

Referee report on the COMET experiment (JINR participation)

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The reports given to the Program Advisory Committee of JINR on 3 February 2020 outline the proposal submitted by JINR researchers to carry on activities on muon physics, to search for tiny effects possibly pointing to the existence of new physics, through the study of Lepton Flavor Violating reactions, for the years 2021-2023. This would be done within a new theme: Search for New Physics in the Charged Lepton Sector, including three projects.

The first is the COMET experiment at J-PARC in Japan, which aims at a sensitive search for lepton flavor violating neutrinoless conversion of muons into electrons in the nucleus field ($\mu^- + N \rightarrow e^- + N$). The experimental sensitivity goal for this process is order of 10^{-15} for Phase-I and 10^{-17} for Phase-II, which is a large factor of improvement over existing limits. COMET is scheduled to proceed through Phase-I and Phase-II experimental schedules. The JINR group intends to contribute to the R&D work and the construction of two sub-detectors, namely the ECAL and the straw tracker system. The first contribution deals with tests and characterization of LYSO crystals that will constitute the calorimeter. The work for the straw tube system is more qualifying, since it will eventually include the realization of a construction facility at JINR for both phase I and II. The COMET group is large, 24 heads, with an excellent fraction of FTEs of 15.4. With such a number of FTEs the JINR group should be relatively more visible and ambitious within the COMET collaboration and take more and well identified construction and data analysis responsibilities. Last year, after the general review of neutrino and muon physics experiments, COMET was assigned to the second priority category B.

JINR is also involved in an experiment at Fermilab, in preparation, Mu2e, also looking for small deviations from the SM possible indications of new physics, notably through the same highly suppressed reaction studied by COMET. The project is at the forefront of the international research in the field. The hardware contributions include two main items: the cosmic ray veto (CRV) and the crystal ECAL. The main highlights for the work for Mu2e are the collaboration with Virginia Univ. for the realization of the CRV and some R&D on crystals. Apart from the institutional representation there are no specific responsibilities of the JINR researchers. The future plans for Mu2e include the production of CRV modules at Virginia and the realization of test stands at JINR for electronics and CRV modules. The group includes 20 heads for a total number of FTEs of 10.6, which is reasonable. The question is if the proposed activities are commensurate to such a large group consistency. The quality of the group is not backed up by an adequate level of responsibility within the international collaboration. In 2019, after the general review of neutrino and muon physics experiments, Mu2e was assigned to the third priority category C. Last but not least, for this experiment one is confronted to issues related to the collaboration of JINR colleagues in USA.

Finally, the MEG-II experiment at PSI in Switzerland, for which we have the participation of 12 scientists for a total number of 6.4 FTEs. The purpose of the experiment is a search for the forbidden decay $\mu \rightarrow e + \gamma$ at the sensitivity level of $\sim 5 \times 10^{-14}$. The expected contributions only include maintenance work (drift chambers), software activities for event display and DAQ, simulations and possibly data analysis.

In conclusion, the referee:

- 1) supports the decision to establish a new research theme on such a hot scientific topic and to provide the necessary resources for a long-term, visible JINR participation.
- 2) thinks that to execute the above strategy, one should aim at four main goals: a concrete hardware contribution (well identifiable detector sub-systems), strong involvement in the main physics analyses, visible responsibilities within the collaboration, commensurate and vibrant participation of young researchers and students.
- 3) has the general feeling that time is not mature to give green light to the three experiments until 2023. One is still lacking clear commitments, *e.g.* with written MoUs, and a convincing project plan regarding point 2). These features would represent qualifying and mandatory conditions for the establishment of a novel and ambitious science theme at JINR.
- 4) would recommend identifying a.s.a.p. one flagship project for which points 2) and 3) could be well addressed and a firm decision taken within a period of one year. During this time slot the situation of additional projects could be better clarified. Funding should be granted now to all projects for this specific purpose. At regime, JINR would be better involved in only two experiments, as much complementary as possible, with a well identified scientific and strategic priority.
- 5) considers that, sticking to the situation as of today, the COMET project at J-PARC is the one most promising in view of the timely fulfillment of requirements 2) and 3).



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