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2D-3D μXRF Elemental Mapping Reconstruction on Archeological Samples

dr. Dariush Hampai

Channeling 2016
Desenzano del Garda, 28th September 2016

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XLab Frascati Scientific Collaboration Network

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- Prof. S.B. Dabagov (Resp.)
- Dr. D. Hampai
- Dr. A. Liedl
- Dr. C. Polese
- Ing. F. Lucibello
- Dr. A. Marcelli
- Dr. G. Cappuccio
- E. Capitolo (tecn.)
- M. Iannarelli (tecn.)

Detectors

INFN - ENEA - CERN

X-ray Spectroscopy – X-ray Imaging

INFN – Diamond Light Source - ENEA – University of Rome "Sapienza" - CNR-IM – University of Bicocca – University of Florence – University of Minsk – Lebedev Physical Institute TPU-Tomsk – NRNU MEPhI – NASRA IAPP

Novel Source – Nanoray (Eur. Proj.)

Labor, University of Rome "Sapienza" - University of Rome "Tor Vergata"

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- Study on X-ray Optics
  - Polycapillary Optics
  - MCP
- X-ray Spectroscopy
  - X-ray Fluorescence
  - X-ray Absorption
- X-ray Diffraction
- X-ray Imaging
- Tomography
- Novel setup (Sources - Detectors)

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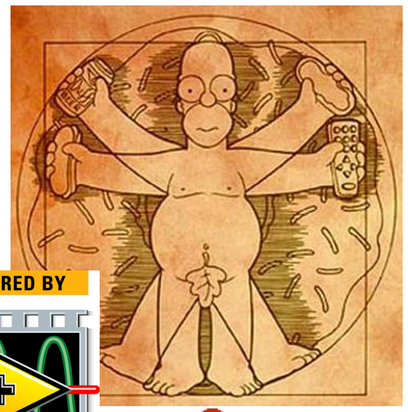
- μXRF (2D and 3D mapping)
- TXRF
- Detector Characterization
- in future: High Resolution Imaging and μCT



POWERED BY

NATIONAL INSTRUMENTS LabVIEW

XLOS - Vitruvio

- High Resolution Imaging
- μCT
- X-ray Optics Characterization
- Detector Characterization
- Study on Novel Sources

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RXR - rainbow X-ray

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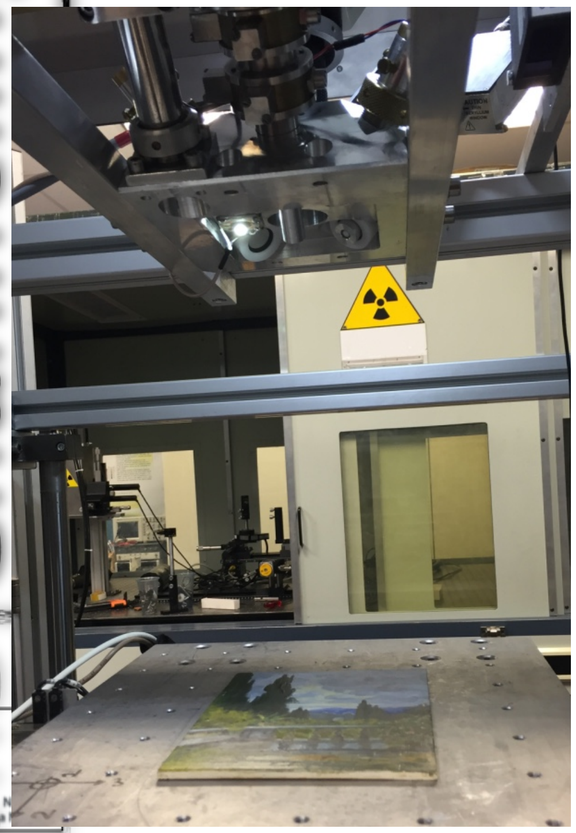
XENA - X-ray Elemental station for Non-destructive Analysis

XLab-Frascati… today

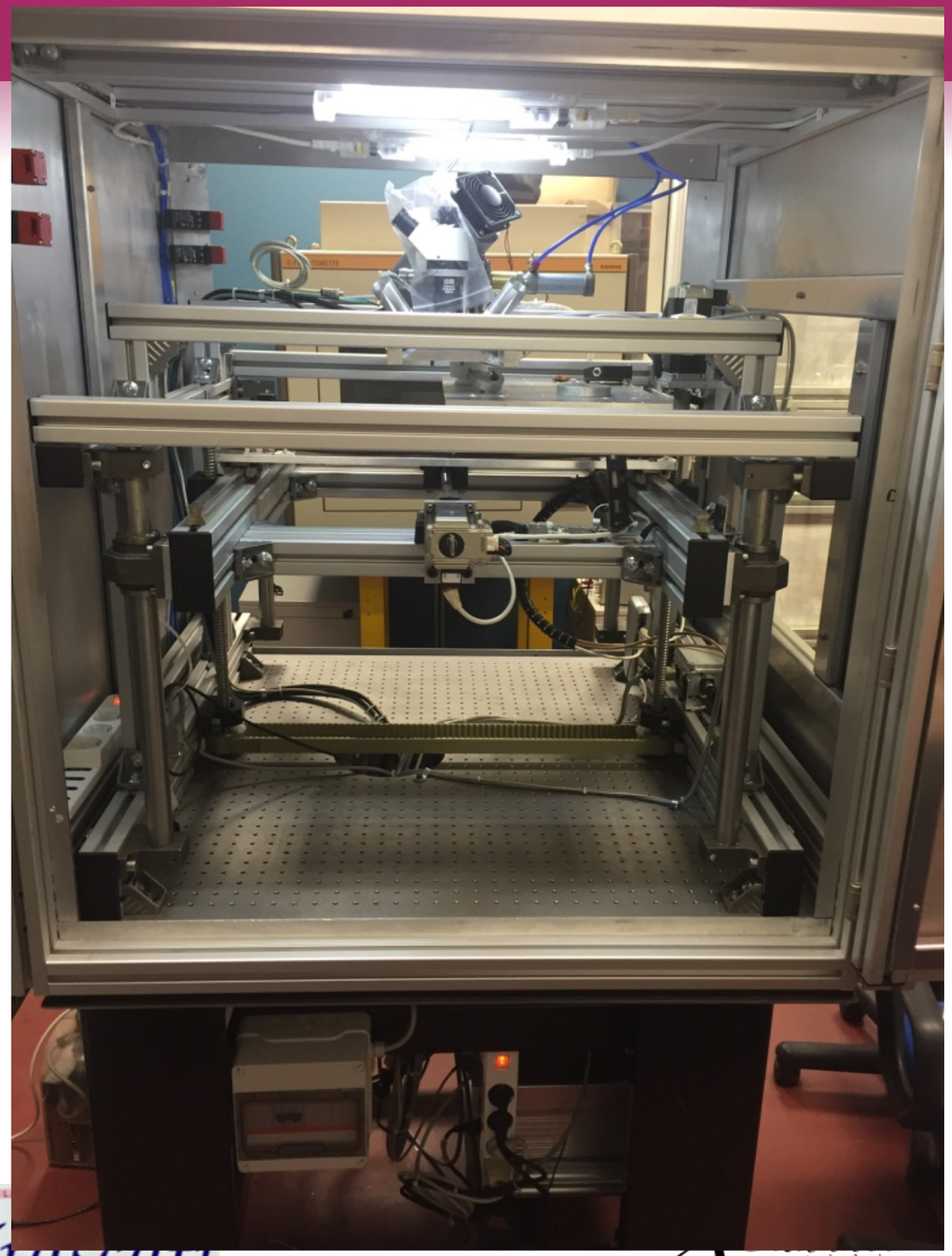
- Study on X-ray Optics
  - Polycapillary Optics
  - MCP
- X-ray Spectroscopy
  - X-ray Fluorescence
  - X-ray Absorption
- X-ray Diffraction
- X-ray Imaging
- Tomography
- Novel setup (Sources - Detectors)

RXR

- Cabinet: 1 m^3
- micro-spot X-ray Source MoKa
- full lens for primary beam
- 2 half lenses for detectors (in progress)
- 2 SDD detectors (in progress)



- focusing system (optical microscope and 2 lasers)
- laser prophilometer (resolution 10 μm)
- xyz heavy stage (~800N)
- xyz micro-stages (vacuum)



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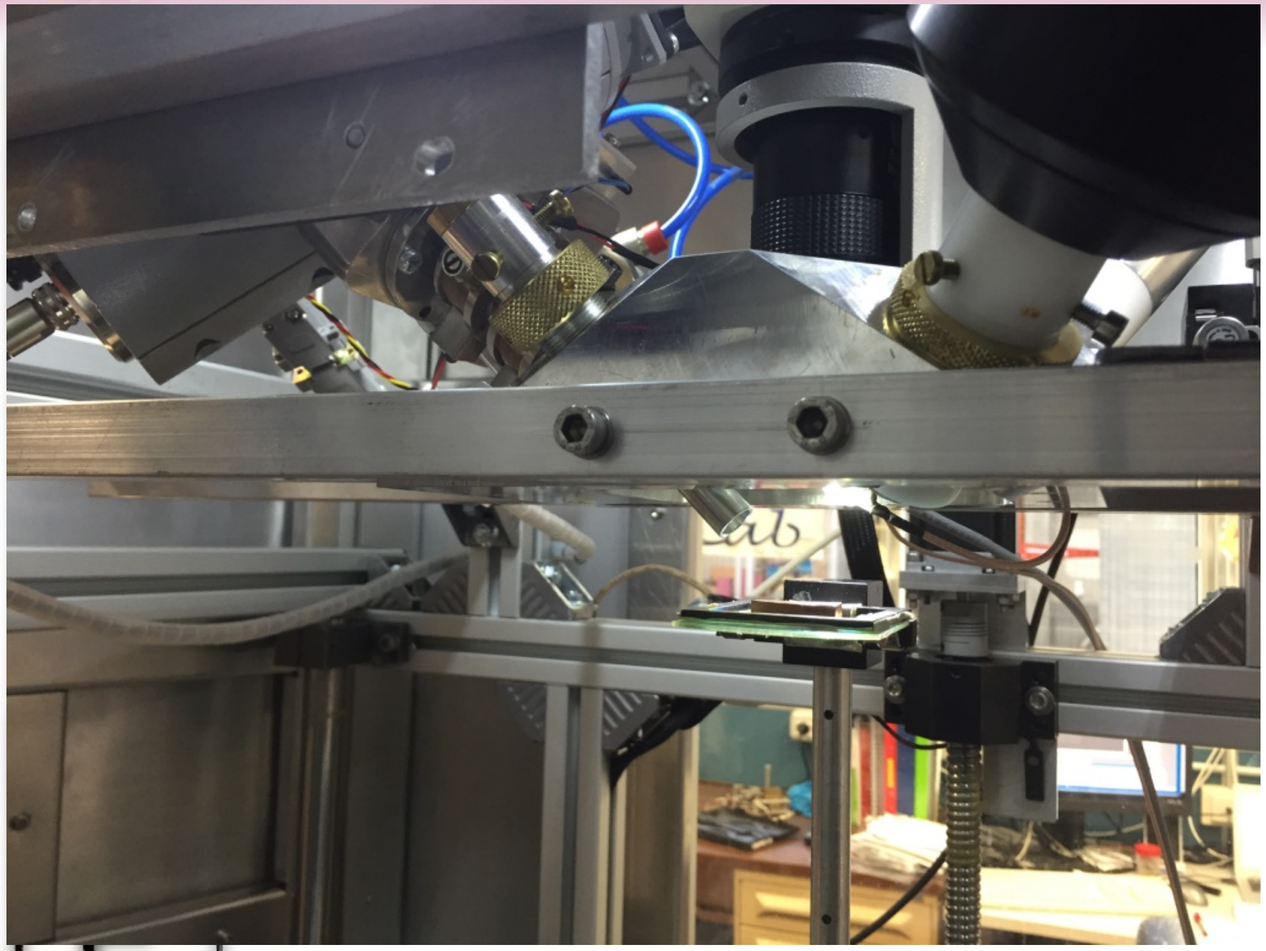
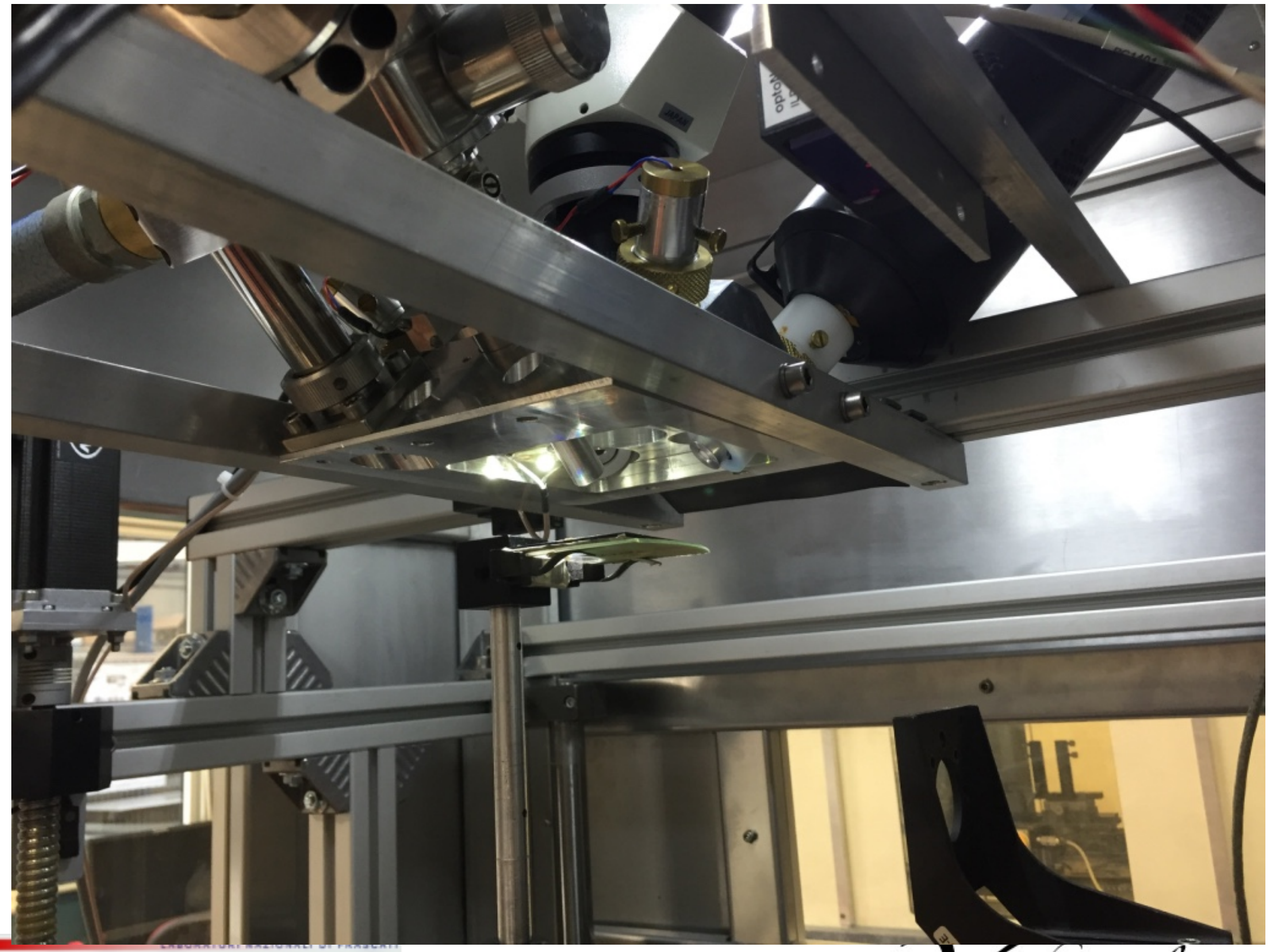
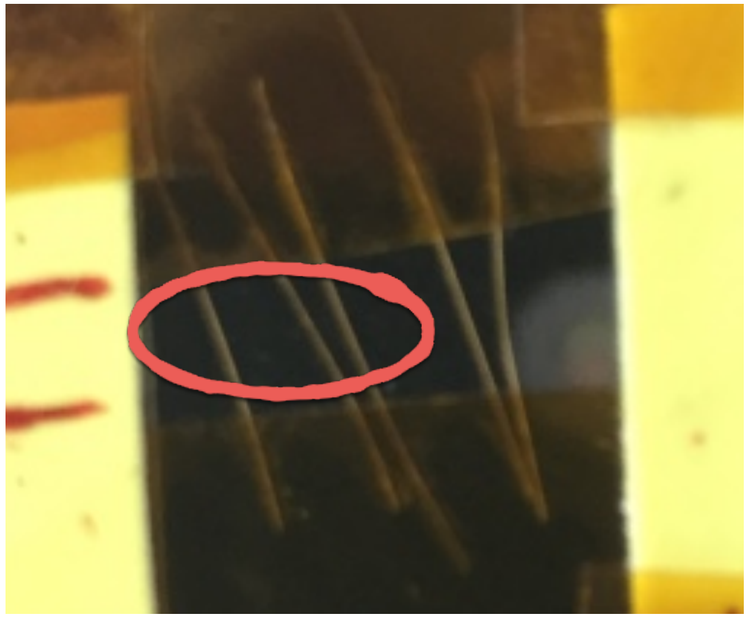
RXR: the core



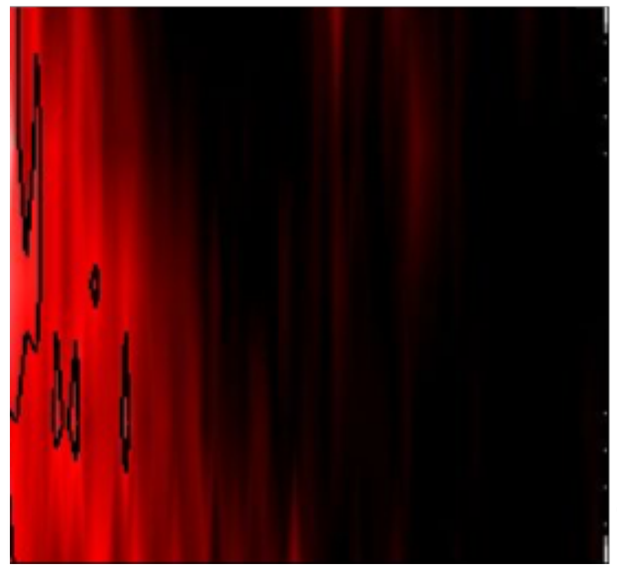


Resolution in Z



- scan XY ($\Delta x=\Delta y=50\mu m$)
- Acq. time = 10 sec / point
- Several Points with prophilometer Laser (10μm res.)
  - Values starting from 27.25 up to 27.30 mm

Au (L)



Si

Less than 80 μm

RXR Facility

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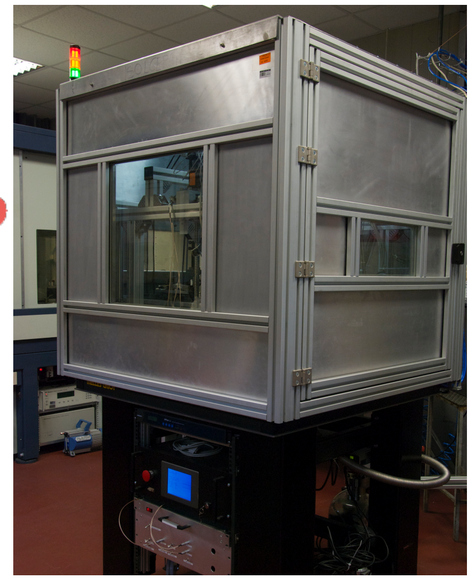
Cultural Heritage: the setup could also be moved for "in situ" measurement

Dust analysis with very low concentration:

- Air Pollution
- Antarctic dust



Geological Applications

Medical and Pharmacological Applications

Environmental Pollution

Forensic Applications

Study on New Materials

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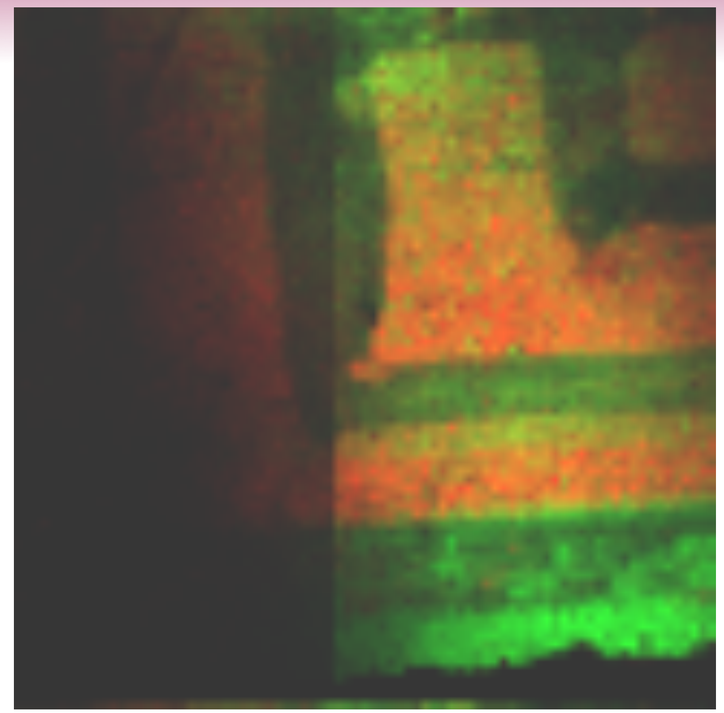
Roman Fresco

- scan XY ($\Delta x = \Delta y = 250 \mu m$)
- Acq. time = 5 sec / point
- Area: 20 x 20 mm^2



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Roman Fresco

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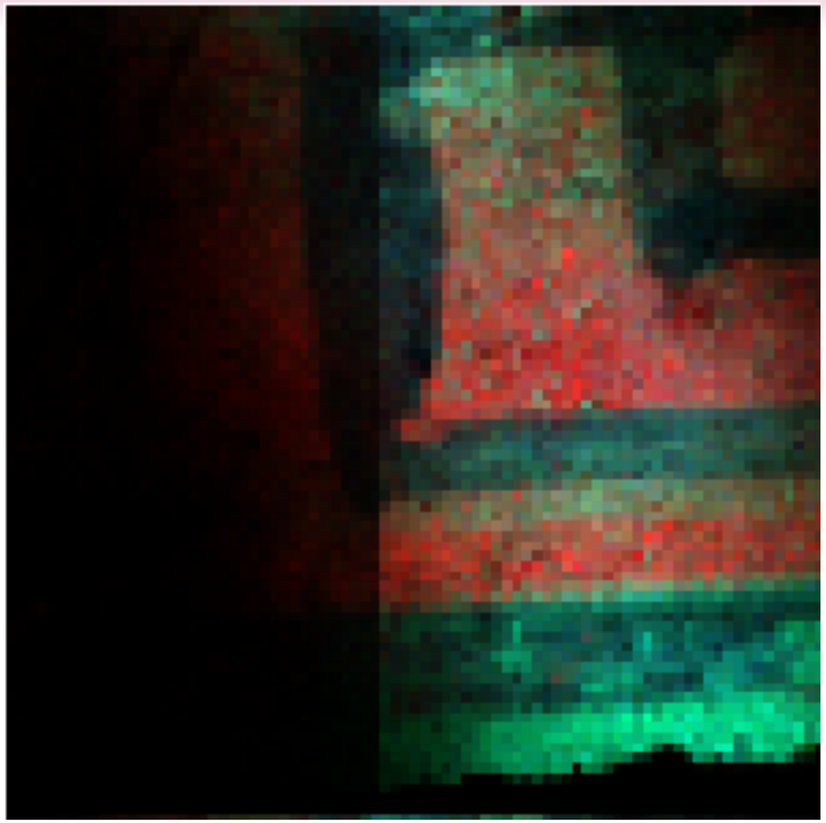

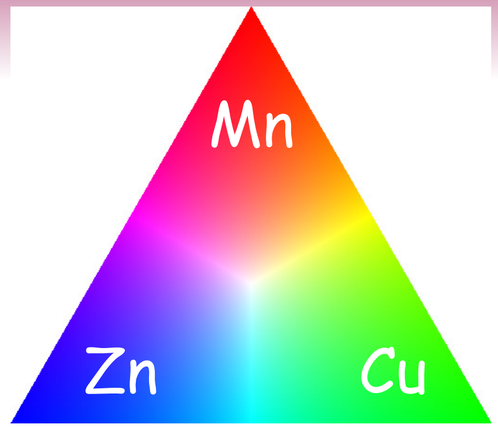

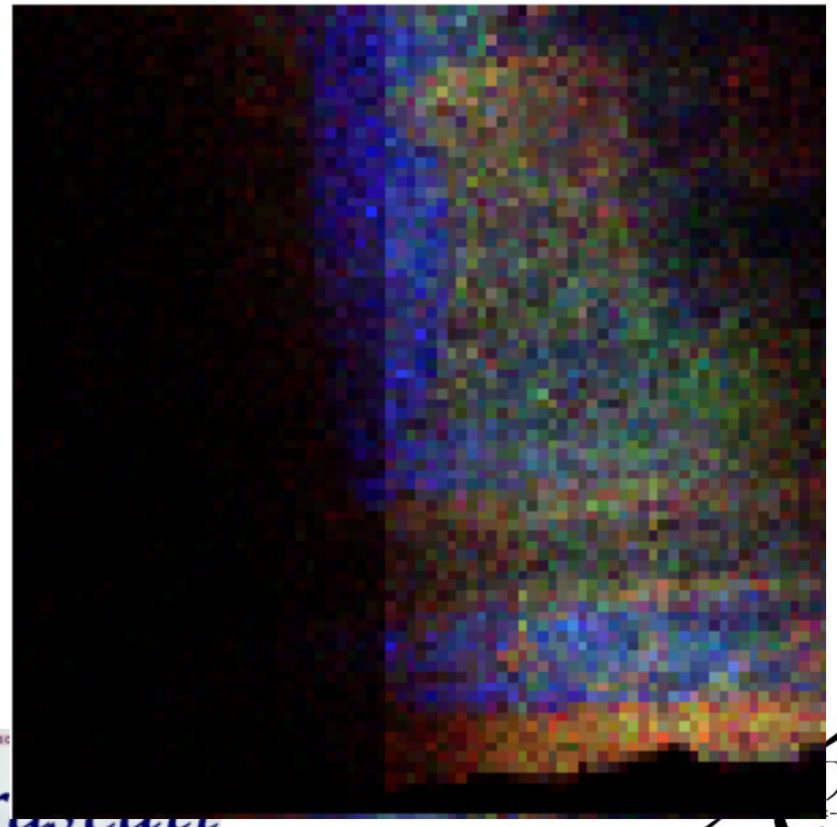

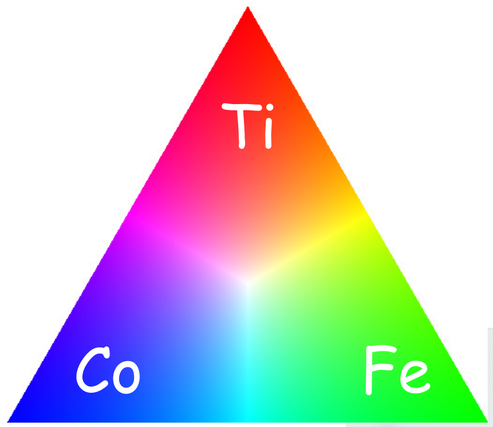

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"Romanelli Cave"

archaeological site (Paleolithic period - Late Pleistocene) located in Apulia.The researchers have found several Upper Palaeolithic artifacts made by stone-knapping.

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The "Gran Carro" Site

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wide settlement situated on the Lake Bolsena basin at a depth of four - five meters

dating from the beginning of the Early Iron Age (9th to the midway of 8th BC - Iron Age)

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Archeological task for researchers

- The elemental analysis of the artifacts: provenience of the raw materials.
- The analysis of the elemental inclusions specified of precise site permits a better identification of the origin: superficial (2D) and bulk (3D) micro-fluorescence mapping.
- useful informations for geologists
- social and economical relations of prehistorical communities

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Flint by "Romanelli Cave"

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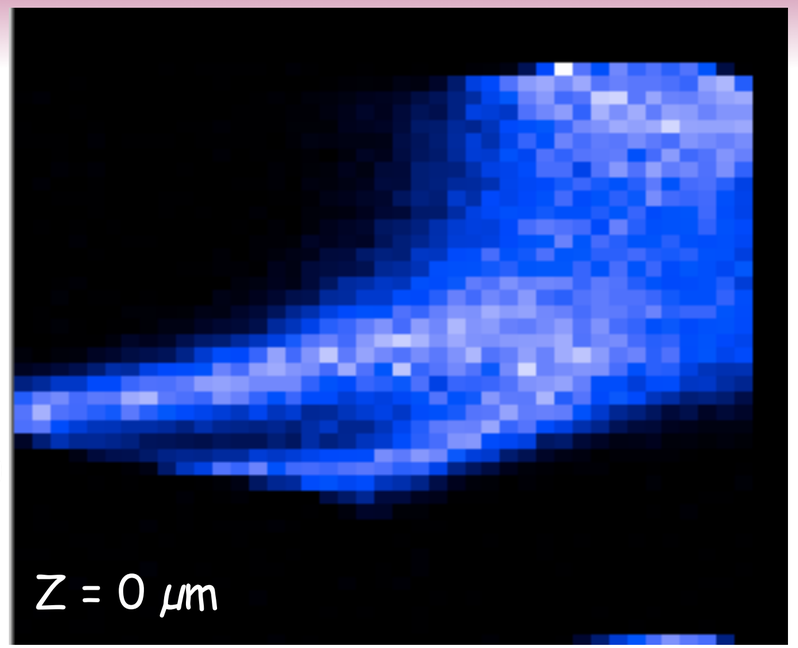
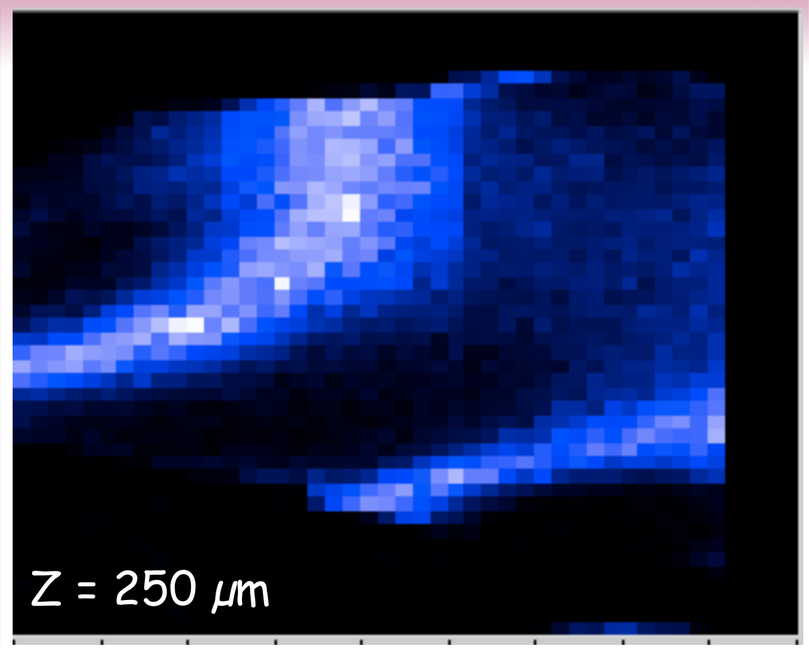
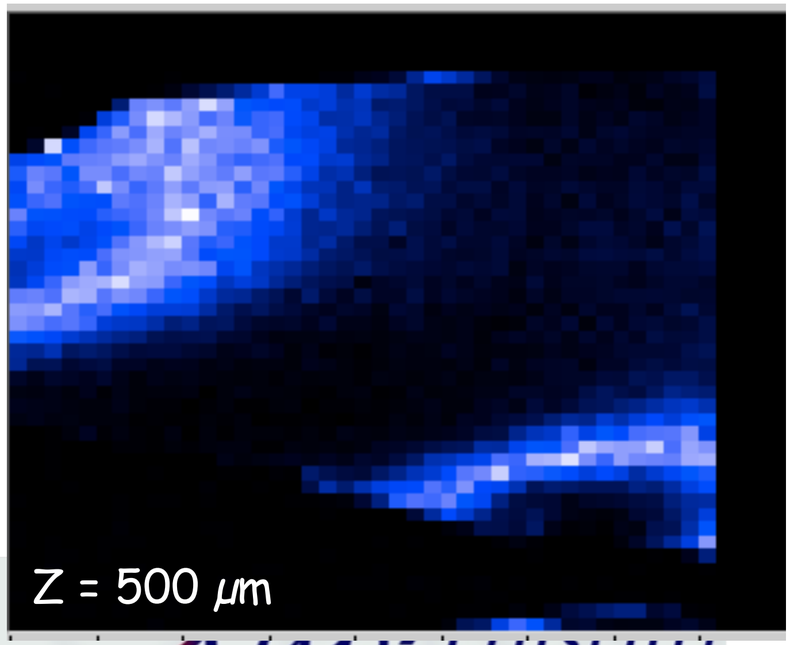
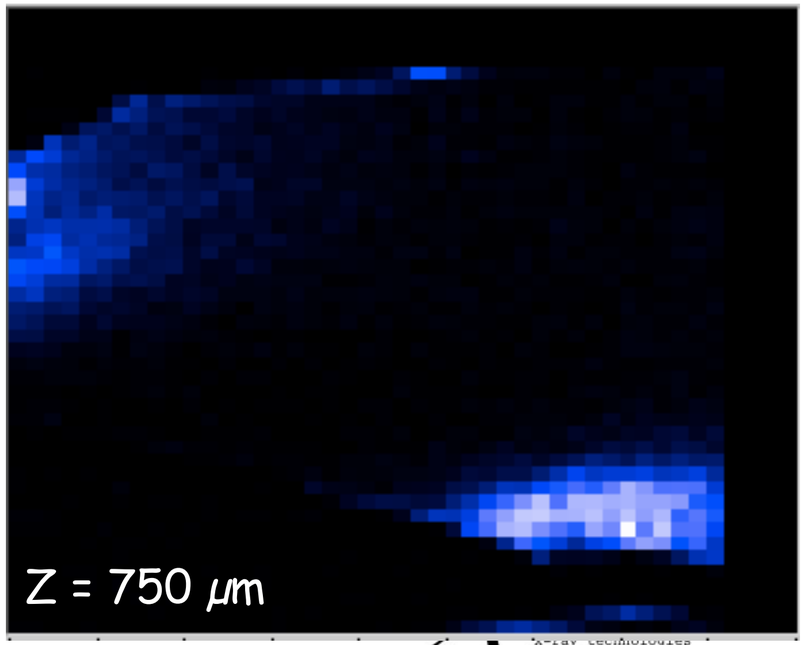
scan XYZ ($\Delta x=\Delta y=\Delta Z=250\mu m$)
Acq. time = 5 sec / point
Area: 20 x 20 x 1 mm^3



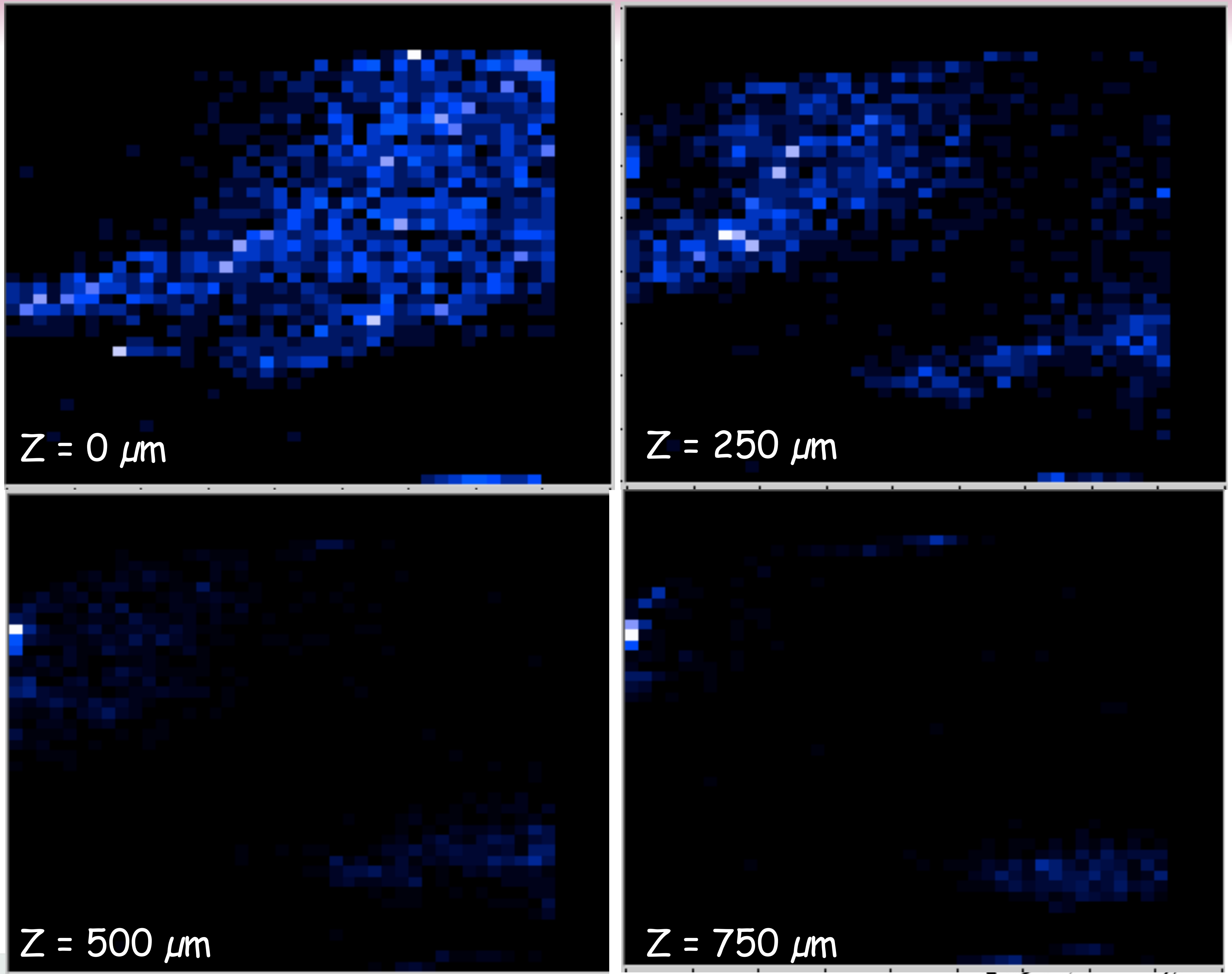






Flint by "Romanelli Cave"

- scan XYZ (Δx=Δy=ΔZ=250μm)
- Acq. time = 5 sec / point
- Area: 20 x 20 x 1 mm^3
- Selected Energy: Iron



Flint by "Romanelli Cave"

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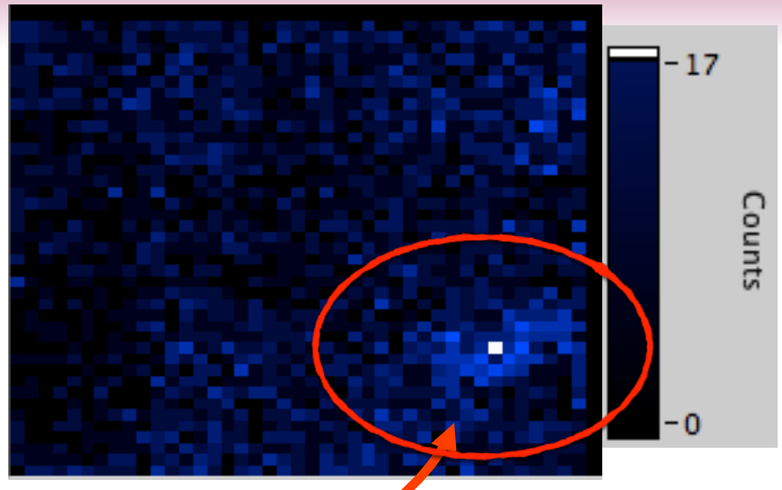
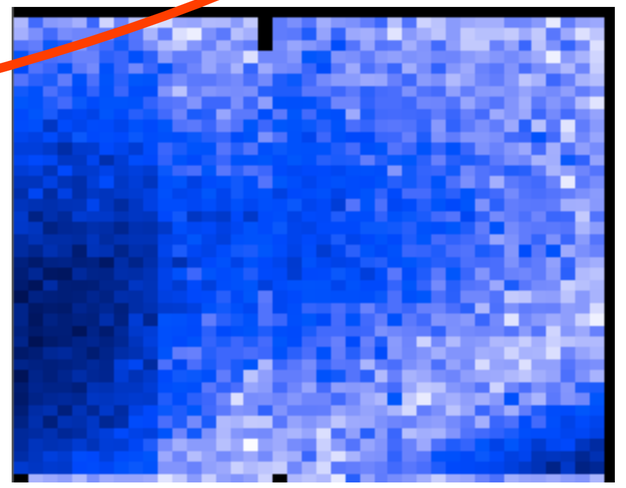
- scan XY ($\Delta x=\Delta y=50\mu m$)
- Acq. time = 5 sec / point
- Area: 2 x 2 mm^2
- Selected Energy: Total, Iron





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Conclusions

- 2D/3D μXRF scanning with RXR experimental setup
- First results for "Romanelli Cave" and "Gran Carro" site.
- For Future… Improve the RXR capability:
  - Confocal setup for low energy (less than 3 keV) (we have made now the optimized lens)
  - CCD detector for full-field XRF mapping
  - quick acquisition mode through a reference trigger

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Thank You for Your Attention

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