Preparation status of the J-PARC E16 experiment in 2016

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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 approval, we were required to demonstrate the experimental feasibility and show the prospects of acquiring sufficient funds and of beam-line construction. Toward the full approval, the technical design report was submitted to PAC in May 2014, and the revision was performed twice, as per the requirements of PAC. The most recent revision has been submitted to PAC in Jan. 2017.

The aim of the experiment is to perform to systematically study the spectral modification of vector mesons, particularly the ϕ meson, in nuclei by 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, the aim is to accumulate 1×10^5 to 2×10^5 events for each nuclear target (H, C, Cu, and Pb) and to deduce the dependence of the modification on the matter size and the meson momentum. At the same time, the e^+e^- decays of the ρ, ω, and J/ψ mesons can be measured, while the 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 1×10^{10} particle per spill (2-s duration and 5.52-s cycle) of in the high-momentum beam line and 0.2%-interaction targets, which brings a background particle rate of 5 kHz/mm^2 at the most forward region of the trackers. In order to cope with such a high rate, the GEM tracker has been adopted. [a]

The construction of the high-momentum beam line, where we will perform the experiment, was started in JFY 2013 by KEK and scheduled for completion in JFY 2015. However, the construction has been delayed owing to a radiation accident at J-PARC in May 2013 and the budgetary limitation partly caused by the accident. The current target date of the first beam is Mar. 2019 in the most optimistic scenario. While such a tight budgetary situation, the spectrometer magnet reconstruction was completed in JFY 2015 by KEK.

Our spectrometer has 26 modules. Owing to the budget limitations, our first goal of the staged construction plan is to construct eight modules, which covers approximately one third of the full acceptance.

The development of the detectors was completed, and we have been in the production phase since 2013. For the GEM Tracker (GTR),[3] the production of GEM and the read-out strip board has been underway since 2013. Parts for six modules (out of eight, as mentioned above) have been completed. The CFRP frames, which are used to install the GEM chambers in the spectrometer, have also been made for two modules. For the HBD,[4] which is one of our electron ID detectors, two modules are currently under construction at RIKEN. The read-out electronics including preamplifier for the two GEM detectors, GTR and HBD, have also been purchased, for six and two modules, respectively. They use an APV25 chip and SRS, both of which are CERN-made. We joined the RD51[5] collaboration in CERN which aims to develop multi-pixel gas detectors including GEM.

The lead-glass (LG) EM Calorimeter, another electron ID detector, utilizes the recycled LG from the TOPAZ experiment. The reshaping of LG blocks for eight modules (330 blocks) was completed at the KEK engineering center. Electronics for two modules has been purchased, and it uses the DRS4 chip.[6]

The development of trigger electronics is still underway.[7] The trigger signal for vector mesons consists of two electron candidates. An electron candidate is defined by the coincidence of corresponding hits in LG, HBD, and the outermost layer of GTR, located immidiately in front of HBD. ASICs for the amp-shaper-discriminator to generate the trigger primitive of the two GEM detectors have been produced in cooperation with the KEK e-sys group. To generate a global trigger signal, an FPGA board "UT3"(developed by Belle II) is used. To transfer the trigger primitives to UT3, we developed another module called "TRG-MRG." The development of firmware for these modules is underway, and a system test connecting all the modules with detectors is planned for the end of JFY 2017.

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a) At the COMPASS experiment, the GEM tracker was operated at a particle rate of 25 kHz/mm^2.[8]

References

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