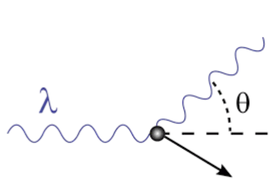
SPECTRUM OF COMPTON SCATTERING

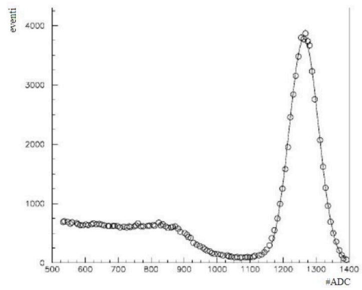
Cesium-137 is a radioactive isotope which decays via beta emission (half life of 30.2 years) to a an excited metastable state of Barium ^{137m}Ba. This state decays with a half-life of 153 seconds to the ground state ^{137}Ba emitting a photon with energy E_0 = 662 keV. We want to study the spectrum of ^{137}Cs and the effect of Compton scattering.

1. Generate 10000 photons with energy E_0.
2. Each photon is detected with a NaI crystal which has a resolution of 3%. Use a Gaussian convolution and plot the distribution of detected energy E_i of all photons. Make sure reasonable binning are used for the histogram and labels and units are added. The expected distribution should be a Gaussian entered at E_0.
3. Assume that each photon has a 60% probability of undergoing Compton scattering in the crystal.
4. The energy E_f of the photon after the scattering is given by where me is the mass of the electron (511 keV) and θ is the angle of the photon after scattering as shown in the figure.

$$E_f = \frac{E_i}{1 + (E_i/m_e)(1 - cos\theta)}$$



5. The angle θ must be generated casually assuming that the differential cross section
$$\frac{d\sigma}{d\cos\theta} \propto 1 + \cos^2\theta$$
If you do not know how to do this, you can generate a flat distribution for θ (with a penalty).
6. Plot the distribution of for all 10000 photons. You should still see a peak around E_0 and a continuous distribution (a Fermi-Dirac shape) for E_f<0.



Save a PDF file for each of the above 2 plots. Use comprehensions and dictionaries to implement the simulation and plotting the required plots. Define a function `Compton` (with proper arguments and return values) to simulate the scattering for each photon of energy E_i at each step for each particle.

Evaluation will be based on use of python features and data structures, comprehensions (instead of C-style for loops), dictionaries, NumPy objects, labels, units, and clarity of plots.