DØreco status and plans

Laurent Duflot

LAL- Orsay

DØ Algorithm Software coordinator

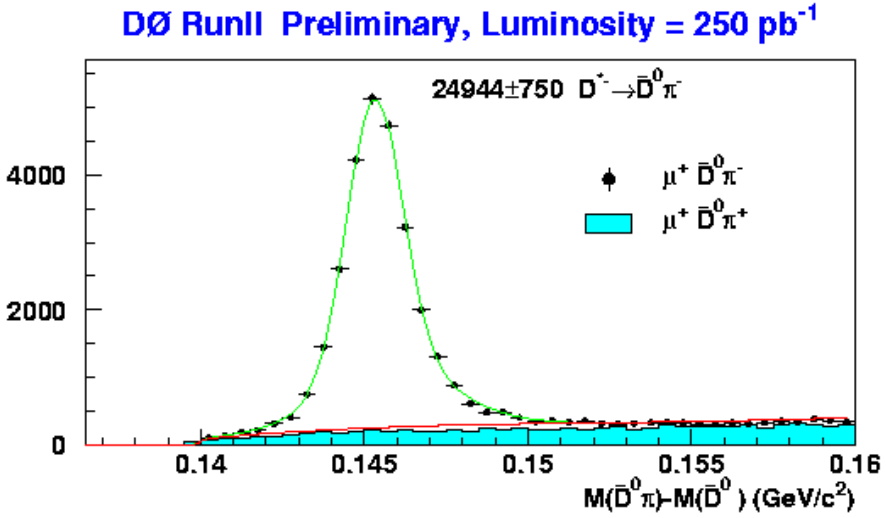
- Follow-up and progress since last review
- Current issues
- Perspectives

Dedicated to Harry Melanson

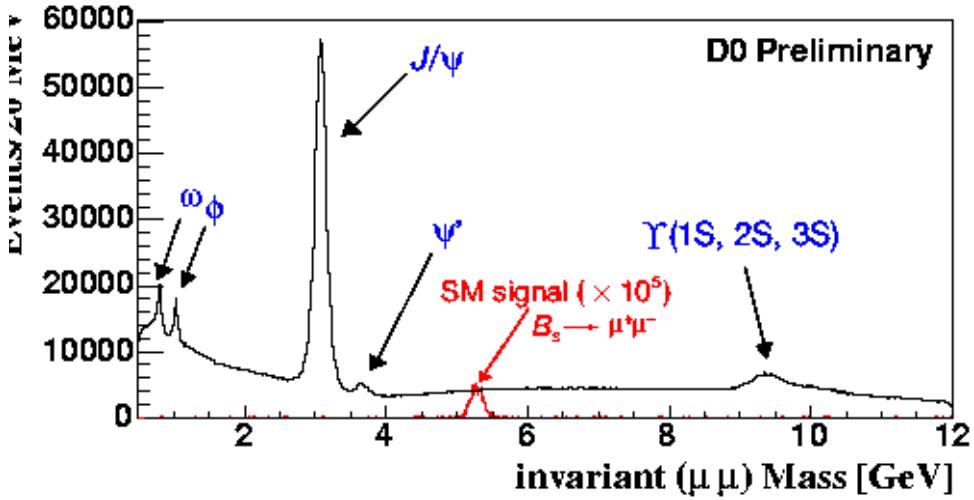
Tracking

- Last year, we reported on the introduction of new tracking algorithms in production release p14 with improved performances (efficiency & fake rates)
- The new tracking allows the collection of quality physics samples that can be used to further understand the detector (conversion for material studies, resonances with tracking for muon efficiency, etc).
- We have numerous quality physics results directly linked to the tracking : B physics, top and Higgs results with b tagging, etc

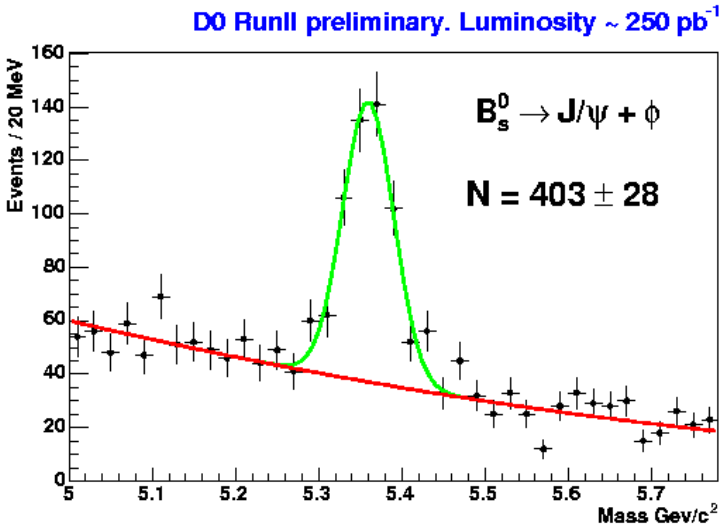
D*-D mass difference in $B \rightarrow D^* \mu \nu$ evts

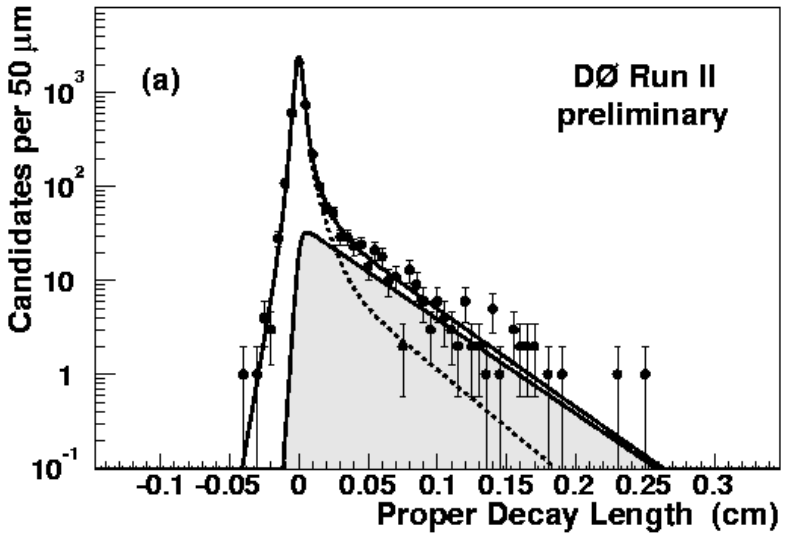


Search for $B_s \rightarrow \mu \mu$

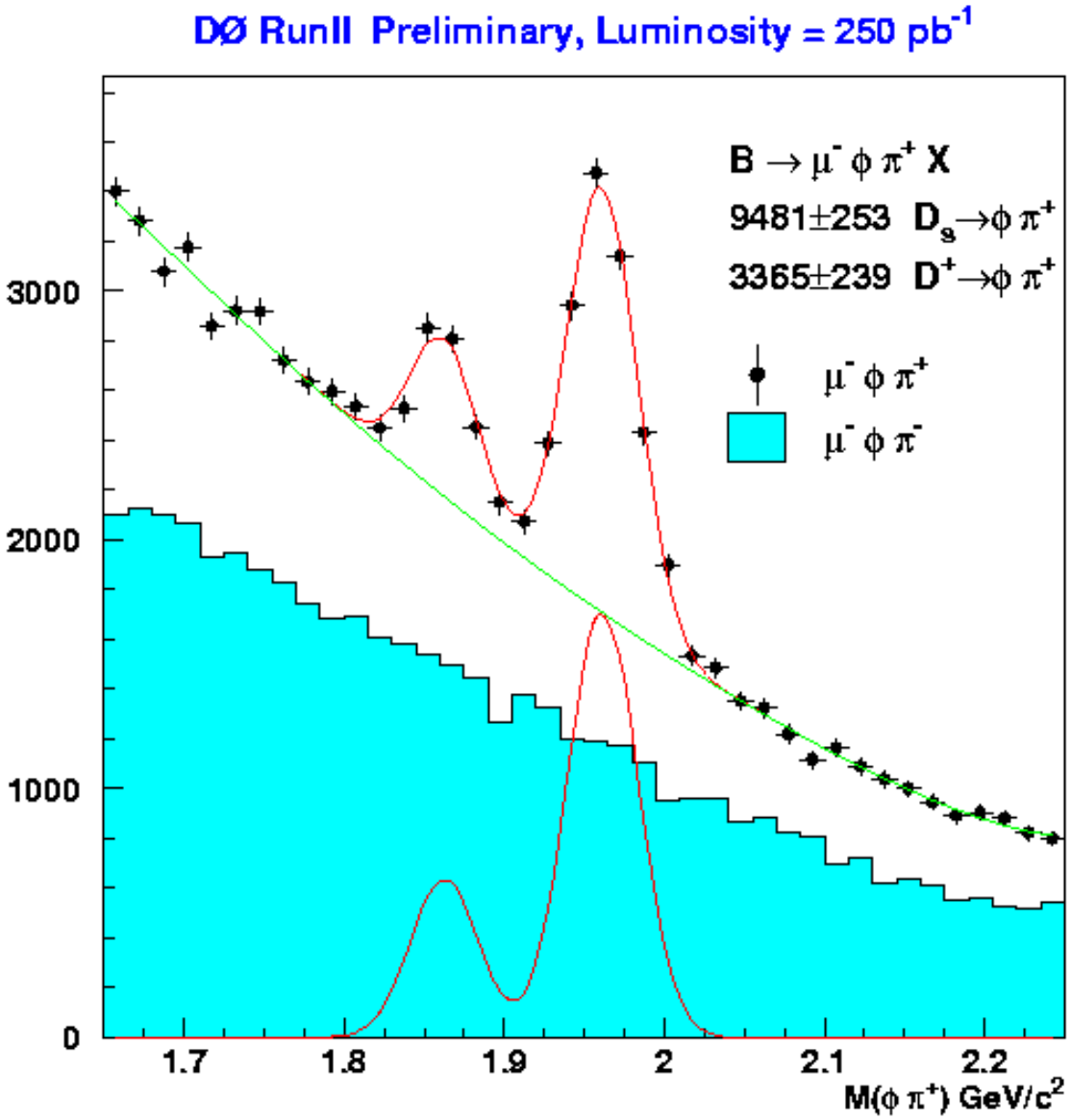


$B_s \rightarrow J/\Psi \, \phi$

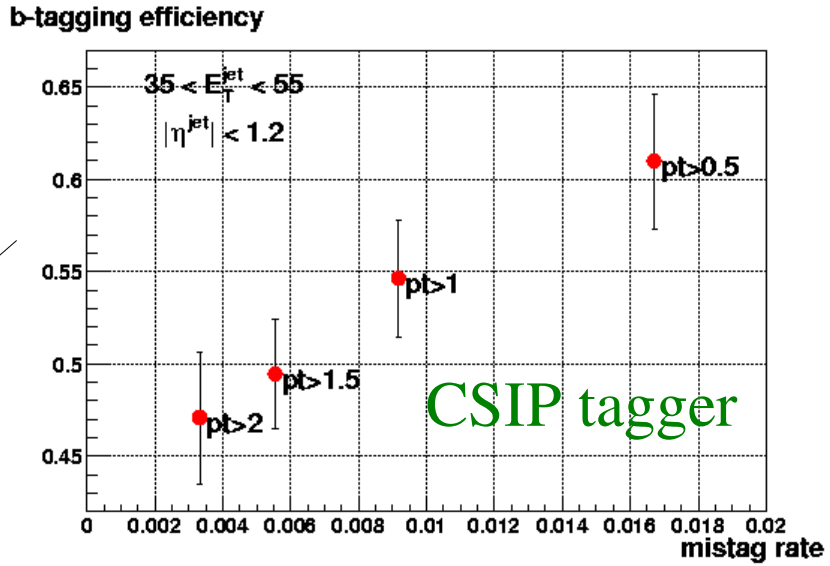




$B_s \rightarrow D_s \mu X$

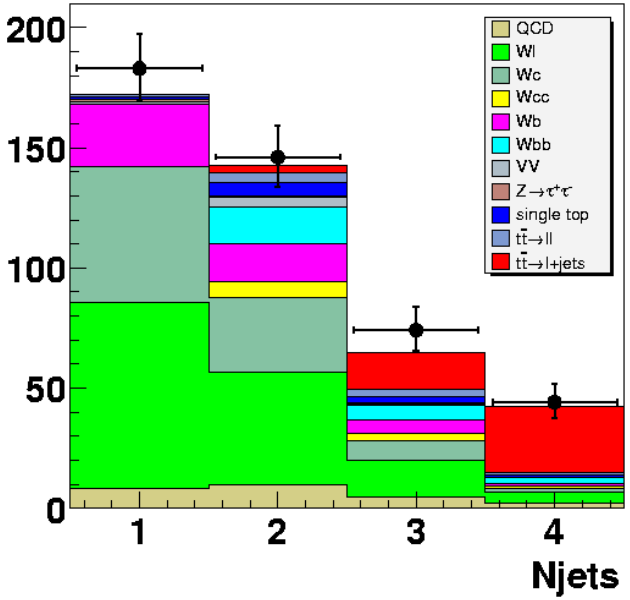


Top in l+jet with b-tagging

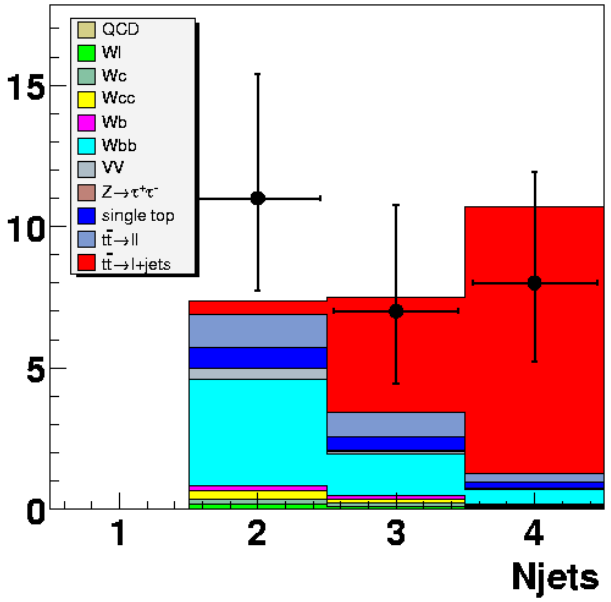


one b tag

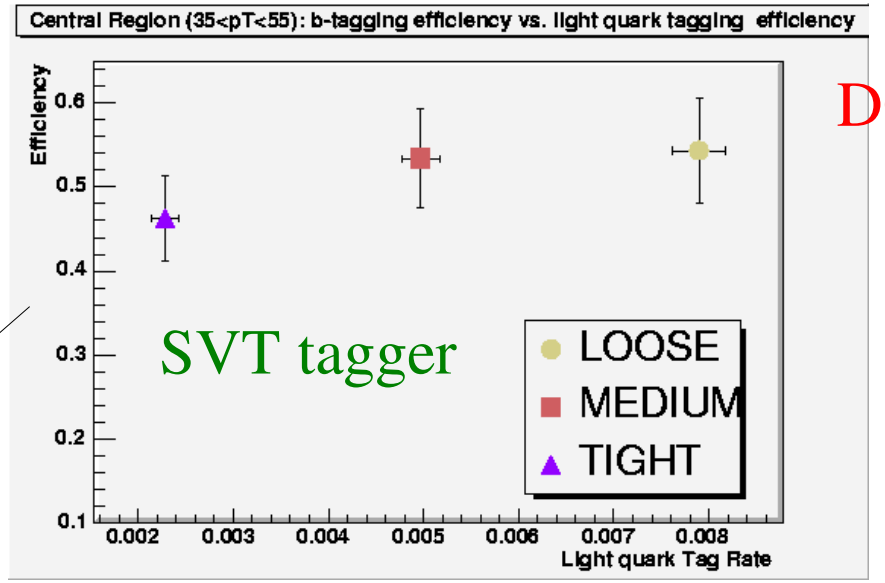
two b tag



DØ preliminary



Top in l+jet with b-tagging

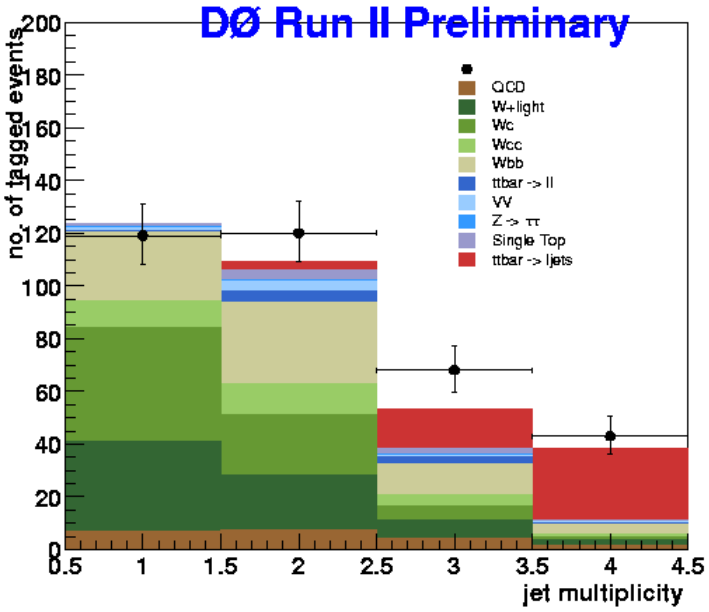


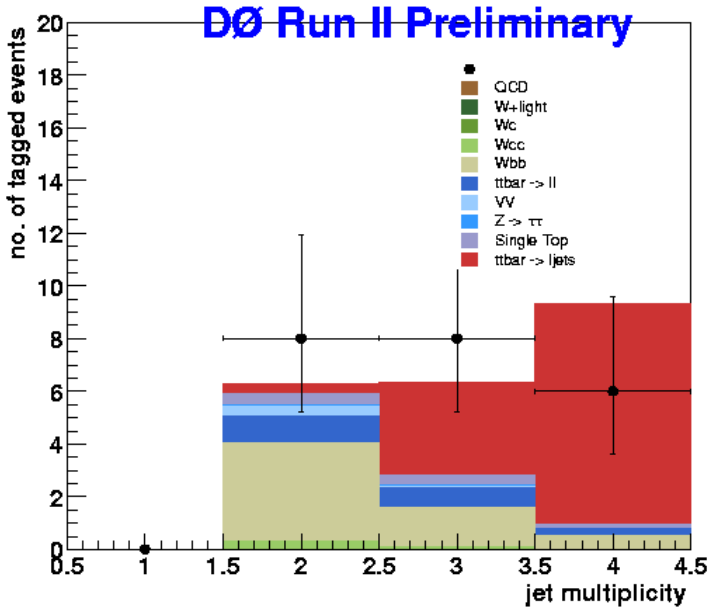
DØ preliminary

SVT tagger

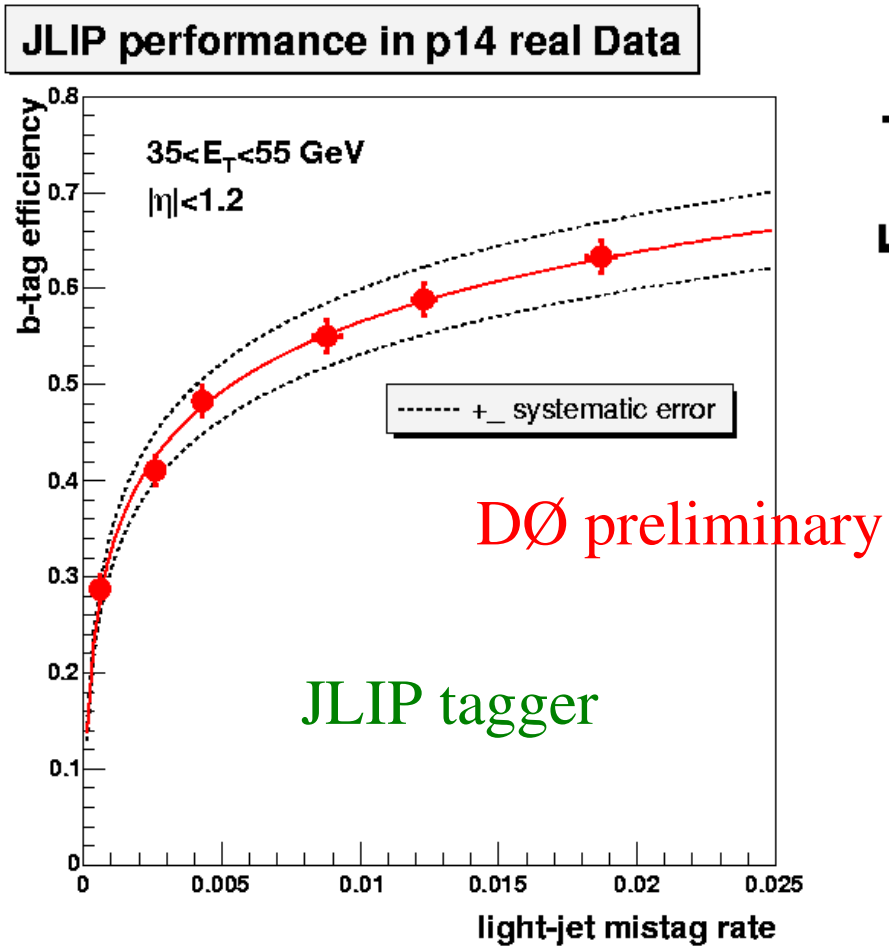
one b tag

two b tag



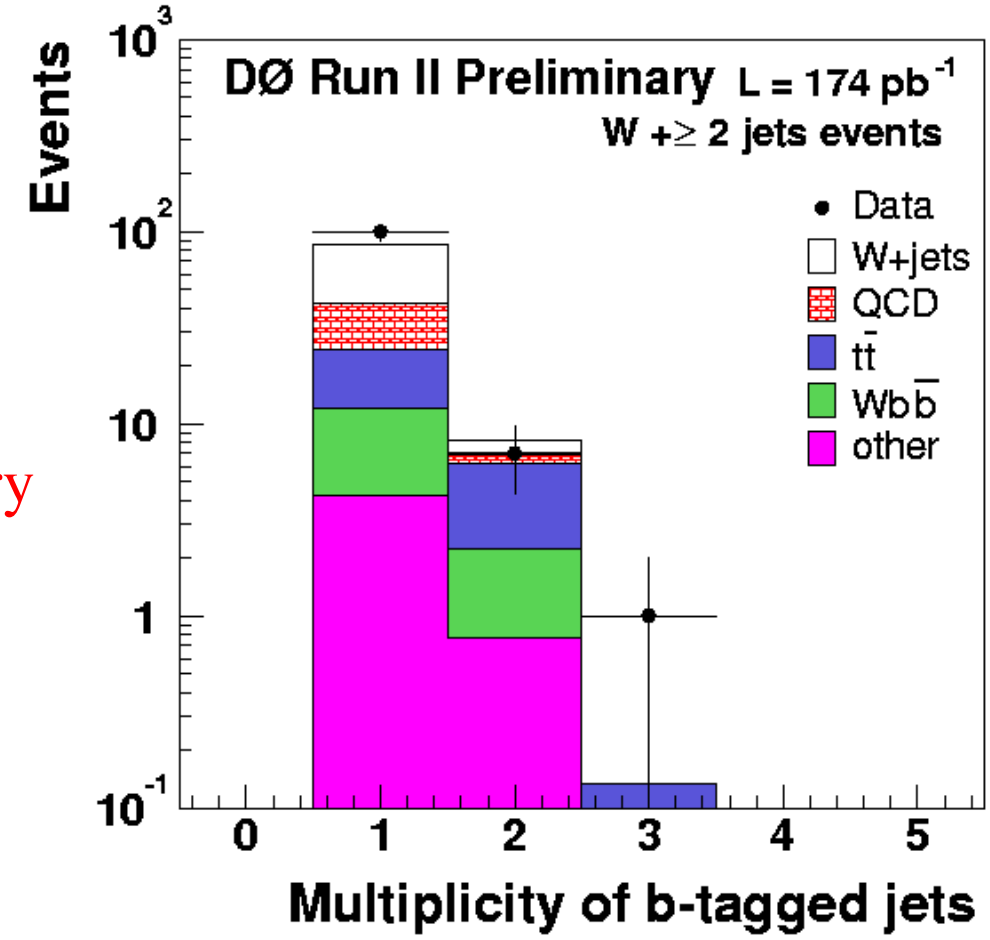


W+jets / Wbb studies



DØ preliminary

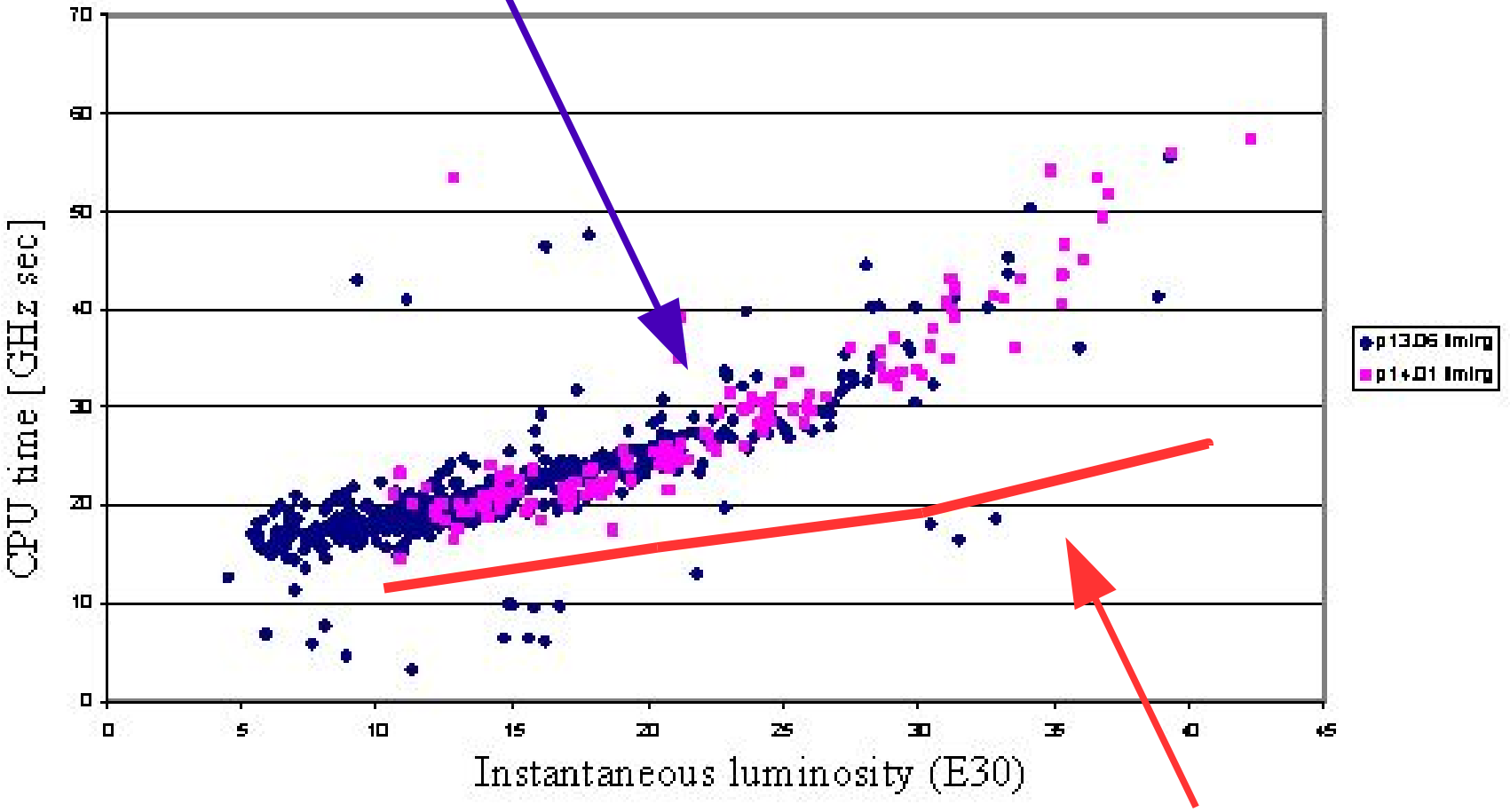
JLIP tagger



Tracking timing

- The committee recommended addressing the timing performance issues of the reconstruction, which is dominated by the tracking.
- At the time of the review studies were already going on. We identified that a small fraction of events were driving the average CPU time.
- We identified a source of problems in the tracking : unusual clusters in the CFT from particles looping in the CFT, creating large clusters. Identifying the problematic clusters and breaking them into pieces allowed us to improve significantly reco timing
- More on that later....

Old p13 / p14.01 CPU time / event



p14.06.01 CPU time / event

Thumbnail data-tier

- The thumbnail (TMB) is the basis of most analyzes, for faster turn-around in analysis it is "streamed" in physics defined skims.
- We kept the calorimeter chunk, despite the increase in size. It turned out to be essential for
  - Quick development and adoption of new algorithms : new photon ID, improved electron ID and jet ID, etc
  - Quick turnaround in data reconstruction: partial reconstruction to correct calorimeter electronics problems "T MBfixing"
    - Pass1 basis of summer conference results and first papers
    - Pass 2 (with p17 algo) ~ finished, for winter conf and papers

Thumbnail data-tier

- Based on the success of TMB+ (with calorimeter), we decided to introduce the tracker, preshower and muon hits/clusters in TMB++ for the p17 release (now):
  - We first optimized the chunk sizes
  - Will allow re-reconstruction of tracks
    - Lower pT cut for B physics
    - Algorithm developments, e.g. Muon tracking, hit counting in front of photon candidates, etc
  - Size ~ 60-80 kB/evt
  - Planning on abandoning the DST data-tier [this time reprocessing will start from RAW data to fully benefit from calibrations]

Improvements in p17

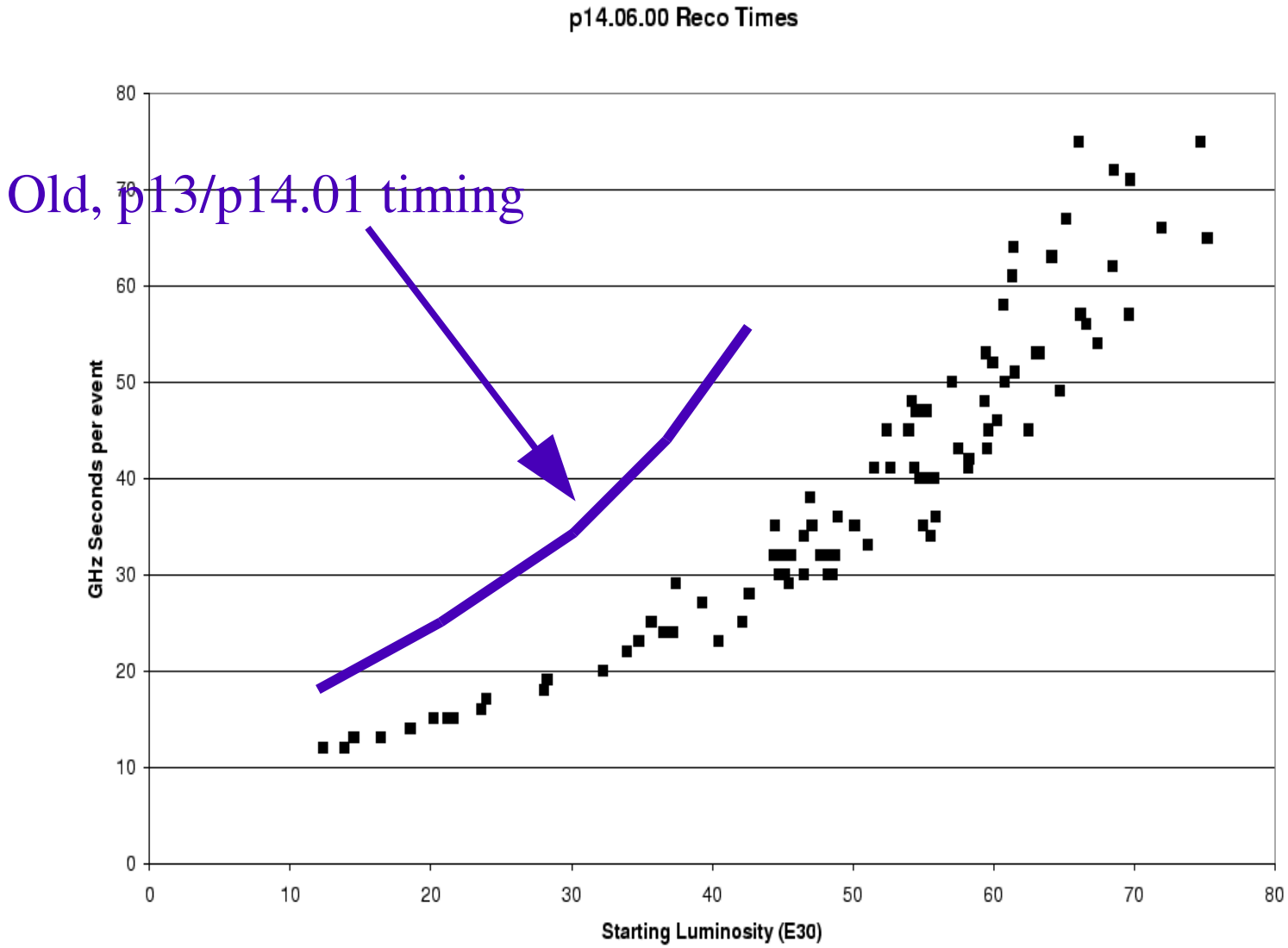
- The next production release for DØreco has just been cut: p17.00.00
- Calorimeter:
  - Much improved understanding of the calibration
  - Algorithm to reduce effect of noise
  - New photon ID, improved electron ID and jet ID
- Muons :
  - Improved segment reconstruction
  - Support for the upgraded detector (“bottom hole”)
- Tracking:
  - New alignment

Highlights only

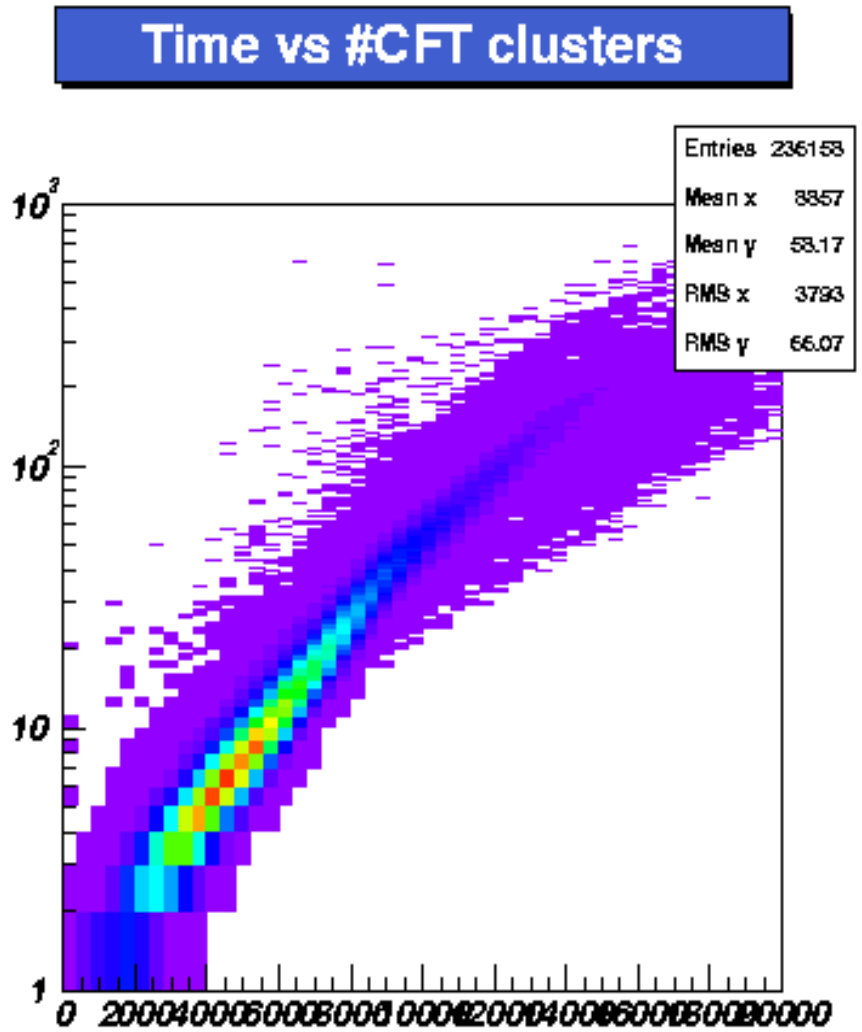
Current issues

- Although we made a very significant improvement to the timing of the tracking algorithm last year, the tracking is inherently non linear with occupancy.
- The TeVatron is delivering luminosities much higher than in the previous year, the record store luminosity is a factor of two higher than that reported last year.
- We have reached a regime where the reconstruction cannot keep up with data taking at the highest luminosities with the current farm plant.

Reco timing


p14.06.00 Reco Times
Old, p13/p14.01 timing
GHz Seconds per event
Starting Luminosity (E30)
0
10
20
30
40
50
60
70
80

NB: time in real sec, x1.6 for sec/GHz



- CPU time strongly correlated with CFT occupancy as expected
- Not driven by rare “slow” events, i.e. not similar to last year
- Not quick solution....

Reco timing task force

- We have put together a task force to examine all aspects of the tracking : detector issues, algorithm, coding....
- We are pleased to report that the Computing Division has reacted quickly and allowed two C++ experts to work on improving the tracking code and algorithm on a very short notice.
  - Philippe Canal & Jim Kowalkowski
- On the D0 side we have two experts from the tracking, including the code author, D0 code experts and people from physics groups that will evaluate the impact on physics of any change we will make to the algorithm.
- Daily contacts between experts, weekly meetings to track progress

Reco timing task force

- Significant progress have already been made
  - Analysis of the algorithm
  - Improvement to the data structure being made
  - Local optimization gave ~10% improvement
  - Investigating modification of the algorithm
- Investigating dependence with track pT cut, physics / trigger....
- Also investigating other hot spots in reco, including largest memory consumers
- The timescale for convergence of the task force is October. OK with current shutdown plans

Planning for the future

- According to the planning, in the next few years the TeVatron would deliver peak luminosities 2 to 3 times higher than the current record.
- The RunII detector was designed on the assumption that such luminosities would be achieved when running with 132 ns bunch spacing, not 396 ns. The number of interactions per crossing will be significant and the tracking devices will be primarily affected.
- The tracking must be tuned for these very high luminosities

Future : tracking

- The developments in the tracking algorithm will have to address complex and changing detector conditions :
  - Next summer, we will install an additional innermost layer (L0) to the Silicon Microstrip Tracker, with significant improvement to impact parameter reconstruction expected
  - We envision replacing the current CFT electronics with a version ("TripT") providing rough timing information ("Z" position of the hit) to reduce the effective occupancy of the CFT and reduce the tracking time (under D0 review and Lab review)
  - The SMT detector may suffer from ageing, we must build in robustness in the tracking algorithm
  - The occupancy will be very important due to the high initial luminosities, however the luminosity is rapidly decreasing during a store

Future:

- The high luminosity will affect tracking efficiency and consequently
  - Vertexing efficiency: misvertexing could be a problem
  - Electron, muon finding
  - B tagging
- We may have to adjust the electron, photon and jet algorithms to cope with the higher occupancy (isolation, contributions from pileup and multiple interactions, etc)
- The data size will increase with occupancy

Summary

- The current (p14) version of reco allowed us to present strong physics results.
- The main limitation (understanding of the calorimeter) is being addressed with p17
- We have improved the speed of the tracking algorithm, however this is still a problem at the highest luminosity
  - Task force with D0 and CD experts
- Exciting times ahead with a detector upgrade next year and very high luminosity in the next years
  - Layer 0, TripT?