Preparation status of the J-PARC E16 experiment in 2018

S. Yokkaichi[*1] for the J-PARC E16 Collaboration

We have 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 will be performed at the J-PARC Hadron Experimental Facility. Scientific ("stage-1") approval was granted to the experiment E16 by PAC in March 2007. For the full ("stage-2") approval, the demonstration of experimental feasibility and the prospects of acquiring sufficient funds and beam-line construction are necessary. Therefore a technical design report was submitted to PAC in May 2014, which was revised twice according to the requirements of PAC. The most recent revision was submitted to PAC in Jan. 2017.

In the PAC held in Jul. 2017, stage-2 approval for the 40 shifts (320 hours) of a commissioning run was granted. In this run, the background measurement at the new beamline should be performed. The high-momentum beam line, where the experiment will be conducted is being constructed by KEK. As of Jan. 2019, the target date of the first beam and our commissioning run is between Jan. and Apr. in 2020, depending on the budgetary status of KEK.

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 modification the size of matter and meson momentum. The e^+e^- decays of the ρ, ω, and J/ψ mesons can be measured simultaneously. Their yields depend on the trigger condition required to suppress the background e^+e^- pairs.

In order to increase the statistics by a factor of 100, we plan to use a 30-GeV primary proton beam with an intensity of 1×10^{10} protons per beam pulse of 2-sec duration and 5.52-sec cycle, in the high-momentum beam line. We also use 0.2%-interaction targets that produce an interaction rate of 10 MHz at the targets.

Our spectrometer has 26 modules. Owing to budget limitations, our first goal of the staged construction plan is to construct eight modules, which approximately covers one third of the full acceptance. With the eight-module configuration, we proposed Run-1 with 160 shifts (1280 hours) of physics run after the commissioning run. In the Run-1, we will be able to accumulate the statistics as six times as that of E325 and obtain the velocity dependence of spectral modification in the Cu target, as shown in Fig. 1.

*1 RIKEN Nishina Center

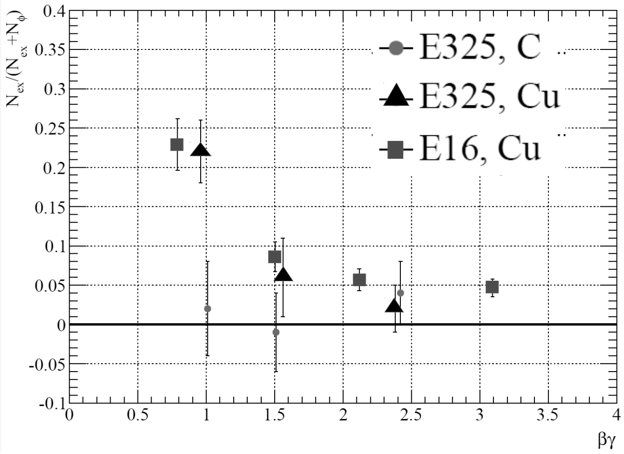

Fig. 1. Expected signal of the spectral modification of ϕ in Run-1. As the measure of the modification, the ratio of excess amount to the amount of mesons in ϕ-peak is examined and plotted as a function of $\beta\gamma$ of the mesons.

The development of detectors and front-end modules has been completed. We have proceeded the production of detectors such as GEM Tracker (GTR) for tracking,[3] Hadron Blind Čerenkov detector (HBD),[4] and Lead-Glass calorimeter (LG) for electron identification. We joined the RD51[5] collaboration in CERN that aims to develop multi-pixel gas detectors including GEM. We use SRS, which is a readout-system developed by RD51, for GEM readout. For LG readout, a front-end module that uses the DRS4 chip[6] has been developed by ourselves.

The development of trigger electronics is still underway.[7] Test of the amp-shaper-discriminator boards to generate the trigger signal at GTR and HBD are in progress toward the production planned in Apr. 2019. The firmwares on the trigger logic and distribution modules are also under construction toward the integrated test planned in May 2019.

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`),Y. Morino *et al.*, JPS Conf. Proc. **8**, 022009 (2015). Y. Komatsu *et al.*, JPS Conf. Proc. **12**, 020005 (2017).
2) R. Muto *et al.*, Phys. Rev. Lett. **98**, 042501 (2007).
3) W. Nakai *et al.*, RIKEN Accel. Prog. Rep. **49**, 195 (2015).
4) K. Kanno *et al.*, Nucl. Instrum. Methods Phys. Res. A **819**, 20 (2016).
5) `http://rd51-public.web.cern.ch/RD51-Public/`.
6) `https://www.psi.ch/drs/drs-chip/`.
7) T. N. Takahashi *et al.*, J. Phys. Conf. Ser. **664**, 082053 (2015).