Contribution ID: **203** Type: **Poster**

Transient CHI Plasma Start-up Simulations and Projections to NSTX-U

Thursday 16 October 2014 14:00 (4h 45m)

Transient Coaxial Helicity Injection (CHI) in the National Spherical Torus Experiment (NSTX) has generated toroidal current on closed flux surfaces without the use of the central solenoid. When induction from the solenoid was added, CHI initiated discharges in NSTX achieved 1 MA of plasma current using 65% of the solenoid flux of standard induction-only discharges. CHI is incorporated into the NSTX-U machine design, to be used for the start-up phase of a full non-inductive current ramp-up scenario. The objective for first two years of CHI research on NSTX-U is to re-establish transient CHI start-up in the new vessel geometry, and to generate 400 kA of closed-flux start-up current. In support of these planned experiments, the TSC code has been used to develop transient CHI start-up scenarios using the full NSTX-U vessel geometry, implemented during the past year. We have also used the resistive MHD code NIMROD, to understand the mechanisms that lead to the generation of closed flux plasma in a transient CHI discharge. These simulations show that the new machine capabilities on NSTX-U significantly enhance CHI-startup capability. Simulations have also confirmed the role of the magnitude of the injector flux, the importance of a narrow flux foot print width, and rapid time scales required for reducing the injector voltage and (current) in increasing the magnitude of the closed flux fraction [1]. What is particularly noteworthy is that the NIMROD simulations suggest that the reconnection mechanisms for transient CHI appear to be very similar to 2-D Sweet-Parker type reconnection, and 3-D effects do not seem to be important.

This work is supported by U.S. DOE contracts DE-FG02-99ER54519, DOE-FG02-12ER55115, and DE-AC02-09CH11466.

[1] F. Ebrahimi, et al., submitted to Phys. Plasmas

Country or International Organisation

USA

Paper Number

TH/P6-55

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Session Classification: Poster 6