Dilution Analysis

Method

- $A_{meas} = \frac{\left(Y_+ + \frac{1}{2}\mathrm{n(bg)}\right) - \left(Y_- + \frac{1}{2}\mathrm{n(bg)}\right)}{\left(Y_+ + \frac{1}{2}\mathrm{n(bg)}\right) + \left(Y_- + \frac{1}{2}\mathrm{n(bg)}\right)} = \frac{Y_+ - Y_-}{Y_+ + Y_- + \mathrm{n(bg)}}$ ⟶ $Y_{+(-)}$ = yield from polarized protons; n(bg) = background events

- Define a dilution factor: $f \equiv \frac{Y_+ + Y_-}{Y_+ + Y_- + \mathrm{n(bg)}}$

- $A_{exp} = \left(\frac{Y_+ - Y_-}{Y_+ + Y_- + \mathrm{n(bg)}}\right)\left(\frac{Y_+ + Y_- + \mathrm{n(bg)}}{Y_+ + Y_-}\right) = \frac{1}{f} A_{meas}$

- So the first step to find the dilution factor is to express the number of detected electrons in terms of the contribution from each material (background).

- $\mathrm{n(bg)} = n_f + n_{He} + n_N$

$$f \equiv \frac{\rho_f l_f \sigma_f}{\rho_C l_C \sigma_C} = \frac{n'_f}{n'_c}$$

- $n_c = \rho_C l_C \sigma_C + \rho_{He}(L - l_C)\sigma_{He}$
- $n_{empty} = \rho_f l_f \sigma_f + \rho_{He} L \sigma_{He}$

$$n'_{He} = \frac{L(1-f)}{L(1-f) + f l_c} n_{empty} - \frac{fL(1-f)}{L(1-f) + f l_c} n_c$$

$$n'_C = \frac{L - l_c}{L(1+f) + f l_c} n_{empty} - \frac{L}{L(1+f) + f l_c} n_c$$

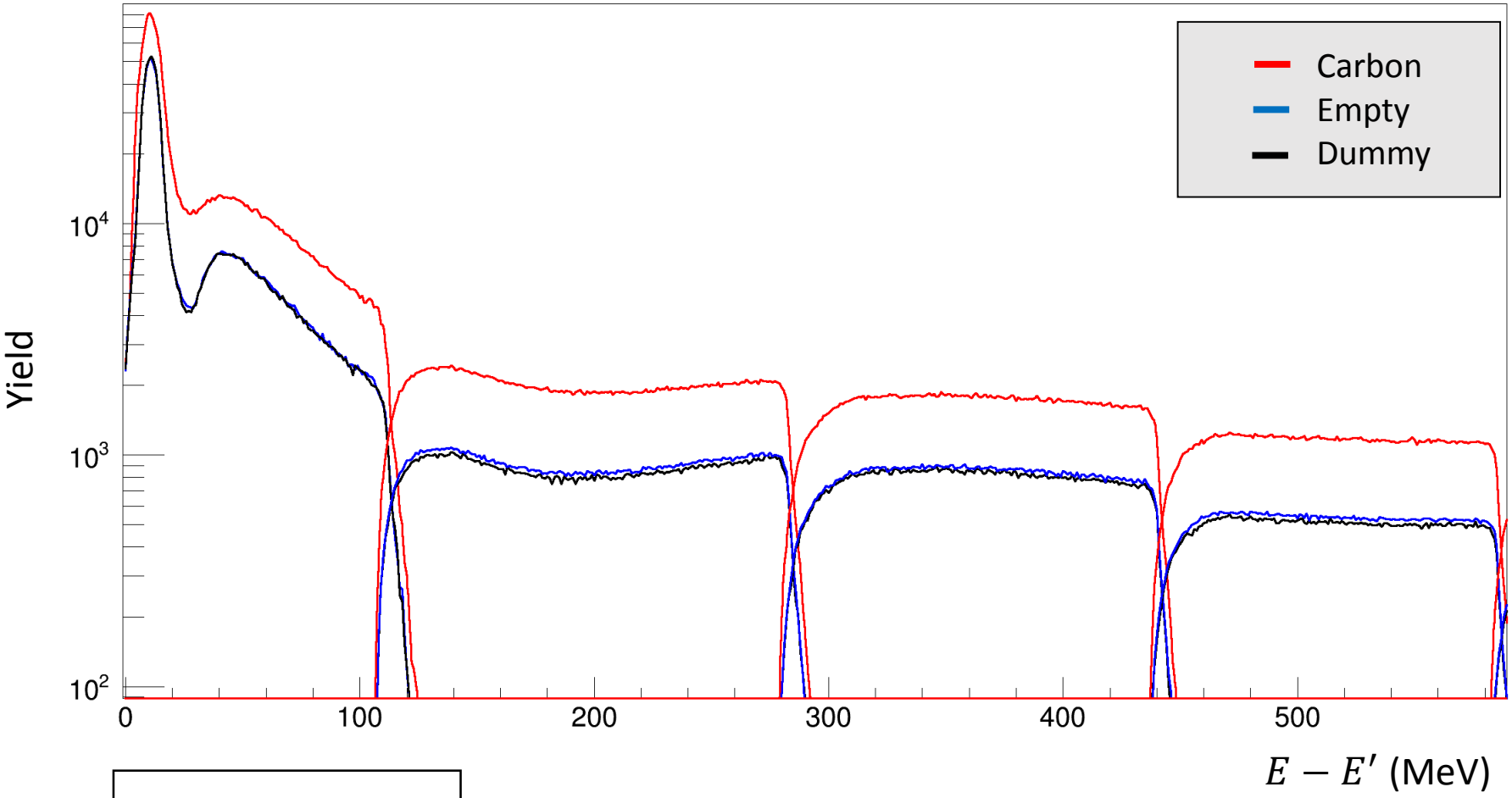
- $n_N = \rho_N l_N \sigma_N + \rho_{He}(L - l_N)\sigma_{He}$

  For nitrogen counts assume the following:
  - $\sigma_N = 7\sigma_D + \sigma_n$
  - $\sigma_C = 6\sigma_D$
  - $\sigma_N = \frac{7\sigma_D + \sigma_n}{6\sigma_D}\sigma_C = \left(a + b\frac{\sigma_n}{\sigma_D}\right)\sigma_C$

$$n'_N = \frac{\rho_N l_N}{\rho_c l_c}\left(a + b\frac{\sigma_n}{\sigma_D}\right) n'_c + \left(1 + \frac{l_N}{L}\right) n'_{He}$$

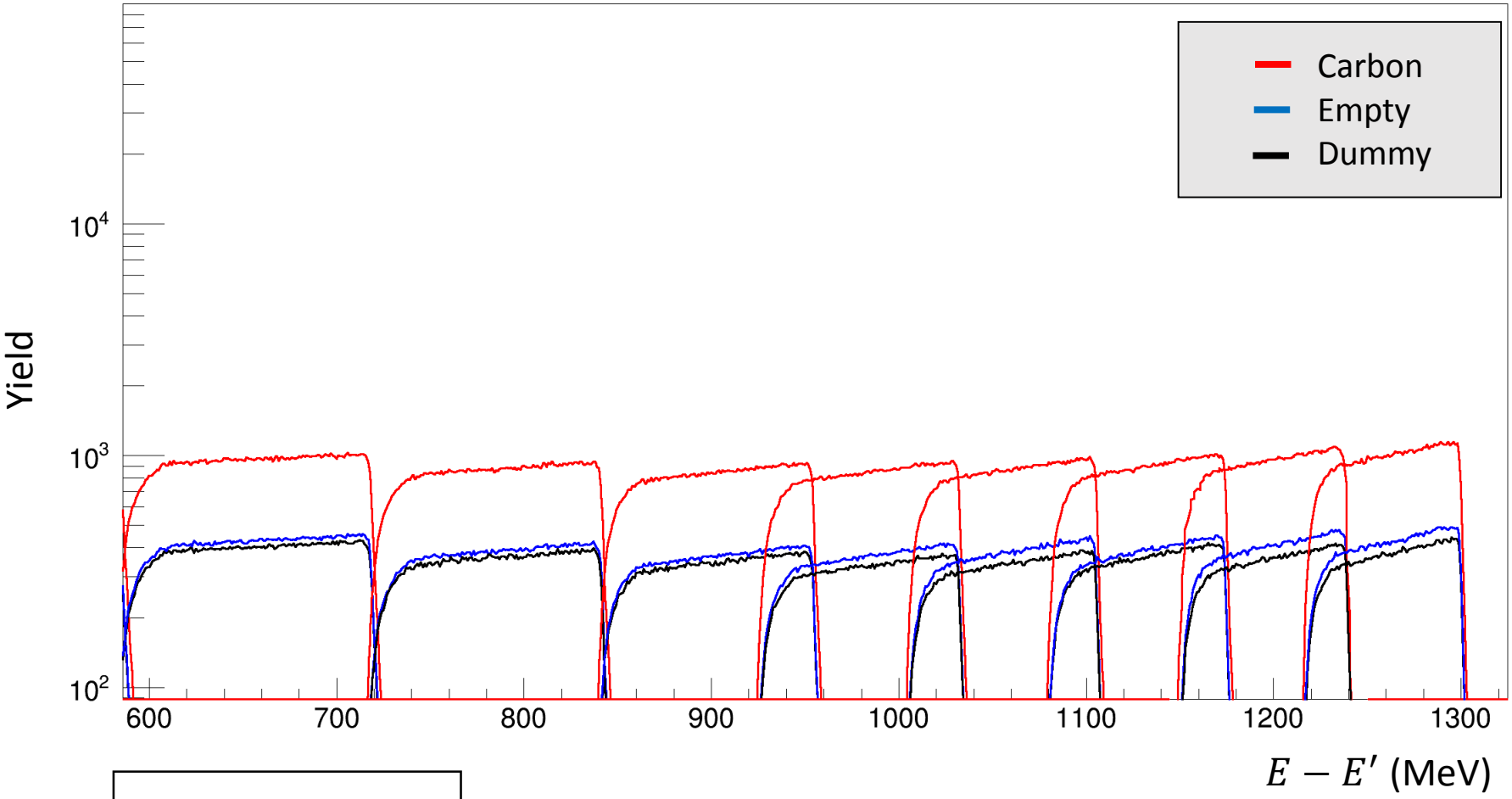
Now the background contribution from each material is expressed in terms of known quantities (from dilution runs).

2.254 GeV 5T Yield



$$\text{Yield} = \frac{N * ps}{Q * LT}$$

2.254 GeV 5T Yield



$$\text{Yield} = \frac{N * ps}{Q * LT}$$

To Do:

- All dilution runs are replayed.
- Next step is to organize dilution runs by target type for each beam energy/momentum setting (in progress)
- With all dilution runs organized I can determine normalized counts/bin for each setting and target.
- $\frac{\sigma_n}{\sigma_D}$ obtained from world data?