G4MICE vs ICOOL

Chris Rogers,
ASTeC,
Rutherford Appleton Laboratory
G4MICE and ICOOL

- **G4MICE**
  - Written for MICE experiment
  - Based on G4 physics model
    - Tracking
    - Physics processes
  - Adds field maps for multipoles, solenoids, rf cavities
  - Plus some beam optics, mapping, analysis routines
  - Last time I did a detailed study of the tracking was ~ 3 years ago
  - Tracking by integration of Lorentz force with 4th order RK

- **ICOOL**
  - Written for simulation of cooling for Nu Factory and Mu Collider
  - Internal physics and tracking routines
  - Many different field models
  - “Well known” by community
Cell Model

- 3 m cell
  - Start with just magnets
  - Then add pillbox cavities
  - First look at rf field maps also
    - Not in most of my simulations, but will want it sometime
  - Ambition to add Parmila solenoid field maps
  - Then add IH2
  - Don't look at windows yet
    - But will want this also soon
    - Presume if we have IH2 that's “good enough”
**ICOOL, magnetic field only**

- \(x(\text{step}) - x(1\times10^{-5})\) [mm], where step is step size in tracking
- BiLinear interpolation from a field map
  - Grid spacing 5 mm in \(r\) and 1 mm in \(z\)
- Disable dynamic step size allocation
- Use ICOOL field map in G4MICE
  - Compare tracking in ICOOL step=1e-5 m with G4MICE step=1e-4 m
  - Compare G4MICE field map with ICOOL

- Use G4MICE field map, all BiLinear interpolation
  - Tracking in ICOOL with ICOOL field map, step size 1e-5 m
  - Compare with tracking in G4MICE with G4MICE field map
Choose grid size for magnetic field map
- Quite a hard cut-off as z grid size changes
- Gradual cut-off for radial grid size
- Choose $dz = 0.05$ m, $dr = 0.02$ m, step=0.1 m
  - Enable dynamic step size allocation
  - Nominal error 1 mm
- Introduce RF cavity
  - Analytical model for pill box
  - Compare ICOOL step size 1e-4 with G4MICE
  - x limited by magnetic field map size
  - 0.1 m step size still ok
Absolute value of field seen by particle travelling at c
Peak E-Field = 17.5 MV/m, peak B-field ~ 20 mT
Introduce RF field map from superfish

- Compare with pillbox
- Look for self-consistency
Now add liquid Hydrogen
- Stochastics switched off!
- Look at difference between G4MICE tracking and ICOOL

Switch on stochastics
- Track through 20 cm of IH2 in field map
- Look at distributions before and after IH2
- 1e5 muons with initial $p=230$ MeV/c, no transverse
Conclusions

- Simulation codes compare well
- For identical field models, tracking in G4MICE is convergent on tracking in ICOOL
- Started checking Superfish field map routines
- Physics processes in IH2 look similar