Features of the Rodless Ultra Low Aspect Ratio Tokamak

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The replacement of the conventional metal centre-post in spherical tokamaks (STs) for a plasma centre-post (PCP, the TF current carrier) is the ideal scenario for a ST reactor. A simple rodless ultra low aspect-ratio tokamak (RULART) using a screw-pinch PCP ECR-assisted with an external solenoid has been recently proposed, aiming to be the most compact RULART[Ribeiro C., SOFE-2015]. In that proposal, the solenoid provided the stabilizing field for the PCP and the toroidal electrical field for the tokamak start-up plasma, which, after evolving, will stabilize further the PCP, acting as stabilizing closed conducting surface. That RULART will require relative low TF, and the compactness (high ratio of plasma-vessel volume) may provide passive stabilization and easier access to L-H mode transition. New features of this RULART will be presented: 1) stability analysis of the PCP, which initially has a MHD stable hollow current profile; 2) equilibrium simulations for the tokamak plasma, and 3) its potential use with helium plasmas for assisting experiments of aneutronic reactions. This is envisaged via pairs of proton (p) and boron (^{11}B) ion beams, whose sources can be arranged in several ways, such as placed symmetrically (top & bottom) to respect of the vessel horizontal mid-plane (VHMP), at the HFS, with a quasi-vertical line-of-sight (sufficiently for the beams miss the sources of each other, while allowing a near maximum relative velocities, thus reactivity). The p-^{11}B reactions should occur at HFS close to the PCP surface, and between VHMP and the ring-type anode. Some born α-particles should cross the PCP and be dragged by the ion flow (higher momentum exchange) towards the anode but, unlikely this ion flow, will not bend towards the anode but escape directly into a direct electricity converter placed behind of it, since $v_{\alpha} >> v_{i\text{-}drift}$. The energy of the α-particles which fail to the reach the convertor will reach evenly the vessel directly or via thermal diffusion, after heating the plasma [favorable by the large excursion (~2a), if the α-particles are created at VHMP], leading to the lowest power wall load possible, because the spherical vessel. This might be a potential hybrid direct-steam cycle conversion reactor scheme, nearly aneutronic, and with no ash or particle retention problems, as opposed to the D-T thermal reaction proposals.