An Oblate FRC Concept for SSX*

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The field-reversed configuration (FRC) is a magnetically confined compact torus (CT) plasma with little or no toroidal magnetic field, in which β is inherently ~ 1. With the added advantages of no coils or other components linking the plasma (a "pure" CT) and plasma exhaust streaming freely along the scrape-off layer (SOL) out each end to remote divertor targets, the FRC is very attractive as the basis of a fusion reactor. So far, prolate (long, $L \gg r_{sep}$) FRCs have been studied experimentally much more than oblate ($L < r_{sep}$) FRCs. However, if plasma transport in stable FRCs is diffusive, then the confinement time scales as $\tau \sim r^2$ with little dependence on length L, and then oblate FRCs would make the most compact reactors.

We will modify the SSX facility by installing a new, oblate copper flux conserver and realigned diagnostics, to investigate the basic stability and confinement properties of oblate FRC plasmas. We compute FRC equilibria with our equilibrium code EQLFE. The preferred geometry has a close-fitting, oblate, trapezoid-of-revolution conducting wall to stabilize tilt and shift $n = 1$ instabilities and other low-n axial and radial MHD modes. In this design, there will be no additional central conductor. The preferred geometry also expands the near-separatrix, magnetically confined plasma axially, to produce a large V''/V' for improved stability to pressure-driven $m = 0$ or "sausage" local modes. The proposed geometry is compatible with the existing SSX plasma guns, one at each end of the vacuum chamber, and with FRC formation by the merging counter-helicity spheromak method presently in use. SSX produces FRC plasmas in the MHD fluid regime over a range of collisionalities, using He glow conditioning to improve density control. The proposed research will be the first experimental test of oblate FRC stability with strong flux conserver stabilization.

Characterization: A1, A2

*Work supported by the U.S. Department of Energy under DE-FG02-00ER54604, and DE-FG02-92ER54139, and General Atomics discretionary funding.