



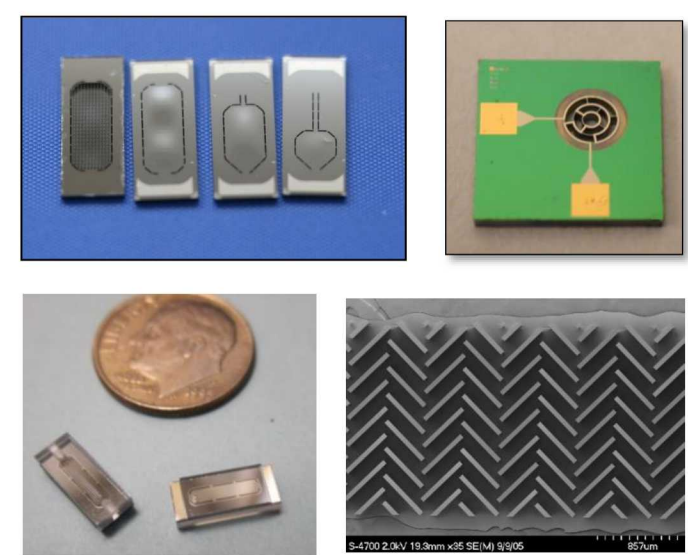
Field Portable Micro GC and Micro GCxGC System Development for Chemicals and Biogenic VOCs

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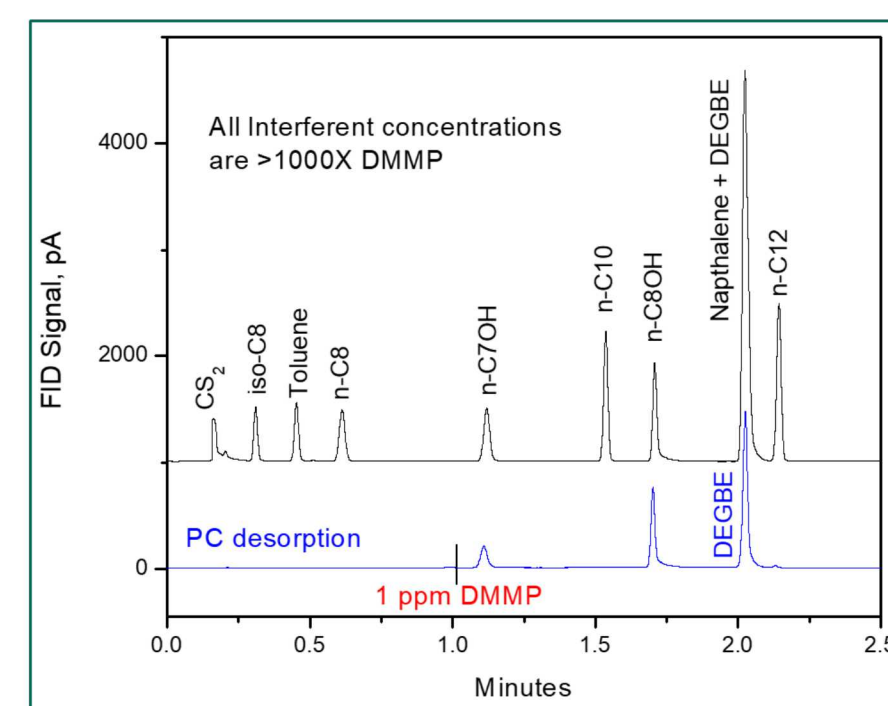
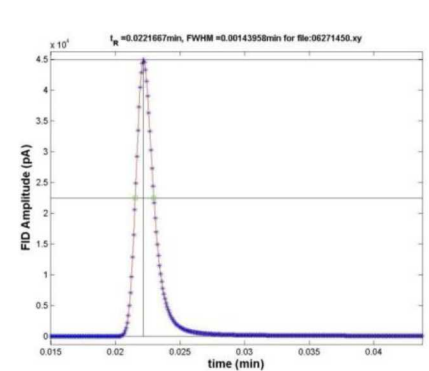
Overview

- MicroGC-based systems developed for chemicals & biogenic VOCs.
- Microfabrication reduces size, weight, and can improve performance.
- Small formats including handheld, wearable, UAV and installed.
- Demonstrated sub-ppb detection in 0.5-120 sec in complex backgrounds and field installations for 22 months without false alarm.
- MicroGCxGC peak capacity over 50/sec.
- Many types of preconcentrators (PC), micro GCs and detectors implemented modularly for point-of-use applications.
- Many applications: toxic chemicals, natural gas and biogenic VOCs from breath, bacteria, algae and agriculture.

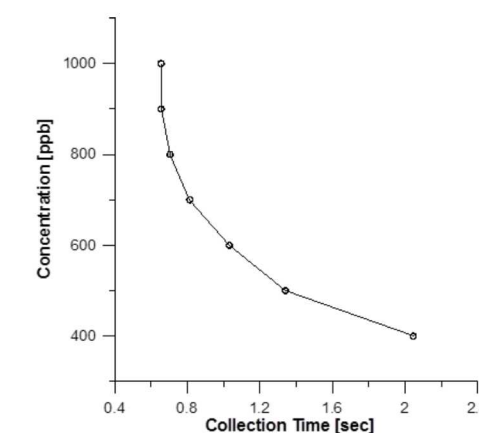
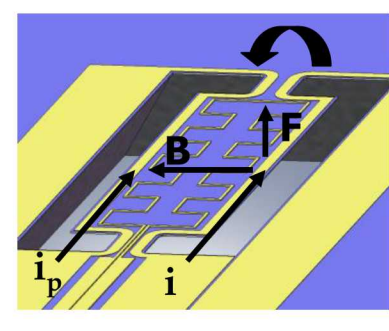
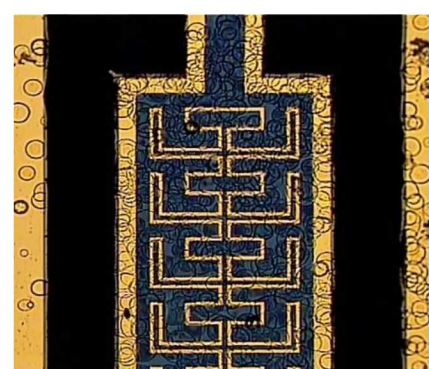
Low-Power MEMS PCs: portable GC injectors



DMMP: 3 sccm, 1.5 J,
FWHM 144 msec

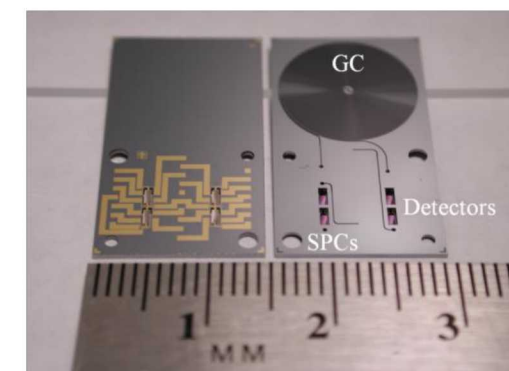


Smart PC/Detector and Monolithic Integration

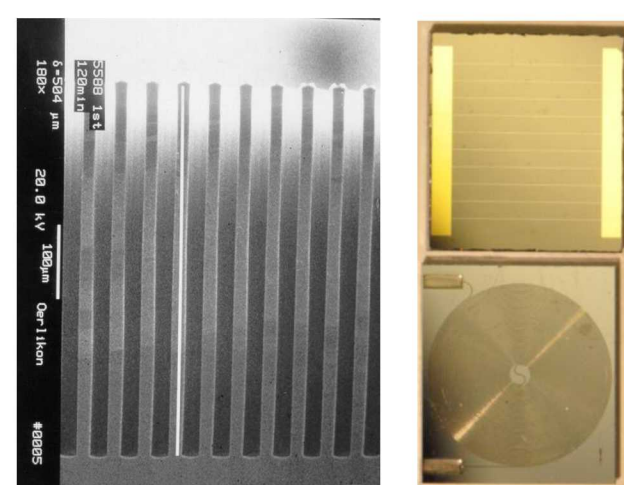


MEMS Smart PC: Real-time adjustment of collection time, enhanced dynamic range.

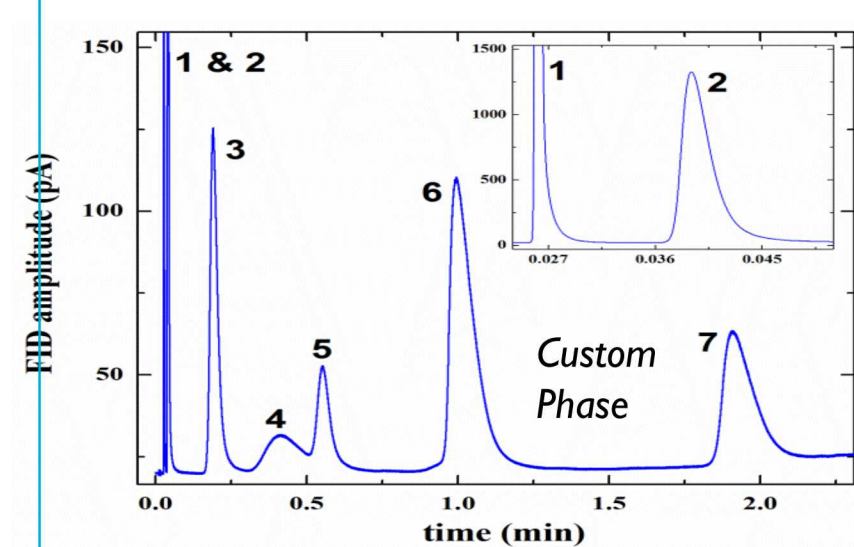
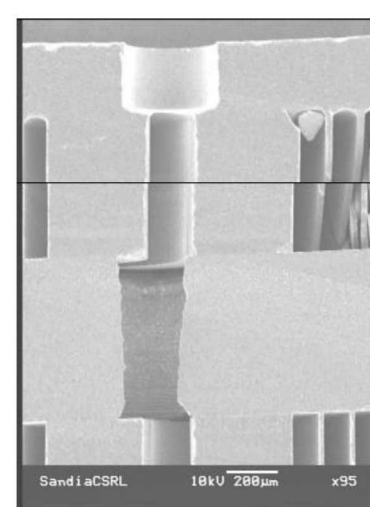
Silicon microfab for cost, integration, low dead volume, wearable format



MicroGC and Micro GCxGC for Diverse Analytes

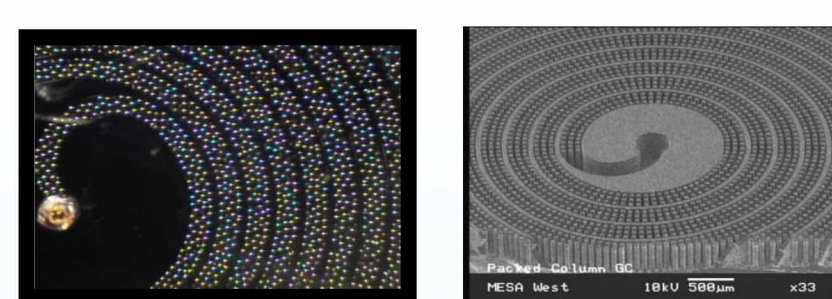
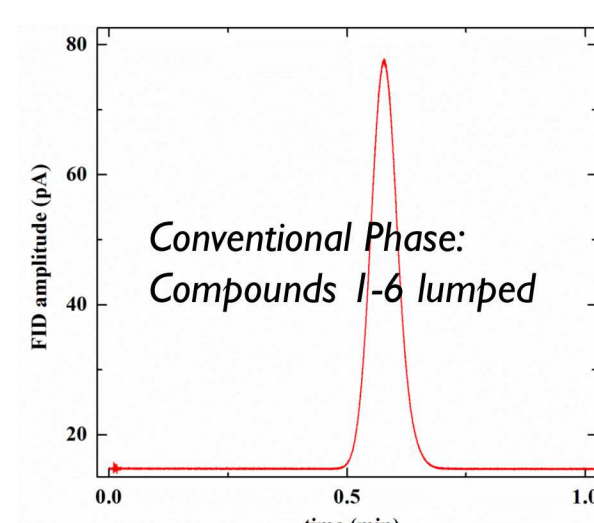


MEMS open-tubular or packed.
To 10,000 plates/m.
 $L \leq 5m$, $w \geq 20 \mu m$, $d \leq 700 \mu m$.
Stacking for longer columns.
High-performance thin-film heater

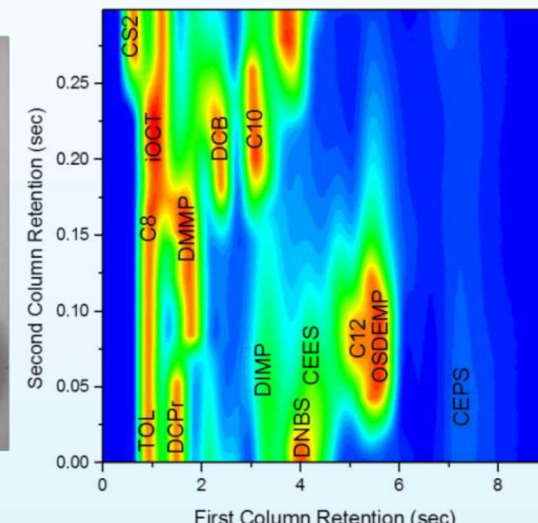
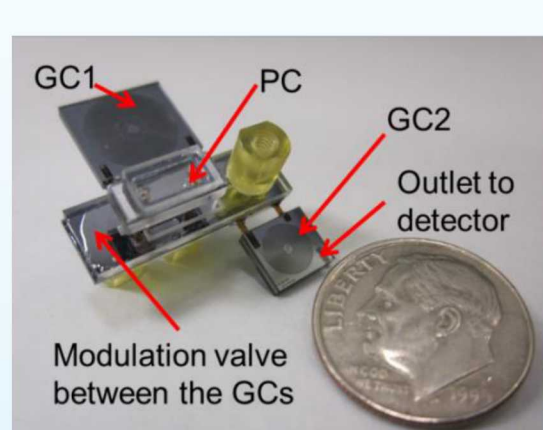
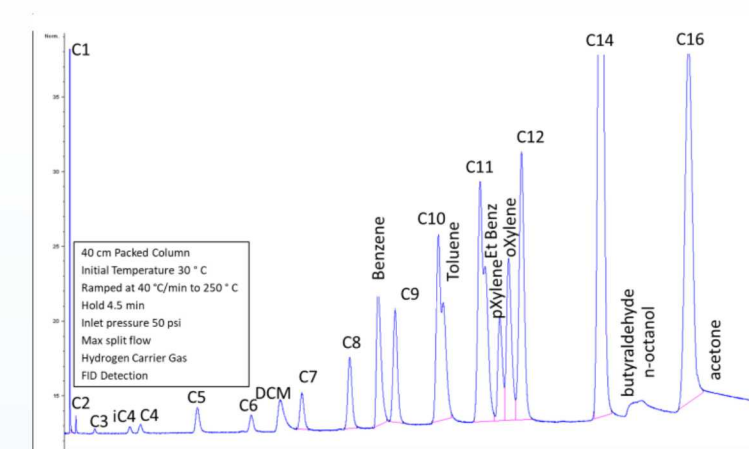
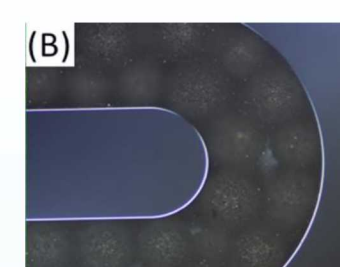


(1) methane, (2) ethane, (3) propane, (4) isobutane, (5) n-butane, (6) n-pentane, (7) n-hexane

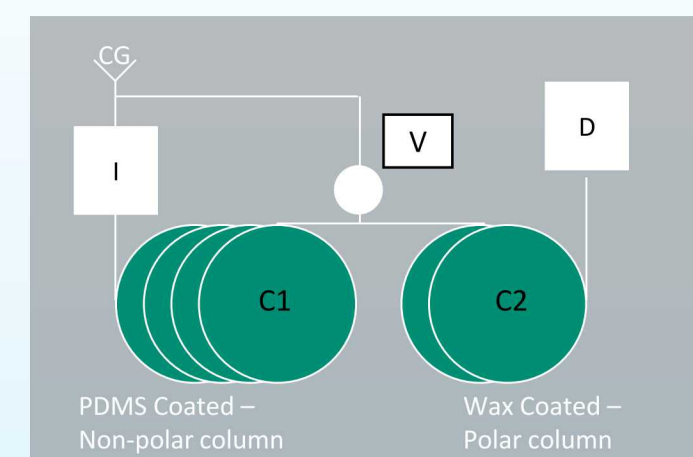
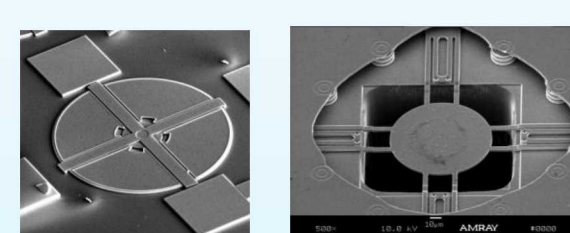
Separation on MicroGC with custom phase not possible conventionally enabling further miniaturization



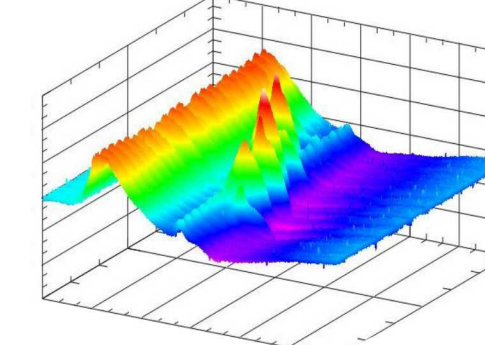
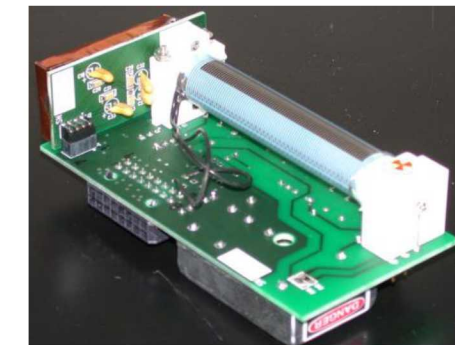
Bead or MEMS packed



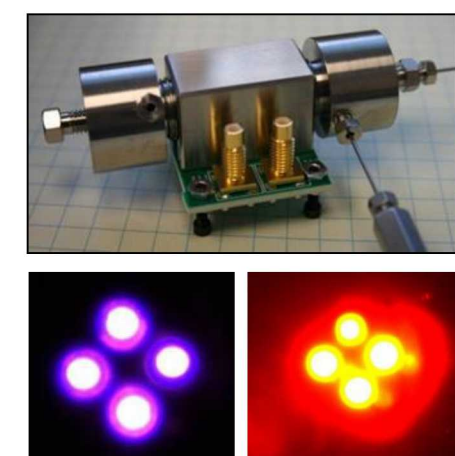
Stop-Flow Micro GCxGC



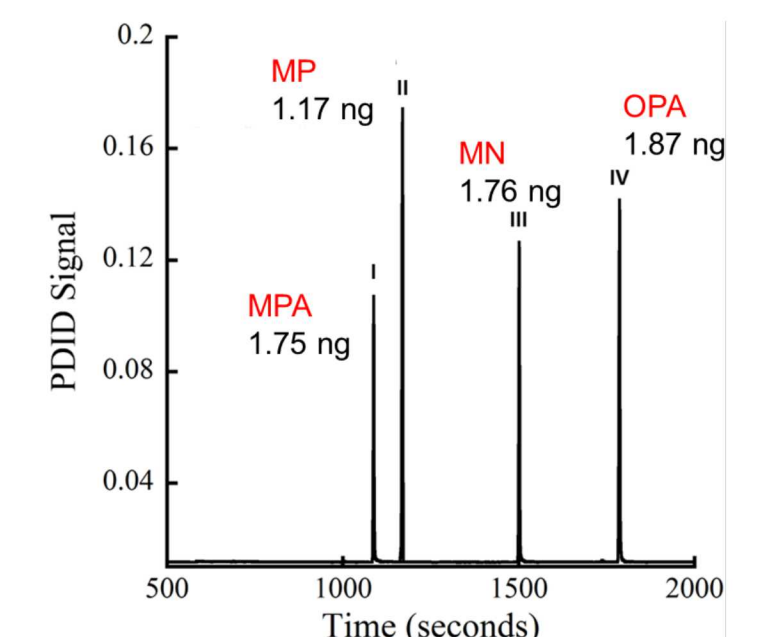
Many Detector Options for a Variety of Portable Applications



Mini-IMS: Manufacturing reduces cost & log increases performance. Positive & negative modes. MicroGC integration & VOC detection



Mini Pulsed Discharge Ionization Detector (PDID) with GC for bioVOCs. TB VOC detection with 0.02 ppb sensitivity. MicroPDID in development.



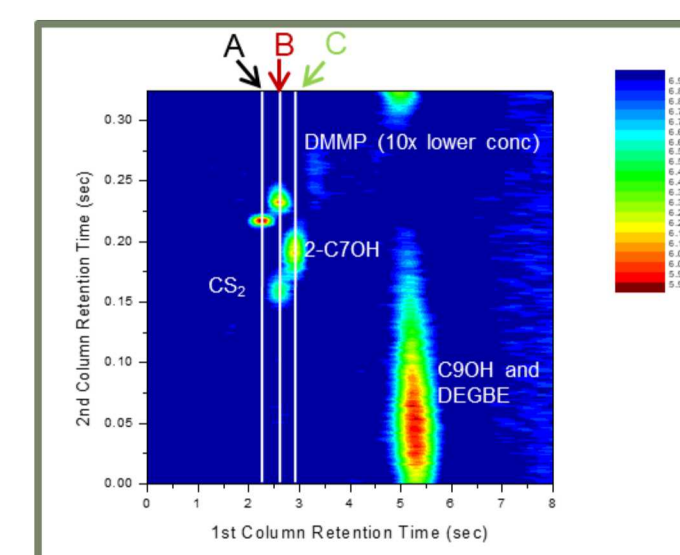
Other sensors fabricated & demonstrated up to TRL8-9: SAW, Smart PC, TCD, NEMS Resonator

Many Form Factors for Portable and Installed Use

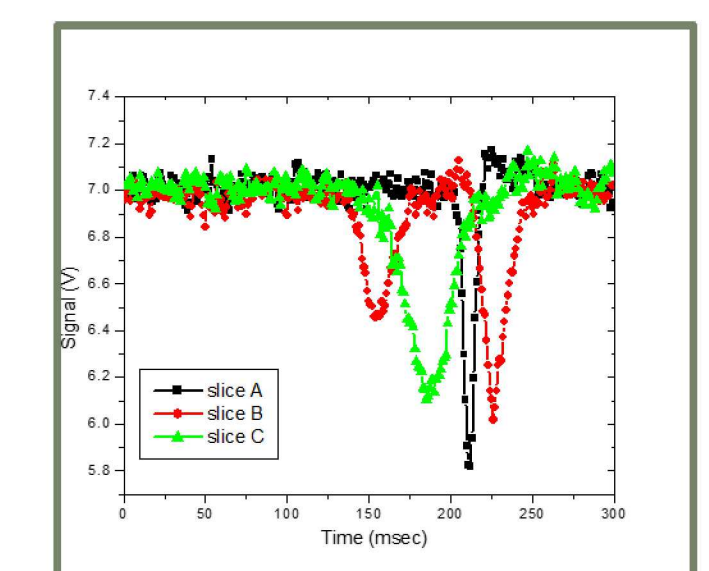


Wearable, handheld, UAV, installed units. 22 month demo in Boston Subway: 450,000 analysis, no false alarms, 17,000 remote tests.

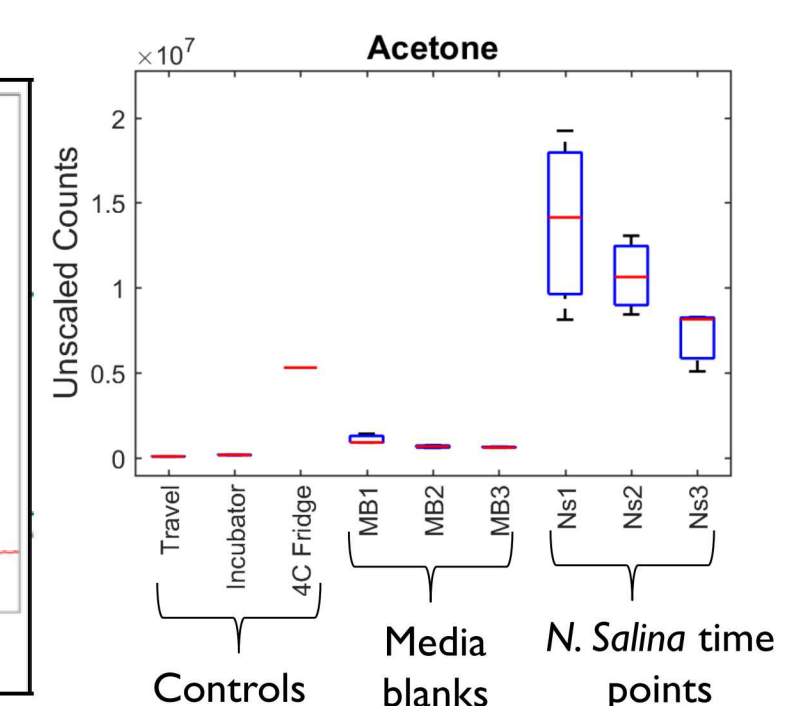
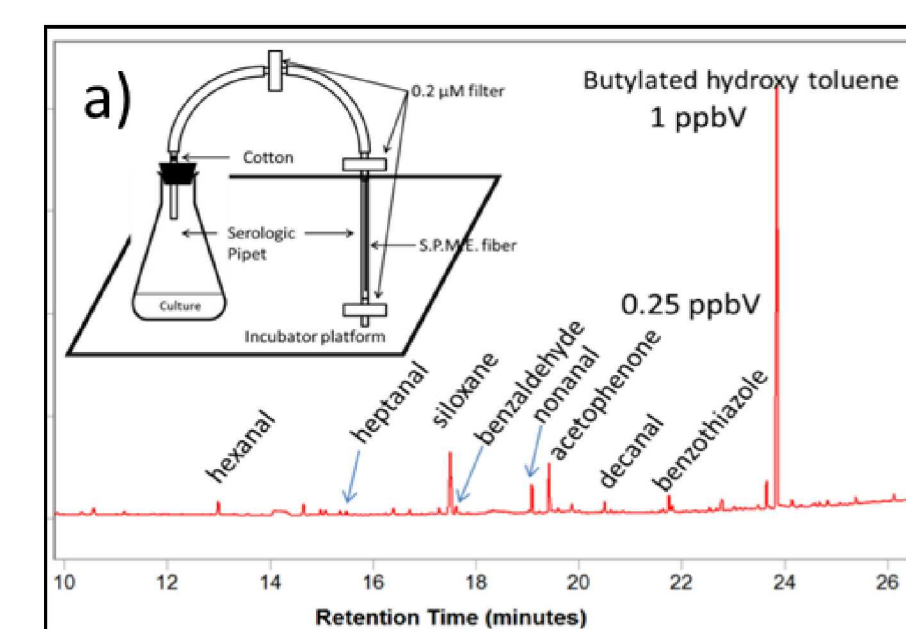
Micro GCxGC for Chemicals and Biogenic VOCs



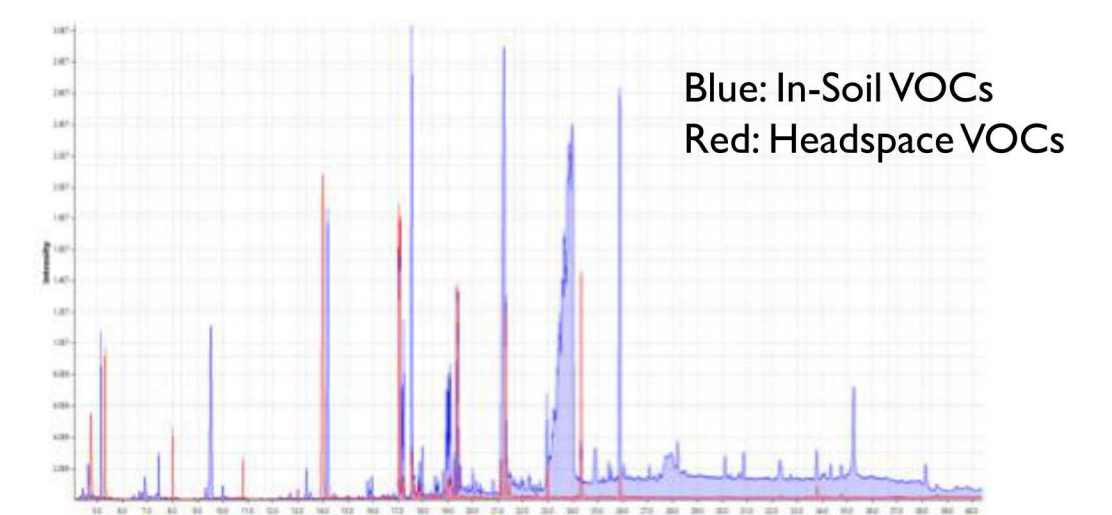
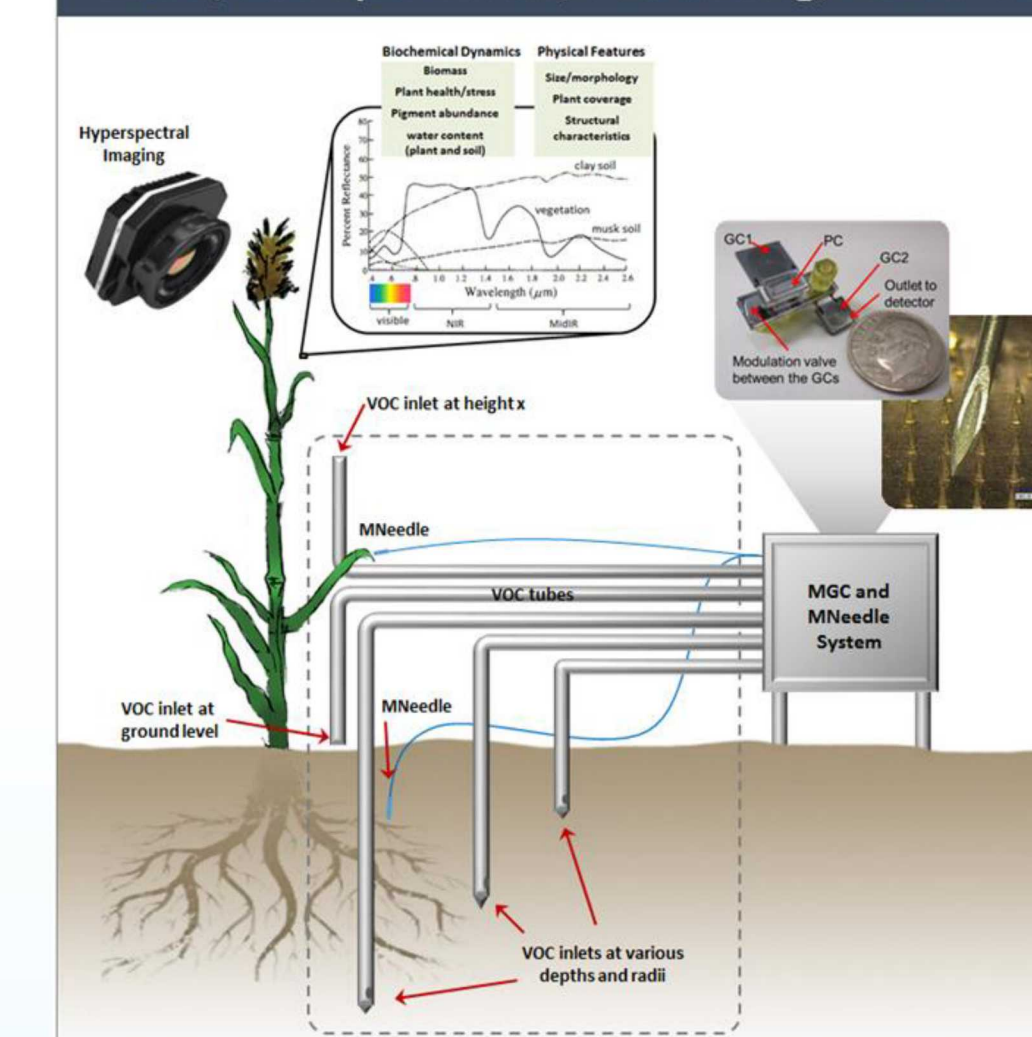
> 50 compounds/sec with pneumatically-modulated, stop-flow Micro GCxGC and resonator detector



Modularity for Many Applications



Data, Computation, Modeling, Toolkits



Acknowledgments

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