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Plasma Production and Preliminary Results from ADITYA Upgrade Tokamak

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Ohmically heated circular limiter tokamak, ADITYA (R_0 = 75 cm, a = 25 cm) has been upgraded into a tokamak named ADITYA Upgrade (Aditya-U) having divertor configuration [1]. The main goal of ADITYA-U is to carry out dedicated experiments relevant for bigger fusion machines including ITER, such as runaway generation and dynamics, disruption prediction and mitigation studies along with confinement improvement with shaped plasma. The ADITYA tokamak was completely dismantled and ADITYA-U assembly was completed in March-2016. Following the successful testing of magnet coils up to the design parameters during the integrated power testing, basic diagnostics along with the data acquisition systems were installed for the first phase of plasma operation. After installation of first wall components in new circular shaped vacuum vessel of ADITYA-U [2], plasma operations are resumed in the upgraded machine in a Graphite limiter (toroidal belt limiter) configuration with hydrogen plasma. The first discharge in ADITYA-U has been obtained on 1st December 2016. In recent first phase operation, repeatable plasma discharges of plasma current of ~ 80 kA – 95 kA with duration of 80 – 100 ms with toroidal magnetic field B_T (maximum) ~ 1T and chord average electron density 2.5 x 10^{19} m^{-3} has been obtained. Later, the discharge duration has been enhanced up to 180 ms with the application of negative converter power supply operation. The discharge in hydrogen gas is initiated using filament preionization and gas breakdown has been obtained in each of ~ 700 discharges (first phase) without a single failure in a fill-in pressure range of 0.8 – 2.0 x 10^{-4} Torr. The discharge failures in the current ramp-up phase mostly due to improper impurity burnouts have been overcome by extensive wall conditioning techniques such as glow discharge cleaning (GDC) in Hydrogen and in mixture of gases (Hydrogen-Argon, Hydrogen-Helium) along with intense short plasma pulses in ECR produced plasma background. The disruptions during the plasma current-flattop due to sudden growth of MHD modes are steered through by properly adjusting the ramp rate of plasma current. The generation of runaway electrons are controlled using high fill in pressure during the breakdown phase and by suitable external hydrogen gas puffing during the plasma current flat-top. Maximum line-averaged plasma density ~ 2.5 x 10^{19} m^{-3} and temperature (estimated) > 150 eV have been achieved in the discharges. Integration of subsystems like data acquisition and remote operation along with plasma production and preliminary plasma characterization of ADITYA-U plasmas will be presented in this paper.

References:

[1] Ghosh J. et al 2016 Upgradation of ADITYA tokamak with limiter configuration to ADITYA upgrade tokamak with divertor configuration 2016 IAEA Fusion Energy Conf. (Kyoto), 17-22 October, 2016 (FIP/P4–46) Nucl. Fusion submitted. Pre-print: https://nucleus.iaea.org/sites/fusionportal/Shared%20Documents/FEC%202016/fec2016-preprints/preprint0720.pdf

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