Status of the J-PARC E16 experiment in 2022

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

The proposed spectrometer comprises 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.

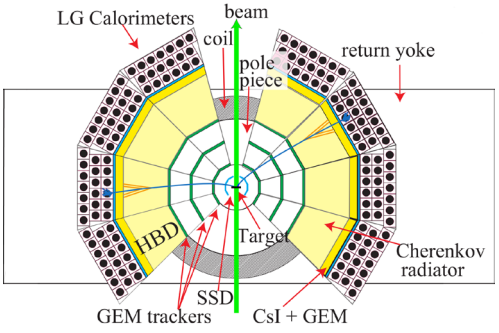

Fig. 1. Cross-sectional plan view of the E16 spectrometer in the eight-module configuration for Run-1.

Commissioning runs, in total 403 hours as summarized in Table 1, were performed in 2020-21 at the newly constructed 'High-momentum beam line'.[3] Owing to budget limitations, a limited number of modules were installed in the commissioning runs. In these runs, electron identification performance was confirmed.[4] The read out circuit for the data collection is described in Ref.[5]

In the next beam time planned in 2023, full eight modules shown in Fig. 1 will be operated. In the previous runs, six modules of SSD was borrowed from J-PARC E07 group. However, they will be replaced by the newly developed eight modules with the cooperation of the CBM group at GSI.

Table 1. Run-time summary. Run-0d demonstrates prospect.

	Run-0a 2020	Run-0b 2021	Run-0c 2021	Total	Run-0d 2023
Period	6/4-20	2/11-28	5/28-6/9		(5-6)
Days	17	18	12	47	
Beam time (h)	159	110	134	403	100
Raw data (TB)	33	28	46	97	-

The major issue detected in the commissioning runs is the micro beam structures, which deteriorate the DAQ performance[3] due to the time-localized high beam intensity. It was typically ten times as high as the nominal value of the beam intensity. In other words, the typical beam rate is 5 GHz because the intensity is 1×10^{10} protons per 2 sec duration; however, the actual beam rate increased to 50 GHz locally due to the micro structures.

Some countermeasures have been discussed and will be applied in the next beam time. Before Run-1 (physics run), we plan to perform a beam study to check whether the countermeasures can improve the DAQ performance, and construct the acceptable trigger rate by tuning threshold, coincidence pattern and time window, and beam intensity, with the upgraded DAQ system.

In Aug. 2022, our proposal for Run-1 based on the updated technical design report was reviewed. The approval for Run-1 was deferred, and only 200 hours of beam time was approved for the beam study (101 hours) and trigger study (100 hours) as mentioned above.

In J-PARC, an upgrade work of MR[a] was performed from 2021 summer (just after the Run-0c) to 2022 autumn, and a test operation of MR had started. Owing to the malfunction of the septum magnet and so on, we expect the next beam time, namely, a slow extraction beam for users, in May 2023 at the earliest case.

References

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3) S. Yokkaichi, RIKEN Accel. Prog. Rep. **55**, 54 (2022).
4) S. Nakasuga *et al.*, Nucl. Instrum. Methods Phys. Res. A **1041**, 167335 (2022).
5) T. N. Takahashi *et al.*, IEEE Trans. Nucl. Sci. **68**, 1907 (2021).

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a) J-PARC Main Ring Accelerator