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New approach in laser inertial fusion

Yuri Chivel
MerPhotonics (France)

One of the main problems in creating a laser inertial fusion reactor is the conversion of neutron flux energy into electrical energy and the design of the first wall. In this paper, it is proposed to use a first wall made of glass that is transparent to neutron flux and laser radiation, to use water as an absorber of neutron flux energy, and to use a low-temperature thermodynamic cycle to generate electrical energy. The reactor is made in the form of sphere with diameter 4m and consists of many disk laser modules. The first wall is made, for example, from fused silica KU-1 glass, behind which there is a 20 cm thick water channel. All glass surfaces have a nanostructured AR surface. The known effect of induced optical absorption under the influence of neutron flux and ionizing radiation is overcome by heating the glass in the range 70-150 C^0 . In addition, this effect has little influence on transmission KU-1 at a wavelength of 532 nm [1]. The laser system consists of 500 disk active elements in the form of segmented spherical layer . Each segment consists from active element Pr^{3+}:YLF with slope efficiency 60% at 532 nm [2] and spherical cavity mirrors - 100% and translucent . The disk active elements are pumped by laser diodes, the radiation from which is supplied to each segment from the edges using a system of fiber cables. External concentric cavity is formed by external 100% mirrors. At a linear phase of generation development , in outer concentric cavity spectral and spatial structure of laser radiation are formed. Transverse mode with waist at the centre of sphere have a most high Q. When a thermonuclear spherical target is thrown into the center of the sphere , generation develops in short cavities with formation of a volumetric synchronized nanosecond pulse that compresses the target . With a total energy of 200 kJ, taking into account the high degree of uniformity of target illumination , a D-T target density of 300 g/cm^3 is easily achived.

To initiate a thermonuclear reaction a volumetric fast ignition scheme is used ,based on a system of six colliding picosecond laser beams with a total energy 6-10 kJ. Ignition could be achived with ions generated via collisionless shock excited directly in the plasma corona surrounding the compressed target [3,4]. Volumetric collision of ion beams in plasma ensures their effective stopping and thermalization of ions with energy up to 30 MeV and fast ignition of the fusion.

References

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