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O4.201 Plasma-based dynamic volume holographic elements for high-intensity lasers

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The manipulation of intense laser fields by solid-state devices is severely limited due to nonlinearities and damage threshold issues as the fluence of high-intensity laser pulses is more than five orders of magnitudes larger than what conventional materials can sustain. In recent years, novel concepts how structured plasmas can be used as damage-less optics, e.g. in the form of mirrors [1], wave-plates and polarizers [2,3], emerged. Plasma holograms created by the overlap of two lasers at the surface of a flat foil where demonstrated to be able to induce optical angular momentum to high-intensity pulses [4]. We demonstrate that it is possible to create volumetric plasma holograms that allow to store complex phase information of optical fields. Our concept allows to create holographic optical elements using moderate intensity laser pulses which are subsequently read out by highintensity pulses. These holograms can e.g. act as focussing elements that at the same time can compensate phase-errors in the read-out pulse via pre-compensation. In order to demonstrate the high phase-sensitivity of the volume hologram, we show in simulations that it is possible to store and retrieve complex phase information such as that of Laguerre-Gaussian (LG) laser pulses. LG laser pulses are of strong current interest in the context of particle acceleration concepts, their production with intensities far above the relativistic threshold, however, remains challenging. Plasma volume holograms offer a potential way to produce such pulses at ultra-relativistic intensities.

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