NSTX-U Weekly Report (February 26, 2016)

FY 2016 NSTX plasma operations
Operation Targets: Total - TBD
Completed: 3.86 run week and 388 plasma shots

NSTX-U and Princeton University researchers recently published articles in the journal of Nuclear Fusion linking quantum mechanical, atomistic modeling of liquid lithium with macroscopic plasma experiments conducted on the Magnum-PSI linear plasma device located at FOM-DIFFER in The Netherlands. The paired papers, published by Tyler Abrams (former PhD student advised by M. Jaworski of PPPL, now at GA), Nuclear Fusion v56 (2016) 016020 and Mohan Chen (post-doctoral researcher in Emily Carter's research group at Princeton University), Nuclear Fusion v56 (2016) 016022 in the January issue of Nuclear Fusion sought to explain anomalously low erosion rates from high-temperature lithium experiments when subjected to high fluxes of deuterium plasma. The Princeton University group applied novel Density-Functional-Theory methods to demonstrate that LiD compounds were likely to be formed in the temperature ranges and concentration levels expected in the plasma exposures. A mixed material model developed by Abrams, utilizing D-Li diffusivities derived from the PU quantum modeling, was then able to quantitatively reproduce the suppressed erosion measured in Magnum-PSI after taking into account several changes in erosion due to the LiD surface concentrations. Mixed material erosion experiments will continue with the upcoming High-Z Divertor facility enhancement which will provide a divertor analogue to the Magnum-PSI experiments and further explore the use of liquid lithium as a high-temperature plasma-facing component. (M. Jaworski)

NSTX-U researcher Michael Jaworski (PPPL) gave an Outreach talk titled, "Overview of solid and liquid plasma-facing component research for fusion energy at PPPL" on Thursday, February 18th, 2016 at the National Energy Technology Laboratory (NETL, Albany, OR campus). The talk included recent highlights of research on plasma-facing components and the research approach taken to developing and evaluating novel components in the NSTX-U. Additional discussions were held on collaborative development of liquid plasma-facing components. (M. Jaworski)

On Feb. 23, 2016, S. Kaye, R. Hawryluk, G. Neilson and M. Zarnstorff of PPPL visited DOE to present the present plans for PPPL implementation of remote collaboration capabilities. In particular, R. Hawryluk gave the Introduction, G. Neilson discussed plans for PPPL as the national facilitator for the W7X collaboration, and S. Kaye discussed the approach that has been taken for NSTX/NSTX-U collaborations, and plans for implementing additional technical capabilities to enhance off-site participation in meetings and directly in experiments. Part of this plan includes establishing a remote participation center, which would be multiple use, serving NSTX-U and outgoing collaborations on W7X, EAST, MAST-U, etc. (S. Kaye)

Run Coordination (J. Menard, S. Gerhard)

On Monday 2/22 and Tuesday 2/23/2016, 20 Ohmic discharges were taken towards XMP-115 (ISOFLUX Commissioning). These shots started from the two “isodnull” discharges developed on 2/19/2016; here, “isodnull” refers to the ISOFLUX algorithm used for controlling diverted shapes, while “isoelong” is the algorithm used for controlling inner wall limited shapes. In the

initial discharges, control transitioned to the isoelong algorithm at 200 ms, and then to the isodnull algorithm at 400 ms. Over the series of 20 discharges, the two control algorithms were shifted forward, until isoelong was turning on at 100 ms, and then isodnull at 200 ms. The latter was during the current ramp, allowing the single algorithm to be used for the entire 700ms flat-top duration. A number of MHD locked-mode events were observed to cause severe perturbations to the plasma, but the shape controller allowed the plasma to recover from the large disturbances.

On Wednesday 2/24, 18 shots were taken in support of XMP-115 (ISOFLUX Commissioning) and XMP-137 (Increasing Ip and kappa in L- and H-mode). These discharges produced the first H-mode scenario at 800kA and achieved a kappa ~ 1.95 at li ~ 0.9 (203532) using 3.1 MW of NBI from two beams above 70 kV. This was an improvement from H-mode discharges in January that achieved kappa ~ 1.75 at I_p = 600kA with similar heating from three beams at lower voltage. The higher voltage beams from this day provided initial data for beam spectroscopy diagnostics. Many of the discharges were devoted to developing a ramp-up scenario including the handoff between various shape control algorithms and the timing of heating, diverting and fueling.

20 Ohmic shots were taken towards XMP-140 (PF-5 Proportional EFC Test) on Thursday 2/25. These shots used a new PCS algorithm that applies a 3D field in direct proportion to the field in any of the TF, PF, or OH coils. In this instance, it was used to apply an n=1 field of magnitude proportional to the PF-5 current. Numerous proportionality constants and phases of this n=1 field were applied. The Ohmic target plasma had been selected based on the large MHD modes that it was susceptible to, and an applied field phase and magnitude was found that eliminated nearly all of these MHD modes. This provides a good start towards error field correction in higher-beta plasmas in NSTX-U.

19 shots were taken towards the combined efforts of XMP-137 and XMP-115 on Friday 2/26. These shots utilized the error field correction strategy determined on the previous day. An attempt at dr-sep control using ISOFLUX revealed a bug in the PCS code, which was corrected later in the day but not yet tested in operations. L-mode scenarios with ~1 MW of NB heating were run at plasma current Ip = 800 kA for a ~1.8 second discharge, and Ip = 1000 kA for a ~1.2 second discharge; these are the longest discharge durations and highest currents yet achieved in NSTX-U.

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

NSTX-U plasma operations continued this past week with experiments to further develop the use of ISOFLUX control and on H-mode development. Progress was also made on establishing n=1 error field correction on a series of ohmic shots >700kA. Time was taken this week to complete modifications to the Gas Injection System (GIS) to reconfigure electronics and add higher Voltage protection as needed to address recent failures. GIS operational controls were also updated to address Voltage break-down failures associated with the low plenum pressures seen on some of our longer pulse plasmas. By the end of the week, high field side GIS injectors were back in service. Time was also taken to replace the NB1A ion source with a fresh spare which is now being conditioned. The new MAPP diagnostic is successfully taking data.

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.