Homework 8
Due: *Monday, April 25, 2020*

1. Energy Spread: Consider a positron beam with a flat top profile, i.e. $\rho(\xi) = +\rho_0, \xi_0 \leq \xi \leq \xi_0 + \pi/4$, where all variables are in normalized units placed inside a linear wakefield such that the head of the beam experiences peak accelerating force.
(a) What is the field experience by the positrons inside the beam?
(b) Calculate the fractional energy spread of this beam $\Delta E = \frac{E_{max} - E_{min}}{E_0}$, where E_0 is the average energy of the trailing bunch.
(c) Determine the efficiency of beam loading? i.e. how much energy is left in the wake after it is loaded?

2. Conceptual problem: In the study of beam loading in the nonlinear regime, we stated that if the electrons arrive on axis with no transverse momentum, it implies that they have zero longitudinal momentum as well. Why is that?

Jupyter Notebook
3. With notebook in "Beam Loading in the linear regime (beam driver)" folder to verify predictions of the linear theory. In particular for the "flattened wakefield" show that the peak beam density, max bunch length, accelerating field, and the efficiency are consistent with equations derived in class. Select $n_b^{driver} = 0.005$ as the initial driver density.

4. (not graded, requires direct manipulation of input deck) Use the notebook in "Beam Loading in the linear regime (beam driver)" folder as a starting point to verify your calculations in question 1. In particular demonstrate the relationship between efficiency and total charge loaded in the wakefield.