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High Performance Field Reversed Configurations

MICHL BINDERBAUER, Tri Alpha Energy, Inc.

The field-reversed configuration (FRC) is a prolate compact toroid with poloidal magnetic fields [1]. FRCs could lead to economic fusion reactors with high power density, simple geometry, natural divertor, ease of translation, and possibly capable of burning aneutronic fuels. However, as in other high-beta plasmas, there are stability and confinement concerns. These concerns can be addressed by introducing and maintaining a significant fast ion population in the system. This is the approach adopted by TAE and implemented for the first time in the C-2 device. Studying the physics of FRCs driven by Neutral Beam (NB) injection, significant improvements were made in confinement and stability. Early C-2 discharges [2] had relatively good confinement, but global power losses exceeded the available NB input power. The addition of axially streaming plasma guns, magnetic end plugs as well as advanced surface conditioning leads to dramatic reductions in turbulence driven losses and greatly improved stability [3]. As a result, fast ion confinement significantly improved and allowed for build-up of a dominant fast particle population. Under such appropriate conditions we achieved highly reproducible, long-lived, macroscopically stable FRCs with record lifetimes [4]. This demonstrated many beneficial effects of large orbit particles and their performance impact on FRCs Together these achievements point to the prospect of beam-driven FRCs as a path toward fusion reactors. This presentation will review and expand on key results and present context for their interpretation.

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