# Leading the Way in GCxGC Instrumentation

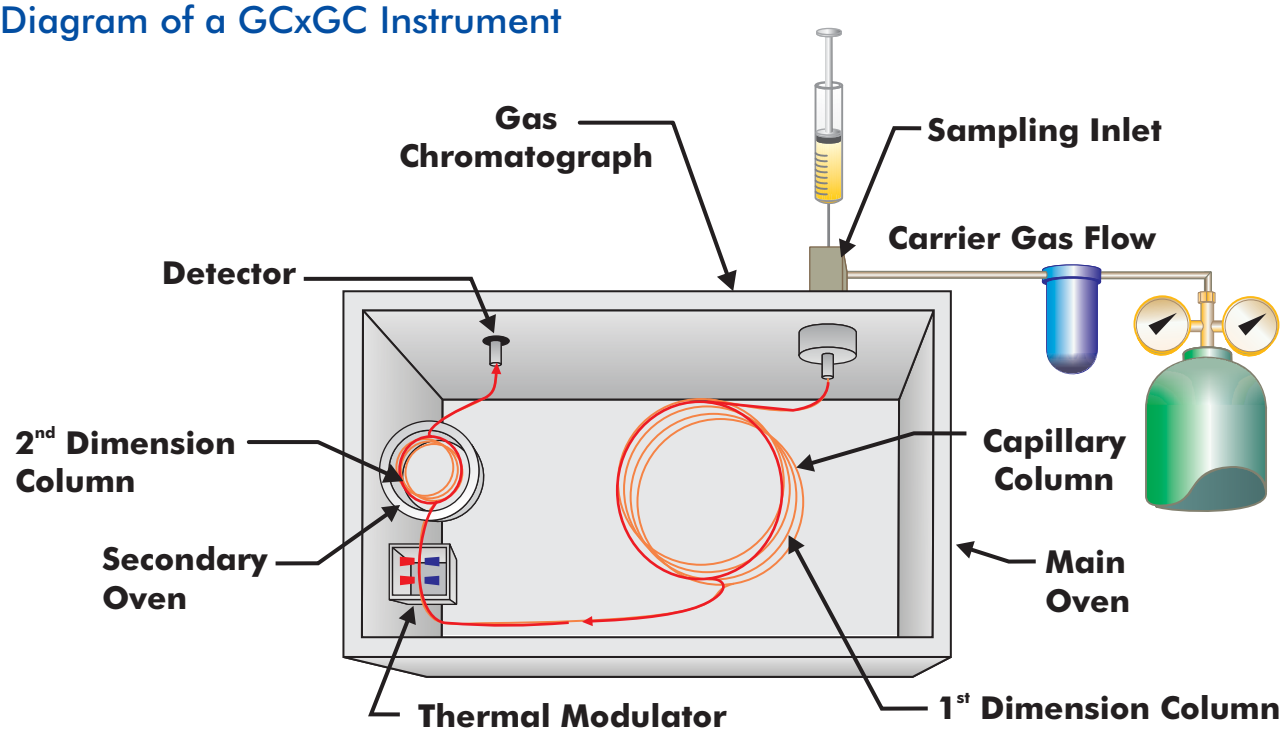
## What is GCxGC?

GCxGC, or comprehensive two-dimensional gas chromatography, is a technique that utilizes two columns of differing selectivities connected in series by a modulation device. The end result of the technique is dramatically increased peak capacity, improved peak resolution, and up to an order-of-magnitude increase in compound detectability. As opposed to heart-cutting (2DGC), GCxGC passes all effluent from the primary column through the secondary column, maximizing sample resolution throughout the entire analysis. Heart-cutting can only accomplish this in a narrow, pre-determined time window. Hundreds-to-thousands of individual heart-cutting analyses would be required to accomplish what LECO's GCxGC delivers to you in one analysis.

LECO's GCxGC Thermal Modulator, **now with an available consumable-free option**, is the key to the enhancement of peak detectability. The modulator, located between the two columns, consists of a robust dual-stage, quad-jet system that creates two distinct cooled trapping zones which ensures all of the effluent from the first column is properly focused prior to thermal release into the second column. A secondary oven is used for optimization of the second dimension separation.

GCxGC occurs by the subsequent re-injection of effluent from one chromatographic column into a second orthogonal column. The cycle of refocusing and re-injection is matched to the time required for compounds to elute from the second GC column, resulting in separation of compounds across a plane rather than just along a line.

## Diagram of a GCxGC Instrument

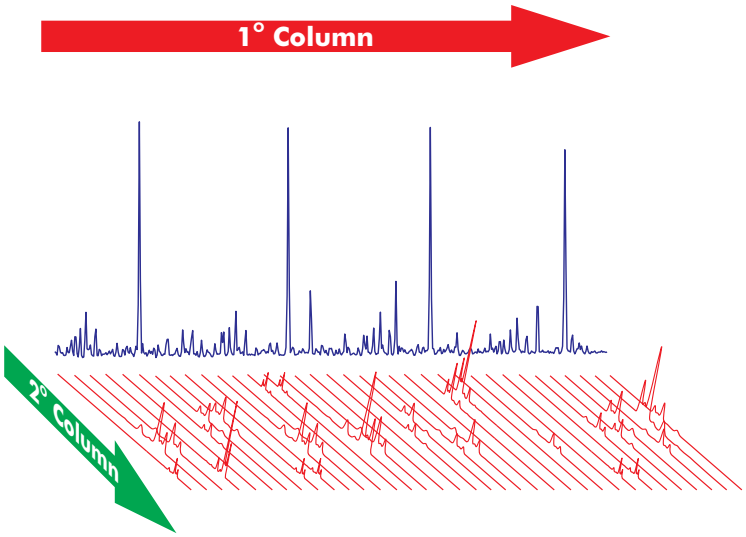



***The GCxGC hardware (modulator and secondary oven) are mounted inside the primary GC oven. Control of the GC autosampler, GC, LECO's GCxGC thermal modulator, and the selected detector are fully integrated within a single computer using LECO's ChromaTOF® software.***

# The Answers to Your Chromatographic Challenges

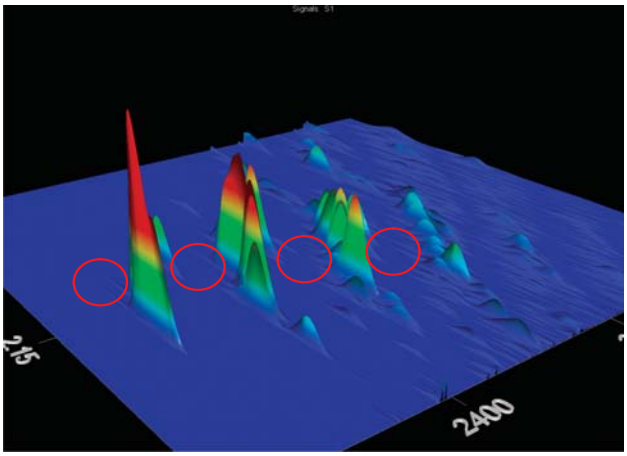
## Why Do I Need GCxGC?

Simple answer—resolving power! Ever struggle to separate a compound of interest from matrix background or nearby coeluting peaks? Due to the orthogonal nature of the separation mechanism in GCxGC, compounds are easily separated from matrix interferences. Baseline separation for each peak of interest can be clearly seen on a visually elegant retention plane.




***Schematic demonstrating the creation of a GCxGC surface plot. The linear signal received by the detector is mathematically realigned to form the three dimensional chromatogram.***

The use of GCxGC will also provide your laboratory with increased peak detectability. Because true GCxGC incorporates a modulation device, peaks eluting from the primary column are quantitatively segmented into smaller sections prior to release onto the second column. This "segmenting", combined with the cryo-focusing of the modulator, delivers peak widths as narrow as 50 ms to the second column. These segmented cryo-focused peaks provide up to an order-of-magnitude increase in signal-to-noise. With this focusing you will gain the ability to separate your peaks of interest AND you will lower the limit of detection of your chromatographic system to levels unachievable in traditional GC methods.




***GCxGC chromatogram of a diesel sample showing the loss of sulfur (red circles) after refining.***

## Thermal Modulation

Thermal modulation delivers the highest performance of any available modulator for GCxGC. Other types of thermal or valve-based modulators do not match up to the ruggedness, reliability, and performance of LECO's patented GCxGC modulator. With LECO's GCxGC system, modulation is accomplished via a dual-stage, quad-jet thermal modulator positioned between the two columns. LECO's thermal modulator allows for on-column cryo-focusing within the GCxGC system, providing increased peak detectability and increased separation of coeluting compounds.

## Thermal Modulation Without the Hassle of Liquid Nitrogen

With the addition of LECO's Consumable-Free Modulator you can now choose the compound volatility range you need to modulate. If your application requires you to modulate at extreme low volatility, the traditional $LN_2$ cooled modulator is recommended. However, if your method does not require you to modulate highly volatile compounds, the Consumable-Free Modulator will save you time and money without sacrificing performance.

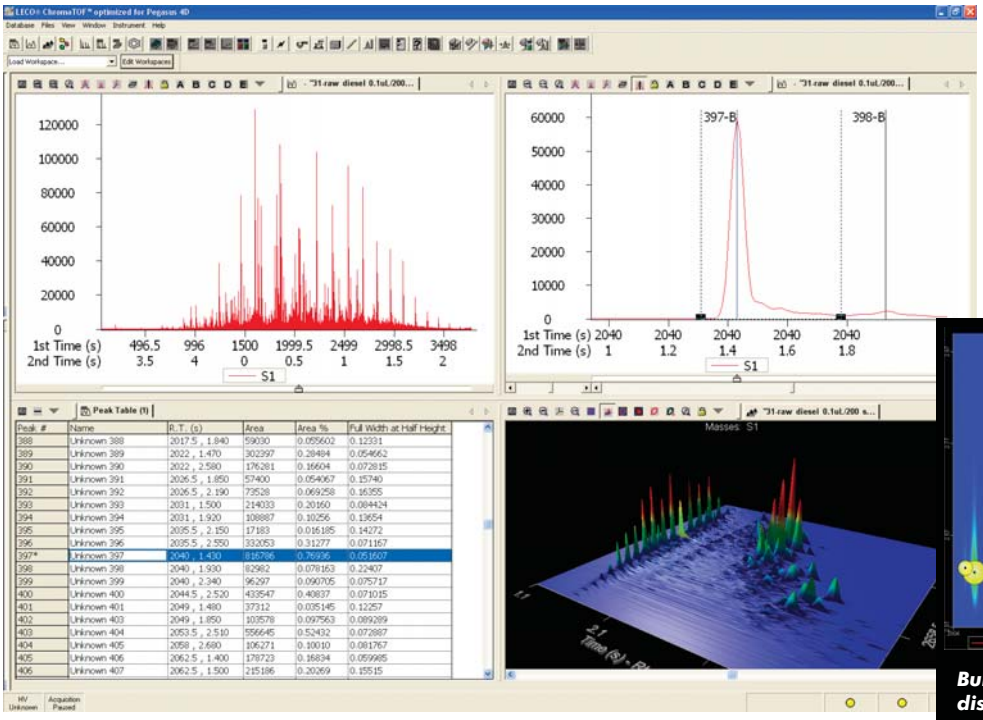
LECO's thermal modulation design gives you the upper hand in laboratory productivity. Ease-of-use and flexibility for second column choice allow for improved analytical results. Ask yourself—if you're not getting complete results from your second dimension, are you really justifying the purchase of a GCxGC instrument?

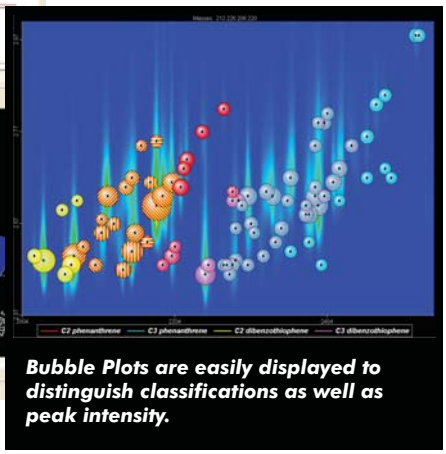
# Leading the Way in Advanced GCxGC Data Processing

## ChromaTOF® Software

LECO's pioneering efforts in GCxGC data processing have resulted in the most comprehensive software package available. Offering the industry's most advanced data-mining algorithms, ChromaTOF combines ease-of-use with advanced chromatographic techniques and three dimensional chromatogram visualization to deliver a seamless data analysis package well suited for both routine and research-level use. Even the most demanding analytical samples will be easily characterized, resulting in increased component identification and laboratory productivity.

- User-defined classifications – peak grouping based on proximity in chromatographic plane
- Bubble plots – peak intensity represented by circle radius
- Custom generated reports
- Built-in spreadsheets for advanced data-mining
- Data exporting for secondary software analysis
- Advanced Automated Peak Find algorithm
- Contour and surface plot 3D chromatogram visualization



***Bubble Plots are easily displayed to distinguish classifications as well as peak intensity.***

Peak Table (1)

| Peak # | Name | R.T. (s) | Classifications | UniqueMass | Area | Area % |
|---|---|---|---|---|---|---|
| 376 | Benzene, 2-butenyl- | 5140 , 1.170 | C4 Benzene | 117 | 1538995 | 2.3140 |
| 386 | Benzene, 2-butenyl- | 5190 , 1.200 | C4 Benzene | 89 | 322884 | 0.48549 |
| 400 | Benzene, 1-methyl-3-(1-methylethyl)- | 5240 , 1.140 | C4 Benzene | 119 | 1008683 | 1.5167 |
| 441 | Benzene, 2-ethyl-1,4-dimethyl- | 5370 , 1.170 | C4 Benzene | 119 | 2227039 | 3.3486 |
| 635 | Naphthalene | 6040 , 2.060 | Naphthalene | 128 | 3039449 | 4.5701 |
| 1036 | Naphthalene, 1-methyl- | 7010 , 1.930 | C1 Naphthalene | 115 | 2319808 | 3.4880 |
| 1108 | Naphthalene, 1-methyl- | 7140 , 2.010 | C1 Naphthalene | 142 | 2113343 | 3.1776 |
| 1417 | Biphenyl | 7650 , 2.070 | Biphenyl | 154 | 1253861 | 1.8853 |
| 1519 | Naphthalene, 1-ethyl- | 7800 , 1.820 | C2 Naphthalene | 141 | 1376714 | 2.0700 |
| 1536 | 1,1'-Biphenyl, 4-methyl- | 7820 , 1.690 | C1 Biphenyl | 168 | 314007 | 0.47214 |
| 1585 | Naphthalene, 2,6-dimethyl- | 7890 , 1.840 | C2 Naphthalene | 156 | 1109035 | 1.6675 |
| 1795 | Naphthalene, 1,3-dimethyl- | 8160 , 1.970 | C2 Naphthalene | 141 | 735212 | 1.1055 |
| 1872 | Naphthalene, 1-ethyl- | 8270 , 2.020 | C2 Naphthalene | 156 | 250039 | 0.37596 |
| 1892 | Naphthalene, 2-(1-methylethyl)- | 8290 , 1.700 | C3 Naphthalene | 155 | 94854 | 0.14262 |
| 2008 | 1,1'-Biphenyl, 4-methyl- | 8450 , 1.980 | C1 Biphenyl | 168 | 1312337 | 1.9732 |
| 2031 | Benzene, 1,1'-ethylidenebis- | 8480 , 1.780 | C3 Naphthalene | 167 | 12686 | 0.019074 |
| 2041 | Naphthalene, 1-propyl- | 8490 , 1.740 | C3 Naphthalene | 141 | 194757 | 0.29284 |
| 2066 | 1,1'-Biphenyl, 4-methyl- | 8520 , 1.990 | C1 Biphenyl | 168 | 509795 | 0.76653 |
| 2092 | 1(2H)-Naphthalenone, 3,4-dihydro- | 8550 , 1.990 | C1 Biphenyl | 90 | 36484 | 0.054858 |
| 2120 | Naphthalene, 1,4,5-trimethyl- | 8580 , 1.750 | C3 Naphthalene | 155 | 142313 | 0.21398 |
| 2130 | Naphthalene, 1,4,5-trimethyl- | 8600 , 1.780 | C3 Naphthalene | 155 | 129745 | 0.19508 |
| 2164 | Naphthalene, 1,4,5-trimethyl- | 8650 , 1.750 | C3 Naphthalene | 155 | 986836 | 1.4838 |
| 2183 | Naphthalene, 1,4,5-trimethyl- | 8680 , 1.790 | C3 Naphthalene | 170 | 140984 | 0.21198 |
| 2184 | 1-Isopropenylnaphthalene | 8680 , 1.960 | C1 Biphenyl | 153 | 39085 | 0.058768 |
| 2217 | Naphthalene, 1,4,5-trimethyl- | 8720 , 1.820 | C3 Naphthalene | 155 | 225433 | 0.33896 |

***Compound classifications can be displayed in peak tables to provide quick identification and ease of filtering.***