PGAI-NT and archaeometry at the PGAA facility of MLZ

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Thanks to the advancements in signal processing and digital recording techniques in recent years, the range of available spectrometry and imaging methods utilizing neutrons has significantly expanded. Especially *Prompt Gamma Neutron Activation Analysis Imaging and Neutron Tomography* (PGAI-NT), a non-destructive method to obtain and effectively visualize position sensitive spectrometry data sets, shows promising results for material research and archaeometry [1].

PGAI-NT

PGAI-NT is the combination of a position sensitive three-dimensional extension of a sample's *Prompt Gamma Neutron Activation Analysis* (PGAA) and *Neutron Tomography* (NT). In contrast to a bulk-sample analysis, a PGAI sub-volume is established by the intersection of a pencil-like collimated neutron beam and a narrowly collimated *field of view* of an orthogonally placed gamma detector.

The resulting element distribution is visualized via differently colored voxels, while their respective abundance is visualized by different color intensities. Hence the term PGA-Imaging. For illustration and an improved sample relation, the voxel-matrix is embedded into the tomography volume of the sample [2, 3].

All-In-One Instrument

Because of its application areas, PGAI-NT should be user friendly and cost effective. For this reason, we opted for an All-In-One Instrument approach, conducting both sub-methods at the same instrument site. The PGAA facility [4] of MLZ offers, due to its collimator system and flexible instrument design, a great basis.

Recent developments

We report on recent PGAI-NT setup developments at the PGAA facility and on various measurements of archaeological samples, combining PGAA and NT in dependence of their properties to different degrees.

With the completed change from parallel to conical beam tomography, the full capacity of the facility's collimator system is now used. The semi-integration of the cone-beam NT setup into the standard PGAA setup enables for a quicker application switch. A new position sensitive neutron detector was designed and the performance of the optimized setup was tested.

In the course of a PGAI-NT real sample test-run, the composition and internal structure of various Roman (Fig. 1) and Celtic (Fig. 2) objects were studied.

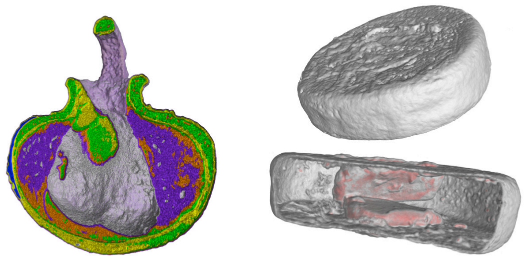

***Figure 1**:* Slice through the NT of a roman amulet vessel made of lead-bronze (left). Materials of different composition and/or density are colored differently. NT of a roman coin weight mainly made of lead (top right). Slice through the coin weight (bottom right), revealing copper pellets previously detected via PGAA (red).

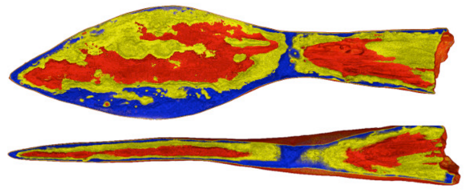

***Figure 2**:* Depth (top) and width (bottom) NT cross sections of a Celtic arrow head. Materials of different composition and/or density are colored differently.

References

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