A study of deuterium-deuterium fusion-born triton burnup in various plasma currents at EAST tokamak

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In deuterium (D) plasma discharge experiments in magnetic confinement fusion devices, the 1 MeV triton created by the D-D reaction is considered to be test particles of deuterium-tritium (D-T)-born alphas since the kinetic parameters of the 1 MeV tritons are quite similar to those of the alphas. A relatively high secondary D-T neutron emission rate can indicate that the tritons slow down properly because the D-T reaction cross section has a peak of approximately 100 keV. The triton burnup ratio, that is, the secondary 14 MeV D-T neutron emission yield divided by the 2.5 MeV D-D neutron emission yield, which is almost the same as the 1 MeV triton yield, is used as the index of the triton confinement ability of fusion devices [1]. In the Experimental Advanced Superconducting Tokamak (EAST), the neutron activation system (NAS) was installed to evaluate the shot-integrated secondary D-T neutron yield since 2018 experimental campaign [2]. The initial measurements showed that the secondary D-T neutron yield was approximately 10^{11} n/shot. Recently, a newly developed scintillating-fiber (Sci-Fi) detector [3] characterized by high detection efficiency was installed in EAST to study the 1 MeV triton confinement and/or loss in various plasma currents. The D-D-born triton confinement and/or loss, as well as their energy and spatial distributions for the calculation of secondary D-T neutron emission, were obtained in the numerical simulations using the Lorentz orbit code (LORBIT) [4] with the energy slowing down process. The experimental triton burnup ratio of approximately 0.1% ranging from the plasma current of 400 kA to 600 kA in the EAST deuterium plasmas with neutral beam injection (NBI) heating was consistent with the analysis of the numerical simulations. This result in the EAST tokamak is comparable to that achieved in the similarly sized Korea Superconducting Tokamak Advanced Research (KSTAR) tokamak with similar plasma current condition.

References

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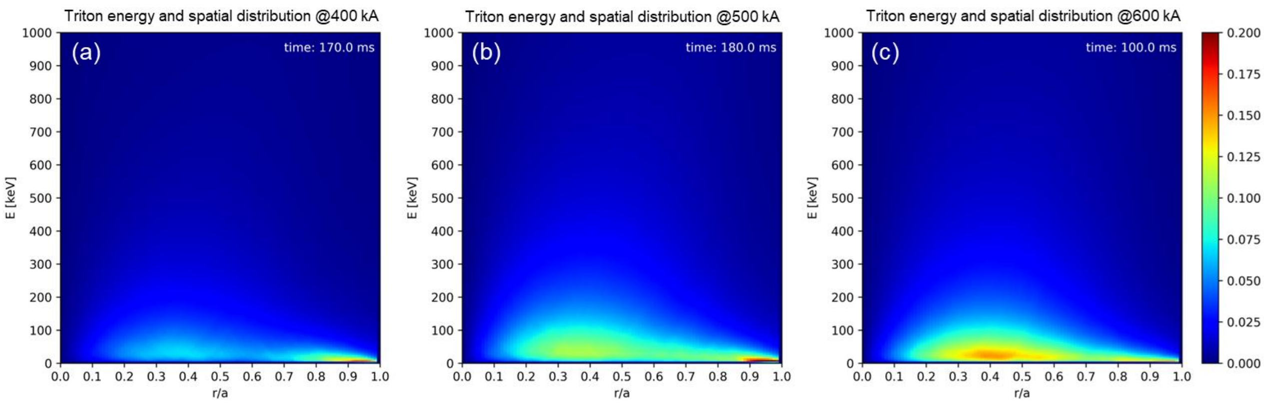

Figure 1. The triton energy and spatial saturation distributions during NBI heating in EAST deuterium plasmas in shots (a) #127628 with I_p = 400 kA, (b) #127630 with I_p = 500 kA, and (c) #127633 with I_p = 500 kA, respectively.