Essentially, the problem I am now running into is that the plasma ends with more energy than it starts with. The equations I use for calculating the thermal and kinetic energy in the plasma are

and

where T is the temperature of the plasma in Kelvin, and vp is the speed of the plasma in m/s. Both of these depend on time. For vp we have the differential equation for the force, but for T we use the isentropic flow equation for temperature, which starts out as

We then expand the mach number in term of sound speed in the usual way:

Putting this back into the isentropic flow relation

And multiplying by T

Solving for T

Note that we have an equation for vp as a function of time, and we obtain the initial gas temperature from the yield, or else use it as an input

Aside: formulating the temperature in this way means that both the kinetic and thermal energy of the plasma are functions of the plasma velocity. Neat!

At any rate, using this formulation, for the PuFF plasma and circuit, with the resistances of both resistors set to 0, this yields:

Where the *0* subscript denotes an initial value and the *f* subscript denotes the final value. Continuing from above, this means

Which is more than the 8.86 GJ of starting thermal energy. However, if we take into account the initial kinetic energy, which is 3.84 GJ then

Which is more than the combined final thermal energy and kinetic energy, so energy is conserved in that sense. More troublingly however, I added the thermal energy to a plot of all the energies in the circuit, shown below

A close up of a map

Description automatically generated

I had to rotate it sideways to make the text more legible, but as shown the total energy, calculated as follows

Starts off around 10.3 GJ, increases to 12.7 GJ, and decreases to 98.8 GJ at the end. I am not quite sure how to proceed here; guidance would be appreciated. I also attached the matlab figure and the code I have been using.