SciFi Recon Efficiency Study

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Story so far

The SciFi reconstruction code is nearing a fully working stage. Yet comprehensive analysis of the performance has not been conducted.

I will be working towards answering the question:

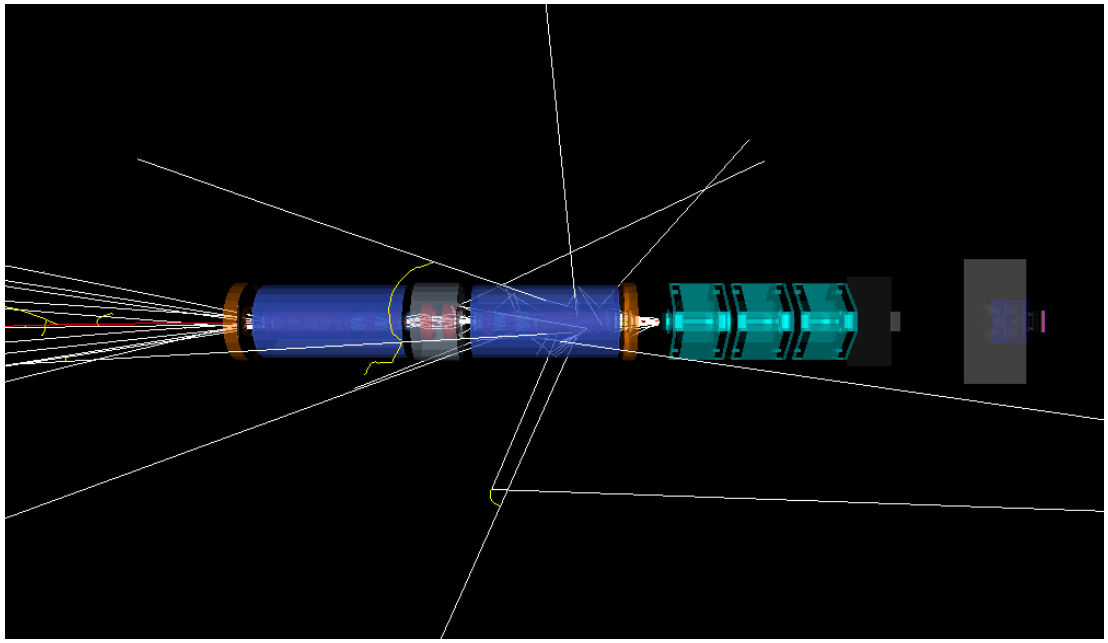
"What is the reconstruction efficiency for SciFi Tracks"

Not as simple as it first seems. . .

The Simulation

Using standard *Step4.dat* geometry and SciFi Recon routines as shipped in every MAUS release.

Custom code to systematically analyse the final reconstruction information available in the data structure.



The Monte Carlo Data

A lot of high intensity data to push the reconstruction software.

Number of Spills	99
Particles per Spill	50
Number Primary Tracks	4950
Number of SciFi Tracks	5940
Number of Helicals Reconstructed	5865
Number of Straights Reconstructed	75
Number of MC Hits	600019
Number of MC Noise Hits	0
Number of MC Tracks	8026
Number of Digits	119919
Number of Clusters	105795
Number of Spacepoints	35527

Some Terminology

MAUS Data Structure is quite large and still growing. These are the components that I will refer to.

Monte Carlo (MC) Components

MC Hits	Interaction sites between some particle and a component of the tracker.
MC Tracks	The path the simulated particles follow. Each have a unique ID number.

Reconstruction Components

Digit	A group of 1 or more nearby hits that will liberate electrons within the Scintillating Fibres
Cluster	A group of 1 or more nearby Digits that will cause a significant signal in one plane of the tracker.
Spacepoint	A group of at least 2 clusters from the trackers planes that corresponds to a physical measured point of a particles track
SciFi Tracks	The reconstructed track using at least 4 spacepoints (for a helical track) from different tracker stations.

The Goals

We have 3 main goals as part of this study:

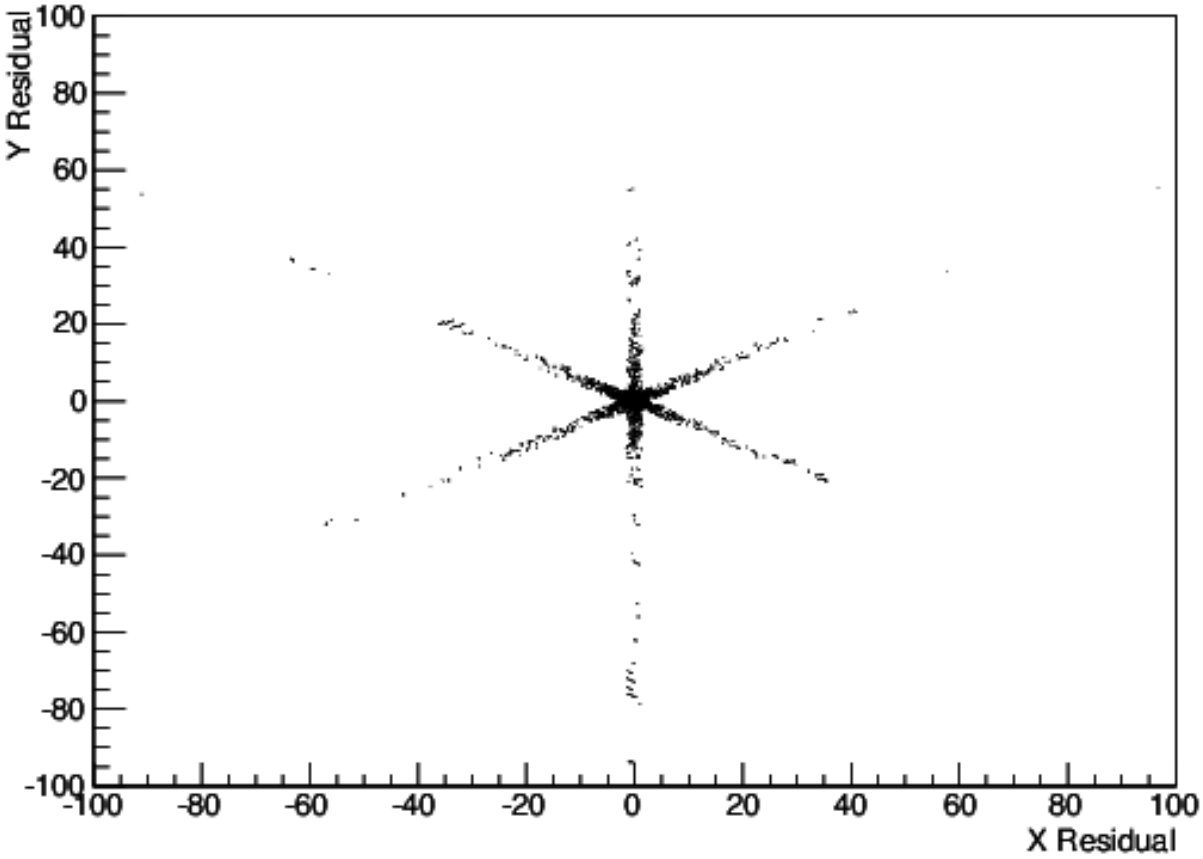
1. To perform some sanity checks on the reconstruction routines. No bugs/memory leaks and physics behaving as it should.

2. To put some measurable and reproduceable quantities on the performance of the track fitting functions.

3. To find out where and why our current functionality breaks down. Too many tracks, too many spacepoints, particle decays, etc.

Digit Verification

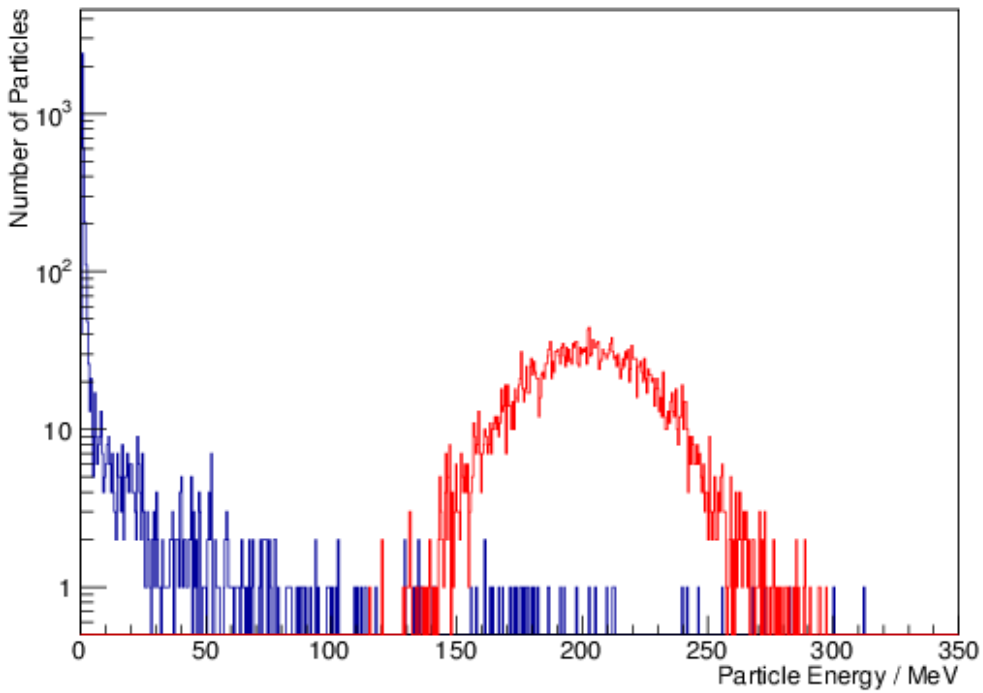
Reconstructed Digits are found in a single fibre. X-Y residuals therefore reproduce the structure of the fibres.



Digit Verification

Each digit made up of several MC Hits due to ionisation energy losses and components of EM showers.

The energy of used Primary and Secondary particles.



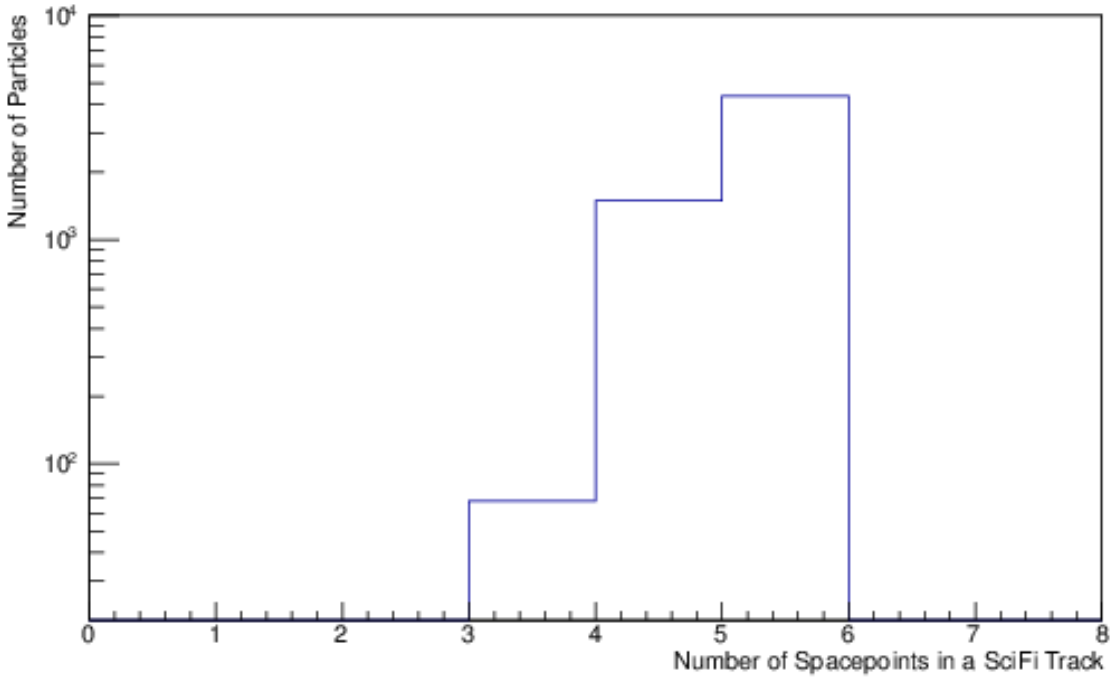
Acutal digits formed by : 4068 Primary Particles & 3958 Secondary Particles

Spacepoint Verification

We expect spacepoints to be made from at least two digits from two different planes, but possibly more. (Actually 3.375 Average)

We also expect between 2 and 5 spacepoints per Reconstructed SciFi Track.

(Straight ≥ 3) & (Helical ≥ 4)



SciFi Track Analysis

Analysed 5940 SciFi Tracks from 28072 Spacepoints
(79% of reconstructed spacepoints)

Corresponding to a total of 8026 MC Tracks.

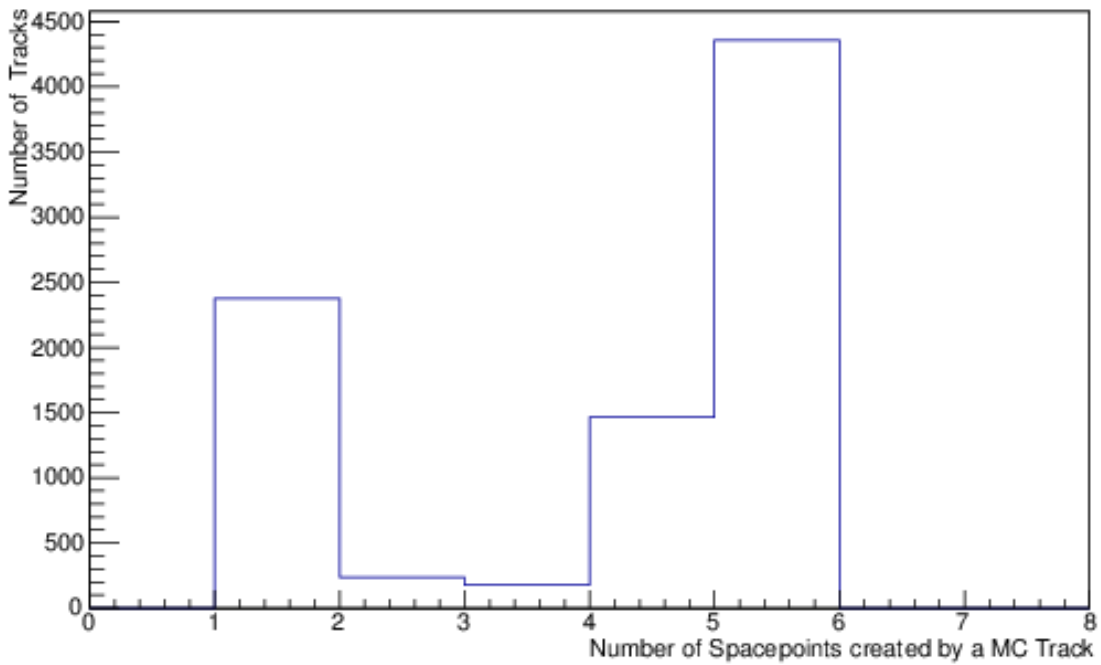
I will define a *Matched Track* as

"*The Track ID that appears in the most SciFi Track spacepoints.*"

Identification Errors - The Matched Track

Ideal tracks contain spacepoints with a single common MC Track ID. This is not always the case.

Missed particle interactions or decays in addition to finite measurement resolution causes errors.



Identification Errors - Spacepoints

Find the Matched MC Track - see if there are spacepoints where it doesn't occur
These must be incorrect.

0 Spacepoint Errors	5812 (97.97%)
1 Spacepoint Errors	110 (1.72%)
2 Spacepoint Errors	18 (0.31%)

Identification Errors - Track ID

It is possible to reconstruct a SciFi Track that matches no MC Track?

If there is no MC Track ID that appears in more than half the spacepoints, we can say that this track is incorrect.

We find 16 (0.27%) SciFi Tracks with no Matched MC Track.
So it is possible!
(Actually all 4-point Straight Tracks)

Incorrect Spacepoints

137 Spacepoints missing the Matched Track ID

How many tracks contain a decaying primary?
If we check the incorrect spacepoint for ancesestors
16 of 146 (11.0%) are daughter particles.

The other 89.0% don't contain daughter particles.
Need to find out where they came from. Perhaps another track?

Overlapping Tracks

Looking at the second most common Track ID in a SciFi Track.
If this produces more than one spacepoint, we have a (partially) overlapping track.

This occurred in 281 SciFi Tracks
(4.7%)

59 Were secondary particles, produced from the Matched Track
(0.99%)
208 Were other unrelated particles
(3.7%)

The Questions

- Only 79% of spacepoints become tracks. What about the others?
- How many spacepoints are missed rather than incorrect? Did they join the wrong SciFi Track?
- How many Track IDs are missed rather than incorrect? Did we fail to distinguish any particles?

Todo List

- Global event spacepoint cross checks. If we have an incorrect spacepoint, where did it go?
- Place limits on the event size that can be handled with the desired efficiency.
- Determine any differences between the two Trackers.
- Pre-emptively create a list of expected SciFi Tracks from the pure MC Data to compare.