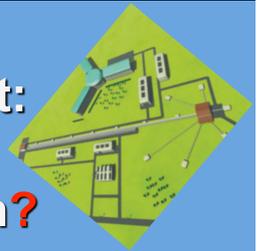


WG12 – APPLICATION: CULTURAL HERITAGE



Symposium The ESS Project: Opportunities for Italian Research?



NEUTRONS TO ILLUMINATE THE PAST

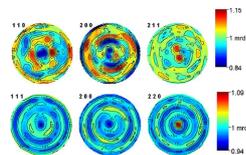
The discovery of an ancient artefact often raises a variety of questions such as the correct determination of its historical and cultural time frame, the place and method of production, the choice of treatments and conditions for restoration and preservation.

Neutrons techniques are a strategic tool to address these questions and, in general, for macro- and micro-structural analysis.

NEUTRON TECHNIQUES FOR CULTURAL HERITAGE

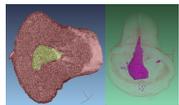
TOF-Neutron Diffraction (ND)

NT is a tool for quantitative phase, strain, crystallites size and texture analysis of archaeological samples, as shown in this image.



Neutron Tomography (NT)

NT gives important insight on the 3D structure of delicate and unique objects such as the archaeological artefacts, and objects hidden by thick concretions like in the case of items recovered from sunk ships. The following image refers to nail covered with thick layer of carbonates.



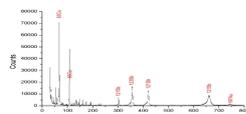
Another interesting use might be in the Epigraphy of lead ingots recovered from sunk ships of Roman Age. Lead Ingots show rectangular areas carrying stamped marks which are a combination of characters and images.

The knowledge of this combination would allow the knowledge of the producer and of the age of the find. The following figures show the surface of one ingot and the reconstructed NT images showing a leaping dolphin and the name RUSSIN.



Neutron Resonance Capture Analysis (NRCA)

NRCA uses neutron resonance to determine elemental and isotopic composition of the artefact.

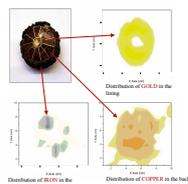


Neutron Diffraction Imaging (NDI)

NDI gives the spatial distribution of crystallographic phases in the interior of an object by the reconstruction from a pencil beam scan of neutron TOF diffraction.

Neutron Resonance Transmission (NRT)

NRT is an epithermal technique developed within the Ancient Charm European project (FP6). Neutron absorption resonances can be used for nuclide identification and quantitative elemental (& isotopic) composition analysis.



All the previous techniques are non-invasive and non-destructive: they can be used without preparation or sampling of material from the investigated object.

INSTRUMENT DEVELOPMENT PROJECTS

A Multitask instrument able to perform integrated Imaging, elemental, texture and phase analysis

A single instrument which could perform integrated measurements at a single facility would be a great achievement for Cultural Heritage research:

- a) by reducing activation of the sample because of the reduced total exposure time,
- a) by reducing transportation problems as a substantial number of measurements could be performed on one site.

Two main configurations for the set-up:

- 1) for **bulk and imaging techniques** which require a large beam configuration: TOF- Neutron Diffraction (TOF-ND), Neutron Tomography (NT), Neutron Resonance Capture Analysis (NRCA), Neutron Resonance Transmission (NRT).
- 2) for **imaging techniques** which require a pencil beam configuration: Neutron Diffraction Imaging (NDI).

To implement such configurations a **thermal epithermal neutron beam** with the possibility to activate **Time of Flight chopping** would be required.

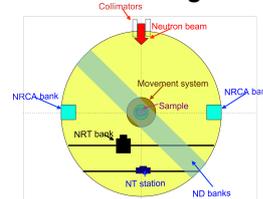


Figure 1. suggested layout of the multitask instrument

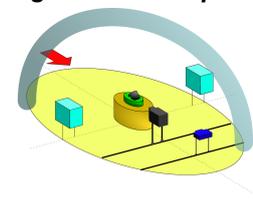


Figure 2. suggested 3D layout of the multitask instrument

The instrument should be **modular**, enabling the operation of **integrated measurements**. The detector **modules** (diffraction banks, NRCA banks, tomograph, NRT pixelated banks) should be positioned **on guide-mounted carriers** so as to be easily and quickly set-up at the correct position and removed from the working position.

The **neutron beam** should have two possible configurations: one with a **large beam** and one using a **pencil beam collimation**. The sample would be mounted on a **moving system** with the possibility of **coarse and fine adjustment** (x, y, z, ω).

WG12 MEMBERS

| | |
|---|--|
| R. Triolo Coordinator (Univ. Palermo) | triolo@unipa.it |
| P. Di Leo (CNR – IMAA) | pdileo@imaa.cnr.it |
| G. Festa (Univ. Roma Tor Vergata) | giulia.festa@roma2.infn.it |
| F. Grazzi (CNR-ISC) | francesco.grazzi@fi.isc.cnr.it |
| G. Lazzara (Univ. Palermo) | g.lazzara@unipa.it |
| C. Mondelli (CNR-ILL) | mondelli@ill.fr |
| E. Perelli Cippo (Univ. Milano Bicocca) | enrico.perelli@mib.infn.it |
| M. Picollo (CNR-IFAC) | m.picollo@ifac.cnr.it |
| R. C. Ponterio (CNR-IPCF) | ponterio@me.cnr.it |
| A. Sodo (Univ. Roma Tre) | sodo@uniroma3.it |
| M. Tardocchi (CNR-IFP) | tardocchi@ifp.cnr.it |
| D. Tresoldi (CNR-IPCF) | resoldi@me.cnr.it |
| P. Tisseyre (Sovr. del Mare) | philippe.tisseyre@regione.sicilia.it |