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Development of Fully Noninductive Scenario at High Bootstrap Current Fraction for Steady State Tokamak Operation on DIII-D and EAST

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A main goal for EAST is to investigate an approach to fully noninductive long-pulse operation based on high bootstrap fraction under fusion relevant conditions. Building on results of previous DIII-D experiments , first joint experiments on DIII-D have developed a fully noninductive plasma scenario with EAST-similar plasma cross section shape, plasma current formation consistent with the superconductive coils on EAST, and values of plasma current, toroidal field, and heating power consistent with the new EAST capabilities. These EAST demonstration discharges on DIII-D have achieved and sustained fully noninductive conditions at fBS≥80%, beta_N≥3.0, beta_T~2.0%, and fGreenwald≥90%. Data supports that an ITB observed at large minor radius (rho~0.7) can be consistent with steady-state operation. Excellent energy confinement and high normalized pressure (beta_N>3) were maintained even with the low NBI torque (~3 Nm) expected on EAST. ELM dynamics appear as a limiting instability toward stationary sustainment of even higher performance. These fully noninductive high bootstrap discharges need to pursue integration of ELM control on both of DIII-D and EAST. The experimental conditions on DIII-D have been used to simulate possible advanced steady-state scenarios for EAST, and the first experimental tests of these scenarios on EAST will be presented. Simulations using PTRANSP with the CDBM transport model show that such DIII-D scenarios are accessible on EAST for 0.5MA steady-state plasma at βN~2.4 and with bootstrap current fraction of 65% by utilizing half of the total EAST H&CD capabilities planned for 2014. A weak core magnetic shear similar to the DIII-D scenario and with ITB footprint at □rho~0.6 is achieved in the simulations. The scenario demonstrated on DIII-D and predicted for EAST could be extended to durations much longer than the current relaxation time and even the wall equilibration time using the expected EAST capabilities in the upcoming campaign, prior to the IAEA conference. Success of this endeavor will be a significant progress toward the goal of fusion energy.

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Author: Prof. GONG, Xianzu (Insititute of Plasma Physics, Chinese Academy Sciences)

Co-authors: Dr GAROFALO, Andrea (General Atomics, P.O. Box 85608, San Diego, California 92186-5608, USA); Dr WAN, Baonian (Institute of Plasma Physics, Chinese Academy of Sciences); Prof. LI, Jiangang (Institute of Plasma Physics, Chinese Academy of Sciences)

Presenter: Prof. GONG, Xianzu (Insititute of Plasma Physics, Chinese Academy Sciences)

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