MF-O16

1st Asia-Pacific Conference on Plasma Physics, 18-23, 09.2017, Chengdu, China

Active feedback control of radiation for power exhaust in EAST long-pulse operations

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The active feedback control of radiation power, which is acknowledged as the most promising means for steady-state heat flux control, has been implemented in the EAST tokamak. The main aim of active radiative control is protecting divertor target plates from overheating [1]. When some minor impurity gas (neon, argon, etc.) is injected into vacuum, a series of radiation process exhaust heat flux effectively [2].

By using the supersonic molecular beam injection (SMBI) [3] located at the midplane as the feedback actuator to inject a sequence of short neon gas pulse, the radiation power of the boundary plasma can be controlled effectively in real time, and the gas puffing valves located at divertor target plates are combined with SMBI as the feedforward actuator to increase radiation power further. The radiation power is calculated by the data from AXUV [4], and the algorithm to do PID operation is inserted in the EAST Plasma Control System (PCS).

In the long-pulse steady-state discharges with tungsten divertor, a reliable control capability is achieved. Either in L-mode or in H-mode, the total radiation power can be maintained on the pre-set target value (figure 1(b)). The control error is acceptable and no control instability is found. Meanwhile, even if the radiation power of core plasma is increased, the store energy of plasma has no significant decline, which means the plasma performance do not degrade seriously. The temperature of divertor target plates are in a low level during the radiative control cycle (figure 1(a)), while the particle flux towards divertor target is also well controlled.

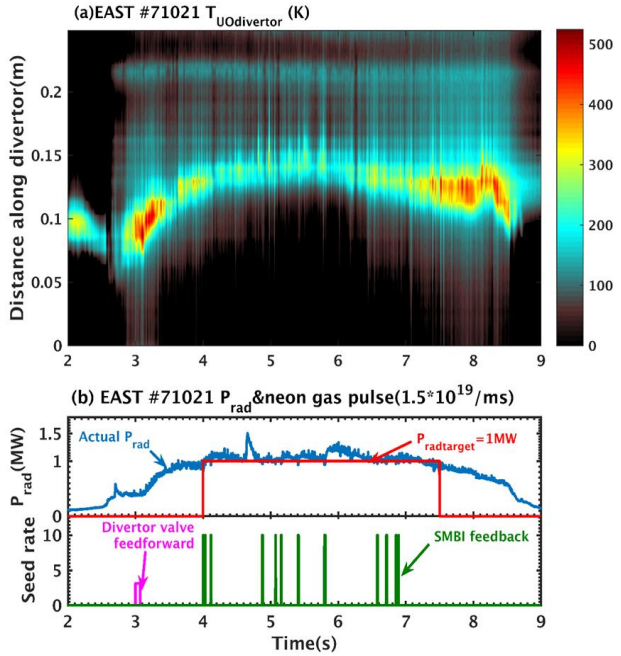

Figure 1. (a) The colormap of temperature of the upper outer divertor target plates against time for shot #71021. The y-axis of figure (b) represents the distance along the upper outer divertor target plate. (b) Results of radiative feedback control in EAST shot #71021.

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