§2. Super Dense Core Plasma (location of IDB)

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During a sequence of many LID discharges, the wall conditioning take place and thus the wall pumping capability is enhanced. SDC plasmas with somewhat lower temperatures can then be obtained even without the LID. For longer pulse operation in the SDC mode, however, active pumping by the divertor is essential. Figure 2-a (the previous page SDC-I) shows that with continuous pellet injection at intervals of ~160 ms and $\Delta N = 1\times10^{21}$ particles, we have successfully maintained a quasi-steady-state SDC operation for nearly 0.6 s. In Fig. 2-b, the density profiles just before and after pellet injection (t = 1600 ms, 1620 ms) are depicted. The pellet particles are fueled in the region where ∇n is high, not in the central region (3.65 m < R < 4.05 m). Somehow the temperature and plasma pressure (product of the density and temperature) drops by 20 % in the central region. As indicated by the diamagnetic signal (W_p), the change in pressure is small, except the central region. Perturbations by the pellets on the temperature and density profiles can be reduced by optimizing the pellet size for particular discharge conditions.

SDC plasma performance depends on the configuration (R_{ax}). This is partly because of geometry effects. The NBI tangency radius is 3.70 m; thus, the power deposited in the core (ρ < 0.5) for R_{ax} = 3.65 m is substantially lower than that for R_{ax} = 3.75 m. Pellet fuelling is more effective for larger R_{ax} because the pellets are injected from the outside and therefore a higher fraction of the pellet particles is deposited in a larger outward shifted core than in a smaller inward shifted core region.

The minor radial extent of the SDC is determined by the IDB foot (jump in ∇n) location (R_{foot}), and increases with R_{ax} and β. The rotational transform profiles for finite $<\beta>$ = 0.66 % and 1.2 % equilibria are plotted as a function of R (ρ) for the configuration with R_{ax} = 3.75 m [Fig.1-a (b)] to show a large Shafranov shift of the configuration. There exist two distinct regions, separated by the R_{sp} radius, which is defined as illustrated in Fig.1-c (with enough negative shear in the inner region, it is nearly the same as the zero shear radius (R_{zs})). Inside this radius (R_{sp}), the rotational transform profile has modest negative shear, or nearly zero for low beta cases. In the outer region (outside this location), the shear is large positive. R_{sp} is qualitatively insensitive to the shape of pressure profile, p(r), for fixed average beta. Figure 1-d shows R_{sp} (calculated for the pressure profiles similar to the observed ones) and R_{foot} as a function of the average beta for three different configurations (R_{ax} = 3.65m, 3.75m, 3.85m). The IDB foot point falls close to R_{sp} in the rotational transform. The difference between R_{sp} and R_{foot} is found to be less than ~ 0.1 m.

The "standard" configuration (R_{ax} = 3.75 m) with $\beta(0)$ = 4.4 %, and the IDB foot at ρ = 0.55 yields an SDC with optimum performance. For the outward shifted configuration (R_{ax} = 3.85 m), the SDC grows with increasing β and the IDB foot is close to the last closed surface at β = 1.38 %. For the inward shifted case (R_{ax} = 3.65m), the SDC is smaller, with the IDB foot at ρ = 0.45 and $<\beta>$ = 0.5%. The "super dense" effect is weaker in the present experiments so far.

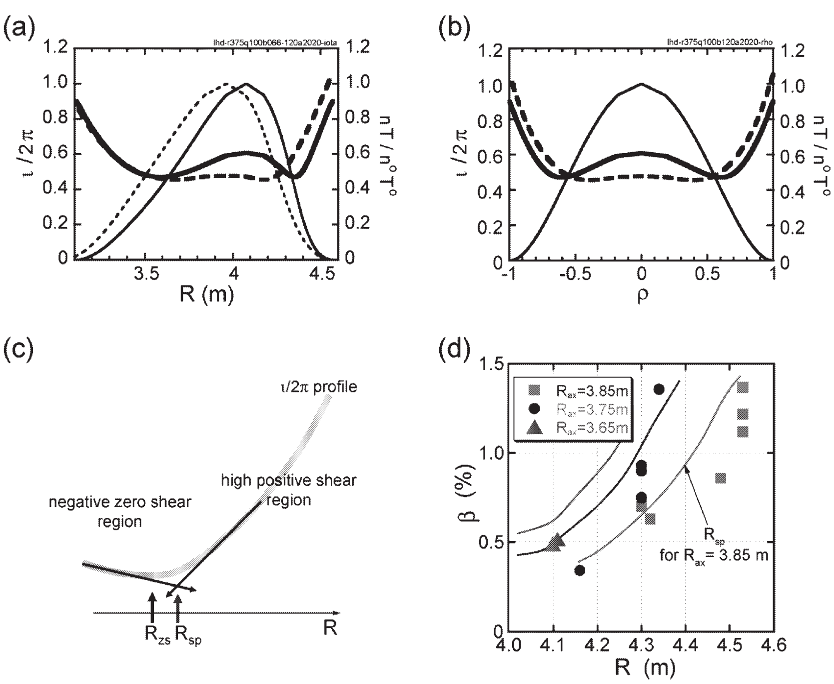

Figure 1. (a) Calculated rotational transform profiles with average βs of 0.66 % (the dotted lines) and 1.20 % (the solid lines) . Pressure profile shape is $(1-\rho^2)^2$ for both cases. Pressure and $\iota/2\pi$ are plotted in terms of R. (b) Pressure and $\iota/2\pi$ are plotted in terms of ρ. (c) Definition of R_{sp}. (d) With increasing β and R_{ax}, the foot location of the IDB (R_{foot}) increases. The red, blue and green curves are R_{sp} for R_{ax} = 3.85, 3.75, 3.65 m, respectively.