Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

PEM032-12 Room: Exibition hall 7 subroom 1 Time: May 24 16:47-17:00

MHD instabilities and their control in JT-60U

Akihiko Isayama[1*]

[1]Japan Atomic Energy Agency

Steady-state sustainment of a plasma with high beta value (the ratio of plasma pressure to magnetic pressure) is essential for a fusion reactor. It is known that a variety of magnetohydrodynamic (MHD) instabilities are prone to appear with increasing the beta value. Since the instabilities cause decrease in temperature and density, suppression of them is required. On the other hand, they can be used for controlling the beta value and impurity content of the plasma. Thus, establishing control schemes of MHD instabilities is an important research topic in tokamaks. One of the instabilities to be controlled is an neoclassical tearing mode (NTM), which appears in a high-beta plasma and degrades the plasma pressure through the formation of magnetic islands with the full width of about 10% of the plasma minor radius. To suppress the NTMs, highly localized current drive by electron cyclotron (EC) wave (electron cyclotron current drive, ECCD) at the island region with the deposition width comparable to or narrower than the island width is considered to be promising.

In the JT-60U tokamak (major radius: 3.3 m, minor radius: 1 m), research and development to control NTMs using EC waves (110 GHz, 5 s, 3 MW at maximum) have been progressed steadily. By scanning the ECCD location precisely, it was found that the effect of ECCD on NTM stabilization strongly depends on the ECCD location, and that the stabilization effect decreases significantly if the misalignment of the ECCD location from the mode location becomes larger than about half of the full width of the magnetic island, which corresponds to misalignment of about 5 cm in JT-60U. In addition, the NTM island was destabilized for misalignment comparable to the full island width. These behaviors were reproduced by simulation including the modified Rutherford equation, which describes the evolution of NTM islands. Furthermore, ECCD only in the island O-point was successfully performed by modulating the injection power of the EC wave at about 5 kHz in synchronization with the island rotation. It was found that the stabilization effect is more than twice stronger than that without power modulation. Destabilization of NTM for injection at the island X-point was also observed. The degree of the stabilization and destabilization effects was consistent with a model calculation on ECCD in the island region.

Keywords: instability, tearing mode, tokamak, plasma, nuclear fusion