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ICC/1-1Ra: Progress on HIT-SI and Imposed Dynamo Current Drive

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Efficient current drive and profile control are primary goals of the Helicity Injected Torus (HIT) current drive program. With the achievement of greatly improved parameters on HIT-SI came the discovery of Imposed Dynamo Current Drive (IDCD) a method of efficiently sustaining a stable equilibrium with the possibility of current profile control. A model of IDCD, which predicts the current ramp up, the injector impedance, and the current profile in HIT-SI is presented. The model indicates that dynamo current drive does not need plasma generated fluctuations and a stable equilibrium with profile control through fluctuation profile control can be sustained, a major advance. Appling IDCD to ARIES-AT and ITER at 80 kHz gives injector powers less than 10 MW, dB/B = 10-4 and fluctuation amplitudes of plasma and flux about the mean flux surface of a few ion gyro radii, indicating the effect on confinement may be acceptable. Since very low fluctuation, in the reactors, can provide current drive for the entire plasma the effect of fluctuations on the plasma current profile is extremely important.
On HIT-SI two injectors, with n=1 symmetry and oscillating 90o out of phase, inductively sustain an n=0 spheromak (Ro = 0.34 m, a = 0.2 m) by IDCD. Very good progress, since the last meeting, on the HIT-Steady Inductive (HIT-SI) experiment includes: achieving 55 kA of toroidal current, 40 kA of separatrix current, a current gain of 3 (the spheromak record) [Victor B. S. et al., Phys. Rev. Lett. 107, 165005 (2011)], measuring the relaxation time, discovering IDCD, and observing and simulating a new three phase evolution to the higher currents. The simulations are 3D two-fluid MHD and are done using NIMROD. This research addresses the issues that conventional RF and neutral beam current drive are very power-inefficient, leading to high recirculating power fraction in a reactor, and that lack of profile control causes disruptions.

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