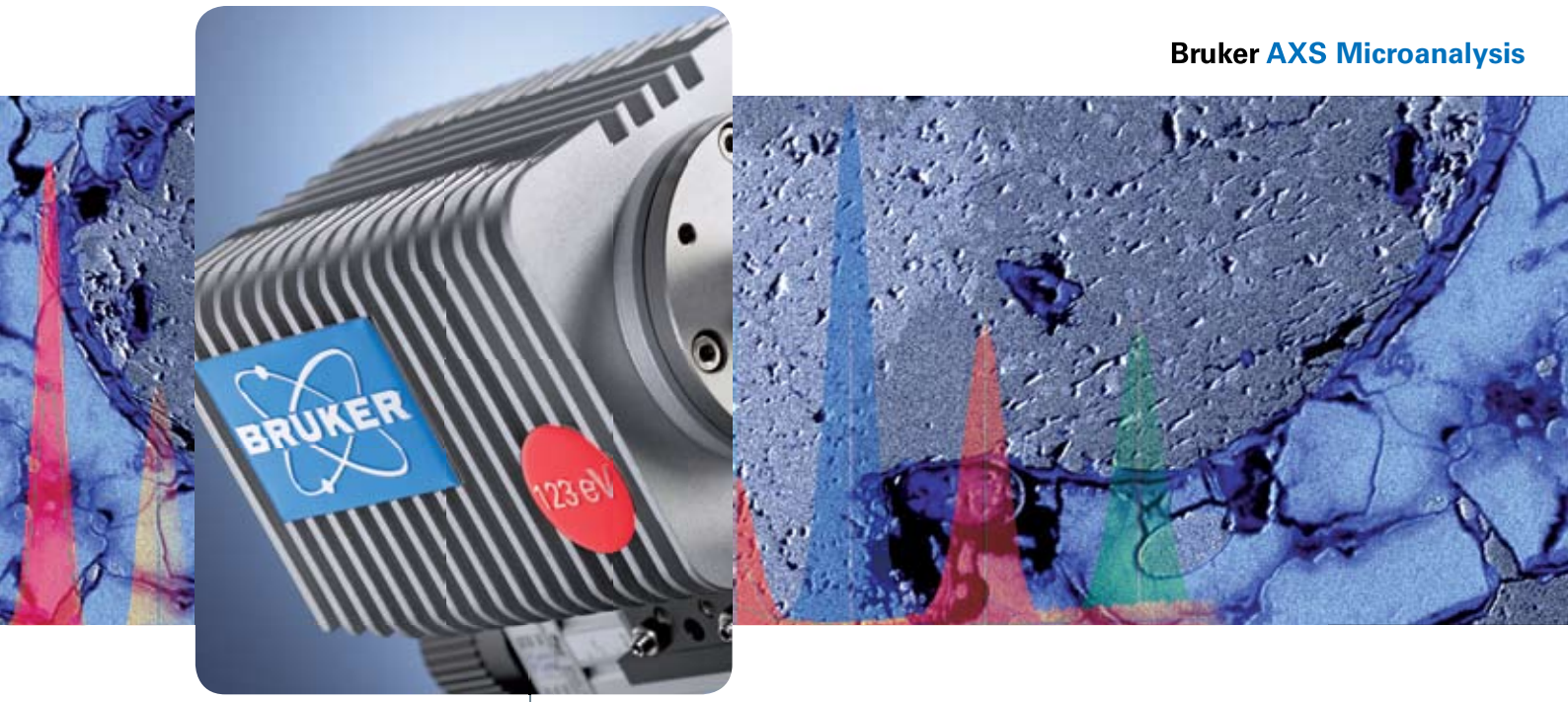
BRUKER

Bruker AXS Microanalysis



QUANTAX

- EDS Analysis for SEM and TEM

think forward

MICROANALYSIS

The new QUANTAX EDS systems – unprecedented speed, accuracy and ease of use

Our unique 5000 series of LN_2–free XFlash® Silicon Drift Detectors and the latest version of the powerful ESPRIT software deliver extraordinary performance in qualitative and quantitative energy-dispersive microanalysis.

QUANTAX – the future of microanalysis

The design of Bruker's QUANTAX microanalysis system is based on many years of experience in developing and manufacturing energy-dispersive X-ray spectrometers in close partnership with our user community. Our users' requirements have driven development priorities:

- Reliable analysis results
- Intuitive operation, powerful visualization options
- Convenient result presentation
- Integration with complementary analytical methods

The EDS spectrometer

The QUANTAX EDS system is modular and can be easily configured for any application.

The outstanding hardware is controlled by the intuitive ESPRIT software suite. The ESPRIT interface is carefully tailored to the way that you actually work. All the tools and controls to easily acquire, display, and analyze your data are at your fingertips.

ESPRIT features both standardless and standard-based quantification and also offers the unique possibility of combining standardless and standard-based algorithms in one evaluation procedure.

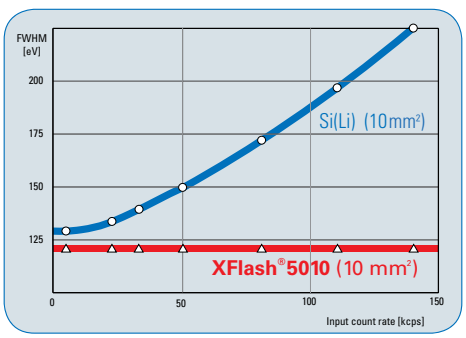
Evaluation can be done automatically or interactively. Interactive operation allows expert users to optimize their analysis, while our flexible and powerful automated batch processing is ideal for applications requiring repetitive analyses, such as quality control.

The high-performance, liquid nitrogen-free XFlash® Silicon Drift Detectors (SDDs), in combination with the unique hybrid pulse processor technology, guarantee optimal performance under all conditions. The XFlash® Detectors unite unbeatable technical parameters with high reliability.

Ultra fast signal processing electronics and new analytical options like real-time spectrometry, ColorScan and HyperMap turn QUANTAX into the fastest and most comprehensive EDS system on the market.

Superior technology, intelligent solutions, and attention to detail in both the design and manufacturing processes combine to ensure the high quality of QUANTAX EDS systems.

Bruker's signal processors for single-channel operation (upright) and with four channels for the XFlash® QUAD (horizontal)



Comparison of the energy resolution of the XFlash® 5010 and a 10 mm² Si(Li) detector at various input count rates

The XFlash®
started a new era

The 5000 series XFlash® Silicon Drift Detectors display high pulse load capability combined with excellent and stable energy resolution (down to 123 eV). Their optimized electron trap allows interference-free analysis even at low excitation energies. Special software adaptations and the world's most comprehensive atomic data library – now also containing N-lines – make QUANTAX the perfect system for nanoanalysis.

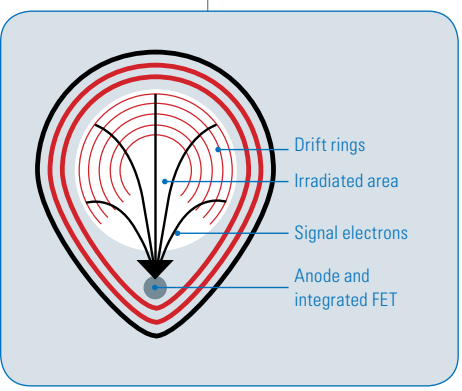
The XFlash® Detectors are based on Bruker's long experience in developing liquid nitrogen-free detector technology. Today, with more than 3,000 detectors currently in use, Bruker AXS Microanalysis is the acknowledged leader in SDD technology.

The heart of this modern detector technology is a silicon chip using the principle of sideward depletion and a small anode to minimize capacitance (and thus maximize the effective signal-to-noise ratio). This mode of operation allows the XFlash® Detectors to cope with extremely high count rates while also maintaining an energy resolution unrivaled by any other energy-dispersive detection system.

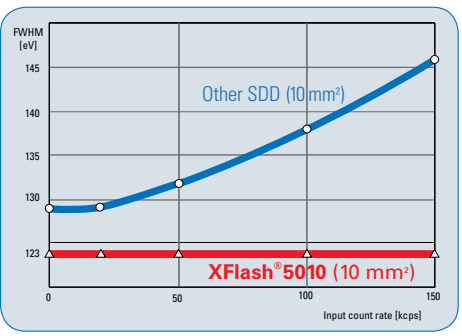
The chip temperature is stabilized by a two-stage, passive Peltier cooler. The great advantage of Peltier cooling is that it introduces absolutely no vibrations that could degrade the operation of the microscope (unlike other systems that use noisy mechanical coolers). Already in 1998, our innovative technology received the „Macres Award - Best Instrumentation" from the Microbeam Analysis Society of America.

XFlash® 5010 features the best energy resolution ever specified for a commercial X-ray detector – 123 eV. On top of that, the resolution is specified at an input count rate of 100,000 cps. Conventional Si(Li) detectors are usually specified at 1,000 or 2,500 cps.

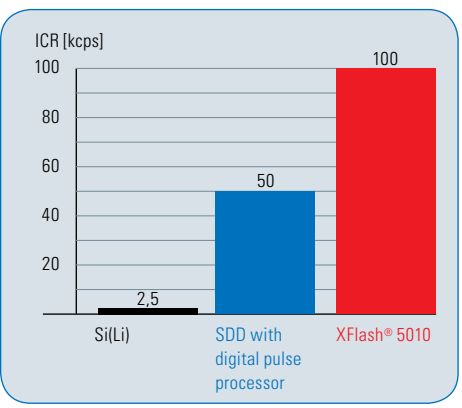
This outstanding energy resolution allows an excellent peak separation, especially in the low energy range below 1 keV, resulting in outstanding performance for light element detection and quantification.



XFlash® 5010's droplet-shaped detector chip



Comparison of the energy resolution of the XFlash® 5010 and another SDD at increasing count rates



Input count rate of several detectors at their best resolution

When working with applications that deliver low count rates, such as applications with cold field emission scanning electron microscopes or transmission electron microscopes, high detection efficiency is necessary. The XFlash® 5030, with an active area of 30 mm², complies with this requirement and, at the same time, achieves a superb energy resolution.

The XFlash® QUAD impresses with incredible speed and excellent energy resolution. This detector has four independently operating 10 mm² sensors on a single chip that provide a total active area of 40 mm². The great advantage of this new design concept is that the detector maintains the high energy resolution of a single 10 mm² SDD while offering 4 times the solid angle and throughput capability. This detector can collect a maximum of 1,100,000 cps into the spectrum. Due to the combination of large solid angle and supreme energy resolution, the XFlash® QUAD is also suitable for low beam current and low energy applications. With its four separate sensors, this detector can process the fourfold number of counts compared to a single-channel system.

Hybrid pulse processor

Bruker's hybrid pulse processor, specially developed for XFlash® SDDs, combines the best of both worlds: analog and digital techniques facilitate signal processing at extremely high count rates. This makes the system up to ten times faster than conventional Si(Li) detectors using digital pulse processors. Even at low count rates, QUANTAX accelerates analysis due to its extremely low dead times. At 1,000 cps the system performs 30 % faster than – and at 5,000 cps, twice as fast as – conventional Si(Li) systems.

The third graphic on the left shows the superiority of Bruker's hybrid pulse processors compared to SDDs operated with digital pulse processors. Our unique technology also makes problematic pile-up software correction techniques unnecessary, even at high input count rates.

All specifications are of course warranted in situ on the SEM or TEM. The detectors are adaptable to all types of SEMs or TEMs. A perfect detector/microscope interface and optimum conditions regarding covered solid angle and take-off angle are guaranteed in all cases.

XFlash® is a registered trademark of Bruker AXS Microanalysis GmbH.

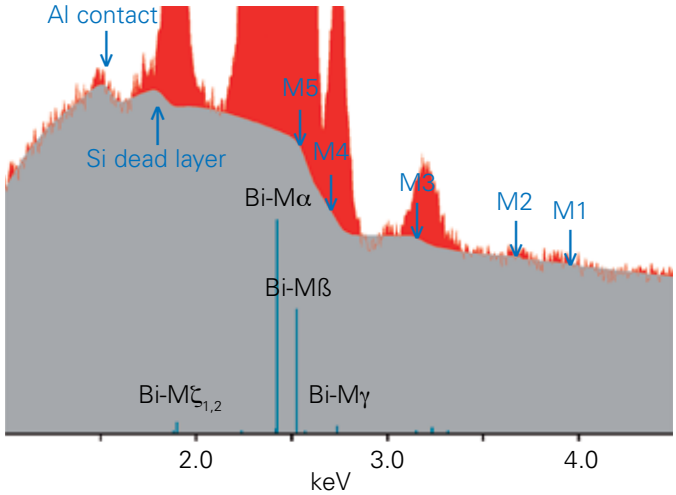
Energy resolution	Resulting energy resolution	
Mn Kα	C Kα	F Kα
133 eV	65 eV	73 eV
123 eV	**46 eV**	**54 eV**

Input count rate	Speed advantage XFlash® vs. Si(Li)
1,000 cps	30 %
5,000 cps	50 %
750,000 cps	10 times faster

Element identification and spectrum evaluation

Carefully designed down to the smallest detail while following customer requirements: Bruker sets new standards for ease of use and in spectrum evaluation.

Real-life samples consist of many different materials and structures such as fragments, powders and fibers. Standard-based quantification techniques are often not appropriate, as adequate standards are not available or the samples cannot be prepared properly.



Calculation of the bremsstrahlung background according to a physical model. The graphic shows the magnified representation of the adaptation to a bismuth spectrum. The absorption edges of the single element lines and the detector effects (Al contact, Si dead layer) are visible.

Standardless P/B-ZAF quantification

In these cases, Bruker recommends using our unique standardless quantification method. This method relies on peak-to-background ZAF evaluation (P/B-ZAF) and provides reliable quantification results for all types of samples – even for challenging analysis tasks.

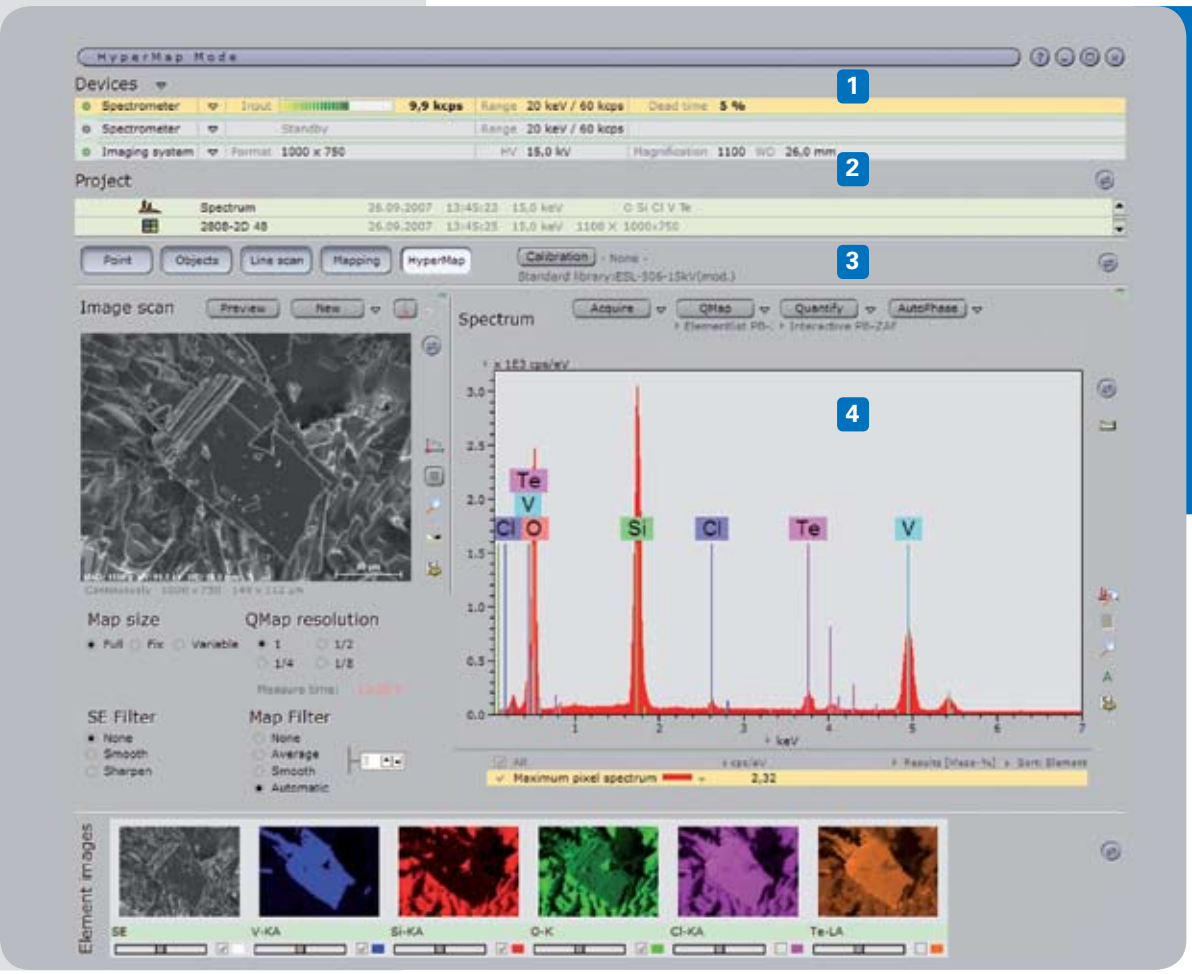
The P/B-ZAF algorithm is based on a physical model using information obtained from bremsstrahlung background radiation as an internal standard for quantification. Peak-to-background (P/B) ratios used for calculating quantitative data are more robust than net intensities used by other algorithms. Accordingly, rough-surfaced samples and particles can be accurately quantified.

The P/B-ZAF method is a genuinely standardless approach; all information necessary for complete and exact quantification is extracted from the spectrum itself. No additional information stored in spectra libraries is required, as in many other approaches also called „standardless".

The world's most comprehensive atomic data base

ESPRIT's enhanced atomic data base guarantees proper identification and correct deconvolution of overlapped element lines and therefore a reliable quantification. Important additional information regarding the position, classification or relative intensity of the existing L and M-lines is included in ESPRIT. Furthermore, N-lines are integrated into the software – a worldwide first. The intensity of these lines exceeds the intensity of the M-lines at very low excitation energies (≤ 3 keV). In this way, they play an increasingly important role in nanoanalysis.

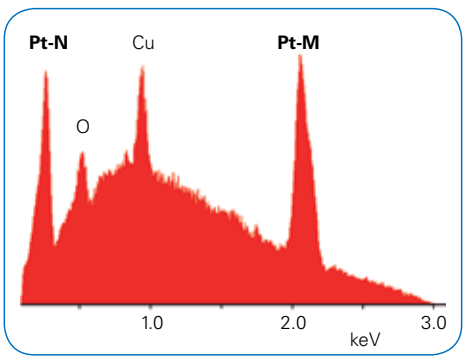
QUANTAX 400



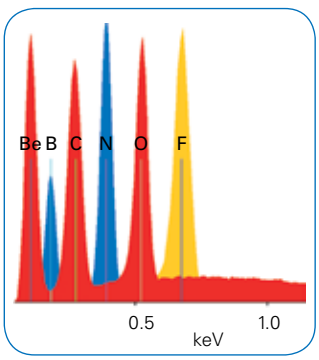
ESPRIT user interface

1. Hardware section
2. Project section
3. Acquisition and evaluation
4. Function-specific section, selected function is highlighted
5. Main menu

ESPRIT allows analyses to be carried out automatically or in an interactive mode permitting the user to monitor and control every step of the quantification procedure. Every spectrum processing or evaluation option can be selected consecutively. The menus are clearly structured and show high functionality. An integrated „expert system" supports the user during the analysis and gives hints for optimizing the evaluation.

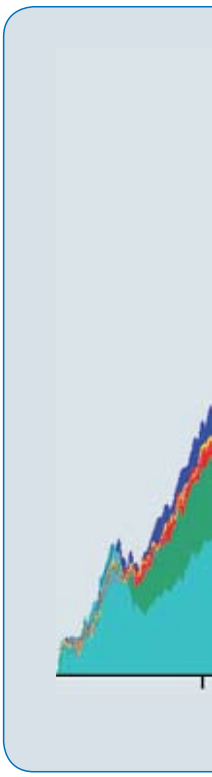


Platinum spectrum acquired at 3.0 kV. At this excitation energy, the platinum N-line is almost as high as the M-line.



Composite spectrum made up of several single measurements showing XFlash® 5010's impressive performance in the light element range.

Standard-based spectrum evaluation

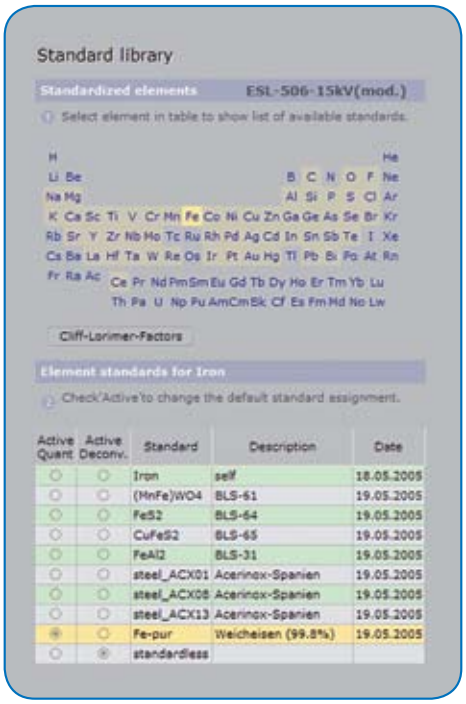


In addition to our comprehensive standardless P/B-ZAF quantification method, ESPRIT provides a standard-based method relying on net intensities and $\Phi(\rho,z)$ matrix correction. This approach is implemented in the ESPRIT HSQuant software module.

Compared to the standardless method, the standard-based quantification yields the highest possible accuracy. However, standard-based measurements involve considerable efforts.

If all necessary requirements are met, accuracy is often better than two percent. Apart from the high parameter stability and reproducibility, this analysis method also requires standards with matrix similar to the sample. QUANTAX provides the user with easy-to-use library management tools. Pure element standards as well as composite standards can be measured and added with only a few mouse clicks. Standards to be used for a particular analytical task can be determined automatically by the system or manually by the user if desired.

Standard-based quantifications using a single reference sample can be used for routine analyses in process and quality control. In these cases, highly accurate and reproducible results are already achieved by means of calibration measurements on the reference sample without involving a standard library.



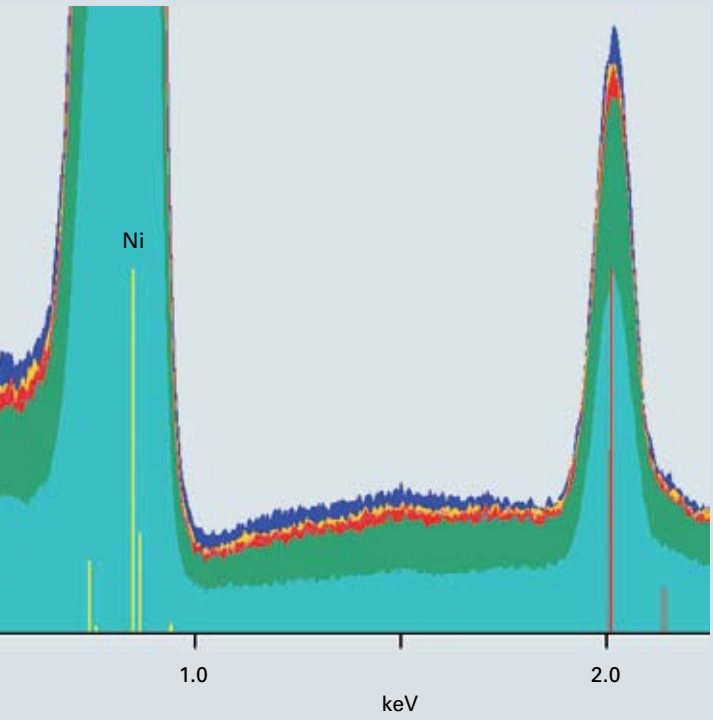
Dialog for the easy selection of appropriate standards for quantification

The best of two worlds – the combination of $\Phi(\rho,z)$ and P/B-ZAF analysis

In 2005, Bruker introduced a method that combines the advantages of the standard-based $\Phi(\rho,z)$ correction with those of the true standardless P/B-ZAF-approach. If adequate standards are available, they are used to quantify corresponding elements. All other elements are automatically quantified using the standardless method.

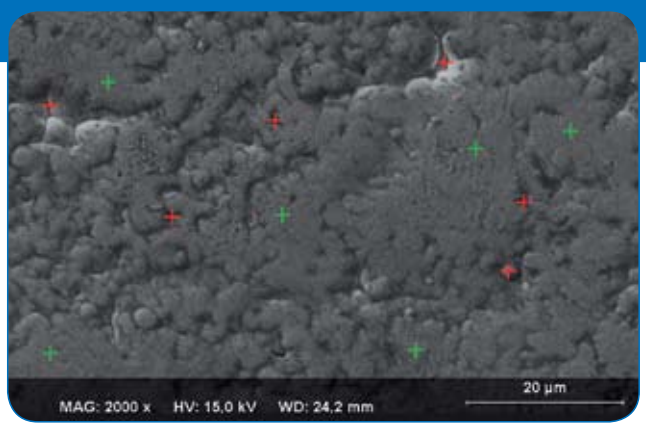
The user-friendly operating philosophy, the integrated help menu and the detailed documentation permit a fast familiarization with the system for beginners. But this combined method's high efficiency will also convince the more experienced user.

Comparison of standardless and standard-based quantification



Overlay of the spectra acquired at the six measuring points in rough-surfaced areas of the sample (red crosses in the image below)

Surface of a galvanic nickel phosphide film with smooth (green measuring points) and rough (red measuring points) areas



Smooth areas			Rough areas		
Measuring point	Ni[%]	P[%]	Measuring point	Ni[%]	P[%]
1	95.28	4.72	7	95.01	4.99
2	95.29	4.71	8	94.72	5.28
3	95.26	4.74	9	95.32	4.68
4	95.38	4.62	10	94.64	5.36
5	95.29	4.71	11	94.64	5.36
6	95.25	4.75	12	96.06	3.94
Average	95.29	4.71	Average	95.06	4.94
Target value 4.72 % P			Acceptable tolerance ± 0.25 %		

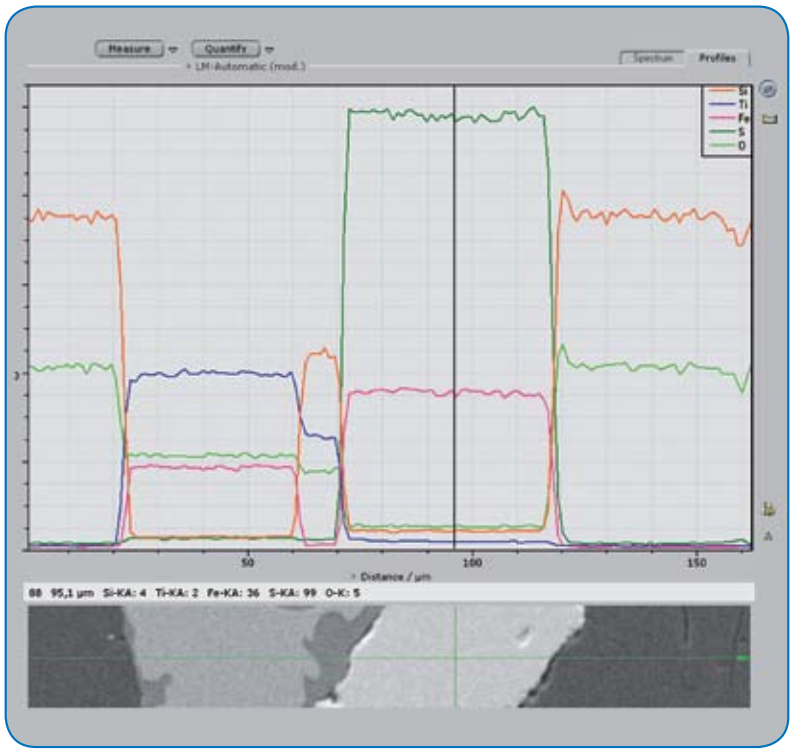
The standard-based analysis with Φ(ρ, z)-correction delivers unrivaled results in the case of smooth areas. However, the analysis of rough areas is quite problematic.

Smooth areas			Rough areas		
Measuring point	Ni[%]	P[%]	Measuring point	Ni[%]	P[%]
1	95.27	4.73	7	95.32	4.68
2	95.29	4.71	8	94.31	4.69
3	95.33	4.67	9	95.31	4.69
4	95.31	4.69	10	95.30	4.70
5	95.28	4.72	11	95.21	4.79
6	95.30	4.70	12	95.35	4.65
Average	95.30	4.70	Average	95.30	4.70
Target value 4.72 % P			Acceptable tolerance ± 0.25 %		

The standardless P/B-ZAF-method delivers the best results for the analysis of rough surfaces.

Your SEM learns to see colors

TV, computer screens or digital photography in black and white are remnants of the past. Nowadays everything is in color. Surprisingly, black and white images are still common in electron microscopy. The ultra fast QUANTAX hardware now delivers the necessary count rates for generating element distribution images in color with the accuracy and speed of an electron image.



Qualitative line scan of an oxidic sample. A magnified image of the analyzed area is displayed below the line scan. Interesting points can be exactly located by moving the vertical line cursor.

Linescan

When analyzing element distributions in a sample, the advantages of the high-speed, high-resolution XFlash® SDDs in combination with the hybrid pulse processor technology are outstanding. The results for which you had to wait for hours in the past are now on your desk within a few minutes or even seconds.

The ESPRIT line scan feature collects element profiles at incredible speed providing the user with noticeably more convenience. Acquisition needs only a fraction of the time compared to standard Si(Li) systems using digital pulse processors.

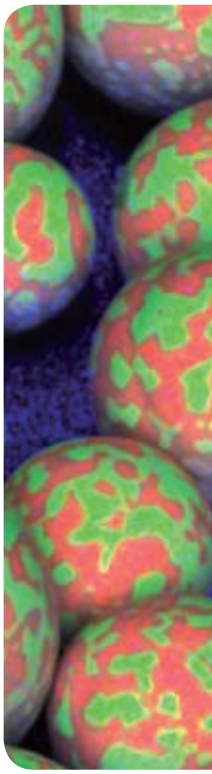
ESPRIT – an intuitive, easy-to-use interface provides flexible analysis options. All important information is visible at a glance.

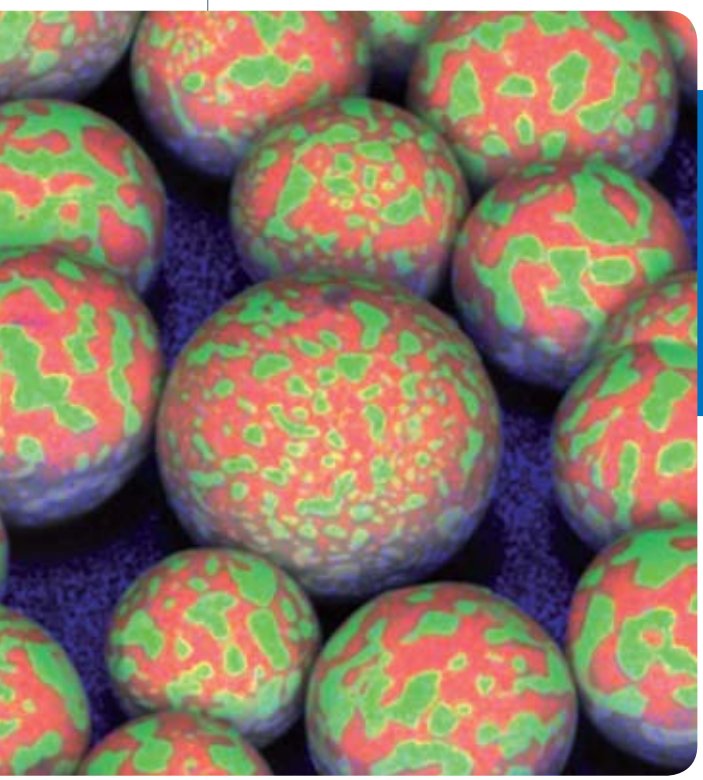
The line to be profiled can be freely drawn on the SEM image with a few mouse clicks. After having determined the elements of interest in the overview spectrum, the magnified electron image and the scanned line are displayed directly below the line scan profile. The line scan profile can then be immediately related to the topography of the electron image.

In contrast to other EDS systems, QUANTAX allows an unlimited number of elements to be selected for line scan analysis. Variable scan speed is combined with pixel and line averaging capabilities to enable the use of high beam currents, even for sensitive samples.

Complete spectra are stored at every pixel along the scanned line. Identifying and evaluating new elements is possible at any time later without having to collect new line scan data. In-depth analyses need not be carried out at the microscope; they can easily be performed on a remote computer.

Especially when dealing with rough surfaces or particles, line scans based on intensities only may lead to wrong results due to varying absorption in the sample. Quantitative line scans using the P/B-ZAF evaluation method avoid such misinterpretation and therefore generate highly reliable quantitative element profiles.





High-resolution mapping –original size 2048 x 1536– of tiny solder pellets on carbon adhesive tape. Lead is represented in green, tin in red and the adhesive tape, which can be seen between the pellets, in blue. QUANTAX's high precision makes it possible to see details typically seen in SE images – in color!

Element mapping

QUANTAX collects maps up to ten times faster than conventional systems. Brilliant element distribution images are generated right in front of your eyes like never before!

As a part of the intuitive ESPRIT software, the element mapping feature is easy to use. All needed data is clearly laid out and results are only a mouse click away.

If you are used to waiting for hours for a reasonable map, prepare for a completely new experience: high-resolution maps within minutes. In addition to a large number of pixels, the Bruker system's high resolution also means high information density at each pixel, clearly showing even minor differences in concentration.

Single element maps can contain up to 65,000 colors. There is no limitation to the number of simultaneous element maps and all elements from beryllium (4) to americium (95) can be mapped.

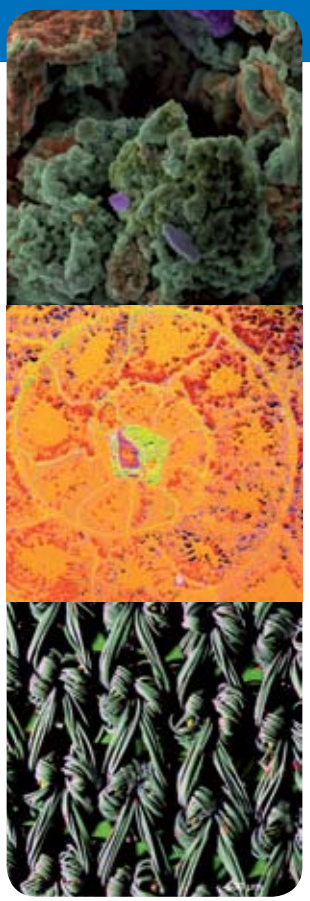
Mapped images can be displayed as single element maps or superimposed. SE or BSE images can be added to the map showing topographical information on phases, micro-inclusions, grains, etc.

Discover brilliant element images of unprecedented quality after only a few minutes of acquisition.

Just like quantitative line scan, quantitative mapping delivers impressive results even for rough surfaces and particles. The advantages of the P/B-ZAF approach are evident here.

Real-time spectrometry

QUANTAX's extreme speed permits a totally new approach to spectrometry. Detailed information on the element distribution of a sample becomes visible instantly thanks to the XFlash® detector technology and can be refined with every repetitive scan.



High-resolution mapping – images of various materials

HyperMap – discover new insights

ESPRIT HyperMap provides users with complete new perspectives.

HyperMap is Bruker's version of position-tagged spectrometry (PTS). This technique was first introduced in 1996 by Princeton Gamma-Tech (now part of Bruker AXS Microanalysis). Spectra are stored at each pixel of a map or line scan. This allows collected data to be completely reanalyzed at any time, including examination of new elements, without having to acquire new data.

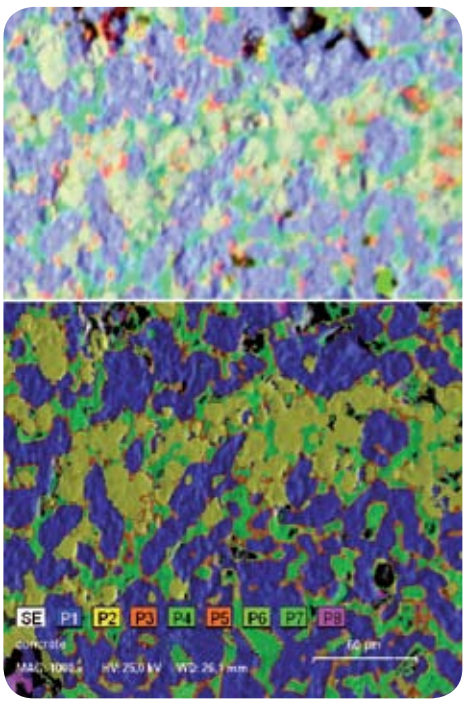
Until now, all available systems had a critical problem: due to the low count rates delivered by Si(Li) detectors, a precise evaluation was obtained only after an excessively long acquisition time.

With the introduction of the XFlash® detector technology, the mapping techniques have become of practical relevance, since the result statistic is now sufficient after measuring for only a few minutes.

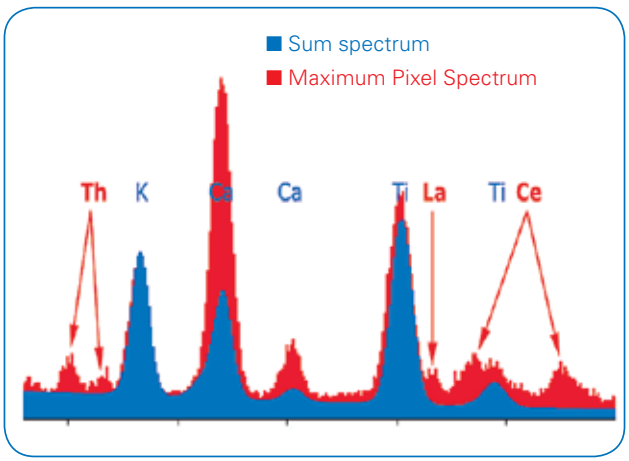
Thanks to these technical improvements, the mapping function has been extended by additional features to obtain further valuable information on sample composition.

Maximum Pixel Spectrum

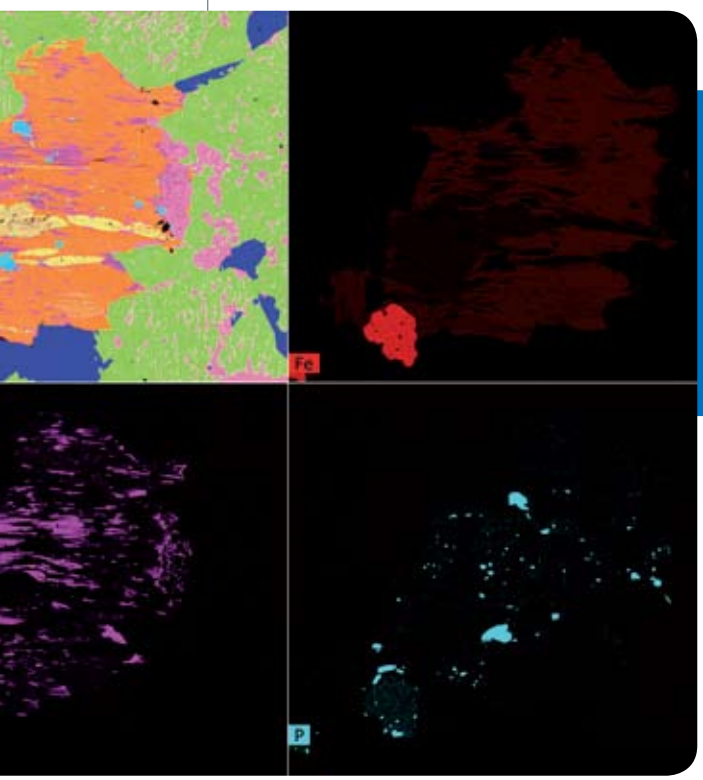
This feature was originally developed by the National Institute of Standards and Technology (NIST). It is actually quite simple: a spectrum is synthesized by determining the highest count value in each channel of all spectra in the HyperMap. In this way, elements can be found, even if they are contained only in one single pixel.



If mappings become unclear due to the element distribution and the resulting color contrast (such as in the shown mapping of a concrete sample with the elements aluminum, silicon, calcium and iron), phase analysis helps achieve a clearer representation of the sample's characteristics.



Maximum Pixel Spectrum of a granite sample (red) that indicates traces of the rare lanthanoids cerium, lanthanum and thorium. These elements are not evident in the sum spectrum (blue).



HyperMap of a granite sample, qualitative representation. The distribution of the single elements iron (Fe), titanium (Ti) and phosphorus (P) is highlighted.

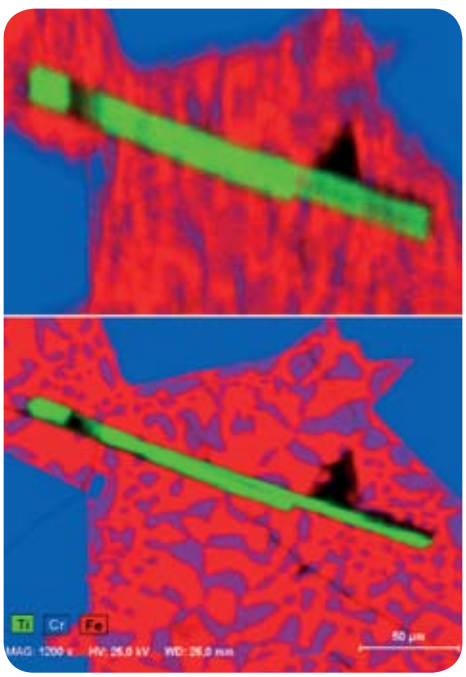
Phase analysis

ESPRIT Autophase can be used on qualitative and quantitative maps, as well as on HyperMaps. This feature reliably determines which phases are present in your sample. The phases can be identified automatically or manually according to the user's preferences (e.g. histogram analysis or predefined objects).

Phase analysis result of a granite sample. (Sample courtesy of the Berlin Museum of Natural History)

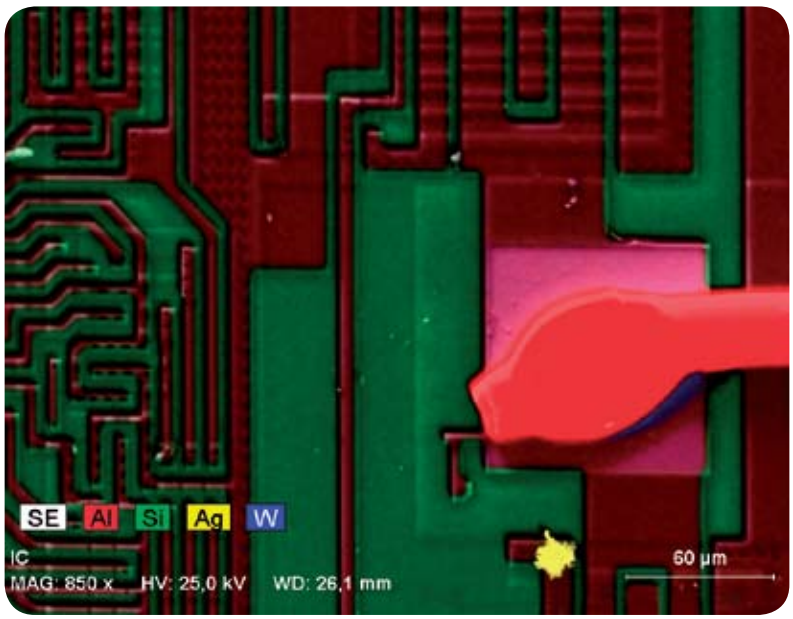
Drift correction

When acquiring a map at a high beam current or over longer periods of time, the electron image may drift. This effect also occurs in the case of sample charging. ESPRIT Drift Correction compensates for the drift. This feature can be used on HyperMaps, as well as on normal mappings and image acquisition.



The drift correction feature compensates for image distortions. The top half of the picture shows a mapping without drift correction; the bottom half, the same with drift correction.

ESPRIT Report



There are certain fields where compromises can not be accepted. One of them is your final analysis step – report generation.

QUANTAX offers one of the most modern and convenient tools for report generation, result presentation, and archiving. Spectra, images, tables, and graphics can be stored or archived individually or in projects containing all material belonging to a user-defined topic. Several export formats can be used for flexible data exchange with third-party software applications.
A simple mouse click transfers a complete report to Microsoft Word.

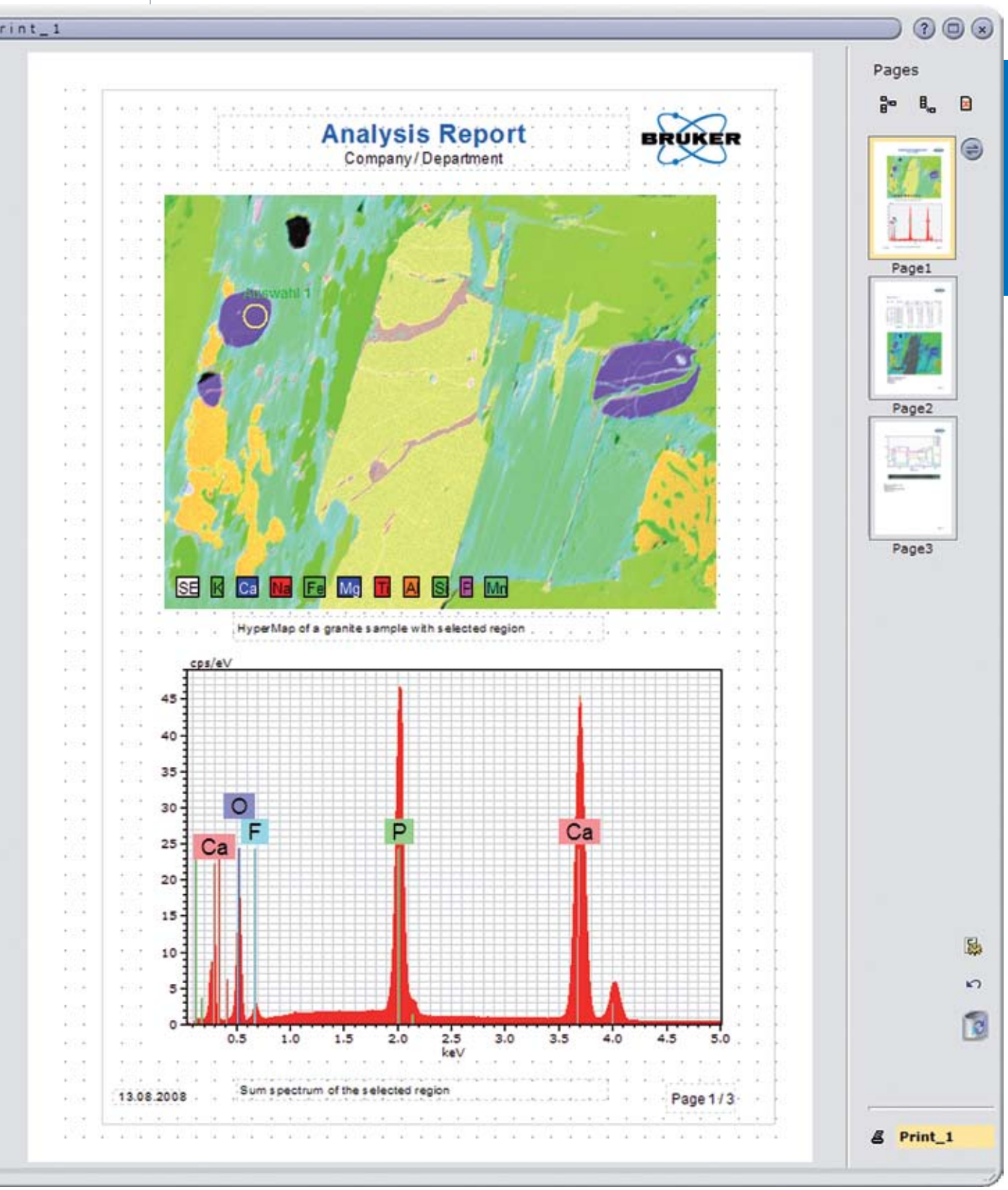
The ESPRIT Report Editor enables the user to freely generate templates (e.g. in the corporate design of your company). All results – spectra, maps, line scans, tables, graphics, and images – can be read, rearranged, resized, edited, and supplemented with annotations. Spectra, maps, line scans, and tables can be altered directly and at any time later in the Report Manager. Easy-to-use tools for adding text, objects and drawings are included to help customize presentations.

Whatever your demands might be, ESPRIT will give you the means to fulfil them.

Combining Methods

In order to obtain additional analytical information, QUANTAX can be integrated with various software and hardware solutions making it easy to obtain results from complementary analytical methods. For special applications, QUANTAX provides an API interface for external control.

Enthusiastic QUANTAX users from all over the world and more than 3,000 installed XFlash® detectors encourage us to continue striving for constant technological progress!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Analysis Report
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SE K Ca Na Fe Mg Ti Al Si F Mn
HyperMap of a granite sample with selected region
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QUANTAX systems

QUANTAX model	200	400	800	QUAD
Short description	Entry level modular EDS system	Universally applicable modular EDS system	High-end modular EDS system	Top of the range 4-channel EDS system
Available detectors	XFlash® 5010 XFlash® 5030	XFlash® 5010 XFlash® 5030	XFlash® 5010 XFlash® 5030	XFlash® QUAD 5040

ESPRIT software

Module	Description
Spectrum	Spectra acquisition, element identification
Quant	Automatic standardless quantification
EQuant	Extended spectrum analysis options
UQuant	User defined quantification strategies
HSQuant	Combined $\Phi(\rho,z)$ and standardless analysis
CLQuant	Cliff-Lorimer quantification
SpecMatch	Spectrum matching, search similar spectra
Scan	Image acquisition
ColorScan	Colored element image
SEMLink	Data communication with microscope
Vision	Digital image processing and enhancement
MultiPoint	Automatic multi-point and object analysis
Line	Spectrum data based line scan
QLine	Quantitative line scan

Module	Description
Map	Ultra high speed digital X-ray mapping
QMap	Quantitative mapping
HyperMap	Mapping with hyper spectral database
MaxSpec	Element trace determination for HyperMap
DriftCorr	Correction of specimen drift
Project	Data management and filing system
Report	Result presentation and report generation
User	Multi-user operation and administration
LAN	Client/server architecture
Support	Application support and remote diagnosis
StageControl	Motorized stage control
JobControl	Automatic task processing
AutoPhase	Automatic phase analysis
Feature	Feature analysis, chemical classification

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