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Simulations of Pellet Injection in Tokamaks using AMR

R. Samtaney[1], S. Jardin[1], P. Colella[2], D. Martin[2]

[1] Princeton Plasma Physics Laboratory
Princeton University, Princeton, NJ 08543
[2]Lawrence Berkeley National Laboratory
Berkeley, CA 94720

Abstract

Injecting small pellets of frozen hydrogen is a proven method of fueling tokamaks. Experimentally it is known that the density distribution, after the pellet ablates upon encountering the high temperatures in a tokamak, is not consistent with the distribution inferred from assuming that the ablated material remains on flux surfaces where ablation occurred. The subsequent redistribution of mass is due to MHD processes. In this poster, we will report on the progress made toward simulating the pellet injection process using an Adaptive Mesh Refinement (AMR) technique. AMR is essential to provide the resolution required to simulate realistic pellet sizes relative to device dimensions (typical ratios are $O(10^{-3})$). The mathematical model is the single-fluid resistive MHD equations with source terms in the continuity equation along with a pellet ablation rate model given by Parks[1]. Further, we use a source term in the momentum equations to mimic toroidal effects in a Cartesian geometry. The numerical method used is a explicit 8-wave upwinding formulation [2], coupled with a projection method to enforce the solenoidal property of the magnetic field. The Chombo[3] framework is used for AMR. Preliminary results show that AMR is essential for well-resolved simulations of pellet injection.

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[1] P. B. Parks and R. J. Turnbull, Phys. Fluids, vol. 21, pp:1735, 1978.
[2] Powell et al. Journal of computational physics, vol. 154, pp:284-309, 1999
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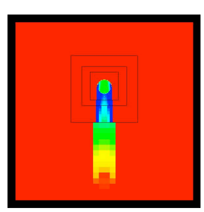

Figure 1: Density image of a pellet propagating in a uniform magnetic field. Note the increased density trailing behind the pellet. The black boxes are the AMR mesh boundaries.