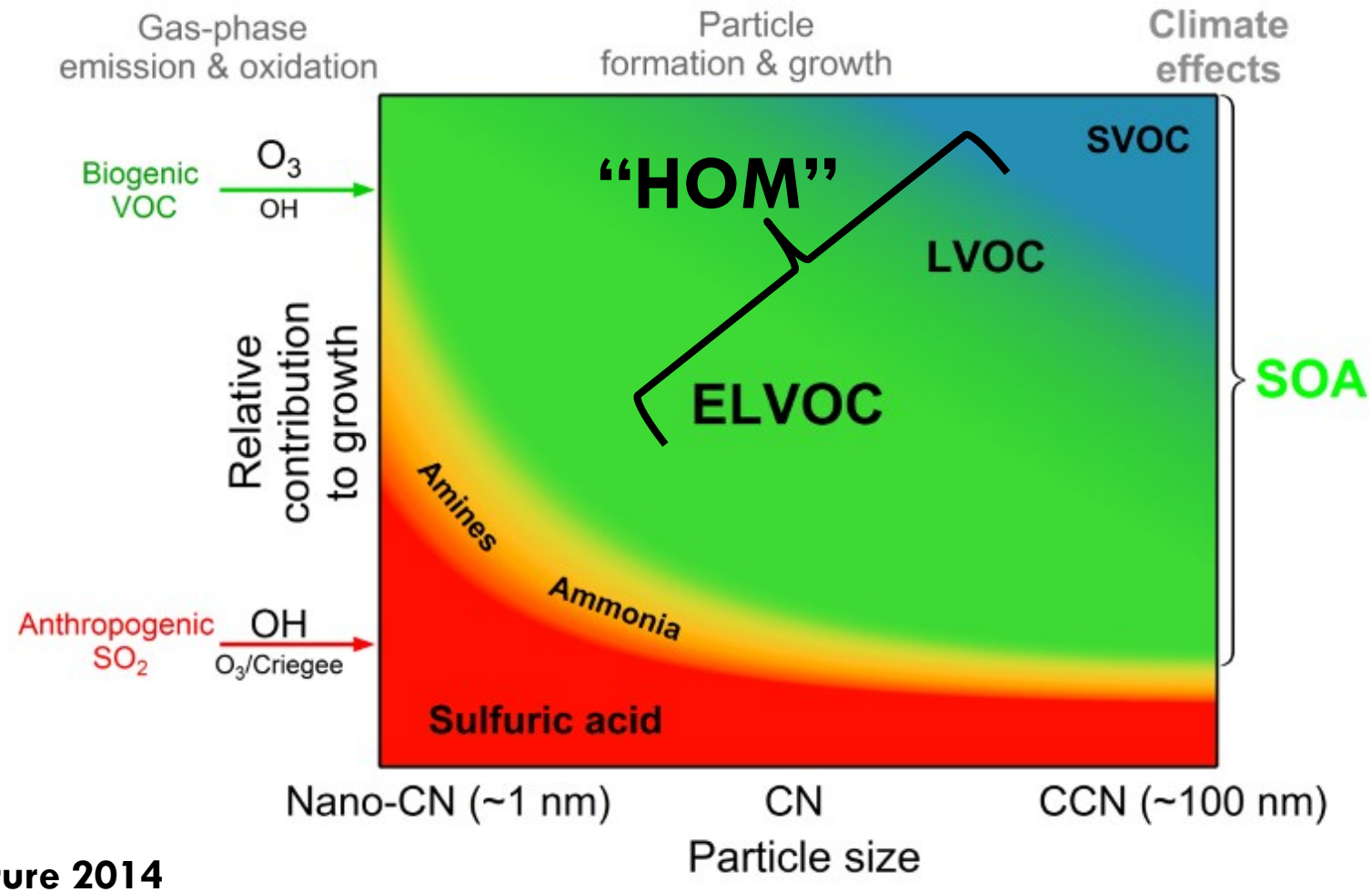
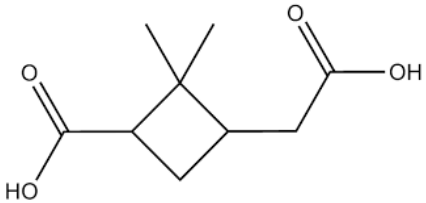
Vapors that grow particles



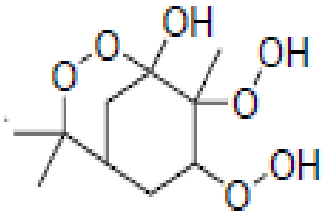
Ehn et al Nature 2014

Calibration needs

- Reproducible, independently quantified, and transportable source of *several* multi-functional organics and a some inorganics
- Use to constrain instrument response as a function of molecular properties
- The challenge is that
  - we don't know what the structures of most ELVOC and LVOC
  - even if knew the structures, unlikely commercial products exist and synthesis likely very dangerous and/or very expensive
  - likely hundreds of individual compounds – can't calibrate to them all



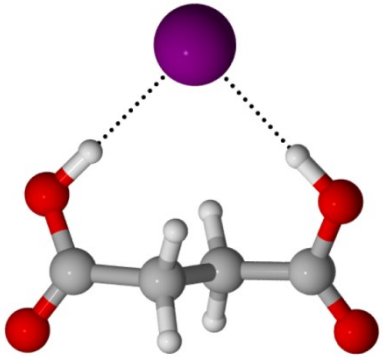
Pinic acid (SVOC), sort of commercially available?

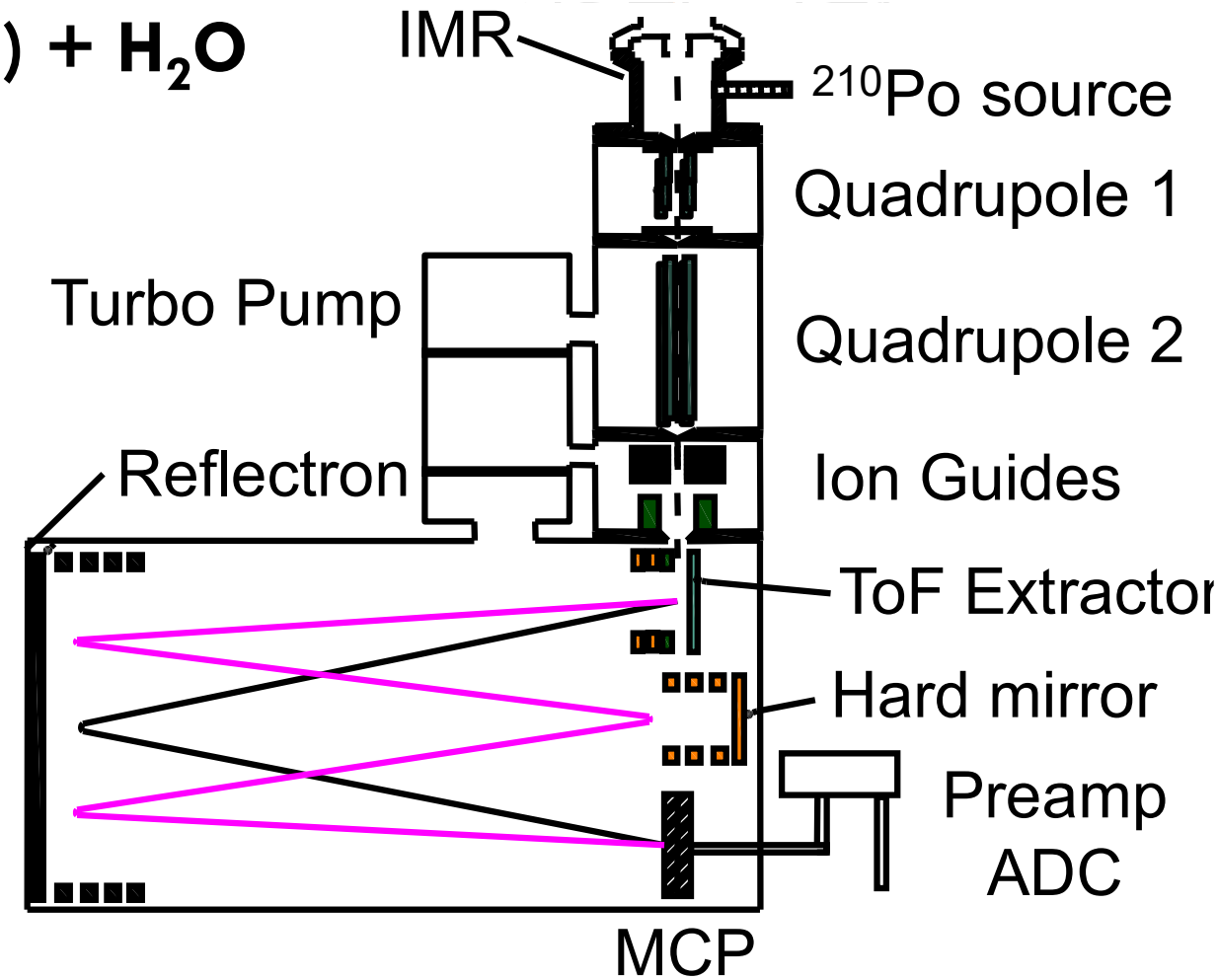


A possible HOM

Iodide Adduct Chemical Ionization

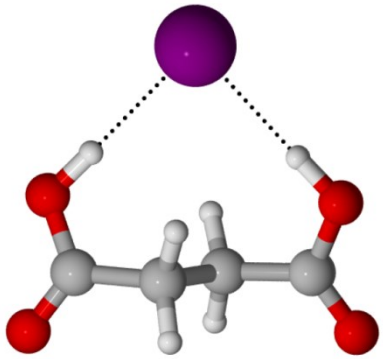
- $I^-(H_2O) + X \rightarrow I^-(X) + H_2O$





Lee and Lopez-Hilfiker et al ES&T 2014; Lopez-Hilfiker et al, AMT 2016; Iyer et al, JPCA 2016

Ion chemistry



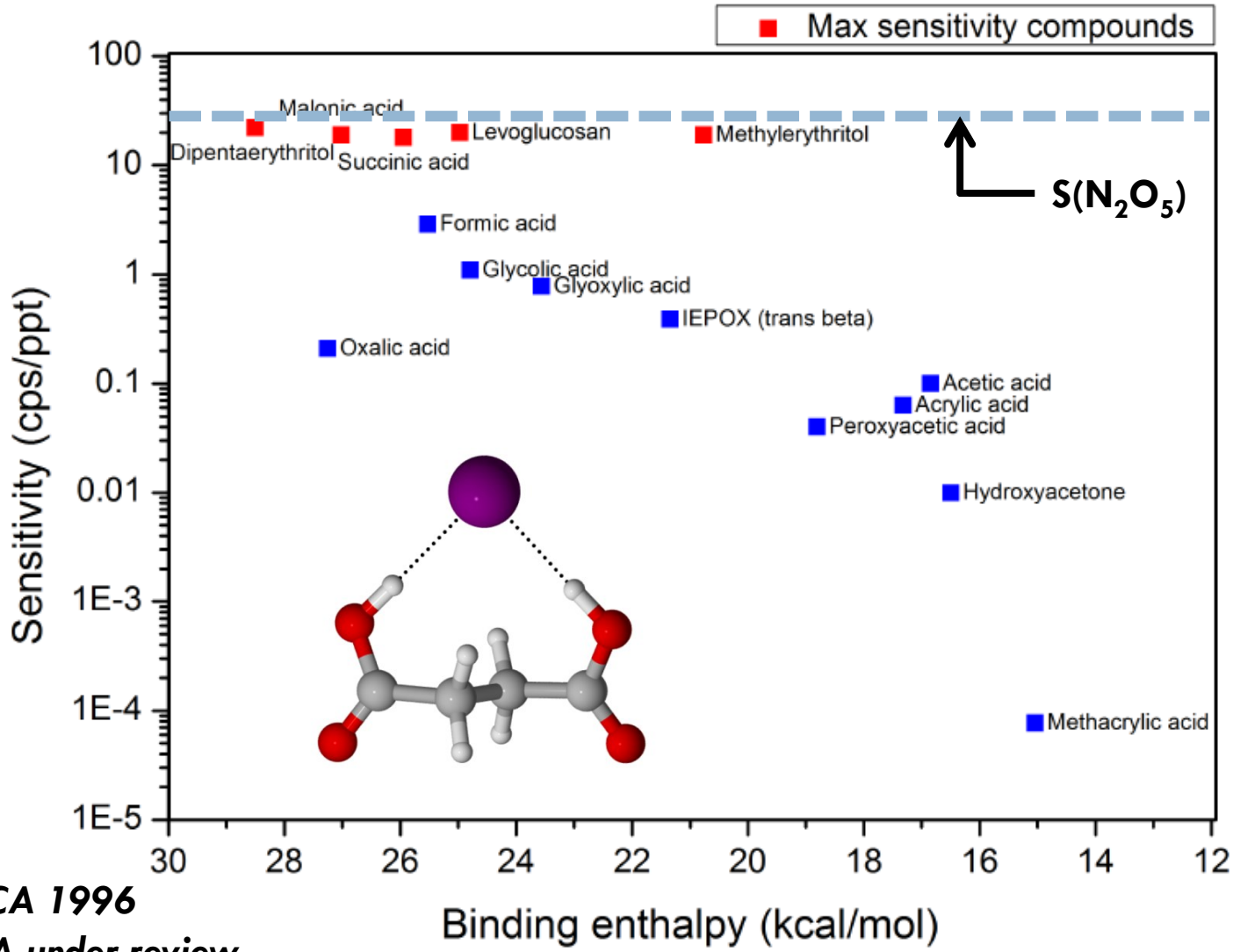
$$\frac{Signal_{i_X}}{[X]} \propto \left[\int_0^t k_f[I^-]dt\right] T_{i_X}\left(\frac{m}{Q}, \varepsilon, B_{i_X}\right)$$

- $I^-(H_2O) + X \rightarrow I^-(X) + H_2O$ **net forward rate**
  - **no faster than collision limit**

- $I^-(X) \rightarrow I^- + X$ **decomposition**
  - **function of binding energy and instrument settings**

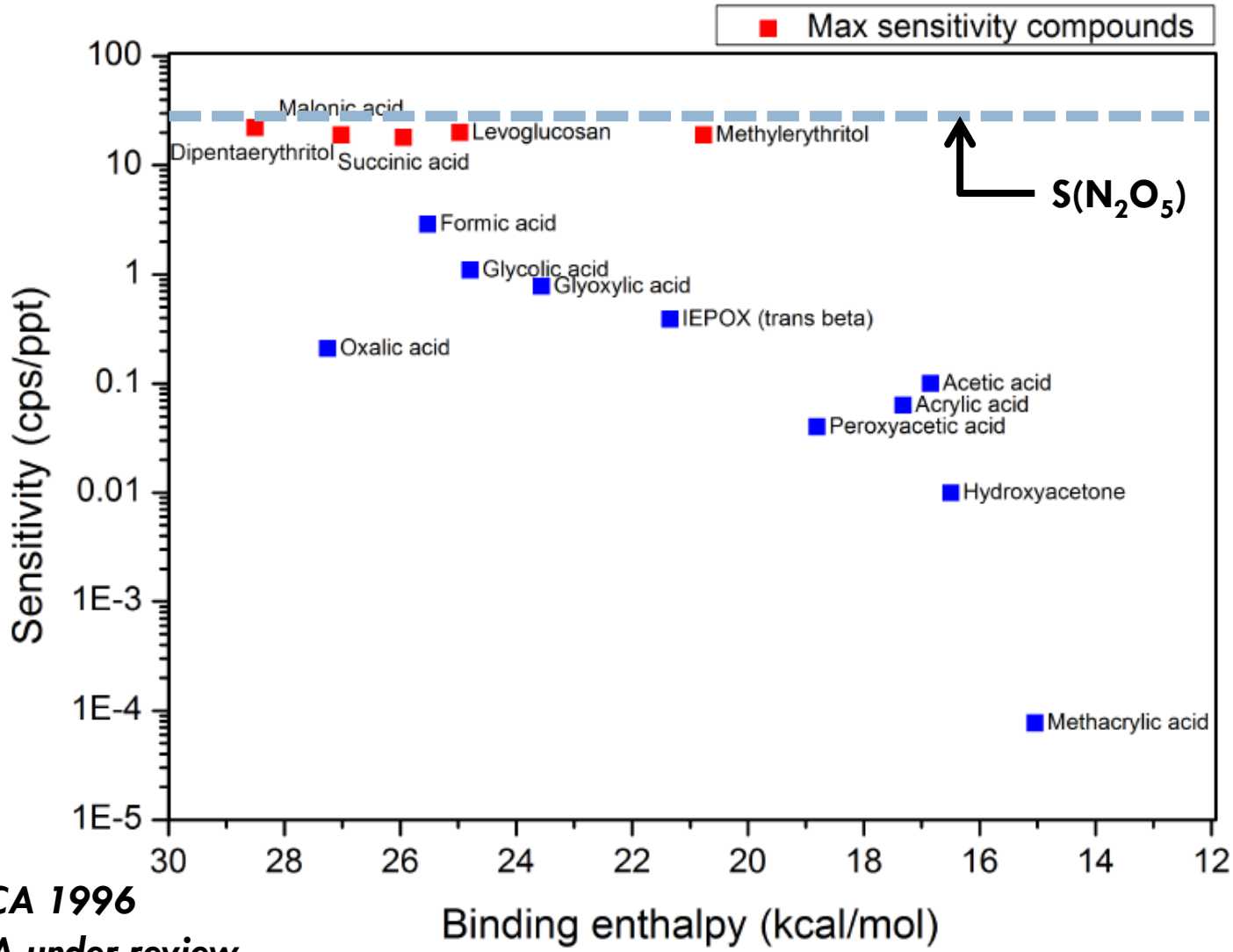
Lopez-Hilfiker et al, AMT 2016

Sensitivity, collision limit, binding enthalpy



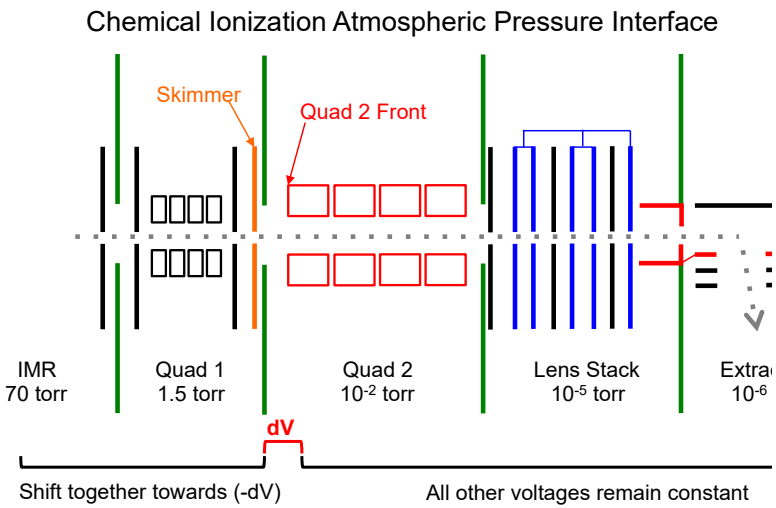
Huey, et al JPCA 1996
Iyer, et al JPCA under review

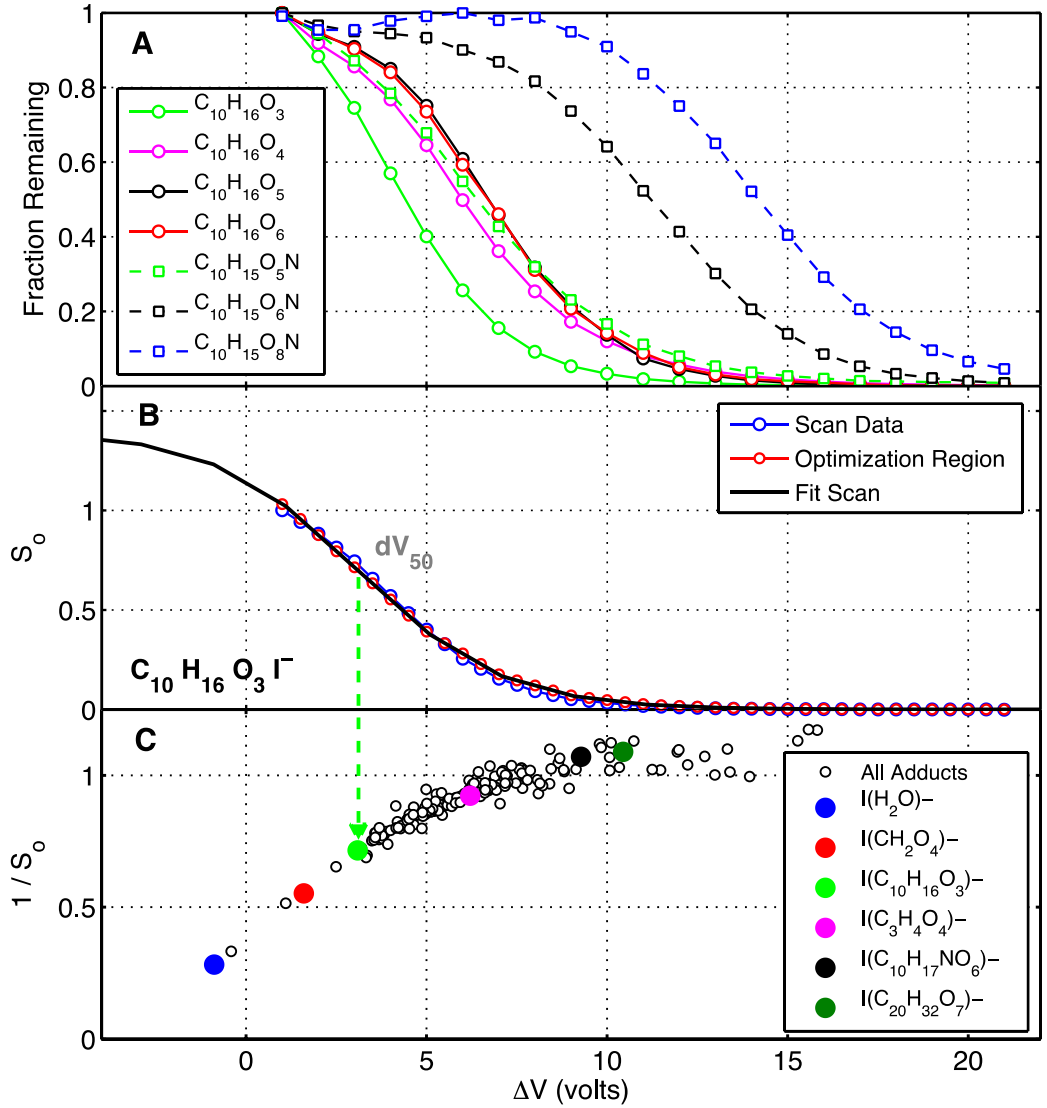
Key standards allow determination of collision limit



Huey, et al JPCA 1996
Iyer, et al JPCA under review

Field strength, binding energy, transmission





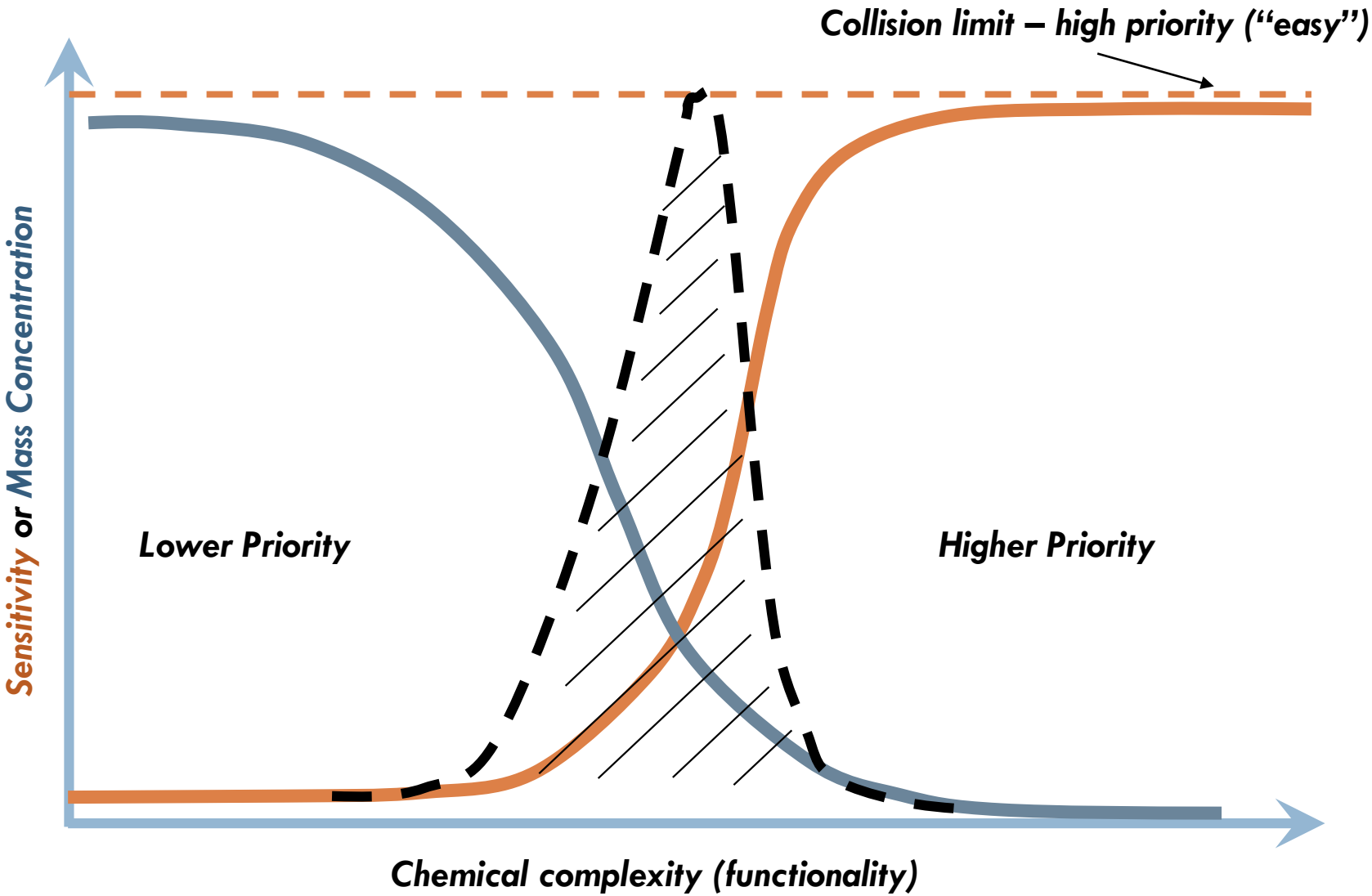
Calibration needs

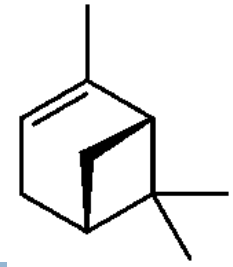
- **Reproducible, independently quantified, and transportable source of *several* multi-functional organics and a some inorganics**

- **Likely does not need to be many (some even very simple) to allow quantification of a broad suite of components**

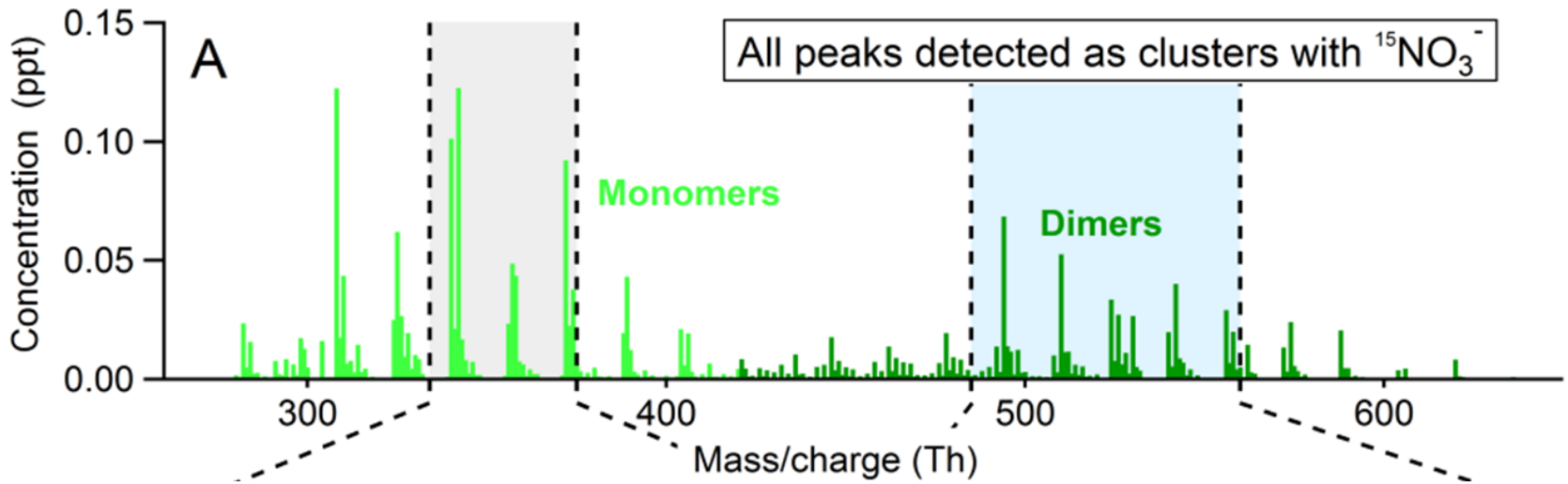
- **Span a range of binding energies, molecular weight, and functional groups**

Calibration priority space





+ Ozone Or OH → HOM Products

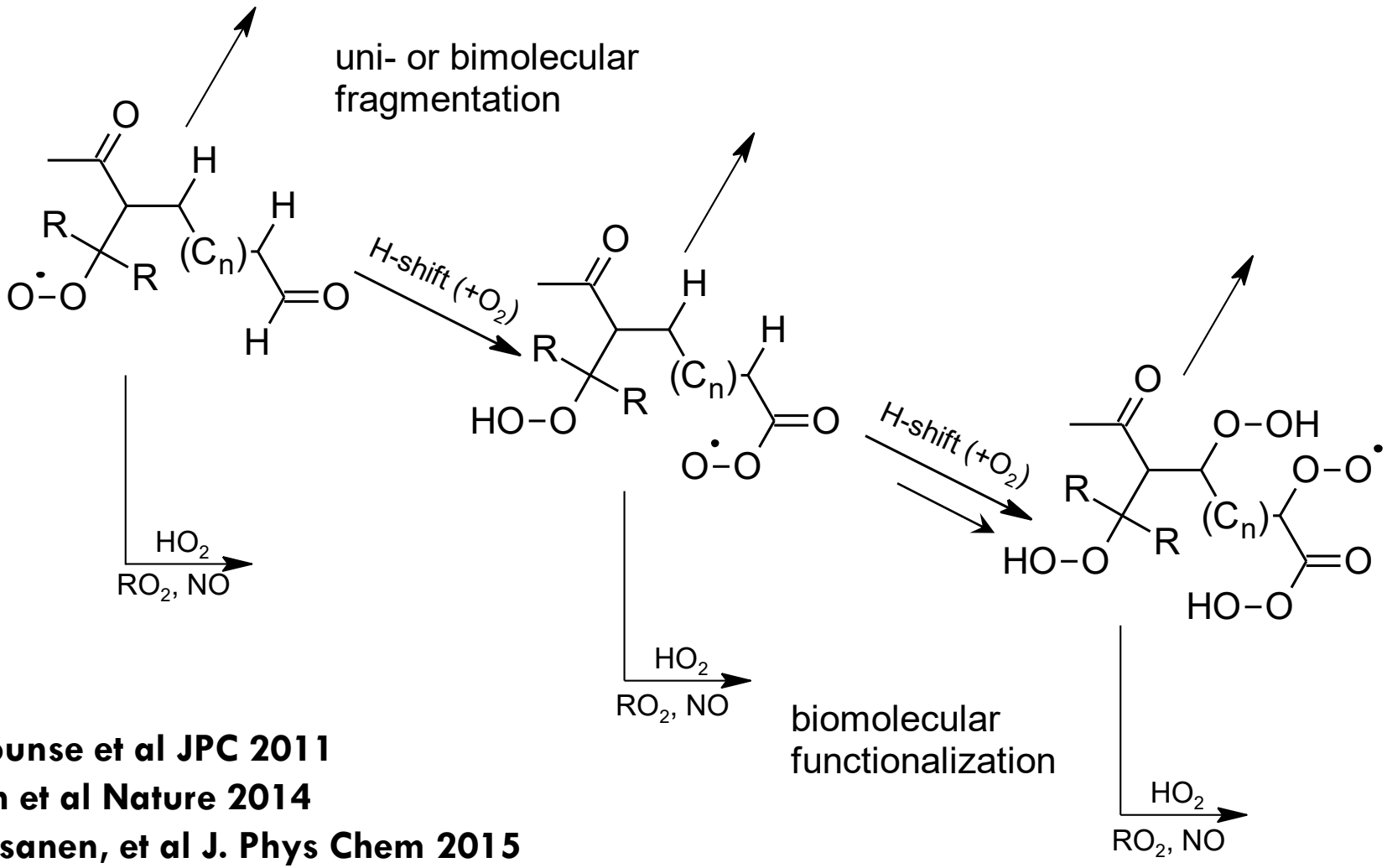


$C_{8-10}H_{14-16}O_{7-11}$

$C_{18-20}H_{28-32}O_{10-18}$

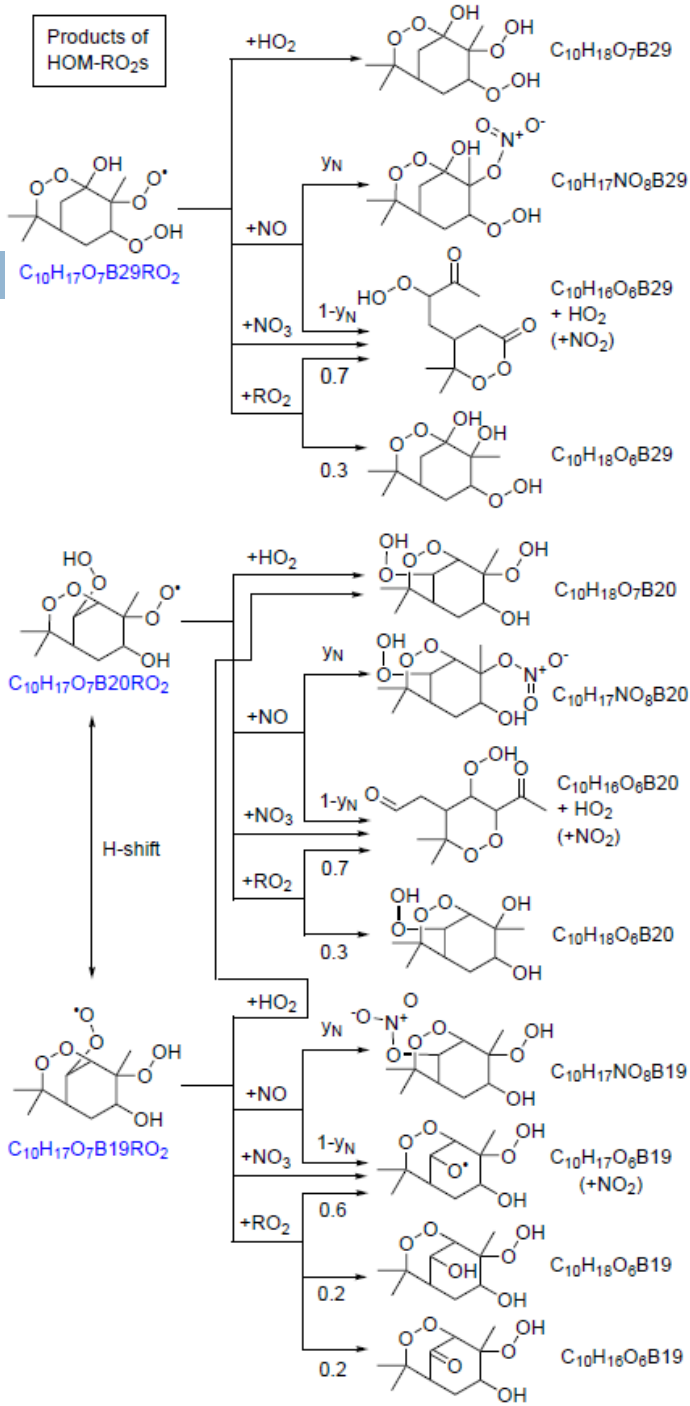
Ehn et al, Nature 2014
Berndt et al, Nat. Comm 2016

Mechanism: Organic peroxy radical ($RO_2^{\cdot}$) autoxidation

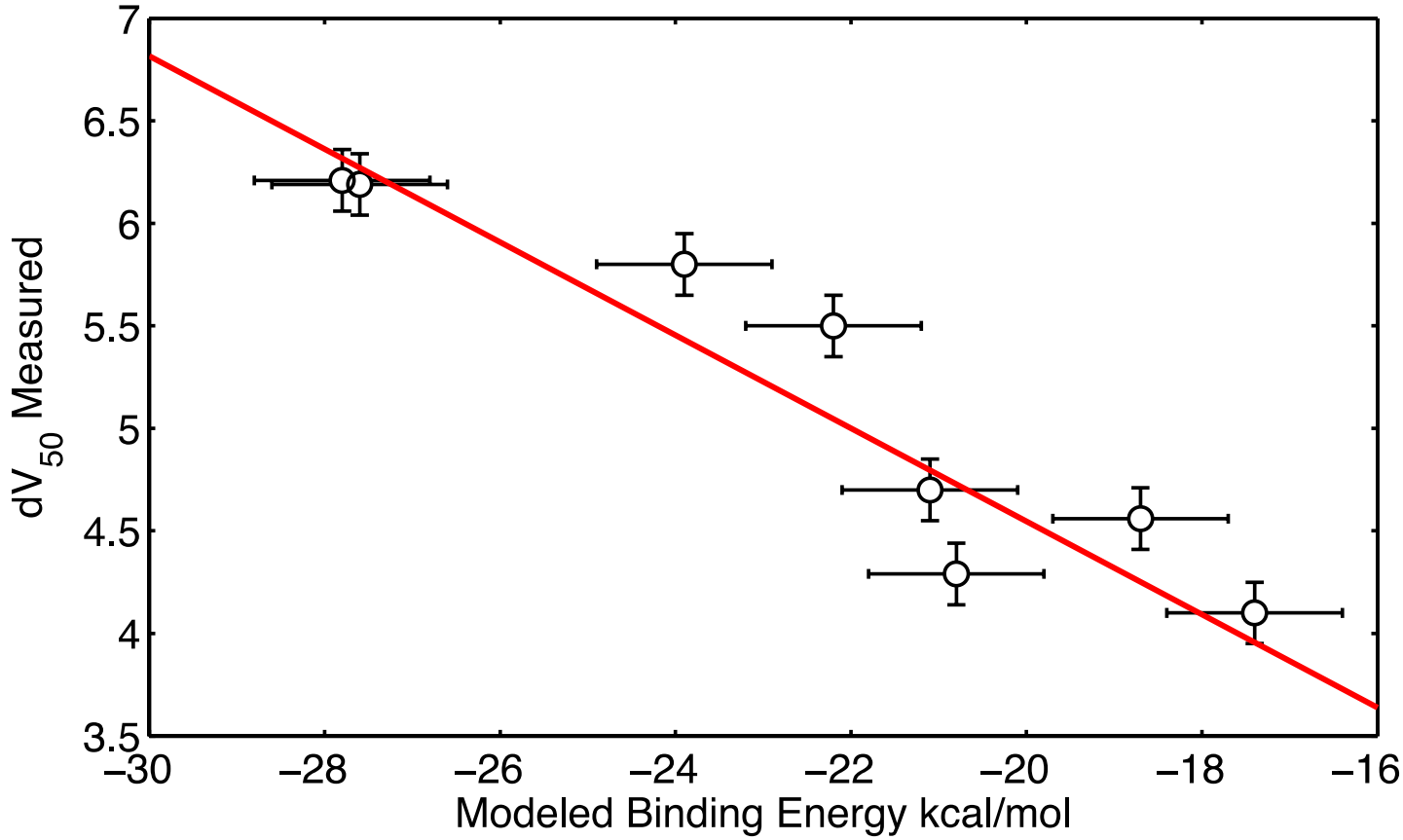


Crounse et al JPC 2011
Ehn et al Nature 2014
Rissanen, et al J. Phys Chem 2015

More chemistry

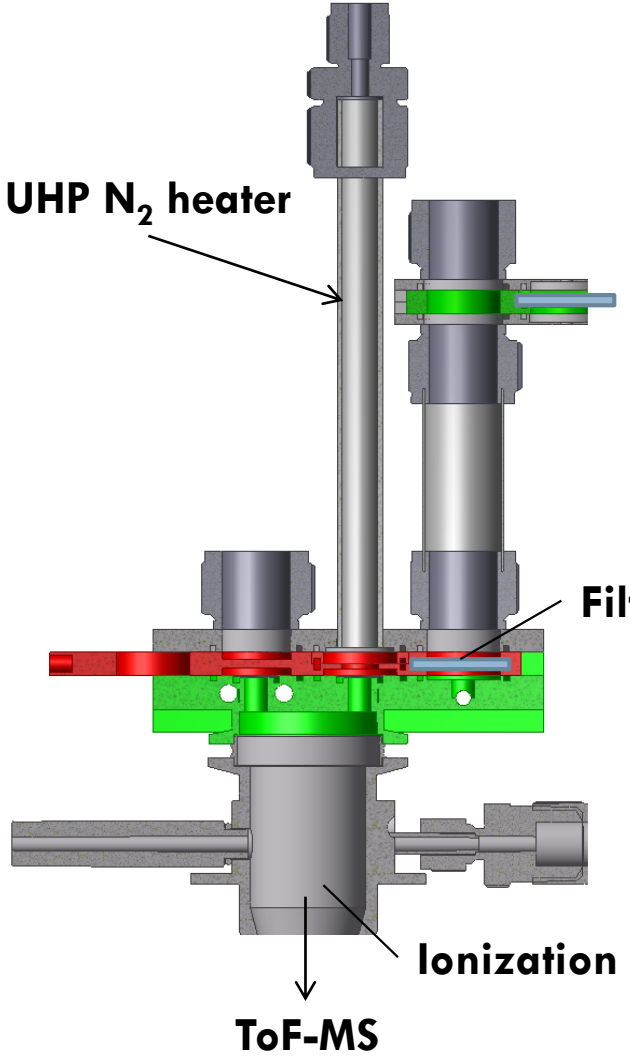


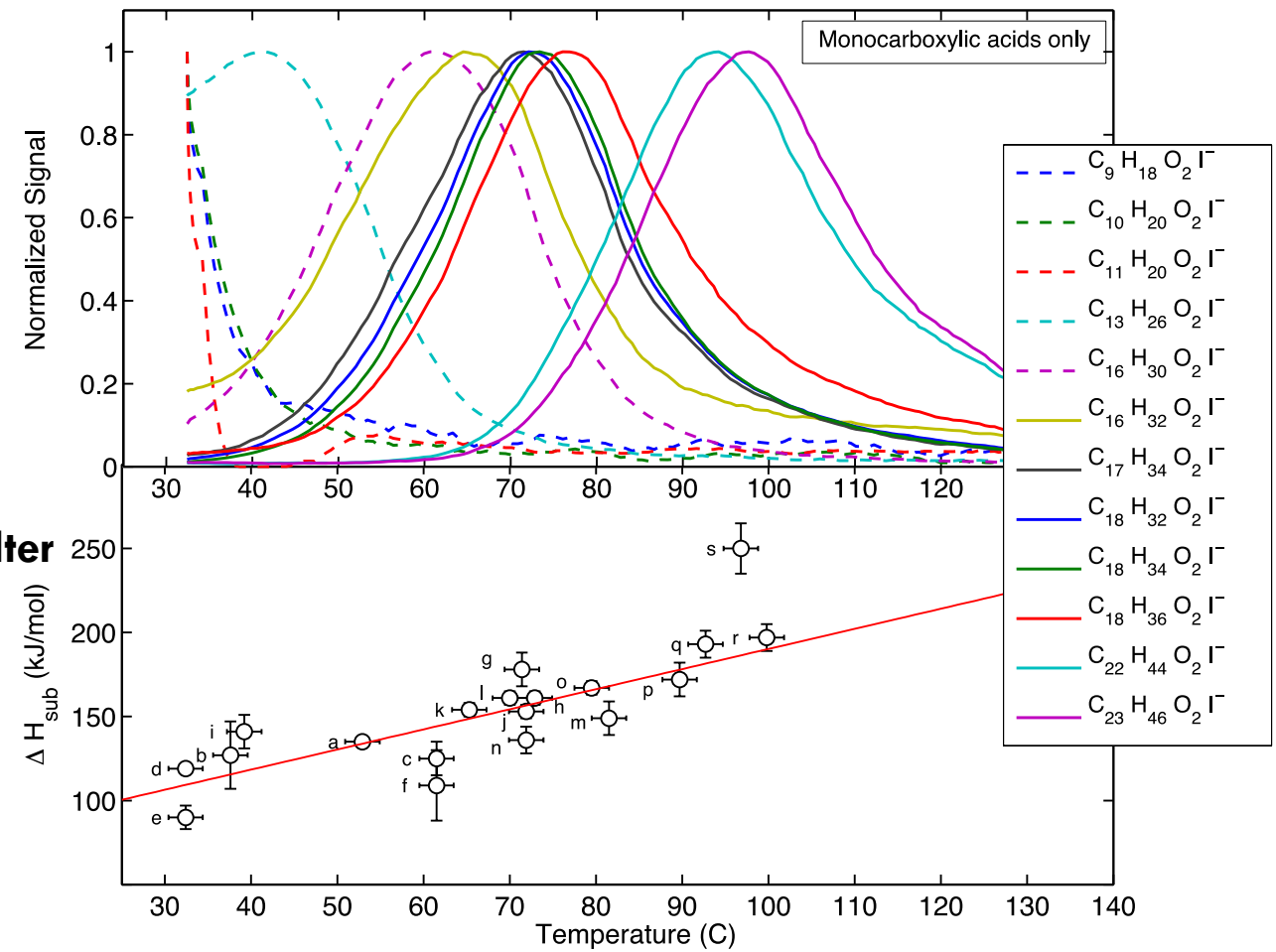
Field strength, binding energy, transmission



Lopez-Hilfiker, et al AMT 2016
Iyer et al, JPCA 2016

UW FIGAERO HR-ToF-CIMS





Lopez-Hilfiker et al AMT 2014