Tracking for next generation Mu2e

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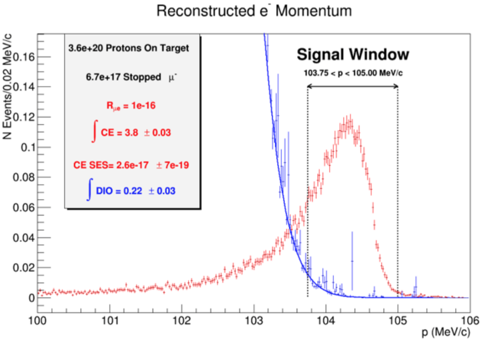
Summer student final presentation

September 22, 2015

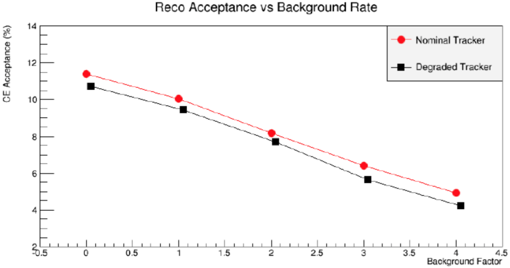
Why thinking on Mu2e-II tracker now (1)

- A significant part of DIO background in the signal window is due to the high momentum resolution tails
- misreconstruceted tracks with $p_{rec} > p_{true}$ have hits with mis-assigned drift directions



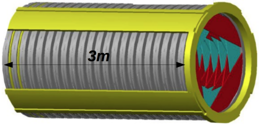
Why thinking on Mu2e tracker now (2)

- Expected Mu2e-2 background is three times higher than that expected for Mu2e
- efficiency of the existing algorithm falls down by a factor of 2
- background and efficiency considerations : start thinking of Mu2e-2 now



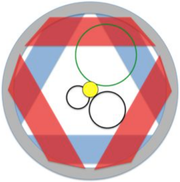
Tracker geometry

Tracker is made of $\sim$ 23000 straws aligned transverse to the axis of DS and distributed along a $\sim$ 3m lenght.



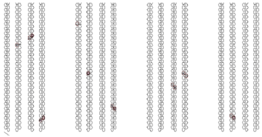
These straws are arranged in **planes**, made of two **faces** rotated by 30°

Tracker will intercept only a small fraction of flux of electron from DIO. At nominal B-field of 1 T, absolute majority of DIO electrons go into the central hole



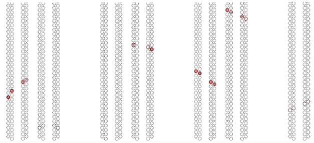
Plane geometry

Current configuration: it results difficult to identify a trajectory made by hits produced by the same particle



making two faces on the same plane parallel could improve track search.

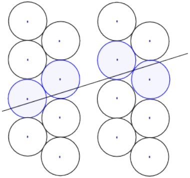
Track search colud be seeded by segments, rather than by individual hits



Segment Candidate initialisation

Reconstruct a straight line tangent to four circles

- Strategy : fix hit in the first and last straw, run over all possible hits in the central straws



- Calculate distance between the hit and the segment. If distance is small the hit is added to the segment candidate

Segment Candidate reconstruction(1)

- we are interested in knowing slope(a), intercept(b) and time when a particle hit the tracker(t_0) at z=0
- Calculate $\chi^2 = \sum_i \Delta x_i^2 = \sum_i (az_i + b - x_i - vs_i(t_i - t_0))^2$ and minimize it

Attention!

We cannot measure dritf times but we know propagation time due to electronic and the measured time

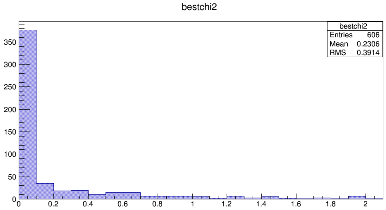
$$t_i = t_{0_i} + t_{drift} + t_{prop}$$

- Calculation of parameters results a **linear problem.** Given a combination of drift signs it can be solved analitycally

Segment Candidate reconstruction(2)

- Distances between layer are small $\rightarrow$ starting time is the same per each layer
- Using the reconstructed segment t_0's, the track time can be also calculated

- χ^2 results are well consistent with the local coordinates of the tracker
- uncertainty in segment reconstruction results consistent with drift time spatial resolution



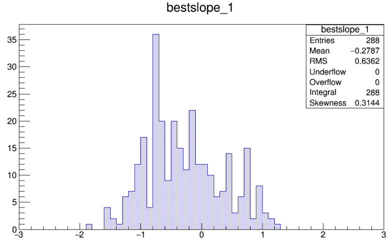
Choice of the best segment

At this moment we have a list of segment candidates. How define which is the best one?

- $< t > \geq t_0$
- $t_{drift_{max}} > \Delta t$ where $\Delta t = < t > - t_0$
- we choose the segment with the smallest χ^2
- ntrk>0: for the algorithm validation, use the existing algorithm, look at events with found tracks

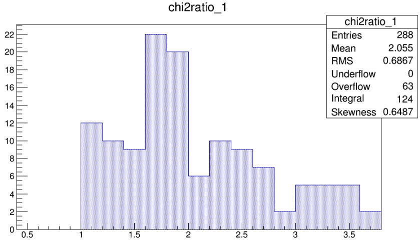
Slope distribution

- Knowing slope distribution it is important to reduce background : it is possible to fix a range for interesting result.
- for found segments, the slope $\left|\frac{dr}{dz}\right| < 2$

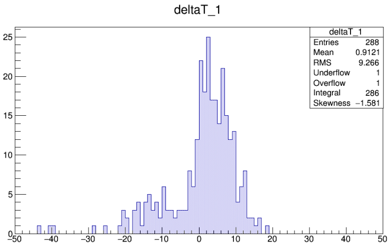


χ^2ratio

Sometimes drift radii are very small, in this situation a flip in a drift direction doesn't affect the χ^2 bestχ^2 and next bestχ^2 should be similar



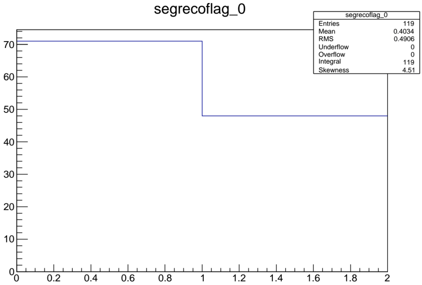
Δt_0



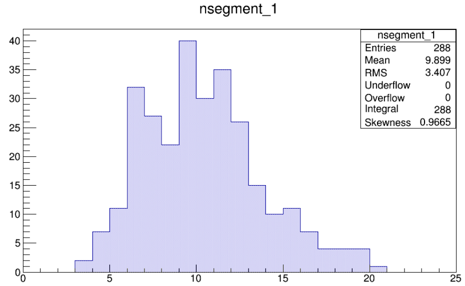
- Jump from segment t_0 to the particle track t_0 and compare it with the MC t_0
- Information on t_0 can be used to select interesting event and discard background
- σ from fit results smaller then the μbunch time and t_{drift}^{max}

seg_reco_flag distribution

- seg_reco_flag is a parameter which tell us how often our drift sign prediction correspond to the MC .
- seg_reco_flag=0 dritft signs are misreconstructed seg_reco_flag=1 calcultated drift sign in agreement with the MC



Number of segment per event



- Number of segment per track reconstructed
- To seed track reconstruction we need at least two segments. The greater number of segment per track, the better we can reconstruct it.

Summary

- Ambitious goal: improve Mu2e tracking at high rates
- first steps in developing the new pattern recognition algorithm
- the track segment reconstruction algorithm is working
- proving, step by step, that our assumptions and expectations are correct