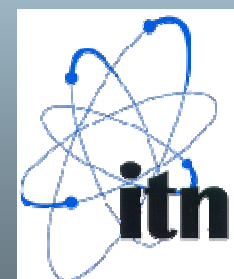


External Beam Analysis of Roman Glasses



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Introduction

Implementation of an external beam analysis system at ITN microprobe beam line allows studying art and archaeological objects, non-destructively and without requiring sampling. Using the OM 50 triplet quadrupole system and an extraction nozzle equipped with ultra-thin Si_3N_4 membranes, the objects are analysed resorting to PIXE and RBS.

Preliminary results regarding the study of a group of archaeological Roman glasses are presented here.

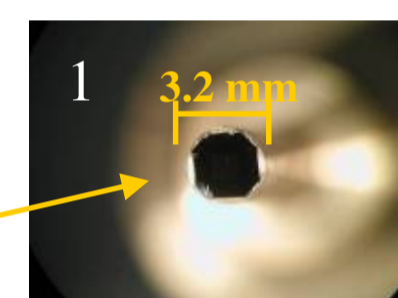
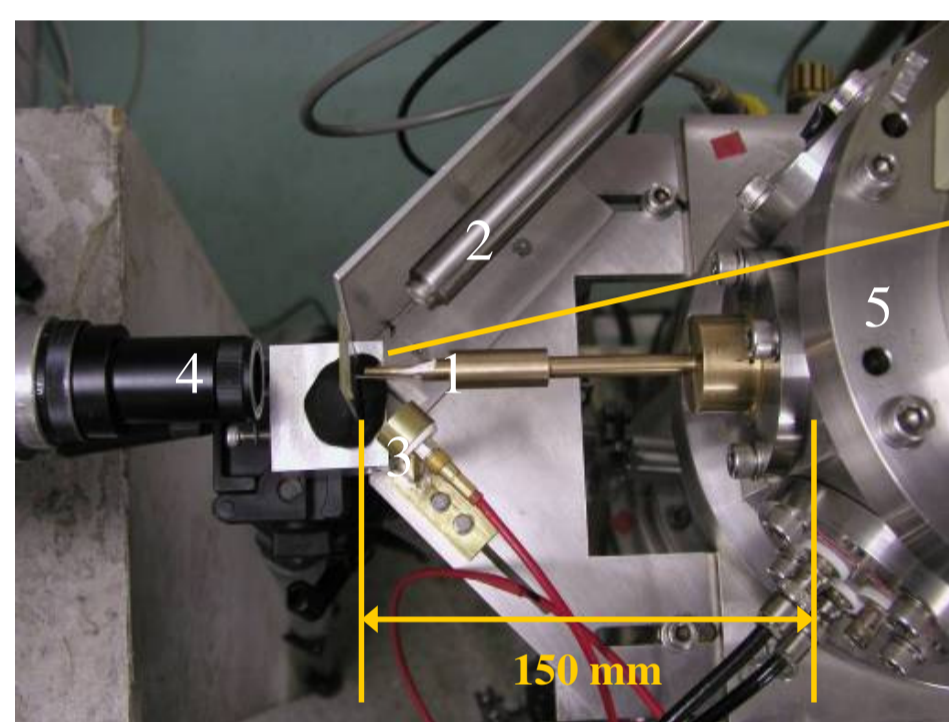
Spatial Resolution

Experimental Conditions

- 2 MeV H^+ beam, 2.5 MV Van de Graaff accelerator
- Oxford Microbeams type microprobe with OM-DAQ
- Object slits: $500 \times 500 \mu\text{m}^2$
- Collimation slits: $1 \times 1 \text{ mm}^2$
- Typical beam current: $\sim 1 \text{ nA}$

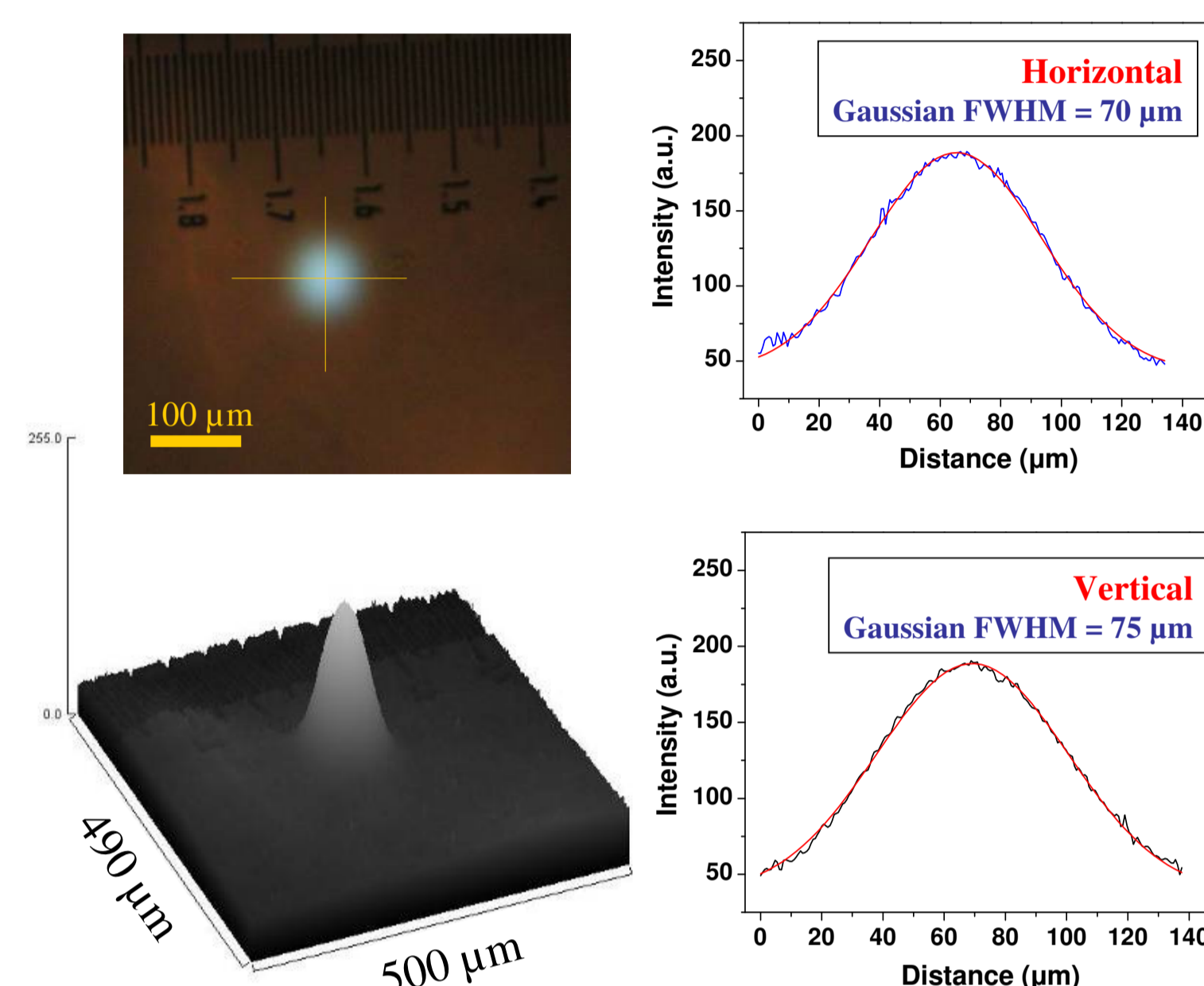
Setup

- Exit nozzle: 15 cm tube from end of vacuum chamber; 43 cm from the last quadrupole
- Exit window: $1 \times 1 \text{ mm}^2$, 100 nm thick Si_3N_4 membrane (SPI)
- Microscope in front viewing position to the exit nozzle
- Glass window for initial alignment and focusing
- Microscope glass slide with engraved scale ($10 \mu\text{m}/\text{div.}$) at 3 mm from exit window
- Controlled helium flow

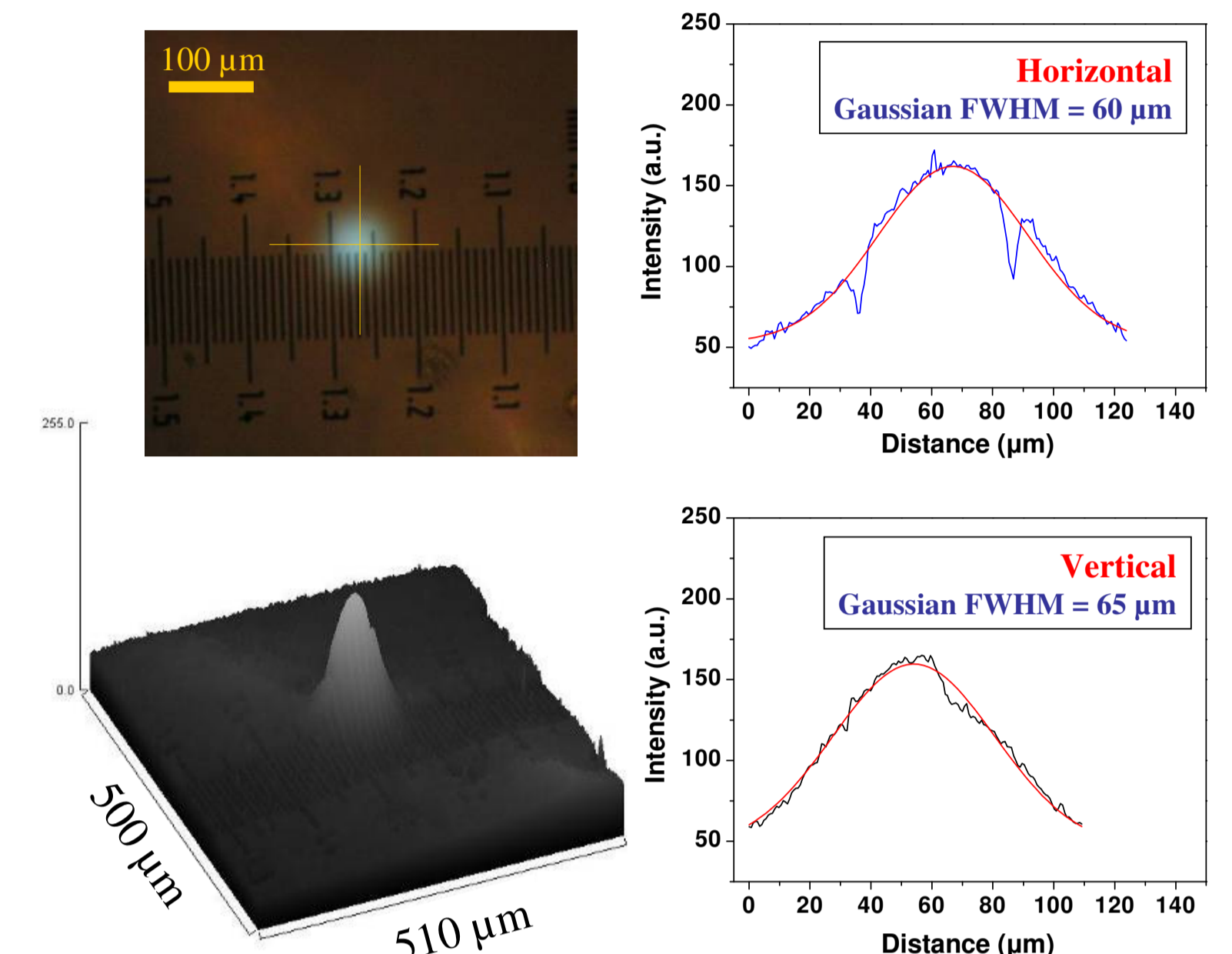


- 1 - exit nozzle
- 2 - 30 mm^2 SDD Röntec
- 3 - RBS detector
- 4 - microscope
- 5 - vacuum chamber

Irradiation in air



Irradiation with He flow



Helium flow improves the spatial resolution. Implementation of He flooded volume will further enhance the quality of PIXE and RBS spectra. In this configuration an external proton beam with 1-3 nA current, and 70-100 μm spatial resolution, is currently obtained.

The Roman Glasses from Quinta da Bolacha

A group of glasses was recovered from an excavation site of a Roman *villa*, in Quinta da Bolacha, Amadora, Portugal, that is believed to have had two different occupations between the 3rd and 4th centuries AD [1]. Fragments from two contexts (nr. 17 – 2nd occupation and nr. 19 – 1st occupation) were analysed, in order to materially define each of these moments.

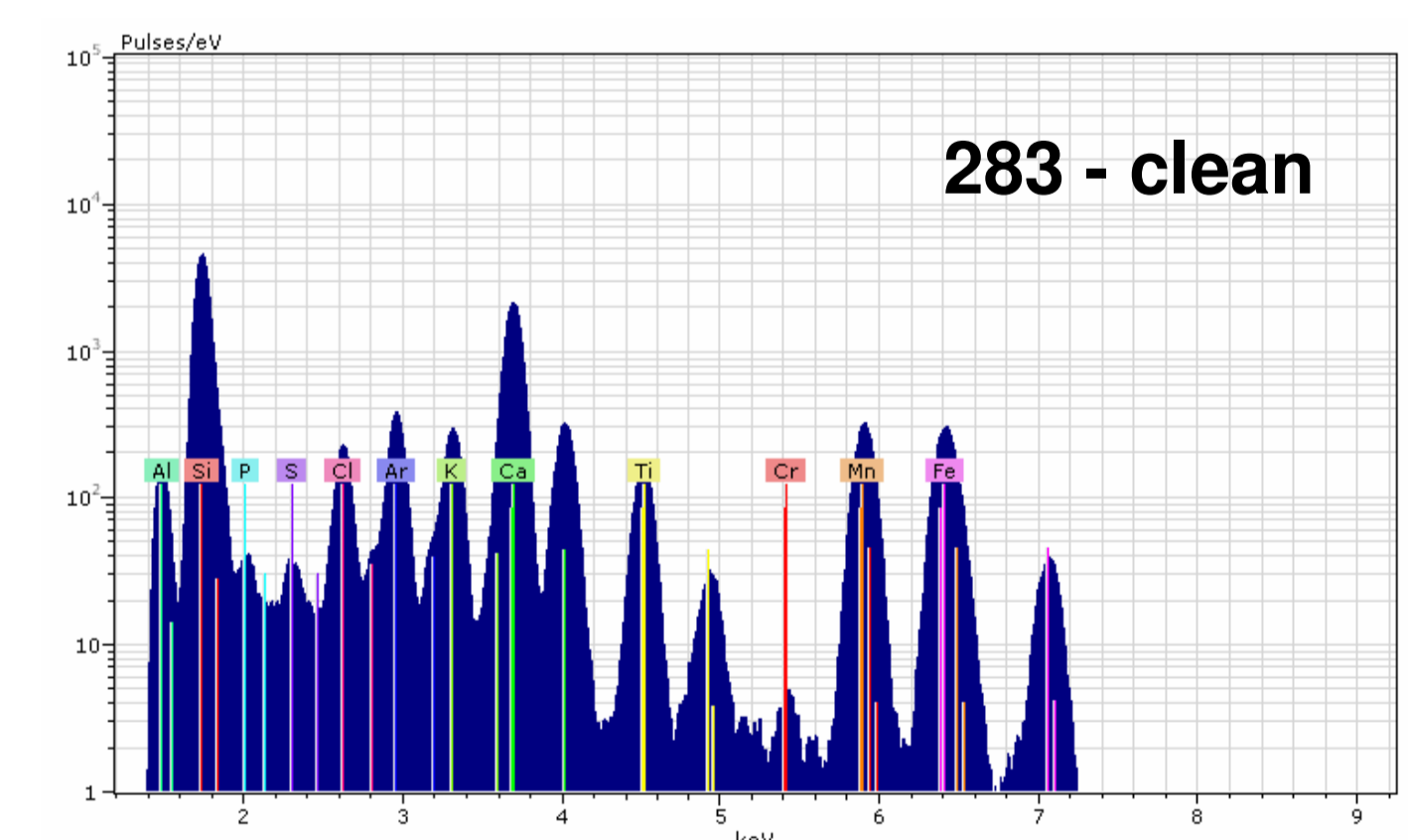
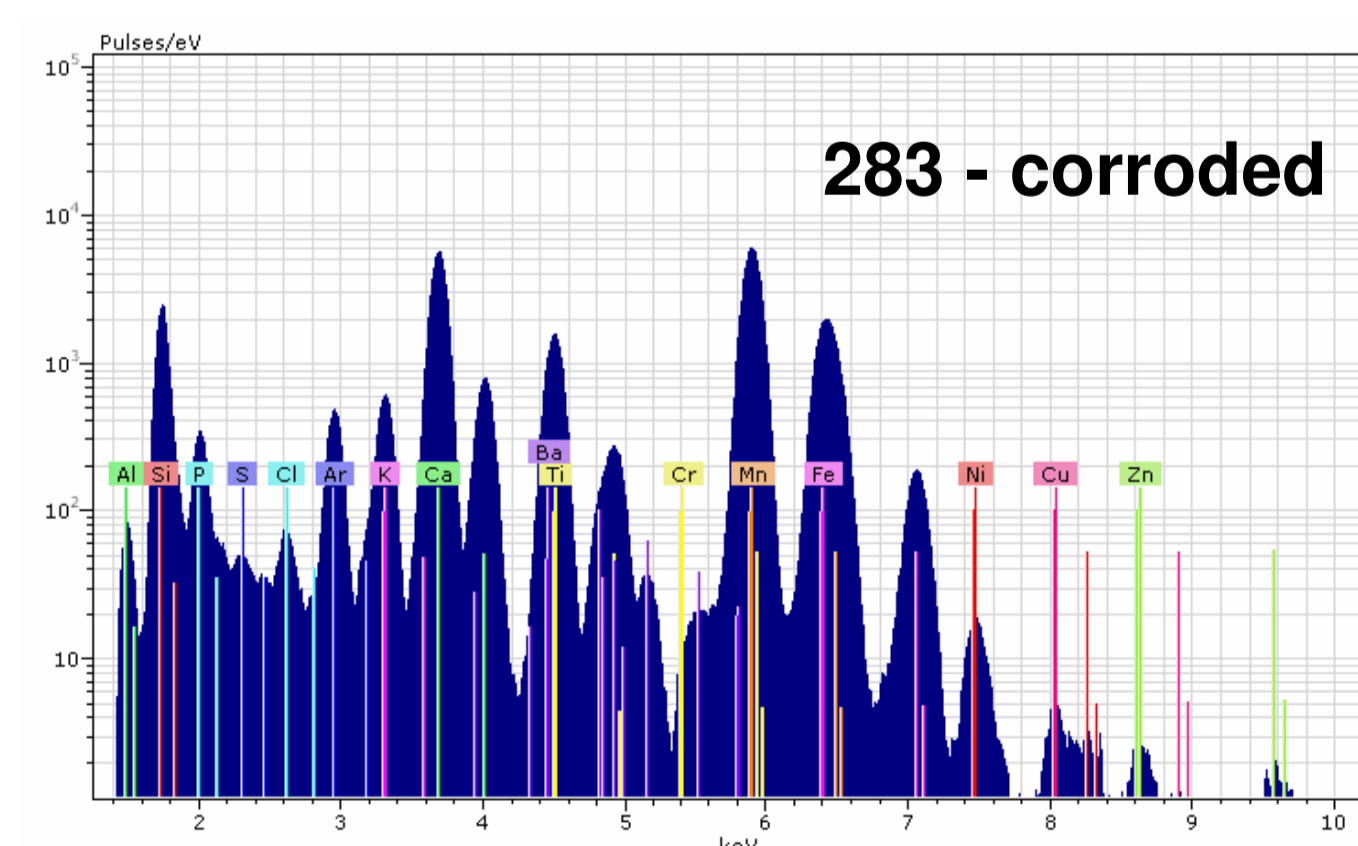
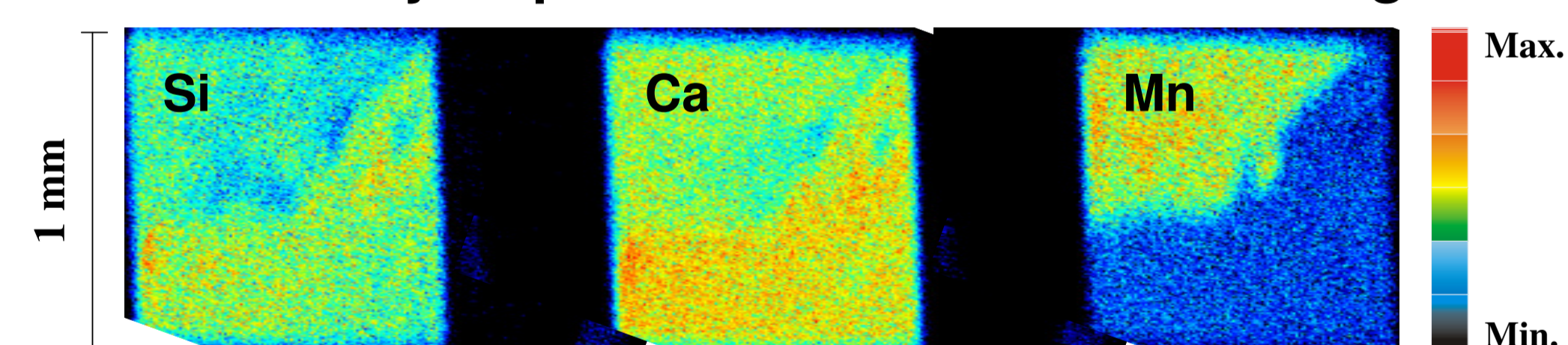
Characterisation

The poor state of conservation of the fragments, namely delaminating of the glass surfaces, was determinant for using *external beam analysis*.



Results and Discussion

Point analysis performed after beam scanning



- Corroded areas show increased concentrations in Mn and Fe.
- The presence of Sb and Pb in the blue tile 193/03, indicates use of opacifying agents (e.g. $\text{Ca}_2\text{Sb}_2\text{O}_7$, $\text{Ca}_2\text{Sb}_2\text{O}_6$ and/or $\text{Pb}_2\text{Sb}_2\text{O}_7$) [2].
- The presence of Cu and absence of Zn and Sr in 92/01-smaller fragment, contrarily to 92/01-larger fragment, indicate that these two fragments do not belong to the same original object, as initially supposed.
- There is evidence that glasses from context 19 do not have Cr in their composition.

Conclusions

- Improving system performance by He flooding the region of analysis and focusing optimization, makes 50 μm resolution an attainable goal.
- Area analysis by automatic raster scan is still possible under external microbeam conditions.
- The referred opacifying agents were in use until the 4th century AD, which confirms the time interval of the *villa's* occupation.
- The presence of Cr may be useful as a fingerprint for context identification

References:

- [1] - MIRANDA, Jorge Augusto, ENCARNÇÃO, Gisela, *Villa Romana da Quinta da Bolacha, Campanha de Abril/Maio de 1997, Relatórios-4*, Gabinete de Arqueologia Urbana, Associação de Arqueologia da Amadora, 1998.
- [2] - DAVISON, Sandra, *Conservation and Restoration of Glass*, Butterworth-Heinemann, Elsevier Science, Oxford, 2003, ISBN-0-7506-4341-2
- [3] - PAYNTER, Sarah, "Analyses of Colourless Roman Glass from Binchester, County Durham" in *Journal of Archaeological Science*, 33, 2006, 1037-1057.