Modeling of Large ELM Suppression for High Confinement Plasma in DIII-D*

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A 3-D field line integration code (TRIP3D) is used to calculate magnetic field diffusion coefficients due to stochastic field lines in the edge of DIII-D plasmas in which edge localized modes (ELMs) are suppressed by resonant magnetic perturbations. The ELM suppression depends on the magnetic perturbation amplitude, safety factor, heating power and plasma density [1]. In these experiments normalized radial magnetic perturbations of 2.6×10^{-4} at the 95% flux surface produce complete ELM suppression, while plasma confinement stays high. The axisymmetric equilibrium magnetic field in TRIP3D is provided by the EFIT code, while perturbed field is calculated by the TRIP3D code. The enhanced diffusion coefficients and collisionless electron conductivity due to stochastic magnetic fields are estimated for cases with and without ELM suppression.

The TRIP3D modeling indicates that the stochastic magnetic field inside 95% flux surface is rather important for enhanced edge transport and the suppression of large ELMs. Large magnetic islands often appear in deep plasma during ELM suppression. A Gaussian-like distribution of magnetic flux perturbation for short path integrals ensures field lines have many revolutions. The calculated radial particle diffusion coefficients produced by stochastic magnetic field at 95% flux surface are 0.29 m^2/s for full ELM suppression and 0.046 m^2/s for no ELM suppression with corresponding collisionless electron conductivities of 6.7 m^2/s and 1.25 m^2/s. The averaged thermal conductivity estimated from the energy confinement time is 1.2 m^2/s, where $\chi_e^{AV} \approx a^2/\tau_E$.

With the introduction of an edge resonant magnetic perturbation the average field line length decreases starting from $\psi_N \sim 0.7$ outward due to an increasing fraction of short field lines that escape and hit the divertor target plates. These escaping field lines are distributed uniformly across a relatively broad radial region (typically of order a few centimeters) and uniformly in the toroidal direction. Therefore, the stochastic magnetic boundary created by the resonant magnetic perturbations is expected to decrease the peak heat load on the divertor target plates.

[1] T.E. Evans, R.A. Moyer, P.R. Thomas, et al., Phys. Rev. Lett. **92**, 2350003-1 (2004).

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