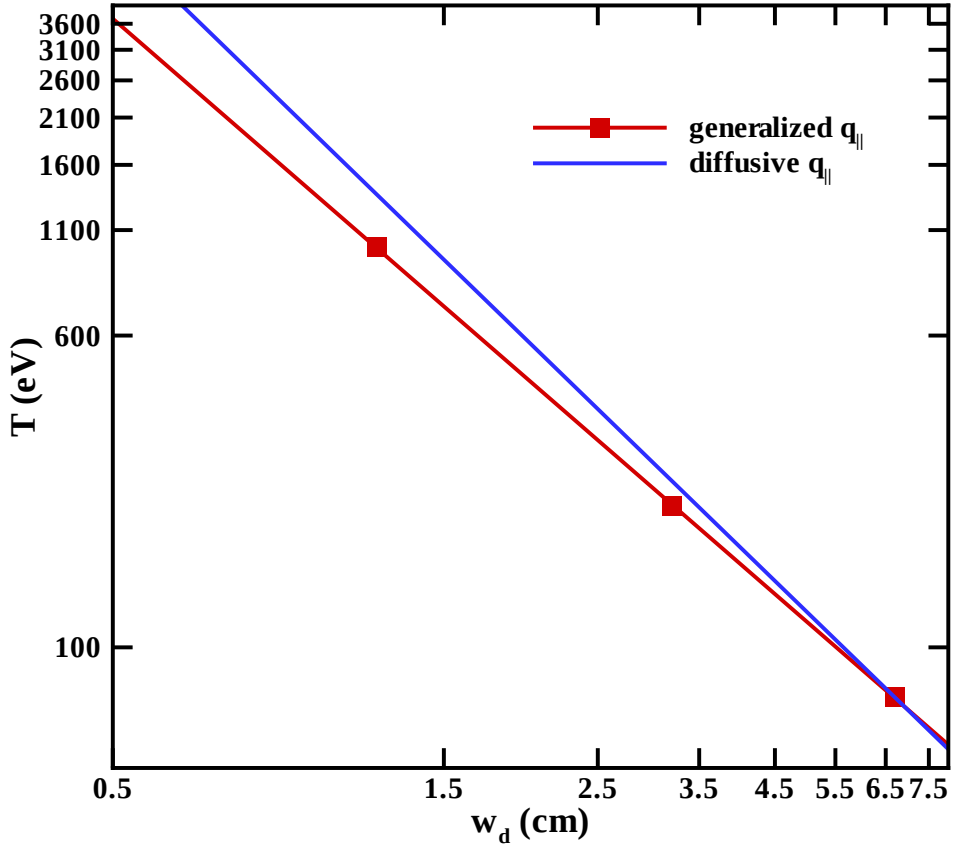
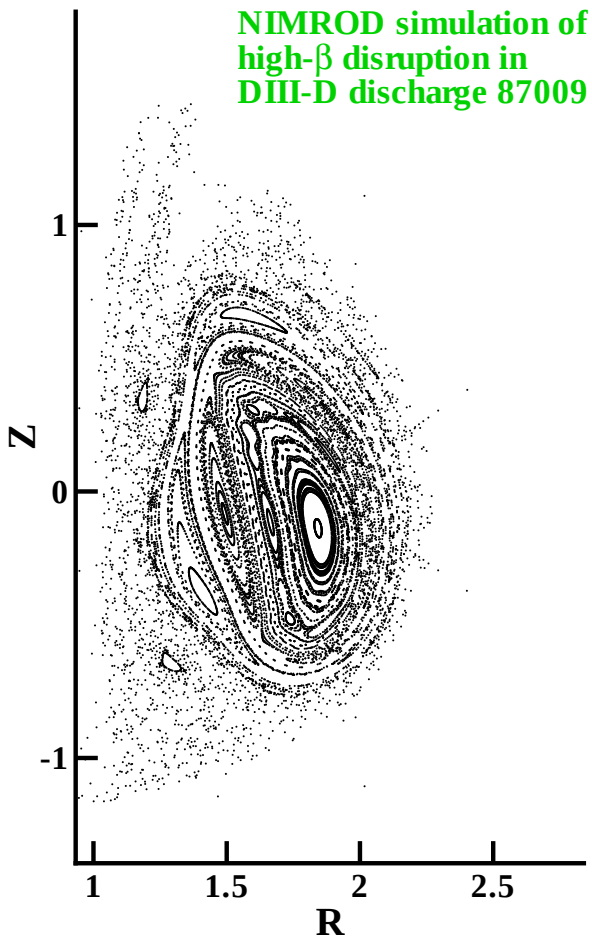
Generalized $q_{||}$ predicts more robust flattening.

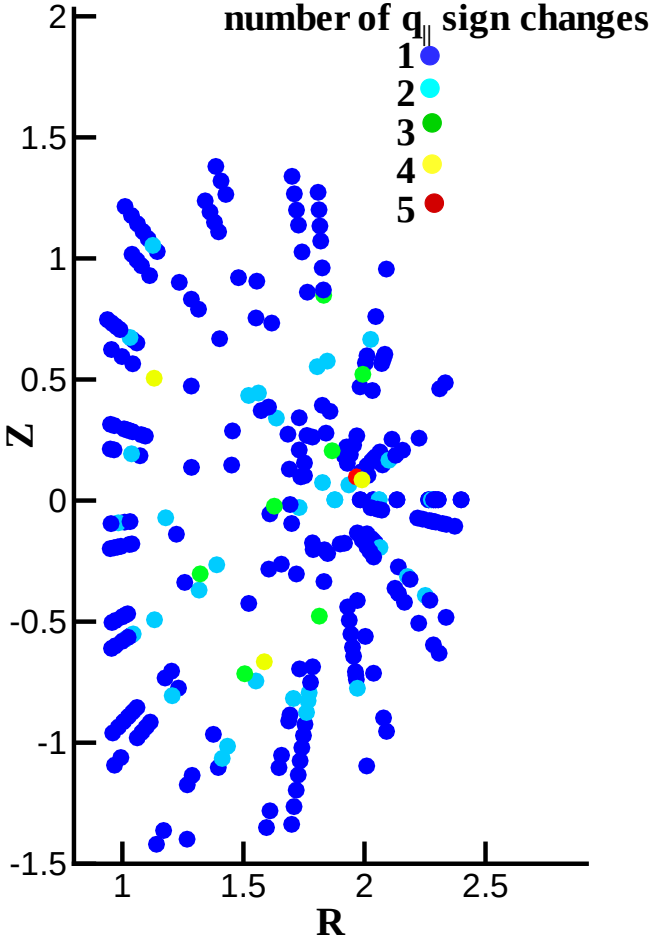
- Cylindrical, diffusive analytical scaling with[12] $\kappa_{||} \sim T^{5/2}$, $T \sim w_d^{-1.6}$. [a]
- Toroidal, diffusive numerical scaling[13] $T \sim w_d^{-1.7}$. [b]
- Generalized numerical scaling $T \sim w_d^{-1.5}$.



Nonlocal $q_{||}$ useful in disruption simulations.

- Simulation of disruption in DIII-D shot 87009 [14] results in field line chaos. [a]

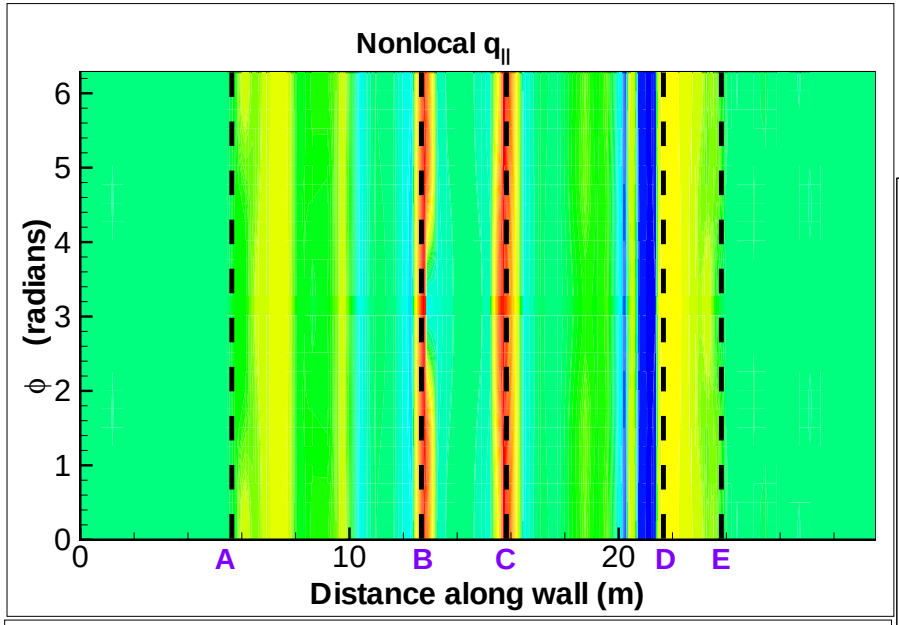


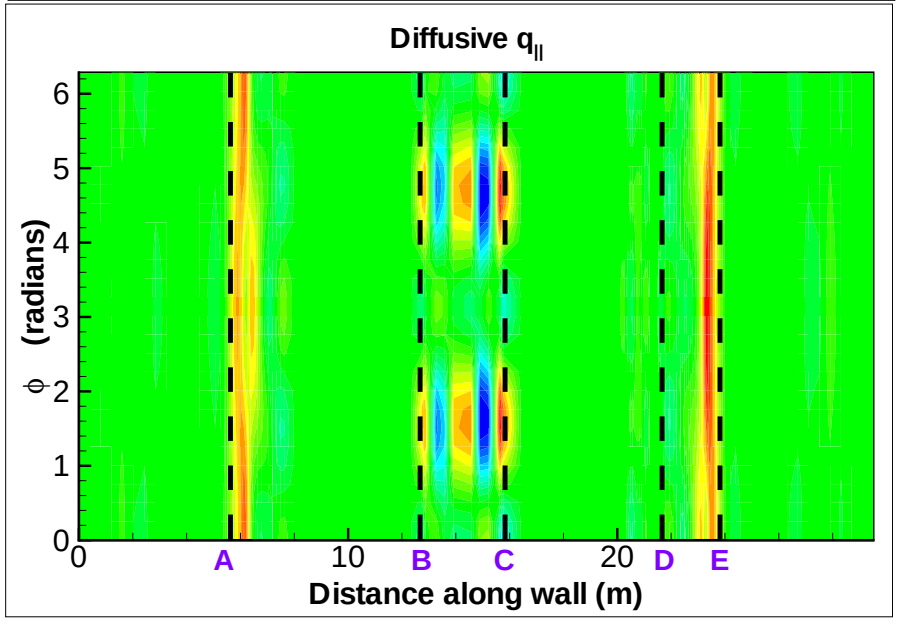


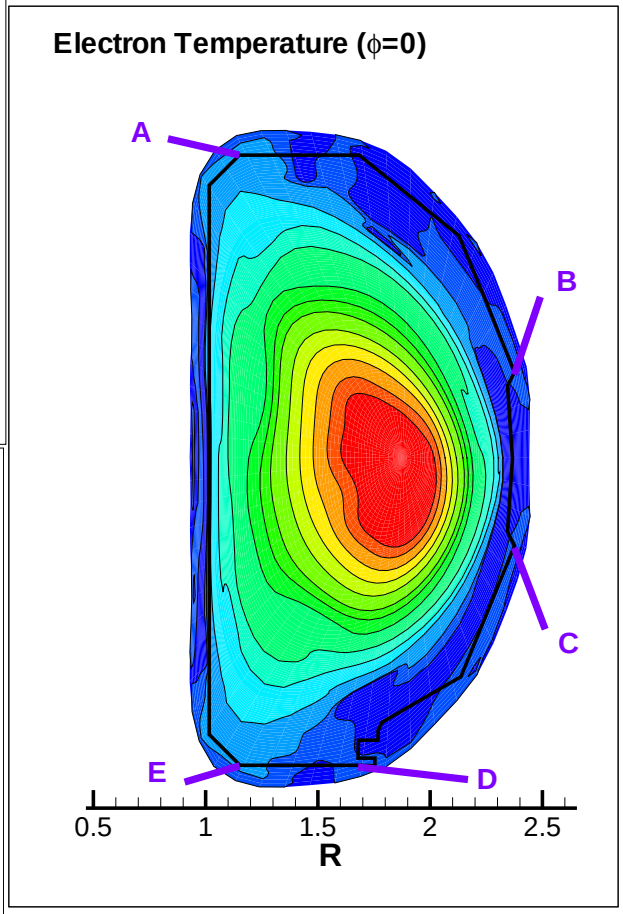
[a] 14 J. D. Callen, *et al.*, Phys. Plasmas **6**, 2963 (1999).

Nonlocal closure qualitatively different than diffusive closure.

- Heat flows rapidly along field lines hitting the wall.







Conclusion

- Developed nonlocal closures that encompass Landau, collisional, and particle trapping physics in general toroidal geometry.
- Implemented massively parallel semi-implicit approach in NIMROD code for application to high-performance, toroidal fusion experiments.
- Combination of generalized closure theory and massively parallel numerics permits simulation of parallel particle dynamics on fluid time scales.
- Scaling of $T \sim w_d^{-1.5}$ for nonlocal $q_{||}$ predicts robust flattening of temperature across magnetic islands.
- Preliminary application of nonlocal $q_{||}$ in disruption simulations reproduces qualitative features of wall heat loads.

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