Study of fast-ion losses induced by sawteeth and disruption instabilities in the HL-2A tokamak

Zhang Y. P.,[1, a)] Liu Yi,[1] Isobe M.,[2] Yuan G. L.,[1] Chen W.,[1] Ding X. T.,[1] Song X. Y.,[1] Yang J. W.,[1] Li X.,[1] Yan L. W.,[1] Yang Q. W.,[1] Duan X. R.,[1] and HL-2A team

[1] Southwestern Institute of Physics, P.O. Box 432, Chengdu 610041, China
[2] National Institute for Fusion Science, 322-6 Oroshi-cho, Toki 509-5259, Japan

[a)] E-mial: zhangyp@swip.ac.cn, Tel: +86-28-82850359, Fax: +86-28-82850300

Since the good confinement property of fast ions is an essential requirement for realization of an ignited fusion reactor, the behavior of fast ions in magnetically confined fusion plasmas is one of the important research subjects in fusion study. For these reasons, a very active field of research has opened up during the last decade on energetic ion physics [1-3].

A new scintillator-based lost fast-ion probe (SLIP) has been developed in HL-2A to measure the loss of neutral beam ions [4]. The scintillation light produced by lost fast ions is measured with a high-speed video camera. The frame rate of the camera during this experiment is 1 kfps. Before the appearance of the sawtooth, this fast-ion loss image shows a single luminous spot consistent with loss at a single energy and pitch angle. This spot first appears when NBI source turn-on and it is interpreted as the prompt loss of beam ions. Compared to the spots due to the prompt loss, the spots induced by sawteeth has a broad range of energies and pitch angles. The energy of the sawtooth-induced lost fast-ions ranges from 25 keV to 35 keV, and the pitch angle ranges from 65° to 75°. There may be some interactions between MHD and fast ions, which causing the fast ion losses with the wide range of energy and pitch angle. During disruptions, the spots on the screen are significantly changed. Firstly, the brightness of the spots is largely enhanced, indicating that the losses of the NBI beam ions dramatically increase during the disruption. Secondly, the shape of the spots is changed tremendously and the area of the spots increases obviously during the disruption. The possible reason is that the transport of beam ions from the plasma core to the edge varies dramatically during the disruption because of strong magnetic perturbations and the change in the plasma current profile. The clear experimental evidence of enhanced loss of beam ions during a disruption has been achieved by the SLIP system.

References

[1] Fasoli A. et al. 2007 *Nucl. Fusion* **47** S264
[2] Heidbrink W.W. et al. 2009 *Phys. Rev. Lett.* **103** 175001
[3] Chen X. et al. 2013 *Phys. Rev. Lett.* **110** 065004
[4] Zhang Y. P. et al. 2014 *Rev. Sci. Instrum.* **85** 053502