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Modifying PGAA for the measurement of bronze samples

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Bronze and other copper-based alloys have been used in the human history for a few thousand years already as construction material in arts and technology. Usually Sn and/or Zn can be found as main alloying elements together with some minor components as Al, P, Mn, Fe, As and Pb. Prompt gamma activation analysis is a multi-elemental and non-destructive nuclear analytical technique used for determination of major, minor and some trace elements in the whole volume of valuable objects. The detection limits for the minor elements strongly depend on the matrix of the object material. Since copper represents a difficult matrix for PGAA analysis, the method is not as popular for the determination of composition of various copper alloys.
Irradiating already a few grams of copper alloys with neutrons leads to the emission of a broad-energy-range gamma-rays (from 90 keV up to 8 000 keV) and so creating high count-rates, high background signal and long dead times in the detecting system during the PGAA measurement. The main gamma emission from copper is in the low energy range up to about 650 keV. However, also at energies above 7000 keV characteristic gamma rays are emitted. Tin has its characteristic gamma rays at energies between 1100 keV and 2300 keV. Various minor elements that may be found in bronze alloys as aluminum, manganese, iron, nickel, zinc, and lead have also characteristic gamma rays in the same range and above 7000 keV. Thus, if attenuating strongly energies below 1000keV, we can avoid saturating the detector with unnecessary signal.
The standard PGAA instrument was modified with the introduction of a lead attenuator in front of the gamma-ray detector and so reducing the intensity of gamma rays with lower energy. Having the advantage of a high-intensity cold neutron beam at the PGAA facility at MLZ in Garching, we can irradiate the objects with high neutron flux and detecting only the high energy gamma-rays. With decreasing the count rate and the dead time through the lead attenuator we obtain reasonable values for detailed sample analysis.
Based on a recent study while using a 10 mm thick lead attenuator for the PGAA measurement of samples with high boron concentrations, this method is tested for the analysis of bronze samples. First results will be presented during this presentation.

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