Art & Conservation Series – Part IV

XRF Data Processing in Art and Conservation with ESPRIT Reveal

Dr. Henning Schroeder
Michele Gironda
Dr. Roald A. Tagle Berdan

Bruker Nano Analytics

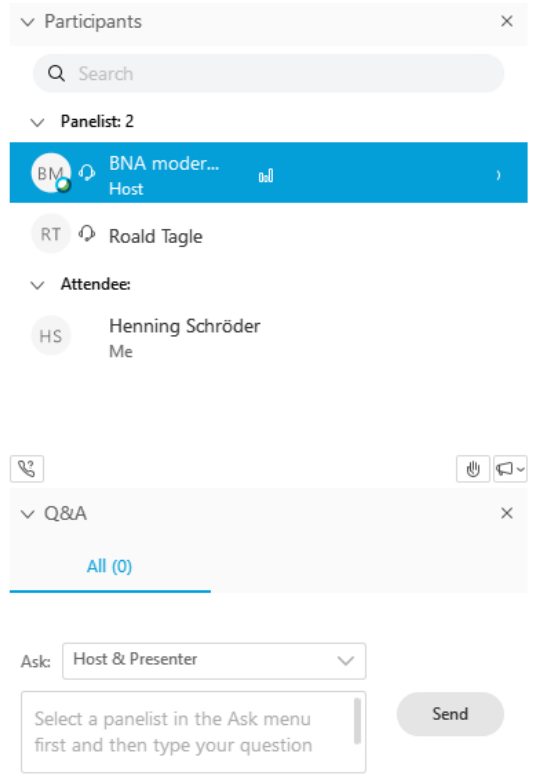
Art & Conservation Series – Part IV

Questions and Answers

- If you have questions during this webinar, please **type your questions**, thoughts, or comments in the **Q&A box** and **press Send**.

- We ask for your understanding if we do not have time to discuss all comments and questions within the session.

- Any unanswered questions or comments will be answered and discussed by e-mail or in another Webex session.



Art & Conservation Series – Part IV

Speakers

Dr. Henning Schröder

Product Manager
Micro-XRF

Bruker Nano GmbH

Michele Gironda

Market Segment Manager
Art & Conservation

Bruker Nano GmbH

Dr. Roald A. Tagle Berdan

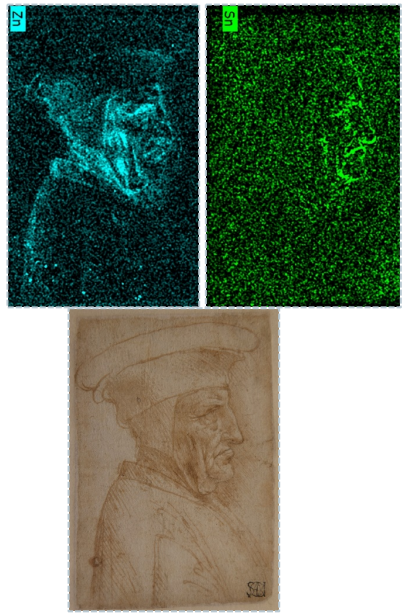
Senior Application Scientist
Micro-XRF

Bruker Nano GmbH

Art & Conservation Series – Part IV
Overview

- Introduction
- Features of ESPRIT Reveal
- XRF Data Processing with ESPRIT Reveal
    1. Oil painting: Venice
    2. Ceramic: Glaze Pottery
    3. Coin: Roman Denarius
- Live Demonstration
- Summary
- Questions and Answers

Micro-XRF in Art
Introduction



Trace element sensitive

Information from depth in the sample

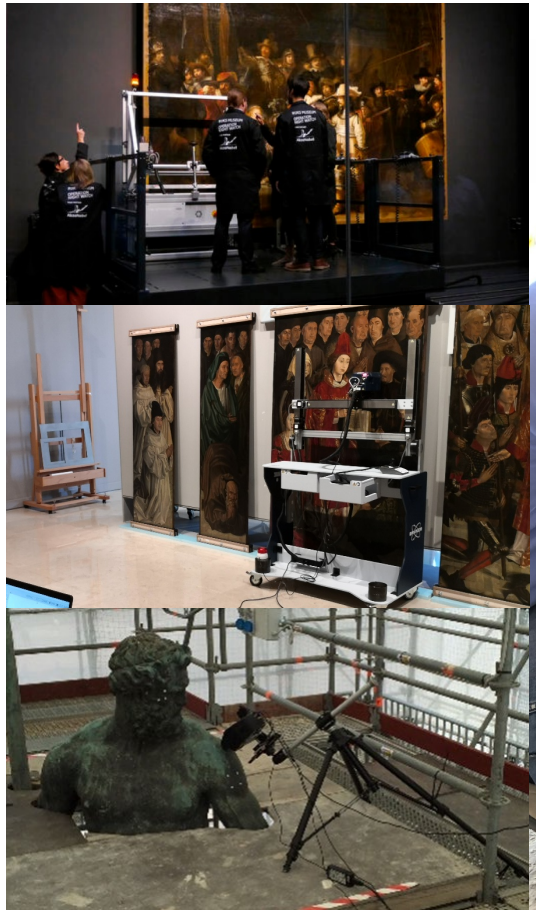
No sample preparation

- XRF is an element specific technique as each element absorbs and emits fluorescence at its individual energy
- The element concentration can be determined from this data
- An XRF scanner records the fluorescence on multiple points to determine the element distribution
- X-rays can penetrate deeper into matter than visible light allowing identification of hidden paintings or faded colors

Micro-XRF in Art

XRF and Art – a Hand in Hand Partnership

- XRF has proven to be a **core analytical technique** in Cultural Heritage studies
- XRF provides key information on objects: **reliable**, **fast**, and **non-invasive**
- **But** application needs are not always the same. They differ in crucial ways with respect to the **what**, the **where**, and the **how.**
- Bruker offers several instruments for one analytical principle



Micro-XRF in Art

Our Product Portfolio for Art and Conservation

- Bruker offers the perfect instrument for your specific needs

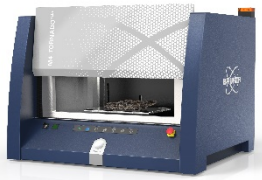
mapping

spot

TRACER Family

ELIO

CRONO



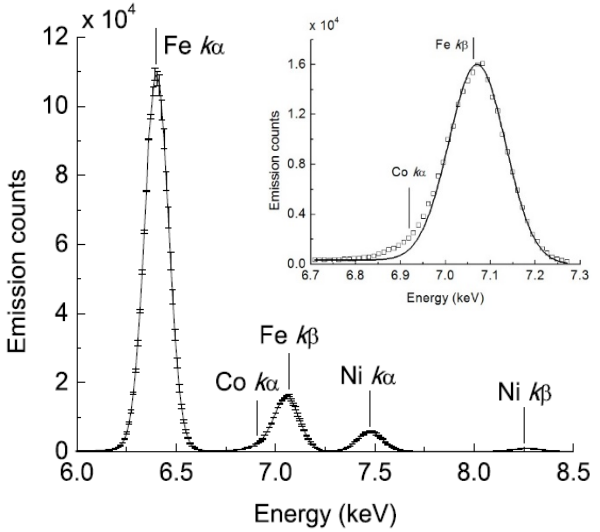
M4 TORNADO

M6 JETSTREAM

portable ⟷ laboratory based

X-Ray Fluorescence Data
Introduction

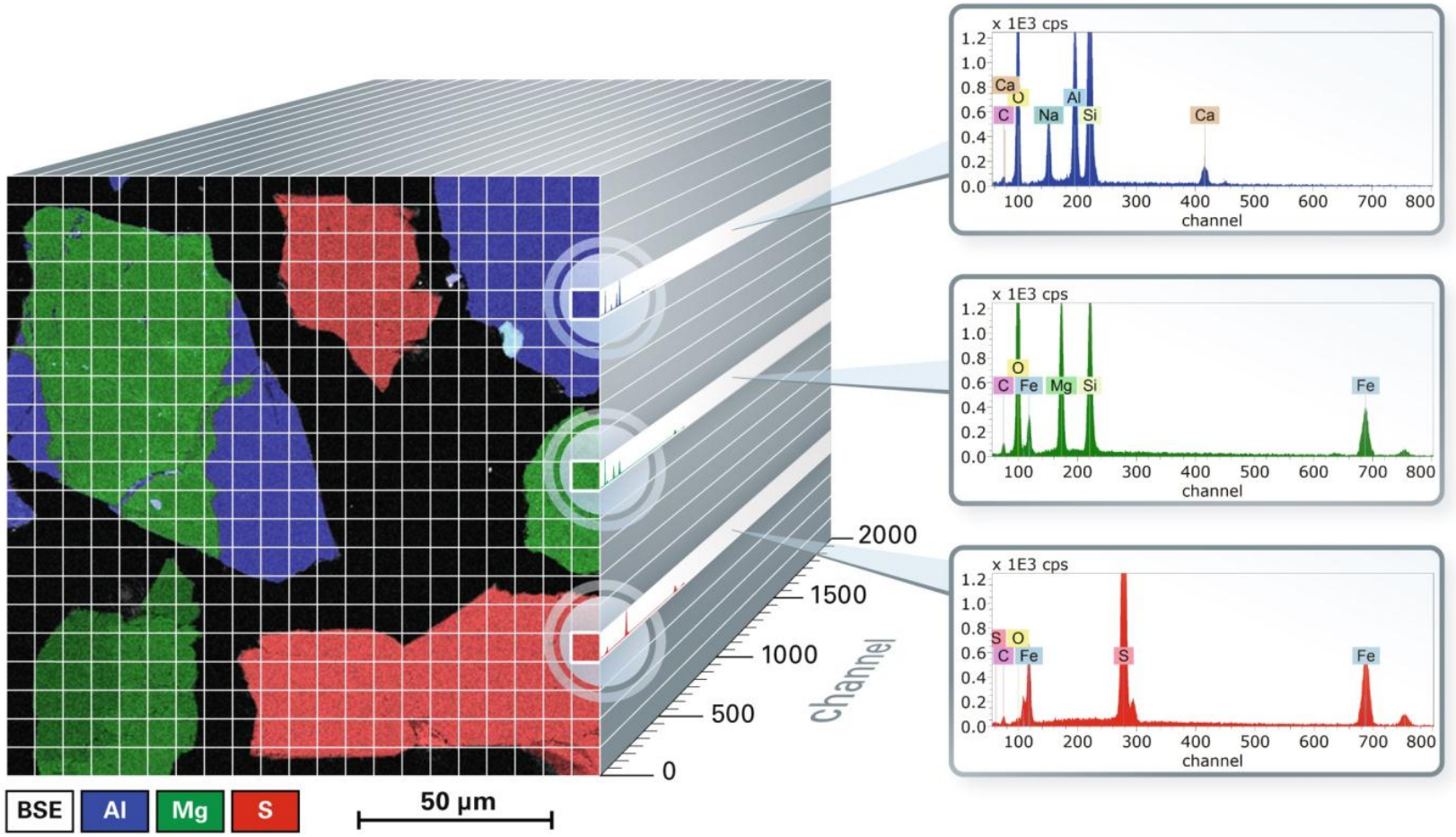
- **XRF-spectra** show the fluorescence as a function of detector channel or energy
- Each element can have several peaks
- The peak position is characteristic for each element
- The intensity can be related to the concentration of the element
- A correct reading of a spectra gives a very solid information about the presence of a given set of elements with the possibility to determine the quantity of that specific element



Tutankhamun's iron dagger and its gold sheath

X-Ray Fluorescence Data

From Point to Area Measurements



X-Ray Fluorescence Data
a Universe of Data

The latest technology developments and the flexibility in the design available in our portfolio of instruments give access to a universe of data depicting the magic link between chemistry and art

X-Ray Fluorescence Data
From Point to Area Measurement

This generates an extremely high degree of complexity when it comes to move **from data** to **information**

It is important to:

- interrogate
- sort
- analyze the data set

with a fast and reliable tool about aspects that are under investigation.

Mining into data becomes a necessity and it is in this activity Bruker is investing important engineering efforts to complete its instruments designed for art studies.

ESPRIT Reveal
What is ESPRIT Reveal?

- XRF data analysis is a core competence of the Bruker Nano GmbH
- First ESPRIT version published in 2003
- ESPRIT Reveal is designed for Art & Conservation
- Focus: Analysis of XRF spectra and XRF hypermaps
- Import XRF data recorded with ELIO, CRONO, M4 TORNADO or M6 JETSTREAM
- Export: report, data file, Excel, image
- Easy installation, offline use only

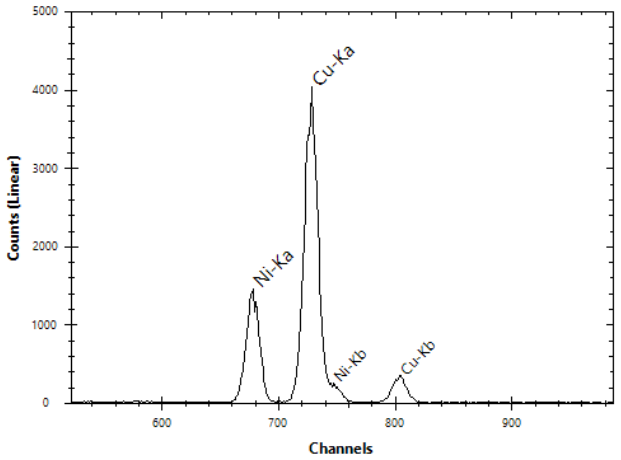
ESPRIT Reveal
Import Data Structure

Spectra can be exported from the ELIO or CRONO software as simple text, image, or spt-, mca-, spx-file

* .spx file

instrument information

measurement information



Hypermap (or map) files contain a spectrum for each point

* .bcf file

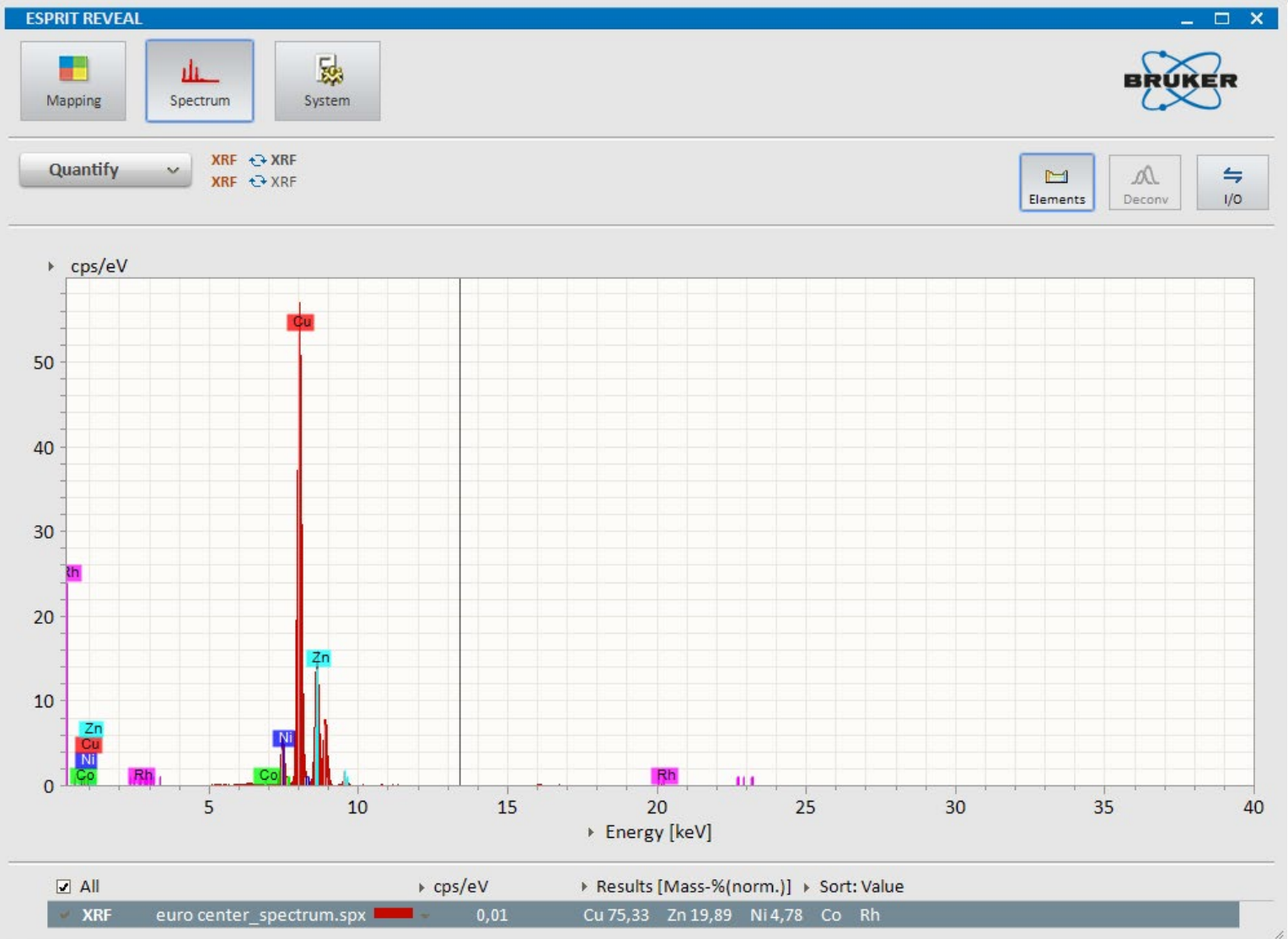
instrument information

measurement information

quantitative results

ESPRIT Reveal

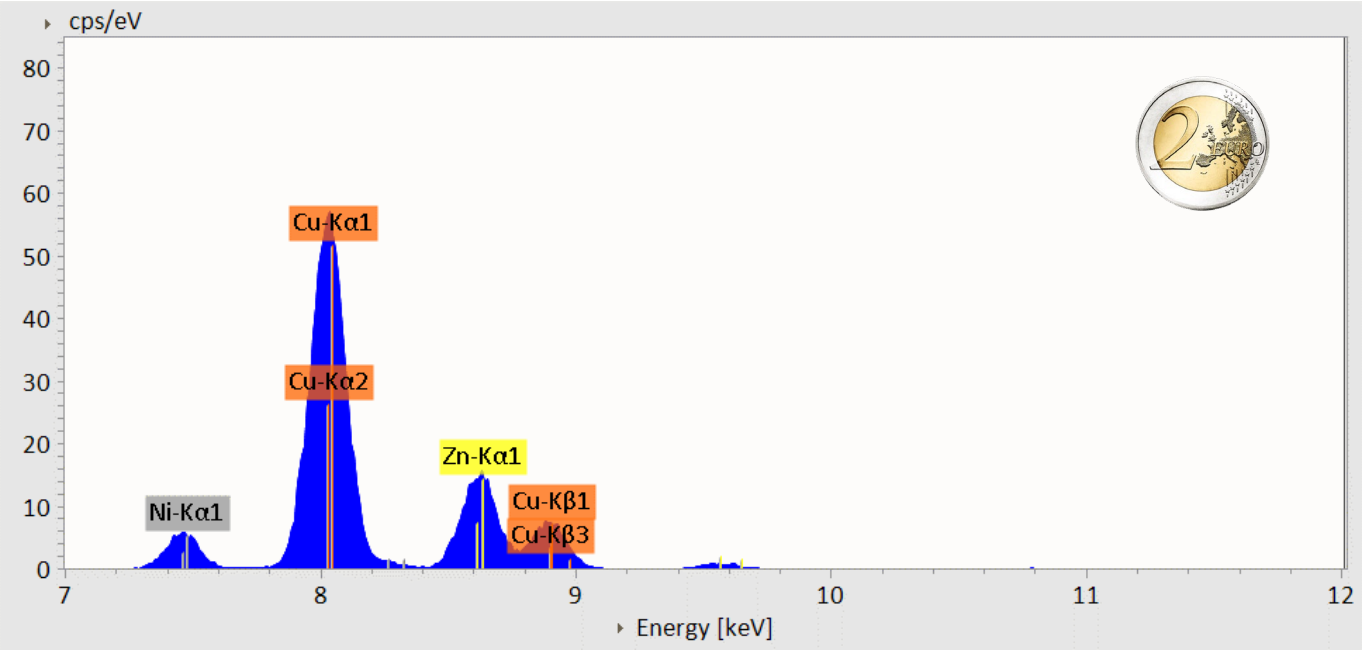
The Spectrum Workspace



ESPRIT Reveal
Spectra Processing Features

Processing of spectra

- easy manual and automatic peak identification
- automatically optimized ROI setting for selected elements
- compare spectra
- background subtraction and deconvolution / peak fitting
- spectra quantification with selectable and customizable evaluation methods



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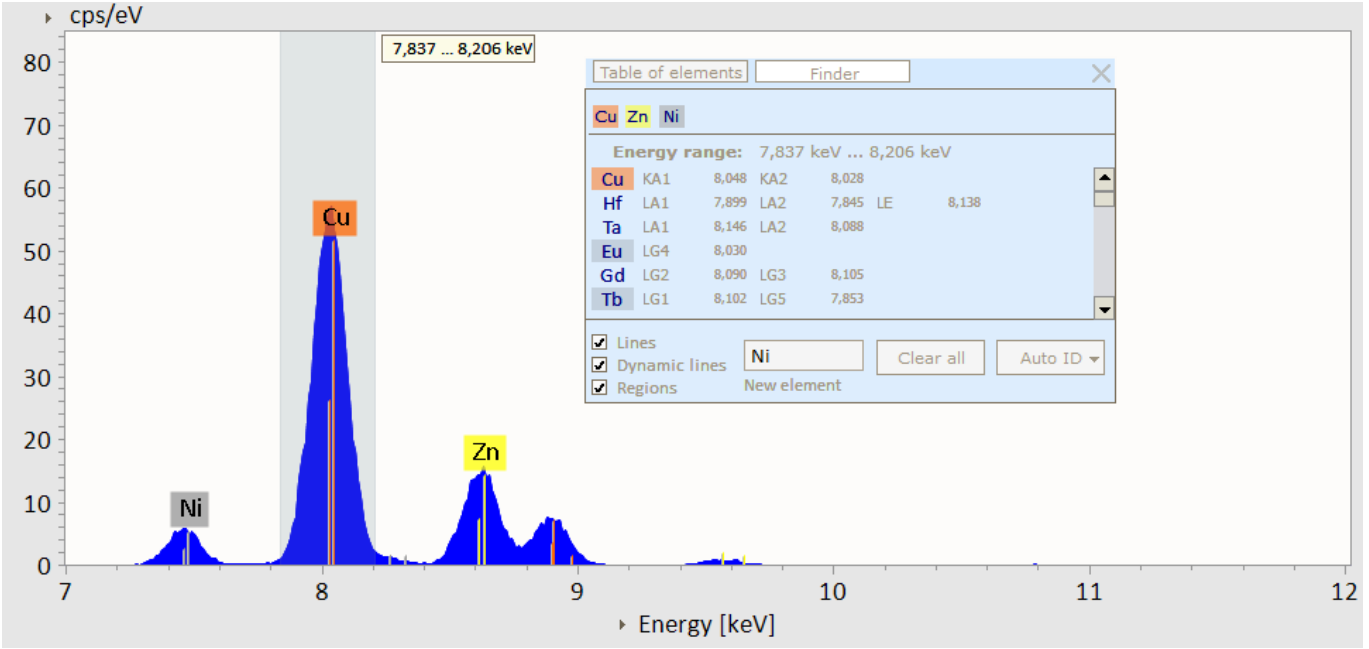

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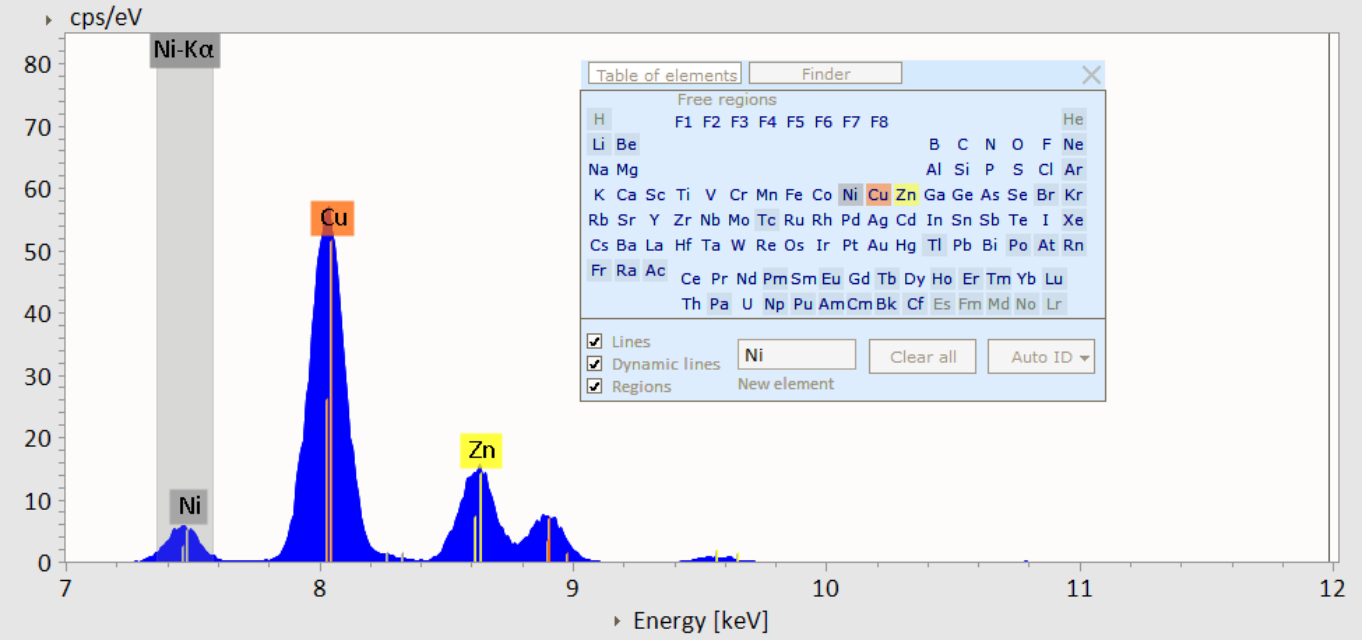

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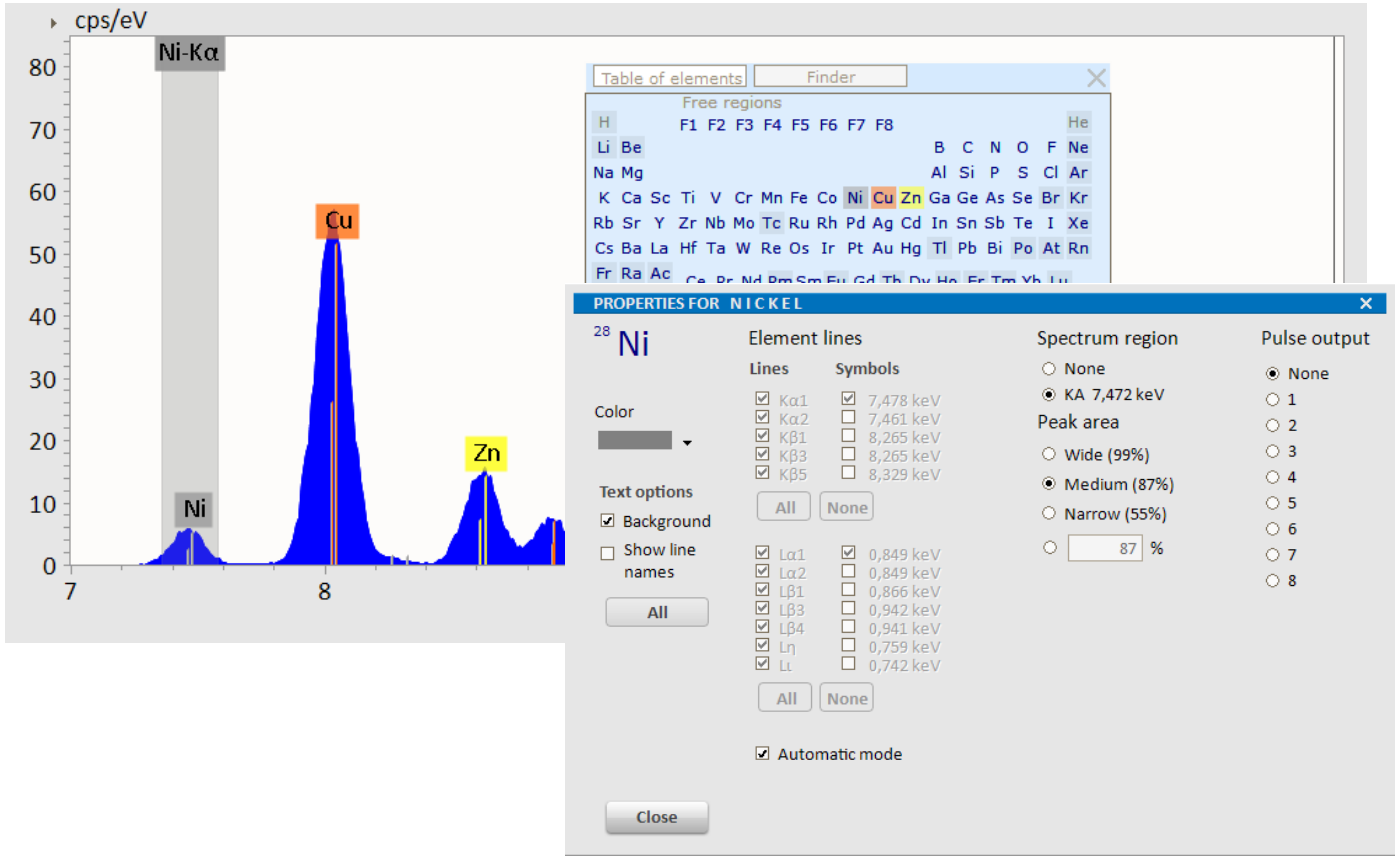

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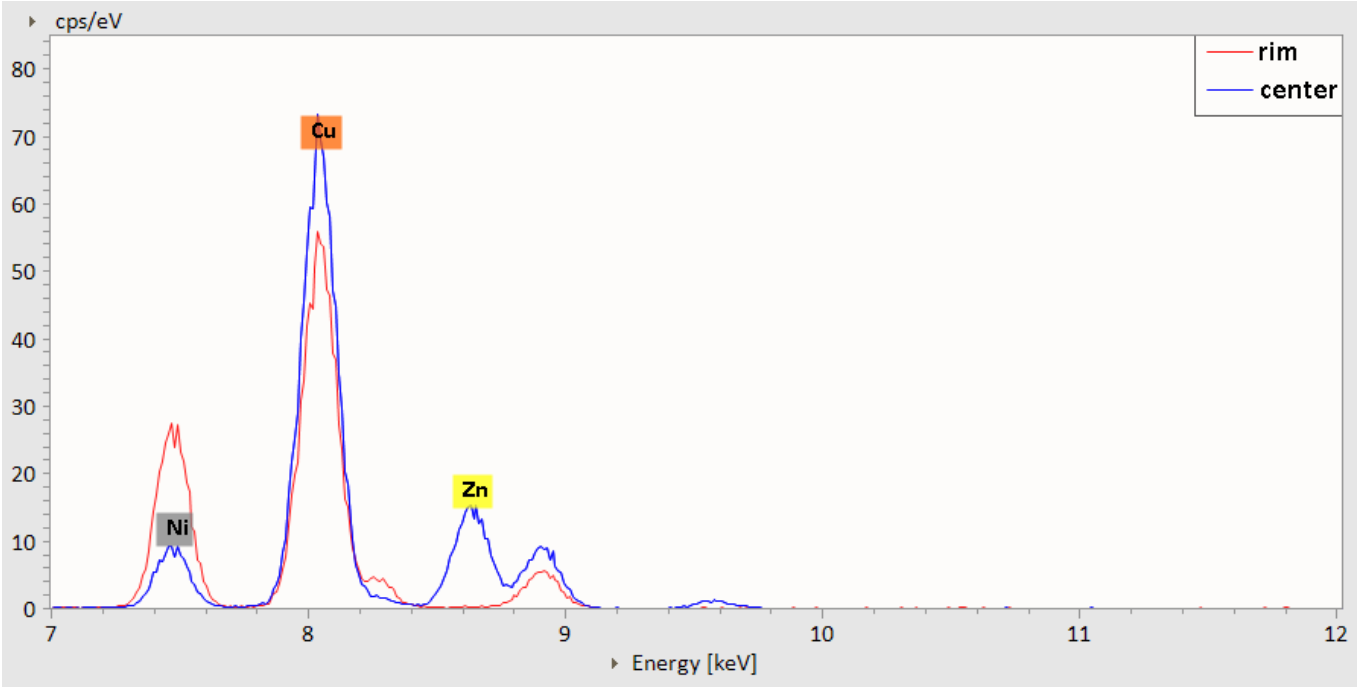

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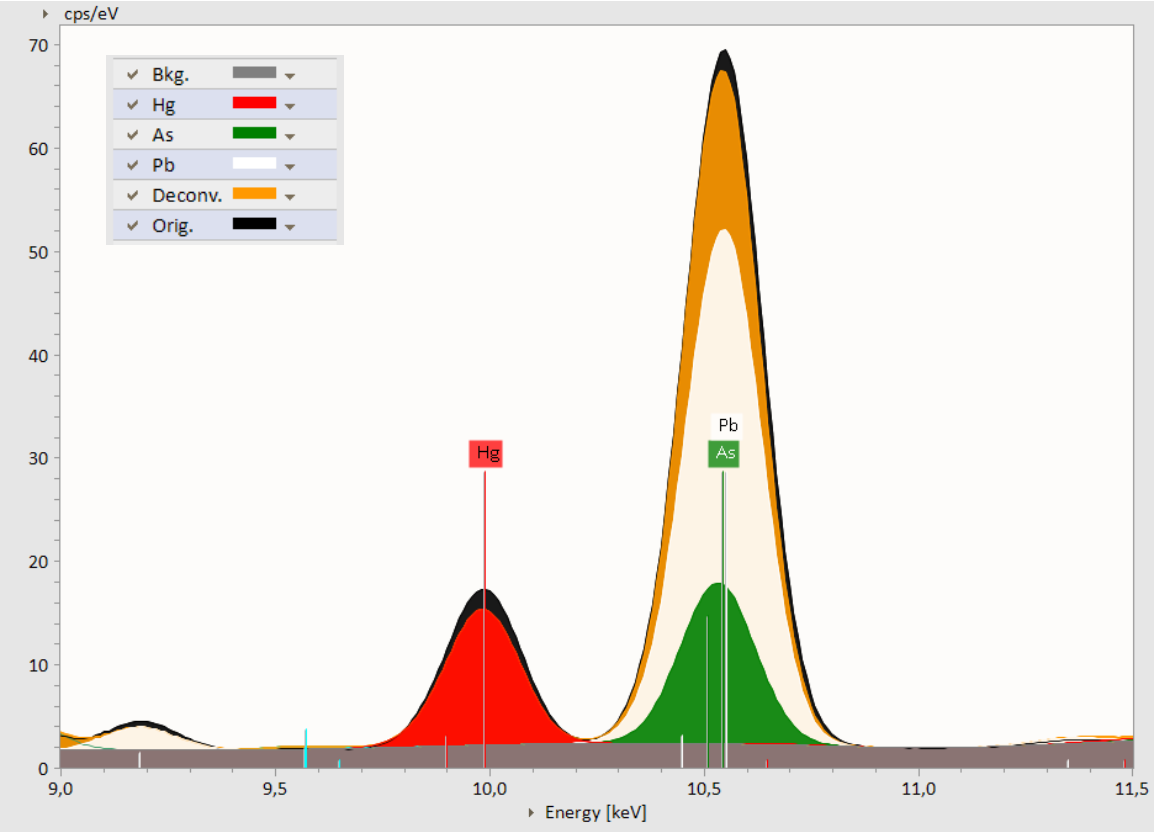

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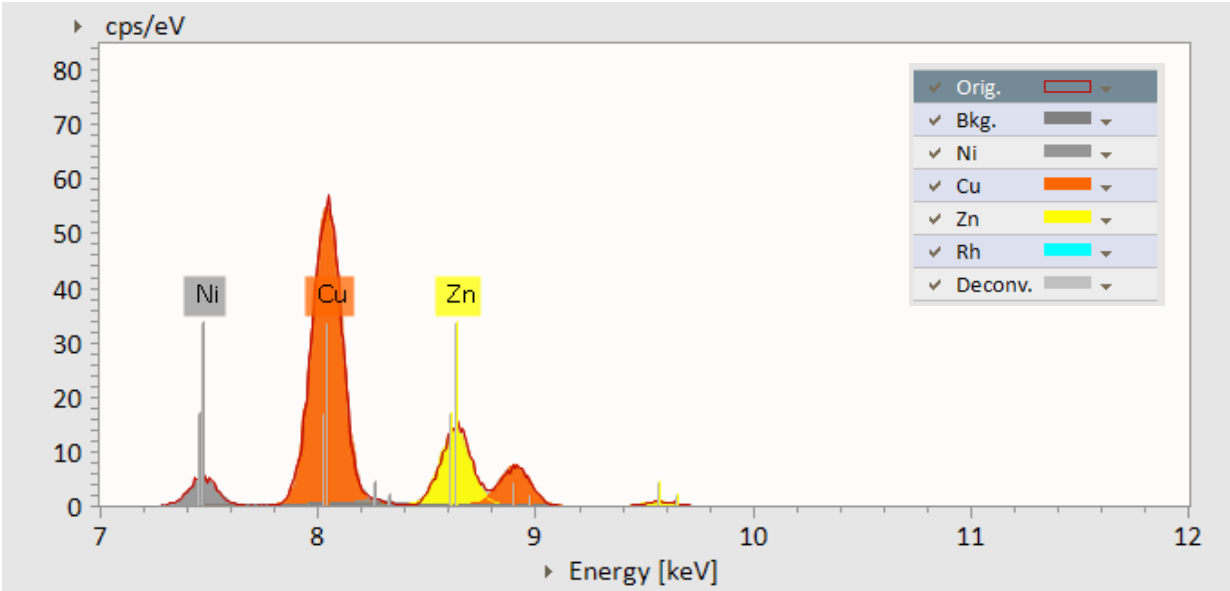
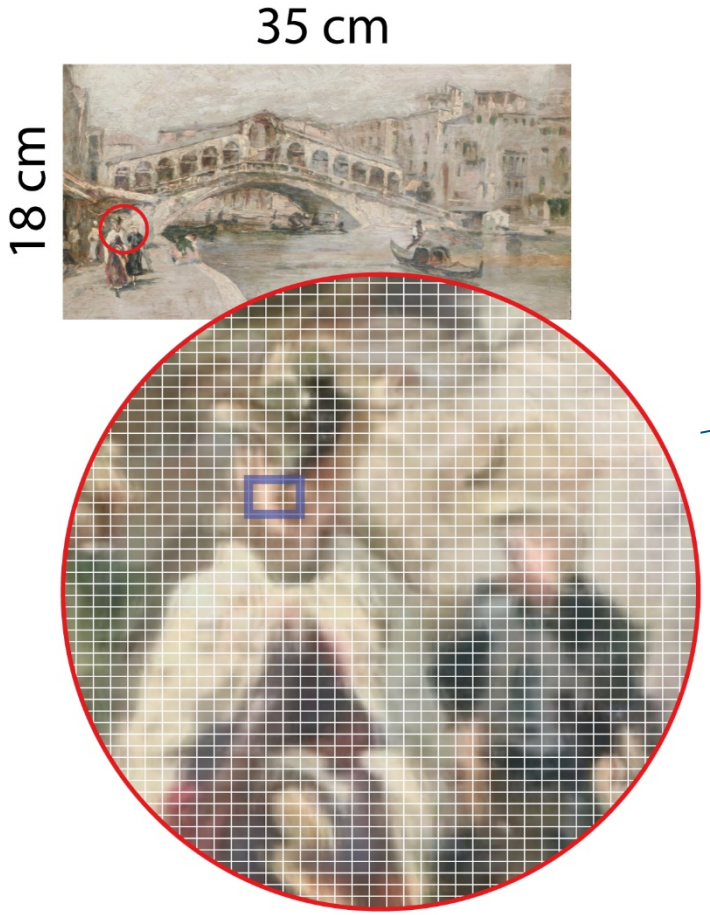
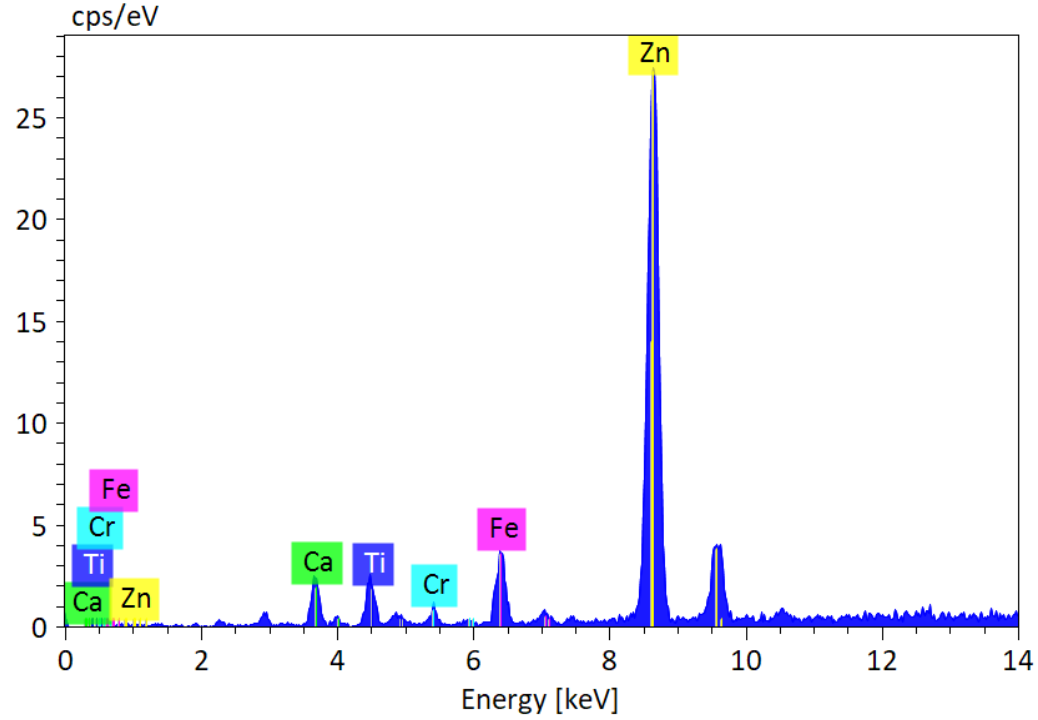


Element	At. No.	Netto	Mass Norm. [%]	rel. error [%] (1 sigma)
Cu	29	60899	75,7	0,7
Zn	30	14829	19,2	0,2
Ni	28	5539	5,2	0,1
Rh	45	38	0,0	0,0
		Sum	**100,0**	

ESPRIT Reveal
What is a Hypermap?

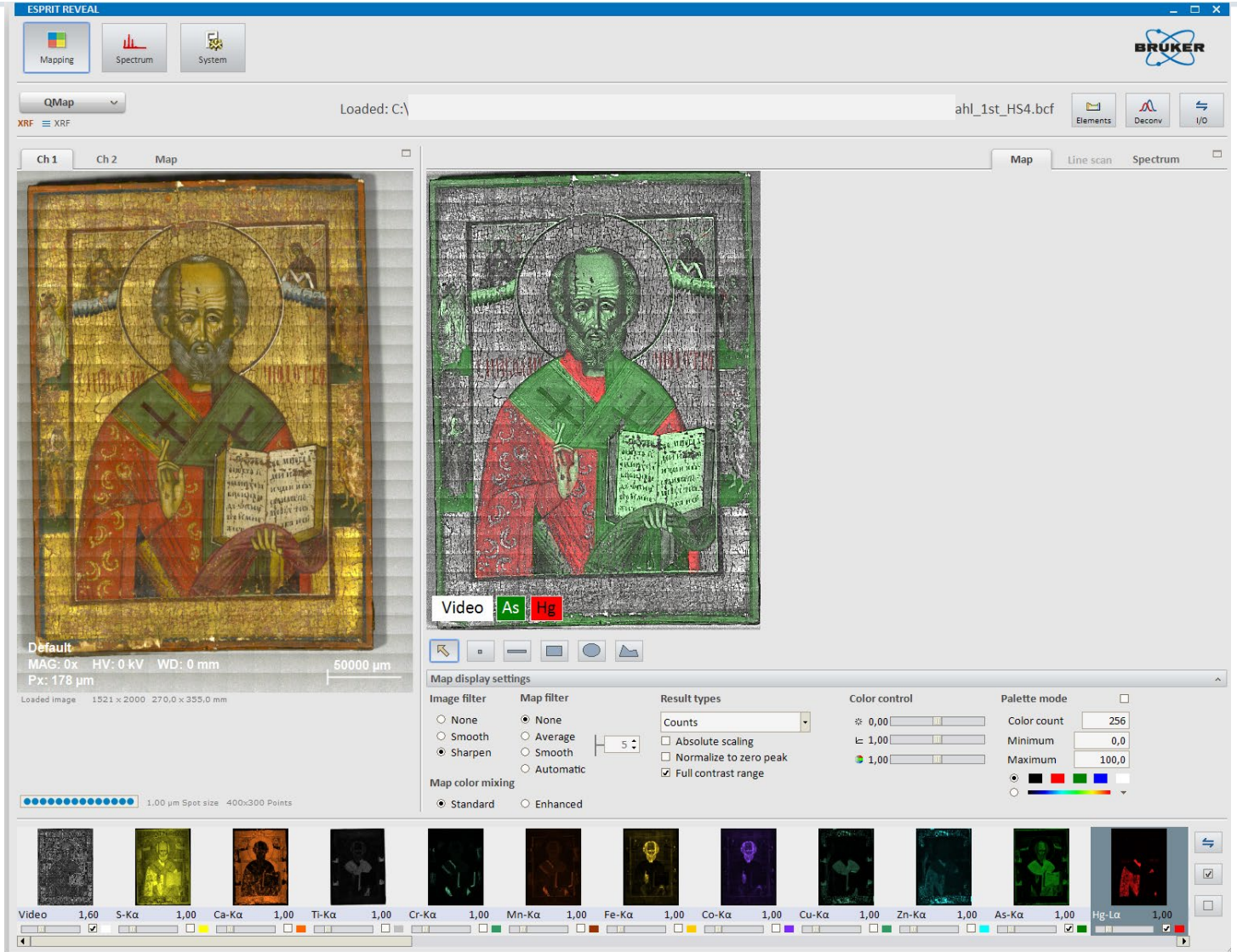




Hypermaps contain a spectrum for each point on the sample

ESPRIT Reveal

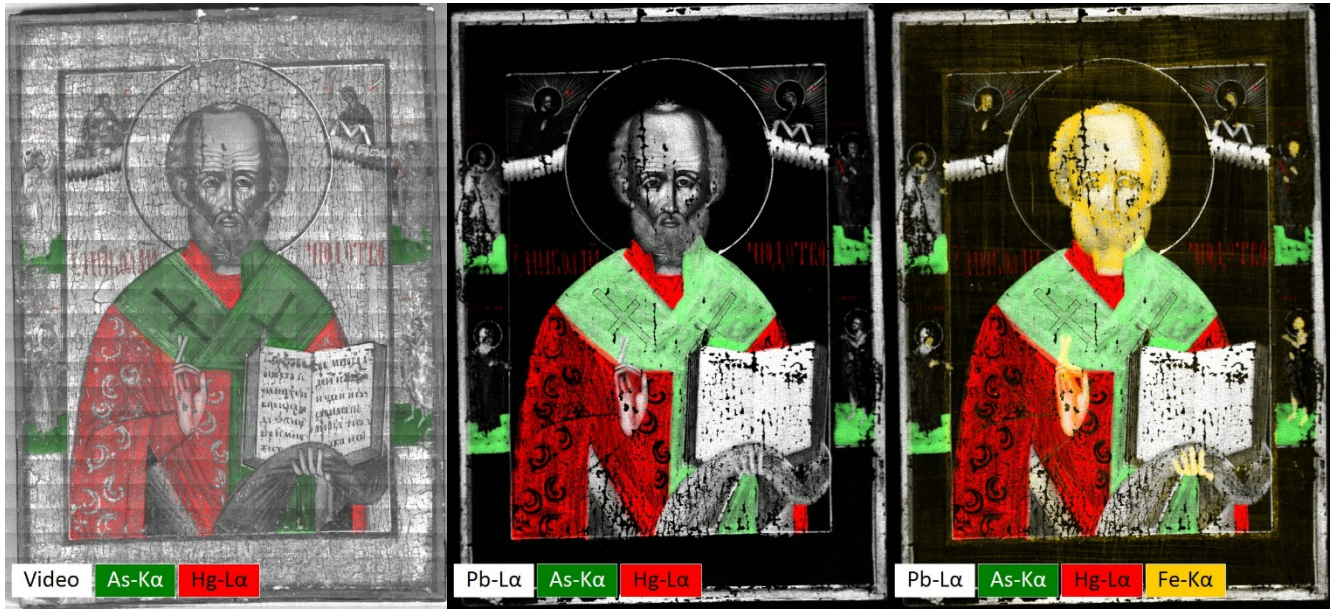
The Mapping Workspace



ESPRIT Reveal
Hypermap Processing Features

Processing of hypermaps

- visualization and overlay of sample images and hypermaps for multi-element display
- cut and extract object spectra
- maximum pixel analysis
- background subtraction and deconvolution



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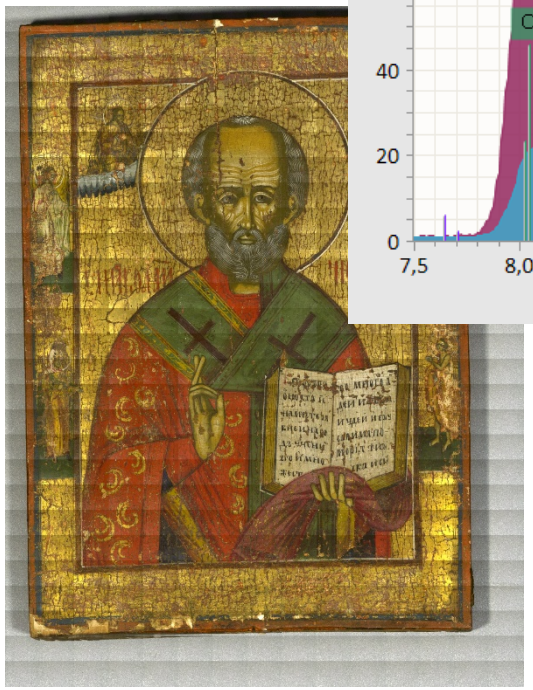

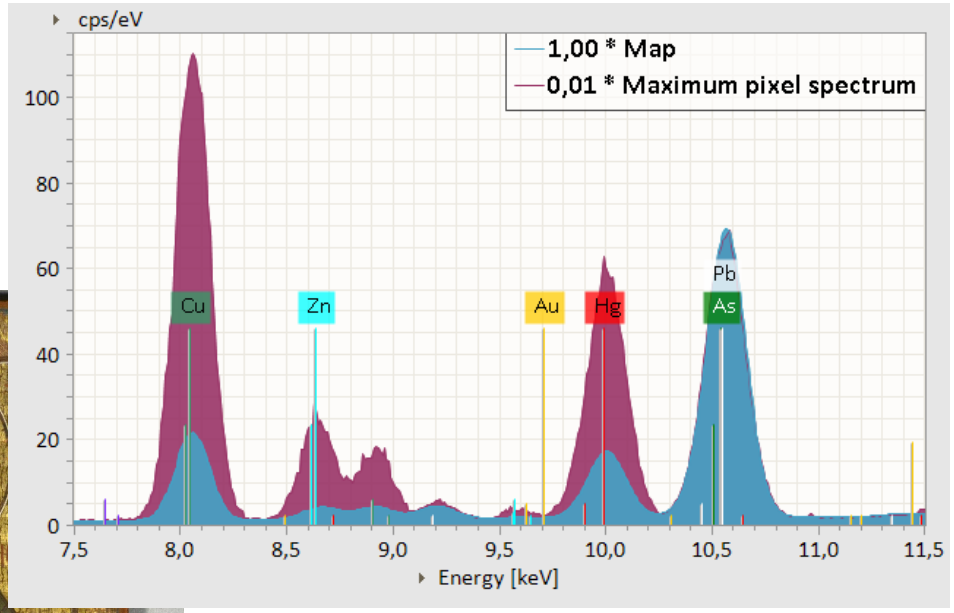

ESPRIT Reveal
Hypermap Processing Features

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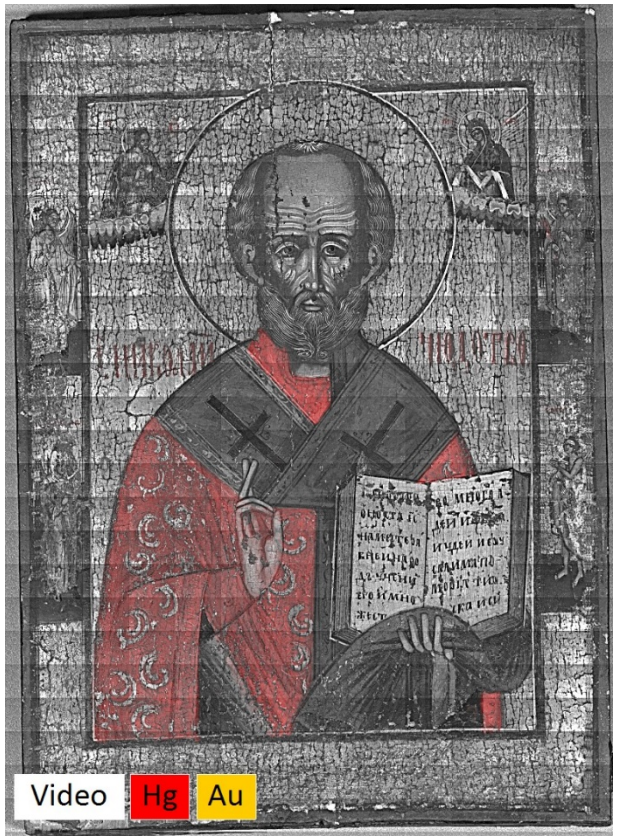
without deconvolution



with deconvolution

XRF Data Processing with ESPRIT Reveal

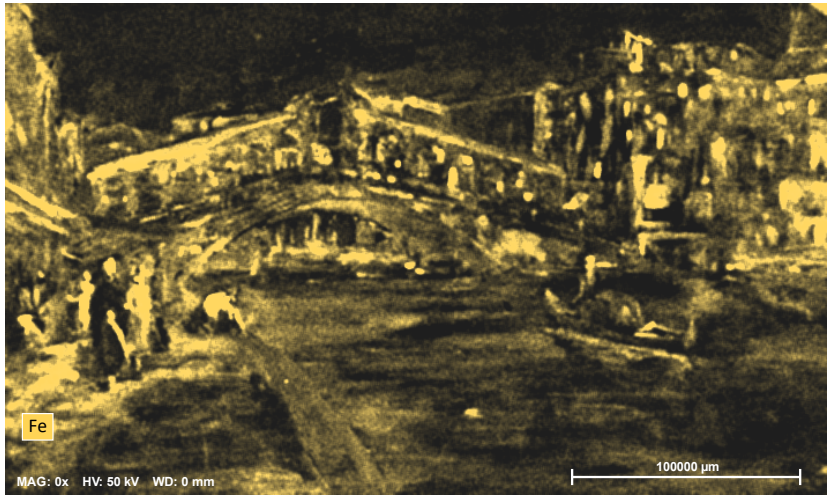
Oil Painting

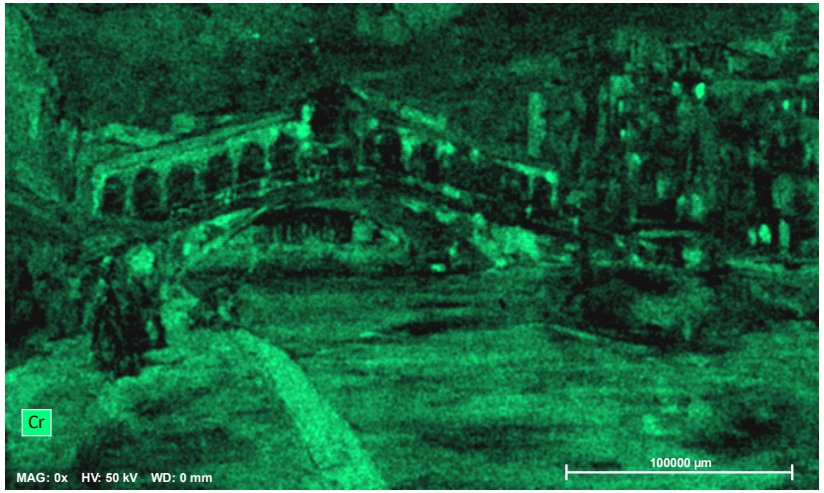
Visual image

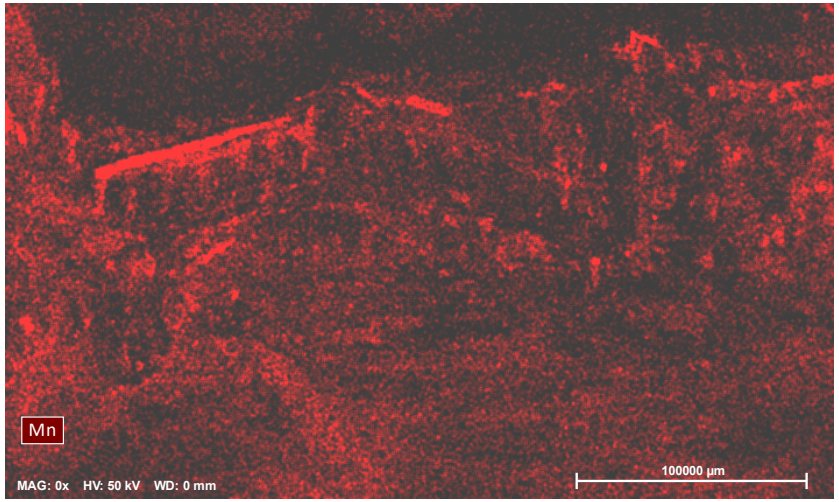
- Oil painting on wood
- Nice combination of elements (modern pigments)
- Depicting the grand canal, Venice

XRF Data Processing with ESPRIT Reveal

Oil Painting







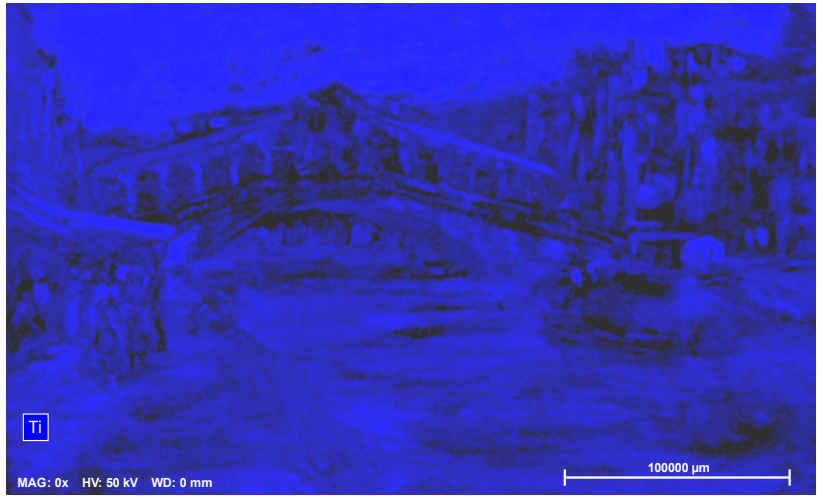
XRF Data Processing with ESPRIT Reveal

Oil Painting

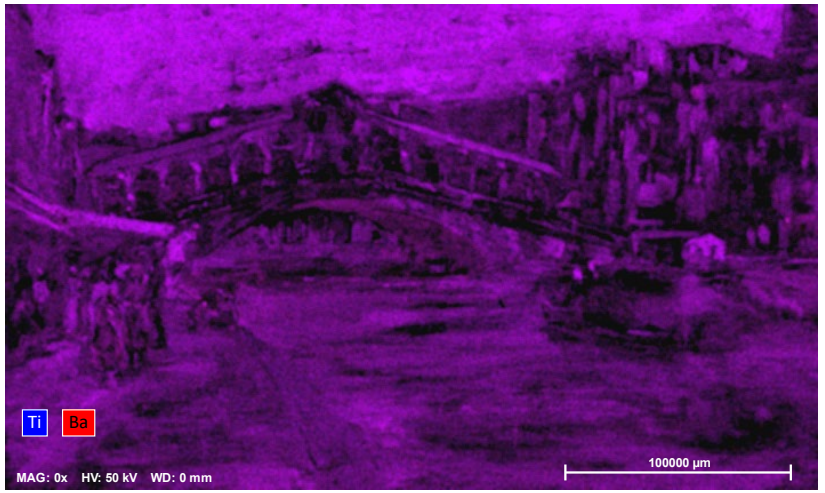
- Oil painting on wood
- Painting image reconstruction
- Elements display only

XRF Data Processing with ESPRIT Reveal

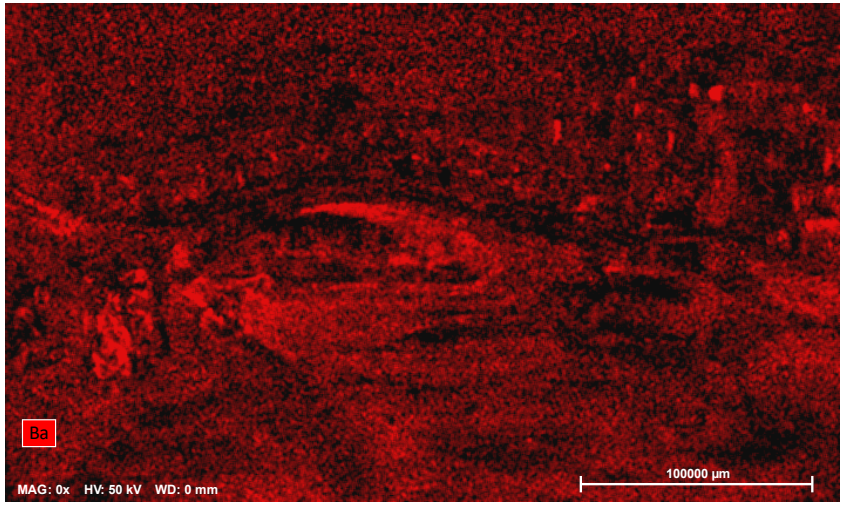
Oil Painting



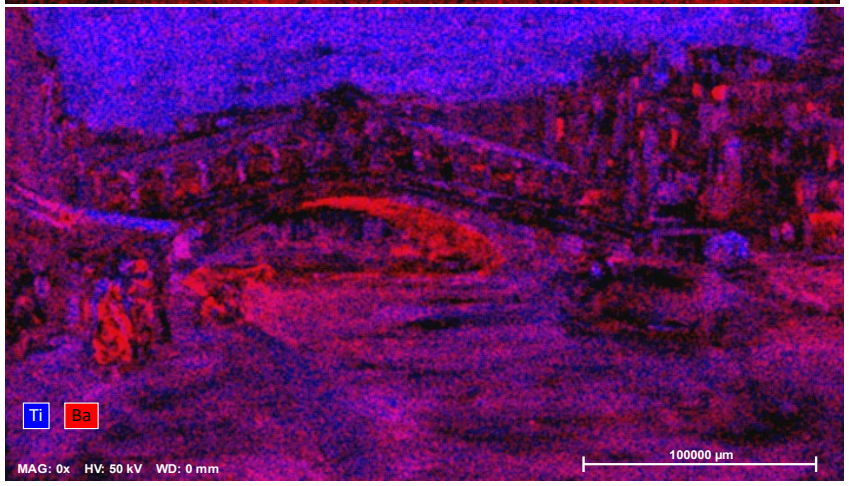
Titanium



Titanium and barium, without deconvolution



Barium



Titanium and barium, with deconvolution

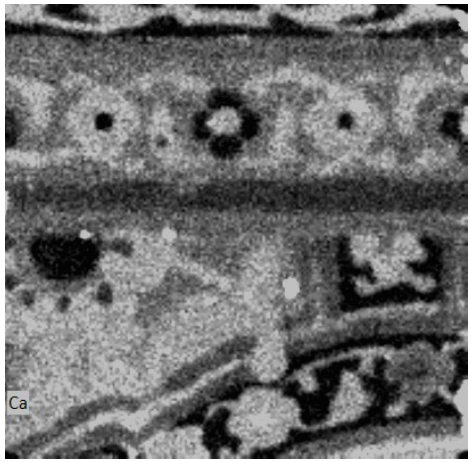
XRF Data Processing with ESPRIT Reveal

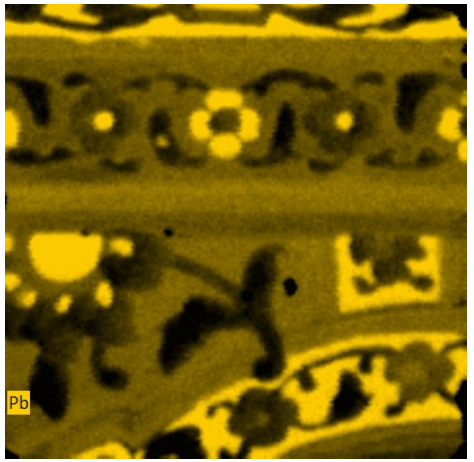
Ceramics

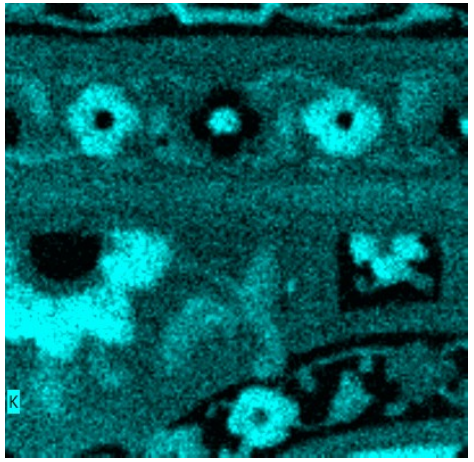
- Glaze pottery
- Safavid Dynasty (1501 AD to 1722 AD), Iran
- XRF data provided with the curtesy of the Archaeology department, Peking University, China

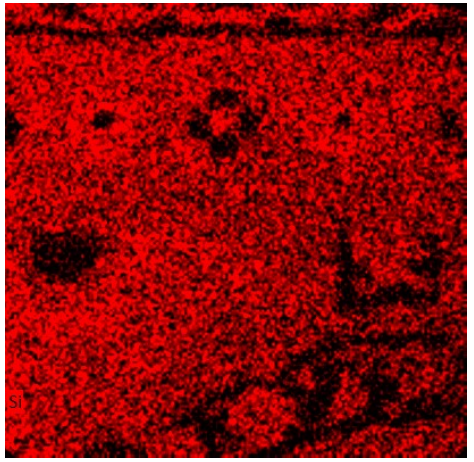
XRF Data Processing with ESPRIT Reveal

Ceramics



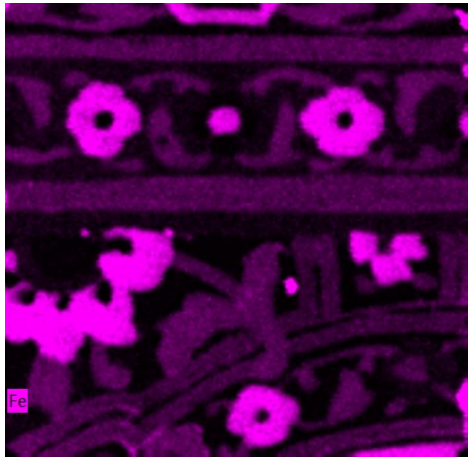


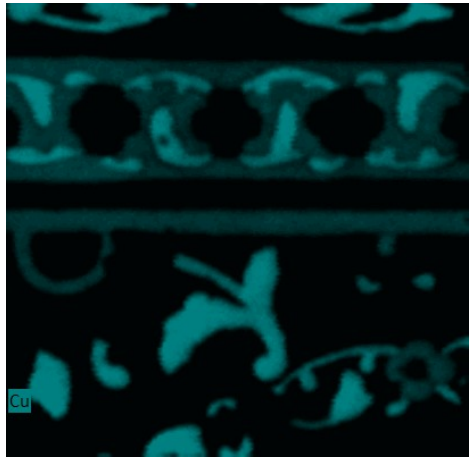


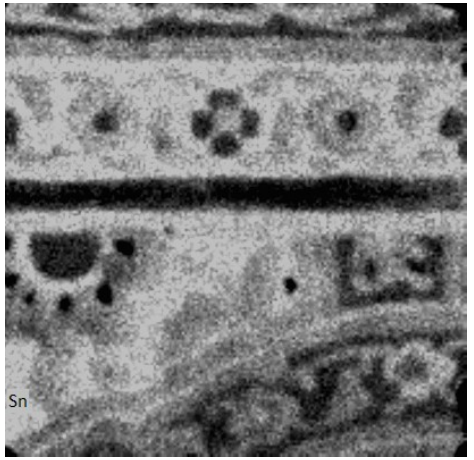


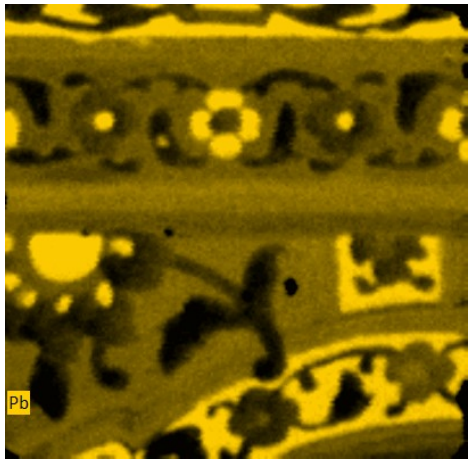
XRF Data Processing with ESPRIT Reveal

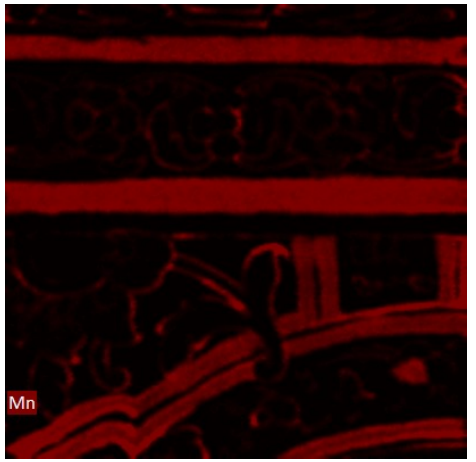
Ceramics

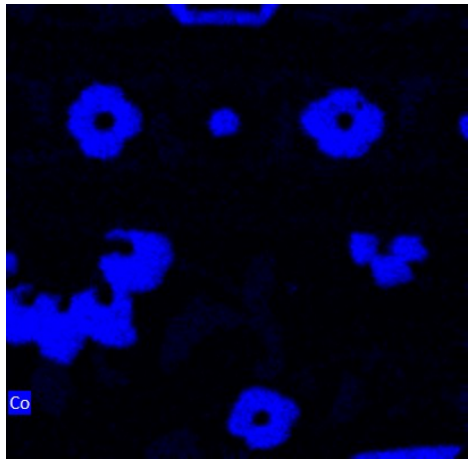




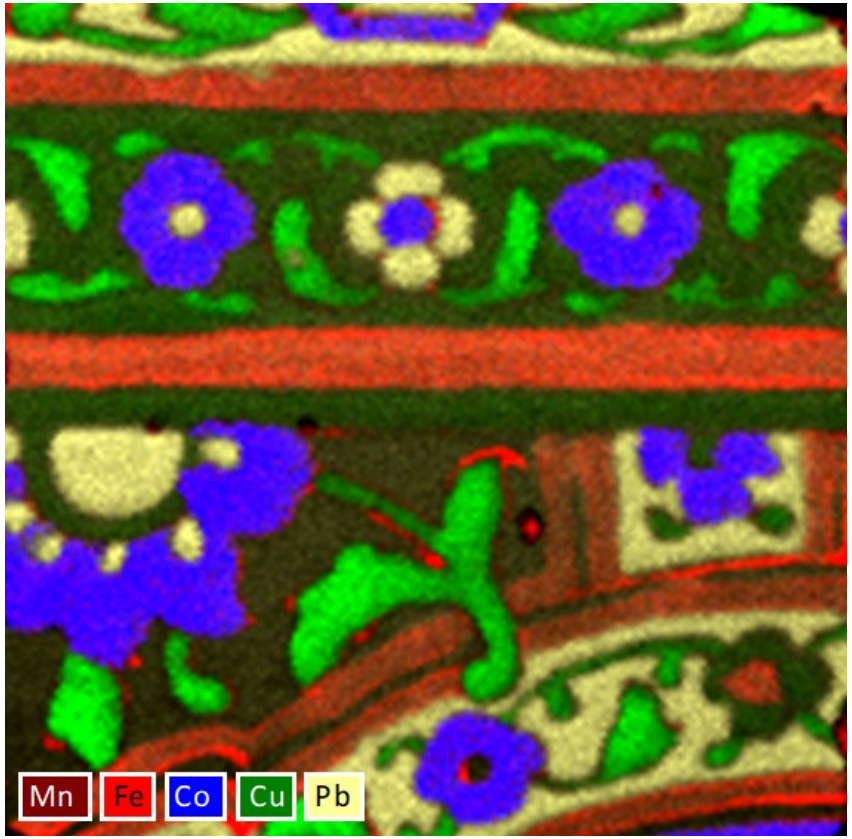








XRF Data Processing with ESPRIT Reveal
Ceramics



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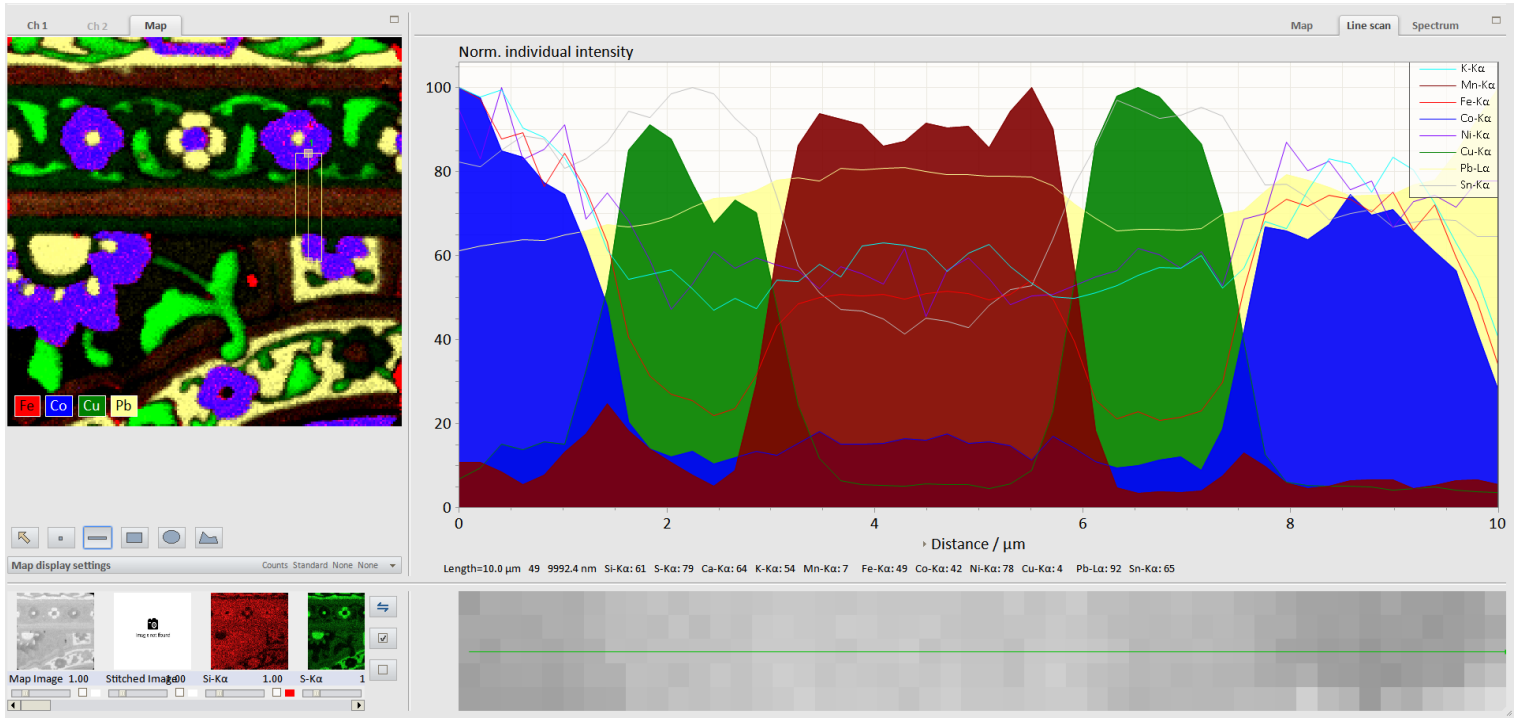
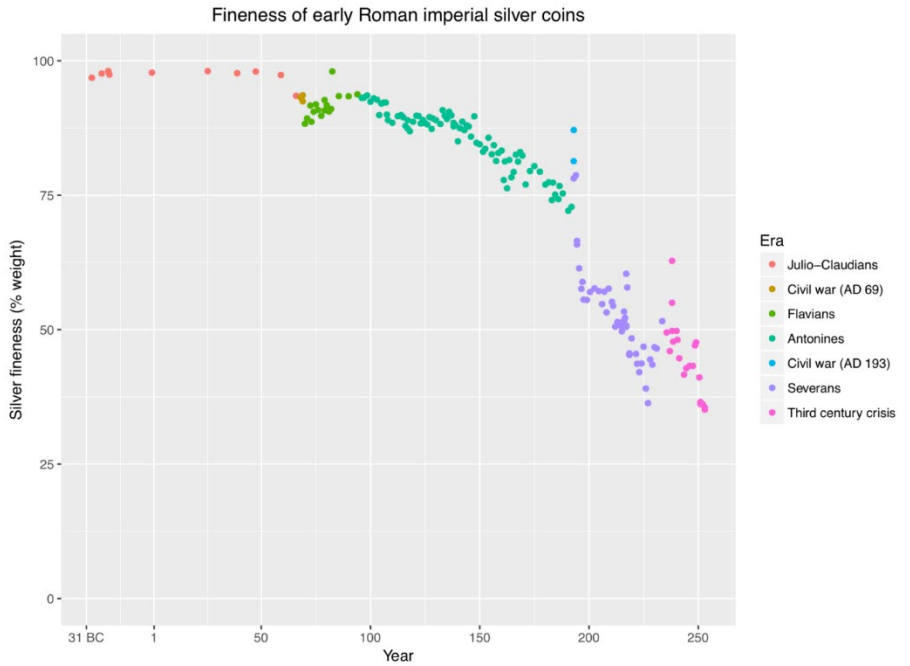


XRF Data Processing with ESPRIT Reveal

Denarius Coin

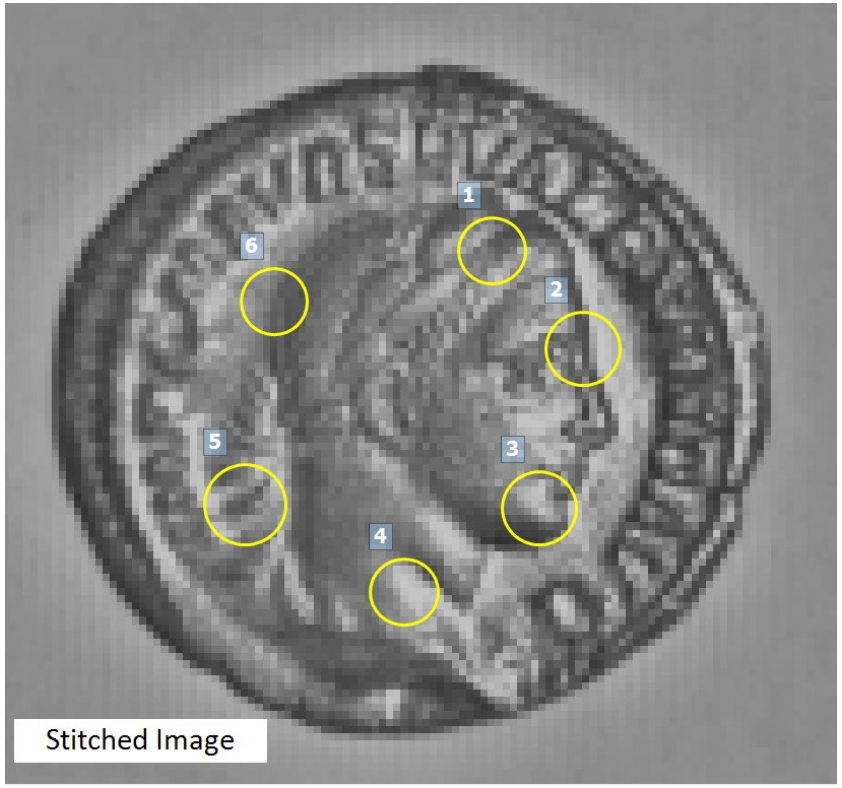
- Roman denarius (coin) depicting Roman emperor Severus Alexander (208 – 235)
- Matching production time via composition



Source: https://en.wikipedia.org/wiki/Denarius

XRF Data Processing with ESPRIT Reveal

Denarius Coin



- quantification with ESPRIT Reveal: ~ 90% Ag

All		Results [Mass-%(norm.)] ▸ Sort: Value							
✓ XRF	1	Ag 93,24	Cu 5,66	Pb 0,58	Au 0,25	Ni 0,17	As 0,04	Fe 0,02	Bi 0,03
✓ XRF	2	Ag 90,32	Cu 8,63	Pb 0,57	Au 0,25	Ni 0,16	As 0,05	Fe 0,01	Bi 0,01
✓ XRF	3	Ag 93,71	Cu 5,21	Pb 0,55	Au 0,25	Ni 0,18	As 0,05	Fe 0,02	Bi 0,01
✓ XRF	4	Ag 88,32	Cu 10,58	Pb 0,53	Au 0,29	Ni 0,19	As 0,05	Fe 0,04	Bi 0,01
✓ XRF	5	Ag 92,87	Cu 6,03	Pb 0,53	Au 0,30	Ni 0,19	As 0,04	Fe 0,03	Bi 0,02
✓ XRF	6	Ag 91,88	Cu 7,00	Pb 0,54	Au 0,29	Ni 0,18	As 0,05	Fe 0,03	Bi 0,02

XRF Data Processing with ESPRIT Reveal

Denarius Coin

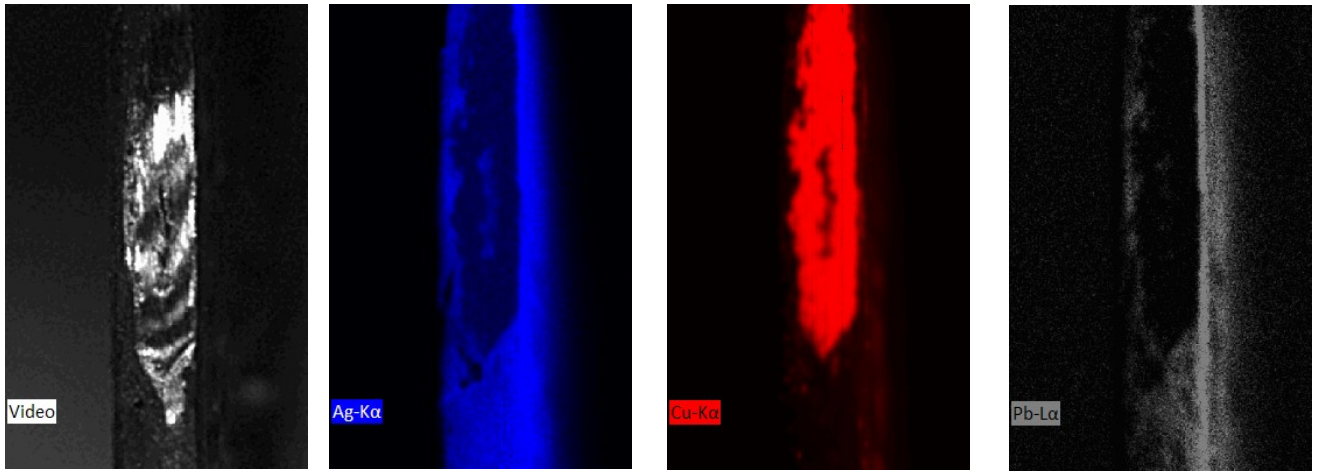
Source: https://en.wikipedia.org/wiki/Denarius

- quantification with ESPRIT Reveal: ~ 90% Ag
- mismatch in Ag content and historic background

XRF Data Processing with ESPRIT Reveal

Denarius Coin

- The composition is very different between the patina on the surface and the core
- Composition of the core is in line with the expected Ag-content of roman coins from this time
- For historic alloy is important to consider effects of patina when quantifying



View of the coin rim

All		Results [Mass-%(norm.)]	Sort: Value					
XRF	Core.spx	Cu 62.19	Ag 37.10	Pb 0.38	Au 0.12	As 0.10	Fe 0.10	Bi 0.00	Rh
XRF	Patina.spx	Cu 5.41	Ag 93.39	Pb 0.79	Au 0.31	As 0.05	Fe 0.03	Bi 0.02	Rh

XRF Data Processing with ESPRIT Reveal

Denarius Coin

Source: https://en.wikipedia.org/wiki/Denarius

- quantification with ESPRIT Reveal: ~ 37% Ag
- Ag content matches historic background

XRF Data Processing with ESPRIT Reveal

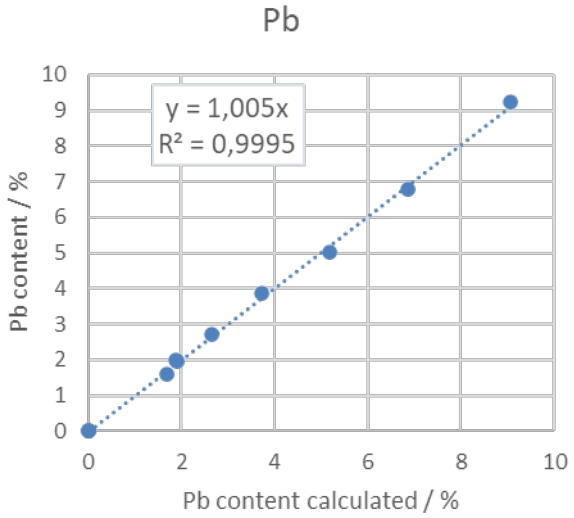
Development of a Standard Supported Fundamental Parameter Quantification

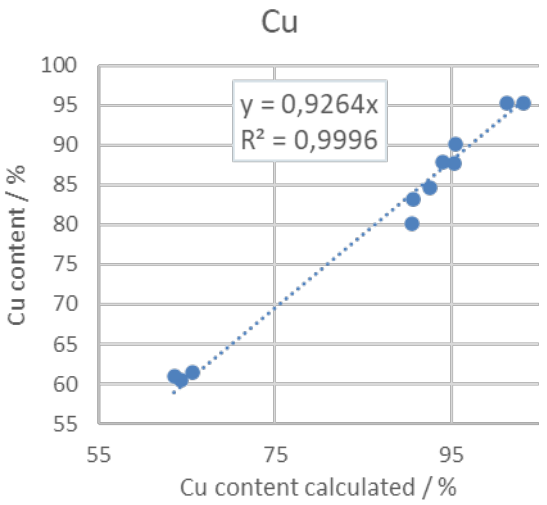
A) Setting up an instrument specific calibration

- wide range of elements
- 60 second for following element alloys
- fixed collimator size
- precisely focused

B) Refining with certified standards

- Standard supported fundamental parameter (FP) quantification with ELIO
- certified alloys





live demonstration

by

Dr. Roald A. Tagle Berdan

Summary

BRUKER has very seriously decided to serve the Art & Conservation market designing and developing instruments. The wide portfolio perfectly allows to size a measurement campaign on very specific customer needs.

Data evaluation tools are key to complete analytical instruments and ESPRIT Reveal is a perfect solution as it is:

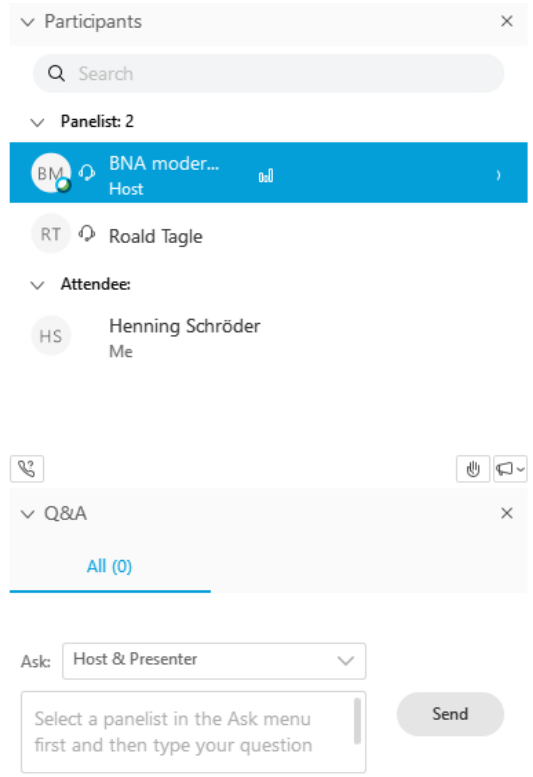
- Easy to install, operate and learn
- Fast, reliable and perfectly optimized to work in combination to our instruments (ELIO and CRONO in particular)
- Complete in covering common advanced analytical needs for either qualitative and quantitative analysis

Art & Conservation Series – Part IV
Questions and Answers

- If you have questions during this webinar, please **type your questions**, thoughts, or comments in the **Q&A box** and **press Send**.

- We ask for your understanding if we do not have time to discuss all comments and questions within the session.

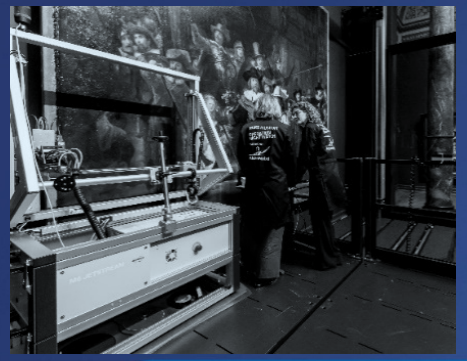
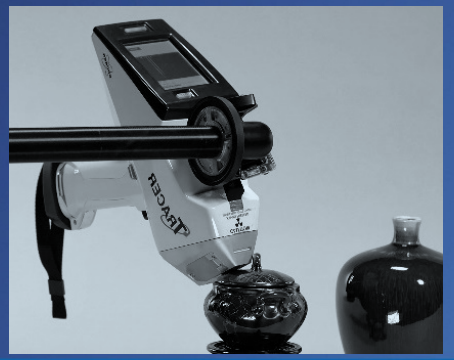
- Any unanswered questions or comments will be answered and discussed by e-mail or in another Webex session.



Art & Conservation Webinar Series

Overview

Part I	– May 6th	New Horizons of micro-XRF
Part II	– May 27th	Flexible and portable-XRF mapping solutions: Bruker's ELIO and CRONO spectrometers
Part III	– June 16th	TRACER: the benchmark in handheld-XRF for cultural heritage
Part IV	– September 24th	XRF Data Processing in Art and Conservation with ESPRIT Reveal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For more information please contact us

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