Organic aerosol composition using Thermal Desorption Aerosol Gas Chromatograph (TAG) combined with High Resolution Time-of-Flight Aerosol Mass Spectrometer (HR-ToF-AMS)

TAG-AMS

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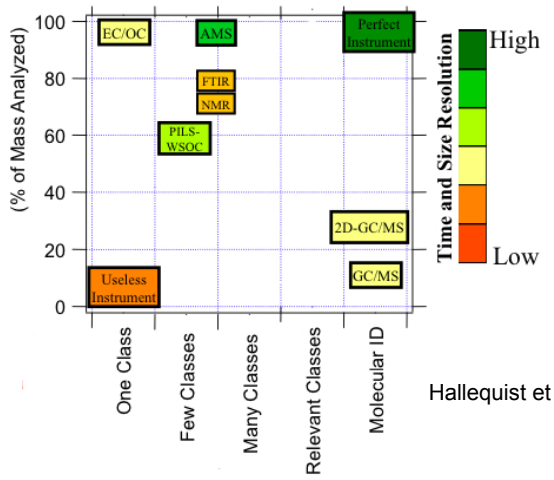
Outline

- Motivation
- Instrument description
- TAG-AMS project
- Standard measurements
- Field deployment at CalNex 2010
- Summary

“Towards the perfect instrument”



Hallequist et al, ACP, 2009

Combined AMS and TAG instrument: TAG-AMS

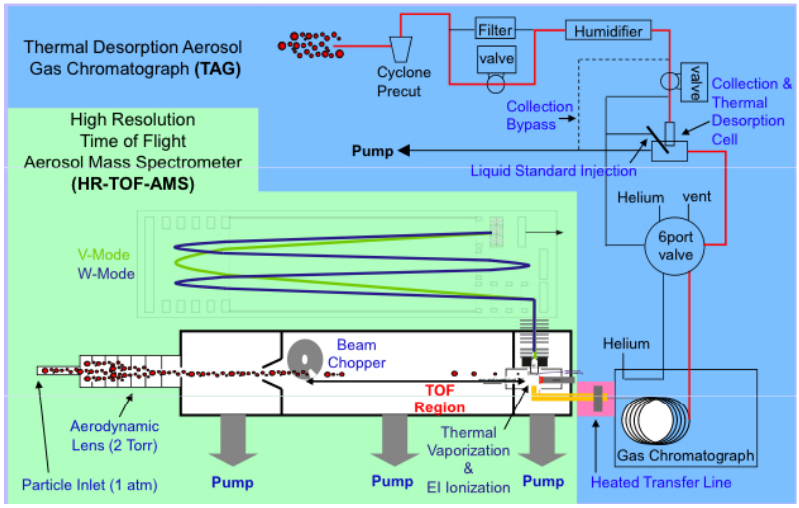
Thermal desorption aerosol GC/MS (**TAG**) (Williams et al, AS&T, 2006)

- Automated sample collection on CTD cell
- Molecular speciation, Marker compounds
- Hourly time resolution

Aerosol Mass Spectrometer (**AMS**) (Jayne et al, AS&T, 2000)

- $PM_{1.0}$ organic and inorganic mass concentrations and size distributions
- HR-ToF-MS: H:C, O:C, N:C ratios

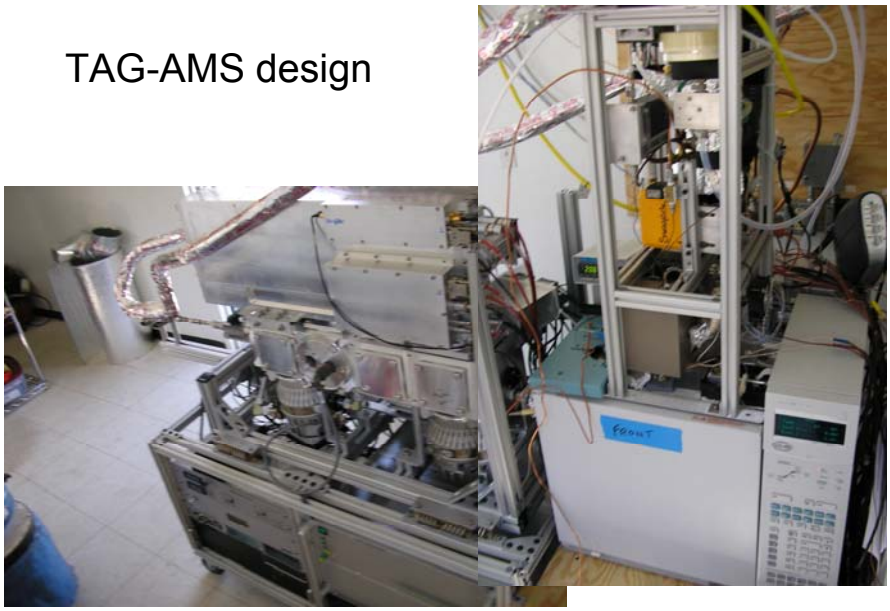
TAG-AMS design

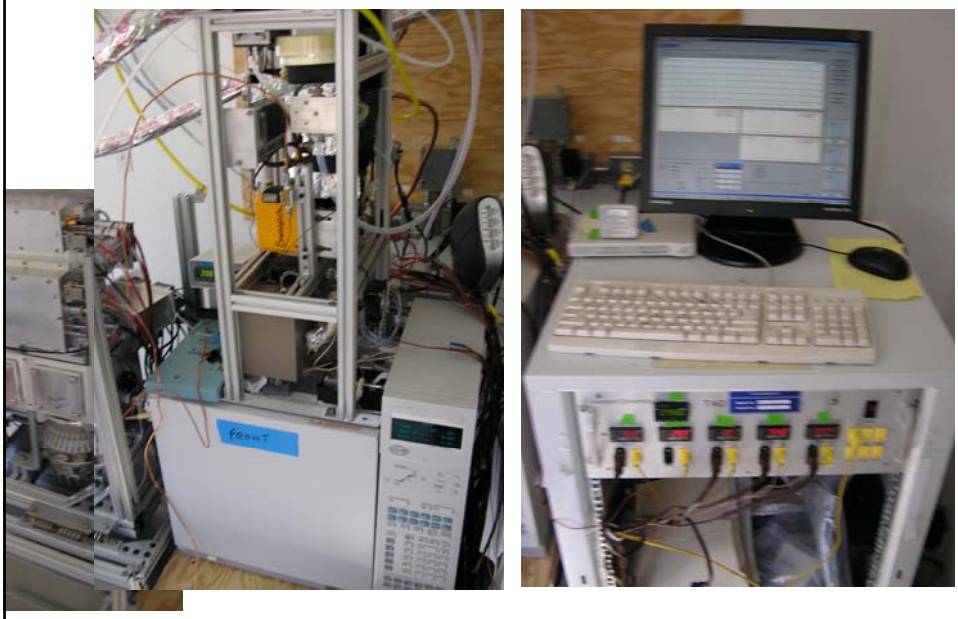


courtesy of Brent Williams

Automated data acquisition switching
Chopper blocks particle beam during TAG analysis

TAG-AMS design





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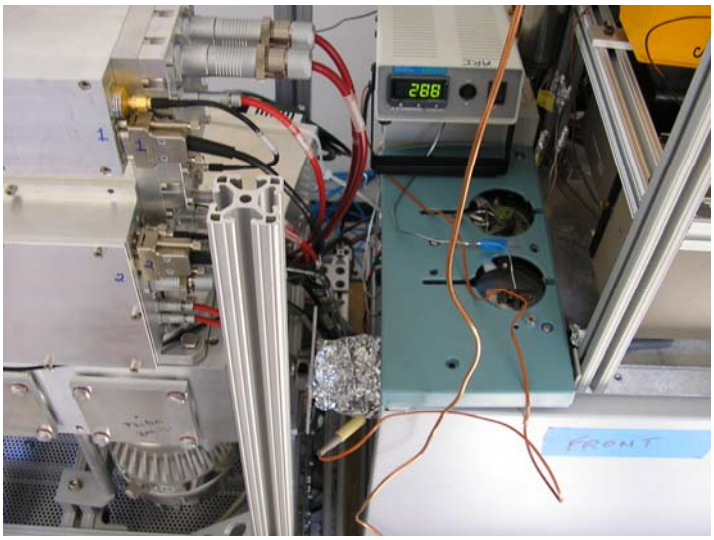

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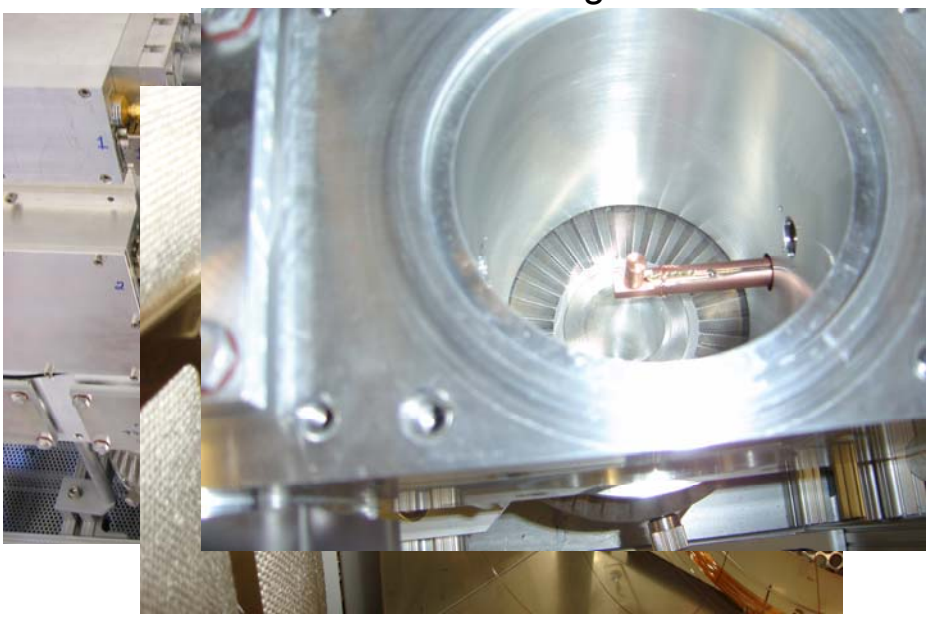

TAG-AMS project overview

Collaboration between

Aerosol Dymanics, Inc. (Nathan Kreisberg, Susan Herring)

University of California at Berkeley (Allen Goldstein, David Worton, Gabriel Isaacman)

Aerodyne Research, Inc.

TAG-AMS project overview

Collaboration between

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- CTD cell (filter based cell → reduced aerosol bounce)
- Automated standard injections on the CTD cell

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- GC as a modular AMS equipment

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Aerodyne Research, Inc.

- TAG-AMS interface
- acquisition and analysis methods for TAG-AMS data
- commercialize the TAG collector as a module

TAG-AMS project overview

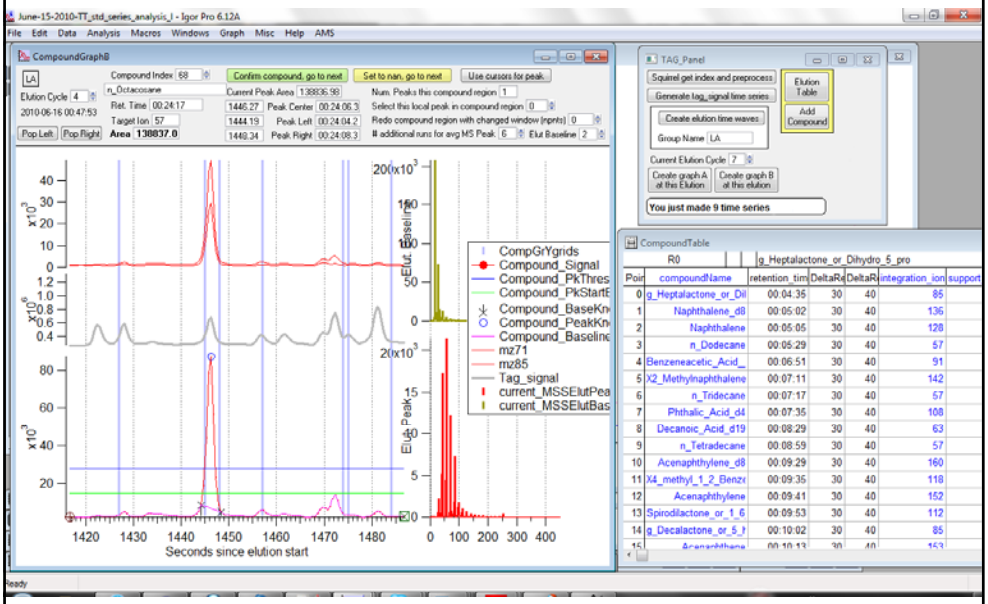
Goal → 3 commercially available TAG systems

- Standalone TAG collector
Williams et al., AS&T 2006, Williams et al., JGR, 2007

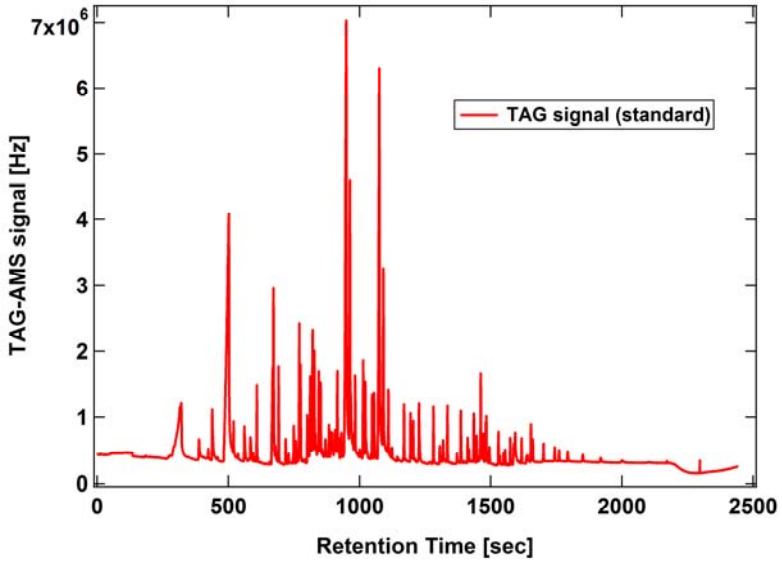
- TAG collector with new HR-ToF-MS
Po Valley campaign, Summer 2009

- TAG-AMS → TAG module for existing AMS
CalNex 2010 campaign

TAG Igor analysis tool



TAG-AMS standard chromatogram



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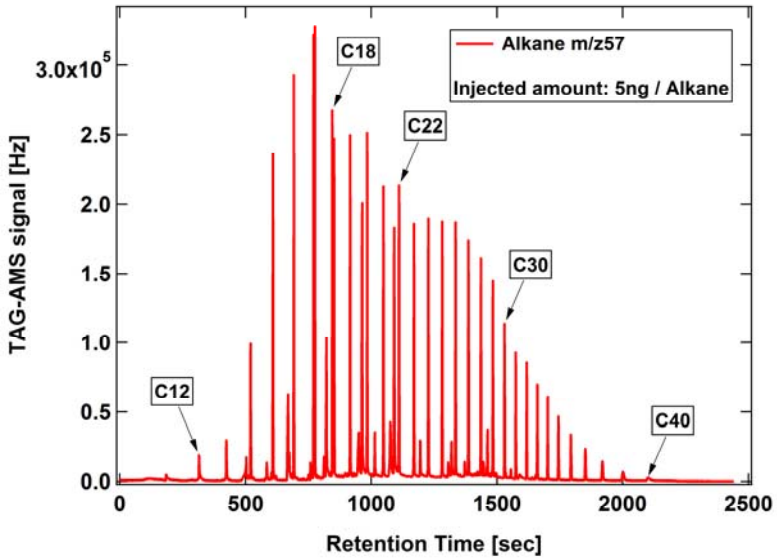
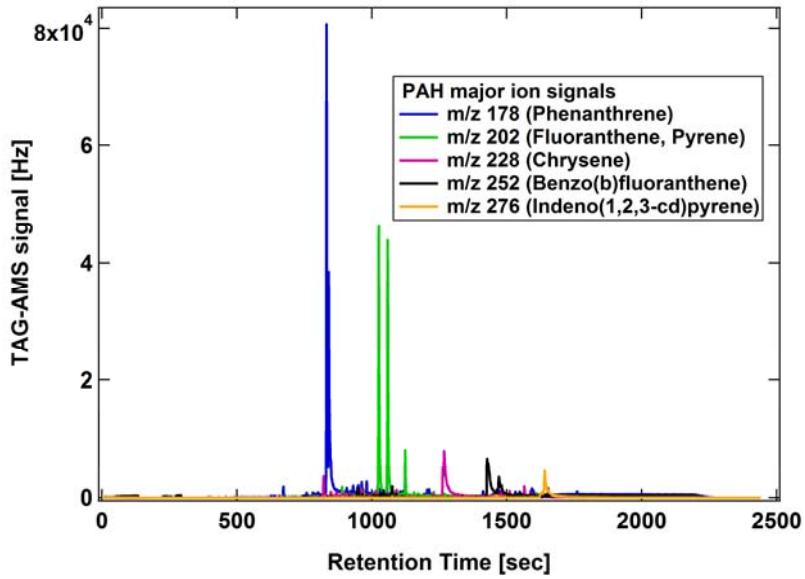


TAG-AMS PAH standard chromatogram

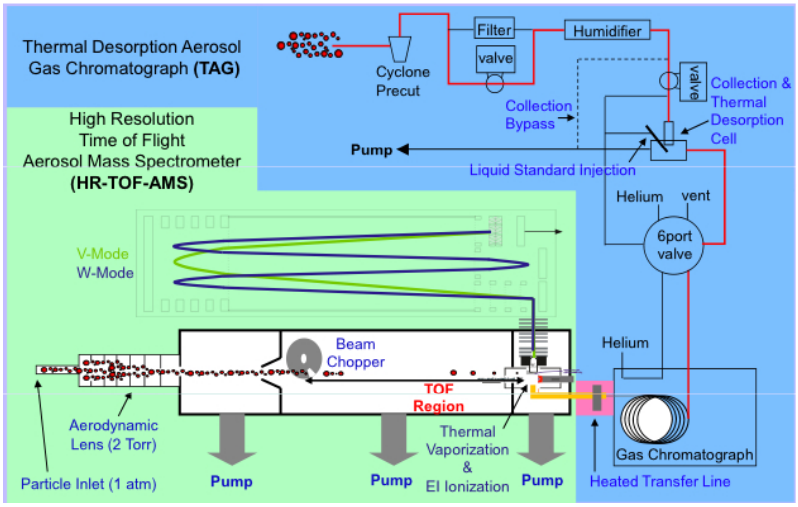


First TAG-AMS field deployment

- May 15th - June 15th 2010 CalNex ground site (Pasadena, CA)

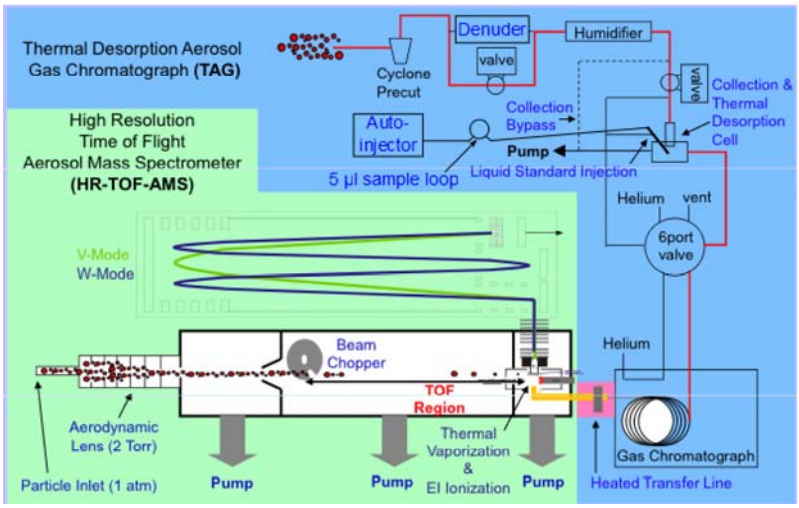
- 5 weeks' operation
- over 2 weeks of continuous measurements

TAG-AMS CalNex design



courtesy of Brent Williams

TAG-AMS CalNex design



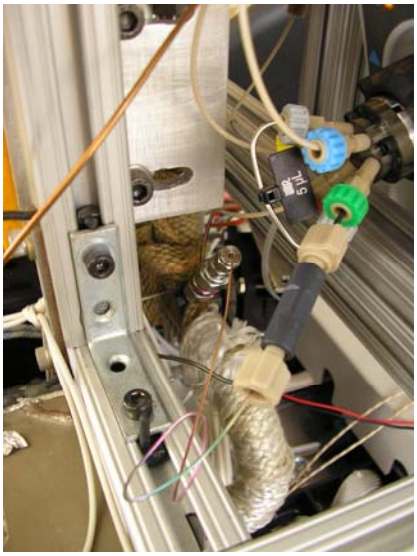
courtesy of Brent Williams

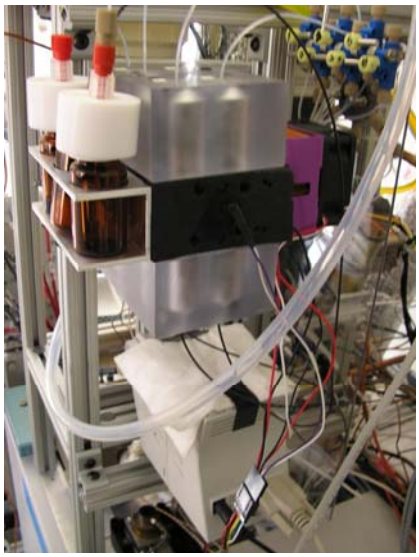
Measurement Cycles

- Simultaneous AMS measurement and sample collection with TAG
- Subsequent analysis of desorbed and GC separated aerosol constituents
- Measurement cycle (120 min)
  - 60 min AMS measurements (V-mode) + 60 min TAG sampling
  - 60 min TAG analysis

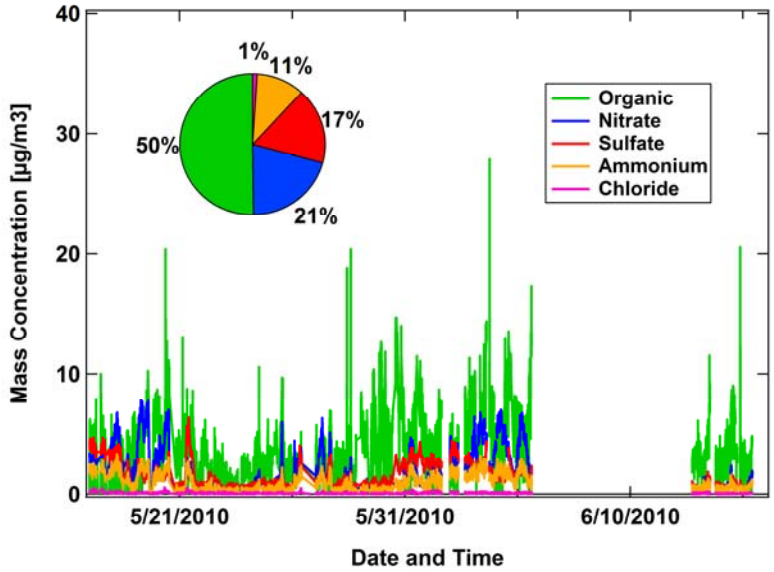
- Internal standard (deuterated compounds)
- External standard (compound mixture of alkanes, acids, PAH, steranes, hopanes etc.)
- Blank measurement
- External and internal standard measurements with syringe and auto-injector

TAG-AMS CalNex design

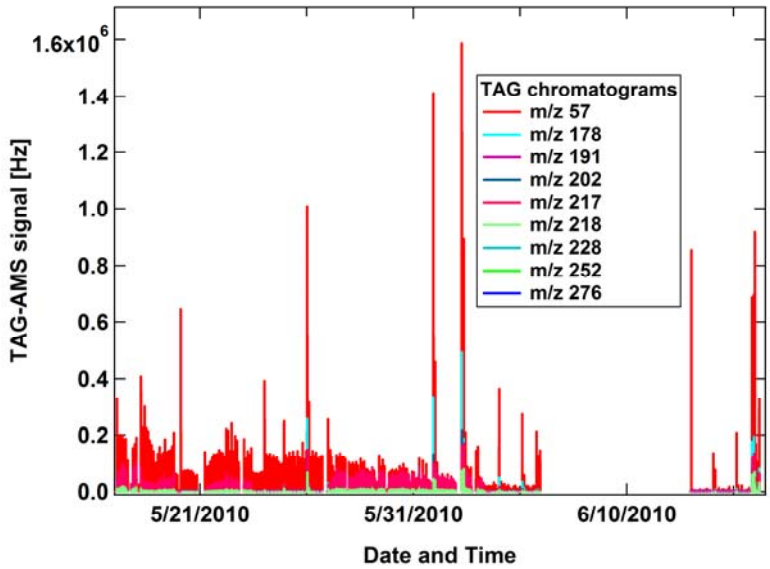




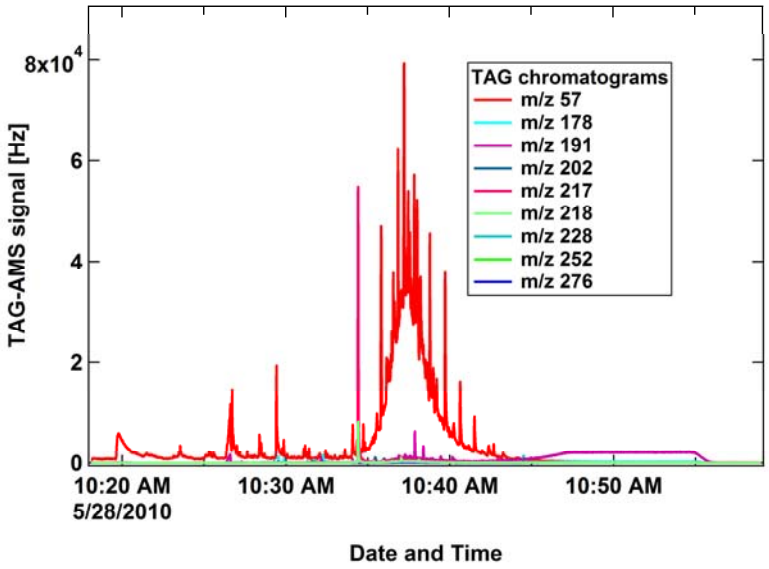
CalNex data sample overview I



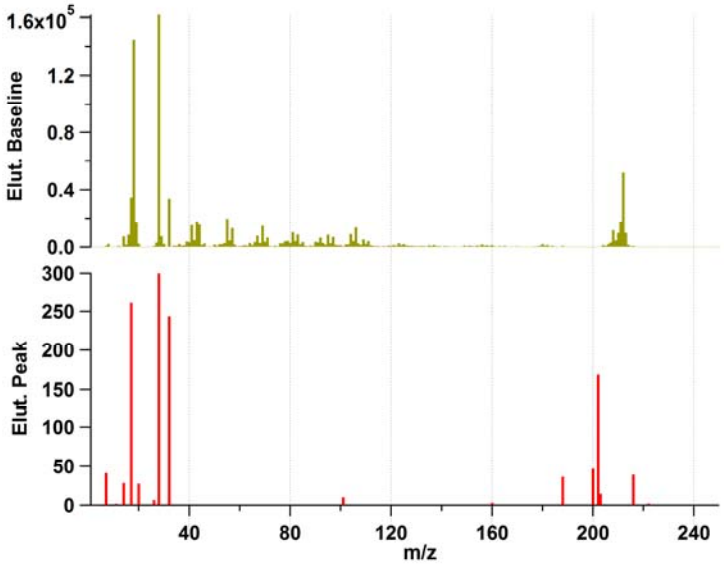
CalNex data sample overview II



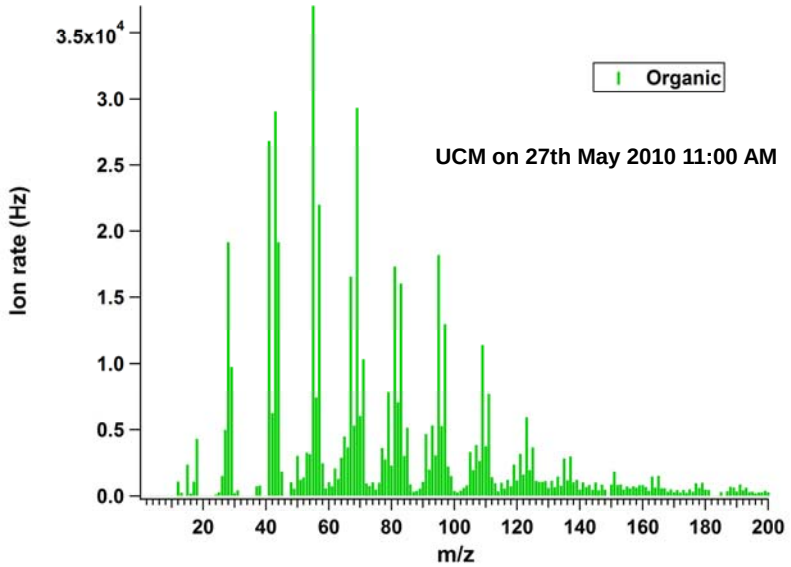
CalNex chromatogram



Ambient Pyrene



Unresolved Complex Mixture (UCM)



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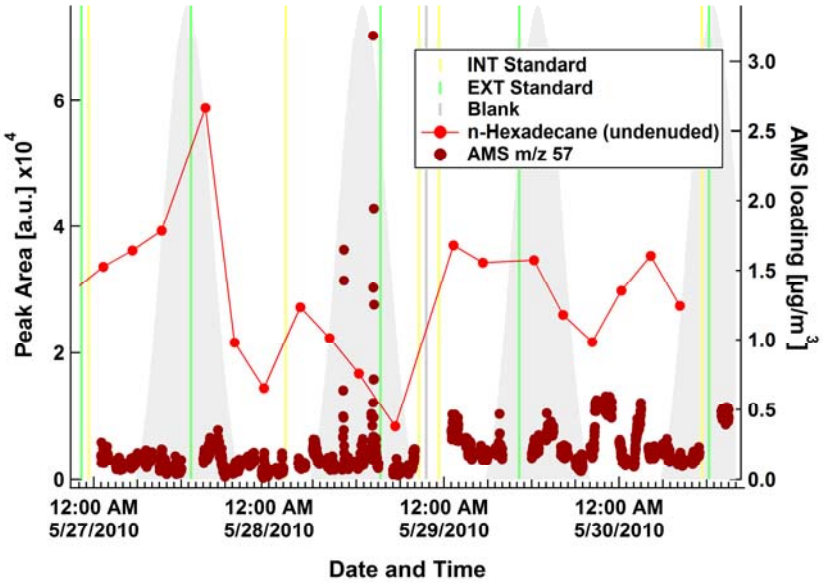
Undenuded vs. Denuded



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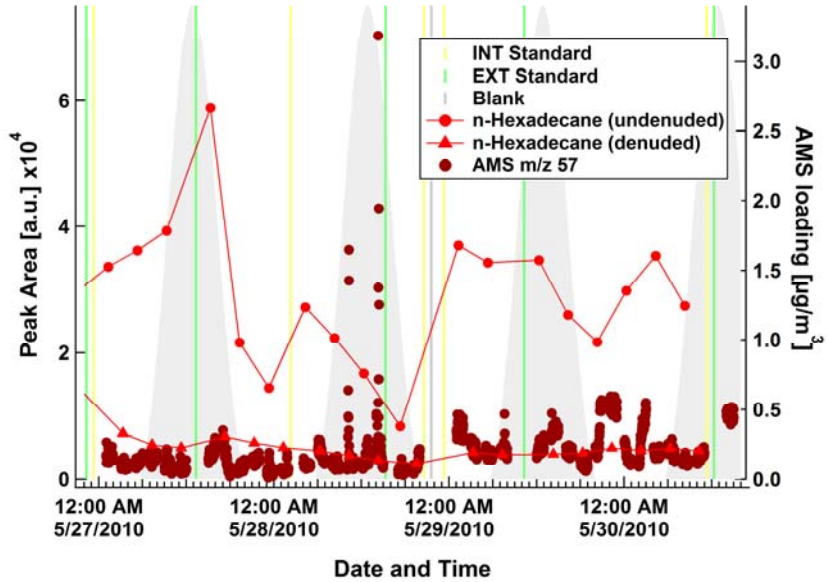
Undenuded vs. Denuded



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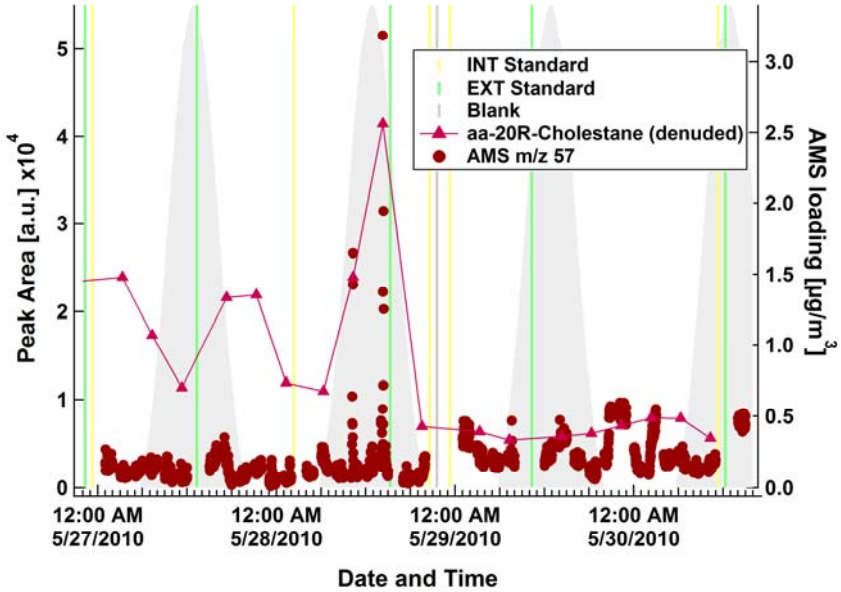
Petroleum Source Fingerprinting



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Summary & Outlook

Standalone automated TAG-AMS measurements

Analysis tool exits and will be further developed/improved

Demonstrated proof-of-concept: TAG-AMS field deployment

- Bulk NR-$PM_{1.0}$ speciation and sizing
- Molecular speciation of organic tracer compounds

Technical improvements

- GC oven, control unit, TAG-AMS interface

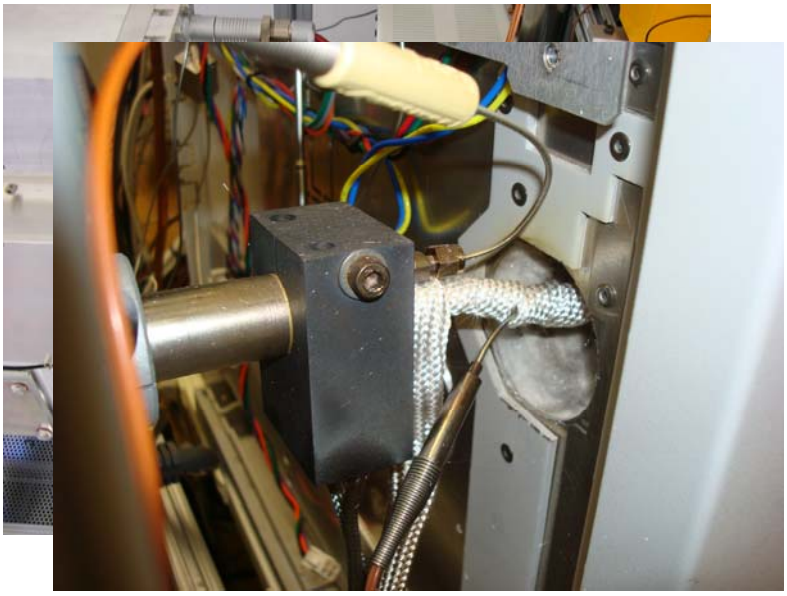
PMF analysis of TAG-AMS measurements

- PMF analysis for TAG data
- Correlate changes in average AMS mass spectra to changes in abundances in molecular marker compounds

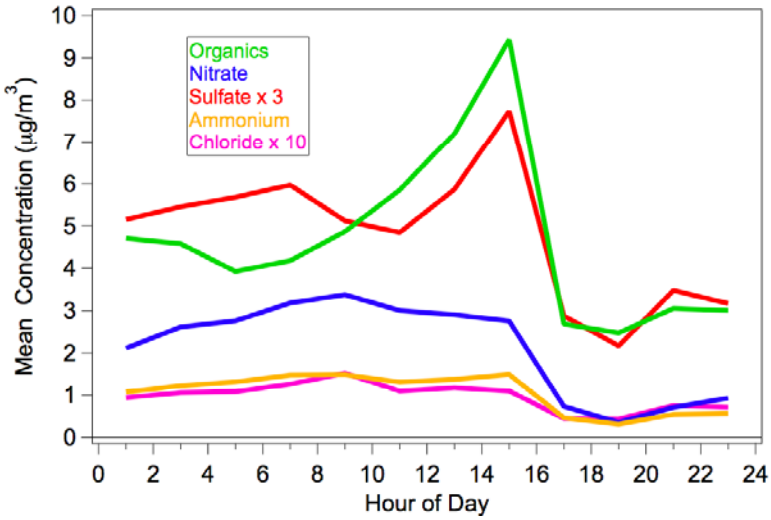
V-mode → W-mode

Thank you!

TAG-AMS design

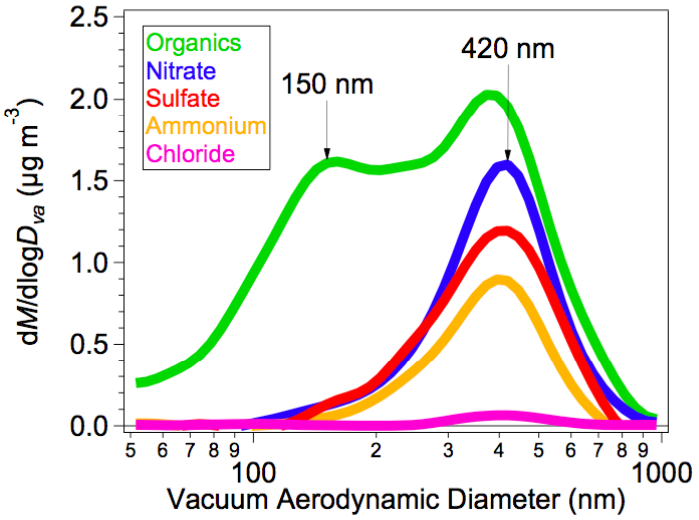


TAG-AMS bulk diurnal trends



- Organics afternoon peak ⌫ SOA

TAG-AMS study-average size distribution



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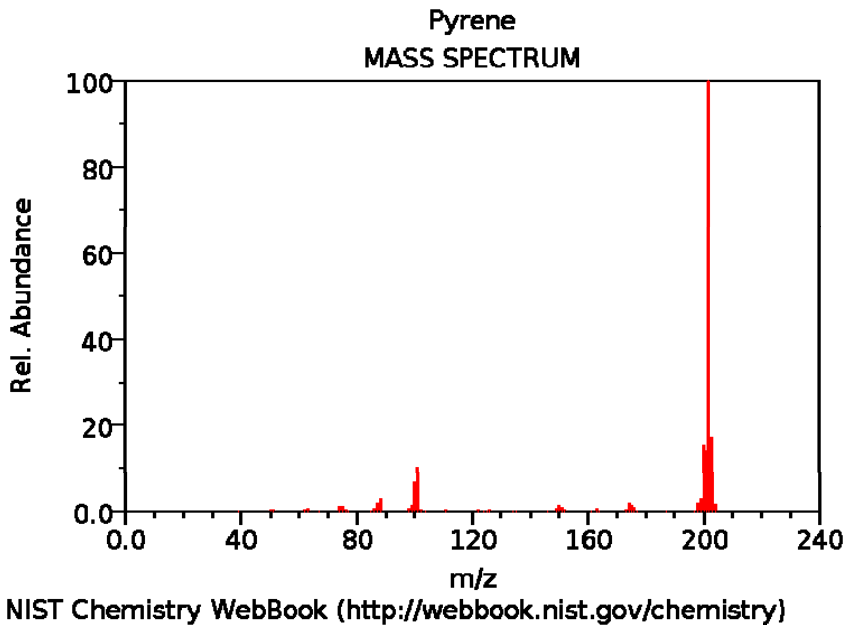

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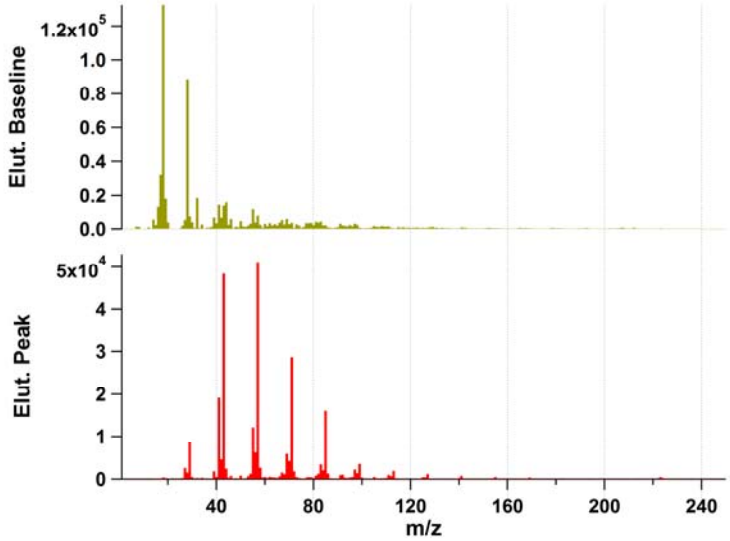
TAG-AMS alkane mass spectrum