



# **Vocus ELF PTR-TOF**

Real time on-line VOC analyzer  
THE most compact PTR-TOF analyzer

# Vocus PTR-TOF

VOCUS



**V/focus--lon focusing**



**VOC plus---See more, see better**



**VOC Us**

**VOC by Us**

**VOC with Us**

**VOC for Us**

ptrms.online



# Models

Vocus Elf



Vocus M



Vocus S



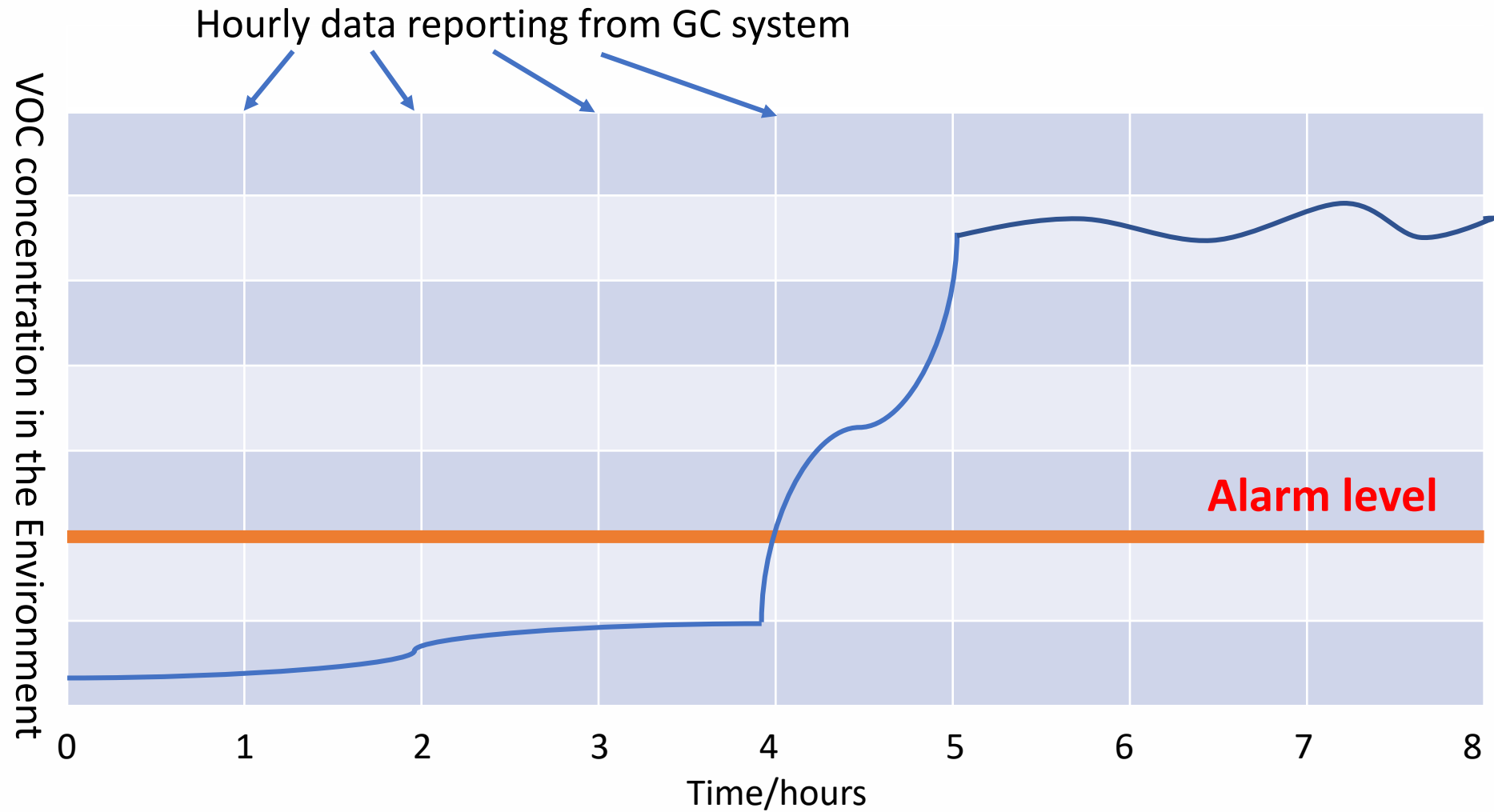
Vocus 2R



# Specs

	灵敏度 cps/ppb Xylene	检测限 1分鐘平均/1秒平均 Xylene	最高质量 分辨率 M/ $\Delta$ M	重量 (kg) 尺寸(mm)	能耗 最大/一般 (W)
Vocus 2R	10,000	1 ppt (0.001 ppb)/ 10 ppt (0.01 ppb)	15,000	160 kg 480*615*1480	600/590
Vocus S	10,000	1 ppt (0.001 ppb)/ 10 ppt (0.01 ppb)	7,000	120 kg 480*615*1130	600/590
Vocus M 工业检测型	2,000	<5 ppt (< 0.005 ppb), 1 min	2,500	120 kg 480*615*1130	600/590
Vocus Elf 小精灵型	500	<20 ppt (< 0.02 ppb), 1 min	750	55 kg < 0.125 m <sup>3</sup> 380*500*650 mm	450/400

# VOC alarm (pollutant in the factory )

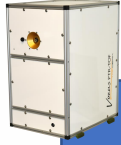


# Time is money!

## Higher sample throughput



# Fence-line VOCs monitoring, alarm, emergency response --Mobile VOCs analyzer



xxx industry park

# VOCs composition is 'evolving'

--important to have full spectra

RESEARCH

## RESEARCH ARTICLE

ATMOSPHERIC CHEMISTRY

### Volatile chemical products emerging as largest petrochemical source of urban organic emissions

Brian C. McDonald,<sup>1,2\*</sup> Joost A. de Gouw,<sup>1,2</sup> Jessica B. Gilman,<sup>2</sup> Shantanu H. Jathar,<sup>3</sup>

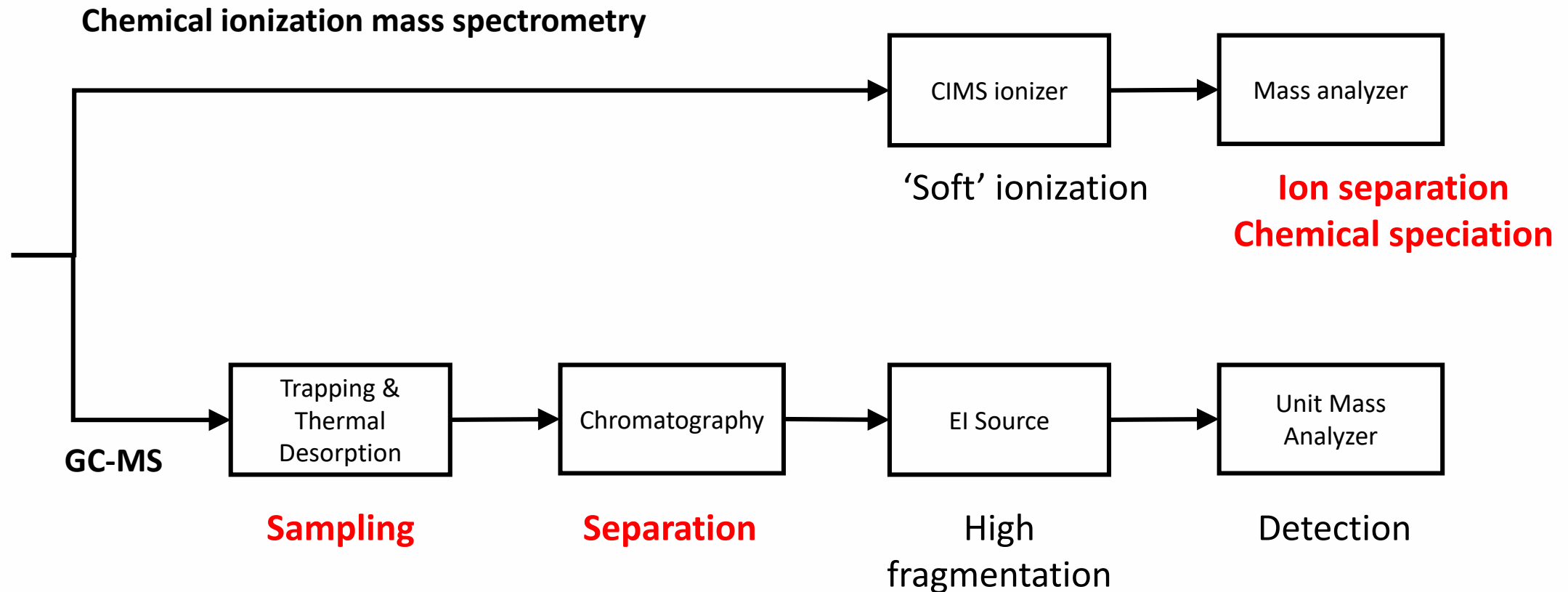


McDonald et al., Science 359, 760 -764 (2018)

- There are hundreds of VOCs in ambient air
- The composition of ambient VOCs is 'evolving' as manufacture changes. More substances will show up on the regulated list
  - Full spectral analysis is crucial**
  - important to set off alarm when encountered with highly concentrative unknown VOCs



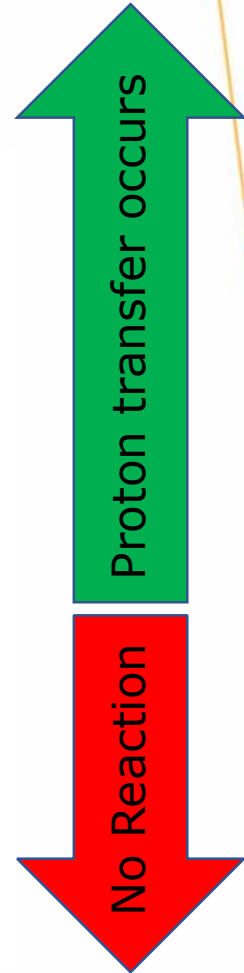
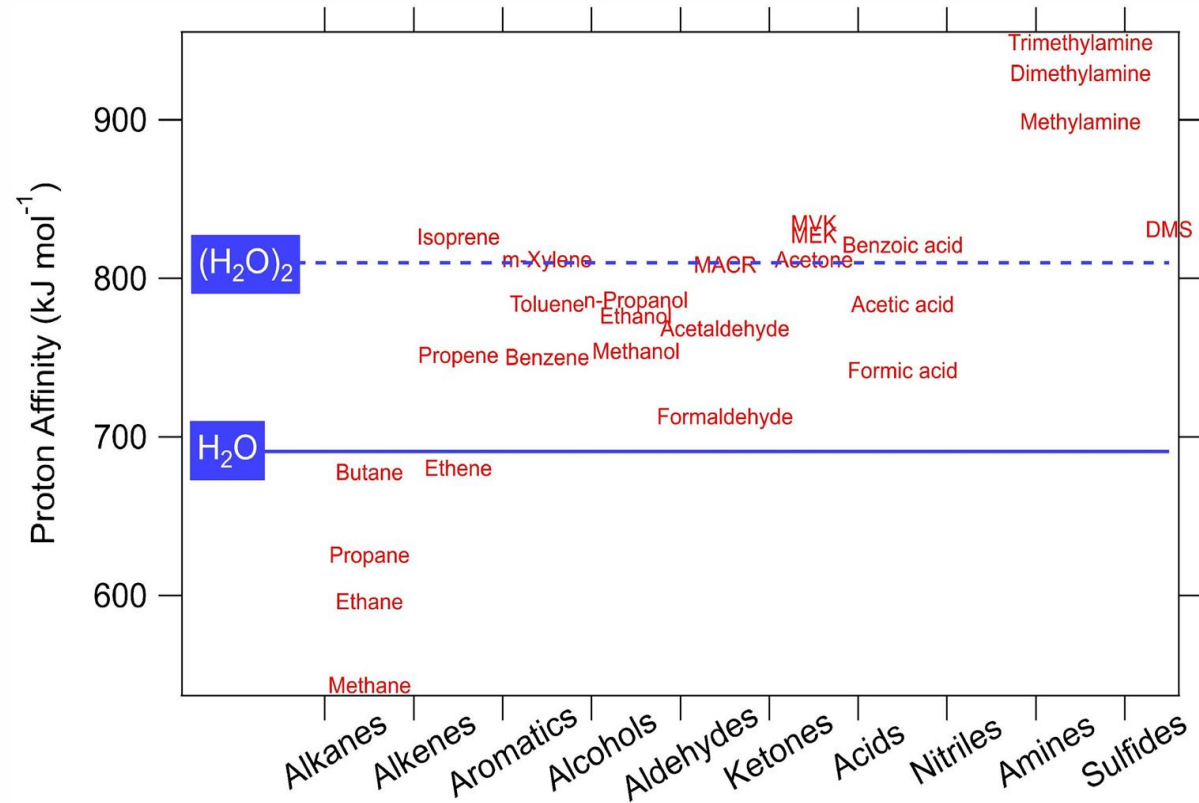
# Direct inlet-Chemical ionization Mass spectrometry



# Proton Transfer Reaction Mass Spectrometry

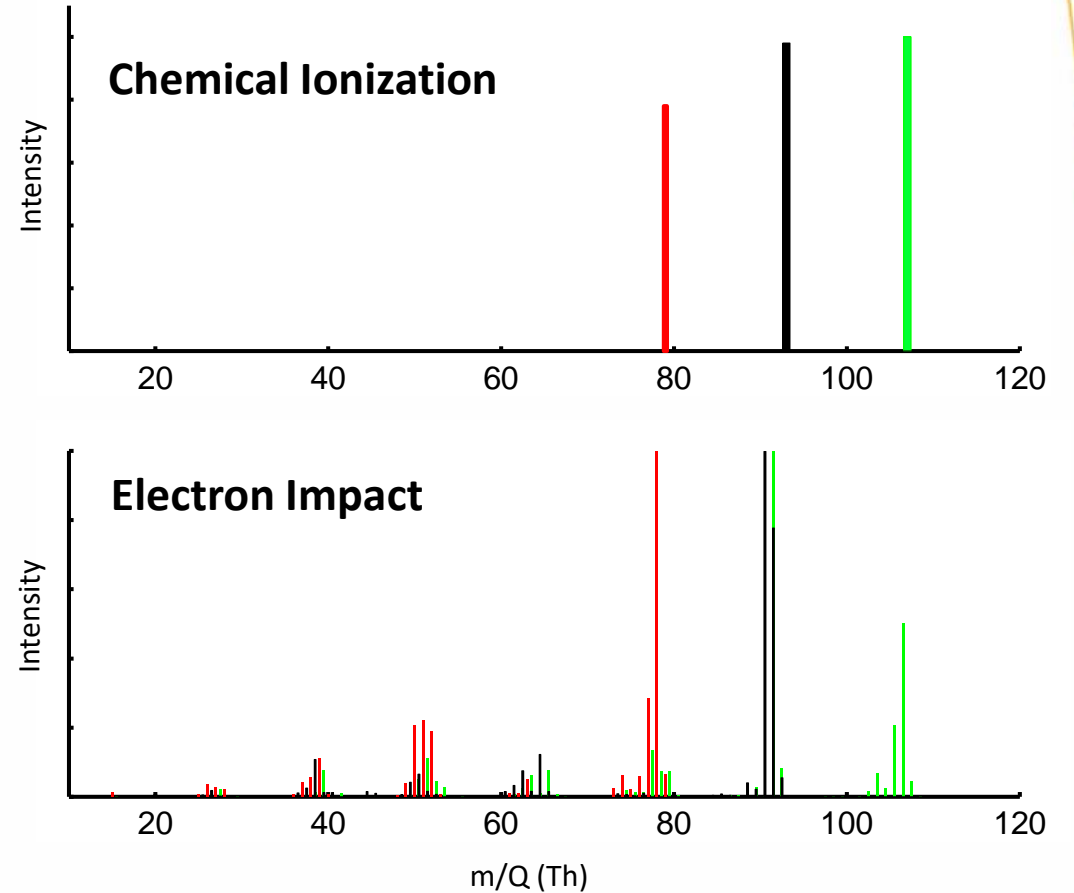


- **Transfer proton to M, Detect (M)H<sup>+</sup>**
- **Reaction occurs** if R has higher proton affinity than reagent ion [H<sub>3</sub>O<sup>+</sup> or (H<sub>2</sub>O)H<sub>3</sub>O<sup>+</sup>]
- **Exothermic and fast for**
  - Most alkenes
  - Aromatics
  - Most functional groups

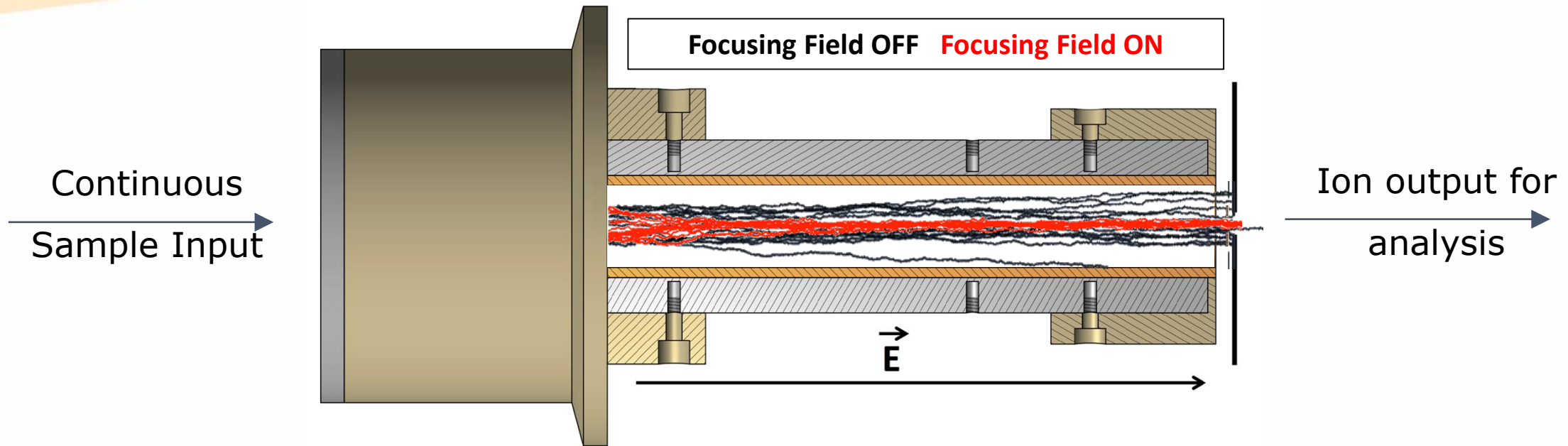


# PTR ionization greatly simplified the spectra

- Mass spectra resulting from the ionization of a mixture of **Benzene**, **Toluene**, and **Xylene** with chemical ionization (top) and electron impact ionization (bottom)
- Chemical ionization simplifies the mass spectrum compared to **conventional ionization techniques which result in extensive fragmentation**
- Chemical ionization results in an **easily interpretable mass spectrum**, therefore eliminating the requirement of pre-separation (e.g. GC)

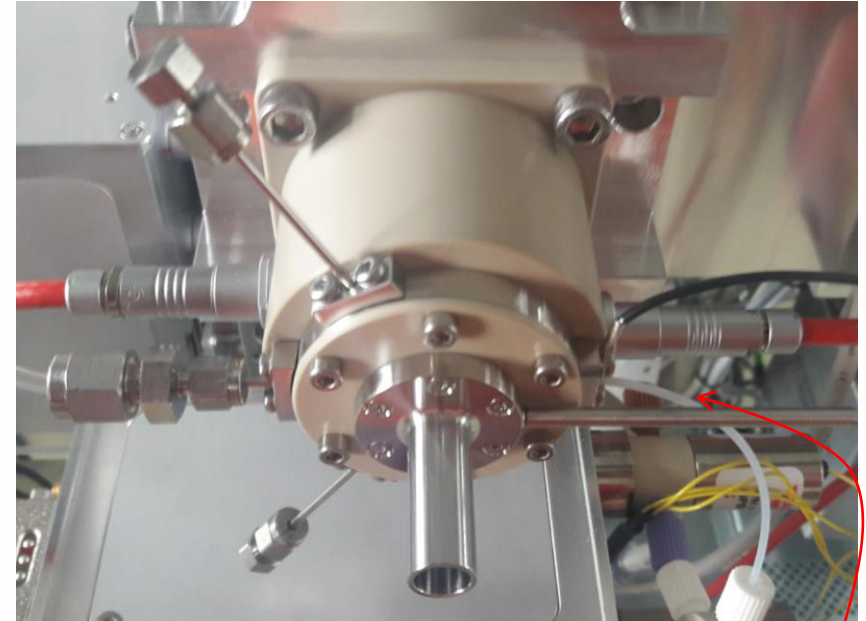
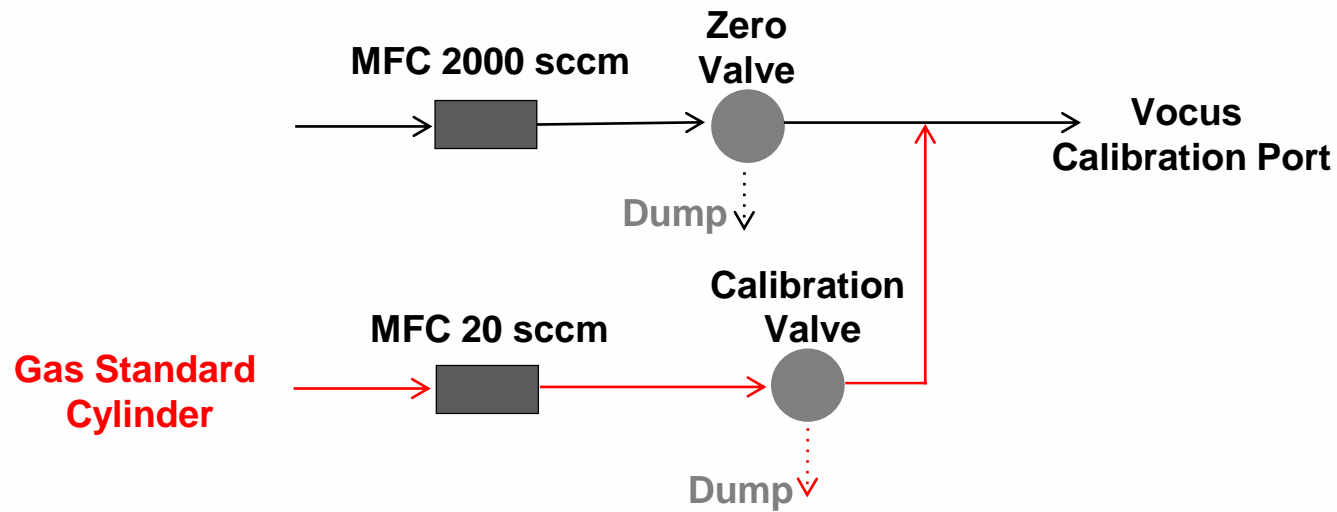


# Vocus: A leap forwards in reactor design



- Vocus is a patented technology developed at TOFWERK combining both a bright ion source and focusing reactor, maximizing detection efficiency.
- **The result: Sensitivity boost of >10x** utilizing ion focusing which eliminates ion losses, pushing the level of detection and precision of VOC measurements to new limits.

# Calibrations with Gas Standards

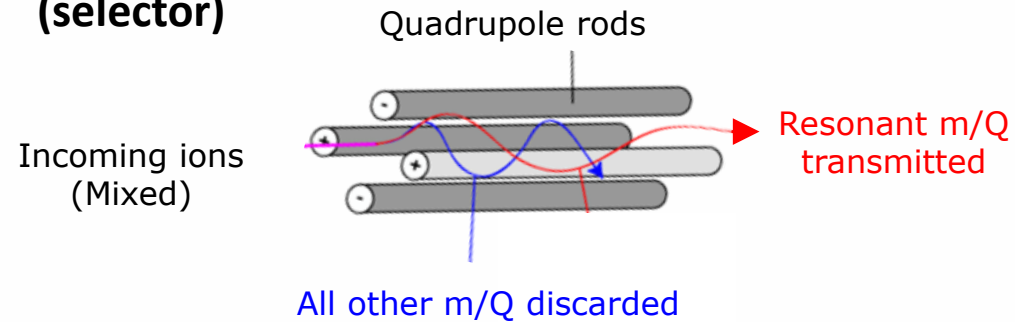


**Vocus  
Calibration Port**

- Dynamic dilution of gas cylinder standards for online calibrations
- Calibration valve and Zero valves are computer controlled, PEEK solenoid valves
- Dual purpose calibrate/zero port on Vocus inlet ensures reproducibility
- All components internally mounted and standard feature of all Vocus models

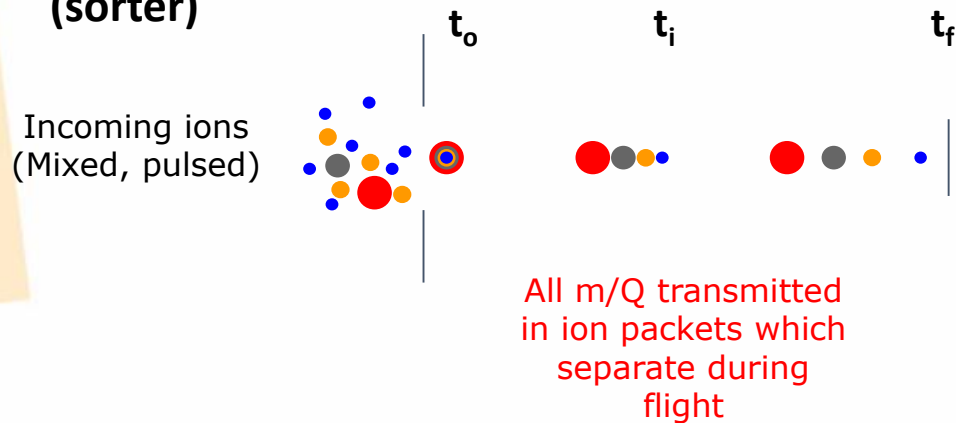
# Selecting the right mass analyzer

## Quadrupole (selector)



- Measures only one  $m/Q$  at a time
- Slow to measure complete spectrum (scan)
- Typically unit mass resolution
- Poor duty cycle when many ions are monitored

## TOF (sorter)



- Measure entire mass spectrum simultaneously
- TOF is fast: >40,000 unique spectra per second
- TOF can have high resolving power ( $M/dM$ ) and good mass accuracy allowing
  - Separation of isobars
  - Elemental analysis allows identification of unknowns

# Semi-quantitative analysis

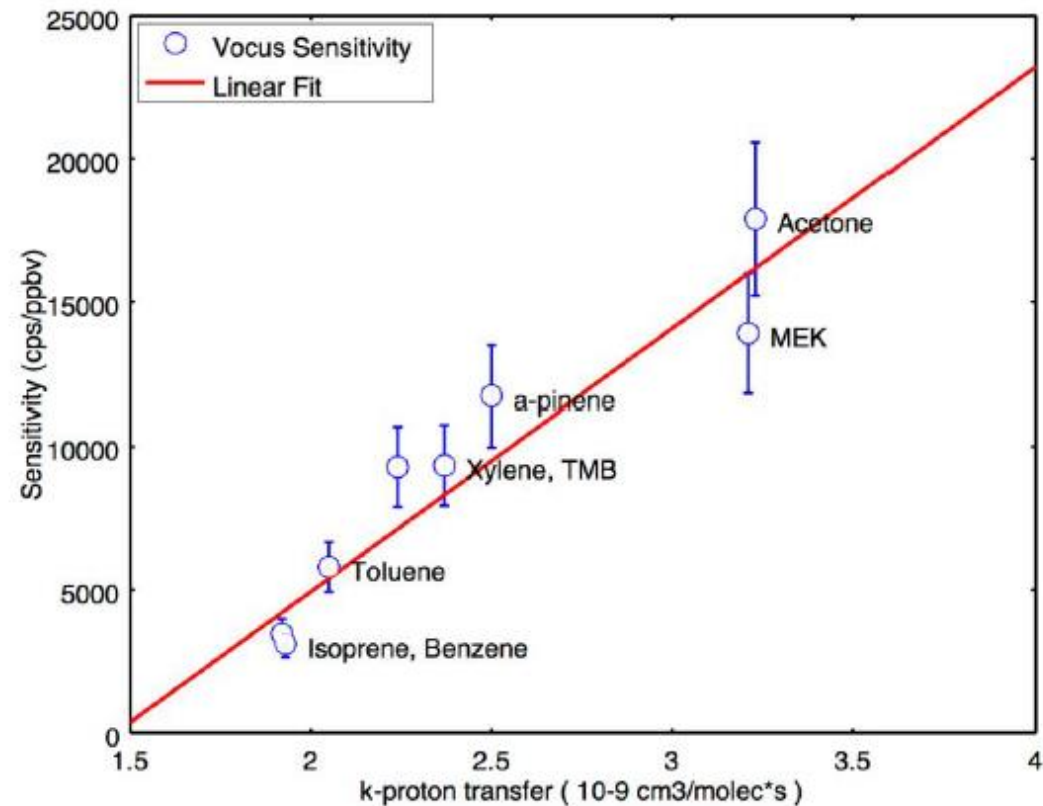
Response factor of various VOCs are solely dependent on the proton transfer reaction rate coefficient  $k$ .

$$[R] = \frac{[RH^+]}{[H_3O^+]_0} \times \frac{1}{kt} = \frac{\text{cps } (RH^+)}{\text{cps } (H_3O^+)} \times \frac{1}{kt} \quad (2)$$

式中： $[H_3O^+]_0$ 为 $H_3O^+$ 的初始浓度； $[R]$ 表示待测物R的绝对浓度； $t$ 为离子通过反应区的平均时间。

$k$ 是质子化反应的速率常数

Vocus sensitivity and  $k$ (proton transfer)

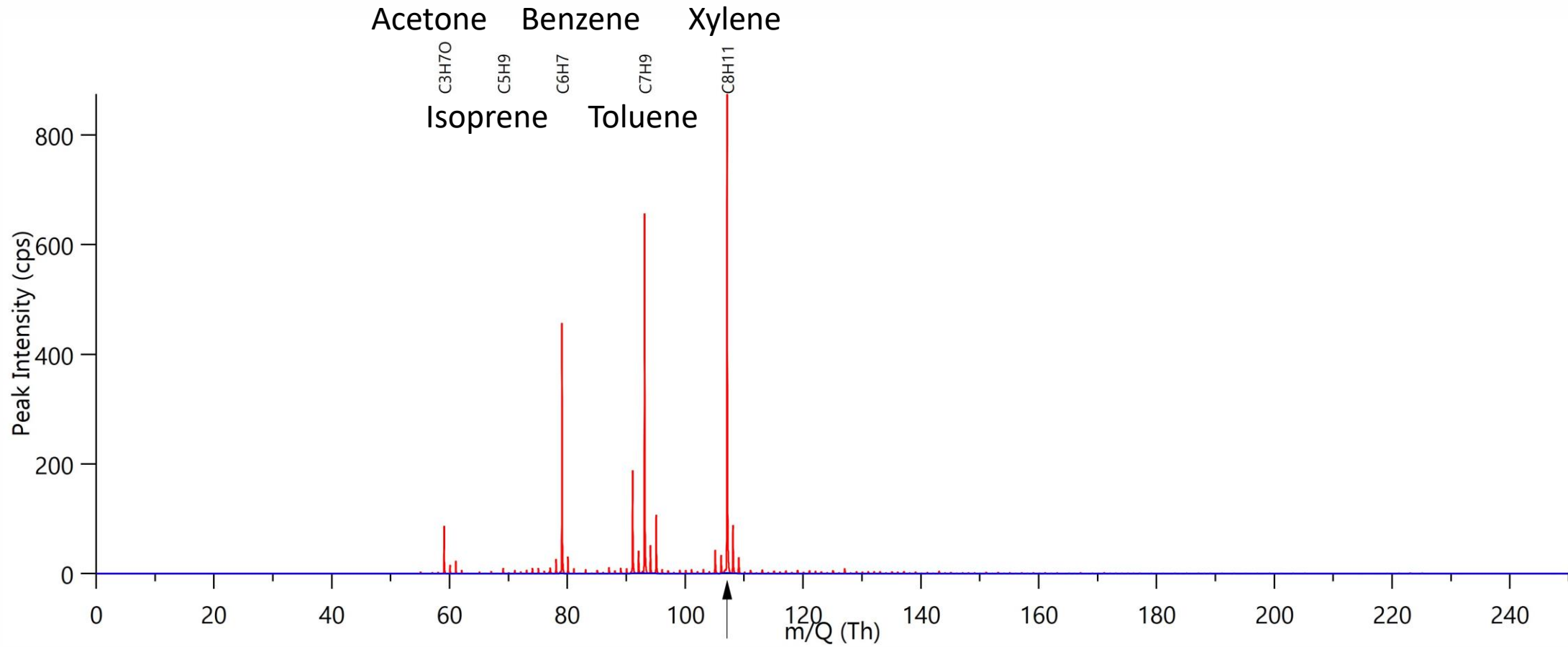


The most compact PTR-TOF on the market  
**Vocus ELF**

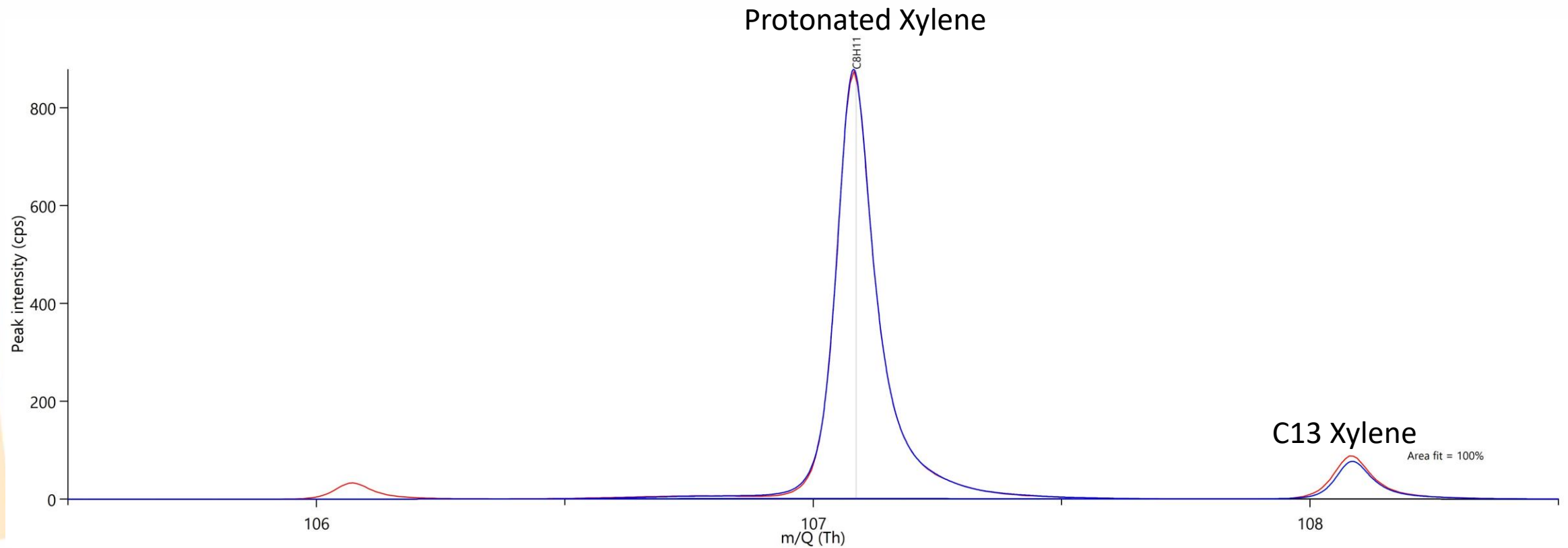




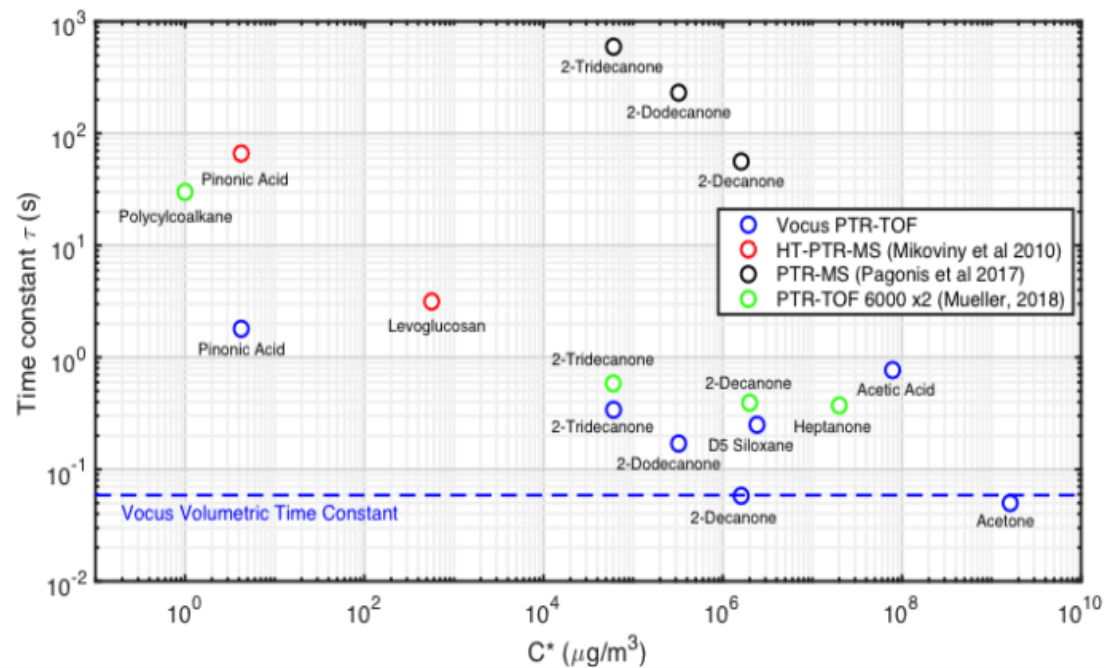
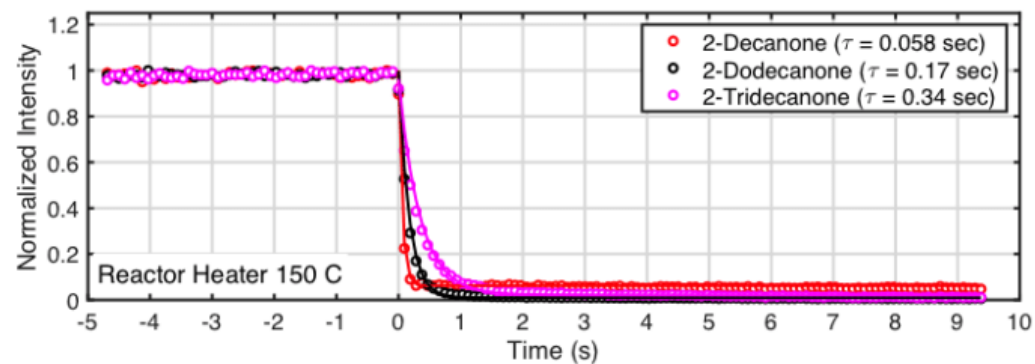
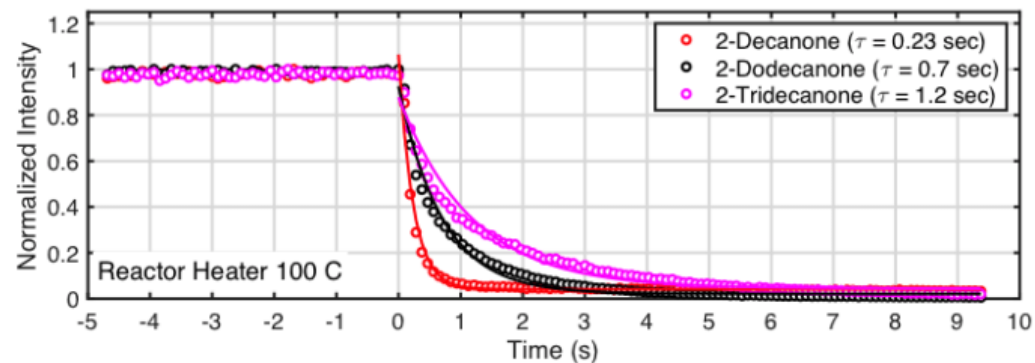
# Vocus ELF-typical spectra



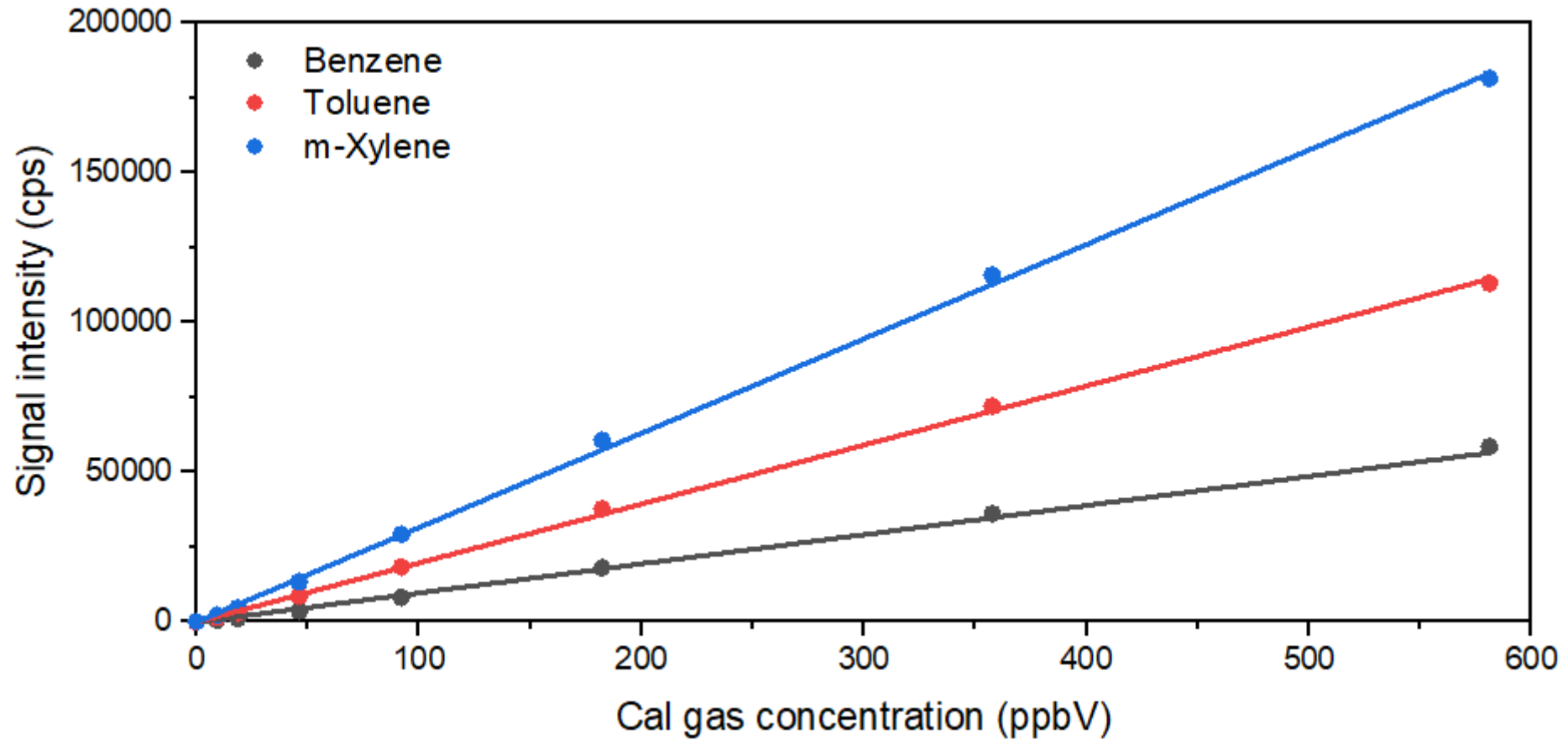
# Vocus ELF-typical spectra



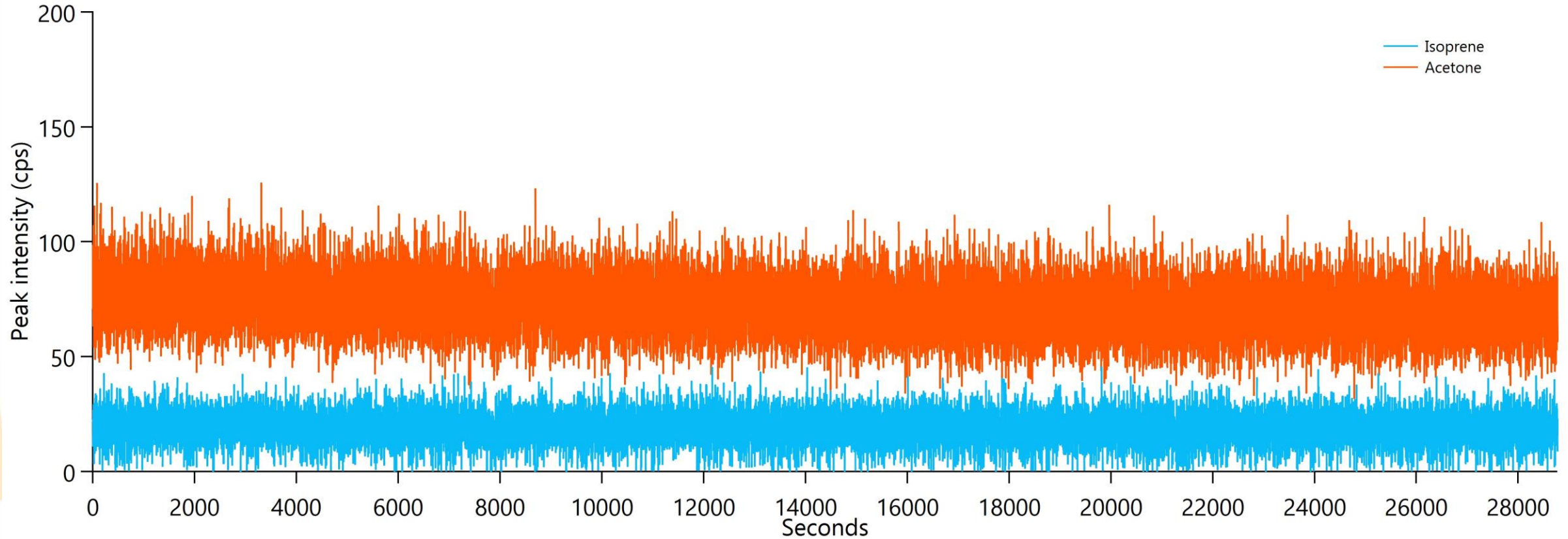
# Fast instrument response



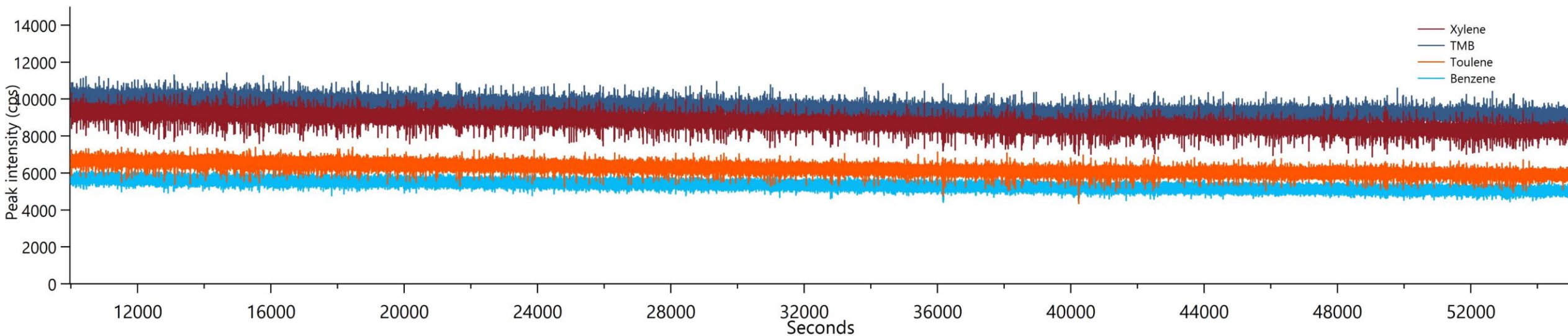
# Wide linearity range



# Vocus ELF-baseline stability

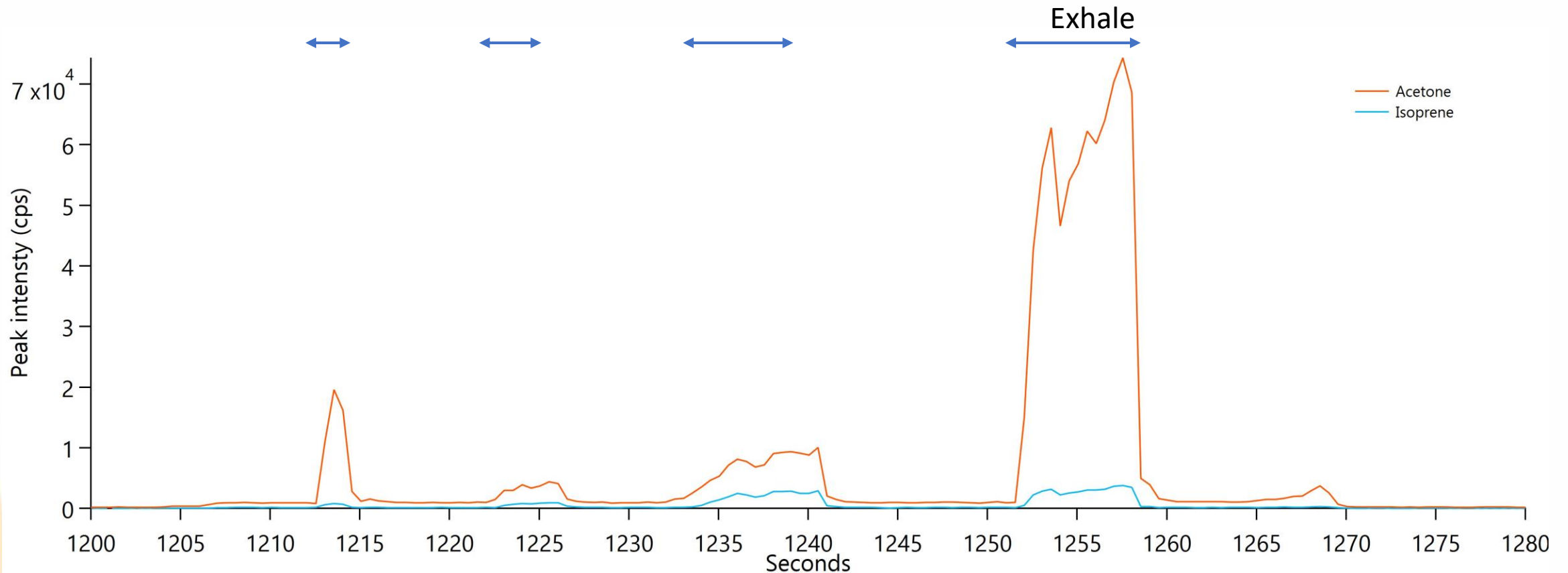


# Vocus ELF-Signal stability



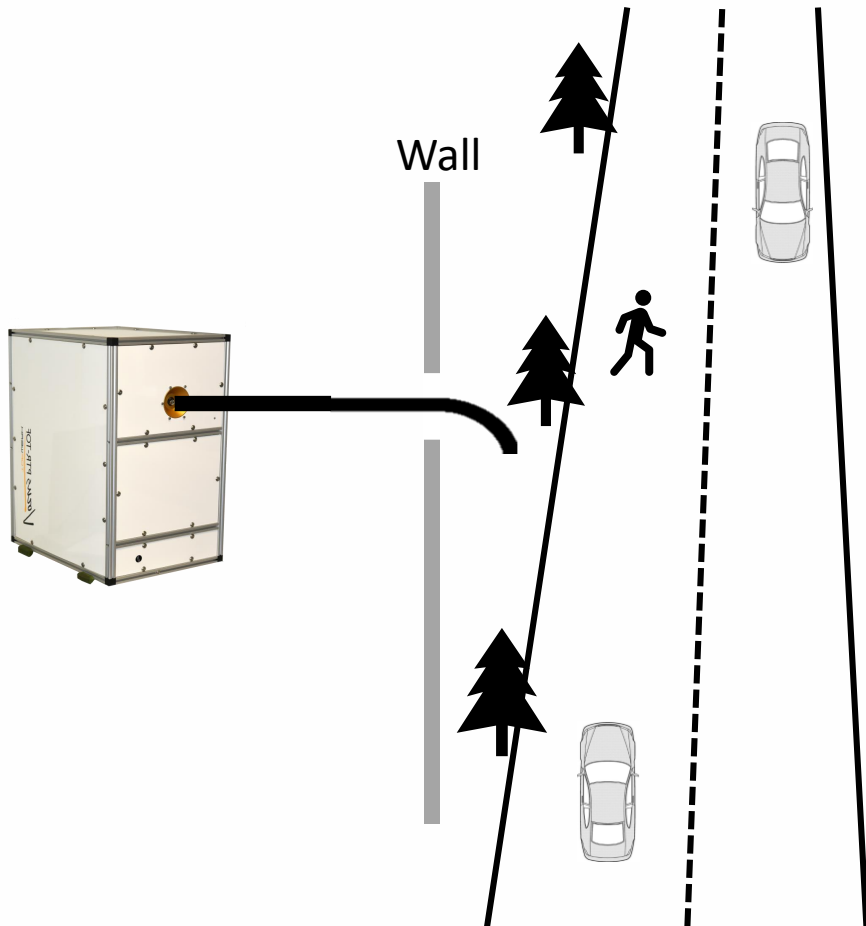
- Superior signal stability over a measurement of 12.5 hours

# Case 1: Direct analysis of exhaled breath

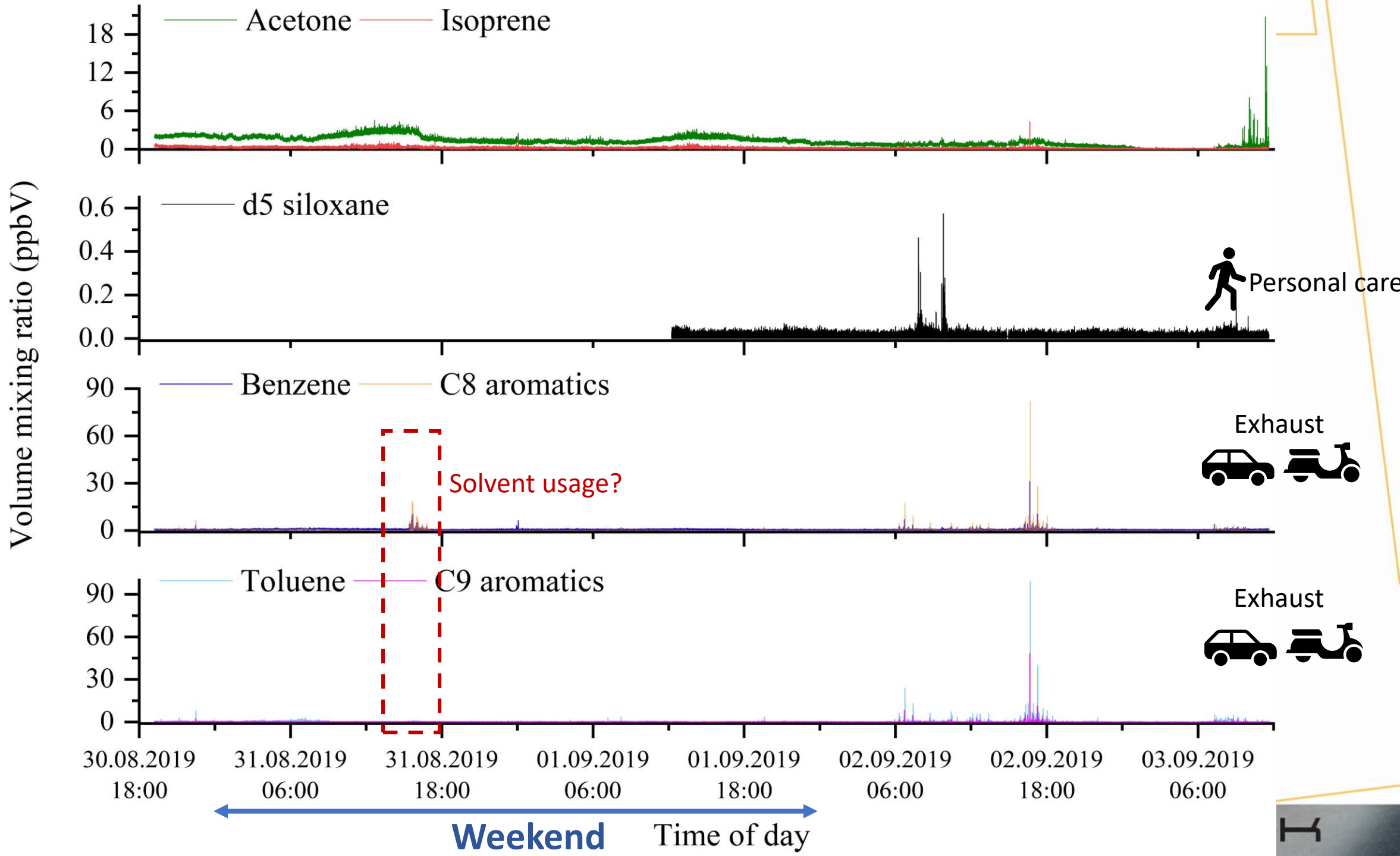


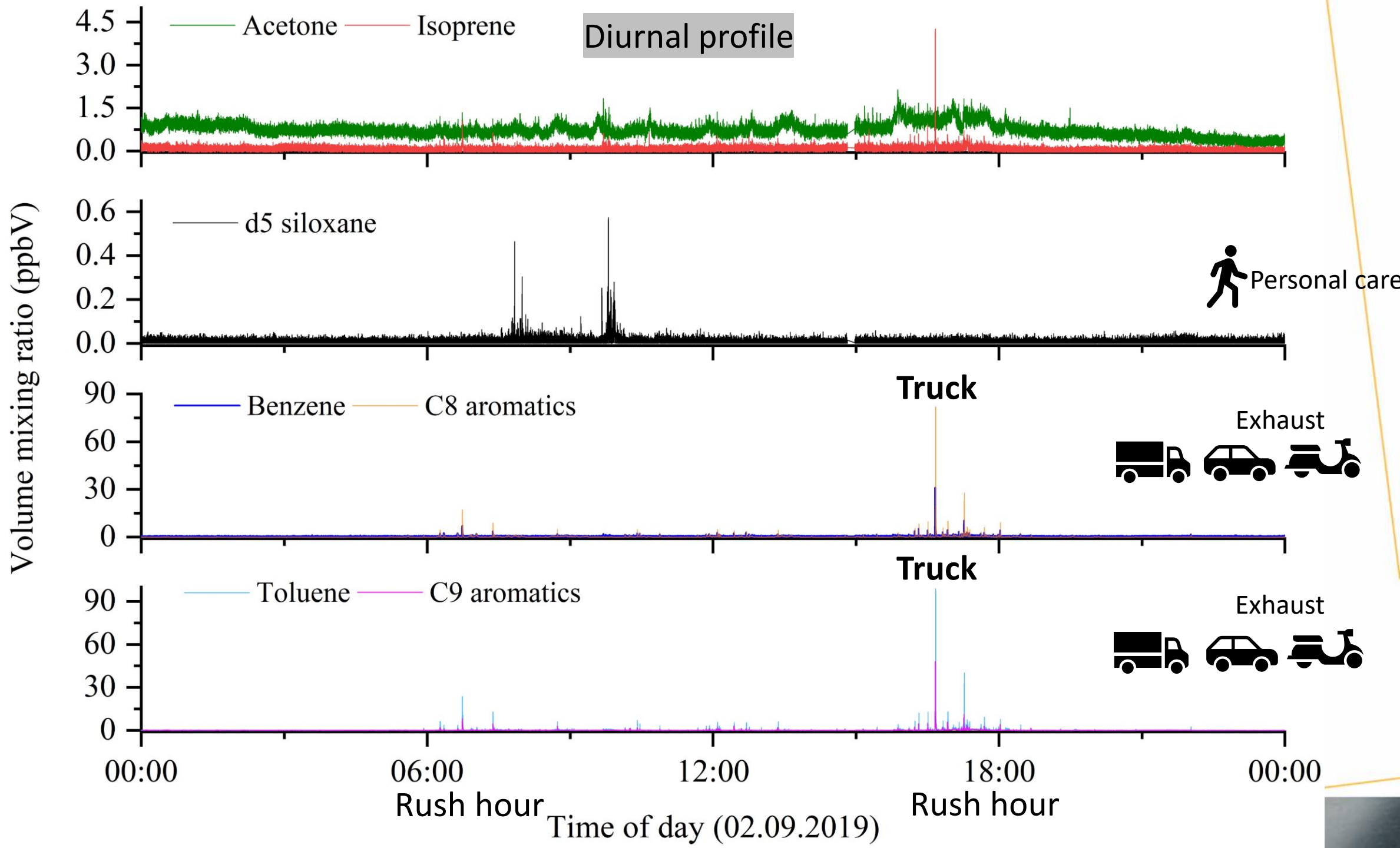
- Acetone and isoprene in exhaled breath of a volunteer were picked up with good sensitivity and response time.

# Case 2: stationary monitoring







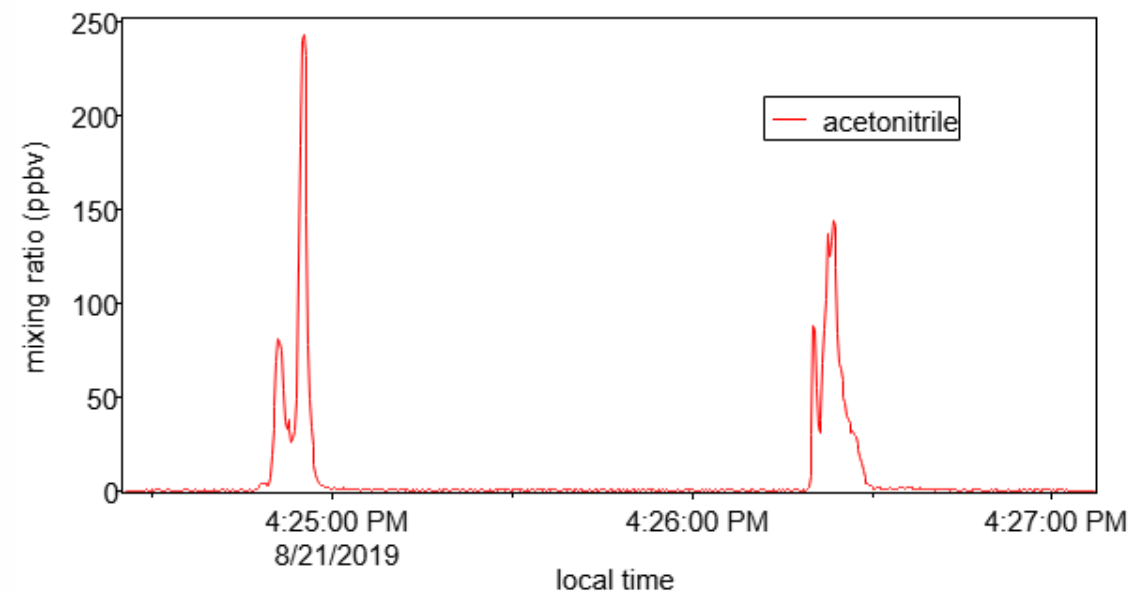
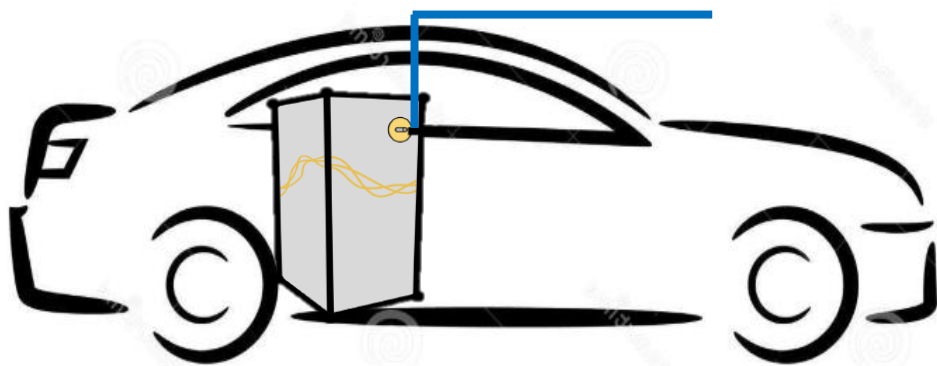


# Case 3: ELF on the wheels

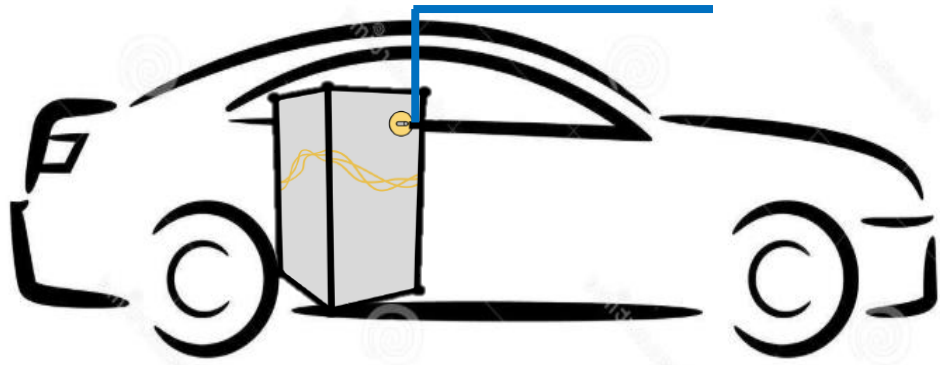
- Simply striped on the back seat of a normal passage car or any other mobile platform
- Easy to lift and install
- Can be powered for 2-3 hrs with a normal UPS
- No need for special anti-damping system
- Integrated software



# Mobile ELF: organic solvent storage area

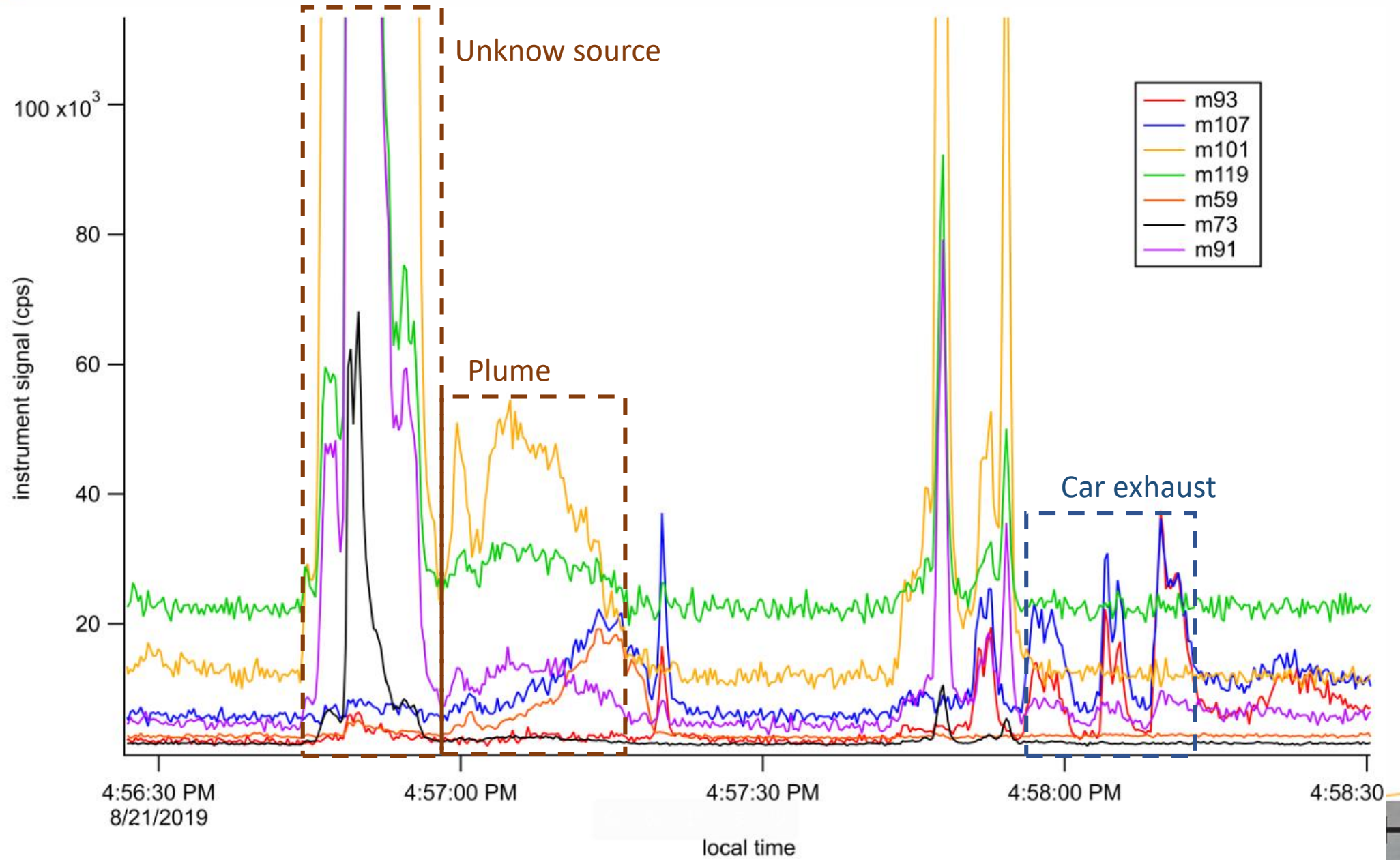


# Mobile ELF: urban area (Thun)

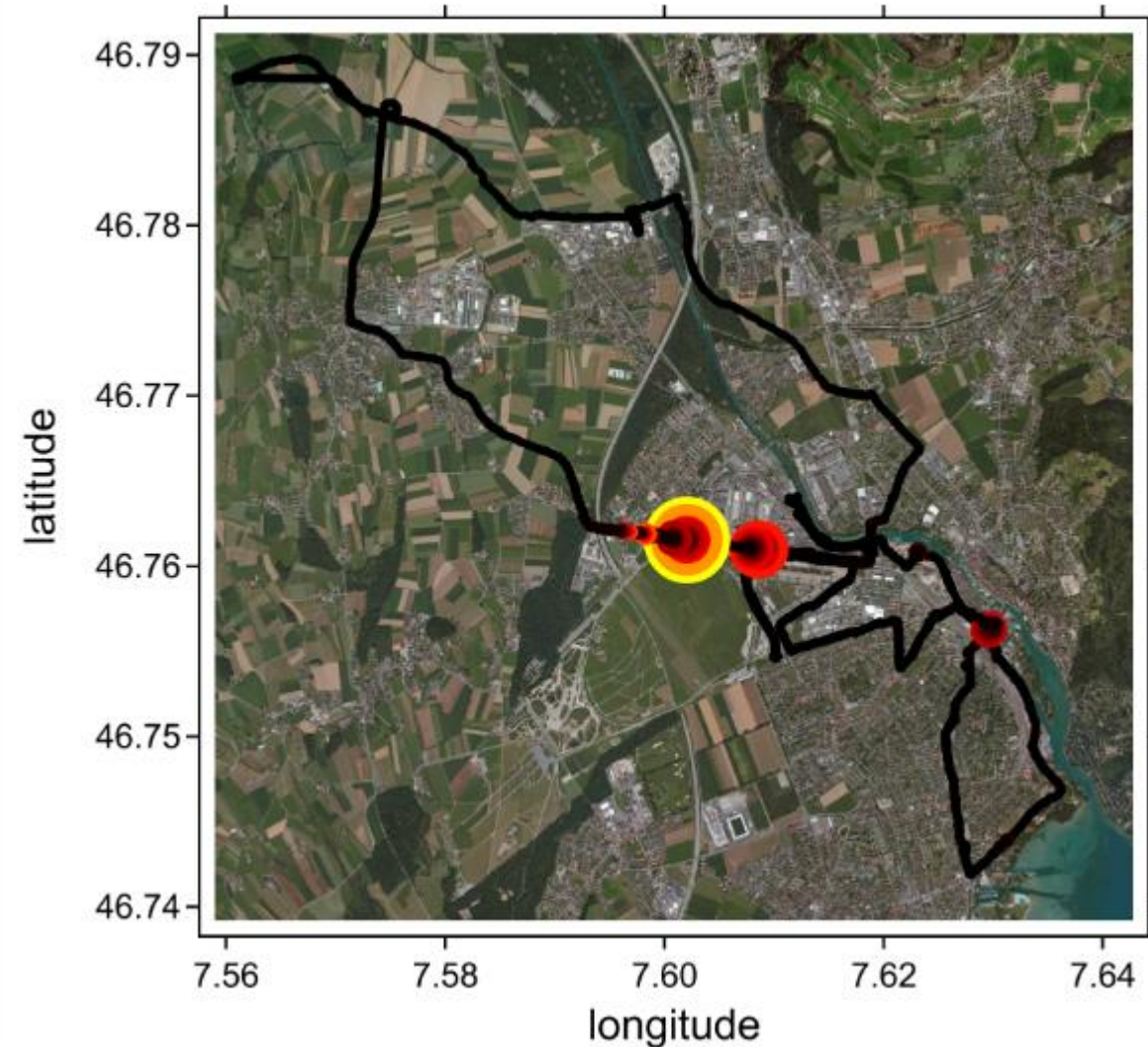
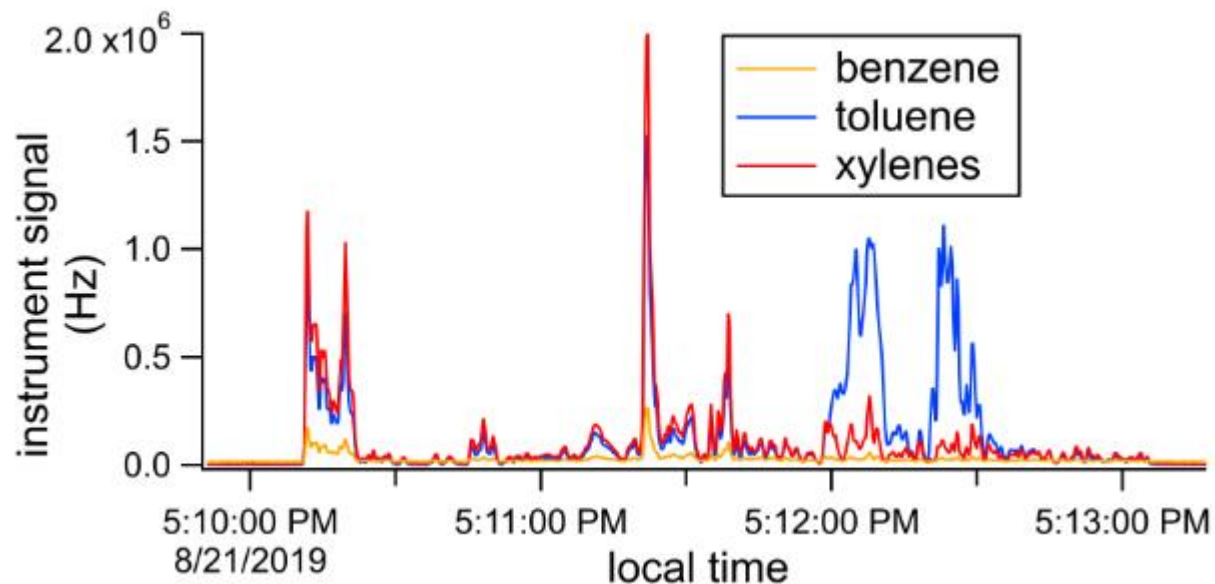


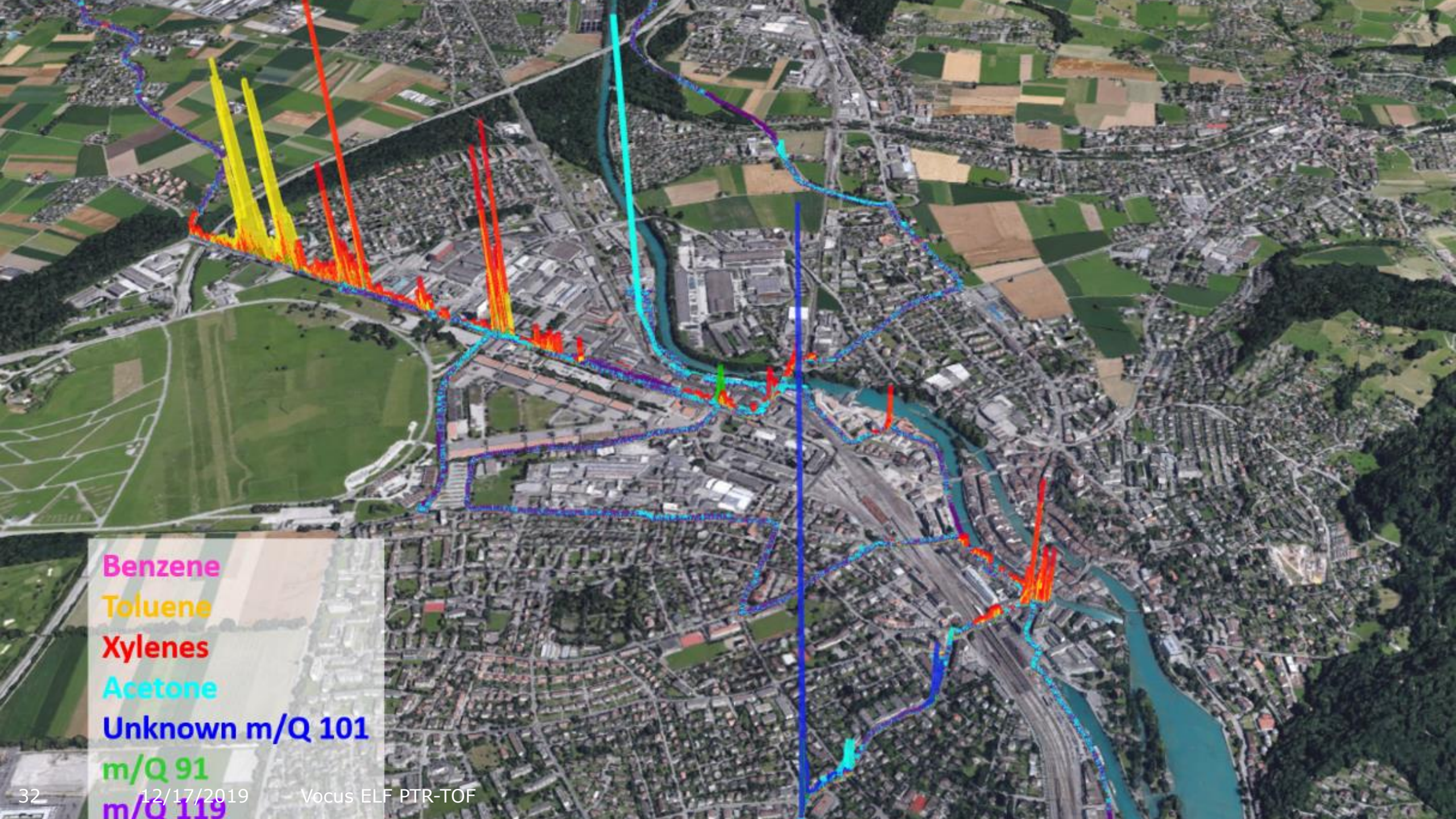
Thun, Switzerland

# Mobile ELF: catch various emission sources



# Mobile ELF: high aromatics emission on heavy traffic area





Benzene

Toluene

Xylenes

Acetone

Unknown m/Q 101

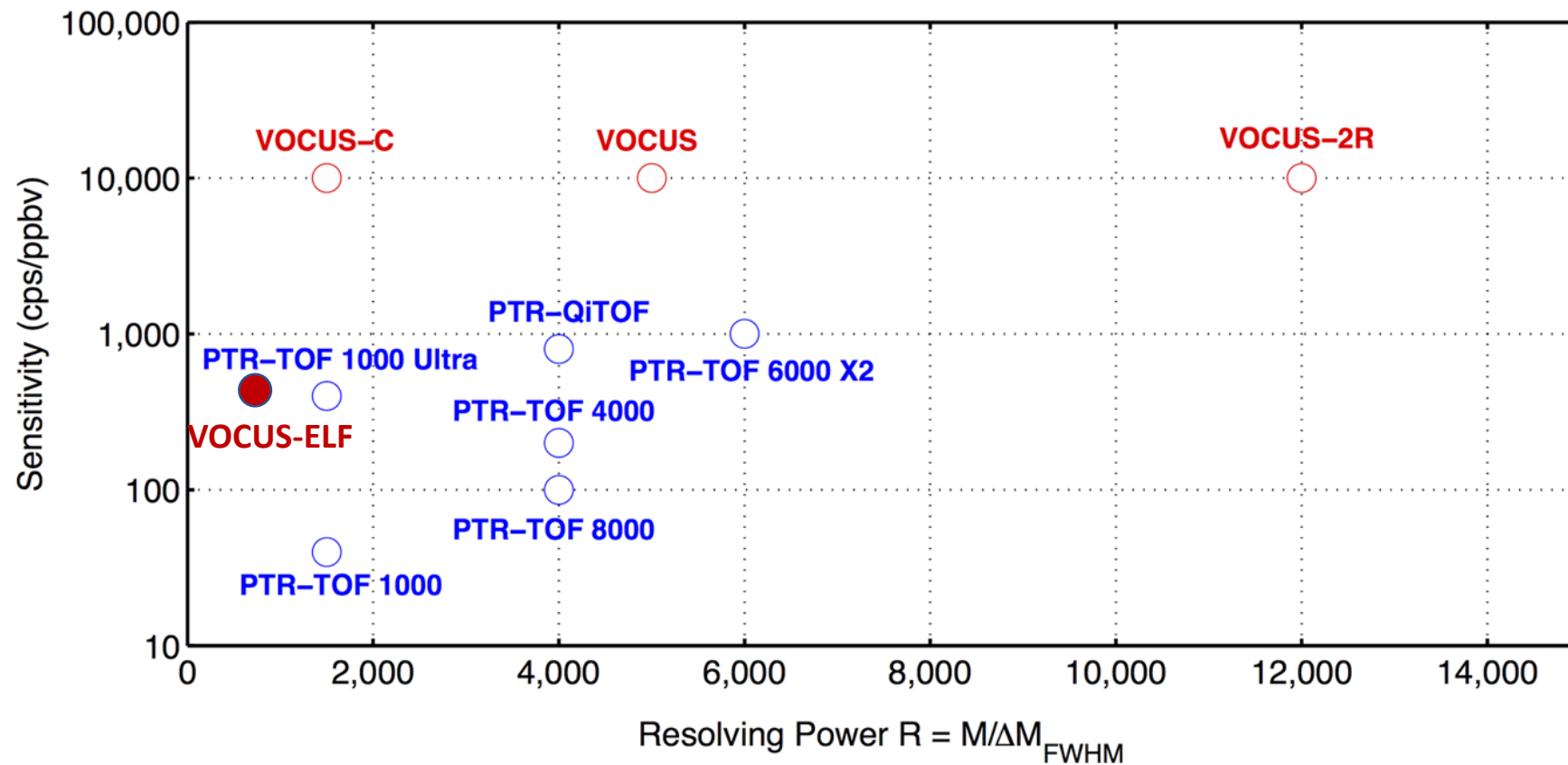
m/Q 91

m/Q 119



# Less is more

Vocus



1:1 size comparison to Ionicon PTR-TOF

Specs	Vocus ELF	SYFT	Ionicon TOF 1000
Size (cmXcmXcm)	38 x 60 x 65	91 x 73 x 90	60 x 91 x 80
Weight (kg)	55	210	125
Power consumption (W)	400	?	1500
LOD (1-min)	<20 ppt	<100 ppt	<20 ppt
Sensitivity (cps/ppbV)	500	?	120
Mass resolution	> 1100	Unit resolution	> 1500
<i>Response time</i>	<100 ms	<200 ms	<100 ms
<b><i>Response time when measuring 15 substances</i></b>	<100 ms	2 minutes	<100 ms
<b>Semi-quantitative estimation of unknowns</b>	Yes	NO	Yes
<b>Alarm on unknowns</b>	Yes	NO	Yes
Auto-calibration/zero	Yes	Yes	No
Mobility	Excellent	Average	Good
Price	Medium	High	High



UNIVERSITY OF HELSINKI



u<sup>b</sup>

UNIVERSITÄT  
BERN



復旦大學  
FUDAN UNIVERSITY



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Korea Institute of  
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MAX PLANCK INSTITUTE  
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# The most compact PTR-TOF

Vocus Elf  
小 精 靈  
巧 確 敏



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