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Impact of High Field & High Confinement on L-mode-Edge Negative Triangularity Tokamak (NTT) Reactor

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"NTT"is a unique reactor concept based on "power-handling-first"philosophy by locating long-leg (~2.7m) divertor at outboard side with negative triangularity δ<0 and making flux tube expansion to maximize heat exhaust surfaces (grazing angle ~2°).

Our previous design (Ip=21MA, A=Rp/ap=3, Rp=9m, HH=1.12, Bt=5.86T) uses standard magnet design based on the wedge support and maximum field is limited to 13.6T due to stress limit 800MPa and large reactor size. It allows adoption of currently available Nb3Sn superconductor at 4.5K as well as Bi2122/Pb high Tc superconductor at 20K. NTT configuration has technical merits of having space in the inboard except narrowest point to place the blanket piping and auxiliary systems such as pellet injector line and ECH waveguides. Outward placing of the divertor is favorable for pumping conductance.

Parameter studies on impact of high Bt and HH for A=3, 3.5 are shown where HHIpA=69.3MA, n/nGW=0.85 and qcy=3.5 are fixed. The reduction of major radius to Rp=7m is possible with improved confinement (HH=1.5) while Bmax is nearly constant. In this case, fusion power is reduced to Pf=2GW and the neutron wall load stays almost constant qn~1.4-1.5MW/m2 while the normalized beta βN becomes higher βN=2.9. For fixed HH=1.2, higher Bmax=16T enables to reduce major radius to Rp=7m. In this case, fusion power Pf and neutron wall load qn increases while βN stays almost constant. For A=3.5, we observe similar trend. The plasma volume is smaller (Vp~1000m3) compared with A=3 case (Vp~1500m3). But requirement for Bmax for fixed HH=1.2 becomes rather high Bmax=19.5T. With improved confinement (HH=1.5), reduction of major radius to Rp=7m is possible leading to Ip=13.3MA, Bt=7.53T, n=0.9 x 1020 m-3, Pf=1.9GW, Bmax=15.5T, PCD=115MW (\eta CD=0.5 x 1020 A/m2W is assumed). We made configuration design for this case and the equilibrium calculation. Extended wedge support allows σmax within 800MPa at 4.5K. It is concluded that both high magnetic field and high confinement are important for the realization of reasonably compact NTT fusion reactor as future R&D.

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