Features of the high field ultra-low aspect ratio tokamak

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The basic features of the medium-size high field ultra-low aspect ratio tokamak (HF-ULART) has been recently proposed[1]. The major objective is to explore very high beta under the minimum toroidal field as a target plasma, and then explore higher pressure values using the combined minor and major radius adiabatic compression (AC) technique. This might be one of potential pathways scenario for an ultra-compact pulsed neutron source based on the spherical tokamak(ST) concept. The major characteristics of typical target plasma are: R_o=0.51m, a=0.47m, aspect ratio A=1.1, k=2, $\delta\approx0.8$, B(R_o)=0.1T (0.4T max.), I_p=0.5MA (2MA, max.), $n_e(0)$~$1x10^{20}m^{-3}$, $T_e(0)$~1keV, and discharge duration τ_d~100ms. The vessel is spherical, made of SS, and insulated from the natural diverted (ND) plasma by thin (few centimetres) tungsten (W) semi-spherical limiters. The central stack is made of cooper cover by a thin (~2mm) W sleeve. No internal PF coils or solenoid is envisaged. This helps the compactness due to the close plasma-vessel fitting, capitalizing of wall stabilization as previously envisaged in the RULART proposal[2], while also potentializes easier H-mode (small edge neutral source volume), which has already been observed in Pegasus ohmic H-mode ND plasmas, using inboard gas fuelling[3]. The major source of initial heating is provided by I_p generated from RF (e.g. EC and EBW) in combination with transient Coaxial/Local Helicity Injection (CHI/LHI) techniques, as both have been successfully demonstrated in STs. By applying the AC technique over a very high beta plasma, that is, I_p=0.5MA, B(R_o)=0.1T, R_o=0.51m, a=0.47m, A=1.1, k=2, $\delta\approx0.8$, q_Ψ(Peng)=22, T_e/T_i =263/486eV (scaled from ref.4), $n_e(0)$~$0.15x10^{20}m^{-3}$[4], the following final values can be reached for short period (~ms): I_p=1.0MA, B(R_o)=0.61T, R_o=0.33m, a=0.28m, A=1.2, k=1.6, $\delta\approx0.1$, q_Ψ(Peng)=12, T_e/T_i=1.9/3.4keV, $n_e(0)$~$2.8x10^{20}m^{-3}$. Preliminary neutron yield and MHD stability calculations and some fixed and free-boundary equilibrium simulations by VMEC[5] and FIESTA codes, respectively, will be also presented.

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