Contribution ID: **487**   Type: **Poster**

PHYSICS OF THE HIGH FIELD ULTRA LOW ASPECT RATIO TOKAMAK

Wednesday 7 June 2017 13:40 (2 hours)

A medium-size High toroidal magnetic Field Ultra Low Aspect Ratio Tokamak (HF-ULART) is proposed. The major objective of this is to explore the highest beta limit possible under the maximum toroidal field(TF) to have also high plasma pressure, using present day technology and achievements of tokamak fusion research.

This is the right pathway scenario to initiate studies for a potential ultra-compact pulsed neutron source(UCPNS) based on the spherical tokamak(ST) concept, which later, may lead to more steady-state neutron source or even to a fusion reactor, via realistic design scaling.

The major characteristics of this device are: plasma major radius *Ro*=0.52m, plasma minor radius *a*=0.42m, aspect ratio of *A*=1.24, plasma vertical elongation *k*=2, triangularity *delta*=0.9, TF at the centre of the vessel of *B(Ro)*<1T, plasma current of *Ip*<0.5MA, central density of *ne(0)*=1e20m-3, central electron temperature of *Te(0)*=1keV, and discharge duration of *t*=100ms.

The vessel is spherical, made of stainless-steel, and insulated from the natural diverted(ND) plasma by thin(few centimeters) tungsten(W) semi-spherical limiters. No internal poloidal field coils or solenoid is envisaged. This helps the compactness (relative close plasma-vessel fitting in order to capitalized of potential wall stabilization as envisaged in the RULART proposal[1]) and to easy plasma/neutron shield via a thin(2mm) W bored rod covering the cooper central stack. This might be the only pre-cooled component by liquid nitrogen flow, thus maintaining the whole design simple and cheap.

The major source of initial heating is provided by *Ip* generated from RF in combination with Coaxial Helicity Injection(CHI) techniques, as both have been successfully demonstrated separately in STs: RF in LATE/QUEST and CHI in NSTX/Pegasus.

After a very high beta configuration is attained (potentially in H-mode as observed in Pegasus ohmic H-mode in natural divertor configuration using inboard gas fuelling), adiabatic compression(AC) technique is applied via raising *B(Ro)* to higher values(<2T) and possibly synchronised with the raise of *Ip* to 1MA, both for short period(few milliseconds) in a similar way was conducted in TUMAN-3 tokamak. At the peak of AC phase, single cryogenic pellet injection followed by neutral beam injection(NBI) heating are used for further raising Te(0) in a high density peaked profile target, leading to high neutron yield, similar to PEP(JET) or super-shot(TFTR) high performance discharges.

This HF-ULART can help the revival of the use of the AC technique in tokamaks, alongside the ST-40, a larger, less compact, and more complex device, currently under construction[2]. In addition, studies in HF-ULART as a UCPNS help also to test the feasibility of similar compact neutron source via the spheromak concept with the AC technique[3].

Preliminary equilibrium and stability simulations prior the use of the AC technique will be presented, and basic neutronic calculations, at the peak of this phase. Constraints of plasma power load in the vessel, plasma control and gas fuelling (inboard and outboard) systems, and central stack design, will be also discussed.

[1]C.Ribeiro, Proc. 26th Symposium on Fusion Eng.(SOFE), Austin, 2015.
[2]M.Gryaznevich et al., 18th International Spherical Torus Workshop(ISTW), Princeton University, 2015.
[3]P.Sieck et al., US-Japan Workshop on Compact-Torus, Irvine-CA, 2016.

Eligible for student paper award?

No

Author: Dr RIBEIRO, Celso

Presenter: Dr RIBEIRO, Celso

Session Classification: W.POS: Poster Session W

Track Classification: Experimental devices