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## **Measurements of Fast-Ion Losses Induced by MHD Instabilities Using Scintillator-Based Probe in the HL-2A Tokamak**

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Understanding and controlling the confinement of fast ion populations is increasing in importance as we approach self-ignited devices. MHD instabilities in magnetically confined plasmas can often be driven by a population of fast ions. In contrast, these instabilities can often lead to the anomalous loss of fast ions. Therefore, numerous efforts have been dedicated to studying the fast ion transport and the interplay of fast ions and MHD modes.

In 2013 HL-2A experimental campaign, the loss of neutral beam ions induced by MHD instabilities has been measured with a new scintillator-based lost fast-ion probe (SLIP). A single luminous spot appears on the scintillator plate when NBI source turn-on. The spot is consistent with loss at a single energy and pitch angle and it is interpreted as the prompt loss of beam ions. The position and size of this spot is steady during the whole NBI heating. Another luminous spot can be seen on the scintillator plate during TM. Moreover, the spot becomes brighter with the TM becomes stronger. Along with the disappearance of the TM, the spot dims and then vanishes. The position of the second spot in the scintillator plate is located in the region with lower energy and lower pitch angle, in contrast to the first spot. The energy and pitch angle of the lost fast ions induced by TM are 30 keV and 60°, respectively. The time evolution of the images of fast-ion losses due to long-lived mode (LLM) and sawtooth was also measured during a discharge. The energy and pitch angle of the lost fast ions induced by LLM are 25 keV and 67°, respectively. Compared to the spots due to TM and LLM, the spot induced by sawtooth 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°. The brightness of the luminous spot due to LLM is significantly weaker than the brightness of the spot due to sawtooth, which imply that the deteriorated effect of sawtooth on the confinement of fast ions is obviously stronger than the effect of LLM. There may be some interactions between MHD modes and fast ions, which causing the fast ion losses with the wide range of energy and pitch angle.

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