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Overview of Recent Physics Results from NSTX

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NSTX is currently being upgraded to operate at twice the toroidal field and plasma current (up to 1 T and 2 MA), with a second, more tangentially aimed neutral beam for current and rotation control, allowing for pulse lengths up to 5 s. Recent NSTX physics analyses have addressed topics that will allow NSTX-U to achieve the research goals critical to a Fusion Nuclear Science Facility. These goals include accessing low collisionality and high beta, producing stable, 100% non-inductive operation and assessing Plasma Material Interface (PMI) solutions to handle the high heat loads expected in the next-step devices. Including rotation and kinetic resonances, which depend on collisionality, is necessary for predicting experimental stability thresholds of fast growing Ideal Wall and Resistive Wall Modes. Non-linear gyrokinetic simulations have been performed to study transport of heat, particles and momentum in the core plasma, and its dependence on collisionality and profile shapes. These studies include coupling between low- and high-k turbulence, the effect of rotation and non-local transport. PMI studies have focused on the effect of ELMs and 3D fields on plasma detachment and heat flux handling. DEGAS-2 has been used to study the dependence of gas penetration on SOL temperatures and densities for the MGI system being implemented on the Upgrade. 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 high retention of lithium in the divertor as well as large neoclassical diffusivity. Noninductive operation and current profile control in NSTX-U will be facilitated by Coaxial Helicity Injection as well as RF and NB heating. CHI studies using NIMROD indicate that the reconnection process is consistent with the 2D Sweet-Parker theory. Full wave AORSA simulations show that RF power losses in the SOL increase significantly for both NSTX and NSTX-U when the launched waves propagate in the SOL. TAE avalanches can affect NB driven current through energy loss and redistribution of fast ions. Upgrade construction is moving on schedule with first operation of NSTX-U planned for Autumn 2014.

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