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Developing tools to accelerate divertor design and full-power operation

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We aim to address the design and operation challenges of future tokamak fusion reactors by developing tools which combine data and simulations with automation and uncertainty quantification techniques. We will present recent progress towards this goal in model development, workflow automation, and plans to develop and validate these tools in collaboration with current and near-term experimental facilities including the DIII-D national fusion facility.
The divertor is a critical part of any high-power tokamak device and an integral part of the overall design, strongly impacting the plasma operating space and choice of poloidal field coil configuration. The time required to identify and refine performant divertor designs has the potential to delay the whole design process. Once a tokamak is constructed, ramp-up to full power operation is dependent on managing risks of damage to the divertor and other plasma facing components. As with design, the time required to assess the safe operating space of the divertor with confidence could delay the start of full power operation. We aim to accelerate these timelines by automating the assimilation of data and simulations and their uncertainties.
The physics basis of our tools is provided by two open-source codes: The well-established UEDGE (https://github.com/LLNL/UEDGE) and a new code, Hermes-3 (https://github.com/bendudson/hermes-3/). The Hermes-3 code has been developed based on BOUT++ and is capable of multi-fluid transport and turbulence calculations in tokamak single and double-null geometries. We will present these tools, their advantages and disadvantages, and their potential role as part of a larger multi-fidelity suite of modelling tools to accelerate the design and operation of tokamak fusion reactors.

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