b-jet triggers

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on behalf of the *b*-jet signature group

(and direct input from J. Cogan, P. Hansson, F. Parodi and E. Strauss)

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Introduction

Outline

1. Introduction
2. Beam spot update from the b-jet perspective
3. Tracking in jets: SiTrack vs IDScan
4. Updated data/MC comparison results for online taggers
5. μ-jet triggers evolution
6. Rates and global rejection

Introduction

Where do we stand?

Two classes of primary triggers to satisfy different needs:

1. μ-jet triggers to select a calibration sample for both online and offline b-tagging:
   - select events containing an offline muon-jet pair;
   - topological algorithm matching a LVL1 jet with a LVL2 muon;
   - prescale adjustments for signatures with different thresholds in order to accumulate μ-jet candidates with uniform distribution in jet p_T;
   - well understood on data;
   - starting from period G, they are used for offline b-tagging calibration and b-jet cross section measurements.
2. b-jet triggers to select multi b-jet events where jet triggers can't reject enough:
   - algorithms based on impact parameters exploiting likelihood approaches and JetProb technique;
   - beam spot is used as a primary vertex estimation in the transverse plane;
   - commissioning on data is being finalized;
   - so far in PT to study beam spot dependence, correlation with offline taggers and overall performance.

Beam spot

Important achievements in 2010 for *b*-jet triggers

Particularly sensitive to beam spot position and width shifts:

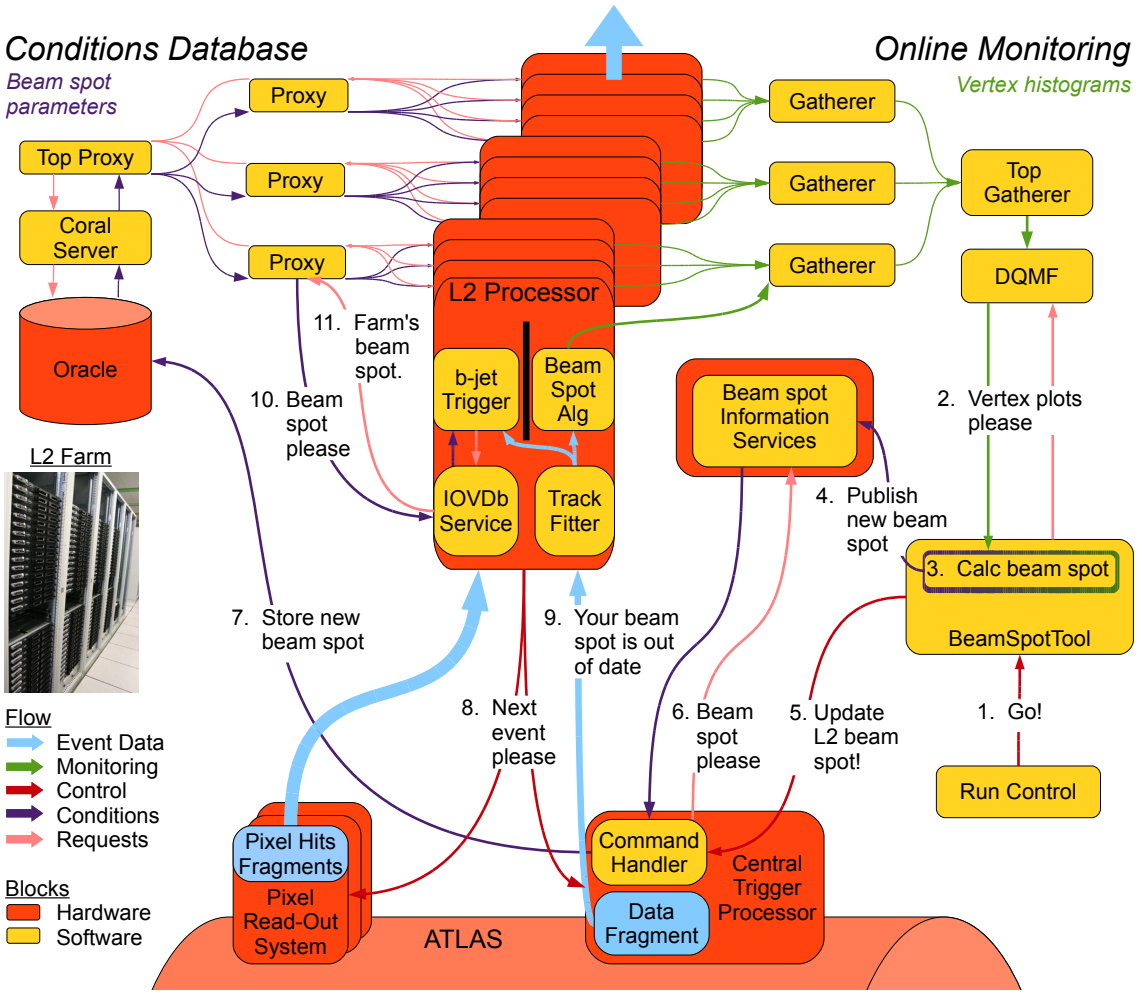
- primary vertex computation only along the z coordinate since tracking is performed in RoIs;
- transverse impact parameter significances are computed taking into account the beam profile as it is known online.

Beam spot monitoring was already available for the 900 GeV running, but since:

1. COOL update to inject into HLT farm new parameters within a run is in place and well tested;
2. mechanism to correct the resolution width taking into account the LVL2 track resolution is developed and online.

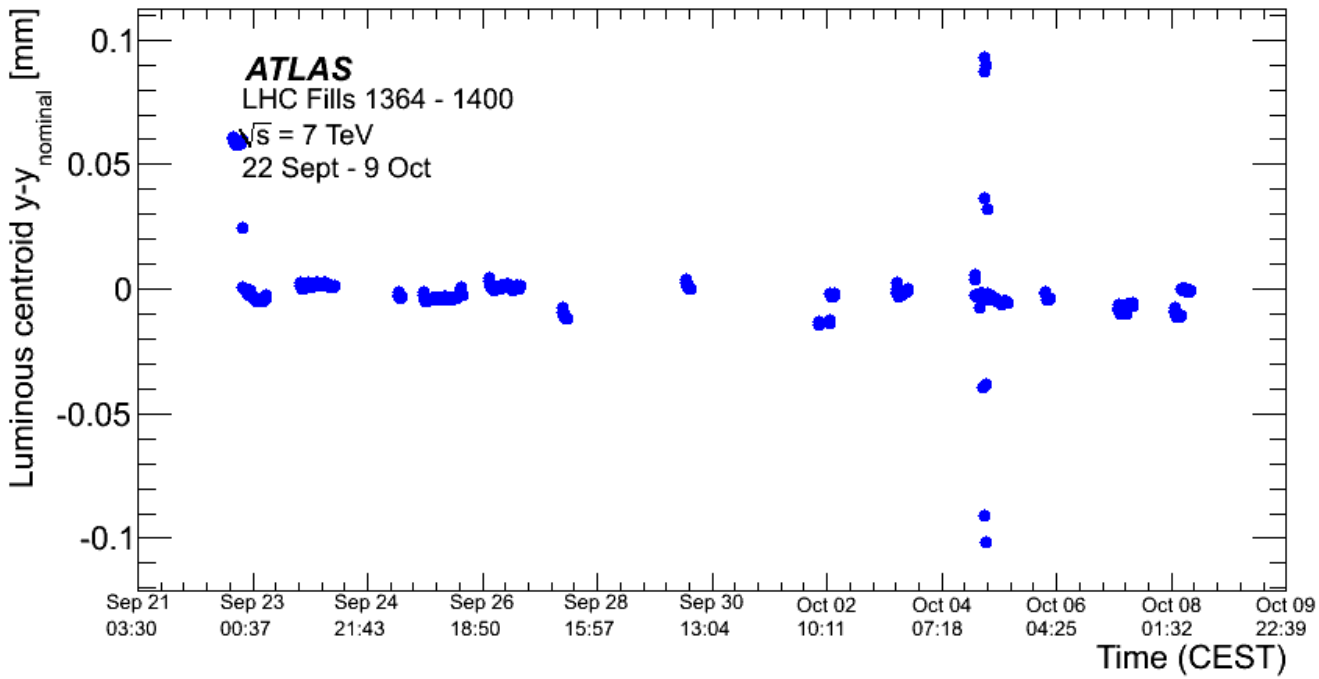
Beam spot

1. Beam spot update



Beam spot

1. Beam spot update

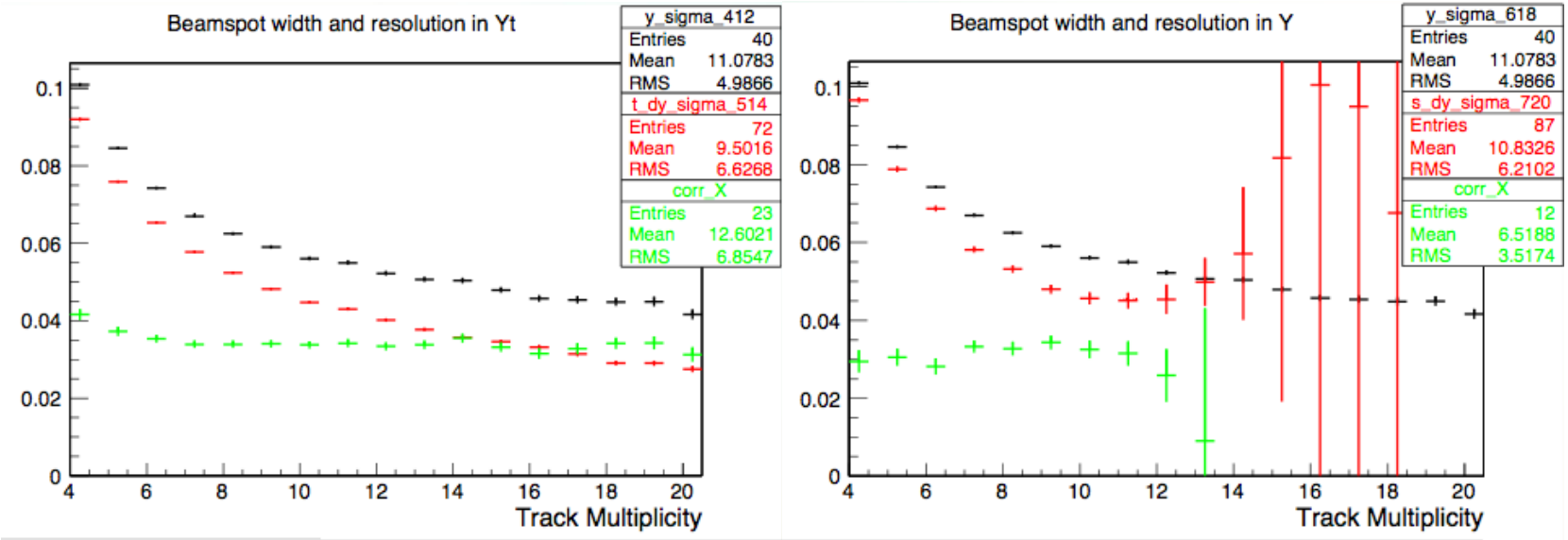


- so far, human intervention to trigger the update to gain experience;
- now need to define automatic checks to automatize the entire loop.

Beam spot

2. Resolution corrected width

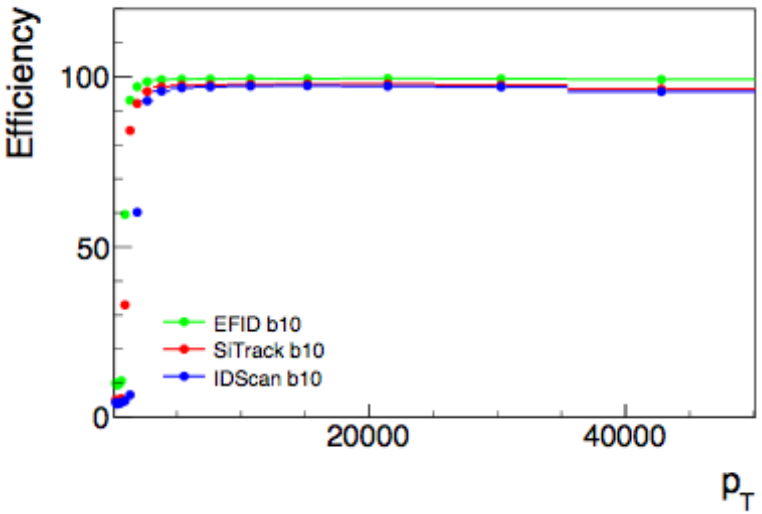
- raw width;
- MC truth and split vertex resolution;
- corrected width.

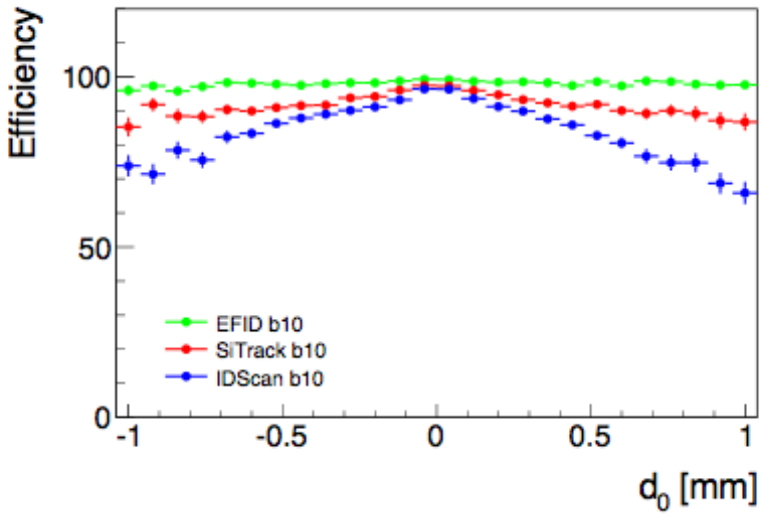


Tracking comparison in jets

Plots using JetTauEtMiss stream from run 162526

- efficiency is with respect to offline tracks not matched to any physics object;
- in general comparable performance of LVL2 algorithms, lower SiTrack fake rate drove the decision about the primary tracking algorithm when it was requested;
- both algorithms are still running in commissioning trigger and allow further studies;
- among the studies, the LVL2 d_0 acceptance needs investigations since it is expected to be flatter, as in other instances.





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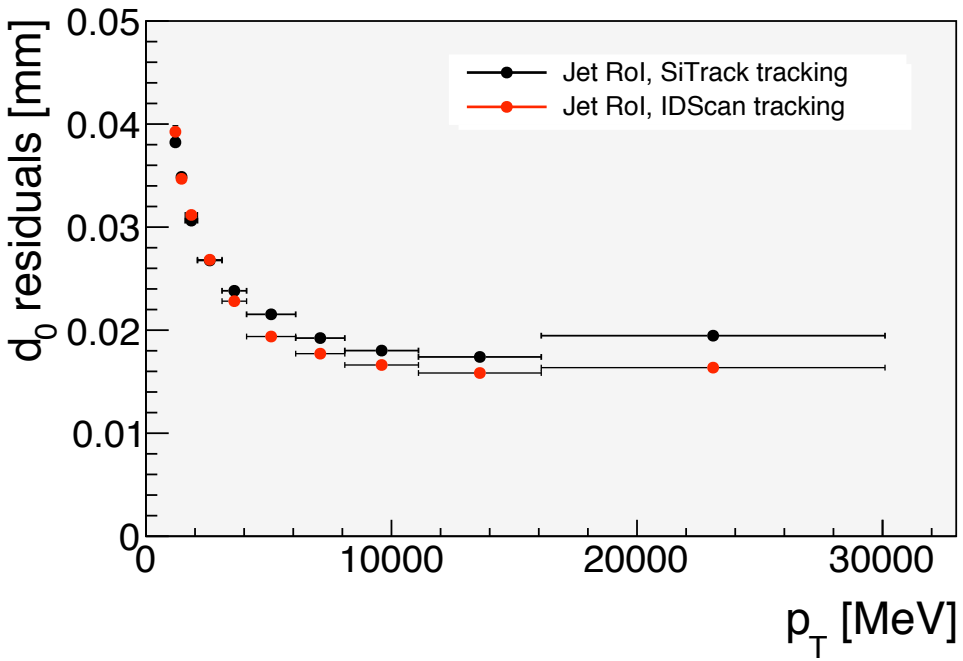
- in general comparable performance of LVL2 algorithms, lower SiTrack fake rate drove the decision about the primary tracking algorithm when it was requested;
- both algorithms are still running in commissioning trigger and allow further studies;
- just a first look at d_0 resolution in p_T bins: preliminary plot.



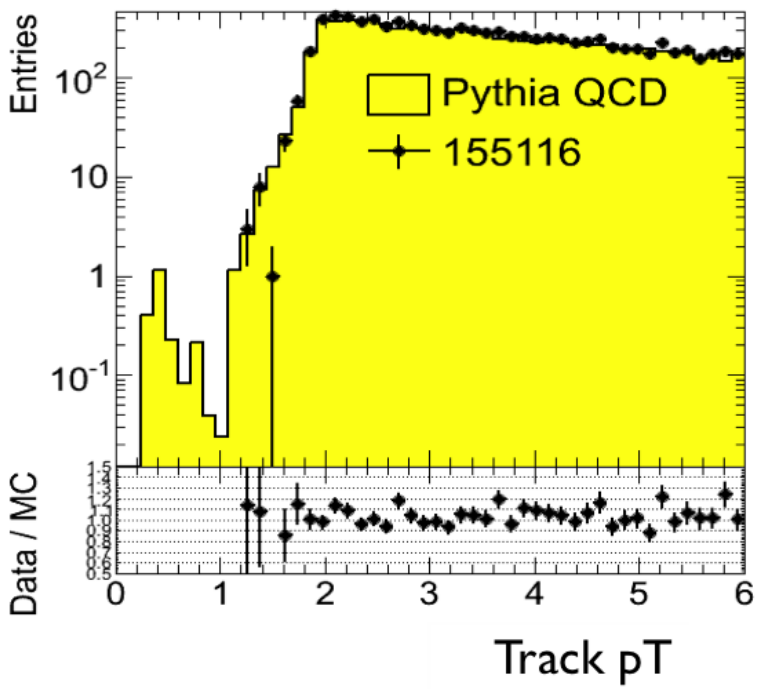
b-jet trigger performance

Data/MC comparison

For data/MC comparison studies:

- could not performed detailed analysis on whatever run;
- focus on runs with good beam spot knowledge;
- focus on relatively old runs to have the same track selection in simulation and online;
- candidate run 155116.

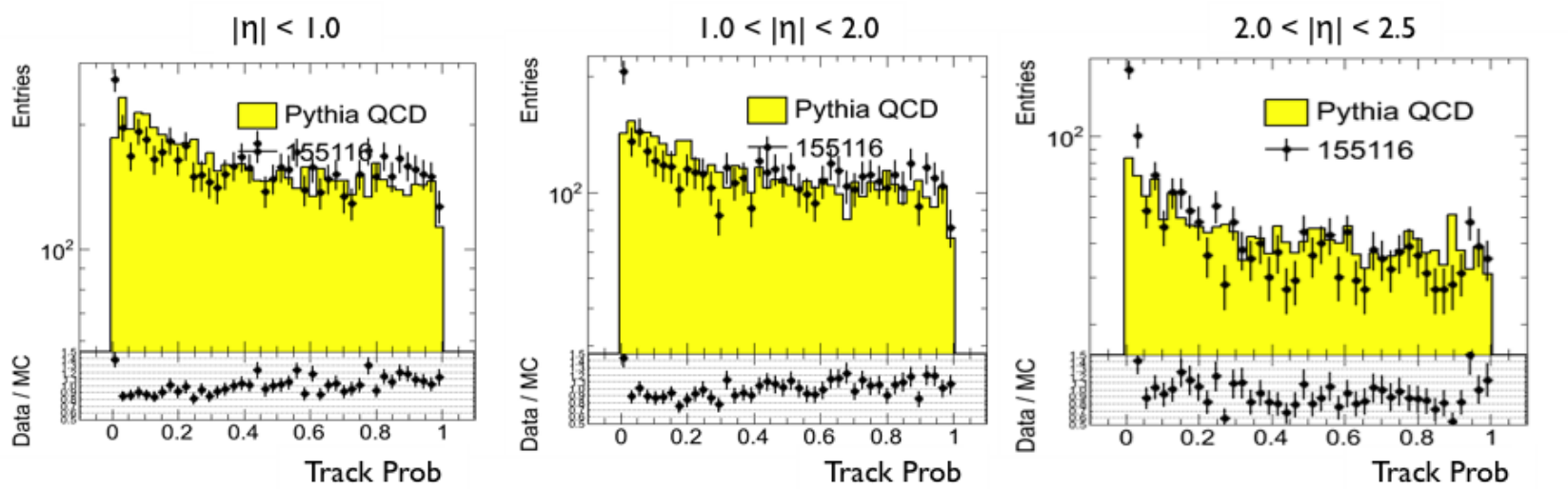
BS	offline	online
$\Rightarrow$ x	-0.0335	-0.347 $\Leftarrow$
$\Rightarrow$ y	0.611	0.613 $\Leftarrow$
z	-1.6	-2.25
$\Rightarrow \sigma(x)$	0.0332	0.0335 $\Leftarrow$
$\Rightarrow \sigma(y)$	0.0335	0.0289 $\Leftarrow$
$\sigma(z)$	50.3	36.8



b-jet trigger performance

Track probability to originate from PV at LVL2

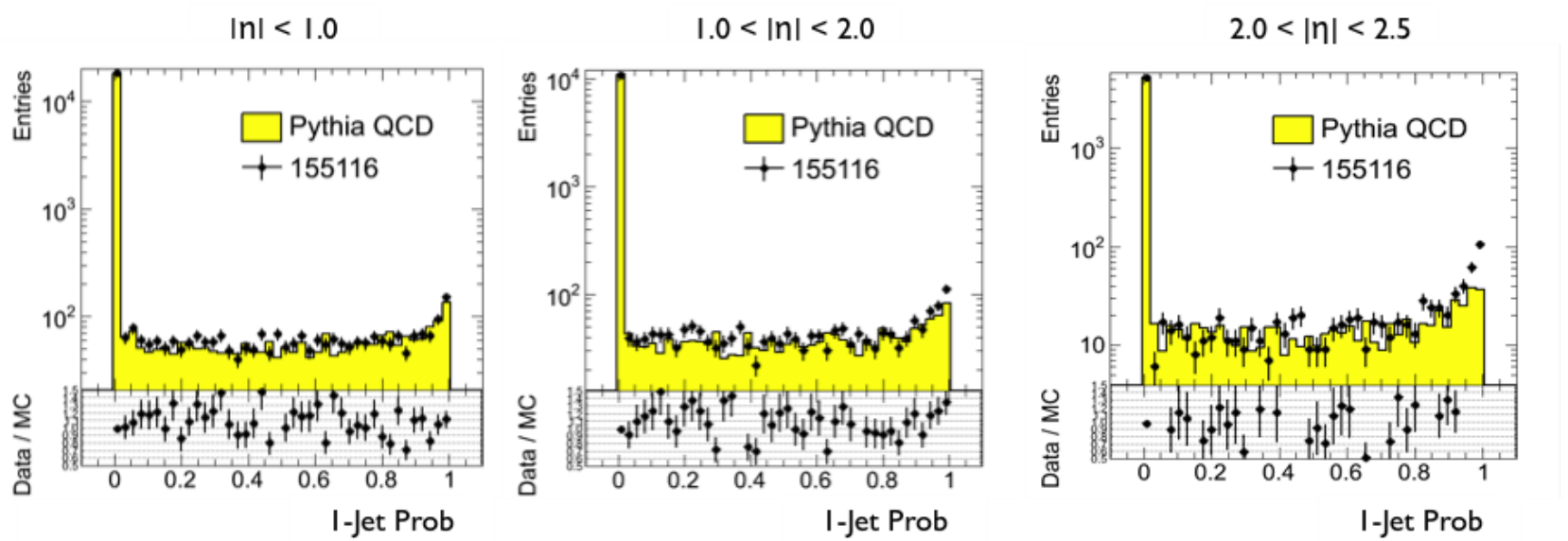
- good data/MC agreement, especially at low η (this trend is only see at LVL2);
- slightly better agreement at the EF level.



b-jet trigger performance

Overall jet probability to originate from PV at LVL2

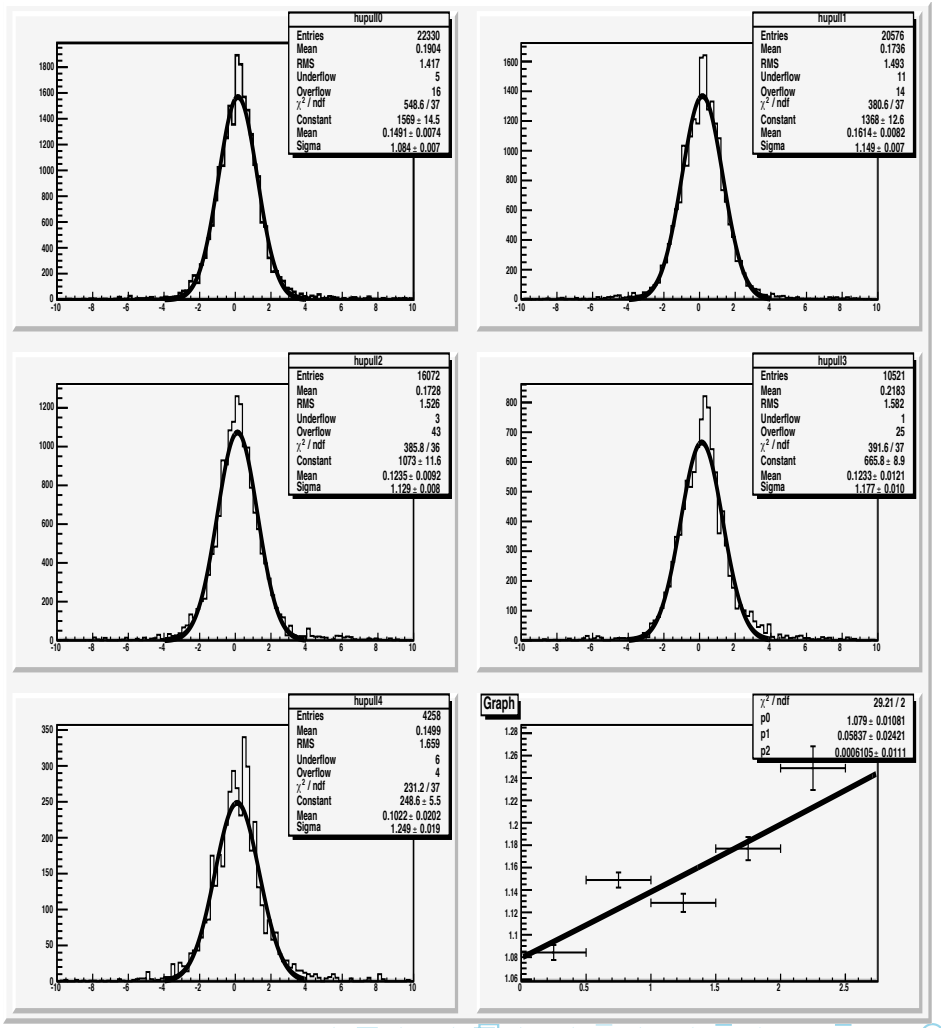
- peak at 0 is due to jet RoI with no reconstructed/selected tracks;
- a higher b content is seen at high η (also in track prob distributions) and is related to the LVL2 d_0 track pull;
- mismatch at high η for displaced tracks probably due to a track selection fix which is being validated at CAF now.



b-jet trigger performance

d_0 pull degradation for LVL2 tracking

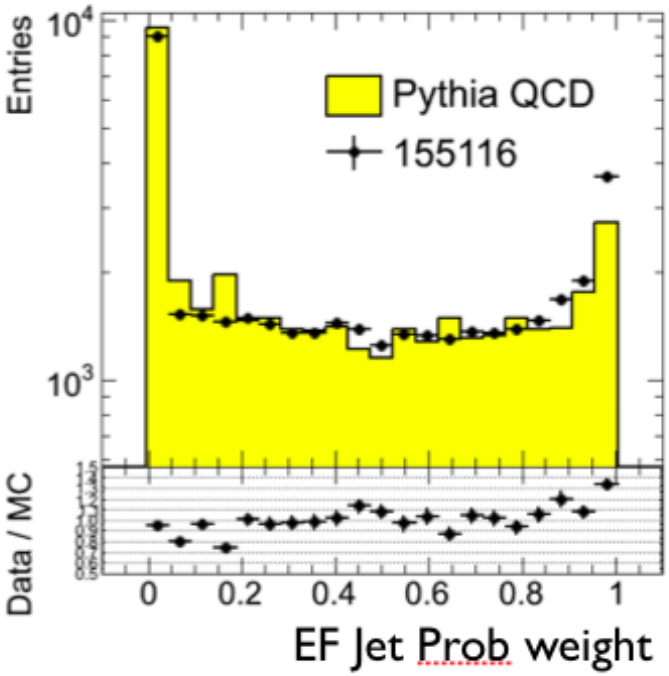
- plots based on MC top sample;
- trend is visible in η and not in p_T;
- EF tracking is not affected;
- impact on b-tagging performance is found to be negligible therefore no a posteriori correction is taken.

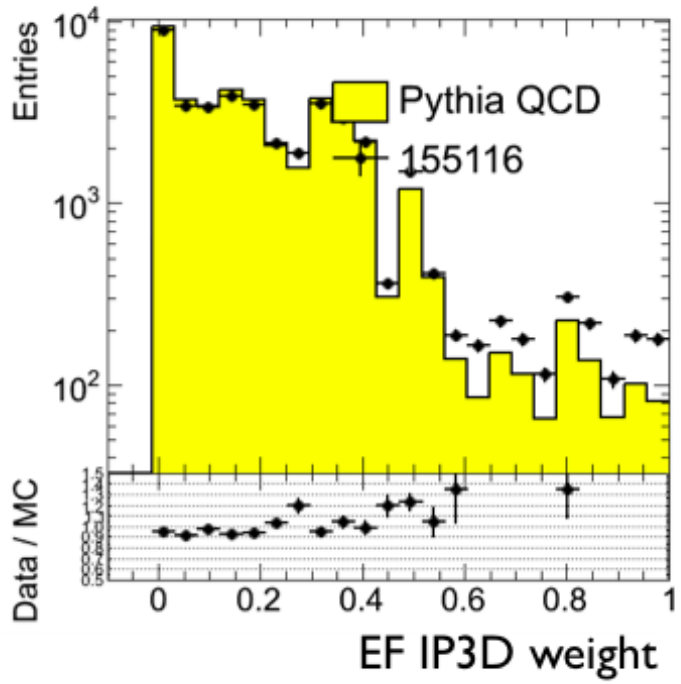


b-jet trigger performance

data/MC comparison for main EF taggers

- in general better agreement in Jet Prob distributions;
- new EF likelihood calibrations being validated now;
- given the better data/MC agreement, working points are being defined using JetProb.

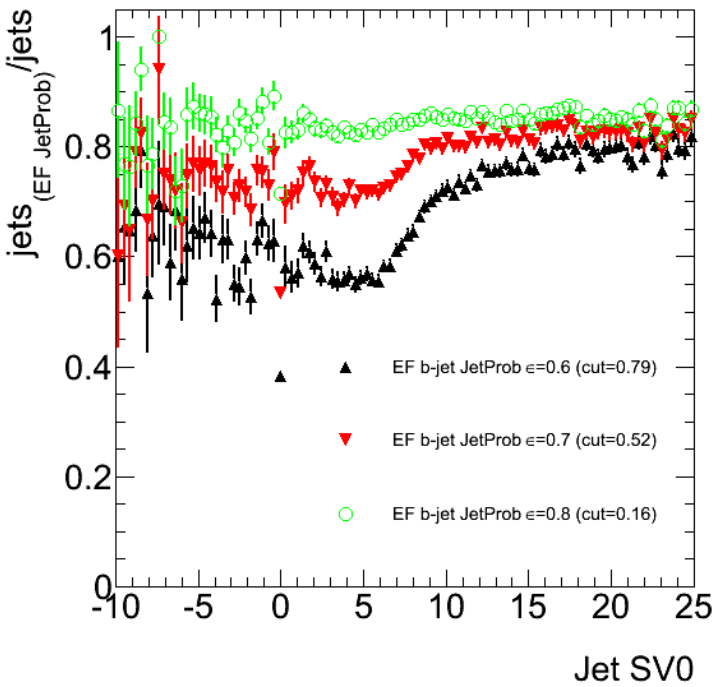


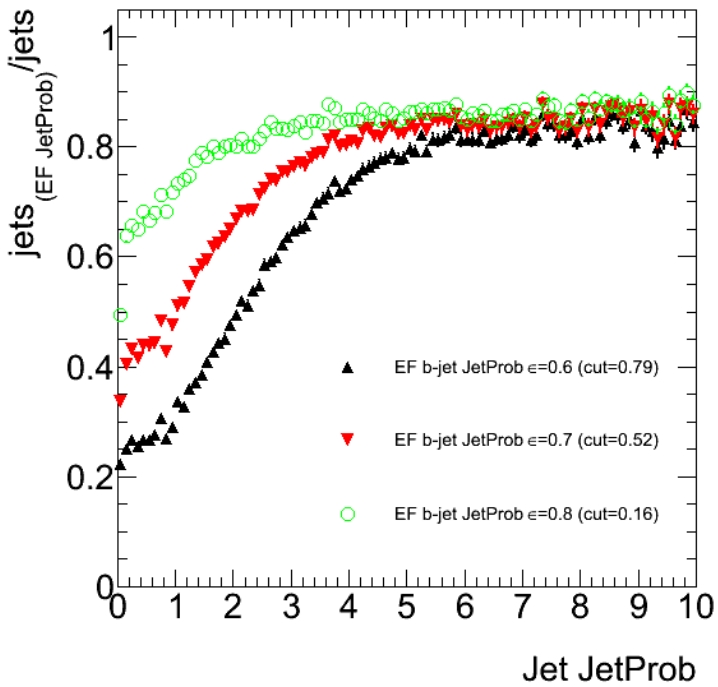


b-jet trigger performance

EF JetProb correlation with offline SV0 and JetProb

- based on MC sample and for various HLT working points;
- better correlation using the same tagger;
- saturation at 85% indicates a trigger bias;
- bias contribution seems to be due to empty RoIs and matching near $\eta = 2.5$ (since not related to *b*-tagging itself).



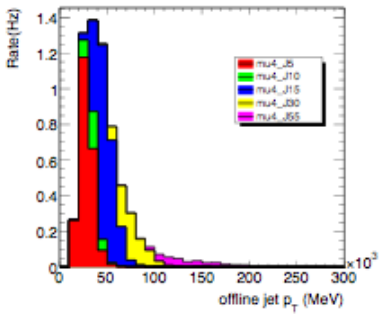


μ-jet trigger evolution

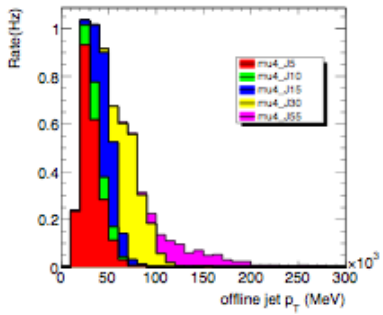
Fixed allocated bandwidth and all rejection at LVL2

- linear prescale interpolation for intermediate lumi points;
- purity (fraction of events containing an offline μ-jet candidate) is found to be 94% (95%) in data (MC);
- starting from period G prescales are in place to enhance the higher pt spectrum.

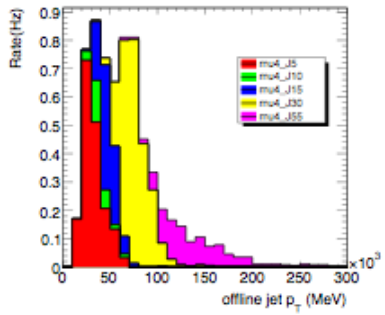
2e31



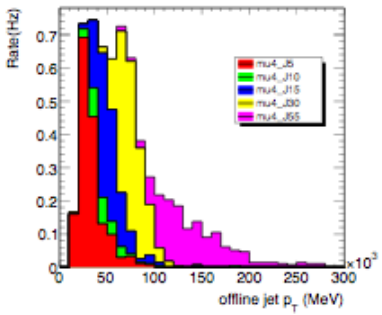
4e31



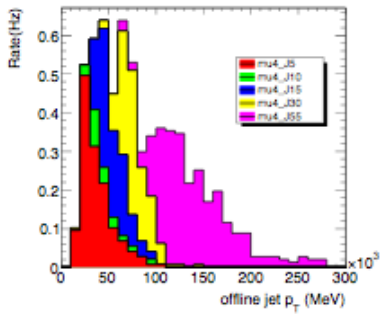
6e31



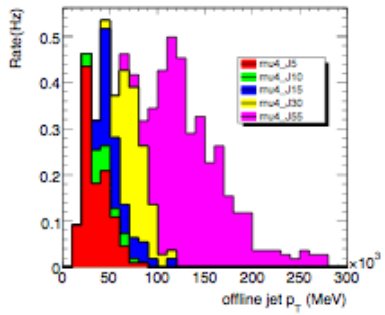
8e31



1.5e32



2e32



b-jet trigger rates and menu

General considerations

Overall load on the system will depend on allocated bandwidth and physics input.
A general comment already heard during this workshop: fruitful discussions with combined performance groups but would expected a lot more input from physics groups as well.

- you already know we are unhappy with the present allocated bandwidth corresponding to 5 Hz of exclusive rate for both μ-jets and b-jets;
- work ongoing to better synchronize μ-jet and single b-jet triggers to enlarge the sample for efficiency studies;
- studies in the offline b-tagging community are ongoing to estimate the efficiency error per p_T bin as a function of the available sample selected with μ-jet triggers;
- many options are available for b-jet trigger optimizations, more physics input is needed!

b-jet trigger rates and menu

General considerations

For μ-jet triggers:

- can be easily adjusted with PS with no serious impact on their usefulness;
- all of the selection is performed at LVL2 minimizing the EF input rate;
- a clear roadmap do exist up to 5e32,
- a further jet threshold (mu4_L1J75_matched) may be added in 2011.

For b-jet triggers:

- single b-jet triggers are for commissioning and monitoring purposes;
- we are studying possible optimizations for the 2011 and possibly we will only retain b_10_IDTrkNoCut and b_10 for tracking and b-tagging monitoring;
- multi b-jet triggers should be run as much as possible unprescaled: chain rejections depend on various factors, approximative numbers can be quoted (next slides).

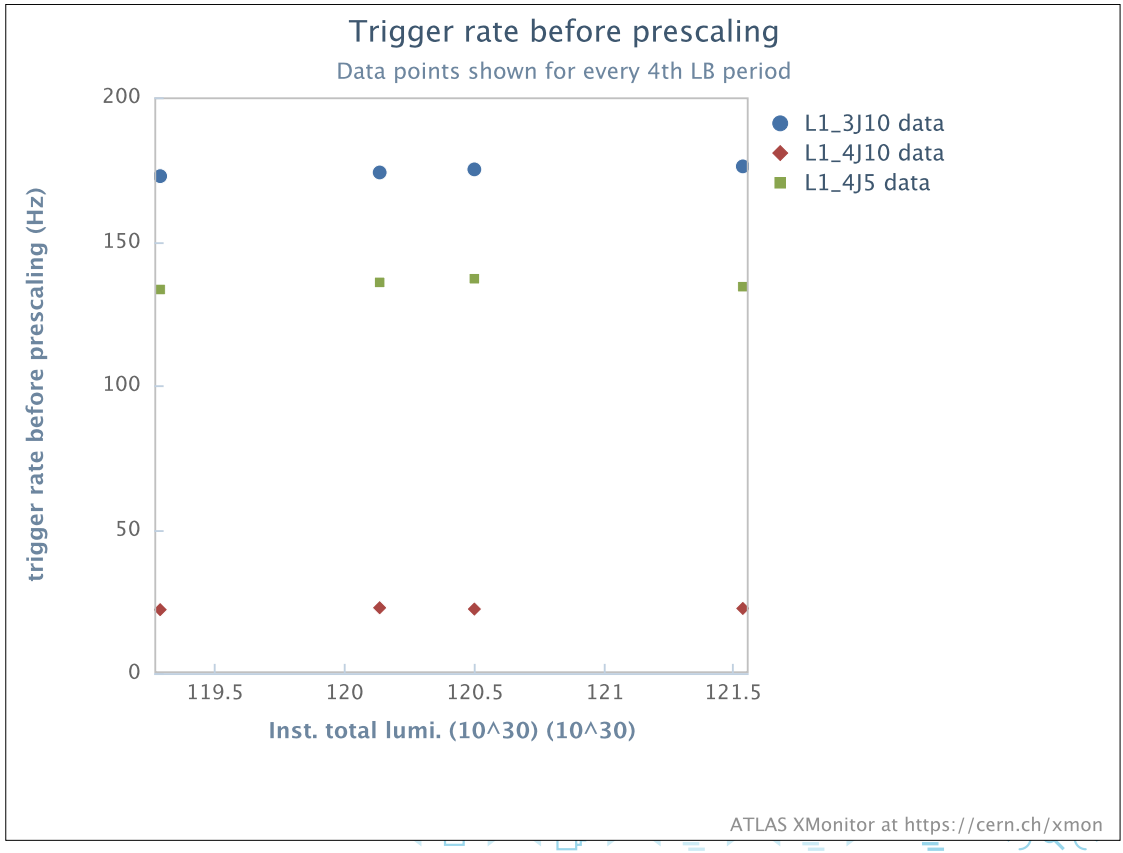
b-jet trigger rates and menu

Unprescaled LVL1 multi-jet rates

LVL1 multi-jet rates at 10e31
from run 162690, LBs 264-272:

L1_3J10	11.8 $\pm$ 1.1Hz
L1_3J15	4.75 $\pm$ 0.7 Hz
L1_4J5	8.4 $\pm$ 0.9 Hz
L1_4J10	1.6 $\pm$ 0.4 Hz

LVL1 multi-jet rates at 1.2e32
from one of the latest LHC fill using xmon:



b-jet trigger rates and menu

Recap on menu composition

Multi b-jet triggers

EF_b15_4L1J5	L2_b15_4L1J5	L1_4J5
EF_2b10_4L1J5	L2_2b10_4L1J5	L1_4J5
EF_3b10_4L1J5	L2_3b10_4L1J5	L1_4J5
EF_2b10_3L1J10	L2_2b10_3L1J10	L1_3J10
EF_2b15_3L1J15	L2_2b15_3L1J15	L1_3J15
EF_b10_4L1J10	L2_b10_4L1J10	L1_4J10
EF_3b10_4L1J10	L2_3b10_4L1J10	L1_4J10
EF_3b15_4L1J15	L2_3b15_4L1J15	L1_4J15

μ-jet triggers (X=5, 10, 15, 30, 55 GeV)

EF_mu4_L1JX_matched	L2_mu4_L1JX_matched	L1_MU0_JX

Single b-jet triggers

EF_b10	L2_b10	L1_J10
EF_b10_IDTrkNoCut	L2_b10_IDTrkNoCut	L1_J10
EF_b15	L2_b15	L1_J15
EF_b30	L2_b30	L1_J30

b-jet trigger rates and menu

Global rejection on real data affordable by *b*-jet triggers in 2011?

- assuming algorithms as they are now online;
- new EF likelihood calibrations have been released (in validation at CAF now);
- computing efficiency on *b*-jets from MC top sample having SV0 > 5.72;
- computing rejection on real data using b10_IDTrkNoCut chain.

For JetProb tagger:

efficiency	LVL2 cut	EF cut	LVL2 rejection	HLT rejection
0.7	0.02	0.79	1.6	6.5
0.6	0.27	0.93	2.1	13
0.5	0.77	0.96	5.5	23

For IP3D tagger (for EF results, we need new calibrations):

efficiency	LVL2 cut	LVL2 rejection
0.7	0.5	17
0.6	0.68	31
0.5	0.81	65

b-jet trigger rates and menu

Global rejection affordable by *b*-jet triggers in 2011?

- scaling the LVL1 multi-jet item rates at 5e32 the input LVL2 rate is $\sim$ 0.5 KHz;
- assuming 1-2 Hz per multi *b*-jet chain we need global rejections of 500/500/200/50 for chains starting from L1_4J5/L1_3J10/L1_3J15/L1_4J10;
- worst scenario and latest assumption: JetProb will have the role of selecting events at 5e32.

Global rejection per chain type:

R=6.5 on single jets

chain	rej
1b/4j	$\sim$ 2
2b/3j	$\sim$ 15
2b/4j	$\sim$ 9
3b/4j	$\sim$ 75

R=13 on single jets

chain	rej
1b/4j	$\sim$ 4
2b/3j	$\sim$ 60
2b/4j	$\sim$ 30
3b/4j	$\sim$ 580

R=23 on single jets

chain	rej
1b/4j	$\sim$ 6
2b/3j	$\sim$ 200
2b/4j	$\sim$ 100
3b/4j	$\sim$ 3000

Conclusions

- tracking was demonstrated to be stable and efficient in the whole 2010 data-taking period;
- ready to fully rely on the automatic beam spot update;
- estimation on real data of global rejection factors of b-jet triggers ensures an affordable rate for both LVL2 and EF for the whole 2011 data-taking period;
- few enhancements still in the pipeline (new EF likelihood calibrations and slight track selection update);
- b-jet trigger menu is finalized but not fixed, any physics input is more than welcome;
- b-jet triggers will be in rejecting mode by the start of 2011;
- μ-jet triggers in good shape and already used by flavor tagging group.