

# Experimental study of core MHD events in thousand-second improved confinement plasma in EAST

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Recently, stationary plasma with a world-record pulse length of 1056 second was obtained, where a stable internal transport barrier (ITB) is present in electron temperature channel. The core magneto-hydrodynamics (MHD) events with  $m/n=1/1$  or  $m/n=3/2$ ,  $m$  is the poloidal mode number and  $n$  is the toroidal mode number, have been observed near e-ITB region. The time evolution of frequency and the 2-D structures of these modes are studied by combination of soft X-ray (SXR) imaging and electron cyclotron emission (ECE) diagnostics. The  $m/n=1/1$  mode exhibited with a feature of frequency chirping down in time with a chirping rate corresponding to the rate of electron diamagnetism drift frequency change. A twisted pattern is reconstructed by SXR tomography of  $m/n=1/1$ . The  $m/n=3/2$  has a smaller frequency comparison to  $m/n=1/1$ , and carries an  $m/n=3/2$  island with detectable size. The destabilization of core MHD modes are due to a combination effects of strong central heating by electron cyclotron resonance heating (ECRH) and lower hybrid current drive (LHCD). It is found the  $m/n=3/2$  mode is dominate before  $t < 23$  second, and  $m/n=1/1$  becomes dominate later. Transitions between  $m/n=3/2$  and  $m/n=1/1$  is found in the entire discharge after  $t=23$  second. Self-regulation system resulted from multiscale interaction between core MHD instabilities and electron temperature gradient induced turbulence is a contributing mechanism for sustaining the steady state long pulse high confinement regime. A negative current is generated in the magnetic axis with  $m/n=1/1$ , which anomalously broad the core current profile. The transition between  $m/n=1/1$  and  $m/n=3/2$  is due to the mode coupling due to forced magnetic reconnection induced by  $m/n=1/1$  mode. The interaction between MHD modes and fast electrons and the actively control of those modes are discussed.

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