

# Transient Plasma Photonic Structures as Robust Optical Elements

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High power lasers are large because they are based on relatively low damage-threshold optical components. A more robust and compact medium for amplifying and manipulating intense laser pulses is plasma. Here we demonstrate that a transient plasma photonic structure can be created using two mechanisms. In the first, plasma is selectively created by ionising gas using the beat wave of counterpropagating laser pulses. In the second mechanism, a transient plasma structure is created ballistically by the space-charge fields of electrons bunched by the ponderomotive force of the counter-propagating laser pulses. These fields impart phase correlated momenta to ions, and then ions ballistically evolve into a volume Bragg grating. We show, in experiments undertaken at the Central Laser Facility, Rutherford Appleton Laboratory, that these plasma structures can be used to create compact waveplates, mirrors, lenses and plasma-based amplifiers.