9th Asia-Pacific Conference on Plasma Physics, 21-26 Sep, 2025 at Fukuoka

Interpretive modeling of Grassy ELM transport in the scrape-off layer and the influence on divertor tungsten erosion

Jingheng Zhao[1], Guoliang Xu[1], Rui Ding[1], Hui Wang[1], Linyi Meng[1], Qin Zhang[1] and Junling Chen[1]

[1] Institute of Plasma Physics, Chinese Academy of Sciences

e-mail (speaker):jinheng.zhao@ipp.ac.cn

A revised Free-Streaming Model (FSM), which includes the effect of overlap from previous ELMs, is developed to simulate the grassy ELM transport in the SOL of EAST. It has been verified that FSM[1] can be used to describe the type-I ELM transport in the SOL and capture the temporal particle and heat flux evolution on the divertor targets[2][3]. However, when the ELM frequency is sufficiently high that no inter-ELM phase can be distinguished in the consecutive ELMs, the parallel ELM transport will be inevitably affected by the tail of previous ELMs.

As indicated by the divertor Langmuir probe data, the grassy ELMs exhibit a relatively more rapid decay compared to typical type-I ELMs. The phenomenon has been successfully reproduces by the revised FSM for grassy ELMs with the frequency ranging from 500 Hz to 2200 Hz. The time-dependent 2-dimensional ELM distribution is derived by applying the model to different magnetic field lines outside the separatrix. It is found that during ELMs the magnetic connection length from OMP to divertor target is elongated compared to steady-state phase, and the elongation effect diminishes with the increase of ELM frequency. Compared to type-I ELMs, the shorter magnetic connection length and weaker initial perturbation of grassy ELMs lead to weaker perpendicular diffusion. Based on the ELM transport modeling, the intra-ELM W erosion along the divertor target is calculated. Consistent with previous type-I ELM results, the W erosion during grassy ELMs is mainly caused by the energetic C^{6+} originating from the pedestal region. With the increase of the ELM frequency, the total W erosion firstly decreases due to the notable reduction of ELM size, then increases when the ELM frequency becomes high enough that the inter-ELM phase disappears.

References

[1] D.Moulton et al, Plasma Physics. Control. Fusion. 55,085003(2013)

[2] C. Guillemaut et al, Nucl. Fusion. 58, 066006(2018)

[3] Guoliang Xu et al, Nucl. Fusion. 61, 086011(2021)

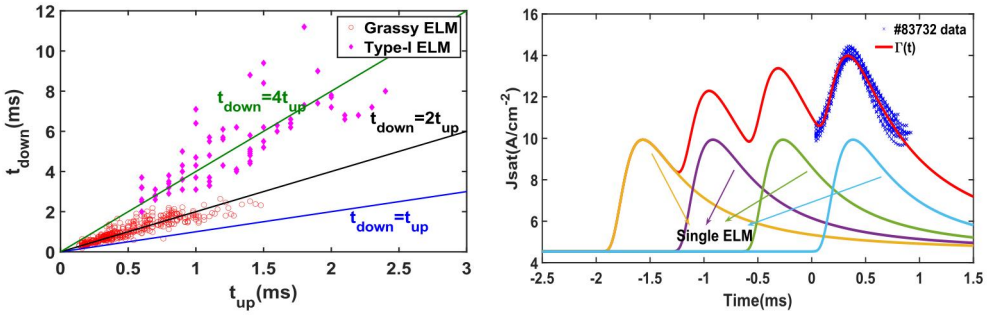

Figure1. Statistical characteristics of ELMs and overlap effects schematic diagram for one shot in EAST

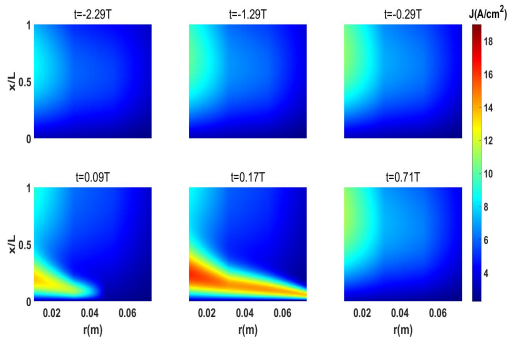

Figure 2. 2D flux density evolution in several periods

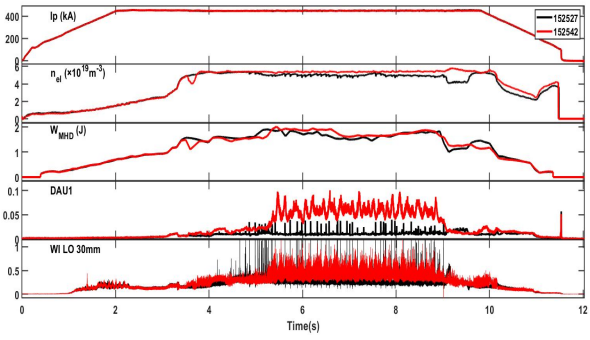

Figure3.W erosion comparison for different ELM types