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New findings on the control of filamentation of intense laser beams propagating in underdense plasma[1]

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In indirect drive ICF ignition designs, the laser energy is delivered into the hohlraum through the laser entrance holes (LEH), which are sized as small as practicable to minimize X-ray radiation losses. On the other hand, deleterious laser plasma processes, such as filamentation and stimulated back-scatter, typically increase with laser intensity. Ideally, therefore, the laser spot shape should be a close fit to the LEH, with uniform (envelope) intensity in the spot and minimal energy at larger radii spilling onto the LEH material. This keeps the laser intensity as low as possible consistent with the area of the LEH aperture and the power requirements of the design. This can be achieved (at least for apertures significantly larger than the laser's aberrated focal spot) by the use of custom-designed phase plates. However, outfitting the 192 beam NIF laser with multiple sets of phase plates optimized for a variety of different LEH aperture sizes is an expensive proposition. It is thus important to assess the impact on laser-plasma interaction processes of using phase plates with a smaller than optimum focal spot (or even no phase plates at all!) and then de-focussing the beam to expand it to fill the LEH and lower its intensity. We find significant effects from the lack of uniformity of the laser envelope out of the focal plane, from changes in the characteristic sizes of the laser speckle, and on the efficacy of additional polarization and/or SSD beam smoothing. We quantify these effects with analytic estimates and simulations using our laser plasma interaction code pF3D.

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