Abstract Submitted
for the DPP06 Meeting of
The American Physical Society

A Preconditioning Strategy for Fully Implicit Newton-Krylov Simulations of Resistive Magnetohydrodynamics[1] DANIEL REYNOLDS, University of California San Diego, RAVI SAMTANEY, Princeton Plasma Physics Laboratory, CAROL WOODWARD, Lawrence Livermore National Laboratory — Computational MHD of tokamak plasmas poses severe challenges due to its wide range of spatio-temporal scales, strong anisotropy and nonlinearity. Additionally, resistive MHD experiences increased ill-conditioning as the spatial meshes are refined to resolve diffusive layers. We present a fully implicit Jacobian-Free Newton-Krylov method for resistive MHD. Within this strategy, we present a preconditioning approach efficiently solve the linear system during the Krylov stage. The preconditioning stragegy is based on operator splitting in which the hyperbolic and diffusive sub-systems of the equations are separately preconditioned. The hyperbolic or ideal MHD part is preconditioned by an eigenmode decomposition, similar to those employed in upwind methods, and considering the fast and/or Alfvén waves. The diffusive sub-system of the equations is preconditioned using a multigrid technique. We demonstrate that such an approach grows increasingly necessary for efficient solution strategies as the spatial mesh is refined. We demonstrate our method with examples from MHD wave propagation, and magnetic reconnection.

[1]Supported by the DOE SciDAC Terascale Optimal PDE Solver project, and the DOE SciDAC Applied Partial Differential Equations Center.

Ravi Samtaney
Princeton Plasma Physics Laboratory

Date submitted: 24 Jul 2006 Electronic form version 1.4