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Modeling of Wall Pumping Effects on the Global Particle Balance

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It is widely recognized that particle balance in magnetic fusion devices is a critical issue, affecting the overall machine performance, fuel economy and even environmental safety. This is particularly true with future steady-state fusion devices. For short-pulsed experiments in currently operating devices, core plasma density control is often done with the help of wall pumping effects. By nature, however, wall pumping is saturable. Cryo-pumps are often employed to obtain a large pumping speed. Unfortunately, cryo-pumping has also a finite capacity, leading to the necessity of developing new concepts of non-saturable wall [1].

To provide a technical guidance on the new concept development for plasma-facing components (PFCs), in the present work zero-dimensional particle balance modeling has been performed under conditions, relevant to those employed in LHD and also ITER, assuming 4 reservoirs; (1) core plasma; (2) SOL; (3) gas phase; and (4) wall. The particle confinement times are defined respectively for the core plasma and SOL regions. Along with ordinary vacuum pumping, wall pumping due to co-deposition and inward diffusion can be assumed in this model, as shown in the case study shown below. Effects of wall pumping on the overall particle balance will be discussed in detail. The modeling result from a case study on the density decay observed in LHD in the second campaign, when PFCs were made of stainless steel, is shown in Fig. 1.

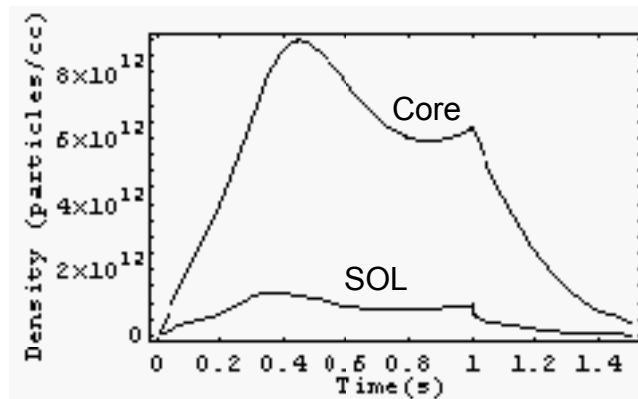


Fig. 1 Density decay in the core and SOL in LHD.