CO11-1 First Experiment of Terahertz-Wave Spectrophotometry by Compton Backscattering Using KURRI-LINAC

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INTRODUCTION: The terahertz (THz) wave spectrophotometry by Compton backscattering (CB) using relativistic electron bunches has been proposed [1]. In this method of the spectrophotometry, the characteristics of the continuous-spectrum THz waves are converted into those of the other wavelengths which are easily measured by the CB. We start to develop the THz-wave spectrophotometry by the CB with coherent transition radiations (CTRs) of KURRI-LINAC.

EXPERIMENTS: According to the theory of the CB, the wavelength of the CB photon λ_{CB} is given by the wavelength of the injected photon λ_{In} from the following equation [1]:

$$\lambda_{CB} = \frac{\left[1+(\phi\gamma)^2\right]}{4\gamma^2}\lambda_{In}$$

where ϕ and γ are the angle between the electron orbit and the emitted direction of the CB photon and the electron energy in the unit of its rest mass, respectively. Intense millimeter-wave CTRs in the renge of 1-3 mm have been observed at KURRI-LINAC [2]. Because a photo detector used in the photo counting has sensitivity in the visible region, the optimized electron energy would be about 20 MeV for the THz-wave spectrophotometry by the Compton backscattering. Then, the spectra of the CTR at the electron energy of 20 and 32 MeV were measured by the Martin-Puplett type interferometer which was set in the experimental room. The CTR spectrum at the energy of 20 MeV was similar to the CTR spectrum at the energy of 32 MeV. However, the intensity of the CTR at the energy of 20 MeV and the current of 1.2 μA was about one tenth of that at the energy of 32 MeV and the current of 1.8μA. The enhancement of the electron-beam profile and the loss in the transportation system of the CTR beam would cause the decrease of the CTR intensity.

In the beginning of the experiments, the CB photons, which were generated by the CTR reflected on the mirror of the Martin-Puplett type interferometer, were investigated with a photomultiplier tube module (Hamamatsu inc. H8259). Band-pass filters were used in order to select the wavelengths of the CB photons. In the visible region, the optical transition radiation (OTR) was an intense background. The signal of the CB photons could not be separated from the background noise of the OTR.

In order to increase the CB photon, the position where the CTR beam was reflected was changed by a hole-coupled plane mirror in the parallel beam. As shown in Fig. 1, the hole-coupled plane mirror was located in the accelerator room. A hole-coupled millimeter-wave absorber, which had the almost same profile as the mirror, was used in front of the mirror to separate the OTR and CB photons. The OTR intensity detected by the photomultiplier tube module at the energy of 32 MeV and the current of 5.7 μA was about three times as high as that at the energy of 20 MeV and the current of 3.5 μA. Therefore, the transportation efficiency at the energy of 20 MeV was about a half of that at the energy of 32 MeV. When the electron energy was 32 MeV, the photon flux with the millimeter-wave absorber was higher than that without it in the whole wavelengths. However, when the electron energy was 20 MeV, the photon flux without the millimeter-wave absorber was 7% higher than that with it in the blue region. Although it was not cleared why the OTR was increased by the millimeter-wave absorber, the increase of the photon flux in the blue region would be caused by the CB due to the CTR and electron beam.

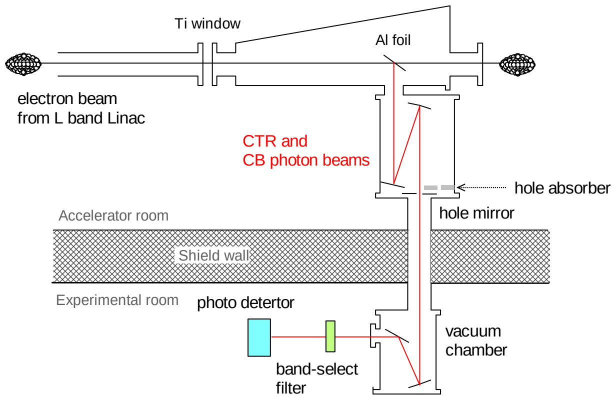

Fig. 1. Layout of the THz-wave spectrophotometry experiment in KURRI-LINAC.

RESULTS: We have carried out the preliminary experiments of the THz-wave spectrophotometry by the CB with KURRI-LINAC and observed a sign of the CB photons. However, it was difficult to evaluate the CB photon spectrum quantitatively by using the CTR because the intense OTR were generated in the visible region, too. We plan to use the coherent synchrotron radiations with small bending magnets for the THz-wave spectrophotometry in the next step.

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REFERENCES:

[1] N. Sei *et al.*, Appl. Phys. Exp., **1** (2008) 087003/1-3.
[2] T. Takahashi and K. Takami, Infrared Phys. Technol., **51** (2008) 363-366.

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