Homework n.4

a.a. 2022-2023

Monte Carlo method and simulation

1) Evaluate the integral $\mathrm{I} = \int_{-\infty}^{+\infty} e^{-\frac{x^2}{2}}\, dx$ using two Monte Carlo methods:
   A) miss or hit
   B) the mean method.
   C) From the obtained value, considering that $I = \sqrt{2\pi}$, get an estimate of the irrational number π.

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2) – OPTIONAL – Generate a histogram with 10000 events extracted from the $f_1(E)$ part of the energy spectrum f(E) of Homework n.1 (consider only $f(E) = f_1(E)$)
including the effect of a gaussian resolution $\sigma(E)/E = 10\%/\sqrt{E(MeV)}$.
Consider that to implement the resolution, each energy value E_i extracted from the spectrum f(E) has to be smeared for the resolution $\sigma(E_i)$.

Hint: fill the histogram with the smeared energy according to resolution:
$E_i' = g[E_i; \sigma(E_i)] = E_i + \sigma(E_i)\, g[0;1]$
where g[0;1] is a random variable distributed as a gaussian with zero mean and unitary standard deviation.

Compare qualitatively the histogram with the result obtained evaluating the convolution integral.

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3) Reproduce the experimental distribution of the KL decay distances from the IP in Homework n.3.

Simulate:

- angular distribution of KL (neglect the Phi boost): $dN/d\Omega \propto \sin^2(\theta)$
- distribution of KL decay vertices (probability to decay according to an exponential law)
- resolution on the x,y, z coordinates of the reconstructed vertex of 1 mm (assume gaussian resolutions)
- Neglect interaction of KL with beam pipe and DC inner wall.

Evaluate:

- the geometrical acceptance for KL decays in the considered fiducial volume in Homework n.3
- the distribution of the distance from IP for the events decaying inside the FV.
- the distribution of the transverse distance from IP (transverse with respect to the beam direction along the z axis) for the events decaying inside the FV.