Bechmarking DIV1D on SOLPS-ITER simulations of TCV plasmas

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Future tokamak reactors will require real-time feedback control to handle the enormous heat and particle fluxes coming from the ignited plasma core to the wall in the heat exhaust called the divertor [1, 2]. Heat exhaust controllers should bring and maintain the divertor plasma in a detached regime, characterized by low plasma temperature and pressure, to reduce heat loads to the wall and stay within material limits. To minimize commissioning time and involved risks, controller designs should be guided by dynamic physics-based models. Although detached plasmas are simulated with increasing accuracy by large-scale physics-based models, excessive computation times for dynamic cases necessitate complimentary faster dynamic models for the design, verification and validation of heat exhaust controllers for future reactors.

In this contribution we benchmark DIV1D, a new 1D dynamic physics-based model of the divertor plasma [3], on SOLPS-ITER simulations of TCV plasmas. SOLPS-ITER is a large-scale model used to determine 2D edge and divertor plasma equilibria [4, 5]. We present a novel 1D interpretation of static 2D SOLPS-ITER divertor plasmas that captures the heat flux as it flows from a region near the X-point (upstream) to the divertor target wall. Using the 1D interpreted SOLPS-ITER profiles, we fit the heat flux profiles of DIV1D by modeling cross-field transport with an effective flux expansion factor. Additionally, a homogeneous neutral background is imposed to constrain the neutral density and improve the fit of the temperature profile. The benchmark of DIV1D shows reasonable to good agreement with 1D interpretations of SOLPS-ITER for low divertor plasma temperatures and serves as a basis to further develop DIV1D as a dynamic model to guide tokamak heat exhaust control efforts.

References

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