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Real-time control system of neoclassical tearing modes in the HL-2A tokamak

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The stability and performance of tokamak plasmas are routinely limited by various magneto-hydrodynamic (MHD) instabilities, such as neoclassical tearing modes (NTMs). This paper presents a rather simple method to control the NTMs in real time (RT) on a tokamak, including the control principle of feedback approach for RT suppression and stabilization for the NTMs. The control system combines Mirnov, electron cyclotron emission (ECE) and soft X-ray (SXR) diagnostics used for determining the NTM positions. A methodology for fast detection of 2/1 or 3/2 NTM positions with 129x129 grid reconstruction within 0.6 ms is elucidated. The forty poloidal angles for steering ECRH/ECCD launcher are used to establish the alignment of antenna mirrors with the center of the NTM and to ensure launcher emission intersecting with the rational surface of a magnetic island. Pilot experiments demonstrate the RT control capability to track the conventional tearing modes (CTMs) on HL-2A tokamak. The 2/1 CTMs have been suppressed or stabilized by the ECRH power deposited on site or with steerable launcher. The total time to scan fully poloidal cross section is ~200 ms with spatial resolution of ~0.5 cm. The magetic island is determined by an ECE diagnostic system of 60 channels with spatial resolution about 1 cm. So far, we are improving the NTM control system. The total time will be decreased to ~50 ms from ~200 ms, which is enough to control any NTMs. Further dedicated studies on reliability of the actual NTM control scheme and minimum power requirements will be demonstrated in the Spring's experimental campaign in 2018.

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