HLT tracking in TPC

Off-line week 41 2007

Gaute Øvrebekk

Outline

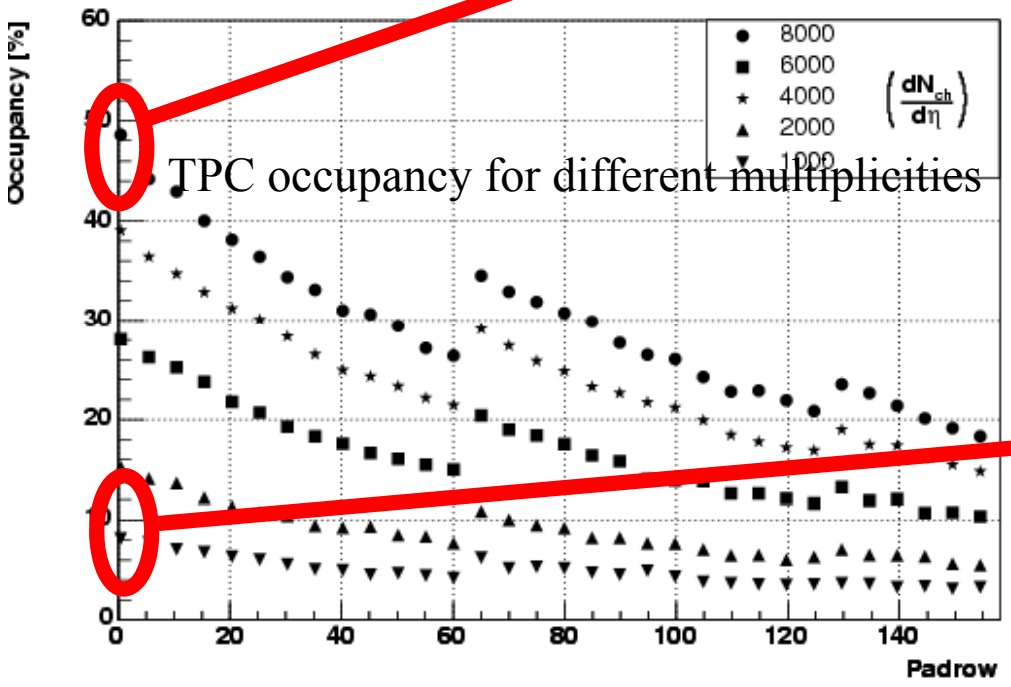
- Overview ClusterFinder/Tracker.
  - Methods/Algorithms.
  - Results for Pb+Pb.
- Preparation for p+p run:
  - Reconstruction efficiency.
  - Benchmark on the HLT-Cluster.

Multiplicities and occup

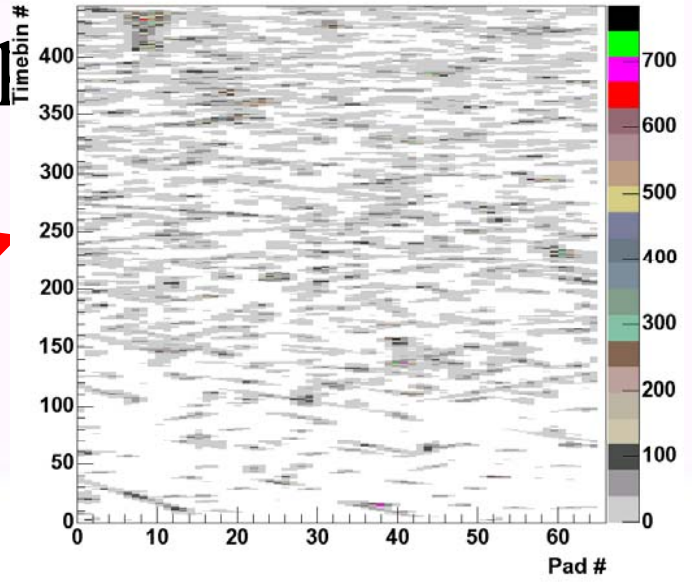
What to expect?

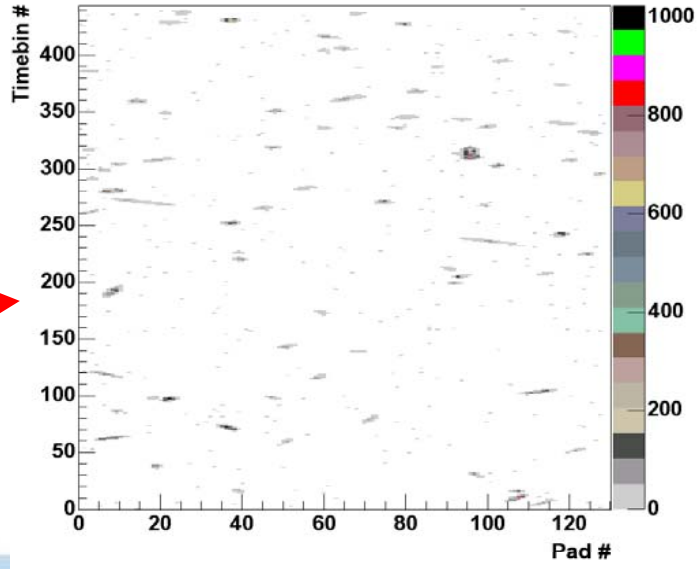
Extreme assumption: $dN_{ch}/dy=8000$

Extrapolations from RHIC: $dN_{ch}/dy=2000-4000$

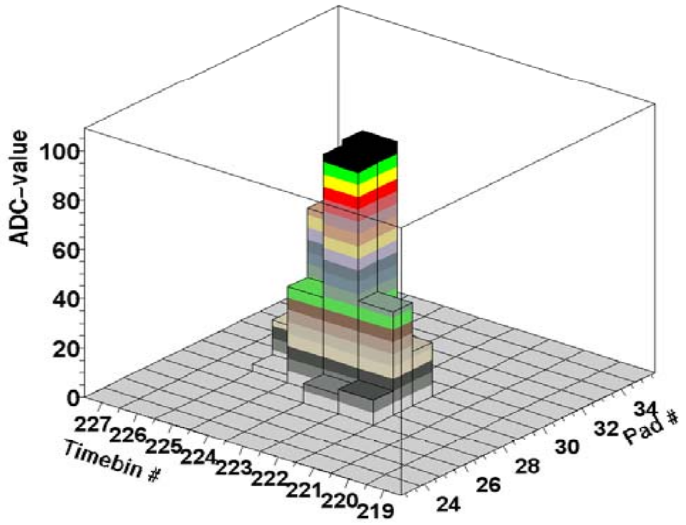


TPC occupancy for different multiplicities





TPC tracking methods



Cluster finding
Reconstruct space points
from 2D clusters

Sequential tracking

Track reconstruction
Connect space points into tracks
and fit them to a model (helix)

Alternative/Additional tools:

¤ Hough Transform

¤ Cluster deconvoluter and refitter

Cluster Finding

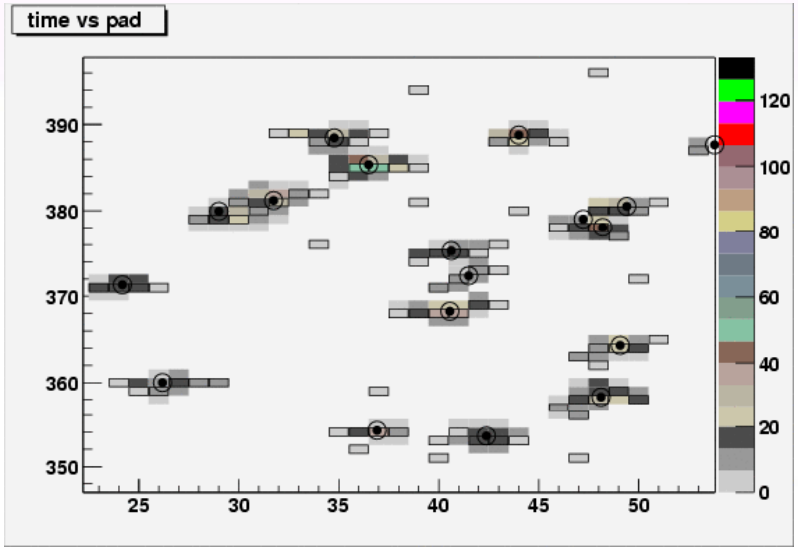
Input: ADC-sequences above threshold

Cluster Finder

- Simple sequence matching between neighboring pads

- Centroids calculated as weighted mean of ADC-values

Simple deconvolution scheme:
Split clusters at local minima



ClusterFinder

Reading all data to memory
Finding Cluster Candidates
Finding Clusters

A **Cluster Candidate** is defined to have signals in a minimum of two consecutive timebins on one pad.

examples:

data(timebin)=[-1,-1,-1,3,-1,-1,6,23,56,16,3,-1,-1,-1,3,-1]

data(timebin)=[-1,-1,-1,3,-1,-1,6,23,56,16,14,24,76,19,3,-1,-1,3,-1]

Deconvoluted when signal falls and rises again.

Calculates:
Total Charge
Time (Center of gravity)

A **Cluster** is defined to have Cluster Candidates in minimum two consecutive pads, where the absolute difference in time for the two Cluster Candidates is <=1.

example:

Pad 33 has Cluster Candidates with time: [70 , 300 , 390]
Pad 34 has Cluster Candidates with time: [13 , 245 , 390]
Pad 35 has Cluster Candidates with time: [12 , 167 , 391]
Pad 36 has Cluster Candidates with time: [13 , 168 , 391 , 440]

After this initial step we look for single timebin signals(tails) in firstpad-1 and lastpad+1

Similar deconvolution scheme in pad direction.

An On-Line tracker needs to:

- be robust
- be fast
- find primaries at
  high and intermediate pT
- …

Tracking Algorithm

Input: 3D space points

Track Finder

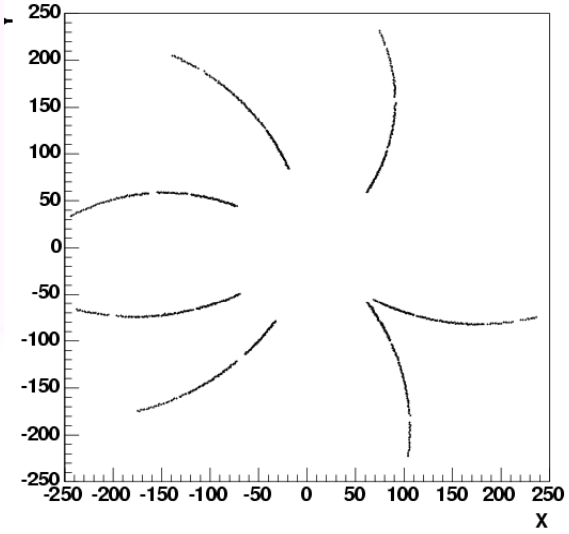
- Conformal mapping

$$x' = \frac{x - x_v}{r^2} \qquad y' = -\frac{y - y_v}{r^2}$$

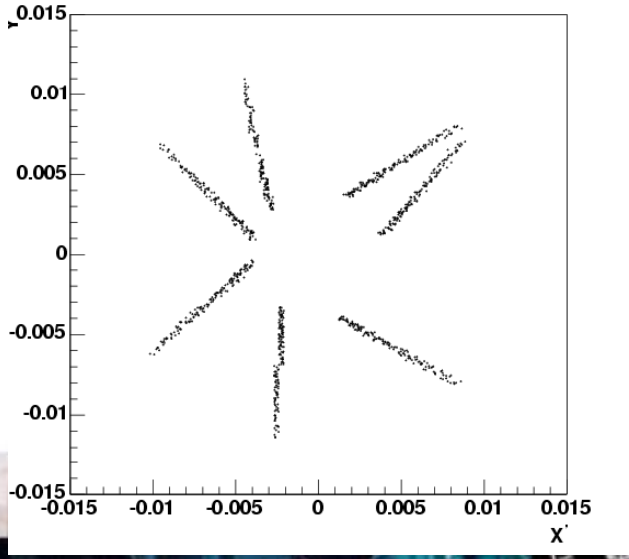
$$r^2 = (x - x_v)^2 + (y - y_v)^2$$

- "Follow-your-nose"
Build tracks from outer to inner TPC-radius

Real space



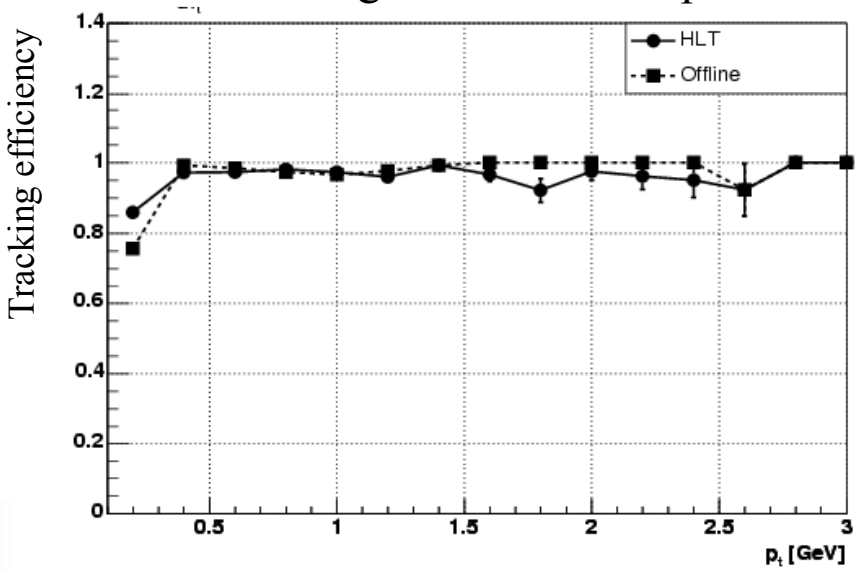
Conformal space

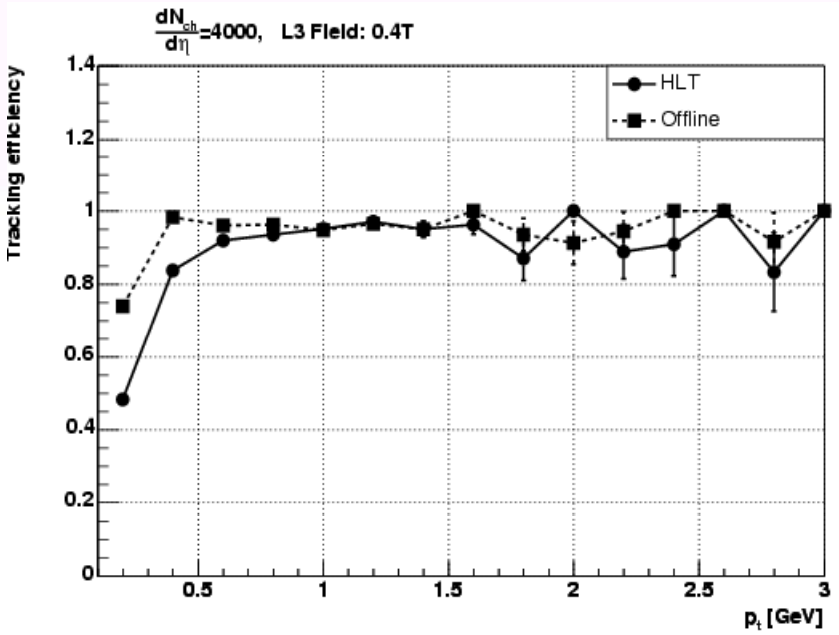


Performance for Pb+Pb events

Has been tested on Pb-Pb. Published in 2004

Tracking efficiencies vs pt





$dN_{ch}/d\eta$=1000

$dN_{ch}/d\eta$=4000

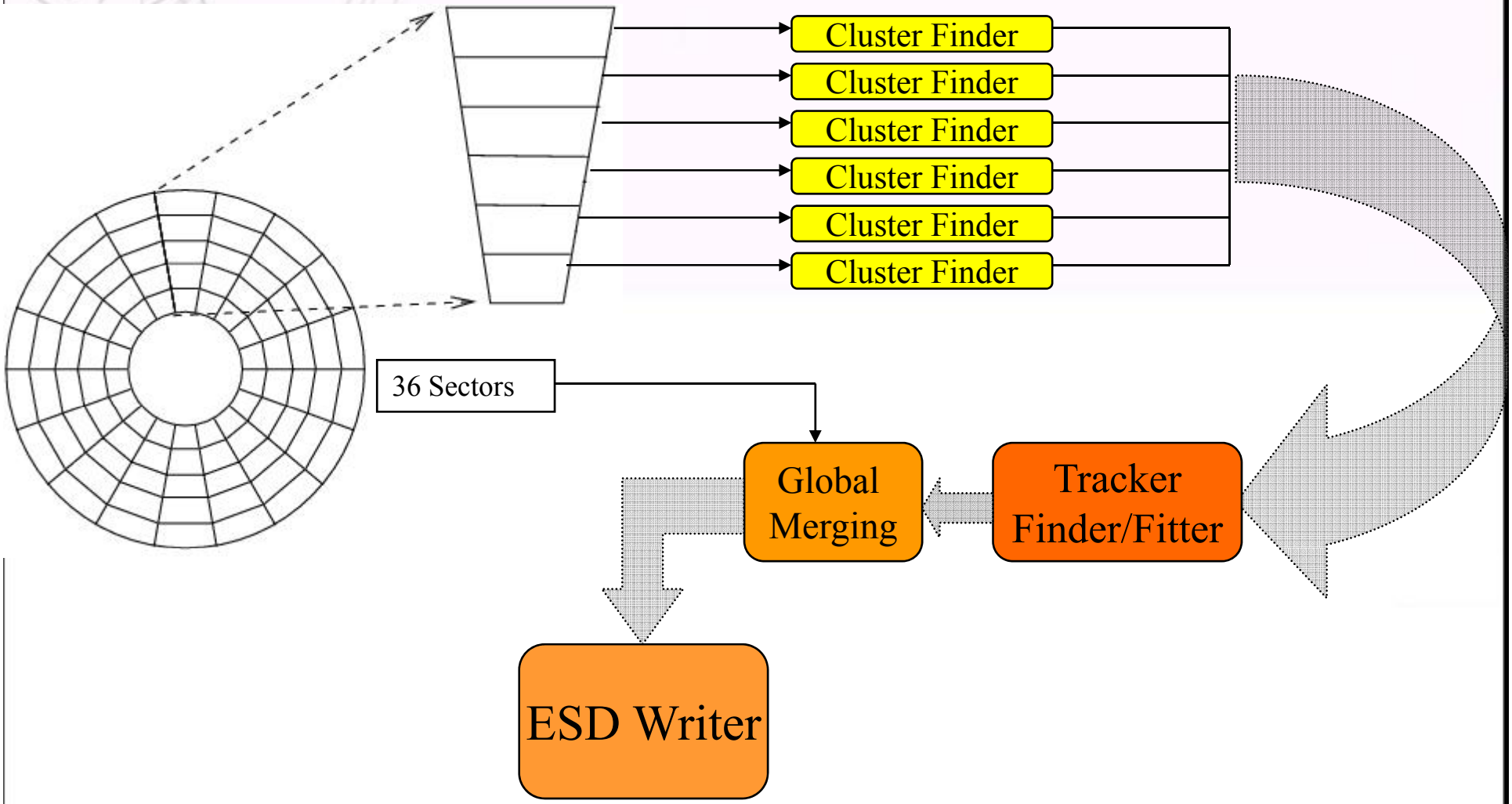
$$\text{Efficiency} = \frac{\text{Found “good” tracks}}{\text{Generated “good” tracks}}$$

Sequential tracking - secondaries

- Efficiency of 80% for Kaons and Lambdas.

- Can be improved by a second tracking pass, taking input all unassigned clusters from the first pass.
  No vertex constrain is imposed on the track follower
  (conformal mapping done with respect to the first associated cluster on track)

Sequential tracking – dataflow



Preparation for p+p run

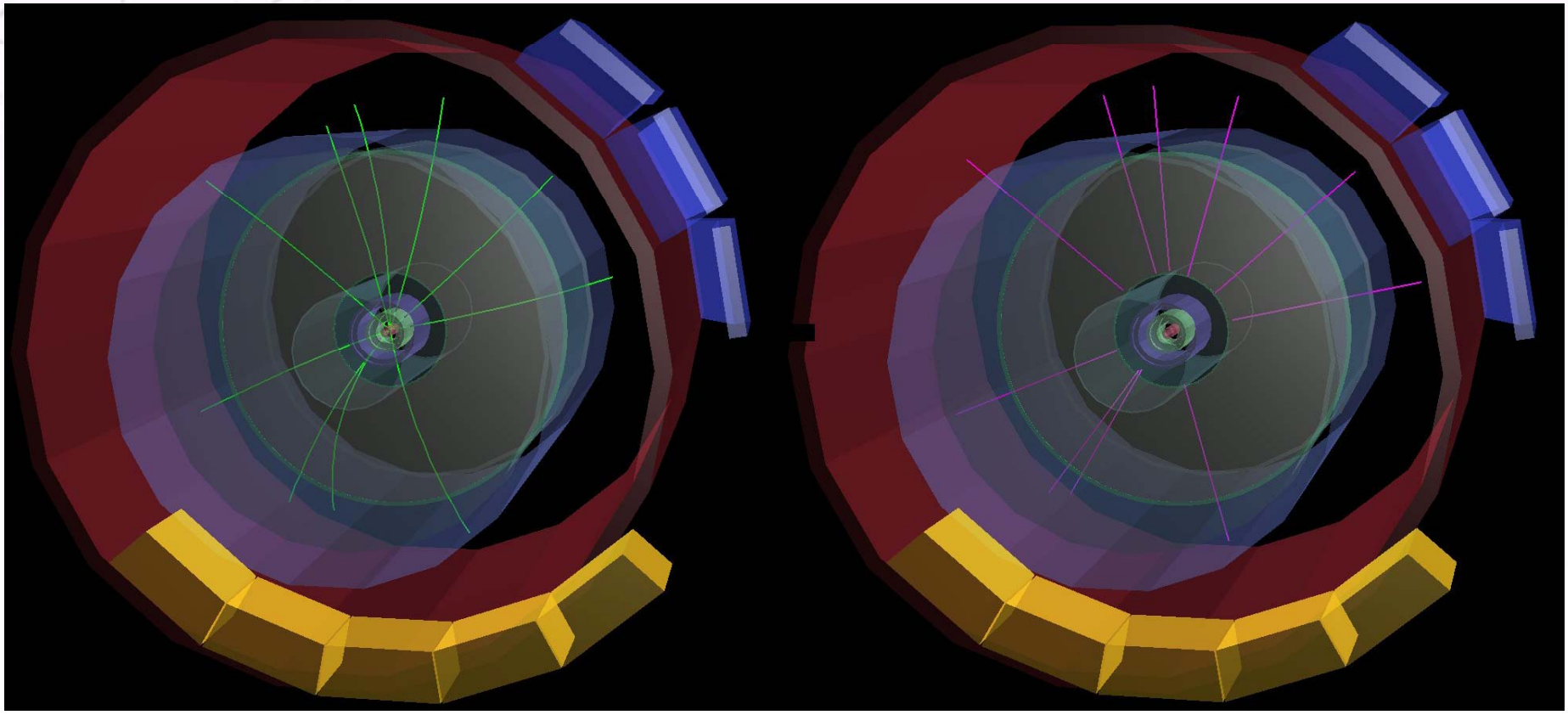
Simulation of 1000 π^+

0.7 GeV/c < p < 5 GeV/c

60 < theta < 120

Primary π^+

Kine HLT

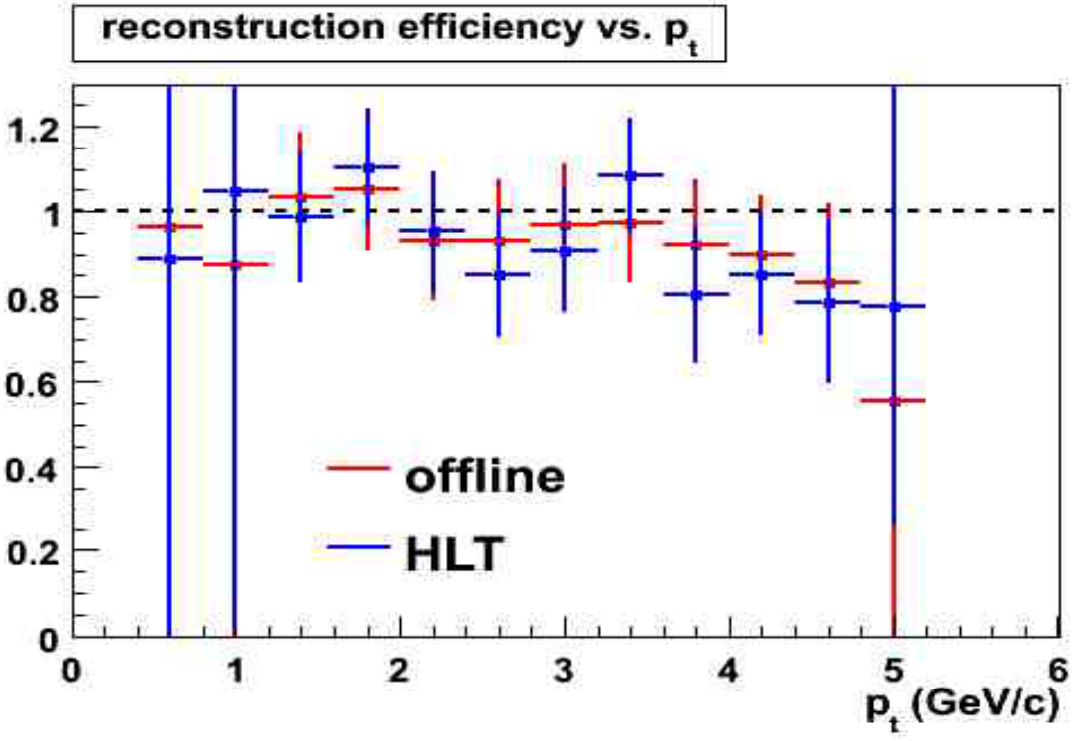


For HLT magnetic field was not set in ESD file. Momentum is correct, but wrong in drawing.

HLT and Offline divided by simulated

Overall Efficiency for primaries :

- HLT: 95%
- Offline: 94%

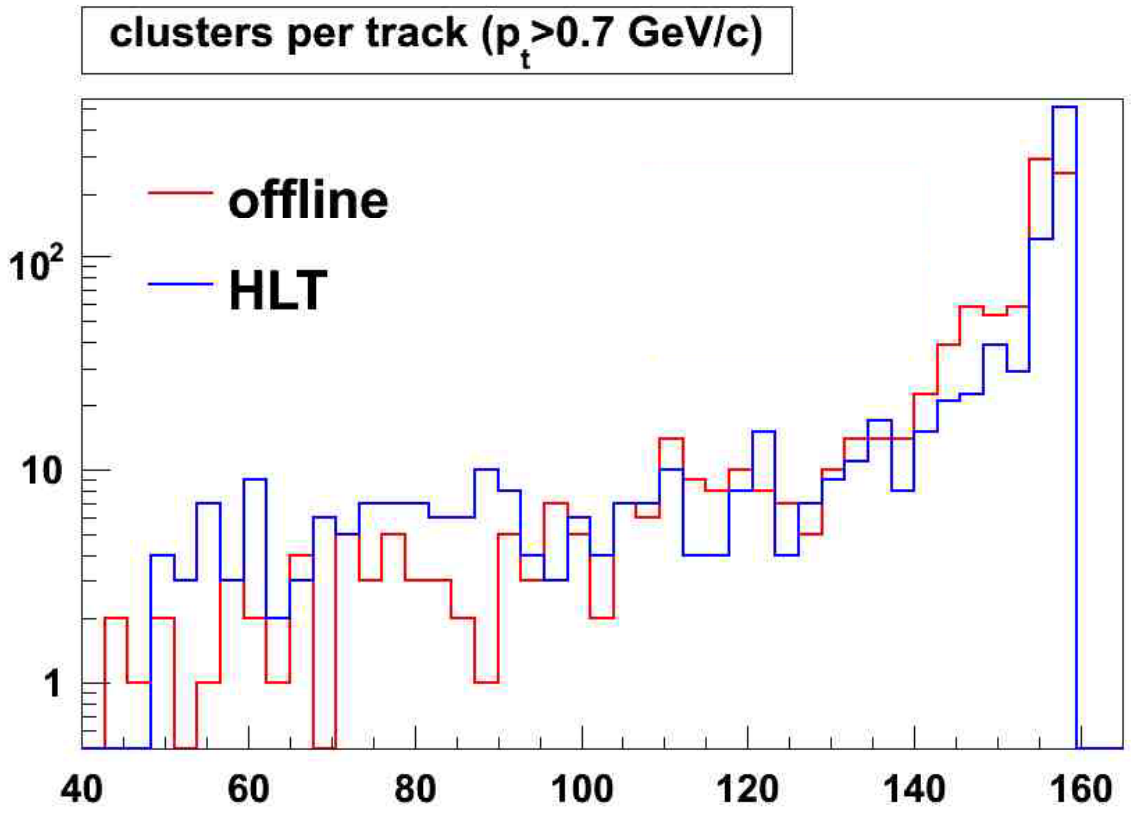


How many clusters are associated to a track

Total number of clusters on tracks:

HLT: 139946

Offline: 138719

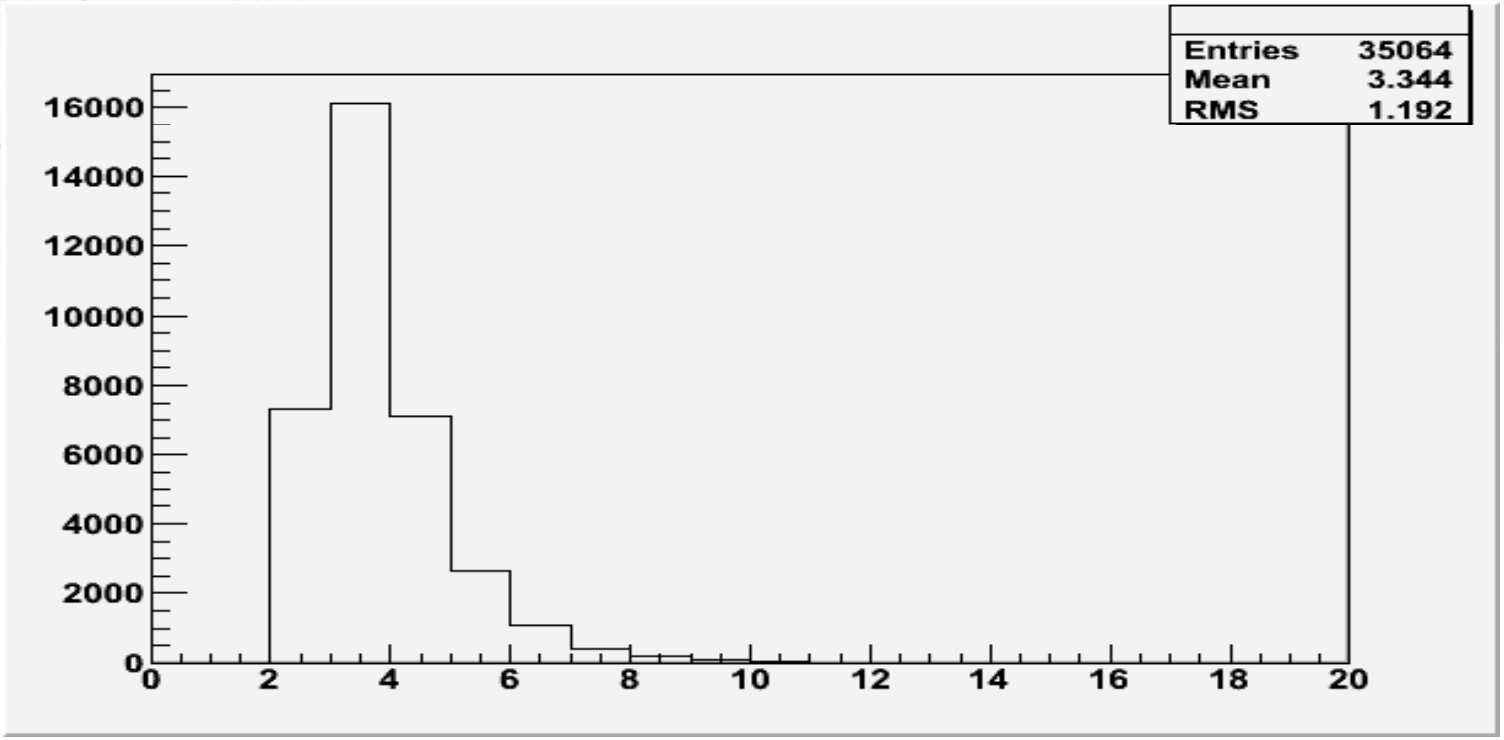


10 000 Pythia Events

Used ConfigPPR.C

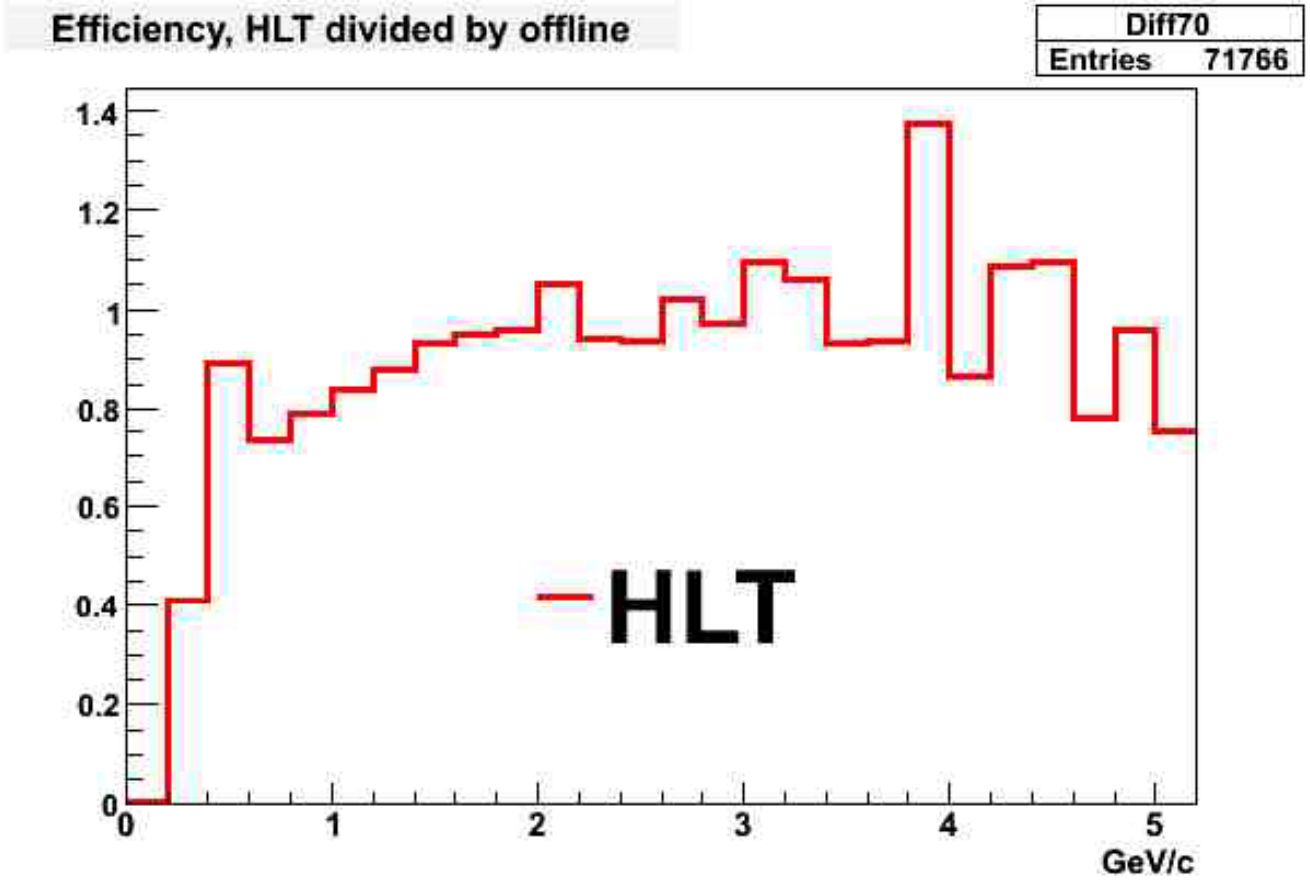
kPythia6

Number of pads in a Cluster



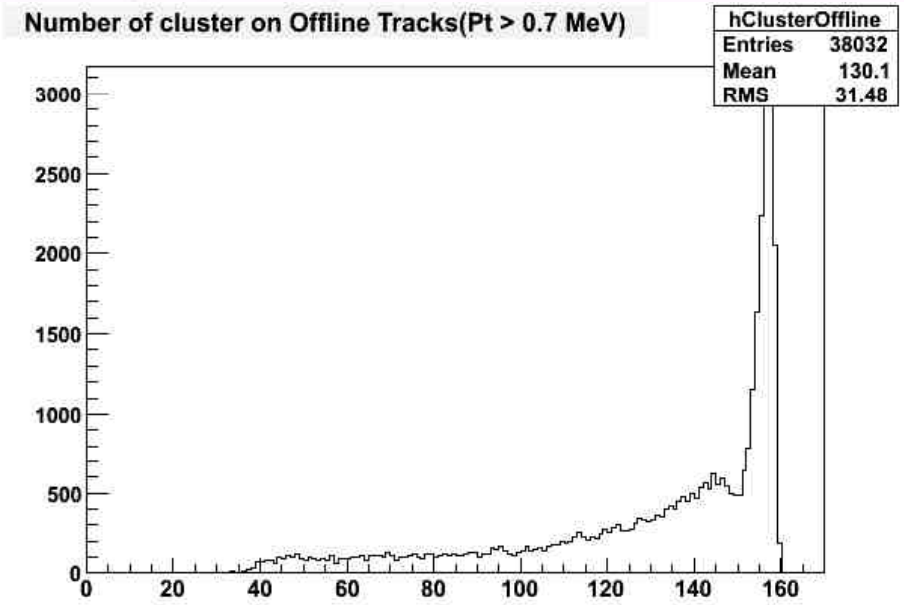
	HLT	Off-Line	PadRow Crossings
Total Number of Clusters		858 828	???

HLT divided by Offline. Efficiency.

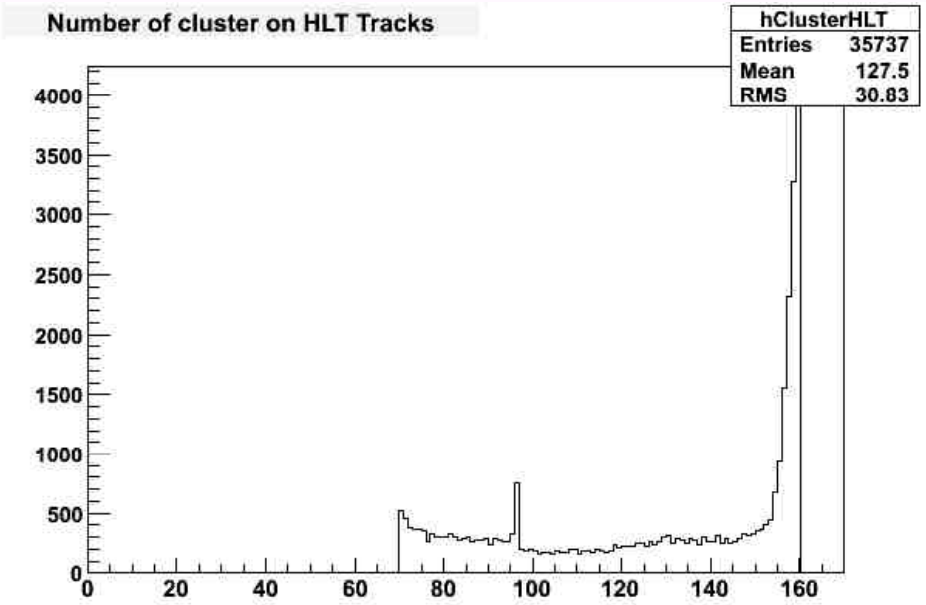


How many clusters are associated to a track.

Off-Line



HLT



Benchmark on the HLT-Cluster

- Setup for one sector
  - 6 ClusterFinders running in parallel on 6 CPUs
  - 1 Tracker running on one CPU.
- Results (old decoder)
  - ClusterFinder: 240 Hz
  - Tracker: ~200 Hz
  - Stable run for 6 hours.

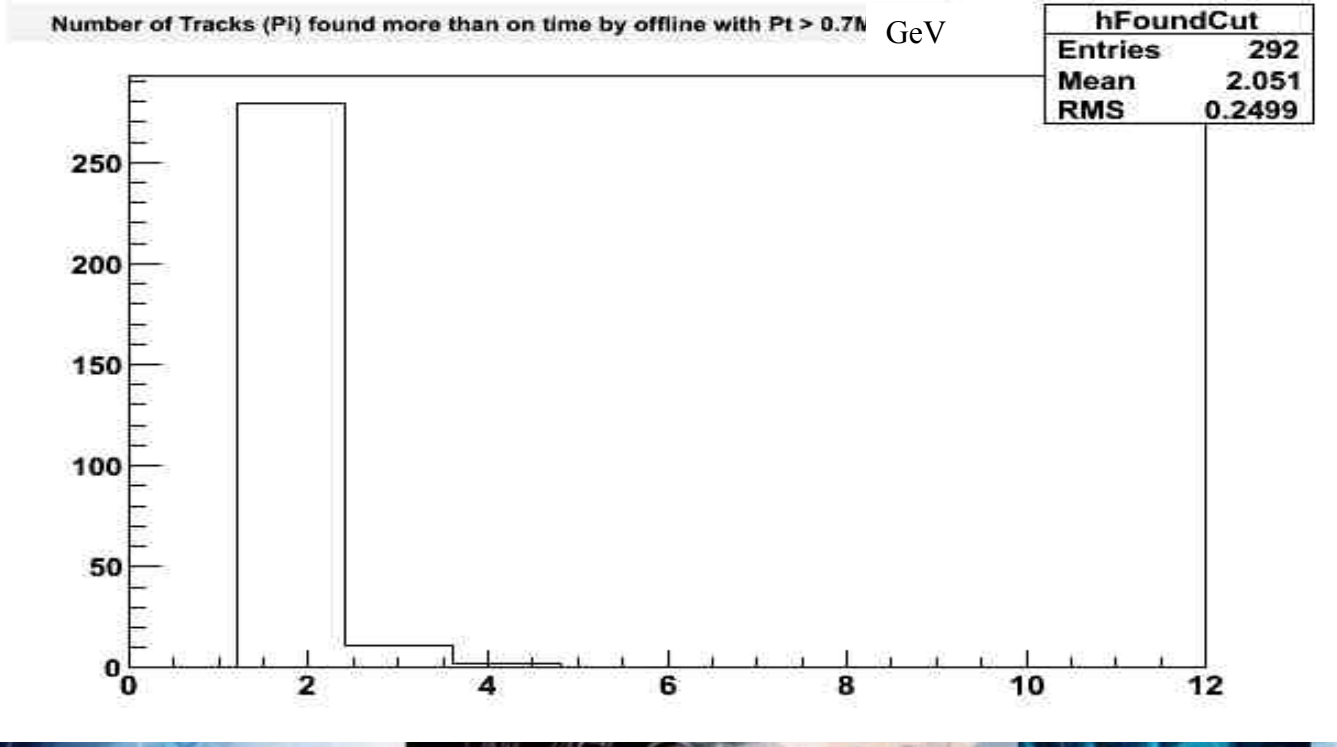
ToDo

- Further study of performance.
- Comparison to MC and Offline.
  - Some open questions -> Next slides.

Questions for the offline Tracker.

Observation: Tracks pointing to the same MC track
(Offline reconstruction in aliroot v4-06-Release, KinkIndex > 0 rejected)

Explanation?



Primary π^+, p_t>0.7GeV/c

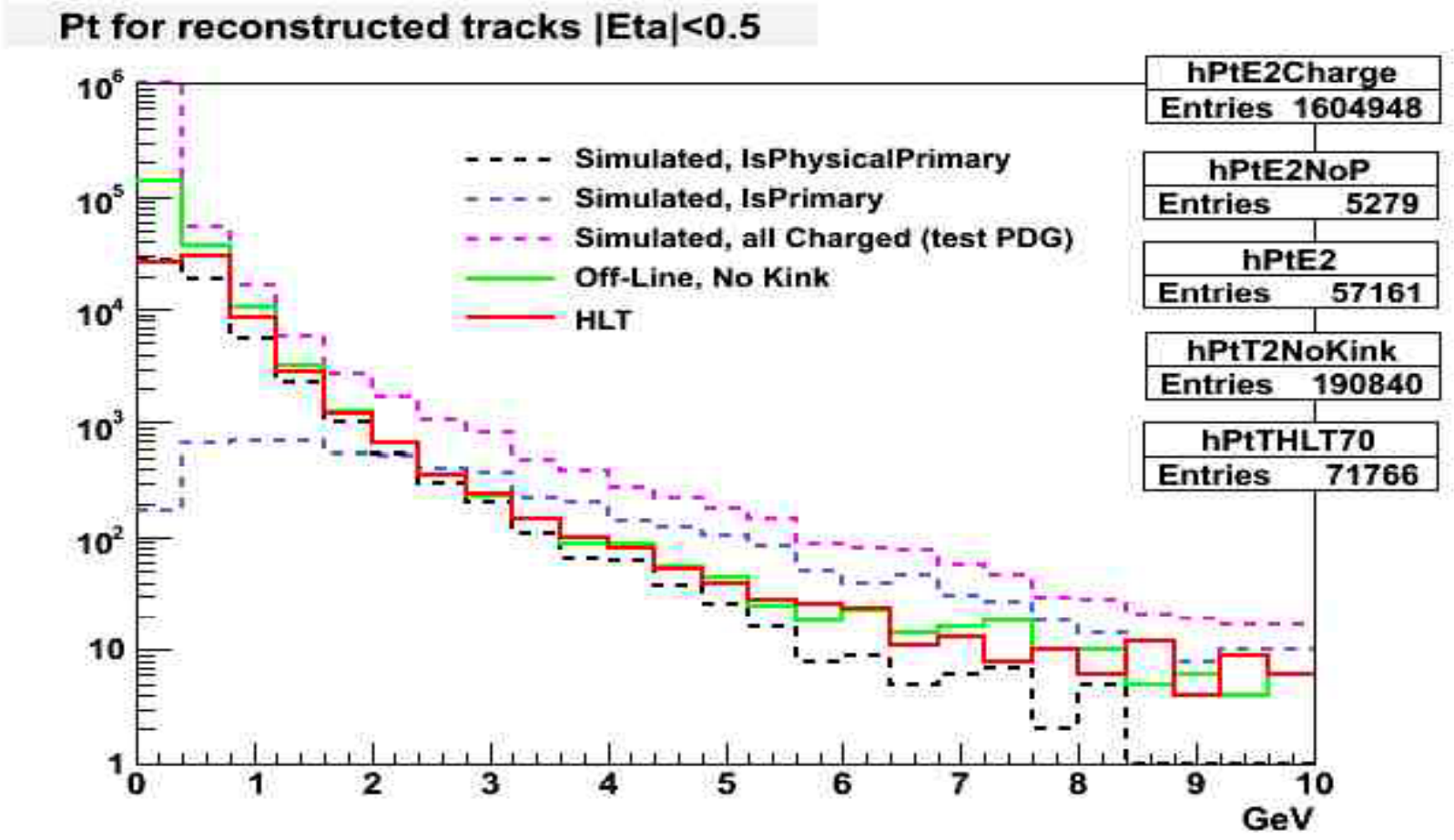
(TPCrefit, ITSrefit, HEAD 24.09.07)

track	TPC label	# clusters	p_t (GeV/c)	kink index (0)
0	8	159	2.73978	0
1	9	158	3.02013	0
2	3	158	3.16608	0
3	7	155	3.62226	0
4	2	136	0.96183	0
5	4	154	2.37975	-5
6	1	155	4.48729	-3
7	0	159	3.31072	-1
8	6	157	2.88375	-4
9	9	158	3.01235	-2
10	5	41	4.84928	0

Technical questions

- What does each negative kink index mean?
- Which of 2 kink indices assigned to the same track do we keep?
- Why are MC primaries more than physical primaries?
  stack->GetNprimary() and stack->IsPhysicalPrimary(index)==kTRUE

Transverse momentum of HLT, Off-line and Simulated

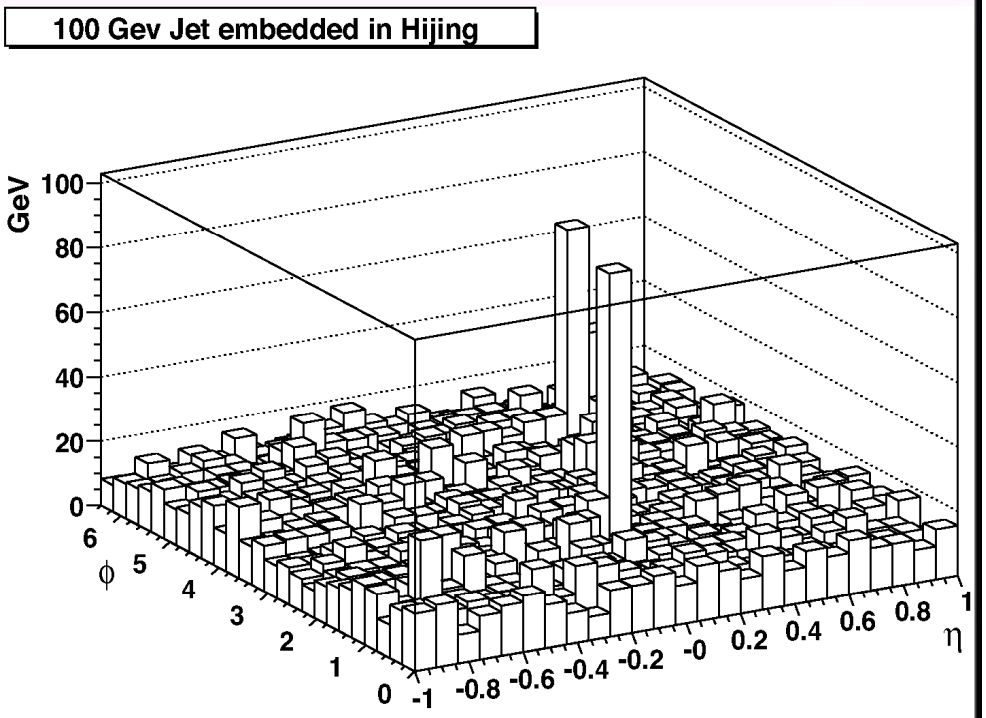


Physics triggers

Selecting events containing:

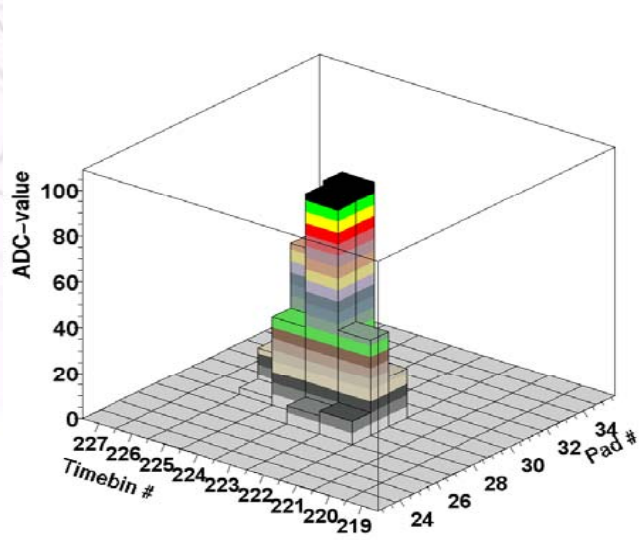
- Jets
- Open charm
- J/ψ and Υ

...

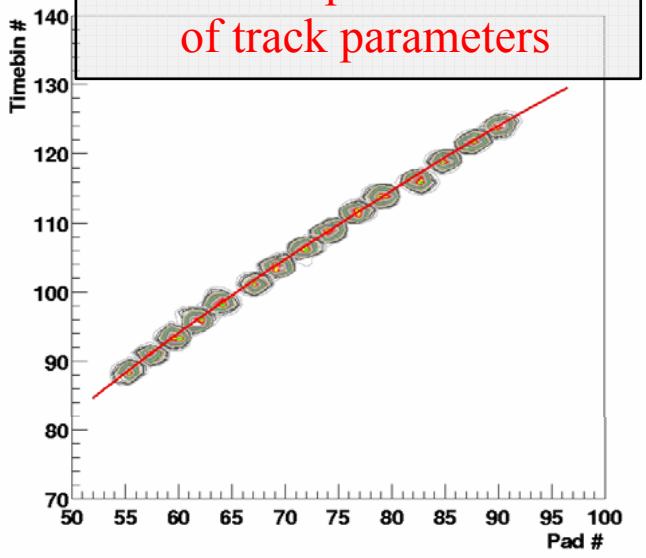


- Complete event selection/rejection
- Region-of-interest readout

TPC tracking methods



Cluster shape is a function of track parameters



Cluster finding
Reconstruct space points from 2D clusters

Sequential tracking

Iterative tracking

Track reconstruction
Connect space points into tracks and fit them to a model (helix)

Track seed finder

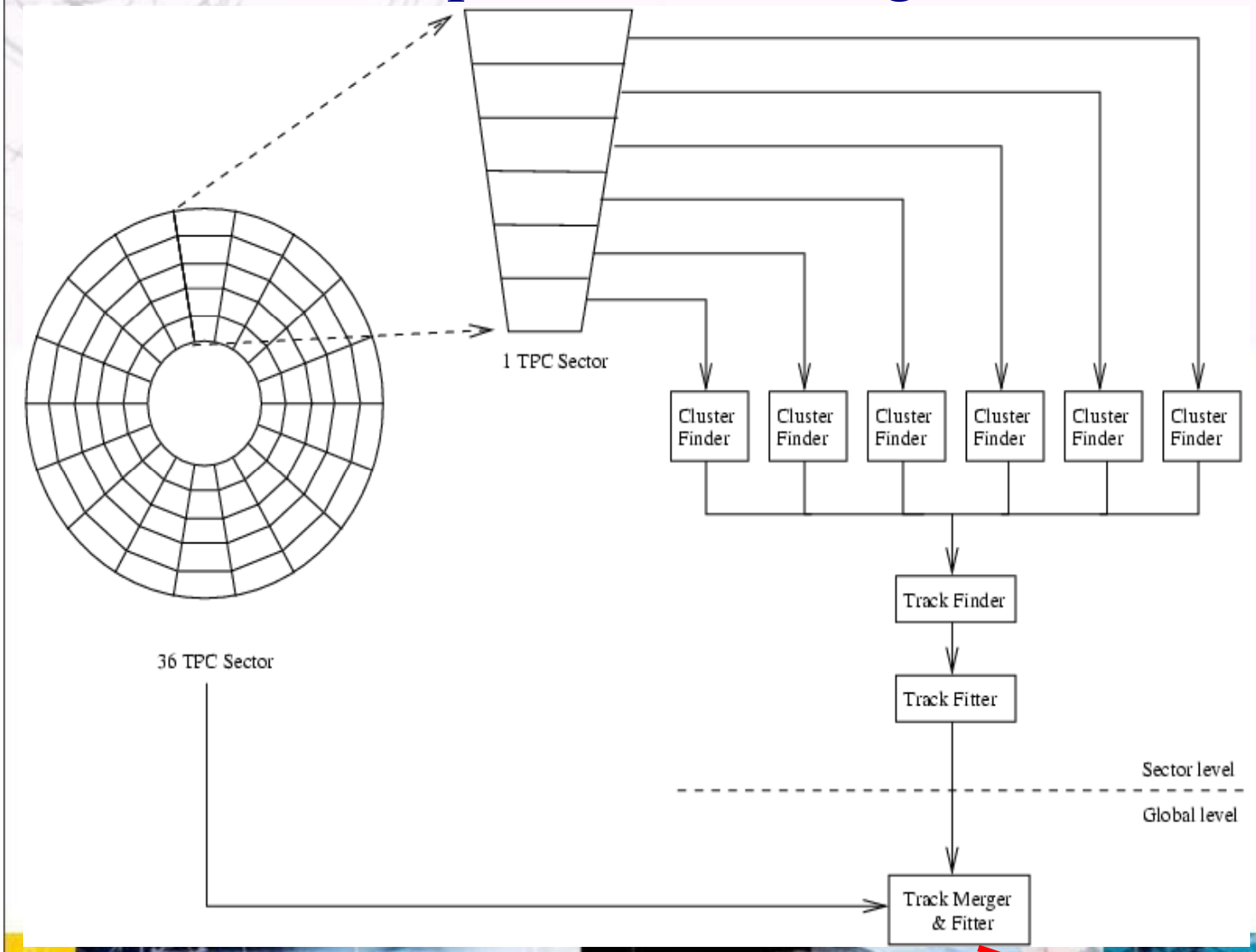
Track candida

Cluster finder / fi

Space points

Track fitter

Sequential tracking – dataflow



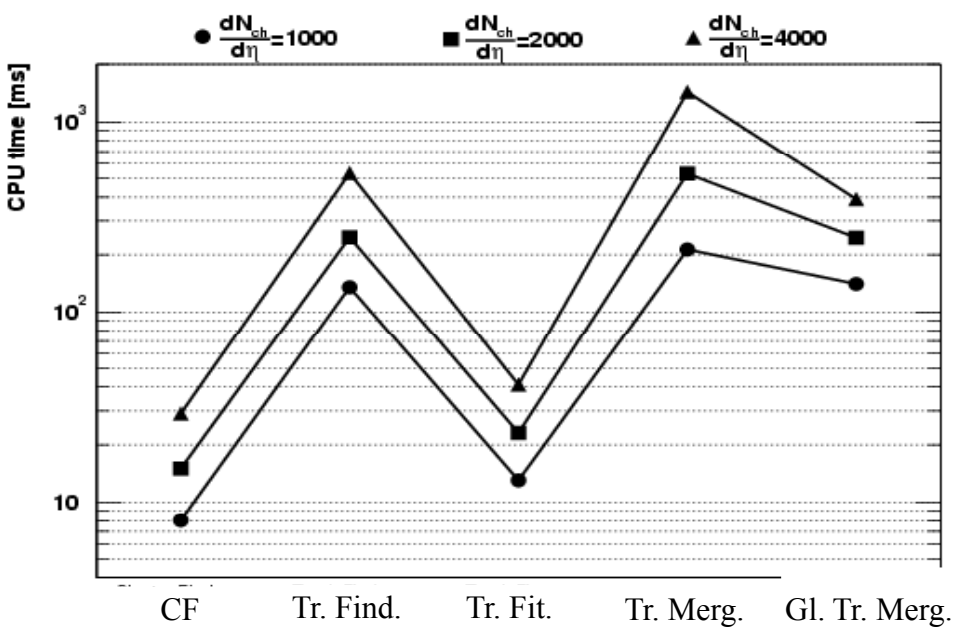
Optical links

Front-End Processors:
HLT-RORC
(Readout Receiver Card)

Sector processors

Global/event processors

Sequential tracking – computing requirements

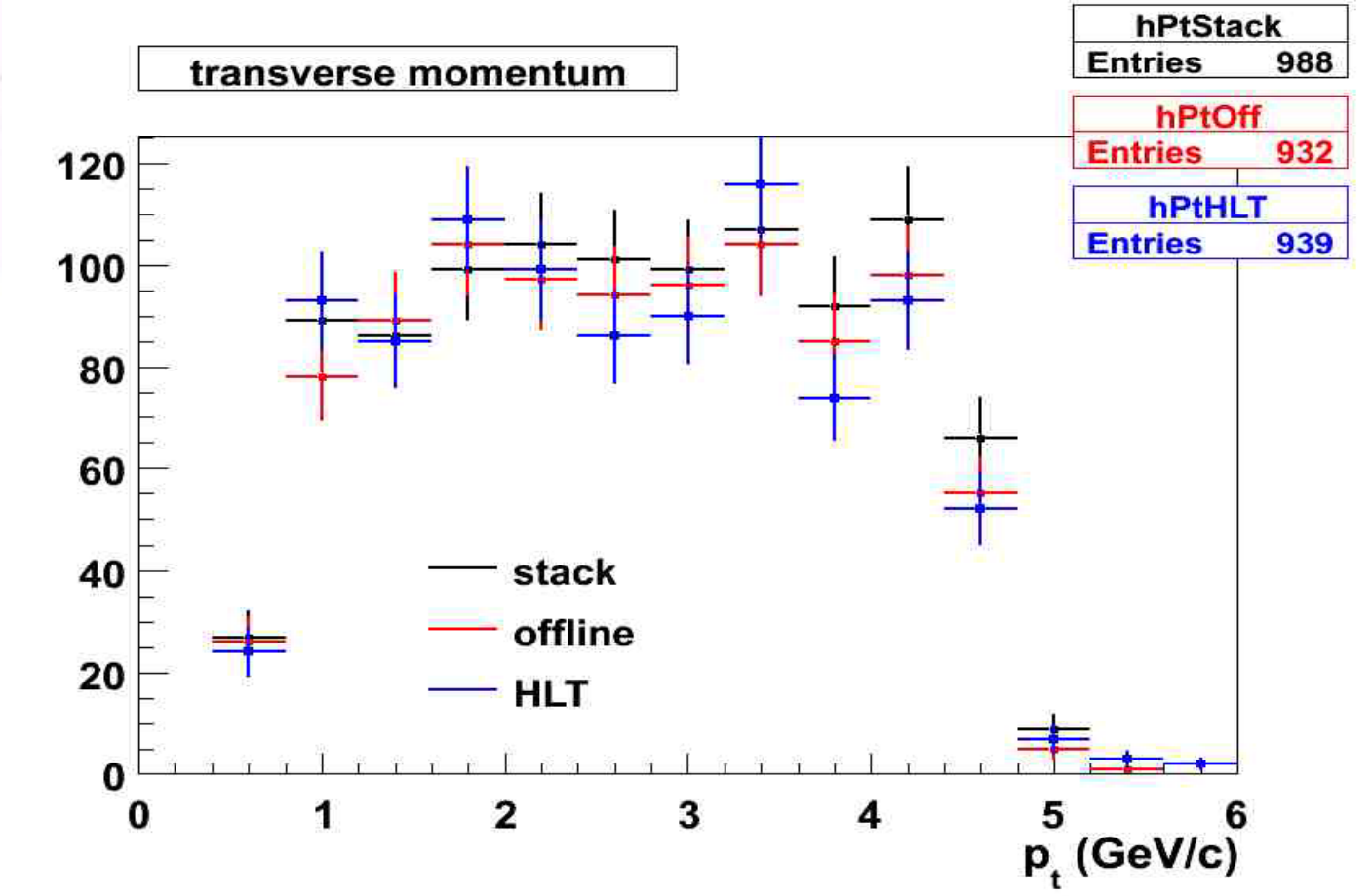


	Pentium III, 800 MHz		**Pentium 4, 2800 MHz**	
$dN_{ch}/d\eta$	CPU-time [s]	#CPU	CPU-time [s]	#CPU
1000	7.5	1500	3.4	680
2000	14.0	2800	6.3	1260
4000	29.5	5900	13.2	2650
6000	47.3	9460	21.2	4240

#CPU = Equivalent number of required CPUs @ 200 Hz processing rate

Hough Transform ?????

Transverse momentum for HLT, Offline and Simulated



compression techniques ???