Abstract Submitted
for the DPP06 Meeting of
The American Physical Society

Viscous Heating of Ions through Saturated Fine-Scale MHD Instabilities in a Z-Pinch at 200-300 KeV Temperature MALCOLM HAINES, Imperial College, CHRISTINE COVERDALE, CHRIS DEENEY, P. DAVID LEPELL, BRENT JONES, Sandia National Laboratories, J.P. APRUZESE, Naval Research Laboratory — Pulsed power driven Z-pinches yield large X-ray powers at stagnation, the energy of which can exceed by up to factors of 3 or 4, the estimated kinetic energy of the implosion. Furthermore, when electron temperatures are measured at stagnation similar in temperatures would not lead to pressure balance. These problems can be resolved by a theoretical model in which short wavelength (ka $>>$ 1, and viscous Lundquist number $\sim$ 1), fast growing, m=O MHD instabilities reach a saturated amplitude, and the associated viscous dissipation of the vortices leads to ion heating. Equating this heating rate to the equipartition of energy to electrons leads to an estimate of the ion temperature and pinch radius at pressure balance. Extremely high ion temperatures in the range of 200-300 KeV are predicted from this model for stainless steel wire array experiments on Z at Sandia. These have been confirmed from time-resolved Doppler broadening spectroscopic measurements of the optically thin Fe He-δ line. This conversion of magnetic energy into ion thermal energy occurs on the nanosecond timescale, and can prevent radiative collapse. Any accompanying loss of magnetic flux in this highly conducting plasma can be explained by the occurrence of a large number of hot spots along the axis, with electron density and temperature variating not exactly in phase. This leads to a significant value of the integral of E.dl. Dl along the axis due to the grad Pe term in Ohm's law, analogous to the magnetic field generating term found in laser-plasma interactions. Ref 1. M.G. Haines, et al; Phys. Rev. Lett. 96, 075003 (2006) Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under Contract DE-ACO4-94AL85000.

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Date submitted: 31 Jul 2006 Electronic form version 1.4