G4MICE vs ICOOL

Chris Rogers,

ASTeC,

Rutherford Appleton Laboratory
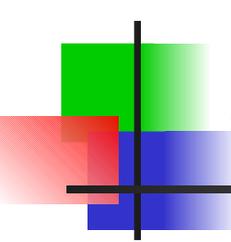
G4MICE and ICOOL

- 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

Start   End
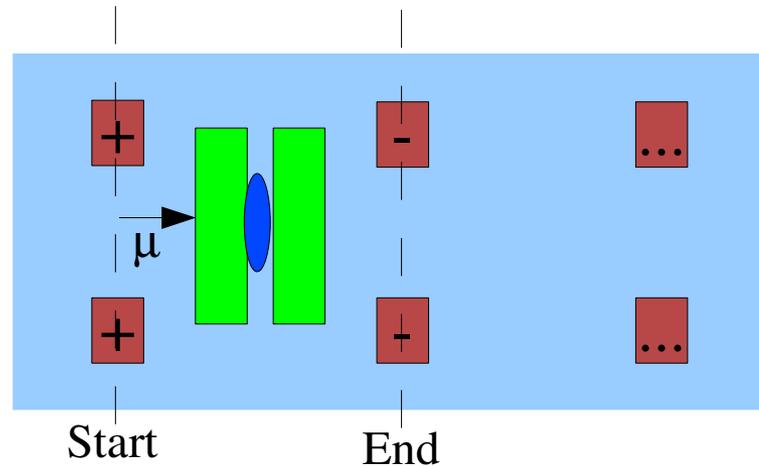
- 3 m cell
  - Start with just magnets
  - Then add pillbox cavities
  - First look at rf field maps also
    - Not in most of my simulations, but will want it sometime
  - Ambition to add Parmila solenoid field maps
  - Then add lH2
  - Don't look at windows yet
    - But will want this also soon
    - Presume if we have lH2 that's "good enough"
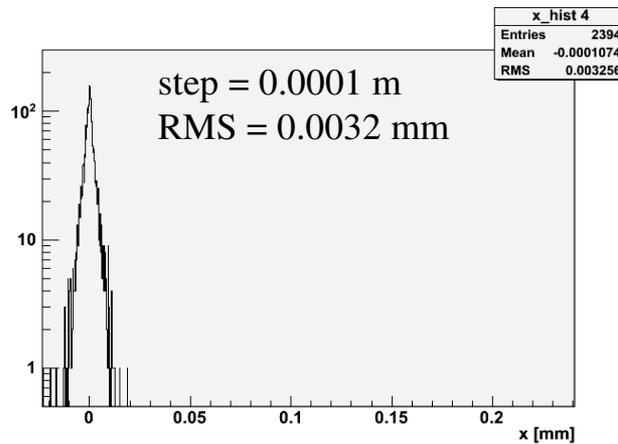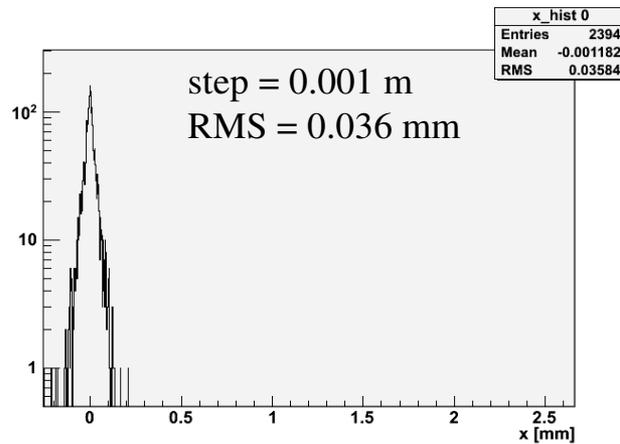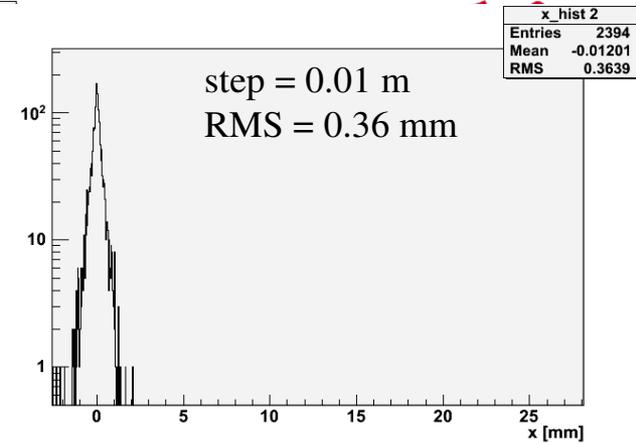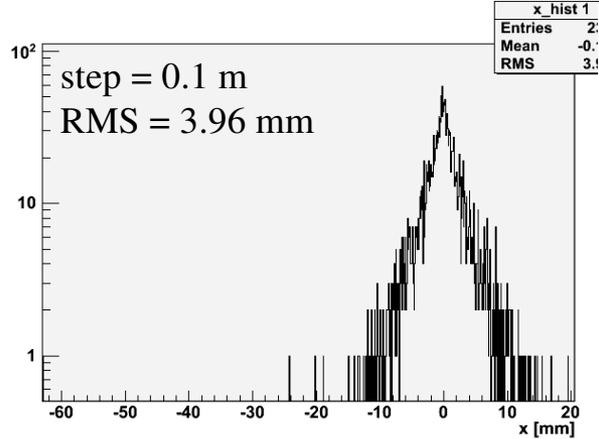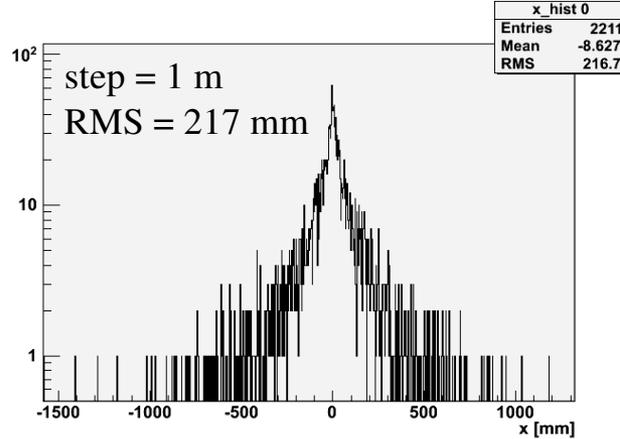
- **ICOOL, magnetic field only**
  - $x(step) - x(1e-5)$ [mm], where step is step size in tracking
  - BiLinear interpolation from a field map
    - Grid spacing 5 mm in r and 1 mm in z
 - Disable dynamic step size allocation
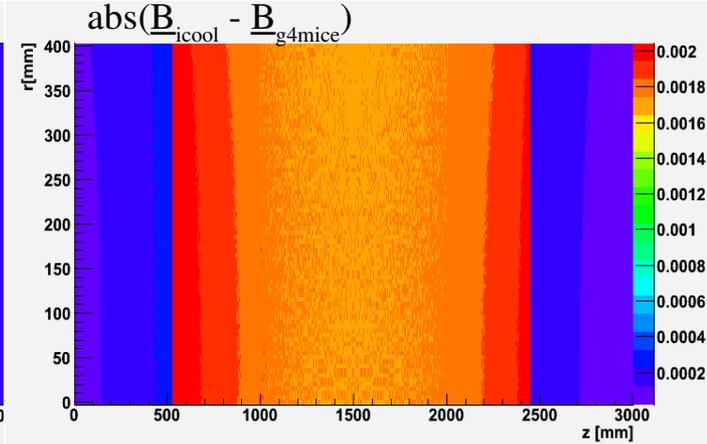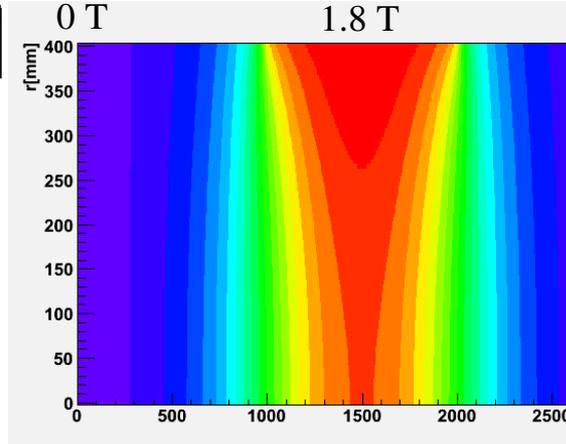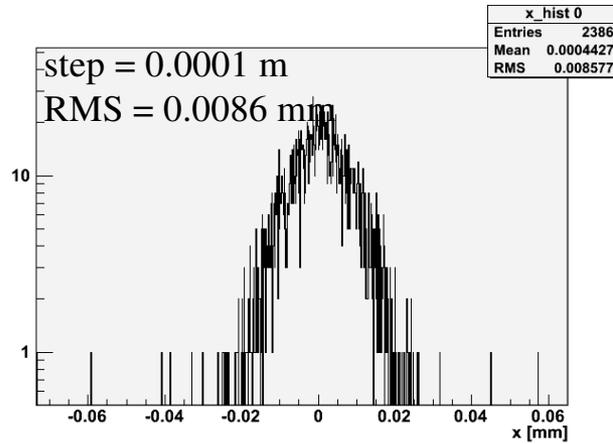
- Use ICOOL field map in G4MICE
  - Compare tracking in ICOOL step=1e-5 m with G4MICE step=1e-4 m
 - Compare G4MICE field map with ICOOL
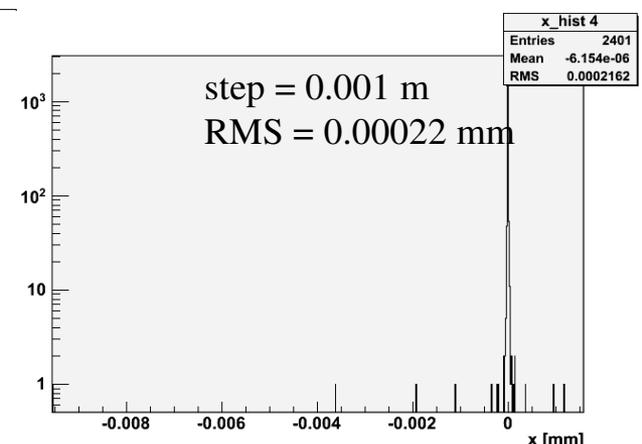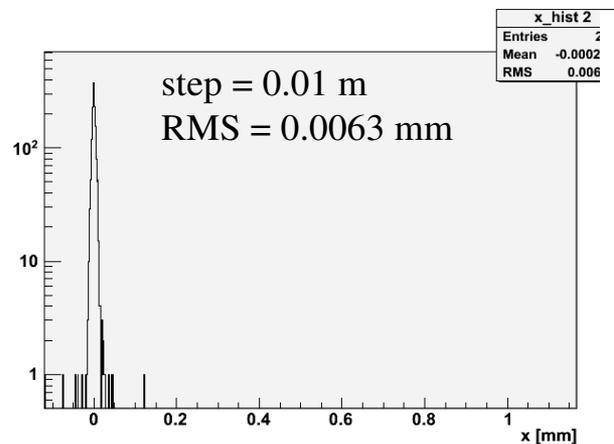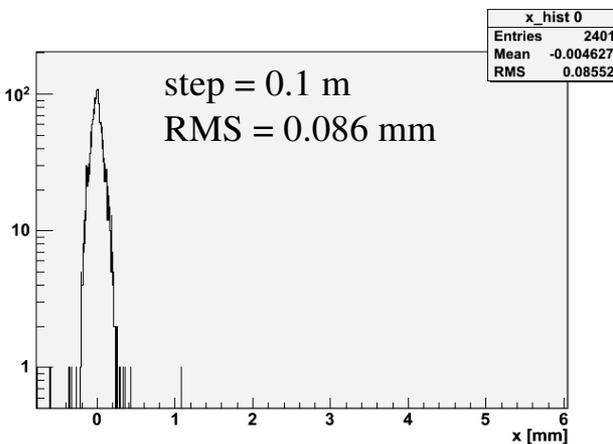
- Use G4MICE field map, all BiLinear interpolation
  - Tracking in ICOOL with ICOOL field map, step size 1e-5 m
  - Compare with tracking in G4MICE with G4MICE field map
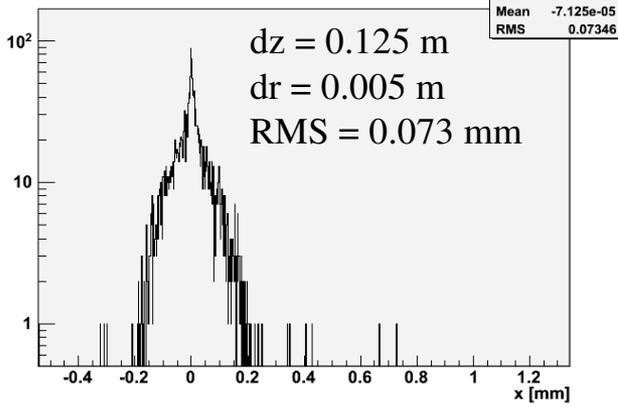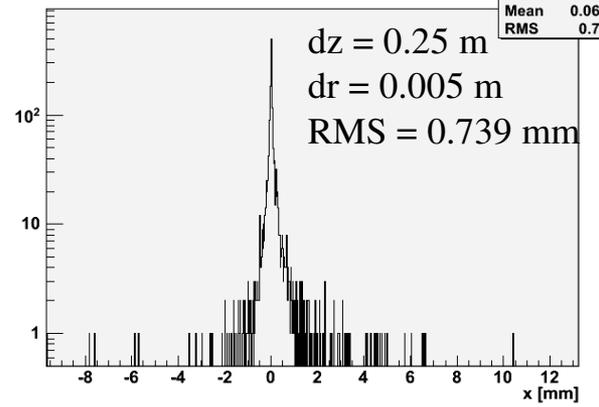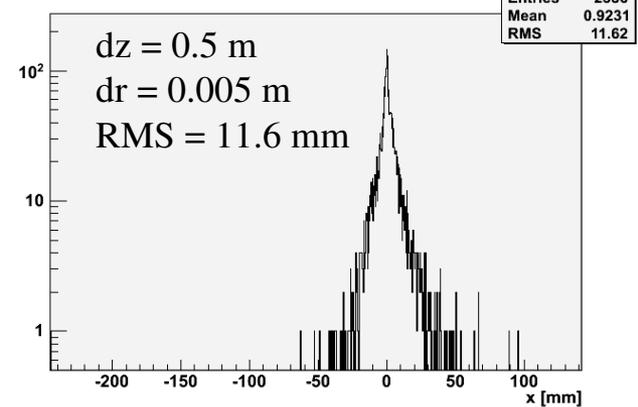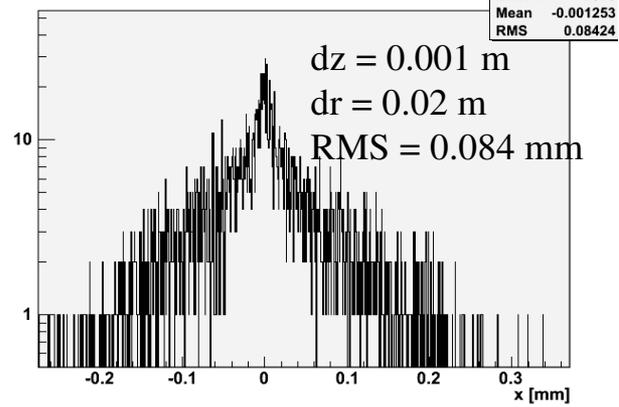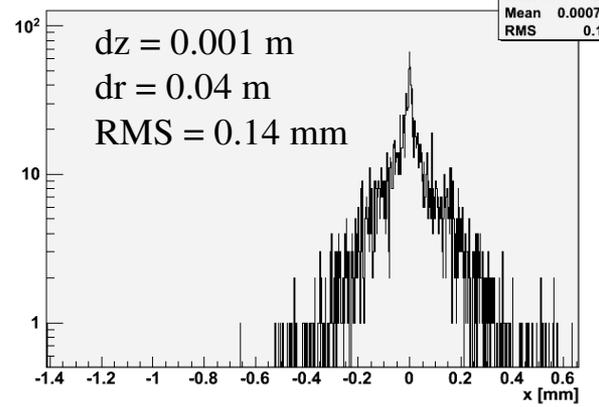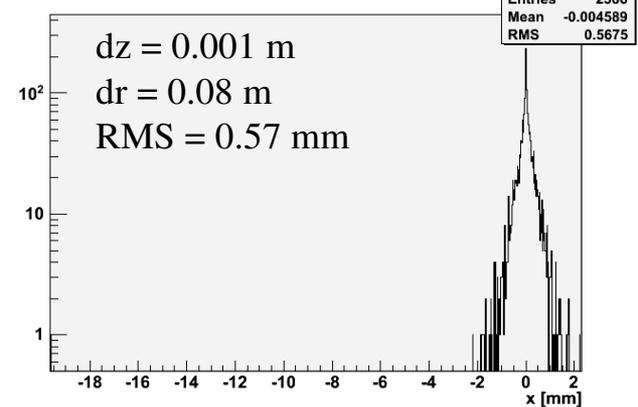
- Choose grid size for magnetic field map
 - Quite a hard cut-off as z grid size changes
  - Gradual cut-off for radial grid size
- Choose dz = 0.05 m, dr = 0.02 m, step=0.1 m
 - Enable dynamic step size allocation
  - Nominal error 1 mm
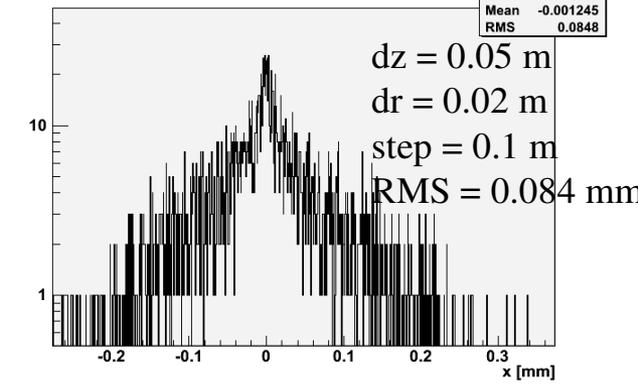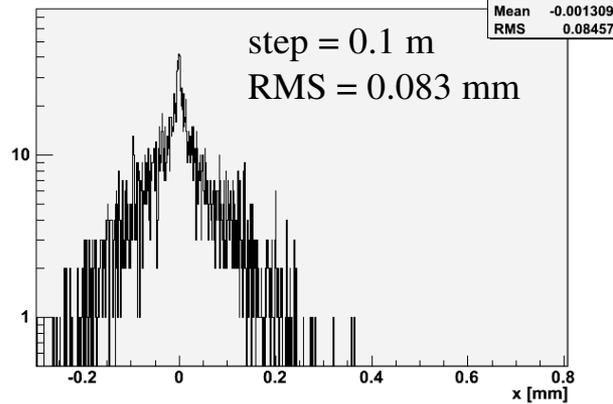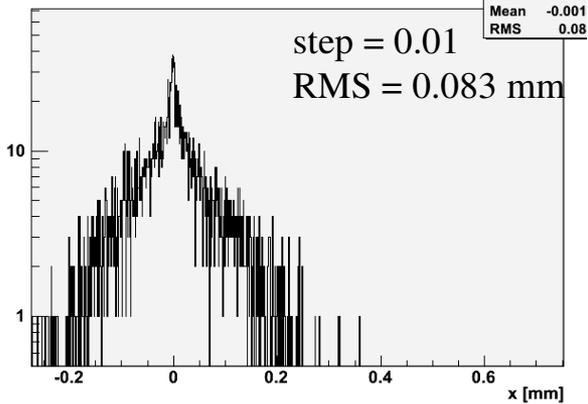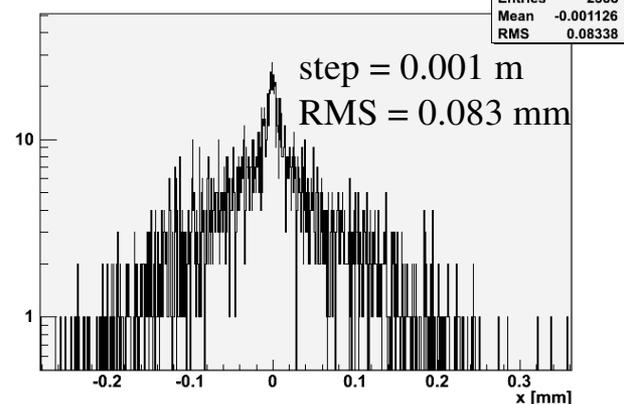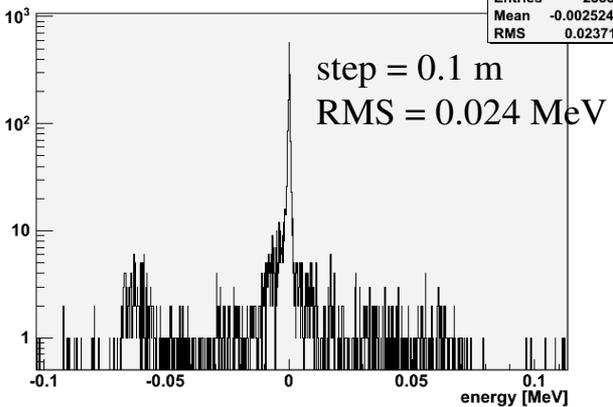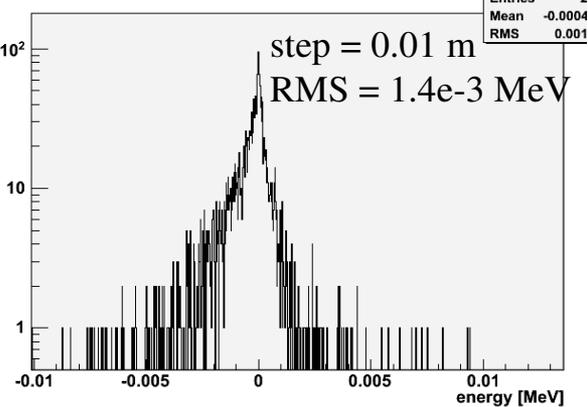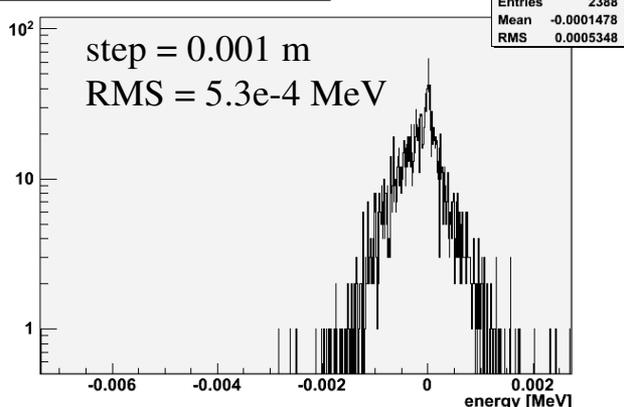
- Introduce RF cavity
 - Analytical model for pill box
  - Compare ICOOL step size 1e-4 with G4MICE
 - x limited by magnetic field map size
  - 0.1 m step size still ok
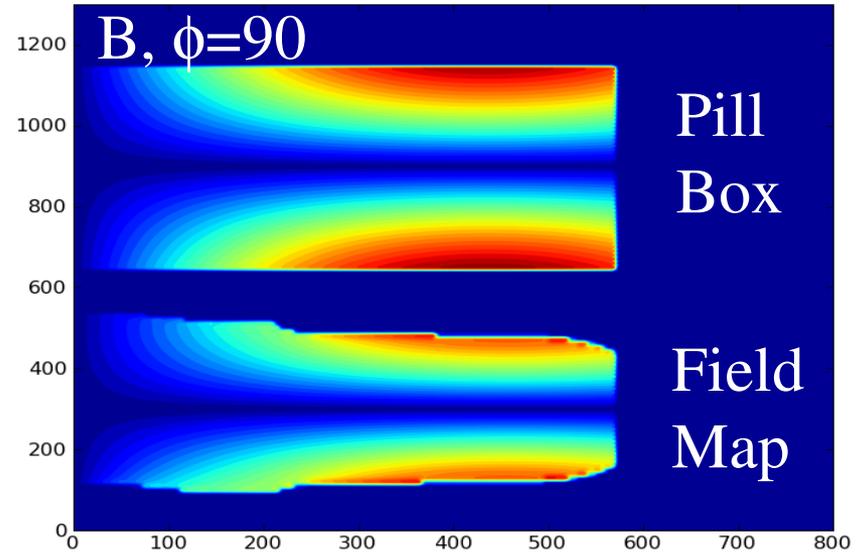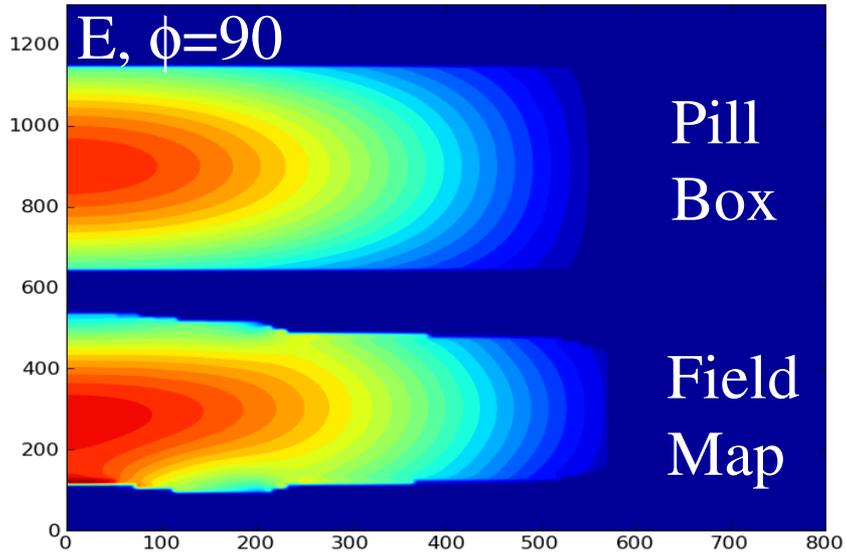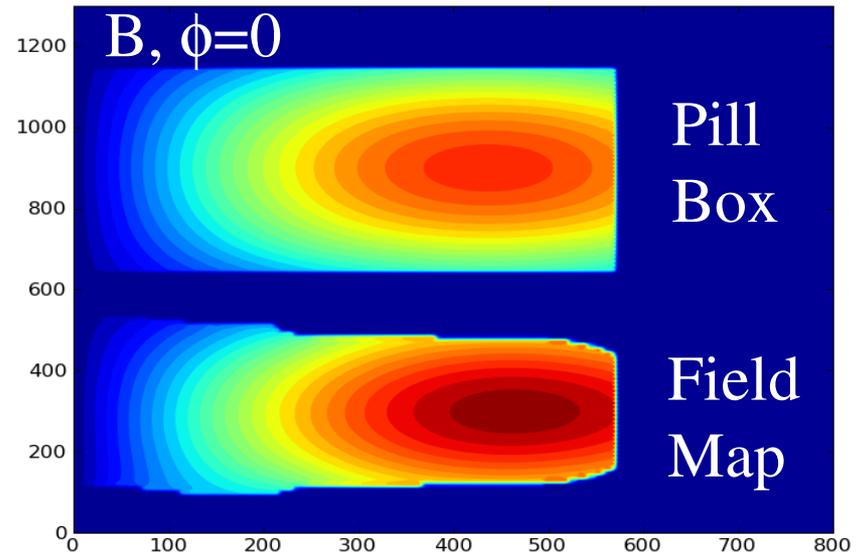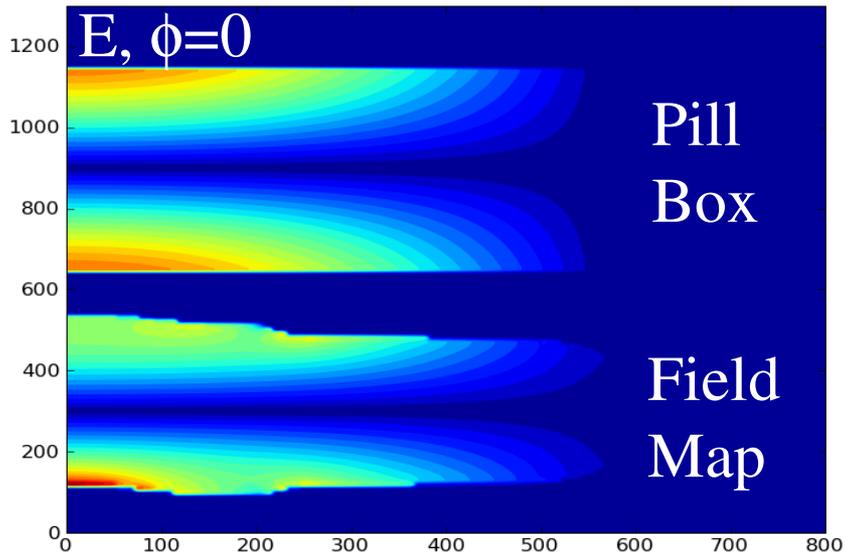
Absolute value of field seen by particle travelling at c
Peak E-Field = 17.5 MV/m, peak B-field ~ 20 mT
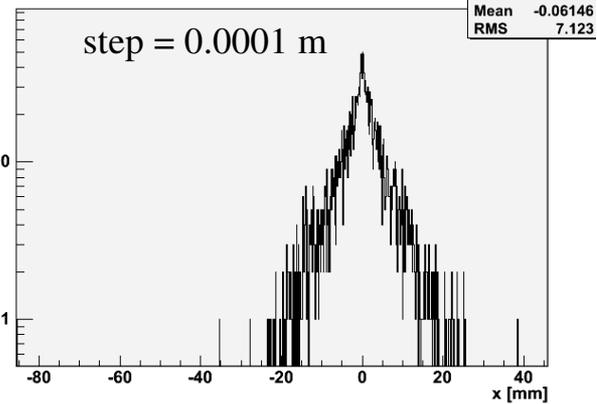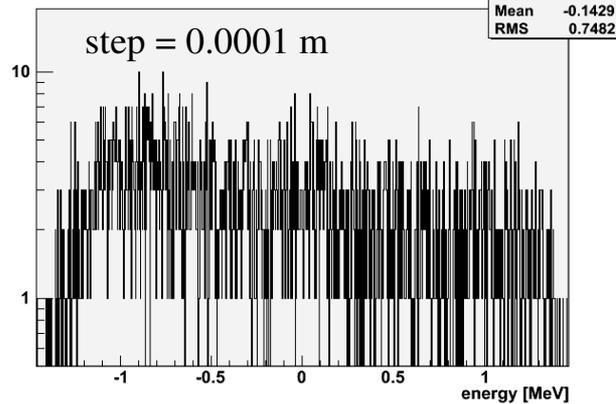
Introduce RF field map
from superfish

- Compare with pillbox
- Look for self-consistency
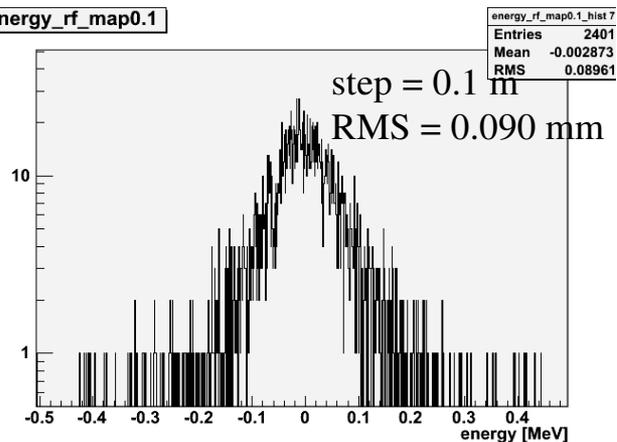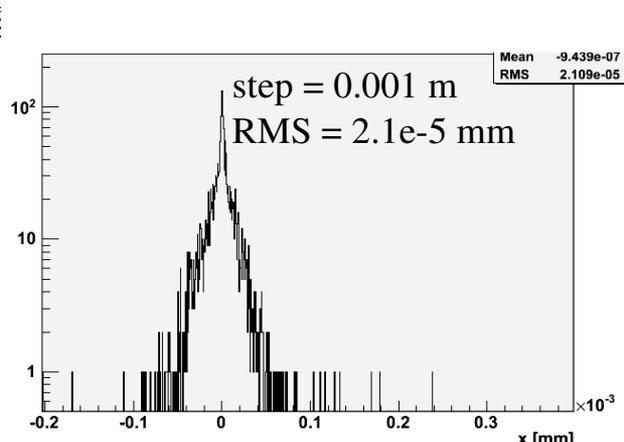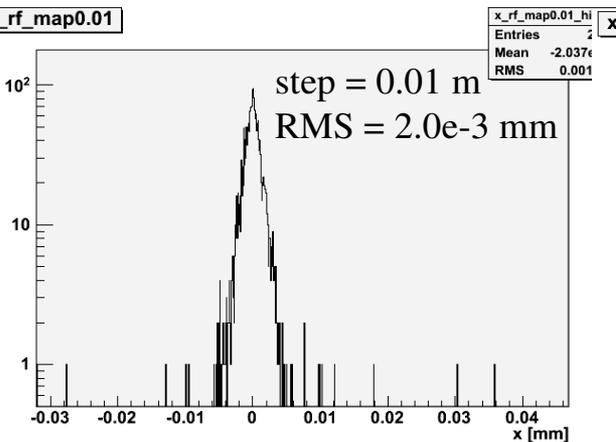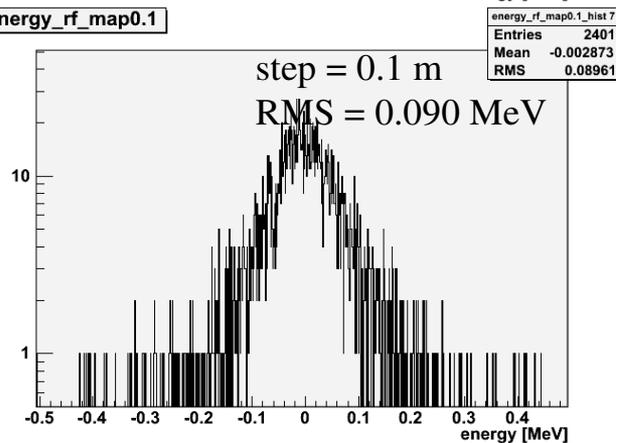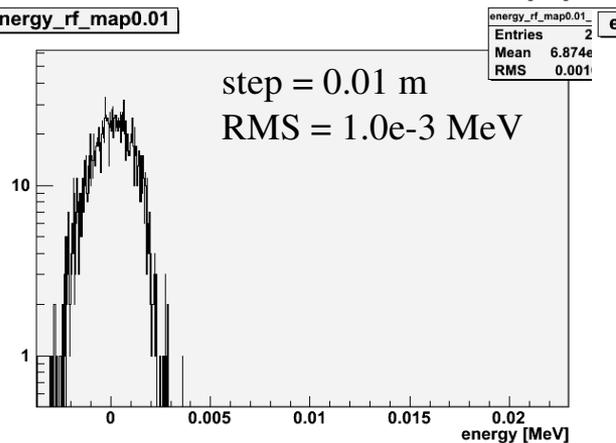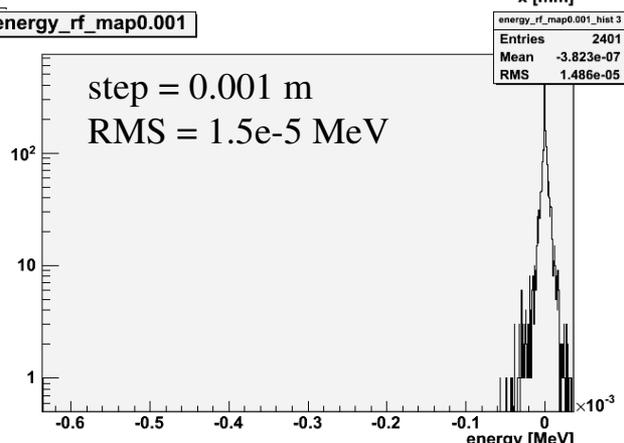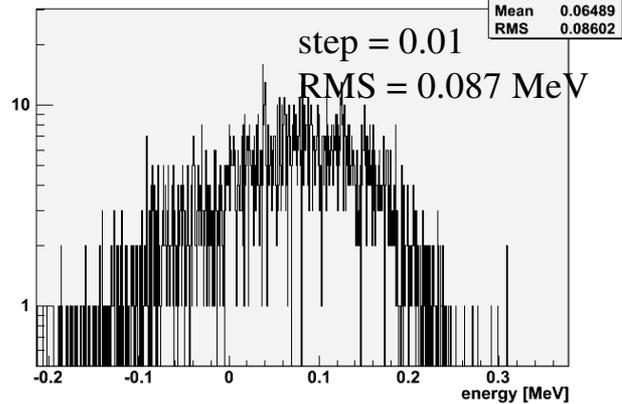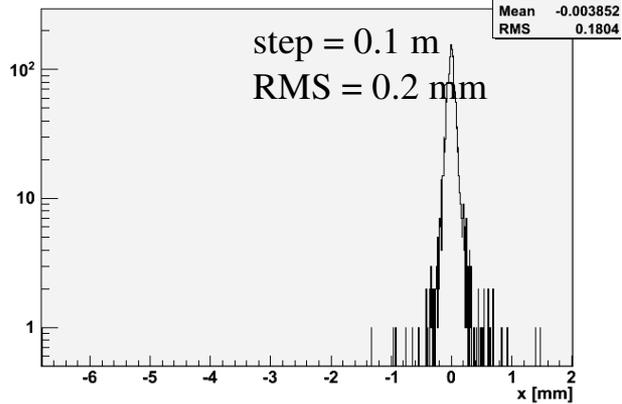
- **Now add liquid Hydrogen**
  - Stochastics switched off!
  - Look at difference between G4MICE tracking and ICOOL
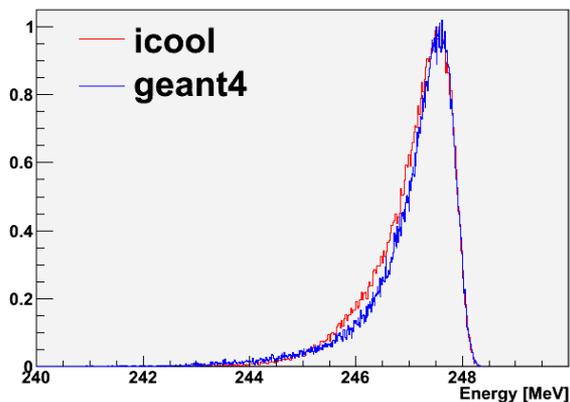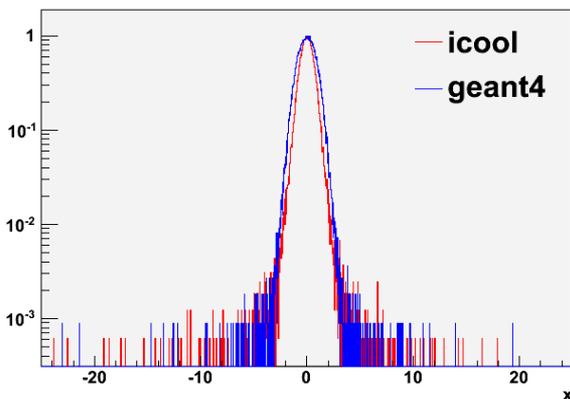
- **Switch on stochastics**
 - Track through 20 cm of lH2 in field map
  - Look at distributions before and after lH2
  - 1e5 muons with initial p=230 MeV/c, no transverse

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