Response function and Statistical approach for particle circulation on QUEST

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Particle circulation with pumping and fueling terms has been analyzed by the global particle balance equation with unknown wall-release Q_{rel}(t) and wall-retention Q_{ret}(t). In this study, first, we are aiming at measuring or inferring Q_{rel}(t) and Q_{ret}(t) by independent methods and understanding their behaviors in the long time scale. He partial pressure P_{He} is monitored for behavior of released particles Q_{rel}(t) from the wall in the hydrogen plasma discharges and plasma driven permeation probes (PDP) at multi-locations are used to deduce Q_{ret}(t). Secondly, in order to understand the particle circulation responding to transient perturbations, dynamical approach is developed. This approach aims at determining a system function of a "plasma+wall particle circulation system", especially to understand particle retention and release processes. One example of the response function for wall retention flux is shown in Fig.1. This indicates that retention increases just after H2 puff and then decays exponentially. Observed PDP signals are well reproduced by this response function, $t^3 exp(-t/\tau)$.

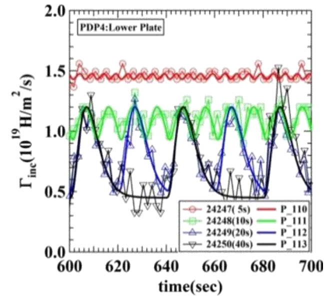

Fig.1 Incident H-fluxes at various puff intervals (5s to 40sec). Symbols are experimental data and solid curves are numerical ones.

Thirdly, in order to achieve a steady state plasma, the particle circulation must be kept constant. Statistical approach has been used to examine the time evolution of the recycling using response of H_α signal with respect to fuelling during the discharge. In QUEST the puff interval $\tau_{interval}=1/f_{gas}$ is fed back controlled to keep the recycling flux constant. Under the well-conditioned wall a transition from a high recycling state HR to a low recycling state LR was found on H_α signal, as shown in Fig. 2a. Since the fixed amount of H_2 is only injected, the external pumping system is fixed, and the P_{rf} is fixed, the variation in the decay curve corresponds to the change in the wall release and retention processes. The time dependent probability function $f(\tau_{interval}$,t) is derived from similar SSTO discharges for divided time windows (Fig. 2 b). It is noted that $f(\tau_{interval})$ evolves in time during the discharge, indicating that the retention and release process is governed by a time developing probability function.

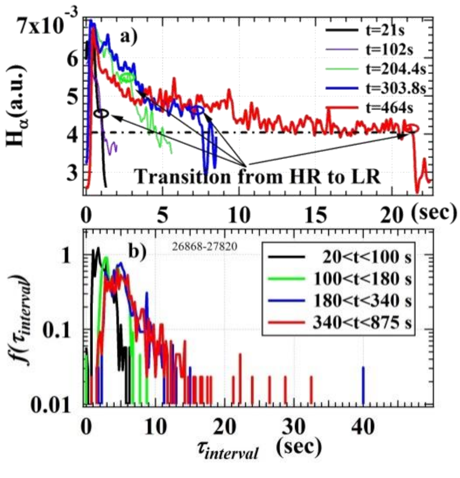

Fig.2 *(a) H_α transition at various time slices, (b) time dependent probability function of $\tau_{interval}$*