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Experimental study of MHD instability effect on MeV ion confinement in KSTAR

K. Ogawa[1,2], J. H. Kim[3], J. Jo[3], S. Sangaroon[4], L. Y. Liao[2], E. Takada[5], and M. Isobe[1,2,4]
e-mail (speaker): ogawa.kunihiro@nifs.ac.jp
[1]National Institute for Fusion Science, National Institutes of Natural Sciences, Toki, Japan
[2]The Graduate University for Advanced Studies, SOKENDAI, Toki, Japan
[3]Korea Institute of Fusion Energy, Daejeon, Republic of Korea
[4] Mahasarakham University, Maha Sarakham, Thailand
[5]National Institute of Technology, Toyama Collage, Toyama, Japan

One of the critical issues in realizing a fusion reactor is how we confine energetic particles, which are the main heating source of fusion burning plasma. In deuterium plasma experiments in KSTAR, deuterium-deuterium fusion reaction born 1 MeV tritons were utilized to study the MeV confinement ability by measuring triton burnup ratio defined by (secondary deuterium-tritium fusion neutrons)/(deuterium-deuterium fusion neutrons) using the neutron activation system. Although the numerical calculation based on an orbit following model predicts the MeV triton confinement becomes better as the increase of the plasma current I_p, experimentally obtained shot-integrated triton burnup shows the triton confinement ability degrades from I_p ~0.9 MA [1].

We have installed a scintillation fiber detector for time-resolved measurement of the MeV triton confinement ability [2]. The time evolution of the secondary deuterium-tritium neutron flux by the scintillation fiber detector shows that the deuterium-tritium neutron flux is lower in I_p of 0.9 MA case compared to I_p of 0.8 MA case. Comparison between time-resolved measurement of the triton burn-up ratio and numerical simulations suggests that magnetohydrodynamic instability is a candidate for degrading the triton confinement capability. We found that the triton burnup increases due to the application of off-axis electron cyclotron current drive (Fig. 1). The slightly increased safety factor in the plasma center induced by the off-axis electron cyclotron current drive could suppress the amplitude of the tearing mode. We will present the details of the effect on the magnetohydrodynamic instability on the MeV ion confinement in KSTAR.

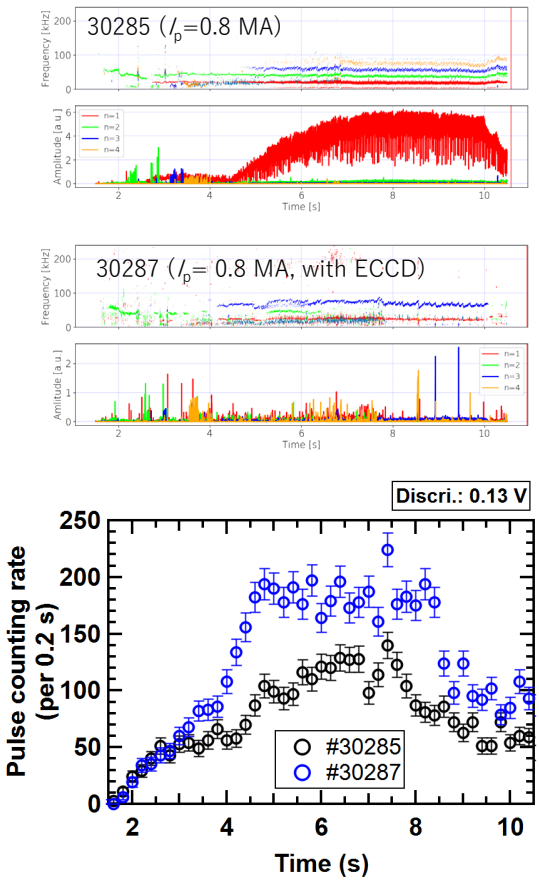

Fig. 1 (top) Magnetic fluctuation amplitude measured by magnetic probes. (bottom) Comparison of the time evolution of the secondary deuterium-tritium neutron flux measured by the scintillation fiber detector in #30285 (I_p of 0.8 MA, without

References

[1] J. Jo et al., Rev. Sci. Instrum. **87** 11D828 (2016).
[2] K. Ogawa et al., Rev. Sci. Instrum. **95** 073539 (2024).