ANALYTIC MODEL TO ESTIMATE THERMONUCLEAR NEUTRON YIELD IN Z-PINCHES USING THE MAGNETIC NOH PROBLEM. R. A. Agnew[1] and J. T. Cassibry[2], [1]The University of Alabama in Huntsville, Technology Hall N205, Huntsville, AL 35899, [1]The University of Alabama in Huntsville, Technology Hall S232, Huntsville, AL 35899.

Introduction: The objective was to build a model which could be used to estimate neutron yield in pulsed z-pinch experiments, benchmark future z-pinch simulation tools and to assist scaling for breakeven systems. To accomplish this, we utilized a recent solution to the magnetic Noh problem, (Velikovich, et al. 2012), a self-similar solution with cylindrical symmetry and azimuthal magnetic field [1]. The self-similar solution provides the conditions needed to calculate the time dependent implosion dynamics, from which we assume batch burn and calculate neutron yield. The solution to the model is presented. The ion densities and time scales fix the initial mass and implosion velocity, providing estimates of the experimental results given specific initial conditions. We show agreement with experimental data (Coverdale, et al. 2007). A parameter sweep was done to find the neutron yield, implosion velocity and gain for a range of densities and time scales for DD reactions.

Experimental Data Comparison: To validate the simulation, the time scales were set so that the resulting implosion velocity was almost identical to that estimated in the Coverdale paper. The length was assumed to be the pinch length of 2 cm given in the paper and γ was set to 1.5 to account for the other materials in the gas puff. The initial mass was $4.05\text{x}10^{-5}$ kg/m and was used to calculate the initial density, assuming the radius to be 4 cm [2]. It was found that linear time steps worked better than log steps, and the number of time steps was increased by a factor of 4 in an attempt to reach convergence. The program was run normally, with the exception that once the mass behind the shock was greater than or equal to the initial mass, the program would break out of the integration loop. It would then output the mass behind the shock, the neutron yield and the implosion velocity, where the implosion velocity was taken to be the velocity at the shock. The results are given below in Table 1 along with the results from the Coverdale paper.

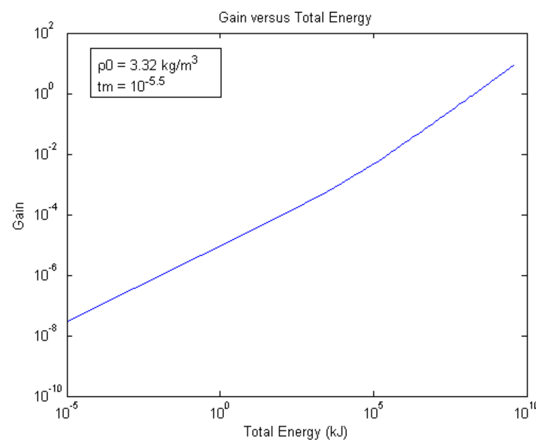
Table 1: Neutron Yield Results

	Neutron Yield	Implosion Velocity
Cloverdale	3.90E+13	1.00E+06
This work	3.39E+13	8.34E+05

The percent difference between the neutron yield of our work and the Coverdale paper is about 13%, which is within the range of uncertainties in plasma experiments.

Gain Calculation: A typical plot showing the system gain versus the total energy is given below in Figure 1 for an initial density of 3.32 kg/m^3 and a time scale of $10^{-5.5}$. The initial density and time scale are given in the insert. As can be seen from the plot, for high energies it is possible for the system to exceed a gain of unity.

Figure 1: Resulting Gain versus Total Energy Plot



References:

[1] Velikovich, A. L., Giuliani, J. L. et al (2012) *Physics of Plasmas*, 19, 1 – 12.

[2] Coverdale, C. A., Deeney, C. et al (2007) *Physics of Plasmas*, 14, 1-7.