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EX/P2-14: Non-inductive Current Start-up and Plasma Equilibrium with an Inboard Poloidal Field Null by Means of Electron Cyclotron Waves in QUEST

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ECW Start-up scenarios in QUEST: Non-inductive current start-up using ECW (f=8.2 GHz, P_{rf}\ll 140 kW, O-mode, N_\parallel 0<0.4) has been investigated from a view point of multiple ECR interaction, large up-shift and auto resonance condition (N_\parallel~1) in QUEST. Due to large up-shift of N_\parallel at R_{1ce}, ECCD with mildly relativistic electrons moving in the wave momentum direction can be expected. The start-up rate dI_p/dt of 0.3-0.5 MA/sec was achieved within 0.2 s after rf injection. During this phase rapid build up of the energy spectrum of mildly relativistic electrons is observed. This fact strongly supports the ECR current drive scenario based on the relativistic resonace interaction.
Equilibrium with an inboard poloidal field null:
MHD equilibrium state with an inboard poloidal field null is characterized by high beta-p. Parameters are a=0.27 m, R0=0.79 m, \delta/a=0.4 and epsilon*beta-p=1.5, respectively. Here delta denotes the Shafranov shift. The Rs locates at ~ 0.5 m. During the flattop phase, Ip reached to 25 kA with a positive dependence of Bz and could be sustaiend for ~ 10 s. Loop voltage was less than 10 mV ,the line density 0.5E18 m^3 (< the cutoff density) and Te was measured < 100 eV by Thomson scattering. The value of Shafranov lamnda was kept ~5. Using observed HX temperature of ~ 50 keV and assumed density of the energetic electrons of ~ 10 % of density beta-p (=phot/poloidal mag. pressure) due to energetic electrons is consistent with that in MHD equilibrium.
Relaxation oscillations of this equilibrium: High beta-p equilibrium oscillates at the frequency of ~ 20 Hz under some conditions for 10 −20 kA. The slow rise and sharp drop in Ip are correlated to changes in density, Rs, shift and the HX energy spectrum emitted from the current carrying electrons. The out-of-phase relation in two energy windows(20-100 keV and 200-400 keV) of HXs suggests that electrons are preferably accelerated against the induced return electric field (~20 mV/m) during the Ip rise. Thus, confinement of the energetic electrons affects the stability of this equilibrium.

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