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Experimental Characterization of Rubidium Vapor Photoionization in a Meter-Scale Rubidium plasma source

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AWAKE is a proof-of-principle proton driven plasma wakefield electron acceleration experiment that requires a 10 meter long plasma source with a density of 1014-1015 cm-3. To create this plasma, an ultrafast terawatt laser pulse ionizes rubidium vapor at the required density. Although the ionization process can be described as a form of tunnel ionization, the Keldysh parameter is on the order of unity, causing some commonly applied approximations to break down. By selecting a laser with the D1 and D2 transition lines within its bandwidth the effects of anomalous dispersion in the vapor will broaden the pulse significantly from its transform limited with on a centimeter scale. By propagating the laser pulse over meter scales the resulting laser pulse length will be significantly broadened unless ionization occurs over the entire vapor column. The laser's pulse length can act as an ionization diagnostic. We describe the results of experimental characterization of the photoionization process through a meter long heat pipe oven using a 100 fs FWHM laser pulse and compare them to numerical results of standard ionization models.

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