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Fast Three Dimensional Reconstruction of Magnetohydrodynamic Equilibria in Plasma Confinement Devices[1] S.K. SEAL, M.R. CIANCIOSA, S.P. HIRSHMAN, A. WINGEN, R.S. WILCOX, E.A. UNTERBERG, Oak Ridge National Lab — High-fidelity reconstruction of plasma equilibria in confinement devices like stellarators and tokamaks with external three dimensional (3D) fields is computationally very expensive and routinely requires days, even weeks, to complete using serial approaches. Here, we present the performance results of coupling the 3D plasma reconstruction code, V3FIT, with PARVMEC, the recently developed parallel version of VMEC. We present the parallel design of this coupled software along with a scalability analysis to identify its performance bottlenecks. Dependence of its scalability limits on model parameters is derived. These analyses are supported by scaling studies on over 6,000 processor cores of a Cray XC30 supercomputer. PARVMEC, which dominates the total runtime of the reconstruction procedure, is shown to deliver speedup improvements of over one to two orders of magnitude, depending on whether the equilibrium computations are carried out in a free or fixed boundary mode. The overall speedup of the coupled reconstruction code is shown to deliver over 40X improvement enabling fusion scientists to carry out high-fidelity 3D plasma reconstruction analyses in only a few hours instead of in days/weeks for the first time.

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