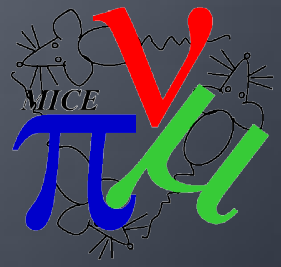
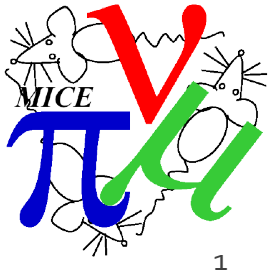
Sophie Middleton – Imperial College London

Spin Tracking in MAUS



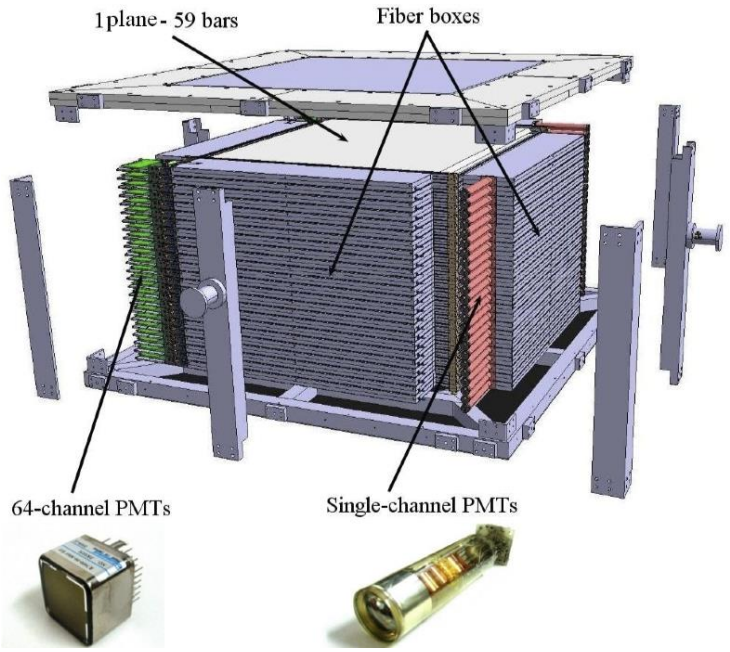
Introduction

- Question : Can we tell the difference between forward polarized and backward polarized muons by their decay electrons energy spectrum in the EMR?
- Looking at:
  - Depolarization of beam - Muon spin changes as it traverses the cooling channel due to presence of electric and magnetic fields and scattering effects
  - Effects of polarization of muon beam on the number of decay electrons seen at EMR



The Electron-Muon Ranger

- The EMR:
  - 48 planes
  - 59 Bar per plane
- The Planes:
  - Alternate between horizontal and vertical orientations
- The Bars:
  - Triangular in shape:
    - Base 3.3cm
    - Height 1.7cm
    - Length 1.1 m
    - WLS fiber in each = 1.2 mm diameter



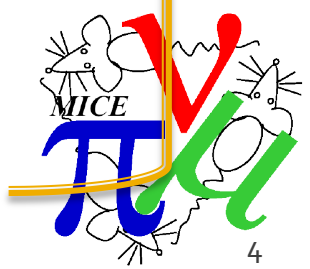
Spin Tracking in MAUS

EMR Simulation

Set up an EMR Monte Carlo

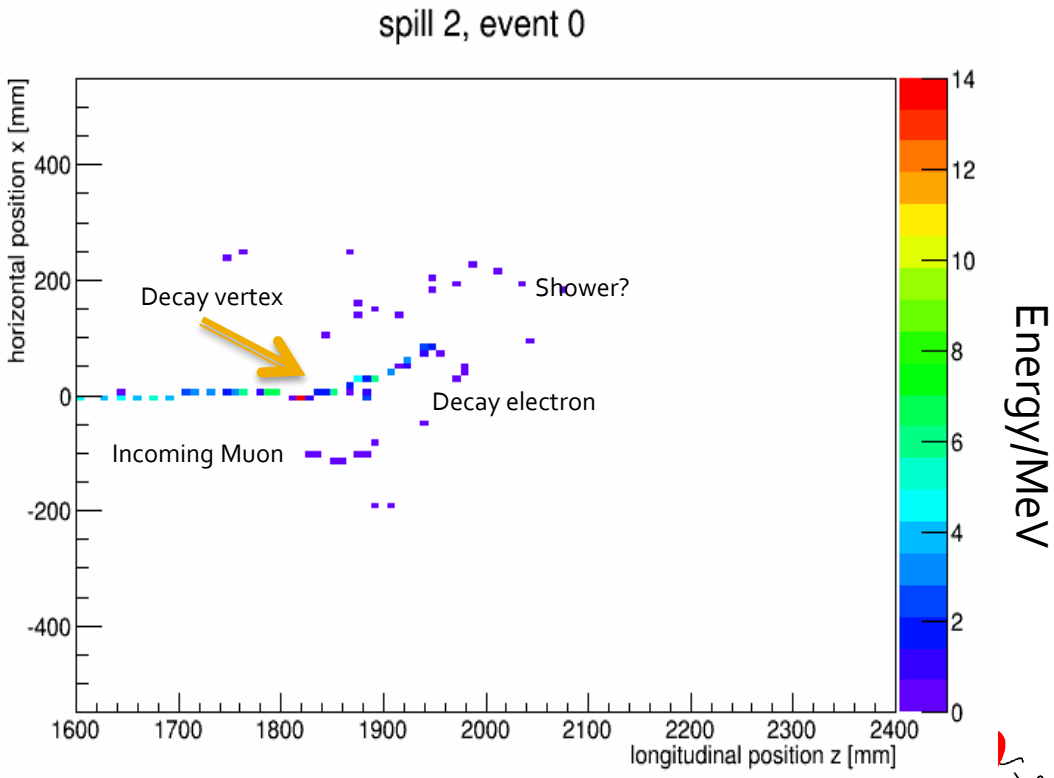
- Uses EMR Geometry and working code
- Example uses forward polarized muon beam
- Spin Tracking "on"
- Polarized muon decays "on"

Features which I have added to MAUS



Example of a Track

- Histogram shows hits in EMR from MC
- Muon is set to move along Z axis
- Colors= Energy Dep. in EMR
- These are "hits" in the EMR
- Single Events can be plotted with muon decay vertex and decay electron track



Fitting

- Better optimization done by minimizing:

$$\sum (\theta_0 - \theta_i)^2$$

- 3 parameters: x_0, y_0 and theta_0
- Where:

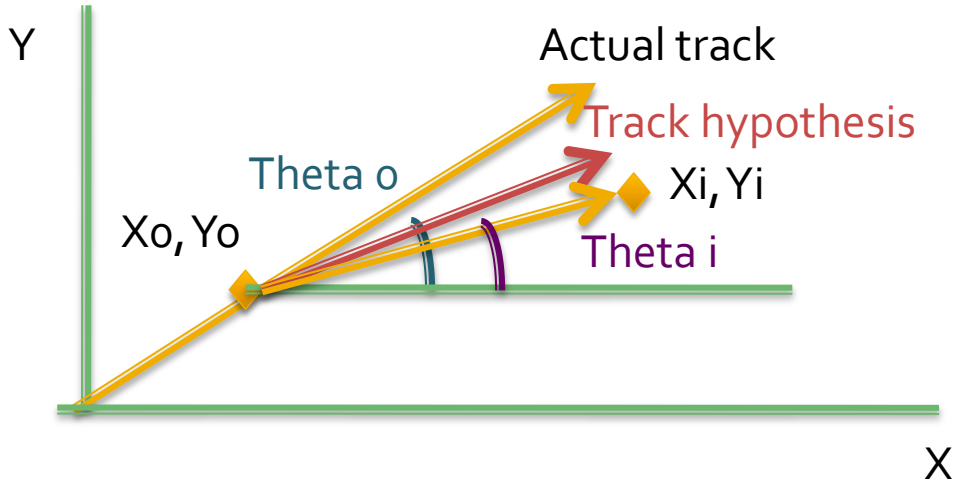
$$\theta_0 = arctan2(y(x) - y_0, x)$$

$$\theta_i = arctan2(y_i - y_0, x_i - x_0)$$

- Equation of line :

$$y = tan(\theta_0)(x - x_0) + y_0$$

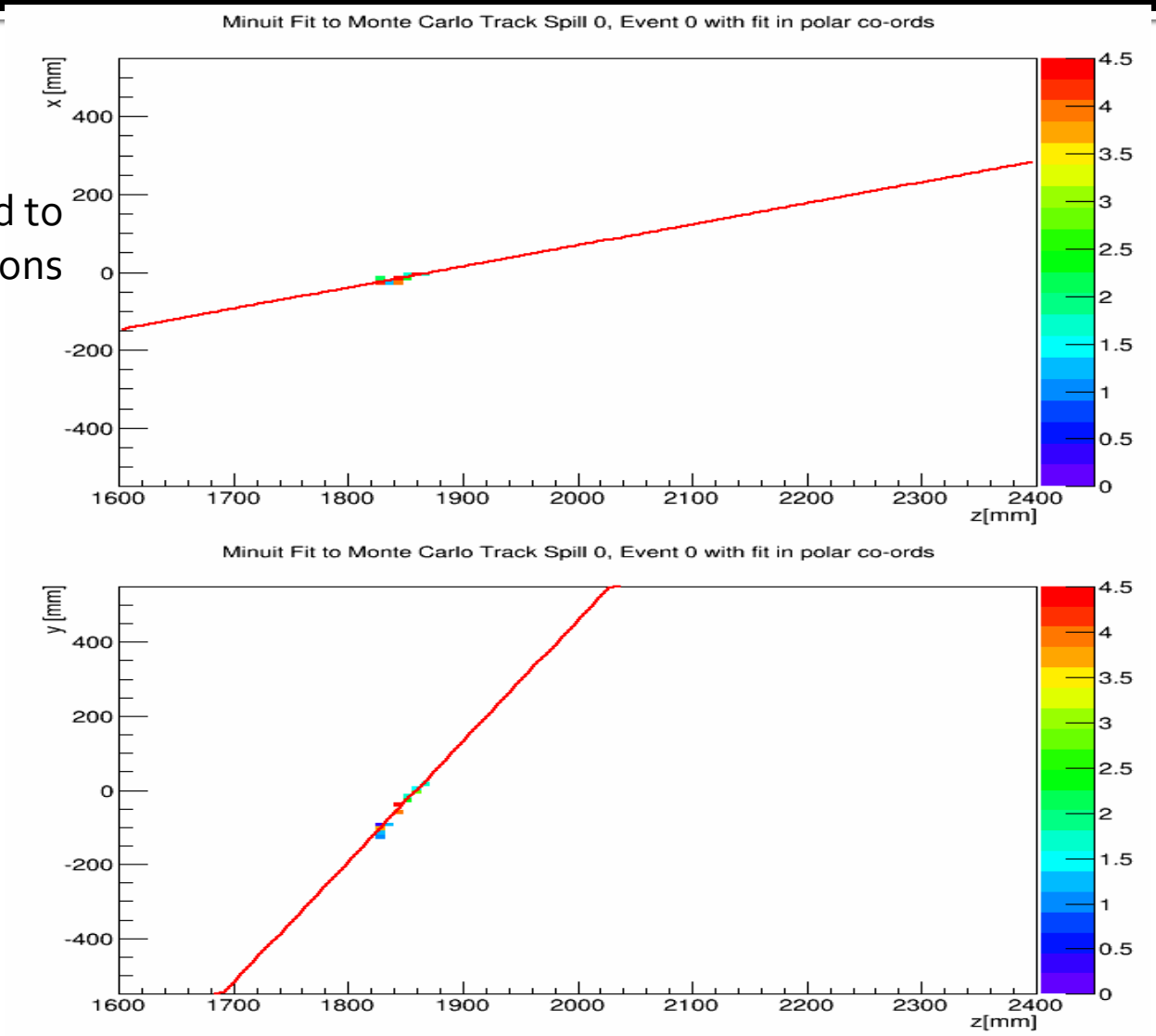
What these correspond to:



Monte Carlo Fit

Cuts applied to remove muons (t >100ns)

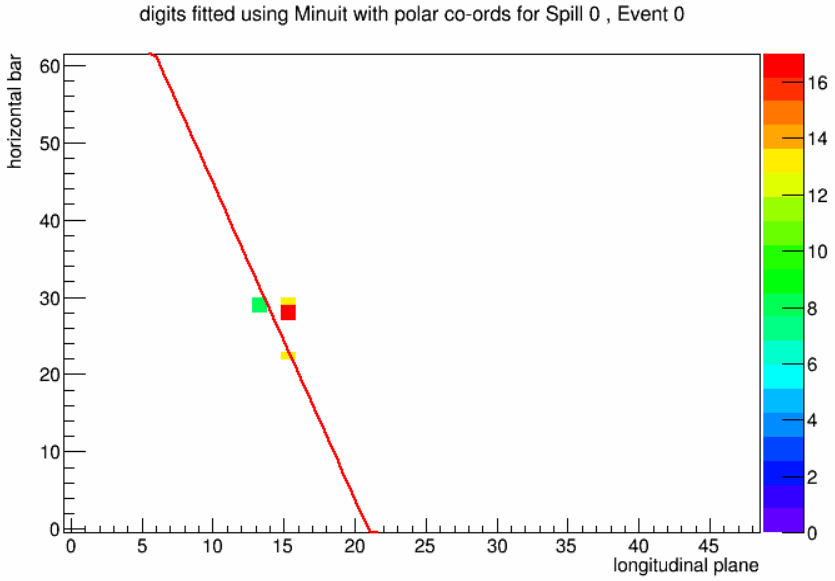
Fitted line = via polar fit



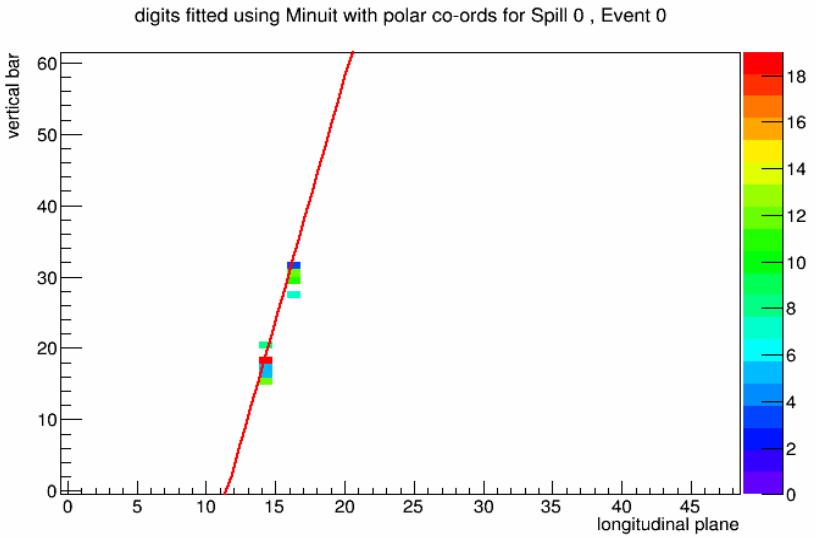
Colours = E. dep in MeV

Digits Fit

X-Z with colours =Time Over Threshold



Y-Z with colours =Time Over Threshold



- Process of converting the energy deposited to ADC counts (colours proportional to ADC charge)
- Use bar and plane number instead of distance from start
- Fit parameters limited by efficiency->Needs consideration

Using Muon Track Information

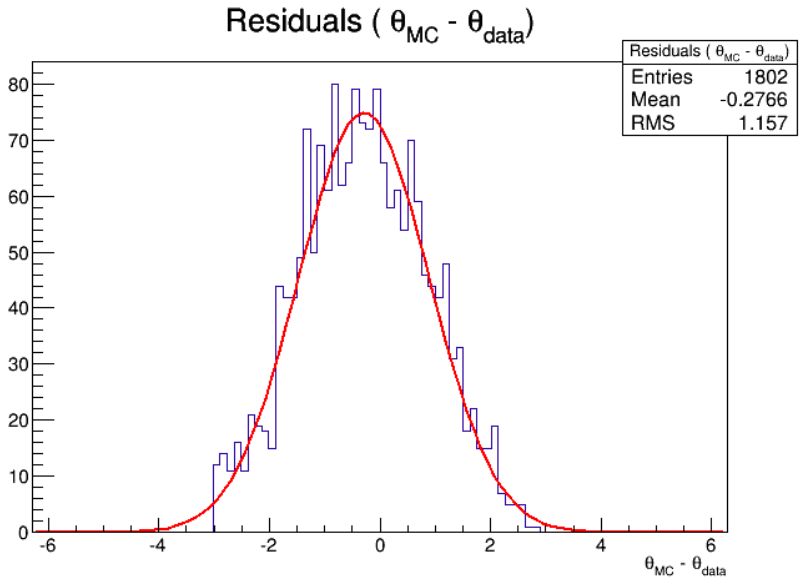
- In MC muon tracks are parallel to axis - In reality they may not be
- Have to get a better way of knowing initial x and z (i.e. decay vertex)
- Fit to muon track and use this info to determine where to start the positron track fit
- Allow to vary by a few bars either side of this to get best fit

Issues and Solving them

- The muon vertex is not always at nominal plane = 15, bar = 30 point. There is a little spread. If we hard code this in it effects the reconstruction
- There is a good minimum when the vertex on edges of EMR i.e plane = 48, bar = 59 (or equivalently plane = 0, bar = 0)
- Some issues when almost horizontal track → looking into using vectors instead (still in progress)

Residuals

- Theta-RMS=1.157 rad… not good resolution…..needs investigation!



Source Of Errors

- A few ideas:
  - Track curvature - scatters make the track not straight → turn off scattering in MC
  - Mis-reconstruction of the vertex - the positron track is pulled away from the true position →Use MC truth for the vertex
  - Finite resolution of the bars - inherent size of the bars →Use MC truth for the energy deposits
  - Noise and showering - digits away from the positron track get lit up → Turn off secondary electrons (G4 production threshold)
  - Algorithm → could be due to an error in the way I am doing it!

Spin Tracking in MAUS

What's Next?

Future Work

- Carry out reconstruction and analysis on EMR Data from 2013
- Look at geometrical effects e.g. how is resolution effected by where muon is in detector and what direction it is travelling in when it decays
- Look at sources of errors e.g. Look at readout effects e.g. cross talk (signal from different bar detected) and mis-cabling
- PID
  - Reject Pions and electrons via TOF2 – TOF0 time cut
  - Look at mis-ID esp. for pions
- MC of real beamline

Thank You for Listening!

Any Questions?