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Gamma-ray beam produced by a plasma lens focused electron bunch

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High energy gamma-ray beams have become an immensely useful tool for probing hot dense matter, material synthesis, and cancer therapy. In this report, an accelerator electron bunch is focused and modulated in a plasma lens and then converted into a gamma-ray source using bremsstrahlung radiation in a dense material, as indicated in Figure 1. In the linear regions with beam density much smaller than plasma density, a proper plasma density needs to be chosen to produce a high quality gamma-ray beam with a small spot size and low divergence, which can be applied in the radiograph of complex and dense objects with sub-millimeter resolution. Compared to the case without plasma lens, a sixfold increase in the brilliance of the gramma-ray beam can be expected. As the bunch charge increases and bunch density approaches plasma density, micro-bunching of the bunch due to the nonuniform transverse wakefield and bunch energy chirp is observed, leading to a significant increase in gamma-ray beam divergence.

References

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2. Z.-H. Hu et al., Physics of Plasmas 26, 073104 (2019).

Figure 1