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4P38 - Hybrid fluid/kinetic modeling of dense plasma focus devices using USim and VSim

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The Dense Plasma Focus (DPF) is a compact coaxial pulsed plasma source of radiation, especially neutrons. Researchers have known for some time that a DPF will produce more neutrons than one would expect from a purely thermal fluid prediction [S. Lee and S. H. Saw, Appl. Phys. Lett. 92, 021503 (2008)], and therefore the most accurate DPF simulations take into account kinetic effects [A. Schmidt, et al., Phys. Rev. E 89, 061101 (2014)]. Therefore, we are investigating how to leverage and integrate fluid and kinetic tools to study the DPF. We use the codes USim and VSim for this work. USim is a 3D capable, fluid plasma modeling framework that simulates the dynamics of charged fluids using any of a range of fluid models (for example, ideal MHD, extended MHD, or multi-fluid) on an unstructured grid. VSim is a 3D capable, kinetic particle-in-cell, FDTD modeling framework that can model fields with either Maxwell or Poisson equations. We present the results of varying initial conditions in the fluid code, such as density and background gas fill, on the formation of the pinch. We also present the results of varying the fluid model from ideal to extended MHD, including in particular Hall terms, to determine the effect of the electric field. We compare results with similar studies done in Athena [A. Beresnyak, et al., "Current disruption and electric field in dense plasma focus", 2018 APS DPP meeting, Portland OR; NO6.00002]. Finally we show the results of transitioning from fluid to full kinetic models and discuss the tools and algorithms we used for that. For all of this work, we use parameters relevant to the Hawk DPF at Naval Research Lab [S. Jackson, "Charged particle acceleration experiments in a dense plasma focus driven by a high-inductance generator", 2018 APS DPP meeting, Portland OR].

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