Transport barrier using a vorticity source in 5D gyrokinetic simulations

G. Lo-Cascio[1], E. Gravier[1], T. Réveillé[1], M. Lesur[1], X. Garbet[2],
Y. Sarazin[2], K. Lim[3], L. Vermare[4], A. Guillevic[1], V. Grandgirard[2]

[1] *IJL, UMR 7198 CNRS, Université de Lorraine, 54000 Nancy, France*

[2] *CEA, IRFM, F-13108 Saint-Paul-lez-Durance, France*

[3] *Swiss Plasma Center, CH-1015 Lausanne, Switzerland*

[4] *Ecole Polytechnique, LPP, CNRS UMR 7648, 91128 Palaiseau, France*

The present work addresses the necessary preparatory step in view of exploring impurity transport across transport barriers which characterize improved confinement regimes. Two ways of producing a strong shear of the $\mathbf{E} \times \mathbf{B}$ poloidal flow have been investigated using GYSELA gyrokinetic simulations[1] in a flux-driven regime. The first one uses an external vorticity source[2] that polarizes locally the plasma, and the second one enforces a steep density profile. In both cases a transport barrier is created as a result of a reduced magnitude of turbulence. This reduction is strongly correlated with the shearing of turbulent structures[3] as attested by the reduction of the auto-correlation length of the potential fluctuations as well as a reduction of the large scale structures of the $k_\perp$ spectra. By discriminating neoclassical and turbulent contributions to the total heat flux through effective transport coefficients

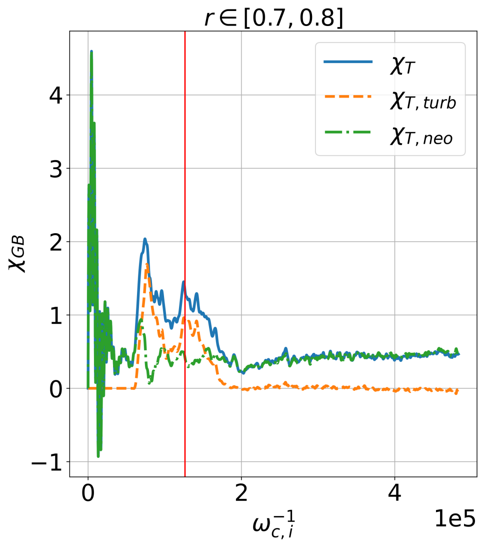

Figure 1: χ_T *(See Eq(1)) in* $\chi_{GB} = \rho^\star \rho_i c_{s,i}$ *units as a function of time near the vorticity source (*$r = 0.75$*). Red line is the activation time of the vorticity source.*

$$Q = Q^{turb} + Q^{neo} = -n\left(\chi_T^{turb} + \chi_T^{neo}\right)\nabla T \quad (1)$$

we can monitor the evolution of the χ_T radially averaged coefficients. The reduction in heat diffusivity near the source (See Fig.1) caused a core temperature increase. The turbulence intensity appears to be reduced not only in the vicinity of the vorticity source, but also in the core region. A detailed analysis of the physical mechanisms at work will be presented.

References

[1] V. Grandgirard et al., Comput. Phys. Commun., vol. 207, pp. 35–68, 2016.

[2] A. Strugarek et al., Plasma Phys. Control. Fusion, vol. 55, no. 7, p. 074013, 2013.

[3] P. Terry, Rev. Mod. Phys., vol. 72, no. 1, p. 109, 2000.