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Unstoppable GC-MS technology to boost efficiency in toxicology testing laboratories

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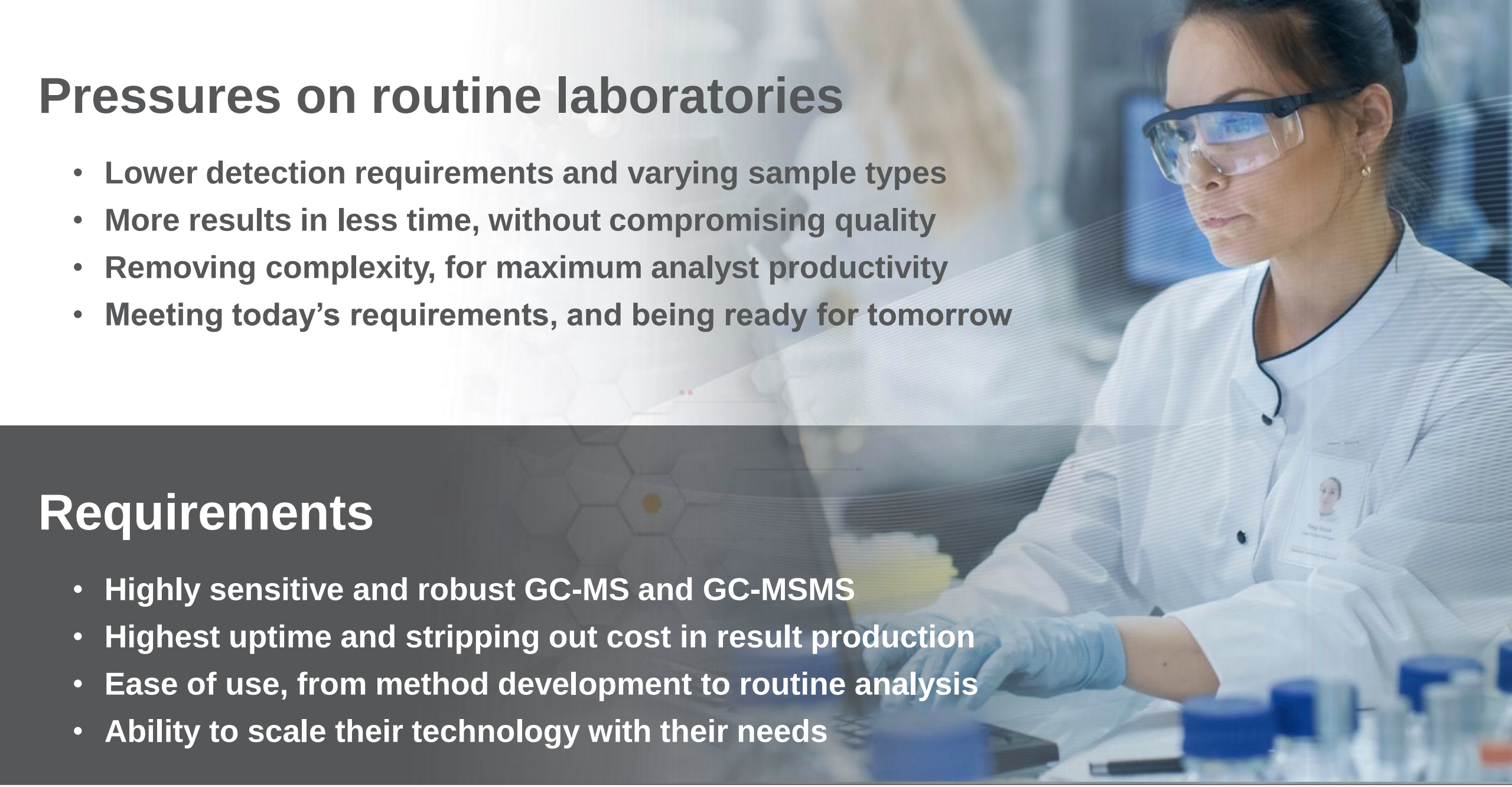
Emerging Markets

Pressures on routine laboratories

- Lower detection requirements and varying sample types
- More results in less time, without compromising quality
- Removing complexity, for maximum analyst productivity
- Meeting today's requirements, and being ready for tomorrow



Requirements

- Highly sensitive and robust GC-MS and GC-MSMS
- Highest uptime and stripping out cost in result production
- Ease of use, from method development to routine analysis
- Ability to scale their technology with their needs

ISQ 7000 GC-MS & TSQ 9000 GC-MS/MS system highlights

Ultimate **sensitivity** with Advanced Electron Ionization source

Extended **uptime** with inherent robustness and NeverVent™ technology

Routine **ease of use** from method development to daily operation

True **scalability** to face evolving regulatory requirements

UNSTOPPABLE

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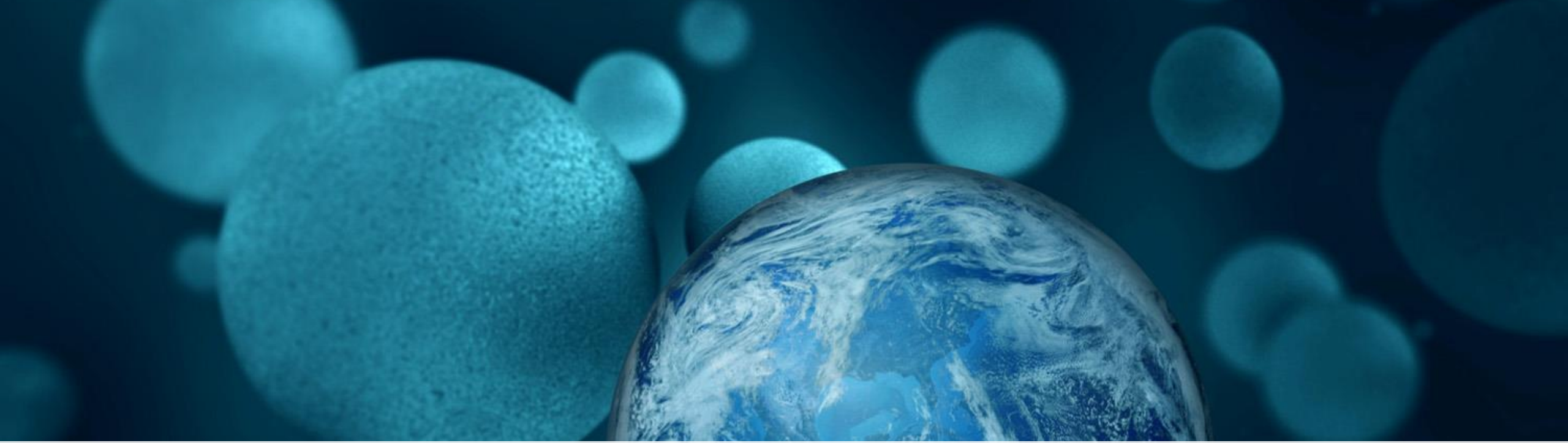

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ISQ 7000 Configurations, & Upgrade

ISQ 7000 GCMS – Full Scalability from low to high-end performances

S/N	> 750:1	> 2000:1	> 300:1 (100fg oncolumn)
IDL	< 10 fg	< 5 fg	< 1.0 fg

Installation Specifications

Typical Specifications

ISQ 7000 (66L/s) ExtractaBrite

First entry, most affordable solution

ISQ 7000 (300L/s) ExtractaBrite

Best performances/price ratio

ISQ 7000 (300L/s) VPI EI ExtractaBrite

High-throughput solution with NeverVent Technology

ISQ 7000 (300L/s) VPI EI/CI ExtractaBrite

EI/CI solution leveraging the NeverVent technology

ISQ 7000 (300L/s) AEI

Top-tier solution with upmost sensitivity and robustness

Field upgrade path across the ISQ 7000 configurations, <u>but no upgrade from ISQ QD or LT</u>

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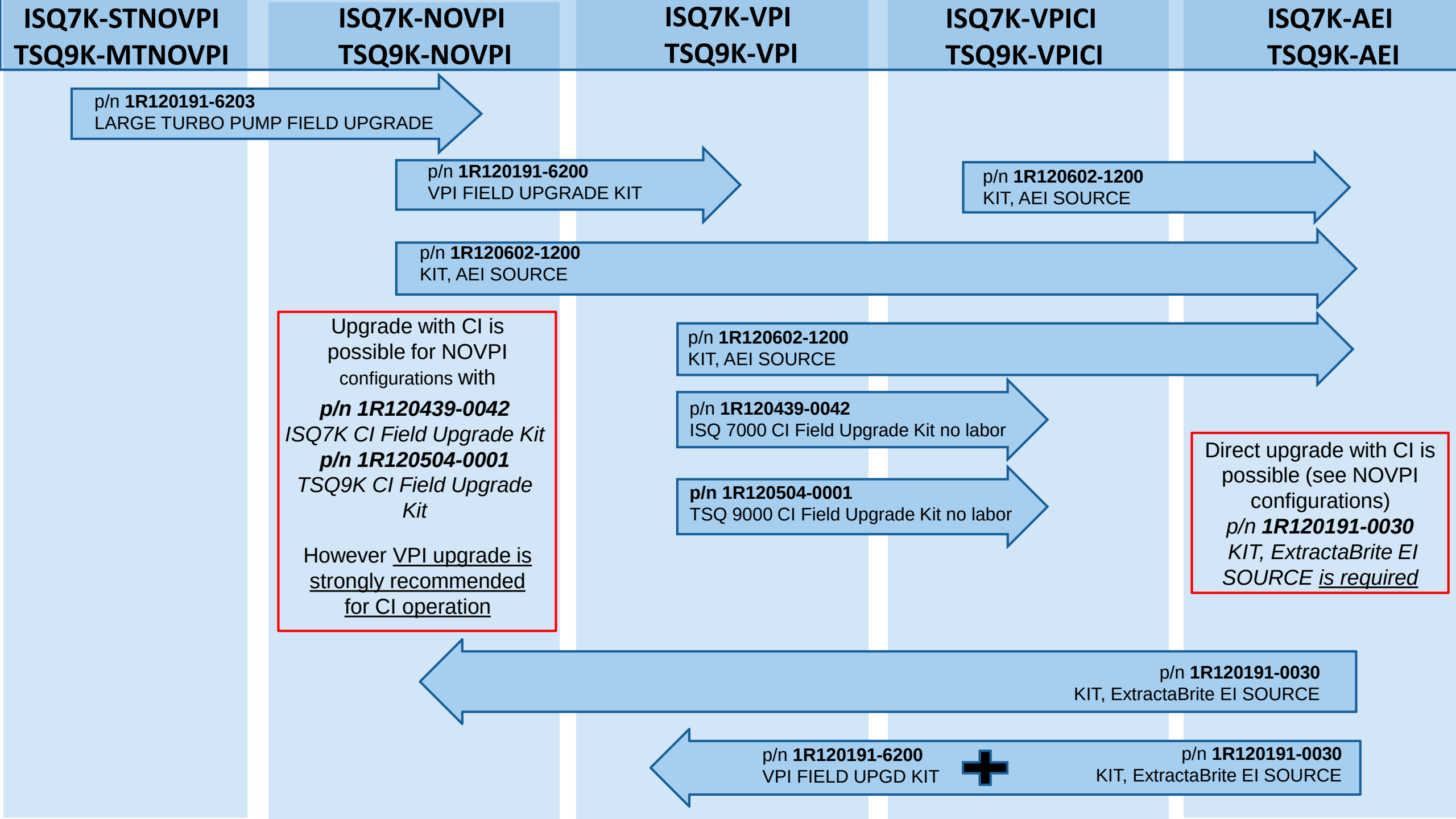
ISQ 7000 Technical Specifications

Specification	ISQ7K-STNOVPI	ISQ7K-NOVPI	ISQ7K-VPI	ISQ7K-VPICI	ISQ7K-AEI
In **EI** mode, 1 µL of 1 pg/µL OFN m/z 272 , scanning from 50 – 300 Da	750:1 (*)	2000:1 (*)	2000:1 (*)	2000:1 (*)	300:1 (100fg)
In **PCI** mode, 1 µL of 100 pg/µL BZB m/z 183, scanning from 80 – 230 Da	Not Included	Not Included	Not Included	300:1	Not Included
In **NCI** mode, 2 µL of 100 fg/µL of OFN m/z 272, scanning from 50 – 300 Da	Not Included	Not Included	Not Included	2000:1	Not Included
IDL for m/z 272 in SIM mode in EI	≤ 10 fg	≤ 5 fg	≤ 5 fg	≤ 5 fg	≤ 1 fg (*)
Ionization Modes	EI	EI	EI	EI and CI	EI
Carrier Gas Choice	He only	He or H_2	He or H_2	He or H_2	He or H_2
Instant Connect Helium Saver Injector	Compatible	Compatible	Compatible	Compatible	Compatible
Turbomolecular High Vacuum Pump	66 L/s	300 L/s	300 L/s	300 L/s	300 L/s
NeverVent (VPI + V-Lock)	Not Included (No Direct Probes)	Not Included (No Direct Probes)	NeverVent as standard Optional Direct Probes	NeverVent as standard Optional Direct Probes	Not Included (No Direct Probes)
t-SIM / AutoSIM	Y	Y	Y	Y	Y
SmartTune	Y	Y	Y	Y	Y
Quadrupole Scanning Speed	20,000 Da/s	20,000 Da/s	20,000 Da/s	20,000 Da/s	20,000 Da/s

(*) Installation specification

Competitive comparison xls tool *(download)*


ISQ7K-STNOVPI
TSQ9K-MTNOVPI
ISQ7K-NOVPI
TSQ9K-NOVPI
ISQ7K-VPI
TSQ9K-VPI
ISQ7K-VPICI
TSQ9K-VPICI
ISQ7K-AEI
TSQ9K-AEI
p/n 1R120191-6203
LARGE TURBO PUMP FIELD UPGRADE
p/n 1R120191-6200
VPI FIELD UPGRADE KIT
p/n 1R120602-1200
KIT, AEI SOURCE
p/n 1R120602-1200
KIT, AEI SOURCE
Upgrade with CI is possible for NOVPI configurations with
p/n 1R120439-0042
ISQ7K CI Field Upgrade Kit
p/n 1R120504-0001
TSQ9K CI Field Upgrade Kit
However VPI upgrade is strongly recommended for CI operation
p/n 1R120602-1200
KIT, AEI SOURCE
p/n 1R120439-0042
ISQ 7000 CI Field Upgrade Kit no labor
p/n 1R120504-0001
TSQ 9000 CI Field Upgrade Kit no labor
Direct upgrade with CI is possible (see NOVPI configurations)
p/n 1R120191-0030
KIT, ExtractaBrite EI SOURCE is required
p/n 1R120191-0030
KIT, ExtractaBrite EI SOURCE
p/n 1R120191-6200
VPI FIELD UPGD KIT
+
p/n 1R120191-0030
KIT, ExtractaBrite EI SOURCE

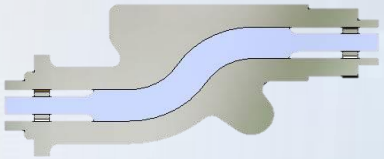
Mass Spec Components Same for All Product Offerings

New ISQ 7000 Single Quadrupole GC-MS

Unique Dual-Filament

ExtractaBrite™ ion source
or
AEI source

s-shaped ion guide



Solid, homogeneous, and maintenance-free metal quadrupole rods

DynaMax™ XR detection

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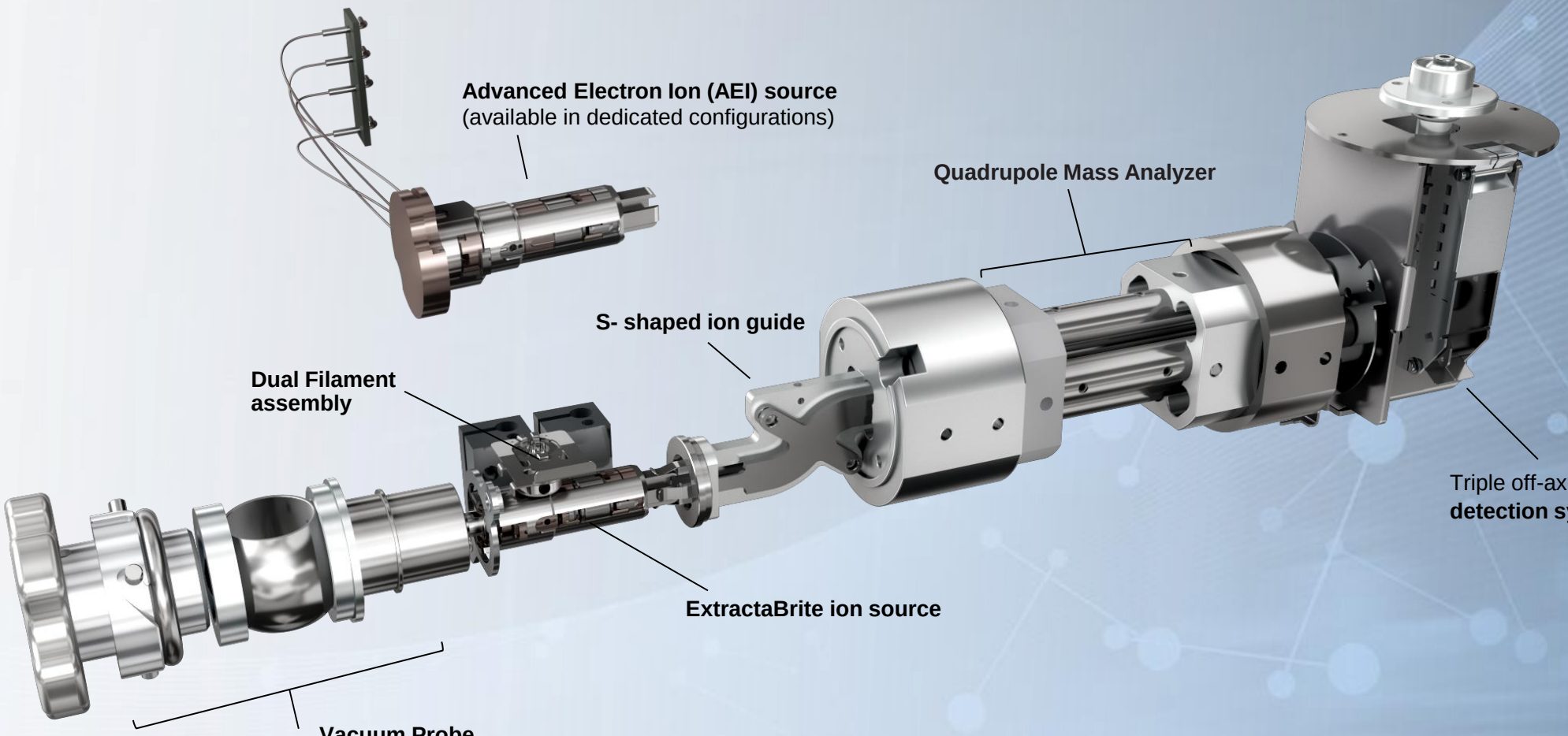
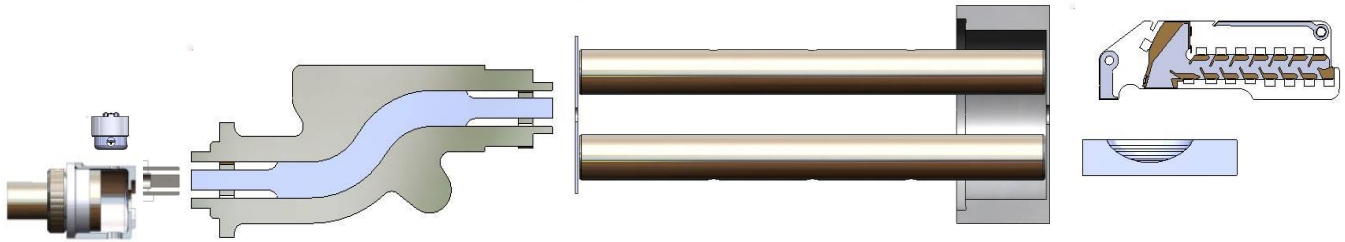
ISQ 7000 GCMS – Designed with Intention



Why Triple Quadrupole GC-MS/MS?

Single Quadrupole GC-MS

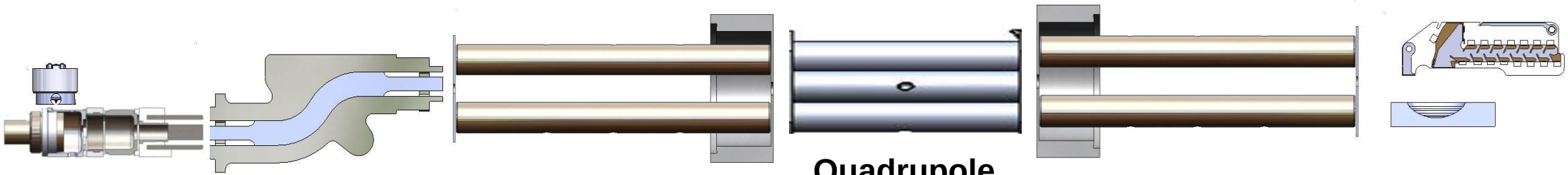
MS



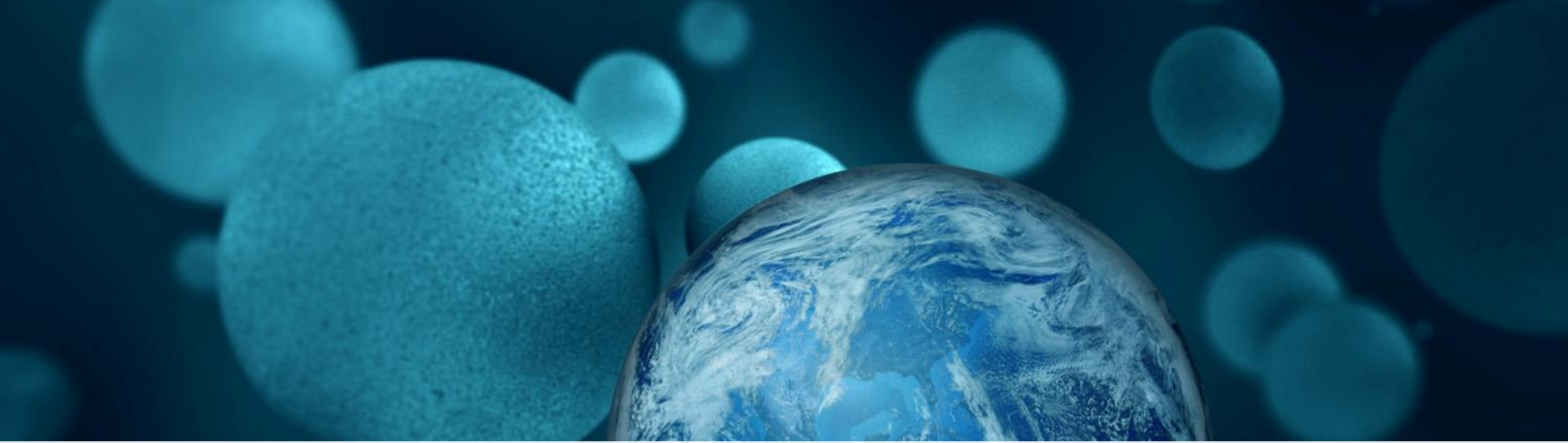
Ion Source | Ion Transfer Optics | Quadrupole | EM Detector

Triple Quadrupole GC-MS/MS

MS | MS



Ion Source | Ion Transfer Optics | Quadrupole 1 (Q1) | **Quadrupole 2 (Q2) Collision Cell** | **Quadrupole 3 (Q3)** | EM Detector



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TSQ 9000 Configurations & Upgrade

TSQ 9000 GC-MS/MS Industrial Design

One product with different configuration options

TSQ9K-MTNOVPI

TSQ9K-NOVPI

TSQ9K-AEI

TSQ9K-VPI

TSQ9K-VPICI

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TSQ 9000 GC-MS/MS– Flexible purchase options which are scalable in the field

< 4 fg | < 2 fg | < 0.4 fg

IDL

* *SRM Instrument detection limit* ***verified at installation*** *(5 fg OFN injected n=8, 99% confidence)*

TSQ9K-MTNOVPI
ExtractaBrite EI
240l /s

Most accesible entry from SQ>TQ

TSQ9K-NOVPI
ExtractaBrite EI
300L/s

Best price to performance ratio

TSQ9K-VPI
NeverVent
ExtractaBrite EI

High-throughput solution with NeverVent Technology

TSQ9K-VPICI
NeverVent
ExtractaBrite EI & CI

High-throughput EI/CI solution with NeverVent technology

TSQ9K-AEI
Advanced EI

Ultra high perfromance and robustness with Advanced EI technology

Full field upgrade path for TSQ 9000 configurations, but no upgrade from TSQ 8000, or TSQ Duo

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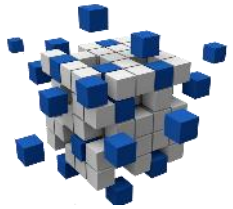
TSQ 9000 GC-MS/MS Upgrade tool

Upgrade / From	Large Turbo Pump Upgrade	VPI Upgrade	EI (Electron Ionization) - Extractabrite Source	CI (Chemical Ionization) Upgrade	AEI (Advanced Electron Ionization) - AEI Source
Upgrade Part Number:	1R120191-6203	1R120192-6200	1R120191-0030	1R120504-0001	1R120602-1200
Pre-requisite(s):	None	Large Turbo Pump, EI Source	None	Large Turbo Pump, EI Source	Large Turbo Pump
TSQ9K-MTNOVPI	↑	↑	✓	↑	↑
TSQ9K-NOVPI	✓	↑	✓	↑	↑
TSQ9K-VPI	✓	✓	✓	↑	↑
TSQ9K-VPICI	✓	✓	✓	✓	↑
TSQ9K-AEI	✓	↑	↑	↑	✓



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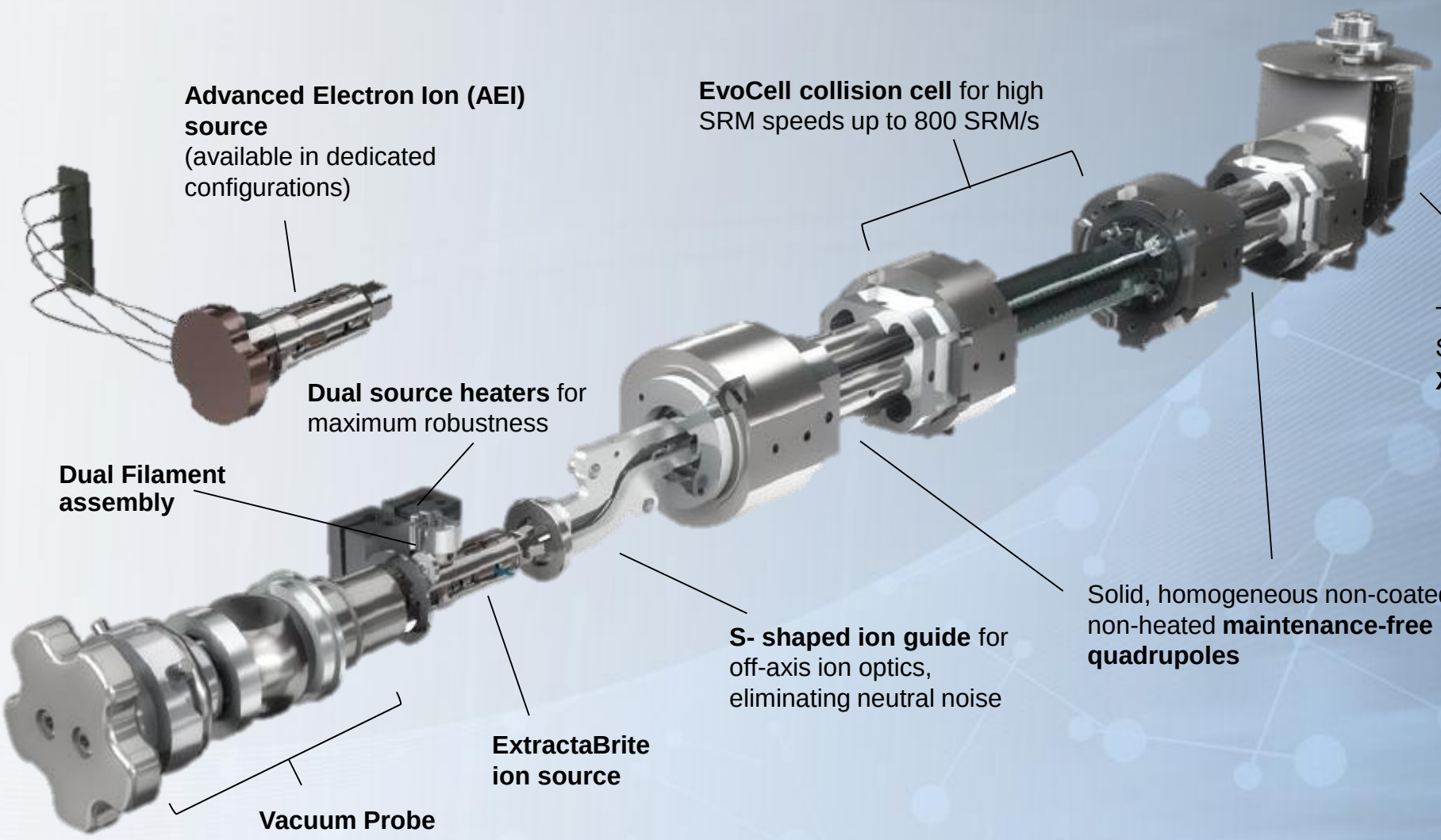
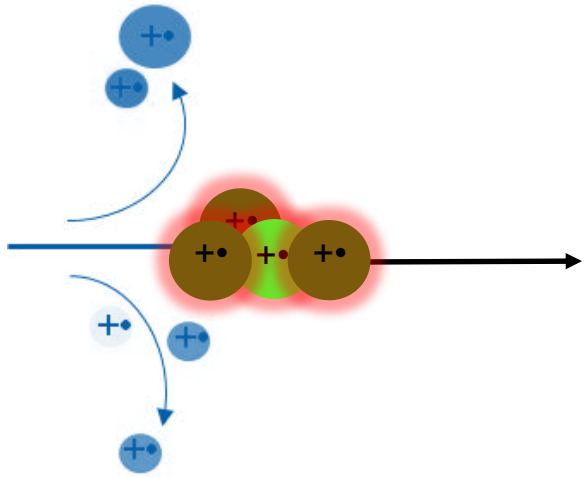
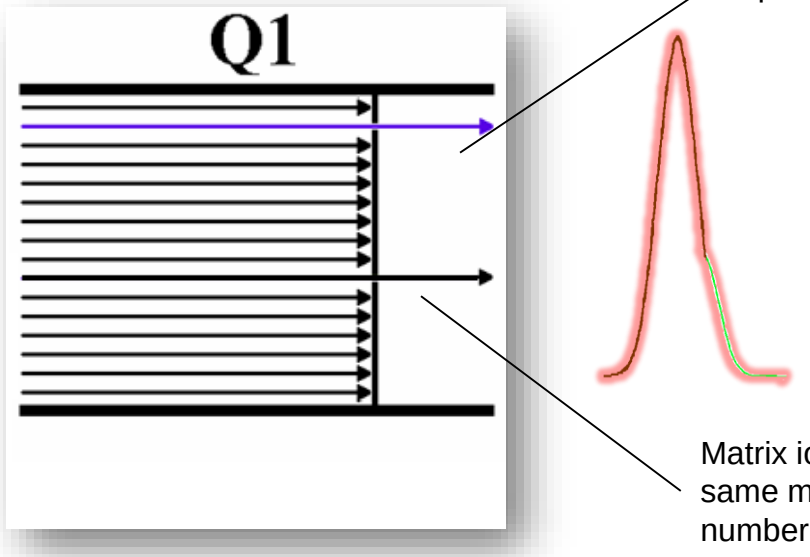
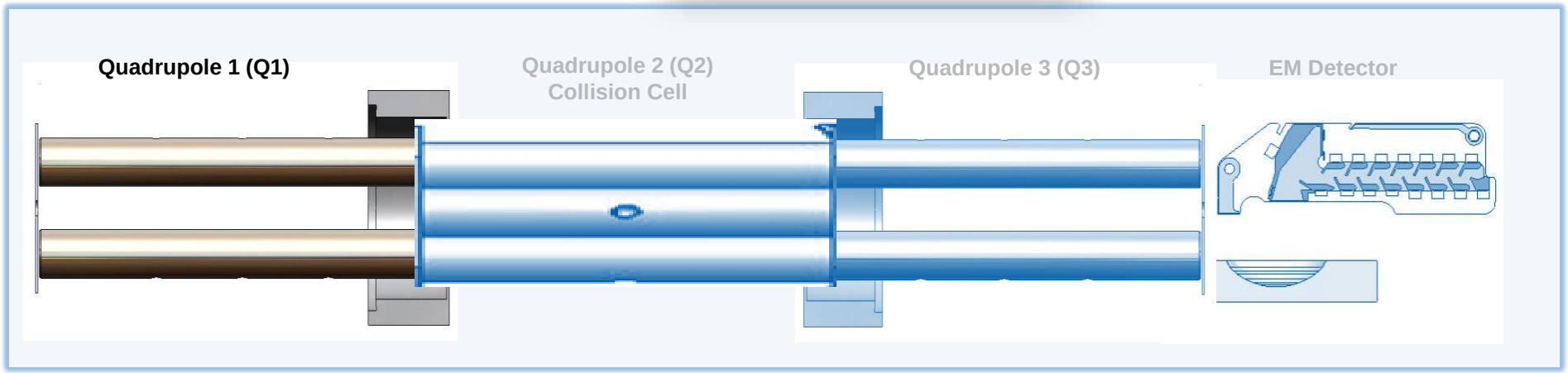
TSQ 9000 GC-MSMS system – Designed with intention



Triple Quad GC-MS: Q1 Precursor Ion Selection

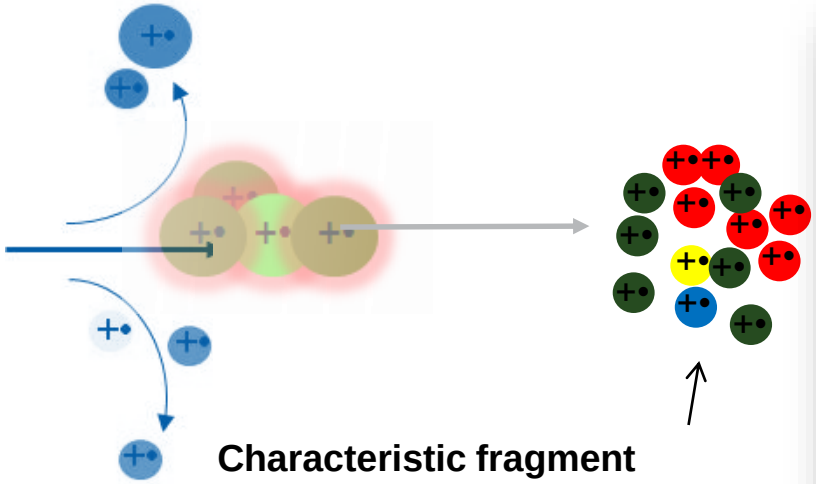




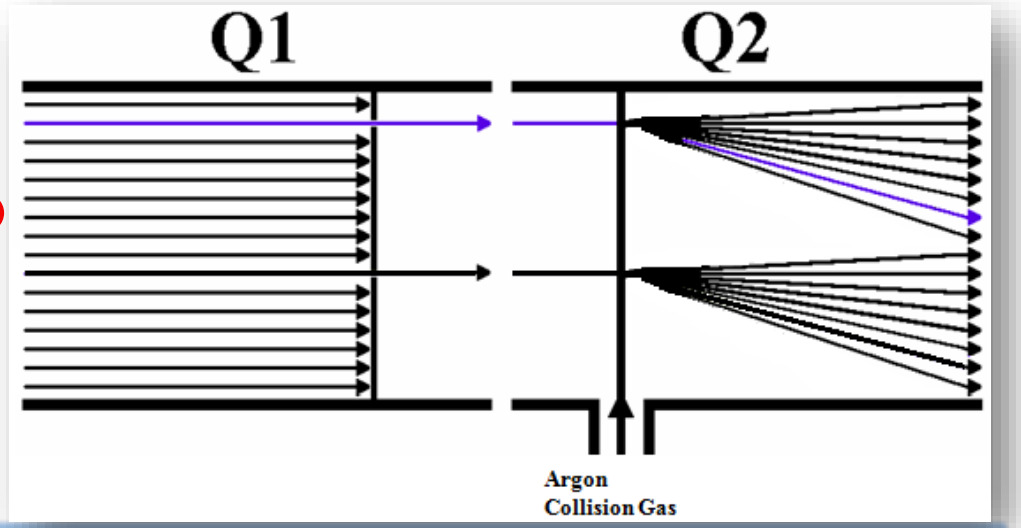


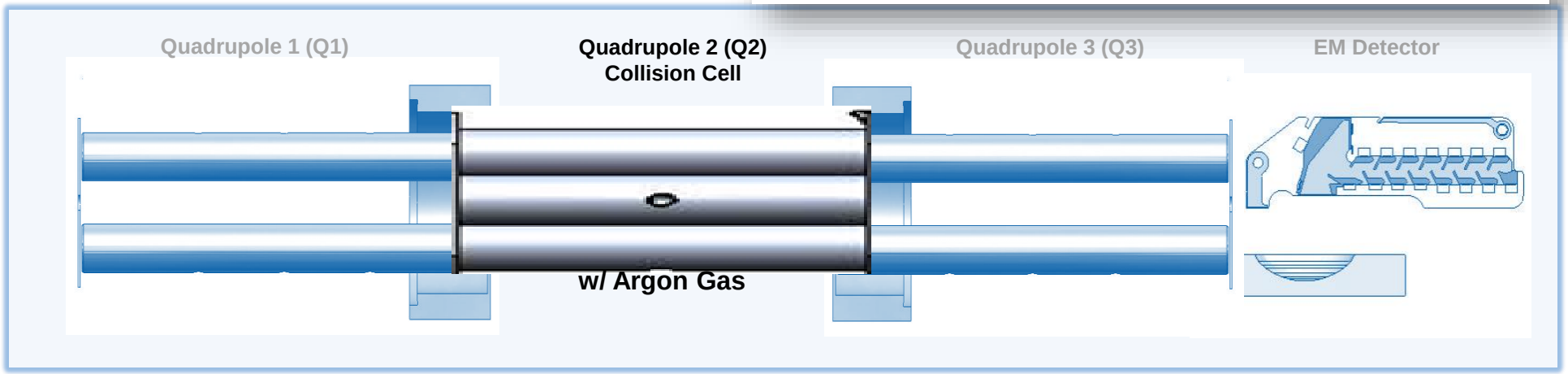
Triple Quad: Q2 Collision-Induced Dissociation (CID)

Fragmentation of both analyte and matrix ion



Characteristic fragment





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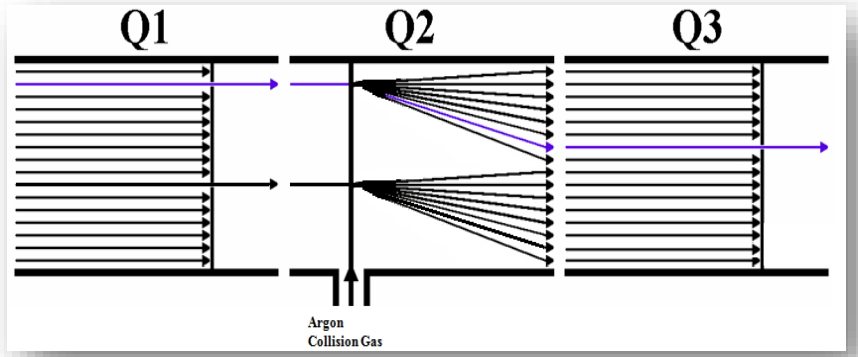
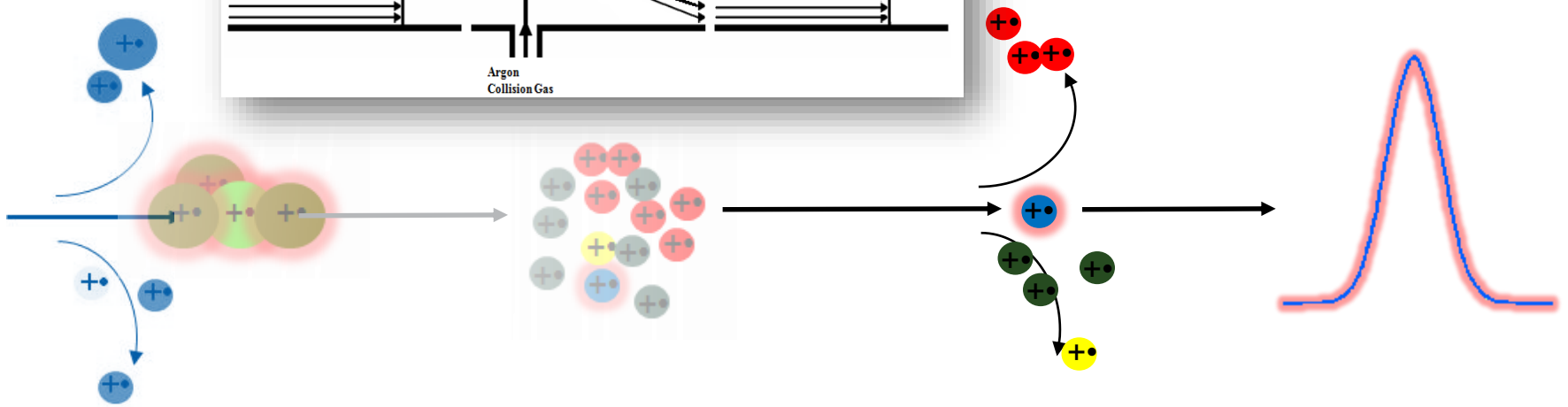
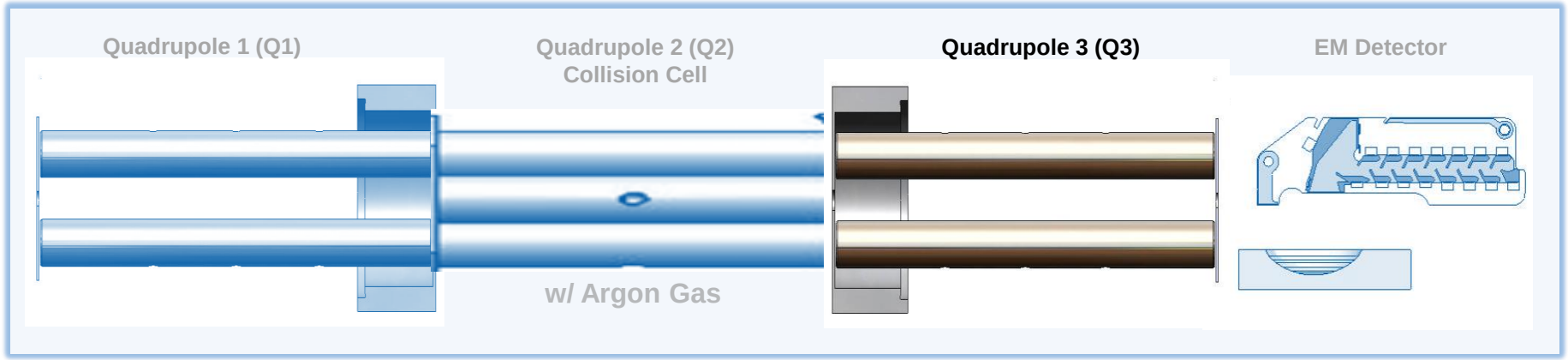
Triple Quad GC-MS: Q3 Product Ion Selection

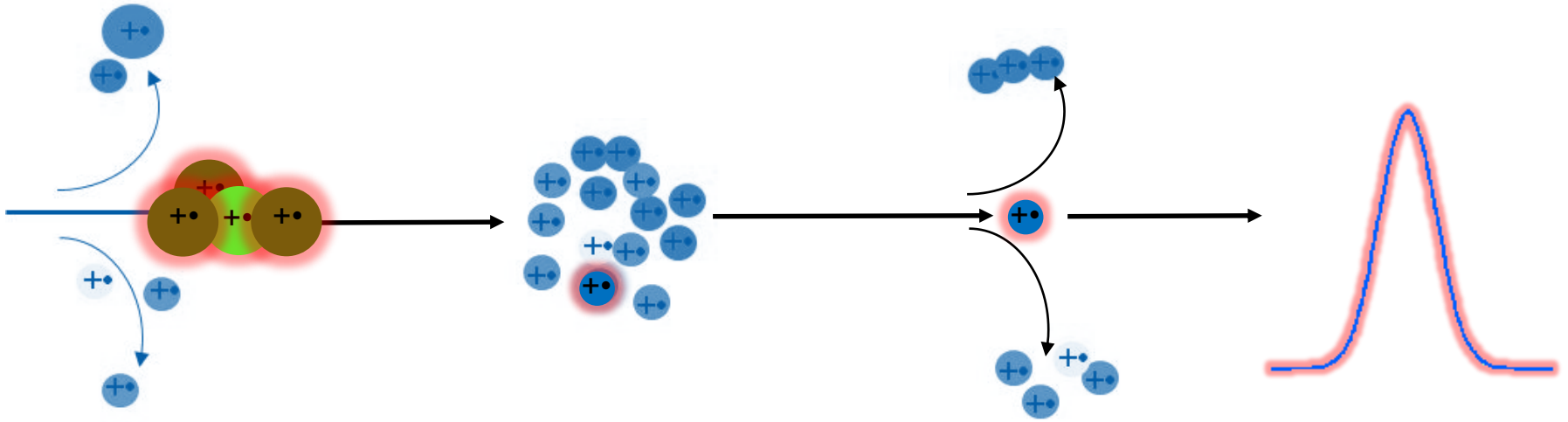


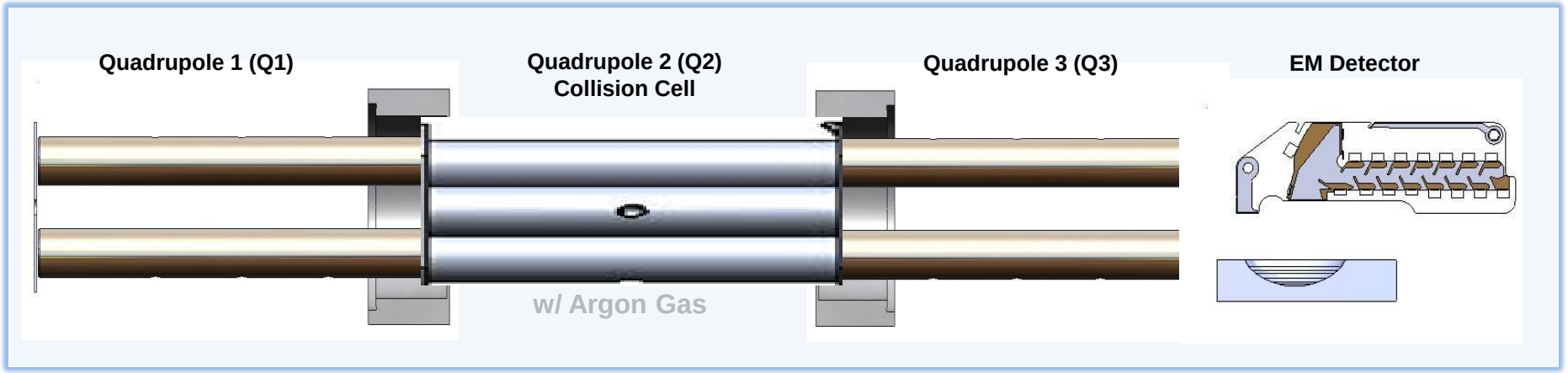
Selection of unique product ion of analyte



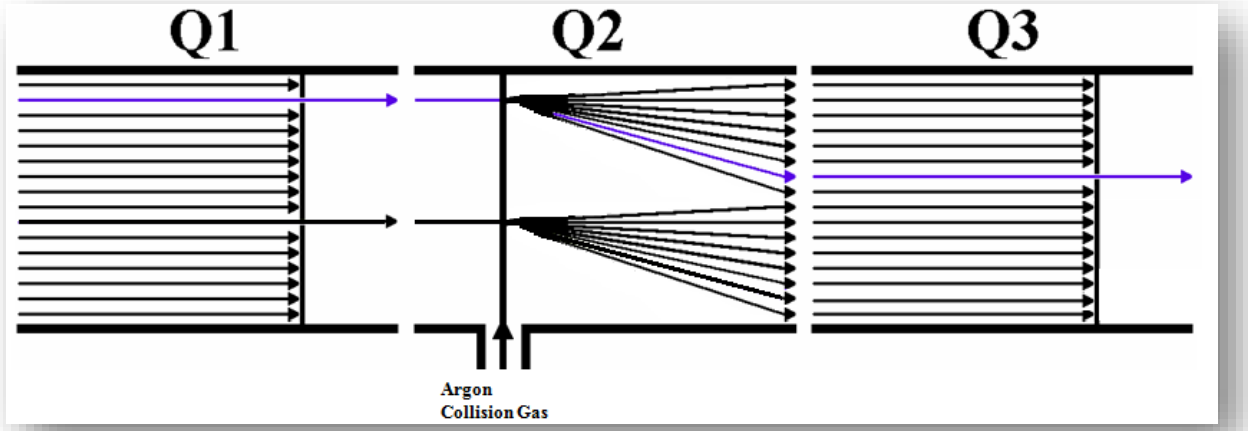


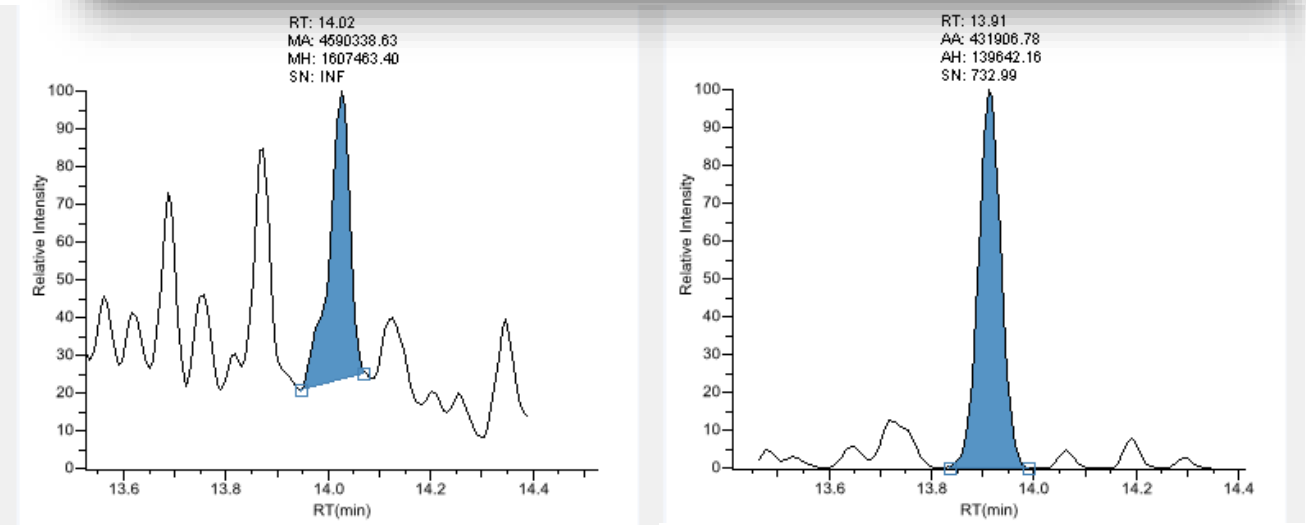
Triple Quad GC-MS: Selected Reaction Monitoring (SRM)





Triple Quad GC-MS: Selected Reaction Monitoring (SRM)



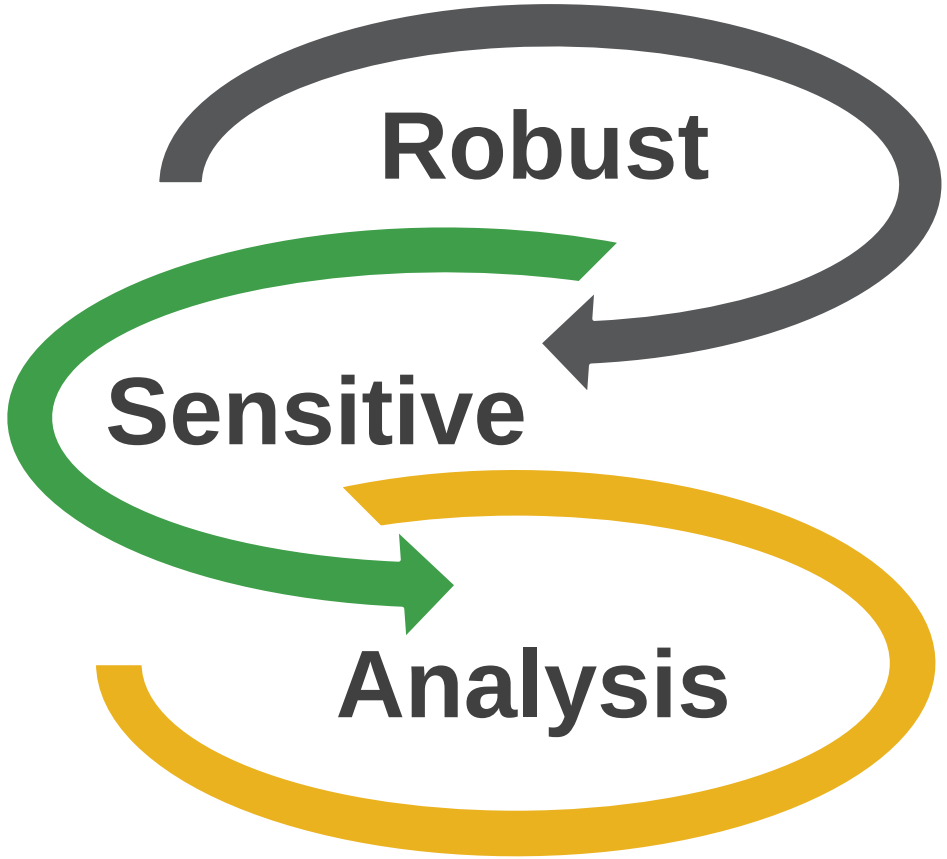


SIM on *m/z* 158 **SRM on *m/z* 158 > 99**

- NDBA in drinking water

Experimental

- Instrumentation overview
- Standard preparation
- Sample preparation
- GC-MS consumables
- GC-MS conditions
- AutoSRM – Easy Method Development



Ultimate Sensitivity with the new AEI source

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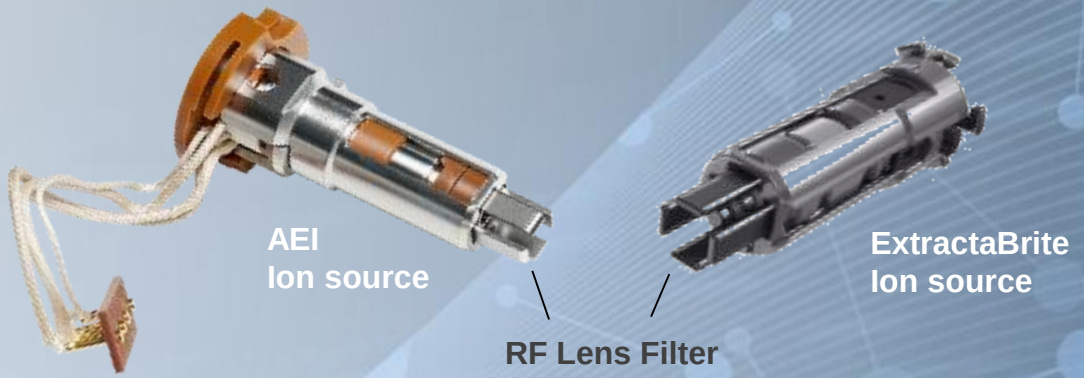
Introducing the Advanced Electron Ionization (AEI) source

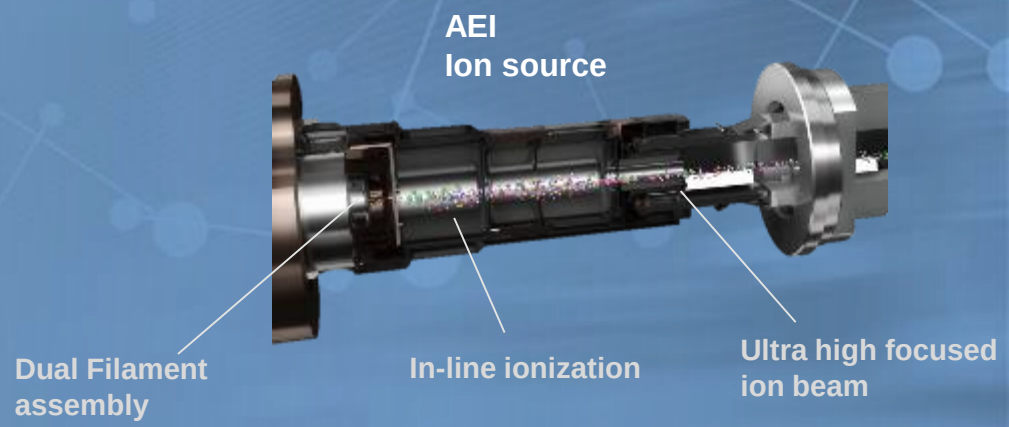
Inheriting from the Thermo Scientific™ ExtractaBrite™ ion source

- Highly inert material
- Independent dual heater
- Proprietary RF lenses
- Dual filament design



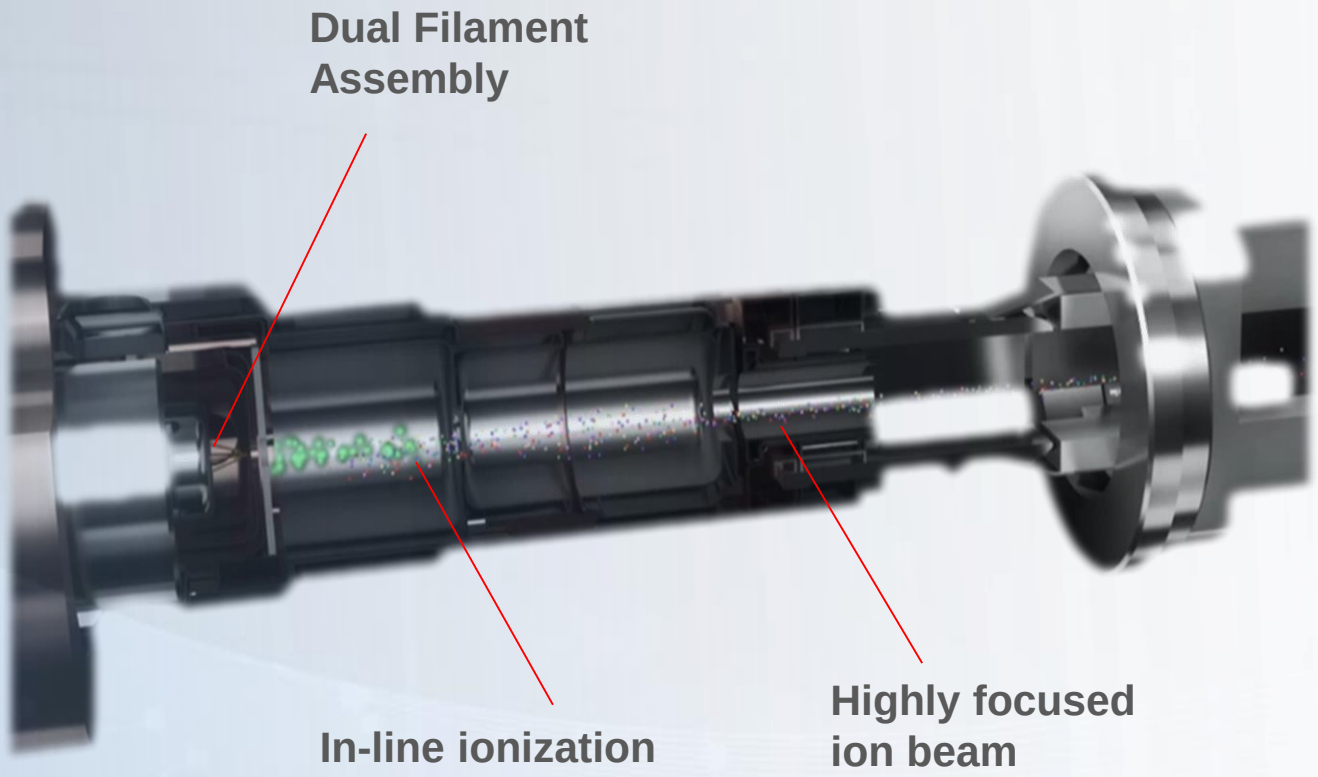
Adding innovative design for superior sensitivity and robustness

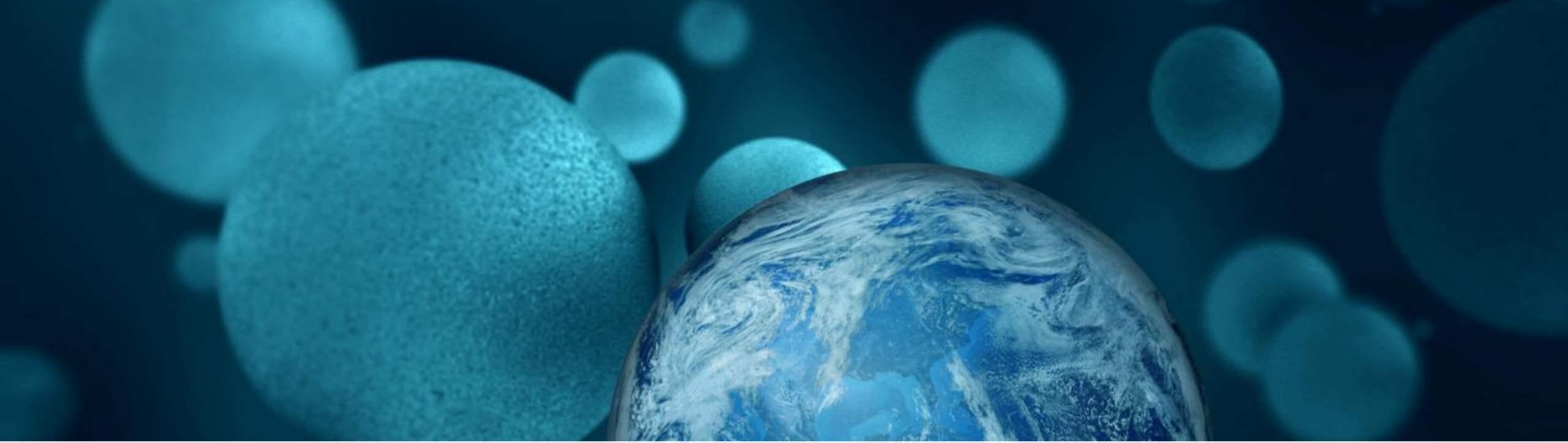
- Highly efficient ionization
- Tightly focused ion beam



Advance Electron Ionization (AEI) source – extended robustness

- Highly focused ion beam makes this ion source extremely robust
- Maintenance frequency is significantly reduced even with difficult matrices
- Utmost sensitivity is now achieved with extended robustness, ideal for challenging samples





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NoVent Solution vs V-Lock on Thermo Scientific GCMS

NoVent vs V-Lock

- Both solutions allows the user to replace the analytical GC column connected to a Mass Spectrometer, without breaking the vacuum.

- The V-Lock is an innovative proprietary technology which uses the VPI to isolate the MS and maintain the vacuum when the column is disconnected. It requires a VPI enabled configuration.

- The NoVent uses a microfluidic Silflow connector to supply an auxiliary gas to the MS when the analytical column is disconnected. It is the solution for all the NO VPI configurations and for the new AEI source

Pros & Cons

V-Lock

- It has the advantage to avoid any additional connection to the column end, which could be potentially source of dead volumes or leaks
- Additional advantages are that it is unique on the market and it easier to use compares to the No-Vent
- The cons is that it requires a more expensive VPI enabled MS configuration. Additionally it is not compatible with the new AEI source

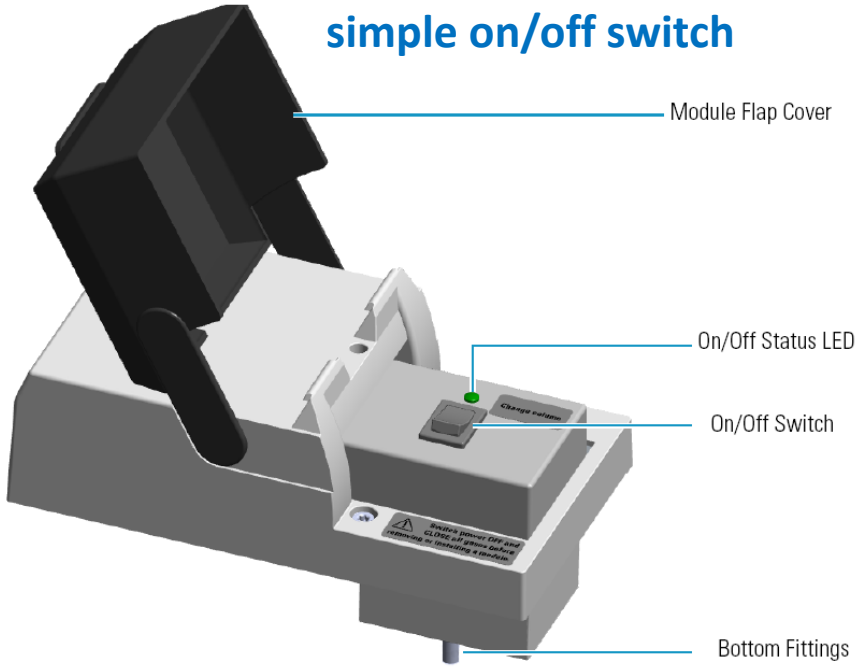
No-Vent

- The advantage is that it can be used for the NO-VPI configuration
- The cons is that it requires additional connections to the column and an Aux Gas supply

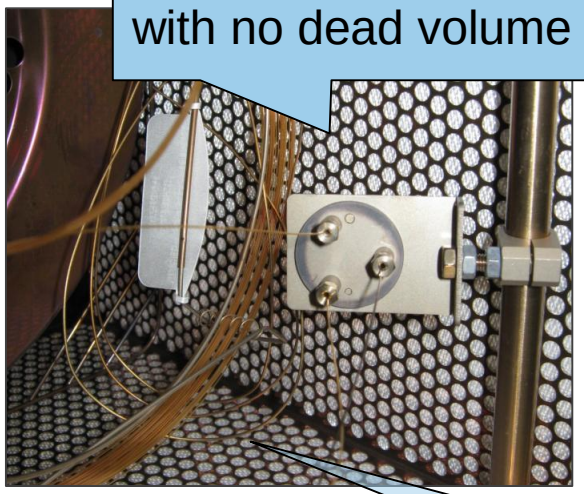
Thermo NoVent Microfluidics Module

- Microfluidics Silflow, completed with a manual on/off switching for the Aux Gas supply, calibrated restrictions and connectors

NoVent Microfluidics Module with simple on/off switch



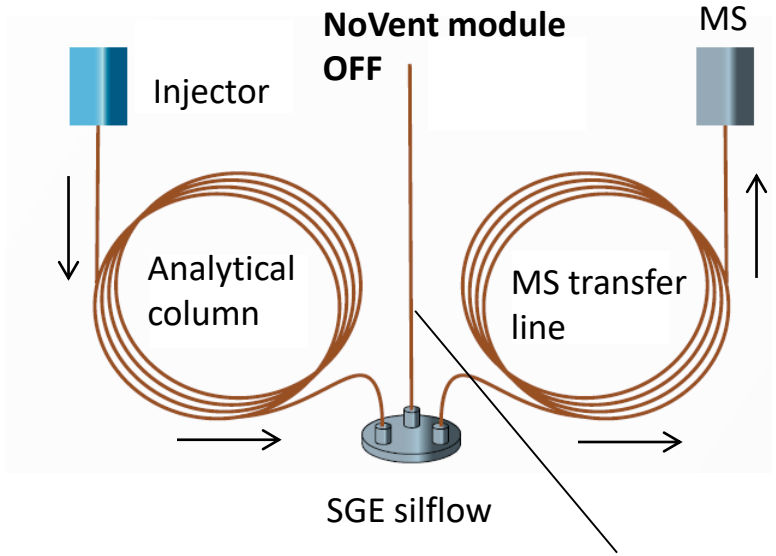
NoVent Microfluidic connected to column and flow restrictors with no dead volume



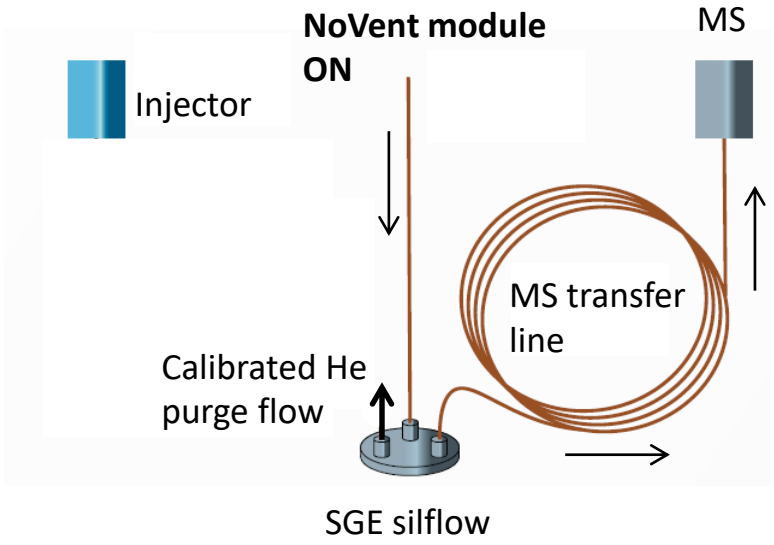
GC Oven

NoVent module: principle of operations

During standard operation the NoVent module is switched OFF



No flow inside this restriction. No additional flow to the MS



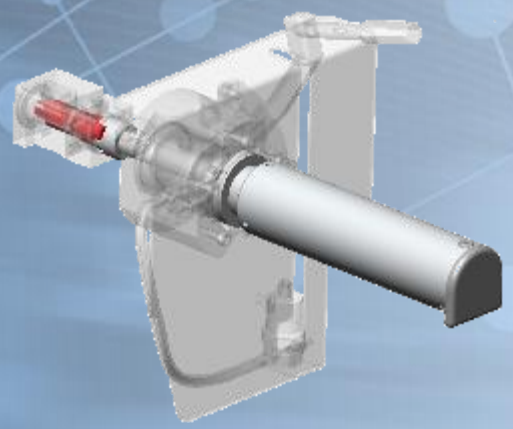
During column replacement the NoVent module is switched ON

Thermo NoVent Microfluidics is simpler to be used, no gas flow setting required

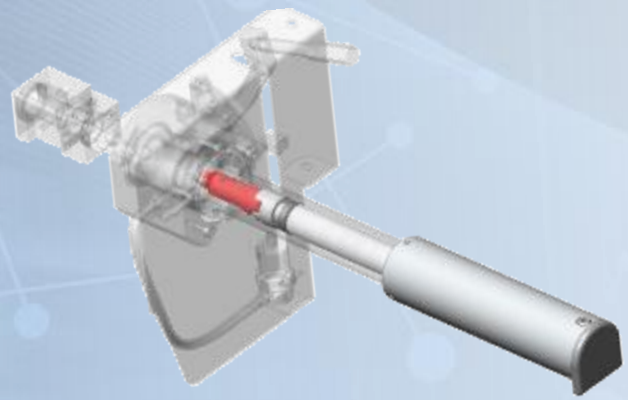
NeverVent technology for no vent source exchange

Extends the capability of the vacuum probe interlock **(VPI)** design with the newly introduced source plug, **V-Lock**

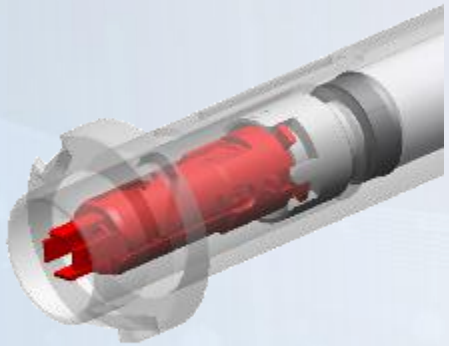
Through the VPI, no need to vent mass spec system for extracting the wireless ExtractaBrite ion source



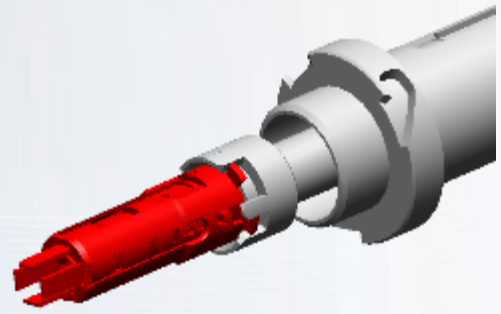
Step 1. Insert removal tool



Step 2. Remove source



Step 3. Hot source is held in tool



Step 4. Push source out of tool

Liberating routine labs with ISQ & TSQ: Using NeverVent Technology

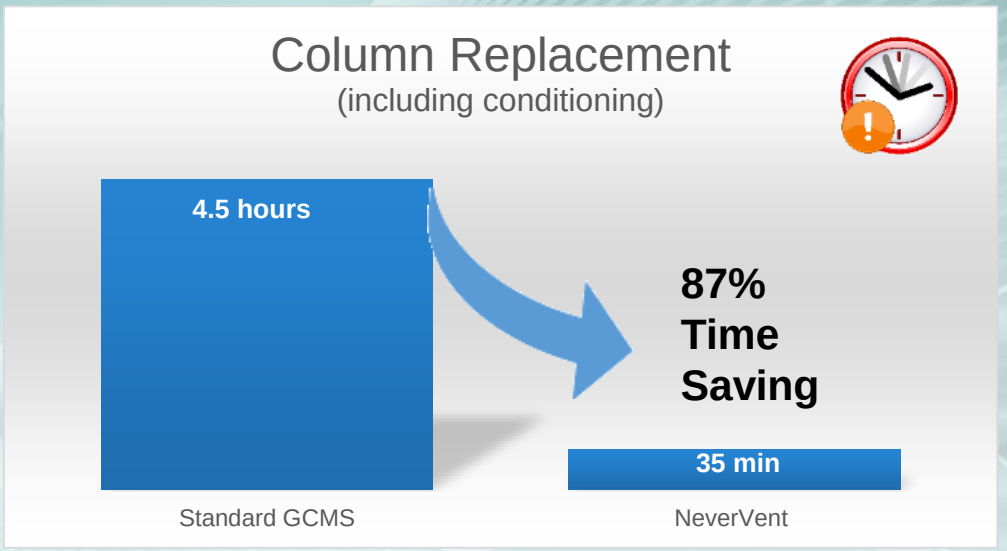
V-Lock

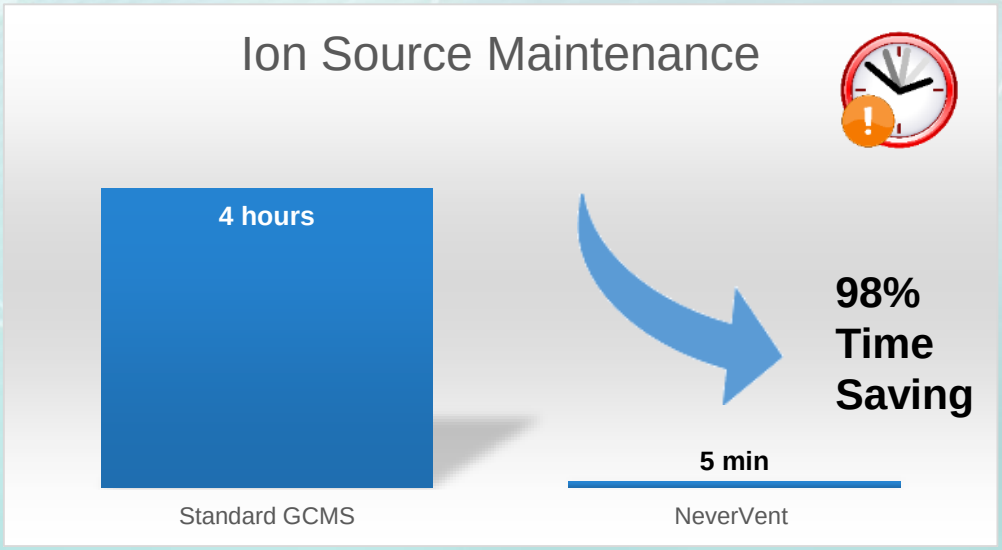
Allows vent free GC column exchange

No complicated fluidics / extra connections

ExtractaBrite

Vent free source exchange





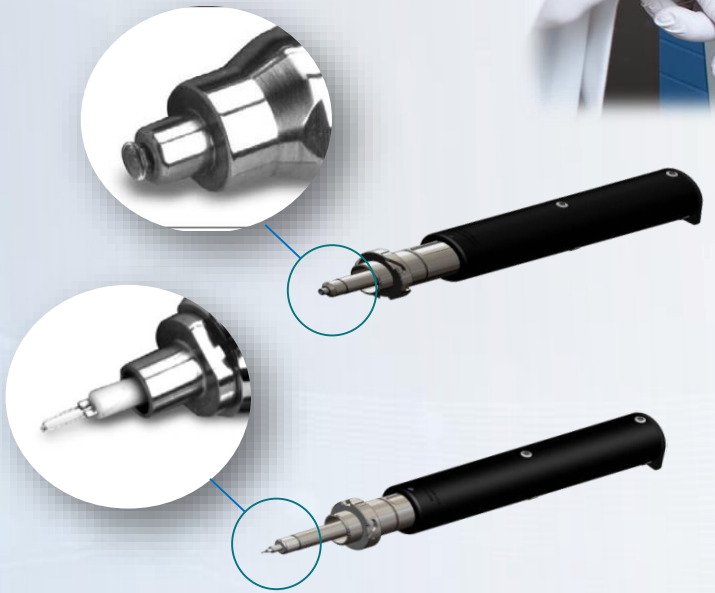
Extended capability with the VPI

Direct Sample Probe - ideal for materials difficult to elute chromatographically

- Designed to eliminate sample preparation time
- Compatible with all modes of ionization and mass analysis
- Simplified use through the Vacuum Probe Interlock (VPI)

- **Direct Insertion Probe (DIP)** – ideal for solid samples or trace components in solid matrices such as forensic samples, tissue, etc.

- **Direct Exposure Probe (DEP)** – ideal for liquids or solids dissolved in a suitable solvent.



Routine Ease of Use

Retention Time Alignment

- Easy and fast SW tool to maintain retention times during routine operation
- n-Decane (C10) is used as the only target reference compound
- No need for long calibration sequence
- Only one injection is needed providing quick method transfer in GC or GC-MS

- Run C10 on the reference column
- Fast isothermal run possible

- If you trimmed the column
- If you replaced the column

- Simply input the new reference RT and the column void time (air peak)

- The SW calculate the new carrier flow or column dimension settings to update the method

Auto SIM – Streamlined method set up workflow

Fullscan

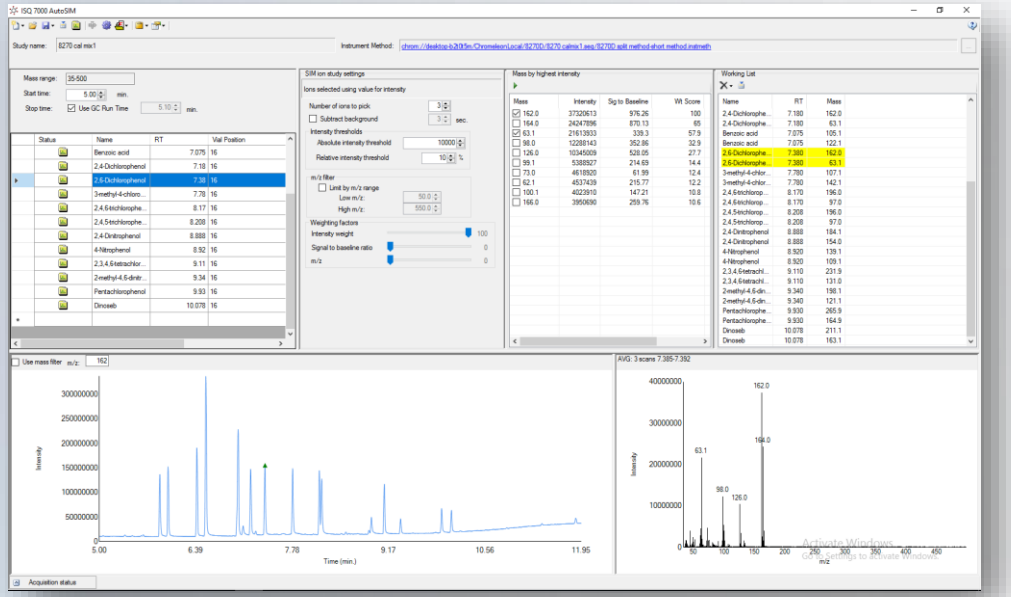
- Library search
- List of compunds and RT

develop

- AutoSIM to automatically select ions

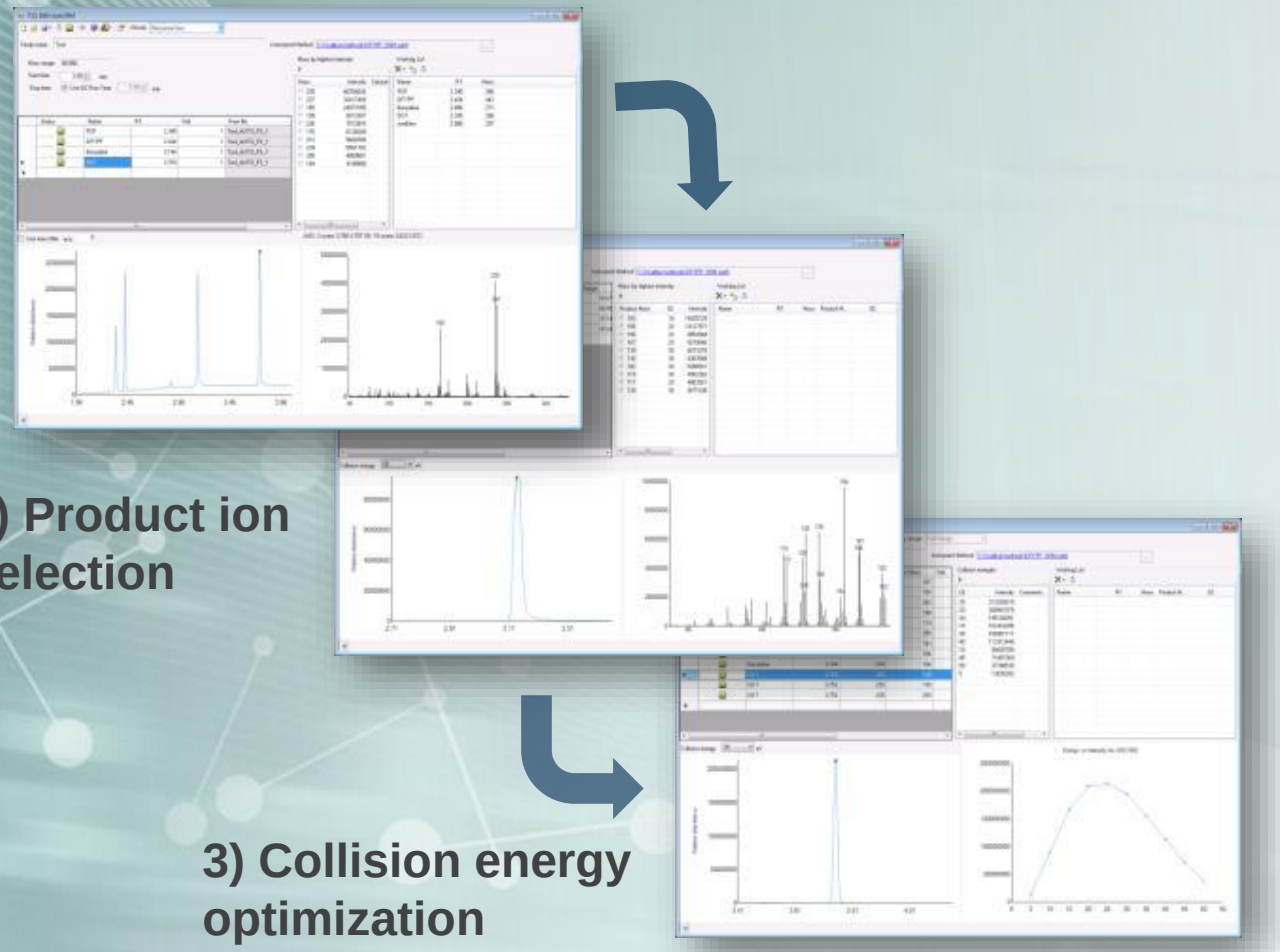
GO

- Link to Data System
- Update method
- Acquire and quantify



A real time saver and productivity booster

1) Precursor ion selection



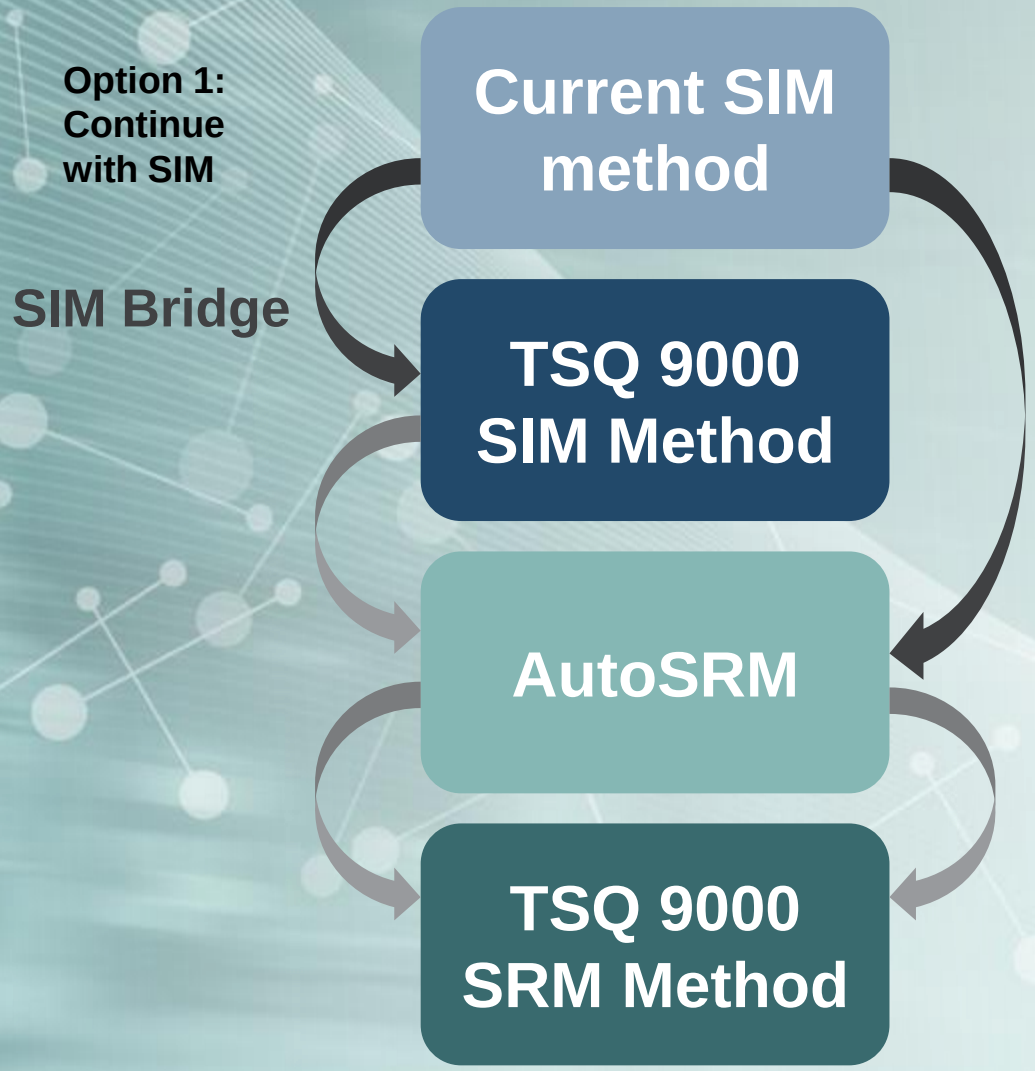
2) Product ion selection

3) Collision energy optimization

AutoSRM

- A triple quad method development expert integrated into your system
- Provides full method development independence
- Fully optimised SRM transitions *for your system*, even for less experienced users
- Saves huge amount of time and effort

Method Development - From Single Quad, to Triple Quad



SIM Bridge

- Simple tool to migrate from single quadrupole to triple quadrupole
- SIM methods exported from other sources to be translated to the TSQ 9000 system method
- SIM methods can be immediately run on the TSQ 9000 system or through AutoSRM to translate the SIM information into a powerful SRM method

Scalable in a changing laboratory environment

ThermoFisher SCIENTIFIC

Perfect for today, ready for tomorrow

- Fit for purpose GC-MS solution
- Grows with evolving regulatory requirements
- Base to advanced configurations
- Full field upgrade path

Ultra high sensitivity and robustness
ISQ 7000 AEI

High-throughput solution
ISQ 7000 NeverVent EI & CI

High-throughput solution
ISQ 7000 NeverVent EI

Accessible high performance
300L/s ExtractaBrite

Affordable first entry
66L/s ExtractaBrite

Perfect for today, ready for tomorrow

- Grows with laboratory requirements
- From base to advanced configurations
- Full field upgrade path

Ultra high performance and robustness
TSQ 9000 AEI

High-throughput solution
TSQ 9000 NeverVent EI & CI

High-throughput solution
TSQ 9000 NeverVent EI

Affordable performance
300L/s ExtractaBrite

Most accesible entry from SQ>TQ
240L/s ExtractaBrite

Automated Sample Handling and Introduction

Static Headspace
(Syringe based)

Dynamic
Headspace
(ITEX)

SPME

Sample
Preparation

Static
Headspace
(Valve&Loop)

Purge & Trap

Thermal
Desorber

ThermoFisher SCIENTIFIC

APPLICATIONS

UNSTOPPABLE

ThermoFisher SCIENTIFIC

Analysis of Drugs of Abuse (DoA) by Single Quadrupole GC-MS

Sensitive and robust unknown screening workflow using Advanced Electron Ionization

- ✓ High-throughput unknown screening of urine samples
- ✓ High sensitive full scan acquisition and signal deconvolution
- ✓ Simple and fast SPE as sample prep

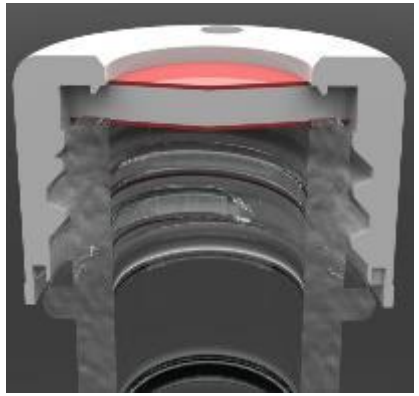
Thermo Scientific AN 10592 – Sensitive screening of DoA in human urine by GC-MS following a simple SPE

For Forensic Use Only.

LVR Customer Testimonial

Sensitive screening for drugs of abuse in human urine using single quadrupole GC-MS following a simple solid phase extraction

CCS Products Used For DoA Study



SureStop

HyperSep silica based SPE

LinerGOLD

TR-DoA5 15m, 0.25 mmID, 0.25 um p/n **26AF130P**

LVR- Clinic Viersen Pharmacy and Laboratory (Germany)

- Determination of Asservates with GC-MS
- Mostly: Urine Samples
- Rare: Drug Screening in Serum
- No analysis of hair

SPE Sample Preparation

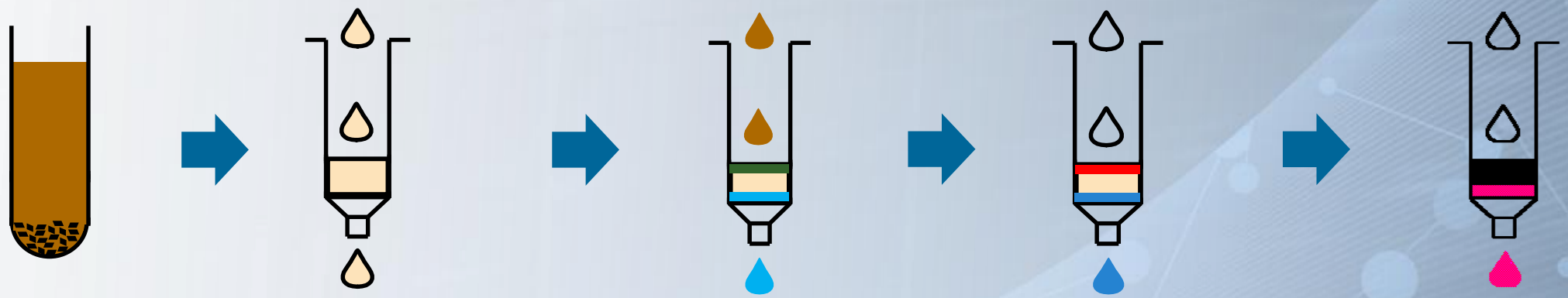
3 ml urine +30 µl ß-Glucuronidase Incubate at 56 °C for 30 min

Conditioning with 3ml Methanol Pre-equilibration with formic acid 0,1 %

Sample application

Rinsing: 1 ml formic acid 0,1 % 0,5 ml Methanol/Water 50:50 + 0.1 % formic acid

Analyte Elution with 2 x 1,5 ml 5 % NH3 /Methanol at pH 9

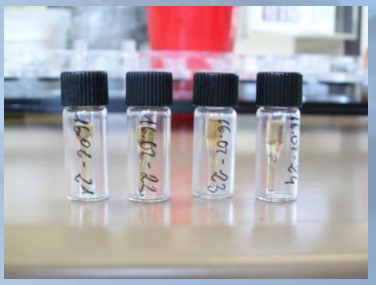


Thermo Scientific™ HyperSep™ Verify CX Cartridges

200 mg sorbent bed 3 ml volume

p/n 60108-777

Evaporate the eluate at 65°C under air stream. Dissolve extract with 50 µl Methanol, centrifuge the sample before inject 1 µl into the GC-MS system



GC-MS Experimental conditions

Trace1310 GC Oven	
Initial temperature:	70 °C
Initial hold time:	0.5 min
Ramp 1 rate:	22 °C/min
Ramp 1 final temperature:	320 °C
Ramp 1 hold time:	2 min

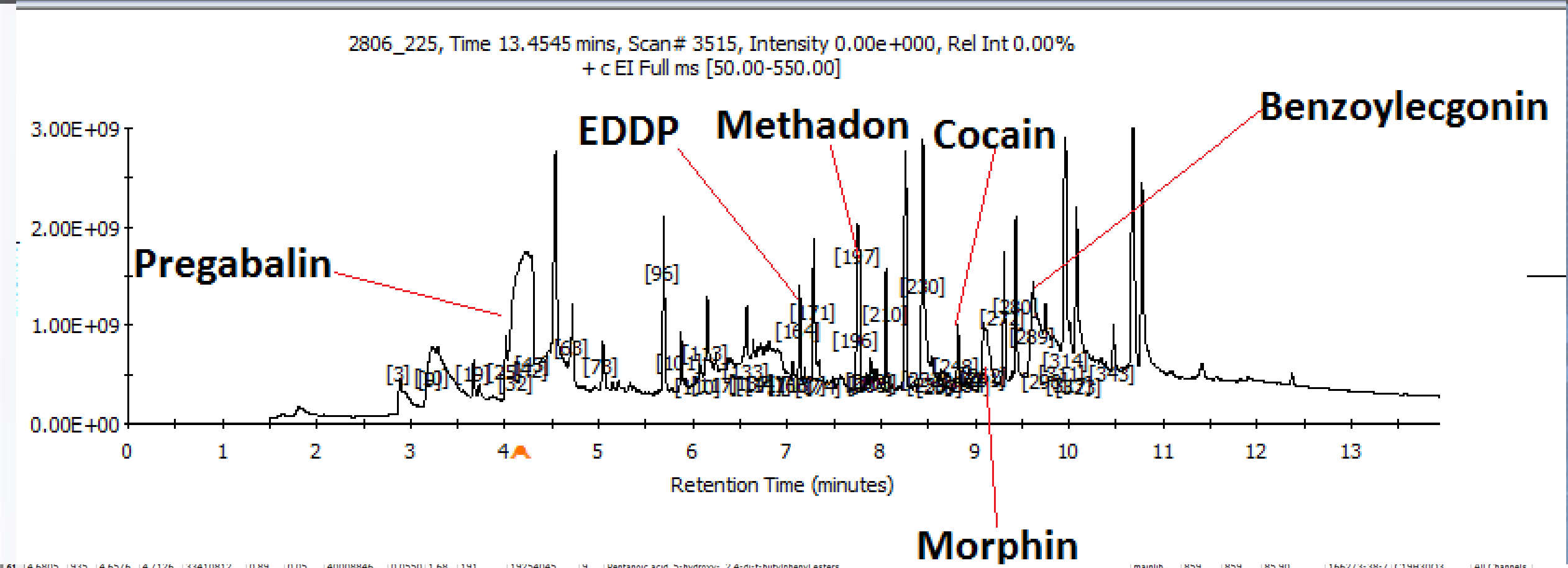
S/SL Method	
S/SL mode:	Splitless with Surge
Temperature:	280 °C
Splitless time:	1 min
Split flow:	20 mL/min
Surge pressure:	172 kPa
Surge duration:	1 min
Purge flow:	5 mL/min
Carrier mode:	Constant Flow
Carrier flow:	1.5 mL/min
Vacuum compensation:	On

ISQ 7000 - AEI	
MS transfer line temperature:	250 °C
Ion source temperature:	270 °C
Ionization mode:	EI
Acquisition start time (or solvent delay):	1.5 min
Start mass:	50 amu
End mass:	550 amu
Scan time:	0.2 s

- Trace™ TR-DoA 35MS (p/n 26AF130P) 15m, 0.25mm ID, 0.25 um
- LinerGOLD™ GC Focus Liner (p/n 453A-1255-UI)
- Triplus ™ 100 LS Autosampler (1uL injection)
- Thermo Scientific™ Chromeleon™ Chromatography Data System (CDS)
- AnalyzerPro® software to perform automated MS signal deconvolution

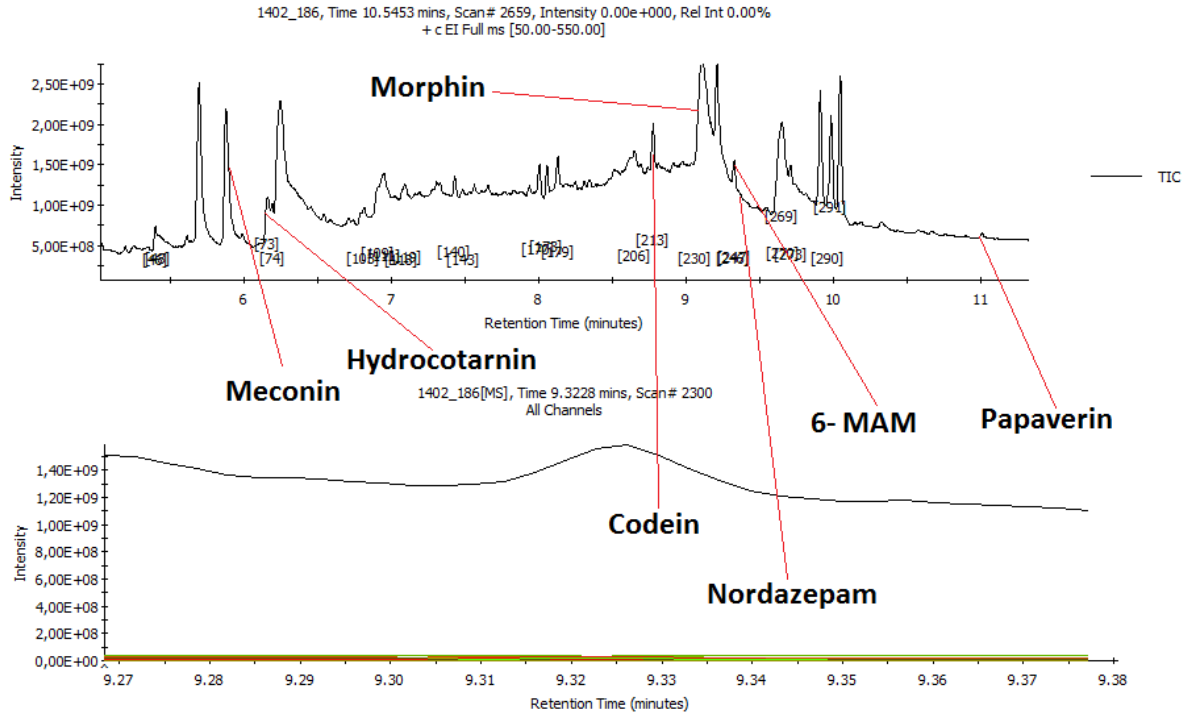
ThermoFisher SCIENTIFIC

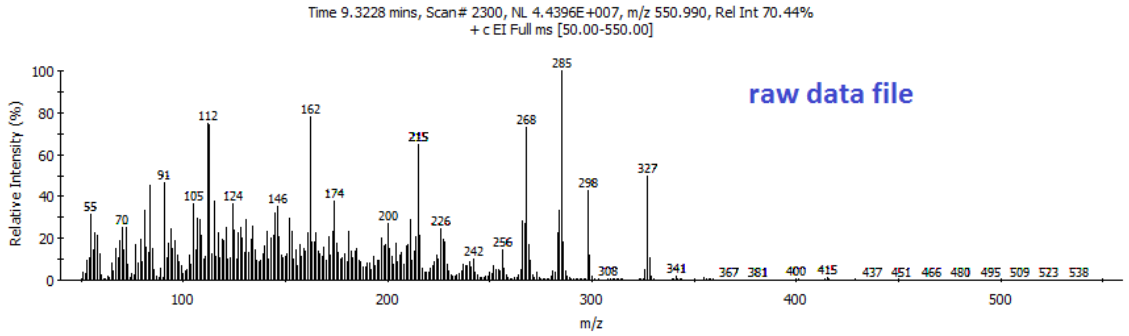
Urine sample from a forensic case study

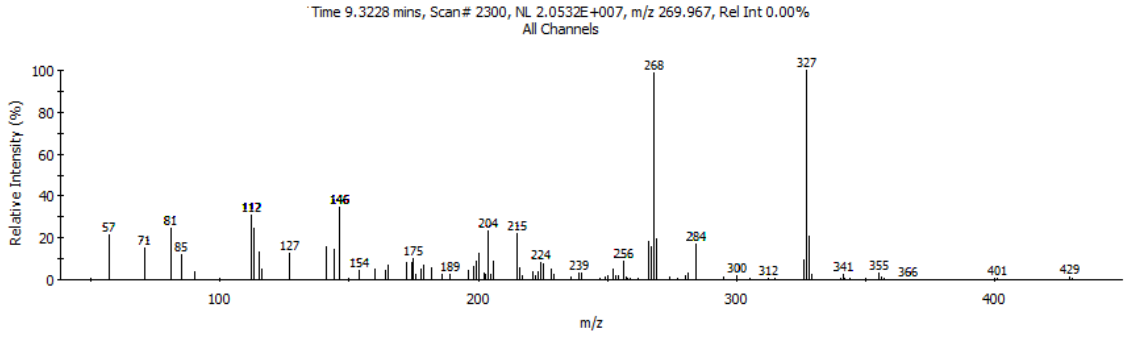


61	4.6805	935	4.6576	4.7126	33410812	0.89	0.05	40008846	0.0550	1.68	191	19254045	9	Pentanoic acid, 5-hydroxy-, 2,4-di-t-butylphenyl esters	mainlib	859	859	85.90	166273-38-7	C19H30O3	All Channels
500	12.8295	3331	12.8211	12.8390	202875	0.01	0.00	423698	0.0179	0.07	280	72435	10	Phenanthro[1,2-b]furan-10,11-dione, 6,7,8,9-tetrahydro-6-(hydroxymethyl)-1,6-dimethyl-, (-)-	mainlib	622	749	66.01	17397-93-2	C19H18O4	All Channels
4	2.9323	421	2.9064	2.9416	15536096	0.42	0.02	13241580	0.0352	2.48	91	7344907	6	Phenylacetic acid, 4-cyanophenyl ester	mainlib	640	745	67.15	n/a	C15H11NO2	All Channels
118	6.2620	1400	6.2544	6.2766	7513656	0.20	0.01	11987111	0.0222	1.24	113	1791872	20	Phosphoramidous difluoride, dimethyl-	mainlib	689	995	78.08	814-97-1	C2H6F2NP	All Channels
126	6.4185	1446	6.3983	6.4362	41462138	1.11	0.06	55004455	0.0378	3.17	149	22590648	13	Phthalic acid, 2-ethylhexyl isobutyl ester	mainlib	774	794	78.00	n/a	C20H30O4	All Channels
548	13.6628	3576	13.6553	13.6714	1450555	0.04	0.00	2940500	0.0160	0.65	207	788253	9	Pirprofen -CO2 page 983 in PMW part 2	pmwtox3n	823	885	84.16	n/a	C12H14ClN	All Channels
34	4.1737	786	4.1569	4.1717	37608415	1.01	0.06	76045999	0.0148	3.46	56	7647393	17	Pregabalin	nist extern	685	685	68.50	148553-50-8	C8H17NO2	All Channels
534	13.4043	3500	13.3947	13.4083	1334556	0.04	0.00	3296551	0.0136	0.72	207	461859	14	Propane-1,3-diol 4-nitro benzeneboronate	mainlib	646	805	69.37	85107-43-3	C9H10BNO4	All Channels
301	9.8059	2442	9.7976	9.8127	3852603	0.10	0.01	7430121	0.0151	0.66	124	1916511	5	Propanoic acid, 3-amino-3-(2-fluorophenyl)-, ethyl ester	mainlib	602	696	63.02	218165-97-0	C11H14FNO2	All Channels
185	7.5544	1780	7.5237	7.5809	26220762	0.70	0.04	23275599	0.0572	1.87	58	10709959	14	Pyridazine-3,5-dicarbonitrile, 1,6-dihydro-4-amino-6-imino-1-(2-nitrophenyl)-	mainlib	608	807	66.77	n/a	C12H7N7O2	All Channels
526	13.4315	3508	13.4265	13.4421	1495259	0.04	0.00	2591805	0.0157	0.71	207	742896	10	Pyrido[2,3-d]pyrimidine, 4-phenyl-	mainlib	741	952	80.43	28732-75-4	C13H9N3	All Channels

Urine sample from a forensic case study of Heroin consumption





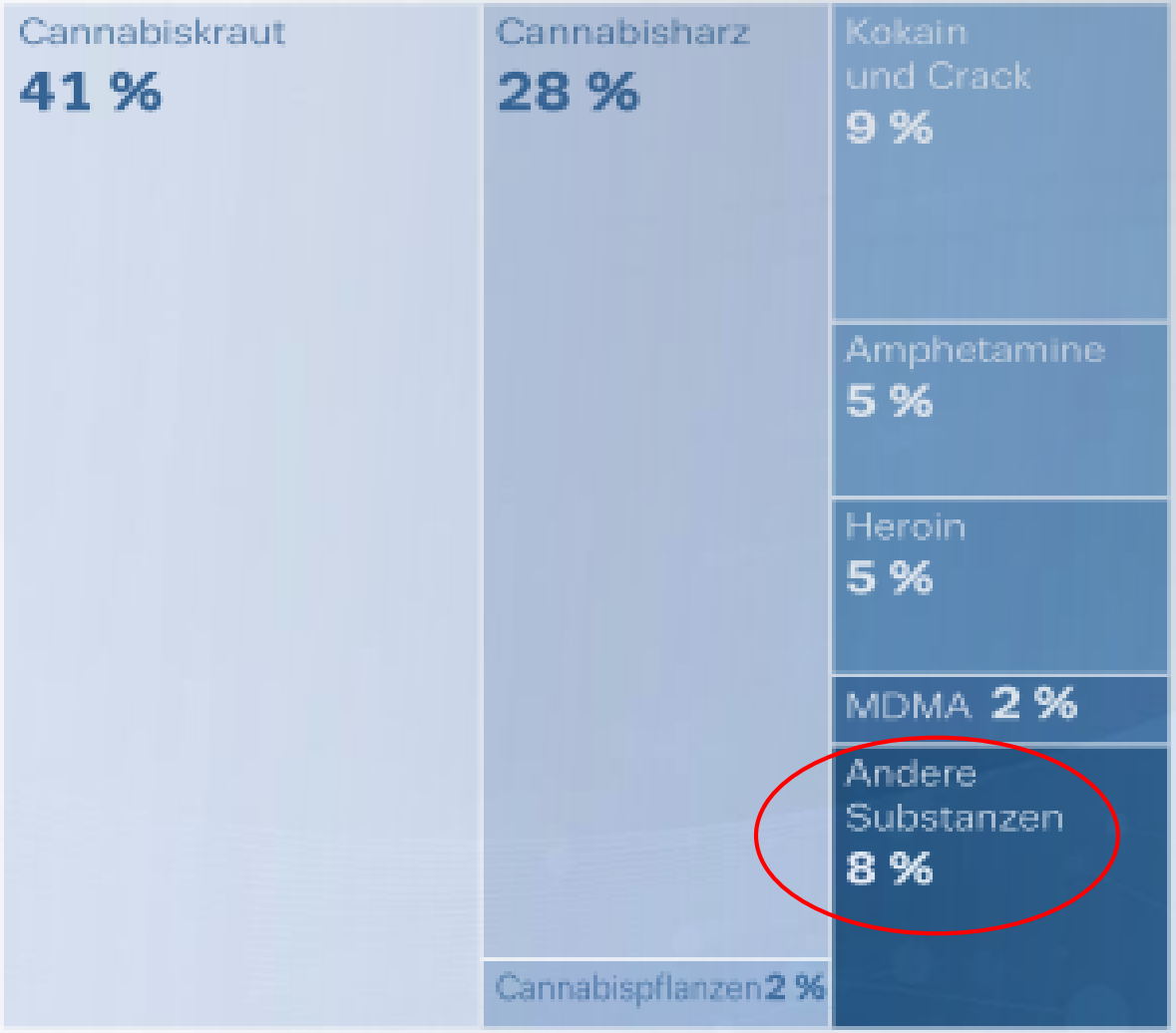


Summary Report

	RT	Scan	Start RT	End RT	Area	Area %	Total %	Height	Width	Purity	Base Peak	Base Peak Area	Ions	Name	Library	Forward	Reverse	Confidence %	CAS #	Chemical
184	8.2208	1976	8.2032	8.2533	23268524	0.68	0.04	18411323	0.0501	0.66	154	11297944	16	6-Methyl-5,6,7,8-tetrahydro-2-thioxo-4-quinazolinone	mainlib	564	721	61.11	104829-71-2	C9H12N2
246	9.3228	2300	9.3018	9.3463	170375816	4.98	0.33	162778951	0.0446	4.98	327	30221656	9	6-Monoacetylmorphine	mainlib	635	648	63.89	2784-73-8	C19H21
459	13.6625	3576	13.6542	13.6676	801988	0.02	0.00	1881333	0.0134	0.47	207	334277	4	6-Nitro-8-methoxy-2H-chromene	mainlib	939	994	95.55	62063-07-4	C10H9N
82	6.3264	1419	6.3071	6.3505	2794864	0.08	0.01	2800075	0.0434	0.10	189	1827515	4	6H-Cyclobuta[c]phenanthrene	mainlib	667	727	68.50	83469-43-6	C15H10
89	6.5169	1475	6.4934	6.5404	10424753	0.30	0.02	9517074	0.0470	0.47	58	4757095	4	7-Isoquinolinol, 1,2,3,4-tetrahydro-6-methoxy-2-methyl-1-[2-(3,4,5-trimethoxyphenyl)ethyl]-	mainlib	610	676	62.98	n/a	C22H29
443	13.0299	3390	13.0234	13.0344	878462	0.03	0.00	2201379	0.0110	0.52	207	524321	8	8-Chloro-5-quinolinecarboxylic acid	mainlib	880	977	90.91	121490-68-4	C10H6Cl
401	11.9484	3072	11.9468	11.9589	1458012	0.04	0.00	3270712	0.0121	0.54	207	904489	14	8-Chloro-5-quinolinecarboxylic acid	mainlib	772	956	82.72	121490-68-4	C10H6Cl
420	12.3429	3188	12.3309	12.3446	1558512	0.05	0.00	2999270	0.0137	0.49	207	910648	9	8-Chloro-5-quinolinecarboxylic acid	mainlib	764	999	83.45	121490-68-4	C10H6Cl
341	10.8022	2735	10.7879	10.8076	327909	0.01	0.00	537872	0.0197	0.05	285	25266	6	8-Dimethyl(isopropyl)silyloxypentadecane	mainlib	532	653	56.83	n/a	C20H44
257	9.4622	2341	9.4521	9.4734	2106316	0.06	0.00	2929602	0.0214	0.20	248	1047415	12	8-Methoxy-1,3,4,5-tetrahydro-2H-1-benzazepin-2-one tbdms	mainlib	497	558	51.53	n/a	C17H27
289	9.9520	2485	9.9430	9.9629	1615828	0.05	0.00	2226785	0.0199	0.16	90	466335	4	8-Quinolinamine, N-(trimethylsilyl)-6-[(trimethylsilyl)oxy]-	mainlib	675	830	72.15	36972-87-9	C15H24
207	10.2241	2565	10.2085	10.2364	1818353	0.06	0.00	2178951	0.0270	0.18	215	628151	6	AB-PINACA	caymanspectrallibrary.nist.hp	488	506	50.11	n/a	C18H26

Detection of Legal High

EU drug report 2017 on seized drugs



- Legal highs are new psychoactive drugs that contain various chemical ingredients, some of which are illegal while others are not.
- They produce similar effects to illegal drugs like cocaine, cannabis and ecstasy, but are structurally different enough to avoid being controlled under the Misuse of Drugs Act.
- They are either stimulants (making users feel energized), sedatives (making users feel relaxed or euphoric), or psychedelics (altering perceptions and making users hallucinate)

Detection of Legal High

How to identify new drugs of abuse ?

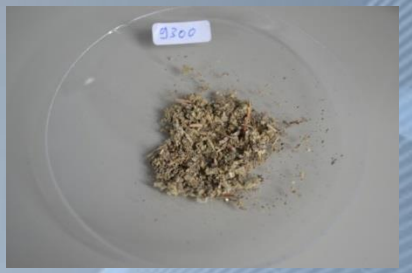
Unknown mass spectrum in the analysis

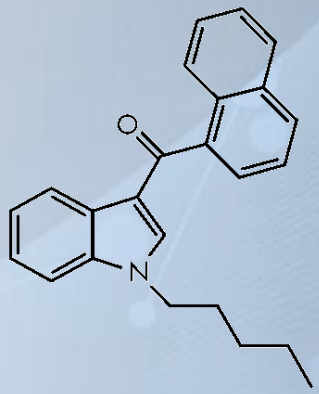
Free Nist Format Libraries on the web
https://www.caymanchem.com/app/template/SpectralLibrary.vm

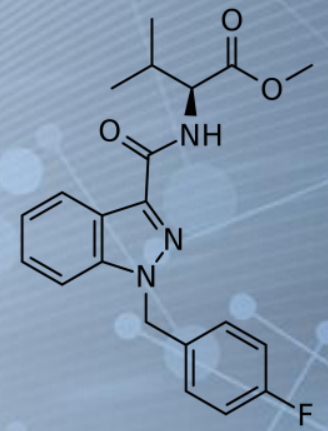
Scientific working group for the analysis of seized drugs
http://www.swgdrug.org/ms.htm

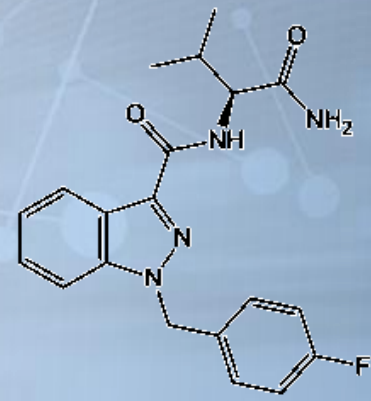
Synthetic Cannabinoids

- Used as legal alternative to Marijuana







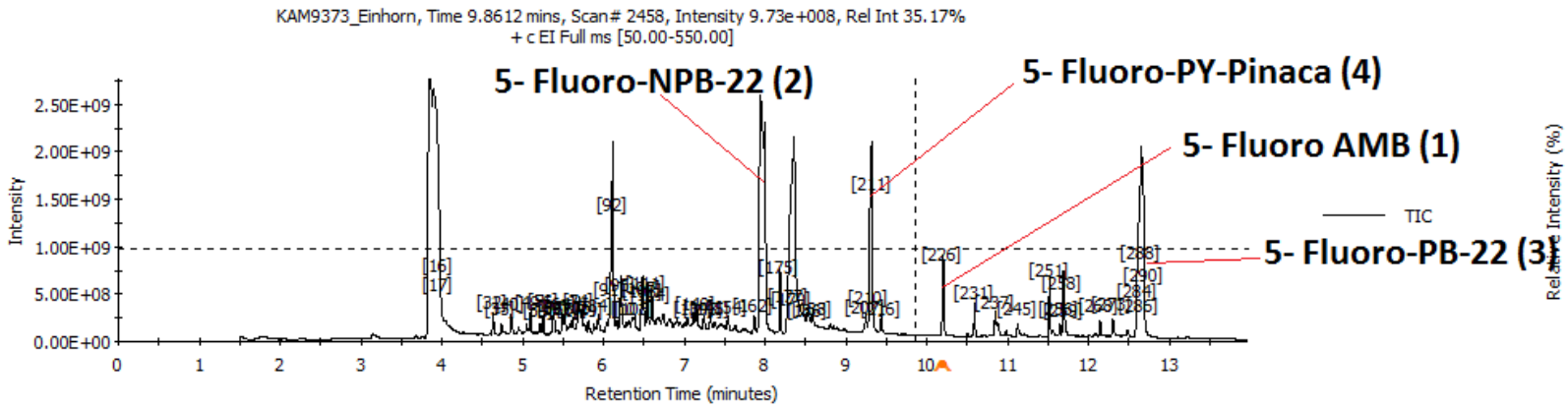


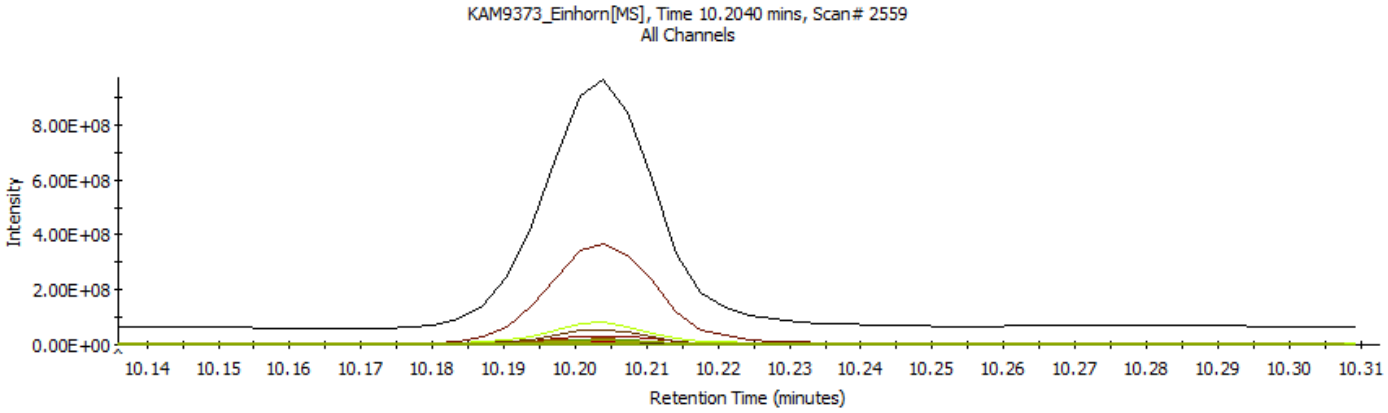
Characteristics of synthetic cannabinoids:

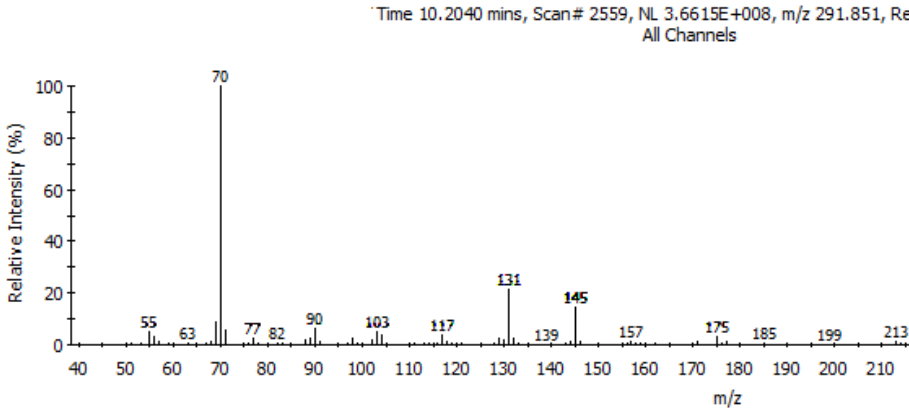
They are more potent than THC:

- JWH 018 is 4 times more potent than THC
- AB- Fubinaca is 40 times more potent than THC
- AMB- Fubinaca is 85 times more potent than THC

Analysis of a herbal mixture



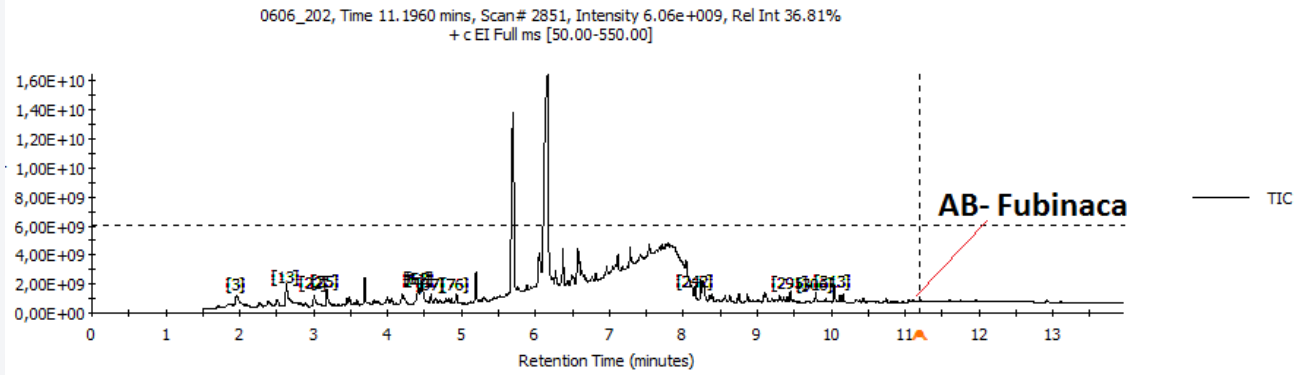


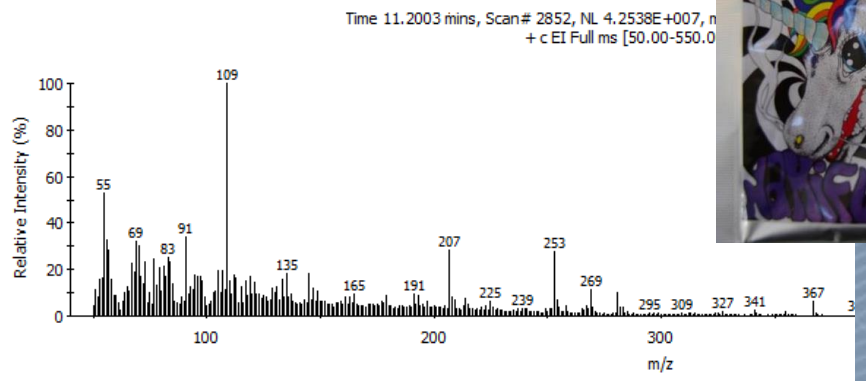


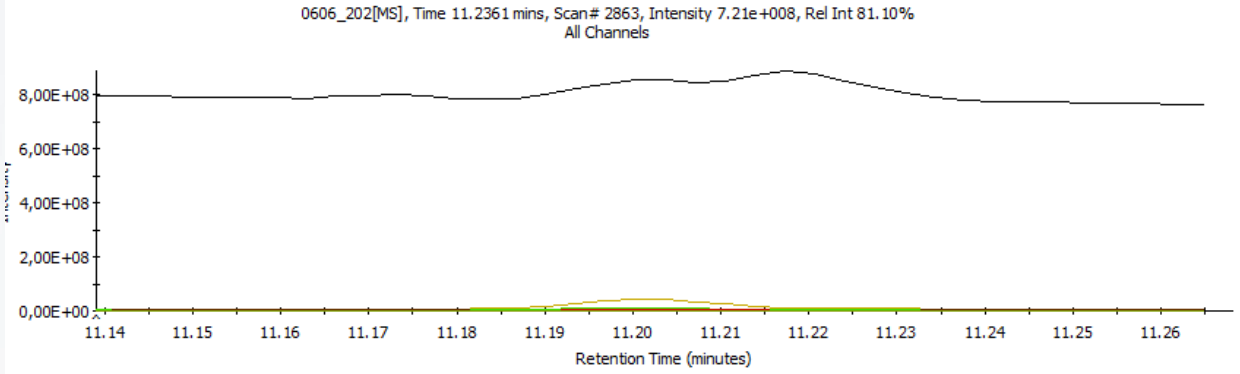
Summary Report

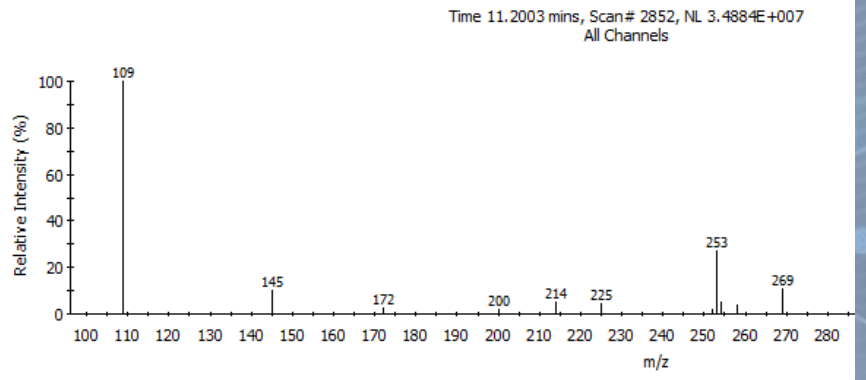
	RT	Scan	Start RT	End RT	Area	Area %	Total %	Height	Width	Purity	Base Peak	Base Peak Area	Ions	Name	Library	Forward	Reverse	Confidence %	CAS #	Ch
211	9.3163	2298	9.2813	9.3602	2987745215	94.24	8.26	1981215426	0.0789	65.20	233	450088003	128	5-Fluoro-AMB 1	nist extern	615	652	62.61	n/a	C1
172	8.0817	1935	8.0640	8.1119	6562407	0.21	0.02	5702785	0.0479	2.12	145	1785192	15	5-Fluoro-NPB-22 2	nist extern	651	656	65.25	1445579-79-2	C2
300	13.2242	3447	13.1760	13.2953	15457413	0.49	0.04	6446598	0.1193	5.74	232	6893094	16	5-Fluoro-PB-22 3	nist extern	858	860	85.86	1400742-41-7	C2
226	10.2040	2559	10.1700	10.2792	994597873	31.37	2.75	891206463	0.1092	69.64	70	421098086	132	5-Fluoro-PY-PINACA 4	nist extern	842	868	84.98	n/a	C1
122	6.7417	1541	6.7185	6.7662	99187041	3.13	0.27	97147490	0.0477	15.40	189	11522203	127	5-Isopropylidene-6-methyldeca-3,6,9-trien-2-one	mainlib	709	771	72.76	n/a	C1
104	6.4152	1445	6.3840	6.4387	1831395	0.06	0.01	1702170	0.0546	0.34	173	1339152	7	5-Methoxyindole-2-carboxylic acid	mainlib	830	869	84.17	4382-54-1	C1

Urine sample from a subject who consumed a herbal mixture









eport

	Scan	Start RT	End RT	Area	Area %	Total %	Height	Width	Purity	Base Peak	Base Peak Area	Ions	Name	Library	Forward	Reverse	Confidence %	CAS #
5	2309	9.3320	9.3755	229595075	1.41	0.19	216550176	0.0435	9.96	91	19606602	67	5-Pregnen-3á-ol-20-one, trifluoroacetate	mainlib	660	663	66.09	n/a
5	1641	7.0531	7.1341	848822253	5.20	0.70	453051579	0.0810	5.42	109	184232865	28	5-[5-Methyl-2-furyl]hydantoin	mainlib	711	767	72.78	68641-80-5
5	1519	6.6508	6.6856	62933412	0.39	0.05	80055457	0.0348	1.34	84	5474128	24	7,9-Di-tert-butyl-1-oxaspiro(4,5)deca-6,9-diene-2,8-dione	mainlib	624	693	64.47	82304-66-3
5	1676	7.1836	7.1956	28468176	0.17	0.02	71785844	0.0121	1.71	112	16810394	10	7-Oxabicyclo[4.1.0]heptan-2-one	mainlib	700	862	74.86	6705-49-3
38	3003	11.6894	11.7323	2804968	0.02	0.00	2405942	0.0428	0.15	253	2259907	4	9-Azabicyclo[3.3.1]non-2-ene-9-carboxylic acid, 6-(acetyloxy)-, ethyl ester, endo-	mainlib	705	999	79.32	49690-31-5
9	1931	8.0590	8.0927	10814589	0.07	0.01	10808414	0.0337	0.26	144	5067083	6	9-Oxononanoic acid	mainlib	604	879	68.65	2553-17-5
03	2852	11.1724	11.2344	74623681	0.46	0.06	63275248	0.0621	2.55	109	41191665	15	AB-FUBINACA Urin 2301 215, t=594 sec	spice	637	709	65.86	118528-00-0
3	1679	7.1982	7.2154	19747026	0.12	0.02	47594057	0.0172	0.79	113	1766320	8	Acetic acid, 2-(1-buten-3-yl)-2-nitro-, ethyl ester	mainlib	687	824	72.81	n/a
9	1936	8.0658	8.1061	77025120	0.47	0.06	80078742	0.0402	1.62	82	20235869	19	Allopseudococaine	mainlib	625	810	68.05	518-97-8
9	1981	8.2073	8.2515	1230133171	7.53	1.02	1402501798	0.0442	33.41	91	63070273	122	Androst-2-en-17-one, (5à)-	mainlib	799	888	82.57	963-75-7

Urine sample from a subject who consumed a herbal mixture

0606_202, Time 10.3871 mins, Scan# 2613, Intensity 0.00e+000, Rel Int 0.00%
+ c EI Full ms [50.00-550.00]

Metabolit AB Fubinaca

Mass 109

Time 10.3874 mins, Scan# 2613, NL 5.3140E+007, m/z 93.416, Rel Int 1
+ c EI Full ms [50.00-550.00]

0606_202[MS], Time 10.4418 mins, Scan# 2629, Intensity 4.76e+008, Rel Int 44
All Channels

Retention Time (minutes)

Review Library Search Results

Component 322, RT 10.3874 minutes

AB-FUBINACA Urin 2301 215, t=594 sec, CAS# 118528-00-0

Rel Intensity (%)

m/z

Summary Report

	RT	Scan	Start RT	End RT	Area	Area %	Total %	Height	Width	Purity	Base Peak	Base P
316	10.1595	2546	10.1370	10.1811	469663537	2.88	0.39	486405081	0.0441	19.36	69	14628
317	10.2140	2562	10.2005	10.2298	1848820	0.01	0.00	2191195	0.0293	0.16	282	94506
318	10.2616	2576	10.2384	10.2876	5605266	0.03	0.00	5172648	0.0492	0.27	451	13785
319	10.3296	2596	10.3098	10.3479	2187202	0.01	0.00	2395848	0.0380	0.13	451	70882
320	10.3330	2597	10.3026	10.3882	173402449	1.06	0.14	133583802	0.0856	4.23	136	90266
321	10.3568	2604	10.3386	10.3711	1541544	0.01	0.00	1742443	0.0325	0.10	303	40635
322	10.3874	2613	10.3600	10.4114	113963159	0.70	0.09	113083797	0.0515	4.89	109	47138
323	10.4384	2628	10.4063	10.4614	252955269	1.55	0.21	242522470	0.0551	9.51	57	68050
324	10.4894	2643	10.4649	10.5004	1667841	0.01	0.00	1805756	0.0354	0.12	315	68952
325	10.5030	2647	10.4809	10.5249	19284361	0.12	0.02	17114688	0.0439	1.03	228	46028
326	10.5575	2663	10.5376	10.5749	2903079	0.02	0.00	2502131	0.0372	0.18	197	18709

Library Search Results

	Name	Library	Forward	Reverse	Probability	Confidence	MW	Formula	CAS #
☐	FUB-AMB	nist extern	860	890	29.58	86.90	383.0	C21H22FN3O3	n/a
☑	AB-FUBINACA Urin 2301 215, t=594 sec	spice	857	884	26.13	86.51	368.0	C20H21FN4O2	118528-00-0
☐	EMB-FUBINACA	nist extern	844	912	16.88	86.44	397.0	C22H24FN3O3	n/a
☐	AB-FUBINACA	nist extern	832	899	11.24	85.21	368.0	C20H21FN4O2	1185282-01-2
☐	AB-FUBINACA isomer 2	nist extern	818	893	7.03	84.05	368.0	C20H21FN4O2	n/a

OK Cancel Help

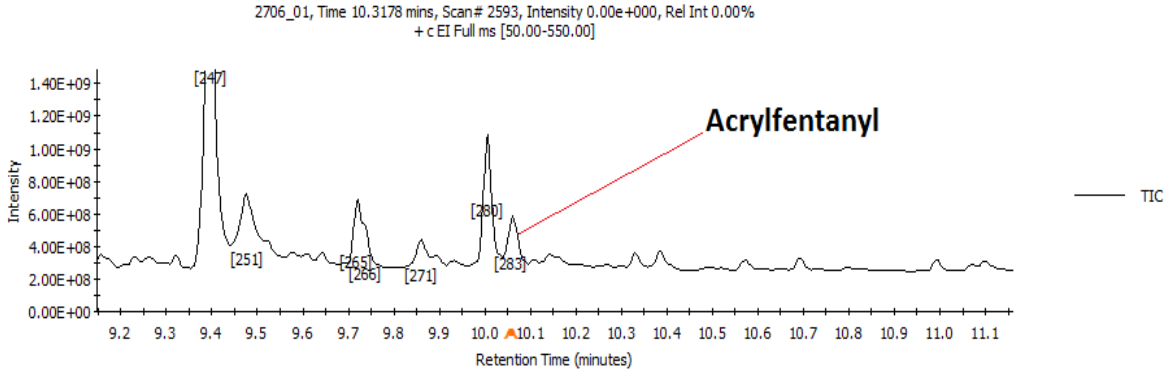
CAS #	Chemical Formula	Data Channel	Comment
111-02-4	C30H50	All Channels	
n/a	C13H9ClF2N2O	All Channels	
37965-31-4	C32H25NSi	All Channels	
37965-31-4	C32H25NSi	All Channels	
		All Channels	
n/a	C17H18ClNO2	All Channels	
n/a	C21H22FN3O3	All Channels	
n/a	C16H34O	All Channels	
		All Channels	
		All Channels	
		All Channels	

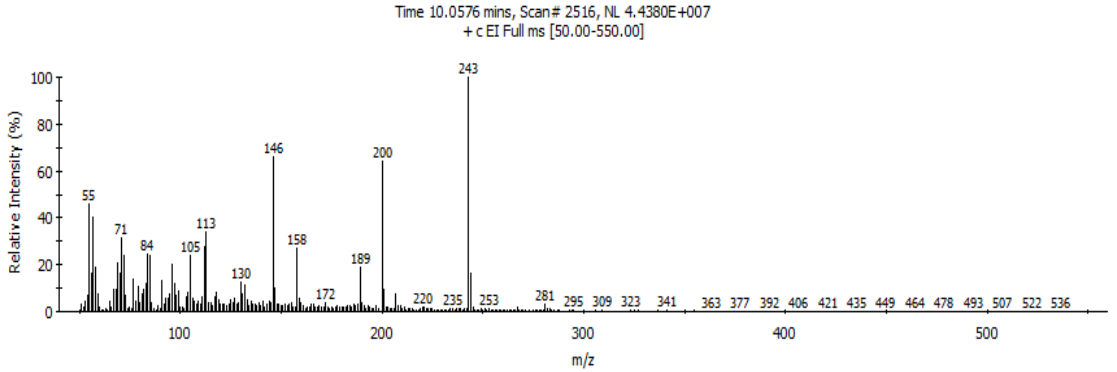
Synthetic Opioids:

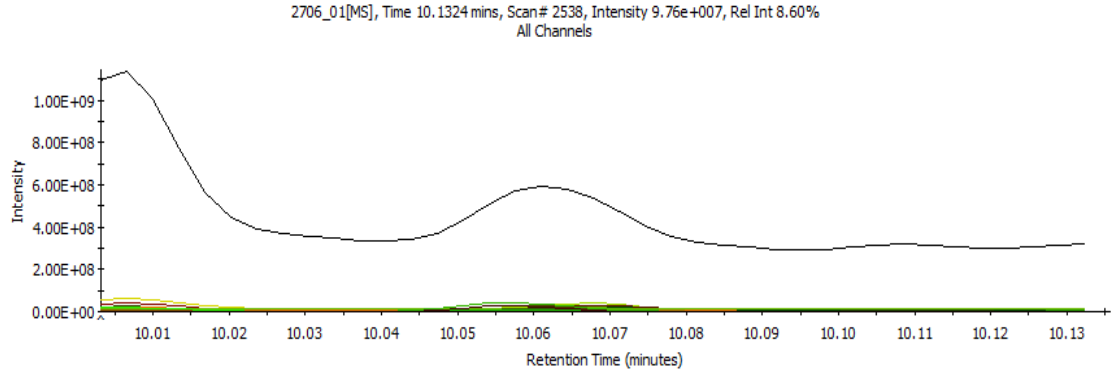
- U 47700
- Acrylfentanyl
- Ocfentanyl
- Carfentanyl

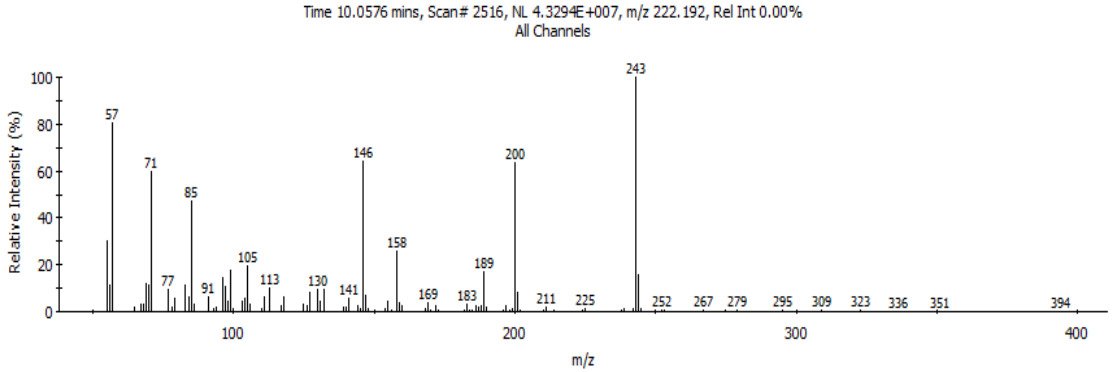
Fentanyl derivates are responsible for the increase of drug related deaths in the USA and Canada

Synthetic Opioids – Urine sample acrylfentanyl









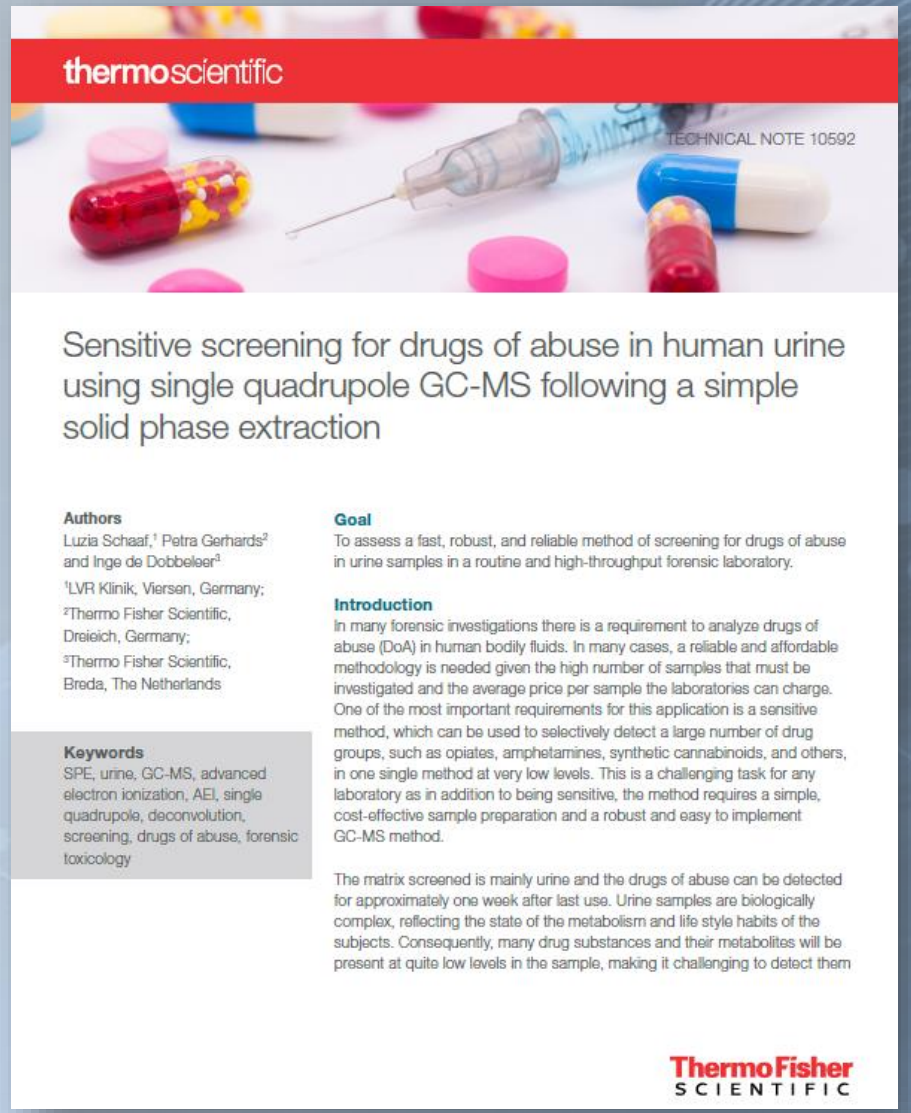
Summary Report

	RT	Scan	Start RT	End RT	Area	Area %	Total %	Height	Width	Purity	Base Peak	Base Peak Area	Ions	Name	Library	Forward	Reverse	Confidence %	CAS #	Chemical Formul
208	8.7176	2122	8.6897	8.7354	177563309	4.94	0.50	181495002	0.0457	18.63	147	9091387	115	Acetic acid, 17-(1-hydroxy-ethyl)-10,13-dimethyl-2,3,4,7,8,9,10,11,12,13,16,17-dodecahydro-1H-cyclopenta[a]phenanthren-3-yl ester	mainlib	794	794	79.40	n/a	C23H34O3
203	8.6019	2088	8.5802	8.6160	46308123	1.29	0.13	53690772	0.0358	6.74	112	1623886	74	Acetic acid, 17-(1-hydroxy-ethyl)-10,13-dimethyl-2,3,4,7,8,9,10,11,12,13,16,17-dodecahydro-1H-cyclopenta[a]phenanthren-3-yl ester	mainlib	649	653	65.02	n/a	C23H34O3
510	13.8158	3621	13.8075	13.8203	404884	0.01	0.00	904249	0.0129	0.36	208	119071	5	Acetic acid, 5-bromo-2-penten-2-yl ester	mainlib	692	984	77.96	n/a	C7H11BrO2
321	10.8705	2755	10.8669	10.8773	226893	0.01	0.00	553147	0.0104	0.22	206	154078	4	Acetic acid, [(2,4,6-triethylbenzoyl)thio]-	mainlib	787	824	79.81	67902-78-7	C15H20O3S
342	11.2480	2866	11.2400	11.2531	406116	0.01	0.00	748354	0.0132	0.27	206	184986	4	Acetic acid, [(2,4,6-triethylbenzoyl)thio]-	mainlib	754	934	80.80	67902-78-7	C15H20O3S
360	11.5031	2941	11.4905	11.5042	543261	0.02	0.00	1466331	0.0137	0.34	280	162699	5	Acetic acid, [(2,4,6-triethylbenzoyl)thio]-	mainlib	651	986	75.15	67902-78-7	C15H20O3S
283	10.0576	2516	10.0371	10.1010	379215333	10.56	1.06	356031219	0.0640	25.52	243	46258080	102	Acrylfentanyl	nist extern	739	771	74.86	79279-03-1	C22H26N2O
23	4.4118	856	4.3840	4.4527	29493073	0.82	0.08	27665850	0.0688	5.06	105	13257142	14	Alpha-ethoxycarbonyl-alpha-ethylbenzyl benzoate	mainlib	758	809	77.33	97080-45-0	C19H20O4
71	6.1123	1356	6.1037	6.1287	13331563	0.37	0.04	16456571	0.0250	1.43	112	7934348	7	Aminomaleimide	mainlib	775	835	79.30	37770-94-8	C4H4N2O2
271	9.8603	2458	9.8283	9.8897	208765772	5.81	0.59	158934334	0.0614	16.85	93	7592085	131	Androstan-17-one, 3,11-dihydroxy-, (3à,5á,11á)-	mainlib	860	861	86.03	739-26-4	C19H30O3

ISQ 7000 AEI - High sensitivity and high robustness GC-MS

GC-MS Maintenance:

- ✓ daily: tune check (incl. air/ water tune)
- ✓ daily: standard sample with Morphin as sensibility check
- ✓ every 10 urine samples another standard sample
- ✓ every 50 urine samples: liner change
- ✓ every 150 urine samples full tune
- ✓ every 600 urine samples clean the source


thermoscientific

TECHNICAL NOTE 10592

Sensitive screening for drugs of abuse in human urine using single quadrupole GC-MS following a simple solid phase extraction

Authors
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Keywords
SPE, urine, GC-MS, advanced electron ionization, AEI, single quadrupole, deconvolution, screening, drugs of abuse, forensic toxicology

Goal
To assess a fast, robust, and reliable method of screening for drugs of abuse in urine samples in a routine and high-throughput forensic laboratory.

Introduction
In many forensic investigations there is a requirement to analyze drugs of abuse (DoA) in human bodily fluids. In many cases, a reliable and affordable methodology is needed given the high number of samples that must be investigated and the average price per sample the laboratories can charge. One of the most important requirements for this application is a sensitive method, which can be used to selectively detect a large number of drug groups, such as opiates, amphetamines, synthetic cannabinoids, and others, in one single method at very low levels. This is a challenging task for any laboratory as in addition to being sensitive, the method requires a simple, cost-effective sample preparation and a robust and easy to implement GC-MS method.

The matrix screened is mainly urine and the drugs of abuse can be detected for approximately one week after last use. Urine samples are biologically complex, reflecting the state of the metabolism and life style habits of the subjects. Consequently, many drug substances and their metabolites will be present at quite low levels in the sample, making it challenging to detect them

ThermoFisher SCIENTIFIC

TFS Workflow Solution for the Determination of DoA

Immuno Assays

- **CEDIA®** Cloned Enzyme Donor Immunoassay (β-Galactosidase)
  - Optimized for most analyzers, the CEDIA immunoassays are valued worldwide for their accuracy, precision, lot-to-lot dependability and stable shelf life
- **EIA (DRI®)** Enzyme Immunoassay (G6PDH)
  - Liquid, ready-to-use reagents in convenient packaging for use on a variety of chemistry analyzers

Sample preparation

- **HyperSep Verify** CX and AX
- Vials and Closures
- **LinerGold** GCLiners
- **TraceGold** GC columns

GCMS analysis

- **ISQ 7000**, Single Quad
- **TSQ 9000**, Triple Quad
- **Qexactive HRAM**, GC-Orbitrap


thermoscientific
APPLICATION NOTE 10493
Sensitive determination of THCCOOH in hair to regulatory requirements using Triple Quadrupole GC-MS/MS

Forensic Analysis of THC-COOH in hair - Sample Preparation

Hair samples of 50 mg

- Wash with 2–3 mL of dichloromethane
- Cut into 10–20 mm pieces.

Spike

- THC- COOH
- deuterated IS THCCOOH-d3

Calibration

- calibration levels 0.05, 0.2, 0.5, 1 pg/mg
- Internal standard at 0.2 pg/mg

Hydrolysis

- at 75 °C in 1 mL of 5 M NaOH for 45 minutes.

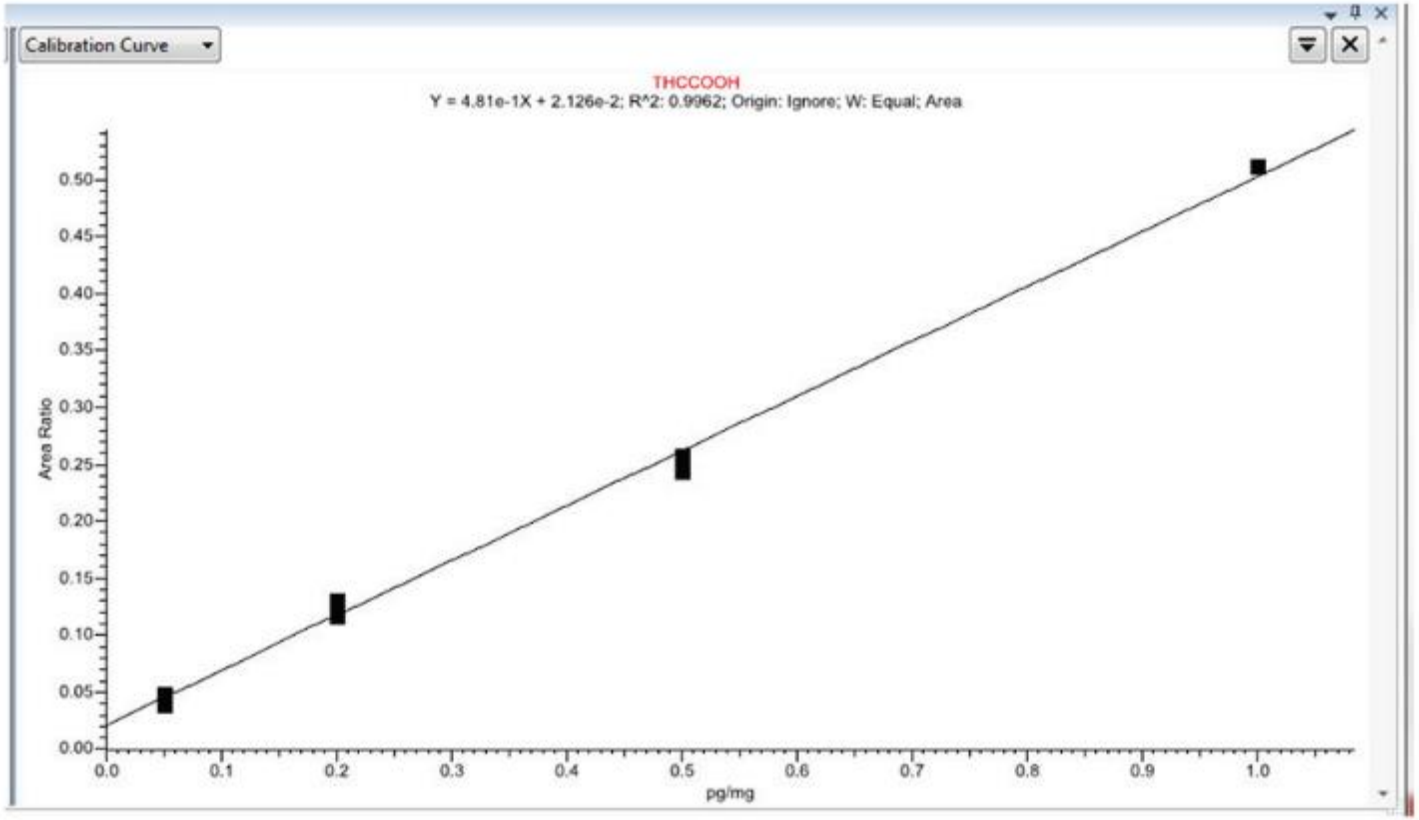
Extraction and derivatization

- Acidify up to pH 4 with concentrated acetic acid.
- Vortex
- Add 4 mL n-hexane:ethyl acetate (9:1).
- evaporate to dryness
- derivatize with 50 µL PFPA and 25 µL HFIP at 70 °C
- Reconstitute in 50 µL hexane;
- 2 µL injection on GCMSMS

Instrument

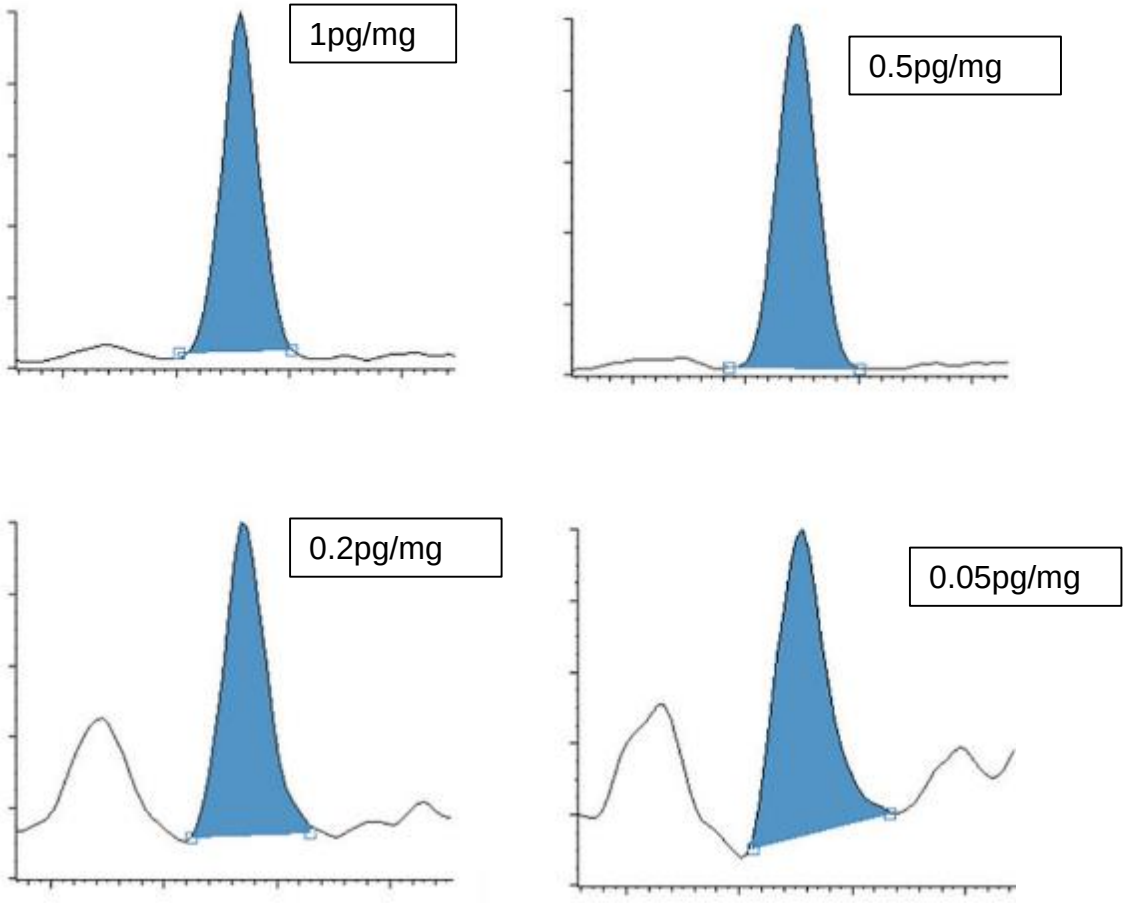
- Trace1310 GC
- TSQ 9000 with ExtractaBrite ion source
- Triplus RSH Autosampler

Forensic Analysis of THC- COOH in hair - Results



R2= 0.9962; 5 replicate injections of cal curve
Hair spiked with 0.05, 0.2, 0.5 and 1 pg/mg

Forensic Analysis of THC-COOH In Hair - Results



Agency Organization	Cut-off Level pg/mg
Society of Hair Testing (SOHT)	0.20
Gesllеschaft fur Forensiche und Toxikologische Chemie (GFTCh)	0.05
Substance Abuse and Mental Health Services Administration (SAMHSA)	0.05

ISQ 7000 GC-MS and TSQ 9000 GC-MS/MS systems

For more information

thermofisher.com/unstoppableGCMS

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We enable our customers to make the world healthier, cleaner and safer.