Two-track resolution in MPD-TPC

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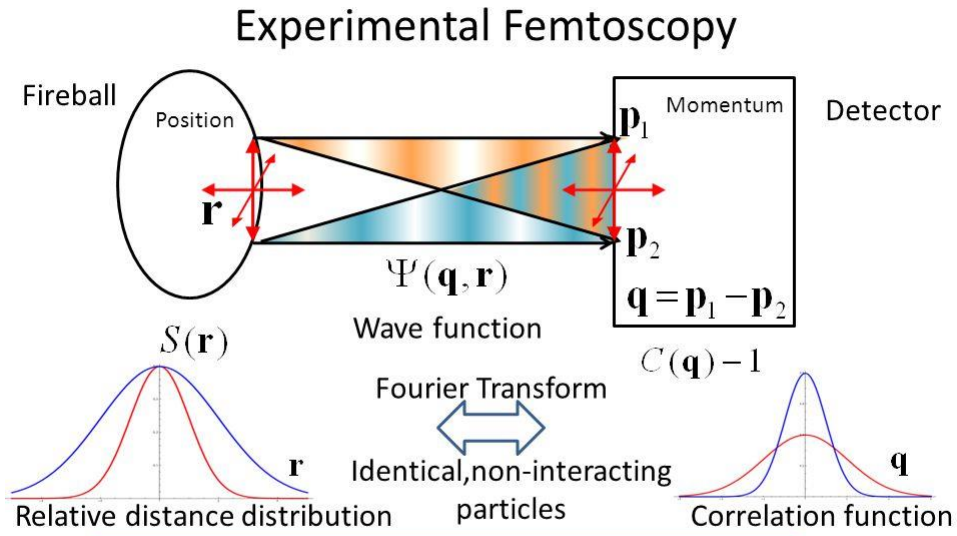
For MPD Collaboration

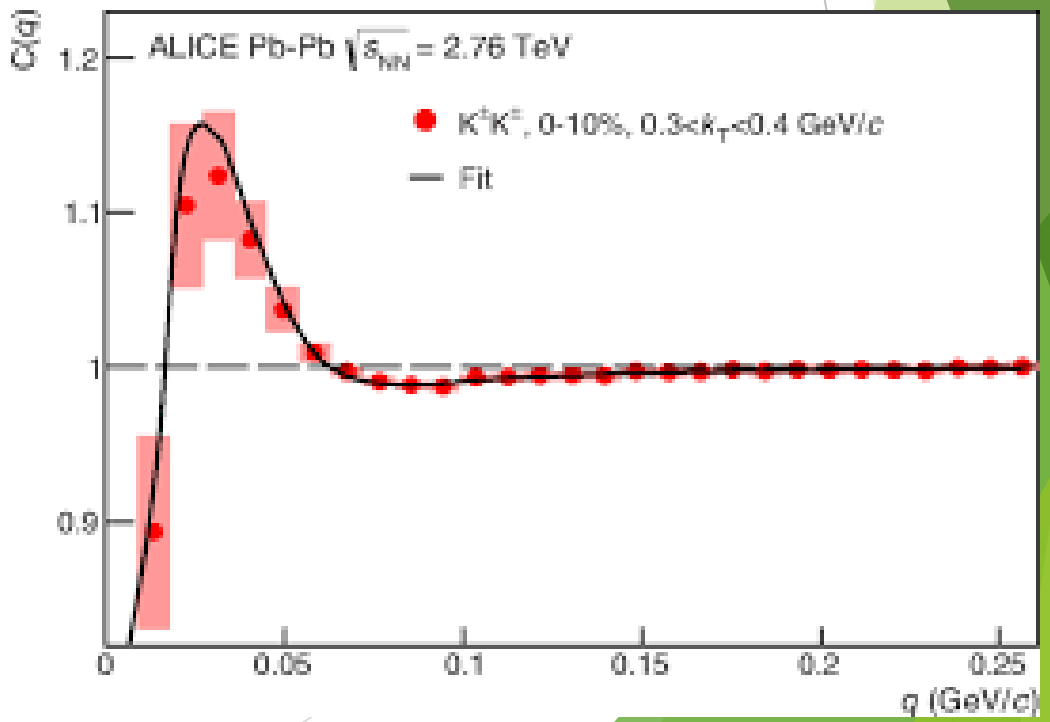
Outline

- Correlation functions
- Two track effects in femtoscopy
- Simulation setup
- Two-track cuts
- Results
- Summary, plans

Correlation function

- Used to get information about shape of source that emits particles
- Calculated as ration of pairs from same to pairs from mixed events as a function of momentum difference





Two-track effects in femtoscopy

- Momentum smearing
- Contaminations

} Not considered here

- **Splitting** – reconstruction of single particle as many tracks – increasing value of CF
- **Merging** – reconstruction of pair of particles as single tracks – decreasing value of CF

Simulation setup

- 1M of UrQMD AuAu@11GeV events at centrality 0-5%
- Mpdroot from may
- Fixed event vertex (0,0,0)
- MpdDstFiles with fixed DCA calculations and n-sigma calculations (MpdPIDOnTheFly)
- Analysis with NicaFemto
- Pi+pi+ considered only

Simulation setup

- Track cuts:
  - |DCA XY| <1.25 cm
  - |DCA Z| <0.75 cm
  - Nhits >=30
  - |N-sigma pion| <2
  - $-0.3<m^2<0.15$ GeV$^2/c^4$ (if p>0.5 GeV/c)

Pairs cuts

- Removing splitting
  - Removing tracks seems to be splitted (usually by hit maps)
- Removing merging
  - Removing tracks that are close in TPC (bigger probability of merging)

Pair cuts

- Average TPC separation
- Shared pads fraction
- Shared hits fraction
- TPC entrance distance (first layer)
- Minimal TPC distance
- Quality pair cut
- Delta phi* cut
- Delta eta cut

Pair cuts

- Problem with TpcHit array
  - Huge memory consumption
  - Not stored in MpdDst structure

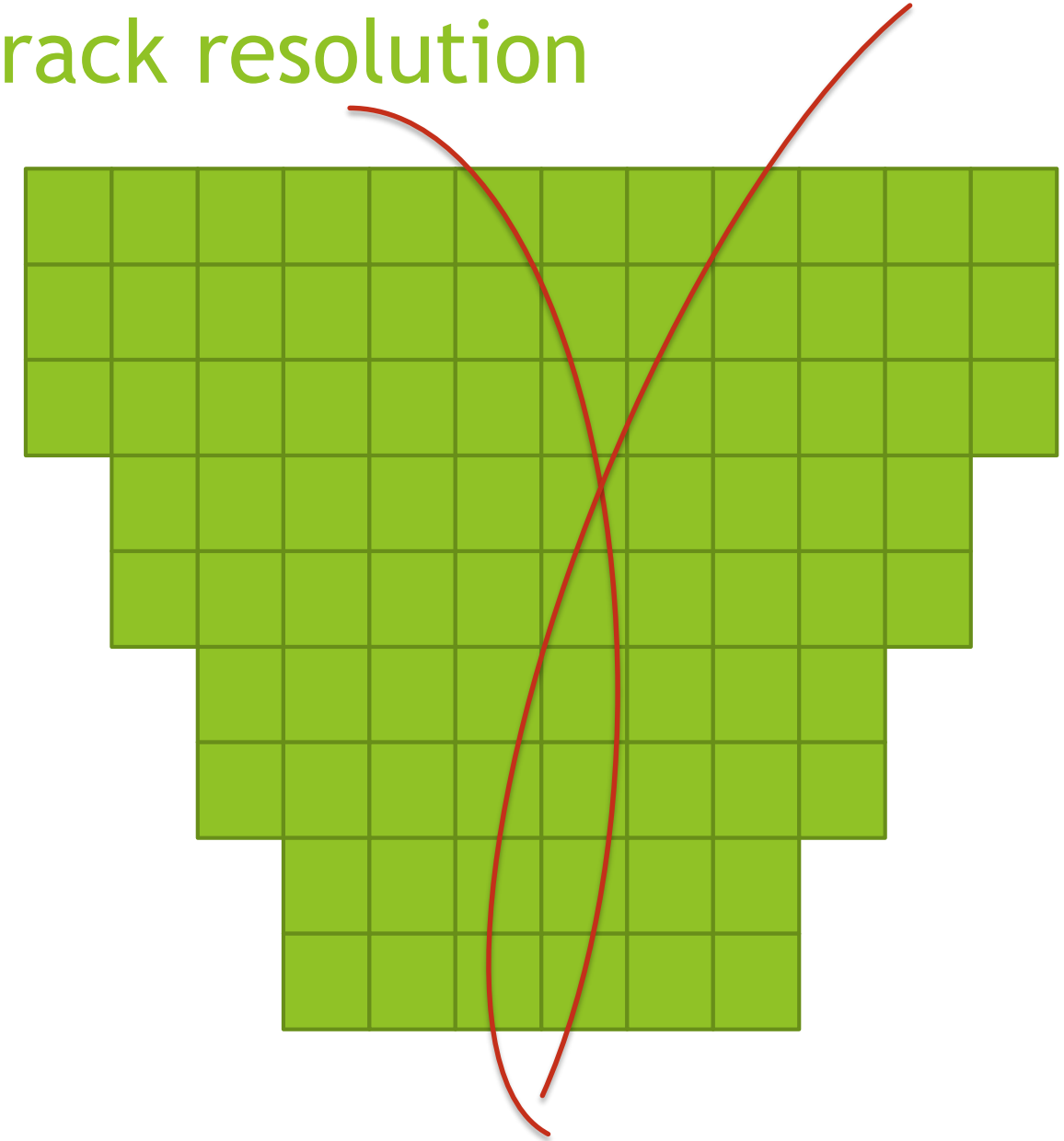
Pair cuts

- Solution
  - Calculation of particle properties from MpdHelix
  - Only required information – array of layers with hits

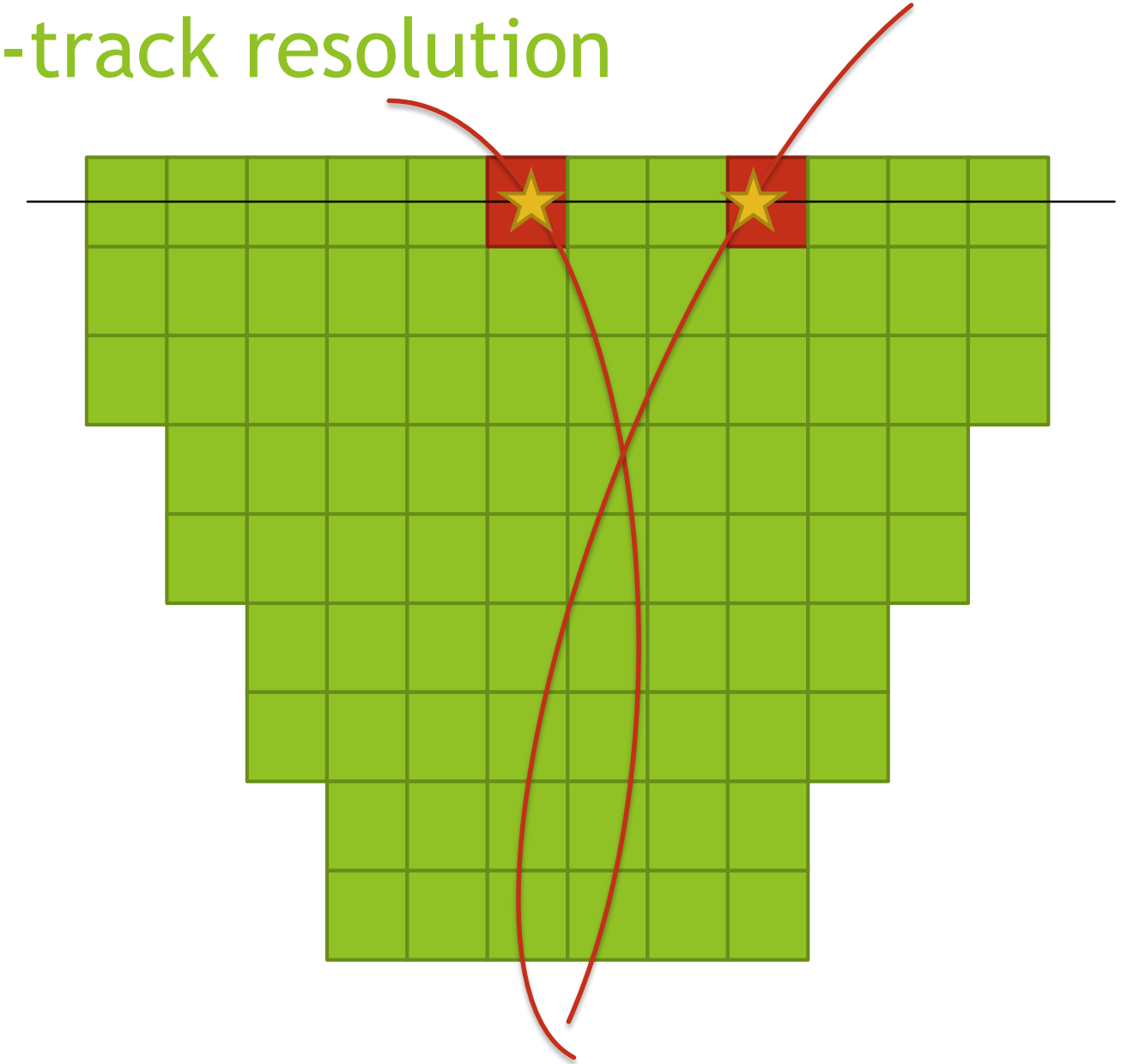
Pair cuts

- Loop over 53 layers
  - Calculate helix length that pass to middle of layer
  - Calculate pad ID from helix
  - Calculate array of hits (store in single UInt_t in form of bitmap)
- Shared hit = shared pad + TpcHit in both pads
- Nhit = NHit1+NHit2

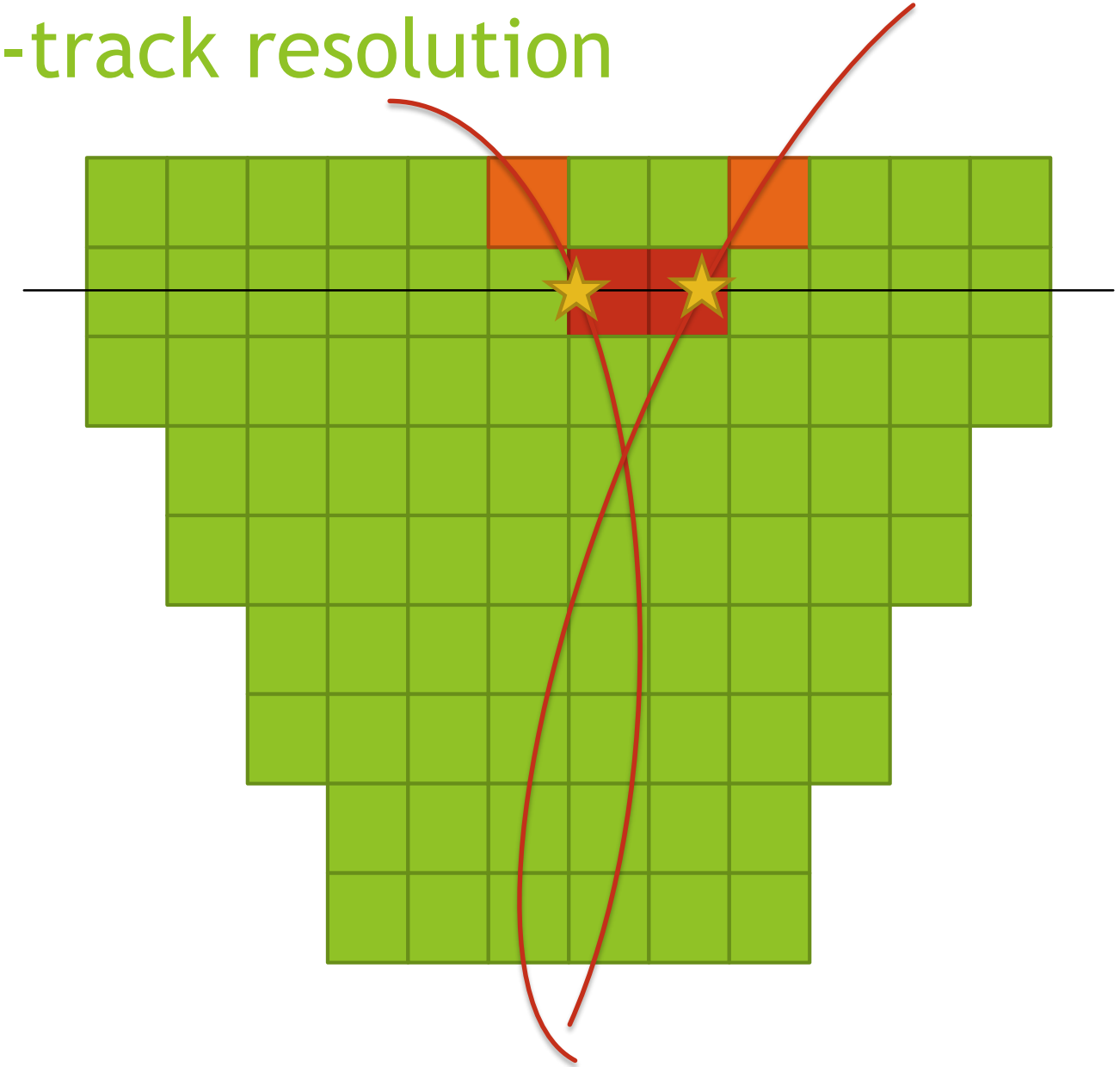
Two-track resolution



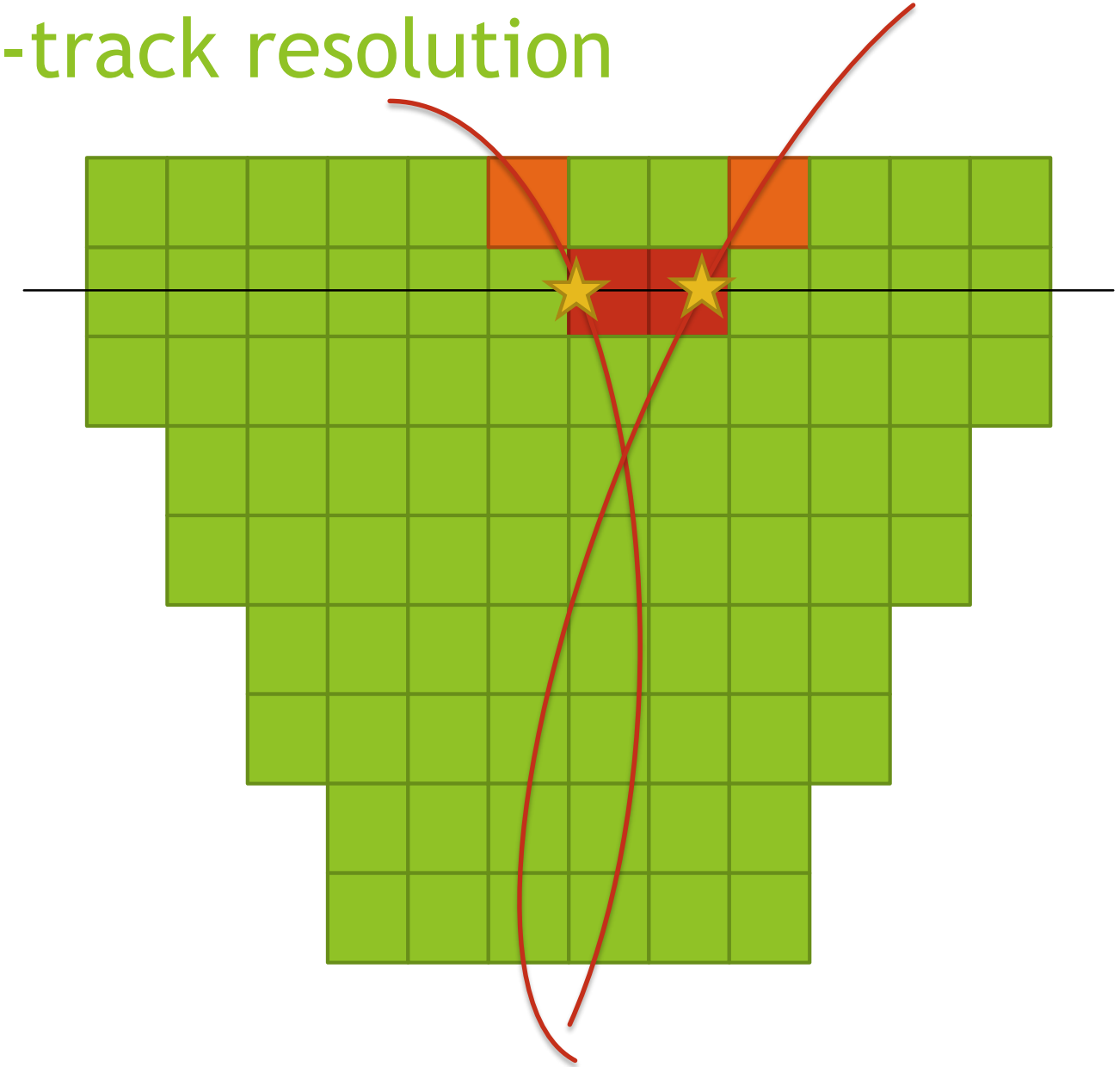
Two-track resolution



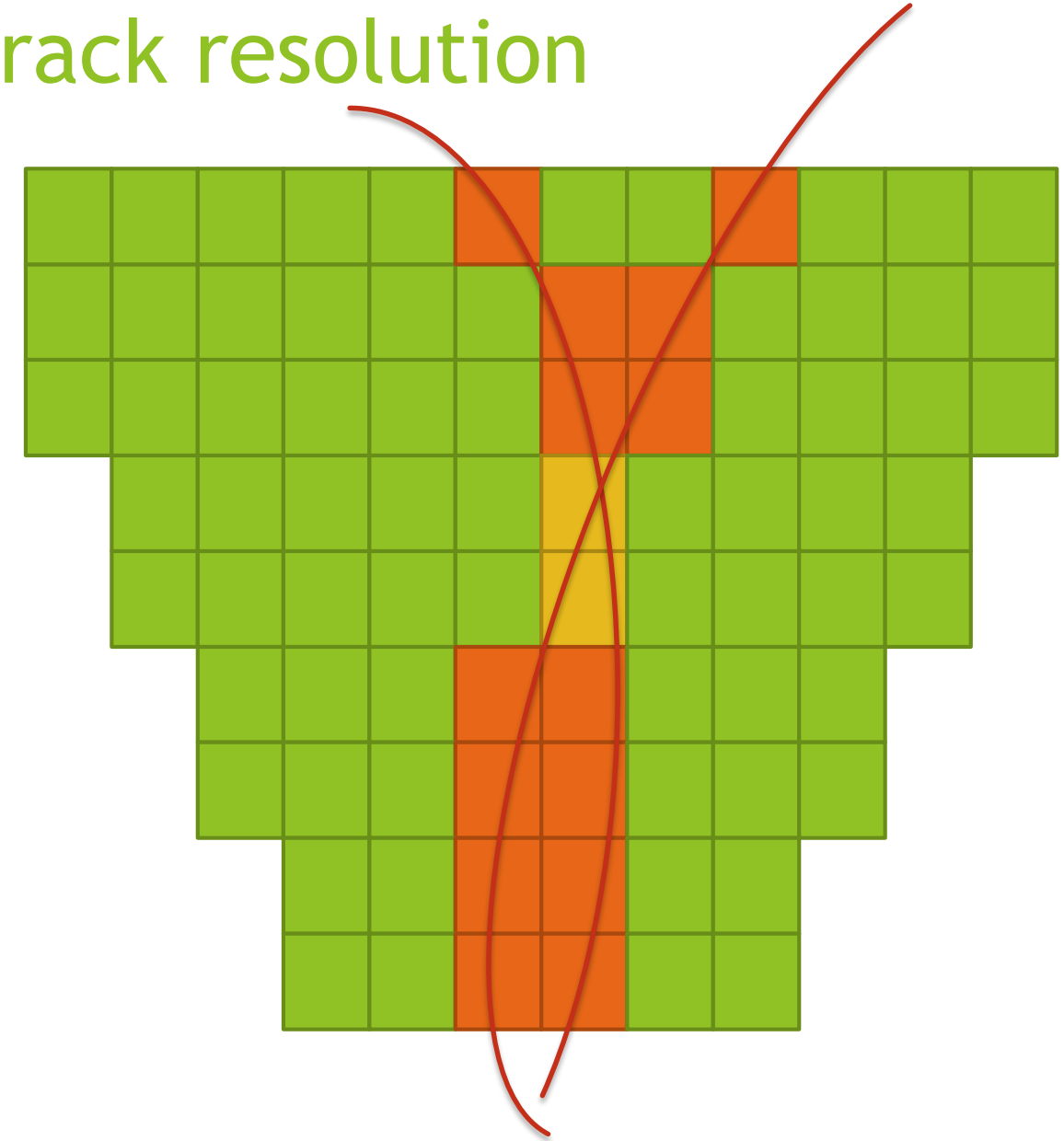
Two-track resolution



Two-track resolution



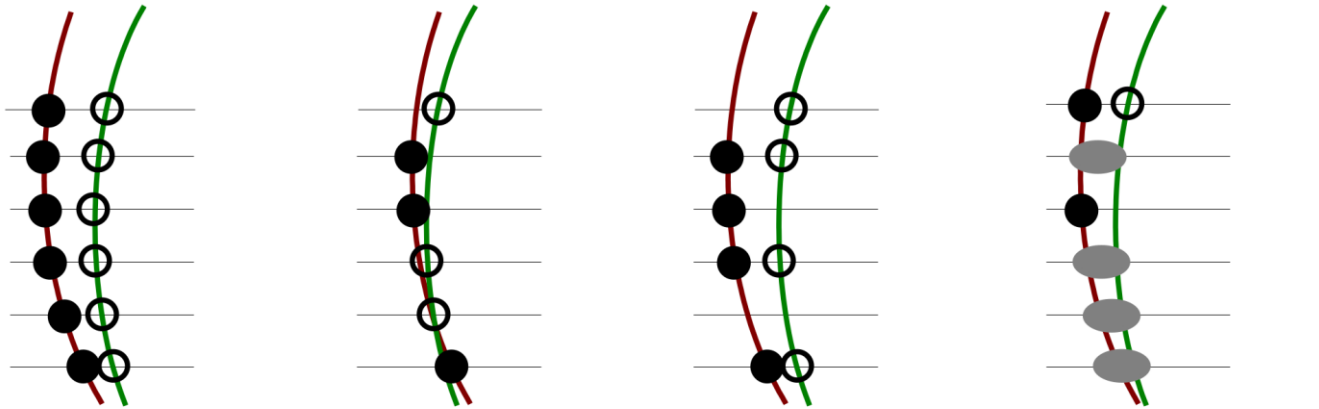
Two-track resolution



Quality cut

$$q_i = \begin{cases} -1 \text{ if both tracks have a hit in padrow} \\ 0 \text{ if none of the tracks have a hit in padrow} \\ +1 \text{ if only one track has a hit in padrow or } \textbf{a hit is shared} \end{cases}$$

$$Quality = \frac{\sum q_i}{N_{hits}}$$



Separate tracks
Quality = -0.5
GOOD

Probably a split track
Quality = 1.0
GOOD

Probably separate tracks
Quality = -0.125
GOOD

Probably a split track
Quality = +0.36
GOOD

Used in ALICE
https://indico.cern.ch/event/58648/contributions/2057099/attachments/993464/1412718/AK_FemroPairQA.pdf

Results

- Setup 1 – SMALL Entrance
  - TPC av sep <0,900> cm
  - Shared pads <0,1>
  - TPC entrance dist <2.5,900> cm
  - Min TPC dist <0,10000> cm
  - Quality <-1,0>
  - Shared hits <0,0.05>

Results

- Setup 2 – MEDIUM ENTRANCE
  - TPC av sep <0,900> cm
  - Shared pads <0,1>
  - **TPC entrance dist <3.5,900> cm**
  - Min TPC dist <0,10000> cm
  - Quality <-1,0>
  - Shared hits <0,0.05>

Results

- Setup 3 – LARGE ENTRANCE
  - TPC av sep <0,900> cm
  - Shared pads <0,1>
  - **TPC entrance dist <4.5,900> cm**
  - Min TPC dist <0,10000> cm
  - Quality <-1,0>
  - Shared hits <0,0.05>

Results

- Setup 5 AVERAGE SEP
  - TPC av sep <4,900> cm
  - Shared pads <0,1>
  - TPC entrance dist <0,900> cm
  - Min TPC dist <0,10000> cm
  - Quality <-1,0>
  - Shared hits <0,0.05>

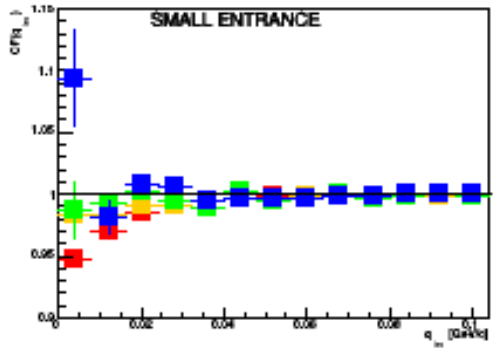
Results

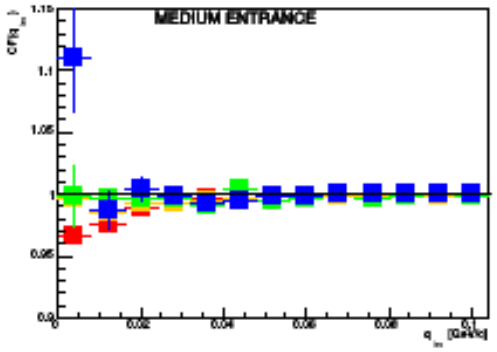
- Setup 6 SMALL+HIT
  - TPC av sep <0,900> cm
  - Shared pads <0,1>
  - **TPC entrance dist <2.5,900> cm**
  - Min TPC dist <0,10000> cm
  - Quality <-1,0>
  - Shared hits <0,0.05>
  - **Nhits>=10 (track cut)**

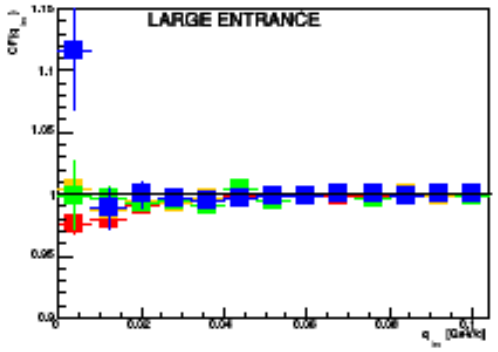
Results

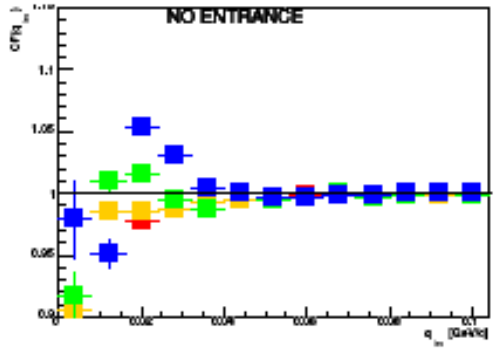
- Setup 7 SMALL+Q
  - TPC av sep <0,900> cm
  - Shared pads <0,1>
  - **TPC entrance dist <2.5,900> cm**
  - Min TPC dist <0,10000> cm
  - **Quality <-1,1>**
  - Shared hits <0,0.05>

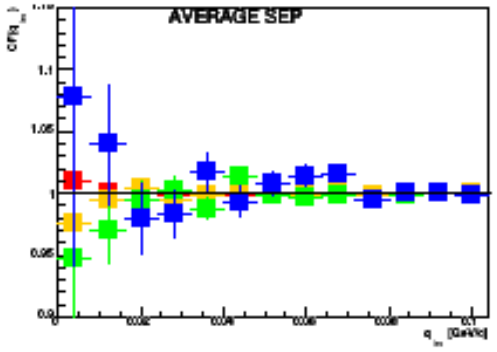
Results

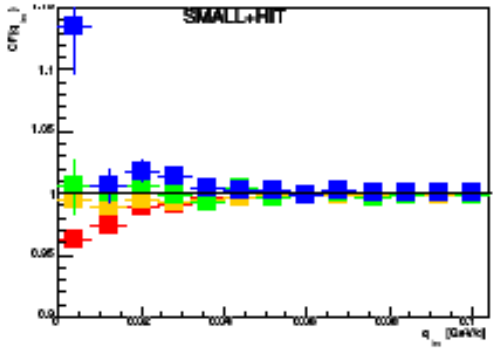

SMALL ENTRANCE

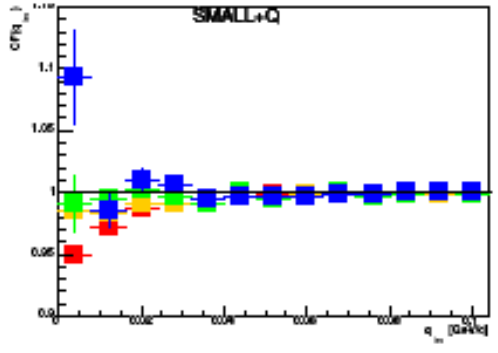

MEDIUM ENTRANCE

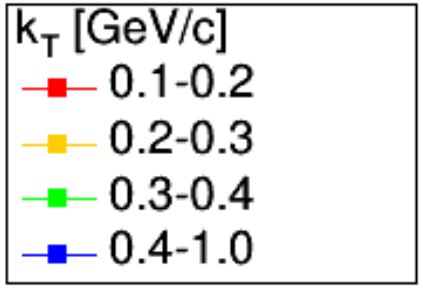

LARGE ENTRANCE


NO ENTRANCE


AVERAGE SEP

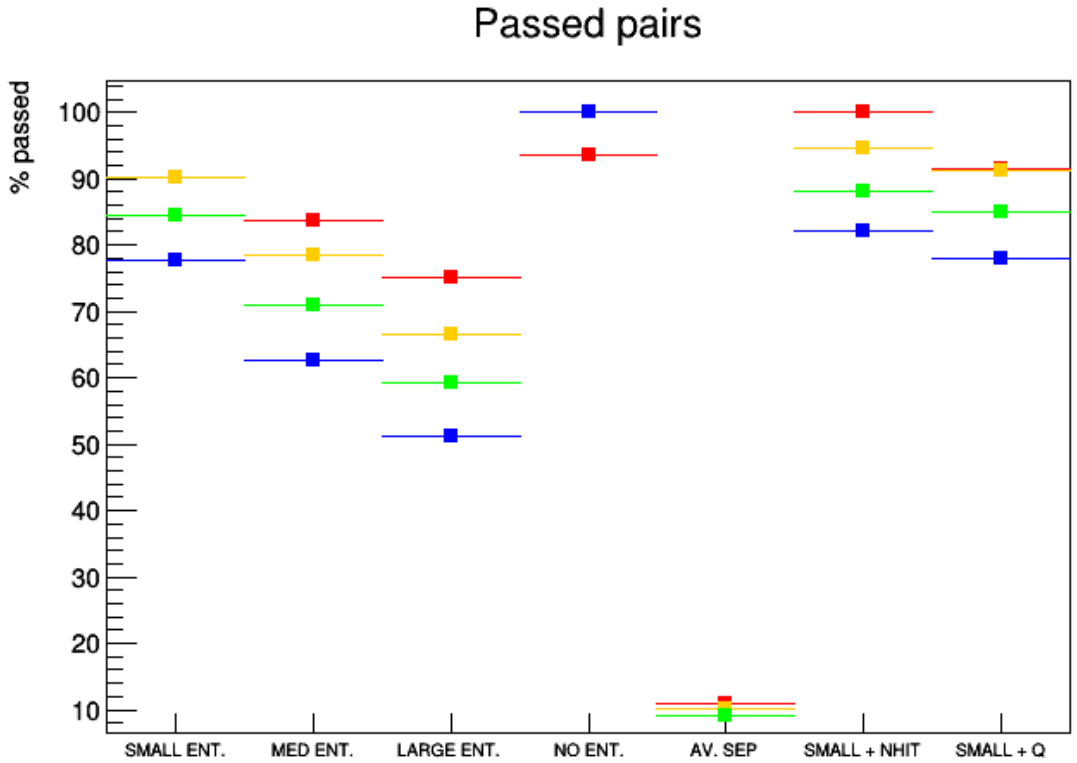

SMALL+HIT


SMALL+Q


k_T [GeV/c]
0.1-0.2
0.2-0.3
0.3-0.4
0.4-1.0

Number of pairs (first 4 bins of CF)

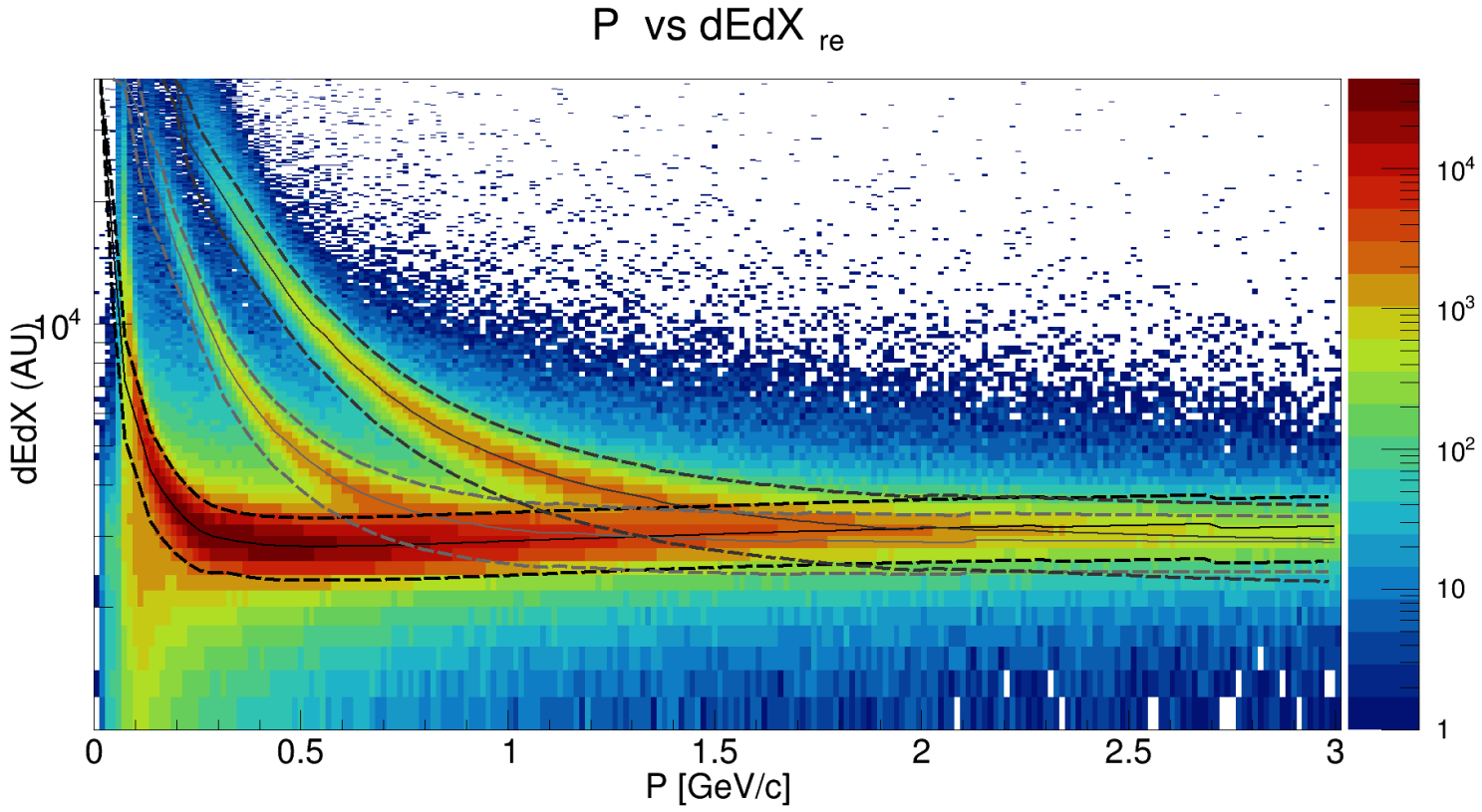
Normalized to maximum numer of pairs in all setups

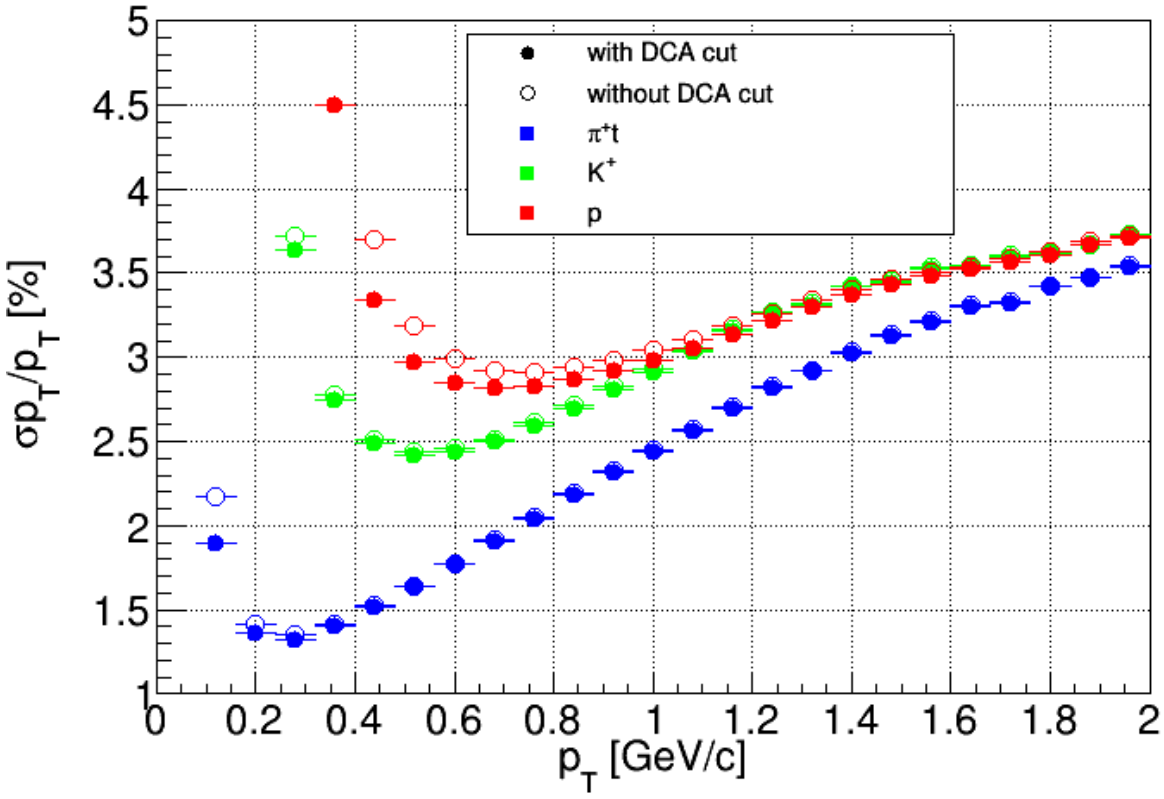


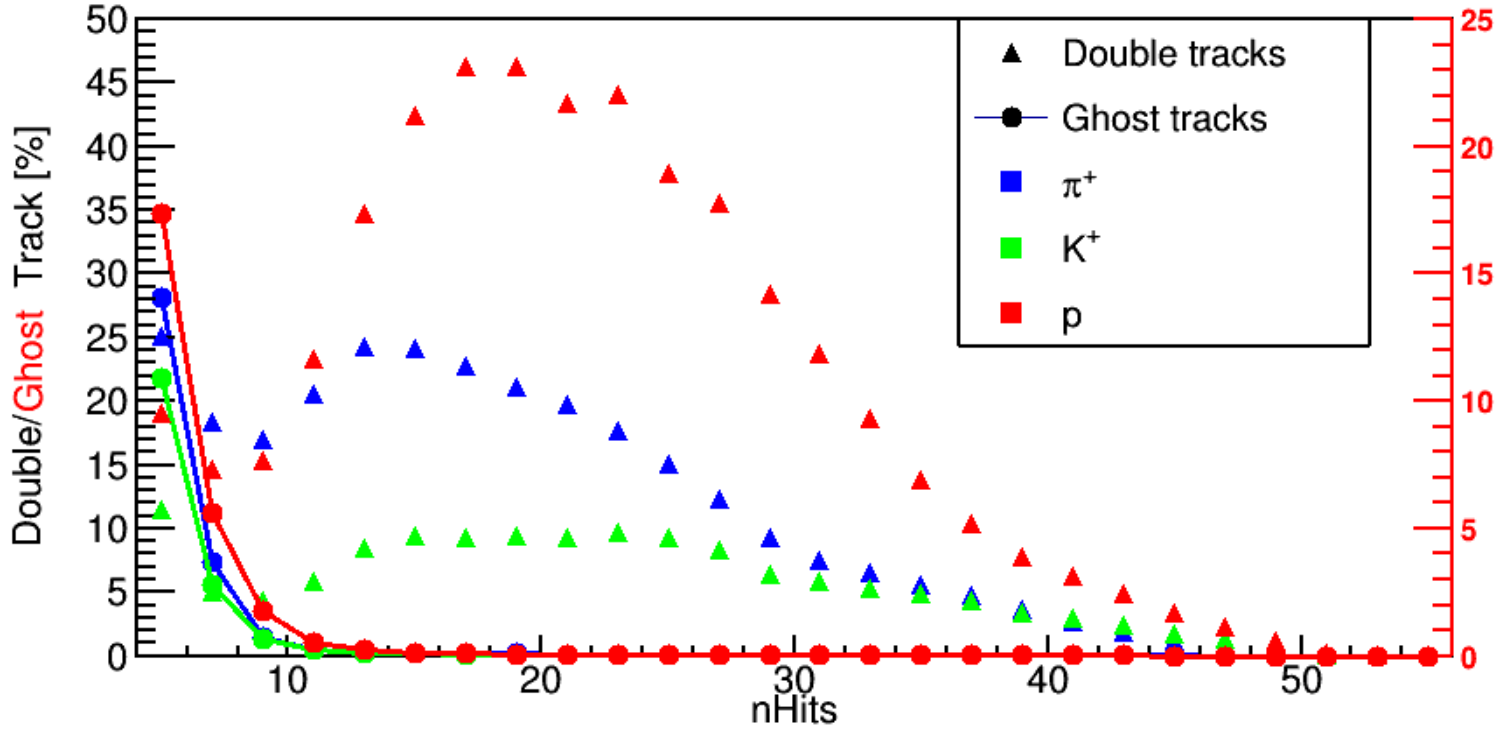
Summary

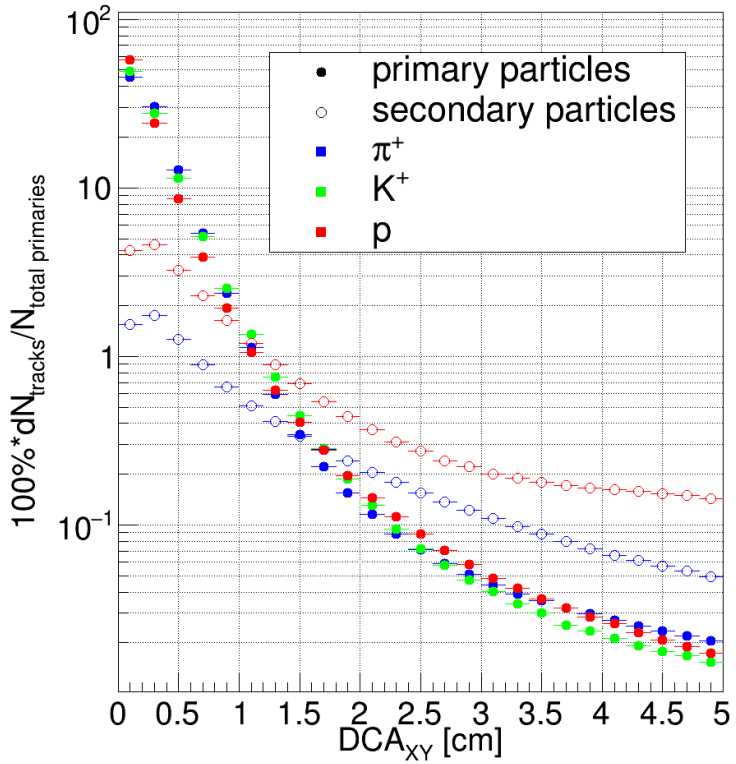
- Seems that optimized cut is TPC entrance >3.5 cm and 4.5 or better for lowest kt
- Splitting is observed especially at high kT and is not removed by quality cut
- Next steps
  - Taking into account FSI between particles and purity
  - Calculations for 3D case

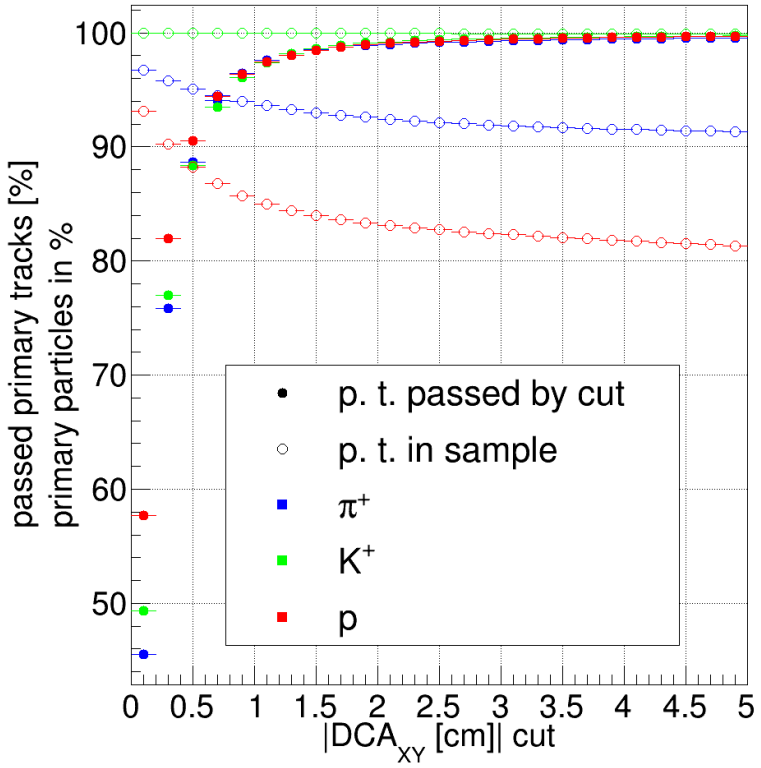
Backup slides

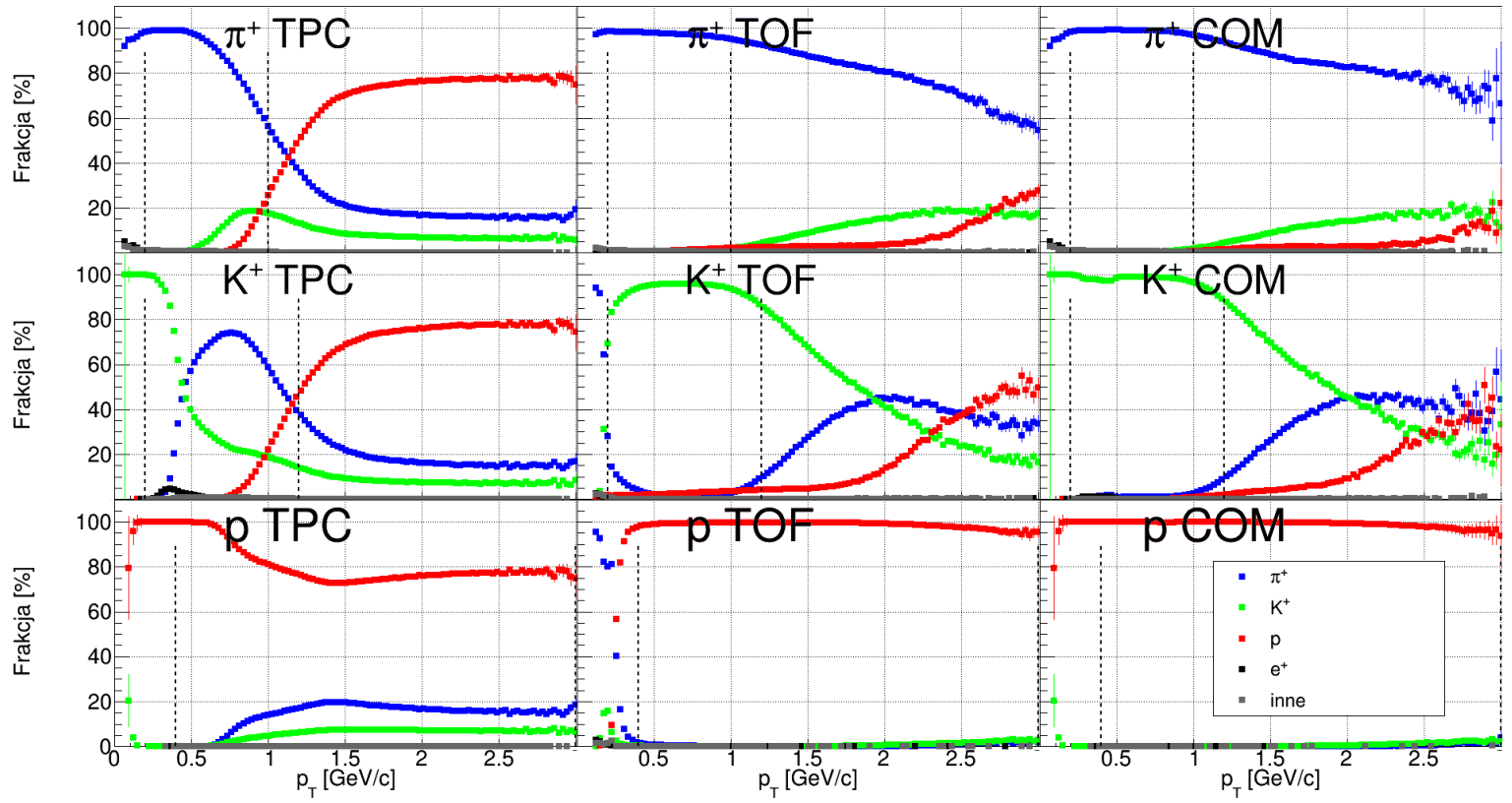



with DCA cut
without DCA cut
π+t
K+
p
σpT/pT [%]
pT [GeV/c]
5
4.5
4
3.5
3
2.5
2
1.5
1
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2


Double/Ghost Track [%]
nHits
Double tracks
Ghost tracks
π+
K+
p
0
5
10
15
20
25
30
35
40
45
50
10
20
30
40
50


primary particles
secondary particles
π+
K+
p
100%*dN_tracks/N_total primaries
DCA_XY [cm]


p. t. passed by cut
p. t. in sample
π+
K+
p
passed primary tracks [%]
primary particles in %
|DCA_XY [cm]| cut


π+ TPC
π+ TOF
π+ COM
K+ TPC
K+ TOF
K+ COM
p TPC
p TOF
p COM
Frakcja [%]
p_T [GeV/c]
π+
K+
p
e+
inne