

GCxGC Overview What modulator should I use?

What is multidimensional GC?





Why do we need multidimensional GC?







First dimension separation (min)







Basic instrumentation requirements (Phillips and Liu, 1989)





Visualising the data



3D

plot

SepSolve Analytical

Choosing a modulator

 There is no "one size fits all" configuration

 Both have their own pros and cons

 The choice will depend on the application





Detectors for GC×GC

- Mass spectrometry (MS)
- Flame ionisation detection (FID)
- Atomic emission detection (AED)
- Sulfur chemiluminescence detection (SCD)
- Vacuum ultraviolet (VUV) spectroscopy
- Electron capture detection (ECD)



Overview of detectors for` GC×GC (based on 2243 results from Google Scholar between 2010 – 2022)



What sample introduction can be used with GC×GC?





Flow modulation

Key advantages

- Efficient modulation of volatiles
 - Extends application range

- Simple, consumable-free operation
 - Low capital/running costs

- Excellent repeatability
 - For routine analyses and large sample batches







INSIGHT-Flow

Robust, repeatable and affordable multi-dimensional GC





How does it work?

Reverse fill/flush (RFF) flow modulation





For more on the development of RFF flow modulators, see Griffith et al, J. Chromatogr. A, 1226 (2012) 116–123

Simplifying flow modulation

Flow modulation





Simplified parallel detection

¹t_R (min)

Flow modulation

8 GC×GC-SCD 7 4.5 (5)⁸ 4.0 6 5 3.5 10 4.5-(5) ⁸¹₇ GC×GC-TOF MS 7 3.5 6 10 ¹t_R (min) 11 12 8 ²t_R (s) Trace peak in the MS data may have been 5. overlooked SCD data ensures the sulfur peak is targeted and identified 10 15 20 30 25 35 40



²t_k (s)

Confident identification in complex matrices



- Tear gas lachrymators from a clothing extract
- Confident identification of capsaicin (64 ppb) and dihydrocapsaicin (72 ppb) even at trace levels



Quantitation of lachrymators



 Four-point calibration curves based on GC×GC–TOF MS analysis of the five lachrymator standards with a concentration range of 20–2000 pg/µL (20–2000 ppb).



Key advantages

- Enhanced sensitivity
 - Analytes are enriched in the carrier gas

Enhanced peak capacity

• Simpler method development





Refocussing and enrichment of analytes in the carrier gas





Refocussing and enrichment of analytes in the carrier gas





Refocussing and enrichment of analytes in the carrier gas











INSIGHT-Thermal Thermal modulation A cryogen-free thermal modulator with unbeatable productivity Cold jet Column holder Hot jet









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	- Analy	ytica



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Fully unattended analysis to maximise sample throughput

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Extending the analyte range

The challenge...





Extending the analyte range

Modulation of C₇





Flow modulation

Smart design

Fast and accurate column installation

Smooth surfaces to prevent column breakages

Flow modulation

Thermal modulation



Column holder (patent-pending) ensures precise alignment of the column between the jets



Is icicle formation really an issue?

Flow modulation

Thermal modulation



10 L/min cold jet flow

0.5 L/min **STANDBY** cold jet flow



Enhanced peak capacity for detailed characterisation



• We can help to optimise your method and make the most of the separation space



Non-target screening of river water for emerging pollutants Flow module



Sensitive, non-target screening of environmental samples (e.g., water, soil and sludge)



Summary

What modulator should I use?

	FLOW	THERMAL	
Advantages	No volatility restrictionsSimple parallel detectionLow cost of entry	SensitivityPeak capacityEase-of-use	
Limitations	 Limited sensitivity* (*Unless coupled with preconcentration techniques) 	 Not suitable for very volatiles 	
Example applications	Aroma profilingVolatile biomarkersRoutine analyses	 Petrochemical fingerprinting Environmental forensics Metabolomics 	





Summary

The INSIGHT® modulator series

INSIGHT-Flow

- Adjustable sample loop and bleed line control kit for greater flexibility in method development
- Proven operation in high-throughput contract labs
- Dual-channel GC×GC for doubled productivity



INSIGHT-Thermal

- Flexible method development, with advanced jet control to extend the analyte range
- Smart design for fast, yet precise, column installation
- Confident, unattended analysis within easy-tomanage sequences







