

US EPA ARCHIVE DOCUMENT

Evaluation of Mobile Source Emissions and Trends Using Detailed Chemical and Physical Measurements

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EPA STAR Project Kickoff Meeting
Nov 16, 2010

Project Participants

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- Lawrence Berkeley National Laboratory
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Research Objectives

- Study on-road motor vehicle emissions
 - measure emission factors
 - fleet-average values for LD (gasoline) and HD (diesel)
 - HD diesel truck emission factor distributions
 - quantify long-term emission trends
- Characterize emissions at high level of chemical and physical detail, using new instrumentation

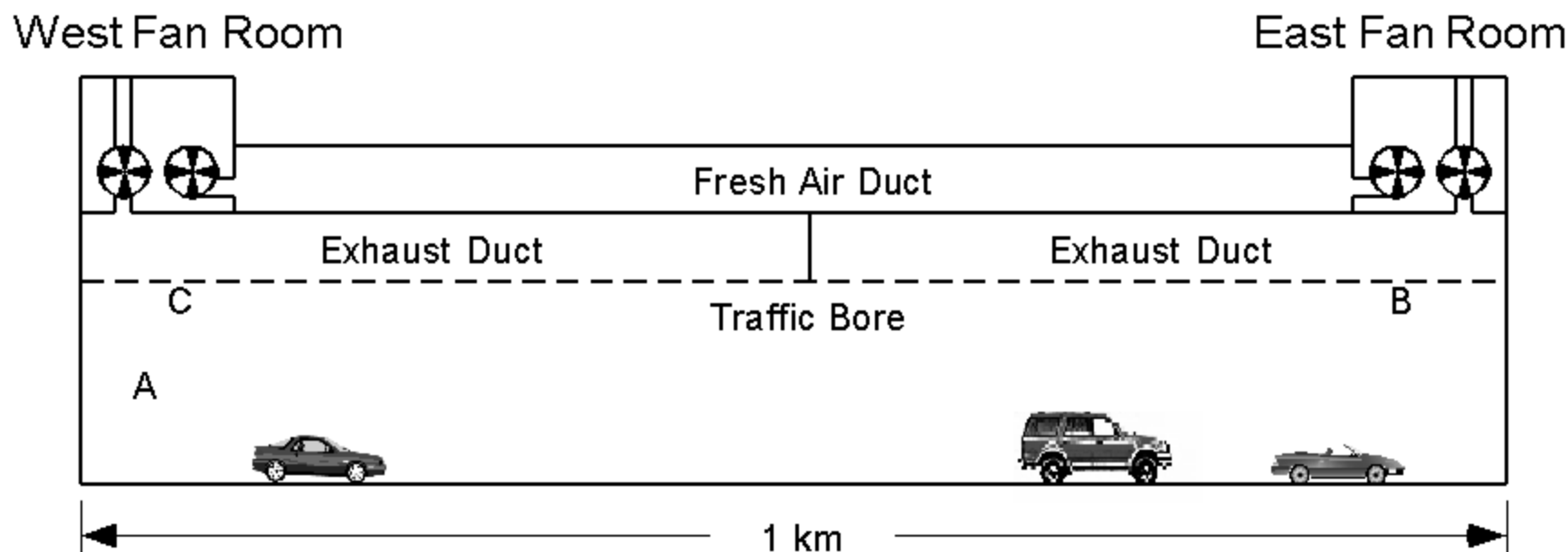
Caldecott Tunnel Field Study Site

Highway tunnel in SF Bay area with 3 separate 2-lane traffic tubes (“bores”)

Special feature of Caldecott: HD trucks not allowed in middle bore

Measured emissions at east end in bores 1 and 2 (4% uphill grade)

Previous emission measurements at same site: 1997 and 2006



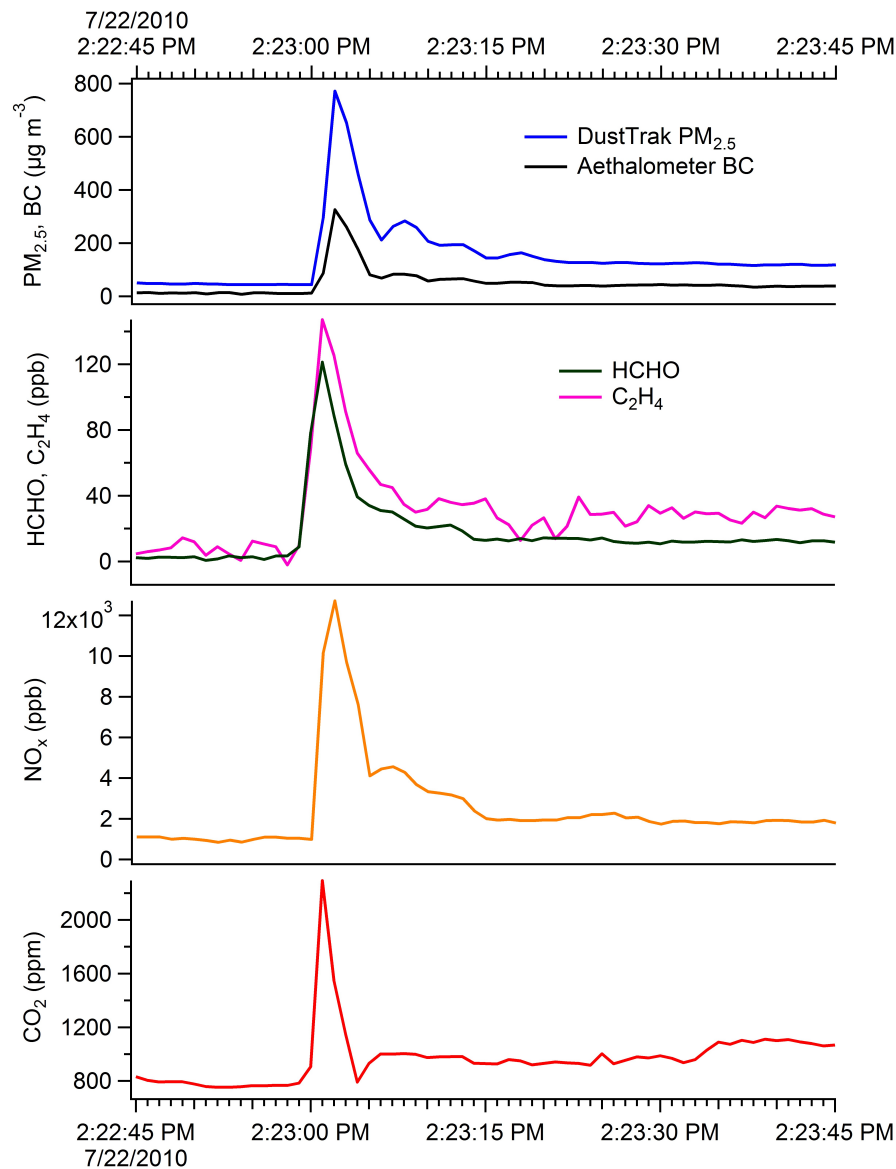
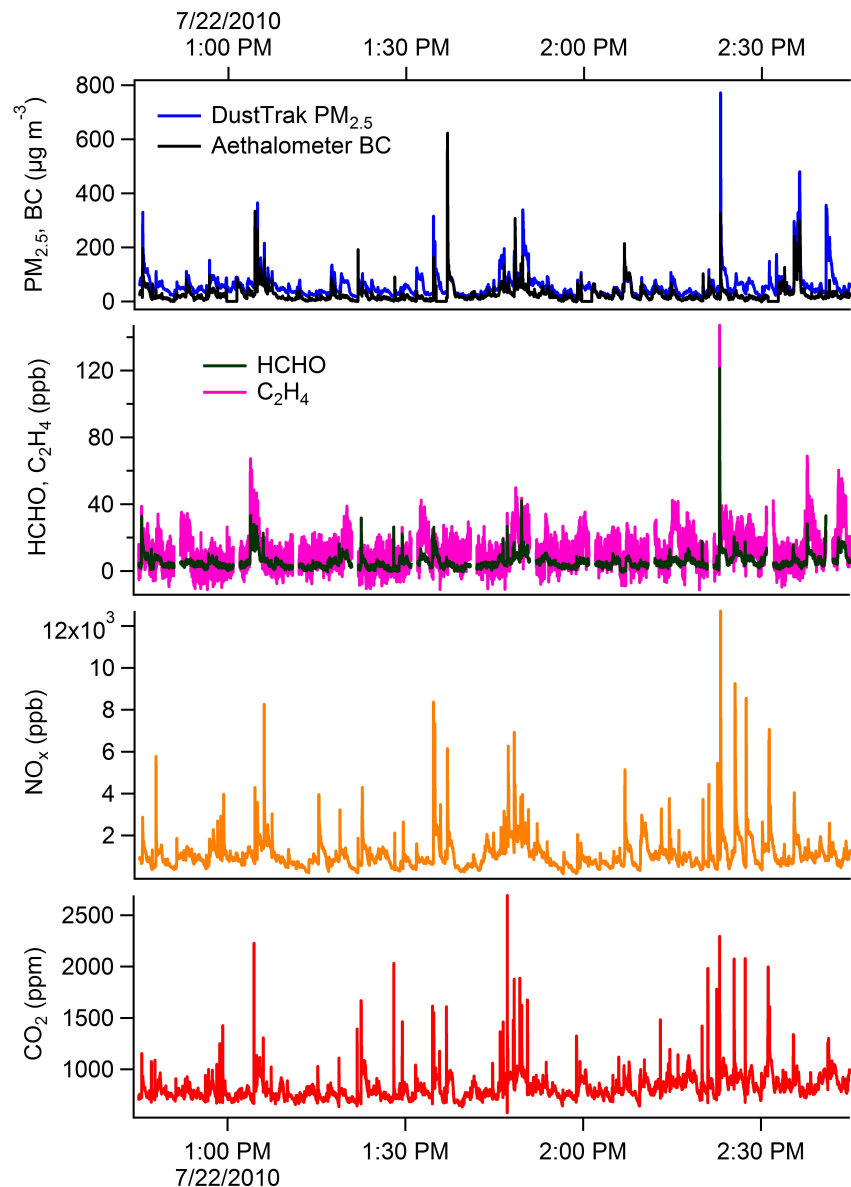
Gas-Phase Measurements

Pollutant	Measurement Method	Time Resolution
CO ₂	Infrared absorption (LICOR-820)	1 sec
CO, HCHO, ethene	Infrared absorption (QC-TILDAS)	1 sec
C3-C4 HC	Online GC-FID (adsorbent trap, Plot Q column)	1 h
C5-~C16 HC	Online GC-MS (adsorbent trap, DB-624 column)	1 h
Aromatic HC	Proton transfer mass spectrometry (PTR-MS)	1 sec
NO, NO _x	Chemiluminescence	1 sec
NO ₂	QC-TILDAS, CAPS	1 sec

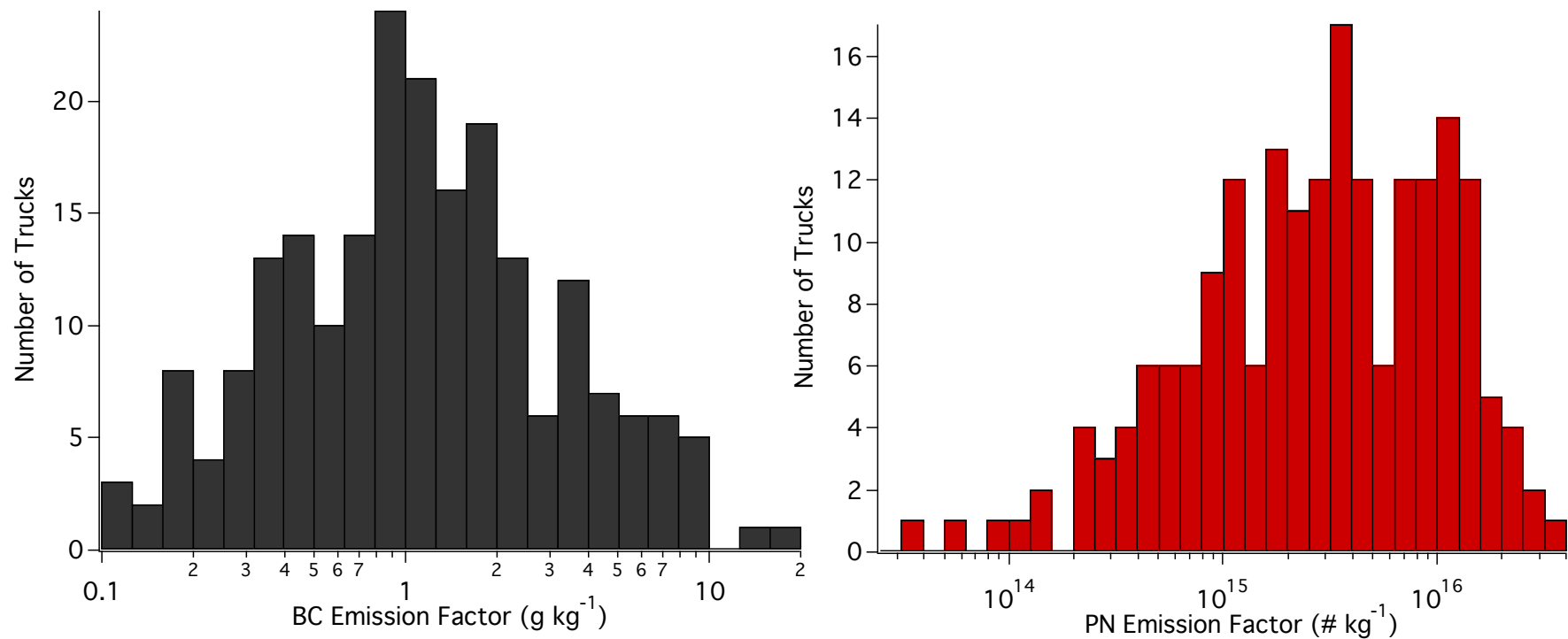
Particle Measurements

Pollutant	Measurement Method	Time Resolution
PM _{2.5} mass	Teflon filter/gravimetric analysis	2 h (IOP only)
PM “mass”	Dustrak (optical method)	1 sec
OC/EC	Quartz filter/thermal optical analysis	2 h (IOP only)
OC species	Online GC-MS (impaction + thermal desorption)	1 h
Speciation D _p < 1µm	SP-HR-TOF-Aerosol Mass Spectrometer (AMS) laser – can see refractory aerosol (BC)	1 s
BC	Aethalometer & Photoacoustic	1 s
Optical	Multi angle absorption photometer (MAAP) & light extinction (CAPS) both at 640 nm	1 s
PN (number)	Various CPC	1 s

Emission Factors for Individual Trucks



BC and **PN** Emission Factors



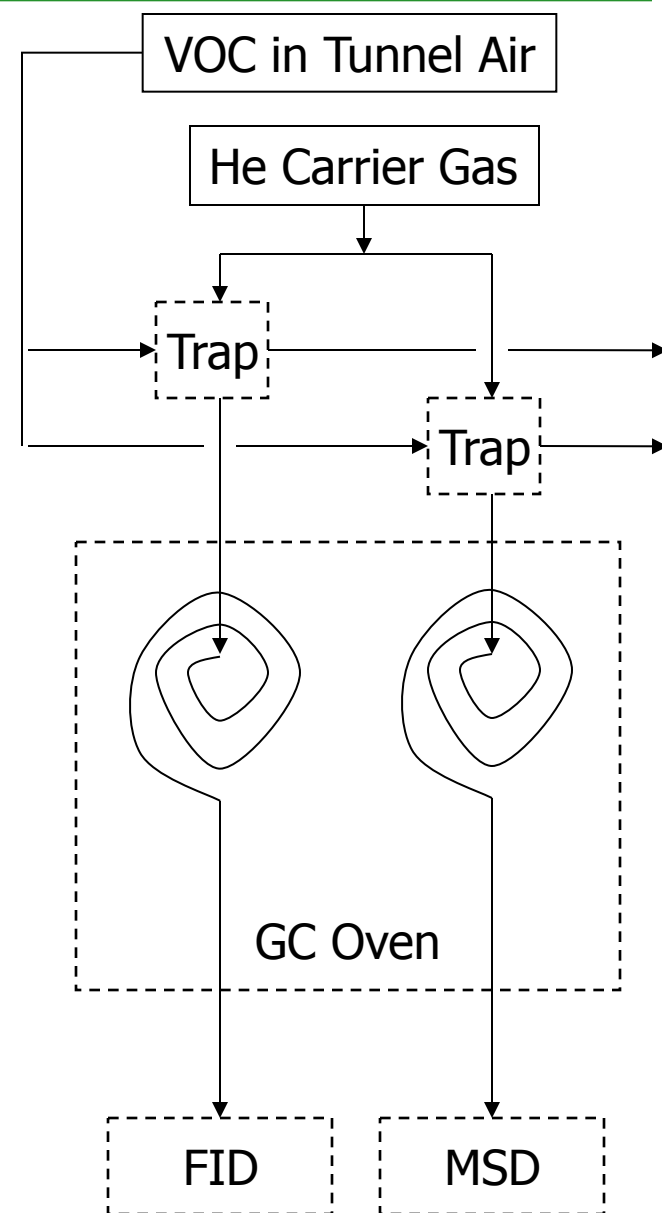
Emission factors for 226 individual HD diesel trucks measured at Caldecott tunnel in summer 2006. Source: Ban-Weiss et al (ES&T 2009).

Tunnel VOC Measurements

- Measured ~200 VOC in situ with 30 minute collection periods

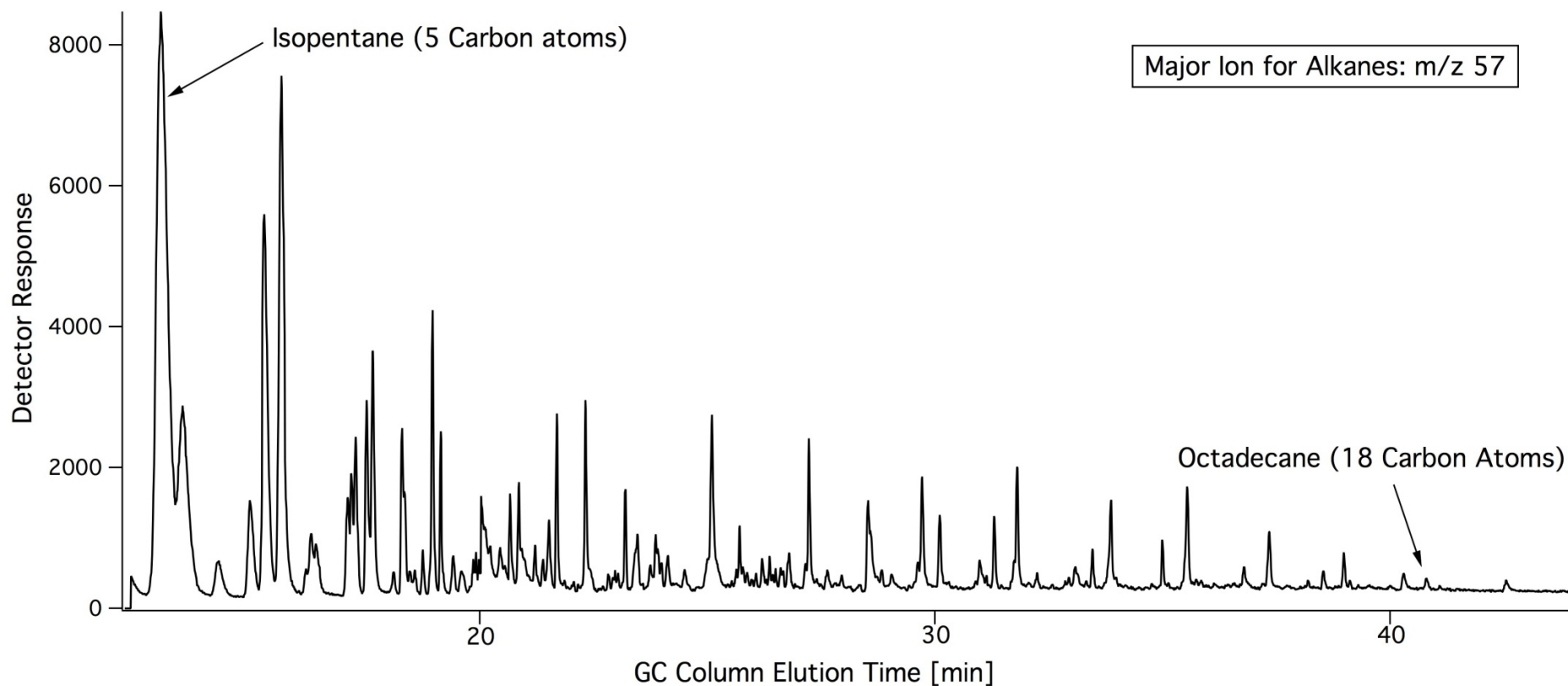
Instrumentation

- Gas chromatograph with 2 detectors:
 - Mass selective detector (MSD)
 - Flame ionization detector (FID)
- Two separate channels for compounds of higher & lower volatilities
 - Custom multi-phase adsorbent traps
 - Optimized chromatographic separations using capillary columns

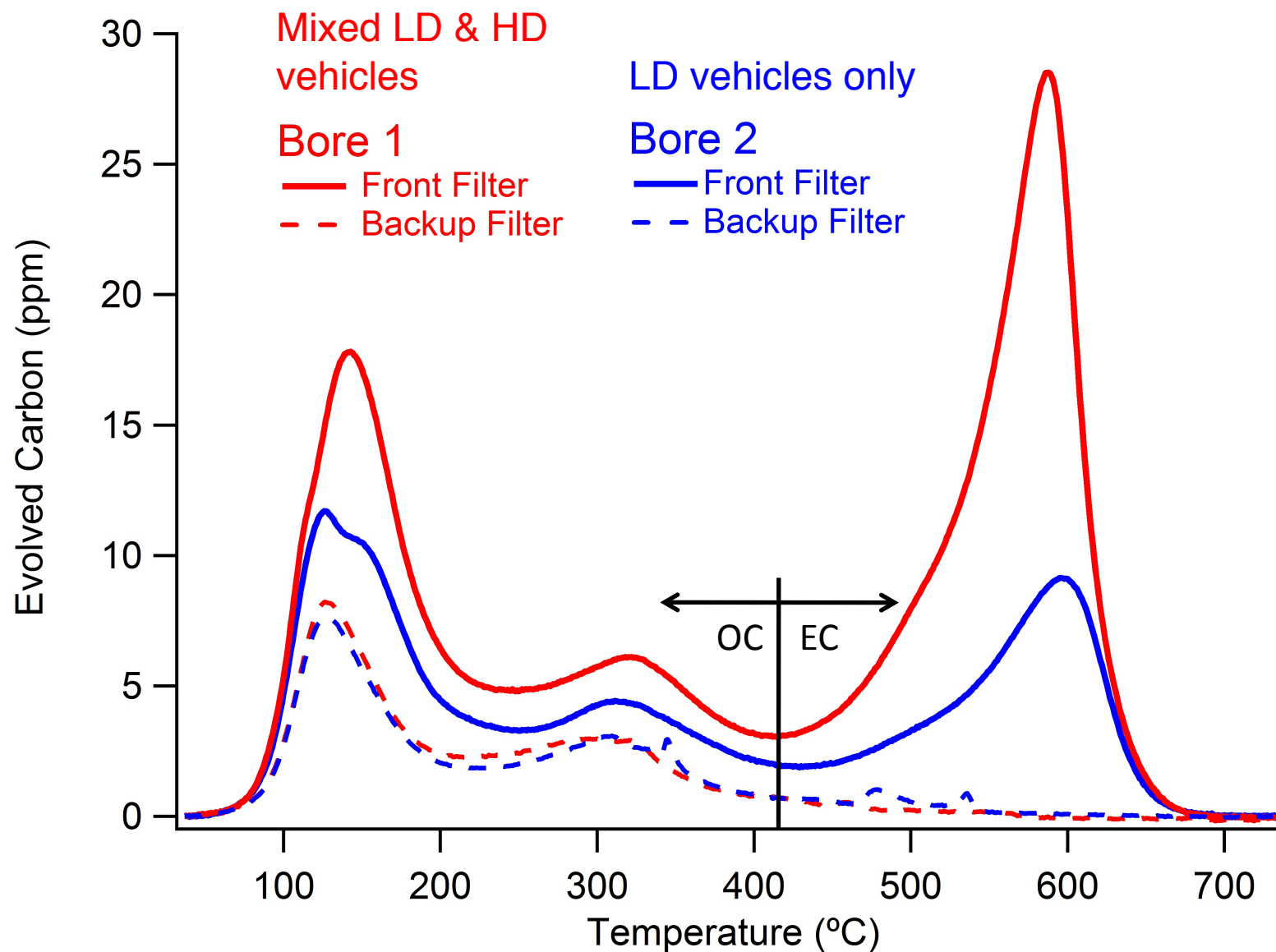


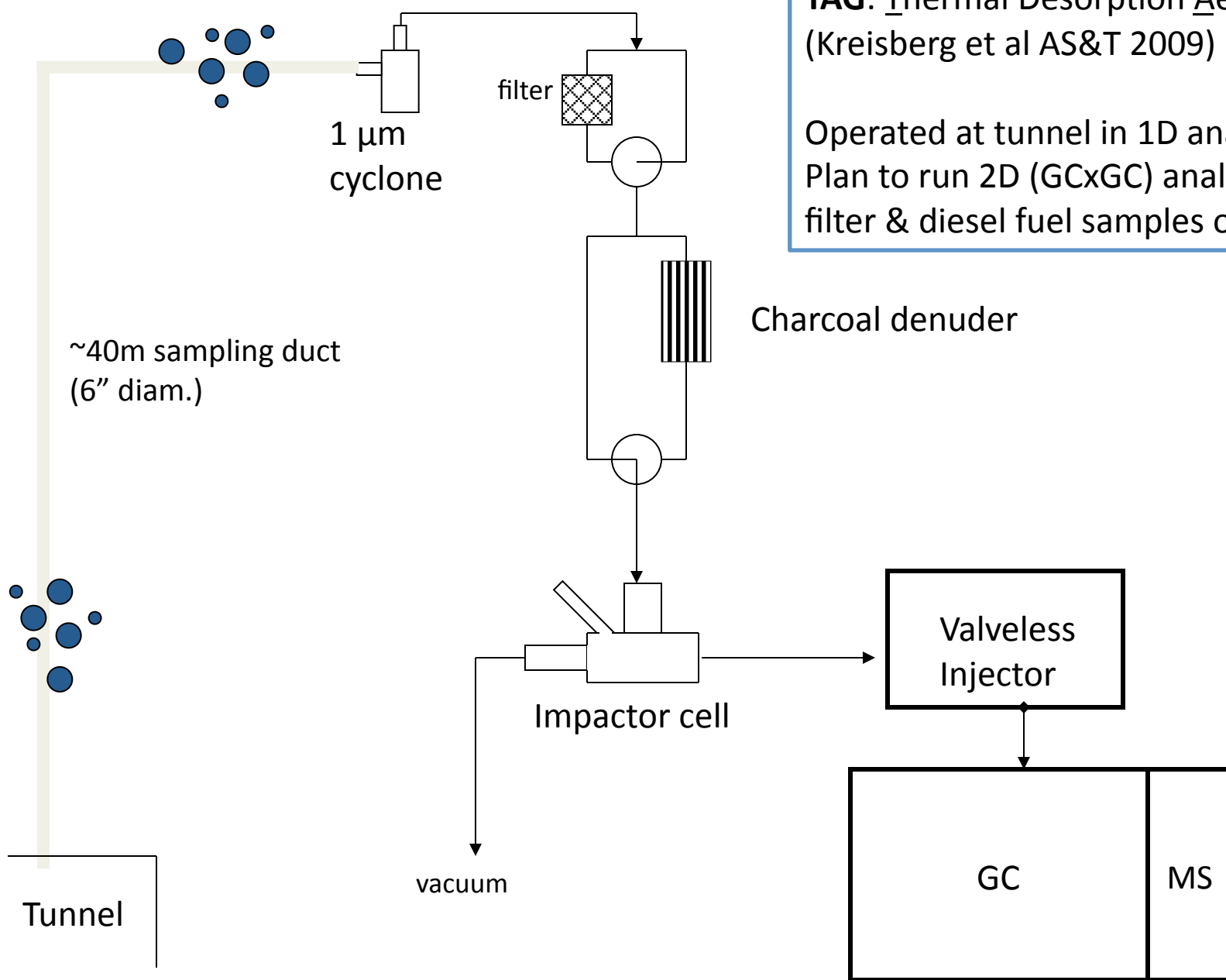
Tunnel VOC Measurements

- Straight chain alkanes, branched alkanes & cycloalkanes
- Alkenes & alkynes
- Aromatics & polycyclic aromatic hydrocarbons (PAH)
- Aldehydes, ketones & alcohols



Quartz Filters for OC & EC

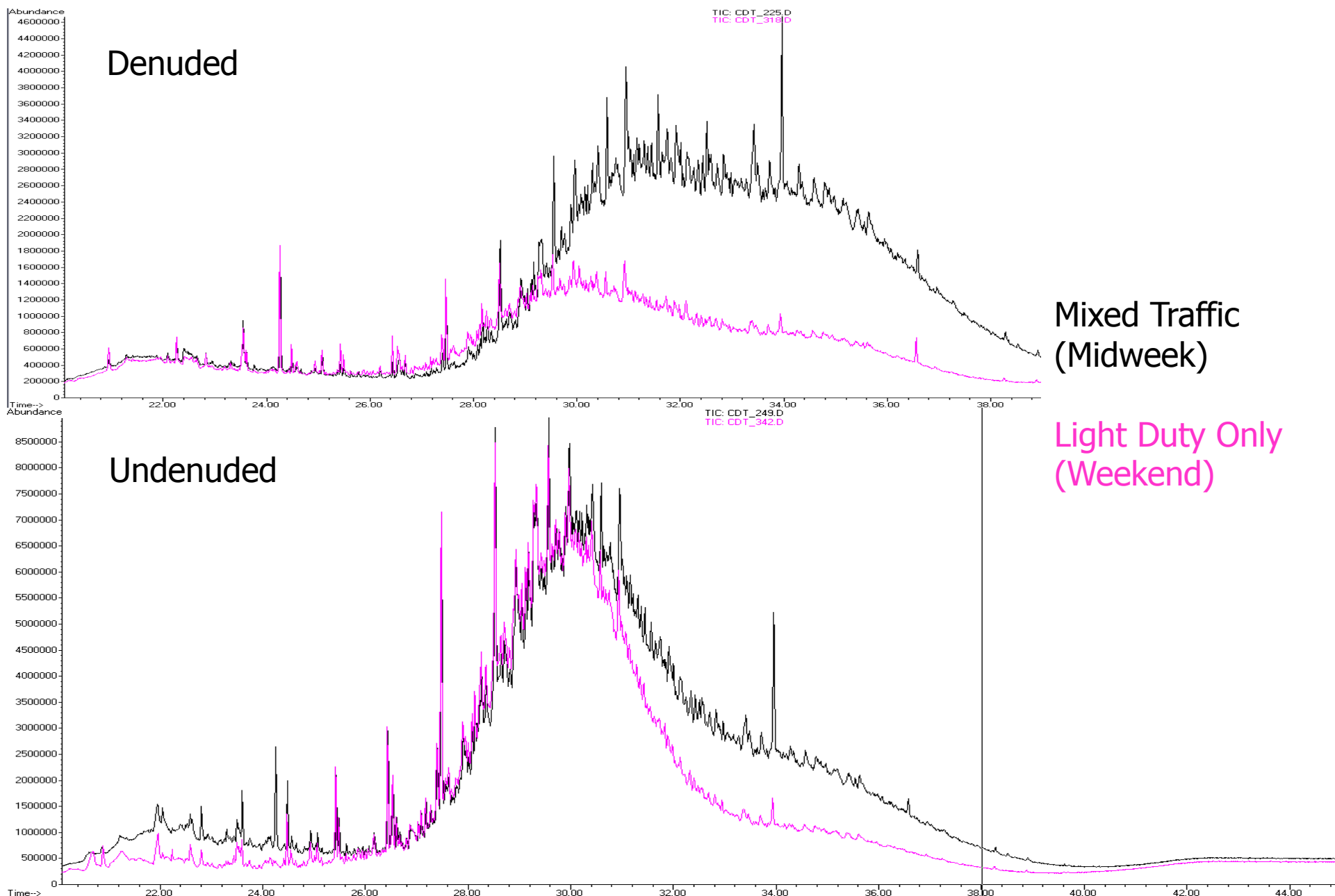




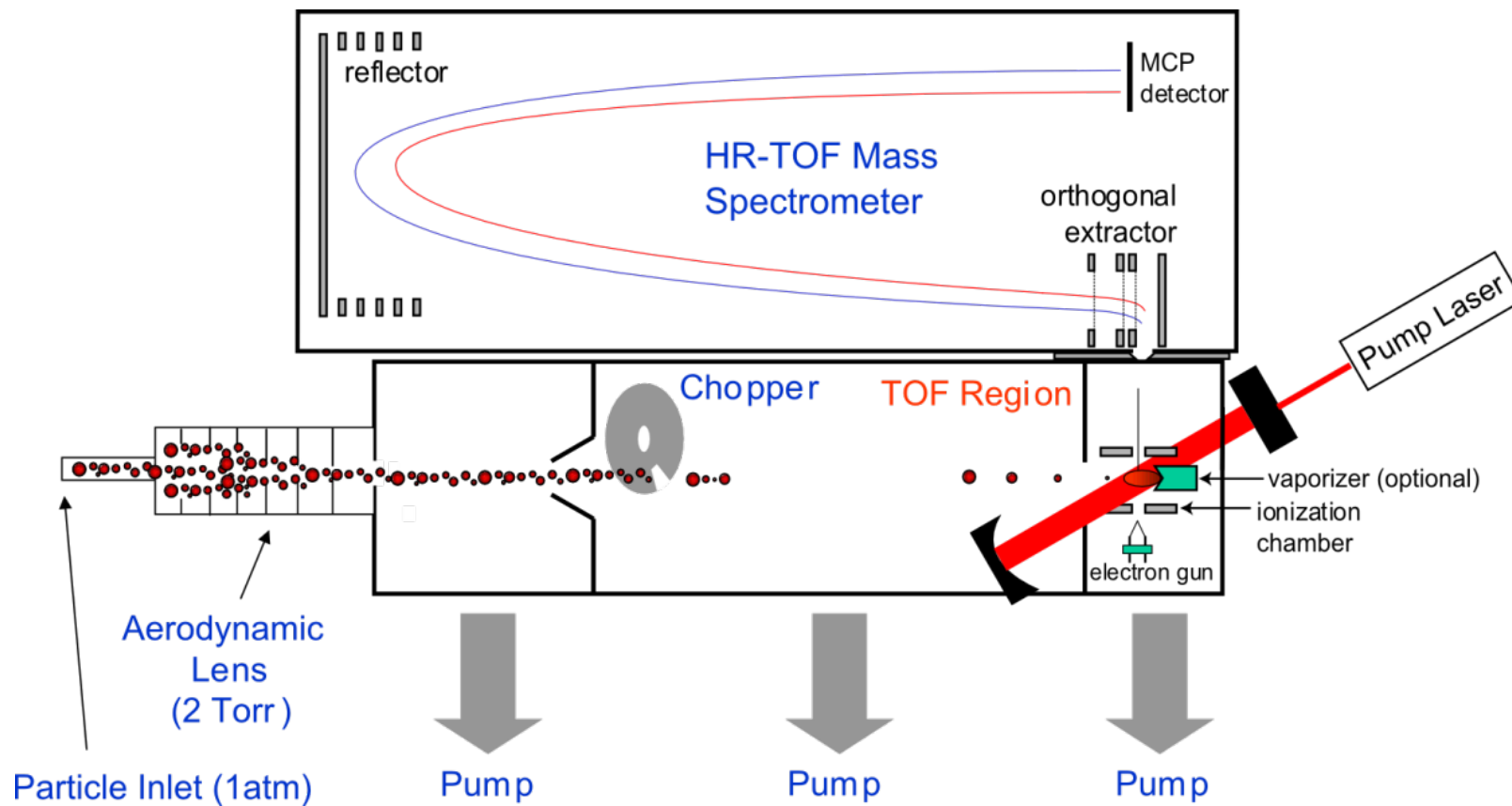
TAG: Thermal Desorption Aerosol GC
(Kreisberg et al AS&T 2009)

Operated at tunnel in 1D analysis mode
Plan to run 2D (GCxGC) analyses on quartz filter & diesel fuel samples offline

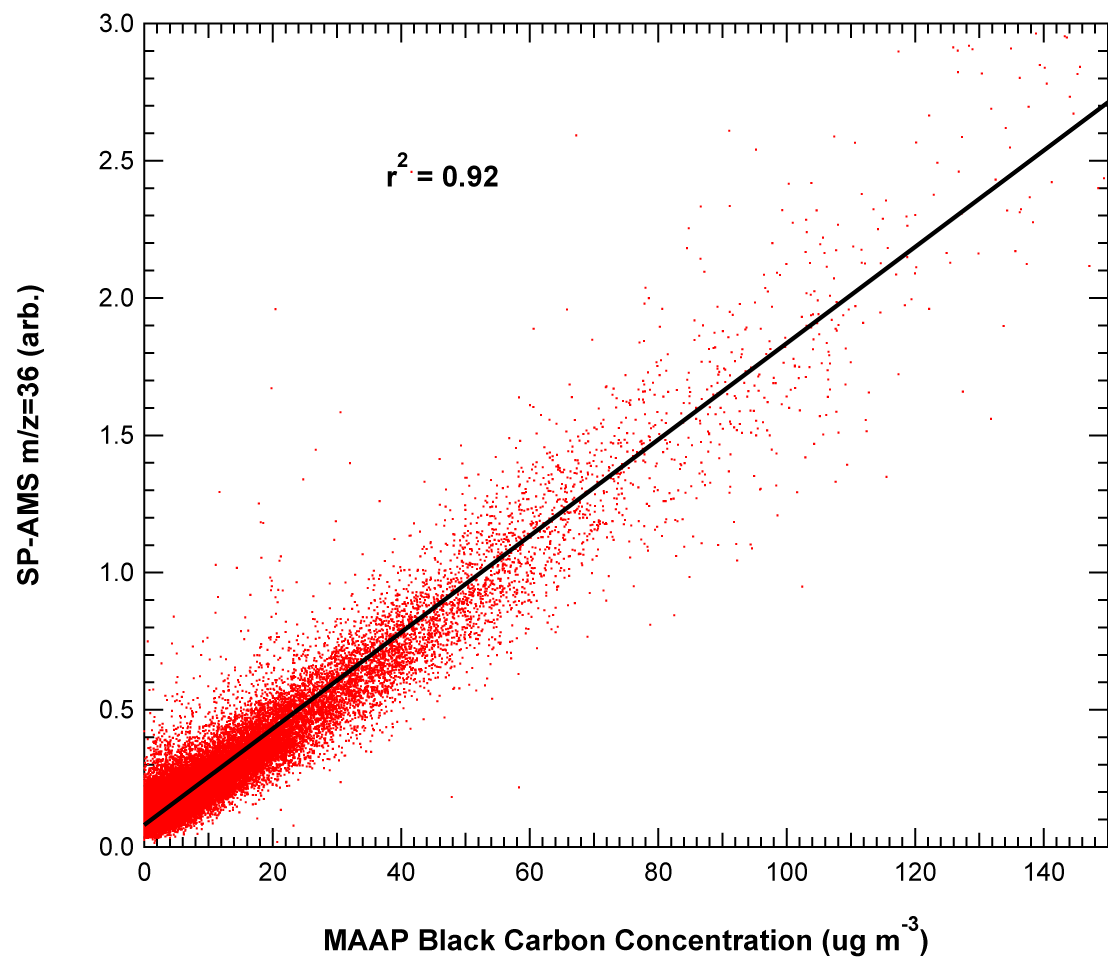
Particulate Organic Carbon Speciation



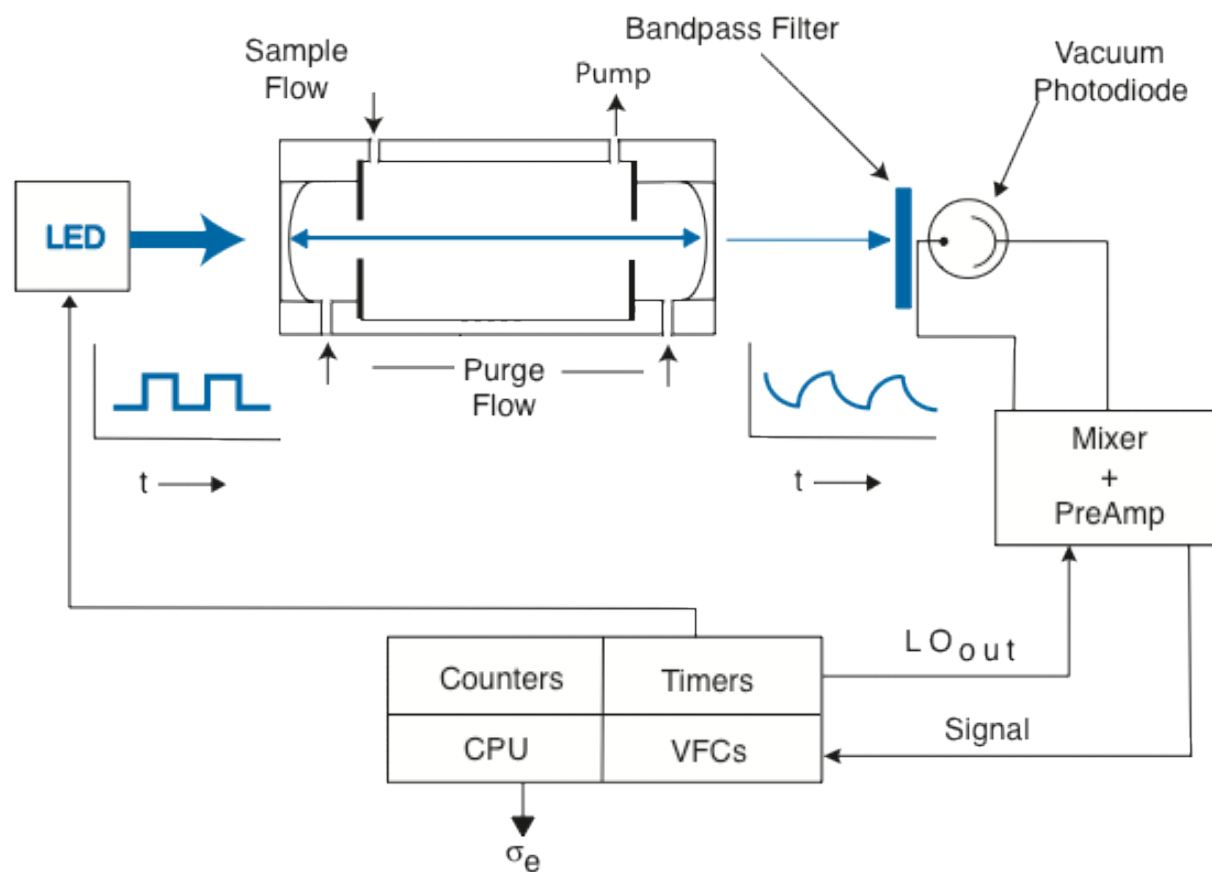
SP-AMS



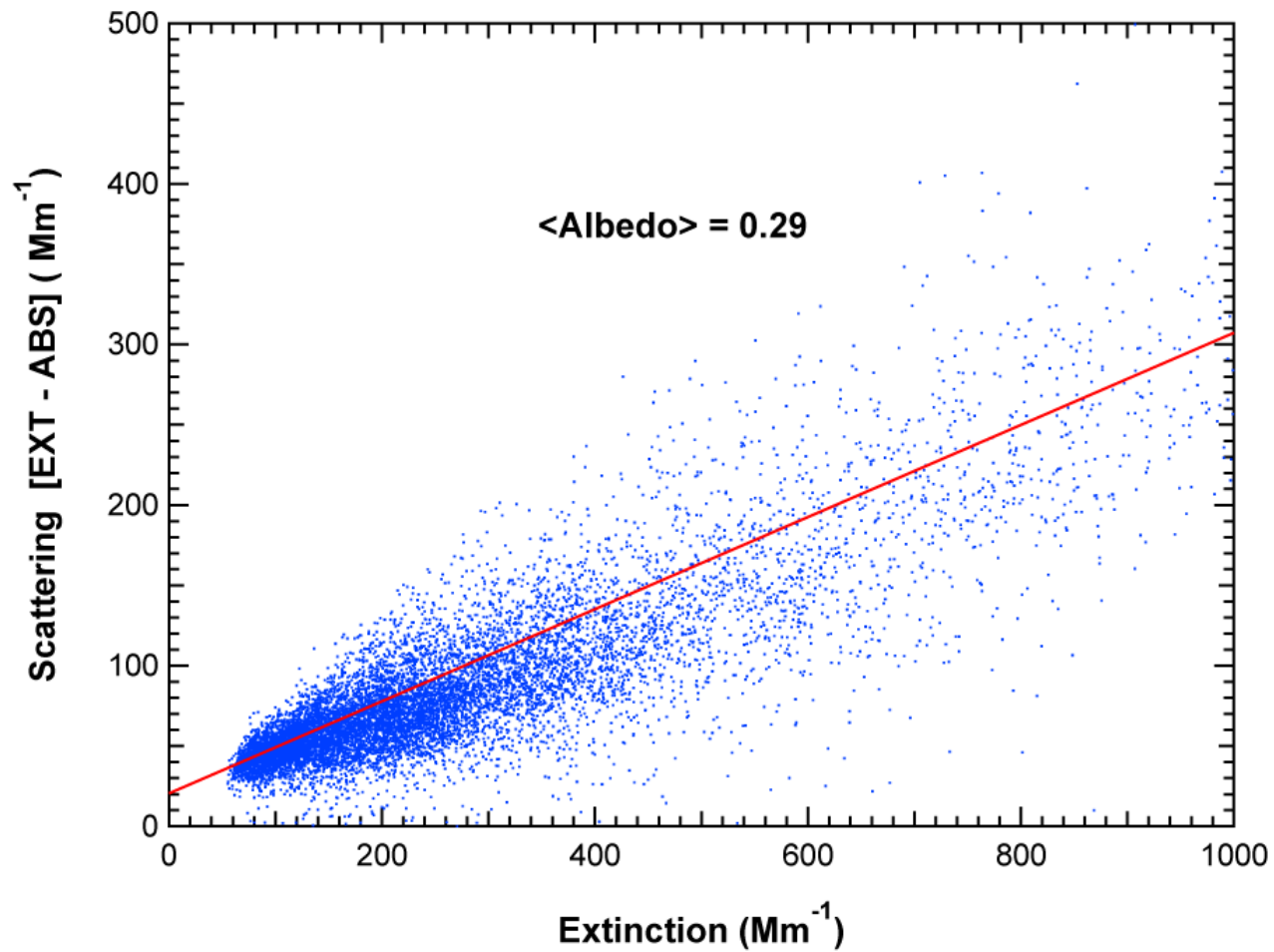
SP-AMS C_3^+ vs Black Carbon



CAPS PM Extinction



Single Scatter Albedo



Summary and Next Steps

- Field study @ Caldecott completed last summer
- Laboratory analyses coming along...
 - filter samples
 - liquid fuel samples
- Data analysis efforts underway...
 - chemical speciation of VOC & PM emissions and relationship to fuel composition
 - individual truck emission factors
 - fleet-average emission factors & trends