TARDIS-C: A TARGET DIAGONISTIC FOR MEASURING MATERIAL STRENGTH AT HIGH PRESSURE, MODIFIED TO PREVENT TARGET DEBRIS DISPERSION INTO MAIN NIF CHAMBER

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A goal of the National Ignition Facility (NIF) at Lawrence Livermore National Laboratory is to better understand solid matter behavior at extreme conditions. Diagnostic tools such as the Target Diffraction In-Situ (TARDIS) diagnostic have been designed to record data of solid material compressed to tens of Mbars over a short time scale. The TARDIS diagnostic consists of a shielded box lined with filters and image plates to capture the x-ray diffraction lines produced by a compressed sample. NIF drive beams heat a carefully designed ablator to ramp compress the target to high pressure. A backlighter produces an x-ray source which diffracts off the compressed target and onto the image plates. On the side of the shielded box opposite the target, an aperture provides a line of sight for Velocity Interferometer System for Any Reflector (VISAR) measurements of the shock as it progresses through the target. The target material has an unimpeded path from the target location through the image plate hole and onto the VISAR blast shield. To reduce the blast shield's exposure to target debris and minimize the amount of debris contaminating the NIF chamber, a barrier of transparent material has been placed in the opening. This allows VISAR to view the target and monitor shock progress in the target material while also confining and trapping target debris within the TARDIS diagnostic.

While the NIF drive beams (~120 kJ laser pulse) vaporize or melt most of the ablator and sample material, small pieces of unvaporized target debris and the TARDIS tantalum pinhole opening remain present and are driven toward the VISAR debris shield with velocities in the range of several kilometers per second. To assess whether this fast moving debris could damage the transparent barrier and still contaminate the VISAR shield and NIF chamber, an LLNL hydrocode with a Johnson-Holmquist-Beissel constitutive model was used to analyze the extent of damage produced by the debris field.

In order for the modified TARDIS diagnostic to function identically to the original diagnostic, many constraints were imposed on the transparent barrier. The barrier's size and shape was designed to maximize the VISAR field of view, while not shadowing the image plates. External dimensions were limited by beam alignment fixturing. A single pane of protective transparent material could not be used as the debris impact shock would result in fracturing of the entire pane; it would not be possible by visual inspection to determine whether debris had escaped the diagnostic. In developing a multi-pane solution, care had to be taken to ensure that the front panes would not be so strong that debris would rebound and reenter the NIF chamber through the original TARDIS diagnostic entrance hole. Consideration also had to be given to the failed transparent material to ensure it did not create more debris, which could reenter the NIF chamber. These considerations, as well as additional design observation will be expanded upon.

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