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P4.042 Design of real-time feedback system for detachment control in COMPASS

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Mitigation of the intense heat flux to the divertor is a crucial issue for safety operation of ITER and next-step devices. The divertor heat fluxes can be significantly reduced by operating detached plasmas, where a huge amount of energy carried by plasma particles is converted into isotropic radiation. In COMPASS-U the power decay length is expected to be small due to high magnetic field, which induces high power fluxes in divertor, so the risk of reaching limits of the plasma-facing components is imminent. To ensure safe operation of the divertor, a real-time control system, which adjusts the degree of detachment by impurity seeding in the divertor region, should be implemented.

After performing a series of gas selection experiments nitrogen occurs to be the optimal impurity. The dependence of the target heat flux decrease on amount of seeded nitrogen was estimated. In COMPASS reaching partially detachment regime is confirmed by measurements of the new divertor probe array, so the new proposed RTFS will be using combined measurements of Langmuir and Ball-pen probes as input, which allows real-time calculation of impacting heat flux. The MARTe system was used to implement the RTFS based on measurement of heat flux at two distinct locations at the outer target. Results from previous campaigns were used for conscientious estimation of time constants, including the most significant part corresponding to impurity propagation from the seeding location. The most dramatic benefit for increasing RTFS working speed was obtained by decreasing length of the gas path, which was reached by relocating the piezo-valve closer to the vessel.

This work allows to prepare the system, which is a starting point for empirical studies of RTFS based on probe measurements in COMPASS. Design of the RTFS is made such that it could be modified later on in accordance with COMPASS-U needs.

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