Innovations in GC & GCMS for the Environmental Laboratory
Environmental GC-MS Workflow

- Automation for sample preparation
- Consumables that simplify and improve results
- Accuracy Speed and Productivity
- Innovating GC for demanding routine / applications
- Lower limits of detection for regulatory compliance
- Robust performance for simple and complex matrices
- Software that matches specific environmental analysis requirements
- Tools that simplify data analysis

Workflow Solutions from Sample Prep to Reporting
Product Innovations to Simplify Your Workflow
TRACE 1300 Series GC-Injector and Detector Modularity
Tailor Instrument Configurations within Minutes

- Pneumatic control
- Inlet/detector bodies
- Specific electronic control boards
- GC oven
- Electronic boards
- Proportional solenoid valves for gas control
- Pneumatic manifold
- Inlet body heater and insulation
- Column connection (inside the oven)

Future | Past
**TRACE 1300 Series**

**TRACE 1310:** Touch screen interface provides instant access for ease of use and local control

**TRACE 1300:** Local built-in ultra-simplified user interface – two buttons and four LEDs.

**Modules available:**

**INLETS:** SSL - SSL backflush - PTV - PTV backflush – GSV (Gas Sampling Valve)

**DETECTORS:** FID - TCD - ECD - NPD - FPD - PDD - MS*

**OTHER OPTIONS:** Oven Cryo - Aux carrier

**SOFTWARE:** Chromeleon, TraceFinder, XCalibur

* Supported ISQ, TSQ-EVO, TSQ Duo, Q-Exactive
Complete Touch Screen for Direct Control

- Complete touch screen for direct control
- Method development & status control
- Multi language capabilities
- Maintenance, run log and video tutorials
SSL Inlet Designed for Performance, Robustness, PM Simplicity

**Going Beyond the Standard:**

- Less Frequent PM Scheduling
- Injector maintenance is quick, simple and easy
- Cool head and septum
- Lower septum bleeding
- Longer septum lifetime for high productivity
- No septum sticking for quick maintenance
- Entire injector body can be removed for efficient cleaning-have a spare for even faster PM recovery
- Increased column lifetime and MS sensitivity
Purge and Trap Adapter for TRACE 1300 (Volatile Methods)

- Purge and Trap Adapter is a modification to the 1300 SSL Module
- Purge and Trap Adapter allows direct coupling of the Purge and Trap transfer line to the heated inlet
  - Reduces potential cold spot at PTC / GC interface
- No cut or unions are required in the carrier gas pathway
- Quickly and easily adapted back to liquid injections
Trace 1300 GC Oven - Thermal Mass Reduction – Increased Productivity

- A robust and simple idea for superior oven performance
  - Use of perforated sheet metal walls
  - Layered insulation materials
  - Larger exhaust air doors
  - Fast cooling and heating
  - Same size of TRACE GC oven
  - Both side available for MS x-lines (no electronics)
Product Innovations to Simplify Your Workflow
Integrated Sampling System
Liquid Auto-sampler – AI/AS 1310

- Alignment-free
  - No alignment procedures at installation or for syringe replacement
- Symmetrical (for front or back side mounting)
  - One unique option with automatic recognition
Trace 1300 series with Dual AS 1310 Configuration

- 310 total sample capacity
- Gemini mode
- Minimal space coverage
- Trace 1300 to inject on two separate injection ports for simultaneous two+ channel analysis (GEMINI configuration)
- Ensures full injector maintenance capability as well as injector/detector module exchangeability
- Confirmation Analysis – Pesticides/PCBs
TriPlus RSH – Automated Robotic Sample Handling

- Basic Liquid configuration fully compatible with...
- Agitator and Heated oven for HS, SPME or sample prep
- SPME fiber conditioning for SPME applications
- Vortexer for Intensive sample mix
- Barcode reader for sample tracking
- Peltier heating or cooling of samples
- More sample trays for higher capacity
Triplus RSH: Syringe tools and ATC/TR stations

- TriPlus RSH is compatible with a wide range of syringe volumes
- ATC station enables unattended syringe exchange during a sequence
TriPlus RSH: Substantially Reducing $/sample Lab Cost

Automated basic sample handling and sample prep

- **Calibration dilution**: automatically prepare calibration points adding internal standards

*Labor costs strongly reduced with improved accuracy*
Product Innovations to Simplify Your Workflow

ISQ Single Quadrupole Mass Spectrometer
ISQ Series GC-MS: ISQ QD, ISQ QD 300, and ISQ LT
• **Thermo Scientific™ ExtractaBrite™** Ion Source
  • Repeller, ion volume, lenses and “RF lens”
  • Contained in a keyed, easy-to-work-with cartridge sleeve
  • No tools required for assembly or disassembly
  • High efficiency ion focusing optics
  • Repeller works with the RF Lens for a ‘push / pull’ approach to ion extraction
A Tour of the ISQ Series Design

ExtractaBrite Ion Source

Lenses 1, 2 and 3 plus the RF lens, along with the repeller and ion volume are contained in a sleeve, all of which can be removed from ISQ LT while the system is under vacuum.

The ability to remove the entire ion source from ISQ LT without venting means you are never down and always productive.
Thermo Scientific™ ExtractaBrite™ Ion Source Cartridge

Not in sample path.
Does not require frequent cleaning

In the sample path.
Scrub with Aluminum oxide, rinse and sonicate

Not in sample path.
Replace if contaminated.
Patented RF Lens

- The RF lens is the first RF source the ionized helium sees, protecting the ion guide and analytical quads **Robustness**
- The RF lens is kept very hot by the lens stack heater, preventing ion burn from forming **Robustness**
- The RF lens is designed as a part of source, can be removed to clean during routine source maintenance **Easy maintenance**
- The repeller is designed to overcome this ion burn once it does form, further extending robustness
Designed for Selectivity

- **S-Shaped Flatapole Ion Guide**
  - Dramatic reduction in neutral noise
  - Excited but neutral helium follows a linear path from the ion source, and therefore does not reach the mass analyzer and detector
  - No electronic ‘zero’ noise suppression required
  - Maintain ion ratio performance, even at very low concentrations
  - Peaks not riding on neutral noise background, making it easier for automated peak detection and review
How Does Thermo address Neutral Noise?

Signal to Noise: high intensity and low noise = high sensitivity in real analysis

Patented ExtractaBrite™ Source

off-axis ion guide pre-filter

homogeneous non-coated, maintenance-free quadrupole rods
NoVent MS: For any Routine GC-MS Applications

- NoVent module allows GC-MS user to perform quick, reliable column maintenance without venting the system.

- User not puzzled with gas flow settings because there are no additional flow controllers.

- System core is the SGE Silflow, completed with a manual on/off switching, calibrated restrictions and connectors.
NoVent Module: Principle of Operation

- During standard operation, the NoVent module is switched OFF

- During column replacement the NoVent module is switched ON
U.S. EPA Method Analysis Kits - Product Overview

“A solution focused on Environmental customers that need high sensitivity and throughput instrumentation”

8270D Analysis Kit Contents

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Column</td>
<td>TG-5MS w/ 5m guard, 30m X 0.25mm X 0.25µm</td>
</tr>
<tr>
<td>Injection liner</td>
<td>4mm ID x 105 mm, pack of 5</td>
</tr>
<tr>
<td>Graphite/Vespel Ferrule</td>
<td>0.1 - 0.25 mm, pack of 10</td>
</tr>
<tr>
<td>Septa BTO Coated</td>
<td>11 mm, pack of 50</td>
</tr>
<tr>
<td>EPA 8270D CD</td>
<td>(Contents: user guide, instrument and processing methods, compound retention times, method specific reports, trouble shooting info, etc)</td>
</tr>
</tbody>
</table>

- Ready to use package with method, troubleshooting and pre-loaded report package
- Set of consumables included (column, liner, septa, etc.)
- Compatible with Chromeleon 7.2 SR4 Mub or newer and Trace Finder EFS 4.1 or newer
- Compatible with ISQ QD and ISQ LT
Product Innovations to Simplify Your Workflow
TSQ Duo Triple Quadrupole Mass Spectrometer
What is Triple Quadrupole GC-MS/MS?

Single Quadrupole GC-MS

Ion Source  Ion Transfer Optics

Triple Quadrupole GC-MS/MS

Ion Source  Ion Transfer Optics
What is Triple Quadrupole GC-MS/MS?

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What is Triple Quadrupole GC-MS/MS?

Single Quadrupole GC-MS

Triple Quadrupole GC-MS/MS
What is Triple Quadrupole GC-MS/MS?

Single Quadrupole GC-MS

- Ion Source
- Ion Transfer Optics
- Quadrupole
- EM Detector

Triple Quadrupole GC-MS/MS

- Ion Source
- Ion Transfer Optics
- Quadrupole 1 (Q1)
- Quadrupole 2 (Q2) Collision Cell
- Quadrupole 3 (Q3)
What is Triple Quadrupole GC-MS/MS?

Single Quadrupole GC-MS

Ion Source  Ion Transfer Optics  Quadrupole  EM Detector

Triple Quadrupole GC-MS/MS

Ion Source  Ion Transfer Optics  Quadrupole 1 (Q1)  Quadrupole 2 (Q2) Collision Cell  Quadrupole 3 (Q3)  EM Detector
Why not a GC Triple Quadrupole?

- Time investment & timing
- Regulatory/Prescribed Methods
- Cost
- MS/MS method development
- System & software familiarization
• Simply Unique GC-MS/MS

• Excellent Performance
  • Selected Ion Monitoring (SIM)
  • Full Scan
  • Selected Reaction Monitoring (SRM)
  • Other MS/MS modes

• Chromeleon 7 - Operational Simplicity™
SQ Mode: Full Scan

SVOC in full scan on TSQ Duo GC-MS/MS
SQ Mode: Single Quad Spectral quality

- Fully library searchable mass spectra generated
- No spectral distorting gases in ion path
# Triple Quad GC-MS: Selectivity Advantages

<table>
<thead>
<tr>
<th>What does it allow?</th>
<th>What does this mean?</th>
<th>What do I get?</th>
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</thead>
</table>
| Reduced selectivity in sample prep          | • Less steps  
• More compounds  
• More matrices                                           | • Faster turnaround  
• More efficient methods  
• Less costly analysis  
• More flexible                                               |
| Consolidated GC-MS methods                  | • More compounds together in one run                      | • Faster turnaround  
• More efficient methods  
• Less costly analysis  
• More flexible                                               |
| Compressed chromatography                   | • Faster run times                                        | • Faster turnaround  
• More efficient methods                                       |
| Easy data processing                        | • Auto-integrators work!                                  | • Faster turnaround                           |
| More confidence                             | • Less susceptible to changeable matrix composition       | • Faster turnaround  
• Higher quality                                               |
Triple Quad GC-MS: Selected Reaction Monitoring (SRM)

- Acibenzolar-S-Methyl in difficult matrix

**High Selectivity**
- Reduce selectivity in sample preparation
- Consolidated GC-MS methods due to high performance
- Compressed chromatography possible
- Easy data processing

**SIM on m/z 182**

**SRM on m/z 182 > 153**
Make the step to triple quad when you choose

- Translate your current method into TSQ Duo method using SIM bridge
  - Continue with SIM analysis now and move to MS/MS later
  - Or immediately go to MS/MS analysis
AutoSRM: MS/MS Independence

1) Precursor ion selection

2) Product ion selection

3) Collision energy optimization

AutoSRM automates the development of SRM methodology
• Triple quadrupole GC-MS brings many advantages to the lab and can improve the quality and efficiency of traditional single quadrupole GC-MS analyses

• The transition to this technology from single quadrupole is especially easy with systems specifically designed with this in mind, such as the Thermo Scientific TSQ DuoTriple Quadrupole GC-MS/MS
Chromeleon CDS Simplifies Chromatography Process

Intelligent Functionality – it does everything you need

Chromeleon 7 manages the steps in between

Workstation and Enterprise solution
Leadership Technology with Unstoppable Productivity

**Instant Connect Modules**
- Interchangeable injector & detectors
- No special training
- No dedicated tools
- No on-site service
- Tailored GC configurations

**Vent Free Source Removal**
- High performance, reliable & easy to use
- Maximize instrument up time

**Vent Free Column Maintenance**
- Quick, reliable column maintenance without breaking vacuum

**Dual Detector Microfluidics Kit**
- Splits single column effluent between two GC detectors (including MS)

**Unique GC & GC-MS Innovated Productivity Breakthroughs**
MORE…Unique Innovated Productivity Breakthroughs

Automated Tool Change (ATC)

- Increase analytical flexibility and lab productivity by automating sample prep and calibration procedures, thus eliminating human error

Chromeleon

- Scalable Chromeleon CDS platform for Chromatography and MS

TSQ Duo

- Transition to Triple Quad Technology on your Timetable at Single Quad Costs

Support Services

- Instrument Support Plans
- On-site Application Support
- On-site Training Support

Leadership Technology with Unstoppable Productivity
Complete Coverage of the Specificity Spectrum

Increasing Analytical Specificity

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<th>TRACE 1300</th>
<th>ISQ Series</th>
<th>TSQ Duo</th>
<th>TSQ 8000 Evo</th>
<th>DFS</th>
<th>Q Exactive GC</th>
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<td>Single Quadrupole MS</td>
<td>SQ &amp; TQ MS</td>
<td>Triple Quadrupole MS</td>
<td>Magnetic Sector HRMS</td>
<td>Orbitrap</td>
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<tr>
<td>Detection with Multiple Detectors</td>
<td>Confirmation by Mass Spectrum or SIM</td>
<td>Mass Spectrum and MS^x</td>
<td>High performance, easy to use MS/MS for non-experts</td>
<td>High-Resolution Full Scan and SIM</td>
<td>HRAM GC-MS/MS</td>
</tr>
<tr>
<td>Pesticides, PCBs, Volatiles</td>
<td>EPA Regulated Methods (524, 525, 8260, 8270)</td>
<td>EPA Regulated and PBM (524, 525, 8260, 8270)</td>
<td>Target Analysis in Complex Matrix</td>
<td>Dioxins, PCBs, Other POPs</td>
<td>Discovery (Unknown Unknowns)</td>
</tr>
<tr>
<td>Petrochemical and Chemical</td>
<td>Forensic chemistry and toxicology</td>
<td>Academic research and teaching</td>
<td>Pesticides in Food, Drugs in body fluid</td>
<td>EPA 1613, 8270A, 8290</td>
<td>Revolutionizing the field of GC-MS</td>
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