Ultrahigh brilliance X- and γ-rays generation based on laser wakefield accelerators at SIOM

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Abstracts: *We presented the latest experimental results of X- and γ-rays generation via three different schemes such as betatron radiation, synchrotron radiation with an undulator, and inverse Compton scattering based on a high-quality laser wakefield accelerator which was powered by a 1-Hz 200-TW femtosecond laser facility at SIOM.*

In a laser wakefield accelerator (LWFA), a relativistic femtosecond laser pulse can excite a plasma-density wake with ultra-high accelerating fields reaching 100 GV/m, in which trapped electrons can be accelerated to GeV-class over a distance of centimeter-scale. Remarkable progress has been made over the past decade in generating quasi-monoenergetic e-beams with energies extending up to multi-GeV, making the LWFA promising as a compact accelerator, which will have potential applications, such as x-ray free electron lasers, γ-ray radiation sources and particle colliders.

In this report, we presented the latest experimental results of X- and γ-rays generation via three different schemes such as betatron radiation, synchrotron radiation with an undulator, and inverse Compton scattering based on a high-quality cascaded LWFA which was powered by a 1-Hz 200-TW femtosecond laser facility at SIOM. The cascaded LWFA developed at SIOM has the ability to generate tunable high-quality e-beams (<1% rms energy spread, ~ 50 pC at the peak energy tunable from 200 to 500 MeV, < 0.4 mrad rms divergence), which were used to generate compact femtosecond X-ray sources. By employing a self-synchronized all-optical Compton scattering scheme, in which the electron beam collided with the intense driving laser pulse via the reflection of a plasma mirror, we produced tunable quasi-monochromatic MeV γ-rays (33% full-width at half-maximum) with a peak brilliance of $\sim 3.1\times10^{22}$ photons s^{-1} mm^{-2} $mrad^{-2}$ 0.1% BW at 1 MeV, which is one order of magnitude higher than ever reported value in MeV regime to the best of our knowledge. By manipulating the plasma density distribution, we obtained betatron radiation at several-tens keV controllable in yield and peak energy. Besides, an experimental setup for developing intense coherent x-ray radiation sources using the high-quality LWFA electron-beams, a linear transport system consisting of seven quadrupoles to focus the electron beam and one dipole for generating the dispersion, and a 6-meter-long undulator with a period of 2 cm has been recently assembled. The synchrotron radiation at ~30 nm based on the LWFA electron-beams has been detected in the first-phase experiments.