Status of the J-PARC E16 experiment in 2020

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We proposed the experiment E16[1)] to measure the vector meson decays in nuclei in order to investigate the chiral symmetry restoration in dense nuclear matter. The experiment started at the J-PARC Hadron Experimental Facility.

This experiment aims to systematically study the spectral modification of vector mesons in nuclei, particularly the ϕ meson, using the e^+e^- decay channel with statistics that are two orders larger in magnitude than those of the precedent E325[2)] experiment performed at KEK-PS. In other words, it aims to accumulate 1×10^5 to 2×10^5 events for each nuclear target (H, C, Cu, and Pb) and deduce the dependence of the spectral modification on the size of matter and meson momentum.

A scientific ("stage-1") approval was granted to the experiment E16 by PAC in March 2007. For the full ("stage-2") approval, a technical design report was submitted to PAC in May 2014 and reviewed for experimental and budgetary feasibility. In the PAC meeting held in July 2017, the stage-2 approval for 320 hours of a commissioning run was granted. In this run, background measurement at the new beamline is required. The construction of High-momentum beamline, where the experiment will be conducted, has been completed by KEK in June 2020.

Our proposed spectrometer has 26 modules. As shown in Fig. 1, a module consists of Lead-glass calorimeter(LG) and Hadron-blind detector (HBD) for electron identification, as well as three-layers of GEM Trackers (GTR) and a single layer of silicon strip detecor (SSD) as the tracking devices. Owing to budget limitations, the commissioning run was started with a limited number of modules.

The first half of the commissioning run, called Run-0a, was successfully performed in June 4–20, 2020, with a configuration of 6(SSD)-6(GTR)-4(HBD)-6(LG) modules.[3)] The beam was delayed from February in the original plan, owing to a bureaucratic issue and possibly because of the COVID-19 pandemic, in the Nuclear Regulatory Agency, to issue the permission for the new beamline. As a user beamtime, 159 hours were executed, including 10-hours of downtime in total; each downtime was less than 30 min. (downtimes over 30 min were compensated). Here, "downtime" is due to problems caused by the accelerator or the beamline operation and not by users.

As the design, a primary proton beam with an intensity of 1×10^{10} protons per 2 sec duration (5.2 sec cycle) was delivered to our spectrometer. The interaction rate at the targets (C and Cu) is 10 MHz because the total interaction length of the targets is 0.2%. One of our concerns, GEM breakdown under a high particle rate, was not observed in HBD. In GTR, the breakdown of 13 strips was observed in 300-GTR, which caused approximately 11% of dead region in total, but operation was continued. The electron ID performance of HBD and LG were roughly confirmed.

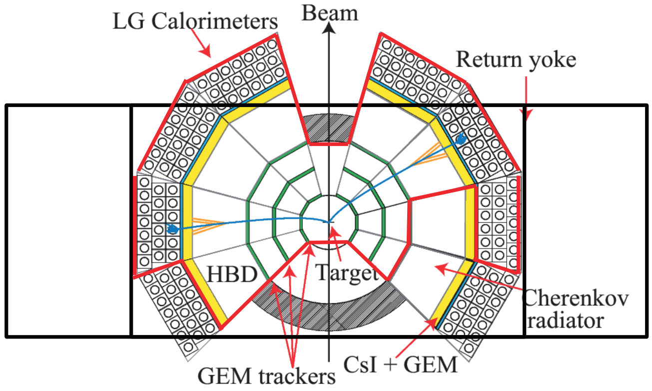

Fig. 1. Plan view of the proposed E16 spectrometer in the eight-module configuration for Run-1. The red lines show the parts that have been constructed as of December 2021, for the commissioning run planned for February 2021 (Run-0b). The SSD located in the innermost layer is not shown.

A background study was performed, and the LG single rate was found to be two times as high as the expectation, which is a scaled value of the E325 experiment. However, a factor of two is within the designed margin. The origin of the background will be studied to improve the situation.

As of January 2021, the second half of the commissioning run, Run-0b, is scheduled for February 2021. GTR and HBD were uninstalled from the spectrometer after the Run-0a, and refurbished in J-PARC and RIKEN, respectively. Additionally, two GTR and two HBD modules were newly constructed, and installed in November–December 2020 along with the refurbished ones. Consequently, a 6(SSD)-8(GTR)-6(HBD)-6(LG) were installed, as shown by the red lines in Fig. 1.

After Run-0b, Run-1 (physics run) is planned for autumn 2022. Its approval should be obtained at the J-PARC PAC. We have to update the technical design report for Run-1 based on the result of Run-0 and submit by December 2021, following which discussion will be conducted at the PAC held in January 2022.

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References
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