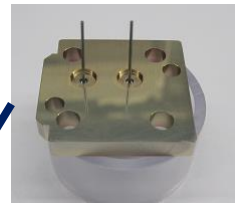
Mass Spectrometer Optimization

Angela Smith Henry, Ph.D.
Applications Chemist
CSD Supplies Division

Agilent
Trusted Answers

Agilent Inert Flow Solution

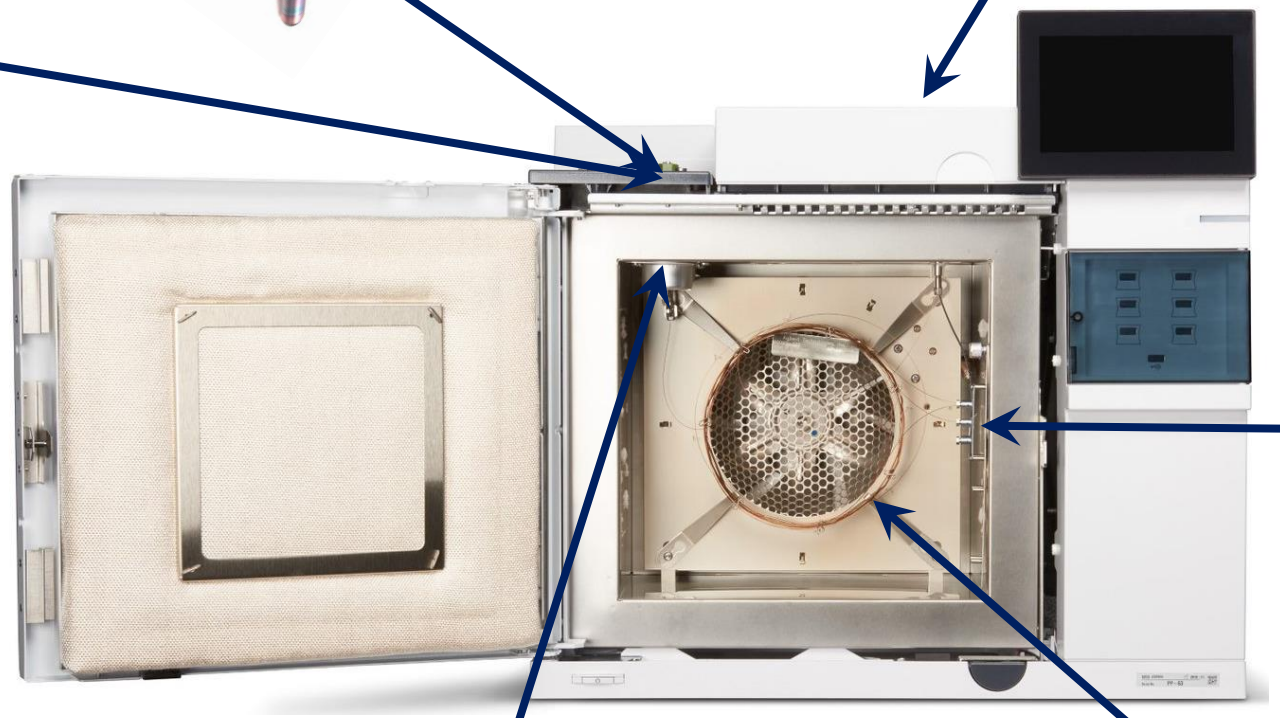
Agilent UltiMetal Plus – TCD, FPD, NPD/FID jets



Agilent UltiMetal Plus inlet weldment, shell and transfer lines

Agilent Ultra Inert inlet liner

Agilent UltiMetal Plus ferrules



Agilent UltiMetal Plus capillary flow technology devices, Ultimate union

Agilent J&W Ultra Inert GC column

Agilent Ultra Inert gold seal

Is MS Method Development Different to Other GC Detectors

How do I know if my flow conditions, gain, and scan speed are right?

Is MS Method Development Different to other GC Detectors?

What do we need to think about?

Column dimensions

Column flow

Solvent delay

Source and quadrupole temperatures

Column installation depth

Type of tune

Scan/SIM (MRM transitions – MS/MS)

Gain

EM voltage (MS/MS)

MS amenable parameters

Length x 0.25 mm x <1 µm

1 to 2 mL/min** (**MS dependent)

Dependent on solvent, column, GC parameters

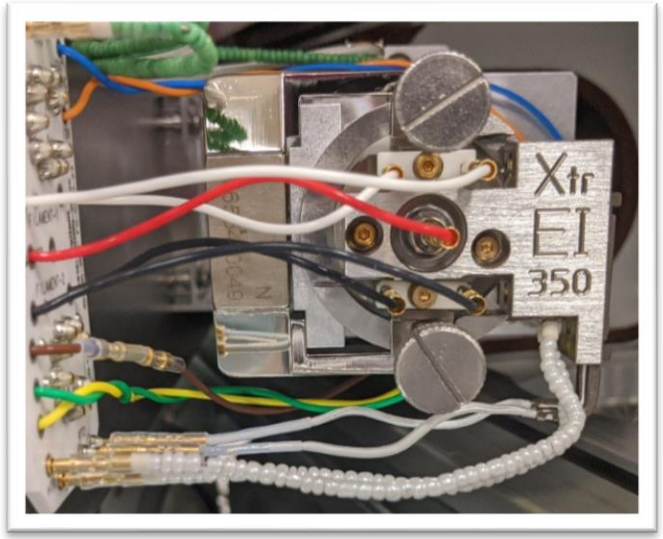
Analysis dependent

Mass spectrometer dependent

InertPlus vs. High Efficiency Source Mass Spectrometers

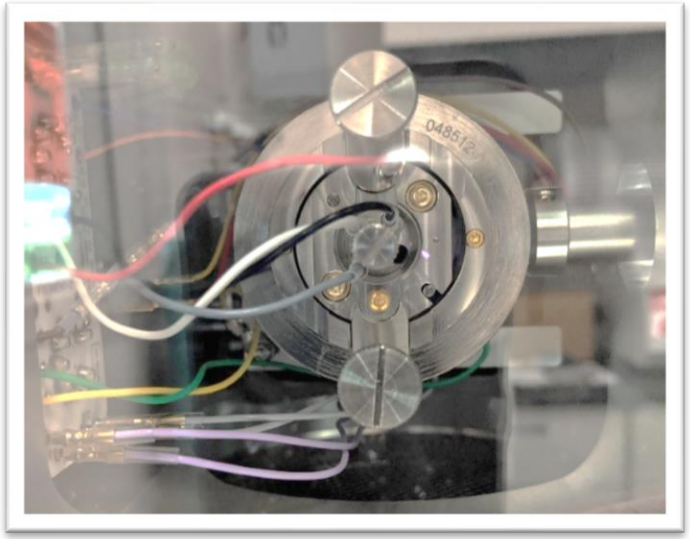
InertPlus, extractor source

- Inert source body
- Familiar source body design to 5975
- Extractor lens voltage bias can increase ion transfer



High efficiency source (HES)

- Inert source body
- Redesigned ion optics for greater ion transfer efficiency
- When to use this?
  - Low level analytes in clean matrices



Data Quality: What Are the Best Flow Conditions to Use for MSD?

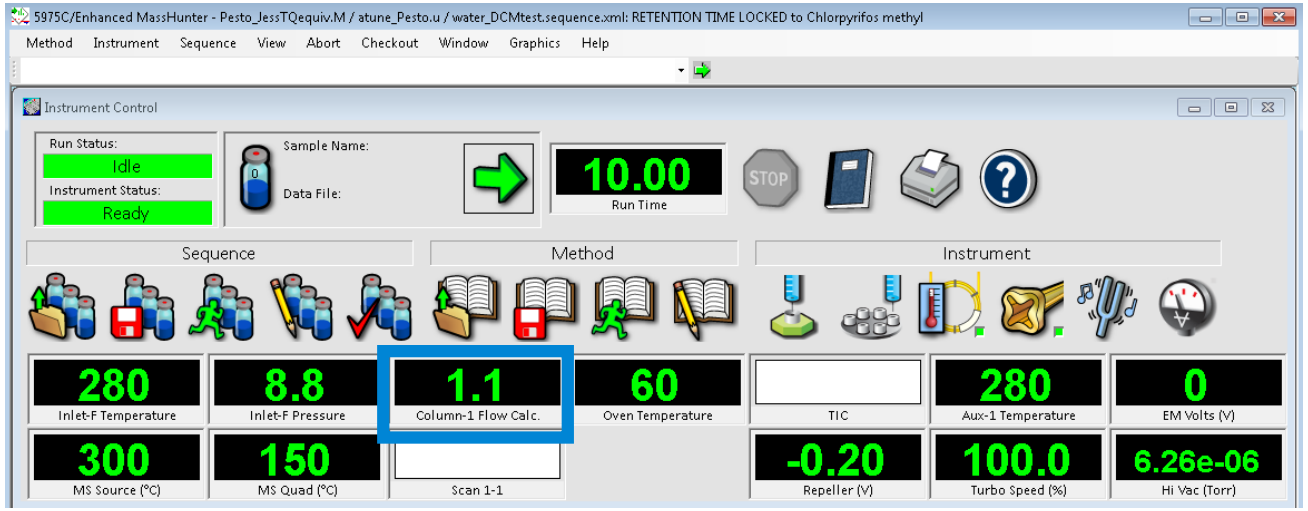
Use constant flow methods

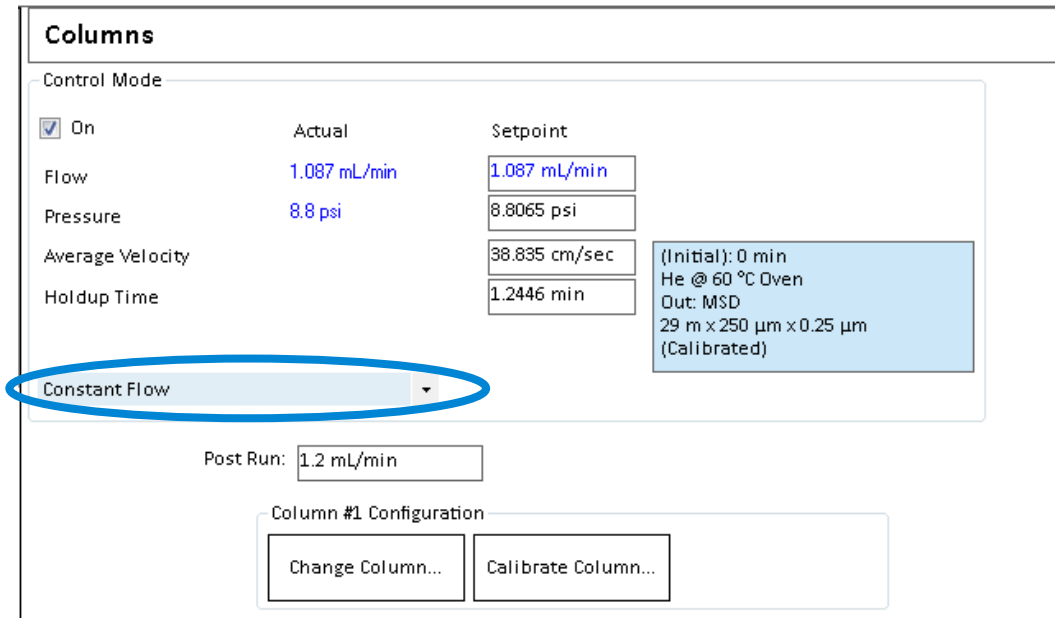
5977 Extractor, InertPlus, or older sources

- Suggested flow rate range: 1 to 2 mL/min
- Optimal flow: 1 to 1.2 mL/min

5977B High Efficiency (HES) source

- Suggested flow rate range 1 to 1.5 mL/min
- Optimal flow: 1 to 1.2 mL/min

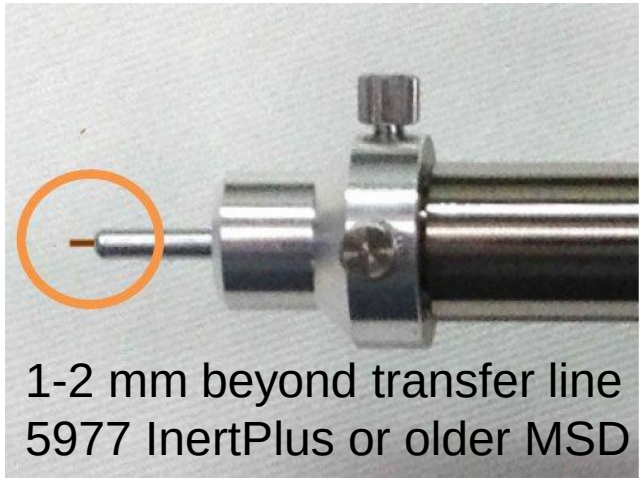




Data Quality: What Is the Proper Column Installation into MSD?

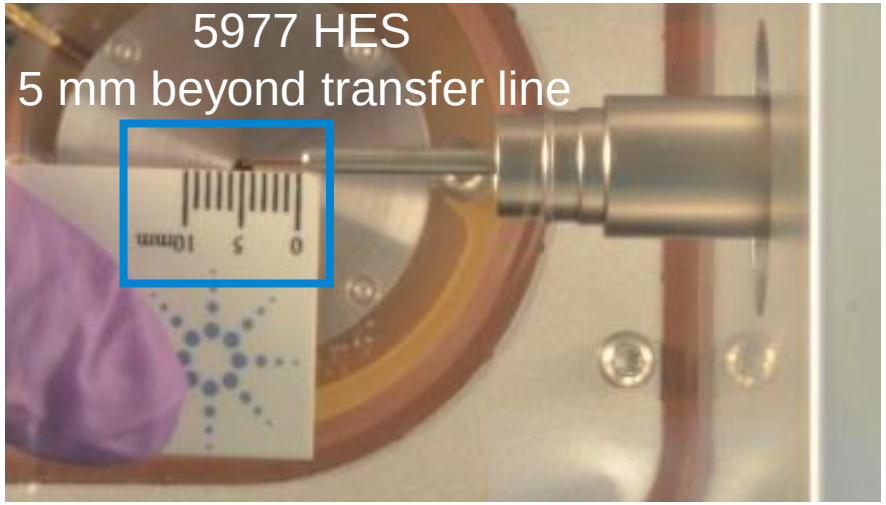
Agilent 5977 extractor or InertPlus, or 5975 MSD

Installation length: 1 to 2 mm beyond end of transfer line



5977B HES

Installation length: 5 mm beyond end of transfer line



Remember to re-install the ceramic tip, spring, and nut after column installation

Ceramic tip for 5977, 7000 or 7010 series
G3870-20542

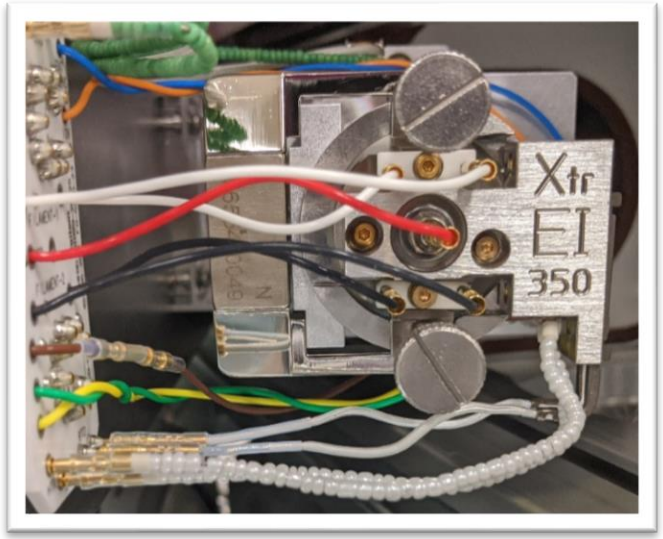
Transfer line spring
G7005-20024

Transfer line cap
G3870-20543

Data Quality: Choosing the Right Type of Tune

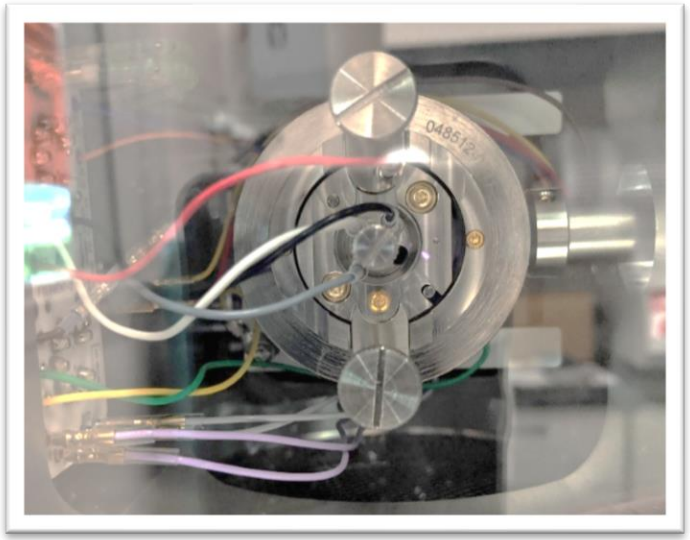
InertPlus, extractor source

- Atune
  - Default, typical tune
- Etune
  - Applies voltage to extractor lens
  - May get better sensitivity and S/N ratio

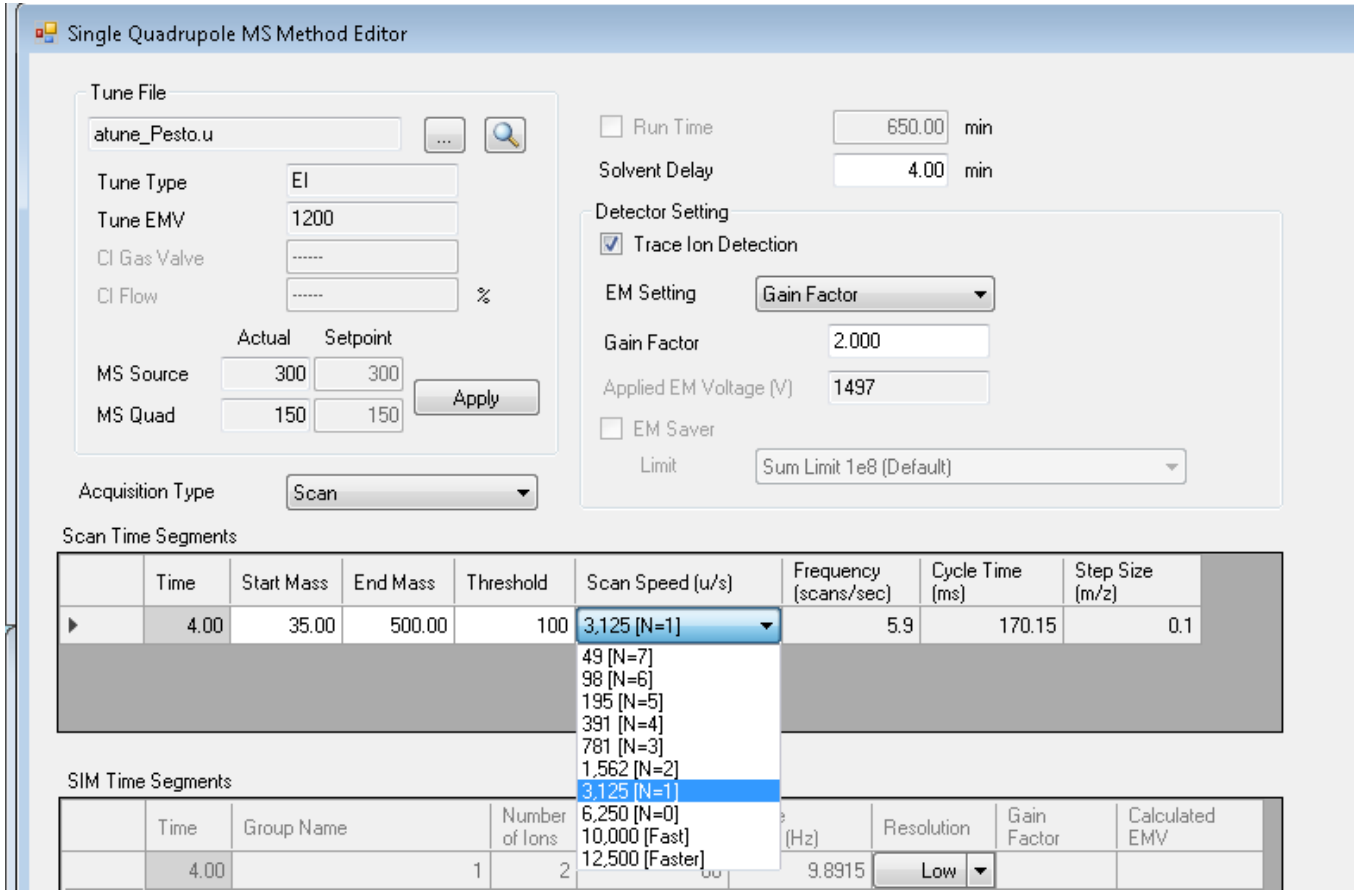


High Efficiency Source (HES)

- Atune
  - Default, typical tune
- HES_Atune
  - Applies voltage to all optics
  - Increased sensitivity and S/N ratio



Data Quality: How Do I Know if My Scan Speed Is Right?



Best acquisition frequency

- ~ 2.5 to 5 Hz

Optimal number of points across peak

- 8 to 12+ points across a peak

Set scan speed at N=1 or N=2

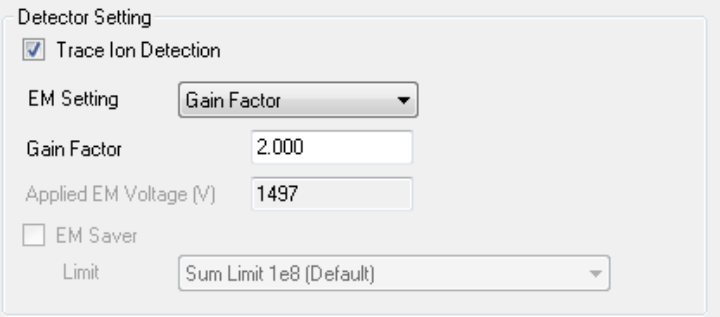
- Frequency in 2.5 to 5 Hz range
- Generally most samples will have 8 to 12+ points across a peak

What about SIM dwell time?

- Default 100 ms = good start
- Depends on number of ions in time segment
- Watch frequency (scan/s) as you add ions or change dwell time

Data Quality: How Do I Know if My Gain Is Right?

- Good practice: Start at gain 1
- Best practice: Choose lowest gain factor for detection of most and least intense ions over target concentration range
  - Ideal gain could be <1
  - Lowest suggestion gain: 0.3
- Avoid high gain for long periods of time
  - High gain can shorten life of EM



Process for testing gain levels: Do I need to increase my gain?

- Test gain factor in highest and lowest concentration standards
  - Choose most intense compound/ion
  - Run known standard at highest concentration with gain = 1 (or current gain)
  - Is largest ion peak between $3x10^6$ – $6x10^6$ counts?
  - If yes, run lowest concentration standard
    - Are all compounds detectable?
  - If no, try a different drawout lens or increase/decrease gain (for example, from gain 1 to gain 2)
    - Repeat process

Gain selection: https://www.agilent.com/cs/library/technicaloverviews/public/5991-2105EN.pdf

Data Quality: Source and Quadrupole Temperatures

Are they really that important?

Source

"Default" – 230 °C

Recommended: 250 to 280 °C

Turn up the heat when:

- Running PAHs – up to 300 or 320 °C

May require optimization

- Watch peak tailing and increase source temp by ~10 to 20 °C

Quadrupole

Default – 150 °C = Recommended

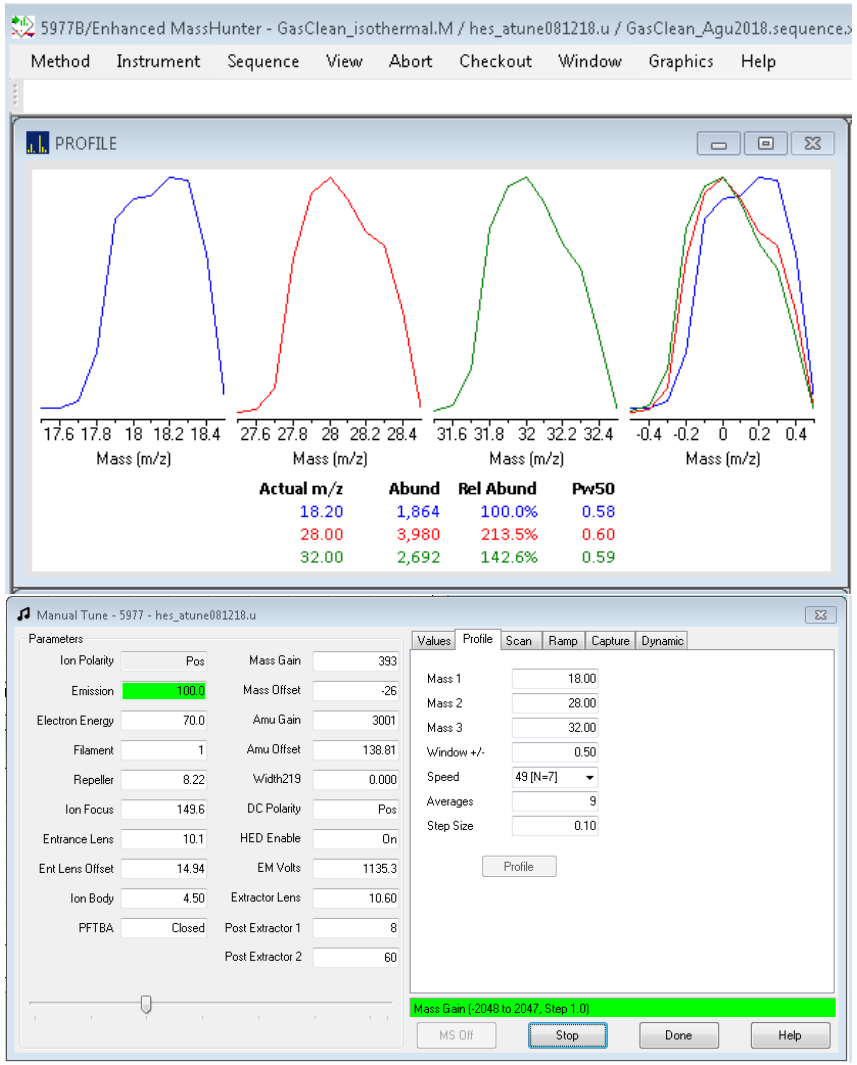
More forgiving than source temperature

Turn up the heat when:

- Running PAHs – up to 180 or 200 °C

Recommendation for GC/MS:
Source: 250 to 280 °C
Quadrupole: 150 °C

If My System Is Leak-free, What Should My Air Ion Abundances Be?



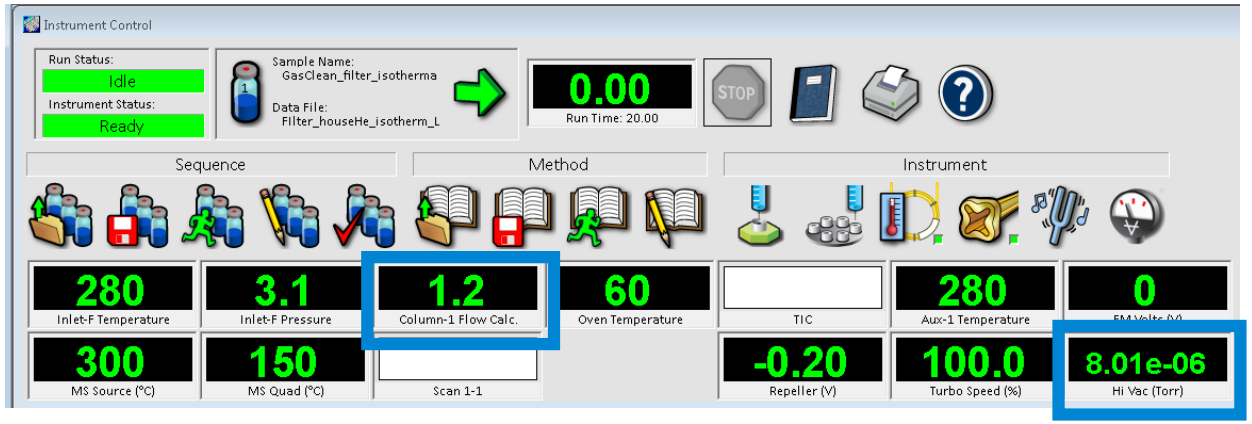
- These are just estimates
  - H_2O: ~2,000 counts (less is ok)
  - N_2: ~10,000 counts (less is ok)*
  - O_2: ~3,000 counts (less is ok)

*Make sure to purge your Gas Clean filter

High vacuum gauge pressure (for SQ):

~1 x10^{-5} torr†

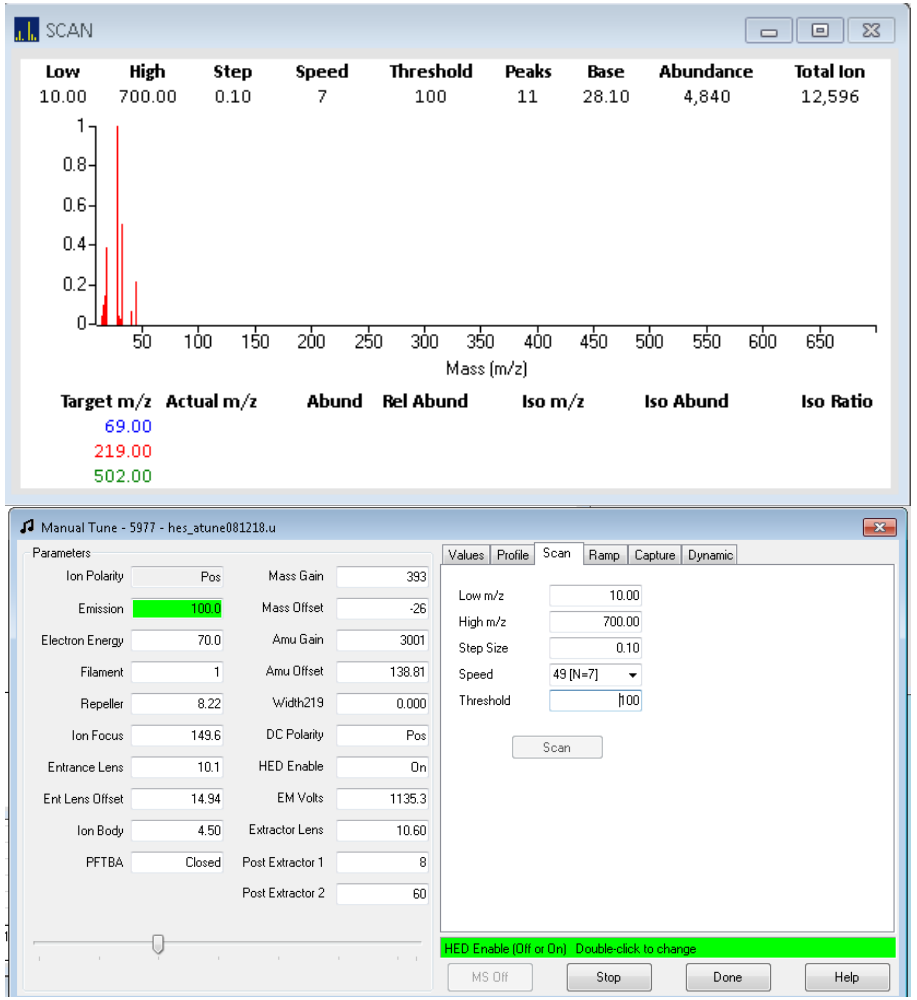
† dependent on flow rate



Good Habit: Run a Manual Scan to Review Background Peaks

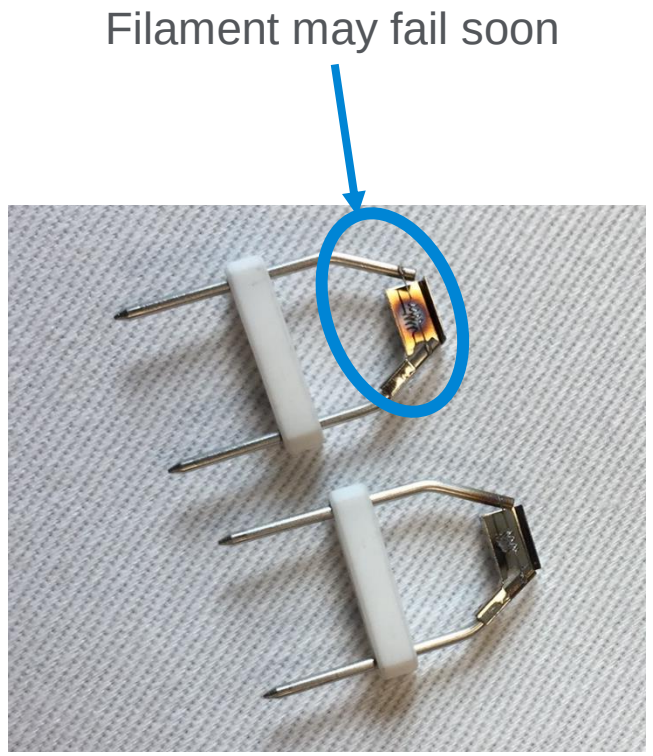
Understand what the normal scan range background looks like

- Look at your normal scan range and an extended scan range
- 35 to 500 and 10 to 700
- Use your normal threshold
- Perform the scan after initial set-up and after major changes (new column, source clean)
  - Track the results in notebook or on computer
- Normal number of peaks in manual scan: ~100 to 250 peaks



Good Habit for Filament Care: Have an Extra Pair (or Two) Ready

- Have (at least) two extra filaments ready
  - More than one GC/MS system? Keep >2 on hand, depending on the number of systems.
- Check filaments when you clean the source
  - Look for discoloration behind the filament and unraveling of the coil
  - Replace them as a pair*
- End-of-life filaments may cause diminished response or odd artifacts in TIC
  - Keep them, just in case the problem is not the filaments

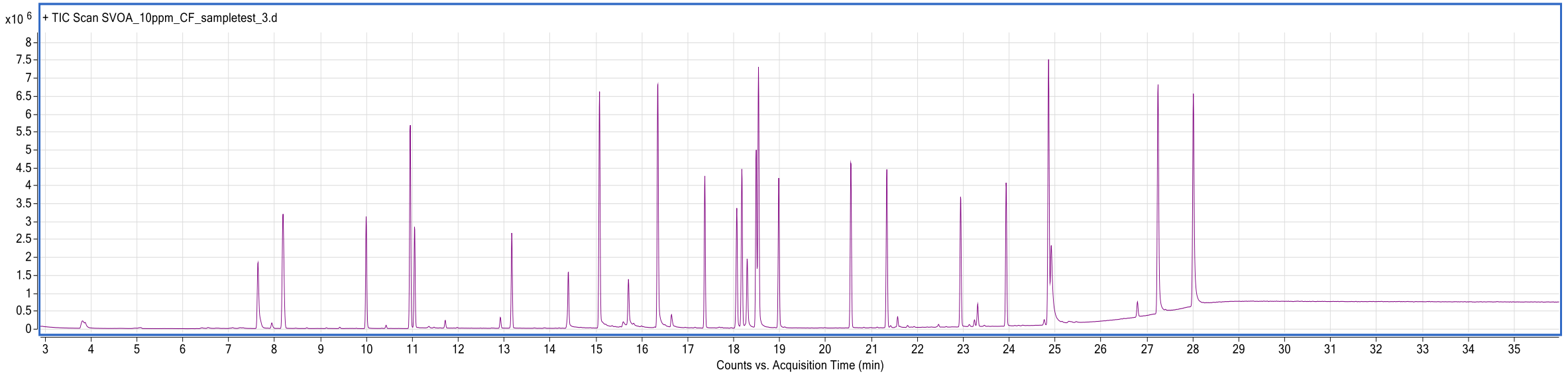


Agilent 5977 InertPlus, extractor, and 5975 filament assemblies: G7005-6001

Careful: High efficiency sources (5977B HES single quadrupole MS and 7010 HES tandem quad MS/MS) have different filament designs from 5977B InertPlus, extractor source and older MSD designs

Good GC Habits and Flow Path = Happy MS

Good Habit: Have System “Baselines”



Known standard: Agilent Semivolatiles checkout standard 5190-0473

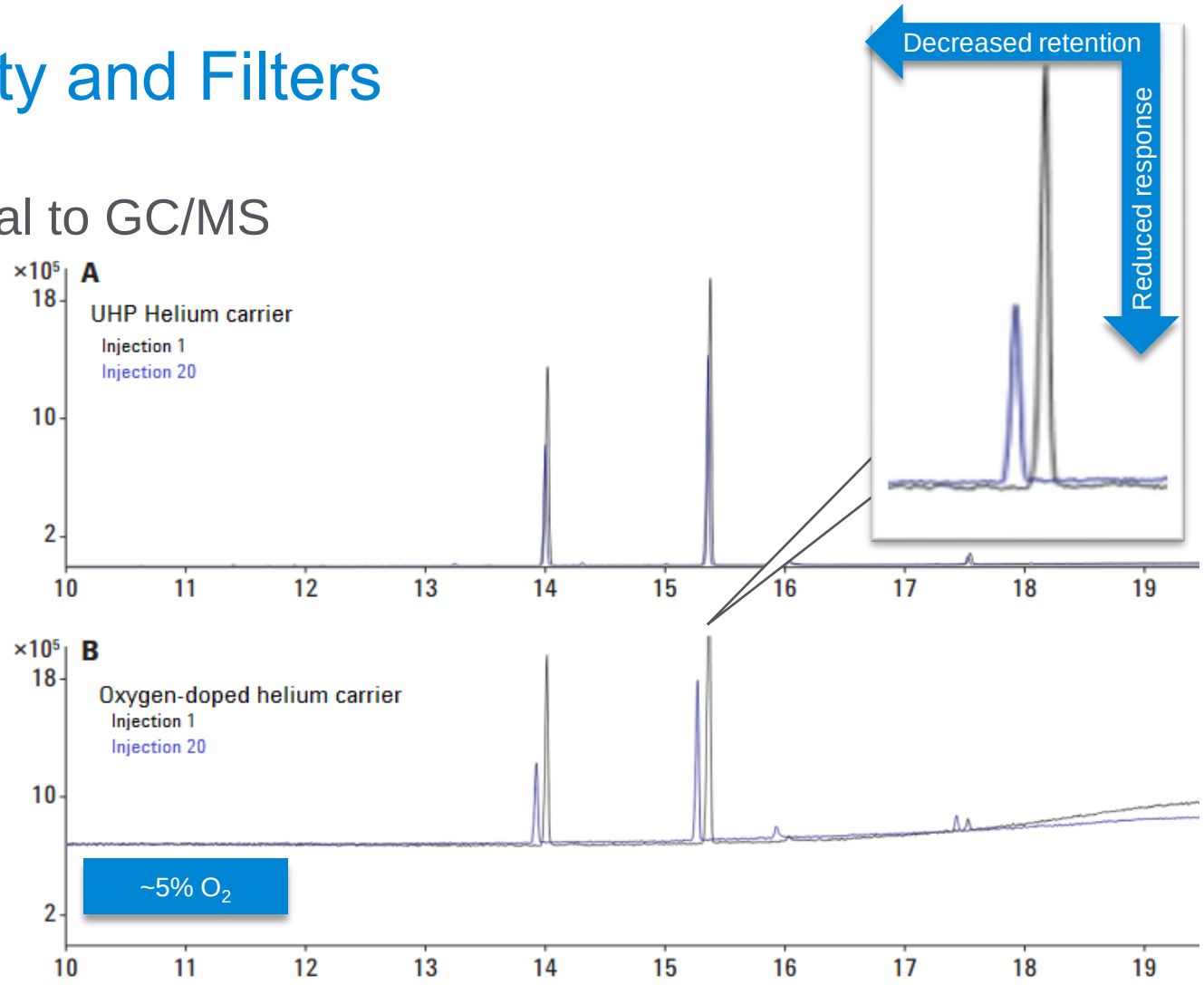
What kind of system baselines?

- System blank – Should only see a rise in baseline with temperature (column bleed)
- Solvent blank – May contain contaminant peaks (for example, phthalates, siloxanes)
  - Best practice: Use the same bottle of solvent that was used for any dilutions/extractions
- Known standard – GC/MS checkout standard, DFTPP tuning mix, or known calibration standard at easily detectable level for your system (for example, 1-10 ppm)

Let's Talk About Gas Quality and Filters

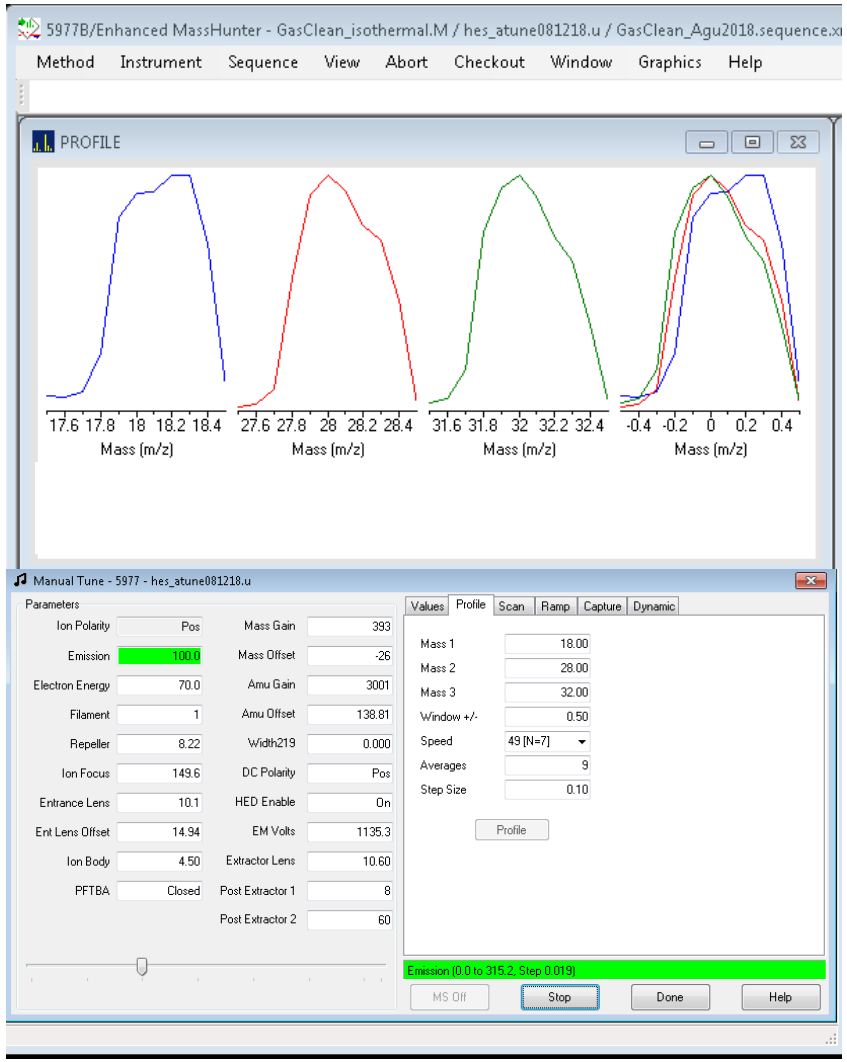
- Oxygen in carrier gas is detrimental to GC/MS
  - Reduced response
  - Elevated background
  - Irreversible column damage
  - Impaired electron multiplier functior
  - Premature filament, liner lifetime

- Use UHP carrier gases
  - 99.9995% or greater
- Use Gas Clean carrier gas filters



GC/MS filter
Agilent p/n
CP17973

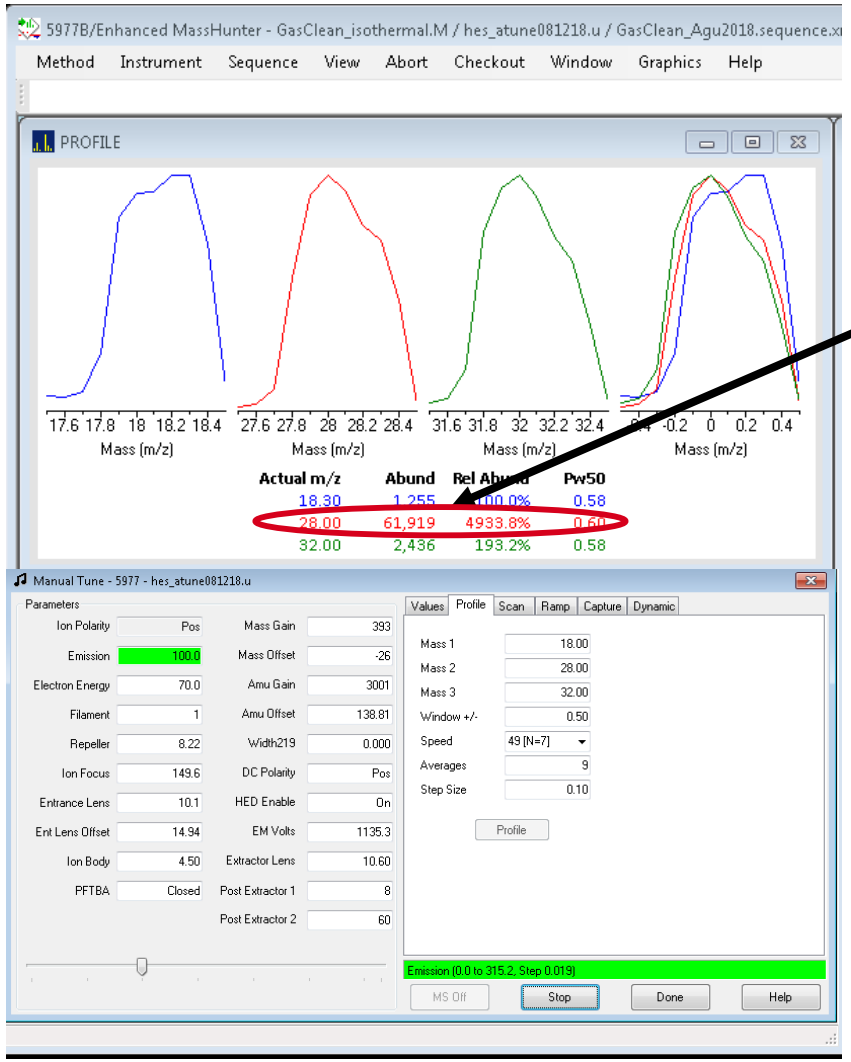
I Have Gas Filters and High-Quality Gas, but I Still Have a High Background



Use manual tune (before any experiments) to check for leaks/background

- Ions 18, 28, 32 m/z

I Have Gas Filters and High-Quality Gas, but I Still Have a High Background



Use manual tune (before any experiments) to check for leaks/background.

- Ions 18, 28, 32 m/z

60,000 counts for N_2 is definitely high

What to check:

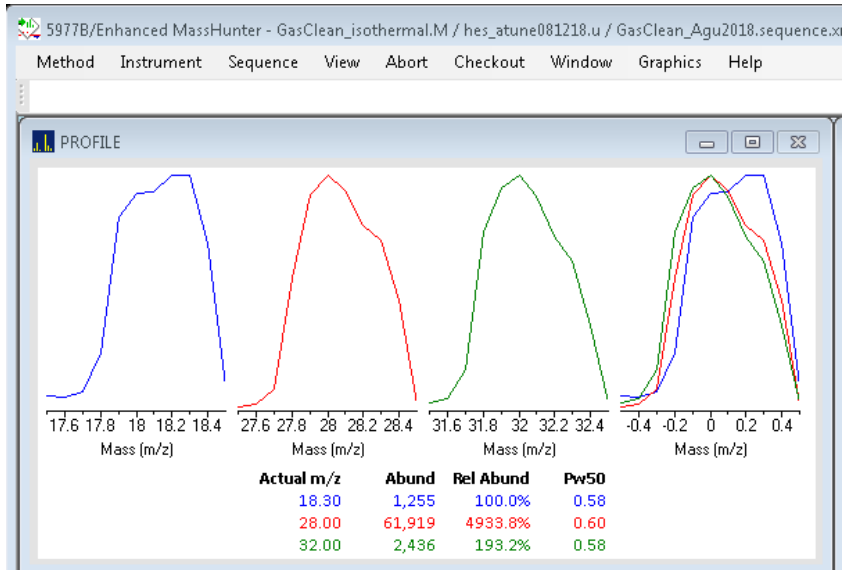
1. Verify gas fittings are leak-free

   Water/methanol mixture (external to GC/MS **only**)

   Leak detector

Agilent G3388B leak detector

I Have Gas Filters and High-Quality Gas, but I Still Have a High Background



Use manual tune (before any experiments!) to check for leaks/background.

- Ions 18, 28, 32 m/z

60,000 counts for N_2 is definitely high

What to check:

1. Gas line fittings (done)

2. Check the vent valve, MSD transfer line nut and side door

Use Leak Detector or Electronics Duster to Find Your Leaks

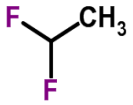
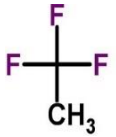
Why use a leak detector?

- High sensitivity
- Recommended for leak detection in gas plumbing and fittings

Agilent G3388B leak detector

link

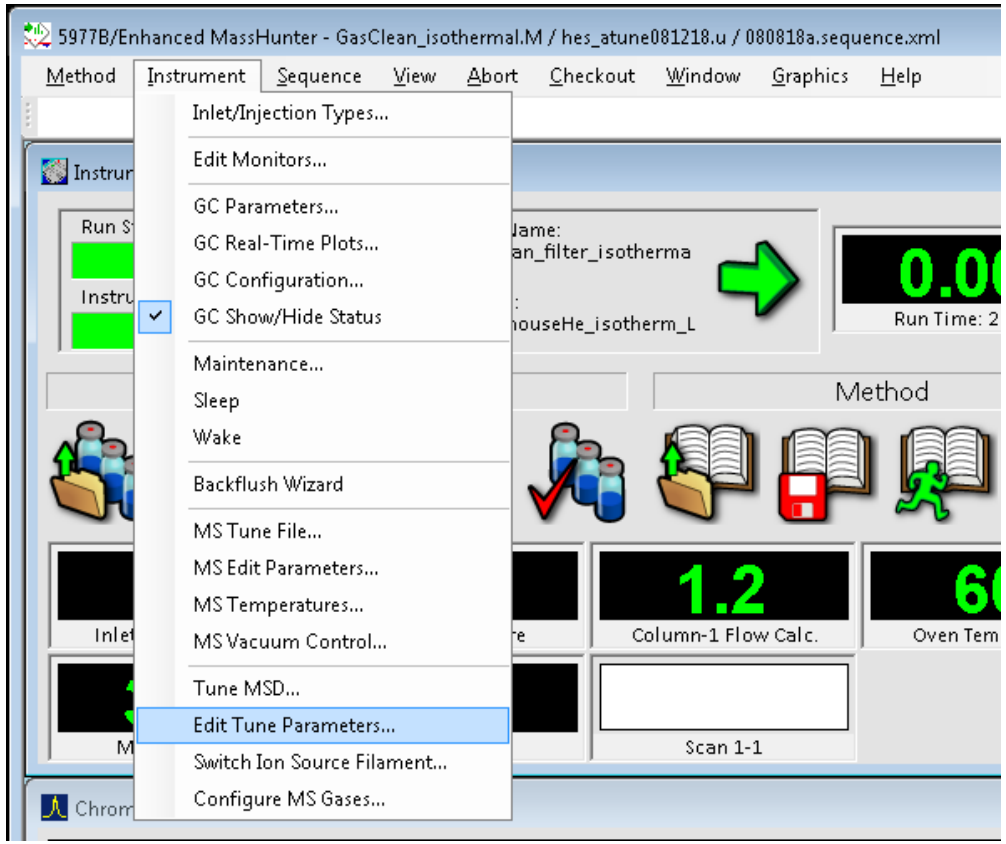
Typical Electronic Duster Components and Ions

	1,1-difluoroethane	*m/z* 51,65
	1,1,1-trifluoroethane	*m/z* 69
	1,1,1,2-tetrafluoroethane	*m/z* 69,83

Use electronics duster

- Hold can upright (don’t spray liquid)
- Spray short bursts around possible leak points
- “Live” tune profiling for ions to pinpoint leak

Using Electronics Duster to Find System Leaks: Manual Tune



MassHunter data acquisition

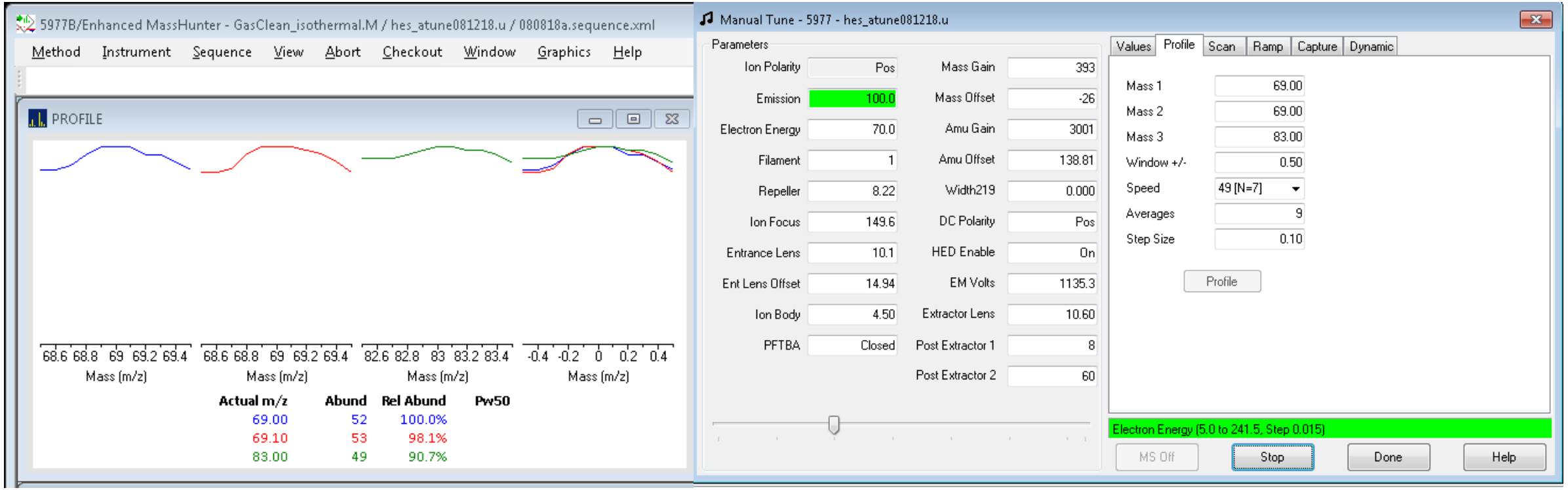
Navigate to MSD Manual Tune in the Data Acquisition

- Instrument > Edit Tune Parameters

Or

- View > Tune Vacuum Control
  - Parameters > Manual Tune

Using Electronics Duster to Find System Leaks: Manual Tune



- Use Profile tab to watch the main ions (69 and 83 m/z for my electronics duster)
- Spray short bursts at vent valve, transfer line, and side door

Check the Transfer Line Nut for Leaks

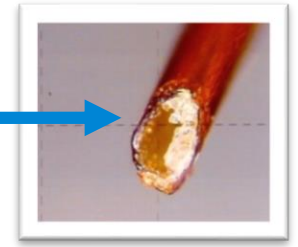
- Using a graphite/vespel ferrule
  - Install with the flat end of ferrule facing the MSD

- Nut “loosens” with heat cycles
- If you find a leak:
  - Tighten in small increments and then check again until no leak
  - Try to not overtighten the nut
    - If you have to apply a lot of pressure, vent and check the ferrule/threads

Be careful with the transfer line nut

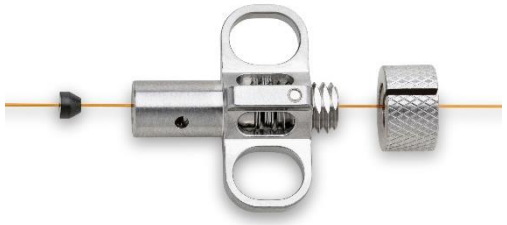
- Over-tightening damages transfer line threads, column
- Audible squeaking → over-tightening

Crushed end of column



Self Tightening Column Nuts: No Leaks, No Downtime, No Frustration

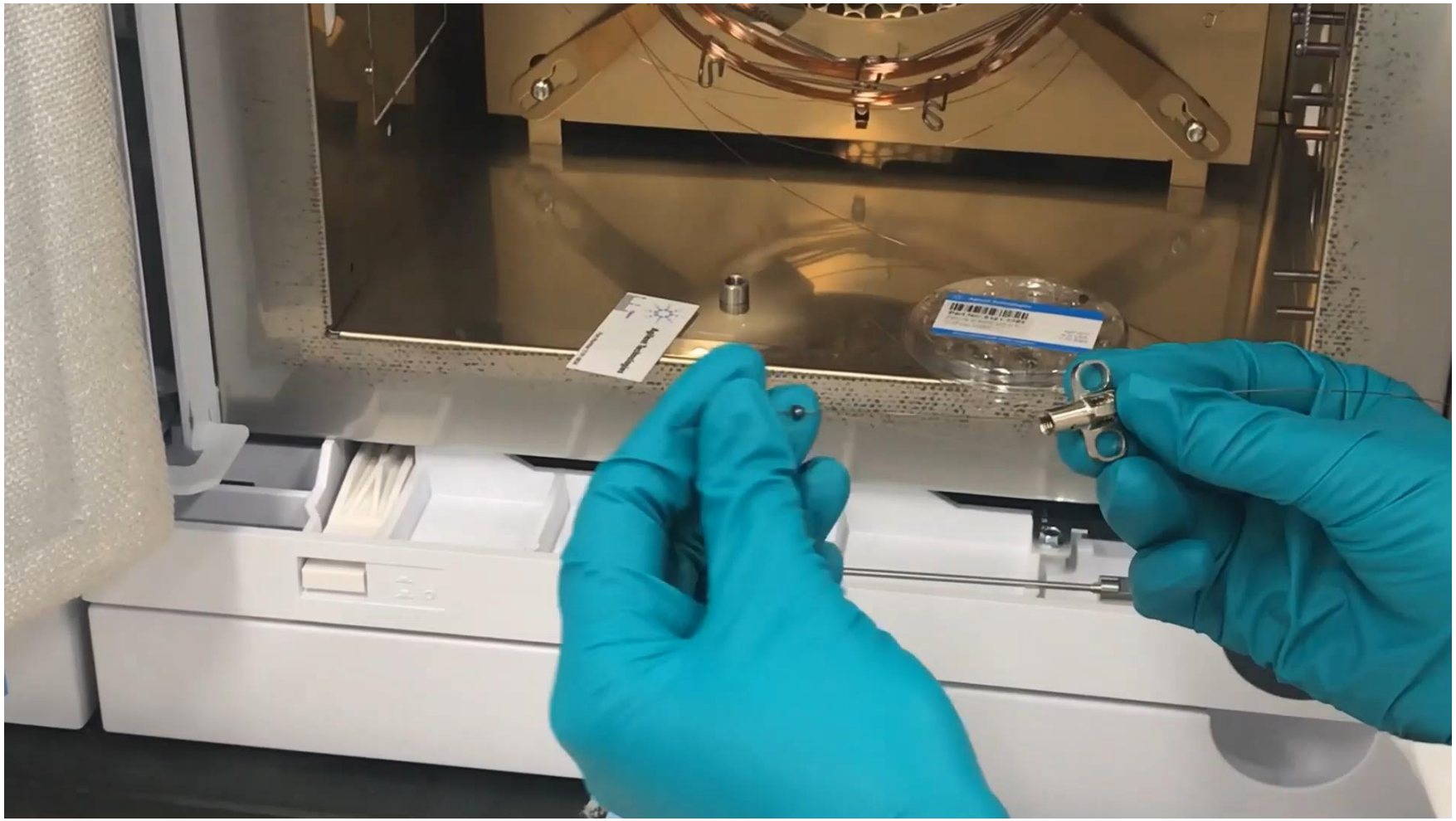
- Spring-driven piston continuously presses against ferrule
- Automatically retightens when ferrule shrinks
- Wing design for finger tightening
- Easier and faster to install
- Collar holds column in place
- No tools needed



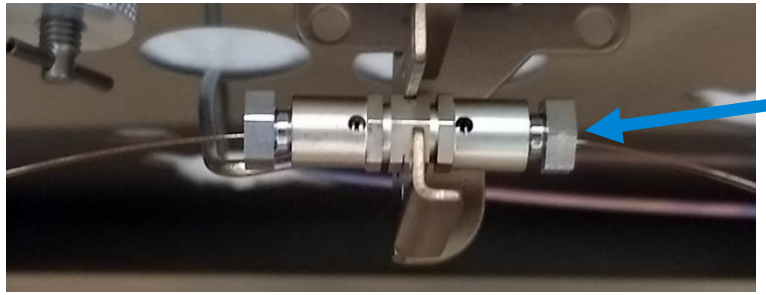
For mass spectrometry transfer line

For GC inlet or detector

Easier Installation into the Mass Spectrometer with the New Self Tightening Column Nut and Collar



Good Habit: Check Other Connection Points in the GC



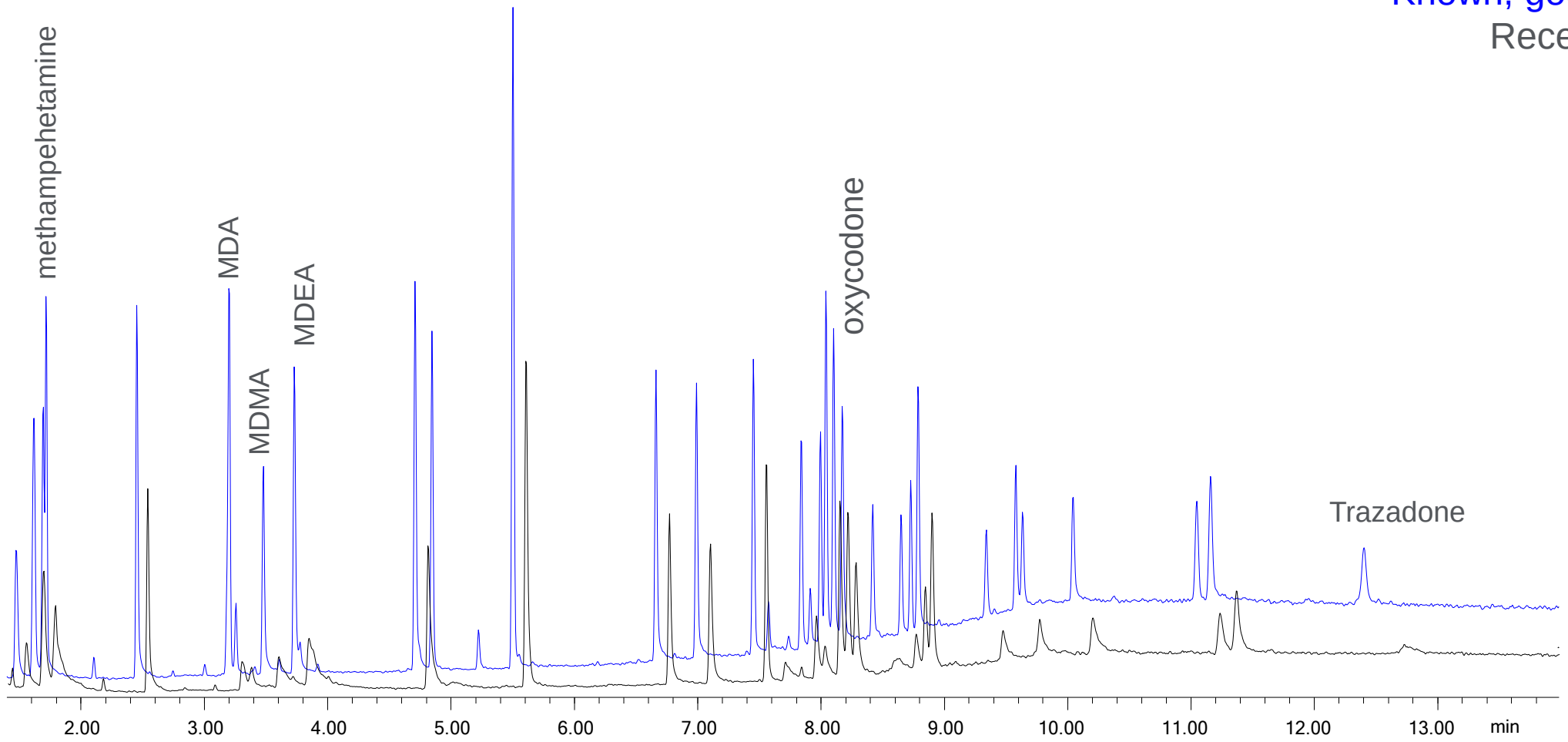
- Check the inlet
  - Installed with a quarter turn with a wrench
- Inlet nut may need slight tightening after heating cycles

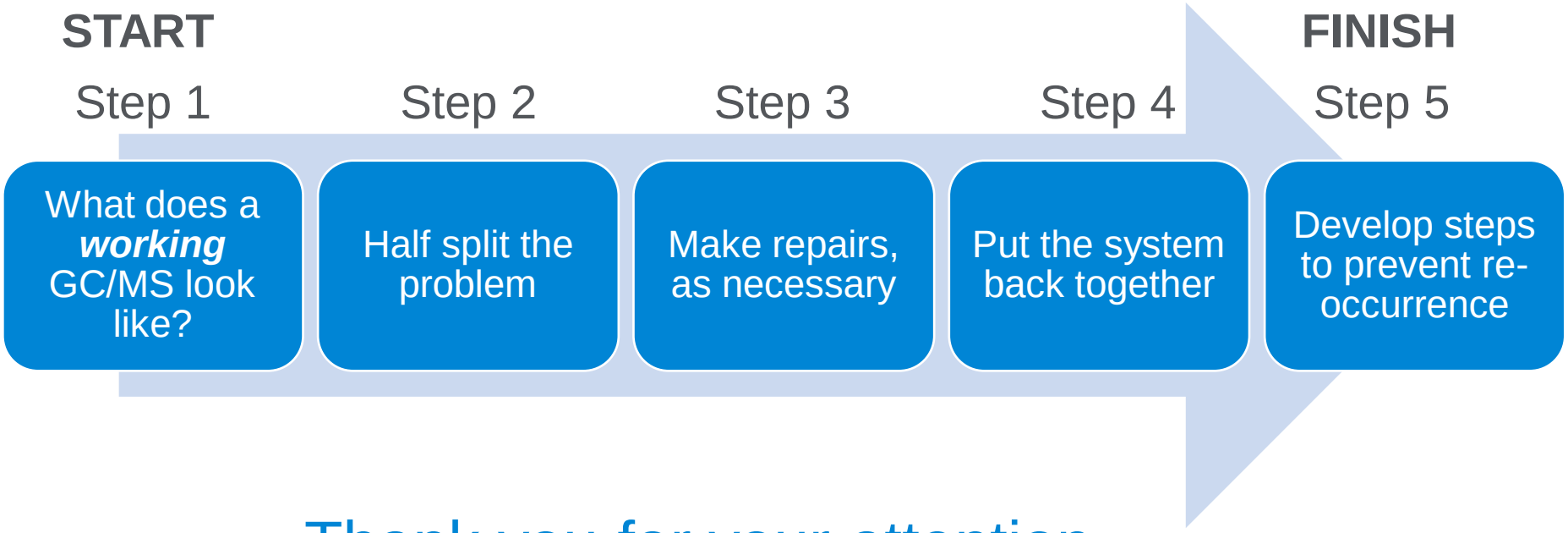
  - Or, preswage flexi-metal ferrules
  - Or, use Self Tightening column nut for inlet
    - Use graphite/vespel ferrules with self-tightening nuts

- Check CFT connections
- Use leak detector or electronics duster
  - Short bursts of electronics duster at each connection point

Remember to Do Pre-emptive Maintenance, so This Doesn't Happen to You

Known, good run
Recent run





Thank you for your attention

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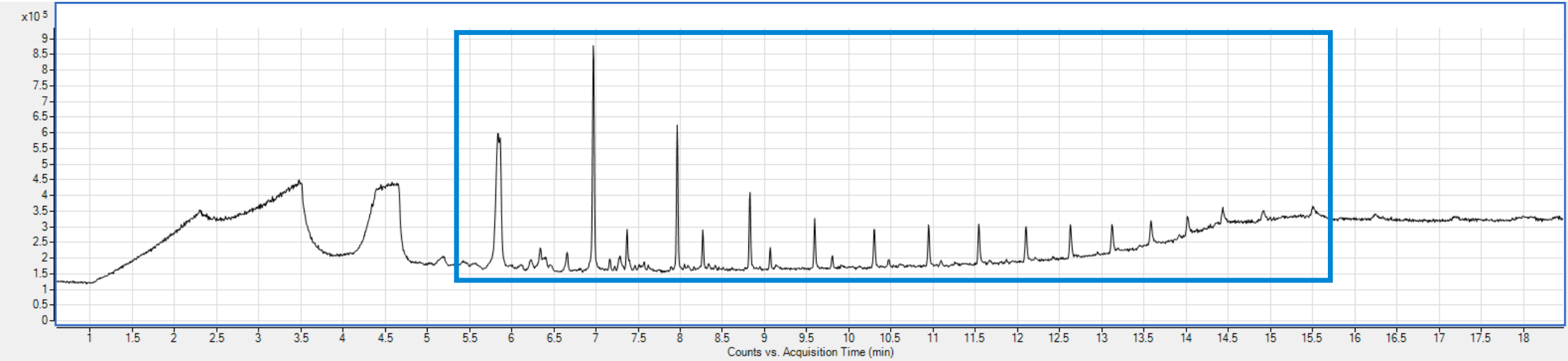
Switching Methods from High Flow Rates or Different Column Dimensions

Method translator

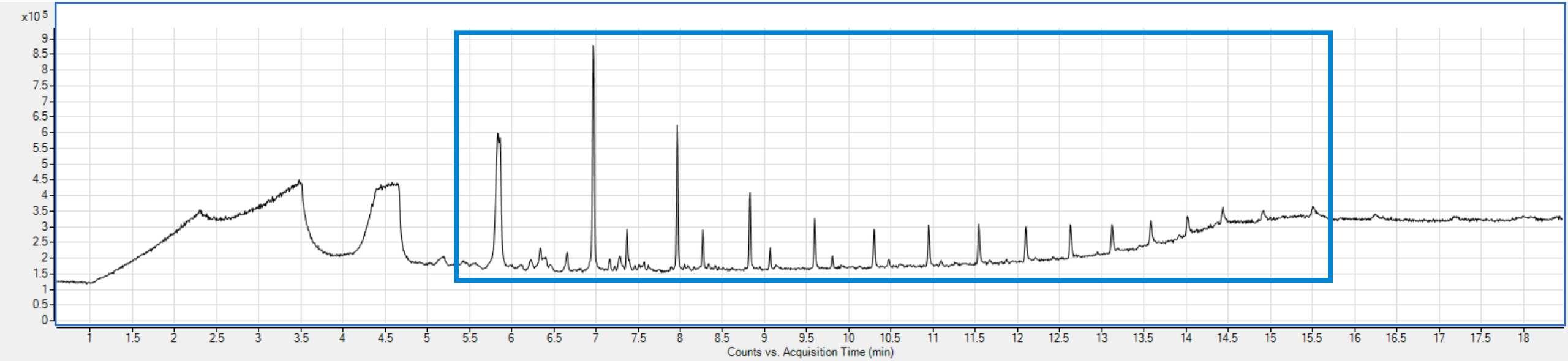
Too Many Peaks Case Study: What Are These Repeating Peaks?



Is it column bleed?

Are these peaks from my solvent?

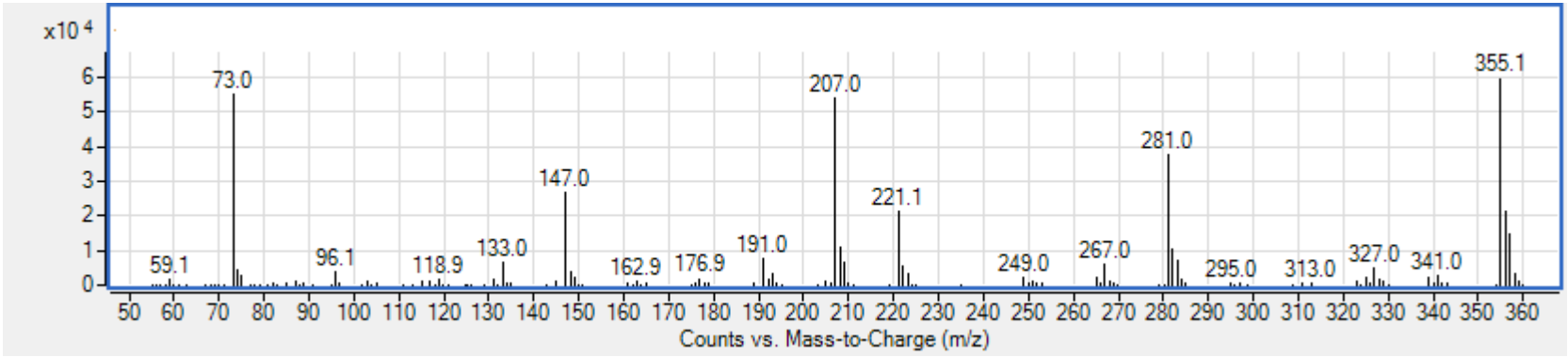
Septum Maintenance: TIC of an Inlet Septum



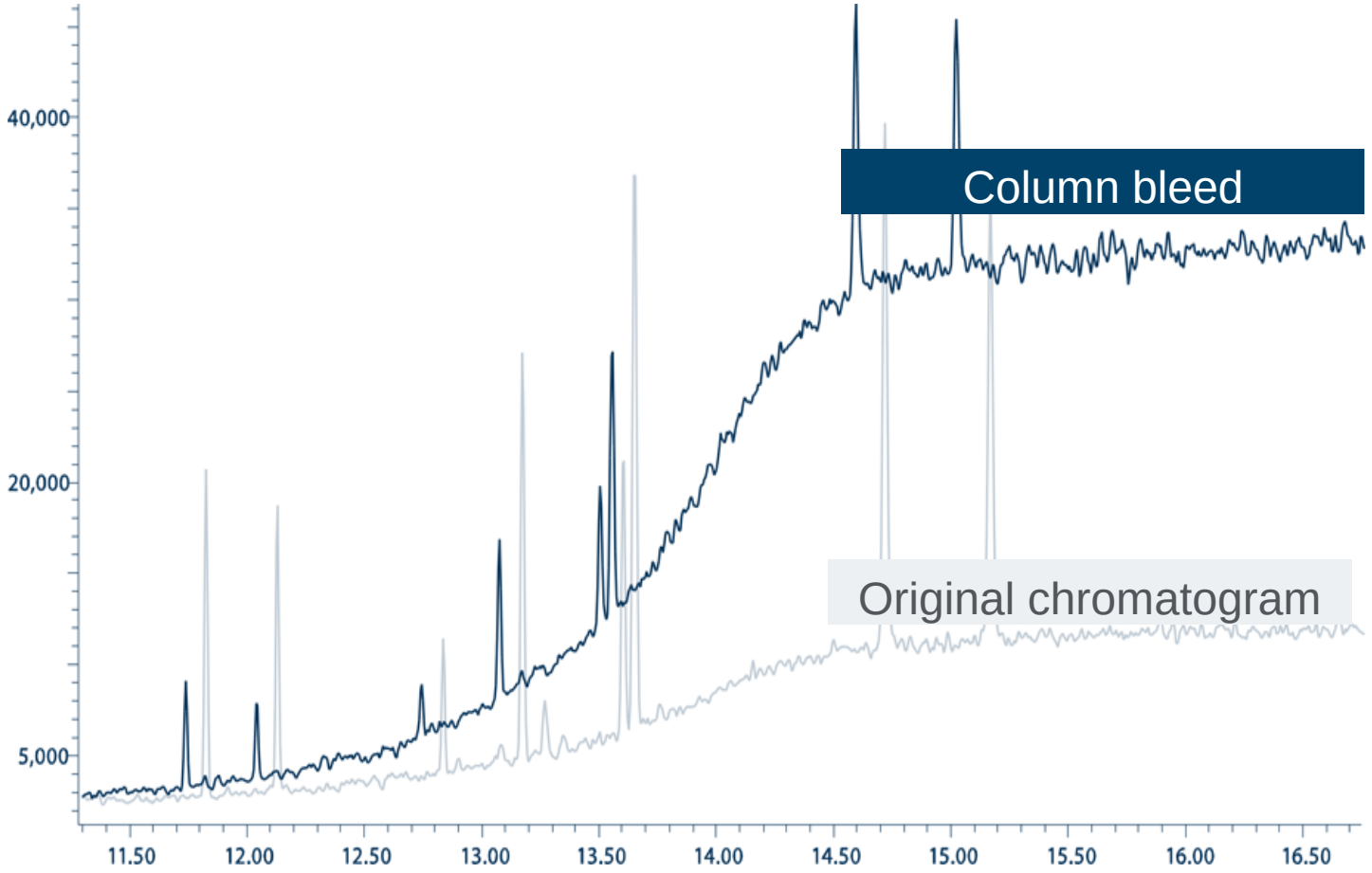
Common ions for siloxane molecules
73
147
207
281
355

Septa contamination in wash vials or inlet liners can be diagnosed by looking for siloxane polymers in your total ion chromatogram. Each peak in the chromatogram corresponds to a cyclized (ring structure) siloxane molecule. These molecules fragment with very similar patterns.

Example spectrum:



One Last High Background Discussion: Troubleshooting Column Bleed

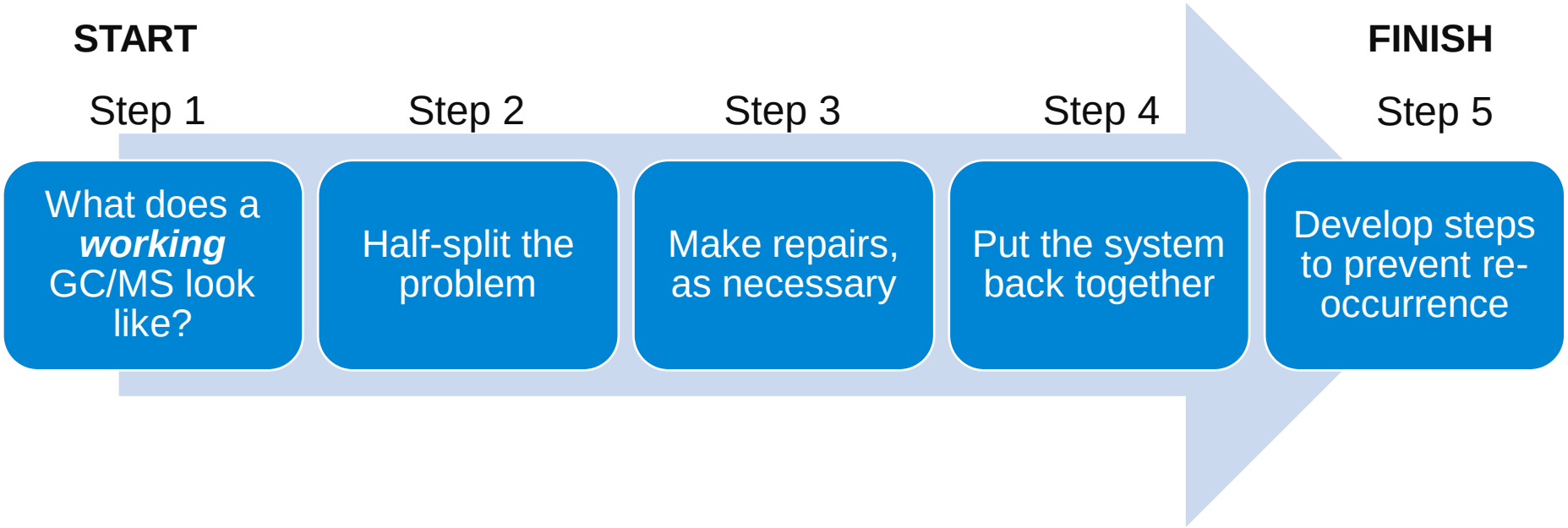


- Have you installed or conditioned the column?
- Are you exceeding the column's upper temperature limit?
- Is your column's film size too thick?
- Could leaks be present in your flow path, or are your carrier gases contaminated with air?
- Do you need to change your split vent trap?

Good habit: Save a chromatogram from immediately after the column was installed. Overlay the problematic chromatogram with your reference chromatogram to determine whether column bleed may be a problem.

What Steps Should I Follow When Troubleshooting?

Follow a Logical Troubleshooting Procedure



Troubleshooting Starting Points

Check parameters

- Do method parameters match what you see in/on the system

Autosampler

- Are sample/wash vials dirty or have particulates?
- Watch syringe moving/make an injection, or remove syringe and manually pull up solution.
- Try a manual injection to rule out the autosampler

Recent maintenance?

- Determine if users have completed normal maintenance recently
- Change liner, inlet septum, syringe, trim column

Quick MSD check

- Generate a tune report to see if the current tune is working. This does not change any parameters.

Sample you know

- Inject a checkout sample you know
- Do you observe the expected peaks in the expected sizes at the expected retention times?