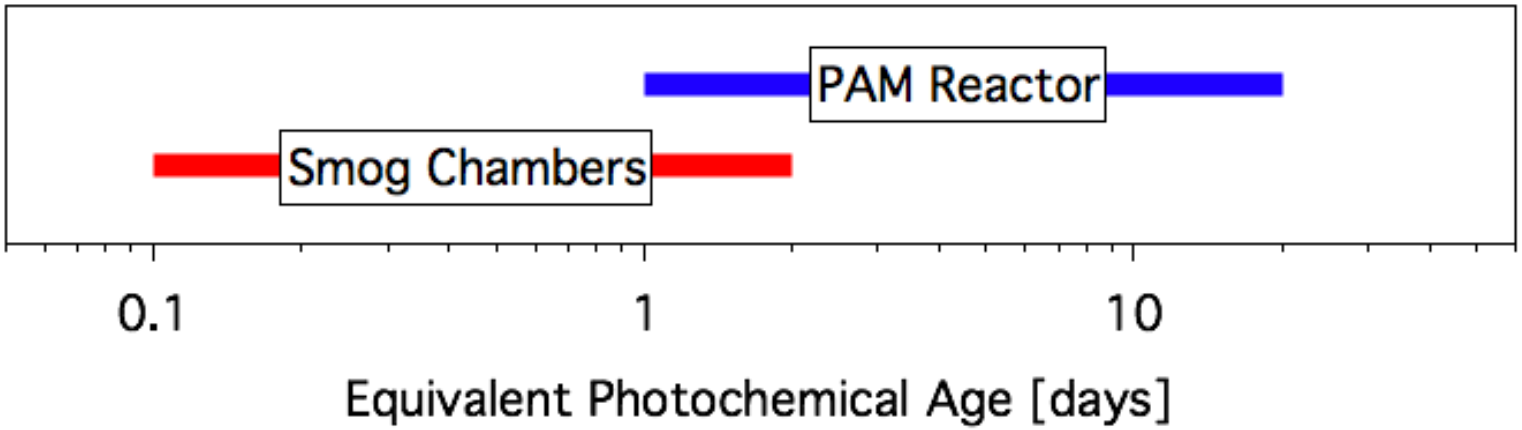
Updates on Aerodyne PAM Oxidation Flow Reactor

Andy Lambe

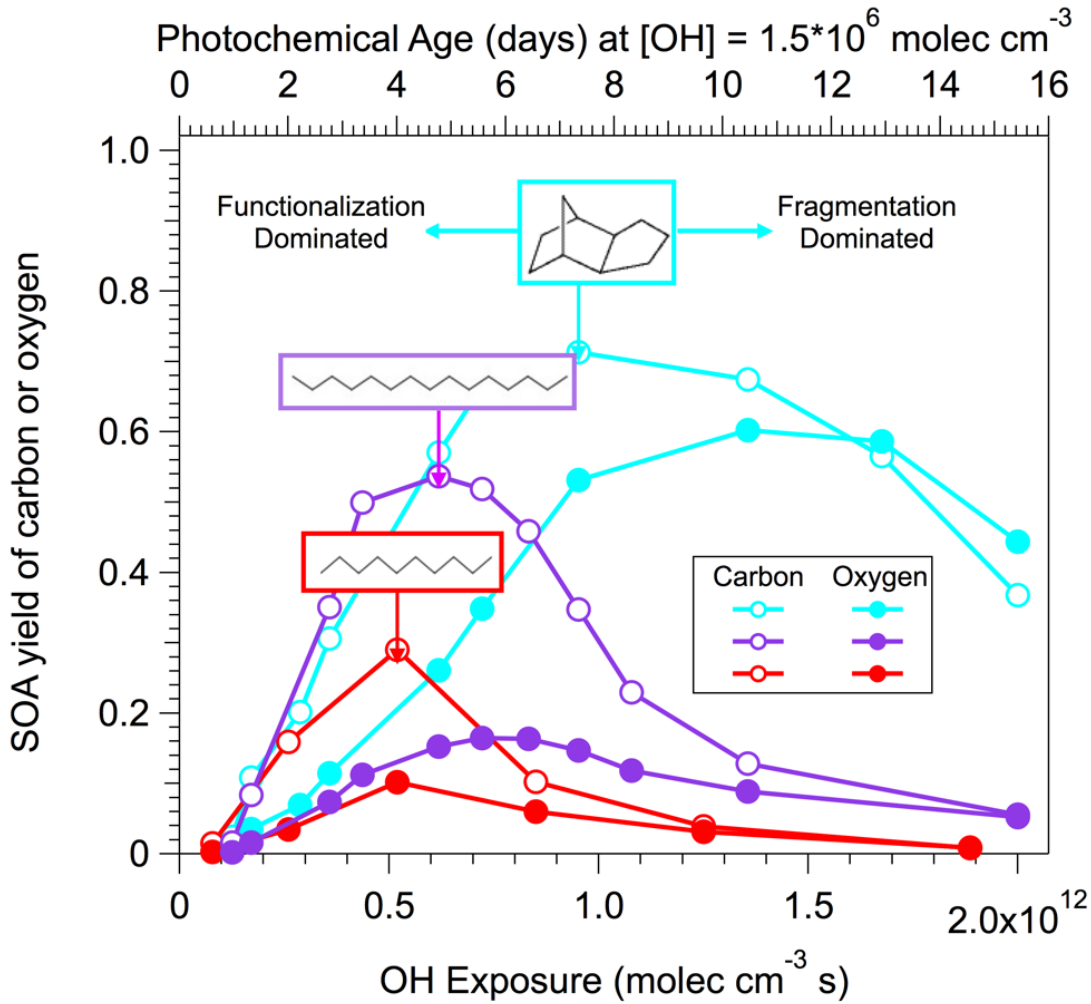
Potential Aerosol Mass (PAM) Oxidation Flow Reactor

- Developed by Bill Brune, improved and manufactured by Aerodyne
- Flow-through reactor, precursors exposed to O_3, OH, $\mathbf{NO_3}$; HO_2, $\mathbf{NO_x}$



Characterization: Kang et al., 2007; Lambe et al., 2011, 2015; Bruns et al., 2015
Modeling: Chen et al., 2013; Li et al., 2015; Peng et al., 2015, 2016

SOA formation from multi-generation oxidation of precursors

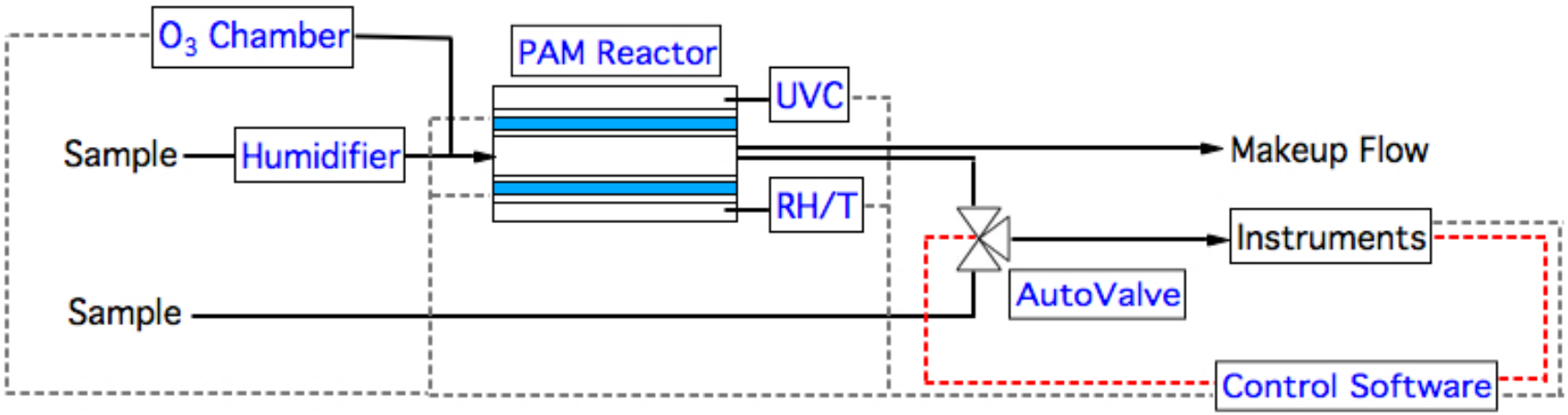


Lambe et al., 2012
Chen et al., 2013
Tkacik et al., 2014
Ortega et al., 2016
Palm et al., 2016

Deliveries

Serial #	Delivery	Institution
001	Dec 2016	Washington University in St. Louis
002	Feb 2016	Pacific Northwest National Laboratory
003	Feb 2016	Desert Research Institute
004	Mar 2016	Aerodyne
005	Jun 2016	Chinese Academy of Sciences
006	Apr 2016	Ohio State University
007	Jul 2016	Hankuk University
008	Jul 2016	Aerodyne
009	Jul 2016	Peking University
010	Aug 2016	Finnish Meteorological Institute
011	Sep 2016	Laboratorie des Sciences du Climat et de l'Environnement
012	Nov 2016	National University of Singapore
013	Dec 2016	University of California – San Diego

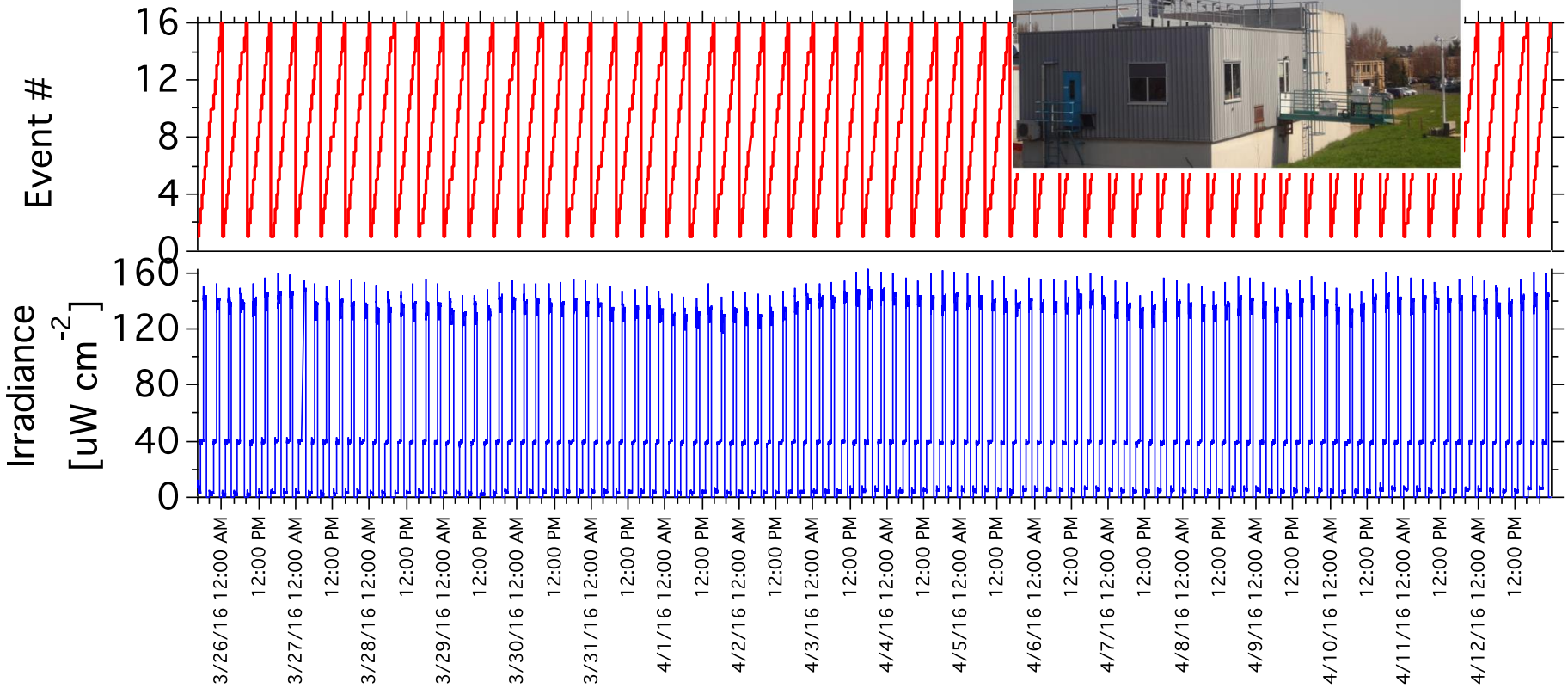
System Components



- Oxidation flow reactor with “OFR185” and “OFR254” capability
- O_3 chamber, Humidifier
- Autovalve, RH/T, Photodiode, User I/O Box, Flow Controllers
- E-box with ballasts and control board
- PAMControls software

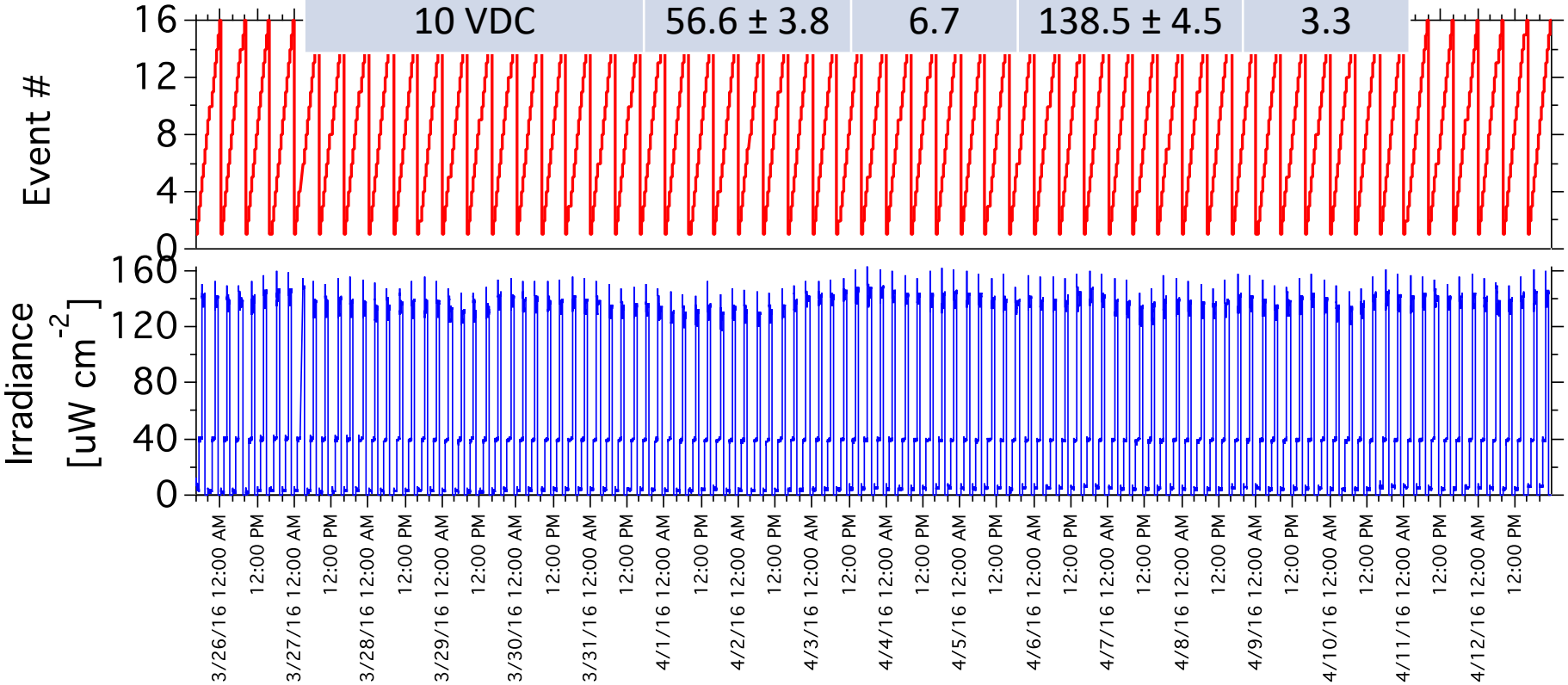
- FIELD DEPLOYABLE

Unattended field operation in Mar 2016 Gif-sur-Yvette, France



OVERVIEW

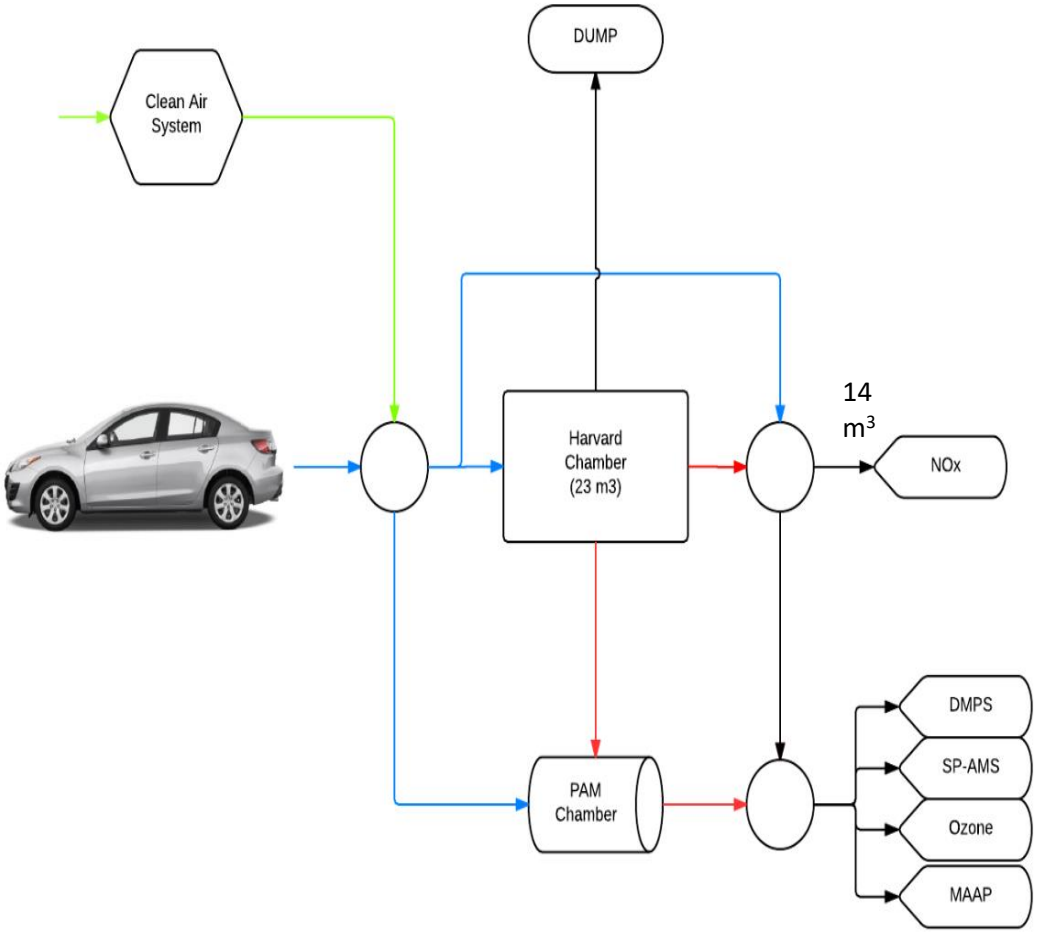
"OFR185" Dimming Voltage	O_3 / ppm	RSD (%)	Irradiance / uW cm^{-2}	RSD (%)
1 VDC	3.6 ± 0.5	12.8	4.2 ± 1.0	24.2
3 VDC	20.3 ± 1.4	6.8	40.0 ± 0.4	0.9
10 VDC	56.6 ± 3.8	6.7	138.5 ± 4.5	3.3



OVERVIEW

FINNISH METEOROLOGICAL INSTITUTE

CMMCh Harvard Photochemical Chamber chamber vs PAM



Hilkka Timonen, 4th PAM Users Meeting

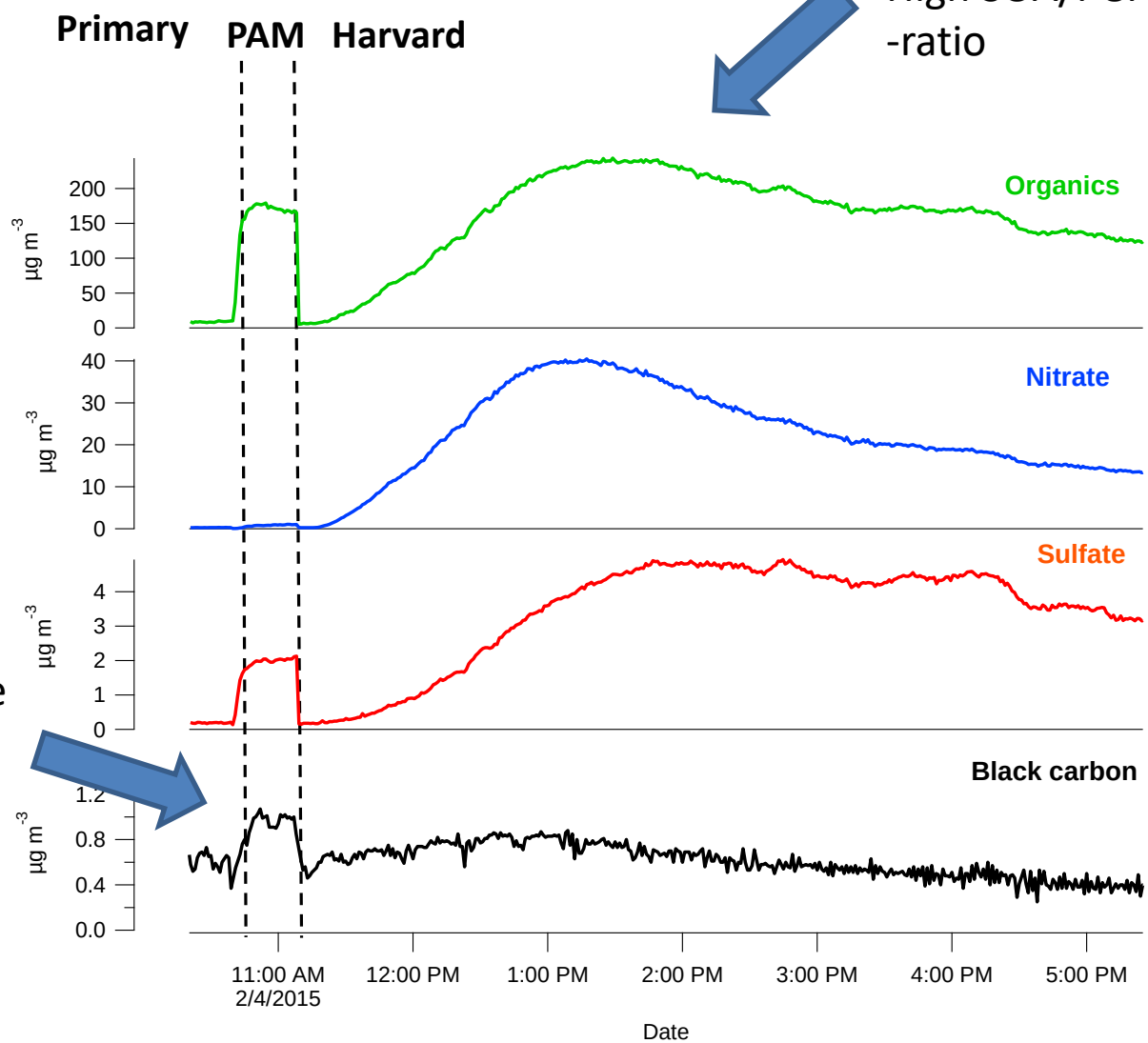
- Teflonbag, with side 2.4 m
- 180 UVA 340nm lamps

FINNISH METEOROLOGICAL INSTITUTE

CMMCh Harvard Photochemical Chamber chamber vs PAM

High SOA/POA -ratio

Increase In BC



Hilkka Timonen, 4th PAM Users Meeting

OH oxidation with NO_x

$$O_3 + h\nu_{254} \rightarrow O(^1D) + O_2$$

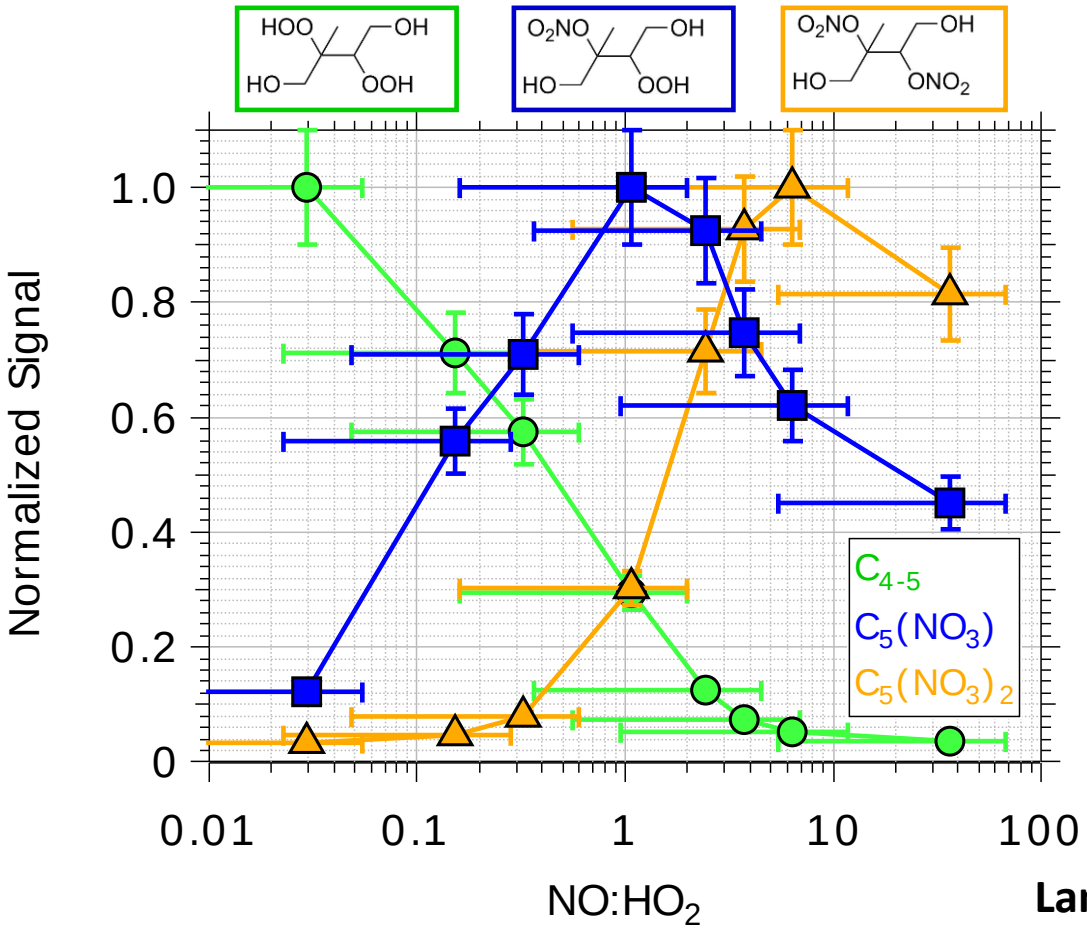
$$O(^1D) + H_2O \rightarrow 2OH$$

$$O(^1D) + N_2O \rightarrow 2NO$$

$$N_2O + h\nu_{185} \rightarrow O(^1D) + N_2$$

Lambe et al., in prep
Peng et al., in prep

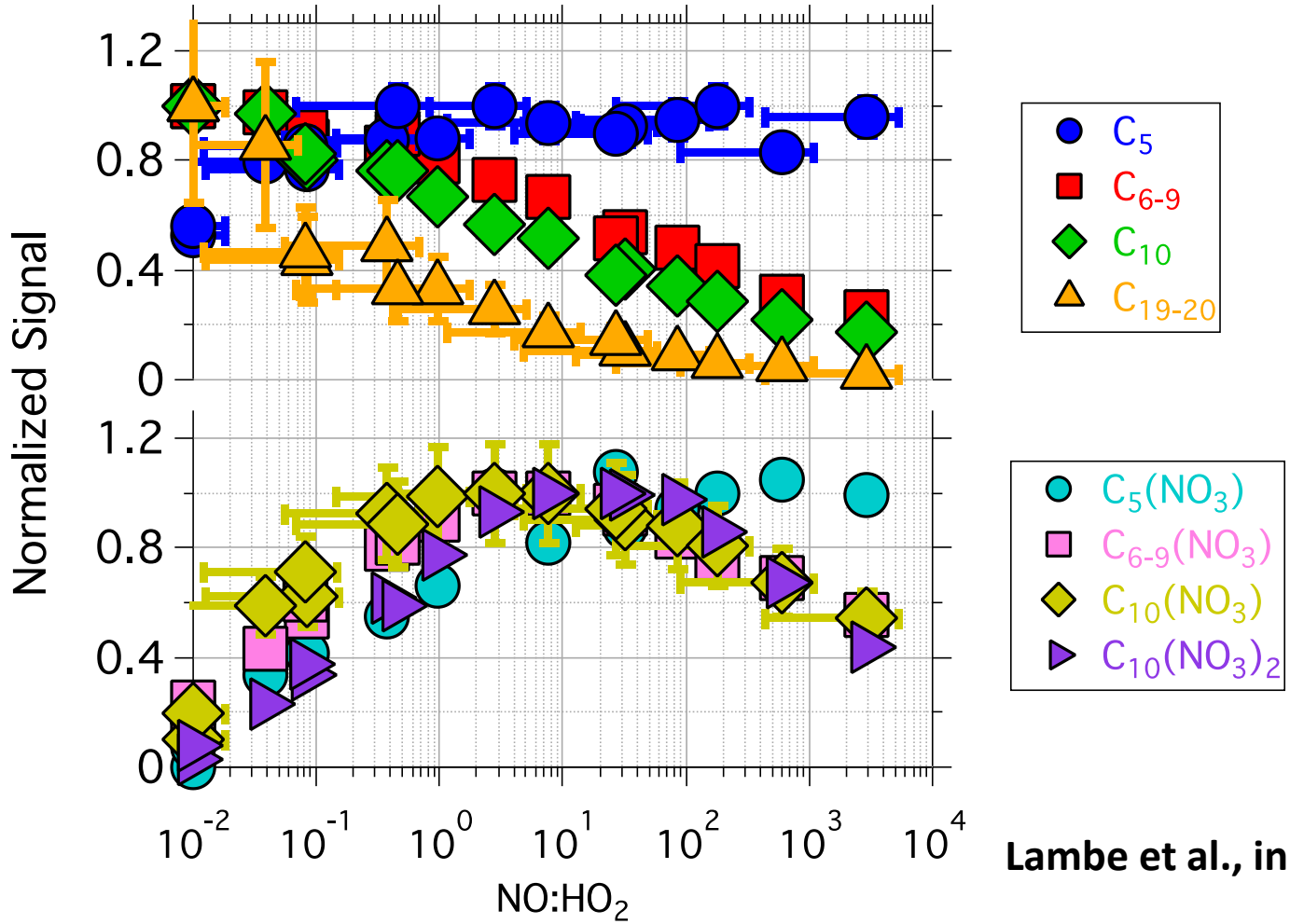
Transition from RO_2+HO_2 to RO_2+NO-dominant conditions: isoprene



Lambe et al., in prep

NEW TECHNIQUES

Transition from RO_2+HO_2 to RO_2+NO-dominant conditions: α-pinene



Lambe et al., in prep

NEW TECHNIQUES

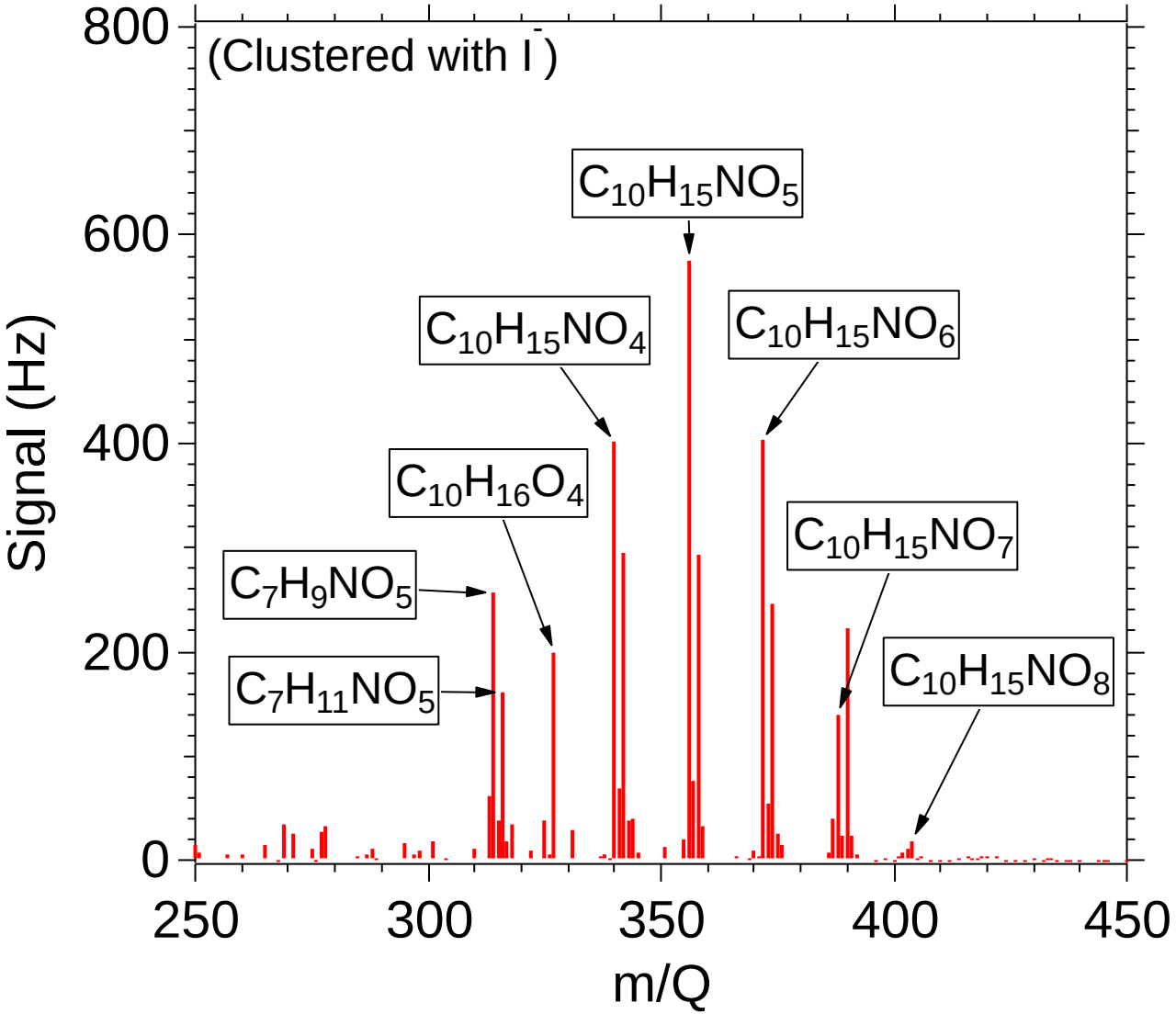
NO_3 radical generation

$$O_3 + NO_2 \rightarrow NO_3 + O_2$$

$$NO_3 + NO_2 \rightarrow N_2O_5$$

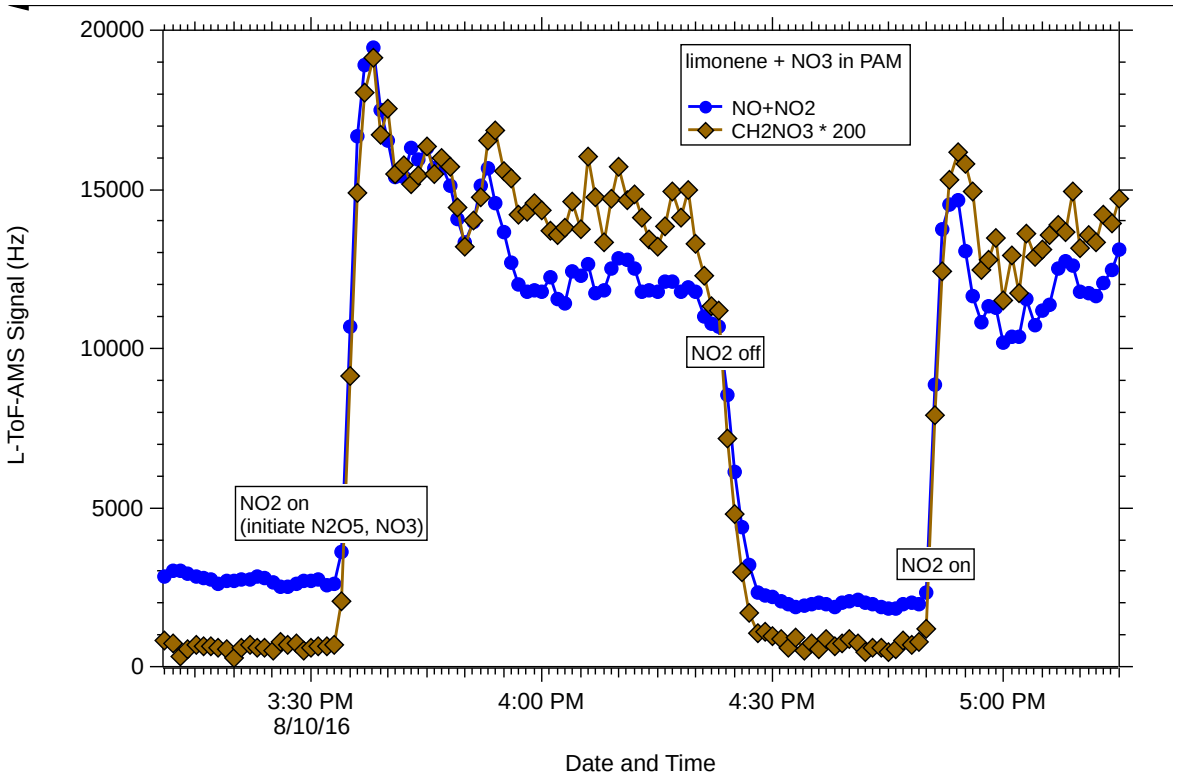
$$N_2O_5 \rightarrow NO_3 + NO_2$$

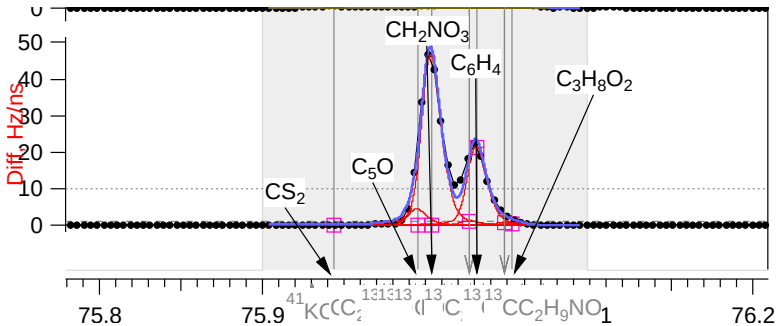
α-pinene + NO_3 products detected with I-CIMS



NEW TECHNIQUES

SOA from limonene + NO3, detected with L-ToF-AMS





NEW TECHNIQUES

Outlook

- ~10 deliveries per year
- NO_3 radical to supplement OH radical (+ NO_x)
- Minor tweaks to hardware and software
- Synergistic applications with mass spectrometers

https://sites.google.com/site/pamwiki/home