Referee's comment on the project GEMMA-III
(Investigation of neutrino properties
with the low-background germanium spectrometer GEMMA-III, 2019-2021)

The goal of the GEMMA-III project is to study the fundamental parameters of neutrino. Within the initial formulation of the Standard Model neutrinos are massless particles. However, already now it is known that the Standard Model should be extended to some more general theory in particular because of neutrinos which are the only particles exhibiting experimentally well-confirmed properties beyond the Standard Model. In many extensions of the Standard Model which account for neutrino masses and mixings neutrinos acquire nontrivial electromagnetic properties that hence allow the direct electromagnetic interactions of neutrinos with electromagnetic fields and charged particles or with particles which have magnetic moments. Unfortunately, in the easiest extension of the Standard Model a tiny value for the neutrino magnetic moment is predicted at the level less than $\sim 10^{-19}$ Bohr magneton. In addition, in spite of reasonable efforts in studies of neutrino electromagnetic properties, up to now there is no experimental confirmation, neither from terrestrial laboratory studies nor from astrophysical observations in favor of non vanishing neutrino electromagnetic characteristics. However many experimenters and theoreticians really believe that the neutrino have much greater magnetic moment values and are eagerly searching for it. Therefore, neutrino magnetic moments, once being experimentally confirmed, will open a window to new physics beyond the easiest extension of the Standard Model.

As the primary result of the GEMMA-I phase of the project the best world terrestrial experiment upper limit on the neutrino effective magnetic moment has been obtained as 2.9×10^{-11} Bohr magneton. The discussed next phase of the GEMMA project (GEMMA-III) is aimed for the further increase of sensitivity to the neutrino magnetic moment and will reach the level of about $\sim 9.0\times10^{-12}$ Bohr magneton. This seems quite a reasonable and attainable goal for the GEMMA collaboration. The claimed limit on the neutrino magnetic moment will be reached because of reasonable improvements in characteristics of the GEMMA-II experimental setup in respect to those of GEMMA-I. The most important, in particular, are the following:

1. increasing by factor 2 in the total neutrino flux at the detector because of much closer position of the detector to the reactor core;
2. increasing by factor 3.7 in the total mass of the detector;
3. decreasing of the energy threshold from 2.8 keV to 200 eV.

Furthermore, the experimental setup will be located in the new position (room) with much better (by an order of magnitude) γ-background conditions and will be installed on a moveable platform. The later gives an opportunity to vary on-line the neutrino flux and thus suppress systematic errors.

Due to new low-threshold germanium detectors it will become possible to study the another interesting effect – coherent elastic neutrino-nucleus scattering (CENNS). This process is predicted by Standard Model and recently was observed in accelerator by COHERENT collaboration. It was never observed for the reactor neutrinos, so it would be interesting to compare the obtained results. Due to a very high resolution of new detectors (production of CANBERRA) it will be possible to decrease an energy threshold till 200 eV which makes such detection possible. It is expected to have about 200 events per day from CENNS, so GEMMA-III project can investigate this process with a high precision and put a limit on non-standard neutrino interactions. Some other interesting investigations including sterile neutrino search or reactor monitoring are possible within this project.

The JINR team of the GEMMA-II project has an ample experience in carrying out the first-rate experiments in physics of low-energy weak interactions and there is no doubt that the proposed project can be successfully implemented and thus deserves all possible support.

Prof. S.A. Voronov
National Research Nuclear University MEPhI
(Moscow Physics Engineering Institute)
e-mail: sergvor@gmail.com