WEBINAR 2021

# **New Software Functionality:** How next generation software results in better performance and time-efficient operation

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# How next generation software results in better performance and time-efficient operation

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Ph D, Analytical Chemistry, Hamburg

2001 Method Development Bruker AXS

Now Head of Product Management XRF

Karlsruhe, Germany

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Ph D, Geoscience, Hannover

2019 Product Management Bruker AXS

Product Management XRF

Karlsruhe, Germany

# Outline


01 Introduction to XRF

02 What a Software needs

03 How to calibrate your Spectrometer

04 Latest Features

05 Routine Operations without PC

06 SMART Standardless Solutions

07 Summary

08 Q&A

# When to use X-ray Fluoresence (XRF) Analysis?

Elemental compositions often define the properties or quality of a compound, material or product.

- XRF is used for fast and accurate analysis of elemental compositions in various materials
- XRF is an established analytical tool for process and quality control in the industry
- XRF allows to meet changing quality requirements based on excellent data quality
- XRF analysis can be used, e.g., to define material value based on grade control (mining)
- XRF analysis adds value and can often determine the suitability of a product for specific applications (high tech functional material)

# Mature Technology in XRF?
# Are there any Changes to Address Future Requirements

Applications are getting more demanding for higher accuracy, better precision, better detection of traces

New legislation is enforcing extended analysis – more elements, lower detection limits, closer monitoring

Examples:

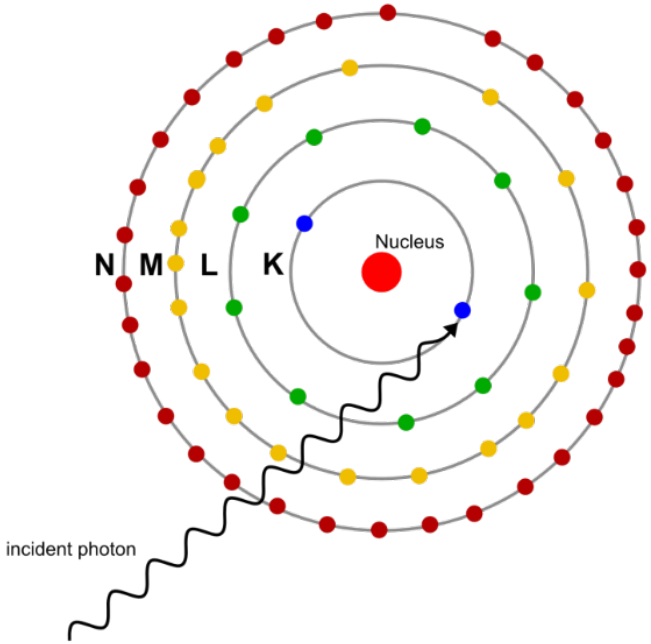
- Sand/Quartz: Construction, playgrounds, glass or solar cells, semicon wafers (Fe content)
- Coal: heating, power generation, electrodes for aluminium, electrodes for batteries (S, Cl, trace elements)
- Pt/Rh – jewelry, car catalysts, electrodes in fuel cells (Traces, thickness)
- Additives in lubricants and polymers – use the expensive additives sparsely while meeting the desired performance

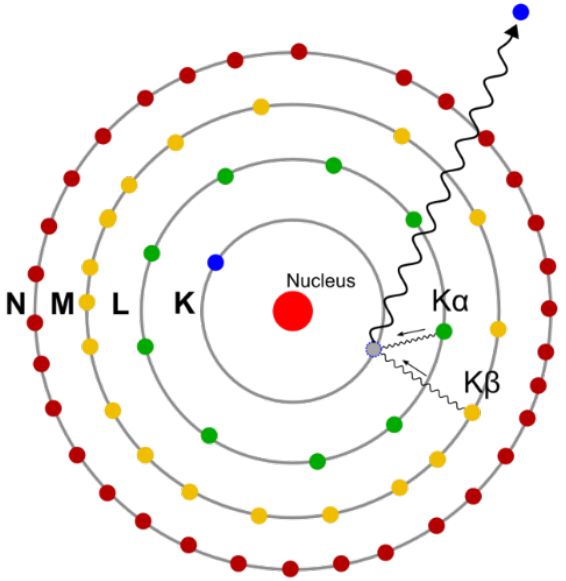
# XRF X-ray Fluorescence Analysis X-ray Spectrometry

- ... is the method to do qualitative and quantitative analysis of elemental
- composition by excitation of atoms and detection of their characteristic
- X-rays: one form of “Electromagnetic Radiation“

| Energy [keV] | Wavelength | Description |
|---|---|---|
| < $10^{-7}$ | cm to km | Radio waves |
| < $10^{-3}$ | µm to cm | Microwaves |
| < $10^{-3}$ | µm to mm | Infrared light |
| 0.0017 - 0.0033 | 380 to 750 nm | Visible light |
| 0.0033 - 0.1 | 10 to 380 nm | Ultraviolet light |
| **0.1 - 100** | **0.01 to 10 nm** | **X-rays** |
| 10 - 5000 | 0.0002 to 0.12 nm | Gamma radiation |

# X-ray Fluorescence Analysis (XRF) Principle – Photoelectric Effect




- Sample excited with an X-ray beam causing fluorescence
- Electron ejected from an inner shell of its atom
- Electron from a shell farther out falls into the vacancy
- Energy difference is emitted as an X-ray photon
- Discrete energy or wavelength  is characteristic for the emitting element / transition
- Intensity of characteristic radiation is proportional to concentration of the element in the sample

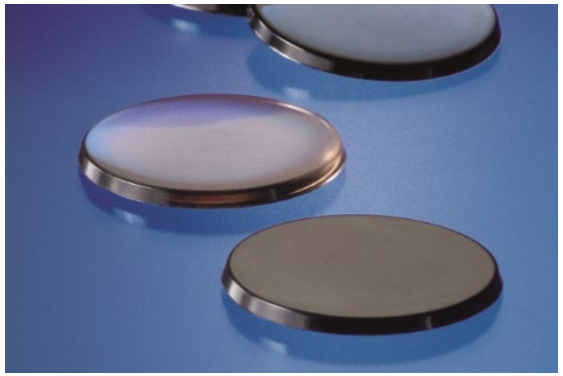
# X-ray Fluorescence Analysis Capabilities

- Qualitative Analysis
  - Identification of elements
  - “What’s inside?”
- Quantitative Analysis
  - Determination of concentrations
  - “How much is inside?”
- Semi-Quantitative Analysis
  - Estimation of concentration
  - “About how much?”

- Solid and liquid samples can be analyzed directly:
- Little or no sample preparation required
- Analysis is non-destructive to the sample
- Sampling-to-analysis result time is relatively short
- Quantitative and qualitative analyses are possible
- Accuracy and long-term stability
- Elemental range: (Be) Na to U
- Linearity from ppm to 100%


# Sample Preparation – Driven by Application

Fused beads – Best results for Major Element QC



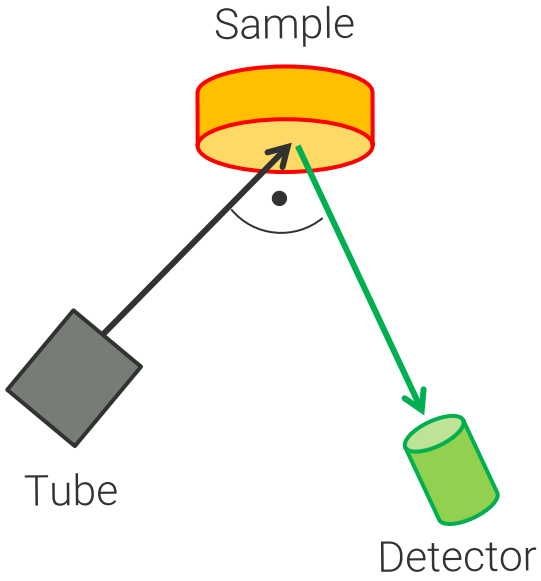
Powder – Fastest preparation, less precise

Pressed Pellets – Simple, fast, great for traces

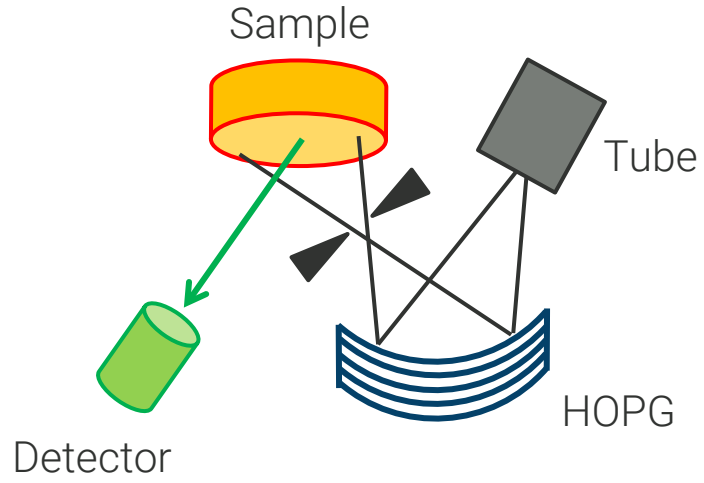
Liquid – Simple and reproducible

# EDXRF Excitation Techniques
# Direct Excitation vs. Polarized Excitation

S2 PUMA




S2 POLAR




Direct excitation:

- Leads to very high intensity
- But also to higher background intensity

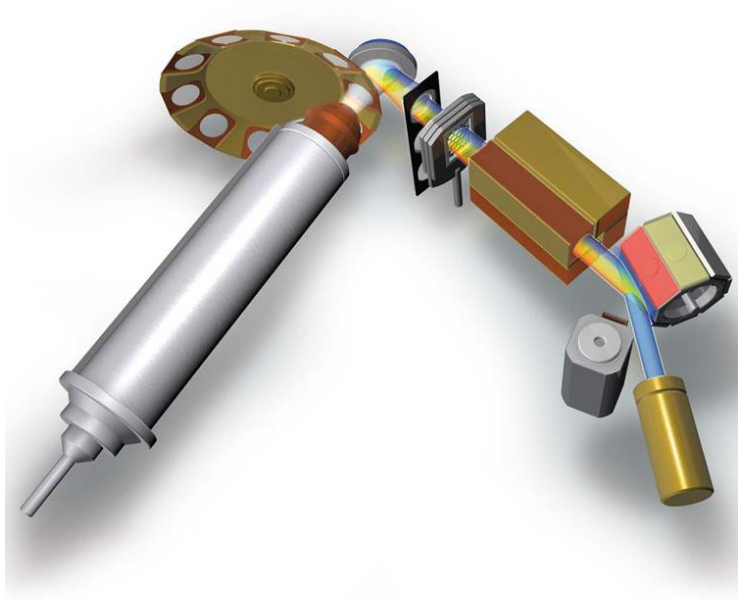
Polarized excitation:

- Reduced background due to polarization
- Improved signal to background ratio (better LLD)

# Wavelength-Dispersive XRF (WDXRF)

Analytical flexibility and high performance for sub-ppm traces

- 4 kW excitation
  20 – 60 kV
- 5 – 170 mA
- 10 beam filters
- 4 collimators
- 8 crystals
- 2 detectors



S8 TIGER WDXRF Beam path


Floorstanding WDXRF S8 TIGER

With 1, 3 or 4 kW

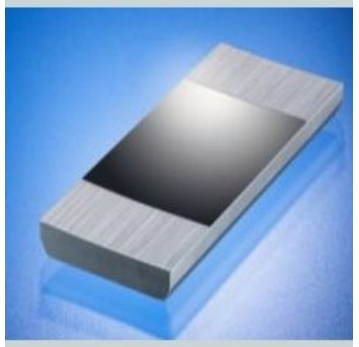
# X-ray Fluorescence Analysis (XRF)
# The Comparison of Energy and Wavelength Dispersive Spectrometers

## EDXRF

- Mechanical simplicity
- Cheaper
- Sensitivities: down to the ppm level
- Records the entire spectrum
- Easy operation
- Smaller, “can be brought to the sample”

## WDXRF

- High precision mechanics
- Higher capital
- Precision: <0.05%
- Higher resolution
- Sensitivities: down to the ppm level, but roughly one to two orders more sensitive
- Records the counts at a given wavelength
- Very fast analysis
- Highest sample throughput




# What requirements for a modern spectrometer software?

- Intuitive user interface
- Full functionality
- Different user levels
- Short processing times
- High stability
- Flexible data management

Modern XRF software offers better analytical performance and safes time!

(training, operation, evaluation)

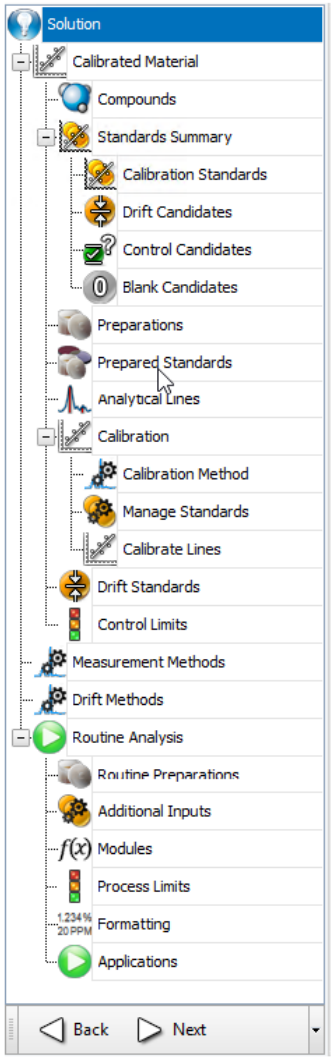

SPECTRA.ELEMENTS: Next Generation XRF Software Platform

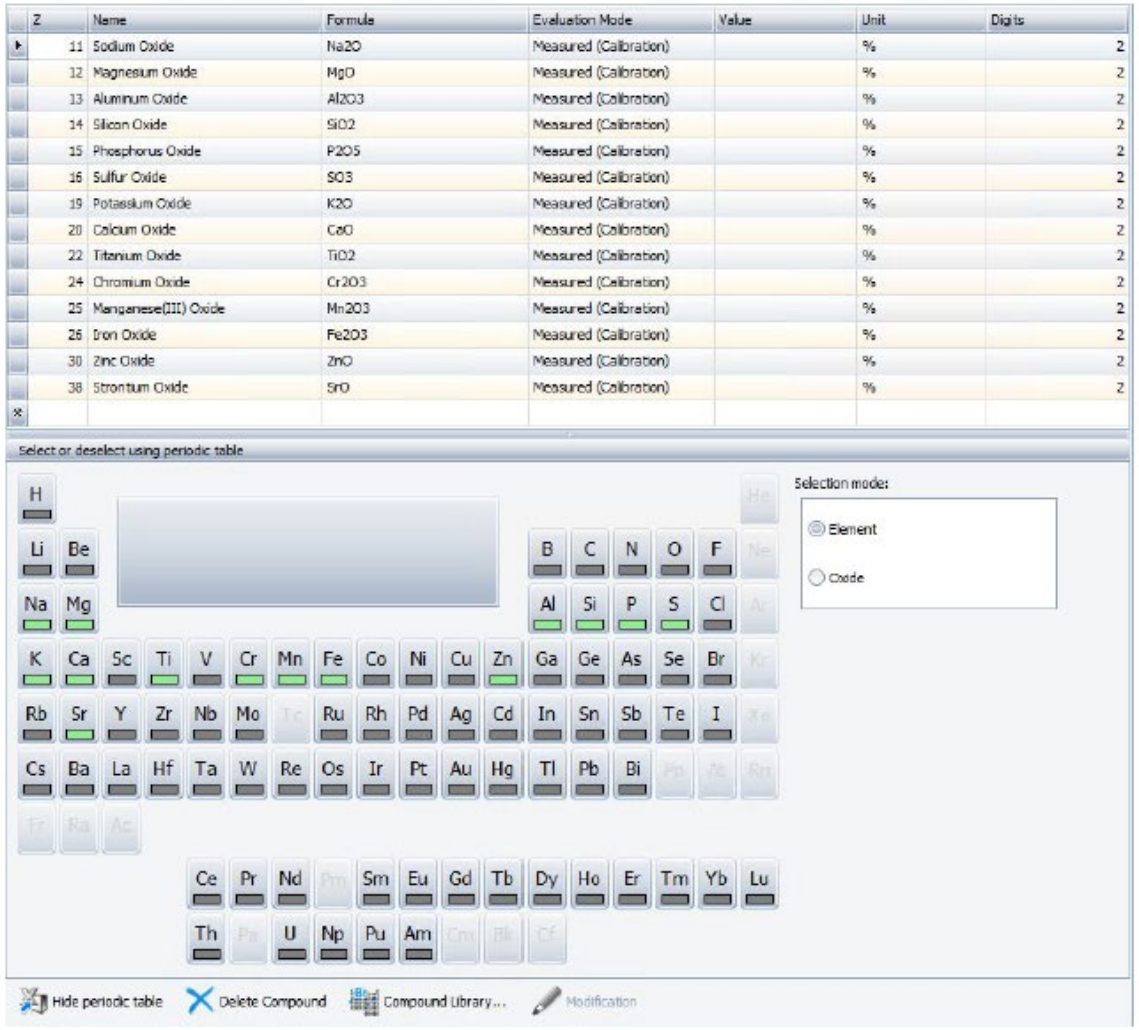
NEW SOFTWARE FUNCTIONALITY

# How to Calibrate

# The WIZARD walks you smoothly through the calibration process

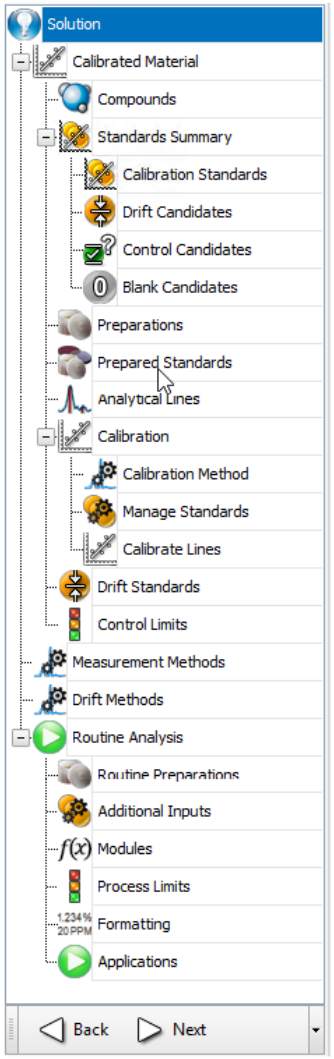
- The proven tree-structure guides the user through the calibration:
  - Define the compounds to be measured
  - Make use of a broad compound library or define your own “special” compound
  - Defined the matrix
    - Use Compton balance for Oxygen

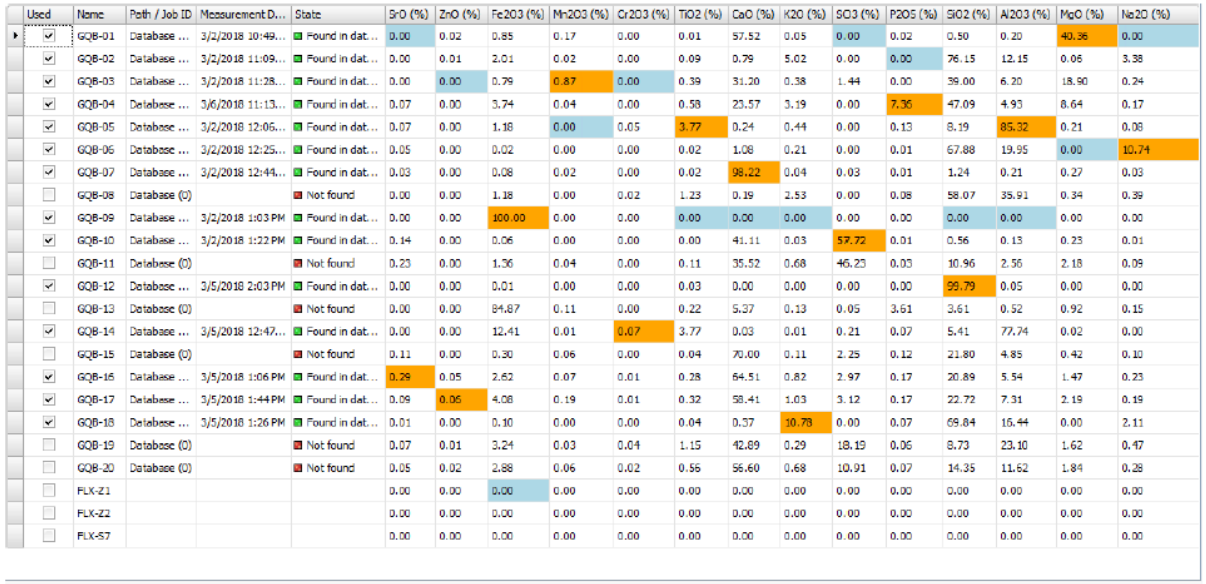


# The WIZARD walks you smoothly through the calibration process

- The proven tree-structure guides the user through the calibration:
  - Copy & Paste compositions of the reference materials
    - Auto illustration of high and low contents
  - Select control standards, drift and blanks (or decide to add them later)

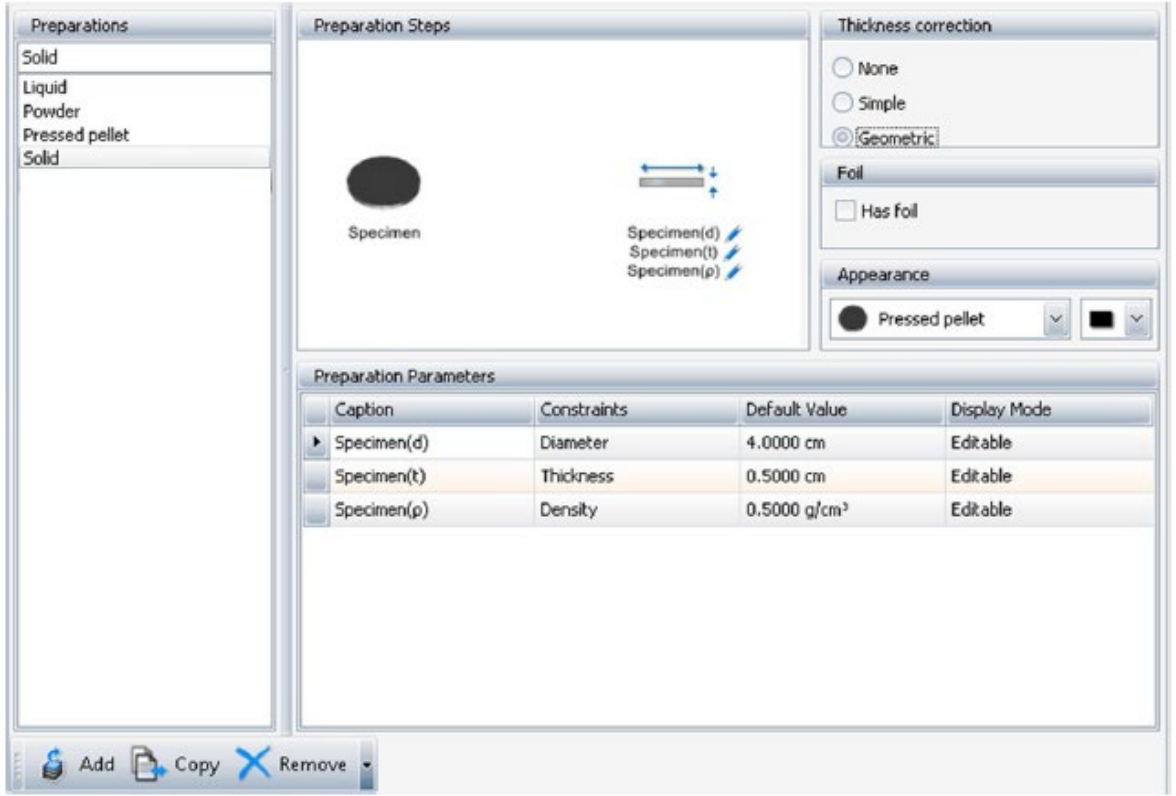


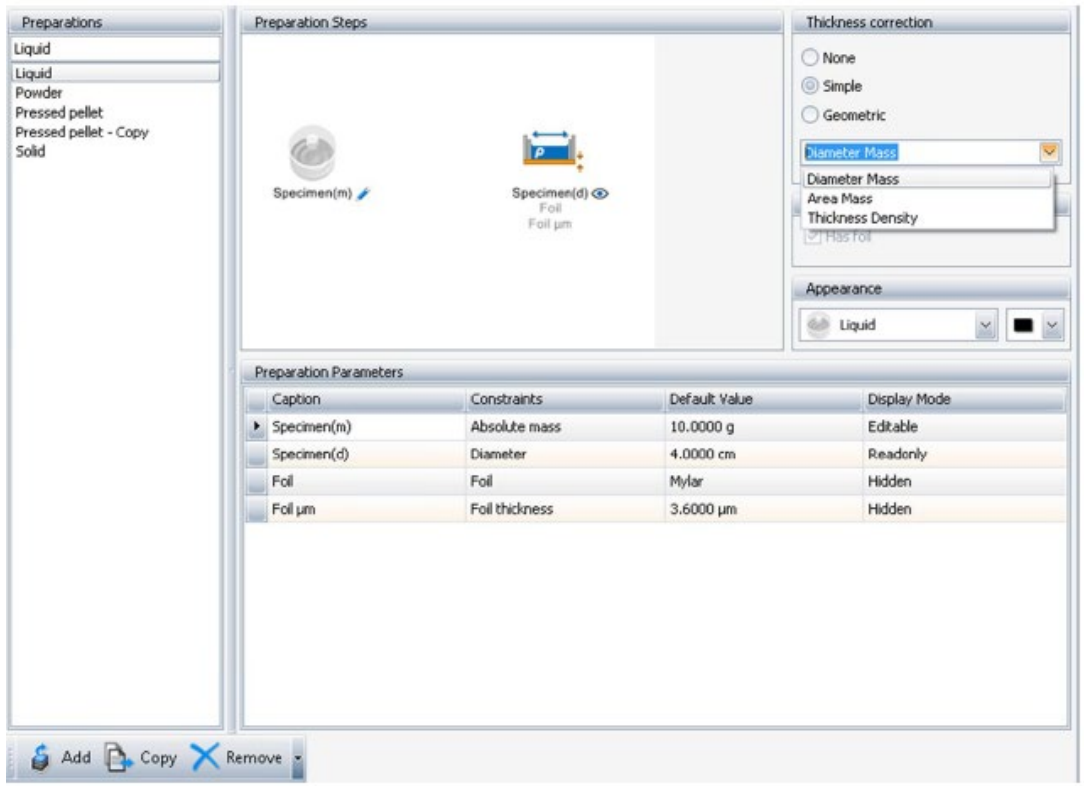



| Used | Name | Path / Job ID | Measurement D... | State | SrO (%) | ZnO (%) | Fe2O3 (%) | Mn2O3 (%) | Cr2O3 (%) | TiO2 (%) | CaO (%) | K2O (%) | SO3 (%) | P2O5 (%) | SiO2 (%) | Al2O3 (%) | MgO (%) | Na2O (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ☑ | GQB-01 | Database ... | 3/2/2018 10:49... | Found in dat... | 0.00 | 0.02 | 0.85 | 0.17 | 0.00 | 0.01 | 57.52 | 0.05 | 0.00 | 0.02 | 0.50 | 0.20 | 40.36 | 0.00 |
| ☑ | GQB-02 | Database ... | 3/2/2018 11:09... | Found in dat... | 0.00 | 0.01 | 2.01 | 0.02 | 0.00 | 0.09 | 0.79 | 5.02 | 0.00 | 0.00 | 76.15 | 12.15 | 0.06 | 3.38 |
| ☑ | GQB-03 | Database ... | 3/2/2018 11:28... | Found in dat... | 0.00 | 0.00 | 0.79 | 0.87 | 0.00 | 0.39 | 31.20 | 0.38 | 1.44 | 0.00 | 39.00 | 6.20 | 18.90 | 0.24 |
| ☑ | GQB-04 | Database ... | 3/6/2018 11:13... | Found in dat... | 0.07 | 0.00 | 3.74 | 0.04 | 0.00 | 0.58 | 23.57 | 3.19 | 0.00 | 7.36 | 47.09 | 4.93 | 8.64 | 0.17 |
| ☑ | GQB-05 | Database ... | 3/2/2018 12:06... | Found in dat... | 0.07 | 0.00 | 1.18 | 0.00 | 0.05 | 3.77 | 0.24 | 0.44 | 0.00 | 0.13 | 8.19 | 85.32 | 0.21 | 0.08 |
| ☑ | GQB-06 | Database ... | 3/2/2018 12:25... | Found in dat... | 0.05 | 0.00 | 0.02 | 0.00 | 0.00 | 0.02 | 1.08 | 0.21 | 0.00 | 0.01 | 67.88 | 19.95 | 0.00 | 10.74 |
| ☑ | GQB-07 | Database ... | 3/2/2018 12:44... | Found in dat... | 0.03 | 0.00 | 0.08 | 0.02 | 0.00 | 0.02 | 98.22 | 0.04 | 0.03 | 0.01 | 1.24 | 0.21 | 0.27 | 0.03 |
| ☐ | GQB-08 | Database (0) | | Not found | 0.00 | 0.00 | 1.18 | 0.00 | 0.02 | 1.23 | 0.19 | 2.53 | 0.00 | 0.08 | 58.07 | 35.91 | 0.34 | 0.39 |
| ☑ | GQB-09 | Database ... | 3/2/2018 1:03 PM | Found in dat... | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ☑ | GQB-10 | Database ... | 3/2/2018 1:22 PM | Found in dat... | 0.14 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 41.11 | 0.03 | 57.72 | 0.01 | 0.56 | 0.13 | 0.23 | 0.01 |
| ☐ | GQB-11 | Database (0) | | Not found | 0.23 | 0.00 | 1.36 | 0.04 | 0.00 | 0.11 | 35.52 | 0.68 | 46.23 | 0.05 | 10.96 | 2.56 | 2.18 | 0.09 |
| ☑ | GQB-12 | Database ... | 3/5/2018 2:03 PM | Found in dat... | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 99.79 | 0.05 | 0.00 | 0.00 |
| ☐ | GQB-13 | Database (0) | | Not found | 0.00 | 0.00 | 84.87 | 0.11 | 0.00 | 0.22 | 5.37 | 0.13 | 0.05 | 3.61 | 3.61 | 0.52 | 0.92 | 0.15 |
| ☑ | GQB-14 | Database ... | 3/5/2018 12:47... | Found in dat... | 0.00 | 0.00 | 12.41 | 0.01 | 0.07 | 3.77 | 0.03 | 0.01 | 0.21 | 0.07 | 5.41 | 77.74 | 0.02 | 0.00 |
| ☐ | GQB-15 | Database (0) | | Not found | 0.11 | 0.00 | 0.30 | 0.06 | 0.00 | 0.04 | 70.00 | 0.11 | 2.25 | 0.12 | 21.80 | 4.85 | 0.42 | 0.10 |
| ☑ | GQB-16 | Database ... | 3/5/2018 1:06 PM | Found in dat... | 0.29 | 0.05 | 2.62 | 0.07 | 0.01 | 0.28 | 64.51 | 0.82 | 2.97 | 0.17 | 20.89 | 5.54 | 1.47 | 0.23 |
| ☑ | GQB-17 | Database ... | 3/5/2018 1:44 PM | Found in dat... | 0.09 | 0.06 | 4.08 | 0.19 | 0.01 | 0.32 | 58.41 | 1.03 | 3.12 | 0.17 | 22.72 | 7.31 | 2.19 | 0.19 |
| ☑ | GQB-18 | Database ... | 3/5/2018 1:26 PM | Found in dat... | 0.01 | 0.00 | 0.10 | 0.00 | 0.00 | 0.04 | 0.37 | 10.78 | 0.00 | 0.07 | 69.84 | 16.44 | 0.00 | 2.11 |
| ☐ | GQB-19 | Database (0) | | Not found | 0.07 | 0.01 | 3.24 | 0.03 | 0.04 | 1.15 | 42.89 | 0.29 | 18.19 | 0.06 | 8.73 | 23.10 | 1.62 | 0.47 |
| ☐ | GQB-20 | Database (0) | | Not found | 0.05 | 0.02 | 2.88 | 0.06 | 0.02 | 0.56 | 56.60 | 0.68 | 10.91 | 0.07 | 14.35 | 11.62 | 1.84 | 0.28 |
| ☐ | FLX-Z1 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ☐ | FLX-Z2 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ☐ | FLX-S7 | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

# Sample preparation

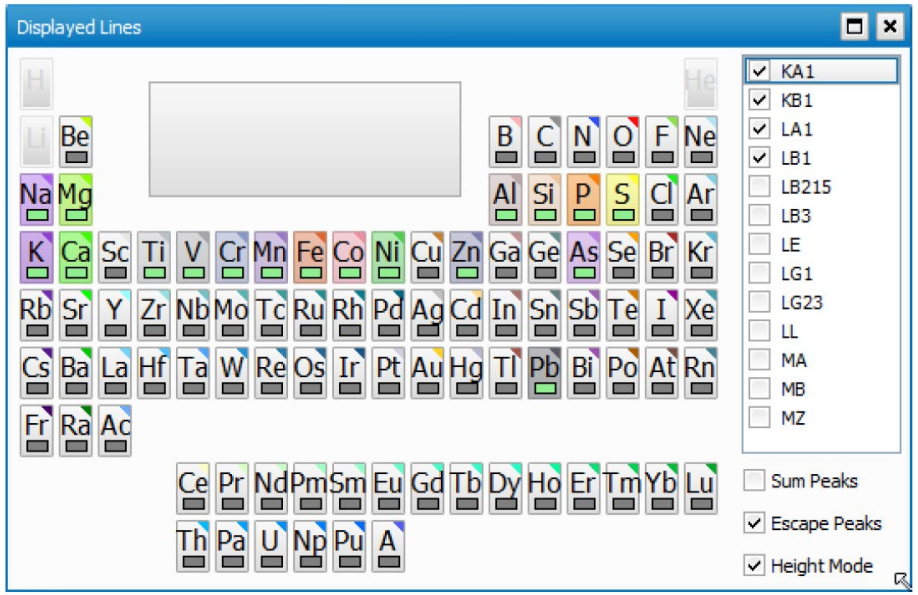
- Select e.g., type, geometry, flux, using check boxes and drop-down menus.
- The WIZARD performs an **automatic thickness correction** using the density of the material

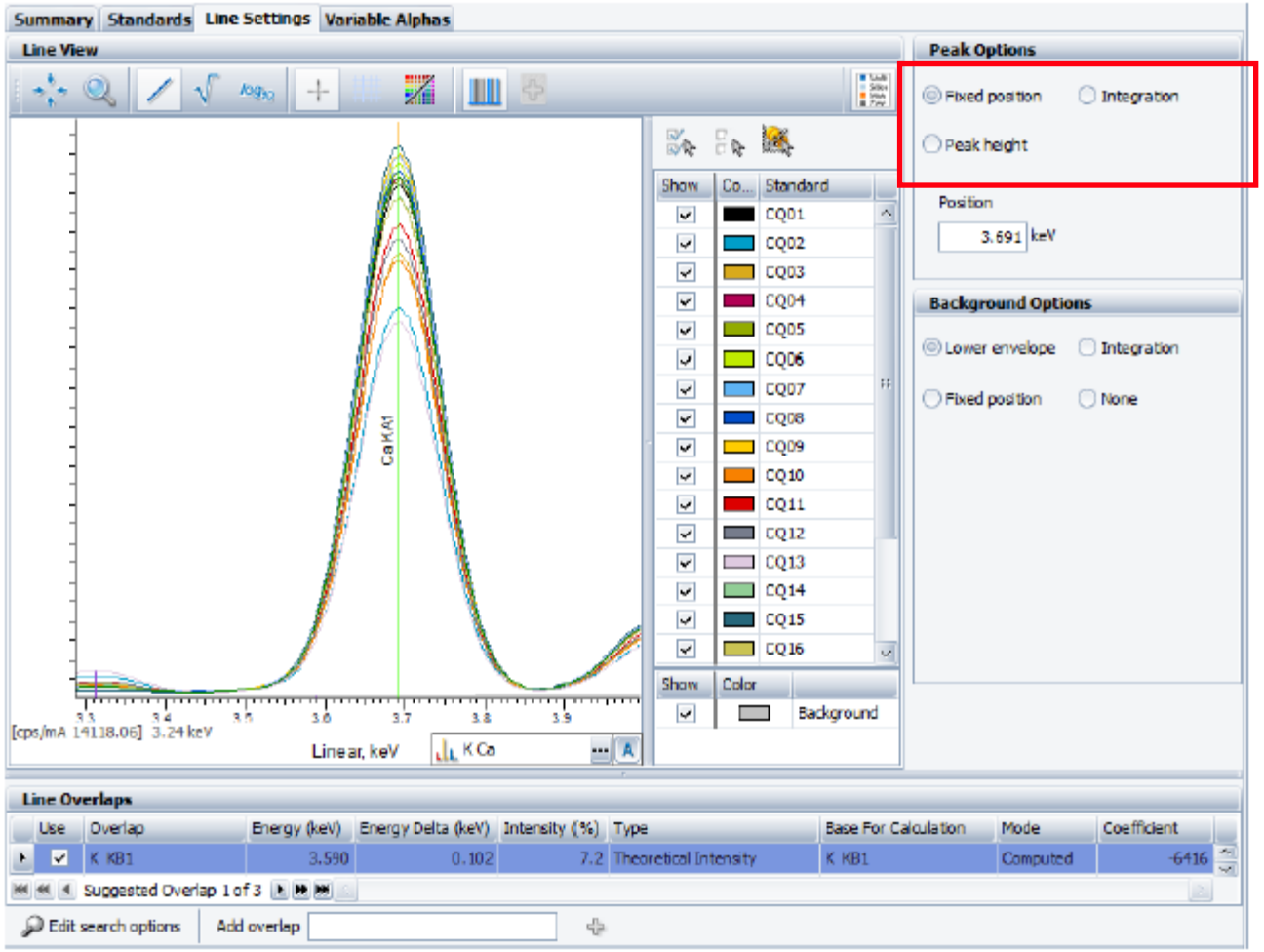


# The WIZARD walks you smoothly through the calibration process

Once the standards are measured the software provides various options to optimize your calibration based on the properties of your samples

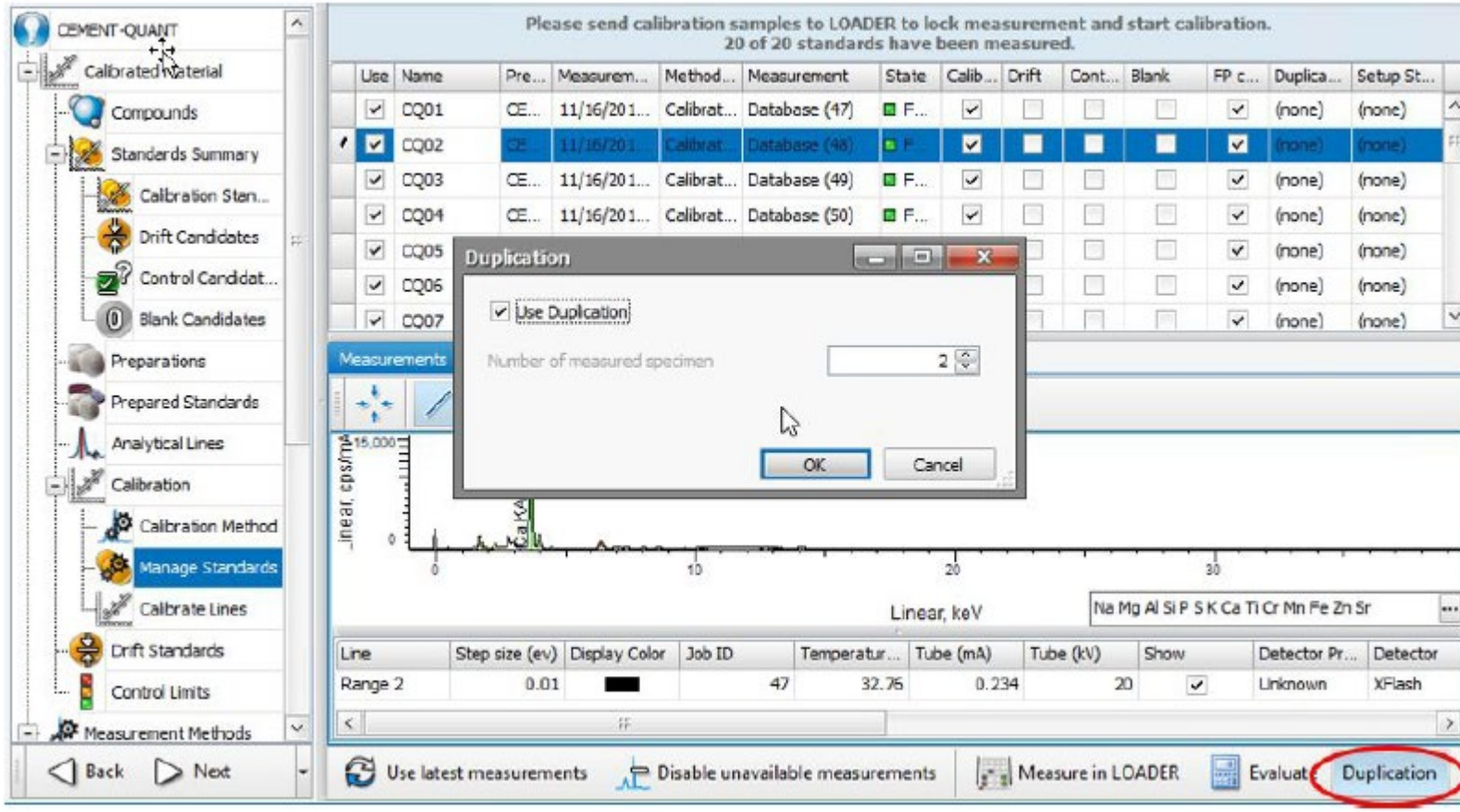


# The WIZARD walks you smoothly through the calibration process

Some processes require duplicate standard measurement.

This can be setup easily in SPECTRA.ELEMENTS.

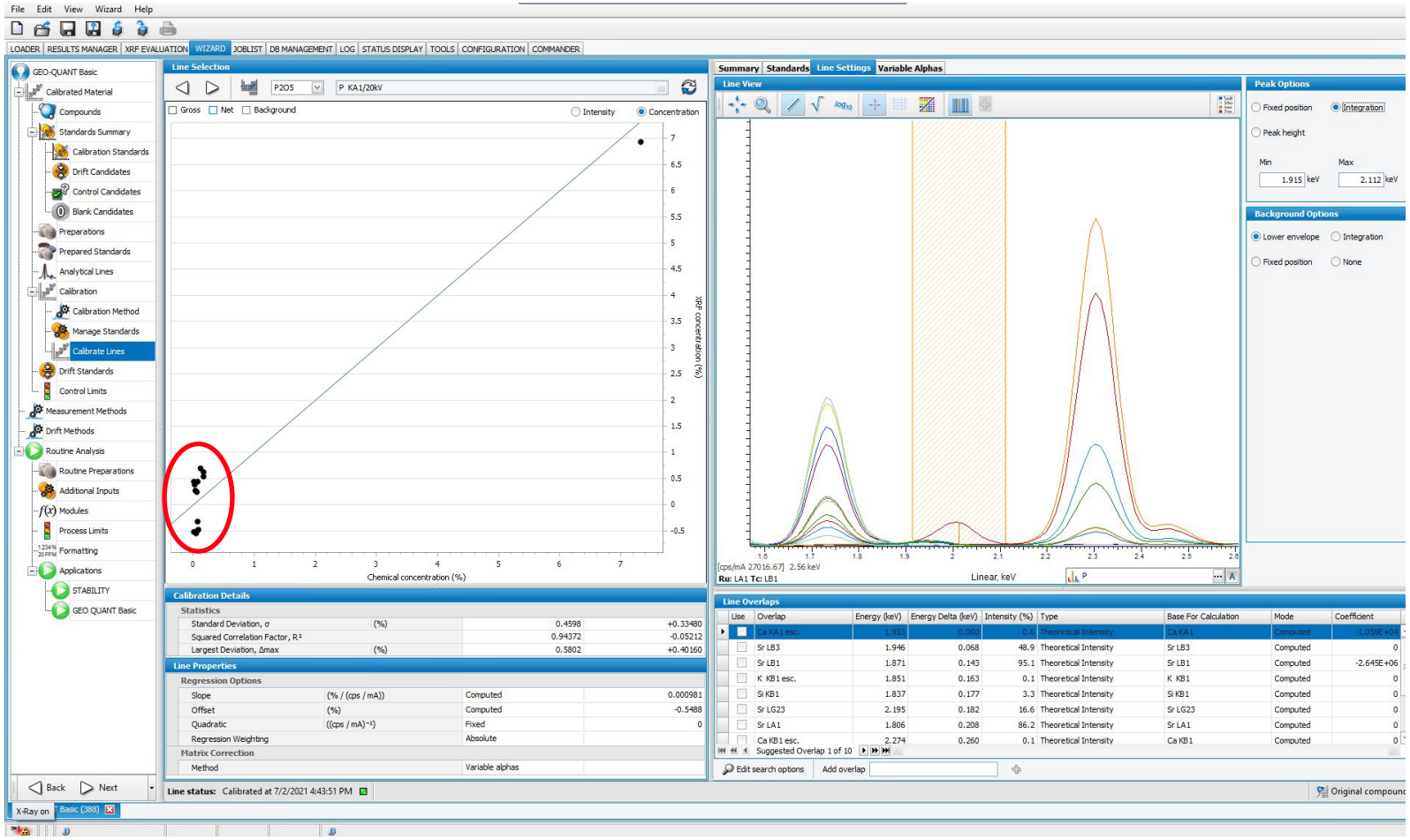


# Calibration example

## Smart overlap correction

Examples 1: P2O5 in geo-materials

- Poor correlation if all potential overlaps are unchecked ($R^2$ = 0.944)



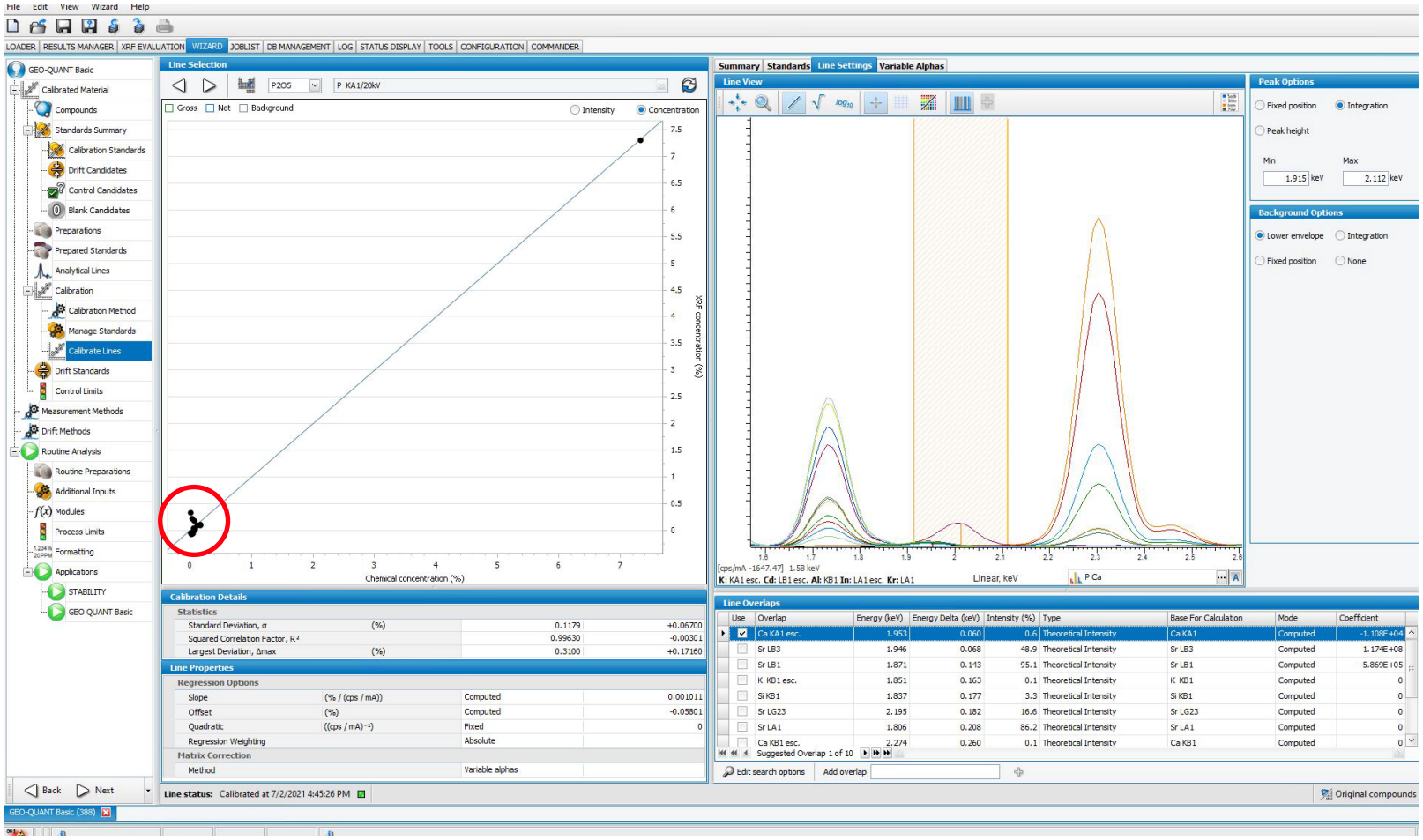
# Calibration example

## Smart overlap correction

Examples 1: P2O5 in geo-materials

- Poor correlation if all potential overlaps are unchecked ($R^2$ = 0.944)

- Significant improvement if Ca KA1 escape peak overlap correction is applied ($R^2$ = 0.996)

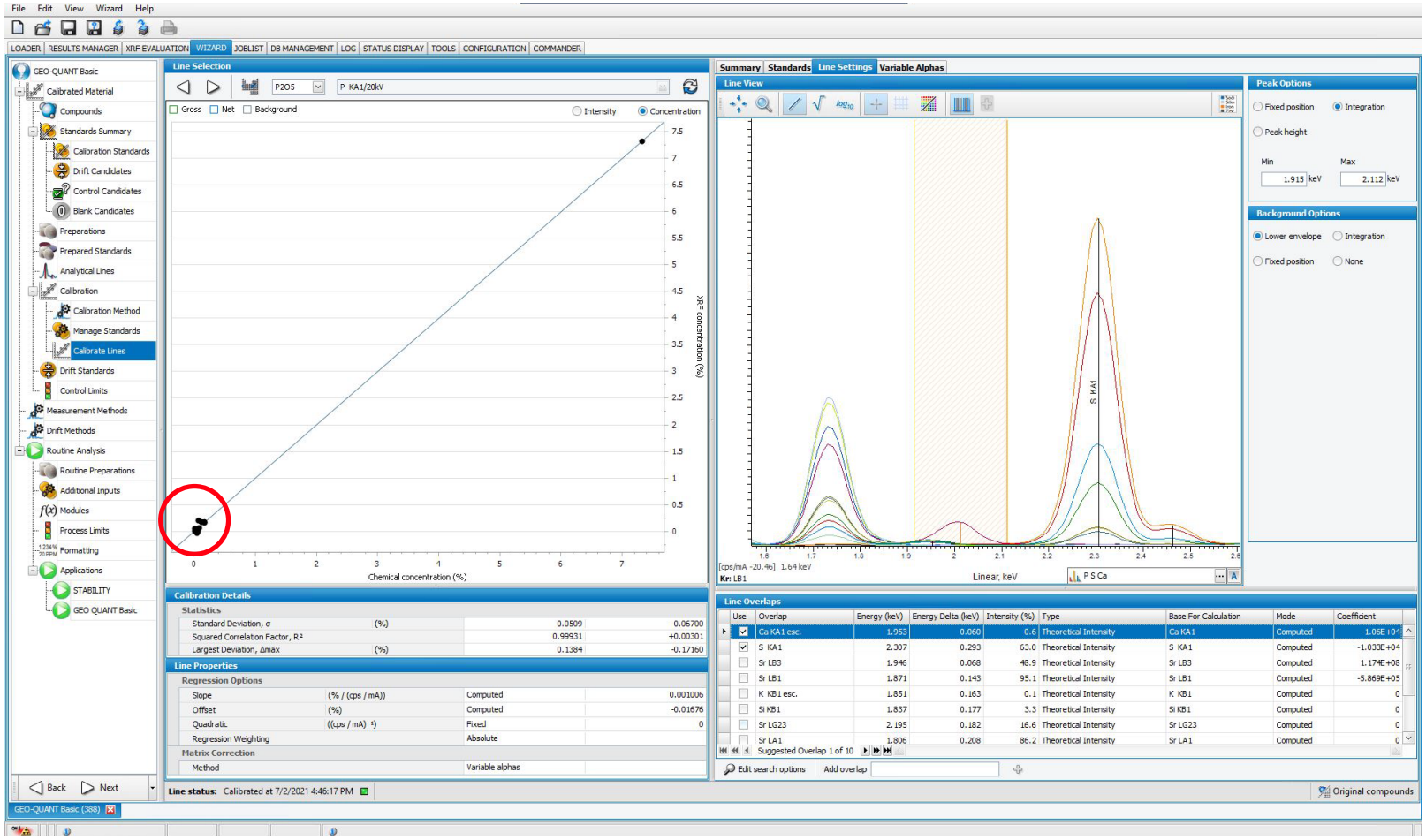


# Calibration example

## Smart overlap correction

Examples 1: P2O5 in geo-materials

- Poor correlation if all potential overlaps are unchecked ($R^2$ = 0.944)
- Significant improvement if Ca KA1 escape peak overlap correction is applied ($R^2$ = 0.996)
- Further improvement if S KA1 is considered ($R^2$ = 0.999)



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Examples 1: P2O5 in geo-materials

- Poor correlation if all potential overlaps are unchecked ($R^2$ = 0.944)
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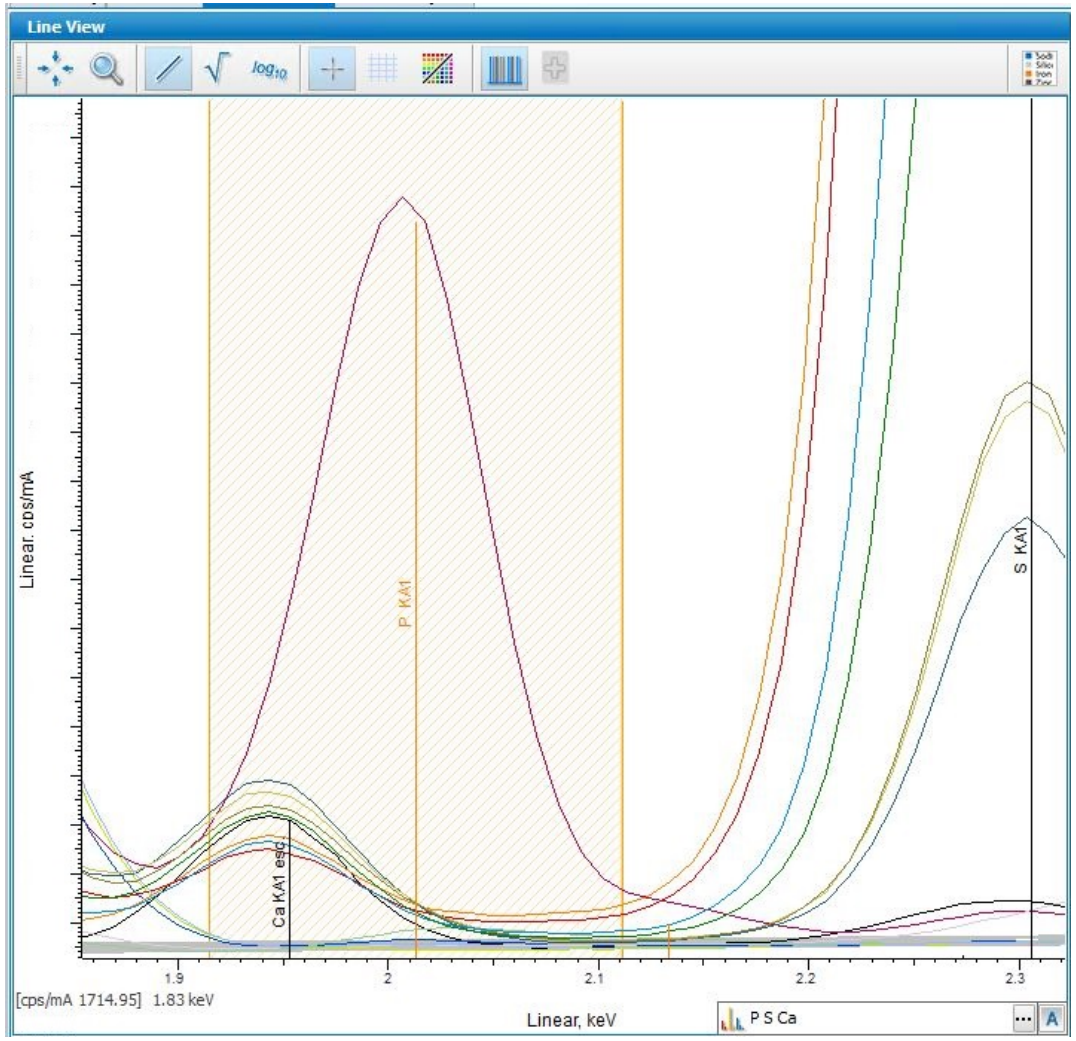
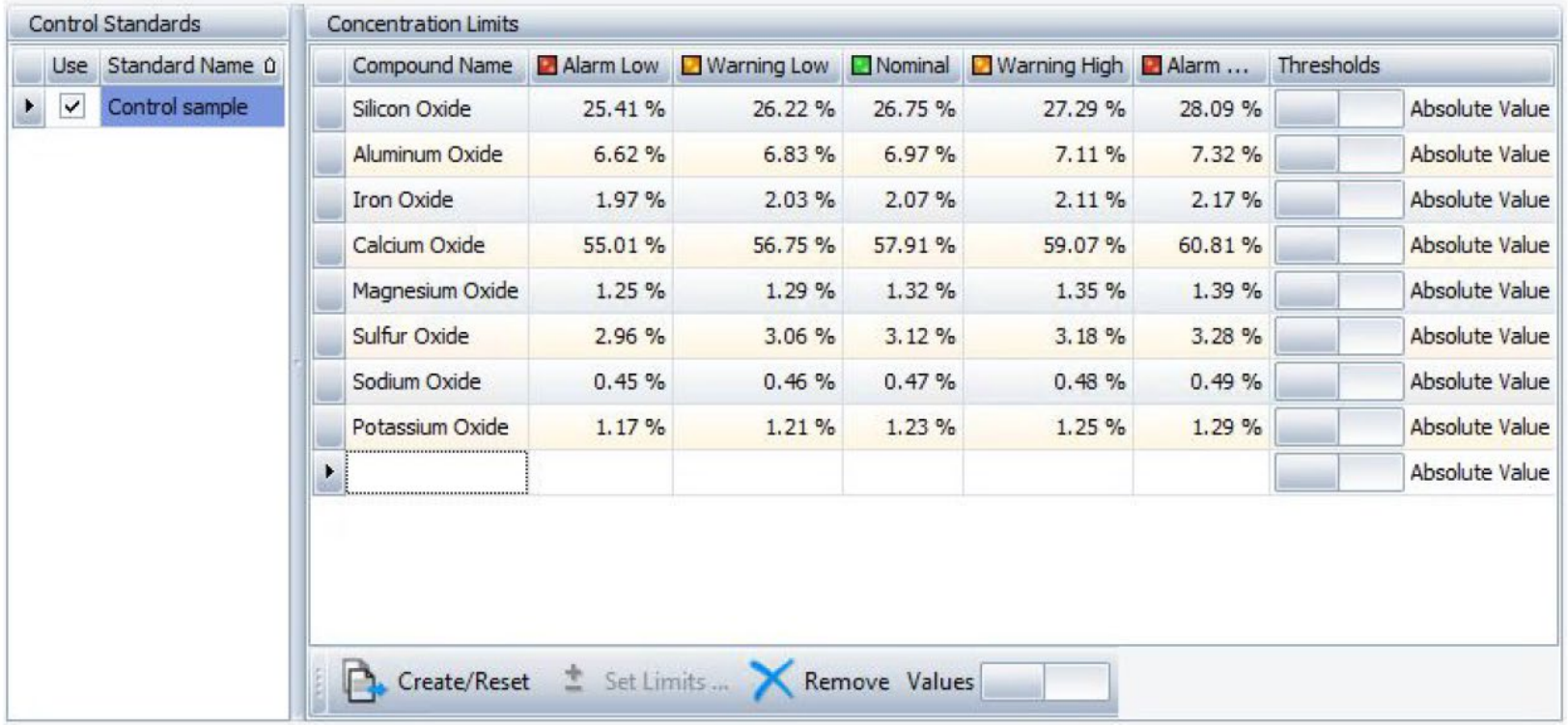


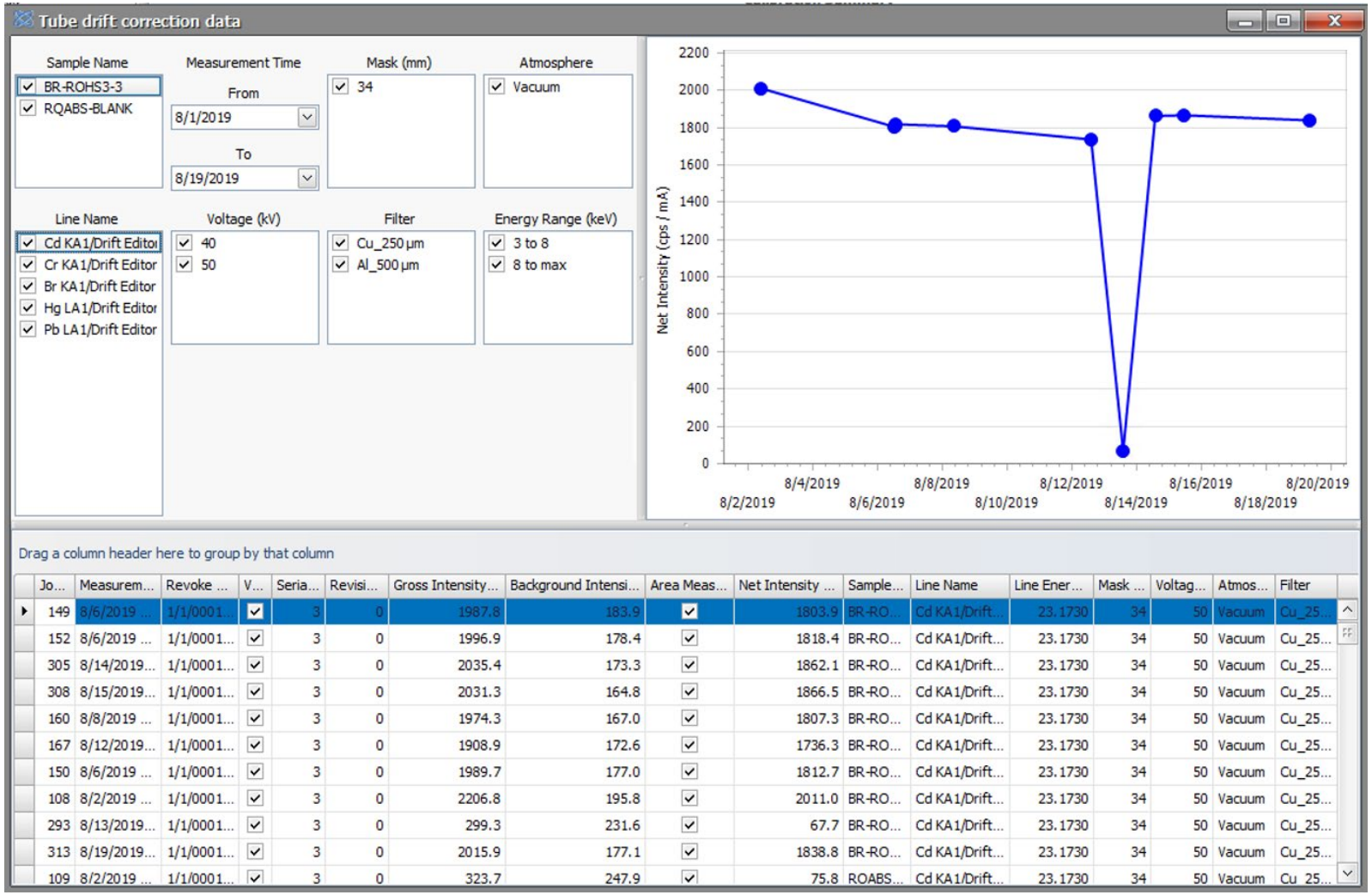
# Setting Control Limits

- Setup color-coded control limits for allow a quick decision during production, e.g.:
  - Normal → all good
  - Warning → production can continue but a closer look or re-analysis may be needed
  - Alarm → immediate production stop



# New drift monitor

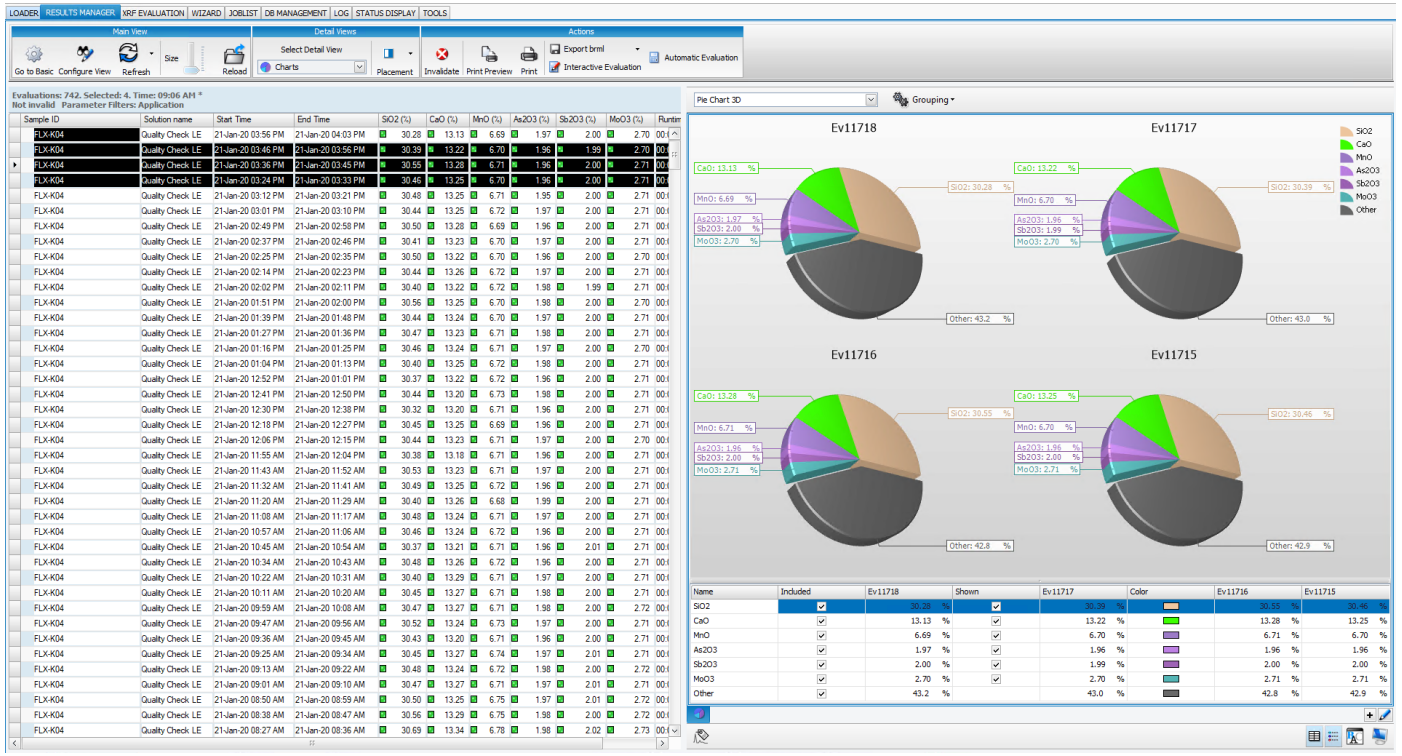
- Possible Reasons for a Warning/Alarm:
  - Material out of spec
  - Contamination
    - Check spectra for untypical features / element ratios
  - Broken sample
    - Check camera image / sample
  - Instrument drift
    - Use drift standards and the new **drift monitor** to quickly evaluate your system.




| Jo... | Measurem... | Revoke ... | V... | Seria... | Revisi... | Gross Intensity... | Background Intensi... | Area Meas... | Net Intensity ... | Sample... | Line Name | Line Ener... | Mask ... | Voltag... | Atmos... | Filter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 149 | 8/6/2019 ... | 1/1/0001... | ☑ | 3 | 0 | 1987.8 | 183.9 | ☑ | 1803.9 | BR-RO... | Cd KA1/Drift... | 23.1730 | 34 | 50 | Vacuum | Cu_25... |
| 152 | 8/6/2019 ... | 1/1/0001... | ☑ | 3 | 0 | 1996.9 | 178.4 | ☑ | 1818.4 | BR-RO... | Cd KA1/Drift... | 23.1730 | 34 | 50 | Vacuum | Cu_25... |
| 305 | 8/14/2019... | 1/1/0001... | ☑ | 3 | 0 | 2035.4 | 173.3 | ☑ | 1862.1 | BR-RO... | Cd KA1/Drift... | 23.1730 | 34 | 50 | Vacuum | Cu_25... |
| 308 | 8/15/2019... | 1/1/0001... | ☑ | 3 | 0 | 2031.3 | 164.8 | ☑ | 1866.5 | BR-RO... | Cd KA1/Drift... | 23.1730 | 34 | 50 | Vacuum | Cu_25... |
| 160 | 8/8/2019 ... | 1/1/0001... | ☑ | 3 | 0 | 1974.3 | 167.0 | ☑ | 1807.3 | BR-RO... | Cd KA1/Drift... | 23.1730 | 34 | 50 | Vacuum | Cu_25... |
| 167 | 8/12/2019... | 1/1/0001... | ☑ | 3 | 0 | 1908.9 | 172.6 | ☑ | 1736.3 | BR-RO... | Cd KA1/Drift... | 23.1730 | 34 | 50 | Vacuum | Cu_25... |
| 150 | 8/6/2019 ... | 1/1/0001... | ☑ | 3 | 0 | 1989.7 | 177.0 | ☑ | 1812.7 | BR-RO... | Cd KA1/Drift... | 23.1730 | 34 | 50 | Vacuum | Cu_25... |
| 108 | 8/2/2019 ... | 1/1/0001... | ☑ | 3 | 0 | 2206.8 | 195.8 | ☑ | 2011.0 | BR-RO... | Cd KA1/Drift... | 23.1730 | 34 | 50 | Vacuum | Cu_25... |
| 293 | 8/13/2019... | 1/1/0001... | ☑ | 3 | 0 | 299.3 | 231.6 | ☑ | 67.7 | BR-RO... | Cd KA1/Drift... | 23.1730 | 34 | 50 | Vacuum | Cu_25... |
| 313 | 8/19/2019... | 1/1/0001... | ☑ | 3 | 0 | 2015.9 | 177.1 | ☑ | 1838.8 | BR-RO... | Cd KA1/Drift... | 23.1730 | 34 | 50 | Vacuum | Cu_25... |
| 109 | 8/2/2019 ... | 1/1/0001... | ☑ | 3 | 0 | 323.7 | 247.9 | ☑ | 75.8 | ROABS... | Cd KA1/Drift... | 23.1730 | 34 | 50 | Vacuum | Cu_25... |

# Customize your views and reports


- Basic and Advanced Mode allows you to focus on the key information during routine operation and switch quickly to the details of interest in case further evaluation is needed.



NEW SOFTWARE FUNCTIONALITY

# Latest Features

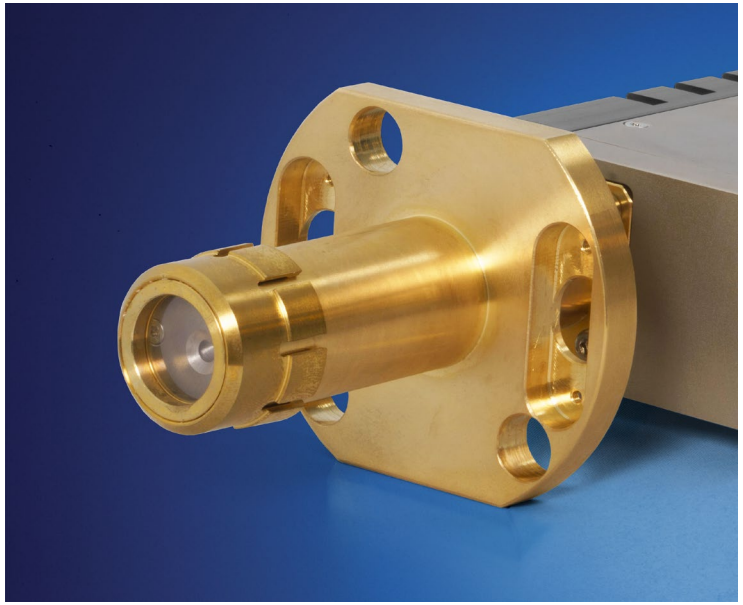
LATEST FEATURES

# HighSense™ XP Detector
# Now available for the S2 PUMA Series 2

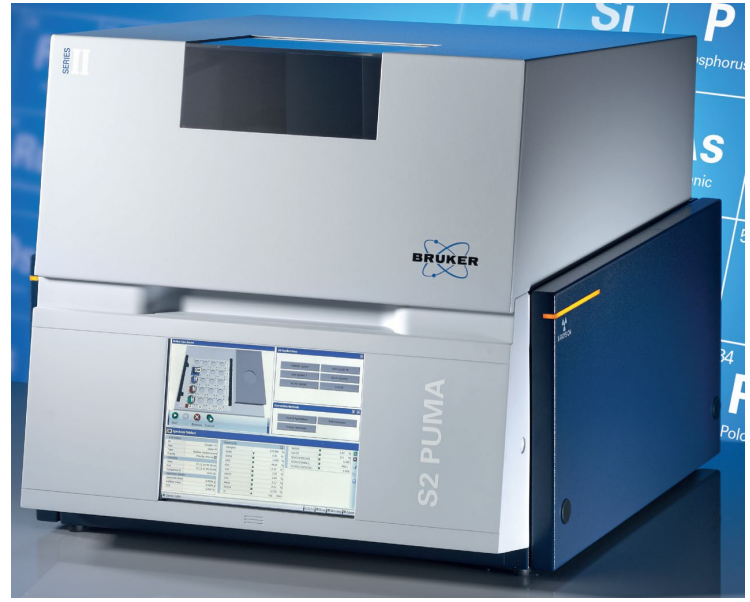
## State-of-the-Art Hardware & Next Generation Software

- New premium detector for all elements (C to Am)
- Robust, high transmission Graphene window (non-toxic)
- Bruker's detector chip technology
- Further enhanced cooling (Peltier) performance

- New SPECTRA.ELEMENTS with **Dynamic Detector Profiling**



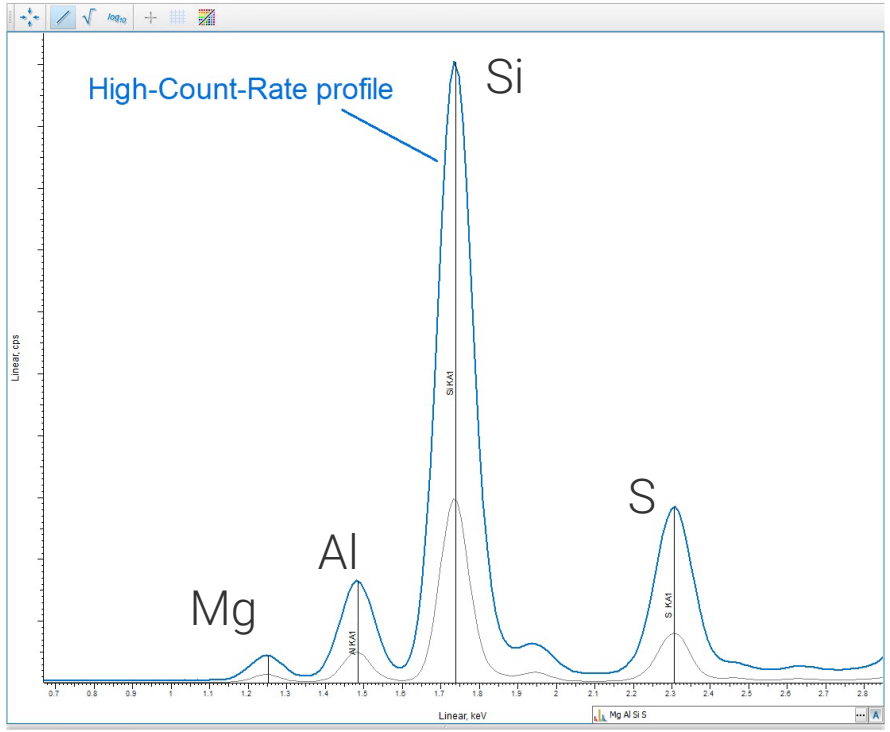
New HighSense XP Detector




S2 PUMA Series 2 with XY Autochanger

# The Benefits of Detector Profiling

- New, fully integrated feature in SPECTRA.ELEMENTS
- Flexible: Make your selection each analytical range
  - **High Resolution** for optimal peak separation of neighboring elements
  - **High-Count-Rate** to boost the throughout or decrease LLD




Achieve up to 4 x higher net intensity with the High-Count-Rate profile

→ Enhance the performance for heavy trace elements in polymers

SPECTRA.ELEMENTS

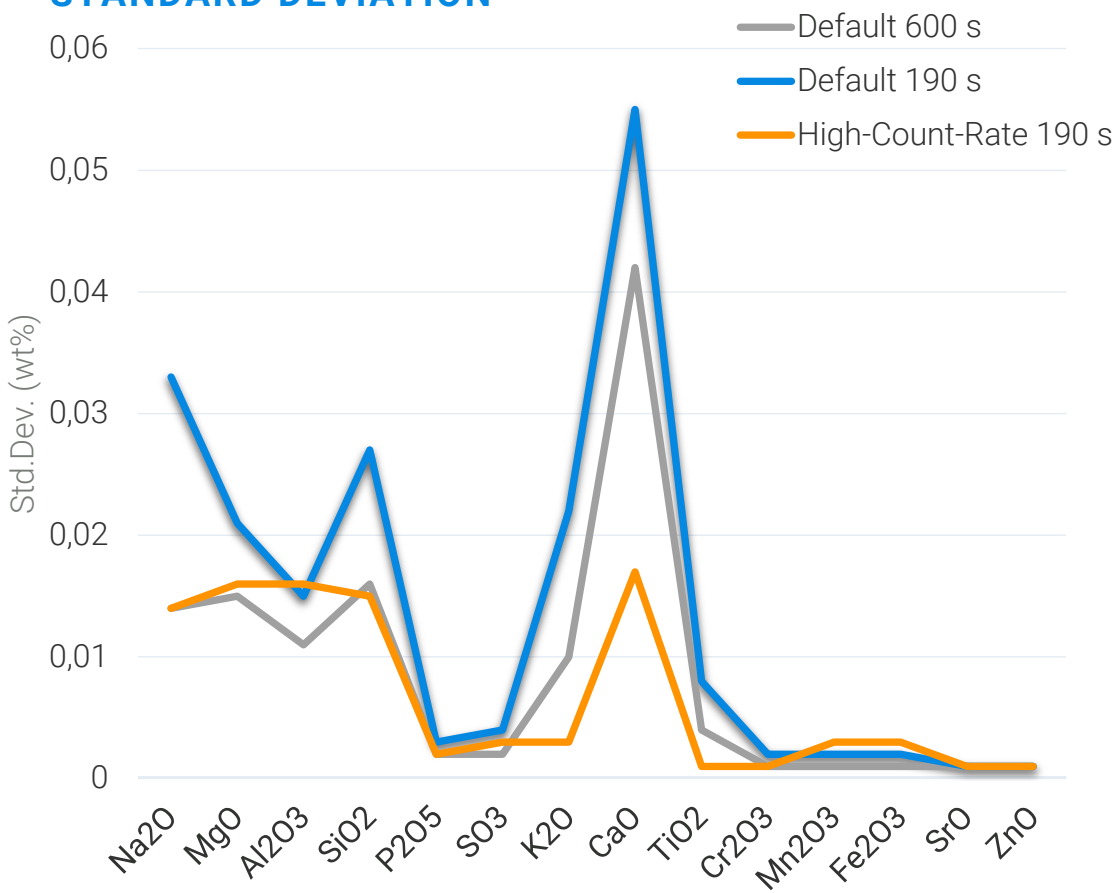
Easy. Fast. Smart. Powerful.

# The Benefits of Detector Profiling

## Precision Test

- Cement QC sample
- 3 ranges, 190 or 600 s total counting time, 25 repetitions

The High-Count-Rate setting allows to reduce the counting time factor of ~3

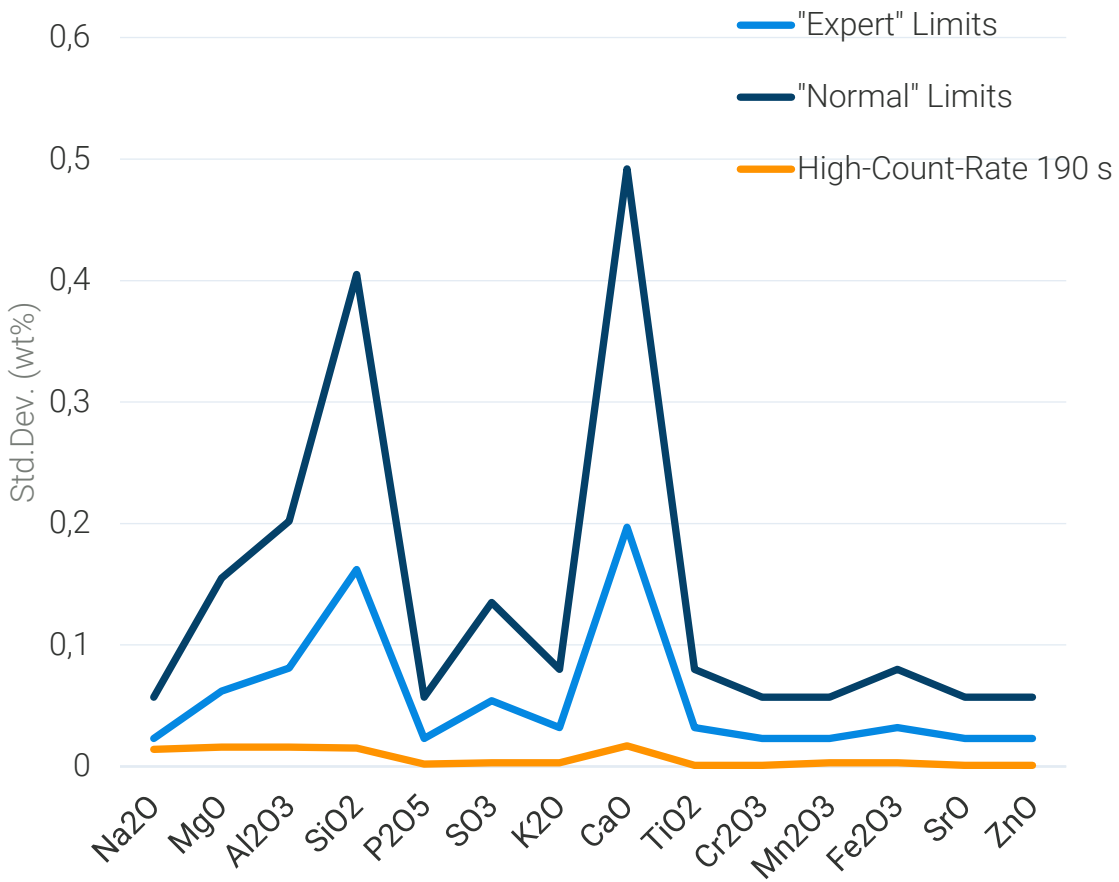


# The Benefits of Detector Profiling

## ISO 29581 / EN 196-2:

A Cement norm which defines two categories of precision (repeatability) :
“Normal” and “Expert”

- The S2 PUMA Series 2 with HighSense XP meets standard deviation limits easily.

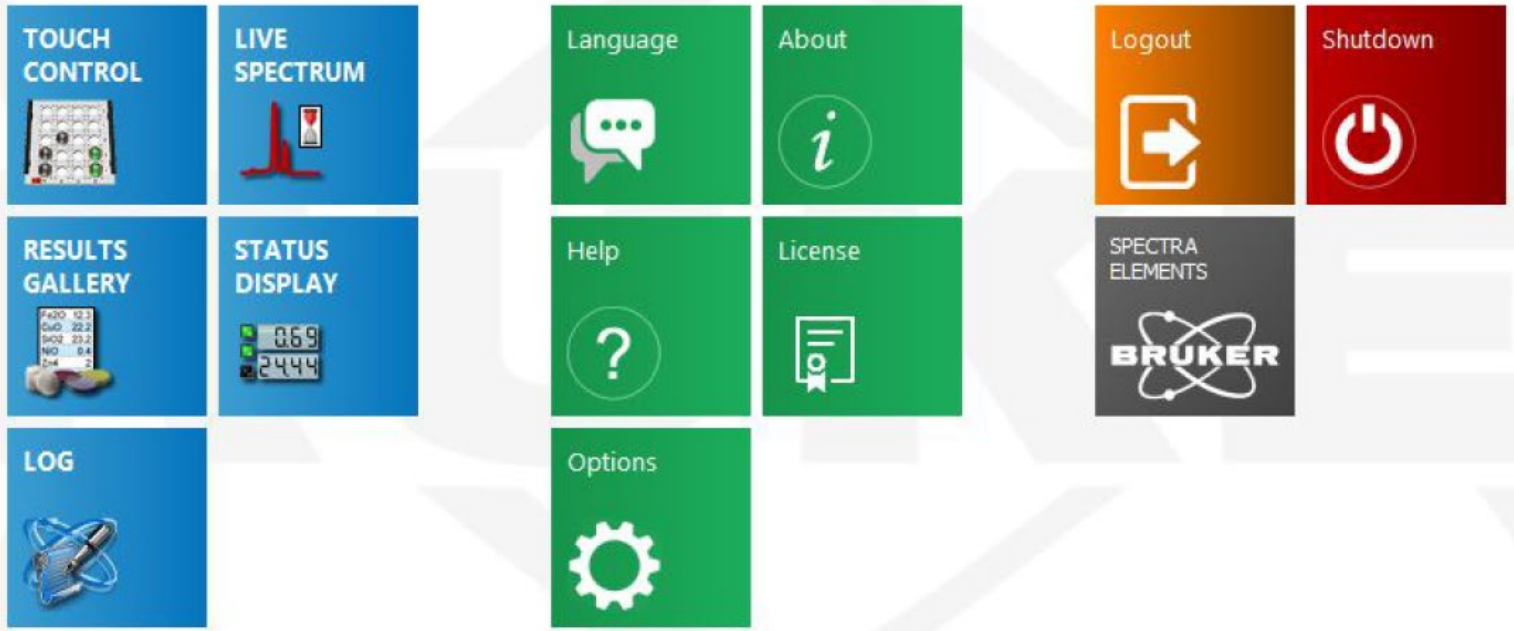


NEW SOFTWARE FUNCTIONALITY

# Routine Analysis

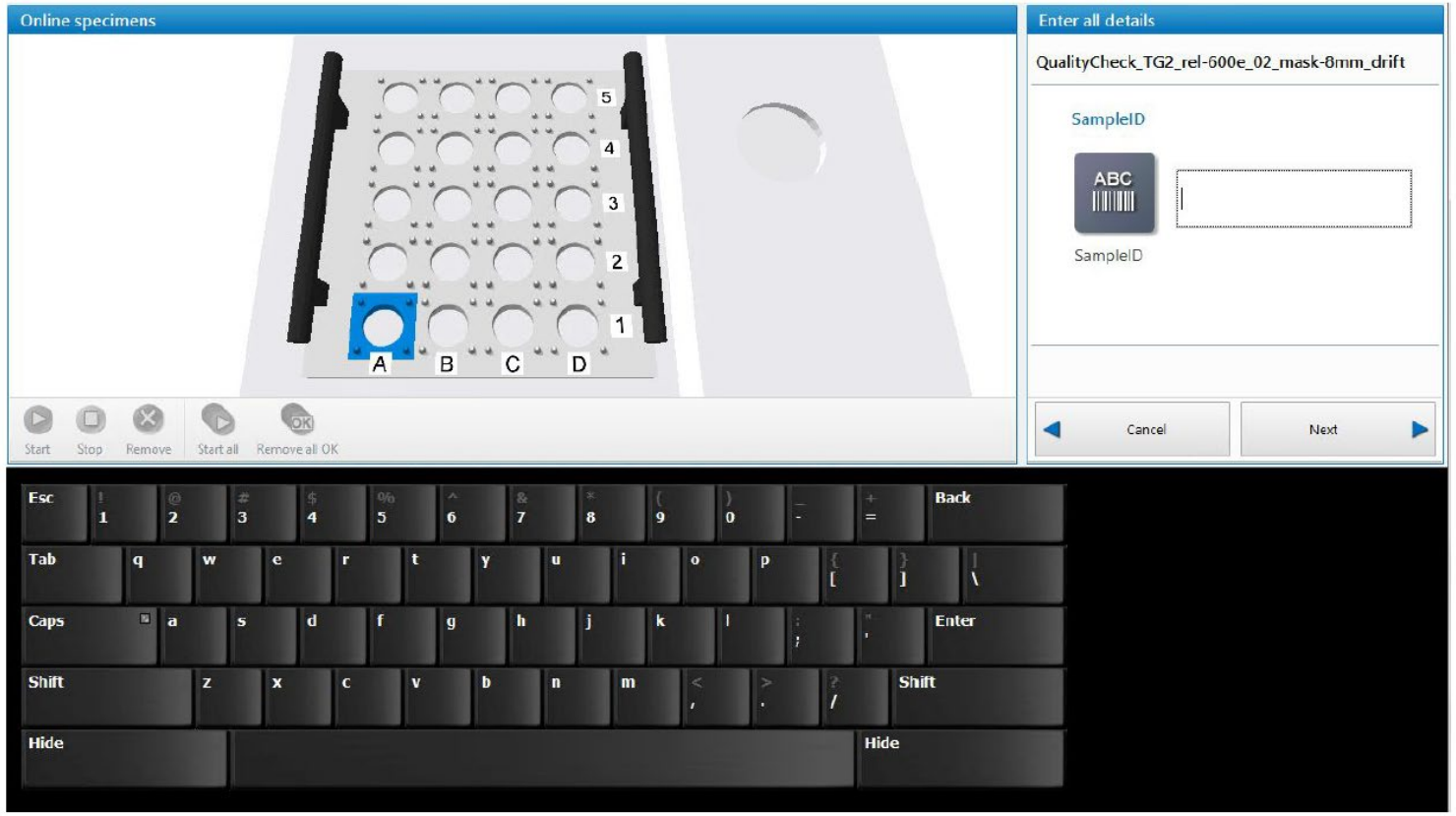
# Daily Operation made easy!

## TouchControl – Home Screen



# Daily Operation made easy!

## TouchControl – LOADER

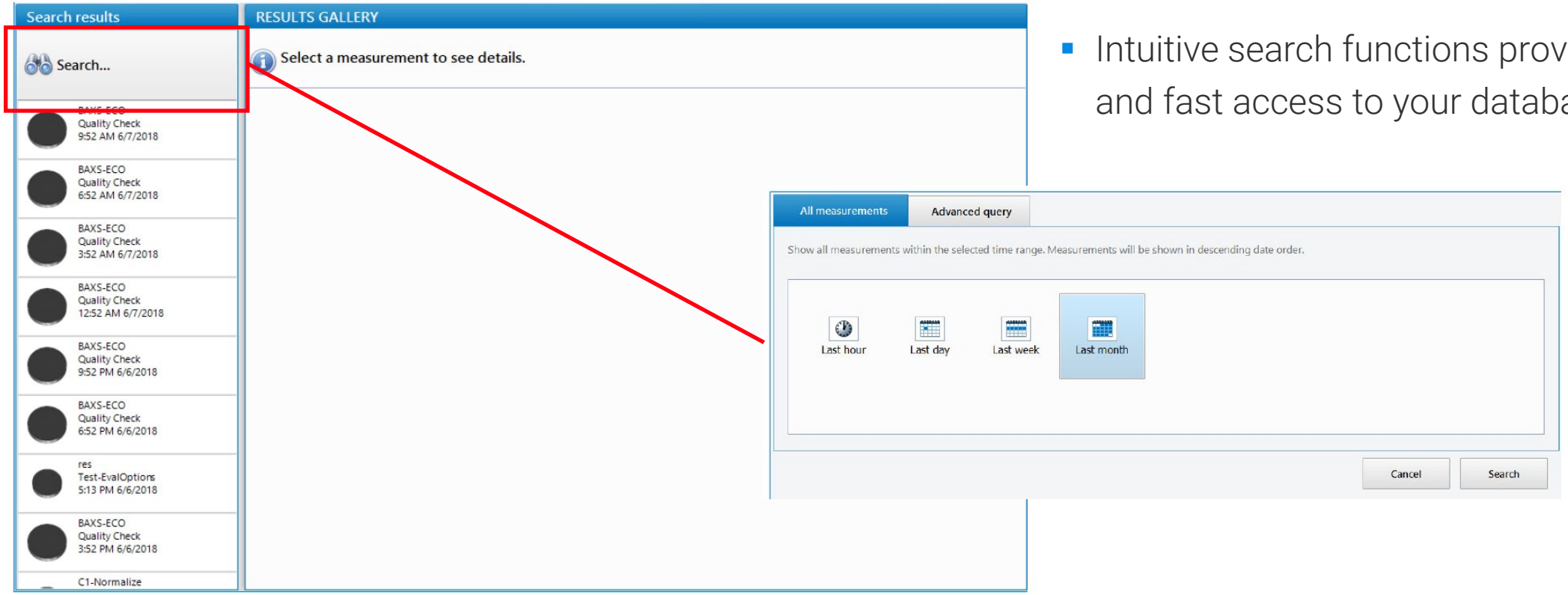



- Select a position on the LOADER
- Select the method
- Enter the sample ID
- Enter method specific sample information (e.g., LOI)
- Hit start!
- Get the results within minutes!

- Remain fully flexible: Stop, modify, adjust priority …

# Daily Operation made easy!

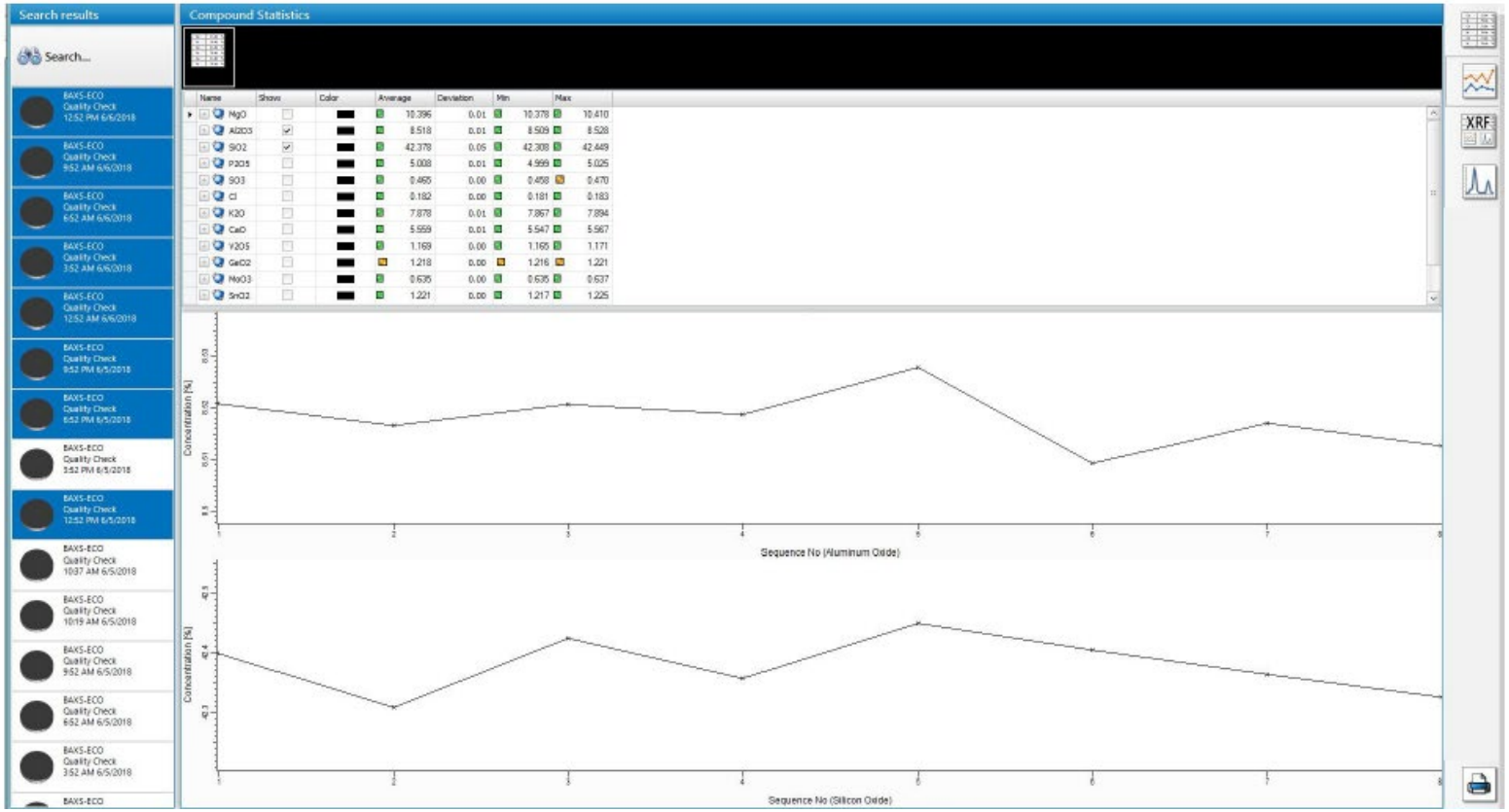
## Results Gallery




- Intuitive search functions provide easy and fast access to your database

# Daily Operation made easy!

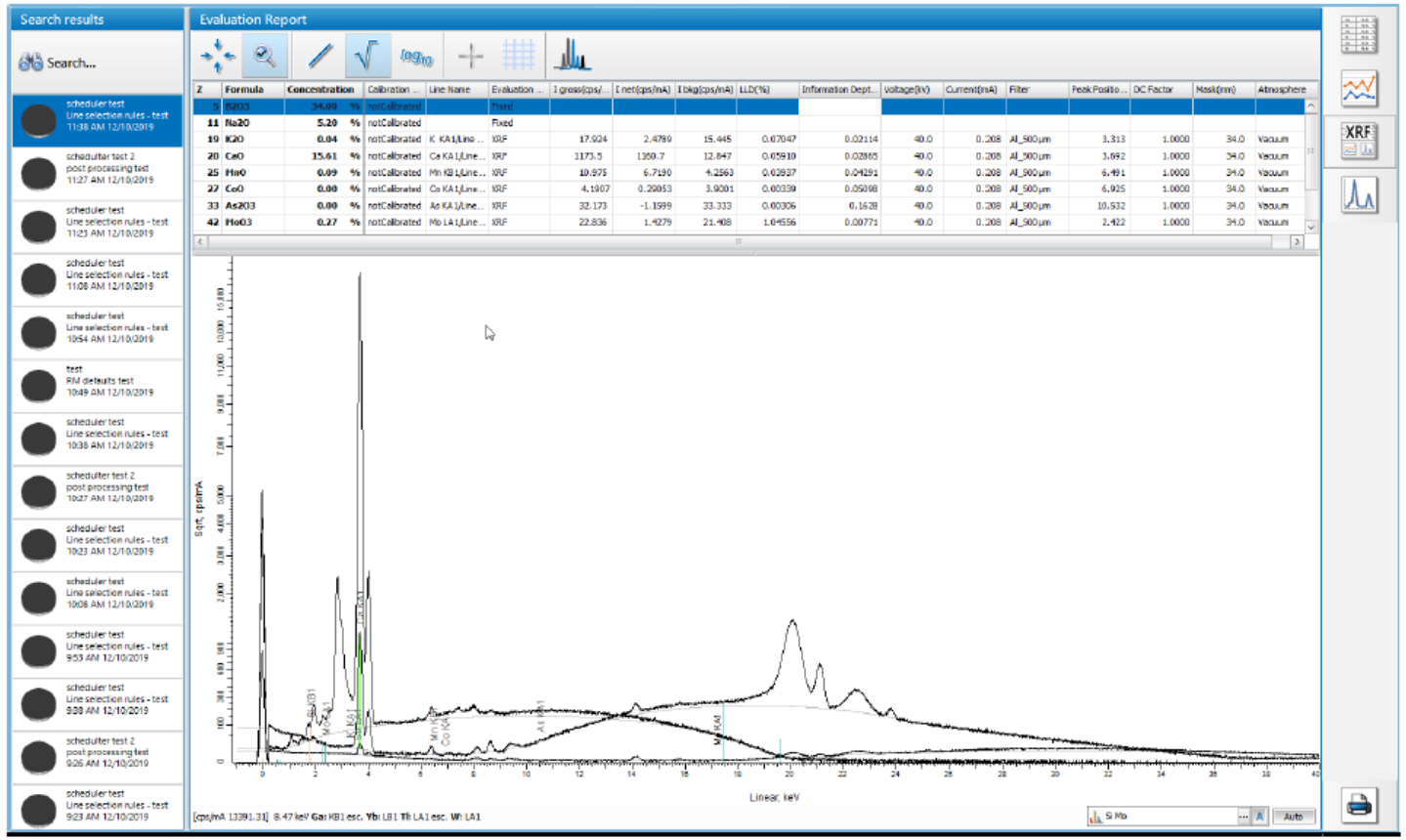
## Results Gallery




- All information at your fingertips
- Quick access to statistics to monitor the production process
- Color coding based on customized concentration limits

# Daily Operation made easy!

## Results Gallery




- Check the results
- Evaluate and compare spectra (zoom-in, add lables/lines, …)
- Print/export the data

NEW SOFTWARE FUNCTIONALITY

# Standardless Solutions

# SMART-QUANT FP and WD
# Best standardless analysis with EDXRF and WDXRF

SMART-QUANT  is set up to work in full Fundamental Parameter (FP) mode – this means no calibrations necessary!

Excellent for raw material testing and whenever special samples outside the analytical routing need to be measured.

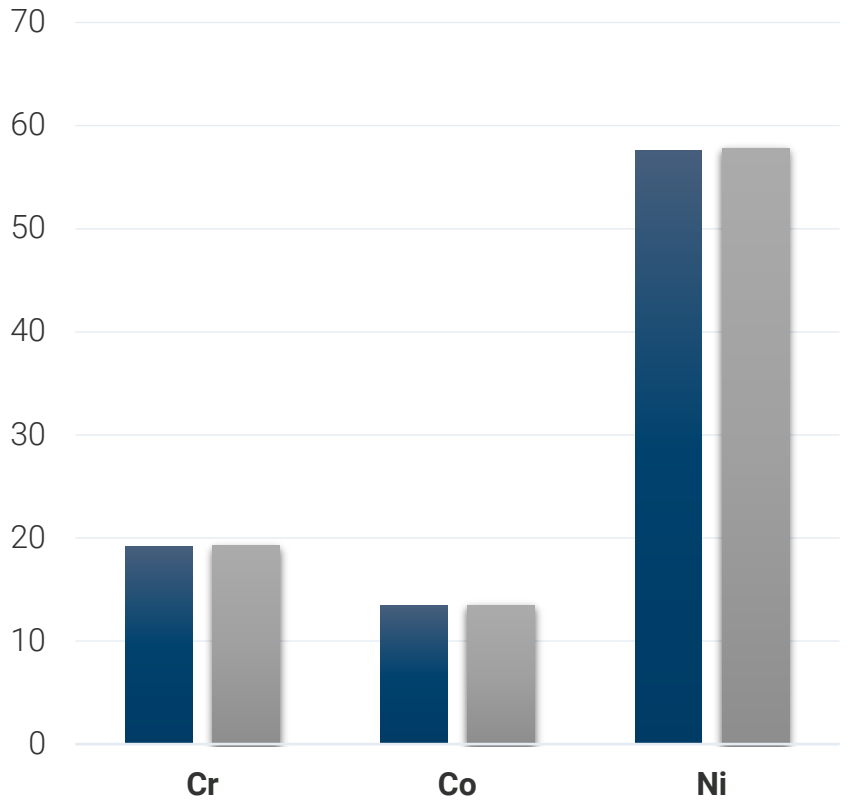
- F to Am (FP) / Na to Am (WD)
- ppm to 100%
- Air, Helium, Vacuum
- 30 and 50 kV

SMART-QUANT: Push-button solution for quick and reliable analysis of unknown samples

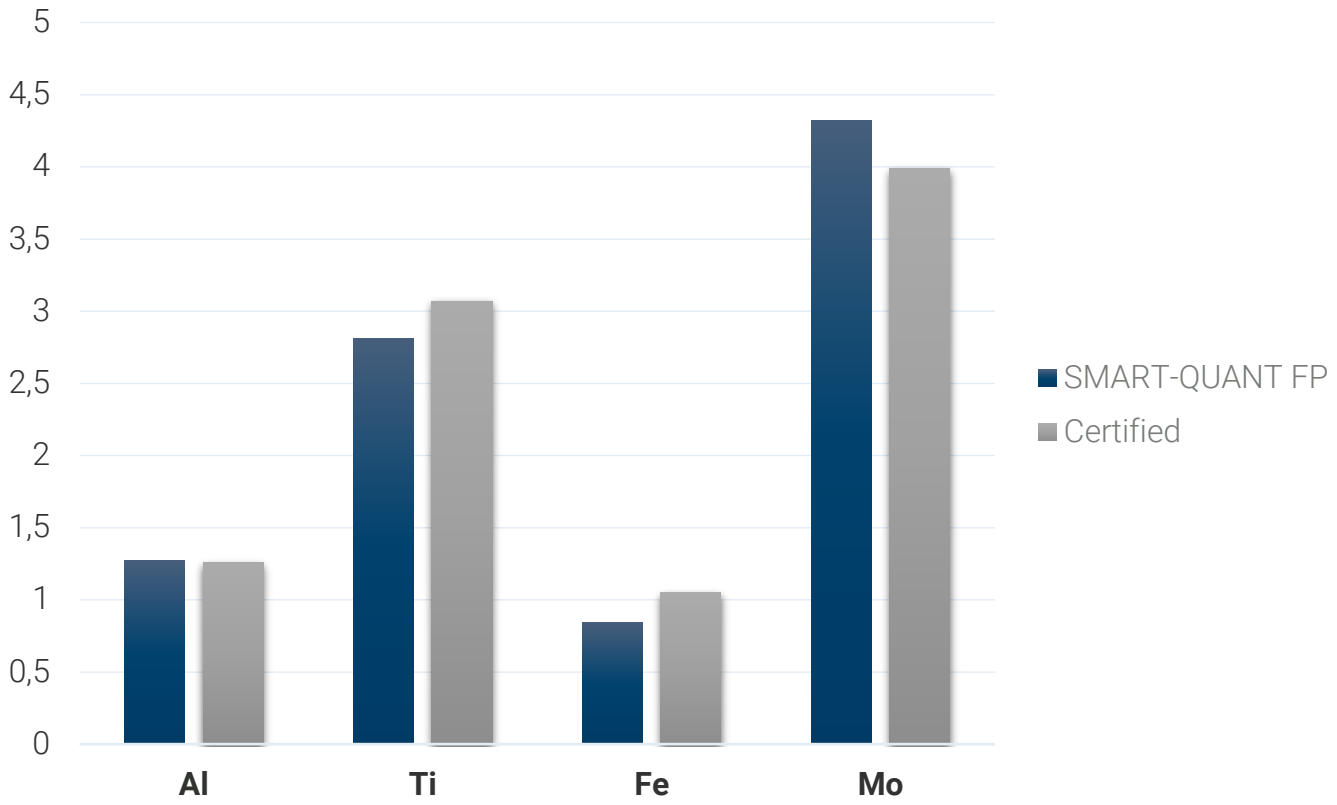

S6 JAGUAR: Full WDXRF performance in a benchtop unit

# SMART-QUANT FP
# Powered by HighSense XP

## MAJOR ELEMENTS

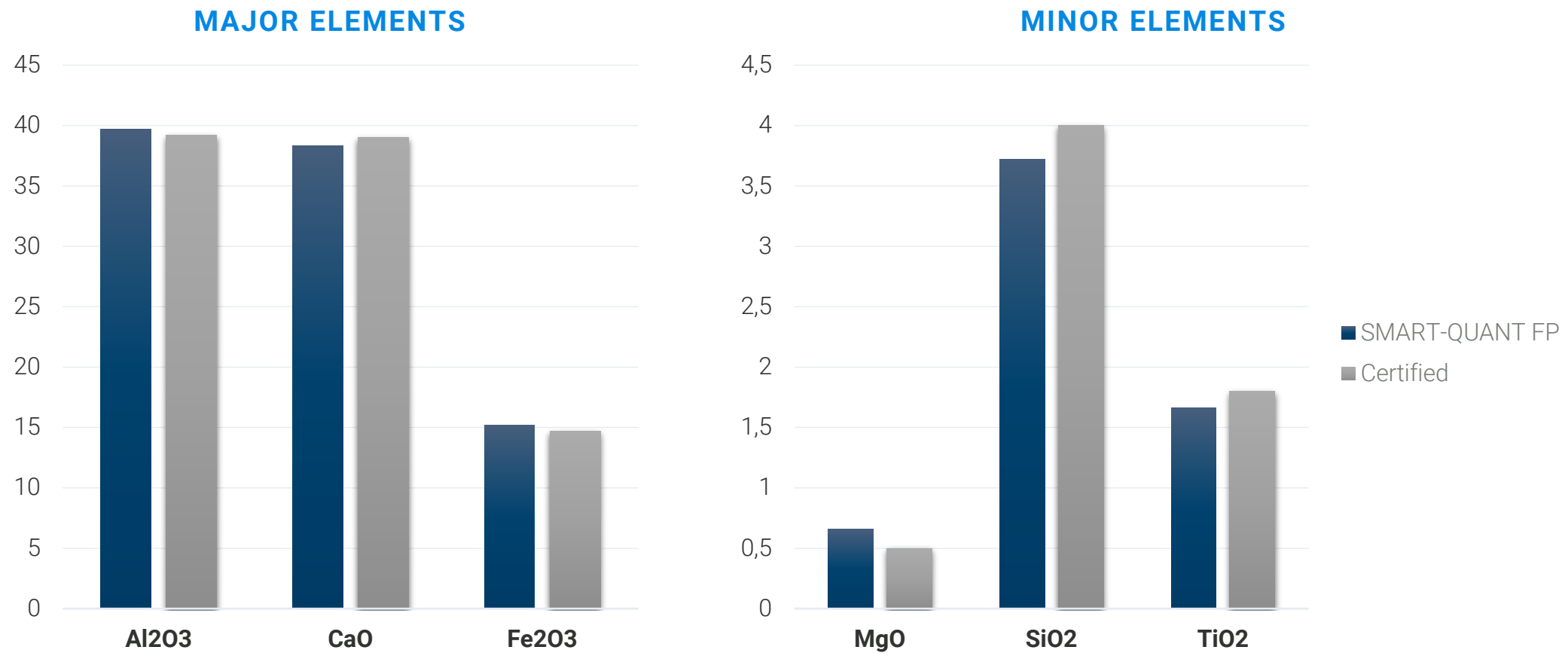



## MINOR ELEMENTS




Nickel Alloy – Waspaloy, concentrations in wt%

# SMART-QUANT FP
# Powered by HighSense XP




High Al Cement, concentrations in wt%

# Elemental Analysis: Pharma & Cosmetics

- Strict regulations apply to ensure the quality of resulting medications and other products. This makes reliable and precise analysis inevitable.
- XRF is particularly suitable for
  - quick verification of incoming **raw material**
  - at-line production monitoring (Process Analytical Technology, PAT)
  - foreign body identification (FBI), and
  - **heavy metal impurity** analysis.

- Cosmetic and personal care products must meet high product quality standards due to their applications.

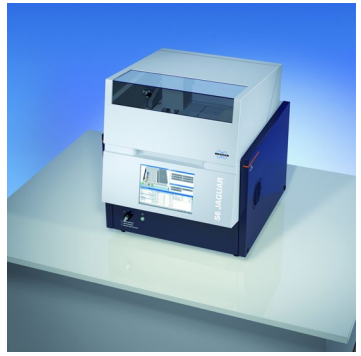
# Elemental Analysis: Pharma & Cosmetics

21 CFR Part 11-compliance

- SPECTRA.ELEMENTS is fully compliant

- The Part 11 features are smoothly integrated to ensure ease-of-use and worry-free operation – being always prepared for the next audit

- *Key features:*
  - Audit trailing
  - Electronic signatures / validation
  - Dedicated user levels
  - Customizable views



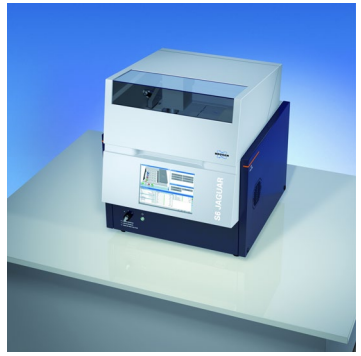
# Elemental Analysis: Pharma & Cosmetics

## IQ/OQ Documentation and Support

- **Installation Qualification:** Establishes that the instrument is received as designed and specified and that it is properly installed

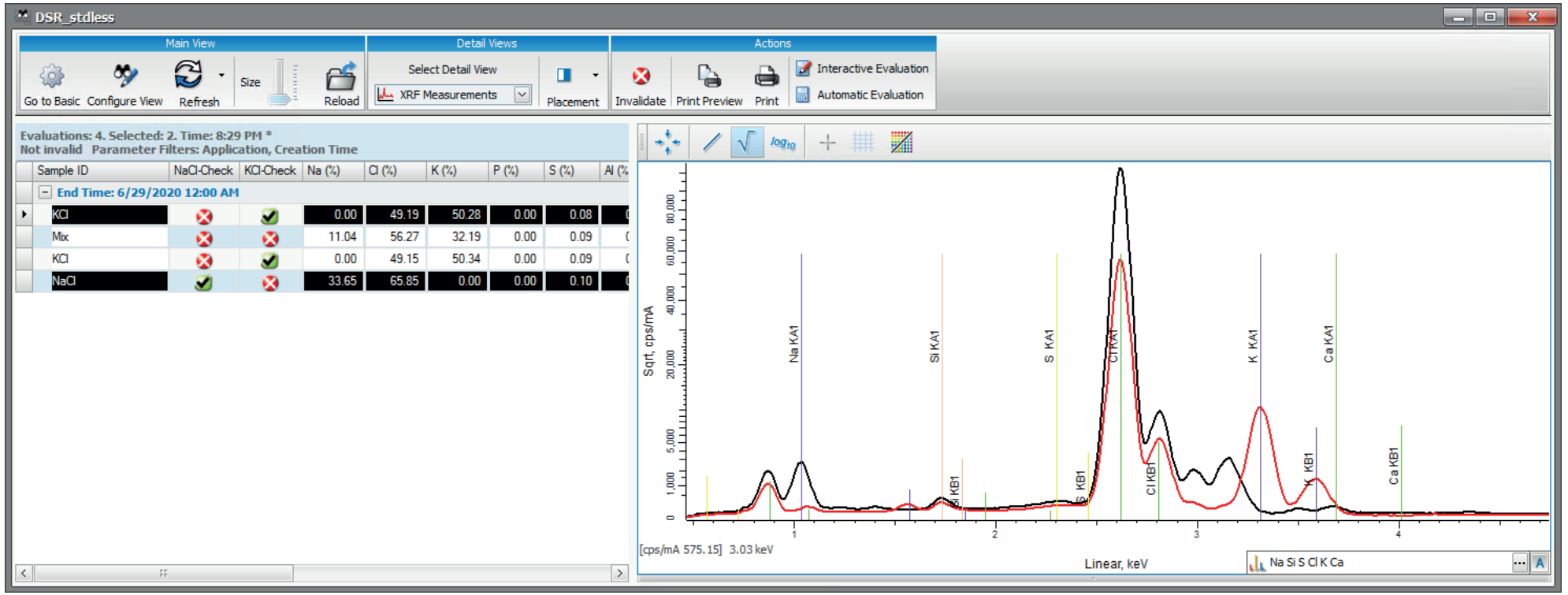
- **Operation Qualification:** Demonstrates that the instrument will function according to the operational specifications (acceptance testing).

- **IQ/OQ:** Performed together with our Part 11 trained Service Engineer



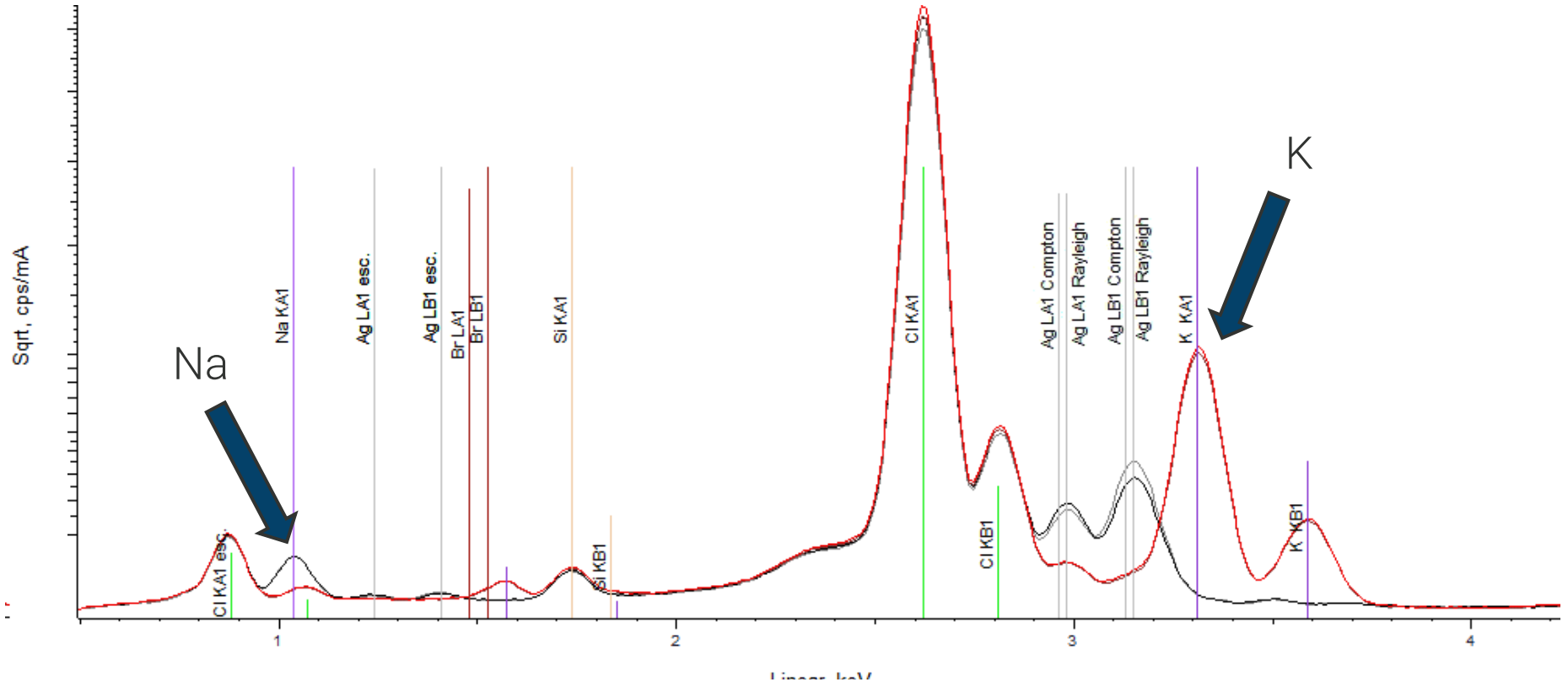
# SMART-QUANT FP
# Elemental Analysis: Pharma & Cosmetics

- Customizable concentration thresholds and configurable views allow to make a quick decision (reject or accept)



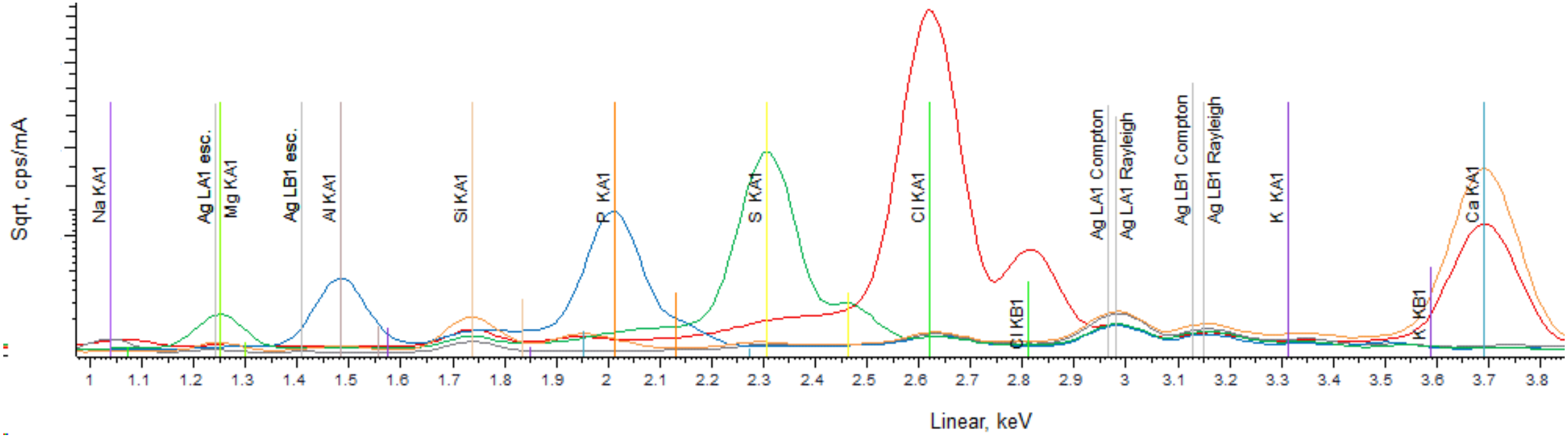
# SMART-QUANT FP
# Elemental Analysis: Pharma & Cosmetics

- Differentiate quickly between KCl and NaCl



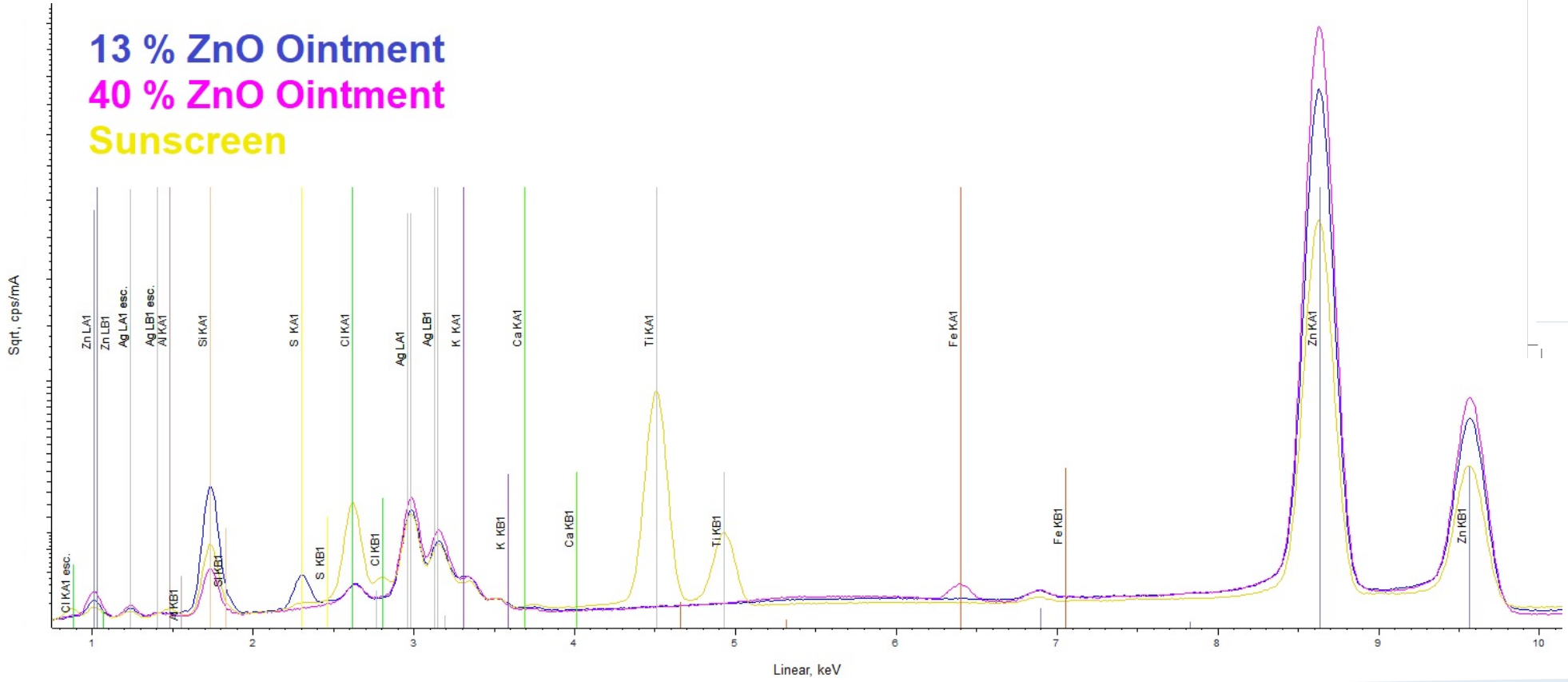
# SMART-QUANT FP
# Elemental Analysis: Pharma & Cosmetics

- Differentiate quickly between $CaCl_2$, $MgSO_4$, $AlPO_4$, and $CaCO_3$



# SMART-QUANT FP
# Elemental Analysis: Pharma & Cosmetics

- Identify material based on ZnO and/or $TiO_2$ contents, without providing information about the matrix




NEW SOFTWARE FUNCTIONALITY

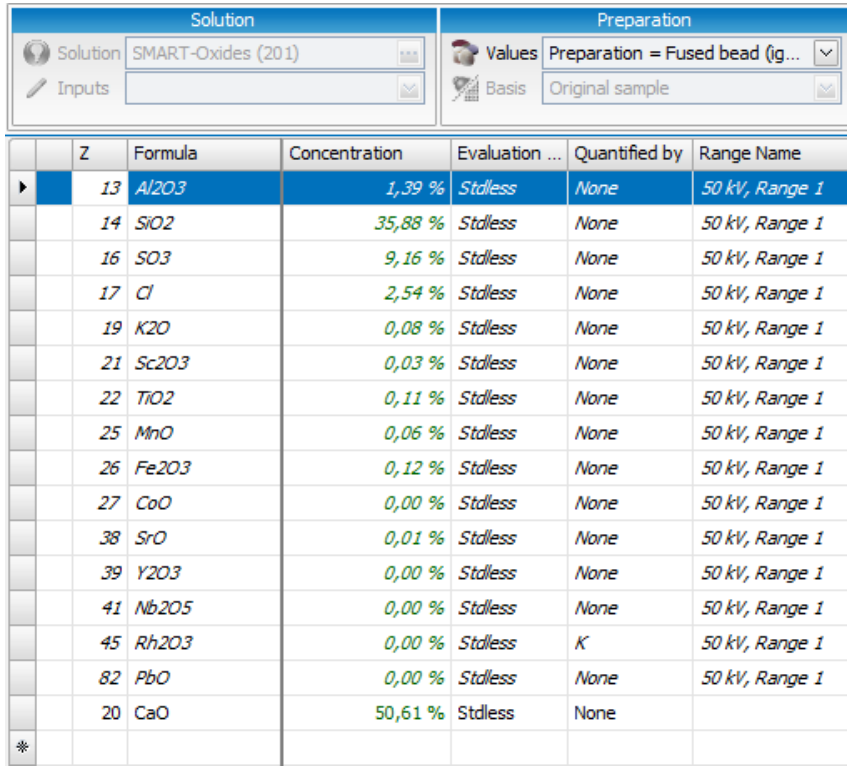
# Summary

# SPECTRA.ELEMENTS
# Next Generation Spectrometer Software

## Faster. Smarter. Easier.

Faster operation

- Optimized hardware-software workflow
- Immediate data processing
- Smooth navigation
- Rapid access to database




| Z | Formula | Concentration | Evaluation ... | Quantified by | Range Name |
|---|---|---|---|---|---|
| 13 | Al2O3 | 1,39 % | Stdless | None | 50 kV, Range 1 |
| 14 | SiO2 | 35,88 % | Stdless | None | 50 kV, Range 1 |
| 16 | SO3 | 9,16 % | Stdless | None | 50 kV, Range 1 |
| 17 | Cl | 2,54 % | Stdless | None | 50 kV, Range 1 |
| 19 | K2O | 0,08 % | Stdless | None | 50 kV, Range 1 |
| 21 | Sc2O3 | 0,03 % | Stdless | None | 50 kV, Range 1 |
| 22 | TiO2 | 0,11 % | Stdless | None | 50 kV, Range 1 |
| 25 | MnO | 0,06 % | Stdless | None | 50 kV, Range 1 |
| 26 | Fe2O3 | 0,12 % | Stdless | None | 50 kV, Range 1 |
| 27 | CoO | 0,00 % | Stdless | None | 50 kV, Range 1 |
| 38 | SrO | 0,01 % | Stdless | None | 50 kV, Range 1 |
| 39 | Y2O3 | 0,00 % | Stdless | None | 50 kV, Range 1 |
| 41 | Nb2O5 | 0,00 % | Stdless | None | 50 kV, Range 1 |
| 45 | Rh2O3 | 0,00 % | Stdless | K | 50 kV, Range 1 |
| 82 | PbO | 0,00 % | Stdless | None | 50 kV, Range 1 |
| 20 | CaO | 50,61 % | Stdless | None | |

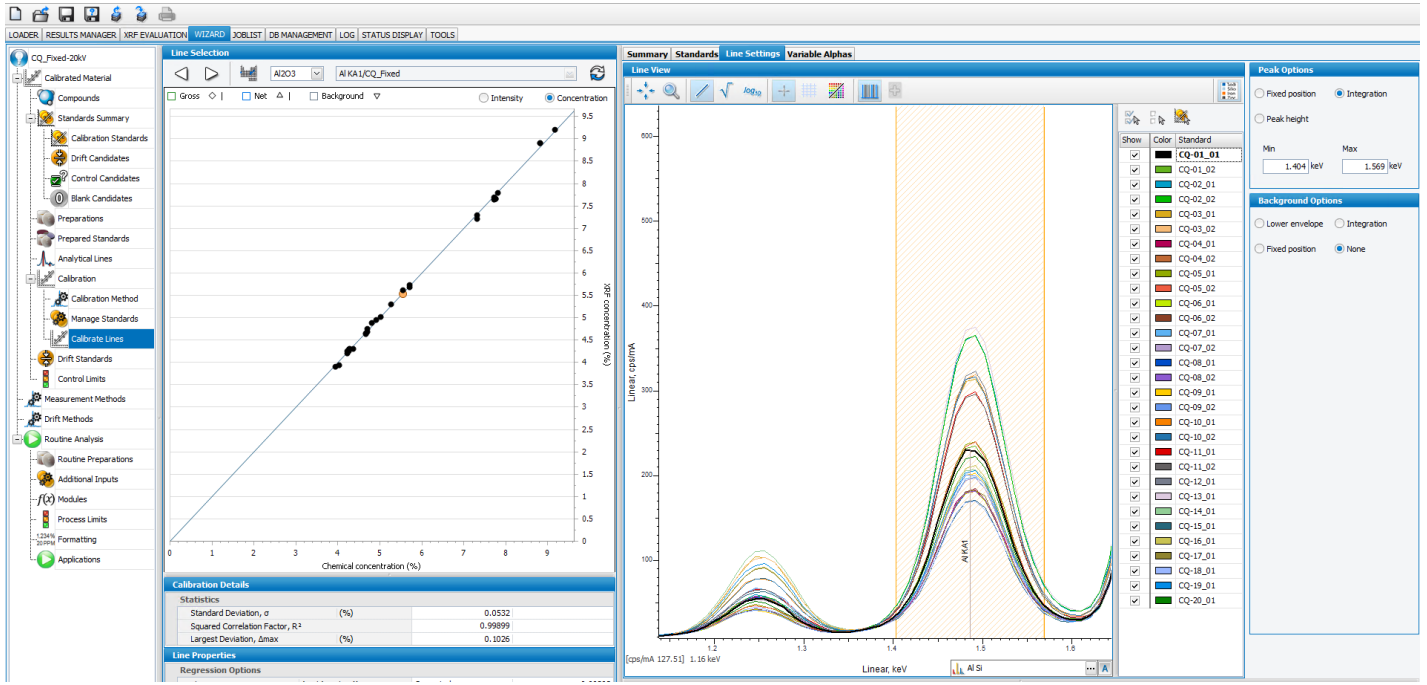
Evaluate your measurements in no time!

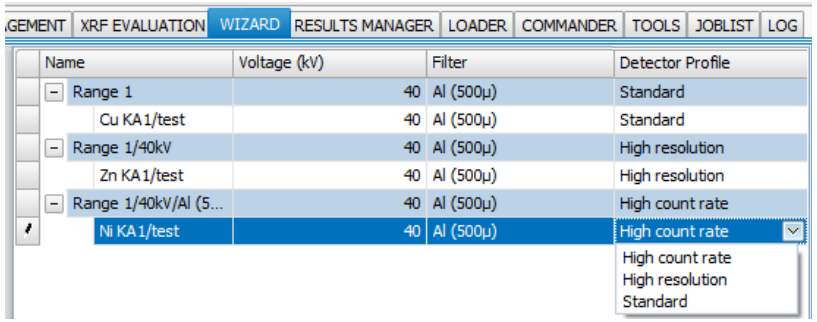
# SPECTRA.ELEMENTS
# Next Generation Spectrometer Software

Faster. Smarter. Easier.

Smarter features

- Dedicated User Levels
- Basic & Advanced Mode
- Detector Profiling
- Aut-O-Matrix
- Loss-Eliminated Alphas,
- Pressure compensation
- Blanks, duplicates, QC
- Post-Processing
- Automation ready



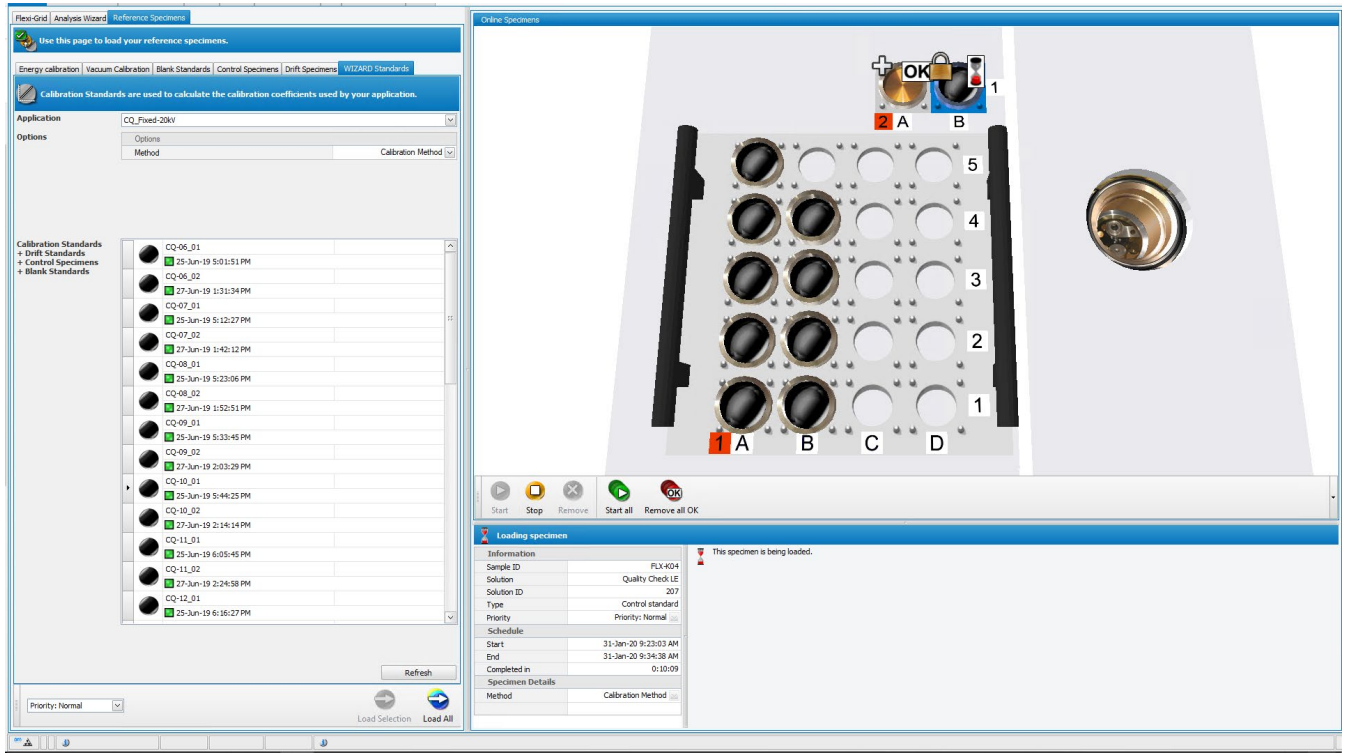



# SPECTRA.ELEMENTS
# Next Generation Spectrometer Software

## Faster. Smarter. Easier.

Easier to use

- Quick learning with new User Interface
- Hints provide help when needed
- WIZARD: the proven tree-structure guide you through the calibration process
- LOADER: Intuitive interface for routine operation
- RESULT MANAGER: Access all your data quickly and get extended reporting




The LOADER: load / unload samples; adjust priorities; start / stop your measurements;  view your results.

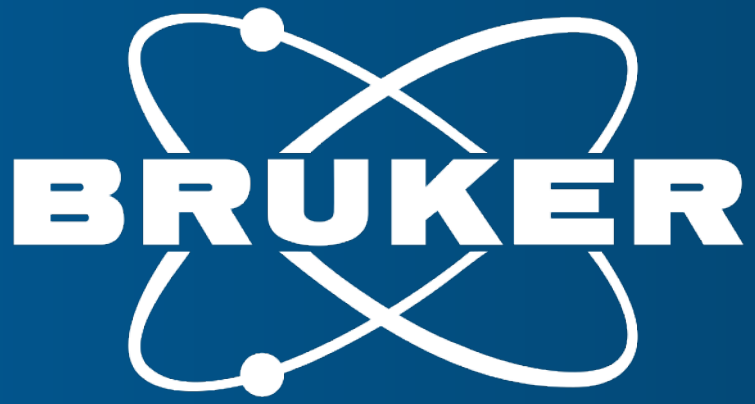
# Any Questions?

Learn more about ‘Feed and Pet Food Analysis’

In our 15.09.2021 webinar – Sign Up Now!

# **Thank you!**

Kai Behrens, Frank Portala, Adrian Fiege




Innovation with Integrity