DT PERFORMANCE AND CALIBRATION

PLANS FOR 2017 COMMISSIONING

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for the DT Group
Torino Run Coordination Workshop 24-01-2017

- → DT Performance:
  observables vs conditions, towards continuous monitoring
- → DT calibration: features and plans
- → Work Organization
- → Plans for 2017 commissioning

DT PERFORMANCE

Observables

* Local Trigger efficiency (and quality)
* Hit efficiency
* Efficiency to associate hits to reconstructed track segments
* Hit spatial resolution
* Segment time resolution
* (Background)

Conditions

* Instantaneous Luminosity
* Pile-Up
* Time
* (Integrated Luminosity)

DT LOCAL TRIGGER AND TWINMUX SUPER-PRIMITIVE EFFICIENCY

In 2016 the TwinMux trigger system became operational (details in Gianni's talk).

It allows to merge DT and RPC information for any station.

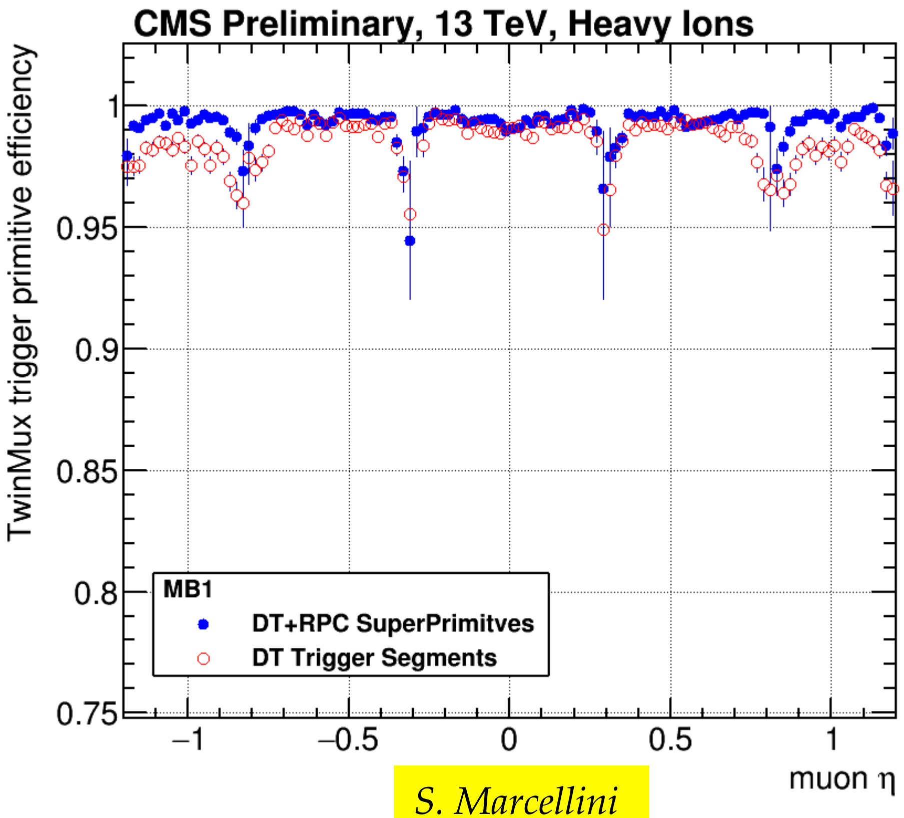
→ The usage of this merged information was optimized with several rounds of tests and offline analysis.

→ The chosen algorithm consists in:

* Matching DT primitive and RPC cluster in space ($\Delta \phi \leq 15$ mrad) and time (± 1BX).
* Unless the quality of the DT primitive is maximum (8 associated hits), the BX assignment is given by RPC.

→ Improving BX assignment means increasing efficiency, especially in the high η regions where the DT timing is spoiled by non uniform B-field.

→ Average efficiency increase was measured to be **1.3%**



S. Marcellini

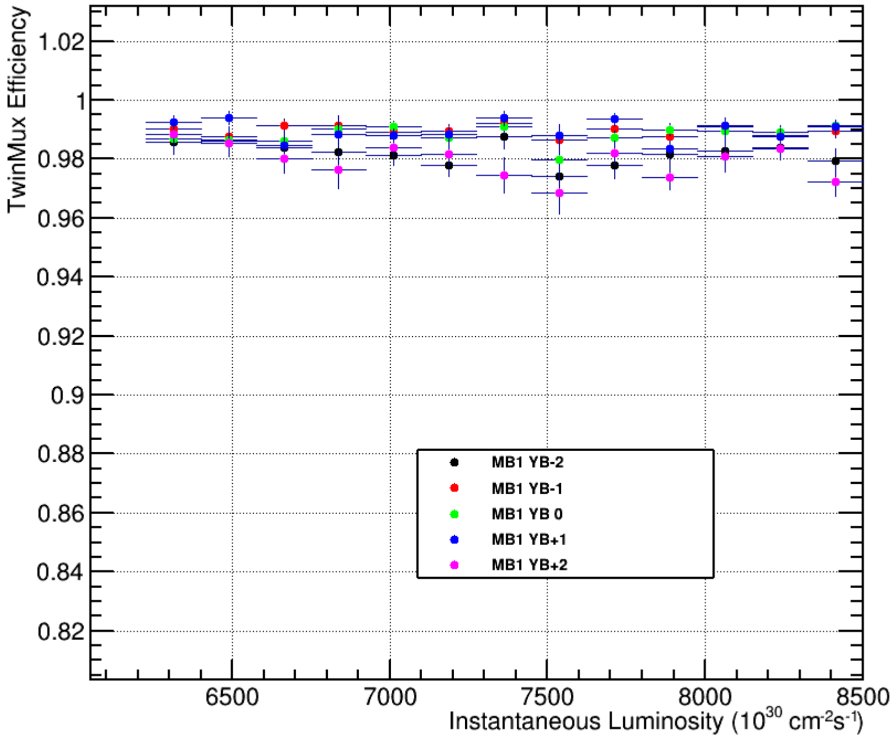
DT LOCAL TRIGGER EFFICIENCY

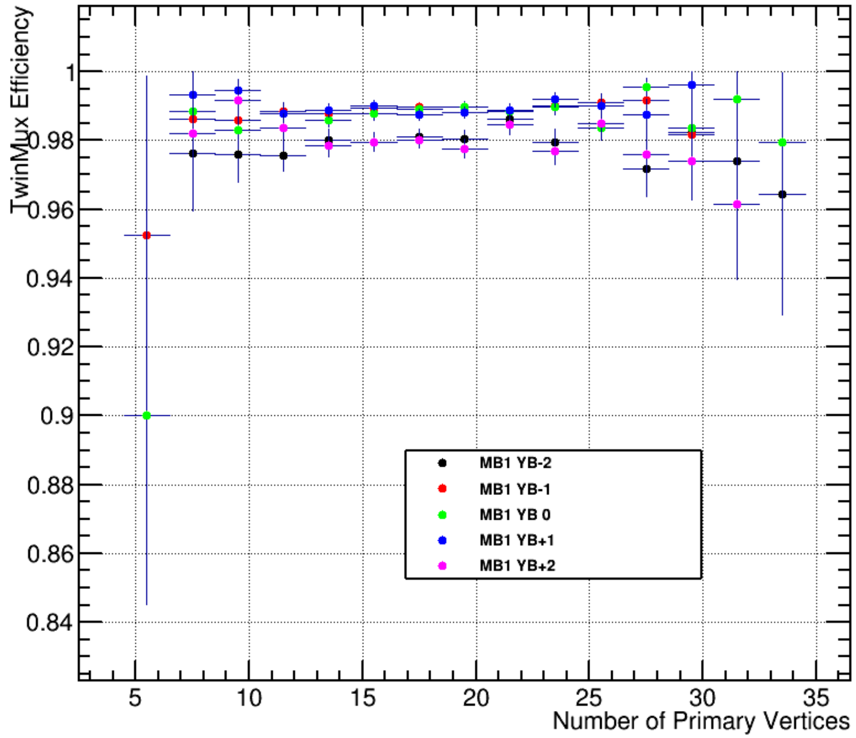
Check dependency on Luminosity and Pile-Up.

→ No trend still visible in the considered ranges.

→ Tools for continuous monitoring are being set-up.

S. Marcellini

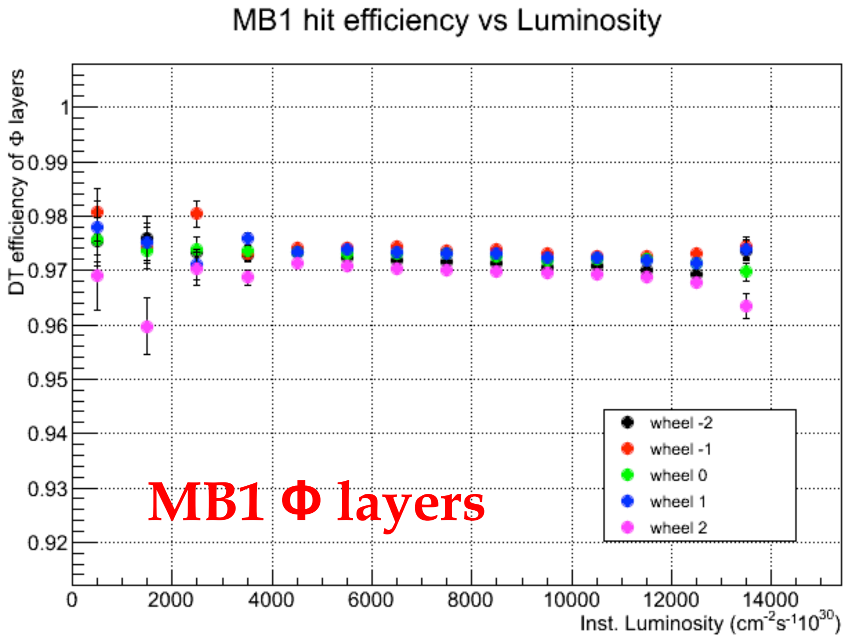


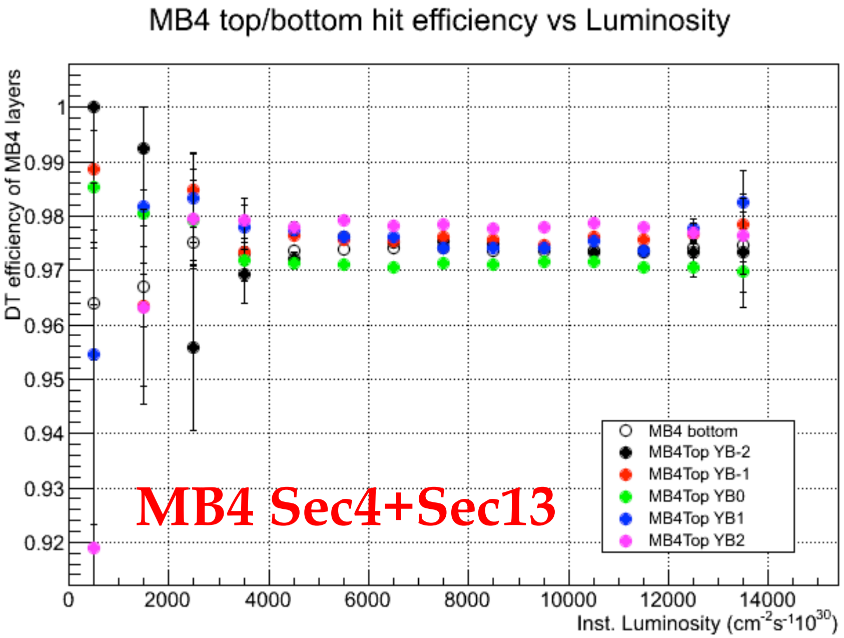


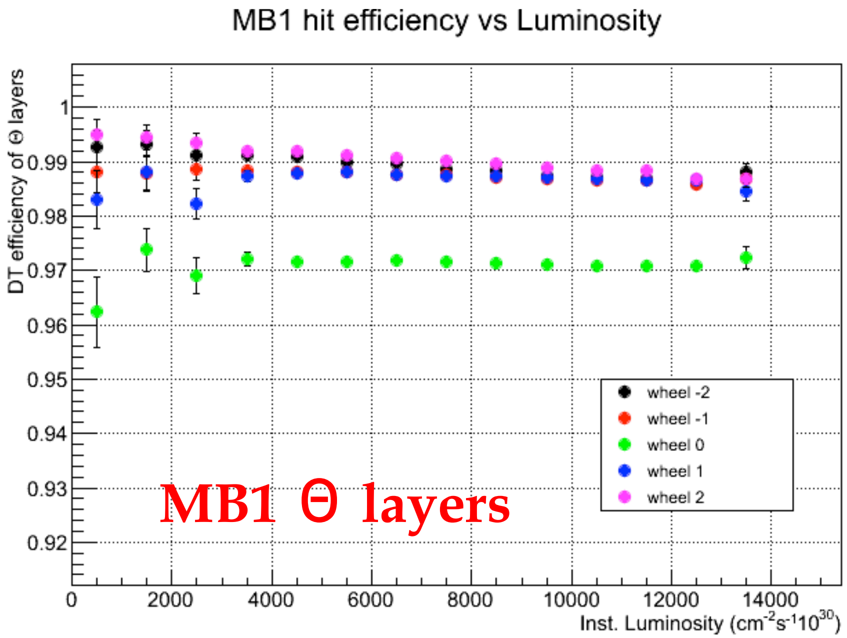
DT HIT EFFICIENCY

VS INST. LUMINOSITY (AND PU)

* Luminosity and PU strongly correlated within most data samples collected in 2016 (here only Lumi is shown)
* Monitoring is needed especially for hottest chambers: MB1's in YB+-2, and top MB4's.
* Very mild trend visible in Θ layers of MB1's: all wheels but YB0



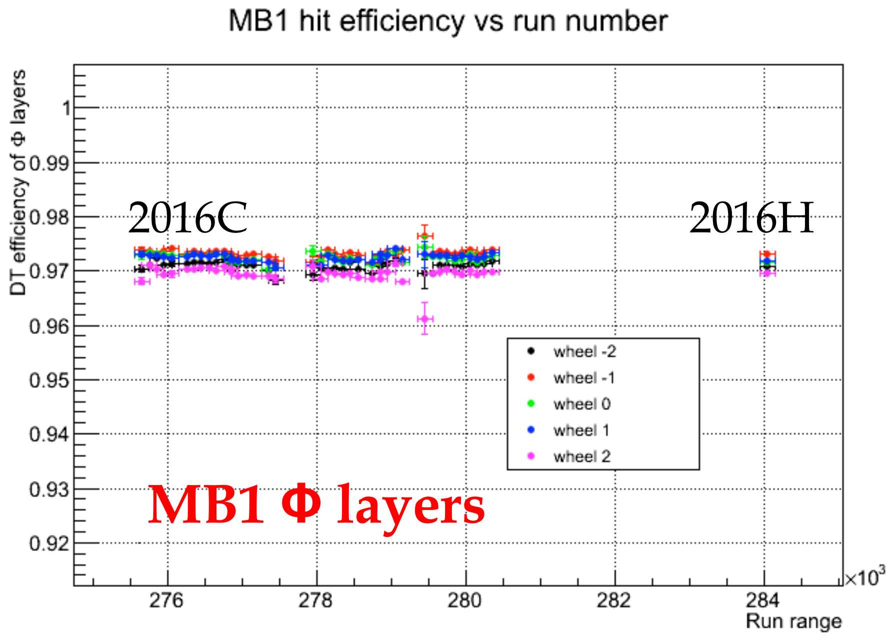


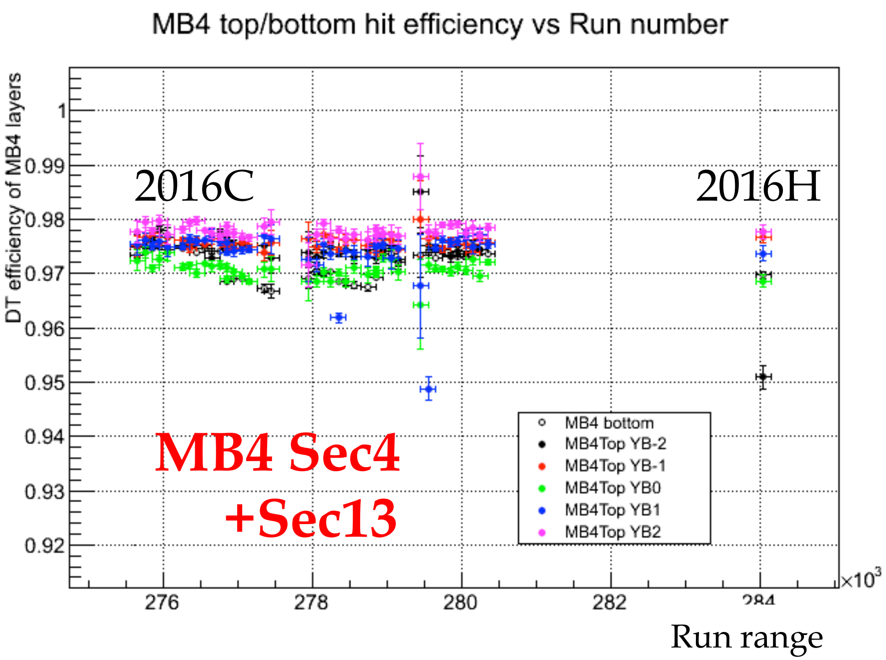


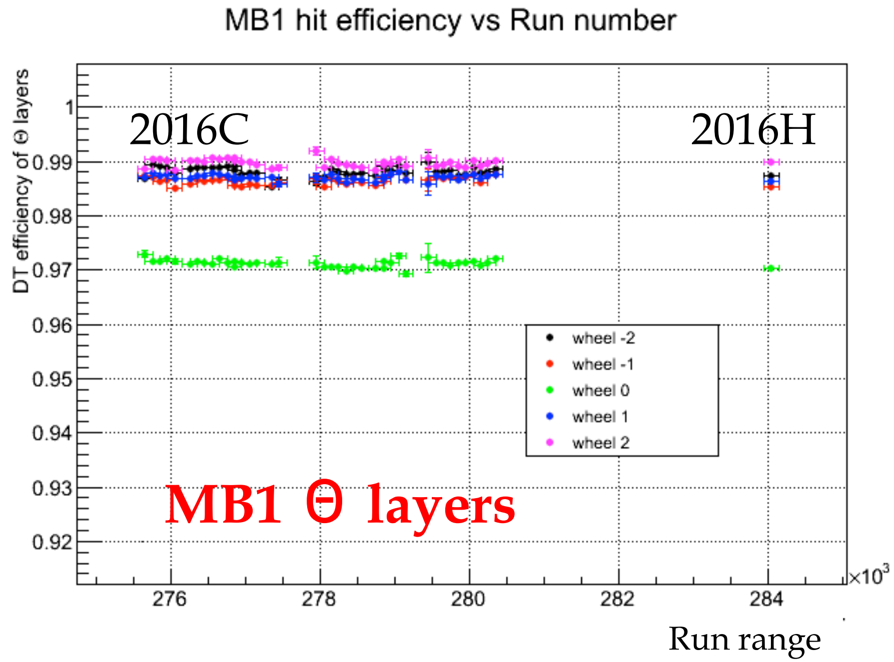
DT HIT EFFICIENCY
VS RUN NUMBER (~ TIME)

Monitoring efficiency vs time
(better, in the future: vs Integrated Luminosity)
aims at spotting early hints of detector ageing.

(None from 2016C to 2016H)





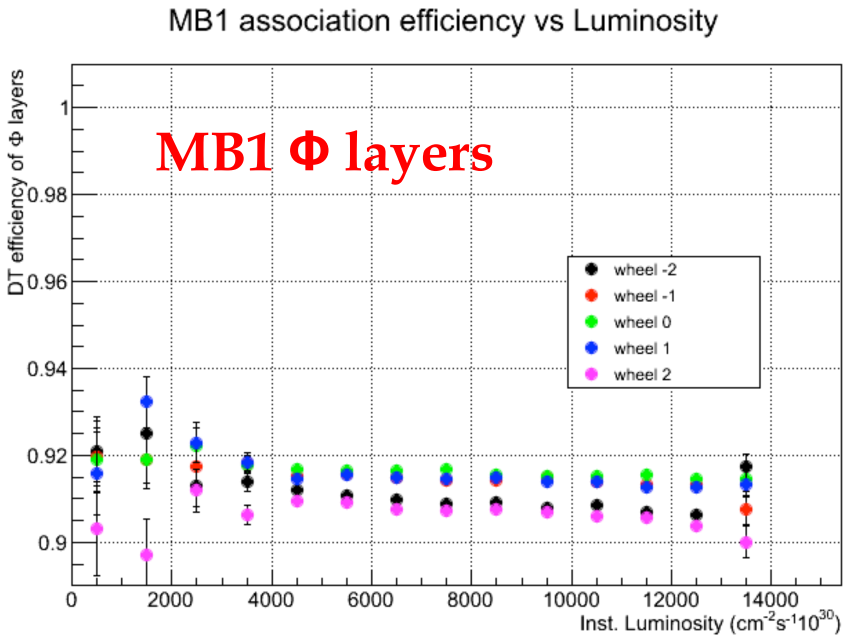


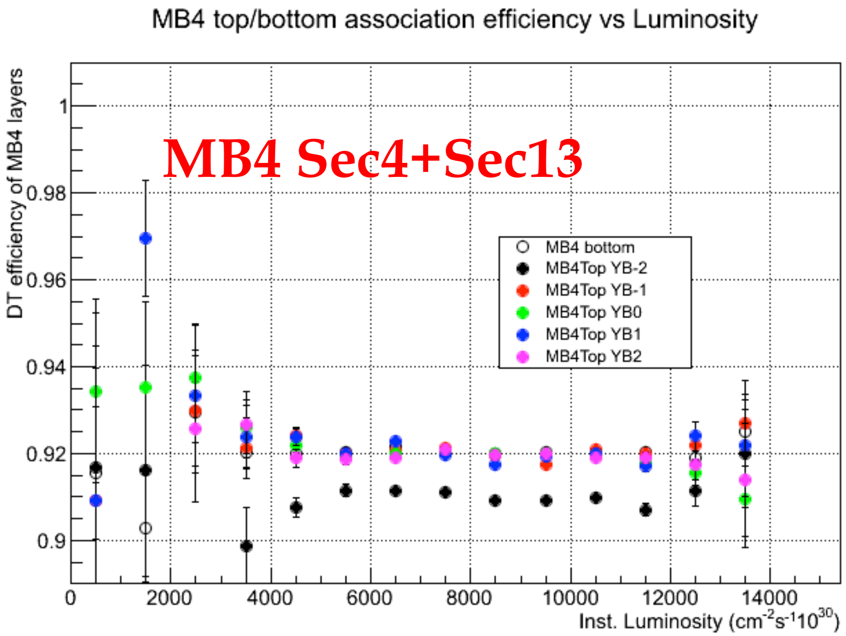
DT HIT ASSOCIATION EFFICIENCY VS INST. LUMINOSITY (AND PU)

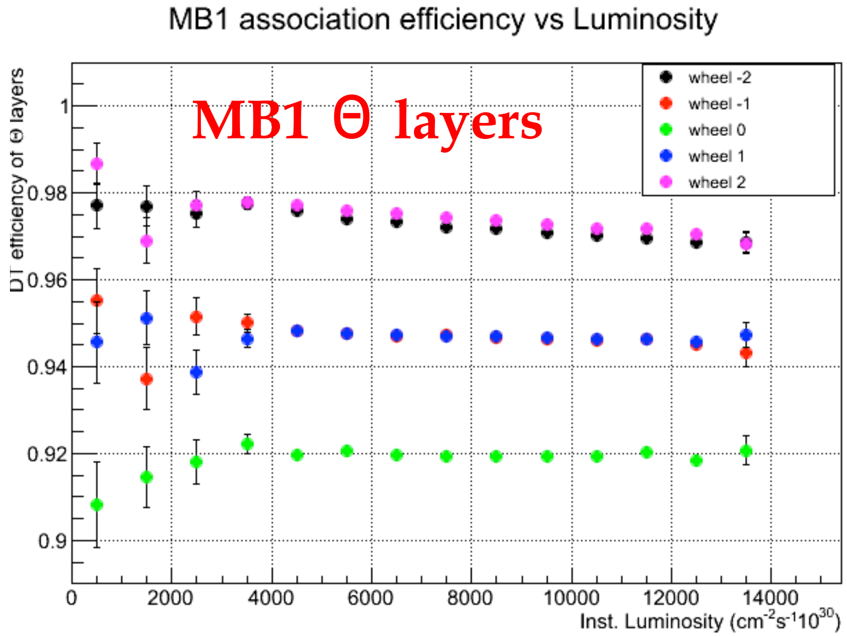
→ In order to consider a layer efficient, not only a hit must be found within the tube where it is expected, but it must also be aligned with hits in other layers.

→ Hit multiplicity has more significant effect on this efficiency, due to the TDC dead time:
  * it is visible in most MB1's layers.
  * No trend so far in top MB4's.

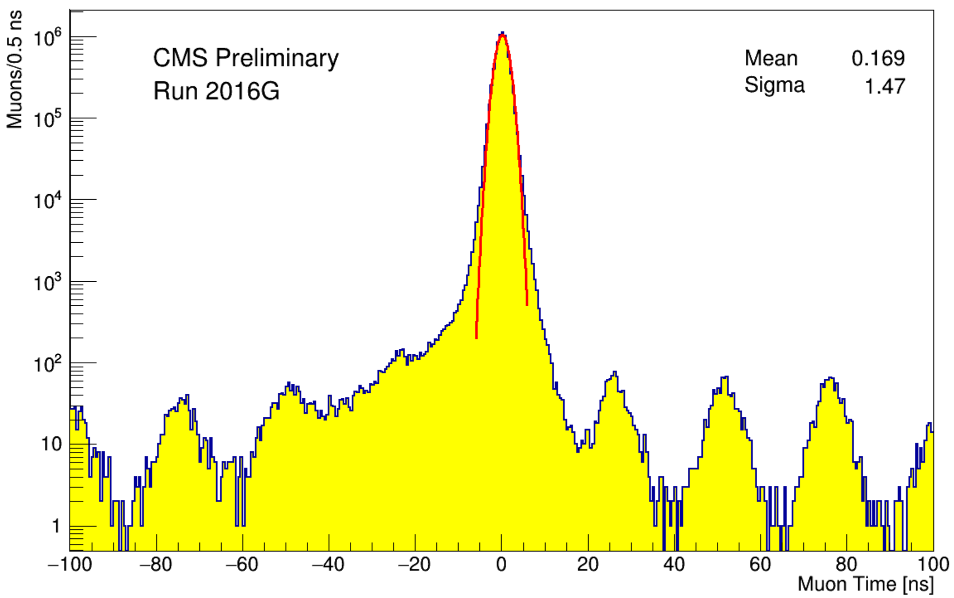
(No dependency observed on run number)







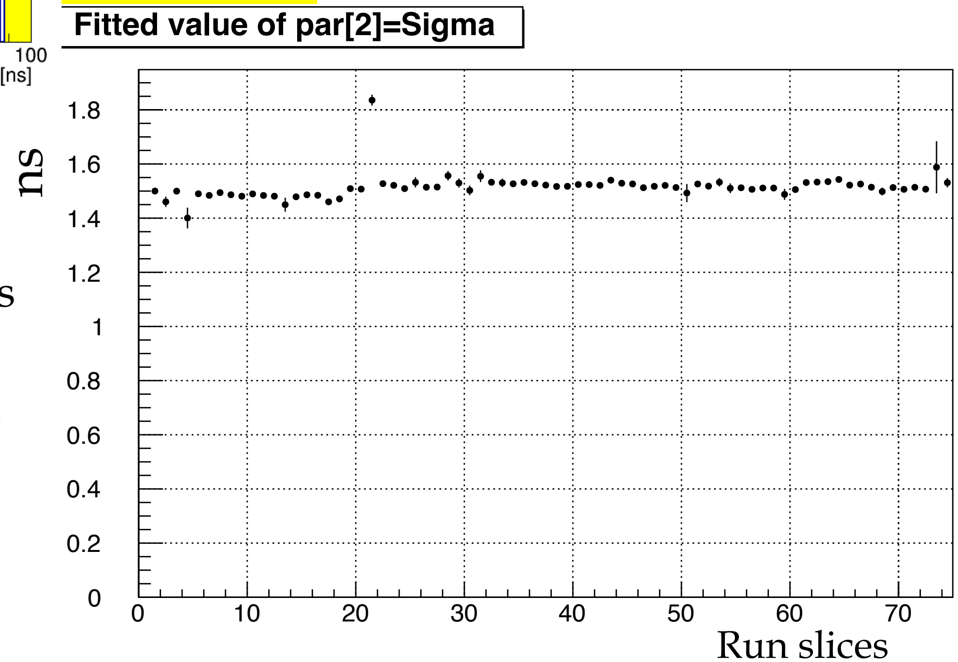
DT TIME RESOLUTION



The DT time distribution makes visible the 25 ns beam structure.

The fit of the central peak provides the DT time resolution = 1.5 ns

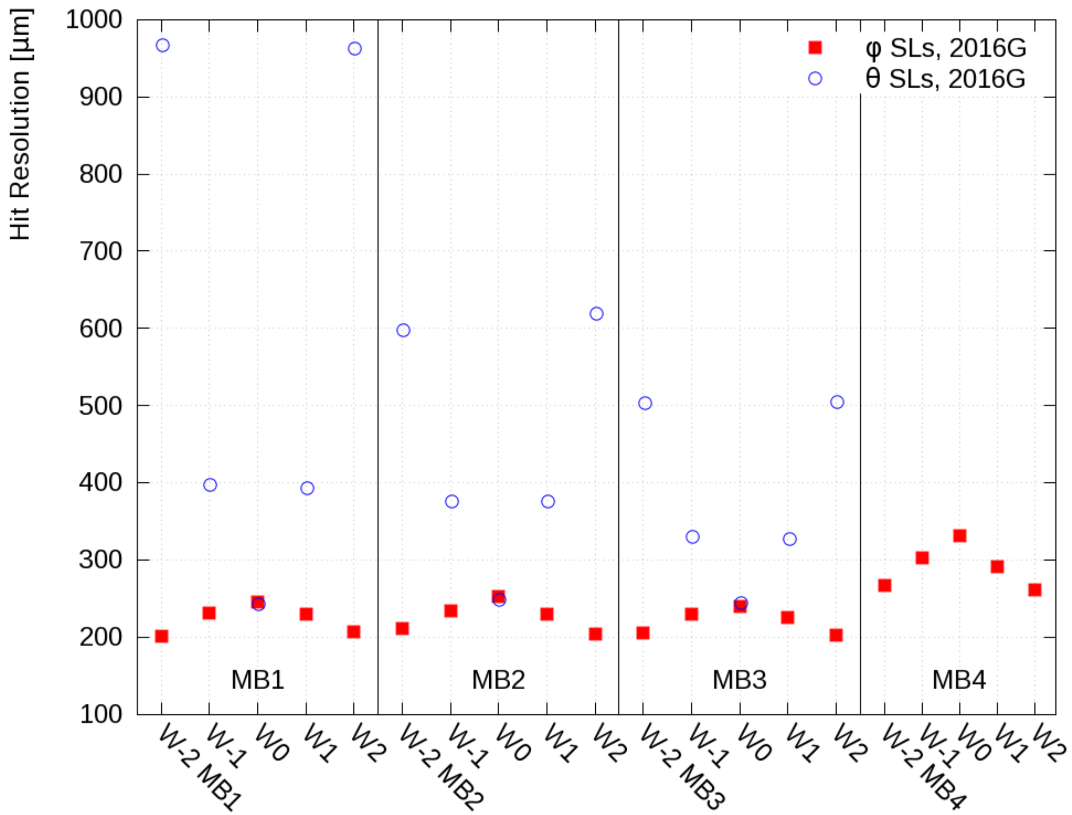
P. Traczyk



This time resolution can be computed in slices of run number in order to check its stability vs time.

DT HIT SPATIAL RESOLUTION

Results for spatial resolution on Run2016G are compatible with previous year (see *https://twiki.cern.ch/twiki/bin/view/CMSPublic/DTDPGResults201120152*)



N. Amapane

We are setting up the tools for regular monitoring

DT CALIBRATION: FEATURES

→ DT calibration consists in determining the two parameters of the linear relationship between the measured drift time and the wanted hit position within the tube: "tTrig" (intercept) and "vdrift" (slope).

→ The procedure is based on the minimization of hit residual w.r.t. ro reco-segments and hasn't substantially changed for the last few years.

→ Calibration STEPS:

1. run vdrift calibration using a recent Global Tag as a starting point
2. run tTrig calibration using the newly determined vdrift and minimizing hit residuals
3. repeat step 2. iteratively using each time the tTrig obtained in the previous step (1-2 times)

see *https://twiki.cern.ch/twiki/bin/viewauth/CMS/DTCalibrationTools*

→ DT calibration is run periodically on dedicated data streams, on the Express stream and PromptReco.

→ A few 10^5 events with good muons are required.

→ The framework for automatic handling of the procedure was recently upgraded, tested and deployed.

DT CALIBRATION: PLANS

P. Traczyk

Current activities

- DT calibration will be switching over to the new framework
- The framework will be included in official CMSSW (pull request coming soon)

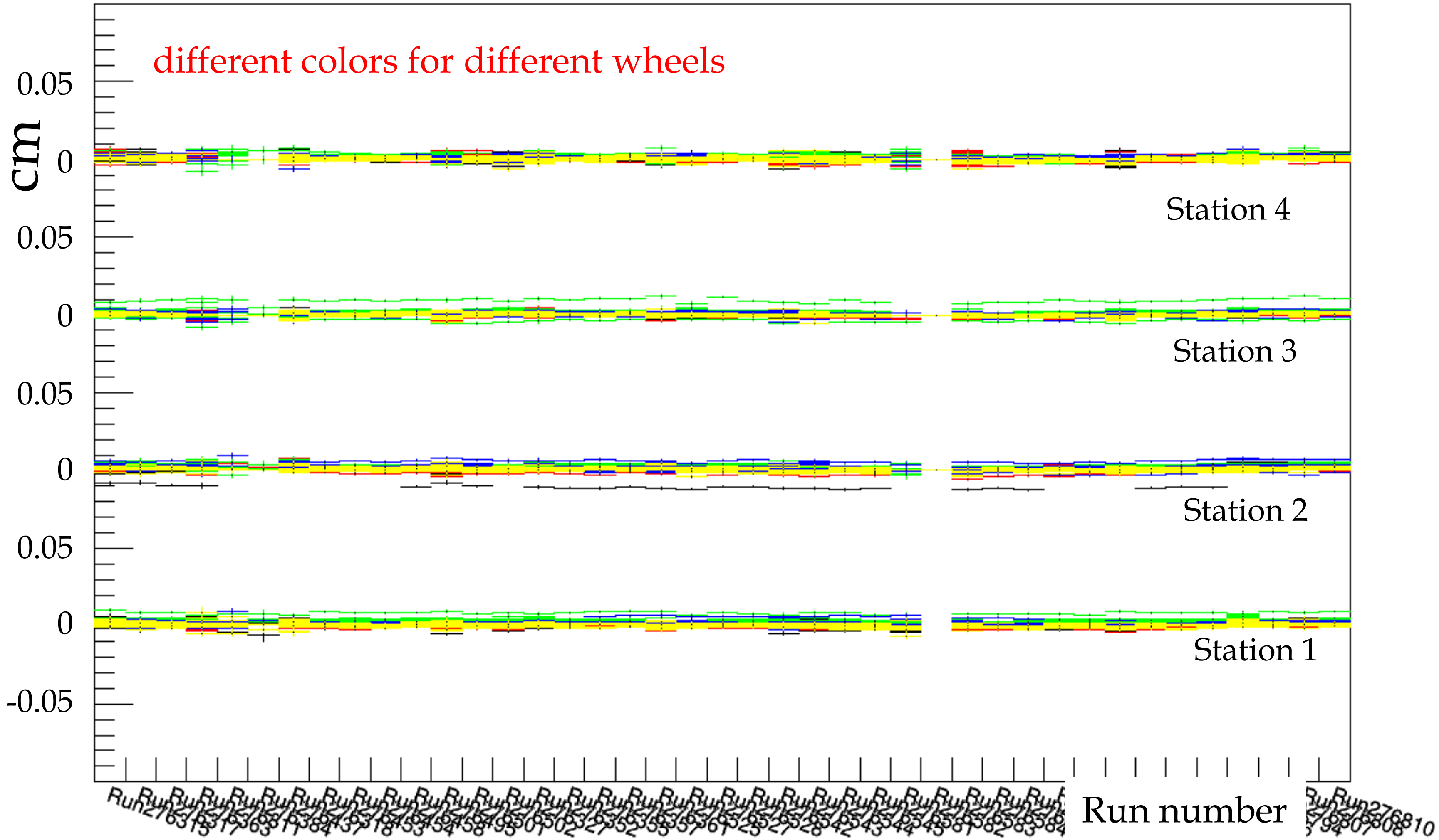
- Reviewing the performance of the calibration steps
  - Checking the gain that we get from multiple iterations
  - Making the residual histograms wider, at least in the first iteration (in the past we had cases where the residual peak would fall outside the histogram bounds and the fits would fail, leading to tTrig values that were off)
- Implementing history plots of residuals vs Run (example in next slide for 2016 PromptReco)

19.01.2017 Piotr Traczyk, DT DPG 7

Residual history plot

P. Traczyk

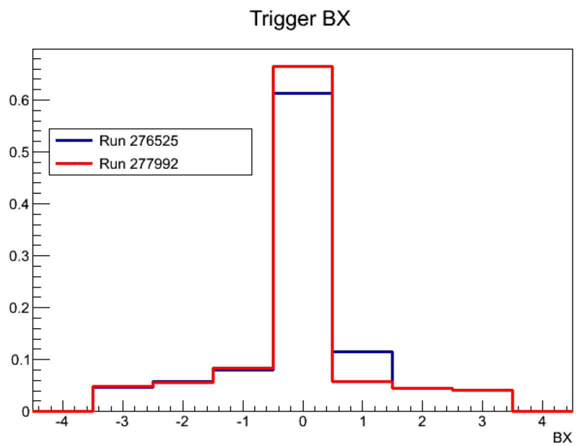
Run2016D Means of residuals in SuperLayer Φ1 vs time.



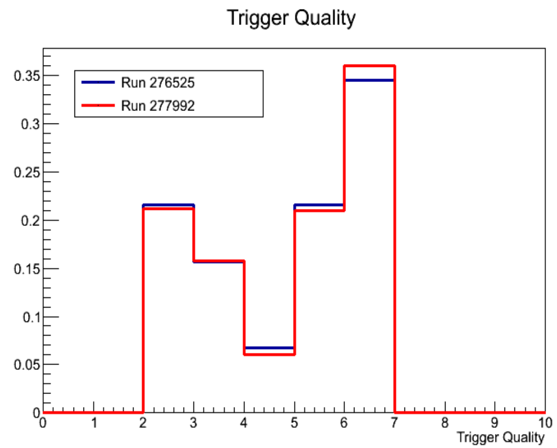
DT FINE SYNCHRONIZATION

Adjusting the clock of each single DT chamber in order to set it in phase with LHC improves the trigger performance (more primitives found in BX=0)

Before fine synch.
After fine synch.



BX assignment

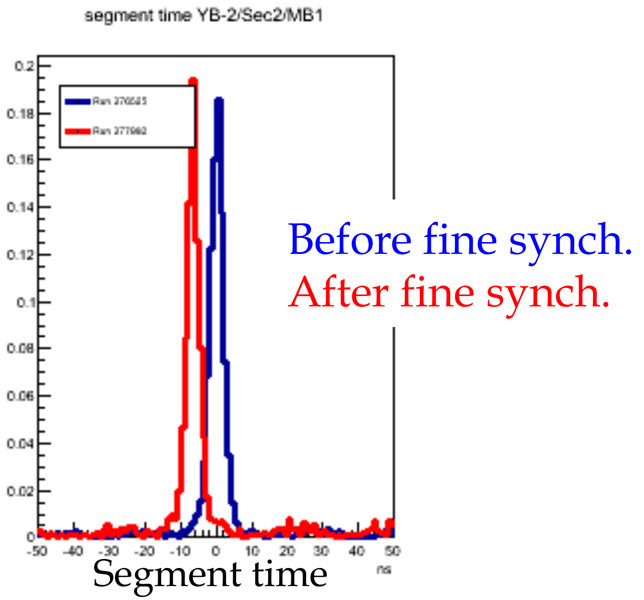


Trigger quality

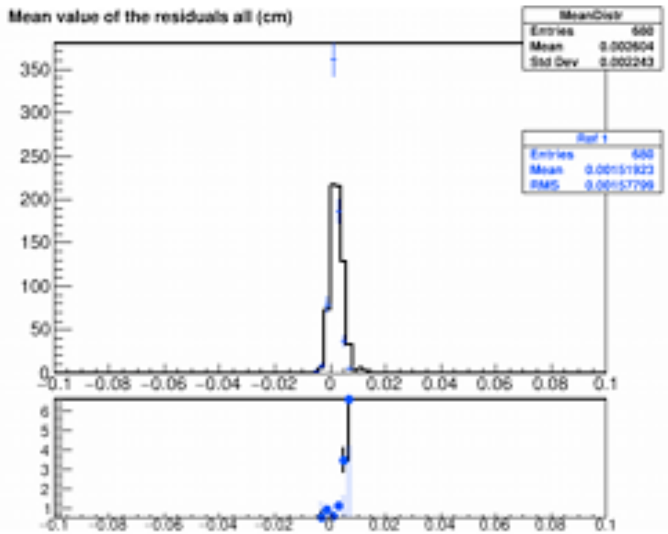
Fine synchronization was performed in August 2016
(thanks to A. Alvarez Fernandez)

Since the same clock is used by local trigger and readout (TDC),
the calibration also needs to be adjusted after trigger fine synchronization.

ADJUSTING CALIBRATION AFTER DT FINE SYNCHRONIZATION



After trigger fine synchronization a time shift was observed in the readout: e.g in the time associated to reconstructed segments



After adjusting the calibration the residual distribution improved significantly:

the release validation test, performed automatically, ... failed!

PROMPT OFFLINE WORK ORGANIZATION

Prompt feed-back to RC and DT community is provided by DT DOC 2 shifter
See:
https://twiki.cern.ch/twiki/bin/viewauth/CMS/DTAnalysisLHCRuns

→ The offline shifter has three main tasks to accomplish:

1) The Prompt Offline Analysis has to be run on the largest run of each fill, the plots must be saved on web and scrutinized. An entry per run should be made in the e-log with a clear, complete yet synthetic report on the problems observed.

2) The Early Run Certification is to be done in real time on the DT workspace within Run Registry, for every run that has been analyzed.

3) The Tree Production should be run by default at least once a week, on large good quality runs, or on demand (from online crew or analysts)

→ Weekly report is given at the DT meeting (Wednesday at 11).

→ Shifts last 1 week. Credits in 2016 were 0.75 points/day.

→ We are organizing procedures and task description for future Muon DOC 3 who is thought to be in charge of continuous trend monitor. (Examples in slides 4-7, 12)

PLANS FOR 2017 COMMISSIONING

Commissioning with cosmics

* HV scan data-taking and analysis: find/validate lower working points to increase longevity of chambers most exposed to radiation (top MB4's, high η MB1's).

* Compare results to last year, to spot any hints of ageing.

Commissioning with early collisions

* Calibration → Fine Trigger Synchronization → Calibration

* Check and optimize procedure for continuous monitoring (DOC3 shifter)

BACK-UP

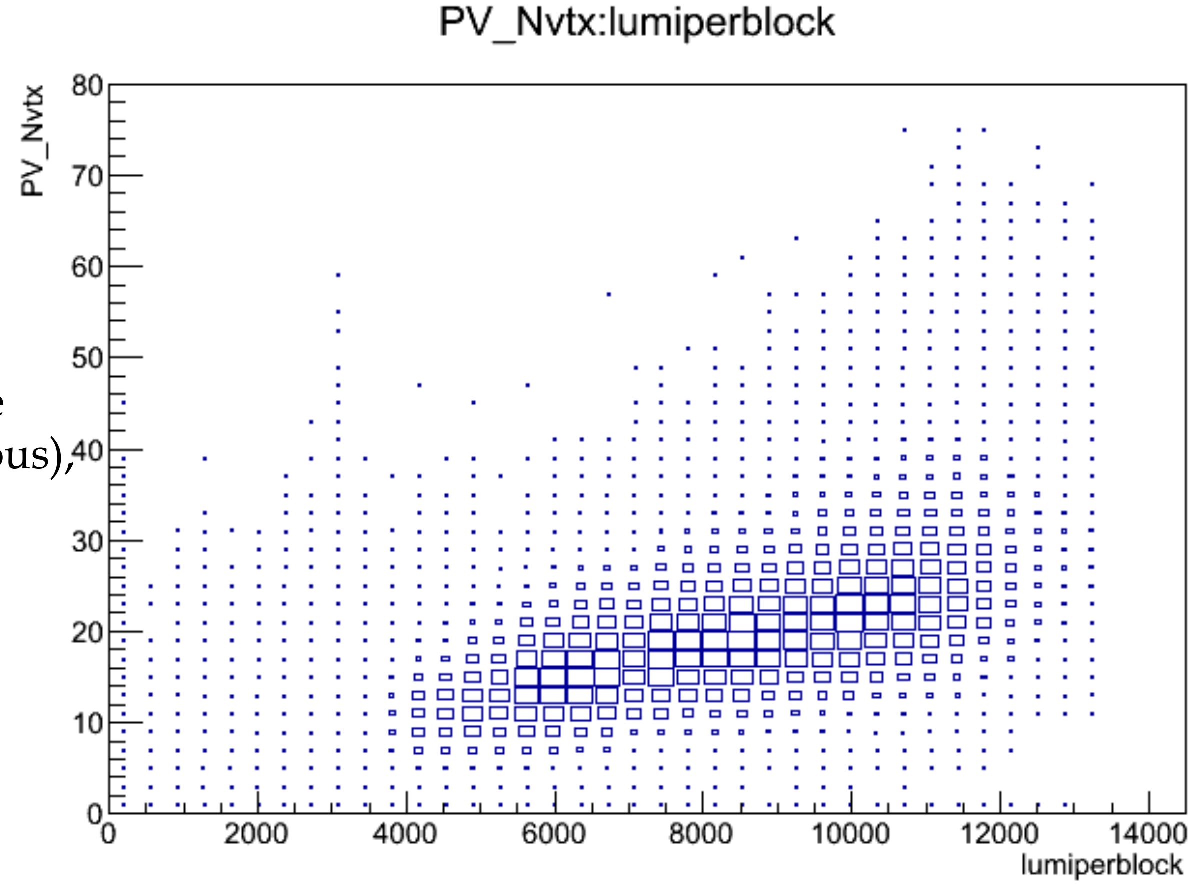
Correlation between Inst. Lumi and PU

Within the same beam bunch structure, Pile-Up and Inst. Luminosity are correlated.

This was the case for most 2016 data and this is why we only showed the efficiency dependency on luminosity.

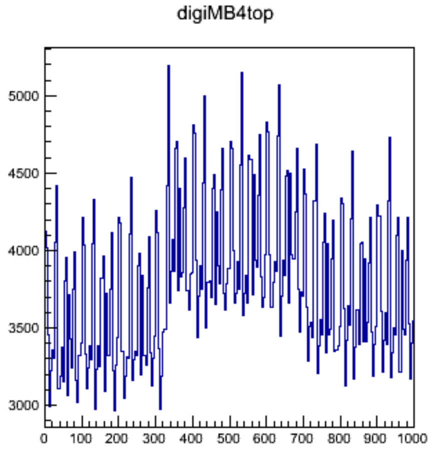
In principle the two conditions can be decoupled and can have some different effects on our main observables. (e.g. Luminosity is responsible for n-background (asynchronous), PU for track multiplicity in high η regions.)

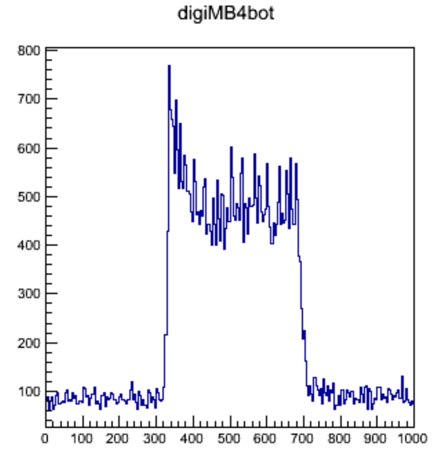
So we keep monitoring both.



Hottest DT regions (1)

The background caused by High Luminosity/High Pile-Up is concentrated in the "top MB4s", that are exposed to neutron gas, and in the high η MB1's, that collect (fragments of) tracks from Minimum Bias.

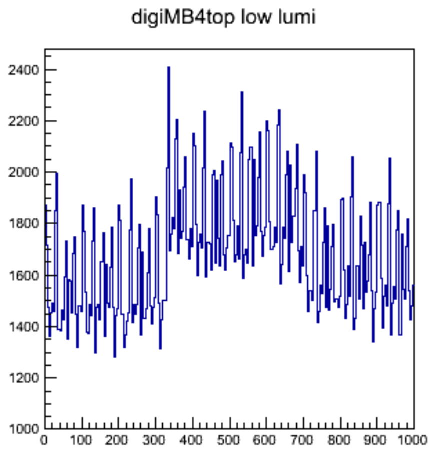


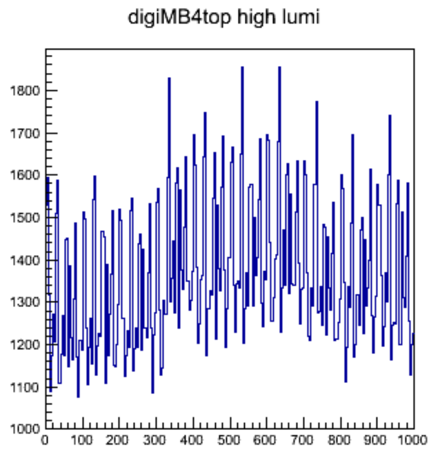


Left: Drift time distribution in top MB4 (Sector 4)

Right: Drift time distribution in bottom MB4 (Sector 10)

(100K events)

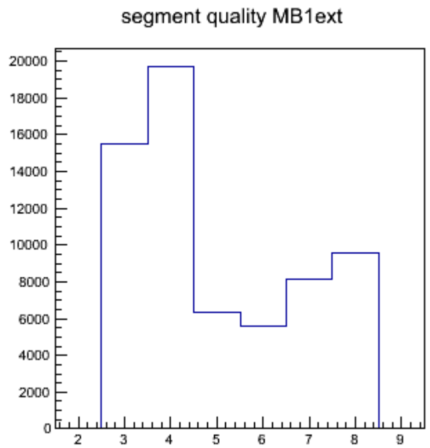


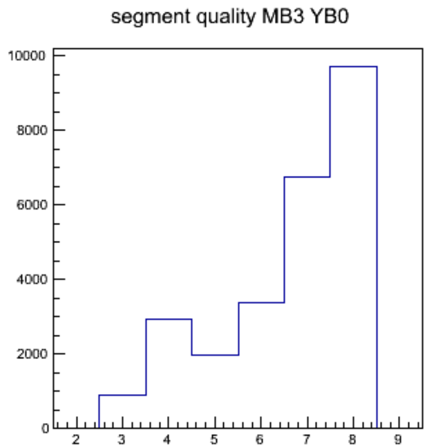


Left: Drift time distribution in top MB4 for Lumi < $5\ 10^{33}\ cm^{-2}\ s^{-1}$

Right: Drift time distribution in top MB4 for Lumi > $12\ 10^{33}\ cm^{-2}\ s^{-1}$

Hottest DT regions (2)

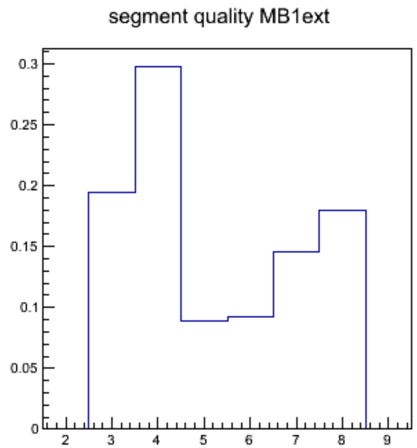


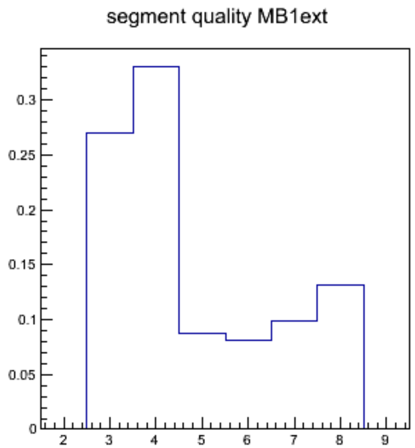


Left: Segment quality distribution in MB1/YB2

Right: Segment quality distribution in MB3/YB0

(100K events)





Left: Segment quality distribution in MB1/YB2 for Lumi < 5 10^{33} cm^{-2} s^{-1}

Right: Segment quality distribution in MB1/YB2 for Lumi > 12 10^{33} cm^{-2} s^{-1}

Both types of background will be monitored regularly.
Detailed studies are ongoing to assess their exact dependencies on beam conditions.

Why Θ layers of YB0 have lower efficiency than external wheels