Status of simulation

Background study ($p\bar{p} \to \pi^+\pi^-$ and $p\bar{p} \to K^+K^-$)
New algorithm for track-finder

Anastasia Karavdina

KPH, University Mainz

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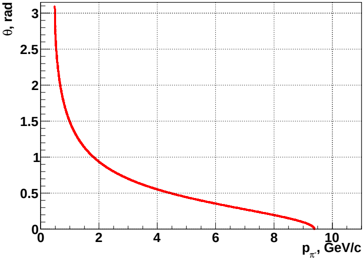
Outline

- $p\bar{p} \to \pi^+\pi^-$ and $p\bar{p} \to K^+K^-$ (simulation in phase space)
  - Description of simulation
  - Results (and comparison with $\bar{p}$ signal)
- Cellular Automaton as Track Finder
  - Introduction in Algorithm
  - Toy simulation
  - Implementation in PANDAROOT and results

Background study: $p\bar{p} \rightarrow \pi^+\pi^-$

Simulation with **EvtGen**:
PHSP(phase space model)
P_{beam} = 8.9 GeV/c, $\theta \in$(0,π) rad, $\phi \in$(0,2π) rad.
10^6 events

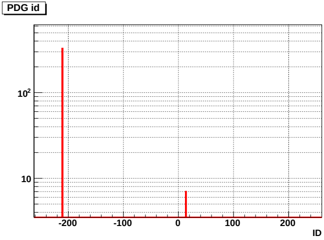


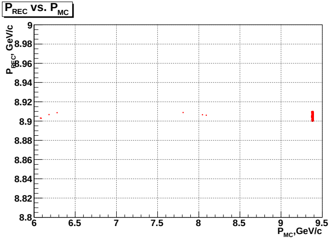
track-candidates:
789
after cuts for $(\theta, \phi)_{trk-cand}$:
334 (0.03%)

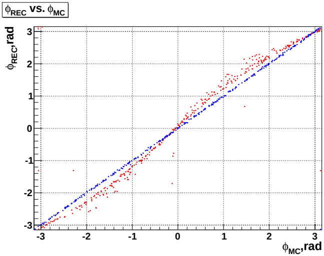
In back-propagation usual assumption for particle is used ($\bar{p}$ and $P = P_{beam}$)

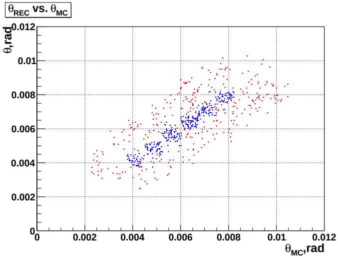
Results

Most of reconstructed particles are π^- (4 tracks from μ^-)

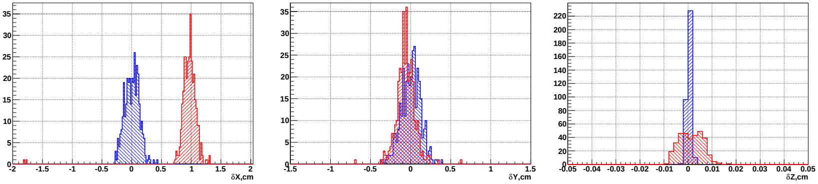








Comparison results for $\bar{p}$ & π^- signal



Distribution for π^-:
shifted in X-coordinate and wider in Z-coordinate, but for Y-coordinate looks similar to $\bar{p}$ distribution.

Correct study for nonpoint-like beam is needed!
(Include beam/target size and beam emittance)

Conclusion

- $p\bar{p} \to \pi^+\pi^-$ and $p\bar{p} \to K^+K^-$ were simulated with EvtGen(**PHSP**)
- Due to wrong assumption for back-propagation (particle momentum) is possible distinguish such background from signal (for point-like beam)

Plans

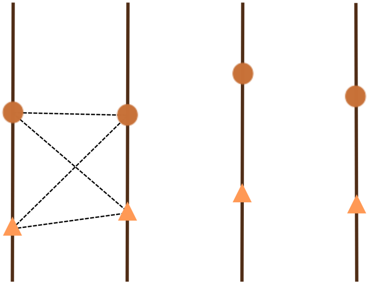
- Model for real cross-section is needed (generator $p\bar{p} \to \pi^+\pi^-$: M. Zambrana & D.Khaneft)
- Study with beam structure

Cellular Automation as a Track Finder

- A cellular automation for track search successfully used for HERA-B experiment at DESY and as algorithm for hardware trigger for CBM experiment at GSI.
- Authors claim high speed and stability of this algorithm in comparison to any other simple algorithms of track searching.
- Aim of this study:
  - Check it for our case
  - Compare cellular automation with standard track finder for the luminosity monitor

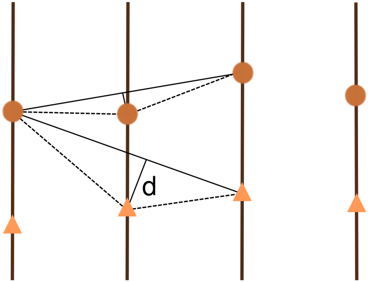
Cell

- Cell is a segment connecting two hits in neighboring layers. For taking into account inefficiencies (dead strips and so on) one can build cell skipping over one layer.



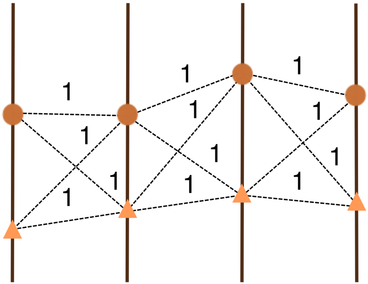
Neighbors

- Cells with common point can be considered as neighbors. (track is a straight line -> additional requirement for bend angle of track line in middle point between two cells)



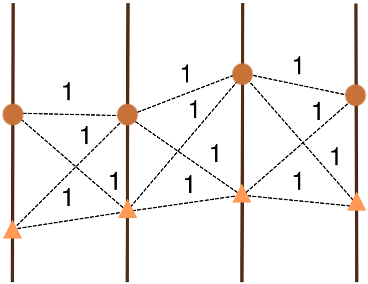
Instead of minimal bend angle -> requirement for distance between common point and line between extremities of cells (d_{max}).

Position value of cell



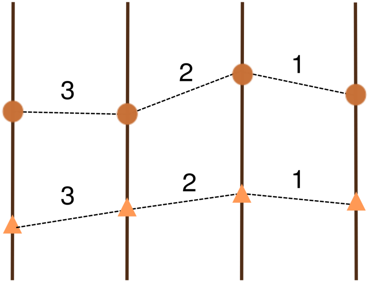
During evolution position value (**pv**) (an integer number) for each cell characterize its position on the track.
In the beginning all cells have **pv** equal 1.

Position value of cell



In each step of evolution cell looks on neighbors in the previous layers and increase its **pv** by unit one if there is neighbor with the same **pv**.

Position value of cell



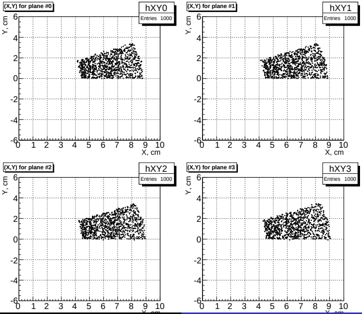
The evolution stops if there is no more neighbors with the same **pv**.

- All cells changing their states simultaneously.
- Track candidates are build from cell with the highest **pv**, adding its neighbor with (**pv**-1) and so on.

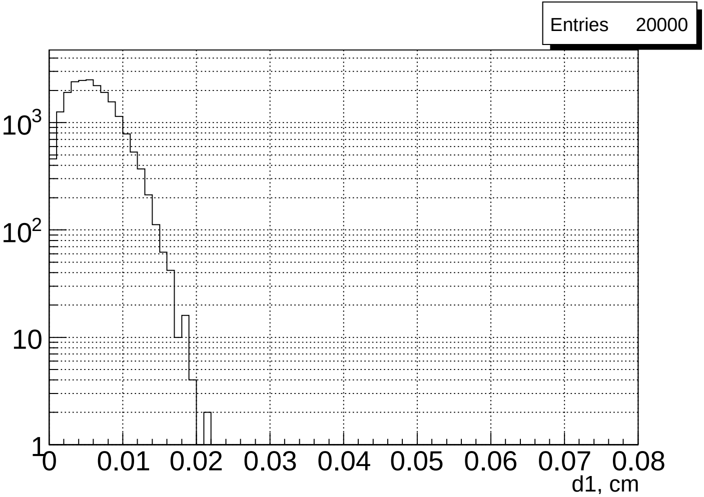
Test with Toy Simulation

(conditions close to real design of the luminosity monitor)

- Tracks start from point (0,0,0) with uniformly distributed angles $\phi \in (0, 20^\circ)$ and $\theta \in (0.23^\circ, 0.45^\circ)$
- Hits are build at z = 1100, 1110, 1120, 1130 cm.
- For taking into account multiple scattering effect each hit has different error respectively to plane position (σ={10, 31, 71 or 119} μm)



Determination d_{max}



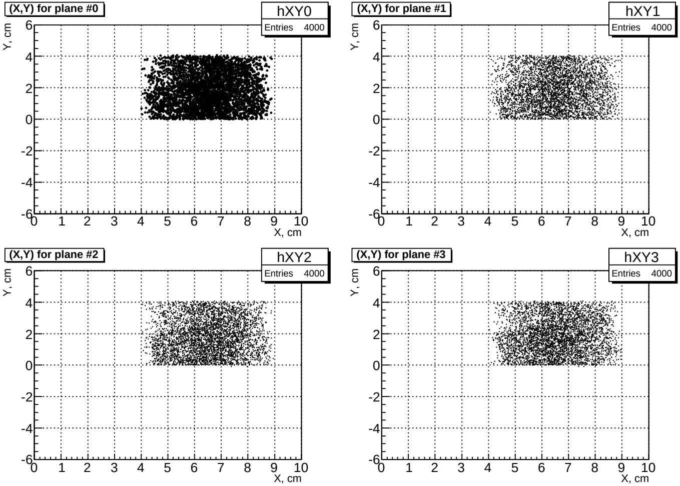
It's reasonable to set d_{max} = 20μm.

Efficiency

N_{trk}	N_{rec}	%(of total)	N_{good}	%(of total)
1	1	100	1	100
5	5	99.1	4	0.9
			5	98.2
	6	0.1	4	0.1
	7	0.1	4	0.1
	8	0.2	4	0.2
	9	0.4	4	0.4
	11	0.1	4	0.1

Test with Toy Simulation(Noise)

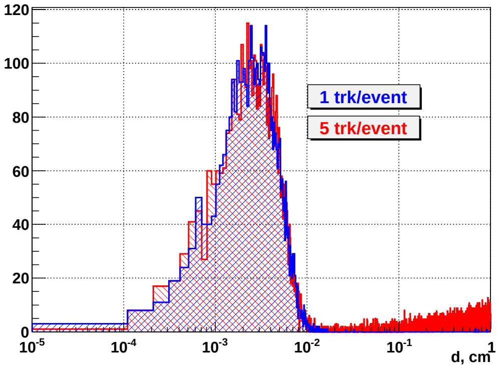
Noise hits are uniformly distributed
$(X \in [4,9]cm, Y \in [0,4]cm)$



Efficiency (with noise)

N_{trk}	N_{rec}	%(of total)	N_{good}	%(of total)
1	1	99.8	1	99.8
	2	0.2	1	0.2
5	4	0.1	4	0.1
	5	98.5	4	1.1
			5	97.4
	6	0.9	5	0.9
	7	0.2	4	0.2
	10	0.2	4	0.2
	11	0.1	4	0.1

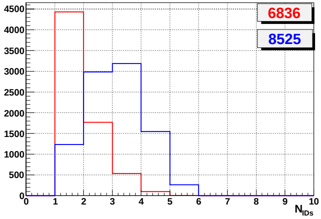
New class **PndLmdTrackFinderCATask** with the same interface like **PndLmdTrackFinderTask**



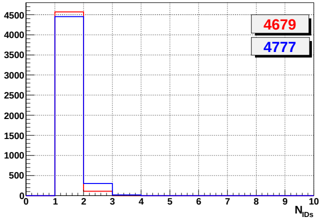
d_{max}=20 μm.

Cellular Automation vs. Track-Following: Efficiency

Simulation: 5 $\bar{p}$, P_{beam}=1.5 GeV/c
(928 events with 5 tracks = 4640 tracks)



$\phi \in (0, 20°)$

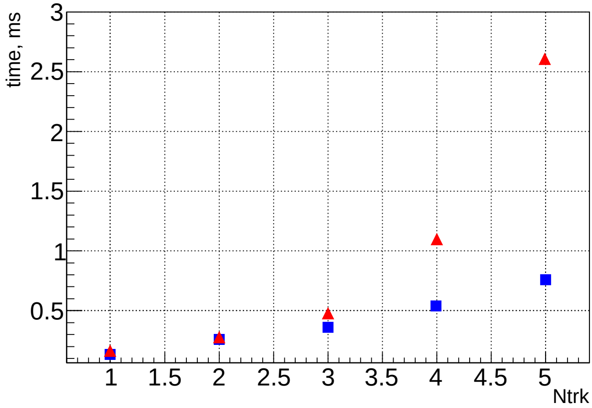


$\phi \in (0, 360°)$

- ghost tracks:
  47% for CA
  84% for TF

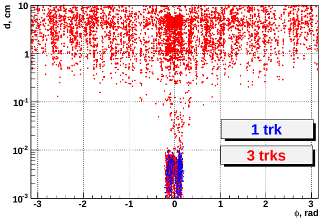
- ghost tracks:
  0.8% for CA
  3% for TF

Cellular Automation vs. Track-Following: Speed

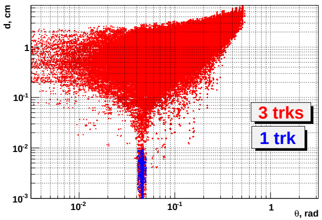


For 3 (and more) tracks per event "track-following" algorithm is faster.

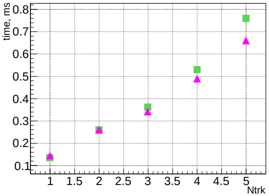
Reduction number of cells with $\Delta\phi \& \Delta\theta$ requirements



cut: $\phi \in (-0.3, 0.3)$ rad



cut: $\theta \in (0.025, 0.055)$ rad



Cellular Automation
Track-Following

Conclusion

- Cellular Automation was tested in Toy Simulation
- and implemented in PANDAROOT
- For high density of tracks Cellular Automation algorithm has higher efficiency and less number of ghost tracks compare to track-following algorithm
- But speed is not extremely higher

Plans

- Extend algorithm for case with missing plane(s)
- Speed optimization (rewriting software code)

Background study: $p\bar{p} \longrightarrow K^+K^-$

Simulation with **EvtGen**:
PHSP(phase space model)
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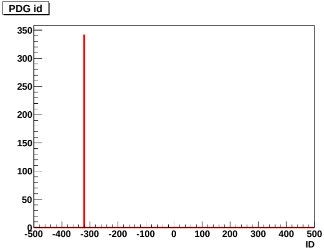
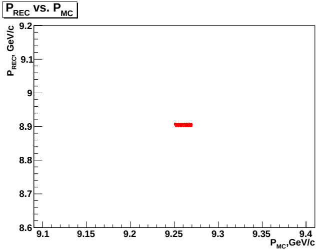
10^6 events

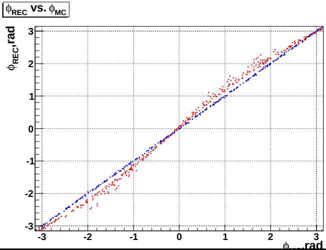
track-candidates:
695
after cuts for $(\theta, \phi)_{trk-cand}$:
341 (0.03%)

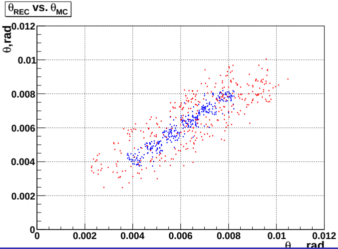
In back-propagation usual assumption for particle is used ($\bar{p}$ and $P = P_{beam}$)

All of reconstructed particles are K^-

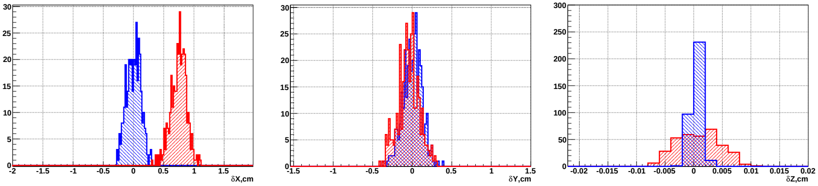








Comparison results for $\bar{p}$ & K^- signal



Distribution for K^-:
shifted in X-coordinate and wider in Z-coordinate, but for Y-coordinate looks similar to $\bar{p}$ distribution.

Correct study for nonpoint-like beam is needed!
(Include beam/target size and beam emittance)

θ_{cand} and ϕ_{cand} cut tracks from π^+ (K^+)