

An Introduction to “WIENFILTER”

Exercise 2: Using it As a Spin Rotator

Recommended readings

- Section “2.7 - Wien filter” in ../../documentation/eRHICelectronWF.pdf
- Section “4 - Rotation in dipoles and solenoids” in ../../documentation/polarizationOfZgoubi.pdf
- Zgoubi Users’ Guide, regarding the keywords used in the exercise (WIENFILTER, OBJET/KOPT=2, FIT[2], REBELOTE, etc.). Hint: use the index (last 3 pages of the Guide) to locate the related sections in Part A and Part B.
- During the exercise, it is recommended to keep 2 copies of the guide at hand, with one copy opened at the Index (last 3 pages of the document).

Keywords we play with in this exercise

WIENFILTER is used in this exercise (pp. 168 and 306 in the Users’ Guide). B and E are set so to ensure (i) straight trajectory across the Wien filter, (ii) proper spin rotation from initial longitudinal orientation.

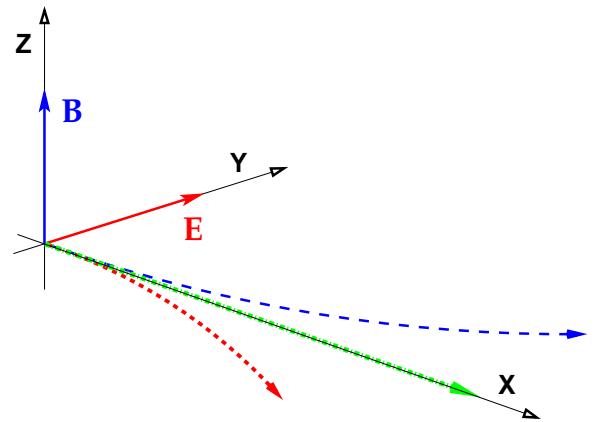
Working hypotheses

- The Wien filter length is L
- Take $\vec{E} \parallel \vec{Y}$ and $\vec{B} \parallel \vec{Z}$ (as sketched to the right)
- E and B fields are taken hard-edge so to allow tight comparison with theory
- Electron trajectory is straight, so $E = v B$

Expectations include:

- Straight trajectory across the Wien filter (green, in the figure)
- 30° spin rotation

$$\theta_Z = \underbrace{(1 + a\gamma) \frac{BL}{B\rho}}_{\approx 50^\circ \text{ from } \vec{B}} - \underbrace{(a\gamma + \frac{\gamma}{1 + \gamma}) \beta^2 \frac{BL}{B\rho}}_{\approx 20^\circ \text{ from } \vec{E}} = 30^\circ$$



Numerical experiments

- 1/ Set up a Wien filter in zgoubi with length $L = 0.5$ m, and B and E such to (i) ensure straight trajectory, (ii) ensure 30° spin Z-rotation. FIT can be used. Compare with theory.
- 2/ Check the effect of step size on the accuracy on spin rotation value:
 - 2.a - Using REBELOTE, get a scan of θ_Z for Δs varied from .01 cm to 10 cm in 100 steps. Plot θ_Z versus Δs (can use gnuplot to plot data read from zgoubi.fai).
 - 2.b - Let's do it differently, namely, check the effect of step size on E and B values instead: Add FIT prior to REBELOTE, so to constrain θ_Z to its expected 30° value. The variables in the FIT are E and B. Plot E and B versus Δs .
- 3/ Align three 30° Wien filter rotators to get 90° spin rotation. Make sure the spin rotation amounts to the expected value. Compute the spin transport matrix.

3/ Add fringe-fields, re-do a FIT on E and B for straight trajectory and $\theta_Z = 30^\circ$ spin rotation.
Compare the new E and B values with the hard-edge case.