Concurrence of high quality electron and bright betatron radiation from laser-plasma accelerator

With the support by the National Natural Science Foundation of China (Grant No. 11334013), Prof. Chen Liming's team in the Institute of Physics, Chinese Academy of Sciences, reported a new method about the enhancement of laser-driven betatron X-ray radiation, which was published in *PNAS* (2014, 111(16): 5825—30).

While accelerating longitudinally in the laser wakefield, electron beams also oscillate transversally (wiggling motion), which emits spatially coherent betatron X-rays. Due to the *fs* time-scale, this source can be used in the time-resolved dynamic probe in biological and condensed matter applications. However, the existing laser-driven betatron source suffers the limitation of X-ray conversion efficiency, and usually one cannot obtain bright betatron X-rays and high-quality electron beams with low emittance and small energy spread simultaneously in the same accelerating wave. A new method was therefore proposed to solve this problem. Prof. Chen's team performed the experiment in Lawrence Livermore National Laboratory in the USA. The experimental results overcame the bottle-neck mentioned above, and drastically enhanced the betatron radiation with high-quality electron beams. Two distinct electron bunches were observed in a single laser shot, one featured with a quasi-monoenergetic spectrum and the other with a continuous spectrum and higher electron energy and charge. The latter was able to generate high flux betatron X-rays. The numerical simulation reveals that two bunches of electrons are injected at different stages due to the bubble evolution. The first bunch is injected at the beginning to form a stable quasi-monoenergetic electron beam, while the second one is injected later due to the oscillation of the bubble size during the propagation.

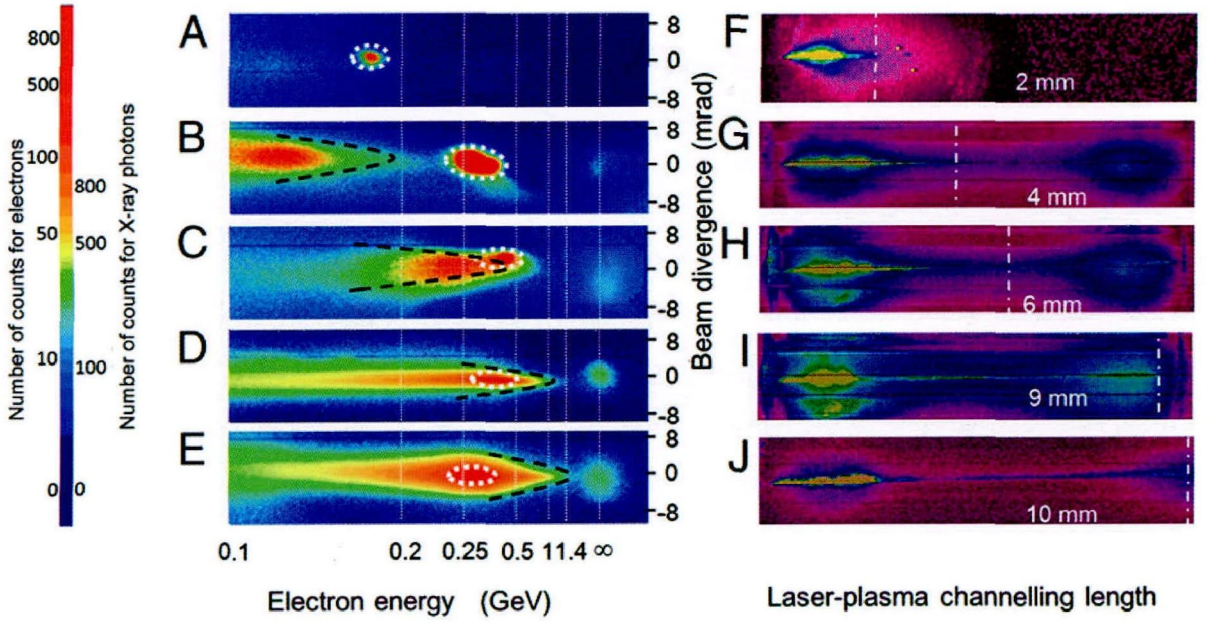

Figure Accelerated electron beams, betatron X-rays and plasma channel measurement. (A-E) show the spectrum characteristics of the electron beams and the betatron X-ray beam profile. (F-J) show the corresponding Thomson scattering obtained from the nozzle. Electron bunches appear as the channel length increases.