Status of Coherent Radiation Beamline at KURRI-LINAC

T. Takahashi
Research Reactor Institute, Kyoto University, Japan

In the electron linear accelerator at Research Reactor Institute in Kyoto University (KURRI-LINAC), properties of several types of coherent radiation (synchrotron radiation [1], transition radiation [2], Cherenkov radiation [3], diffraction radiation, and Smith-Purcell radiation [4], pre-bunched FEL [5]) in the THz-wave and millimeter-wave regions have been experimentally investigated since 1991. The beamline for the millimeter-wave spectroscopy has been constructed [6], in which coherent transition radiation (CTR) has been used as a light source and the spectroscopic research of N_2O gas [6] and electron spin resonance using a pulsed magnet [7] have been demonstrated.

The KURRI-LINAC consists of an injector, pre-buncher, two accelerator tubes. The specifications are represented in Table. 1.

Table 1. Specifications of KURRI-LINAC

Operation Mode	Short Pulse	Long Pulse
RF frequency	1300 MHz	
Energy	46 MeV	30 MeV
Pulse Width	2～100 ns	0.1～4 μs
Repetition Rate	1～300 Hz	1～200 Hz
Peak Current	8 A	500 mA
Beam Power	Max. 10 kW	

This linac has been operated for collaboration research programs with other universities since 1964 and research activities have covered the nuclear data with pulsed neutron source, electron irradiation, and coherent radiation. The time of operation in 2006 was about 2,700 hr. The distributed user-time to the research of coherent radiation is about ten weeks per year. The schematic diagram of the beamline is shown in Fig. 1.

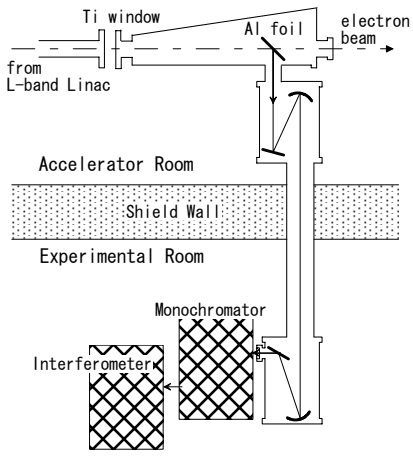

Fig. 1. The schematic diagram of the coherent radiation beamline.

The forward coherent transition radiation emitted from a Ti window and the backward one from an Al-foil are used as a light source. The beamline is equipped with a grating-type monochromator and a Martin-Puplett type interferometer in series. When the interferometer is used as a spectrometer the grating in the monochromator is replaced with a flat mirror. Three types of detectors are prepared, i.e. a liquid-helium-cooled Si bolometer (Infrared Lab.), a hot-electron InSb bolometer (Infrared Lab.), and a millimeter-wave diode-type detector (DXP-10, Millitec) according to the sensitivity and the response time. The degree of instability of the observed intensity is within 2%.

Coherent radiation is especially useful as a pico-second pulsed light source for the time-resolved spectroscopy and the pulseradiolysis study. Since the accelerating frequency of this linac is 1.3 GHz (L-band), the interval between pulses in the CTR pulse train is 770 ps (23 cm). The spectrum from the successive bunches is constituted of the higher harmonics of 1.3 GHz [6]. As a result, the CTR can be treated as a light source with a continuous spectrum only when the spectral resolution is lower than $1/23 = 0.0434$ cm^{-1} and the delay in the time-resolved measurement is restricted within 770 ps. In order to lift these restrictions, the single-bunch beam has been generated by installing a high-speed avalanche-type pulser in the electron injector. The degree of impurity of single bunch was estimated to be 1.5% by means of the cross-correlation interferogram.

The following researches in the millimeter-wave region are in progress at this beamline:

a) Optical conductivity of superionic conductors (collaboration research),

b) Optical properties of water (collaboration research),

c) Optical properties of polymeric materials under irradiation (collaboration research),

d) Development of pulseradiolysis system.

[1] Y. Shibata, *et al.*, Phys. Rev. A **44** (1991) R3449.
[2] Y. Shibata, *et al.*, Phys. Rev. A **45** (1992) R8340.
[3] T. Takahashi, *et al.*, Phys. Rev. E **50** (1994) 4041.
[4] Y. Shibata, *et al.*, Phys. Rev. E **57** (1998) 1061.
[5] Y. Shibata, *et al.*, NIM **528** (2004) 162.
[6] T. Takahshi, *et al.*, Rev. Sci. Instrum. **69** (1998) 3770.
[7] Y. H . Matsuda, *et al.*, Physica B **346-347** (2004) 519-523.