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P4.1103 Benchmarking the TGLF turbulent transport code for a Q=10 burning spherical tokamak plasma using GS2

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Spherical Tokamaks (STs) could provide a route towards a compact fusion reactor due to advantageous properties such as high plasma beta. A GW-scale ST plasma is explored where Q=10 and R=2.5m. In this design 110 MW of NBI is needed to provide 9 MA of non-inductive current, where the remaining 12 MA is pressure driven. To penetrate into the core a 1 MeV on-axis beam is needed, leading to low momentum injection into the plasma. An estimate of the resulting flow suggests a Mach velocity of M~O(0.01) compared to the ion sound speed. A key question is whether this is sufficient to stabilise turbulence. A burning ST would operate in an unexplored regime and high fidelity modelling is required to assess confinement in such a device. Codes such as TGLF and GS2 have been used to model the turbulent transport. Predictive heat transport calculations have been performed with JINTRAC using the TGLF transport model. Figure 1 illustrates that the predictions are highly sensitive to flow. In the M=0 case confinement insufficient to achieve the target profiles for Q=10. The confinement dramatically improves with M and the target profiles are reached at M=0.03. This would suggest that the low flow generated by the NBI may suppress the turbulence sufficiently to recover the confinement necessary for Q=10. TGLF must be verified and tuned for high beta ST plasmas with subsonic flows, as they are different to the conventional regimes for which TGLF was developed. TGLF linear micro-instability calculations have been compared to GS2 for STs and conventional tokamaks, which reveal differences in growth rates at lower aspect ratio. Priorities are to understand these differences and to assess whether TGLF's prediction of sensitivity to flow is physical. Comparing against MAST shots will help validate TGLF in the ST regime.

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