

Lab Confirmations & Unknown Analysis

2025 ACDC Summit – Understanding the Roles of Lab-Based Analysis – May 29, 2025

Alex J. Krotulski, PhD

Center for Forensic Science Research and Education, Horsham, PA, USA





DRUG CHECKING @ CFSRE

SAMPLE SUBMISSIONS

Collaborators

- ▶ PH, HR, DC programs, etc.
- ▶ Accept “all” sample types***
 - ▶ Drug materials (>10 mg)

Label & Mail-In

- ▶ Samples in proper packaging (e.g., Ziplock, mylar bags)
- ▶ Good labeling (i.e., unique IDs)
- ▶ Shipping via preferred shipper (e.g., FedEx, USPS, UPS, etc.)
 - ▶ Notifications / emails

Laboratory

- ▶ Receipt & Logging
- ▶ Testing & Analysis



TESTING & ANALYSIS

- **Qualitative Testing**

- GC-MS
- LC-QTOF-MS
- DART-QQQ-MS (*evaluation*)

- **Quantitative Testing**

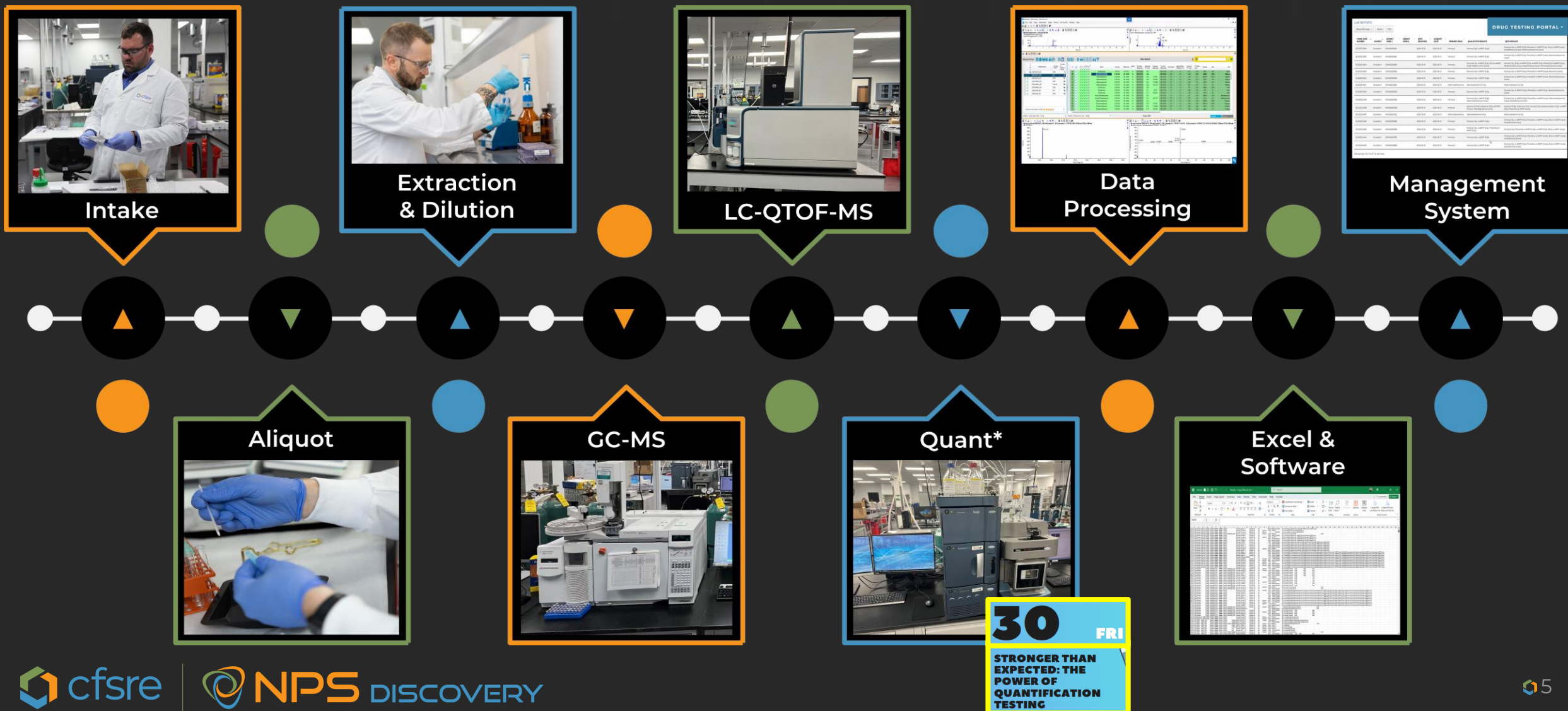
- GC-MS
- LC-QQQ-MS (*validation*)
- DART-QQQ-MS (*evaluation*)

- **Other Testing**

- NMR, FTIR, Test Strips, etc.



TESTING & ANALYSIS



TRACKING & REPORTING – *CURRENT MODEL*

	A	D	H	I	J	L	M	P	Q	R	T	X
	CFSRE Case	QuantMass	Collection Date	Received Date	Aliquotted Date	Package2	PackageColor2	MaterialForm2	MaterialColor2	SuspectedContents2	Results	QuantSummary
3	DC_2024_0017	20.48	12/23/2023	1/3/2024	1/3/2024	NA	NA	TABLET	ORANGE	ADERALL	Methamphetamine (1p)	Methamphetamine (3.1%)
7	DC_2024_0021	5.53	12/23/2023	1/3/2024	1/3/2024	NA	NA	SOLID	WHITE	UNKNOWN	Cocaine (1p)	Cocaine (73.2%)
8	DC_2024_0022	2.09	12/23/2023	1/3/2024	1/3/2024	GLASSINE BAG	BLUE	SOLID	WHITE	DOPE	Fentanyl (1p), Xylazine (4.6p), 4-ANPP (0.5p), Phenethyl-4-ANPP (trace)	Fentanyl (12.5%), Xylazine (68.6%), 4-ANPP (3.8%)
9	DC_2024_0023	2.47	12/23/2023	1/3/2024	1/3/2024	GLASSINE BAG	BLUE	SOLID	WHITE	DOPE	Fentanyl (1p), Xylazine (4.8p), 4-ANPP (0.5p), Phenethyl-4-ANPP (trace)	Fentanyl (14.2%), Xylazine (66.5%), 4-ANPP (4.4%)
10	DC_2024_0024	1.96	12/23/2023	1/3/2024	1/3/2024	GLASSINE BAG	BLUE	SOLID	PINK	DOPE	Fentanyl (1p), Xylazine (27.4p), Lidocaine (2p), 4-ANPP (1.3p), Phenethyl-4-ANPP (trace)	Fentanyl (2.9%), Xylazine (65.2%), 4-ANPP (1.9%), Lidocaine (4.4%)
11	DC_2024_0025	4.29	12/23/2023	1/3/2024	1/3/2024	PLASTIC CONTAINER	ORANGE	SOLID	CLEAR	CRACK	Methamphetamine (1p), Dimethyl sulfone (trace)	Methamphetamine (57.4%)
12	DC_2024_0026	2.2	12/23/2023	1/3/2024	1/3/2024	GLASSINE BAG	BLUE	SOLID	WHITE	DOPE	Fentanyl (1p), Methamphetamine (0.1p), para-Fluorofentanyl (trace), Xylazine (5.6p), 4-ANPP (0.6p), Phenethyl-4-ANPP (trace)	Fentanyl (10.6%), Xylazine (58.9%), para-Fluorofentanyl (0.9%), 4-ANPP (3.8%), Methamphetamine (1.5%)
16	DC_2024_0030	1.79	12/23/2023	1/3/2024	1/3/2024	PLASTIC CONTAINER	GREEN	SOLID	WHITE	CRACK	Cocaine (1p), Lidocaine (1.5p)	Cocaine (33.4%), Lidocaine (49.8%)
17	DC_2024_0031	3.17	12/30/2023	1/3/2024	1/3/2024	PLASTIC BAG	NA	SOLID	CLEAR	UNKNOWN	Methamphetamine (1p)	Methamphetamine (61.7%)
18	DC_2024_0032	2.21	12/30/2023	1/3/2024	1/3/2024	PLASTIC BAG	NA	SOLID	WHITE	COCAINE	Cocaine (1p)	Cocaine (76%)
22	DC_2024_0041	6.09	12/2/2023	12/22/2023	1/23/2024	GLASSINE BAG	NA	SOLID	WHITE	DOPE	Cocaine (1p), Fentanyl (0.1p), Xylazine (0.4p), 4-ANPP (trace), Norcocaine (trace)	Fentanyl (5%), Xylazine (25.6%), 4-ANPP (1.6%), Cocaine (41.4%)
23	DC_2024_0042	2.6	12/2/2023	12/22/2023	1/23/2024	GLASSINE BAG	NA	SOLID	WHITE	DOPE	Fentanyl (1p), Xylazine (4.7p), 4-ANPP (0.4p)	Fentanyl (12.9%), Xylazine (71.7%), 4-ANPP (4.1%)
25	DC_2024_0044	5.03	12/2/2023	12/22/2023	1/23/2024	GLASSINE BAG	NA	SOLID	WHITE	DOPE	Fentanyl (1p), Xylazine (3.4p), 4-ANPP (0.4p), Caffeine (trace)	Fentanyl (14.4%), Xylazine (68.1%), 4-ANPP (3.7%), Caffeine (0.3%)
26	DC_2024_0045	2.74	12/2/2023	12/22/2023	1/23/2024	GLASSINE BAG	NA	SOLID	WHITE	DOPE	Fentanyl (1p), Methamphetamine (0.1p), Xylazine (4.6p), 4-ANPP (0.2p), Ethyl-4-ANPP (trace), Phenethyl-4-ANPP (trace), Diphenhydramine (trace)	Fentanyl (9.6%), Xylazine (71.1%), 4-ANPP (1.8%), Methamphetamine (0.7%)
27	DC_2024_0046	4.09	12/2/2023	12/22/2023	1/23/2024	GLASSINE BAG	NA	SOLID	WHITE	DOPE	Cocaine (1p), Fentanyl (0.3p), Xylazine (1.6p), 4-ANPP (0.1p)	Fentanyl (8.6%), Xylazine (43.1%), 4-ANPP (2.7%), Cocaine (23.8%)
28	DC_2024_0047	3.07	12/2/2023	12/22/2023	1/23/2024	GLASSINE BAG	NA	SOLID	WHITE	DOPE	Fentanyl (1p), Xylazine (4.3p), 4-ANPP (0.4p)	Fentanyl (12.5%), Xylazine (69%), 4-ANPP (4.1%)
29	DC_2024_0048	4.73	12/7/2023	12/22/2023	1/23/2024	GLASSINE BAG	NA	SOLID	WHITE	DOPE	Fentanyl (1p), Acetyl fentanyl (trace), Xylazine (1.7p), 4-ANPP (0.3p), Phenethyl-4-ANPP (trace)	Fentanyl (24.3%), Xylazine (43.9%), 4-ANPP (5.3%)
30	DC_2024_0049	3.37	12/7/2023	12/22/2023	1/23/2024	PLASTIC CONTAINER	GREEN	SOLID	WHITE	COCAINE	Cocaine (1p), Lidocaine (0.6p), Dimethyl sulfone (trace)	Cocaine (33.4%), Lidocaine (32%)
31	DC_2024_0050	10.15	12/7/2023	12/22/2023	1/23/2024	PLASTIC CONTAINER	RED	SOLID	WHITE	CRACK	Cocaine (1p)	Cocaine (50.7%)
33	DC_2024_0052	3.71	12/16/2023	12/22/2023	1/23/2024	GLASSINE BAG	NA	SOLID	WHITE	DOPE	Fentanyl (1p), Cocaine (0.4p), Heroin (trace), Xylazine (4.8p), 4-ANPP (0.2p), Levamisole (trace), 6-Monoacetylmorphine (trace)	Fentanyl (8%), Xylazine (62.3%), 4-ANPP (1.2%), Cocaine (2.3%)
34	DC_2024_0053	2.43	12/16/2023	12/22/2023	1/23/2024	GLASSINE BAG	NA	SOLID	WHITE	DOPE	Fentanyl (1p), Methamphetamine (0.1p), para-Fluorofentanyl (trace), Xylazine (4.9p), 4-ANPP (0.5p), Phenethyl-4-ANPP (trace)	Fentanyl (8.3%), Xylazine (66.5%), para-Fluorofentanyl (0.3%), 4-ANPP (3.4%), Methamphetamine (0.8%)
35	DC_2024_0054	2.45	11/27/2023	12/22/2023	1/23/2024	GLASSINE BAG	NA	SOLID	WHITE	DOPE	Fentanyl (1p), Xylazine (3.4p), 4-ANPP (0.6p), Phenethyl-4-ANPP (trace)	Fentanyl (13.3%), Xylazine (69.6%), 4-ANPP (6%)
41	DC_2024_0133	6.62	1/24/2024	2/7/2024	2/7/2024	PLASTIC CONTAINER	PURPLE	SOLID	WHITE	CRACK	Cocaine (1p)	Cocaine (60.1%)
42	DC_2024_0134	1.87	1/24/2024	2/7/2024	2/7/2024	GLASS VIAL	PINK	SOLID	WHITE	CRACK	Cocaine (1p)	Cocaine (60.4%)
43	DC_2024_0135	4.11	1/24/2024	2/7/2024	2/7/2024	PLASTIC BAG	YELLOW	SOLID	WHITE	COCAINE	Cocaine (1p), Lidocaine (0.9p)	Cocaine (30.9%), Lidocaine (35.2%)
44	DC_2024_0136	2	1/24/2024	2/7/2024	2/7/2024	GLASSINE BAG	NA	SOLID	WHITE	DOPE	Fentanyl (1p), Xylazine (12.3p), 4-ANPP (0.1p), Ethyl-4-ANPP (trace)	Fentanyl (4.2%), Xylazine (76.4%), 4-ANPP (0.5%)

TRACKING & REPORTING – **COMING SOON!**

DRUG TESTING PORTAL ▾

Drug Testing Work in Progress

Workflow Procedure

Number of Cases

Drug Testing Lab Reports

Filters:

Summary Report ▾

All Test Results ▾

Pennsylvania Groundhogs ▾

04/22/2025

05/22/2025

SUBMIT

LAB REPORTS

Show 50 rows ▾

Excel

CSV

Search:

CFSRE CASE NUMBER	AGENCY	AGENCY CODE 1	AGENCY CODE 2	DATE RECEIVED	ALIQOT DATE	PRIMARY DRUG	QUALITATIVE RESULTS	QTOF RESULTS	QUANTITATIVE RESULTS	LAST REPORT DATE
DC2025-5488				2025-05-15	2025-05-15	2C-B	2C-B (1p)	2C-B (1p)		2025-05-21
DC2025-5489				2025-05-15	2025-05-15	Cocaine	Cocaine (1p)	Cocaine (1p), Norcocaine (trace)		2025-05-21
DC2025-5485				2025-05-15	2025-05-15	Heroin	Heroin (1p), Noscapine (0.9p), 6-Monoacetylmorphine (0.3p), Papaverine (0.1p), Caffeine (0.1p), Acetylcodeine (0.1p), Dextromethorphan (trace)	Noscapine (4.5p), Heroin (1p), 6-Monoacetylmorphine (0.3p), Papaverine (0.3p), Acetylcodeine (0.1p), Dextromethorphan (0.1p), Caffeine (trace)		2025-05-21
DC2025-5484				2025-05-15	2025-05-15	Heroin	Heroin (1p), 6-Monoacetylmorphine (0.3p), Acetylcodeine (0.1p), 3-Monoacetylmorphine (trace)	Heroin (1p), 6-Monoacetylmorphine (0.1p), Papaverine (trace), Acetylcodeine (trace)		2025-05-21
DC2025-5487				2025-05-15	2025-05-15	Methamphetamine	Methamphetamine (1p)	Methamphetamine (1p)		2025-05-21

INTERESTED IN SENDING IN SAMPLES?

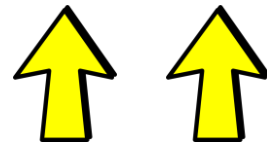
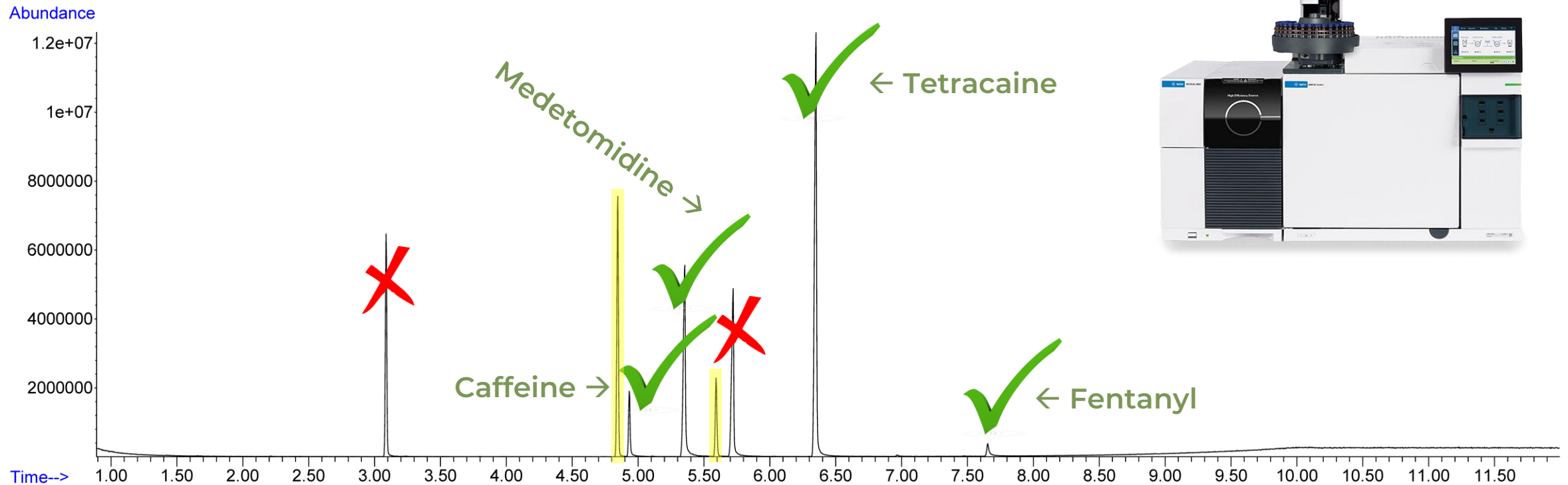
- **Email Us:** Alex Krotulski (alex.krotulski@cfsre.org) & Josh DeBord (joshua.debord@cfsre.org)





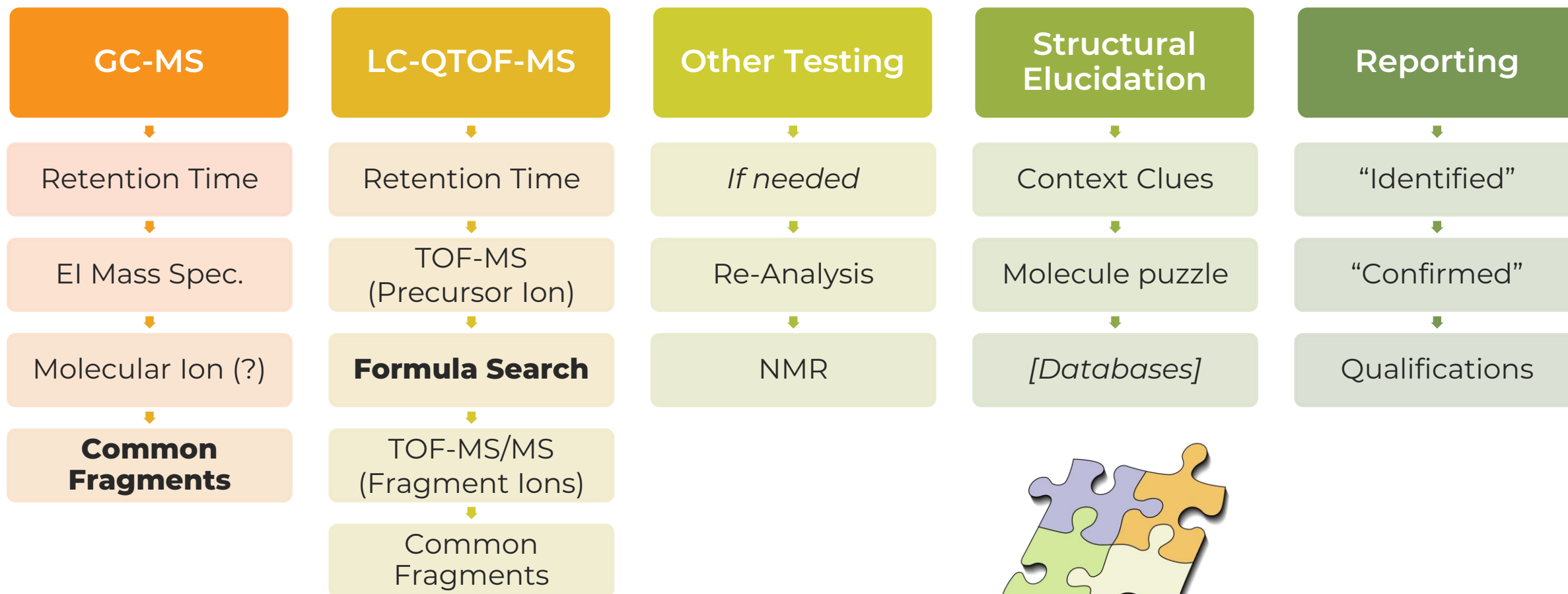
UNKNOWN ANALYSIS

UNKNOWN ANALYSIS

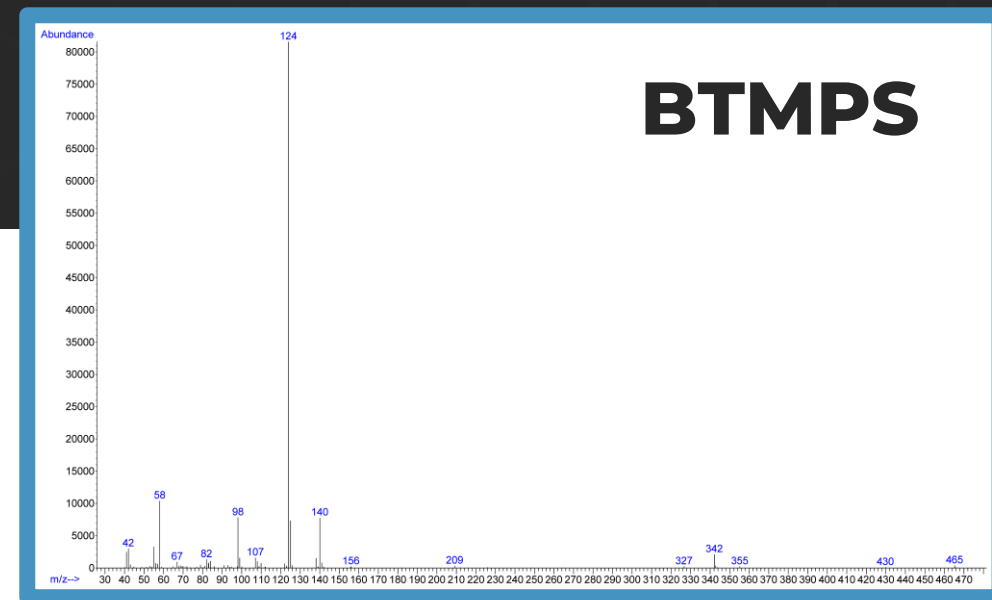
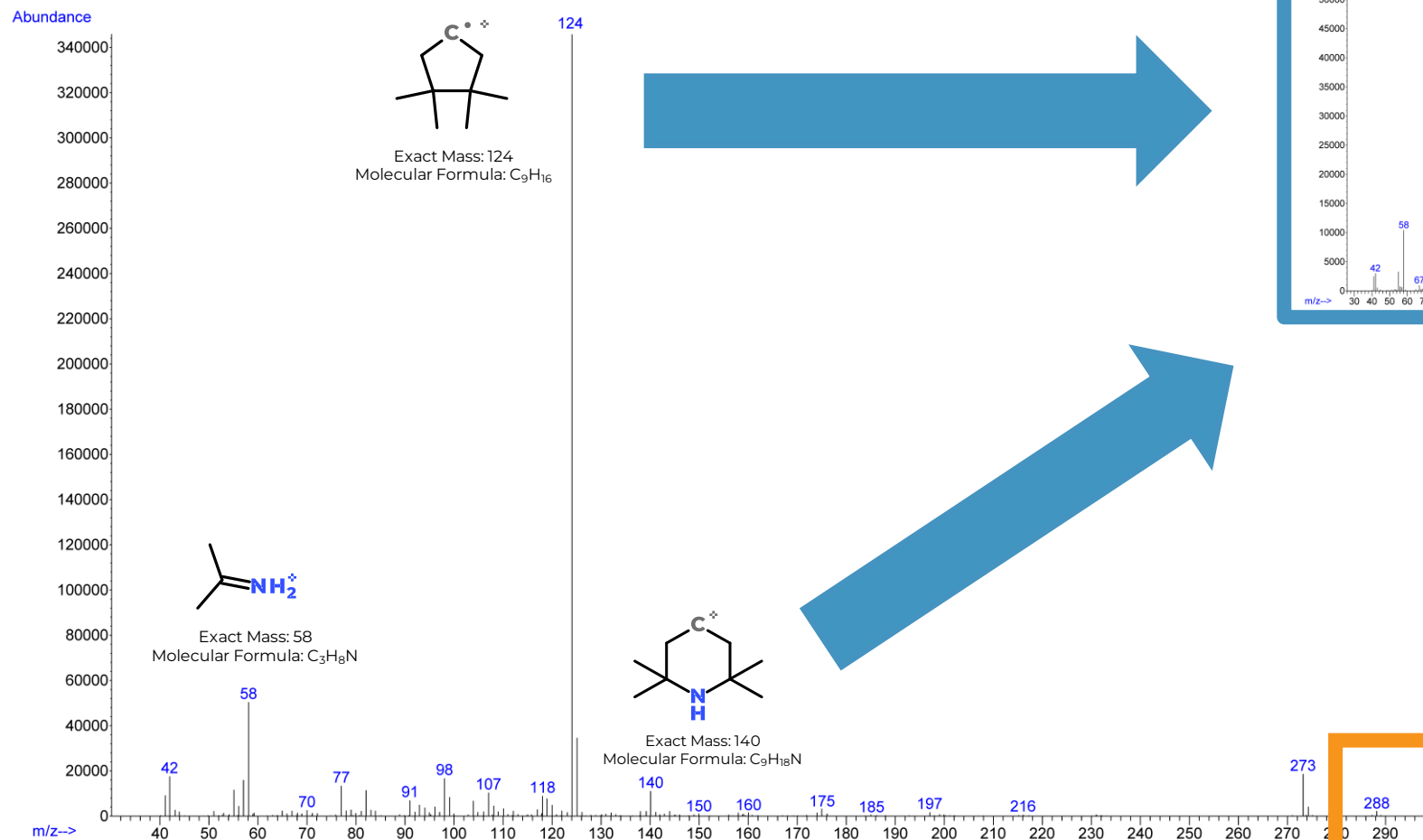


Unknowns

UNKNOWN ANALYSIS



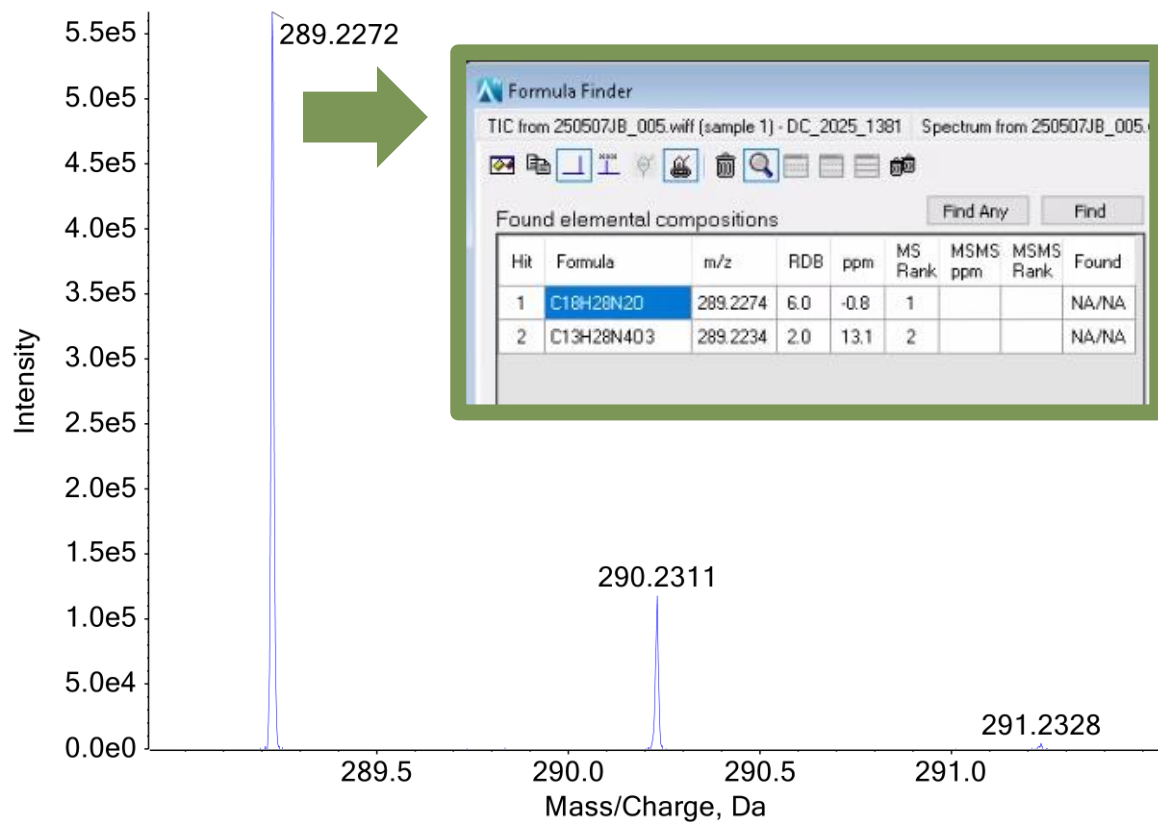
GC-MS DATA



Molecular Ion

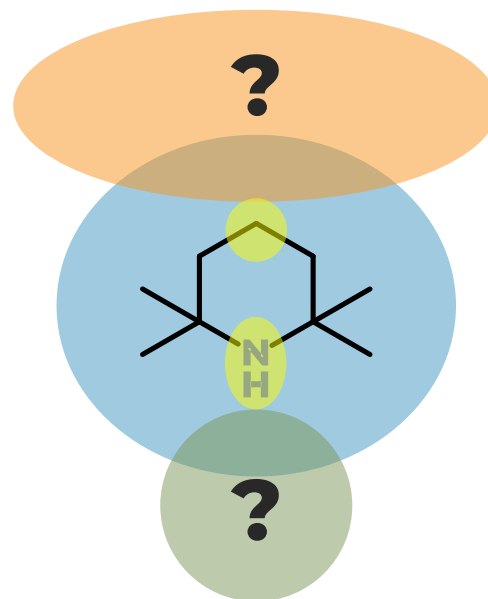
LC-QTOF-MS DATA

TOF-MS Data (Intake Molecule)



Putting the Puzzle Together

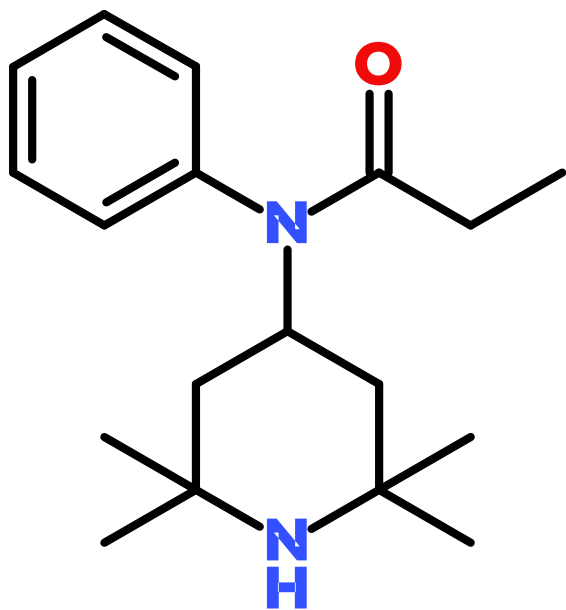
- Full Molecule: C18H28N2O
- TM-Piperidine Ring: C9H17N (+2H)
- Difference: C9H11NO



Google search results for C9H11NO. The search results show various chemical structures and names, including N ethyl benzamide, Ethylbenzamide, Nmr, Phenylalaninal, 4-Dimethylaminobenzaldehyde, and C9H11NO isomers.

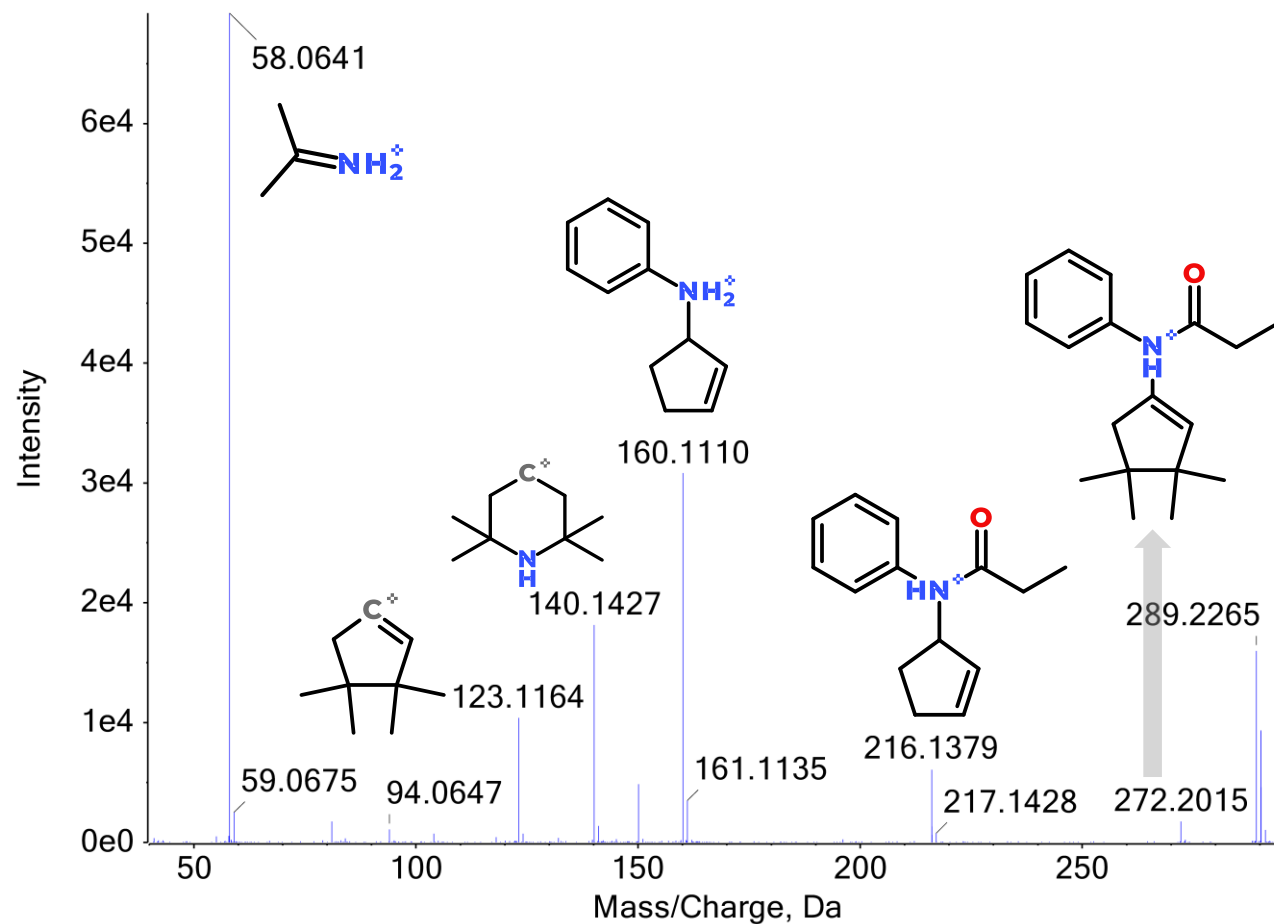
LC-QTOF-MS DATA

Suspected Structure



Tetramethylnorfentanyl

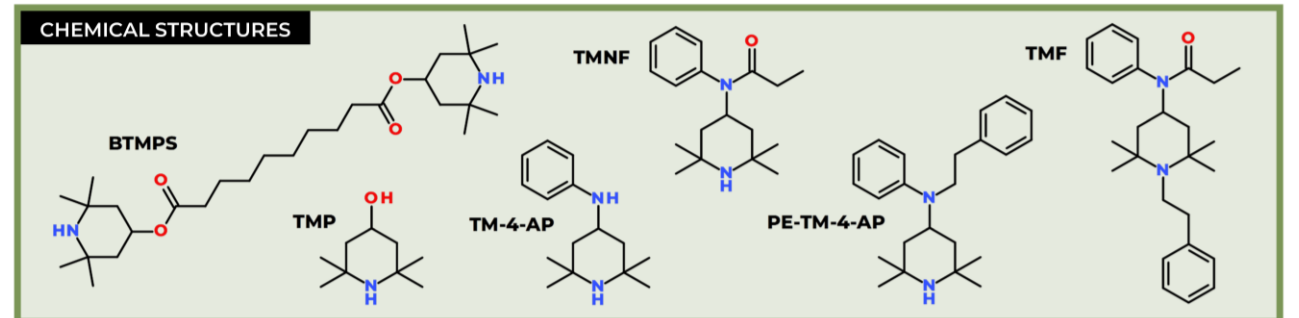
TOF-MS/MS (Fragment Ions)



BTMPS & TMS-RELATED SUBSTANCES

- Several unknown substances related to BTMPS and fentanyl →
- Began appearing in late 2024
- We can go back and update prior “unknown substance” results
- What’s next? I don’t know...

SUBSTANCE	FORMULA	MOLECULAR ION [M+]	EXACT MASS [M+H] ⁺	GC-MS FRAGMENT IONS
BTMPS	C ₂₈ H ₅₂ N ₂ O ₄	480	481.4000 [2+: 241.2036]	342, 140, 124*, 98, 58
Tetramethyl-4-Piperidinol (TMP)	C ₉ H ₁₉ NO	157	158.1539	142*, 124, 98, 86, 58
Tetramethyl-4-AP (TM-4-AP)	C ₁₅ H ₂₄ N ₂	232	233.2012	217, 175, 160, 140, 124, 98*, 77, 58
Tetramethylnorfentanyl (TMNF)	C ₁₈ H ₂₈ N ₂ O	288	289.2274	273, 140, 124*, 98, 77, 58
N-Phenethyl Tetramethyl-4-AP (PE-TM-4-AP)	C ₂₃ H ₃₂ N ₂	336	337.2638	245, 140*, 115, 98, 77, 58
2,2,6,6-Tetramethylfentanyl (TMF)	C ₂₆ H ₃₆ N ₂ O	392	393.2900	301, 160, 105, 70 <small>[Pending confirmation by standard]</small>



#	DATE	REGION	BTMPS	TMP	TM-4-AP	TMNF	PE-TM-4-AP	TMF	OTHER NOTABLE SUBSTANCES
1	Aug. 2024	East	X	X					Fentanyl, Tetracline, Medetomidine
2	Aug. 2024	Midwest	X	X					Fentanyl
3	Oct. 2024	East	X	X	X	X	X		Heroin, Cocaine
4	Dec. 2024	East	X	X					Fentanyl, Xylazine, Lidocaine
5	Dec. 2024	West	X	X					Fentanyl, pFF
6	Dec. 2024	Southwest	X			X			Fentanyl, Lidocaine
7	Jan. 2025	East		X	X	X	X		N/A
8	Jan. 2025	Midwest	X	X	X	X	X		Fentanyl, Lidocaine
9	Feb. 2025	East		X					N/A
10	Mar. 2025	Southwest	X		X	X	X	X	Fentanyl, Lidocaine
11	Apr. 2025	East		X	X	X			Fentanyl, Lidocaine
12	Apr. 2025	East	X		X	X			Fentanyl, Lidocaine
13	Apr. 2025	East	X		X	X			Fentanyl, Xylazine, Lidocaine
14	Apr. 2025	West			X	X			Fentanyl, Lidocaine
15	May 2025	East	X	X					Fentanyl, pFF, Xylazine, Lidocaine
16	May 2025	East	X		X	X	X	X	Fentanyl, Carfentanil, Lidocaine
17	May 2025	East			X	X			Fentanyl, Tetracline, Medetomidine

ACKNOWLEDGEMENTS

- **CFSRE's Drug Checking Team & Staff**

- Josh DeBord, Max Denn, Alexis Quinter, Angel McDowell, John Beer, & Many More

- **Collaborators & Partners**





THANK YOU! QUESTIONS?

Alex J. Krotulski, Ph.D.

Director – Toxicology & Chemistry – CFSRE

Program Manager – NPS Discovery

alex.krotulski@cfsre.org

