Implementation and Validation of Non-Uniform Magnetic Fields into PENELOPE penet

Jacob Groeneveld1,2, Fletcher Barrett1,3, Charles Kirkby1,2

1 University of Calgary / Department of Physics and Astronomy, Calgary, AB.
2 Jack Ady Cancer Centre / Division of Medical Physics, Lethbridge, AB.
3 Tom Baker Cancer Centre / Division of Medical Physics, Calgary, AB.

- This work provides a reliable and accurate means of simulating electron transport via PENELOPE in non-uniform (realistic) magnetic fields.
- We validate our implementation of non-uniform magnetic fields in PENELOPE against a 4th-order Runge-Kutta (RK4) numerical solution.

Impact / Innovation

Materials & Method

- A means of introducing a magnetic field map to PENELOPE simulations from a user-defined text file is developed.
- We introduce a trilinear interpolation scheme into PENELOPE source code so that the field can be obtained at any point in the volume.
- As validation, 6, 12, and 18 MeV test electrons with a polar angle of 45° were transported through a linearly increasing magnetic field directed parallel to the z-axis with a strength from 0 T to 10 T over 50 cm.
- 25 MC trajectories for each energy were evaluated against the RK4 prediction.

Results

Electron trajectories in a linearly increasing magnetic field predicted by MC and RK4 methods.

The cumulative error is shown as the difference between the MC and RK4 methods. The 95% confidence interval from 25 histories is shown by the shaded region.

Conclusions

- PENELOPE simulations using our implementation of arbitrary non-uniform magnetic fields yield electron trajectories consistent with RK4 solutions and our implementation can be confidently used in further studies.

References


EMAIL: Jacob.Groeneveld@ucalgary.ca

Code available on GitHub