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Enhancing the efficiency of laser and plasma based accelerators using bichromatic driver pulses

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The importance of the laser and plasma based accelerators is well known. The tuning of the laser and plasma parameters is the crucial point of this technology. Earlier we already have done numerical simulations to determine the beam parameters of a laser driven plasma based electron accelerator, i.e. the parameters of both the laser beam and the victim electron bunch [1]. In a latter study, we improved our simulations such that it is capable to deal with bichromatic driver pulses [2]. We simulated the effects of mixing the second harmonic to the original driver pulse with 800 nm wavelength and got promising results. The most important one is, that by properly tuned laser parameters, it is possible to transfer 30% more energy to the victim bunch by the same intensity than that is achievable by applying a monochromatic, infra red driver pulse. It is also possible to realise this idea in practice with a moderate additional effort. Our studies suggest that laserplasma electron accelerators may be relevant tools in material science, e.g. radiography, or in medical sciences, e.g. radiotherapy. For the latter applications, mostly electrons with a few tens of MeV energy are needed [3]. For higher penetration depth, electrons with a few hundred MeV kinetic energy may be needed. Both energy ranges can be achieved using laserplasma electron accelerators. According to our studies, using an 800nm wavelength laser these energies can be achieved if the laser intensity lies between 10ˆ17 - 10ˆ21 W/cm2 and the pulse duration lies between 5 and 75 fs. In our calculations the maximum of the beam waist was 80 um and they suggest that larger beam waists result in higher energy gain, i.e. larger beam waists may reduce the required laser intensity to achieve the same energy gain, even by one or two orders of magnitudes. [1] M. A. Pocsai, S. Varró, I. F. Barna, Laser and Particle Beams (2015), 33, 307-313. [2] M. A. Pocsai, S. Varró, I. F. Barna, Nucl. Instr. Meth. Phys. Res. B (2016) 369, 50-54. [3] K. S. Clifford Chao and Carlos A. Perez, Radiation Oncology: Management Decision 2n. Edition, chap. 3. p. 29. (ISBN: 978-0781732222)

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