Hydrodynamic and Symmetry Safety Factors of Hiper's targets

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Introduction

The use of Petawatt class lasers opens the possibility to directly deliver ignition energy to the target, in Inertial Confinement Fusion (ICF), within the Fast-Ignition strategy. A reduced energy is required by the main laser pulse, ignition being achieved by ultrafast and ultra intense ignition lasers. First designs show that implosion speed due to the main pulse is reduced, which suggests that hydrodynamic instabilities could be reduced. Along the line of previous works in indirect-drive implosion scheme, an hydrodynamic safety factor and symmetry safetuy factor are computed for the HiPER target design. Three targets are studied and compared with help of 2D hydrodynamic simulations and instability modeling.
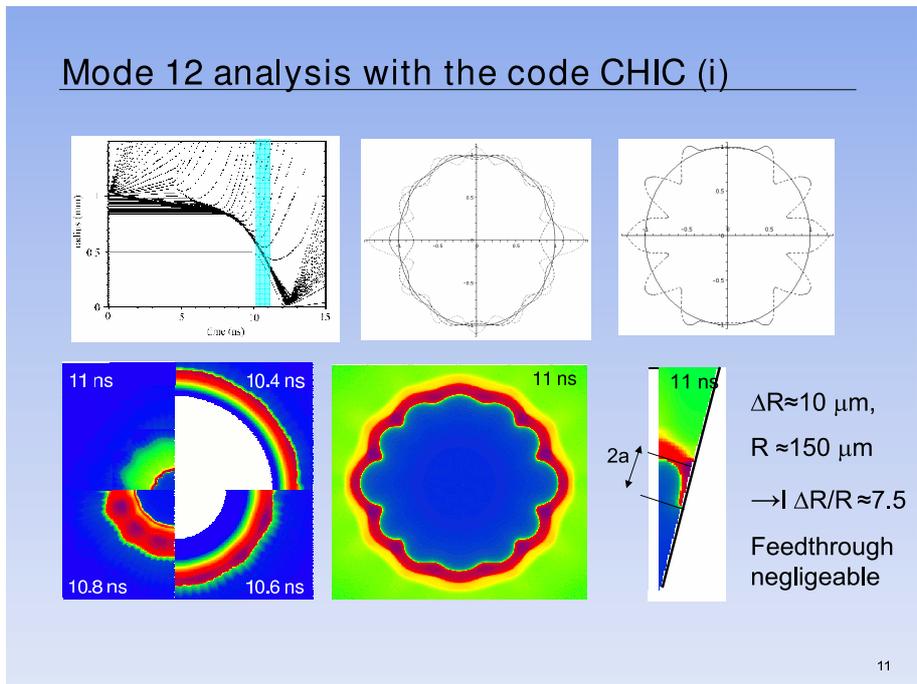
Three realistic targets with FI HiPER framework

Three targets have been investigated.
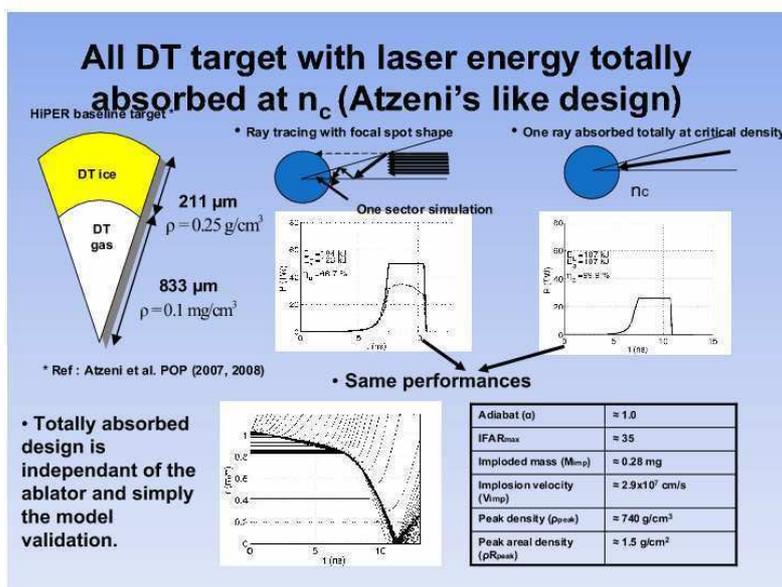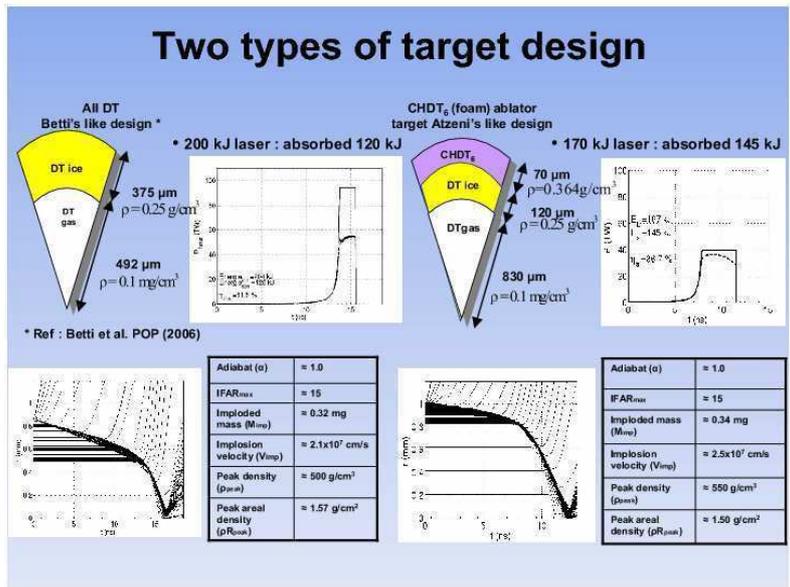
These targets are irradiated by a 48 beams configuration which spectrum characteristics are 0.15 % RMS and a 94 % energy ratio. The maximum asymmetry illumination is defined by a Legendre polynomial l=12 which has a maximum relative amplitude of 0.005 ($\tilde{I}/I$).

Hydrodynamic perturbations analysis

Illumination asymmetries are not directly transmitted to the target. The whole perturbation process occurs in three main steps. The first perturbation step is due to the imprinting of laser beams on the targets. It lasts up to the beginning of the accelerated phase. Here laser illumination perturbation are converted into pressure forces which alters the 1D central symmetry of the

converging flow. The second step is the classical ablative Rayleigh-Taylor instability wich exponentially amplifies imprinted perturbations. Then the final compression stage occurs at a quasi negligeable acceleration, but Bell-Plesset instability occurs. This perturbation post-processing of 1D simulations has been compared succesfully to full 2D CHIC simulations.
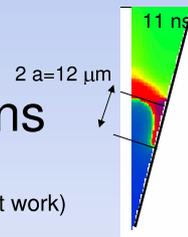

Perturbations influence on density and burn fraction

It is shown that perturbed zone during the final compression stage can affect the high density inner region into which Fast-Ignitor laser should add its energy, which allows to compute a safety factor based on the possible burn fraction due to a density decrease in the target.
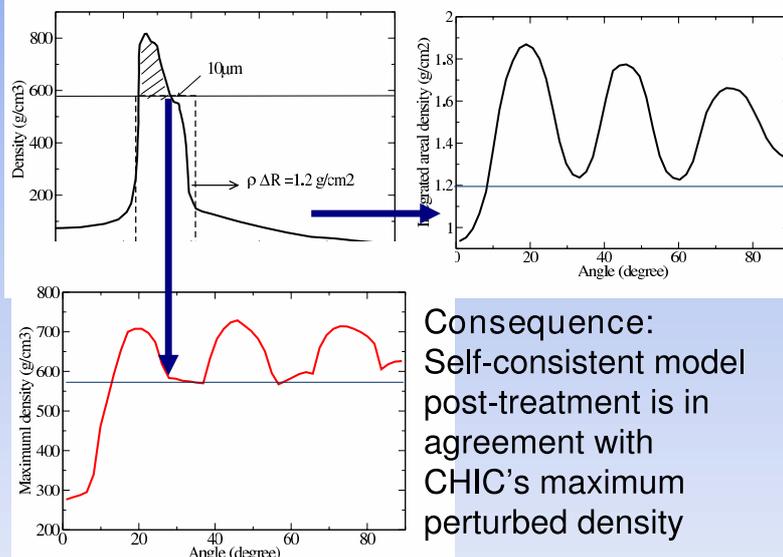
Finally, the safety factor of the three target designs has been evaluated and target designs have been compared each other.

Energy-Power diagram
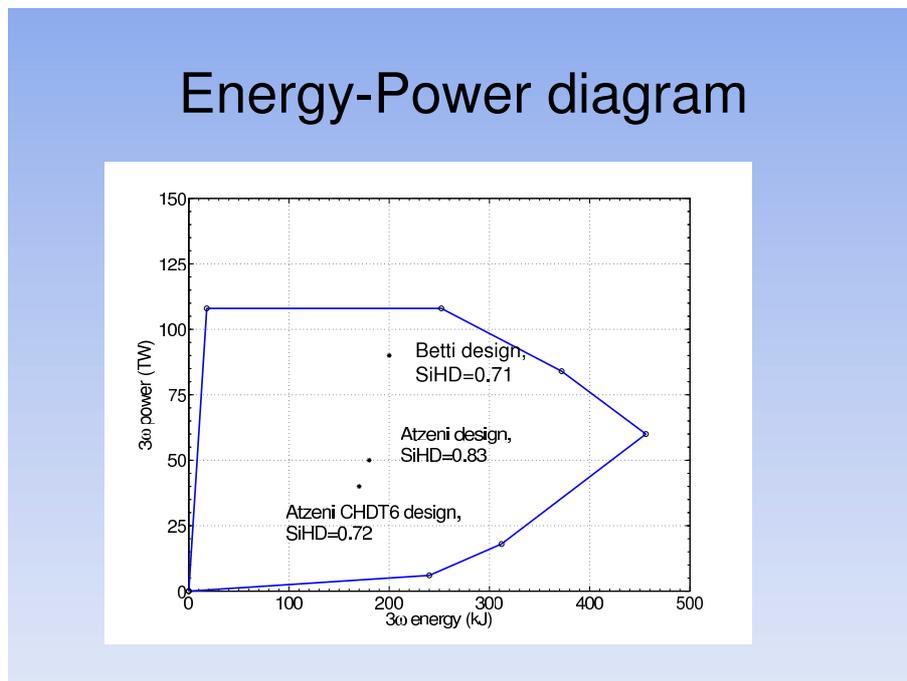
Conclusion

This work is a part of HiPER workpackage 9. The main purpose is here to investigate stability of target designs and to suggest a modeling strategy for large wavelength perturbations. 2D perturbed simulations as well as rather well known models have been cross-checked and used to build a preliminary safety factor.