Rapid Thermal Modulation Ion Spectrometry (RTMIS)

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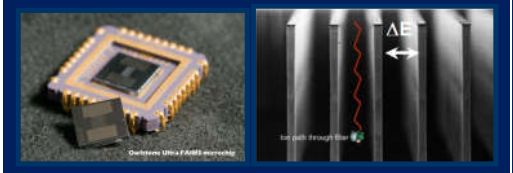
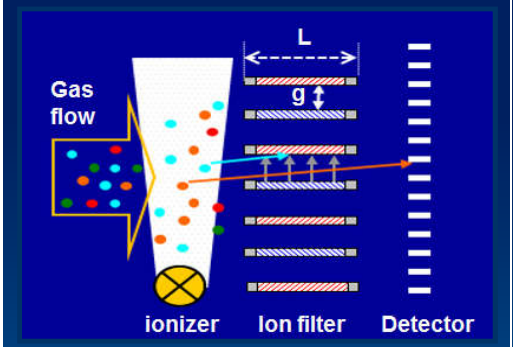
RTMIS is a new technology with roots that lie in Ion Mobility Spectrometry (IMS) and its variants (e.g. *Differential Mobility Spectrometry* and *Field Asymmetric Ion Mobility Spectrometry*). The clear differentiator of RTMIS from IMS (and its variants) is that RTMIS operates over extreme (and rapidly variable) Electric Field ranges (0 to > 80kV.cm^{-1}, 0 to > 350Td at 1atm). In this regime ion temperatures may be modulated from ambient to in excess of 1000ºC on microsecond timescales. This extreme *thermal modulation* enables a controlled and high-speed manipulation (or switching) of the ion chemistry within the separation channel (the ion drift region). For example, molecular ion fragmentation *via* thermal dissociation can be induced, providing structural information for chemical classification (in a similar manner to that seen in a *mass spectrometer*). Chemical separation and identification is essentially derived from the unique kinetic and thermodynamic behavior of ions assessed over a very broad *Effective Temperature Range*.

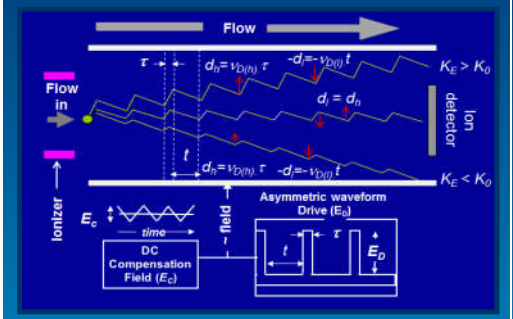
Technology



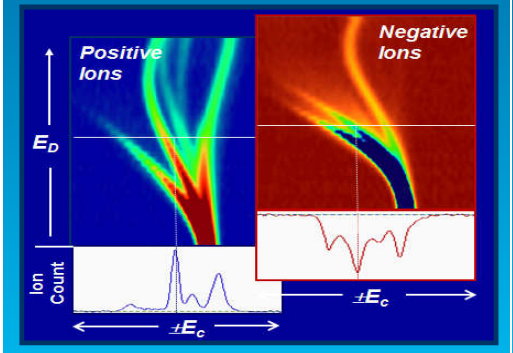
Micro-channel ion filters enable use of *extreme fields* and *micro-second timescale* separations



Ions are derived from the analytical sample by means of a **Non-RAD** Corona Discharge ionizer



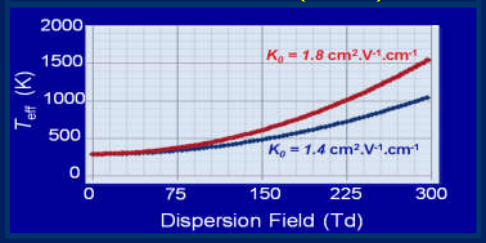
Ions are separated in a high frequency (27MHz) oscillating field applied between the ion separators



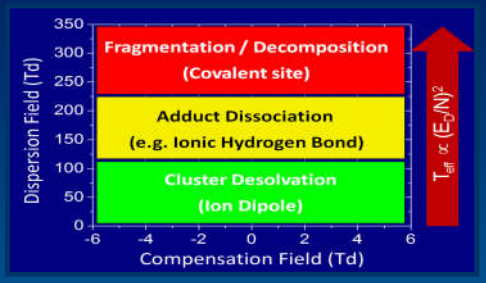
A DC tuning voltage applied in parallel with the oscillating field delivers dense *information rich* spectra on second timescale updates

Characteristics

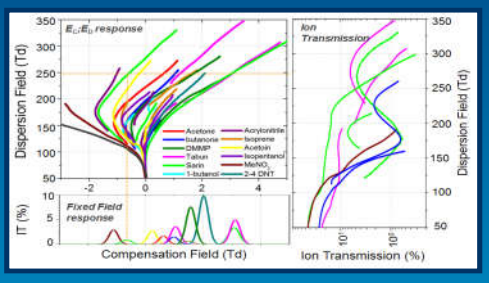
$$T_{eff} = T + \zeta M K_0^2 N_0^2 (E_D/N)^2 / (3k_b)$$



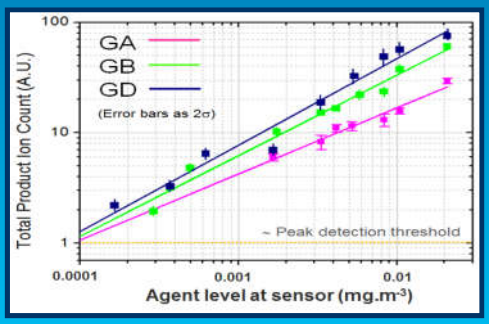
A critical aspect of extreme field operation is the ability to control ion chemistry in the ion filter (ion temperature is ∝ to the *square* of the field)



Ion separations are kinetic driven – it is possible to selectively dissociate or fragment the ion "in-filter"

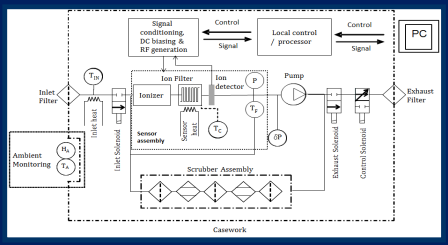


This gives rise to distinct, analyte specific 3-dimension spectra

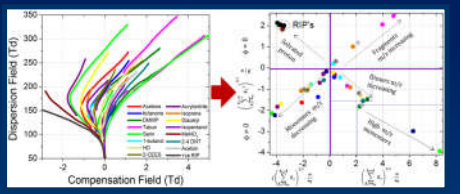


Unprecedented sensitivity in the real-time detection of organo-phosphorus compounds

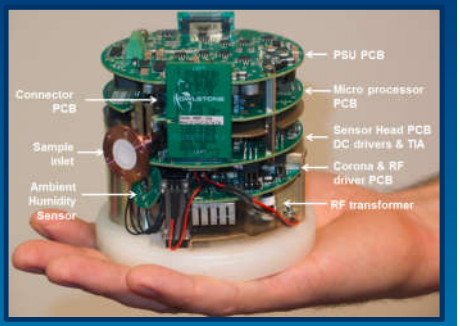
Systems & Platforms



Closed loop systems architecture allows for stable operation over environmental extremes



User interface software enables third-parties to perform data reductions for spectral library development



Fully integrated miniaturized system developed for DTRA – hardware layout

Ruggedized CWA, TIC & VOC sensor unit (OwlSensT)

Key Reference

Ashley Wilks, Matthew Hart, Andrew Koehl, John Somerville, Billy Boyle, David Ruiz-Alonso; Characterization of a miniature, ultra-high-field, ion mobility spectrometer, Int. J. Ion Mobil. Spectrom. 15 (2012) 199-222

Acknowledgments

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