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Fully implicit adaptive mesh refinement algorithm for reduced MHD BOBBY PHILIP, MICHAEL PERNICE, LUIS CHACON, LANL — In the macroscopic simulation of plasmas, the numerical modeler is faced with the challenge of dealing with multiple time and length scales. Traditional approaches based on explicit time integration techniques and fixed meshes are not suitable for this challenge, as such approaches prevent the modeler from using realistic plasma parameters to keep the computation feasible. We propose here a novel approach, based on implicit methods and structured adaptive mesh refinement (SAMR). Our emphasis is on both accuracy and scalability with the number of degrees of freedom. As a proof-of-principle, we focus on the reduced resistive MHD model as a basic MHD model paradigm, which is truly multiscale. The approach taken here is to adapt mature physics-based technology[1] to AMR grids, and employ AMR-aware multilevel techniques (such as fast adaptive composite grid –FAC– algorithms) for scalability. We demonstrate that the concept is indeed feasible, featuring near-optimal scalability under grid refinement.[2] Results of fully-implicit, dynamically-adaptive AMR simulations in challenging dissipation regimes will be presented on a variety of problems that benefit from this capability, including tearing modes, the island coalescence instability, and the tilt mode instability.

[1] L. Chacón et al., *J. Comput. Phys.* **178** (1), 15- 36 (2002)
[2] B. Philip, M. Pernice, and L. Chacón, *Lecture Notes in Computational Science and Engineering*, accepted (2006)

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