GeV class laser wakefield electron acceleration using the J-KAREN-P laser

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Abstract

With the development chirped pulse amplification (CPA) technology, femtosecond Ti: sapphire lasers with powers of TW ~ PW have been implemented in laboratories around the world. By the incidence of such ultrashort high-power lasers into gases, plasma waves with electric field strength of 100 GeV/m can be driven in the wake of the laser pulses. The periodic plasma wave has a similar structure as that of a conventional radio-frequency (RF) cavity and can accelerate the electrons to over GeV within centimeter distance. This compact laser wakefield acceleration (LWFA) scheme attracts great interests for its potentials in high energy physics studies and the realization of a table-top x-ray free electron laser. LWFA has become one of the primary research topics in laser plasma physics.

In Kansai Photon Science Institute (KPSI), the J-KAREN-P laser delivers laser pulses with intensity up to 1020 W/cm2 in the long-focus chamber. Such a 0.1 Hz petawatt class laser allows us to do systematical study on LWFA with electron energies at GeV level. We treat LWFA as an advanced accelerator and focus on optimizing the electron beam qualities on the aspects of maximum energy, pointing and charges. For challenging the electron energy, we utilized a two gas-jet set-up with the first jet as injector and the second jet as booster. For stable electron beam generation, we utilized the density transition regime by the insertion of a blade. For high charge electron beam generation, we produce electron beams in the ionization injection regime by using high-Z doped mixture gas. While challenging such parameters, interesting physical phenomena have been observed. For the next step, we will continue to optimize the electron beams and try some applications using the generated high brightness electron beams.

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