NSTX-U Weekly Report (November 10, 2017)

FY 2018 status: NSTX-U is in a maintenance and repair outage.

Recovery

For the PF coils, the PPPL Magnet Team traveled to Nazareth, Pa to meet with Everson Tesla to discuss prototype fabrication. For the Polar Region components, performed additional finite element analysis on the coil support slings, and redesigned the bolted capture feature on the PF1A and PF1B supports. For the Passive Plates, the Analysis Group is investigating the effects of magnetic damping and the potential reduction in EM load resulting from these effects.

The NSTX-U Recovery Project Plasma-Facing Component group conducted the first set of high-heat flux tests at the Applied Research Laboratory (ARL) located at Penn State University on November 7th. Following successful procurement of a testing sub-contract with ARL on October 25th, a Material Survey Test was conducted using the Electron Beam Physical Vapor Deposition (EB-PVD) at ARL from Nov.1 until Nov. 7. Candidate materials for high-heat flux regions of the NSTX-U were subjected to intense heating in a procedure to rank the materials based on destructive testing. The results will be used to help select the optimal material for use in high-heat flux components of the NSTX-U. M. Jaworski (PPPL) and T. Gray (ORNL) conducted the testing at ARL. D. Youchison (ORNL) was present during testing and provided consultation. The Material Survey Test is the first half of the procured testing contract which will also conduct prototype testing of the NSTX-U Recovery project high-heat flux tile design. Results will be reviewed at the PFC Preliminary Design Review (PDR) scheduled for November 15th.

Research

Steve Sabbagh attended the 22nd Workshop on MHD Stability Control at the University of Wisconsin-Madison and gave a talk entitled “Progress on Disruption Event Characterization and Forecasting in Tokamaks (DECAF)”. The talk showed analysis of NSTX, NSTX-U, and KSTAR plasmas regarding disruption prediction and tool development, kinetic equilibrium reconstruction, and stability analysis in connection to the DECAF code. Topics included an overview of the code, forecasting global MHD stability boundaries in NSTX, automated identification of MHD instabilities in NSTX and NSTX-U, kinetic equilibrium reconstruction of KSTAR plasmas including MSE, and initial stability investigation of high non-inductive fraction plasmas in KSTAR.

On November 8, the paper "Application of Townsend avalanche theory to tokamak startup by coaxial helicity injection" by K.C. Hammond, R. Raman, and F.A. Volpe was published online in Nuclear Fusion [https://doi.org/10.1088/1741-4326/aa8fa4]. For many years, the basic experimental requirements to achieve a successful plasma breakdown in a tokamak have been derived using the Townsend avalanche theory. To date, the theory has primarily been applied to the conventional startup technique of generating a loop voltage with the central solenoid. This paper extends the theory to determine corresponding requirements for an alternate method, Coaxial Helicity Injection (CHI), which facilitates startup without a solenoid or loop voltage. The theory is shown to offer an explanation for the cause of a failure mode occasionally observed during NSTX CHI experiments in which breakdown did not occur in the lower divertor gap (the desired start-up area) but instead occurred in the upper divertor gap (undesired). In addition, the theory predicts that CHI experiments planned for NSTX-U will be able to use up to four times as much prefill gas as was used in NSTX, permitting greater experimental flexibility. The methodology used in this study is applicable to the design of CHI systems in larger tokamaks and STs such as, for example, a FNSF. This study was carried out with funding from a DOE Office of Science Graduate Student Research (SCGSR) award, which permitted Ken Hammond to work with the NSTX-U team on-site at PPPL for four months in the fall of 2016.