A New Conjoined RF Ion Guide for Enhanced Ion Transmission

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Introduction
The use of RF-only ion guides in mass spectrometers is widespread, they are of particular utility in intermediate pressure regions between atmospheric pressure ionisation sources and the higher vacuum analyser chambers. Progress on the efficiency of ion acceptance and transport in such devices at ever increasing operating pressures has been significant over the past 15 to 20 years with designs utilising more traditional multipole ion guides through to various stacked ring electrode designs which operate well in the tens of millibar regime. Here we present a discussion on the design and performance of a novel conjoined stacked ring ion guide, which provides highly effective off-axis ion transportation through the intermediate pressure region of a tandem quadrupole mass spectrometer.

Methods
The experiments were conducted on a modified Quattro Premier XE tandem quadrupole mass spectrometer, where an additional vacuum chamber was constructed between the atmospheric pressure source and the single source ion guide to accommodate the new ion guide. The new vacuum chamber is directly pumped by a rough pump to a pressure of around 2 mb. All data were acquired using electrospray ionisation, both infusion and LC introduction of various samples, and comparative measurements made between the new ion guide and the original single ion guide design.

Preliminary Results
The new conjoined ion guide consists of two stacked ring electrode arrangements which have parallel ion optical axes but which are radially offset by about 1 cm. Along the radial dimension between the ion guides the ring electrodes are slotted providing a path for ion movement. The first, larger diameter (1.5 cm), section of the guide is aligned with the ion ingress from the source region, a DC potential difference between this region and the second, smaller diameter (0.5 cm), ion guide extracts and focuses the ions from the main gas stream into the second guide. The ion optical axis of the second ion guide is aligned with the ion optical axes of the subsequent ion guide and quadrupoles. A significant benefit of this off-axis design is that gas and other entrained neutrals streaming in from the source are essentially prevented from entering, and contaminating, subsequent stages of the mass spectrometer. With this geometry, ion transmission increases in excess of 10x have been attained over the standard single ion guide geometry. The ion guide was found to operate most effectively at around 2 mb pressure with applied RF in the 40 to 300 V pk-pk range and at a frequency of around 1 MHz. DC offset values between the guides were typically in the 10 to 30 V range.

In this presentation, the design concept of the conjoined ion guide will be discussed and data will be presented illustrating the performance characteristics as a function of variation in operational parameters.