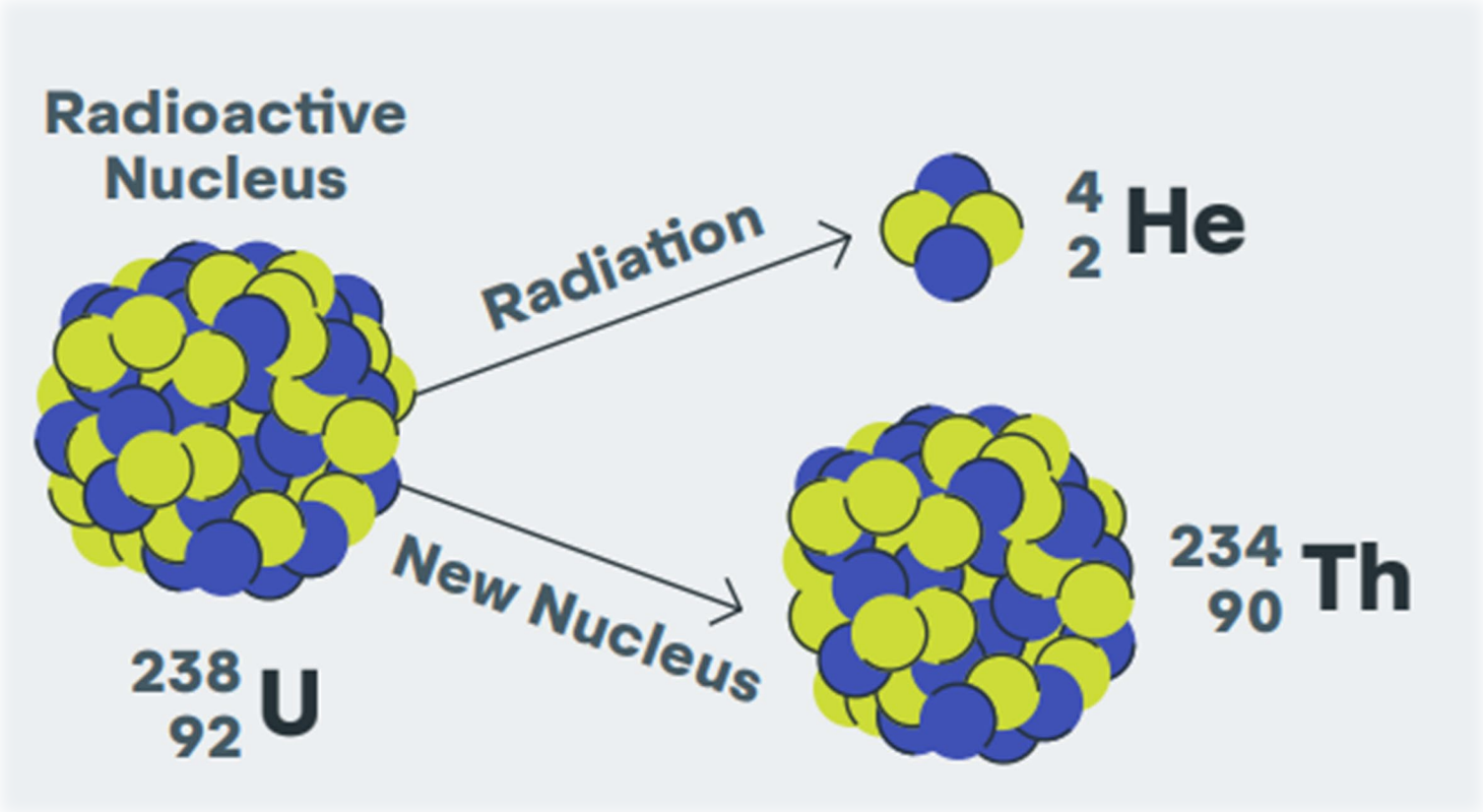
Evaluation of Hydrogen as an Alternative Carrier Gas for GC-MS/MS Analysis of Pesticides

Victor Cutillas and Amadeo R. Fernández-Alba

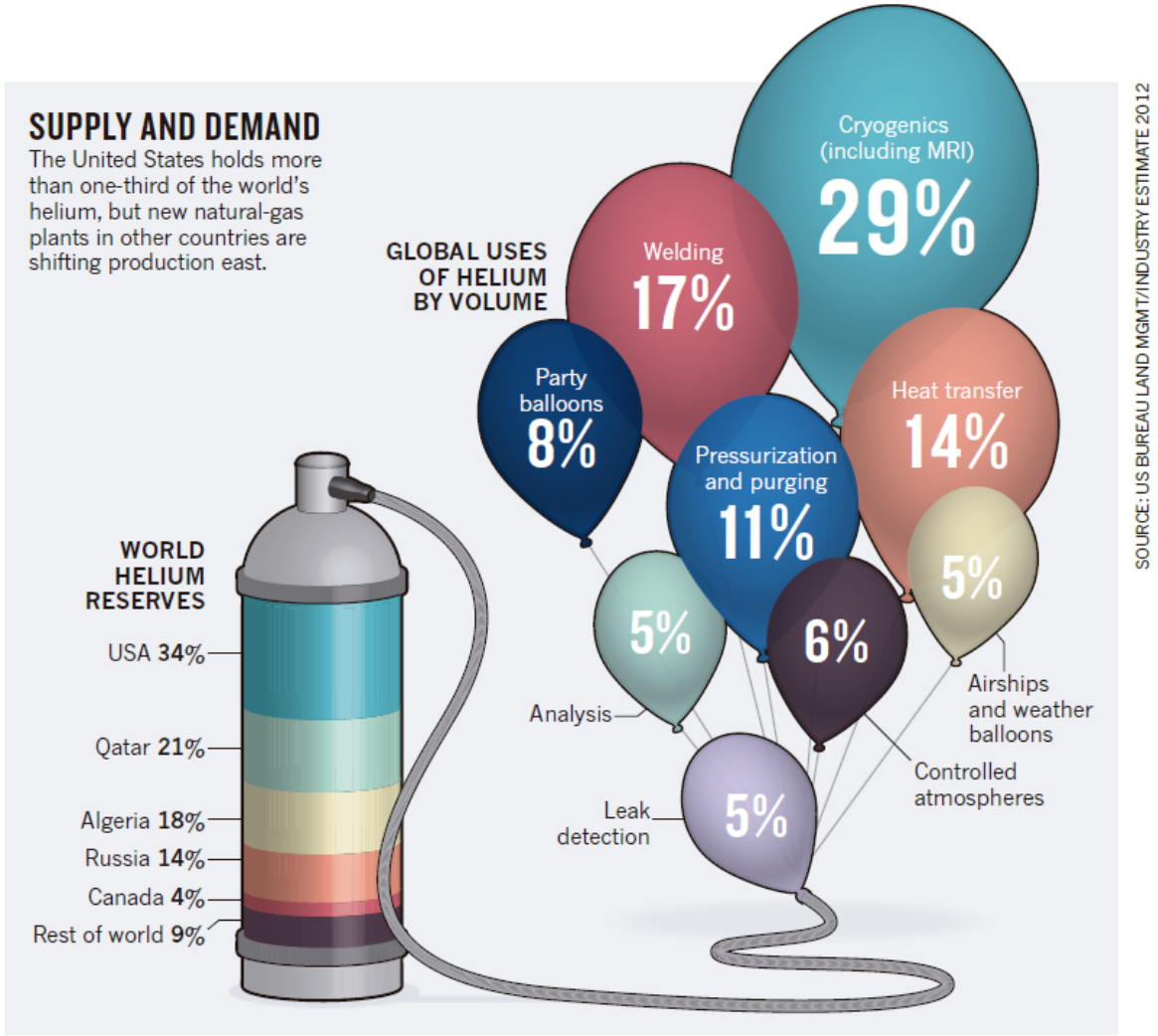
The majority of helium originates from the radioactive decay of uranium and thorium. This gas is located under the Earth's crust, alongside other natural gases. When the helium concentration surpasses 0.3%, it is commercially extracted from natural gas.



Helium – A gas facing extinction. ACS Green Chemistry institute

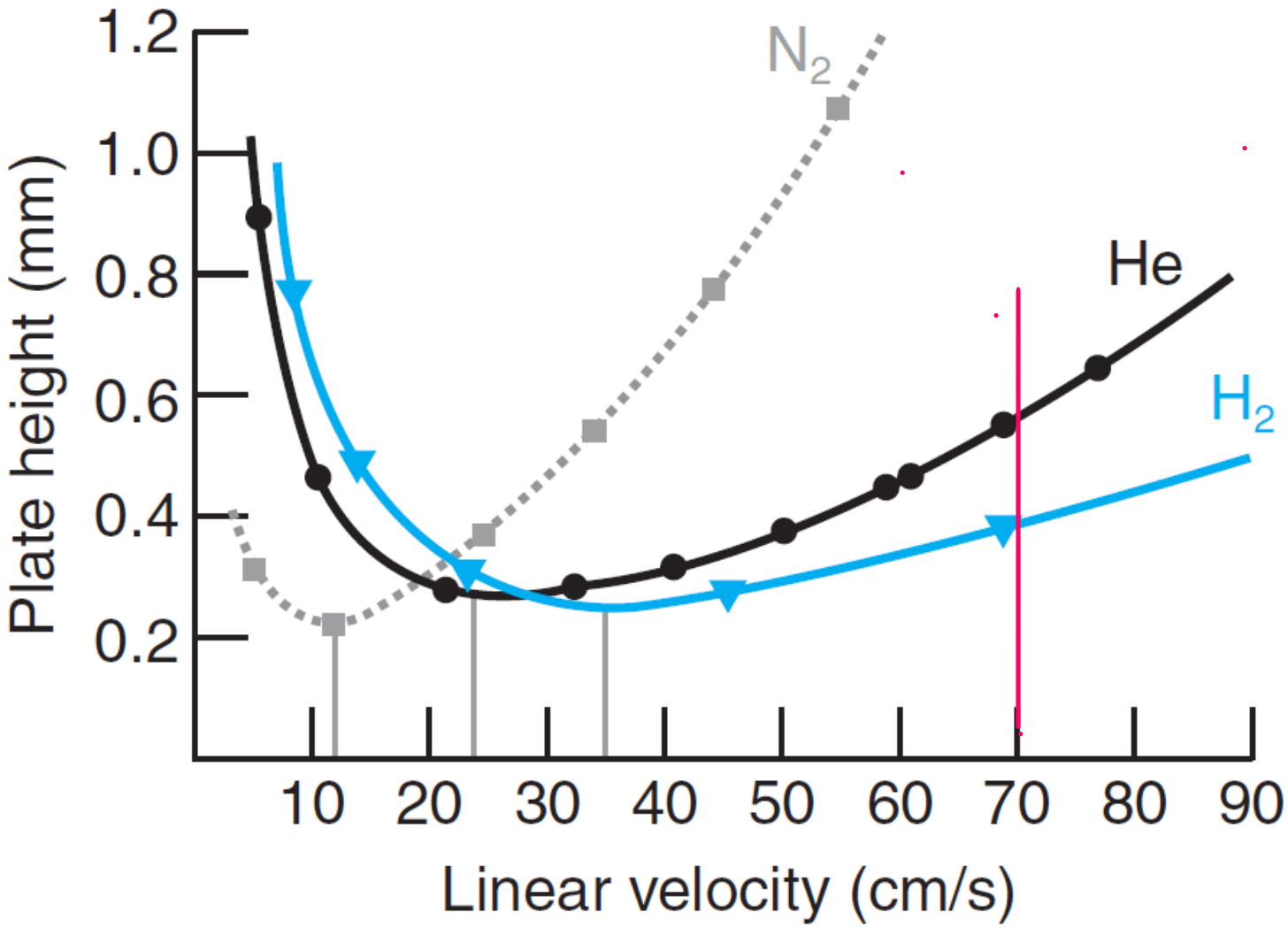
Helium shortage

Nuttall, W. J.; Clarke, R. H.; Glowacki, B. A. Stop Squandering Helium. *Nature* **2012**, *485* (7400), 573–575.



Hydrogen generator
Precision Trace 250cc

- Suitable for flame gas and carrier gas at trace detection limits
- 99.9999% purity
- Internal leak detection with automatic shutdown features
- Proven PEM technology to generate hydrogen safely and reliably
- Regenerative PSA dryers to ensure highest level of purity
- Automatic loading pump as standard
- Maintenance limited to replacing de-ionizer cartridge
- Creates hydrogen on demand, minimal storage of hydrogen in the system
- Short and easy start-up and shutdown procedures



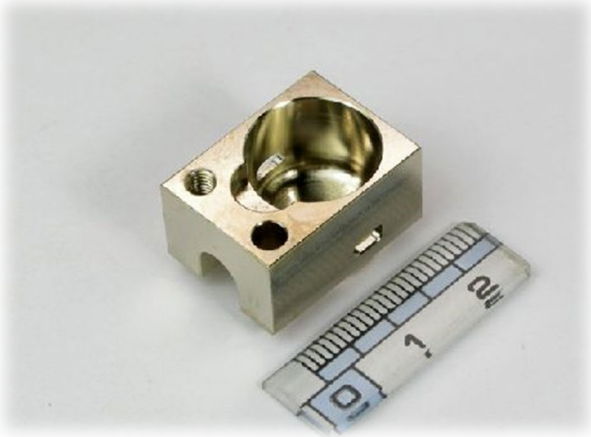
Quantitative Chemical Analysis, Daniel C. Harris, 8th Edition

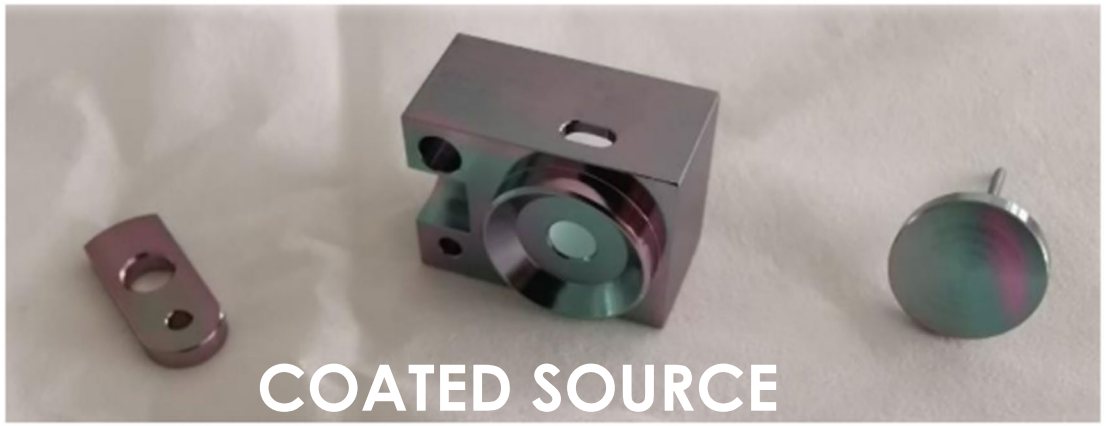
	Helium	Nitrogen	Hydrogen
Diffusivity	+	-	+ +
Viscosity	-	-	+
Cost	- -	+	+
Availability	- -	+	+
Inertness	+	+	-
Others	For some detection techniques (e.g. BID) it is the only solution	Peak resolution worsens with increasing velocities	Cannot be used with some detectors, explosion risk (!)
Conclusion	Ideal carrier gas	Alternative to helium for easy to separate components	For many applications, good results and faster

Shimadzu solutions for helium shortage – Nerea Lorenzo Parodi

INERTNESS

Hydrogenation/dechlorination of some compounds





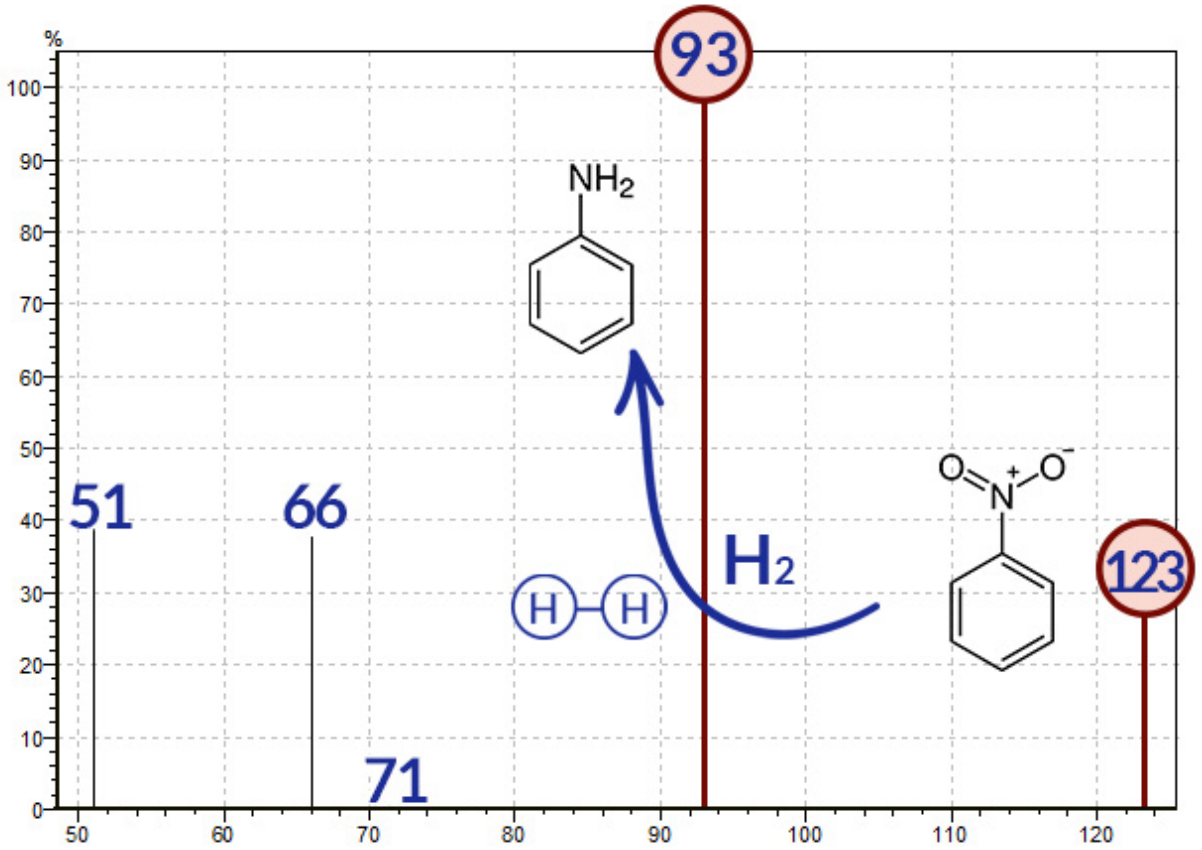
Vacuum performance

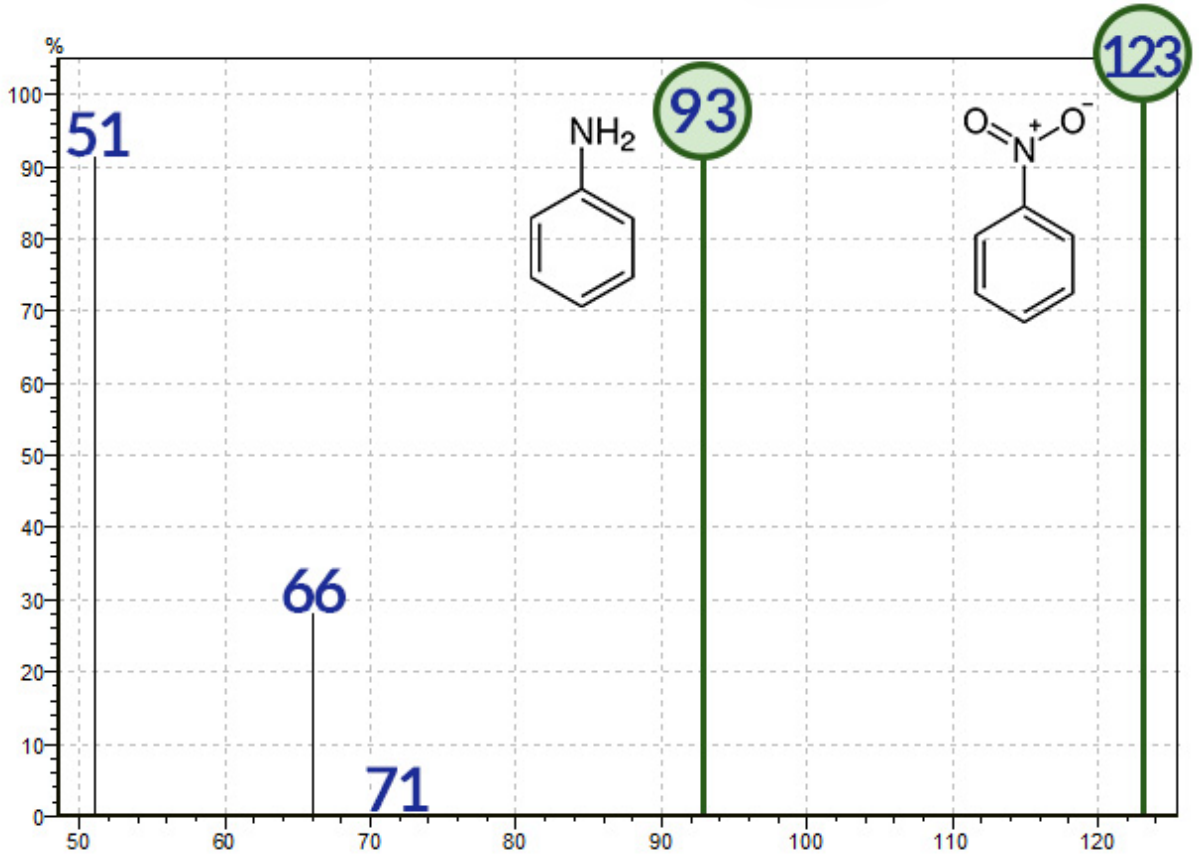
Use narrow-bore chromatographic columns (0.15-0.18 mm) and low carrier gas flow rates.

INERTNESS

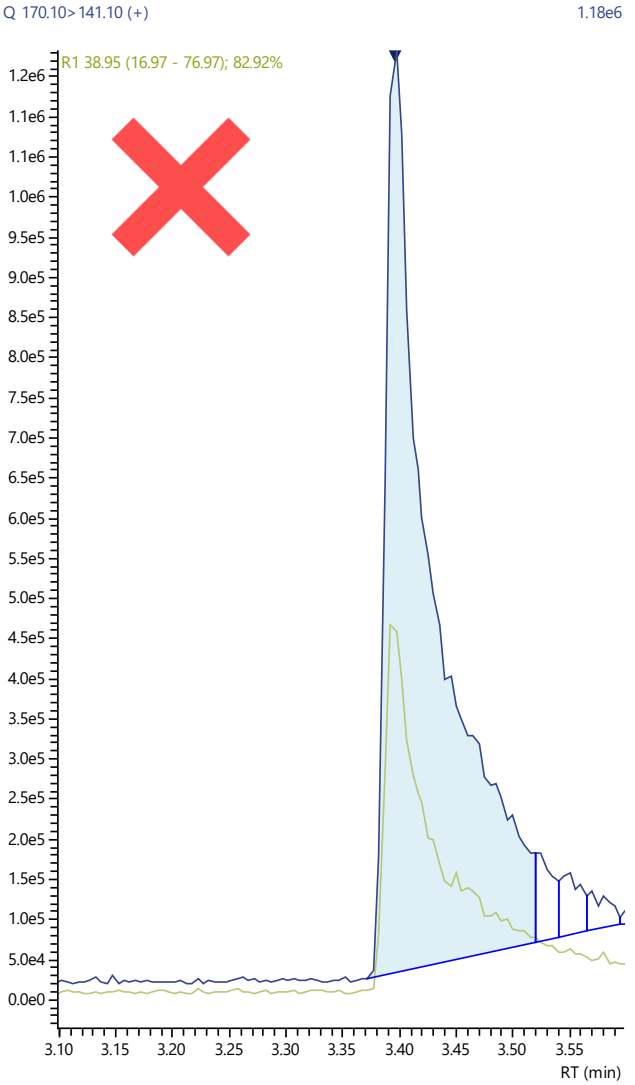
NITROBENZENE TEST

1ppm Nitrobenzene standard





2-Phenylphenol HYDROGENATION



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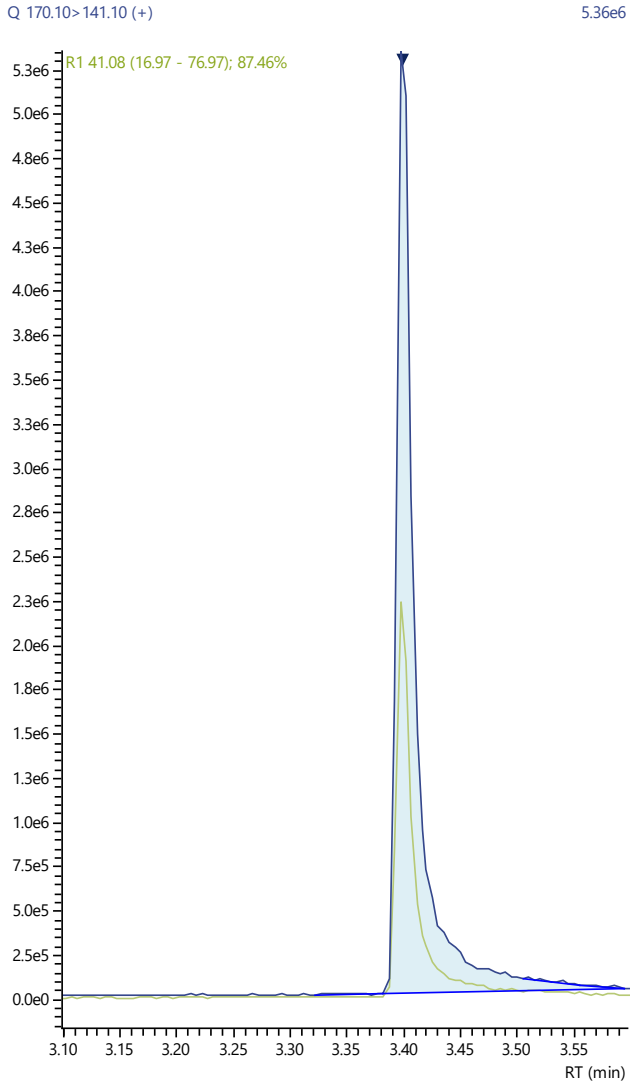
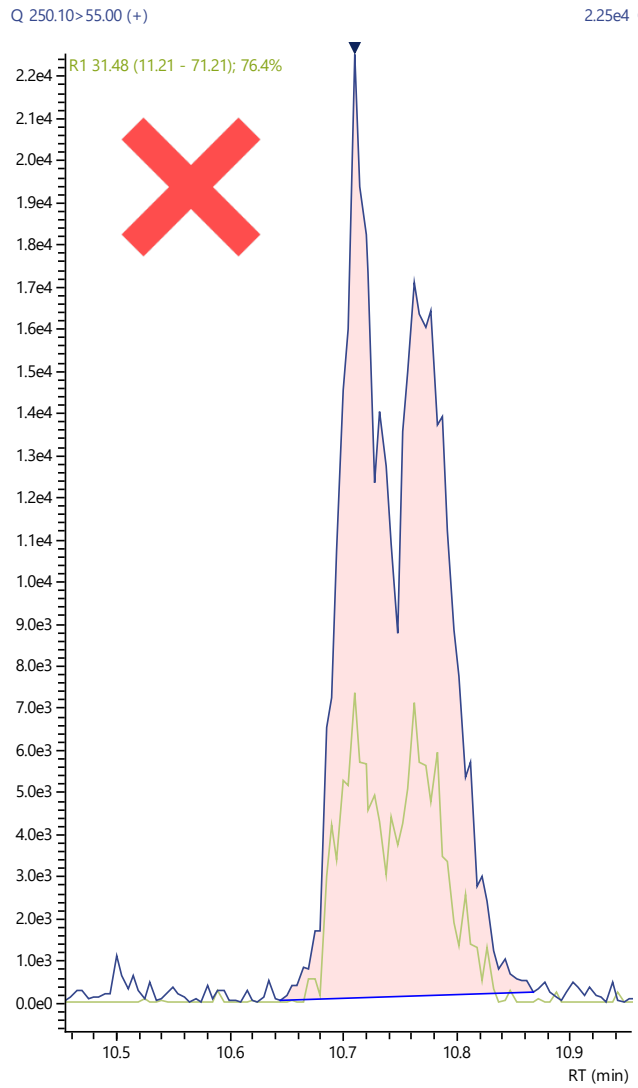
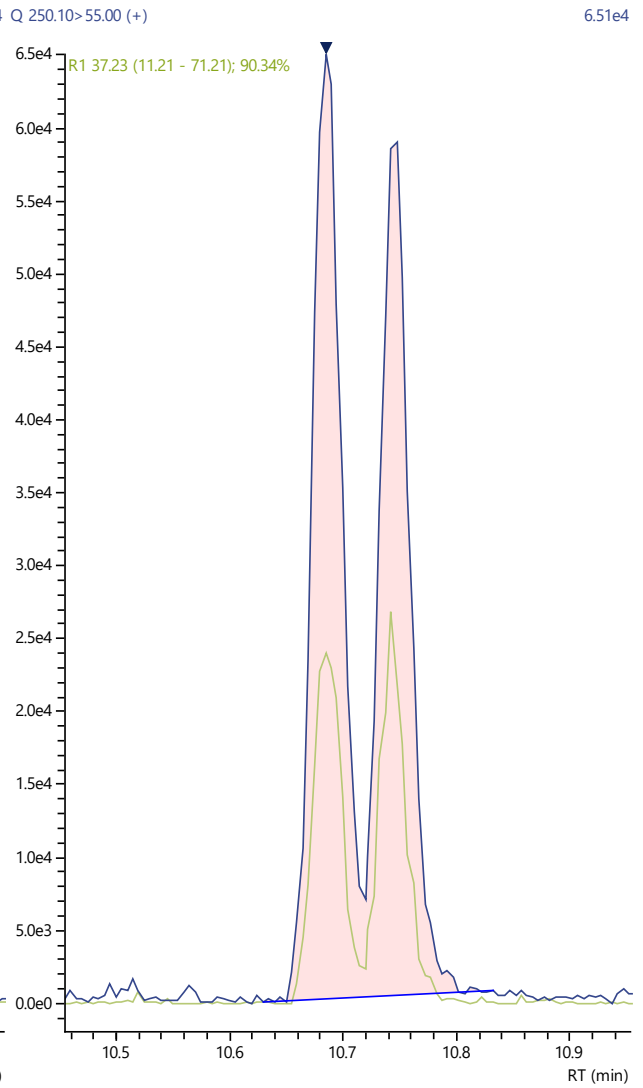


Tau-Fluvalinate HYDROGENATION



Tau-Fluvalinate



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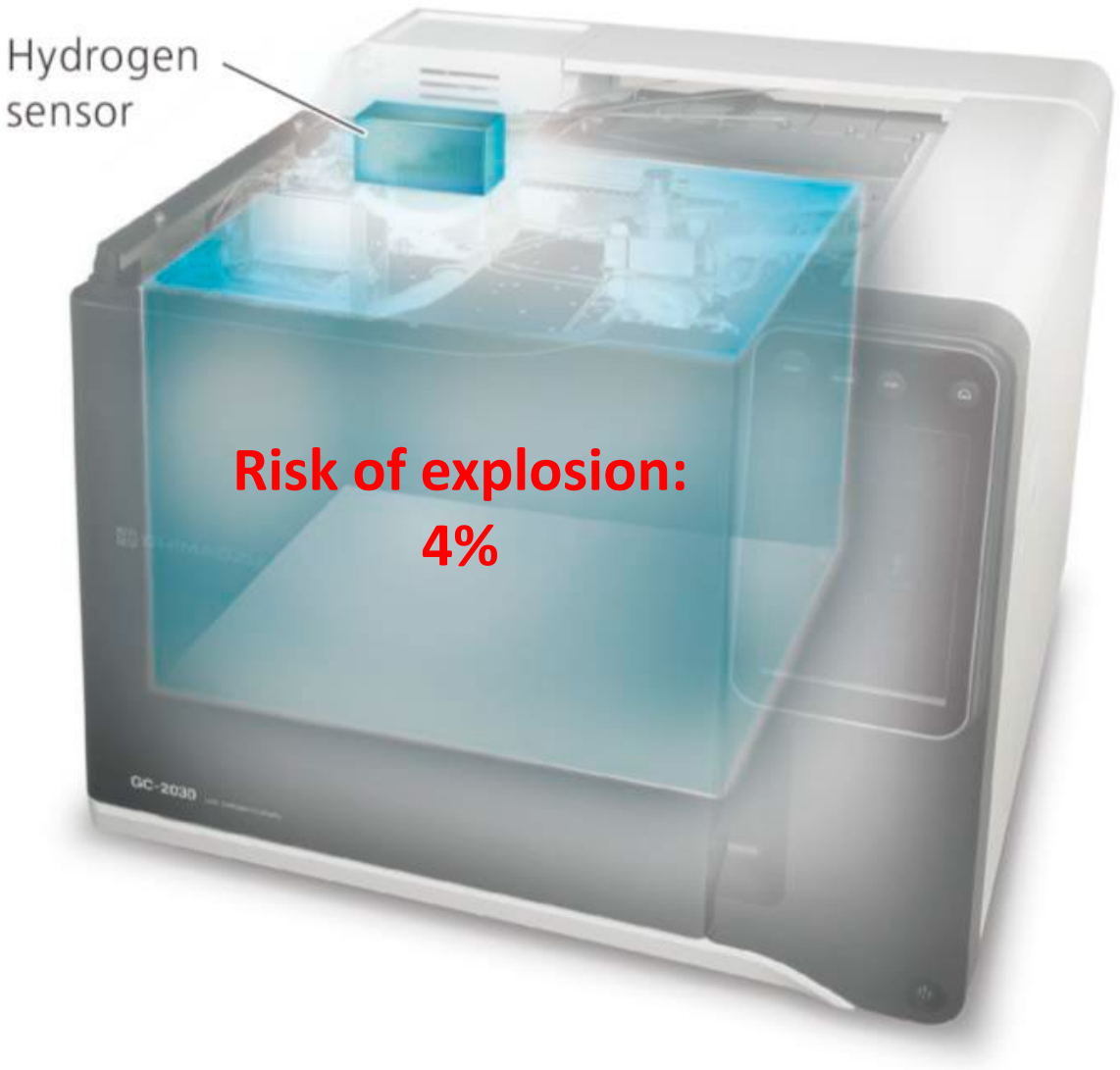
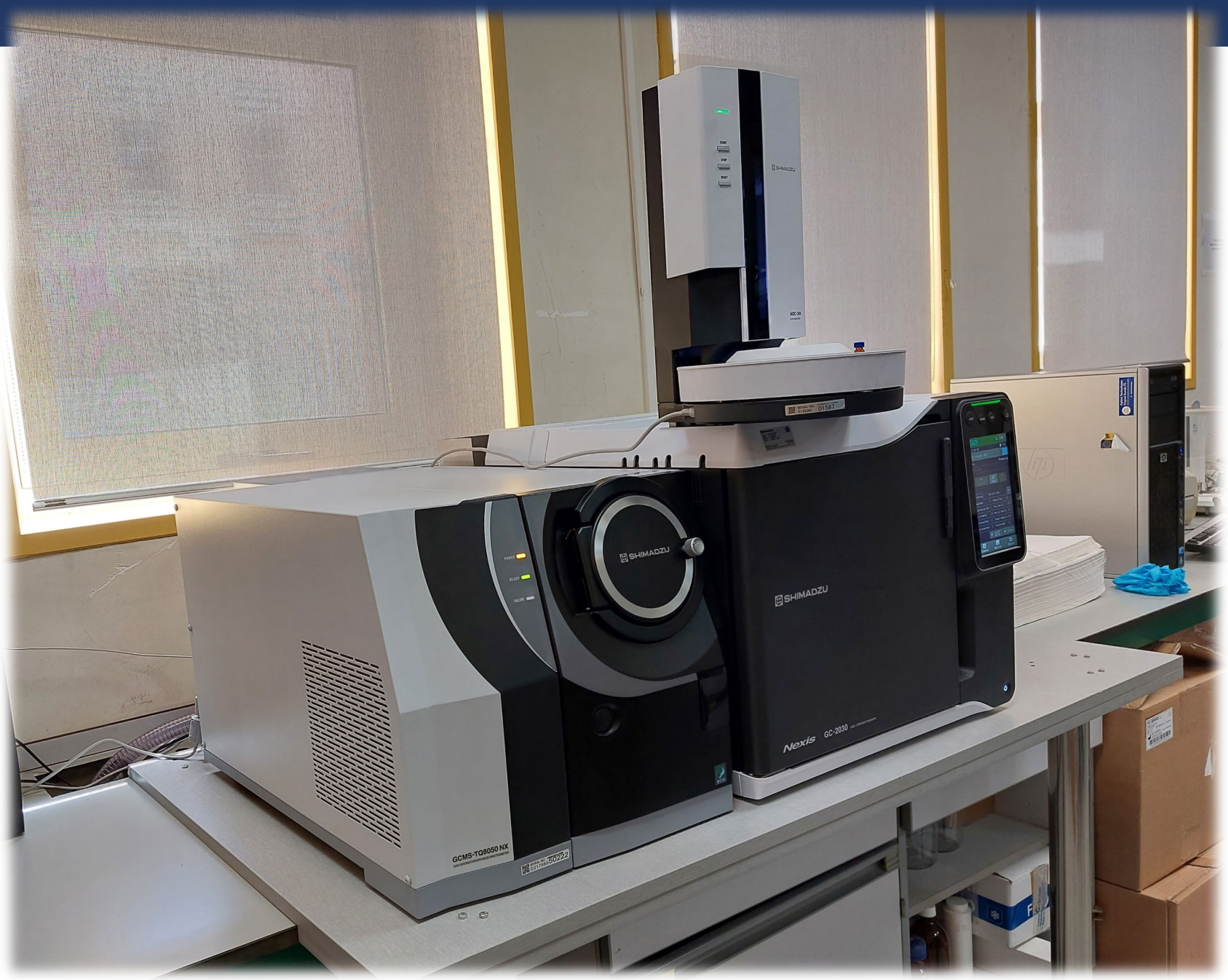
Shimadzu solutions for helium shortage – Nerea Lorenzo Parodi



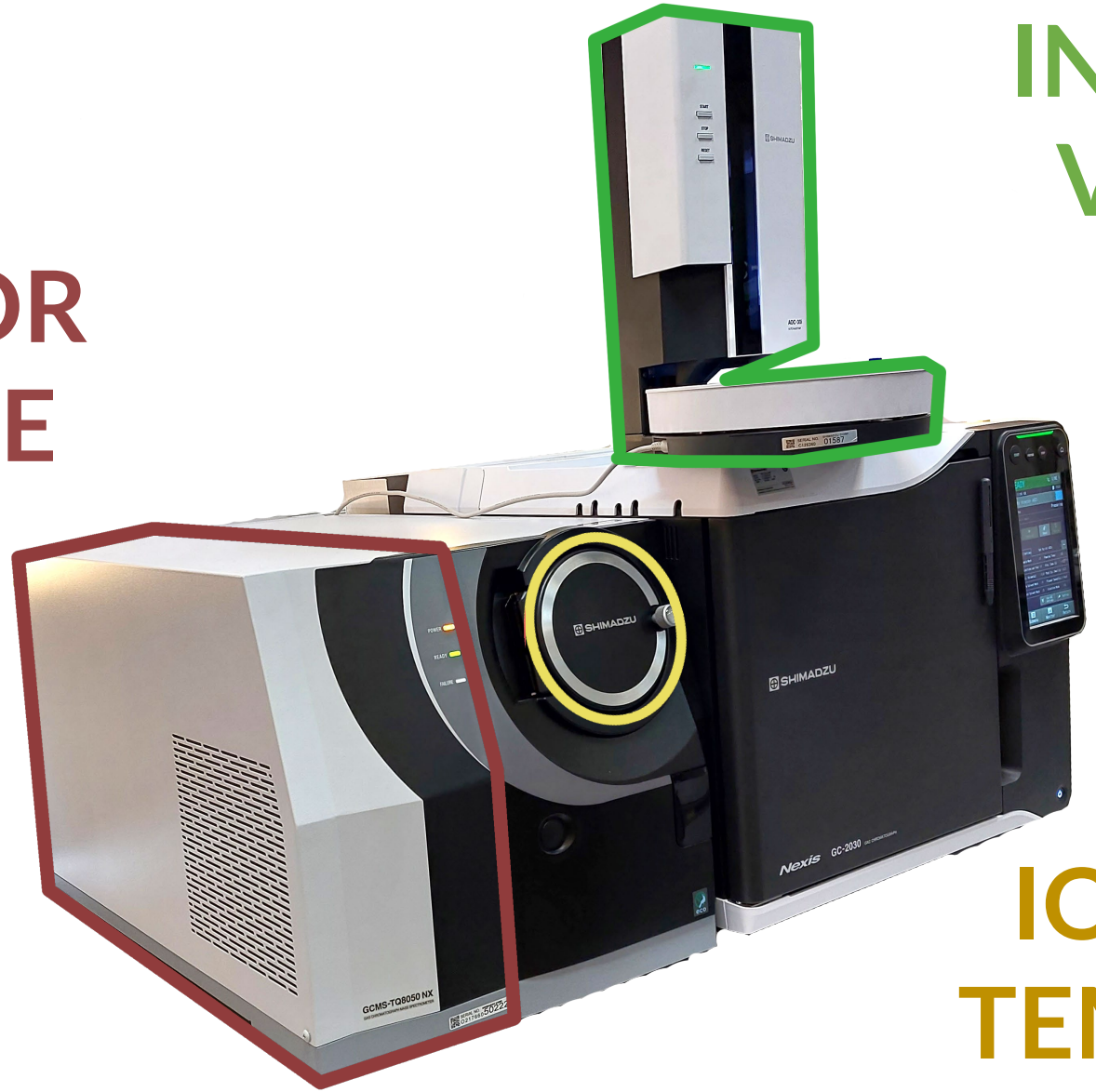
Fast responding AFC automatically identifies hazardous leaks but, in addition, GC-2030 is built with a hydrogen sensor

Hydrogen concentration in GC oven:
1 % - Error Message, AFC flow stop
2 % - System shuts down


SHIMADZU
GCMS-TQ8050 NX
SHIMADZU
Nexis GC-2030

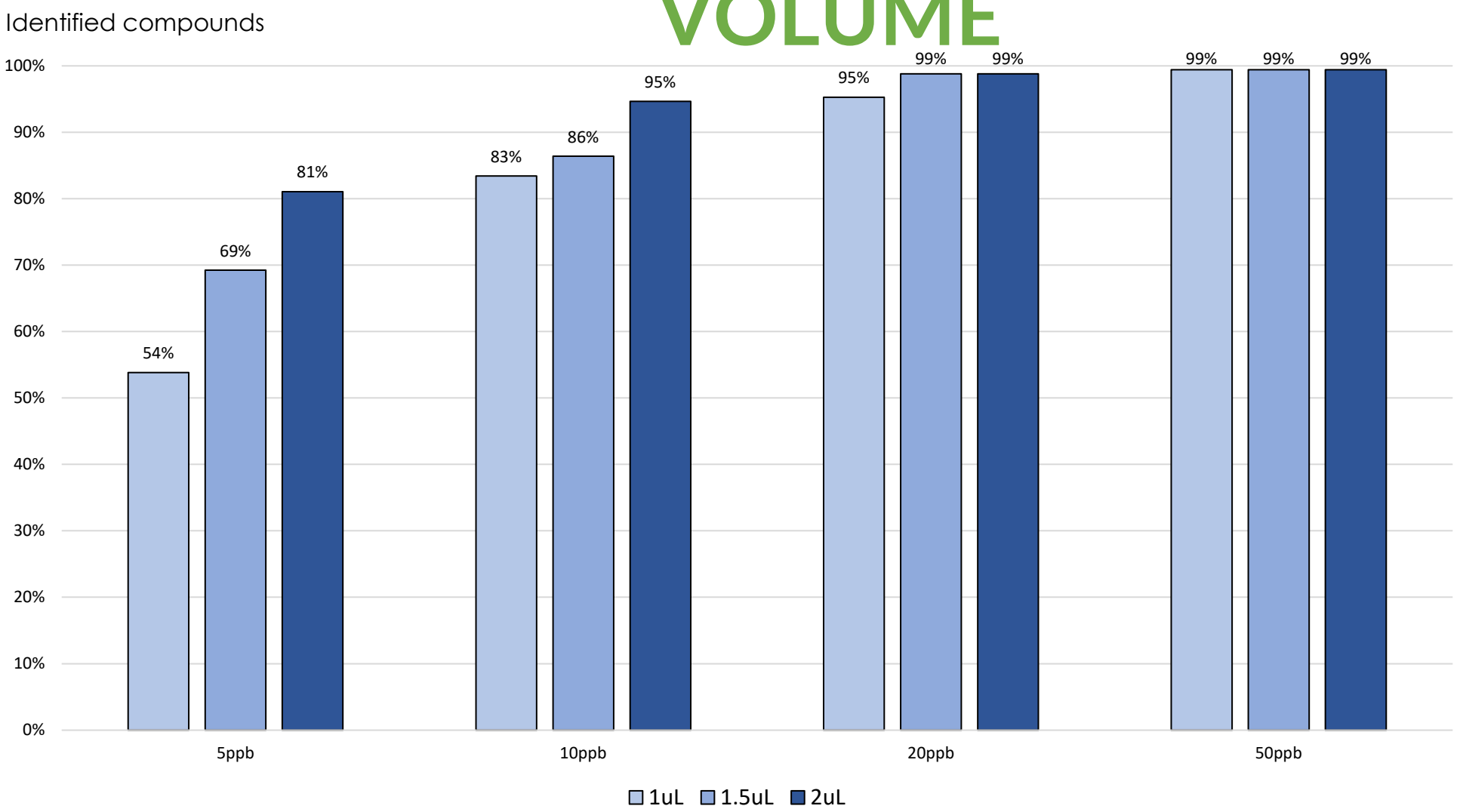
INJECTION VOLUME

DETECTOR VOLTAGE



ION SOURCE TEMPERATURE

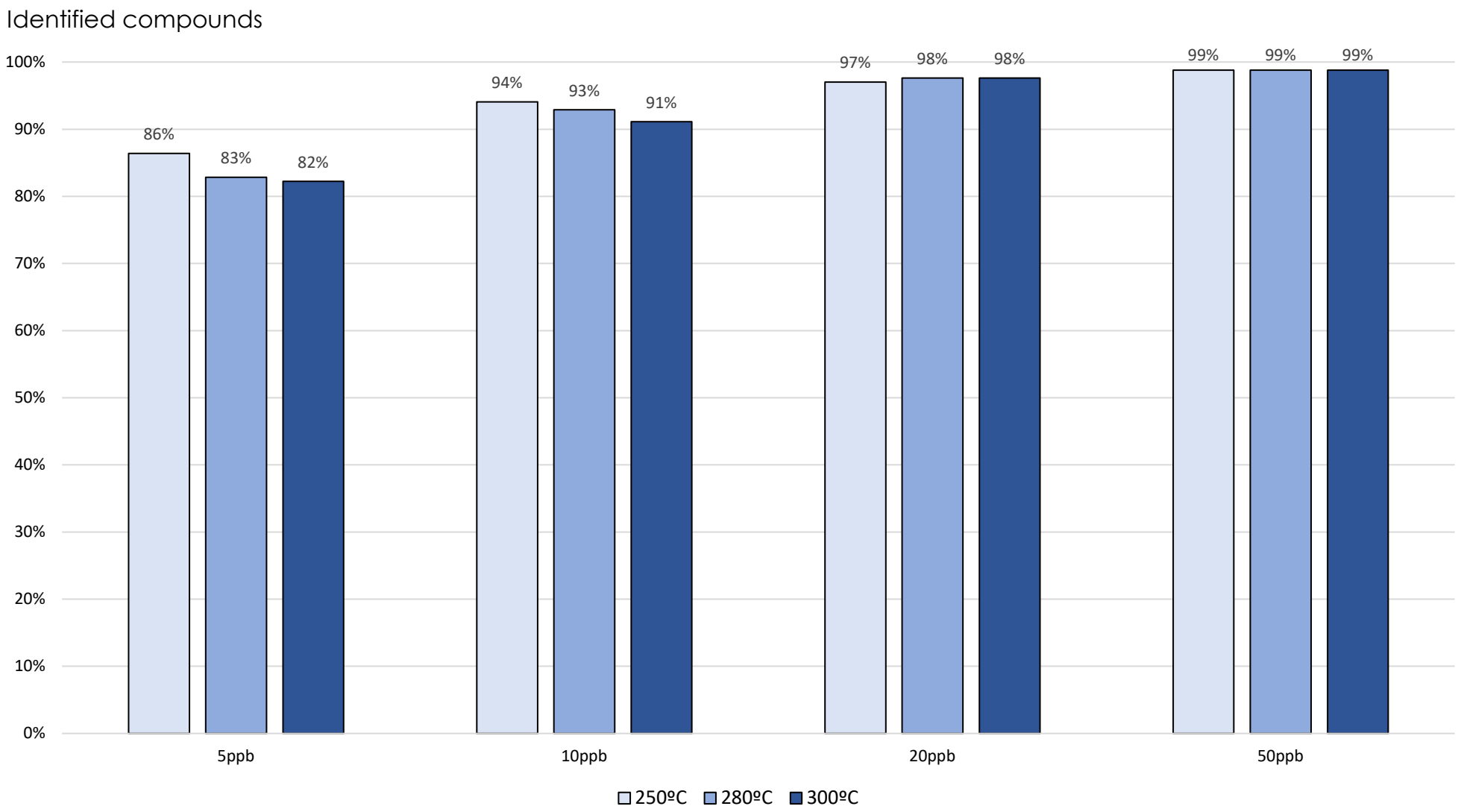
INJECTION VOLUME



Amount of matrix

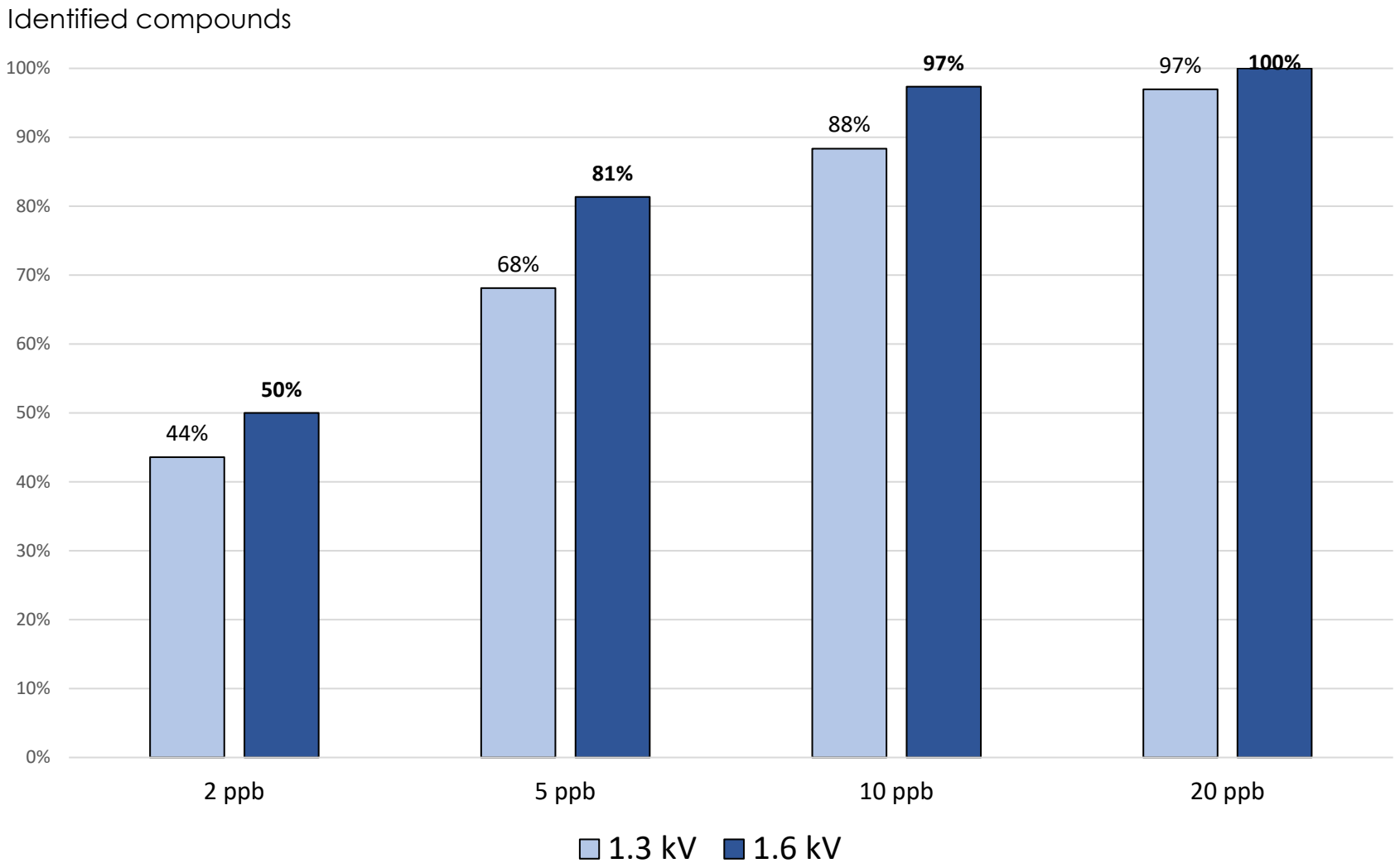
Liner backflush

ION SOURCE TEMPERATURE



There are no major differences

DETECTOR VOLTAGE



>1.6kV
SATURATION OF SOME COMPOUNDS:
Pebulate
Molinate
Hexachlorobenzene
Tefluthrin

Voltage for MRM up to 2kV

GCMS-TQ8050

Chromatograph:

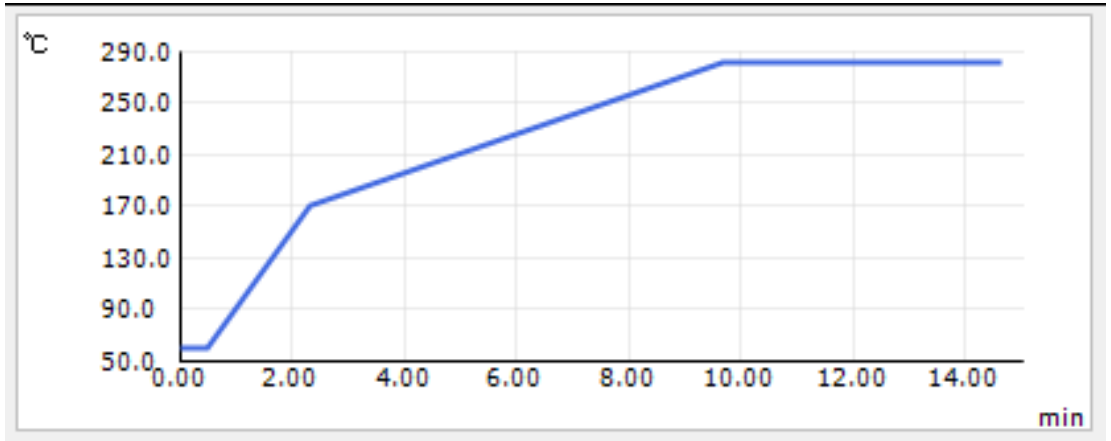
2030 PTV injector
Injection program temperature: 70ºC->280ºC (350ºC/min)
Injection volume: 1µL
Splitless mode
Column: Shimadzu SH-I-5 MS (20m, 0.18 mm, 0.15 µm)
Linear velocity: 70 cm/s
Equilibration time: 0.5 min

Mass spectrometer:

MRM acquisition mode
Ion source temperature: 280ºC
Interface temperature: 280ºC
Solvent cut time: 2 min
Detector voltage 1.6kV

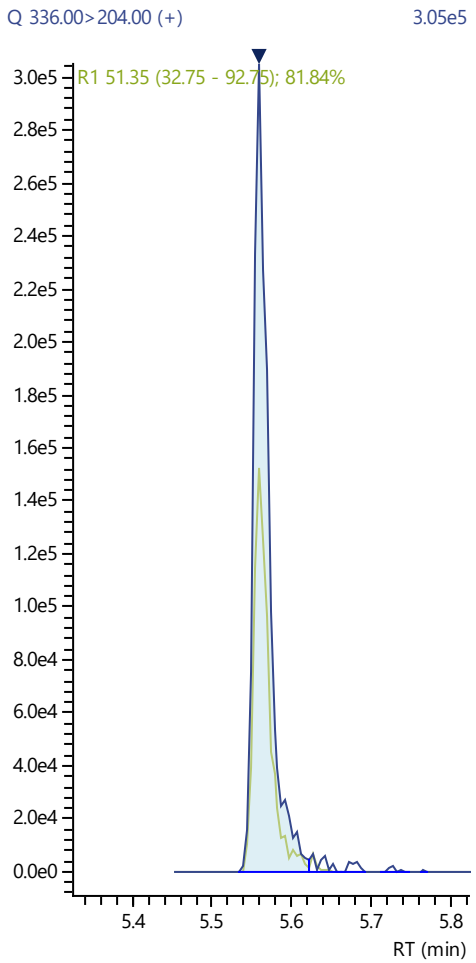
Column oven temperature program:

Rate	Temperature	Hold Time
-	60	0.5
60	170	0
15	280	5

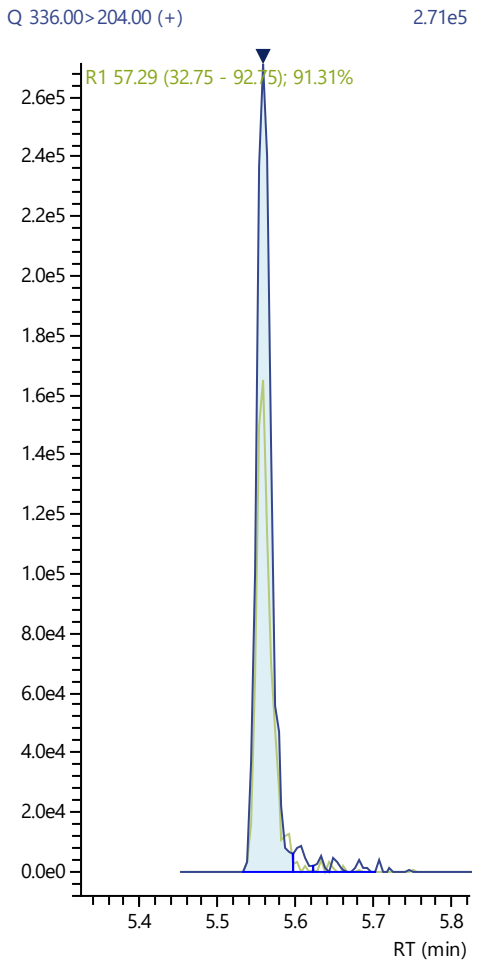


Tetraconazole (100 µg/Kg Tomato)

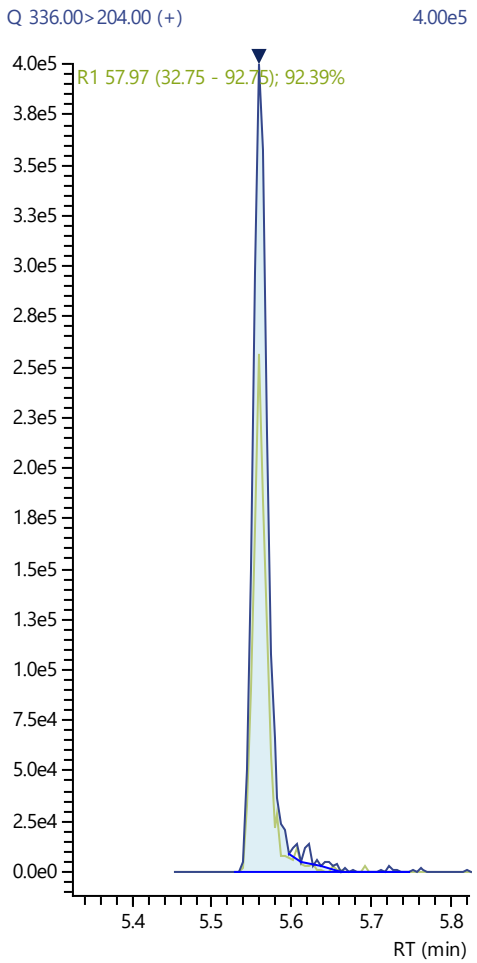
Restek Topaz Wool



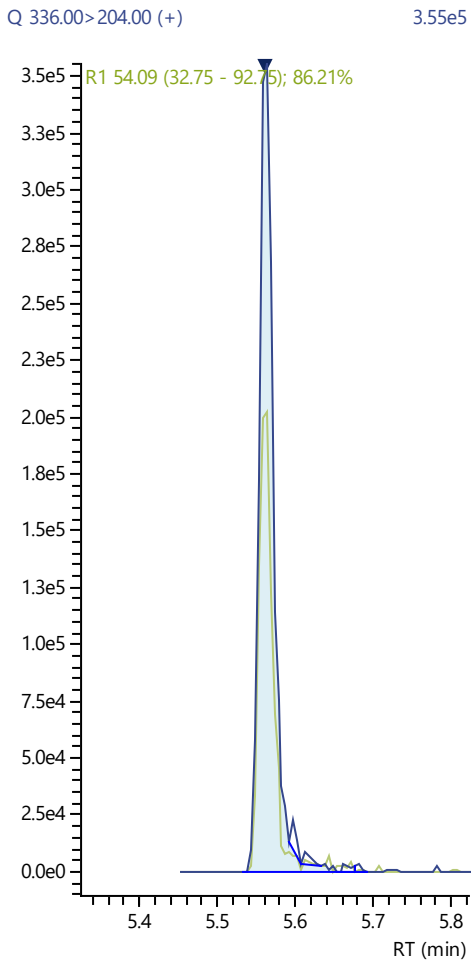
Shimadzu Based deact. Wool



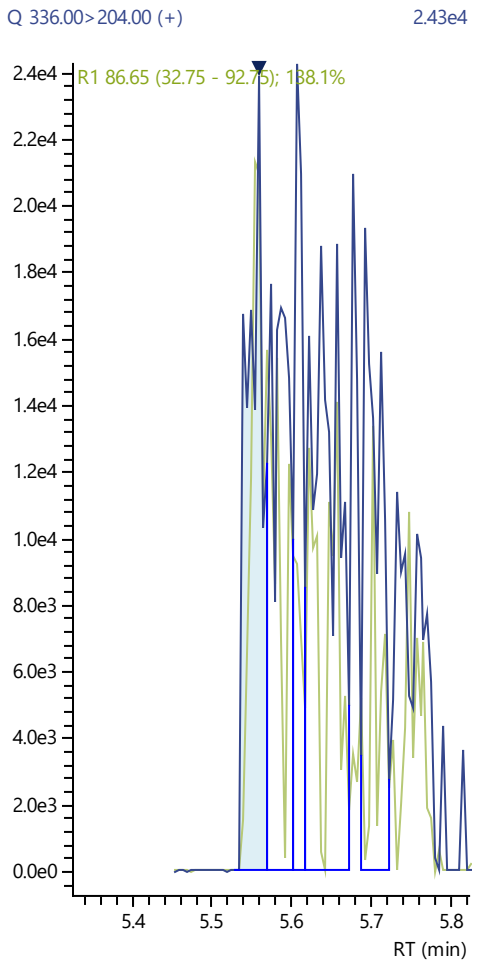
Shimadzu IP deact. Wool



Shimadzu Siltek deact. Wool

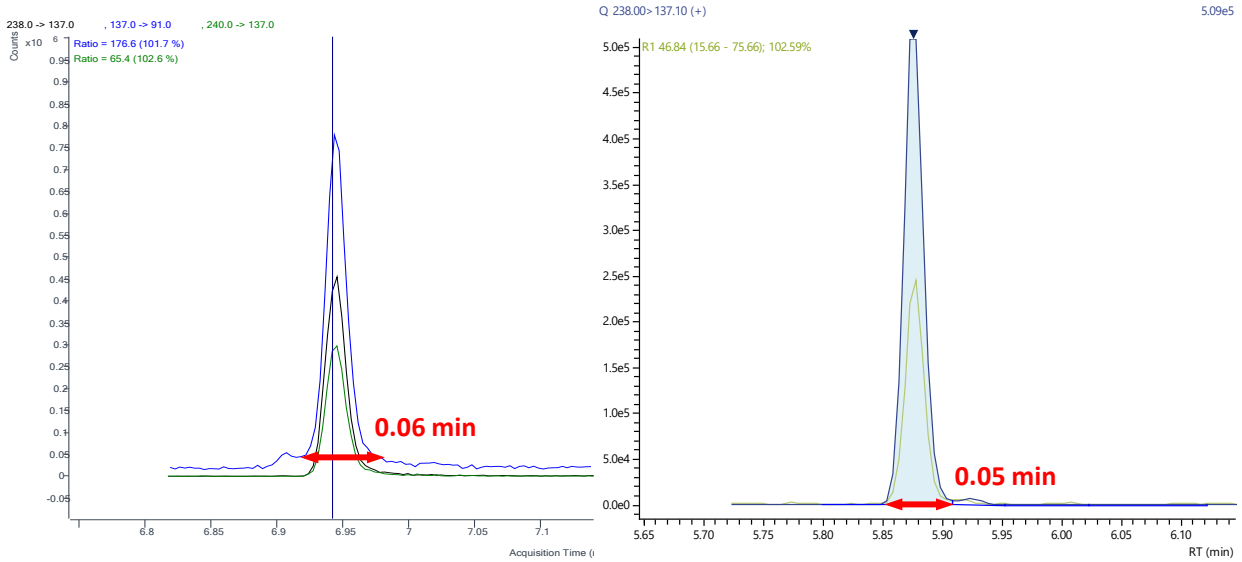


Restek Topaz No Wool

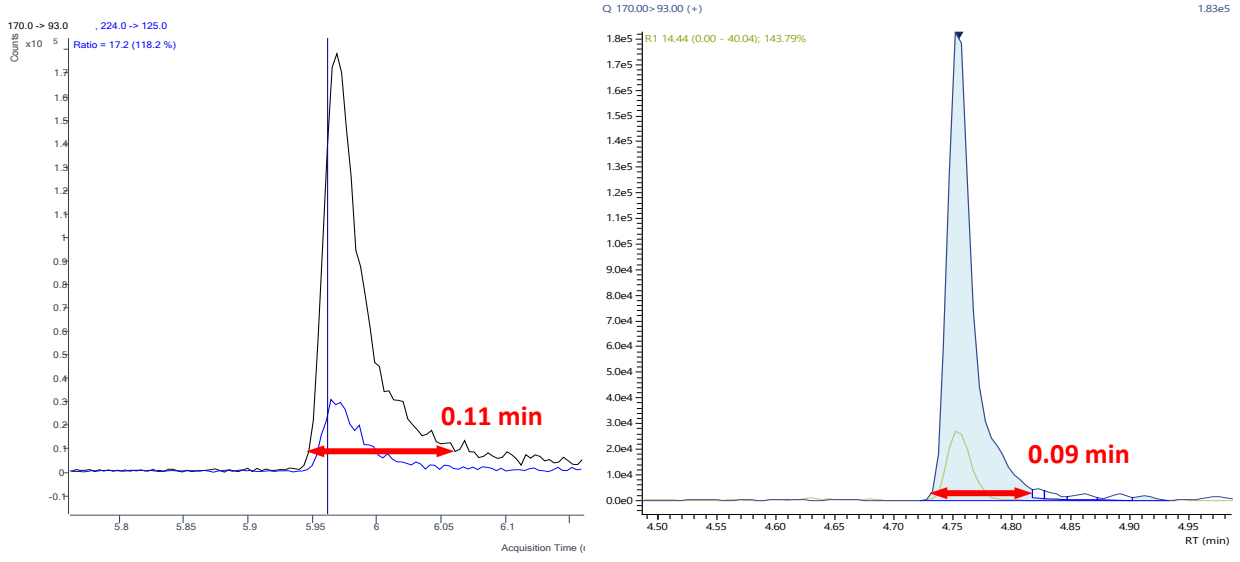


150 Pesticides
100 µg/Kg
Tomato

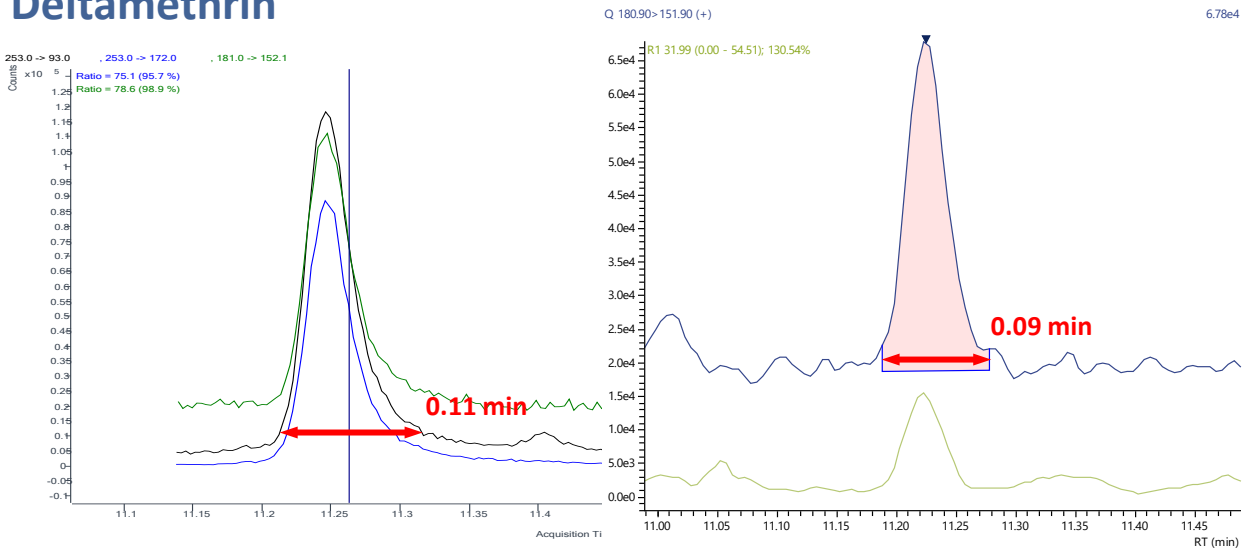
Tolylfluanid



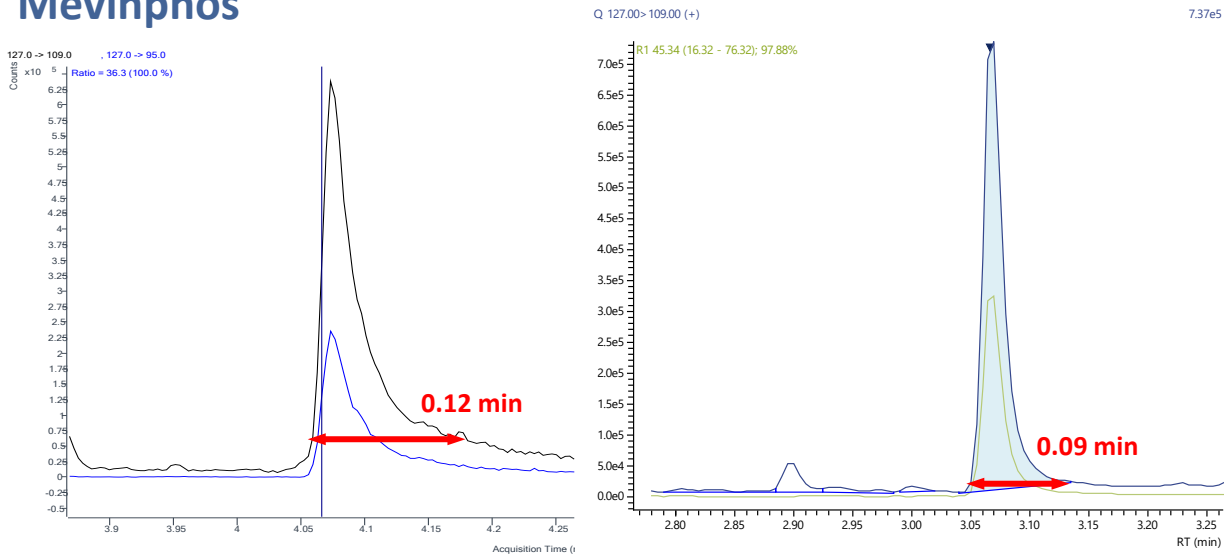
Formothion



Deltamethrin

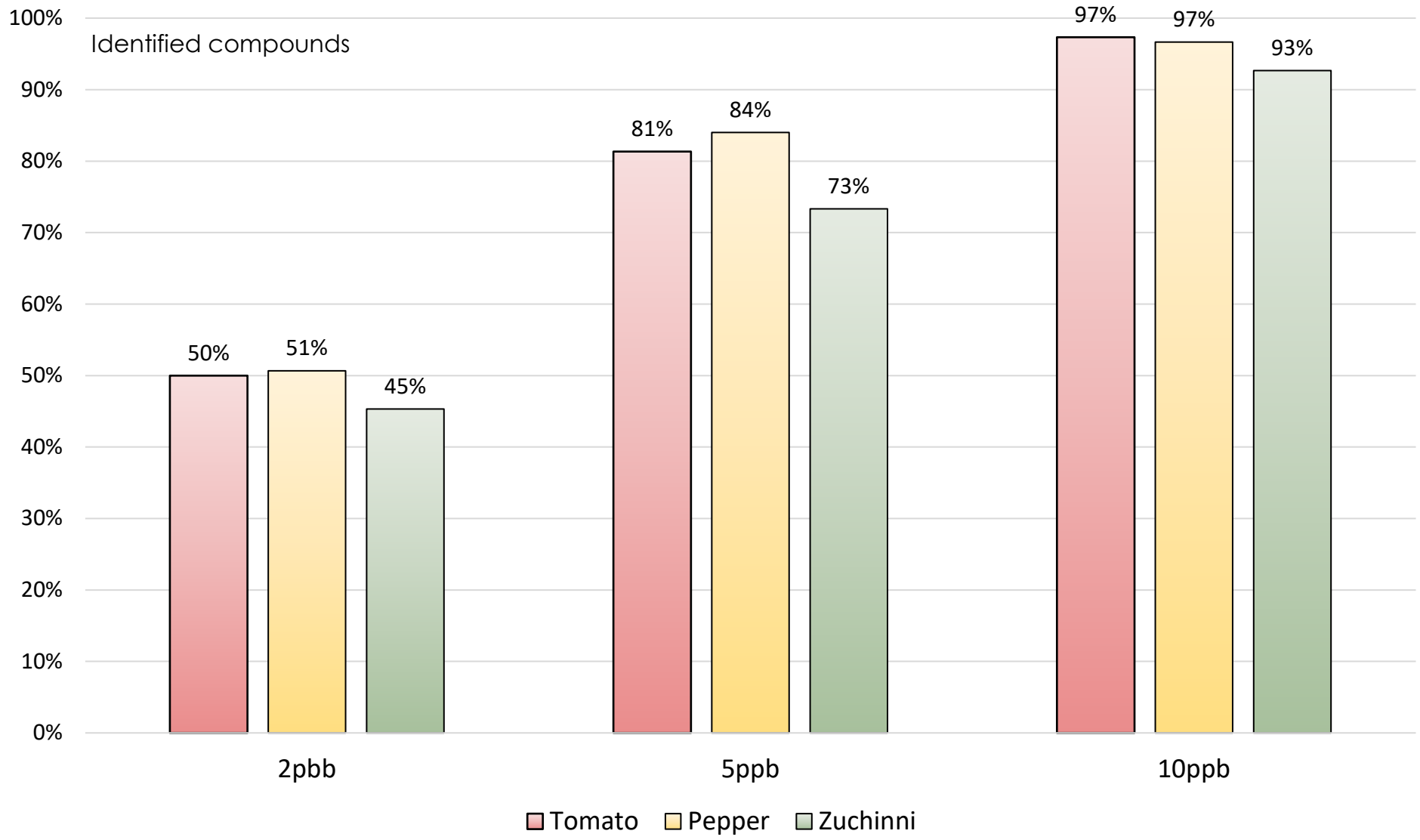


Mevinphos



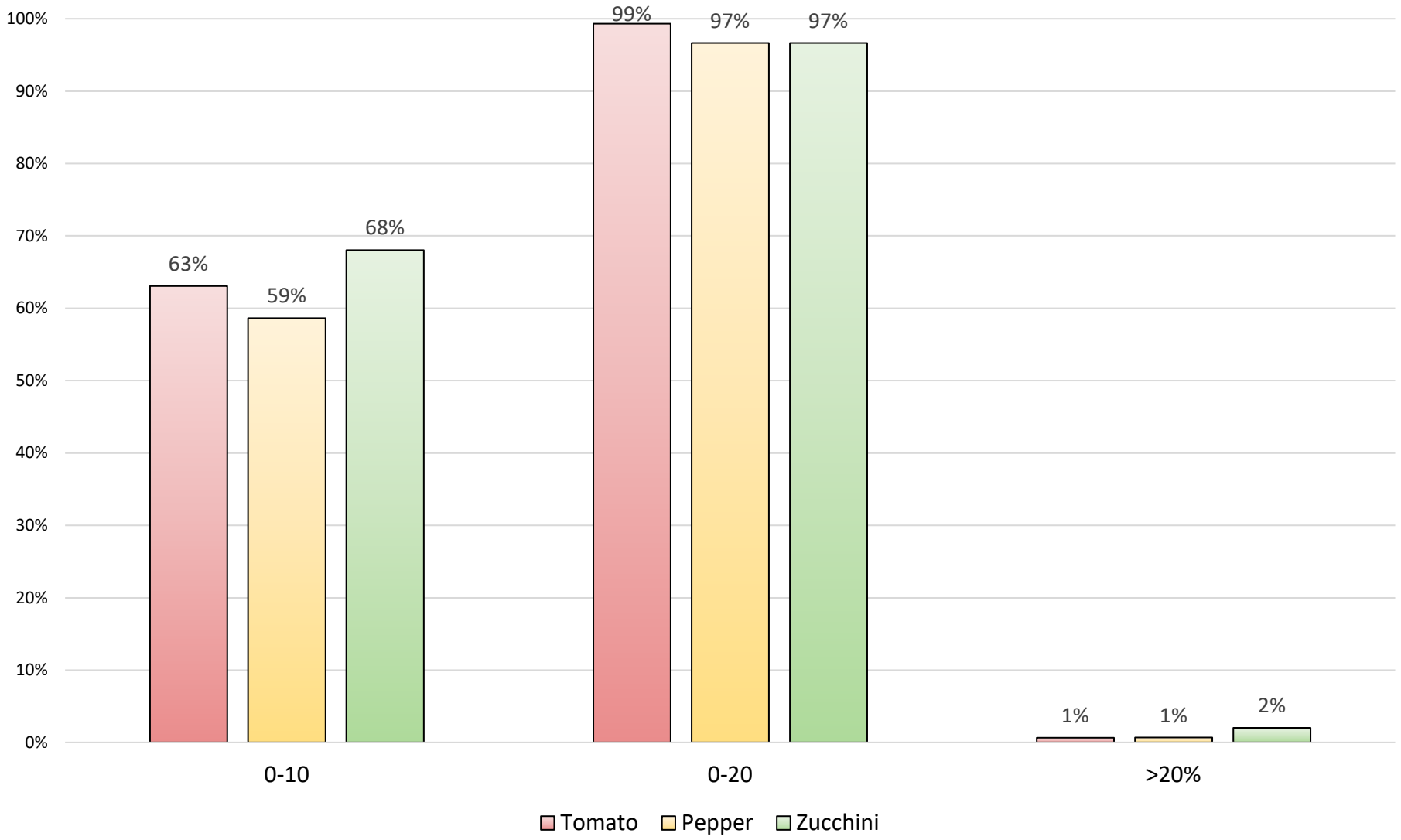
SENSITIVITY

150 Pesticides

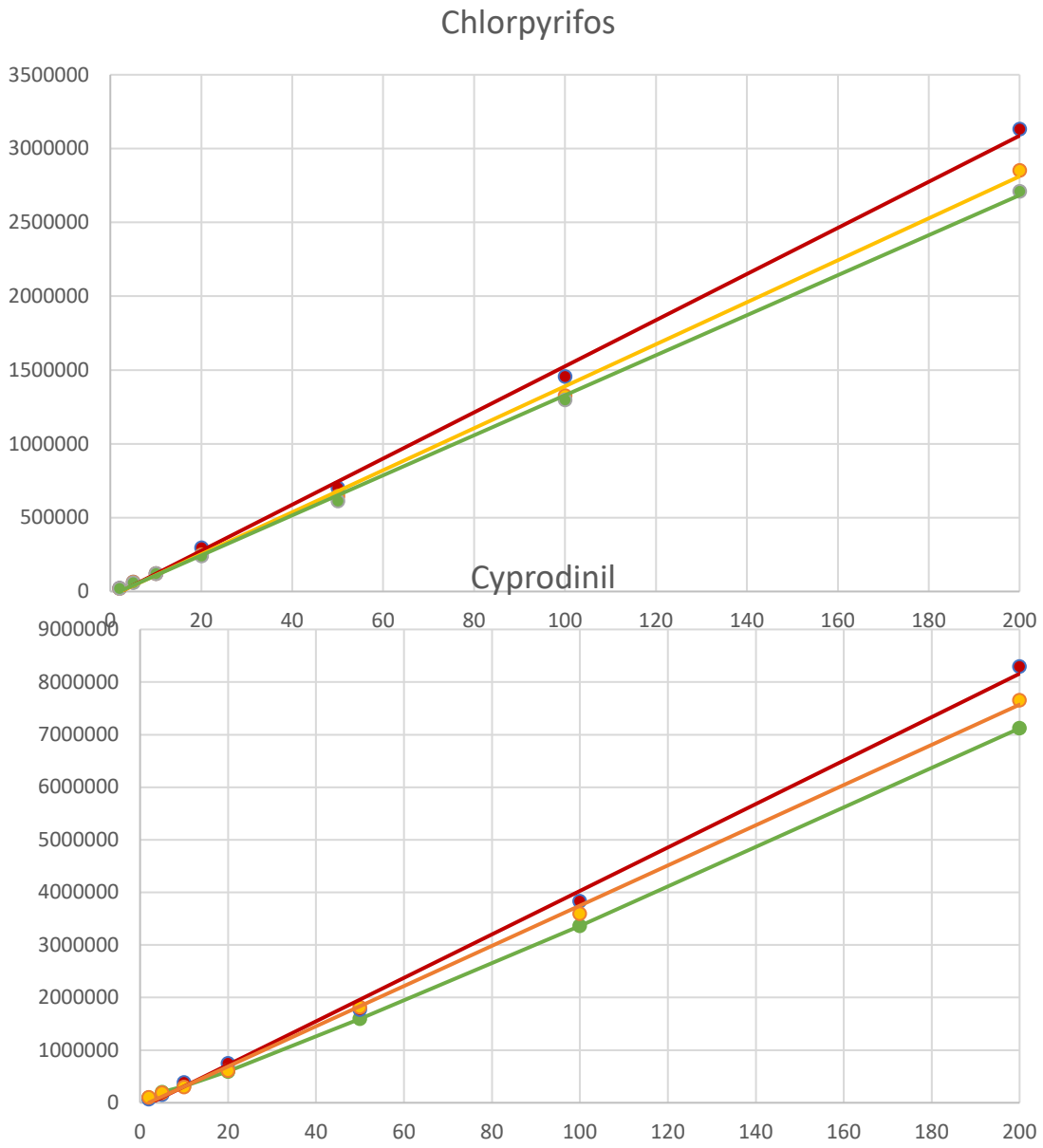


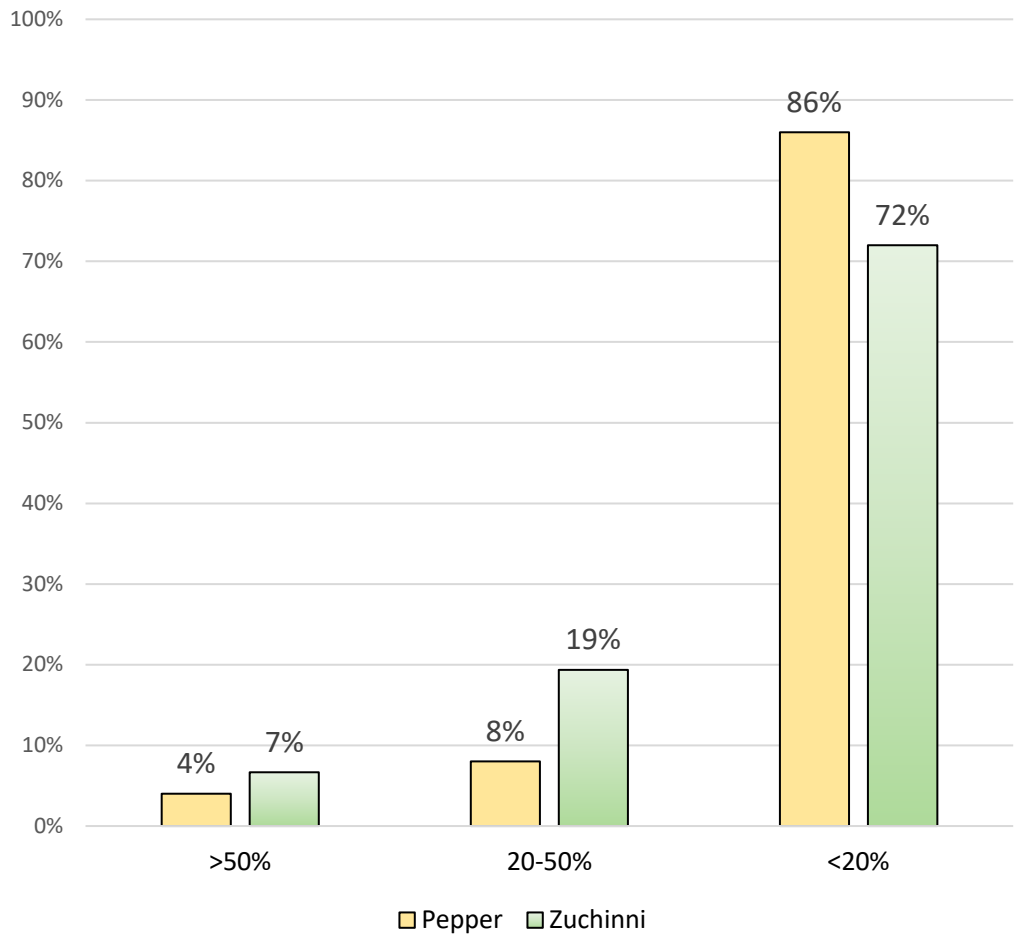
REPRODUCIBILITY – RSD(%)

150 Pesticides
10 µg/Kg



MATRIX EFFECTS





REAL SAMPLES

Matrix	Boscalid		Cypermethrin		Cyprodinil		Flutolanil		Lambda-Cyhalothrin		Pyrimethanil		Pyriproxyfen	
	Hydrogen	Helium	Hydrogen	Helium	Hydrogen	Helium	Hydrogen	Helium	Hydrogen	Helium	Hydrogen	Helium	Hydrogen	Helium
Potato							0.024	0.031						
Spinach			0.008	0.011										
Lemon											0.009	0.011	0.014	0.018
Peach					0.015	0.017								
Pear					0.058	0.07								
Grape	0.036	0.046			0.232	0.289								
Orange													0.009	0.014
Nectarine					0.106	0.137								
Tomato									0.109	0.111				

Proficiency test EURLFV-25

(melon)

GCMS/MS-Hydrogen	EURLFV Sample results	Robust Mean X* (mg/kg)	Z-Sore
Chlorpyrifos	0.004	0.005	**-1.1**
Chlorpyrifos-methyl	0.072	0.090	**-0.8**
Diazinon	0.086	0.104	**-0.7**
Fenazaquin	0.069	0.078	**-0.5**
Fenitothrion	0.076	0.085	**-0.4**
Flutriafol	0.301	0.304	**0.0**
Mepanipyrim	0.075	0.081	**-0.3**
Profenofos	0.099	0.117	**-0.6**
Pyriproxyfen	0.232	0.245	**-0.2**

CONCLUSIONS

- Hydrogen is no longer considered a safety risk in the lab due to the numerous safety measures modern systems incorporate.
- While the diffusivity and viscosity values of hydrogen surpass those of helium, its lack of inertness must be monitored.
- Sensitivity is sufficient to detect more than 80% of identified compounds at 5 ppb.
- The optimized method displays strong reproducibility and minimal matrix effects.

In summary, using hydrogen as a carrier gas in GC-MS/MS appears to be a viable alternative to helium for the analysis of pesticide residues.

http://www.eurl-pesticides.eu

Thank You for Your Attention

EURL EUROPEAN UNION REFERENCE LABORATORY