Muon trigger and b-jets punchthrough

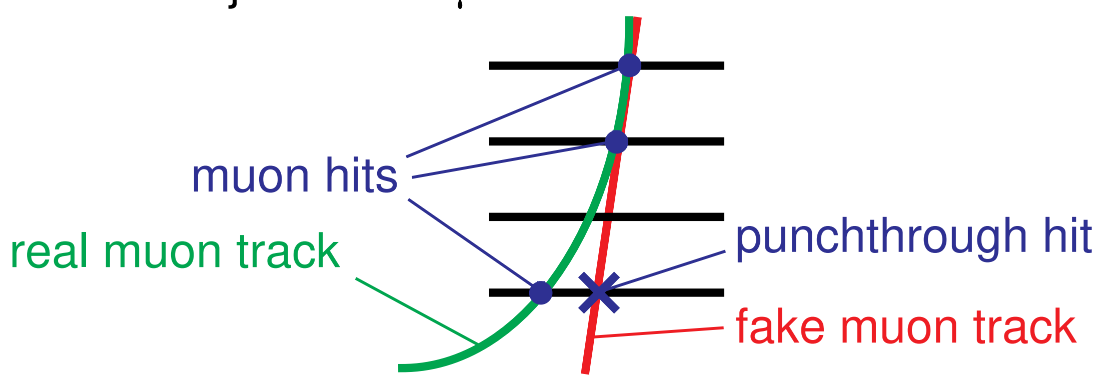
G. Wrochna
CERN

Question:

- **Is the Tail Catcher needed to protect the Muon System from punchthrough?**

Possible problem:

- **Trigger p_t overestimation for a muon in a jet**
  - highest trigger "background" are low p_t μ with overestimated p_t
  - in the past the effect was studied for single μ within a random "bath" of hits
  - the effect might be enhanced by the presence of c- or b-jet around μ



Punchthrough with(out) Tail Catcher

Absorber budget in front of MB/0/1

- **LOI:** **10.1 λ**
- **TP:** **9.4 λ** **(with TC)**
- **proposed:** **8.1 λ** **(without TC)**

Random hits

Decreasing 10.1 λ to 8.1 λ increases punchthrough 10 ×.

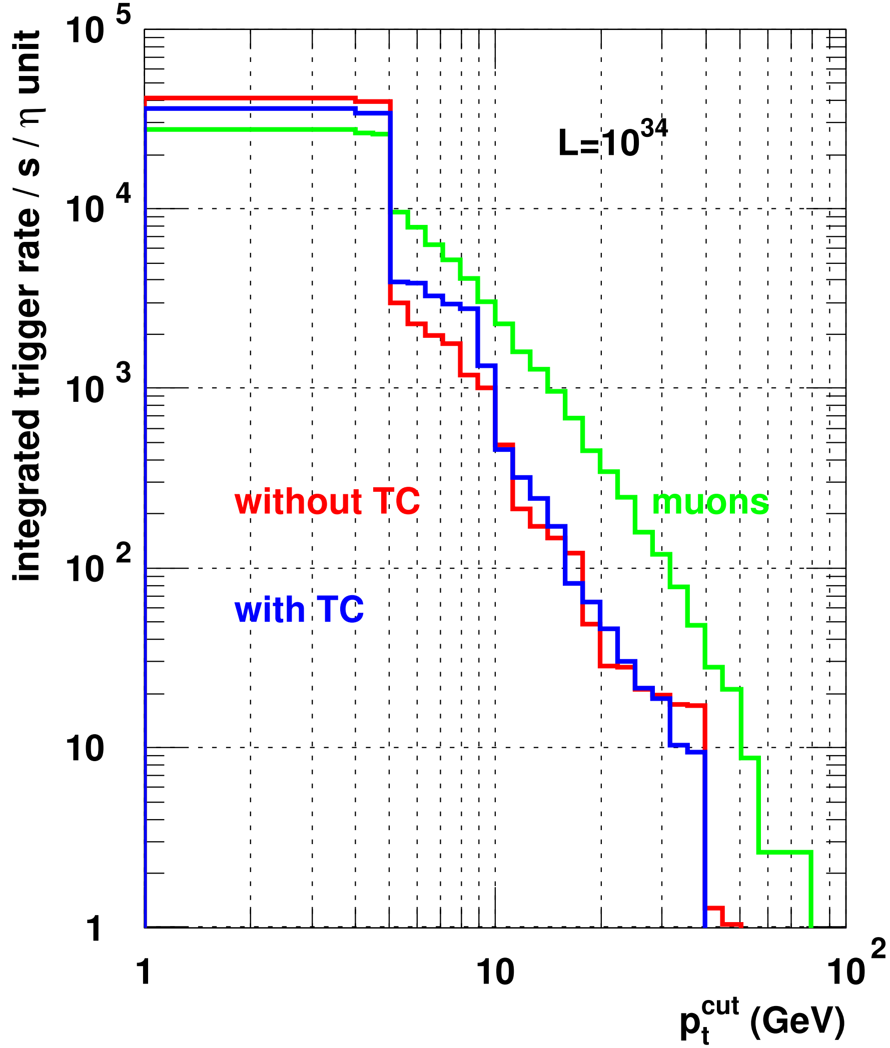
Total rate dominated by n → γ → e do not exceed 1 Hz/cm^2.

Uncorrelated tracks

RPC trigger rate due to uncorrelated hadrons is not increased significantly (see Fig.)

Correlated tracks

Isn't the rate enhanced by the presence of c- or b-jet around μ ?



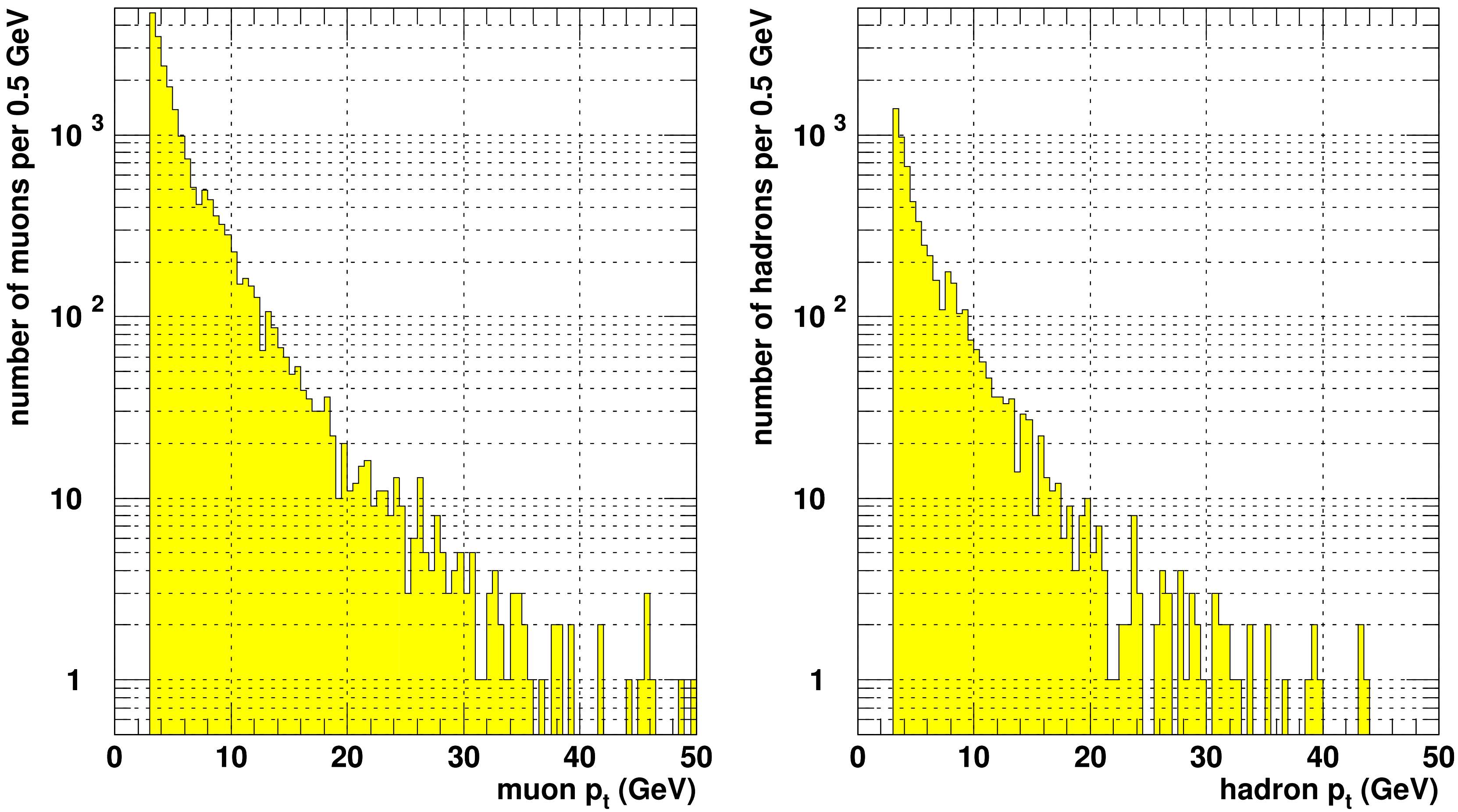
see ***http://cmsdoc.cern.ch/~wrochna/punch/punch.ps*** for details

Muons & punchthrough from b-jets

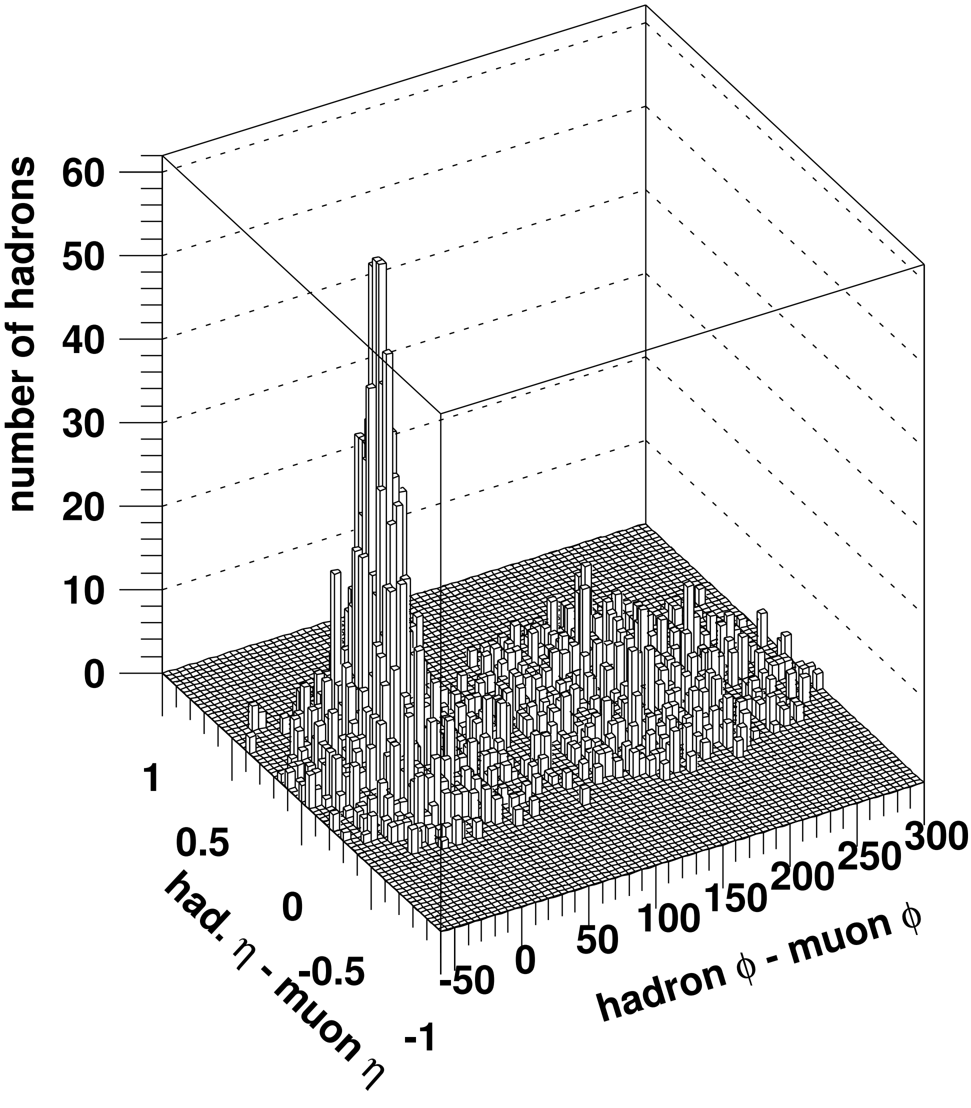
- **EVENT GENERATION**
  - Sample of $b\bar{b}$ events with p_t^{jet} > 3 GeV generated with PYTHIA 5.7
  - 20 000 events with muon of p_t^{μ} > 3 GeV and $|\eta^{\mu}| < 0.28$ selected
  - 5 849 hadrons with p_t^{had} > 3 GeV and $|\eta^{had}| < 0.28$ found in this sample
- **DETECTOR SIMULATION**
  - CMS geometry without TC described by CMSIM / GEANT
  - All muons and hadrons tracked through CMS
  - Hadron showers simulated in detail by FLUKA / GEANT
  - RPC Trigger simulated by CMSIM / MRPC software
  - Trigger algorithm applied to single muons and full events
- **ANALYSIS**

  Compare:
  - real muon momentum p_t^{μ}
  - momentum measured by trigger p_t^{trig} for single muons
  - momentum measured by trigger p_t^{trig} for muons in jets

p_t spectra of selected particles



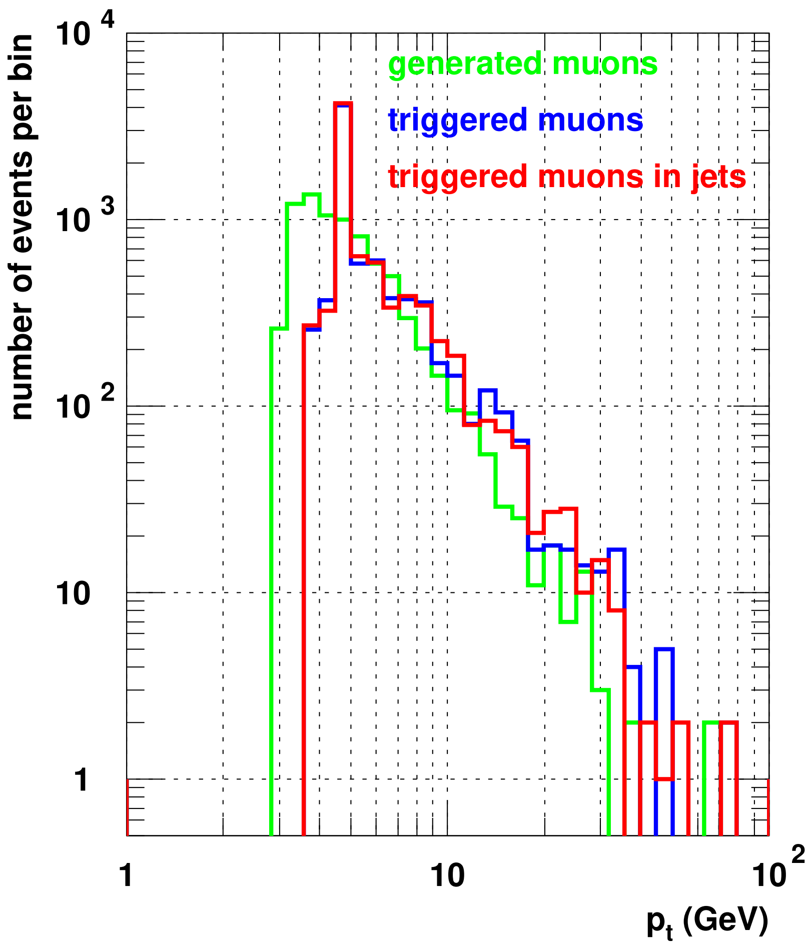
Event topology

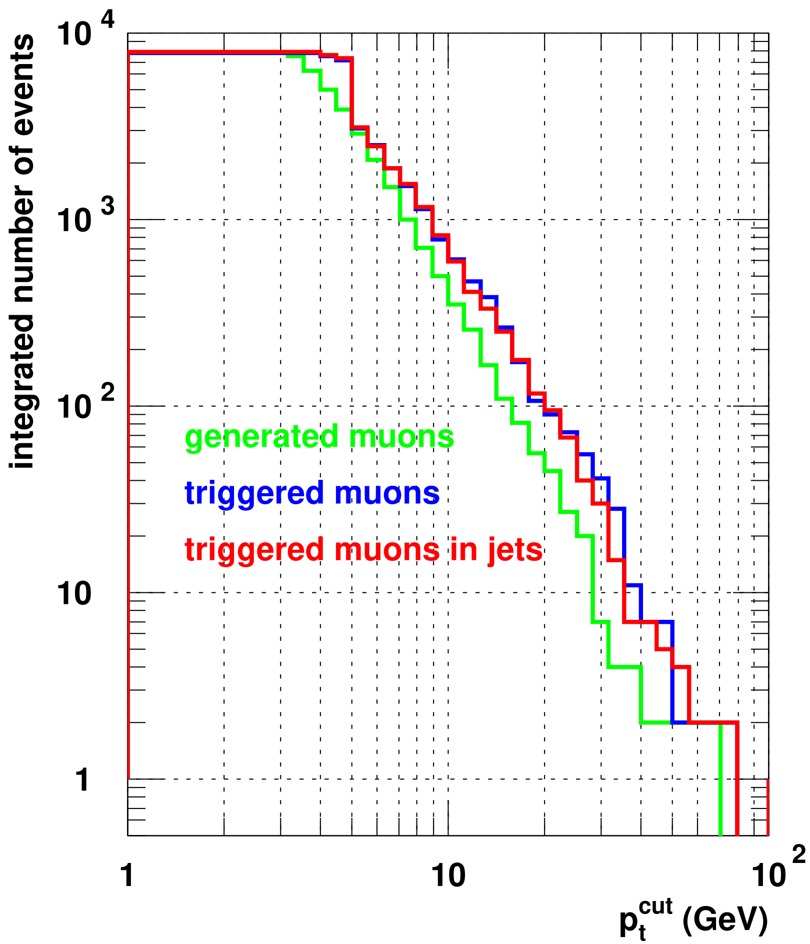


Hadron position in respect to the leading muon.

Two-jet structure is clearly visible.

Spectra of p_t^{μ} and p_t^{trig}





No significant difference between single muons and muons in jets

Trigger answer for muons in jets

No significant difference between single muons and muons in jets is seen.

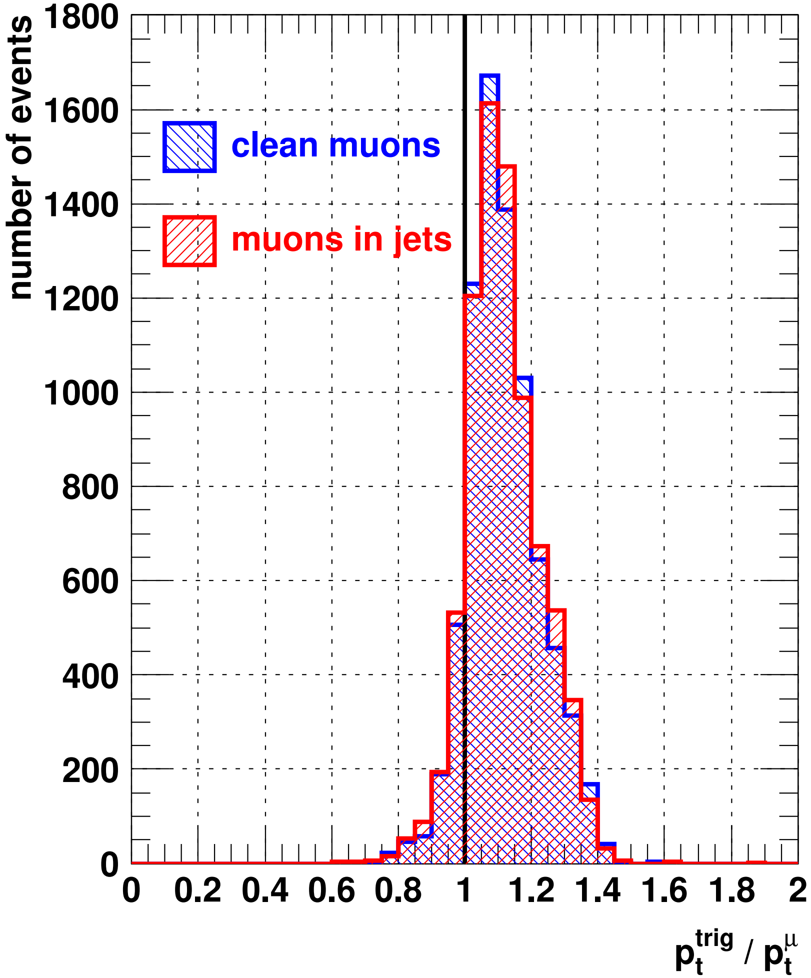
⇓

Presence of jets around muons has no effect on RPC trigger.

The study was done without TC.

⇓

TC is irrelevant for triggering on muons from b- and c-jets.



Conclusions

- **The following effects of punchthrough have been studied:**
  - Random hits rate [Hz/cm^2] and its influence on chamber performance, pattern recognition and momentum measurement
  - Increase of the trigger rate due to random punchthrough hits
  - Increase of the trigger rate due to punchthrough tracks
  - Increase of the trigger rate because of the p_t overestimation for a muon accompanied by a jet (b- and c-quark decays)
- **Obtained results cannot justify the need for the TC because its influence was found to be negligible.**
- **The study was done for the RPC trigger but in principle the Drift Tube trigger, based on several layers per station, should be even more resistant to this kind of background.**
- **It is not yet proven, however, that the precise momentum measurement will not be affected by punchthrough if there is no TC.**

Plans for further study

Punchthrough effect on pattern recognition & track fitting in Drift Tubes

- **Mismeasurement of p_t for a muon in a jet**
  - some punchthrough hits might be taken instead of real μ hits
  - this is important for high p_t, at low p_t the precision is given by Tracker
  - usually high p_t μ to be precisely measured are isolated; exceptions:

    $t \rightarrow b \rightarrow J/\psi \rightarrow 2\mu$

    stop $\rightarrow Z \rightarrow 2\mu$
- **Fake muon tags of b-jets**
  - μ tag needed to suppressed QCD background
  - can be faked by a μ created in a hadronic shower within the jet

The study should be done in three steps:

- **generation of a sample of events** (with a help of Physics Group)
- **tracking through the CMS with CMSIM / GEANT / FLUKA** (easy)
- **pattern recognition and track fitting in Drift Tubes** (by Padova group)