High order modes of intense second harmonic light produced from self-generated and preformed plasma apertures

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Due to their ability to sustain extremely high amplitude electromagnetic fields and transient density and field profiles, plasma optical components are being developed to amplify, compress and condition high power laser pulses. We recently demonstrated the potential to use a relativistic plasma aperture, produced during the interaction of a high power laser pulse with an ultrathin foil target, to tailor the spatio-temporal properties of intense fundamental and second harmonic light generated [1].

Here, we numerically explore the interaction of an intense laser pulse with a preformed aperture target (Figure 1) to generate second harmonic laser light with higher-order spatial modes [2]. The maximum generation efficiency is found for aperture diameter close to the full width at half maximum of the laser focus and for a target thickness on the micron-scale. The spatial mode generated is shown to depend strongly on the polarisation of the drive laser pulse, which enables changing the output light between a linearly polarised TEM_{01} and a circularly polarised Laguerre–Gaussian, LG_{01}, mode. This demonstrates the use of a plasma aperture to generate intense, higher frequency light with selectable (at high power) spatial mode structure.

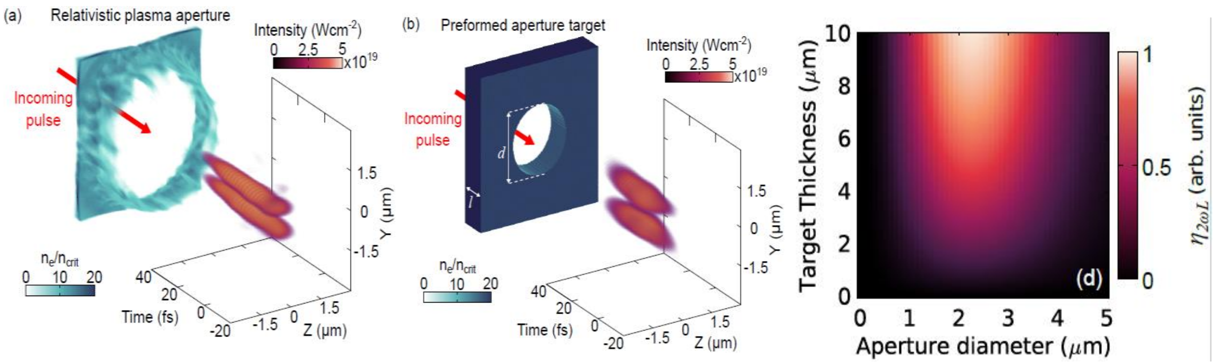

Figure 1: Example 3D simulation results demonstrating the generation of relativistically-intense frequency-doubled light in a higher-order spatial mode (TEM_{01}), driven by intense laser light in a fundamental TEM_{00} mode, from: (a) a self-generated relativistic plasma aperture; (b) a preformed aperture. (c) Normalised conversion efficiency to 2ω as a function of target aperture parameters.

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References
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