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Evolution of locked mode under the existence of non-axisymmetric fields in KSTAR

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Since 2013 KSTAR campaign, we have investigated the effect of non-axisymmetric (NA) fields on the evolution of magneto-hydrodynamic (MHD) instabilities by using the error field (EF) correction coils. Locking and EF penetration were induced by the torque imbalance between the intrinsic rotation and external magnetic braking. Further increase of the n=1 EF resulted in minor and major disruptions. As anticipated by the magnetic braking effect, the stronger n=2 NA field case exhibited earlier EF penetration and locking. On the contrary to the locking phenomena, subsequent minor and major disruptions were delayed and even avoided by the stronger n=2 NA field. Analysis of the n=1 locked mode amplitude revealed that the n=2 NA field started to hinder the growth of n=1 locked mode when the mode amplitude reached certain level in Ohmic discharges. The starting level of the hindrance appears to rely on the n=2 NA field strength. More interestingly, the fast growth was recovered just before minor disruption. Nevertheless, the pure n=1 EF case without n=2 NA field did not show clear change of the growth rate after locking and just exhibited gradual increase of the locked mode towards the minor disruption. A kinematic model of tearing-kink interaction is in qualitative agreement with the experimental observations. In neutral beam (NB) heated L-mode discharges, the overall effect of n=2 NA field appears similar to that in the Ohmic discharges. However, the detailed evolution towards major disruption was somewhat different. With n=2 NA field, initial minor disruptions were much weaker than those in the reference discharge without n=2 NA field. To reach a comparable level of minor disruptions in the reference discharge, we needed stronger n=1 EF in the discharge of n=2 NA field. Electron cyclotron emission imaging (ECEI) showed different patterns of minor disruption depending on the existence of n=2 NA field. As in the Ohmic discharge, the resulting major disruption was delayed in the NB heated L-mode discharge as well. A series of experimental results in various discharge conditions show the possibility of using NA fields to control or delay the plasma disruption process.

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Author: Dr KIM, Jayhyun (National Fusion Research Institute)

Co-authors: Dr AYDEMIR, Ahmet (National Fusion Research Institute, Daejeon, Korea); Dr HAN, Hyunsun (Nuclear Fusion Research Institute, Korea); Mr LEE, Jeongwon (Seoul National University); Dr PARK, Jong-Kyu (Princeton Plasma Physics Laboratory); Dr BAK, Jun Gyo (National Fusion Research Institute); Mr CHOI, Minjun (Pohang University of Science and Technology); Dr KO, Won Ha (Korea, Republic of); Dr OH, Yeong-Kook (National Fusion Research Institute); Dr IN, Yongkyoon (National Fusion Research Institute)

Presenter: Dr KIM, Jayhyun (National Fusion Research Institute)

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