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OV/3-1: Overview of Physics Results from the National Spherical Torus Experiment

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Research on the National Spherical Torus Experiment, NSTX, targets physics understanding needed for extrapolation to a steady-state ST Fusion Nuclear Science Facility, pilot plant, or DEMO. The unique ST operational space is leveraged to test physics theories for next-step tokamak operation, including ITER. Present research also examines implications for the coming device upgrade, NSTX-U. Energy confinement increases as collisionality is reduced by lithium (Li) wall conditioning. Nonlinear microtearing simulations match experimental electron diffusivity quantitatively and predict reduced electron heat transport at lower collisionality. Measured high-k turbulence is reduced in H-mode. Beam-emission spectroscopy measurements indicate that the poloidal correlation length of pedestal turbulence increases at higher electron density and gradient, and decreases at higher Ti. Plasma characteristics change nearly continuously with increasing Li evaporation, and ELMs stabilize due to edge density gradient alteration. Global mode stability studies show stabilizing resonant kinetic effects are enhanced at lower collisionality. Combined radial and poloidal field sensor feedback controlled n = 1 perturbations and improved stability. The disruption probability due to unstable RWMs is reduced at high betaN/li > 11. Greater instability seen at lower betaN is consistent with decreased kinetic RWM stabilization. A model-based RWM state-space controller produced long-pulse discharges exceeding betaN = 6.4 and betaN/li = 13. Precursor analysis shows 99% of disruptions can be predicted with 10ms warning and a false positive rate of only 4%. Disruption halo currents rotate toroidally and can have significant toroidal asymmetry. Global kinks cause measured fast ion redistribution. Full-orbit calculations show redistribution from the core outward and toward Vpar/V = 1. The snowflake divertor configuration enhanced by radiative detachment shows large reductions in steady-state and ELM heat fluxes (peak values down from 7 MW/m2 to less than 1 MW/m2). Non-inductive current fraction (NICF) up to 65% is reached experimentally. NSTX-U scenario development calculations project 100% NICF at Ip = 1MA. Coaxial helicity injection has reduced the inductive startup flux, with L-mode plasmas ramped to 1MA requiring 35% less inductive flux. *Supported in part by US DOE Contract DE-AC02-09CH11466.

Country or International Organization of Primary Author

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Collaboration (if applicable, e.g., International Tokamak Physics Activities)

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