Propagating in a Magnetic Field in AdePT

AdePT developers

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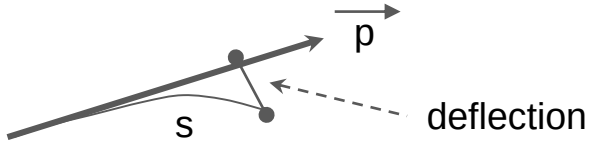
Propagation in a magnetic field



AdePT breaks each physics step into segments to decrease chance to miss a volume

- deflection from momentum direction smaller than pre-set ‘miss distance’
- this allows to precalculate this distance - simpler than G4’s which uses test step’s sagitta.

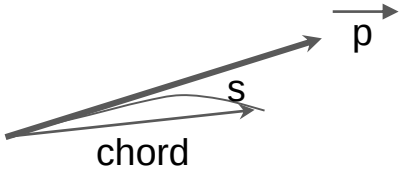
An integration substep charged particle tracks the minimum of

- The remaining distance to achieve the physics step
- The estimated length that produces the deflection

The initial version implements a helix for constant magnetic field (e.g. Bz in example13)

- The field and integration method are selected in electron kernel using a ‘fieldPropagation’ interface

Challenges and approximations



Each integration segment must be checked against the geometry

- Except if the chord length is smaller than the isotropic safety

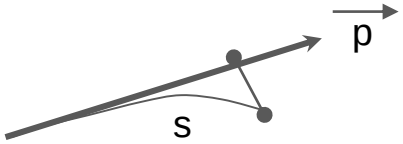
So substantially different code paths are involved (independent of integration method):

- whether (or not) a volume boundary is encountered by the chord, but also
- a variable number of ‘chord’ segments.

Currently the results of the boundary crossing are approximated

- the location is that of the first attempted chord-boundary intersection;
- the momentum direction is estimated using the initial and final momentum.

Improvements



Overcame issues with particles stuck at boundaries

The geometric (isotropic) safety is reused or recalculated

- reduced the number of navigator calls and improved performance.

Tackled tracks that need large number of ‘chord’ substeps

- A maximum number (default=100) is imposed (to limit divergence)
- Reducing it to 10 yielded 10% performance improvement - but involves more approximate msc length conversions.
- Investigating how to benefit with minimal or no extra such approximation.

A global step limit ensures that charged particles looping in a low-density medium do not live ‘forever’

- Count the global steps without a change in number of electrons, if only electrons are left in event,
- After a maximum number (200) of these in a row, the simulation is ended.

Outlook

Integration using Runge-Kutta (5th order Dormand Prince) for non-uniform fields

- is under development

Reducing divergence remains a challenge - and it's coupled with need for some tracks to interrogate the navigator (potentially repeatedly)

Methods with interpolation (recently used in Geant4) offer intermediate points

- But 'ordinary' 7 stage methods (DoPri5) need 60 FP values!

Evaluating alternative RK methods with reduced storage (will require fewer registers)

- but no interpolation is possible - intermediate values are overwritten!