

DESIGN WINDOWS AND TRADE-OFFS FOR INERTIAL FUSION ENERGY POWER PLANTS*

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Abstract: The response of the chamber walls and surrounding systems to high-yield, high repetition rate shots is a major feasibility issue for inertial fusion energy (IFE). Many approaches for wall protection have been studied but they were mostly based on assumed target yield and spectrum. U.S. declassification and increased international effort on unclassified target physics now enable us to include target design in system optimizations. With renewed interest in IFE in U.S., the ARIES Team initiated a two-year an integrated study of IFE chambers and chamber interface with the driver and target systems. The study aims at identifying design windows, trade-offs, and key physics/technology uncertainties for various IFE chamber concepts instead of producing a signal design point. Two reference target designs were chosen for study: heavy-ion indirect target designs of LLNL/LBL and direct-drive target design of NRL. The major difference between the two targets is the fraction of energy in the X-ray channel (~1% for direct drive and ~25% for indirect-drive target). Because response and survivability of the first-wall chamber is most sensitive to prompt X-ray energy, the two reference target designs bracket the possibilities for trade-off studies. Three main classes of chamber concepts are analyzed including dry walls, solid structures with protective zones (*e.g.*, wetted walls), and thick liquid concepts. The design windows for these six combinations of target and chamber are explored. Starting from target spectrum, incident energy and particle fluxes on the wall of the chamber have been calculated and thermal response of the wall is analyzed. These analyses lead to certain design windows for chamber size, wall material and temperature, chamber gas/vapor constituent, etc. Most of these parameters are also constrained by the design widow for successful injection and tracking of the targets in the chamber as well as the design window for final optics and beam propagation in the chamber. Parametric systems studies as well as safety analysis are also performed to identify relative advantages of each concept.

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