Effects of Trapped Energetic-Ion-Driven Resistive Interchange Modes on Deuterium Beam Injections and Background Plasmas of LHD


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Effects of Trapped Energetic-Ion-Driven Resistive Interchange Modes

- Energetic particles (EPs) trapped in the helical ripple.
- EICs should be affected by characteristics of PERP NBIs.
- EICs affect bulk plasmas as well.

Plasma experiments with deuterium PERP NBIs were done in this year. EIC was observed in hydrogen plasma experiments of LHD [1].

Energy ion driven Resistive interchange mode (EIC) in H-plasmas

In large helical device (LHD), there is the helical ripple of \( \phi > 10 \text{kV} \). The large electrostatic potential seems to change transports of edge regions then \( n_e \) and \( T_e \) seems to increase in edge region.

The drop rate by EIC is up to 60%. The drop rate is proportional to amplitudes of magnetic fluctuations induced by EICs.

The change of the neutral flux measured by NPA and the ion saturation current measured by Langmuir probes on divertor plates are observed with EICs.

The large electrostatic potential seems to cause transports of edge regions then \( n_e \) and \( T_e \) seems to increase in edge region.

Mode of occurrence of EICs with D-PERP NBIs

- EIC occurrence is observed with higher injection beam energy (40 kV→60 kV).
- The (nEP) loss is evaluated with same way with PERP NBIs.
- This values is the same order as the decrease of Wpdia \( \sim 30 \text{[kJ]} \).

Estimation of loss rate of EPs (nEP) loss

- There are 20 Langmuir probes (14 plates for Langmuir probes.) on each diverter plate.
- The (nEP) loss is evaluated with same way with PERP NBIs.
- This values is the same order as the decrease of Wpdia \( \sim 30 \text{[kJ]} \).

Grape potential is induced by EICs with relatively small amplitudes of magnetic fluctuations \( B_z \) \( \sim 10^{-3} \text{T} \). The spatial change of potential is observed in the edge region.

The change of an ion flux is the transport barrier of H ions. Then, the deposition of power from NBIs is changed. This can cause increase of \( \beta \).

MODES OF OCCURRENCE OF EICs WITH D-PERP NBIS

- Plasma experiments with deuterium PERP NBIs were done in this year.
- The helically trapped particles in deuterium are provided by PERP NBIs. EICs should be observed.

Waves of EICs of D-PERP NBIs

- Waves frequency and intense deuterium beam injection, O-16

Response of total neutron emission rate (Sn)

- Time series are plotted with \( \delta t = 40 \text{~ms} \). The growth of Sn peaks is observed in the edge region.

Continuous change of duration time of EICs

- The increases of Sn peaks are proportional to the amplitude of magnetic fluctuations induced by EICs.

Interesting phenomena observed with EICs

- The increase of ripple in line emission of impurity ions are observed with EICs.

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1. Energetic ion driven Resistive interchange mode (EIC) in H-plasmas

- A pair of divertor plates.
- EICs are only observed in the one side of equilibrium.

2. EIC with deuterium enhanced perpendicularly (PERP) NBIs

- Plasma experiments with deuterium PERP NBIs were done in this year.
- The helically trapped particles in deuterium are provided by PERP NBIs. EICs should be observed.

3. Mode of occurrence of EICs with D-PERP NBIs

- Large magnetic fluctuation is induced with higher injection beam energy (40 kV→60 kV).
- The (nEP) loss is evaluated with same way with PERP NBIs.
- This values is the same order as the decrease of Wpdia \( \sim 30 \text{[kJ]} \).

4. Effects of EICs on EPs with D-PERP NBIs

- The neutral flux, measured by CNPA up to 65 keV, increases with EICs after the injection beam energy, \( \text{D-PERP NBIs} \).

5. Effect of EICs on bulk plasmas with D-PERP NBIs

- The ion temperature in edge region as well as \( n_e \) is observed in the edge region.

6. Interesting phenomena observed with EICs

- The growth of Sn peaks is observed in the edge region.
- The increases of Sn peaks are proportional to the amplitude of magnetic fluctuations induced by EICs.