Referee report

on proposal of JINR participation in the project extension COMET@J-PARC for the period 2022-2024

"Search for new physics in the charged lepton sector"

Discovery of neutrino oscillations shows that lepton flavor conservation strongly violated in the neutrino sector. In the Standard Model (SM) this violation can be explained through the addition of nonzero neutrino masses, and thus SM must be extended. Nevertheless, up to date this is the only experimental fact. At the same time in some versions of extended SM, it is natural to expect existence of the charged-lepton flavor violation (CLFV) processes. The found smallness of the neutrino squared mass difference strongly suppresses SM contributions to the CLFV processes, which is practically unreachable at experimental facilities. On the other hand, beyond SM the CLFV processes could occur with higher probability due to interactions at characteristic energy scale of New Physics Λ. This carries the fundamental sense of experimental search for CLFV processes, where this search is the important low energy test of SM and the method to look for New Physics.

One of the most promising process provided by experiments that utilize high intensity muon beams to search for CLFV are the $\mu \rightarrow e$ transitions. Currently there are few competitive projects on measurement of $\mu \rightarrow e$ conversion: MEG at PSI for the process $\mu^+ \rightarrow e^+\gamma$, Mu3e at PSI for the process $\mu^+ \rightarrow e^+e^-e^+$, Mu2e at Fermilab and COMET at J-PARC for coherent neutrinoless conversion of a muon to an electron in the field of a nucleus $\mu^- N \rightarrow e^- N$. All these projects have extremely high sensitivity of measurements and plan to improve the previous upper limits by three-four orders of magnitude.

Experiment COMET (COherent Muon to Electron Transition) at J-PARC focused at search for neutrinoless, coherent conversion $\mu^- + Al \rightarrow e^- + Al$ in a muonic atom of aluminum. It will be realized in two phases, Phase-I (C-shape beam line) and Phase-II (S-shape beam line). Current limits for single-vent sensitivity (SES) in CLFV $\mu \rightarrow e$ transitions are in the 10^{-12}– 10^{-13} range and probe effective new physics mass scales $\Lambda > 10^3$ TeV/c^2, far beyond the direct reach of colliders. Next-generation experiment COMET on the timescale at 2023-2024 in Phase-I expects to improve these sensitivities by as much as two orders of magnitude. The goal of the full experiment at 2026-2027 in Phase-II is a SES of $\approx 2.6 \cdot 10^{-17}$. This dramatic improvement in sensitivity offers genuine discovery possibilities in a wide range of new physics models.

The purpose of the current project extension is continuation in participation of the physicist team from JINR in COMET@J-PARC experiment. In the reported period (2019-2021) the JINR group successfully fulfilled its obligations concerning construction of the detector. This group includes scientists from Russia and from the JINR member states as well. The main efforts of the JINR group for the next period will be in participation in creation and maintenance of the straw tracker stations with 9.8 mm straw for COMET Phase-I, electromagnetic calorimeter, participation in simulation and data analysis. More specific plans of JINR team for the COMET experiment is to participate in LYSO crystals QA tests; participation in the CRV R&D, design and construction; assemble

and maintenance of the COMET setup; participation in shifts; R&D and production of the 5 mm straw for 1-st and 2-nd phases of COMET experiment.

Summarizing, and taking into account undoubtedly valuable expected scientific results, I recommend extending the participation of the JINR team in experiment COMET@J-PARC for the period of 2022-2024 with first priority.

Leading scientific researcher, BLTP JINR

Doctor of Science in physics and mathematics A.E. Dorokhov

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Подпись сотрудника
Объединенного института
ядерных исследований
Дорохова А.Е.
УДОСТОВЕРЯЕТСЯ
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Объединенный институт ядерных исследований