ThermoFisher SCIENTIFIC

Elemental and isotopic analysis: solutions for food authenticity, quality and safety

Dr Niel Williams

Sales representative Inorganic Mass Spectrometry

September 8th 2022

RAFA 2022

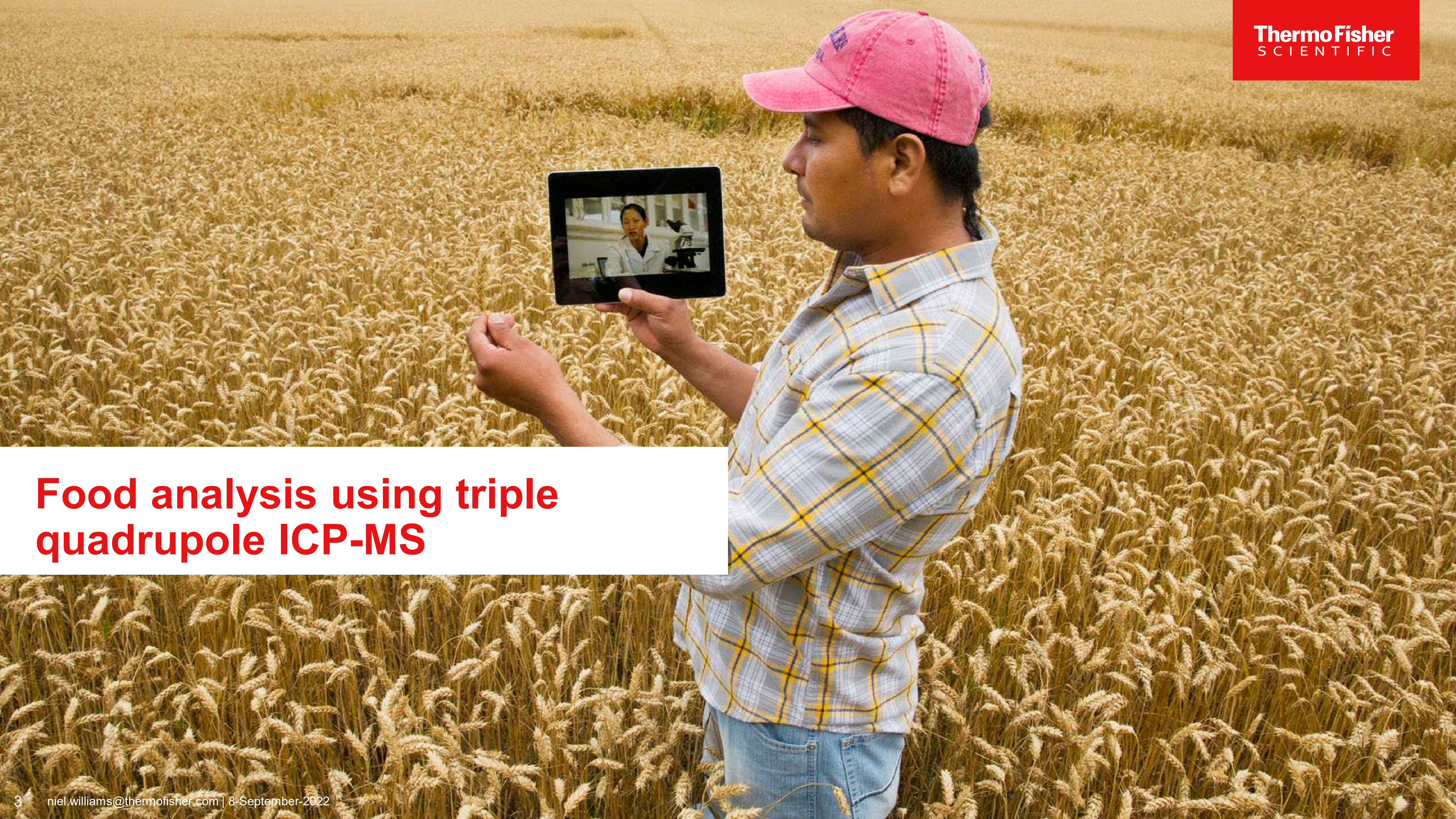
The world leader in serving science

Agenda

1 Food analysis using triple quadrupole ICP-MS

2 Elemental analysis workflow

2 Isotope analysis workflow



Food analysis using triple quadrupole ICP-MS

Regulatory limits

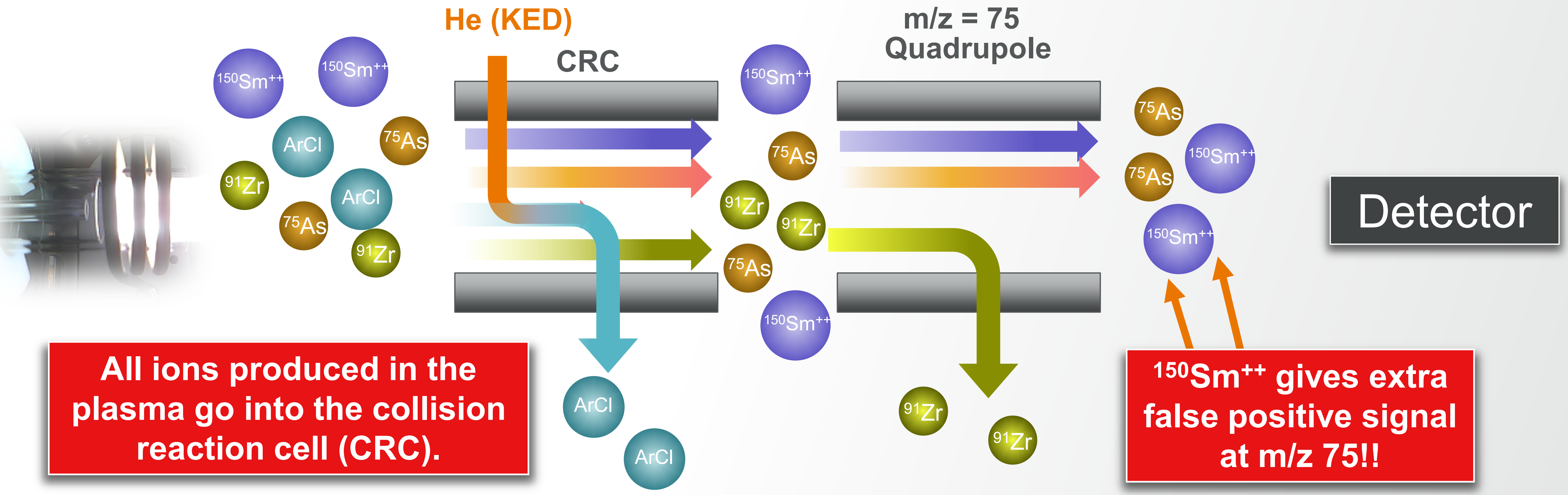
- Regulations for nutritional and toxic elements in baby foods vary globally
- Toxic elements low limits – subject to regular amendments!
- The Baby Food Safety Act introduced on 25th March 2021 in US reduces low limits for heavy metals in baby foods e.g., Hg → 2 $\mu g \cdot kg^{-1}$

Toxic element	Lowest limit value globally ($\mu g \cdot kg^{-1}$)	Target conc. = 30% of the limit ~MLOQ ($\mu g \cdot kg^{-1}$)
As	10	3.0
Cd	5	1.5
Hg	2	0.6
Pb	5	1.5
Sn	5000	1500

Regulatory limits – How can interferences bias?

Toxic element	Lowest limit value globally (µg·kg^{-1})	Target conc. = 30% of the limit ~MLOQ (µg·kg^{-1})	Commonly analyzed isotope	Potential interferences
As	10	3.0	$^{75}As^{+}$	$^{150}Nd^{++}$, $^{150}Sm^{++}$
Cd	5	1.5	$^{111}Cd^{+}$	$^{95}Mo^{16}O^{+}$
Hg	2	0.6	$^{202}Hg^{+}$	$^{186}W^{16}O^{+}$
Pb	5	1.5	$^{206-208}Pb^{+}$	-
Sn	5000	1500	$^{118}Sn^{+}$	-

As determination using SQ ICP-MS with KED mode



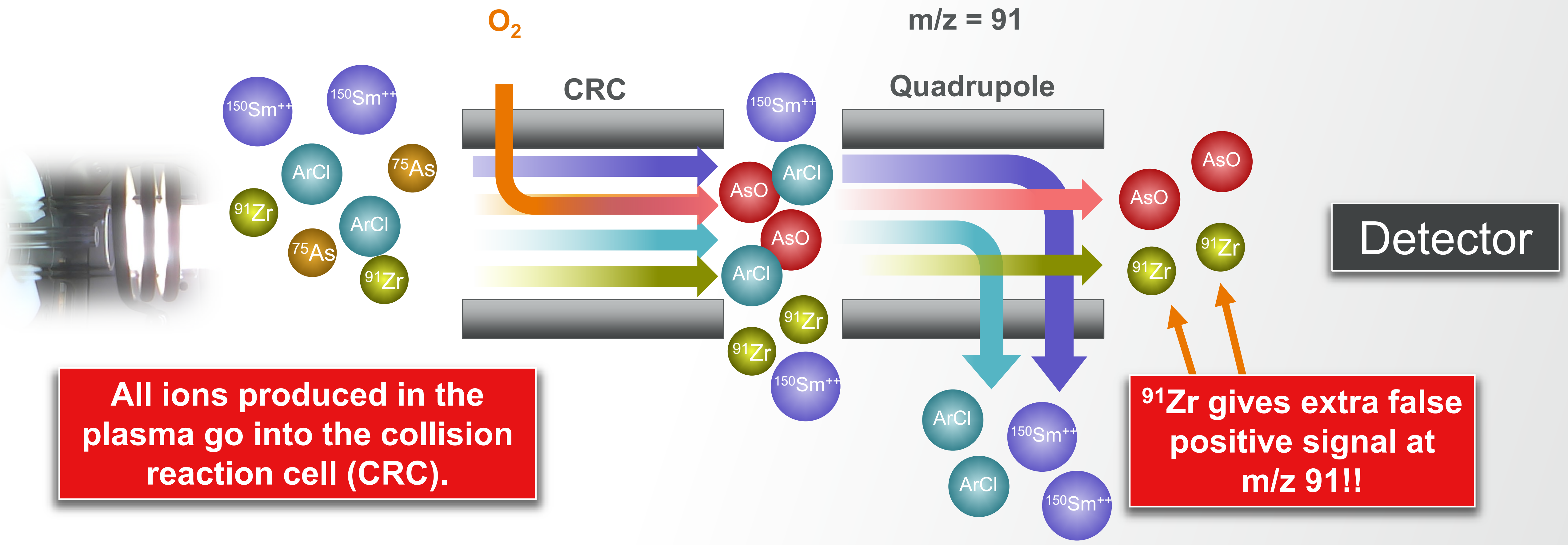
All ions produced in the plasma go into the collision reaction cell (CRC).

$^{150}Sm^{++}$ gives extra false positive signal at m/z 75!!

What happens if we use a reactive gas?

 niel.williams@thermofisher.com | 8-September-2022

As determination using SQ ICP-MS with O2 mode



All ions produced in the plasma go into the collision reaction cell (CRC).

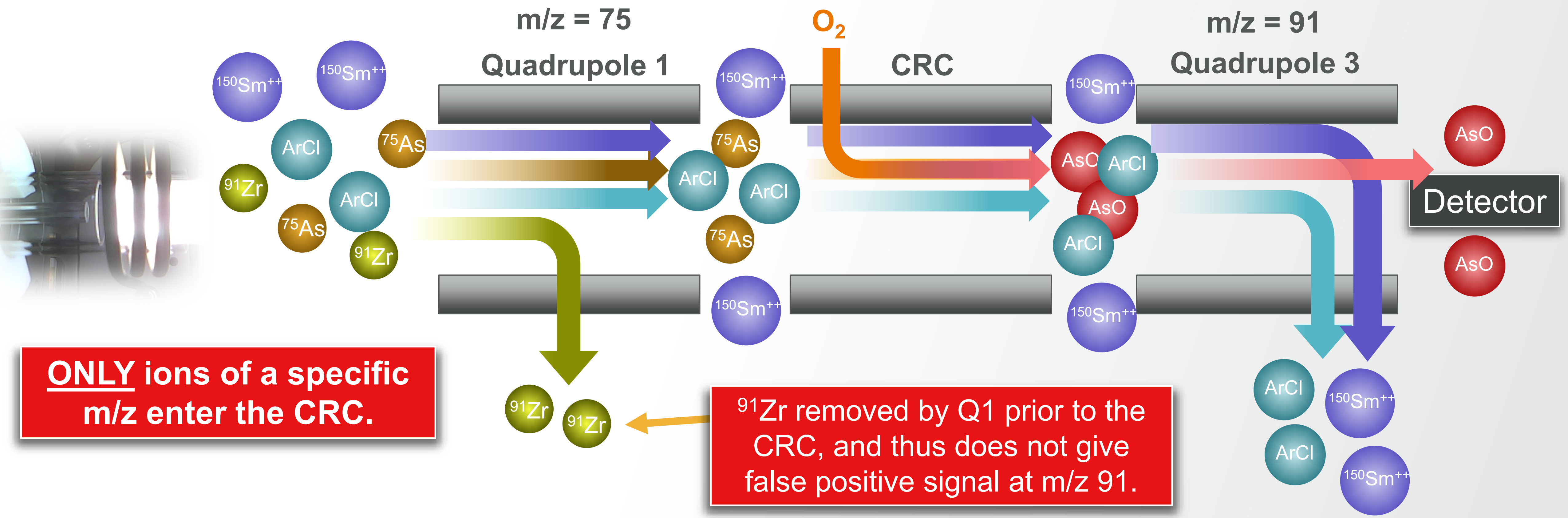
^{91}Zr gives extra false positive signal at m/z 91!!

What happens when we add an extra quadrupole?

niel.williams@thermofisher.com | 8-September-2022

Why do we need another quadrupole?

Consider analysis of As using TQ-ICP-MS with Collison/Reaction Cell – O_2 mode



ONLY ions of a specific m/z enter the CRC.

^{91}Zr removed by Q1 prior to the CRC, and thus does not give false positive signal at m/z 91.

Interference free analysis with iCAP TQe ICP-MS system

niel.williams@thermofisher.com | 8-September-2022

Impact of interferences

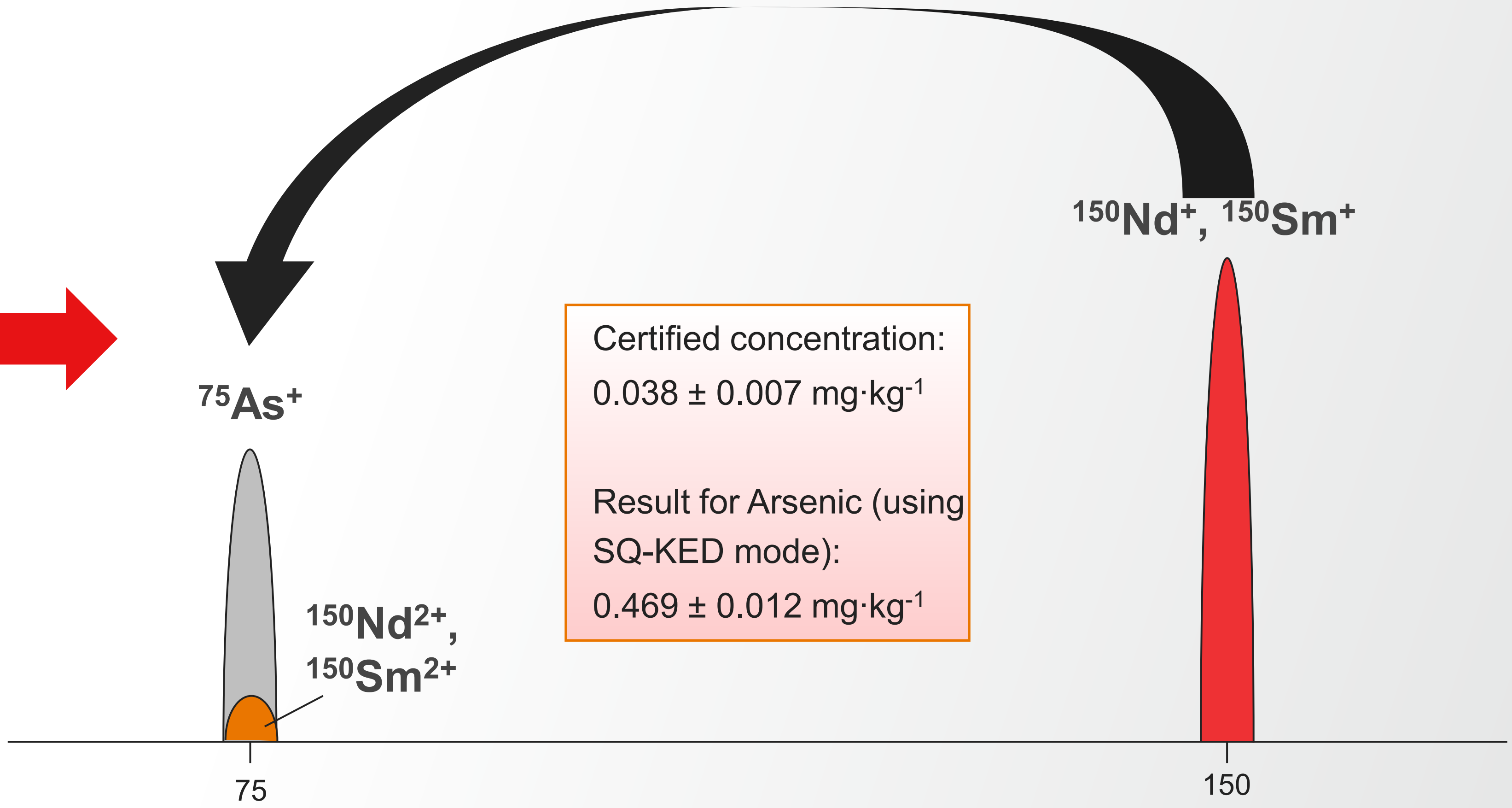
Thermo Fisher SCIENTIFIC

National Institute of Standards and Technology (NIST) CRM 1515 – Apple Leaves

Table 2. Information Mass Fraction Values for Elements in SRM 1515

	Mass Fraction (mg/kg)
Nitrogen (N)[a]	23100
Sulfur (S)	1800
Antimony (Sb)	0.013
Bromine (Br)	1.8
Cerium (Ce)	3
Chromium (Cr)	0.3
Cobalt (Co)	0.09
Europium (Eu)	0.2
Gadolinium (Gd)	3
Gold (Au)	0.001
Iodine (I)	0.3
Lanthanum (La)	20
Neodymium (Nd)	17
Samarium (Sm)	3
Scandium (Sc)	0.03
Terbium (Tb)	0.4
Thorium (Th)	0.03
Tungsten (W)	0.007
Uranium (U)	0.006
Ytterbium (Yb)	0.3

ugh total nitrogen is certified, nitrogen determined by the Kjeldahl procedure is n



Certified concentration:
0.038 ± 0.007 mg·kg^{-1}

Result for Arsenic (using SQ-KED mode):
0.469 ± 0.012 mg·kg^{-1}

Doubly charged interferences cause enhancement effects

niel.williams@thermofisher.com | 8-September-2022

Which type of ICP-MS should be used?

Single Quad ICP-MS

Thermo Scientific™ iCAP™ RQ ICP-MS

- Compact footprint
- Quick connect and push-fit sample intro components
- Innovative QCell Collision Cell

Interference Removal	KED
Polyatomic	☑
Isobaric	X
Doubly charged	X

Triple Quad ICP-MS

Thermo Scientific™ iCAP™ TQe ICP-MS

- Additional quadrupole for superior interference removal
- Built-in safety for handling reactive gases
- 2 mass flow controllers with optimized flow rates

Thermo Scientific™ iCAP™ TQ ICP-MS

- Additional quadrupole for superior interference removal
- Built-in safety for handling reactive gases
- 4 mass flow controllers with optimized flow rates

Interference Removal	KED, Reactive Gas
Polyatomic	☑
Isobaric	☑
Doubly charged	☑

niel.williams@thermofisher.com | 8-September-2022

Analysis of Baby food

Instrument configuration

- iCAP TQe ICP-MS
- ASX560 with ASXPRESS® PLUS (Teledyne Cetac Technologies)
- O_2 mode utilized for all analysis
- 1 minute 19 seconds analysis time

Sample Preparation

- 0.4 ± 0.05 g of dry sample or 2.0 g of wet sample + 5 ml HNO_3 + 1 ml HCl
- Closed vessel microwave digestion for 20 mins at 1200 W
- Dilution factors – 125x for dry samples, 25x for wet samples

Thermo Scientific™ iCAP™ TQe Instrument Parameters

ThermoFisher SCIENTIFIC

Footprint – Smallest footprint of any ICP-MS

1 **SEM**– with improved lifetime

2 **Quadrupole –** Dwell times - 0.2 s for As, Hg, Se; 0.1 s for Cd, Fe, Pb, Sb, Sn; 0.05 s for others. 5 sweeps, 3 main runs

3 **QCell** – O_2 mode only

4 **Additional 'Q1'** quadrupole for best interference removal

5 **Interface settings -** RF power 1550 W Nebulizer : Borosilicate glass micromist, 400 µL·min^{-1} at Ar flow rate 1.13 L·min^{-1}

6 **MFC –** 100% O_2, 0.34 mL·min^{-1} or 0.7 mL·min^{-1} (analyte dependent)

Robust and innovative design for greater ease of use

Detection limits

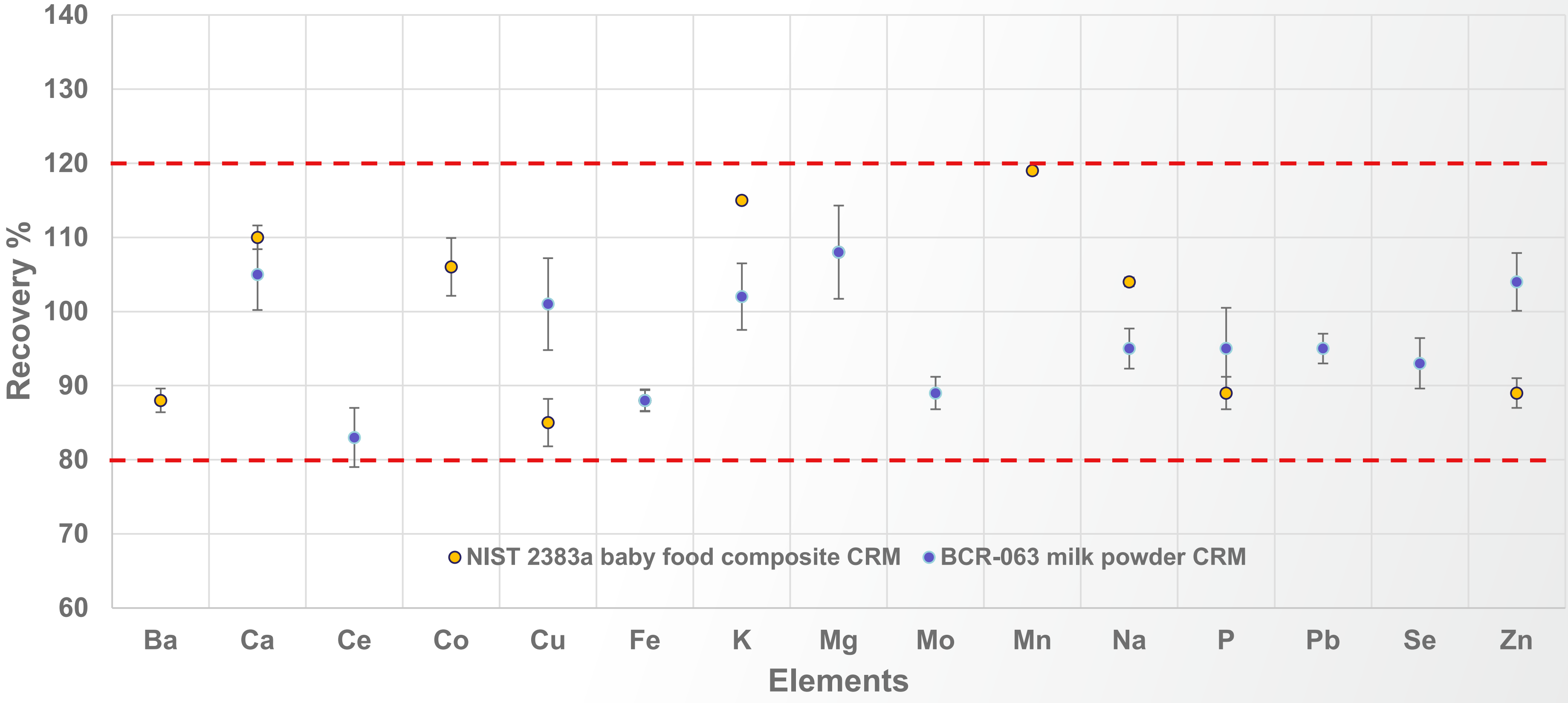
- Instrument detection limit (IDL) based on standard deviation of blank concentrations
- Instrumental limit of quantification (ILOQ) in solution
  - 3 x IDL
- Method LOQ in baby food samples (MLOQ)
  - 125 x LOQ for powders
  - 25 x LOQ for purees

Toxic elements

Element	R^2	BEC ($\mu g \cdot L^{-1}$)	IDL ($\mu g \cdot L^{-1}$)	ILOQ = 3 x IDL ($\mu g \cdot L^{-1}$)	MLOQ in dry samples (125 x LOQ) ($\mu g \cdot kg^{-1}$)	MLOQ in puree or wet samples (25 x LOQ) ($\mu g \cdot kg^{-1}$)
^{75}As	**0.9995**	**0.002**	**0.004**	**0.012**	**1.44**	**0.29**
^{9}Be	0.9994	0.024	0.126	0.377	47.1	9.4
^{111}Cd	**> 0.9999**	**0.007**	**0.003**	**0.009**	**1.09**	**0.22**
^{59}Co	> 0.9999	0.001	0.001	0.004	0.49	0.10
^{52}Cr	0.9993	0.028	0.032	0.096	12.0	2.4
^{63}Cu	0.9996	0.024	0.013	0.040	5.0	1.0
^{56}Fe	0.9993	0.190	0.058	0.174	21.8	4.4
^{202}Hg	**> 0.9999**	**0.002**	**0.0003**	**0.001**	**0.11**	**0.02**
^{60}Ni	0.9993	0.060	0.033	0.099	12.4	2.5
^{208}Pb	**> 0.9999**	**0.006**	**0.001**	**0.004**	**0.45**	**0.09**
^{78}Se	0.9999	0.005	0.010	0.030	3.7	0.7
^{118}Sn	**0.9998**	**0.015**	**0.003**	**0.009**	**1.11**	**0.22**
^{51}V	0.9995	0.059	0.021	0.064	8.0	1.6

Data for more elements can be found in AN 00209

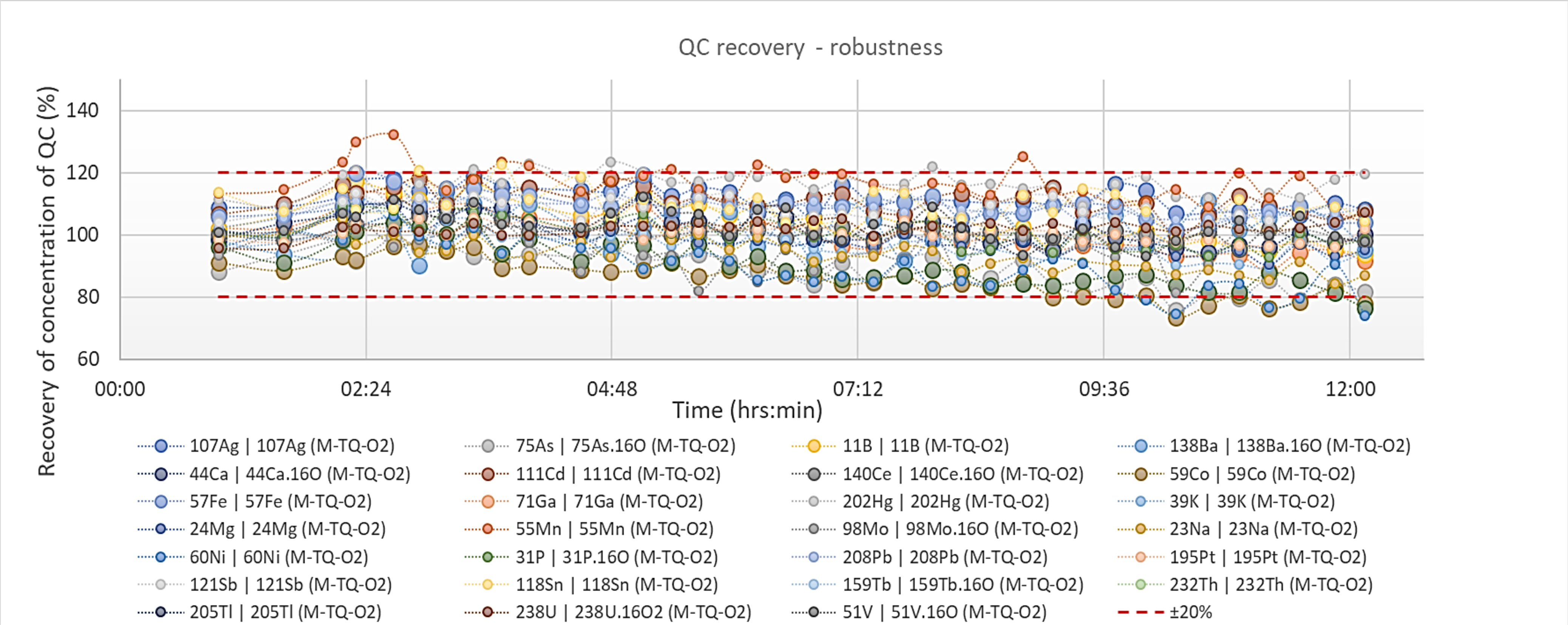
Accuracy – analysis of certified reference materials



Excellent agreement with certified values achieved

Robustness – QC standard recovery

- QC standard concentration – 0.1 µg·kg^{-1} Hg, 1 µg·kg^{-1} other traces, 20 mg·kg^{-1} major elements

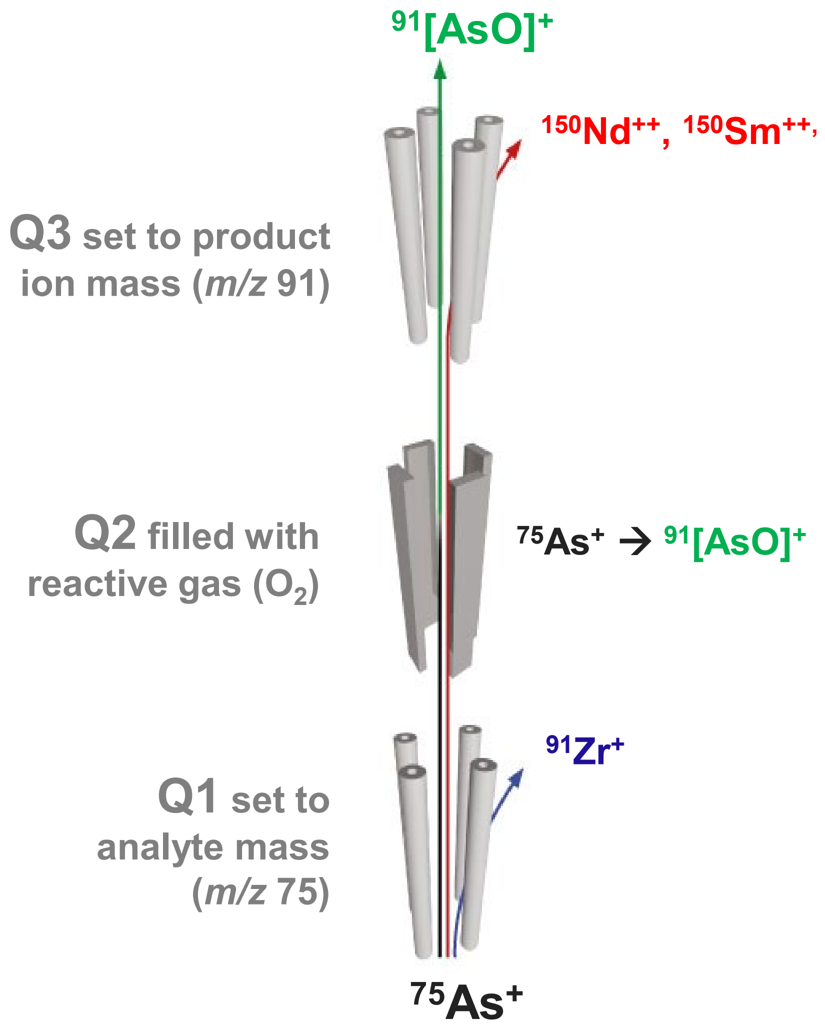


Consistent QC recovery obtained throughout the entire measurement time

niel.williams@thermofisher.com | 8-September-2022

Analysis of arsenic

iCAP TQe – O_2 mass shift



75As (M-SQ-KED)

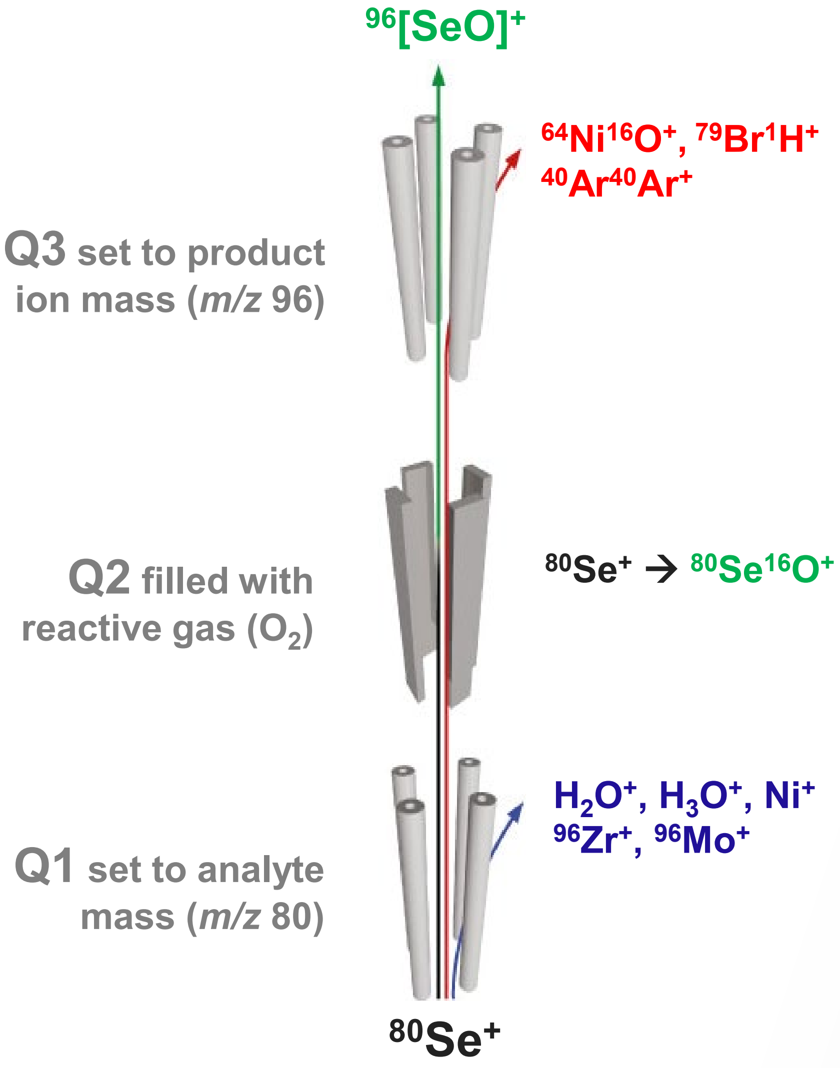
		^{75}As [µg·kg^{-1}]
Kinetic Energy Discrimination (KED)	Original Sample	0.034 ± 0.06
	Sample + 20 µg·L^{-1} REE	**1.00 ± 0.02**
	Sample + 50 µg·L^{-1} REE	**2.44 ± 0.1**

75As | 75As.16O (M-TQ-O2)

		^{75}As [µg·kg^{-1}]
TQ-O_2 mode	Original Sample	0.028 ± 0.003
	Sample + 20 µg·L^{-1} REE	0.027 ± 0.004
	Sample + 50 µg·L^{-1} REE	0.034 ± 0.003

Analysis of selenium

iCAP TQe – O_2 mass shift



78Se (M-SQ-KED)

		^{78}Se [µg·kg^{-1}]
Kinetic Energy Discrimination (KED)	Original Sample	0.029 ± 0.01
	Sample + 20 µg·L^{-1} REE	6.46 ± 0.2
	Sample + 50 µg·L^{-1} REE	16.22 ± 0.5

80Se | 80Se.16O (M-TQ-O2)

		^{80}Se [µg·kg^{-1}]
TQ-O_2 mode	Original Sample	0.015 ± 0.009
	Sample + 20 µg·L^{-1} REE	**0.015 ± 0.004**
	Sample + 50 µg·L^{-1} REE	**0.021 ± 0.007**

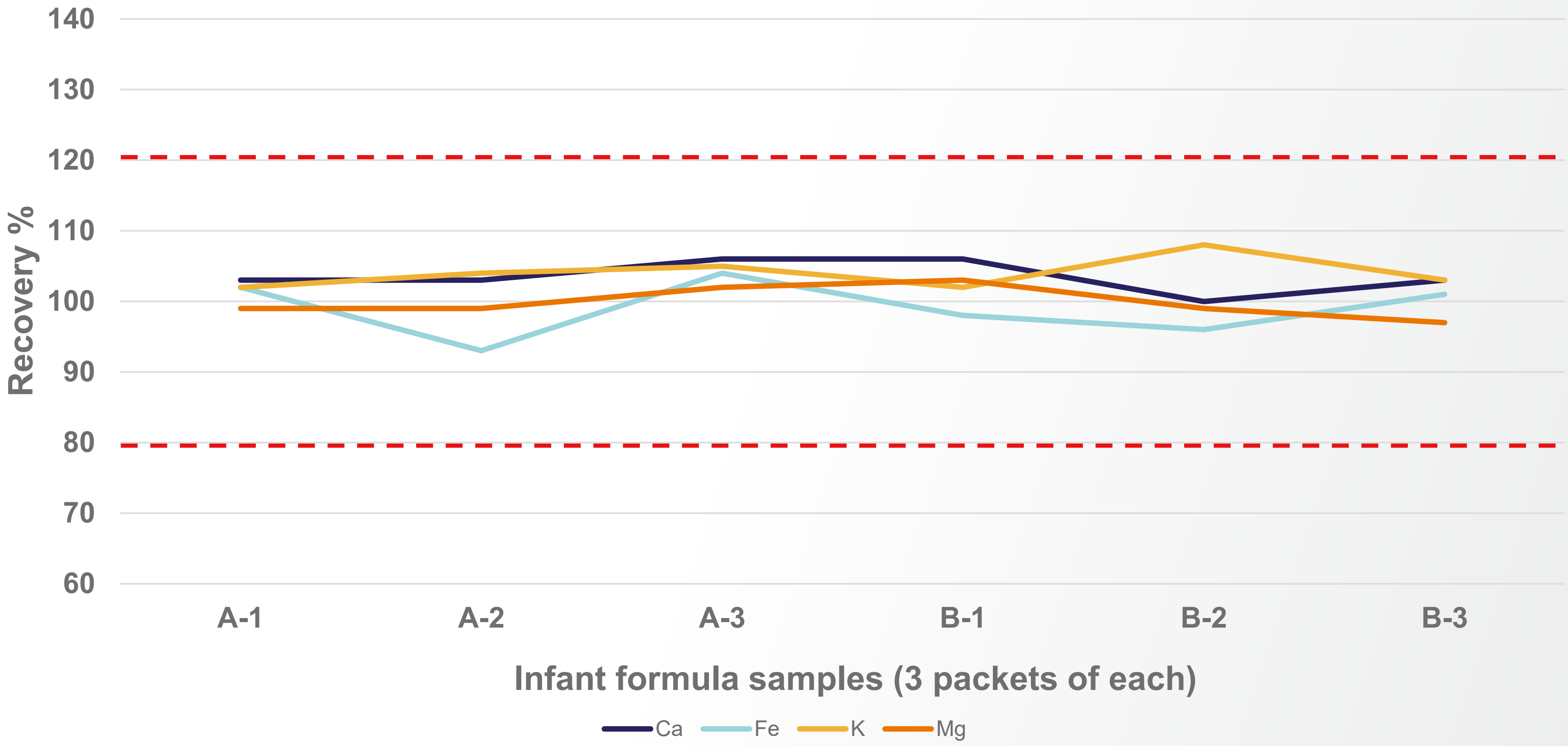
Food Nutrition & Safety Measurements Quality Assurance Program (FNSQAP) organized by National Institute of Standards and Technology (NIST)

	Dates	Samples	Nutritional Elements	Toxic Elements
FNSQAP Exercise 1 - Spring 2021	Samples received: April 10, 2021	Infant Formula A	Na, K, Ca, Mg	-
		Infant Formula B		
		Baby Food A	-	As, Cd, Hg, Pb
		Baby Food B		
FNSQAP Exercise 2 - Spring 2022	Samples received: May 10, 2022	Infant Formula B	Cr, Mo, Se	-
		Infant Formula C		
		Cocoa Powder	-	Cd, Pb
		Chocolate Drinking Mix		

- Three packets of each sample provided → three results for each analyte required

FNSQAP Ex-1, NIST

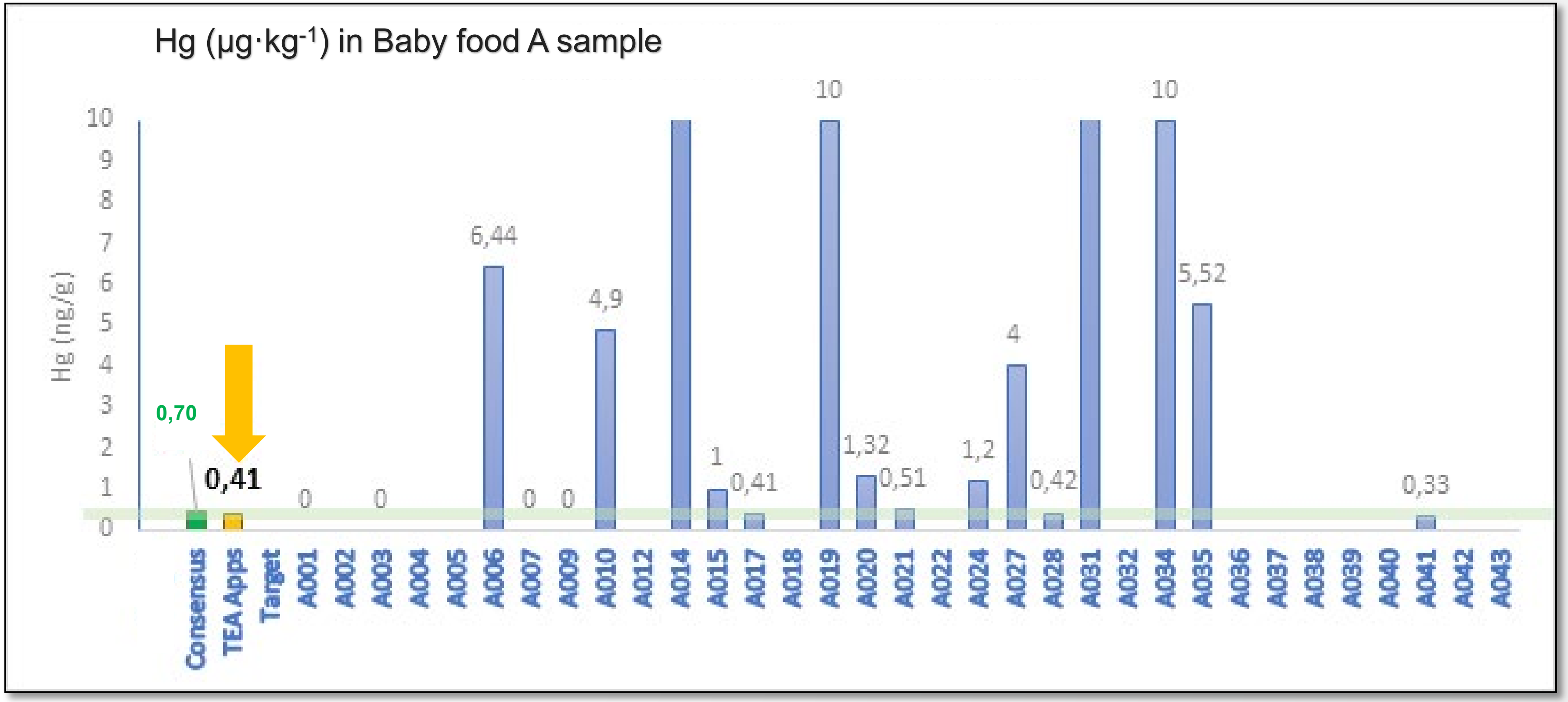
Results - Major elements in Infant formula samples



Excellent agreement with certified values achieved

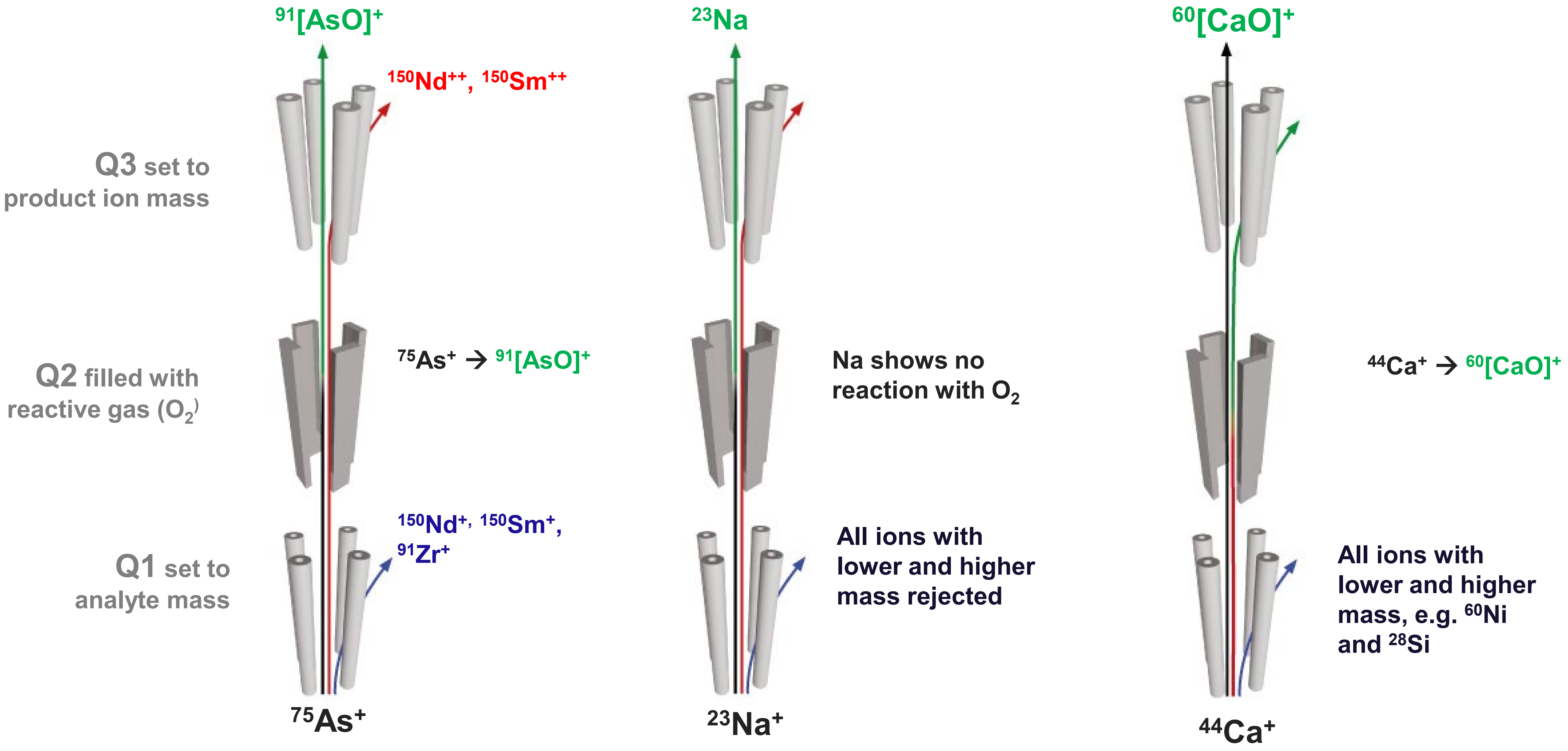
FNSQAP Ex-1, NIST

Results - Mercury in provided samples, our data point in yellow



- Only 18 reported values for mercury out of 33 participants
- Many reported values extremely high – false positives?
- Single mode iCAP Tqe ICP-MS analysis was able to provide accurate values close to LOQ level for mercury!

Even easier method development: single mode analysis



niel.williams@thermofisher.com | 8-September-2022

Even easier method development: single mode analysis

Single mode analysis using just TQ-O_2 mode

- Very straightforward method development – one mode for all elements
- Improved interference removal for key analytes (e.g. V, As, Se, Cd, Hg) eliminates false positive results

Advantages:

- Reduced method runtime enables increased laboratory productivity

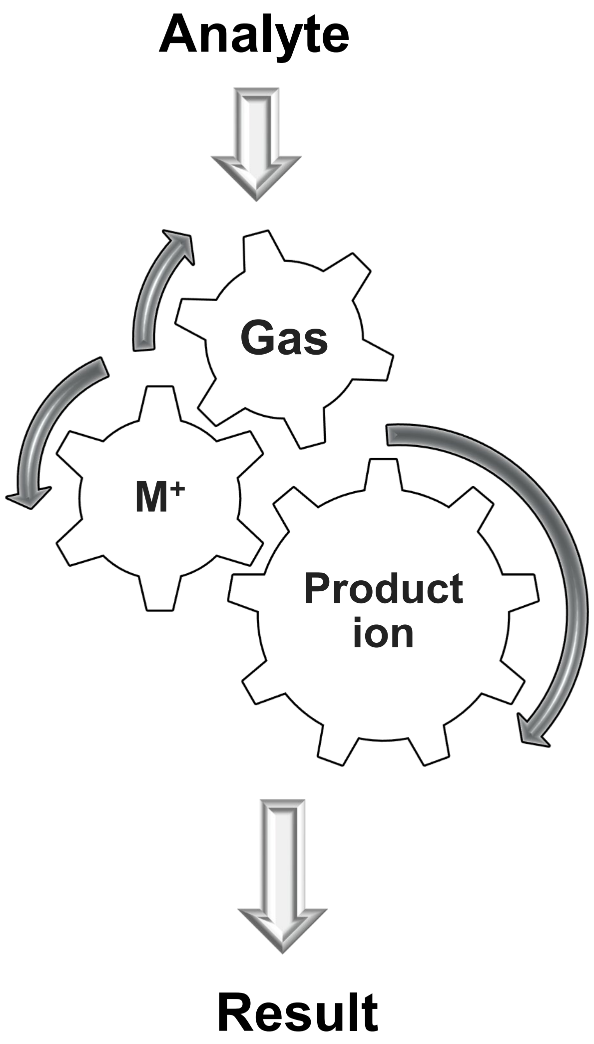
Reduced sample turnaround times

Increased throughput

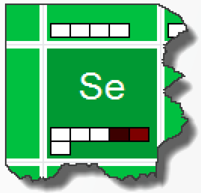
Improved return on investment

niel.williams@thermofisher.com | 8-September-2022

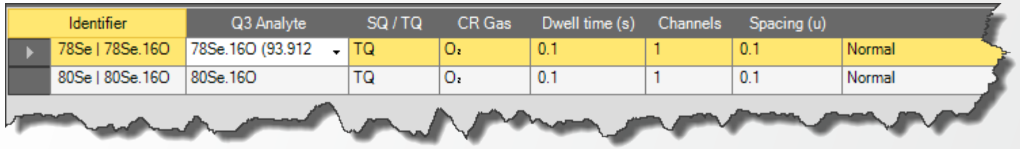
‘Reaction Finder’ - method development assistant



- Select Element/Isotope of interest

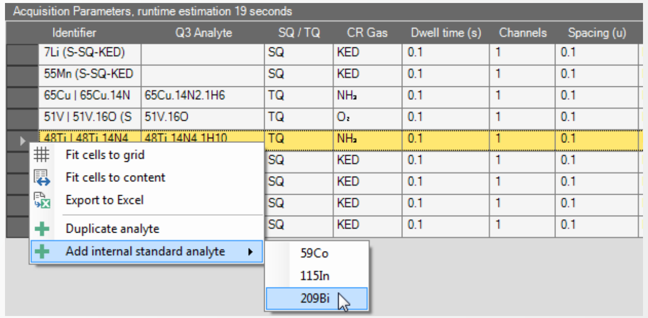


- Reaction Finder proposes most appropriate gas/scan setting combination



Identifier	Q3 Analyte	SQ / TQ	CR Gas	Dwell time (s)	Channels	Spacing (u)	
78Se | 78Se.16O	78Se.16O (93.912	TQ	O_2	0.1	1	0.1	Normal
80Se | 80Se.16O	80Se.16O	TQ	O_2	0.1	1	0.1	Normal

- Choose from list of Internal Standards



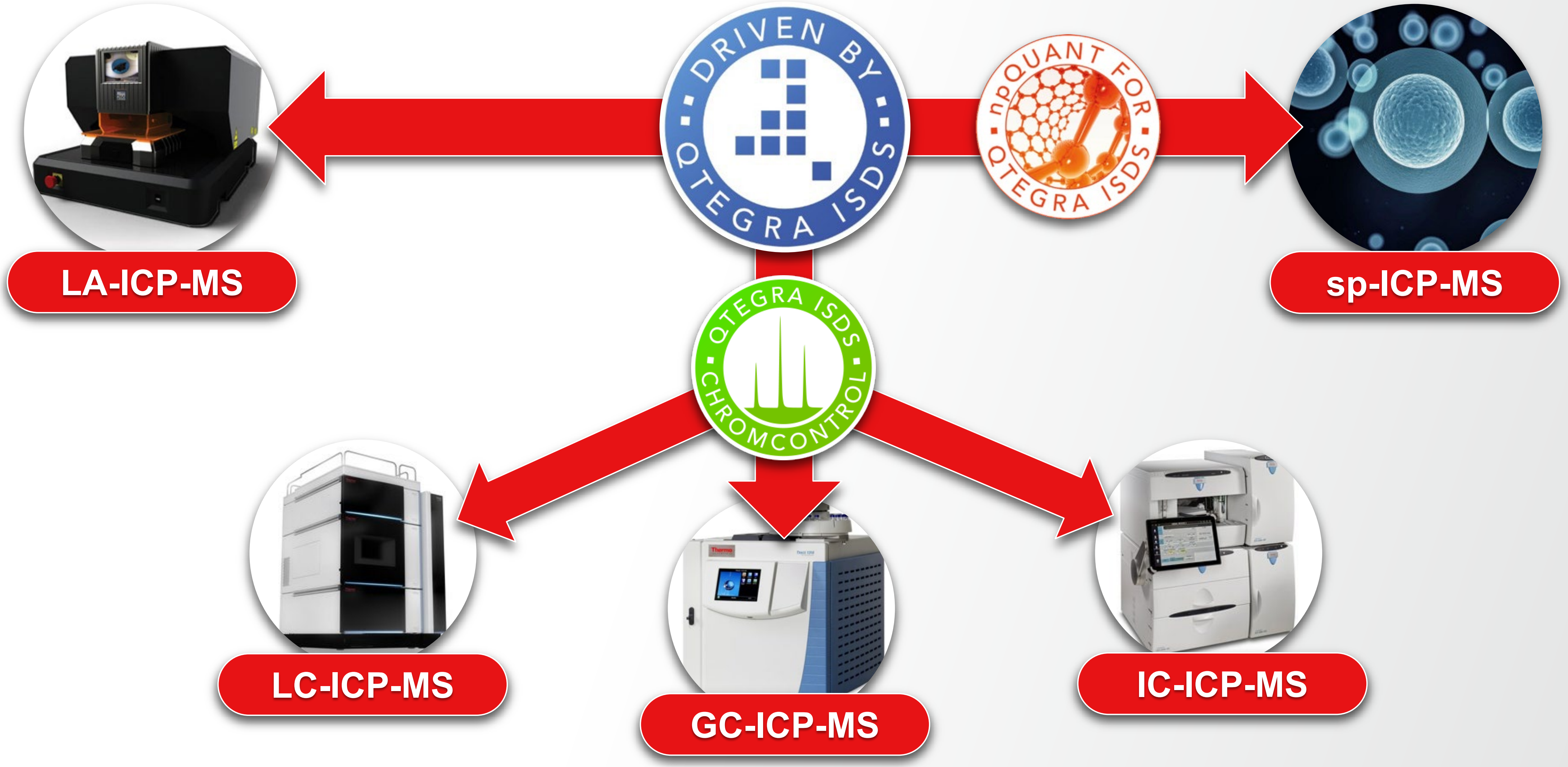
Acquisition Parameters, runtime estimation 19 seconds

Identifier	Q3 Analyte	SQ / TQ	CR Gas	Dwell time (s)	Channels	Spacing (u)
7Li (S-SQ-KED)		SQ	KED	0.1	1	0.1
55Mn (S-SQ-KED		SQ	KED	0.1	1	0.1
65Cu | 65Cu.14N	65Cu.14N2.1H6	TQ	NH_3	0.1	1	0.1
51V | 51V.16O (S	51V.16O	TQ	O_2	0.1	1	0.1
48Ti | 48Ti.14N4	48Ti.14N4.1H10	TQ	NH_3	0.1	1	0.1
		SQ	KED	0.1	1	0.1
		SQ	KED	0.1	1	0.1
		SQ	KED	0.1	1	0.1
		SQ	KED	0.1	1	0.1

Redefining triple quadrupole ICP-MS with unique ease of use

niel.williams@thermofisher.com | 8-September-2022

Options for transient signals analysis in Qtegra ISDS with Thermo Scientific™ iCAP™ TQ ICP-MS



Elemental analysis workflow

Food cycle quality control

Thermo Fisher SCIENTIFIC

Soils, leaves, plants, crops

Food and animal feed

Production of compost

Why run elemental analysis in food?

ThermoFisher SCIENTIFIC

N

Nitrogen

- Monitoring protein content

Protein

- Determination of the nutritional quality of the products
- Transparent labelling - nutritional, health, safety and economical point of view
- Price definition and quality comparison enablement based on % protein declarations

S

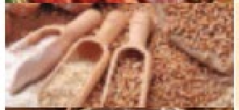
Sulfur

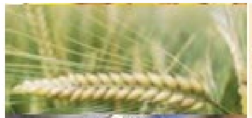
- Of essential importance for synthesis of amino acids and vitamins
- Cattle – good regeneration of the udder during lactation
- Horse – essential for healthy hoof growth
- Brewery – preserving the shelf life of beer and securing the safety of the raw materials and final products

Official methods

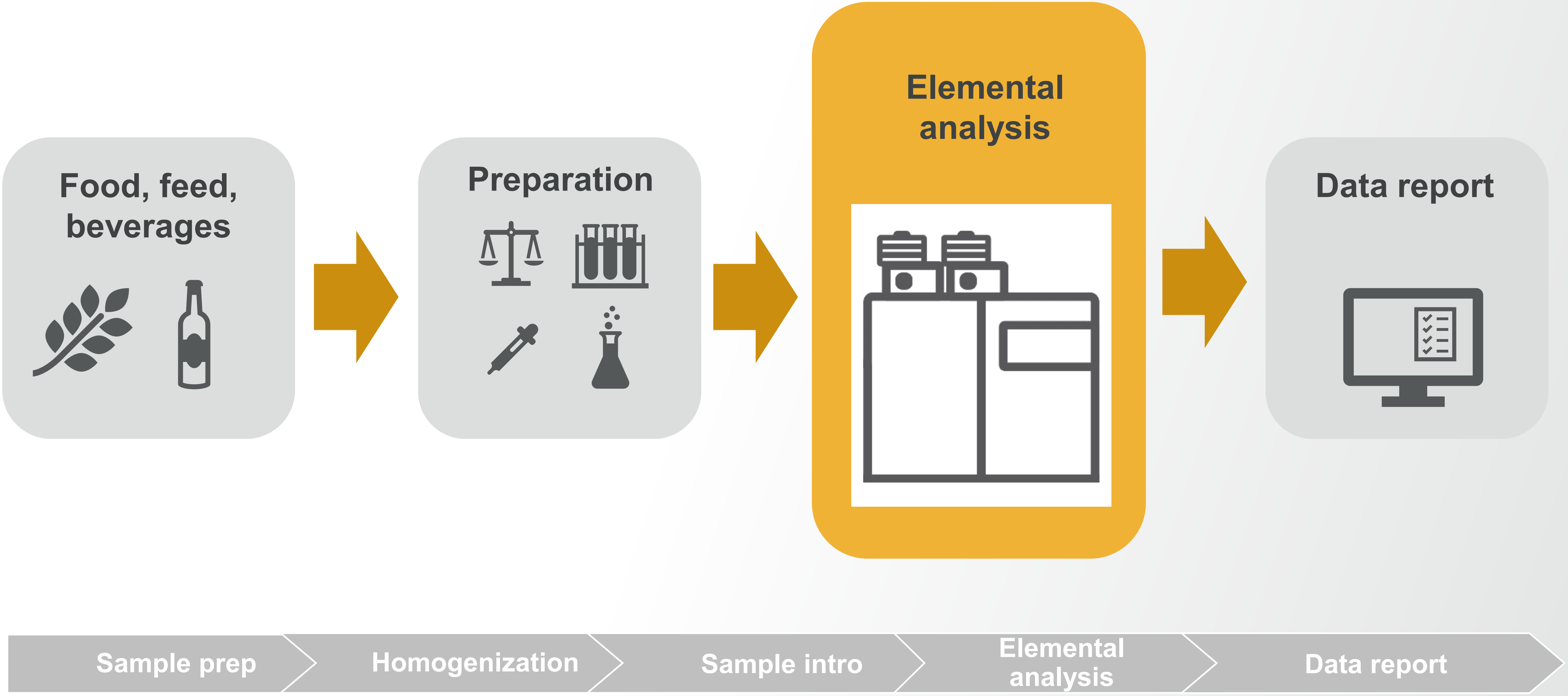
Interlaboratory data standardization

- Dumas (combustion) methods for N/Protein determination as the alternative to the Kjeldahl method

Application	Official Association	Official Method
	**AACC (American Association of Cereal Chemists)**	Crude Protein in Cereal, 46-30, 1999
	**AOAC (Association of Official Analytical Chemists)**	Official Method 990.03. Protein (crude) in Animal Feed 4.2.08
	**AOAC (Association of Official Analytical Chemists)**	Official Method 992.15. Crude Protein in Meat and Meat Products including Pet Foods 39.1.16
	**AOAC (Association of Official Analytical Chemists)**	Official Method 992.23. Crude Protein in Cereals, Grain and Oilseeds 32.2.02
	**AOAC (Association of Official Analytical Chemists)**	Official Method 997.09 Nitrogen in Beer, Wort, and Brewing Grains Protein (Total) by Calculation (Combustion Method)
	**AOAC (Association of Official Analytical Chemists)**	Official Method 972.43 Microchemical Determination of Carbon, Hydrogen and Nitrogen
	**AOCS (American Oil Chemists Society)**	Official Method Ba 4e-93 (revised 1995). Combustion Method for Determination of Crude Protein

	**ASBC (American Society of Brewing Chemists)**	Official Method 1996. Nitrogen Determination in Barley
	**ASBC (American Society of Brewing Chemists)**	Total Nitrogen in Wort and Beer by Combustion Method. Report of Subcommittee, 1994
	**DIN, EN, ISO 16634-1, 2008 (International Organization for Standardization)**	Food Products – Determination of the Total Nitrogen Content by Combustion According to the Dumas Principle and Calculation of the Crude Protein Content. Part 1: Oil Seeds and Animal Feeding Stuffs
	**DIN, EN, ISO 16634 – 2 (International Organization for Standardization)**	Food Products – Determination of the Total Nitrogen Content by Combustion According to the Dumas Principle and Calculation of the Crude Protein Content. Part 2: Cereals, Pulses and Milled Cereal Products
	**IFFO (International Fishmeal and Fish Oil Organization Ltd.)**	Nitrogen Determination in Fish Meal by Combustion Method
	**ISO 14891 (International Organization for Standardization)** **FIL 185 (International Dairy Federation)**	Nitrogen Determination in Dairy Products by Combustion Method
	**Office International de la Vigne et du Vin**	Resolution OENO 13/2002 Quantification of Total Nitrogen by Dumas Method (Must and Wines) Quantification de l'Azote Total Selon la Methode de Dumas (Mouts et Vins)

Elemental analysis workflow



Flash*Smart* Elemental Analyzer

ThermoFisher SCIENTIFIC

What is the Thermo Scientific™ Flash*Smart* ™ EA?

- An elemental analyzer which operates with the dynamic flash combustion (modified Dumas method) with the Thermal Conductivity Detector (TCD).

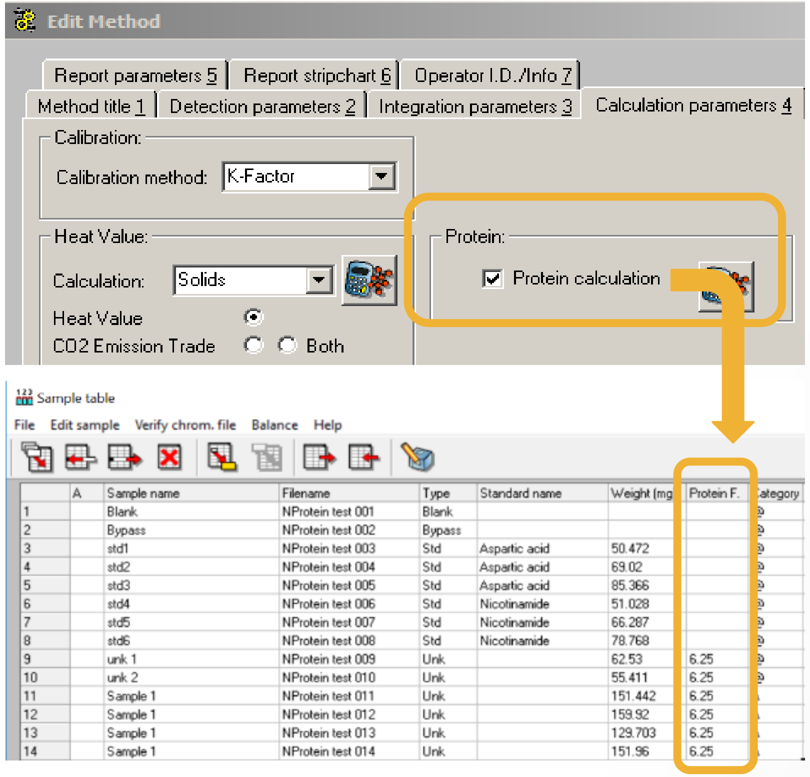
What is Flash*Smart* EA measuring?

- Carbon, hydrogen, nitrogen, sulfur and oxygen

How is the sample introduced in the system?

- Thermo Scientific™ MAS Plus Autosampler for solids, viscous and liquids (weighed in containers)
- Thermo Scientific™ AI/AS 1310 Liquid Autosamplers

Data report



Thermo Scientific™ Eager*Smart*™ Data Handling Software

- Specific factors for the conversion of nitrogen content to protein content (FAO)
- **Acquired data:**
  - **Nitrogen**
  - **N/Protein**
  - **Sulfur**
- Personalized reports

All-in-one analyzer

Flash*Smart* EA applications






Crops

- Cereals and beans are the main component of the human diet and of feeding stock for domestic animals
- In addition to its dietary importance, protein content has become a quality guideline for some cereal trade transactions

Sample	N%	Protein %	RSD%
Corn	1.14	7.10	0.74
Bran	2.27	14.19	0.81
Wheat	1.74	10.89	0.30
Rice	1.10	6.27	0.83
Soy	6.21	38.81	0.55
Lentils	3.84	23.99	0.55
Beans	3.54	22.15	0.69
Peas	4.46	27.89	040
Green beans	3.90	24.40	0.53

Dairy products

- Solid, liquid and viscous dairy products
- Nitrogen/Protein determination for food quality control and R&D purposes
- Protein content and labeling requirements enable consumers to compare price and quality

Sample	N%	Protein %	RSD%
Raw milk	0.476	3.04	0.61
Pasteurized milk	0.510	3.25	0.68
UHT milk	0.529	3.38	0.56
Milk powder	5.46	34.83	0.30
Emmental	3.38	21.07	0.88
Parmesan	5.21	33.25	0.80
Provolone	4.35	27.77	0.67
Spread cheese	3.36	20.99	0.99
Yoghurt	0.515	3.28	0.95

Meat products

Thermo Fisher SCIENTIFIC

- Meat products require homogenization
- Nitrogen/Protein determination for food quality control

Sample	N%	Protein %	RSD%
Cured ham	4.51	28.19	0.35
Coppa	4.34	27.12	0.71
Beef sausage	2.99	18.69	1.54
Wurstel	2.42	15.15	0.83
Salame	3.18	19.87	0.49
Bacon	2.75	17.19	1.15
Mortadella Bologna	3.27	20.44	1.32

Isotope analysis workflow

Isotope fingerprints

Product origin of fruits and vegetables, animal meat

$\delta^{34}S$

$\delta^{18}O$

Watering of beverages and product origin of coffee, wine, liquor, water, sugar, animal meat, flavors

Mislabeling of fruits and vegetables, animal meat

$\delta^{15}N$

Watering of beverages and product origin of coffee, wine, liquor, water, sugar, animal meat, flavors

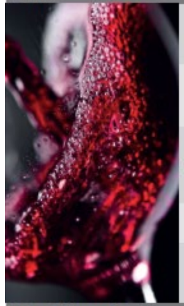
$\delta^{2}H$

Adulteration of honey, liquor, wine, olive oil, butter, flavors, animal meat

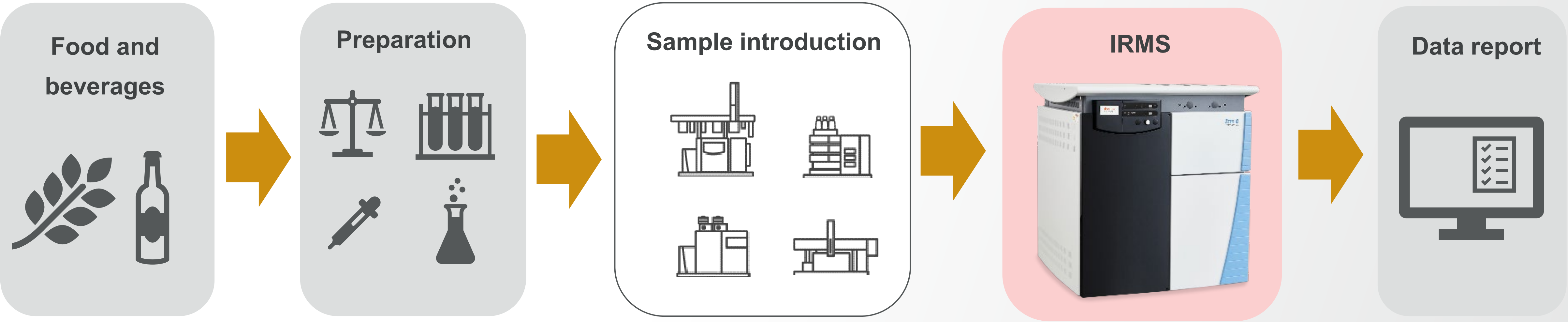
$\delta^{13}C$

Official methods in food integrity applications

- CODEX ALIMENTARIUS INTERNATIONAL FOOD STANDARDS (FAO/WHO)
  - Recommended methods of analysis and sampling CXS 234-1999
- CEN Technical Committee 460 ‘Food Authenticity’ Working Group 6 - IRMS

Product	Official method	Isotope fingerprint	Sample	What does it address?	Analytical solution
Wine					
	OIV-MA-AS2-12	$\delta^{18}O$	Water	Adulteration, Geographical origin, Year of vintage	Thermo Scientific™ GasBench II System, Thermo Scientific™ Dual Inlet
	OIV-MA-AS312-06	$\delta^{13}C$	Ethanol, Wine must, Grape sugar	Adulteration, origin	Thermo Scientific™ EA IsoLink™ IRMS System, Thermo Scientific™ GC IsoLink II™ Interface for GC-IRMS
	OIV-AS312-07	$\delta^{13}C$	Glycerol in wines	Adulteration by addition of glycerol from C4 maize or Fossil sources	GC IsoLink II Interface for GC-IRMS, Thermo Scientific™ LC IsoLink™ Interface for IRM-LC/MS
	OIV-OENO 510-2013	$\delta^{13}C$	Acetic acid in wine, vinegar		GC IsoLink II Interface for GC-IRMS, EA IsoLink IRMS System
	OIV-OENO 510-2013	$\delta^{18}O$	Water in wine, vinegar	Adulteration, Geographical Origin, Year of Vintage	Thermo Scientific™ GasBench II System, Dual Inlet
Sparkling wine					
	OIV-MA-AS314-03	$\delta^{13}C$	CO_2 in sparkling wine	Origin and authenticity of sparkling wine	GasBench II System, EA IsoLink IRMS System, GC IsoLink, Dual Inlet
Spirits					
	OIV-AS312-07	$\delta^{13}C$	Glycerol in spirits	Adulteration by addition of glycerol from C4 maize or Fossil sources	GC IsoLink II Interface for GC-IRMS, LC IsoLink Interface for IRM-LC/MS
Fruit Juice					
	EU – CEN 1995	$\delta^{13}C$	Sugars	Adulteration	GasBench II System, LC IsoLink Interface for IRM-LC/MS, GC IsoLink II Interface
	USA – AOAC 1981	$\delta^{13}C$	Sugars	Adulteration	GasBench II System, LC IsoLink Interface for IRM-LC/MS, GC IsoLink II Interface
	EU – CEN 1998	$\delta^{13}C$	Sugars and pulp	Adulteration	GasBench II System, LC IsoLink Interface for IRM-LC/MS, GC IsoLink II Interface
	EU – CEN 1995	$\delta^{2}H$ and $\delta^{18}O$	Water	Adulteration	GasBench II System, LC IsoLink Interface for IRM-LC/MS, GC IsoLink II Interface
	AOAC method 2004.01	$\delta^{13}C$	Ethanol (From Fermentation)	Adulteration	GasBench II System, LC IsoLink Interface for IRM-LC/MS, GC IsoLink II Interface
Fruit Juice (Concentrate)					
	AOAC 1992	$\delta^{18}O$	Water	Adulteration	GasBench II System, LC IsoLink Interface for IRM-LC/MS, EA IsoLink IRMS System
Honey					
	AOAC method 991.41	$\delta^{13}C$	C-4 plant sugars at concentration >7%	Adulteration of honey	EA IsoLink IRMS System
	AOAC method 998.12	$\delta^{13}C$	C-4 plant sugars at concentration >7%	Adulteration of honey	EA IsoLink IRMS System
Cheese					
	EU Reg 548/2011	$\delta^{13}C$	PDO	PDO Grana Padano	EA IsoLink IRMS System

Isotope analysis workflow

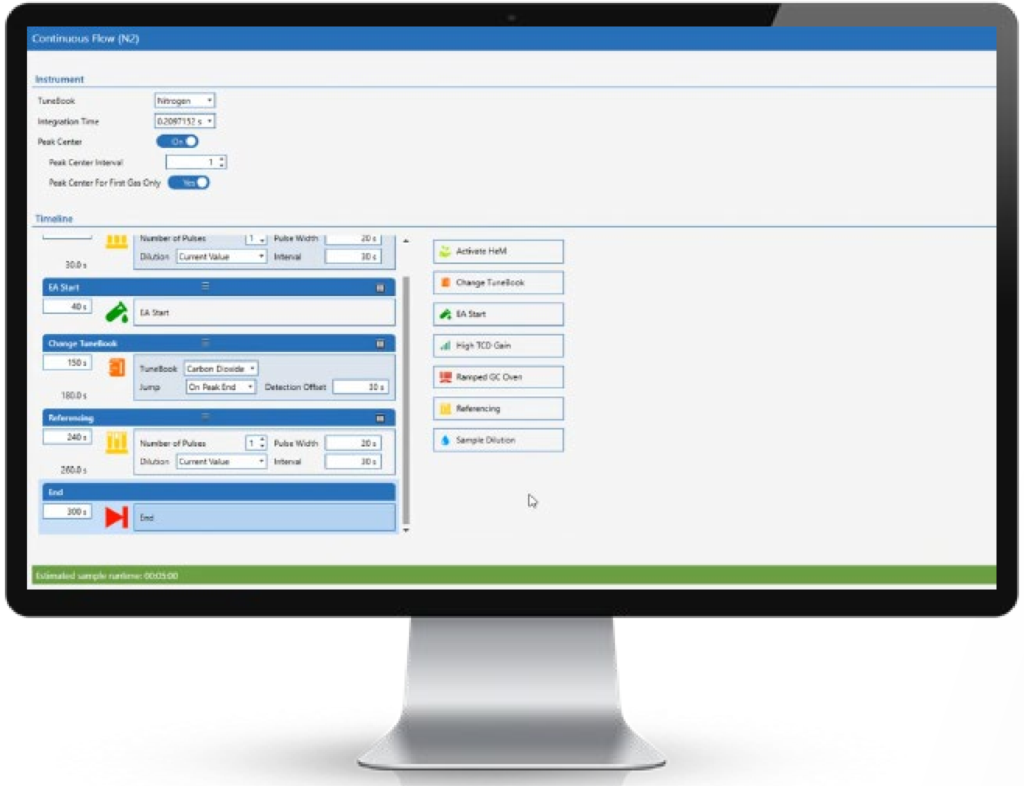


Sample prep → Sample intro → Conversion → IRMS analysis → Data report

IRMS portfolio

Thermo Fisher SCIENTIFIC

Driven by Thermo Scientific™ Qtegra™ Intelligent Scientific Data Solution (ISDS) Software



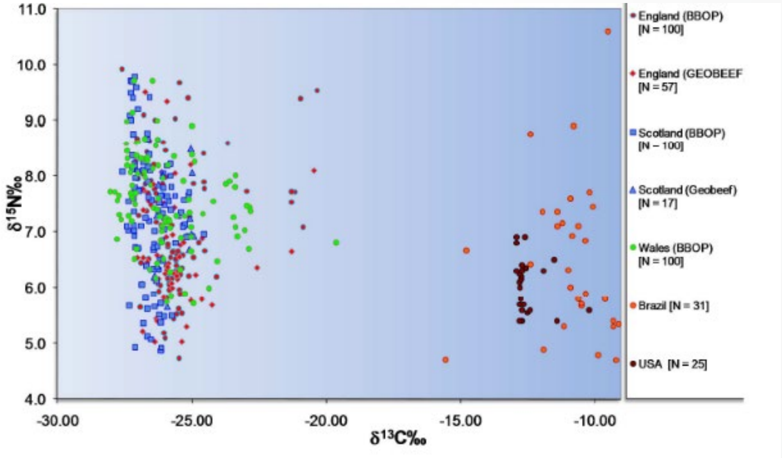
Why Qtegra ISDS Software?

- Automate workflows
- Simplify your experience
- Improve efficiency

DRIVEN BY QTEGRA ISDS

Where does my beef come from?

Thermo Scientific™ EA IsoLink™ IRMS System

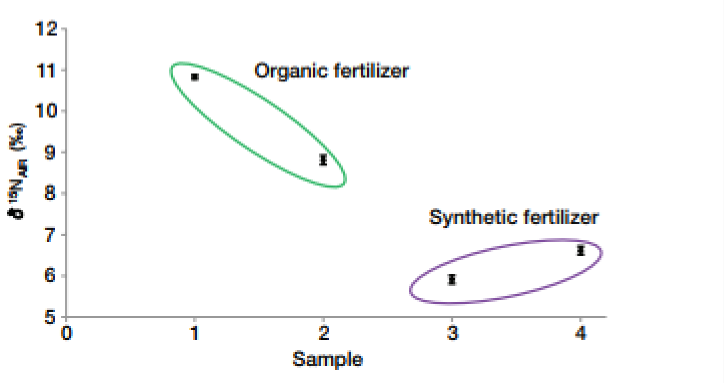


Heaton et al., 2008

- Carbon and Nitrogen isotope fingerprint
- Pasture varies between C3 and C4 plant groups, which result in difference in animal (i.e., dietary differences)
- UK cattle reared on C3 diet, whilst Brazilian cattle reared on C4 diet

Was my produce organically grown?

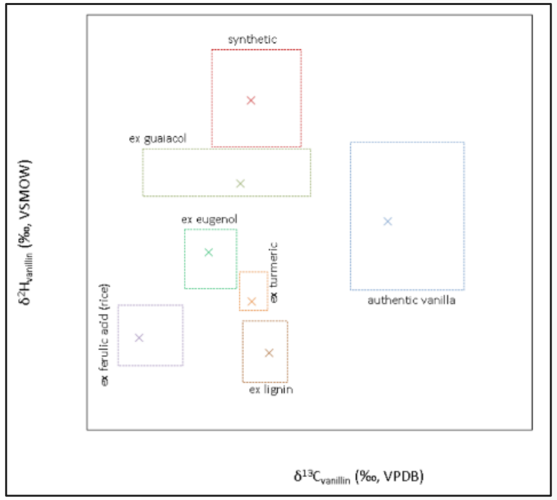
Thermo Scientific™ EA IsoLink™ IRMS System



- Nitrogen isotope fingerprint
- Differentiation of nitrogen isotopes in plants and soils due to ammonia volatilization, denitrification, nitrification, etc.
- Organic (+8‰ to +20‰) versus synthetic fertilization (+3‰ to +6‰)

What is in my ice cream?

Thermo Scientific™ GC IsoLink II™ IRMS System

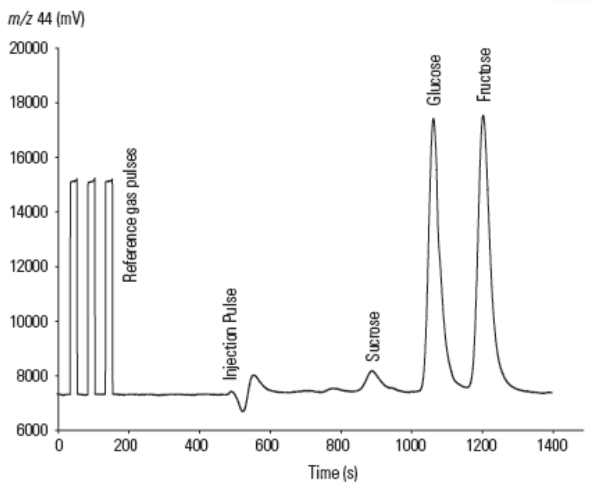


Courtesy D. Psomiadis, Imprint Analytics

- Carbon and Hydrogen isotope fingerprint
- Investigation the origin of vanillin in ice cream, cakes, cookies
- Natural (vanilla pods) vs. synthetic (e.g. wood, petroleum) vs. biosynthetic (e.g. cloves, rice, corn)

Was my honey sweetened?

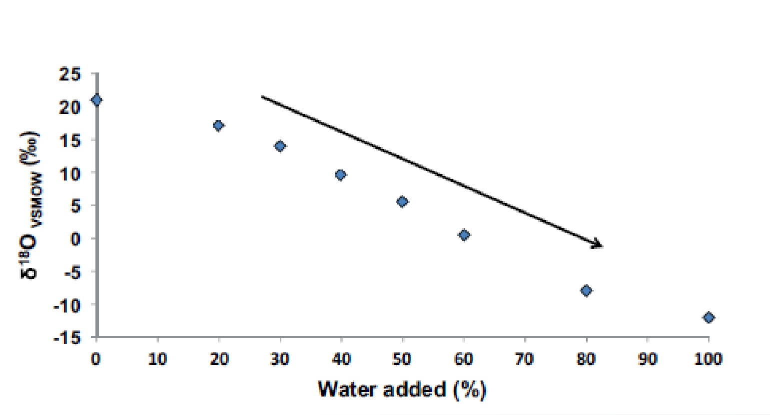
Thermo Scientific™ LC IsoLink™ IRMS System



- Carbon isotope fingerprint
- Honey adulteration by addition of exogenous sugars
- Official method AOAC 998.12 (detection limit 7% sugar from C4 plant source) by EA-IRMS
- Compound specific analysis of individual sugars by LC-IRMS

Was my wine watered down?

Thermo Scientific™ GasBench Plus IRMS System



- Oxygen isotope fingerprint
- Geographical origin and adulteration OIV-MS-AS2-12
- Grapes have local-regional fingerprint associated with local-regional rainfall
- If adulterated by water or juices, the oxygen isotope fingerprint changes

Summary and Conclusion

- **Triple Quad ICP-MS** – Single method
  - 30 elements – Toxic and nutritional
  - Excellent interference removal
- **Elemental Analysis** – C,N,O,S and H
  - Nitrogen/Protein determination
  - All in one analysis of liquid and solid samples
- **Isotopic analysis**– origin and authenticity
  - Bulk and compound specific information
  - Fully integrated peripherals

Thermo Fisher SCIENTIFIC

Come speak to us at booth #2

Solutions for all your analytical needs

Visit www.thermofisher.com for more information

Thank you