Integrated core-pedestal modeling with the AToM framework*

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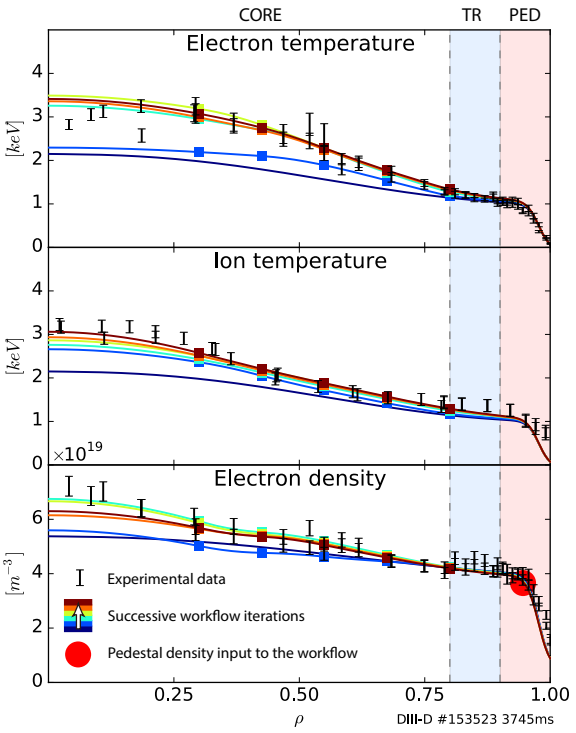
In this presentation we will report on two novel integrated simulation capabilities of the Advanced Tokamak Modeling (AToM) framework. The original AToM[0] SciDAC-3 project was a 3-year effort that concluded in 2017. For the period 2017-2022, a new 5-year AToM SciDAC-4 project has begun. First, we give an overview of coupled core-pedestal integrated simulations, with application to DIII-D plasmas. These simulations take into account the strong interplay between core turbulent-plus-collisional transport, pedestal structure, current profile and plasma equilibrium. Integrated modeling workflows capable of calculating the steady-state self-consistent solution to this strongly-coupled problem have been developed and implemented in AToM via the OMFIT-TGYRO [1] and the IPS-FASTRAN [2] workflows. Here, kinetic plasma equilibrium is computed by EFIT using profile data from the transport solver and kinetic bootstrap current from the neoclassical module.



Given an EFIT equilibrium, core profiles are evolved by the transport solver by combining collisional and turbulent fluxes to maintain balance with heating and fueling sources. The updated value of the global plasma pressure is passed to EPED to obtain the self-consistent pedestal structure. For the OMFIT-TGYRO-TGLF-NEO workflow (see plot), the scheme is iterated to convergence in a few iterations and is independent of initial profiles. By using **only the electron density at the top of the pedestal** as an input, profiles are calculated from magnetic axis to separatrix – in good agreement with experiment (DIII-D 153523, 3745ms). Second, we will review a key subcomponent of these coupled core-pedestal simulations: the time-dependent (i.e, mulitple time-slice) kinetic EFIT reconstruction. Here, a self-consistent kinetic neoclassical bootstrap current calculation with NEO is coupled to the EFIT equilibrium solve. This ensures the highest-accuracy calculation of the bootstrap current and consistent plasma equilibrium across the entire plasma profile.

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References

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