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Impact of localized radiative loss in inertial confinement fusion implosions[1]

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Enhanced radiative loss from impurities that mix into the reacting deuterium tritium (DT) plasma has been identified as one of the principle degradation mechanisms that can limit fusion energy production in inertial confinement fusion (ICF) experiments [1-2]. In this work, the impact to fusion energy production due to the radiative loss from a localized mix in ICF implosions using high density carbon capsule targets is quantified [3]. The radiative loss from localized mix and local cooling of the reacting plasma conditions was quantified using multi-axis neutron and x-ray images to reconstruct the hot spot conditions during thermonuclear burn. Such localized features arise from ablator material that is injected into the hot spot from the growth of capsule surface perturbations, particularly the tube used to fill the capsule with deuterium and tritium fuel. Observations, consistent with analytic estimates, show the degradation to fusion energy production to be linearly proportional to the fraction of the total emission that is associated with injected ablator material and that this radiative loss has been the primary source of variations, of up to 1.6 times, in observed fusion energy production. Reducing the fill tube diameter has increased the ignition metric χno α from 0.49 to 0.72, 92% of that required to achieve a burning hot spot. [1] T. Ma et al., Phys. Rev. Lett. 111, 085004 (2013). [2] S. P. Regan et al., Phys. Rev. Lett. 111, 045001 (2013). [3] A. Pak, et al. Phys. Rev. Lett 123, 1450001 (2020).

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