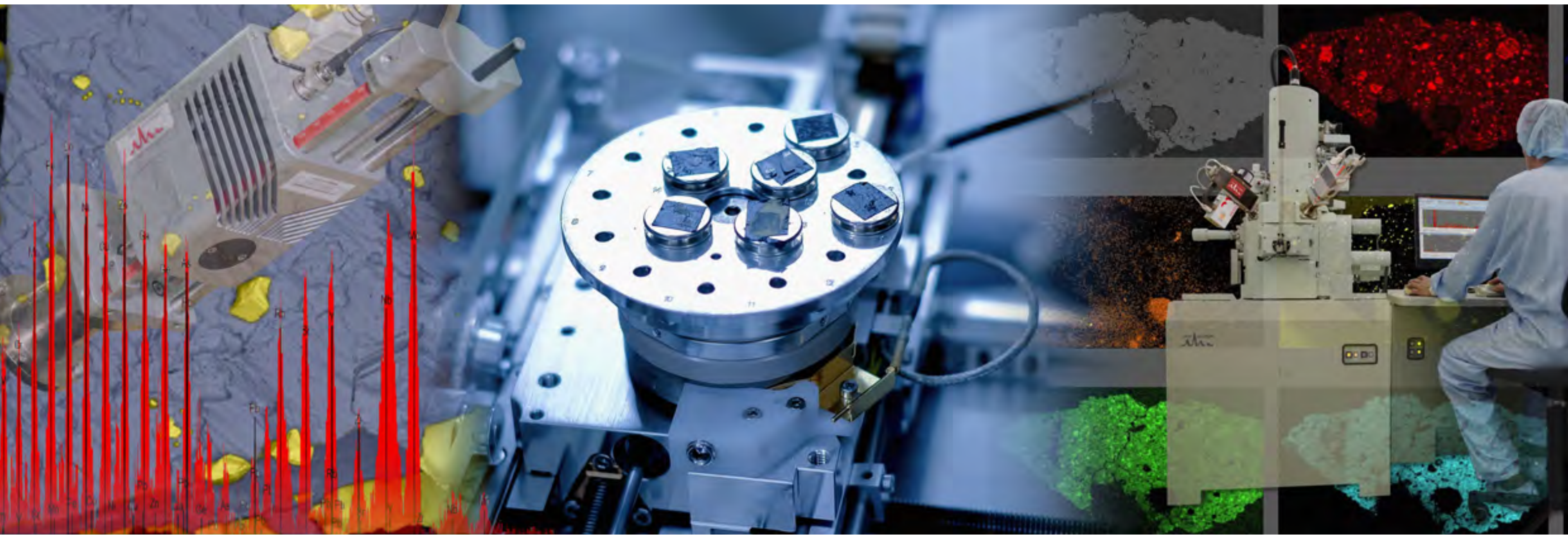
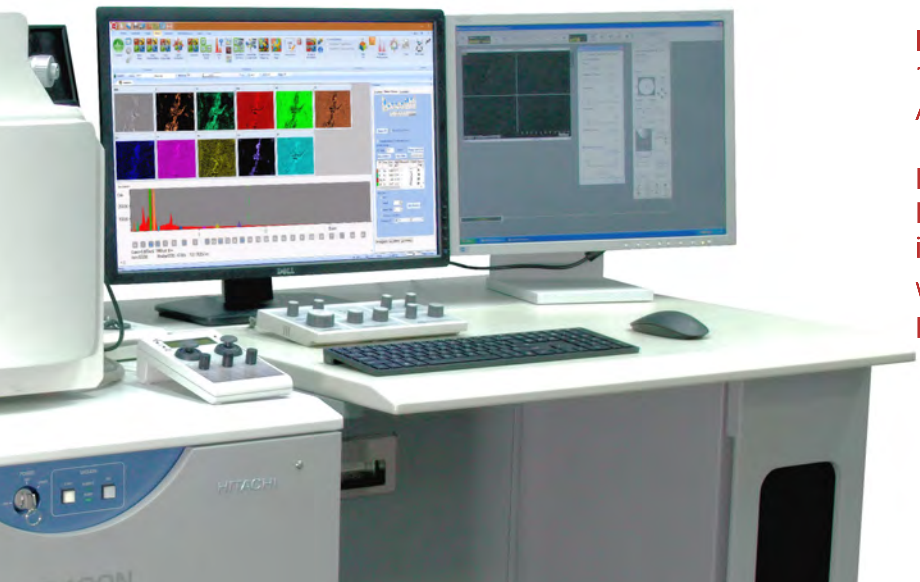
IRIDIUM ULTRA

SEM/EDS system



https://www.ixrfsystems.com/sem-eds/



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MADE IN U. S. A.

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IRIDIUM ULTRA

SEM/EDS system

Energy dispersive spectrometry (EDS)
for scanning electron microscopy

IXRF SYSTEMS

SEM/EDS: advanced energy dispersive spectrometer system

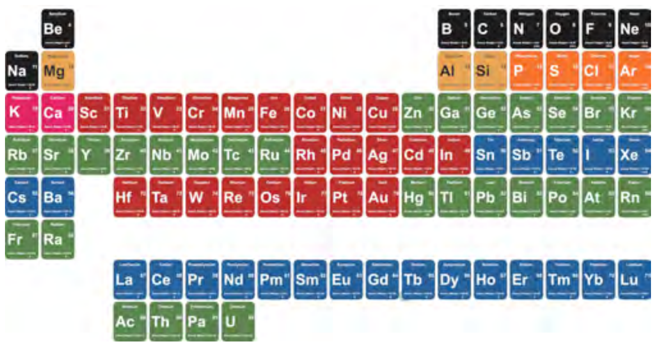
For almost three decades IXRF has been designing and manufacturing high-end X-ray microanalysis systems that are fitted to Scanning Electron Microscopes (SEM/EDS). Our first EDS system was delivered to Los Alamos National Lab in 1993.

Our Windows-based software suite, Iridium Ultra, has been continuously refined and enhanced over many years and is recognized as the best in the industry by expert users. Development has been user driven using the Kaizen approach of Feedback, Efficiency and Evolution.

Almost 10 years ago, IXRF pioneered and commercialized micro-spot X-ray sources and software for scanning electron microscopes. The SEM-XRF product line was designed to deliver greatly extended elemental analysis coverage coupled with enhanced sensitivity by employing combined e-beam and X-ray beam excitation.

In 2014, IXRF launched our ATLAS series of general purpose, micro-spot energy dispersive X-ray fluorescence (microEDXRF) spectrometers for elemental analysis and hyperspectral imaging of sodium (Na) through uranium (U) in almost any sample matrix.

Based in Austin, Texas, our company specializes in providing the most advanced microanalysis technologies across our three product lines: SEM/EDS, SEM-XRF and microXRF.



XRF Periodic Table

- Active imaging system (AIS)
- Digital pulse pocessing (DPP)
- 10/100 Mbps Ethernet communication
- 4096 multi-channel analyzer
- CE marked
- Supports legacy Si(Li) detectors
- Multiple buffers for mapping at high CPS
- Display: count rate / detector voltages
- Oscilloscope functions
- Shaping: 0.25, 0.5, 1, 2, 4, 8, 16 and 32 µs

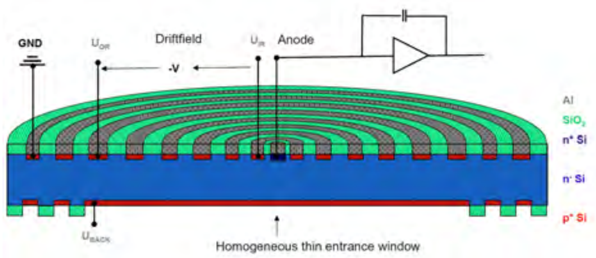
550i Digital Pulse Processor with Digital Imaging System

Silicon drift detectors (SDD) for EDS analysis on a SEM

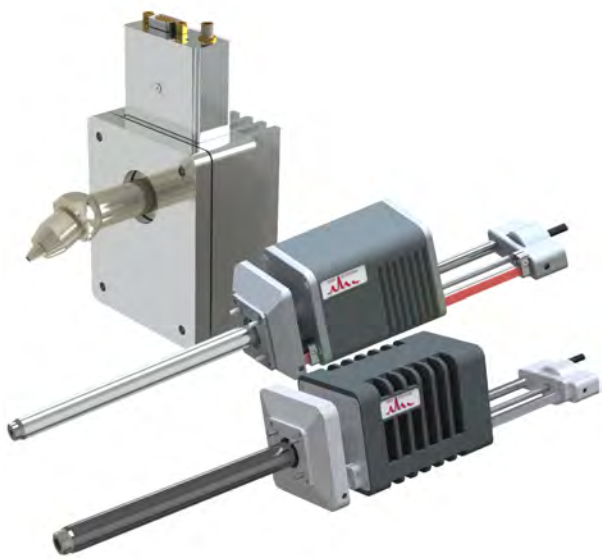
IXRF's range of Peltier-cooled silicon drift detectors are designed to be compatible with all commercially available SEM systems and can be configured as a modern Si(Li) detector replacement on most older EDS systems. Our SDDs provide exceptional and stable performance over a wide range of count rates (up to >1Mcps input rate).

SDD detectors convert the energy of each individual X-ray photon into a voltage signal of proportional size. An incoming X-ray is converted into a charge by the ionization of atoms in the semiconductor crystal. Next this charge is converted into the voltage signal by the FET preamplifier. Finally the voltage signal is input into the pulse processor (550i DPP) for measurement.

The major distinguishing feature of a SDD is the transversal field generated by a series of ring electrodes that causes charge carriers to 'drift' to a small collection electrode. The 'drift' concept of the SDD allows significantly higher count rates coupled with a very low detector capacitance.



SDD Detector Schematic



Active area (mm^2)	10	30	60	100
Resolution* Mn Kα (eV)	123-127	126-128	126-130	128-133
Resolution* C Kα (eV)	51	52	55	55
Window options	AP3.3, Si_3N_4 or beryllium			

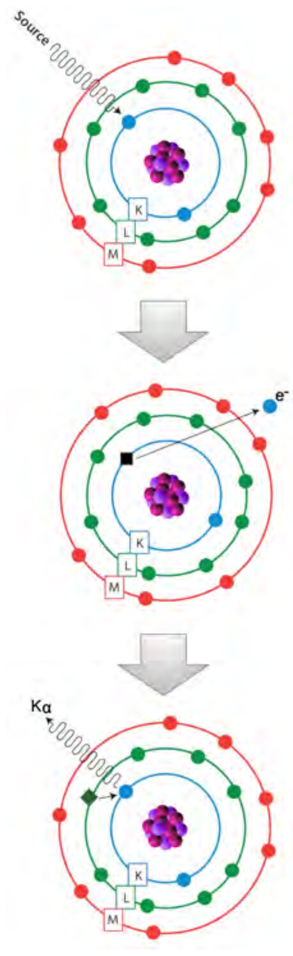
Benchtop, standard diameter and large diameter SDD detectors are show along with *typical specifications by size.

How does X-ray fluorescence work ?

In X-ray fluorescence (XRF), an electron can be ejected from its atomic orbital by the absorption of an electron or light wave (photon) of sufficient energy (see image at right). The energy of the exciting electron or photon (hv) must be greater than the energy with which the inner shell electron is bound to the nucleus of the atom. When an inner orbital electron is ejected from an atom (middle image), an electron from a higher energy level orbital will be transferred to the lower energy level orbital. During this transition a photon may be emitted from the atom (bottom image).

This fluorescent light is called the characteristic X-ray of an element. The energy of the emitted photon will be equal to the difference in energies between the two orbitals occupied by the electron making the transition. Because the energy difference between two specific orbital shells, for a given element, is always the same, the photon emitted will always have the same energy.

For a particular energy (wavelength) of fluorescent light emitted by an element, the number of photons per unit time (generally referred to as peak intensity or count rate) is related to the amount of that element in the sample. The counting rates for all detectable elements within a sample are usually calculated by counting, for a set amount of time, the number of photons that are detected for the various elements' characteristic X-ray energy lines. Therefore, by determining the energy of the X-ray peaks in a sample's spectrum, and by calculating the count rate of the various elemental peaks, it is possible to qualitatively establish the elemental composition of the samples and to quantitatively measure the concentration of these elements.



XRF Theory

IRIDIUM ULTRA

X-ray Microanalysis System

Analytical microscope users conducting research and routine analysis can now perform more comprehensive and efficient microscopic studies on complex samples using IXRF's Iridium Ultra software suite. Complementing both current and legacy electron microscopes, Iridium Ultra X-ray microanalysis software is designed to process incoming data from X-ray detector technology and provide a real-time high-resolution map of the elemental constituents on the surface a sample.

Iridium Ultra saves time and increases productivity

Scientists in fields such as metallurgy, geology, semiconductors, failure analysis, product development and applied research have reduced their analysis times from hours to minutes when pairing easy-to-use Iridium Ultra software, and a state-of-the-art Peltier cooled silicon drift detector (SDD), with their scanning or transmission electron microscopes.

Quantitative and qualitative analysis

Scanning electron microscopes (SEM) coupled with an energy dispersive X-ray detector (EDS) are extensively employed to provide insight into a sample's chemical or elemental makeup. SEM/EDS technique can provide information on the elements present, their relative concentrations and spatial distribution over very small areas/volumes (generally micron scale and down). Standardless EDS is considered a semi quantitative elemental analysis technique. However, with suitable standards and careful attention to experimental detail, EDS can be rigorously quantitative. In addition to intensity-based elemental maps, deconvoluted intensity maps, ratio maps, and quantitative maps, Iridium Ultra can automatically create phase maps. Principle Component Analysis (PCA) is a standard feature as well.

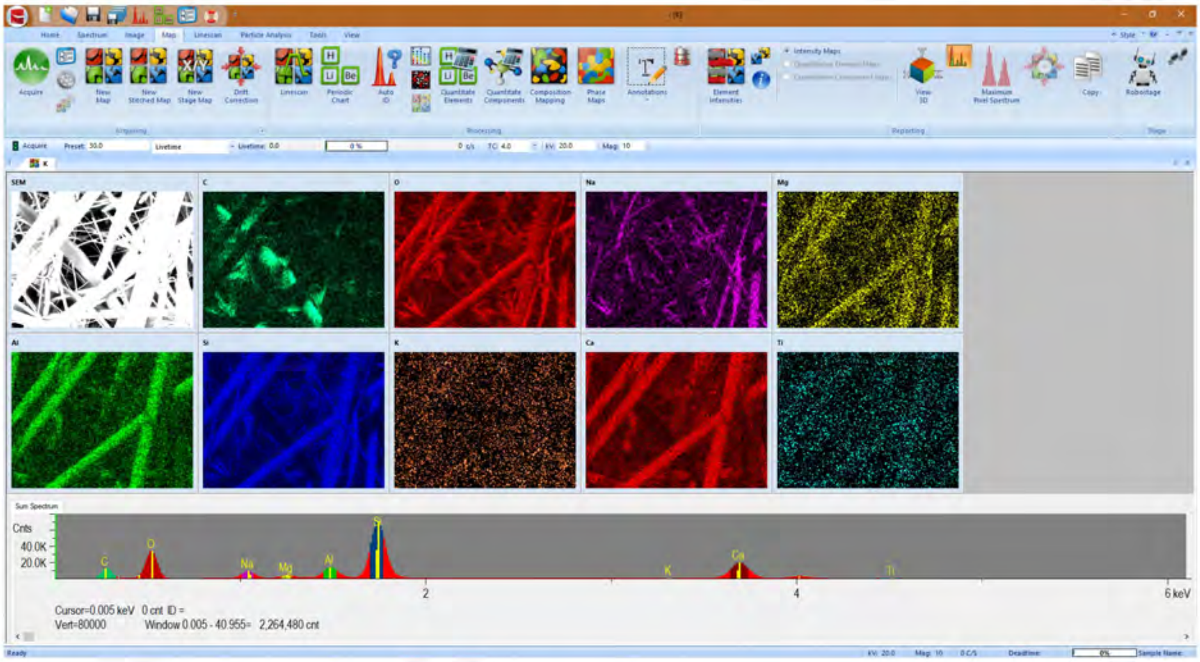
Upgrade options are available

If you have a working detector and just need new software and electronics, IXRF can upgrade everything but the existing detector. Our electronics interface with every EDS detector. IXRF guarantees resolution and light element performance. Advanced Ethernet electronics enhance light element performance and allow faster digital imaging and X-ray elemental mapping.

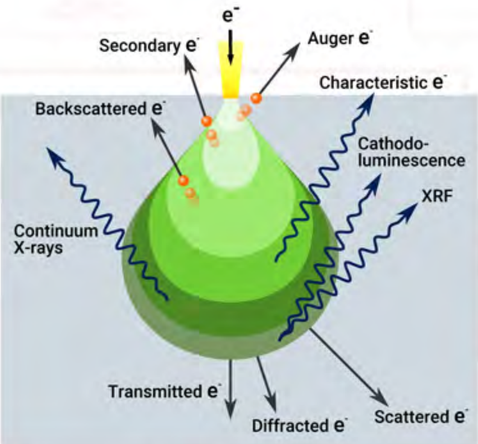
Microscope showing phase map calculated from principle component analysis (PCA).

Automatic Standardless Quantification using ZAF

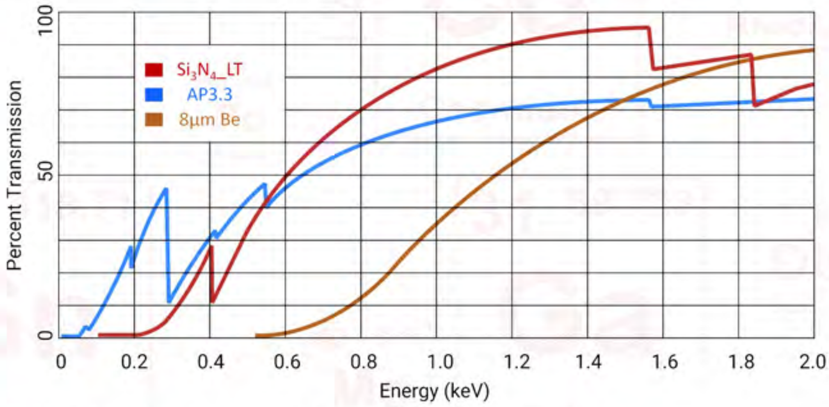
Direct Image Acquisition, Phase Maps, Quant Maps
Multipart Automation, Segmentation, Morphology



Typical map tab view of Iridium Ultra user interface.
SEM map is shown at upper left. Elemental maps, shown in the main screen area, are color coded to the peaks in the EDS spectrum. All common tools, for this tab, are conveniently available in the ribbon graphical control element at screen top.



Schematic of interaction volume.

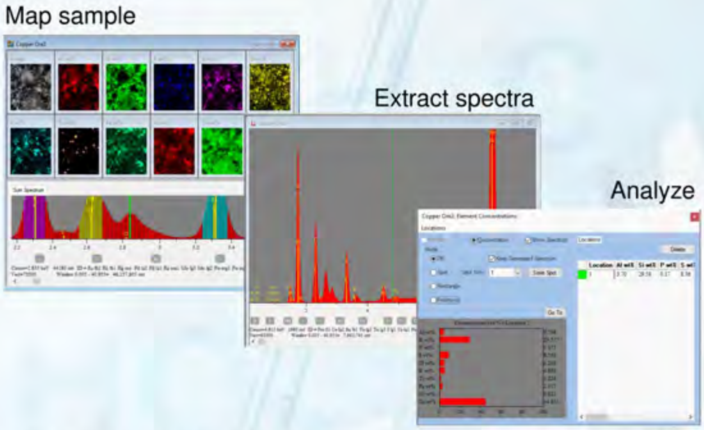


Plot of X-ray transmission for available SDD window options.
For mapping and analysis of the lightest elements, traditional beryllium X-ray windows are insufficient. For these applications, IXRF offer a choice of highly transmissive windows: a polymer window (AP3.3) or silicon nitride (Si_3N_4).

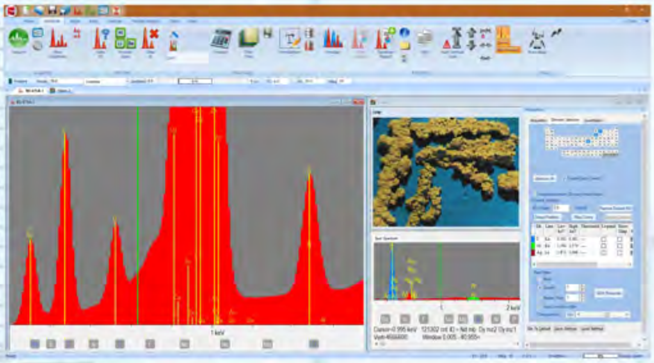
IXRF 30 mm^2 SDD assembly with manual slide mechanism.

Cross platform software

For our SEM/EDS, SEM-XRF and microXRF products, IXRF offers Iridium Ultra: an all-inclusive state-of-the-art software suite featuring a myriad of comprehensive qualitative and quantitative capabilities supporting both e-beam and X-ray excitation. Included are stage control and automation, data acquisition, spectral manipulation (including deconvolution and artifact removal), mapping, imaging, and statistical analysis tools. The platform is unsurpassed in it's ability to provide elemental and phase (PCA) mapping, line scans, critical dimensions as well as morphological analyses. Iridium Ultra SEM/EDS systems are compatible with virtually all SEM makes and models, providing a perfect upgrade opportunity.

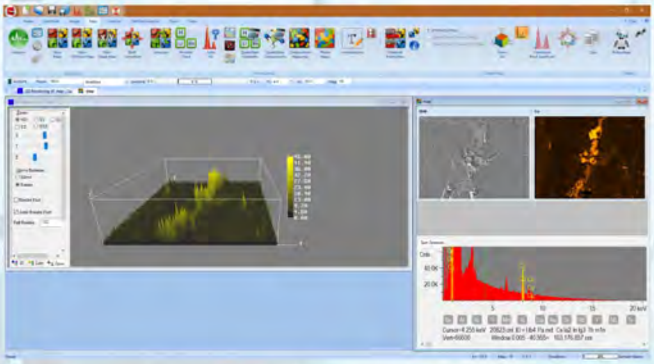


Workflow for SEM/EDS with Iridium Ultra is straightforward. A portion of SEM image is selected for elemental mapping. Spectra extracted from user defined areas are then analyzed. A formal report may be automatically created if desired.

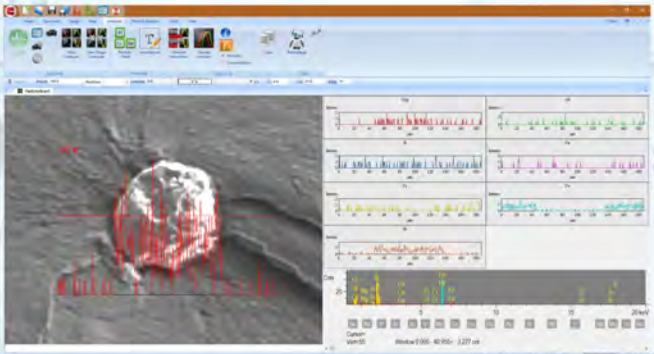


Overlay map and spectrum of a sample. Note that the spectrum shows clearly resolved peaks for beryllium, carbon and oxygen. The dialog box allows map color selection.

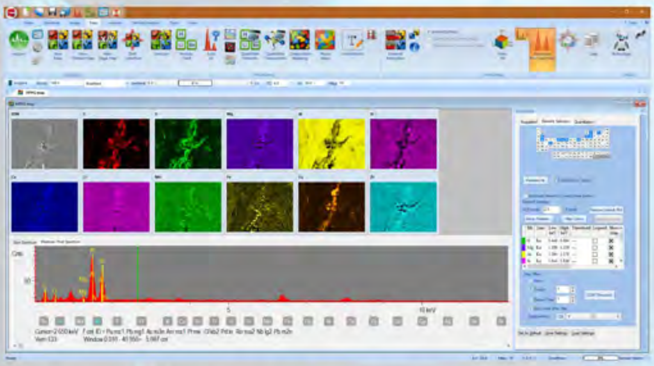
Comparison of SEM/EDS and SEM-XRF for a Al-Ta-Mn alloy specimen - showing optional X-ray excitation - fully resolves all elements, allowing accurate quantification by standardless FP.



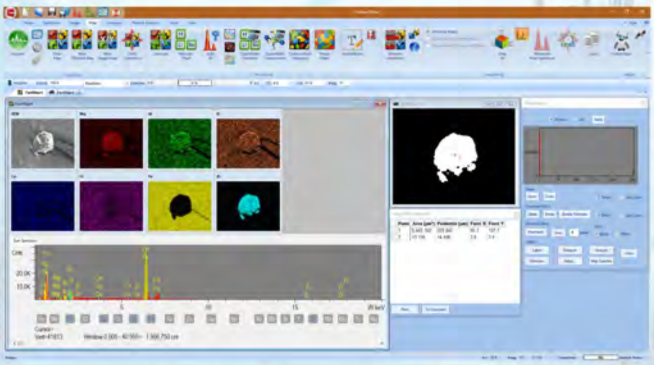
In 3D Viewer, the intensity of each pixel in a map is used as a height (Z axis), thus providing a unique view. This example shows a 3D plot for Cu in a mineral sample.



In Linescan, an arbitrary line can be drawn to calculate the elemental composition across a map. It is an excellent tool for determining the location of phases, particles and features.



Maximum Pixel Spectrum is constructed by selecting the max pixel value within each energy plane, ignoring the remaining pixels. Highly localized trace constituents are easily found.

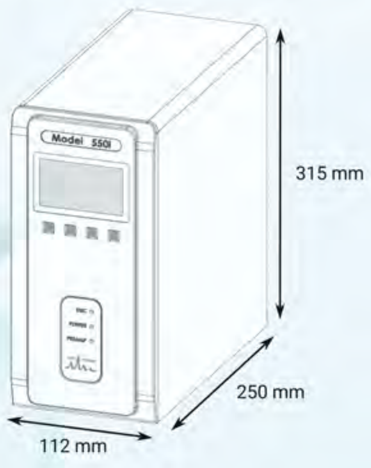


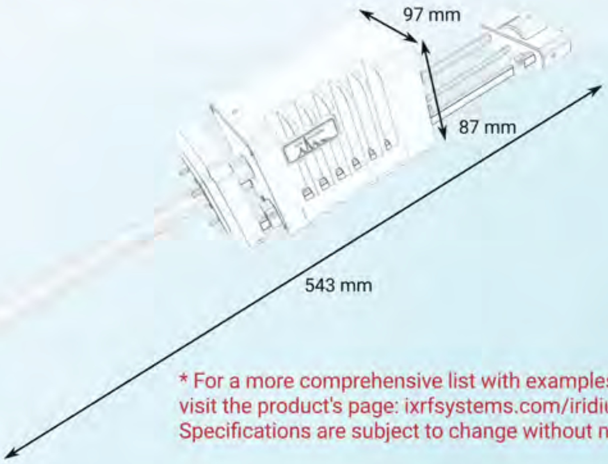
Using a metal sample as an example, the highly automated morphology tools in Iridium Ultra provide sum spectra analysis of a bright Zr-rich inclusion ... with just a few mouse clicks.

Iridium Ultra features*

Category	Feature
Ease of use	Intuitive operation for both novice and expert users
Ease of use	Acquire and report data with as little as one mouse click
Ease of use	Routine tasks are automated for quick and easy analysis
Ease of use	Simultaneous live and review mode
Ease of use	Dynamic periodic table - add/edit elements during data collection
Spectrum	Artifact removal: escape peaks, sum peaks, shelf, tail, shift, Bremßtrahlung
Spectrum	Deconvolution of peaks for accurate net intensities
Spectrum	Multiple spectral overlays with normalization option
Spectrum	Multiple spectra display with live-view capability
Spectrum	Line markers, logarithmic scaling, cps-scaling, and auto-adjustment
Spectrum	Interactive element identification tools
Spectrum	Auto peak identification (auto ID)
Spectrum	Automatic or manual spectral processing
Spectrum	Event counter for any number of selected ROIs
Spectrum	Import and export of various common data formats
Quant tools	Automatic peak ID and quantification
Quant tools	P/B-ZAF
Quant tools	Phi(Rho, Z) - optional
Quant tools	P/B-Foil (TEM thin film) - optional
Quant tools	Hall method (TEM biological) - optional
Quant tools	Cliff-Lorimer (CL for TEM) -optional
Quant tools	Match - to user defined folders of spectra
Quant tools	Least squares (LS)
Quant tools	Combo (e-beam and X-ray beam combined quant)
Linescan	Line profiling for any number of elements or ROIs
Linescan	Arbitrary selection of scan line position, length, and angle
Linescan	Multiple scans with data accumulation for reduction of sample stress
Linescan	Manual start and stop or preselected acquisition time
Linescan	Spectral database containing all sample points
Linescan	Selection of elements prior, during, or after line scan acquisition
Linescan	Filter and display options for result presentation and graphics export
Linescan	Overlay linescan on SEM image or elemental map
Linescan	ASCII and Excel® format export of line profile data
Mapping	4096 x 4096 pixels is supported for single maps and for image stitching
Mapping	Automatic stitching for very large area mosaics
Mapping	Automatic drift correction
Mapping	Selection of elements prior, during, or after map acquisition
Mapping	Complete spectrum is stored for each mapped point
Mapping	Traditional raster mapping
Mapping	Intensity, decovoluted intensity and composition maps
Mapping	Ratio maps
Mapping	Thermal maps
Mapping	Three dimensional viewer
Mapping	Maximum pixel spectrum
Mapping	Phase analysis and mapping
Mapping	Principle component analysis (PCA)
Mapping	Scatter plot analysis
Mapping	Segmentation
Mapping	Extensive annotation tools
Automation	Continuous unattended operation
Automation	Methods (recipes) can be set up by an expert, and then used by an operator
Automation	Multipart acquire
Automation	Robostage - fully automated stage control and stage maps
Options	Forensic glass by ASTM E2926
Options	Automated particle analysis
Options	SEM-XRF (micro-spot X-ray source for SEM)
Options	Customer specific code for special applications
Options	Customer specific application or protocol development

Category	Feature
Morphology	Area
Morphology	Box
Morphology	Breadth
Morphology	Center of gravity
Morphology	Circularity
Morphology	Compactness
Morphology	Convex perimeter
Morphology	Elongation
Morphology	Equiv. circular diameter
Morphology	Feret
Morphology	Feret angle
Morphology	Feret diameter
Morphology	Feret elongation
Morphology	Form factor
Morphology	Length
Morphology	Max
Morphology	Mean
Morphology	Min
Morphology	Number of holes
Morphology	Perimeter
Morphology	Principal angle
Morphology	Roughness
Morphology	Roundness
Morphology	Secondary angle
Morphology	Sigma
Morphology	Sum
Imaging	External electron beam control for image acquisition
Imaging	Digital images from selectable analog signal sources
Imaging	Independent selection of time, resolution and scan modes
Imaging	Pixel, line and frame averaging including power line synchronization
Imaging	Automatic and manual brightness & contrast
Imaging	Display of histogram
Imaging	µ-marker and image legend display including configuration options
Imaging	Intuitive discrimination of phases by colors and shades in electron images
Imaging	Combination of topological and chemical contrast
Imaging	Easy searching for points and regions of interest
Imaging	Progressive scan with improving image quality
Imaging	Choice of configurable image filters including binarization and inversion
Imaging	Brightness, contrast and gamma correction
Imaging	Overlay image for markers, legends and user defined graphics
Imaging	Interactive length, area, and angle measurements in overlays
Imaging	Multi-stage image processing with multiple "undo" functionality
Imaging	Image import and export in all common graphic formats
Imaging	Twain export and windows clipboard supported
Imaging	Compensates the image shift of the scanned specimen area
Reporting	Single click reports
Reporting	Single-command formatted report pages, multi page reports, and prints
Reporting	Report designer to customize presentation templates
Reporting	Associative report templates for different standard analyses
Reporting	On-screen editing of existing reports and personalized report templates
Reporting	Direct print facilities and graphic export (jpg, tiff, wmf, bmp, etc.)
Reporting	Export of report entries in several data formats (ASCII, XML, MS Office)
Reporting	Easy exchange of graphic items via Windows clipboard
Reporting	Extensible and hierarchically structured data management
Reporting	Supports single data objects and complex data types
Reporting	Saving of single files or complete work results with a single command
Reporting	Individually retrievable data items including settings and meta-information
Reporting	Saving of single files or complete work results with a single command





* For a more comprehensive list with examples, please visit the product's page: ixrfsystems.com/iridium_ultra. Specifications are subject to change without notice.