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First observation of γ -ray beam production via Compton scattering of undulator X-rays in an electron storage ring

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For the first time, we succeeded in observing the γ -ray beam production via Compton scattering of X-rays at an electron storage ring. Compared with laser Compton scattering, the X-ray Compton scattering is attractive because γ -ray energies can be drastically increased approaching to the ring energy. We developed a new innovative γ -ray beam source at NewSUBARU, which is a 1 GeV storage ring. Soft X-rays of 92 eV was obtained from an undulator, and was reflected back to the original ring by a Mo/Si multilayer mirror, whose reflectance reached 65.8% with a concave refractive surface to make a focus at the scattering point. Our method is unique and cost-effective by completing all the processes at one beamline.

Recently, we conducted a demonstration experiment of the X-ray Compton scattering. The reflected X-ray direction was optimized by precision rotary stages attached to the multilayer mirror. The γ -ray energy spectrum was measured by a PWO calorimeter with and without X-ray reflection to subtract a residual-gas bremsstrahlung radiation background. As a result, a clear Compton spectrum was observed with a significance of 12.5σ , showing the Compton edge of 0.543 GeV as predicted. The γ -ray production rate of X-ray Compton scattering was 1.36 kcps for the energies above 0.160 GeV and quantitatively understood from the luminosity with the known cross section. This achievement is applicable, for instance, to SPring-8-II, where the maximum γ -ray energy can be raised up to 5.4 GeV with 92 eV X-rays for the next-generation hadron photoproduction experiments.

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