Associating Cal Showers with Tracks
Track/Mip and Track/Shower Algorithms for PFA Template

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Tracks
- cheated, from Perfect PFA

Track Extrapolation Maps
- maps spacepoint to track extrapolated to E0, EM Shower Max, H0

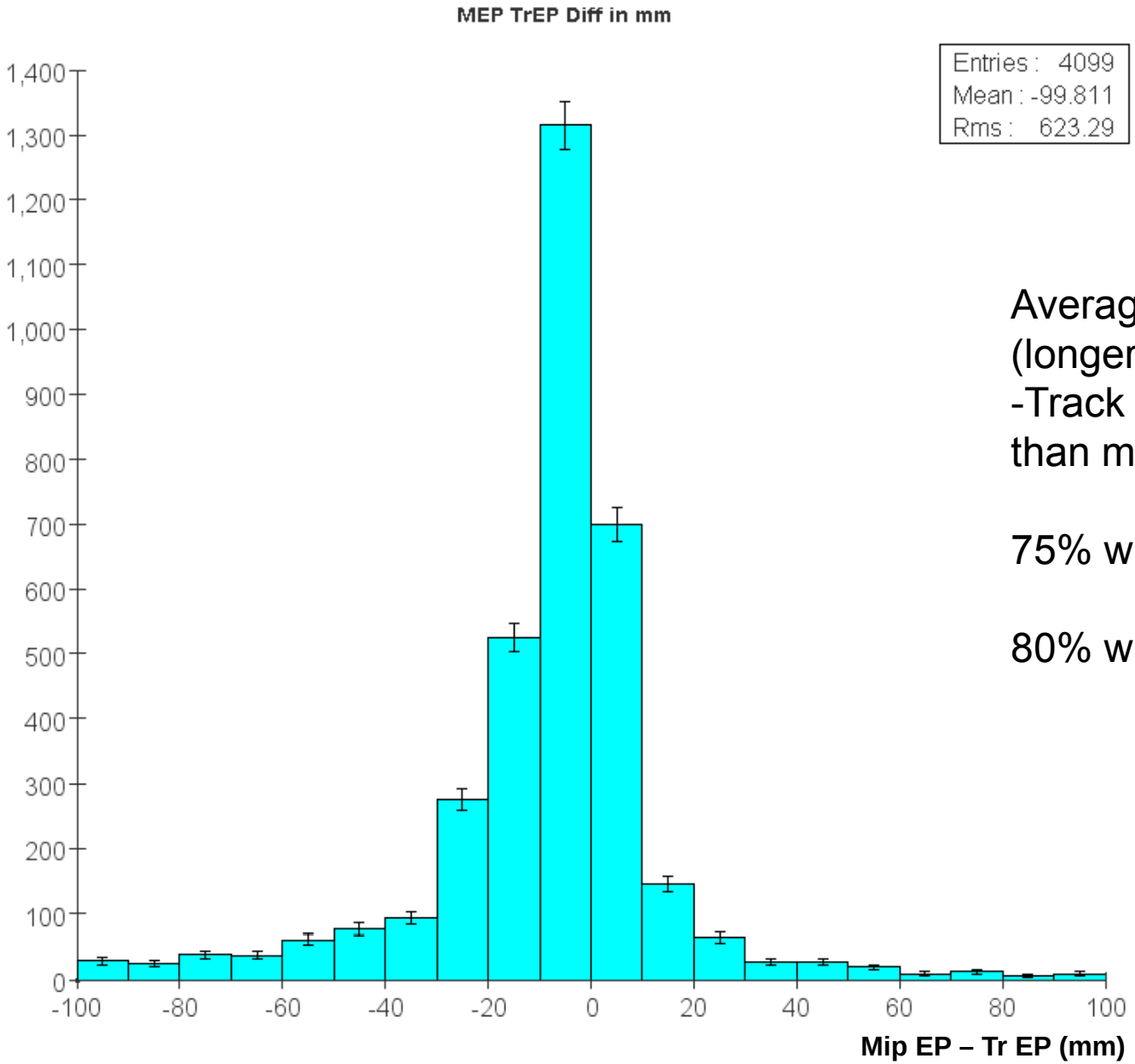
Track Mip Cluster and Interaction Layer Finder
- uses CAL hits layer-by-layer to build mip cluster on extrapolated track
- based on hit densities, independent of hit energies
- outputs are mip cluster, interaction layer of track

Mip Comp Driver
- compares mip clusters, calculates hit purity

Track Shower Cluster Finder
- associates clusters to tracks using track extrapolation maps
- uses cluster proximity and E/p measure
- iterates expanding cone until E/p minimum is met or max cone size is reached
- outputs are track shower clusters (includes mips, core, and shower)

Shower Comp Driver
- compares track shower clusters, calculates purity and efficiency of match

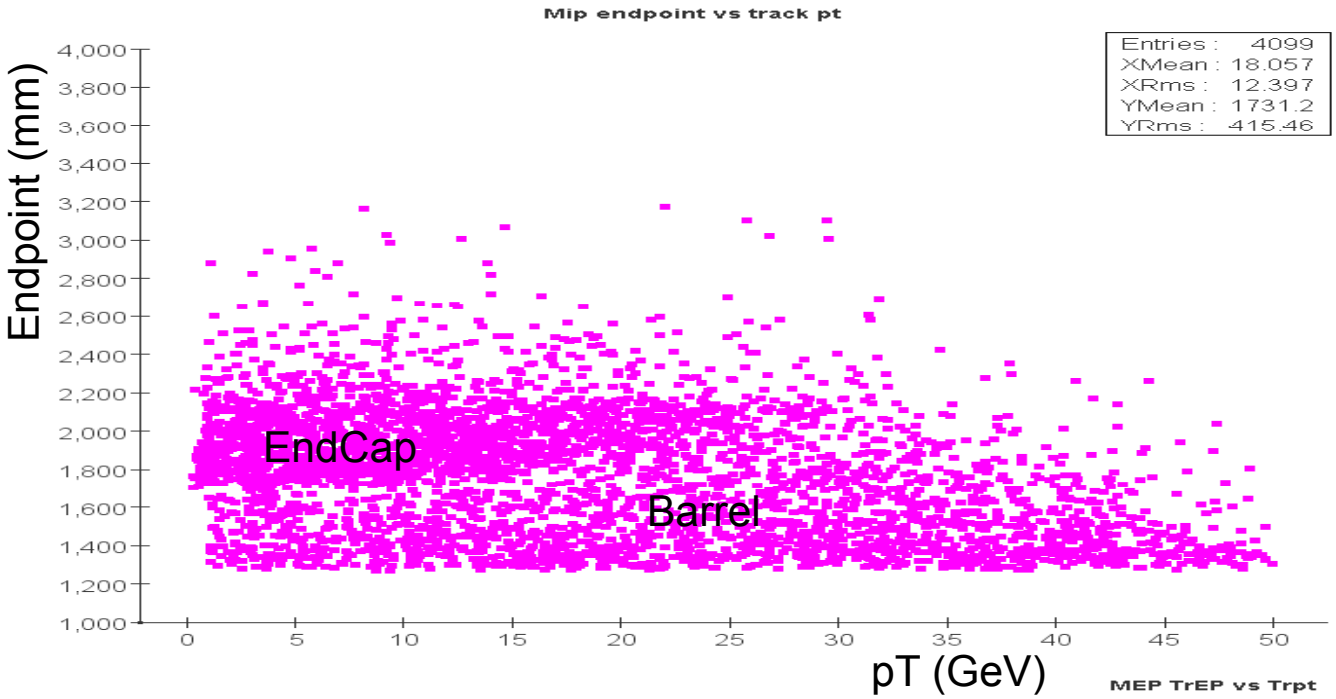
Comparison of Mip Cluster endpoint and Track (MC Truth) endpoint



Average is -10 cm (longer negative tail -Track endpoint deeper than mip endpoint)

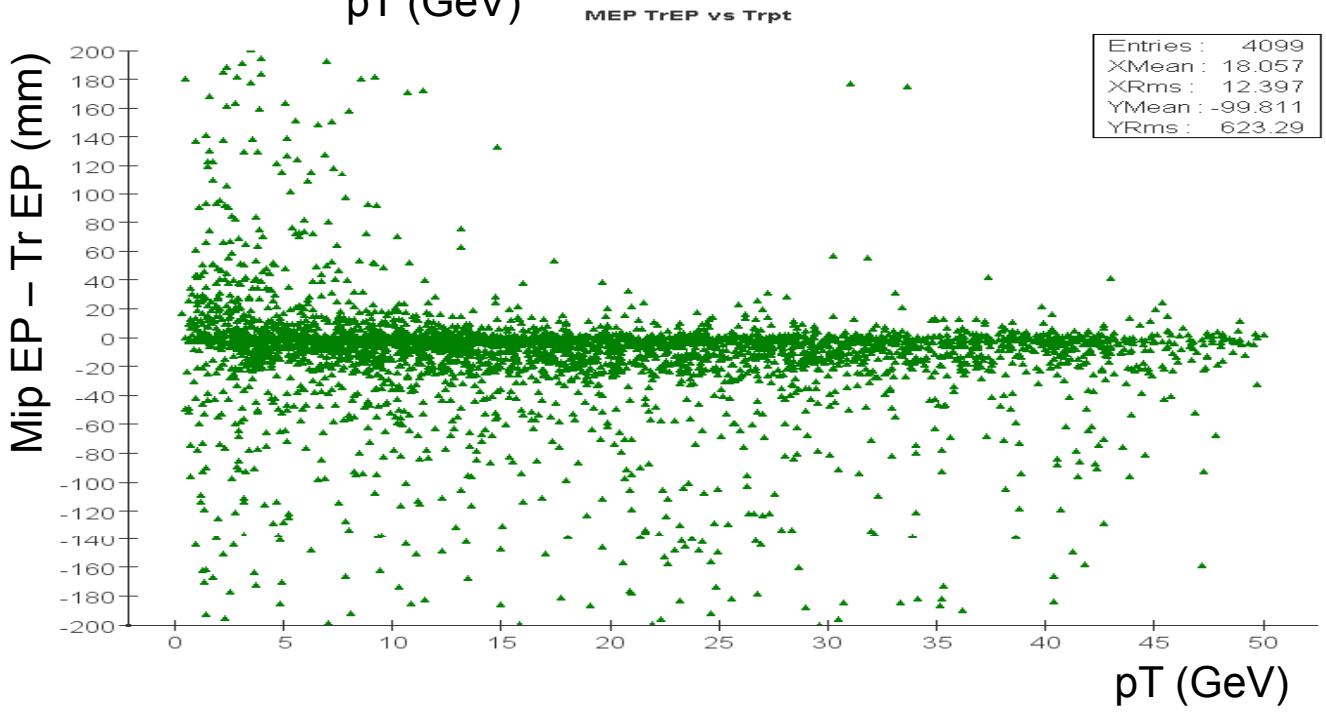
75% within 3 cm

80% within 5 cm

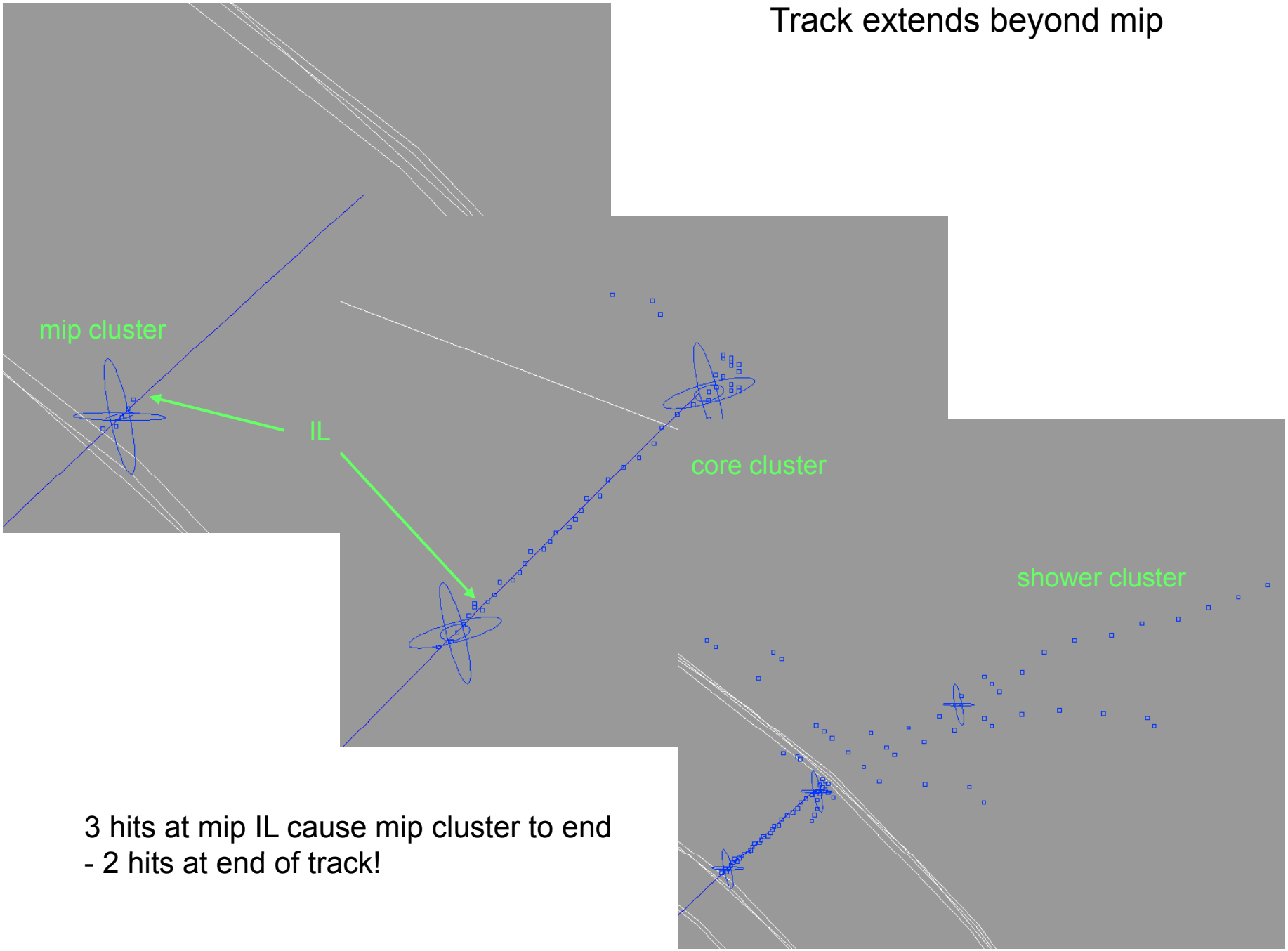


Track longer than mip
- no pT dependence
(mostly no mip IL=0)

Track shorter than mip
-occurs at lower pT
(density parameter)

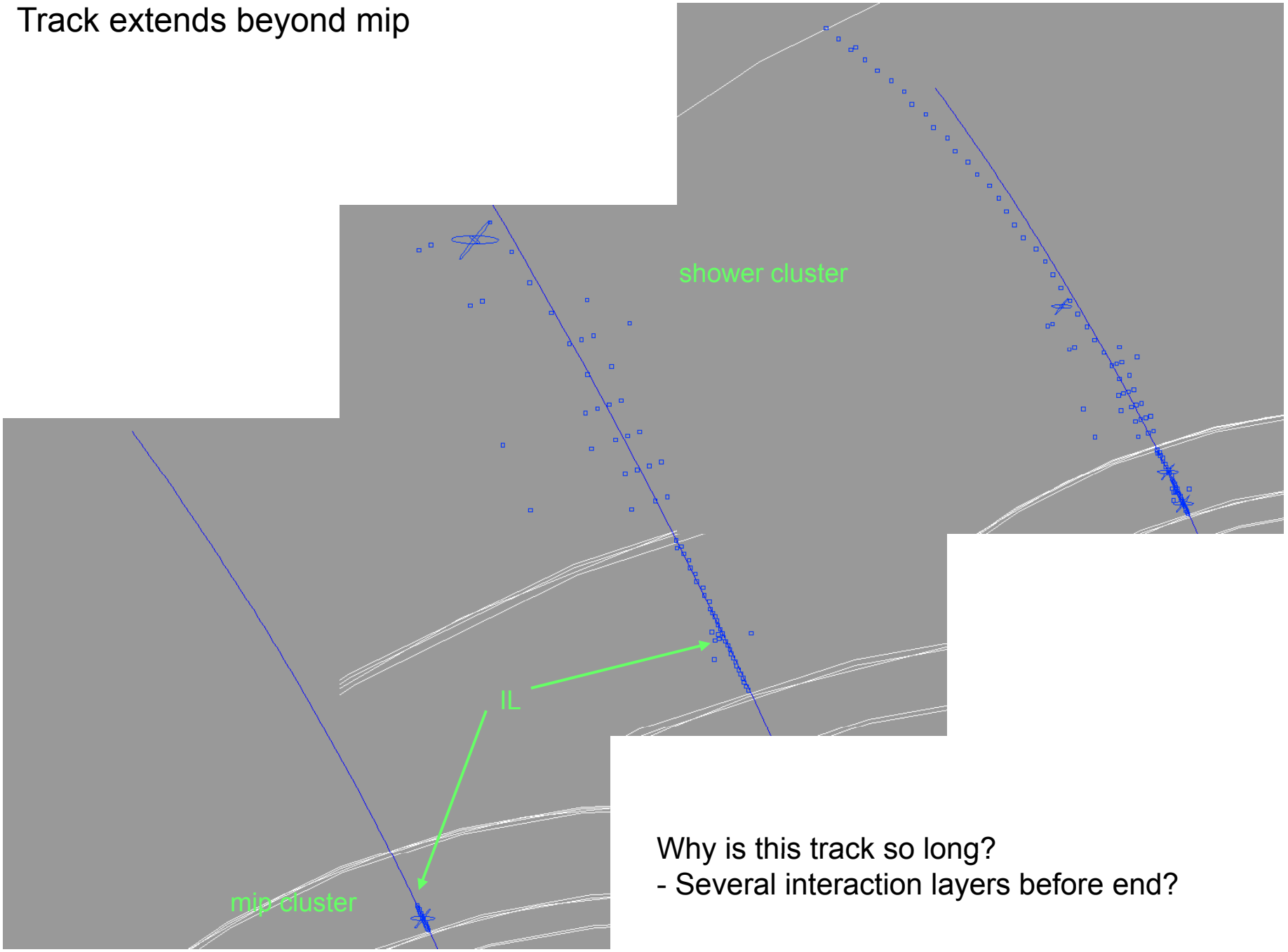


Track extends beyond mip



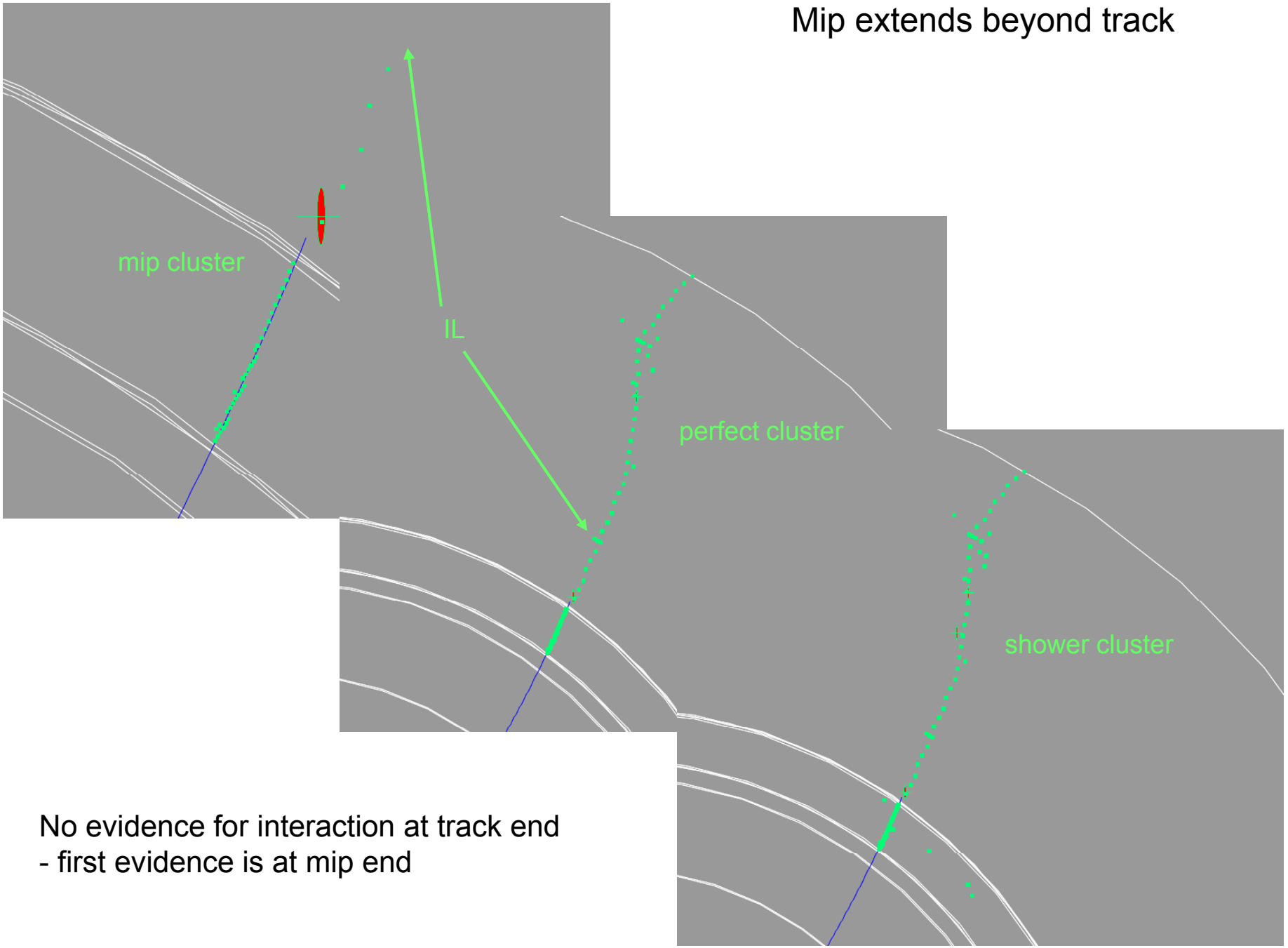
3 hits at mip IL cause mip cluster to end
- 2 hits at end of track!

Track extends beyond mip



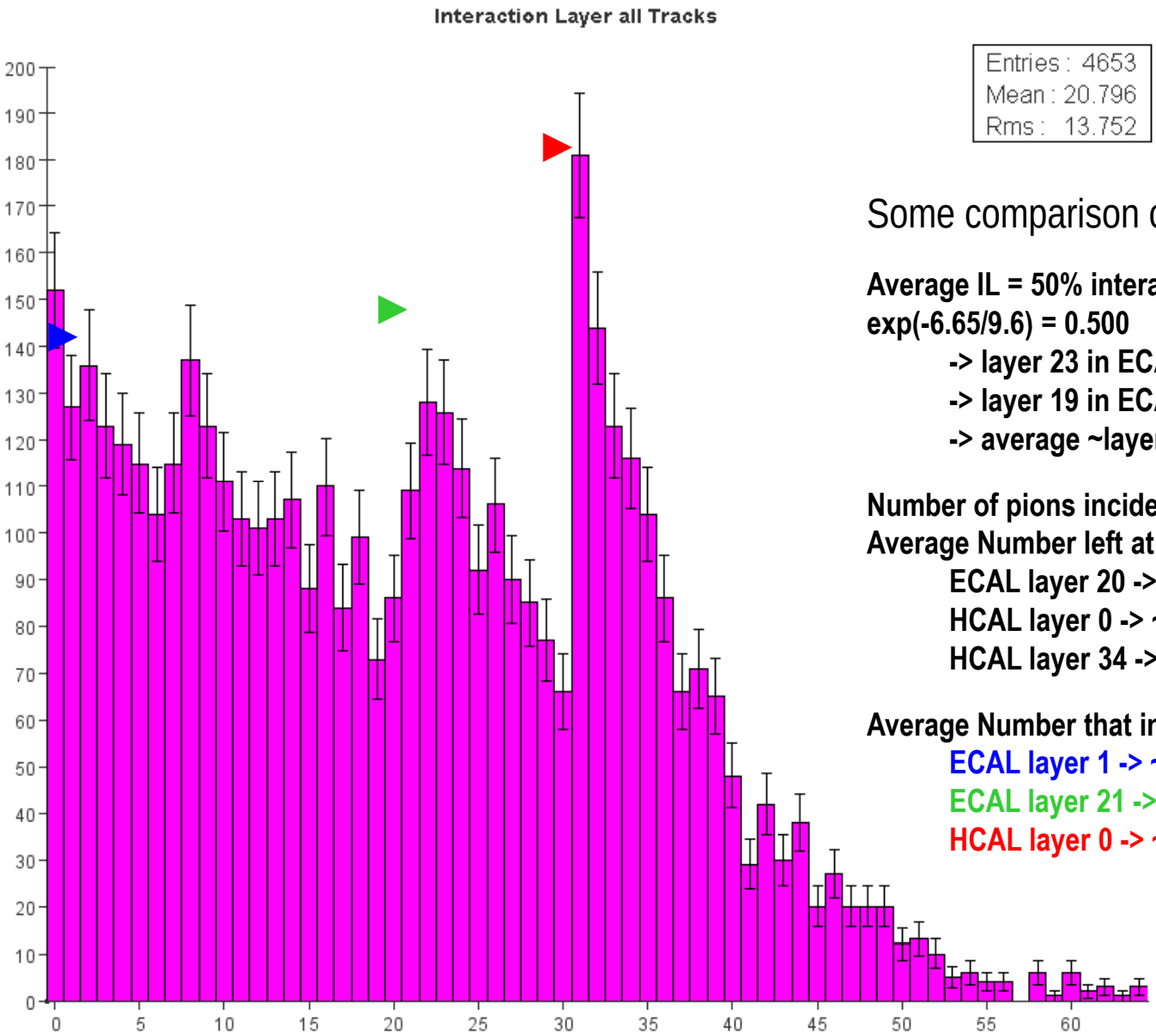
Why is this track so long?
- Several interaction layers before end?

Mip extends beyond track



No evidence for interaction at track end
- first evidence is at mip end

Performance of Track Mip Finder – Determination of IL



Some comparison calculations :

Average IL = 50% interact/pass = ~6.65 cm W -> exp(-6.65/9.6) = 0.500

-> layer 23 in ECAL (incident at 90 degrees)
-> layer 19 in ECAL (incident at 45 degrees)
-> average ~layer 21 == plot (20.8)

Number of pions incident at layer 1 = 4500
Average Number left at :

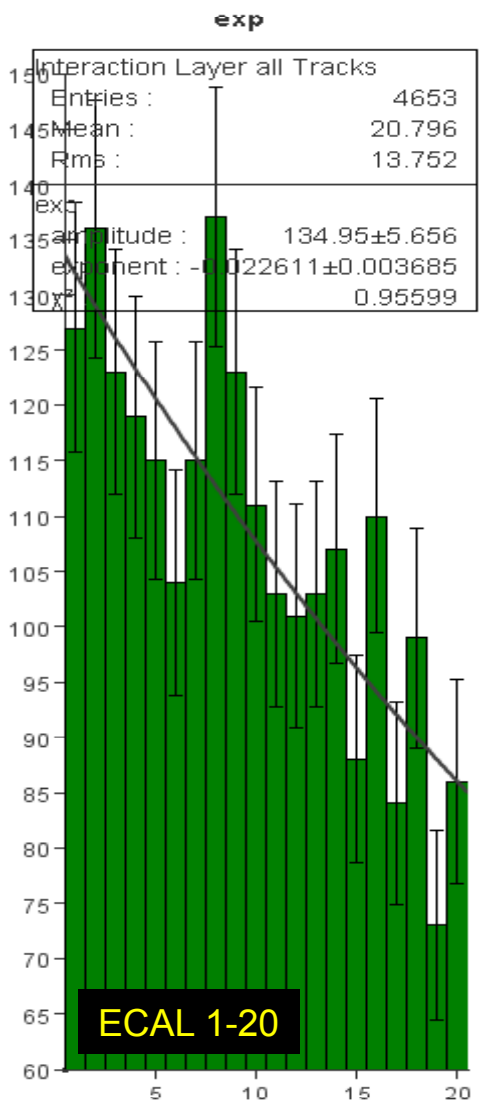
ECAL layer 20 -> ~2422
HCAL layer 0 -> ~1312
HCAL layer 34 -> ~3

Average Number that interact :

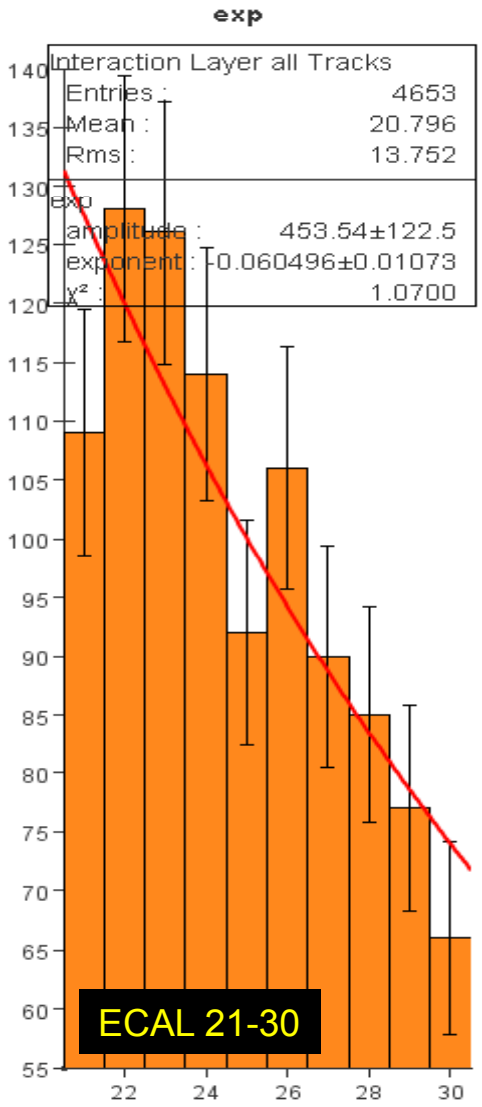
ECAL layer 1 -> ~141 ▶
ECAL layer 21 -> ~150 ▶
HCAL layer 0 -> ~182 ▶

1-50 GeV pions, 4-176 degrees in SiD01

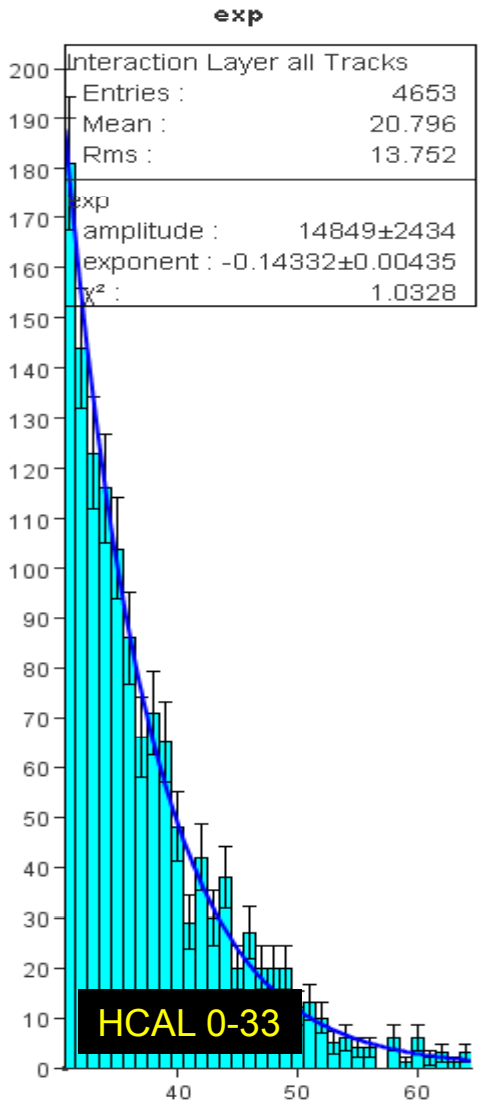
Performance of Track Mip Finder – Fits of exponential to shape



exponent = -0.023 ± 0.004
(-0.031 expected)
-> 2σ too flat

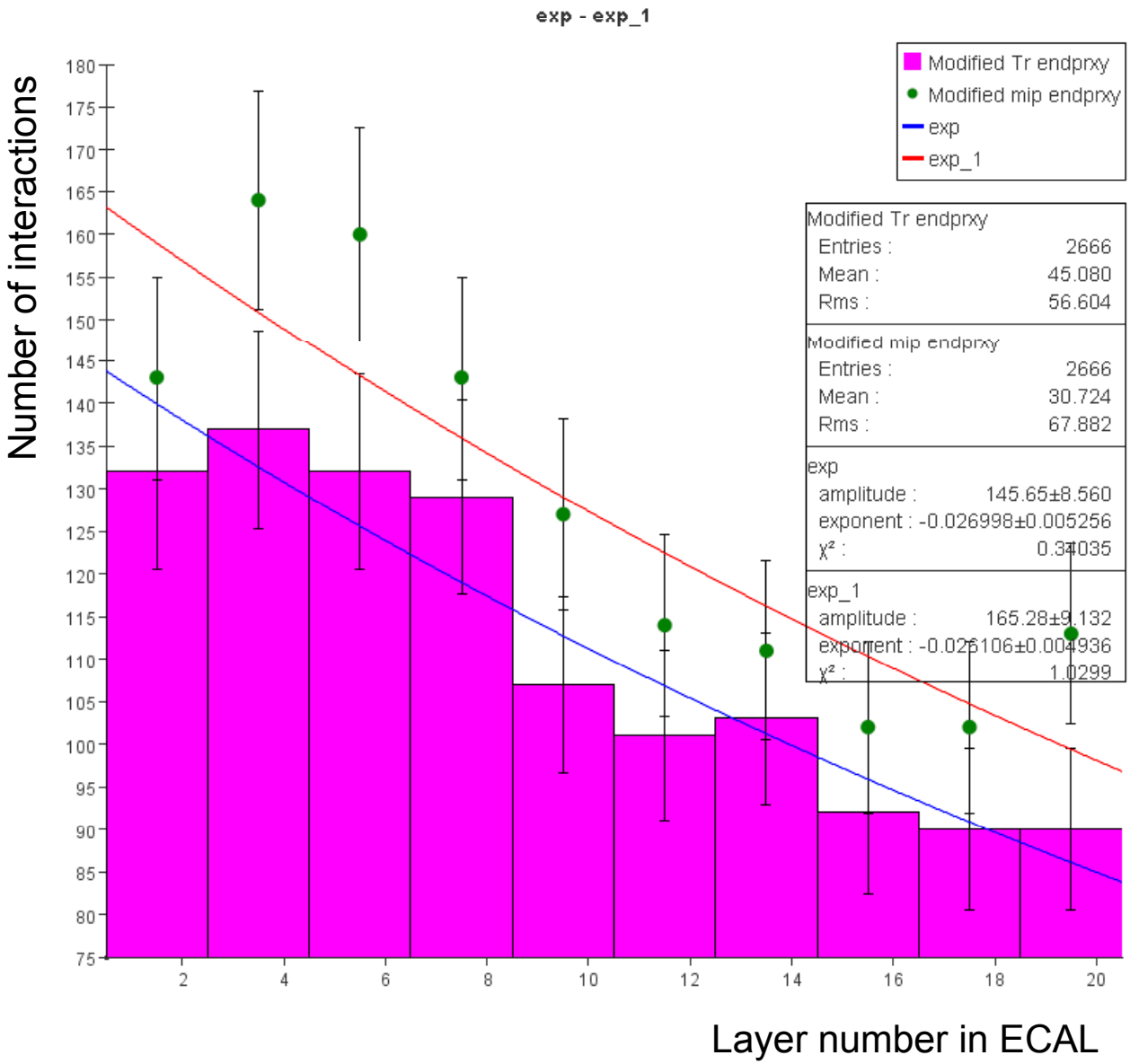


exponent = -0.060 ± 0.011
(-0.063 expected)
-> perfect



exponent = -0.143 ± 0.004
(-0.143 expected)
-> perfect

Comparison of Track and Mip Endpoints – exponential fit to ECAL 1-20



exp = -0.027 ± 0.005

exp = -0.026 ± 0.005

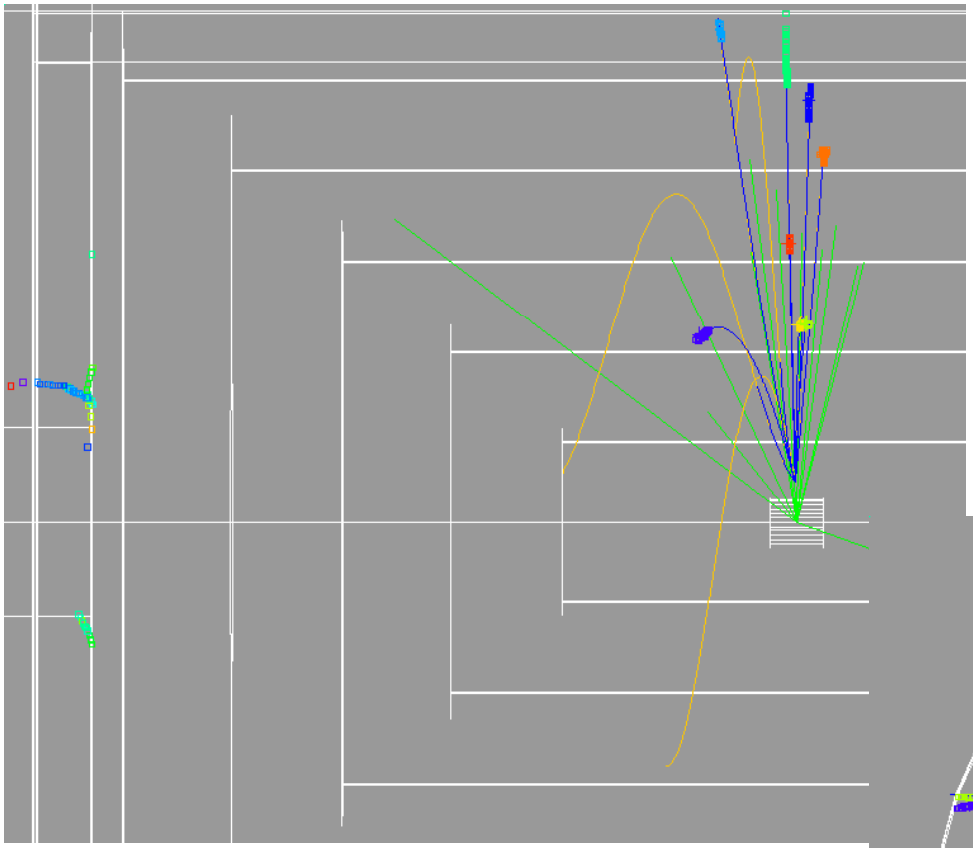
Mip and MC Track EPs display the same shape close to expected value (within 1σ)

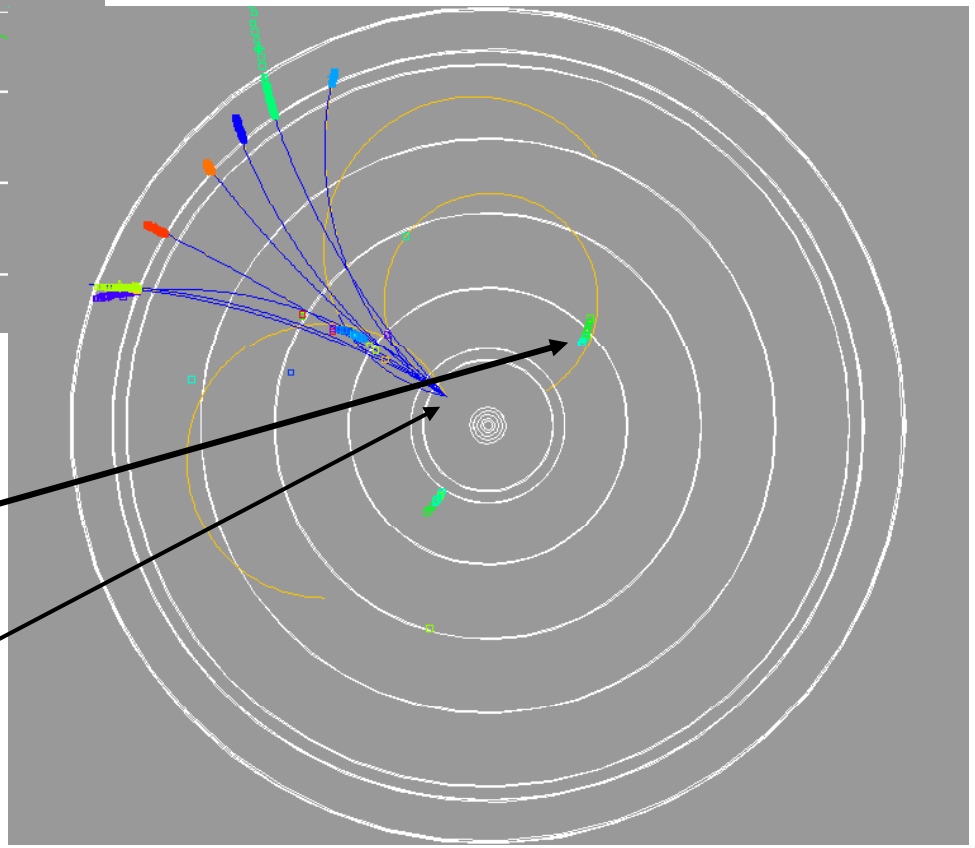
Normalization – different # of interactions in first layer

Why are there no mip clusters – IL=0?

(this started as a single pion!
-ended as 11 perfect PFA tracks!)

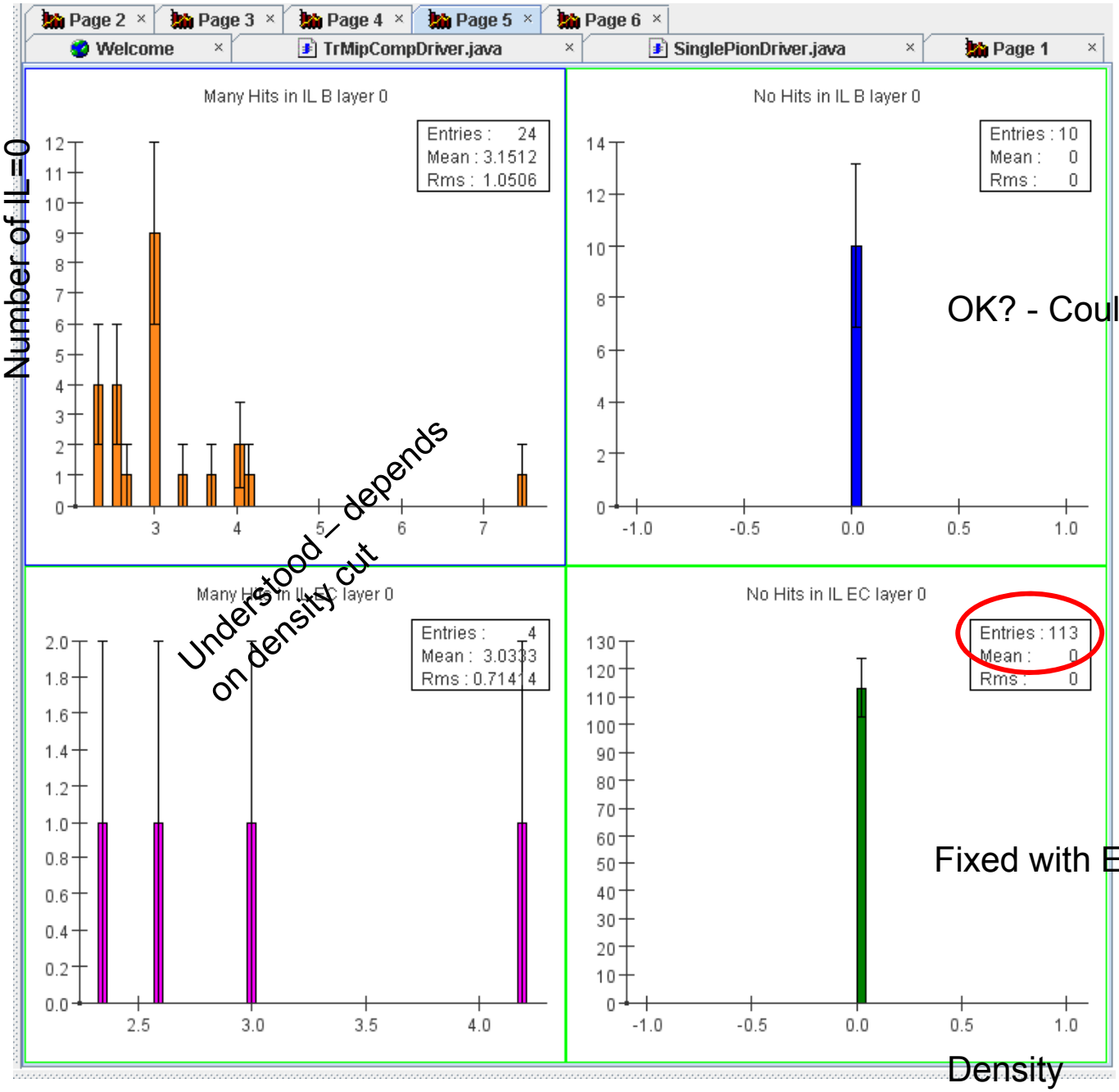
Effects PFA performance!!!





Fix with helix accounting for Eloss along trajectory?

Mip finder adjusts for non-IP tracks



~2000 input pions

OK? - Could be real interactions

Fixed with Eloss in helix?

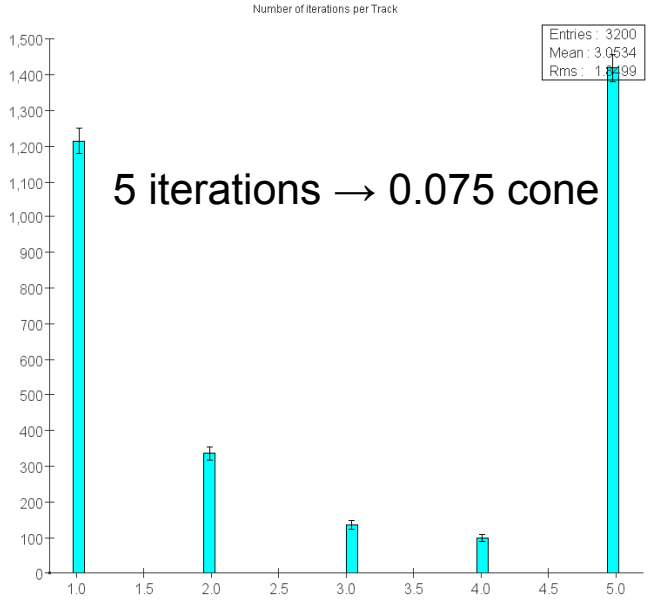
Summary of Track Mip Finder Performance

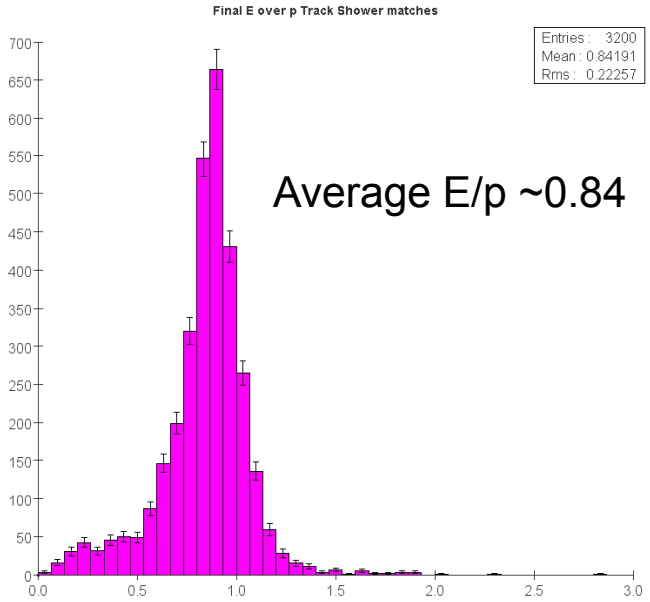
Mip finder associates CAL hits to extrapolated tracks
- uses cal hit density defined in code – no energy needed
- no calibration for mip cluster energy – dE/dx used (required)*

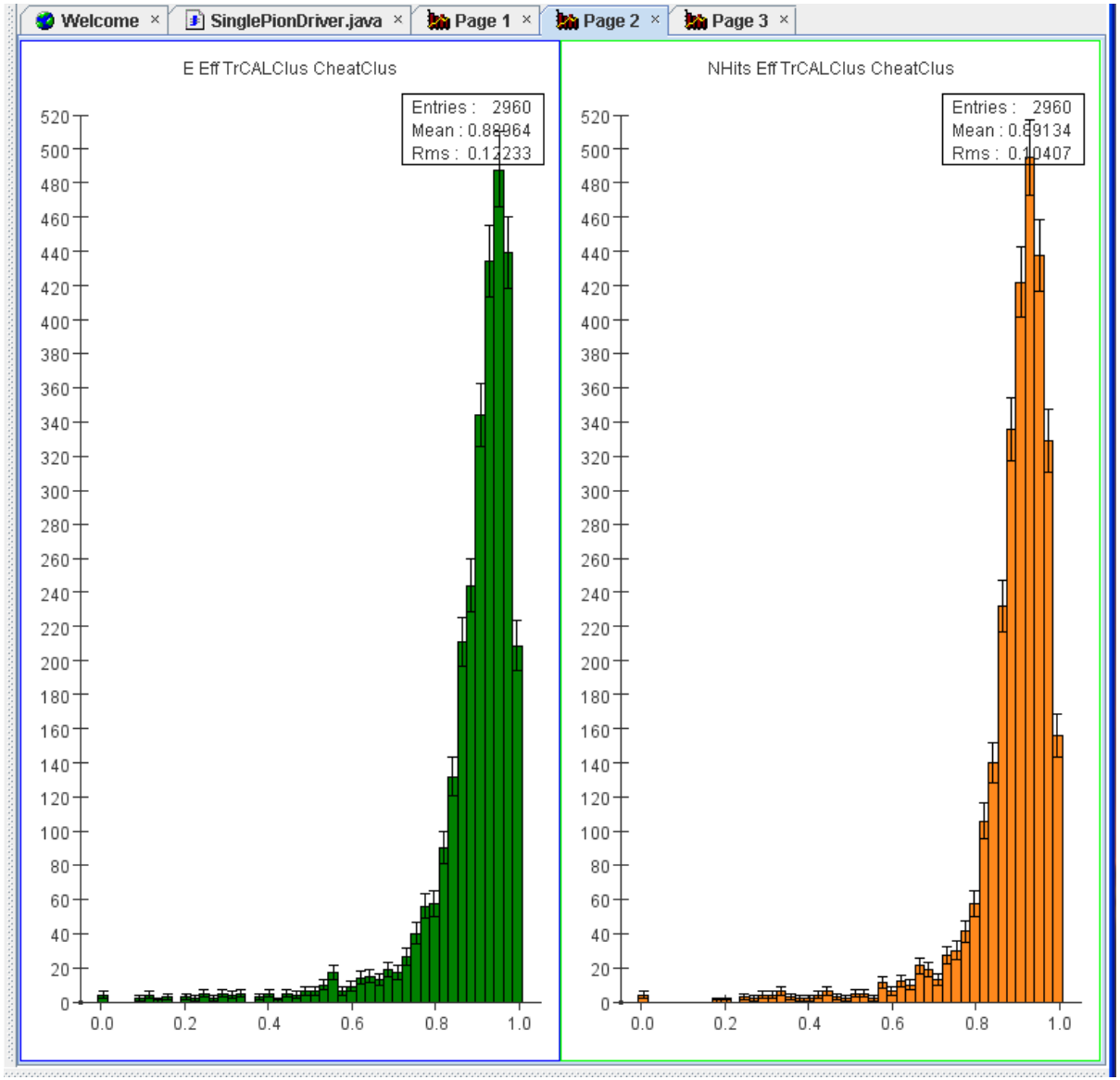
Also determines layer of first particle shower interaction
- good agreement with expected IL distribution from material
- good agreement with MC Track endpoint (understood differences)
- useful as starting point for Track/Shower association (next part of talk)

Left to do :
- optimize density cut (done?)
- energy dependence of IL? Ron's claim?
- use Eloss-dependent helix to improve endcaps
- allow for tracks that enter ECAL from beampipe after layer 0

Track/Shower Association on single pions

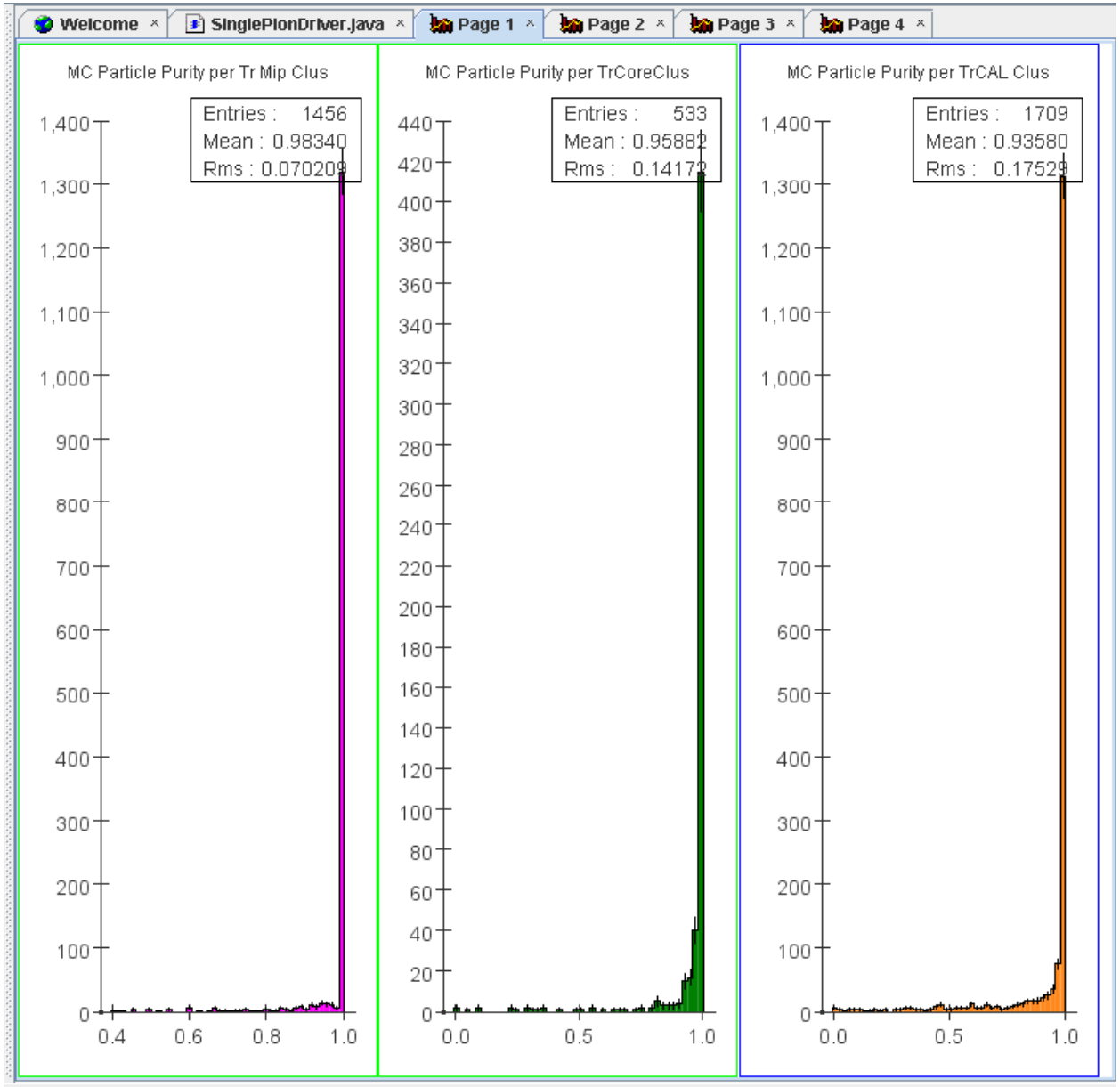






Efficiency ~ 89% E or hit

Track/Shower Association on ZZ events



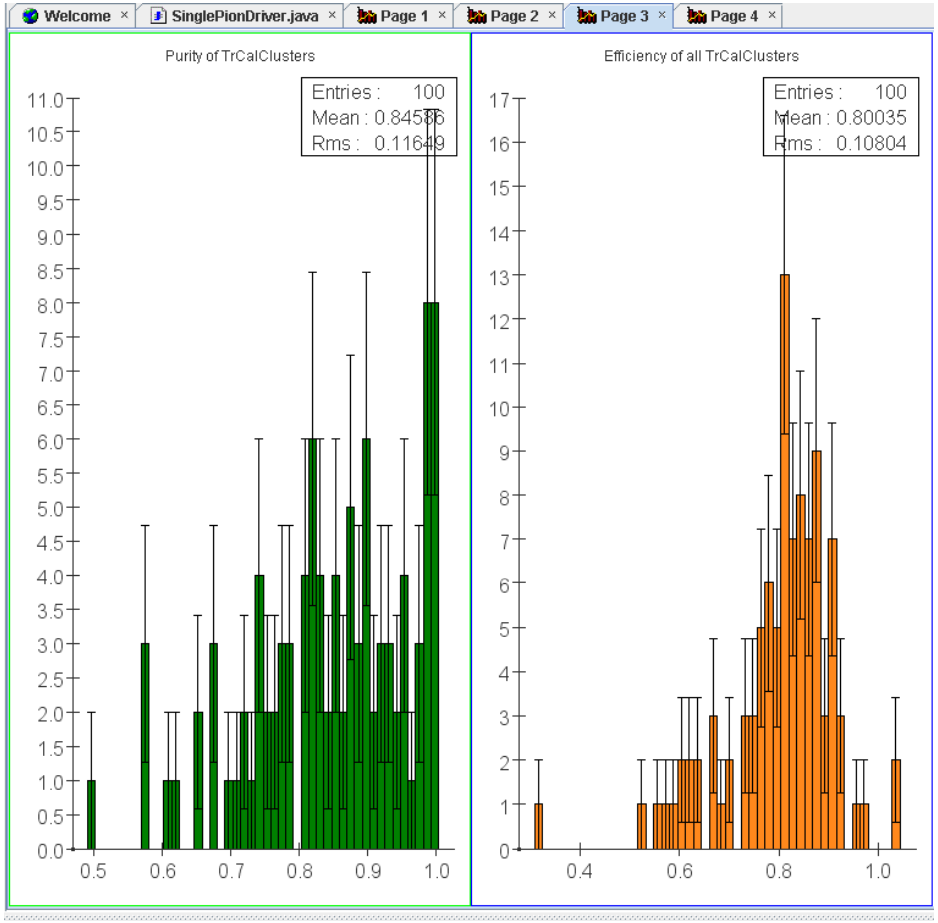
Per Track purities :

Mip = .98

Core = .96

Overall = .94

Purity and Efficiency of Track/Shower Clusters



Sum of all track/showers per event