PRINCETON PLASMA PHYSICS LABORATORY

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*Scientific Opportunities and Challenges in the Upgraded National Spherical Torus Experiment**

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ABSTRACT:
Upon completion, the National Spherical Torus Experiment - Upgrade (NSTX-U) will be the most capable spherical torus (ST) facility in the world fusion program. A major mission of NSTX-U is to develop the physics and technology basis for a Fusion Nuclear Science Facility (FNSF). The ST-based FNSF has the promise of achieving the high neutron fluence needed for reactor component testing at reduced size and with modest tritium consumption. The unique operating regimes of NSTX-U will also contribute to important issues in plasma-material interactions and burning plasmas to optimize the performance of ITER. NSTX-U is being constructed at PPPL, and the project is nearly complete with preparations for plasma operation now underway. Compared to NSTX, NSTX Upgrade will double the magnetic field, plasma current, and heating power and increase the plasma duration by up to a factor of 5. These upgrades are projected to produce a 5-10 fold increase in the fusion performance parameter $n\tau T$ and increase the average plasma pressure to values approaching present-day tokamaks. A much more tangential 2nd Neutral Beam Injection (NBI) heating system is projected to provide 2-3 times higher current drive efficiency enabling attainment of 100% non-inductive operation needed for steady-state FNSF operation. With higher fields and heating powers, the NSTX-U plasma collisionality will be reduced by a factor of 3-6 to explore how energy confinement depends on plasma collisionality and temperature. If the favorable trend of increased confinement at reduced collisionality observed in NSTX extends to lower collisionality, high fusion neutron fluences could be achievable in very compact ST devices. An overview of magnetic fusion, motivations for ST research, NSTX-U engineering highlights, and NSTX-U research plans will be presented.

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BIOGRAPHY:
Dr. Jonathan Menard, Princeton Plasma Physics Laboratory (PPPL), is presently the Program Director for the National Spherical Torus eXperiment – Upgrade (NSTX-U) and is responsible for guiding the scientific research program of NSTX-U working with the NSTX national research team. Dr. Menard's research interests include the magnetohydrodynamic (MHD) equilibrium and stability properties of spherical torus (ST) and tokamak plasmas, advanced operating scenarios in the ST, and the development of next-step ST options for fusion energy. After receiving a bachelor's degree in nuclear engineering from the University of Wisconsin-Madison in 1992, Dr. Menard went on to receive a master's and a Ph.D. in plasma physics from Princeton University, Department of Astrophysical Sciences, in 1994 and 1998, respectively. He conducted post-doctoral research at PPPL before joining the research staff in 1999. Among his honors, Menard was awarded a U.S. Department of Energy Magnetic Fusion Science Fellowship in 1993, the Princeton University Honorific Fellowship in 1996, received the "Best Student Paper" award from the American Nuclear Society Fusion Energy Division in 1998, received the Presidential Early Career Award for Scientists and Engineers in 2004, was a recipient of the Kaul Prize in 2006, was named a fellow of the American Physical Society in 2010, and was the co-winner of an R&D 100 award in 2012.