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

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Channeling 2016
Desenzano del Garda, 28th September 2016
XLab Frascati Scientific Collaboration Network

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Detectors
INFN - ENEA - CERN

X-ray Spectroscopy - X-ray Imaging
INFN - Diamond Light Source - ENEA - University of Rome "Sapienza" - CERN - University of Bari - 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"
• 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)
XLab-Frascati

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

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

LabVIEW

XLOS - Vitruvio

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

Channeling 2016
• 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)
- Cabinet: 1 m³
- 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 proflilometer (resolution 10 µm)
- xyz heavy stage (~800N)
- xyz micro-stages (vacuum)
RXR: the core
Resolution in Z

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

Less than 80 $\mu m$
Cultural Heritage: the setup could also be moved for “in situ” measurement

Geological Applications

Environmental Pollution

Study on New Materials

Dust analysis with very low concentration:
  • Air Pollution
  • Antarctic dust

Medical and Pharmacological Applications

Forensic Applications
Roman Fresco

- scan XY (Δx=Δy=250µm)
- Acq. time = 5 sec / point
- Area: 20 x 20 mm²
Roman Fresco
"Romanelli Cave"

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

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)
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
Flint by “Romanelli Cave”

scan XYZ ($\Delta x = \Delta y = \Delta Z = 250 \mu m$)
Acq. time = 5 sec / point
Area: $20 \times 20 \times 1 \text{ mm}^3$
Flint by “Romanelli Cave”

scan XYZ (Δx=Δy=ΔZ=250µm)
Acq. time = 5 sec / point
Area: 20 x 20 x 1 mm³
Selected Energy: Iron
Flint by “Romanelli Cave”

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

• 2D/3D $\mu$XRF 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
Thank You for Your Attention