STATUS AND PERSPECTIVES OF LVD AT GRAN SASSO

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Introduction - The present status of the Large Volume Detector (LVD) of the Gran Sasso Laboratory is reported. The experiment is a modular array of liquid scintillation counters and limited streamer tubes, designed in order to be a massive neutrino observatory, coupled with a fine-resolution tracking system.
As most experiments in underground laboratories, which have a low statistics of events and require long running times, the LVD is a multipurpose experiment [see ref.1] but with different priorities of the researches. The main physics goal is neutrino astronomy, firstly detection of supernova neutrinos and secondly high-energy and solar neutrinos. Since the expected number of ν-interactions is of order of 900 for a collapse at the distance of the galactic center, the LVD is a real neutrino observatory, able to make a detailed analysis of the energy and temporal distributions of the burst. In addition to neutrino astrophysics, excellent possibilities exist to study cosmic ray and high energy elementary particle physics.

The experiment - The apparatus consists of five towers (see fig.1), with total mass ~ 4000 tons, dimensions (40 x 13) m^2 area and 12 m height, geometric acceptance ~ 7700 m^2sr for an isotropic flux. The LVD experiment is made of two major parts: an active volume of scintillator and a tracking system. The first consists of 1,800 tons of liquid scintillator in 1520 counters (1.5 m^3 each) with 3 PMs on the top of each counter in a 3-fold coincidence within 150 nsec. The second consists of 15,000 limited streamer tubes (6,3 m long, 1 cm^2 cross section) in 190 L-shaped modules with a digital read out in two coordinates. Each tracking module is linked to a group of 8 scintillator counters (see fig.2) to form a grid of 8 horizontal and 5 vertical layers, with an angular resolution of ~ 0.5°. Because of the many physics objectives, the electronic system of the scintillation counters [see ref.2] has been designed in order to have a wide range in energy (from 0.8 MeV up to ~ 1 TeV for each counter) and time (resolution ~ 2 nsec) measurements. Part of the first tower started taking data in June 1991; some energy spectra recorded so far (see fig.3) show the muon peak in spite of the still poor statistics.

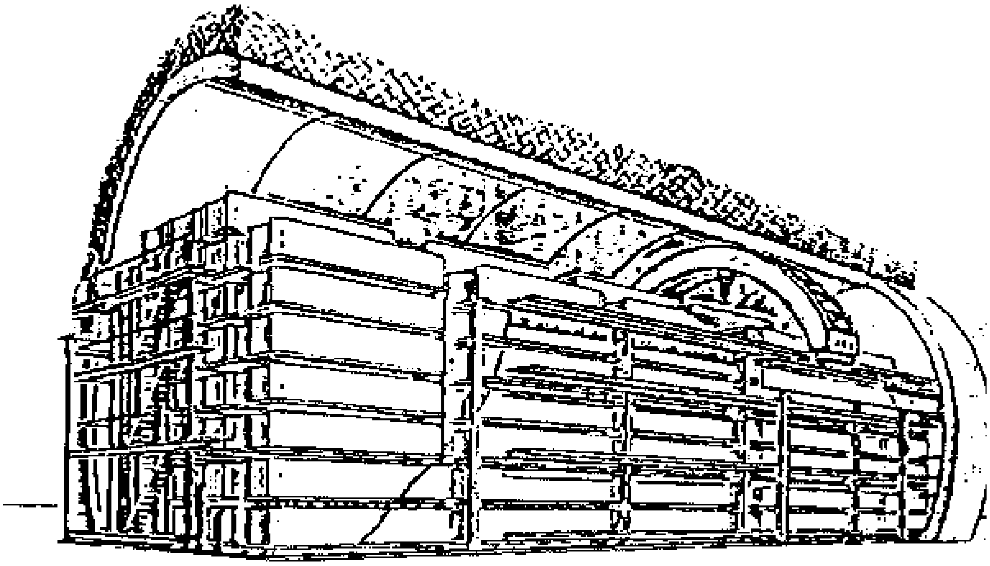


Fig. 1 General view of the LVD.

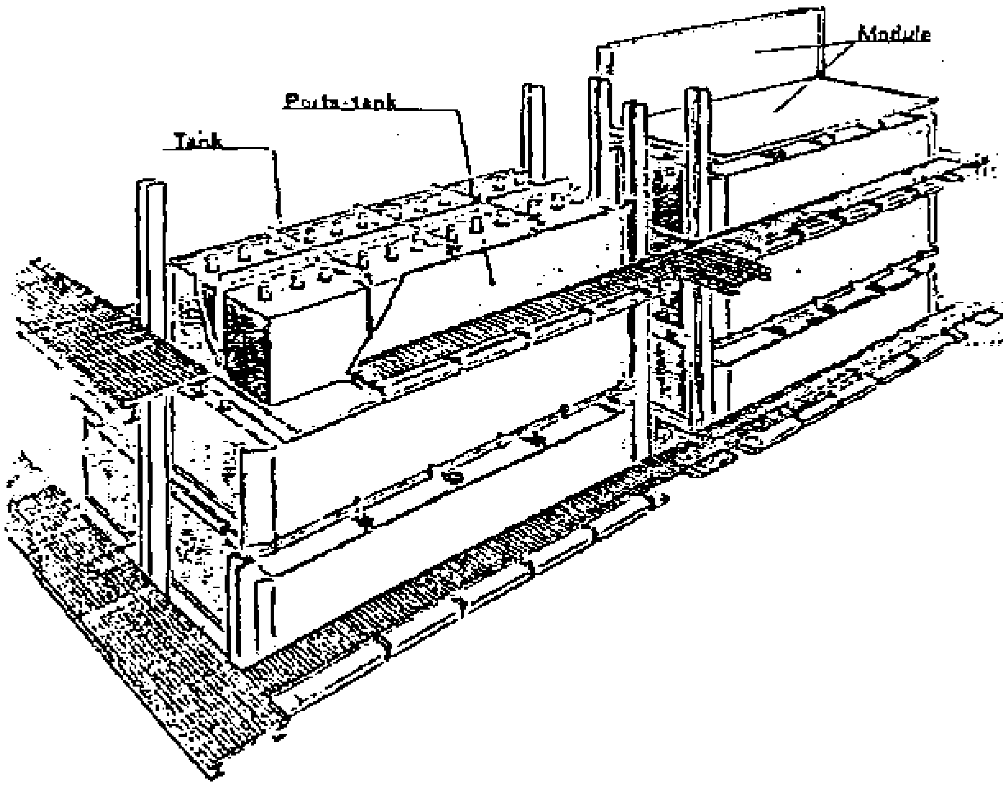
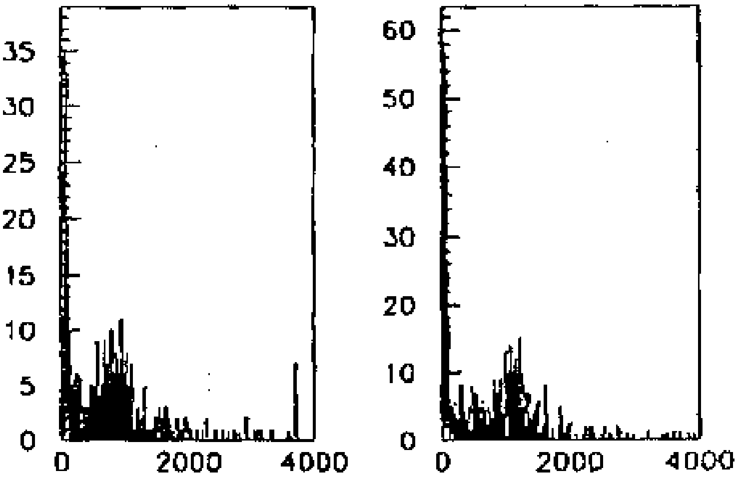


Fig. 2 Detail of the LVD assembly system.

Physics aims - Since the main signal of supernova neutrinos is due to $\bar{\nu}_e$ interactions with protons, the LVD has been designed in order to detect both products of this reaction, namely a prompt e^+ pulse above the threshold E_{th} = 5 MeV, and a delayed γ-ray pulse above the threshold E_{th} = 0.8 MeV, active during a 500 μsec gate opened by the main trigger. Additional supernova neutrino events in LVD are produced by ν_e-e scattering, and by neutral and charged current interactions of neutrinos and antineutrinos of any flavour with the ^{12}C nuclei of the scintillator.
Large possibilities are connected with cosmic ray physics in LVD, in which a single vertical muon releases 160 MeV in a counter. Besides single muons and μ-bundles, the wide energy range of the detection system allows to record μ→e decay and very high energy hadronic or electromagnetic cascades (including their associated neutrons).
Among other aims, we wish to mention that atmospheric neutrino oscillations can be studied at a level better than $\Delta m^2 \sim 10^{-4}$ eV^2 for maximum mixing angle. Proton decay in the SUSY channel $p \to K^+ \nu$ can be studied with a very good signature given by the K^+ decay chain up to a lifetime of order 10^{32} years. Magnetic monopoles can be studied for velocities $\beta \geq 5 \times 10^{-4}$, being the Parker bound reached in few years of data taking.

References
1 - C. Alberini et al., Nuovo Cim., 9C, 237, 1986
2 - A.Bigongiari et al., Nucl. Instr. and Methods, A288, 529, 1990

Fig. 3 - High-energy threshold spectra for two counters



MODULE 1, COUNTER 1 MODULE 2, COUNTER 8