PROGRAM OF RESEARCH INTO FUNDAMENTAL INTERACTIONS BY PIK REACTOR – PART IV: A STUDY OF ASYMMETRY OF NEUTRON BETA-DECAY

A.P. Serebrov[1], A.V. Vasiliev, O.M. Zherebtsov, A.N. Murashkin, S.V. Sbitnev, A.K. Fomin

B.P. Konstantinov Petersburg Nuclear Physics Institute, Gatchina, Russia

Measurement of the electron and neutrino asymmetries of neutron-beta decay with polarized cold neutrons on GEK-4' channel of the PIK reactor is to be carried out at the accuracy level of (1-2) 10^{-3}, as well as neutron life time measurement with accuracy of 1 s. The article describes preparation of the experiment.

Key words: polarized cold neutrons, asymmetries of beta-decay, superconducting solenoid

An experimental installation for measuring a neutron decay asymmetry has been elaborated (Fig. 1-4) [1]. The basis of an experimental installation is a superconducting solenoid, with the magnetic field strength being 0.35 T in the area of a homogenous field, and with intensity being 0.80 T in the area of a magnetic mirror at current of 1000 A. Correlation coefficient A in a neutron beta decay is measured owing to magnetic collimation of the angle of electron escape and averaging over one of neutrino escape. Magnetic collimation is carried out by a magnetic mirror, while averaging over the angle of neutrino escape is made owing to collection of all protons from a neutron beta-decay with a spread electric potential. The neutron wave length in the beam is limited, from below (7 Å), to a bismuth filter inside the channel for suppressing gamma-background. Creation of polarization of a neutron beam and its analysis can be made with polarized He-3 cells. To avoid edge effects, associated with brownout of voltage at boundaries of electrostatic system, the time-flight technique with a beam chopper and a velocity selector are suggested to be used. It will enable to determine area of neutron decay. Application of crossed electric and magnetic fields causes protons and electrons to separate. Knowing the point of neutron decay and using the time-of-flight technique for protons, a longitudinal component of the proton momentum can be measured. Thus, it will allow pass over to measuring the neutrino asymmetry B. Finally, the time-of-flight neutron technique makes it possible to make measurements of a neutron lifetime - τ_n, in

[1] Serebrov Anatoliy Pavlovich
Russia, 188300, Leningrad district, Gatchina, Orlova Roscha, PNPI
Тел.: +7 81371 46001
Факс: +7 81371 30072
E-mail: serebrov@pnpi.spb.ru

addition to measuring an electron asymmetry. Measuring neutron lifetime will require absolute measurements of a neutron flux, which presents not a simple and separate task.

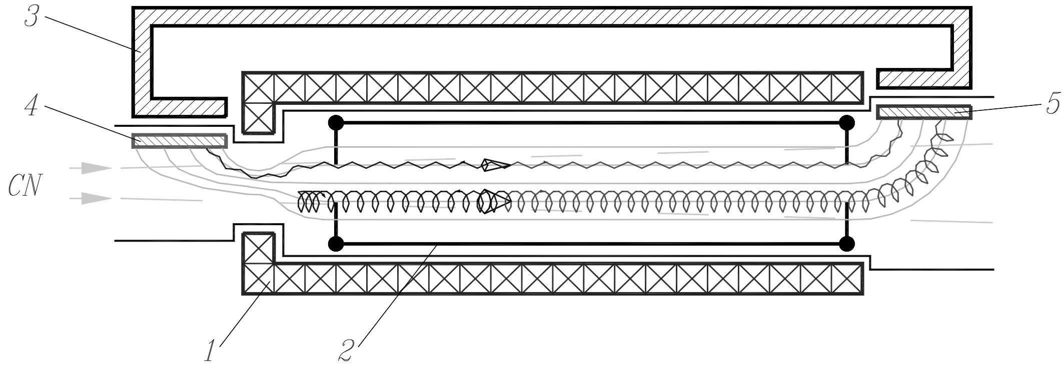

Fig. 1. An experimental scheme for measuring an electron asymmetry of neutron decay. The neutron beam is polarized with He-3 polarized cells, it passes through a flipper and after a collimator gets into the area of decay, restricted by the electrodes. All protons are pulled out of the area of neutron decay by an electric field and get onto the detector (5). Electrons move onto the detector (4). 1 – a superconducting solenoid with a magnetic mirror, 2 – a cylindrical electrode, 3 – a ferrum yoke, 4 – an electron detector, 5 – a proton detector.

Fig. 2. Creation of an installation for measuring asymmetries of a neutron decay. (Superconducting solenoid, helium cryostat.)

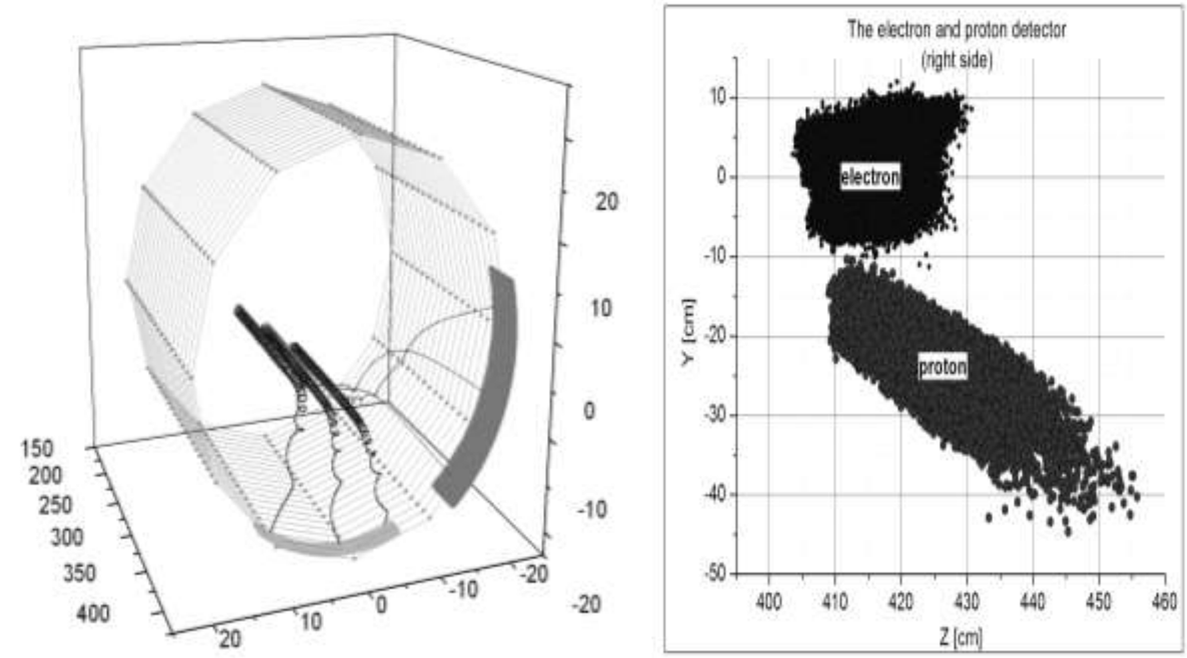

Fig. 3. A scheme of separation of electrons and protons in crossed electric and magnetic fields.

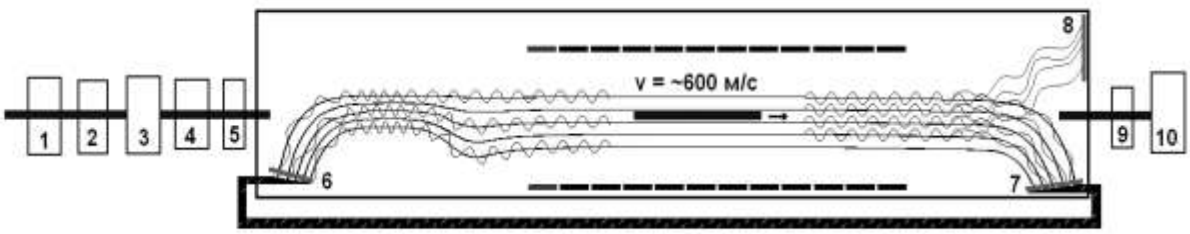

Fig. 4. An experimental scheme employing the neutron time of flight technique to detect a neutron decay point. 1 – a velocity selector, 2 - ^{3}He polarizer, 3 – a beam chopper, 4 – a spin-flipper, 5 – a thin neutron detector, 6 – an electron detector, 7 – an electron detector, 8 – a proton detector, 9 – a neutron detector, 10 – a beam polarization analyzer.

Thus, the installation under construction enables to conduct complex research of a neutron decay: measurement of asymmetries *A* (electron) and *B* (neutrino) with relative accuracy (1-2)·10^{-3}, as well as neutron lifetime with accuracy 1 s.

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