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#472 SUMMARY

SUMMARY REVIEW

SUBMISSION

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TITLE AND ABSTRACT

Title: Physics Design of the NSTX Upgrade

Abstract

Access to low collisionality is important to more fully understand transport, stability, and non-inductive start-up and sustainment in the ST. For example, NSTX [1] and MAST [2] observe a strong (nearly inverse) scaling of normalized confinement with collisionality, and if this trend holds at low collisionality, high fusion neutron fluences could be achievable in very compact ST devices. Such considerations motivate the proposed upgrade of NSTX to higher toroidal field = 0.55T --> 1T, plasma current = 1MA --> 2MA, NBI heating power = 5MW --> 10MW, aspect ratio A=1.3 --> 1.5, and pulse length =1-1.5s --> 5s. To enable engineering design of the upgrade, systematic free-boundary equilibrium calculations have been performed to determine the upgrade poloidal field requirements as a function of plasma shape, magnetic balance, internal inductance, and beta. NSTX plasma current ramp-up and flat-top flux consumption scalings and modelling have been utilized to design the Upgrade solenoid to support up to 5s flat-top durations at 2MA flat-top current. Recent assessments of the divertor heat flux scaling in NSTX project to peak divertor heat fluxes of 20MW/m^2 in the Upgrade for conventional divertor configurations with flux expansion ~20. Very high flux expansions of ~40-60 have recently been shown to successfully reduce peak heat flux in NSTX, and additional divertor poloidal field coils are being incorporated into the Upgrade design to support high flux expansion "snowflake" [3] and "X/Super-X" [4] divertors and strike point control for high heat flux mitigation. TRANSP simulations indicate that more tangential neutral beam injection (NBI) can increase NBI current drive efficiency by up to a factor of two, support fully non-inductive operation at 1MA plasma current values, enable control of the core q profile, and ramp-up the plasma current from intermediate current (~0.4MA) to near mega-ampere levels. The incorporation of coaxial helicity injection start-up, preliminary global stability calculations, and other design activities will also be described.

[1] S. Kaye, et al., Nucl. Fusion **47** (2007) 499-509

[2] M. Valovic, et al., Nucl. Fusion **49** (2009) 075016

[3] D.D. Ryutov, Phys. Plasmas **14**, 064502 (2007)

[4] P.M. Valanju, et al., Phys. Plasmas **16** 056110 (2009)

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