

## **NSTX-U Weekly Report (April 21, 2017)**

**FY 2017 status: NSTX-U is in a maintenance and repair outage.**

### **NSTX-U Research (J. Menard)**

The paper “Feedback control design for non-inductively sustained scenarios in NSTX-U using TRANSP” by M.D. Boyer, R.G. Andre, D.A. Gates, S.P. Gerhardt, J.E. Menard, and F.M. Poli has been published in Nuclear Fusion [<https://doi.org/10.1088/1741-4326/aa68e9>]. This paper examined a method for real-time control of important plasma performance related parameters during non-inductively sustained scenarios in NSTX-U. The work used TRANSP, a time-dependent integrated modeling code for prediction and interpretive analysis of tokamak experimental data that is developed at PPPL, as a simulator. TRANSP simulations of non-inductively sustained scenarios were used to study the sensitivity of the parameters to disturbances (e.g., changes in confinement characteristics) and the response to the available actuators (independent neutral beam modulation and shaping changes were considered). These results were used to develop a linearized dynamic response model of the system and a multi-variable model-based control scheme was designed that accounts for the tight coupling of magnetic and kinetic variables in non-inductive scenarios, as well as the limited available range of actuation. Simulations show that modest changes in the gap and beam powers can improve response time of the system, reject perturbations, and track target values of the controlled parameters.

The paper “Current Start-Up Using the New CHI System,” by K. Kuroda, R. Raman, K. Hanada, et al., was published in Plasma and Fusion Research: Rapid Communications Vol. 12, 1202020 (2017) [[http://www.jspf.or.jp/PFR/PFR\\_articles/pfr2017/pfr2017\\_12-1202020.html](http://www.jspf.or.jp/PFR/PFR_articles/pfr2017/pfr2017_12-1202020.html)]. The paper reports the first results from the recently implemented transient coaxial helicity injection (CHI) system on the QUEST device located at Kyushu University in Japan, including the generation of up to 29 kA of CHI produced toroidal plasma current. The QUEST CHI experiment uses a new CHI electrode configuration, complementary to the ones implemented on NSTX/NSTX-U. The University of Washington and PPPL groups participated in the QUEST CHI experiment as a part of the QUEST/NSTX-U US-Japan collaboration.

The paper titled "Quasilinear diffusion coefficients in a finite Larmor radius expansion for ion cyclotron heated plasmas" by J. Lee (MIT), J. Wright (MIT), N. Bertelli (PPPL), E F. Jaeger (XCEL), E. Valeo (PPPL), R Harvey (CompX), and P. Bonoli (MIT) was published in Physics of Plasmas [<http://aip.scitation.org/doi/pdf/10.1063/1.4982060>]. In this paper a reduced model of quasilinear velocity diffusion by a small Larmor radius approximation is derived to couple the Maxwell's equations and the Fokker Planck equation selfconsistently for the ion cyclotron range of frequency (ICRF) waves in a tokamak. The quasilinear diffusion coefficients are implemented in a coupled code (TORIC-CQL3D). In particular, this coupling is done by making use of the recent extension of TORIC, which includes the non-Maxwellian ion effects in the ICRF minority heating regime developed by N. Bertelli and E. Valeo.

Jon Menard attended the Chinese Fusion Engineering Test Reactor (CFETR) Physics International Advisory Committee (IAC) Meeting held April 19-20, 2017 in Hefei, China. The IAC was charged to comment on the proposed experimental validation plan, scenario, stability, and exhaust development, and proposed progress metrics.

Steve Sabbagh gave a general presentation on plasma, fusion, stability, and PPPL tokamaks to the Austin-Healey Sports & Touring Club on 18-April-2017. The group plans to tour PPPL this summer.

### **NSTX-U Recovery Project (R. Hawryluk)**

The twelfth and final NSTX-U Design Verification and Validation Review (DVVR), this one on Real Time Control and Protection, was completed this week. The external participants included: Tom Todd (EOC chair), Axel Winter (IO), David Humphreys (GA), Michel Huguet (ITER retired), Jim Irby (MIT) and Dave Terry (MIT). The observations/suggestions are now being organized into corrective actions.

A design integration review was completed for the polar region of the machine. Participants included PPPL NSTX-U Responsible Engineers with involved scope, various PPPL subject matter experts, and several Extent of Condition (EoC) committee members including Tom Todd, the EoC Chair. The purpose was to evaluate various design options for the many components involved in this part of the machine. Advantages and disadvantages of various approaches were identified. The results of this review, along with guidance from the final EoC meeting in May, will define the path forward for several major design decisions.

Regarding test cell work, the Poloidal-CHERS diagnostic in-vessel passive plates have completed vacuum preparation (including a bake) following fit-ups, and are ready for installation. The removal, inspection and silver plating of the TF, OH and CHI bus under the machine has started, and the installation and alignment of the FIRETIPS diagnostic wave guides continues.

A Management Safety Walkthrough of the coil winding facility was conducted on Friday, 4/14. Action items are being addressed.

A Specification and Statement of Work (SOW) for the procurements of Inner PF coils is nearing completion.

Vendor grit blasting of the first spool of PF1A coil conductor began this week.

Work continues in the Neutral Beam Clean Room on the assembly of a second spare ion source. Pre-op testing of the first spare ion source has been successfully completed. Test data has been reviewed, and some steps will be repeated before declaring this source an active spare.

Voith Hydro and PPPL engineers met this week to discuss a possible fixed price subcontract to resurface the D-MG#1 bearing journal in a stoning operation. Also, GE Power Inc. in Pittsburgh will submit a proposal to update the aging MG cyclo-converter controls.

The final design review of the NSTX-U Test Cell Video Surveillance System was held this week.