Karlsruhe Institute of Technology

CDCTrackFinderLegendre

F2F Tracking meeting prague
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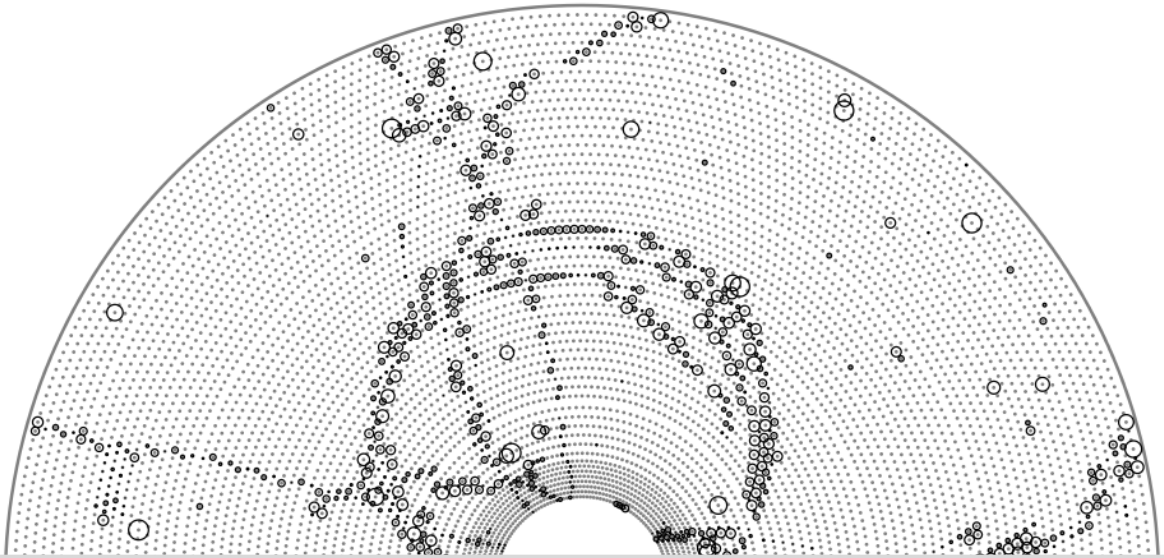


Outline

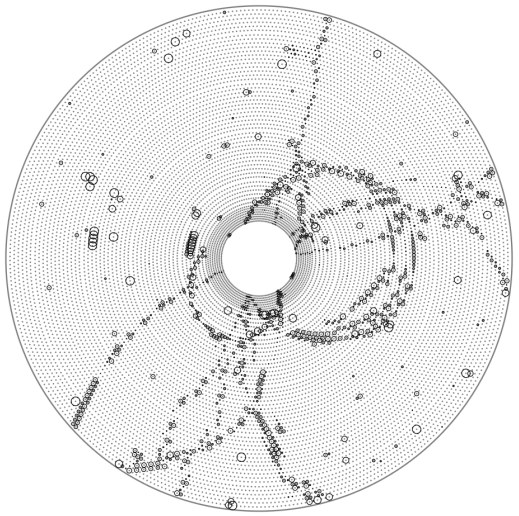
- Introduction
- Legendre transform
- Voting
- Track reconstruction
- Stereohits assignment
- Plans & conclusion

Introduction

- We need high efficient tracking for gathering as much as possible useful information about particles in events.

- In general LegendreFinder based on conformal transformation of the hits with further finding of common tangents to the hits.

- Algorithm based on article "*Implementation of the Legendre Transform for track segment reconstruction in drift tube chambers*" (Nuclear Instruments and Methods in Physics Research A 592 (2008) 456-462)



Conformal transformation

- Conformal transformation:

$$x' = \frac{2x}{x^2 + y^2}$$

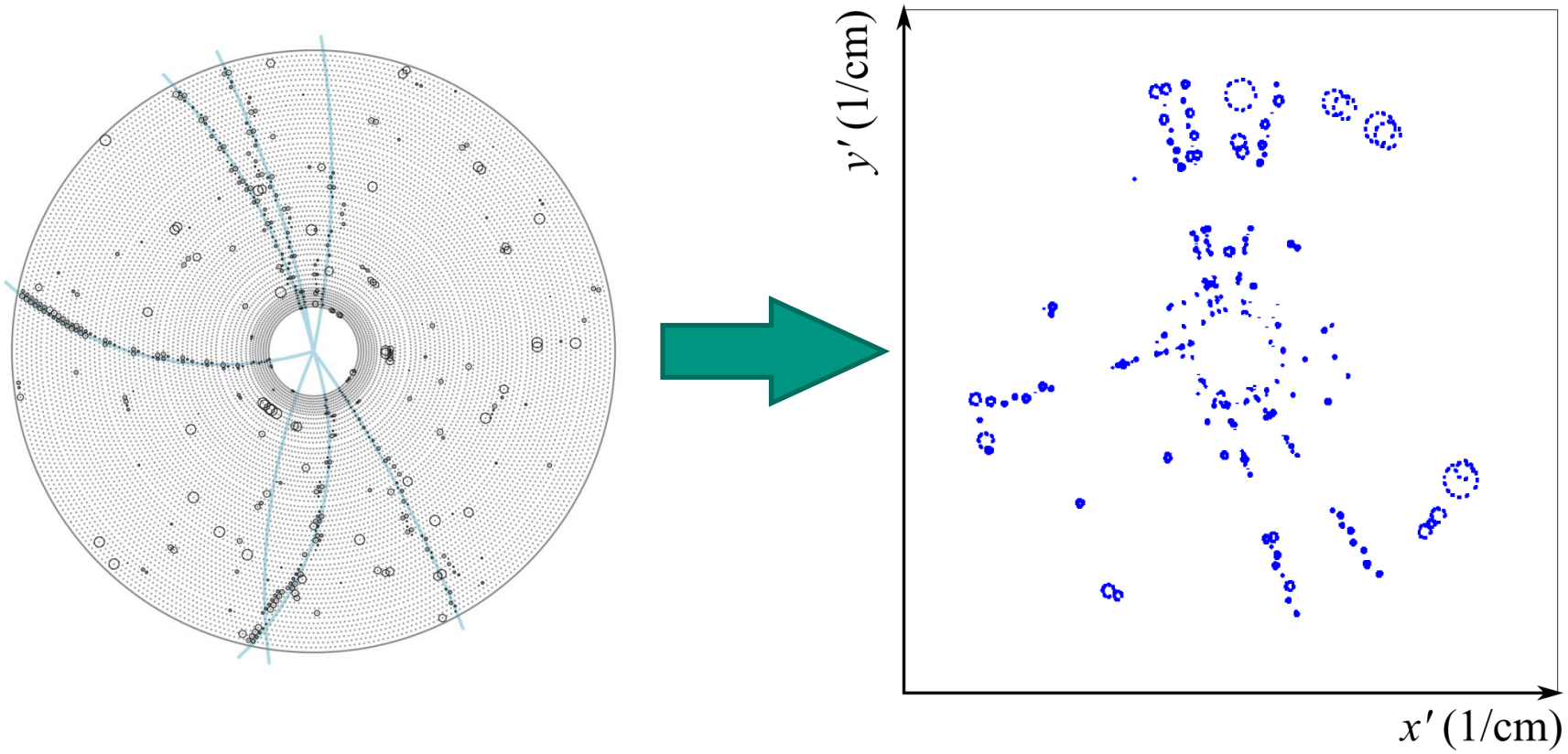
$$y' = \frac{2y}{x^2 + y^2}$$

- After applying this transform circles trough origin become lines, and circles with coordinates (x_0, y_0) and radius r become circles with radius

$$r' = \frac{2r}{x_0^2 + y_0^2 - r^2}$$

Conformal transformation

- Applying conformal transform to event:

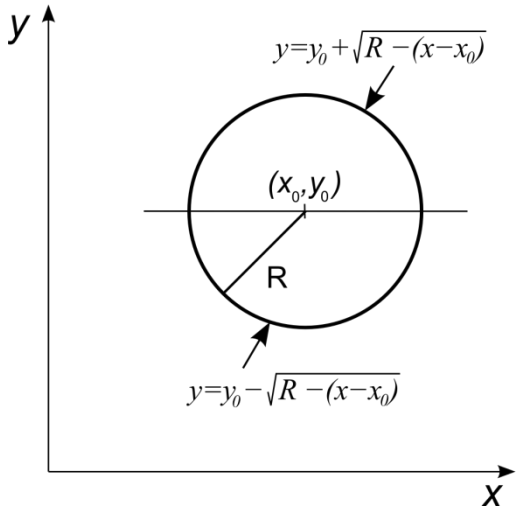


Drift circles representation

- Each drift circle can be presented as:

$$f(x) = \begin{cases} f_1(x) = y_0 + \sqrt{R^2 - (x - x_0)^2} \\ f_2(x) = y_0 - \sqrt{R^2 - (x - x_0)^2} \end{cases}$$

- Algorithm is based on applying Legendre transformation to each drift circle in conformal space

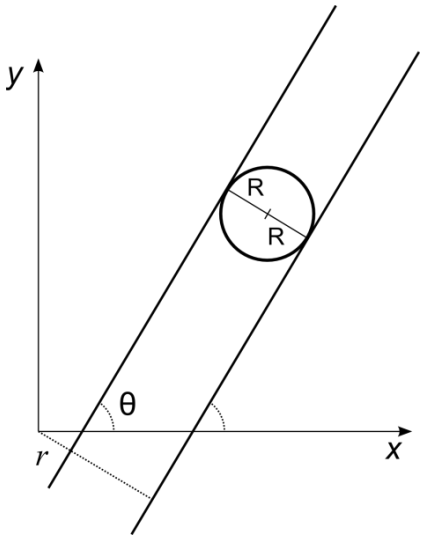


Transformation into Legendre space

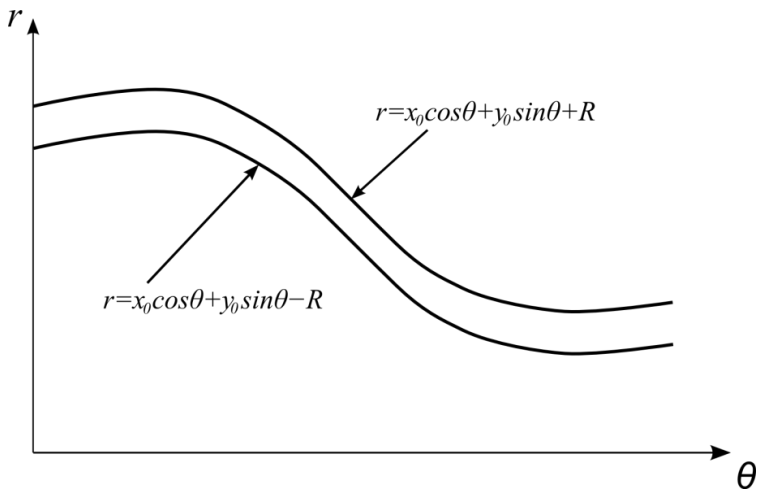
- Legendre transform of the circle can be written in next form:

$$f(x) \overset{\mathcal{L}}{\leftrightarrow} \begin{cases} r = x_0 + \cos\theta + y_0 \sin\theta + R & \text{for concave} \\ r = x_0 + \cos\theta + y_0 \sin\theta - R & \text{for convex} \end{cases}$$

which presents tangents to the circle



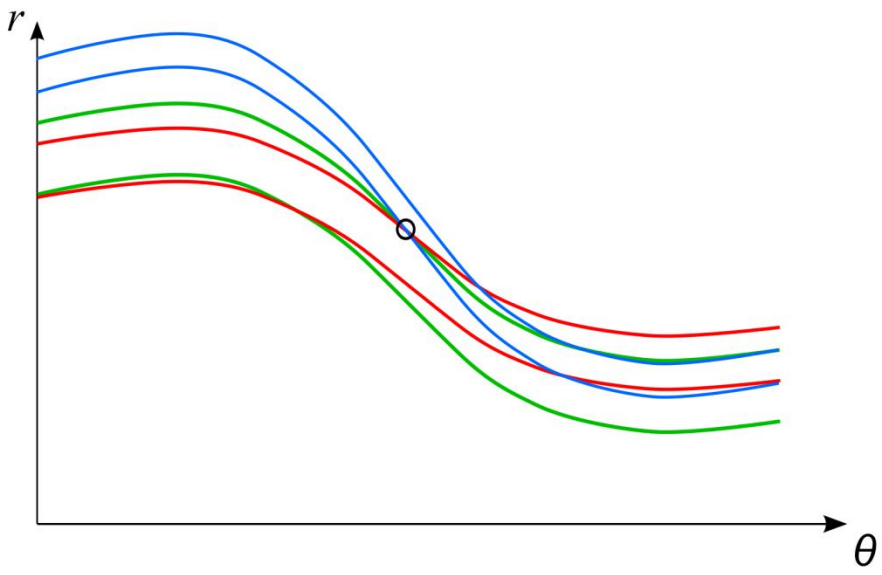
- Representation of the circle in the r, θ Legendre transformation space

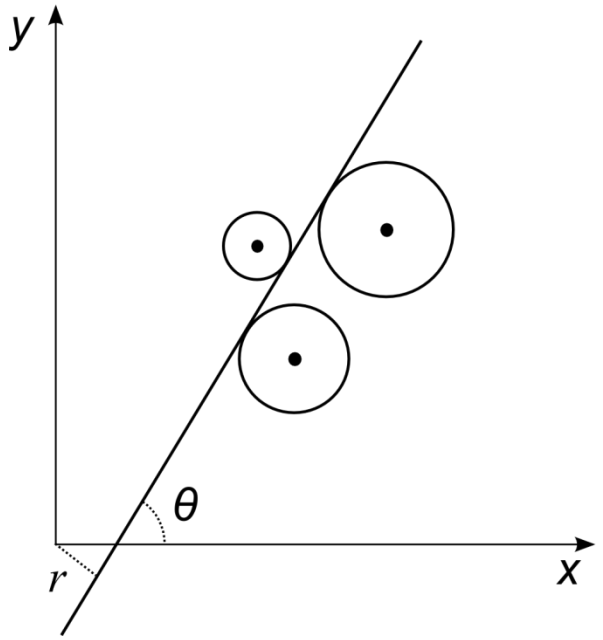


Finding of tracks

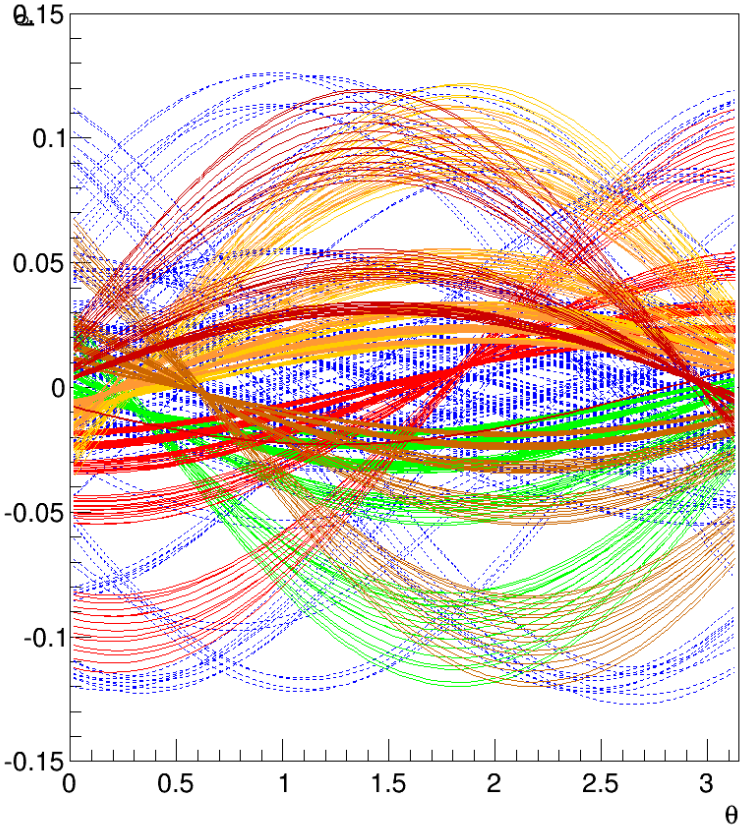
- The point of sinogram intersection in r, θ space represents the common tangent to the drift circles in conformal space

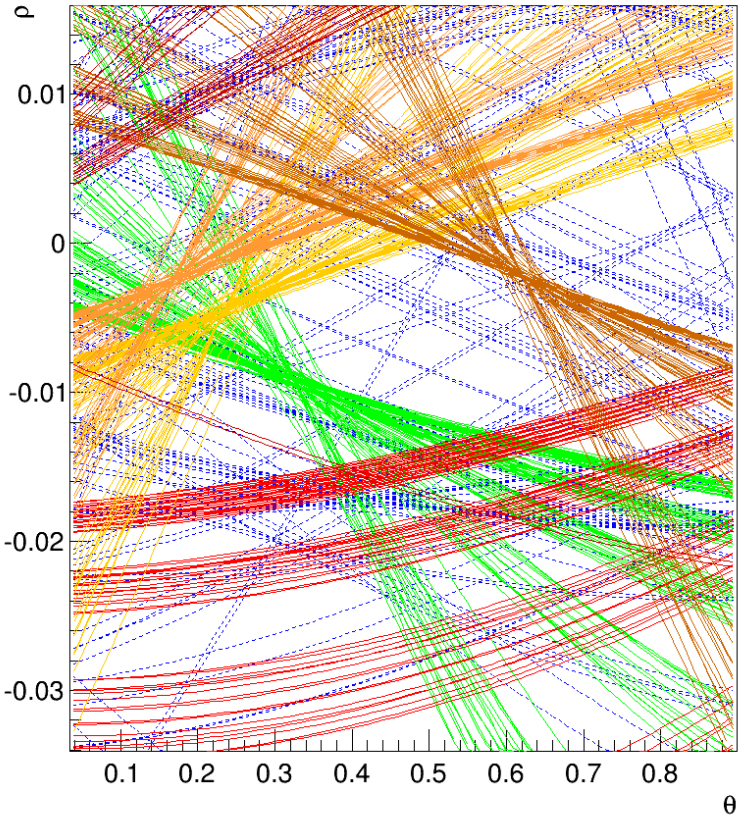
- Most contributing point defines equation of most common tangent





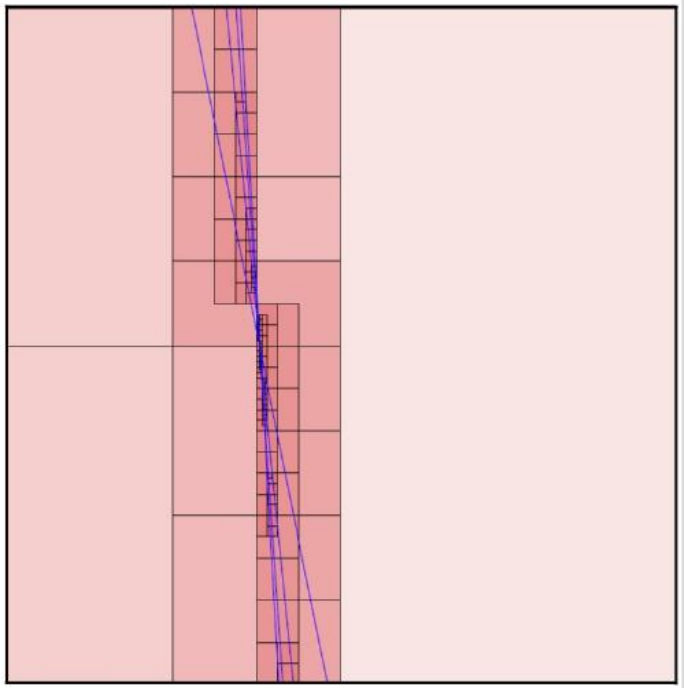
Sinograms of simulated event



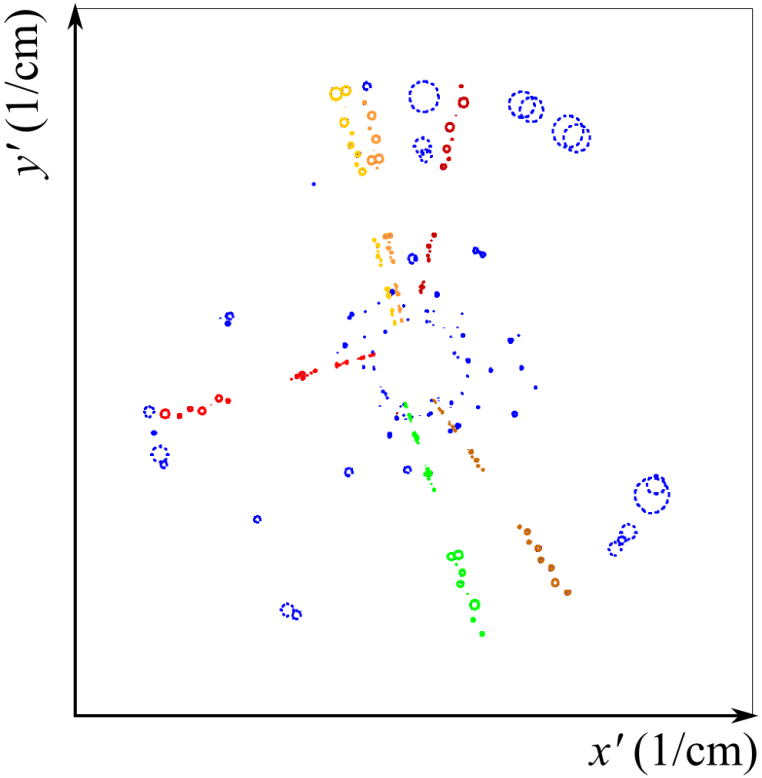


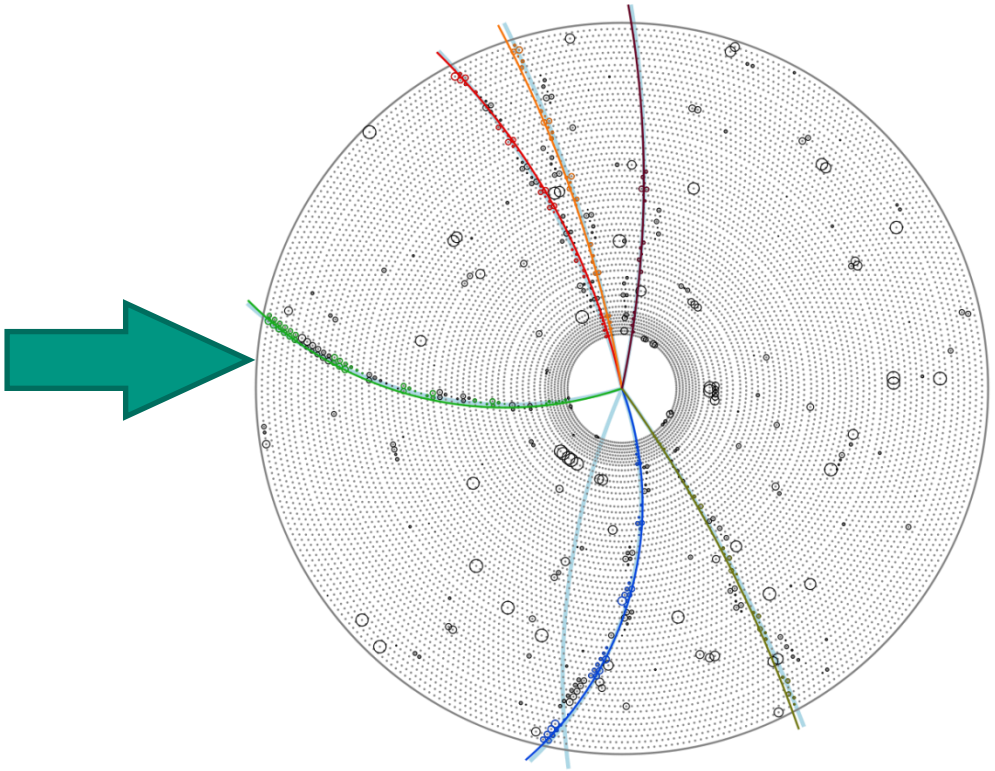
Voting

- Voting algorithm uses dividing (r, θ) space into 4 bins
  - Find most settled bin – it must reach predefined threshold
  - It should contain most common tangent to hits set
  - Recurrently repeat bin dividing and voting until desired (r, θ) resolution reached
- Candidate with higher number of hits and which passing nhits threshold is selected
- After finding candidate – remove its assigned hits from hits collection and repeat search again



Actual results of algorithm



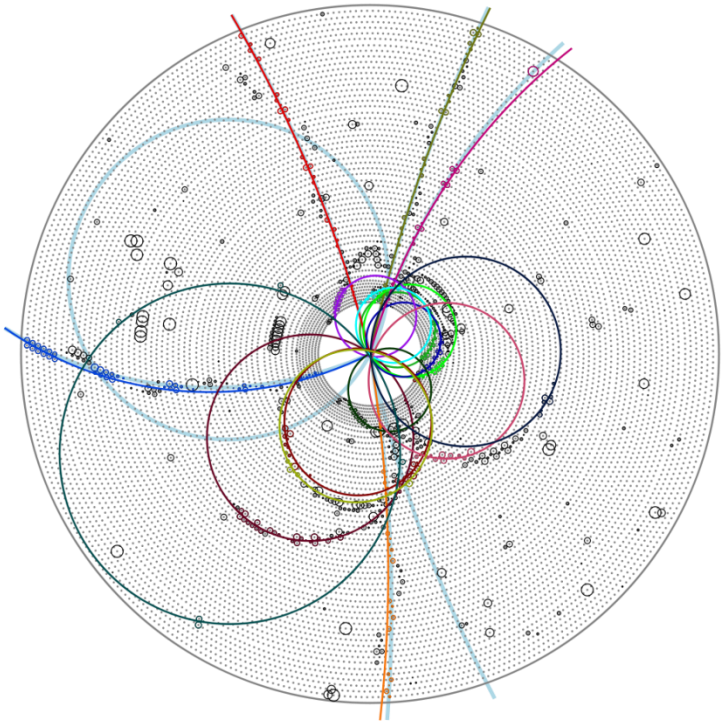


CDCTrackFinderLegendre: strengthens and weakness

- Working only with tracks originating from IP
- Algorithm working only with axial hits – stereohits used for theta angle definition only
- Efficient for finding tracks with high momentum
- Too time consuming for events with huge amount of hits

CDCTrackFinderLegendre: strengthens and weakness

CDCTrackFinderLegendre



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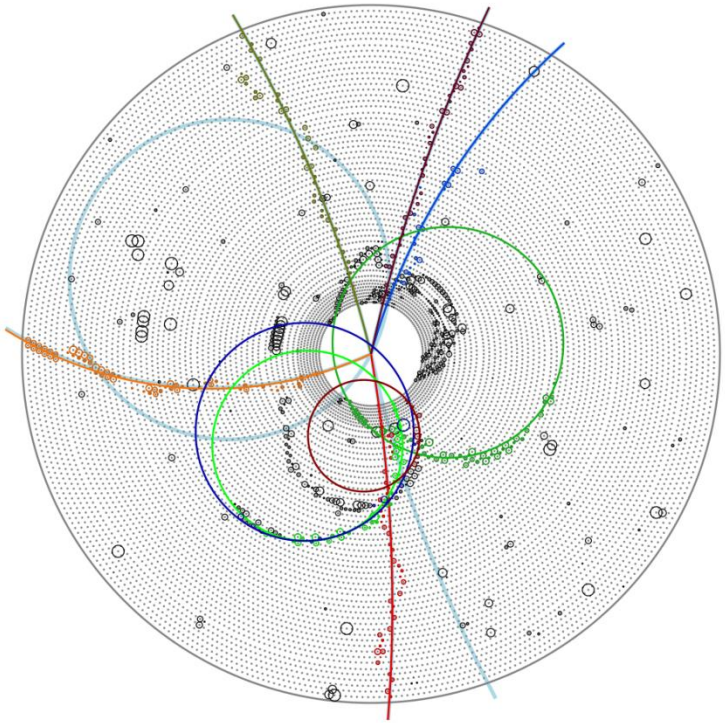


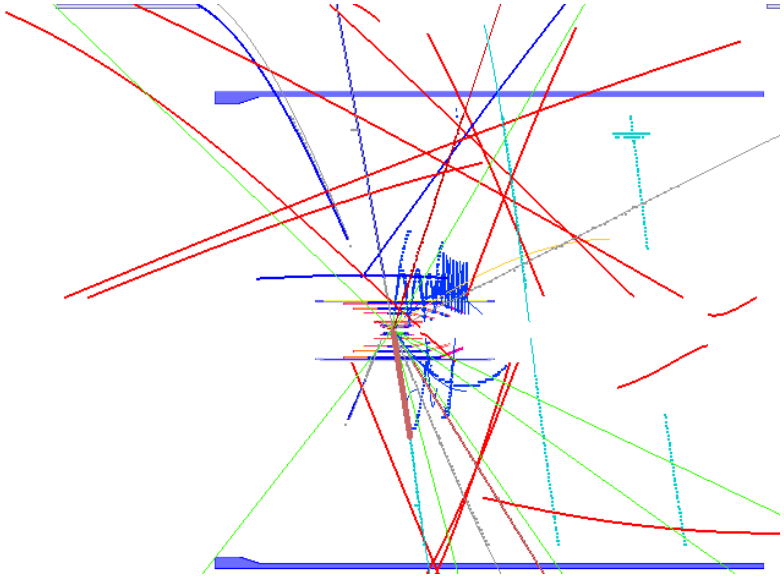
- Legendre finder works pretty well even for low p_t tracks
- But trying to reconstruct non-IP tracks with few track segments

Stereohits assignment

- Next algorithm of stereohits assignment implemented currently:
  - Minimize distance between stereohit and track candidate with 1-D fitting procedure
  - Hit is assigned to the track with the smallest distance
  - For each track candidate select only those stereohits which give smallest error after z-momentum estimation

Stereohits assignment

- Procedure working quite well, but sometimes may give some unexpected results:



- In November developing of stereohits assignment algorithms has been dedicated to Kyiv group (Volodymyr Aushev, Rostislav Shevchenko)

CDCTrackingFinderLegendre: plans

- Voting procedure optimization:
  - Allowing bin overlapping when reaching limit – in progress
  - Check effects of less steps in higher r region – first implementation has been done, together with bin overlapping finder became more efficient for low p_t tracks
- Implementing fitting procedure – in progress
- Blob analyzer
- Stereohits assignment – in progress
- Quality criteria introduction

Conslusions

- CDCTrackingFinderLegendre can perform fast track finding
- Works quite good with high-p_t tracks
- Limited to tracks originating from IP

Thank you for attention!