Contribution ID: **669** Type: **Poster**

Plasma Response to Sustainment with Imposed-dynamo Current Drive in HIT-SI and HIT-SI3

Wednesday, 19 October 2016 08:30 (4 hours)

The Helicity Injected Torus - Steady Inductive (HIT-SI) program studies efficient, steady-state current drive for magnetic confinement plasmas using a novel experimental method. Stable, high-beta spheromaks have been sustained using steady, inductive current drive which is significantly more efficient than RF or neutral beams when scaled to a reactor. Externally induced loop voltage and magnetic flux are oscillated together so that helicity and power injection are always positive, sustaining the edge plasma current indefinitely. Imposed-dynamo Current Drive (IDCD) theory further shows that the entire plasma current is sustained. The method is ideal for low aspect ratio, toroidal geometries and is compatible with closed flux surfaces. Experimental studies of spheromak plasmas sustained with IDCD have shown stable magnetic profiles with evidence of pressure confinement. New measurements show coherent motion of a stable spheromak in response to the imposed perturbations. On the original device two helicity injectors were mounted on either side of the spheromak and the injected mode spectrum was predominantly n=1 due to the geometry. Coherent, rigid motion indicates that the spheromak is stable and a lack of plasma-generated n=1 energy indicates that the maximum q is maintained below 1 during sustainment. Results from the HIT-SI3 device are also presented. Three inductive helicity injectors are mounted on one side of the spheromak flux conserver. Varying the relative injector phasing changes the injected mode spectrum which includes n = 2, 3, and higher modes. Spheromaks have been sustained with toroidal current three times greater than the quadrature sum of injector currents. This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Fusion Energy Sciences, under Award Number DE-FG02-96ER54361.

Paper Number

EX/P3-42

Country or International Organization

United States of America

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Session Classification: Poster 3

Track Classification: EXS - Magnetic Confinement Experiments: Stability