Validation of the Tsunami code through the Condensation Debris Experiment

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Since the early 1990's, TSUNAMI has been the main simulation code used to model gas dynamics in thick-liquid inertial fusion energy (IFE) target chambers. Other applications include modeling the National Ignition Facility chamber and mini-chamber. Typically, gas dynamics systems modeled with TSUNAMI have had three distinct temporal phases: the high energy density plasma physics stage, including laser and/or heavy-ion beam energy deposition; the hydrodynamics expansion phase; and the late time period during which condensation takes place, in-flight and/or onto surfaces. The TSUNAMI code is aimed at modeling the second phase, making use of information from the first, and providing input to model the third. TSUNAMI has always relied on the assumption that high-energy density physics phenomena happen on short time scales, and only a few integrated effects need to be taken into account. Simple scaling laws or coarse mapping of detailed plasma physics code output were said to provide relevant initial conditions. While various models of the code, such as the hydrodynamics core and the ablation models have been benchmarked against experiments or other codes, the overall set of assumptions has never been validated against a relevant experiment. The novel Condensation Debris Experiment (CDE) constitutes the first "integrated" validation of TSUNAMI. CDE presents the aforementioned three phases and other similarities with IFE: a point-like source of hot debris, x-ray induced ablation, expansion of the gas into a shaft and the chamber, and then, ultimately, its condensation in-flight and on the walls of the chamber. CCD pictures and pressure measurements from the first two CDE experimental campaigns, performed on the Z laser facility at Sandia National Laboratory in New Mexico, are used to validate "Visual Tsunami," the latest version of the code [1]. Agreement between the code and the experimental results is satisfactory and confirms the ability of Visual Tsunami to be used as a design tool for gas dynamics systems.

[1] C.S. Debonnel et al., "Visual Tsunami: A versatile, user-friendly radiation hydrodynamics design code," these proceedings