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Preconditioning and Scalability of Implicit Extended MHD Plasma Simulation by FETI-DP Domain Substructuring[1] ALAN H. GLASSER, Los Alamos National Laboratory — The large range of multiple length and time scales in extended MHD plasma simulation makes it imperative to achieve efficient computation of implicit time steps on petascale parallel computers. The limiting factor is the rate of convergence of Krylov iterative solution of large, sparse matrices, which in turn depends on the condition number of the matrix, the ratio of the largest to smallest eigenvalues. As the size of the problem and the number of processors increase, it is essential that the condition number approximately approach a limit, not rise indefinitely, the property called scalability. Recent analytical work has proven this property for the application of the FETI-DP method of domain substructuring to a limited class of elliptic PDEs [1]. This method provides a coarse solution which assures scalability, and also an effective local method of preconditioning. We explore the extension of these results to more general systems, using computational rather than analytical methods to demonstrate scalability [2].

[1] Axel Klawonn and Olof B. Widlund, Dual-Primal FETI Methods for Linear Elasticity, Comm. Pure Appl. Math. 59, 1523-1572 (2006).
[2] A. H. Glasser and X. Z. Tang, The SEL macroscopic modeling code, Comp. Phys. Comm. 164, 1-3, 237-243 (2004).

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Alan H. Glasser
Los Alamos National Laboratory

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