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UTST合体プラズマにおけるCCS法を用いたプラズマ位置形状同定および渦電流分布再構成

Plasma shape and eddy current profile reconstruction in UTST merging plasma using CCS method

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The merging start-up method is one of the center solenoid (CS)-less start-up schemes and has been demonstrated in START/MAST (UKAEA) [1], TS-3/TS-4 [2-3] and UTST (Univ. Tokyo) [4]. Further, recently, axial plasma merging has been attracting attention as fueling operations of spherical tokamak (ST) reactor. In this method, first, two initial STs are generated. Secondary, these STs are pushed towards midplane of the device. Finally, these STs merge to form a single ST with heating caused by magnetic reconnection.

In order to establish a reproducible and suitable merging process, the positions of the initial STs should be controlled actively. However, at this stage there is no technique to reconstruct plasma shape during merging. Plasma shape reconstruction technique is essential for controlling the merging start-up/ fueling operations in spherical tokamak (ST) experiments.

In this study, Cauchy condition surface (CCS) method [5-7] was applied to reconstruct the plasma surface (or LCFS) as well as the eddy current profile at three different phases of plasma merging ((a) Merging initial phase, (b) Merging phase, (c) After merging) in UTST device. Unlike conventional CCS method, quadratic boundary elements were employed to discretized complex vacuum vessel and CCS boundaries. Further, different CCS shapes were set in each phase during merging adequately.

Though the reconstruction needs further improvement in (a) Merging initial phase, both the profiles of magnetic flux and eddy current have been reconstructed with fairly good accuracy even if 3 percent white noise was added on the sensor signals.

In future magnetic sensors will be installed on the UTST device based on these analytical results to verify the possibility of real time control of merging ST experimentally.

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