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

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The JT-60SA superconducting tokamak **[JT60SA2018]** is one of the most suitable reactors yet to explore and study ITER and DEMO relevant scenarios. This includes the study of microinstabilities that lead to anomalous transport and greatly limit the reactor performance. In this contribution we model the turbulent transport in a representative, planned, high-performance, JT-60SA plasma discharge, scenario 1 **[JT60SA2018]**, with local gyrokinetic GENE **[Jenko2000]** simulations. The goal is to predict and understand anomalous transport in reactor relevant regimes. The discharge features a double-null separatrix, 41 MW of Neutral Beam Heating (NBH) and a high predicted ratio β of the normalised plasma kinetic to magnetic pressure. The large value of β implies that both perpendicular and parallel magnetic field fluctuations have to be retained, since they both play a role in the underlying instabilities.

We obtain the following key results. When using parameters computed from reduced transport models [**Hayashi2011**, **Tani1992**, **Shinya2000**] the nonlinear gyrokinetic simulations predict a turbulent heat flux well below the injected 41MW from NBH and ECH. In an attempt to match the total turbulent heat flux with the injected power we increased the ion and electron temperature and density gradients and noted that the fluxes were very sensitive to small variations of these background values, reflecting the stiffness of the profiles. The scenario is in fact near the critical gradient of the present turbulence regime and is therefore very sensitive to variations in the input parameters.

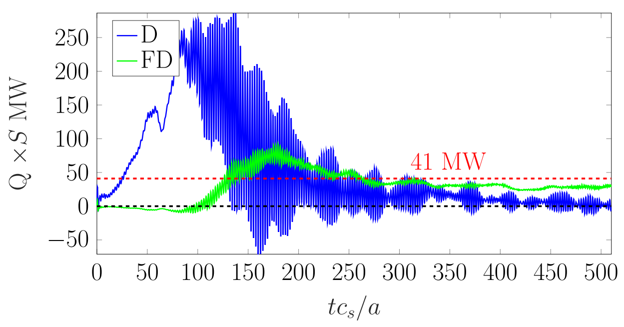

FIG 1. Time trace of the heat flux for main ions (blue) and fast ions (green)

Additionally, when considering fast ions in our simulations we destabilise a very high frequency mode that dominates the heat flux time-trace, as is illustrated in Fig. 1. Linear simulations show that this mode is very sensitive to the fast ion parameters, in particular the fast ion temperature and temperature gradient, as illustrated in Fig 2. We discuss the consequences this feature could have on the efficiency of NBH. Finally, for an ion temperature gradient above 40% of the nominal value we furthermore encounter the "non-zonal" transition [**Pueschel2013**] leading to extremely stiff transport and effectively an operational limit.

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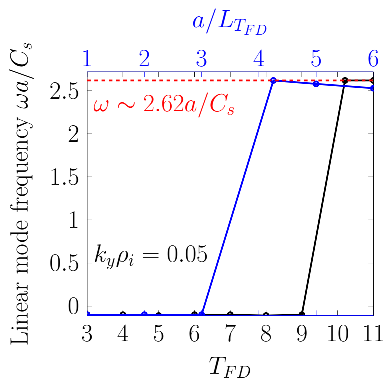

FIG. 2 Real frequency of the most unstable mode as a function of the fast ion temperature (T_{FD}) or temperature gradient ($a/L_{T,FD}$)