ULTRALOW BACKGROUND EXPERIMENTAL SET-UP FOR Ge-76 DOUBLE-BETA DECAY SEARCH

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Neutrinoless double-beta decay experiments are unique for studying the neutrino Majorana mass. The highest sensitivity may be achieved in experiments with Ge-76 because HPGE-detectors allow to use a large amount of material studied, possess a good energy resolution and a low background of its own. The sensitivity of the first generation experiments (where up to 500 gramms of Ge-76 were used) is $T1/2 > 10^{24}$ years. This corresponds to Majorana neutrino mass of 2 eV. To increase the sensitivity we have built a new experimental set-up with a record low intrinsic background level which allows to work with the germanium detector assembly with a mass up to 20 kg. If one uses enriched HPGe-detectors [1] it is possible to achieve an upper limit $T1/2 > 10^{25}$ years for a year-long period of mesurements. The principal difference of this set-up is the period of the use of semiconductor germanium both as a construction material and as a passive detector shielding.

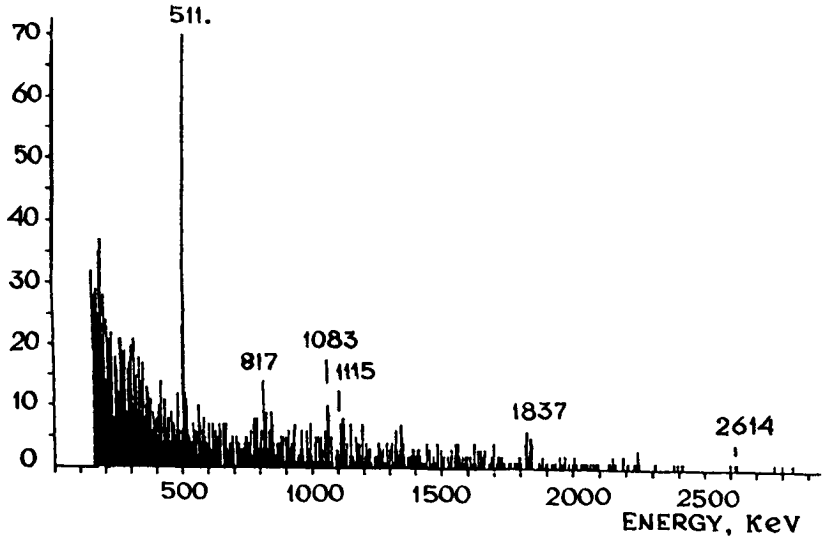

Fig. 1. Background spectrum of 116 cm³ HPGe detector, run-time 1004 hours, 5 KeV/channel summed

This work has been done in two stages. In the first stage [2] we measured the level of germanium intrinsic background. The HPGe-detector has been installed into a thick-walled germanium cavity in an ultra-low background arrangement. The measurements were carried out in the laboratory of the Nuclear Research Institute of the Ukrainian SSR Academy of Sciences situated in the Solotvino salt mine at the depth of 436 m that is equivalent to 1000 m. w. e. The background spectrum of 116 cm HPGe detector for 1004 hours of running time is presented in fig. 1. One can see the only annihilation peak of 511 keV while other irregularities are not statistically backed. The most probable source of radioactivity could be beta-plus decay of Ga-68 from the Ge-68 decay that was produced in the Ge-70 (n, 3n)Ge-68 reaction while the germanium shielding and the detector itself were on the surface of the earth. The counting rate decreases in agreement with the known half-life of 280 days. The background level in the energy range of neutrinoless double beta-decay of Ge-76 (100 keV bin around the energy 2041 keV) is equal to 1.5 ± 0.5 (keV kg Year)$^{-1}$, while 70% of the background level is the result of Ge-68-decay. One can suppose that for a detector made of enriched Ge-76 (as a result of Ge-70 absence) the background would be a factor of 3 less. Therefore in the measurement using the HPGe-detector made of enriched Ge-76 in this istallation, it is possible to get data on the shape of the spectrum of the double-neutrino decay if the period is about 10^{21} years.

In the second stage we have built a new set-up which is capable of housing a germanium multidetector up to 20 kg of mass with the same shielding quality. The main parts of the installation are shown in fig. 2. It contains a flexible copper cold trap and a germanium thermal screen to preserve microphoning and thermal losses of the massive germanium detector holder. The FET and other nongermanium details are moved of under the multidetector shielding, which is a germanium monocrystal 170 mm thick. The set-up was examined on the surface of the earth with one HPGe-detector 0.62 kg in weight. The energy resolution measured for 2.6 MeV gamma transition in Tl-206 was 3.2 keV and that of the pulser being 2.05 keV (FWHM).

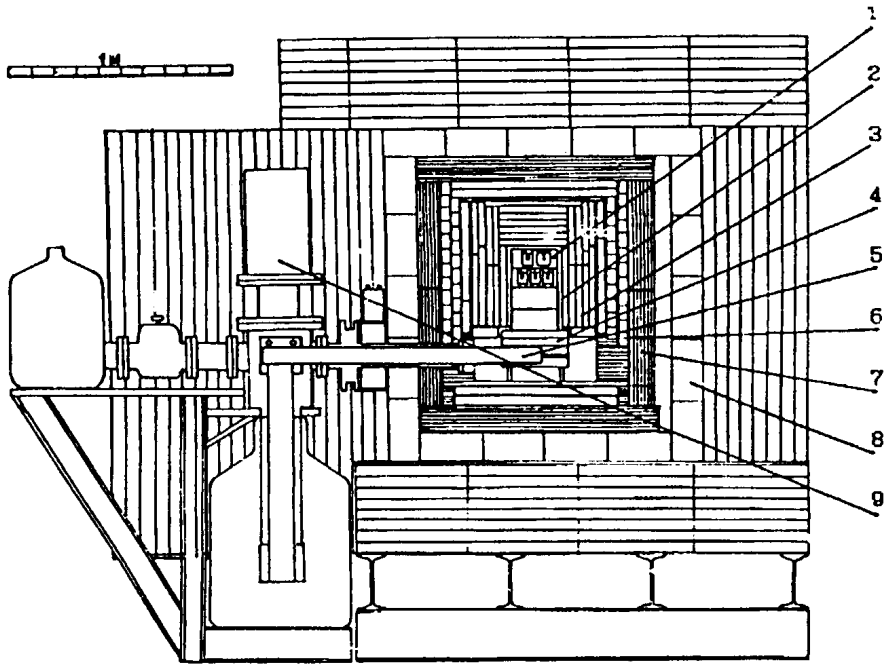

Fig. 2. Experimental arrangement scheme: detector holder (1); germanium termal screen (2); germanium shield (3); nitrogen cooled copper table (4); flexible foil copper cold trap (5); mercury, copper, polyethylen shield (6, 7, 8); ion-pump (9)

The arrangement is ready to be transferred to the Gran Sasso underground laboratory to start this experiment in 1990 in collaboration with the Max Plank Institute fur Kernphysik, FRG and the Kurchatov Institute of Atomic Energy, USSR.

REFERENCES

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2. *Popeko L. A. et al.* Pisma v JETP. Vol. 50. No. 5. P. 222 — 225.