TEMPEST Simulations of the neoclassic radial electric field and bootstrap current*

X. Q. Xu, and Z. Xiong

Lawrence Livermore National Laboratory, Livermore, CA 94550 USA

The simulations presented here are carried out for large aspect ratio circular geometry with $\epsilon = 0.1$. The ion density and temperature profiles are initialized as a tanh function of radius centered around the middle of simulation domain $[N(x) = n_0 + n_m \tanh((x - x_m)/\Delta_n)]$. The boundary ion distribution is a fixed Maxwellian with $N(x_0) = 1 \times 10^{20} m^{-3}, N(x_L) = 9 \times 10^{19} m^{-3}, T_i(x_0) = 3keV$, and $T_i(x_L) = 2.7keV$ during a simulation. The radial boundary condition for the potential is $E_r(x_0) = \phi(x_L) = 0$. Two electron models are used. For calculation of the electric field, the electron model is Boltzmann $n_e = \langle n_i(\psi, \theta, t = 0)\rangle \exp(e\phi/T_e)/\langle \exp(e\phi/T_e)\rangle$, where $\langle\rangle$ represents the flux surface average. This choice of coefficient for Boltzmann electron model means that there is no cross field electron transport. For the calculation of the bootstrap current, a kinetic electron model is used. The neoclassical radial electric field from TEMPEST simulations agrees with the standard neoclassical expression $\langle U_{i\|}\rangle = (cT_i/Z_i e B_p)\,[k(\partial \ln T_i/\partial r) - (\partial \ln P_i/\partial r) - (Z_i e/T_i)(\partial\langle\Phi\rangle/\partial r)]$. The radial electric field is generated due to the neoclassical polarization and the relative maximum charge separation is only 0.4%. A time history of the flux surface averaged electric potential shows clean geodesic acoustic oscillations generated by the initial conditions, which then relax to a steady state, consistent with the previous studies [1,2]. The bootstrap current from TEMPEST simulations with both kinetic ions and electrons are compared with Sauter's model [3]. Comparisons with theory for systematic scans in safety factor q and collisionality will be discussed. The impact of the magnetic separatrix and the Scrape-Off-Layer physics on the radial electric field and bootstrap current will be reported.

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[2] Novakovskii S V, *et al.*, 1997 *Phys. Plasmas* **4**, 4272.

[3] Sauter, O, *et al.*, 1999 *Phys. Plasmas* **7**, 2834; 2002 *Phys. Plasmas* **9**, 5140.

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