Using a Multipole Expansion for Startup in the DIII–D Tokamak*

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The magnetic field null conditions for plasma startup in DIII–D are established using a multipole expansion of the flux contribution from each element of the poloidal coil set to compute the vacuum magnetic field in real time using the measured coil currents. The use of this procedure has improved the breakdown conditions as evidenced by the formation of the current channel with a toroidal electric field as low as 0.4 V/m without rf assistance. This represents a significant improvement over previous normal operation. Improved null conditions enhance the sensitivity of the minimum loop voltage to the wall conditions of the vacuum vessel. Results relating the breakdown voltage to carbon impurities are presented. We show that the observed difference between the radius of the poloidal field null and the radius of plasma initiation is a manifestation of finite aspect ratio, explained by the variation of the electric potential along the field line from the breakdown region to the wall.