Title: Energetic particle transport in compact advanced tokamak reactor

Authors: Y. Ghai[1], D.A. Spong[1], J.M. Park,[1] Jacobo Varela[2], Luis Garcia[3], Juan Ortiz[3],
[1]*Oak Ridge National Laboratory, Oak Ridge, Tennessee 36831-60, USA*
[2]*Institute of Fusion Studies-University of Texas, Austin, USA*
[3]*Universidad Carlos III de Madrid, 28911 Leganes, Madrid, Spain*
Email: ghaiy@ornl.gov

Energetic alpha particles generated as by-product of D-T fusion reactions may give rise to plasma instabilities such as Alfvén eigenmodes (AEs) [2], which can de-confine alphas, leading to inefficient plasma self-heating and erosion of the wall-components. Analyzing the impact of energetic alpha particle transport in such reactor level fusion devices is of crucial importance for optimizing the design of a fusion pilot plant, particularly in achieving steady state burning plasma conditions, where the confinement of energetic alpha particles plays a pivotal role. We aim to analyze the energetic particle transport due to Alfvén instabilities in a projected net electric fusion pilot plant concept known as the Compact Advanced Tokamak (CAT) reactor[1]. A key aspect in this physics-optimized tokamak is to replace the inductive current with a combination of 'bootstrap current' (which arises naturally from orbit effects at high pressure gradients), and auxiliary current drive (form radio-frequency heating). Linear simulations using our gyro-fluid code FAR3d indicate several unstable Alfvén eigenmodes (AEs) with significant growth rates in the CAT-reactor case. Nonlinear simulations using FAR3d will shed further light on the energetic particle transport associated with these unstable AEs, the generation of zonal flows and its consequences on the performance of a fusion pilot plant which needs to sustain burning plasmas at steady-state.

References:

[1] R.J. Buttery et al, Nuclear Fusion, **61**, 046028 (2021).
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This research is sponsored by the U.S. Department of Energy, Office of Science, Office of Fusion Energy Sciences, under award: DE-AC05-00OR22725, and the Laboratory Directed Research and Development Program of Oak Ridge National Laboratory, managed by UT-Battelle, LLC, for the U. S. Department of Energy.