



solid partners
proven solutions

GCXGC SOLUTIONS FOR HYDROCARBON GROUP-TYPE ANALYSIS OF DIESEL AND JET FUELS

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OVER A DECADE OF GCXGC..



- Principal research
 - Academic focus on
 - modulation technology,
 - column sets
 - exploring boundaries
 - Methods
 - Further hyphenation
 - Poor (practical) application focus
- How can we get GCxGC to really deliver value?

APPLICATING FOR JET/DIESEL CHOICES...



- Columns? Modulation? Method? Quantitation?
 - Separation capacity to separate groups over b.p. range
 - Robustness
 - Simplicity. Operator should be able to operate and maintain
 - Repeatability, comparison to other methods

APPLICATING FOR JET/DIESEL

A TURN KEY SOLUTION



- Reverse GCxGC
 - Best peak capacity
- Flow Modulation
 - Very repeatable, simple in design and powerful (enough)
- FID
 - Universal Response, cost effective, familiar and robust
- Application Ready
 - No hardware only, no Engineering. You start work
- Quality control included

APPLICATING FOR JET/DIESEL

TURN KEY SOLUTION

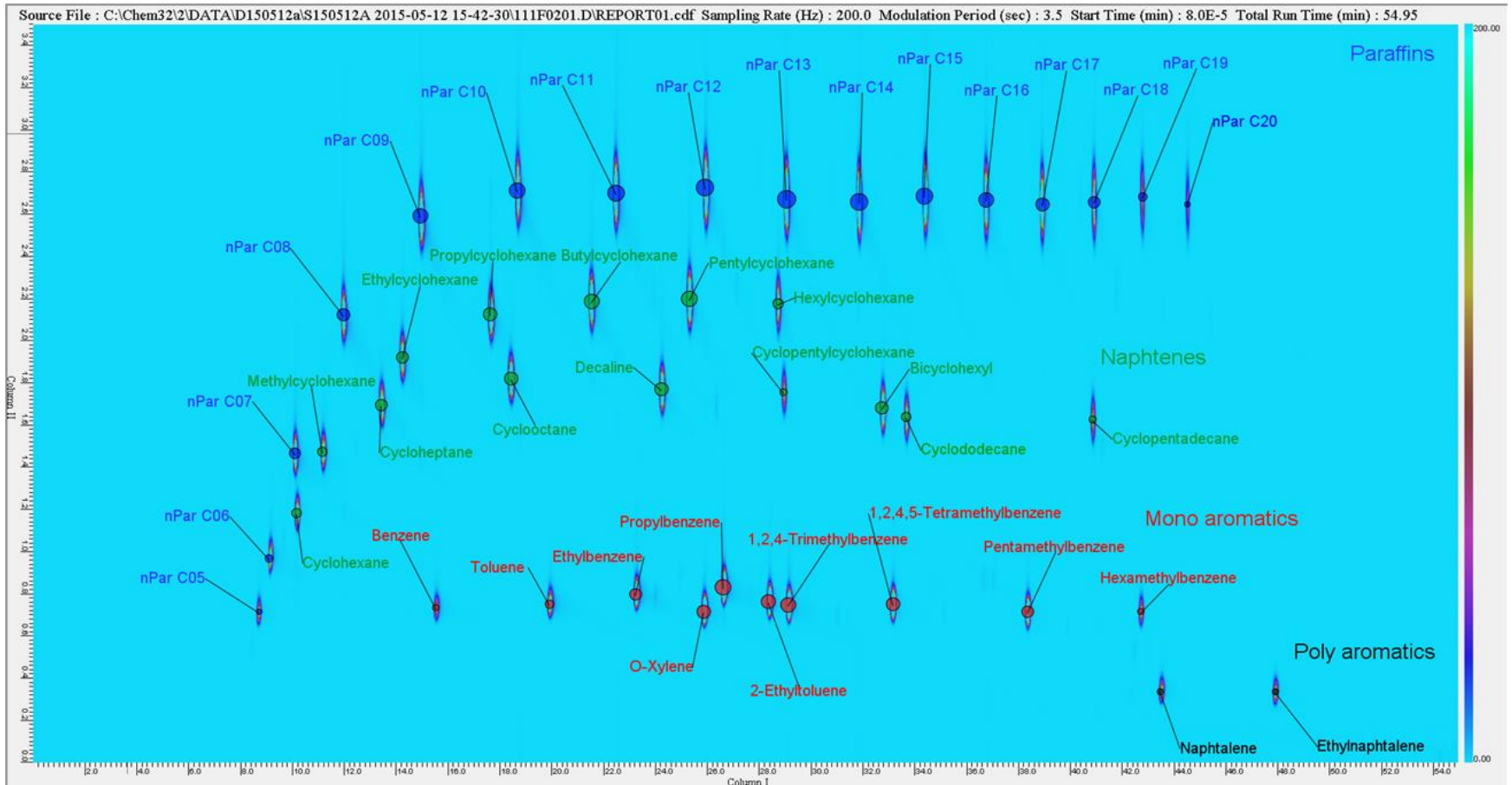


- Separation by Groups & Selected Individual compounds
 - Paraffin's
 - Iso-paraffins
 - Naphthenes
 - Aromatics
 - FAMES
- 1 method, B.P up to 450C
- Allows for different Fuel types, incl. Biodiesel.
- Robustness, Repeatability, and comparability
- Simplicity that works

JET FUEL

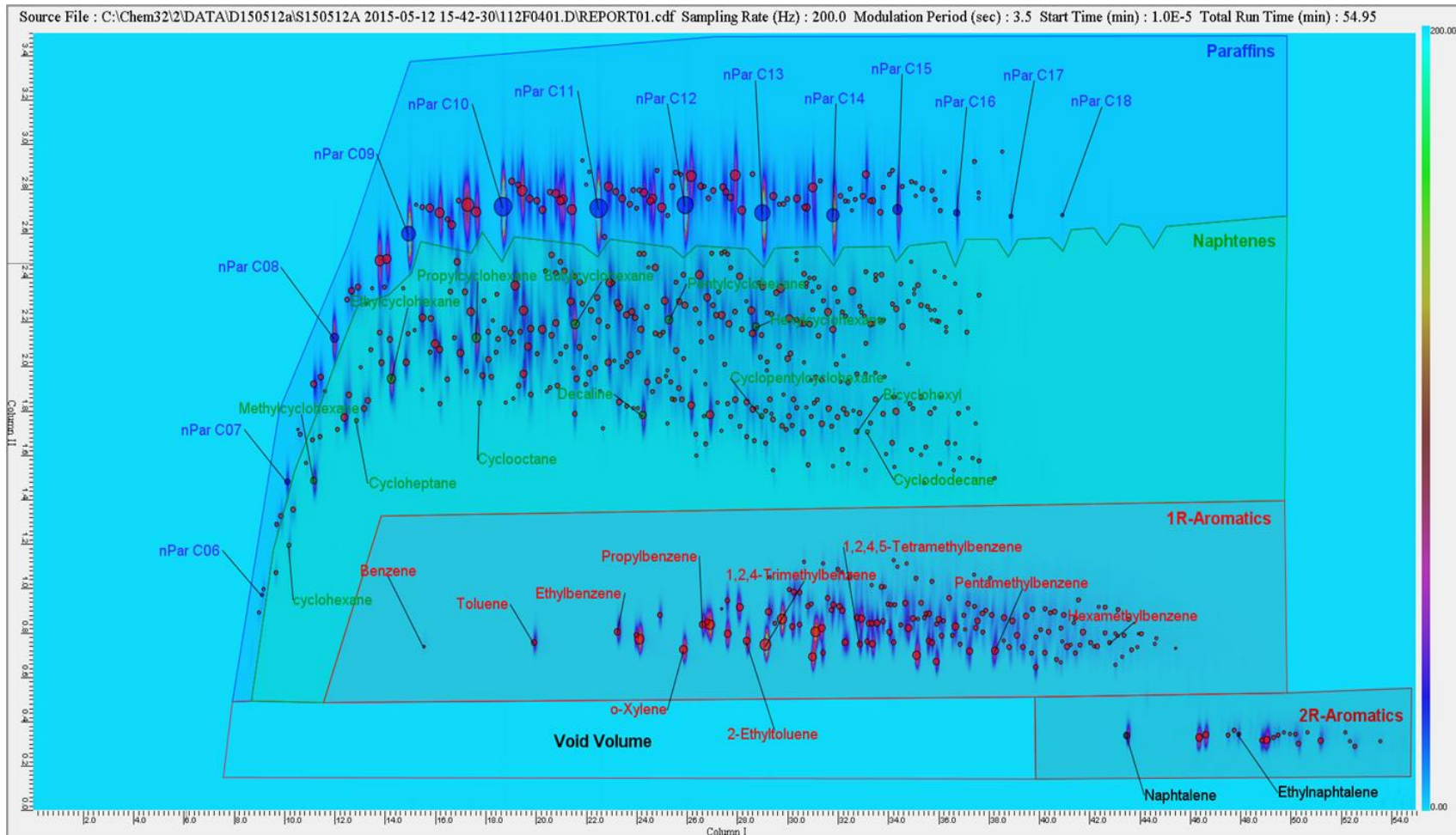


JET FUEL REFERENCE STD



JET FUEL

PAC QC MATERIAL 00.02.717



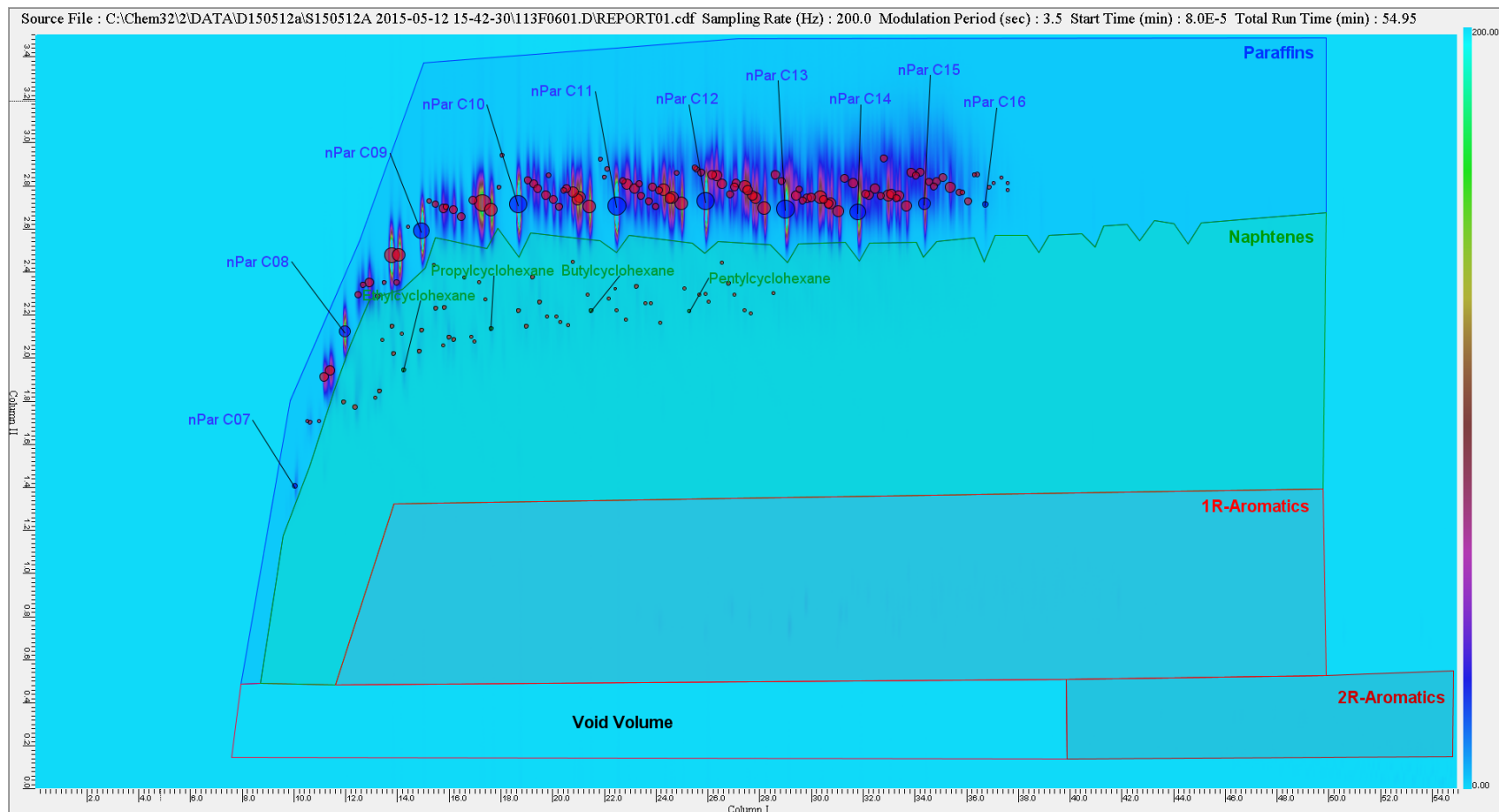
JET FUEL

PAC QC MATERIAL

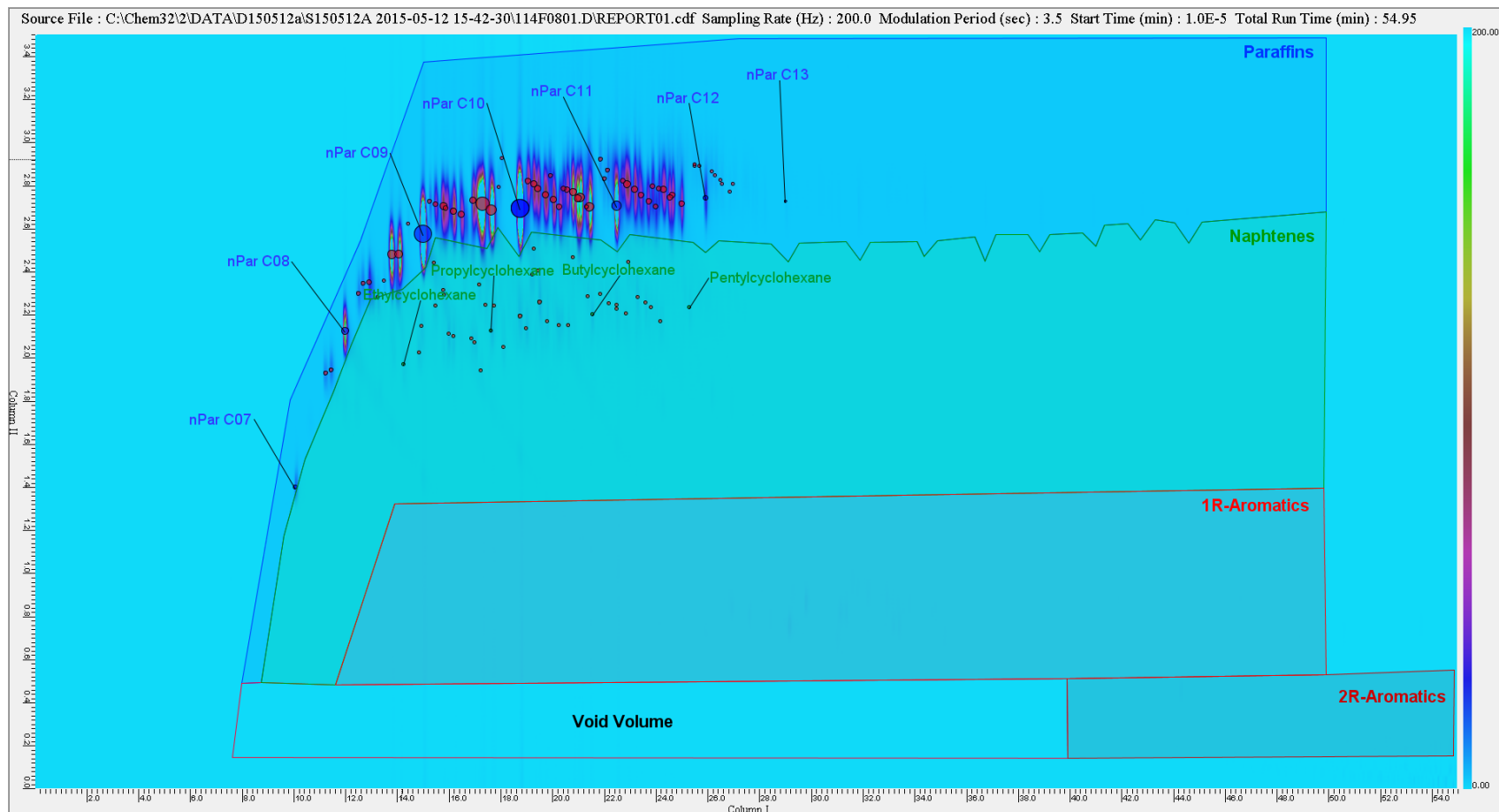


Component	Mass% standard	Mass% found	Difference
nPar C05	0.51	0.51	0.00
nPar C06	1.00	1.00	0.00
nPar C07	2.00	2.00	0.00
nPar C08	2.50	2.46	0.04
nPar C09	3.50	3.42	0.07
nPar C10	4.00	3.97	0.03
nPar C11	4.75	4.73	0.02
nPar C12	5.25	5.22	0.03
nPar C13	5.50	5.47	0.03
nPar C14	5.00	5.02	0.02
nPar C15	4.25	4.27	0.02
nPar C16	3.50	3.51	0.01
nPar C17	2.75	2.76	0.01
nPar C18	2.00	2.00	0.00
nPar C19	1.00	1.00	0.00
nPar C20	0.50	0.50	0.00
Bicyclohexyl	2.35	2.37	0.02
Butylcyclohexane	3.50	3.52	0.03
Cyclododecane	1.25	1.27	0.02
Cycloheptane	2.00	2.03	0.03
Cyclohexane	1.25	1.28	0.03
Cyclooctane	2.75	2.80	0.05
Cyclopentadecane	0.75	0.76	0.01
Cyclopentylcyclohexane	0.75	0.75	0.00
trans-Decahydronaphthalene	2.75	2.75	0.00
Ethylcyclohexane	2.00	2.02	0.02
Hexylcyclohexane	1.50	1.49	0.01
Methylcyclohexane	1.25	1.29	0.04
Pentylcyclohexane	4.00	3.92	0.07
Propylcyclohexane	2.75	2.75	0.00
1,2,4,5-Tetramethylbenzene	2.75	2.76	0.01
1,2,4-Trimethylbenzene	3.50	3.51	0.01
2-ethyltoluene	3.00	3.01	0.01
Benzene	0.50	0.50	0.00
Ethylbenzene	2.00	2.00	0.01
Hexamethylbenzene	0.50	0.52	0.01
o-Xylene	2.75	2.75	0.00
Pentamethylbenzene	2.00	1.98	0.02
n-Propylbenzene	4.00	4.00	0.00
Toluene	1.05	1.05	0.00
2-Ethynaphthalene	0.55	0.55	0.00
Naphthalene	0.55	0.55	0.00
Total Paraffins	48.00	47.82	0.18
Total Naphtenes	28.84	29.00	0.16
Total Aromatics	23.16	23.18	0.02
	100.00	100.00	

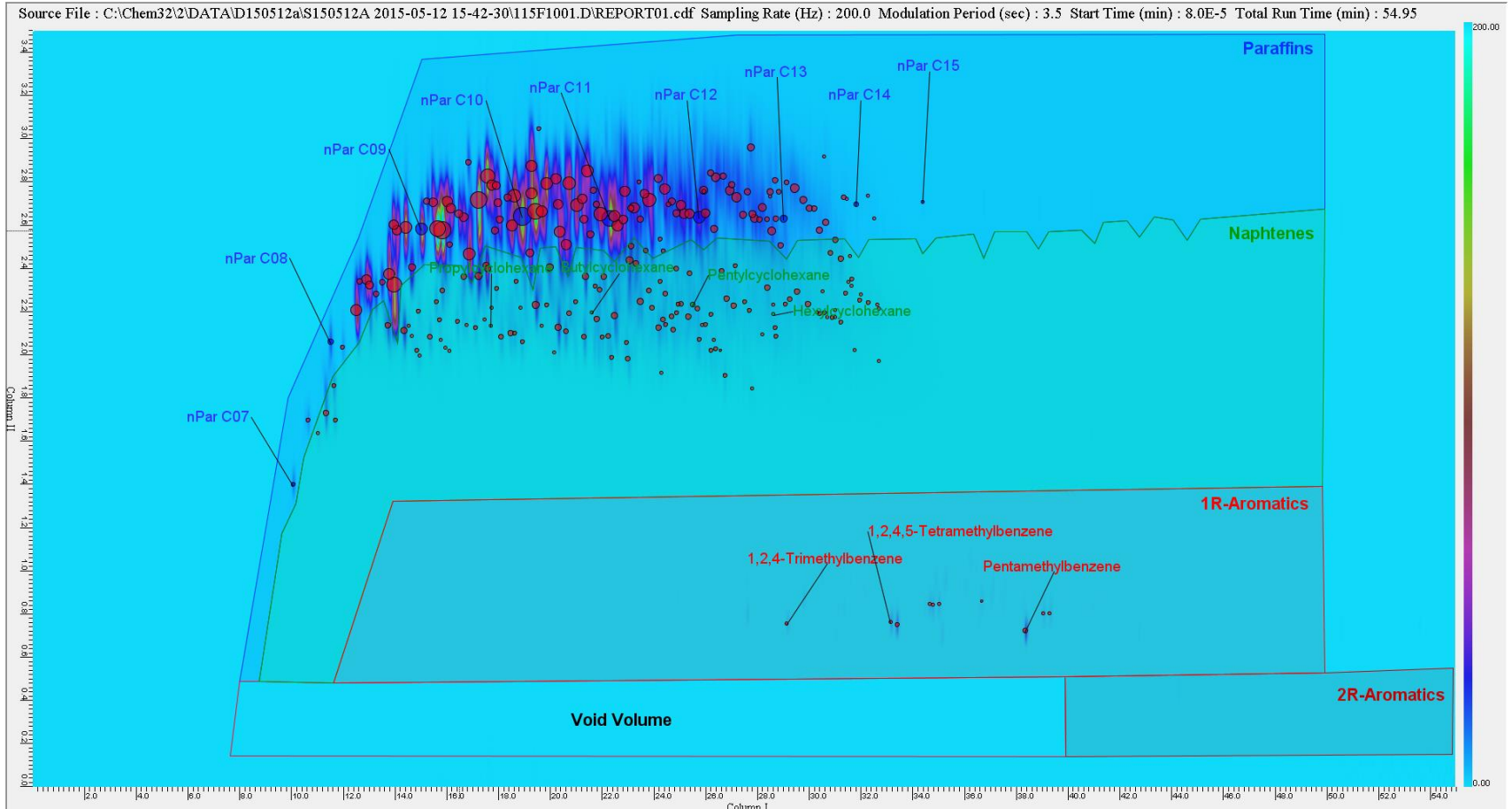
JET FUEL SPK 5018



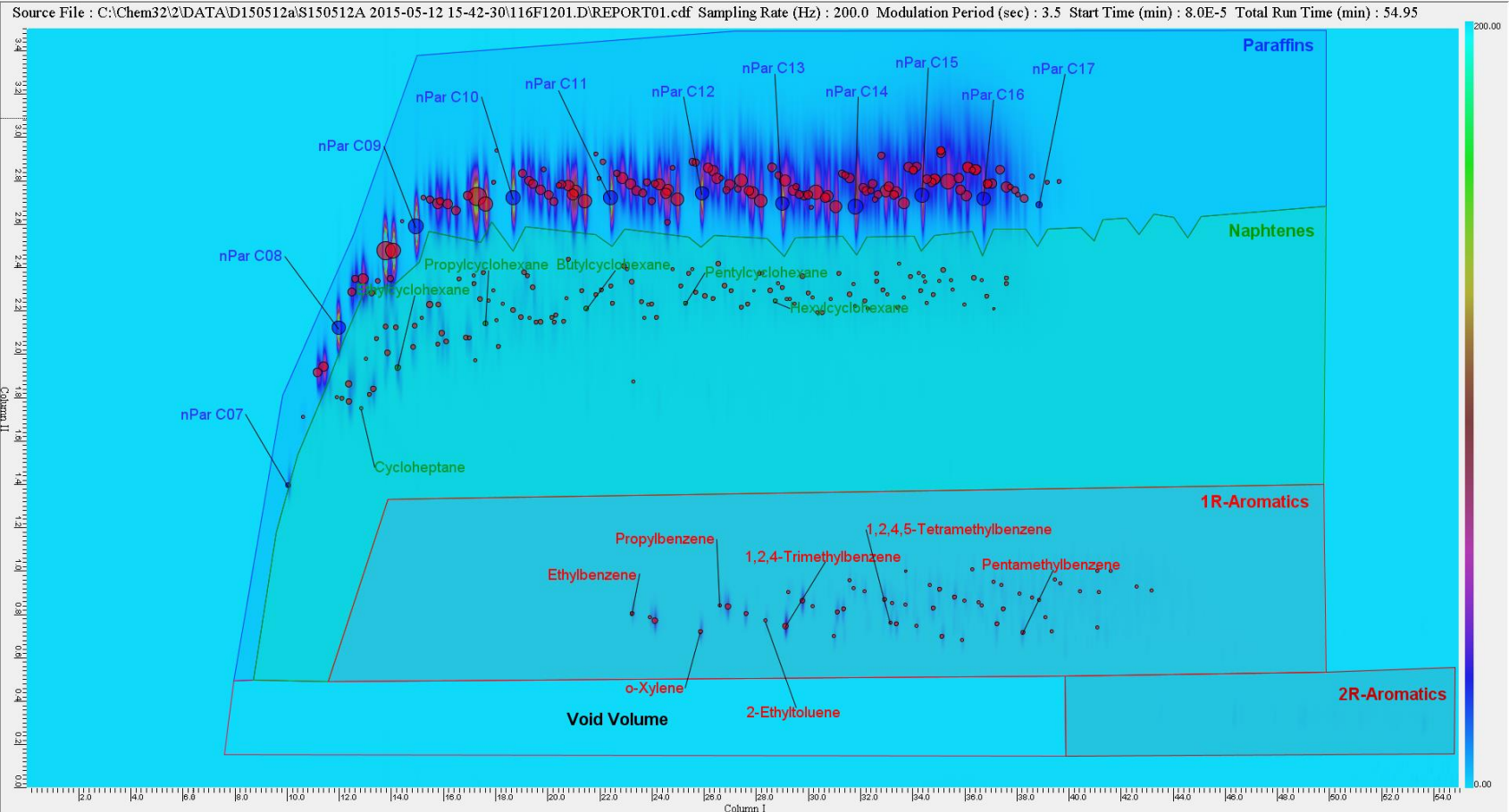
JET FUEL SPK 5172



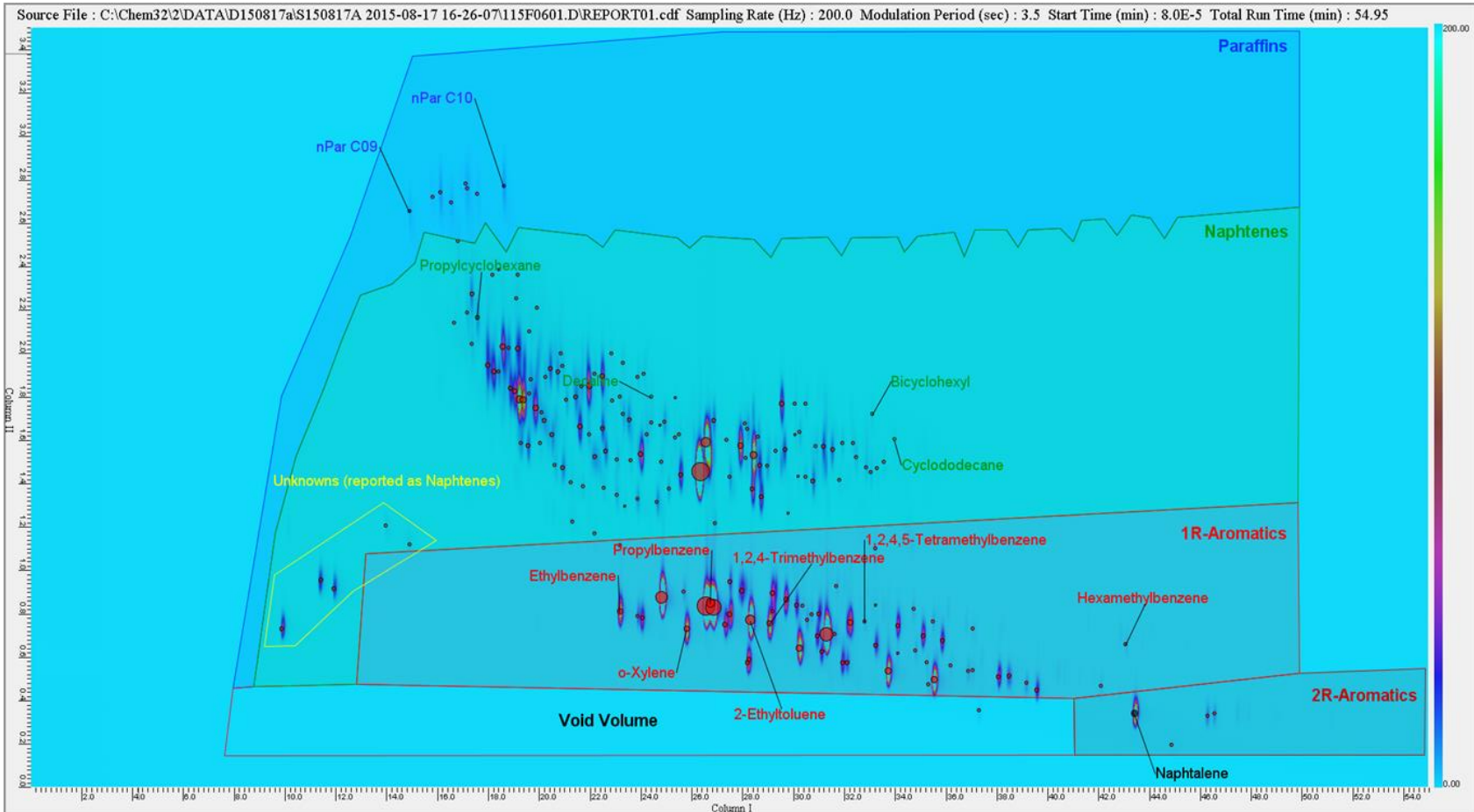
JET FUEL SPK 5642



JET FUEL SPK 5698

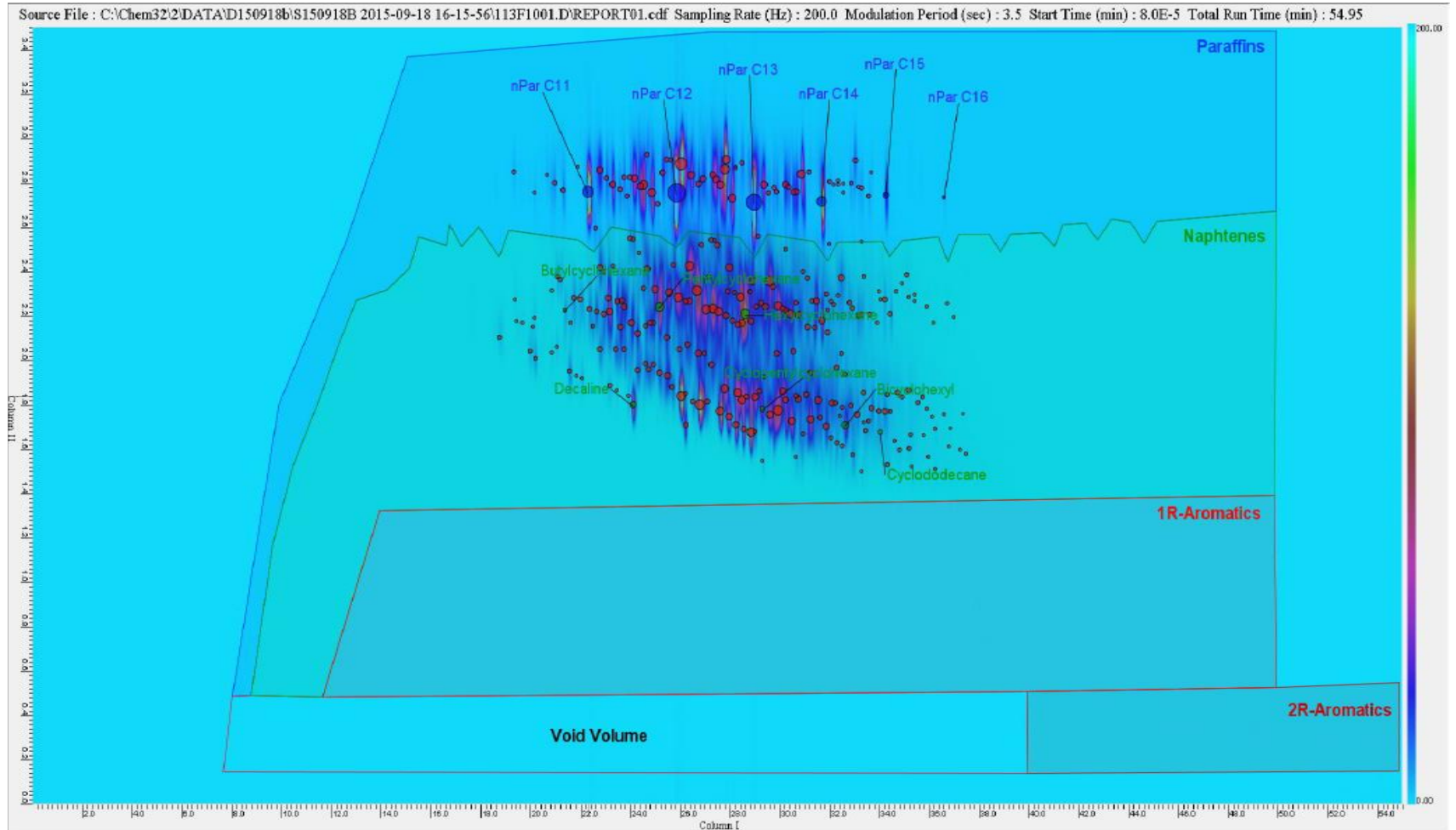


JET FUEL 'KERO' 1

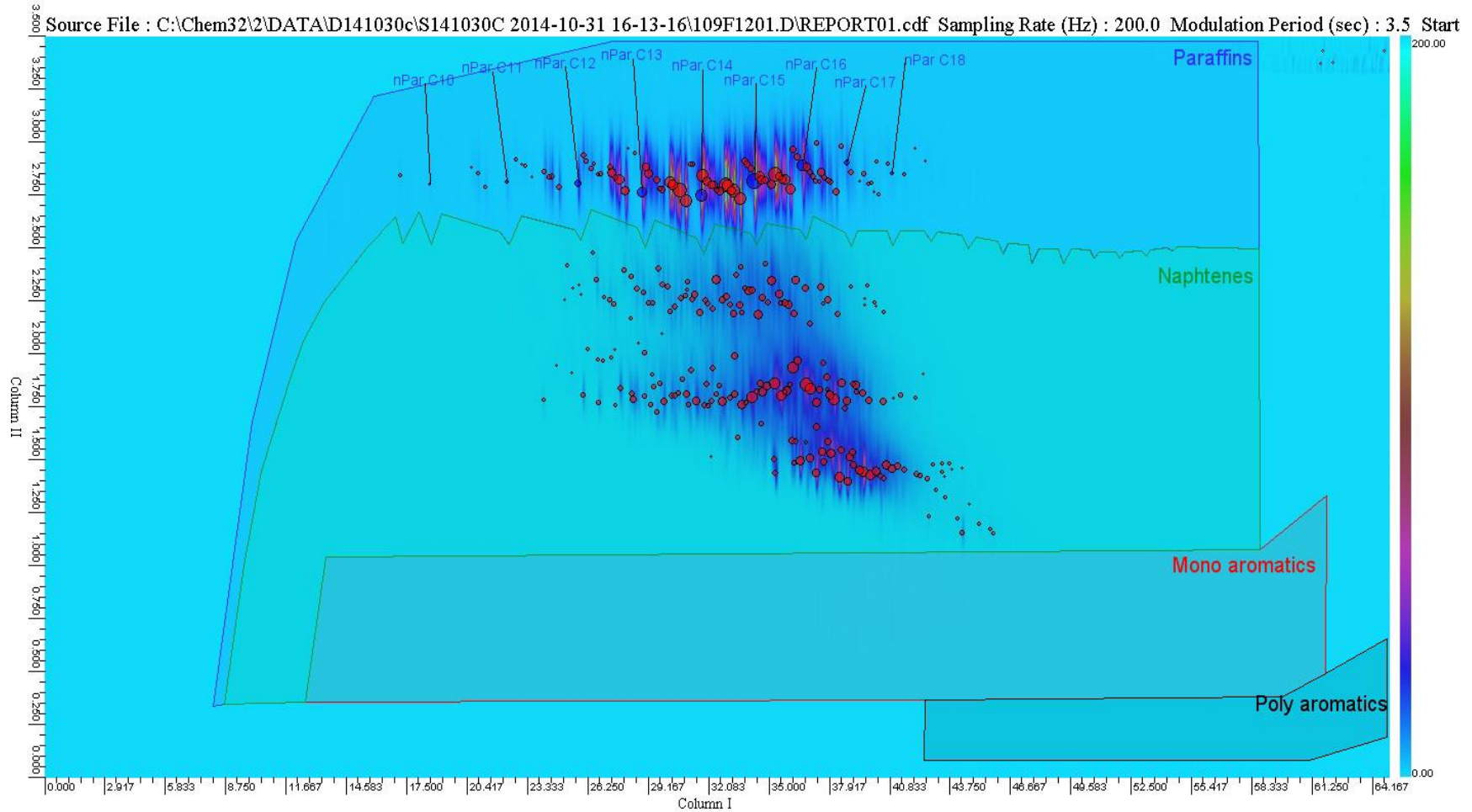


JET FUEL

JET W/O AROMATICS



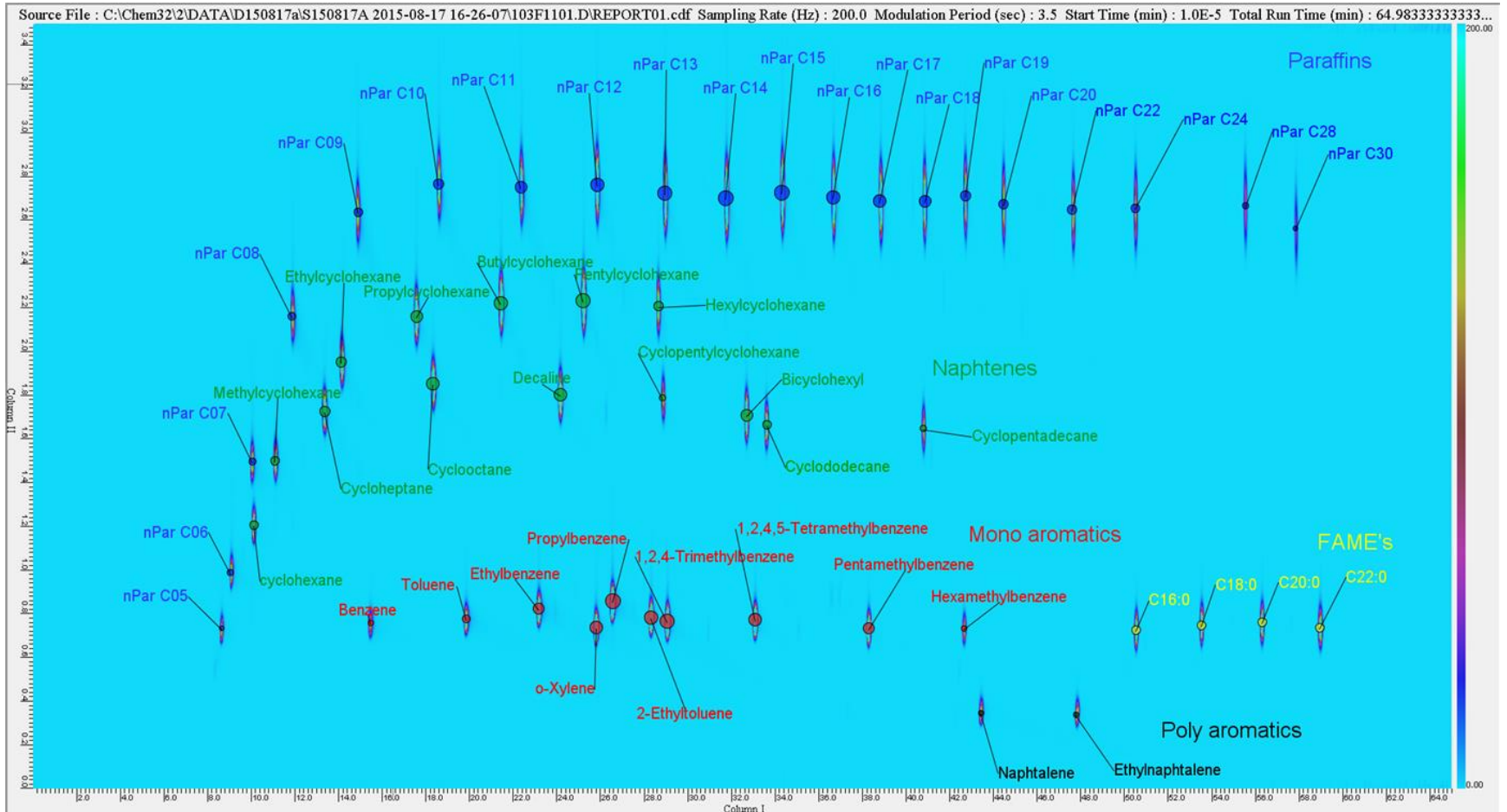
JET FUEL BASE FLUID



DIESEL



DIESEL REFERENCE STD



DIESEL FUEL

PAC REFERENCE MATERIAL

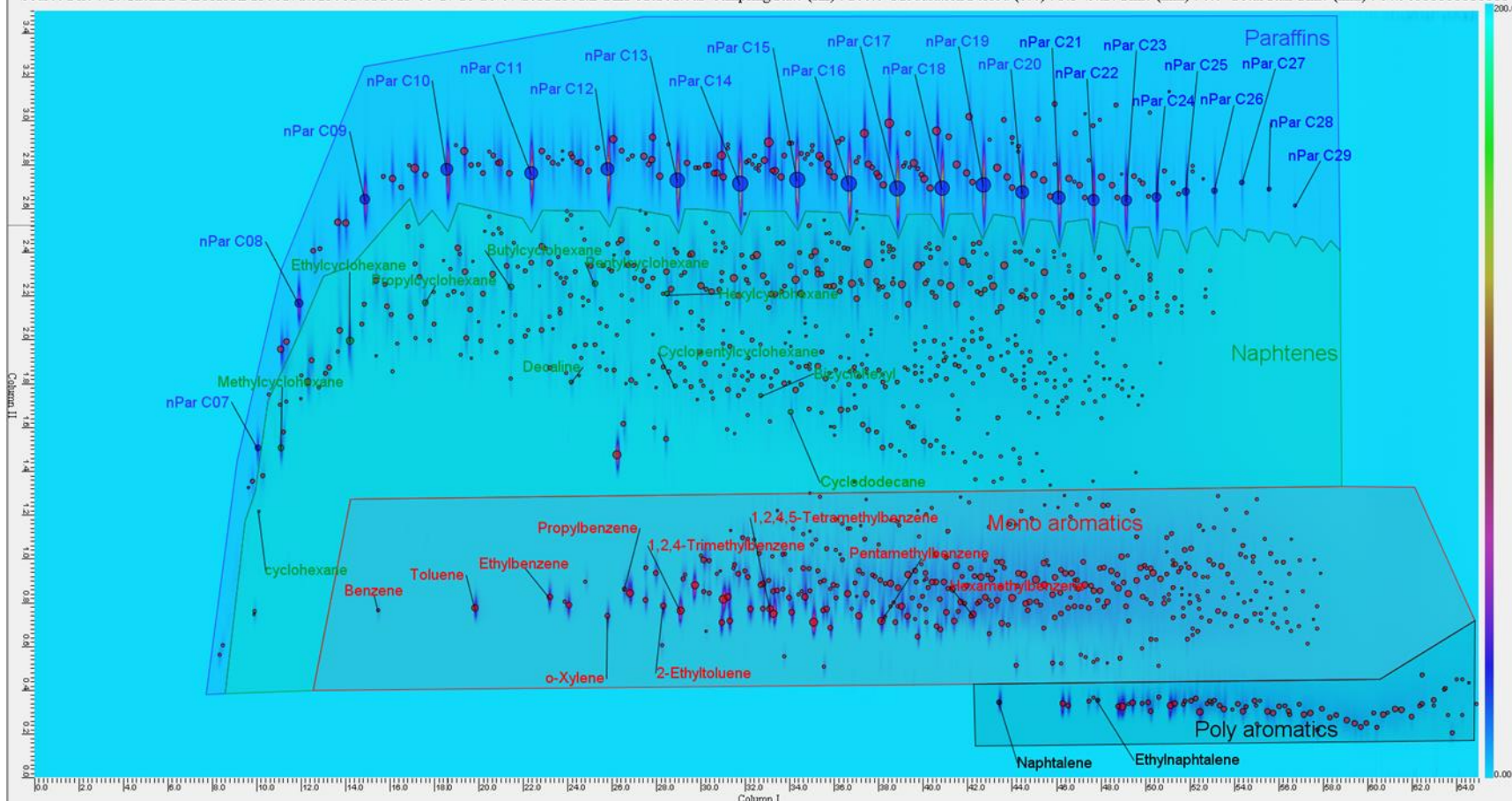


Component	Mass% standard	Mass% found	Difference
nPar C05	0.50	0.51	0.01
nPar C06	0.75	0.73	0.02
nPar C07	1.00	0.98	0.02
nPar C08	1.25	1.19	0.06
nPar C09	1.50	1.43	0.07
nPar C10	2.00	1.96	0.04
nPar C11	2.50	2.47	0.03
nPar C12	3.25	3.23	0.02
nPar C13	4.00	3.99	0.01
nPar C14	4.50	4.53	0.03
nPar C15	4.25	4.27	0.02
nPar C16	3.50	3.55	0.04
nPar C17	3.00	3.04	0.04
nPar C18	2.50	2.55	0.04
nPar C19	2.00	2.02	0.02
nPar C20	1.50	1.51	0.01
nPar C22	1.50	1.52	0.02
nPar C24	1.25	1.26	0.01
nPar C28	0.75	0.75	0.00
nPar C30	0.50	0.49	0.01
C16:0 FAME	1.50	1.50	0.00
C18:0 FAME	1.50	1.50	0.00
C20:0 FAME	1.50	1.49	0.01
C22:0 FAME	1.50	1.48	0.02
Bicyclohexyl	2.35	2.39	0.04
Butylcyclohexane	3.50	3.52	0.02
Cyclododecane	1.25	1.27	0.02
Cycloheptane	2.00	2.01	0.01
Cyclooctane	2.75	2.78	0.03
Cyclopentadecane	0.75	0.76	0.01
Cyclopentylcyclohexane	0.75	0.75	0.00
trans-Decahydronaphthalene	2.75	2.75	0.00
Ethylcyclohexane	2.00	1.99	0.00
Hexylcyclohexane	1.50	1.50	0.00
Methylcyclohexane	1.25	1.27	0.02
Pentylcyclohexane	4.00	3.93	0.07
Propylcyclohexane	2.75	2.73	0.02
Cyclohexane	1.25	1.26	0.01
1,2,4,5-Tetramethylbenzene	2.75	2.77	0.02
1,2,4-Trimethylbenzene	3.50	3.51	0.01
2-ethyltoluene	3.00	3.01	0.01
Benzene	0.50	0.49	0.01
Ethylbenzene	2.00	1.98	0.02
Hexamethylbenzene	0.50	0.52	0.02
Pentamethylbenzene	2.00	1.99	0.01
n-Propylbenzene	4.00	3.99	0.01
Toluene	1.05	1.03	0.02
o-Xylene	2.75	2.74	0.01
2-Ethyl naphthalene	0.55	0.55	0.00
Naphthalene	0.55	0.55	0.00
Total Paraffins	42.008	41.99	0.02
Total FAME	6.001	5.963	0.04
Total Naphtenes	28.85	28.93	0.08
Total Aromatics	23.14	23.12	0.02
	100.000	100.00	

DIESEL FUEL REGULAR DIESEL 1

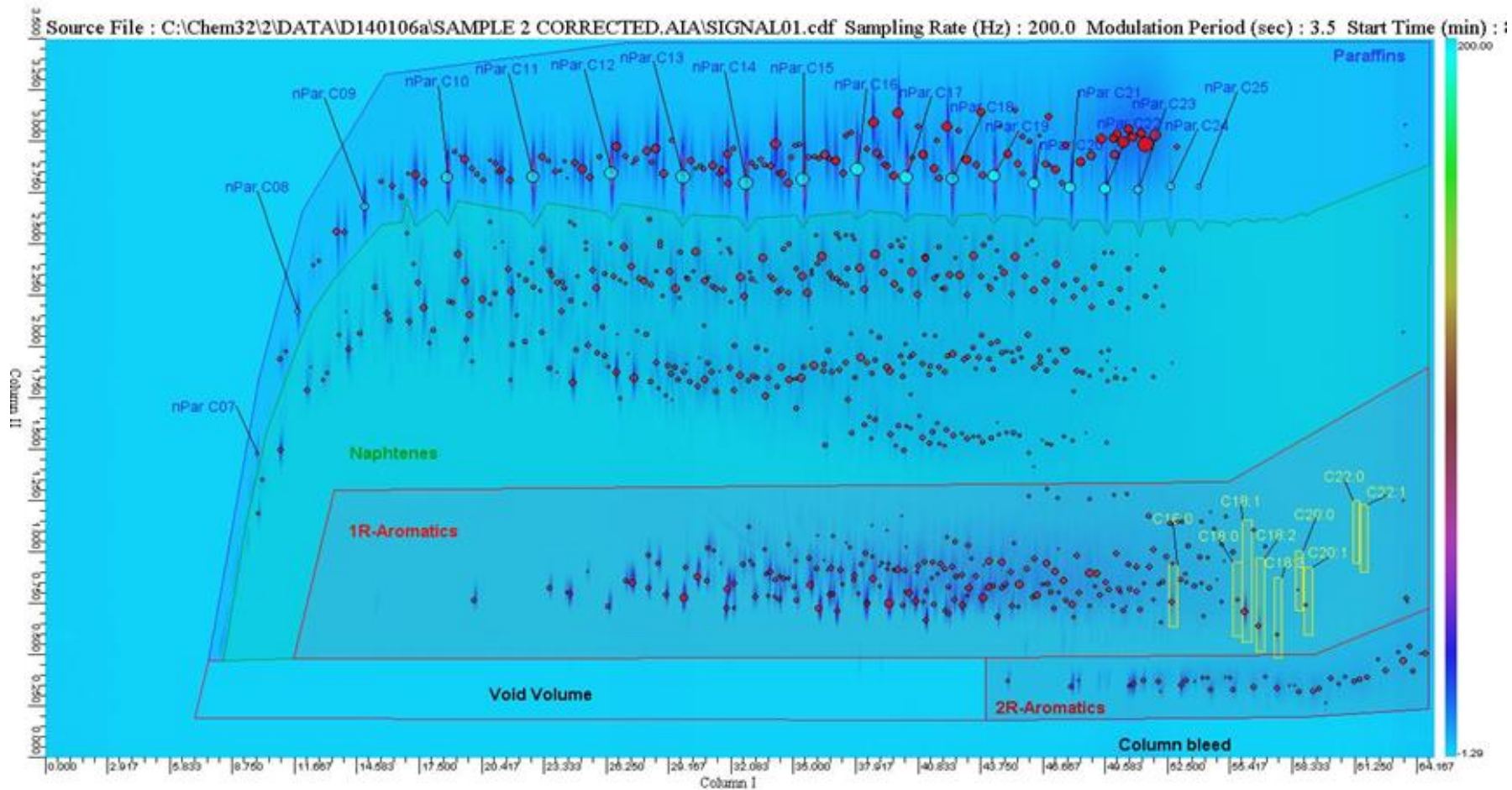


Source File : C:\Chem32\2\DATA\D150817a\S150817A 2015-08-17 16-26-07\105F1501.D\REPORT01.cdf Sampling Rate (Hz) : 200.0 Modulation Period (sec) : 3.5 Start Time (min) : 0.0 Total Run Time (min) : 64.9833333333333



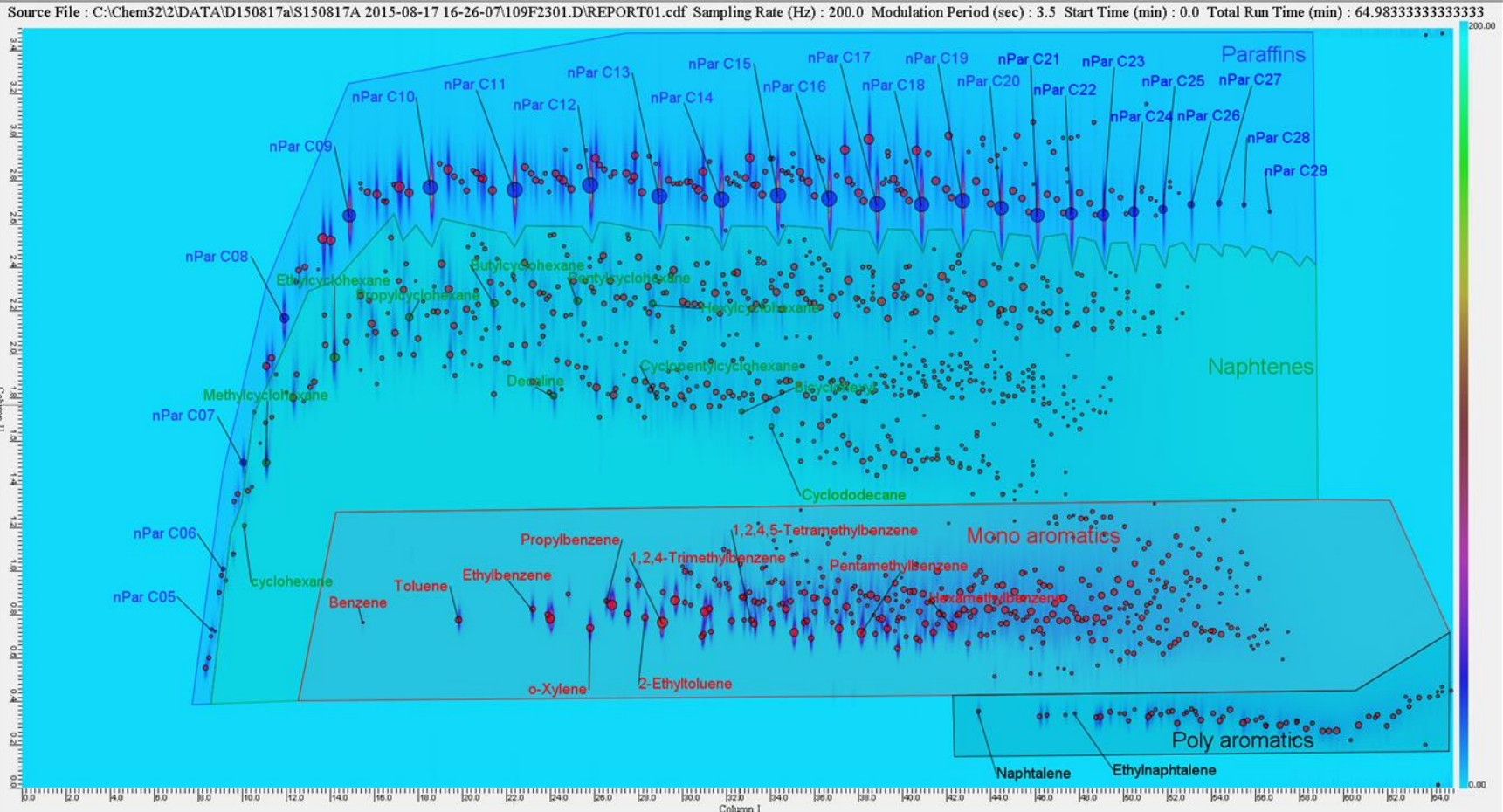
DIESEL FUEL

SHELL V-POWER DIESEL



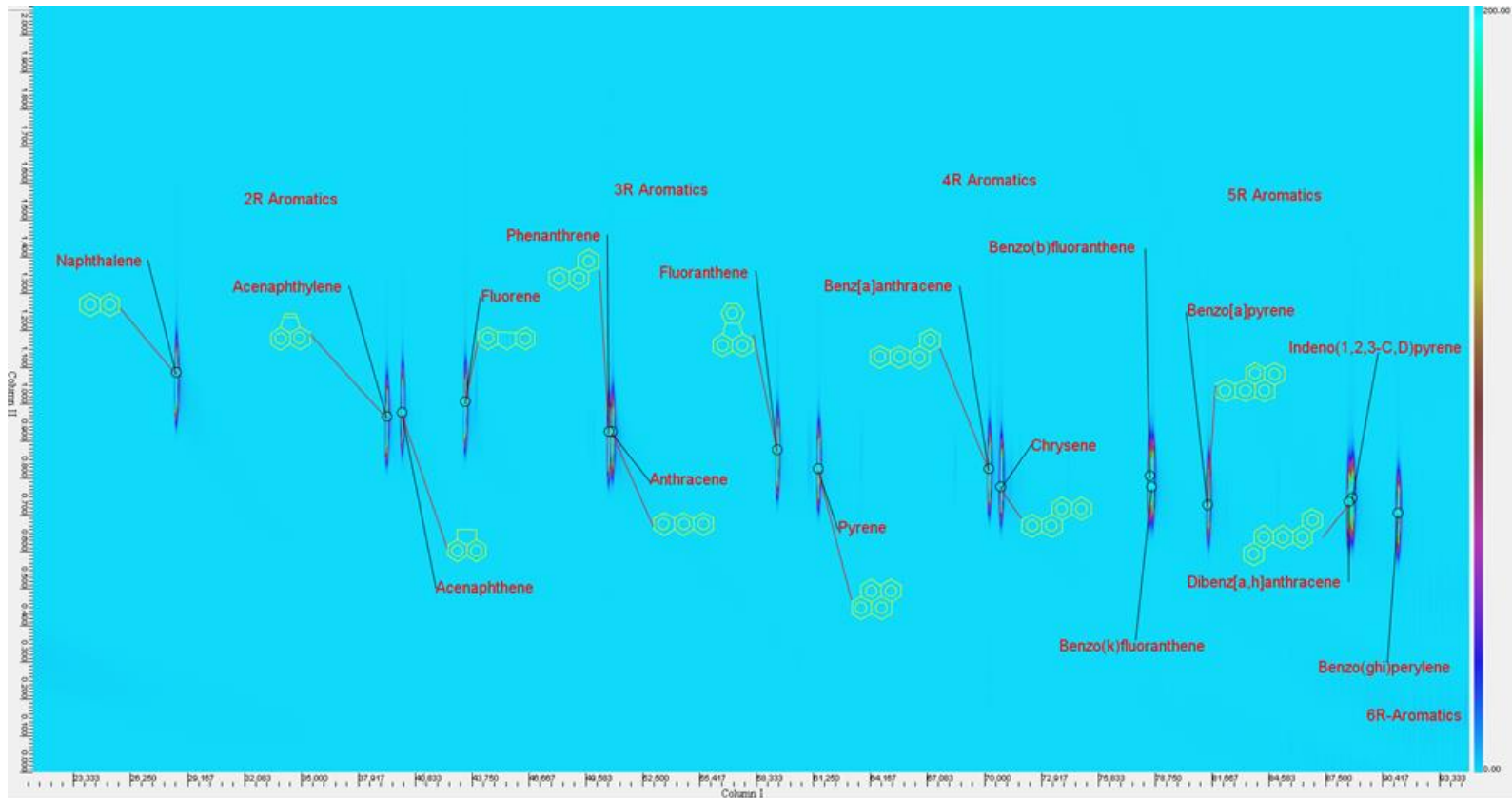
DIESEL FUEL

DIESEL "R5"



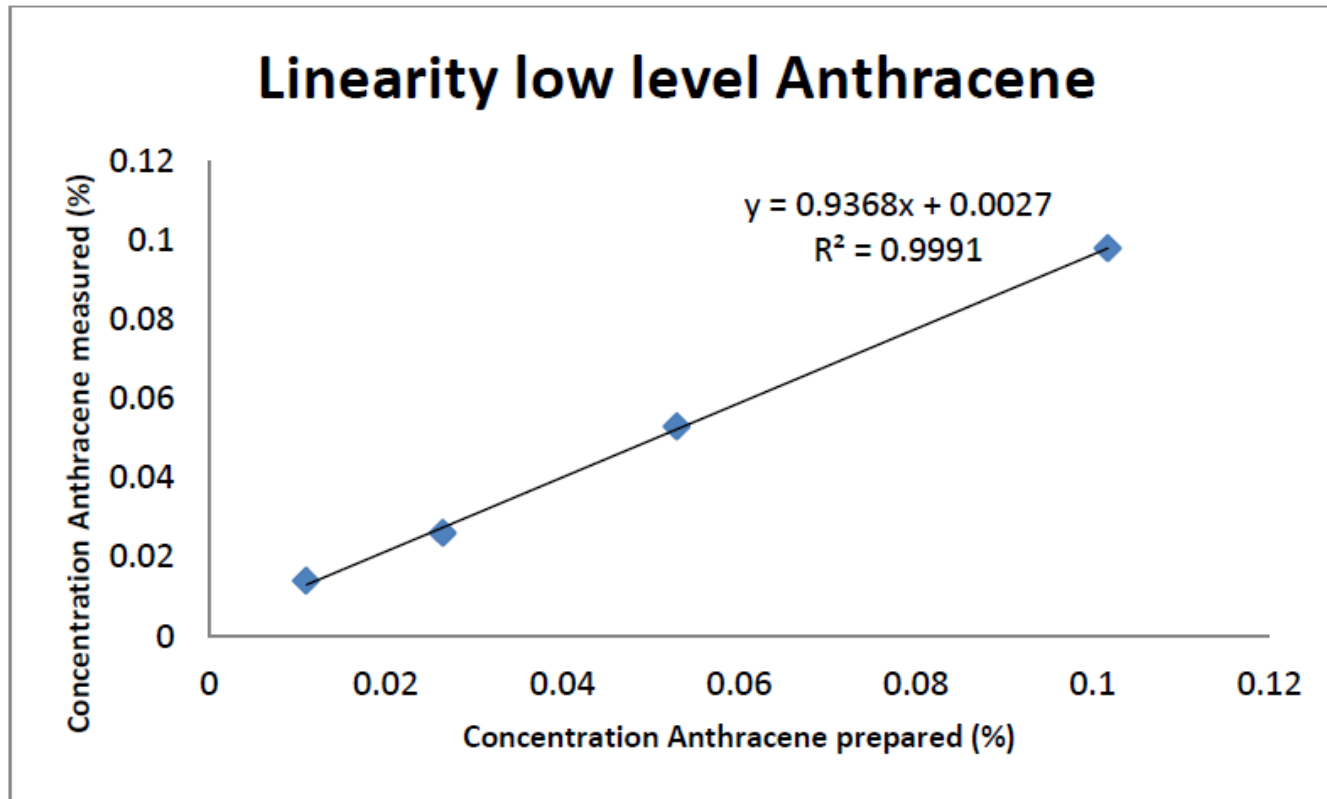
OTHER APPLICATIONS

POLY NUCLEAR AROMATICS



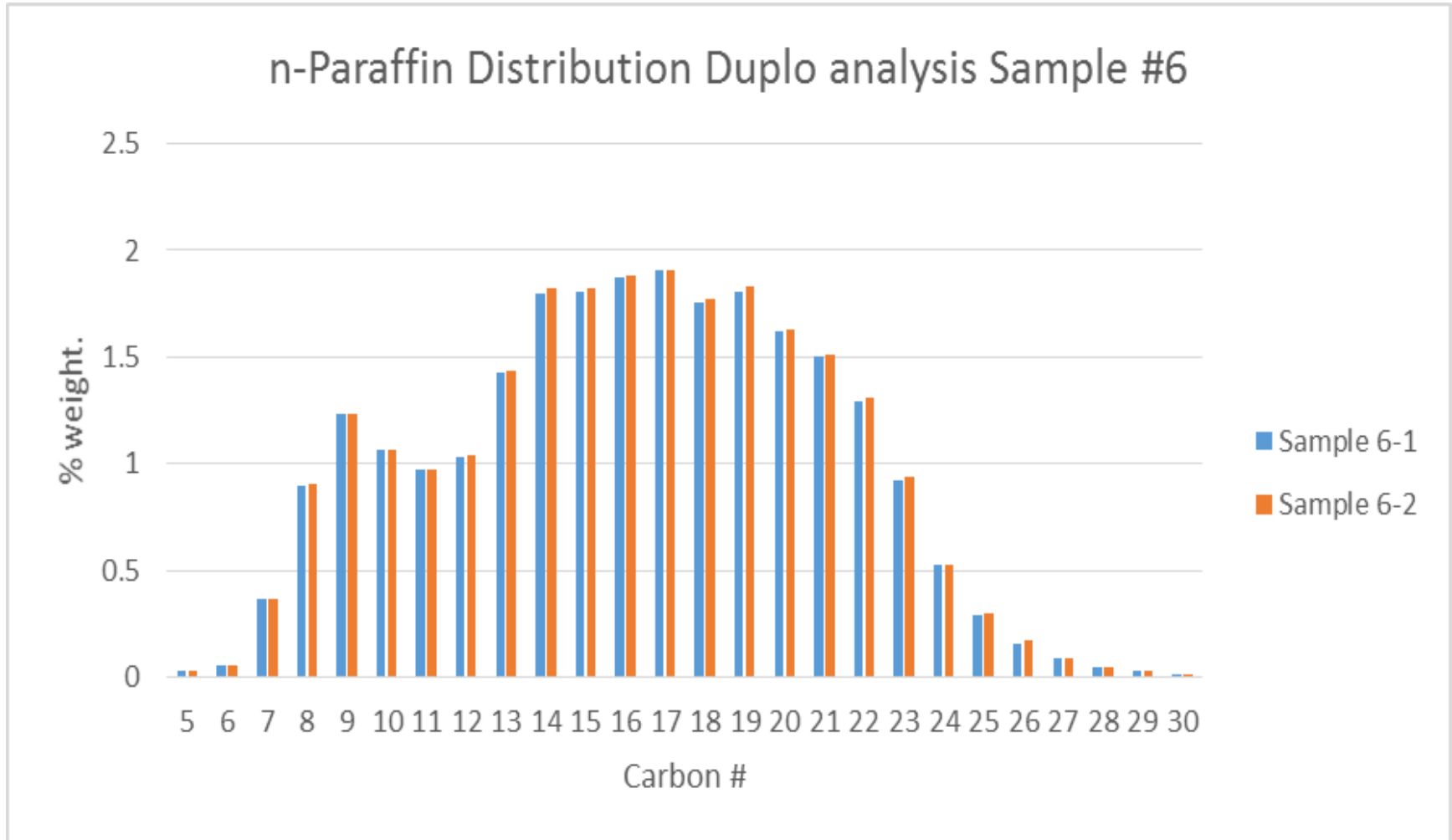
LINEARITY & DETECTION LIMIT

POLY NUCLEAR AROMATICS



REPEATABILITY

DIESEL

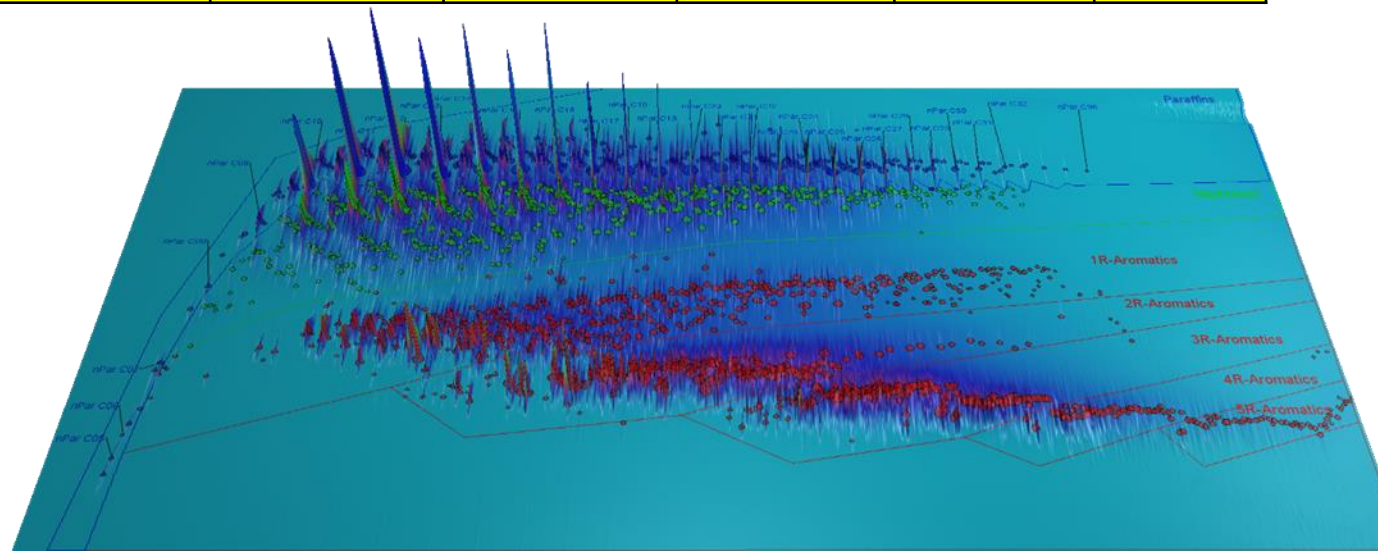


REPEATABILITY

LIGHT CYCLE OIL

Run	1R aromatics (% m/m)	2R aromatics (% m/m)	3R aromatics (% m/m)	4R aromatics (% m/m)	Naphthenes (% m/m)	n-Paraffins (% m/m)	Paraffins (% m/m)
1	14.89	26.03	22.59	0.80	10.18	7.44	25.51
2	14.80	26.05	22.65	0.81	9.98	7.56	25.72
3	14.88	25.89	22.70	0.83	9.83	7.40	25.87
4	14.86	25.81	22.78	0.84	9.97	7.40	25.74
5	14.84	25.99	22.73	0.71	9.87	7.43	25.86
6	14.84	25.64	22.59	0.74	9.86	7.35	26.17
7	14.92	25.74	22.72	0.79	10.11	7.39	25.72
8	14.87	25.99	22.55	0.75	9.63	7.42	26.19
9	14.77	25.92	22.73	0.74	9.86	7.45	25.99
10	14.69	26.12	22.67	0.76	9.74	7.43	26.02
MIN	14.69	25.64	22.55	0.71	9.63	7.35	25.51
MAX	14.92	26.12	22.78	0.84	10.18	7.56	26.19
Average	14.84	25.92	22.67	0.77	9.90	7.43	25.88
stdev	0.0677	0.1498	0.0744	0.0439	0.1631	0.0554	0.2184
RSD	0.46%	0.58%	0.33%	5.7%	1.7%	0.75%	0.84%

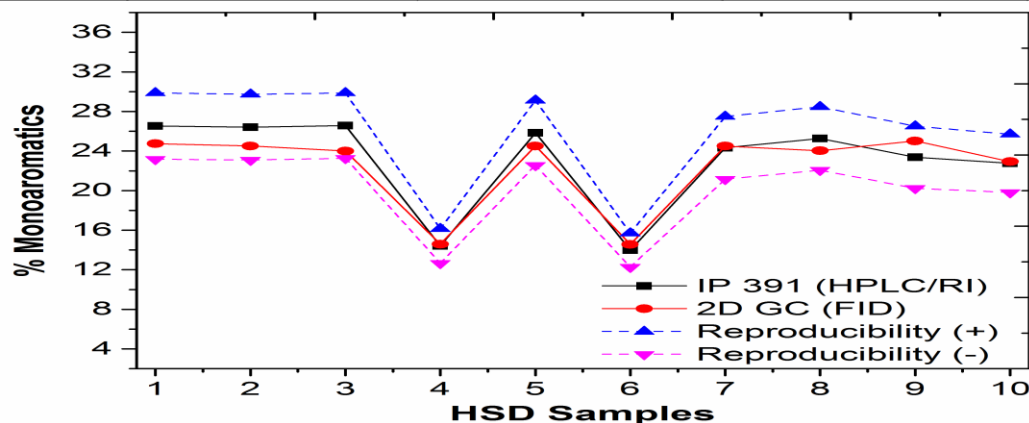
Sample: Light Cycle Oil sample



ACCURACY/PRECISION/BIAS

GCXGC VS IP391 - MONOAROMATICS

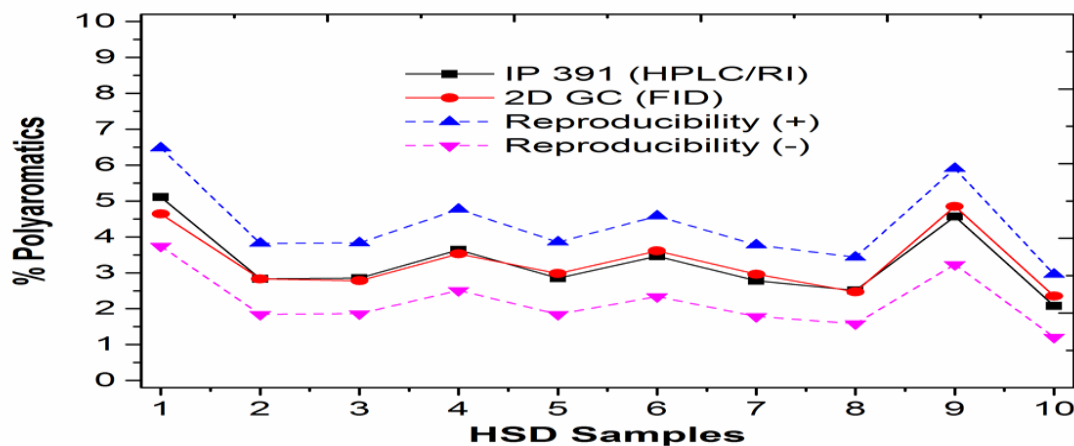
Sample	Monoaromatics, % by mass		Reproducibility calculation as per IP 391 method	
	IP 391 method (HPLC/RI detection)	2D GC method	Reproducibility (+)	Reproducibility (-)
HSD -1	26.53	24.75	29.88	23.18
HSD -2	26.42	24.51	29.74	23.10
HSD -3	26.57	24	29.87	23.27
HSD -4	14.41	14.59	16.15	12.67
HSD -5	25.85	24.51	29.13	22.57
HSD -6	13.99	14.57	15.70	12.28
HSD -7	24.33	24.5	27.50	21.16
HSD -8	25.27	24.03	28.48	22.06
HSD -9	23.37	25.02	26.51	20.23
HSD -10	22.76	22.93	25.71	19.81



ACCURACY/PRECISION/BIAS

GCXGC VS IP391 - POLY-AROMATICS

Sample	Polyaromatics, % by mass		Reproducibility calculation as per IP 391 method	
	IP 391 method (HPLC/RI detection)	2D GC method	Reproducibility (+)	Reproducibility (-)
HSD -1	5.11	4.64	6.48	3.74
HSD -2	2.83	2.83	3.82	1.84
HSD -3	2.85	2.78	3.84	1.86
HSD -4	3.64	3.53	4.77	2.51
HSD -5	2.85	2.98	3.85	1.85
HSD -6	3.46	3.61	4.58	2.34
HSD -7	2.78	2.96	3.78	1.78
HSD -8	2.51	2.47	3.44	1.58
HSD -9	4.57	4.85	5.91	3.23
HSD -10	2.08	2.35	2.95	1.21



SUMMARY

GCXGC ANALYZER

- 1 system, 1 method
 - Simple hardware: Flow Modulation + FID
- Reports all relevant groups including FAMES
- Sample range Jet/Diesel/Biodiesel (450C FBP)
- Standards and Reference Materials
- Robust, comparable and actionable data

GCxGC can be simple and performed in routine.

GCXGC

FUTURE CHALLENGES



- Widen implementation, produce more real sample data in routine use.
- Standardization



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