

Status of the J-PARC E16 experiment in 2021

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We proposed the experiment E16¹⁾ 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 prior E325²⁾ 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 nucleus and meson momentum. The number of modified mesons could be larger for larger nucleus and lower meson momentum because the decay probability inside the nucleus is enhanced for such cases.

Our proposed spectrometer consists of 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 detector (SSD) as the tracking devices.

The first commissioning run of E16 experiment, called Run-0a, was successfully performed in June 4–20, 2020, with the newly constructed ‘High-momentum beam line.’³⁾ Owing to budget limitations, a limited number of modules were installed in the commissioning run.

The second half, called Run-0b, was performed in Feb. 11–28, 2021, with the newly installed modules, namely, 6(SSD)-8(GTR)-6(HBD)-6(LG) modules. Unfortunately, the beam time was aborted, after only 109.5 h of execution, because of a malfunction of MR ESS.^{a)} To compensate for the unexecuted beam time, Run-0c was performed in May 29–June 9, 2021, for 134 h. In these two runs, 28 and 46 TB of raw data were recorded. In our beam time, approximately 24 h were required to start-up the GEM-detectors under the beam environment. The beam intensity was gradually increased during this period, and the amplification voltage of GEM was also increased carefully to avoid discharges. Furthermore, another 24 h were required to confirm the satisfactory performance of electron ID counters. Thus, for each divided beam time, we required at least 48 h for the tuning of the GEM-detectors.

In Run0-c, we made the two-electron trigger to accumulate the physics data, and found the DAQ live time was reduced to 15%, which contradicted with the measured DAQ dead-time length and trigger accept rate. This was caused by the higher trigger-request rate, localized in time, over the Poisson distribution, owing to

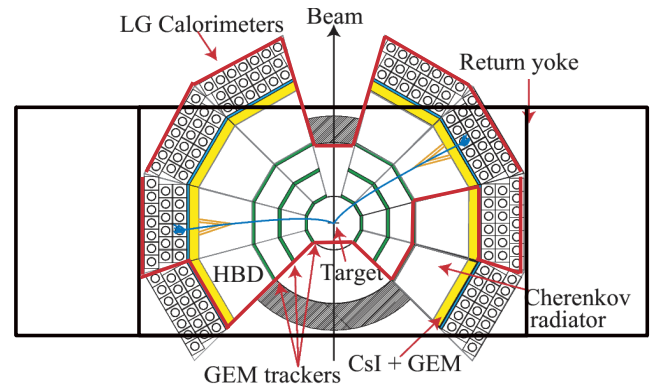


Fig. 1. Plan view of the E16 spectrometer in the eight-module configuration for Run-1. The red lines show the parts that have been operated in Run-0b/c in 2021. The SSD located in the innermost layer is not shown.

the beam micro structures of 5 ms and 5.2 μ s cycles. The latter was newly found in this beam line, while the former was also observed in another beam line (K1.8) with lesser strength. As a result of our analysis, origins of both structures were estimated, and countermeasures were prepared. Moreover, DAQ upgrade to reduce the data transfer time is on-going, and the live time is 55% in the simulation, assuming the present beam structure. If the structures are reduced, the live time is recovered to 75% or more.

After Run-0c, the HBD and GTR were uninstalled for maintenance, including exchange of the damaged GEMs. The maintenance of the GTR is performed in J-PARC, whereas the HBD maintenance should be performed at the Main Bldg. in RIKEN Wako, using an N_2 -filled glove box located in a class-1000 clean room. In November 2021, two LG modules are newly installed in the spectrometer. Re-installation of the GTR (HBD) will be completed in Aug. (Nov.) 2022.

The next beam time of J-PARC is planned to start in Dec. 2022, or later. Before Run-1 (physics run), we plan to perform a beam study to check whether the countermeasures can improve the DAQ performance, in cooperation with Beam line group and accelerator group at J-PARC. Subsequently, Run-1 could be performed. This plan has not been endorsed by PAC yet, thus a review will be performed in 2022.

References

- 1) S. Yokkaichi *et al.*, J-PARC proposal No. 16 (http://j-parc.jp/researcher/Hadron/en/pac_0606/pdf/p16-Yokkaichi_2.pdf); S. Ashikaga *et al.*, JPS Conf. Proc. **26**, 024005 (2019).
- 2) R. Muto *et al.*, Phys. Rev. Lett. **98**, 042501 (2007).
- 3) S. Yokkaichi, RIKEN Accel. Prog. Rep. **54**, 107 (2021).

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^{a)} J-PARC 30-GeV Main Ring Accelerator, Electro-static septum for the slow extraction.