STUDIES IN QUARK NUCLEAR PHYSICS AT LEPS

Synchrotron radiation is generated when electrons are bent in a magnetic field. This radiation is used in research in the atomic, molecular, organic, material and medical sciences to probe materials on a molecular level. However, there is another way to probe the smaller microscopic world; nuclear and nucleon structure.

High energy real photons produced by means of inverse Compton scattering are very useful for such a purpose. The most powerful way to investigate hadrons is to use electroweak probes due to the reduced theoretical complexity of this method. Using a stored electron beam with energy of 8 GeV, an intense γ-ray beam in the GeV energy region can be produced.

The LEPS (Laser-Electron-Photons) facility was constructed at beamline **BL33LEP** for nuclear and hadron physics experiments with primary support from Monbusho (the Ministry of Education) and STA. Construction of the beamline began in 1998 with the modification of accelerator components. A laser injection system was constructed in the first quarter of 1998 and the experimental hall was completed in March 1999.

Figure 1 shows an overall view of the LEPS system. The purpose of the beamline is to inject a laser light beam which collides with the electron beam, allowing the extraction of high-energy photons produced via inverse Compton scattering. High energy photons are produced in the direction of the 8 GeV stored-electron beam. A bending magnet in the storage ring after to the collision point components is used to measure the energies of knocked-on electrons. Electrons with 4.5 - 6.5 GeV are tagged in this manner, corresponding to 1.5 - 3.5 GeV γ-rays. γ-rays extracted from the ring are guided in the vacuum chamber to the experimental hall. In the experimental hall, there

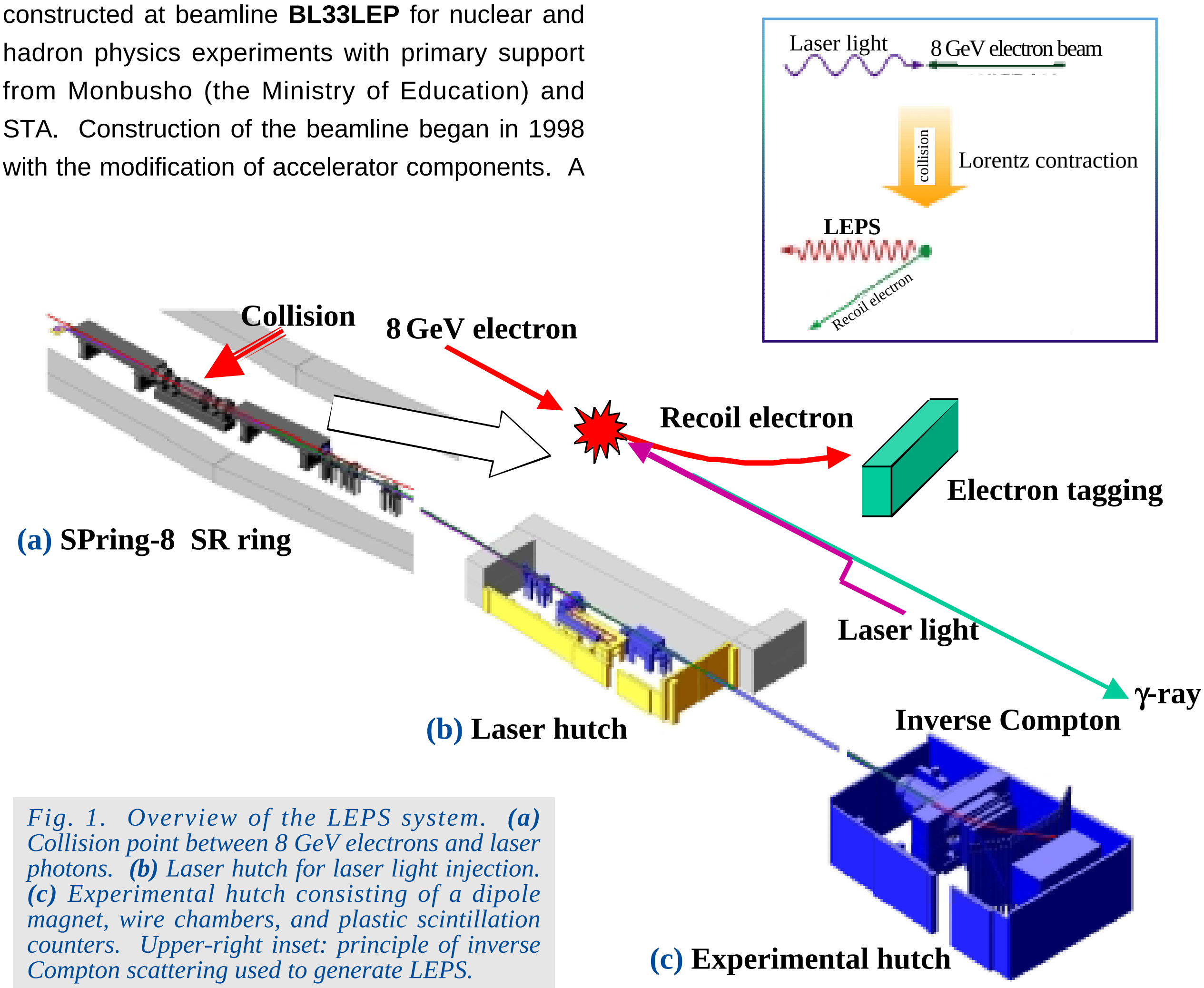

*Fig. 1. Overview of the LEPS system. **(a)** Collision point between 8 GeV electrons and laser photons. **(b)** Laser hutch for laser light injection. **(c)** Experimental hutch consisting of a dipole magnet, wire chambers, and plastic scintillation counters. Upper-right inset: principle of inverse Compton scattering used to generate LEPS.*

are two hutches along the beamline. The first one , at the exit of the beam tunnel is the laser hutch and is used mainly for laser injection. The second one is for experimental devices including a spectrometer dipole magnet, drift chambers and plastic scintillation counters.

The first and second hutches are connected with a beam transport pipe. A laser beam injection was made for the first time at this site, and the high-energy photons (LEPS) from the inverse Compton scattering were observed in the laser hutch using a newly-developed Lead Tungstate (PWO) scintillation counter.

The γ-rays were detected by the calorimetric method. A calorimeter consisting of nine rectangular PWO crystal cells [1] was placed behind a sweep magnet. Energy calibration of each PWO scintillation counter was carried out with gas Bremsstrahlung [2]. The measured energy spectra for beam exposures centered on each crystal were convoluted using a known radiation spectrum and a resolution function of the crystal . The energy spectra obtained from nine PWO scintillation counters were summed to generate the total γ-ray spectrum.

Figure 2 shows the energy spectrum of LEPS, which clearly demonstrates that high-energy photons up to 2.4 GeV are created by inverse Compton scattering between 8 GeV electrons and laser light. The maximum energy calibrated with the photon spectrum from the gas Bremsstrahlung agrees with that calculated using special relativity theory.

The emittance of the γ-ray beam was also measured using the PWO detector. The horizontal and vertical widths of the γ-ray (LEPS) beam were found to be σ_x = 3 mm and σ_y = 2 mm, respectively, at a distance of 40 m from the collision point. These values are consistent with those expected using a Lorentz factor of E_e/m_ec^2 = 16,000, demonstrating the extremely good precise emittance of the 8 GeV electron beam in the storage ring at SPring-8.

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References

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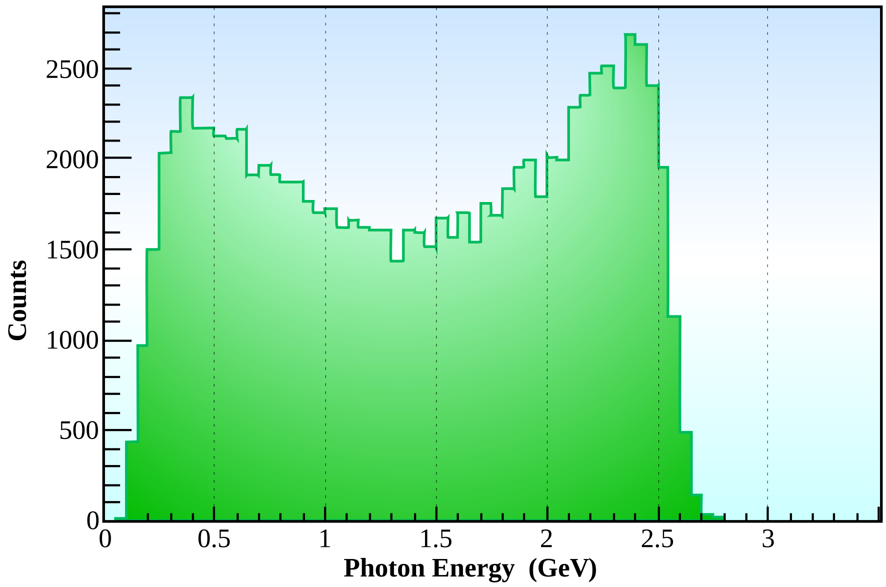

Fig. 2. Energy spectrum of the γ-rays produced by the inverse Compton scattering between 8 GeV electrons and laser light.