Developments in MIND Reconstruction

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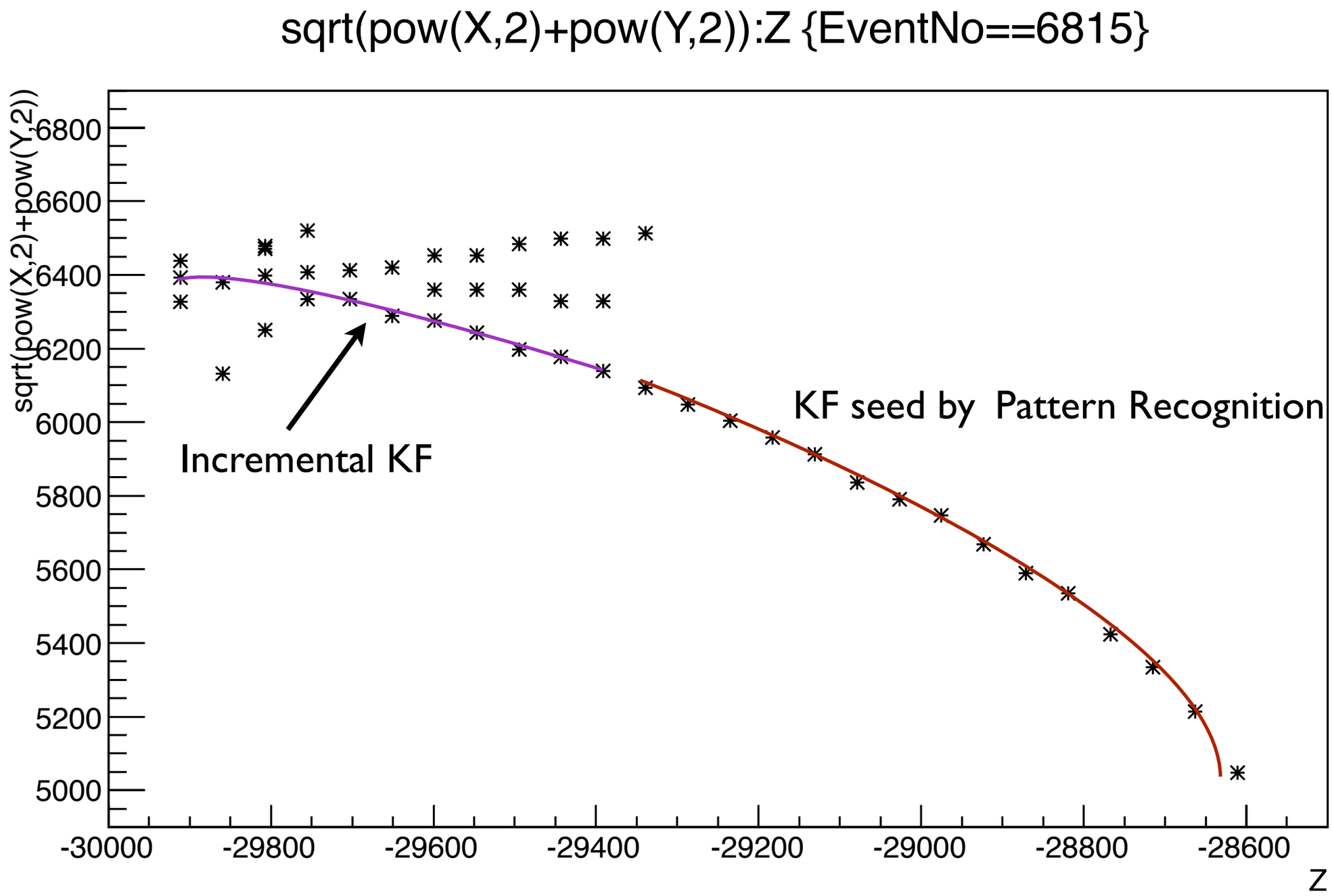
8th IDS-NF Plenary meeting
Glasgow, 19/04/2012

Functioning of the present code

- Pattern recognition performs track finding by incremental Kaman Filtering or by Cellular Automata.
- Primarily, it looks for the plane occupancy along Z (neutrino direction) and search for longest ´free section´ which contains single hit planes.
- Depending on the number of free planes either of the methods is chosen.
- Selected track is fitted by Kalman Filter (RecPack).

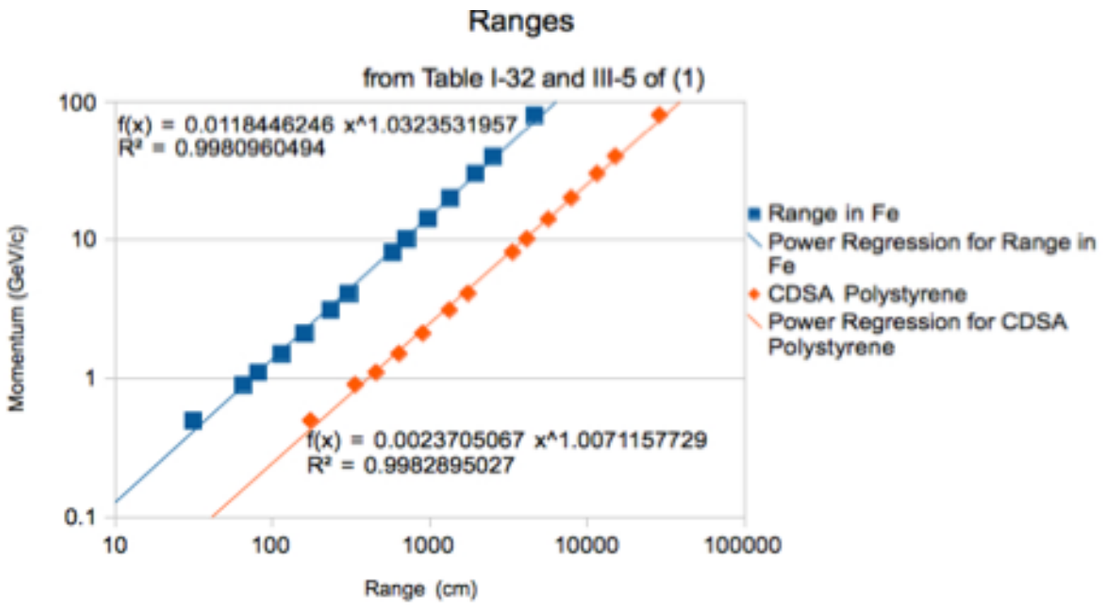
An Example



Present reconstruction can find only one track by Kalman filtering

Momentum Estimate from Range

- Seed state plays a crucial role in Kalman filtering.
- Momentum for PR seed is calculated from range to make seed calculation more reliable.
- Used the Muon Stopping Power and Range Tables(1) to generate ranges for Iron and Polystyrene.
- Better fits using power law, previously the assumption was based on linear extrapolation.

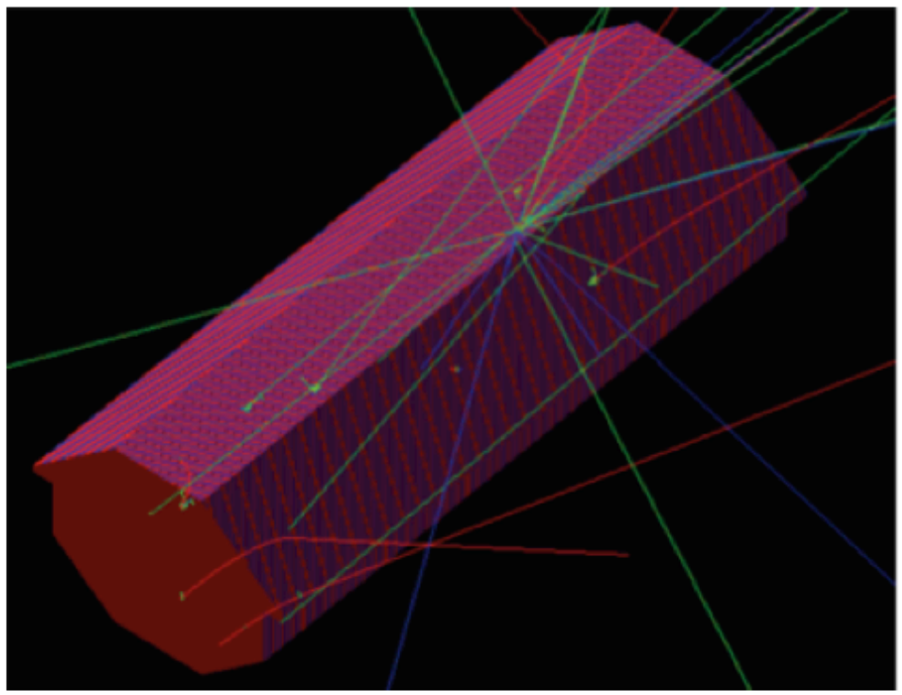


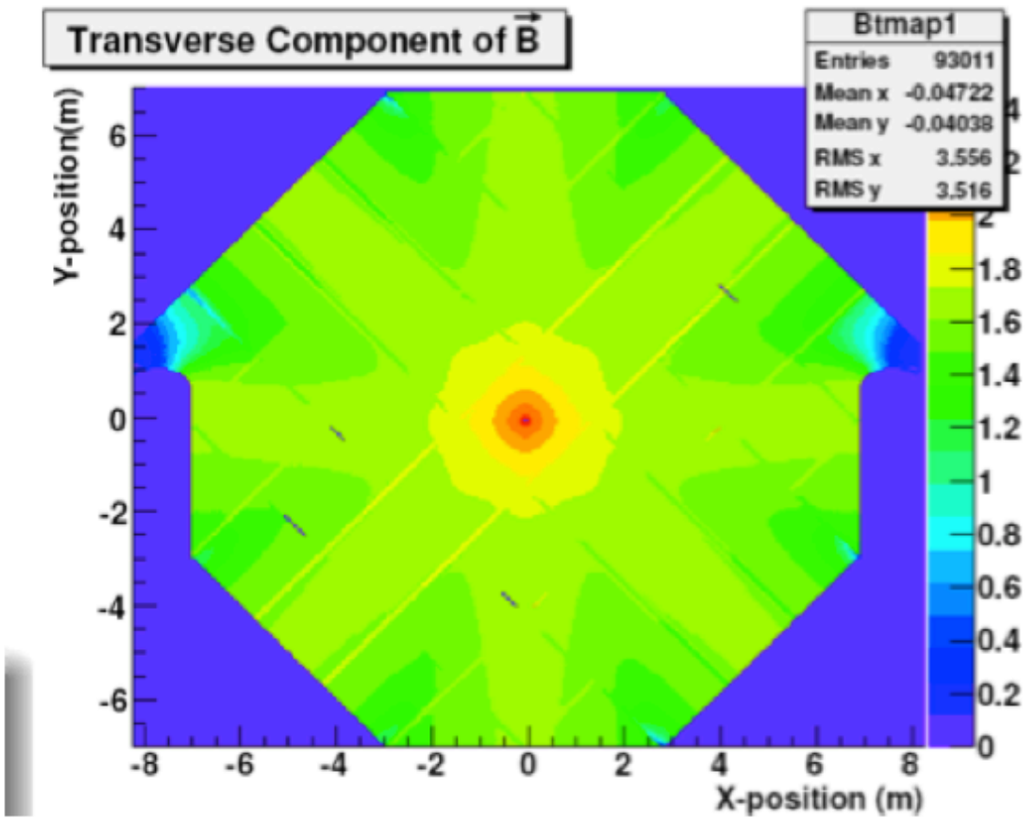
Ref. 1: Atomic data and Nuclear Data **78**, 183-356 (2001)

New Reconstruction

- Reconstruction has been improved to deal with the octagonal geometry and the toroidal field.

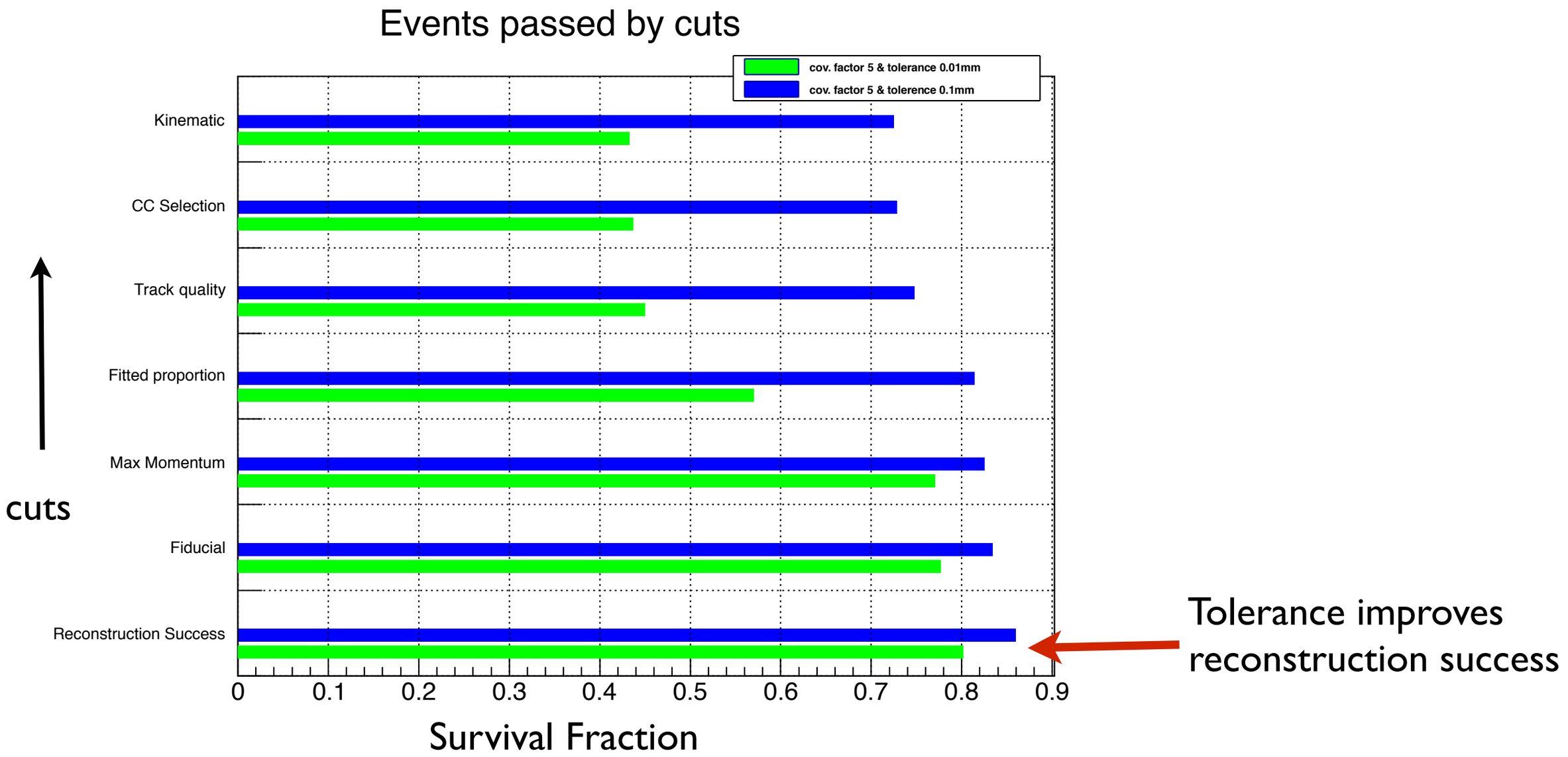
- Since field is not uniform anymore numerical extrapolations are used. To avoid a large number of steps (>100) tolerance for extrapolation to the target surface is increased inside RecPack (from 0.01 to 0.1 mm).





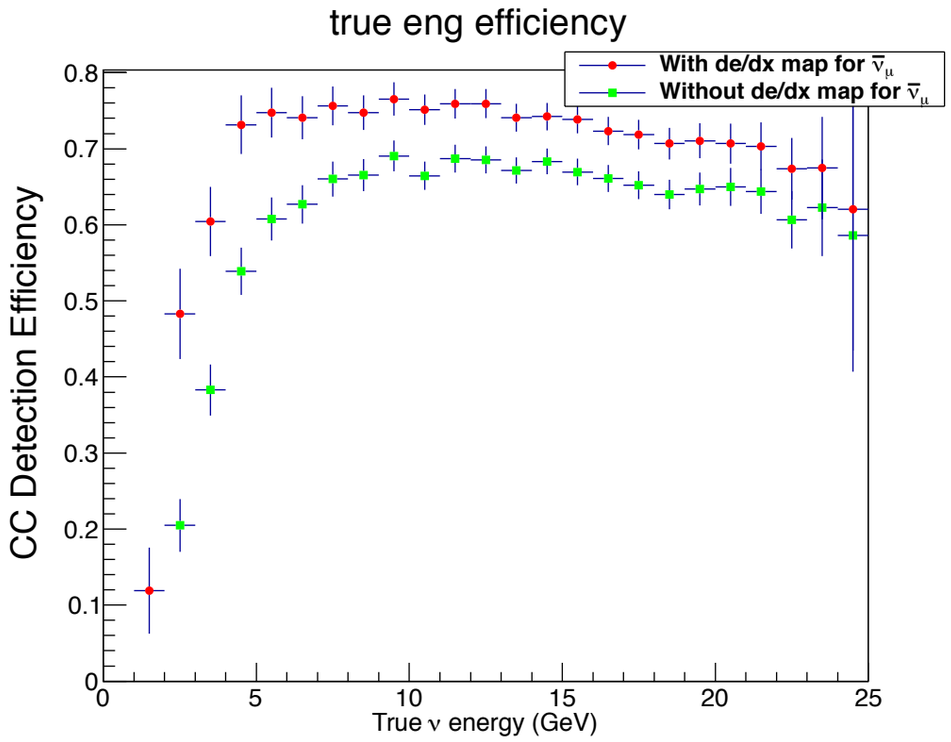
New Reconstruction

- Before 20% loss in ``Fitted proportion'' and 14% in ``Track quality'' cuts.
- Tolerance of extrapolation changed from 0.01mm to 0.1mm.

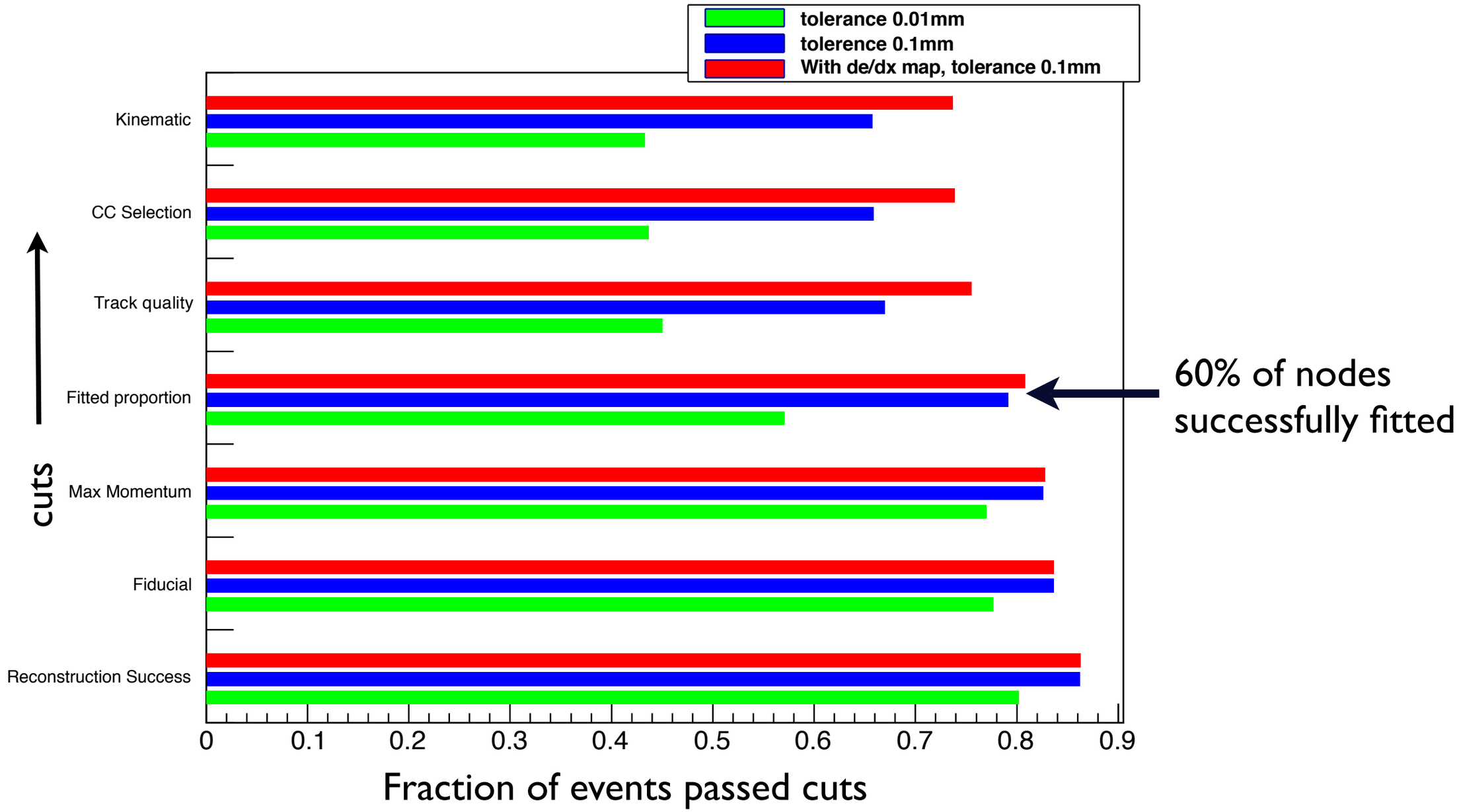


Energy Loss Map

- To improve reconstruction de/dx map is introduced.
- During each extrapolation RecPack updates energy loss according to momentum at that particular extrapolation.
- Earlier entire track extrapolation was performed by constant dE/dx .
- Energy loss correction is crucial for the low energy tracks reconstruction.
- Map contains measurements of dE/dx for momentum 0-5 GeV/c.
- Energy losses for other particle IDs are scaled by the muons dE/dx.

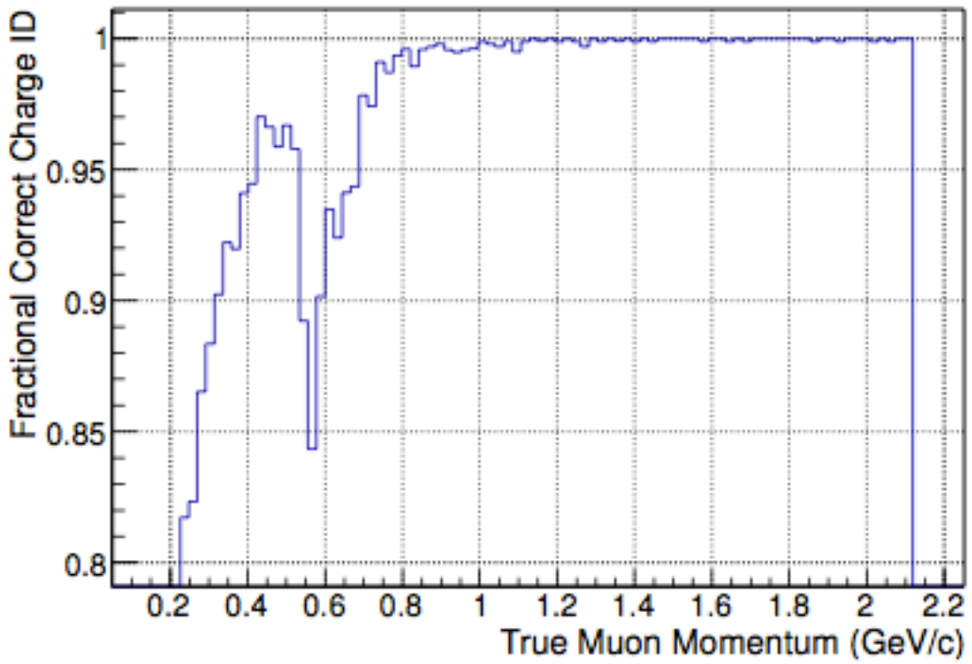


Implication of Energy Loss Map

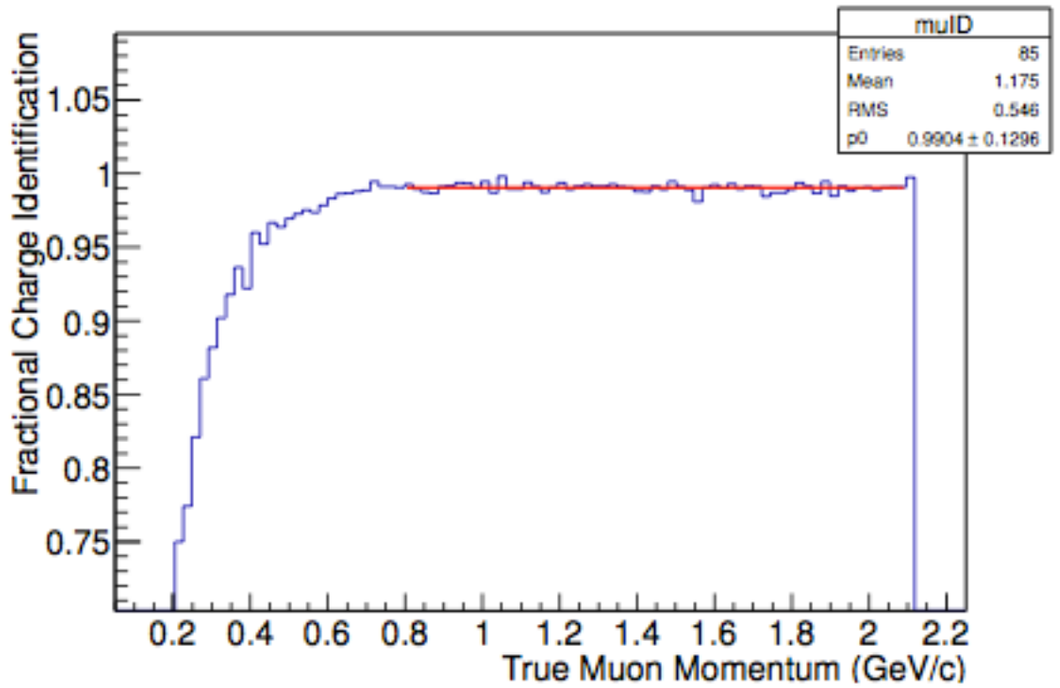


For low energy

Old Charge ID Efficiency

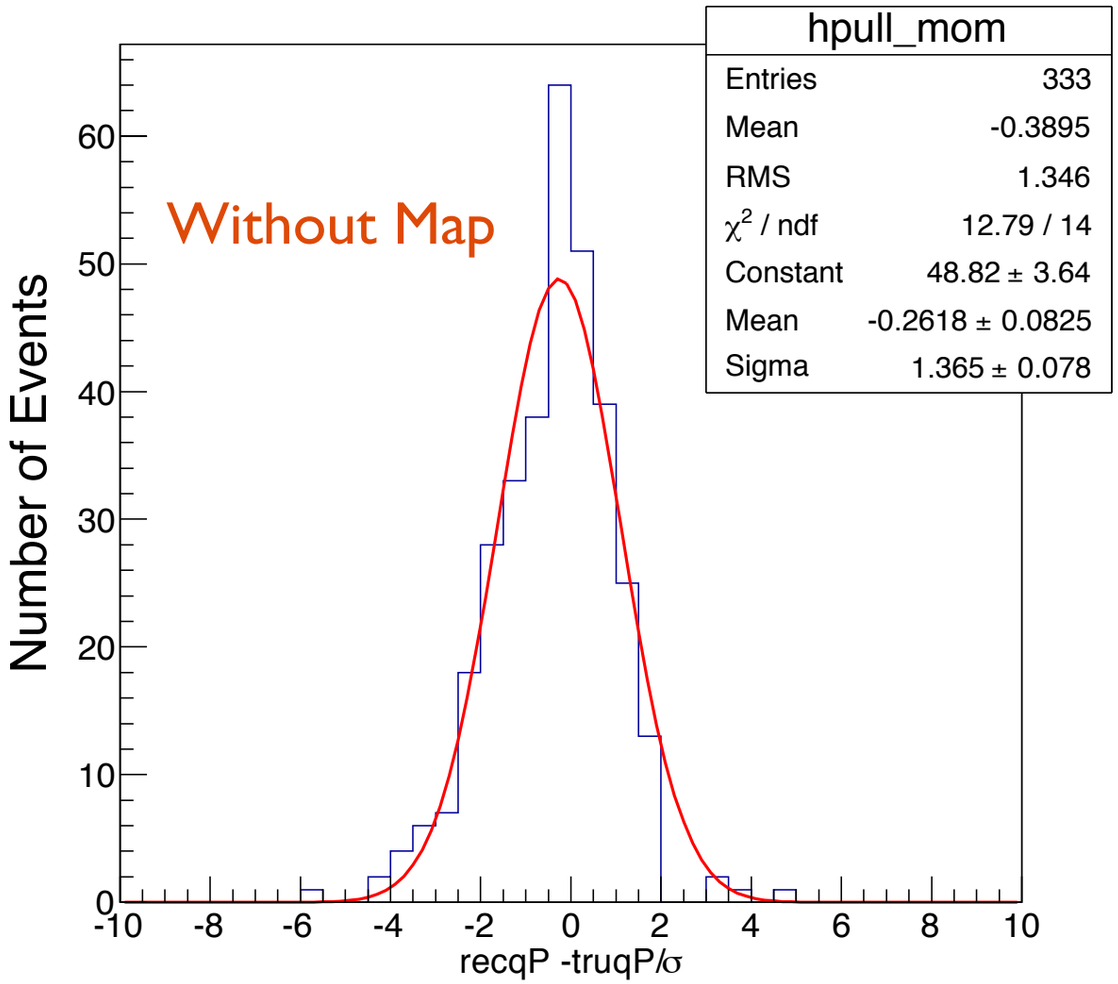


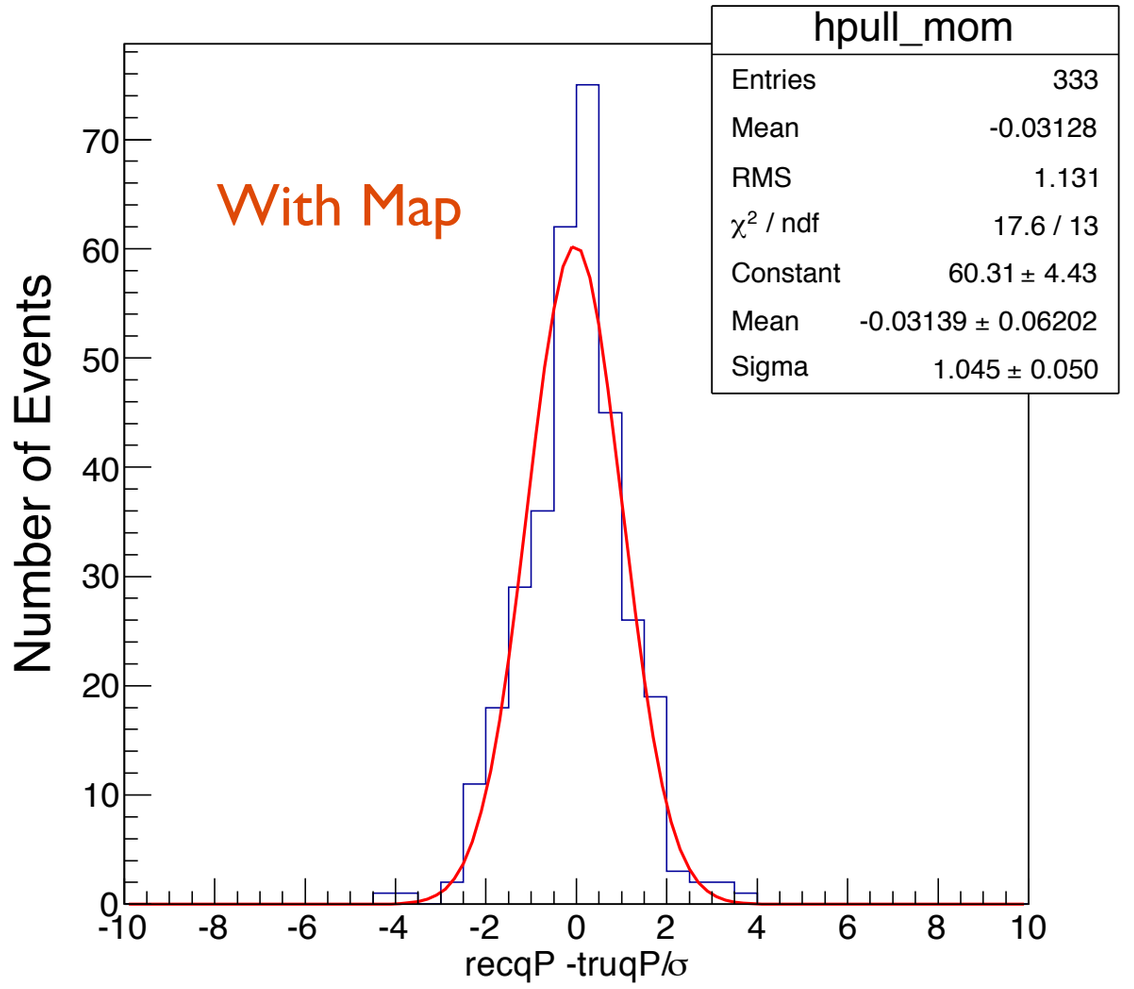
New Charge ID Efficiency



- Dip at 0.5 GeV/c no more .
- 99% charge ID efficiency plateau achieved .

Momentum Pull





Pattern Recognition by Cellular Automata

- If number of free planes < 5 then the pattern recognition is performed by Cellular Automata.

- Vector of trajectories are obtained from Cellular Automata .

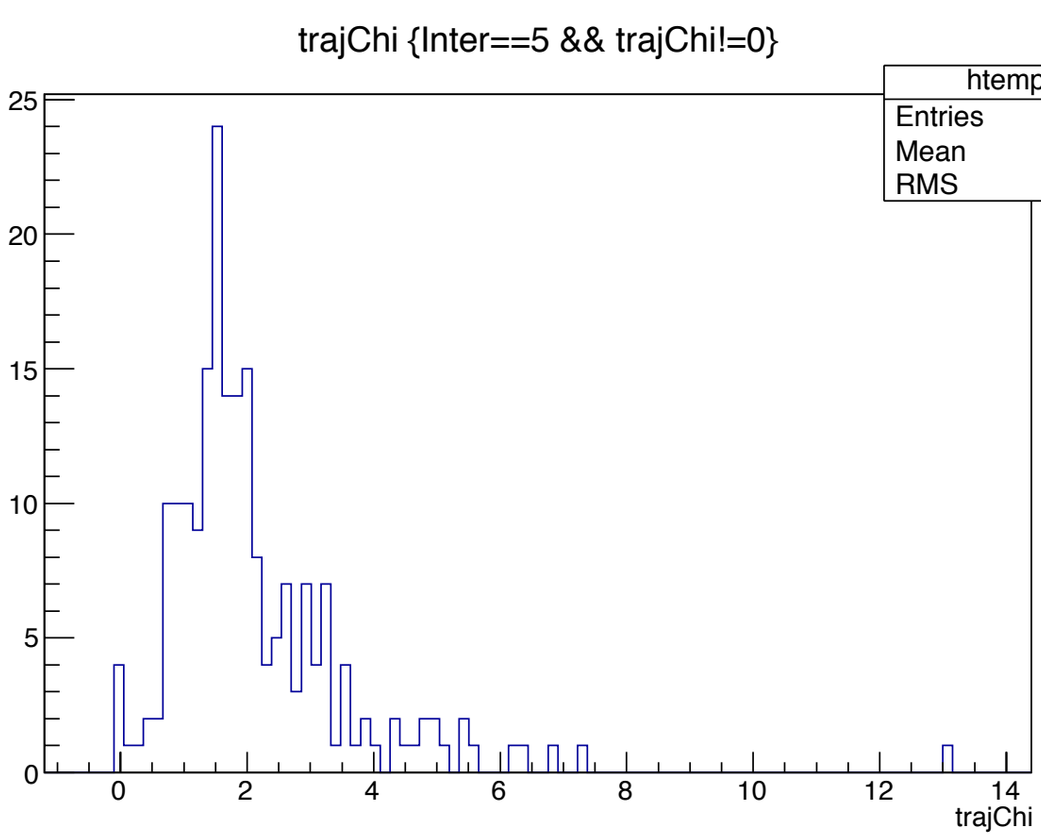
- So far the best trajectory is obtained after passing through several rejection criteria and passed into the fitter .

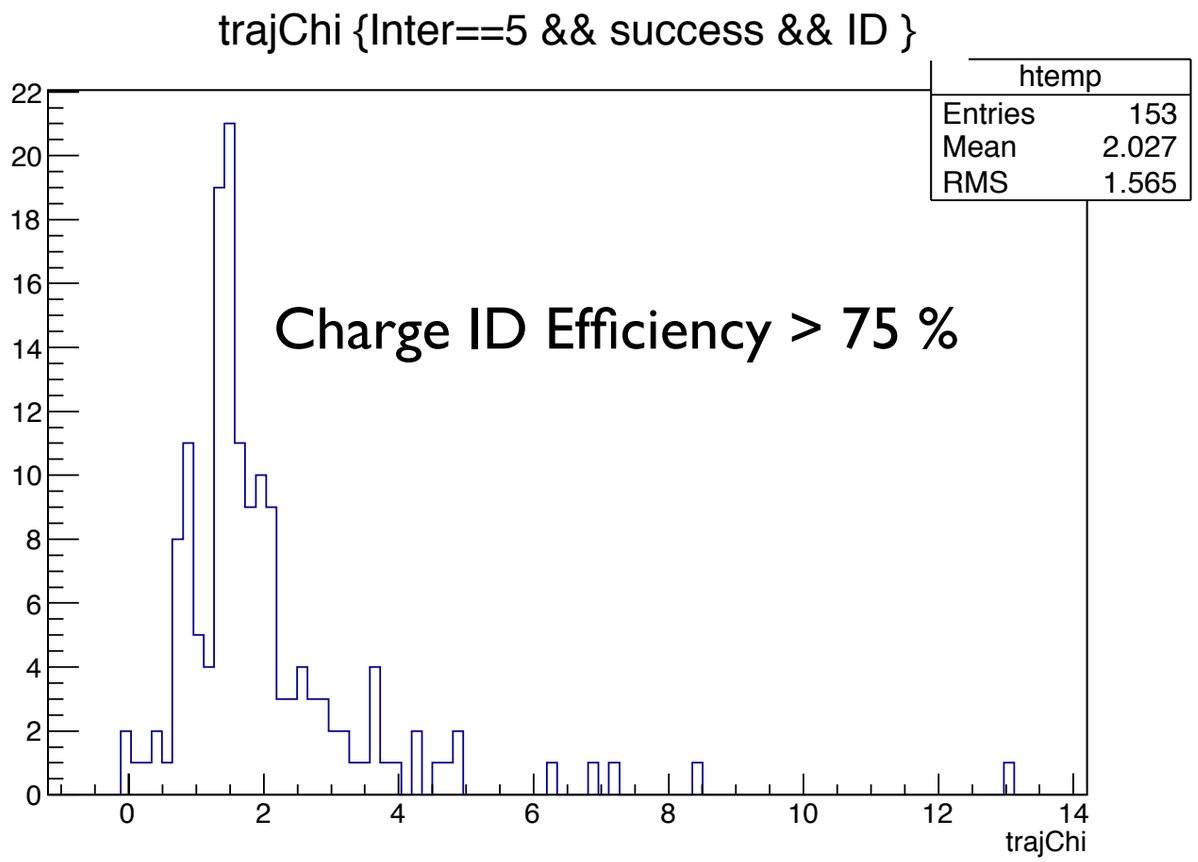
- Two approaches investigated to sort the best one from the vector; firstly, sorting by hits and secondly, sorting by length of the trajectories .

- Track containing max number hits passed to the fitter.

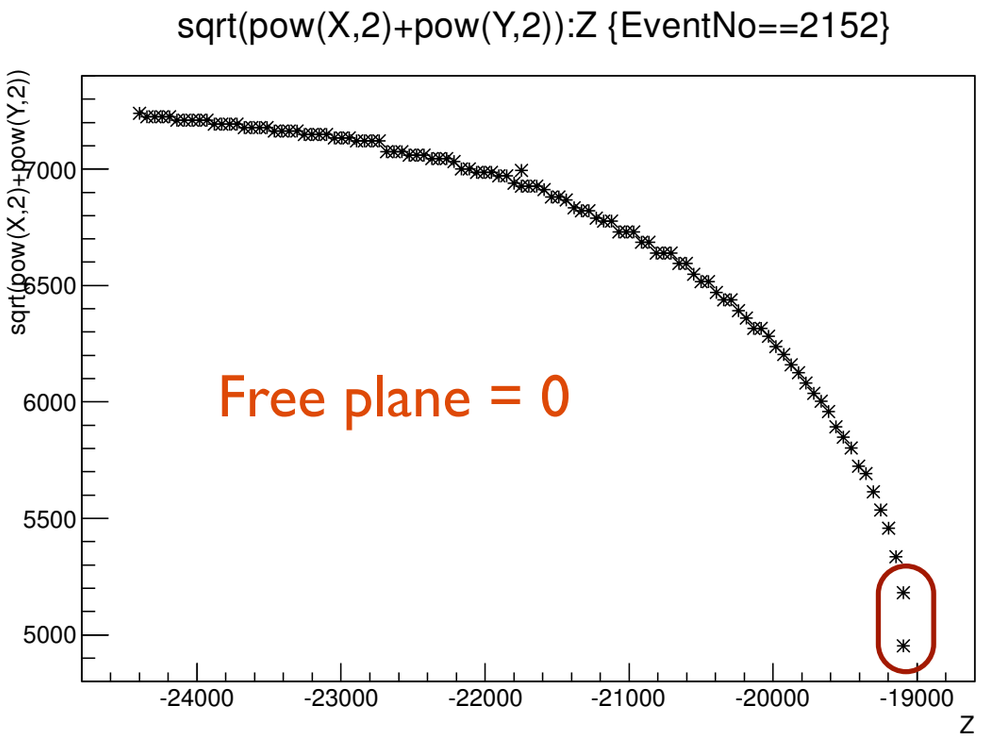
Track Quality (chi2/ndf)

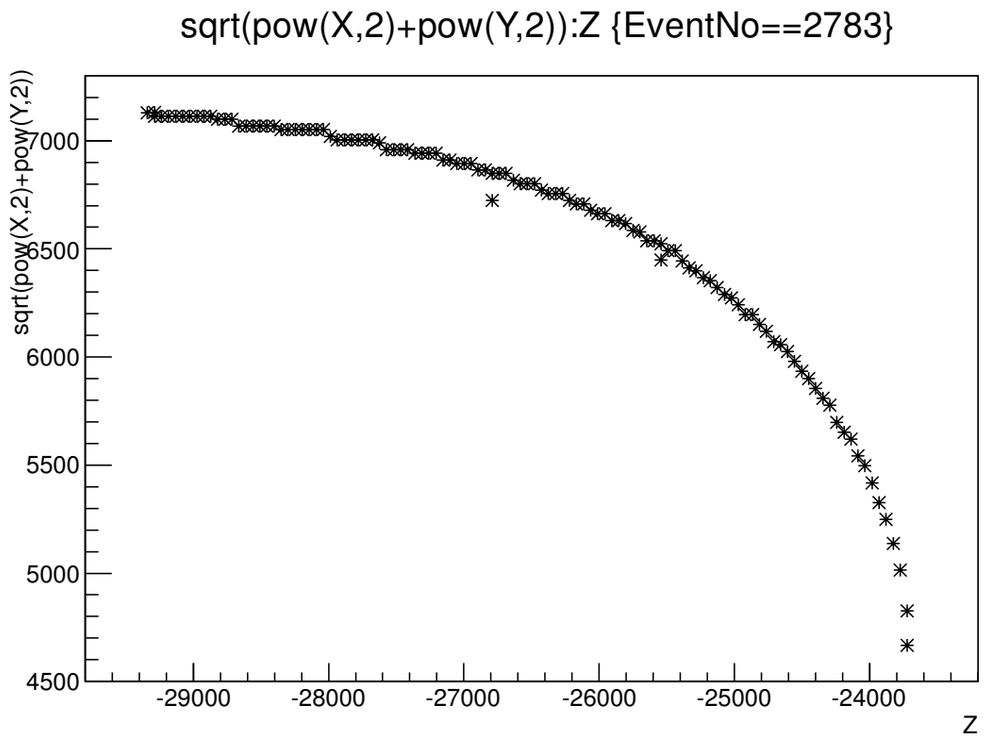
For 7 GeV neutrinos

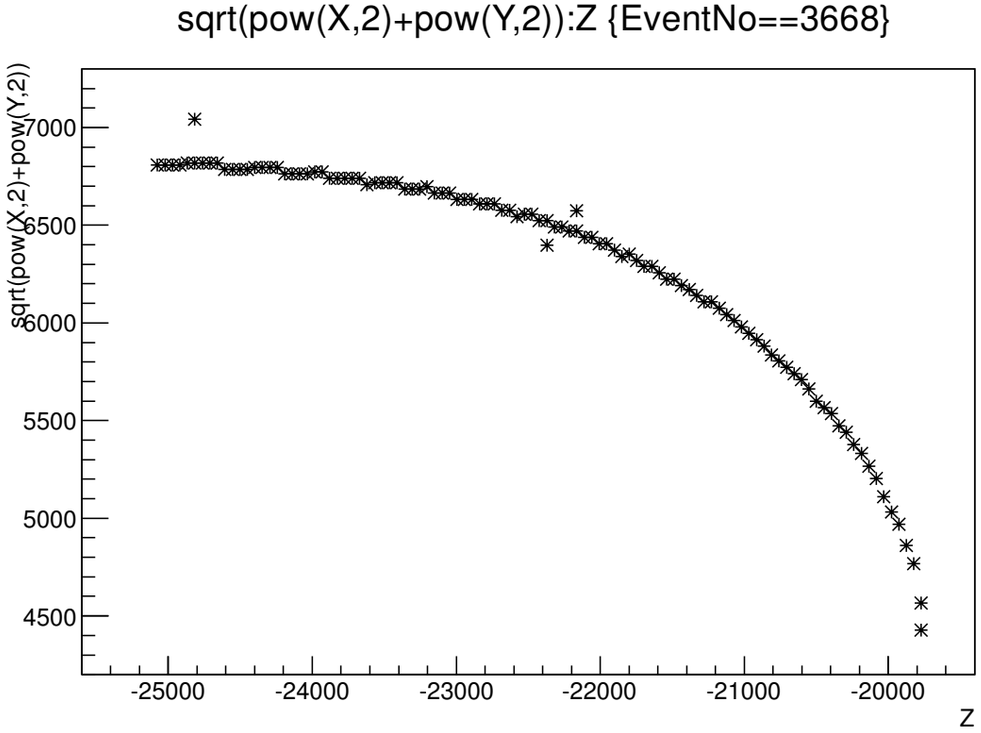




Some unwanted CA events



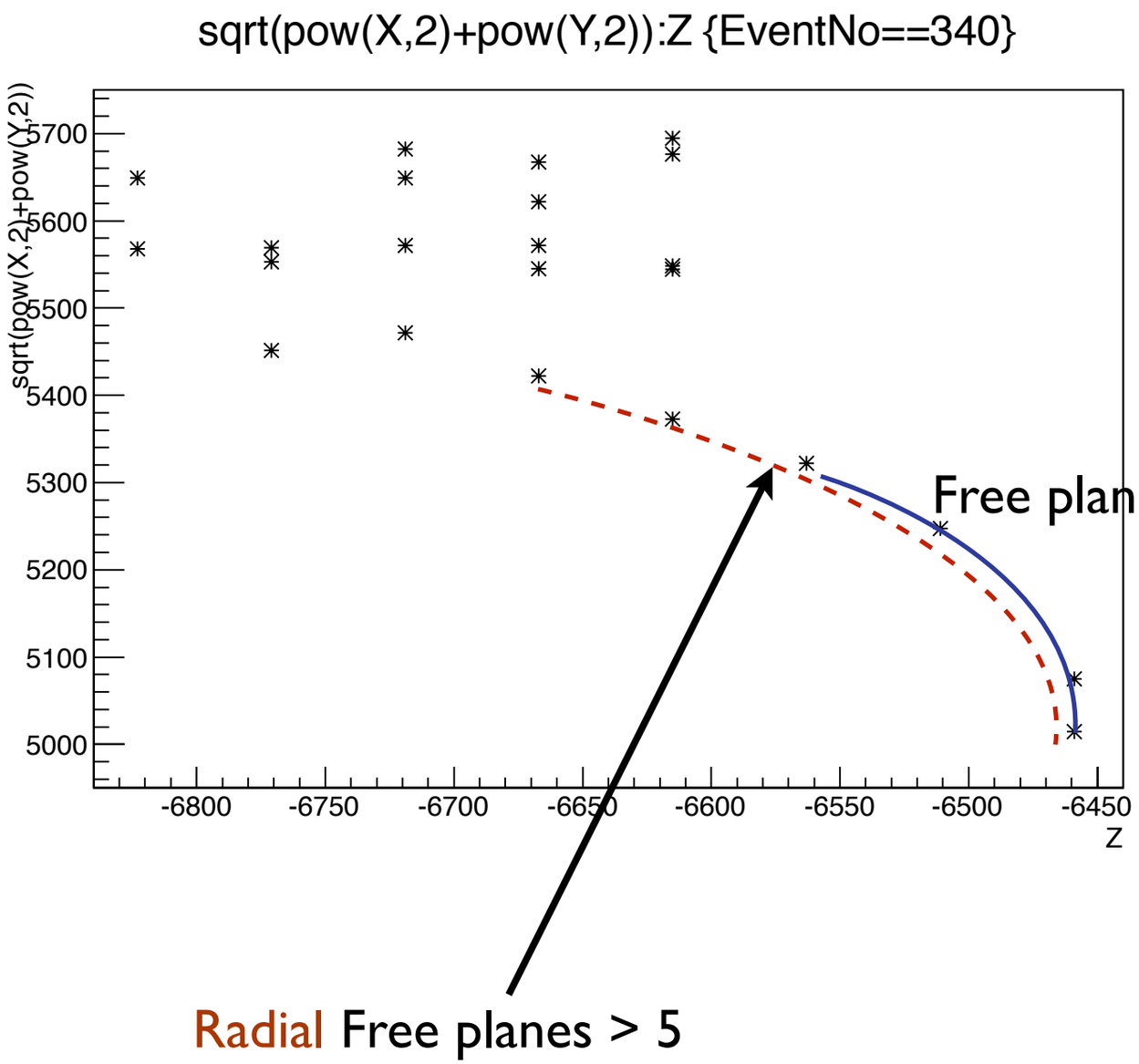




- Free planes counting along R .

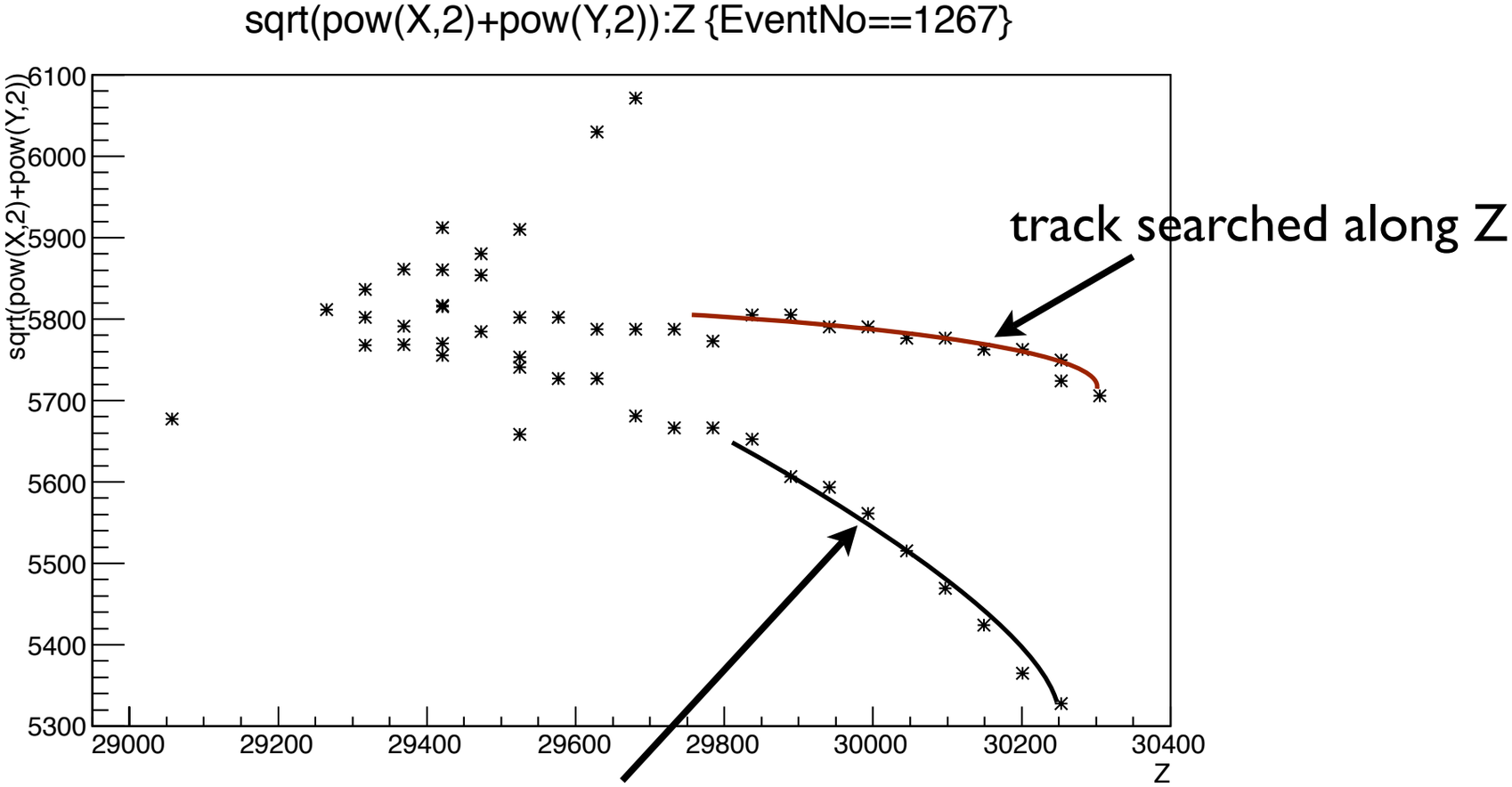
- Consider which one is larger and depending on the number method is chosen.

Possible advantage of radial search



- Radial search can help to avoid CA .
- By incremental filtering track can be extracted from the shower.

Multiple track finding



Searching for Free plane both radially and along Z will facilitate multiple track finding.

Conclusions

- Reconstruction has adopted toroidal field of MIND.

- New reconstruction (energy loss map, momentum from range calculation, tolerance) improves reconstruction efficiency for low energy also.

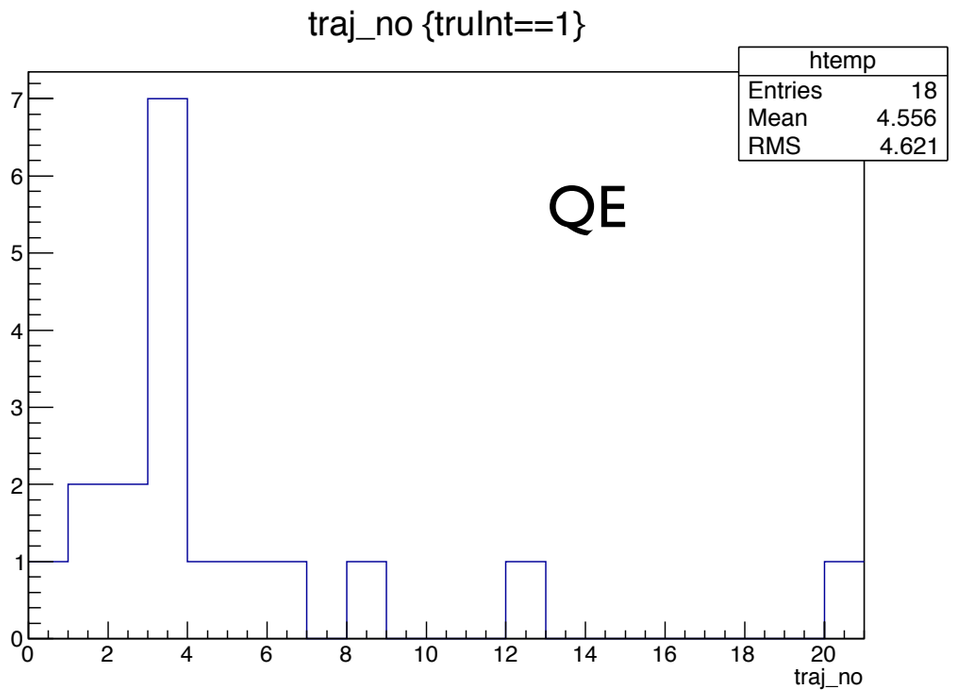
- For 10 GeV MIND, work in progress for pattern recognition in order to recover low energy events and to find several tracks.

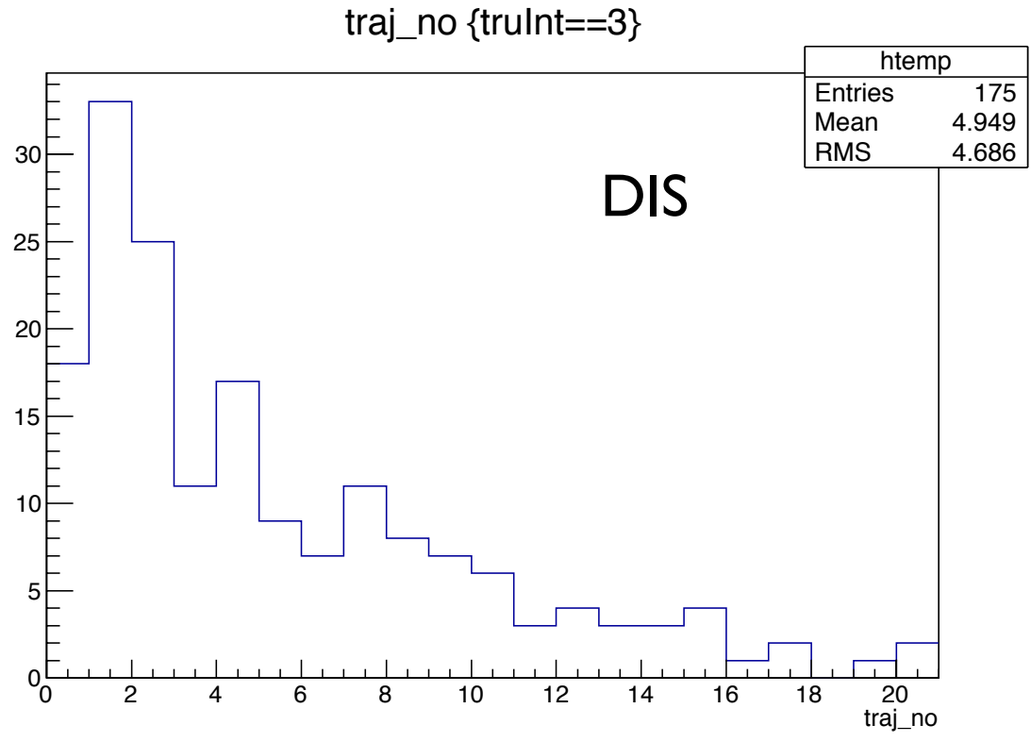
- This will help in shower reconstruction as well.

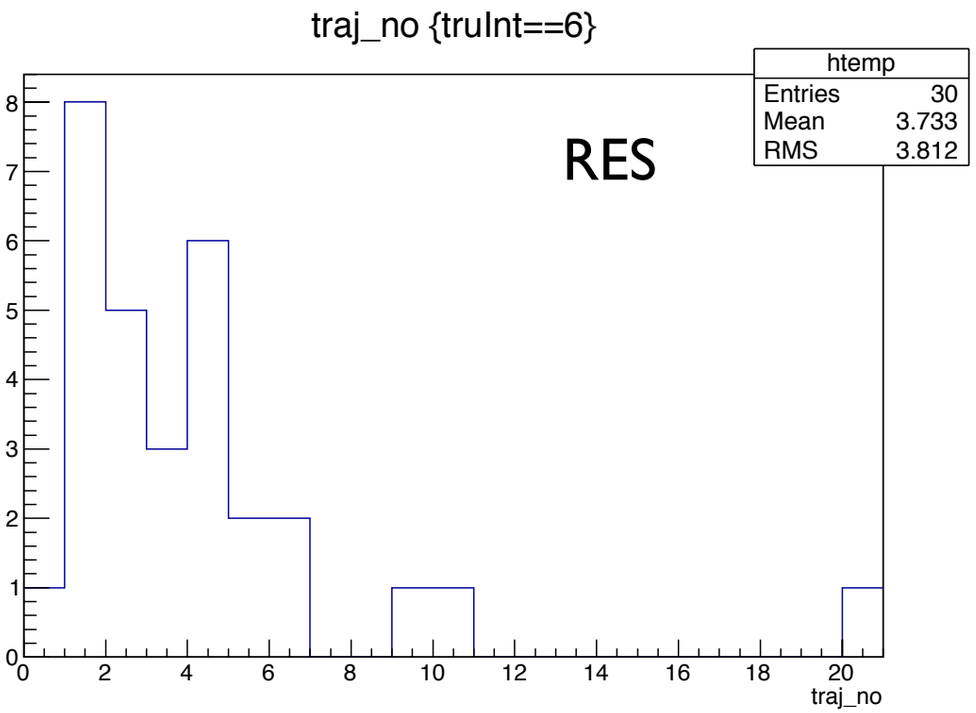
- Reusing of hit during pattern recognition.

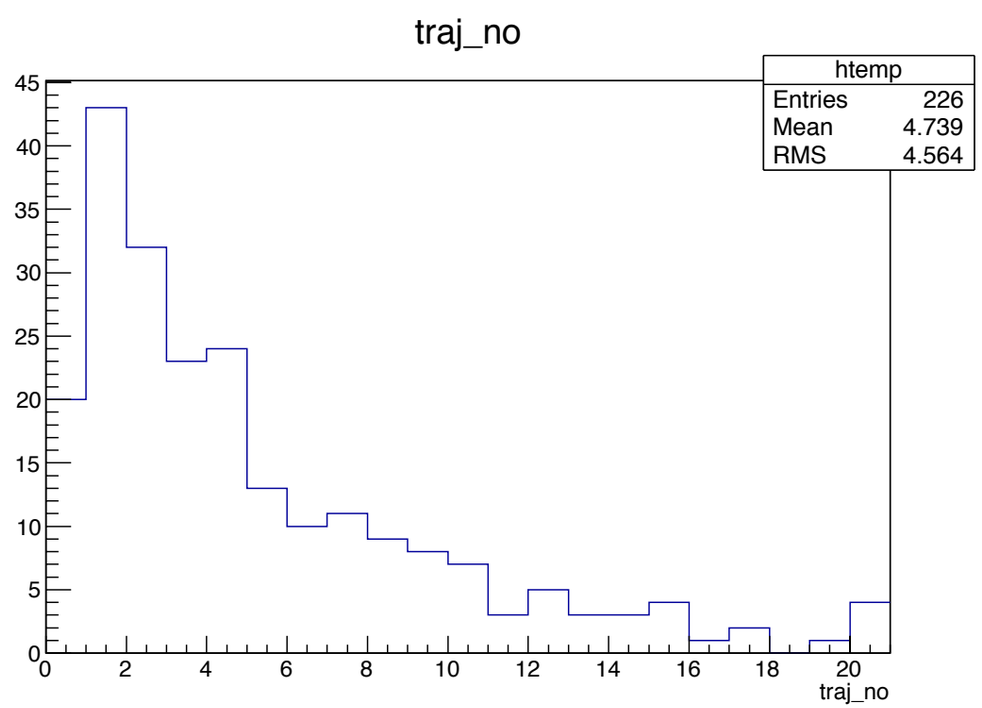
Extra

Number of trajectories for different interaction types

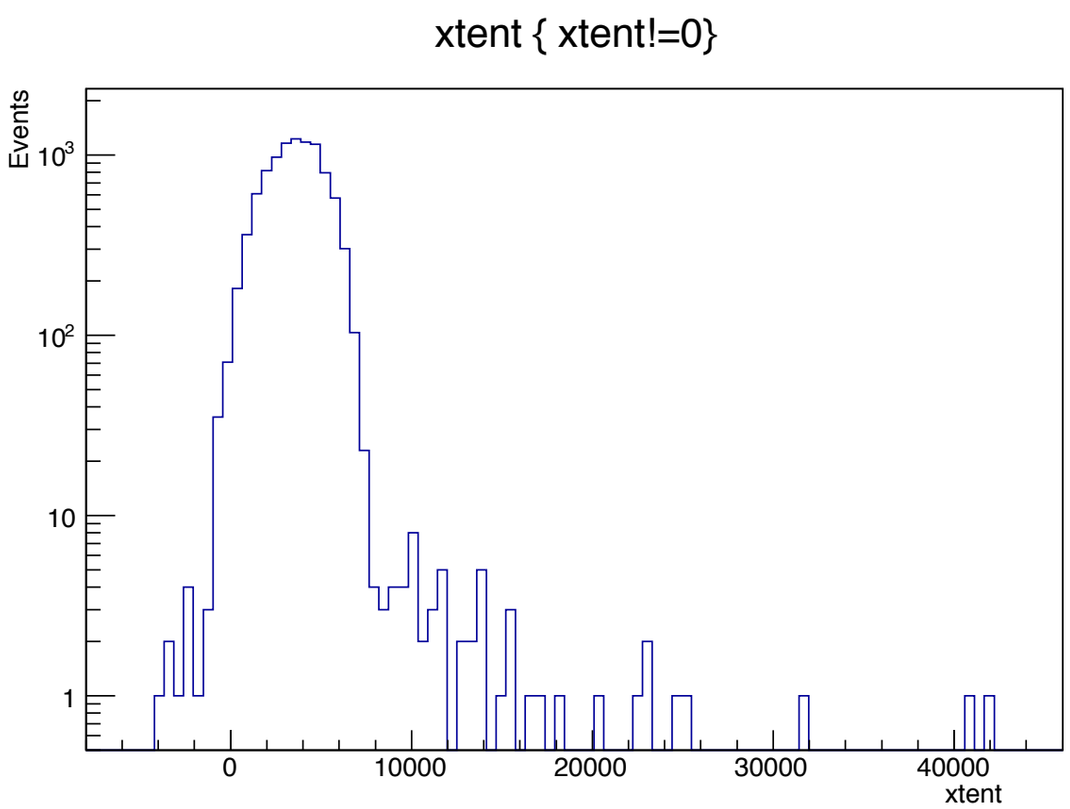


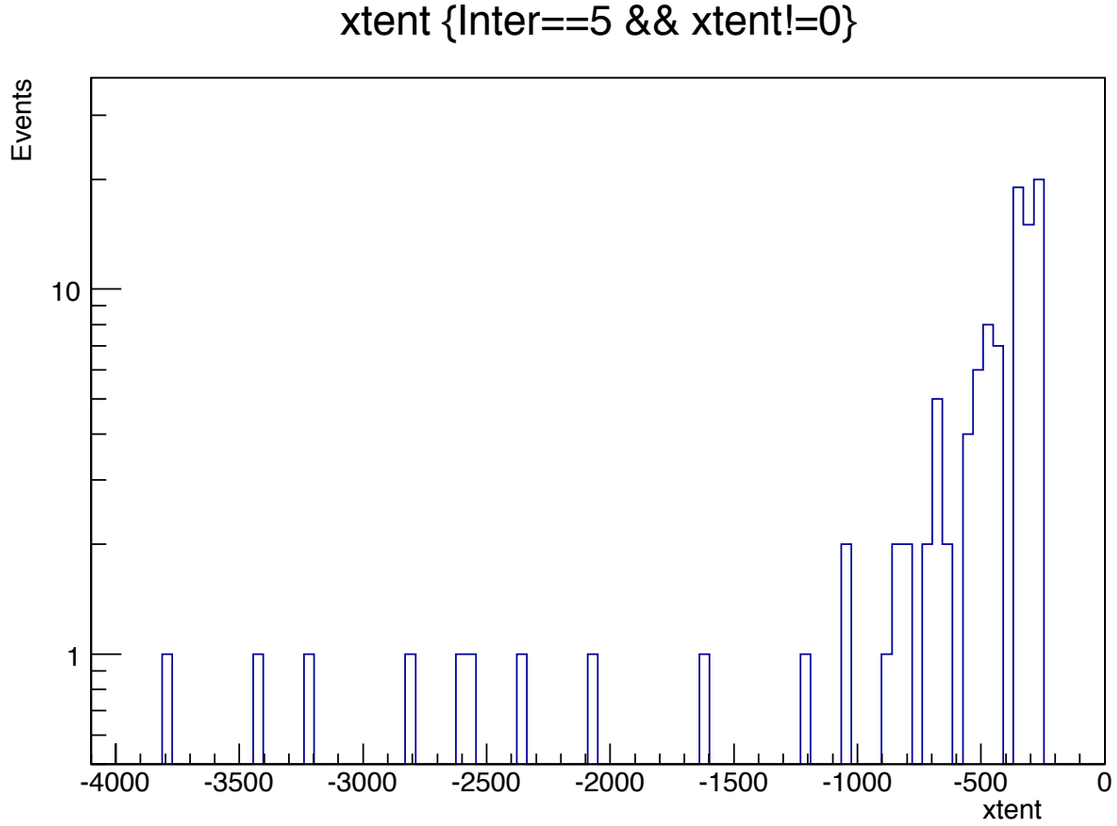






Extent of the tracks





- Extent of CA tracks are negative because they are calculated in opposite direction than that of the incremental Kalman Filtering.