Ultra Sensitive γ-Spectroscopy for the Solar Neutrino Experiment BOREXINO ◇

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The presented work was triggered by BOREXINO, an experiment which is dedicated to the measurement of the ^{7}Be-neutrinos of the sun. The tolerable limit for the radio purity of ^{238}U,^{232}Th in the liquid scintillator of the solar neutrino experiment is in the range of 10^{-16}g/g as the detector should have the capability to detect 50 neutrino interactions per day in a target of 100t with an energy theshold of 250keV [1]. Neutron activation analysis and new counting techniques were developed for the analysis of foreseen detector components. The most stringent limits are set by the scintillator which is going to be used as the target. Some of the requested purity levels are compiled in tab. 1.

Material	*U (g/g)*	*Th (g/g)*	*K (g/g)*
Scintillator	10^{-16}	10^{-16}	10^{-14}
Water	10^{-13}	10^{-13}	10^{-10}
Nylon	10^{-12}	10^{-11}	10^{-8}

Table 1: Purity design goals for BOREXINO

The liquid scintillator samples have been irradiated for approximately 100h at the research reactor FRMI at Garching. For the analysis of the various detector components radiochemical separation methods have been combined with $\beta - e^{-} - \gamma$ and $\beta - \gamma$ counting modes which were geared to the modes of the most important nuclides [2,3]. These separation methods are used to reduce the activity of the investigated matrix which builds up during the irradiation. Neutron activation analysis is also used as a multielement analytical technique to monitor trace elements in high purity materials giving valuable hints for the effectivity of cleaning and refining techniques applied to the detector components. The irradiated samples were split into different groups of radionuclides and counted on the most efficient detectors. The use of delayed $\beta - e^{-} - \gamma$ coincidences improves the detection limit for ^{238}U by two orders of magnitude compared to γ-spectroscopy [4,5]. The used set-up is shown in fig. 1. This has also arisen the need to reduce the correlated background in the γ-spectrometers which is dominated by the cosmogenic component producing bremsstrahlung and neutrons in the lead shield of the spectrometer.

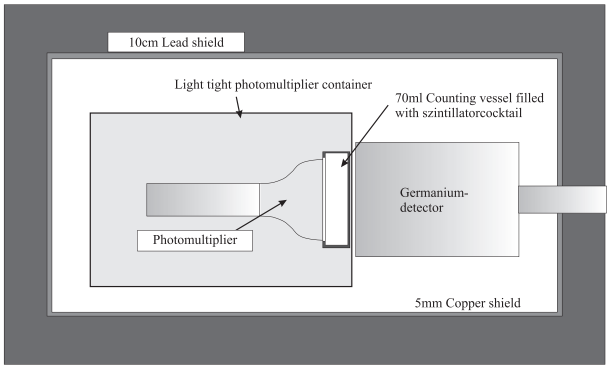

Fig. 1: Experimental set-up used for coincidence measurements

In the near future the detectors will be moved to the newly erected low background laboratory at Garching. This should not only reduce the uncorrelated background but also the correlated one reducing the event rate by an estimated factor of 20 in the energy range between 5keV and 2.5MeV.

References

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