SIMULATION OF A BETATRON SOURCE GENERATED WITH THE PETAL LASER

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In Laser WakeField Acceleration (LWFA), an ultra-short laser pulse drives a wakefield in a low density plasma that can accelerates electron bunches to high energy. The transverse wiggling of the electron beam in the wake creates X-rays known as betatron radiation. Due to its small source size and short duration, the betatron source could be a promising source for X-ray imaging with a high-temporal and high-spatial resolution. In this paper, we study the possibility to create a betatron source with the 1 kJ and 500 fs PETAL laser, which will operate in the LMJ facility in France. This work could pave the way toward new applications of betatron sources, such as X-ray imaging of shock experiment on the LMJ-PETAL facility, in the inertial confinement fusion and laboratory astrophysics domains.

First, the fact that the PETAL laser might not be optimized for LWFA and betatron emission as either its energy is too low or its duration is too long according to the matching conditions for LWFA is discussed. However, we then show with PIC simulations that it's still possible to accelerate a quasi mono-energetic electron beam and generate a betatron source with this laser. According to our simulations, a 200 pC beam can be injected in a down-ramp density gradient, and then accelerated up to a few GeV after 10 cm of propagation in low plasma of density. We investigate the properties of the produced radiation: a broadband spectrum up to several tens of keV and a good collimation of the order of 10 mrad have been obtained.