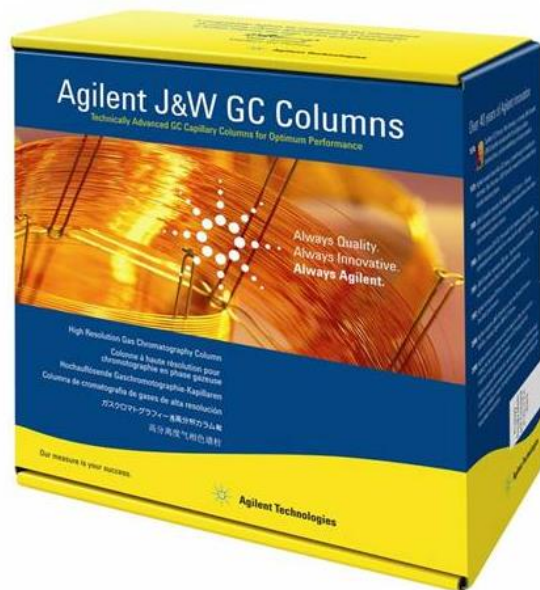


# GC Best Practices & Troubleshooting



# Troubleshooting Tips

## 1. Isolate the problem.

(Blank Runs, Inject Un-retained Compound, Know what it is not)

## 2. Change only one variable at a time.

## 3. Compare before/after chromatograms.

(Peak shape, response, retention, baseline rise, background, look for trends, etc.)



## 4. Make sure it makes sense to do what you're doing...

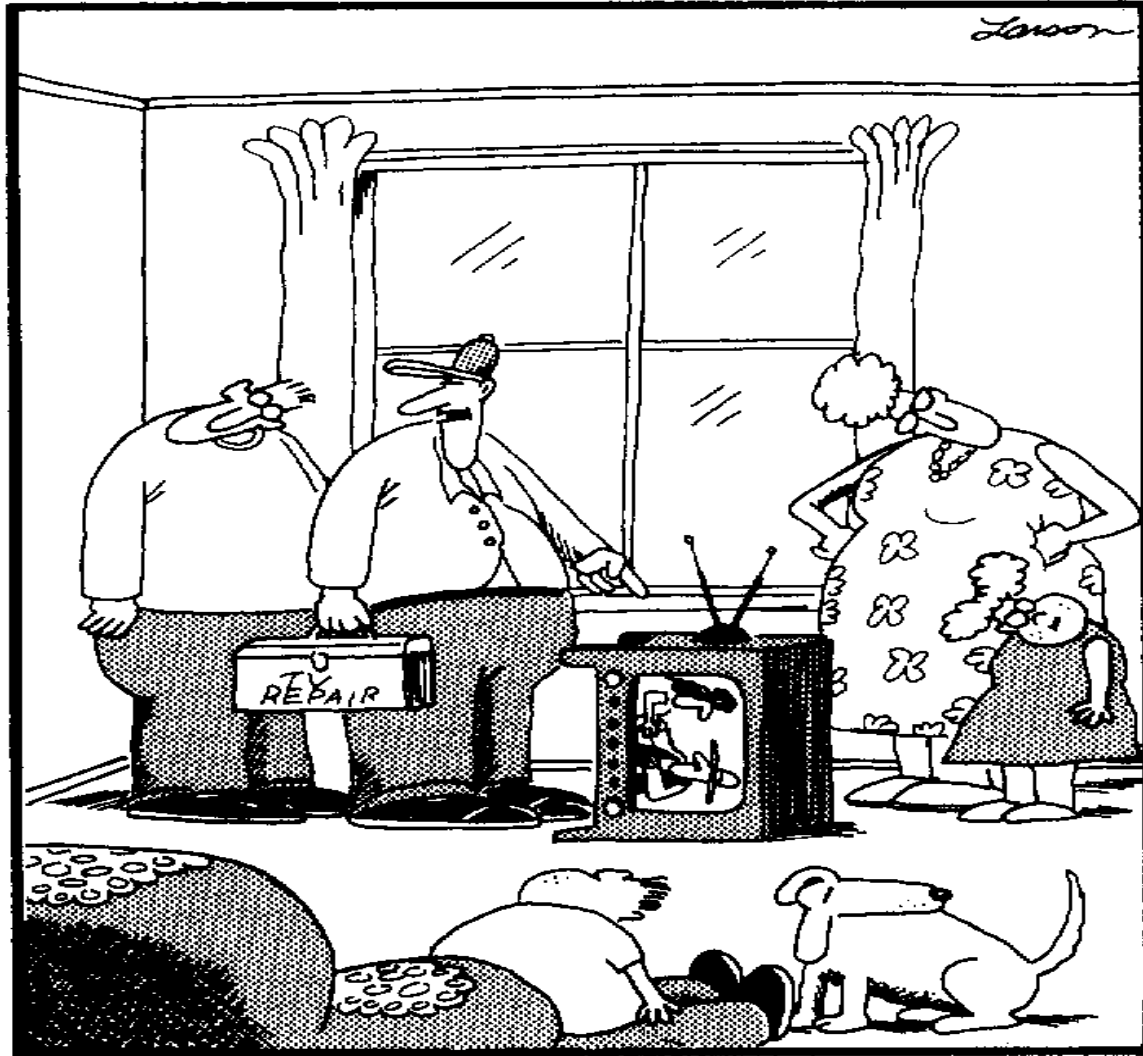


## 5. Be careful of distractions





## 6. Sometimes just a fresh set of eyes is all that is needed.



"Well, here's your problem, Mr. Schueler."



# What Can Possibly Go Wrong?

INJECTOR – contamination, flow settings, flow path issues, overload, valve settings, faulty consumables

COLUMN – contamination, flow settings, flow path issues, damage (activity & bleed), breakage

DETECTOR – contamination, flow settings, flow path issues, electronics

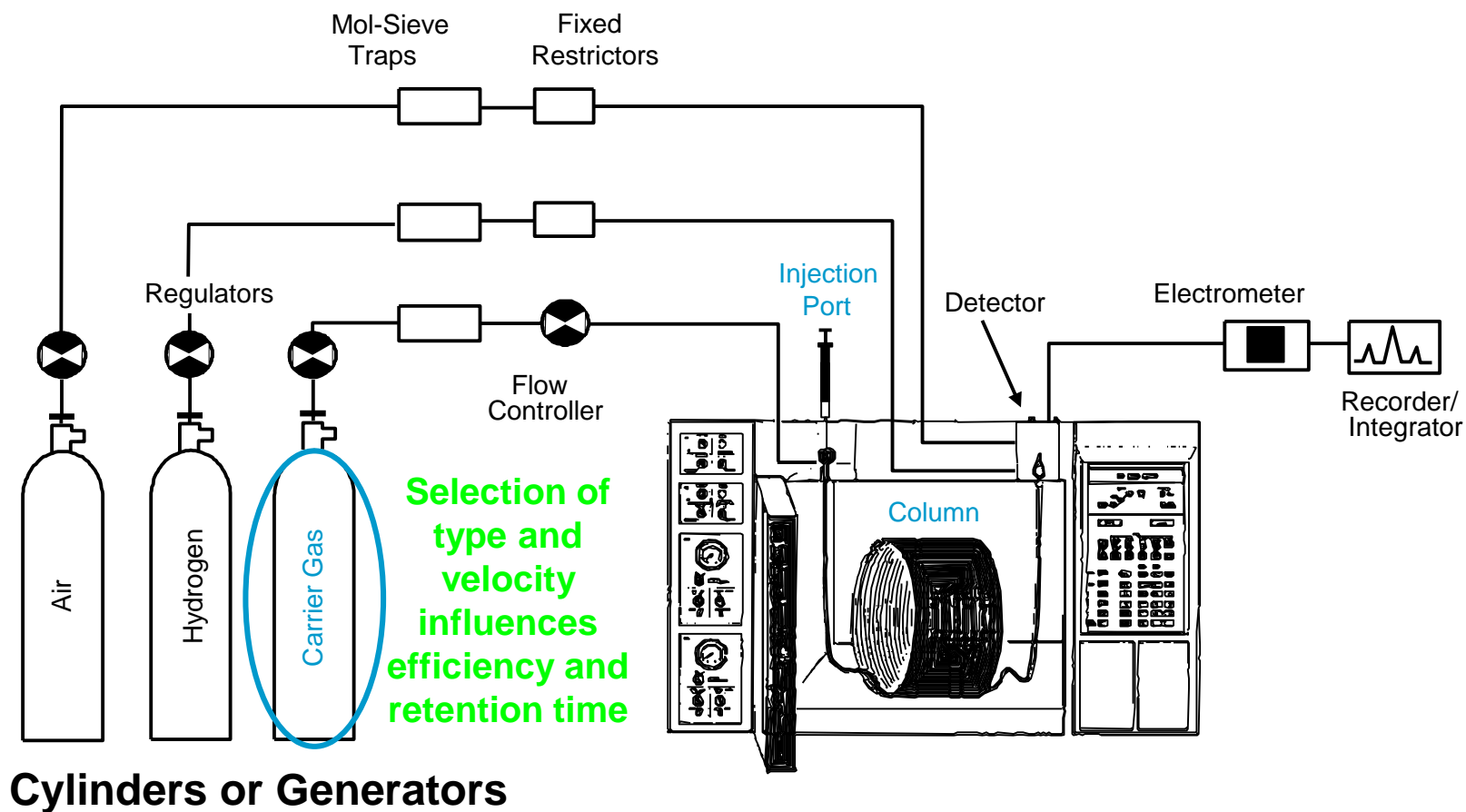


# Logical Troubleshooting

- **Troubleshooting Starts with Isolating the problem**
  - There are 5 basic areas from where the problem arises
    - FLOW
    - INJECTOR
    - COLUMN
    - DETECTOR
    - ELECTRONICS  
(Temperature)
  - But of course it can always be some COMBINATION
- **Knowing what can & can't cause the symptom is the key**

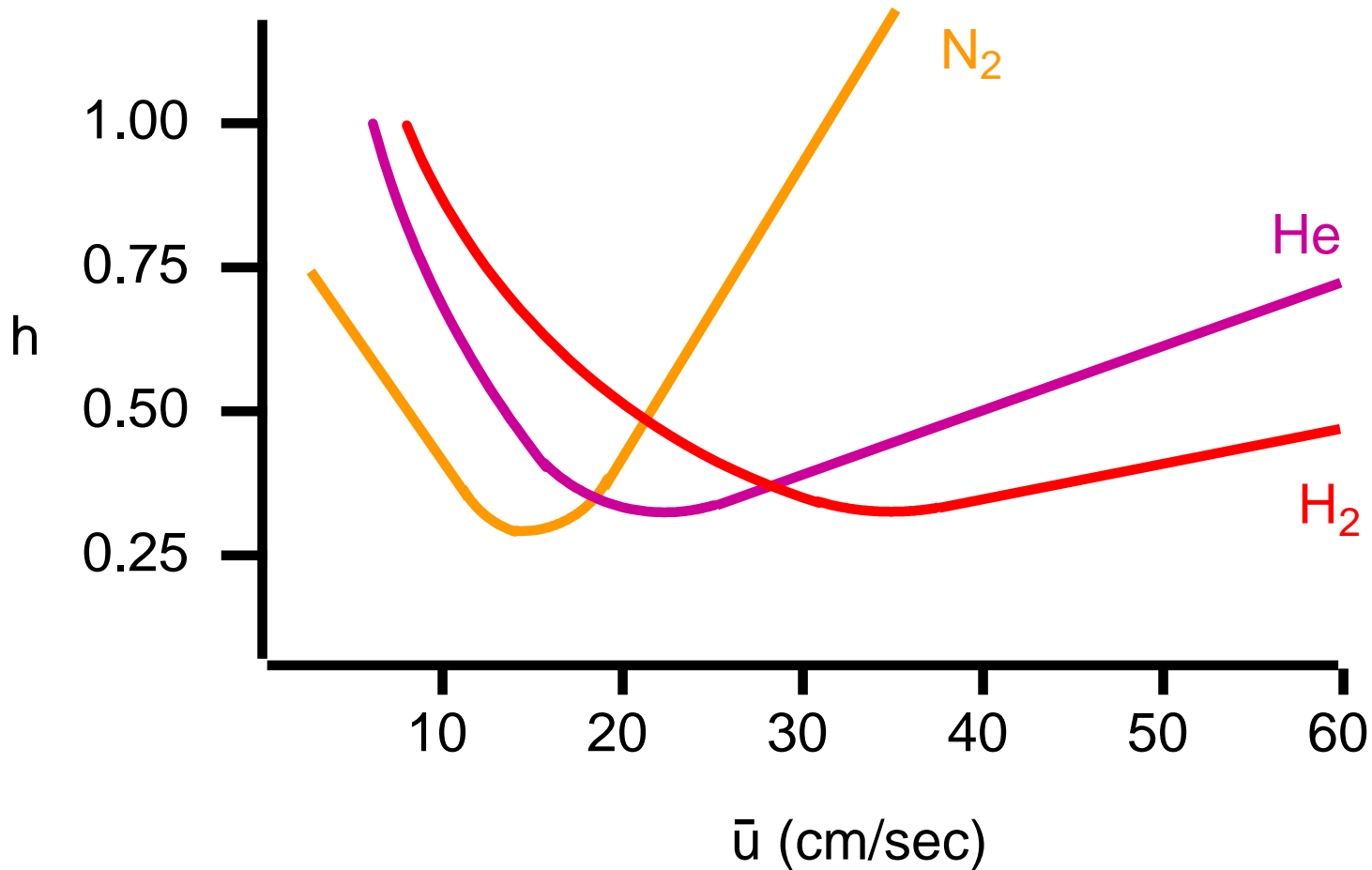


# Typical Gas Chromatographic System





# van Deemter Curves



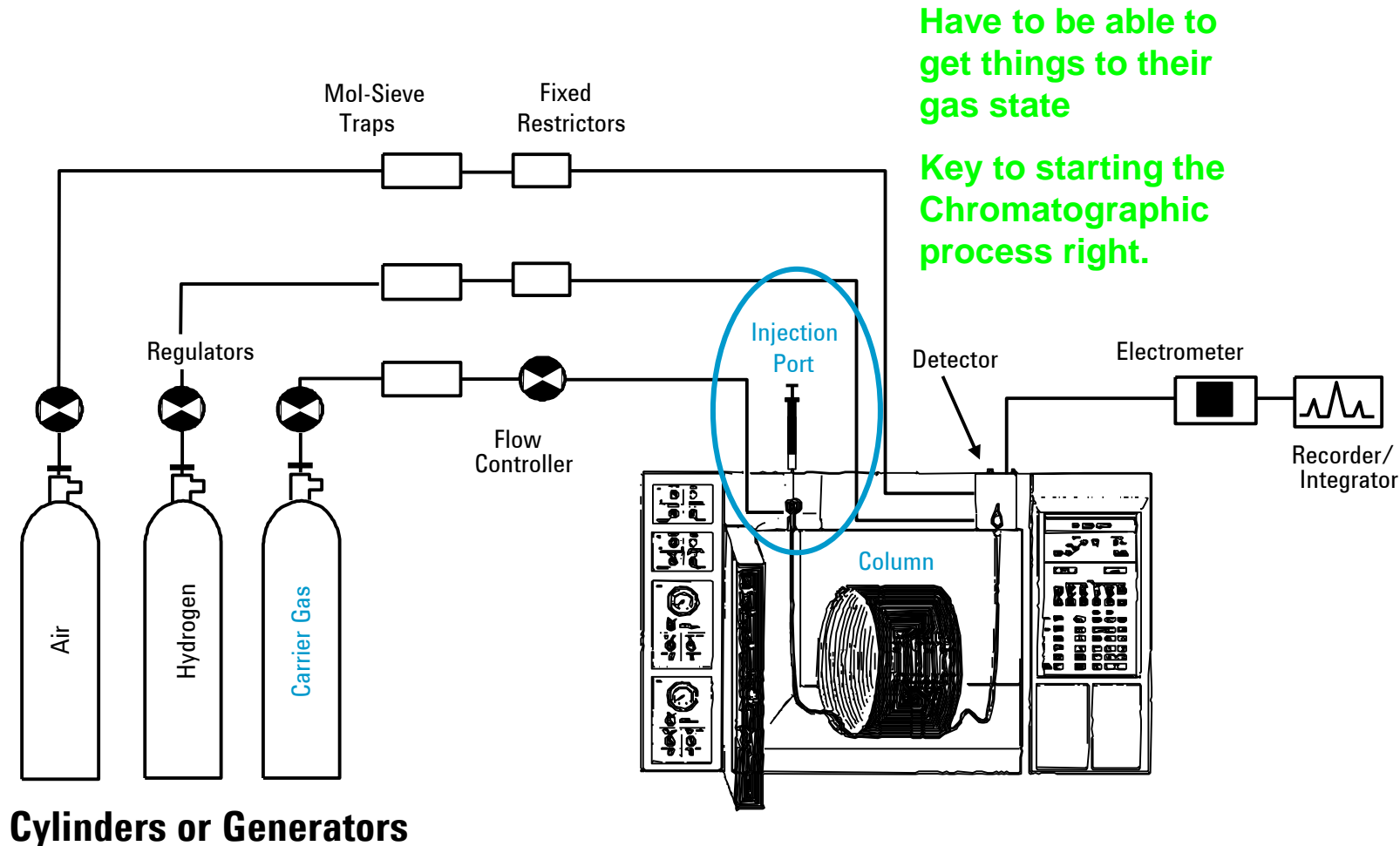
# CARRIER GAS

Type	Velocity Range ( $u_{\text{opt}}$ – OPGV)
Nitrogen	8-16
Helium	20-40
Hydrogen	30-55

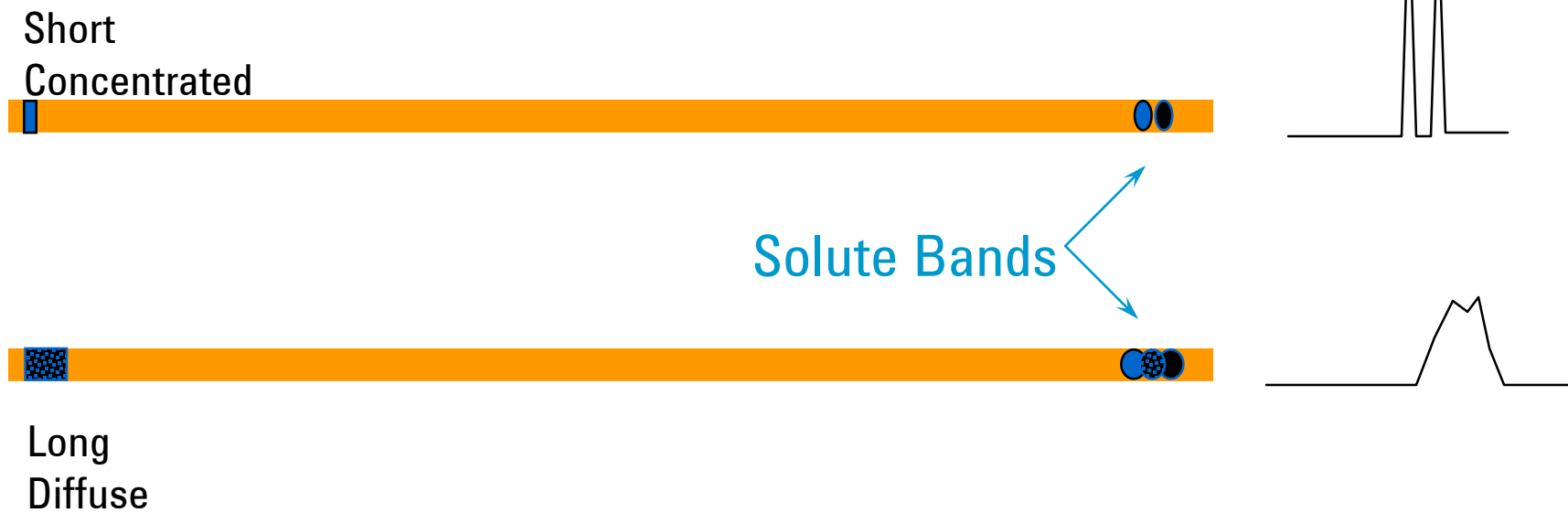
# Gas Clean Filters



# Typical Gas Chromatographic System



# Influence of Injection Efficiency



**Same column, same chromatographic conditions**

# Injectors

Split

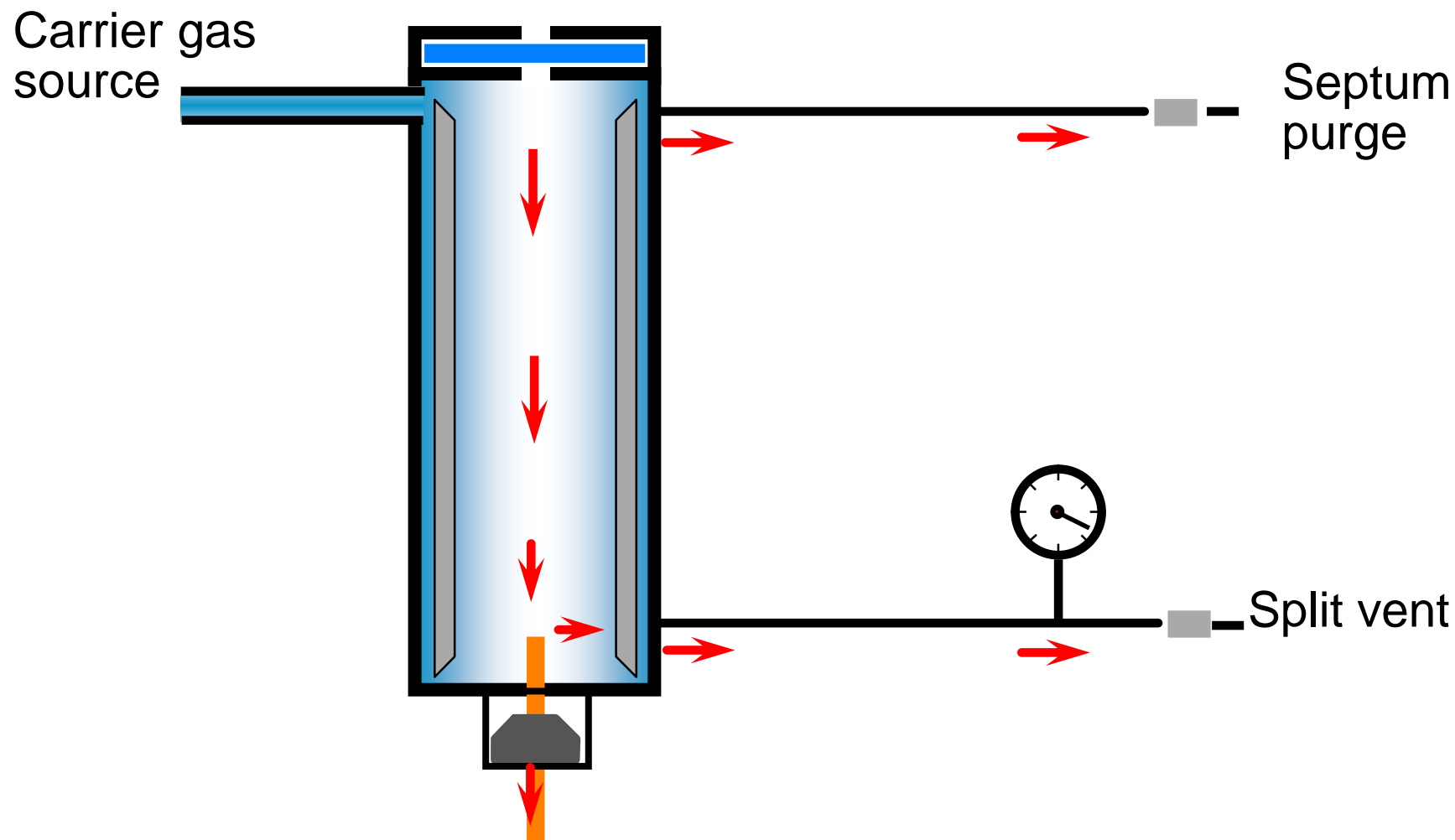
Splitless





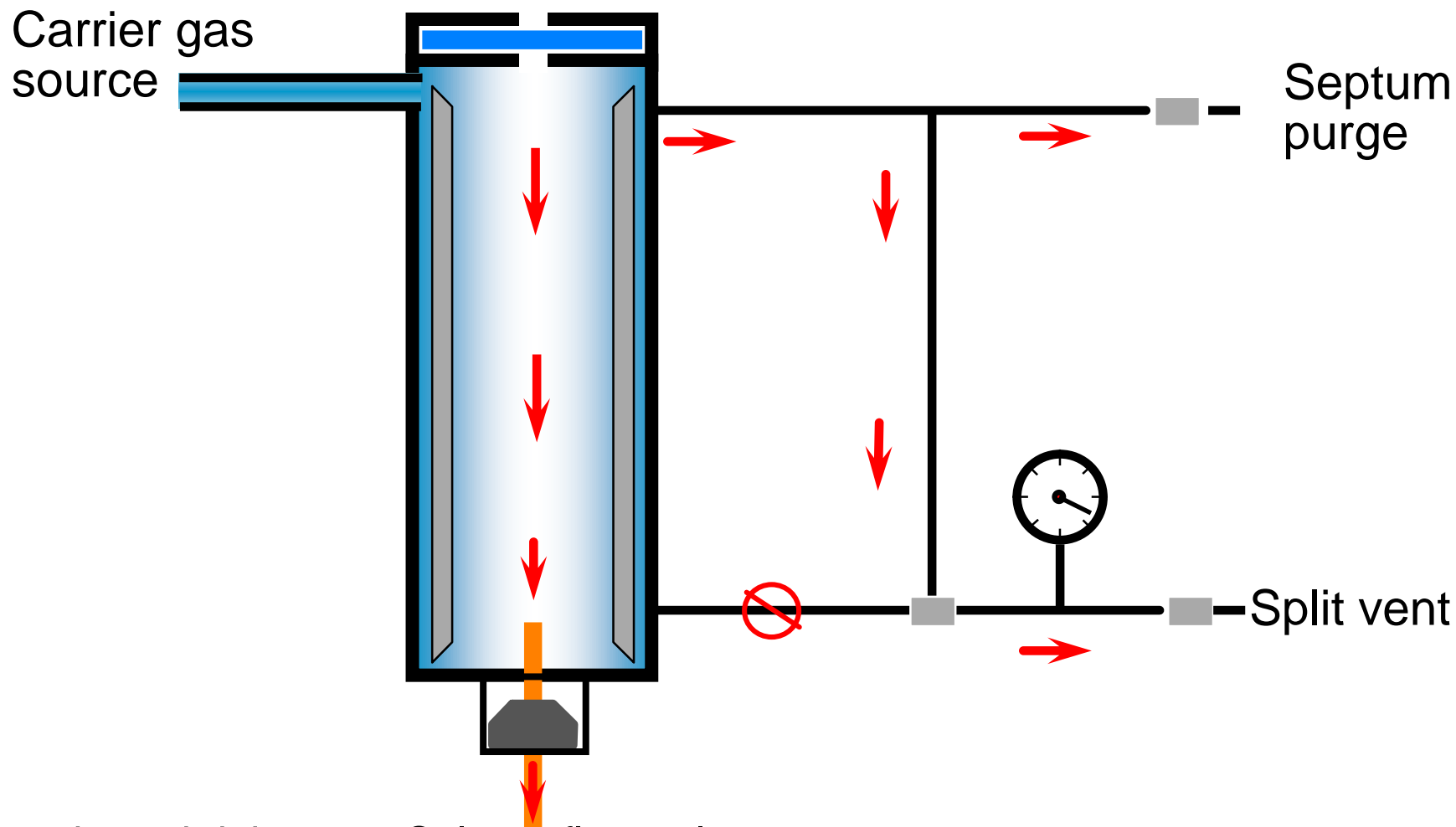
# Split Injector

## Flow Path



# Splitless Injector

## Purge Off At Injection



Flow through injector = Column flow only

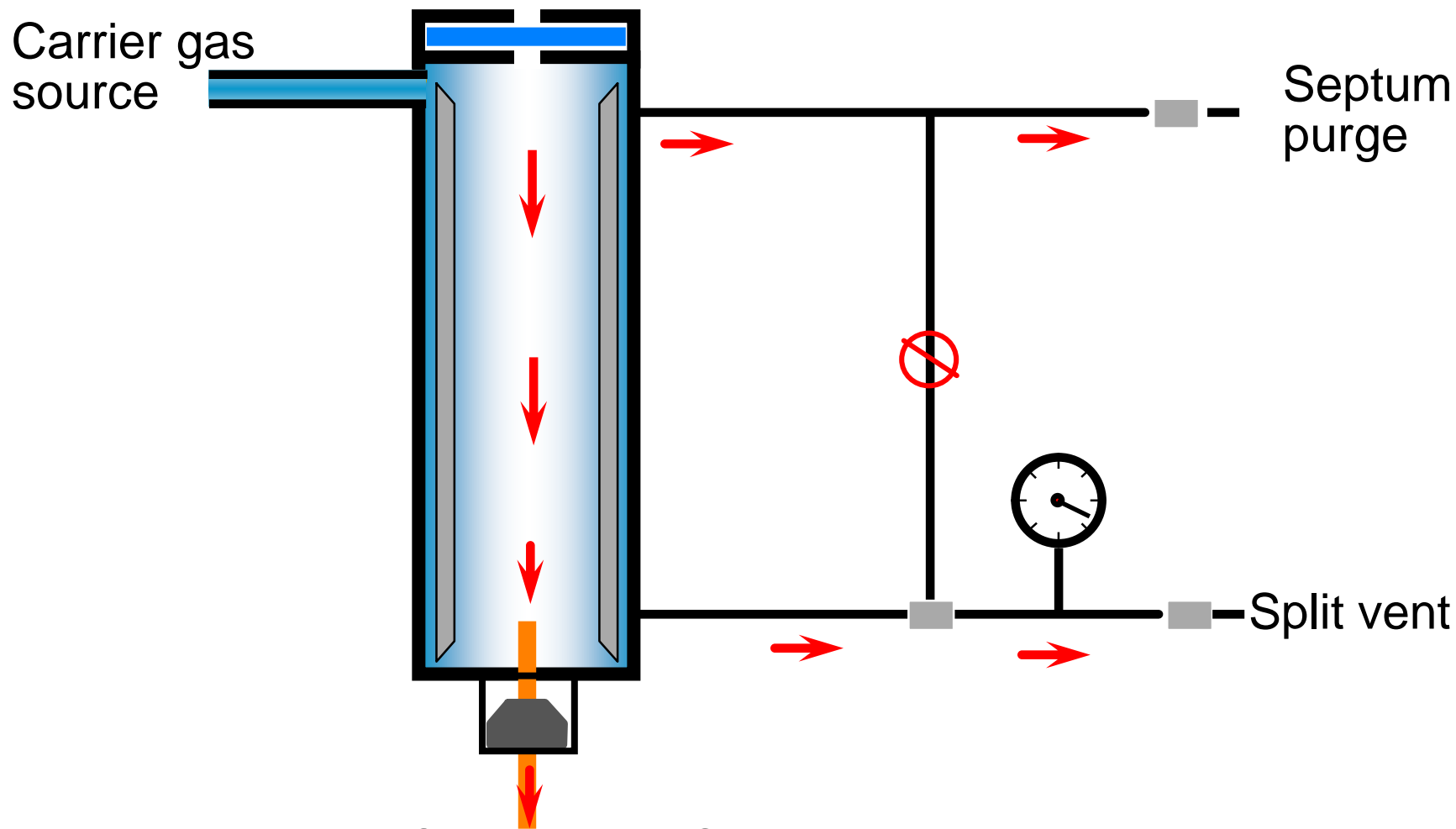


Agilent Technologies

Group/Presentation Title  
Agilent Restricted  
Month ##, 200X

# Splitless Injector

## Purge On After Injection



Flow through injector = Column flow + Split Vent Flow



Agilent Technologies

Group/Presentation Title  
Agilent Restricted  
Month ##, 200X

# Split Injector

## Major Variables

Split ratio - determines amount of sample onto column and efficiency of injection (sensitivity vs peak shape)

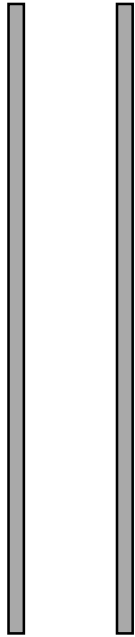
Liner - influences efficiency of vaporization/discrimination

Temperature - hot enough to vaporize sample without degradation or causing backflash

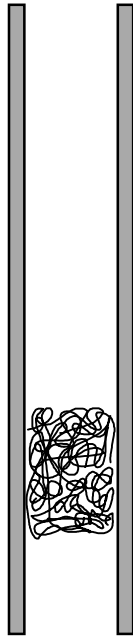
Injection volume - typically 1-3uL, increasing it does not have as much of an effect as one might think



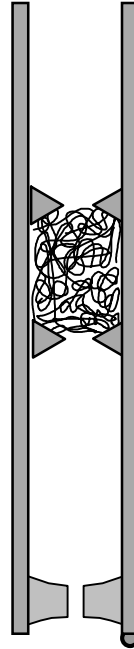
# Split Liners – What's What?



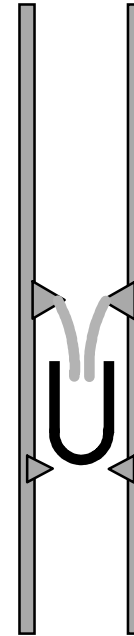
Straight  
tube



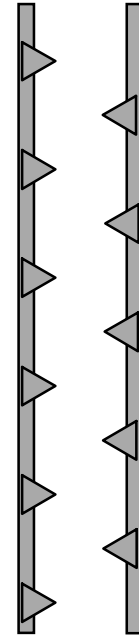
Straight  
tube with  
glass wool



Fixed glass  
wool



Inverted  
cup

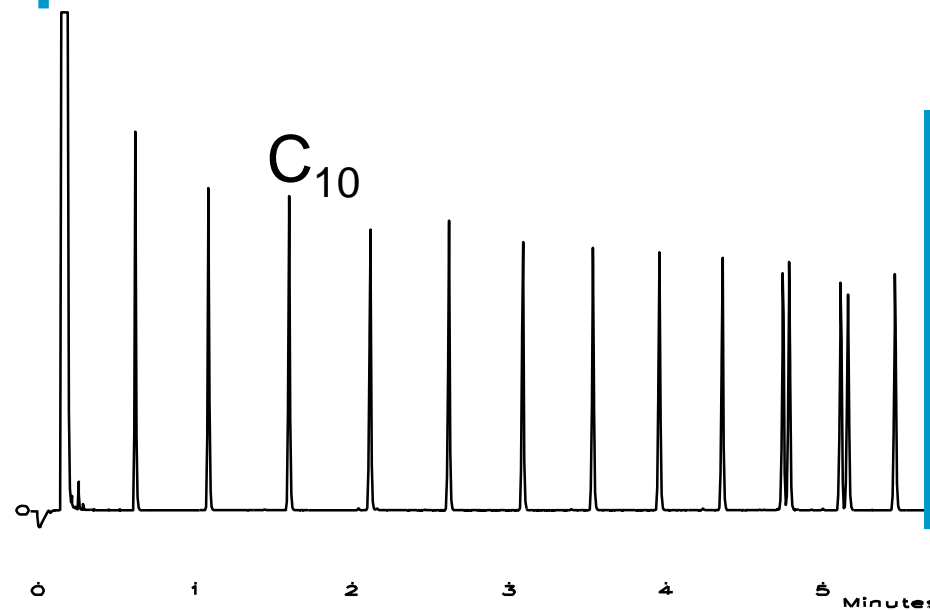


Baffle

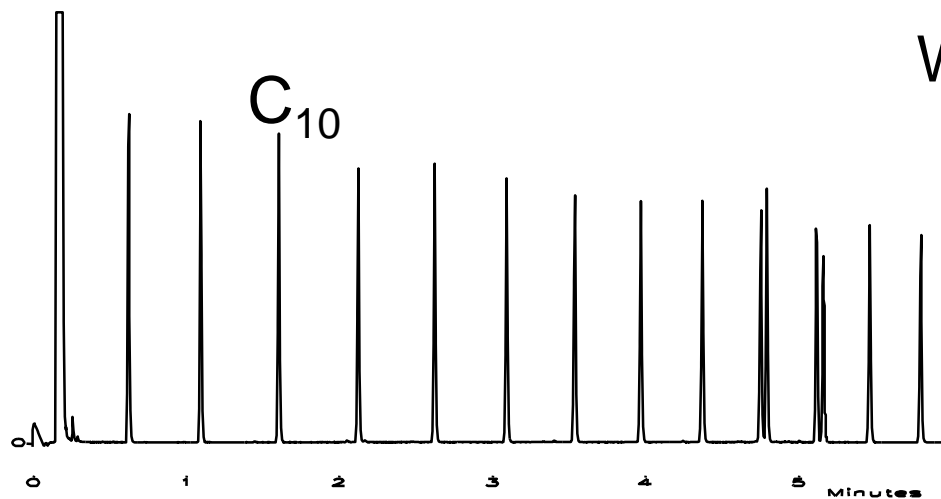


# Split Liner

Packed with Glass Wool



Without Glass Wool Packing



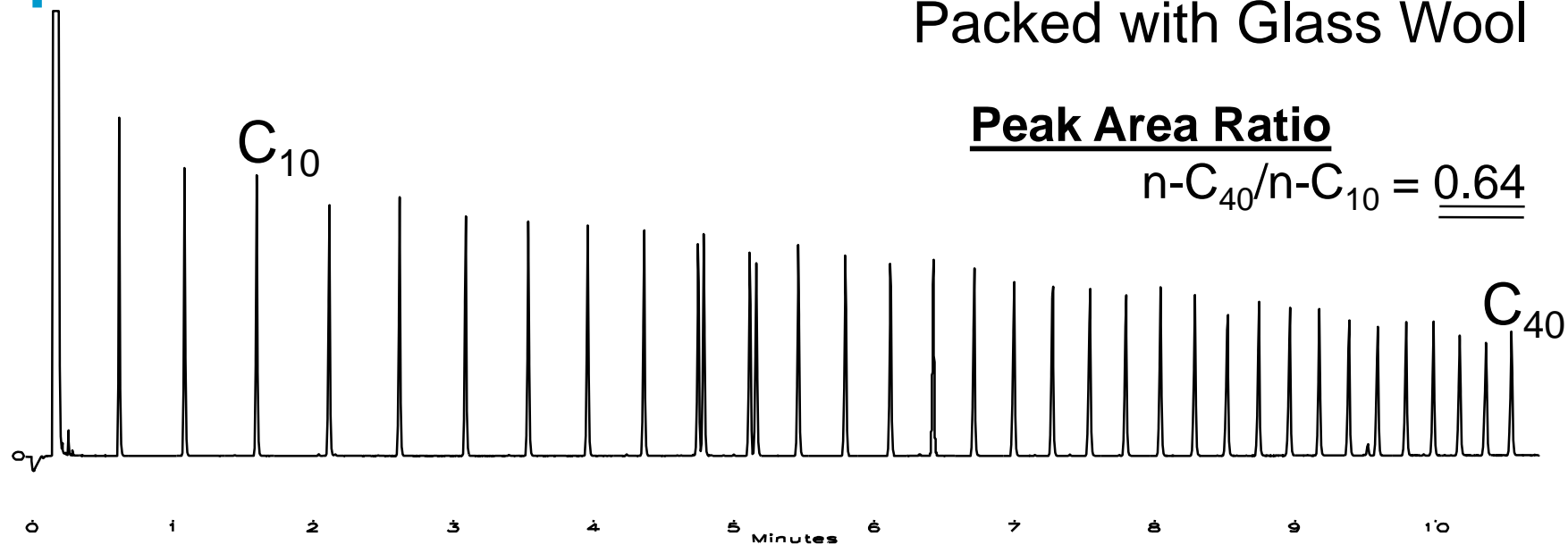


# Split Liner

Packed with Glass Wool

**Peak Area Ratio**

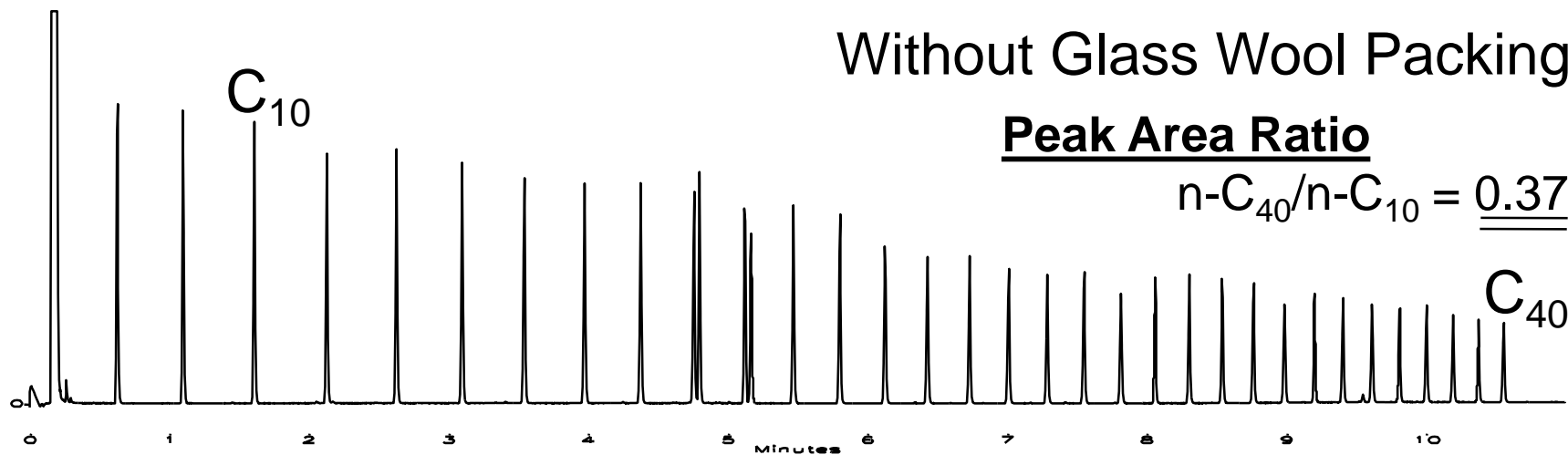
$$n\text{-C}_{40}/n\text{-C}_{10} = \underline{\underline{0.64}}$$



Without Glass Wool Packing

**Peak Area Ratio**

$$n\text{-C}_{40}/n\text{-C}_{10} = \underline{\underline{0.37}}$$



Agilent Technologies

Group/Presentation Title  
Agilent Restricted  
Month ##, 200X

# Splitless Injector

## Overview

Most of the sample is introduced into the column

Used for low concentration samples

Wider peaks are obtained than for split injections

# Splitless Injector

## Major Variables

Purge activation time - determines amount of sample onto column and efficiency of injection (sensitivity vs peak shape)

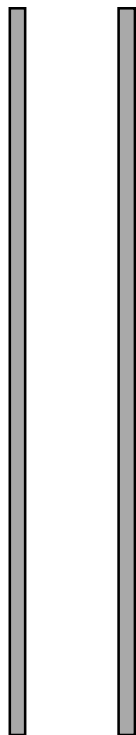
Liner - preventing backflash more critical than vaporization properties (double tapered type recommended)

Injection volume - typically 1  $\mu$ L or less (backflash)

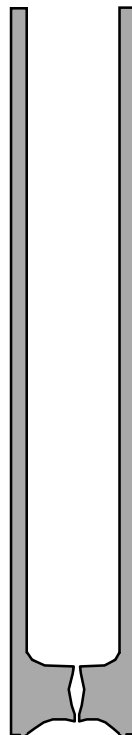
Temperature – long residence times allow for lower temps

# Splitless Injector

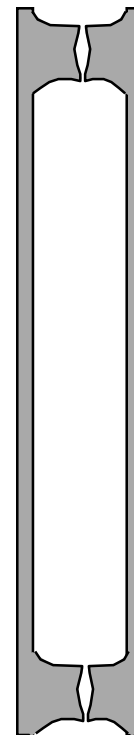
## Liners



Straight  
tube



Bottom  
restriction



Dual  
restriction



# Solvent Vapor Volume Calculator

Vapor Volume Calculator

**Solvent Properties**

Acetonitrile

Boiling Point (°C) : 81.6

Density (g/cm³) : 0.782

Mol Wt. (amu) : 41.05

**Injection Liner**

5183-4647 single-tapered sy

Liner Volume (μL) : 850

**Injection volume (μL)**

1.00

**Inlet Temperature (°C)**

250

**Inlet Pressure (gauge)**

12.08

☐ kPa ☒ psi ☐ bar

**Estimated Volume**

448 μL

**% Capacity**

52%

**Solvents**

Add Remove Defaults

**Liners**

Add Remove Defaults

Vapor Volume Calculator

Liner capacity exceeded! Choose a liner of greater volume or modify method parameters.

**Solvent Properties**

Water

Boiling Point (°C) : 100

Density (g/cm³) : 0.998

Mol Wt. (amu) : 18.02

**Injection Liner**

19251-60540 straight split

Liner Volume (μL) : 990

**Injection volume (μL)**

1.00

**Inlet Temperature (°C)**

280

**Inlet Pressure (gauge)**

14.993

☐ kPa ☒ psi ☐ bar

**Estimated Volume**

1243 μL

**% Capacity**

125%

**Solvents**

Add Remove Defaults

**Liners**

Add Remove Defaults

# Backflash (carry-over) can give false positives!



"You're fired, Jack. The lab results just came back, and you tested positive for Coke."

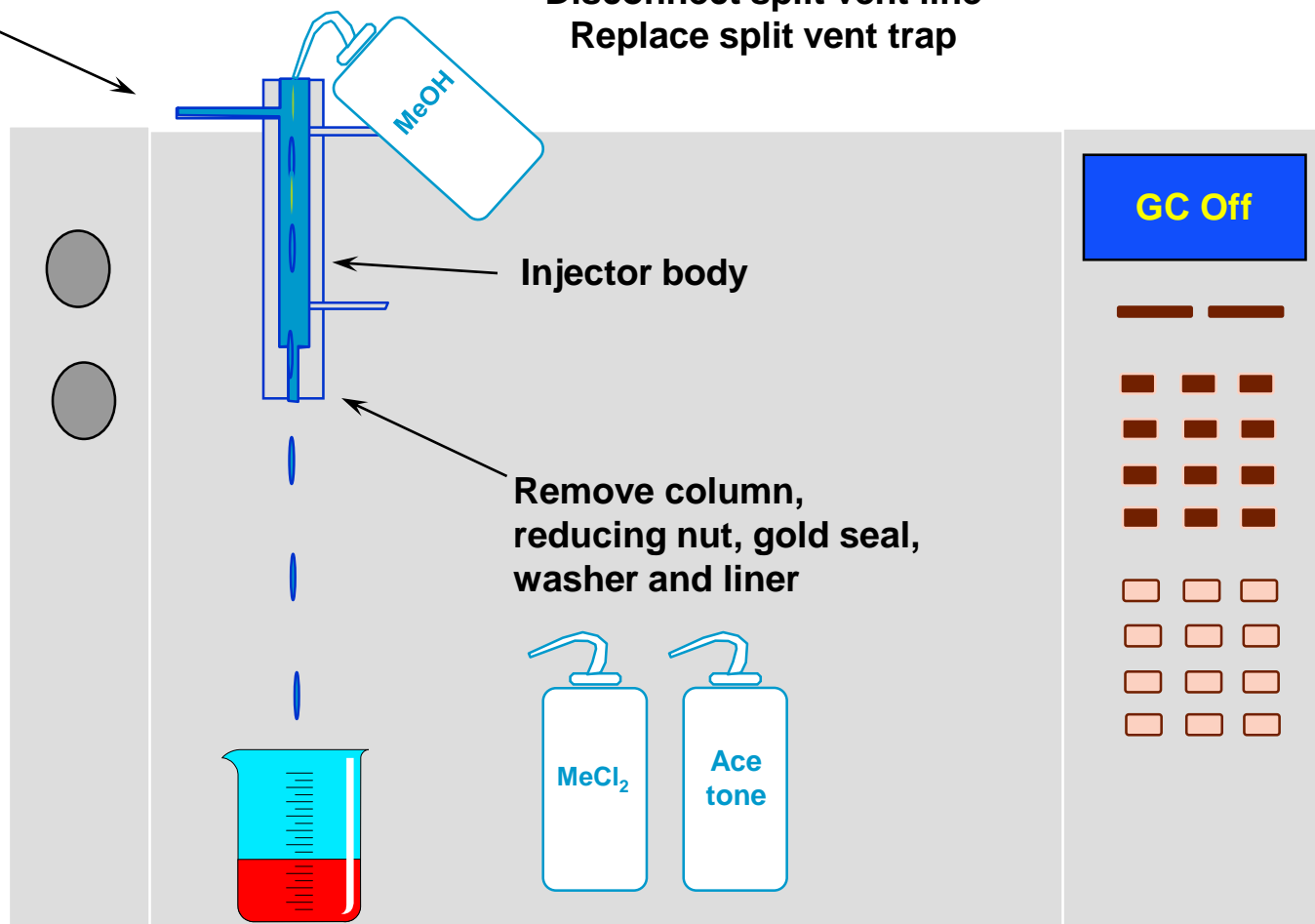




# Cleaning the Split/Splitless Injector

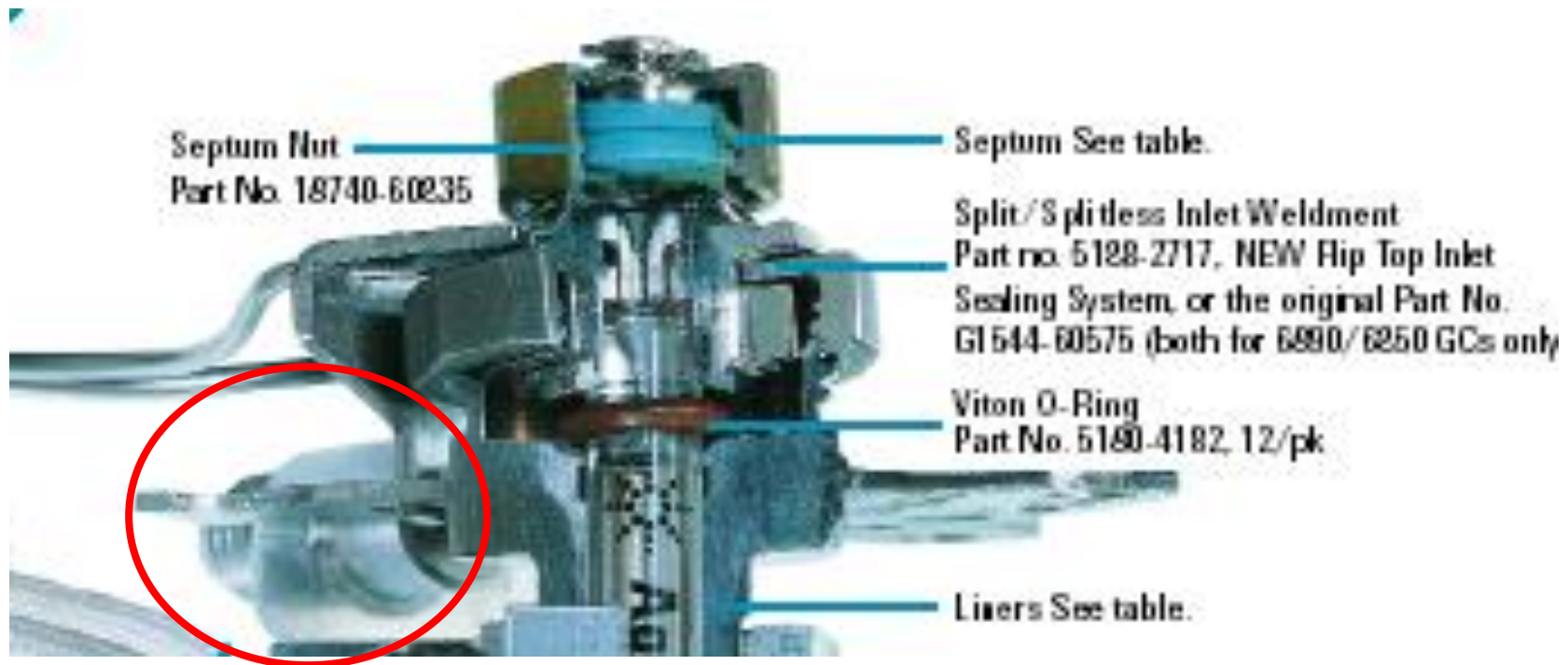
Carrier gas flow off

Disconnect split vent line  
Replace split vent trap



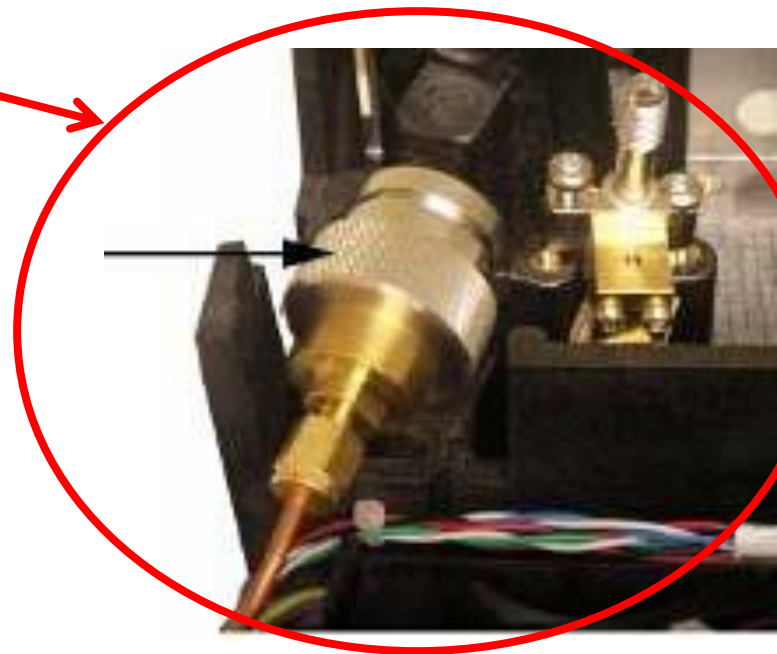
# Finding the Split Vent Trap

Follow the split vent line back to the EPC



# Finding the Split Vent Trap

Remove cover at Split Vent



# Replacing the Split Vent Trap

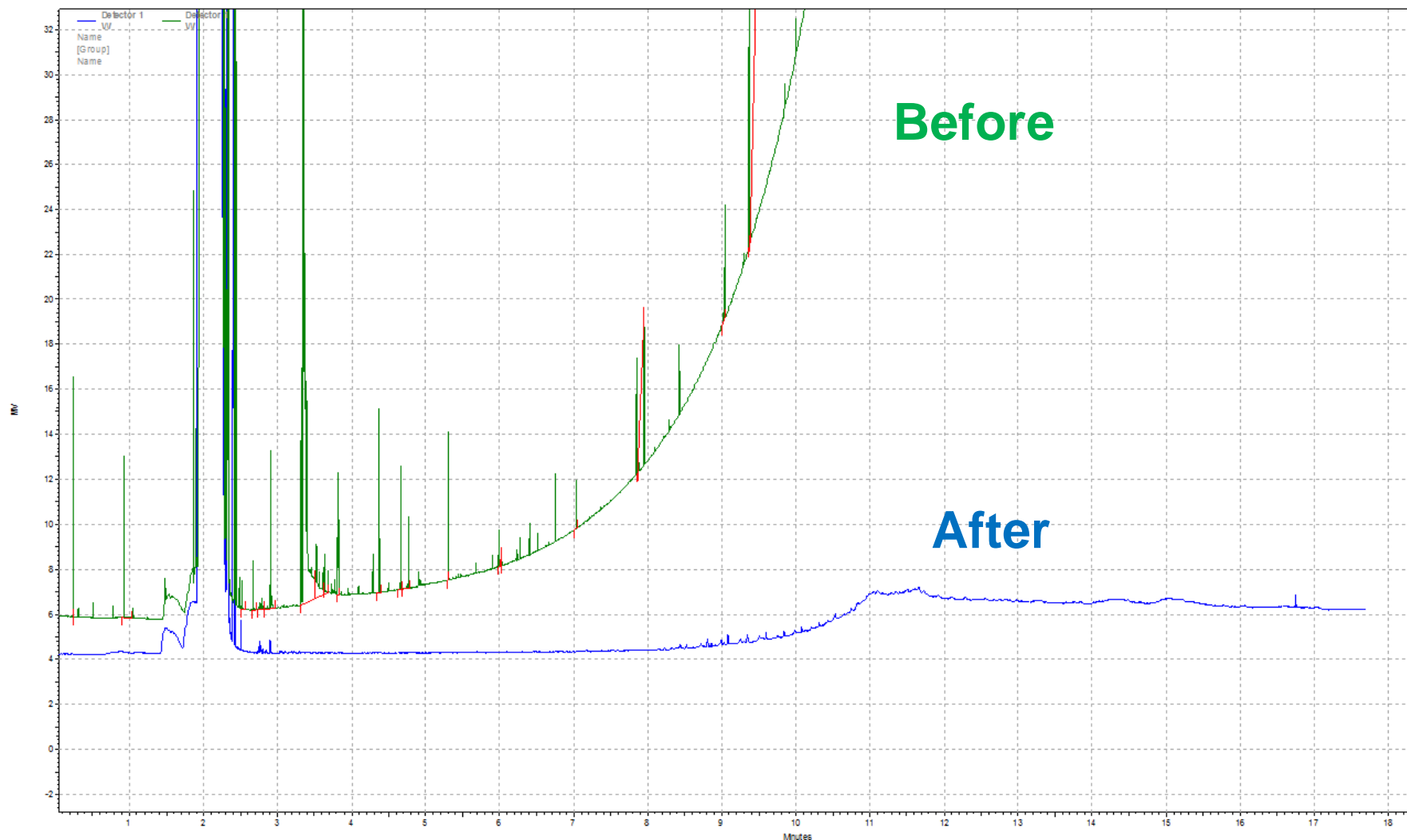
Finger Tight Knurled Nut



G1544-80530



# Split Vent Trap Changed (Column Bleed?!?)



# Split/Splitless Pulsed Injection

Pressure Pulse contains sample expansion and transfers analytes to the column faster.

## Pulsed Split

- the most volatile components and solvent effected most
- faster sample transfer not as critical since it's already fast

## Pulsed Splitless

- sample containment more critical than in split injection
- much sharper peaks than in traditional splitless injection





# Select Pulsed Splitless Mode in Inlets

Instrument | Edit | Inlets: (6890)

■ Oven Temp

Temperature (°C)

Plot...

Time (min.)

Injector Valves **Inlets** Columns Oven Detectors Signals Aux Runtime Options

Front: EPC Split-Splitless Inlet

Mode: Splitless Gas: He

On Split Splitless **Pulsed Splitless** Pulsed Split

☒ Total Flow, mL/min

Actual	Setpoint
	250
	8.81
	53.6

Purge Flow to Split Vent: 50.0 mL/min @ 2.00 min

☒ GasSaver 20.0 mL/min @ 2.00 min

Front

Apply

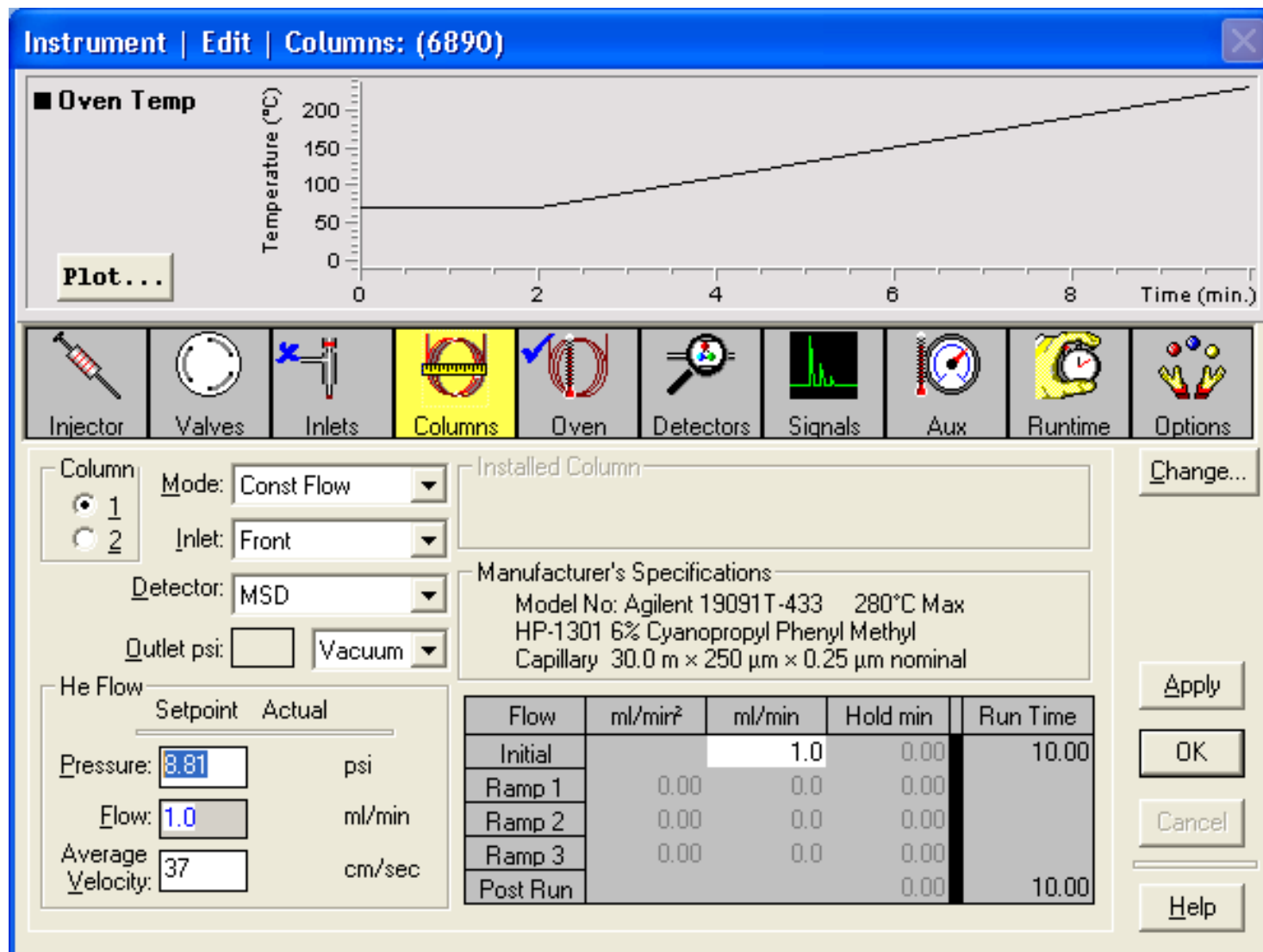
OK

Cancel

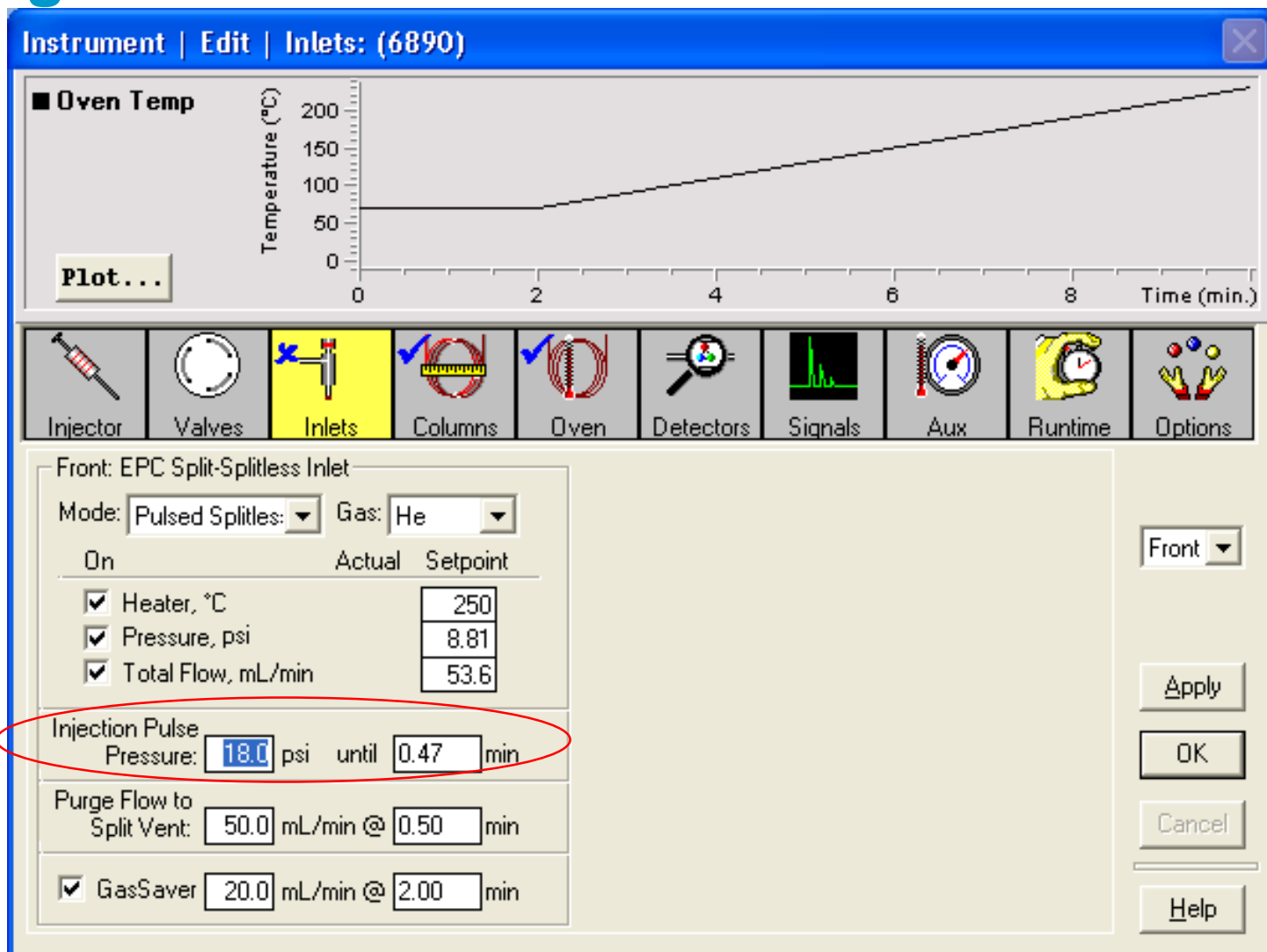
Help



# Check the Splitless Pressure



# Double or Triple the Pressure for ~1 sec less than the Purge Activation Time



# The BIGGEST Problem in GC is...

There are more things that DON'T go through a GC than DO!

....therefore, don't inject anything and you'll never have problems.

OK, inject, but realize that everything just got dirty...deal with it!



# Where Does it Get Dirty?

Here

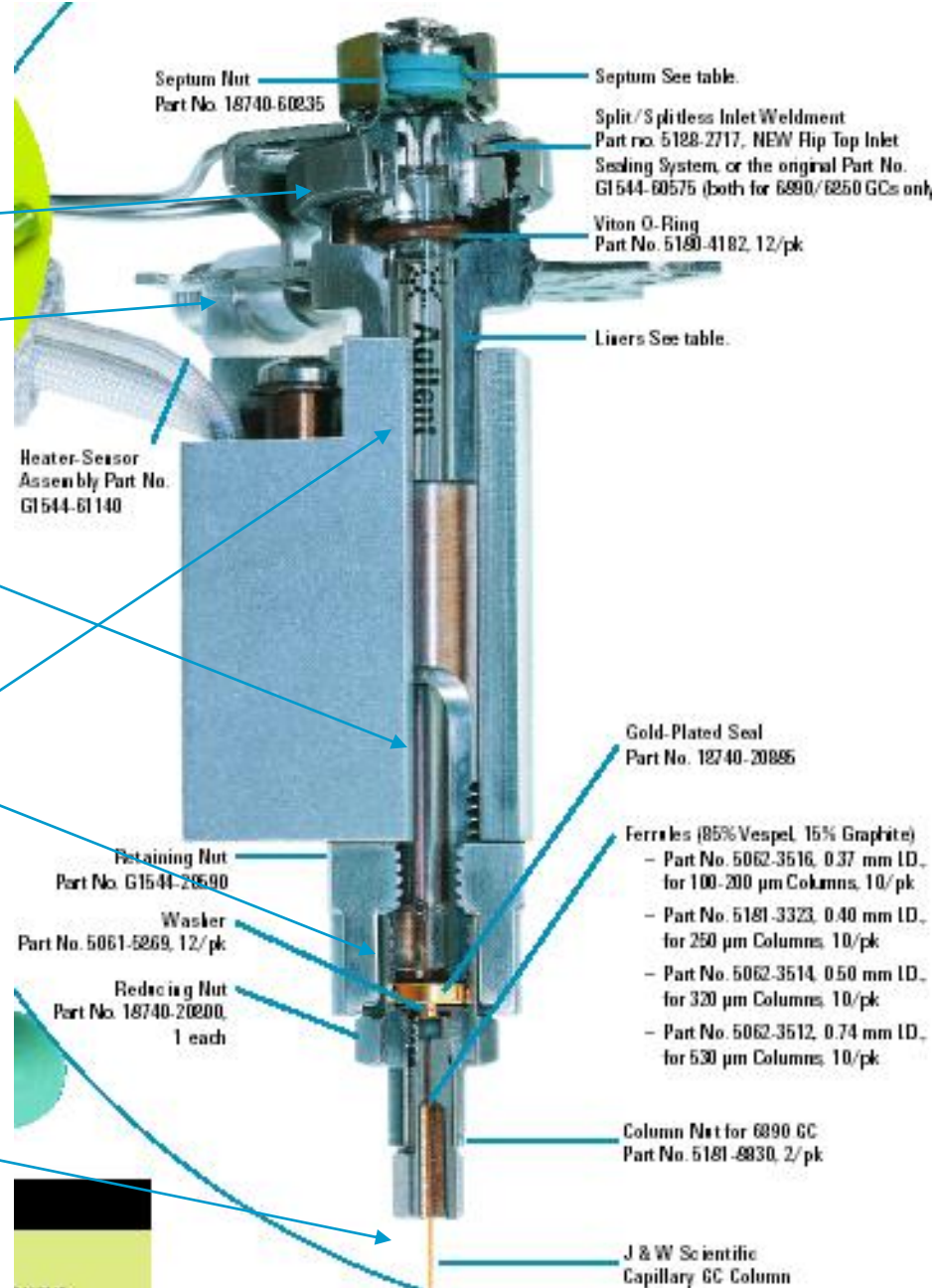
Here

Here

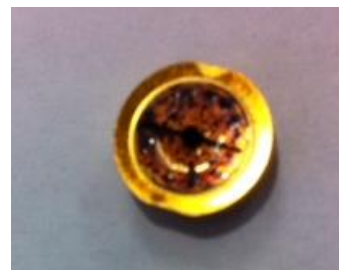
Here

Here

Here



# What Are You Doing!?

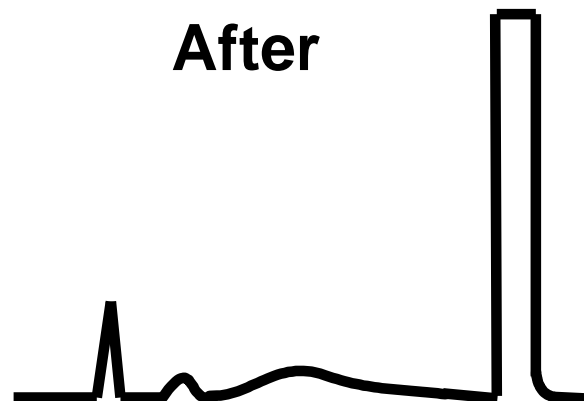


# Bonus Peaks or Ghost Peaks

Before



After



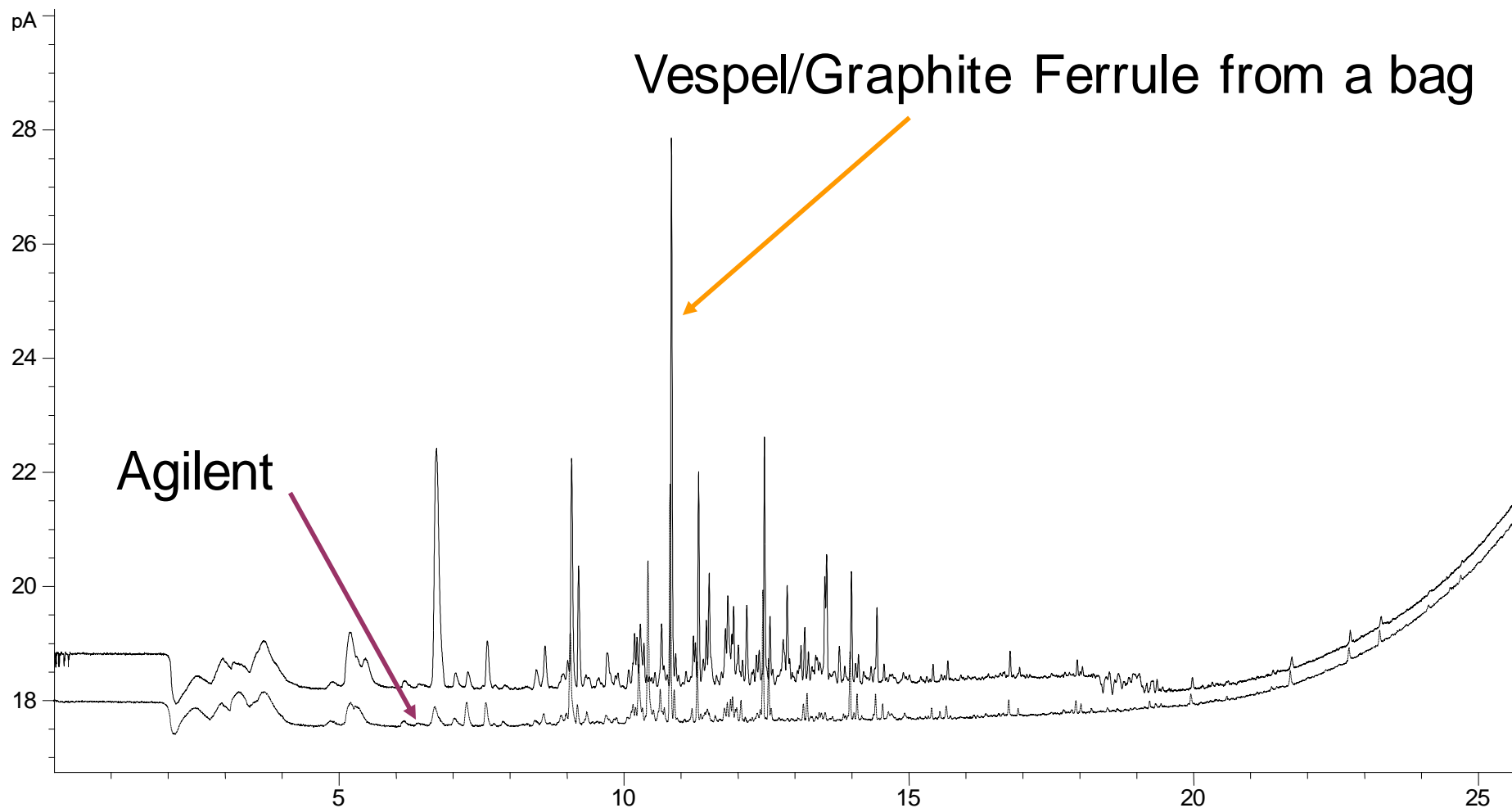
Contamination in INJECTOR or FLOW (carrier gas)

- Contaminated consumables
- Carryover from a backflash or previous sample
- Bad tank of gas or traps have expired
- Septum bleed

**\*TIP = Run a blank run...it should be blank!**



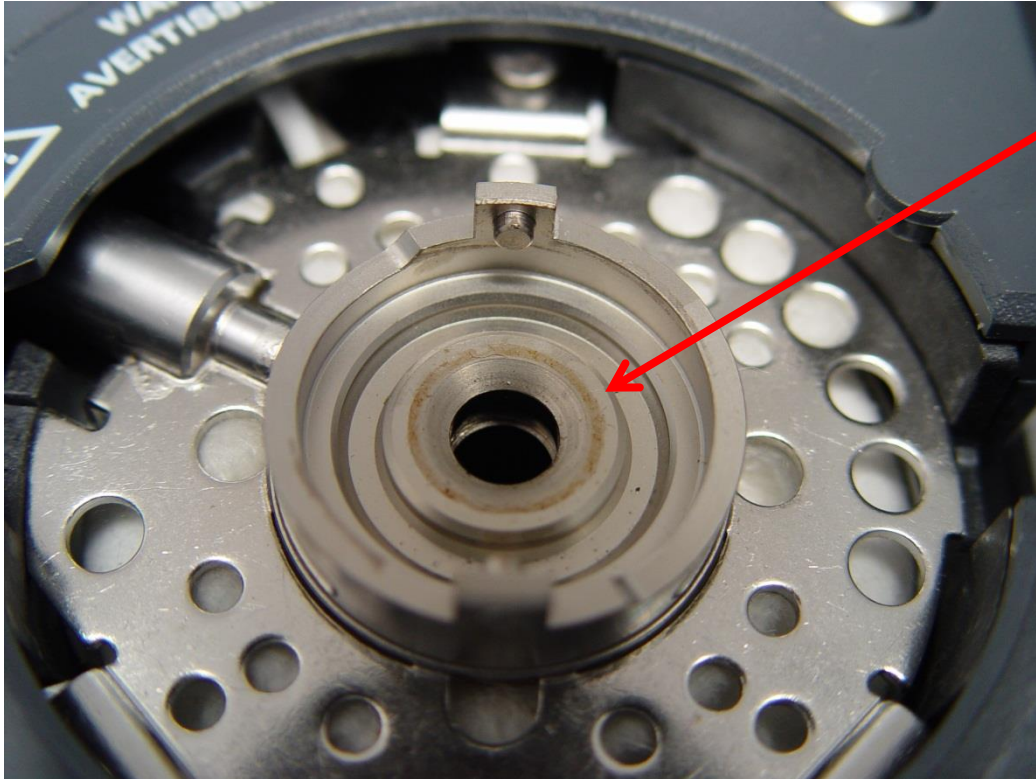
# Bonus Peaks - Ferrule Contamination





# More “Off-Brand” O-Ring Issues

## Controlled Substances Analysis, H2 Carrier



Residue on top of  
inlet weldment

### Problem Resolution:

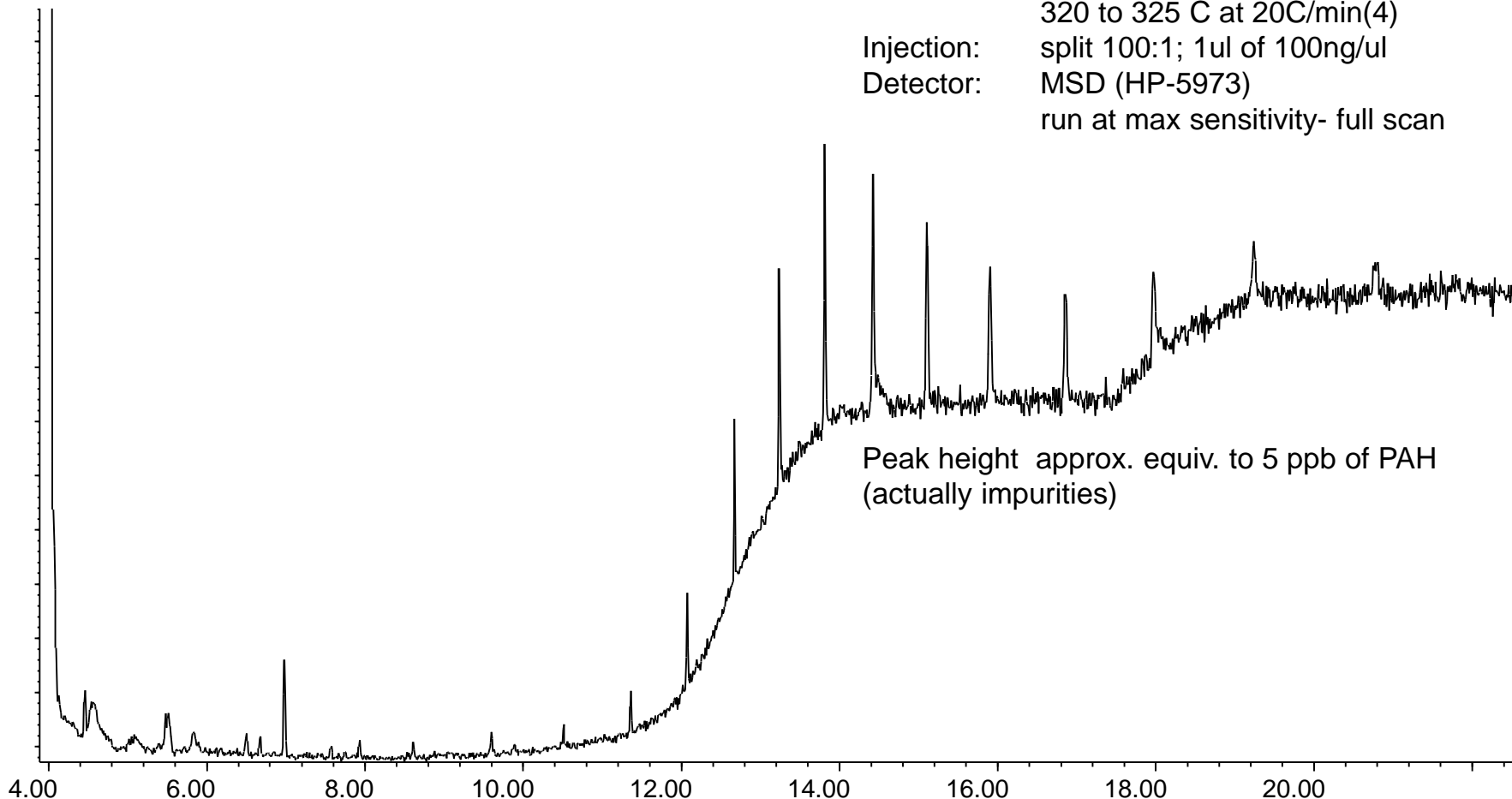
Agilent Non-Stick Liner O-Ring  
p/n 5188-5365, 10PK



# Septa Bleed vs Column Bleed (MSD)

Source of peaks from outside of the column

Columns: HP 5MS  
30mx0.25mmx0.25um  
Oven: 80 to 160C at 25 C/min,  
160 to 320 C at 3 C/min(4),  
320 to 325 C at 20C/min(4)  
Injection: split 100:1; 1ul of 100ng/ul  
Detector: MSD (HP-5973)  
run at max sensitivity- full scan

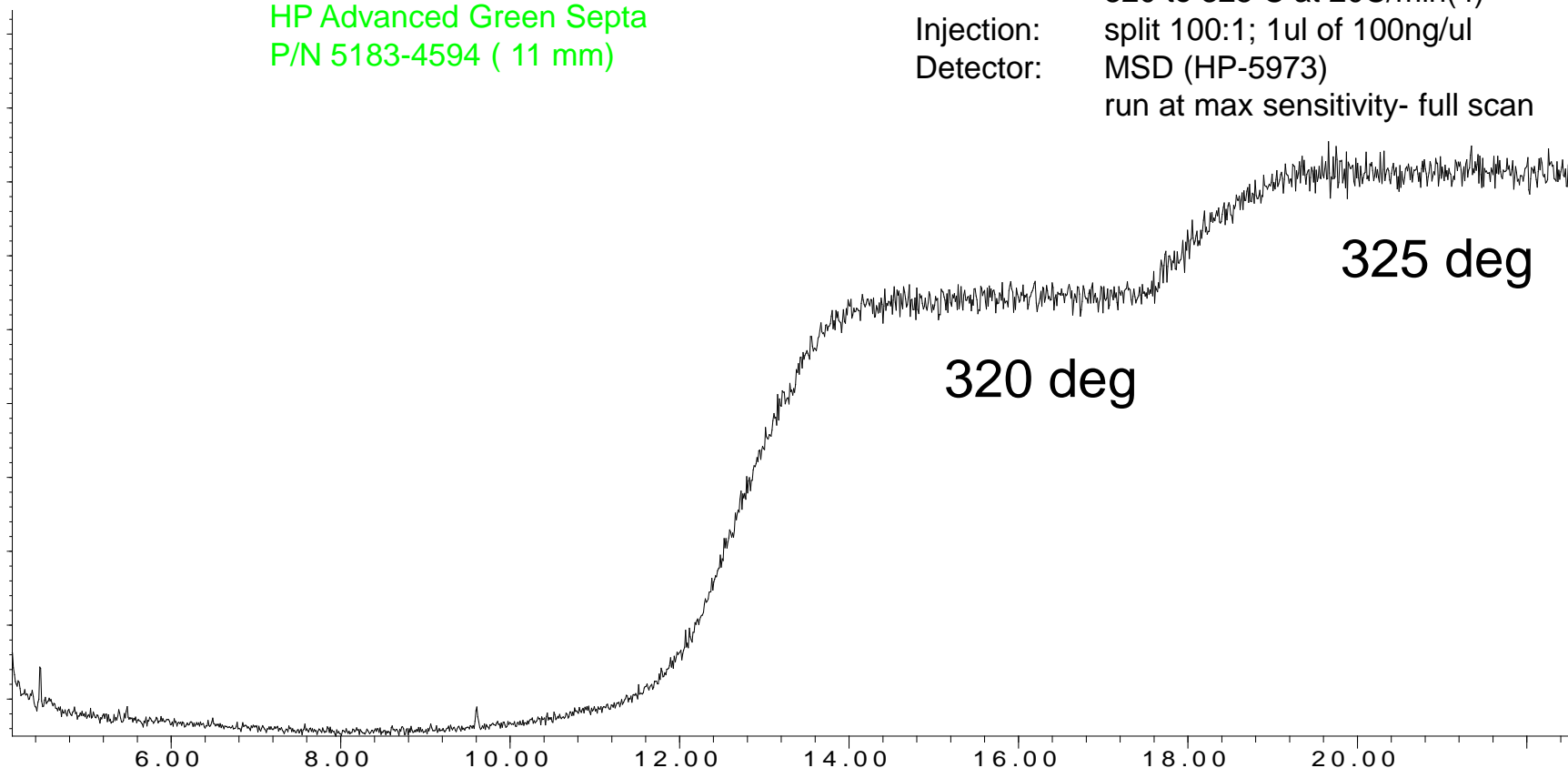


# Septa Bleed vs Column Bleed (MSD)

Source of peaks from outside of the column *ELIMINATED*

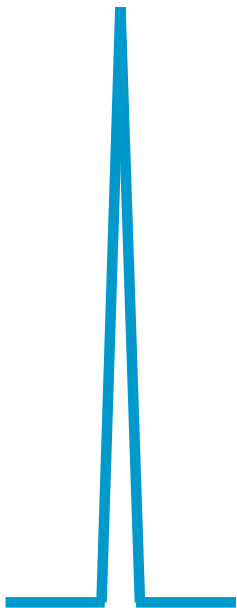
**New Septa Installed**  
HP Advanced Green Septa  
P/N 5183-4594 ( 11 mm)

Columns: HP 5 MS  
30mx0.25mmx0.25um  
Oven: 80 to160 C at 25 C/min,  
160 to 320 C at 3 C/min(4)  
320 to 325 C at 20C/min(4)  
Injection: split 100:1; 1ul of 100ng/ul  
Detector: MSD (HP-5973)  
run at max sensitivity- full scan



# Peak Tailing

**Before**



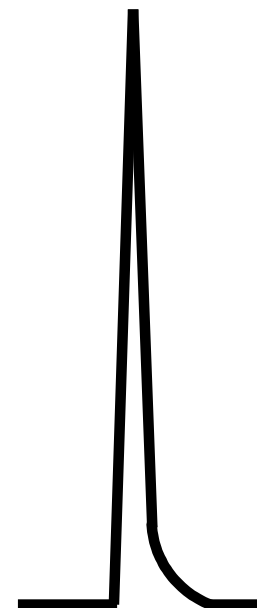
INJECTOR or COLUMN is Active

- Reversible adsorption of active compounds  
(-OH, -NH, -SH)

FLOW problem

- dead volume, obstruction, poor installation, or  
severe column contamination

**After**

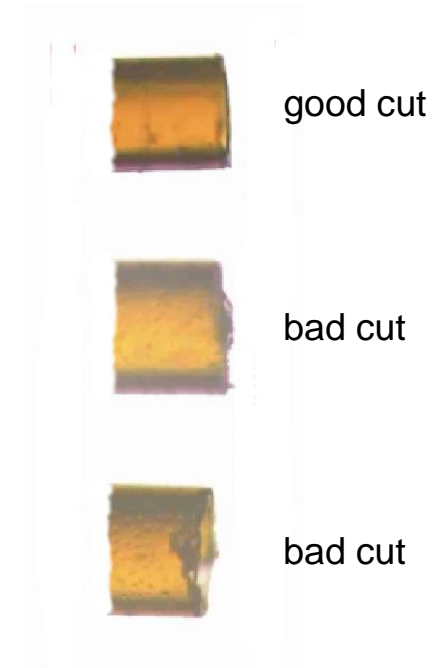
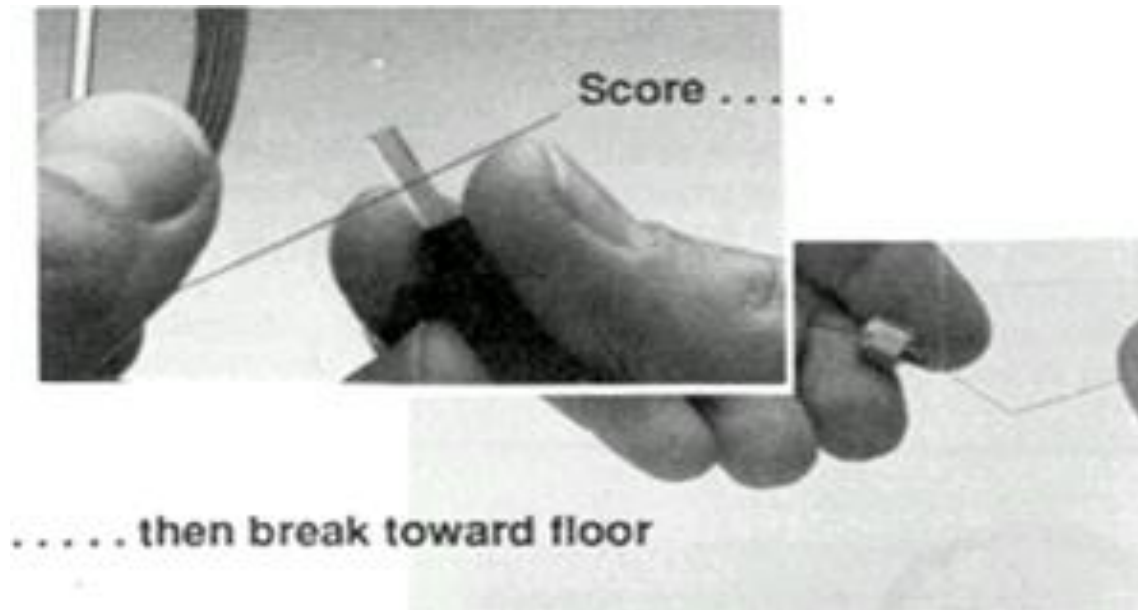


Miscellaneous – temperature issues for late eluters, overloading of PLOT columns, co-elution, polarity mismatch between phase, solute or solvent, and some compounds always tail

\*Tip = Inject a light hydrocarbon, should not tail unless flow path problem.



# Flow Path Matters

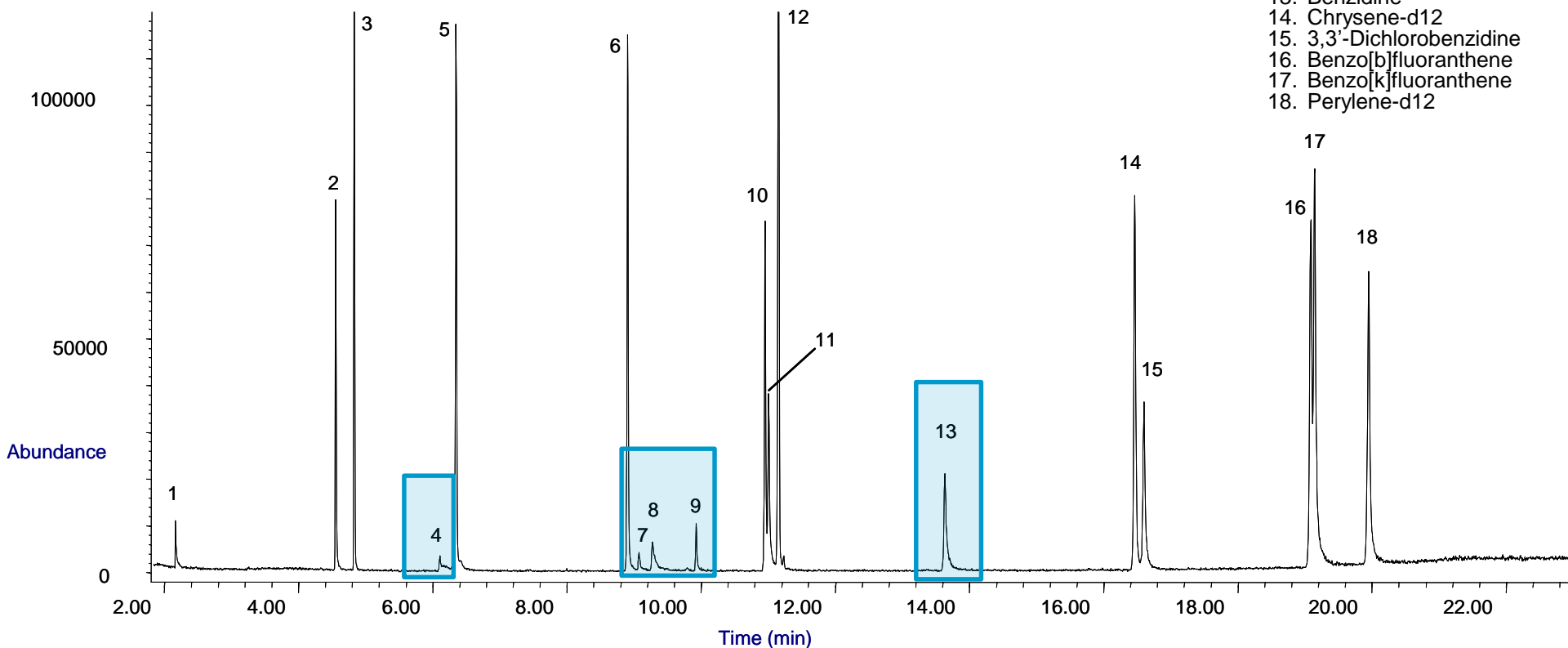


A flat, 90° square cut will be optimal for all connections

# Symptom – Tailing of Active Compounds

Sample: 0.5 ng on column loading with ISTD  
Column: 20m 0.18mm 0.18µm  
Carrier: Helium 37cm/sec, Ramped flow; 0.7ml/min (0.1min) to 1.3ml/min (15ml/min<sup>2</sup>)  
Oven: 35°C (2.5 min) to 80°C (40°C/min), 15°C/min to 200°C, 8°C/min to 275°C (2 min)  
Injection: 0.5µl, Splitless, 280°C, purge flow 30ml/min at 0.75 min  
MSD: Transfer Line 290°C, Source 300°C, Quad 180°C

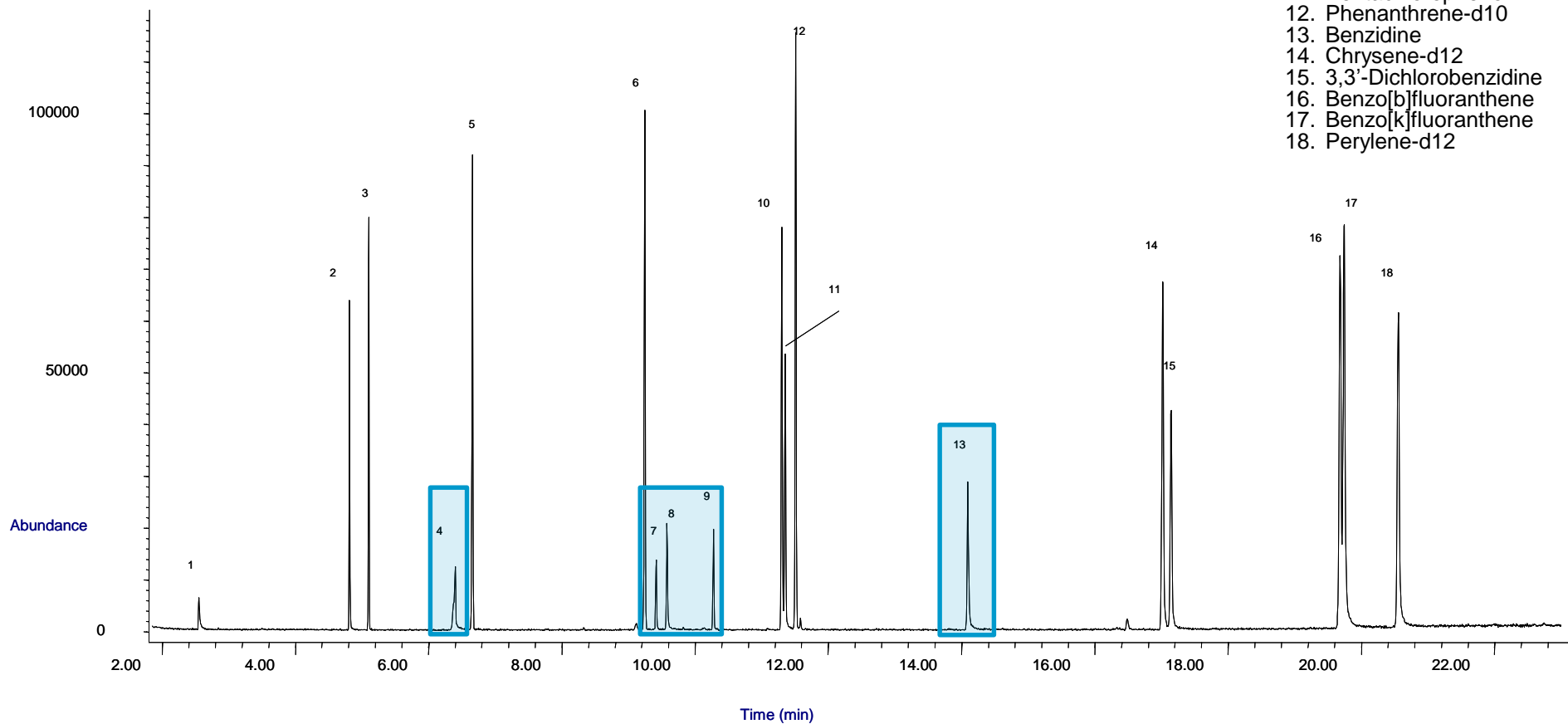
1. n-Nitrosodimethylamine
2. Aniline
3. 1,4-Dichlorobenzene-d4
4. Benzoic Acid
5. Naphthalene-d8
6. Acenaphthene-d10
7. 2,4-Dinitrophenol
8. 4-Nitrophenol
9. 2-Me-4,6-dinitrophenol
10. 4-Aminobiphenyl
11. Pentachlorophenol
12. Phenanthrene-d10
13. Benzidine
14. Chrysene-d12
15. 3,3'-Dichlorobenzidine
16. Benzo[b]fluoranthene
17. Benzo[k]fluoranthene
18. Perylene-d12



# Solution – Ultra Inert GC Column

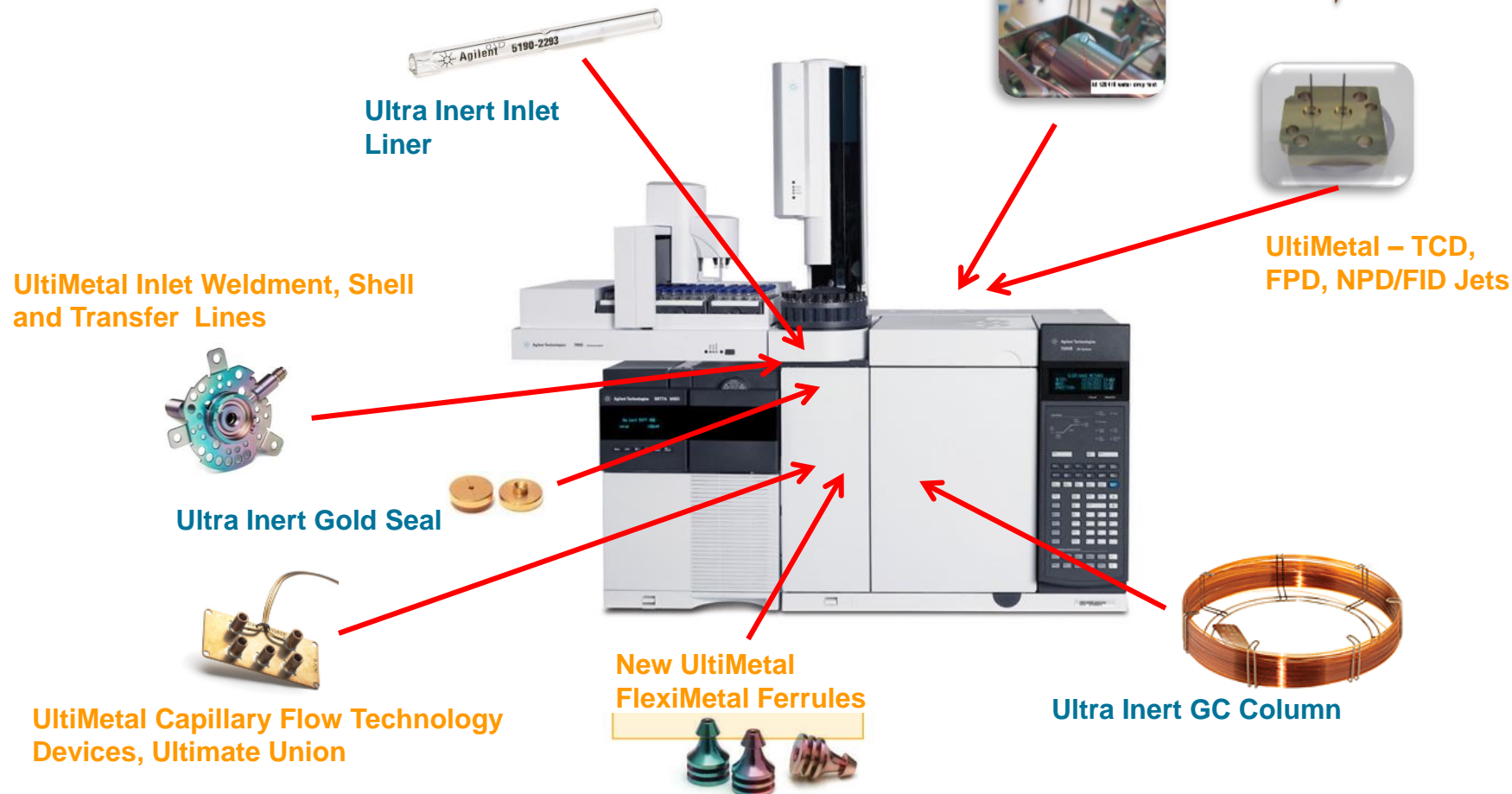
Sample: 0.5 ng on column loading with ISTD  
Column: 20m 0.18mm 0.18µm  
Carrier: Helium 37cm/sec, Ramped flow; 0.7ml/min (0.1min) to 1.3ml/min (15ml/min<sup>2</sup>)  
Oven: 35°C (2.5 min) to 80°C (40°C/min), 15°C/min to 200°C, 8°C/min to 275°C (2 min)  
Injection: 0.5µl, Splitless, 280°C, purge flow 30ml/min at 0.75 min  
MSD: Transfer Line 290°C, Source 300°C, Quad 180°C

1. n-Nitrosodimethylamine
2. Aniline
3. 1,4-Dichlorobenzene-d4
4. Benzoic Acid
5. Naphthalene-d8
6. Acenaphthene-d10
7. 2,4-Dinitrophenol
8. 4-Nitrophenol
9. 2-Me-4,6-dinitrophenol
10. 4-Aminobiphenyl
11. Pentachlorophenol
12. Phenanthrene-d10
13. Benzidine
14. Chrysene-d12
15. 3,3'-Dichlorobenzidine
16. Benzo[b]fluoranthene
17. Benzo[k]fluoranthene
18. Perylene-d12



# Improved Performance

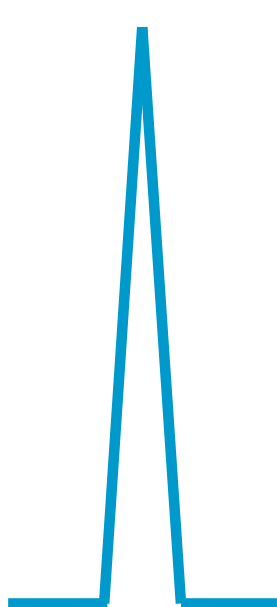
## Improving the Entire Flowpath



...now from a single supplier



# Split Peaks

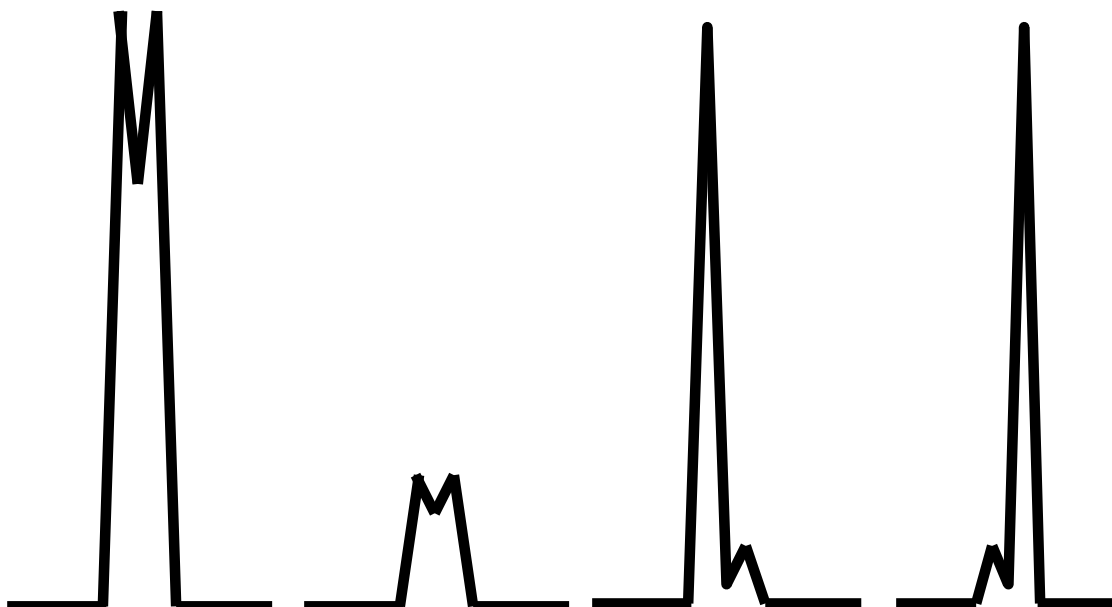


INJECTOR (poor sample introduction)

- Injecting the sample twice (some how?)
- Mixed sample solvent (polarity difference)
- Sample in syringe needle (manual inject)

INJECTOR (activity)

- Breakdown (not really a split peak, 2 peaks)
- Sample degradation in injector



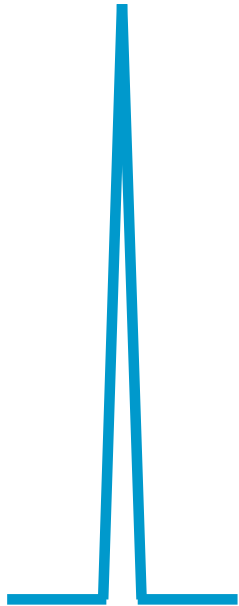
VOLATILITY

High boilers dropping out  
on Cold Spots

- Transfer line temps
- Unions or fittings not  
tracking column temp



# Broad Peaks



## INJECTOR

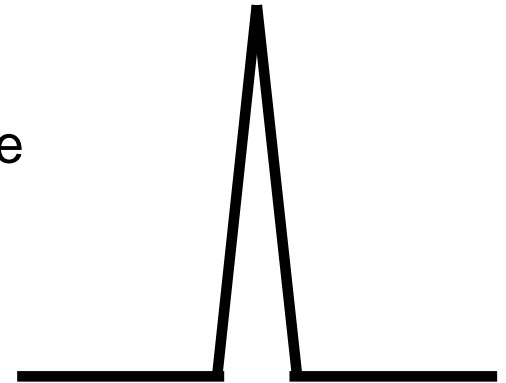
- Poor Installation
- Change in settings (temps/flows)
- Poor sample focusing
- Large change in sample concentration

## FLOW

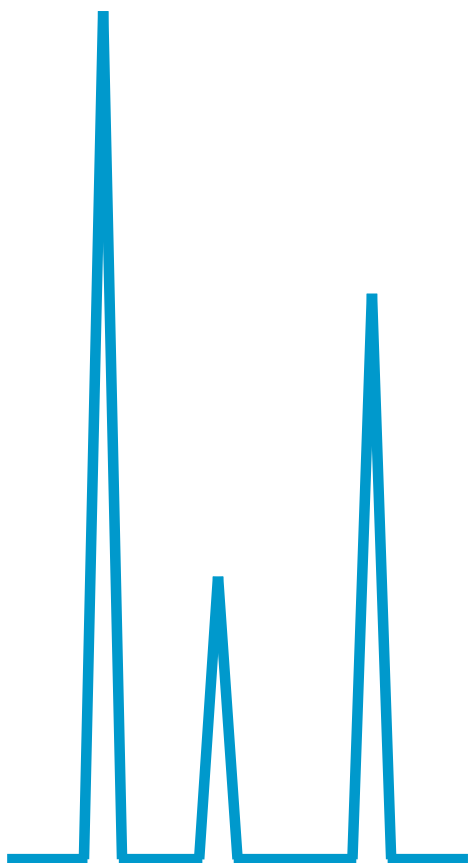
- Change in gas velocity
- Constant Flow vs Constant Pressure

## COLUMN

- Contamination
- Damaged/old stationary phase
- Reverse Solvent Effect



# No Peaks



DETECTOR (not on or not operational)

INJECTOR (not working)

- Plugged syringe/plunger not moving

- Wrong injector (or detector)

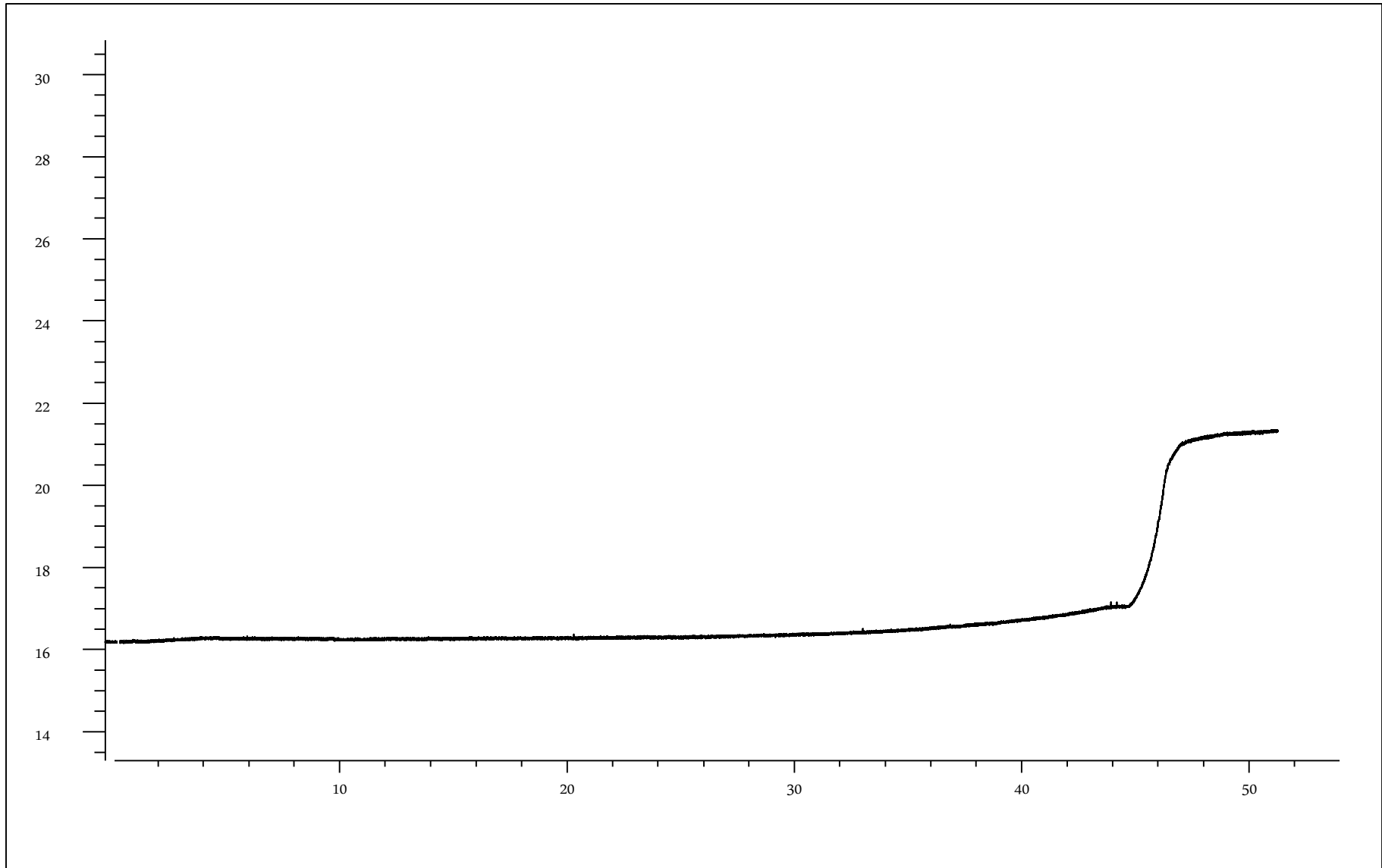
- Huge leak/no carrier gas flow (older systems)

NOT the COLUMN Unless...

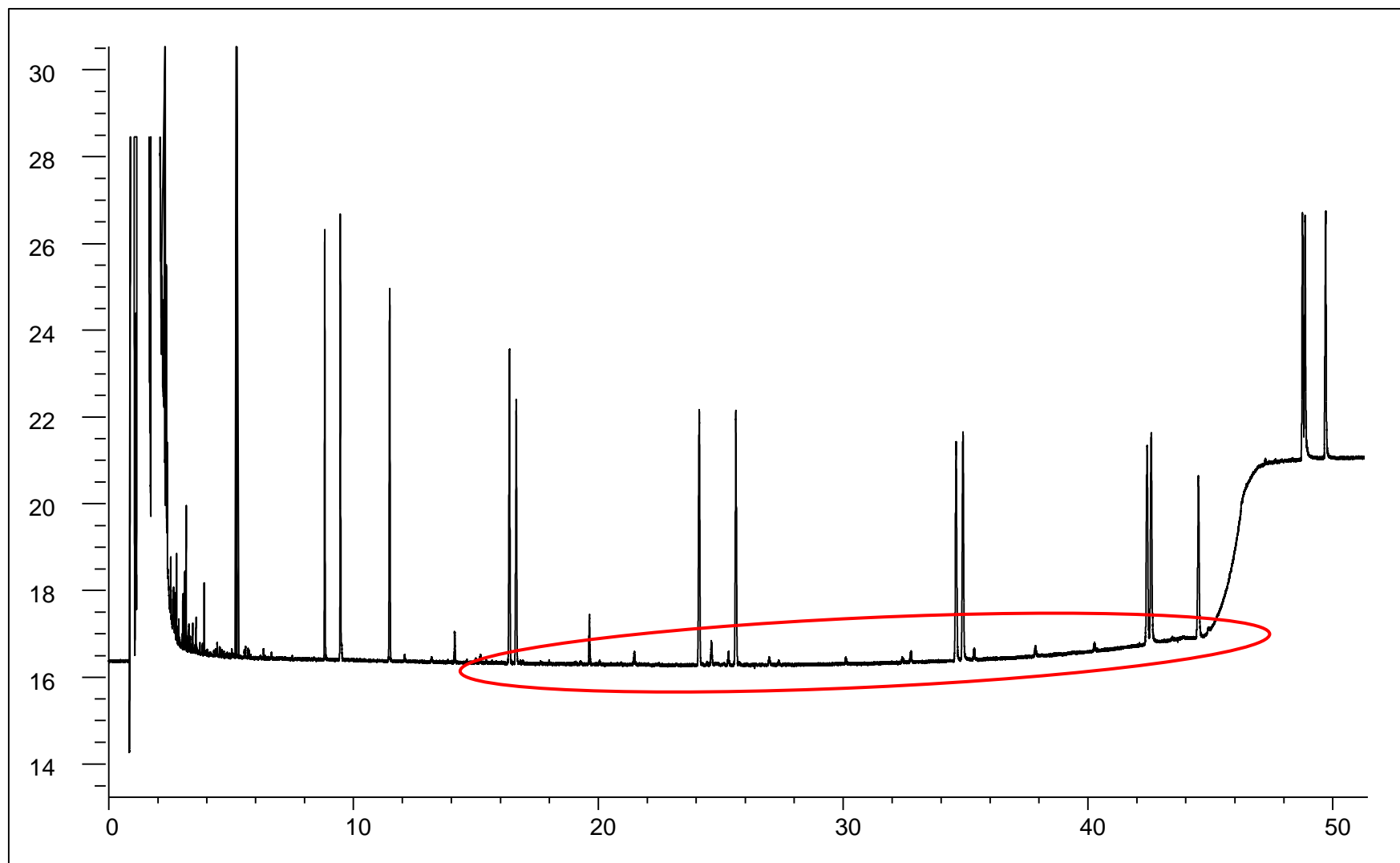
- Broken column

- No column

# Symptom – No Peaks



# Solution - Unplugged Syringe



# Peak Response

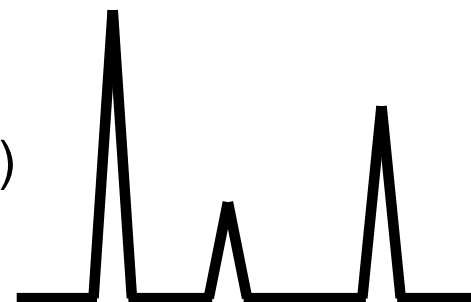
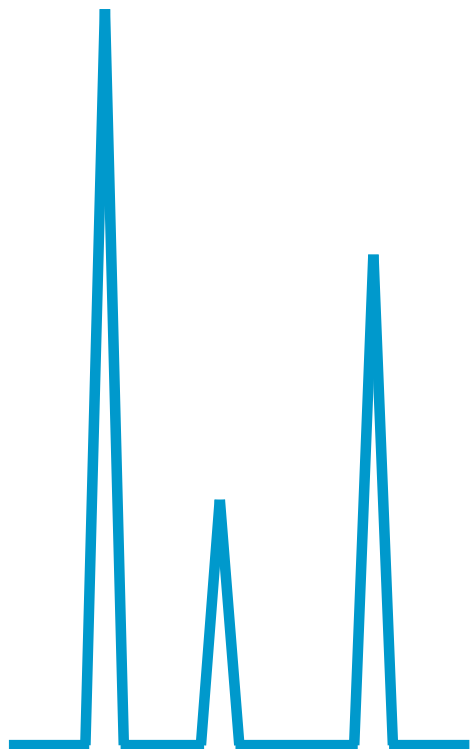
All Change in Size

## INJECTOR

- Leaky syringe
- Split ratio set incorrectly
- Wrong purge activation time
- Septum purge flow too high
- Injector temperature too low\*

## DETECTOR (response problem)

- Settings or flows changed
- Electronics failing

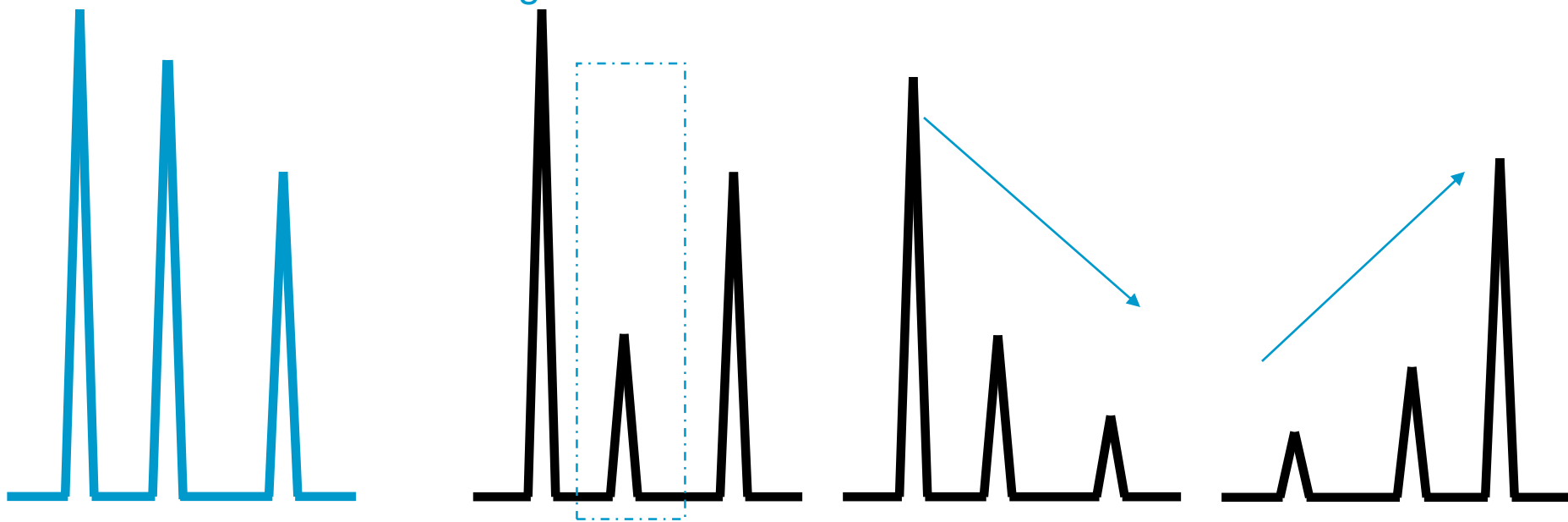


\*Tip = Ask is it all of them or some of them, if all then injector or detector



# Peak Response

Some Change in Size



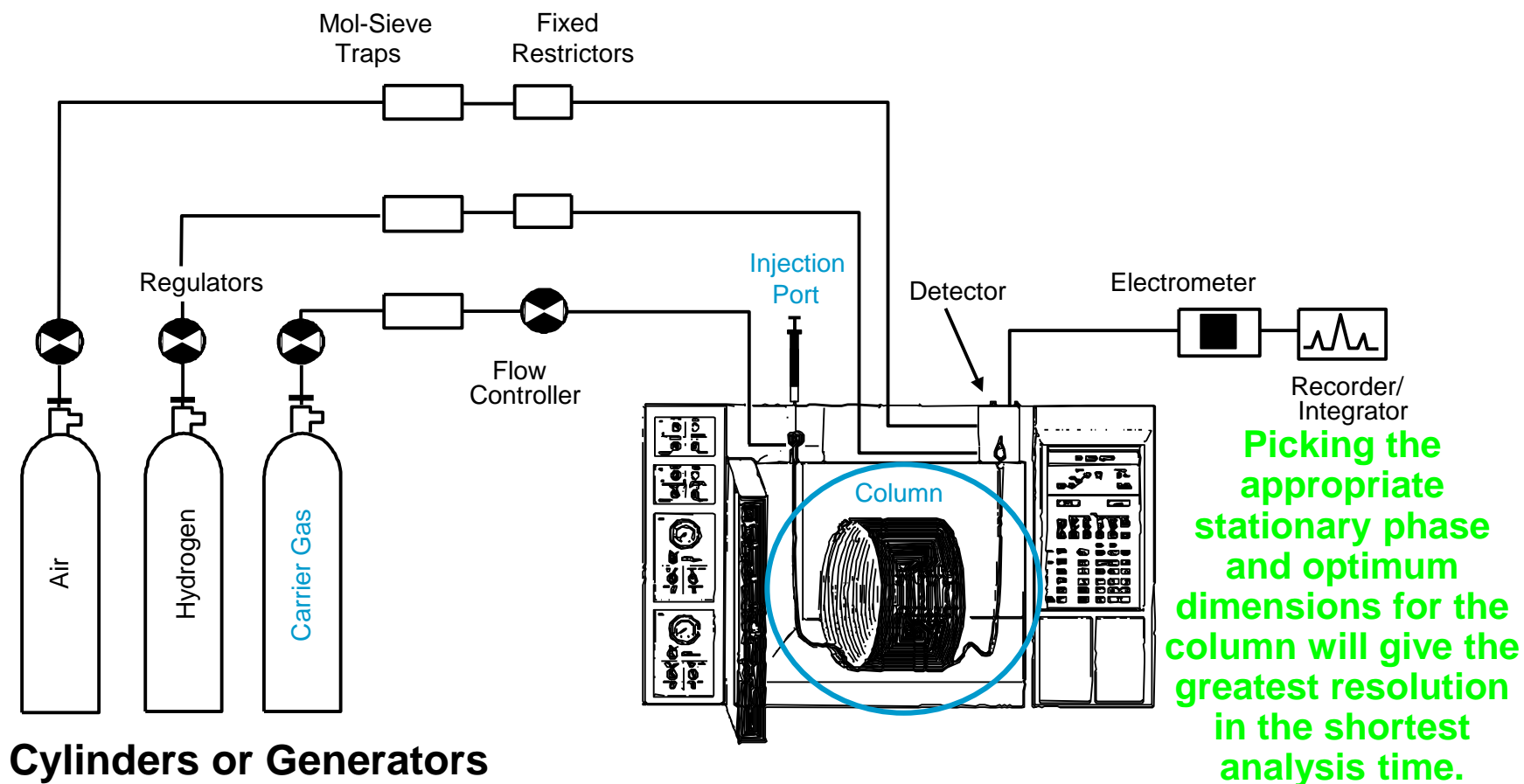
INJECTOR or COLUMN is active/contaminated

- Irreversible adsorption of active compounds (-OH, -NH, -SH)
- Decomposition of sample
- Temperature Change – Discrimination
- Evaporation from sample

\*Tip = If only some change, then ask which ones? If active compounds then activity. If tracks volatility then cold spots or inlet discrimination.



# Typical Gas Chromatographic System





# Peak Fronting

Shark Fin Shaped or Just Slight

COLUMN (contaminated)

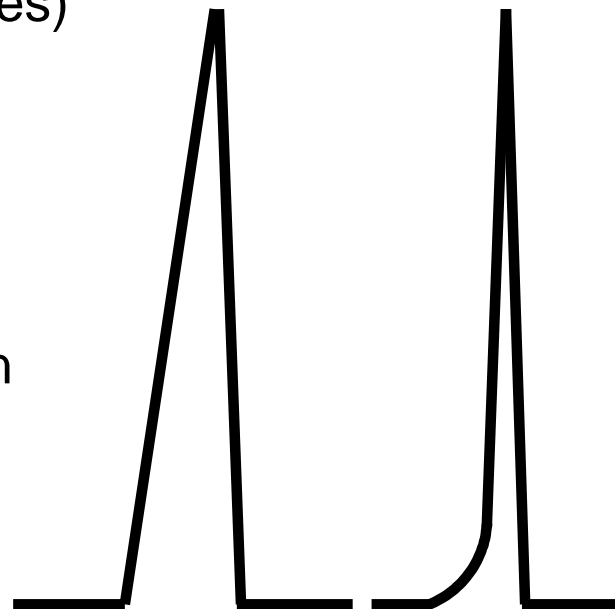
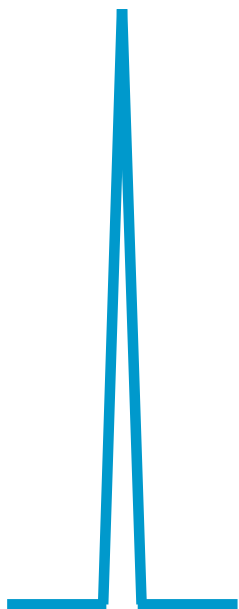
- Overload (More pronounced with large solute and phase polarity differences)

INJECTOR

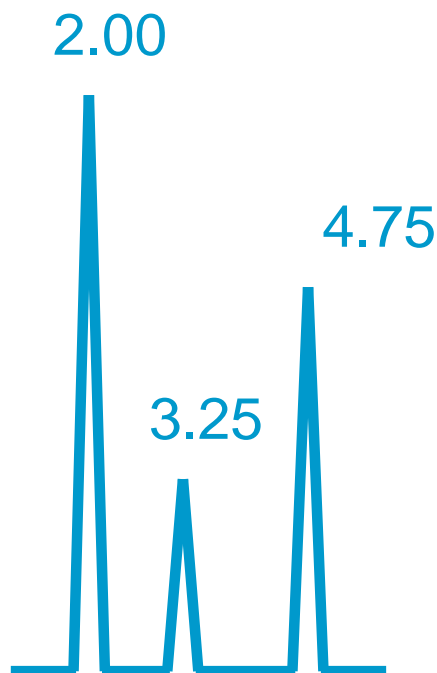
- Poor efficiency (flow/temp)
- Column installation
- Compound very soluble in injection solvent (need retention gap)
- Mixed sample solvent

OTHER

- Co-elution
- Breakdown



# Retention Time Shift



## INJECTOR

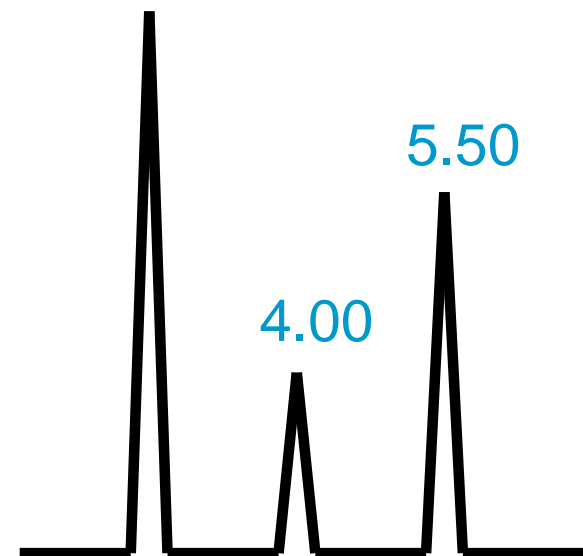
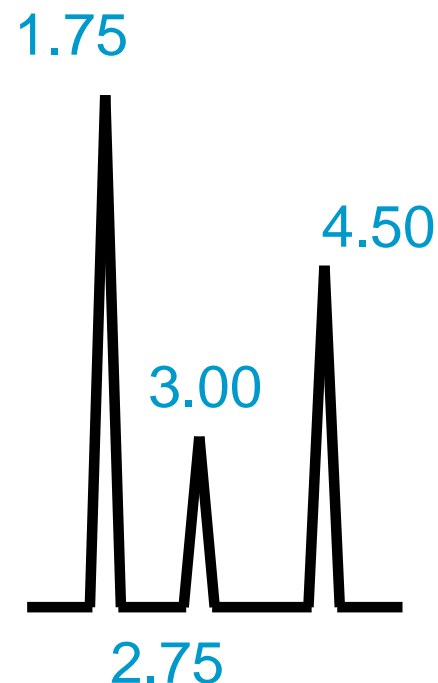
- Change in injection solvent
- Large change in sample concentration

## FLOW

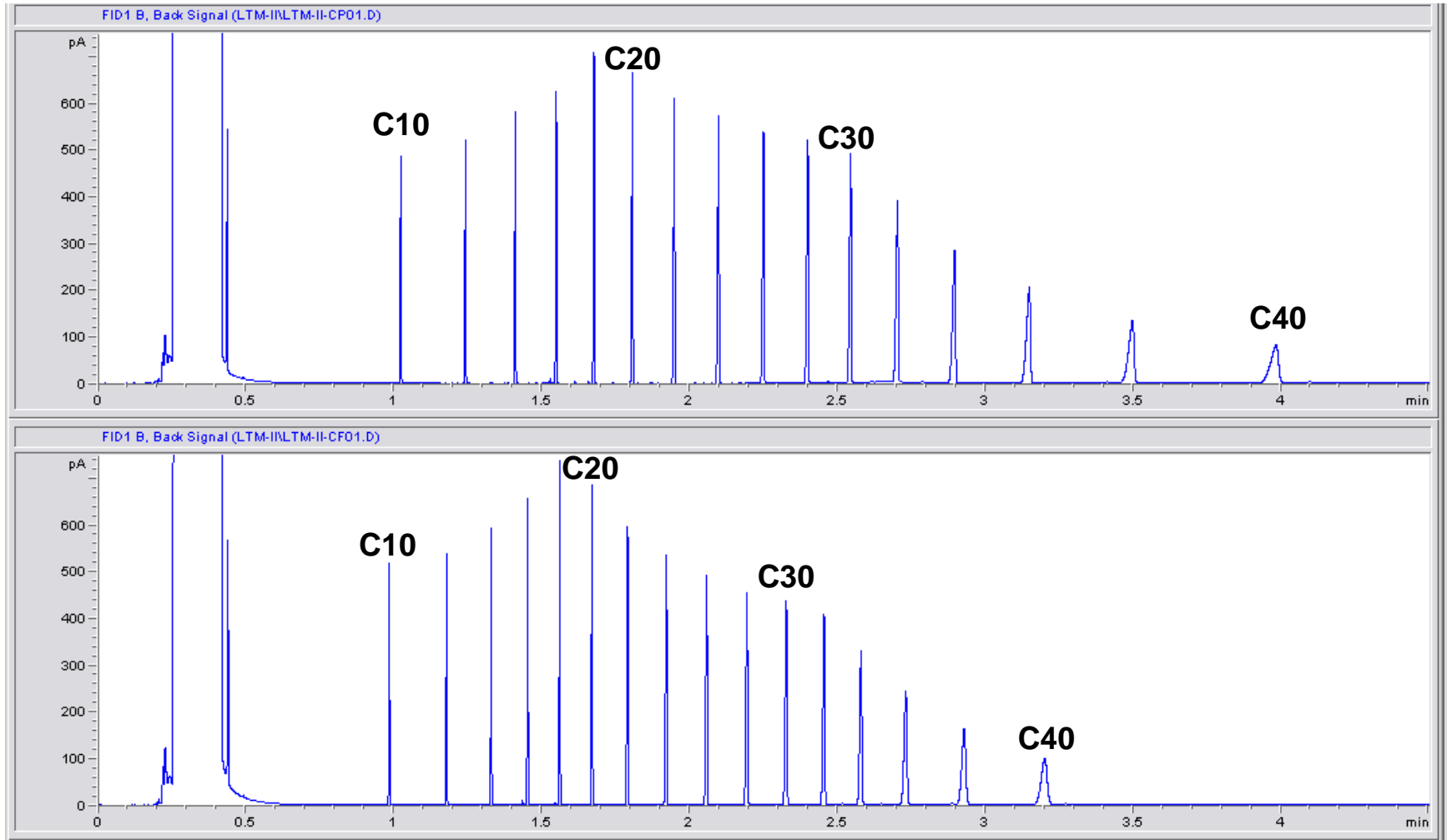
- Leak in the septum
- Change in gas velocity

## COLUMN

- Contamination
- Damaged stationary phase
- Loss of stationary phase
- Change in temperature



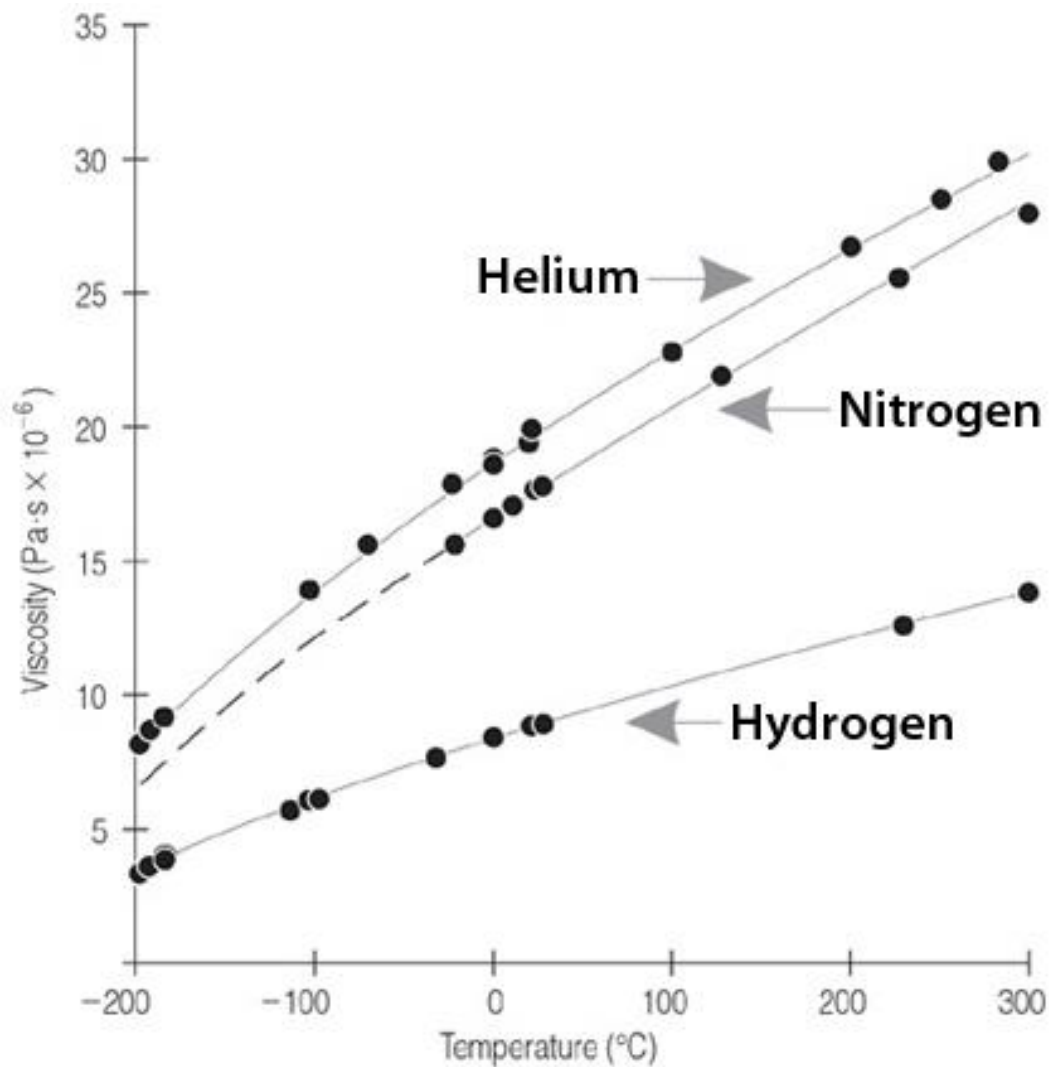
# Constant Pressure vs Constant Flow Retention



Under constant pressure conditions, flow decreases as temperature increases.  
(viscosity of a gas increases as temperature increases)



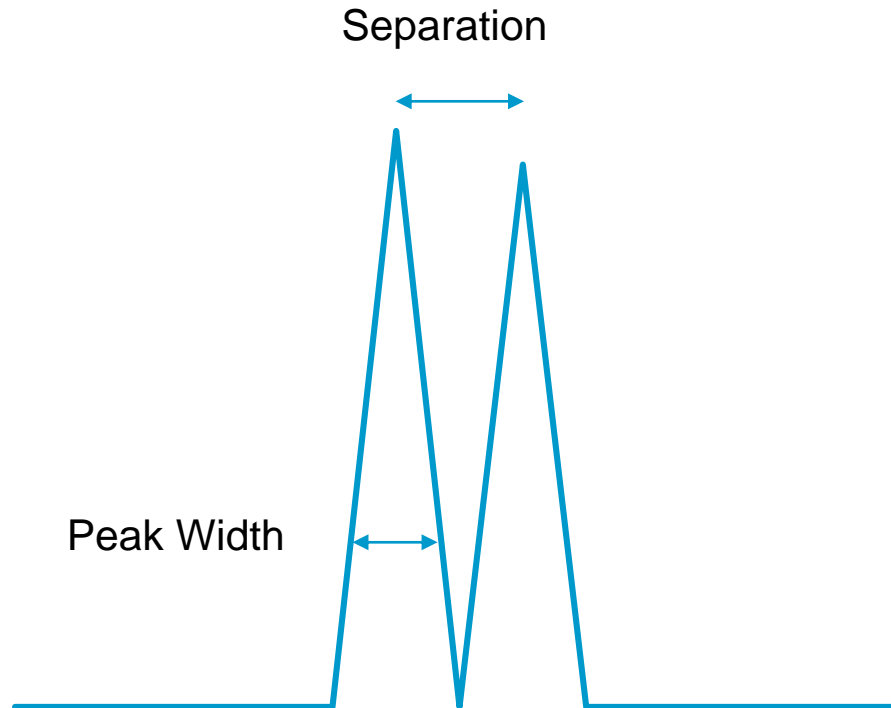
# Gas Viscosity vs Temperature



*J.V. Hinshaw, Column Connections, LCGC Asia Pacific, 12(2), 1100 (2009).*



# Loss of Resolution

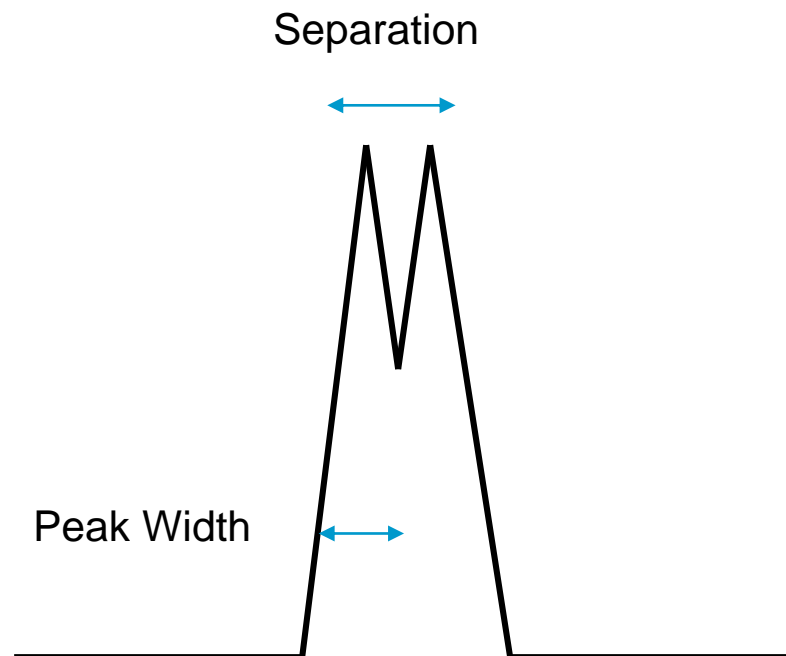


**Resolution is a function of separation and peak width**

# Loss of Resolution - Separation Decrease

## COLUMN

- Different column temperature
- Contamination (more phase?)
- Matrix components co-eluting
- Different column phase?



# Loss of Resolution - Peak Broadening

## FLOW

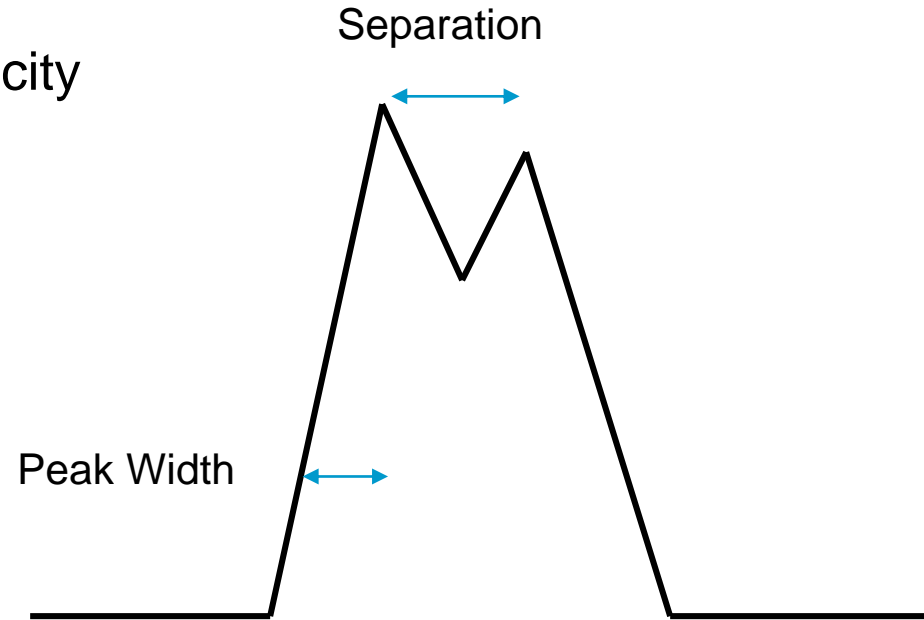
- Change in carrier gas velocity
- Make-up gas

## COLUMN

- Contamination
- Phase degradation

## INJECTOR (efficiency)

- Settings, Liner, Installation, etc.



# Typical Problems of Optimized Methods becoming Unoptimized...and the Reason Why.

- Peak Tailing – Flow Path or Activity
- Bonus Peaks – In Sample or Back Flash (Carry Over)
- Split Peaks – Injector Problems, Mixed Solvent
- No Peaks – Wasn't Introduced, Wasn't Detected
- Response Changes – Activity, Injector Discrimination, Detector Problem
- Peak Fronting – Overload or Solubility Mismatch, Injector Problems
- Shifting Retention – Leaks, Column Aging, Contamination or Damage
- Loss of Resolution – Separation Decreasing, Peak Broadening
- Baseline Disturbances – Column Bleed, Contamination, Electronics
- Noisy or Spiking Baseline – Electronics or Contaminated Detector
- Quantitation Problems – Activity, Injector or Detector Problems



# Quantitation Problems

## DETECTOR

- Poor stability (electronics) or Baseline disturbances (contamination)
- Outside detector's linear range or wrong settings

Activity (adsorption) in INJECTOR or COLUMN

## INJECTOR

- Technique, settings, conditions
- Syringe worn

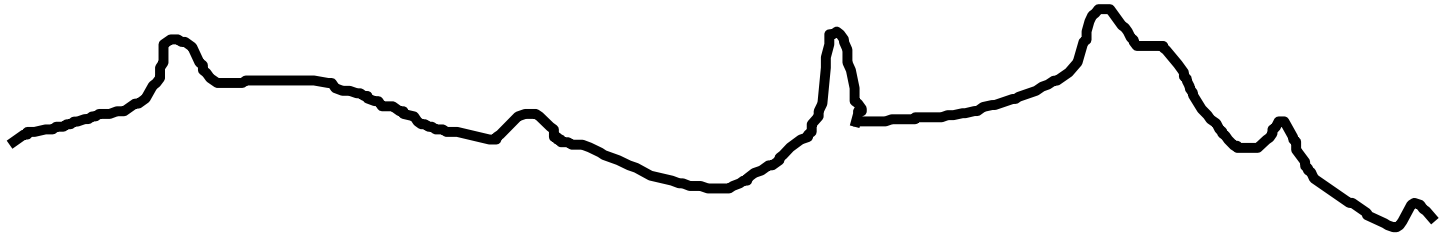
## OTHER

- Co-elution
- Matrix effects
- Sample evaporation – leaky vials
- Sample decomposition

# Baseline Disturbances

Sudden Changes, Wandering, or Drifting

## WANDER



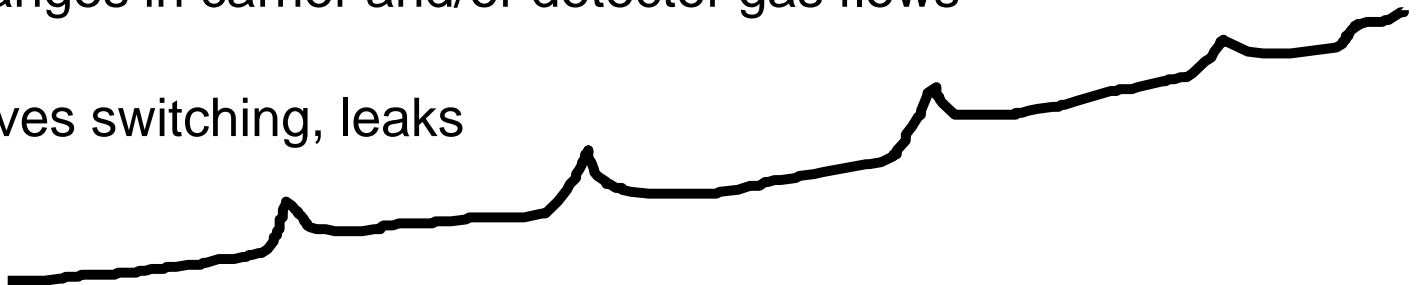
COLUMN or DETECTOR

- Not fully conditioned or stabilized (electronics)
- Contamination

FLOW

- Changes in carrier and/or detector gas flows
- Valves switching, leaks

## DRIFT



# Noisy Baseline

MILD



SEVERE



FLOW

- Contaminated gas
- Incorrect detector settings

COLUMN

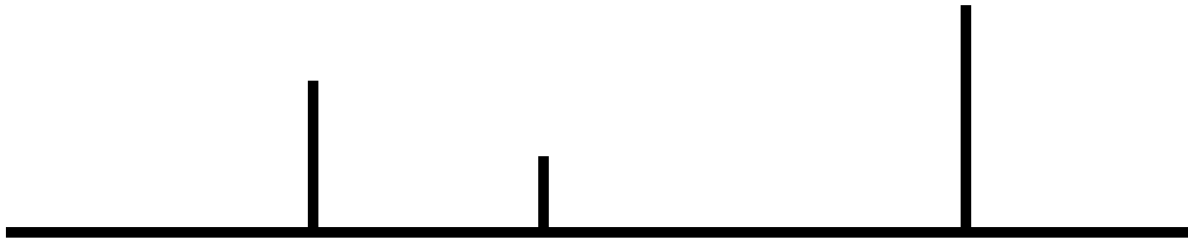
- Bleed if at high temperature
- In detector flame (poor installation)

DETECTOR

- Air leak - ECD, TCD
- Electronics malfunction



# Spiking Baseline



## DETECTOR

- Particles entering the detector
- Random: poor connection
- Regular: nearby "cycling" equipment (electronics)

# Remember

**Complete system = Carrier Gas + Injector +  
Column + Detector + Data System**

**Multiple cause and effect**

**Do not change too many variables at  
once**

# Self-Tightening Column Nuts

Innovative spring-driven piston continuously presses against ferrule

- **Less wasted time:** No retightening needed after repeated thermal cycles
- **Ease of use:** Finger-tight, consistent connections *without tools*
- **Leak Free = Lower column bleed:** Longer column life

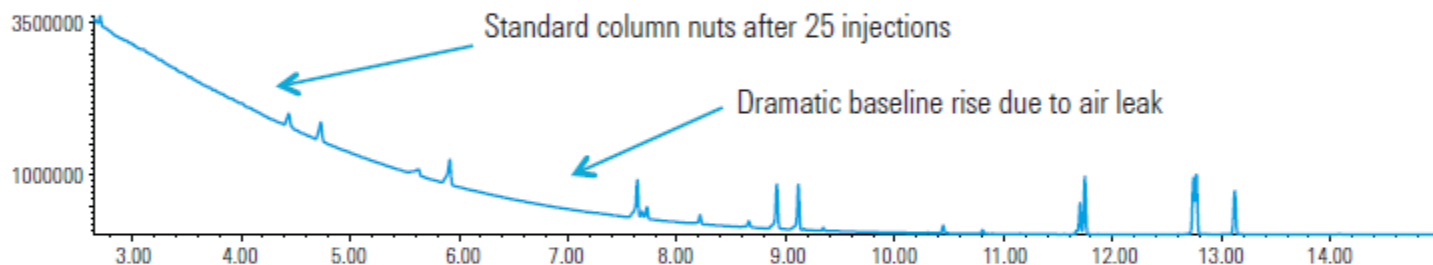
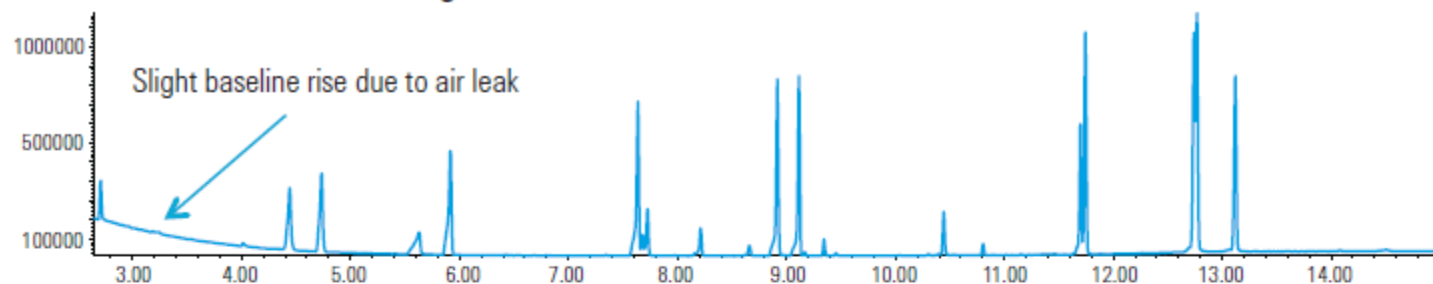


Video at [agilent.com/chem/STnutvideo](https://www.agilent.com/chem/STnutvideo)

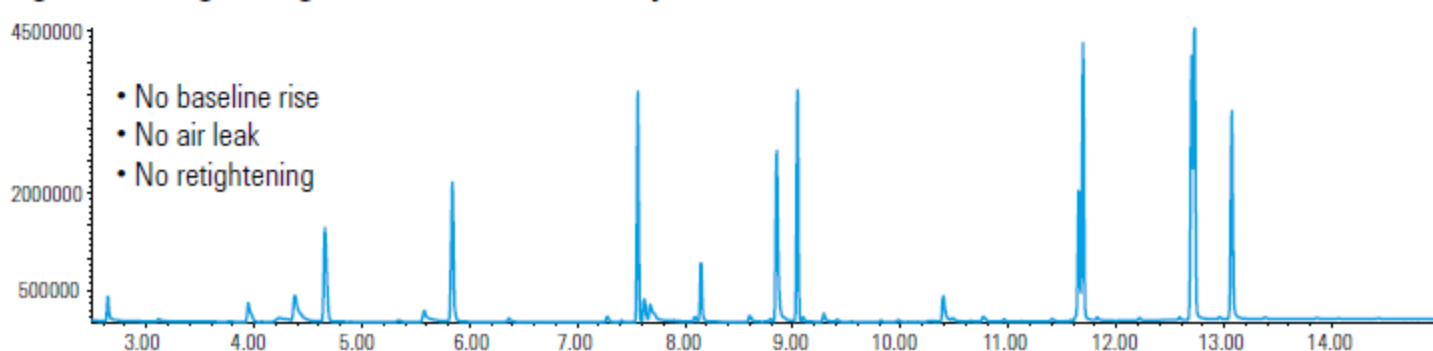


# Self-Tightening Column Nuts

**Standard column nuts new fitting**



**Agilent Self Tightening Column Nuts after 400 injections**



# Changes in Column Dimensions, Gas Type or Velocity Require Changes in Temp Program Rates

GC Method Translation

Criterion: ☒ Translate Only ☐ Best Efficiency ☐ Fast Analysis ☐ None **Speed gain: 1.66552**

	Original Method	Translated Method																																																
<b>Column</b>																																																		
Length, m	30	<input checked="" type="checkbox"/> 30																																																
Internal Diameter, $\mu\text{m}$	250.0	<input checked="" type="checkbox"/> 250.0																																																
<b>Film</b>																																																		
Thickness, $\mu\text{m}$	0.25	<input type="radio"/> Unlock																																																
Phase Ratio	250.0	<input checked="" type="radio"/> 0.25																																																
		<input type="radio"/> 250.0																																																
<b>Carrier Gas</b>	Helium	<input type="checkbox"/> Hydrogen																																																
Enter one Setpoint																																																		
Head Pressure, psi	9.023	3.106																																																
Flow Rate, mL/min	1.2	1.5000																																																
Outlet Velocity, cm/sec	Very large	Very large																																																
Average Velocity, cm/sec	39.29	65.44																																																
Hold-up Time, min	1.27249	0.764023																																																
Outlet Pressure (absolute), psi	0	<input checked="" type="checkbox"/> 0																																																
Ambient Pressure (absolute), psi	14.696	<input type="checkbox"/> 14.696																																																
<b>Oven Temperature</b> 3-ramp Program																																																		
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Sample Information None

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Criterion: ☐ Translate Only ☐ Best Efficiency ☐ Fast Analysis ☒ None **Speed gain: 1.92318**

	Original Method	Translated Method																																																
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Sample Information None

*Method Translation Software to the Rescue!*





# Troubleshooting Resources

## Online Troubleshooting and Maintenance Videos

<http://www.chem.agilent.com/en-US/Technical-Support/Instruments-Systems/Gas-Chromatography/Pages/troubleshootingvideos.aspx>

## GC Troubleshooting Guide

<http://www.chem.agilent.com/en-US/Products-Services/Instruments-Systems/Gas-Chromatography/pages/gp6770.aspx>

## Method Translation Software

<http://www.chem.agilent.com/en-US/Technical-Support/Instruments-Systems/Gas-Chromatography/utilities/Pages/gcmethodtranslation.aspx>



# Agilent Better GC Connections

[www.agilent.com/chem/betterGCconnections](http://www.agilent.com/chem/betterGCconnections)

Order the poster...

**SIX TIPS FOR TIGHTER GC CONNECTIONS AND BETTER RESULTS**

Inspecting your GC column connections is a key part of good preventive maintenance – and a laboratory practice that you simply cannot afford to overlook. That's because poor, leaky connections can cause:

- Empty baselines
- Loss of expensive, high-quality gas
- Shorter column and detector life
- Decreased system sensitivity
- Reduced system productivity

This poster highlights the critical GC connection 'hotspots' to help you fix problems before they compromise your results.

The Mechanics of Confidence

There is a lot that often happens behind the scenes and out of sight of your data.

To learn more about creating and maintaining leak-free GC connections, go to [agilent.com/chem/betterGCconnections](http://agilent.com/chem/betterGCconnections)

Agilent Technologies

The poster features a diagram of a GC system with numbered hotspots (1-6) and six corresponding tips:

- 1. The Agilent Double Nut and Nut that are not appropriate for your application.** The Double Nut is a unique design that allows for a secure, leak-free connection. It is not a standard nut and should not be used in place of the Double Nut.
- 2. Insufficient tightening of ferrules is a common operator error.** Insufficient tightening of ferrules can cause leaks. The Agilent Self Tightening Ferrule (STF) is designed to provide a secure, leak-free connection. It is not a standard ferrule and should not be used in place of the STF.
- 3. Insufficient tightening of the column nut is a common operator error.** Insufficient tightening of the column nut can cause leaks. The Agilent Self Tightening Column Nut (STCN) is designed to provide a secure, leak-free connection. It is not a standard column nut and should not be used in place of the STCN.
- 4. Poor quality ferrules can cause leaks.** Poor quality ferrules can cause leaks. The Agilent Self Tightening Ferrule (STF) is designed to provide a secure, leak-free connection. It is not a standard ferrule and should not be used in place of the STF.
- 5. Poor quality column nuts can cause leaks.** Poor quality column nuts can cause leaks. The Agilent Self Tightening Column Nut (STCN) is designed to provide a secure, leak-free connection. It is not a standard column nut and should not be used in place of the STCN.
- 6. Poor quality ferrules can cause leaks.** Poor quality ferrules can cause leaks. The Agilent Self Tightening Ferrule (STF) is designed to provide a secure, leak-free connection. It is not a standard ferrule and should not be used in place of the STF.

View the video...

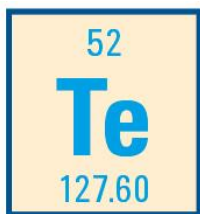
Better\_GC\_Connections\_08c-FINAL\_3280x720

Agilent Technologies  
Part Number 5987-0020

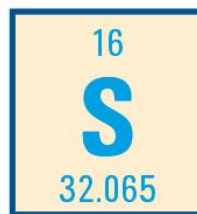
Agilent Self Tightening Column Nut with short graphite polyimide blend ferrule

00:52

The video shows a close-up of a GC column connection. A hand is shown tightening a column nut onto a ferrule. The ferrule is a short, curved, light-colored piece. The column nut is a black, cylindrical piece. The video is titled 'Better\_GC\_Connections\_08c-FINAL\_3280x720' and features the Agilent Technologies logo and part number 5987-0020. A text box at the bottom right identifies the components as 'Agilent Self Tightening Column Nut with short graphite polyimide blend ferrule'. The video player interface shows a progress bar at 00:52.



**Technical Support**



**1-800-227-9770, #3**

**1 (214) 883-2260 (Eric)**



**E-mail:**

**[gc-column-support@agilent.com](mailto:gc-column-support@agilent.com)**

**[Eric.pavlich@agilent.com](mailto:Eric.pavlich@agilent.com)**

