Characteristic time for halo current growth and rotation

ALLEN BOOZER, Columbia University — Halo currents, $I_h$, flow in part through plasma on open magnetic lines and in part through the walls. A halo current has the same function as the wall current of a resistive wall mode and arises when a kink cannot be wall stabilized. When flowing in the plasma, the halo current can produce no forces, so $j_h = (j_{||}/B)\vec{B}$ with $\vec{B} \cdot \nabla j_{||}/B = 0$. To avoid too strong a coupling to stable kinks, the wall interception must be of sufficient toroidal extent, which implies the width of the halo current channel $\Delta_h \approx aI_h/I_p$, where $aI_h/I_p$ is the amplitude of the kink, $a$ is the minor radius, and $I_p$ is the plasma current. The equation for the growth of the halo current is $dI_h/dt = I_p/\tau_g$, where $\tau_g \approx (\mu_0/\eta_h)(a^2/4)/s_{eff}$ and $s_{eff}$ is a dimensionless stability coefficient. The rocket effect of the plasma flowing out of the two ends of the magnetic field lines in the halo can set the magnetic perturbation into toroidal rotation at a Mach number, $M_h$, comparable to unity. The rotation period is $\tau_r = (2\pi R_0/C_s)/M_h$, where $R_0$ is the major radius and $C_s = \sqrt{(T_e + T_i)/m_i}$ is the speed of sound. NSTX results appear consistent for $s_{eff} \sim 0.5, M_h \sim 1$, and $T_{e,i} = 10eV$.

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