BL31LEP
Laser-Electron Photon II

1. Introduction

BL31LEP is known as the LEPS2 beamline. It injects 355-nm UV-laser light to the 8 GeV electron storage ring, providing a γ-ray beam (laser electron photon) up to 2.4 GeV by backward Compton scattering between the laser photons and the electron beam. This γ-ray beam is delivered to the LEPS2 experimental building, which is located beyond the storage ring. This beam irradiates the γ-rays to targets, and measures the hadron photoproduction.

BL31LEP beamline has two separate experimental setups. One is for the BGOegg experiment, which uses an electromagnetic calorimeter as the main detector. The other is the solenoid spectrometer experiment, which uses charged particle trackers as the main detectors.

In FY2019, the first result from the BGOegg experiment was published and detector development of the solenoid spectrometer was performed. Below are highlights from FY2019.

2. Results of the BGOegg experiment

The search for baryon excited states was one of the research programs in the BGOegg experiment. The internal structure of hadrons can be discussed by experimentally clarifying the mass spectra and quantum numbers of highly excited states and comparing them with theoretical models. The first published paper [1] reported the π^0 meson photoproduction process off the proton target and measured differential cross sections and photon beam asymmetries. Here, the photon beam asymmetry represents the bias in the π^0 azimuthal angle distribution with respect to the linear polarization direction of the photon beam. These results provided basic data for partial wave analyses to explore the contributions of baryon resonances in the π^0–proton system. This is the world's first result to measure photon beam asymmetries with a high accuracy over a wide π^0 angle region for photon beam energies exceeding 1.9 GeV. When π^0 mesons were produced backwardly in this energy region, a sharp dip structure in the π^0 polar angle dependence of photon beam asymmetries appeared, suggesting an interference by a highly excited state.

3. Status of development of the solenoid spectrometer

The solenoid spectrometer should support studies of 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 solenoid magnet with a 3-m diameter and a magnitude of 1 T was shipped from Brookhaven National Laboratory in the United States. Currently, detectors that can detect both photons and charged particles are being developed.

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 (Bγs), and aerogel Cherenkov counters (ACCs) (Fig. 1). A liquid-hydrogen target 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 particles 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 time-of-flight information of charged particles with a resolution below 100 ps.

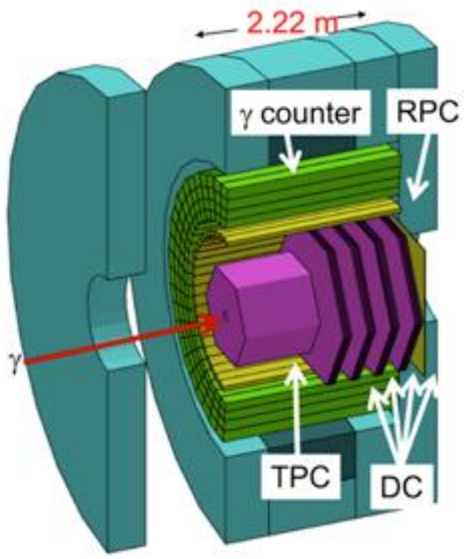

Fig. 1. Schematic of the LEPS2 solenoid spectrometer.

From the momentum and velocity of a charged particle, the particle mass is determined. For high-momentum particles, ACCs are used to identify the particle. In FY2019, detector commissioning tests of the solenoid spectrometer were performed.

In 2019A experiments, the DCs, TPC, FRPCs, and Bγs were tested. The data acquisition system successfully acquired data from these detectors simultaneously. In 2019B, the TPC was repaired because the electron drift velocity in the TPC was slower than the nominal value. During the repair, all BRPCs were installed in the solenoid. In February, the repair work of the TPC was complete, and test experiments were performed. Data continues to be analyzed to reconstruct the Lorentz vectors of the charged particles and photons for the study of hadron physics.

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Reference:

[1] "Measurement of neutral pion photoproduction off the proton with the large acceptance electromagnetic calorimeter BGOegg", N. Muramatsu et al., Phys. Rev. C 100 (2019) 055202.