Agilent

Trusted Answers

GC and GC/MS Frequently Asked Questions

A History of GC and GC/MS

Chromatography was invented by the Russian botanist, Mikhail Tswett, in 1903 to separate pigments in plants. It comes from the Greek words chroma, meaning color, and graphein, meaning to write. Therefore, chromatography literally means "to write color."

The study of mass spectrometry started with the investigation of gas discharge during the 19th century. Through this research, anode (negative ions) and cathode (positive ions) rays were discovered. During the mid-19th century, Julius Plücker studied light emitted from discharge tubes and noted how applied magnetic fields influenced the glow of the emitted light. In 1869, Johann Wilhelm Hittorf observed that rays emitted from a negative electrode caused fluorescence when interrupted by a solid object while in a gas discharge tube.

Later, when JJ Thomson passed a stream of ionized neon through a magnetic and electric field in a discharge tube, he noticed a deflection, creating two separate patches. He collected these patches using photographic plates, and discovered that the difference between them was caused by varying masses—resulting in a different trajectory when a magnetic and electric field is applied.

Building on the theory that applying magnetic and electric fields in a vacuum could separate masses, the first mass spectrometer (MS) was built in 1919 and was used to separate and identify naturally occurring isotopes. However, it wasn't until 1932 that Kenneth Bainbridge was able to develop an MS with more accurate resolving power and precision.

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In this eBook, you'll find answers to the questions that Agilent technical experts hear most often from our GC and GC/MS customers. To instantly access the information you need, click the following links or use the navigation tabs at the bottom of each page.

General Knowledge

Chromatographers worldwide use GC and GC/MS to ensure the safety of our food, protect our environment, and develop life-saving pharmaceuticals—and that's just for starters. The more you know about these techniques, the further you can take your science.

How does chromatography work?

Chromatography is used to separate closely related compounds by moving a sample through a stationary phase using a mobile phase to facilitate movement.

The basic philosophy of chromatography is to separate compounds based on their chemical properties. One of the oldest types of chromatography is paper chromatography, and it's still the easiest to demonstrate. If you write on paper with a nonballpoint pen and spill water on it, the ink will begin to move away from the spill and separate into different colors. In this case, the ink is the sample, the paper is the stationary phase, and the water is the mobile phase. The way the ink components separate has to do with their chemical properties such as size, weight, and polarity or affinity for the mobile phase.

Here are the most common types of chromatography used today:

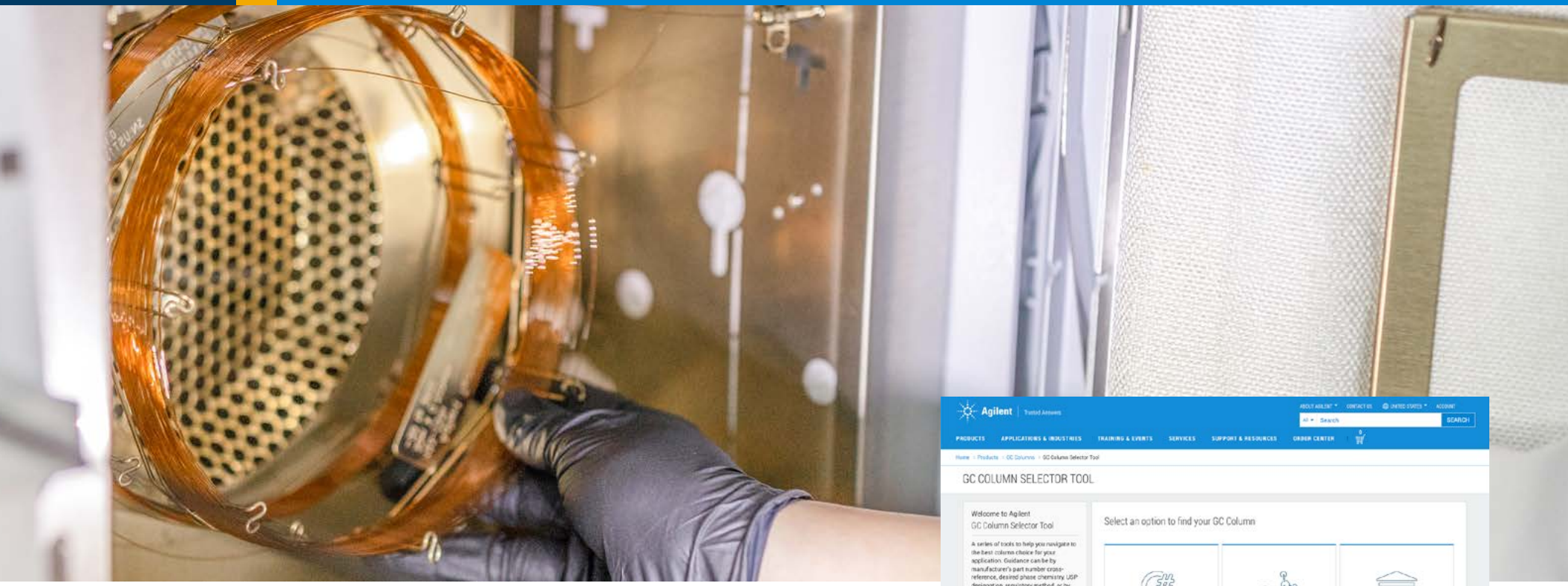
- **Gas chromatography (GC)** separates compounds based on boiling point first, and polarity and molecular weight second. Generally, GC works best with volatile compounds that are not very polar. Various detectors can be used in conjunction with GC to selectively detect analytes of interest.

  GC samples can start as a liquid, solid, or gas. Samples are converted into a gas (vaporized), and the compounds in the gas are separated using a column. The GC column can be packed with material or coated with a film, both of which separate compounds based on affinity for the column phase. Meanwhile, the role of the gaseous mobile phase is to move compounds through the column without chemically interacting with them.

- **Thin layer chromatography (TLC)** works similarly to paper chromatography. However, instead of filter paper, a plastic or glass plate is coated in silica and the sample is spotted onto the plate. TLC offers higher resolution between compounds than paper chromatography, and is useful in separating color components. It also separates UV characteristics that can be viewed using further light sources.

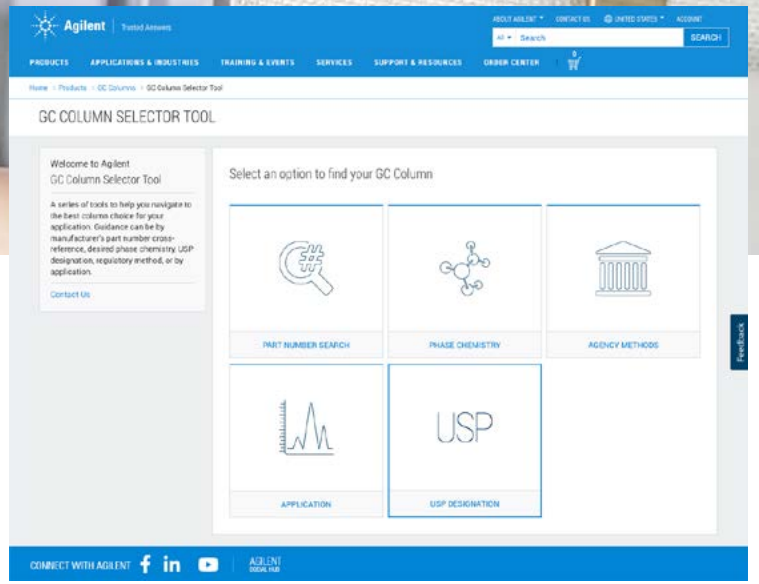
- **Liquid chromatography (LC)** separates compounds in liquid form by polarity and size, using a liquid mobile phase that interacts with the compounds of interest. LC uses a wide range of detectors from diode array detectors (DAD) to mass selective detectors (MSD).

Agilent 7010D triple quadrupole GC/MS



Why is GC column polarity important?

Agilent GC columns are categorized by polarity based on the phase used. There is no one phase that is perfect for all compounds. If you think about GC as a shopping mall, the various phase types are like the shops that line a moving walkway. Some people will be more interested in bookstores, while others may not leave the walkway until they see a sporting goods shop. Analytes going through a GC will act similarly, in that some compounds need a more polar phase for separation, while others don't. For this reason, it's important to make sure that you are using the right column phase to separate your compounds.



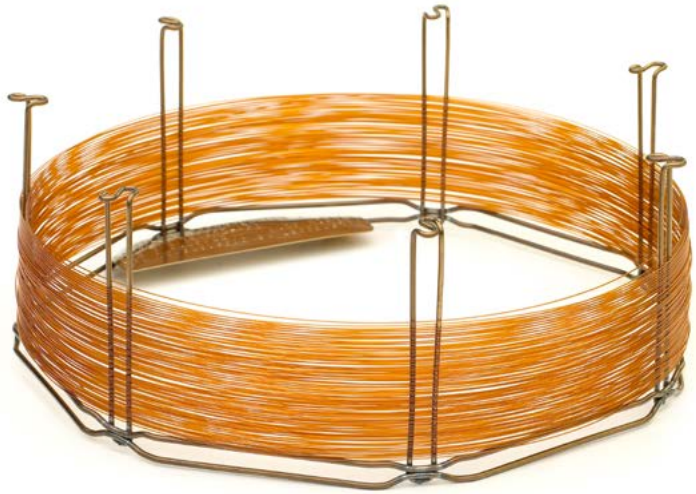
Use the GC column selector tool to quickly and easily find the right GC columns.
Try it now

What is the significance of GC column dimensions?

There are three parts to GC column dimensions: length, diameter, and film thickness. All are important and play a big role in your chromatography.

Let's think about GC like a moving walkway through a shopping mall, where people can leave the walkway at any time to shop. Ideally, there should be enough stores to appeal to different people, so that they "separate" from each other by the time the walkway ends.

- The longer the walkway (column length), the longer it will take to pass through the mall, and the more chances there are to interact with shops.
- The wider the walkway (column diameter), the more people can stand side by side. However, if the walkway is narrow, people will be closer to the shops, giving them more time to look at the stores.
- Fewer shops (thinner film) mean that people will reach the end of the walkway quickly. More shops (thicker film) mean that more people can travel through the mall at the same time without crowding.



Bulky packed metal

- Rigid and difficult to work with

Glass tubing

- Allowed for a more even surface
- Extremely fragile

Glass capillary

- Smoother surface enabled better polymer coating efficiency
- Rigid, had to be handled with care

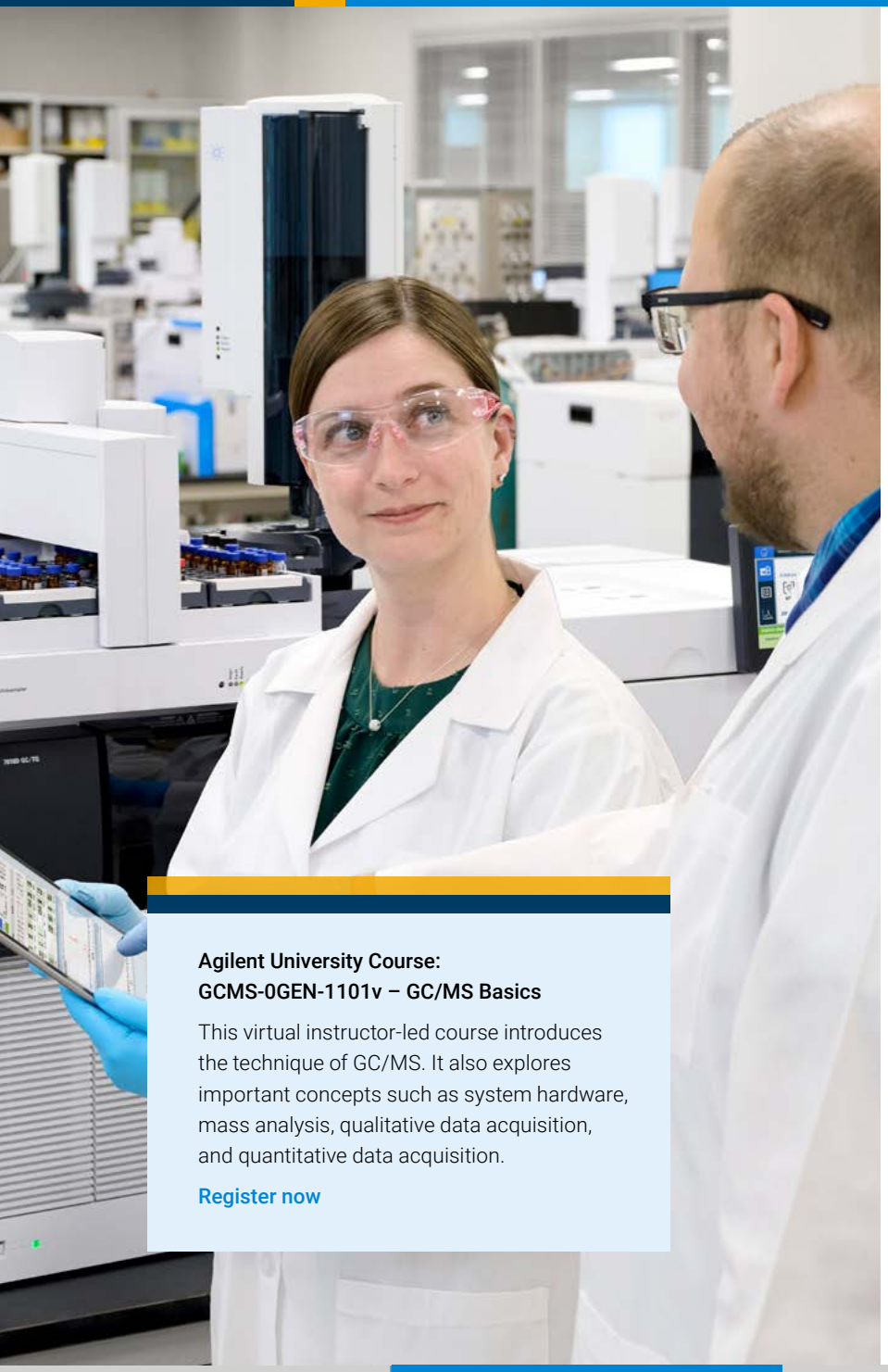
Glass capillary layered with silicone rubber or polyimide

- Similar to fiber-optic cables
- Flexible, easy to work with

Wall-coated open tubular (WCOT) capillary columns

- Up to six layers of polyamic acid solution applied to the fused silica
- Dehydrated to form thin layers of polyimide on top of the glass
- Very easy to work with

The evolution of GC columns



Agilent University Course:
GCMS-0GEN-1101v – GC/MS Basics

This virtual instructor-led course introduces the technique of GC/MS. It also explores important concepts such as system hardware, mass analysis, qualitative data acquisition, and quantitative data acquisition.

Register now

What are the basic principles and mechanisms of GC/MS?

Mass spectrometry uses magnetic and electric fields to separate masses for identification. The information obtained from a mass spectrometer (MS) includes the molecular ion, which indicates molecular weight, and fragments that suggest functional groups and analyte structure.

In its most basic form, an MS consists of a sample inlet, ion source, focusing lenses, mass analyzer, detector, and vacuum pump. The inlet introduces the sample into the MS, either by a batch inlet or a direct probe. Batch inlets are most common, and they "leak" an externally volatized compound into an evacuated ionization chamber.

Once inside the ionization chamber, the source will ionize the sample. The goal of the source is to form gaseous ions, which is accomplished through the gas phase or desorption, and can be either hard or soft.

- A gas phase source ionizes compounds already in a gaseous state. This type of source is restricted to thermally stable compounds with a boiling point less than 500 °C and a molecular weight fewer than 103 Da.
- Desorption sources form gaseous ions directly from solid or liquid samples. The benefits of desorption are that the sample doesn't need to be volatile and can have a molecular weight of up to 105 Da.
- A hard ionization source applies enough energy to leave the compound in an excited state. When the bonds relax, compound fragmentation will occur. These fragmented ions indicate the chemical bonds, functional groups, and structure of the molecule.

(Continued on next page)

Soft ionization doesn't apply as much energy, leading to less fragmentation and more of the molecular ion being present.

Once the analyte is ionized, it enters the mass analyzer where ions are separated by their mass-to-charge ratio. There are many kinds of mass analyzers:

- Magnetic sector analyzers
- Quadrupoles
- Time of flight (TOF) analyzers
- Ion trap analyzers
- Fourier transform analyzers

After separation in the mass analyzer, the ions hit a detector, where the signal is multiplied by an electron multiplier. Ionization, mass analysis, and detection are all conducted in a vacuum chamber, facilitated by a turbo pump and a rough pump. A turbo pump uses high-speed fans to push gas molecules and accelerate them from the vacuum side to the exhaust side of the pump. To prevent stalling, turbo pumps also have a mechanical (rough) pump connected to the exhaust.

Finally, information passes through a transducer that converts the signal from electrical to digital and stores it on a computer.

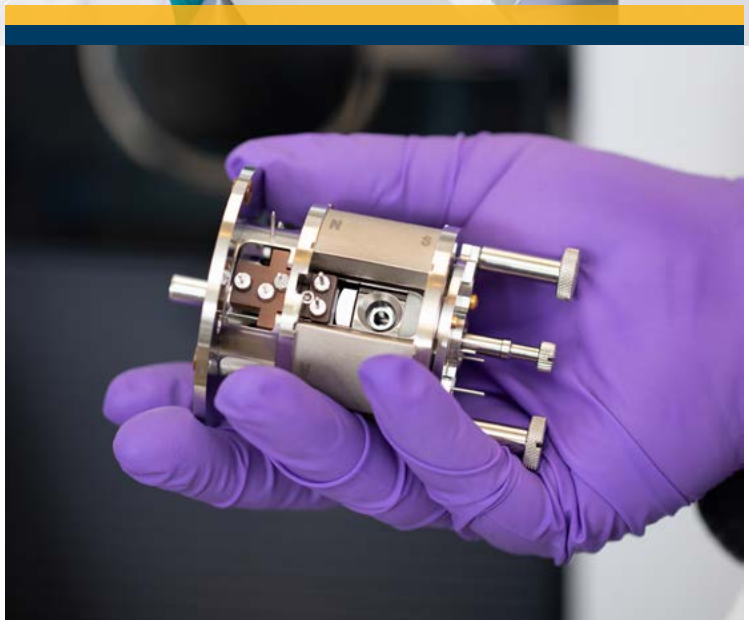
Here's how a quadrupole mass analyzer works

Two rods are attached to a DC (+) voltage, while another two rods are connected to an RF/AC (-) voltage. Ions are accelerated between the two rods as DC and RF potentials are applied. The ratio of DC to RF potential is kept constant, and allows resonant ions to pass through the detector. Nonresonant ions collide with the rods and become neutral. In this way, the applied voltage acts as a filter for the ions that will reach the detector.

How do chemical and electron impact ionization differ?

Chemical ionization is a soft ionization technique in which gaseous atoms are ionized by collisions with an ionized reagent gas. In this environment, the excess ionized reagent gas (usually methane) is in the source, so it's the only compound that can interact with the analyte. This is considered a soft ionization because it doesn't produce much fragmentation and generates mostly molecular ions.

In electron impact ionization, a molecule is bombarded with electrons, exciting the molecule. When the molecule relaxes, the bonds are broken and fragmentation of the compounds occurs, which is why it is called a hard ionization technique.



Versatile Agilent GC/MS ion sources deliver maximum robustness for any analysis. Options include electron impact (EI), chemical ionization (CI), extractor, and high-efficiency sources.

Learn more

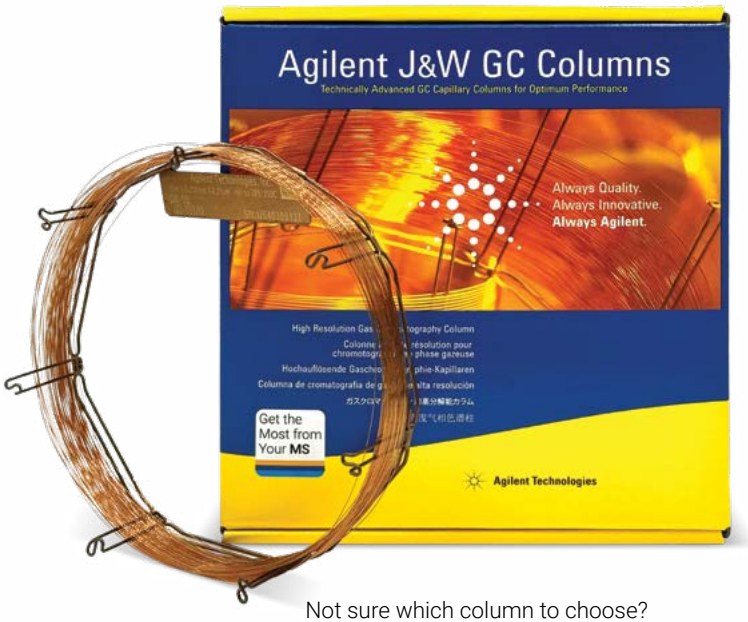
What is the difference between standard, mass spec, and Ultra Inert columns?

Standard columns are good for general applications, but as detectors grow more sensitive, any background noise becomes more apparent. With a mass spectrometer (MS), there are several factors that can create background noise in your chromatogram, and one such factor is column bleed.

Mass spec columns have about 50% less column bleed than the standard versions, making them ideal for use with sensitive detectors, like an MS.

Agilent Ultra Inert GC columns go through an extra step to make them more inert to active compounds. As the compounds move through the GC column, analytes interact with the column phase, creating separation between compounds.

Think about GC like a moving walkway through a shopping mall, where people can leave the walkway at any time to shop. Ideally, there should be enough stores to appeal to different people, so that they "separate" from each other by the time the walkway ends. However, if one person goes into every shop and looks at every item, it would be difficult to get that person to the end of the mall. This person (analyte) would be considered "active." To combat this activity, Ultra Inert GC column phases were designed to be less attractive to these active analytes. While we still want compounds to "look at the shop windows," we don't want them spending too much time browsing inside a single store.



Not sure which column to choose?
Use our **GC columns eSelector tool**

What is headspace and how does it work?

Headspace injections are when you sample the “headspace” above a liquid. This technique is typically used for volatile organic compounds, when the sample is stable to nearly the boiling point of water, or in a potentially nonvolatile matrix. Headspace is normally sampled with a headspace sampler or by using solid phase microextraction (SPME) fibers or arrows—both with 20 or 40 mL vials.

The Agilent 8890 GC pairs with the 8697 headspace sampler-XL tray to provide the utmost flexibility for labs with demanding needs.

Learn more

What is the difference between split and splitless?

Split and splitless are GC inlet injection modes, and they are normally discussed in the context of liquid injections. With split injections, a portion of the injection is thrown away. The amount discarded depends on the split ratio (that is, 100:1 means 1% of the sample gets onto the column). Typically, split injections are used for samples with high concentrations of analytes.

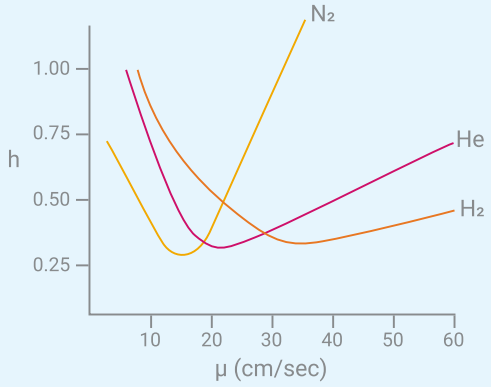
In splitless injections, the entire sample reaches the head of the column. This technique is intended for trace analyses.

How do I choose the right carrier gas for my detector?

You're likely using helium as a carrier gas for most of your GC methods because it's inert and works well with different detector types. But did you know that you might have other options? Hydrogen, for example, is a better choice for FID systems. Nitrogen is also a viable carrier gas for most systems, except for TCD.

So, how do you choose one gas over another? One big factor is availability. When you're developing a GC method, especially one that you plan on using long-term, pick a gas that has a reliable source. Nothing is worse than running out of carrier gas in the middle of a run and having to shut down production. Also, consider what your current gas lines are plumbed for, and whether you'll run your gases from a cylinder or a generator. While generators help prevent downtime caused by waiting for a gas shipment, their initial cost can be prohibitive.

Speed is also important when selecting a carrier gas. Consider this Van Deemter curve, which shows how the linear velocity of a gas will affect column efficiency. The dip in each plot is the velocity at which a compound will spend the optimum amount of time in the column, providing the best peak shape.



General depiction of a Van Deemter curve performed with different carrier gases. Here, nitrogen has the slowest optimum velocity at around 15 cm/sec, helium sits at around 21 cm/sec, and hydrogen has the fastest optimum velocity at 35 cm/sec.

If you were using helium as a carrier gas at an optimized linear velocity, switching to nitrogen would mean slowing down velocity to maintain optimum peak shape. This change would increase your run time. Switching to hydrogen carrier gas, on the other hand, would increase your velocity and decrease your analysis time while maintaining peak shape.

All columns have different optimum velocities, so there's no one perfect velocity for each gas. The important thing is to choose the right gas and velocity for your column, detector, and analytes.

What should I consider when using hydrogen as an alternate to helium carrier gas?

First, if you are performing headspace analysis, you cannot purge the vial with H_2. You must use N_2 or He. Keep in mind, too, that hydrogen has a higher velocity than helium at the same flow rate. Therefore, you need to decrease your column flow for optimum ionization.

When using helium, the optimum flow rate would be 1 to 1.5 mL/min for a standard source and 0.8 to 1.2 mL/min for a high-efficiency source. If you go too fast, you'll dilute the ions in your source and decrease sensitivity. For optimum ionization with hydrogen carrier gas, your flow should decrease to about 0.7 mL/min for a standard inert source and 0.5 mL/min for a high-efficiency source. Decreasing the flow also means that your vacuum pumps won't have to work as hard to keep up with the increase in gas flow velocity.

Finally, try to avoid using dichloromethane and carbon disulfide as solvents. Because hydrogen is not an inert gas, chemical reactions can occur at high temperatures. One way to minimize interactions is to start with a cool inlet and ramp your inlet temperature.

Avoid these situations when using H_2 as a carrier gas:

- Chlorinated solvents and hot inlets
  - DCM + hot inlet + H_2 + (tiny bit of H_2O) = HCl
- Heavily chlorinated compounds
  - Dechlorination
- Nitrocompounds (such as nitrobenzene)
  - Hydrogenation

Best practices when using H_2 as a carrier gas:

- Remove the cover from the front of the MS
- Use a 9 mm extraction lens
- Keep your column flow rate at 0.5 to 1.2 mL/min
- Switch to a "more efficient" column (30 m × 0.25 mm × 0.25 µm or 20 m × 0.18 mm × 0.18 µm)
- Use gas filters, especially with a H_2 generator
- Allow the system to bake out longer (may require running overnight with filaments on)

Resources to help conserve or convert your GC/MS carrier gas

Handle the Hassles of the Helium Shortage

Explore ways to manage price fluctuations and potential delivery interruptions with helium carrier gas for GC analyses.

Helium Conservation Cost Savings Calculator

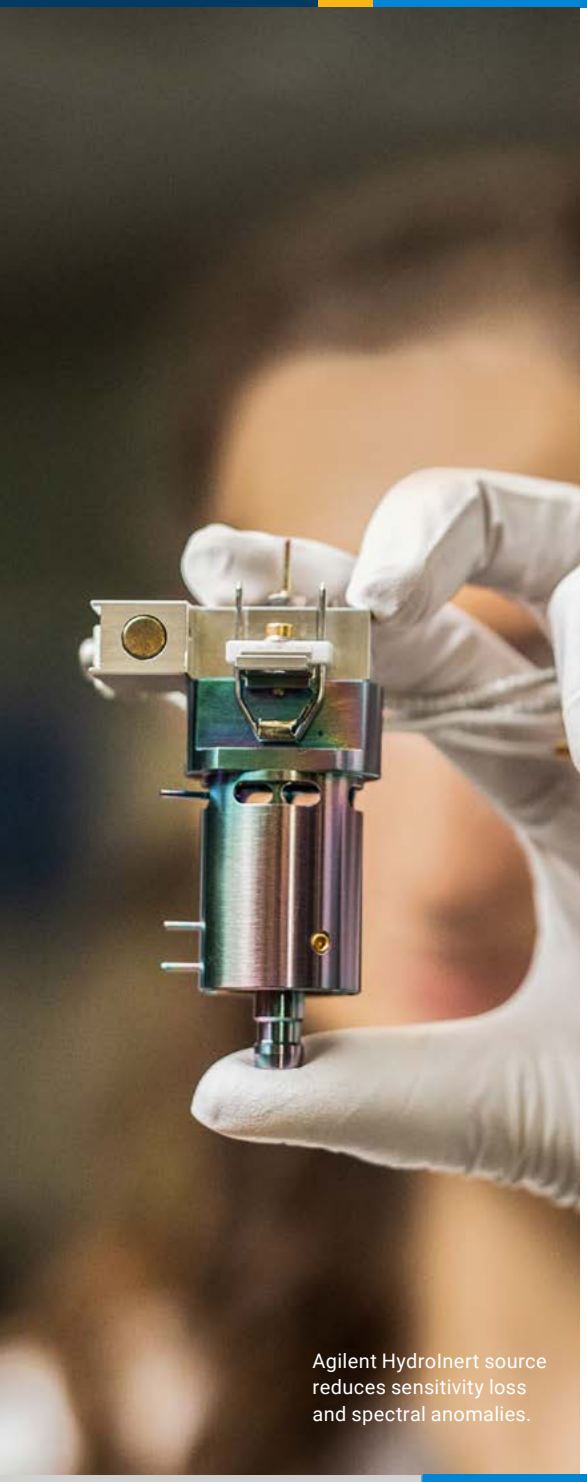
See how much you could save by using Agilent Gas Saver with and without nitrogen standby.

Helium Conservation Module

Prevent disruptions by managing your helium use.

Agilent EI GC/MS Instrument Helium to Hydrogen Carrier Gas Conversion User Guide

Get detailed instructions on converting your Agilent EI GC/MS system from helium to hydrogen carrier gas.

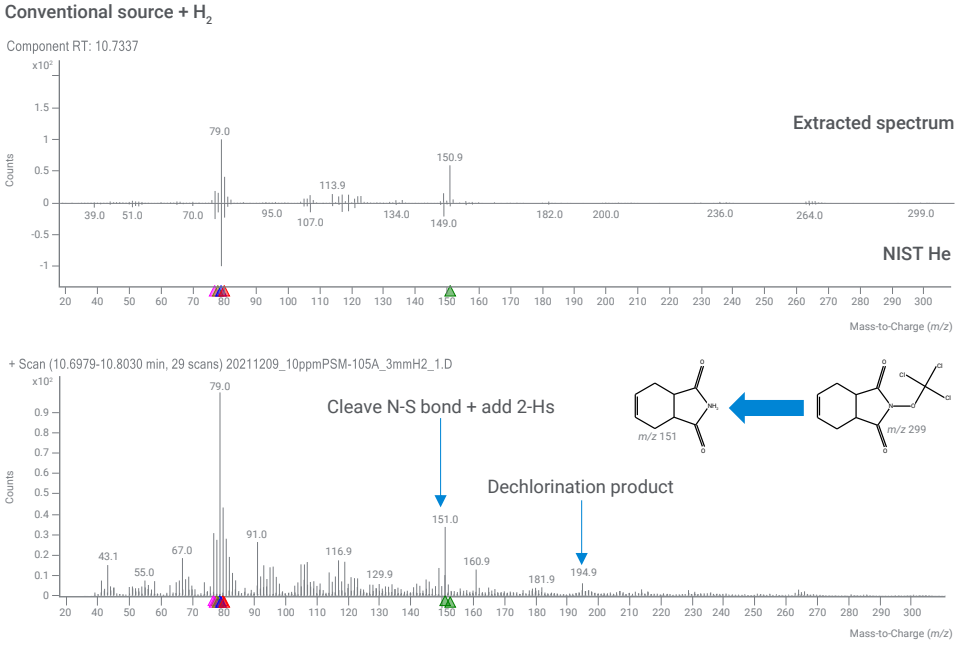


Agilent HydroInert source reduces sensitivity loss and spectral anomalies.

How does the Agilent HydroInert source preserve spectral fidelity with hydrogen carrier gas?

When you use hydrogen as a carrier gas with traditional ion sources, the fragmentation pattern can be a bit different due to spectral tilt. Spectral tilt is caused when certain compound classes, like heavily chlorinated compounds, dechlorinate after reacting with hydrogen in the ion source.

The Agilent HydroInert source reduces spectral tilting when using hydrogen carrier gas. Here, when captan was analyzed using the HydroInert source, the expected abundances of 149 *m/z* and 151 *m/z* were maintained. They were also similar to the abundances found in a NIST database.



This comparison of a deconvoluted mass spectrum (top) to a library mass spectrum, NIST17.L (bottom), shows the dechlorination of captan in a traditional ion source. Hydrogen carrier gas was used with an extractor source and 3 mm lens. Here, the raw spectrum shows evidence of nitrogen-sulfur bond cleavage with the presence of the 151 *m/z*. A dechlorination product is also present at 195 *m/z*, further demonstrating the occurrence of spectral tilting.

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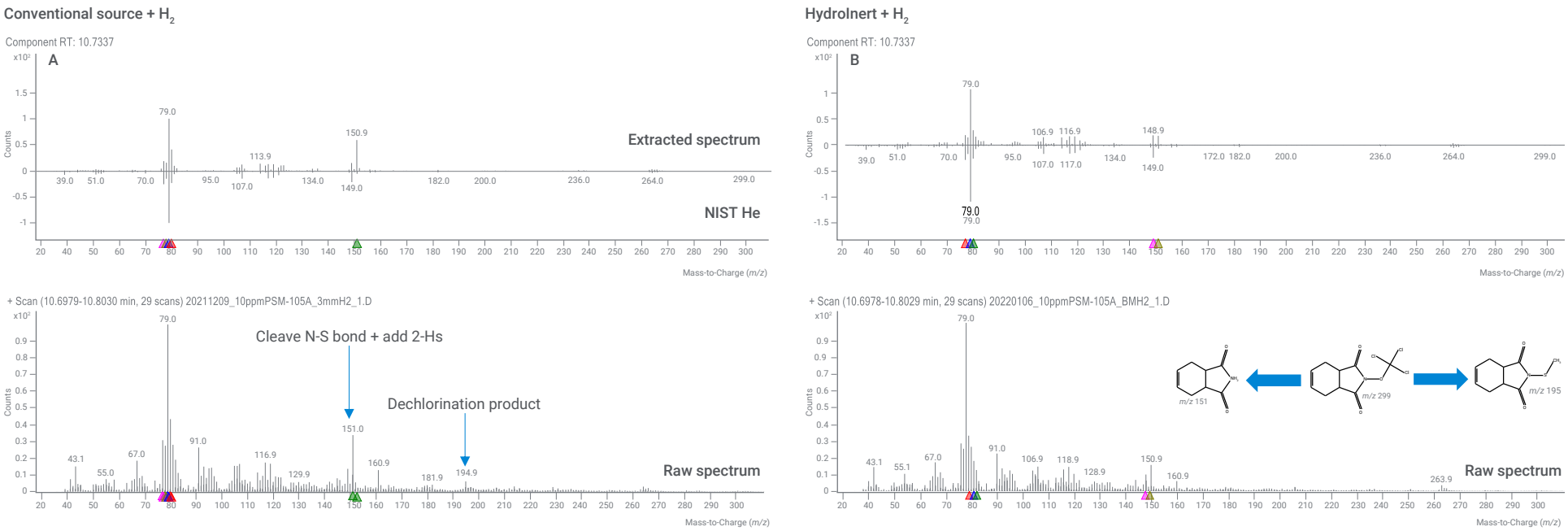
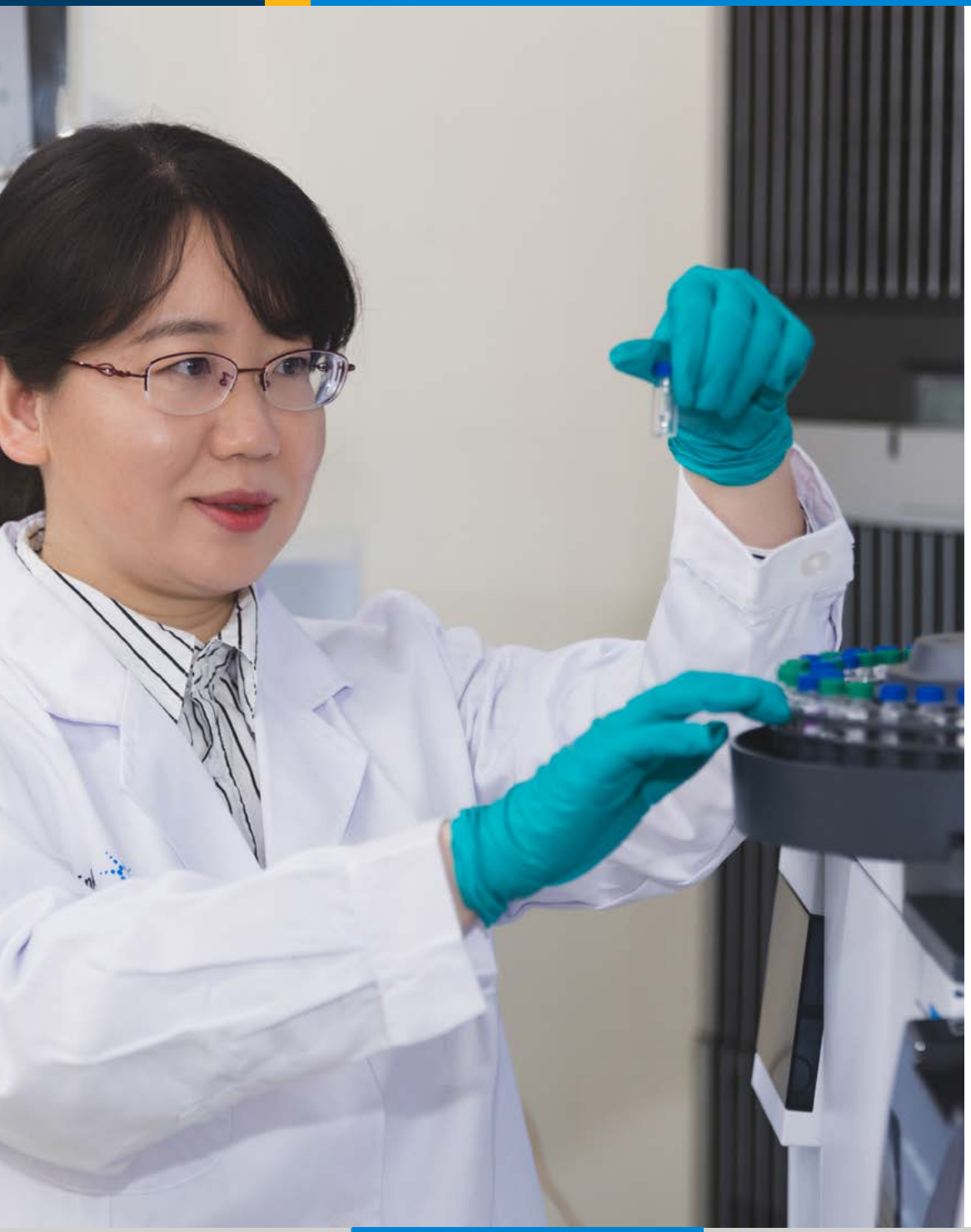


Comparison of extracted mass spectrum (top) to library mass spectrum, NIST17.L (bottom), for captan with H_2 carrier gas. (A) Extractor source with 3 mm extraction lens. (B) HydroInert source with 9 mm extraction lens.

Agilent HydroInert source

Compound Class	Example Compounds	H_2 Carrier Gas + Conventional GC/MS Source	H_2 Carrier Gas + HydroInert Source
Nitro Compounds	Nitrobenzene, fenitrothion, ethalfluralin	Unacceptable	Differentiating
Heavily Chlorinated Compounds	DDT, endrin, heptachlor, BHC compounds, pentachlorophenol	Unacceptable	Differentiating
Polycyclic Aromatic Hydrocarbons (PAHs)	Benzo(b)fluoranthene, benzolg,h,ilperylene	Neutral	Neutral
Alkanes >C24	Tetratriacontane, hexadecane, tetracontane	Neutral	Neutral
Pesticides	Deltamethrin, fipronil, permethrin, captan	Unacceptable	Differentiating
Fragrance/Flavor Compounds	Musk ketone, musk ambrette, linalool	Unacceptable	Differentiating
Volatile Organic Compounds	1,4-dioxane, trichloromethane, bromodichloromethane	Neutral	Differentiating

This table lists how various compound classes are affected by hydrogen carrier gas—and if the Agilent HydroInert source will be a differentiating factor.



What solvent is best for liquid injection on GC/MS?

Commonly used solvents include hexane, toluene, dichloromethane, ethyl acetate, isooctane, and (to an extent) acetone. Acetonitrile is another option, but it can leave a long tail in the baseline and may require pulsed splitless injection optimization. Methanol is also commonly used, especially in forensics.

Above all, the solvent should be compatible with your analytes (which should remain stable in the solvent), as well as with your sample preparation and GC analysis.

The Agilent 7650A automatic liquid sampler (ALS) provides consistent injection of up to 50 samples on Agilent GC and GC/MS systems for more accurate, reproducible results.

Learn more

Maintaining Your GC/MS

GC/MS maintenance needs depend on many parameters, such as matrices, frequency of use, sample type, gas quality, and maximum operating temperatures. For example, if you use your GC/MS every day, and analyze samples like environmental soil or pesticides in food, you'll likely have to perform daily maintenance. You may also need to perform a source cleaning every one or two months.

Diligent GC maintenance, backflush, and proper sample preparation can reduce the amount of source cleaning required, but it will still have to occur at some point. This section will provide you with some tips and best practices.

How often should I change columns?

Columns are like running shoes. If you leave them in the box, they'll last forever. But how much you run—and what type of terrain you run on—will either increase or decrease lifetime.

Every wall coated open tubular (WCOT) column has three parts: stationary phase, fused silica, and polyimide coating. All must be treated with care due to their temperature limits and preferred sample types. There are several things that you can do to help extend the lifetime of your column and monitor its performance over time.

Make sure that your connections are leak free. Maintaining leak-free connections is the single most important thing that you can do to maximize column life. That's because oxygen will destroy your column phase, dramatically increase your baseline at high temperatures, and lead to poor peak shape.

Oxygen can also enter your GC system through gas lines. For this reason, it's important to use **Agilent Gas Clean filters** to help purify your carrier gas and detect the presence of oxygen. Once the filter has reached 0.1 ppm of oxygen, it will turn from blue to gray, which indicates that it's time for a replacement.

Don't exceed the maximum allowable operating temperature (MAOT). Your column phase and fused silica should have at least one temperature listed, or sometimes two. These numbers indicate the isothermal maximum temperature and the programmed maximum temperature. You can think of these temperatures in terms of lifting weights:

- The isothermal temperature is like a lighter weight that you can lift multiple times before your muscles grow exhausted. Likewise, you may be able to hold your column at the maximum isothermal temperature for 200, 300, or even 500 hours before it reaches its limit of operation.
- The programmed temperature is like a heavy weight that can cause injury after just a couple of reps. Exceeding this temperature will shorten column life, much like lifting too heavy a weight will cause you to pull a muscle.

Matrix matters, and so does sample preparation. In GC, sample preparation products aren't used as frequently as they are with LC analysis. For example, it may be tempting to simply turn up the heat to force your sample out of the column. You might also want to save time by using the "dilute and shoot" approach.

However, when you analyze samples in a heavy matrix, these shortcuts can lead to more downtime in the end. Heavier-matrix samples can cause compounds not to vaporize at the same time, leading to thermal discrimination. This in turn can cause other problems, like clogging up the front end of your GC. Also, if you're analyzing high concentrations of very active compounds, your column could have a shorter lifespan than a column analyzing clean gas samples.

Get to know your GC column, and pay attention to changes

Performing periodic quality checks helps you verify that your system and column are working properly. For instance, if your retention times shift or peak shapes start to look different—and no front-end maintenance was carried out—it could indicate a problem. Also, if column bleed suddenly increases, it may be time to replace the column.

Tip: Self-tightening column nuts let you form leak-free connections without tools. Their spring-driven piston design continuously presses against the ferrule, which compensates for ferrule expansion and contraction during repeated oven temperature cycling.

Learn more

Agilent University Course:
GC-7890-2231z – How to Replace the GC Split/Splitless Inlet Liner & Septum & O-Ring

Regular GC inlet maintenance will help avoid chromatographic issues. In this video, Herb Brooks, an Agilent service engineer, demonstrates how to replace the inlet liner, septum, and O-ring on an Agilent 7890 GC.

Register now

How often should I change liners?

To keep your GC operating at peak performance, first make sure that you're using the right liner for your analysis. Liners aid in vaporizing your samples and help to guard against nonvolatile compounds making their way onto the column. We also recommended choosing a liner with the right coating, such as Ultra Inert inlet liners, to help guard against activity.

Good quality controls should be used to monitor peak shape over time and determine how frequently the liner needs replacing. You should also replace septa regularly, because even though Agilent septa are plasma coated and have a center guide to prevent coring, they do have limits. A good rule of thumb: If it's time to replace your liner, it's also time to replace your septum.

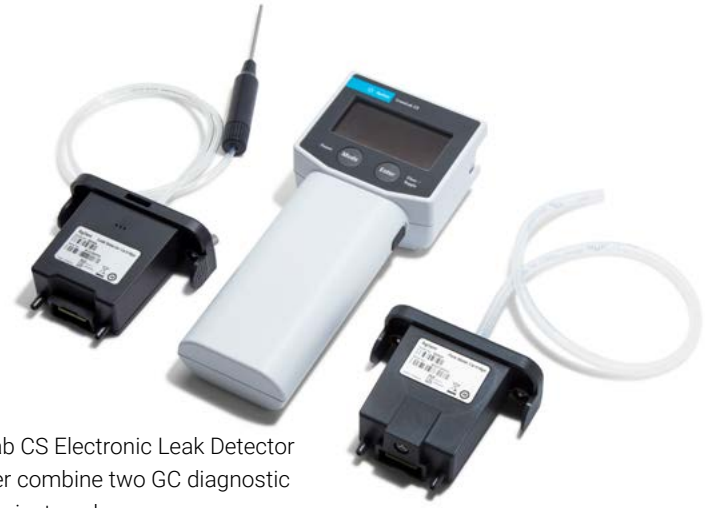
Another easy maintenance check is to test that your syringe plunger can move easily before you start your run. That's because certain matrices and solvents can clog a syringe over time. It's best to verify smooth syringe movement before you press Run Sequence, and replace your syringe if you feel any resistance.

Need help finding the right inlet liner?
Try our GC inlet liner selector tool. Get started

How do I check for leaks?

If you're using an MS, you can perform an air and water check to see if there is a leak in your system. Air and water levels should be below 10% for your system to run, but ideally, they should be less than 3%. If you find a leak, check all your connection points, the MS transfer line, the septum nut, and the column connection to the inlet.

A leak detector is also a great tool to locate the source of leaks in either the GC or the gas lines connecting to the GC. Another option is using an electronics duster (without bitterant) to "profile" whether there are leaks at any of the connection points. If you know the *m/z* values, you can use Profile in manual tune to look for the *m/z* when you spray short bursts of the duster at those locations.



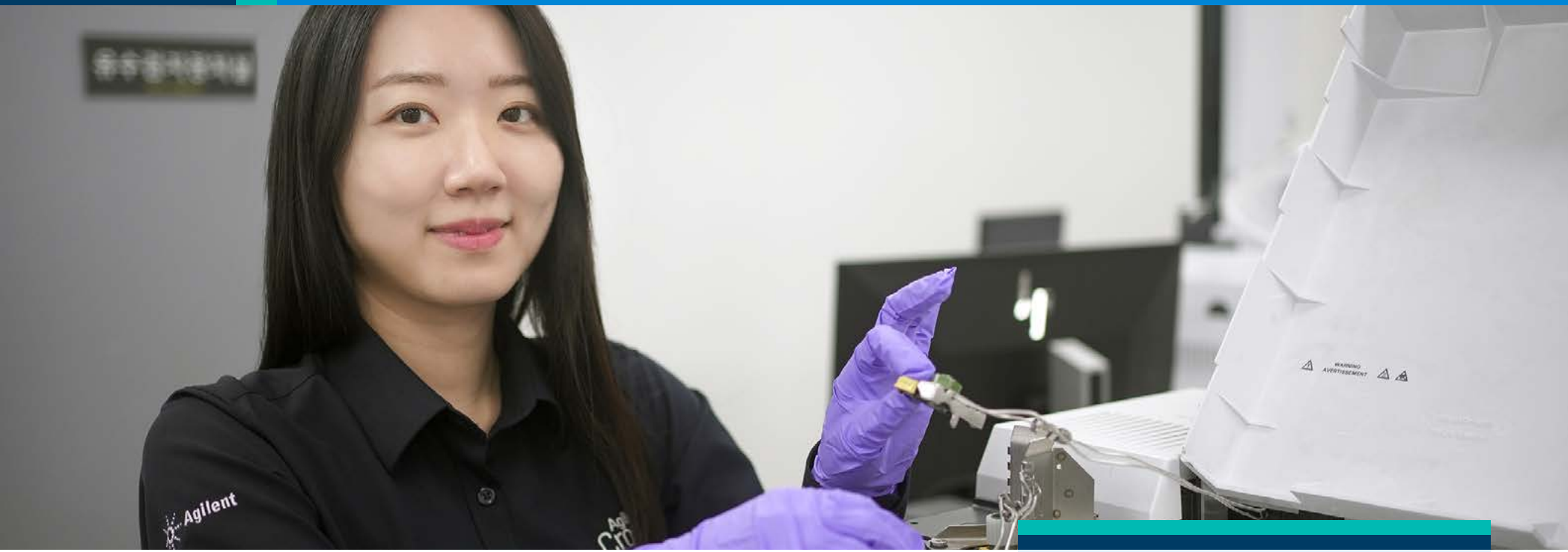
The Agilent CrossLab CS Electronic Leak Detector and ADM Flow Meter combine two GC diagnostic tools into one convenient package.

See how it works

Video: Learn how and where to check for leaks at gas sources and fittings using the Agilent CrossLab CS Electronic Leak Detector

Our chemist walks you through the lab checking for leaks at the gas sources, Gas Clean filter system, and gas fittings.

Watch now



When should I replace the filaments?

It largely depends on the frequency of use. However, there are ways to maximize filament lifetime:

- Make sure that the system is leak free and that O_2 and H_2O < 2% and N_2 < 10%.
- Inspect the filaments when you clean the source. If the filaments seem to be untwisting, then replace them before they fail.

Filament assembly for the Agilent 7010 triple quadrupole GC/MS

Essential supplies for gas chromatography systems

Agilent technical experts have compiled a list of recommended supplies that will help keep your lab operational, prevent disruptions, and maintain optimal performance.

Download guide

Can preslit vial cap septa prevent septa leakage into the inlet or sample?

Yes, preslit vial cap septa reduce the risk of septa coring and leaking with multiple injections. The trade-off is that preslit septa should only be used with low-volatile solvents. Volatile solvents, such as dichloromethane (DCM), are not recommended. There is also a risk of losing sample volume or analytes of interest when using preslit vial cap septa. As always, it's a balancing act.

Note: When performing headspace analysis of VOCs in water, you should inspect the inlet septum at least once per month and change it if needed. Inlet septa that sit at moderate to high temperatures will become brittle over time.

I use the MS with complex matrices every day. Should I tune daily or weekly?

If your standard operating procedure states “Tune every day,” then tune every day. For weekly tuning, you may want to run a test to see if your results are stable throughout the week.

If your current tuning schedule is working, you can stick with it. However, you might be able to decrease tuning frequency by testing whether peak responses or response factors are stable as the week goes by.

GC and GC/MS webinar series

Whether you’re a GC veteran or a beginner, this series will help you become a better chromatographer. So you get the reproducible results you need to make your lab more productive.

Register now

What chemicals should I use to perform a standard instrument check?

This answer requires two parts, because you need different compounds to separately verify that the GC and the MS are working. To confirm that the MS is working, we recommend using PFTBA in your autotune. PFTBA will break apart into 69, 219, and 502 ions, and you can adjust the voltages on the lenses to make sure your MS is operating properly.

For GC columns, you should use a quality control test mix of either the compounds you are analyzing or compounds that test the health of the column. With this mix, you want to confirm that it's verifying the correct concentrations and that your peak shape is what you expect it to be. The test mix for each column will vary depending on the column phase type, inertness level, and compounds of interest.

While it's advisable to base a column test mix on the compounds you'll be analyzing, you can also replicate the test performed on the column QC sheet. Every Agilent column includes a QC sheet listing compound names and measures of efficiency and selectivity, along with some method parameters. However, the required number of components partly depends on your specific analysis.

Tuning and performance standards for GC/MS

Agilent offers a range of certified chemical standards that are integral to instrument tune verification, performance verification, and analytical GC and GC/MS workflows. All standards are manufactured under ISO 17025 and Guide 34 certification, so you can have confidence that they meet Agilent benchmarks for quality and reproducibility. What's more, Agilent guarantees a shelf life of at least one year for many of our standards.

Order now

When replacing and conditioning a column, should I install it into the MS?

Yes, columns should be connected to their inlet and detector before conditioning. Also, verify that your system is leak free by performing an air and water check. If there's a leak, or if the column isn't connected to the detector when you increase oven temperature, oxygen and heat could damage the column phase. You would then need to cut off a few meters of the damaged column.

It's also more efficient to condition your column after connecting it to your MS and inlet and pumping down your MS. That way, you're ready to run your samples.

Proper column conditioning: The temperature and duration of conditioning varies depending on the column phase and the maximum temperature that you're planning to operate at. One suggestion is to heat the column to the maximum temperature needed (no higher than the maximum recommended temperature) with the gas flow on. Then hold that temperature for about one hour.

A column is considered conditioned when the baseline is flat and is no longer decreasing, which is easy to see on an a flame ionization detector (FID). As the column is first taken up to temperature, you'll initially see a jump in the baseline, which should then decrease and level out. Also, if you don't need to operate at the maximum column temperature, there's no need to condition the column at this temperature. That way, you can reduce conditioning time to less than two hours.

Conditioning your GC column

Column conditioning is an important step for achieving the best performance, increasing lifetime, and preventing excessive baseline noise. Watch our video for guidance on proper column conditioning.

Watch now

How does JetClean maximize instrument uptime and productivity?

Agilent JetClean is a technology that you can add to an Agilent GC/MS system to help reduce manual source cleaning. That's great news when you consider that it can take an entire day to vent the system, clean the source, and have the GC/MS/MS ready to run.

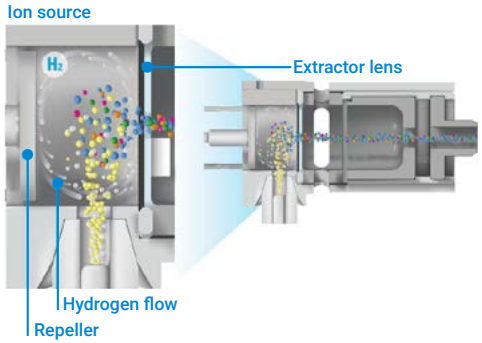
In the following example, an applied sample was prepared using QuEChERS extraction. Although QuEChERS is a great sample cleanup technique, the MS/MS system still needed to be cleaned once a month. Comparatively, the same samples prepared on an MS using JetClean in the clean only mode were able to run from August 18 to January 14. **That's an 80% reduction in the need for cleaning.**

Calendar comparison of ion source cleaning: Standard ion source versus ion source with JetClean.

JetClean is also superior to traditional bakeouts using helium gas. To demonstrate the difference, we marked up two ion source lenses with red permanent ink. One lens was installed into an ion source and a bakeout was performed. The other lens was installed into an ion source and one JetClean cycle was performed.

When the two lenses were compared, the lens that had undergone one JetClean cycle was clean in all of the locations that came into contact with hydrogen. The lens that only underwent a traditional bakeout still had red ink residue.

How does JetClean work?



A low flow of hydrogen is introduced directly to the MS source during or after analysis, keeping the source clean for weeks, or even months.

Learn more about JetClean

Image of ion lenses after helium bakeout and after one JetClean cycle.

How do I prevent loss of column efficiency and resolution?

The best way to prevent loss of column efficiency and resolution is to treat your column well. That means not exceeding the maximum allowable operating temperatures and guarding against injecting heavy matrices.

There are three ways to protect your column from heavy matrices:

1. Select a liner that has either glass wool or a glass frit to help prevent nonvolatile compounds from clogging the column.
2. Use a sacrificial guard column that can be replaced routinely and will trap any debris or active compounds before they reach the analytical column.
3. Use sample preparation techniques to clean up your samples before injecting them. It doesn't matter how amazing your GC setup is—if you inject a substandard sample, you can expect substandard results.

An inert GC column is only the beginning

For trace-level analysis of active compounds, an inert flow path from injection to detection is essential—and now, easy to accomplish.

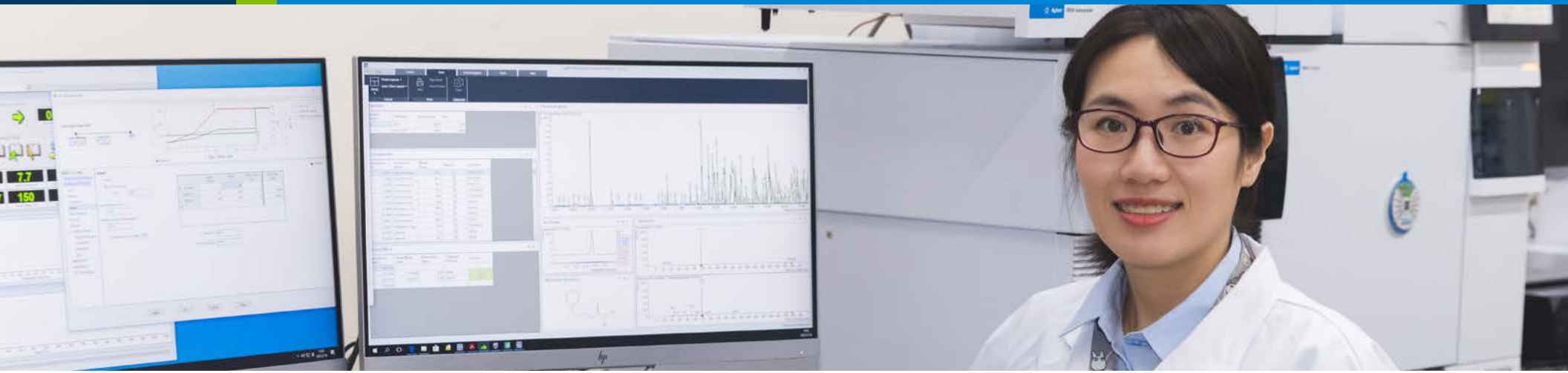
Agilent Inert Flow Path solutions minimize activity along every step of your GC and GC/MS flow path. So, you can improve system performance, ensure better results, and process more samples without unplanned maintenance and recalibration.

Learn more

Method Development and Optimization

The goal of GC method development is to optimize chromatographic separation of analytes while using your instrument components efficiently. Adjusting method parameters—as well as optimizing your GC consumables—may be necessary to achieve effective chromatographic runs.

In this section, we've outlined some best practices for selecting standards, choosing the right liner, evaluating detectors, and more.



How do I develop methods in MRM/SRM mode?

A free Agilent University course shows you how MRM optimizer can help you develop the MS/MS method for MRMs and SRMs: **GCMS-7000-2090r – How to Select Product Ions for Triple Quadrupole GC/MS Analyses**

In this recorded lecture, Dr. Frank J. Van Lenten walks you through the initial steps of MRM method development, including the selection of precursor and product ions. Several different scenarios are presented to help you develop MRM methods more efficiently and effectively. This seminar is presented using an Agilent 7000 triple quadrupole GC/MS system running on MassHunter GC/MS Acquisition software revision B.07.05 and MassHunter Qualitative Analysis B.07.00.

Topics covered:

– Determining precursors from MS1 scan or library data.

– What happens during product ion scanning?

– Do I use profile or centroid data?

– Setting up product ion scan in MassHunter Acquisition.

– Using design experiments assistant to create a production scan sequence.

– Using MassHunter qualitative analysis to look at the data.

Other free GC/MS and GC/MS/MS courses include:

GCMS-7000-2123r MassHunter Triple Quadrupole GC/MS Acquisition Method Parameters: Product Ion Scan and MRM (Ver. B.07)

This course explores product ion scan and MRM acquisition modes. You will also learn how to identify the MS parameters needed to acquire data in these modes and understand how they affect the data.

Register today

How do I select an internal standard (ISTD) for my GC/MS analysis?

It depends on the compounds that you're analyzing and (to a point) the consumables you're using. For example, you can't use a carbon frit liner when analyzing deuterated PAHs, since these compounds bind with carbon. Here are some general selection guidelines:

- Choose an ISTD that won't appear in your standard, that's stable and not active, and that's possibly related to the compounds in the mixture (not required).
- The compound should fall in the middle of the elution order. When using multiple ISTDs, make sure that they're spread out across the elution order.
- Hold the ISTDs at one concentration across your calibration curves. If you look at 0.1 to 50 ppm, then select a concentration with easy identification of those ISTDs, such as 10 to 20 ppm. ISTDs remain at 10 ppm in every calibration standard, while the compounds of interest range from X to Y.
- If a deuterated version of a compound of interest is available (and not too expensive), then that may be the best ISTD for your analysis.

Unfortunately the answer isn't always cut and dry. For example:

- Six deuterated PAHs can be used for EPA 8270 and EPA 525 (GC/MS and GC/MS/MS analyses of pesticides in food).
- Some analysts use phenanthrene-d10 alone for pesticides analyses.
- In GC-ECD studies of endrin and DDT breakdown, lindane (γ-BHC) can be used as an "internal standard," being a stable pesticide with good, consistent GC-ECD response.
- For some nitrosamines in water analyses by GC/MS/MS, N-nitrosodi-n-propylamine-d14 (NDPA-d14) can be applied, as recommended in EPA 521.
- Diiodobenzene has been used as an internal standard for forensic toxicology work.

How do I select the right MSD for my sample or analytical requirements?

If you're analyzing diverse compounds, such as semivolatile organic compounds, pesticides, and hydrocarbons, a mass selective detector (MSD) is generally your best option. That's because you can gather mass spectral information with retention time. For example, if you want to find all GC-amenable pesticides, then we'd recommend a GC/MS or GC/MS/MS—especially for low-ppb ranges.

There are several detectors that can be used with GC, each with different sensitivity ranges.

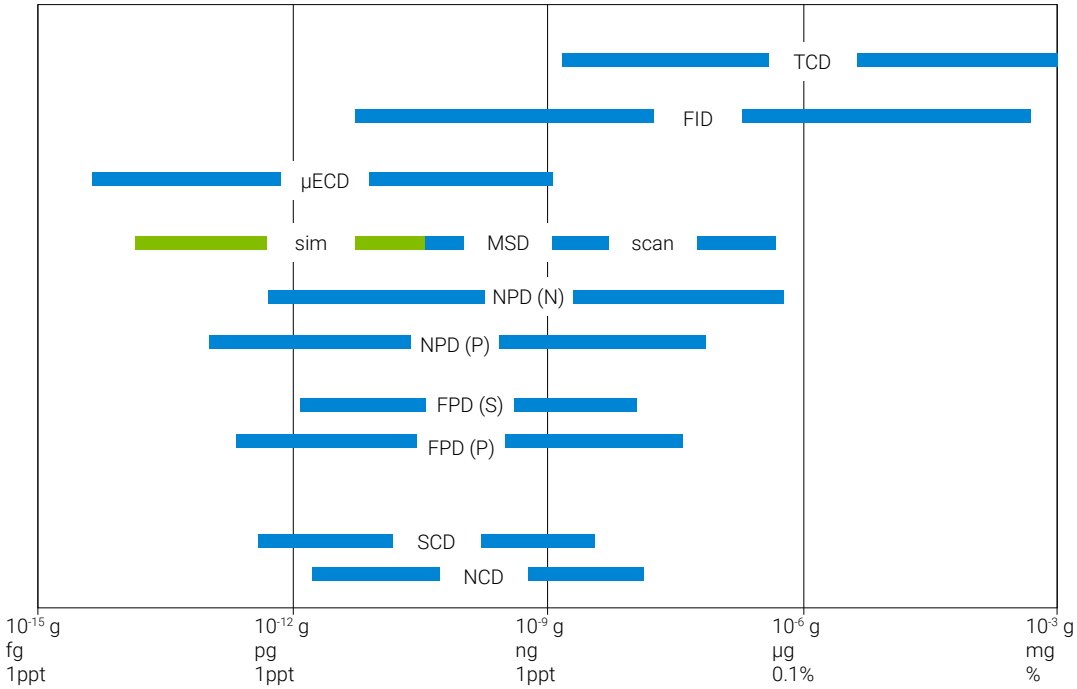


Diagram of sensitivity ranges for various gas chromatography detectors.

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Flame ionization detectors (FID)

With FID, effluent from the column mixes with hydrogen and air and is pyrolyzed by a flame. Most organic compounds, upon combustion, produce ions that can conduct electricity through a flame. This conduction of electricity produces an increased signal output when an organic compound passes through the flame, creating a peak. FID is very sensitive for hydrocarbons and can detect quantities as low as 10–13 g/sec. If you're looking at a single class of compounds, like hydrocarbons or FAMES that can be well separated, an FID will usually work well. Note that the FID will respond to organic compounds (C-H bonds).

There's little or no FID response for these inert gases: H_2O, CO_2, CO, N_2, O_2, and CS_2.

Nitrogen phosphorus detectors (NPD)

An NPD is a type of thermionic specific detector, where analytes are ionized by thermal energy, and is selective for nitrogen- and phosphorus-containing compounds. A hydrogen/air mixture is ignited by a rubidium or cesium bead to form a cold plasma, which can range from 600 to 800 °C. Electrons are ejected from this plasma and flow between an anode and a cathode. Effluent then mixes with hydrogen and is exposed to plasma (similar to FID) and a heated ceramic bead coated with an alkali metal facilitates ionization. When nitrogen- or phosphorus-containing analytes are present, they interact with electrons between the anode and cathode, causing a measured increase in current.

NPD is 50 times more sensitive for nitrogen-containing compounds and 500 times more sensitive for phosphorus-containing compounds than FID. If you're looking for herbicides or pesticides with nitrogen or phosphorus, then GC-NPD is a good choice. Note that NPD doesn't respond to N_2 or NH_3, because the nitrogen atom must be chemically bonded to the carbon atom.

These detectors are most commonly used in applications such as pharmaceuticals, industrial hygiene, toxicology, tobacco, and environmental analysis of herbicides/pesticides.

Electron capture detectors (ECD) and flame photometric detectors (FPD)

If you're only looking at halogenated pesticides or other compounds with high electronegativity, then GC-ECD is your best choice. For organophosphorus pesticides or other phosphorus-containing compounds, we recommend an FPD with a phosphorus filter.

An FPD can also be set for sulfur detection. Alternatively, a sulfur chemiluminescence detector (SCD) is another viable option for sulfur detection and has been commonly used in petroleum products.

Micro-electron capture detectors (µECD)

µECD is commonly used in environmental sample testing due to its selectivity and sensitivity for halogenated compounds.

Here's how it works:

Step 1. Effluent passes over a radioactive source (usually a nickel ß emitter).

Step 2. Electrons from the emitter ionize the carrier and make up gas (usually nitrogen), creating a detectable current that serves as a continuous background.

Step 3. When electronegative organics and halogenated compounds pass over the emitter, they grab the free electrons, causing the current to decrease. The magnitude of the decrease in current is proportional to the size of the peak.

(Continued on next page)

Thermal conductivity detectors (TCD)

Also known as a katharometer, TCD is a nondestructive detection technique and is ideal for all compounds, making it an excellent general-purpose detector. Inside the detector is a filament, a thin platinum or gold wire that is heated electrically.

The detector contains a switching valve that rapidly switches between two gas flows:

– A reference gas, which serves as a background

– A make-up gas that combines with the column effluent

The thermal conductivity of each gas is measured and compared, and analytes within the make-up gas stream generate differences in thermal conductivity, which are measured and quantified.

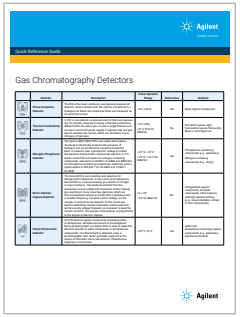
Because TCD compares the resistance of a reference gas versus a make-up gas and effluent, fluctuations or leaks will affect the sensitivity and the chromatogram. Air leaks in the TCD system can manifest chromatographically as an unstable baseline or a negative dip on the peak tail. To verify the flow, connect a flow meter to the TCD using the TCD adapter and measure each flow individually. If there's a greater than 10% difference, there may be a leak in the gas line.

While a TCD doesn't have high sensitivity, it's nondestructive and fairly universal in selectivity, so it can be used in series with another detector. The carrier gas that you choose will also be your reference gas and should come from the same source. If you choose helium or hydrogen as your carrier, the sample will usually cause the thermal conductivity to fall and create positive peaks. With nitrogen carrier, the thermal conductivity usually rises because most substances are more conductive than N_2, creating negative peaks.

Detectors for routine to advanced GC applications

Because your gas chromatography methods can be diverse and have specific requirements, Agilent offers a GC detector portfolio that addresses a broad array of applications.

Learn more



Read our gas chromatography detectors quick reference guide

Explore the features of and differences between GC detectors.

Download now

How do I choose the right mass spectrometer?

With single and triple quadrupole mass spectrometers, ions are filtered by their mass-to-charge ratio in the quadrupole. On a single quadrupole, the ions are then converted to signal with an electron multiplier. Conversely, on the triple quadrupole, those ions are sent to a collision cell where they can be fragmented again. They are then filtered out once more by yet another quadrupole before being converted to electronic signals.

Ions enter all mass spectrometers through the GC column and become ionized. However, they are filtered differently depending on the type of MS being used.

Single Quad	Triple Quad	Time of Flight (TOF)
Sample is vaporized into a GC column		
Compounds are separated in the GC		
Analytes interact with electrons or ionized reagent gas in the source to form ions		
Ions are filtered by their mass/charge ratio in quadrupole		Ions sent through flight tube, with small ions moving through faster than large ions
Ions are converted to a signal in the electron multiplier	Selected ion sent to collision cell for further fragmentation	Ions are detected based on their arrival time
	Ion fragments selected in second quad mass filter	
	Ions are converted to a signal in the electron multiplier	

General description of how ions move through different types of mass spectrometers.

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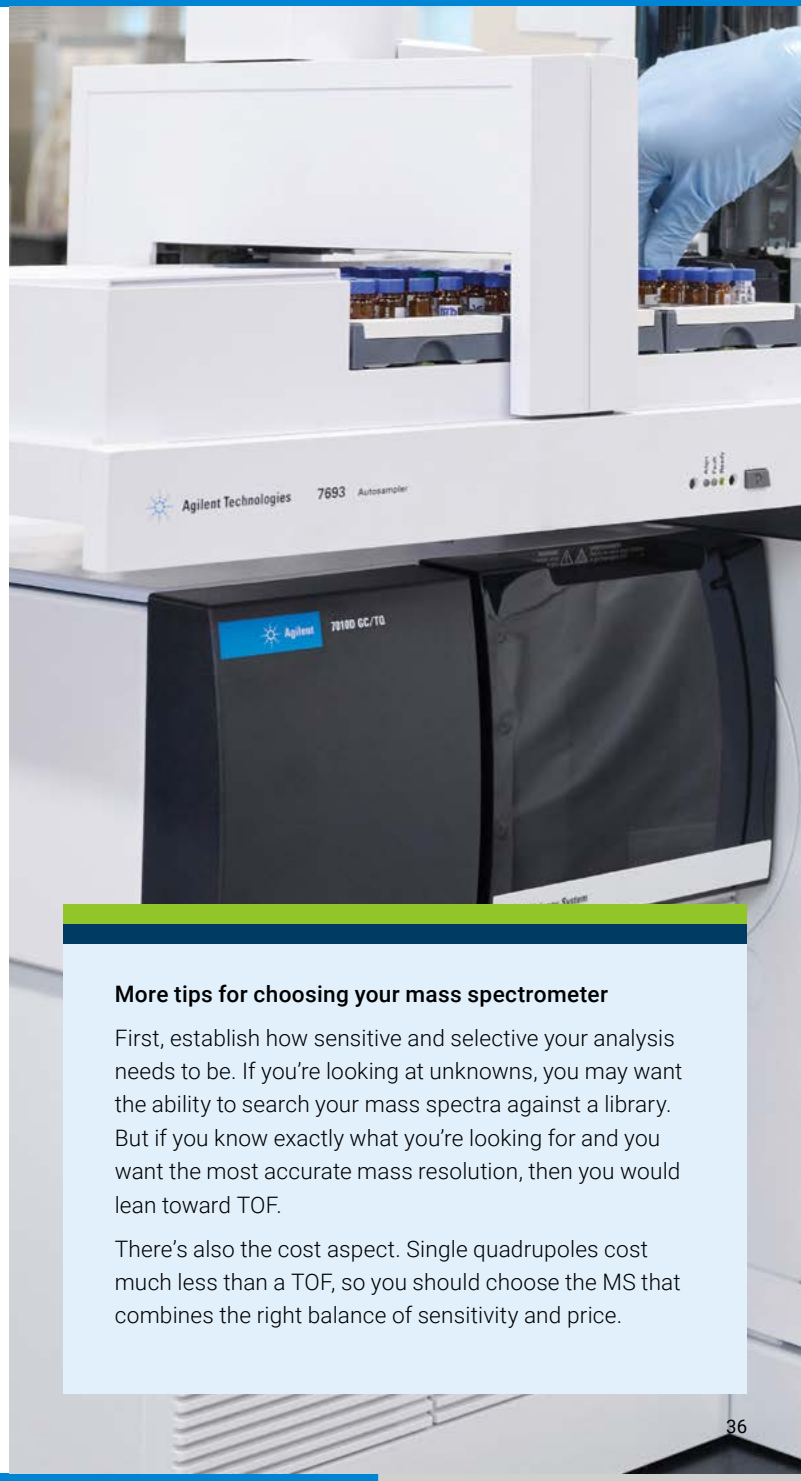

More tips for choosing your mass spectrometer

First, establish how sensitive and selective your analysis needs to be. If you're looking at unknowns, you may want the ability to search your mass spectra against a library. But if you know exactly what you're looking for and you want the most accurate mass resolution, then you would lean toward TOF.

There's also the cost aspect. Single quadrupoles cost much less than a TOF, so you should choose the MS that combines the right balance of sensitivity and price.

Single quadrupoles

Single quadrupoles are the most familiar types of MS, and are easy to use because of their robustness. They have two types of ionization: universal, also termed electron impact (EI), and selective, which provides both positive and negative chemical ionization. In addition, single quadrupoles can have either hard or soft ionization. The type you choose depends on your analytes of interest, how they fragment, or how much you want them to fragment.

Data can be collected in scan or selected ion monitoring (SIM) mode, and you can adjust the scan speed based on how many ions you're looking for.

Triple quadrupoles

Also called tandem mass quadrupoles, triple quadrupoles don't always have three quadrupoles in a row. Occasionally, there's a hexapole or an octupole in the middle, but the term "triple quadrupole" is still used. With triple quadrupoles, the additional collision cell and quadrupole allow you to have a lower level of detection and selectivity. You can also run a triple quadrupole like a single quadrupole, if you like.

With both single and triple quadrupoles, several libraries are available to help you identify unknowns.

Time of flight (TOF)

In TOF, ions travel through a drift (flight) tube, with smaller ions traveling faster than larger ions and detection being based on arrival time. This process allows for high resolution of mass spectra and enhanced selectivity. So, if you're looking for accurate mass and qualitative analysis tools, TOF is the detector for you.

One downside is that there aren't as many libraries for TOF as there are for single and triple quadrupoles, mostly because TOFs are less common.

What are the rules of thumb for choosing an inlet liner?

Liners can vary by body type or pack material, and selecting which one is best for your analysis will depend on several factors. Most importantly, your liner should be deactivated for your compounds, since a liner's purpose is to maximize analyte amount on the column without excessive interaction. Agilent offers both standard and ultra inert deactivation.

Get help with choosing the right liner. Try our **quick reference eSelector tool**

Think about what type of sample introduction is being used.

- Solid phase microextraction (SPME) injections require a narrow ID SPME liner to prevent band broadening as much as possible.
- Headspace injections, if splitless, require a 2 mm ID liner to prevent band broadening. If you need to split the headspace injection, then we suggest a mid-wool single-taper low pressure drop liner (see part number **5190-2295**).
- Liquid injections depend on what compounds you're analyzing for.

Splitless injection

If you're doing trace analysis, then you're most likely using splitless injection and need a splitless liner. You can use a double-taper (reduced backflash potential) or single-taper liner with the correct deactivation if the sample is clean (for example, drinking water or liquid residual solvents).

If the sample is dirty (such as soils, landfill leachate, wastewater, or food), then you need a deactivated liner. The liner should also have a barrier like glass wool (**5190-2293**) or a glass frit (**5190-5112**). The goal is to prevent nonvolatile matrix from getting into the column, which could cause more frequent column trims or replacements.

Split injection

High-concentration samples, or "dilute and shoot" sample preparation, require a split injection and split (or universal) liner. Viscous samples require a wool plug in the middle/upper section of the liner to wipe the needle. We suggest a mid-wool single-taper low pressure drop liner (**5190- 2295**). The downside of this liner is that it contains a large amount of wool and you may see smaller areas compared to other split liners.

If the sample isn't viscous, then you could use a mid-frit liner (**5190-5105**). Most split liners come with a barrier, since you need a spot for volatilization. If you're not sure whether you're going to use a split or splitless liner, alternate between a mid-wool single-taper low pressure drop liner and a mid-frit liner.

What is a good approach for analyzing unknown compounds?

If the compounds are “unknown unknowns” and you need to perform compound discovery, then use Q-TOF instruments, such as GC/Q-TOF and LC/Q-TOF. These instruments have software to help determine fragments and potential compound identity.

If the compounds are “unknown to me,” then you can use GC/MS in scan mode (however, GC/Q-TOF is still best for trace levels). Start with a general-purpose GC/MS method—such as one with a slow oven ramp and longer final hold time—to ensure that everything elutes off the column. Make sure to run a solvent blank to subtract any background from your solvent, and potentially a method blank if you’re performing sample preparation. Also, ensure that your scan range is large enough to detect compounds that you may be interested in. Usually, 40 to 500 amu is a good range to start with.

Software programs like Agilent MassHunter Unknowns Analysis, together with a library like NIST20, can help you examine the peaks in your chromatogram. The NIST library doesn’t feature every compound, but it’s comprehensive. Depending on your column, there could be a potential for coeluting peaks. To identify your peaks, you may need to perform your analysis on a second column with a different polarity.

Can I quantify GC/MS results in either scan or SIM mode?

The short answer is yes. We suggest building a calibration curve of your compounds and using internal standards to help avoid issues with bad injections or minor detector fluctuations. Selected ion monitoring (SIM) mode offers more sensitivity than scan mode, because you're focusing on the ions you're looking for. Also, if you are using SIM mode for your analytical method, we recommend mirroring this method in scan mode. This way, if you suspect that compounds have shifted out of your SIM windows, you can verify retention times and update your SIM windows if needed.

Agilent University Course:
GC-0GEN-2090rV2 – Factors to Consider When Optimizing Your Method

In this lecture, Dr. Lee Polite presents the factors to consider when optimizing your method for better resolution, improved sensitivity, and faster cycle time.

Register today

Troubleshooting

GC and GC/MS troubleshooting depends on what you're analyzing, what you can change, and what samples you run. For example, if peak shape is poor, then you may need a different column. However, if peak tailing increases over time, then you may just need a new liner or a column trim.

In this section, we'll walk through the solutions to several common issues, so you can get back to your analysis.

How do I improve peak shape?

First, you need to figure out if your peaks are fronting or tailing.

Peak fronting, also referred to as a "shark fin," is when too much sample is injected onto a column, exceeding the column's capacity.

How do you determine whether you're exceeding column capacity? The number-one consideration is your column's internal diameter (id). In general, the larger the id, the higher the capacity of the column will be.

Think of it like a path through the woods. If the path is wide, more people can walk along at the same time, but if the path is narrower, only a few people can walk together comfortably. Likewise, you can analyze higher concentrations on columns with a larger id.

Also, thicker-film columns have an increased capacity compared to thinner-film columns. Let's go back to our woodland path analogy. Imagine that there are flowers on the path that walkers stop to admire before moving on. The more flowers there are, the longer it will take to walk along the path, so more people can be on the path at the same time. In a similar way, thicker-film columns have so many things to "look at," that the "path" doesn't become overloaded. For this reason, columns with thicker films also tend to have greater retention than thin-film columns with longer run times.

If you're experiencing peak fronting, there are three ways to solve your problem:

1. Decrease your injection volume.

2. Increase your split ratio to decrease how much sample gets onto the column.

3. Dilute your samples.

Remember, too, that just because GCs are rugged doesn't mean that you should test their limits by injecting the most concentrated sample you can find.

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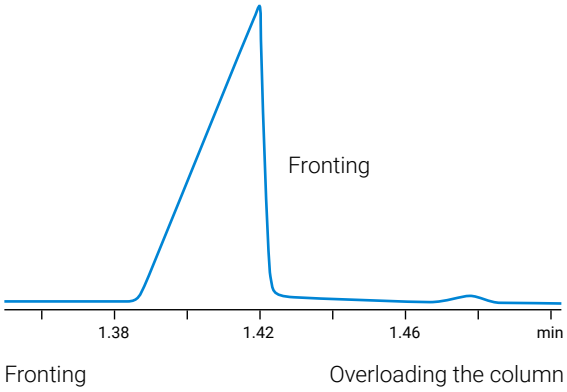


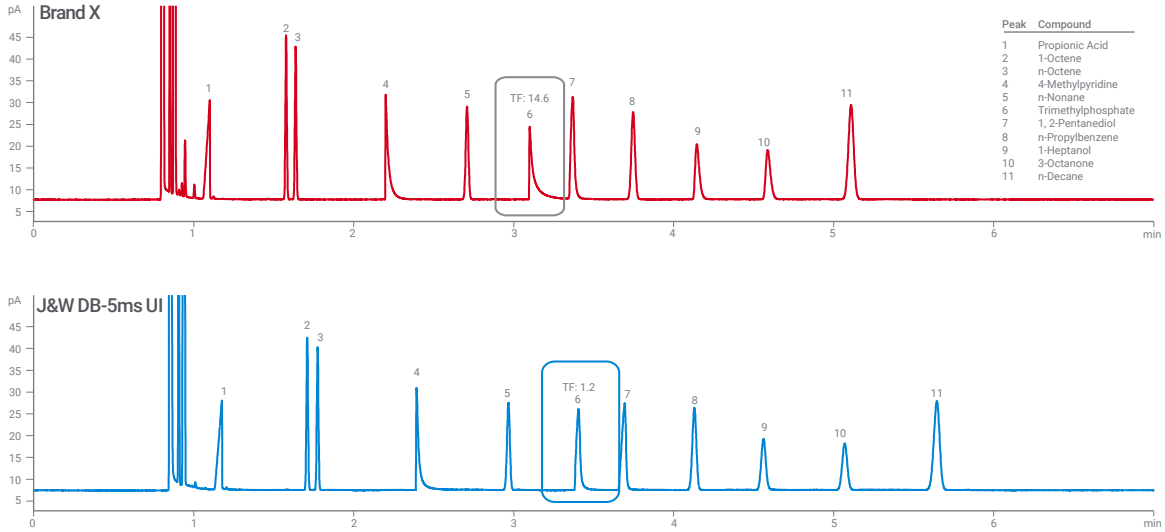
Example of peak fronting due to overloading the column.

Peak tailing is caused by activity—and the column isn't always to blame. Activity can come from anywhere in the flow path that the sample comes into contact with, including the liner or gold seal.

In our woodland path analogy, you would expect people to admire the flowers briefly before moving on. However, if a person (analyte) gets drawn to a particularly beautiful flower (column phase), they'll spend more time at that location. That's called "activity" or an "active site." When you have an active site, those compounds will have a tail as they enter the detector.

A remedy for peak tailing is to choose flow path supplies that are coated to prevent compounds from interacting with active sites. Ultra Inert inlet liners are best for active compounds because their ultra inert coating allows them to do what they're supposed to do: Vaporize samples.

Picking the right column for difficult compounds can be tricky because not all phases will stand up to challenging compounds, such as acids and bases. Agilent GC columns are evaluated with test mixtures during manufacturing and testing. These mixes contain both standard and difficult compounds, as you can see in the following example.



Comparison of test mix analyzed on a J&W DB-5ms UI GC column versus a Brand X 5ms GC column.

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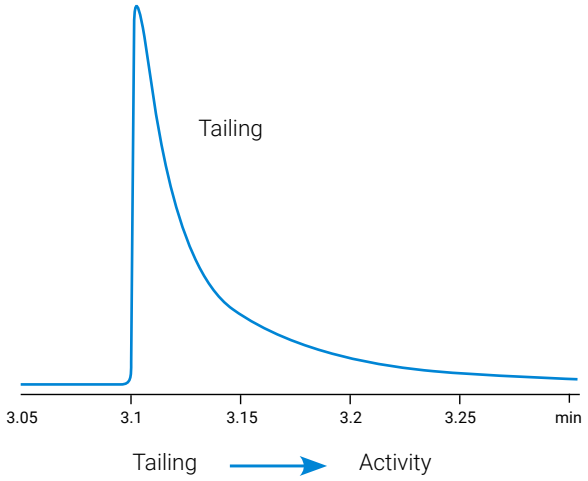
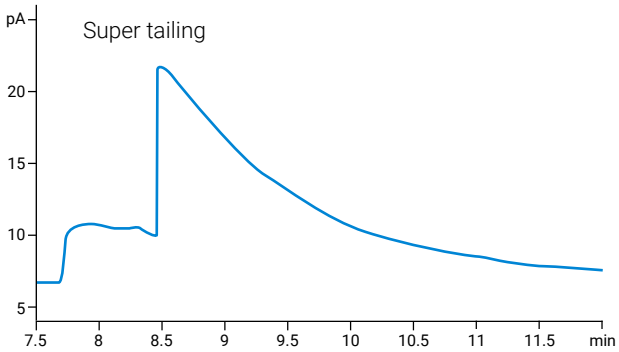


Example of peak tailing due to activity on a GC column.

If an analyte and a column phase are strongly mismatched—even within the same family of phases—a problem called **super tailing** can occur.

With super tailing, analytes aren't fully adsorbed, because no column phase is "interesting" enough. It may look like a long flat increase in the baseline, so you might think that nothing is there. But as long as you have column flow, the analytes will eventually elute. If you know that your injection worked and your column is installed properly, you might need to pick a column with a better deactivation for your analytes.



Demonstration of super tailing on a GC column.

New 7010D triple quadrupole GC/MS

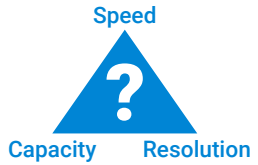
Want to explore more troubleshooting techniques?

A surprising number of problems involve fairly simple and often overlooked components of the GC system or analysis. The Agilent GC troubleshooting guide can help solve common problems and stay productive.

Download guide

How do I improve resolution?

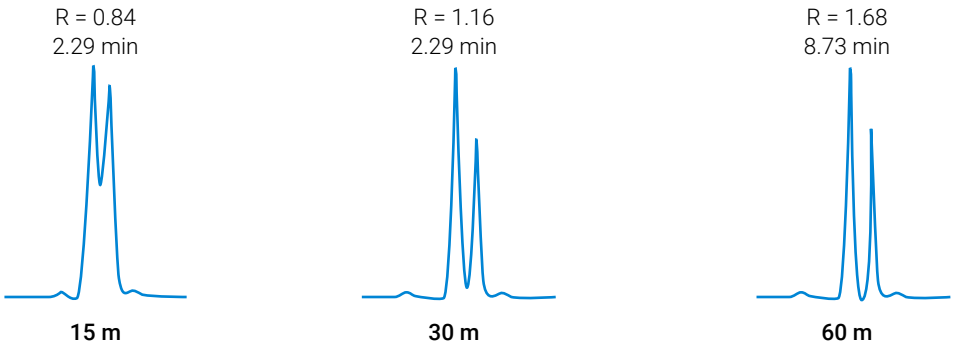
There are ways to improve resolution, but you may have to sacrifice either the speed of your analysis or the capacity of your column. Speed, column capacity, and resolution are all important considerations that must be balanced.



Option 1: Increase resolution but lose speed

When analysts want to increase resolution, they usually decrease the column flow rate or increase the column length, both of which increase overall run time. However, the following chromatograms demonstrate that you don't get double the resolving power from a column that's twice as long.

As you can see, column length doesn't impact resolution as much as other column dimensions do.



Resolution of two compounds on GC columns with lengths of 15 m, 30 m, and 60 m.

(Continued on next page)

Option 2: Increase resolution but decrease column capacity

Another way to increase resolving power is by decreasing column id, which comes at a cost of column capacity.

The following illustration represents the path of a single TNT molecule. Instead of traveling in a straight line, the molecule interacts with the solid phase or film layer on the column. Each time the molecule interacts with the solid phase, it will diffuse into the phase, come to an equilibrium, and continue traveling down the column.

More phase interaction points mean more chances for analytes to interact with the column—and more potential for compounds to resolve. (Additional phase interaction points are also why longer columns improve resolution.)

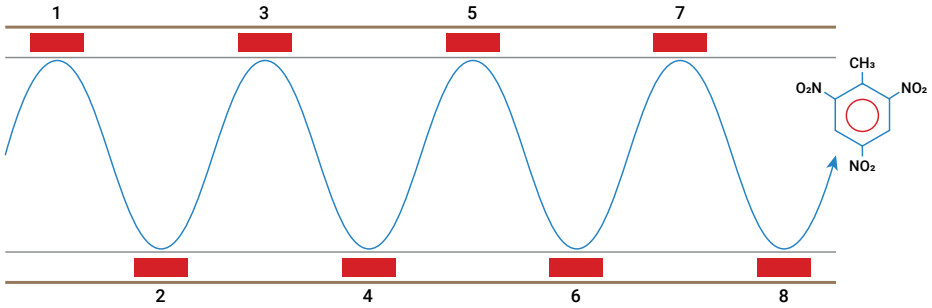


Illustration of a TNT molecule interacting with column phase as it moves through GC column.

As the TNT molecule traveled through the column, it interacted with the solid phase eight times, which may sound like a high number of interactions. But let's see what happens when the column diameter is decreased.

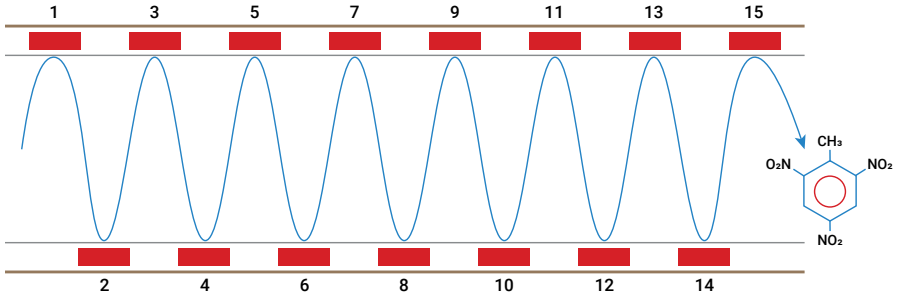


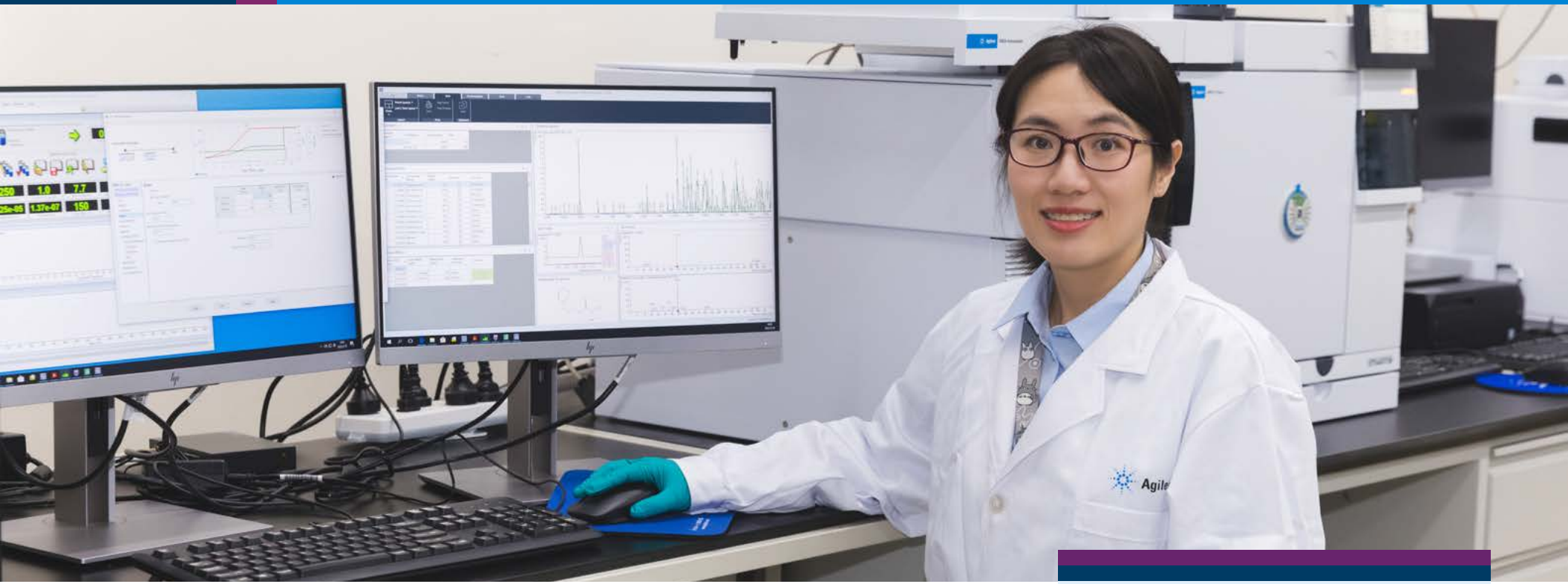
Illustration of a TNT molecule interacting with column phase as it moves through a GC column with a smaller internal diameter.

Even if the same flow is maintained, the TNT molecule will interact with the solid phase more often. By simply decreasing the diameter, the potential interaction points increase from 8 to 15. That means almost twice the number of opportunities for compounds to interact and diffuse into and out of the solid phase. When there's more interaction between the compounds and column, separation power increases. This is how smaller id columns provide more resolution for the same length of column.

A side effect of decreasing column diameter is a decrease in sample capacity, so make sure that you don't overload the column. When a column is overloaded, "shark fin" peaks will appear.

In general, the larger the column id, the greater its capacity. This means that a larger id like 0.53 mm, also known as megabore, can handle a higher concentration of compounds than a smaller id column. (Much like a five-lane highway can handle a larger volume of cars than a one-lane country road.)

A column with a 0.25 µm film thickness and a 0.25 mm id will have a capacity between 80 to 160 ng. If you wanted to decrease the id (to 0.18 mm, for example) to increase resolving power, the column would have a capacity between 25 and 55 ng. To compensate for this significant decrease in capacity—and avoid overloading—the operator would have to decrease the injection volume or increase the split ratio.



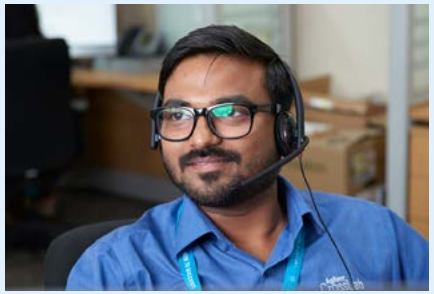
How do I improve signal-to-noise levels?

Improving the signal-to-noise ratio of a compound is all about increasing sensitivity. Try choosing a more sensitive detector, selecting a column with less bleed, or using sample preparation techniques before injecting a sample into the GC.

What causes spiking and how do I avoid it?

Normally, spiking is due to some form of electrical interference. There are two types:

- Baseline spikes are usually around the same size and are caused by an issue with an electrical motor.
- Random spikes vary in size and frequency, but the cause is usually a clog in the line or a column installation issue.



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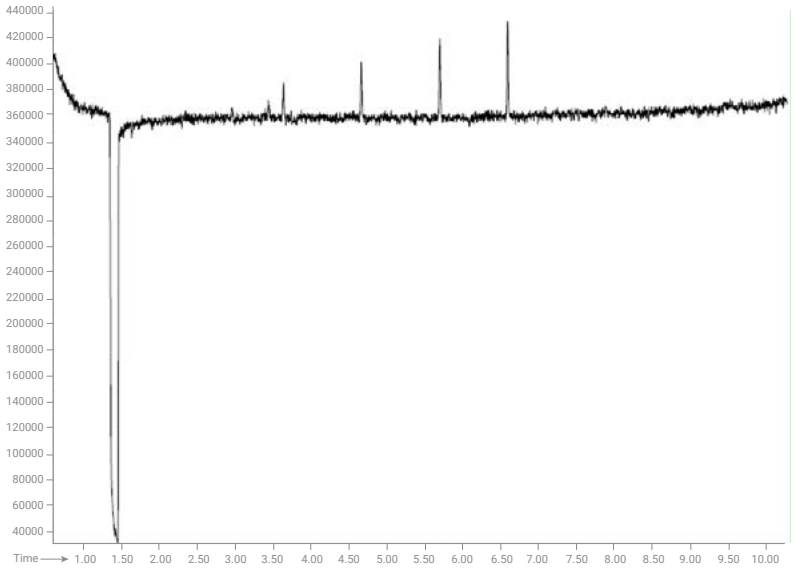
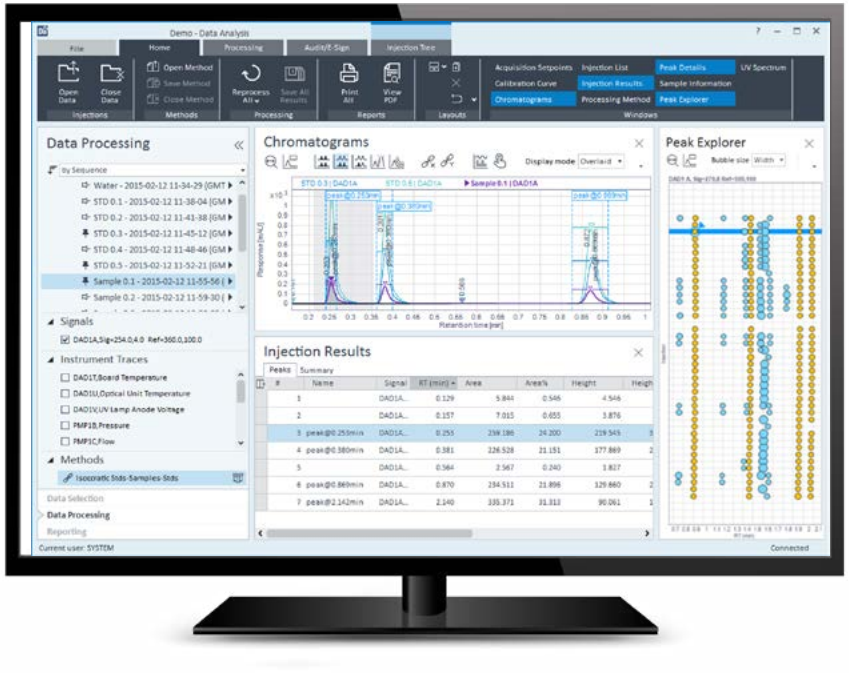
What can cause a negative peak in GC/MS?

Gas impurities are a major cause of negative dips/peaks. When this happens, you'll observe an initial high baseline followed by a large dip, as shown in the following chromatogram. Negative peaks may also be observed when a filament reaches the end of its life.



Chromatogram of a negative peak observed on a GC/MS.



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Optimizing your peak integration parameters can be a frustrating trial-and-error process. OpenLab CDS Integration Optimizer eliminates the guesswork, saving you time and rework.

Watch video

Where do ghost peaks come from?

Ghost peaks from previous injections can be caused by carryover on the column, syringe, or inlet. They may also represent siloxane peaks from the inlet septum (if over compressed or cored), the vial cap septa, or the inlet liner O-ring.

Here are some tips for avoiding ghost peaks.

Wash your vials. Always perform at least two syringe washes with Wash A and Wash B to ensure that the sample is well cleaned out. Do the same for prewashes. If your samples are dirty and the water in the clean solvent wash vials becomes discolored, then you need more syringe washes.

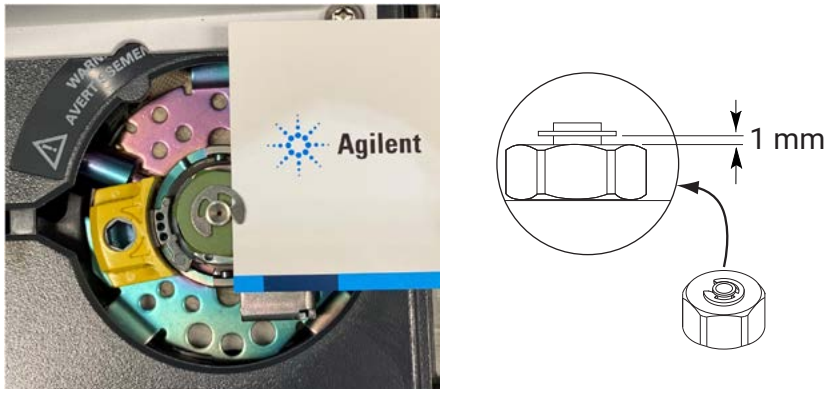
Avoid backflash. Use the **vapor volume calculator** and verify that the inlet liner isn't being overloaded.

Eliminate carryover from the previous run. Wide peak humps early in the chromatogram mean that either your end temperature wasn't high enough or it wasn't held long enough.

- If these peaks are analytes of interest, then increase the end temperature or extend the hold time at the final temperature. Just be sure to stay at or below the maximum column operating temperature.
- If these peaks are matrix or unimportant to you, do a precolumn or midcolumn backflush. This will send the matrix back through the column and out the split vent. Alternatively, if you have a GC non-MS detector, like GC-FID, you could perform a postcolumn backflush.

Check your septum nut and O-rings. Too often, when MS users see peaks in their chromatogram that aren't supposed to be there, they perform a NIST search on the peak. If the search indicates some sort of siloxane-based peak, they conclude that it must be a column bleed and wrongfully blame the column. However, columns can never create peaks. A likely culprit creating these ghost peaks may be your septum or liner O-ring.

Septa are meant to be changed to maintain a seal. They should be tightened just until the c-clamp is about 1 mm from the nut or high enough to slide a business card under the c-clamp. If an inlet isn't holding pressure at the desired temperature, even with proper tightening of the septum nut, don't try to tighten down the nut even more. Over-tightening leads to septum bleed and can potentially strip the threads on the weldment.



Proper height of a correctly installed septum nut.

What can cause split peaks, peak tailing, and drifting baselines?

Many factors can cause changes in chromatography and lead to events like split peaks, tailing, or drifting baselines.

Split peaks

Split peaks can result from erratic syringe plunger depression, mixed sample solvents, poor column installation, sample degradation in the inlet, or poor sample focusing.

Drifting baselines

Drifting baselines can be related to gas quality, so always use Gas Clean filters on the carrier and detector gases. Also, check for these problems:

- Inlet or column contamination (fixed with maintenance)
- An incompletely conditioned column
- An unequilibrated detector
- A change in carrier gas flow rate during the temperature program when using constant pressure, which can normally occur in MS, TCD, or ECD

Peak tailing

Activity causes tailing. If we use a woodland path analogy, interactions between people (analytes) and flowers (phase) should last for an expected amount of time. But when a compound becomes very attracted to a phase, or falls into a hole, it will spend more time in that location. That's what we call activity or an active site. And when you have an active site, those compounds will have a tail as they enter the detector. (This is also why we coat sites that we don't want our compounds to interact with.)

To avoid peak tailing, perform inlet and column maintenance. If the peak tailing has worsened over time, try trimming the column or replacing the liner, septum, or gold seal. Also, Ultra Inert flow path supplies can help reduce tailing (although some active compounds will always tail). Finally, ensure that the column phase and compound class/polarity are well matched.

Why is water difficult to observe in GC and how can it be quantified using GC?

Water is a challenging analyte in GC because an FID requires C-H bonds to observe differences in baseline response. FID also produces water as a by-product of the flame. With MSD, water is a background component of the atmosphere, so there will always be some type of background if you're trying to detect water.

Tips for aqueous injections

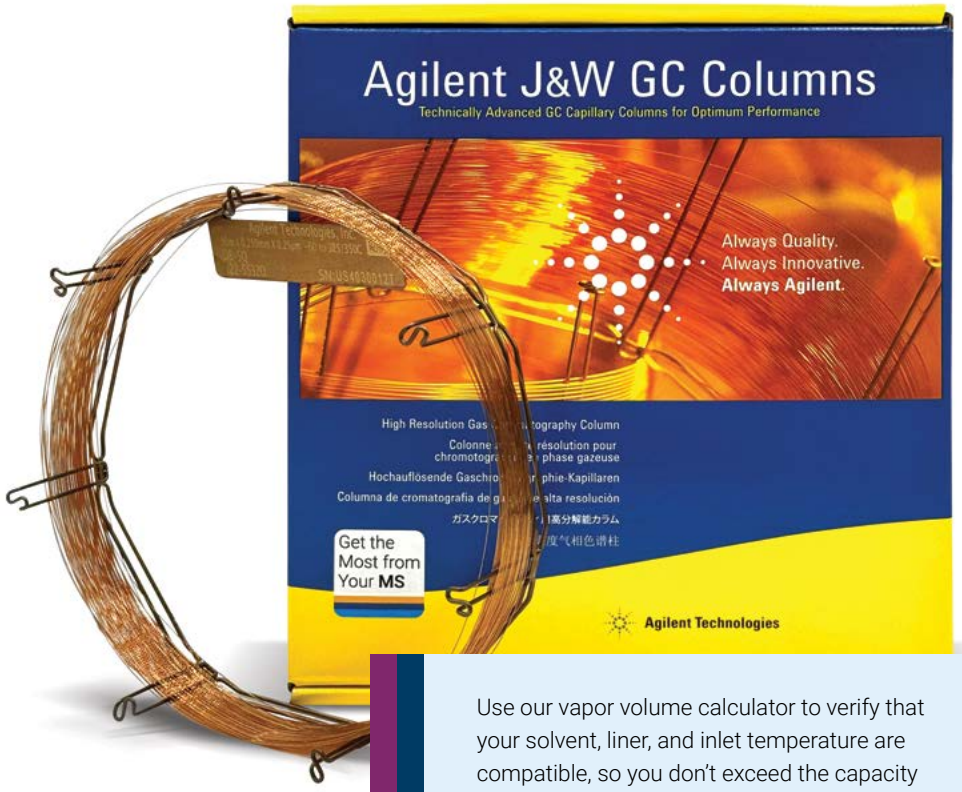
When phases weren't bonded, carrying out multiple water injections and heating to high temperatures could cause phase damage and "washout." Now, with bonded and crosslinked phases like Agilent J&W DB-WAX UI, this is no longer the case.

If water isn't bad for the column, then why should you avoid injecting aqueous samples into the GC? The bigger concern with aqueous injections has to do with backflash, which can lead to carryover or ghost peaks.

Backflash occurs when solvent expansion surpasses the capacity of the liner.

Consider the ideal gas law: PV = nRT

This law states that when pressure is held as a constant, volume will be proportional to temperature. As the temperature of a gas increases, so does the volume. And when a liquid is injected into a hot inlet, not only will it vaporize, but it will expand. Every liner has an associated capacity volume. So, when a vapor expands past that volume, the vapor will go wherever it can (like toward the septum or outside the liner), resulting in backflash.



Use our vapor volume calculator to verify that your solvent, liner, and inlet temperature are compatible, so you don't exceed the capacity of the liner.

Learn more

How do I determine the source of contamination within my chromatograph?

Start at the front of the GC and work toward the MS, ruling out the issues that are easiest to fix before addressing more complicated problems.

First, determine if the contamination is in your instrument. Remove the syringe and do a true blank injection with only the carrier gas flowing through the system. If you see any peaks, then there's contamination somewhere in your GC or GC/MS system.

Follow these steps:

1. Replace the liner and do an instrument blank.
2. Check the split vent trap (consider when it was last changed).
3. Trim the column (you may have to replace it and run an instrument blank).
4. Clean the inlet. If you're using an MSD, you may also need to clean the MS source.

If the instrument blank shows nothing other than the normal baseline increase with the temperature ramp, the GC is clean. If you aren't sure if the baseline increase is normal, then compare it to a previous run when you knew your system was working.

Second, run a blank solvent injection. If you see unusual peaks, it could be a contaminated solvent. Use a new or different bottle and run that new solvent blank. If you still see unexpected peaks, try a new syringe and rerun those solvent blanks.

Make sure to slowly go through these troubleshooting steps along the sample path from syringe to inlet, column, and detector. Perform quick, easy fixes before jumping to time-intensive fixes like replacing columns or cleaning your ion source.

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