Sample Preparation Product

Air Sampler for PFAS

FM4

GL Sciences

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PFAS that can be collected using FM4

	Group		Compounds
Ionic PFAS	Perfluoroalkyl sulfonic acid	PFSAs	PFEtS, PFPrS, PFBS, PFHxS, PFOS, PFDS
	Perfluoroalkyl carboxylic acid	PFCAs	PFPrA (C3)- PFTeDA (C14), PFHxDA, PFOcDA
	Fluorotelomer sulfonic acid	FTSAs	6:2 FTSA, 8:2 FTSA
	Fluorotelomer unsaturated carboxylic acid	FTUCAs	8:2 FTUCA, 10:2 FTUCA
	Perfluorooctanoic sulfonamide acetic acid	FOSAAs	N-MeFOSAA, N-EtFOSAA
Neutral PFAS	Perfluorooctanoic sulfonamide	FOSAs	FOSA, N-MeFOSA, N-EtFOSA
	Perfluorooctanoic sulfonamide ethanol	FOSEs	N-MeFOSE, N-EtFOSE
	Fluoroteromer alcohol	FTOHs	4:2 FTOH, 4:3 FTOH, 6:2 FTOH, 6:3 FTOH, and 8:2 FTOH, 8:3 FTOH, 10:2 FTOH
	Fluoroteromer iodine	FTIs	6:2 FTI, 8:2 FTI, 10:2 FTI
	Fluorinated iodine alkane	FIAs	PFDoI
	Fluorinated diiodoalkane	FDIAs	PFBuDiI, PFHxDiI, PFODiI
	Fluorobromine-containing compounds		BTFBB (C8H3BrF6), BPFB (C6BrF5)

FM4, Air Sampler for PFAS

Comprehensive Sampling Device

Both a particulate substance and a gaseous substance can be simultaneously collected using one compact sampler. Because it is possible to evaluate the collection amount for each material, comprehensive PFAS evaluation is possible.

Capable of Collecting Gaseous PFAS (FTOH, etc.)

The collection of gaseous PFAS in the air, which are difficult to collect, is now possible using the newly activated carbon desorption material.

Excellent Recovery Rate

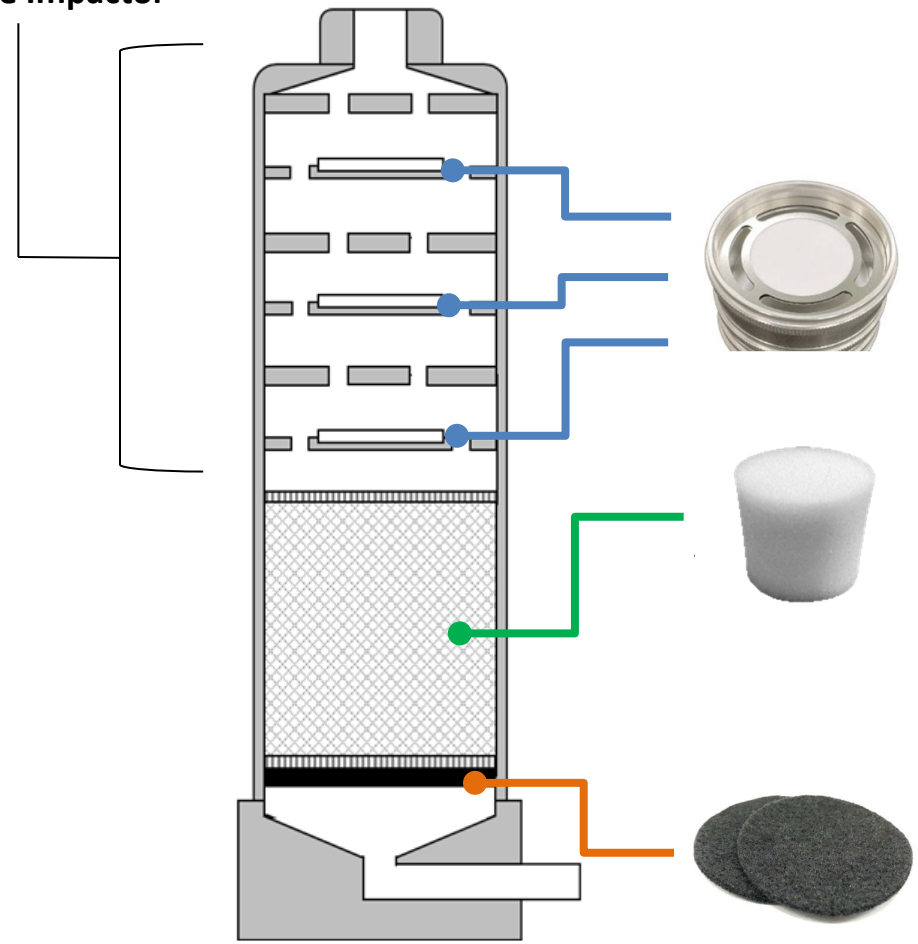
We achieved recovery rates for various PFAS.

Compact and Portable

A lightweight and compact air sampler that is easy to carry and does not have a large footprint.

Product composition and collection target

Cascade Impactor



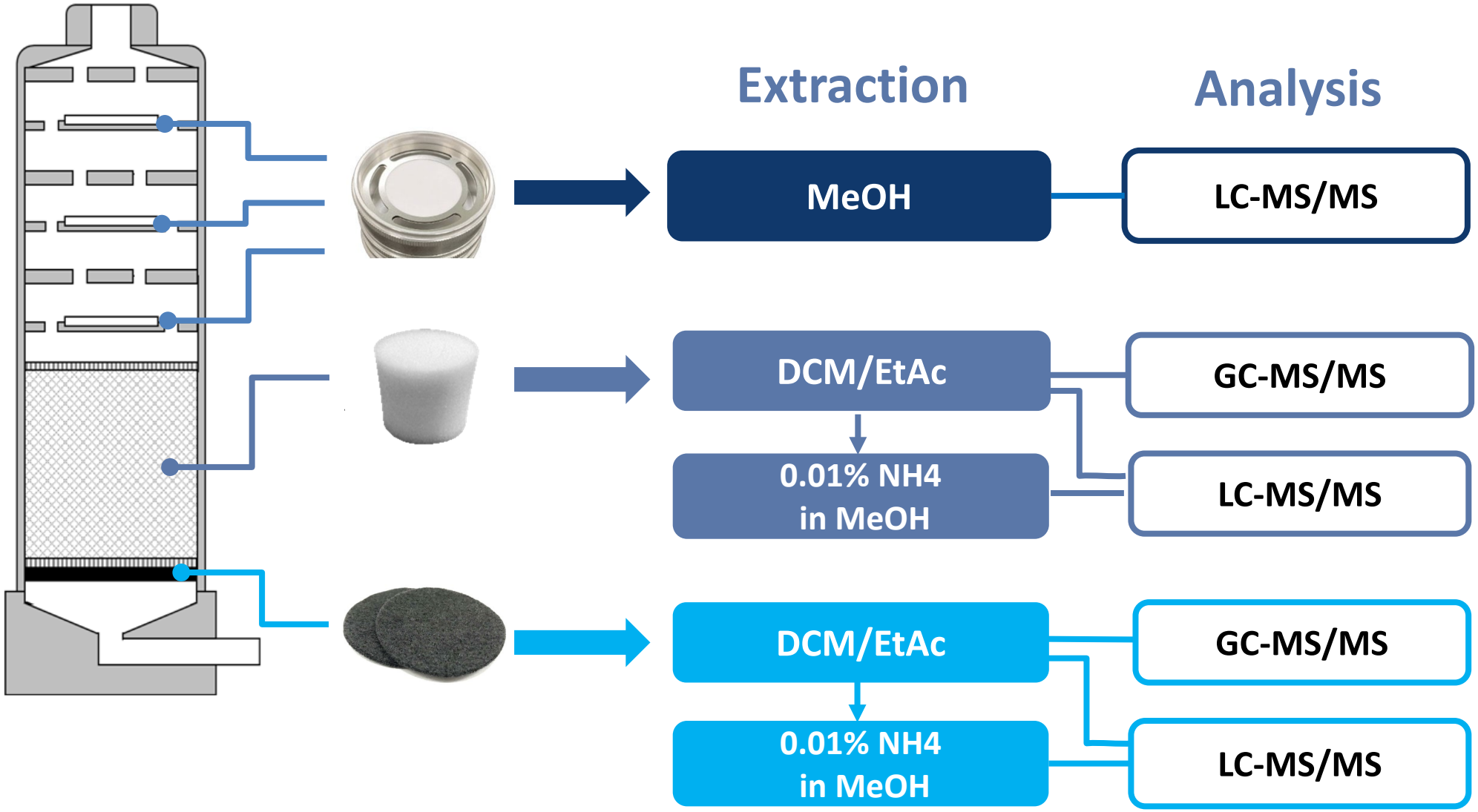
Quartz Fiber Filter (QFF) × 3

Stage 1: > 10 um
Stage 2: 2.5 - 10 um
Stage 3: 1.0 - 2.5 um

Polyurethane Foam (PUF)

Activated Carbon Fiber Disk (GAIAC) × 2

Extraction and analysis method



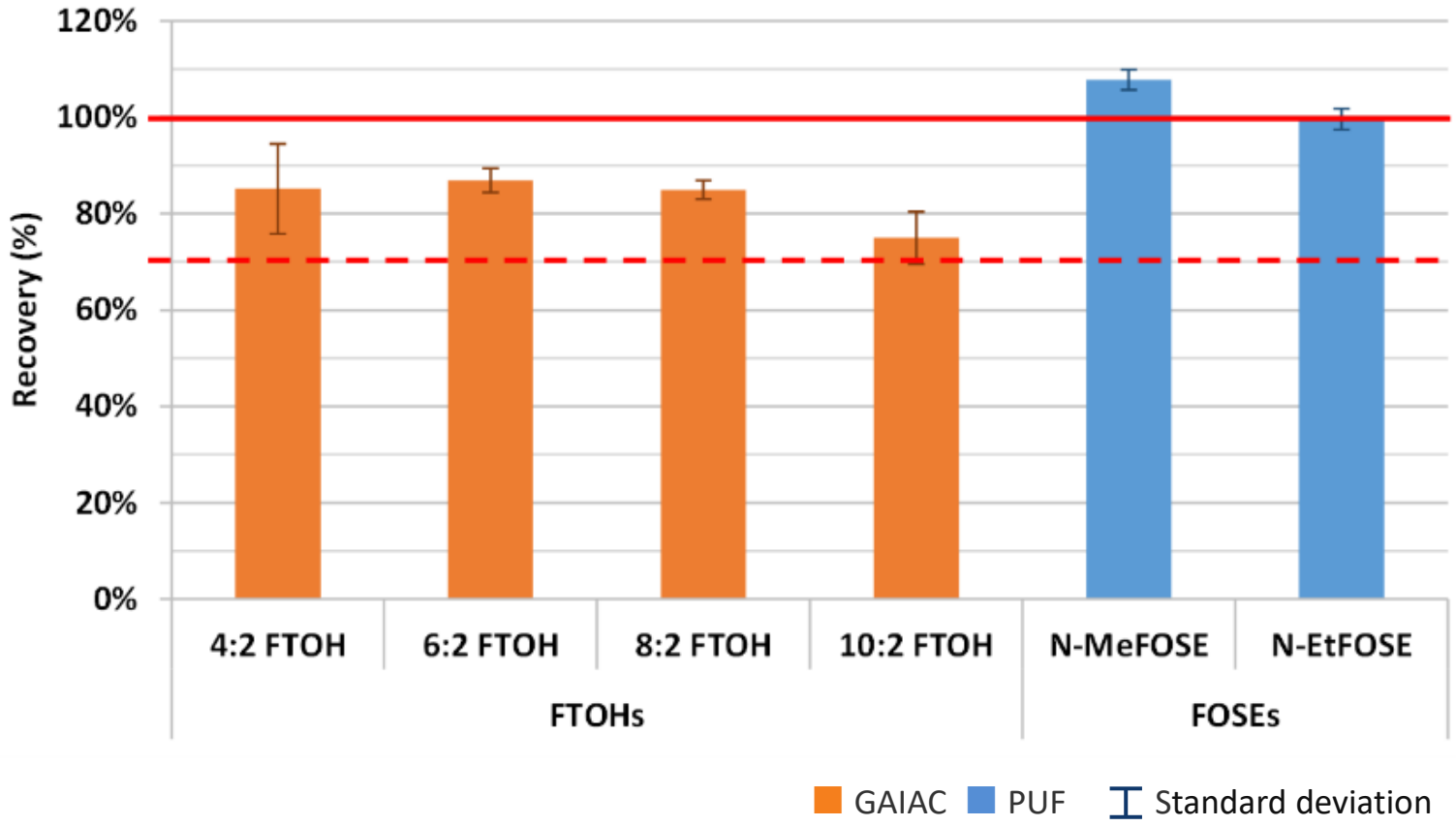
GAIAC™, Carbon Fiber Disk

A newly developed new functional activated carbon adsorbent (GAIAC) is used for obtaining gaseous PFAS.

Conventional activated carbons have complicated pores; although they can be adsorbed, they cannot be fully eluted. GAIAC is an innovative sorbent composed of synthetic resin fiber with optimized pore and surface activity, which enables the collection and elution of PFAS.

Recovery Rate of Gaseous PFAS

Excellent recovery for the most volatile 4:2 FTOH



20 L / min, 48 hours sampling
Results when various labeled compounds 5 ng are added to PUF

PFAS That Can Be Collected and Extracted with FM4

GL Sciences

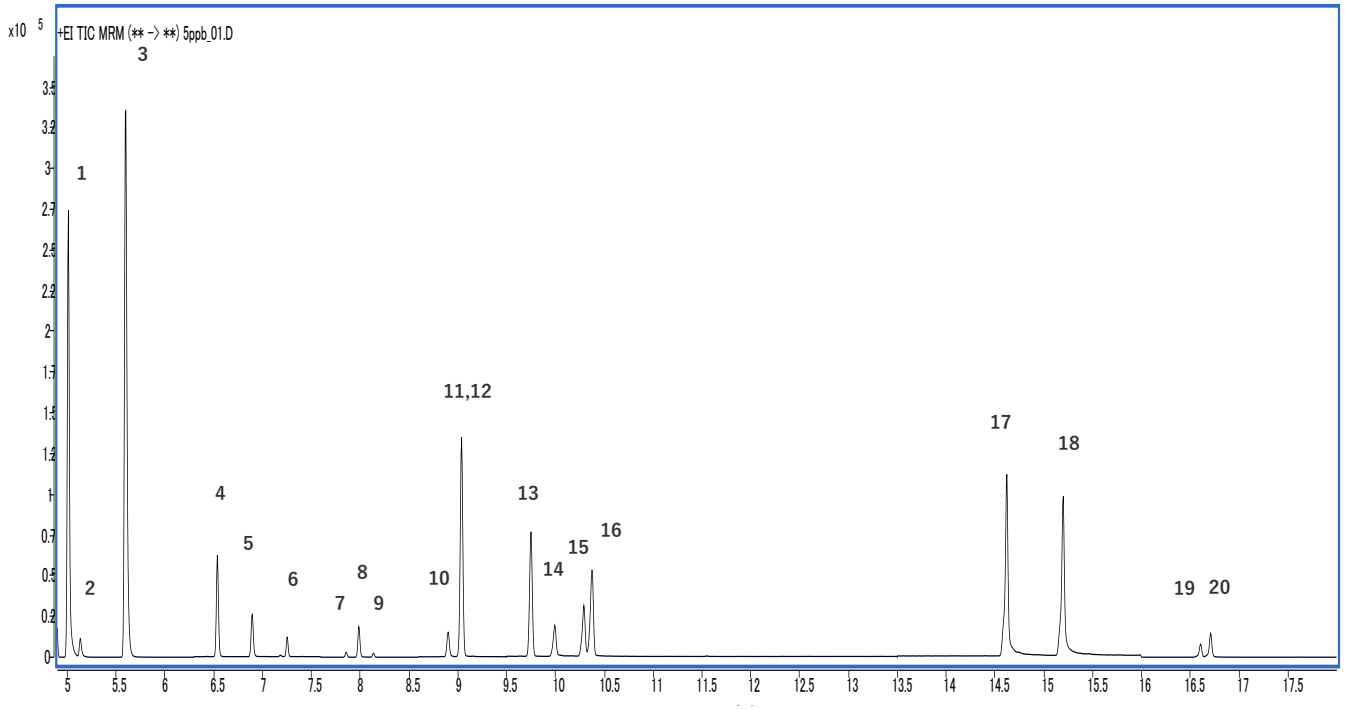
No.	Compounds	Abbreviation	CAS RN	LC-MS/MS	GC-MS/MS
1	Perfluorobutanoic acid	PFBA	375-22-4	x	
2	Perfluoropentanoic acid	PFPeA	2706-90-3	x	
3	Perfluorohexanoic acid	PFHxA	307-24-4	x	
4	Perfluoroheptanoic acid	PFHpA	375-85-9	x	
5	Perfluorooctanoic acid	PFOA	335-67-1	x	
6	Perfluorononanoic acid	PFNA	375-95-1	x	
7	Perfluorodecanoic acid	PFDA	335-76-2	x	
8	Perfluoroundecanoic acid	PFUnA	2058-94-8	x	
9	Perfluorododecanoic acid	PFDoDA	307-55-1	x	
10	Perfluorotridecanoic acid	PFTrDA	72629-94-8	x	
11	Perfluorotetradecanoic acid	PFTeDA	376-06-7	x	
12	Perfluoro-n-hexadecanoic acid	PFHxDA	67905-19-5	x	
13	Perfluoro-n-octadecanoic acid	PFOcDA (PFODA)	16517-11-6	x	
14	Perfluorobutanesulfonic acid	PFBS	375-73-5	x	
15	Perfluorohexanesulfonic acid	PFHxS	355-46-4	x	
16	Perfluoroheptanesulfonic acid	PFHpS	375-92-8	x	
17	Perfluorooctanesulfonic acid	PFOS	1763-23-1	x	
18	Perfluorodecanesulfonic acid	PFDS	335-77-3	x	
19	Perfluorooctanesulfonamide	FOSA	754-91-6	x	
20	N-ethylperfluoro-1-octanesulfonamide	*N*-EtFOSA	4151-50-2	x	x
21	n-methylperfluoro-1-octanesulfonamide	*N*-MeFOSA	31506-32-8	x	x
22	N-methylperfluoro-1-octanesulfonamidoacetic acid	*N*-MeFOSAA	2355-31-9	x	
23	N-ethylperfluoro-1-octanesulfonamidoacetic acid	*N*-EtFOSAA	2991-50-6	x	
24	2-(N-methylperfluoro-1-octanesulfonamido)-ethanol	*N*-MeFOSE	24448-09-7		x
25	2-(N-ethylperfluoro-1-octanesulfonamide)-ethanol	*N*-EtFOSE	1691-99-2		x
26	6:2 Fluorotelomer sulfonic acid	6:2 FTSA	27619-97-2	x	
27	8:2 Fluorotelomer sulfonic acid	8:2 FTSA	39108-34-4	x	
28	4,8-Dioxa-3H-perfluorononanoic acid	ADONA (DONA)	919005-14-4	x	
29	Hexafluoropropylene oxide dimer acid	HFPO-DA (GenX)	13252-13-6	x	
30	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1	x	

No.	Compounds	Abbreviation	CAS RN	LC-MS/MS	GC-MS/MS
31	8:2 Fluorotelomer unsaturated carboxylic acid	8:2 FTUCA	70887-84-2	x	
32	8:2 Polyfluoroalkyl phosphate diester	8:2 diPAP	678-41-1	x	
33	1H,1H,2H,2H-Perfluoro-1-hexanol	4:2 FTOH			x
34	1H,1H,2H,2H-Perfluoro-1-octanol	6:2 FTOH			x
35	1H,1H,2H,2H-Perfluoro-1-decanol	8:2 FTOH			x
36	1H,1H,2H,2H-Perfluoro-1-dodecanol	10:2 FTOH			x
37	Pentafluoroethanesulfonic acid	PFEtS	354-88-1	x	
38	Sodium prefluoro-1-propanesulfanate	PFPrS		x	
39	2,2,3,3,3-Pentafluoropropionic acid	PFPrA	422-64-0	x	
40	2H-perfluoro-2-dodecenoic acid	10:2 FTUCA		x	
41	3-(Perfluorobutyl)propanol	4:3 FTOH	83310-97-8		x
42	3-(Perfluorohexyl)propanol	6:3 FTOH	80806-68-4		x
43	3-(Perfluorooctyl)propanol	8:3 FTOH	1651-41-8		x
44	1H,1H,2H,2H-Perfluorooctyl iodide	6:2 FTI	2043-57-4		x
45	1H,1H,2H,2H-Perdluorodecyl iodide	8:2 FTI	2043-53-0		x
46	1H,1H,2H,2H-Perfluorododecyl iodide	10:2 FTI	2043-54-1		x
47	Pentacosafluoro-1-iodododecane	PFDoI	307-60-8		x
48	Octafluoro-1,4-diiodobutane	PFBuDiI	375-50-8		x
49	Perfluoro-1,6-diiodohexane	PFHxDiI	375-80-4		x
50	Hexadecafluoro-1,8-diiodooctane	PFODiI	335-70-6		x
51	1,3-Bis(trifluoromethyl)-5-bromobenzene	BTFBB	328-70-1		x
52	Bromopentafluorobenzene	BPFB	344-04-7		x

* Compounds that have been confirmed as of March 2022

Analyses of Neutral (Volatile) PFAS using GC-MS/MS

Analytical Conditions and MRM Chromatogram



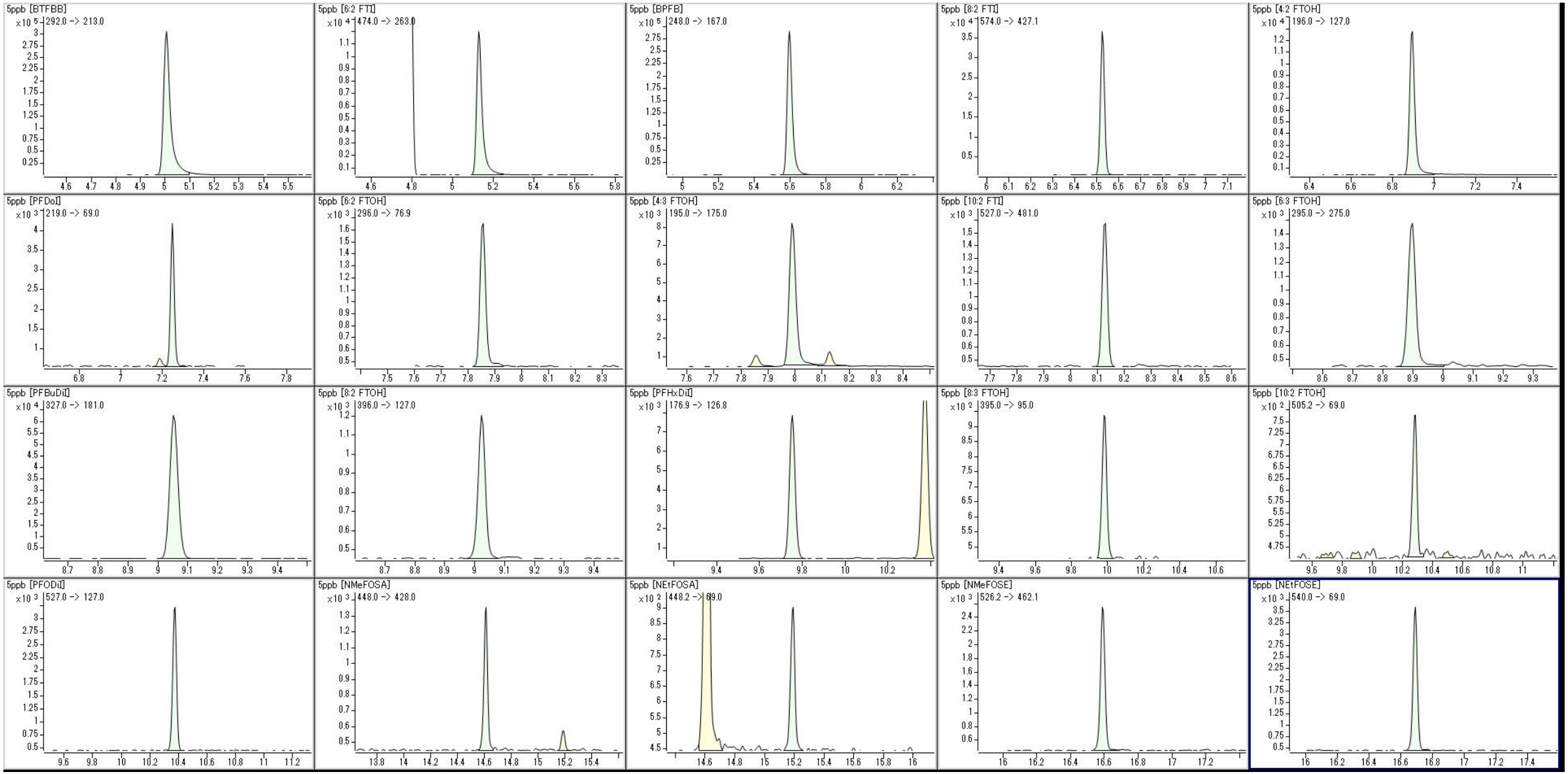
System	8890/7010B Triple quadrupole GC/MS (Agilent Technologies, Inc)
Column	InertCap Pure-WAX (GL Science Inc.) 0.25 mm I.D. × 30 m, df = 0.25 µm
Injection	Splitless
Injection Vol.	2 µL, 200°C
Carrier Gas	He, 1.2 mL / min
Column Temp.	Rate (°C / min) / Temp (°C) / hold (min): 0 / 40 / 2; 10 / 200 / 0; 20 / 250 / 20
Ion Source temp.	320 °C
Ion mode	EI
Mode	MRM

No.	Compounds	R.T.(min)	No.	Compounds	R.T.(min)	No.	Compounds	R.T.(min)	No.	Compounds	R.T.(min)
1	BTFBB	5.00	6	PFDoI	7.25	11	6:3 FTOH	8.90	16	10:2 FTOH	10.28
2	6:2 FTI	5.13	7	6:2 FTOH	7.86	12	8:2 FTOH	9.02	17	*N*-EtFOSA	14.61
3	BPFB	5.60	8	4:3 FTOH	7.99	13	PFHxDiI	9.75	18	*N*-MeFOSA	15.19
4	8:2 FTI	6.53	9	10:2 FTI	8.13	14	8:3 FTOH	9.98	19	*N*-MeFOSE	16.59
5	4:2 FTOH	6.90	10	PFBuDiI	9.05	15	PFODiI	10.38	20	*N*-EtFOSE	16.69

Transitions and Collision Energy

No.	Compounds	R.T. (min)	Transition 1			Transition 2		
			Q1	Q3	CE	Q1	Q3	CE
1	BTFBB	5	292	213	26	294	213	18
2	6:2 FTI	5.13	474	263	28	327	181	16
3	BPFB	5.6	248	167	24	248	117	22
4	8:2 FTI	6.53	574	427	8	547	313	20
5	4:2 FTOH	6.9	196	127	10	196	77	26
6	PFDoI	7.25	219	69	28	169	69	16
7	6:2 FTOH	7.86	296	77	26	344	95	24
8	4:3 FTOH	7.99	195	175	8	195	95	24
9	10:2 FTI	8.13	527	481	8	527	145	10
10	6:3 FTOH	8.9	295	275	8	295	181	24
11	8:2 FTOH	9.02	396	127	12	131	69	22
12	PFBuDiI	9.05	327	181	8	327	69	60
13	PFHxDiI	9.75	177	127	28	281	181	22
14	8:3 FTOH	9.98	395	95	12	131	69	20
15	10:2 FTOH	10.28	505	669	60	131	69	60
16	PFODiI	10.38	527	127	14	381	69	60
17	*N*-EtFOSA	14.61	448	69	60	131	69	28
18	*N*-MeFOSA	15.19	448	428	12	131	69	28
19	*N*-MeFOSE	16.59	526	462	18	462	93	28
20	*N*-EtFOSE	16.69	540	69	54	540	448	20
21	d_4-4:2 FTOH	6.83	199	130	6	248	130	8
22	$^{13}C_2$-d_2-6:2 FTOH	7.82	298	129	6	248	130	8
23	$^{13}C_2$-d_2-8:2 FTOH	8.99	409	69	60	448	129	4
24	$^{13}C_2$-d_2-10:2 FTOH	10.25	515	96	19	495	69	60
25	d_5-*N*-EtFOSA	14.57	450	430	12	450	380	18
26	d_3-*N*-MeFOSA	15.16	433	114	28	433	413	16
27	d_7-*N*-MeFOSE	16.57	465	415	14	530	465	16
28	d_9-*N*-EtFOSE	16.66	449	428	14	449	378	20

MRM Chromatogram (5 ng/mL)



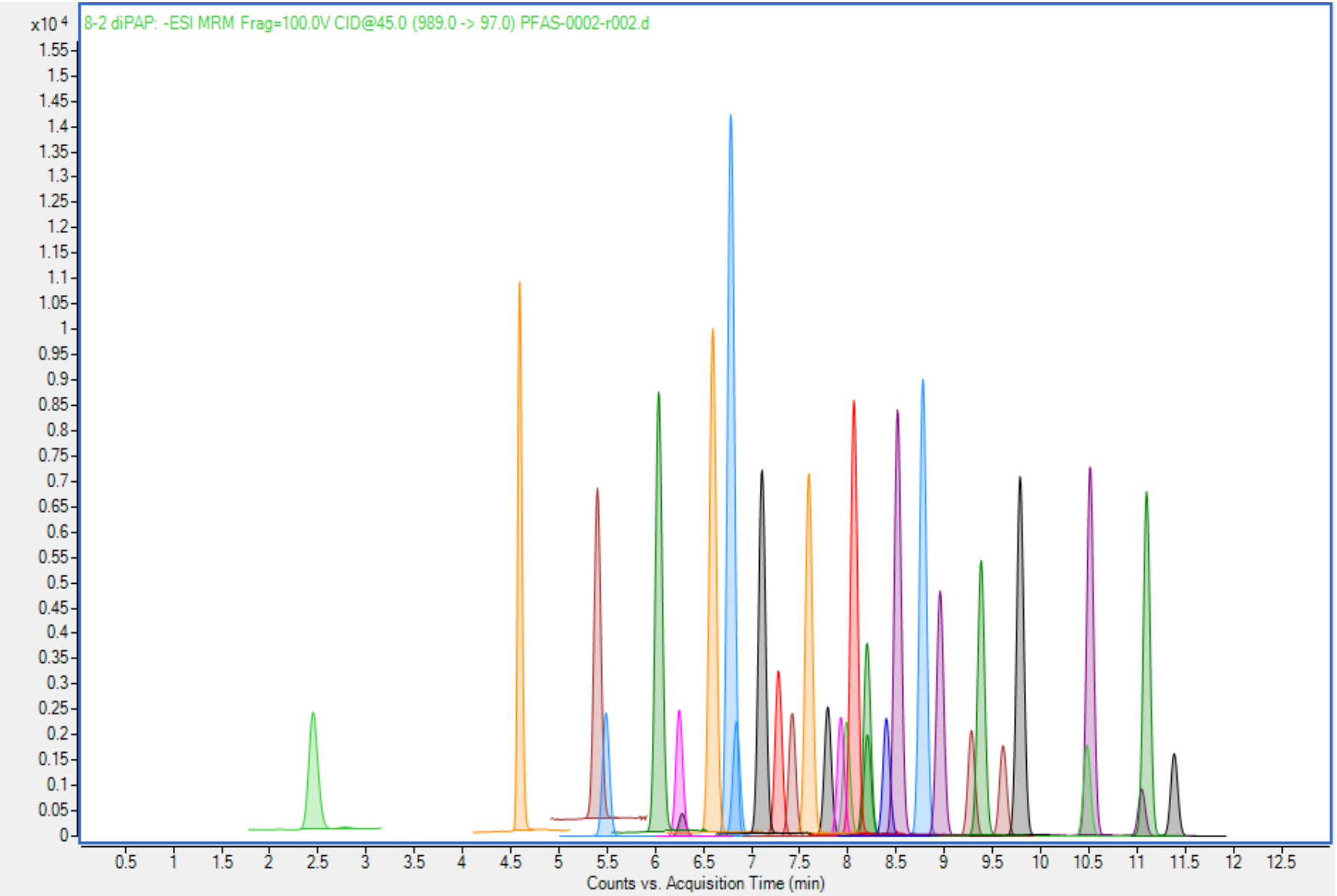
Analyses of ionic PFAS using LC-MS/MS

Analytical Conditions

System	Agilent1260 Infinity II Prime LC System						
Column	InertSustain AQ-C18 (GL Sciences Inc.) 1.9 µm, 2.1 mm I.D. × 100 mm						
Delay Column	Delay Column for PFAS 3.0 × 30 mm (GL Science Inc.)						
Mobile Phase (A)	2 mmol/L aqueous ammonium acetate solution						
Mobile Phase (B)	Acetonitrile						
Gradient	Time (min)	0	1.5	10	11	11.1	15
	A %	90	70	0	0	90	90
	B %	10	30	100	100	10	10
Flow Rate	0.3 mL/min						
Injection Volume	2 µL						
Column Temp.	40 °C						
Sample Cooler	10 °C						

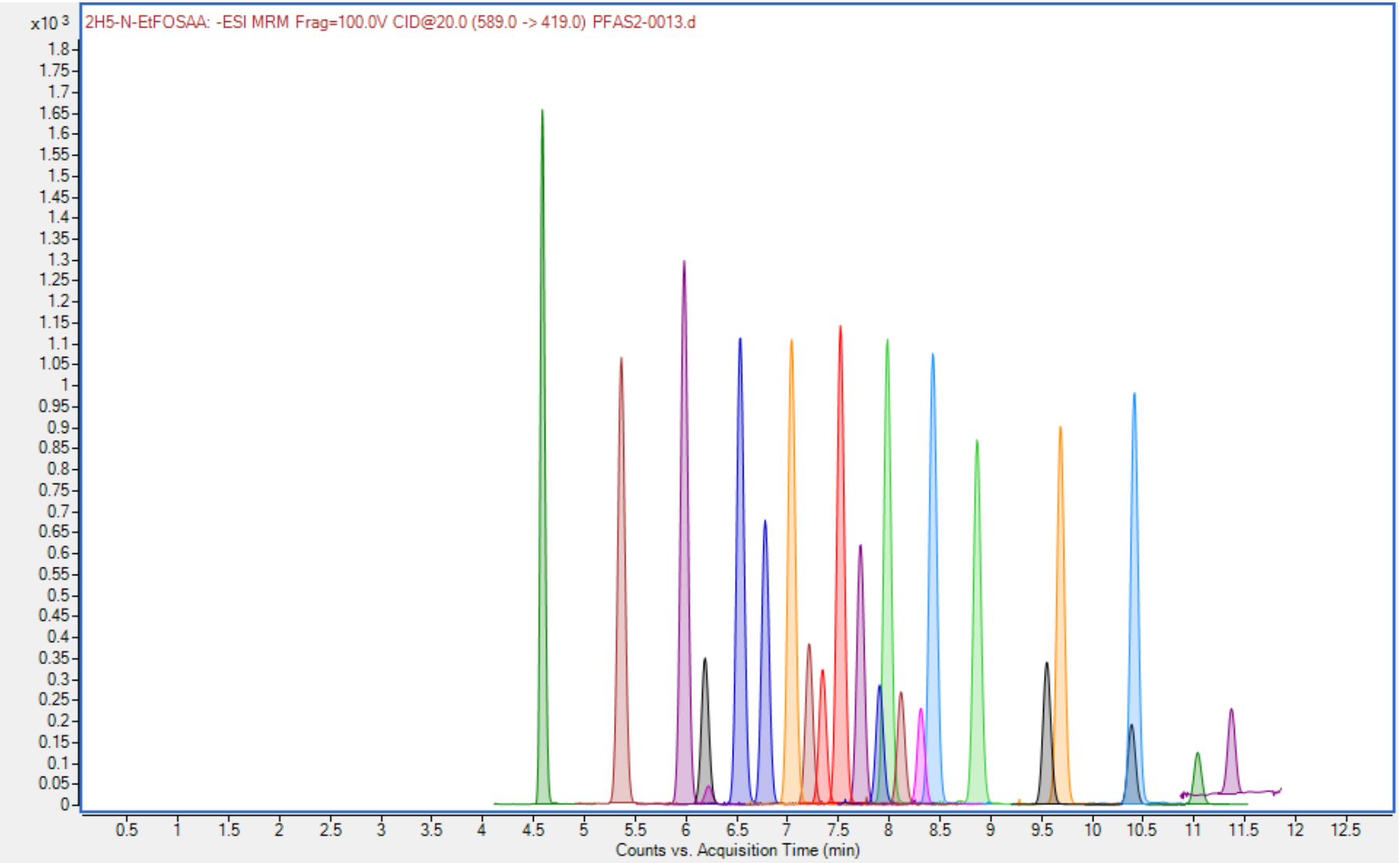
System	Agilent Ultivo Triple Quadrupole LC/MS system
Ionization Mode	AJS (Negative)
Drying Gas Temp.	300 ° C
Drying Gas Flow Rate	10 L/min
Sheath Gas Temp.	400 ° C
Sheath Gas Flow Rate	12 L/min
Nozzle Voltage	0 V
Nebulizer gas pressure	50 psi

MRM Chromatogram



Compounds	R.T.(min)
PFPrA	2.46
PFBA	4.61
PFPeA	5.41
PFPrS	5.50
PFHxA	6.04
PFBS	6.27
HFPO-DA	6.29
PFHpA	6.61
ADONA	6.81
6:2 FTSA	6.85
PFOA	7.12
8:2 FTUCA	7.29
PFHxS	7.40
PFNA	7.61
8:2 FTSA	7.80
PFHpS	7.94
N-MeFOSAA	8.00
PFDA	8.08
10:2 FTUCA	8.21
N-EtFOSAA	8.23
PFOS	8.41
PFUnA	8.51
9Cl-PF3ONS	8.78
PFDoDA	8.95
PFDS	9.26
PFTrDA	9.36
FOSA	9.61
PFTeDA	9.76
8:2 diPAP	10.43
PFHxDA	10.46
PFOcDA	11.02
N-MeFOSA	11.04
N-EtFOSA	11.37

Internal Standard MRM Chromatogram



Compounds	R.T.(min)
$^{13}C_4$-PFBA	4.61
$^{13}C_5$-PFPeA	5.41
$^{13}C_5$-PFHxA	6.04
$^{13}C_3$-PFBS	6.27
$^{13}C_3$-HFPO-DA	6.29
$^{13}C_4$-PFHpA	6.60
$^{13}C_2$-6:2 FTSA	6.86
$^{13}C_8$-PFOA	7.12
$^{13}C_2$-8:2 FTUCA	7.29
$^{13}C_3$-PFHxS	7.43
$^{13}C_9$-PFNA	7.61
$^{13}C_2$-8:2 FTSA	7.79
d_3-*N*-MeFOSAA	7.99
$^{13}C_6$-PFDA	8.07
d_5-*N*-MeFOSAA	8.21
$^{13}C_8$-PFOS	8.41
$^{13}C_7$-PFUnDA	8.51
$^{13}C_2$-PFDoDA	8.94
$^{13}C_8$-FOSA	9.74
$^{13}C_2$-PFTeDA	9.76
$^{13}C_4$-8:2 diPAP	10.42
$^{13}C_2$-PFHxDA	10.46
d_3-*N*-MeFOSA	11.03
d_5-*N*-EtFOSA	11.36

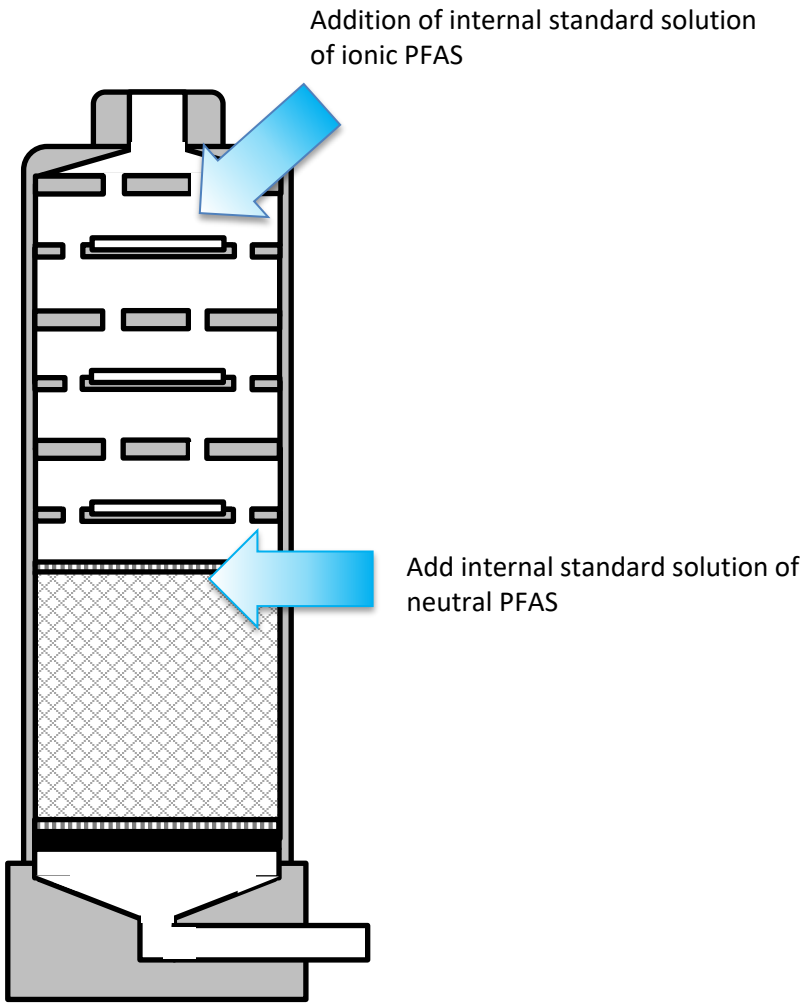
MRM Transitions

No.	Compounds	RT (min)	Transition 1			Transition 2		
			Q1	Q3	CE	Q1	Q3	CE
1	PFPrA	2.46	163	119	10	-	-	-
2	$^{13}C_4$-PFBA	4.61	217	172	6	-	-	-
3	PFBA	4.61	213	169	6	-	-	-
4	$^{13}C_5$-PFPeA	5.41	268	223	4	-	-	-
5	PFPeA	5.41	263	219	6	-	-	-
6	PFPrS	5.50	249	99	30	249	80	45
7	$^{13}C_5$-PFHxA	6.04	318	273	4	-	-	-
8	PFHxA	6.04	313	269	6	313	119	22
9	$^{13}C_3$-PFBS	6.27	302	80	40	-	-	-
10	PFBS	6.27	299	80	40	299	99	34
11	$^{13}C_3$-HFPO-DA ($^{13}C_3$-GenX)	6.29	287	169	4	-	-	-
12	HFPO-DA (GenX)	6.29	285	169	4	285	185	16
13	$^{13}C_4$-PFHpA	6.60	367	322	8	-	-	-
14	PFHpA	6.61	363	319	6	363	169	18
15	ADONA (DONA)	6.81	377	251	8	377	85	40
16	6:2 FTSA	6.85	427	407	23	427	81	44
17	$^{13}C_2$-6:2 FTSA	6.86	429	409	24	-	-	-
18	$^{13}C_8$-PFOA	7.12	421	376	8	-	-	-
19	PFOA	7.12	413	369	10	413	169	15
20	$^{13}C_2$-8:2 FTUCA	7.29	459	394	16	-	-	-
21	8:2 FTUCA	7.29	457	393	12	457	343	44
22	PFHxS	7.40	399	80	53	399	99	45
23	$^{13}C_3$-PFHxS	7.43	402	80	65	-	-	-
24	$^{13}C_9$-PFNA	7.61	472	427	8	-	-	-
25	PFNA	7.61	463	419	10	463	219	18
26	$^{13}C_2$-8:2 FTSA	7.79	529	509	27	-	-	-
27	8:2 FTSA	7.80	527	507	28	527	81	55
28	PFHpS	7.94	449	80	55	449	99	51
29	d_3-N-MeFOSAA	7.99	573	419	20	-	-	-

No.	Compounds	RT (min)	Transition 1			Transition 2		
			Q1	Q3	CE	Q1	Q3	CE
30	N-MeFOSAA	8.00	570	419	20	570	483	16
31	$^{13}C_6$-PFDA	8.07	519	474	8	-	-	-
32	PFDA	8.08	513	469	6	513	269	18
33	d_5-N-EtFOSAA	8.21	589	419	20	-	-	-
34	10:2 FTUCA	8.21	557	493	16	557	243	44
35	N-EtFOSAA	8.23	584	419	20	584	483	16
36	$^{13}C_8$-PFOS	8.41	507	80	58	-	-	-
37	PFOS	8.41	499	80	60	499	99	55
38	$^{13}C_7$-PFUnDA ($^{13}C_7$-PFUnA)	8.51	570	525	8	-	-	-
39	PFUnDA (PFUnA)	8.51	563	519	7	563	269	16
40	9Cl-PF3ONS	8.78	531	351	28	531	83	32
41	$^{13}C_2$-PFDoDA ($^{13}C_2$-PFDoA)	8.94	615	570	8	-	-	-
42	PFDoDA (PFDoA)	8.95	613	569	9	613	319	22
43	PFDS	9.26	599	80	65	599	99	60
44	PFTrDA (PFTrA)	9.36	663	619	9	663	169	29
45	FOSA (PFOSA)	9.61	498	78	75	498	169	30
46	$^{13}C_8$-FOSA ($^{13}C_8$-PFOSA)	9.74	506	78	49	-	-	-
47	$^{13}C_2$-PFTeDA ($^{13}C_2$-PFTeA)	9.76	715	670	7	-	-	-
48	PFTeDA (PFTeA)	9.76	713	669	10	713	169	33
49	$^{13}C_4$-8:2 diPAP	10.42	993	545	19	-	-	-
50	8:2 diPAP	10.43	989	97	45	989	543	28
51	$^{13}C_2$-PFHxDA	10.46	815	770	12	-	-	-
52	PFHxDA	10.46	813	769	12	813	219	32
53	PFOcDA (PFODA)	11.02	913	869	11	913	169	39
54	d_3-N-MeFOSA	11.03	515	169	30	-	-	-
55	N-MeFOSA	11.04	512	169	27	512	219	23
56	d_5-N-EtFOSA	11.36	531	169	30	-	-	-
57	N-EtFOSA	11.37	526	219	23	526	169	27

FM4 Performance Data

PFAS Recovery Rate

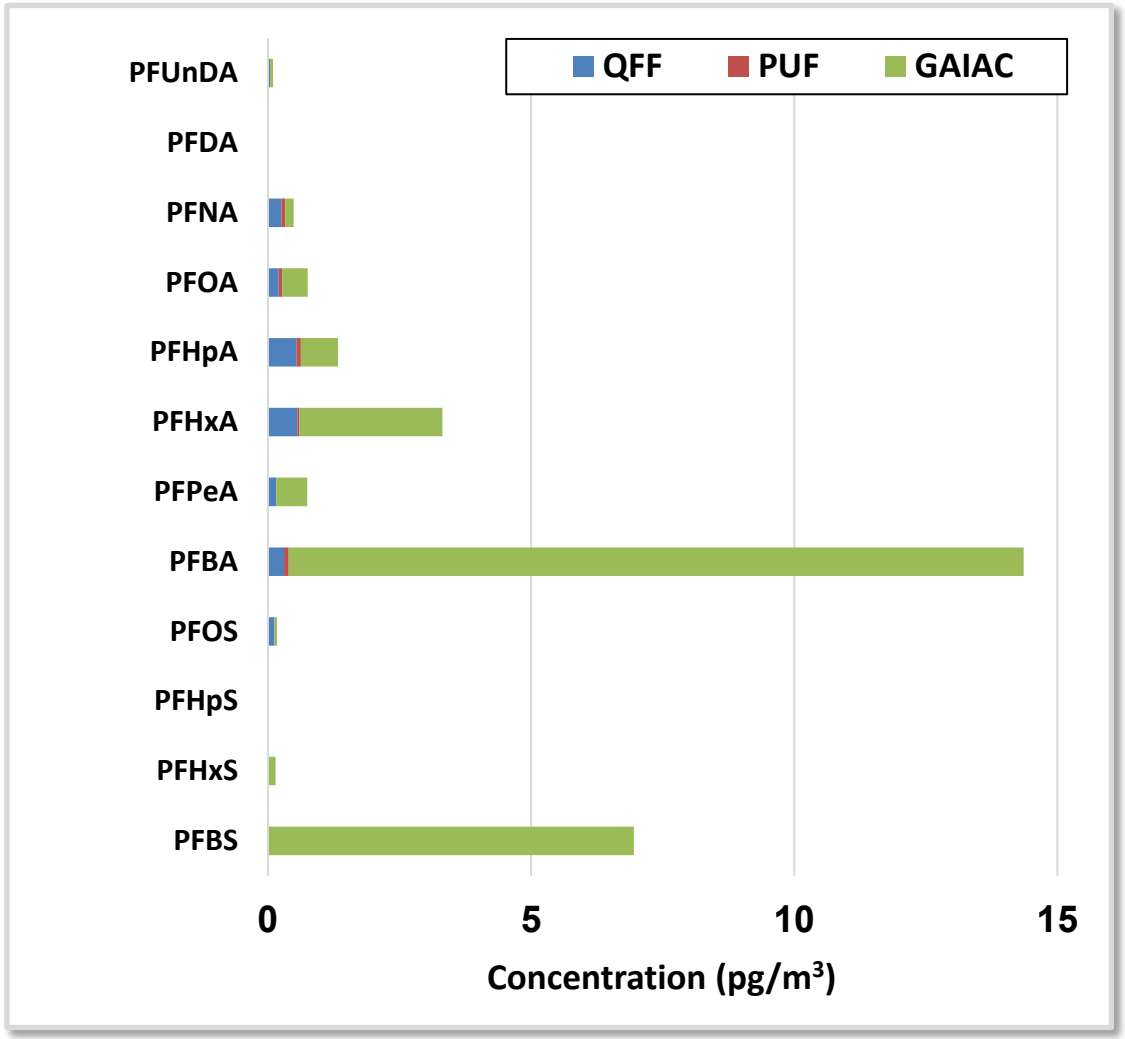


Particle collection	
Compounds	Recovery Rate (%)
$^{13}C_3$-PFBS	94
$^{13}C_3$-PFHxS	94
$^{13}C_8$-PFOS	85
$^{13}C_4$-PFBA	47
$^{13}C_5$-PFPeA	59
$^{13}C_5$-PFHxA	69
$^{13}C_4$-PFHpA	79
$^{13}C_8$-PFOA	85
$^{13}C_9$-PFNA	103
$^{13}C_6$-PFDA	88
$^{13}C_7$-PFUnDA	95

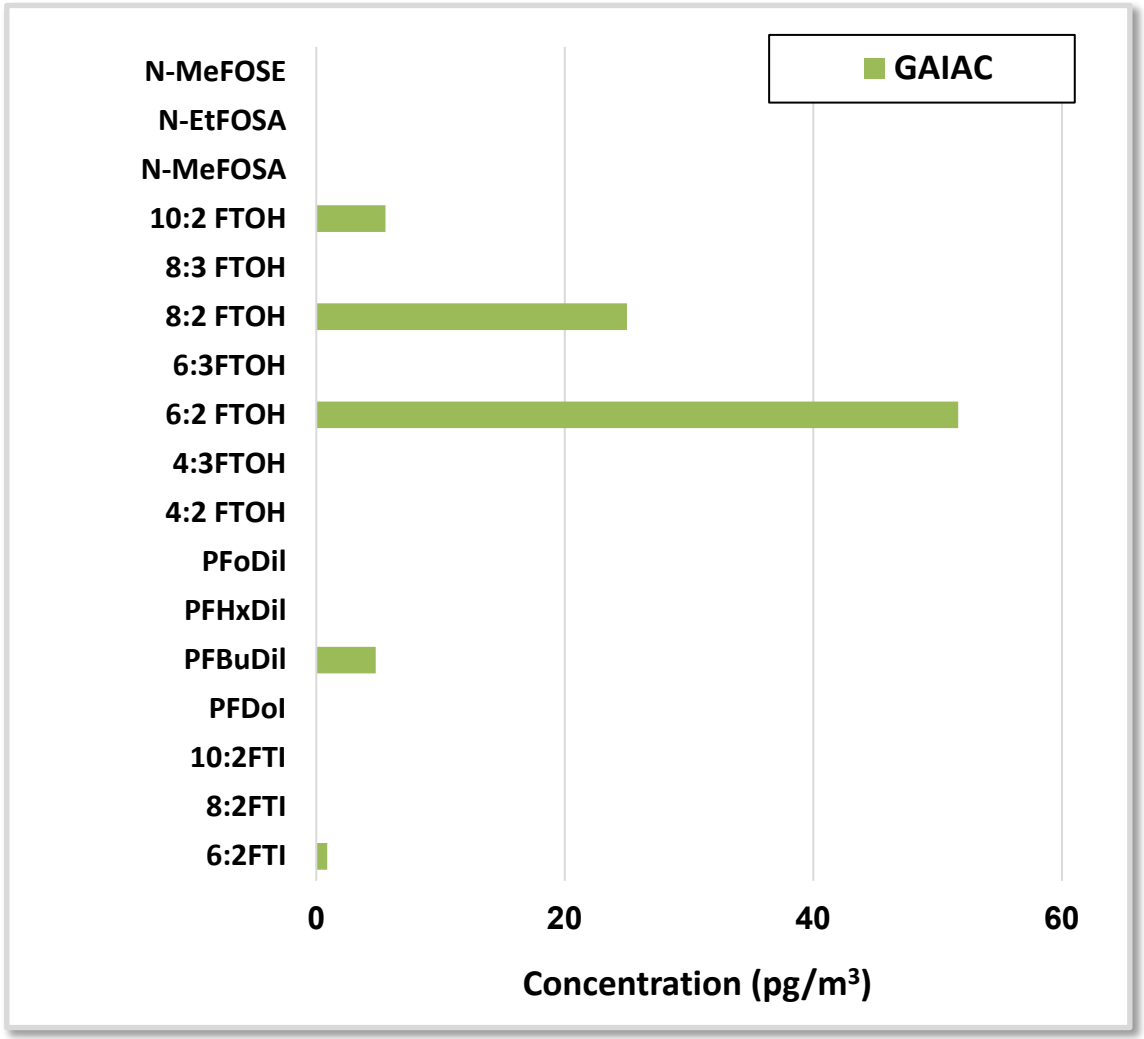
Gas collection	
Compounds	Recovery Rate (%)
d_4 - 4:2 FTOH	91
d_2 - $^{13}C_2$-6:2 FTOH	90
d_2 - $^{13}C_2$-8:2 FTOH	102
d_2 - $^{13}C_2$-10:2 FTOH	84
d_5 -*N*-MeFOSA	71
d_3 - *N*-EtFOSA	78
d_7 -*N*-MeFOSE	110
d_9 -*N*-EtFOSE	110

Air Measurement Example

Ionic PFAS



Neutral PFAS



FM4 Specifications

FM4

Cat.No.	Item	Qty.	Specifications
1050-13015	FM4	1 set	Material: Aluminum (anodizing treatment) Dimension: 60 mm × 195 mm Weight: approx. 900 g Connection: Rc 1/4

FM4

Quartz Fiber Filter (QFF)

Polyurethane Foam

GAIAC

Consumables

Cat.No.	Item	Qty.	Number of use per sampling	Specifications
1050-13022	Quartz Fiber Filter QFF31	100 pcs	3 pcs	Impactor section, 31 mm
1050-13023	Quartz Fiber Filter QFF47	100 pcs	1 pc	Backup, 47 mm
1050-13021	Polyurethane Foam PUF4750	10 pcs	1 pc	47 mm × 50mm
1050-13020	Activated Carbon Fiber Disk (GAIAC FF047)	20 pcs (2/pk x 10pks)	2 pcs	47 mm × 2 mm

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