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# 【Vol. 3】 Report from Koichi Kan

## Study on high-power THz FEL for analysis of materials

Picosecond or femtosecond electron beams are useful for generation of electromagnetic waves. High-brightness electron beams are used for light sources with wavelengths such as terahertz (THz) (mid- or far- infrared) lights with free electron lasers (FELs). Generation and control of high-brightness electron beams are also studied because the quality of light source depends on the electron beam characteristics. High-power THz sources using lasers and electron beams in the THz gap between radio waves and infrared light attract many interests from viewpoints of applications and researches such nonlinear effects or structural control in material science.
Figure 1 shows schematic diagram of the proposed THz source. First, electron beam is generated in a photoinjector driven by a laser and accelerated in a linac for the electron beam energy of 50 MeV. Second, slice energy spread modulation is given in a laser modulator (LM) using THz modulation with a scheme of chirped pulse beating. In the LM, third-harmonic interaction was assumed to ease the choices of undulator parameters and modulation frequency ranging from 2 to 10 THz was considered. Momentum compaction factor of $R_{56}$ in a chicane-type bunch compressor (BC) was optimized for maximizing the bunching factor at THz frequency which is close to the initial modulation frequency. Third, density-modulated electron beam was matched for coherent undulator radiation with a matching section which was composed of two quadrupole magnets. Elegant simulation code was used for the calculation of electron beam from the LM to the exit of the matching section. Finally, coherent undulator radiation in THz undulator was calculated using Genesis simulation code. The lengths of the BC, matching section, and THz undulator were assumed to be ~7 m, 2 m, and 3 m, respectively.
Figure 2 shows the THz pulse energy as a function of the central frequency after the 3-m helical undulator. The laser power for the LM was assumed to be 100 MW. The undulator parameter was changed from 5.2 to 2.1 for optimizing the THz pulse energy at central frequency ranging from 1.8 to 9.8 THz. The maximum THz energy was 750 μJ at 3.9 THz with bunching factor of 0.35. THz energies were 570 and 90 μJ at 5.8 and 9.9 THz, respectively. Thus, THz pulse energy of the order on 100 μJ was indicated and these results suggest feasibilities of this high-power THz source to applications to analysis using nonlinear effects or structural control shown in material science.
Figure 3 shows the Pyramid of the Sun in Teotihuacan, Mexico, which is believed to have been built about 200 CE.

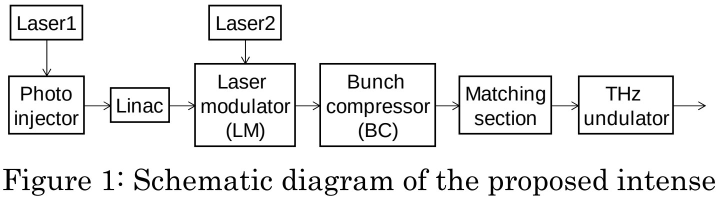


Figure 1: Schematic diagram of the proposed intense THz source driven by a compact accelerator of 35 to 50 MeV.

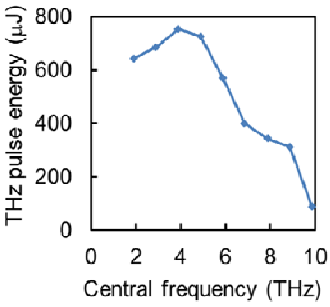

Figure 2: THz pulse energy as a function of the central frequency.


Figure 3: Picture of the Pyramid of the Sun in Teotihuacan, Mexico.