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Fast-ion transport optimization using the integrated TGLF-EP+Alpha Alfvén eigenmode transport model

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Control of Alvfén eigenmodes (AEs) driven by energetic neutral beam injection (NBI) ions in DIII-D is explored with the TGLF-EP+Alpha model. TGFL-EP+Alpha is a reduced model assuming stiff-transport informed by DIII-D experiments and nonlinear gyrokinetic simulations. In DIII-D shot 180625, neutron deficit below classical predictions (a proxy for AE transport of fast ions) is experimentally reduced by up to 35% by moving NBI off axis and/or moving electron cyclotron current drive to on-axis. TGLF-EP+Alpha captures these trends, predicting the evolving neutron signal to well within 10% over the entire current ramp. Adding in the energetic-particle diffusivity predicted to in TGLF-EP to the power-balance analysis brings TGLF thermal-ion temperature profiles into much better agreement with measurements as well. The physics-based TGLF-EP+Alpha model improves over ad hoc energetic particle diffusivity currently used in integrated modeling workflows. It's inexpensive enough for scenario optimization and validated over a wide parametric range.
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