

NSTX-U Weekly Report (March 25, 2016)

FY 2016 NSTX plasma operations

Operation Targets: Total - TBD

Completed: 5.53 run week and 557 plasma shots

On March 23rd, a paper by Fatima Ebrahimi (PPPL) and Roger Raman (University of Washington) entitled "Large-volume flux closure during plasmoid-mediated reconnection in coaxial helicity injection" was published online in Nuclear Fusion as a Letter (<http://dx.doi.org/10.1088/0029-5515/56/4/044002>). In this paper, coaxial helicity injection (CHI), a leading candidate for plasma start-up and current formation in NSTX-U, was numerically studied in NSTX-U through resistive MHD simulations. In these simulations, a large-volume flux closure, and large-fraction conversion of injected open flux to closed flux, in the NSTX-U geometry was demonstrated for the first time. Because of the optimized location of injector flux and flux shaping coils in NSTX-U, which allow a better shaping of the initial flux and narrower injector-flux footprints, major improvements and differences are elucidated in the NSTX-U simulations: (1) the volume of flux closure is large and nearly all of the CHI-generated current is closed-flux current, (2) because of larger reconnecting magnetic field in the injection region, spontaneous reconnection, i.e. plasmoid instability, could occur at every stage of the helicity injection, but the final resulting state is a large volume of closed flux surfaces at equilibrium with a large CHI-generated closed-flux current. (F. Ebrahimi)

Walter Guttenfelder (PPPL) attended the 16th ITPA Transport & Confinement meeting hosted by IPR in Ahmedabad, India, Mar. 16-18, 2016. Topics discussed included: updates on the H-mode confinement scaling database to include ITER-baseline scenarios and data from metal wall machines, low-Z impurity transport, rho-star scaling of intrinsic torque, and transport modeling. Multiple sessions were held jointly with the ITPA Pedestal and Edge Physics group including those on I-modes, L-H transitions, and 3D effects on transport. Some topics being considered for the next ITPA T&C meeting (following IAEA) are intrinsic rotation, updates on joint experiments, and updates on the confinement scaling DB revision. There will also likely be joint sessions held with the Integrated Operation Scenarios group to discuss the status of transport models (e.g. particle transport, neural net modelling, and revisiting current ramp-up/ramp-down). (W. Guttenfelder)

Run Coordination (J. Menard, S. Gerhardt)

XMP-143 (Assess Machine Conditions) was run on 3/21/2016. The goal of these shots was to assess the vessel conditions and recover operations following the two-week outage that included a quick vent to argon and vessel opening for removal of the BN shutter parts. Ohmic scenarios with both 8 kA and 20 kA ohmic current pre-charge levels were examined. The oxygen levels in these discharges were initially elevated, but decreased through the day. By the end of the day, good Ohmic plasma conditions were recovered with reproducible discharges running out past 1.2s, indicating that the impact of the Ar vent and opening on vessel conditions was manageable.

Shots were taken towards XMP-120 (X-point and Strike-point Control) on 3/22/2016. Ohmic and 1 MW L-mode shots were used. Control of the lower X-point radius and height was

established using the PF-1aL and PF-2L coils as actuators. Once this was tuned, the algorithm was used to additionally control the upper X-point position and height, using the upper versions of those same coils. Good control was achieved, and with this development, all PF-coils in use during the shot were controlled by the ISOFLUX algorithms. The final shot of the day set a record pulse length of a 1.9 second I_p flat-top, exceeding in duration of any shot achieved in NSTX.

Further shots were taken towards XMP-120 on 3/23/2016. These 1 MW L-mode shots demonstrated simultaneous control of the outer strike-point in and the X-point height. Good control was demonstrated, as manifest by matches between steps in the lower outer strike-point radius and steps in the radius of divertor C II emission, a non-magnetic measure of the strike-point radius. In parallel with this activity, breakdown at lower toroidal field was assessed: breakdown and ramp-up was achieved at fields as low as $B_T = 0.55$ T with a 20 kA OH current pre-charge, and at fields as low as $B_T = 0.35$ T with an 8 kA OH pre-charge. These breakdown studies demonstrate a required capability for future XPs that desire to scan the toroidal field. The PCS was used to program a notch in the beam power, which demonstrates this capability for use in future XPs and XMPs.

On 3/24/2016, a few discharges were taken towards XP-1506 (Low-beta Error Field Assessment); however, problems with plasma vertical stability, followed by a long period of rectifier troubleshooting, prevented completion of a full applied error field scan. In spite of the limited run time, a reference fiducial shot was developed, and two locked-mode-terminated discharges at a single applied field phase were obtained.

On 3/25/2016, the L-mode morning fiducial discharge, to be used in XMP-144 (NSTX-U Morning Fiducial), was further refined by using the 1B source at 1 MW (instead of the 1C source), and by refining the fuelling. This resulted in a discharge that can be used as the morning fiducial discharge for the remaining run period before the next maintenance period. Work was then done on XMP-142 (Reduced MHD H-mode Development), though progress was limited by comparatively high impurity levels and some facility intermittencies. It is anticipated that the boronization scheduled for 3/26/2016 will result in improved PFC conditions for operations next week.

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

NSTX-U resumed plasma operations this past week after a two-week maintenance period that included a brief argon vent of the vessel. A vacuum vessel boronization was performed on Sunday before resuming operations, and a day was dedicated to ohmic discharges to evaluate machine conditions. Machine conditions clearly improved as that day progressed, and discharges to 1.2 seconds were reproducible by the end of the day. Experiments on H-mode development, error field correction, and on X-Point/Strike Point control were performed this week. Multiple PF coils in isoflux control helped achieve plasma pulse length flat-tops approaching 2 sec, longer than any plasma previously achieved on NSTX. Neutral beam injection was utilized this week with all six NB ion sources operational and being conditioned at total power levels of >6 MW. All six NB ion sources were able to inject power into the plasma. HHFW RF sources 1-4 have completed pre-op testing, and recovery of sources 5 & 6 is nearing completion. A vacuum vessel boronization will be performed on Saturday, March 26th.

The NSTX-U Test Cell will be in restricted access this coming week during plasma operations. Access will be available in the evenings for approved work.