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) of 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. In FY2022, we published our results on the photoproduction of η mesons, and acquired data with the solenoid spectrometer.

2. Status of the solenoid spectrometer experiment

We plan to study exotic hadrons such as a pentaquark candidate composed of five quarks, meson–baryon molecule candidates, and deeply bound antikaonic nuclei. For these experiments, a solenoid magnet with a 3 m diameter and a magnitude of 1 T was shipped from Brookhaven National Laboratory, U.S.A. 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 a deuterium target is installed in the TPC. Charged particles scattered at forward angles and sideways are detected with the DCs and the TPC, respectively. These particles are momentum-analyzed. SCs, which are located close to the target, measure the timing when charged particles are produced using 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. 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.

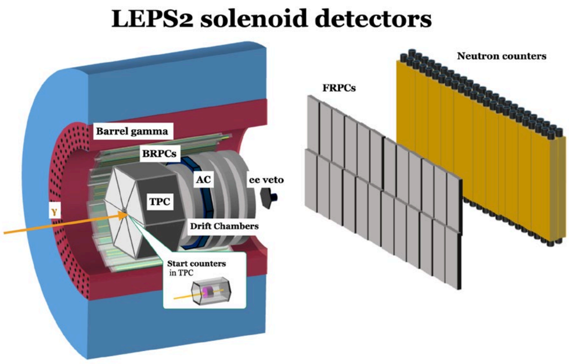

Fig. 1. Schematic of the LEPS2 solenoid spectrometer.

In FY2022, we obtained data of hadron photoproduction from liquid hydrogen and liquid deuterium targets. We successfully observed trajectories of charged particles with the TPC and the DCs. The momenta of particles were measured from the trajectories in the TPC, and the kinds of particles 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 reconstructed the Lorentz vector of each particle. The energy of each incident photon was measured using a tagging counter. Analyses of other detectors are ongoing, and we continue to acquire further data for the study of exotic hadrons.

3. η meson photoproduction by BGOegg experiment

Meson photoproduction is a helpful tool for clarifying the nucleon excitation spectrum. An η meson is an isoscalar particle and contains $s\bar{s}$ quarks as a component. Hence, a ηN state can only couple to nucleon resonances with isospin 1/2 (N*). Moreover, the ηN state is expected to easily couple to N*, which contains the large $s\bar{s}$ component that does not couple with the πN state. We simultaneously measured the differential cross sections and photon beam asymmetries for a single η meson photoproduction on the proton within the center-of-mass energy of 1.82 < W < 2.32 GeV [1]. We produce a GeV photon beam via backward Compton scattering. This photon beam is highly linearly polarized, and the degree of polarization is more than 90% in the highest energy region around the Compton edge. Thanks to this high degree of polarization, the amount of photon beam asymmetry can be measured precisely. The photon beam asymmetry tends to show interference contributions between partial waves, which helps to separate each of the broad resonances when they are overlapping. The η meson was identified in a neutral decay mode: $\eta \rightarrow \gamma\gamma$. All the final-state particles, a recoil proton and two γ's from the η meson decay, were detected by using the BGOegg calorimeter and forward drift chamber. A bump-like enhancement in the differential cross section can be seen at η backward angles. Its strength increases as the η emission angles become more backward, and the peak position is shifted. On the other hand, no bump structure is visible in the differential cross sections of π^0 and ω meson photoproductions [2,3], as shown in Fig. 1. We obtained precise photon beam asymmetries in the wide angular region above 2.1 GeV for the first time. No partial wave analyses can reproduce our new data, so this work provides additional constraints for the interpretation of the bump structure in the high-energy region.

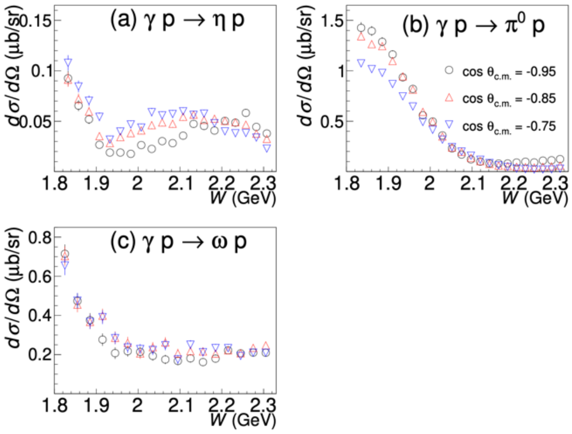

Fig. 2. Differential cross sections of meson photoproduction measured by BGOegg Collaboration.

Niiyama Masayuki[*1] and Hashimoto Toshikazu[*2]
[*1]Kyoto Sangyo University
[*2]Osaka University

References:

[1] Hashimoto, T. *et al.* (2022). *Phys. Rev. C* **106**, 035201.

[2] Muramatsu, N. *et al*. (2019). *Phys. Rev. C* **100**, 055202.

[3] Muramatsu, N. *et al.* (2020). *Phys. Rev. C* **102**, 025201.