3rd Asia-Pacific Conference on Plasma Physics, 4-8,11.2019, Hefei, China

Achievements of active feedback control of divertor heat load in EAST Plasma Control System

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EAST has achieved a total power injection up to 0.3 GJ with ITER-like water-cooled tungsten (W) mono-block divertor. The high performance and long pulse operation will lead to more challengeable divertor heat load, which may damage the divertor target material. Based on the knowledge of divertor physics and plasma-wall interaction (PWI) research, a number of promising methods on divertor issue handling, including advanced snow-flake shape, radiation power elevation and divertor detachment operation have been demonstrated in EAST experiments. This paper will focus on the latter two means and introduce the achievements made from active divertor heat load feedback control in EAST plasma control system (PCS) [1].

In EAST, the AXUV photodiode diagnostic can be used for the absolute total radiated power measurement due to its wide photon response from 7 eV to 6 keV. A data pre-processing system, which was deployed for AXUV diagnostic data acquisition and radiated power calculation, is connected to PCS for exchanging plasma boundary information and pre-processing result in real-time. In addition, EAST has a number of impurity seeding systems, including gas puffing in the upper and lower divertor volumes, super molecular beam injection (SMBI) and pellet injection systems at the outer mid-plane, which can be commanded by PCS [2] and thus facilitate the heat load control. The active radiation feedback control algorithm works excellently since 2016 [3] with neon impurity seeding, the radiation fraction was increased to about 41% in the 2018 campaign (EAST#79968). The active divertor detachment feedback control was implemented successfully with divertor Langmuir probe measurements acquired by PCS in sampling rate 10kHz for evaluating the divertor particle flux or electron temperature. The feedback control algorithm, similar to that developed in JET [4], has the flexibility to control the main density or the particle flux roll-over to achieve partial detachment, which is a promising method for steady-state divertor heat flux control. The control algorithm based on the divertor particle flux worked effectively during the 2018 EAST experiments with either D_2 fueling through low field side using SMBI or impurity seeding from the divertor volume in H-mode plasmas, without significant degrade of the core-plasma performance, i.e., exhibiting good core-edge-divertor integration. Further efforts will be made to extend active feedback control towards long-pulse H-mode detachment maintenance in the near future. The active feedback control of divertor heat load on EAST will benefit the high power, steady state H-mode operation for ITER.

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