

Swedish multiresidue method SweEt goes into Orbitrap technology

Susanne Ekroth



**“Nothing is more simple
than greatness; indeed,
to be simple is to be great.”**



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National Food Agency

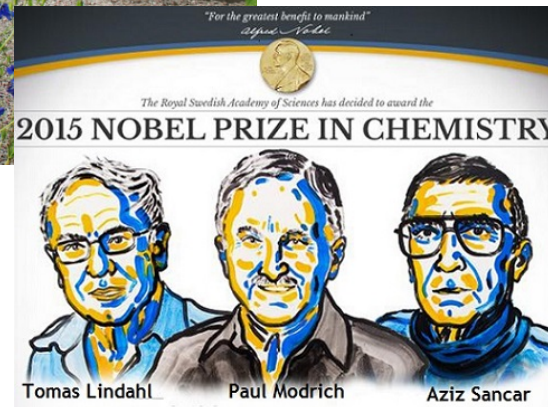
Outline

- Introduction, Uppsala and NFA
- Objectives
- Comparisons to LC-MS/MS and TOF
- Examples and Results
- Future plans
- Conclusions, Pros and Cons

Uppsala



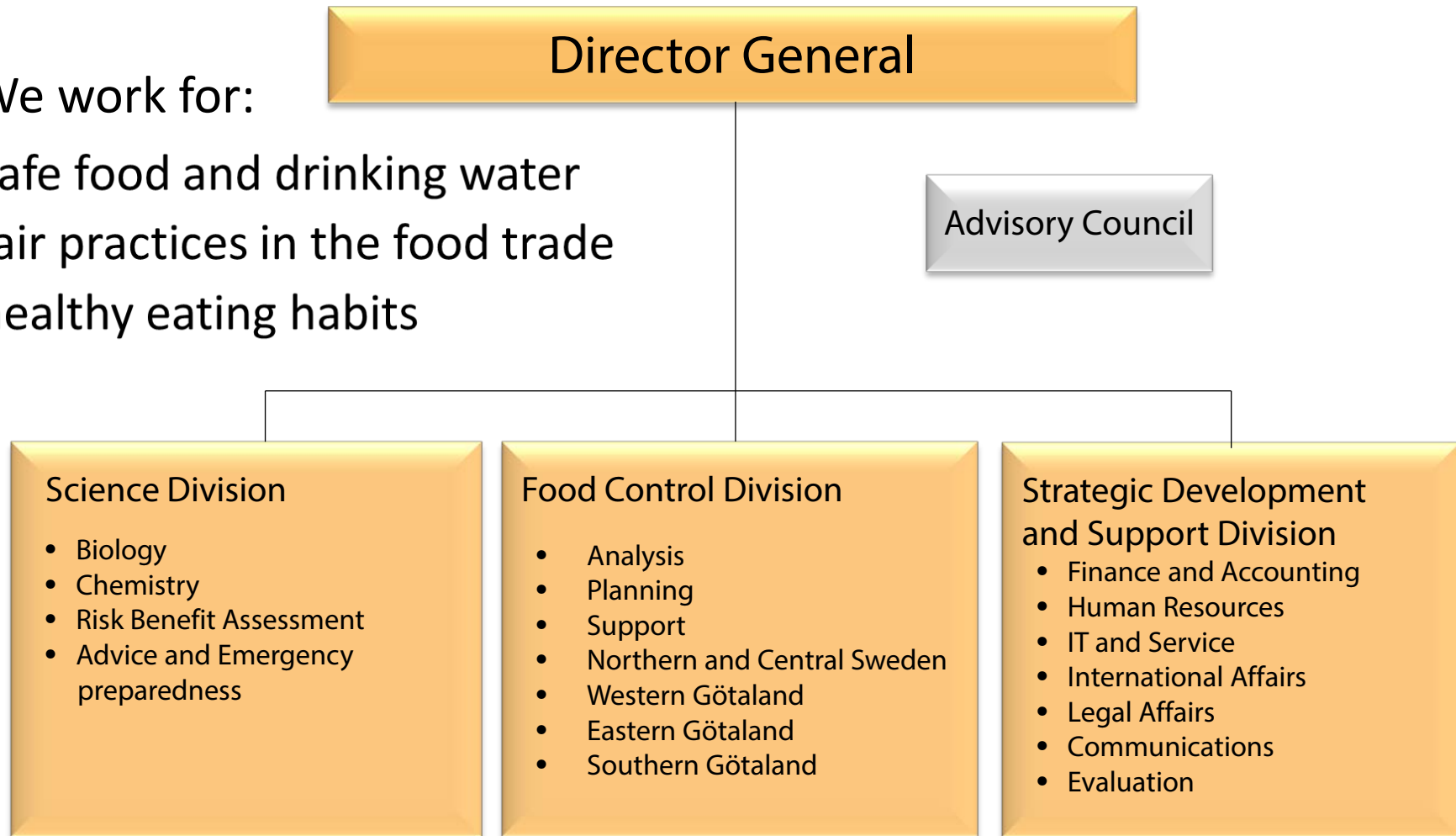
Carl von Linné



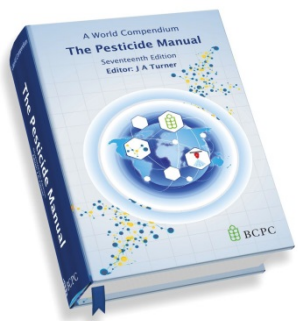
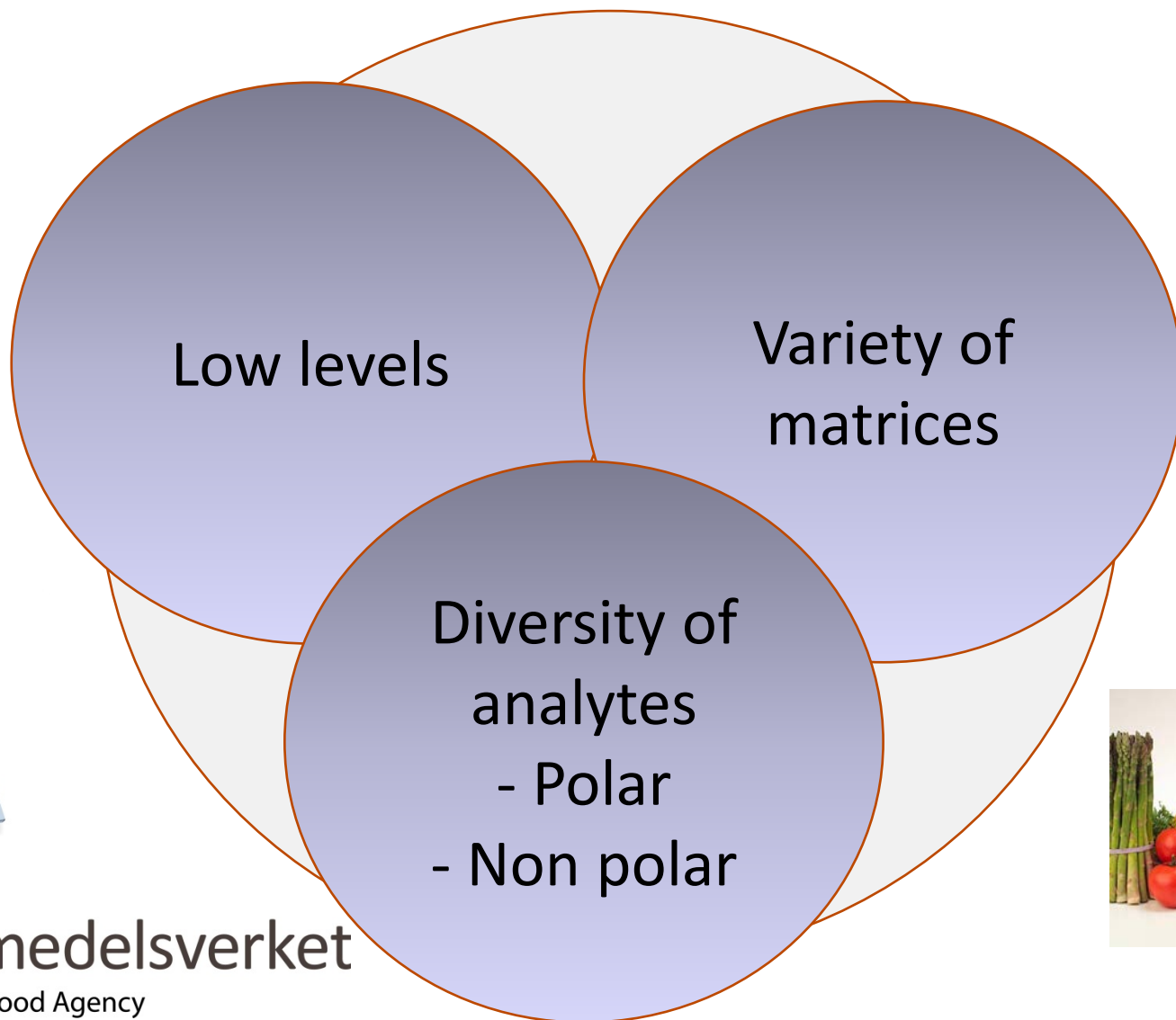
The National Food Agency

We work for:

- safe food and drinking water
- fair practices in the food trade
- healthy eating habits



Challenges working with pesticides




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Validation and Control procedures for Pesticide laboratories



Search:

EURL EU Reference Laboratories for Residues of Pesticides

You are here: Home

EURL Portal

EURL for Fruits and Vegetables

EURL for Cereals and Feeding Stuff

EURL for Food of Animal Origin

EURL for Single Residue Methods

Topics

General Info
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[About EURLs](#)
[RASFF](#)
[Control Programs](#)

AQC Procedures
[AQC Documents](#)
[AQC Panel](#)

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[EURL-FV-SM08](#)
[EURL-CF10](#)
[EURL-AO11](#)
[EURL-SRM11](#)

Workshops
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Method Validation & Quality Control Procedures for Pesticide Residues Analysis in Food & Feed

This guidance document describes the **method validation and analytical quality control requirements** to support the validity of data used for checking compliance with maximum residue limits, enforcement actions, or assessment of consumer exposure to pesticides in the EU.

Method Validation and Quality Control Procedures for Pesticide Residues Analysis in Food and Feed:

NEW UPDATE (14.12.2015):
Document No. **SANTE 11945/2015** (Implemented by 01.01.2016)

If you have **questions to this guidance document**, please use the Guideline Help to submit your question electronically to the QC Panel:

- Link to [Guideline Help](#).

Older versions of the AQC Procedures:

- Document No. **SANCO/12571/2013**
- Document No. **SANCO/12495/2011**

Quicklinks

[EURL-DataPool](#)
[EURL-DataPool \(NEW\)](#)
[EU-MRLs Database \(COM\)](#)
[EU-Legisl. on MRLs \(COM\)](#)
[EU-Legisl. on PPPs \(COM\)](#)
[RASFF Portal DB \(COM\)](#)
[CIRCA BC Login](#)
[How to Use CIRCA BC](#)

Pinboard

[Food of Animal Origin: Reporting Residues of Pesticides, Presentation from EPRW 2016 added!](#)

[EURL AO 10 - Final Report available](#)

[Observations Report on BNPU \(IS for acids\)](#)

SweEt

FV + Honey

448

Extraction

10 g sample
20 ml EtOAc+NaHCO₃
3 min Spex shaker
Na₂SO₄

Centrifugation

Filtration

GC-MS/MS

UPLC-
MS/MS
+
HRMS

Cereals

323

Extraction

5 g sample
10 ml water
10 ml EtOAc (1% HAc)
3 min Spex shaker
Na₂SO₄

Centrifugation

Filtration

GC-MS/MS

UPLC-
MS/MS

AO < 10% fat

96

Extraction

5 g sample
PSA + C18
10 ml EtOAc
3 min Spex shaker
Na₂SO₄

Centrifugation

Filtration

GC-MS/MS

UPLC-
MS/MS

AO > 10% fat

76

Fat determination

Extraction

0.5 g fat
10 ml EtOAc:CH (1+1)
3 min Spex shaker
Na₂SO₄

Centrifugation

Filtration

GPC SX-3
(1+1 EtOAc/CH)

Evaporation

Reconstitution in EtOAc

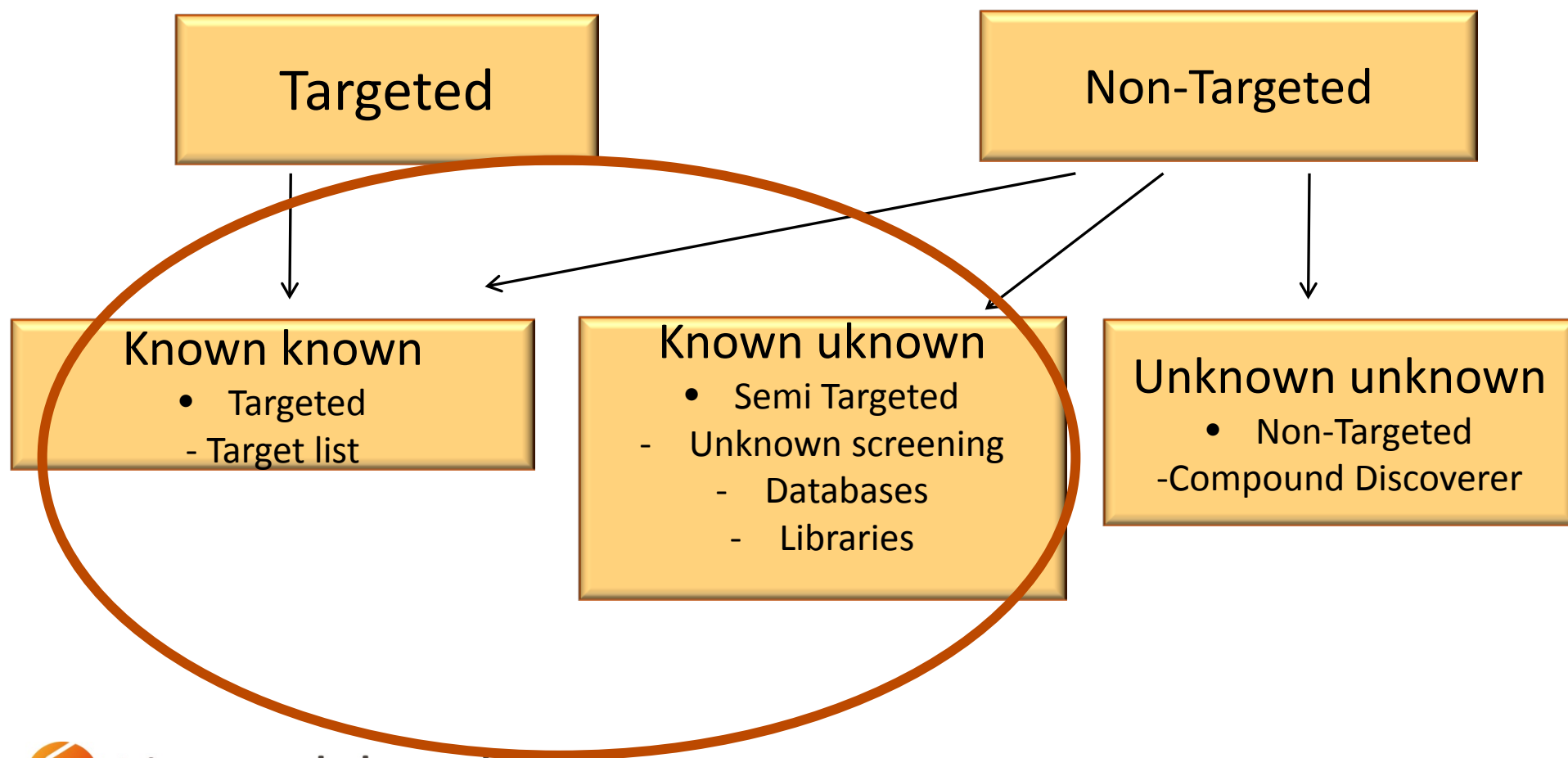
GC-MS/MS

UPLC-
MS/MS

SweEt - Workflow



Workflow for Targeted and Non-Targeted Analyses



Verification of Q Exactive Focus Orbitrap



Linearity



Robustness



Detectability

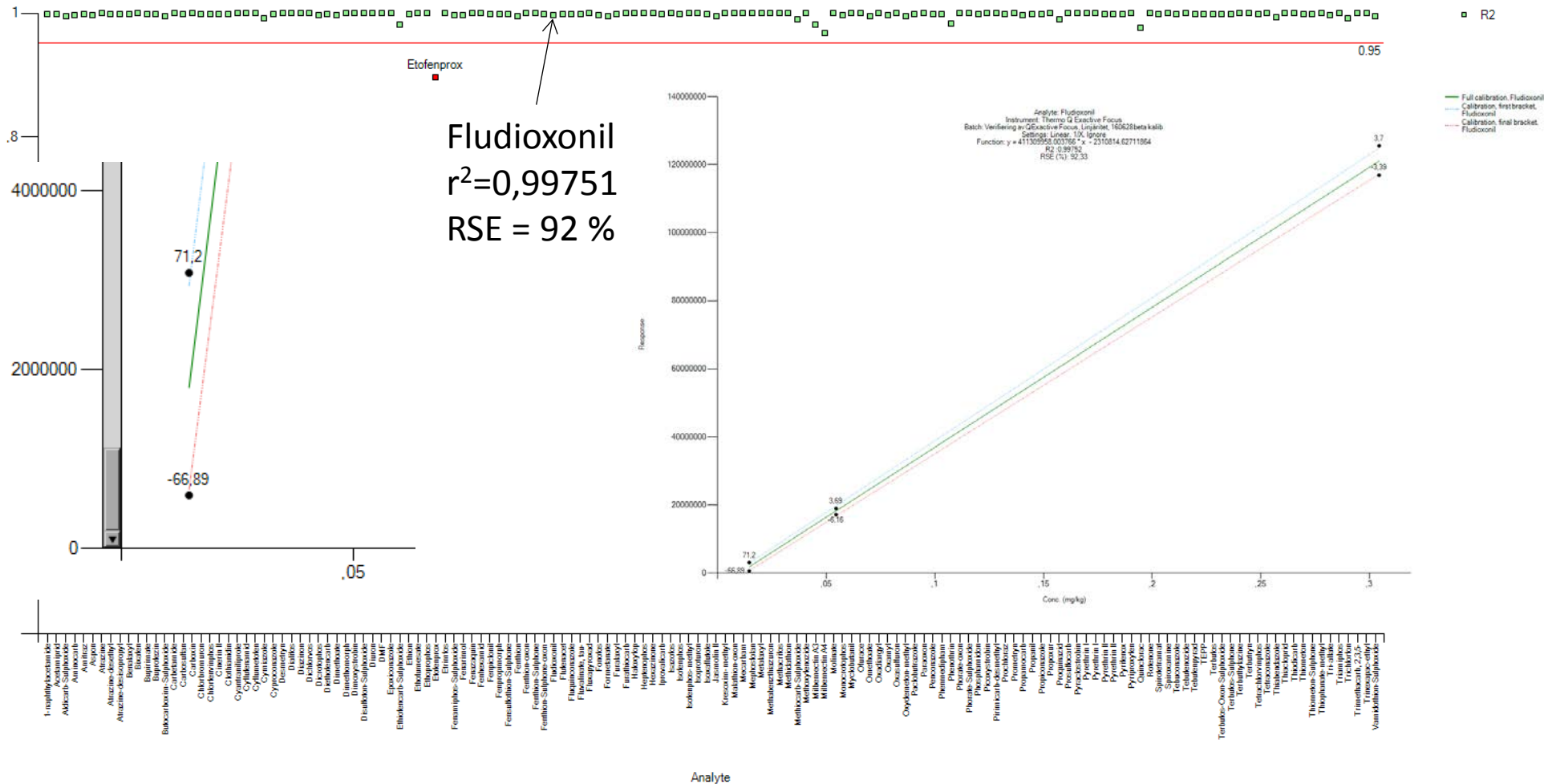


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Linearity – correlation or residuals?

Coefficient of determination (R²) for analytes in batch: Verifiering av QExactive Focus, Linjäritet, 160628 beta kalib
Instrument: Thermo Q Exactive Focus
Regression type: Linear
Weighting: 1/X
Origin: Ignore



Linearity according to SANTE doc

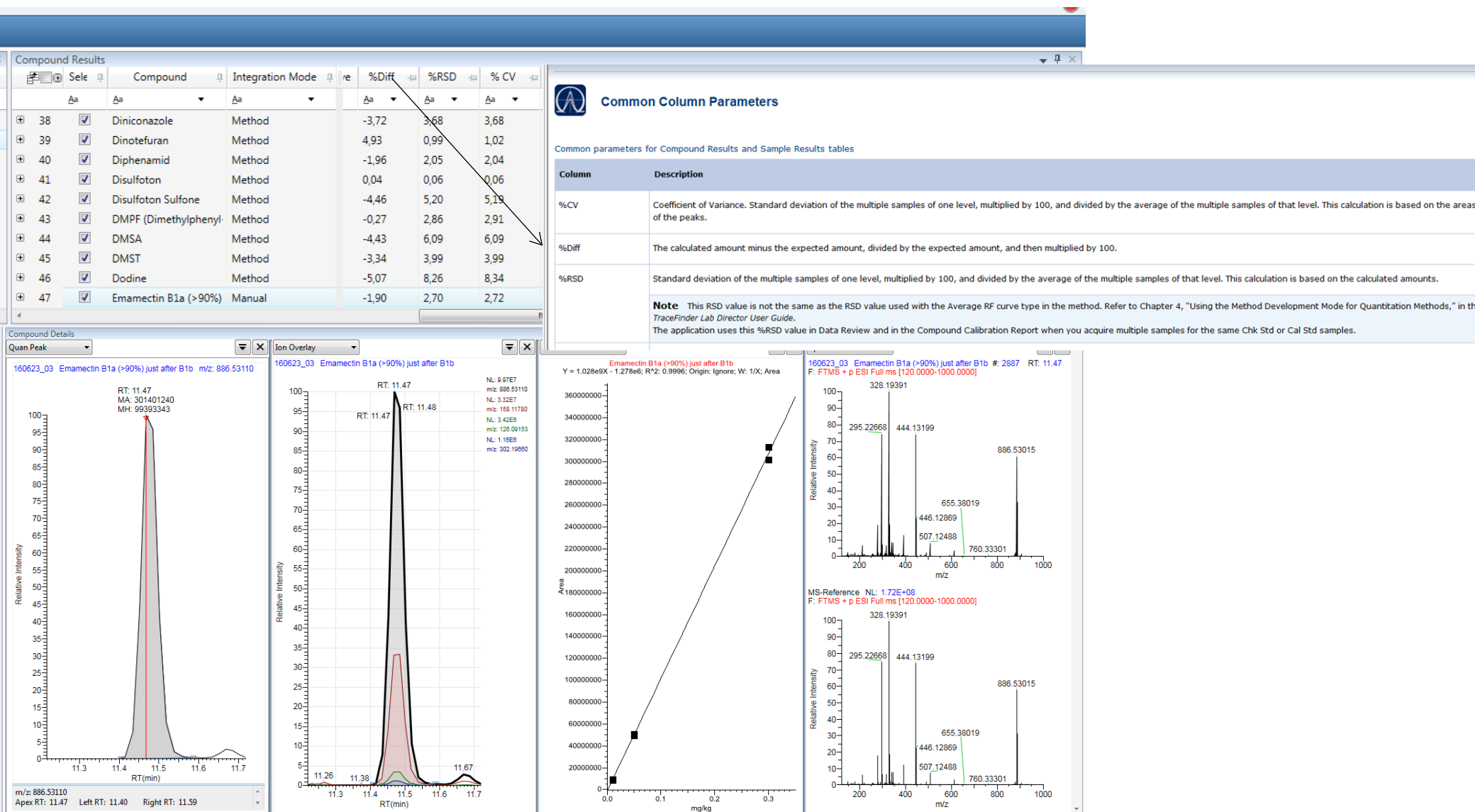
C17 Multi-level calibration (three or more concentrations) is preferred. An appropriate calibration function must be used and the calibration curve should not be forced through the origin without justification. The fit of the calibration function must be plotted and inspected visually and/or by calculation of the residuals, avoiding over-reliance on correlation coefficients, to ensure that the fit is satisfactory within the concentration range of the pesticides detected. If individual residuals deviate by more than $\pm 20\%$ from the calibration curve in the relevant region, an alternative calibration function must be used. In general, the use of weighted linear regression ($1/x$) is recommended, rather than linear regression.



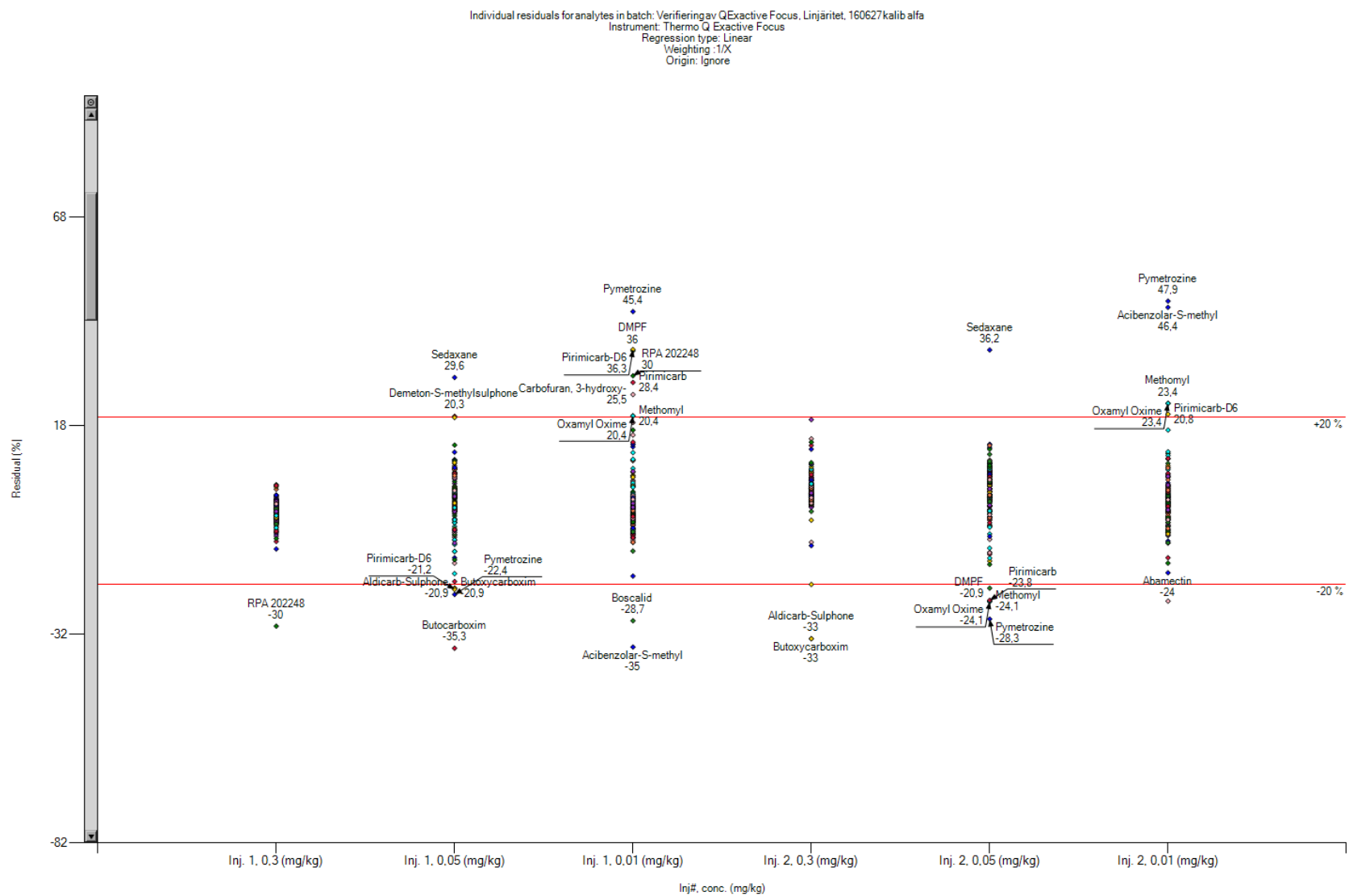
Livsmedelsverket

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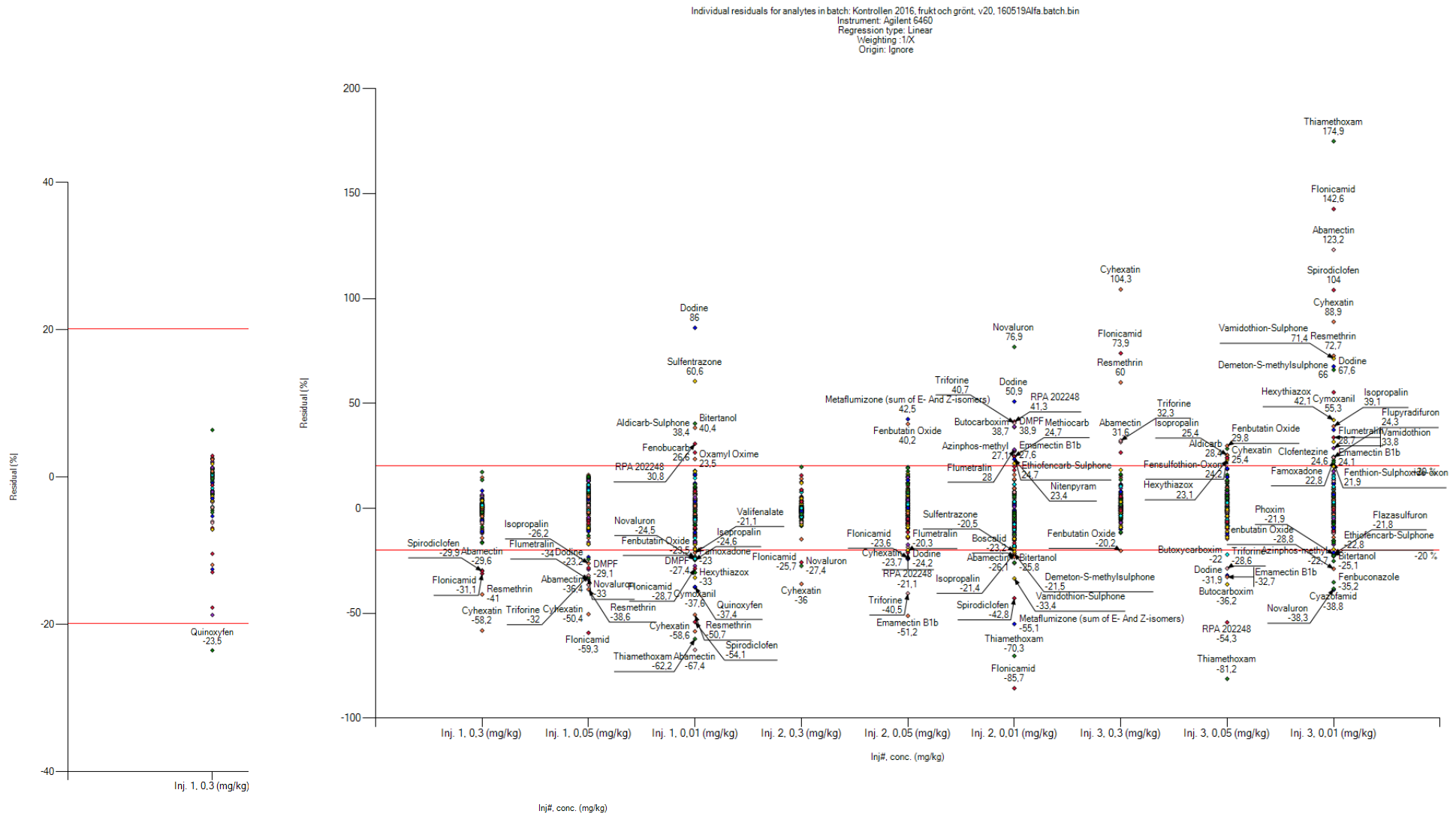
Quantitative View – with residuals



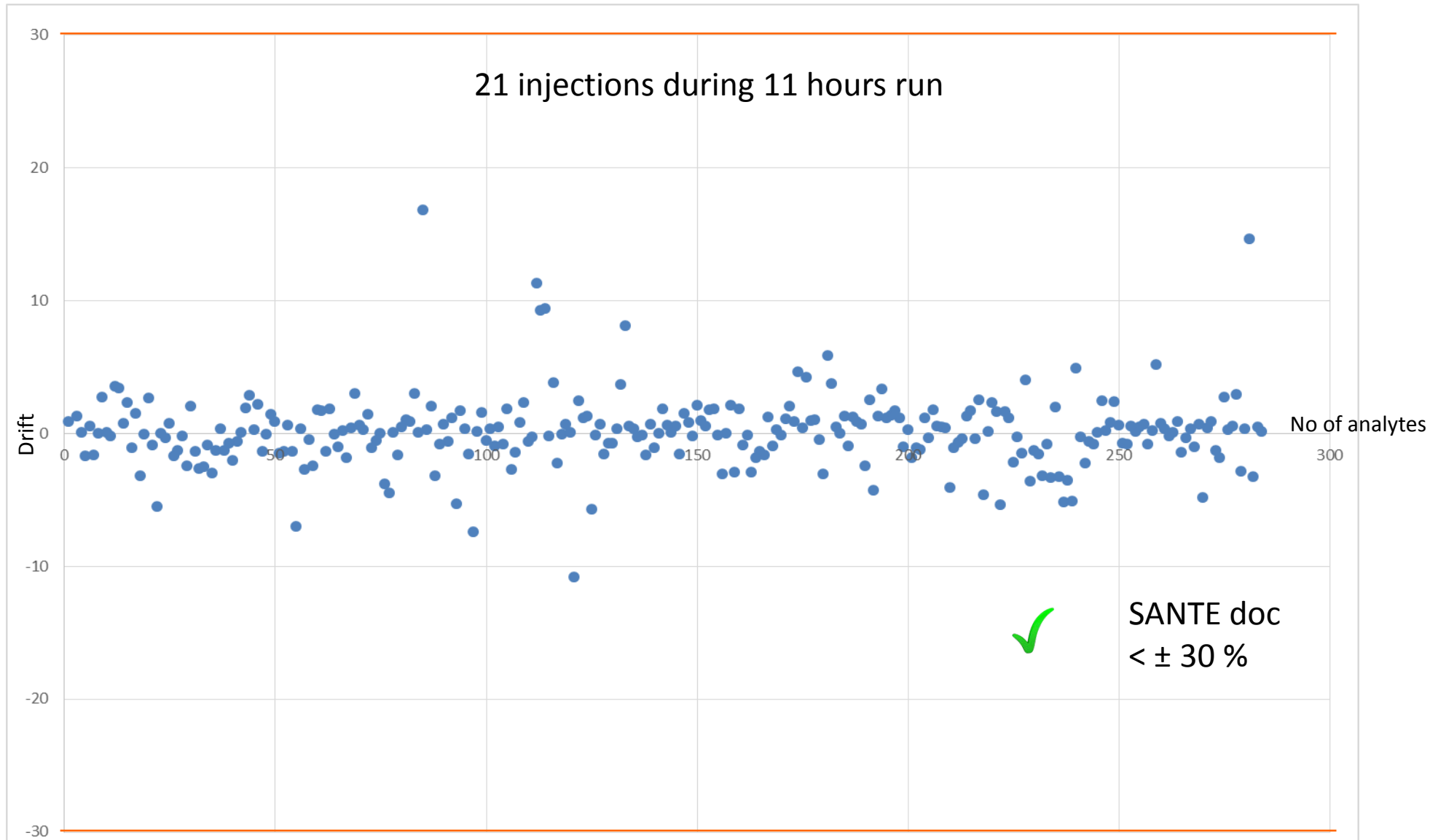
Residuals with Q Exactive Focus Orbitrap



Residuals with current LC-MS/MS system



Robustness of the system



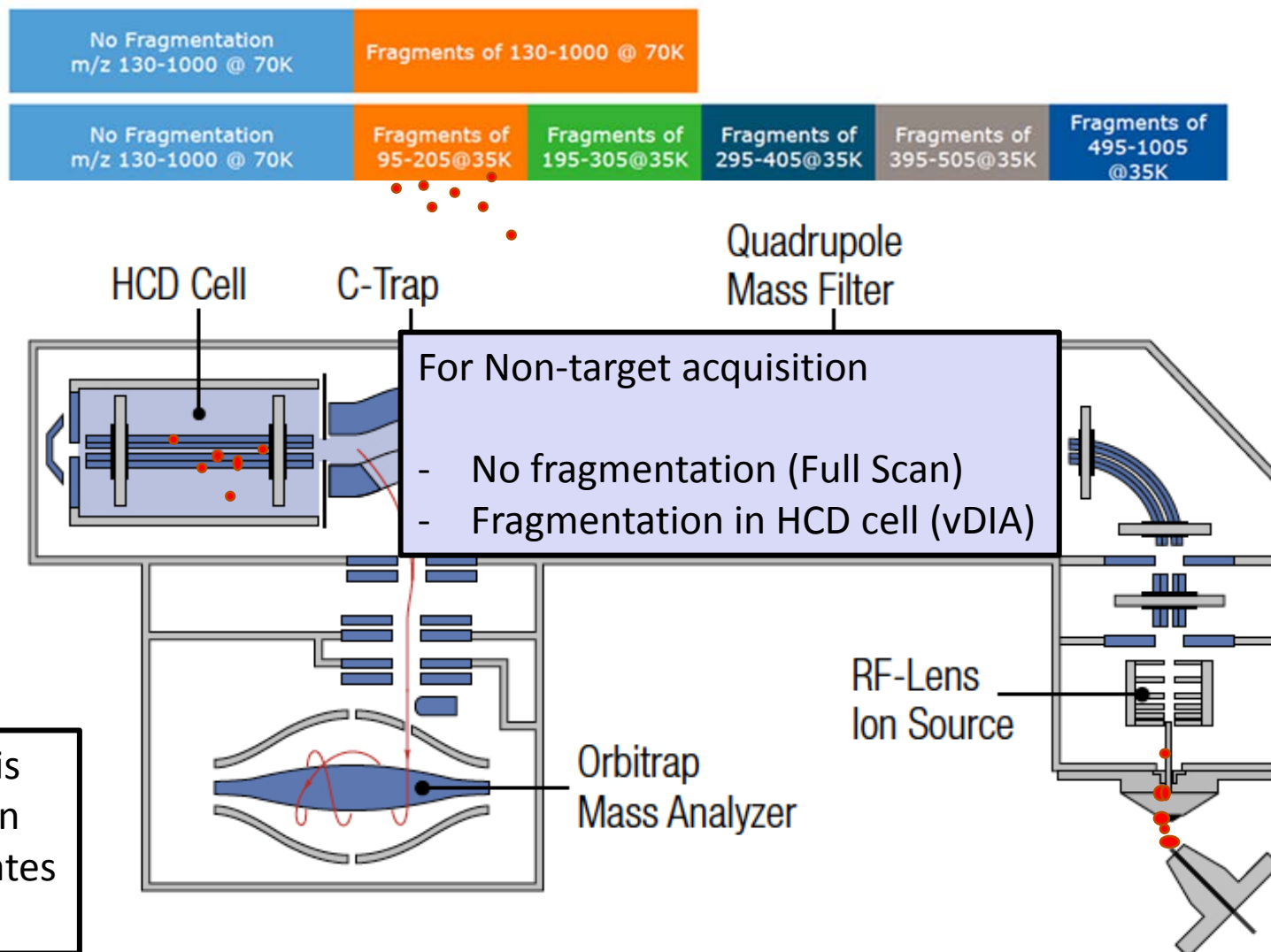
Detectability

EUPT-CF10 2016 wheat calculated with carrot

Pesticide	Assign value mg/kg	LC-MS/MS	Orbitrap
		Reported amount Wheat calib mg/kg (z-score)	Calculated amount Carrot calib mg/kg (z-score)
Azoxystrobin	0.088	0.073 (-0.7)	0.069 (-0.8)
Bixafer	0.074	0.059 (-0.8)	0.072 (-0.1)
Buprofezin	0.048	0.051 (0.2)	0.052 (-0.3)
Tebuconazole	0.091	0.080 (-0.5)	0.076 (-0.6)
Epoxiconazole	0.177	0.174 (-0.1)	0.154 (-0.5)
Pirimicarb-desmethyl	0.048	0.055 (0.6)	0.047 (-0.1)
Pyraclostrobin	0.098	0.081 (-0.7)	0.077 (-0.8)
Tetramethrin	0.096	0.102 (0.3)	0.094(-0.1)
Isocarbophos	0.048	0.057 (0.7)	0.042 (0.6)
Fluopyram	0.250	0.269 (0.3)	0.223 (-0.4)
Prothioconazole-desthio	0.149	0.149 (0)	0.130 (0.6)



Full scan combined with vDIA acquisition



Properties

Properties

Properties of the method

Global Settings

User Role: Advanced

Use lock mass: best

Lock mass inject: —

Chem. peak list: —

User Role
Select the current user role

Properties of Full MS - vDIA

General

Polarity: positive

In-source CID: —

Full MS

Resolution: 70,000

Scan range: 120 to 1000 m/z

AGC target: 1e6

Maximum IT: auto

Microscans: 1

Spectrum data t Profile

variable DIA

Resolution: 17,500

vDIA segmen: 5

vDIA isolation r: 95 to 205 m/z

vDIA isolation r: 195 to 305 m/z

vDIA isolation r: 295 to 405 m/z

vDIA isolation r: 395 to 505 m/z

vDIA isolation r: 495 to 1000 m/z

(N)CE / stepped ce: 30, 80

Fixed first mass: —

AGC target: 3e6

Maximum IT: 200 ms

Microscans: 1

Spectrum data t Profile

Polarity
Use this list box to toggle between positive ion and negative ion polarity.

Global Lists

Tune Files

C:\Thermo\Instruments\Service\Install 25NOV2015\Test-300ulmin.mstune

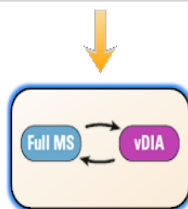
External Hardware

Chromatogram

Experiments

General

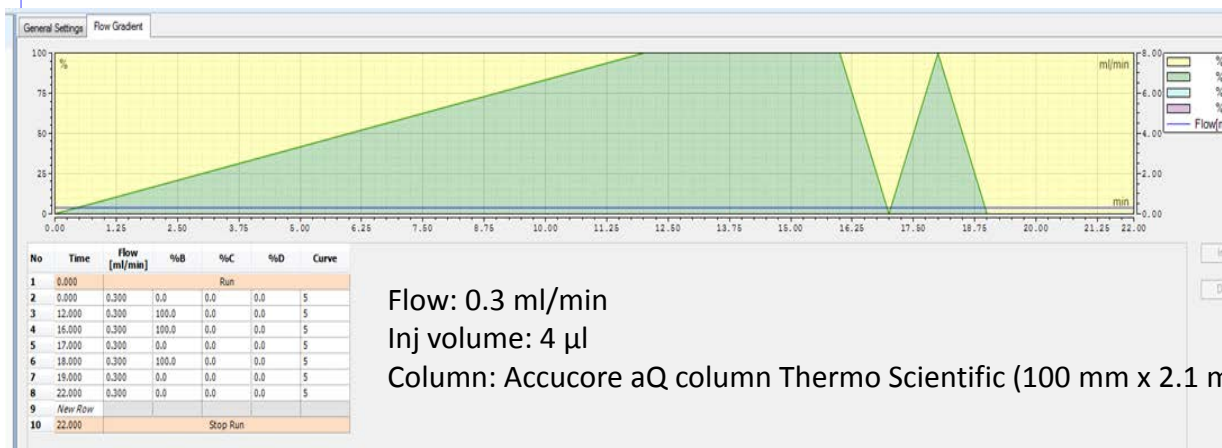
- Full MS
- SIM
- PRM
- Full MS - AIF
- Full MS - vDIA
- AIF



Mobile phase:

A: 5mM ammonium formate and 0.1 % formic acid in water

B: 5 mM ammonium formate and 0.1 % formic acid in methanol



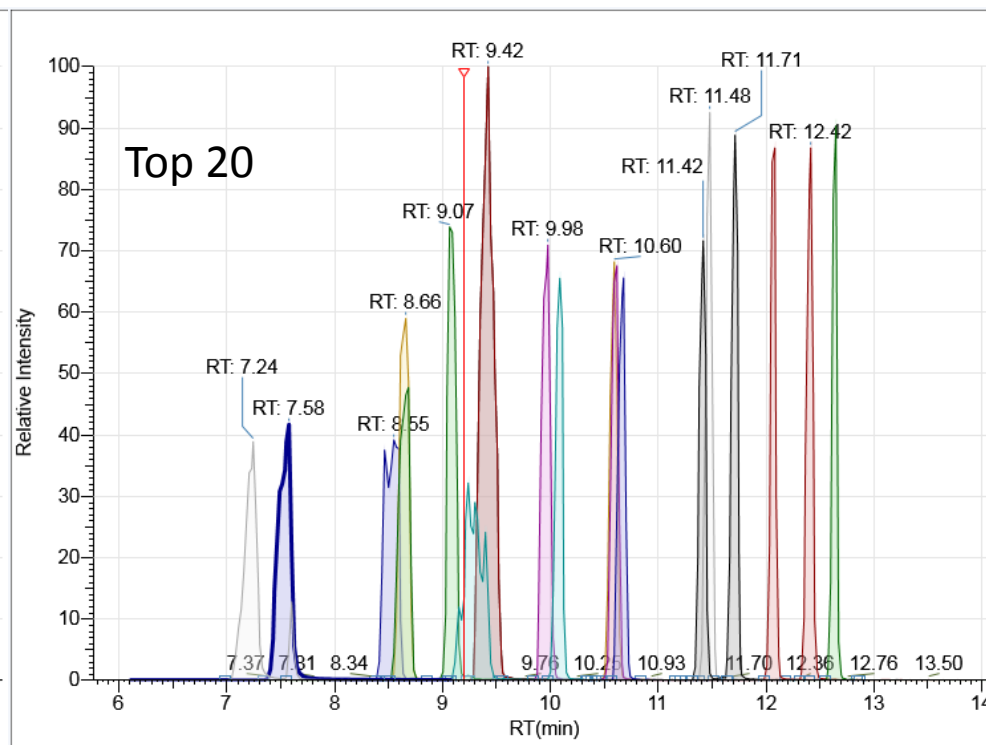
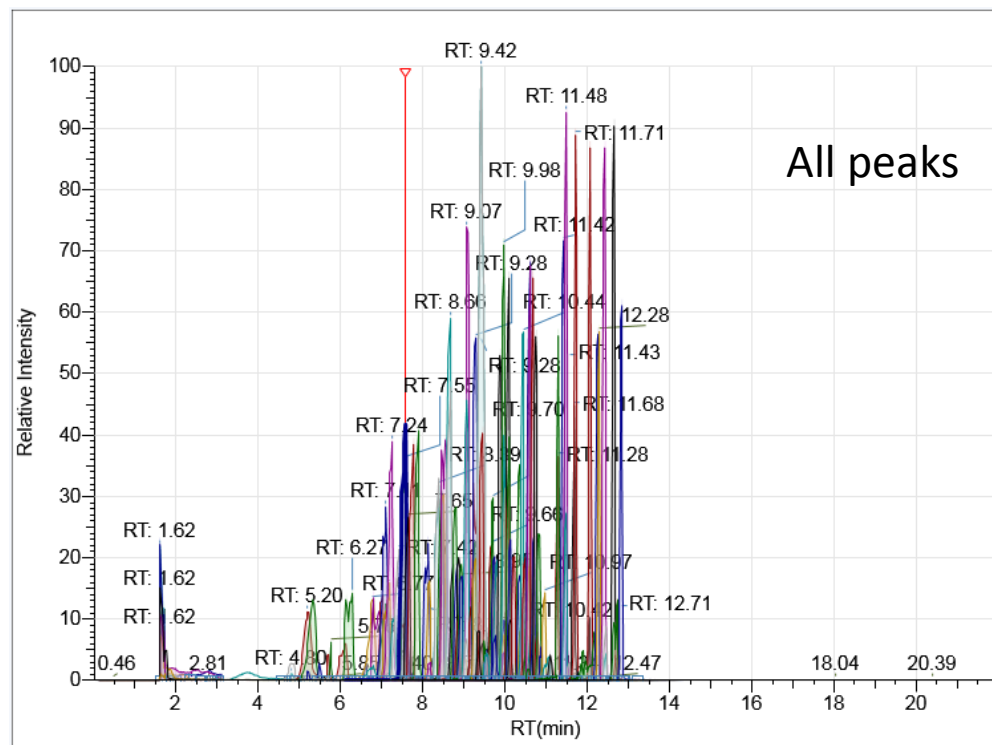
Flow: 0.3 ml/min

Inj volume: 4 µl

Column: Accucore aQ column Thermo Scientific (100 mm x 2.1 mm ID)

Experiment Setup | Summary

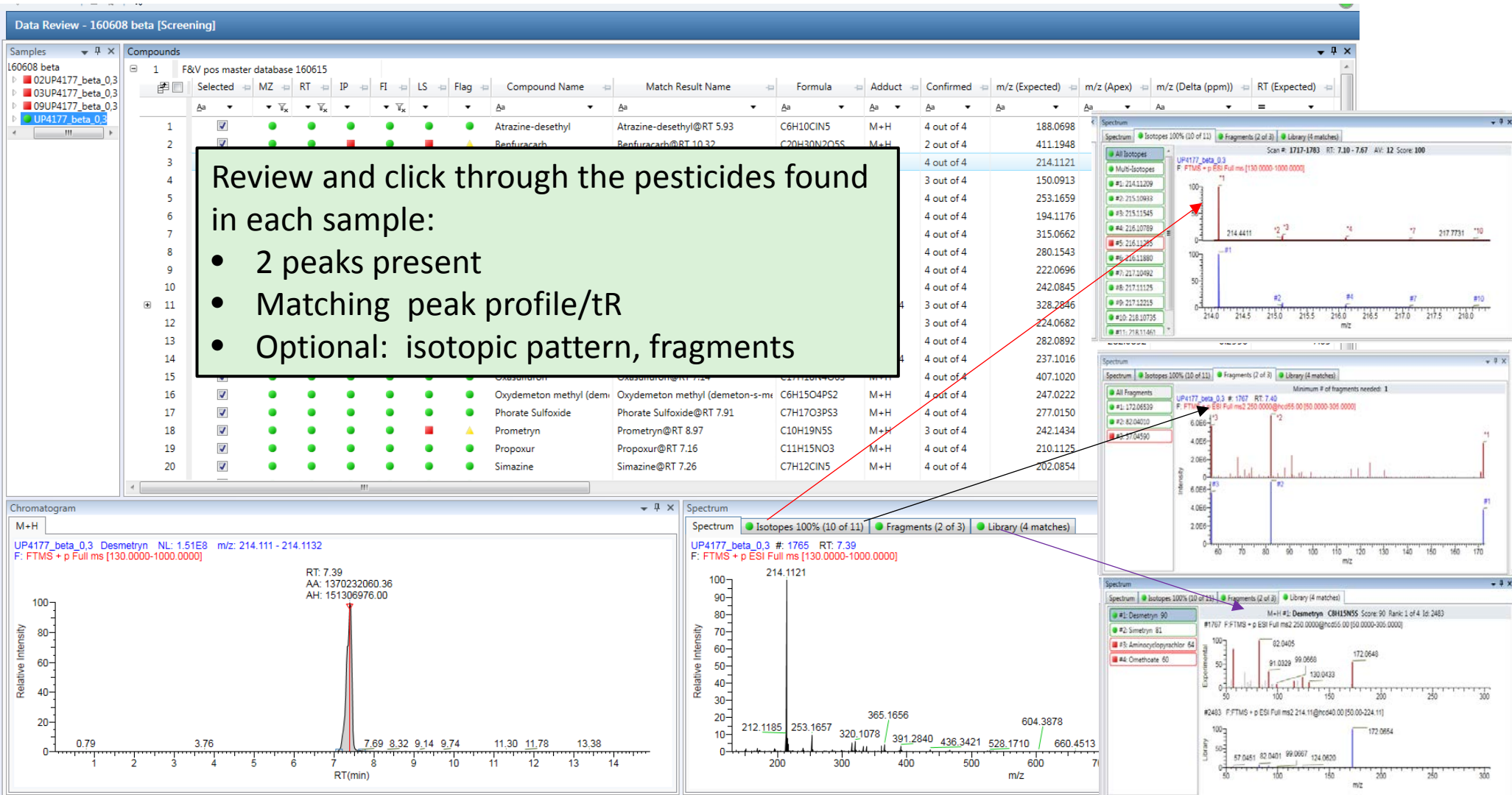
XIC Overlay



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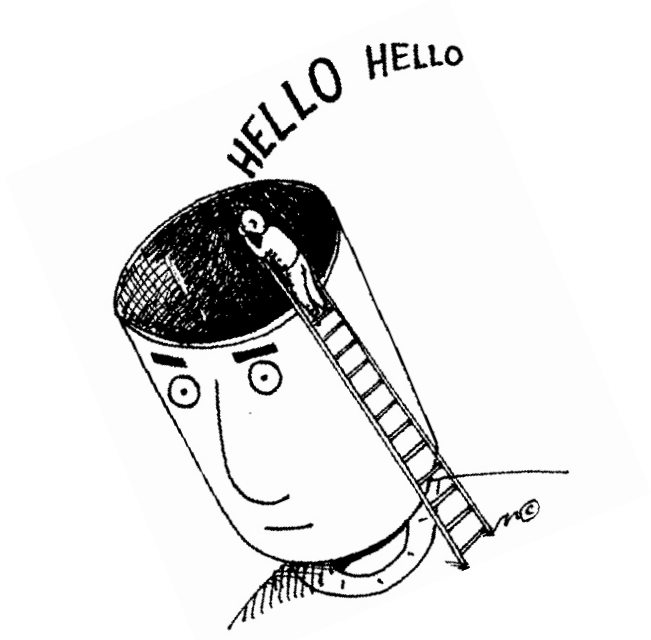
Screening Data Review for Target analyses



Now – let's start with the fun part!

Finding new analytes with

- Thermo databases
- Tracefinder unknowns



Approaches to find new pesticides; Databases & Unknown Screening

Grapes from India

[Screening]

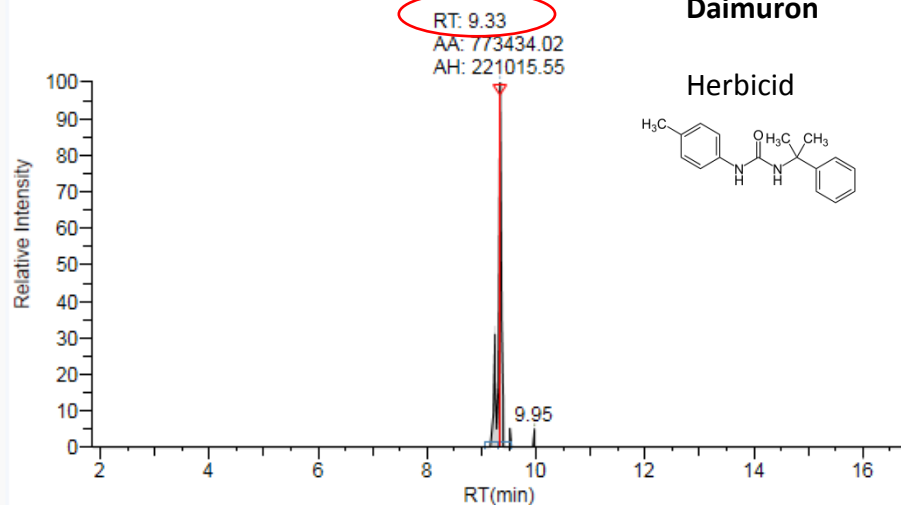
603 Pesticides RT database

Compounds															
	Selected	MZ	RT	IP	FI	LS	Flag	Compound	Match R	Formula	Confin	m/z	m/z (Apex)	m/z (D)	RT (Expected)
26	<input checked="" type="checkbox"/>	●	■	■	●	■	▲	Methomyl	Methomyl@	C5H10N2O2S	M	1 out of 4	80.0801	180.0804	1.6316
27	<input checked="" type="checkbox"/>	●	■	■	●	■	▲	Fenpropidin	Fenpropidir	C19H31N	M	1 out of 4	96.2349	296.2344	-1.6710
28	<input checked="" type="checkbox"/>	●	■	●	●	●	▲	Daimuron	Daimuron@	C17H20N2O	M	3 out of 4	69.1648	269.1644	-1.7548
29	<input checked="" type="checkbox"/>	●	■	■	●	■	▲	Dichlormid	Dichlormid@	C8H11Cl2NO	M	1 out of 4	30.0110	230.0106	-1.8071
30	<input checked="" type="checkbox"/>	●	■	■	●	●	▲	Metolcarb	Metolcarb@	C9H11NO2	M	2 out of 4	66.0863	166.0860	-1.8499

Chromatogram

M+H M+NH4 M+Na

160617_25 Daimuron NL: 2.21E5 m/z: 269.1635 - 269.1662
F: FTMS + p Full ms [120.0000-1000.0000]

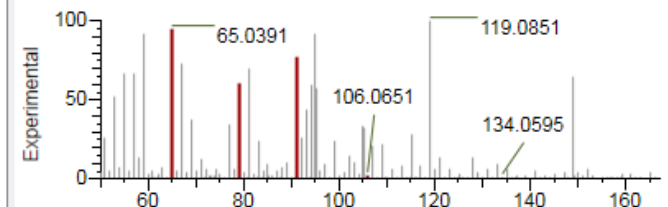


Spectrum

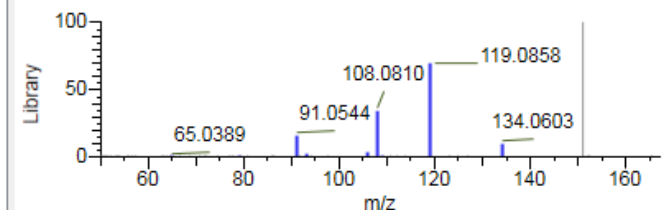
Spectrum Isotopes 86% (1 of 2) Fragments (2 of 4) Library (1 matches)

#1: Daimuron 88

M+H #1: Daimuron C17H20N2O Score: 88 Rank: 1 of 1 Id: 2316
#2001 F:FTMS + p ESI Full ms2 250.0000@hcd55.00 [50.0000-305.0000]



#2316 F:FTMS + p ESI Full ms2 269.16@hcd40.00 [50.00-279.16]



Tracefinder Unknown Screening

Analysis ▾

Local Method View - 160705 prov_Screening_NewCompounds

Batch View

Samples

Data Review

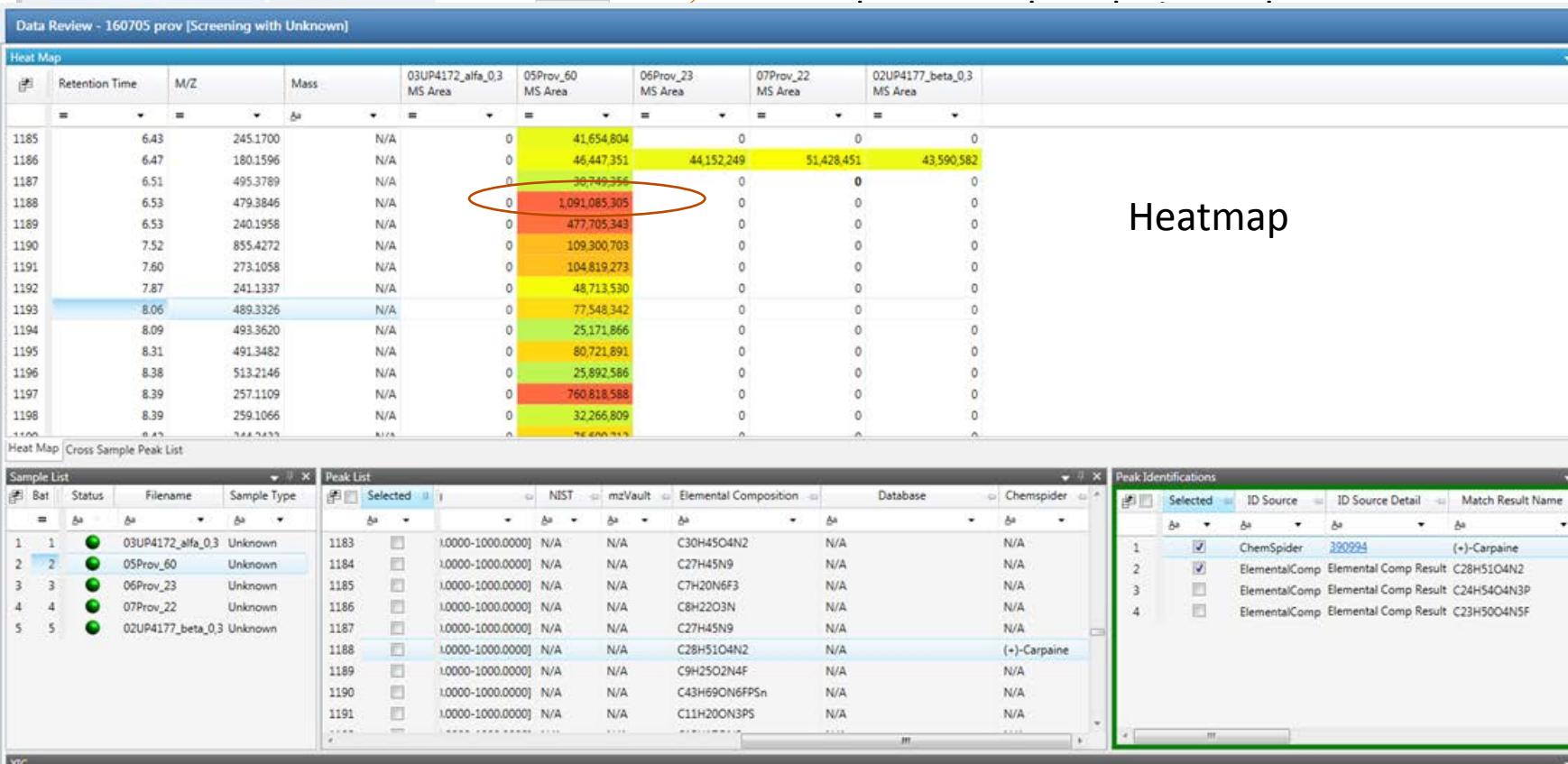
Master method: [Screening_NewCompounds](#)

Settings

Peak Filter Settings

Use RT Limits ☐ Search from minutes

Unknown analysis can be added



Example of a finding in papaya with Tracefinder Unknown Screening

Papaya from Ecuador

Data Review - 160705 prov [Screening with Unknown]

Heat Map

	Retention Time	M/Z	Mass	03UP4172_alfa_03 MS Area	05Prov_60 MS Area	06Prov_23 MS Area	07Prov_22 MS Area	02UP4177_beta_0,3 MS Area
1187	6.51	495.3789	N/A	0	30,749,356	0	0	0
1188	6.53	479.3846	N/A	0	1,091,085,305	0	0	0
1189	6.53	240.1958	N/A	0	477,705,343	0	0	0
1190	7.52	855.4272	N/A	0	109,300,703	0	0	0
1191	7.60	273.1058	N/A	0	104,819,273	0	0	0
1192	7.87	241.1337	N/A	0	48,713,530	0	0	0
1193	8.06	489.3326	N/A	0	77,548,342	0	0	0
1194	8.09	493.3620	N/A	0	25,171,866	0	0	0
1195	8.31	491.3482	N/A	0	80,721,891	0	0	0

Heat Map Cross Sample Peak List

Sample List

Bat	Status	Filename	Sample Type
1	1	03UP4172_alfa_03	Unknown
2	2	05Prov_60	Unknown
3	3	06Prov_23	Unknown
4	4	07Prov_22	Unknown
5	5	02UP4177_beta_0,3	Unknown

Peak List

Selected	Filter String	NIST	mzVault	Elemental Composition	Database	ChemSpider
<input type="checkbox"/>	i + p ESI Full ms [130.0000-1000.0000]	N/A	N/A	C7H20N6F3	N/A	N/A
<input type="checkbox"/>	i + p ESI Full ms [130.0000-1000.0000]	N/A	N/A	C8H22O3N	N/A	N/A
<input type="checkbox"/>	i + p ESI Full ms [130.0000-1000.0000]	N/A	N/A	C27H45N9	N/A	N/A
<input type="checkbox"/>	i + p ESI Full ms [130.0000-1000.0000]	N/A	N/A	C28H51O4N2	N/A	N/A
<input type="checkbox"/>	i + p ESI Full ms [130.0000-1000.0000]	N/A	N/A	C9H25O2N4F	N/A	N/A
<input type="checkbox"/>	i + p ESI Full ms [130.0000-1000.0000]	N/A	N/A	C43H69ON6F5Sn	N/A	N/A

Peak Identifications

Selected	ID Source	ID Source Detail	Match Result Name
<input checked="" type="checkbox"/>	ChemSpider	390994	(+)-Carpaine
<input checked="" type="checkbox"/>	ElementalComp	Elemental Comp Result	C28H51O4N2
<input type="checkbox"/>	ElementalComp	Elemental Comp Result	C24H54O4N3P

Carpaine

From Wikipedia, the free encyclopedia

Carpaine is one of the major alkaloid components of papaya leaves which has been studied for its cardiovascular effects.^[2] Circulatory effects of carpaine were studied in Wistar male rats weighing 314 +/- 13 g, under pentobarbital (30 mg/kg) anesthesia.^[2] Increasing dosages of carpaine from 0.5 mg/kg to 2.0 mg/kg resulted in progressive decrease in systolic, diastolic, and mean arterial blood pressure. Selective autonomic nervous blockade with atropine sulfate (1 mg/kg) or propranolol hydrochloride (8 mg/kg) did not alter the circulatory response to carpaine. Carpaine, 2 mg/kg, reduced cardiac output, stroke volume, stroke work, and cardiac power, but the calculated total peripheral resistance remained unchanged. It is concluded from these results that carpaine affects the myocardium directly. The effects of carpaine may be related to its macrocyclic dilactone structure, a possible cation chelating structure.

References

- ¹ Merck Index, 11th Edition, 1866.
- ² Burdick, Everette M. "Carpaine. An alkaloid of Carica papaya. Chemistry and pharmacology." *Economic Botany* (1971), 25(4), 363-365.
- ³ Hornick, C. A.; Sanders, L. I.; Lin, Y. C. "Effect of carpaine, a papaya alkaloid, on the circulatory function in the rat." *Research Communications in Chemical Pathology and Pharmacology* (1978), 22 (2), 277-289.

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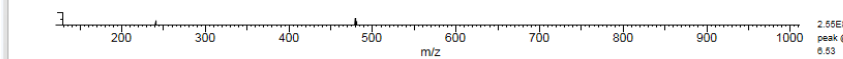
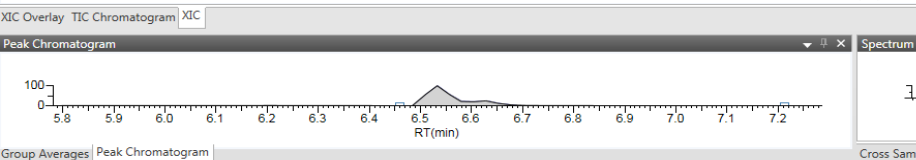
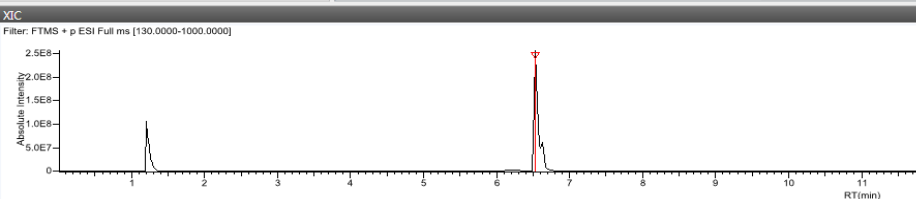
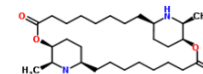
ChemSpider

Search and share chemistry

Simple Structure Advanced History

(+)-Carpaine

Molecular Formula C₂₈H₅₀N₂O₄
Average mass 478.708 Da
Monoisotopic mass 478.377045 Da
ChemSpider ID 390994
6 of 6 defined stereocentres



New pesticides with Tracefinder Unknown Screening

Banana from India

	Retention Time	M/Z	Mass	03UP4172_alfa_0,3 MS Area	05Prov_60 MS Area	06Prov_23 MS Area	07Prov_22 MS Area	02UP4177_beta_0,3 MS Area
1481	7.88	212.1278	N/A	0	0	0	105,808,786	0
1482	7.89	194.0941	N/A	0	0	0	55,588,793	0
1483	7.89	163.0754	N/A	0	0	0	41,292,449	0
1484	7.89	193.0863	N/A	0	0	0	45,122,705	0
1485	8.53	282.2043	N/A	0	0	0	68,180,268	0
1486	8.61	235.1305	N/A	0	0	0	51,202,502	0
1487	8.61	258.2066	N/A	0	0	0	85,239,400	0
1488	8.62	230.1753	N/A	0	0	0	201,504,280	0
1489	8.64	226.1440	N/A	0	0	0	33,447,929	0

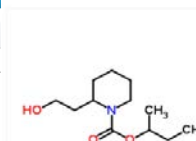
Heat Map Cross Sample Peak List

Sample	Bat	Status	Filename	Sample Type
1	1	●	03UP4172_alfa_0,3	Unknown
2	2	●	05Prov_60	Unknown
3	3	●	06Prov_23	Unknown
4	4	●	07Prov_22	Unknown
5	5	●	02UP4177_beta_0,3	Unknown

Peak	Selected	NIST	mzVault	Elemental Composition	Database	ChemSpider
1483	<input type="checkbox"/>	1.0000-1000.0000	N/A	N/A	C10H11O2	N/A
1484	<input type="checkbox"/>	1.0000-1000.0000	N/A	N/A	C7H16O3NP	N/A
1485	<input type="checkbox"/>	1.0000-1000.0000	N/A	N/A	C8H27ON8P	N/A
1486	<input type="checkbox"/>	1.0000-1000.0000	N/A	N/A	C12H18OF3	Pymetrozine(M+NH4) 235.13019
1487	<input type="checkbox"/>	1.0000-1000.0000	N/A	N/A	C14H28O3N	N/A
1488	<input type="checkbox"/>	1.0000-1000.0000	N/A	N/A	C12H24O3N	Picaridin(M+H) 230.17507

ChemSpider
Search and share chemistry

Simple Structure Advanced History



Icaridin

Molecular Formula C₁₂H₂₃NO₃
Average mass 229.316 Da
Monoisotopic mass 229.167801 Da
ChemSpider ID 111359

3D

More details:

Insect repellent

Names and identifiers Properties Searches Spectra Vendors Articles More

Select	Names and identifiers	Properties	Searches	Spectra	Vendors	Articles	More
<input checked="" type="checkbox"/>	ChemSpider 111359	Icaridin	C1:				
<input checked="" type="checkbox"/>	Database 603 Pesticides RT	Picaridin(M+H) 230.175	C1:				
<input checked="" type="checkbox"/>	ElementalComp Elemental Comp Result	C12H24O3N	C1:				

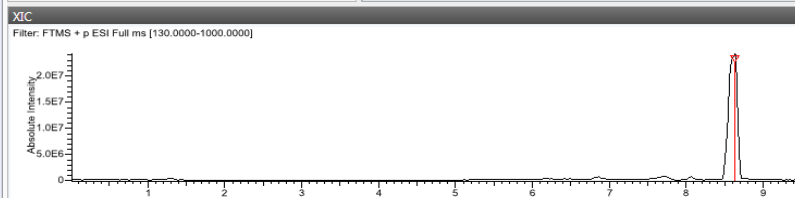
Icaridin

From Wikipedia, the free encyclopedia

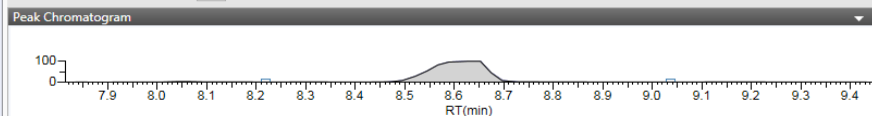
Not to be confused with Icarin.

Icaridin, also known as **picaridin**, **KBR 3023**, under the **INCI** name **hydroxyethyl isobutyl piperidine carboxylate**, and the trade names **Bayrepel** and **Saltidin**, is an **insect repellent**. It has broad efficacy against various insects and is almost colorless and odorless.

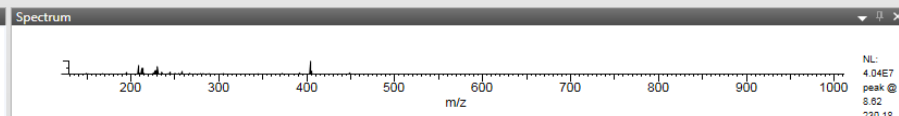
The name *picaridin* was proposed as an **International Nonproprietary Name** (INN) to the **World Health Organization** (WHO), but the official name that has been approved by the WHO is *icaridin*. The compound was developed by the German chemical company **Bayer** and was given the name *Bayrepel*. In 2005, **Lanxess AG** and its subsidiary **Saltigo GmbH** were spun off from Bayer^[1] and the product was renamed *Saltidin* in 2008.^[2]



XIC Overlay TIC Chromatogram XIC

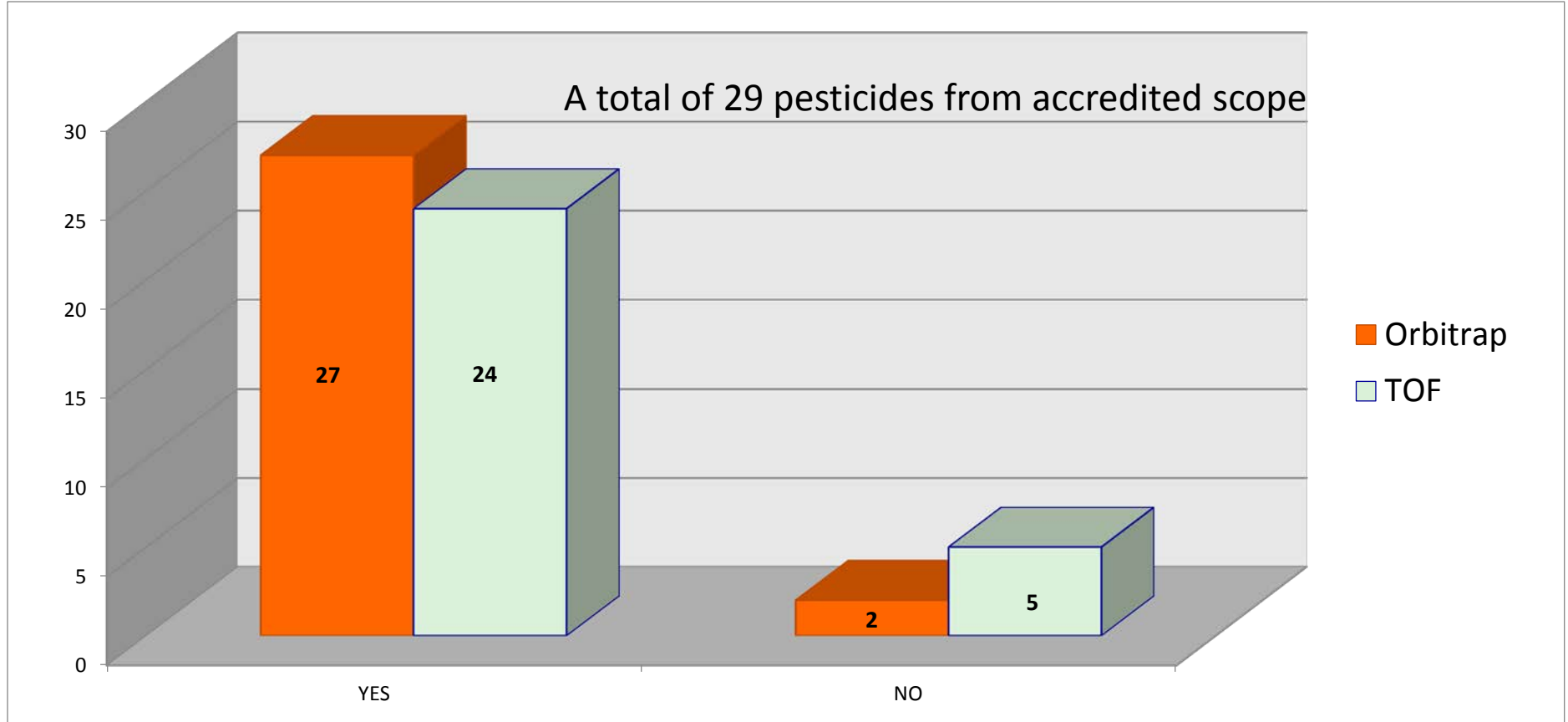


Group Averages Peak Chromatogram



Cross Sample Peak Overlay Library Search Chemical Structure Fragments Isotopes Spectrum

Orbitrap vs QTOF qualitative findings in raw water



Livsmedelsverket

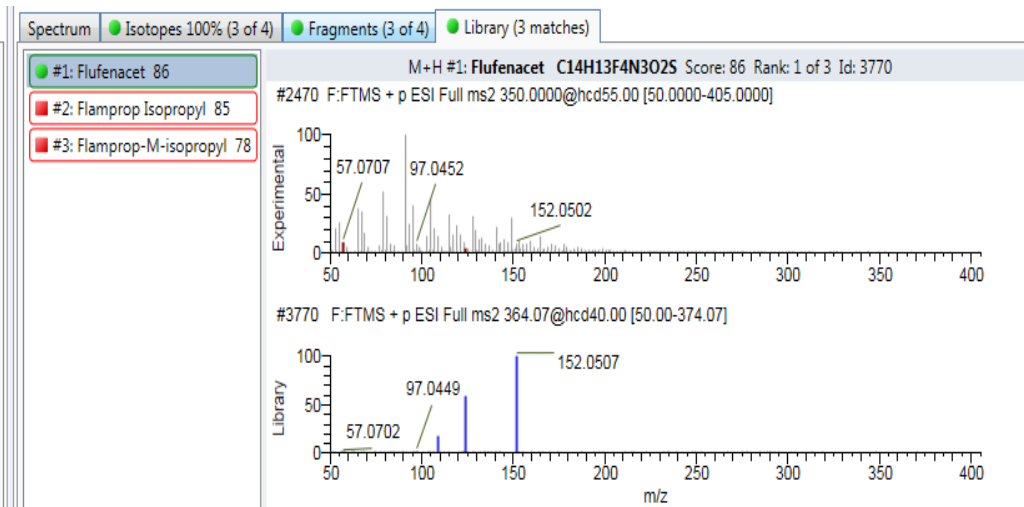
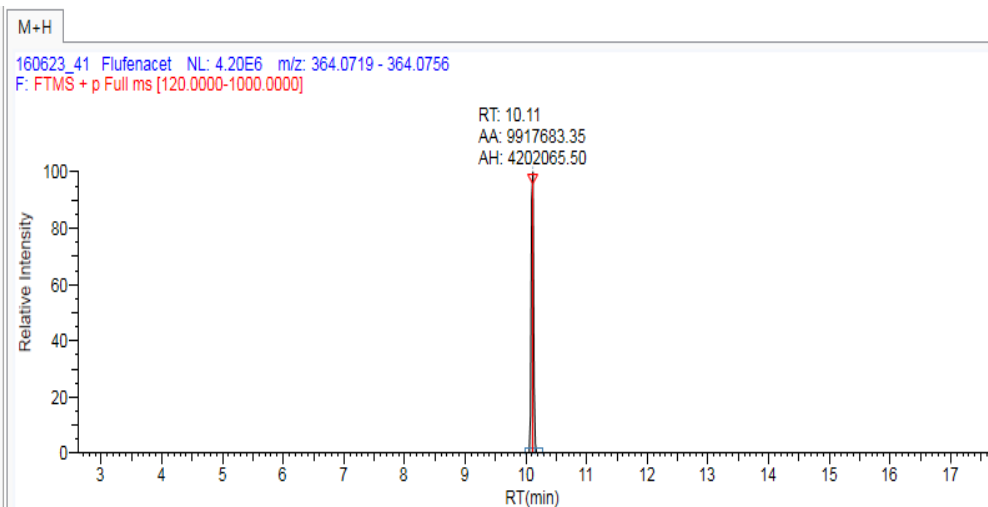
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Flufenacet found by Orbitrap but not QTOF

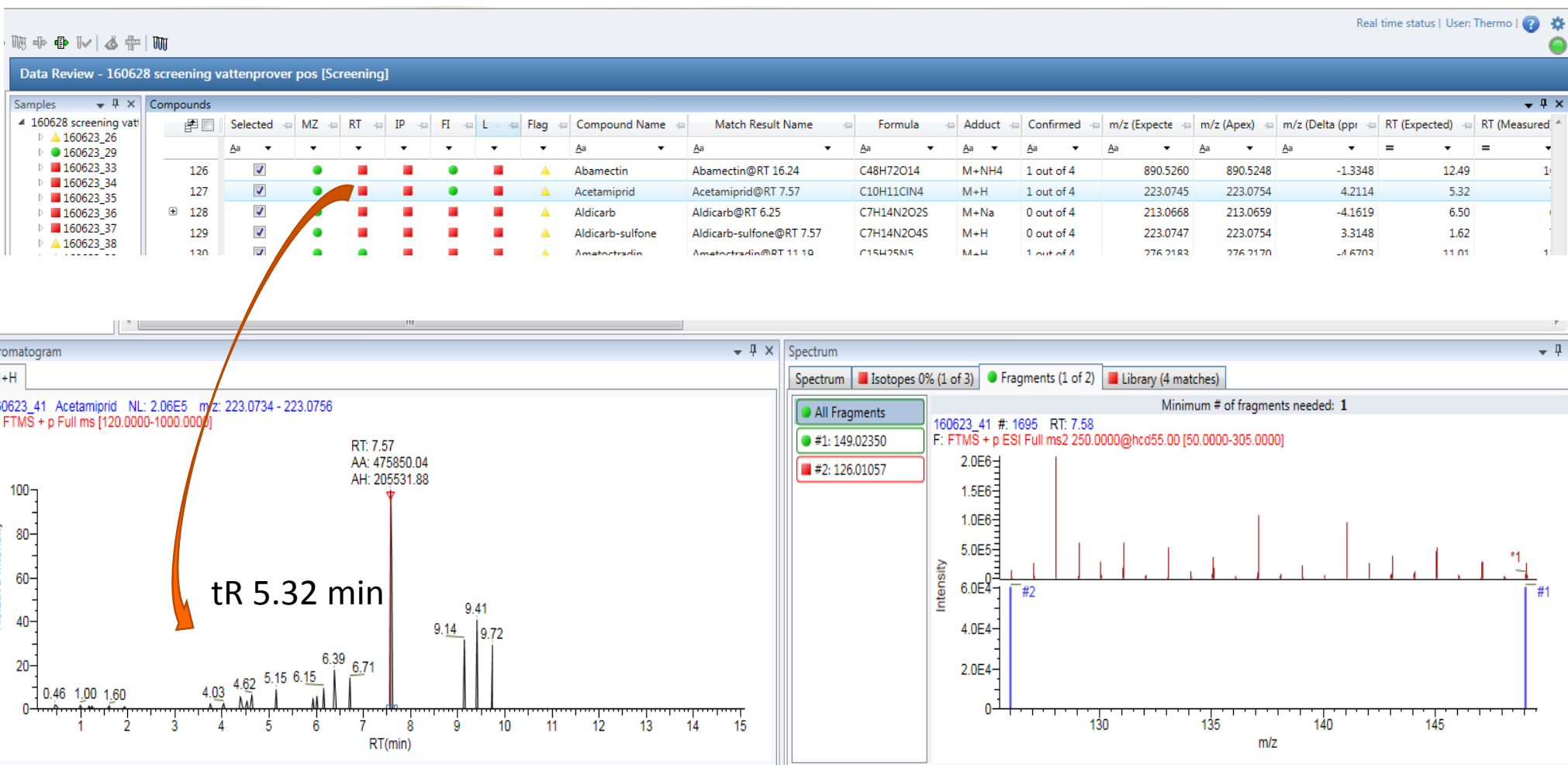
Real time status | User: Thermo | ?

Data Review - 160628 screening vattenprover pos [Screening]

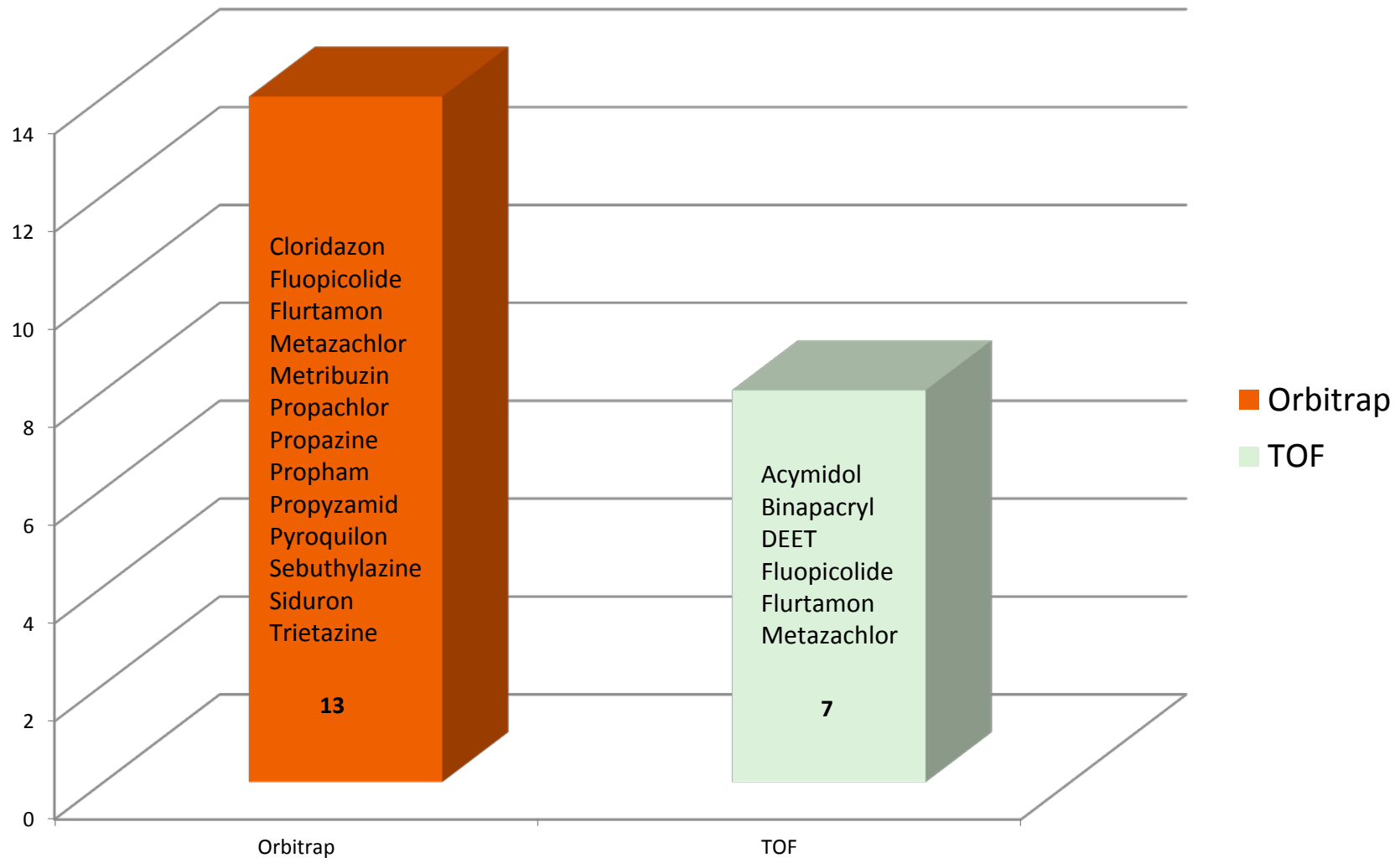
Samples	Compounds	Selected	MZ	RT	IP	FI	L	Flag	Compound Name	Match Result Name	Formula	Adduct	Confirmed	m/z (Expecte	m/z (Apex)	m/z (Delta (pp	RT (Expected)	RT (Measured)
		Δa							Δa	Δa	Δa	Δa	Δa	Δa	Δa	Δa	=	=
160623_26																		
160623_29																		
160623_33																		
160623_34																		
160623_35																		
160623_36																		
160623_37																		
160623_38																		
160623_39																		
160623_40																		
160623_41																		
160623_42																		
283		✓	●	●	●	●	●	●	Flufenacet	Flufenacet@RT 10.11	C14H13F4N3O2S	M+H	4 out of 4	364.0737	364.0738	0.2253	10.10	10.11
284		✓	●	■	■	■	●	▲	Formetanate	Formetanate@RT 5.35	C11H15N3O2	M+H	1 out of 4	222.1237	222.1240	1.3874	1.62	1.62
285		✓	●	■	■	■	●	▲	Ipconazole	Ipconazole@RT 15.43	C18H24ClN3O	M+H	1 out of 4	334.1681	334.1665	-4.6865	11.22	11.22
286		✓	●	●	■	●	●	▲	Iprovalicarb	Iprovalicarb@RT 10.13	C18H28N2O3	M+H	3 out of 4	321.2173	321.2170	-0.7129	9.98	9.98
287		✓	●	■	■	●	●	▲	Isoprocarb	Isoprocarb@RT 6.39	C11H15NO2	M+H	2 out of 4	194.1176	194.1177	0.5964	8.53	8.53
288		✓	●	●	●	■	●	▲	Isoproturon	Isoproturon@RT 8.69	C12H18N2O	M+H	3 out of 4	207.1492	207.1493	0.6397	8.66	8.66
289		✓	●	●	■	●	●	▲	Methabenzthiazuron	Methabenzthiazuron@RT 8.53	C10H11N3OS	M+H	3 out of 4	222.0696	222.0697	0.7088	8.50	8.50



Acetamidiprid found by QTOF but not Orbitrap



Tentative hits



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Databases for screening with tR

- Pest
 - 603
- Databa

Compound Database - 603 Pesticides RT

Tree View Pane

Compound Name

Expand All Collapse All

Peak View Pane

Compound Name	Peak Label	Peak Workflow	Associated Target Peak	Polarity	Charge State	Height Threshold	Area Threshold	Collision Energy	Retention Time (min)	RT Window (sec)
1 Daimuron	T1: 269.16484	TargetPeak		Positive	1	1000	1000	45.00	9.20	10.00
2 Daimuron	T1F1: 269.16484->15	Fragment	T1: 269.16484	Positive	1	1000	1000	45.00	9.20	10.00
3 Daimuron	T1F2: 269.16484->11	Fragment	T1: 269.16484	Positive	1	1000	1000	45.00	9.20	10.00
4 Daimuron	T1F3: 269.16484->10	Fragment	T1: 269.16484	Positive	1	1000	1000	45.00	9.20	10.00
5 Daimuron	T1F4: 269.16484->91	Fragment	T1: 269.16484	Positive	1	1000	1000	45.00	9.20	10.00
6 Daimuron	T2: 286.19139	TargetPeak		Positive	1	1000	1000	45.00	9.20	10.00
7 Daimuron	T2F1: 286.19139->15	Fragment	T2: 286.19139	Positive	1	1000	1000	45.00	9.20	10.00
8 Daimuron	T2F2: 286.19139->11	Fragment	T2: 286.19139	Positive	1	1000	1000	45.00	9.20	10.00
9 Daimuron	T2F3: 286.19139->10	Fragment	T2: 286.19139	Positive	1	1000	1000	45.00	9.20	10.00
10 Daimuron	T2F4: 286.19139->91	Fragment	T2: 286.19139	Positive	1	1000	1000	45.00	9.20	10.00
11 Daimuron	T3: 291.14678	TargetPeak		Positive	1	1000	1000	45.00	9.20	10.00
12 Daimuron	T3F1: 291.14678->15	Fragment	T3: 291.14678	Positive	1	1000	1000	45.00	9.20	10.00
13 Daimuron	T3F2: 291.14678->11	Fragment	T3: 291.14678	Positive	1	1000	1000	45.00	9.20	10.00
14 Daimuron	T3F3: 291.14678->10	Fragment	T3: 291.14678	Positive	1	1000	1000	45.00	9.20	10.00
15 Daimuron	T3F4: 291.14678->91	Fragment	T3: 291.14678	Positive	1	1000	1000	45.00	9.20	10.00
16										

Compound Details Pane

Compound Name: Daimuron

Ionization: None

Chemical Formula: C17H20N2O

CAS No:

Compound Type: Analyte

Compound Groups:

Neutral Mass: 268.1575632

Category: Parent

Internal Standard:



Future plans and developments

Targeted - Tracefinder

- Monitoring of pesticides including search for unknown
- Mycotoxins in cereals
- Toxins in drinking water
- Veterinary drugs in animal origin
- Alkaloids, acryl amide

Untargeted – Compound Discoverer

- Food Fraud
- Emerging risks

Conclusions, Pros and Cons

- + Two techniques on one platform
- + Retrospective analyses – unconditional possibilities
- + Userfriendly, workflow as triplequads
- + Shared databases
- + Affordable
- More work on databases with correct tR

**“Nothing is more simple
than greatness; indeed,
to be simple is to be great.”**



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- Jian Wang (Food Inspec, Canada)
- Walter Hammack (Dep of Agric, Florida, US)

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- Richard Fussel, UK, Global Marketing Manager for Food & Beverage market in Chrom and MS-group
- Frans Schoutsen, NL, Sales Support Expert LSMS and Environm and Food Safety

Thank you for your attention!



Have a nice summer!