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Upgrade of Multi-energy soft x-ray diagnostic and measurements of ELMs in the EAST tokamak

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The multi-energy soft x-ray (ME-SXR) diagnostic has been set up successfully for the EAST tokamak in 2015 year [1]. Though the neural network method [2] has been used to reconstruct the edge electron temperature profile, a theoretical method which can directly reflect the physical information is still required. To calculate the electron temperature through theoretical method, the ME-SXR has been calibrated to study the relative evolution of the edge electron temperature profile during the edge localized mode (ELM) events. The measured electronic bandwidth of the Maze MTi04 multi-channel variable gain transimpedance amplifier [3] in laboratory is well consistent with the nominal value. As the gain of the preamplifier increased from 10^5 to 2×10^7, the bandwidth decreased from 100 kHz to 10 kHz. The relative amplifier gains for different channels (5 arrays ×20 channels) are also calibrated out after the whole system is mounted at EAST device. The measured relative gain error in each array is less than 10 % to the reference channel of this array and is insensitive to the change of the preamplifier gain. Utilizing the pre-discharge signals, the multi-channel programmable gain of preamplifier is designed to be automatically controlled through feedback inter the discharges. The reconstructed edge electron temperature (T_e) profile is also uploaded automatically to the mdsplus server inter the discharges.

On benefit from the fast temporal resolution of Te (~5 kHz), the dynamic of edge electron temperature evolution during Type I and high frequency small amplitude ELMs (~ 1 kHz) is studied. The electron temperature is calculated by means of the ratio of different beryllium foils' emissivity, where the emissivity of each foil array is inverted from the brightness profile through the Abel inversion [4]. This theoretical method is accurate to study the relative T_e profile evolution in the fast time scale. Before the counter-NBI heating the plasma, the ELMs are periodically produced with ~90 Hz and its frequency increases with the heating power [5]. During the counter-NBI injection, the ELM regime converts to the small ELM regime when the plasma density exceeding 3.2×10^{19} m^{-3}. During this high frequency ELM regime, the plasma density, the stored energy and the plasma confinement are gradually increased. The ME-SXR measurements show that the edge Te profile collapses during Type I ELMs, while for small ELM regime the edge T_e profile just shows a very localized collapse of Te profile near the pedestal top. This indicates that the radial scale of the instability mode is ~2 cm for Type I ELMs while ~ sub-cm for small ELMs.

References

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