

Promotion of muon particle physics in an international framework

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Purpose and Significance of the Research

In this research, we promote particle physics with muon through a newly established international cooperative framework, aiming at discovering new physics beyond the standard model of particle physics. This research develops high-intensity muons, high-brilliance muon source, and detector technology to realize next-generation experiments that can elucidate the full extent of new physics. Through a series of research processes, we also aim to nurture talented young researchers who will lead the next generation of scientific research.

This research program is based on the collaboration among the Paul Scherrer Institute (PSI) in Switzerland, the International Center for Particle Physics (ICEPP) at the University of Tokyo, and the Japan Proton Accelerator Research Complex (J-PARC). The research program carries out two experiments searching for conservation violation of the muon charged lepton flavor number (cLFV) with the highest precision in the world (COMET and MEG II experiments) and ultra-precise measurements of anomalous magnetic moment (g-2) and electric dipole moment (g-2/EDM experiment). In addition to these experiments, we will examine the possibility of searching for muon rare processes and muon EDMs with higher sensitivity, as well as collider experiments of positive and negative muons and muon-electron collider experiments as a new plan to produce a large amount of Higgs bosons and enable precise measurements. The results of this research can be widely applied to material and earth science research, atomic physics and material science research, and semiconductor soft-error research.

Organization of the Project Team

The project team consists of researchers from KEK, PSI, and ICEPP. These laboratories have a long-standing cooperation for particle physics using muons (Figures 2 and 3). This collaboration allows development of the world's most intense and brightest muon source and detector technology to make use of them. This research will be conducted under a framework in which young researchers will take the initiative. The young researchers will develop a common technology for the next generation of particle research and its applications. ICEPP and PSI have been collaborating for 20 years through the MEG experiment and its successor, MEG II. KEK and PSI started a regular a workshop on technology related to muon and neutron under the agreement on academic exchange. The first workshop was organized in April 2022 (Figure 4). The project team is ready to start international collaboration on this research immediately.



Figure 2 Muon production target jointly developed by PSI and J-PARC



Figure 3 Muonium production target developed at KEK and used at PSI



Figure 4 KEK-PSI workshop on muon and neutron technology in April, 2022

Plan for Fostering Early-career Researchers

This research aims to provide opportunities for young researchers through the development of common experimental technology and exchange of researchers. In this international framework, young researchers will conduct research in all phases starting from planning, followed by implementation, evaluation, and publication. Young researchers will station at PSI or related institutions in Europe. Research funds be allocated to each development item. This will be used under the judgement of young researchers. Each research group will consist of about 5-10 young researchers, consisting of Japanese graduate students and graduate students from ETH Zurich, Switzerland, and the University of Pisa, Italy (Figure 5). The principal investigator and a co-investigator will join the team as mentors. Regular international workshops will be held to share the progress of the study. In addition, regular research presentations and roundtable lectures will be organized, mainly by young researchers and graduate students, to help them become proficient in English discussions. Through these efforts, we will nurture young researchers who will become the core of our country.



Figure 5 Young researchers at MEG II experiment at PSI



Figure 6 Regular workshop organized at PSI in every three years (many participants from this program)

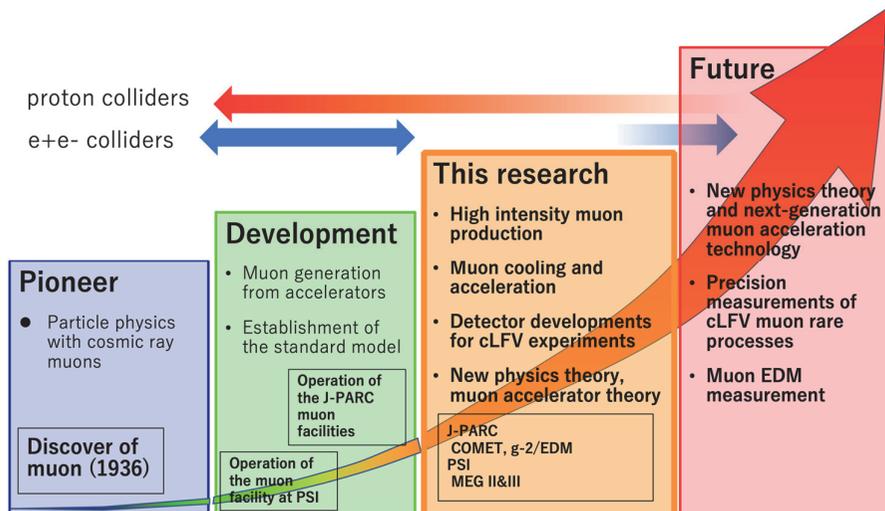


Fig.1 Role and vision of this research

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