MicroFEx

The New External Microbeam Facility

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Our heritage

Jar, Roman glass, II d.C.- III d.C.  
Museu Nacional de Arqueologia

Custódia de Belém, goldcraft, 1506 d.C.  
Gil Vicente (Portugal, act. ~1491-1518)  
Museu Nacional de Arte Antiga

The Temptation (or Temptations) of St. Anthony, oil on wood panels,1495 d.C.-1510 d.C.  
Hieronymus Bosch (The Netherlands, 1450-1516)  
Museu Nacional de Arte Antiga

"Self-portrait in red", collage, 1962 d.C.  
Paula Rego (Portugal, 1935)  
Museu do Chiado

Lady Dragonfly brooch, jewelry, 1904/1905  
René Lalique (France, 1860-1945)  
Fundação Calouste Gulbenkian

Female Figure, drawing, XIX a.C.- XX d.C.  
Auguste Rodin (France, 1840-1917)  
Museu do Chiado

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ITN Facility

- Van de Graaff 2.5 MV
- Nuclear Microbeam line
  - OM 50 quadrupole triplet system
  - Electromagnetic dipoles scanning system
  - Octagonal vacuum chamber
  - OMDAQ acquisition system
  - PIXE, RBS, STIM, IL

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Internal vs External

Non-destructive
Elemental composition
Quantification

- High resolution
- Low detection limits
- Small objects or sampling required
- Sample/object in vacuum

- Lower resolution
- Higher detection limits
- No sampling required
- Object in air
External Beam End-station

- Extraction nozzle downstream of the vacuum chamber

- Transmission window with Si$_3$N$_4$ membrane
  - Thickness = 100 nm
  - Area = 1 mm$^2$
  - Distance to target = 3 mm
External Beam End-station

- Controlled helium flux system
- Object positioning system
  - Coarse components: 12 in. motorised elevator stage, manually driven wheels and rails for horizontal displacement
  - Fine components: 13 mm x-y-z micrometric table
- Beam positioning system
  - 2 lasers
  - Video camera
Beam Size Measurement

Graduated microscope glass slide

1 – Microscope with digital camera
2 – Glass slide
3 – Extraction nozzle
4 – Tube for helium flux
Beam Size Measurement

Without helium
- Horizontal FWHM = 70 µm
- Vertical FWHM = 75 µm

With helium
- Horizontal FWHM = 60 µm
- Vertical FWHM = 65 µm

Images analysed with freeware software ImageJ
Case Study

- The Roman Glasses of Quinta da Bolacha
  - two occupations between 3rd and 4th centuries AD\textsuperscript{[1]}

1st Occupation

- 193/03
- 195

2nd Occupation

- 90/01
- 274
- 283

Context 15
- 19/07/00
- 20/06/00
- 28/06/00

Context 17
- 55
- 72/01

Context 19
- 26/09/00
- 92/01

Revolution context


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Typical Experimental Sequence

1. Collect a preliminary spectrum of a region of interest
Typical Experimental Sequence

1. Collect a preliminary spectrum of a region of interest

2. Produce the maps
Typical Experimental Sequence

1. Collect a preliminary spectrum of a region of interest
2. Produce the maps
3. Collect points spectra
First results

- Correlation between visible alteration and elemental distribution
  - Corroded areas show increased concentrations in Mn and Fe

- Blue tile 193/03: presence of Sb and Pb
  - Indication of the use of opacifying agents such as Ca$_2$Sb$_2$O$_7$, Ca$_2$Sb$_2$O$_6$ and/or Pb$_2$Sb$_2$O$_7$ [2]

First results

- 92/01-smaller fragment: presence of Cu, absence of Zn
- 92/01-larger fragment: absence of Cu, presence of Zn
- Indication that the two fragments do not belong to the same original object, as initially supposed