Effects of Chamber Geometry and Gas Properties on Hydrodynamic Evolution of IFE Chambers

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Understanding the long-timescale, hydrodynamic evolution of IFE chambers following a target explosion is essential for the design and operation of rep rated fusion facilities. Target injection and survival, propagation of laser beams, clearing of chambers, *etc.* critically depend on the chamber environment. The chamber state evolution over hundreds of milliseconds is dependent on a variety of factors, such as chamber geometry, chamber constituents (*e.g.,* gases, aerosol) and their properties and the chamber pre-ignition conditions.

SPARTAN simulation code has been utilized to investigate the IFE chamber evolution. SPARTAN solves full Navier-Stokes equations in 2D Cartesian and cylindrical coordinate system and can handle arbitrary-shape boundaries. The uniform accuracy of the solution on the entire grid domain is achieved by adaptive mesh refinement. We have simulated the dynamic evolution of a 6.5-m-radius chamber filled with either Xe, D, or He at different initial densities. Xenon has been proposed previously as a protective gas. Following the target explosion D, T, and He ions from the target will be implanted in the wall and will eventually diffuse back into the chamber. Initial conditions for SPARTAN are taken from solutions of BUCKY 1-D rad-hydro code. Sutherland law is used to extrapolate thermal conductivity and viscosity data to higher gas temperatures and ideal gas law is used as the equation of state. Chamber wall is assumed to have a constant temperature of 700^{o}C.

The results indicate that thermal conductivity and viscosity of chamber gas as well as the 2D geometrical effects have a major impact on the evolution of the chamber environment. For example, the size and distribution of eddies in the chamber is dependent on the gas viscosity and on the number and configuration of the laser beam channels. The cooling mechanism is driven by heat conduction from gas into the wall and by turbulent mixing combined with thermal diffusion. Shock waves generated from the heating of the chamber gas by the blast are reflected from the chamber wall and produce a host core by compressive heating. For the case of Xe, this hot core can reach a temperature of 20-40 eV. As such, significant ionization exists and radiation may cool this region. The impact of this background plasma on the evolution of the chamber is under study.