Optimized operation of dielectric laser accelerators: Single bunch

Adi Hanuka* and Levi Schächter

Department of Electrical, Engineering Technion–Israel Institute of Technology, Haifa 32000, Israel

(Received 11 September 2017; published 9 May 2018)

We introduce a general approach to determine the optimal charge, efficiency and gradient for laser driven accelerators in a self-consistent way. We propose a way to enhance the operational gradient of dielectric laser accelerators by leverage of beam-loading effect. While the latter may be detrimental from the perspective of the effective gradient experienced by the particles, it can be beneficial as the effective field experienced by the accelerating structure, is weaker. As a result, the constraint imposed by the damage threshold fluence is accordingly weakened and our self-consistent approach predicts permissible gradients of $\sim$10 GV/m, one order of magnitude higher than previously reported experimental results—with unbunched pulse of electrons. Our approach leads to maximum efficiency to occur for higher gradients as compared with a scenario in which the beam-loading effect on the material is ignored. In any case, maximum gradient does not occur for the same conditions that maximum efficiency does—a trade-off set of parameters is suggested.

DOI: 10.1103/PhysRevAccelBeams.21.054001