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SIMULATION OF DIRECT - DRIVE TARGETS FOR MEGAJOULE LASERFACILITIES WITH ACCOUNT FOR NONLOCAL ELECTRON TRANSPORT, FAST ELECTRON GENERATION AND STIMULATED STATTERING OF LASER RADIATION

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The review of theoretical works executed in RFNC-VNIITF on numerical simulations of direct- drive targets is presented. The nonlocal electron transport and laser light absorption model that takes into consideration the stimulated Brillouin scattering (SBS), the generation of fast electrons in processes of two-plasmon decay (TPD) and the stimulated Raman scattering (SRS) are realized in the 1D - radiation hydrodynamics code ERA.The 3D - code is developed for simulations of propagation and absorption of laser radiation in spherically symmetric corona of direct-drive targets with account for cross-beam energy transfer (CBET) and real target irradiation geometry at multi-beam laser facilities. The verification of these models and numerical codes is performed on the base of a comparison with experimental data obtained on OMEGA and NIF lasers facilities. The ERA code simulations of cryogenic direct-drive targets for megajoule facilities with laser radiation wavelengths $= 0.53m$ and $= 0.35m$ are carried out.

The ignition margin [1] of nonuniform thermonuclear targets with an allowance for energy losses due to radiation transfer and electron heat conductivity from hot spot has been accepted as the objective function at carrying out of a target optimization.This physical quantity is calculated with using of a density and temperature profiles from 1D-hydrodynamic calculations performed without regard for a contribution of thermonuclear reaction products to DT-fuel heating and it can be presented as:
$W_Q = (n-1)\int_0^{t_*} \frac{dQ_{fus}/dt}{E+Q} dt$
where: dQ_{fus}/dt –the heat rate by thermonuclear reaction products of "hot spot"- the central region of a target with temperature $T > 1keV$, E - internal energy of hot spot, Q - losses of energy due to electronic heat conductivity and radiation transfer, n - an exponent at approximation of thermonuclear reaction rate by power function of ion temperature, - the moment of maximum compression of a target.

The simulations have shown that SBS of laser light and fast electron generation in processes of TPD and SRS would dramatically lower a probability of thermonuclear ignition of direct - drive targets for laser light with wavelength λ =0.53µm. The ignition margin W_Q increase in ~ 2 times at increase of aspect ratio CH-ablator in ~1.6 times or at transition on glass ablator.However for both cases $W_Q < 1$ for laser radiation with wavelength $= 0.53$ µm. The ignition margins increase in 2-3 times at the transition from the 2-nd to the 3-rd harmonic of the Nd-laser radiation.

The 3D - calculations of laser light propagation in the corona of direct-drive targets performed with account of CBET have shown that this process could lower laser energy absorption in ~ 2 times in experiments on 48-beam laser with energy of ~ 2 MJ in radiation of the 2-nd harmonic Nd-laser. However the introduction of shifts between centers of laser emission lines in the neighboring channels by $10 - 20$ will allow to reduce laser energy losses caused by CBET to 10-20%.

References

[1]. Avrorin E.N., Feoktistov L.P., Shibarshov L.I., Fizika Plasmy 6 (5), 965-972, (1980).

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