

NSTX-U Weekly Report (June 5, 2015)

NSTX-U is in the Upgrade Project outage in FY 2015

The NSTX-U Team Meeting was held on June 5, 2015 at PPPL. The NSTX-U team was updated on the recovery activities of the OH electrical fault event and the associated repair plan. An updated schedule toward research operation and the research program plan were also discussed. The meeting material is available on the web at: http://nstx.pppl.gov/DragNDrop/NSTX_Meetings/Team_Meetings/2015/2015-06/. (M. Ono, J. Menard, PPPL)

On May 20th, a paper by Fatima Ebrahimi (PPPL) and Roger Raman (University of Washington) entitled "Plasmoids formation during simulations of coaxial helicity injection in the National Spherical Torus Experiment" was published online in Physical Review Letters **114**, 205003 (2015). Plasmoids can form under different circumstances in fusion and astrophysical plasmas. Anytime oppositely directed magnetic field lines in a plasma are pushed together and reconnect via some dynamical process and form a long current sheet, the plasmoid instability might occur and cause plasmoids to form. For the first time we have simulated plasmoid instability in a realistic tokamak geometry and have shown that plasmoids can even form during helicity injection in a large fusion device when no other dynamical process (or instability) is initially present. Through resistive MHD simulations, it is demonstrated that during transient Coaxial Helicity Injection (CHI) discharges at high Lundquist number, the elongated current sheet formed through a Sweet-Parker forced reconnection process breaks up, and a transition to spontaneous reconnection (plasmoid instability) occurs. Motivated by the simulations, experimental camera images have been revisited and suggest the existence of reconnecting plasmoids in NSTX. As CHI is a promising candidate for plasma start-up and may ultimately also have the potential for steady-state current drive, it is thus important to understand the CHI physics to be able to correctly model it in simulations of NSTX/NSTX-U and to be able to extrapolate its viability to a reactor. In this paper, our simulations show that plasmoid-mediated reconnection may be the leading mechanism for fast flux closure. For a good start-up plasma current, we need all of the injected open field lines (injector flux) to rapidly reconnect and form closed flux surfaces, and our most recent simulations show that this is possible. (F. Ebrahimi)

Several NSTX-U engineers and researchers participated in the 26th IEEE Symposium on Fusion Engineering (SOFE) held May 31-June 4, 2015, in Austin, Texas. Oral presentations included: "The NSTX-U Program for Closing Gaps to Fusion Energy", by J. E. Menard (PPPL), "Developing Snowflake Divertor Physics Basis in the DIII-D, NSTX, and NSTX-U Tokamaks Aimed at the Divertor Power Exhaust Solution" by V. A. Soukhanovskii (LLNL), "Prospects for Power and Particle Exhaust with High-Temperature Liquid Lithium Divertors" by M. A. Jaworski (PPPL), "NSTX-U Digital Coil Protection System Integration with Existing Plasma Control System" by K. G. Erickson (PPPL), "NSTX Upgrade Power Supply System" by W. Que (PPPL), and "Tensile Strain Mitigation During the NSTX-U OH Coil Cooldown" by P. H. Titus (PPPL). Posters presented included: "The NSTX-U Digital Coil Protection System AutoTester" by G. N. Zimmer (PPPL), "Design and Operation of a Fast Gas Valve for Disruption Mitigation Studies on NSTX-U" by R. Raman (U. Washington), "MDSplus for the NSTX-U Digital Coil Protection System" by G. J. Tchilinguirian (PPPL), "The Materials Analysis Particle Probe Upgrade (MAPP): Summary of Status and Upcoming Experiments in the National Spherical Torus Experiment Upgrade (NSTX-U)" by F. Bedoya (U. Illinois), "Lithium

as a Plasma Facing Component to Optimize the Edge Plasma Performance” by R. Maingi (PPPL), “NSTX Toroidal Field Coil Turn to Turn Short Detection” by S. Ramakrishnan (PPPL), “New DSP-Based Firing Generator for the PPPL AC/DC Converters” by W. Que (PPPL), and “NSTX-U Coils Bus Bars Design and Construction” by N. D. Atnafu (PPPL). R. Maingi was also was an invited instructor for a mini-course on Plasma-Material Interactions just preceding the SOFE conference and delivered a lecture entitled "PMI in fusion devices." (J. Menard)

The following NSTX-U physicists attended the DOE FES/ASCR Workshop on Integrated Simulations for Magnetic Fusion Energy Sciences, held in Rockville, Md from June 2 - 4, 2015, participating in the following panels (S. Kaye):

S. Kaye (PPPL): Panel C: Whole Device Modeling, Panel F: Data Management, Analysis and Assimilation

F. Poli (PPPL): Panel C: Whole Device Modeling, Panel G: Software Integration and Performance

S. Jardin (PPPL): Panel A: Disruptions

G.-Y. Fu (PPPL): Panel A: Disruptions

J. Canik (ORNL): Panel B: Boundary

C.S. Chang (PPPL): Panel B: Boundary

Experimental Research Operations (S. Gerhardt, R. Kaita)

Installation of the Multi-Pulse Thompson Scattering (MPTS) hardware is complete. The laser exit flight tube is being baked and is now open to the NSTX-U vacuum chamber. The alignment of the entire system is being checked and adjusted using a He-Ne laser aligned to be co-linear with the YAG laser beam trajectories. The next activity will be to fire the YAG laser through the system and further check/adjust the alignment. This will be followed by an assessment of the stray laser light and calibration of the system using Rayleigh and Raman scattering. (B. Stratton, PPPL)

Reinstallation has begun for the Lithium Evaporator (LITER) mounting brackets, which had to be removed when the upper umbrella structure was modified for NSTX-U. The first step was to move both LITERs to their ports on the upper dome, and tack weld their brackets in place. Final welding will occur after the LITER alignments are completed. A Final Design Review (FDR) was conducted for the control system for the Lithium Granule Injector (LGI). There was agreement on the use of a National Instruments (NI) PXI system for remote control of the LGI. It was recommended that a separate review be conducted to address the details of interlocks with the machine and operation of the torus interface valve (TIV), which is controlled by a separate system. (R. Kaita, PPPL)

Engineering Operations (A. von Halle, P. Titus)

Recovery from an external arc fault at the Ohmic Heating (OH) coil terminals continued this past week. Drawings and installation procedures for the newly fabricated upper OH water tube supports are ready. The design for the OH Ground Connection and the OH Compression Ring grounding has been reviewed, and a prototype of the OH ground connection is being fabricated. A conceptual design for new OH ground braid supports has been reviewed. Drawings for the new OH coax bus are nearing completion, and additional tests of the epoxy application are being set-up. Silver plating of TF bus connections is in progress, and the plating procedure is being

updated to include verification techniques. Work has started on the mechanical installations associated with the new LLNL spectrometers.

Access to the NSTX-U Test Cell is expected to be available this coming week. Access must be arranged through Work Permits approved by the D-Site Shift Supervisors.