Update on Progress and Challenges in the Development of Heavy Ion Fusion

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Since the completion of the Robust Point Design for heavy ion fusion power plant, progress has been made in addressing key issues and some possible new directions have emerged. Work has continued on thick liquid wall chambers, which are particularly well suited to heavy ion fusion since they allow compact chambers minimizing the stand-off for the final focus magnets and thus improving beam focusing on target. University experiments have continued to address issues related to the disruption and re-establishment of the protective liquid layer in a rep-rated system, including repetitive disruption of jet arrays at UC Berkeley. ARIES-IFE study of thick liquid chambers contributed to our understanding of possible design constraints due to drop and aerosol formation. Studies at Georgia Tech demonstrated the need for flow conditioning and boundary layer trimming of jets in order to minimize excessive drop formation.

Work has continued on HIF indirect-drive targets in an attempt to allow larger spot sizes than the ~2 mm spots required by the baseline target in the RPD. A promising approach is the use of shine shields at both ends of the hohlraum, which allows beams to fill the entire 5-mm-radius target. Radiation flow around the shine shields results in hot spots on the capsule (P_4), but it has been proposed to handle these with shims on the capsule. Experiments on the effectiveness of shimmed targets are being conducted on Sandia's Z-machine.

This larger spot size target design opens the door to other driver and focusing schemes. Work has started exploring a modular driver approach in which many individual accelerators provide the total beam energy on target as apposed to the single accelerator with many (~100) individual beamlets threading common induction cores. The currently favored approach is to use much lower mass ions (e.g., Ne with A = 20 amu) and solendoid magnets in the accelerator instead since solenoids allow transport of very high current beams. Hybrid designs, in which the first half or more of the accelerator uses solenoids and the rest uses quadrupoles (since quad focusing is more efficient at high ion kinetic energy) are also being investigated. Neutralized drift compression and plasma channel focusing are being studied as a way to deliver these high current beams to target. We have also started investigating new chamber designs that would be compatible with this focusing scheme, in particular designs using a vortex flow configuration to establish the thick-liquid-wall.

This talk highlights progress since the last Technology of Fusion Energy Conference in these areas and points out the challenging next steps in the R&D to develop HIF power plants.

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