THE OPTIMIZATION OF CONVERTERS AND DOUBLE SHELL TARGETS OF DIRECT-INDIRECT DRIVE SCHEME FOR MEGAJOULE LASER FACILITY

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Undoubtedly, the great scientific breakthrough in the field of ICF is the achieving of the ignition and high fusion yields in recent NIF experiments with indirect drive targets [1]. Unlike NIF the powerful laser facility, that under construction in Russia [2], will work with using of the 2nd, instead of the 3rd harmonic of Nd-laser and to have the target chamber more adapted for spherically symmetric irradiation of targets. The difficulties in fulfillment of the requirements for thermonuclear ignition of both direct drive [3] and indirect drive targets [4] for the design parameters of Russian megajoule laser facility stimulate a search of an alternative ways to achieve this goal.

Results of analytical calculations of thermal X-ray field inside spherical box with the circular converters which are heating up outside by laser beams of megajoule facility are presented in report [5]. The converters, symmetrically inserted into the walls of the box, are disks made from a foil or a low-density material (foam) with high nuclear number Z that are semitransparent for own thermal radiation. In the system center a spherical target which should be irradiated uniform enough by thermal X-ray radiation from internal surfaces of converters and box walls is located. The basic advantage of a new box design with converters is the absence of problems associated with the entering of laser radiation into box that exist in traditional box designs with laser entrance holes [1, 4]. Essentially the new variant of a direct-indirect drive approach to ICF is suggested. Note, that the term "direct-indirect drive" was introduced for the first time in work [6] where it is offered to surround a spherical target through a vacuum gape by a thin shell made from the gold foil irradiated outside with laser radiation with intensity $\sim 2 \cdot 10^{15}$ W/cm^2 and a wavelength $\lambda = 0.35$ μm. Calculations and experiments specify that the efficiency of energy conversion of a laser radiation into an unidirectional flux of thermal radiation from the rear side of the converter can reach $\nu_{\_} \approx 30$–40 % [6]. Notice also work [7] where a low-density composite material is offered to use as the converter-absorber. As the efficiency $\nu_{\_}$ for offered design in ~2 times lower than for classical scheme of cylindrical box with two laser entrance holes [1] therefore the radiation temperature T_{RAD} achievable in box also will be ~15% lower. According to [5] radiation temperature $T_{RAD} \approx 0.26$–0.28 keV could be achieved in box of new design at laser power $P_L \approx 450$ TW that is confirmed by simulations performed with using of the 2D-dimensional code of radiation hydrodynamic [8]. The new box design is most suitable for a studying of a compression and an ignition of double shell targets that could be possible at same values of the radiation temperatures [9].

The results of parameter optimization of converters for direct-indirect irradiation of ICF targets, that were performed with using of the 1D- and 2D- radiation hydrodynamic codes developed in RFNC – VNIITF, are presented in the report. The tabular EOS and radiation opacities calculated under program RESEOS [10] were used in these calculations. The results of double-shell target simulations performed for the direct-indirect drive scheme and project parameters of Russian megajoule laser are discussed also. Questions about an ignition margin of such targets are considered with the account of turbulent mixing in simulations that use $k\varepsilon$-models proposed in [11, 12].The ignition margin of double-shell targets obtained in these simulations are compared with results of calculations that performed in RFNC – VNIITF for conditions of experiments [1] carried out on NIF with a target gain $G > 1$.

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