Applying Legendre transformation method for Belle II tracking - Update

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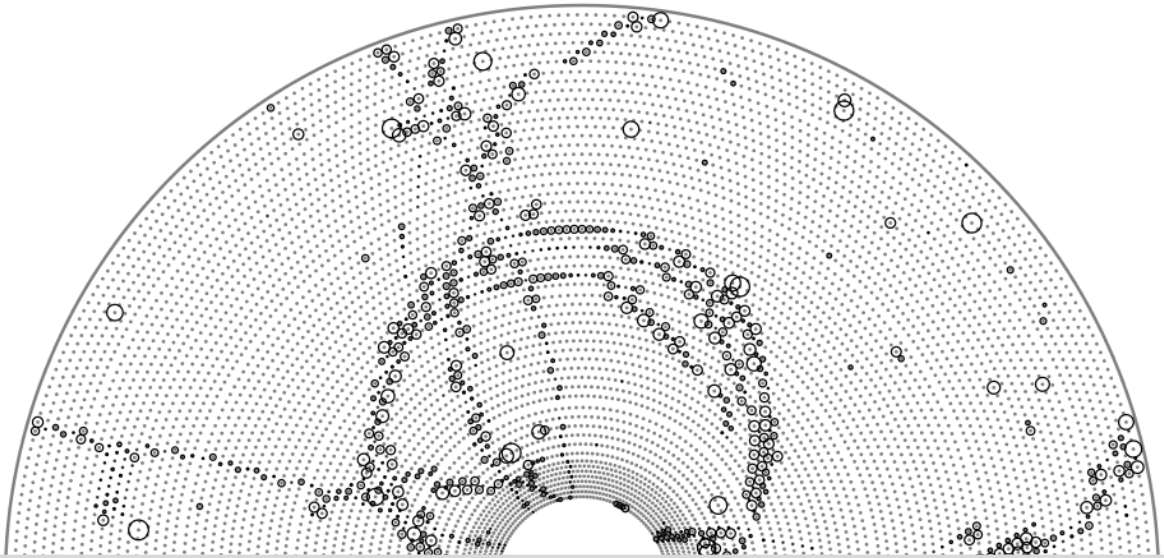
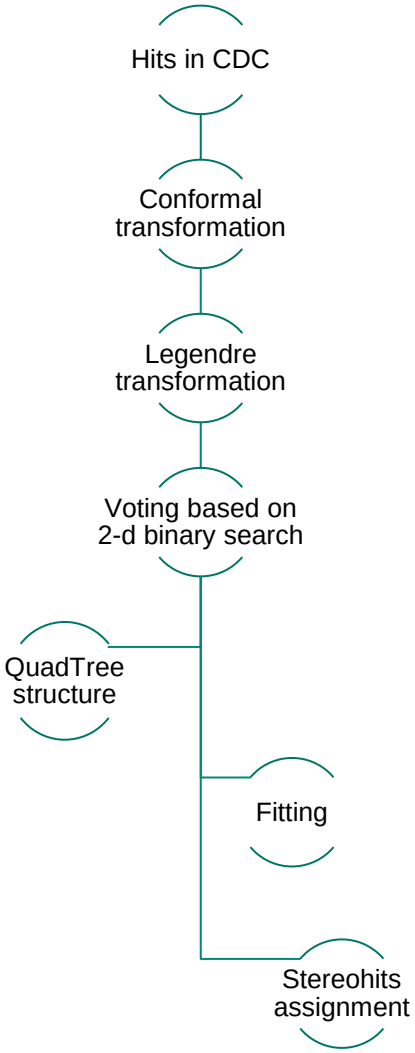
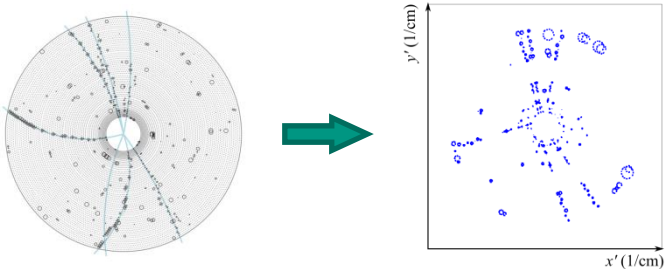
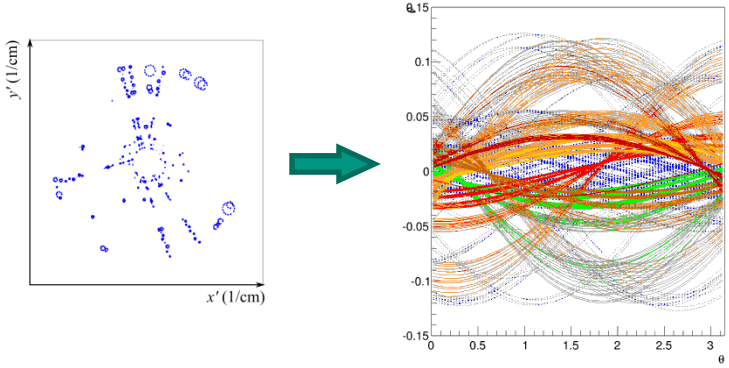
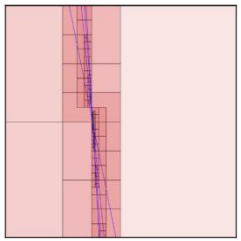


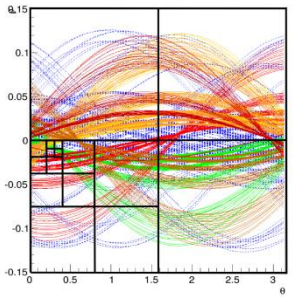
Chain of the method

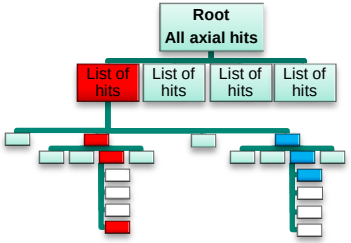












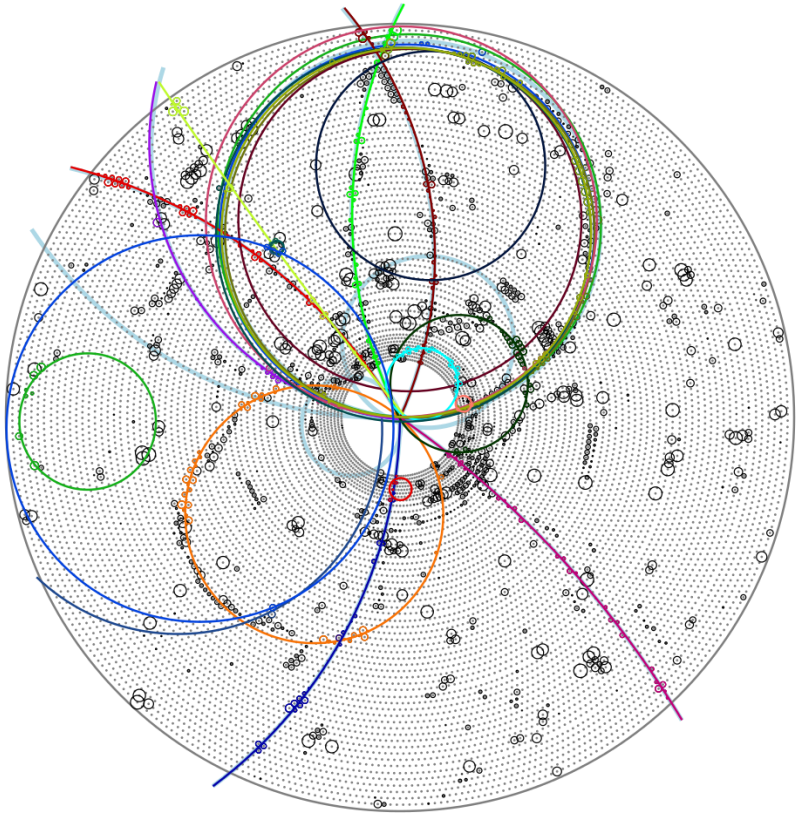
Tracks processing

- After each successful candidate finding:
  - circular fitting procedure applied;
  - unused hit appending to most probable track;

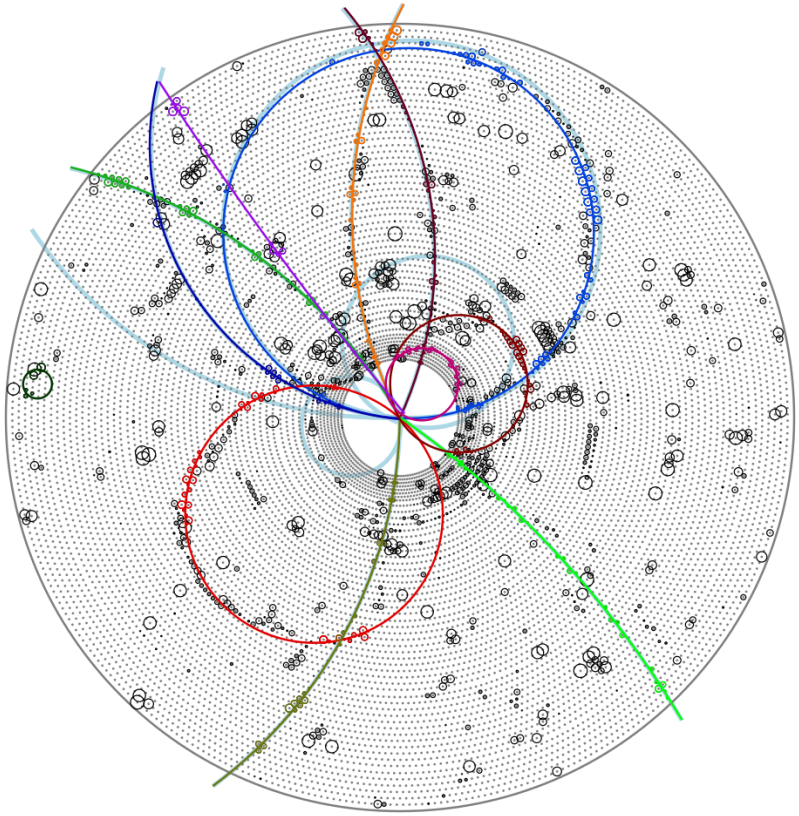
- After finishing pattern recognition with 2-D binary search track merging applied:
  - Based on combination of pairs of tracks ;
  - If two tracks successfully fitted together ($\chi^2/ndf < 1$) tracks are merged into one track

Track merging

- Pair of tracks fitted together by circular fit
- If $\chi^2/ndf < 1$ tracks are merged into one track



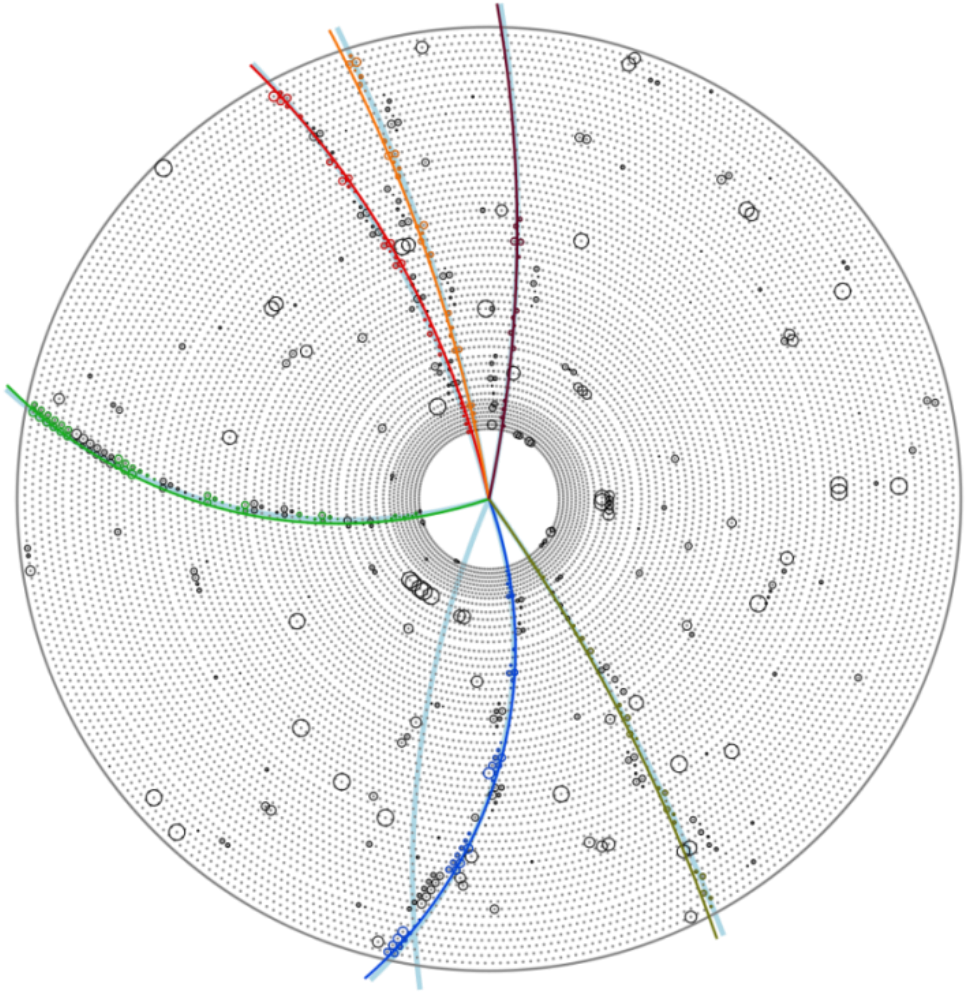
Before



After

Actual results of algorithm

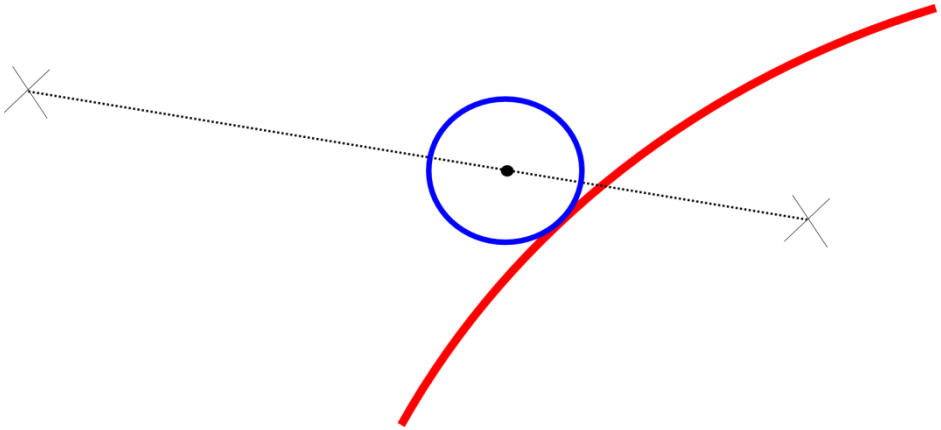
- Simulated event: $B^- \rightarrow D^0(\rightarrow K^- \pi^+)\, \pi^- + \text{beam background}$



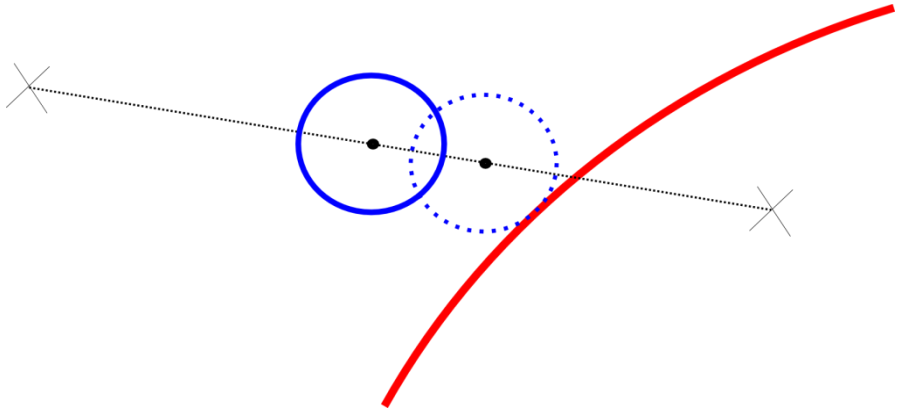
Stereohits assignment

Stereohits representation

- Projections of stereowire, track and produced hit on XY-plane

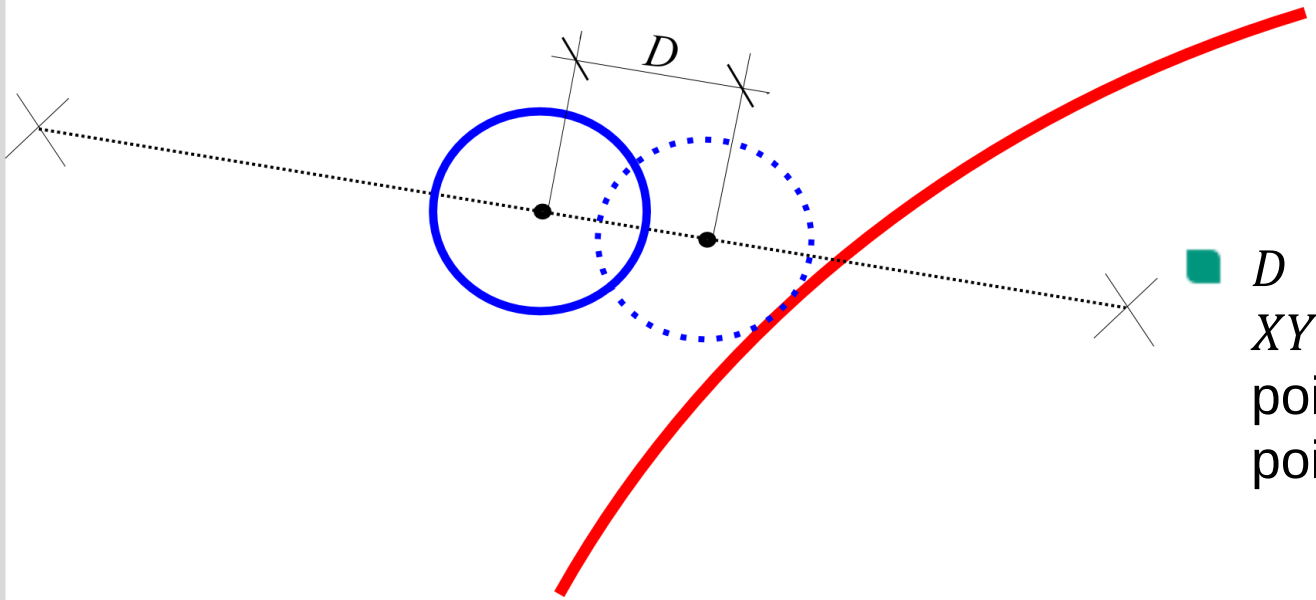


Projection of hit with its production Z −coordinate



Projection of stereohit with assumption $Z_{hit} = 0$ ($\theta = \pi/2$)

How we can estimate Z coordinate?



- D – distance in XY projection between point of hit production and point on wire for $Z_{hit} = 0$

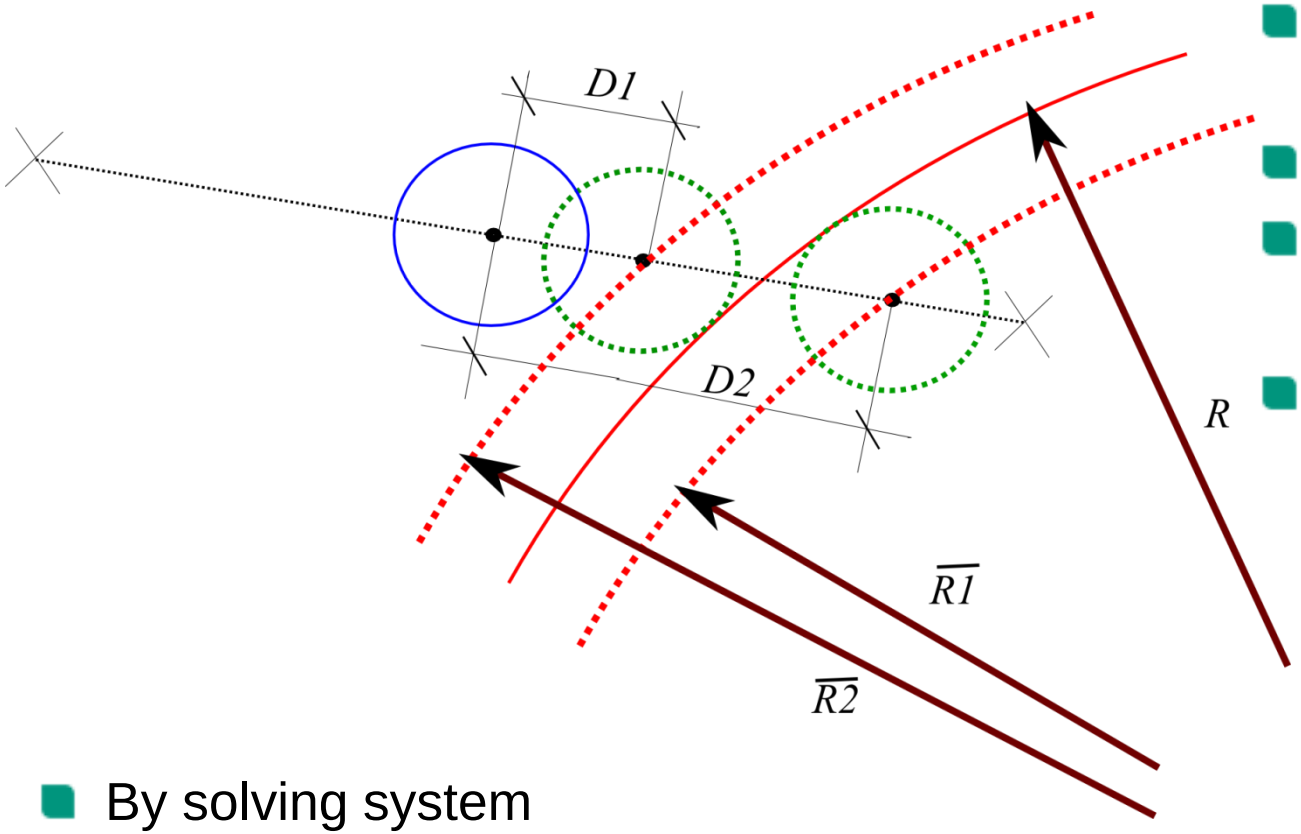
- With formula

$$Z = D \, {L_{wire_Z}}/{L_{wire_{xy}}}$$

we can easily restore Z_{hit} coordinate and polar angle of hit.

- Our goal: correctly estimate distance D

Distance 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

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

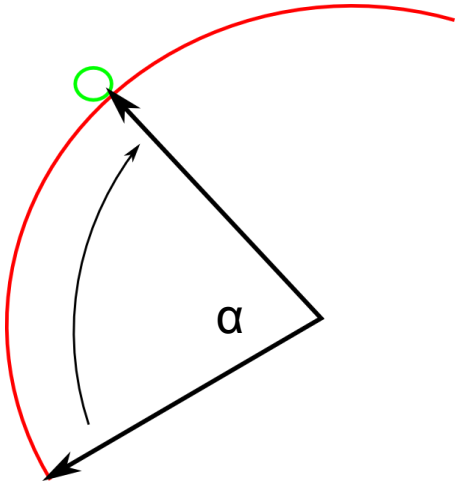
real coordinates $(x; y)$ of hit production could be obrained and distances $D1$ and $D2$ could be calculated

Z coordinate and polar angle estimation

- As was mentioned Z coordinate could be expressed as

$$Z = D \, {L_{wire_Z}}/{L_{wire_{xy}}}$$

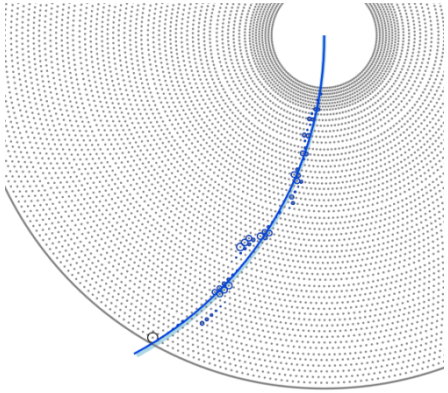
- If we will move along particle trajectory with known polar angle than Z coordinate could be expressed
  - $Z = \alpha \, R_{cand} \, ctg(\theta)$
  - where $\alpha = \arccos\left(1 - \frac{x_{hit}^2 + y_{hit}^2}{2 \, R_{cand}}\right)$
- Hence, we can easily get polar angle θ basing on D (distance) assumption
  - $\theta = \arctan\left(\frac{D \, L_{wire_Z}}{\alpha \, R_{cand} \, L_{wire_{xy}}}\right)$

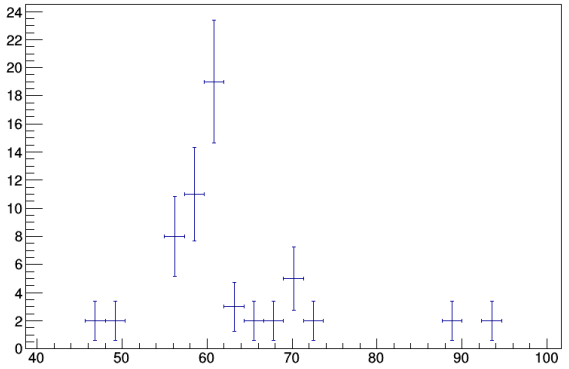


Histograming

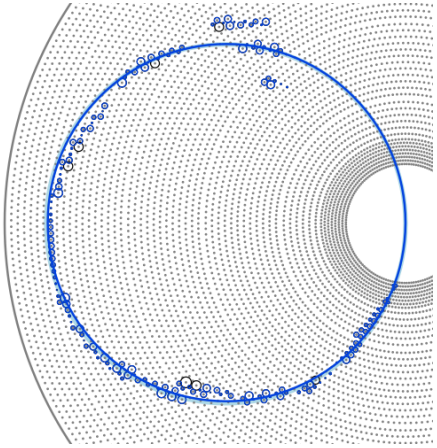
We can fill histogram with all probable polar angles of the track calculated using neighboring stereohits

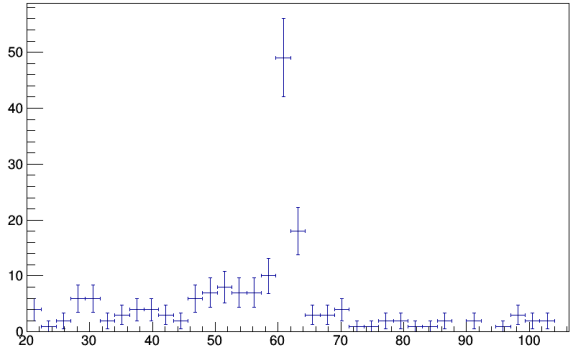
High-pt track
(500 MeV)





Curler
(250 MeV)





Selecting stereohits

- After finding most settled bin its value assigned as a true polar angle of the track

- Next step – inverted task: basing on known polar angle make stereohits assignment which most probably belong to the track.
  - For those purpose we calculate predicted distance D on which hit should move in XY plane with given polar angle

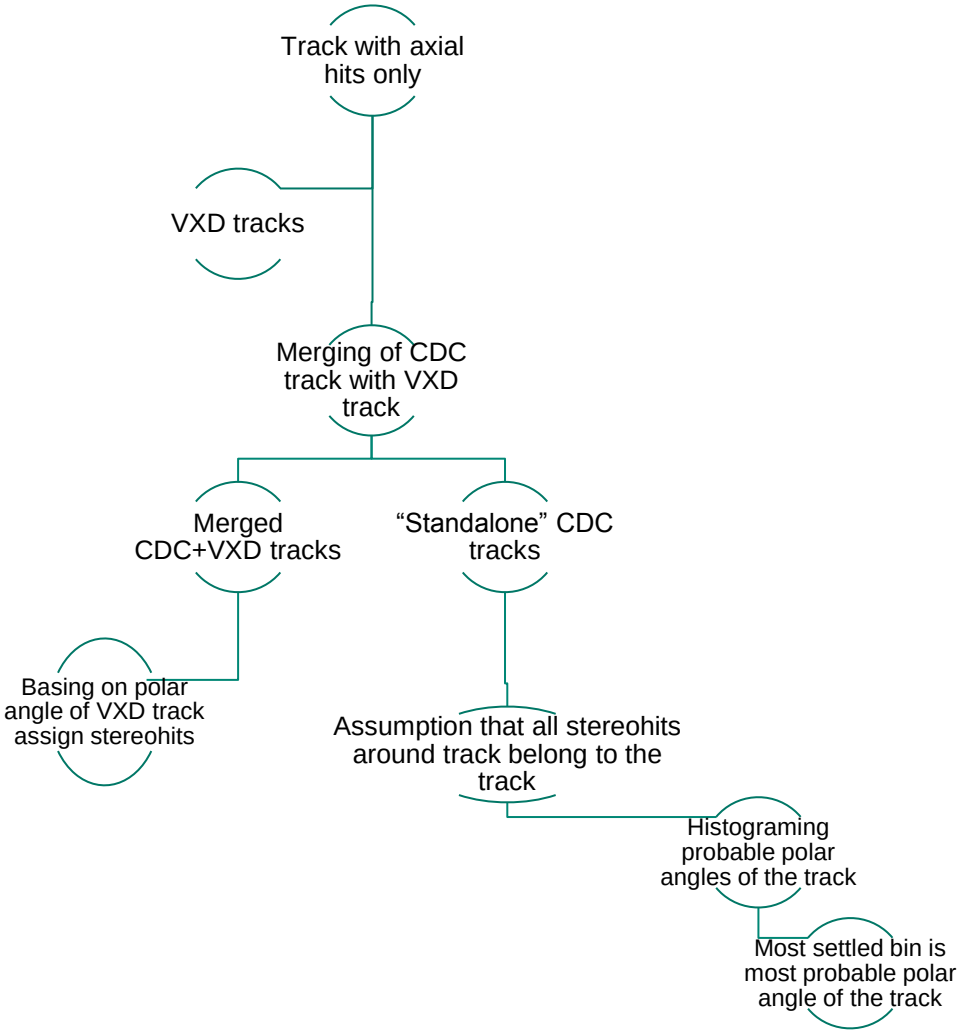
$$D_{predict} = \frac{\alpha\, R_{cand}\, L_{wire_{xy}}}{L_{wire_Z}} \tan\theta$$

  - If predicted distance is comparable to measured for current hit – assign hit to the track

Merging with VXD tracks

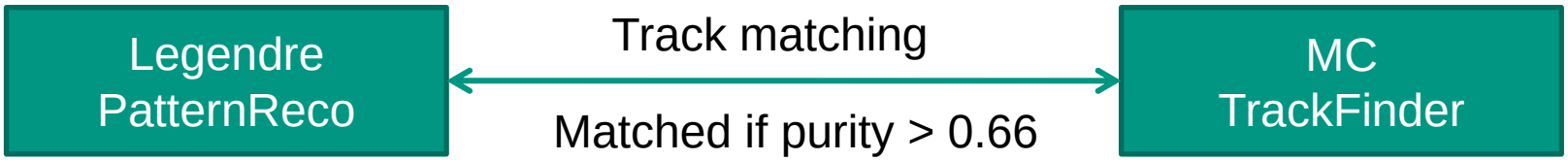
- Main idea – for each CDC track find corresponding VXD track
  - Polar angle of VXD track could be used for further stereohits assignment
- Advantages of the method:
  - More precise polar angle definition than in histograming method
  - Information about VXD tracks available in DataStore, code speed-up
- Weak points:
  - Corresponding VXD track could not always be found
  - Possibility to make wrong combination of CDC+VXD track in events with high multiplicity – *needs to be studied*

Stereohits assignment



Efficiency of the method

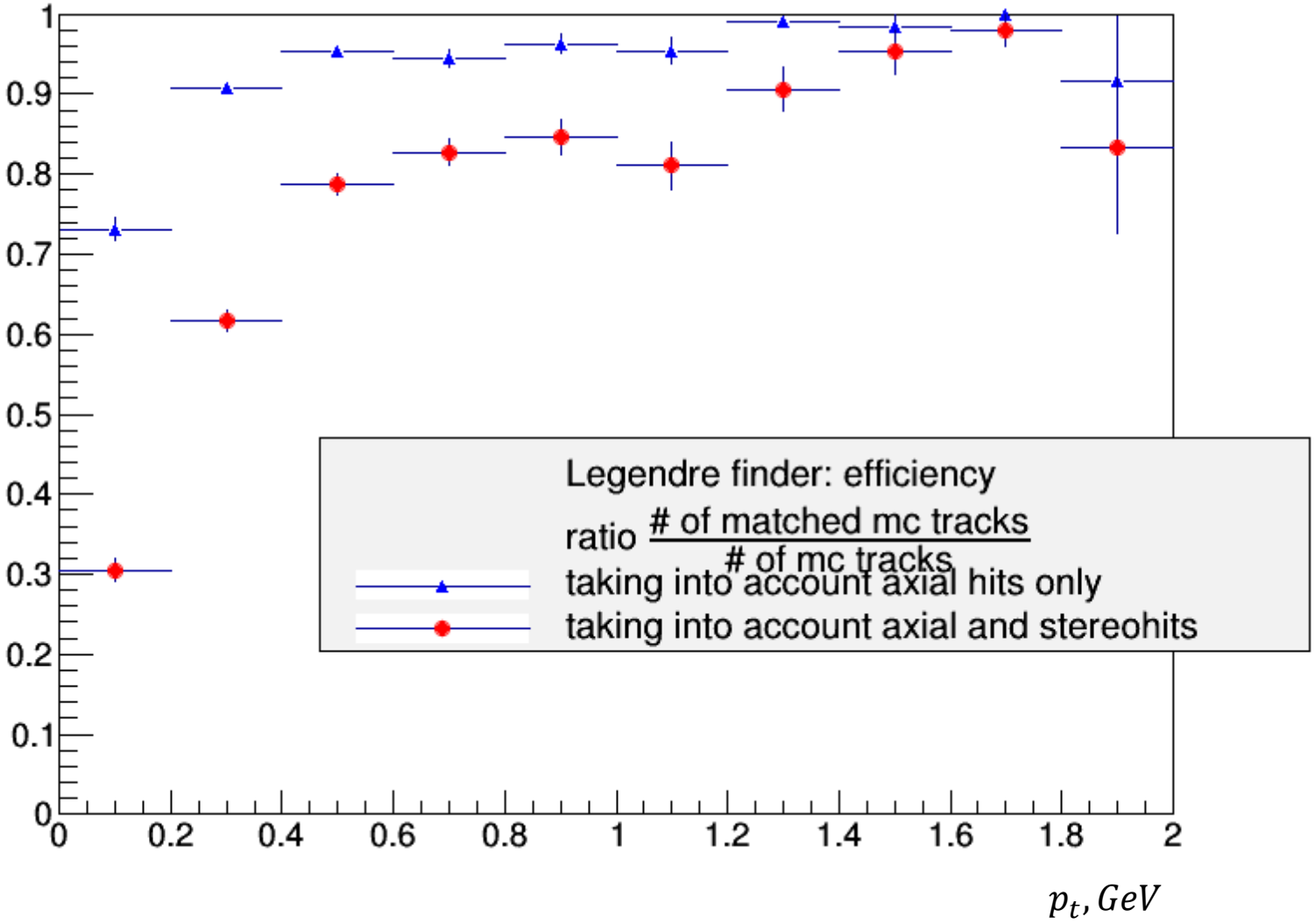
- Efficiency estimation based on Oliver's module *MCTrackMatcher*



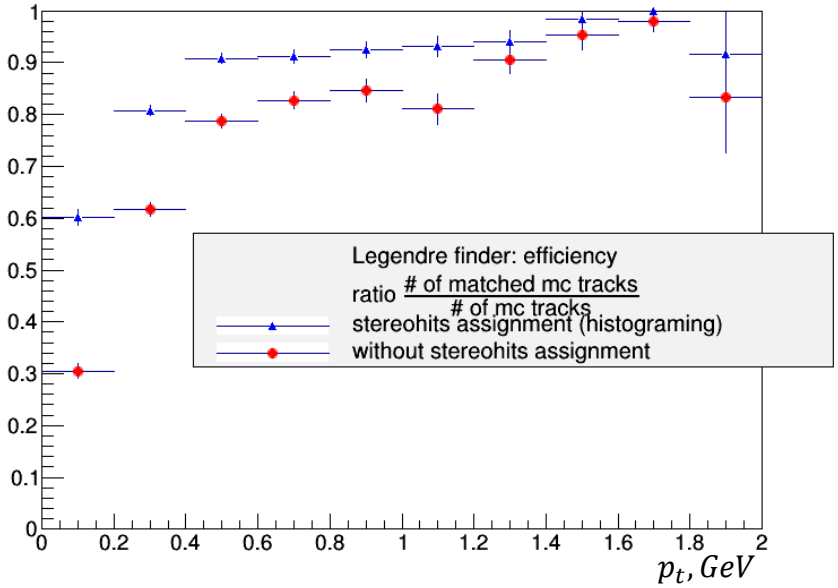
$$\epsilon = \frac{number\ of\ matched\ MC\ tracks}{total\ number\ of\ MC\ tracks}$$

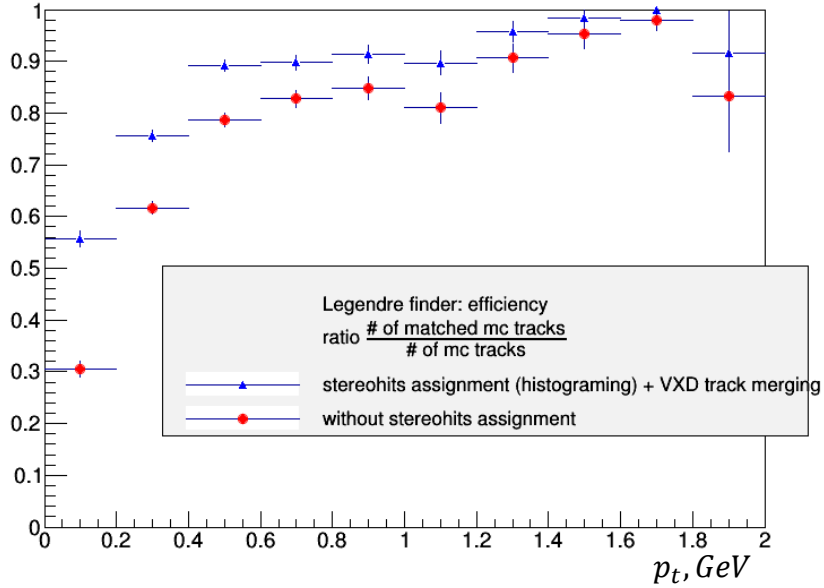
- Efficiency was measured in 2 ways:
  - Taking into account stereohits of RPTracks and MCTracks
  - Taking into account only axial hits of RPTracks and MCTracks

Efficiency (before stereohits assignment)



Efficiency (with stereohits assignment)





- There is no significant improvement in efficiency while using both methods of stereohits assignment.
  - VXD track merging and hits assignment should be improved

Conclusion

- First steps into stereohits assignment were done
- There is still issues with correct polar angle estimation
- For tracks with $p_t > 400\ MeV$ efficiency of 90% was hited!
  - But still it should be better

Thank you for attention!