Status of the BOREXINO Solar Neutrino Experiment ◊

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Aim of BOREXINO is to measure in real time solar neutrinos via pure leptonic neutrino electron scattering $\nu + e \rightarrow \nu + e$. Special interest in BOREXINO is the first determination of the low energy (861 keV) ^{7}Be solar neutrino flux.

Running solar neutrino experiments show a significant lower counting rate as calculated by the Solar Standard Model (see e.g. [1]). However, information from helioseismology confirms the solar standard model to an accuracy within <<1% (see e.g. [2]). In addition, results from the Luna experiment [3] at low energies disfavour explanations based on uncertainties in nuclear cross sections at energies which are typical (≈keV) for the solar center. Indeed, data analysis of the existing experiments leads to the assumption of severe suppression of the charged current solar ^{7}Be-branch (see e.g. [4]). Within the 90% confidence limits a flux of only ≈15% of the expected charged current ^{7}Be neutrinos is consistent with the data, revealing a strong hint for new particle physics.

If neutrinos have non-zero masses and if they mix in analogy to the quark sector, neutrino oscillations arise. It can be shown that certain parameter on neutrino masses and mixing angles provide a solution to the result of all solar neutrino experiments. There exist three parameter areas: small mixing angle (sma) MSW [6] solution with values typically for neutrino mass differences $\Delta m^2 \approx 10^{-6} \rightarrow 10^{-5}\ eV^2$ and mixing strength in the region $10^{-6} < \sin^2 2\theta < 2 \cdot 10^{-5}$, the MSW large mixing angle solution (lma) for the same mass region but almost full mixing strength, and the vacuum oscillation solution (vos) with strong mixing at $\Delta m^2 \approx 10^{-10}$ eV^2. The ^{7}Be neutrino line at 861 keV is almost fully suppressed in the sma-solution whereas in the lma-scenario a ≈50% depletion is expected. If the vos-solution holds a distinct seasonal variation in the ^{7}Be-flux due to the eccentricity of the earths orbit would be seen. Hence, it is possible to separate between these several explanations experimentally in BOREXINO.

BOREXINO also can serve for additional projects in neutrino physics. Search for a magnetic moment can be performed by means of terrestial neutrino sources by investigating the electron recoil shape at low momentum transfer. Via the inverse beta-decay $\bar{\nu_e} + p \rightarrow e^+ + n$ BOREXINO can look for signals from geophysical neutrinos [7] as well as for neutrinos emitted by european nuclear power plants [8]. The latter would serve as a long baseline neutrino oscillation experiment probing the large mixing angle solution for the solar neutrino problem.

BOREXINO is placed in hall C of the underground laboratory at Gran Sasso, Italy at an overburden of about 3500 mwe. Liquid scintillator (total mass ≈300t, fiducial volume ≈100t) will be target and detector material, allowing for high statistic solar neutrino measurement (≈55/d for standard solar model, ≈12/d for sma-solution). The detector is shielded successively from outer radioactivity. The adjacent inner layer serves as shielding and has to provide an increased purity in terms of internal radioactivity. Inside the 'external' tank a stainless steel sphere will support about 2200 phototubes on the inside and 210 tubes at the outside. Latter provide the muon veto Cherenkov system. Tubes inside the sphere will be equipped with light concentrators in order to increase the geometrical coverage and hence the energy resolution.

From beginning of 1995 until summer 1997 several CTF-tests about the feasibility of BOREXINO have been performed. This includes procedures to maintain or to improve the purity of the scintillator. Results on the intrinsic purity of the scintillator are $^{14}C/^{12}C = 1.94 \cdot 10^{-18}$, $^{238}U = (3.5 \pm 1.3) \cdot 10^{-16}\ g/g$, $^{232}Th = (4.4 \pm 1.5) \cdot 10^{-16}\ g/g$, which are meeting the requirements for BOREXINO. A complete discussion of the CTF results including experimental techniques for further background suppression are given in ref. [9] and ref. [10]. Details about the experimental setup of the CTF can be found in ref. [11].

Responsibilities of the Munich group in BOREXINO are:

- The external steel tank.
- Purification of liquid scintillators via Si-Gel and water extraction.
- The Muon-Veto detector (together with MIT and Princeton, USA).
- The nucleus ('module-0') of the liquid handling system.
- The light concentrators.
- PXE-scintillator, light concentrators, muon veto, and liquid handling for the up-graded 'Counting Test Facility' (CTF-II) at Gran Sasso.
- NAA and gamma spectroscopy in the new underground lab in Garching.
- Event reconstruction in BOREXINO and CTF-II (together with Univ. Milano, Genova, Italy).

Since 1998 the external tank has been completed. In 1999 the inner steel sphere has been errected and it is expected to start insertion of the tubes in july 2000. Column purification of liquid scintillators with silica-gel has been tested successfully [14]. Extraction of radioactive radon daughters, which are especially dangerous for BOREXINO, has been demonstrated. Columns of the appropriate dimensions are going to be built up at Gran Sasso in the frame of 'module-0', the central part of the liquid handling system. A 'Munich' design for PM-encapsulation for the tubes of the muon veto detector has been realized [13]. A test chamber for these tubes is going to be installed in hall 2 of the Beschleunigerlaboratorium. The module-0 at Gran Sasso is short before completion which is expected for may 2000. First tests on radon tightness and emanation in module-0 showed very promising results. The design of the light concentrators embedded in pseudocumene is completed. Fabrication started in january 2000 and will be finished in august 2000. The CTF-II has been set up in 1999 and first results on optical properties of PXE are expected in may 2000. High sensitive neutron activa-

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