



IAEA FEC 2014

Contribution ID: 381

Type: Poster

## Progress toward Commissioning and Plasma Operation in NSTX-U

Friday 17 October 2014 14:00 (4h 45m)

The National Spherical Torus Experiment - Upgrade (NSTX-U) is the most powerful spherical torus facility being constructed at PPPL, Princeton USA. The NSTX-U project has entered the last phase of construction, and preparation for plasma operations is now underway. The major mission of NSTX-U is to develop the physics basis for an ST-based Fusion Nuclear Science Facility (FNSF). The ST-based FNSF has the promise of achieving the high neutron fluence needed for reactor component testing with relatively modest tritium consumption. At the same time, the unique operating regimes of NSTX-U can contribute to several important issues in the physics of burning plasmas to optimize the performance of ITER. The NSTX-U program further aims to determine the attractiveness of the compact ST for addressing key research needs on the path toward a fusion demonstration power plant (DEMO). Enabled by key technology innovations, the upgrade will nearly double the toroidal magnetic field  $B_T$ , plasma current  $I_p$ , and NBI heating power compared to NSTX, and increase the TF flat top pulse length from 1 s to 6.5 s. The new center stack will provide  $B_T = 1$  Tesla (T) at a major radius of  $R_0 = 0.93$  m compared to 0.55 T at  $R_0 = 0.85$  m in NSTX, and will enable a plasma current  $I_p$  of up to 2 mega-Amp (MA) for 5 sec compared to the 1 MA for 1 sec in NSTX. The anticipated plasma performance enhancement is a quadrupling of the plasma stored energy and at least doubling of the plasma confinement time, which would result in an order of magnitude increase in the fusion performance parameter  $n\tau T$ . With  $\beta_T \sim 25\%$  at  $B_T = 1$ T, the absolute average plasma pressure in NSTX-U could become comparable to that of present-day tokamaks. A much more tangential 2nd NBI system, with 2-3 times higher current drive efficiency compared to the 1st NBI system, is installed. NSTX-U is designed to attain the 100% non-inductive operation needed for a compact FNSF design. With higher fields and heating powers, the NSTX-U plasma collisionality will be reduced by a factor of 3-6 to help explore the trend in transport towards the low collisionality FNSF regime. If the favorable trends observed on NSTX holds at low collisionality, high fusion neutron fluences could be achievable in very compact ST devices. NSTX-U first plasma is planned for November 2014, at which time the transition to plasma operation will occur.

### Country or International Organisation

USA

### Paper Number

FIP/P8-30

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**Session Classification:** Poster 8