Review
of the JINR group project extension
"Search for new physics in experiments with the Fermilab high-intensity muon beams"

The tests of the Standard Model (SM) and the search for new physics (NP) are the fundamental goals of modem elementary particle physics. There are two strategies for the experimental search for NP: experiments at high energies and measurements at low ones. An example of the first strategy is the current Large Hadron Collider, which has wide horizons of our understanding of the SM. The examples of the other strategy are the current and planned experiments at low energies. All experiments can not only complementary establish limits on parameters of various NP models but also may help us to discover and study properties of hypothetical particles. The planned experiments at Fermilab, g-2 and Mu2e, just belong to the second type. The anomalous magnetic moments of the electron (AMME) and the muon (AMMM) are among the most accurately measured values in elementary particle physics.

The results of the AMMM measurements at Brookhaven (USA) published in 2006 had an accuracy of about 0.54 ppm. Currently, the measurement of the anomalous magnetic moments of leptons (AMML) are one of the main tests of the low-energy SM and play an important role in the search for manifestations of NP. In the SM AMML determined by the contributions of the radiative corrections induced by electrodynamics, weak and strong interactions. Up to now there is a discrepancy between the AMMM of the SM predictions and the direct measurements at the level of 3.6 standard deviations. This is the largest deviation from the SM predictions and the measurements. The planned g-2 experiment at Fermilab has a goal to achieve accuracy 4 times better than the existing result. The competitive project is the g-2 at the J-PARC (Japan), which uses the beam of ultracold muons.

The discovery of neutrino oscillations has allowed us to establish the fact that the lepton flavor number is not conserved. This means that neutrinos have masses and the SM should be expanded. Up to now it is a single experimental fact. However, in the extended versions of the SM it is natural to expect that the lepton flavor is also violated in the charged sector. The little difference discovered between the squares of the neutrino masses leads to the fact that the SM processes in which the lepton number is violated in the charged sector are most unlikely and almost unattainable at the experimental setups. On the other hand, beyond the Standard Model the processes with charged leptons may be more likely due to interactions in a characteristic energy scale of Λ. This is the fundamental meaning of the experimental results with the flavor number violation in processes involving charged leptons, which becomes the important low-energy test of the SM and the way to search for New Physics. One of the most promising reactions is the coherent neutrinoless conversion of the muon into an electron on nuclei ($\mu^- N \rightarrow e^- N$). There are currently two competing specialized measurement projects on $\mu^- \rightarrow e^-$ conversion, it is Mu2e at Fermilab (USA), and COMET at the J-PARC (Japan). Both projects have the highest measurement sensitivity and plan to reduce existing upper limits of the conversion branching ratios on nuclei, by 3-4 orders of magnitude.

This project involves participation of a group of specialists from JINR at the Fermilab experiments to search for new physics. This group includes scientists from Russian institutes and JINR Member States.

It is worth noting the project author team made a big contribution to the experiments MEG, PEN,CDF. The authors of the Mu2e experiment contribute strongly to the multiple tests of the LYSO, CsI, BaF2 crystals and the simulation of their characteristics which allows the collaboration to make the final decision about the assemble of the 1st phase of the Mu2e calorimeter on pure CsI crystals. The authors also played a significant role in the R&D on the design of cosmic ray veto counters (CRV) and modules. They have developed an algorithm of CRV modules assemblies.

The JINR group participates in the creation of the data collection system R&D for straw detectors for the Muon g-2 experiment.

Further plans cover the participation of JINR in the two subsystems of the Mu2e experiment: CRV and calorimeter. The design and creation of the stand for CRV modules quality assurance (QA) and performing this assurance for manufactured modules is a high priority task. The QA for CsI crystals from our Kharkov partner is also the authors'task.

The Muon g-2 experiment will collect data starting in 2018. The JINR colleagues are in charge of creating and supporting the visualization of the data acquisition system (DAQ) and data base system. The participation in this simulation and data processing is also planned for both experiments.

Taking into account the obvious high scientific value of the expected results, I recommend to approve the extension of the project to the period 2018-2020 with the first priority.

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