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Laser pulse propagation in a meter scale Rb vapor plasma

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AWAKE is a proof-of-principle proton-driven plasma wakefield electron acceleration experiment at CERN. The purpose of the experiment is to demonstrate the acceleration of electrons from MeV to GeV scale within a 10 meter plasma with an electron density of 1014-1015 cm-3. An ultrashort terawatt laser pulse ionizes rubidium vapor, creating plasma and seeding the self-modulation instability with a sharp moving ionization front. To mitigate the effects of laser density ramps at the entrance and exit of the plasma, limiting apertures have been proposed. The beam diffracts after passing through the entrance aperture. Also, along propagation of the laser pulse in plasma, dispersion, kerr-induced self-focusing and filamentation may occur. These effects potentially lead to a decrease in laser pulse intensity below the rubidium ionization threshold, thereby limiting the radial and longitudinal extent of the plasma. We present results of numerical studies aimed at finding laser beam parameter suitable to obtain a uniform, 10m-long, at least 1mm in radius plasma.

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