system hardware is calibrated and set in the factory to produce spectra with unit-mass resolution for all masses in range with zero (or near zero) software adjustments. Software adjustments, or calibration points, can be added anywhere in the table within the mass range. This allows the user to easily modify the settings to fit the needs of their experiment.

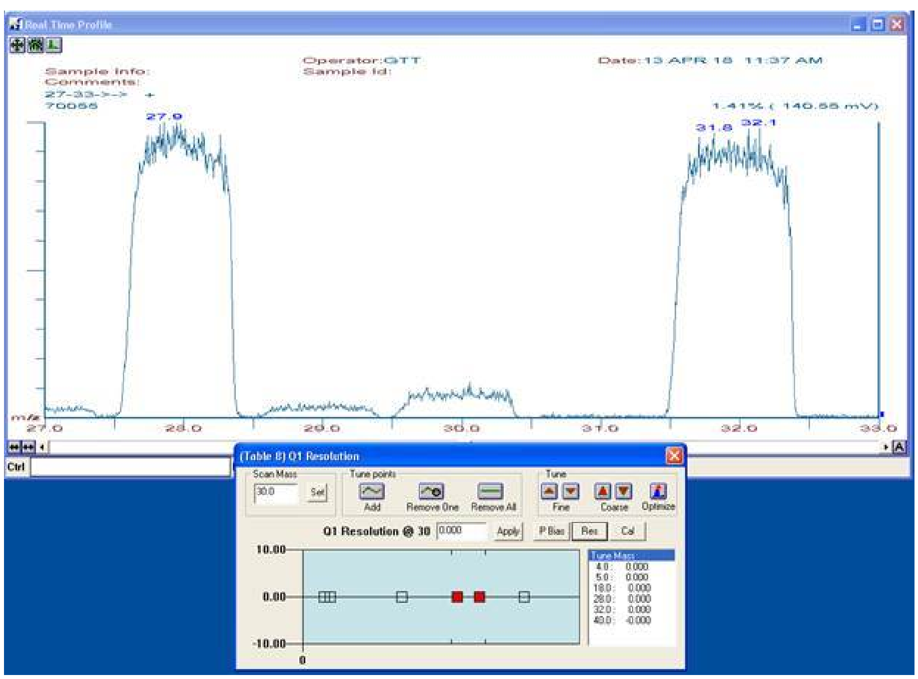


Figure 4. Resolution Calibration Table.

Resolution points at m/z 4, 5, 18, 28, 32, and 40 were added to the table and set to 0.0. When the resolution at m/z 28 is changed, the resolution of the peaks between m/z 28 and the adjacent calibration point is affected. The relative adjustment is illustrated in the resolution calibration table and the changed resolution of m/z 28 and m/z 29 can be seen in Figure 5.

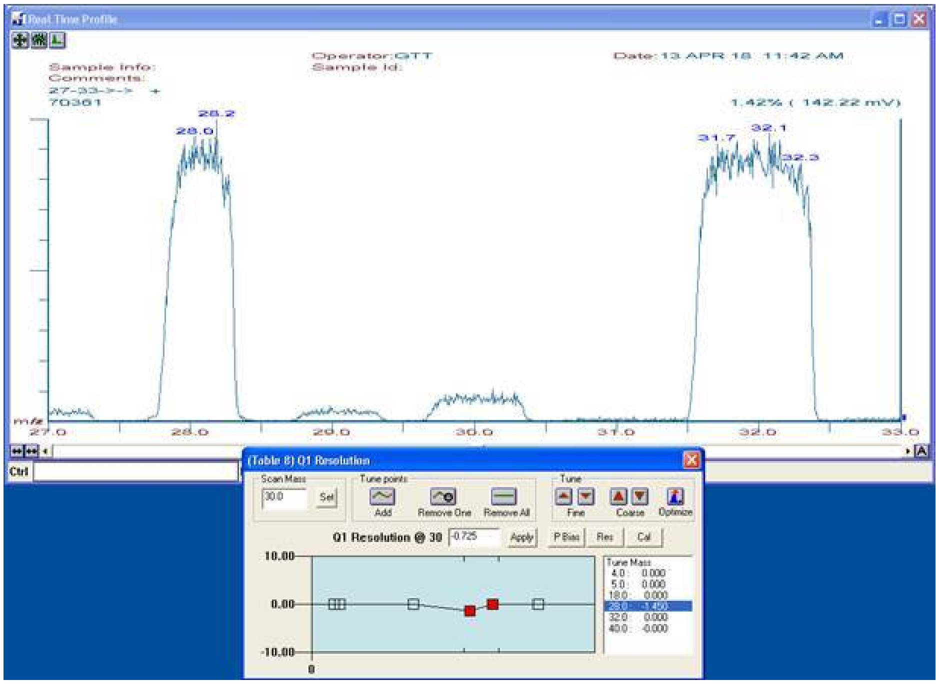


Figure 5. Resolution Calibration – Adjusted Table.

Entire scans with unit-mass resolution, or entire scans under high resolution conditions, can be ran if no specified points are added to the table. Adding many points to the table creates multiple regions, each with different resolution settings across the scan.

An example of a full, 1 – 50 amu, scan with varied resolution is shown in Figure 6. The spectrum was recorded using a 2 second scan, high resolution settings from m/z 3.9 – 4.1 amu, and nominal resolution elsewhere.

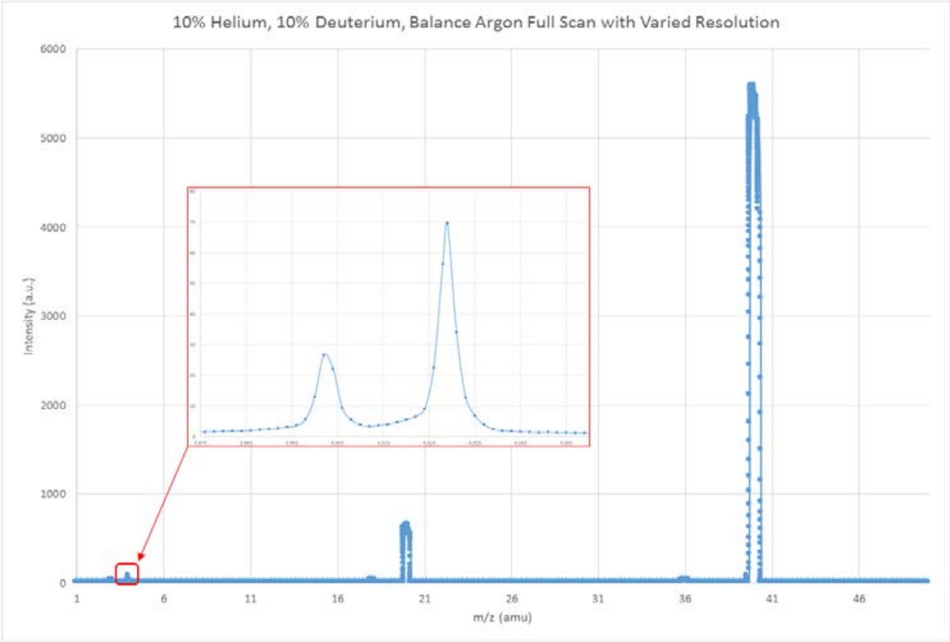


Figure 6. A Mass Spectrum of 1 – 50 amu Showing a Variable Resolution. Sample consists of 10% Helium, 10% Deuterium, and Balanced Argon.

High Abundance Sensitivity

Abundance sensitivity is an accurate value indicating the effectiveness of how the mass spectrometer can measure adjacent peaks. This is crucial for applications involving neighboring spectral signals with drastically different concentrations. Figures 7 and 8 show the excellent abundance sensitivity.

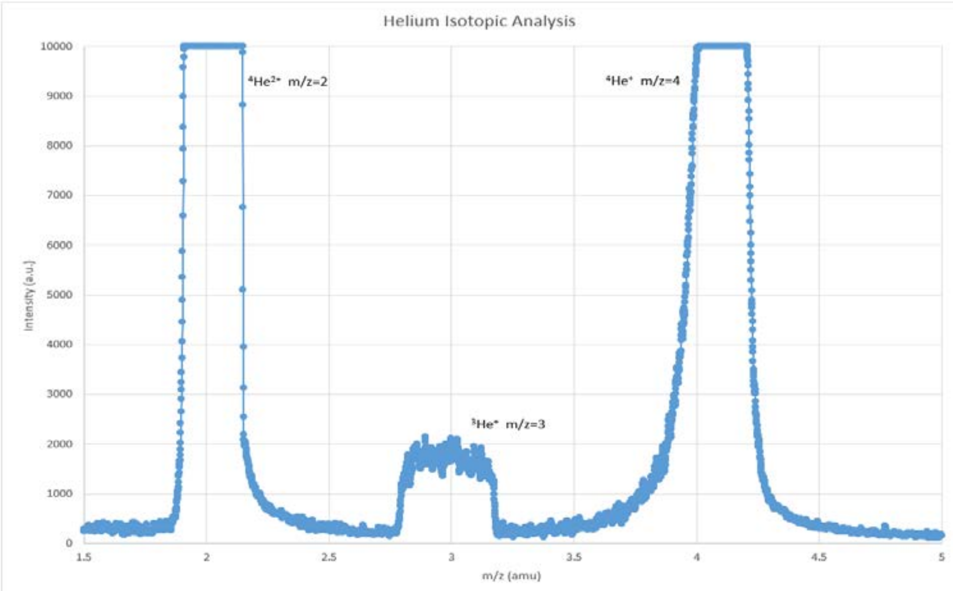


Figure 7. UHP Helium Scan for Analysis of ^{3}He Isotope (1.4ppm Relative Abundance). The Resolution Was Set Appropriately for the Isotopic Analysis (Less than the Maximum Resolution for the Scan).

This abundance sensitivity is observed using high resolution scan conditions. In an analysis of helium and deuterium at varying relative concentrations, a high abundance sensitivity eliminates any spectral interference between the two species. The special overlay in Figure 8 depicts four such scans. The scans were collected using the following:

- UHP helium when introduced to the system (prior to saturating the detector)
- UHP helium (saturating the detector)
- UHP helium mixed approximately 50/50 with a helium/deuterium cylinder (10% helium, 10% deuterium, balance argon)
- 10% helium, 10% deuterium, balance argon cylinder alone

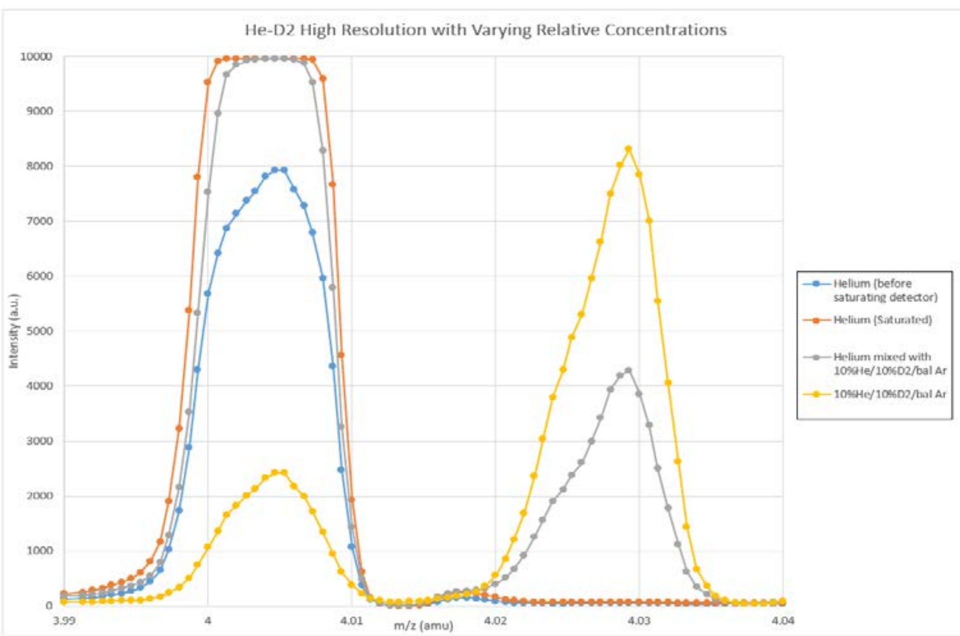


Figure 8. High Resolution Scans of Varying Relative Concentrations of Helium and Deuterium Collected Using a One Second Scan Time, with 1500 Points/amu.

Fast High Resolution Scans

Excellent spectra are delivered without excessive averaging and scan times. For experiments that require many data points in each scan, it is able to collect up to 5000 data points/amu.

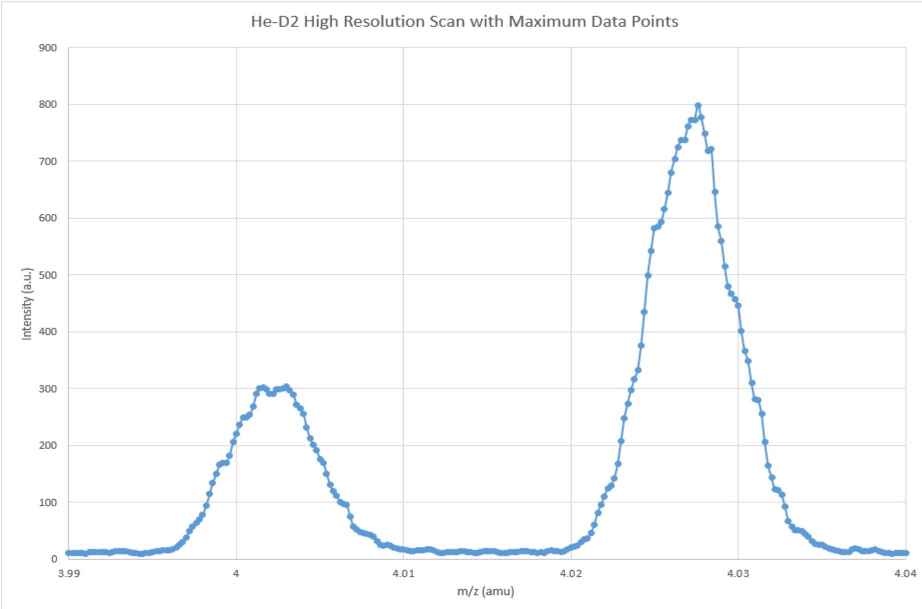


Figure 9. High Resolution Scan of Helium and Deuterium with Maximum Data Points (points/amu) Collected Using One Second Scan with the Maximum Amount of Points/amu. The Scan Range of m/z 3.99 – 4.04 Resulted in 250 Data Points.

High Resolution Mass Stability

Long-term stability of a system is critical for longer analyses or experiments, and to avoid excessive time checking and recalibrating mass position. Under high resolution conditions, stability becomes increasingly more visible and important. To monitor the stability, a cylinder of 10% helium, 10% deuterium, balance argon was connected and analyzed for 24 hours. Spectra at six hour time intervals, beginning at t=0, were used to assess the instrument's stability. Spectra were collected using a 1 second scan with 5000 points/amu. Figure 10 depicts a spectral overlay of the results found. The experiment demonstrated virtually no detectable mass spectral changes over a 24 hour period.

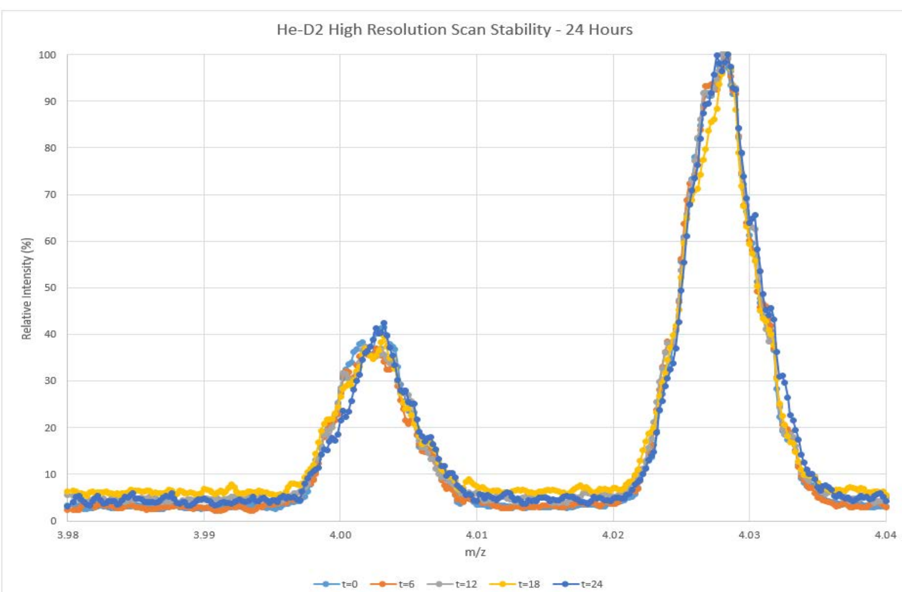


Figure 10. Spectral Overlay of High Resolution Scans During 24 Hour Stability Experiment.

Low Detection Limits

Detection limits of a system are influenced by the resolution setting. Low detection limits at high resolution were experimentally determined using a sample dilution. A cylinder of 10% helium, 10% deuterium, balance argon was diluted with UHP argon using two mass flow controllers. Approximately 50 cc/min of dilution gas was used while the flow of sample was set to 8, 6, 4, 2, and 0 cc/min. This data was used to create a dilution curve and calculate the low detection limits for both species. Tabulated detection limit results for helium and deuterium are shown in Figures 11 and 12, and the dilution curve in Figure 13.

m/z 4.002 10% He / 50sccm Ar					
Concentration	0.00%	0.42%	0.87%	1.36%	1.90%
Average	7.52	1509	3018	4551	6141
Standard Dev	1.65	18	27	30	40
RSD	22%	1.2%	0.9%	0.7%	0.7%
Sig / PPM		**333250**			
LDL(PPM)		**14.9**			

Figure 11. Low Detection Limit Calculation for Helium.

m/z 4.028 10% D2 / 50sccm Ar					
Concentration	0.00%	0.42%	0.87%	1.36%	1.90%
Average	9.02	2626	5163	7397	9079
Standard Dev	1.91	25	50	44	105
RSD	21%	1%	1.0%	0.6%	1.2%
Sig / PPM		**560116**			
LDL(PPM)		**10.2**			

Figure 12. Low Detection Limit Calculation for Deuterium.

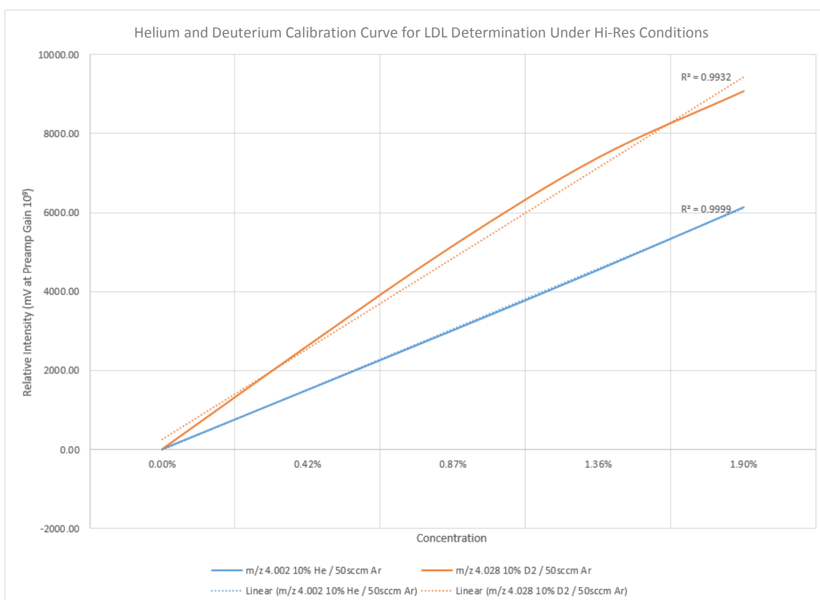


Figure 13. Dilution Curve from Helium-Deuterium Detection Limit Experiment.

Extrel
Core Mass Spectrometers
www.extrel.com
412-963-7530