PRESENT STATUS OF THE LARGE VOLUME DETECTOR (LVD) OF THE GRAN SASSO LABORATORY

LVD COLABORATION

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Abstract

We discuss here the present status of the Large Volume Detector (LVD) to be installed in the underground Gran Sasso laboratory (Italy). The experiment, based on a 90 tons prototype running in the Mont Blanc laboratory, is designed in order to be a very massive Underground Neutrino Observatory (UNO), coupled with a fine resolution Tracking System (TS), to perform a multipurposes physics.

1. Introduction. The Large Volume Detector (LVD)[1] of the Gran Sasso laboratory is an extension of the Liquid Scintillator Detector (LSD)[2,3] running since October 1984 in the Mont Blanc Laboratory, and built by two Institutes (Torino ICGF-CNR and Moscow INR) of this collaboration. The experimental results of the LSD detector are the basis of the LVD experiment which, however, is not only an upgrading of mass by a factor of 20 of LSD, but will allow also for penetrating new studies in the fields of particle physics and astrophysics.

The Underground Neutrino Observatory (LVD/UNO) will consist of about 2 ktons of liquid scintillator, the Tracking System (LVD/TS) will consist of about 10^5 channels of streamer tubes on horizontal and vertical planes. Torino and russian groups have the responsability for LVD/UNO, while Frascati, Bologna, CERN and american groups have the responsability for LVD/TS.

2.Physics of LVD/UNO. The Underground Neutrino Observatory is a multi-purposes experiment suitable for long periods of operation with high reliability and low running cost. This conclusion is based on the experience of the LSD experiment, which is presently running in the Mont Blanc laboratory with an efficiency higher than 90%[4].

The main physics aim of the LVD/UNO is to search for neutrino bursts from collapsing stars in our and neighbouring galaxies. The very good possibility of a liquid scintillation detector to detect neutrinos from collapsing stars has been demonstrated[5] during the occurence of Supernova 1987a in the Large Magellanic Cloud. The bulk of the low-energy thermal neutrinos has been observed in the Mont Blanc LSD experiment, while only the high energy tail[6] of the neutrino spectrum may have been observed in the much larger Kamiokande[7] water Cerenkov detector.

The main signal from a collapsing core is due to positrons from electron antineutrinos interacting with free protons, but additional signature is obtained through detecting electron-neutrino scattering and capture reactions with ^{12}C nuclei in the scintillator. The number of target particles in the scintillator of LVD is $1.7 \cdot 10^{32}$ free protons, $7.2 \cdot 10^{32}$ electrons, and $9.0 \cdot 10^{31}$ ^{12}C nuclei. Hence, the expected number of neutrino interactions from a stellar collapse at the distance of 10 kpc is of order 10^3. This figure allows us to obtain a very high signal to noise ratio in the LVD, since the trigger rate from background (extrapolated from the LSD trigger rate) is expected to be of order of 0.1 Hz for the entire LVD detector.

The scintillation counters in the core of the LVD experiment (about 1 kton of liquid scitillator) are very well shielded against the local radioactivity background by the surface counters and by the shielding of the Fe containers of the scintillation counters. In addition a passive shield (paraffin and Fe) will be installed on the floor of the experimental hall. We plan to use this part of the LVD to search for solar neutrinos through the (ν_e, e^-) elastic scattering reaction, at an energy threshold as low as possible, depending on the trigger rate; on the basis of the LSD data, we estimate that measurements down to 4-5 MeV will be possible.

through measurements of ionization and time of flight. Given the large acceptance of the detector, the Parker bound will be reach in less than 1 year of running time. Another possibility of the LVD experiment is to detect proton decay through the $p \rightarrow K \bar{\nu}$ channel, with a signature given by the energy and timing of the K, μ, e chain.

3. Physics of the LVD/TS. A scintillation module includes 8 counters in a Fe container, with an L-shape coverage with streamer tubes of the NUSEX type, 6 m long and 1 cm^2 cross section. This tracking system will give us a very good spatial information on cosmic ray muons crossing the detector, and of charged particles originating in the detector itself. The LVD/TS will allow us to search for point cosmic sources of high energy muons, horizontal muons, muon bundles. From timing it will be possible to discriminate up-ward and down-ward going muons, particularly impot-tant for studying neutrino oscillations.

4. Present status of the LVD. The production of the scintillator has started in USSR, and a tube factory has been build in USA to fasten the tubes production, in the past made only in Frascati. In the Mont Blanc Laboratory we are testing the shielding (paraffin and lead) and new electronics.

As soon as the Gran Sasso Laboratory is ready (summer 1987) the first scintillation counters and streamer tubes will be installed in order to determine the background conditions and to start measuring and testing the apparatus.

References

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