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Evaluation of the SuperNEMO project: **Investigation of the 2β-decay processes of ^{82}Se with the SuperNEMO detector**

To whom it may concern

The SuperNEMO project is an ambitious enterprise to measure the Majorana mass of the neutrino in neutrinoless double beta ($0\nu2\beta$) decays. At the moment these nuclear decays are the only viable way to access the Majorana nature and mass of the neutrino. The absolute mass scale of the neutrino is not known and only squared mass differences are known from the neutrino-oscillation experiments. Since neutrinos do have mass there is a need to go beyond the standard model of electro-weak interactions and thus the study of the beyond-standard-model physics has been actively pursued by the particle-physics and neutrino-physics theorists all over the world. Despite the huge theoretical efforts dedicated to double beta decay and its various possible mechanisms the field is driven by the experiments. There is an ever expanding community trying to solve the difficulties with the nuclear matrix elements related to the $0\nu2\beta$ decays, partly by exploiting the data accumulated for the $2\nu2\beta$ half-lives. In the field of the $2\nu2\beta$ half-life measurements the NEMO-3 collaboration has for long played a leading role due to its ability to access several different nuclear sources: ^{48}Ca, ^{82}Se, ^{96}Zr, ^{100}Mo (ground and excited states), ^{116}Cd, ^{130}Te and ^{150}Nd. The NEMO-3 installation has been used to measure both the $2\nu2\beta$ and $0\nu2\beta$ decays for the mentioned nuclei and thus far the NEMO-3 equipment has been quite competitive when compared with the past and presently running $\beta\beta$ experiments (Cuoricino, CUORE, SNO+) on the same nuclei. Beyond the nuclei of interest for the NEMO collaboration there are measurements for ^{76}Ge (GERDA, MAJORANA) and ^{136}Xe (EXO, KamLAND-Zen).

The detection of the $0\nu2\beta$ decay in atomic nuclei is of paramount importance for the fields of nuclear, neutrino, particle and astroparticle physics. As stated before these fields are served by the $0\nu2\beta$-decay experiments, the NEMO-3 collaboration playing a decisive role in these efforts. The field of $0\nu2\beta$ measurements is very dynamic and new experiments are being planned

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quite actively. Also the NEMO-3 collaboration and its experimental installation needs to be renewed and this has started already by the establishment of the SuperNEMO collaboration aiming at a SuperNEMO installation in the Modane Underground Laboratory. One or more of the presently running and near-future $0\nu2\beta$ experiments have good chances to detect this decay mode. Then verification of this break-through measurement by other experiments, using different nuclear sources, is needed before the Nobel price can be donated to the finders of $0\nu2\beta$ decay. Also the SuperNEMO collaboration takes part in this ever intensifying race of finding and verifying the existence of the Majorana nature of the neutrino and the associated breaking of the lepton-number conservation. The presently introduced project "Investigation of the 2β-decay processes of ^{82}Se with the SuperNEMO detector" paves the way to the full SuperNEMO installation and its highly competitive role in the race to detect the $0\nu2\beta$ decay in ^{82}Se or some other nucleus suitable for the full-scale SuperNEMO installation. The SuperNEMO Demonstrator is a necessary intermediate phase towards the full-blown detector in order to verify the detector specifications for the large-scale detector that will be assembled together from modules based on the design of the Demonstrator.

The SuperNEMO demonstrator and the full-scale SuperNEMO installation are unique in the field of experimental investigations of the $0\nu2\beta$ decay due to their combined tracking and calorimetric capability. Based on these capabilities a full reconstruction of the decay events is possible and one can learn about the individual energies and angular correlations of the emitted electrons. This, in turn, is required in order to have sensitivity to the eventual mechanism behind the $0\nu2\beta$ decay (Majorana mass, right-handed currents, Majoron, supersymmetry, etc.). Hence, if/when detected, the $0\nu2\beta$ continues to attract interest beyond the first detection by verifications by other experiments and by attempts to unveil the mechanism(s) responsible for the decay. In the latter race the SuperNEMO is the winner since it is the only experiment capable of full event reconstruction and thus the only experiment sensitive to the decay mechanism. As witnessed by the achievements of the NEMO-3 detector, having the same capacity of full tracking as the planned SuperNEMO Demonstrator and the full-fledged installation, the technology is proven feasible and scalable to larger size. The NEMO-3 collaboration is undoubtedly full of world leading experts on construction of such devices and considerable part of this expertise is coming from the laboratories in Dubna, Russia. As with the NEMO-3 installation, also with the SuperNEMO Demonstrator and SuperNEMO full installation a considerable part of the effort is entrusted to the people from Dubna. The proposers of the present project are outstanding scientists with long-term experience in experimental neutrino physics, measurements in underground laboratories, production of decay sources for the measuring devices and

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construction of cutting-edge scientific instruments. The SuperNEMO project will certainly become one of the flagships of the Dubna laboratories, beside the production of new super-heavy elements, due to its potential to discover the Majorana nature of the neutrino.

In my opinion, the SuperNEMO Demonstrator project is highly beneficial to the outside visibility of the Dubna laboratories and for the continuation of the high-level scientific work pursued there. This Demonstrator is of paramount importance in paving the way to the full-scale SuperNEMO detector, a research instrument which is highly competitive and unique in the field of experimental underground science aiming at a breakthrough in particle and astroparticle science. I thus full-heartily recommend the approval of the proposal by the Scientific Council of the Laboratory of Nuclear Problems and by the Program Advisory Committee (PAC) of JINR.

Yours sincerely

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