Trace Level Analysis of V, As and Se Using He Cell Gas via Kinetic Energy Discrimination and Collisional Dissociation in Acidic Matrices.

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Introduction

Recent enhancements in collision cell technology have further advanced the ability of ICP-MS systems to determine elements at trace levels that previously required reaction gases or the implementation of interference equations. The analysis of trace levels of elements such as V , As and Se using a single, simple, acquisition with non-reactive He as a cell gas and the utilization of kinetic energy discrimination (KED) allow for determination of ppt levels for these analytes.

Experimental

Agilent's 7700x ICP-MS was employed for this analysis. The 7700x incorporates Agilent's 3rd generation ORS, called the Octopole Reaction System (ORS^3). The ORS^3 was designed to use He mode with Kinetic Energy Discrimination (KED) as standard, although reaction gases such as H_2 can be also used. Conventional ICP-MS without ORS was emulated with the collision cell operated in "no gas" mode (no cell gas introduced) to provide a comparison of each cell mode and demonstrate the ultimate and excellent removal of polyatomic interferences in the He mode.

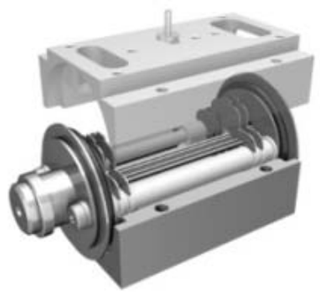
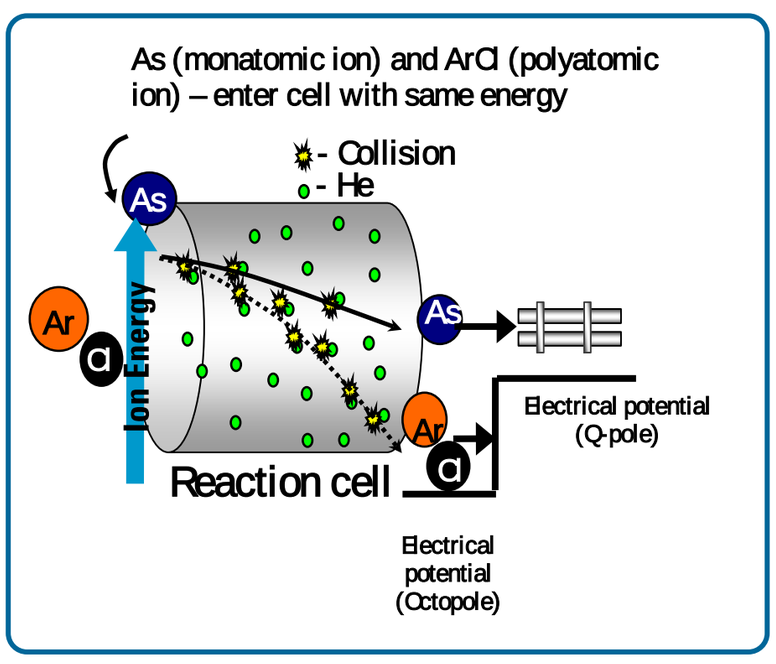


Figure 1 Schematic diagram of reaction cell



Plasma conditions were auto-tuned prior to analysis by selecting "Robust Plasma" in the ICP-MS MassHunter software. Robust plasma conditions provide a hot plasma (~1% CeO/ Ce) . Ion lens voltages were also auto-tuned for maximum sensitivity. The plasma and ion lens parameters are shown in Table 1.

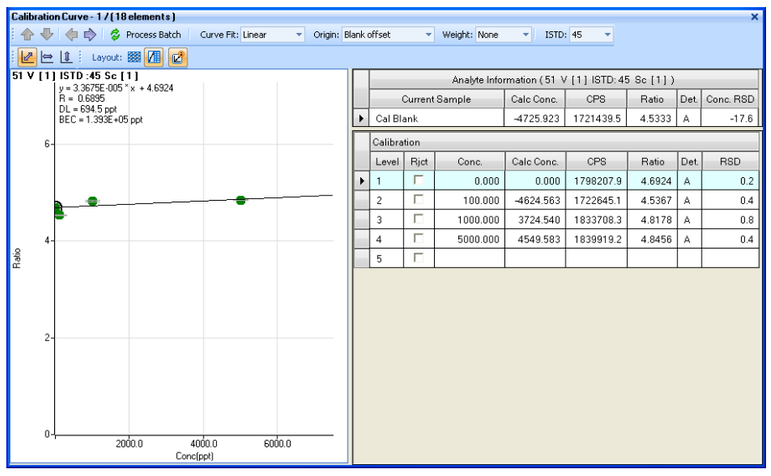
Table 1. 7700x Instrument Operating Conditions

ICP-MS parameter	Value
RF power (W)	1550
Carrier gas (L min^{-1})	0.85
Makeup gas (L min^{-1})	0.15
Extract 1 (V)	0
Extract 2 (V)	-200
Omega Lens (V)	-85
Omega Bias (V)	14.0
He flow (He mode)	10.0 ml min^{-1}
KED (He mode)	5 volts

Results and Discussions

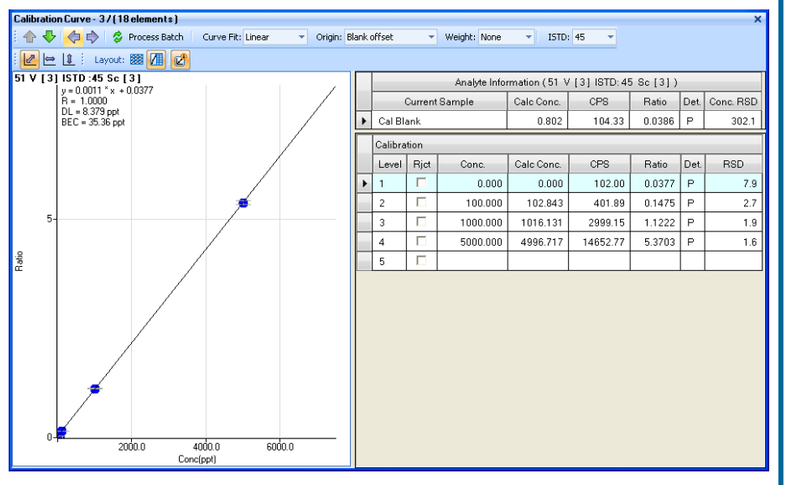
The calibration standards were prepared in a 5% HNO_3 and 5% HCl matrix. The data was acquired in No Gas mode (no gasses were introduced into the ORS) to show the high background interference from the acid matrix and then in He mode, to demonstrate the removal of those interferences created from the acid matrix. Below are the calibration curves produced from each of the analyses, along with the corresponding detection limit and BEC data for each tune mode.

- V Calibration [No Gas] (5% HNO_3 & 5% HCl) Calibration for ^{51}V at 0, 0.1, 1.0, 5.0 ppb



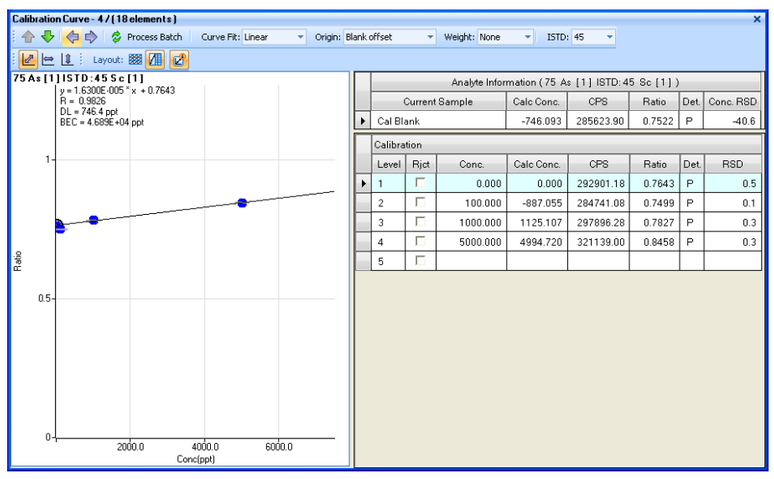
Gas Mode	Mass	Elem.	DL (ppt)	BEC (ppt)
No Gas	51	V	694.52	139344

- V Calibration [He] (5% HNO_3 & 5% HCl) Calibration for ^{51}V at 0, 0.1, 1.0, 5.0 ppb



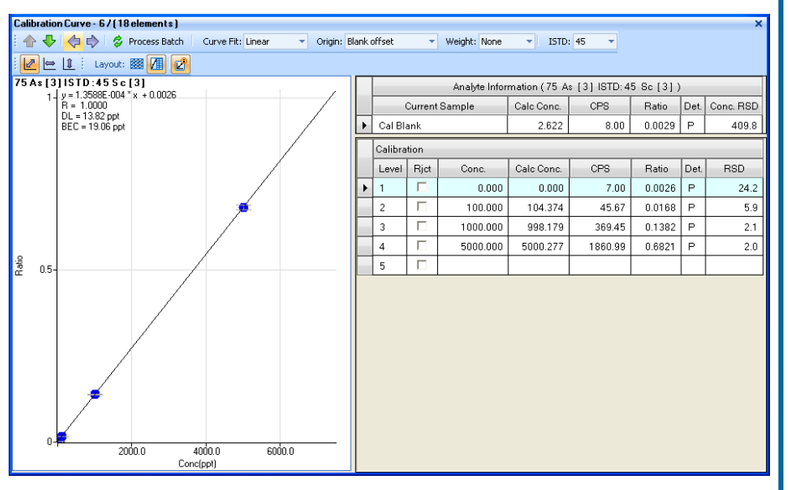
Gas Mode	Mass	Elem.	DL (ppt)	BEC (ppt)
He	51	V	8.3787	35.361

- As Calibration [No Gas] (5% HNO_3 & 5% HCl) Calibration for ^{75}As at 0, 0.1, 1.0, 5.0 ppb



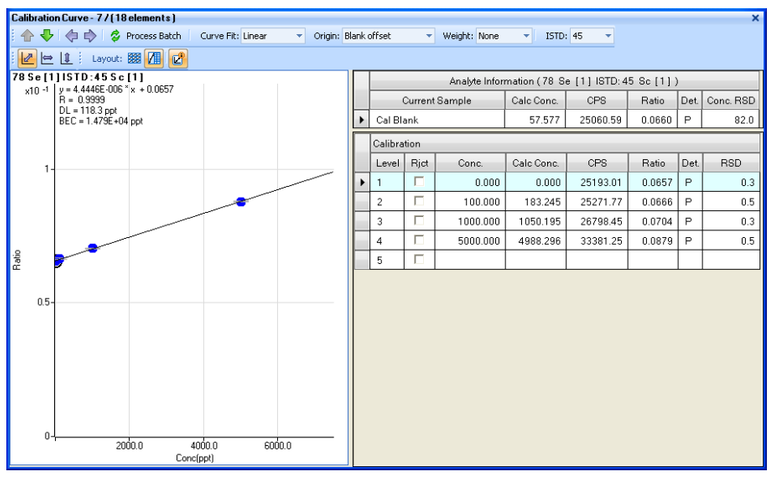
Gas Mode	Mass	Elem.	DL (ppt)	BEC (ppt)
No Gas	75	As	746.37	46893

- As Calibration [He] (5% HNO_3 & 5% HCl) Calibration for ^{75}As at 0, 0.1, 1.0, 5.0 ppb



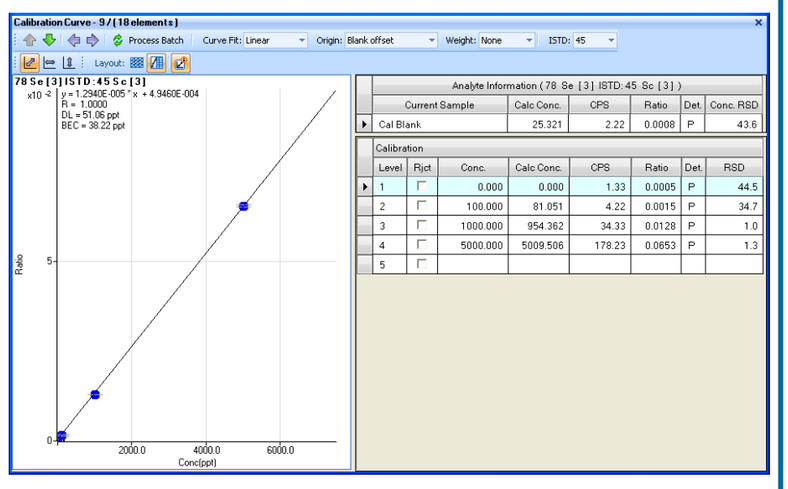
Gas Mode	Mass	Elem.	DL (ppt)	BEC (ppt)
He	75	As	13.824	19.063

- Se Calibration [No Gas] (5% HNO_3 & 5% HCl) Calibration for ^{78}Se at 0, 0.1, 1.0, 5.0 ppb



Gas Mode	Mass	Elem.	DL (ppt)	BEC (ppt)
No Gas	78	Se	118.30	14791

- Se Calibration [He] (5% HNO_3 & 5% HCl) Calibration for ^{78}Se at 0, 0.1, 1.0, 5.0 ppb



Gas Mode	Mass	Elem.	DL (ppt)	BEC (ppt)
He	78	Se	51.063	38.224

The low detection limits and BEC's acquired in the He mode, show the ability of the ORS to effectively remove the polyatomic interferences from the calibration matrix. Where interference equations would have to be used for a No Gas mode acquisition, the He mode provides a much simpler means of removing the polyatomics, resulting in lower DL's. This allows for future applications to be applied which require low determination of these elements that were previously difficult to determine in a high acid matrix.

Conclusions

ORS^3 capabilities:

- The improved interference removal of the ORS^3 means there is no need for reactive gases.
- All analytes can be analyzed in He mode for a faster analysis without the creation of new interferences.
- The excellent performance in the removal of Cl means no need to avoid Cl in the digestion matrix.
- The performance of the ORS^3 is demonstrated in the accuracy at the 100 ppt level for all 3 elements in a Cl matrix.