Preliminary Results from the BOREXINO Counting Test Facility ◇

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At present there are four operating solar neutrino experiments which all measure a lower solar neutrino flux than predicted by Standard Solar Models. The discrepancy between theoretical predictions and experimental observations ranges from about 30% to 60% and this is in general referred to as the Solar Neutrino Problem. Both Non–Standard Solar Models as well as physics beyond the Standard Model of Electroweak Interaction have been proposed in order to reconcile the disagreement between prediction and observation. The goal of the BOREXINO [1] project is to measure directly in real time the mono energetic solar ^{7}Be neutrino flux, the only approved experiment with this objective.

In the BOREXINO experiment, neutrino detection relies on the leptonic process of neutrino–electron scattering within an unsegmented, spherical liquid scintillator target with mass of about 300 tons. The detector will be located in hall C of the underground facilities of the National Laboratory of Gran Sasso (LNGS) in order to shield against cosmic ray induced background.

According to the prediction of the Solar Standard Model there will be 50 ^{7}Be neutrino interactions per day and per 100 tons of target mass depositing an energy above 250 keV. The neutrino signal of the ^{7}Be neutrino line (862 keV) will be observable as a distinct step in the electron recoil spectrum at 660 keV. Ultra high radio-purity levels are an imparative requirement for the feasability of the experiment.

In the frame of the BOREXINO project, a small scale prototype detector (Counting Test Facility – CTF), similar to the BOREXINO detector design, was developed in order to investigate the attainable radiopurity levels [2]. The spectrometer part of the CTF consists essentially of 4.6 tons of liquid scintillator which is contained in a nylon sphere with radius of one meter and this is shielded by 1000 tons of ultrapure water.

One of the most important issues was to evaluate the concentration of ^{14}C in the scintillator. ^{14}C is a pure β emitter with an endpoint energy of 150 keV. The energy spectrum at low energies measured in the CTF coincides with a shape expected from ^{14}C β decay. A value of 1.2×10^{-18} is deduced for the ratio ^{14}C/^{12}C. At this level it will not contribute significantly to the background in the energy range relevant for ^{7}Be neutrino detection.

The question of how to measure the contamination levels of ^{238}U and ^{232}Th at the 10^{-16} g/g level was addressed by measuring delayed coincidences in the decay chains. The determined activities reflect the parent activities under the assumption of secular equilibrium. A value of $(4.2 \pm 2.0) \times 10^{-16}$ g/(g scintillator) could be deduced for ^{238}U from the delayed $\beta - \alpha$ coincidence in the decay of ^{214}Bi$\rightarrow$^{214}Po$\rightarrow$^{210}Pb. From the delayed $\beta - \alpha$ coincidence of the consecutive decays of ^{212}Bi and ^{212}Po a value of $(2.5 \pm 1.2) \times 10^{-16}$ g/g is derived for ^{228}Th. Provided that the short lived isotope ^{228}Th is not differently removed in chemical treatments than the long lived isotope ^{232}Th, this limit is also applicable to the latter. Direct limits for ^{238}U and ^{232}Th are obtained from neutron activation analysis [3].

Preliminary values for the counting rate in the neutrino energy window (*nw*) (250 keV - 800 keV) can be summarized as following: After the recent scintillator purification treatments, the counting rate in the *nw* was about 1900 per day. About 1400 events per day of this rate are related to the residual ^{222}Rn contamination in the water buffer. About 100 events per day originate from muon cerenkov interactions in the water buffer which are not discarded by the muon recognition criteria. There is indication that the events of the residual rate of about 400 per day in the *nw* are located at the surface of the inner vessel. The decay of long living Radon daughter isotopes could account for the observed data. The ongoing experimental efforts are being carried out in order to clarify this question unambiguously.

Important milestones for the preparation of the BOREXINO experiment have been achieved with the CTF at Gran Sasso. One of the most important results is the measured low concentration of ^{14}C in the scintillator. This is an imperative precondition for the feasibility of BOREXINO. Furthermore, the measured contamination levels of uranium and thorium show that the required high purity levels for BOREXINO are attainable in aromatic scintillation liquids.

A variety of purification techniques are currently under investigation and in the near future an alternative scintillator (PXE) with density of 0.99 g/cm^3 will be tested in the CTF. Construction work for BOREXINO will commence in spring 1996 while the final details of the design for the BOREXINO detector is under preparation.

References

[1] G. Bellini et al.,'Borexino: A Real-Time Detector for Low Energy Solar Neutrinos', (INFN-Milan Report, 1991).
[2] S. Schönert, Proc. of the *2nd Rencontres du Vietnam* (1995), Edition Frontiere, to be published.
[3] Goldbrunner et al., this report p. 83

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