§47. Non-inductive Current Drive and Particle Recycling Study in Steady State Divertor Configuration in QUEST

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Summary of achievements[1-29]

In 2012 experiments for rf driven non-inductive plasma production and sustainment have been successfully demonstrated in various magnetic configurations including the standard single null divertor (SN). In the inboard limiter configuration, current start-up has been dominated by stagnated electrons at the optimized B_z/B_t ~ a few %. Typical parameters are: Ip =10 kA for 0.7 s for P_{rf}= 30 kW and B_t=0.13T, B_z=30 G; R=0.58m a=0.36m, and A=1.6. The duration of the limiter plasma could be extended to ~ 300 sec at 60 kW and Ip ~10 kA. The divertor configuration was achieved by applying the additional divertor fields and typical parameters of the divertor plasma are: Ip =15 kA, Prf~ 100 kW, Bt=0.11T, R=0.76m, a = 0.38 m, A=2, κ=1.65. SN and DN configurations could be controlled by adjusting the horizontal B_h field without changing PF coils. The duration of divertor plasma could be extended ~ 40 sec at Prf ~ 60 kW. A new current start-up scenario based on the toroidal precession of the energetic trapped electrons has been demonstrated at higher B_z/B_t >10 % and strongly curved B_z field. This has been achieved by only using divertor coils. Typical parameters are: Ip =10 kA, Prf ~ 100 kW a = 0.27 m, R0 = 0.79 m, Δ/a = 0.4, $\varepsilon\beta_p$ =1.5 and κ<1. The maximum Ip of 35 kA and maximum duration of 180 sec are achieved in this configuration. In order to demonstration the steady state spherical tokamak operation feedback control of recycling particles has been tested. The total pressure and partial pressures of H_2 and H_e, including the recycling and release from the walls could be kept constant for 300 sec, after that the Ha slightly increased and the plasma has been terminated. Gas balance including the wall pumping effects indicates that the dominant process is the wall pumping during the discharge, however, the gas fueling is reducing in the pulse and finally it is very less. Thus particle balance is dominated by the particle recycling. In the next campaign the number of the cryogenic pump is increased from two to three, more effective pumping will be expected.

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