

Accepted Manuscript

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PII: S1350-4495(17)30835-6
DOI: <https://doi.org/10.1016/j.infrared.2018.08.011>
Reference: INFPHY 2664

To appear in: *Infrared Physics & Technology*

Received Date: 15 December 2017
Revised Date: 1 August 2018
Accepted Date: 10 August 2018

Please cite this article as: S. Kashiwagi, T. Abe, H. Saito, F. Hinode, K. Kanomata, S. Miura, T. Muto, I. Nagasawa, K-i. Nanbu, S. Ninomiya, N. Nishimori, Y. Saito, K. Takahashi, H. Hama, Observation of coherent undulator radiation in THz region, *Infrared Physics & Technology* (2018), doi: <https://doi.org/10.1016/j.infrared.2018.08.011>

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Observation of coherent undulator radiation in THz region

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Abstract

The generation of coherent THz radiation from femtosecond electron bunches passing through an undulator was demonstrated with a test accelerator as a coherent terahertz source (t-ACTS) at Tohoku University. The velocity bunching scheme in the traveling wave accelerating structure was employed to generate electron bunches much shorter than the THz wavelength. The electron bunch length was measured with the spectrum analysis method for coherent transition radiation. A 2.5-m long undulator with 25 periods and peak magnetic field of 0.41 T was utilized to generate the tunable coherent undulator radiation ranging from 2.6 to 3.6 THz at the t-ACTS. The measured frequency spectrum and spatial distribution of the coherent undulator radiation are presented.

PACS: 41.60.Ap, 41.60.-m, 52.59.Ye

Keywords: Electron beam, coherent radiation, undulator radiation

1. Introduction

The relativistic and femtosecond electron bunches passing through an undulator are capable of generating high intensity, coherent, and narrowband radiation in the THz wavelength region. The coherent THz undulator radiation having polarization control ability can be used for various types of scientific investigations and applications such as circular dichroism spectroscopy of biomolecules [1].

A test accelerator as a coherent terahertz source (t-ACTS) is currently under development at the Research Center for Electron Photon Science (ELPH) in Tohoku University [2–4], wherein extremely short electron bunches are used to generate intense coherent THz radiation. The accelerator system consists of a specially designed S-band radio frequency (RF) gun [5], alpha-magnet with an energy slit, 3-m-long S-band accelerating structure, and 2.5-m terahertz undulator. The t-ACTS injector system can deliver small emittance and short electron beams by implementing the velocity bunching scheme, where a traveling wave structure is utilized as a bunch compressor [6]. Short electron bunches were employed to generate coherent undulator radiation in the THz wavelength region in the present study.

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