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Novel Approaches for Mitigating Runaway Electrons and Plasma Disruptions in Tokamak ADITYA

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ADITYA tokamak is engaged in carrying out several dedicated experiments on runaway mitigation, disruption control etc. which are of utmost importance for the successful operation of large size tokamaks, such as ITER. Runaway electron generation and mitigation remains challenging topic in the present tokamak research, as these high-energetic electrons can cause severe damage to the vacuum vessel of any tokamak if left uncontrolled. An innovative mechanism has been developed in ADITYA tokamak to mitigate the runaway electrons before they can gain high energies. A localized vertical magnetic field perturbation is applied at one toroidal location to extract runaway electrons. During the start-up phase, ~260 G of perturbation field caused significant reduction in initial runaway electron energies. The applied local vertical field perturbation acts like an error field for the high energetic runaway electrons.

Disruptions: rapid events in which large fractions of the plasma thermal energy is lost, must be avoided for successful operation of a fusion reactor. Disruptions, induced by hydrogen gas puffing, are successfully mitigated by two innovative techniques in ADITYA tokamak. These experiments led to better understanding of the disruption control mechanisms and also can be thought of as one of options for disruption control in ITER. We have demonstrated that (1) a bias electrode placed inside the LCFS of ADITYA tokamak can mitigate disruptions and (2) applying an ICRH pulse with power ~ 50 to 70 kW can also mitigate the disruption successfully. In both the cases the physical mechanism seems to be the control of MHD modes with induced poloidal rotation of edge plasma due to the generated radial electric fields. Real time control of disruption with identifying proper precursors in both the mechanisms is successfully attempted. Analysing thoroughly the huge database of different types of spontaneous and deliberately-triggered disruptions from ADITYA tokamak, a significant contribution has been made to the international disruption database (ITPA). Apart from these several other experiments regarding low loop voltage start-up and current ramp-up have been carried out using ECRH and ICRH. The details of experimental results along with data analysis procedures and plausible mechanisms of different events will be presented in this paper.

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