Trying to ~~Understanding~~ Track Fitting Performances

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Wednesday, 6th December 2017

Track Fitting

Before (pre)release-01-00-00(a)

- In the releases: single particle hypothesis (π)
- In the head: 4 particle hypotheses (μ π K p)
- If pion fit fails, no TrackFitResults
- If track fit fails, returns pion TrackFitResults

Starting from (pre)release-01-00-00(a)

- In both release and head: 3 particle hypotheses (π K p)
- No primary particle hypothesis in the fit
- If track fit fails, returns NULL
- But getTrackFitResultWithClosestMass

Still open points coming from track fitting with wrong particle hypothesis

Tracking Evaluation

Basf2 head 27/11/2017 + feature/trackfitresults_with_chi2_ndf_isFitX

Modification in TrackFitResults and TrackBuilder:

- ✓ Added χ^2, NDF, isFitXxx data members from genfit::FitStatus
- ✓ Added nTrackingHits, nCdcHits, nSvdHits, nPxdHits from RecoTrack

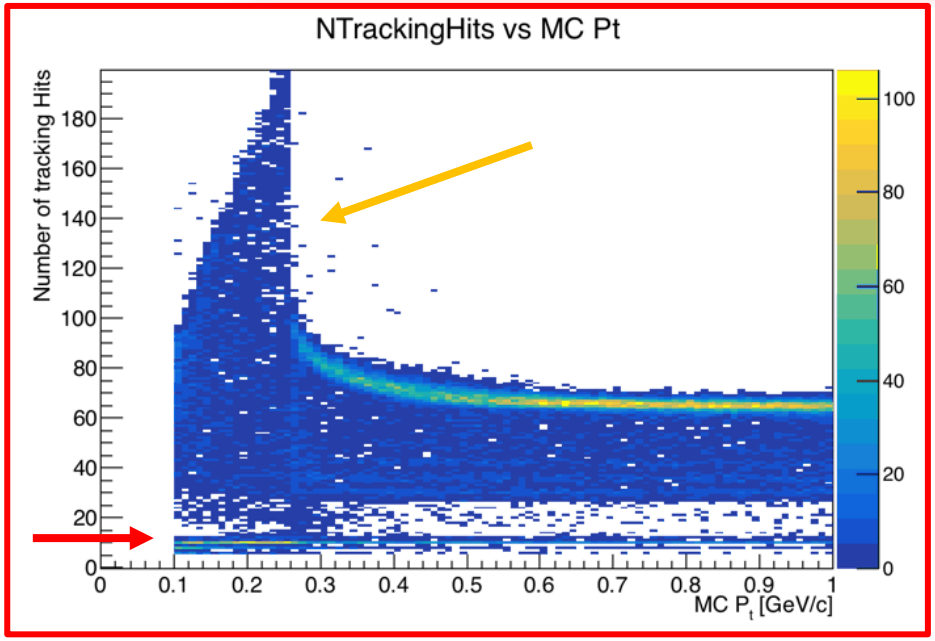
TrackingPerformanceEvaluation_scripts with particle gun:

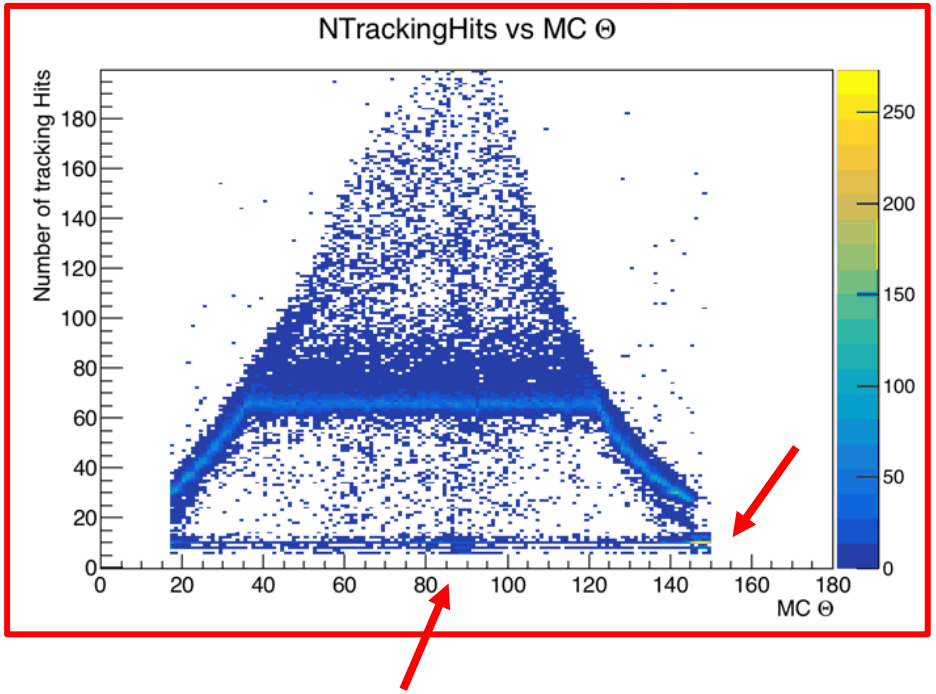
- ✓ 50k events single particle (pion, kaon, proton, deuteron)
- ✓ Uniform p_t [0.1, 1.0] GeV/c
- ✓ Uniform theta [17°, 150°], uniform phi [0°, 360°]
- ✓ No ROI, no BKG, vxdtf2

Modifications in TrackingPerformanceEvaluation module:

- ✓ Single particle Ntuple for an easy browsing
- ✓ Multi particle Ntuple, to cross check different particle hypothesis results in parallel

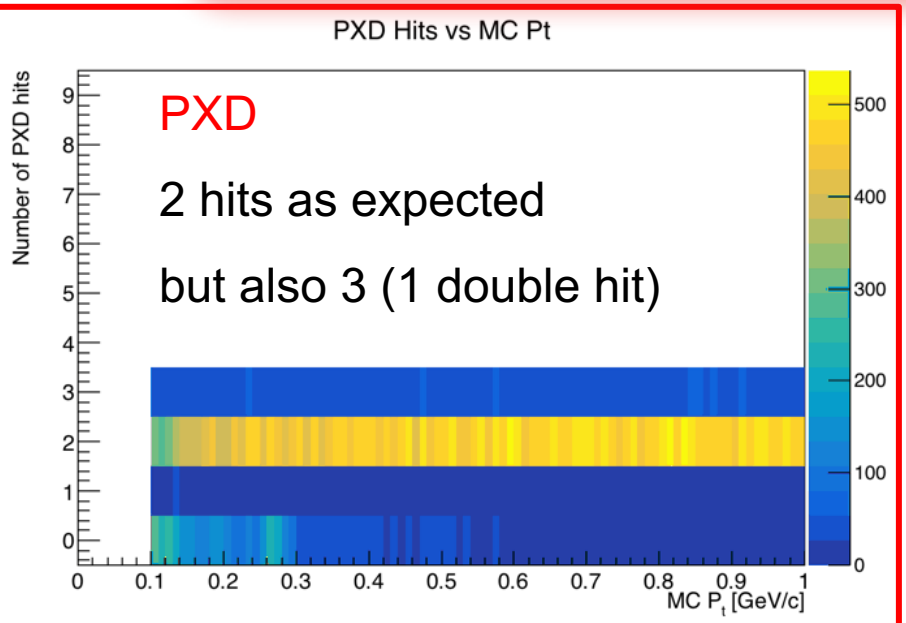
Number of Tracking Hits – pion tracks

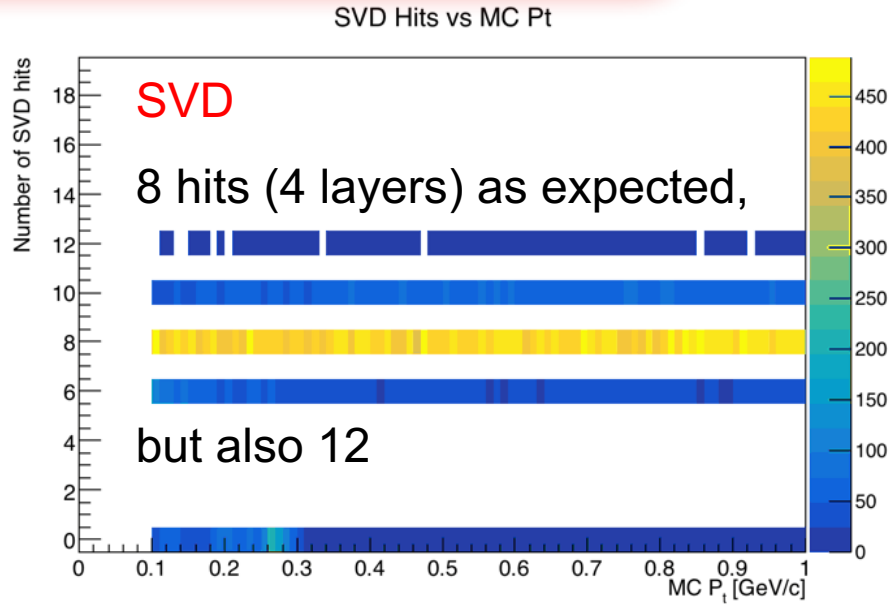


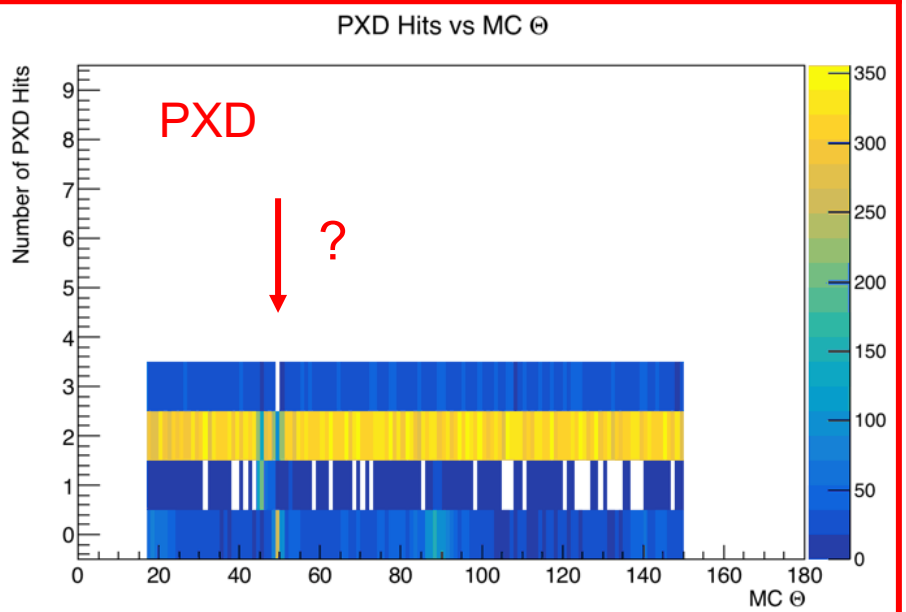


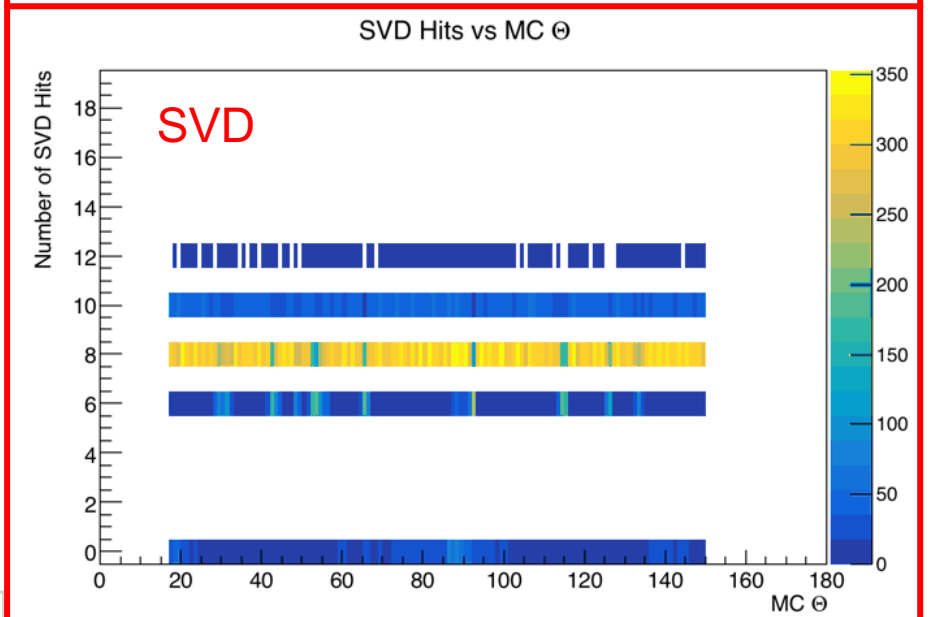
- Below 0.26 GeV/c increased amount of CDC hits – curlers
- Huge amount of CDC hits, very noisy events, can we really track them?
- Horizontal line at 10 hits – no CDC hits, mainly at low pt, 90° or backward

Number of VXD Hits – pion tracks

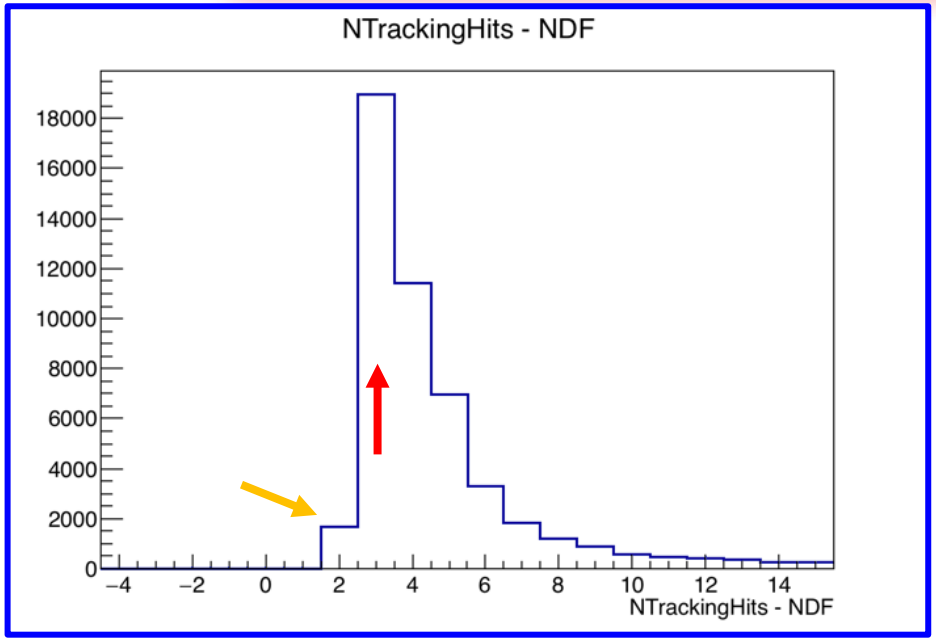


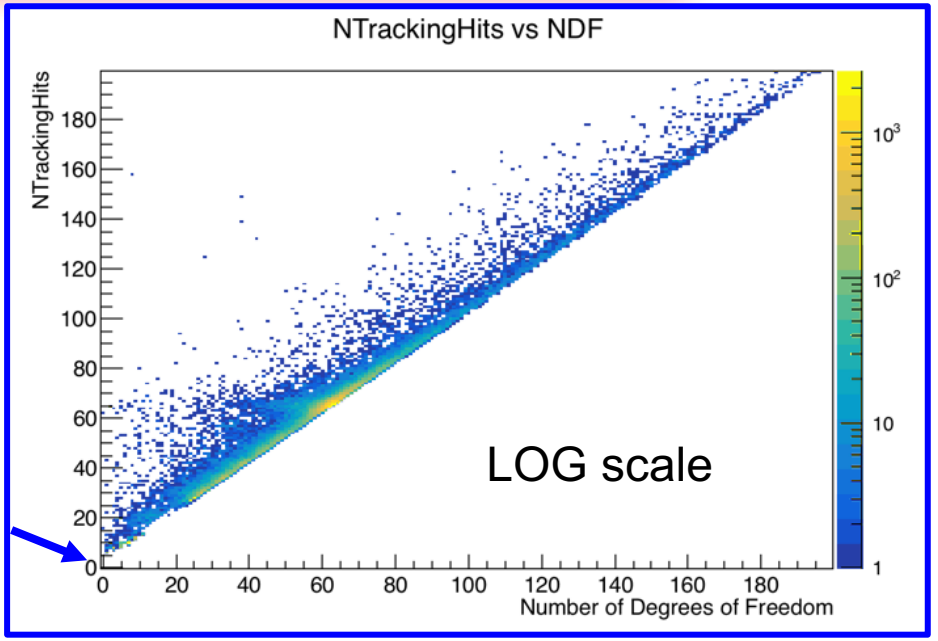






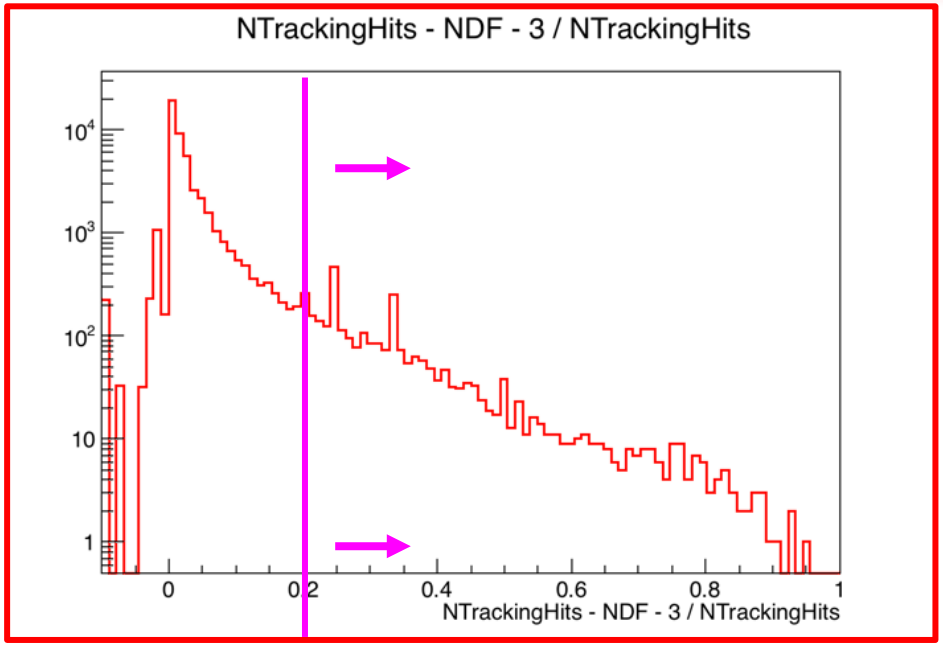
NDF – pions fitted as pions





- number of free parameters = number of hits - NDF
- Why peak at 3? A track has 5 free parameters. Why 2? Why 0 NDF?
- #hits - NDF larger than 3 since DAF removes hit (NTrackingHits is not updated)
- Linear correlation between NTrackingHits and NDF
- Sometimes really a lot of hits are removed

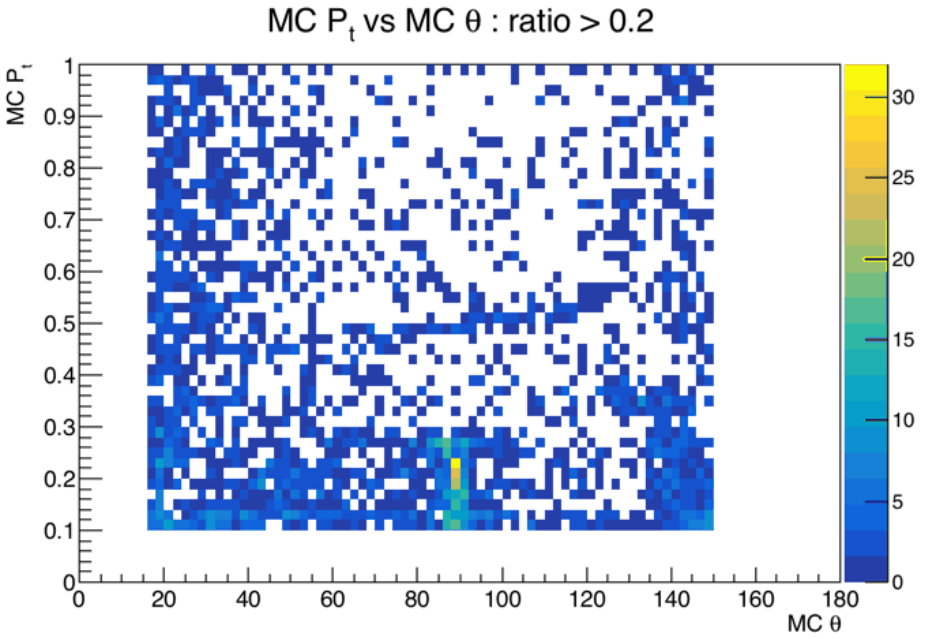
Discarded hits – pions fitted as pions



~ 5.5% of the tracks has more than 20% hits discarded by DAF

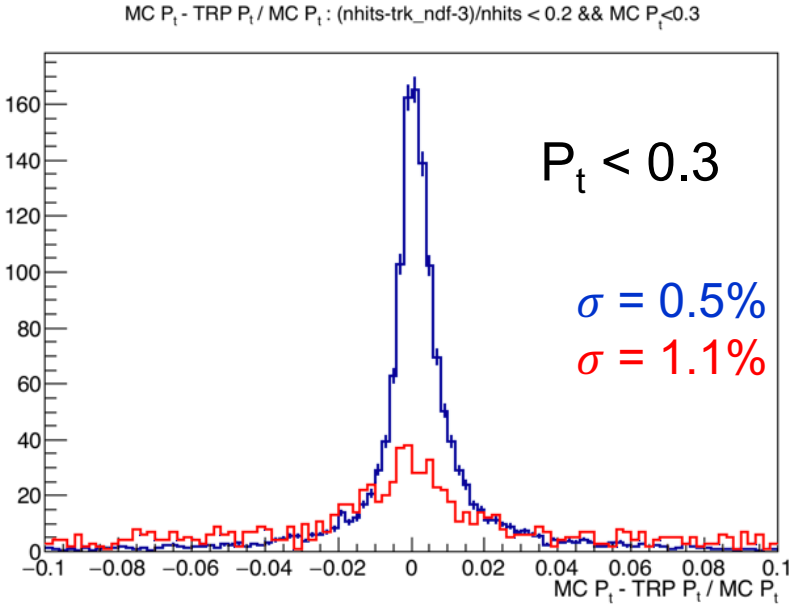
Assuming 3 free parameters (and not 5)

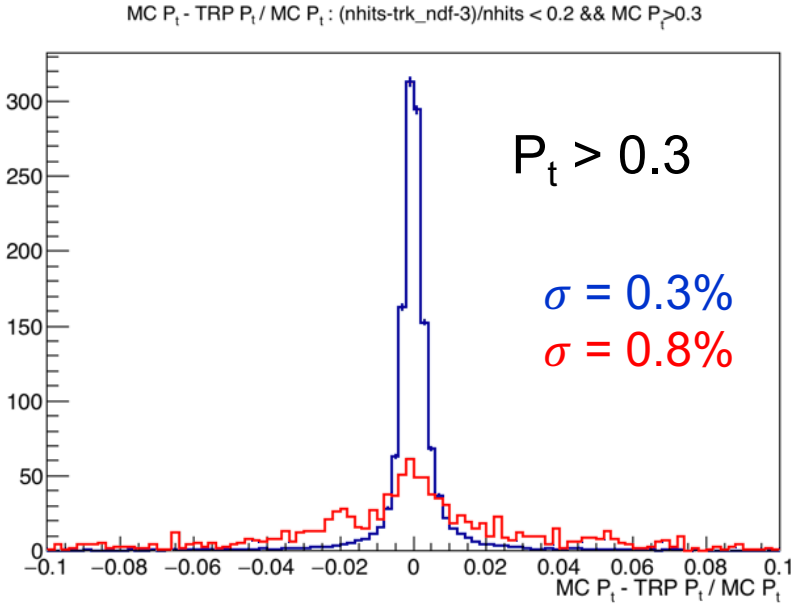
Mostly at low pt or at 90°



Resolution – pions fitted as pions

(#hits – NDF – 3) / #hits < 0.2
(#hits – NDF – 3) / #hits > 0.2

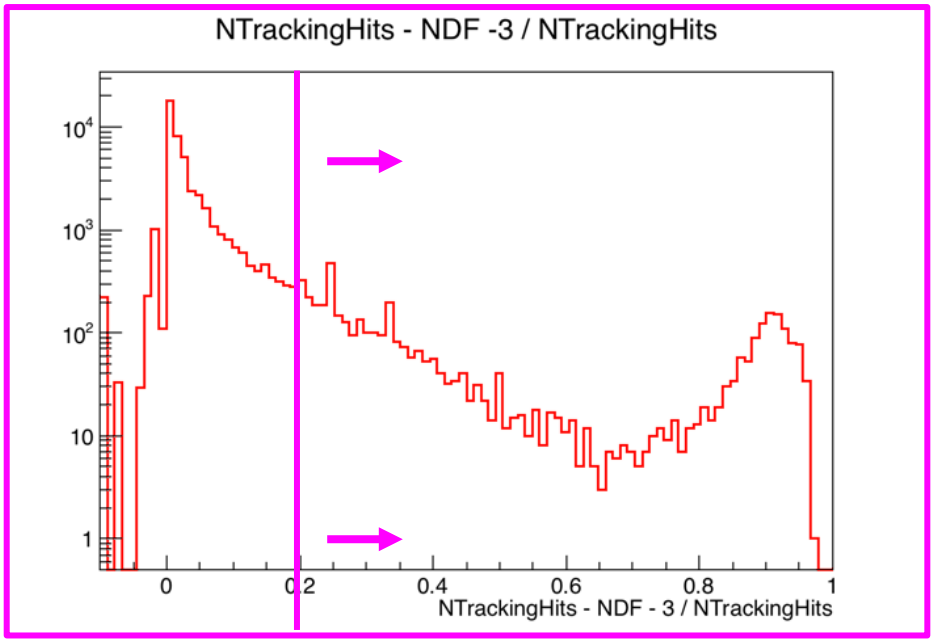




normalized to the same number of entries
fitted with 2 gaussians, taken the width of the narrower one

Tracks with large number of rejected hits show much worse resolution

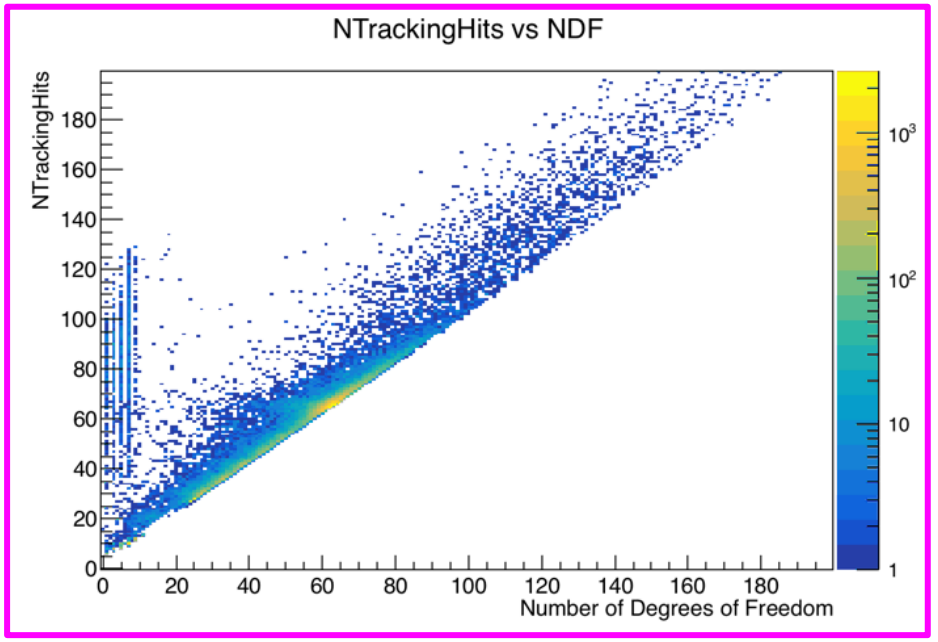
Discarded hits – pions fitted as protons



~ 8.4% of the tracks has more than 20% hits discarded by DAF

Assuming 3 free parameters (and not 5)

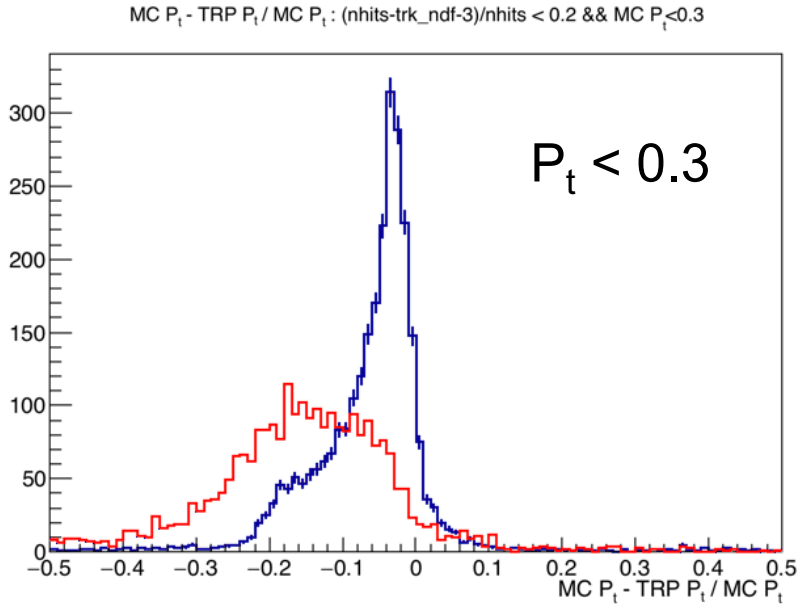
Sometimes a lot of discarded hits only VXD is left

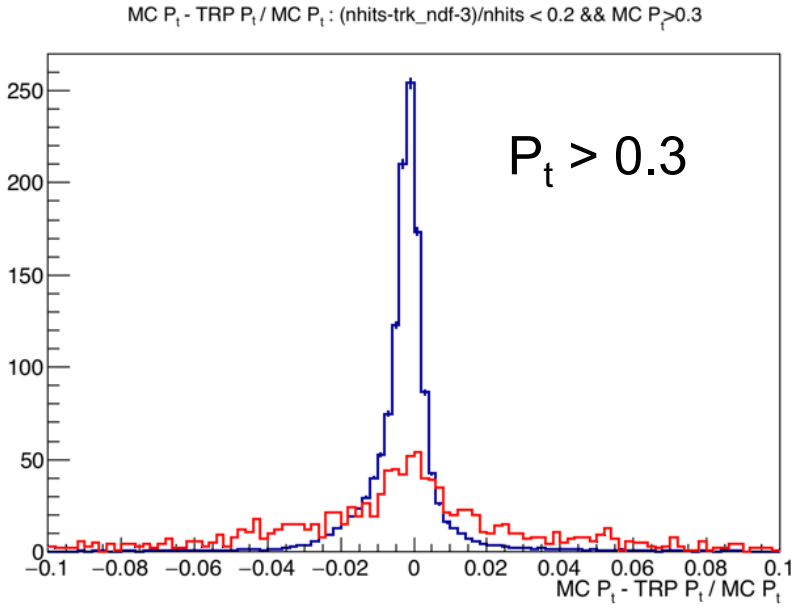


Resolution – pions fitted as protons

(#hits – NDF – 3) / #hits < 0.2

(#hits – NDF – 3) / #hits > 0.2



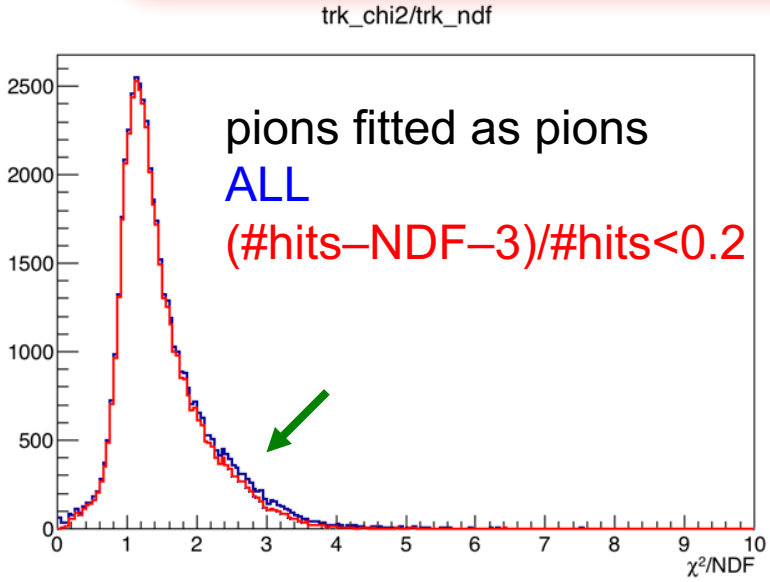


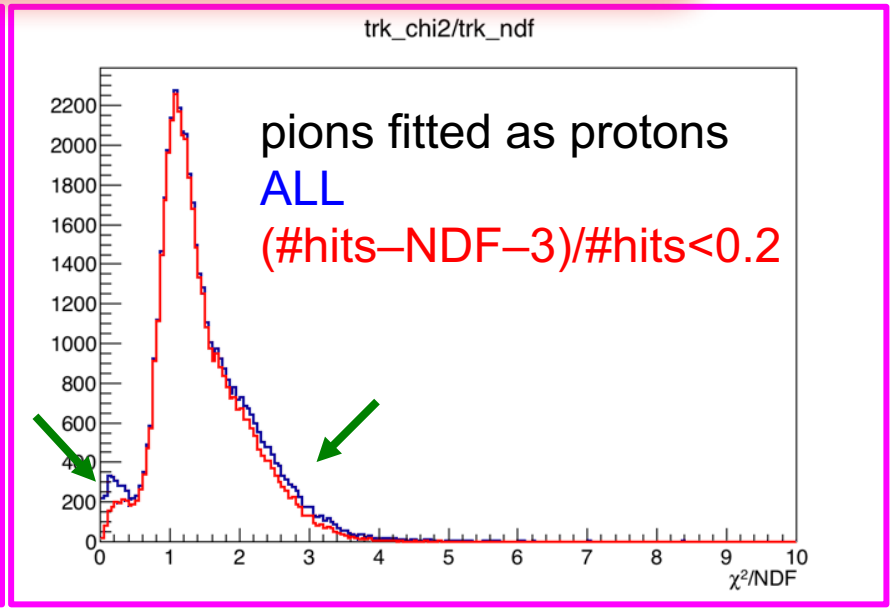
normalized to the same number of entries

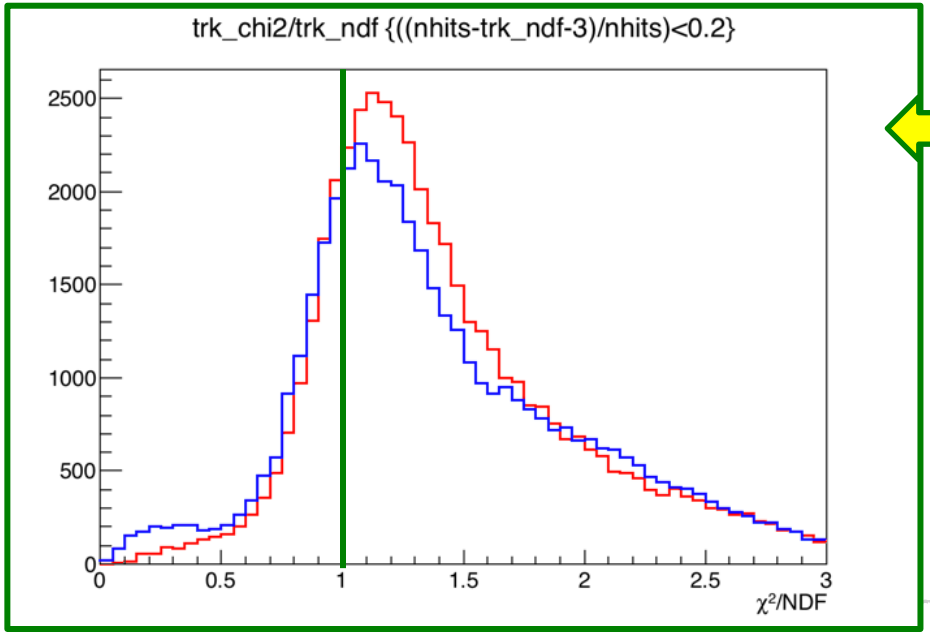
Al high pt tracks with large number of rejected hits -> much worse resolution

At low pt resolution completely screwed up

Chi2/NDF





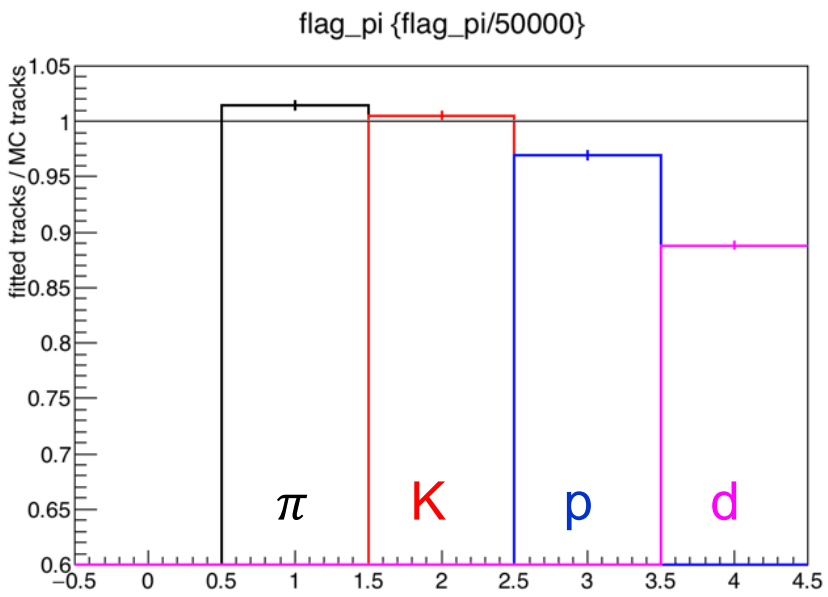


pions fitted as pions
pions fitted as protons
(#hits–NDF–3)/#hits<0.2

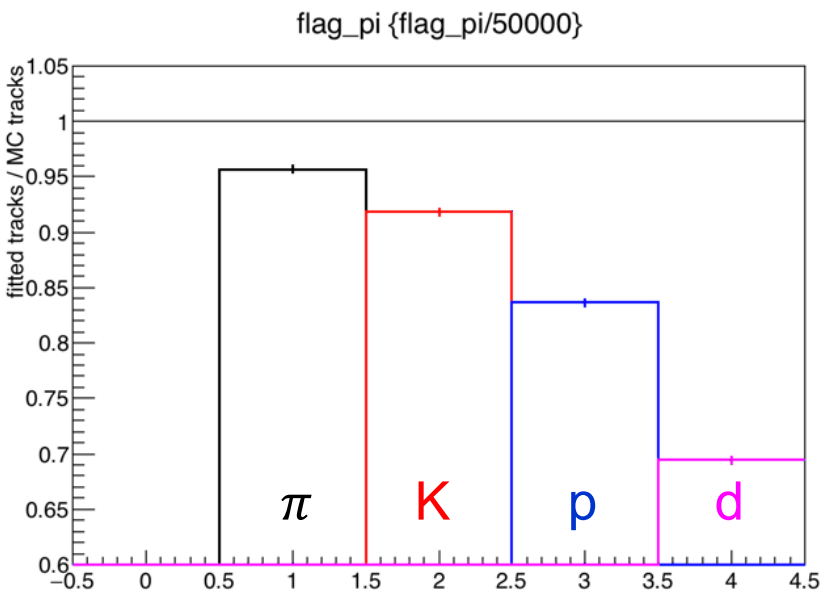
It seems that wrong hypothesis is closer to 1 !?!

Number of fitted tracks - pions

The same track is fitted in parallel with 4 particle hypotheses



TrackFitResults != NULL



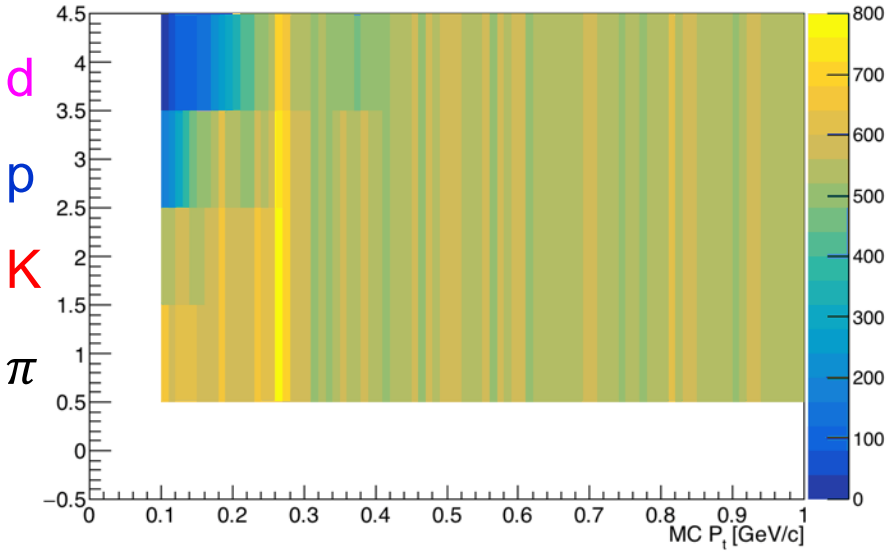
TrackFitResults != NULL
(#hits – NDF – 3) / #hits< 0.2

Without quality selection more tracks due to doubles

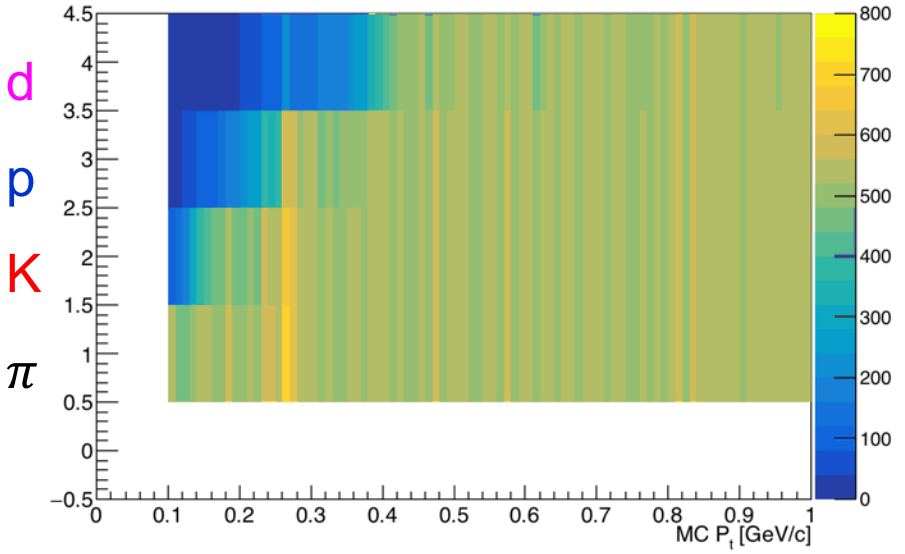
With quality selection wrong hypotheses are cut more

What is doing the selection? - pions

TrackFitResults != NULL

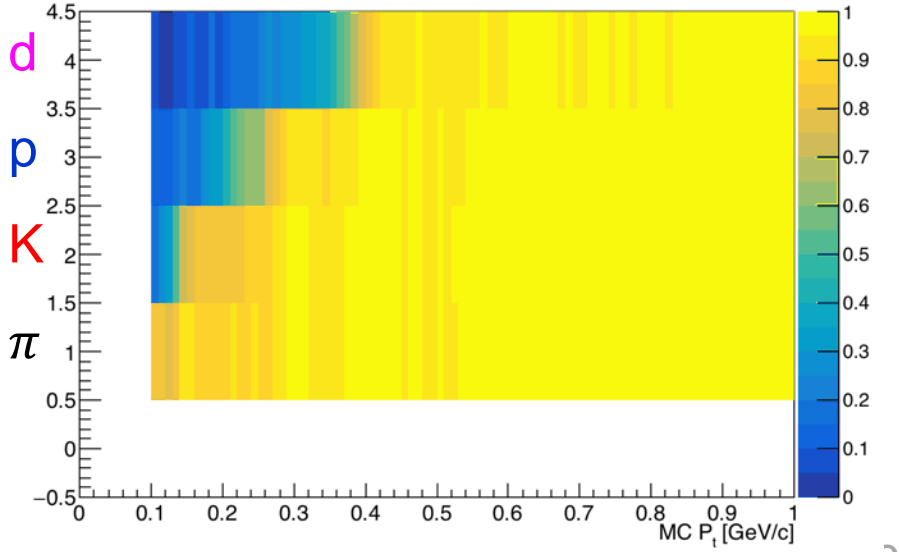


TrackFitResults!=NULL && (#hits–NDF–3/#hits)<0.2



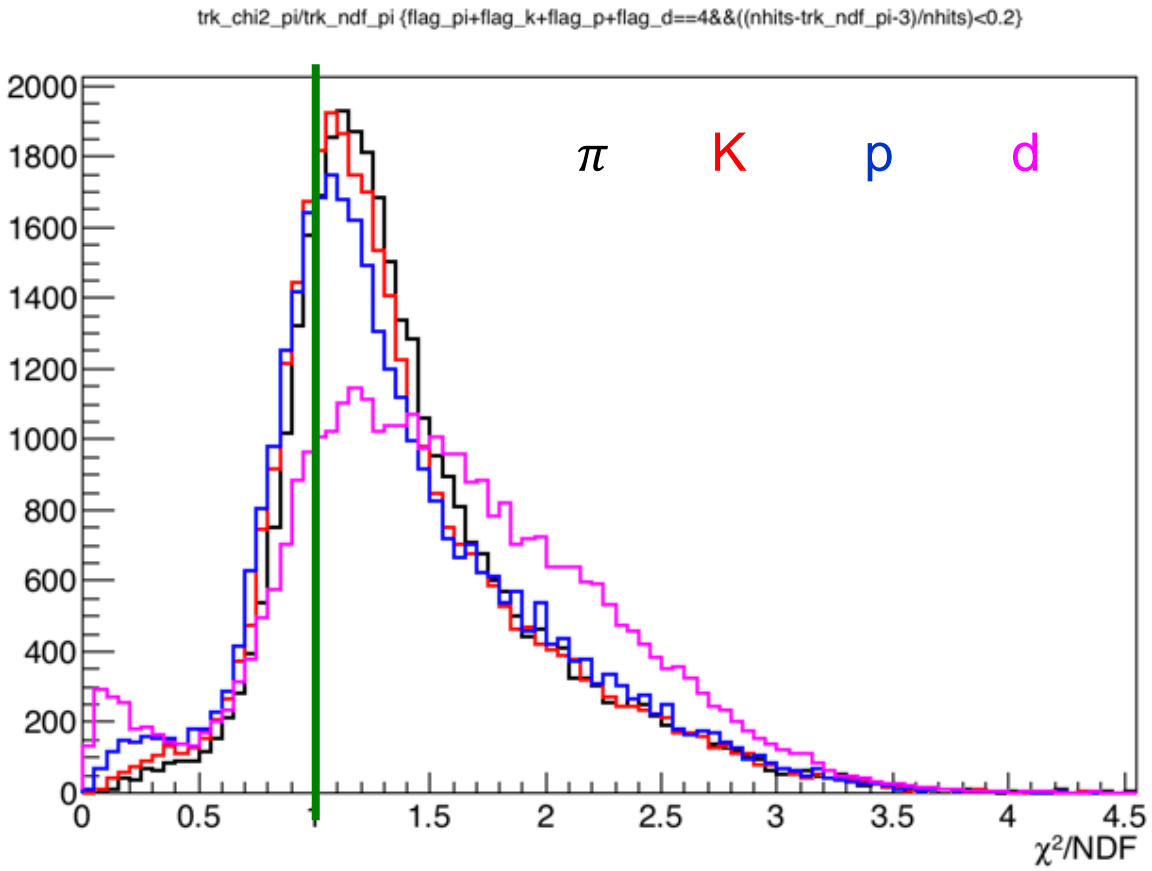
TrackFitResults !=NULL && (#hits–NDF–3)/#hits< 0.2

TrackFitResults !=NULL



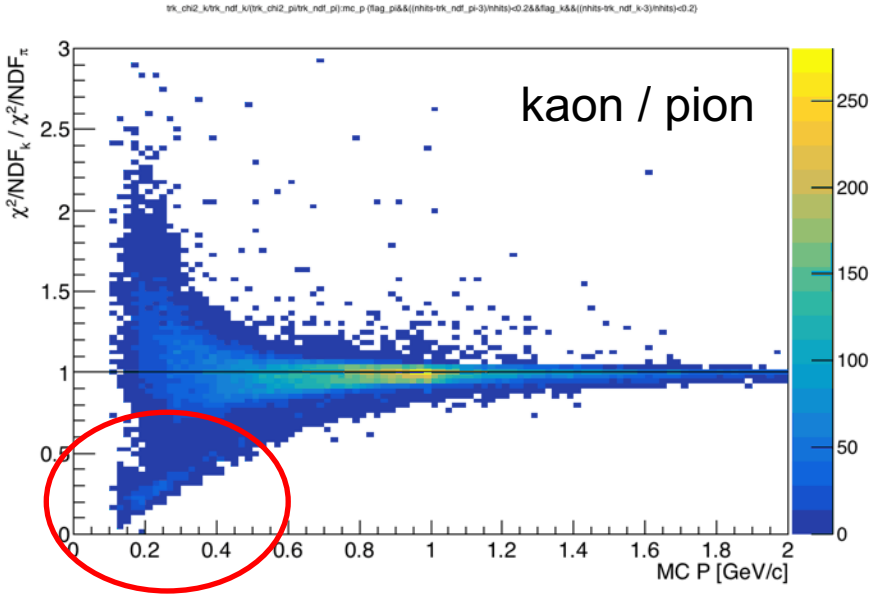
Quality of the fit - pions

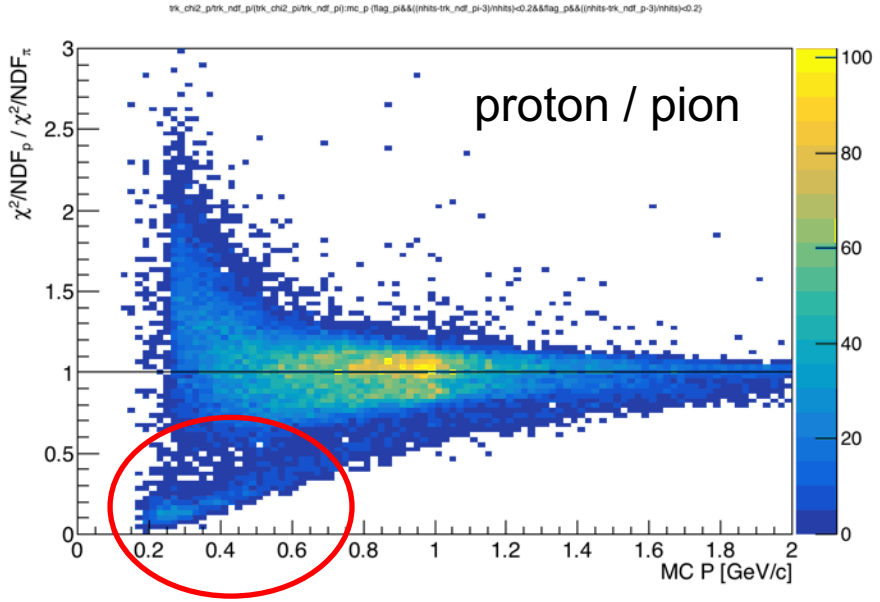
For all of them TrackFitResults != NULL and #hits–NDF–3 / #hits<0.2

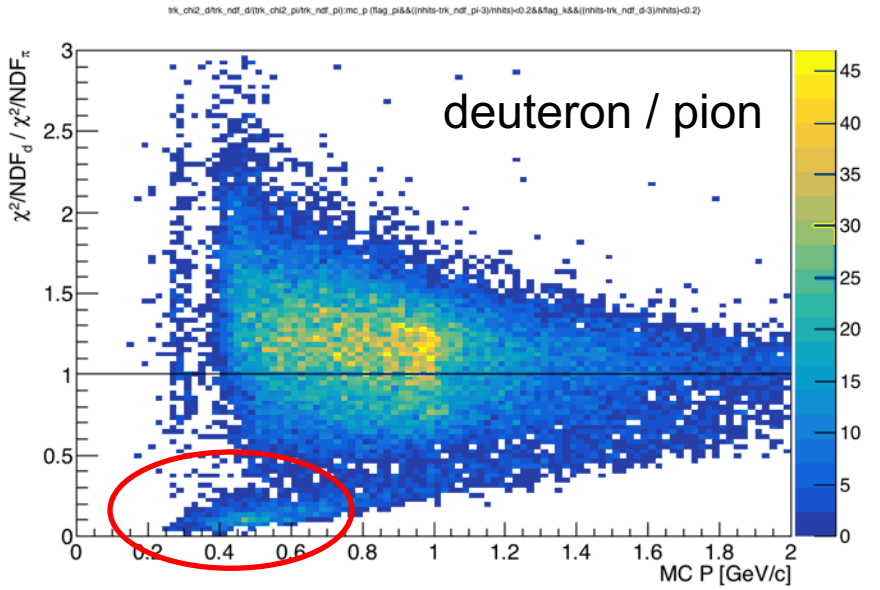


- They are not completely peaked at 1
- Not big differences (apart from d)
- Low value peak, the selection must be improved

Ratio of “Quality of the fit” - pions

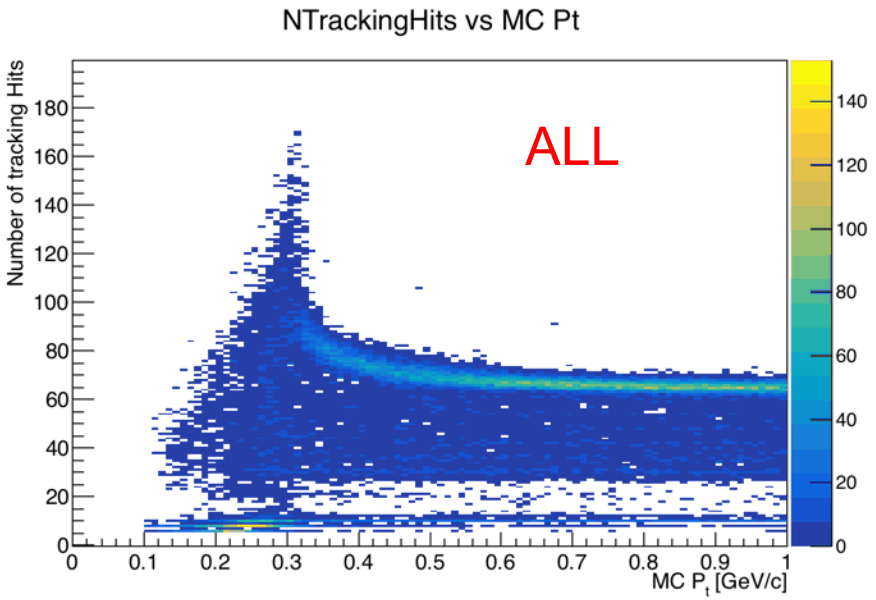


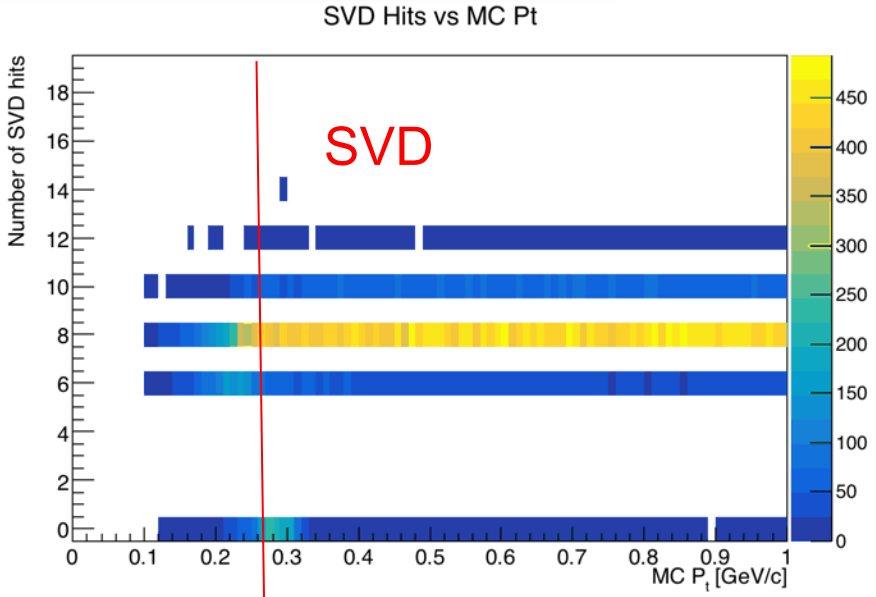


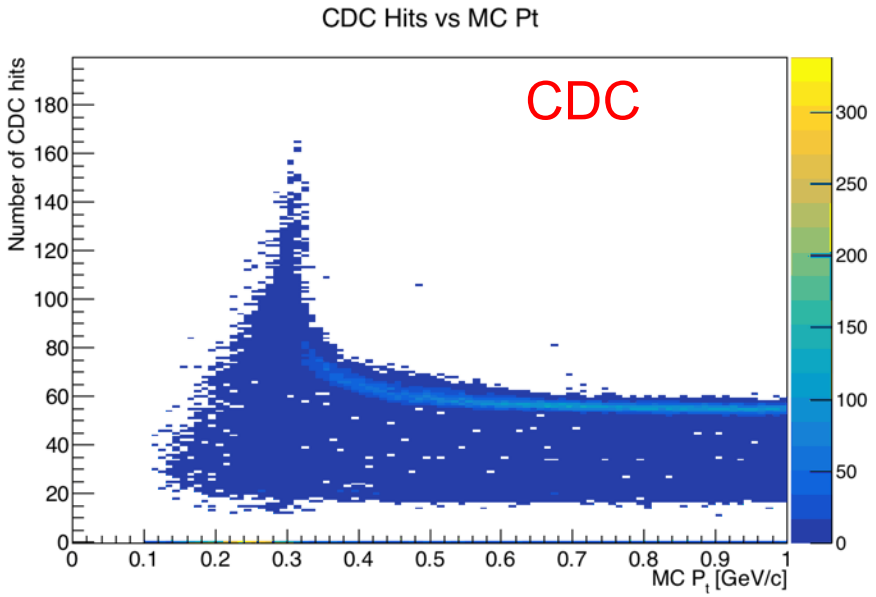


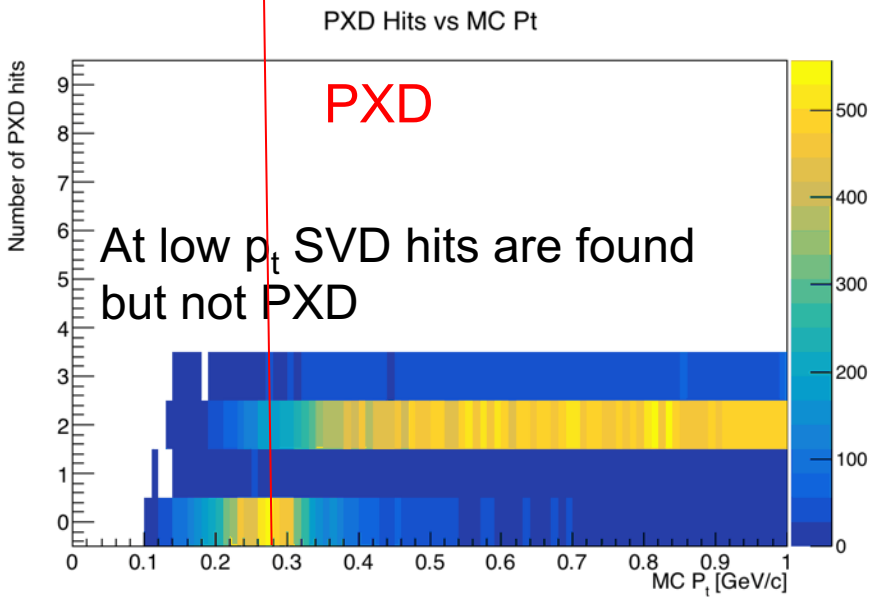
- No real discriminating power
- Bad fitted tracks still present

What about protons? – number of hits

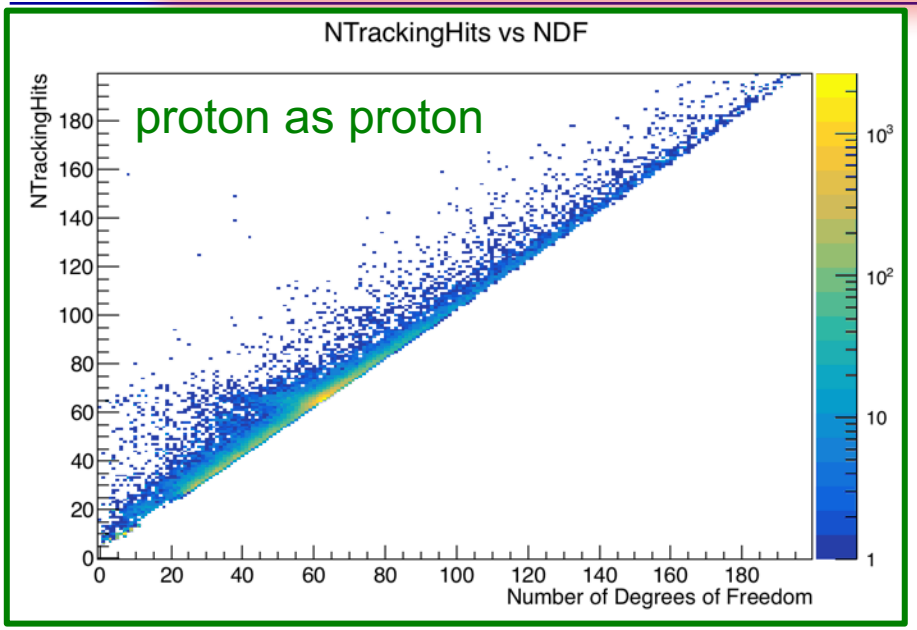


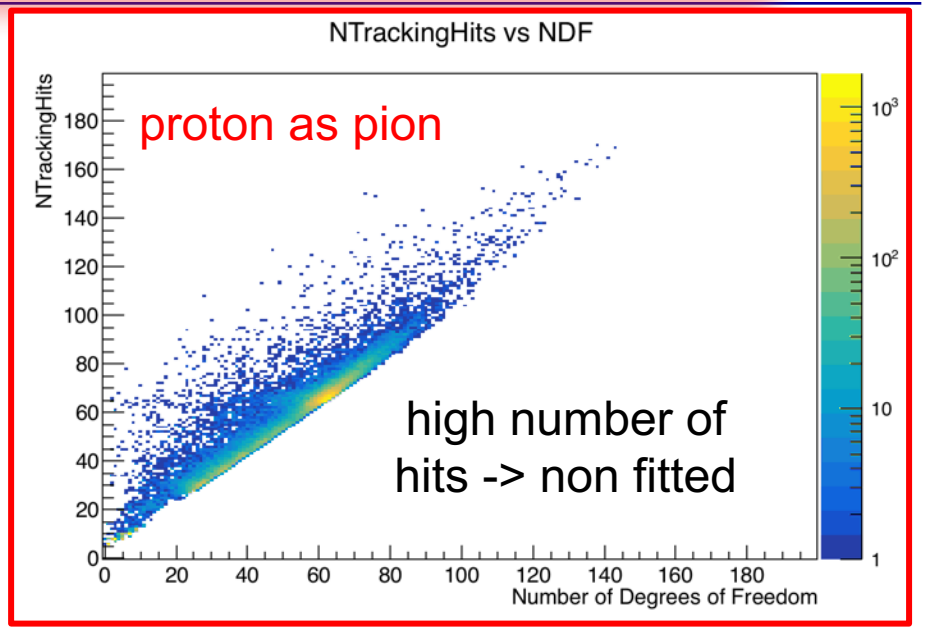


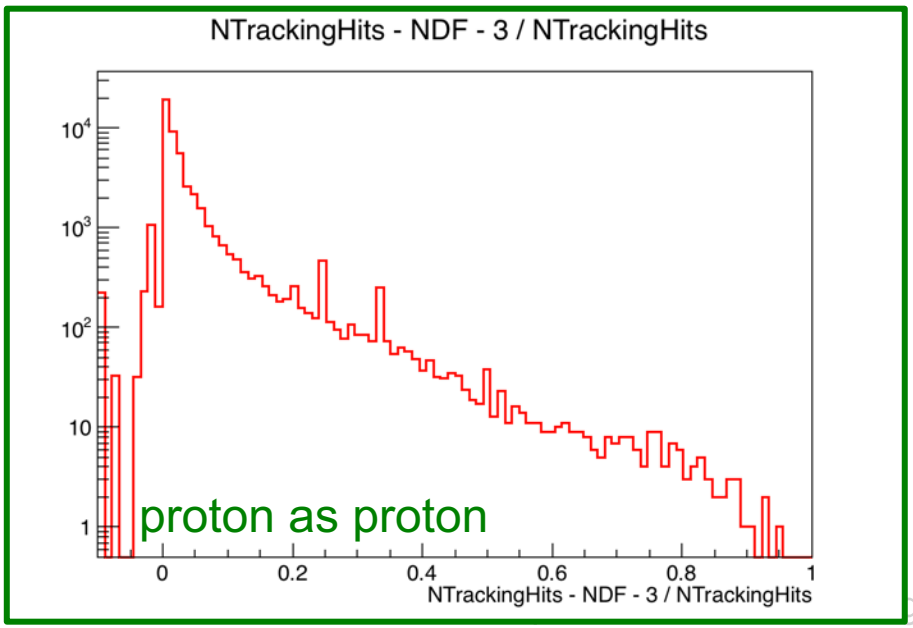


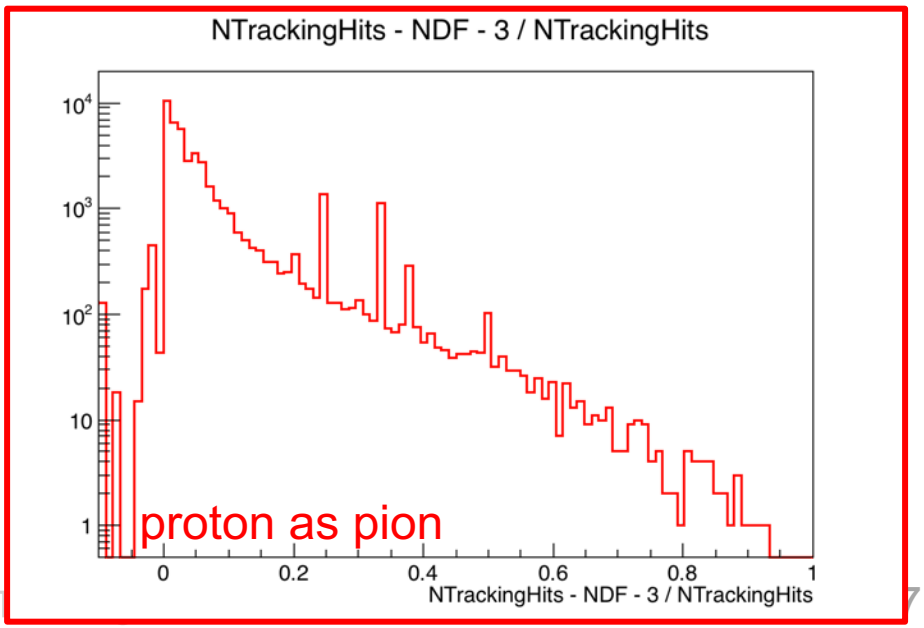


Number of Degrees of Freedom - protons

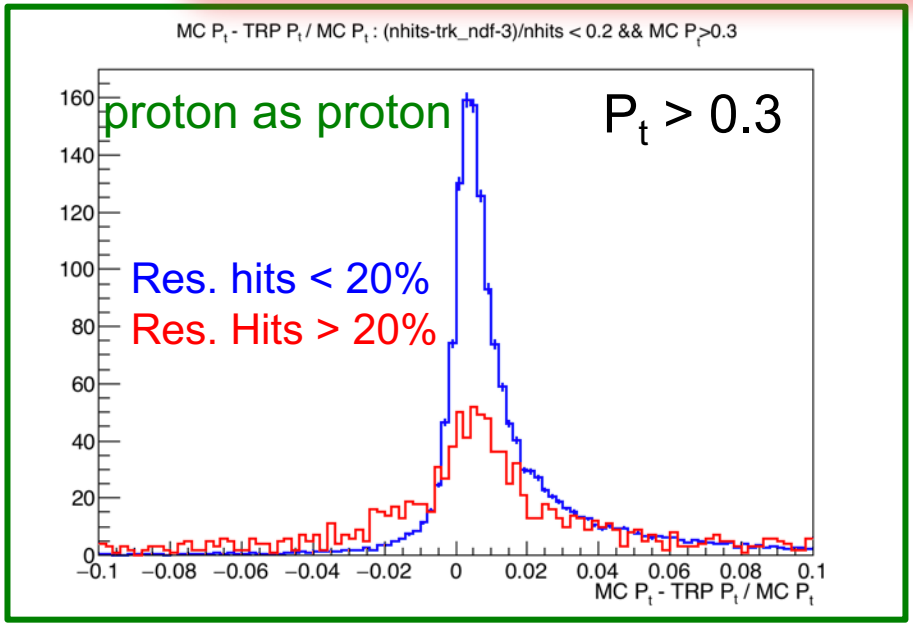


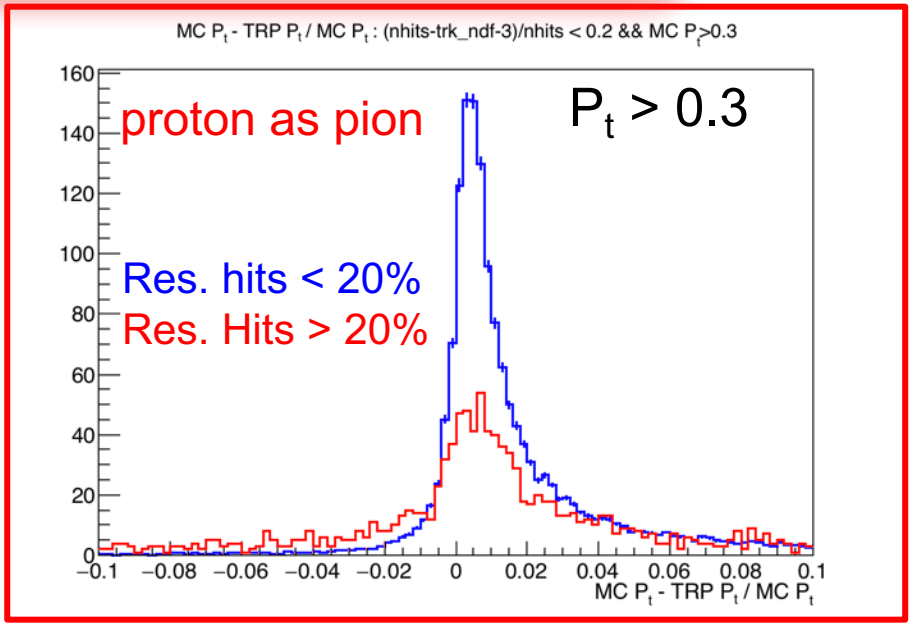


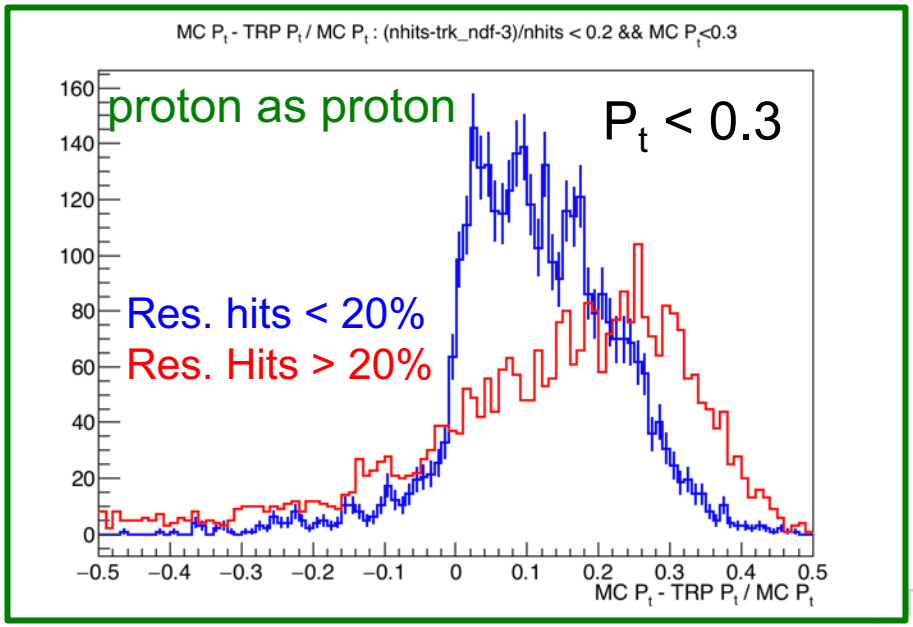


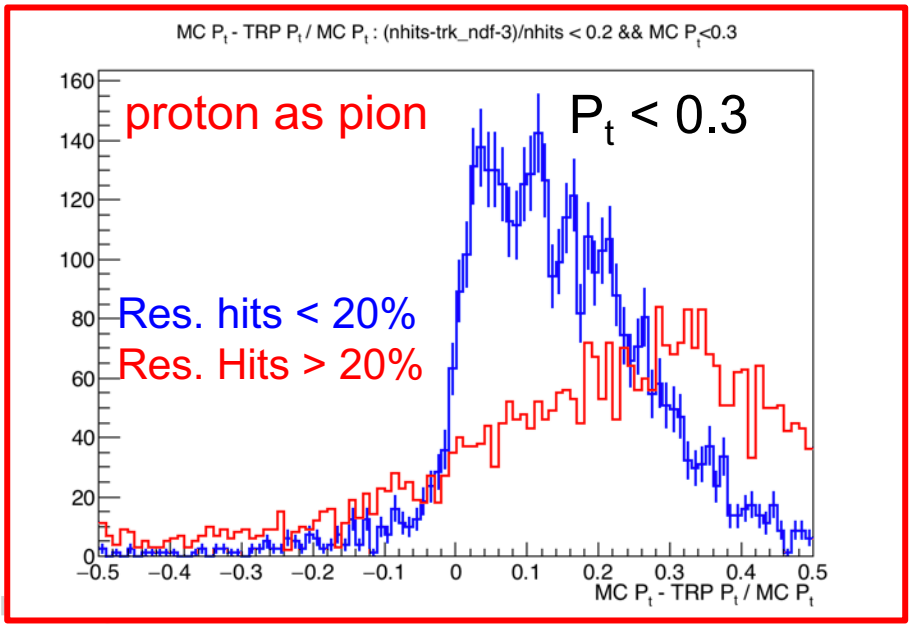


Proton Resolution



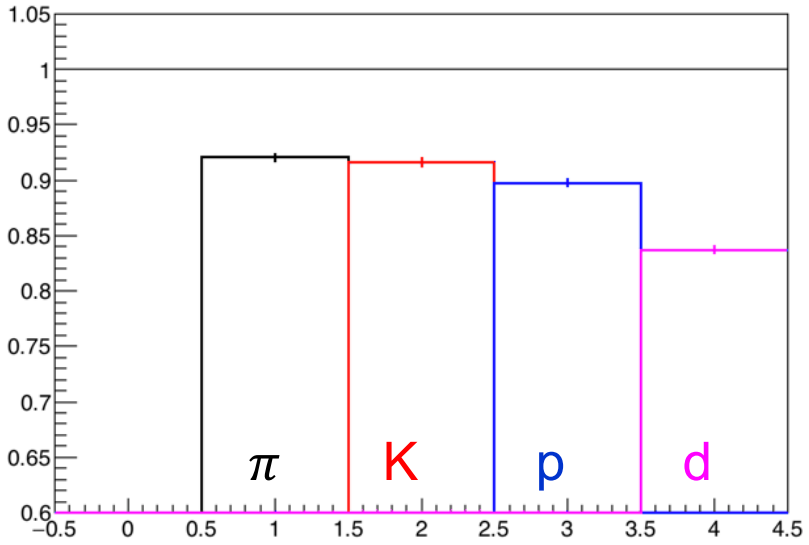




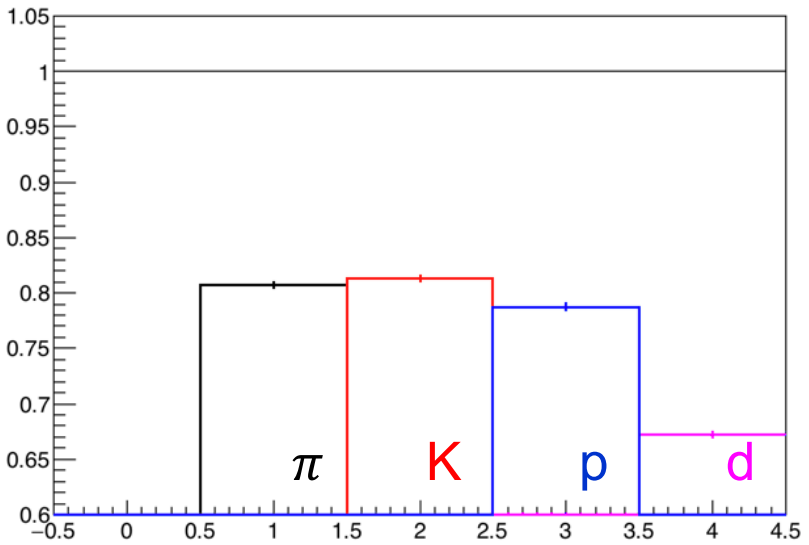


Number of fitted tracks – protons - I

The same track is fitted in parallel with 4 particle hypotheses



TrackFitResults != NULL



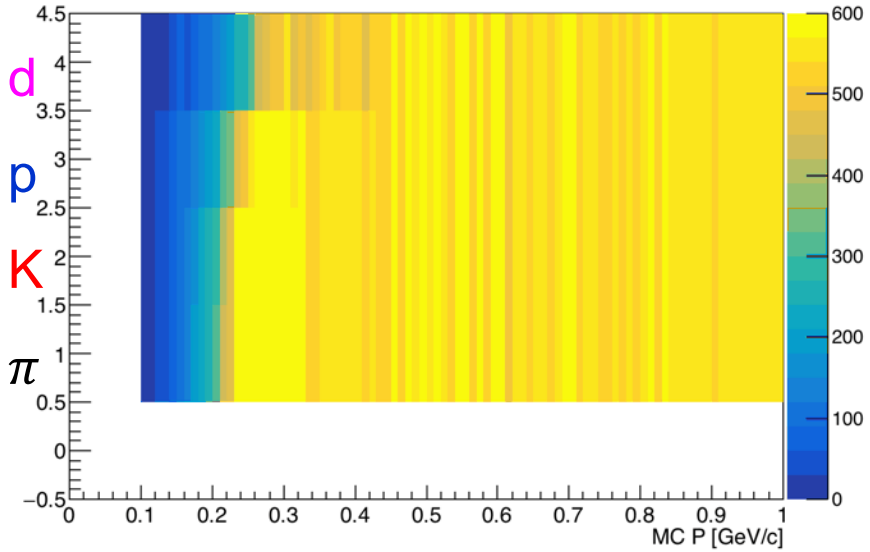
TrackFitResults != NULL
(#hits – NDF – 3) / #hits< 0.2

The proton hypothesis is not the highest efficiency one

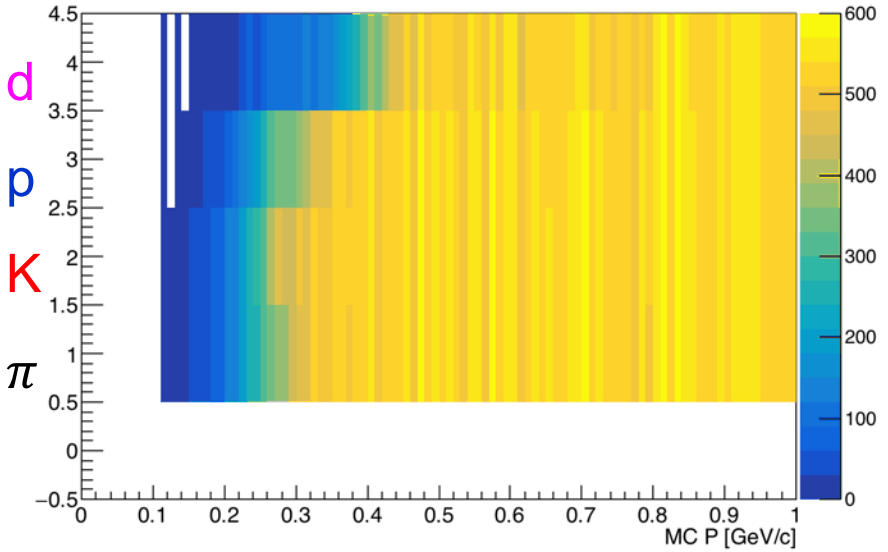
Why?

Number of fitted tracks – protons – II

TrackFitResults != NULL

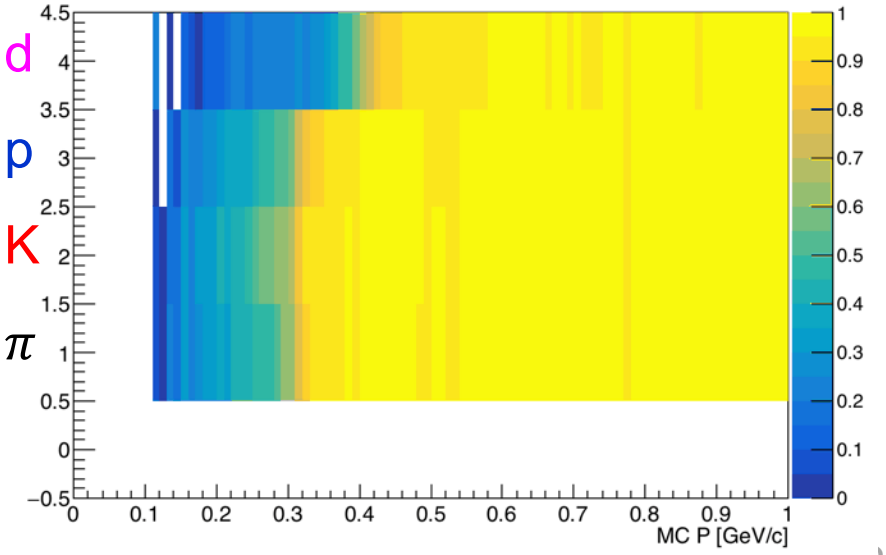


TrackFitResults!=NULL && (#hits–NDF–3/#hits)<0.2

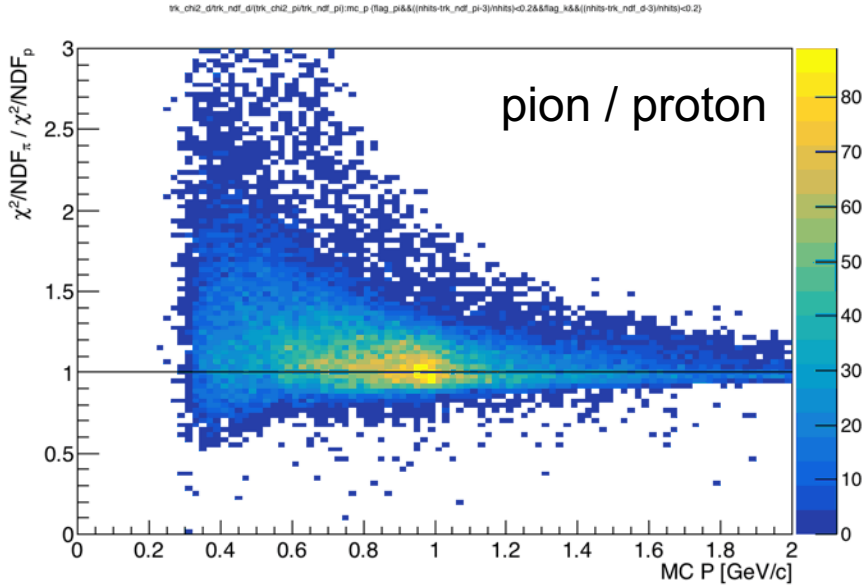


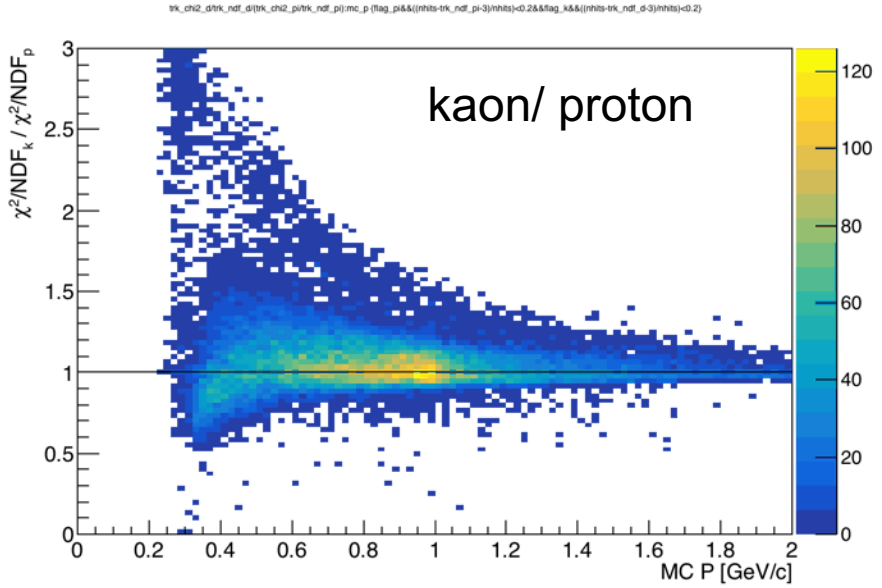
TrackFitResults !=NULL && (#hits–NDF–3)/#hits< 0.2

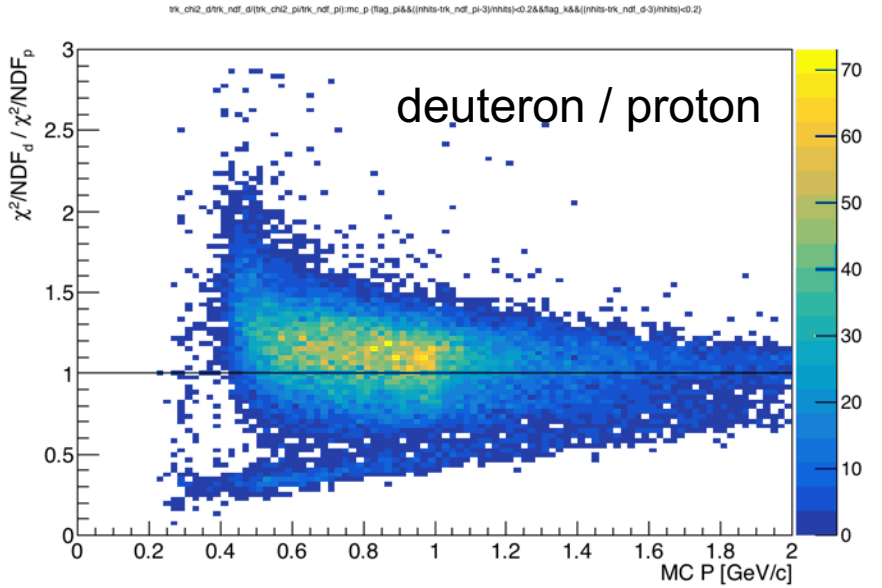
TrackFitResults !=NULL



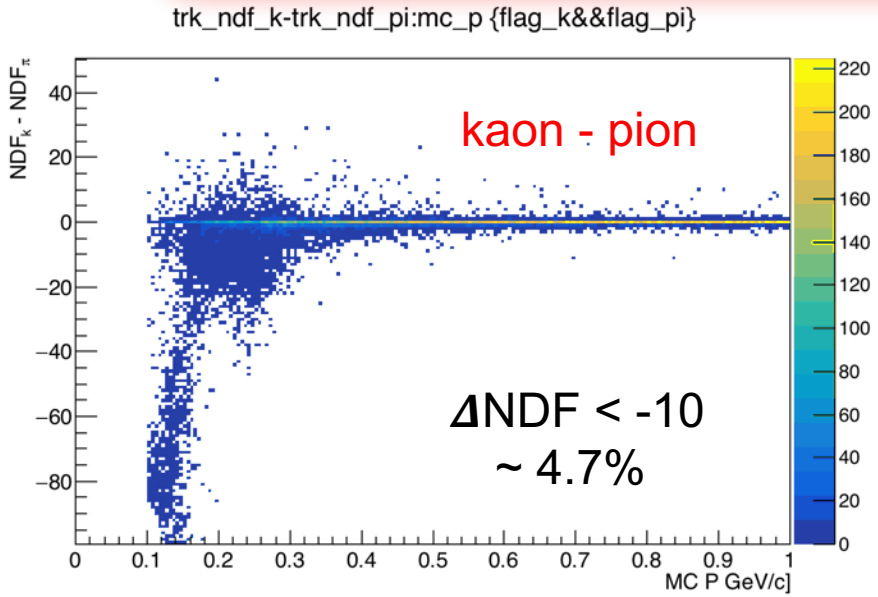
Ratio of chi2/NDF - protons

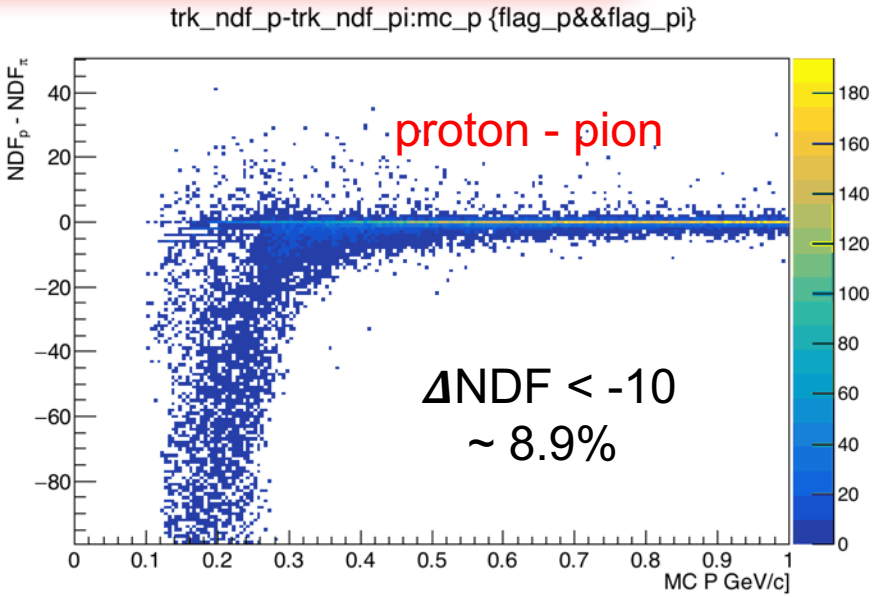


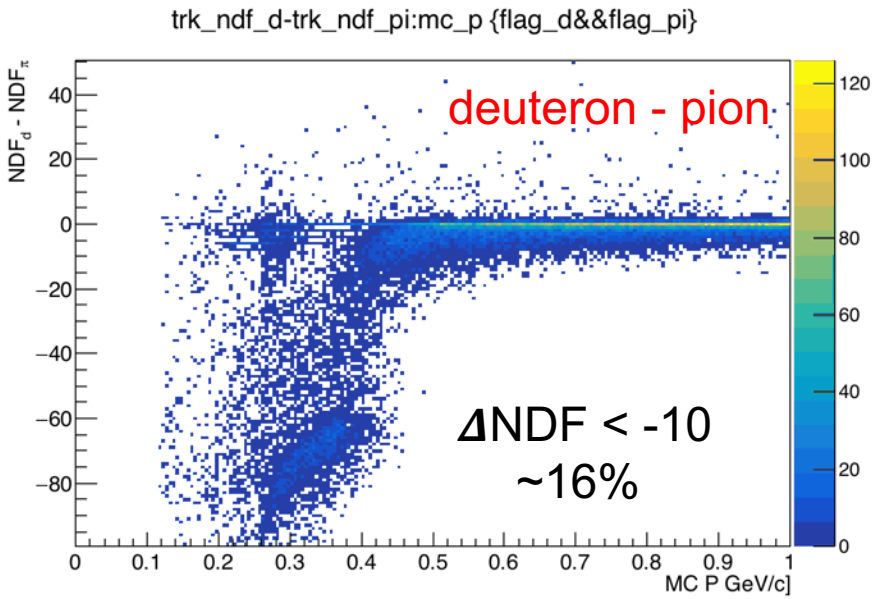




Difference in NDF - pions



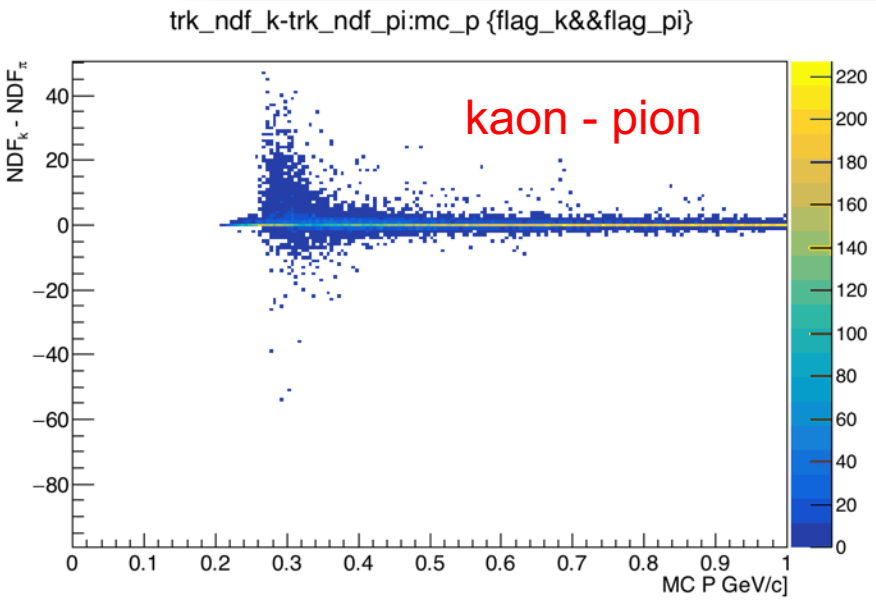


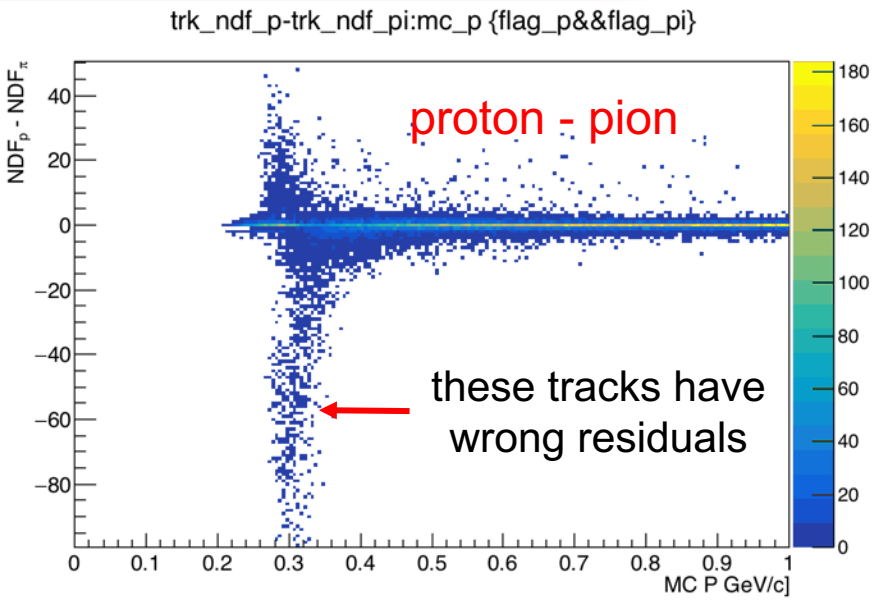


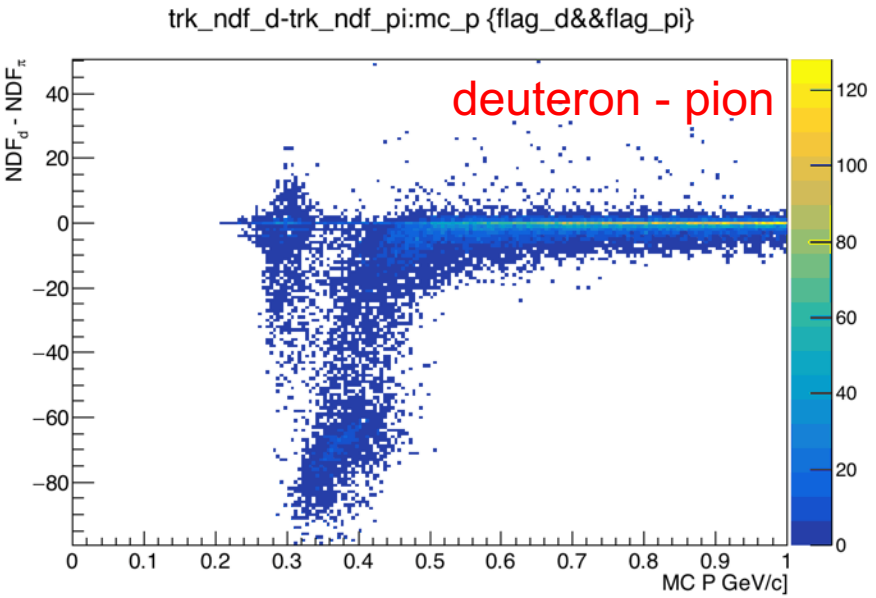
From an idea coming yesterday afternoon during the coffee break

(blame Eugenio and Martin for these additional slides)

Difference in NDF - protons







It seems neither the difference in number of degrees of freedom can help in track cleaning

Trying to summarize

- The number of free parameters from the fit is peaked at 3 and not 5
- Curlers are reconstructed with a large number of hits
- DAF seems to have the possibility to remove a large amount of hits.
- When large number of rejected hits, the resolution is much worse or even screwed
- Is it realistic to keep such fitted tracks?

- Chi2/ndf is not very good to discriminate the correct particle hypothesis
- Chi2/ndf is not peaked at 1 but at a bit larger value. Is it fine?
- The good particle hypothesis does not give always the highest efficiency
- Pion fit seems always better in terms of efficiency. Is there something wrong with proton physics in genfit?