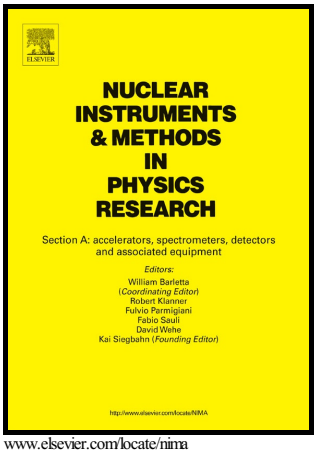

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A bremsstrahlung gamma-ray source based on stable ionization injection of electrons into a laser wakefield accelerator

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Abstract

Laser wakefield acceleration permits the generation of ultra-short, high-brightness relativistic electron beams on a millimeter scale. While those features are of interest for many applications, the source remains constraint by the poor stability of the electron injection process. Here we present results on injection and acceleration of electrons in pure nitrogen and argon. We observe stable, continuous ionization-induced injection of electrons into the wakefield for laser powers exceeding a threshold of 7 TW. The beam charge scales approximately with the laser energy and is limited by beam loading. For 40 TW laser pulses we measure a maximum charge of almost 1 nC per shot, originating mostly from electrons of less than 10 MeV energy. The relatively low energy, the high charge and its stability make this source well-suited for applications such as non-destructive testing. Hence, we demonstrate the production of energetic radiation via bremsstrahlung conversion at 1 Hz repetition rate. In accordance with GEANT4 Monte-Carlo simulations, we measure a γ-ray source size of less than 100 microns for a 0.5 mm tantalum converter placed at 2 mm from the accelerator exit. Furthermore we present radiographs of image quality indicators.

Keywords:
Gamma ray, Laser wakefield acceleration, Ionization injection, Bremsstrahlung, Radiography

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