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Computational modeling of Krypton Gas Puffs on Z[1]

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Large diameter multi-shell gas puffs rapidly imploded by high current ($\sim$ 20MA, $\sim$ 100ns) on the Z generator of Sandia National Laboratories are able to produce high-intensity K-shell radiation. Experiments are currently underway to produce Krypton K-shell emission at $\sim$ 13keV, from double annular shell gas puffs imploded from a 12cm diameter onto a central gas jet. Efficiently radiating at these high photon energies represents a significant challenge which necessitates the careful design and optimization of the gas distribution. To facilitate this we hydro-dynamically model the gas flow out of the nozzle, before imploding that mass distribution using a 3-dimensional resistive, radiative MHD code (GORGON). We present details of how modeled gas profiles are validated against 2-dimensional interferometric measurements of the initial gas distribution, and MHD calculations are validated against power, yield, spectral and imaging diagnostics of the experiments. This approach has enabled us to iterate between modeling the implosion and gas flow from the nozzle to optimize radiative output from this combined system. Guided by our implosion calculations we have designed and implemented gas profiles that help mitigate disruption from Magneto-Rayleigh–Taylor implosion instabilities, while preserving sufficient kinetic energy to thermalize to the high temperatures required for K-shell emission. Predicted increases in yield from introducing a relief feature into the inner gas nozzle to create a radially increasing density distribution were recovered in experiment. K-shell yield is predicted to further increase by the introduction of an on-axis gas jet, although the mass of this jet must be carefully selected with respect to the delivered current to avoid reducing the yield. For Kr gas puffs the predicted K-shell yield increase from addition of a light central jet was realized in the experiments, considerably increasing the yield over previous results. Further confidence in our ability to model different gas profiles was added by comparisons with smaller diameter Ar gas puffs, where simulations reproduce the effect of a central jet for different gas profiles.

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