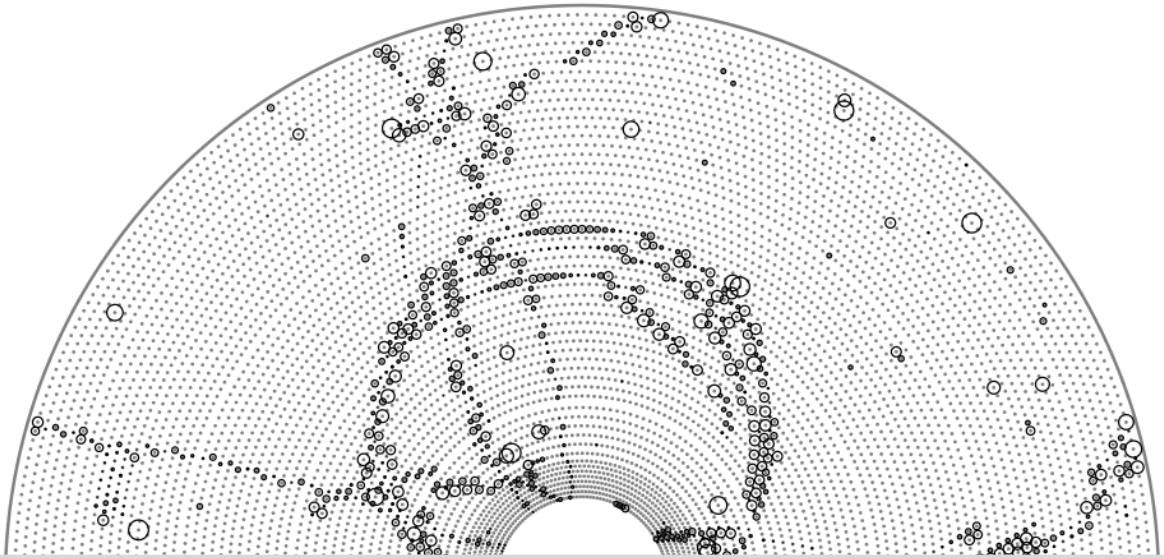
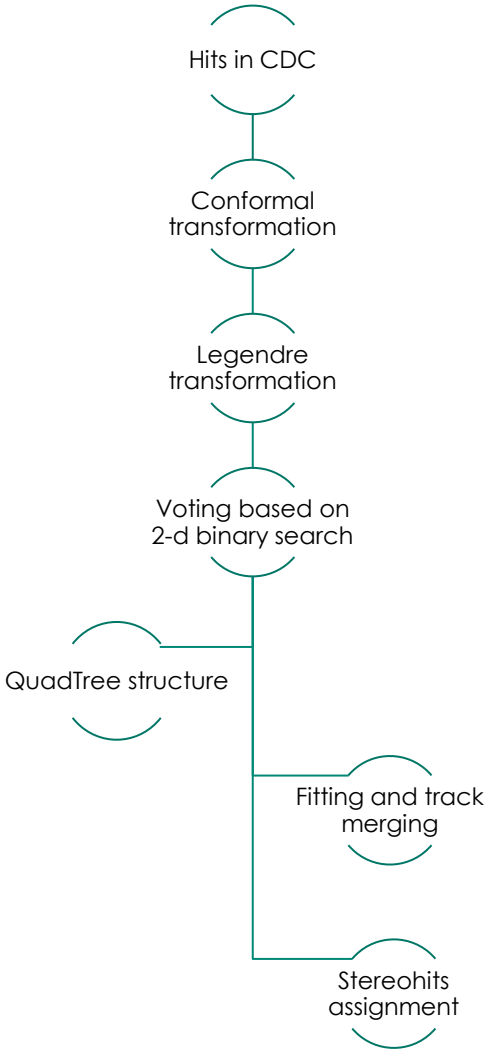
TrackFinderCDCLegendre: current status

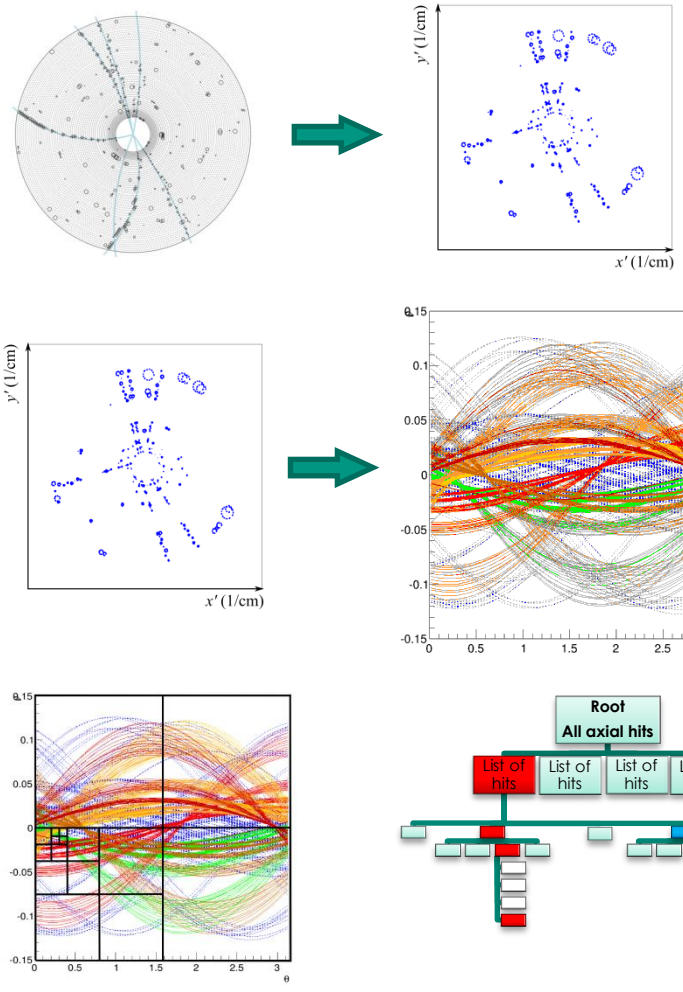
Viktor Trusov
01.20.2015 | F2F Meeting in Prague

Karlsruhe Institute of Technology (KIT)



Chain of the method





Few words about efficiency estimation

- Efficiency estimation based on matching *ideal tracks (MC)* (*TrackFinderMCTruth*) to pattern recognition (PR) tracks (*LegendreFinder*)
- PR track matched to MC if:
  - Most of hits in the PR track belongs to the MC track
  - Most of hits in the MC track belongs to the same PR track
- Threshold on purity of PR tracks: 66%
- Cut on track's production vertex was applied: $d_{xy} < 5cm$
- Calculated as:

$$\epsilon = \frac{number\ of\ matched\ MC\ tracks}{total\ number\ of\ MC\ tracks}$$

Efficiency without and with stereohits

- Relations MC↔PR based on confusion matrix of hits.

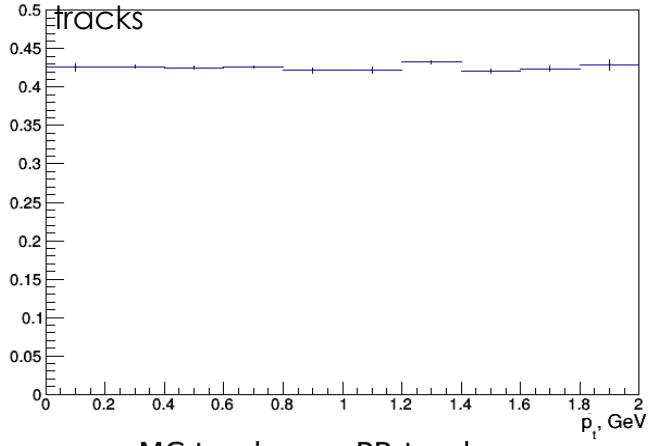
Confusion matrix

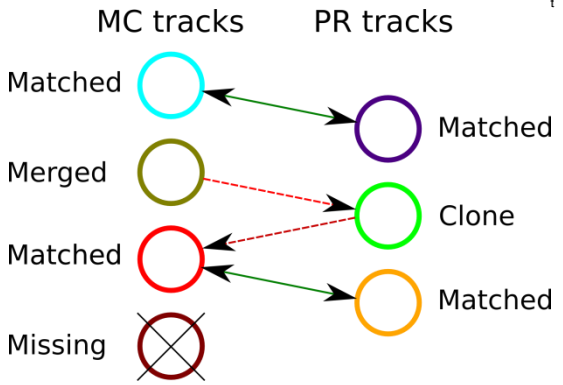
	MC tracks			Background
PR tracks	...	...	...	...
	...	Common hit / NDF content	...	...
	...		...	...
	...	...	...	...
Unassigned	...	...	...	...

Confusion matrix of the example

	mc_1	mc_2	mc_3	mc_4	Background
pr_1	24	0	0	0	0
pr_2	0	6	8	0	0
pr_3	0	0	19	0	0
Unassigned	0	0	0	21	0

Average fraction of stereohits in tracks

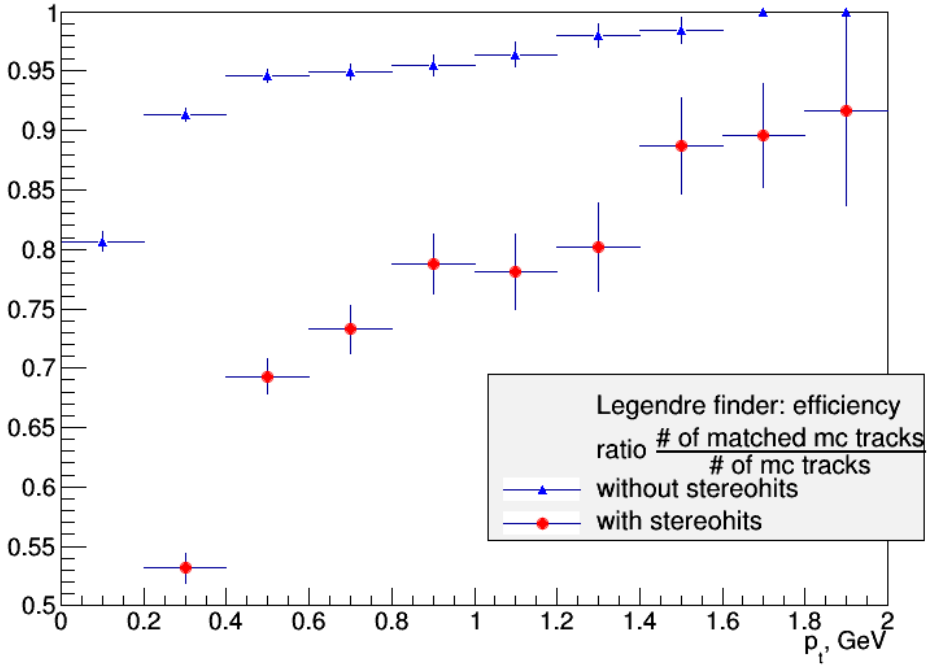




- If fraction of unassigned hits is greater than fraction of assigned to some PR track – no relation MC↔PR created in this case

Efficiency without and with stereohits

- Efficiencies of axial-only finder
  - Not taking into account stereohits of MCTrack
  - Taking into account stereohits of MCTrack

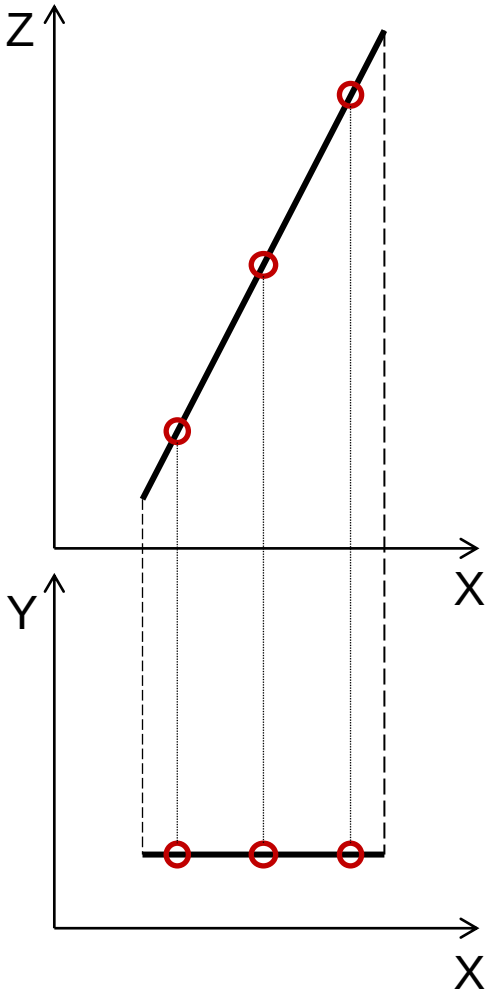


  - Since average fraction of stereohits is ~0.4 this could be a reason of efficiency drop
  - **Task of stereohits finders:** to reach efficiency level of axial finder (blue markers)

The problem

- Stereohits used for measuring polar angle and p_z of the tracks.
- Unlike the axial wires stereo wires doesn't allow to determine XY position of the hits.

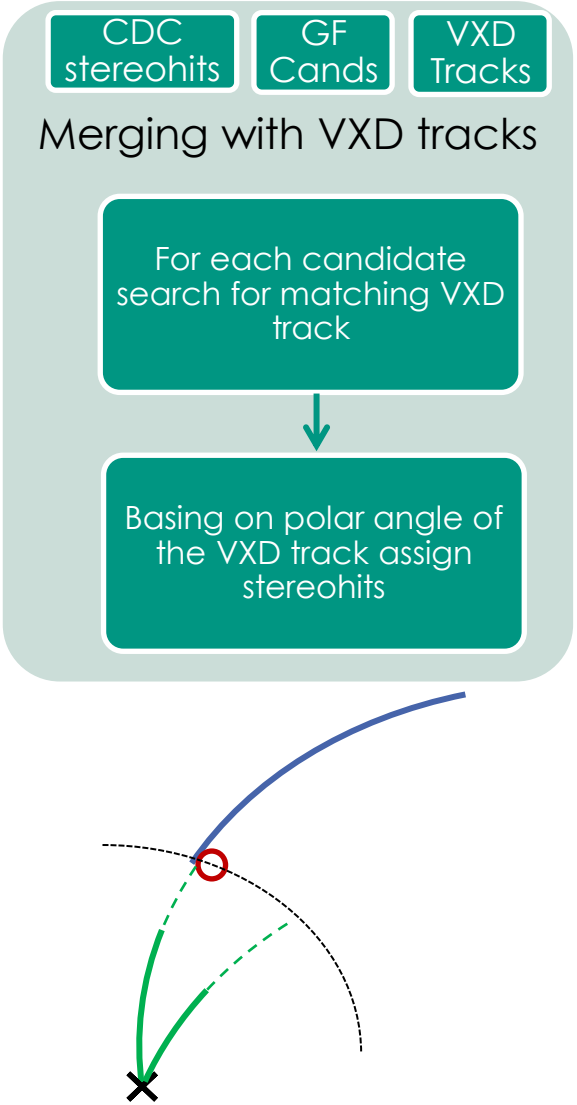
- Assigning of stereohits to the track could be done in 2 ways:
  - Making hypothesis on polar angle of the track and adding hits
  - Making hypothesis on hit's production position basing on most probable parent track



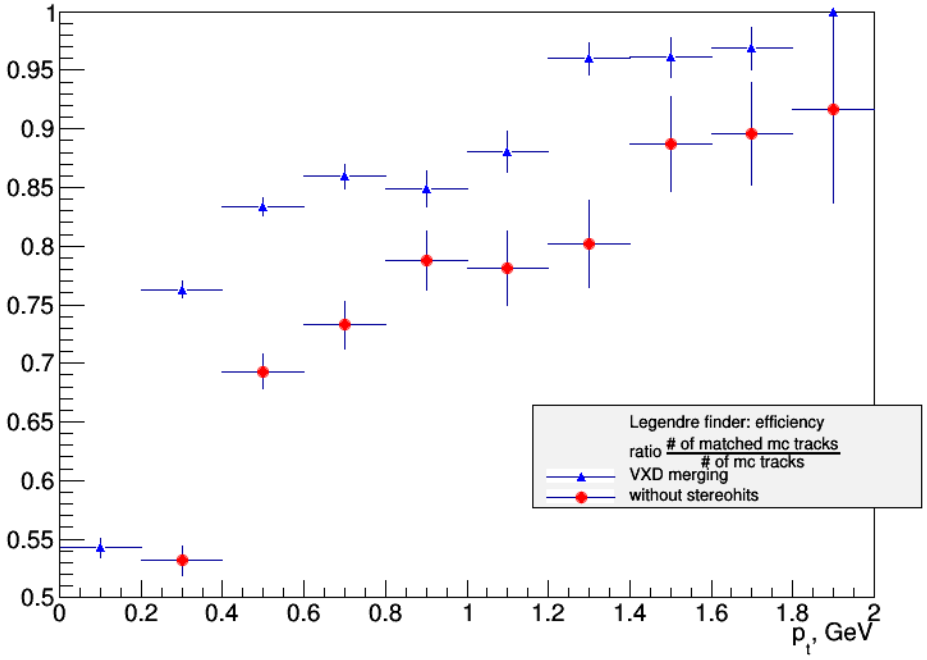
Merging with VXD

- With knowing polar angle of the track we able to assign stereohits to the track using merging with VXD track
  - Polar angle of matching VXD track is taken as polar angle of the CDC track

- Matching of tracks:
  - Take distance to innermost hit of CDC track from IP
  - Extrapolate VXD track on cylinder with radius of measured distance
  - Measure distance from the hit to extrapolated point (in XY plane)
  - Most closest track with distance that doesn't exceeds limit of $3\ cm$ is taken as *matched*



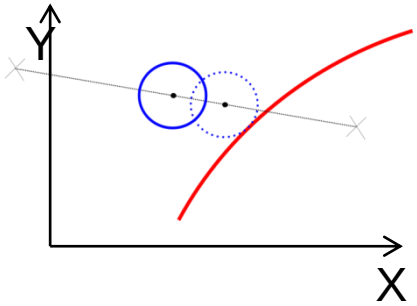
Efficiency of the method (VXD merging)

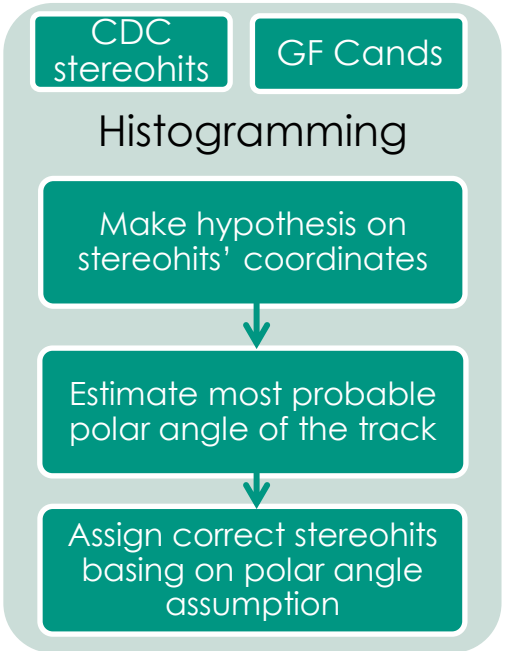


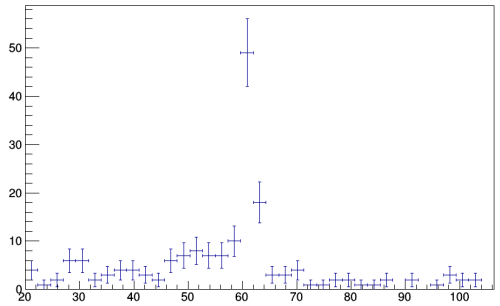
- Method was tuned but there is still some issues with it:
  - Lack of VXD tracks detected
    - for example, 10 cdc candidates vs 3 VXD tracks
  - It produces wrong results for overlapping tracks

Histogramming

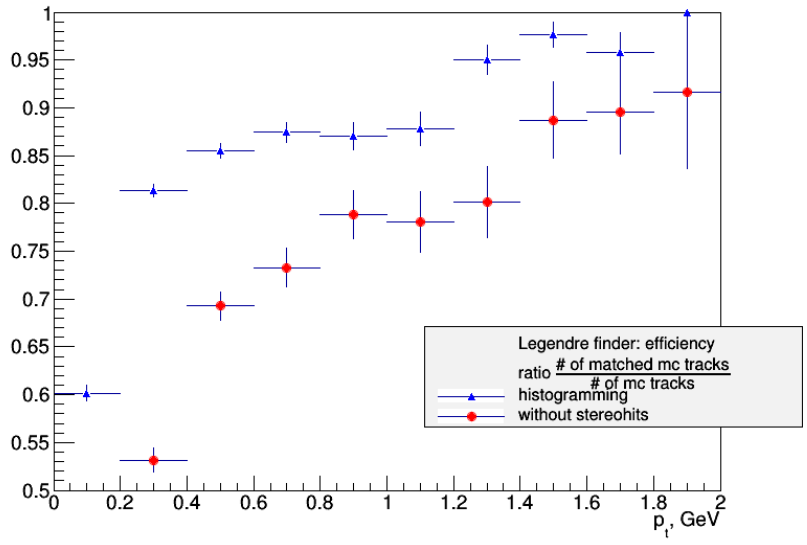
- With estimation of displacements of stereohits against the track we can estimate most probable polar angle of the track
  - Each stereohit can give assumption on track's polar angle
- We collect all polar angle assumptions and fill histogram
  - Position of peak in histogram defines polar angle of the track
  - All stereohits from peak should be added to the track

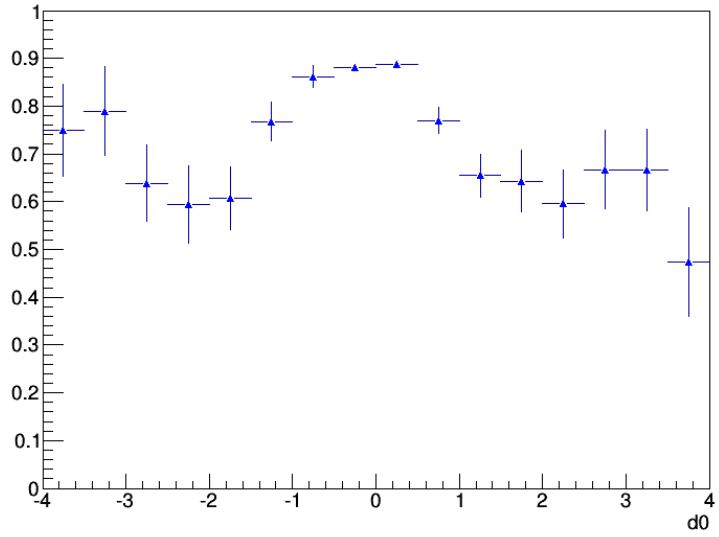






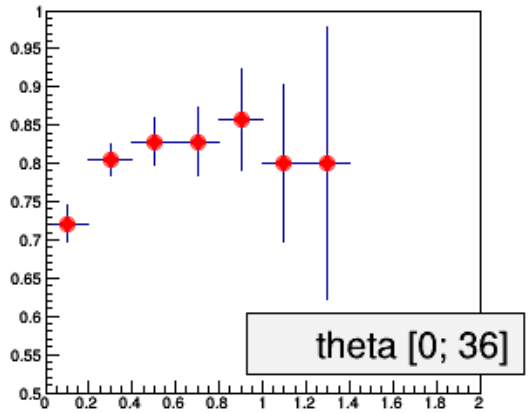
Efficiency of the method (histogramming)

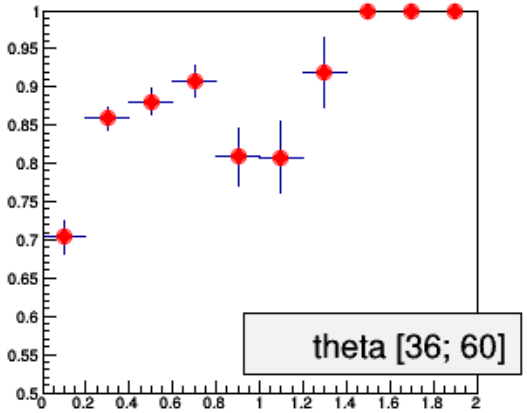


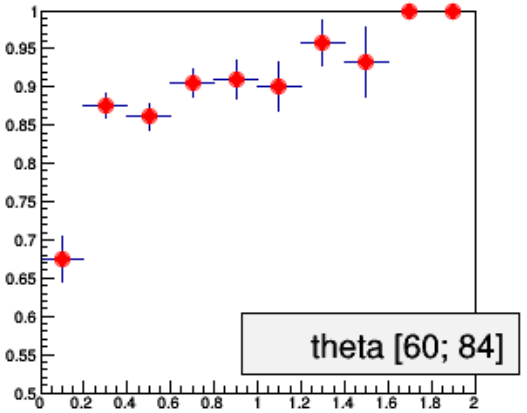


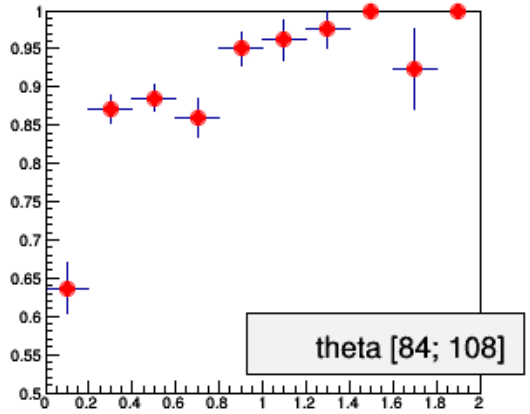
- This method gives similar results
  - But still far from 95% efficiency level
- The method uses assumption that tracks $Z_{vxt} = 0$
  - Efficiency increasing expected after removing this limitation

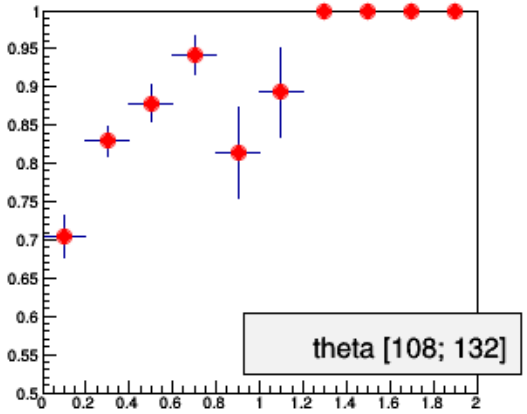
Efficiency vs Pt in bins of polar angle (histogramming)

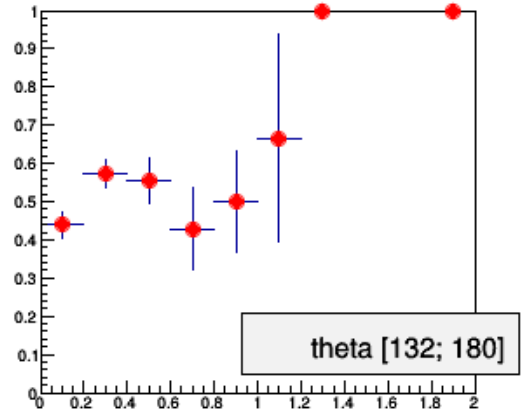










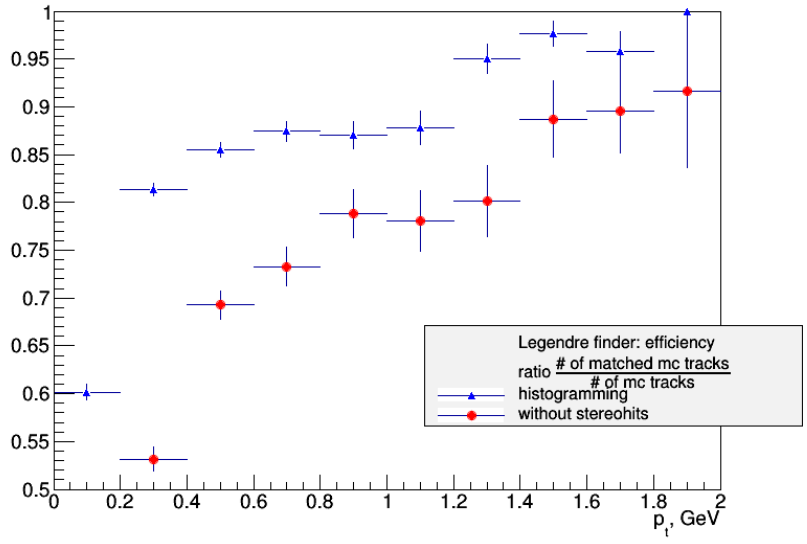


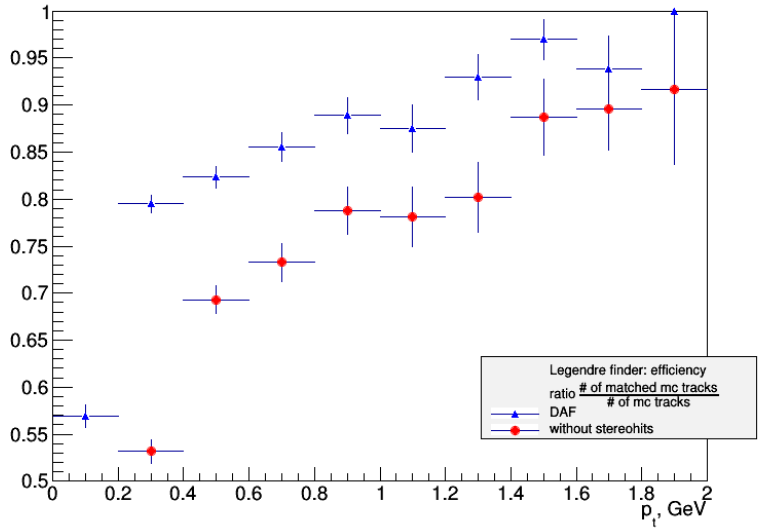
Genfit based stereohits assignment (DAF)

- Involving genfit::DAF into stereohits assignment procedure should increase efficiency and purity
  - It will cost some CPU time – but there will be no need to refit already fitted tracks at later stages

- Main idea:
  - Assigning all stereohits which could belong to the track
  - Process track with DAF
  - Assign correct stereohits basing on fit results (polar angle, Z0) from DAF

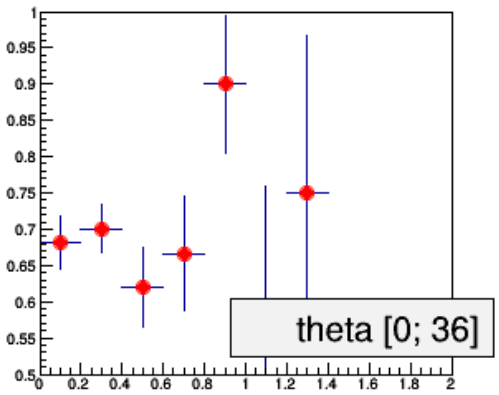
Efficiency of the method (DAF)

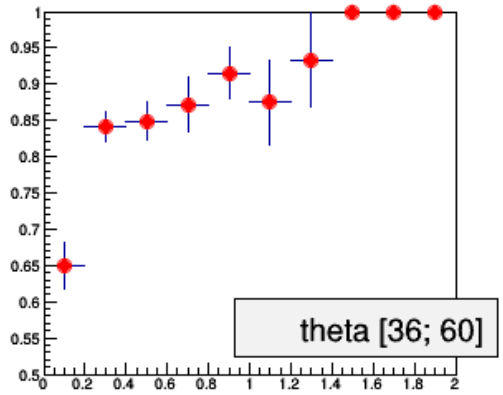


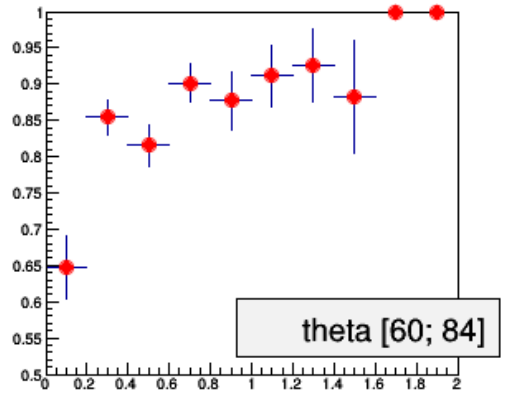


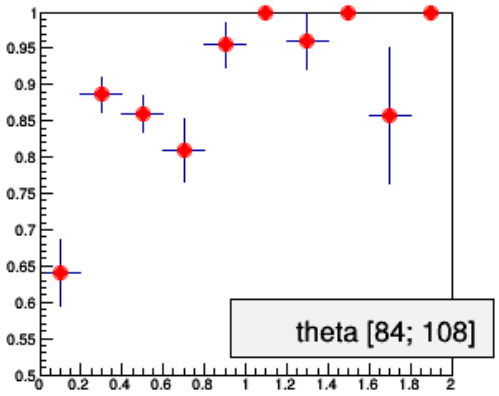
- Efficiency comparable to histogramming method
- Main issue with the method – CPU computing time (approx. x5 than actual track finder)

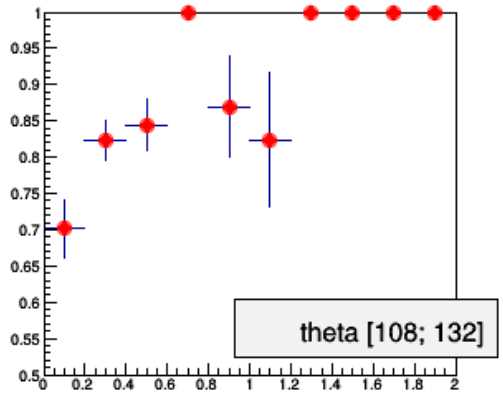
Efficiency vs Pt in bins of polar angle (DAF)

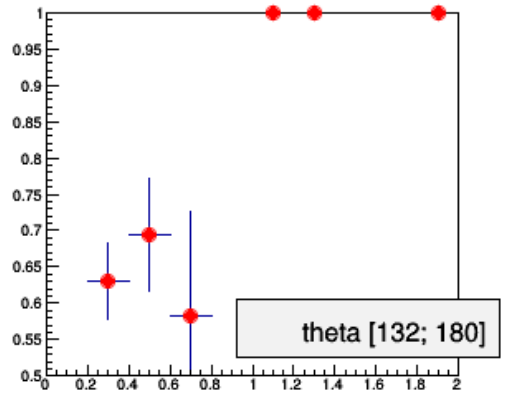




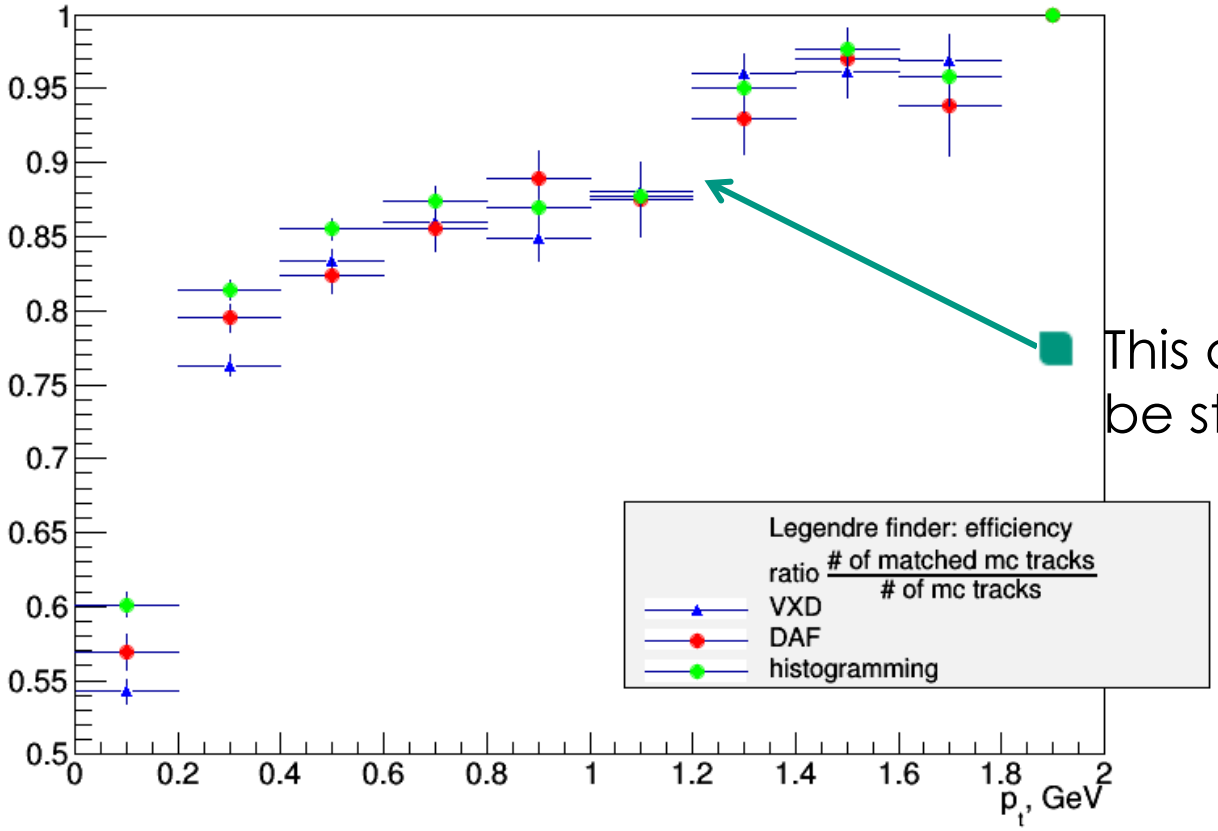








Comparison of 3 stereohits assigners



This drop in efficiency should be studied

- All 3 methods give comparable results
  - Should we use all 3?
  - Which should be main?

Merging with TrackFinderCDCLocal

- Merging of two track finders will allow:
  - to reduce amount of code
  - to make code more understandable and flexible
  - to use common classes
  - and as result to make interaction between CDC tracking modules much simpler
  - and much more…
- I'm starting with integrating hit and track candidate classes from local track finder to legendre track finder
- All legendre-related classes were moved to tracking/trackFindingCDC/legendre

Current status of legendre finder

- QuadTree was modified:
  - Previously: whole quadtree (from root to leaf nodes) was initialized at the beginning of run
  - Now: each event quadtree reinitialized with used nodes only
    - Saving a lot of RAM (~3.4 GB -> 700MB)

- Finder consist of 4 modules:
  - Actual legendre finder
  - 3 stereohits assigners

- New memory leaks were introduced:
  - One reported by Christian (via redmine)
  - Usage of genfit classes should be rewieved…
  - Untracked (yet)

Conclusions

- Few methods of stereohits assignment involved:
  - After tuning all methods showed same results
  - But efficiency level of 95% was not reached yet (with stereohits)

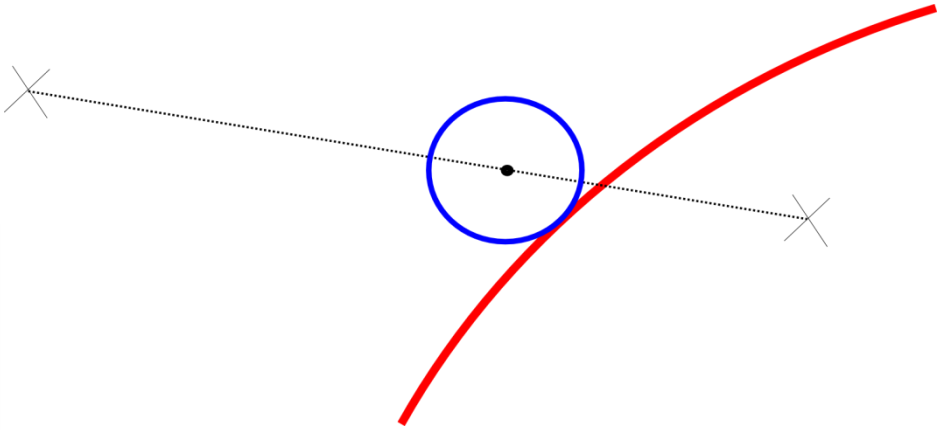
- Merging with TrackFinderCDCLocal has been started
  - … with following refactoring of the code

Thank you for attention!

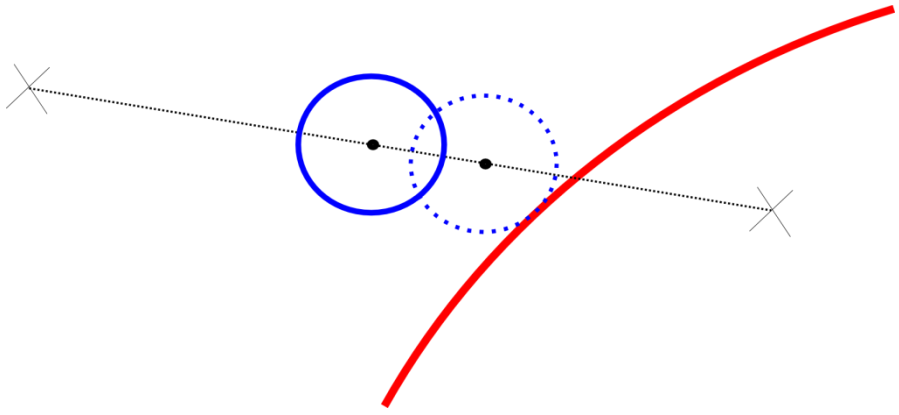
Backup

Stereohits assignment

- As result of Legendre finding we have tracks with axial hits only
  - Our goal is to assign stereohits.
  - Main idea of the method: basing on displacement of stereohits against the track estimate polar angle of the track

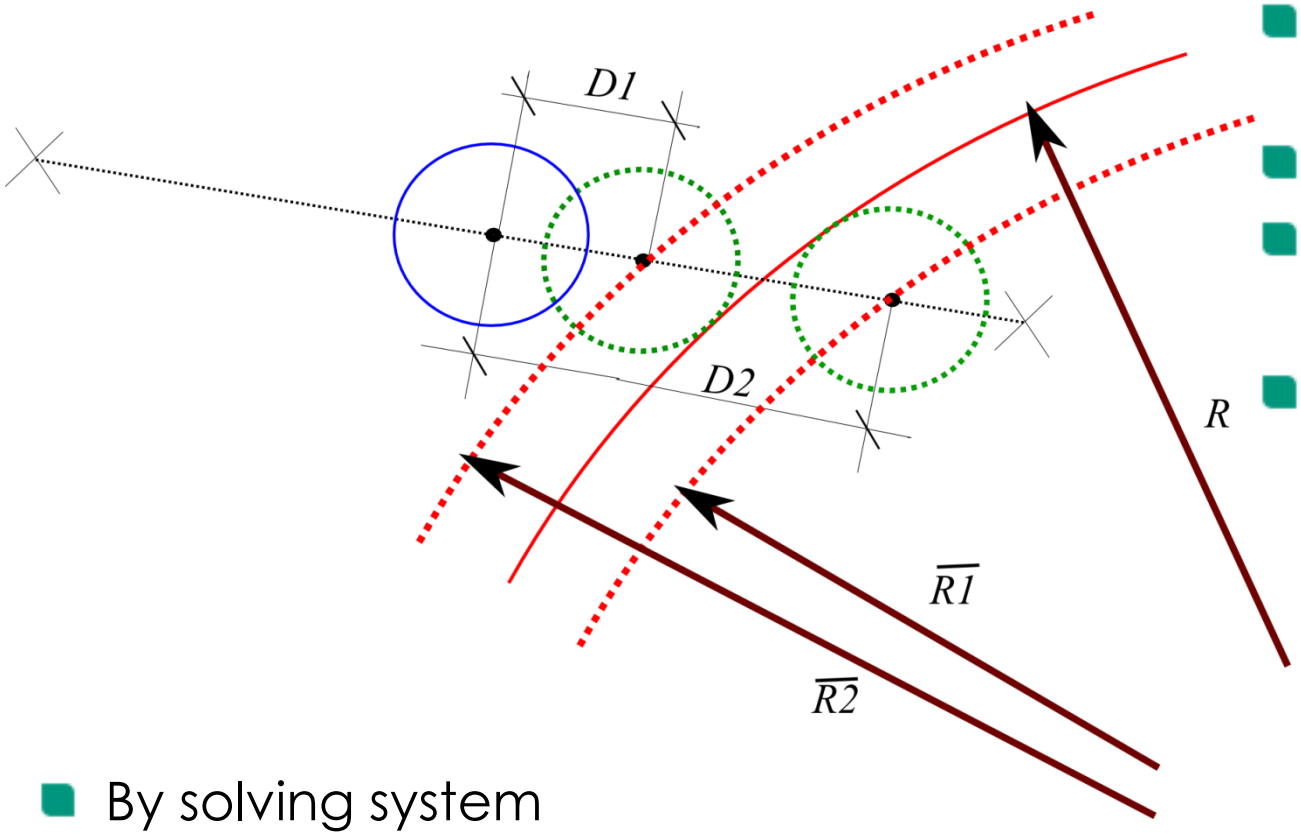


Projection of stereohit hit with its production Z −coordinate



Displacement of stereohit with assumption $Z_{hit} = 0$

Displacement estimation



- R – radius of the track;
- $\overline{R1} = R - driftLenght$
- $\overline{R2} = R + driftLenght$

- We don't know if hit inside or outside of the track, so we have to take into account both possibilities

- By solving system

$$\begin{cases} (x - x_0)^2 + (y - y_0)^2 = \overline{R(1,2)}^2 \\ Ax + By + C = 0 \end{cases}$$

real coordinates $(x; y)$ of hit production could be obtained and displacements $D1$ and $D2$ could be calculated

Z coordinate and polar angle estimation

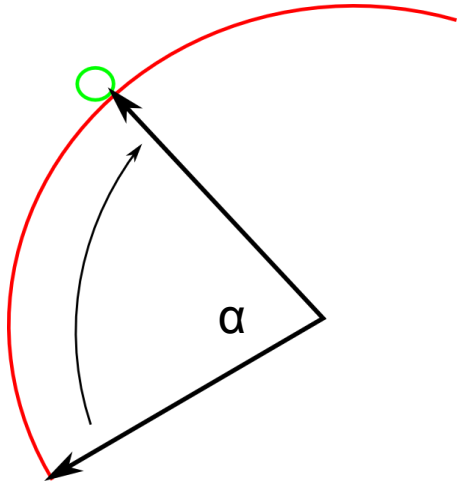
- Z coordinate of hit production could be calculated as

$$Z = D \left. L_{wire_Z} \middle/ L_{wire_{xy}} \right.$$

- If we will move along helical track trajectory with known polar angle then Z coordinate could be expressed

$$Z = \alpha \, R_{cand} \, ctg(\theta)$$

$$\text{where } \alpha = \arccos\left(1 - \frac{x_{hit}^2 + y_{hit}^2}{2 \, R_{cand}}\right)$$



- Hence, we can easily get polar angle λ basing on D (hit displacement) assumption

$$\lambda = \arctan\left(\frac{D \, L_{wire_Z}}{\alpha \, R_{cand} \, L_{wire_{xy}}}\right)$$