Preparation status of the J-PARC E16 experiment: measurement of spectral change of vector mesons in nuclei

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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 (TDR) was submitted to PAC held in May 2014, and the TDR is being revised as per the requirements provided by PAC, and the revised TDR will be submitted to the PAC held in July 2015.

The aim of the experiment is to perform a systematic study of the spectral modification of vector mesons, particularly the ϕ meson, in nuclei, using the e^+e^- decay channel with statistics that are two orders larger in magnitude than those of the preceding 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.

For the experiment, we plan to use a 10^{10}-pps, 30-GeV proton beam in the high-momentum beam line, which is being constructed at J-PARC. In order to increase the statistics by a factor of 100, we will construct a large-acceptance spectrometer that can be operated under 10^7 Hz nuclear interactions at the target. In order to cope with such a high-interaction rate, GEM has been adopted for constructing new tracking and PID detectors.

The construction of the high-momentum beam line, where we perform the experiment, has been on-going since 2013 by KEK. The first beam is scheduled around the end of JFY 2016; it was delayed by a year because of the beam stoppage due to the radiation accident at J-PARC in May 2013. The schedule of the spectrometer magnet reconstruction is also delayed, and it is expected to be completed by July 2015. After the completion of the magnet reconstruction, we can begin installing the detectors in the magnet. The target day of the construction is March 2016. Our spectrometer has 26 modules. Owing to the budget limitations, our first goal of the staged construction plan is to construct eight modules, which correspond to approximately one third of the full installation.

The development of the detectors has almost completed, and we are moving to the production phase. For the GEM Tracker (GTR)[3], the production of GEM has been underway since 2013. Six modules (out of eight, as mentioned above) are currently under construction. The production of frames made of CFRP, which is used to install the GEM chambers in the spectrometer, started in 2014. For the HBD[4], which is one of our electron ID detectors, only two modules are currently under construction. 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), is to be completed at the KEK engineering center within JFY 2014.

The development of the read-out and trigger modules are underway. As a pre-amplifier and front-end module (FEM) of GEM detectors, an APV25 chip and SRS, both are CERN-made, are adopted. We joined the RD51[5] collaboration in CERN in July 2013 to co-develop GEM-related electronics. For HBD, we use the RD51-made APV25 preamp. For GTR, a more smaller preamp using the APV25 chip was fabricated by ourselves and the production started in January 2015. The first version of the FEM for the LG is tested and the revision is on-going.

For the trigger, signals from the GEM foil of GTR and HBD are used. ASICs for the amp-shaper-discriminator to generate the trigger primitive of the two detectors has been produced under the cooperation of the KEK e-sys group. For GTR, the test of the second version is to be started. The test of the first version for HBD is almost completed. To generate a global trigger signal, an FPGA board "UT3"(Belle II collaboration) is used. To transfer the trigger primitives to UT3, we developed another module called "TRG-MRG". The first version of TRG-MRG is already delivered and will be tested at KEK. These tests will be completed by the end of JFY 2014.

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References

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