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Experimental design for generating low-density plasma channels by optical field ionization

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The development of plasma channels with densities below 1x10^18cm-3 is of significant interest to plasma accelerators driven by particle bunches or laser pulses. For the latter it is also important to maintain a low matched spot size Wm over a long interaction region. For several potential applications of plasma accelerators, such as driving light sources, it would also be desirable to operate at multi-kilohertz pulse repetition rates. These requirements are challenging for existing guiding methods owing to difficulties in maintaining small Wm at low densities, or avoiding optical or thermal damage at high repetition rates.

We have proposed forming low-density plasma channels by hydrodynamic expansion of plasma columns formed by optical field ionization (OFI) with elliptically polarized laser pulses. Unlike earlier work on hydrodynamic channels, which utilized collisional heating, OFI-heating is independent of density so can drive channel formation in low density gases.

We will present the design considerations for an experiment to generate OFI plasma channels up to 50mm in length in hydrogen with an axicon lens using femtosecond duration laser pulses. Our investigation deals with some of the key aspects of the experimental design including the interferometric diagnostic, data analysis, and target design.

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