

Gas Chromatography/ Mass Spectrometry

Key Features

- Portable, lightweight GC/MS with laboratory equivalent chromatographic resolution
- Operates under harsh conditions, providing routine calibration and automated performance validation
- Fast startup and cycle times – can process up to 12 samples per hour
- Operates on battery power for up to 2.5 hours, and has an on-board disposable helium carrier gas cartridge



Fast Results Anytime, Anywhere

Take the Torion T-9 portable GC/MS to your samples... wherever they are.

PerkinElmer's Torion® T-9 portable gas chromatograph/mass spectrometer (GC/MS) brings new meaning to portability.

At a total weight of only

32 pounds, this one-of-a-kind GC/MS is also fast, reliable and easy to use. Torion technology integrates a high speed low thermal mass (LTM) capillary gas chromatograph (GC) with a miniaturized toroidal iontrap mass spectrometer to provide a fast, reliable and easy-to-operate GC/MS.

The portable Torion T-9 GC/MS is designed to carry in the field and ideal for rapid screening of chemicals such as environmental volatiles and semivolatiles (VOCs/SVOCs), explosives, chemical threat, and hazardous substances.



Torion T-9 GC/MS: The world's lightest, fastest and most portable capillary gas chromatograph toroidal ion trap mass spectrometer (TMS).

A GC So Small it Can Fit in Your Hand

Don't let the size fool you

Although it was built for portability and speed, the low thermal mass (LTM) capillary GC provides equivalent chromatographic resolution and performance to a benchtop system. The miniature size is achieved by replacing a conventional convectively-heated column oven with a low thermal mass (LTM) column bundle with direct-contact electrical resistive heating. LTM GC uses a small diameter, metal capillary GC column, which is bundled with resistive heating and temperature-sensing wires that are braided

together with insulator strands. This design provides for greater heating and cooling speeds and very low power consumption.

Since column heating requires considerably less operating power than a conventional GC, the Torion T-9 GC/MS extends battery-powered operating time. With its powerful combination of direct resistive heating and rapid temperature ramp rates, the GC can handle the most challenging analytical tasks quickly, while separating analytes in just seconds, for fast, reliable results.

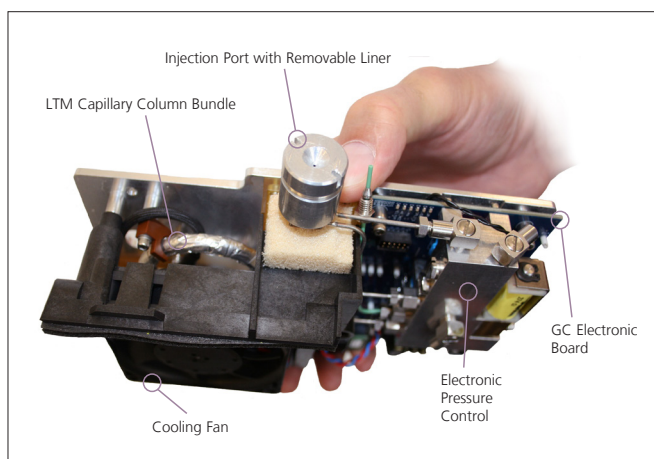
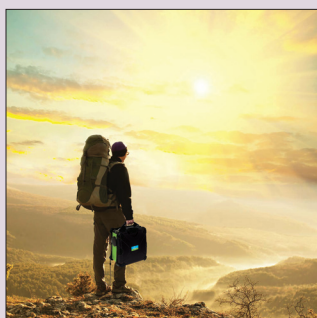


Figure 1. The Torion T-9 Low Thermal Mass Capillary GC is fast and operates reliably.

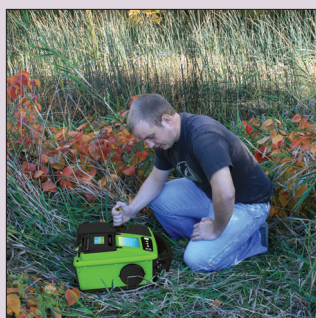
Superior technology

- Small diameter LTM capillary GC for high speed, high resolution separation of chemical analytes
- Rapid temperature programming delivers analysis times of under three min.
- Sensitive and selective mass-based detection of a wide range of chemicals
- Easy to operate with a color touch-screen display and simple navigation buttons



PORTABLE

As a fully self-contained field instrument, the Torion T-9 GC/MS operates on battery power for up to 2.5 hours, and has an on-board disposable helium carrier gas cartridge capable of up to 150 sample runs.



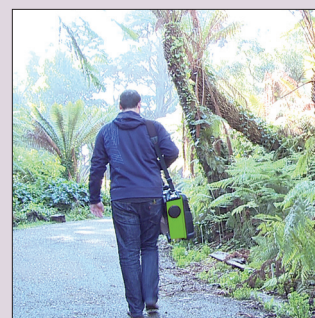
FAST

The system is ready for sample analysis in under 5 min. from a "cold start". Using a high speed GC temperature ramp rate of ~2 °C/sec, run-to-run cycle times are typically ~5 min., allowing for analyses of ~12 samples per hour.



EASY

With an on-board color touch screen, the user interface directs the operator through sample introduction and analysis. The on-board library automates target compound deconvolution and identification. Results are displayed on-screen for quick and easy data interpretation.



RELIABLE

Ruggedized GC-TMS design allows the Torion T-9 GC/MS to operate under harsh conditions. An automated performance validation routine calibrates the instrument to provide reproducible, reliable performance.

True Portability with a Miniaturized MS

A novel Toroidal Ion Trap Mass Spectrometer

Our innovative toroidal ion trap configuration is ideally suited for miniaturization compared to other types of mass spectrometers, such as conventional cylindrical ion traps or linear quadrupole traps. Every component of the instrument has been designed to maximize signal and minimize noise. The novel configuration allows for large trapping volumes despite its miniaturized size. The result is high ion counts and increased sensitivity, low noise levels and excellent spectral quality.

The Torion T-9 mass analyzer operates at $\sim 175^{\circ}\text{C}$. Because the ion trap is heated and operates under vacuum, the electrodes stay cleaner longer. This reduces the need for frequent maintenance, while increasing mass spectral quality and reproducibility. Performing at an elevated temperature also leads to long-term MS resolution stability. The Torion T-9 GC/MS provides better than unit mass resolution over the 41-500 amu mass range (Figure 4).

Toroidal ion trap technology allows for miniaturization

Ion traps are geometrically compact compared to other mass analyzers. The compact toroidal geometry is ideal for miniaturization due to the following:

Smaller ion traps can operate at high pressure ($\sim 10^{-3}$ Torr), so vacuum requirements are less stringent, allowing for smaller pumps which reduces both size and weight.

Less stringent vacuum requirements allow the Torion T-9 to operate off battery power for longer than any other field portable MS.

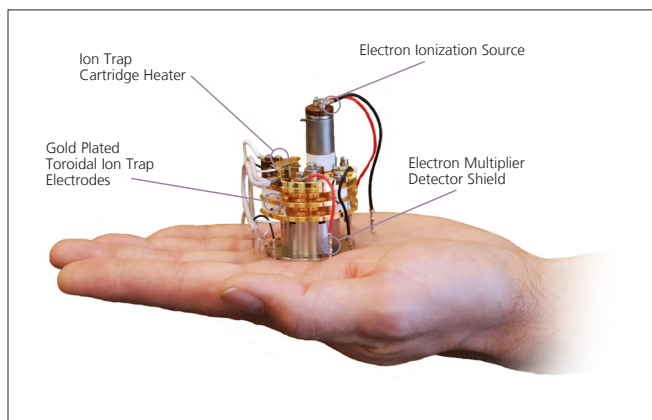


Figure 2. The Torion GC/MS is miniaturized for portability and reliability.

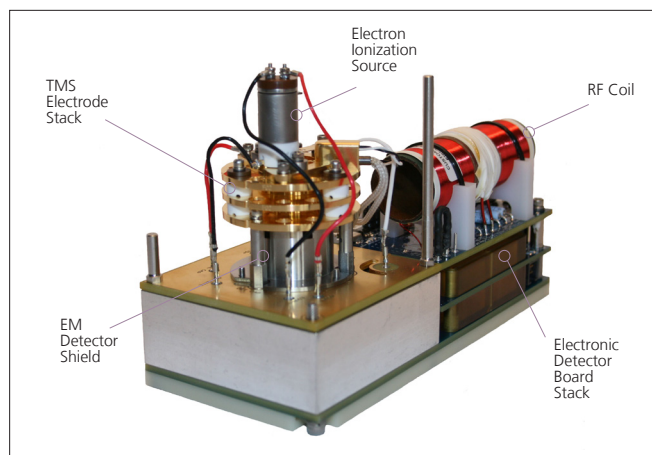


Figure 3. Removable Ion Trap TMS Assembly

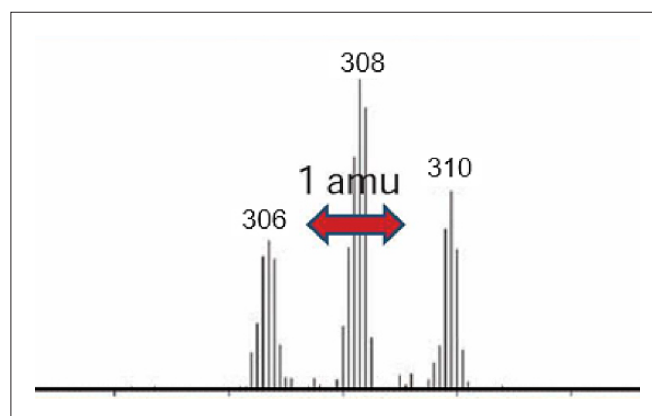


Figure 4. The Torion T-9 has a mass spectral range of 41-500 m/z, with better than unit mass resolution to 300 amu and nominal unit mass resolution to 500 amu. In this example, the resolution of 1,2-Dibromotetrafluorobenzene at m/z 308 is 0.5 FWHM.

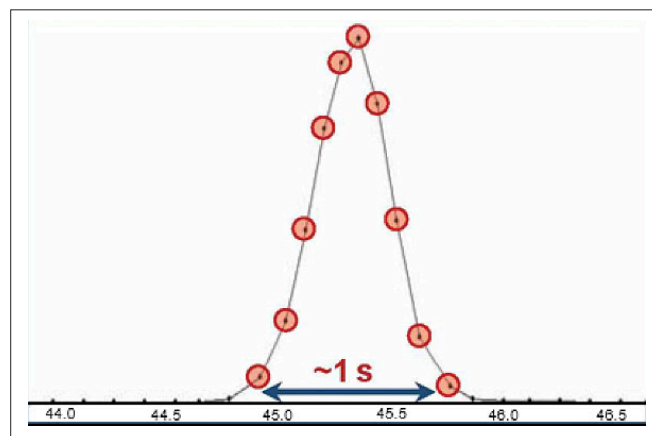


Figure 5. Built for speed. Most chromatographic peaks on the Torion T-9 are ~ 1 sec wide, meaning 60 compounds can be fully resolved and analyzed in 1 min. The scan rate of the MS is also fast at ~ 10 -15 scans per sec. This provides multiple scans across the narrow chromatographic peaks resulting in excellent mass spectral quality.

High speed, high resolution

Torion T-9 GC/MS temperatures can be programmed at a ramp rate of up to 2.5°C per sec. Temperature programming from 50 °C to 300 °C can be done in less than two min., while still maintaining excellent chromatographic resolution. Figure 6 shows ~2 min., high resolution separation of 25 EPA 624 compounds.

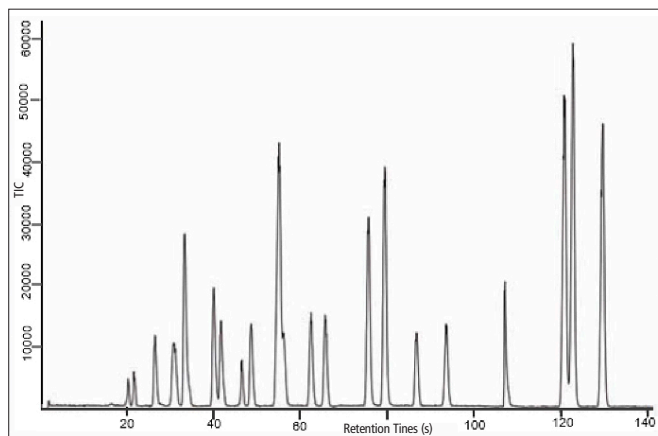


Figure 6. Separation of 25 EPA 624 compounds in ~2 min.

Run-to-run reproducibility

The miniaturized electronic pressure control (EPC) system stabilizes helium flow, which increases chromatographic performance and reproducibility. MS reproducibility is also improved due to the constant helium flow into the ion trap. High run-to-run reproducibility enables accurate target compound identification. In trial tests, retention time reproducibility for 11 peaks was ≤ 2.58 %RSD over 80 analytical runs. (Figure 7 and Table 1).

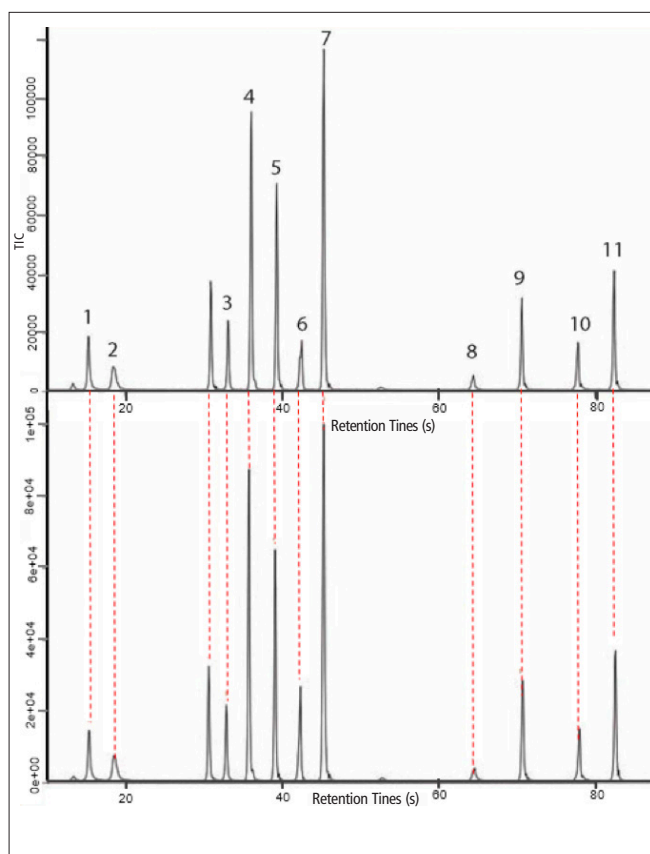


Figure 7. High run-to-run retention time reproducibility.

Table 1. 11 Compounds were analyzed on three different Torion instruments. GC retention times are compared for >80 analytical runs.

| | INSTRUMENT 1 | | INSTRUMENT 2 | | INSTRUMENT 3 | |
|-------------------------------|--------------|-----------|--------------|-----------|--------------|-----------|
| | RT | Ave % RSD | RT | Ave % RSD | RT | Ave % RSD |
| Methylene Chloride | 12.532 | 1.594 | 13.576 | 1.726 | 12.013 | 2.141 |
| Methyltertbutylether | 14.541 | 1.571 | 15.955 | 2.048 | 14.016 | 2.052 |
| Methylcyclohexane | 32.05 | 0.724 | 31.077 | 2.583 | 32.237 | 1.091 |
| Toluene -d8 | 35.564 | 0.731 | 34.464 | 2.024 | 35.678 | 1.005 |
| Perchloroethylene | 39.982 | 0.891 | 38.621 | 1.418 | 38.805 | 0.943 |
| Bromopentauorobenzene | 43.993 | 1.034 | 42.743 | 2.107 | 41.388 | 0.878 |
| Bromoform | 47.217 | 1.203 | 45.882 | 0.654 | 43.701 | 0.779 |
| 1,2 - Dibromotetrauorobenzene | 67.216 | 1.476 | 65.639 | 2.4 | 61.83 | 0.397 |
| Methyl Salicylate | 73.331 | 1.56 | 71.874 | 0.248 | 67.301 | 0.34 |
| Tetrabromoethane | 81.042 | 1.508 | 79.139 | 0.257 | 74.209 | 0.306 |
| Pentadecane | 93.095 | 1.59 | 92.188 | 0.281 | 86.654 | 0.263 |

Automated Advanced TMS Features

Automated functions, based on novel advanced algorithms, operate the Torion T-9 at ideal settings at all times.

AutoTune: Automatically optimizes filament emission, signal resolution and EM detector optimization.

AutoCal: Mass and GC retention scales are automatically calibrated when running this function.

Autolon: Automatically adjusts the ionization time based on the concentration of analyte(s) in the TMS. This results in consistent ion loading of the trap and a reduction of space charge effects. Ultimately this leads to improved and consistent mass resolution and sensitivity.

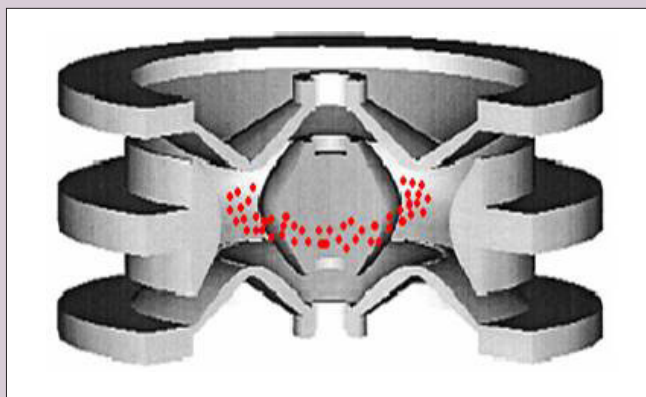


Figure 8. Toroidal ion trap provides large trapping volumes despite its miniature size.

Run In-field Analyses Across Virtually Any Application

The powerful combination of the personal portable Torion T-9 GC/MS and the dedicated line of accessories and consumables provides users the capability to collect and analyze a sample at any location. Identification of target chemical compounds is straight-forward, accurate and rapid. The Torion T-9 system is ideally situated for a variety of applications:

- Environmental
- Forensics/drugs of abuse
- Chemical/petrochemical
- Military
- Security
- Hazardous materials
- First response
- Industrial

Environmental water monitoring

The portability and speed the Torion T-9 system makes it ideal for the analysis of water samples in the field. For example, National Drinking Water Standards currently regulate the maximum total cumulative concentration for the four Trihalomethanes (THMs) (chloroform, bromodichloromethane, dibromochloromethane, and bromoform) at < 80 ppb. As shown in Figure 9, the Torion GC/MS can detect the individual THMs at < 10ppb. The SPME/GC/MS method can be used to rapidly determine compliance of drinking water and ground water samples in the field at the source in less than two min.

The Torion T-9 GC/MS system, consumables and accessories allows users to screen samples in the field that may guide further sampling activities. Rapid analytical results can facilitate time critical decision making at the sample's location.

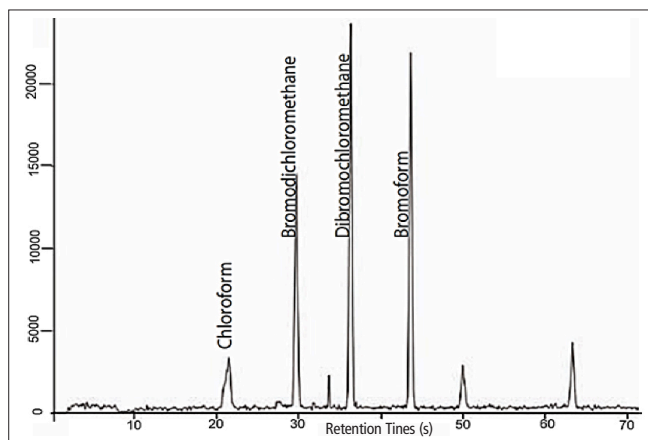


Figure 9. THMs in water. The THMs were extracted from water using a PDMS/DVB SPME phase. The SPME was exposed to the headspace of the sample vial for five min. at ambient temperature.

Instant Results

Identify trace compounds even in complex mixtures with Chromion® automated target compound libraries

Speed matters when making time critical decisions. Now rapid and reliable identification can be performed in the field. The Torion T-9 GC/MS on-board library identifies target compounds in an easy-to-understand table that is displayed on the instrument's touch screen. Our easy-to-use Chromion PC software allows users to custom build target compound libraries. Unique deconvolution algorithms ensure reliable identification of even co-eluting compounds in complex mixtures. Chromion software works in conjunction with the extensive NIST Library database, so unknown peaks can be easily identified. Chromion was designed with the end user in mind. Everything from creating a new GC program to viewing a data file with the background subtracted is simple and intuitive.

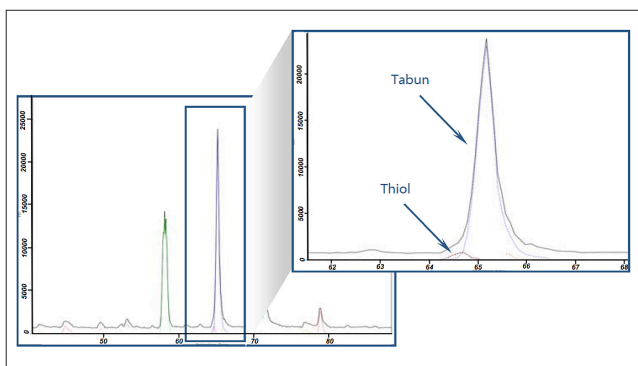


Figure 10. VX breakdown product (Thiol) co-elutes with Tabun.

True deconvolution

Complex mixtures of compounds can be separated and identified with our sophisticated deconvolution algorithm. Peaks that chromatographically co-elute are separately identified by target ions in their mass spectrum and peak shape. Figure 10 shows a VX breakdown product (Thiol) that co-elutes with Tabun. Although Thiol is hidden under the Tabun chromatographic peak, the VX threat is identified.

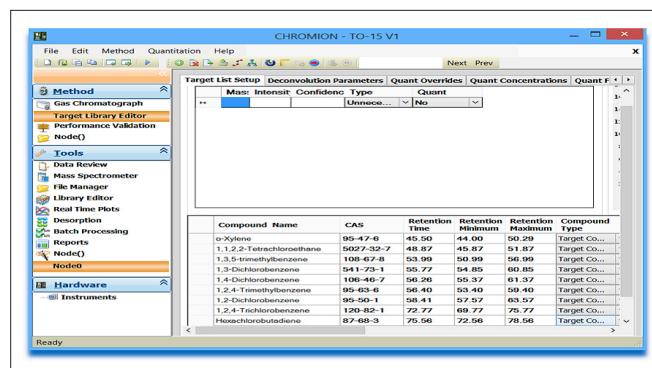


Figure 11. Chromion software works with NIST database.

Chromion's capabilities include:

- Full Instrument Control
- Instrument Monitoring
- Library Customization
- Target Compound Identification
- Unknown Peak Identification
- Quantitation with Internal or External Standards
- Data Review including:
 - Total Ion Chromatograms
 - Reconstructed Ion Chromatograms
 - Background Subtraction
 - Spectra Averaging
 - Selected Ion Plotting

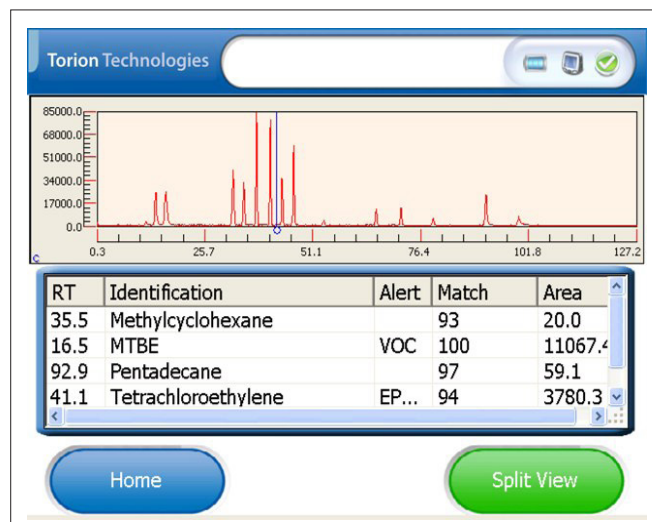


Figure 12. Target compound identification display.

Torion's target compound identification display:

- Names identified compounds
- Displays GC retention times
- Lists alert level for each compound
- Calculates match quality
- Shows unidentified compounds

Simplicity Enhances Portability

Custodion® SPME Syringe

Solid phase microextraction (SPME) is an innovative sampling technology that is quick, easy and reliable. SPME is a solvent-free technique that combines sample extraction, collection and concentration of analytes all in one simple step. Analytes can be extracted from gas, liquid and dissolved solid samples. SPME fiber coating retains chemical compounds from the sample matrix. The fiber coating is typically an immobilized polymer, a solid adsorbent or a combination of the two.

Following sample collection, SPME fiber is inserted directly into the heated injection port of the GC. Analytes are thermally desorbed in the injector, separated in the GC column, and detected by the MS. Custodion SPME Syringes can be reliably used for on-site field sampling or in-laboratory applications.

Calion™ PV Mixes

Torion's Calion PV Mixes (calibration and performance validation standards) are easy-to-use and reliable for field applications. Calion mixes contain standard compounds that are carried in solidified liquid particles, where the compounds maintain equilibrium between the solid particles and the vial's headspace. Custodion SPME sampling of the headspace results in collection of analytes on the SPME fiber from the vapor phase. The collected standards are then injected into the Torion T-9 GC/MS for analysis. Calion PV Mixes are used for instrument calibration, including both mass and retention time calibrations. The combination of Custodion SPME sampling with Calion standards provides robust and rapid capability for in-field calibration of the Torion T-9 GC/MS. No need to worry about spilling liquid standards in the field or laboratory.



Figure 13. Easy sample extraction.

Designed for flexible sampling

The Custodion Syringe houses the SPME fiber with safety and simplicity in mind. With a click of the plunger the SPME fiber is exposed and retracted, as easy as clicking a ball point pen. Users wearing thick protective gloves can still easily operate the Custodion Syringe. The Custodion Syringe is universal and can be used with any laboratory GC.

- Useable with PPE and safety equipment
- Prevents overloading of the GC column and MS detector
- Extends life of the GC column
- Reduces frequent ion trap cleaning
- Eliminates sample to sample carryover



Figure 14. Calion PV Mixes (Calibration and performance validation standards) provide the required compounds for in-field validation and calibration of the system.

PerkinElmer Environmental Health

At PerkinElmer, we're taking action to improve the health and safety of people and their environment. Every day, and across the globe, we enable the scientists' ability to detect, monitor and manage organic and radioactive contaminants, trace and toxic metals, chemical and other impurities in our surroundings.

Our comprehensive portfolio of solutions is designed to empower your science and ensure you receive accurate, reliable results – every time. We have unique detection technologies with innovative user interfaces, as well as the consumables and accessories across multiple analytical techniques, including chromatography, mass spectrometry, atomic spectroscopy and materials characterization. Combine that with the industry's best and most knowledgeable service and support organization, and you can have an unprecedented level of performance and control of your lab operations – while ensuring safety and compliance issues are addressed.

Whether you are running routine analyses on the benchtop or performing the most demanding applications in the field, PerkinElmer is uniquely qualified to understand your requirements, deliver solutions that instill confidence and enable faster, better decisions.



Learn more at www.perkinelmer.com/torion

PerkinElmer, Inc.
940 Winter Street
Waltham, MA 02451 USA
P: (800) 762-4000 or
(+1) 203-925-4602
www.perkinelmer.com



For a complete listing of our global offices, visit www.perkinelmer.com/ContactUs

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