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The ripple electromagnetic calculation: accuracy demand and possible responses (P1-E-239)

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Due to a number of causes (the finite number of toroidal field coils or the presence of concentrate blocks of magnetic materials, as the neutral beam shielding) the actual magnetic configuration in a Tokamak differs from the desired one. For example, a ripple is added to the ideal axisymmetric toroidal field, impacting the equilibrium and stability of the plasma column; as a further example the magnetic field out of plasma affects the operation of a number of critical components, included the diagnostic system and the neutral beam. Therefore the actual magnetic field has to be suitably calculated and his shape controlled within the required limits.

Due to the complexity of its design, the problem is quite critical for the ITER project.

In this paper the problem is discussed both from mathematical and numerical point of view.

In particular, a complete formulation is proposed, taking into account both the presence of the non linear magnetic materials and the fully 3D geometry.

Then the quality level requirements are discussed, included the accuracy of calculations and the spatial resolution. As a consequence, the numerical tools able to fulfil the quality needs while requiring reasonable computer burden are considered. In particular possible tools based on numerical FEM scheme are considered; in addition, in spite of the presence of non linear materials, the practical possibility to use Biot-Savart based approaches, as cross check tools, is also discussed.

The paper also analyses the possible geometrical simplifications of the geometry able to make possible the actual calculation while guarantying the required accuracy.

Finally the characteristics required for a correction system able to effectively counteract the magnetic field degradation are presented. Of course a number of examples will be also reported and commented.