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Simulations of low-density plasma channels capable of high repetition rate operation

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The next generation of Laser Wakefield Acceleration experiments require guiding laser drivers with longer and lower density plasma structures. We present theory and simulations describing an entirely optical mechanism of creating plasma channels 10s of centimetre long and with on axis plasma densities below 10^17 cm^-3. These channels would be suitable for guiding 10 GeV scale LWFA stages and could potentially operate at kHz repetition rates without damage.

Building on over two decades of successful work using Bessel beams to form plasma waveguides [1-3], we study using axicon focussing to produce long columns of hot plasma, the expansion of which can create guiding structures. Unlike collisional heating, using optical field ionization from elliptically polarised light allows the electrons in the plasma column to be heated independently of the density, enabling the formation of a plasma channel at unprecedented low densities. We present results of simulations on the development of the channels, using several different codes to encounter a range of interesting physics.

1. C. G. Durfee III and H. M. Milchberg, PRL 71, (1993)
2. H. Sheng et al, PRE 72, (2005)
3. A. J. Goers et al, APL 104, (2014)

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