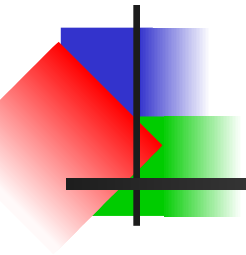

ERIT Simulations in MAUS

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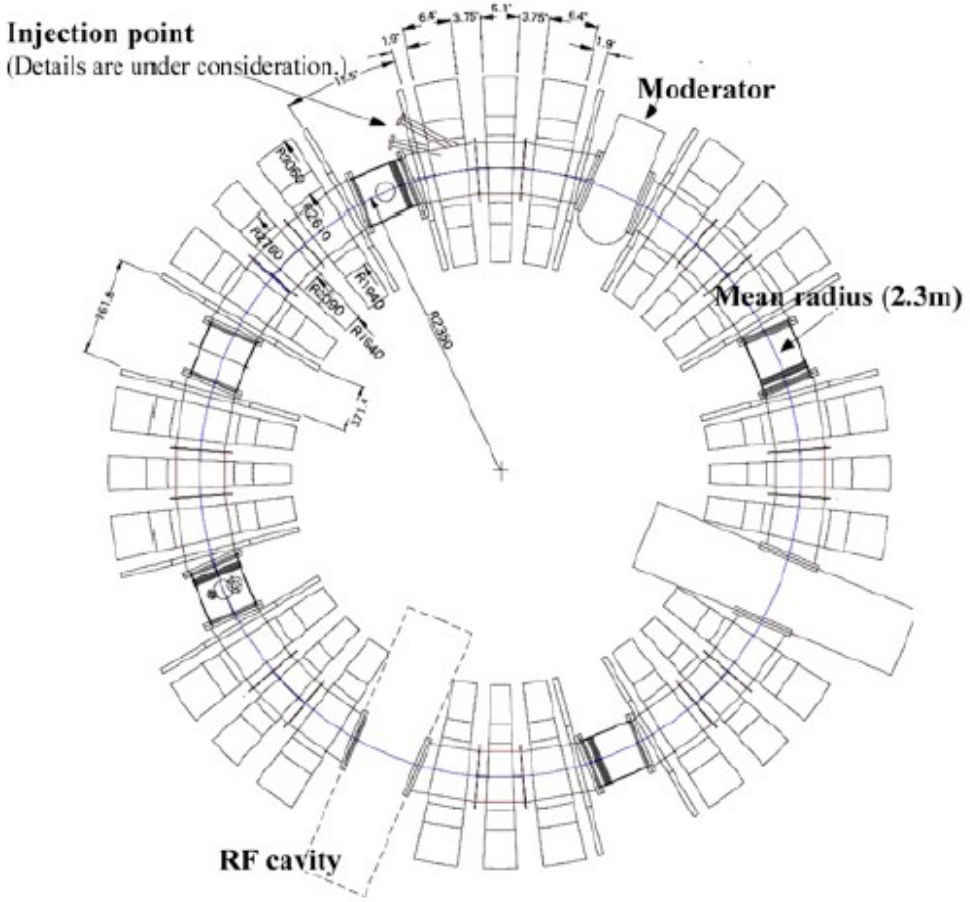
Simulation Of ERIT in MAUS

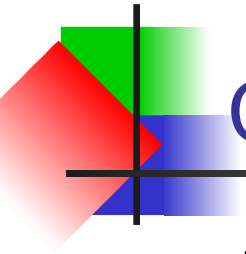
- Can think of several interesting problems to tackle with ERIT
  - Charge exchange injection
  - Multiturn injection
    - Can we put a kicker in? ... no space
    - Can we use phase advance? ... ?
  - Ionisation Cooling
    - How far has parameter space been explored?
    - More diagnostics might be helpful?
  - Space charge effects
- Try to get a reasonable model of ERIT to explore feasibility
  - Start with magnet model
    - Custom field routines
  - Use GEANT4
    - Foil model is easy
    - Space charge becomes very hard

What is MAUS?

- MAUS is Muon Ionisation Cooling Experiment (MICE) tracking and reconstruction code
  - Geant4 bindings
  - Field map routines
  - Accelerator optics routines (fully 6D)
  - Accelerator physics post-processing routines in separate library (fully 6D)
  - No space charge
- Also
  - MICE detector reconstruction routines (probably not useful)
    - Any interest in modelling diagnostics?
  - Configuration management tools
  - Interface to external SQL database containing time indexed configuration (of MICE)
- First attempt to model ERIT
  - Fields modelled as superposition of multipoles
  - Material use Geant4 physics process model
  - Look at closed orbits, tune, Twiss parameters...

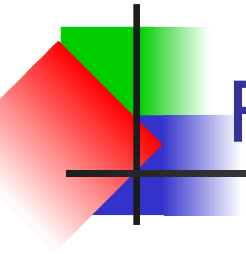
Layout


Injection point
(Details are under consideration.)
Moderator
Mean radius (2.3m)
RF cavity



Comment on VCS

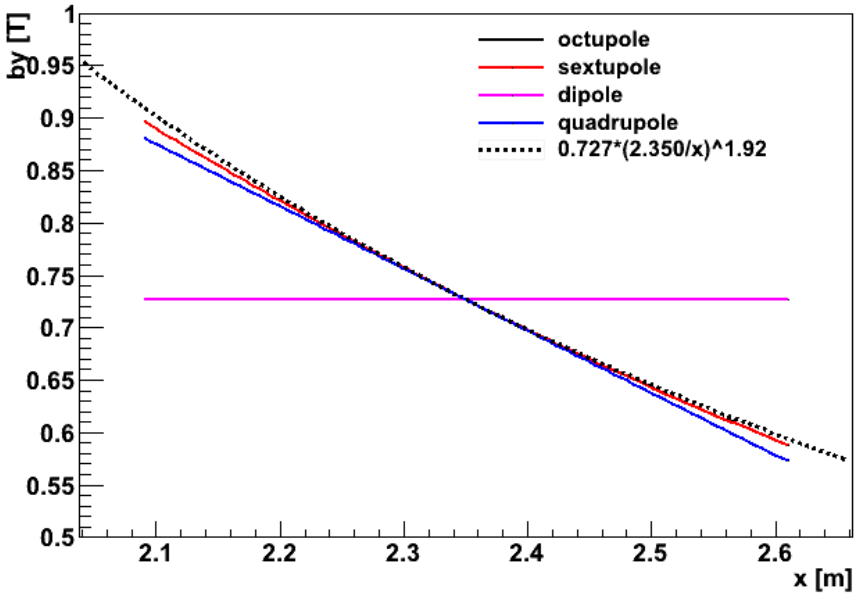
- My geometry files are stored in a version controlled repository
- Available to view at
  - http://bazaar.launchpad.net/~chris-rogers/erit-ffag/devel/files
- Checkout and edit using bzr vcs system like:
  - bzr checkout lp:~chris-rogers/erit-ffag/devel
  - At the moment I use bzr because that's what MICE use
  - svn etc are also fine
- The directories are structured in such a way that we can handle geometry definitions for multiple codes
- I want to make something that works like a code base – i.e. we have geometry files with a bunch of tests to check that the geometry is reasonable



Field Model

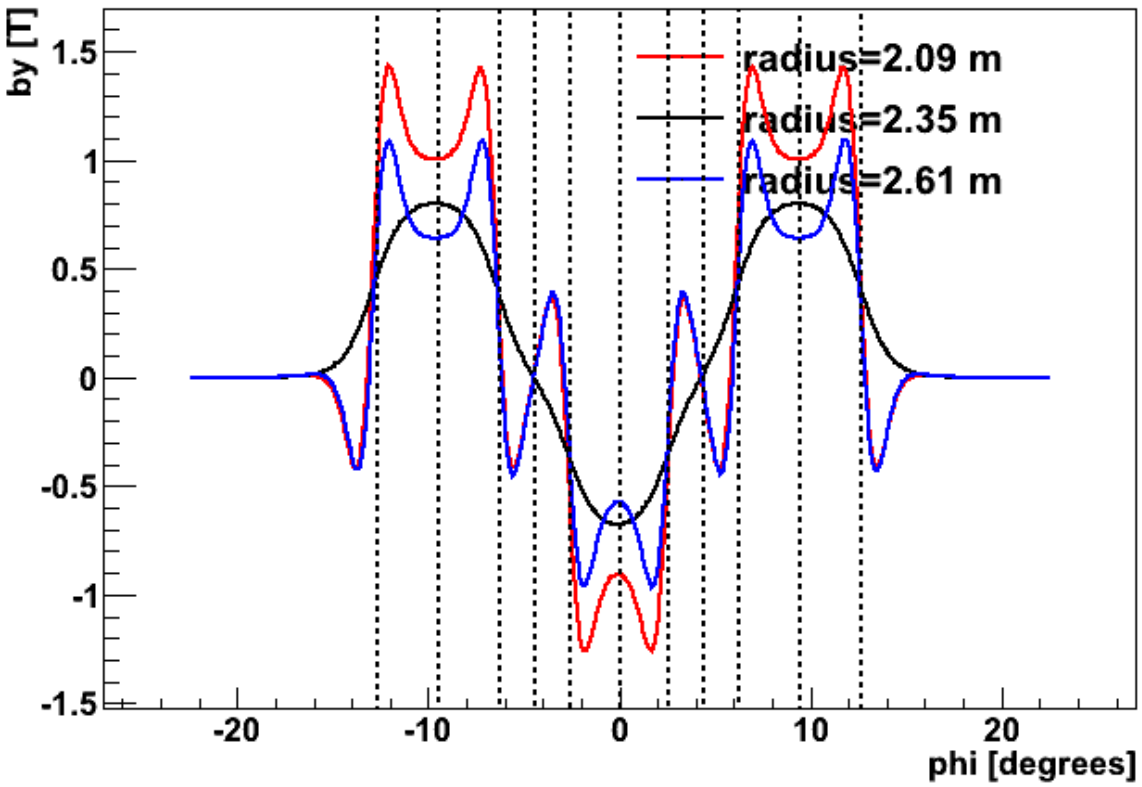
- Model ERIT magnets as a sum of multipoles
- Tanh model for end fields
  - Can't do e.g. edge effects without explicitly tracking
  - Tanh model => exponential fall off at either end
- Sector magnet => put field on a constant radius of curvature
  - Don't include radius of curvature in field expansion
  - So some non-Maxwellianness creeps in (needs fixing)
- Control parameters
  - Field index, dipole field, magnet length
    - Constrained by lattice definition
  - Maximum multipole in field expansion
  - End field fall off

Multipole expansion



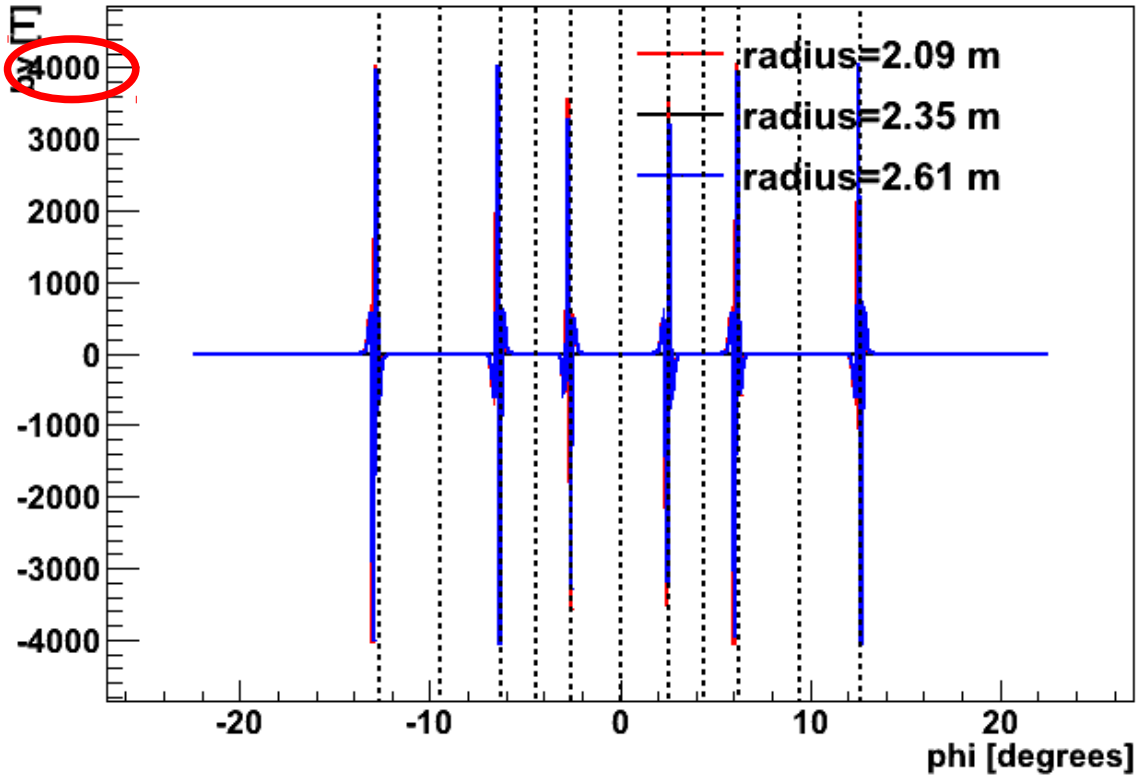
- Use power law expansion to write 1/r as a Taylor series
- Use multipoles for each element in the Taylor series
- Octupole doesn't really contribute much
  - Floating point precision issues
- Truncate series at sextupole order

End field length – off-orbit fields



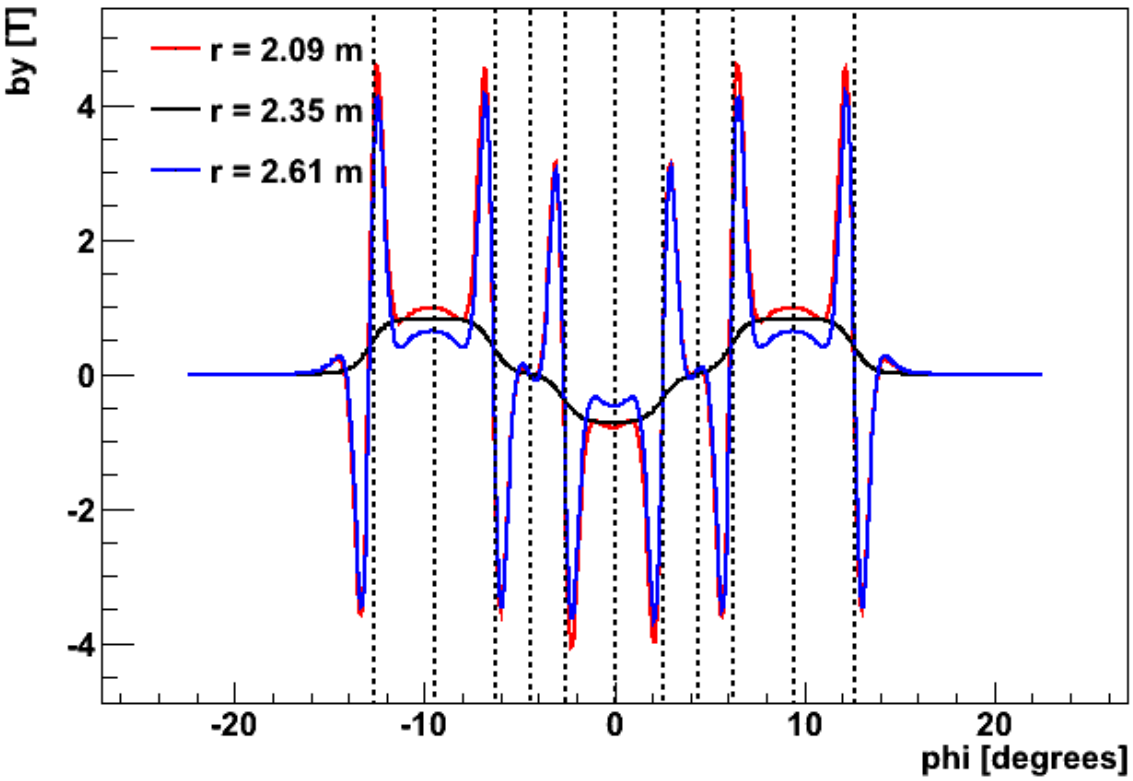
- End field modelled with tanh fall off
  - $f(s) = \tanh[(x+x_0)/\lambda]$
  - Centre length – x0
  - End length - λ
- Get balance between field quality and fringe fields
  - Too short => bad field in magnet centre

End field length – off-orbit fields



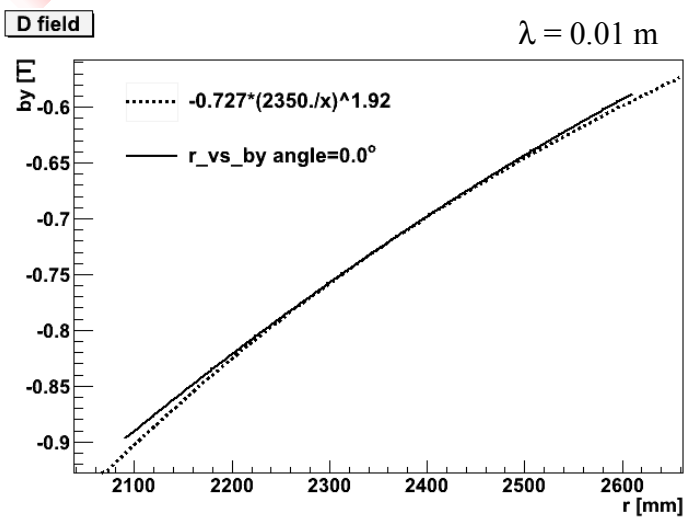
- End field modelled with tanh fall off
  - $f(s) = \tanh[(x+x_0)/\lambda]$
  - Centre length – x0
  - End length - λ
- Get balance between field quality and fringe fields
  - Too short => bad field in magnet centre
  - Too long => bad field at magnet ends

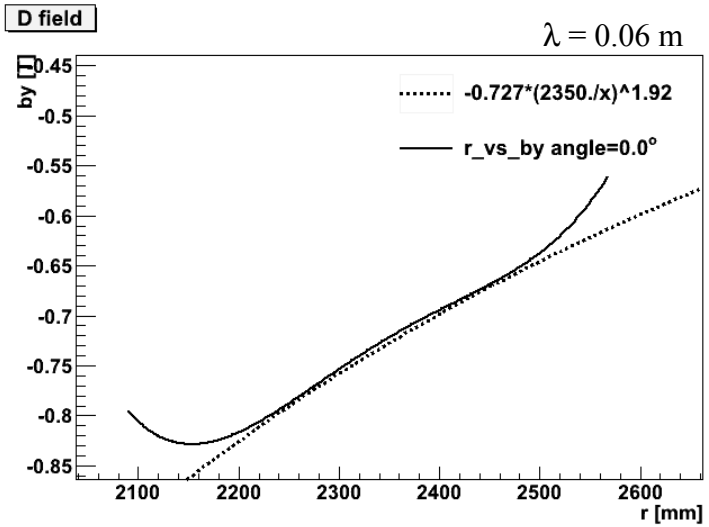
End field length – off-orbit fields



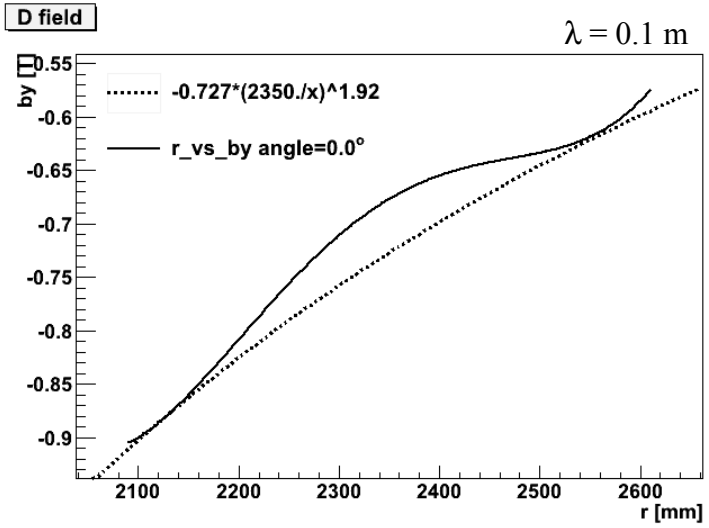
- End field modelled with tanh fall off
  - $f(s) = \tanh[(x+x_0)/\lambda]$
  - Centre length – x0
  - End length - λ
- Get balance between field quality and fringe fields

End field length – field expansion

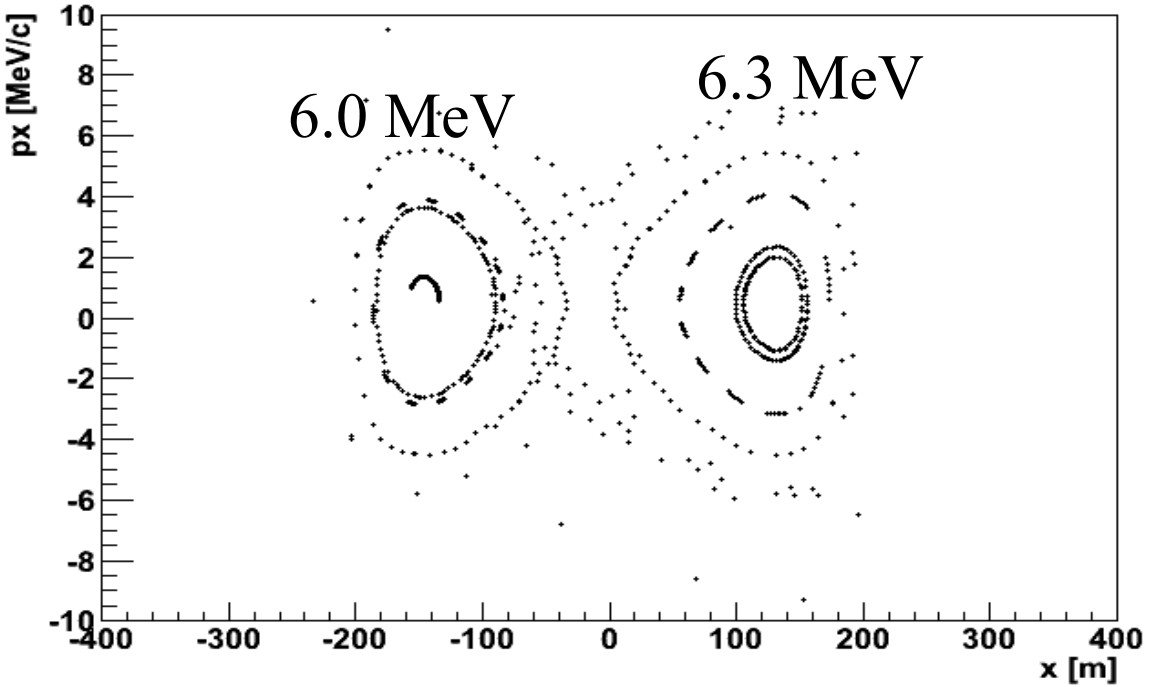




- Dipole field as a function of radius
  - F magnet
  - Poor field quality for longer end lengths

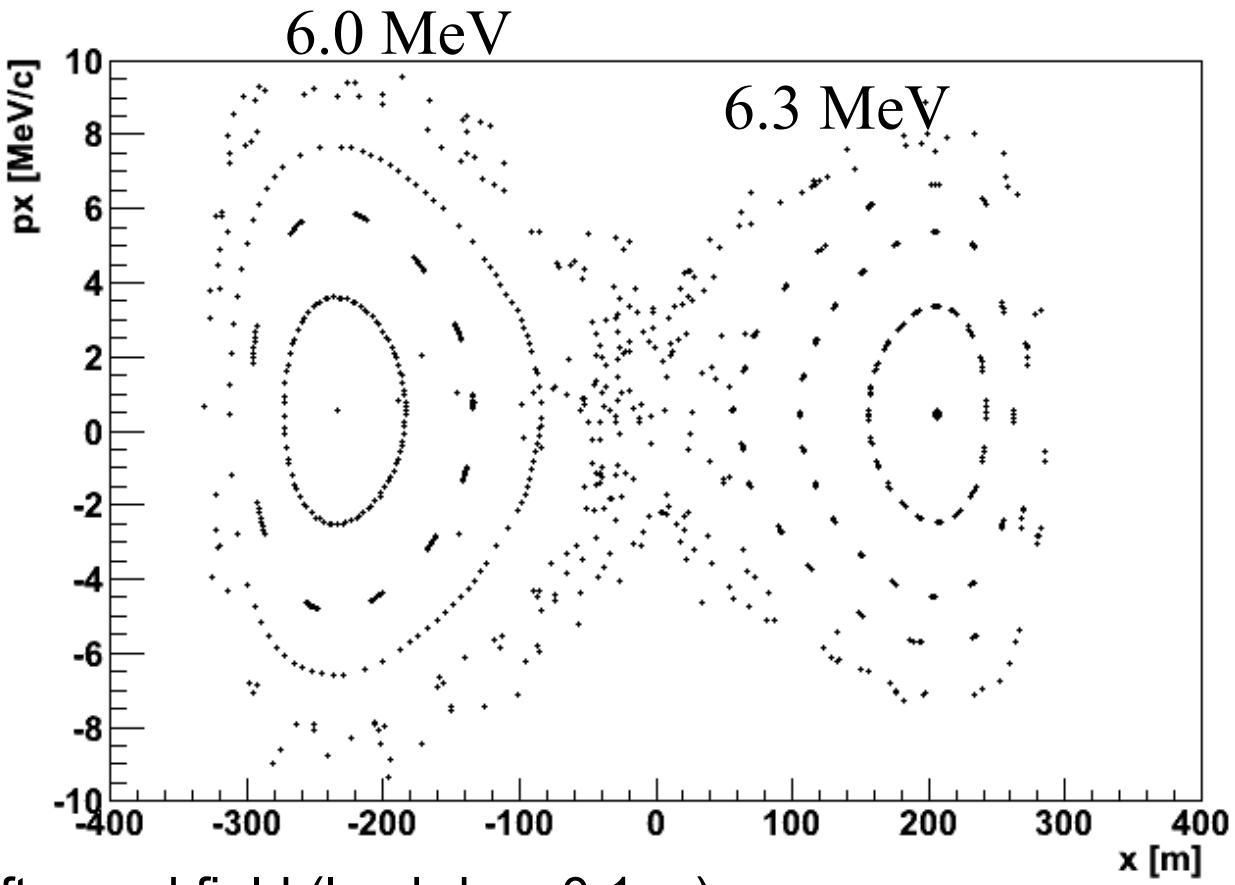


Tracking Simulation



- Two particles shown – 6.0 MeV and 6.3 MeV
- Momentum acceptance is generally not so good
- Couldn't find a closed orbit outside this energy range
- Fringe field length of 0.06 m

Tracking Simulation



- Softer end field (lambda = 0.1 m)

Comments

- Momentum acceptance is too small
- Need to look at the field model
- Use midplane expansion?
  - Needs couple of weeks development time
  - Time is hard to come by
- Then look at multiturn injection, emittance growth etc
- Space charge?
  - Do we really want to use GEANT4? Or something else?
- Any interest in MAUS bureaucracy features
  - Configuration management, event display, diagnostics modelling, ...
    ...
  - Would need 1-2 man years to implement this for ERIT
    - Interface to EPICS
    - Build SQL DB
    - Make diagnostics models