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Theoretical Calculation and Simulation Studies of Magnetic field points descriptions for the consequences of plasma energy

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Abstract:
Amount of handsome work has already been published including with plasma shape, halo current measurement, eddy current and plasma equilibrium properties by numerical techniques. These techniques contain plasma shape, plasma current and plasma scenario of small aspect ratio. Good number of papers has been published to investigate the halo current measurement, eddy current measurement, act forces on vacuum vessel in other Tokamak devices like JET, JT-60U, NSTX and C-MOD, and EAST. The EAST tokamak is designed by China which is considered to be the best superconducting and advanced Tokamak in the world. In the experimental state of EAST, we need to analyze the plasma behavior from initial-to-final state and to maintain the plasma in the same orbit for the long pulse generation. In this work, we have used transformation techniques to transformed plasma magnetic field points (B_r, B_θ and B_φ) and then apply energy integral (δW) to calculating whole plasma energy. The energy integral (δW) is given as [1]

$$\delta W_{plasma} = \pi R \iiint \left[\frac{B^2}{\mu_0} - j_\phi \left(B_x \xi_z - B_z \xi_x \right) \right] dxdydz$$

The energy integral provide the whole energy in static and tilting position and each cross section in three dimensional views as well. In this process, we observed the major sideways force acting on the plasma during the tilting/static position in kink mode (n=1, m=1). Therefore, poloidal halo current have been examined during the vertical displacement event up and down including the magnetic field points description.

Results and descriptions:

When the transformation technique applied to plasma each cross section area including static and tilting position then we have received horizontal forces from the radial component of magnetic field. The parameters a, b, r and z used for calculating each cross section area (static and tilt) by selected sinφ degree see fig.1. The following points have been calculated by transformation method and energy integral.

1. For static position, in one cross section, the peak values of r, z is (±6.4, ±5.5) therefore ($B_{r(max,up)}$,$B_{r(max,down)}$)= (0.5521 , -0.5535). Then the current loop of magnetic field rang is (B_r, $B_\theta)_{max}$ = (0.5543, 0.3205).
2. For tilting position, in one cross section, the peak values of r, z is (±6.6, ±5.8) therefore ($B_{r(max,up)}$,$B_{r(max,down)}$)= (0.5620 , -0.5650). Then the current loop of magnetic field rang is (B_r, $B_\theta)_{max}$ = (0.5601, 0.2100).
3. If poloidal halo current at the inboard wall (R=3.9m) I_{halo} = 3.50 MA and a toroidal field at this location of B_{tor} = 9.8T then the pressure on the inboard wall becomes 1.47 MPa.

Each cross section including static and tilt depends on each magnetic field points (B_r, B_θ and B_φ) [2] and then plasma moves due to magnetic field coordinates. Therefore, we can easily analyze plasma variation and calculation by getting data from energy integral (δW). 8.03023e + 004 to 8.0321e + 004 are the ranges between static and tilt movement of whole plasma energy. The following points have shown the opposite forces, asymmetric and horizontal forces [3];

4. This energy calculation showed the opposite forces during the disruption start.
5. These energy level have shown the asymmetric and horizontal forces on the EAST plasma in kink mode (n=1, m=1).
6. Two observations have been analyzed, major sideways force and horizontal forces.

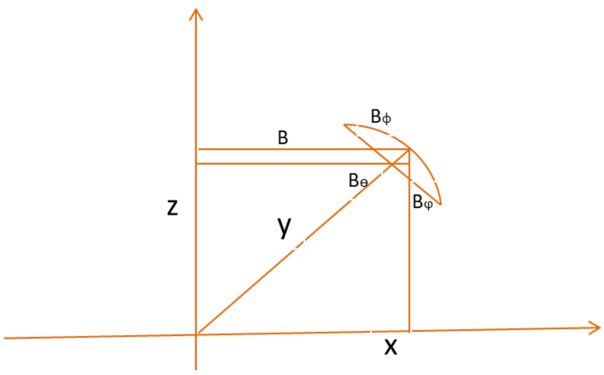

Fig.1 Magnetic field points description in cross section area

References:

[1] Shahab Ud-Din Khan, Yuntao Song, Xufeng Liu, Salah Ud-Din Khan, Development of theoretical model for 3D plasma energy behavior and characteristics, Int. J. Energy Res. Vol. 40, pp.400-407, (2015).
[2] Yuntao Song, et al. Tokamak Engineering Mechanics. ISBN 978-3-642-39574-1, (2014).
[3] Forces on the ITER Vacuum Vessel due to the Plasma in Kink Mode During a VDEIII with Slow Current Quench, ITER_D_26RLC9.