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Recent Physics Results from the National Spherical Torus Experiment

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The National Spherical Torus Experiment (NSTX) has made considerable progress in advancing the scientific understanding of high performance long-pulse plasmas needed for low-aspect-ratio Spherical Torus (ST) concepts and for ITER. Plasma durations up to 1.5s (approximately 5 current redistribution times) have been achieved at plasma currents of 0.7 MA with non-inductive current fractions approaching 70% while achieving β_T and β_N values of 16% and 5.7 (%mT/MA), respectively. Newly available Motional Stark Effect data has confirmed a strong correlation between improved electron energy confinement and degree of magnetic shear reversal, and the low aspect ratio and wide range of achievable β in NSTX are providing unique data for confinement scaling studies. In MHD research, six mid-plane ex-vessel radial field coils have been utilized to infer and correct intrinsic error fields, investigate locked tearing mode thresholds, provide robust rotation control with non-resonant n=3 field ripple, and measure the resonant field amplification spectrum of rotationally-stabilized resistive wall modes (RWMs) and the RWM critical rotation frequency. Advanced boundary shape control has been utilized to study the role of magnetic balance on the H-mode access threshold and ELM stability. Optimal ELM characteristics are typically obtained in a shape with negative bias, i.e. toward lower single null, while balanced double-null shapes maintained during the current ramp have resulted in H-mode regimes with pedestal temperatures nearly twice those of typical H-modes and the first evidence of current-hole formation in the plasma core. In the area of energetic particle research, cyclic neutron rate drops have been associated with the destabilization of multiple large Toroidal Alfven Eigenmodes (TAEs) similar to the “sea-of-TAEs” predicted for ITER, albeit at lower TAE toroidal mode number n=1-6. Finally, non-inductive plasma start-up research is particularly important for the ST concept, and Coaxial Helicity Injection has now produced 60kA of persistent current on closed flux surfaces in NSTX.

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