**Velocity-space analysis of the first fast-ion losses measured in MAST-U using a high-speed camera in the FILD detector**

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A Fast-Ion Loss Detector (FILD) was installed for the first time at MAST during its upgrade in 2021 [1]. FILD consists of a probe near the plasma edge on the low field side that acts as a magnetic spectrometer, collimating the ions and dispersing them onto a scintillator plate. The acquisition system comprises two cameras, one CMOS camera providing enough spatial resolution (up to 1.1 MPx), and one APD camera providing temporal resolution (up to 4 MHz) to infer both the velocity space and the frequency of the fast-ion losses, respectively. For the second MAST-U experimental campaign (2022), the CMOS camera has been upgraded (from 23 Hz to up to 3.5 kHz acquisition frequency), in order to properly capture the temporal variation in velocity-space. In addition, the reciprocating probe of the diagnostic has been commissioned.

The velocity-space of the losses observed in MAST-U has been inferred with the FILDSIM code [2]. The first results show that the low NBI injection energy, plasma current and toroidal magnetic field used in the first campaign have led to larger gyro-radii than expected during the design phase (16 cm versus the maximum design value of 12.5 cm) [1]. In addition, the orbit-following Monte-Carlo code ASCOT [3] has been used to simulate fast-ion losses in a wide range of scenarios, with Bt = [0.4, 0.6] T and Ip = [450, 750] kA to analyse the dependence of the fast-ion loss distribution with the plasma safety factor (q). This has shown that lower q values help bring the losses closer to the probe’s head. The NBI has been modelled in ASCOT5 to generate realistic particle inputs. The modelling of first orbit losses with ASCOT5 has enabled the benchmark of the experimental data measured by FILD, and the numerical simulations of the velocity-space are in good agreement with the experimental results. Furthermore, a scan of the probe’s radial position with respect to the separatrix (17 to 8 cm) has shown an inverse correlation between the number of particles hitting the detector and its proximity to the separatrix. This correlation agrees with the experimental measurements obtained in the second campaign.

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