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A brightness transformer using a beam driven plasma wake field accelerator

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High brightness electron beams are essential for many physics applications, colliders and light sources such as X-ray FEL at SLAC Linear Coherent Light Source (LCLS), Berkeley Advanced Light Source (ALS), and Argonne Advanced Photon Source (APS). Currently operational state of the art photo injectors can produce electron beams with brightness as high as 10^{13} A/(mrad)^2. Here we introduce a new scheme for producing an electron beam with ultra-high brightness. 2D fully parallel PIC simulations of a plasma wakefield experiment driven by an ultrarelativistic drive beam are performed. The simulations show that ultra-high gradient longitudinal fields (>40 GV/m) trap plasma electrons; trapped electrons form a bunch which has a brightness value ($> 10^{15}$A/mrad^2) two orders of magnitude greater than that of the drive beam. The simulations results are supported by the experimental data taken at the Stanford Linear Accelerator Center. Using the simulations we also show how the brightness can be optimized by changing the drive beam parameters.

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