Category: 5) Application of resonant magnetic perturbations for ELM control and implications for ITER.
Oral Contribution

Particle Exhaust During RMP ELM Suppression on DIII-D with an Open and Closed Divertor*

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A common feature in many edge stochastic experiments is a reduction of plasma density ("pumpout"). Pumpout precedes the suppression of ELMs during the application of resonant magnetic perturbations (RMPs) in most DIII-D plasmas. The magnitude of the pumpout of electrons has a ~30% variation for discharges with similar applied RMP field strength and q_{95}. This large variation in pumpout magnitude motivated a more detailed study of plasma sources and sinks during RMP experiments on DIII-D. Recent analysis using a global particle balance and measurements of the D_α poloidal distribution shows that the wall inventory can be strongly affected by changing the average triangularity ($\langle\delta\rangle$) of the plasma (primarily due to changes in δ_{low}). Lower single null (LSN) discharges with similar plasma characteristics (e.g. n_e and electron collisionality) with different $\langle\delta\rangle$ were realized in DIII-D with a significant modification to the lower divertor baffling structure during a vessel upgrade in 2005. In particular, the analysis shows that at $\langle\delta\rangle \sim 0.3$ the integrated plasma efflux during the RMP is greater than the total number of particles removed by the cryopump system, indicating active wall pumping. Conversely, at $\langle\delta\rangle \sim 0.5$ in a scaled ITER-like shape, the plasma efflux during the RMP is balanced by the cryopump exhaust, i.e., no wall pumping is inferred. Additionally, the D_α intensity in the $\langle\delta\rangle \sim 0.5$ discharges increased by ~ 50-100% when compared to the $\langle\delta\rangle = 0.3$ discharges. The observations at $\langle\delta\rangle \sim 0.5$ imply an increase in the scrape-off layer neutral density. This overall result is significant, because it demonstrates density pumpout and ELM suppression without significant wall pumping, a feature that is essential in long-pulse reactors with saturated walls.

Three factors in the discharges at different $\langle\delta\rangle$ have been identified as possibly contributing to the observed difference in the particle balance and recycling characteristics: (1) the significant modification of the lower divertor baffling structure and subsequent change in pump-plenum-entrance vacuum-conductance during the 2005 upgrade; (2) a more closed divertor geometry with reduced leakage to the main chamber; and (3) the changes in the plasma triangularity itself. Lower divertor pumping speed and conductance measurements indicate that the baffle modification should not have a significant effect on the observed difference in wall pumping and recycling. DEGAS2 calculations are being used to quantify the change in divertor closure on the measured result. Finally, changes in the plasma $\langle\delta\rangle$ have been assessed with the ELITE stability code, which show a reduction in the region of stability as $\langle\delta\rangle$ increases, and the TRIP3D field line following code is being used to assess changes in the open field line connection length, L_c, to the graphite wall. In summary, we have found that varying the plasma shape from $\langle\delta\rangle \sim 0.3$ to an ITER-like shape of $\langle\delta\rangle \sim 0.5$ the increased plasma efflux due to the RMP is completely compensated by the cryopumps in DIII-D. It is suggested that this change in cryopump exhaust capability is due to changes in the divertor geometry, namely going from a more open configuration at $\langle\delta\rangle \sim 0.3$ to a more closed divertor configuration $\langle\delta\rangle \sim 0.5$ and/or to particle transport near the plasma edge.

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*This work supported in part by the U.S. Department of Energy Cooperative Agreement under DE-FC02-04ER54698 and in part by DE-AC05-76OR00033, DE-AC05-00OR22725, DE-AC52-07NA27344 and DE-FG02-07ER54917.