Exploration of Nonlinear Compton Scattering Using Multi-PW Laser at CoReLS

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Research on laser wakefield accelerators (LWFA) has greatly benefited from the availability of ultrahigh intensity lasers, producing up to multi-GeV electron beams in a several centimeters-long of plasma.[1-3] Among applications for high energy electron beams from LWFA, strong-field quantum electrodynamics (QED) is an emerging field in fundamental physics.[4] Investigations of strong-field QED can be performed through nonlinear Compton scattering (NCS) between an ultra-relativistic electron beam and an ultrahigh intensity laser pulse. Though this research area brings a series of challenges to be explored, the production of stable multi-GeV electron bunches and the availability of a multi-PW laser at CoReLS [5,6] offer the opportunity to investigate radiation reaction and strong-field QED through electron-photon interactions. In this work, we present recent progress in all optical nonlinear Compton scattering experiments. By applying the laser wakefield acceleration (LWFA) scheme, stable and reproducible 3-GeV electrons were generated from a He:Ne plasma wake driven by a PW laser pulse. The electron beam was collided with an ultra-intense laser pulse ($I>10^{20}$ W/cm^2), producing bright high-energy gamma beams. We present the measurements of collimated high energy gamma beams with energy over 100 MeV and beam divergence of about 1 mrad. We also show clear distinction between other radiation sources observed in experiments, such as Bremsstrahlung and betatron radiation.

References

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