Status of the BOREXINO Solar Neutrino Experiment ◇

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1. Introduction

Main goal of Borexino is the real time spectroscopy of low energy solar neutrinos, especially the monoenergetic ^{7}Be neutrinos at 862 keV. A direct measurement of these neutrinos could confirm the LMA solution for neutrino oscillations and, using the results from the GNO and SNO experiments, the fundamental pp neutrino flux could be determined with an accuracy better than 1 %. Further goals are the measurement of reactor antineutrinos, geoneutrinos and Supernova neutrinos.

The Borexino detector is under construction in Hall C of the Gran Sasso underground laboratory in Italy at a rock overburden of about 3600 mwe. Liquid scintillator (total mass ≈ 300 t, fiducial volume ≈ 100 t) will be target and detector material at once, allowing a high statistics measurement of the ^{7}Be solar neutrino flux (≈ 43/d according to the standard solar model, ≈ 9/d for full flavour conversion). The scintillator is contained in a transparent spherical nylon vessel (8.5 m diameter, 0.1 mm thickness) and surrounded by 1000 tons of a transparent buffer liquid. The scintillator is viewed by 2200 photomultipliers supported by a stainless steel sphere (SSS, 13.7 m diameter), which also separates the inner part of the detector from the external shielding, provided by 2400 tons of pure water. The outer water shield, contained in a steel tank with 18 m diameter, 17 m height is instrumented with 208 photomultipliers serving as a veto for penetrating muons (Outer Detector).

2. Status of the Experiment

Due to changes in the safety regulations of the laboratory, no work involving the use of liquid could be carried in Hall C during the last year. This means especially, that no scintillator operations could be carried out. In the meanwhile, the hardware construction of the detector was continued, and tests of the data acquisition system ("air runs") were successfully performed. Also the data taking of the test detector CTF (containing 4 t of liquid scintillator) was continued.

Work carried out during the last year under with contribution of the Munich group are summarized in the following.

Muon Veto (TU München)
The outer water shielding of the Borexino detector serves at the same time as water Cerenkov detector for atmospheric muons. 208 PMTs mounted on the outer surface of the SSS detect the Cerenkov photons emitted by muons traversing the water tank. All surfaces of the Outer Detector will be covered with reflecting Tyvek sheets in order to increase the light yield. The detection efficiency of this muon veto is higher than 99 %.

Besides the direct muon signal, the muon induced radioactivity is an important background for the detection of pep- and CNO-neutrinos. As some of the muon-induced radionuclides have life times up to 20 minutes, they cannot be suppressed by a simple time cut. For this purpose we are working on a track reconstruction of the muon tracks, in order to apply a localized cut around each muon track.

The first fraction of the Outer Detector PMTs has been installed in the year 2002, the rest is being installed these days, together with the reflecting Tyvek sheets. During the last year the data acquisition system for the muon veto has been completed and successfully tested. Codes for the offline analysis and calibration have been developped. For the track reconstruction, a Monte Carlo simulation has been set up and is being tested.

Scintillator Purification (Princeton University and TU München)

During the last years, many measurements of the concentration of radioactive contaminants in the liquid scintillator have been performed with the proto type detector CTF in the Gran Sasso underground laboratory. Especially water extraction and Silica gel column purification have been extensively studied. It could be shown that the remaining background stems mainly from the long-lived Radon daughters (^{210}Pb, ^{210}Bi, ^{210}Po). A further reduction of a factor ~ 10 would be sufficient for Borexino to achieve a signal/background ration > 1. In laboratory tests in Munich a further improvement of the purification method is under study.

Calibration system (Virginia Polytechnic Institute and State University and TU München)

A calibration of the Borexino detector with localized radioactive sources inside the scintillator is indispensable, as an exact position reconstruction of the events is necessary to apply the virtual fiducial volume cut. Furthermore, for the background suppression an alpha/beta discrimination will be needed which can be studied with appropriate sources.

The calibration system comprises to components: a source insertion system which allows one to introduce and move radioactive sources inside the Inner Vessel, and a camera locating system which can independently measure the source position with an accuracy of ± 2 cm.

◇ This work was supported by the Deutsche Forschungsgemeinschaft (SFB für Astro-Teilchenphysik).