

US EPA ARCHIVE DOCUMENT

Emissions of Gas-Phase Low-Volatility Organic Compounds from Mobile Sources

Jesse H. Kroll ,Eben S. Cross, J. F. Hunter, A. J. Carrasquillo,
J. P. Franklin, S. C. Herndon, J. T. Jayne, D. R. Worsnop, R. C. Miake-Lye, T. B. Onasch
A. Sappok, V. W. Wong



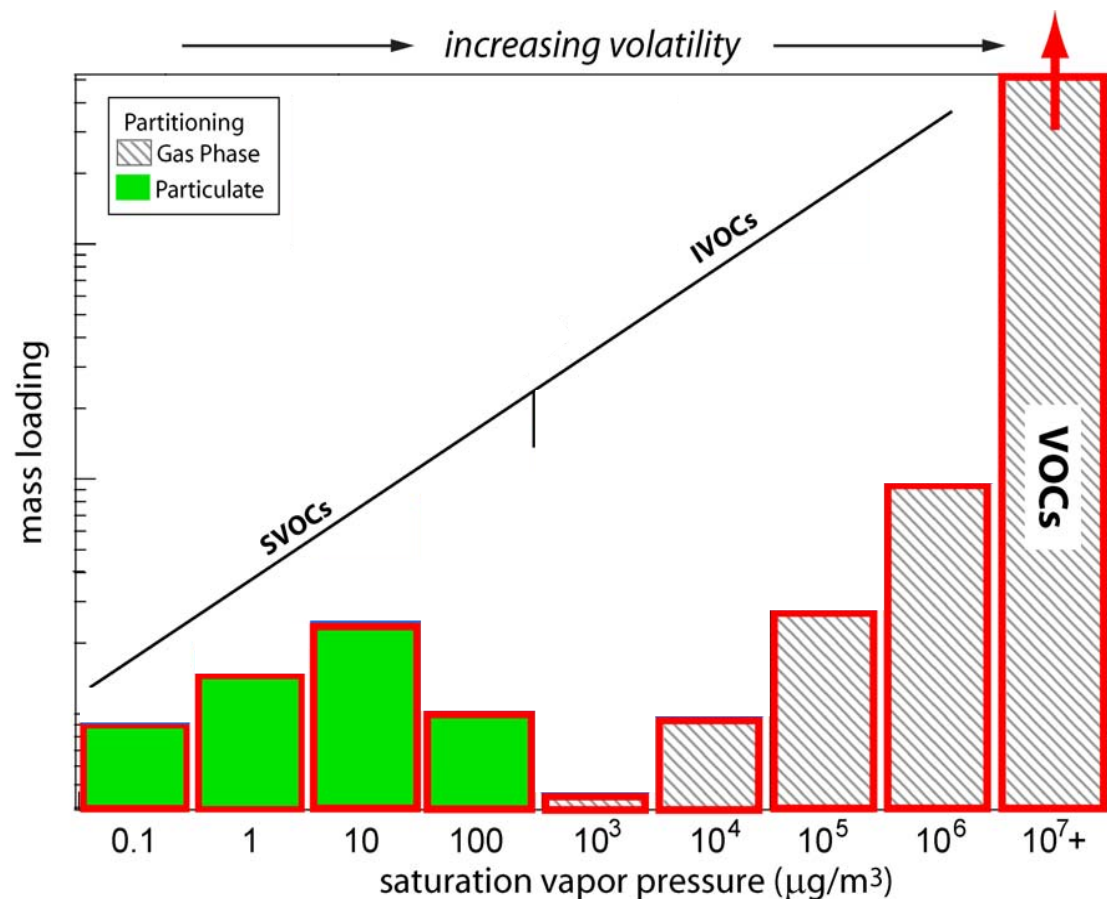
Department of
Civil & Environmental Engineering
Massachusetts Institute of Technology

MIT **ATMOSPHERIC**
CHEMISTRY



EPA STAR-OTAQ Transportation Emissions Research Forum
4 March 2014

Emissions of organic species

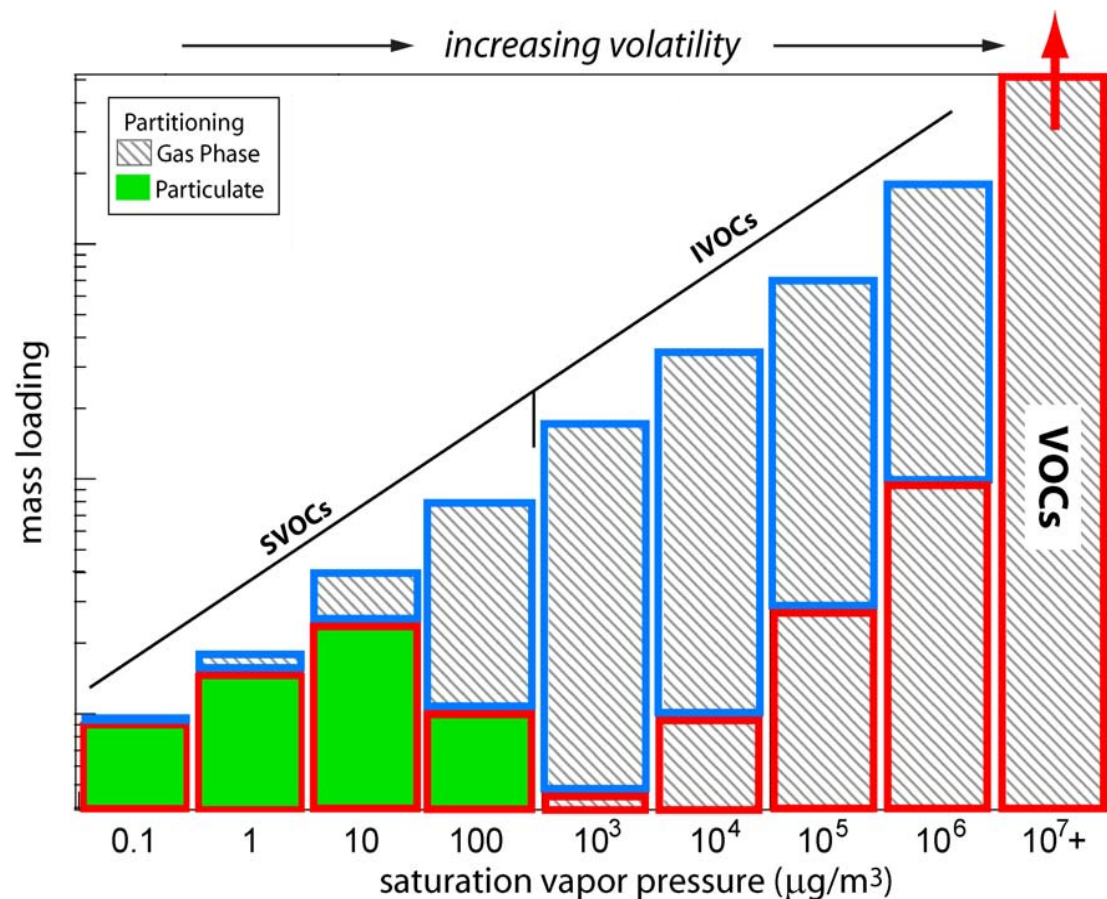


VOC: volatile organic compounds (gas phase)

IVOC: "intermediate volatility" organic compounds (gas phase)

SVOC: semivolatile organic compounds (gas, particle phase)

Emissions of organic species

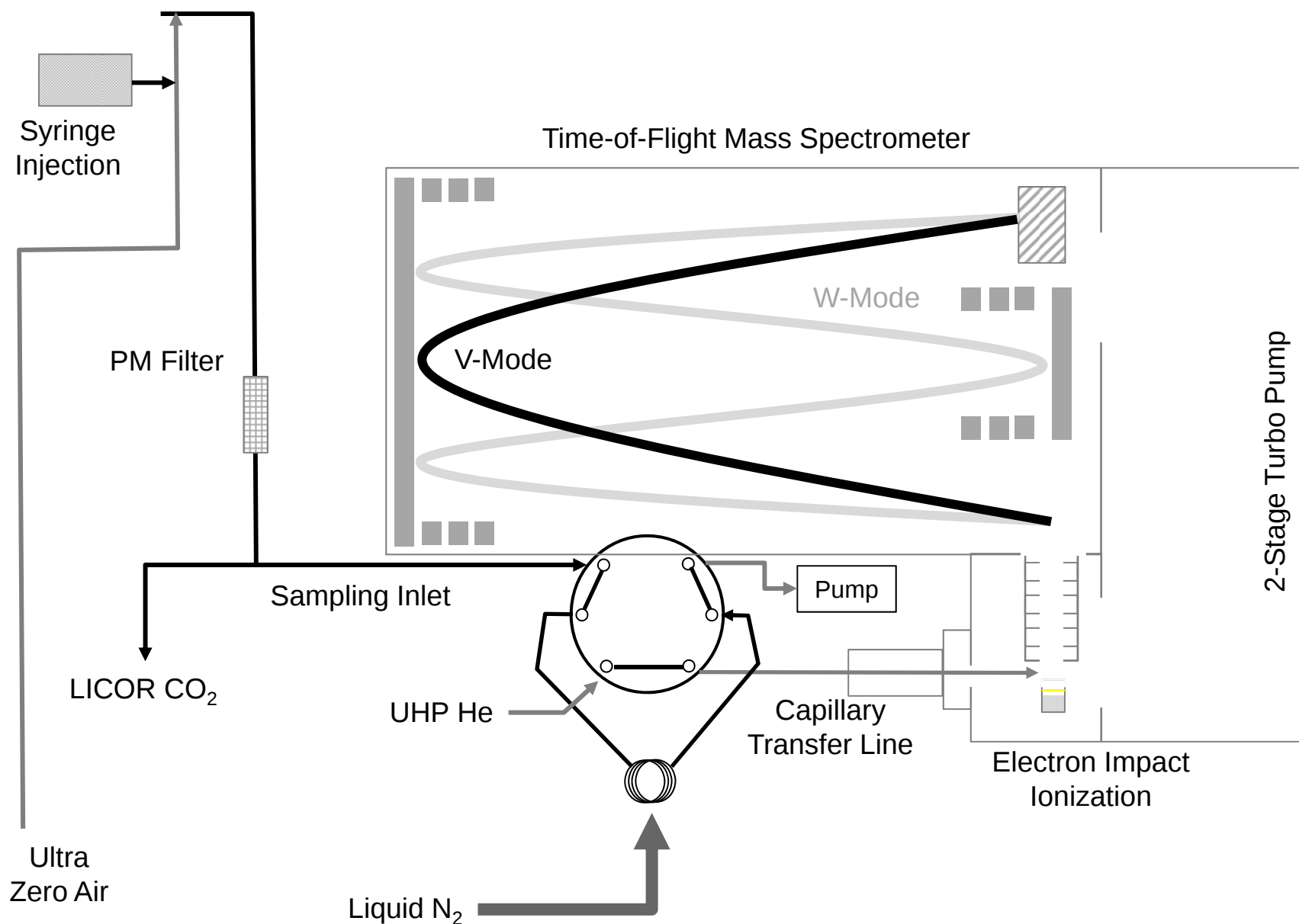


VOC: volatile organic compounds (gas phase)

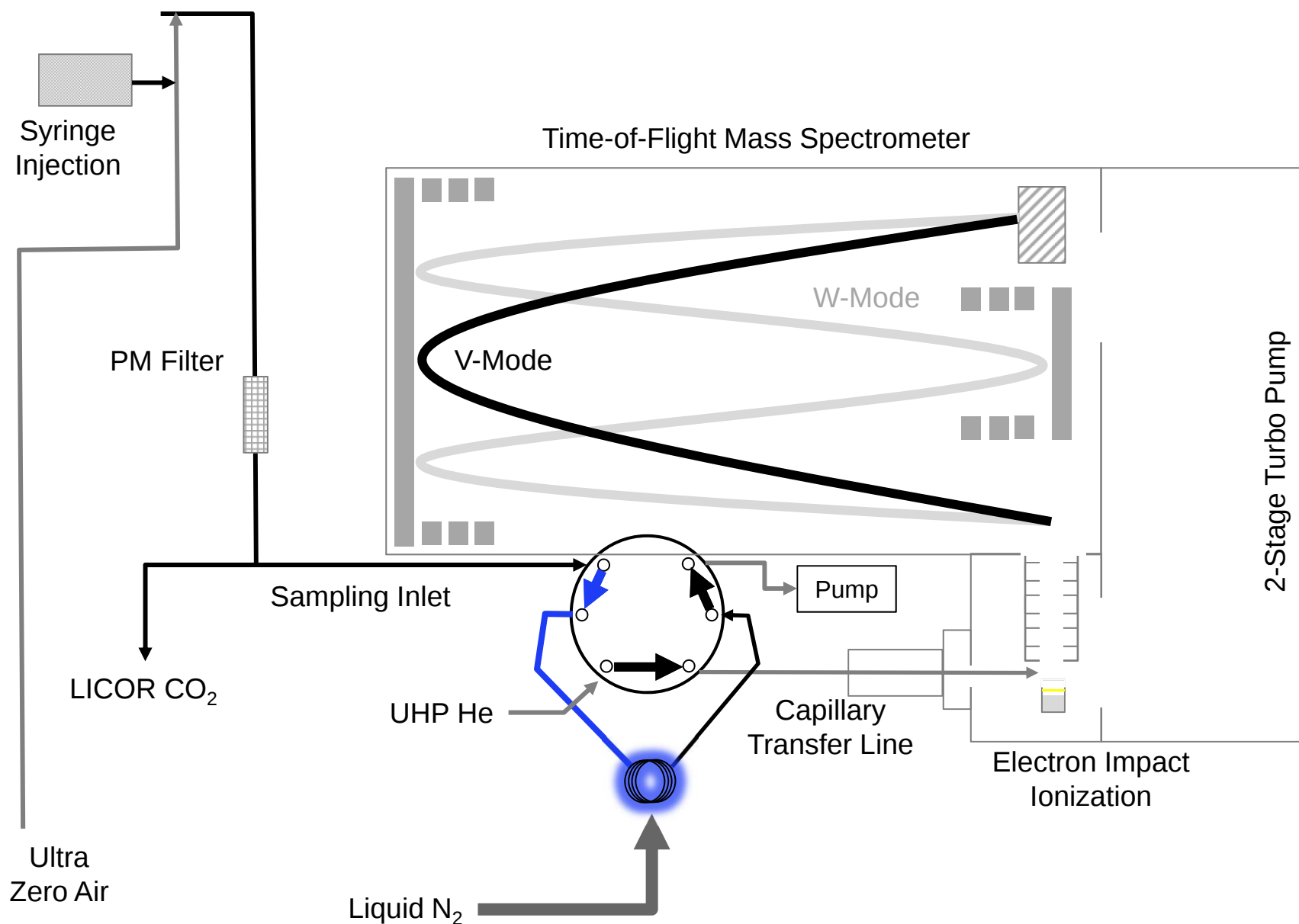
IVOC: "intermediate volatility" organic compounds (gas phase)

SVOC: semivolatile organic compounds (gas, particle phase)

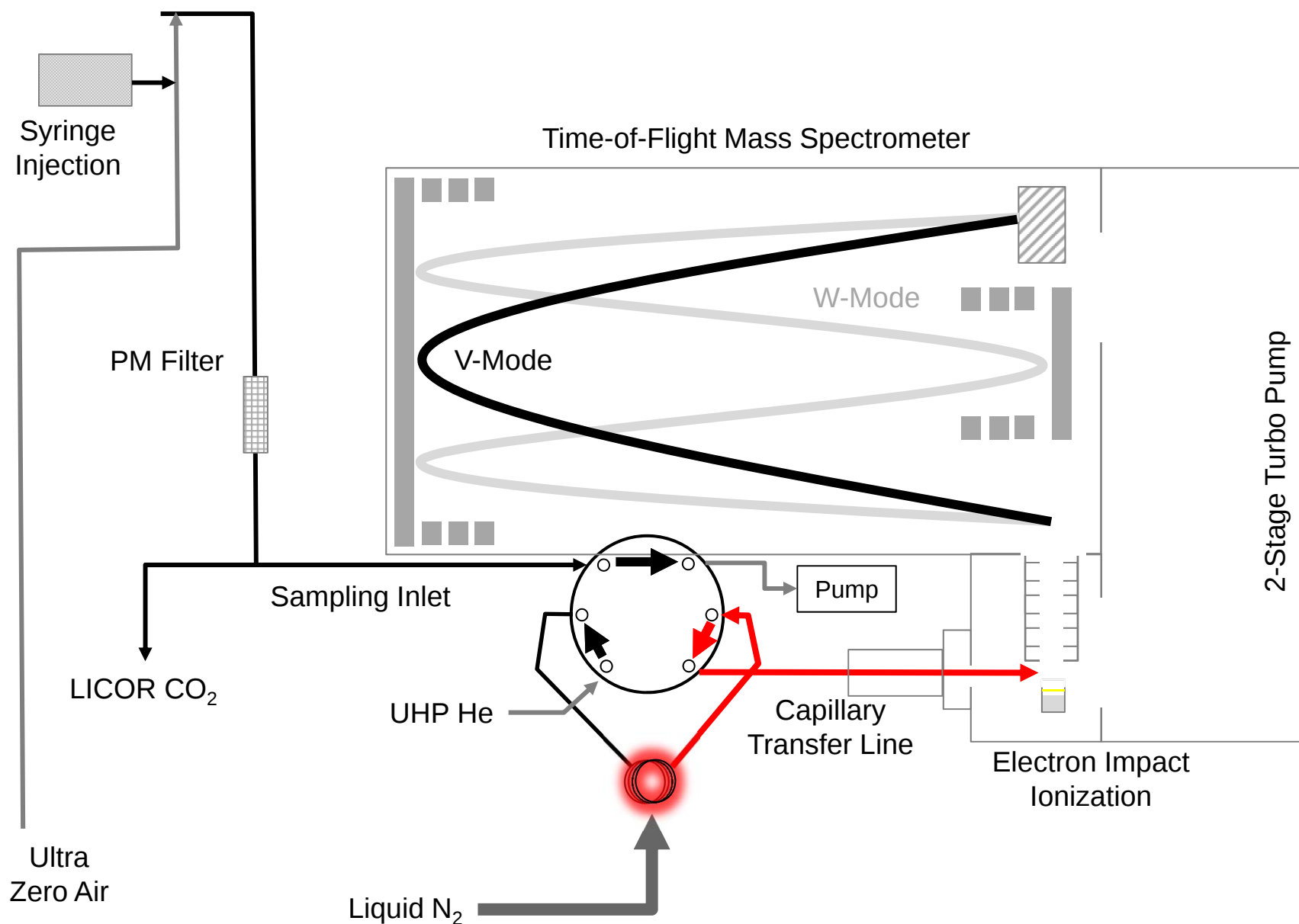
High-resolution electron impact mass spectrometer



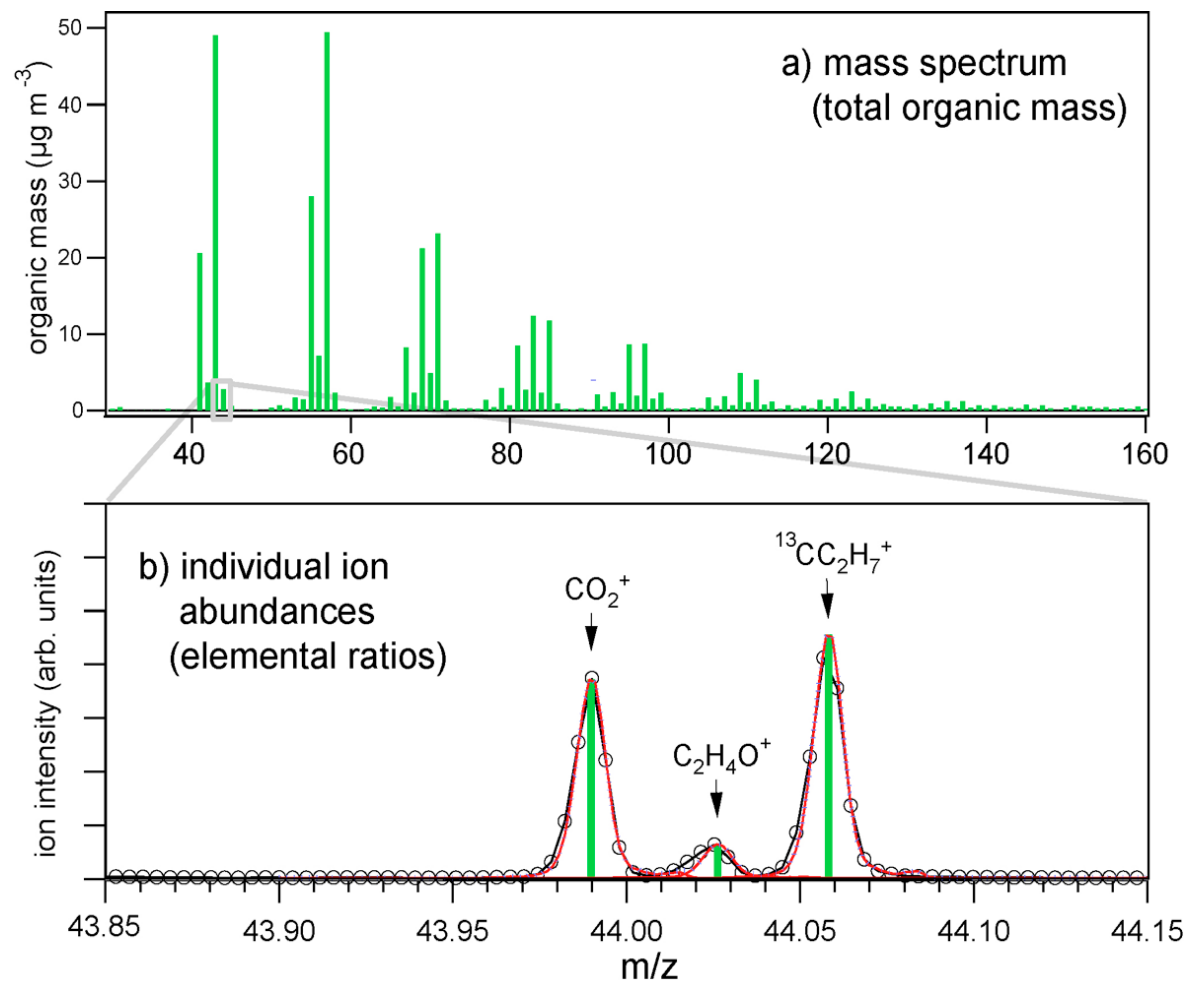
High-resolution electron impact mass spectrometer



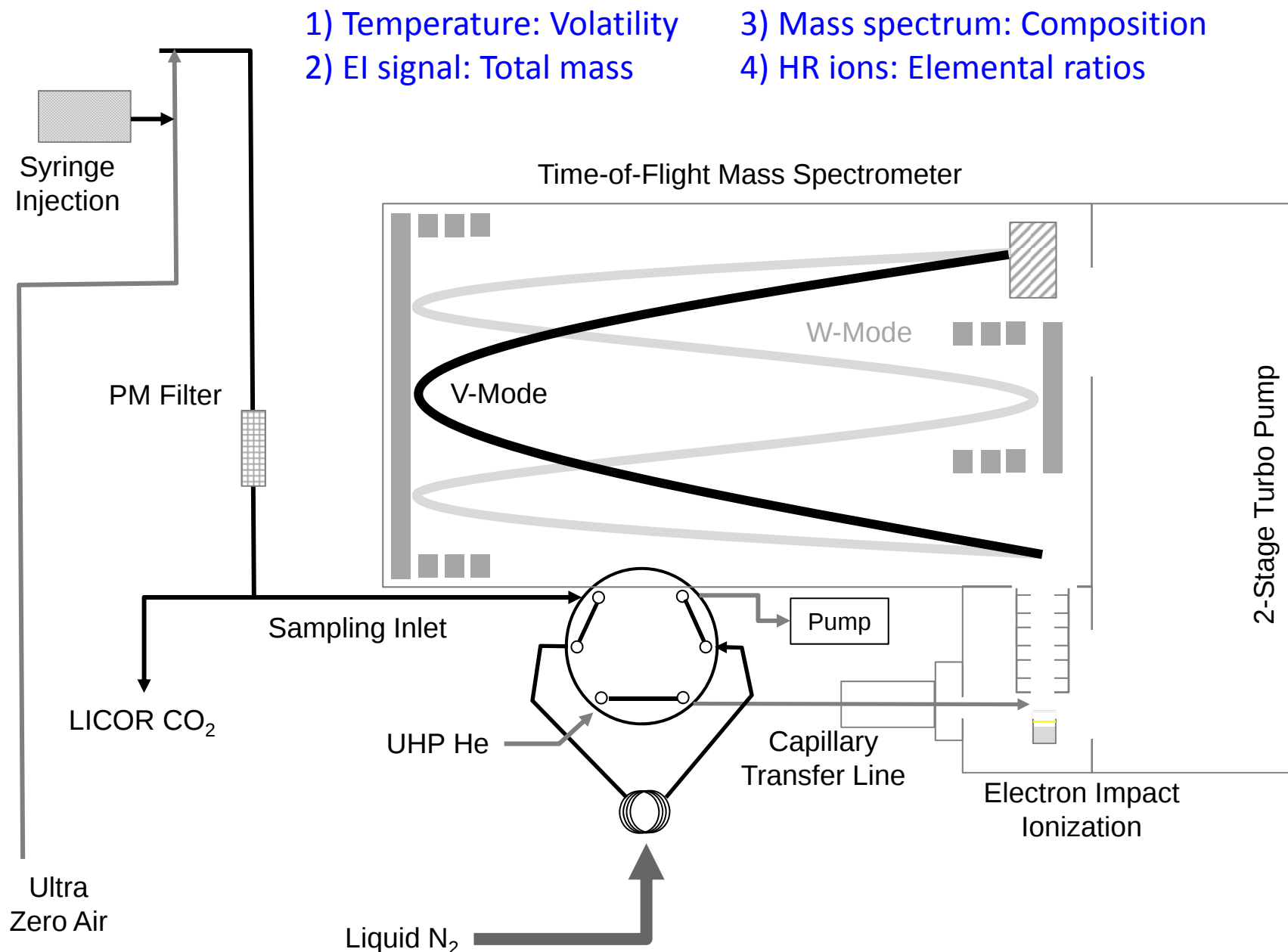
High-resolution electron impact mass spectrometer



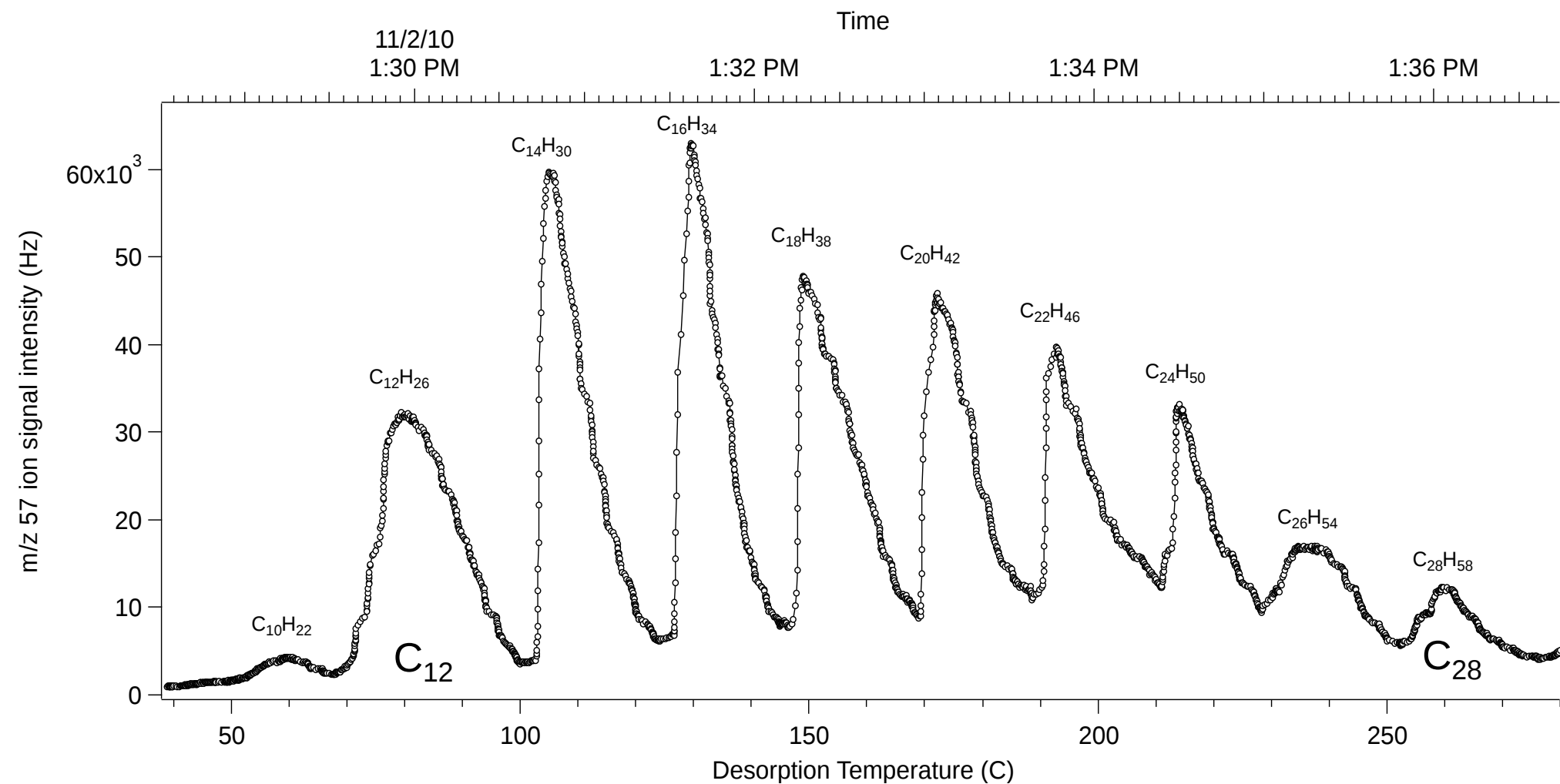
HR-EI-MS data



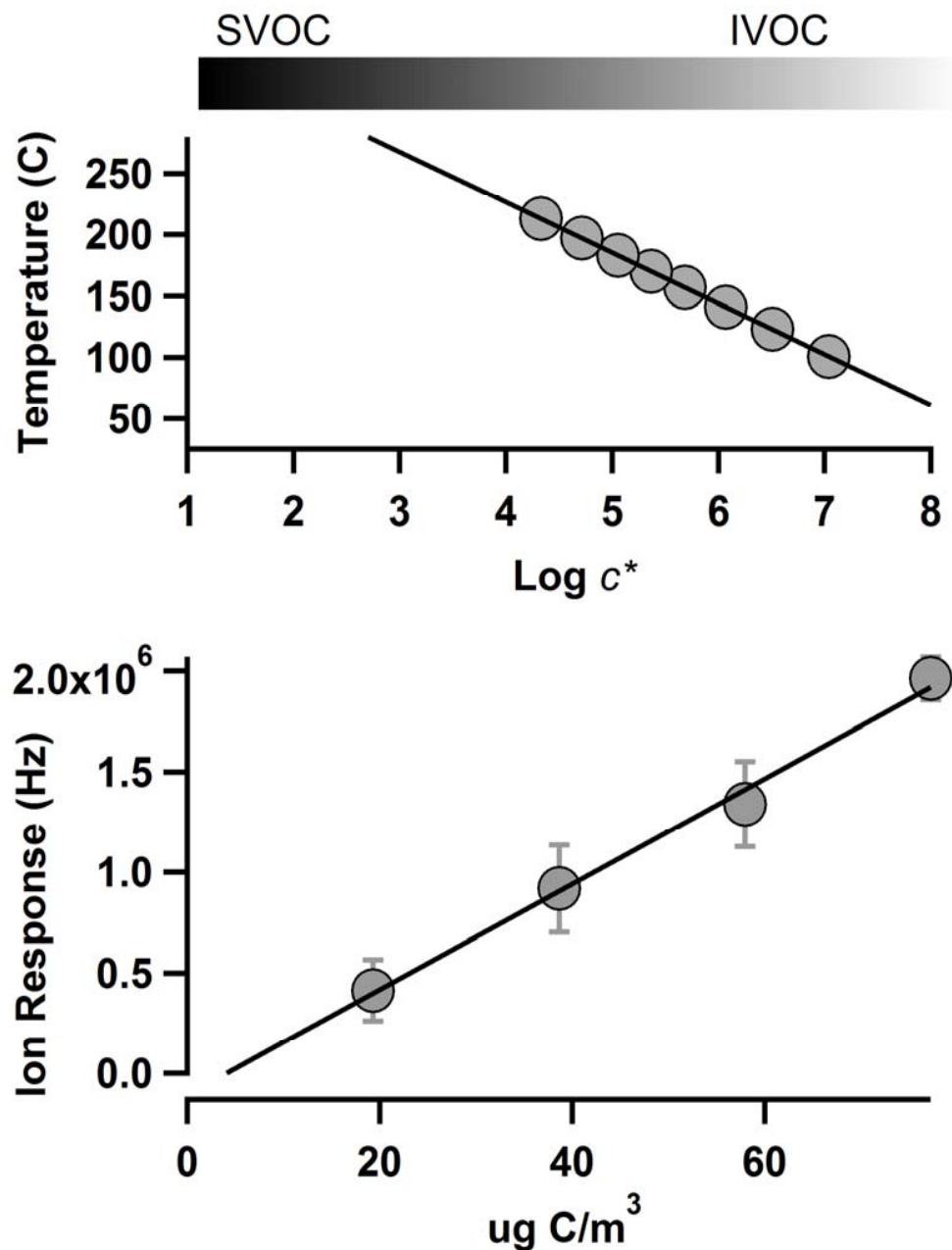
High-resolution electron impact mass spectrometer



Instrument response (*n*-alkanes)



Calibration (volatility, mass concentration)

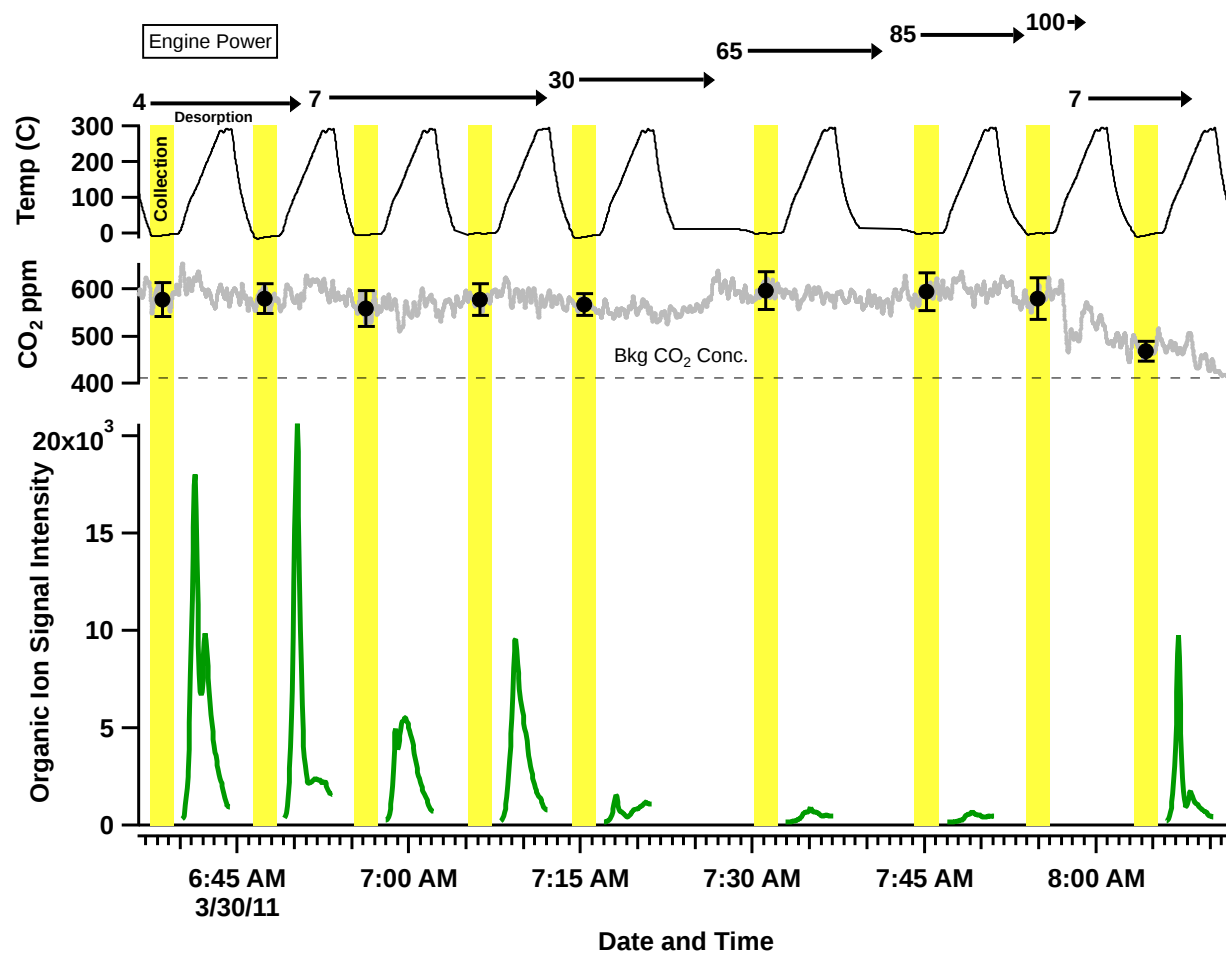


Emissions characterization: aircraft

AAFEX II: Alternative Aviation Fuels Experiment II
Dryden Aircraft Operations Facility, Palmdale CA, March-April 2011

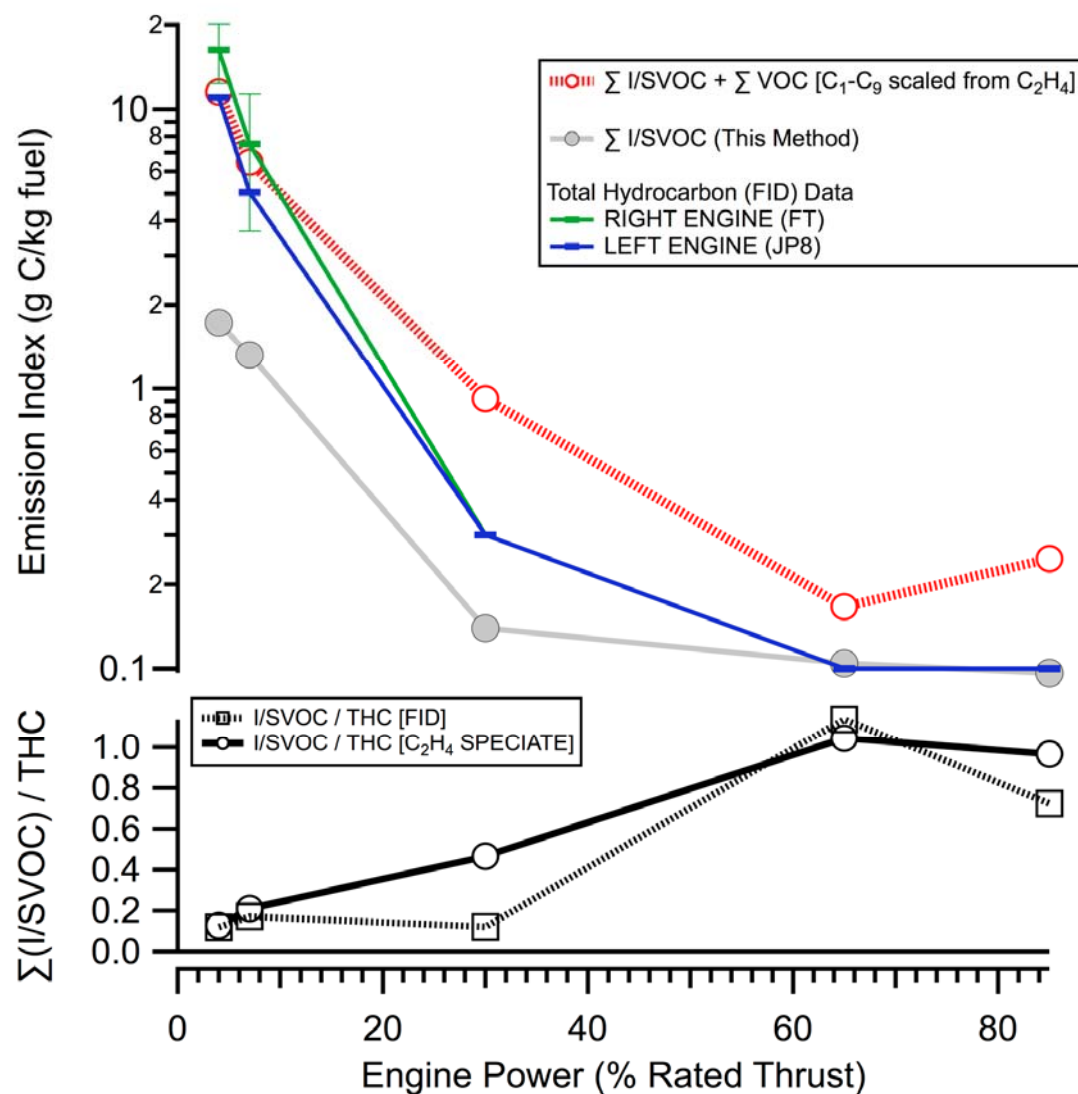
DC-8, two turbofan CFM56-2C1 engines (JP-8 and FT fuels)
Measurements: 150 m downwind

Engine power sweep



- Semicontinuous measurements (2 min collection, 10 min desorption/cooling cycle)
- Can detect rapid changes, transients

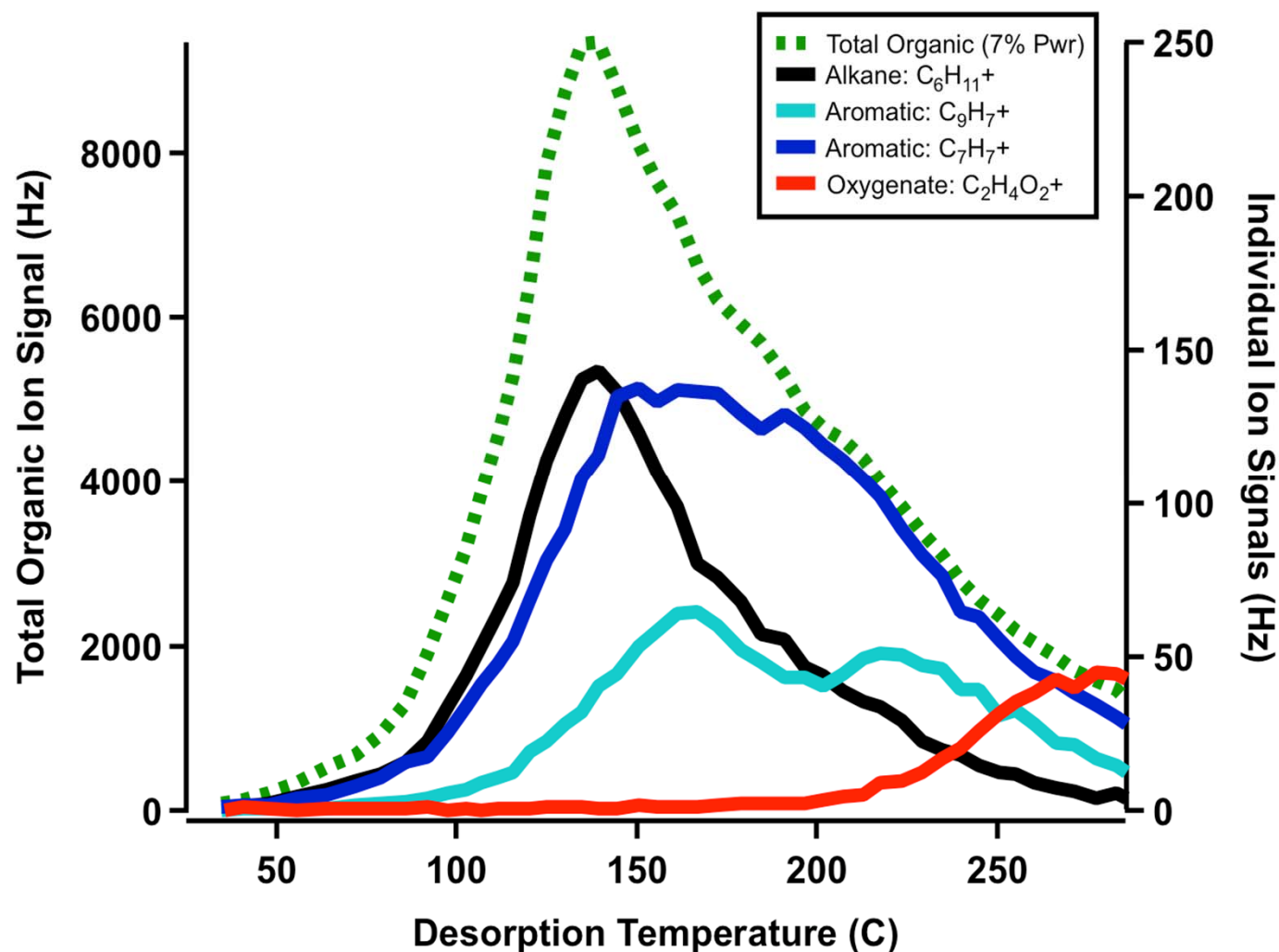
Emission factors, I/SVOC contributions



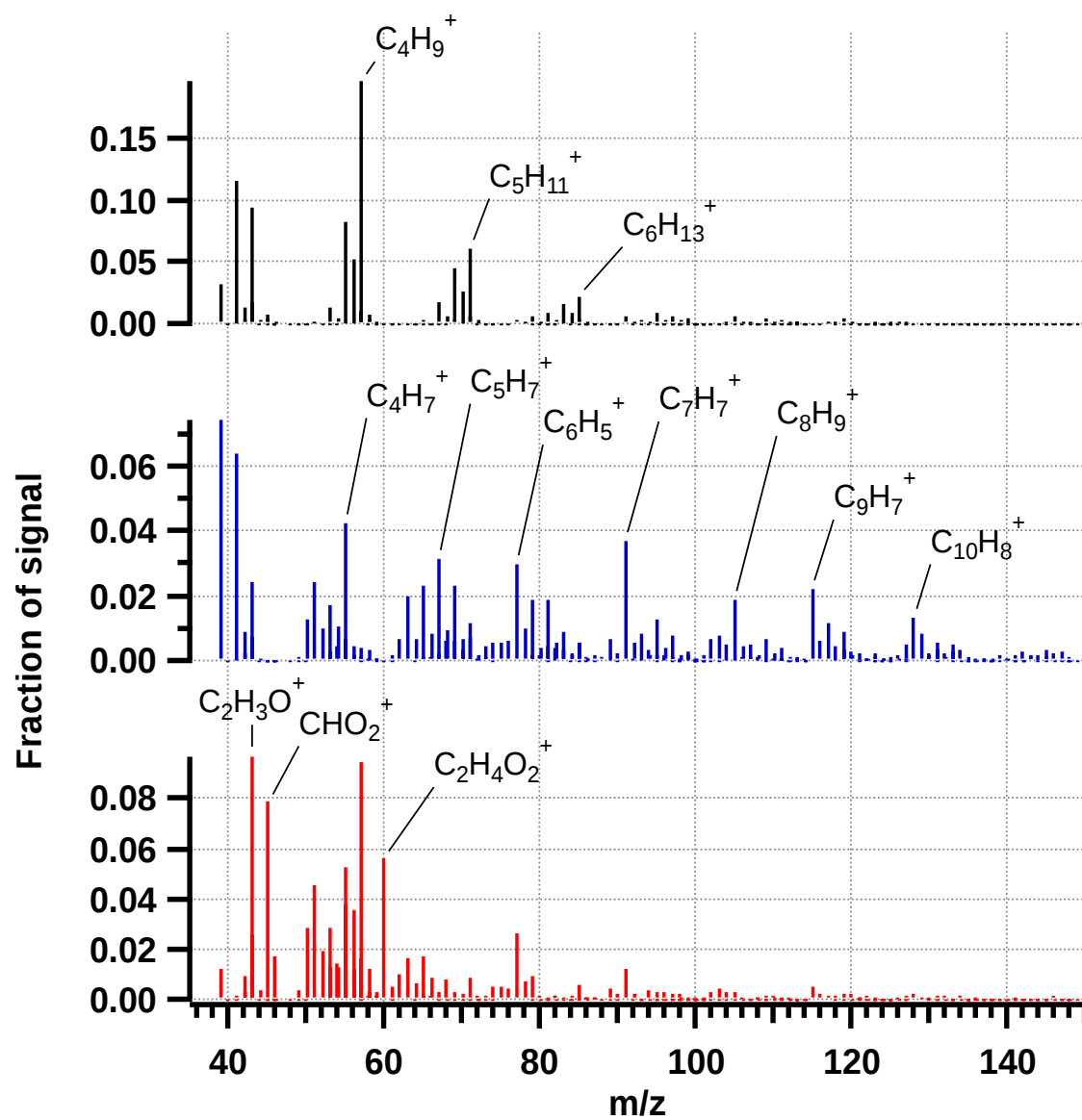
Low powers: I/SVOCs account for 10-20% of organic emissions

High powers: I/SVOCs account for >50% of organic emissions

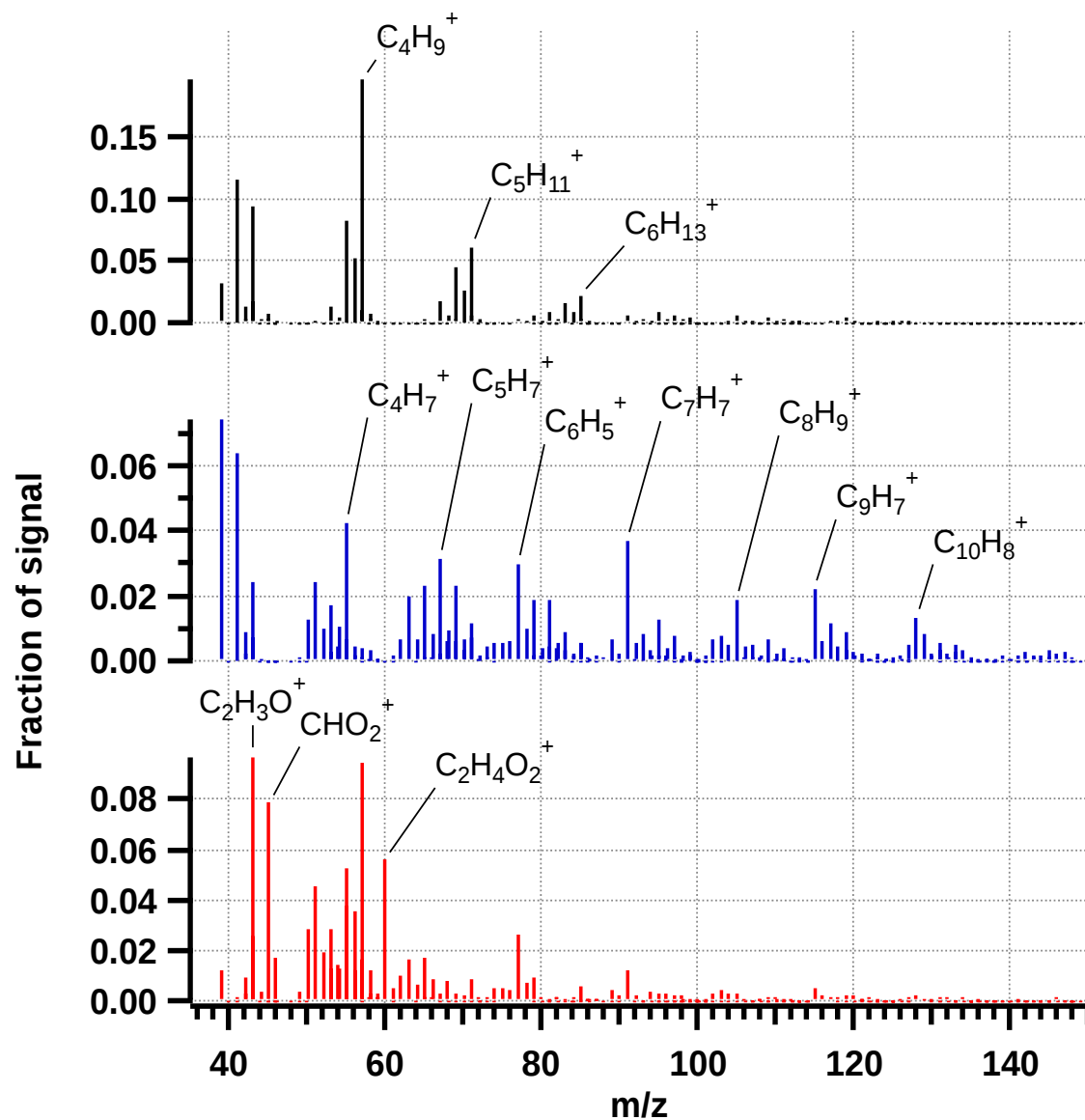
Volatility distribution (7% power)



PMF factors



PMF factors



Saturated HC Factor

H:C = 2.07

O:C = 0.03

Aromatic HC Factor

H:C = 1.36

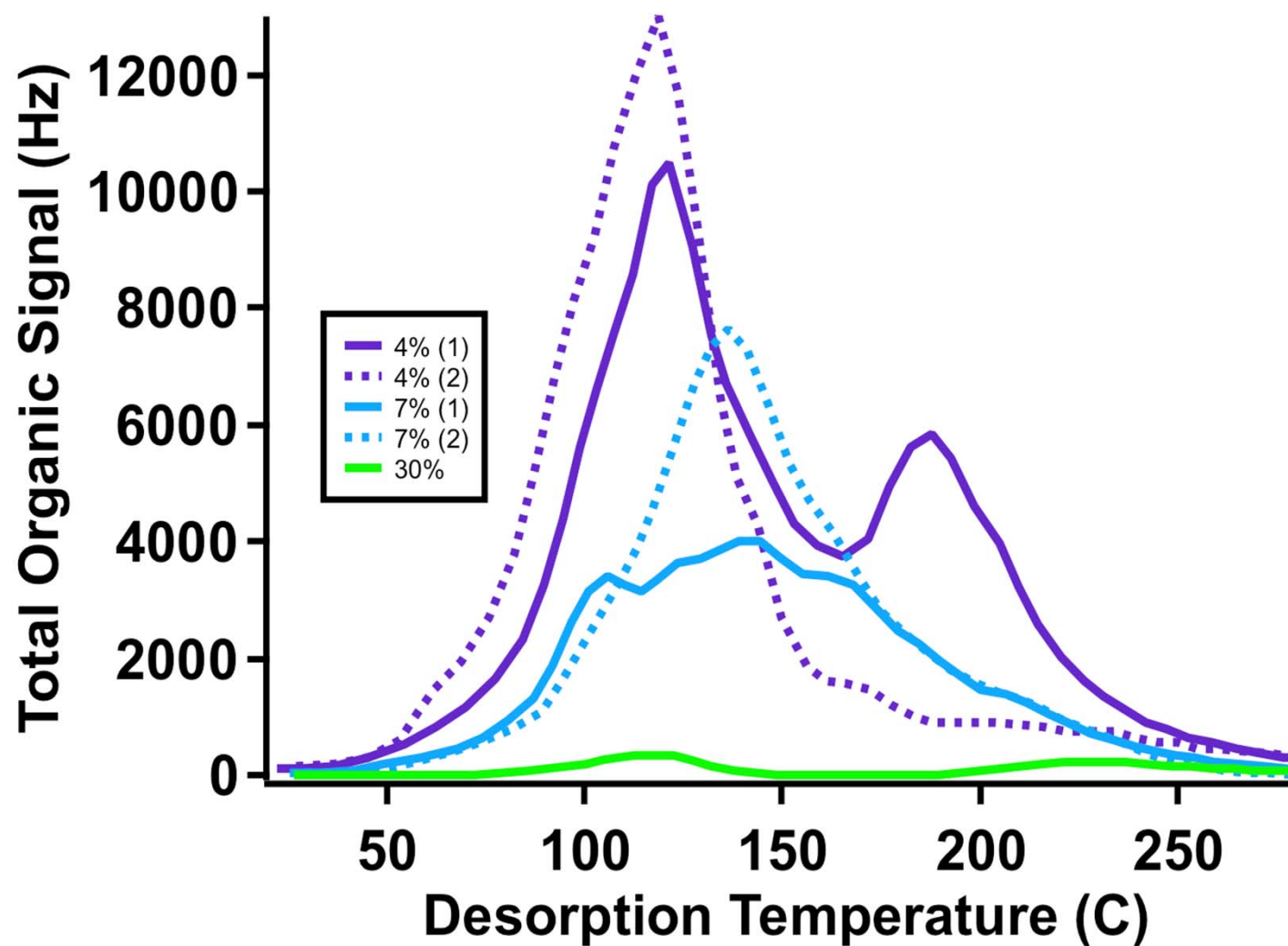
O:C = 0.04

Oxygenated HC Factor

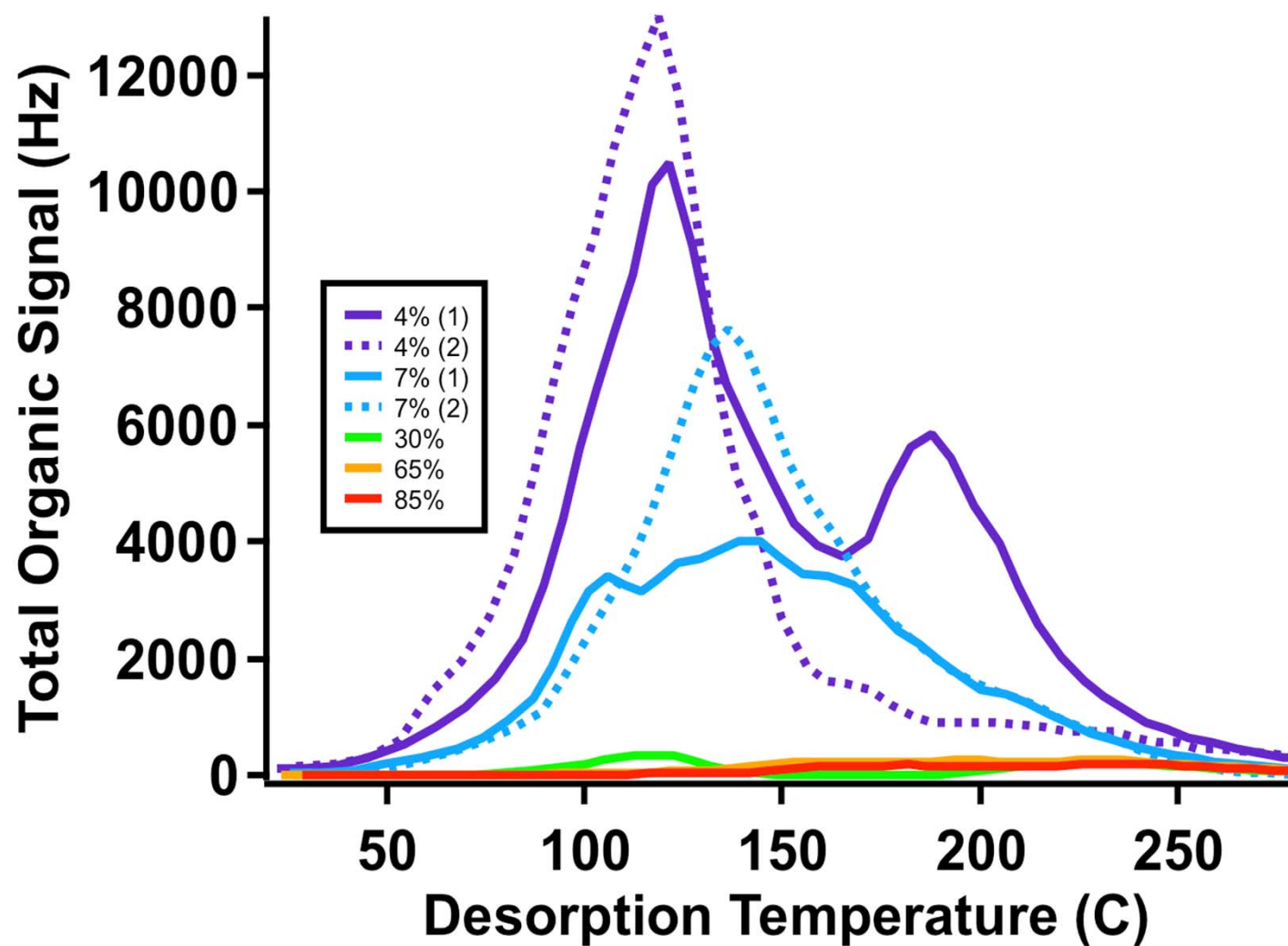
H:C = 1.46

O:C = 0.26

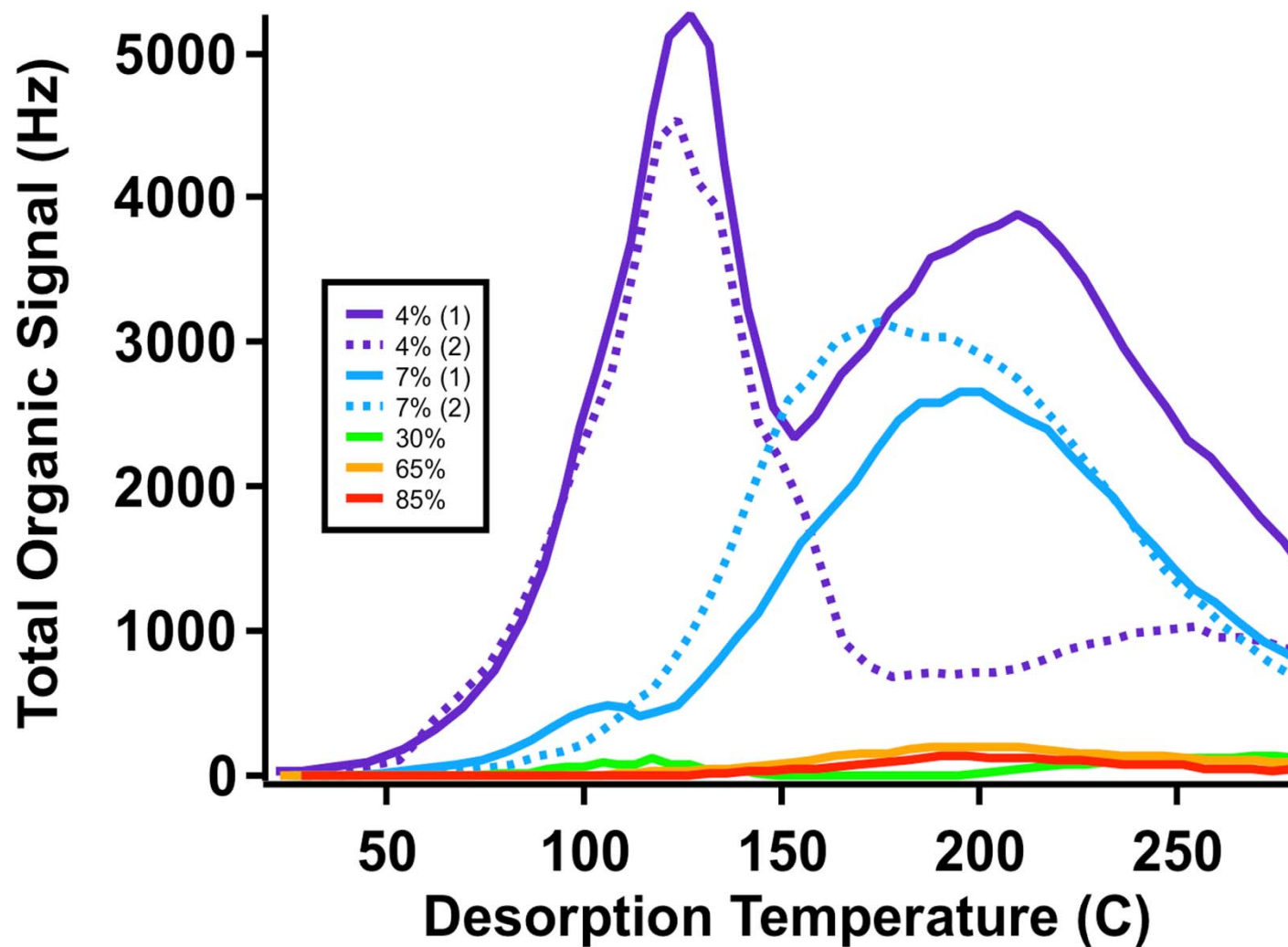
Unsaturated HC factor



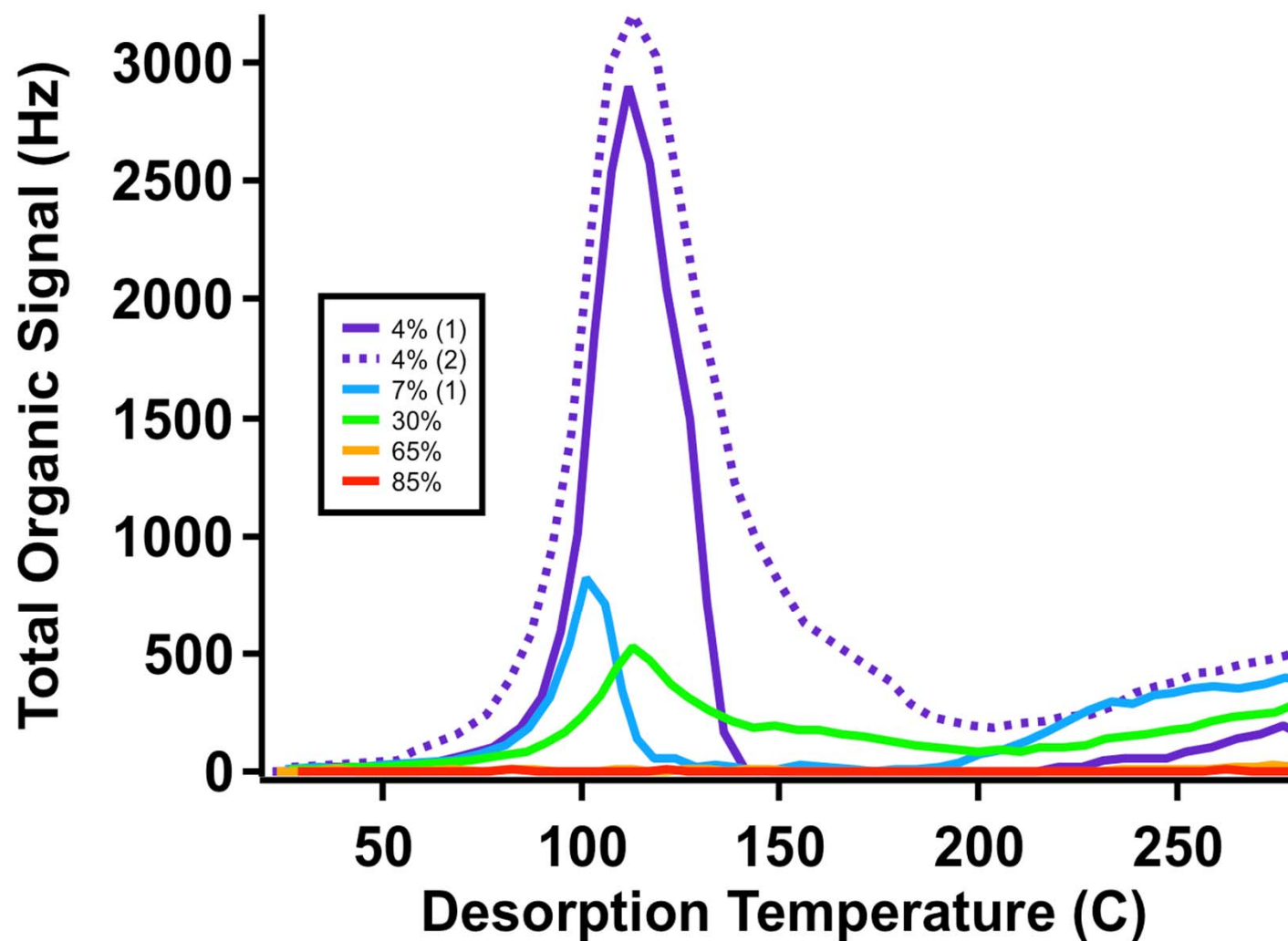
Unsaturated HC factor



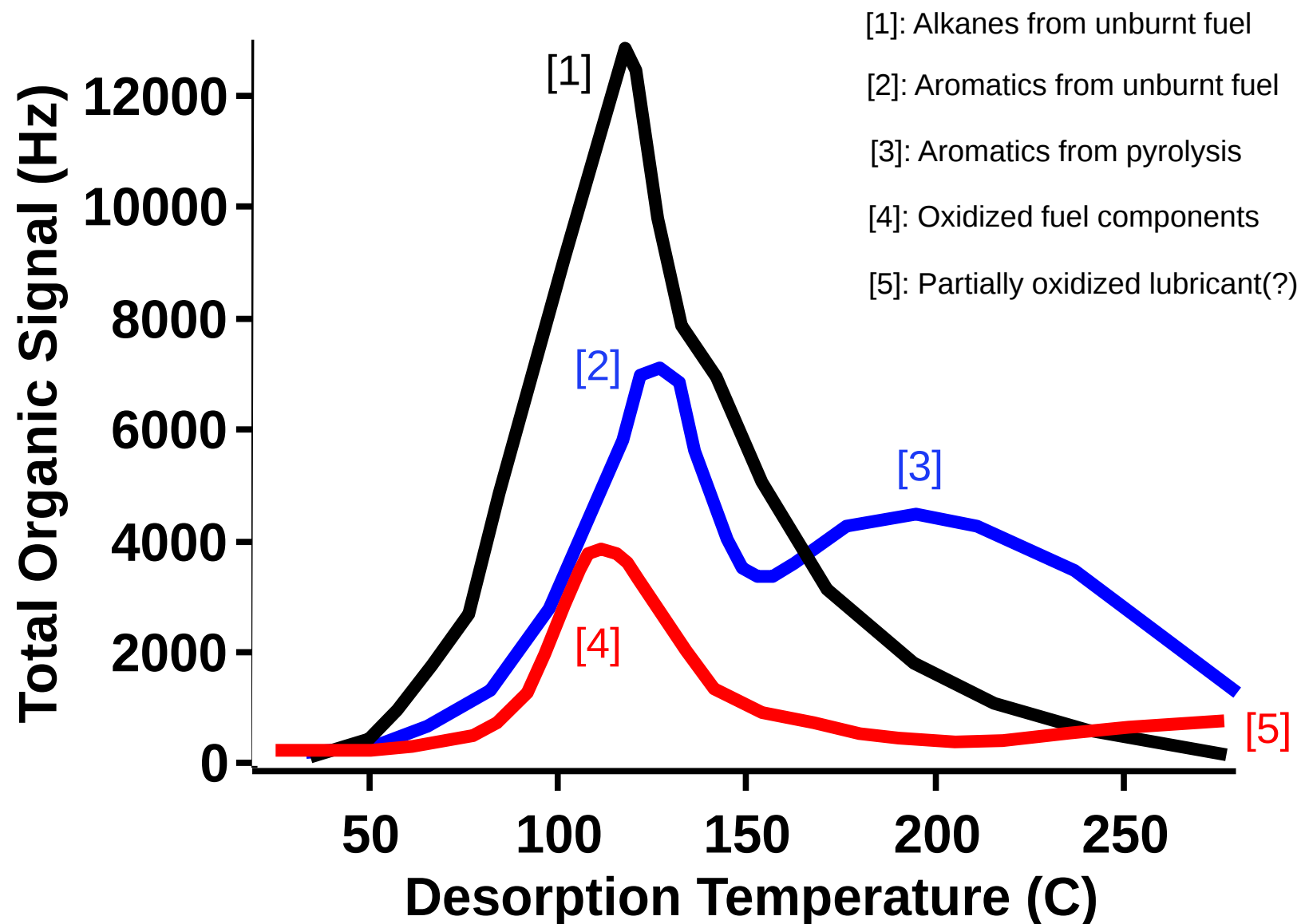
Aromatic HC factor



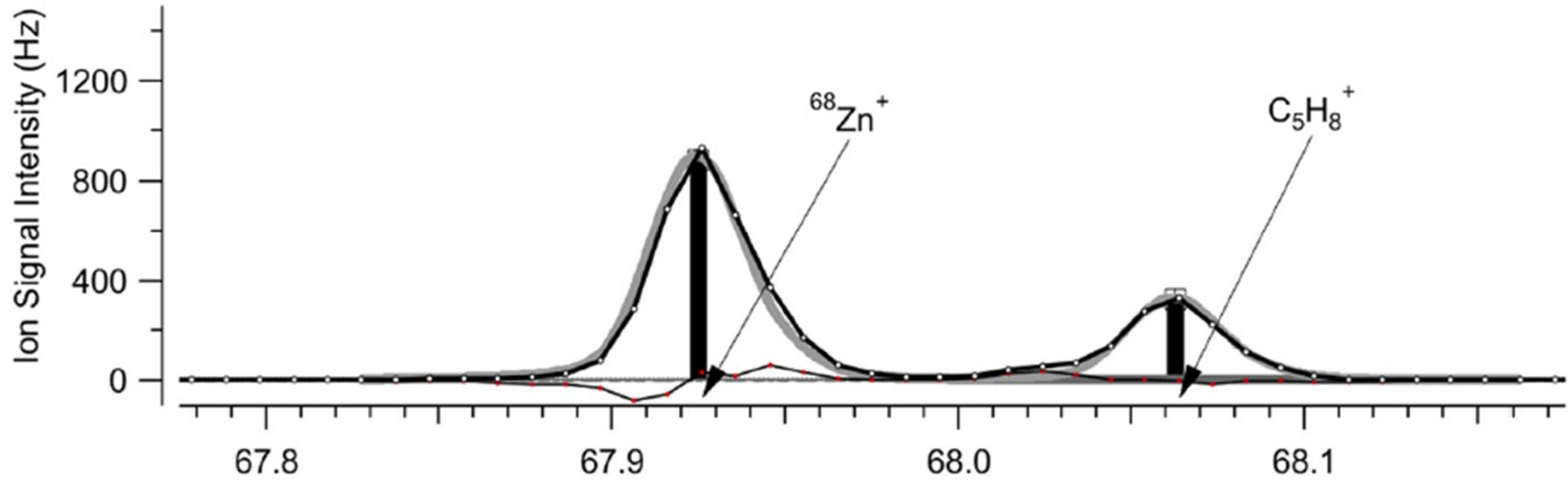
Oxygenated HC factor



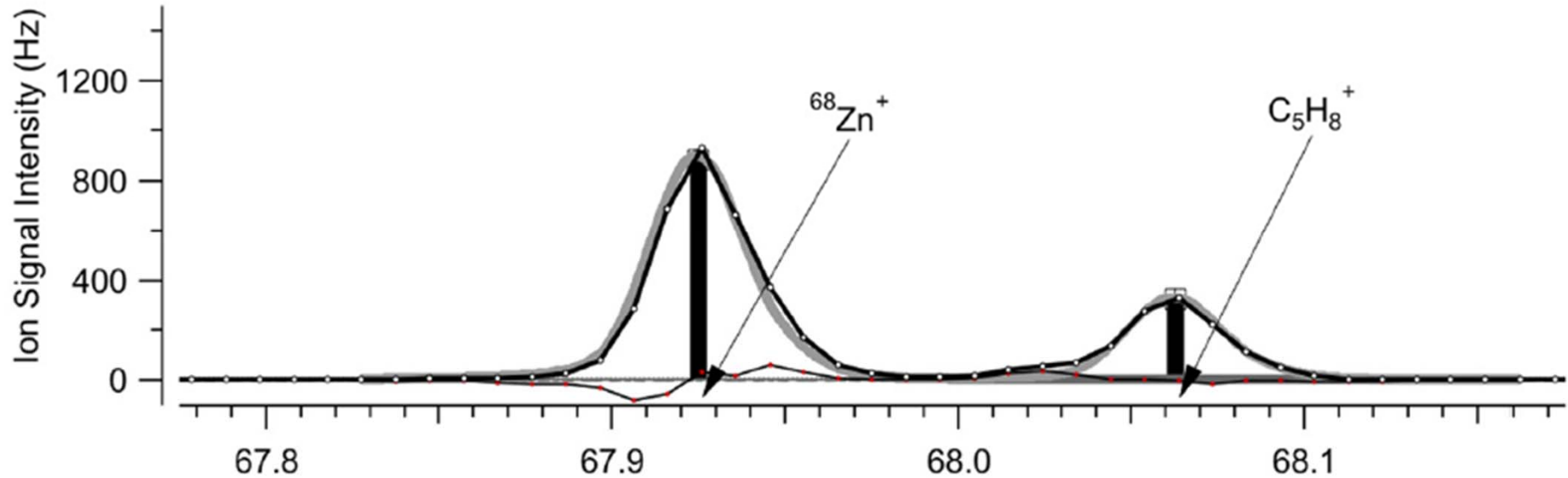
Summary: I/SVOCs from aircraft



Trace elements in emitted particles

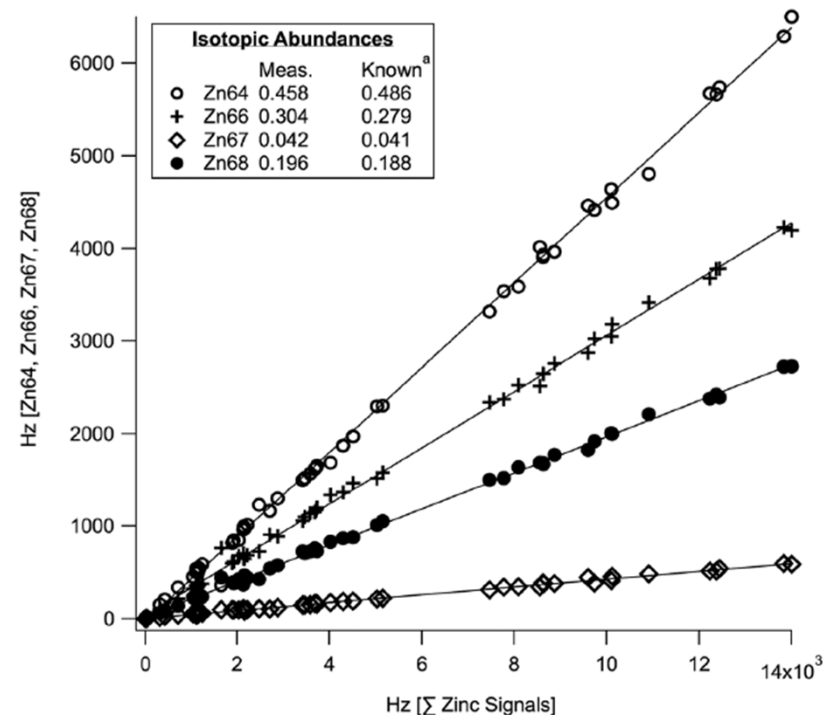


Trace elements in emitted particles



Unambiguous identification
of trace metals:

- Exact mass
- Isotopic abundances

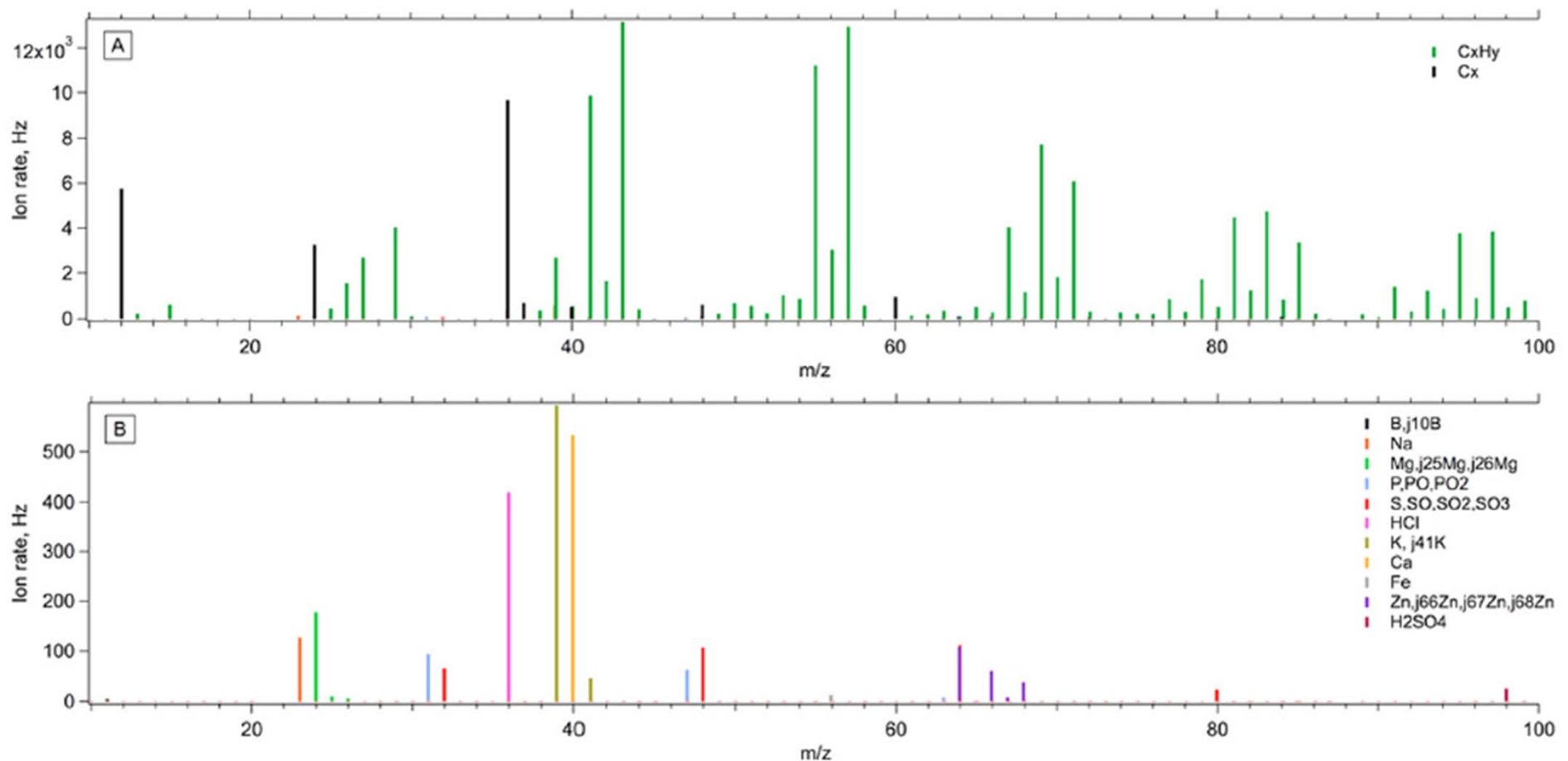


Trace elements in emitted particles

Lubricant components: B, Ca, Mg, P, Zn

Engine-wear markers: Fe, Pb

Others: K, Na, S, Cl



Summary/conclusions

- New instrument for measuring amount, volatility, and (ensemble) composition of IVOCs and SVOCs in near-real time
- Aircraft emissions: Emissions, composition (alkane/aromatic/oxygenate), and volatility all strongly power-dependent (fuel → pyrolysis)
- Diesel engine emissions: Emissions of 0.2-20 mg/kg fuel, depending on engine power; analysis of volatility and composition still in progress
- Follow-on work: Comparison of multiple IVOC/SVOC techniques on the same engine (May-June 2014)

Acknowledgements

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