Differential Mobility Spectrometry / Mass Spectrometry

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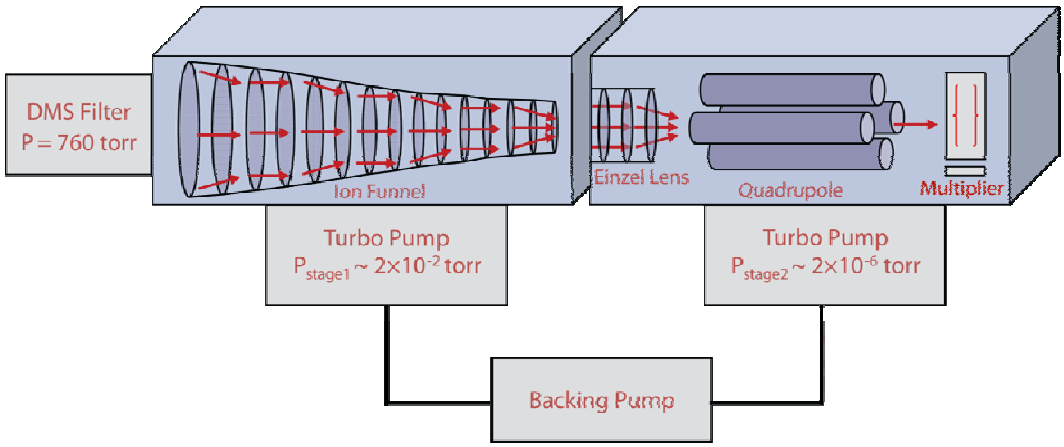
Progress toward the development of a field-portable, prototype differential mobility spectrometry / mass spectrometer (DMS/MS) is described. The current design uses a DMS unit as a chemical filter, separating ions at ambient pressures via the non-linear dependence of an ion's mobility on the RF electric field strength. Here, ions are subjected to an asymmetric alternating RF electric field. The mobility of an ion in high electric fields (E >10,000 V/cm^2) is not independent of the electric field strength; thus, alternating between high and low fields changes the ion mobility. This gives rise to unstable trajectories for some ionic species, causing them to collide with the walls of the analyzer region. A DC compensation voltage is superimposed on the RF field, serving to stabilize the trajectories of ions of interest and allowing them to successfully traverse the DMS portion of the instrument for injection into the inlet of a MS.

The MS portion of the system uses two stages of differential pumping in order to step the pressure down from ambient (760 torr) to a region suitable for mass spectrometry to be performed (~ 10^{-5} – 10^{-6} torr). Ions are transported through stage one (~5×10^{-2} torr) through the use of an electrodynamic ion funnel. An ion funnel is a stack of closely spaced ring electrodes with decreasing internal diameters. A combination of RF and DC potentials are used to focus the ion beam at these intermediate vacuum pressures. Ions exit the ion funnel through a small orifice and enter the high vacuum portion of the instrument. This chamber houses electrostatic focusing lenses, a commercially available quadrupole mass analyzer, and an electron multiplier detector. The focusing lenses will direct the ion beam into the quadrupole for mass selection. The quadrupole and electron multiplier are capable of mass selecting and detecting compounds with less than ppm concentrations and have a linear dynamic range of over six orders of magnitude.



Schematic representation of the DMS/MS system
Ion trajectories are symbolized by the arrows