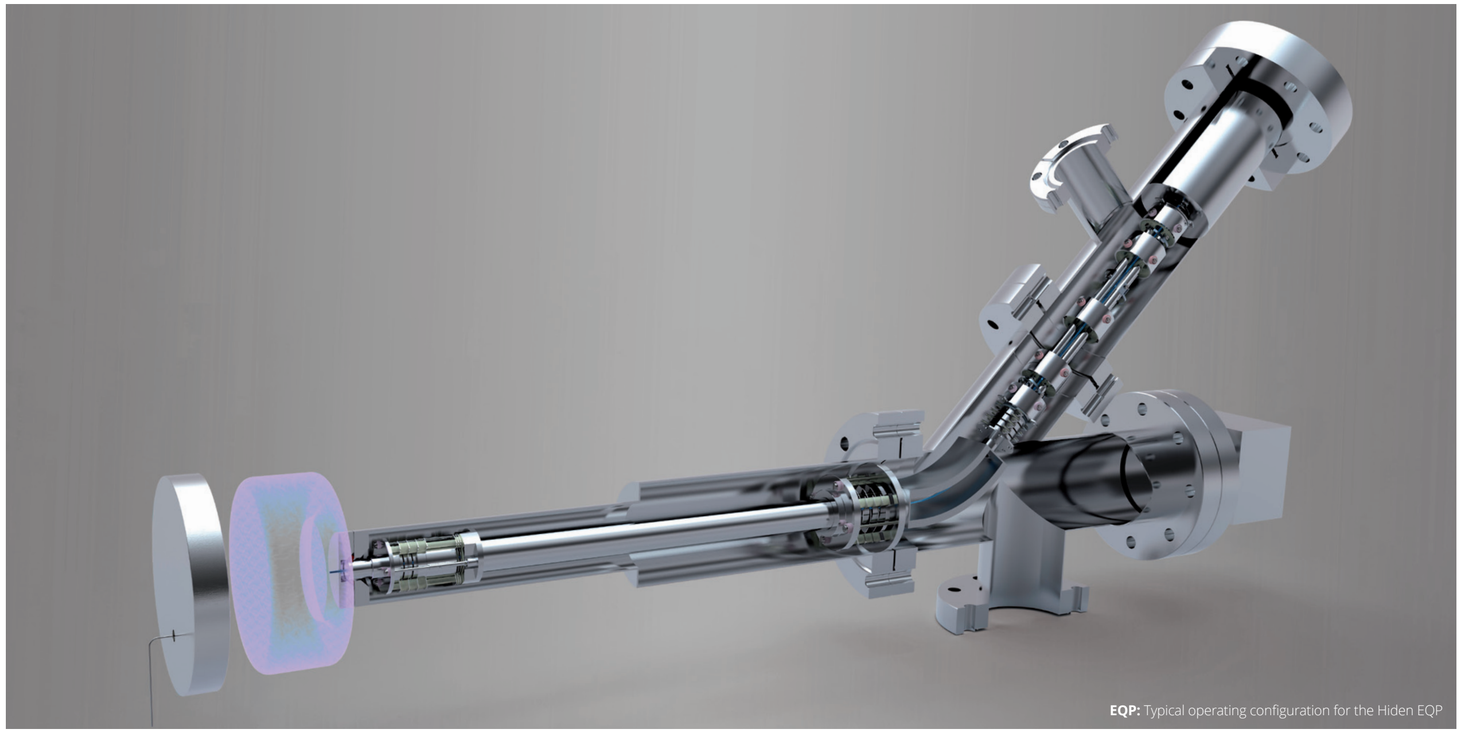
Mass and Energy Spectra of Plasmas 50 ns Time Resolved Measurements



EQP: Typical operating configuration for the Hiden EQP

Introduction

The direct measurement of mass spectra and energy distributions for mass-identified positive and negative ions arriving at target surfaces in plasma reactors has produced useful information. The measurements have been, in the great majority of cases, of the time-averaged distributions even when the applied power to the plasma has been pulsed.

Time-resolved data particularly during initiation and decay of pulsed plasmas would be advantageous. To facilitate such studies we have incorporated a Multi-Channel Scalar (MCS) device into the ion detector system of a Hiden EQP instrument.

MCS may be used as a detector for time resolved analysis in systems such as:

- Beam chopper inlets
- Plasma ignition/modulation/extinction experiments
- Ion flight time measurements

Hiden's internal MCS facility steers the output from the mass resolved ion beam detector sequentially into one of a number of counting channels (bins) to allow high speed time resolved analysis of the monitored ion by counting the number of ions arriving at the detector during the channel time.

It may be used to track high speed changes and obtain time resolved data from external events without the need for external equipment. Because it can operate synchronously with MASsoft's scan generators it may be used to acquire a data surface where time is one of the axes, for example an energy - time surface for ions in a modulated plasma.

Example Data

As examples of the new capabilities of the EQP instrument we show below data obtained for plasmas in a parallel-plate reactor operated using argon as the test gas and with power supplied from either a 25 kHz AC supply or from an RF supply at 13.6 MHz repetitively gated using a square-wave envelope from a signal generator at frequencies of around 500 Hz.

Figure 1 shows a typical variation with time of the energy distribution for Ar^+ ions at 50 mTorr pressure in a 20 kHz plasma. The energy scans were made at intervals of 200 nsec.

For the gated RF plasmas, again using argon as the test gas, the ion energy distributions had considerably more structure. A typical family of IED scans for Ar^+ ions is shown in **Figure 2** for a 25 Watt plasma at 35 mTorr. The data show in particular how the number of ions with high energy arriving at the sampling orifice of the EQP decays rapidly as the plasma becomes established.

Summary

- Multi-Channel Scalar device fitted to the ion detector system to the EQP
- 50 ns time resolution
- Data shows initiation and decay of features in the ion energy spectra that were not possible to obtain with time averaged data

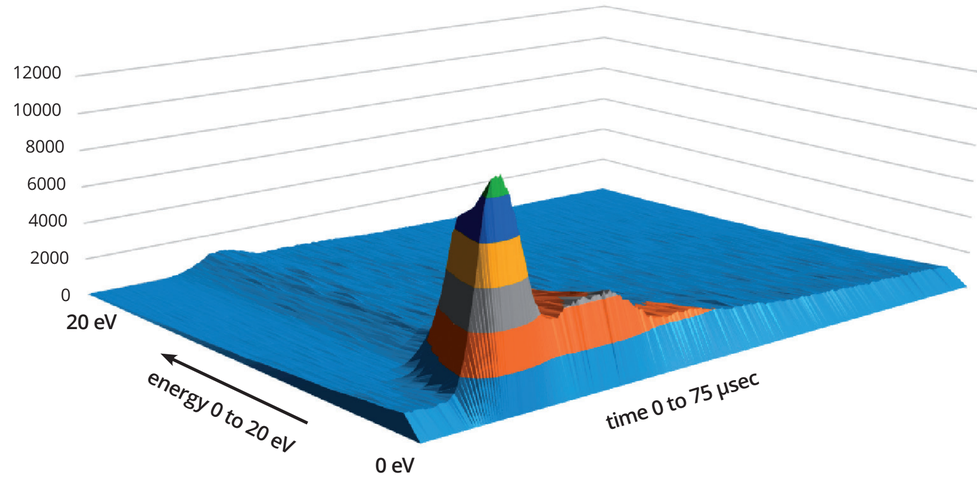


FIGURE 1 : Typical time resolved data of Ar^+ in a 20 kHz 50 mTorr plasma

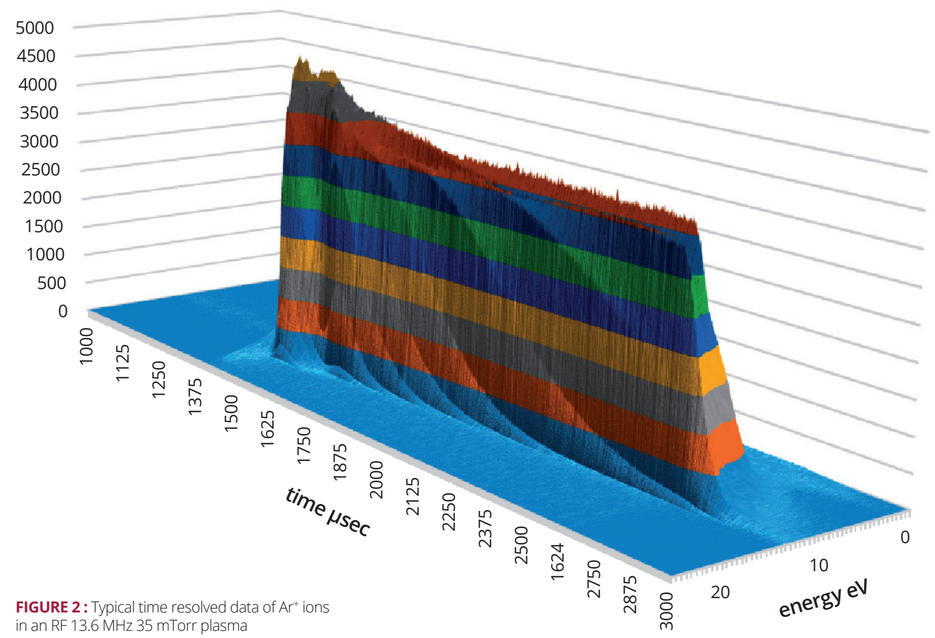


FIGURE 2 : Typical time resolved data of Ar^+ ions in an RF 13.6 MHz 35 mTorr plasma

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