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PROJECT ICARUS: ANALYSIS AND COMPARISON OF INERTIAL CONFINEMENT FUSION LASERS AND PREDICTIONS FOR FUTURE USE IN SPACE PROPULSION

Abstract

Nuclear fusion is one of the few propulsion concepts which can theoretically achieve the moderate thrust (few kN) and high specific impulse (up to 10^6 s) necessary for interstellar flight. Consequently, Project Icarus has chosen to evaluate thermonuclear fusion as the primary propulsion system for the Icarus interstellar probe. Fusion is often characterized by the engineering approach adopted for confining the high temperature (10^8 to 10^9 K) plasma. Although the choice of fusion confinement approach has yet to be made, one of the main candidates is the Inertial Confinement Fusion (ICF) propulsion system. ICF utilizes high-energy beams (lasers, electron beams or ion beams) for compression and confinement of a solid fuel pellet by relying on the rocket effect caused by the radial expansion of the outer layers of the pellet. An inner spherical shell of fuel is imploded, driven by the reaction force created when the beams hit the outer ablator layer of the pellet surface. This work provides an overview and comparison of modern laser technology, assesses current limits of lasers for ICF utilization and speculates on technological extrapolations in the near future. The paper is also analyzing some of the general engineering parameters regarding design and operation of ICF-capable lasers in space including heating issues, efficiency, optics and overall complexity of the design. This is a submission of the Project Icarus Study Group.