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Effect of rotating magnetic helical field on the impurity radiation and the magnetic island in Iran Tokamak 1(IR-T1)

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Abstract

In this paper an attempt is made to explain the behavior of applied resonant magnetic helical field on the impurity radiation and width of magnetic island in Iran Tokamak 1(IR-T1). We report new results which indicate direct interaction between the rotating helical field and inherent m=2 resonant tearing modes.

Introduction

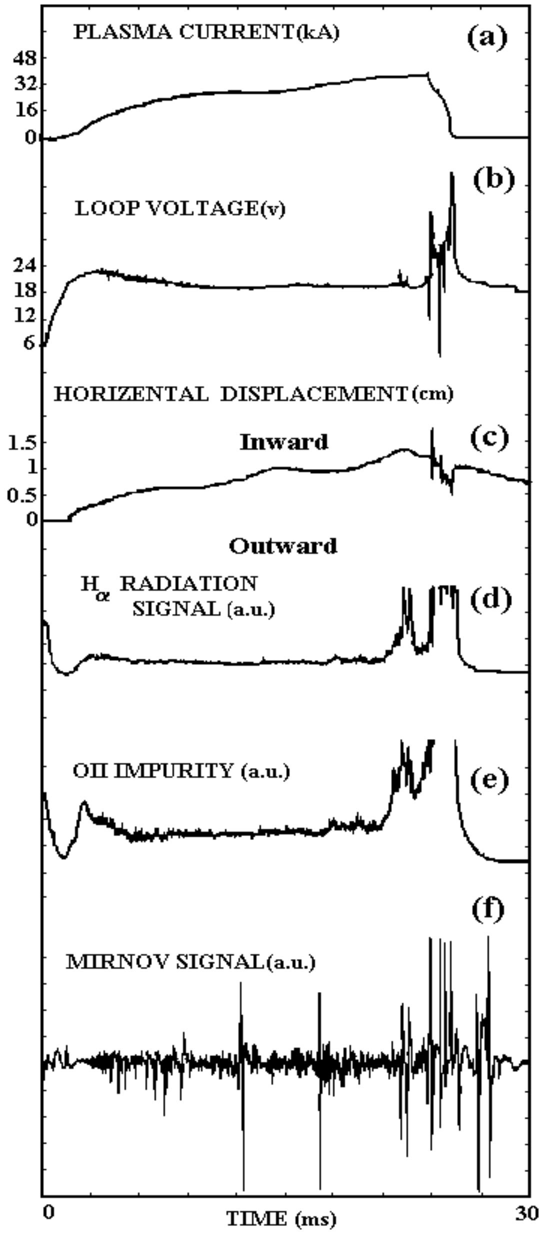
In tokamaks, both high density and low-q operation are limited by disruptions, which involve a sudden loss of confinement and plasma current. A large amount of energy is dumped on plasma facing components and large electromechanical forces are induced. It is generally accepted that density limit, low q and current rise disruptions are connected to the non-linear evolution of the resistive tearing modes with mode numbers m=2, n=1. An important problem in nuclear fusion research is the design of an active control method capable of preventing the growth of these MHD instabilities through the control of rotation a active feedback. Experiment demonstrated that applied oscillating resonant magnetic fields are capable of modulating the MHD mode rotation and control the growth with helical mode number m=2 to apply an externally controlling field rotating with the same frequency of the mode.[1,2]

Experimental set-up

IR-T1 tokamak was built to study MHD instabilities during the low-q discharges. It has a major radius 45cm and a minor rsdius 12.5cm and a circular cross section without a copper shell and divertor and using a material limiter of minor radius 11.5cm. The plasma current is usually less than 60kA. The q(a) in this machine is 2 to 7 (q(a) is the safety factor in the plasma edge). The machine usually runs with a pulse length less than 24ms. The toroidal field is about 7 kG. The line integrated plasma temperature is about 100eV. The plasma density is about $2\times10^{13}cm^{-3}$. IR-T1 tokamak is well equipped with various diagnostics, to measyre the plasma current, plasma position, loop voltage, magnetic fluctuations. Two helical winding with optimized geometry are wound around the vacuum chamber. The minor radus of these two windings is 22 (l=2) and 23(l=3) cm, respectively. In the experiments conducted here the current through the l=2 and l=3 helical windings was between 100-400A, which is very low compared with the plasma current itself (10-60kA). The magnitudes of the RHFs were normally about 0.5-0.01% of that the poloidal field around the resonant surface. The length and the magnitude of the pulse feeding the helical windings could be programmed. The profiles of visible line emissions from OII($\lambda = 4416^{\circ} A$,$2p^2 3s$-$2p^2 3p$); CIII($\lambda = 4644^{\circ} A$,2s3s-2s3p) impurities and H_{α}($\lambda = 6563^{\circ} A$,3-2)live have been determined using a visible spectrometer, in which there is a two lens image system in front of its entrance slit and a multichannel optical fiber attached to its exit slit. The detectors in this system are photomultipliers. The spectral visible line emission of the light impurity ions were investigated.[3]

Experimental results and discussion

In figure 1 we shows the evolution of plasma current (a), loop voltage (b), horizontal displacement (c), H_{α} radiation (d), OII impurity (e) and Mirnov signal (e) during the



disruptive instability. The approximately explosive growth of the precursor activity is presented about time 21ms correlated with increased H_α radiation that observed in fig.1.d and increase OII impurity radiation (fig.1.e). We observed that the radial component of the perturbation was amplified in the plasma when magnetic islands are formed, while the poloidal component was attenuated but, deep inside the plasma, amplified.

Figure 2 show the measurement results of visible line emissions of OII (a,b), CIII (c,d) impurities and H_α radiation (e,f) with and without RHF (l=2). Experimental results suggest that the addition of a relatively small amount of resonant magnetic helical field (l=2 & l=3) to the basic torus configuration could be effective for improving the quality of the discharge by reducing of light impurities radiation and suppressing major disruption.

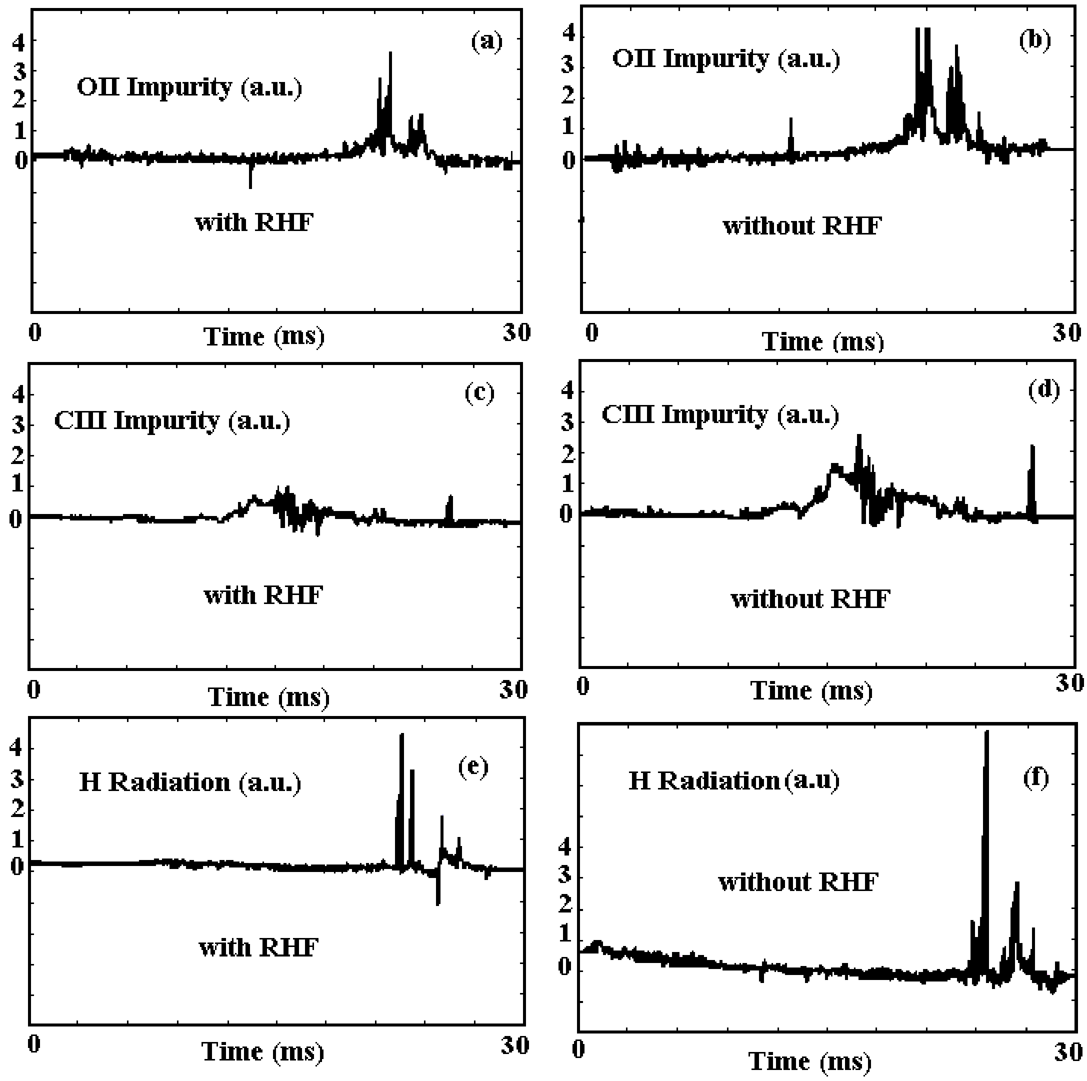


Figure 2

Conclusion

We observed that the addition of a relatively small amount of resonant magnetic helical field (l=2 & l=3) to the basic torus configuration could be effective for improving the quality of the discharge by reducing of light impurities radiation and suppressing major disruption.

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