Features of the high field ultra-low aspect ratio tokamak

C. Ribeiro

1 Laboratório de Física de Plasmas e Fusão, Instituto de Matemática, Estatística e Física, Universidade Federal do Rio Grande, Rio Grande do Sul, Brazil

celso_ribeiro@hotmail.com

The basic features of the medium-size high field ultra-low aspect ratio tokamak (HF-ULART) have 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: \( R_o=0.51 \text{m}, a=0.47 \text{m}, \) aspect ratio \( A=1.1, k=2, \delta \approx 0.8, B(R_o)=0.1T \) (0.4T max.), \( I_p=0.5 \text{MA} \) (2MA, max.), \( n_e(0)\approx 1\times10^{20} \text{m}^{-3}, T_e(0)\approx 1\text{keV}, \) and discharge duration \( \tau_d\approx 100 \text{ms}. \)

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, \( I_p=0.5 \text{MA}, \) \( B(R_o)=0.1T, \) \( R_o=0.51 \text{m}, a=0.47 \text{m}, A=1.1, k=2, \delta \approx 0.8, q_T(Peng)=22, T_e/T_i =263/486 \text{eV} \) (scaled from ref.4), \( n_e(0)\approx 0.15\times10^{20} \text{m}^{-3}[4], \) the following final values can be reached for short period (~ms): \( I_p=1.0 \text{MA}, B(R_o)=0.61T, R_o=0.33 \text{m}, a=0.28 \text{m}, A=1.2, k=1.6, \delta \approx 0.1, q_T(Peng)=12, T_e/T_i =1.9/3.4 \text{keV}, n_e(0)\approx 2.8\times10^{20} \text{m}^{-3}. \) 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.