Solution for homework assignment no. 07

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Exercise 7.1

We are asked to determine the expected standard deviation of λ where $I(\lambda)$ is the Fisher information and $\hat{\lambda}$ an efficient operator. The decay time distributions for $\mathcal{B}^0 \to J/\Psi K_s^0$ and $\overline{\mathcal{B}^0} \to J/\Psi K_s^0$ are

$$N_{\mathcal{B}^0 \to J/\Psi K_s^0} \propto e^{-t}\left[1 + \lambda \sin(0.7t)\right],$$
$$N_{\overline{\mathcal{B}^0} \to J/\Psi K_s^0} \propto e^{-t}\left[1 + \lambda \sin(0.7t)\right].$$

To calculate the standard deviation we shall use a value of $\lambda = 0.3$.

a) We consider 500 decays of $\mathcal{B}^0$.

b) We consider 500 decays of $\overline{\mathcal{B}^0}$.

c) We consider 250 decays of $\mathcal{B}^0$ and 250 decays of $\overline{\mathcal{B}^0}$.

d) Put very nice explanation here.

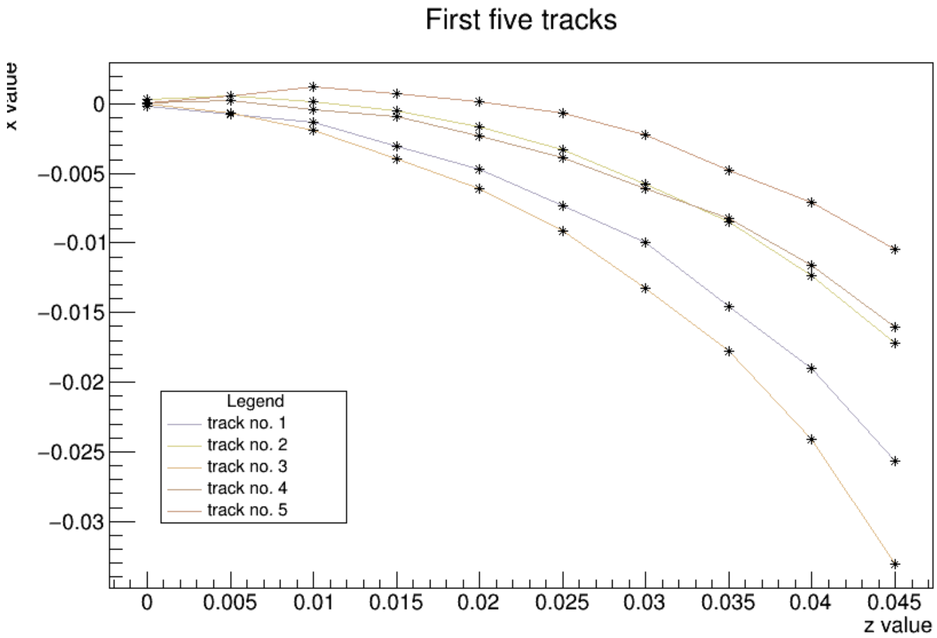
Exercise 7.2

Given electron tracks we are asked to first plot five tracks into one image. Afterwards we shall construct a theoretical model for the motion of electrons under the influence of a magnetic field. Using this model we have to fit it to the given data using a self-written χ^2 model. After plotting different values we eventually state a potential isotope from which the electrons come from.

As usual, please find the script in the text file `exercise7_2.C`.
You can find the visualisation of the tracks of the first five electrons in figure 1.
The model to consider here gives rise to the following equation

$$q \cdot \vec{v} \times \vec{B} = \vec{p} \cdot \vec{v} \cdot \frac{\vec{r}}{r}. \tag{1}$$

Figure 1: Movement of the first five tracks from the file `exercise07.root`. Please not that the x and z positions are switched to enable fitting.



Since we assume that the magnetic field is only pointing perpendicular to the motion of particles, we can simplify the equation. Switching back to cartesian coordinates yields

$$x = -\frac{p_z}{|q| \cdot |B|} \cdot \cos\left(\frac{|q||B|}{m_e}\right), \tag{2}$$

$$y = +\frac{p_z}{|q| \cdot |B|} \cdot \sin\left(\frac{|q||B|}{m_e}\right), \tag{3}$$

where $x^2 + y^2 = \left(\frac{p_z}{|q| \cdot |B|}\right)^2$ and therefore $y = \sqrt{\left(\frac{p_z}{|q| \cdot |B|}\right)^2 - x^2}$.