Tracking ERIT-FFAG in OPAL (2)

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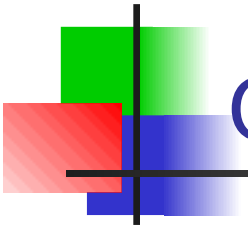
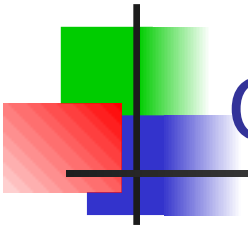


Overview

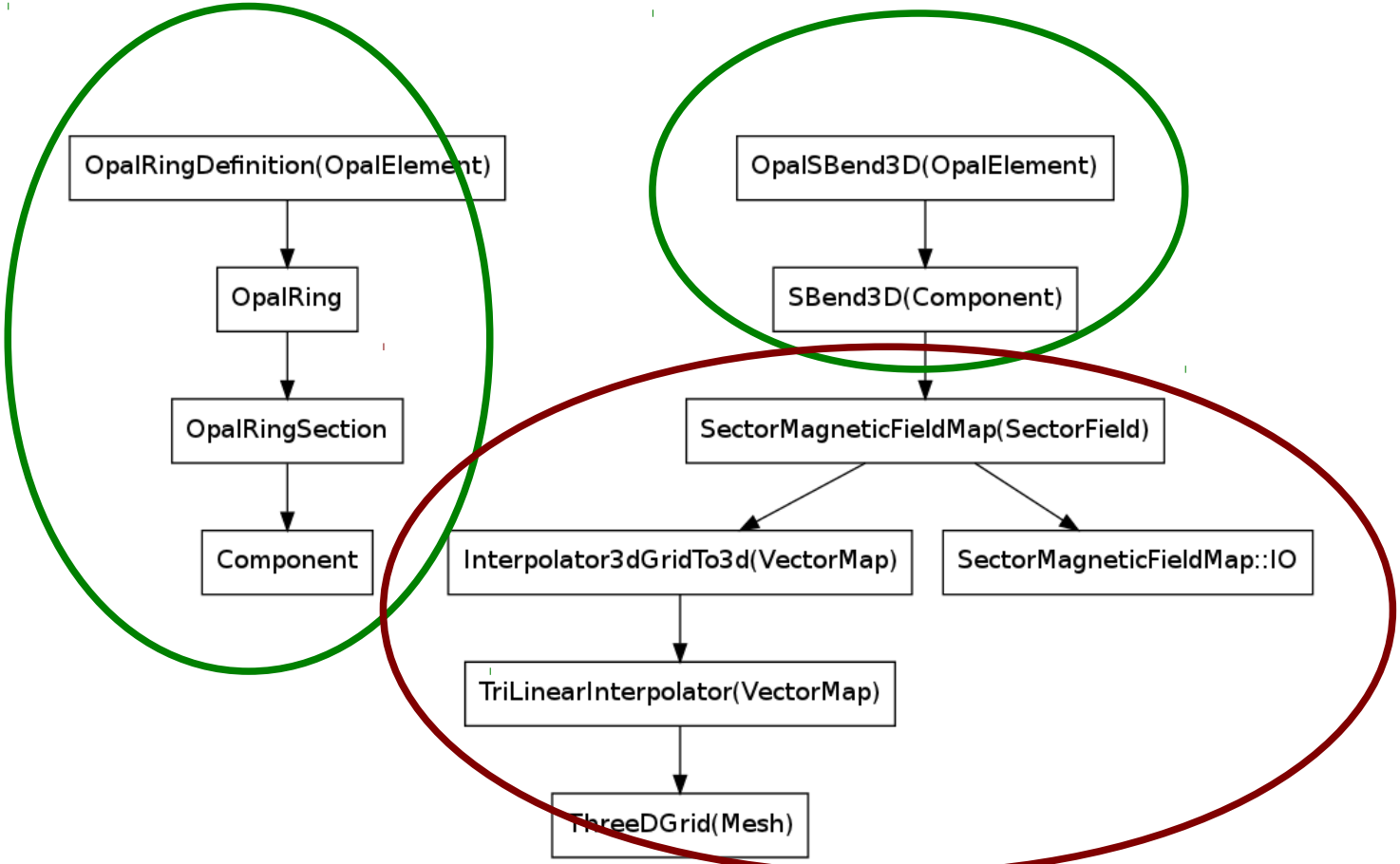
- Previously I tracked ERIT ring using Geant4 based code
- Would like to simulate collective effects
  - e.g. cross check S-Code
- Not possible in Geant4 code
  - G4 tracking loop tracks particle-by-particle
  - Requires aggressive intervention to change this to step-by-step
- Look to OPAL as an alternative
  - Developed by Andreas Adelmann et al (PSI)
- Some potentially very nice features
  - Multibunch space charge solver
  - Reasonable foil model



Overview (cont.)

- OPAL requires modification to adequately track FFAG field maps
  - OPAL-T allows tracking through a set of beam elements in linac-type geometry
  - OPAL-Cycl currently hard coded to use 2D midplane field map + single RF cavity
  - Aim to introduce the capability to track through a set of “arbitrary” beam elements in ring-type geometry
    - I have now mostly finished this phase of coding
    - Still some hard coded elements
    - All bugs/problems should be considered my fault!
- Last time I showed tracking results from OPAL
  - Hard-coded geometry
- Here I present few checks on tracking stability, closed orbit etc
  - Geometry now soft-coded

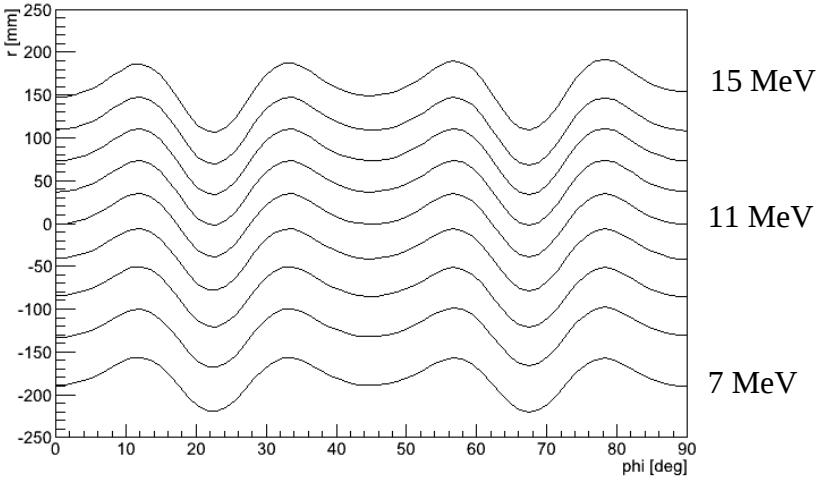
Class diagram



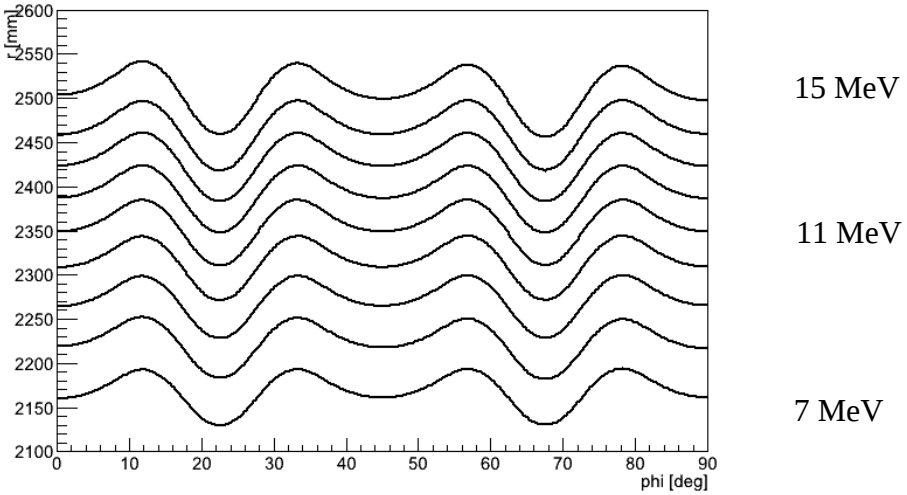
Class diagram for OpalRing and SBend3D: boxes represent classes with arrows representing ownership - owning class points to owned class. Parent classes are shown in brackets. Note that the OpalRingSection is related to the SBend3D through the Component inheritance relationship.

Closed Orbits

Geant4/MAUS



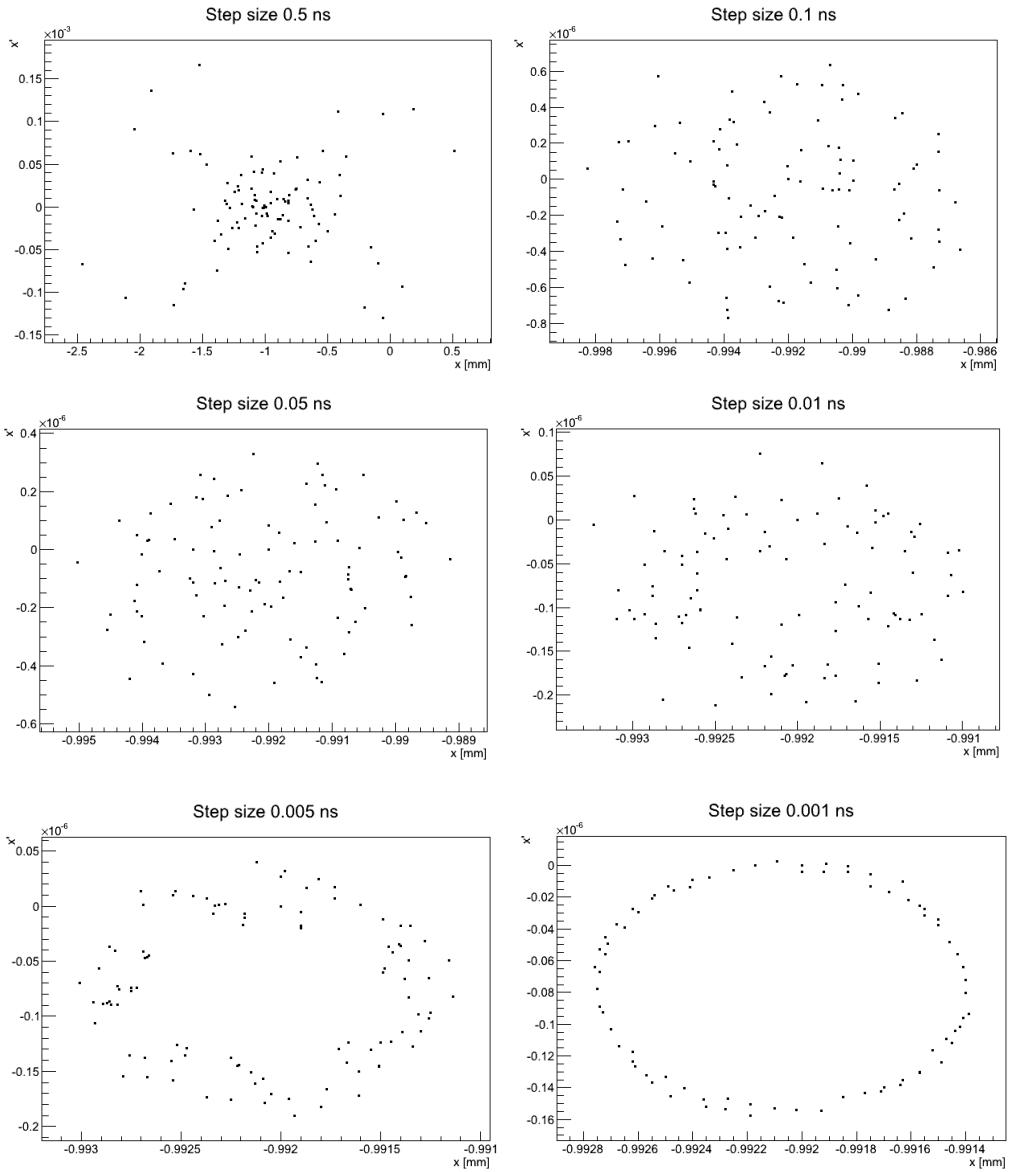
OPAL



- Getting closed orbit through OPAL
  - Note I used identical initial beam conditions in OPAL

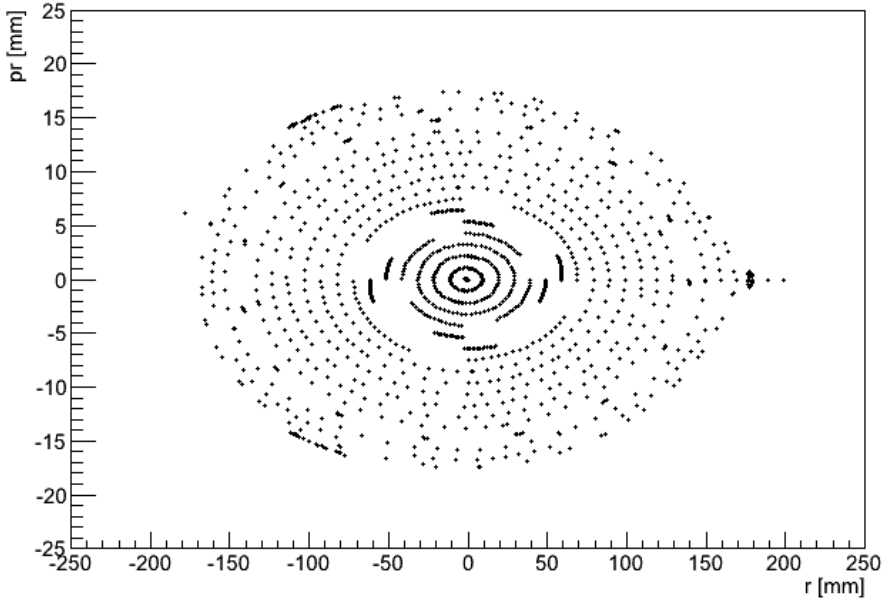
Tracking Stability

- Tracking stability converging with step size
  - 11 MeV proton
  - Velocity = 45.506 mm/ns
  - 300 turns
- Convergence is more or less linear
  - Field map too coarsely grained?
- No closed orbit with step size > 5 ns
- May be feature of PROBE routine
  - Linear interpolation from step ends

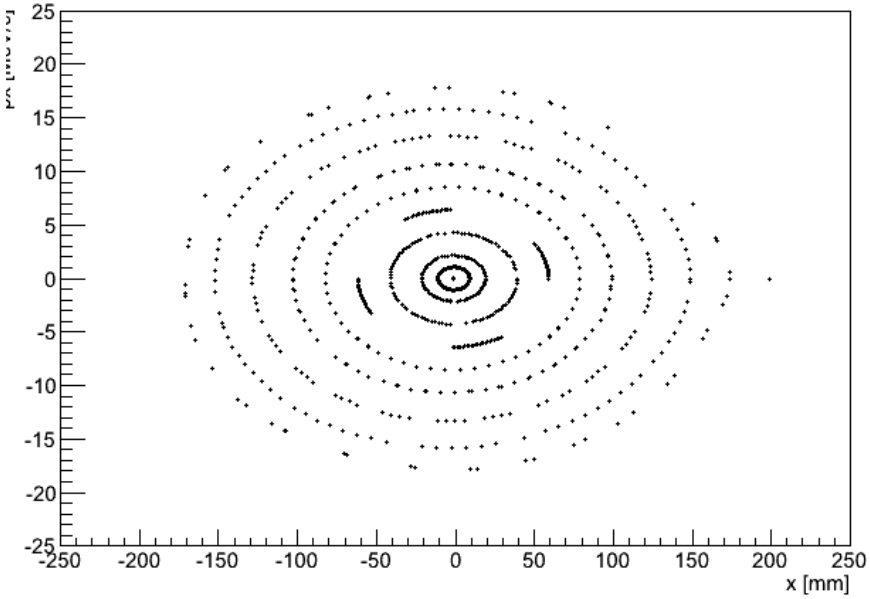


“Dynamic” Aperture - Horizontal

Geant4/MAUS



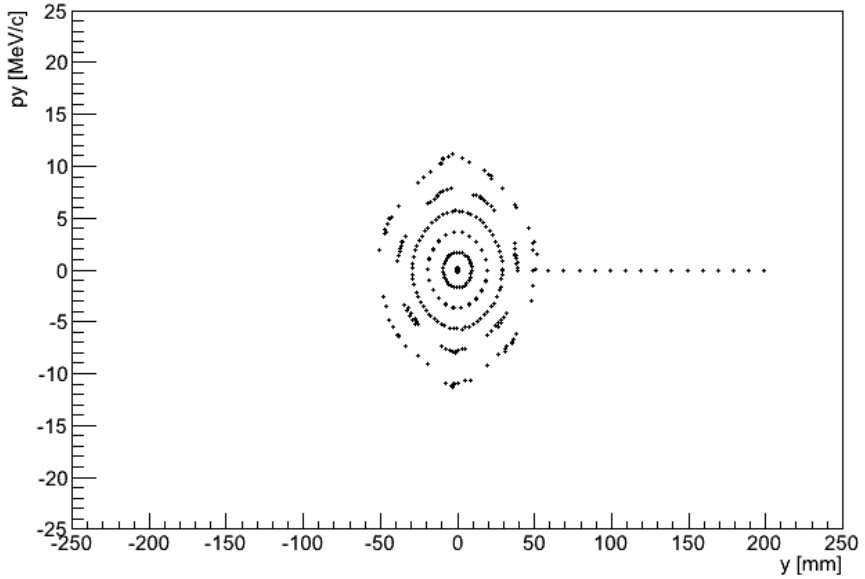
OPAL



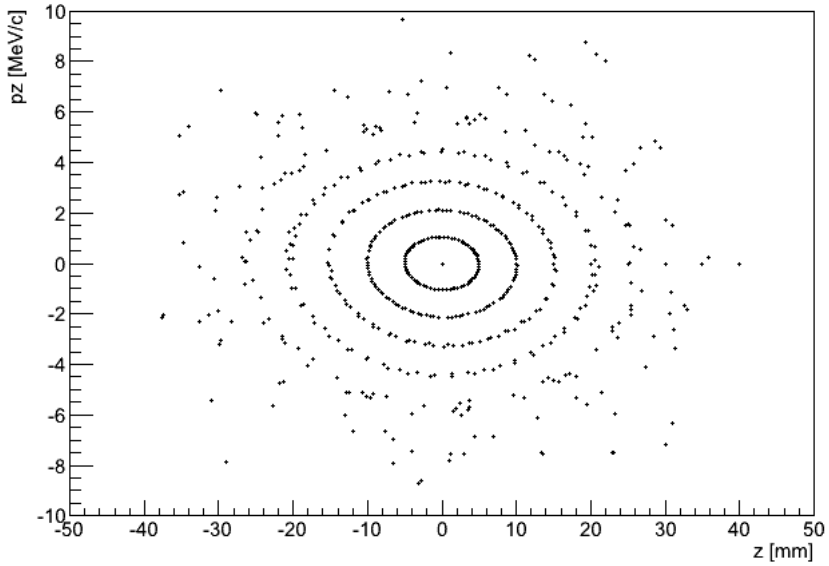
- After 100 turns aperture looks okay in OPAL
  - Some question as to whether this is dynamic aperture or field map aperture
    - Field map extent is +/-250 mm in x
    - Particles are lost after < 1 turn
  - Step size 0.1 ns

Dynamic Aperture - Vertical

Geant4/MAUS

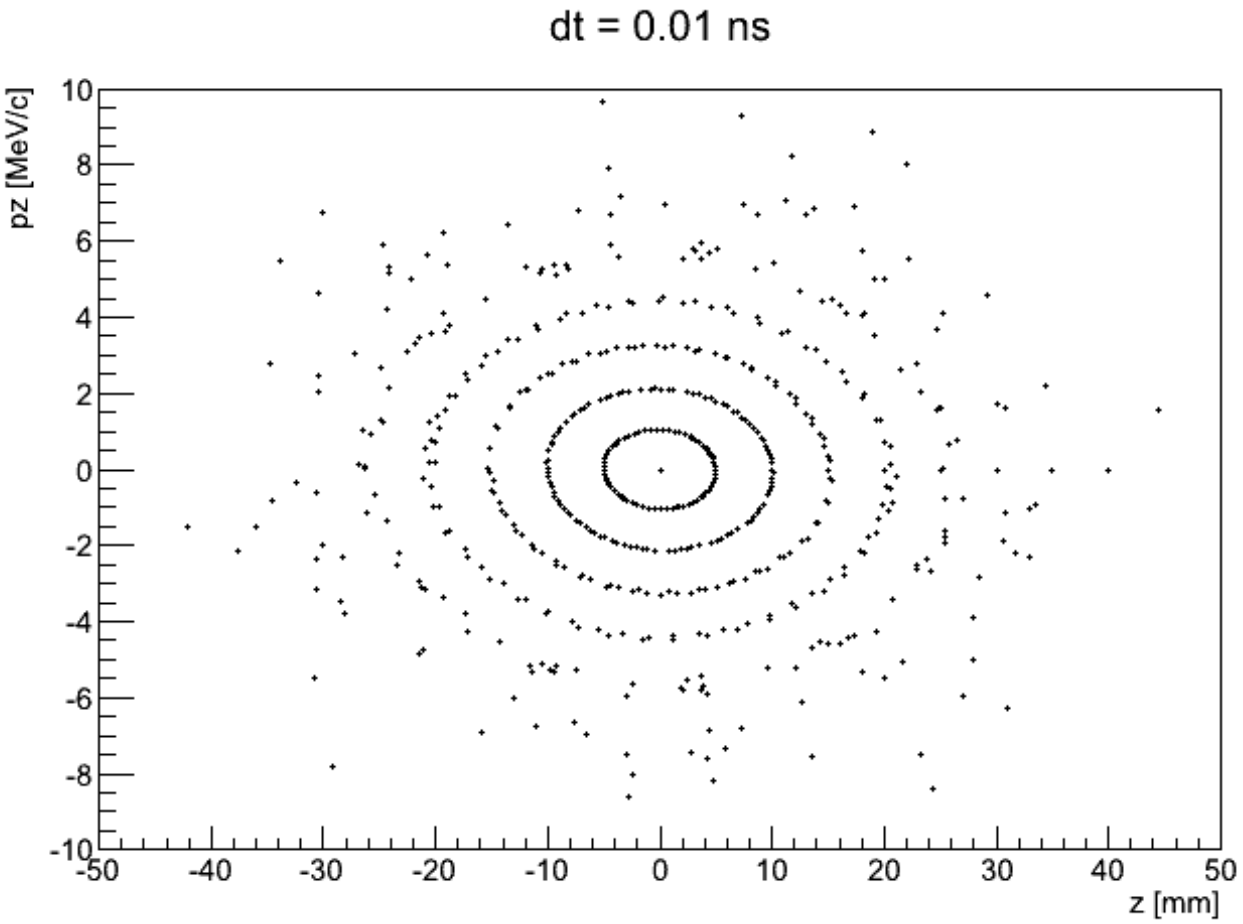


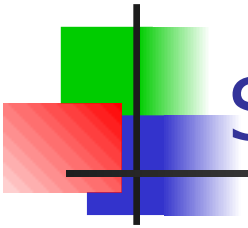
OPAL



- Looks more like a real dynamic aperture
  - Step size 0.1 ns
  - Field map extent is 115 mm
  - Why does OPAL give a worse aperture than Geant4?
    - Particle at (z, pz) = (30.0 mm, 0.0) gets lost after 79 turns

Dynamic Aperture – Vertical (cont)





Summary

- Placement of arbitrary beam cells is now possible
- Now looking at space charge simulation
  - Using FFT for now, probably in 2D only...