Thermal and ponderomotive filamentations of a high-power laser beam propagating through a long gas-filled target

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Gas-filled targets are commonly used in the context of inertial confinement fusion (ICF), both in the laser-indirectly (LID) and magneto-inertially driven (MID) fusion experiments. In both cases, after burning a plastic window containing a low-Z gas, a high-power laser propagates through it, typically over 10 mm. Without loss of generality, we will focus in the following on the LID context where the lasers have to reach the hohlraum's wall without damage, and more specifically on the early propagation, that we defined as the duration between the beginning of the laser pulse and the time needed by lasers to reach the wall (burn-through time). During this phase, laser Bremsstrahlung absorption, electron thermal conductivity and ponderomotive effects compete, leading to potential laser instability seeded asymetry, such as filamentation. Filamentation, either due to thermal or ponderomotive effects [1, 2, 3, 4] is the main mechanism at play in this study, where the propagation of a 351-nm 1-TW 3-ns laser through a 5-mm long gas-pipe is investigated using the OMEGA EP laser facility. Proton deflectometry is used for probing the plasma at different times during the laser pulse. Experiments suggest that strong ponderomotive and thermal filamentations develop, breaking the laser beam in typically 100-μm large filaments. This is in agreement with simulations using the HERA paraxial code where ponderomotive and thermal forces are modeled at the speckle scale. Those results confirm that, in the early stage of laser propagation in the indirect drive approach for inertial confinement fusion, beams' break-up is still a serious concern, possibly seeding defaults in the shell's capsule.

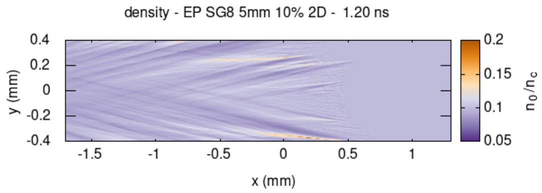

Figure 1: *Electron density from HERA .*

References

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