ANALYSIS OF BEAM STABILITY IN THE KAERI ULTRASHORT PULSE ACCELERATOR

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Abstract

An RF-photogun-based linear accelerator for the Korea Atomic Energy Research Institute (KAERI) ultra-short pulse facility is under construction [1]. It has a symmetric structure with four different beamlines. The UED beamlines will generate ultra-short electron pulses with over 10^6 electrons per pulse for the single-shot measurements on femtosecond dynamics of atomic or molecular structures. Electron bunches with an energy of \(\sim 3\) MeV from the RF photogun can be compressed up to less than 50 fs by achromatic and isochronous bends. The intrinsic r.m.s. timing jitter of the pulses through the bends is estimated to be less than 30 fs with the r.m.s. energy fluctuation of 0.1%. In the THz pump and X-ray probe beamline, two successive laser pulses with a time interval of \(\sim 10\) ns are used to generate two electron bunches having more than 100 pC bunch charges. Two electron bunches are accelerated by a linac up to \(\sim 25\) MeV and separated into individual beamlines by a fast kicker.

INTRODUCTION

The KAERI ultra-short pulse accelerator consists of a 1.5-cell S-band (2856 MHz) RF photogun and a 3-m-long travelling-wave-type linac. The scheme of the facility is shown in Fig. 1.

The time resolution of UED depends on the bunch length and timing jitter. The timing jitter depends mostly on the time of flight of the electron bunches from the RF photogun to the sample. MeV UEDs [4-7] are built in all over the world. All they have straight beamlines. By comparison, KAERI facility is longer than the other facility but it is expected to have low timing jitter because of the 90-degree achromatic and isochronous bend. We estimate the timing jitter, which is caused by the energy fluctuation at the sample when the electron beam has 0.1% of the energy fluctuation, are shown in Fig. 4. The calculated r.m.s. timing jitter with the isochronous bend (red) is 16 fs, and that with the straight beamline (green) is 54 fs.

BEAM SEPARATION

Two bunches of electron generated at about 10 ns intervals by the RF photogun are accelerated to 25 MeV in the same linac. After that, two bunches are separated into individual beamlines by a fast kicker.

Two bunches are vertically deflected by the steering coil. The first bunch is deflected downward about 10 mm after traveling 0.92 m of drift space. It goes straight for generating intense terahertz pulse.
After 10 ns the second bunch is kicked upward by the fast kicker. The length of kicker is 0.5 m and the bending angle is 1.7°. The two bunches have a 20 mm vertical distance in front of a septum and the second bunch is deflected to horizontal direction by the septum magnet. The septum has a 0.2 m length and 15° bending angle. The achromatic bend of the two-bunch beamline consists of the septum, a rectangular dipole, and a triplet. The second bunch is focused to the metal target for generating an x-ray pulse by a triplet after the achromatic bend.

REFERENCES