Forward Spectrometer Update 1/12/20

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Updates

- Still working on implementation of secondary air effects in deconvolution algorithm - contribution preliminarily seems small in comparison to direct conversion
- Looked into INFN FLUKA manual for pair production/bremsstrahlung cross section formulae - results taken from those tabulated by Berger and Seltzer. Not accessible at QUB
- GEANT4 manual gives explicit formula used for energies less than 80 GeV, the form-corrected Bethe-Heitler cross section
- This has been compared to current approach and is being implemented into deconvolution algorithm as well
- Work also being done to produce radiation maps for experimental area. Still some problems in conversion process but once these are fixed, should be straightforward to get desired plots

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Form-Corrected Bethe-Heitler Formula

- Formula given in Tsai's paper https://doi.org/10.1103/RevModPhys.46.815 (as well as in GEANT4 manual) where $x = E/k$

$$\frac{d\sigma(Z,x)}{dx} = \alpha r_e^2 Z[Z + \xi(Z)] \left\{ [x^2 + (1-x)^2] \left[\Phi_1(\delta) - \frac{1}{2} F(Z) \right] + \frac{3}{2} x(1-x) \left[\Phi_2(\delta) - \frac{1}{2} F(Z) \right] \right.$$

- This takes into account various factors such as nuclear screening, pair production in electronic field, Coulomb correction to Born approximation etc.
- Currently used analytic formula given by Klein https://doi.org/10.1016/j.radphyschem.2005.09.005

$$\frac{d\sigma}{dx} = \frac{A}{X_0 N_A} \left[1 - \frac{4}{3} x(1-x) \right]$$

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Comparison of Analytical Formulae

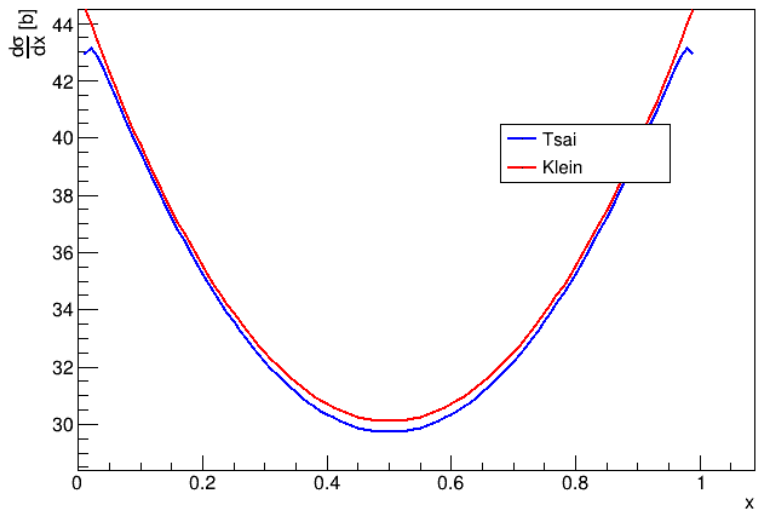

Figure: Comparison of the pair production formulae given by Tsai (blue) and Klein (red).

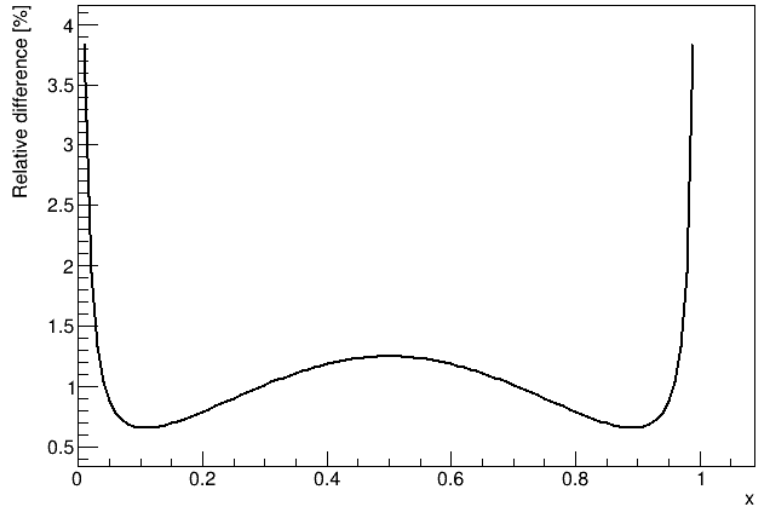

Figure: Plot of the relative percentage difference between Tsai's correcte Bethe-Heitler formula and the high energy approximation by Klein.

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