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Manipulations for delivering HIF beams onto targets: (1) Smoothing by arc wobblers, (2) Differential acceleration in final beam lines

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A. Friedman

LLNL, Livermore CA 94550 USA
and
Heavy Ion Fusion Science Virtual National Laboratory

We describe two techniques related to the delivery of the ion beams onto the target in a Heavy Ion Fusion power plant.
(1) By manipulating a set of ion beams upstream of a target, it is possible to achieve a more uniform energy deposition pattern. We consider an approach to deposition smoothing that is based on rapidly "wobbling" each of the beams back and forth along a short arc-shaped path, via oscillating fields applied upstream of the final pulse compression [A. Friedman, Phys. Plasmas 19, 063111 (2012)]. Uniformity is achieved in the time-averaged sense; the oscillation period must be sufficiently shorter than the target's hydrodynamic response timescale . This work builds on two earlier concepts: elliptical beams [D. A. Callahan and M. Tabak, Phys. Plasmas 7, 2083 (2000)]; and beams wobbled through full-circle rotations [e.g., R. C. Arnold, et al., Nucl. Instr. and Meth. A 199, 557 (1982)]. Arc-based smoothing remains usable when the geometry precludes full-circle wobbling, e.g., for the X-target [E. Henestroza, B. G. Logan, and L. J. Perkins, Phys. Plasmas 18, 032702 (2011)] and some distributed-radiator targets.
(2) By accelerating some beams "sooner"and others "later,"it is possible to simplify the beam line configuration in a number of cases. For example, the time delay between the "foot"and "main"pulses can be generated without resorting to large arcs in the main-pulse beam lines. This may minimize beam bending, known to be a source of emittance growth in space-charge-dominated beams. It is also possible to arrange for the simultaneous arrival on target of a set of beams (e.g., for the foot-pulse) without requiring that their path lengths be equal. This may ease a long-standing challenge in designing a power plant, in which the tens or hundreds of beams entering the chamber all need to be routed from one or two multi-beam accelerators or transport lines.

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Author: FRIEDMAN, Alex (LBNL)

Presenter: FRIEDMAN, Alex (LBNL)

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