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

EX/5-3

Disruptions Mitigation: Disruptions, must be avoided for successful operation of a fusion reactor.

- Disruptions, induced by hydrogen gas puffing, are successfully mitigated by two innovative techniques, (1) Bias Electrode technique and (2) Ion Cyclotron Resonance Heating (ICRH) techniques in ADITYA.
- The injection of hydrogen gas puff excites MHD modes that grow in amplitude and stop toroidal rotation and disrupt the plasma. By applying a positive bias voltage above threshold value of ~ 180 – 190 V to an electrode placed inside the last closed flux surface (LCFS) prior to the gas injection leads to substantial reduction of the growth of magnetic islands corresponding to m/n = 3/1, 2/1 MHD modes. Thus the sudden disruption of plasma current is avoided.
- Although a biased electrode cannot be put even in the very edge region of a reactor grade tokamak, Ion Cyclotron Resonance Heating (ICRH) pulse in a real time feedback mode has been demonstrated for avoiding disruptions in ADITYA tokamak. 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 by the ICRH antenna.

Runaway Mitigation: Runaway mitigation remains challenging topic in the present tokamak research, as these high-energetic electrons can cause severe damage to the vacuum vessel of tokamak if left uncontrolled.

- A localized vertical magnetic field (LVF) perturbation technique is implemented to extract runaway electrons from ADITYA tokamak plasma.
- During the start-up phase, ~260 G of perturbation field caused significant reduction in initial runaways.
- LVF pulse applied during ramp-up phase showed reduction in runaway plasma current leading to stable plasma operations, impurities reduction and discharge consistency improvement.

Contribution in ITPA Disruption Database: Analysing thoroughly many different types of spontaneous and deliberately-triggered disruptions from ADITYA tokamak, a database is generated and significant contribution has been made to the ITPA disruption database.