§41. SHC Operation for τ_E Improvement in LHD

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A new boundary control scheme (SHC boundary) could allow simultaneous achievement of the H-mode type confinement improvement and radiative cooling with wide heat flux distribution in the LHD. In the LHD configuration, there is a vague or " ergodic " boundary with radial width of at least greater than 5 cm where a few hundred eV electron plasma can not be contained and hence the H-mode pedestal can not exist. With an island layer with n / m = 1/1, which shortcircuits the vague boundary, a plasma confining region is sharply separated from an open "ergodic" boundary. The degree of openness in the ergodic boundary is high enough to make the plasma pressure approximately constant along the field line, which in turn separates low density plasma just outside the plasma confining region (the key external condition for achieving a good H-mode discharge) from very high density, cold radiative plasma near the wall (required for effective edge radiative cooling). An example of such proposed SHC boundary for LHD is shown in Fig.1. This could be equivalent to the poloidal divertor with long divertor legs in terms of function (Fig.2)

Success of the proposed concept depends on the true H-mode requirements. Recent tokamak experiments strongly suggest that low density at the SOL surrounding the main plasma region or possibly small density scale length (L_n = (1/n)(dn/dr)) just inside the LCFS is the key H-mode condition, which can be imposed externally. The importance of small L_n is also supported by widely accepted theoretical model for the H mode mechanism, based on the shear of the radial electric field . Experimentally the Er (negative during H-phase) is mainly from the gradient of P term in the radial momentum balance of ions. Thus dEr/dr is given as ~ $-(1 / eBn^2)(dn/dr)(dP/dr)$ where d^2P/dr^2 is assumed to be small. Small L_n or low n makes dEr/dr high and hence possibly suppresses the plasma turbulence responsible for the L-mode edge transport.

In the LHD configuration with the n/m=1/1 island, the LCFS can also be clearly defined within ~ 2 mm and the connection length just outside of the LCFS is ~ 200 m (~ 8 2π R), an ideal SHC boundary configuration. In addition, an n/m =1/1 island itself may be beneficial for the τ_E enhancement since " H-mode" so far has been achieved only when ι at the LCFS is very close to 1.0 or 0.5 (the major rational surfaces) in stellarator devices, W7AS and CHS (two quite different devices in terms of magnetic geometry). Thus the LHD configuration with n/m=1/1 island will probably achieve an H-mode and radiative cooling simultaneously.

A set of the perturbation coils has been installed in the LHD device for generating an island layer with n/m =1/1 and thus SHC boundary experiment will be carried out in the early phase of the LHD experiment. It will be the first active attempt of the tE improvement in the LHD experiment. Recycling needs to be localized in the open region to minimize the density at the LCFS. This may require some kind of baffle.

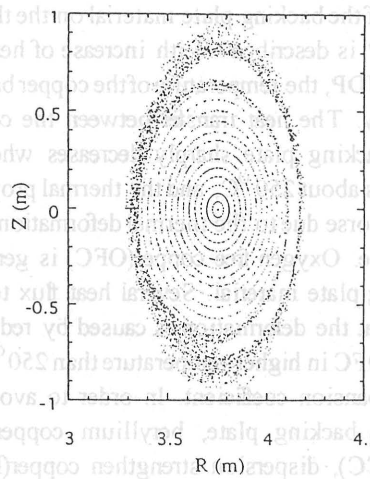

Fig. 1 SHC boundary in LHD

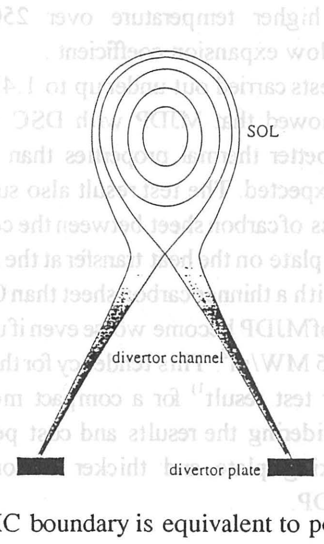

Fig. 2 SHC boundary is equivalent to poloidal divertor