WEBINAR

SETTING YOUR CAREER IN HERITAGE SCIENCE AT ISPC-CNR:
MARIE SKŁODOVSKA-CURIE ACTIONS
POST-DOCTORAL FELLOWSHIPS

TUESDAY 11TH JULY 2023

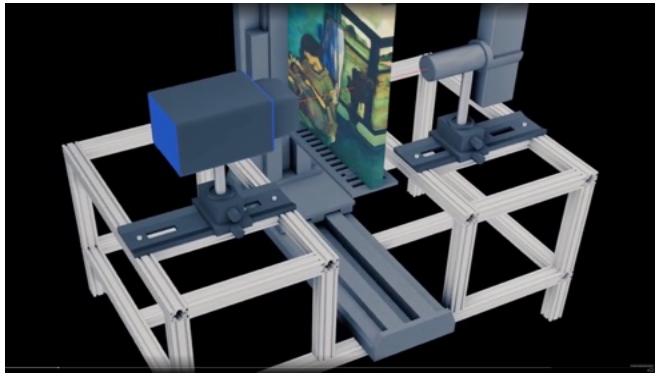
X-ray science for the non-invasive investigation of tangible cultural heritage

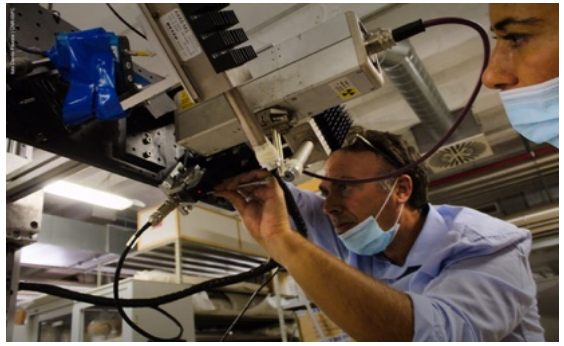
CLAUDIA CALIRI

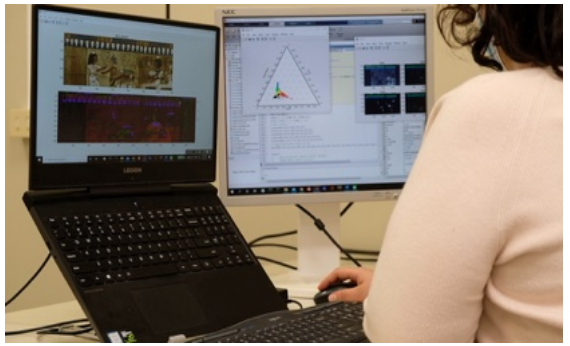
Consiglio Nazionale delle Ricerche

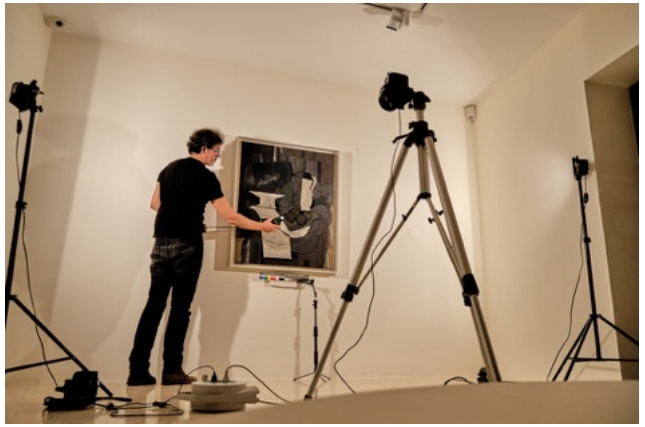
Istituto di Scienze del Patrimonio Culturale

XRAYlab
an advanced mobile laboratory for X-ray techniques and technologies



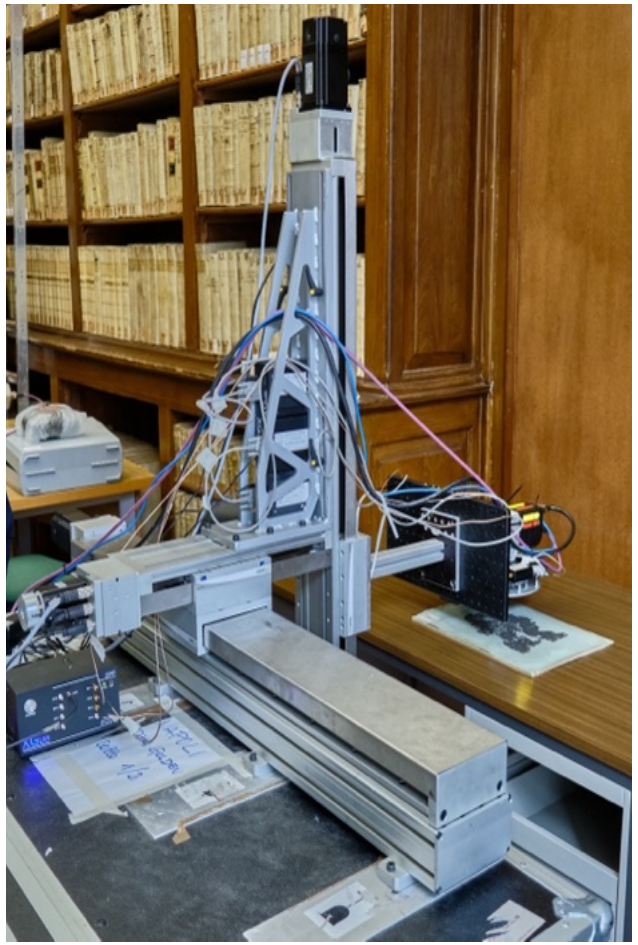






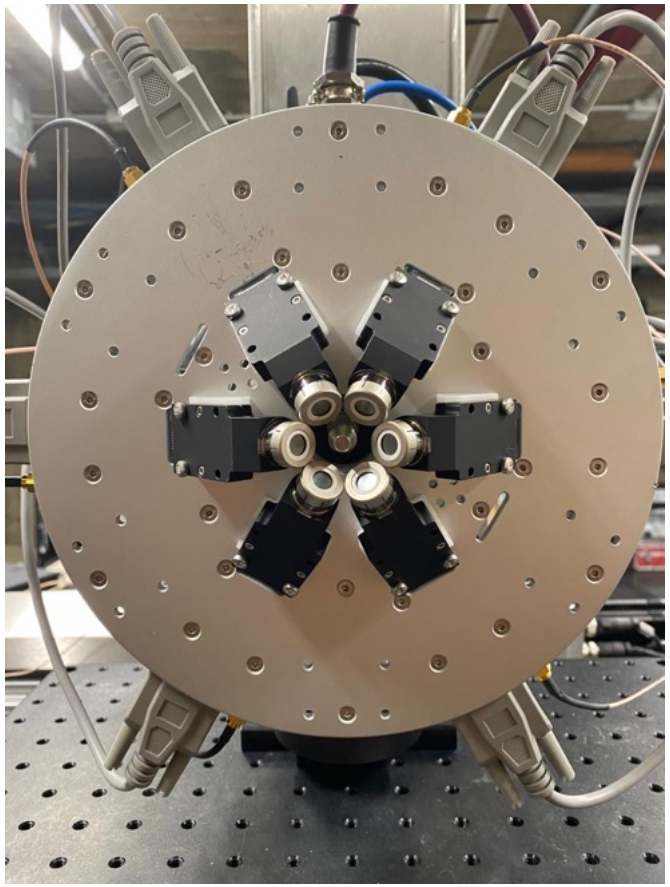
- Scanner MA-XRF Imaging
- Scanner XRD/XRF Imaging
- Scanner micro-XRF e Confocal XRF Imaging
- Full Field XRF Imaging
- High-Resolution XRF Imaging
- TXRF/GIXRF System for ultra-traces detection and selective depth-profile chemical characterization
- Digital Radiography System
- XANES/EXAFS System for degradation processes

Scanner MA-XRF Imaging

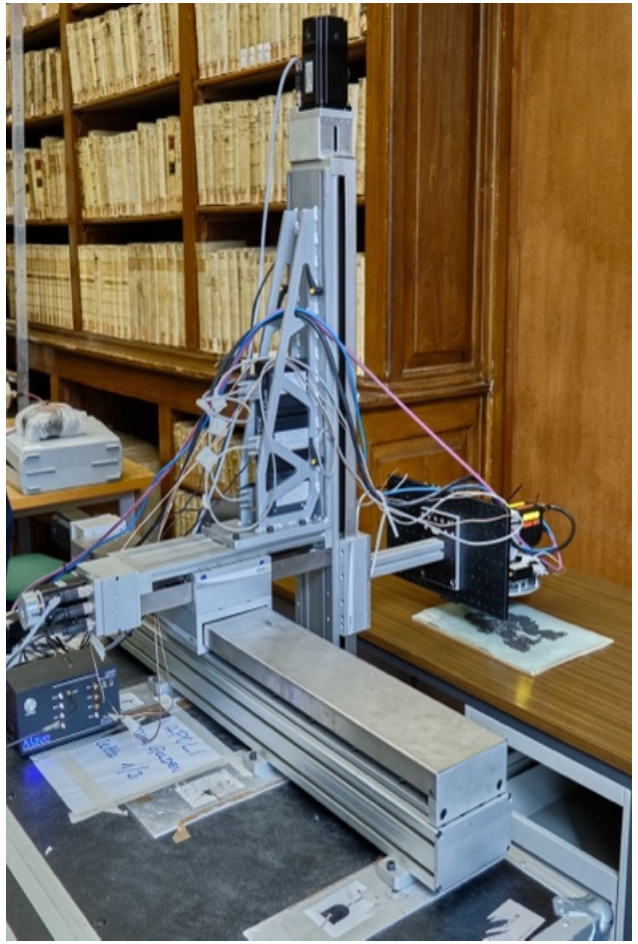


@National Library of Naples - Papyrus Workshop

- Spectroscopic head based on the simultaneous use of 6 detectors for **high chemical sensitivity**.
- **Reconstruction of the sample surface topology** through the odoscopic configuration of the 6 detectors.
- **Very large scanning area** - 120×90cm³.
- **High scanning speed** - 150 mm/sec (5ms dwell-time per 1mm pixel size).
- **Dynamic correction of the instrument-sample distance.**
- **Vertical/Horizontal configuration**.
- **Real-time** monitoring of all measurement parameters and on-the-fly analysis of all XRF spectra with **elemental image processing during scanning.**



Scanner MA-XRF Imaging



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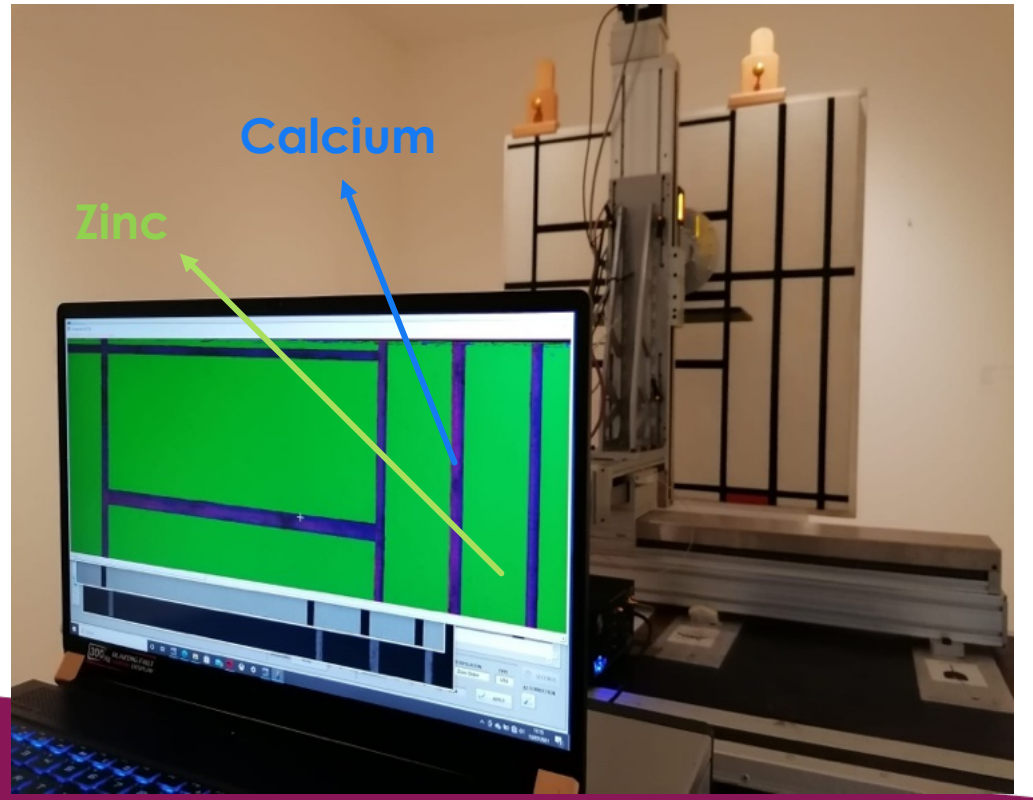
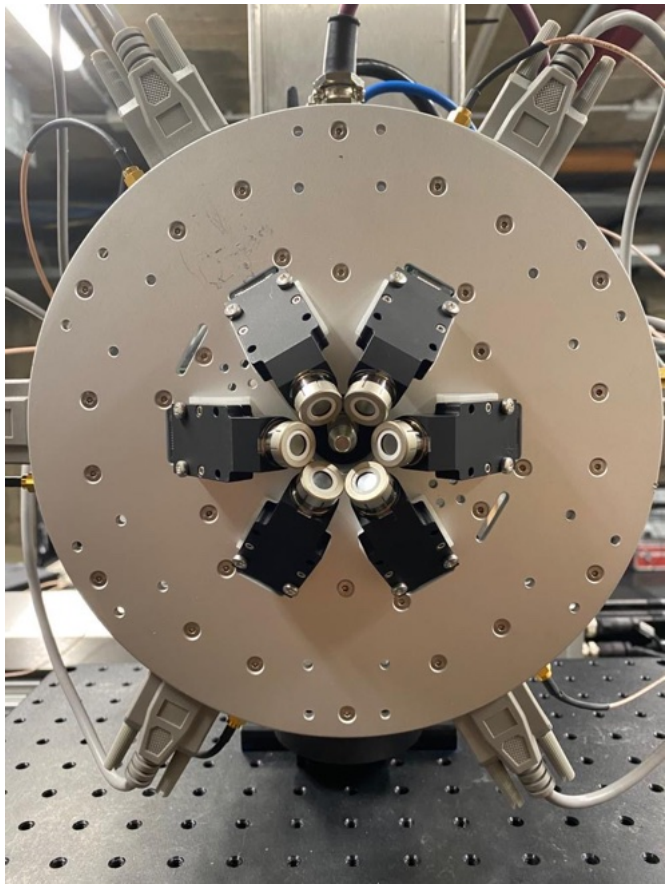




Scanner MA-XRD/ MA-XRF

@Musei Reali (Turin)

- **Scanning-free acquisition of XRD pattern** in the angular range of 16-42 degrees with high resolution in acquisition times of 3 sec/spot;
- **Simultaneous acquisition of XRF spectrum at the**

@ Cappella Brancacci (Florence)

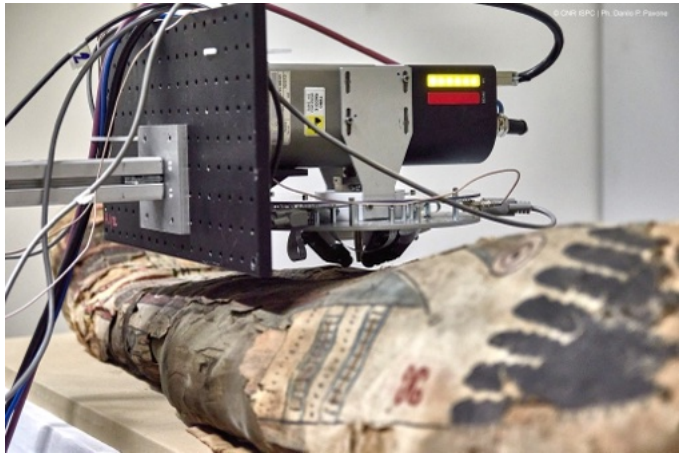
Pb
Piombo

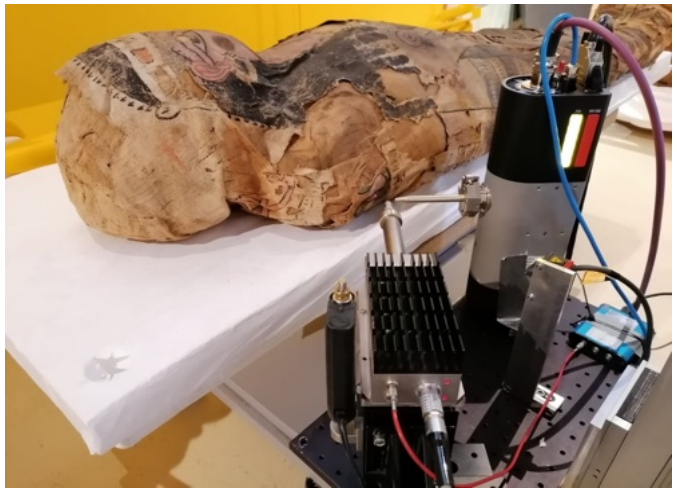
$Pb_3(CO_3)_2(OH)_2$
Idrocerussite

Hg
Mercurio

HgS
Cinabro

Scanner micro-XRF & CXRF Imaging

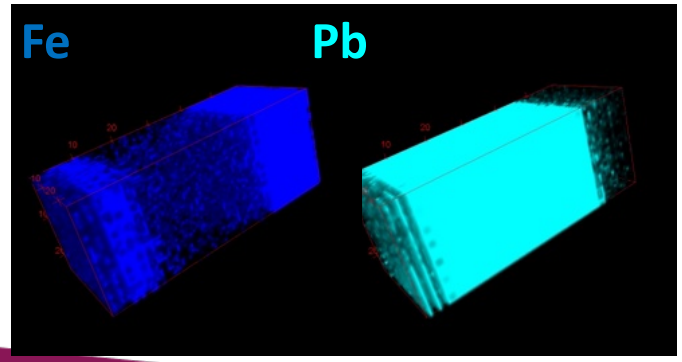




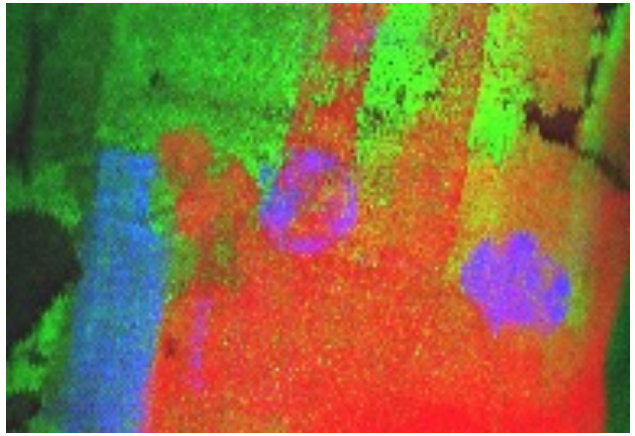
@Archeological Museum in Bologna

- **Multi-technique spectroscopic head** based on the simultaneous use of 4 detectors (micro-XRF) or a single detector coupled with X-ray optics (CXRF);
- **Large Analysis area**: 50x50cm²;
- Scanning speed > 50 mm/sec;
- **Lateral resolution up to 7 microns (micro-XRF);**
- **Stratigraphy resolution up to 10 microns (CXRF);**
- **Vertical/Horizontal configuration.**

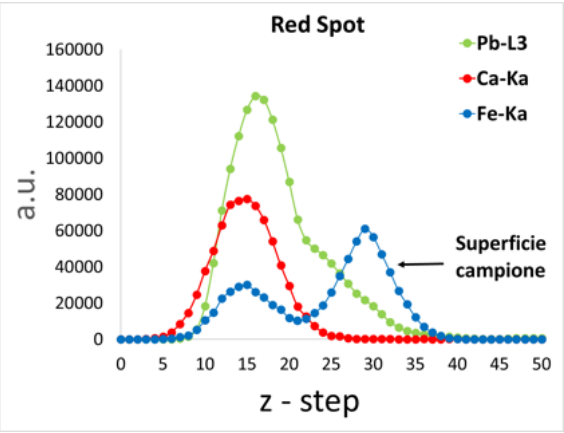
3D stratigraphy reconstruction.



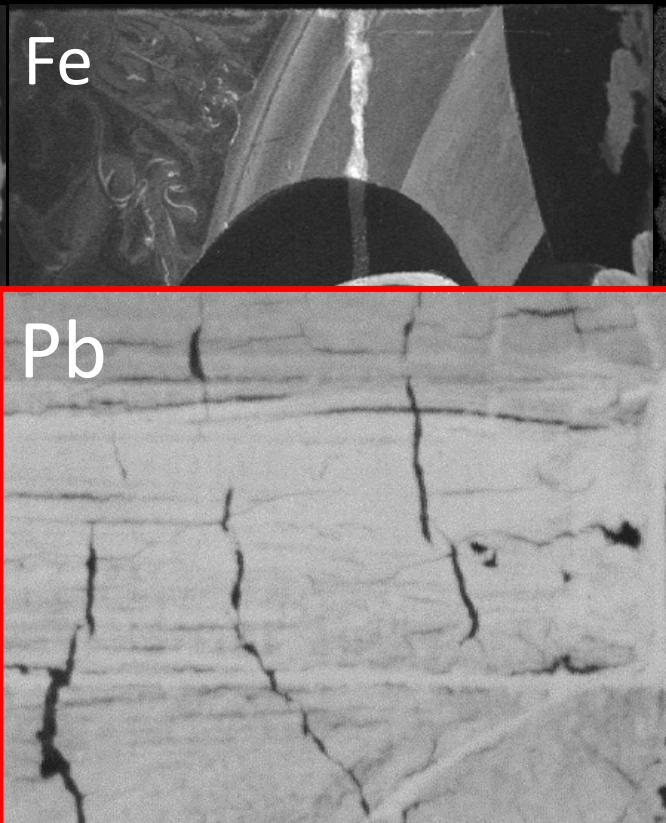
Micro-XRF Imaging CaPbFe

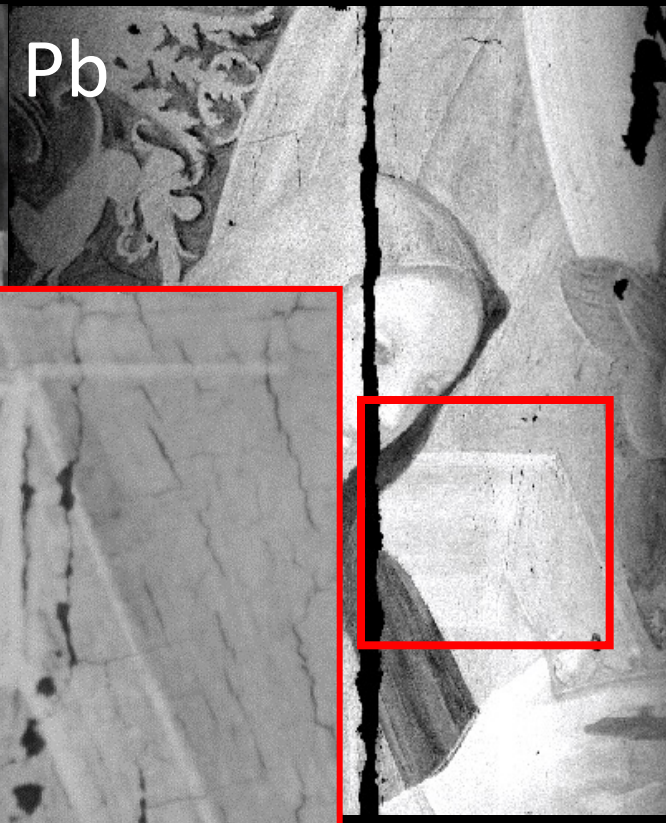


Puntual stratigrafic analysis (CXRF)



MA-XRF Imaging: benefit of **high resolution**



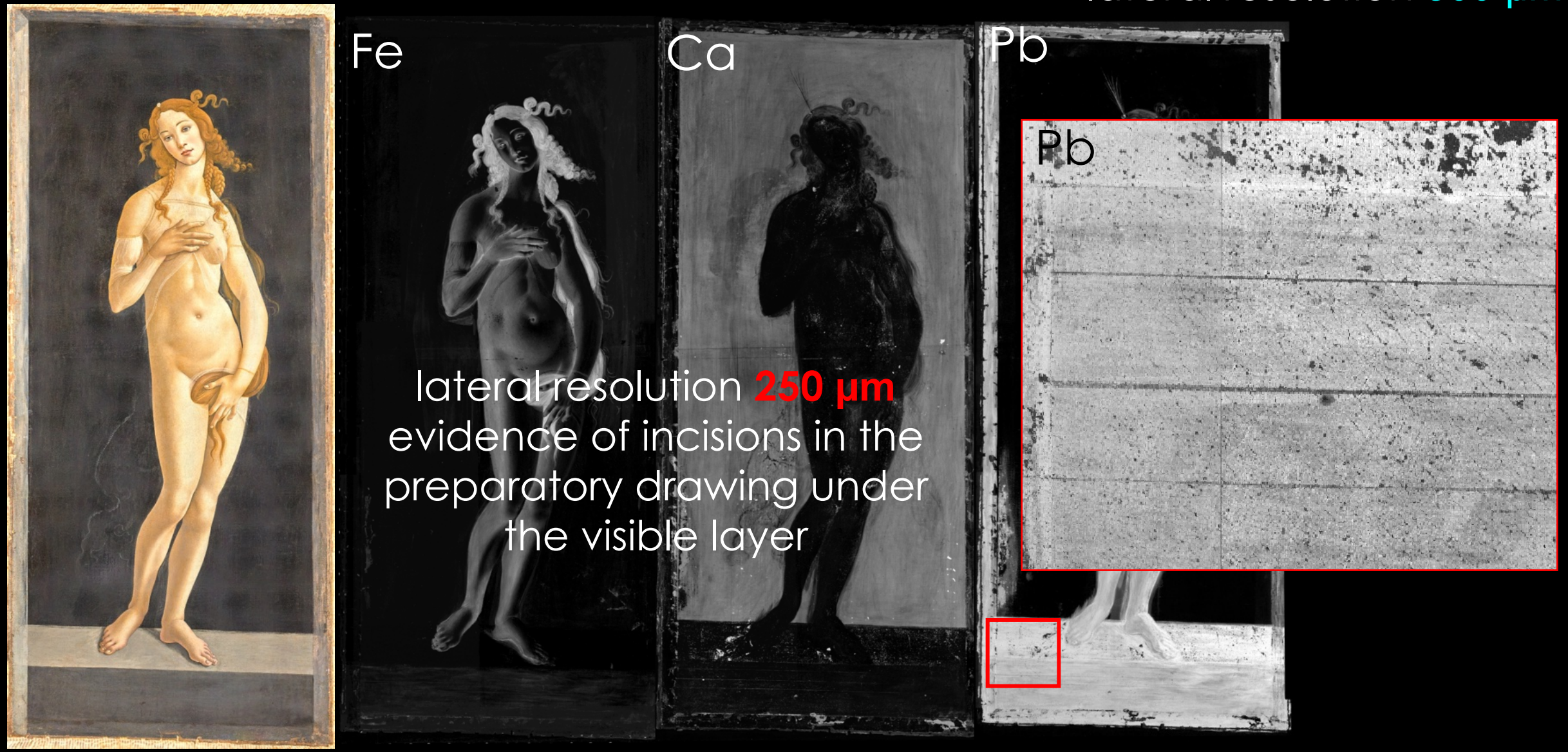


Vergine by Raffaello
@Museo di Capodimonte in Napoli

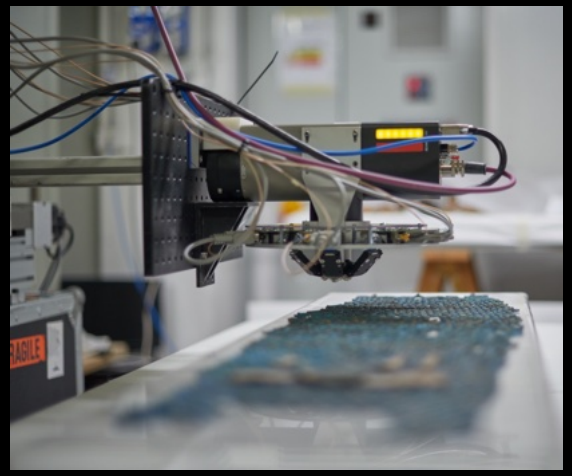
n 250 µm

MA-XRF Imaging: benefit of **high resolution**

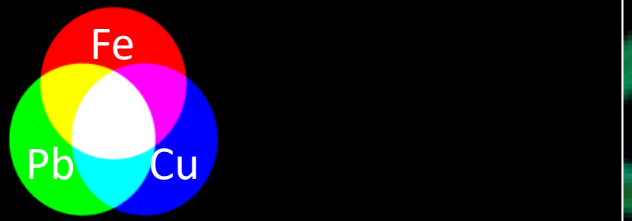
lateral resolution 500 µm



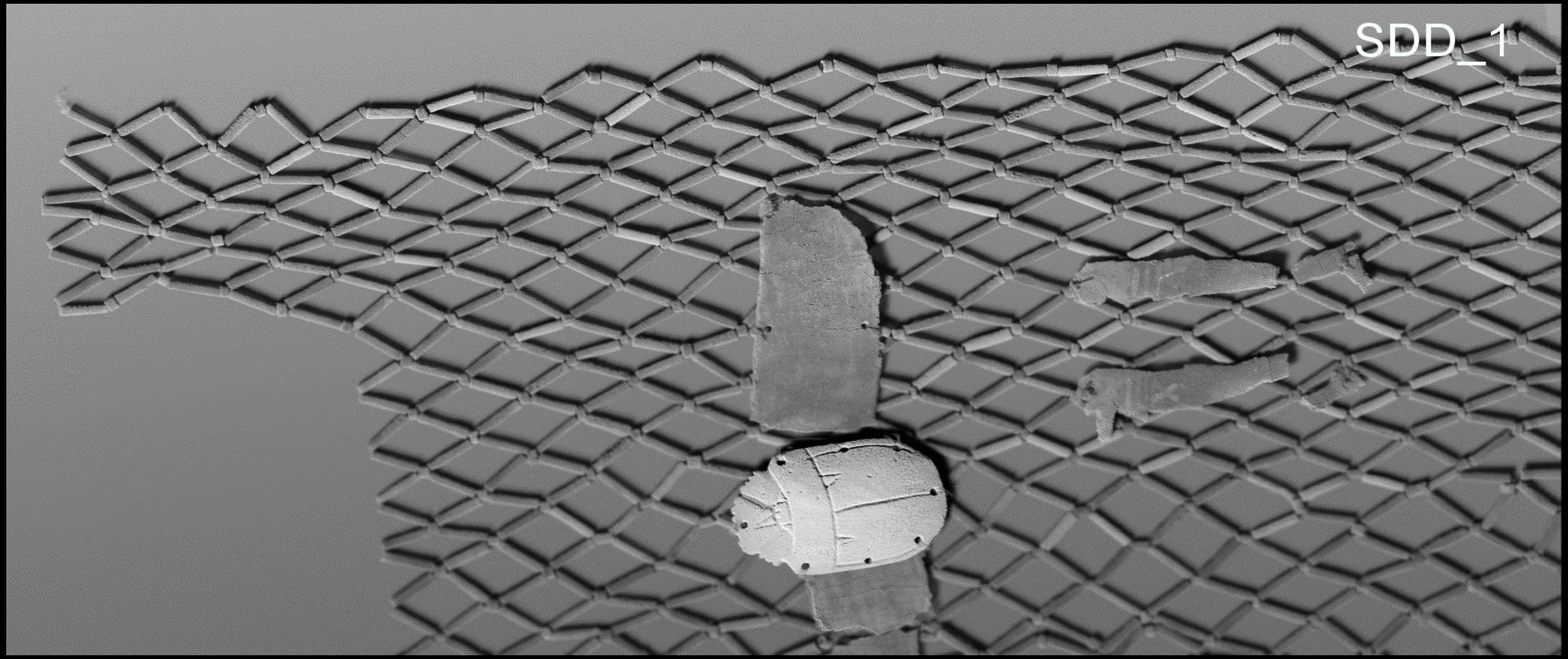
MA-XRF Imaging: benefit of **high resolution**



Lateral resolution 250µm
7ms dwell-time
5.5 Mega pixels



MA-XRF Imaging: Possibility to correct the elemental distribution images for the **surface topology** of the art object



MA-XRF Imaging: benefit of a **fast scanning**

Tomb of king Philip II of Macedon at Vergina, Greece

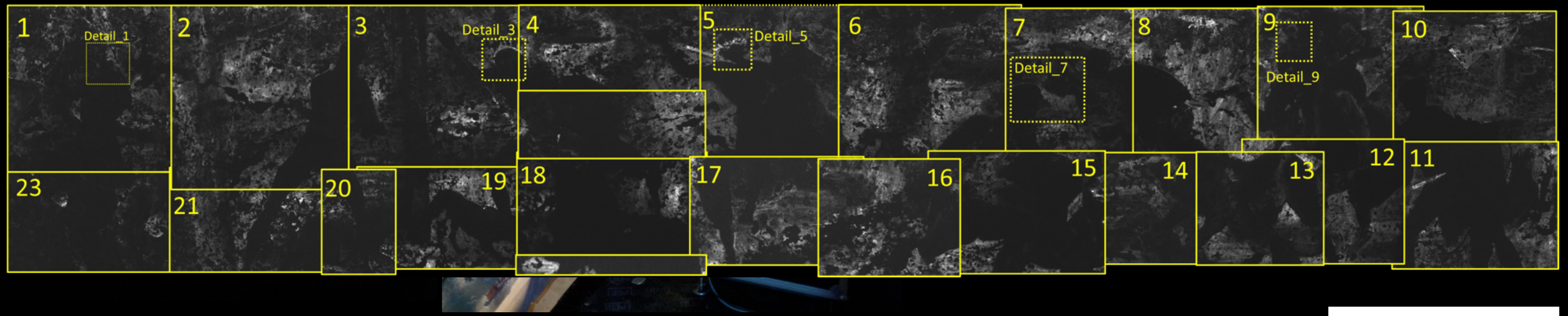
1.16m

5.56m

Hunt Frieze

Entire surface mapped in 6 working days

Copper distribution map



MOLAB proposal by H. Brecoulaki, A. G. Karydas, G.Verri, K. Tsampa

IPERION HS

X-ray investigation of carbonized Herculaneum papyri

Have been possible to detect for the first time in situ even very **small traces of metallic elements in degraded and brittle materials**, such as the **carbonized Herculaneum papyri!**

X-ray investigation of carbonized Herculaneum papyri

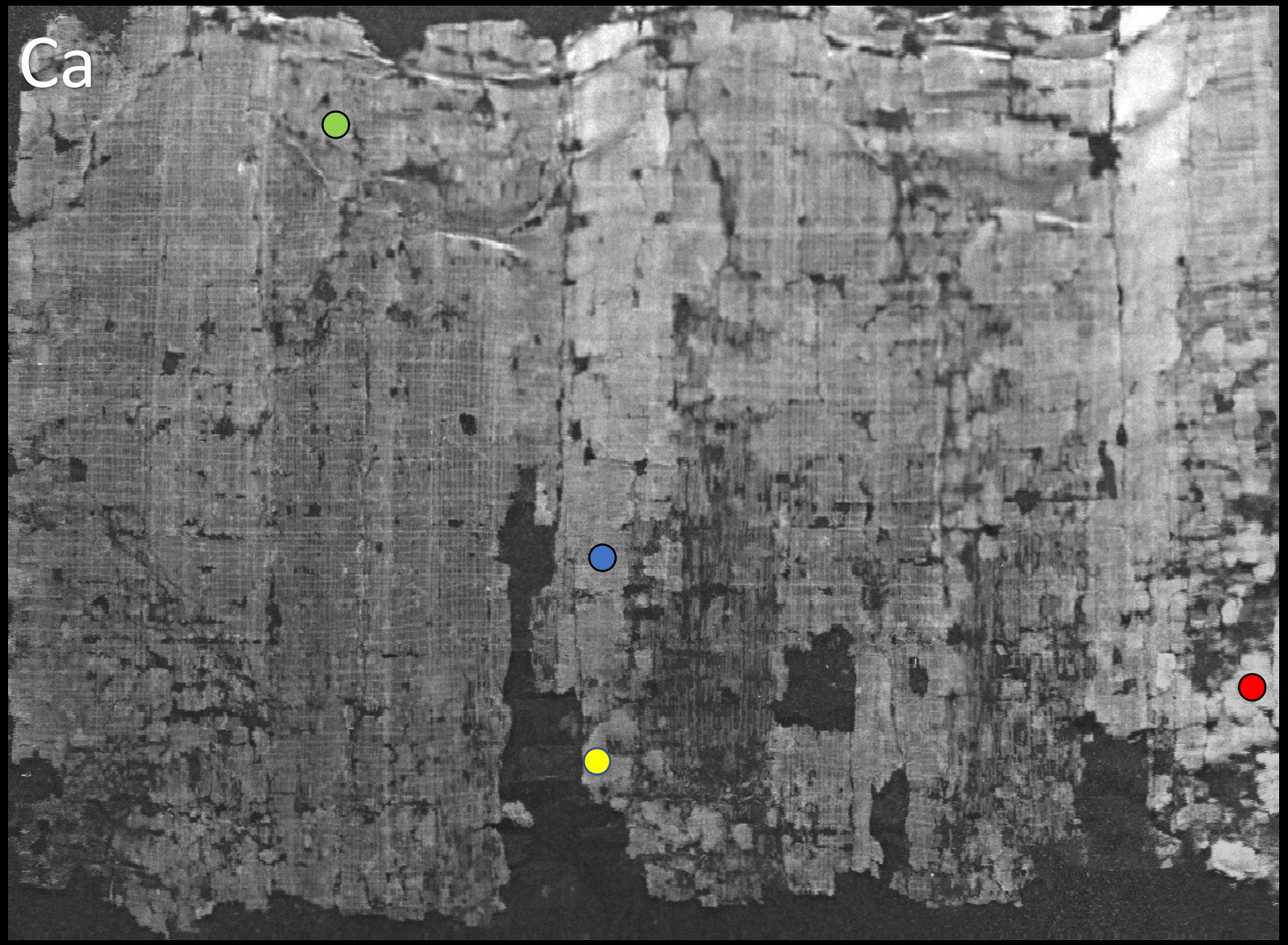
Main topic of the *Greek Schools ERC Project* is to investigate advanced scientific methodologies to improve the reading of the text

MA-XRF to investigate the presence of characterizing metallic elements on the carbonaceous inks

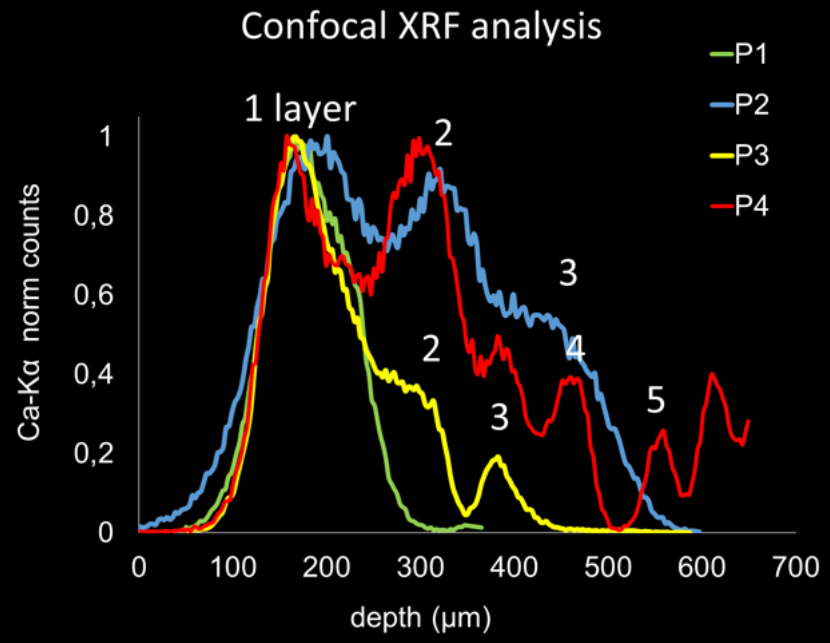
Confocal XRF for identifying and quantifying the presence of overlaid/underlaid layers occurred with the mechanical unrolling

MA-XRF investigation of carbonized Herculaneum papyri

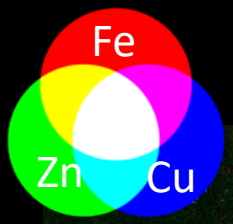
Ca map shows the Papyrus structure and conservation state

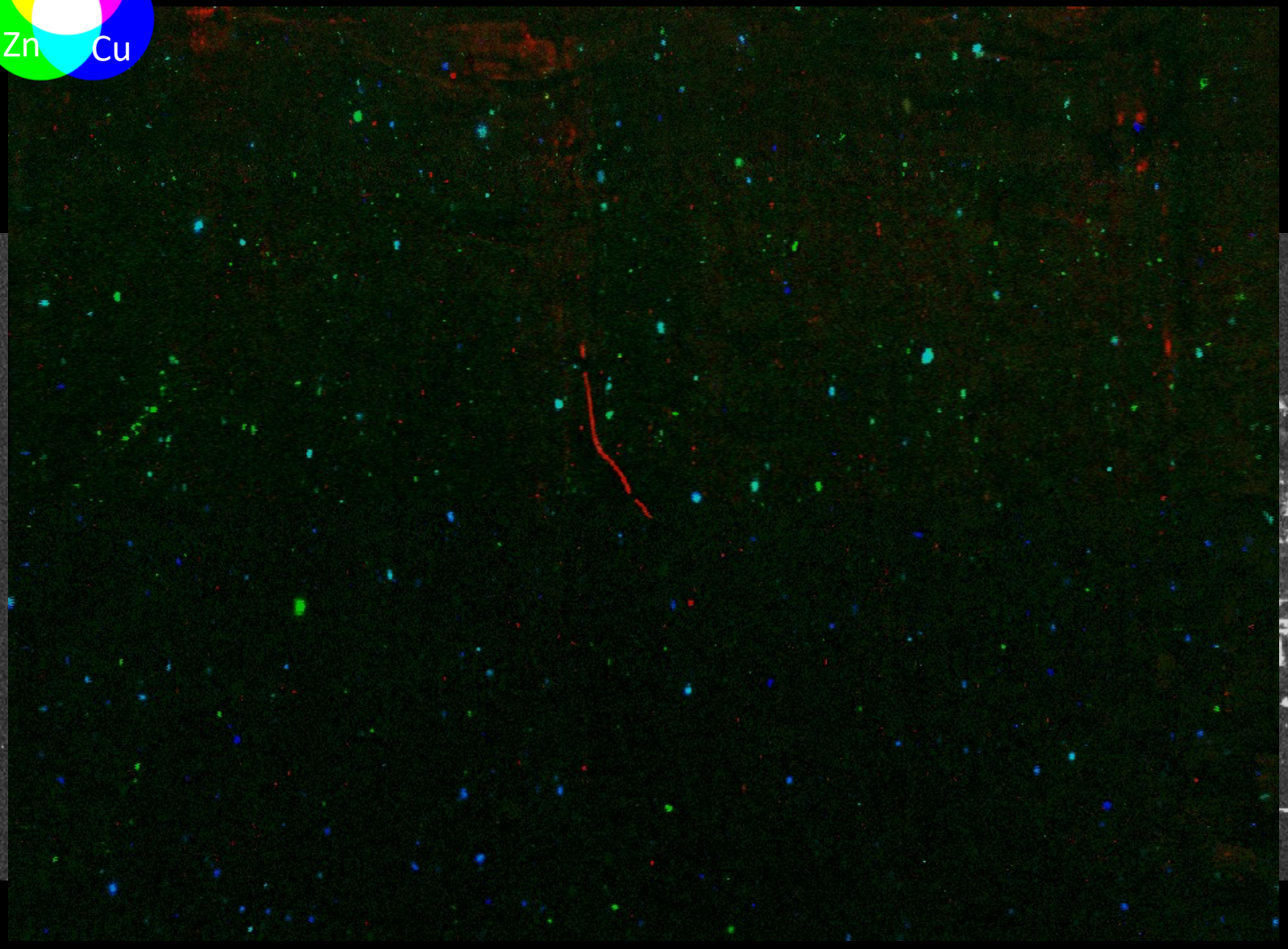


Ca-Kα fluorescence signal along the stratigraphy for the identification of overlaid/underlaid layers

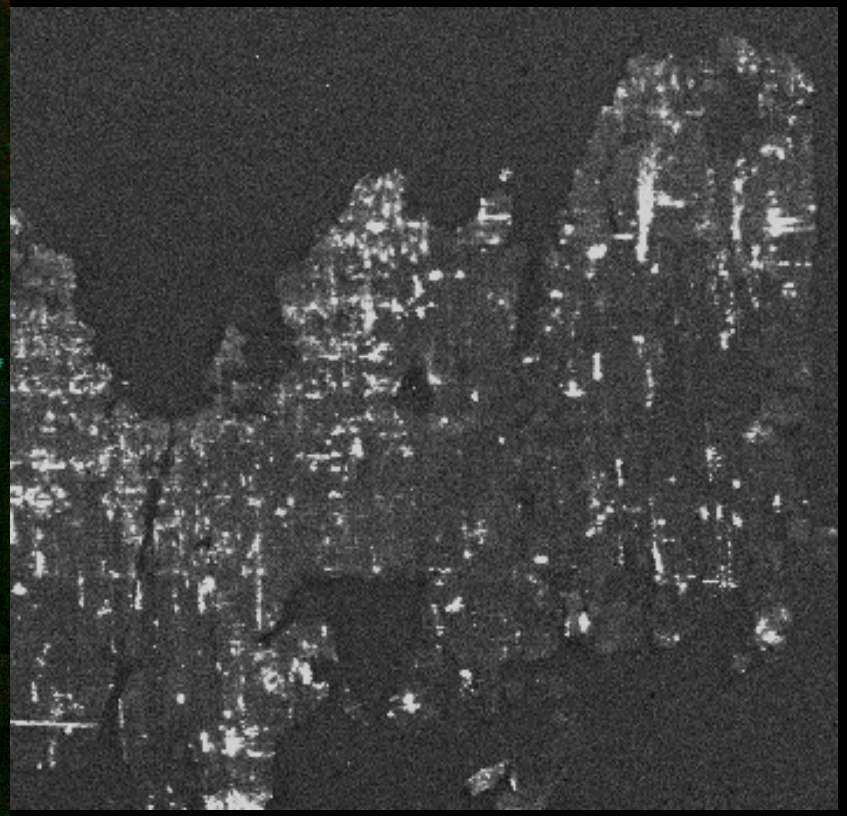


MA-XRF Imaging: benefit of **high sensitivity**





Metals traces (Fe, Zn, Cu) are heterogeneously distributed on the surface



MA-XRF Imaging: benefit of high sensitivity

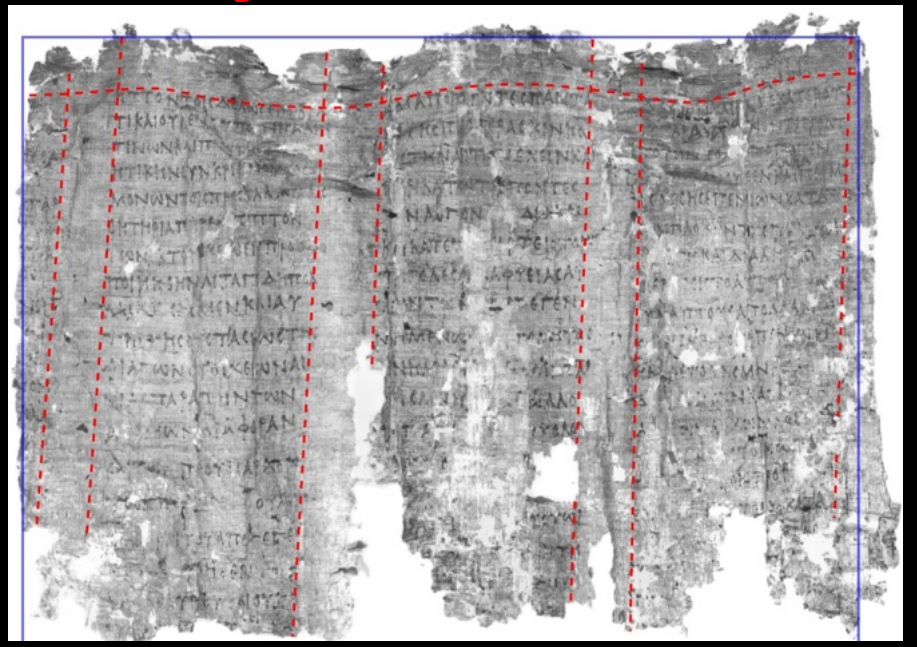
Pb-M

1st direct evidence of what is known from the hystorical literary sources:

From the greek epigrammatist Fania (2nd-1st century BC):
"a ruler and a piece of lead used as an indicator"

From Philip of Thessaloniki (30/40 AD):
"with a ruler, a lead disk, which marks the side of the columns"

From Roman poet Catullus:
"**all the parts are square *by means of lead***"

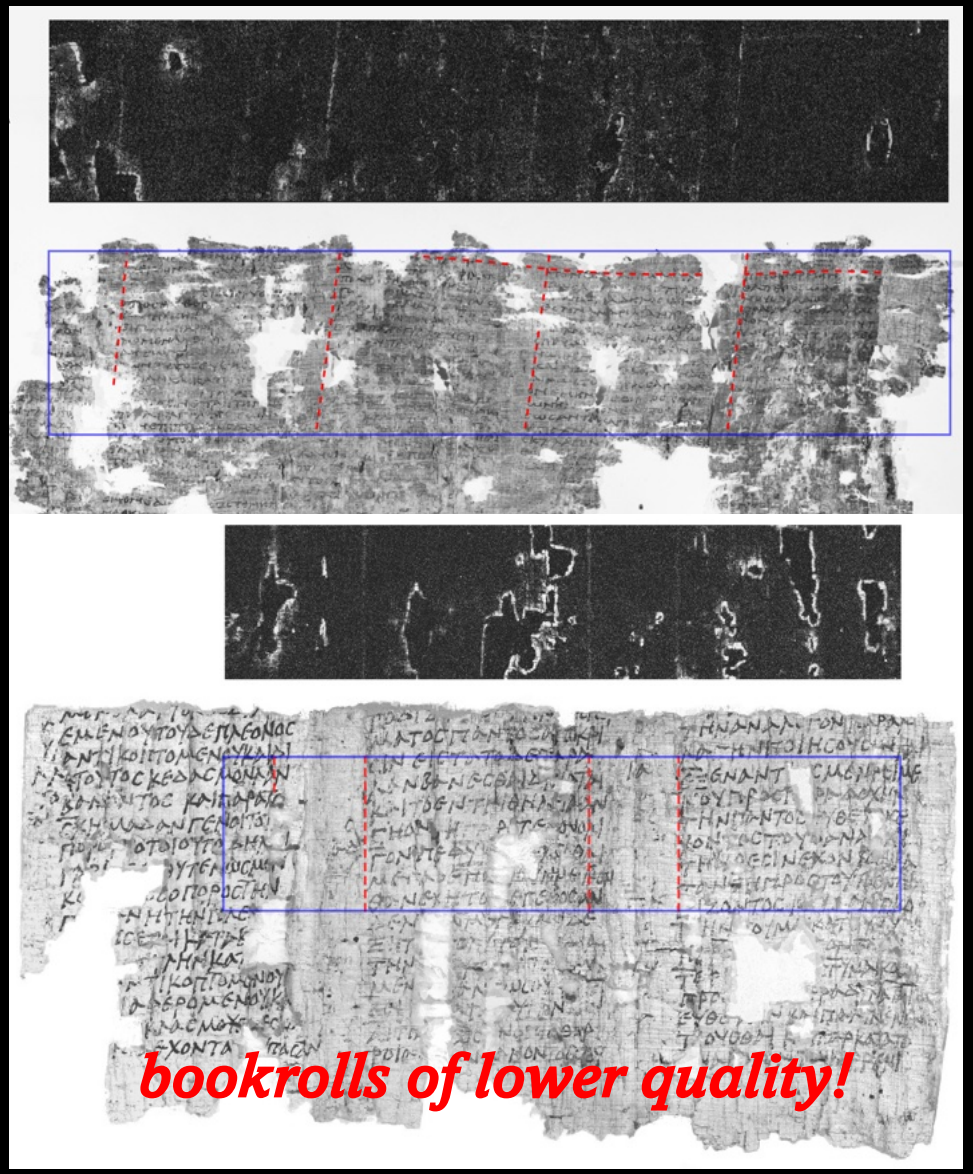


How the scribes preliminarily discriminating the written space from the space to be left blank?

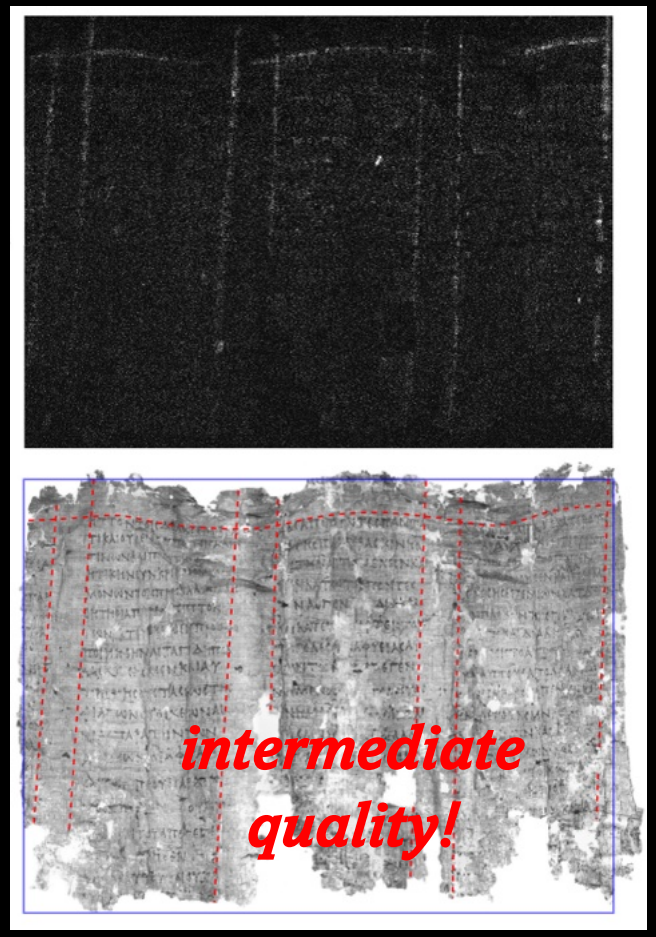
Pb maps revealed a textual layout

MA-XRF Imaging: benefit of high sensitivity

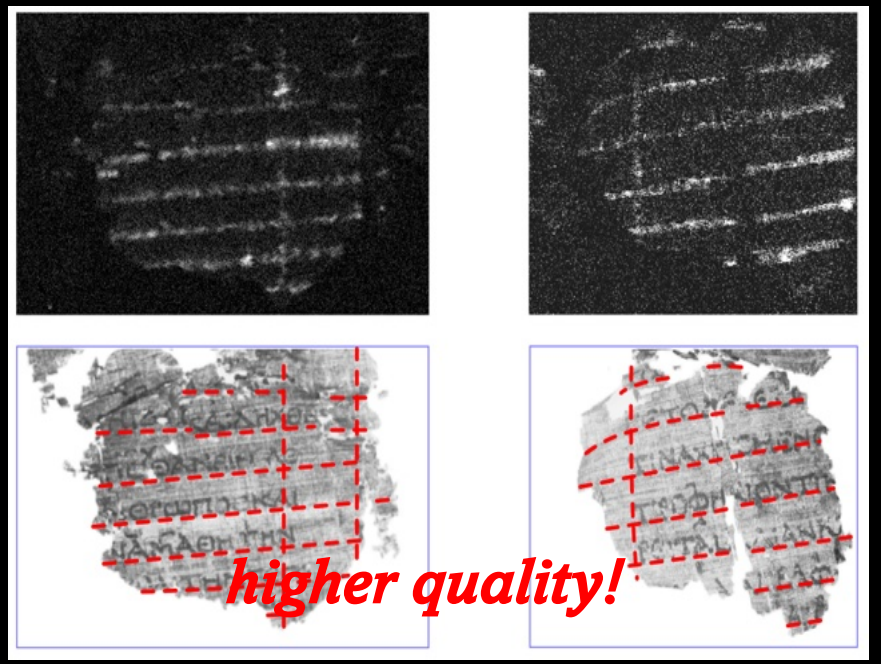
Delimitation of columns



Columns and Intercolums



Columns, intercolums and lines



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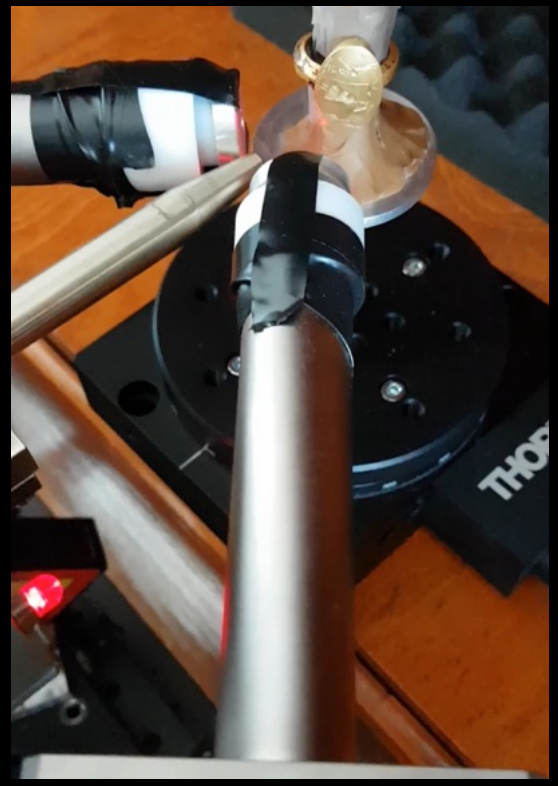
Article | Open Access | Published: 21 April 2023

Layout of ancient Greek papyri through lead-drawn ruling lines revealed by Macro X-Ray Fluorescence Imaging

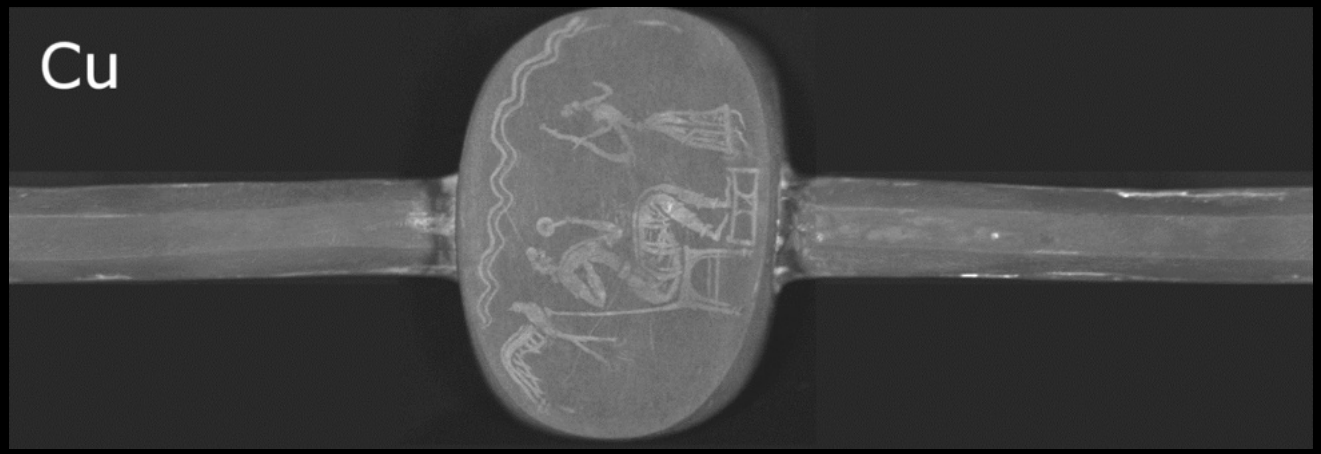
Francesco P. Romano, Enzo Puglia, Claudia Caliri, Danilo P. Pavone, Michele Alessandrelli, Andrea Busacca, Claudia G. Fatuzzo, Kilian J. Fleischer, Carlo Pernigotti, Zdenek Preisler, Christian Vassallo, Gertjan Verhasselt, Costanza Miliani & Graziano Ranocchia

Scientific Reports 13, Article number: 6582 (2023) | Cite this article

Rotational MAXRF scanning - **Full mapping for 3D complex object**



The Griffin Warrior gold signet rings



Full mapping for Information about the elements distribution at soldering areas

Elemental Images combined to the photogrammetry for the 3D Visualization of chemical maps

(MSCA) Global Fellowships programme 2020

XRAYlab (ISPC-CNR) is host laboratory of Project CRAFT:

Cartonnage Regionalism in the Ateliers of the Fayum Territory

CRAFT aims to investigate **Graeco-Roman cartonnage** from Egypt with a multidisciplinary approach, including advanced techniques such as 3D reconstructions and X-ray imaging. The objective is to study the materials and colors used, enabling the identification of artisan production centers and providing valuable information to identify specific local variations

3-year project (2022-2025) supported by the CNR ISPC.
1 year at the XRAYlab (**Catania)**
2 years at UC Berkeley

PI: Dott. Carlo Rindi Nuzzolo

Consiglio Nazionale delle Ricerche

Istituto di Scienze del Patrimonio Culturale

THANK YOU *very much!*

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