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Progress of Indirect Drive Inertial Confinement Fusion in the US

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Indirect drive converts high power laser into x rays using small high-Z cavities called hohlraums. X rays generated at the hohlraum walls drive a capsule filled with DT fusion fuel. Recent experiments have produced fusion yields exceeding 50 kJ where alpha heating provides ~3x increase in yield over PdV work. Comparison of the results to the common Lawson criterion suggests the current implosions performance is ~30% from conditions expected to initiate thermonuclear gain. Improvements to close the gap on the last ~30% are challenging requiring optimization of the target/implosions and the laser to extract maximum energy. The US program has a three-pronged approach to maximize target performance each closing some portion of the gap. The first item is optimizing the hohlraum to couple more energy to the capsule while maintaining symmetry control. Novel hohlraum designs are being pursued that enable larger capsule to be driven symmetrically to both reduce 3D effects and increase energy coupled to the capsule. The second issue being addressed is capsule stability. Seeding of instabilities by the hardware used to mount the capsule and fill it with DT fuel remains a concern. Work such reducing the impact of the DT fill tubes and novel capsule mounts such as three sets of two single wire stands forming a cage, as opposed to the thin membranes currently used, are being pursed to reduce the effect of mix on the capsule implosions. There is also growing evidence native capsule seeds such as micro-structure may be playing a role on limiting capsule performance and dedicated experiments are being developed to better understand the phenomenon. The last area of emphasis is the laser. As technology progresses and understanding of laser damage/mitigation advances, increasing the laser energy to as much as 2.6 Megajoulse at 351 nm and increasing the laser power to 600 TW seems possible. This would increase the amount of energy available to couple to the capsule and allow larger capsules potentially increasing the hot spot pressure and confinement time. The combination of each of these focus areas have the potential to produce conditions to initiate thermo-nuclear ignition. The current understanding, status, and plans for near term research in each of these areas will be presented in the context of what is believed to be needed to obtain burning plasmas on NIF.

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