Simulations of the Si tracking detector for R^3B

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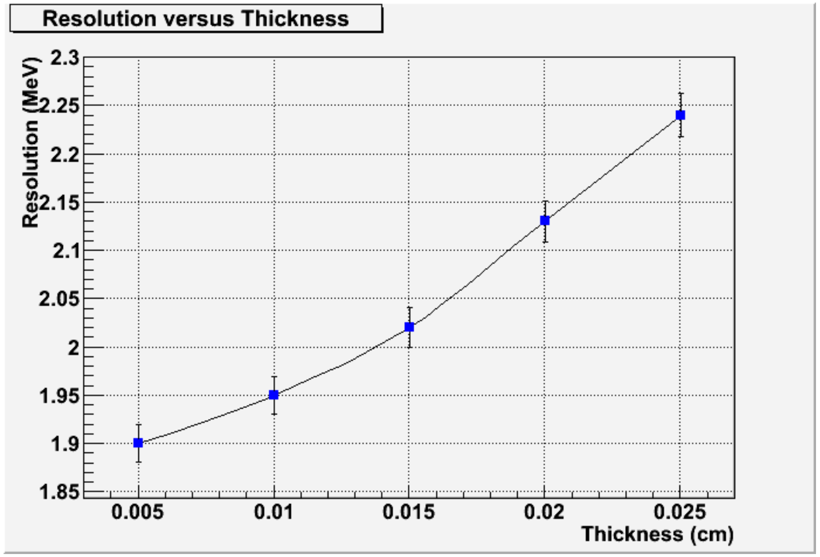
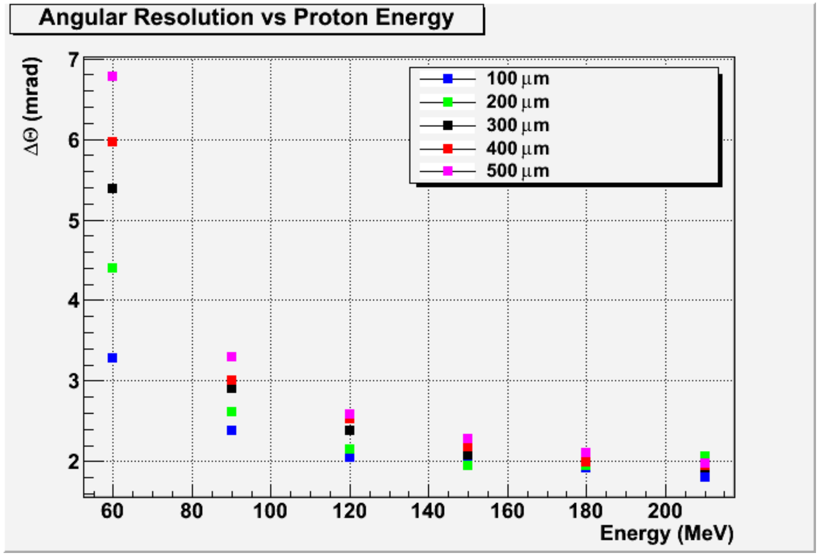
Design constraints

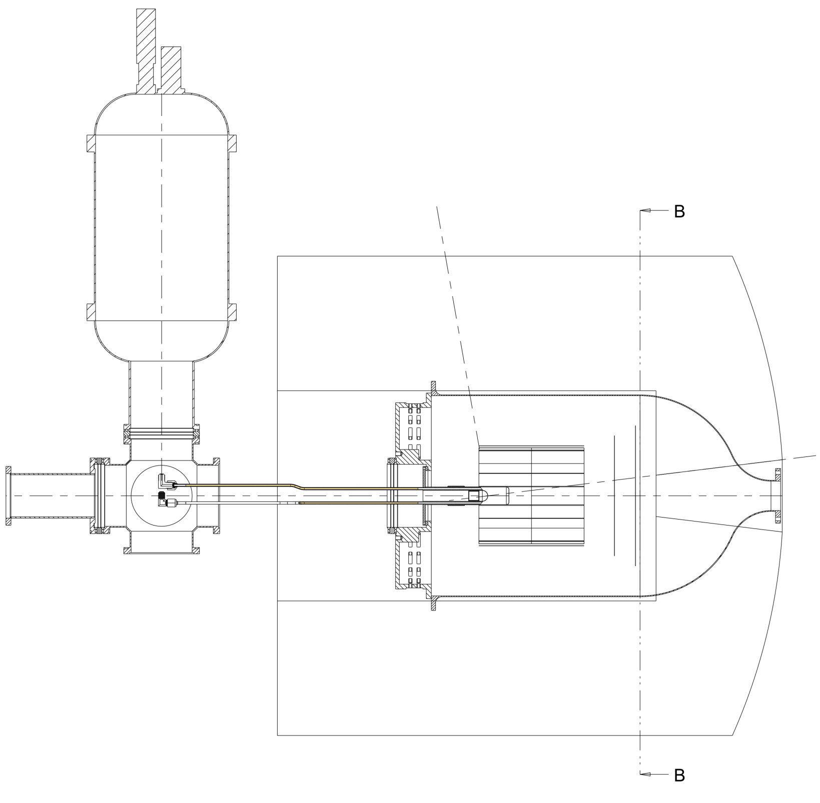
- Must detect protons at most forward angles
- Inner layer as thin as possible
- At least 3 layers
  - Strip redundancy
- Inner layer as close to target as possible
  - Accurate determination of reaction vertex
- No shielding between detector and target





The two designs

Barrel Detector

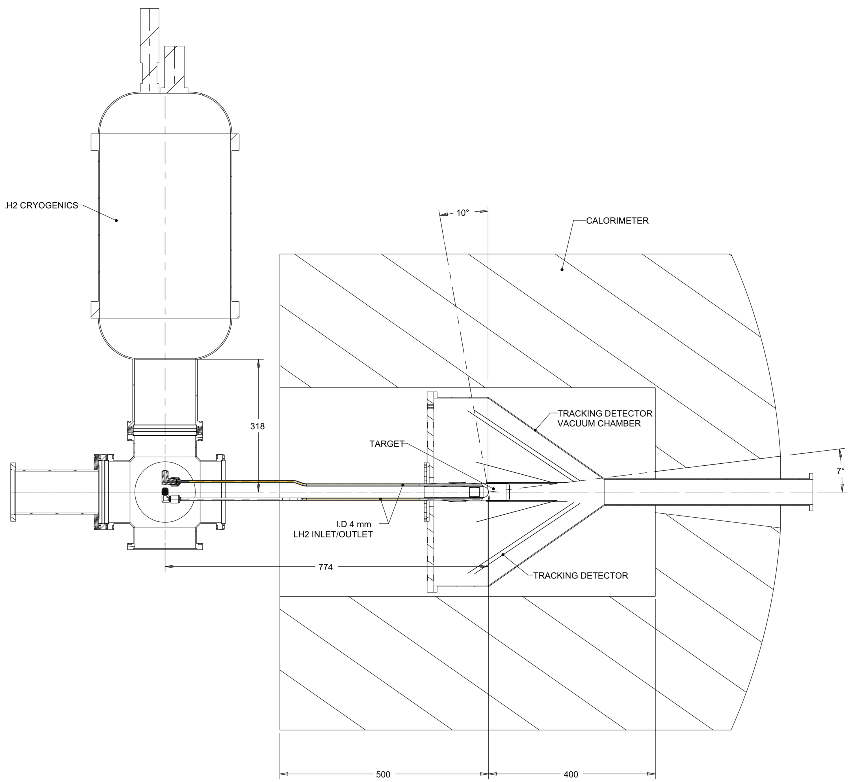


Geometry

- 3 layers of Si strip detectors
  - Orthogonal strips
  - 58 mm, 109 mm and 119 mm from beam axis
- 2 end cap detectors
  - 300 mm and 350 mm from target position
- Easy analysis of positions
- Asics chips positioned at forward angles

The Two Designs

Lampshade Detector

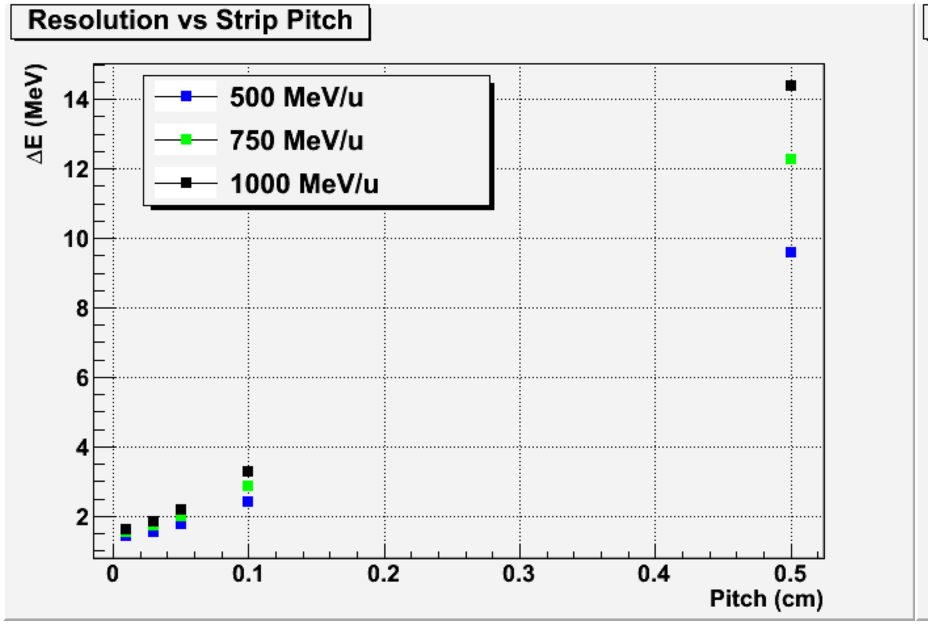


Geometry

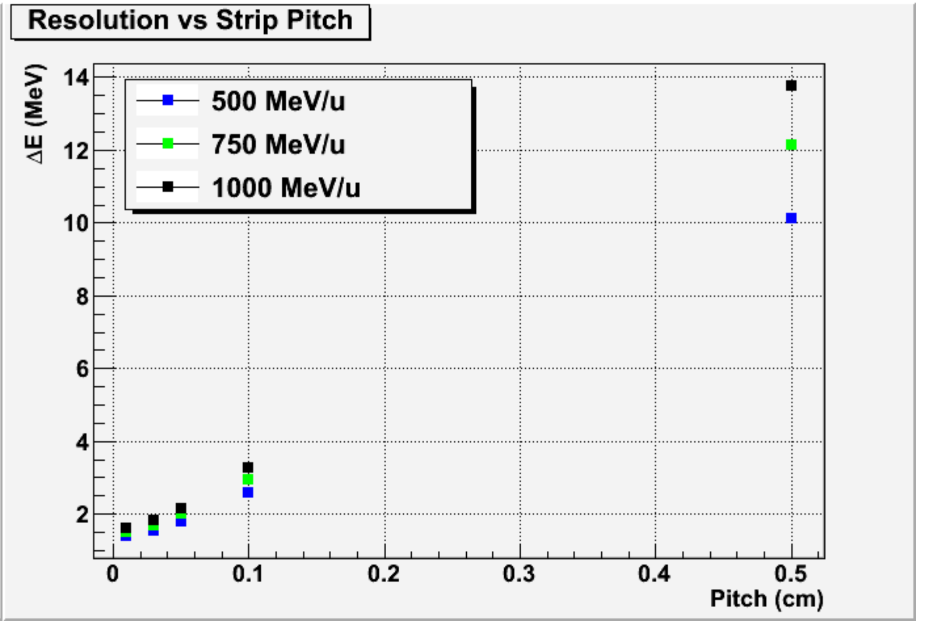
- 3 layers of Si strip detectors
  - Stereoscopic strips
  - 69 mm (14°), 194 mm (33°) and 196 mm (33°) from beam axis at zero position
  - 9.8 mm gap between layer 2 and 3
- All electronics can be placed before target
- Analysis of positions more difficult

Comparison of Resolutions

Barrel Detector

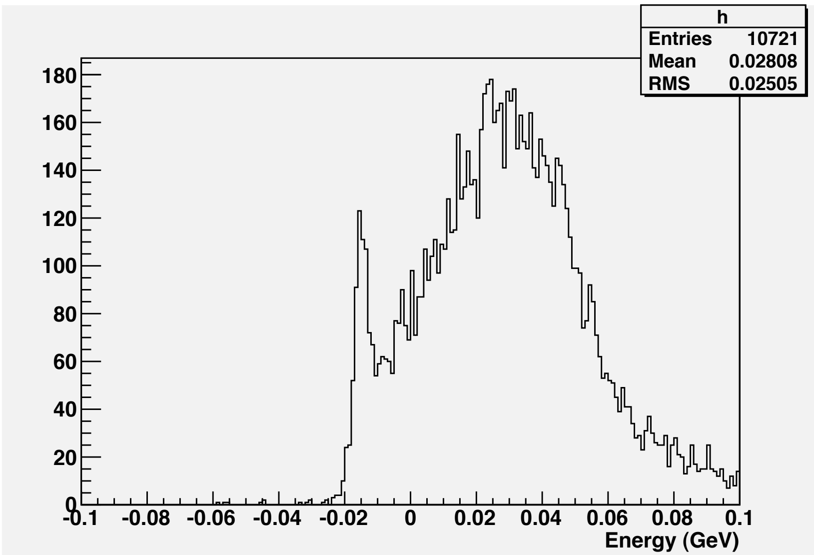


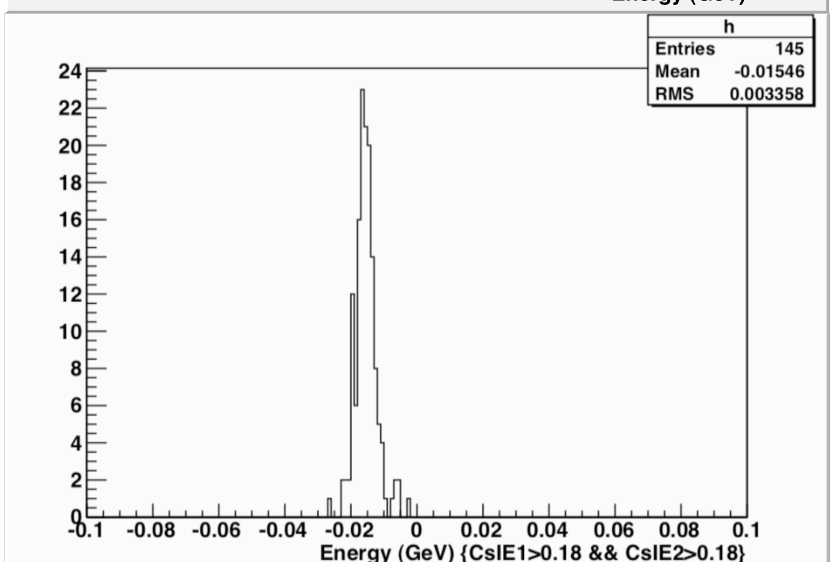
Lampshade Detector



- Resolution is almost the same for both detectors
- Given the advantage of the lampshade detector design, this will be the detector geometry we will go for.

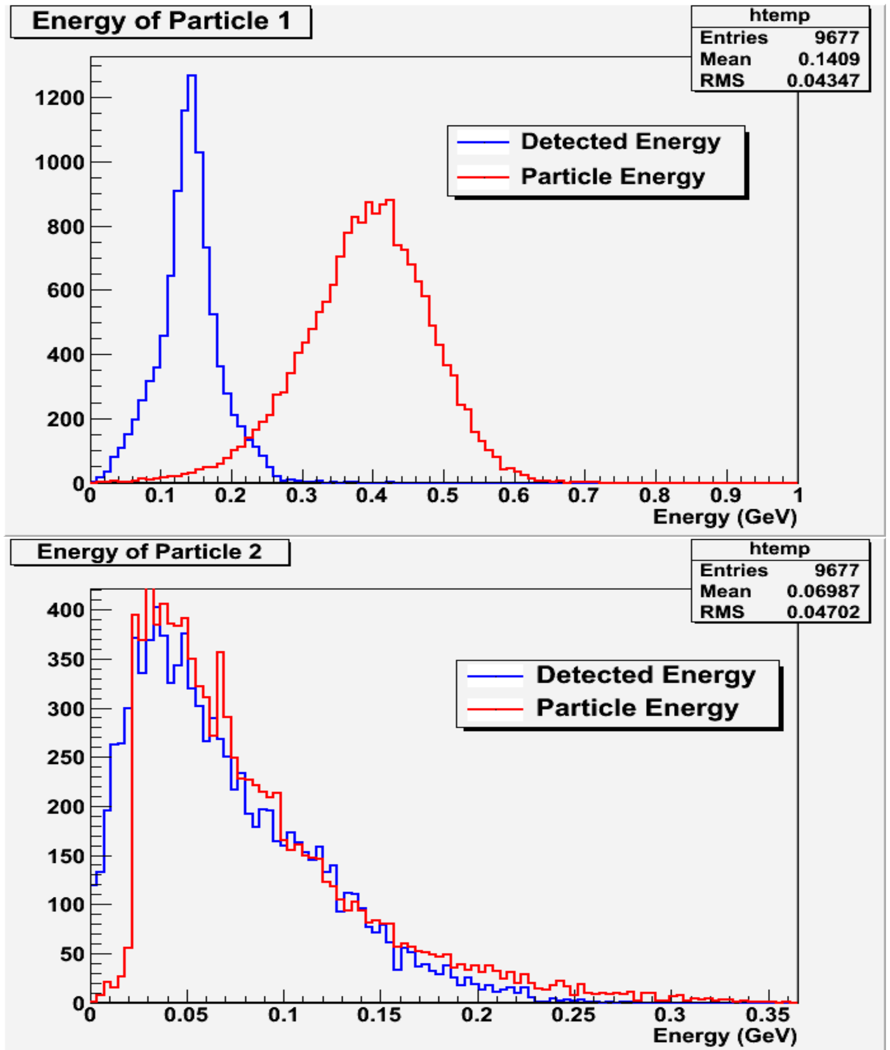
Lampshade resolutions with CALIFA





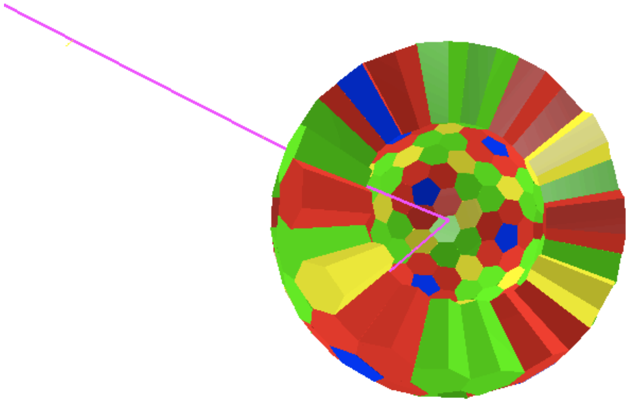
- Separation energy calculated by Si + CsI energies.
- Background from protons punching through CALIFA (above 275 MeV).
- Gate on highest energy CsI energies to cut out background
- ΔEsep = 2.8 MeV
- Eff(m>=2) = 71%

Background Contribution



- Energy profile of particle 1 does not look like detected energies, whereas particle 2 does.
- Detected energies dominated by CsI energy peak at 0.15 GeV.
- Proton punch through ~275 MeV
- Recovery of events needed or use non-punch through protons/ fragment to determine Q-value.

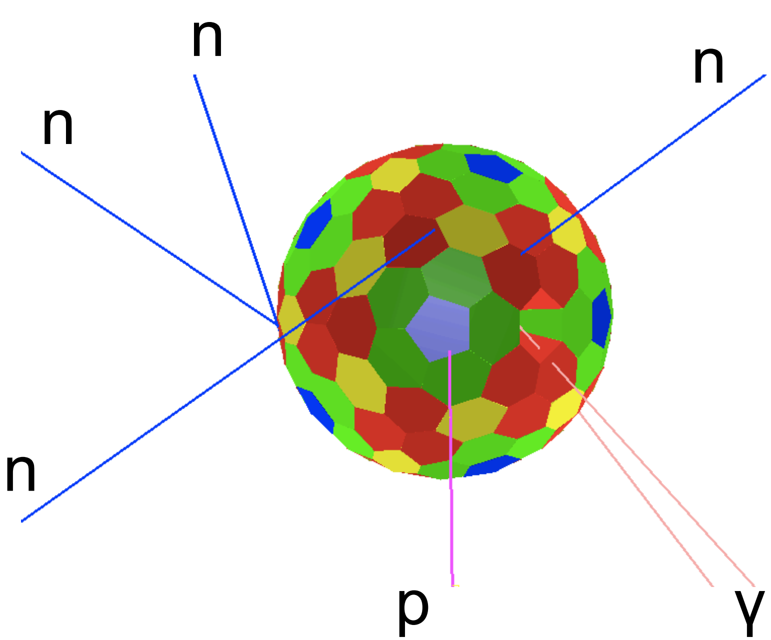
Add-back problems....

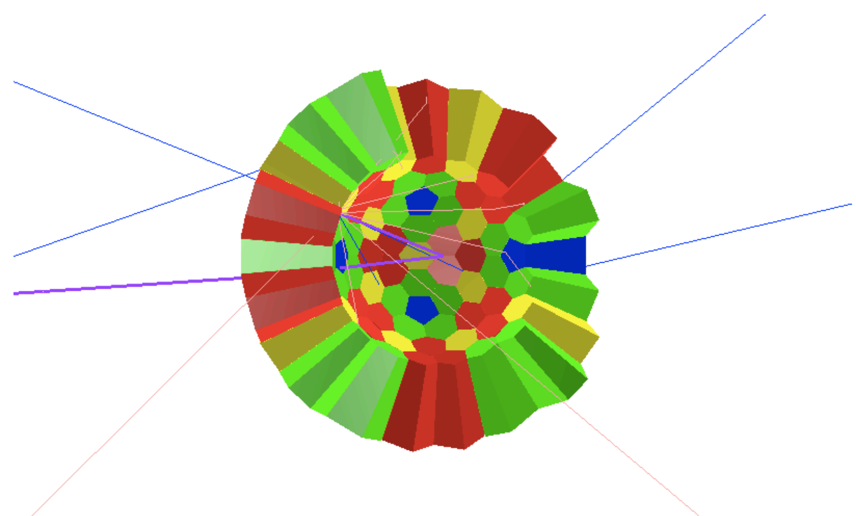


- Secondary nuclear reactions (as with LAND make reconstruction of energy difficult

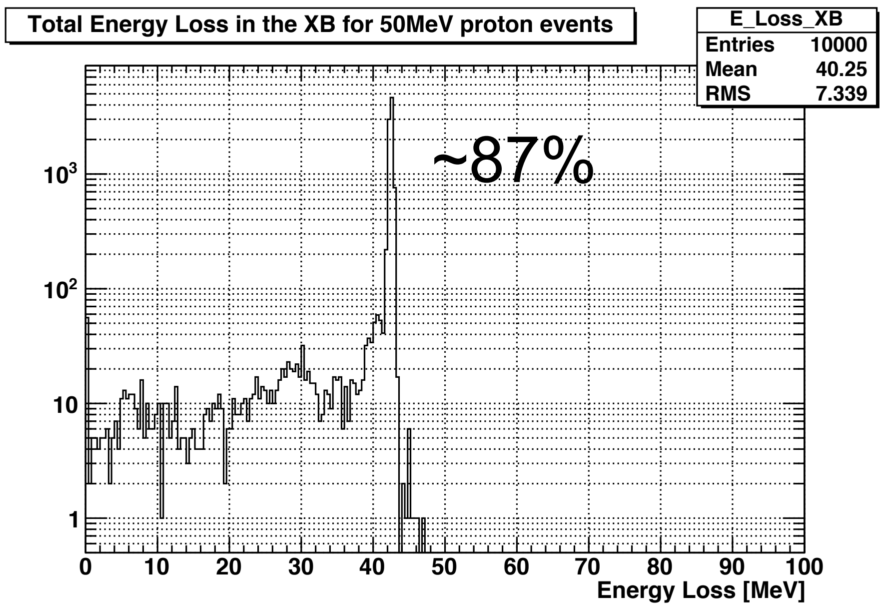
- Punch through occurs for both protons and gammas and is more probable with multiple secondary reactions with energies as low as 2MeV

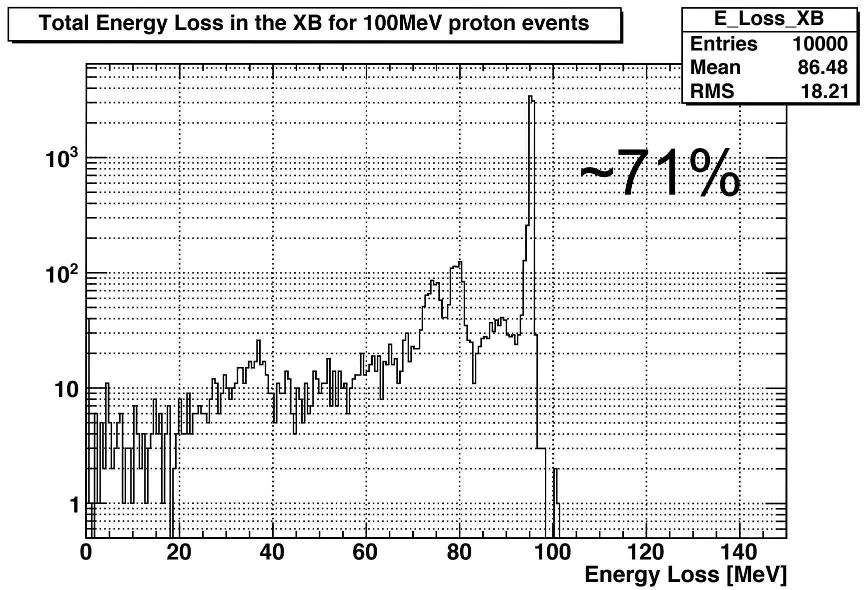
- The first crystal that the proton/gamma enters may not receive the least energy making it hard to get the original position and angle

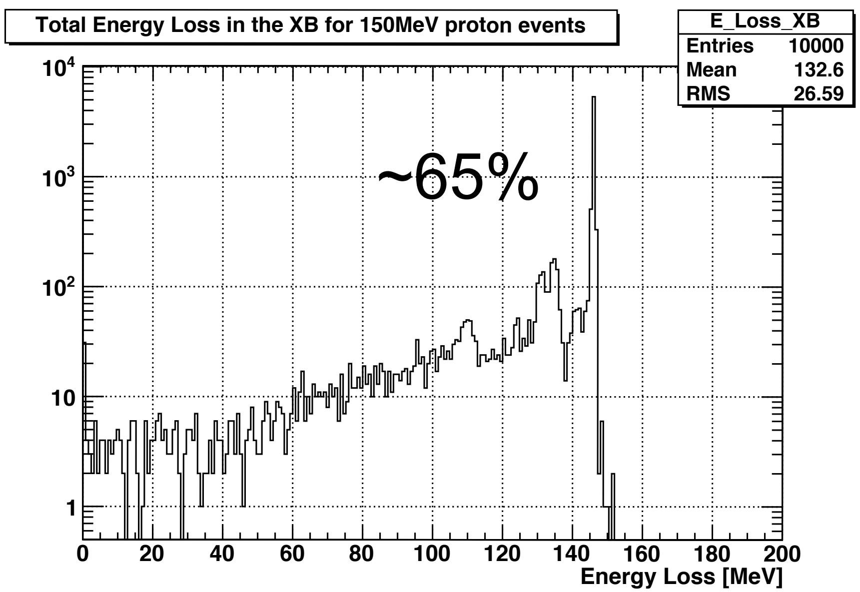


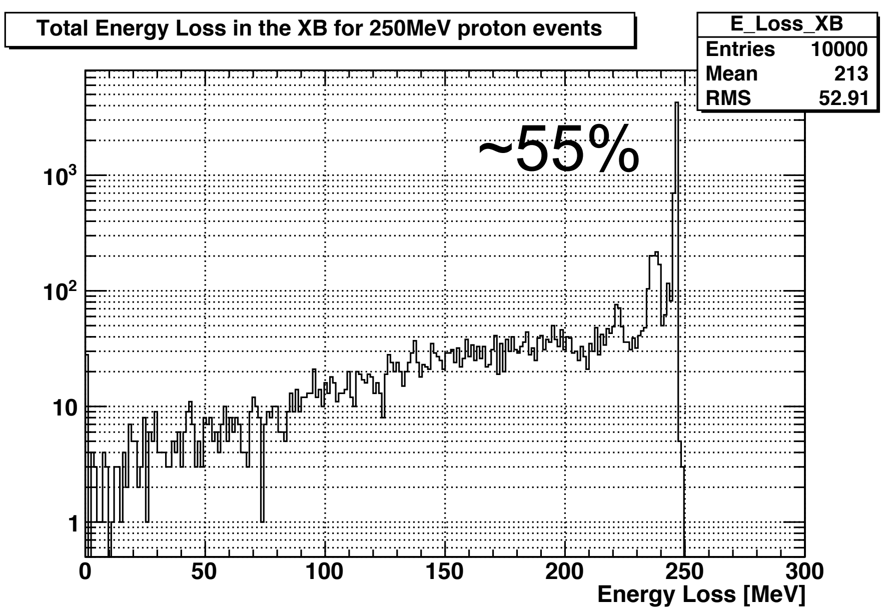


Total Energy loss in the XB for 50,100,150,250 MeV protons



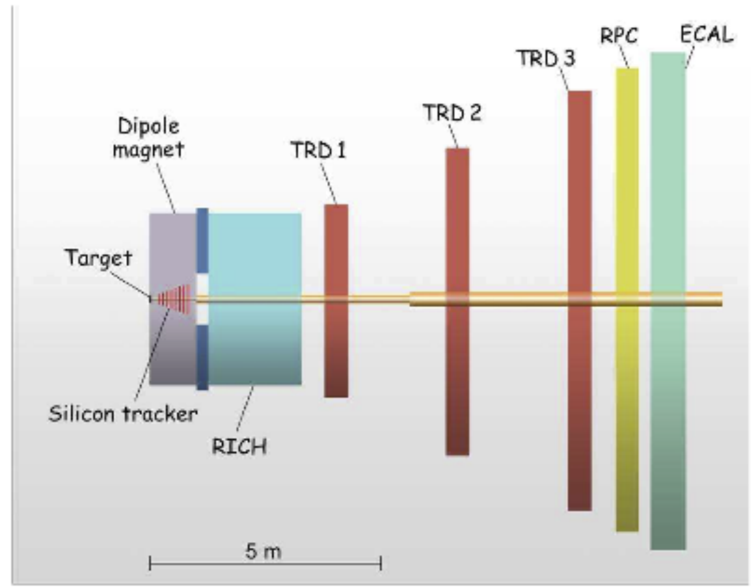


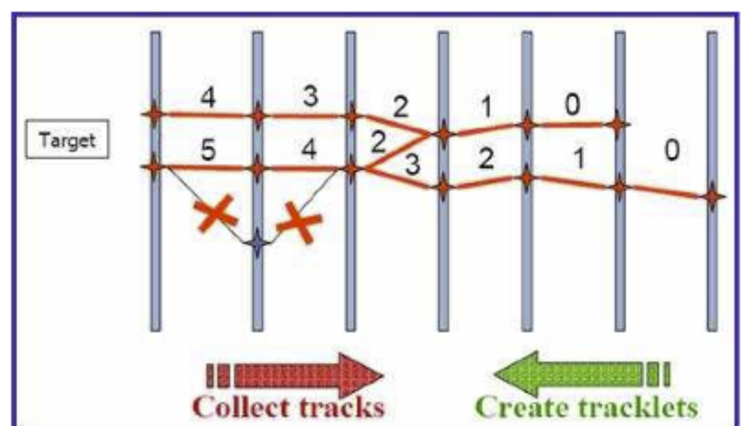




Particle Tracking

- Use of Kalman filter for particle tracking
- Based on “tracklets” forming paths through Si layers
- Least squared fit to tracklets provides particle tracking and hit rejection
  - Allows for strip redundancy
- Help from CBM collaboration
- Introduction of significant background needed





Summary

- Simulations of new R^3B tracking detector implemented in R^3BRoot package
  - Good agreement with R^3BSim
  - Elastics and (p,2p) event generators now included
- Variety of geometries, strip pitch and Si thickness simulated to constrain design
  - Lampshade detector provides both high resolution and efficiency
- Analysis program still in development stage
  - Recovery of background
  - Particle tracking