Overview of Research Plans for NSTX Upgrade*

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The missions elements of the National Spherical Torus eXperiment Upgrade (NSTX-U) research program are to: (1) establish the physics basis for the spherical tokamak (ST) as a candidate for a Fusion Nuclear Science Facility (FNSF), (2) understand and develop novel solutions to the plasma-material interface (PMI) challenge, and (3) advance the understanding of toroidal confinement physics for ITER and beyond. Underlying all of these missions is access to a unique plasma physics parameter regime of high beta combined with reduced collisionality to address fundamental questions about plasma stability and turbulent transport, and greatly extend understanding of toroidal plasma science. To achieve this collisionality reduction with equilibrated profiles, NSTX-U will double the toroidal field, plasma current, and NBI heating power relative to NSTX and will also increase the pulse length from 1–1.5 s to 5–8s. NSTX-U achieved first test plasma in August of 2015, and the NSTX Upgrade Project is now complete. In preparation for utilizing the new capabilities of NSTX-U, the NSTX team completed a comprehensive 5 year research plan in 2013, and the major directions of experimental research for the next three years are well defined. Major elements of the plan include assessments of more tangential injection of the 2nd NBI of NSTX-U for increasing the NBI current drive by up to a factor of 2 and supporting 100% non-inductive operation. The team will also assess NBI plus bootstrap current over-drive for providing non-solenoidal current ramp-up as needed for an ST-based FNSF. NSTX-U researchers will explore novel solutions to the power exhaust challenge for FNSF and DEMO by testing partial detachment, extreme flux expansion using a snowflake or X-divertor, and by testing liquid metal plasma facing components (PFCs). In support of ITER and FNSF, NSTX-U researchers plan to develop advanced disruption avoidance and mitigation techniques and predictive capability for non-linear Alfven eigenmode "avalanches" which can expel fast-ions in NSTX and may exist in the ITER hybrid and reversed shear scenarios. Research plans for a range of topical science areas will be described.

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