Readiness of HIF Using the Single Pass RF Driver

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Readiness for a concerted push to power production was the underlying theme from the inaugural HIF Workshop in 1976 through the review of ICF programs by DOE's Energy Research and Advisory Board in 1979. Using John Lawson's 1987 paper "Whither Heavy Ion Fusion?" [1] as a foil, this paper discusses the continuing vitality of the argument for HIF's readiness against the backdrop that this vision is not in evidence today, having been occluded by political policies causing diversion of the HIF community into peripheral science that, although excellent, is in fact not required to complete the development of a HIF energy source.

Instead of pressing ahead to power production, HIF in the US diverged onto a path that occluded its strength at high beam parameters for ignition and power production and forced HIF into inappropriate competition with laser systems for low level experiments. Then the readiness of HIF based on a half (now whole) century of steady development was stood on its head in the US by concentrating instead on developing essentially from scratch the manifestly unready technology of the linear induction accelerator.

The present paper emphasizes major advances with pellet ignition approaches and the Single Pass RF Driver (SPRFD) that represent the development anticipated at HIF's outset. Writing in 1987, Lawson was reflecting the significant loss of momentum already suffered by HIF, but went further to express pessimism that major advances like the foregoing would happen.

Lawson's main concerns about the RF driver focus on the use of storage rings, particularly the "black cloud" problem, are attacked directly by the reconceptualization of the RF driver without storage rings. SPRFD makes this entire section of Lawson's piece null and void. The combination of the SPRFD and matching cylindrical targets using fast ignition represents "new ideas or inventions" that Lawson admitted could "transform the prospects." Lawson pessimistically averred that such advances were not likely to come along because "our understanding of the basic limitations of accelerators, targets and reactors is now (viz., in 1987) too great."

Diverging from the overall cautionary tone of his article, Lawson misplaced credence in 1987 calculations of pellet performance: "present expectations are reliable." We now know they were not. On the other hand, the performance of HIF pellets, always advantaged by heavy ion beams' classical energy deposition, leaped further toward readiness. SPRFD's exploitation of the increased total useable volume of phase space with many different isotopes provides a path to the small spots needed for fast ignition in cylindrical pellets as simulated by leading scientists [2]. These again "transformed the prospects" for HIF. But, also again, recognition of HIF's readiness on this score is held back by the owners of the most accredited US simulation codes claiming that these cylindrical pellets are classified despite the fact that such claims are not supported by the US classification guide.

The major advances redouble the importance of the basic readiness of accelerator technology that caused much of the excitement at HIF's debut in 1976: predictability of accelerators to work as designed, repetition rate, efficiency, reliability, durability, and project cost-ability. In the four decades since 1976, accelerator technologies, which include computers, electronics generally, control systems, and large project management, as well as RF structures, RF power, and magnets, have continued their monotonic advance, as have beam theory and simulation capabilities.

The future age in which Lawson saw HIF as fitting has arrived: The world stands in need of the large outputs of carbon-neutral synthetic fuels, additional electricity, hydrogen, and potable water that FPC's HIF plants can produce.

[1] J. Lawson, *NIMA* **A278** (1989) 22-4
[2] R. Ramis and J. Meyer-ter-Vehn, *Laser and Particle Beams* (2014), 32, 41–47 and references therein

[2] R. Ramis and J. Meyer-ter-Vehn, *Laser and Particle Beams* (2014), 32, 41–47 and references therein