Straggling Problems

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Statement of the Problem

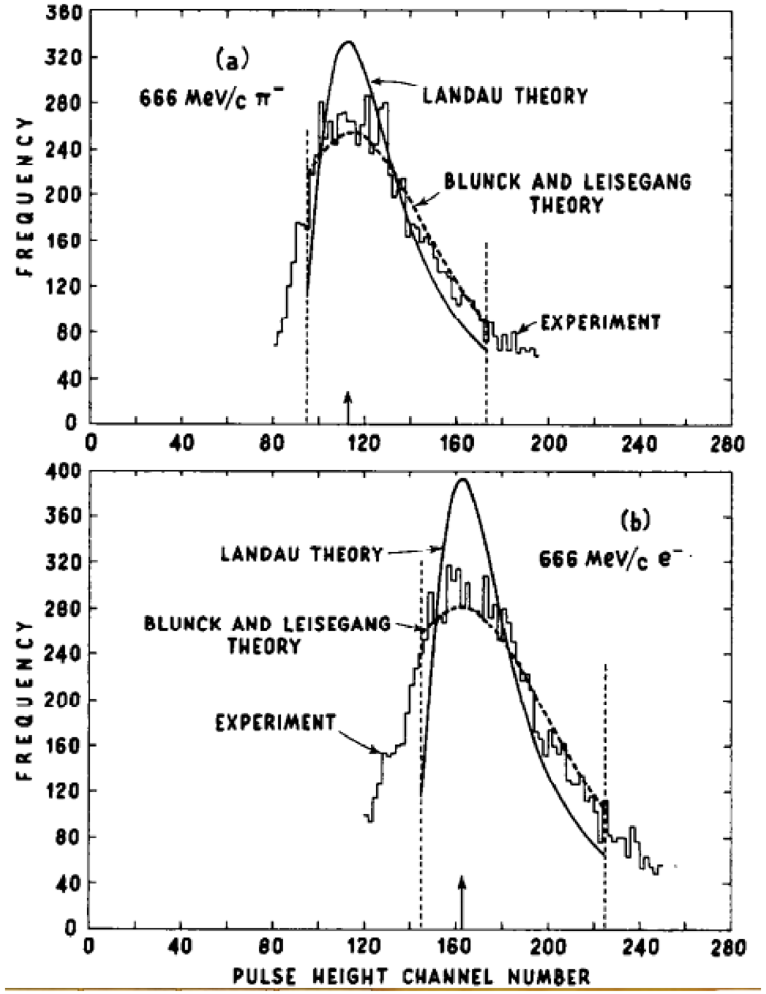
- Landau and Vavilov theory (hereafter simply referred to as “Vavilov theory”) do not quite describe energy loss in a full manner.
- This is because Vavilov theory does not account for electron binding energies.
- We must therefore either modify Vavilov theory or abandon it and find a suitable way to describe straggling.

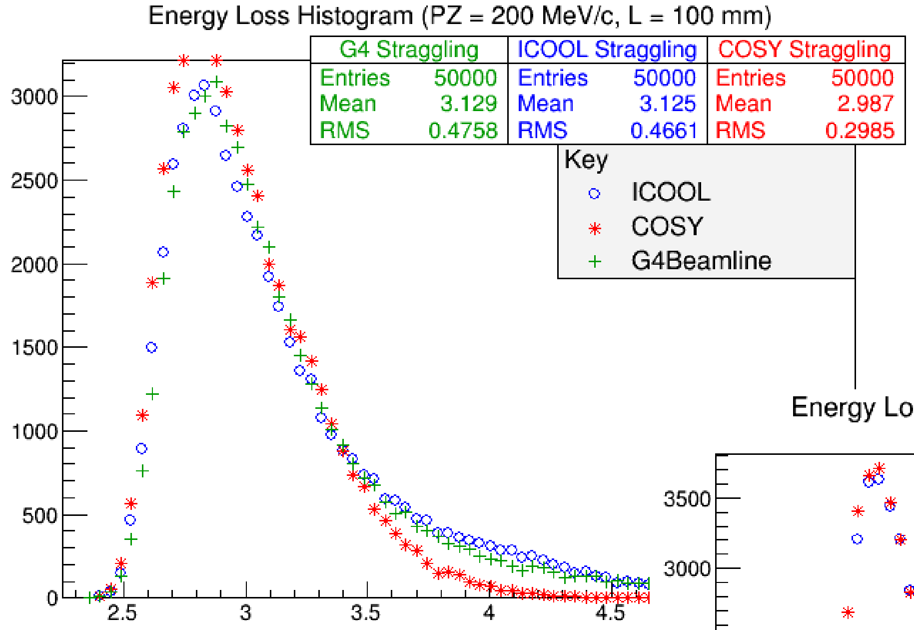
Statement of Attempted Solutions

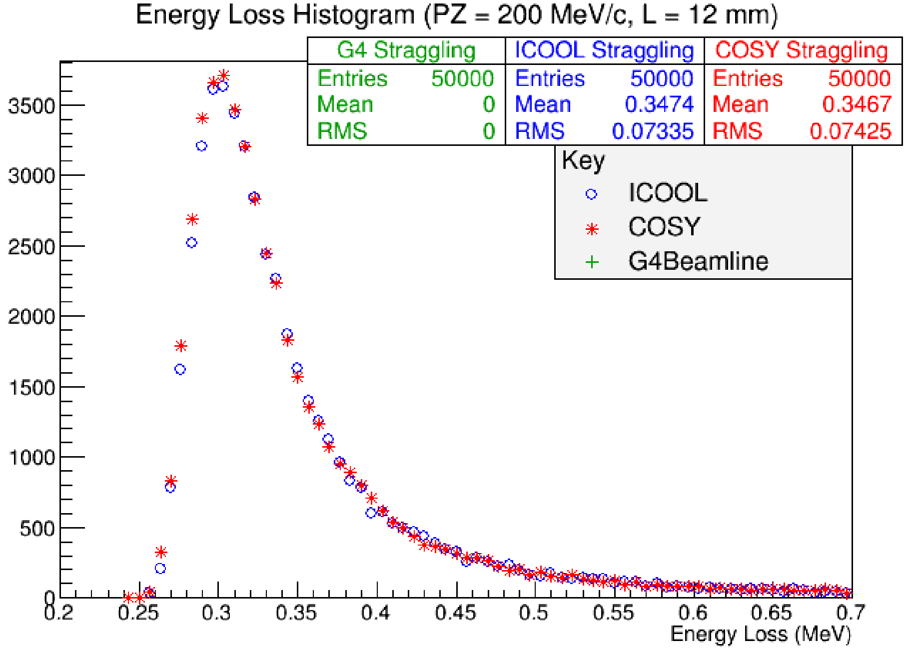
- Blunck and Liesegang (1950) (also used by Mejaddem et. al. (2000)) published a paper in which a correction for the electron binding energy was attempted. This resulted in a better peak position and width (see Fig. 1). However, it is not suitable for our needs (see Fig. 2).
- According to Weinhous (1984):

  "The commonly used Blunck and Leisegang electron energy-loss distribution falls off too rapidly with increasing energy loss. Also, for large thicknesses and/or low-Z media, where their distribution should approach Landau's, it normalizes to 0.92 rather than 1.0, it overestimates the number of very small energy-loss events, and its peak is shifted from lambda = -0.225 to 0.1. Because of these shortcomings, calculations made using this distribution yield a mean straggled energy loss which is lower than the value predicted by the continuous slowing down approximation (CSDA)."

Figures 1 and 2: Blunck-Liesegang Corrections







Statement of Attempted Solutions

- We can also attempt to functionalize the Vavilov parameters α, β. However, the energy loss for thick absorbers cannot be described by any Vavilov function (see Fig. 3).
- Several complicated solutions exist, but many are aimed specifically for small step sizes (i.e. not the desired 10 cm mark).
- Kellerer in particular has published a paper in microdosimetry (radiological physics) which uses the compound Poisson method, which boasts quick and exact results up to an order of your choosing.
- I personally like Kellerer's approach, but I simply cannot figure it out.

Figure 3: Vavilov Fit to ICOOL Histogram