Feasibility studies for all-optical and compact $\gamma$–ray blaster by PetaWatt-class laser pulse and its application


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The all-optical Compton backscattering setup by using laser pulses becomes a promising method in building a compact $\gamma$–ray source [1]. Nevertheless, this method only produces a single $\gamma$–ray flash and other sources are suppressed. In this work, we study the feasibility of producing double $\gamma$–rays flashes by using one 1 PW laser pulse. This method utilises the all-optical setup with a structured solid target as a reflecting foil. The laser pulse is reflected by this foil after propagating a few millimetres into the underdense plasma. The reflected laser intensity is boosted strong enough to invoke radiation reaction as nonlinear Compton backscattering. After that, the electron bunch passes the foil for bremsstrahlung. Our simulation result shows that a collimated $\gamma$–ray beam from the nonlinear Compton backscattering (NCBS) with peak brilliance of $6.7 \times 10^{20}$ photons/s/mm$^2$/mrad$^2$/0.1%BW at 15 MeV is obtained. At the same energy, bremsstrahlung process provided another collimated $\gamma$–ray beam with $2.1 \times 10^{16}$ photons/s/mm$^2$/mrad$^2$/0.1%BW. The double $\gamma$–rays beams can find application for the pump-probe experiment down to the nuclear structure [2].

Figure 1: (Left) Three stages for the generation of $\gamma$–ray blaster. (Right) The photon number spectrum for NCBS and bremsstrahlung.

References
