# ELECTROMAGNETIC ANALYSIS OF BREAKDOWN CONDITIONS IN JET

F. Maviglia[1], R. Albanese[1], A. Alonso[2], P. J. Lomas[3] and JET EFDA Contributors*

*JET-EFDA, Culham Science Centre, OX14 3DB, Abingdon, UK*

*[1]Associazione EURATOM-ENEA-CREATE, Univ. di Napoli Federico II, Via Claudio 21, 80125, Napoli, Italy*
*[2]Asociaciòn EURATOM-CIEMAT para Fusiòn, CIEMAT, Madrid, Spain*
*[3]CCFE, Culham Science Centre, OX14 3DB, Abingdon, UK*
**See the Appendix of F. Romanelli et al., Proceedings of the 22nd IAEA Fusion Energy Conference 2008, Geneva, Switzerland*

*Corresponding author: francesco.maviglia@unirc.it*

This paper presents the breakdown studies carried out in the framework of JET Enhancement Projects for Plasma Control Upgrade (PCU) and Enhanced Radial Field Amplifier (ERFA), so as to ease plasma formation with different sets of coil turns in the radial field circuit for the vertical stabilization of the plasma. It has been known for many years that it is necessary to make a hexapolar magnetic field null on JET to meet the conditions for Townsend avalanche. The electromagnetic conditions to reach the plasma breakdown in the JET machine are strongly dependent on the properties of JET iron core and the effects of the eddy currents driven by the transient electric field on the present passive structures such as vacuum vessel (VV), restraint rigs (RR) and mechanical structure (MS), as well as divertor support structure Mark II (MK2), that introduces an up-down asymmetry.
The study has been carried out by using a linearized dynamic model of JET provided by 2D axisymmetric finite element code CREATE-L [1].
One of the results of the activity is the estimation of the radial field (about 0.2 mT) due to the presence of asymmetric gaps in the iron core, located at z = 4.45 m (and not at z = -4.45 m).
The results of the dynamic simulations have been compared with the experimental measurements, with different breakdown recipes, in term of current slopes, and for different coil turn configurations. The dynamic simulations are in good agreement with the estimation of the total current in the MK2 structure, obtained by using a flux loop placed in the region externally to the MK2 and considering its electrical resistance. This measurement is used at JET as feedback variable for the ERFA circuits in order to compensate the asymmetric contribution brought by the presence of this current in the divertor zone.
A new fast visible camera has been installed and has been used for the first time at JET for studies of plasma breakdown. The new images shows that ionisation cloud appears after the model suggests that the initial transient hexapole null has been superseded by two quadrupole nulls. In these conditions the inboard null could well be preferred for plasma formation for the higher electrical field and shorter path of the ionized particles. It is suggested that the avalanche evolves dynamically towards a region that leans on the part of the first wall where the angle between the force on the plasma and the normal unit vector is larger than 90 deg. In the poloidal plane such a region is delimited by the two points where the stray field is perpendicular to the first wall.

[1] R. Albanese et al., Nucl. Fusion, 38, 1998, pp. 723–738.