NSTX-U Weekly Report (September 20, 2013)

NSTX-U is in the Upgrade Project outage in FY 2013

Fatima Ebrahimi (Princeton University) and her coauthors' paper on "Magnetic reconnection process in transient coaxial helicity injection," Physics of Plasmas **20**, 090702 (2013) was published online (URL:http://link.aip.org/link/?PHP/20/090702&aemail=author). Non-inductive current formation is a critical issue in NSTX and in future ST-based fusion devices. Coaxial Helicity Injection (CHI) is a leading candidate for plasma start-up and current formation. Understanding the dynamics and the mechanism of closed flux surface formation during transient CHI is of great importance and has been an outstanding problem for a long time. In a systematic and detailed approach, this is the first paper that explains the fundamental reconnection mechanism that leads to the generation of closed flux surfaces in a transient CHI discharge. The minimum conditions required for generating closed flux are also obtained. It is found that at sufficiently low magnetic diffusivity (high Lundquist number), and with a sufficiently narrow injector flux footprint width, the oppositely directed field lines have sufficient time to reconnect (before dissipating), leading to the formation of closed flux surfaces. Simulations show that an X point is formed in the injector region, followed by formation of closed flux surfaces within 0.5 ms after the driven injector voltage and injector current begin to rapidly decrease. As the injector voltage is turned off, the fields lines tend to untwist in the toroidal direction and magnetic field compression exerts a radial J × B force and generates a bi-directional radial Etoroidal × Bpoloidal pinch flow to bring oppositely directed field lines closer together to reconnect. The reconnection process is shown to have transient Sweet-Parker characteristics. Numerical simulations hint that transient CHI experiments in NSTX may be the first to demonstrate a forced magnetic reconnection process in a large scale fusion device. (F. Ebrahimi)

E. B. Hooper (LLNL) and his coauthors' paper on "Flux surface closure in helicity injected startup plasmas for NSTX," Physics of Plasmas **20**, 092510 (2013) was published online. The paper report a study of the generation of helicity-injected startup plasmas in NSTX using resistive-MHD (NIMROD) simulations with plasma flows, currents, ohmic heating and anisotropic thermal conduction. Results include buildup of the plasma, formation of an X-point above the injection slot following the end of injection, and the following evolution of the plasma. Non-axisymmetric effects are not important in the plasma evolution. Simulations demonstrate the injection of toroidal flux below the bias poloidal flux and extraction of toroidal flux by the absorber slot. The difference between the two is small but causes sufficient magnetic pressure across the bias flux to expand it into the NSTX volume. X-point formation is triggered as the injector voltage drops to zero; magnetic pressure due to toroidal field entrained in the ExB plasma flow from the injection gap drops, allowing resistive magnetic reconnection even though the total injected current is almost constant. Although, these simulations demonstrate flux closure, an important difference between the simulations and the experiment is that the amount of initially closed flux and the rate at which the toroidal current is incorporated into the closed flux region in the simulations are much less than in the experiment. However, these results provide a physics basis for extending simulations to obtain quantitative agreement. (R. Raman, University of Washington)

Members of the NSTX-U research team attended the 17th International Spherical Torus Workshop at University of York, UK on Sept. 16 – 19, 2013. M. Ono (PPPL) presented an

invited talk " National Spherical Torus Experiment Upgrade – Status and Plans," J. Menard (PPPL) presented an oral talk "Studies of ST-FNSF mission & performance versus device size" and an invited talk “Overview of Research Plans for NSTX Upgrade”, B. Nelson (University of Washington) presented an oral talk "Transient CHI Plasma Start-up and Non-inductive Current Ramp-up in NSTX-U," and Y.K.M. Peng (ORNL) presented an oral talk “AORSA full wave calculations of high harmonic fast wave coupling for NSTX & NSTX-U.” (M. Ono)

While in York, UK, J. Menard (PPPL) participated in the seventh IEA ST executive committee meeting and also chaired a MAST PAC videoconference to discuss preliminary results from the M9 experimental campaign and the status and plans of the MAST Upgrade project. Both meetings were held at the York Plasma Institute. (J. Menard)

Joon-Wook Ahn (ORNL) visited KSTAR to participate in H-mode characterization experiments and ran a session MP2013-05-01-123 in the weeks of August 19 and 26. The purpose of this experiment was to create a small ELM H-mode regime with high confinement by controlling plasma shape. Two parameter scans were completed to investigate impact on the small ELM regime. Each of triangularity (δ = 0.7 –> 0.95) and drsep (-1 cm –> 0.5 cm) was independently varied with other parameters kept constant. It was found that δ alone did not affect the ELM type but drsep close to 0 led to successful creation of a small ELM plasma. Preliminary analysis of ECEI image data showed that fluctuation of emission intensity during the inter ELM period was higher than for standard type-I ELMy plasmas. Work is under way to characterize this small ELM regime and to confirm conditions for its occurrence. (J-W. Ahn)

Engineering Operations (A. von Halle, C. Neumeyer)

NSTX Upgrade construction activities continued with the successful leak check of the VPI mold containing the full TF inner bundle, and the lift of the Mold and bundle into the bake-out oven. After completing the necessary plumbing connections, the oven was brought up to temperature, and the vacuum impregnation (VPI) of the TF inner bundle started. The OH winder has been brought into the coil shop, and is being prepared to wind the new OH coil on the TF bundle after the VPI. For the second neutral beam, hydrostatic testing of the newly installed NB2 High Voltage Enclosure (HVE) cooling lines is in progress, and will be followed by testing of the NB2 Ion Source/Ion Dump cooling lines.

Preparations of non-upgrade equipment for plasma operations in the NSTX-U configuration also continued with the maintenance of the exiting power supply and distribution equipment for the neutral beams. This work is on track to be completed by the end of October.

Access to the NSTX test cell will be available only through previous arrangement with the Upgrade Work Control Center.