Implications of Miniaturising Linear Ion Trap Arrays for Portable Detectors

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Much work has been published on the benefits of reducing the scale of quadrupole instruments in relation to power consumption, pressure tolerance and other critical parameters for robust fieldable systems. However, there is a cost associated with these benefits, namely a potential loss of performance below the useable threshold. This poster reports preliminary results arising from modelling and simulation studies examining the implications of size versus performance trade-offs for miniaturised Linear Ion Trap (LIT) arrays. The effects of miniaturisation have been modelled using both SIMION and CPO (Charged Particle Optics), at values of the quadrupole internal radius from $r_0 = 1\text{mm}$ down to $200\,\mu\text{m}$.

Assuming that axial ejection would be required in a miniaturised LIT array, the efficiency of ion ejection (and hence detection) becomes an inverse function of rod length. However, reducing the rod length also reduces the space charge capacity which may also affect the detection sensitivity. As r_0 decreases, the pseudopotential well depth across the quadrupole decreases. When this becomes significantly lower than the fragmentation energy, collisionally induced fragmentation will cease to be practical. Therefore, the potential for MS/MS within quadrupoles below a certain size will also be adversely affected. While the decreasing potential well depth may be ameliorated by increasing the frequency, this will increase the power requirements of the instrument as a whole to the extent that the expected power saving anticipated by miniaturisation is not realised.