MULTI-BLOCK DEVELOPMENT AND APPLICATION TO A SHEAR FLOW Z-PINCH KINK MODE STABILIZATION

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Abstract. Recent improvements to the 3D high-order finite (spectral) element HiFi [1,2] code allow for combining multiple domain blocks into a single computational domain. The blocks themselves must be structured, but the collection of blocks can be unstructured, forming a semi-structured high-order finite element hexahedral mesh. This new feature allows for much more complex and realistic domains to be modeled, including body-fitted and non-simply connected 3D geometries. Additionally an *a priori* mesh quality analysis [3] is applied to the new meshes to better understand the error associated with deformed mesh elements that result from the more complex geometric domains. Using this new capability of the HiFi code, a verification study of Z-pinch stability against external kink is performed on a semi-structured cylindrical grid. Applications of a shear flow stabilized Z-Pinch with non-axisymmetric geometry are also presented. The non-axisymmetric geometry aims to model changes in the ZaP Z-Pinch experiment design at the University of Washington, and will provide predictive modeling feedback to the experiment.

HiFi is a highly parallel, implicit, high-order finite element code used for solving systems of coupled nonlinear partial differential equations (PDEs), with a particular focus on the single- and two-fluid MHD. Currently, development of the code is centered at the PSI-Center as a collaboration between the University of Washington and the Naval Research Laboratory. The code makes use of the PETSc libraries for solver flexibility and scalability (see poster by A.H. Glasser), the portable HDF5 format for parallel data I/O, and VisIt software for visualization. The PDEs are expressed in the generic flux-source form, such that the user can easily specify the desired physical system of interest. Multiple studies of two- and three- dimensional systems of PDEs have already been performed with HiFi, with their focus ranging from resolving anisotropy of the anisotropic heat conduction equation solutions [4], to effects of grid deformation on global accuracy of differential operators [3], to magnetic reconnection in visco-resistive, electron and Hall MHD [2,5,6]. The Z-Pinch models described above are solved using a visco-resistive MHD model with hyper-resistivity.

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