To a question on possibility of thermonuclear ignition of direct drive targets at megajoule facilities with LASER light WAVELENGTHs of 0.35 microns and 0.53 microns [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2023.50.2023.1.1.100

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The fusion energy of 1.37 MJ has been obtained recently in experiments that performed with indirect‑drive single-shell capsule at NIF facility with laser energy of 1.92 MJ [1]. The possibility of thermonuclear ignition of direct-drive targets have yet to be discovered. The main problems at this approach are the development of hydrodynamic instabilities at the compression of targets and a target preheating by fast electrons (FE) generated in processes of two-plasmon-decay (TPD) and stimulated Raman scattering of laser light in the plasma [2]. The results of numerical simulations of direct-drive single- and double-shell targets performed at the RFNC-VNIITF on purpose to study the possibility to achieve their thermonuclear ignition in experiments at megajoule facilities with laser light wavelength of λ=0.35 μm and λ=0.53 μm are presented.

The calculations of direct-drive single-shell targets, which have been carried out recently by the 1D- ERA code with the taking into account fast electron transport in spectral kinetic approach, have confirmed the main conclusion of the work [3] that the target preheating by FE produced in the TPD and the SRS drastically reduces the possibility to ignite such targets in experiments at facilities with the light in the 2-nd harmonic of the Nd-laser. Apparently, it will be possible to suppress the FE generation by the using of the laser light with λ=0.35 μm and SiO2-ablator for direct-drive single-shell capsule. There is a great danger that filamentation processes of a laser light in plasma could initiate a development of hydrodynamic instability under compression of direct-drive single-shell capsule. For example, the performed 2D- calculations of single-shell capsule have given the decrease in a fusion energy yield of ~ 3 times for the amplitude of the 60-th harmonic perturbation in the symmetry of energy absorbed by the target δqa/qa ~ 0.1 %.

The calculations of direct-drive double-shell target proposed in [4] are executed in the RFNC-VNIITF. The requirements to laser wavelength and short-wavelength perturbations in symmetry of absorbed laser energy are weaken for such targets. The most dangerous to the target [4] are perturbations in the uniformity of absorbed laser energy with harmonics numbers of *l*~10-20 which amplitude should not exceed δqa/qa ≈ 0.5‑1 % according to calculations performed. A problem of a mixing of DT-fuel and a material of an internal shell exists for double-shell targets. The 1D- calculations that carried out for a target [4] without FE generation have given neutrons yield NDT ≈ 1.8∙1018 and a margin of thermonuclear ignition [3] WQ ≈ 6. The computation of this targets with account of mixing process by using of the *kε*-model of turbulent mixing with constants corresponding to the self-similarity "constant" *α*b ≈ 0.04 has led to decrease of WQ and NDT in 2-3 times. However, there is opened a question on the applicability of an empirical models of turbulent mixing to simulation of the ICF targets as Reynolds's numbers are not great in this case. The experiments with double-shell targets will allow to answer this question.

References

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/It/ru/DA-Lykov.docx) [↑](#footnote-ref-1)