# BARYON SPECTROSCOPY IN ($\pi$, $2\pi$) REACTIONS WITH $10^6$ Hz BEAMS AT J-PARC

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Although baryon resonances (N* and $\Delta$*) have been studied for a long time, our knowledge on their mass spectra and properties are still very limited due to their overlapping spectra with large widths. Recently a Dynamical-Couple Channel (DCC) model shows there are significant contributions of ($\pi$, $2\pi$) reactions to high mass baryon resonances. However, there are only 240 thousand events of ($\pi$, $2\pi$) reaction data which was mainly measured in 1970's. Thus, we proposed an experiment E45 to study baryon resonances in ($\pi$, $2\pi$) reaction utilizing $10^6$ Hz $\pi^{\pm}$ beams at J-PARC. We aim at clarifying most of baryon mass levels using increasing ($\pi$, $2\pi$) data with the increased statistics by two orders of magnitude. We also search for exotic baryons such as hybrid baryons predicted by lattice QCD calculations. We measure reactions of $\pi^-p \rightarrow \pi^+\pi^-n$, $\pi^0\pi^-p$ and $\pi^+p \rightarrow \pi^0\pi^+p$, $\pi^+\pi^+n$, as well as $\pi^-p \rightarrow K^0\Lambda$ and $\pi^+p \rightarrow K^+\Sigma^+$ in a large acceptance Time Projection Chamber (HypTPC) inside a Helmholtz dipole magnet. We trigger these reactions by requiring two charged particles in the hodoscope counters surrounding HypTPC. HypTPC is placed inside a superconducting Helmholtz type dipole magnet with the magnetic field of 1.5 T. We will measure these reactions in small momentum steps over a large beam momentum range and perform partial wave analysis to extract properties of each resonance. In this presentation, we will show the experimental design, expected results in simulations, and the status of the detectors.