Preparation status of the J-PARC E16 experiment : measurement of vector meson mass 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. The proposal of the experiment was granted scientific ("stage 1") approval by the PAC in March 2007. For the full approval, we need to establish the experimental feasibility as well as to show the prospects of acquiring sufficient funds and of beam-line construction. Toward the full approval, the technical design report is under preparation for submission to PAC to be held in May 2014.

The mass modification of vector mesons in hot and/or dense matter is predicted on the basis of the QCD because of the restoration of the chiral symmetry in such matter. Mass modifications in matter, however, due to hadronic many-body effects are also predicted. The predictions from these two viewpoints should agree in principle, however, still no clear connections are established between the two thus far.

Many experimental studies, including dilepton invariant mass measurements, have been conducted to approach the problem, and mass modifications in hot and/or dense matter have been observed. However, the origin of the modification has not yet been confirmed; in other words, there is no consensus on the interpretations of the phenomena. Among the experiments, the experiment KEK-PS E325[2], which was conducted by a collaboration including some of the authors, measured the e^+e^- invariant mass spectra in 12-GeV p+A reactions and reported enhancements on the low mass sides of ω and ϕ mesons. These enhancements are consistent with the decrease in the mass of vector mesons predicted using the QCD sum rule. The mass-shape modification of a narrow resonance, ϕ, can be observed only in E325.

The aim of the J-PARC E16 experiment is to perform a systematic study of the mass modification of vector mesons, particularly the ϕ meson, in nuclei, with statistics that are two orders larger in magnitude than those of the preceding E325 experiment. 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 deduce the dependence of the modification on the matter size and meson momentum, which have never been measured. Furthermore, the e^+e^- decays of the ρ, ω, and J/ψ mesons can be measured at the same time.

For this 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 development of the detectors is underway as reported elsewhere[3–8], funded by a MEXT Grant-in-Aid[9]. To summarize, basic studies and beam tests of the two key detectors, the GEM Tracker[3,4] and HBD[5], have been performed. For the former, the required performance has almost been achieved. The specification of GEM is fixed and production of GEM has been underway since 2013. For the latter, stability in a high background environment has been confirmed[6]. The GEM specification is also fixed and we will move to production in 2014. The development of read-out and trigger modules are on going[7]. In particular, for the GEM readout, a CERN-made system has been tested and adopted[8].

Construction of the high-momentum beam line has been on-going since 2013 by KEK. The first beam will be delivered by the end of JFY 2015. In spite of the radiation accident at J-PARC in May 2013, the planned schedule of the spectrometer magnet construction has not changed. Therefore, it is expected to be completed in Jan. 2015. After completion of the magnet construction, we can start the installation of the detectors in the magnet. The target day of the construction is the planned first beam, Mar. 2016. Due to the budgetary limitation, our first goal of the staged construction plan is to construct one-third of the spectrometer.

References

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