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Wobblers and Rayleigh-Taylor Instability Mitigation in HIF Target Implosion

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In the paper a dynamic mitigation mechanism for the Rayleigh-Taylor (R-T) instability is discussed together with heavy ion beams (HIBs) wobbling motion [Phys. Plasmas 19, 024503(2012)]. In general a perturbation of physical quantity would feature the instability onset. Normally the perturbation phase is unknown so that the instability growth is discussed with the growth rate. However, if the perturbation phase is known, the instability growth can be controlled by a superposition of perturbations; the most well-know mechanism is a feedback control to compensate the displacement or the distortion of physical quantity. If the perturbation is induced by, for example, a particle beam axis oscillation or wobbling, the perturbation phase could be controlled and the instability growth is mitigated by the superposition of the growing perturbations.

In actual, HIBs provide a remarkable unique tool to control the initial phases of perturbations [Phys. Rev. Lett. 104, 254801(2010)]. The wobbling HIBs can be generated in HIB accelerators and the oscillating frequency of the HIBs'axes may be several 100MHz~ 1GHz. A direct drive spherical fuel target is illuminated by multiple HIBs and the HIBs'axes are wobbled so that a few percent of the implosion acceleration may be oscillated in time and space. The HIB wobblers may give the controlled initial phase of each perturbation. Therefore, the HIB wobblers could realize the dynamic mitigation of the R-T instability in the fuel target implosion.

In order to find the HIB wobblers'illumination uniformity and the HIB wobblers dynamics, we performed three-dimensinal computations. A few % wobbling-beam illumination nonuniformity is realized in heavy ion inertial confinement fusion (HIF) by a spiraling beam axis motion in the paper. So far the wobbling HIB illumination was proposed to realize a uniform implosion in HIF. However, the initial imprint of the wobbling HIBs was a serious problem and introduces a large unacceptable energy deposition nonuniformity. In the wobbling HIBs illumination, the illumination nonuniformity oscillates in time and space. The oscillating-HIB energy deposition may contribute to the reduction of the HIBs'illumination nonuniformity. Three-dimensional HIBs illumination computations presented here show that the few % wobbling HIBs illumination nonuniformity oscillates successfully with the same wobbling HIBs frequency.

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