SMALL-SCALE ACCELERATOR-BASED RADIATION SOURCES AND THEIR APPLICATIONS

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Abstract

Small-scale accelerator-based radiation sources can be used more widely for developing advanced technologies and exploring new science with high convenience and low cost. Sometimes they are competitive comparing with giant facilities like X-ray free-electron lasers (X-FELs). We have developed a table-top terahertz (THz) FEL for substituting X-ray or millimeter-wave-based security imaging technologies (body scanners) and a laboratory-scale ultrashort electron accelerator for investigating femtosecond dynamics of atoms or molecules with pump-probe experiments. I will present on the status of the development of the small-scale radiation sources and plans for the pump-probe experiments. Additionally recent research results on biological study with the operating KAERI (Korea Atomic Energy Research Institute) THz FEL will be given with the information of the references.

THZ FREE-ELECTRON LASER DRIVEN BY MAGNETRON-BASED MICROTRON

We have developed a laboratory-scale terahertz (THz) free-electron laser by using a compact conventional microtron with a magnetron RF generator. The brief history and references of the developments are listed as follows.

- FIR FEL Development (1995-1998) [1-3]
  - Target wavelength of 30-40 μm with a 12.5-mm-period undulator
  - Failed in FEL lasing
- THz FEL Development (1998-2007) [4-16]
  - Target wavelength of 100-300 μm with a 25-mm-period period
  - First lasing at the end of 1999 (λ=100-170 μm)
  - FEL & beam dynamics study
  - System stabilization & upgrade (λ=100-300 μm)
- THz Applications (2004-present) [17-23]
  - THz imaging, spectroscopy, meta-material study, THz-bio interaction, & so on
- Table-top THz FEL Development (2008-present) [24-27]
  - Rack-type FEL for security inspection (dimensions of 1.5 x 2.5 m^2)
  - Target wavelength of 300-600 μm with the average power of 0.1-1 W

ULTRAFAST ELECTRON DIFFRACTION FACILITIES

An RF-photogun-based linear accelerator for ultrafast pump-probe research is under construction [28]. The layout of the KAERI ultrashort accelerator is shown in Fig. 1. This system has four beamlines. Two of them are for ultrafast electron diffraction (UED) experiments on solid and gas targets. The main target parameters of the UED beamlines are listed on the Table 1. The electron bunch duration and timing jitter of the UED beamlines are designed to be less than 50 fs in FWHM and 30 fs in rms. The UED beamlines can perform single-shot measurement with a temporal accuracy less than 100 fs. This small-scale facility can be used for investigating time-resolved diffraction experiments with samples of gas, liquid, solid, and surface. The performance of the UED for those samples can compete with that of the X-FEL facilities. The details on the facility will be shown in these Proceedings [29].

The application experiments of the UED beamlines will be performed by the collaboration with universities in Korea. We are planning to investigate the reaction dynamics of gas-phase samples of pyridine and cyclohexadiene (CHD) with higher temporal resolutions than those of previous studies.

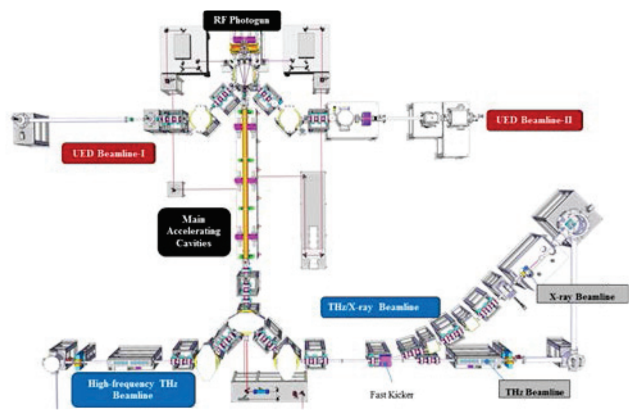

Figure 1: Layout of the KAERI ultrashort accelerator for femtosecond pump-probe experiments.

Table 1: Simulated Beam Parameters of The KAERI UED

Bunch Charge	1 pC
Beam Energy	2.6 MeV
Bunch Length (FWHM)	< 50 fs
Norm. Emittance	0.3 mm mrad
Energy Spread (r.m.s.)	0.3%

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