CO11-1 Study of Intense Terahertz Light Source Based on Superimposing Backward Coherent Diffraction Radiation

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INTRODUCTION: A relativistic electron beam with a short pulse width is suitable for generating intense terahertz (THz) light. We have proposed to develop a monochromatic THz light source based on a superimposing coherent diffraction radiation (CDR). We observed a sign of the superimposing CDR to the electron-beam trajectory with an L-band electron linac at the Kyoto University Research Reactor Institute (KURRI-LINAC) [1]. However, the forward CDR interfered with coherent transition radiation (CTR) generated at a Ti window. It is difficult to evaluate the spectrum of the superimposing CDR quantitatively. The CDR is also emitted behind the electron-beam trajectory. The power of the backward CDR in the THz region is as strong as that of the forward CDR. Then, we have conducted experiments about superimposing backward CDR.

EXPERIMENTS: When a relativistic electron-beam emits radiation by a periodic structure, the resonance wavelength in laboratory system is influenced by Lorentz transformation. The resonance wavelength λ is given by

$$\lambda = \frac{l}{n}\left(\frac{1}{\beta} - \cos\theta\right), \qquad (1)$$

where l, β, and n are the period of the diffraction elements, the velocity of the electron divided by the speed of light, and the order of higher harmonics, respectively. The symbol θ is the angle between the electron-beam trajectory and the direction of the CDR. It becomes π in the case of the backward CDR. Thus, the wavelength of fundamental harmonic of the backward CDR is the same as the double of the period of diffraction elements.

Figure 1 shows the schematic layout of the experimental setup of the backward CDR at KURRI-LINAC. Because an aluminum foil mirror was set to transport the backward CDR to the experimental room, it did not interfere with a CTR beam emitted from the Ti window. A thin aluminum plate, which was located behind the diffraction elements, prevented backward CTR generated by the vacuum chamber interfering with the backward CDR. An aluminum collimator with a diameter of 17.5 mm was located in front of the aluminum foil mirror. The distance between the aluminum foil mirror and the entrance of the diffraction elements was 120 mm, and the inner diameter of the diffraction elements was 30 mm.

Figure 2 shows spectra of the CDR when the period of the diffraction elements was 19 mm. It is noted that the

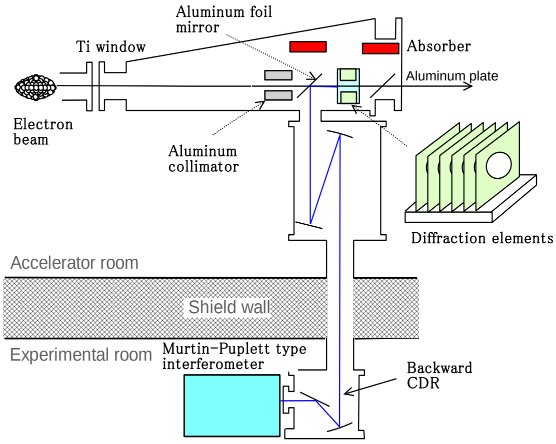

Fig. 1 Schematic layout of the CDR experiment.

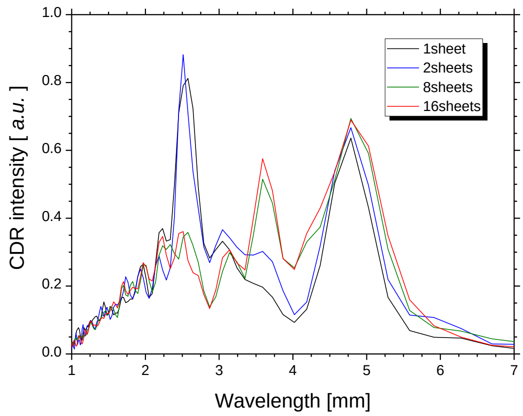

Fig. 2 Spectra of the CDR generated by the diffraction elements.

CDR intensity at wavelength around 3.8 mm, which was double of the period, increased as the number of the diffraction elements increased. However, the intensity did not increase for the number of the diffraction elements exponentially, so that the ratio that the CDR was superimposing was low. Because the bunch length of the electron beam was approximately 10 ps, the interaction length of the superimposing CDR was not longer than the resonance wavelength, and the ratio would become small as the number was larger.

RESULTS: We observed backward CDR generated by diffraction elements with a period of 19mm. Although an enhancement of the CDR intensity was observed at the fundamental resonance wavelength, the ratio that the CDR was superimposing was low. We will plan to use diffraction elements which had a shorter period.

Reference:

[1] N. Sei and T. Takahashi, KURRI Progress Report 2013 (2014) 222.

採択課題番号 26004 重畳的コヒーレント回折放射による高強度テラヘルツ光源 通常採択
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CO11-2

The XEP-e (eXtremely High Energy Plasma/ Particle Sensor for Electron) of the ERG Satellite

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INTRODUCTION: It is well known that satellites and astronauts are always endangered in space due to plasma, radiation particles, neutral particles, ultraviolet rays/X rays and meteoroids/debris. Since we have to support JAXA's projects to keep them safe from the space environment, our group has been researching the radiation environment of space for more than 20 years. Now we are developing a sensor for the ERG (Energization and Radiation in Geospace) satellite. The purpose of the ERG satellite is to investigate the mechanism of radiation belts. It is well known that the energetic electron flux varies during geomagnetic disturbance and especially the relativistic electrons in the outer radiation belt change. However, the data of the electron (10eV - 20MeV) in radiation belt is not enough. The ERG satellite consists of four instrument parts, Plasma/Particle (PPE), geomagnetic field (MGF), Plasma wave (PWE) and electric field (PWE). Before using KURRI-LINAC (Kyoto University), we couldn't calibrate our sensor over 2 MeV electrons.

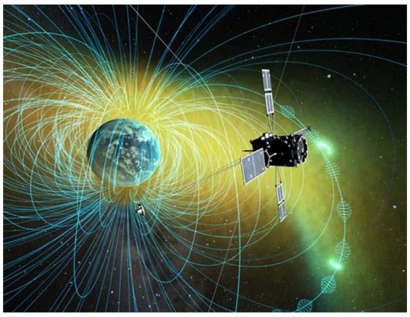

Fig. 1. ERG satellite

EXPERIMENTS: Our sensor that name is XEP-e (Extremely High-Energy Plasma/Particle Sensor for Electron) is one of the PPE. The XEP-e observes 400keV~20MeV electrons and has five solid-state silicon detectors (SSDs) and a high-Z scintillator (GSO). The XEP-e is Fig.2. The first SSD discriminate between electron and other particles. And The 2~5 SSDs and a high-Z scintillator detect its energy. Fig. 3.

We use KURRI-LINAC (Kyoto University) to calibrate its energy (2MeV~20MeV electron). We also use our accelerator in Tsukuba space center under 2MeV electron.

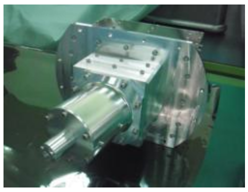

Fig. 2. XEP-e

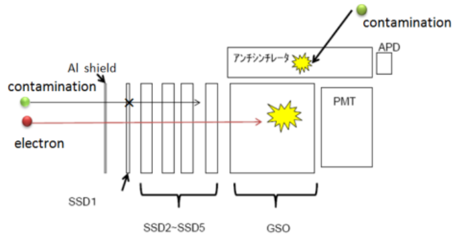

Fig. 3. Principle of the XEP-e

We need very low count rate beam (100~1000cps), so we tried to make this beam by using the XEP-e (EM) last year. And this year we calibrate the XEP-e(Flight Model). As shown in Fig. 4, the data that is got in KURRI -LINAC and simulation data (GEANT4) were very similar between 5MeV and 14MeV. It shows KURRI-LINAC can make very low count rate beam.

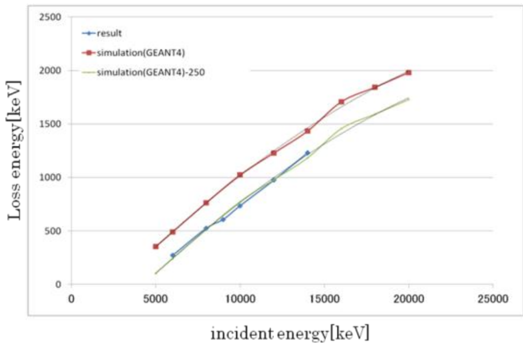

Fig. 4. Incident energy vs Loss energy of the XEP-e (energy range: 5MeV~14MeV)

RESULTS:

There haven't been facilities that can make very low count rate beam over 2MeV in Japan. But now KURRI-LINAC (Kyoto University) can only make low count rate and monochrome beam between 5MeV and 14MeV.

採択課題番号26071　　ERG 衛星搭載超高エネルギー電子観測装置(XEP−e)校正試験　　通常採択
(宇宙航空研究開発機構)東尾奈々、松本晴久、高島健（京大・原子炉）高橋俊晴、阿部尚也（明星電気㈱）江口信次郎、尾本敬信、(㈱ファムサイエンス)藤井雅之