Measurement of the luminosity of electron scaterring at SCRIT

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At the Self-Confining Radioactive-isotope Ion Target(SCRIT) electron scattering facility, we will measure the absolute luminosity value with a luminosity monitor (LMon),[1)] which consists of a CsI calorimeter array and two-dimensional fiber scintillators. Luminosity is expressed as follows:

$$L = \frac{N_{Brems.}}{\sigma_{Brems.}} \cdot \frac{1}{\varepsilon}\,[\mathrm{cm}^{-2}\mathrm{s}^{-1}], \tag{1}$$

where $N_{Brems.}$ is the number of measured bremsstrahlung photons per second, $\sigma_{Brems.}$ is the calculated bremsstrahlung cross section, and ε is transmittance efficiency estimated as the number of detected photons divided by the number of photons generated from the electron target scatterings. Because LMon is located 7 m downstream of the vertex position and there are some obstacles in between such as cryopanels and pipes, ε is as small as 0.30–0.55 depending on the electron beam energy, angle, width, and so on.[2)] Therefore, it is important to evaluate the beam condition and corresponding ε precisely by using a detector simulation to obtain L accurately. In a previous study,[3)] ε was derived by comparing the spatial distribution measured using the fiber scintillators with the simulated one. However, it was found that the fiber scintillators with a spatial resolution of 3 mm are inadequate to determine the beam conditions correctly. Therefore, the spatial distribution is measured with higher resolution by using a silicon strip detector (SSD) in this study.

Figure 1 shows the layout of the new LMon. The SSD has four layers (X,Y,X,Y) of silicon sensors, each of which has a sensitive area of $7.7 \times 7.7\,\mathrm{cm}^2$ and 1536 strips with a pitch of 50 μm pitch. We use two out of the four layers of SSD to measure horizontal and vertical distributions. In addition, two plastic scintillatiors are used: one is used as a trigger counter, and the other is used as a veto counter to remove the background electrons and positrons created upstream. The thickness of the SSD is about 300 μm, and it converts bremsstrahlung into electrons and positrons for the trigger scintillator.

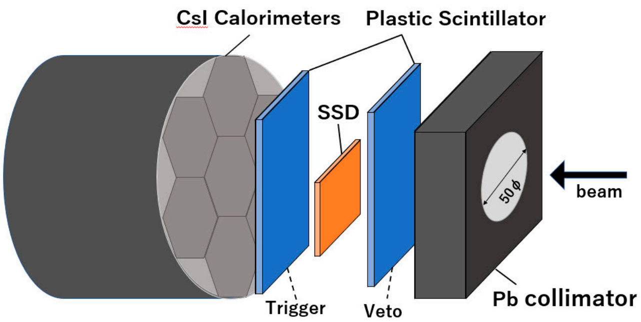

Fig. 1. Layout of the new LMon.

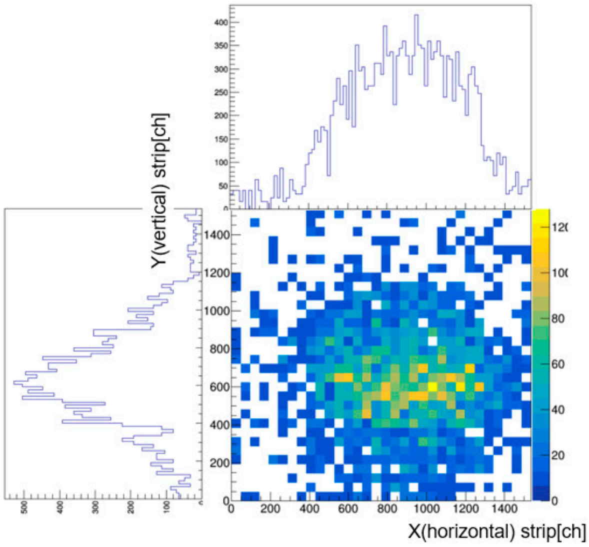

Fig. 2. X, Y and XY distributuins.

Figure 2 shows the measured horizontal and vertical spatial distributions of the bremsstrahlung photons together with the two-dimensional spatial distribution at a beam energy of 150 MeV. About 8000 events were accumulated within 10 min. More detailed spatial distributions than the previous study[1)] are obtained. Since this test experiment was performed without target ions, this distribution represents bremsstrahlung generated from residual gases throughout the straight section of the electron storage ring. As was observed in the previous study, the vertical distribution is sharper than the horizontal one due to obstacles. The spread of the beam is about 1000 ch, which coincides with 5 cm of the collimator hole.

At a next step, the spatial distributions will be measured with target ions. By comparing them with GEANT4 simulation results, a precise value of ε will be obtained. In addition, the DAQ rate must be increased by implementing the zero suppression mode. The acquisition rate is currently limited about 10 Hz at most because the information of all channels of the SSD is recorded in the current DAQ setup. Note that the beam condition and corresponding ε change every moment, and therefore, the spatial distributions have to be measured with a high DAQ rate for a short period in order to obtain accurate total luminosities.

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References

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