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Can FPC's Single-Pass RF Driver Produce a 50 μm Spot Size for Fast Ignition?

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Alex Burke

Fusion Power Corporation / SAIC
Palo Alto, CA 94306

The design of the Single-Pass RF Driver (SPRFD) is similar to four HIDIF-type drivers in parallel. A significant difference in SPRFD is the absence of HIDIF's multi-turn injection storage rings, thereby avoiding the ~10-fold dilution of transverse phase space that occurs during this process. Instead, SPRFD uses patent-pending methods to accomplish longitudinal beam compression, while preserving a low transverse emittance. Preliminary calculations, based on HIDIF's beam parameters and estimated emittance prior to the storage rings, suggest that SPRFD's final spot-size could be as low as 50 μm. A spot size of 50 μm would be very attractive for fast-ignition schemes, especially with a cylindrical target design.

The aim of the present study is to examine all factors contributing, or potentially contributing, to the magnitude and growth of beam emittance in the SPRFD system up to the target itself, in order to validate the 50 μm prediction. This will include the use of particle simulation codes such as Warp and MICHELLE, as well as established theoretical models of beam stability and neutralization. A realistic environment inside FPC's industrial fusion power chamber will be considered, especially with regard to neutralization effects by ambient vapor. The possible benefits of injected plasma neutralization will be assessed. Analysis of final transport and focusing will include interpenetrating multi-species beams as specified by the SPRFD design. Various target irradiation symmetries will be considered. Progress will be reported on the goal of parametric analysis of sensitivities for reliably achieving a 50 μm spot size, at the precise location specified by the tracking system's observation of targeting reticules on the injected lithium sabots that house the fuel pellets.

Primary author: BURKE, Alex (Fusion Power Corp / SAIC)

Presenter: BURKE, Alex (Fusion Power Corp / SAIC)

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