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Overview of recent physics results from NSTX

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The National Spherical Torus Experiment (NSTX) is currently being upgraded to include a center stack capable of producing twice the toroidal field and plasma current (up to 1 T and 2 MA), and a second, more tangentially aimed neutral beam for current and rotation control, allowing pulse lengths up to 5 s. During the two-year construction period, NSTX physics analyses have addressed key topics that will allow NSTX-U to achieve the research goals critical to next step Spherical Tokamaks, such as a Fusion Nuclear Science Facility. These goals include accessing low collisionality and high beta, producing stable, 100% non-inductive operation and assessing PMI solutions to handle the high heat loads expected in the next-step devices. Non-linear GTS studies of NBI-heated L-mode plasmas, which exhibited coupling between ion and electron-scale turbulence and strong effects of ExB shear, have predicted strong ExB suppression of the ion scale turbulence. RF-heated L-mode plasmas show a decrease in electron-scale turbulence following the RF turn-off despite little or no change in either the temperature profiles or local equilibrium quantities, indicating the importance of "non-local" turbulence spreading. Studies of fast growing Ideal Wall Modes (IWM) and Resistive Wall Modes indicate that including rotation and kinetic resonances is necessary for predicting experimental stability thresholds. DEGAS-2 is being utilized to study the dependence of gas penetration on SOL temperatures and densities for the MGI system being implemented on the Upgrade. ELM studies have shown that the peak heat flux increases with the size of the ELM, while the wetted area can decrease or increase, depending on the number of filaments in the heat flux footprint. Strong T_i gradients were associated with strong rotation shear and an E_r well in the pedestal region of EPH-modes. The up to 20% neutron rate decrease associated with TAE avalanches was found to be due primarily to energy loss and a redistribution of fast ions. AORSA-based full wave simulations of fast wave heating that include a finite SOL density show that RF power losses in the SOL increase significantly for both NSTX and NSTX-U plasma scenarios when the launched waves transition from being evanescent to propagating in the SOL. The physics of Coaxial Helicity Injection has been studied using the NIMROD, finding that the reconnection process is consistent with the 2D Sweet-Parker theory. Laboratory and theory studies of lithium evaporation on graphite surfaces indicate that lithium increases oxygen surface concentrations on graphite, and deuterium-oxygen affinity, which increases deuterium pumping and reduces recycling. Source studies showed that the low lithium level observed in the core of lithium-coated wall NSTX plasmas was due to both a high retention of lithium in the divertor region as well as a large neoclassical diffusivity. Upgrade construction is moving on schedule with first operation of NSTX-U planned for Autumn 2014. The project status and operations plan will be given.

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