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Internal Structure of MHD Fluctuations for Various Current Density Profiles during Current Rise Phase of Ohmic Discharge in VEST

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During the current rise phase of tokamak discharges, evolving current density profiles are associated with the MHD fluctuations that are often held responsible for the confinement degradation, or even disruption, early in the discharge. Moreover, VEST, (Versatile Experiment Spherical Torus) for the NBI heated advanced tokamak regime, adopts the fast current ramp up Ohmic discharge, where the study of the reversed shear q profile and the suppression of this "current rise"fluctuations is needed. Here, we present the internal structure of this fluctuations in accordance to the equilibrium current profiles during the current rise phase of VEST, using data from both the external and the internal magnetic diagnostics.

The internal magnetic probe array, upgraded from the previous model, have been used to both constrain the newly developed EFIT-like equilibrium reconstruction and measure the internal magnetic fluctuation. Because VEST hosts a relatively low temperature plasma, the plasma degradation by the introduction of the internal magnetic probe array into the plasma is less than 10%. The mode number is identified by the toroidal and poloidal Mirnov coil array signals analysed by the method based on singular value decomposition.

During a typical Ohmic discharge in VEST, shot #18452, the plasma current is ramped up very fast with dIp/dt<20 MA/s and a hollow current profile and a weak shear safety factor profile are formed. In the spectrogram of the outboard midplane Mirnov coil, the modes n=1 and n=2 are observed, spanning modes (2,1), (3,1) and (3,2).

As the rate of plasma current rise is slowed down to dIp/dt<10 MA/s, as in shot #18390, the skin current is diffused in to form a more broad current profile and a positive shear safety factor profile. Here, the mode (2,1) is suppressed and the mode onset is delayed. We conjecture that this change in the mode structure is related to the attainment of a maximum plasma current of 100 kA in shot #18390, a 25% increase from shot #18452, which is driven with the same loop voltage.

From the internal structure of the instability, it is found that the two peaks of the internal fluctuation amplitude |δBz| are localized around a relevant rational q surface in agreement with the mode structure measured by the external magnetic diagnostics.

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