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Control of Magnetohydodynamic modes by periodic gas-puffing in ADITYA and ADITYA-Upgrade Tokamak

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Prediction and Control of growth of MHD modes more often than not leading to plasma disruptions in tokamaks is key to successful operation of ITER. There exists different mechanisms of controlling MHD modes in tokamaks with their own advantages and disadvantages such as resonant magnetic perturbation (RMP) etc. In this paper we report a novel mechanism for controlling the MHD modes using periodic gas puffs of appropriate magnitude and time-intervals. The experiments are carried out in ADITYA and ADITYA-Upgrade tokamak, which is an air-core, mid-sized (R = 75 cm, a = 25 cm) tokamak, equipped with two garlands of 16 Mirnov coils located at two different toroidal locations to study the Magnetohydodynamic (MHD) phenomena. A gas-puff of suitable amount is injected into the plasma current flat-top region of a typical ADITYA discharge having a saturated MHD mode of drift tearing nature. It is observed that the frequency of the pre-existing MHD mode decreases until ~2-3 ms after the gas-puff pulse and then attains its previous value (Figure 1(b)).

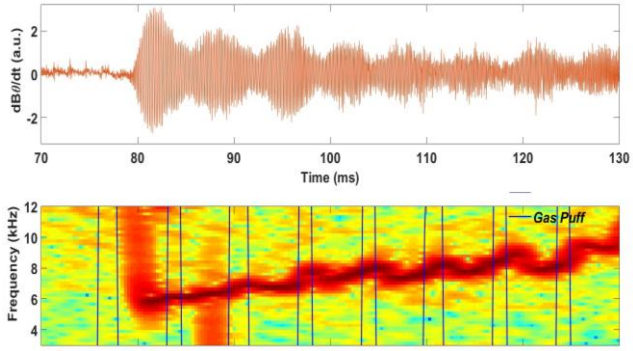

Figure 1: Plot showing time evolution of (a) MHD amplitude and (b) MHD mode frequency along with gaspuff.

This happens with every pulse of the periodic gas-puff chain and hence a modulation of the frequency of the MHD mode with the period of the gas-puff pulse is observed. Extensive simulation using BOUT++ (BOUndary Turbulence 3D 2-fluid tokamak edge simulation) code suggests that frequency reduction cab be due to gas-puffs induced pressure profile modification leading to change in mode rotation frequency (ω*). It has been also observed that the decrease in frequency of the observer MHD modes is proportional to the amount of gas puffed (Figure 2). The simulation results show similar decrease in mode frequency with increase in neutrals. Further, it has been observed that, although the gas-puff reduces the mode rotation frequency, the amplitude of the mode is reduced after each gas-puff (Figure 1(a)). Most interestingly and importantly, it has been observed that these periodic gas-puff leads to improved confinement of the Aditya discharges.

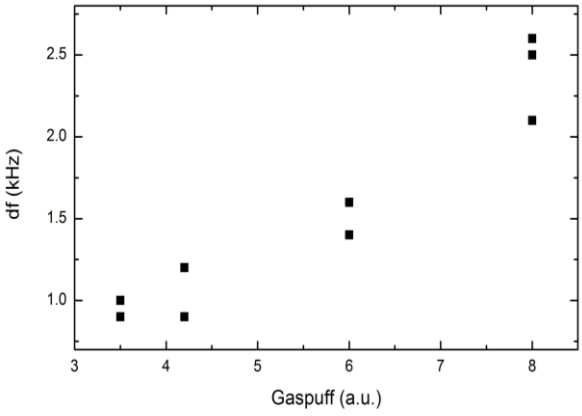

Figure 2: Plot showing magnitude of decrease in MHD mode frequency (in kHz) with respect to applied gas puff amount (in a.u.)

References:

1. R.L. Tanna et al “Overview of recent experimental results from the Aditya tokamak” Nucl. Fusion 57 102008 (2017)