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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 torodial 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, 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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