

# INCA

One fully integrated platform that provides many solutions for microanalysis in the electron microscope



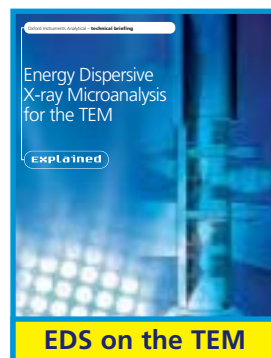
EDS explained



EDS hardware



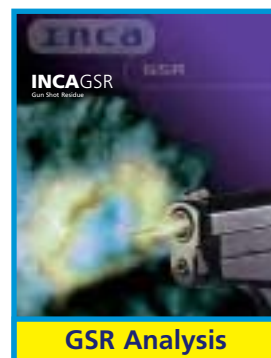
EDS + EBSD



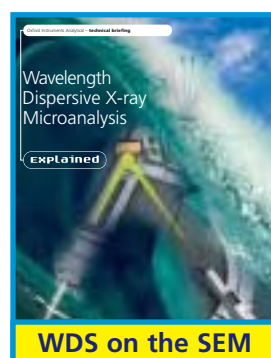
EDS on the TEM



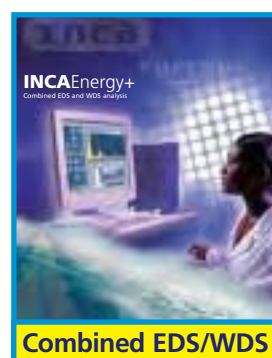
Feature Analysis



GSR Analysis



WDS on the SEM



Combined EDS/WDS



WDS on the SEM

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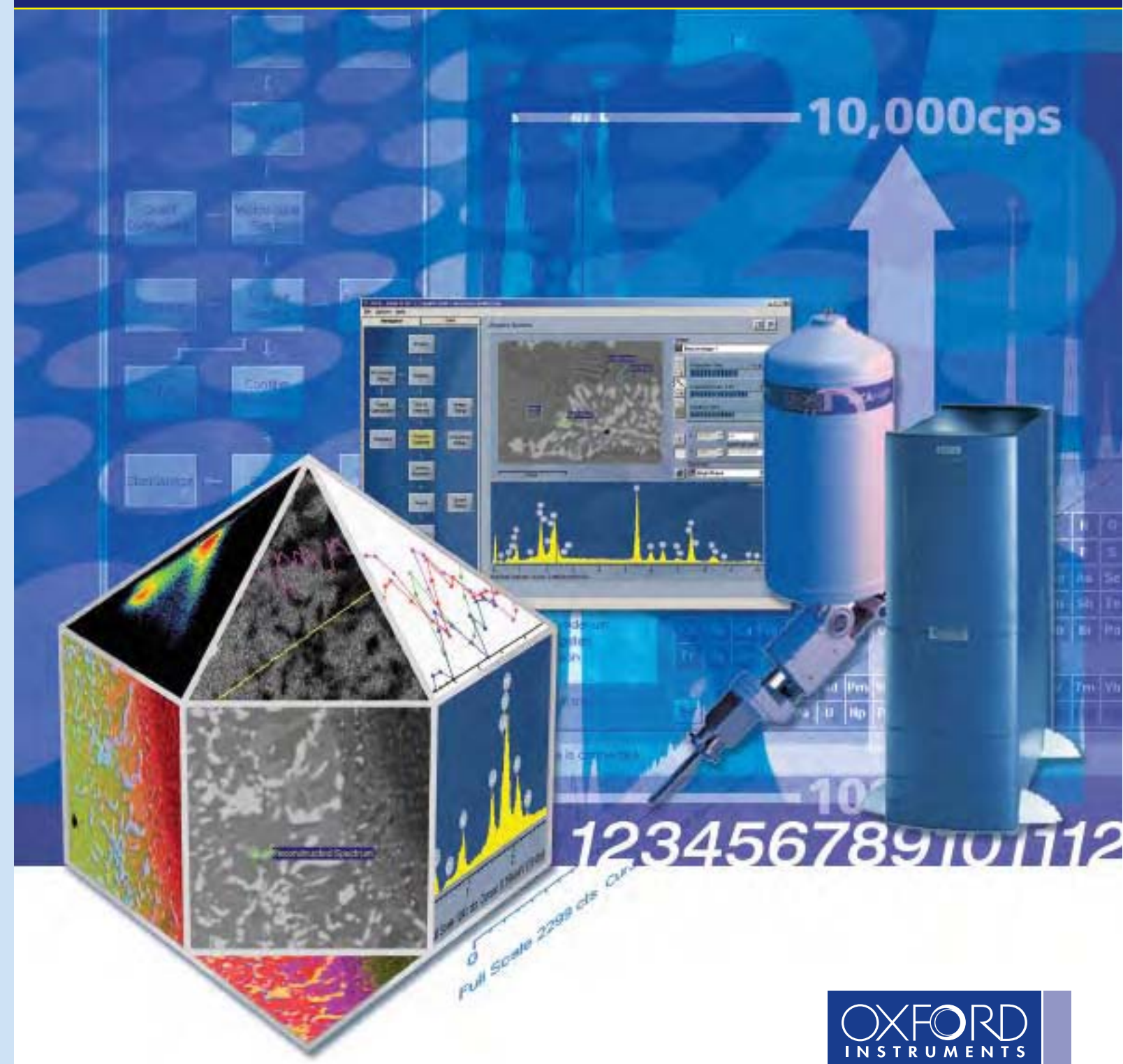
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# INCAEnergy

25 reasons to choose this solution for EDS on the SEM



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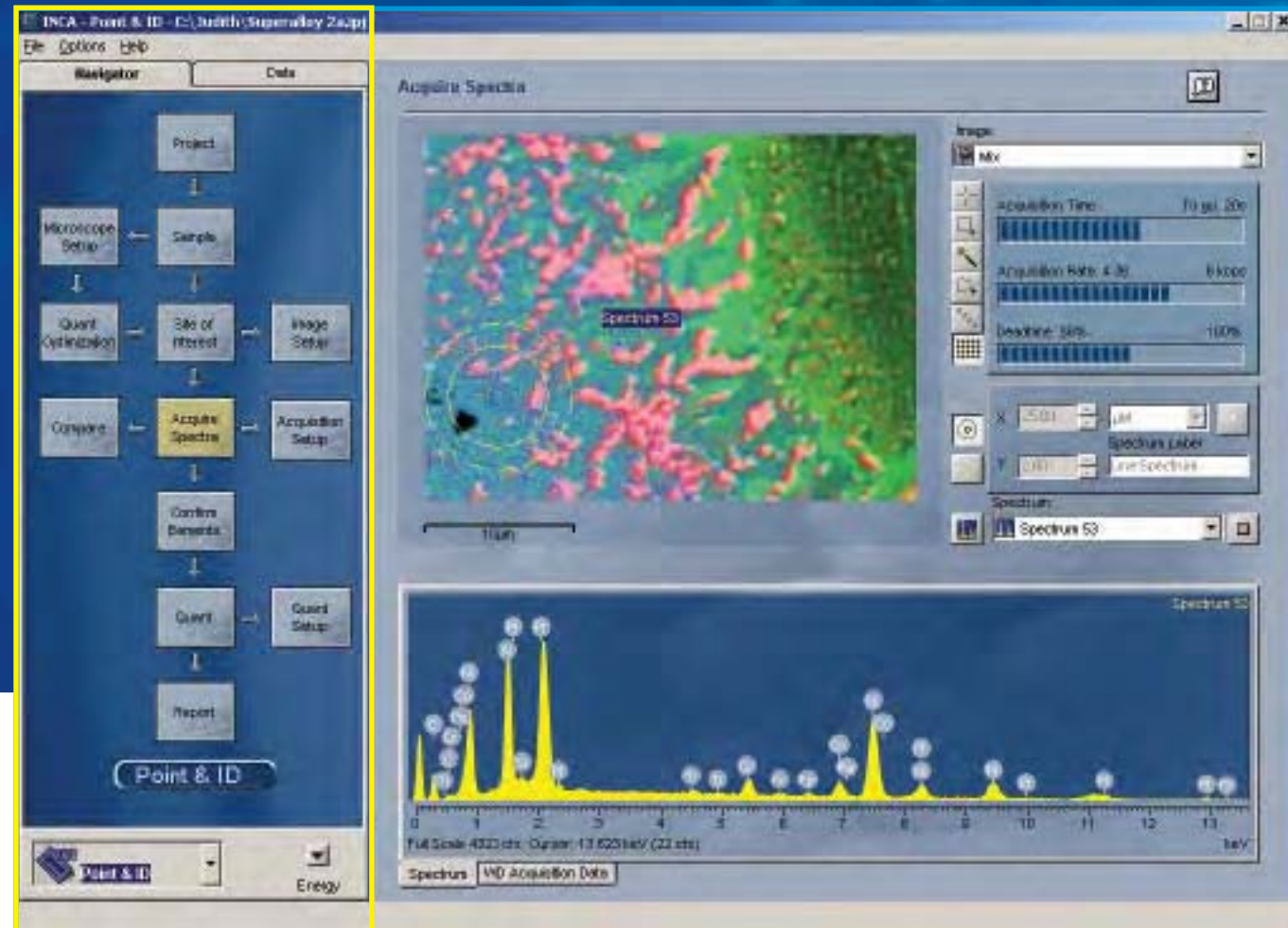
# INCAEnergy EDS System

Oxford Instruments has set new standards for confidence and ease of use in microanalysis. Today **INCAEnergy** remains the industry standard that all other systems aspire to imitate. Here are twenty five reasons why **INCAEnergy** is the system of choice for microanalysts:



**1** Whatever your experience or background, the unique **INCAEnergy** software interface is designed to satisfy your needs. The data you require will be obtained accurately and quickly.

The **INCA** platform is based around the Navigator, which guides you through different tasks in a fast and logical way, while retaining the flexibility to allow you to move around at will. Each Navigator step brings up a screen which contains all the tools required to complete each task.



**2** Reliable data is the foundation for all analysis: Qualitative and Quantitative

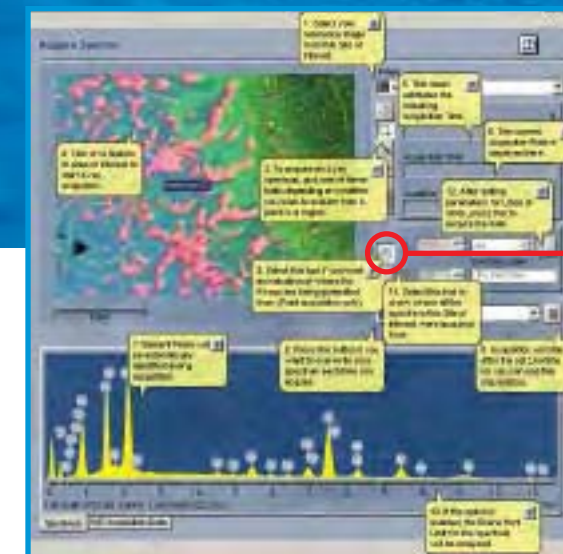
At all operating conditions **INCAEnergy** provides the correct result.

The hardware that detects and measures X-rays is a vital part of an EDS system. **INCA** EDS Detectors and **INCAx**-stream pulse processors are designed to work with **INCAEnergy** to provide the stable output required for accurate and productive analysis at all count rates.

Oxford Instruments custom designs all hardware to provide the reassurance of guaranteed performance on your microscope. Performance that is guaranteed at a realistic count rate of up to 4,000cps.

Both liquid nitrogen and nitrogen-free Si (Li) detectors are available with the same guaranteed specification. **INCADryCool** liquid nitrogen-free detectors are low maintenance and are available for most SEMs.

**3** Guidance and Information is available at the time and place you need it



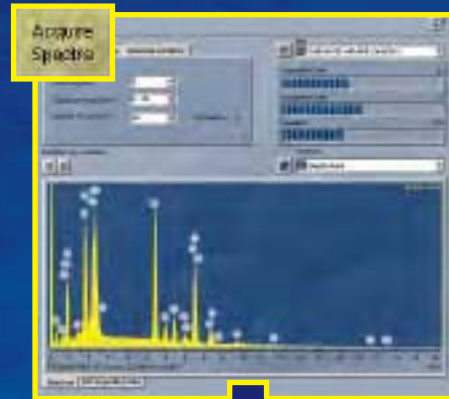
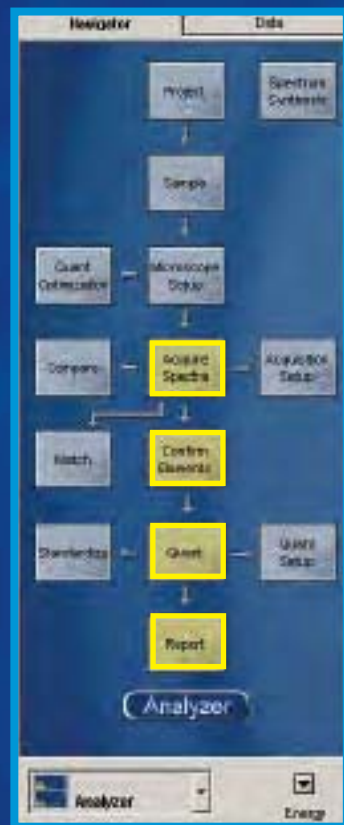
**INCAEnergy** provides real peace of mind, by including help at the center of the system. Bubble help is available on all steps at the touch of a button. From these bubbles, links to the encyclopedia get you straight to the answers to your questions.



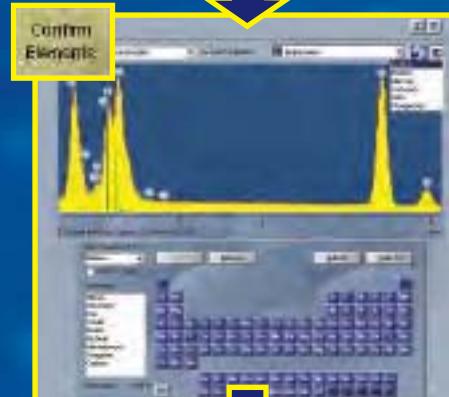
# System Basics: Analyzer

## 4 Four logical steps to identifying your material

The secret to maximizing the number of samples you can analyze is to use a logical interface, which helps analysts of all experiences to maximize productivity. Analyzer is the answer.



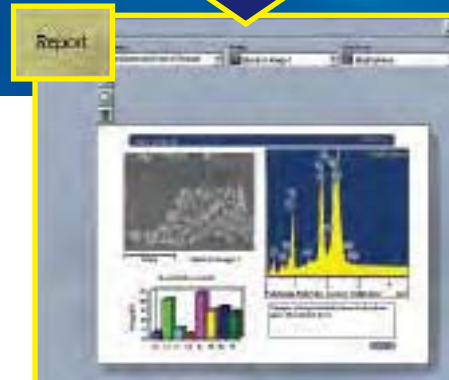
**Acquire Spectra** collects the X-rays being emitted from your sample, and displays them as a X-ray Spectrum. AutoID automatically identifies the peaks in the spectrum and the elements in your sample. The AutoID is constantly updated and refined as more data is collected



**Confirm Elements** provides tools to manually validate the elements detected. Use element markers to check the position and height of spectrum peaks. Check the identification of complex overlaps by comparing peak shapes with the spectrum overlay



In the **Quant** step, quantification of elements is calculated automatically, based on the elements identified, to give the composition of the sample



**Report** your findings on the nature of each sample, using the report formats provided, or create your own format to suit your needs

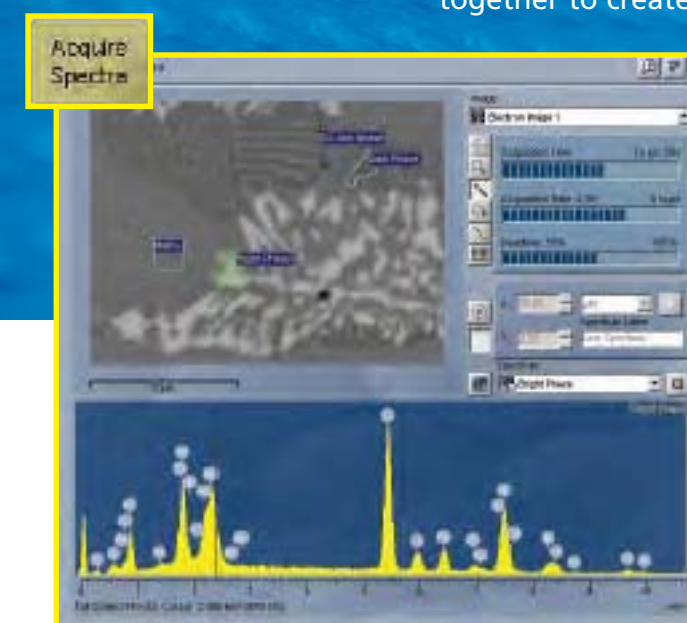
# System Basics: Point & ID

## 5 Image centric analysis is a convenient solution when analyzing materials where spatial information is important



For live spectrum collection and spectrum reconstruction from a datacube (see reason 10), Point&ID ensures you can see exactly where the data has come from.

- Choose to analyze a point, rectangle, feature or free-hand region
- For live analysis the **INCA** beam control electronics will accurately scan the beam over the selected region, while the spectrum is collected
- Increase productivity by selecting a number of analysis areas. The system will collect the data automatically, leaving you more time for other tasks
- When reconstructing spectra from a stored SmartMap, all the X-ray data in the specified pixels is added together to create the spectrum



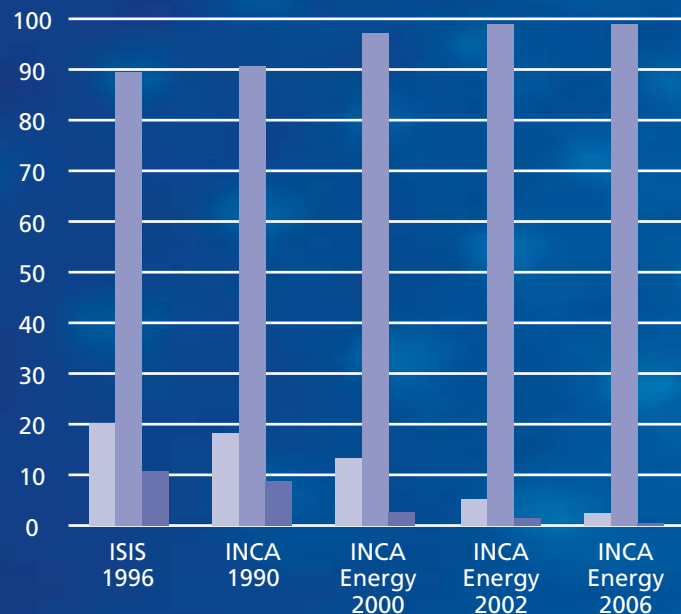
The Point&ID navigator contains all the tools required to identify the elements in the spectrum and to provide a quantitative analysis

# System Basics: Qualitative Analysis

## 6 Be confident in your ability to identify all the elements in your samples

Accurate identification of the elements in a sample is the core requirement of a microanalysis system. A recently published scientific paper<sup>†</sup> has shown that not all microanalysis systems can perform this basic function. INCAEnergy has proven accurate automatic element identification performance. Make sure whatever system you choose can achieve the same.

The graph below summarises Oxford Instruments continuing work to improve its



20 kV AutoID Performance % (59 standard samples, 1000 cps, 100,000cts in spectrum, Element range Be-U)

- False Positive
- Correct ID
- Elements Missed

AutoID accuracy. Tests on 59 common standard materials show how the accuracy has improved in the past 10 years.

INCAEnergy AutoID is more reliable than any other system because:

- INCAEnergy hardware measures the energy of X-rays accurately at all count rates.

Our guarantee to all users is:

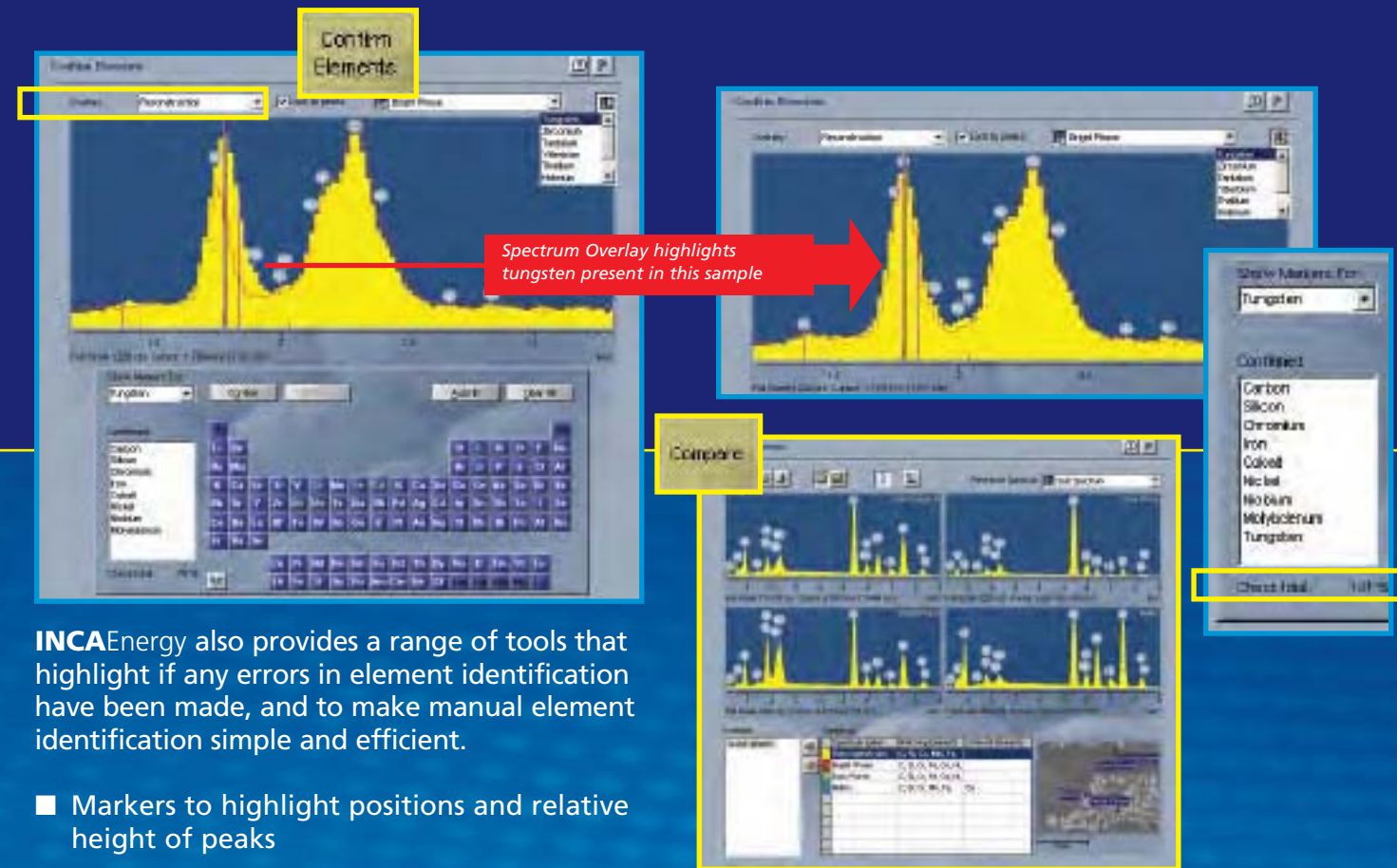
Between 1,000 and 10,000 cps, peak resolution and position will change by less than 1eV\*.

Highly predictable peak shapes and positions are the requirement for accurate real time auto peak identification (AutoID).

- INCAEnergy has the most complete and accurate library of element lines available, including many low energy lines that are not reported in current published literature
- INCAEnergy uses robust algorithms that use line series shape and position to ensure elements are correctly identified even where overlaps are severe

<sup>†</sup> Dispersive X-ray Microanalysis: A Problem That Threatens the Credibility of the Analytical Community' (Microscopy and Microanalysis, Dec 2005, Volume 11 545-561).

\* Measured at MnK $\alpha$  at Process Time 5



INCAEnergy also provides a range of tools that highlight if any errors in element identification have been made, and to make manual element identification simple and efficient.

- Markers to highlight positions and relative height of peaks
- Spectrum Overlay accurately predicts the spectrum shape to show graphically where complex peaks are incorrectly identified
- Check Total™ uses spectrum synthesis technology (see reason 19) to provide a consistency check that shows instantly any

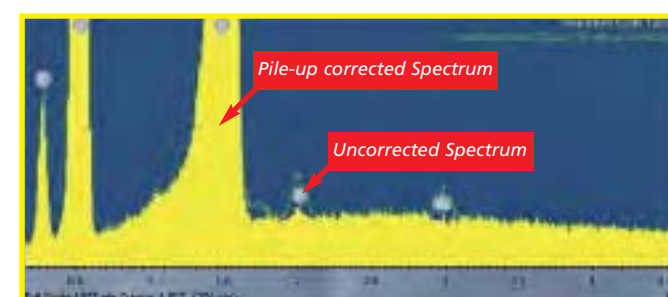
serious errors in element ID. Using this tool, inconsistencies in sample homogeneity, kV, and geometry can also be recognized

- Compare Spectrum gives instant comparison between a number of spectra

## System Basics: Pile-Up Correction

### 7 Pile-Up correction gives the capability to work at more productive count rates

Collecting reliable data at high count rates is difficult because all EDS systems are affected by pulse pile-up. With pile-up correction the sum peaks produced at high count rates are removed automatically meaning accurate qualitative and quantitative analysis at many 1000's of cps.



- Automatic real time identification and correction of any pile-up artefacts in the spectrum including sum peaks
- All pile-up X-rays are correctly replaced at the correct X-ray energy in the spectrum
- Overlay display shows the spectrum before correction, clearly illustrating all artefacts caused by high count rate pulse pile-up.

# System Basics: Quantitative Analysis

**8** Accurate determination of the composition of materials, which works for all types of samples and conditions

Requirements for compositional analysis vary from rough estimates on simple samples to accurate results from spectra with complex overlaps. Whatever your application, **INCAEnergy** has the power to reliably provide the answer.

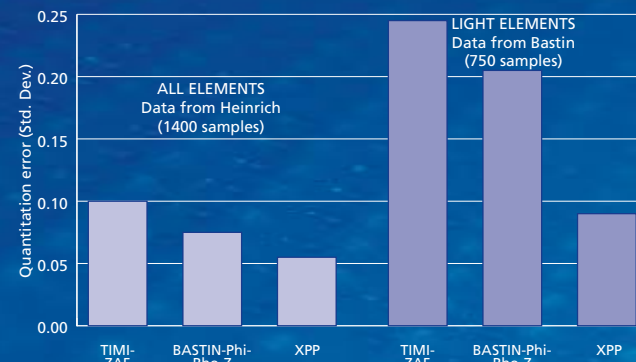
One standardless routine that works for all samples:

- Spectrum processing using top hat filter and least squares fitting
- XPP matrix correction that works for more situations than Phi-Rho-Z or ZAF combined
- Automatic correction for the influence of coating elements

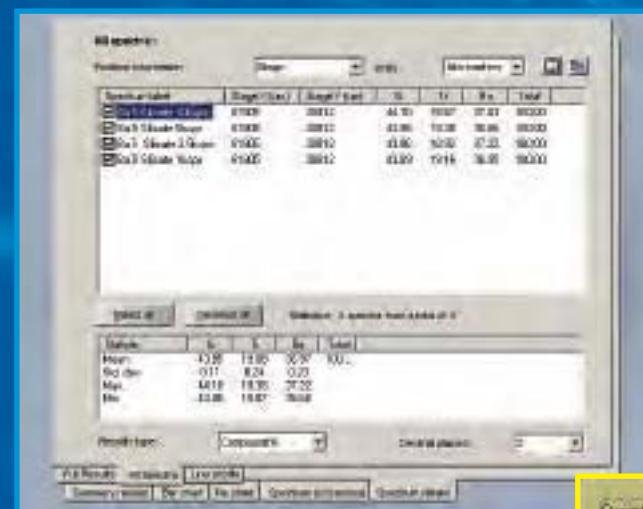
**9** Full quantitative analysis functionality for experienced users looking for the best possible result

- Quant Optimization corrects for beam current changes for un-normalized analysis
- Standardize allows real standards to be used where matrix corrections are large
- Profile optimize fine tunes element profiles for accurate deconvolution of complex peak overlaps

With **INCAEnergy** out of the box results can be relied on in all situations

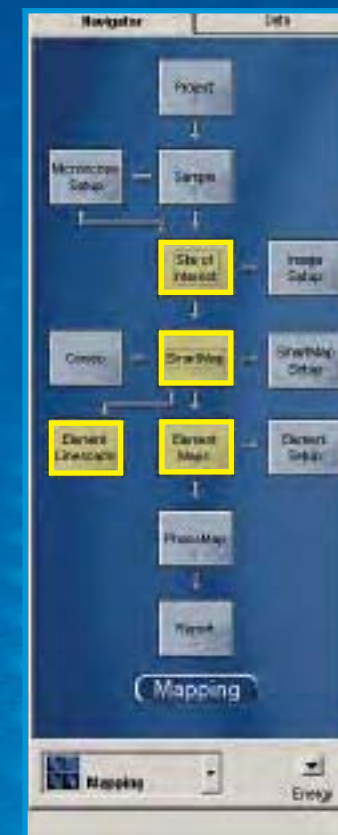


Tests on published data show that XPP results are more accurate than older methods, particularly for light elements



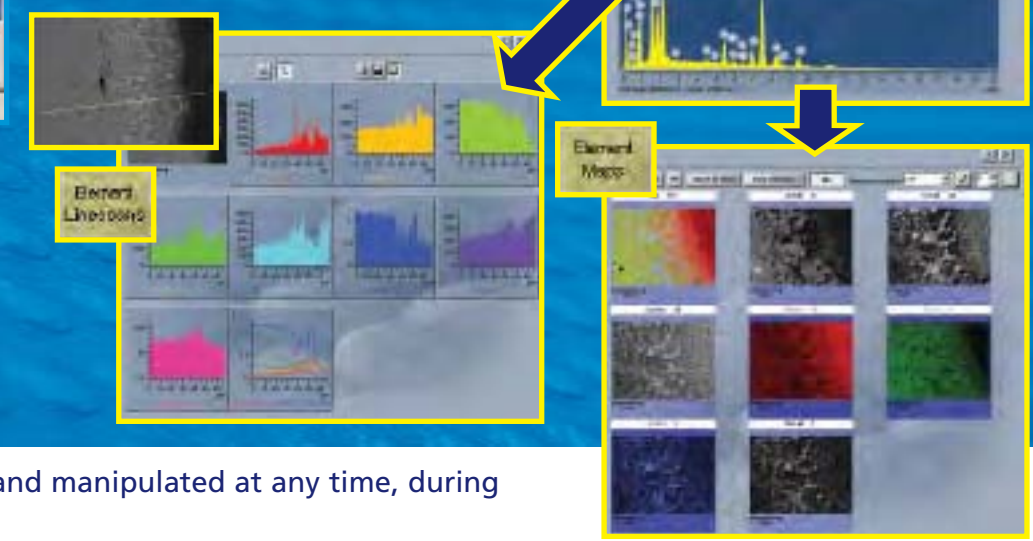
# System Basics: Mapping

**10** One powerful X-ray mapping utility provides all the answers to your questions about spatial distribution



The secret to investigating the spatial distribution of elements in your sample is to have one mapping program which works in every situation. **SmartMap™** is the answer.

- The complete spectrum image datacube is always collected, with dead time corrected X-ray data saved at every pixel. You can therefore be certain that any data reconstructed from the cube will be as accurate as if it was collected live
- The dwell time of the acquisition can be varied to collect data in 'real time', or as a long single frame acquisition

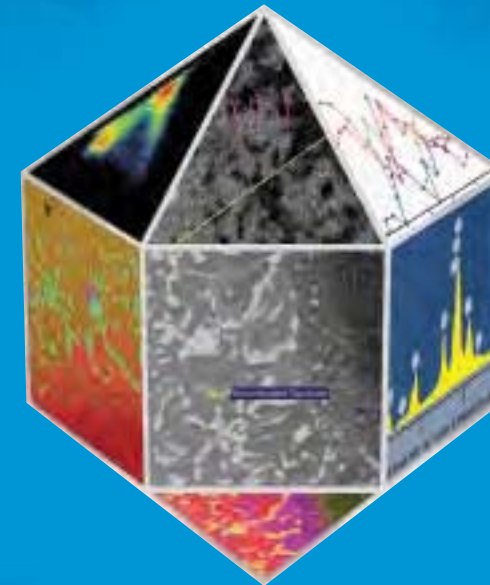


- Data can be viewed and manipulated at any time, during and after acquisition
  - View the data from different elements
  - Alter the X-ray lines and window widths used
  - Collect background maps and linescans
  - Subtract Maps and Linescans

# System Basics: SmartMap™

Take advantage of the potential of SmartMap™. The spectrum image datacube stored during acquisition acts as a virtual sample. All the information needed to perform all these different types of analysis with the **INCA**Energy system is stored

**11** Seven ways to analyse your sample from one SmartMap acquisition



Mapping

Element Maps

System Basics: Linescan Reconstruction

Point & ID

Quant

System Options: Quantitative Linescan

Mapping

Element Maps

System Basics: X-ray Mapping

Element Maps

QuantMap

System Options: QuantMap

Point & ID

Acquire Spectra

Quant

Element	Weight %	Count
Fe	4.85 ± 0.34	38.83
Si	3.99 ± 0.29	6.89
Ca	1.11 ± 0.45	19.98
Co	3.87 ± 0.29	1.49
Cu	7.78 ± 0.46	11.88
Ni	1.67 ± 0.80	33.69
Ti	7.38 ± 1.20	3.64
Mn	24.17 ± 4.28	33.55
Al	12.00 ± 1.13	8.16
Ox	28.58 ± 1.50	9.79
Total	100.00	162.63

System Basics: Spectrum Reconstruction

Mapping

PhaseMap

System Options: Phase Map

Mapping

Cameo

System Options: Cameo+

# System Basics: Spectrum Examiner

**12** Spectrum Examiner is a powerful tool that highlights elements present at low levels or in very minor phases that can be easily overlooked when X-ray mapping

This new algorithm finds elements that would otherwise be invisible when X-ray mapping because:

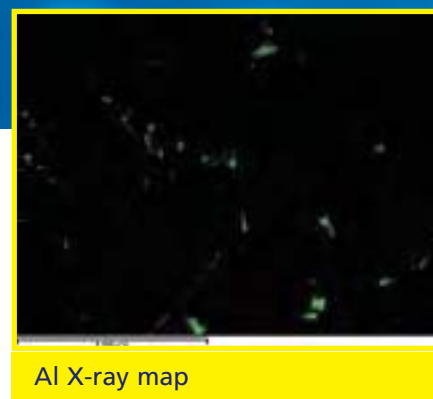
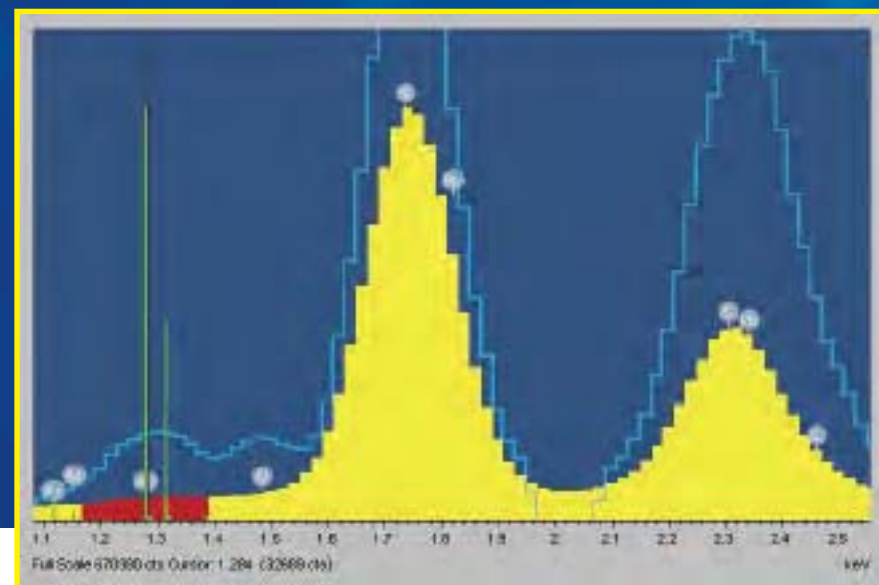
- The element is present at very low concentration
- The element is only present in a minor phase (e.g. Al in the example below)
- Element peaks are overlapped by peaks from elements present in higher concentrations
- Element was not expected to be present in the sample

Using Spectrum Examiner means SmartMap™ can be used to reliably find all the elements present in an unknown sample without the need to collect X-ray spectra first.

Spectrum examiner appears as blue overlay on top of the sum spectrum.

In the mineral sample shown, As and Al are present in minor phases. These elements are clearly highlighted by spectrum examiner overlay.

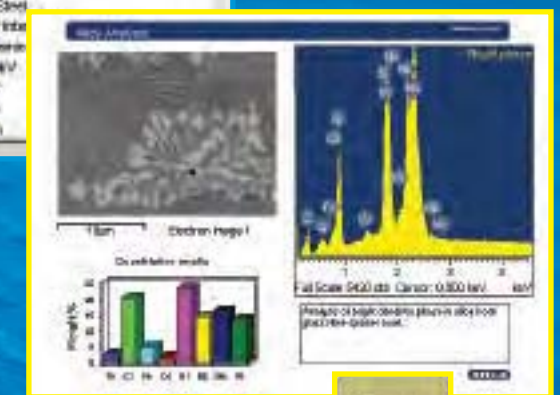
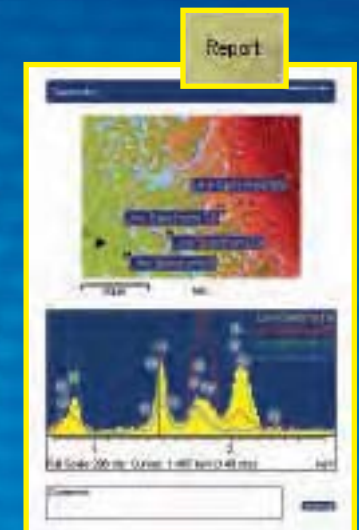
X-ray maps for these two elements show how these elements are concentrated in only small regions.



# System Basics: Saving, Reporting and Exporting Data

**13** INCAEnergy has been designed with data review in mind

- All collected data is stored in the data tree. Data is stored in project files which allow clear data archiving and easy data transport
- The results of analysis can be reported using the one page report templates provided. A report template editor can be used to create templates to fulfil your exact requirements. Reports can be transferred to Microsoft® Word at the press of a button
- Data can be exported in a large number of widely used formats including: bitmap, tiff, JPEG, EMSA, and text file
- A full record of an INCA project can be published as a website
- Images, spectra & maps can be automatically exported into the Olympus Soft Imaging Solutions software packages.



To share data in INCA format with non INCA users, use the freeware INCA viewer.

- The viewer includes many controls for data manipulation, e.g. spectrum rescaling
- System Option: INCA viewer export software is used to export data in the viewer format

# System Options: QuantMap

**14** Accurately display chemical variations where element peaks overlap

QuantMap displays real quantitative chemical X-ray maps by recalculating SmartMap data to correct for the X-ray background, peak overlaps and the sample matrix

- In most cases X-ray mapping will correctly display distribution of an element over the sample surface. However, if there are overlapping peaks in your sample the element distribution may be misrepresented. QuantMapping ensures the correct representation of element variation in maps, even where there are peak overlaps.
- QuantMap uses INCA's proven quantitative analysis algorithms to ensure all elements are correctly identified and displayed in each pixel of the spectrum image.

QuantMaps are created from existing SmartMap data therefore there is no need to choose between traditional X-ray mapping and QuantMapping before you start data acquisition.

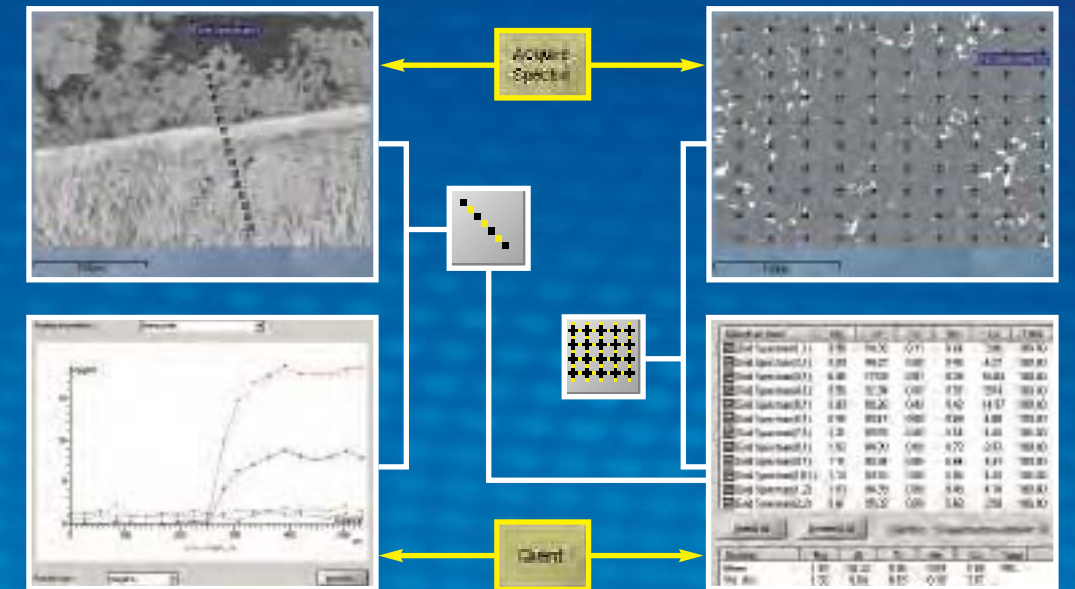


The example shows Pb X-ray map and a Pb Quantmap for the same area. The sample also contains significant levels of S, which overlaps with the Pb M line. The Pb X-ray map is showing the distribution of both Pb and S, whereas the Pb Quantmap shows the correct distribution of Pb.

# System Options: Lines & Grids

**16** Beam automation made simple to study linear variations by collecting data with Lines and Grids software

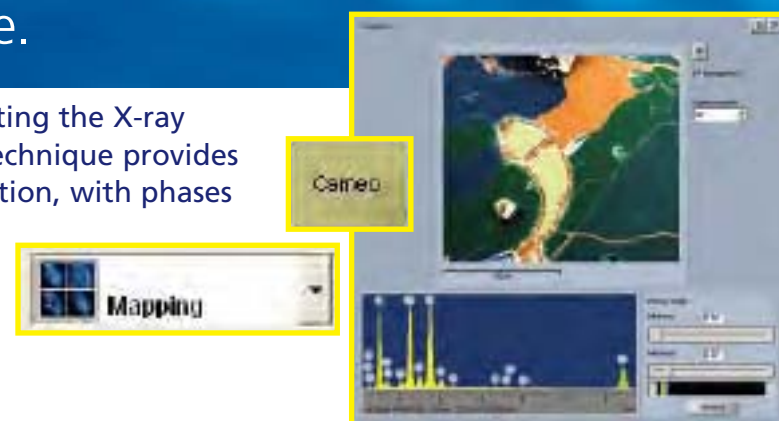
- Take advantage of increased productivity by using unattended collection to collect spectra from lines and grids of points over a sample
- Plot a quantitative linescan of the compositional variation along the line of points



# System Options: Cameo+™

**15** If your eyes could see X-rays, you would be able to see the compositional variations in a sample.

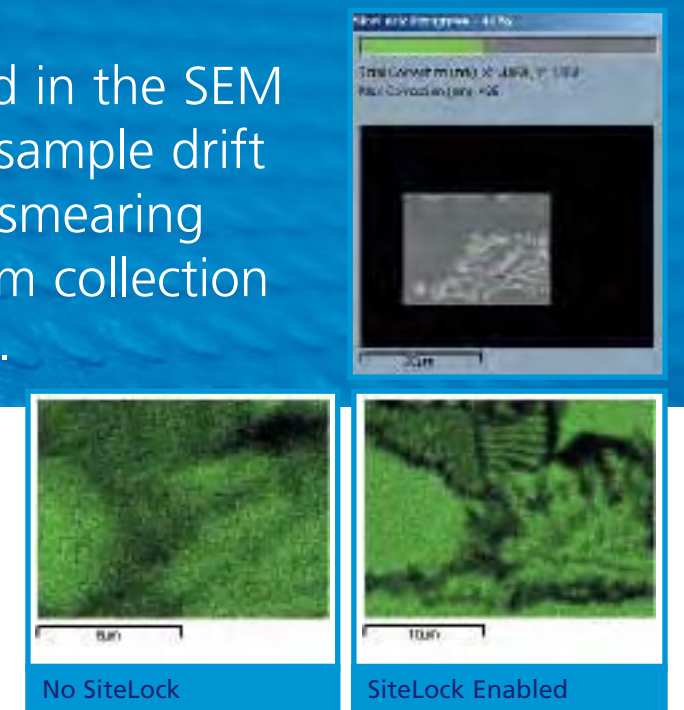
- Cameo+ provides this facility by offsetting the X-ray spectrum into the visible range. This technique provides the most rapid possible phase information, with phases always picked out in the same color.



# System Options: SiteLock™

**17** As the magnifications used in the SEM increase, the problems of sample drift become more noticeable, smearing maps and making spectrum collection from small particles difficult.

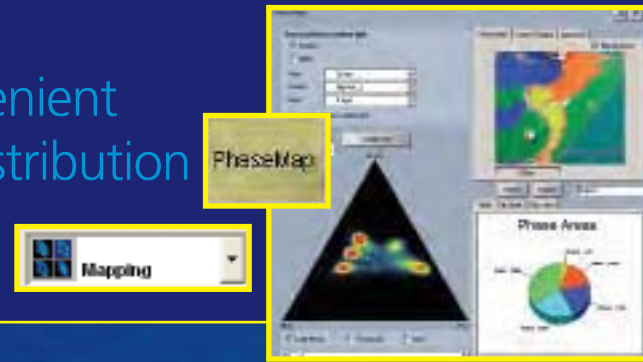
- SiteLock uses the whole electron image to monitor and correct for drift
- Locks even low contrast images and is insensitive to brightness/contrast changes over time
- Corrects drift during spectra acquisition using Point&ID, or SmartMap™





# System Options: Phase Map

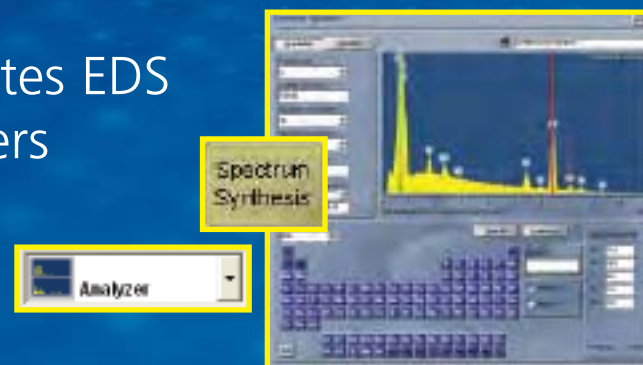
**18** Phase Map provides a convenient method for mapping the distribution of phases in a sample.



- Extracts information from a SmartMap datacube, during or after acquisition
- Works on all sizes of datacubes. Long acquisition times are not required
- Separates phases even when peaks are overlapped (e.g. when working at low kV)
- Chemical information is provided by a reconstructed spectrum for each phase

# System Options: Spectrum Synthesis

**19** Spectrum Synthesis calculates EDS spectra based on parameters selected by the analyst.



Using this tool microanalysis experiments can be planned and optimized, before the sample is even prepared. This saves valuable time, maximizing results and protecting beam sensitive samples.

- Determine the most suitable kV and geometry
- Check for visibility of small peaks and precision of results
- Calculate realistic detection limits
- Check the accuracy of unexpected results

# System Options: Spectrum Match

**20** Spectrum Match answers the question "have I seen this material before?".

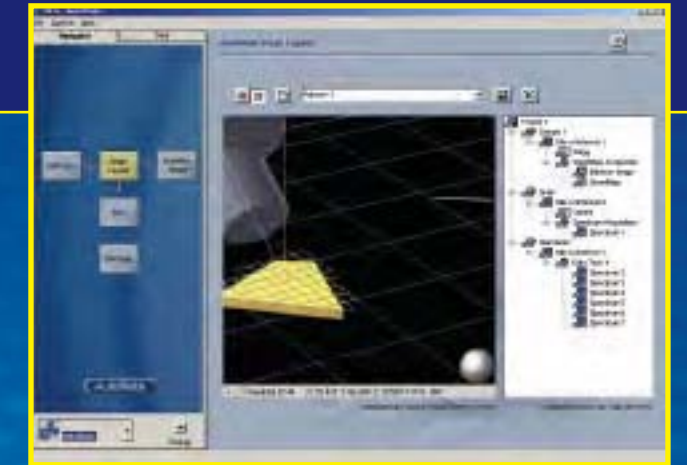


It does this by searching previously acquired or synthesized spectra for close matches.

- Finds similar materials irrespective of kV or geometry
- Two stage match for elements only and composition
- Provides information on the matches found, including the option to open the project containing a proposed match

# System Options: AutoMate+

**21** One route to increased productivity is to use automation to collect data, leaving you more time to concentrate on data interpretation



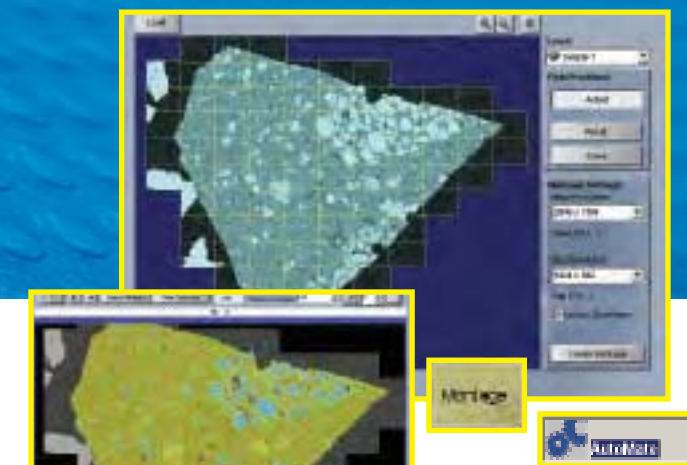
**AutoMate+ provides a dedicated navigator for setup of automated runs, whether simple or complex.**

- Controls the microscope beam and stage
- Collect data over large areas including a line of stage points and a grid for montaging
- Collect spectra, electron images, SmartMaps™ and SmartMap™ linescans

- Use the AutoMate+ macro function to record more complex AutoMate+ tasks
- Produce large area images and SmartMaps using Montage

# System Options: Montage

**22** Montage allows multiple images collected by Automate+ stage control to be stitched together into a single high quality image



- Montage includes the advanced ability to stitch together SmartMap data to provide not just an image, but a combined spectrum image datacube from which data can be reconstructed in the same way as any single SmartMap

- A specially designed image and stage calibration ensures each SmartMap or image is accurately positioned automatically
- Manual adjustment is also available, if necessary, by a simple mouse drag

# System Options: Feature

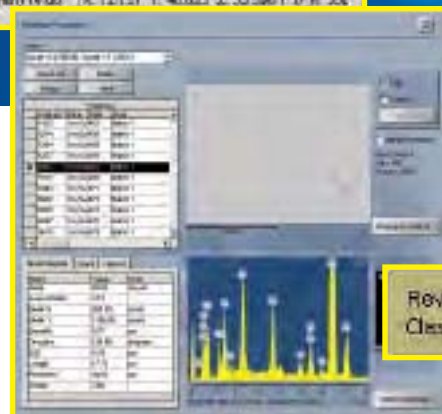
**23** Find particles or inclusions automatically and classify them based on chemistry or morphology

**INCA**Feature provides a solution to particle and inclusion analysis applications that combines easy set-up, rapid and accurate particle detection, and powerful data analysis.

- Control of the microscope stage and beam provides a fully automated technique, for analysis over large areas and multiple samples within the SEM.
- Stage mimic shows positions of samples and particles
- Two stage algorithm ensures particles are accurately detected and analyzed
- Flexible detection criteria, which can be customized for any application
- Image processing options, used to optimise particle detection, may be applied to the either the grey scale or binary image
- Analysis instructions are stored as recipes for easy recall
- Class schemes can be created for specific applications and are easily applied to other datasets
- Review live data during collection
- Use **INCA** 's uniquely accurate AutoID to determine the elements present in every feature so there is no need to know all the elements present before you start the analysis

- Quantification uses the XPP matrix correction, proven to provide superior results for all sample types.
- Review the data for any selected particle and acquire additional data on particles of interest
- All data can be reprocessed and reclassified without the need for data reacquisition

- Feature report templates include:
  - Single particle report
  - Multiple particle reports
  - Statistical tables
  - Histograms, scatterplots & ternary diagrams



# System Options: GSR

**24** A dedicated solution for the detection and analysis of Gun Shot Residue



**INCA GSR** is optimised for finding and accurately identifying residual particles created when a gun is fired. It provides all the important answers for accurate, fast and reliable analysis

- Complies to ASTM E1588
- Includes all the functionality and benefits of **INCA**Feature
- Relocate particles of interest under the microscope beam at the touch of a button

- Manually confirm particles using a dedicated reacquire step
- Comprehensive data analysis tools, providing a fast overview of any dataset
- Specific GSR report templates



# System Options: Steel

**25** Analysis and classification of non-metallic inclusions in clean steel

- Dedicated automated analysis and classification of steel inclusions following standard methods
  - ASTM E2142
  - SS 11116
  - DIN 50602
  - ISO 4967

- Inclusions are detected, analysed and data is reported as specified in the selected standard
- Accurate detection and analysis of sub-micron inclusions
- Superior **INCA** hardware guarantees the accurate identification of carbides and nitrides

ASTM E 2142 Sem1												
Date	06/11/04	Field Area mm2	0.5									
Steel Grade Int		Magnification	100									
Steel Grade Fat		Analyzed Area mm	1183.5									
Heat Number		Number of Fields	2367									
Position		No. of Analysis	1526									
Dimension		AutoSem1										
Test Number												
Type A Histogram of Field Severity ratings												
Class	Width µm	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Thin	2.0-4.0	2263	74	22	0	0	0	0	0	0	0	0
Heavy	4.0-12.0	2368	9	0	0	0	0	0	0	0	0	0
OverSize	>12.0	2343	24	0	0	0	0	0	0	0	0	0
Type B Histogram of Field Severity ratings												
Class	Width µm	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Thin	2.0-9.0	2305	90	20	4	0	0	0	0	0	0	0
Heavy	9.0-15.0	2367	0	0	0	0	0	0	0	0	0	0
OverSize	>15.0	2361	5	1	0	0	0	0	0	0	0	0

- This software can also be applied to tire cord analysis