NSTX-U

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NSTX-U Collaboration Status and Plans for: University of Washington / CHI and DM Research on NSTX-U

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NSTX-U Collaborator Research Plan Meetings
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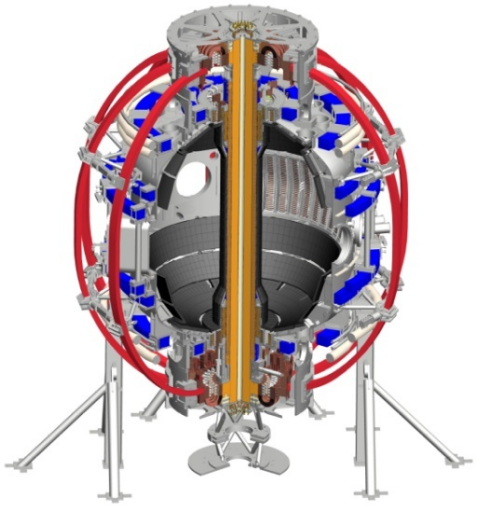

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Collaborating Researchers

- PPPL
  - D. Mueller, S.C. Jardin, D.P. Stotler, G. Taylor, T. Abrams, M. Ono, J. Menard, B.P. LeBlanc, F. Poli, A. Diallo, S.P. Gerhardt, C.E. Kessel, S.M. Kaye, R. Maingi, L. Roquemore, J-K. Park, M. Jaworski
- Princeton University
  - F. Ebrahimi
- LLNL, Univ. of Wisconsin
  - V. Soukhanovskii, E.B. Hooper, F. Scotti, C. Sovinec
- Johns Hopkins, Columbia Univ., Nova Photonics, ORNL, Others:
  - K. Tritz, S. Sabbagh, J. Berkery, H. Yuh, R. Maqueda, T. Gray, L. Baylor, D. Rasmussen, T. Bigelow

CHI Research plans and needs for this year (FY2014) in preparation for NSTX-U operations in FY2015

- Initial NSTX-U Hardware Configuration for Transient CHI Start-up identified
  - Developed initial start-up scenarios for NSTX-U for FY15 Expts.
    - Will use PF1CL, PF1AL, PF2L as the injector flux coils
- MOV rating will be increased from 1.65kV to 2kV
  - NSTX-U Engineering will implement this capability in the near future
    - Initial 2kV capability important for Transient CHI on NSTX-U
- Starting work on energizing CHI cap bank for tests into dummy load
  - FY2015 and 2016 experiments will use existing capacitor bank

CHI Research Plans for FY2015 and FY2016

- Transient CHI Start-up
  - Using PF1C as the primary coil, establish high current targets and asses current generation potential and compare scaling with NSTX results
  - Study improvements to CHI plasma intrinsic T_e in discharges with higher poloidal flux with more complete Li coatings
  - Develop 400kA target scenarios for FY17 and FY18 ramp-up experiments
- Test NB coupling to CHI targets with weak inductive drive
  - Needed for TRANSP analysis
- Assess inductive flux savings and compare to NSTX results
  - Generate discharges that use partial solenoid pre-charge

CHI Hardware Plans for FY2017 & beyond

- CHI operating voltage will be increased to >2kV, <3kV (starting FY17)
  - FY 15 and 16 experimental results will establish upgraded voltage requirements
- Capacitor bank upgrade should be relatively simple
  - New 3kV capacitors identified. These can be swapped for the present 2kV capacitors
  - All other systems in the capacitor bank are capable of supporting up to 3kV operations, may use a larger charging power supply (TBD in FY16)
- New MOV to support Operations at >2kV to be identified after FY15 Operations
  - Precise maximum operating voltage needs to be known
  - Will also use PF1BL to increase and shape injector flux

CHI Research Plans for FY2017 and beyond

- Transient CHI Start-up
  - Heat high current CHI discharges generated during FY15 and 16 with ECH and assess plasma heating and current decay
  - Determine the highest level of start-up currents possible on NSTX-U using as much of the injector flux as possible, with higher CHI voltage
  - Use all of the capabilities available to reduce low-z impurities and increase T_e (Li, ECH, partial metal electrodes, absorber Li coating)

- Use ECH heated high current CHI target and asses NI ramp-up using NBI & HHFW
  - Results from NI ramp-up of inductive targets from FY15 and FY16 & Transp analysis will be used to guide these experiments

TSC Simulation Support

- Continuing to use S.C. Jardin's help to improve on transient CHI model using TSC
  - Continuing to improve start-up scenarios for NSTX-U
  - Generate suitable targets for NI current ramp-up simulations

- F. Poli developing NI current ramp-up scenarios using TSC for inductively generated seed targets
  - Future work will replace inductive targets with CHI targets to support FY17-18 goals for full non-inductive start-up and ramp-up

NIMROD Simulation Support

- E.B. Hooper (NSTX-U supported) simulating NSTX CHI discharges
  - Primary goal is to develop a realistic NIMROD model of NSTX transient CHI discharges
  - Now understanding effect of local gas injection in CHI region
  - Later, extend to NSTX-U discharges

- F. Ebrahimi (not supported by NSTX-U) conducting simulations using pre-programmed coil currents
  - Simulations show agreement with basic CHI model of Jarboe
  - Model continuing to be improved in steps

QUEST CHI activity

- Expect QUEST CHI activity to be coupled to NSTX-U CHI research
  - CHI design completed during March 2014
  - Will test and develop new CHI electrode design on QUEST
  - Order placed for procurement of primary insulators for QUEST CHI
  - Will build power supplies and gas injection systems during next few months
- CHI installation work on QUEST will begin later this summer
  - Two graduate students identified, one student likely to help with NSTX-U CHI during 2015

DM Research plans and needs for this year (FY2014) in preparation for NSTX-U operations in FY2015

- Considerable experimental work finished to develop ITER-like MGI valves for NSTX-U
  - Valve design finalized
  - Engineering team preparing to install these valves on NSTX-U
- Pulsed power supply construction to start soon
  - Based on prototype used for off-line MGI testing, but will be more compact for installation in NSTX-U Test Cell
- Working with D.P. Stotler to develop simulation needs to support MGI research on NSTX-U
  - Goal is to understand gas assimilation physics (unique NSTX-U contribution to MGI research)
    - Needed for knowing how well MGI will work on ITER

DM Research plans for FY15

- Conduct studies to assess gas coupling efficiency for variations in the poloidal injection location
  - Vary plasma shape
- Possible assessment of poloidal injection location variation for a plasma undergoing VDE
  - To support Multi-Machine Joint Research activity

DM Hardware Plans for FY2015 – FY17

- Off-line tests will continue to improve ITER-like MGI valve design
  - Results will feedback to MGI valves on NSTX-U and provide supporting data to ITER MGI valve
- Starting FY16, additional MGI valves will be installed
  - At present a 4th location has been identified and reserved for MGI installation
  - Additional locations (TBD) after FY15 experimental operations and additional needs identified after consultation with DIII-D and other tokamaks
- Starting FY16, MGI operating pressure will be increased to >>5000 Torr – in steps
  - Extent of maximum operating pressure TBD by off line tests in combination with upgrading gas line pressure limits on NSTX-U

DM Research plans for FY16 – FY17

- Understand gas assimilation efficiency for variations in plasma parameters and injection parameters
  - Use modeling support from D.P. Stotler
- Experiments aimed at understanding Disruption Mitigation Physics
  - Transport during TQ
  - Power loading of PFCs
  - Generation of undesirable current on vessel walls
  - Current quench
  - Generation of REs
- Contribute to the assessment of disruption power balance for different disruption types
  - Linked to multi-machine experiments

Ideas to enhance participation in NSTX-U research/program by U.S. Universities

- Student for D.P.Stotler for DEGAS-2 simulation work
  - Understanding gas penetration physics though SOL and pedestal region is very high priory work for both NSTX-U and ITER
    - Graduate student Tyler Abrams has volunteered part of his time to develop an initial model. Need a full time student to develop this very important capability
- F. Ebrahimi has provided valuable Nimrod simulation support using non-NSTX-U funds
  - Need to enhance this activity by attaching a student to work with Fatima Ebrahimi
- U of Wash. interested in developing EPI injector as a faster time-response system for DM on ITER
  - Initial design studies completed & look attractive for ITER
    - UW has laboratory facilities to support this activity
    - Potential for two graduate students to contribute to this important activity that would lead to training them for supporting operations on ITER

Univ. of Washington Research on NSTX-U will Develop Two Important System Capabilities for the ST and ITER

- Transient Coaxial Helicity Injection will develop solenoid-free plasma start-up capability for the ST
  - Initial goal is to develop 400kA targets (FY15 -16)
  - These targets will be heated using ECH to increase T_e (FY17-18)
  - I_p ramp-up of CHI targets will be tested using NBI & HHFW (FY17-18)
  - Numerical simulations will/are supporting experiments (FY14-18)
- ITER-like MGI valves with unique NSTX-U capabilities will help improve MGI system requirements for ITER
  - Developed ITER-like MGI valve for NSTX-U (FY14)
  - At least 4 valves to be installed (FY14 to FY17)
  - Highest priority is to understand gas assimilation efficiency in plasma
  - Study DM Physics including supporting numerical modeling work
- DM based on an EPI injector system may be essential for ITER
  - Completed initial design/scoping studies
  - Well suited for educating new generation to support operations on ITER