Quadrupole Miniaturization – Reconsidered

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Eight years ago, at the 2007 HEMS workshop, we presented our work in characterizing quadrupole performance as quadrupoles are miniaturized. We concluded that presentation with the statement: "…extreme miniaturization of quadrupoles is unlikely to yield analyzers with anywhere near the performance of conventionally scaled quadrupoles." Maybe we were a little hasty…

This year we re-visited quadrupole performance for not-so-extreme miniaturization, using quadrupoles with reduced rod length (4 cm), and reduced rod diameter (4 mm), operating at 6.5 MHz, with a mass range of 100 amu, with unexpectedly remarkable results. We developed a miniaturized closed ion source, scaled to optimize coupling with this small quadrupole, with a glass capillary inlet to sample atmospheric air or other samples brought to a simple atmospheric pressure Flow-by-Tee inlet, and adapted an off-the-shelf 2 ¾ inch Faraday/Multiplier detection flange (from Extorr), all mounted to a five-inch-long vacuum chamber, pumped by a Pfeiffer Vacuum Hi-Pace 10 pump. Reducing quadrupole length promises to allow operation at higher than normal operating pressures; this work evaluates performance at pressures as high as one millitorr chamber pressure.

First results from this characterization show better than one ppm limit-of-detection for a single five-second-long, 50 amu profile spectrum (0-50 amu, 10 points-per-amu, oversampled with a 100 KHz data acquisition rate). Helium in room air is clearly visible at m/z 4, very near the limit-of-detection for this analyzer under these conditions. Traditional mass analyzer figures of merit (abundance sensitivity, limit-of-detection, mass resolution…) will be presented for this quadrupole system, along with representative spectra at various pressures, allowing evaluation of the limitations of this small analyzer.