

BAKSAN UNDERGROUND SCINTILLATION TELESCOPE

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A big underground installation for muon and neutrino detection is generally described. It is situated under a mountain slope at Neutrino Observatory of the Institute for Nuclear Research in Baksan Valley, North Caucasus. The instrument consists of 3132 liquid scintillators, arranged in a semi-cubic geometry $16 \times 16 \times 11 \text{ m}^3$. The shortest distance to the surface corresponds to the depth of 850 hg/cm^2 .

I. General discription. A large installation operates in the underground laboratory of the Institute for Nuclear Research of the USSR Academy of Sciences. The laboratory is located in North Caucasus, Baksan Valley, at the altitude of 1700 m (Chudakov 1977).

The telescope is four-storeyed building, placed in a cave under a mountain slope. Effective depth is 850 hg/cm^2 . The telescope is nearly cubic in shape ($16 \times 16 \text{ m}^2$ area and 11 m height). Framework and floors of telescope are made from low background concrete. The cave walls are covered by low background concrete too. The thickness of framework and floors is 80 cm (160 g/cm^2). Four vertical sides and four horizontal planes are entirely covered by liquid scintillation detectors of standard type. Total number corresponds to 3132 such detectors. The position of telescope under mountain slope is show in fig.1, and itself schematically in fig.2.

Standard detector, with dimensions $70 \times 70 \times 30 \text{ cm}^3$, have been used in the Laboratory formerly, consists of aluminium tank filled with liquid scintillator on the base of white-spi-

rit with PPO and POPOP as addition (Dadykin et al 1970). Every counter is viewed by one photomultiplier (diameter of photo-cathode 15 sm). The detailed description of this detector and its properties is given by Bakatanov and Dadykin (1969).

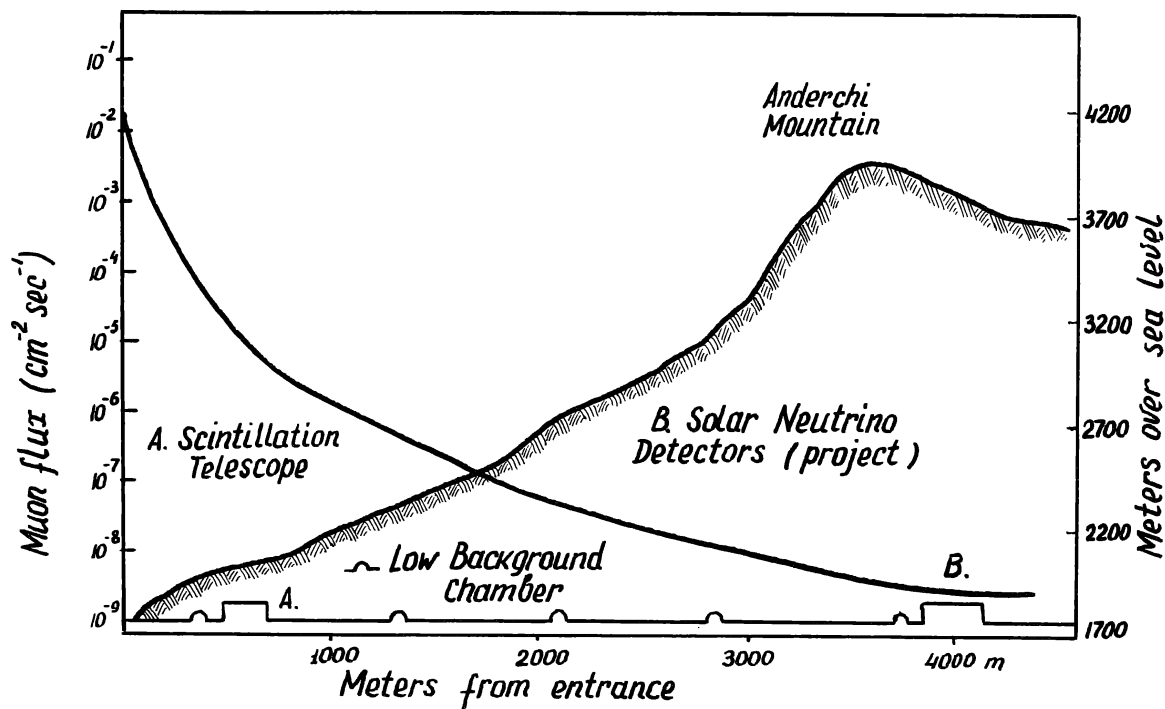


Fig.1

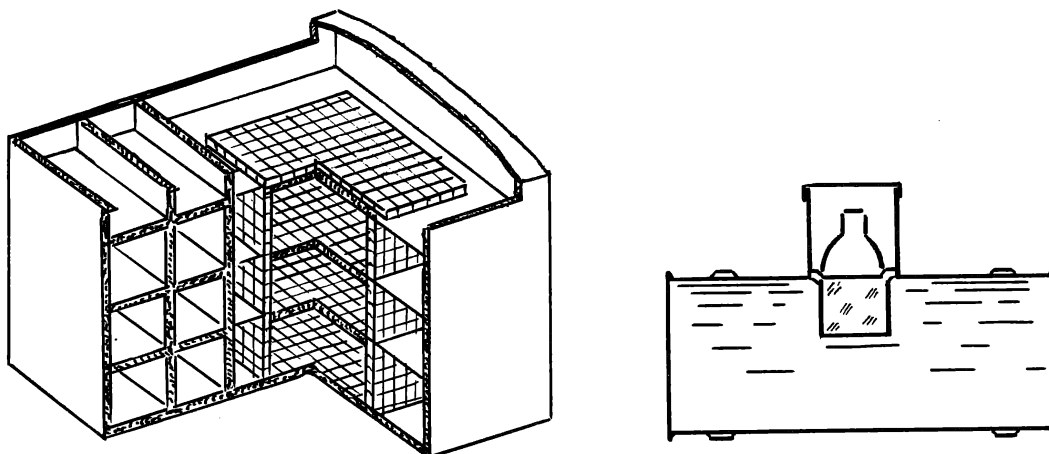


Fig.2

There are possibilities to control amplification coefficient and delay of each photomultiplier. Coefficient of amplification is adjusted by illumination of detector by radioactive source. Pulsed X-ray radiation is used to determine value of photomultiplier delay.

II. Data acquisition system. There are a few parallel outputs for information from each detector. Anode pulses of all detectors of one plane are summed. These signals are used to trigger recording systems, to measure energy loss of particles and for fast timing. Logarithmic converters have range from 25 MeV to 10 GeV (muon, crossing detector, dissipates as average 50 MeV). Time digitizers have range 128 nsec and accuracy 1 nsec. Zero-crossing discriminators are used to measure time of flight.

There are two multitrace oscilloscopes to record rare events. Pulse shape of each plane is recorded on its traces. First oscilloscope (speed 300 nsec per 10 cm) is used to register upward particles with proof in addition to digital system. Second (speed 10 mcsec per 10 cm) registers μ -e decays.

There are two intermediate memories. Memory I is used to determine particle trajectory. Trajectory can be reconstructed from detector numbers, which are recorded by memory I. Individual discriminators have the energy threshold, adjusted to 12.5 MeV, which corresponds to 1/4 of standard muon pulse. Memory II is used to measure energy loss in each detector with the threshold 0.5 GeV (10 penetrating particles). In this case, signal from 5th dynode of photomultiplier enters the individual logarithmic converter with range 10^3 . All kind of information is recorded when there is a specific trigger.

There is on-line mini-computer, which is used for monitoring and for preliminary processing of data flux. Information from intermediate memories as well as time and amplitude data of each plane enter to computer. Information about complex and rare events, which are marked by special trigger is memorized completely and recorded on magnetic tapes and films. For single muons only zenith and azimuth angles are stored. Information from computer memory goes to magnetic tape each 15 minutes for off-line computer handling. Simplified block diagram of data acquisition system of telescope is shown in fig.3.

Data acquisition system allows to take information for a few triggers simultaneously. Each trigger corresponds to following physical problems: (i) The measurement of the muon intensity as a function of the zenith angle and of depth (Alexeyev et al. 1979a); (ii) The variation of the muon intensity in time; (iii) Groups of muons from EAS cores (Chudakov et al. 1979a); (iv) The energy spectrum of electromagnetic and hadronic cascades, produced by high energy muons; (v) Muon-electron decays in atmospheric muon-stopping events and in hadronic cascades (Bakatanov et al. 1979); (vi) The study upward muon flux (Chudakov et al. 1979 b); (vii) The search for bursts of low energy neutrinos from gravitational collapse of stars (Alexeyev et al. 1979 b).

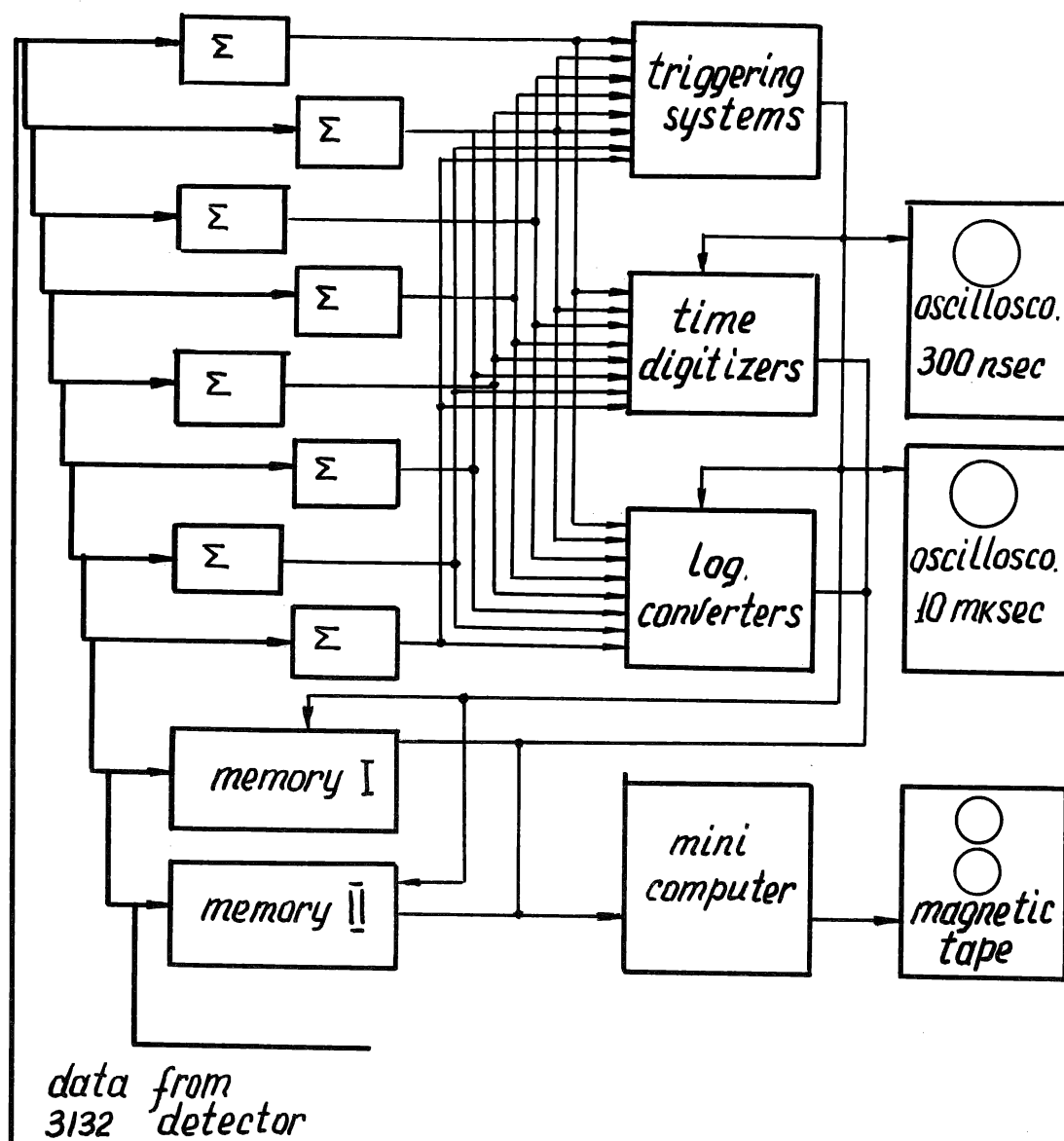


Fig.3

III. Control of telescope operation. Majority of items listed above, require continuons and long operation of telescope. Thus, the stability and reliability of operation of installation is of great significance.

A few kinds of control are used during of operation of telescope. Periodically, value of anode current of each detector is measured when radiated by constant radioactive source to control amplification coefficient of P.M.tube. Measured values go to computer memory and detector numbers with large deviation from ordinary quantity are extracted from computer immediately.

Accuracy of measurement of anode current is $\sim 5\%$. Stability of amplification coefficient, due mainly by high voltage stability, is $\sim 2\%$. This value corresponds to variation of plane rate $< 5 \cdot 10^{-3}$.

Besides, rate of each detector is accumulated in computer memory. These data are used to determine capacity for operation of detectors. Accuracy of rate measurement of single detector is $\sim 3\%$ in 12 hours. These kinds of control as well as future control of time adjustment and logarithmic converters will allow to test each detector completely and continuously during the operation of telescope.

Measure of rate of each plane and trigger, accumulated in computer memory, is used to control triggering system. Besides, automatic control of all voltage will be used. Total test information is extracted from computer to magnetic tape.

IV. Principal characteristics of telescope as angle, amplitude and time resolution are determined by properties of standard detector. Angle resolution is 2° for trajectory length ≥ 10 m. Figure 4 shows amplitude resolution, measured for one horizontal plane with correction length inside detector. This distribution is nearly Landau distribution shape. Time resolution of telescope is discussed in detail by Andreyev et al (1979)

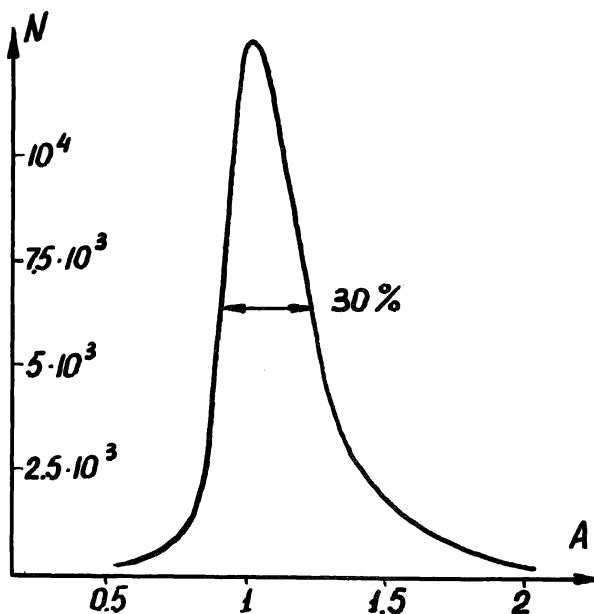


Fig.4

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