dHLT Status Report

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Outline

- Quick overview of dHLT 2006 Review and reminders
- Areas of development up to present
- Status of dHLT on HLT cluster at CERN
- Performance benchmarks
- Next steps

dHLT Review

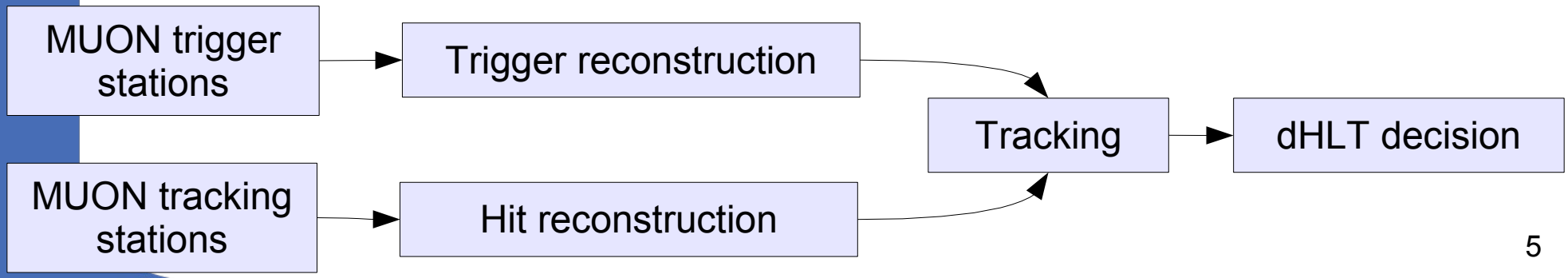
- Full project review in October 2006, was written up into Internal Note (accepted by Editorial Board)
- Two hit reconstruction algorithms (one in software and one for FPGA) and two track reconstruction algorithms benchmarked.
  - Results were satisfactory.
- Chose one official algorithm to implement in HLT at CERN for:
  - hit reconstruction : “Kolkata” software implementation.
  - track reconstruction : “Manso” algorithm using St. 4 & 5
- Unofficial algorithms for track and hit-reco are currently not under active development (pending dHLT commissioning).

Purpose of dHLT

- **Improve the pT resolution to gain sharper pT cut, allowing dHLT to be a more selective filter of raw data.**
- Done by partial event reconstruction in the muon spectrometer tracking chambers.

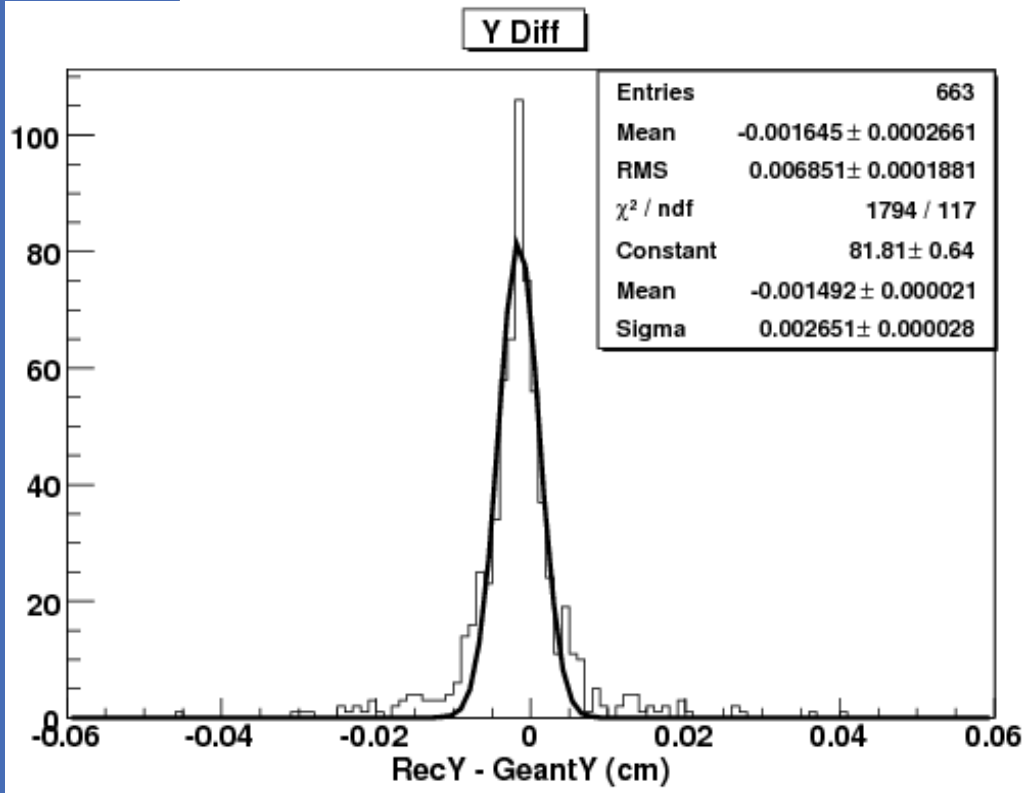
Reminder about algorithms

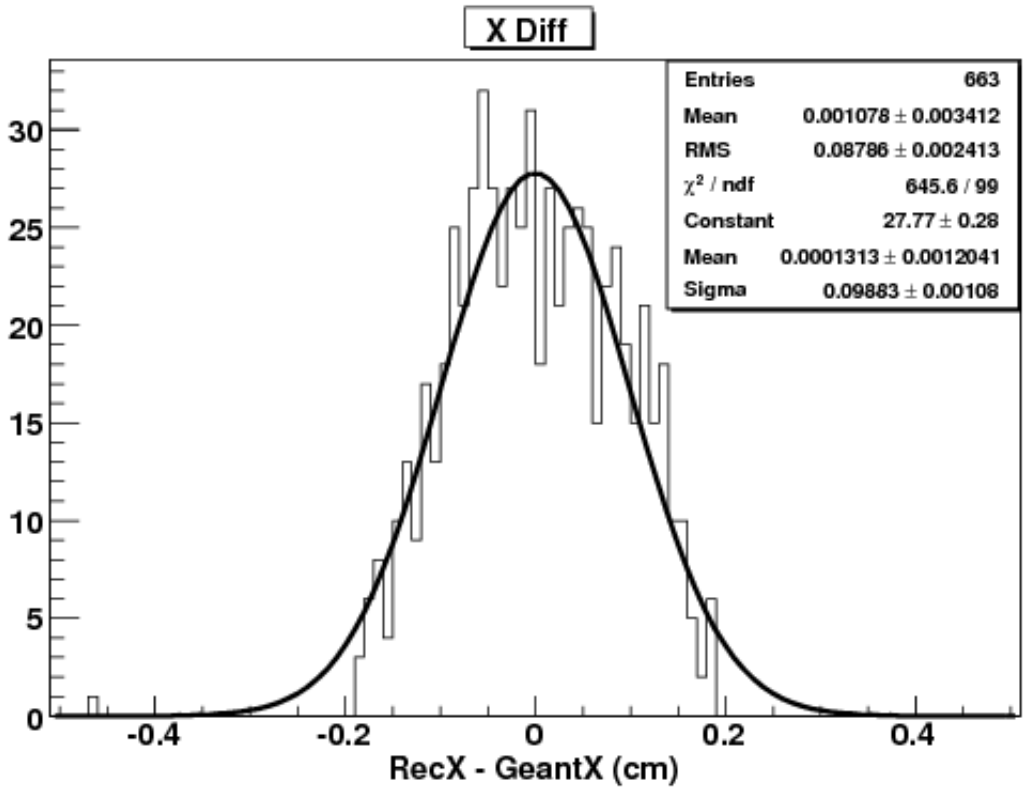
- Hit reconstruction performed on tracking stations 4 and 5. Algorithm applies a DC cut to all channels, then looks for 3 pad clusters on the bending and non-bending plane separately. The centre of gravity is calculated to give the reconstructed X and Y coordinate. X and Y is merged to give reconstructed hit.
- Trigger reconstruction is simply a data transformation from the DDL streams from trigger electronics. The X-Y bit patterns are converted into floating point coordinates in global AliRoot coordinates.
- Tracking uses a track following algorithm which tracks back through the muon filter wall to stations 4 and 5. Circular regions of interest are used to search for and select reconstructed hit candidates forming part of a track. Pt is then estimated from the spatial information on the tracking chambers.



Hit reconstruction resolution (dHLTreview result)

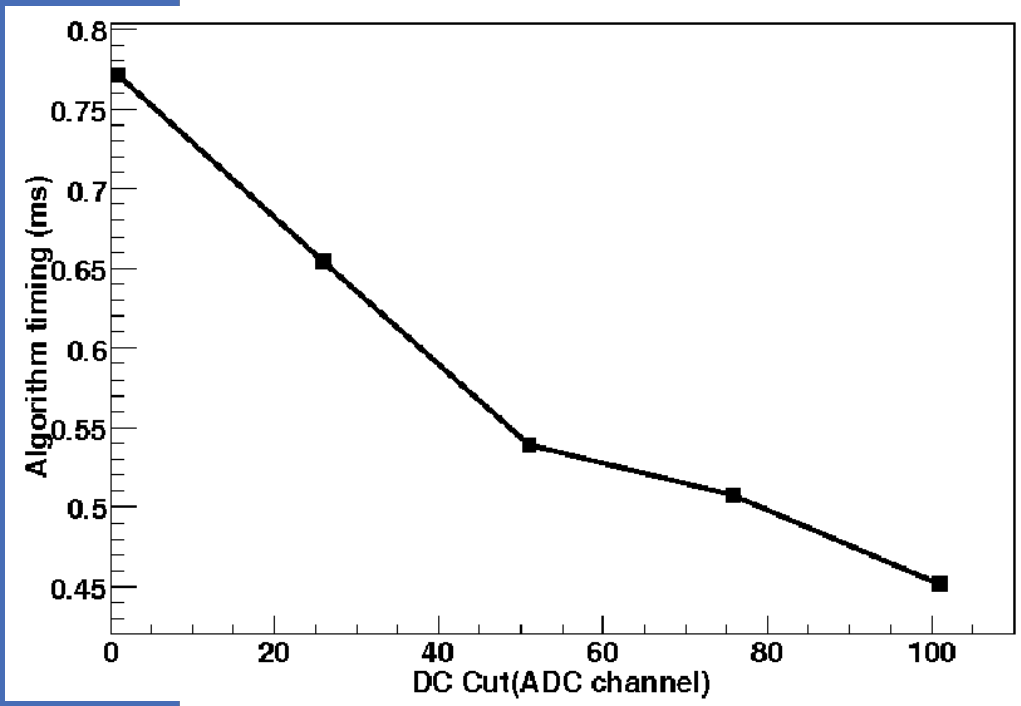
- Bending (Y) plane: 48 ± 30 microns
- Non-bending (X) plane: 0.93 ± 0.08 mm

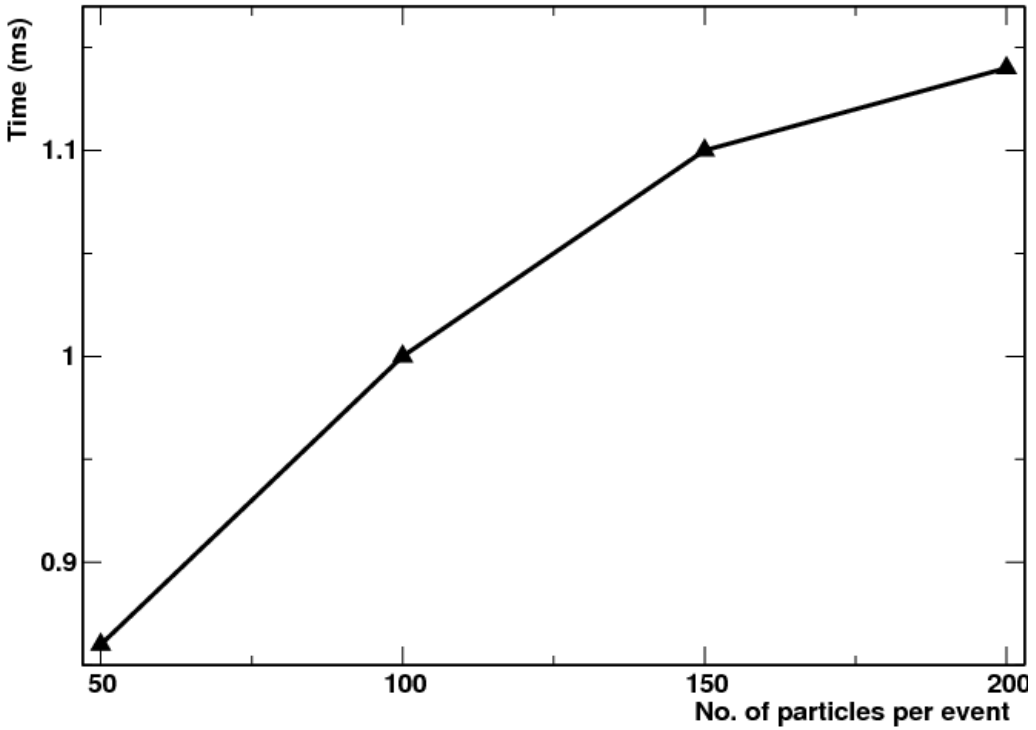




Hit reconstruction timing (dHLTreview result)

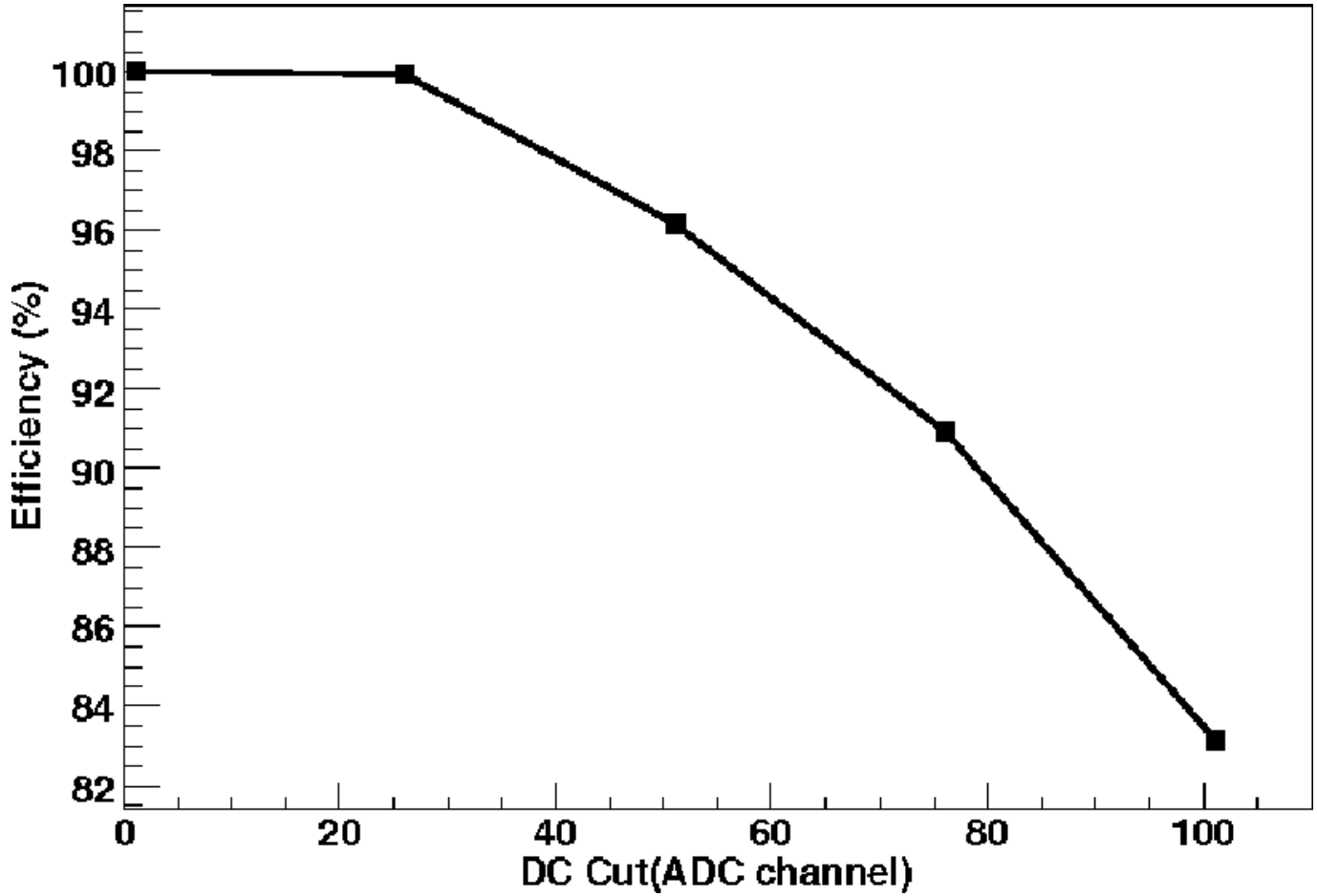
- 1.1 ± 0.1 ms per DDL at a DC cut of 50 channels and nominal 150 tracks in the spectrometer per event.
- Timing performed on a single 2 GHz Pentium CPU





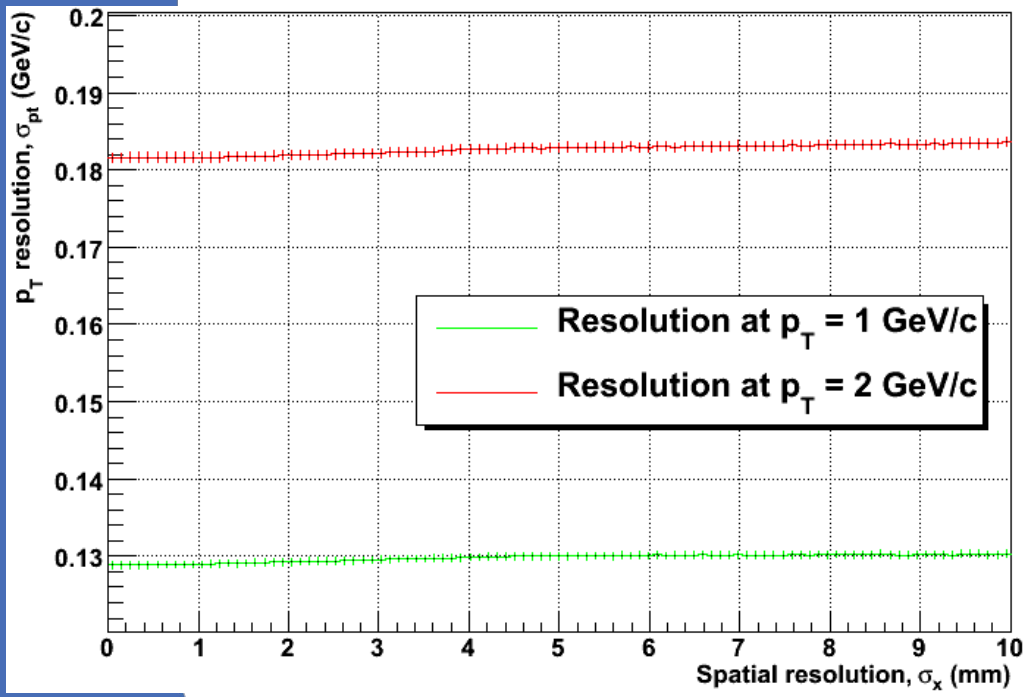
Hit reconstruction efficiency (dHLTreview result)

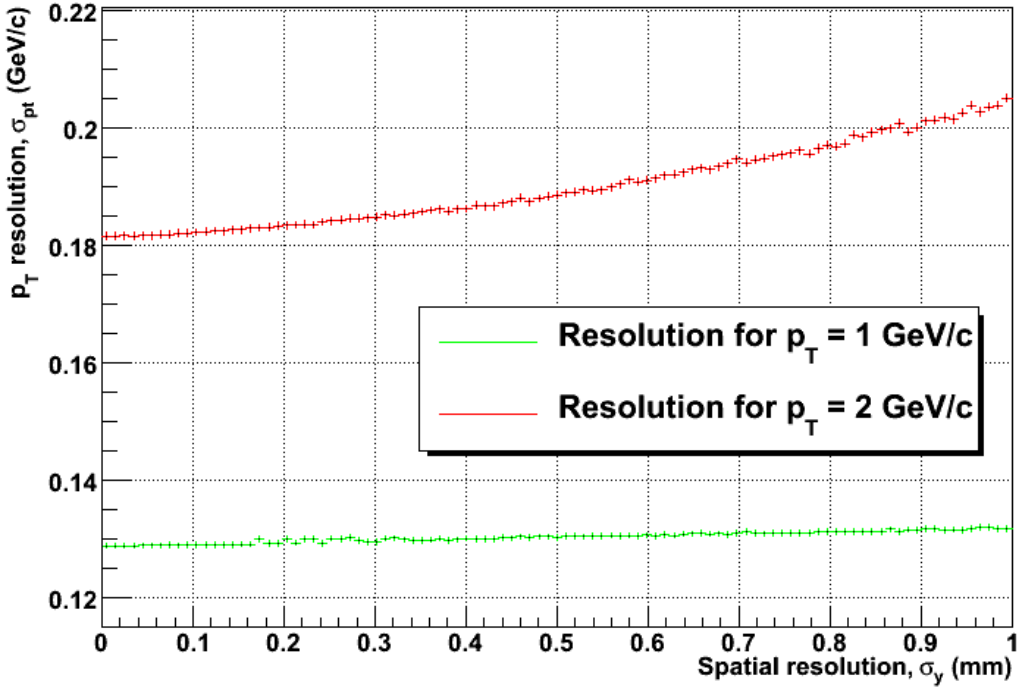
- 96% at the DC cut of 50 channels.



Tracker resolution (dHLTreview result)

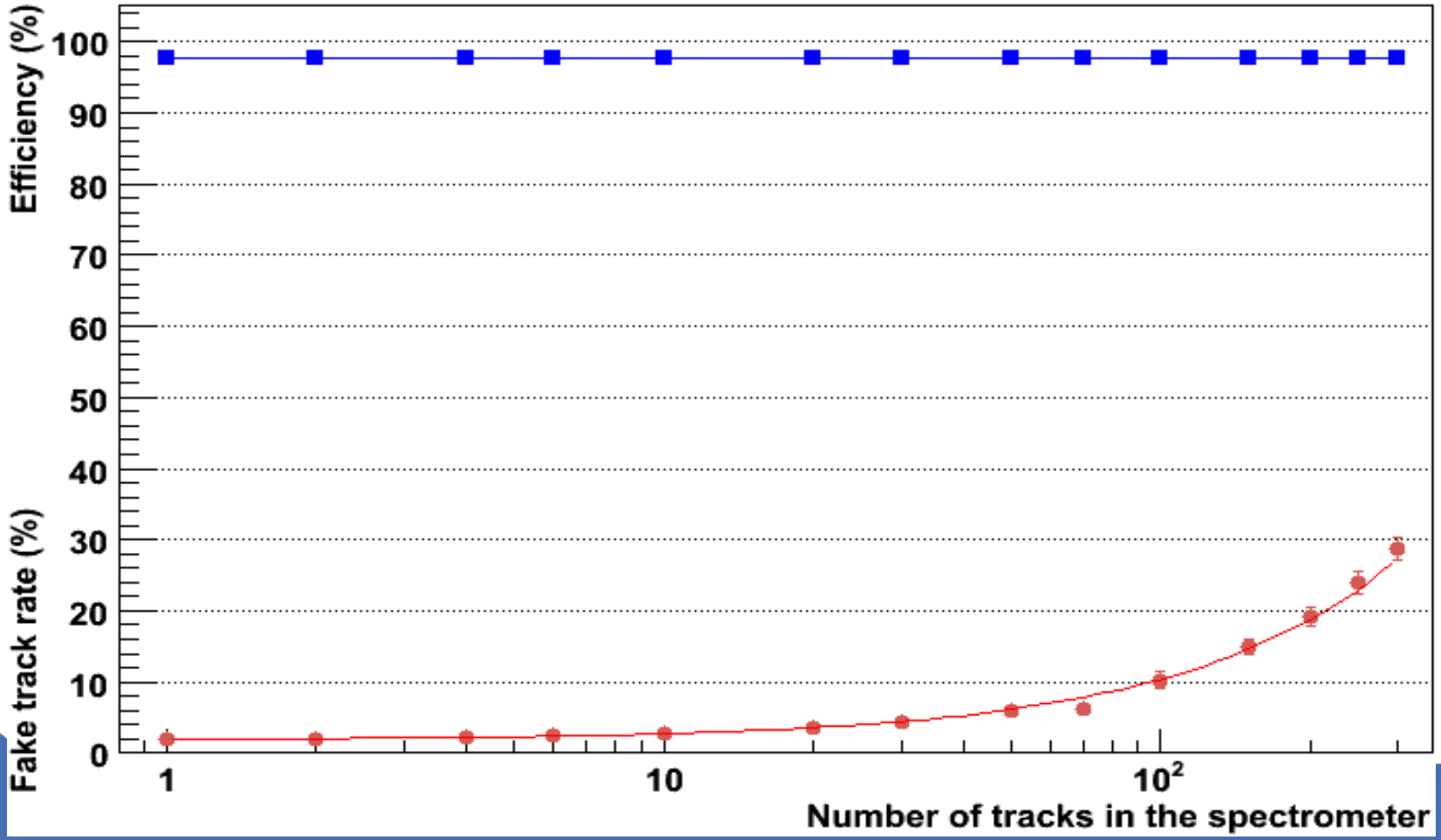
- The resolution at pT equals
  - 1 GeV/c is 0.13 ± 0.01 GeV/c, thats ~13% of pT,
  - 2 GeV/c is 0.18 ± 0.01 GeV/c, or ~10%.
- Resolution quite insensitive to spatial resolution in both bending and non-bending planes.





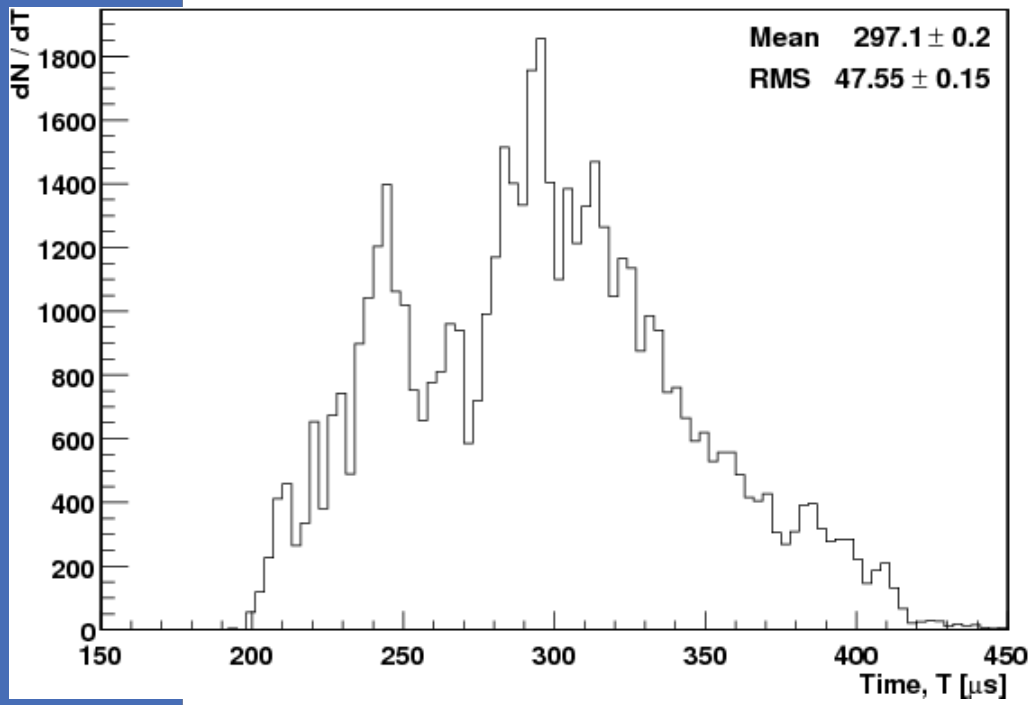
Tracker efficiency (dHLTreview result)

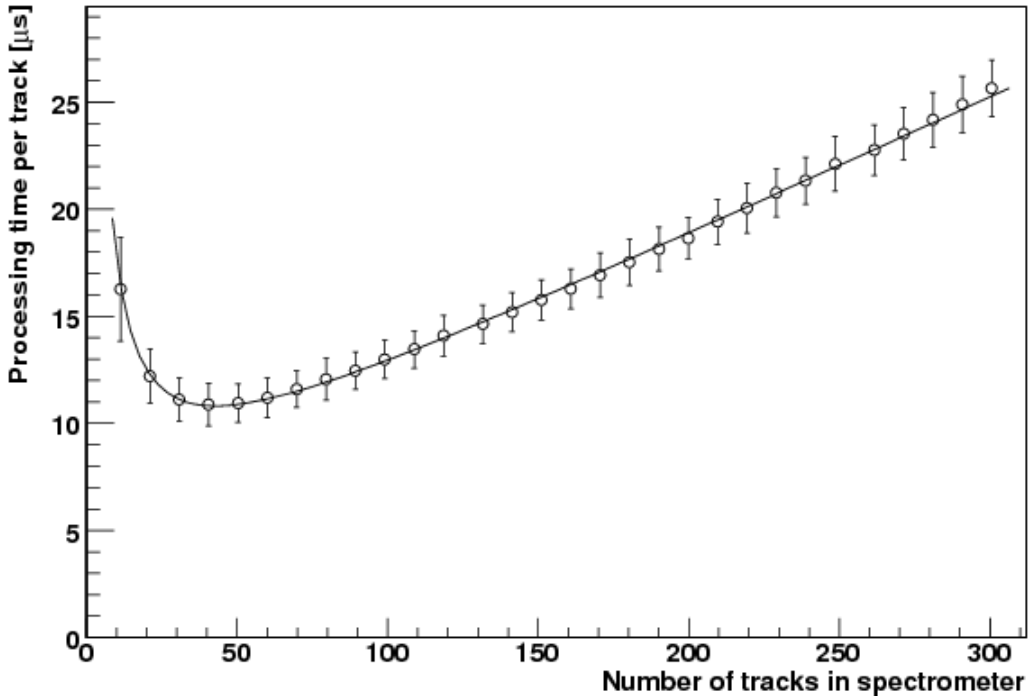
- Above 97% and flat for all numbers of tracks in the spectrometer.
- Fake tracks (all tracks found that are not muons) grows quite rapidly for large numbers of tracks in the spectrometer, but acceptable for p+p runs.



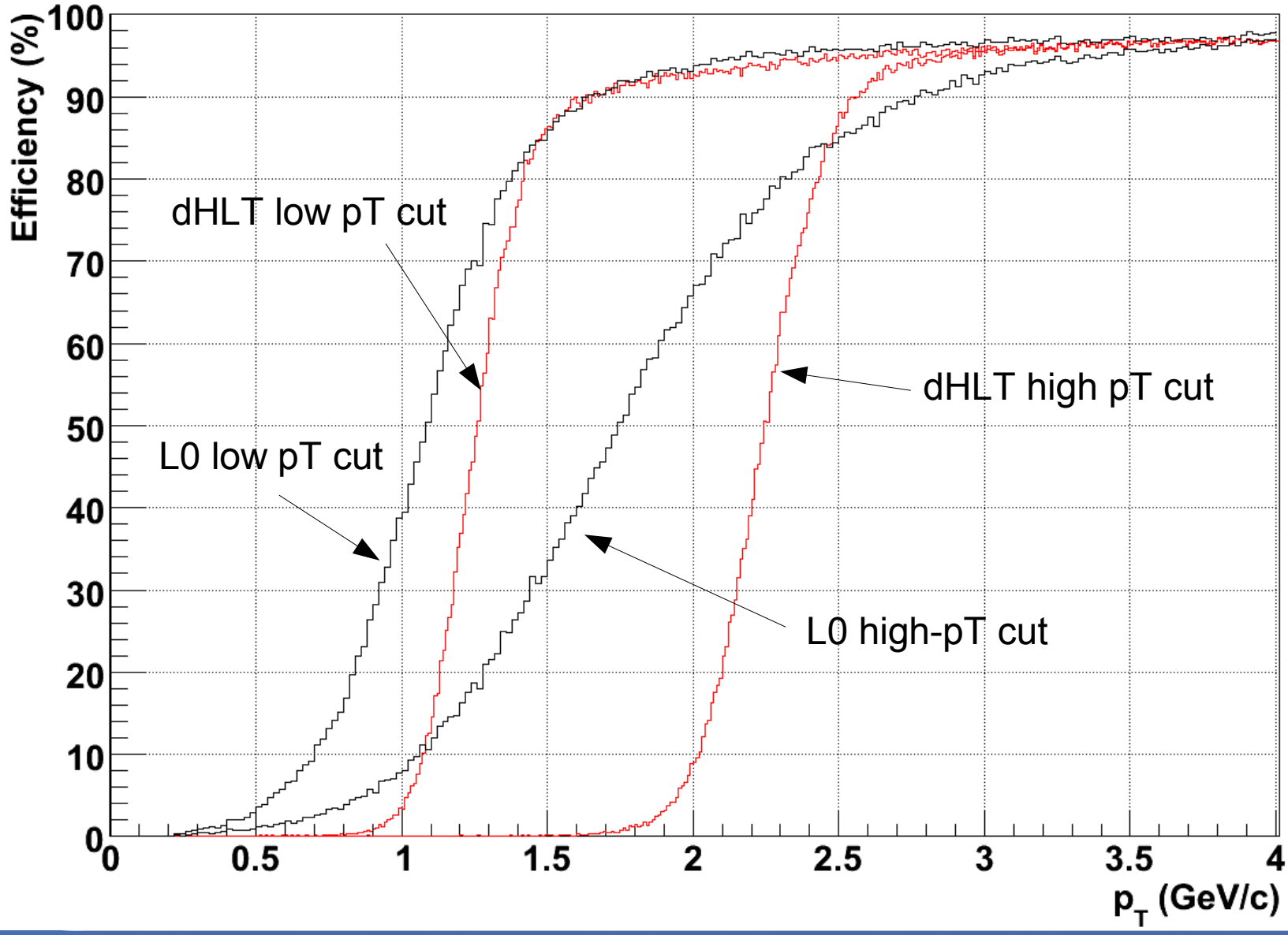
Tracker timing (dHLTreview result)

- 297 ± 48 micro seconds for parameterized HIJING events with central dN/dy = 8000.
- Timed on AMD Athlon 800 MHz





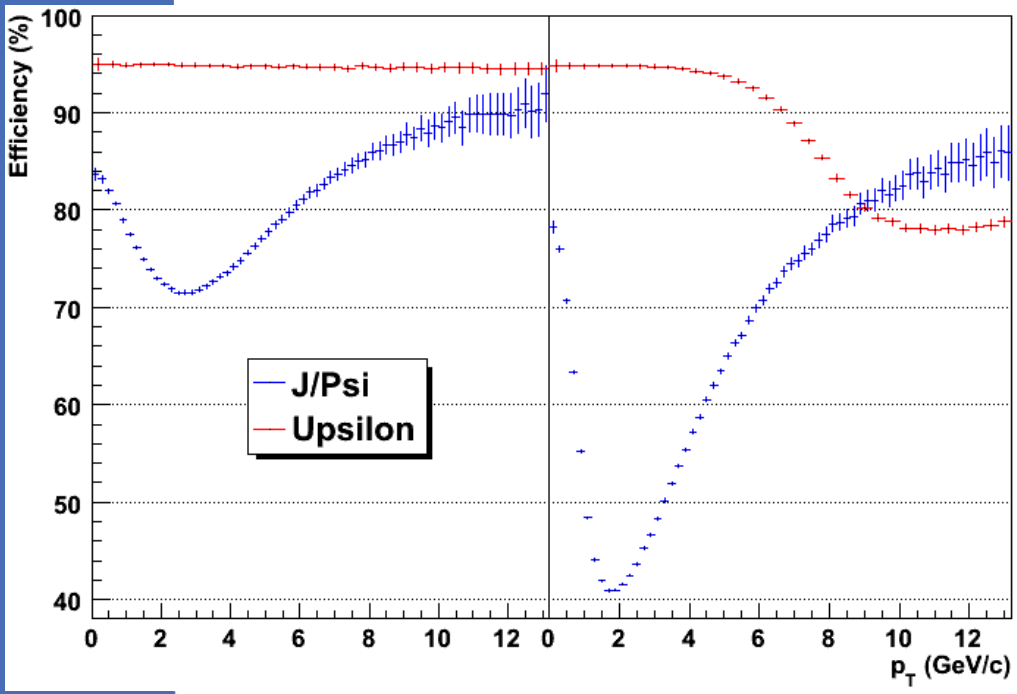
pT cut resolution (dHLTreview result)

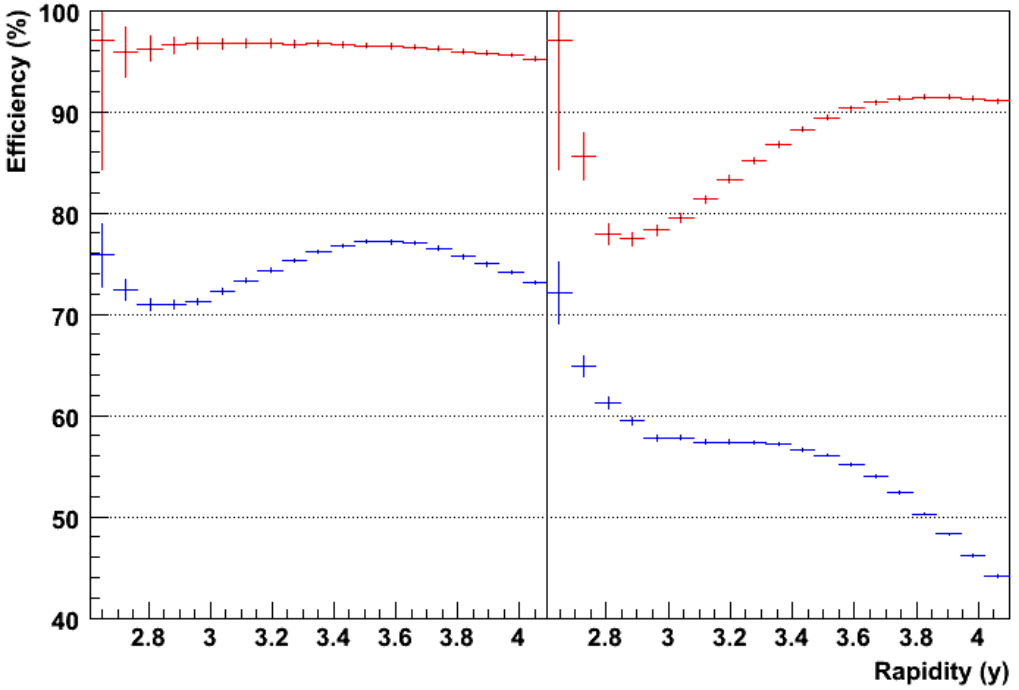


Signal detection / background rejection (dHLTreview result)

Particle	pT cut (GeV/c)	Detection efficiency (%)	
		dHLT	L0
J/ψ	1.	52.6	71.
Υ	1.	94.8	97.
Υ	2.	91.3	88.

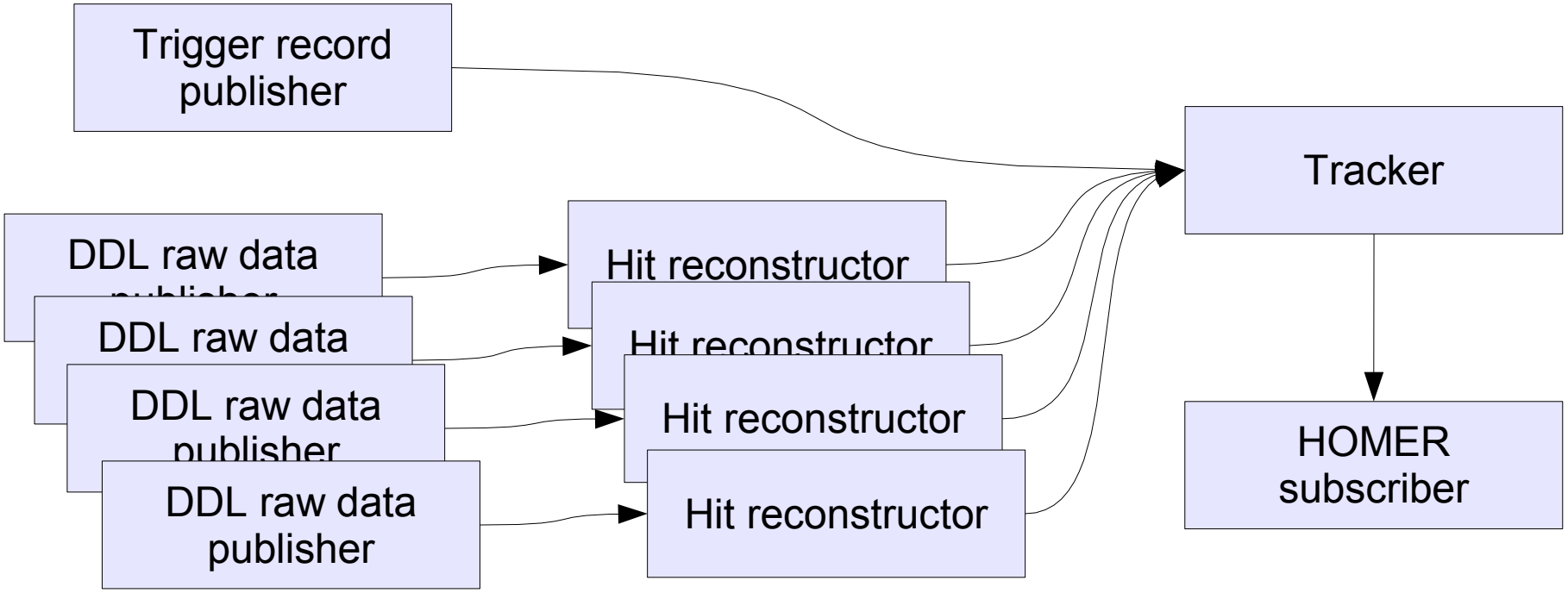
pT cut (GeV/c)	HIJING central event rejection (%)	
	dHLT	L0
1.	13.	3.
2.	76.	40.





dHLT processing rate in Pub/Sub framework (dHLTreview result)

- ~ 1.2kHz, which is well above the design specification.
- Tested on 6 nodes in cluster at UCT-CERN (Oct 2006)
  - 2.6 GHz HT P-IV CPUs, GBE network



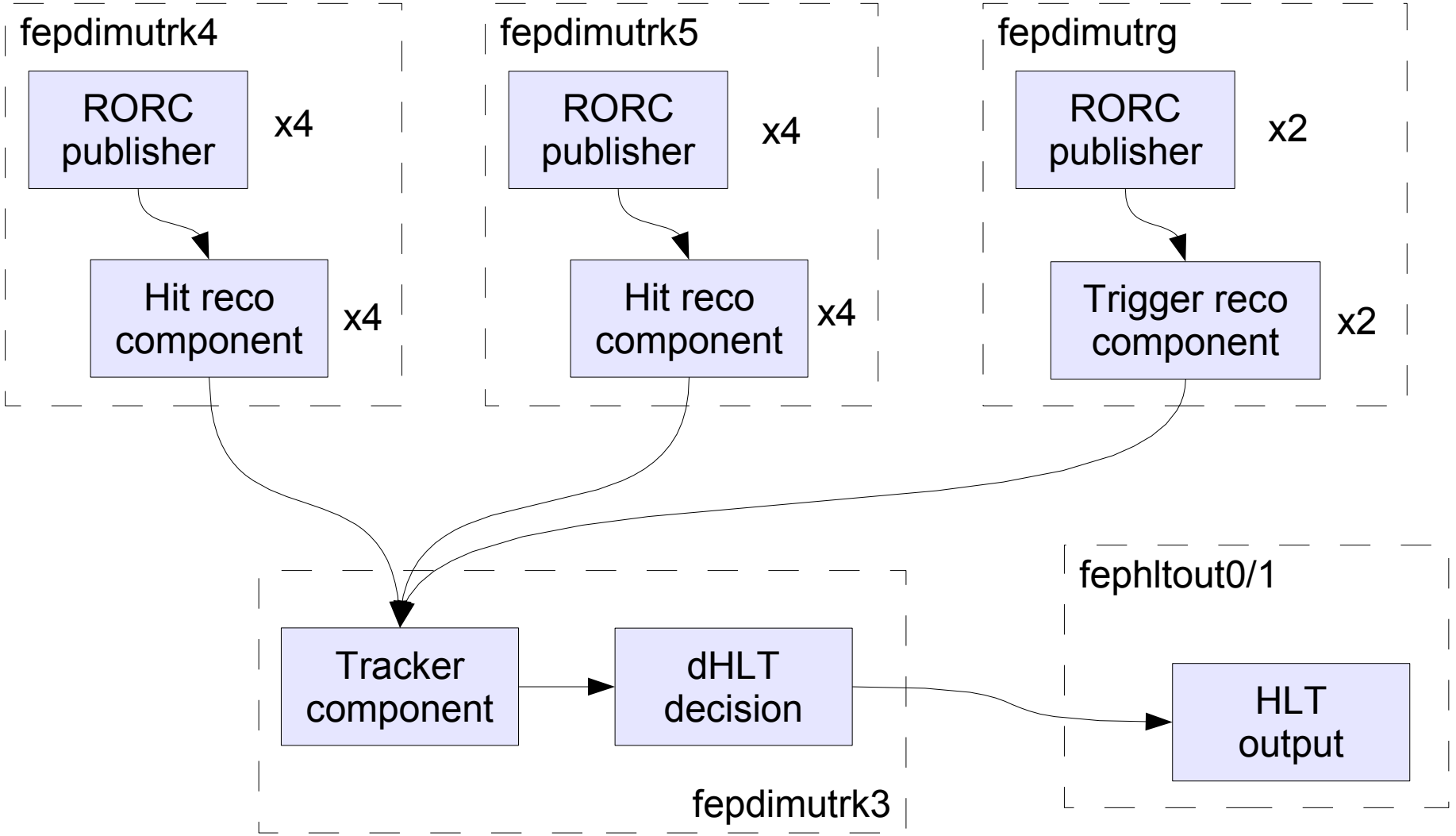
Developments over the past year:

- Integrated all code into AliHLTSystem framework.
  - Allows easy integration into both online HLT framework and AliRoot.
  - Cleaned up the HLT/MUON CVS repository.
- Checked baseline performance parameters at HLT cluster at CERN.
  - Reproducing expected results.
- Explored and prototyped monitoring methods and tools.
  - Work started to migrate to now official (and common) monitoring tools like: AliEVE
- Hit reconstruction component now can also apply ADC calibration.
- Work started for common offline/online raw DDL data decoder for muon spectrometer (ongoing).

Status of dHLT on HLT cluster at CERN

- We have the dHLT implemented on the common HLT cluster at CERN.
- Hardware:
  - 6 front-end processing nodes, 5 for processing tracking stations and 1 for trigger stations.
  - Each node has:
    - Dual AMD Dual-core Opteron processors at 1GHz.
    - 8 Gbytes of main memory.
  - All nodes interconnected with 2 Gigabit ethernet connections.
  - All 22 DDL fiber connections from DAQ are connected, 4 per node, except trigger node: it only has 2.

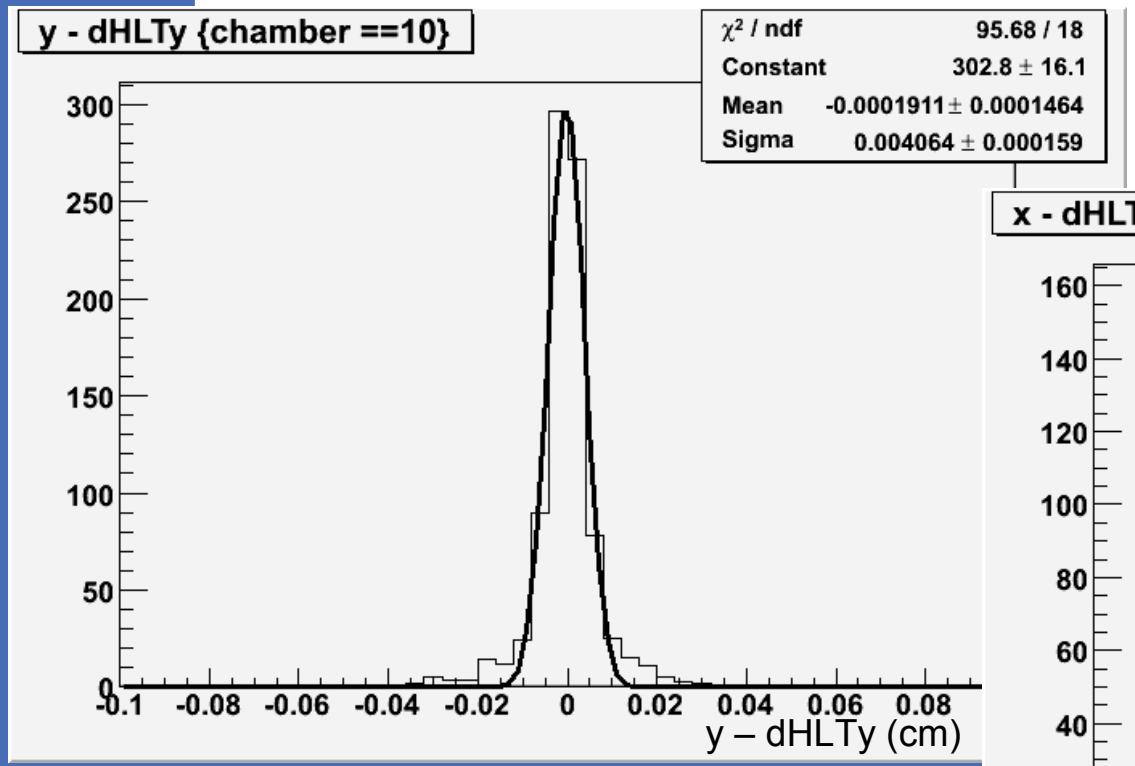
Current production setup of dHLT on the HLT cluster at CERN

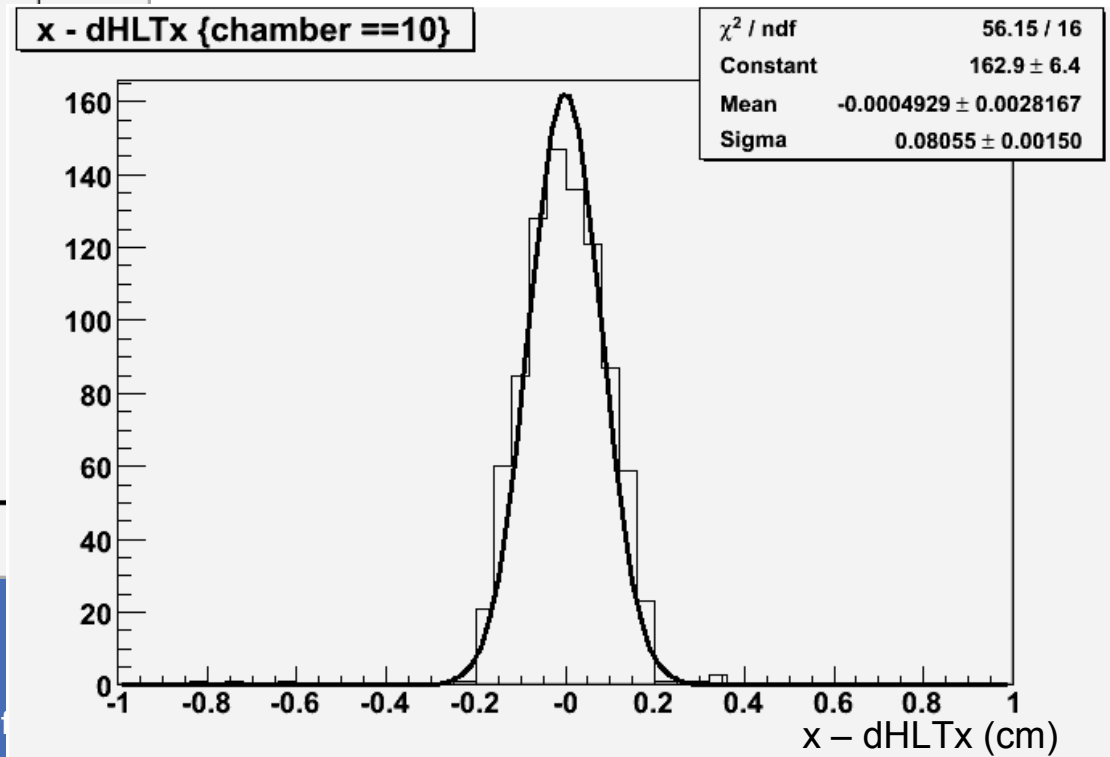


Recent results on HLT-CERN cluster

Performance: Hit reconstruction (Results on HLT-CERN cluster)

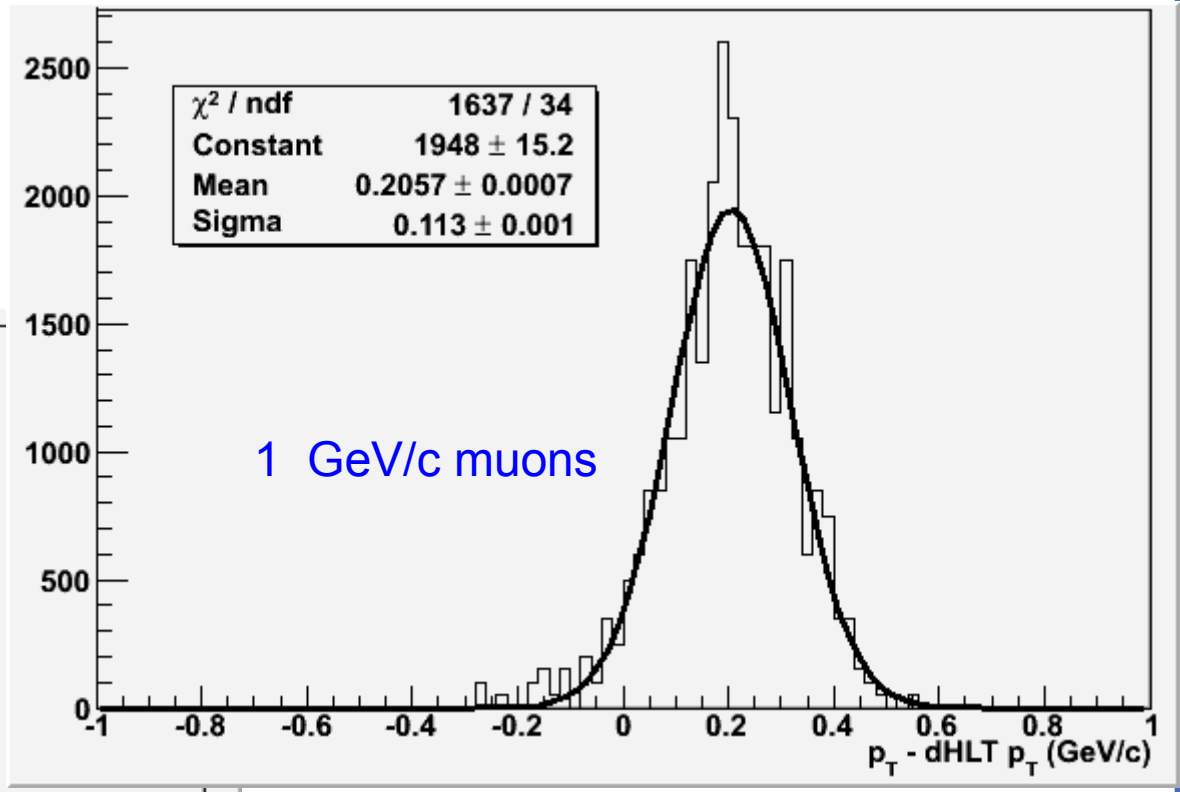
- We have generated runs of single muons and reconstructed them on the HLT-CERN cluster - want to confirm results of dHLT Review
- timing : total average time needed per event: 663.9 microsec.
  - 150 tracks per event = 75 hits per DDL
- Resolution
  - bending (Y) plane ~40 microns
  - non-bending (X) plane ~0.8 mm
- Efficiency : 98.5 %

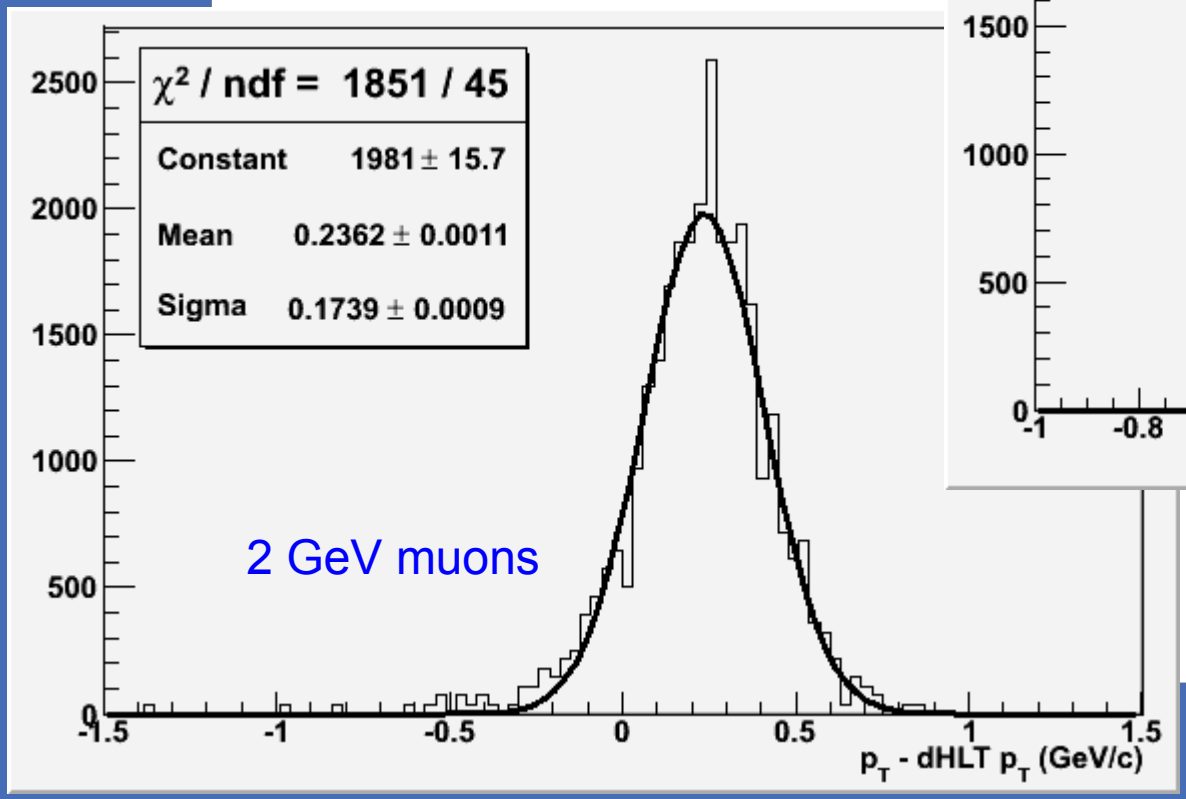




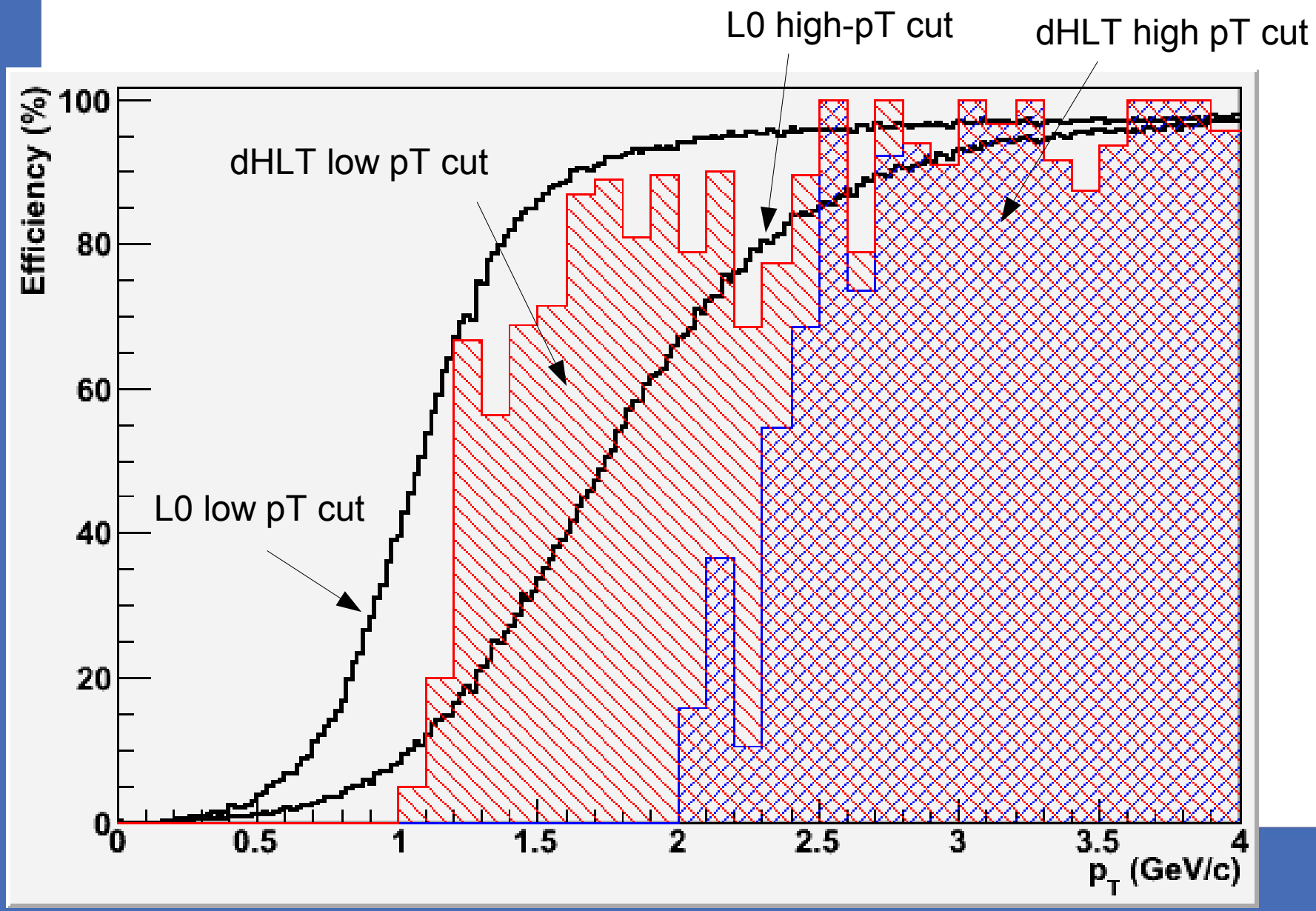
Performance: Tracking (Results on HLT-CERN cluster)

- Tracking efficiency is over 95 % with single muon events.
- Resolution :
  - 1 GeV muons : 113 MeV/c
  - 2 GeV muons : 174 MeV/c



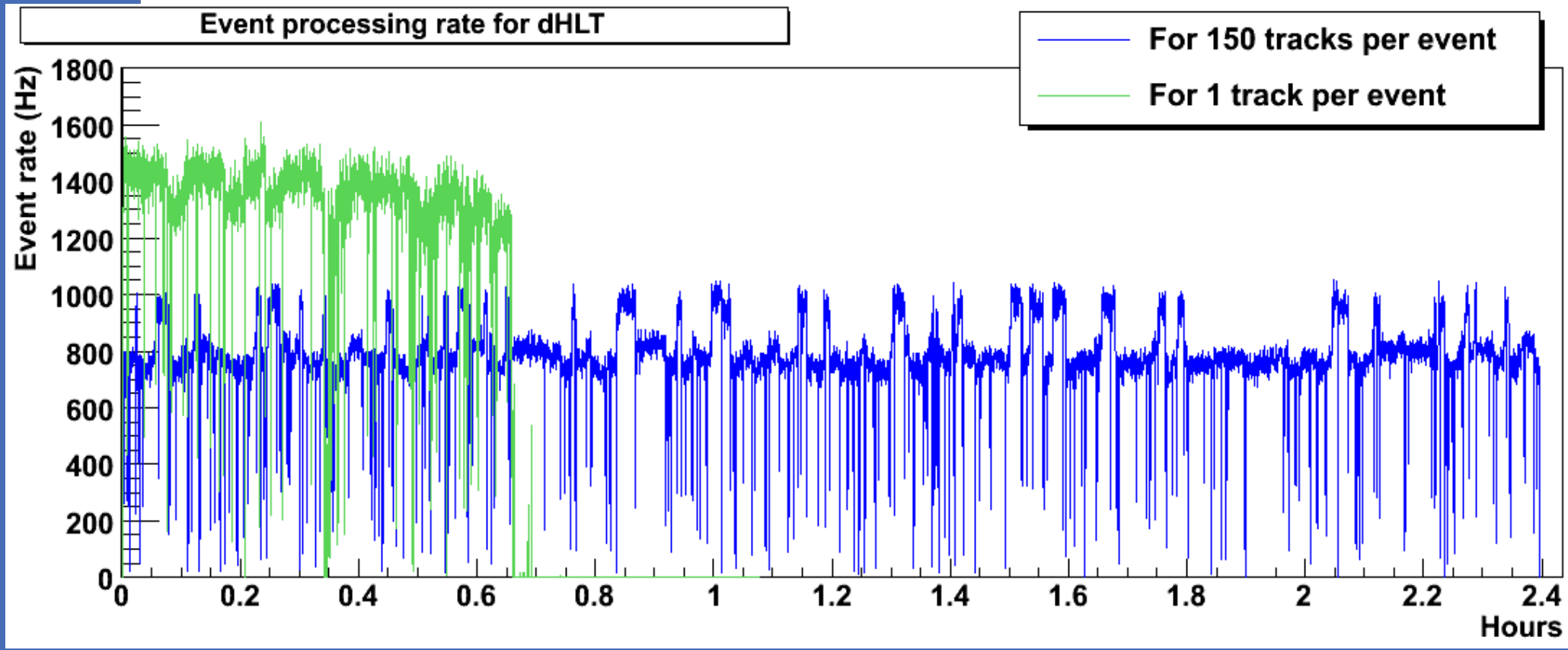


Performance: pT cuts (Results on HLT-CERN cluster)



Performance: Timing (Results on HLT-CERN cluster)

- dHLT processing time required (including overhead) ~ 1/rate
  - gives 0.714 ms for 1 track per event,
  - and 1.33 ms for 150 tracks per event.
- Only using about 50% of CPU and bandwidth.
- **These rates are lower limits**. Can increase rate if load-balanced.



Future developments:

- Complete work on common offline/online DDL raw data decoder for muon spectrometer.
- Pack dHLT result into common HLT-DDL output format.
- Perform systematic physics performance analyses with dHLT on HLT-CERN cluster.
  - Check results with beam-gas and min-bias pp simulations.
  - Optimisation of pT cuts.
  - Optimisation of Manso algorithm search regions.
- Auto generate LUTs from OCDB/HCDB.
- Get ready for muon spectrometer commissioning.

Request to offline team:

- Would like access to compilation test platforms for AliRoot so that CVS commits go more smoothly.
  - Currently problems with compilation on certain platforms are being picked up after a CVS commit. These could / should be caught and fixed before the commit.

The end

Definitions for efficiency and resolution

- Hit reconstruction efficiency = No. hits found by dHLT / No. of GEANT hits.
- Hit resolution = Standard deviation of residual, eg. dHLTy – GEANTy
- Pt resolution = Standard deviation of pT residual: dHLT_pt - Kine_pt
- Tracking efficiency = No. particles found / No. particles triggerable.
  - triggerable particles is one that leaves at least 3 GEANT hits in the trigger chambers.
  - Tracking efficiency for muon only reconstruction is similarly defined:
    - No. muons found / No. muons triggerable.
- Tracking fake rate = No. of fakes / No. particles triggerable.
  - A fake track is one for which we could not find a matching track in the Kine tree.
  - A dHLT track matches a Kine track if every hit in the dHLT track is closer than 5 standard deviations from the GEANT hit of the Kine track.
  - We choose the Kine track which has the smallest fit parameter Q defined as:

$$Q = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{(x^i_{dHLT} - x^i_{GEANT})^2}{\sigma_x^2} + \frac{(y^i_{dHLT} - y^i_{GEANT})^2}{\sigma_y^2} + \frac{(z^i_{dHLT} - z^i_{GEANT})^2}{\sigma_z^2}\right)$$