

HUMAN HEALTH

ENVIRONMENTAL HEALTH

FOOD SAFETY AND QUALITY TESTING SOLUTIONS





Table of Contents

Selecting a Technique for Your Analysis	3
Detection Limits	3
Analytical Working Range	3
Sample Throughput	4
Costs	4
Selecting a System for Your Analysis	5
Selecting a Solution for Your Analysis	6
Sample Preparation Block	6
Titan MPS Microwave Digestion	6
PinAAcle 500 Atomic Absorption Spectrometers	6
PinAAcle 900 Atomic Absorption Spectrometers	6
Optima 8x00 ICP-OES Spectrometers	7
NexION 350 ICP-MS Spectrometers	7
NexION ICP-MS Speciation Solution	7
Separation. Detection. Operation. Integration.	7
Atomic Spectroscopy Detection Limits	8
Consumables	9
TIBCO Spotfire® Software for Food Analysis	10
Service – The Best in the Industry	11
Instrument Service and Repair	11
Qualification and Validation	11
Laboratory Relocation Services	11

FOOD SAFETY AND QUALITY TESTING SOLUTIONS

Analyzing for Metals in Food

Metals present in food can be vital to having a nutritional diet, but can also be deadly depending on what metal, and how much of it, is present in the food we eat. As the food supply chain grows in complexity, regulations become stricter, and consumers demand to know what is in the food they consume, it has become extremely important to test for metals in food.

This guide will walk you through the different technologies and systems available to help you effectively determine what solution fits your metals analysis need.

SELECTING A TECHNIQUE FOR YOUR ANALYSIS

With the variety of atomic spectroscopy techniques available, laboratory managers must decide which of these best suits their particular analytical requirements. Unfortunately, because the techniques complement each other so well, it may not always be clear which is the optimum solution for analyzing metals in food.

Selecting the right technique requires the consideration of various important criteria, including:

- Detection limits
- Analytical working range
- Sample throughput
- Data quality
- Cost
- Interferences
- Ease-of-use
- Availability of proven methodology

In order to help you narrow your selection, many of these criteria are discussed below for Flame AA, Graphite Furnace AA, ICP-OES and ICP-MS. In simple terms, your choice can be guided by answering the four questions in Figure 1.

Detection Limits

The detection limits achievable for individual elements are important in determining the usefulness of an analytical technique for a given analytical problem. Without adequate detection-limit capabilities, lengthy sample pre-concentration procedures may be required prior to analysis.

Typical detection-limit ranges for the major atomic spectroscopy techniques are shown in Figure 2. For a complete listing of detection limits by element for Flame AA, GFAA, ICP-OES (with radial and axial torch configurations) and ICP-MS, see the table on page 6.

Analytical Working Range

The analytical working range can be viewed as the concentration range over which quantitative results can be obtained without having to recalibrate the system. Selecting a technique with an analytical working range (and detection limits) based on expected analyte concentrations minimizes analysis time by allowing samples with varying analyte concentrations to be analyzed together. A wide analytical working range can also reduce sample-handling requirements, minimizing potential errors.

	Flame AA	GFAA	ICP-OES	ICP-MS
How Many Elements?				
Single	■			
Few		■		
Many			■	■
What Levels?				
High ppb-ppm	■		■	
Sub ppb		■	■	■
Sub ppt				■
How Many Samples?				
Very few	■	■		
Few	■	■	■	■
Many			■	■
How Much Sample?				
> 5 mL	■	■	■	■
< 1-2 mL		■		

Figure 1. Technique decision matrix.

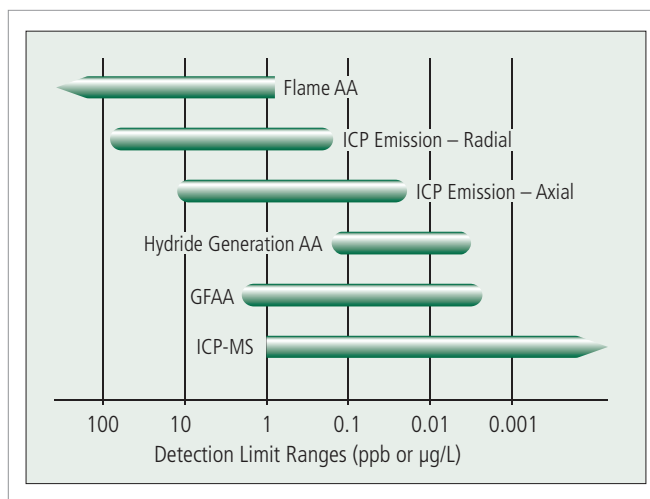


Figure 2. Typical detection limit ranges for the major atomic spectroscopy techniques.

Sample Throughput

Sample throughput represents the number of samples that can be analyzed and is dependent upon a number of factors, including the number of elements that can be determined per unit of time. For most techniques, analyses performed at the limits of detection or where the best precision is required will be more time-consuming than less demanding analyses. Where these factors are not limiting, the number of elements to be determined per sample and the analytical technique will determine the sample throughput.

- **Flame AA** – Provides relatively high sample throughput when analyzing a large number of samples for a limited number of elements. A typical determination of a single element requires only 3-10 seconds. However, Flame AA requires specific light sources and optical parameters in order for each element to be determined and may require different flame gases for different elements. As a result, even though it is frequently used for multi-element analysis, Flame AA is generally considered to be a single-element technique.
- **Graphite Furnace AA** – As with Flame AA, GFAA is typically a single-element technique because, like Flame AA, it requires a specific light source and optical parameters for each element. Because of the need to thermally program the system to remove solvent and matrix components prior to atomization, GFAA has a relatively low sample throughput. A typical graphite-furnace determination requires 2-3 minutes per element for each sample.
- **ICP-OES** – A true multi-element technique with exceptional sample throughput, ICP-OES systems typically can determine more than 73 elements per minute in individual samples. Where only a few elements are to be determined, however, ICP is limited by the sample uptake and washout times for each new sample, usually ranging from 15-45 seconds.
- **ICP-MS** – Also a true multi-element technique with the same advantages and limitations of ICP-OES. ICP-MS can typically determine more than 35 elements per minute in an individual sample, depending on such factors as the concentration levels and required precision. Although ICP-MS has a wide working range, sample dilution or selected ion attenuation is recommended to extend the life of the detector.

Costs

As they are less complex systems, instrumentation for single element atomic spectroscopy (Flame AA and GFAA) is generally less costly than that for the multi-element techniques (ICP-OES and ICP-MS). There can also be a considerable variation in cost among instrumentation for the same technique. Instruments offering only basic features are generally less expensive than more versatile systems, which frequently also offer a greater degree of automation. Figure 4 provides a comparison of typical instrument price ranges for the major atomic spectroscopy techniques.

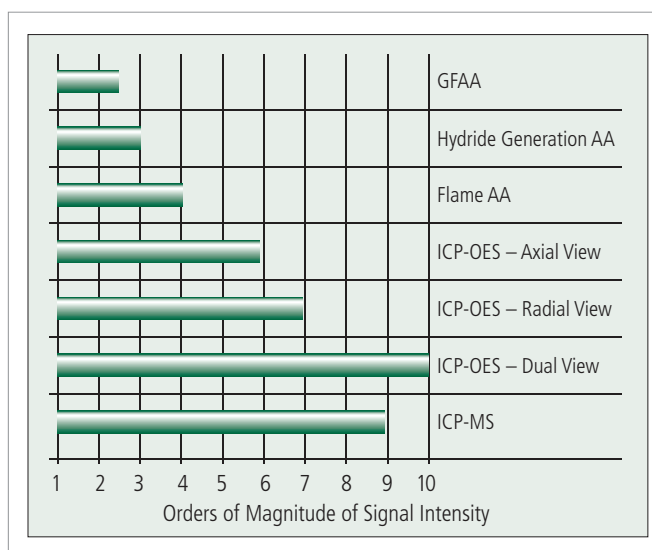


Figure 3. Typical analytical working ranges for the major atomic spectroscopy techniques.

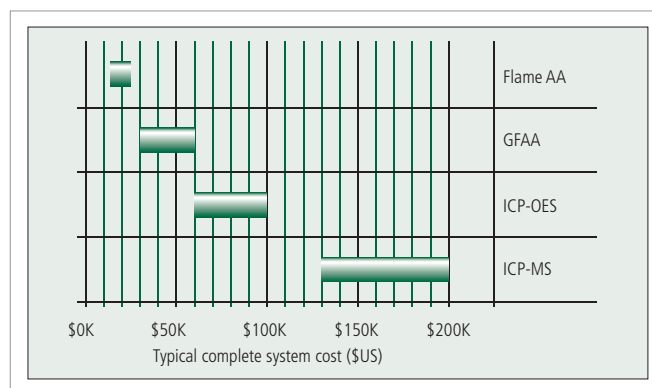






Figure 4. Typical relative purchase prices for atomic spectroscopy systems.

Selecting a System for Your Analysis

TECHNIQUE	STRENGTHS	LIMITATIONS	APPLICATIONS	SYSTEM
Flame AA – Flame Atomic Absorption Spectroscopy	<ul style="list-style-type: none"> • Very easy-to-use • Widely accepted • Extensive application information available • Relatively inexpensive 	<ul style="list-style-type: none"> • Limited analytical working range • Single-element analytical capability • Cannot be left unattended (flammable gas) 	<p>Ideal for laboratories analyzing large numbers of samples for a limited number of elements and for the determination of major constituents and higher analyte concentrations</p> <p>Application: nutrient analysis</p>	<p>PinAAcle 500 and PinAAcle 900F</p> 
GFAA – Graphite Furnace Atomic Absorption Spectroscopy	<ul style="list-style-type: none"> • Exceptional detection limits • Well-documented applications • May be left unattended • Capable of measuring low ppb to ppt concentrations 	<ul style="list-style-type: none"> • Limited analytical working range • Sample throughput somewhat less than other techniques 	<p>Ideal for laboratories analyzing a limited number of elements and requiring excellent detection limits.</p> <p>Application: toxic elements</p>	<p>PinAAcle 900Z/H/T AA Spectrometers</p> 
ICP-OES – Inductively Coupled Plasma Optical Emission Spectroscopy	<ul style="list-style-type: none"> • Exceptional overall multi-element atomic spectroscopy technique • Excellent sample throughput • Very wide analytical range • Good documentation available for applications • May be left unattended • Easy-to-use: tolerant for dissolved solids levels 	<ul style="list-style-type: none"> • Higher initial investment • Limited ability to measure sub ppb concentrations (see page 8) 	<p>Ideal for laboratories analyzing multiple elements in a moderate or large number of samples.</p> <p>Application: nutrient analysis</p>	<p>Optima ICP-OES Spectrometers</p> 
ICP-MS – Inductively Coupled Plasma Mass Spectrometry	<ul style="list-style-type: none"> • Exceptional multi-element capabilities • Ability to perform isotopic analyses • Well-documented interferences and compensation methods • Rapidly growing application information • Detection limits equal to or better than GFAA with much higher productivity • May be left unattended 	<ul style="list-style-type: none"> • Highest initial investment • Method development more complex than other techniques • Limited ability to handle high levels of dissolved solids without sample dilution 	<p>Ideal for laboratories analyzing multiple elements in a large number of samples and requiring a system capable of determining trace and ultra-trace analyte concentrations.</p> <p>Application: nutrients and toxic elements in the same analysis</p>	<p>NexION ICP-MS Spectrometers</p> 

Once you have identified the best solution for your particular application, read on for more in-depth product details.

SELECTING A SOLUTION FOR YOUR ANALYSIS

Sample Preparation Block

With no exposed metal components and an outer shell manufactured from acid-resistant thermoplastic, the sample preparation blocks, (SPB) reduce the chances of sample contamination. Each system is constructed with a solid, PTFE coated, graphite block where a flat heater covers 95% of the block's base. This guarantees temperature uniformity and eliminates hot spots found on hot plates:

- Ideal for any digestion/heating method which requires temperatures below 180 °C
- Provides uniform temperature (± 1.0 °C across the block)
- Delivers even sample evaporation results
- PTFE-coated graphite block resists aggressive, corrosive attack
- Choose from eight different sample preparation blocks

Titan MPS Microwave Digestion

The Titan MPS™ microwave is a top-loading microwave sample preparation system protected by hardware interlocks to ensure safety during operation. Some think all microwave sample preparation systems are the same. But there are several subtle differences that, when considered together, improve the usability of the system:

- This top-loading system with an interlocked lid allows easy loading and removal of vessels
- The cylindrical, pressure resistant, PFA-coated stainless steel oven chamber and optical temperature and pressure reaction monitoring systems ensure the most reproducible results
- Vessels are reusable and guaranteed for one year, for considerable savings on consumables
- Integrated gas collection system efficiently vents the oven chamber to keep it free of gas or acidic vapors
- Color touch-screen controller simplifies programming, data storage, and reaction control

FAST Flame Sample Introduction System

Designed to deliver the lowest cost-per-element analysis on the market, FAST Flame lets you perform your daily workflows with unparalleled speed, consistency and precision. FAST Flame for Flame AA analyses offers laboratories a fast, automated, error-free way to:

- Prepare calibration standards
- Dilute over-range sample solutions
- Add chemicals and other flame sampling needs

PinAAcle 500 Atomic Absorption Spectrometers

The PinAAcle™ AA offers superior durability, longer life, lower maintenance costs, and the fastest return on investment of any Flame AA. Engineered to deliver an uncompromising level of performance at an unbeatable price, the PinAAcle 500 puts the industry's most robust, reliable Flame AA within reach of even the most budget-conscious laboratories:

- Achieve precision of less than 0.3%, consistently better than competitive instruments
- Increase throughput without sacrificing accuracy or precision with an optional FAST Flame sample automation system
- Enjoy the confidence and sample flexibility of working with the world's first Flame AA System engineered for complete corrosion resistance
- Boost profitability with the lowest cost-per element Flame AA analysis using a FAST Flame enhanced system
- Speed through every analysis with the intuitive, icon-based interface of Syngistix Touch™ or Syngistix™ for AA Software

PinAAcle 900 Atomic Absorption Spectrometers

The PinAAcle series of atomic absorption (AA) spectrometers brings AA performance to new heights. Engineered with an array of exciting technological advances, it offers a variety of configurations and capabilities to deliver exactly the level of performance you need:

- Flame only, furnace only, or space-saving stacked design featuring both
- Flame, furnace, flow injection, FIAS-furnace and mercury/hydride capabilities on a single instrument
- Choice of Deuterium or longitudinal Zeeman background correction
- TubeView™ color furnace camera simplifies autosampler tip alignment and sample dispensing
- Syngistix: Workflow-based Syngistix for AA software simplifies every step from method development to report generation

Optima 8x00 ICP-OES Spectrometers

With its groundbreaking features and expanded capabilities, the Optima™ 8x00 series is more than just an evolution of the world's most popular ICP-OES... it's a revolution. Built around the proven design of the Optima platform, the 8x00 series delivers breakthrough performance through a series of cutting-edge technologies that enhance plasma stability, simplify method development and dramatically reduce operating costs:

- **Flat Plate™ Plasma Technology** – with a patented, maintenance-free RF generator uses half the argon of traditional systems dramatically reducing operating costs.
- **Patented Dual View** – offers radial and axial viewing of the plasma for effective measurement of elements with high and low concentrations in the same method.
- **PlasmaCam™ Viewing Camera** – offers continuous viewing of the plasma, simplifying method development and enabling remote diagnostic capabilities for maximum uptime.

NexION 350 ICP-MS Spectrometers

To leverage the true power of ICP-MS in your lab, you need a solution that lets any scientist analyze any sample at any time. All while generating clear, reliable, informative results. Achieving these goals requires an instrument that offers a unique level of simplicity, flexibility and sensitivity – exactly what you get with the NexION® 350 series ICP-MS. Engineered with an array of ground-breaking technologies, – such as the Extended Dynamic Range (EDR) capabilities, allowing you to selectively attenuate the signal of specific masses in order to measure elements with both low and high concentrations in the same food sample in the same run to optimize performance and productivity, – the NexION 350 has changed the face of ICP-MS by being the first instrument to offer:

- Three cones (sampler, skimmer, and hyper skimmer) to eliminate internal maintenance and provide unrivaled stability
- Three quadrupoles to maximize sensitivity for every element in a run
- Three modes of operation (Standard, Collision, and Reaction) for ultimate application flexibility

Table 2. Commonly used techniques for food safety and nutritional labeling analysis.

ATOMIC SPECTROSCOPY APPLICATIONS BY MARKET				
MARKET	TYPICAL APPLICATIONS	COMMONLY USED TECHNIQUES		
		AA	ICP-OES	ICP-MS
Food	Food safety	■	■	■
	Nutritional labeling	■	■	■

Frequency of Technique Used

NexION ICP-MS Speciation Solution

Since many trace metals have a number of species with varying properties—often with profound differences in mobility, bioavailability, and/or toxicity—discerning one from another in a sample has become essential in the food, environmental and clinical research industries.

Speciation analysis of this type is best performed using advanced hyphenated techniques—coupling effective separation with highly sensitive detection/quantification. And no one offers a more integrated, flexible, and accurate speciation solution than PerkinElmer. Take your speciation analysis to the next level with the NexION ICP-MS Speciation Solution.

Separation. Detection. Operation. Integration.

The NexION Speciation Solution brings together our industry-leading Altus™ LC Systems technology and the revolutionary NexION ICP-MS in a seamlessly integrated platform that can be fully controlled with a single, intuitive software for the simplest, most streamlined operator experience available:

- Fully integrated chromatography/ICP-MS system
- Choice of front ends—including LC, GC and even 3rd-party IC systems
- Intuitive, unified software platform to run all components
- Complete speciation solution spanning instrumentation, software, expertise, service and training

Learn more at: www.perkinelmer.com/speciation



Atomic Spectroscopy Detection Limits

ELEMENT	FLAME AA	HG/HYDRIDE	GFAA	ICP-OES	ICP-MS	ELEMENT	FLAME AA	HG/HYDRIDE	GFAA	ICP-OES	ICP-MS
Ag	1.5		0.005	0.6	0.00009	Mo	45		0.03	0.5	0.00008
Al	45		0.1	1	0.0004 *	Na	0.3		0.005	0.5	0.0003
As	150	0.03	0.05	1	0.0004	Nb	1500			1	0.00004
Au	9		0.15	1	0.0001	Nd	1500			2	0.0003
B	1000		20	1	0.001	Ni	6		0.07	0.5	0.0002 *
Ba	15		0.35	0.03	0.00004	Os				6	0.00006
Be	1.5		0.008	0.09	0.0003	P	75000		130	4	0.04 *
Bi	30	0.03	0.05	1	0.00002	Pb	15		0.05	1	0.00004 *
Br					0.04	Pd	30		0.09	2	0.00003
C						Pr	7500			2	0.00003
Ca	1.5		0.01	0.05	0.0003 *	Pt	60		2.0	1	0.0001
Cd	0.8		0.002	0.1	0.00007	Rb	3		0.03	5	0.0002
Ce				1.5	0.00005	Re	750			0.5	0.0003
Cl				2		Rh	6			5	0.00004
Co	9		0.15	0.2	0.00006 *	Ru	100		1.0	1	0.0001
Cr	3		0.004	0.2	0.0003 *	S				10	0.9 *
Cs	15				0.00005	Sb	45	0.15	0.05	2	0.0002
Cu	1.5		0.014	0.4	0.0002 *	Sc	30			0.1	0.001
Dy	50			0.5	0.0002	Se	100	0.03	0.05	2	0.0003 *
Er	60			0.5	0.0001	Si	90		1.0	10	0.09
Eu	30			0.2	0.00007	Sm	3000			2	0.0002
F						Sn	150		0.1	2	0.0002
Fe	5		0.06	0.1	0.0005 *	Sr	3		0.025	0.05	0.00007
Ga	75			1.5	0.00008	Ta	1500			1	0.00001
Gd	1800			0.9	0.0003	Tb	900			2	0.00003
Ge	300			1	0.0006 *	Te	30	0.03	0.1	2	0.0003 *
Hf	300			0.5	0.0003	Th				2	0.00005
Hg	300	0.009	0.6	1	0.001	Ti	75		0.35	0.4	0.0002 *
Ho	60			0.4	0.00004	Tl	15		0.1	2	0.00001
I					0.003	Tm	15			0.6	0.00003
In	30			1	0.00008	U	15000			10	0.00002
Ir	900		3.0	1	0.00009	V	60		0.1	0.5	0.00007 *
K	3		0.005	1	0.001	W	1500			1	0.00003
La	3000			0.4	0.00004	Y	75			0.2	0.00002
Li	0.8		0.06	0.3	0.00005	Yb	8			0.1	0.0001
Lu	1000			0.1	0.00004	Zn	1.5		0.02	0.2	0.0007 *
Mg	0.15		0.004	0.04	0.0001	Zr	450			0.5	0.00007
Mn	1.5		0.005	0.1	0.0001 *						

All detection limits are given in micrograms per liter and were determined using elemental standards in dilute aqueous solution. All detection limits are based on a 98% confidence level (three standard deviations).

All atomic absorption detection limits were determined using instrumental parameters optimized for the individual element, including the use of System 2 electrodeless discharge lamps where available. Data shown were determined on a PerkinElmer AA.

All Optima ICP-OES detection limits were obtained under simultaneous multi-element conditions with the axial view of a dual-view plasma using a cyclonic spray chamber and a concentric nebulizer.

Cold-vapor mercury detection limits were determined with a FIAS-100 or FIAS-400 flow injection system with amalgamation accessory.

The detection limit without an amalgamation accessory is 0.2 µg/L with a hollow cathode lamp, 0.05 µg/L with a System 2 electrodeless discharge lamp. (The Hg detection limit with the dedicated FIMS-100 or FIMS-400 mercury analyzers is < 0.005 µg/L without an amalgamation accessory and < 0.0002 µg/L with an amalgamation accessory.) Hydride detection limits shown were determined using an MHS-15 Mercury/Hydride system.

GFAA detection limits were determined on a PerkinElmer AA using 50 µL sample volumes, an integrated platform and full STPF conditions. Graphite-furnace detection limits can be further enhanced by the use of replicate injections.

All ICP-MS measurements were performed on a NexION ICP-MS with a quartz sample introduction system using a 3-second integration time and ten replicates in de-ionized water. Detection limits were measured under multi-element conditions in Standard mode, except where denoted by an asterisk (*). Detection limits denoted by * were performed in a Class-100 Clean Room using Reaction mode with the most appropriate cell gas and conditions for that element in de-ionized water.

Consumables

With instruments that are the industry standard worldwide, PerkinElmer accessories, consumables, methods and application support meet the most demanding requirements and are the preferred choice in thousands of laboratories globally.

We invest heavily in testing and validating our complete portfolio of solutions to ensure that you receive accurate, repeatable results, on-time, every time throughout the lifetime of your instrument. From Lumina™ hollow cathode lamps that allow automatic setup and provide long lamp lifetime to our Pure

standards that have been analyzed and certified to yield reliable, accurate results, you'll be able to relax knowing you have the best. We also offer a complete portfolio of specialized consumables that deliver reliable performance, control operating costs and maximize the uptime of your instrument.

When you order our precision-designed, genuine atomic spectroscopy PerkinElmer consumables and supplies, you'll get the results you need-accurately and on-time.



Figure 5. Hollow Cathode Lamps



Figure 6. HybridXLT™ Torch

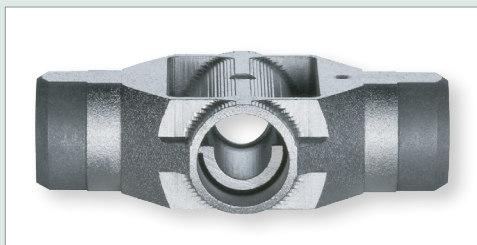


Figure 7. THGA Graphite Tubes with Advanced Platform™.



Figure 8. Inorganic Aqueous Standards.

TIBCO SPOTFIRE® SOFTWARE FOR FOOD ANALYSIS

Improving the security of our food supply is critical to consumers across the globe. Knowing what's in the food we eat is fundamental in ensuring quality, safe food. With the visualization power of TIBCO Spotfire®, food producers can pinpoint what's really in the food they supply and take steps to improve safety, quality and authenticity.

As part of our exclusive TIBCO Spotfire® Software platform, we developed the TIBCO Spotfire® for Inorganic Food Dashboard. The data visualization features of this dashboard make it possible to save both time and money while producing a superior contaminant tracking analysis. With the software you can:

- Drill down into clusters of multidimensional data
- Trace food contaminant origin from initial ingredients to the final product
- Hierarchically categorize ingredient and additive data
- Interact with the data across all visualizations

TIBCO Spotfire®

PerkinElmer is the exclusive global distributor of the TIBCO™ Spotfire® platform for certain scientific and clinical R&D applications.

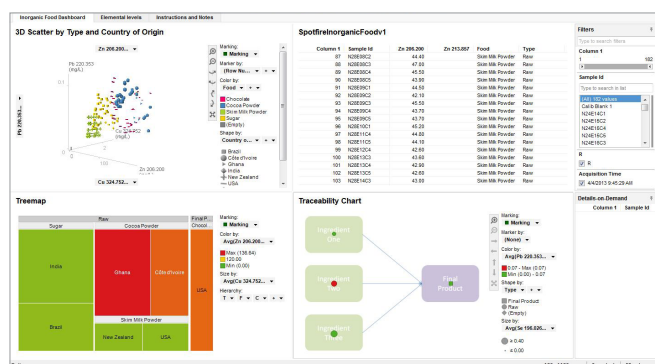


Figure 9. 3D Scatterplot (top left), Data Table (top right), Treemap (bottom left), Traceability Chart (bottom right).

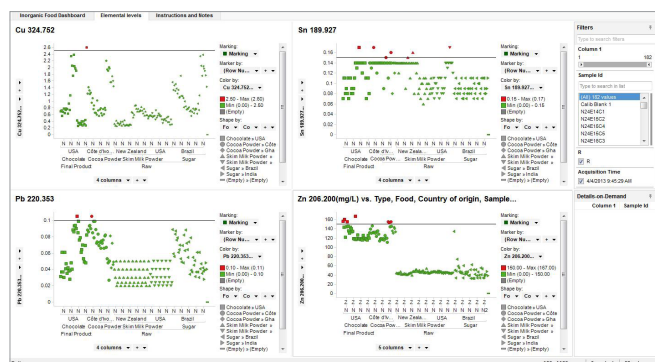


Figure 10. 2D Scatterplots designed to show data above and below each contaminant's regulated limit.

SERVICE – THE BEST IN THE INDUSTRY



Empowering Your Science Driving Your Business

Financial and operational demands on laboratories are becoming tougher every day. It's a constant challenge to find ways to do more, in less time, for less money.

Fortunately, we know how it feels to be in your shoes. After all, we're scientists too. And service engineers, validation experts, asset managers, relocation specialists, and IT professionals. We're a global team. An integrated resource.

A trusted partner offering everything you need to optimize the efficiency of your lab—and your business—from a single source.

Instrument Service And Repair

With a comprehensive program from OneSource, you can maximize laboratory productivity while minimizing administrative headaches and costs. We have the tools, resources and expertise to keep your instruments running, your scientists working, and your business growing:

- Coverage for all technologies and manufacturers
- Highly trained, professional service engineers
- Fast response times
- Extensive parts inventory for prompt availability
- Preventative maintenance programs
- System stability checks
- Equipment installation and warranty services

Qualification And Validation

With a robust range of products and array of service levels, OneSource helps you manage the complexities of the qualification process while controlling costs and ensuring the compliance of every instrument and computer system in your lab:

- Full library of IQ/OQ/PQ protocols covering laboratory technologies worldwide

- Continuous monitoring of regulatory guidelines to stay current
- Customizable programs to suit the compliance requirements of individual laboratories
- Testing of equipment against approved specifications
- Comprehensive suite of products, from automated to traditional protocols
- Concise, easy-to-review qualification reports
- Secure digital archiving of data and records for simplified audits
- Compliant with relevant international standards
- Computer system validation — 21 CFR Part 11 and GAMP 5
- Method validation
- Metrology and calibration services

Laboratory Relocation Services

Whether you're moving across the hall or across the globe, PerkinElmer OneSource Laboratory Services understands the unique requirements of laboratory relocation and can handle every facet from start to finish, supporting a smooth transition and minimized downtime on both ends:

- Expert decommissioning and re-commissioning of instruments
- Help with continued regulatory compliance through proper procedure and documentation
- Complete solutions for labs of all sizes, from handling of hazardous materials to equipment qualification

As one of the most experienced, most complete providers of laboratory services worldwide, OneSource is positioned to offer a more valuable, customizable and profitable partnership. Discover our integrated approach and take advantage of an ideal set of tools to help empower your science and drive your business.

For more information on our laboratory services visit www.perkinelmer.com/onesource

PerkinElmer, Inc.
940 Winter Street
Waltham, MA 02451 USA
P: (800) 762-4000 or
(+1) 203-925-4602
www.perkinelmer.com



For a complete listing of our global offices, visit www.perkinelmer.com/ContactUs

Copyright ©2016, PerkinElmer, Inc. All rights reserved. PerkinElmer® is a registered trademark of PerkinElmer, Inc. All other trademarks are the property of their respective owners.