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Advanced Tokamak Research with Integrated Modeling in JT-60U

NOBUHIKO HAYASHI, Japan Atomic Energy Agency, Fusion Research and Development Directorate

Researches on advanced tokamak (AT) characterized by high normalized beta, high bootstrap current fraction and high confinement have been progressed in JT-60U with integrated modeling. In AT, simultaneous achievement of high performances is important, because physical factors are strongly coupled with each other, resulting in complexity and autonomy. Edge pedestal has coupling physics of core plasma and SOL-divertor-wall characteristics. Its coupling is further enhanced by ELMs. The linkage among them has been systematically clarified in JT-60U experiments [1], in which a plasma rotation also affected the linkage. Although plasma performances may be controlled by the rotation, the rotation was varied not only by an external input but also by the intrinsic mechanism due to plasma itself. To predict and control these complex and autonomous plasmas and to achieve simultaneously high performances, new models are constructed and integrated based on JT-60U experimental analyses. In this paper, we report researches of JT-60U experiments with integrated models of core, pedestal, SOL-divertor-wall, which are important for AT and have coupling physics. It is found that a toroidal rotation with perpendicularly-injected NB is caused by fast ion orbit and driven most efficiently by horizontal injection. This indicates the possibility of producing and controlling an intrinsic rotation in AT. Steeping a pressure gradient in the core beyond the pedestal is found to enhance the ELM energy loss. The pressure gradient optimization is required for AT with high beta and low ELM energy loss. 2D SOL-divertor-wall integrated code is developed and further integrated with 1.5D core-pedestal transport code for understanding the whole coupling physics.

[1] N. Oyama and the JT-60U team., "Overview of JT-60U results toward establishment of advanced tokamak operation", Nucl. Fusion, in print (2009).