Relativistic Mirrors in Laser Plasmas – a Path towards Compact Source of Coherent X-Rays

S. V. Bulanov, T. Zh. Esirkepov, M. Kando, H. Kiriyama, A. S. Pirozhkov

Advanced Photon Research Center, JAEA, 8-1-7 Umemidai, Kizugawa, Kyoto, 619-0215, Japan
Telephone:+81 774-01-3005, Fax: +81 774-01-3316, E-mail: bulanov.sergei@jaea.go.jp

The advent of chirped pulse amplification resulted in the dramatic growth of peak power of lasers and opened the new branch of high field science, delivering the focused irradiance, electric fields of which drive electrons into the relativistic regime [1]. In a plasma a strongly nonlinear breaking wake wave driven by an intense laser pulse can act as a partially reflecting relativistic mirror [2] (the flying mirror [3, 4]), producing an extremely time-compressed focused tightly pulse with a frequency multiplication factor ~ 4γ² (the double Doppler effect). We present the results of experiments [5] on the high intensity laser pulse collision in the underderdense plasma, in which the photon number detected in the reflected radiation approached theoretical limit [6]. This leads to the possibility of very strong pulse compression and extreme coherent light intensification.

The flying mirror is able to generate intense coherent ultrashort XUV and X-ray pulses that inherit their temporal shape and polarization from the original optical-frequency (laser) pulses. This scientific area promises the development of the sources of ultrashort x-ray pulses with the parameters required for studying of complex structures in nanometer scale and in attosecond range.

Fig. 1. Left. 3D PIC simulation of two counterpropagating laser pulse interaction. Enlarged: the reflected electromagnetic pulse. Centre. Experiment setup [4], overlapping laser pulses, and detected signal demonstrating narrow band XUV radiation. Right. Schematic of experimental setup [5], spectra of reflected signal.

References