

New 7693 Autosampler and Multimode Inlet for Drinking Water Analysis

Easier Methods Development
and Improved GC and GC/MS
Sensitivity

Mike Szelewski
Agilent Technologies
Wilmington, DE
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If you could...

Run more samples in your sequence

Improve detection limits

Automate tedious sample and standard preparation steps

Handle active compounds better than before

Make large volume injections without spending a long time on method development

Get better precision

...wouldn't you be happy!



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Two New Products from Agilent to Enhance Lab Productivity



Agilent 7693A Automatic Sampler



Agilent Multimode Inlet



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New 7693A Automatic Liquid Sampling System



**New Injector with 16
Vial Positions**



**New Tray with 150
Vial Positions**



7693A Injector & Tray Features

- 16 (Injector) and 150 (Tray) , 2mL samples
- Removable, 50 vial sample trays
- Injections from 1-50% of syringe size in 1% increments
- Modular, field repairable
- Self Calibrating, alignment like 7683B
- LVI (Large Volume Injection to 250µl per injection)
- Single Sample Heater, Barcode reader/ mixer
- Active gripper
- Compatible with all 6890, 7890, 7820 and 6850 (Injector Only)
- Optional heater/chiller plate (requires circulating bath)

Setting (injecting into S/SL inlet)	Precision (%RSD)
20% to 50%	0.30%
10%	0.80%
2%	1-2%
1%	3-5%



Removable 50 Vial Sample Tray for 2 ml Samples



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New 16 Sample Capacity in ALS Injector



7673C

7683B

7693A



Sandwich Injections with 7693A

Injection Type

☐ Standard	L1 air gap:	0 μ L
☐ 2-layer Sandwich	L2 volume:	1 μ L
☒ 3-layer Sandwich	L2 air gap:	0.2 μ L
☐ Multiple Injections	L3 volume:	1 μ L
	L3 air gap:	0.2 μ L

- Sandwich Injections are possible with single tower
- Air gaps are optional



Lifetime and Reliability Testing

- Lifetime before failure – 120,000 injections



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Sample Prep Programming Flexibility

Sandwich injections (up to 3 layers with air gap)

- Examples of Simple liquid manipulation
 - ISTD addition
 - Reconstitution
 - Mixing (Requires Bar Code Reader / Heater/ Mixer option)
 - Dilution
 - Derivatization
 - In Vial Extraction



*Ambient
Headspace*



*In-vial
Extraction*



*Small-Volume
Sampling*



Derivatization



Dilution



*Internal Standard
Addition*



*Heating/Mixing
Bar Code*



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Example Sample Prep Method for Preparing Standards

Prepare 7 levels of standards, plus a blank

Add varying amount of solvent to vials with inserts (270 – 300 uL)

- Use a wash bottle as a solvent source in rear tower

Add varying amount of standards to 7 vials (30 – 0.3 uL)

- Stock standards solution in a front turret position

Add fixed amount of ISTD solution to 8 vials (3 uL)

- Stock ISTD solution in a front turret position

Total 100 steps – 50 minutes plus 10 minutes setup



Setup Method

Agilent 7890A

Agilent 7890A Injector Program

☒ Use Injector Program

Commands

Dispense

Heat

Load

Mix sample

Move vial

Pumps

Return All

Wait

Washes

Program step setpoints

From position:

Tray vial

To position:

Back Turret

Vial #:

102

1-150

Position:

2

1-3

Comment:

move vial from 102 to b-2

Append

Insert

Replace

Command help

Sampler program steps

Return all vials

Wash syringe in Back tower, drawing from Wash A1 dispensing into Waste A1 1 times

Move vial from tray vial #101 to back turret position #1

Move vial from tray vial #102 to back turret position #2

Move vial from tray vial #103 to back turret position #3

Load 350 µl from vial Wash A2 with 0 µl airgap

Load 70 µl from vial Sample 1 with 0 µl airgap

Load 350 µl from vial Wash A2 with 0 µl airgap

Load 55 µl from vial Sample 2 with 0 µl airgap

Load 350 µl from vial Wash A2 with 0 µl airgap

Load 45 µl from vial Sample 3 with 0 µl airgap

Move vial from back turret position #1 to tray vial #101

Move vial from back turret position #2 to tray vial #102

Move vial from back turret position #3 to tray vial #103

Cut

Copy

Paste

Move Up

Move Down

OK

Apply

Cancel

Help

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Setup Method

Agilent 7890A

Agilent 7890A Injector Program

☒ Use Injector Program

Commands

Dispense

Heat

Load

Mix sample

Move vial

Pumps

Return All

Wait

Washes

Program step setpoints

From injector: Back

From turret position: Wash A2

Syringe position: Solvent Draw

Syringe offset: Use method value

Plunger volume: 350 μ L

Plunger mode: Absolute

Plunger speed: 500 μ L / min

Delay: Use method value

Air gap: 0 μ L

Comment: Load 350uL using 500uL BACK

Append

Insert

Replace

Command help

Sampler program steps

Return all vials

Wash syringe in Back tower, drawing from Wash A1 dispensing into Waste A1 1 times

Move vial from tray vial #101 to back turret position #1

Move vial from tray vial #102 to back turret position #2

Move vial from tray vial #103 to back turret position #3

Load 350 μ L from vial Wash A2 with 0 μ L airgap

Load 70 μ L from vial Sample 1 with 0 μ L airgap

Load 350 μ L from vial Wash A2 with 0 μ L airgap

Load 55 μ L from vial Sample 2 with 0 μ L airgap

Load 350 μ L from vial Wash A2 with 0 μ L airgap

Load 45 μ L from vial Sample 3 with 0 μ L airgap

Move vial from back turret position #1 to tray vial #101

Move vial from back turret position #2 to tray vial #102

Move vial from back turret position #3 to tray vial #103

Cut

Copy

Paste

Move Up

Move Down

OK

Apply

Cancel

Help



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Setup Method

Agilent 7890A

Agilent 7890A Injector Program

☒ Use Injector Program

Commands

Dispense
Heat
Load
Mix sample
Move vial
Pumps
Return All
Wait
Washes

Program step setpoints

From injector: Back

From turret position: Sample 2

Syringe position: Solvent Draw

Syringe offset: Use method value

Plunger volume: 55 µL

Plunger mode: Absolute

Plunger speed: 500 µl / min

Delay: Use method value

Air gap: 0 µL

Comment: unload 295uL into b2=102

Append

Insert

Replace

Command help

Sampler program steps

Return all vials
Wash syringe in Back tower, drawing from Wash A1 dispensing into Waste A1 1 times
Move vial from tray vial #101 to back turret position #1
Move vial from tray vial #102 to back turret position #2
Move vial from tray vial #103 to back turret position #3
Load 350 µl from vial Wash A2 with 0 µl airgap
Load 70 µl from vial Sample 1 with 0 µl airgap
Load 350 µl from vial Wash A2 with 0 µl airgap
Load 55 µl from vial Sample 2 with 0 µl airgap
Load 350 µl from vial Wash A2 with 0 µl airgap
Load 45 µl from vial Sample 3 with 0 µl airgap
Move vial from back turret position #1 to tray vial #101
Move vial from back turret position #2 to tray vial #102
Move vial from back turret position #3 to tray vial #103

Cut

Copy

Paste

Move Up

Move Down

OK

Apply

Cancel

Help

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Setup Method

Agilent 7890A

Agilent 7890A Injector Program

☒ Use Injector Program

Commands

Dispense
Heat
Load
Mix sample
Move vial
Pumps
Return All
Wait
Washes

Program step setpoints

Wait time: 0.2 min

Comment: end of method

Append

Insert

Replace

Command help

Sampler program steps

Dispense 3 µL from vial Sample 3 to vial Sample 2 on the Front tower
Move vial from front turret position #1 to tray vial #104
Move vial from front turret position #2 to tray vial #103
Move vial from tray vial #102 to front turret position #1
Move vial from tray vial #101 to front turret position #2
Pump syringe in Front tower in Sample 3 vial 3 times
Dispense 3 µL from vial Sample 3 to vial Sample 1 on the Front tower
Dispense 3 µL from vial Sample 3 to vial Sample 2 on the Front tower
Move vial from front turret position #1 to tray vial #102
Move vial from front turret position #2 to tray vial #101
Move vial from front turret position #3 to tray vial #110
Wash syringe in Front tower, drawing from Wash A1 dispensing into Current waste vial 10 times
Wash syringe in Front tower, drawing from Wash B1 dispensing into Current waste vial 10 times
Wait for 0.2 minutes

Cut

Copy

Paste

Move Up

Move Down

OK

Apply

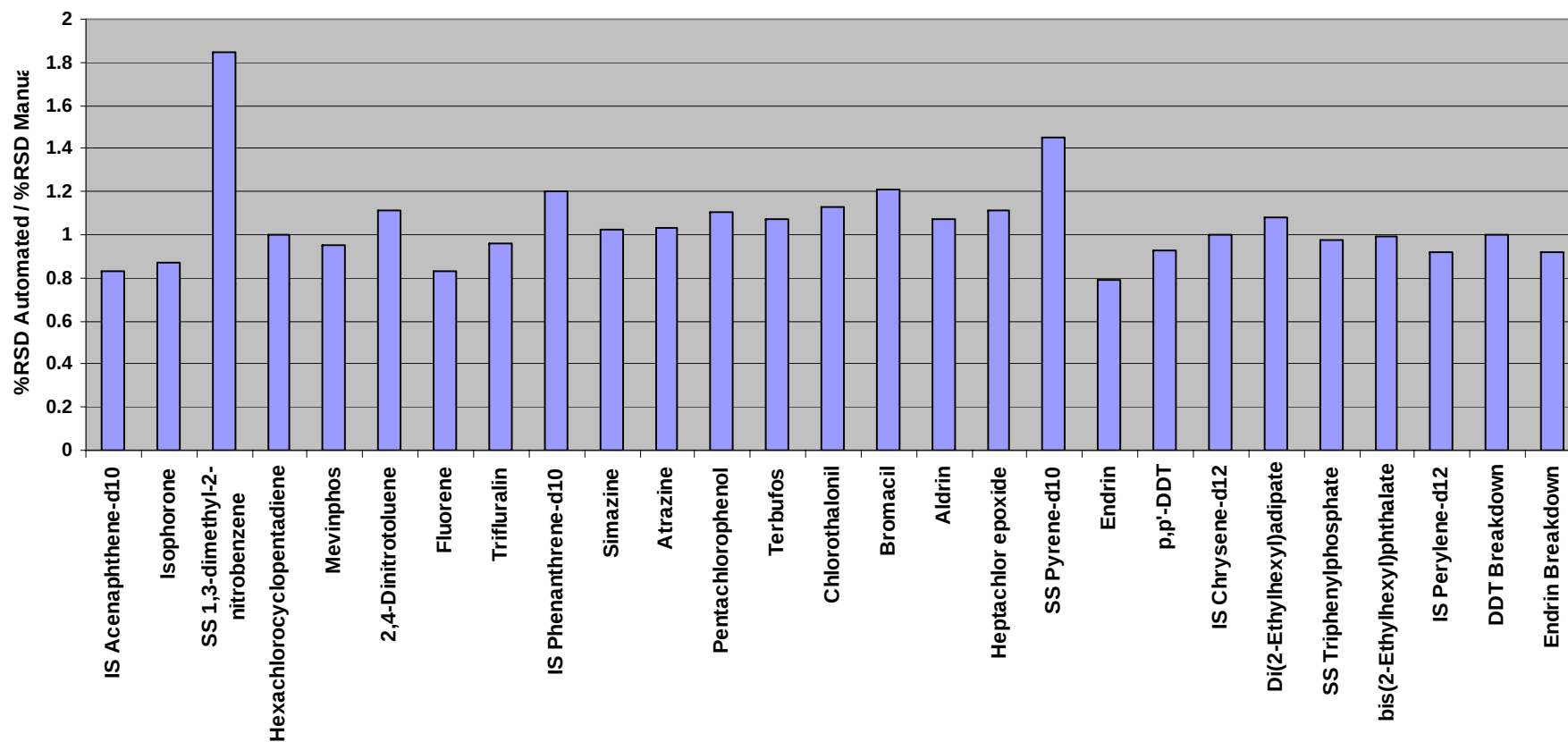
Cancel

Help



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Compare Manual prep vs 7693A prep, Ratio of %RSDs of RRFs from 7 level cal



7693A is as good as a skilled chemist when making a 7-level calibration set



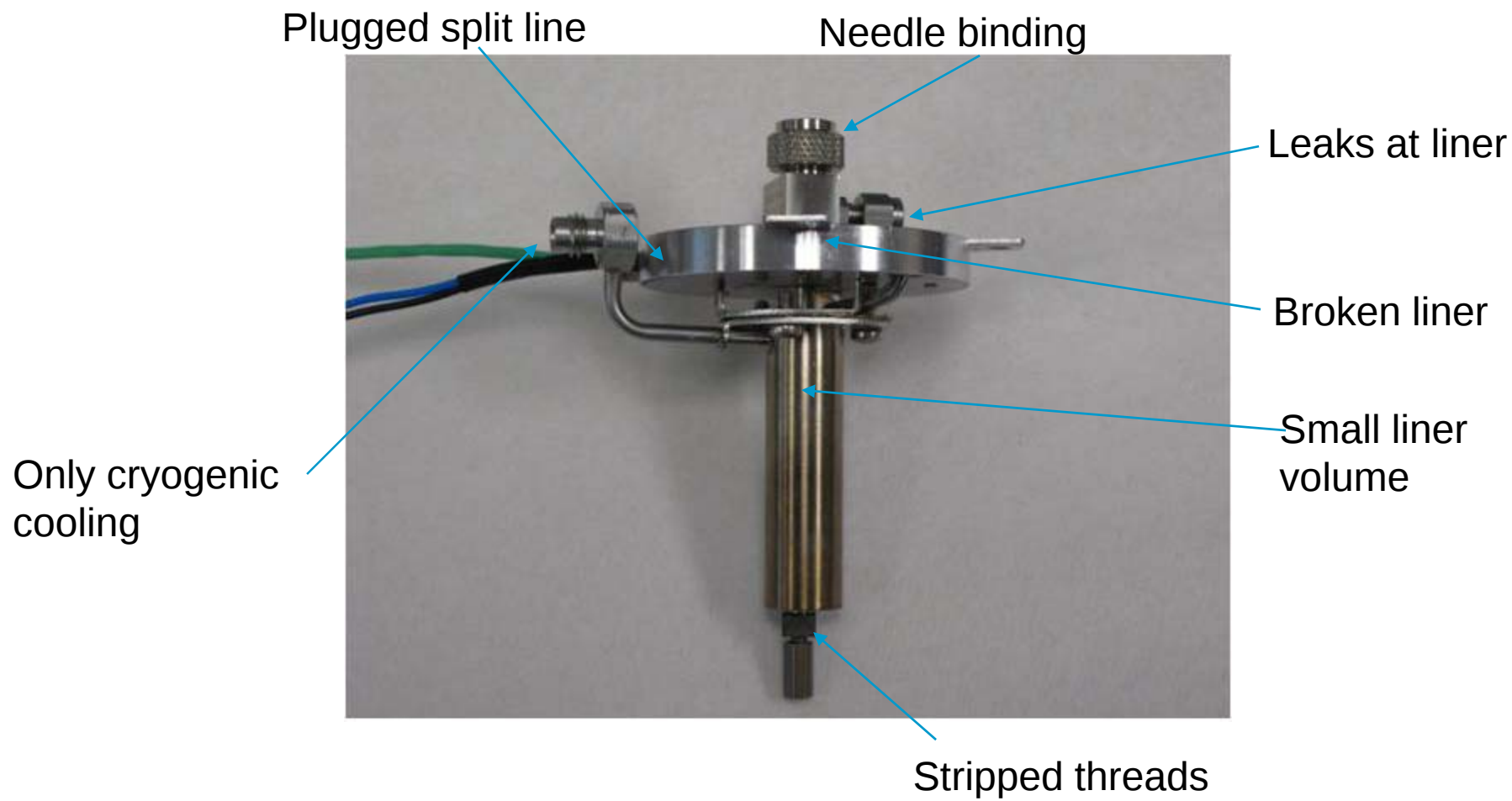
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New Multimode Inlet for Gas Chromatography



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Current Agilent PTV – Support Issues



Agilent's **New** Programmable Inlet - MMI

7890 standard
pneumatics

Air plus CO₂, N₂
cryogenic cooling

7890 standard
capillary fitting



7890 turn-top

Uses 7890 S/SL
liners, septa and
o-rings

Thermocouple
sensing



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Agilent Multimode Inlet Features

Hardware

Temperature range of -160°C to 450°C

Heating @ 15°C/sec

Septum/Liner Easily Changeable

Injection Modes: Hot S/SL, Cold S/SL, PTV in pulsed mode, solvent vent mode, residue removal mode

Support for single stroke injections from 0.1 µL to 250 µL

EPC Compatible with Packed Liners

Compatible with 7890A, 5975C, 7683A/B, CTC Combi PAL

Software

Ten temperature ramps

Solution for solvent vent timing

Integrated into ChemStation, MSD ChemStation, EZChrom, MassHunter



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MMI Programmable Temperature Vaporizing Inlet – injection modes

Hot split/splitless (also pulsed)

- similar to the S/SL inlet using the same liners

Cold split/splitless (also pulsed)

- Significantly more inert than hot splitless
- Can inject 3-5 uL with no solvent venting
- Better sensitivity than hot splitless because large vapor cloud is not formed which travels outside the liner and portions are lost

LVI-Solvent Vent

- An extension of cold splitless
- Large volume injection for maximum sensitivity

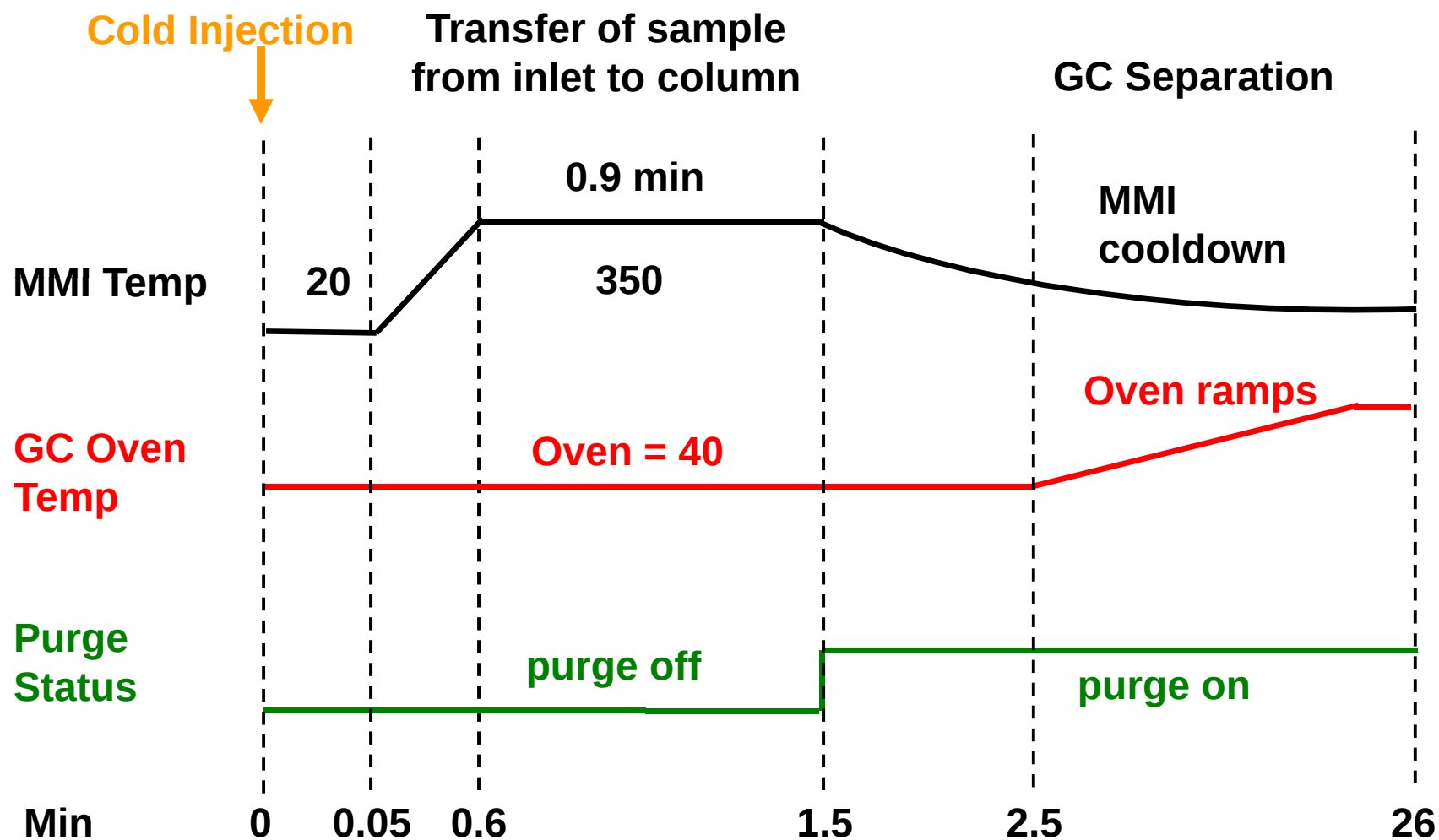


Multiple Mode GC Inlet - Cold Injections

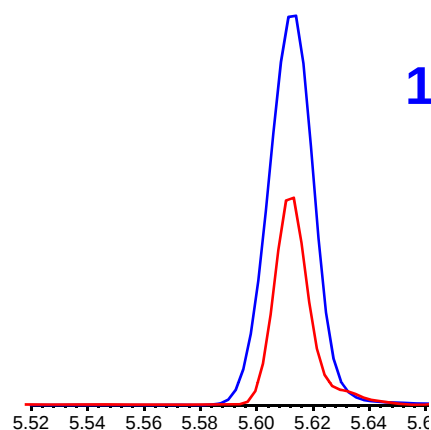
- No syringe-needle discrimination; Minimal inlet discrimination
- No special syringes, liners or consumables
- Large volume injection (5ul to 250ul) - lower detection limits
- Solvent vent/matrix vent - decrease interference / maintenance
- Flexibility (hot/cold split/splitless, temperature programmed vaporization)
- Cold trapping in liner - improves chromatographic peak shape, resolution
- Capillary column backflush with CFT - decreases cycle time, maintenance



MMI Cold Splitless and SV – Temperature and Flow Programs

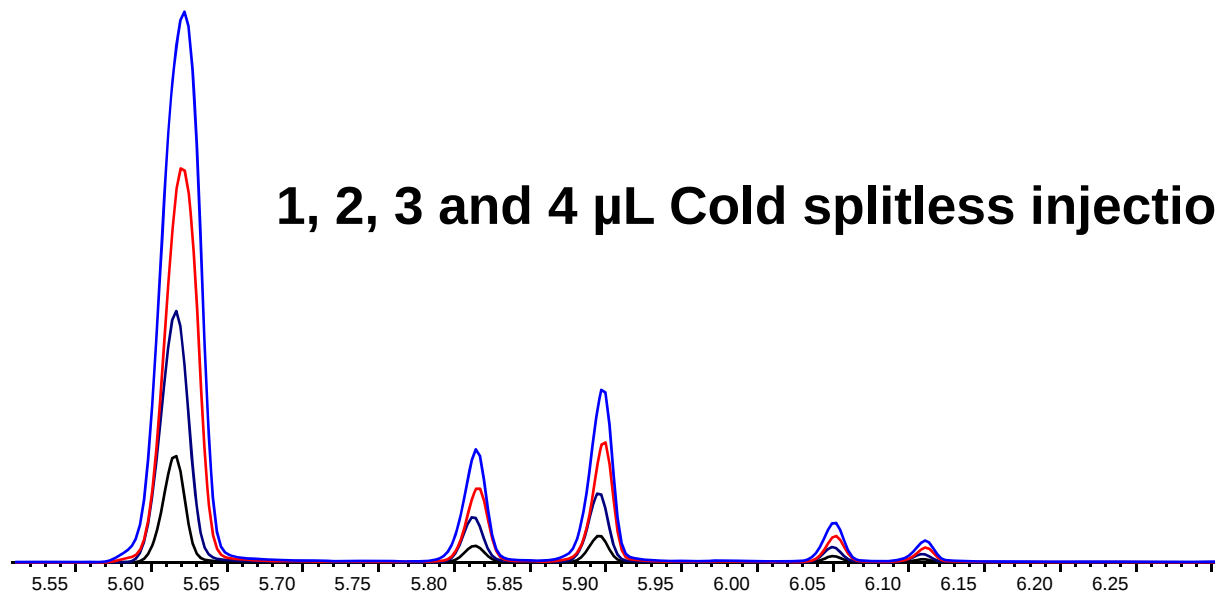


Multimode Injection of Triazine Herbicides



1µL Cold Splitless injection

1µL Hot Splitless injection



1, 2, 3 and 4 µL Cold splitless injections (ethyl acetate)



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Compare cold to hot splitless S/N using the new Multimode Inlet on a 7890-5975 GC/MSD system

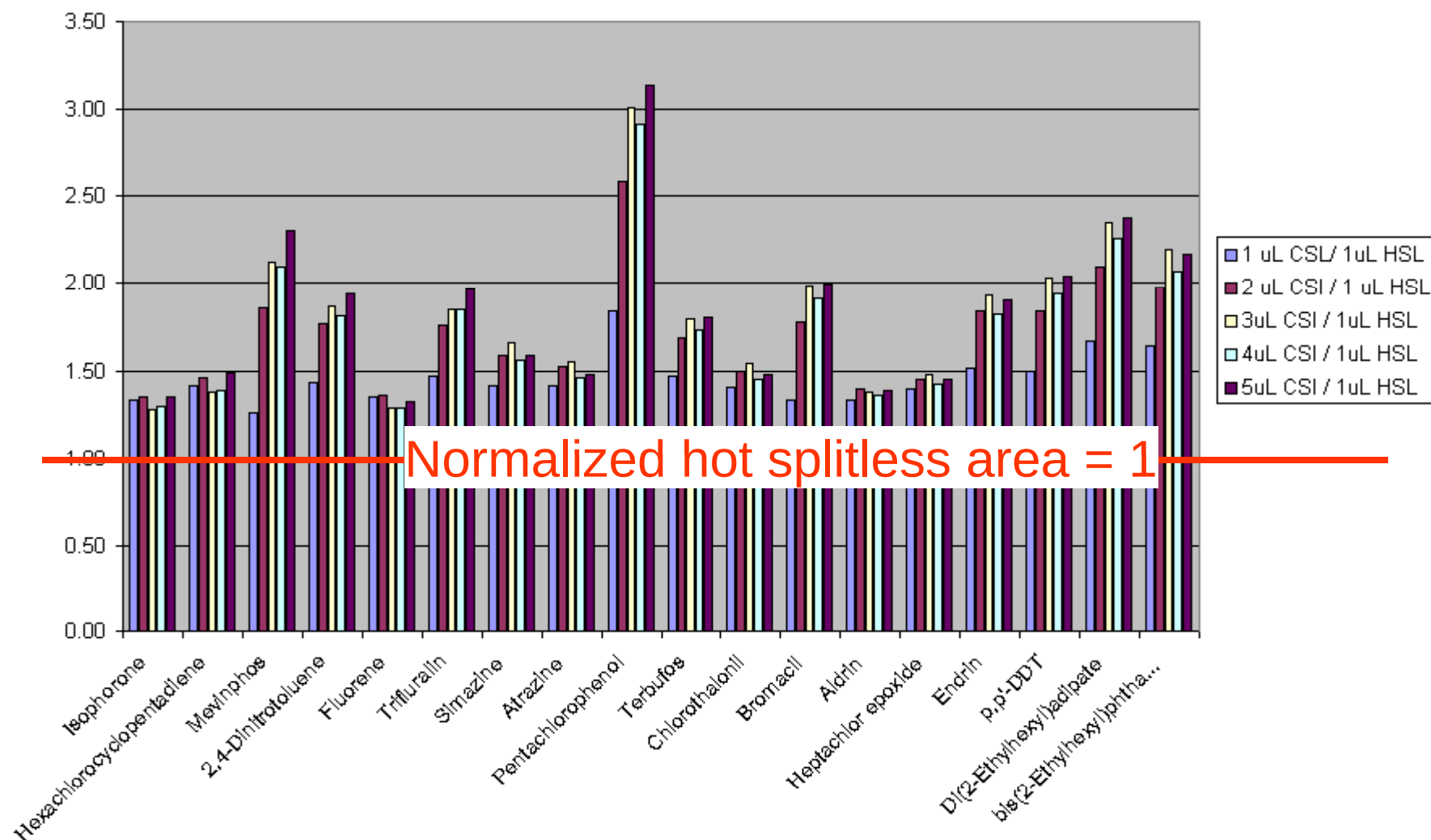
Most “active”
compound
gives largest
improvement



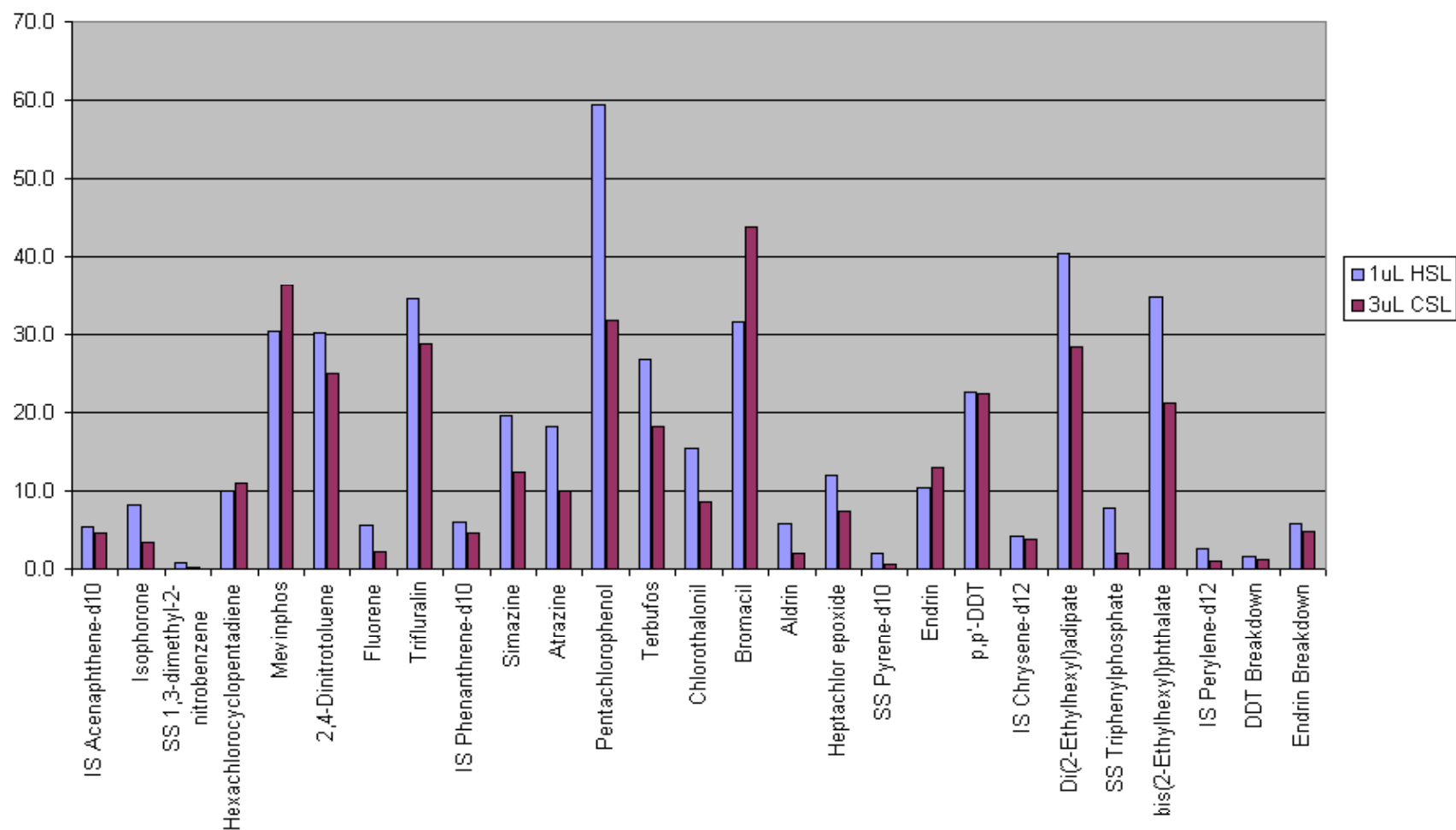
	RT	Mass	Ratio Cold S/N : Hot S/N
Fluorene	11.152	166	1.36
Aldrin	15.205	66	1.33
		263	1.33
Mevinphos	9.338	127	1.33
Pentachlorophenol	12.989	266	2.19
Endrin	17.600	263	1.48
p,p'-DDT	18.600	235	1.51



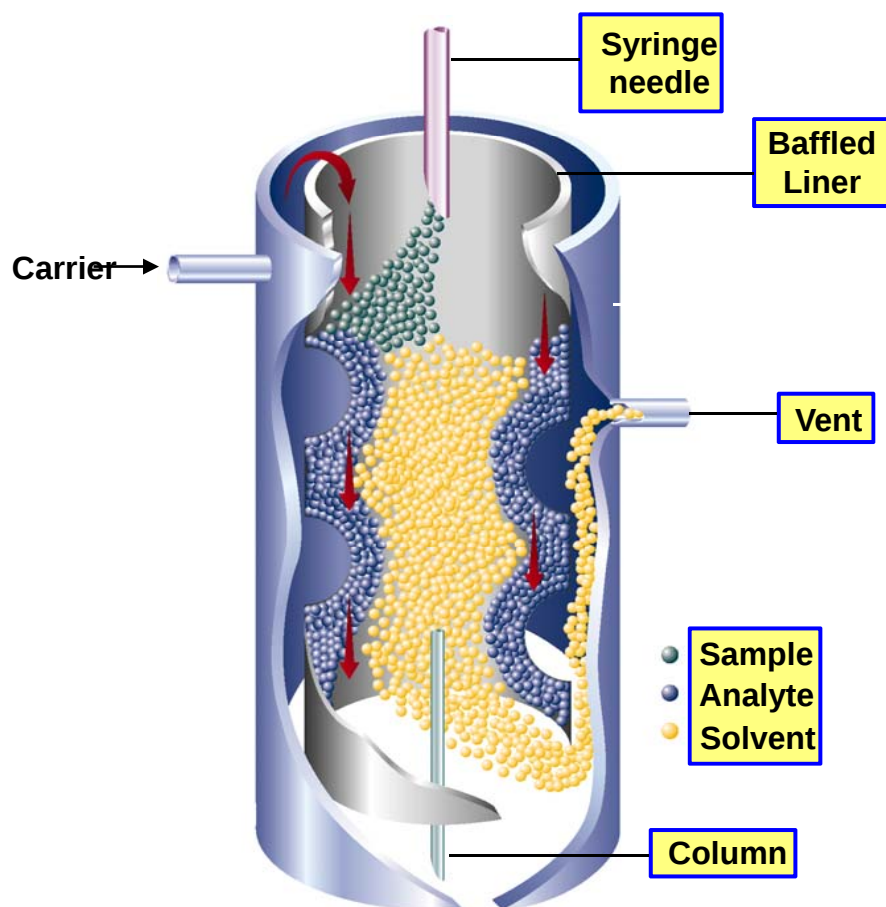
Area Ratios of 1-5 uL Cold SL to 1 uL Hot SL using the New MMI, single taper helix liner



Compare hot-to-cold splitless %RSDs using the new MMI on a 7890-5975 GC/MSD system, 7 level cal



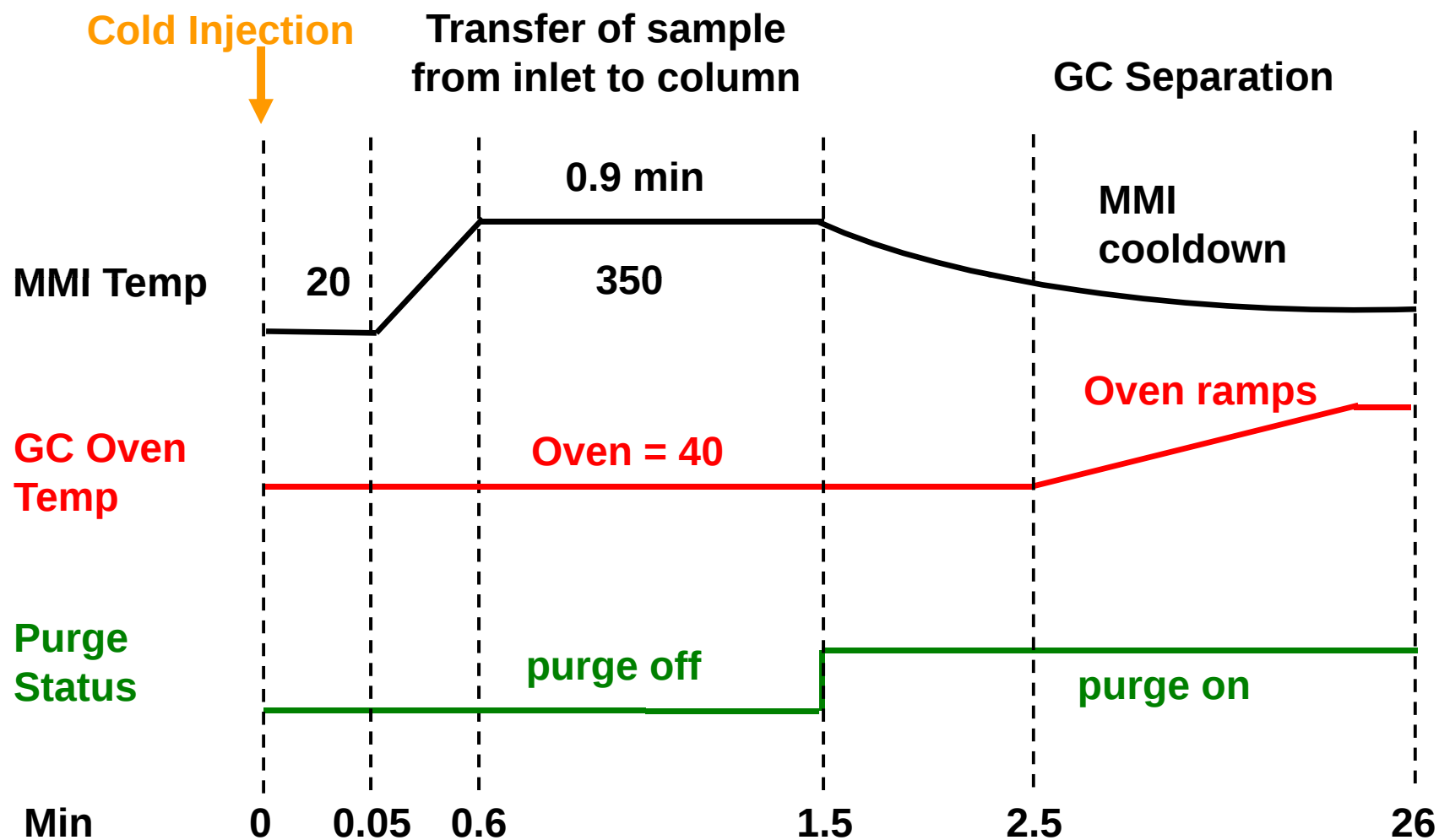
PTV - Solvent Vent (elimination) Mode



- Set inlet temperature at or below solvent boiling point
- Set high split ratio
- Inject sample very slowly into PTV
- Solvent evaporates through split vent
- Close split vent and ramp PTV temperature
- Carry out separation on analytical column



MMI Cold Splitless and SV – Temperature and Flow Programs



New Multimode Inlet “Solvent Elimination Wizard” Built-into ChemStation for Easy Method Development

The screenshot displays the Agilent ChemStation Multimode Inlet (MMI) configuration interface. On the left, a sidebar lists system information: Agilent 7890A at IP Address: 130.30.245.72, Serial Number: US10739024, Firmware Revision: A.01.10.MMI_TEST09, Software Driver Version: 1.00 [000], 11:07:00 AM, GC Connection State: Online, GC RunState: Idle, ALS Run State: Idle, GC Ready State: Ready, Oven Temperature: 50.0 °C, Front Inlet (MM Inlet): Temperature: 40.1 °C, Pressure: 0.174 psi, Flow: 1.374 mL/min, Septum Purge Flow: -0.1 mL/min, Back Inlet (PP Inlet): Temperature: 40.0 °C, Pressure: 0.091 psi, Flow: 0.000 mL/min, Septum Purge Flow: 0.0 mL/min, Front Detector (TCD): Temperature: 40.6 °C, Utility Flow: 0.043 mL/min, Makeup Flow: -0.016 mL/min, Signal Value: 0.0, and Back Detector (FID): Temperature: 39.5 °C.

The main MMI configuration area includes the following settings:

- MM Inlet:**
 - ☒ Heater:
 - ☐ Pressure: 10 psi
 - Total Flow: 25 mL/min
 - ☒ Septum Purge Flow: 3 mL/min
- Mode:** PTV Solvent Vent
- Purge Flow to Split Vent:** 60 mL/min at 6.13 min
- Solvent Elimination Calculator...** (highlighted with a red circle and a yellow callout box)
- Total Estimated Injection Time:** 0.025536 min
- Gas Saver:** ☐ On, 20 mL/min After: 2 min
- Cryo:** ☐ On, ☐ Fault Detection, ☐ Timeout Detection
- Cryo Use Temperature:** 0 °C
- Timeout:** 10 min

A yellow callout box points to the 'Solvent Elimination Calculator...' button with the text: Solvent Elimination Calculator...

At the bottom, there are buttons for: Help, Get Signal Info, Upload Method from GC, Download with Audit Trail, Apply (Download), OK (Exit&Download!), and Done.



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Solvent Elimination Calculation Wizard

Solvent Elimination Calculator

Agilent
Solvent Elimination
Calculation Wizard



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Welcome to the Solvent Elimination Calculator!

Step 1

Please supply the following information.

If you don't know the first analyte boiling point, leave it at 150 °C.

Solvent:

acetone

Injection Volume (uL)

50 uL

Boiling Point of first eluting analyte (°C)

150 °C

LVI Method Help

Next

Cancel

Help



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Time for Optimal Solvent Elimination Relates to Temperature, Pressure, Flow, Type and Volume

Solvent Elimination Calculator

Agilent
Solvent Elimination
Calculation Wizard

Calculated values will change each time an input parameter is modified.

Step 2

Elimination Rate ($\mu\text{L}/\text{min}$) 27.58 Suggested Injection Rate ($\mu\text{L}/\text{min}$) 13.79 Suggested Vent Time (min) 3.63

Inlet Temperature ($^{\circ}\text{C}$) Vent Pressure (gauge) ☐ kPa
Vent Flow (mL/min) Outlet Pressure (gauge) ☒ psi
Injected Volume (μL) ☐ bar

Solvent

LVI Method Help Previous Next Cancel Help



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Upload Parameters to your Method

Solvent Elimination Calculator

Agilent Solvent Elimination Calculation Wizard

Step 3

Confirm Copy values to Method Editor.
(Check parameters to change.)

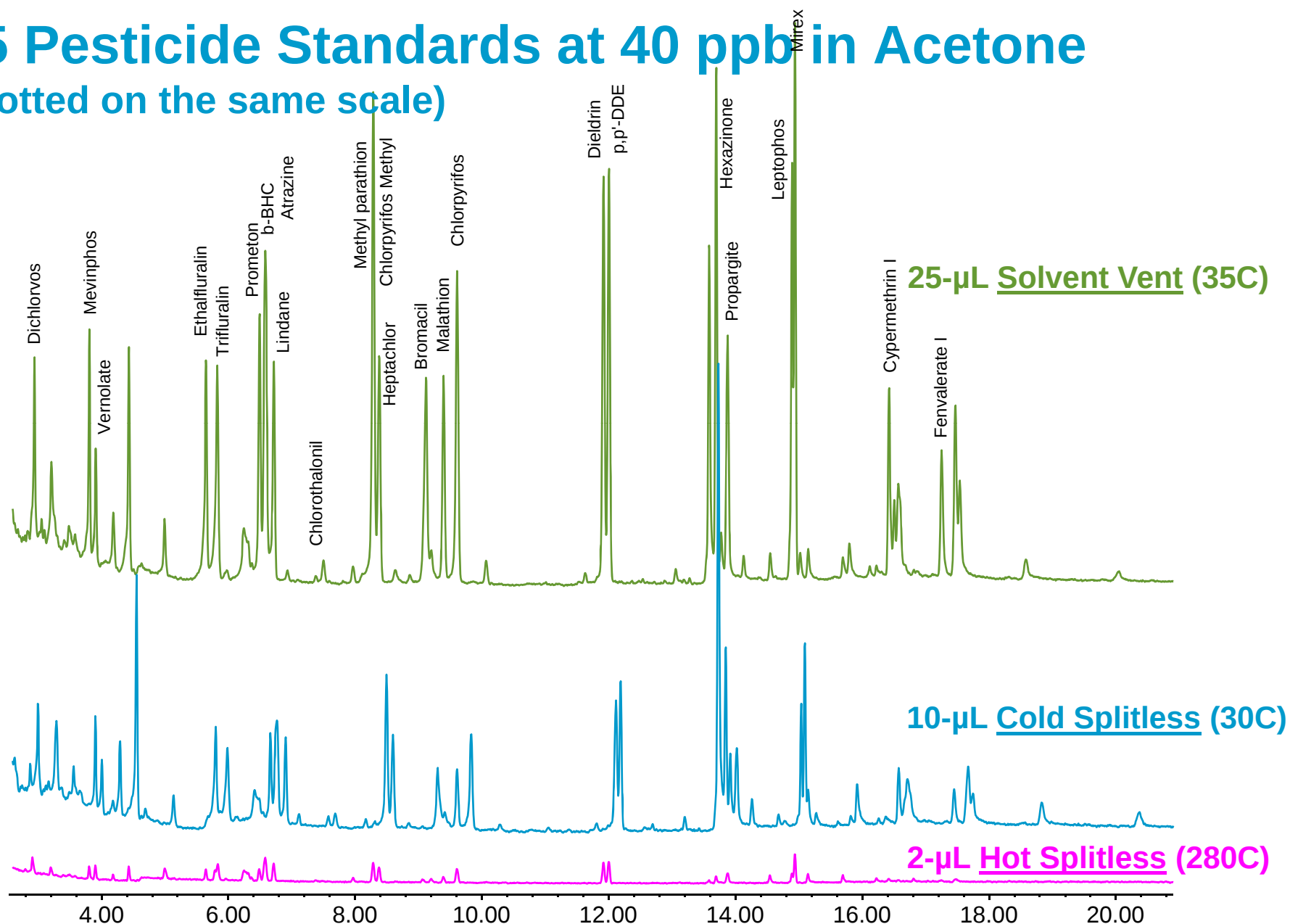
All inlet & injection parameters determined for you

☒	Inlet temperature	5 °C
☒	Initial hold time	3.63 min
☒	First ramp rate	600 °C/min
☒	First temperature	325 °C
☒	First hold time	5 min
☒	Vent time	3.63 min
☒	Vent pressure	5 psi
☒	Vent flow rate	100 mL/min
☒	Purge time	6.13 min
☒	Purge flow rate	60 mL/min
☒	Injection volume	50 µL
☒	Injection rate	14 µL/min
☐	Oven initial temperature	50 °C
☐	Oven initial hold time	6.13 min

LVI Method Help Previous **Confirm and Copy** Cancel Help

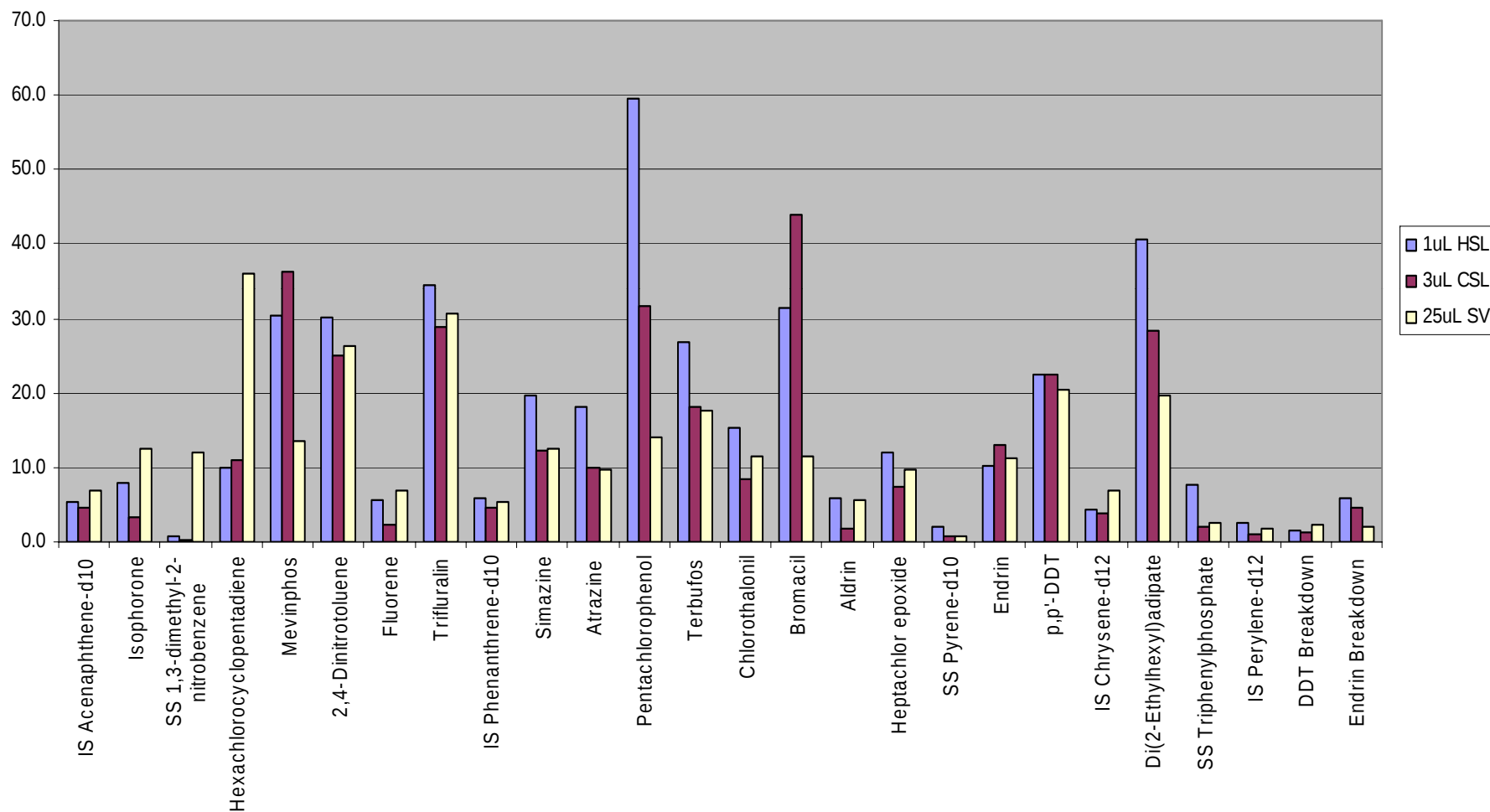
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25 Pesticide Standards at 40 ppb in Acetone (plotted on the same scale)



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Compare Hot SL, Cold SL and SV - %RSDs of 7 Level Cal using the new MMI on a 7890-5975 GC/MSD system



SL=100-10,000 ppb, SV=1-100 ppb



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MMI LVI-SV, Save Time and money with Reduced Sample Prep

Assume the concentration of a water sample is 1ng/mL

Concentrate before inj ...

- Sample Volume = 1000 mL
- Extract 1000 mL and reduce to 1 mL

Conc = 1000 ng/mL

- Inject 1 μ L into the GC
- Amount injected = 1 ng

Use LVI instead ...

- Sample Volume = 100 mL
- Extract 100 mL and reduce to 1 mL

Conc = 100 ng/mL

- Inject 100 μ L into GC
- Amt injected = **10 ng**



New MMI-LVI Methods Development

Where do I start ?

Much easier to develop methods with the new inlet – liner, column and starting conditions remain intact !

- 1 ul injection of your standard in splitless mode
- 3-5 uL injection in cold splitless – stop here if good sensitivity
- 5 ul injection in solvent vent mode
- 25 ul injection in solvent vent mode
- Move up in volume from here if necessary

Always use an empty vial as a test for LVI single or multiple injections



Agilent's New GC Products

- **Agilent's New 7693A ALS increases sample throughput**
 - Auto-alignment, easy installation
 - 16 position injector and 150 sample tray
 - Removable 50 ml vial racks for easy sample loading and storage
- **Automation of common sample prep steps with the 7693A**
 - increases productivity and decreases operator variability
- **A new "Multimode" GC inlet provides flexibility:**
 - Hot or Cold Split, Splitless or Large Volume injections
 - Facilitates solvent venting, residue venting and backflush
 - Easy method development for large volume injections

