BL31LEP
Laser–Electron Photon II

1. Introduction

BL31LEP (LEPS2 beamline) injects 355 nm UV-laser light to the 8 GeV electron storage ring to obtain a γ-ray beam (laser electron photon) up to 2.4 GeV by backward Compton scattering between the laser photons and the electron beam. We deliver this γ-ray beam to the LEPS2 experimental building, which is located beyond the storage ring, irradiate the γ-rays to targets, and measure the hadron photoproduction.

We plan to study exotic hadrons such as a pentaquark candidate composed of five quarks, meson-baryon molecule candidates, and deeply bound anti-kaonic nuclei. For these experiments, a 3-m-diameter solenoid magnet with a magnitude of 1 T was shipped from Brookhaven National Laboratory, USA. We are developing detectors that can detect both photons and charged particles.

The LEPS2 solenoid spectrometer consists of start counters (SCs), a time projection chamber (TPC), drift chambers (DCs), barrel resistive plate chambers (BRPCs), forward resistive plate chambers (FRPCs), barrel γ counters (Bγ's), neutron counters (NCs), and aerogel Cherenkov counters (ACCs). Figure 1 schematically depicts the solenoid spectrometer. A liquid hydrogen or deuterium target is installed in the TPC. Charged particles scattered at forward angles and sideways are detected with the DCs and TPC, respectively. These particles are momentum-analyzed. SCs, which are located close to the target, measure the timing when charged particles are produced using the RF information of the electron storage ring. FRPCs detect charged articles scattered at forward angles about 4 m downstream from the target, and BRPCs detect charged particles in large-scattering-angle regions at 0.9 m in the radial coordinate. FRPCs and BRPCs provide the time-of-flight information of charged particles with a resolution below 100 ps. From the momentum and velocity of a charged particle, the particle mass is determined. For high-momentum particles, we use ACCs to identify the particle. In addition to charged particles, we can detect photons and neutrons using Bγ's and NCs, respectively. In FY2021, we started data collection for the study of hadron photoproduction.

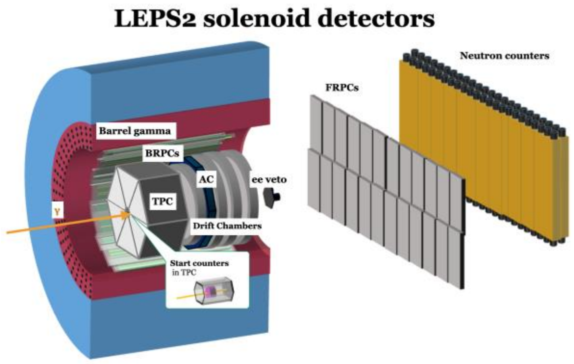

Fig. 1. Schematic of LEPS2 solenoid spectrometer.

2. Status of experiment in 2021

In FY2021, we took data on hadron photoproduction from the liquid hydrogen and deuterium targets. We successfully observed the trajectories of charged particles with the TPC and DCs. The momenta of particles were measured with the trajectories in the TPC, and the types of particle were identified using the time-of-flight measured with the RPCs and *dE/dx* information obtained with the TPC. From the mass and momentum, we reconstruct the Lorentz vector of each particle.

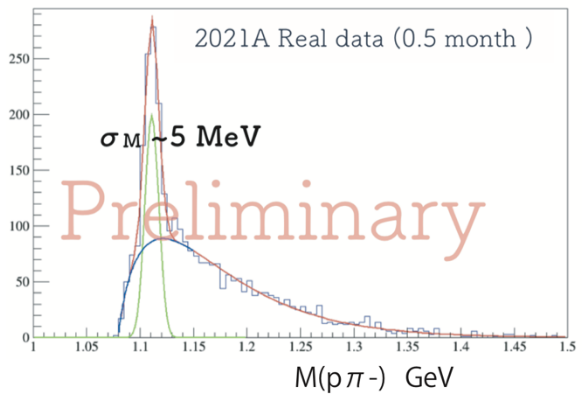

Fig. 2. Invariant mass distribution of proton and π^- pairs.

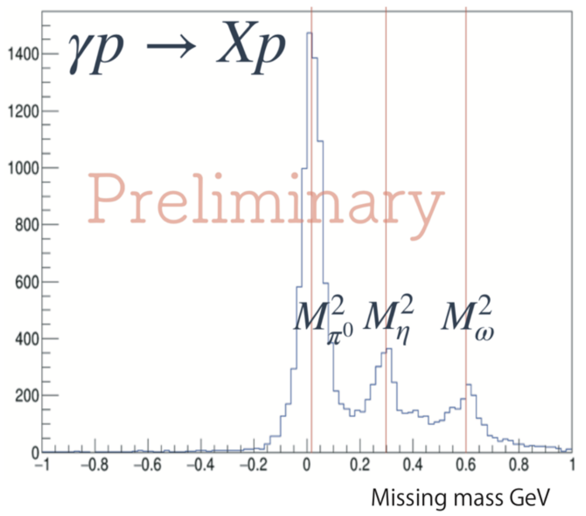

Fig. 3. Missing-mass-squared distribution of $\gamma + p \rightarrow p + X$ reactions.

Figure 2 shows the invariant mass distribution of proton and negative pion pairs. A clear peak of Λ hyperon can be seen at 1.12 GeV, demonstrating that the hadrons with a strange quark are produced and the momenta of daughter particles are measured correctly. The energy of each incident photon was measured using a tagging counter and using the Lorentz vector of a proton measured with the TPC, we can identify mesons utilizing the missing-mass technique. Figure 3 shows the missing-mass-squared distribution of $\gamma + p \rightarrow p + X$ reactions. We can see clear peaks corresponding to the masses of π^0, η, and ω mesons, and confirm that the photon-beam energy is correctly measured and that the data correlation between the tagging counter and the TPC is correct. Analyses of other detectors are ongoing, and we continue to acquire further data for the study of exotic hadrons.

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