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Stable High-quality electron beams from the laser wakefield accelerator at SIOM

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Laser wakefield accelerator (LWFA) holds a great potential as a compact accelerator for its ultra-high accelerating gradient up to 100 GV/m. Over the past decade, significant progress has been made in LWFA and GeV-class femtosecond electron bunches with tens of pC charge can be generated in mm-to-cm-scale plasmas [1]. Such accelerators are being actively pursued for use in applications of table-top free electron lasers (FELs), Compton-scattering γ-ray sources and even high energy colliders [2]. Improving electron beam quality and stability is of curial importance for LWFA-based applications, which is an active field of research.

We have experimentally demonstrated a stable acceleration scheme with the in-house developed 200-TW laser system with a repetition rate of 1-5 Hz [3]. Figure 1(a) shows the schematic layout of the experimental setup for high-quality and stable *e*-beam acceleration. A perforated baffle inserted upstream of a pure helium supersonic nozzle to construct a shock wave and the corresponding longitudinal density tailoring contributes to the injection process with a controllable evolution of the driven laser beam. A synergistic injection (the combination of self-injection and density down ramp injection) is applied to ensure a stable injection [4].

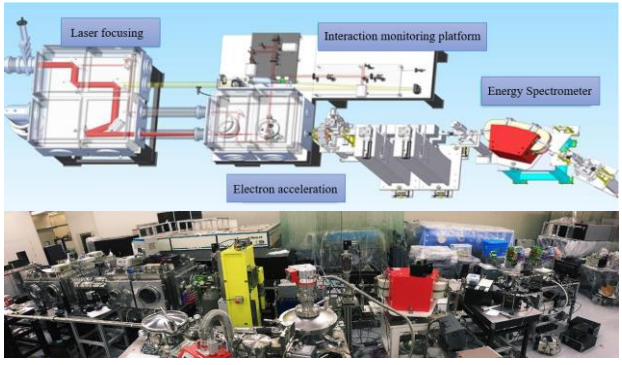

Fig. 1. Schematic layout of the laser wakefield accelerator experiment.

High-quality *e* beams with peak energies in the range of 200-800 MeV, rms divergences of 0.1-0.4 mrad, rms energy spread of 0.2%-1% and beam charge of 10-50 pC were experimentally obtained. Figure (2) shows the typical *e*-beam spectra over consecutive 30-shots and a fluctuation within 3% on *e*-beam peak energy is estimated. The produced *e* beam has an ultrahigh brightness of ~1×10^{16} A/m2/0.1% and reproducibility of 100%.

In recent of our experiment, a dedicate 12-m undulator beamline was carried out for the investigations on compact soft x-ray sources. Attributed to the stable acceleration and fine guiding and transport in the beamline, we have also demonstrated soft X-ray undulator source in exponential gain regime. Such a stable accelerator expedites the proceeding of the LWFA-driven applications and will benefit the realization of laboratory-scale FELs.

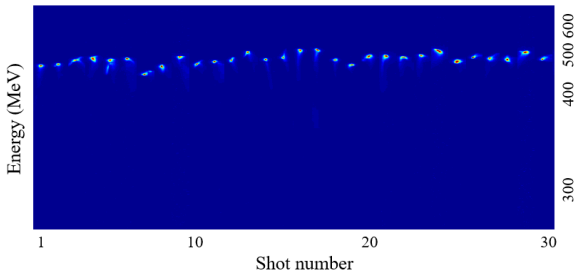

Fig. 2. Spectra of the accelerated *e* beams over 30-shots measured in the spectrometer located 2.3m downstream from the gas target.

References

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Note: Abstract should be in 1 page.