# Gyrokinetic simulations of turbulence in JT-60SA with the GENE code

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The JT-60SA superconducting tokamak [1] has the goal to provide substantial contributions for performance in ITER and DEMO. Its large size (minor radius $\sim$ 1.2m, major radius $\sim$ 3m) and high field ($\sim$ 2.3T) makes it the most suitable reactor yet to explore ITER and DEMO relevant scenarios. Since reactor performance is greatly limited by anomalous transport, the study of mitigation and control of microinstabilities and therefore of the physics of turbulence, is paramount. In this contribution we report on the progress of using gyrokinetic simulations to model the turbulent transport in a representative JT-60SA plasma discharge that features a double-null separatrix, 41 MW of Neutral Beam Heating (NBH) and a high ratio $\beta$ of the normalised plasma kinetic to magnetic pressure. Local gyrokinetic simulations are carried out with the GENE [2] code considering kinetic profiles and MHD geometry that have been predicted for actual JT-60SA experiments, and including collisions and four kinetic species: electrons, main deuterium ions, carbon impurities and fast deuterium ions to model the external NBH heating. The large value of $\beta$ makes it also necessary to retain both transverse and parallel magnetic field fluctuations, consistently with using full $\nabla B$ and curvature drifts of the guiding centre orbits of the kinetic species [3].

With linear simulations we find a large range of electrostatic and electromagnetic modes, including the ion temperature gradient, trapped electron and microtearing modes. Instabilities at the ion scales are well separated from electron scales and we can therefore neglect cross-scale interactions. We test the predictions of the reduced transport models that were used to predict the profiles of the considered scenario with "first-principle" non-linear gyrokinetic simulations. Such GENE simulations at the nominal parameters in fact lead to a turbulent heat flux below the injected 41MW. Furthermore, they indicate that the scenario is near the critical gradients of the underlying instabilities and is therefore very sensitive to variations in the input parameters, especially density and temperature gradients. Temperature and density gradients have been modified so as to match the total turbulent heat flux with the injected power. The value of $\beta$ is also adjusted to avoid the "non-zonal" transition [4] and obtain saturation in the heat fluxes.

## References

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