Remarks on punchthrough in the CMS Muon System

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Two critical regions:

- **barrel / endcap corner — low λ cable path**
  – not discussed today
- **MB/0/1 chamber — least absorber**
  – first results

Three geometry versions:

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

Warning:

Results on punchthrough in TP are based on LOI geometry!

Effects of punchthrough

- **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)**
- **Mismeasurement of p_t for a muon accompanied by a jet**

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

  $stop \rightarrow Z \rightarrow 2\mu$
- **Fake muon tags of b-jets**

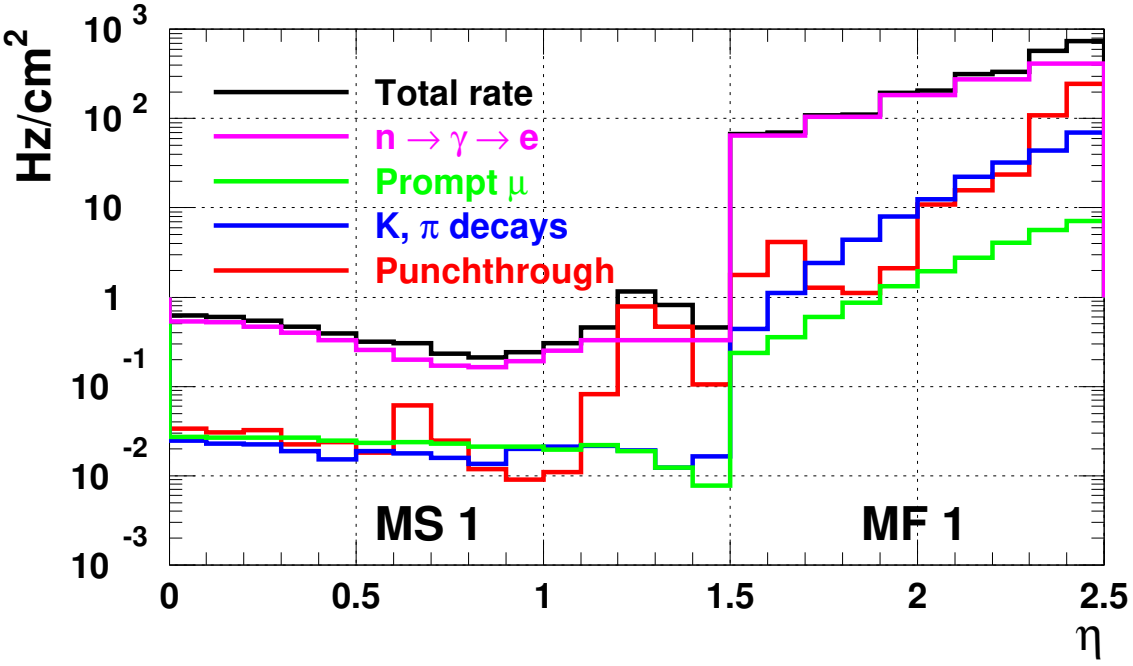
See working document:

/afs/cern.ch/user/w/wrochna/public/html/punch/punch.ps

or **http://cmsdoc.cern.ch/~wrochna/punch/punch.ps**

Random hits rate

TP numbers for LOI geometry (10.1 λ):



Decreasing absorber from 10.1 λ to 8.1 λ increases punchthrough 10 ×.

Total rate increases to 1 Hz/cm^2.

Those are still very comfortable conditions.

Min. bias punchthrough simulation

CMSIM101 / GEANT / FLUKA

Simulation time at SHIFTCMS

μ	$<\pi> \in$ 1-100 GeV	π = 100 GeV	π = 1 TeV	min. bias event
0.04 s	2.2 s	1 min.	5 min.	1 min.

- Rejection factor needed: 10^5-10^6
- Statistics required: 10^8 min. bias events
- CPU time: ~200 years!

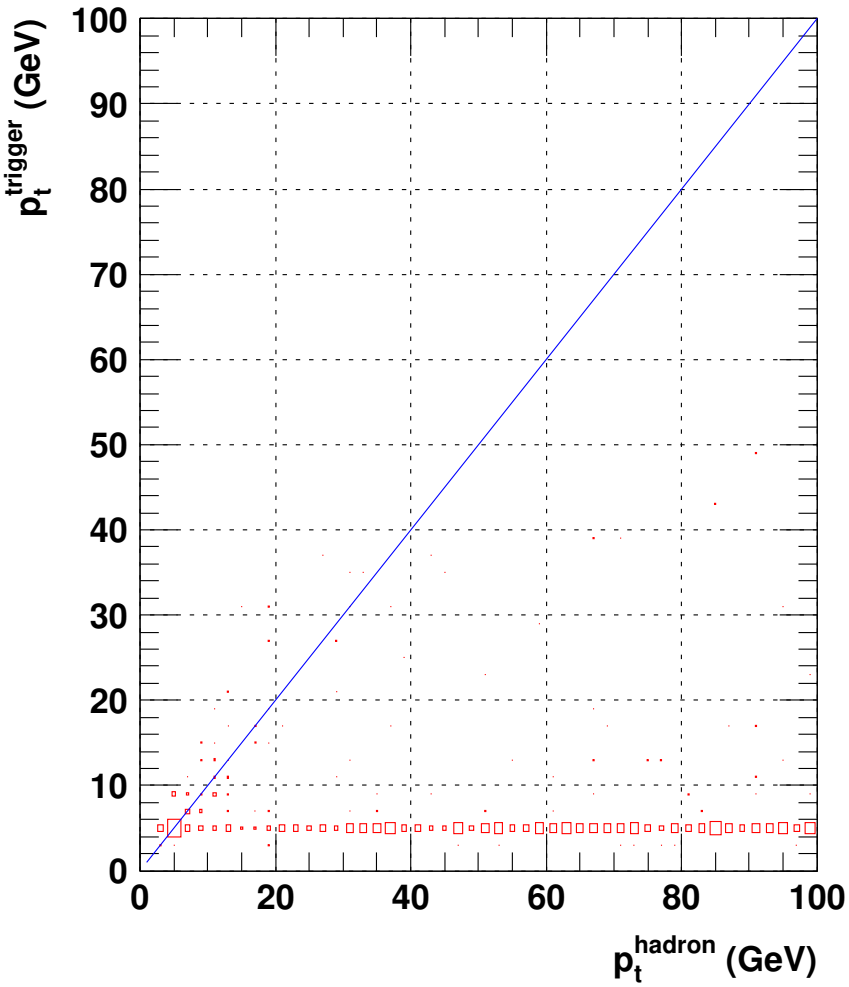
Instead single hadrons were generated with flat $\log_{10}(p_t)$ distribution:

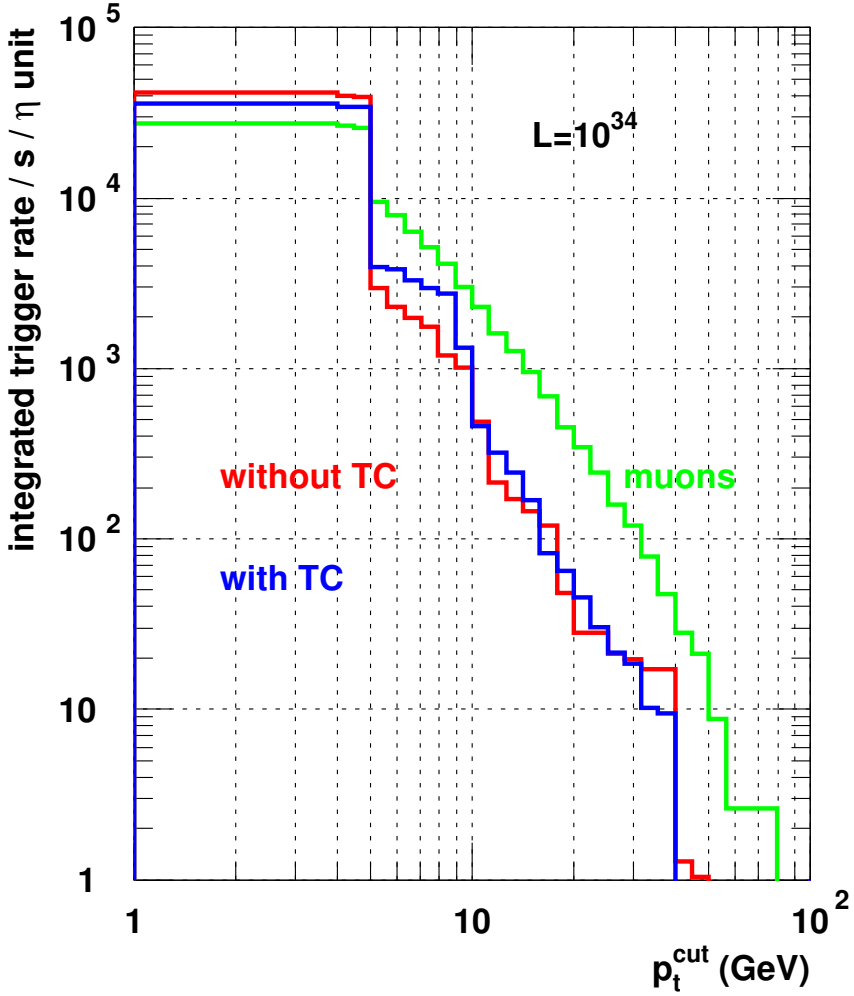
31.62% of π^+, π^-, 5.32% of K^+, K^-, K^0_L, K^0_S, 3.87% of $p, \bar{p}, n, \bar{n}$

Statistics of simulated hadrons

	λ	events simulated	triggered	fraction
with TC	9.4	215 000	803	0.37%
without TC	8.1	140 000	876	0.63%

Punchthrough with(out) Tail Catcher





Conclusions and plans

Removal of the TC does not increase significantly the rate of the RPC based muon trigger due to minimum bias hadrons

To be done next:

- **study the effect on the Drift Tube trigger** (TW?)
- **simulate physics channels mentioned above**
- **identify other channels potentially affected by punchthrough**
  – with a help of Physics Group

Simulation 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**
  – by a Task Force to be appointed at CERN
- **simulation of muon trigger algorithms or full muon reconstruction**
  – by Padova (DT), US&Dubna (CSC), Vienna (TF) and Warsaw (RPC)

Channels to be studied

Trigger rate

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

Off-line pattern recognition and momentum measurement

- **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

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 ×.

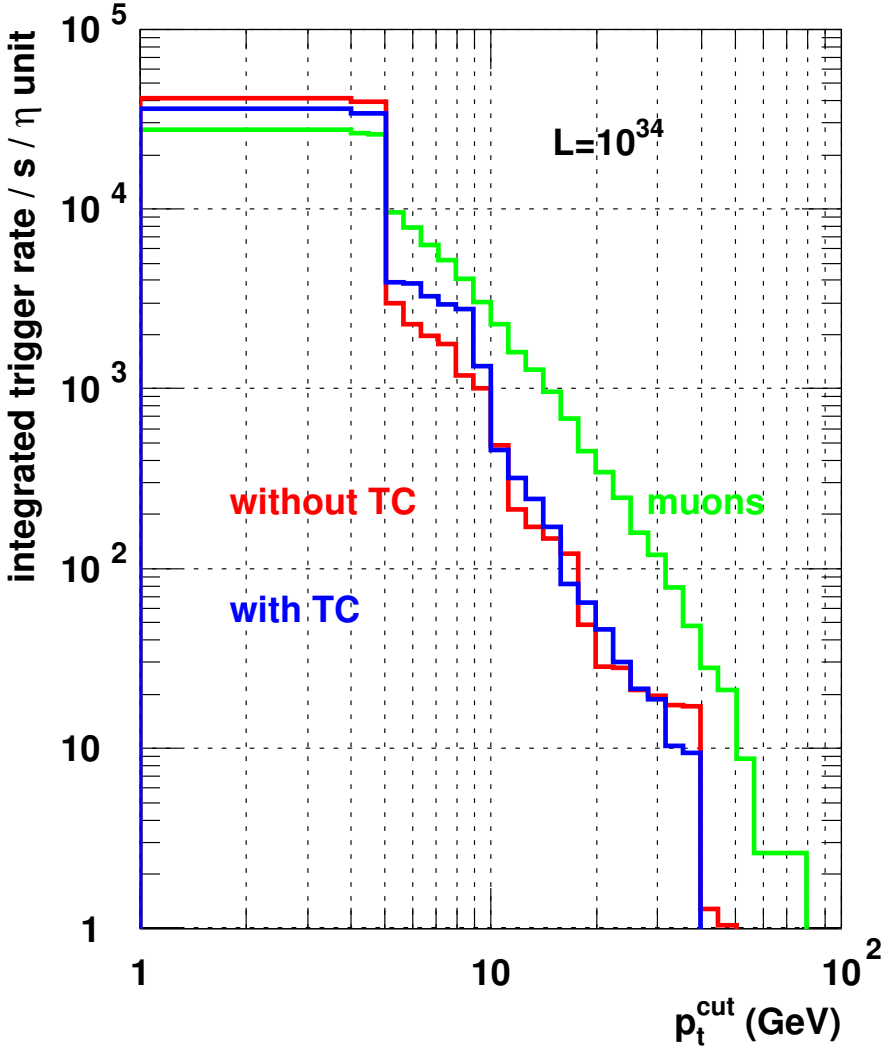
Total rate dominated by n → γ → e do not exceed 1 Hz/cm^2.

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