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/ψ $\rightarrow$ 2μ
  stop $\rightarrow$ Z $\rightarrow$ 2μ
- **Fake muon tags of b-jets**

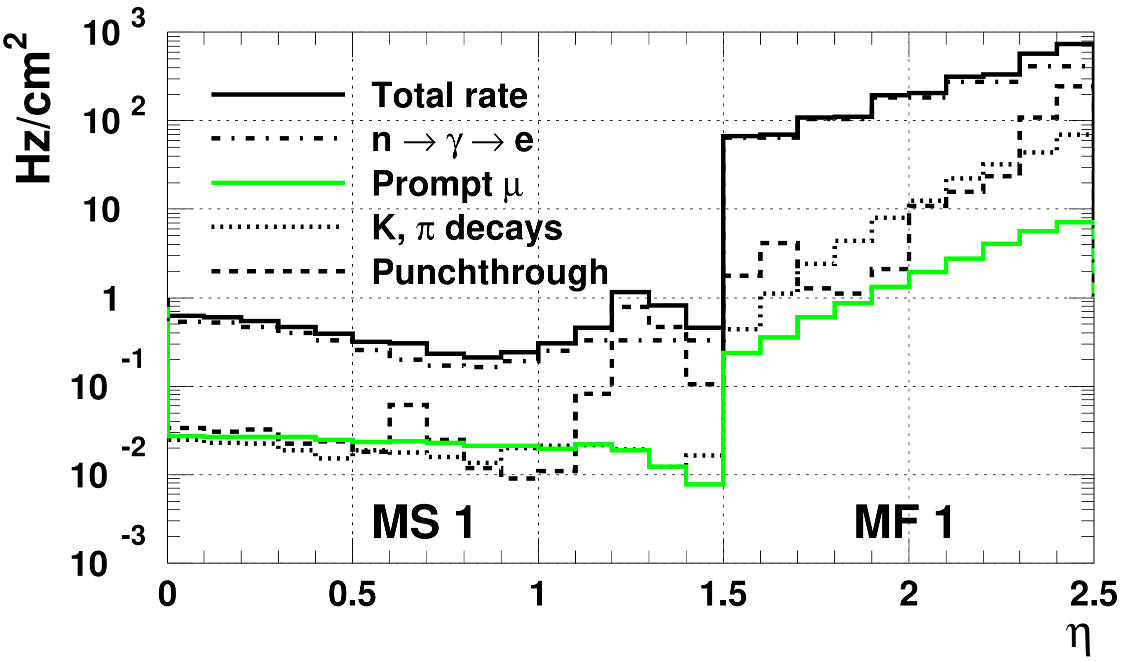
See working document:

/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 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!

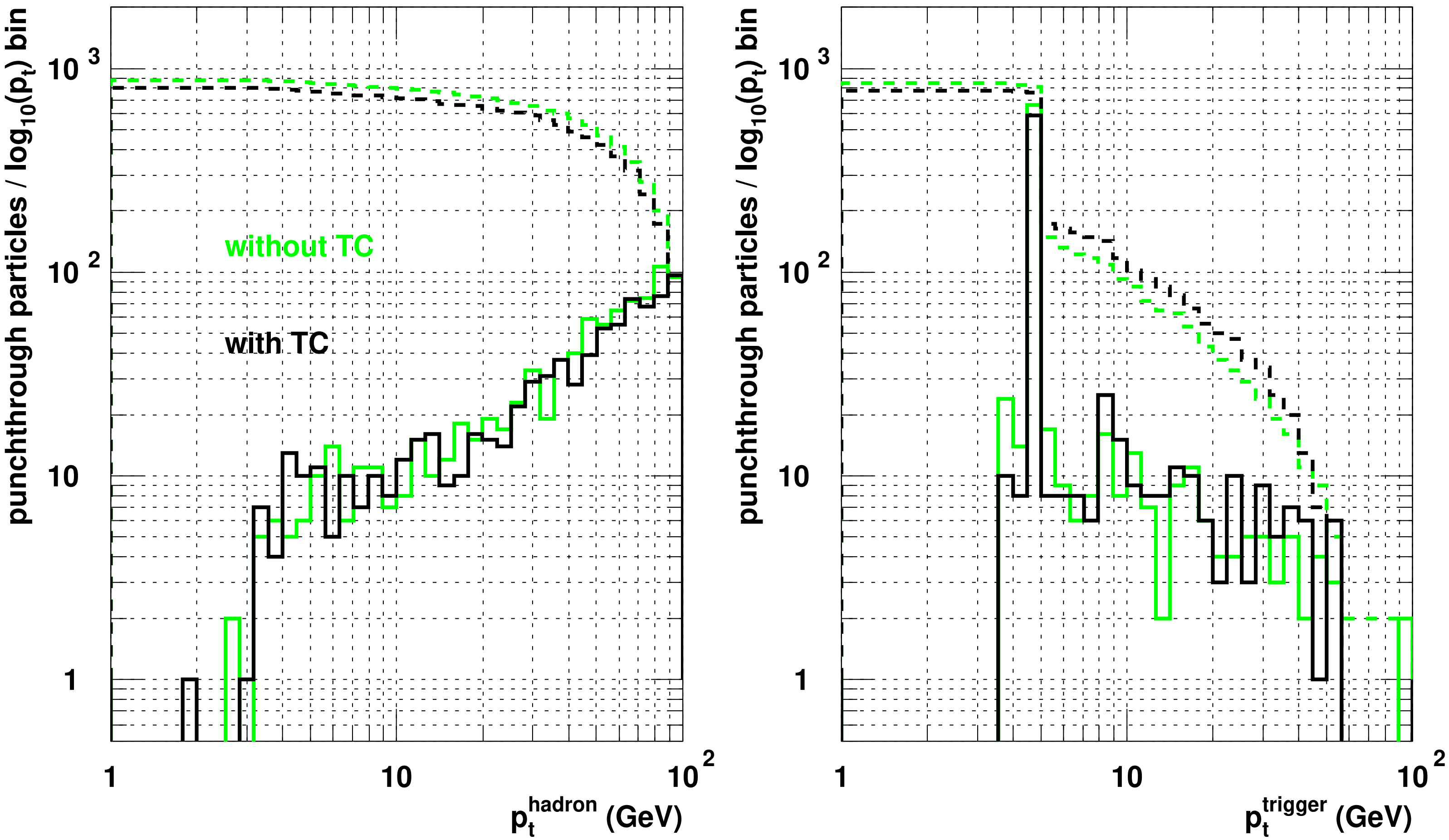
Instead single hadrons were generated with flat $\log_{10}(p_t)$ distribution:

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

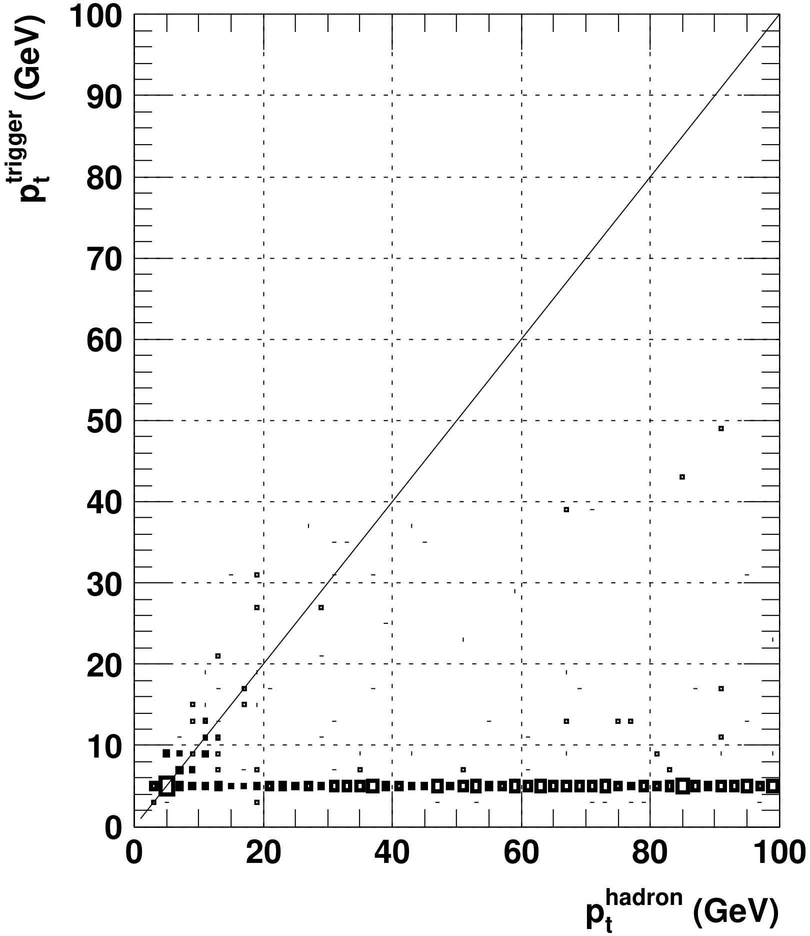
Statistics of simulated hadrons

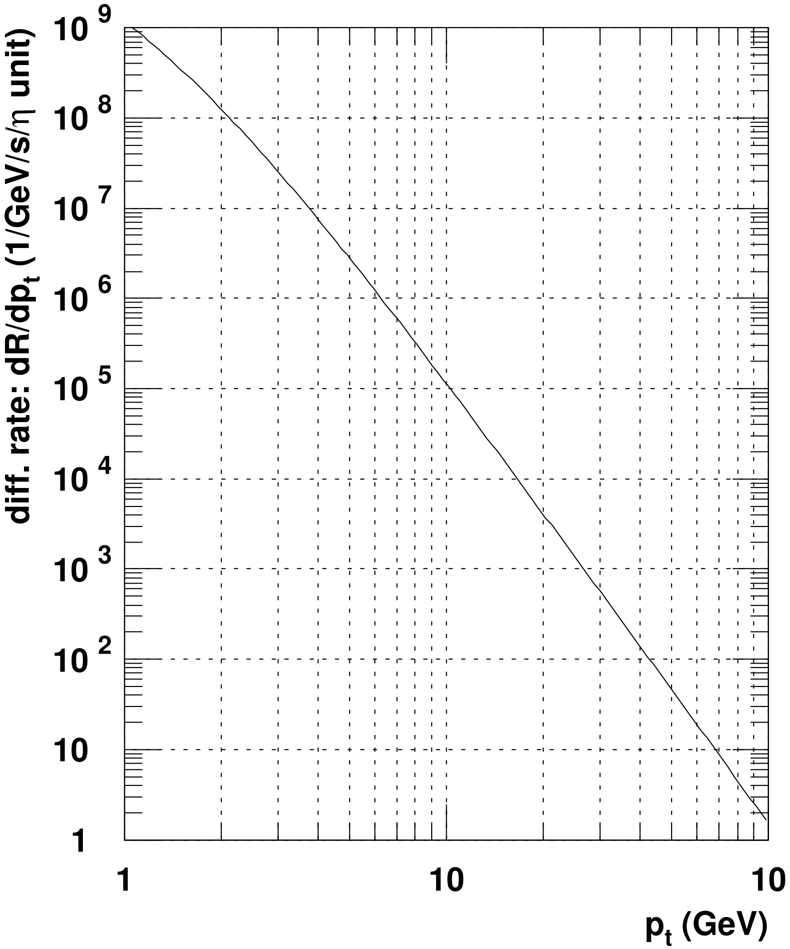
	λ	events simulated	triggered	fraction
with TC	9.4	215 000	803	0.37%
without TC	8.1	140 000	876	0.63%

Spectra of triggering hadrons

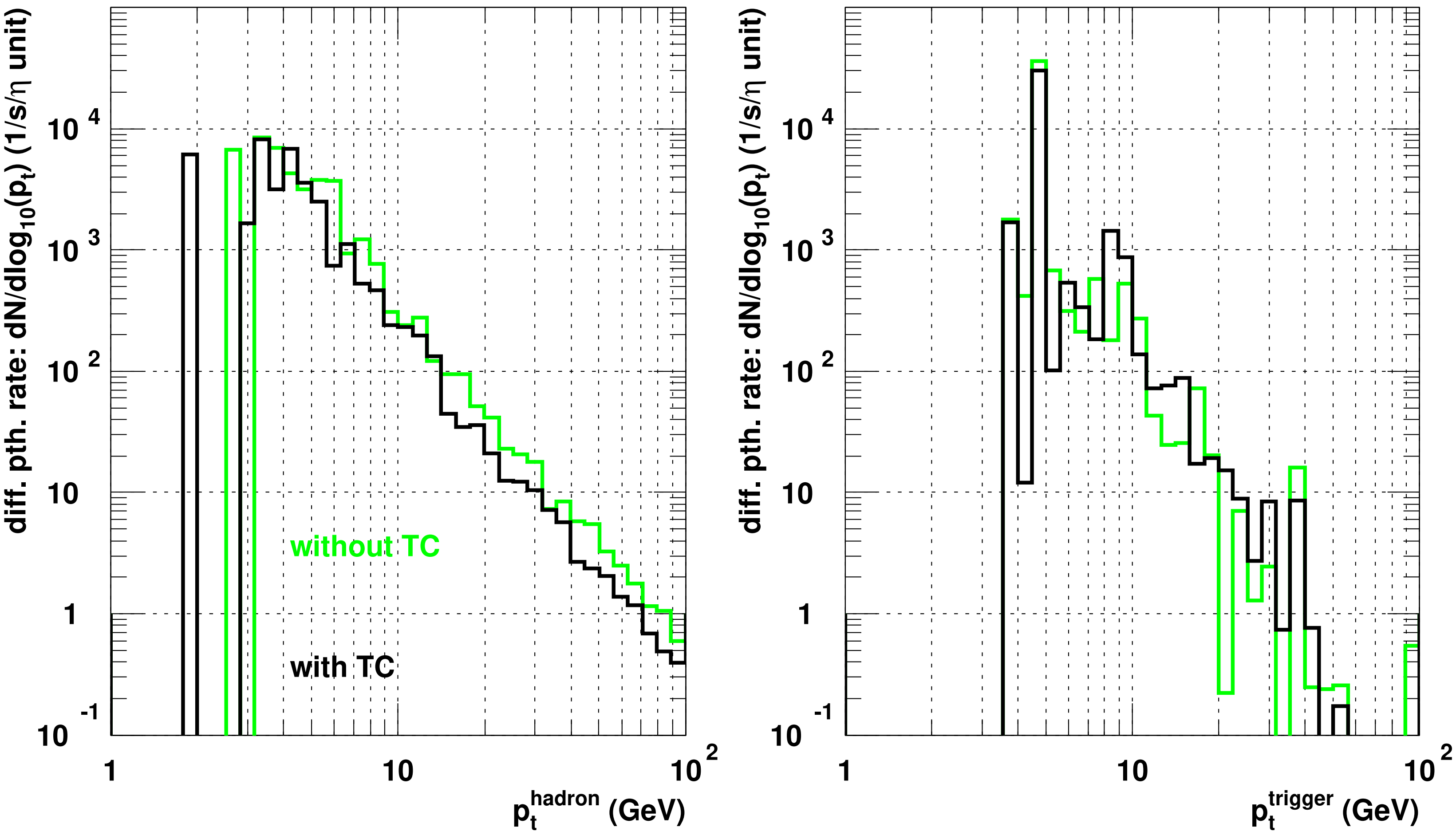


Trigger answer and weight function

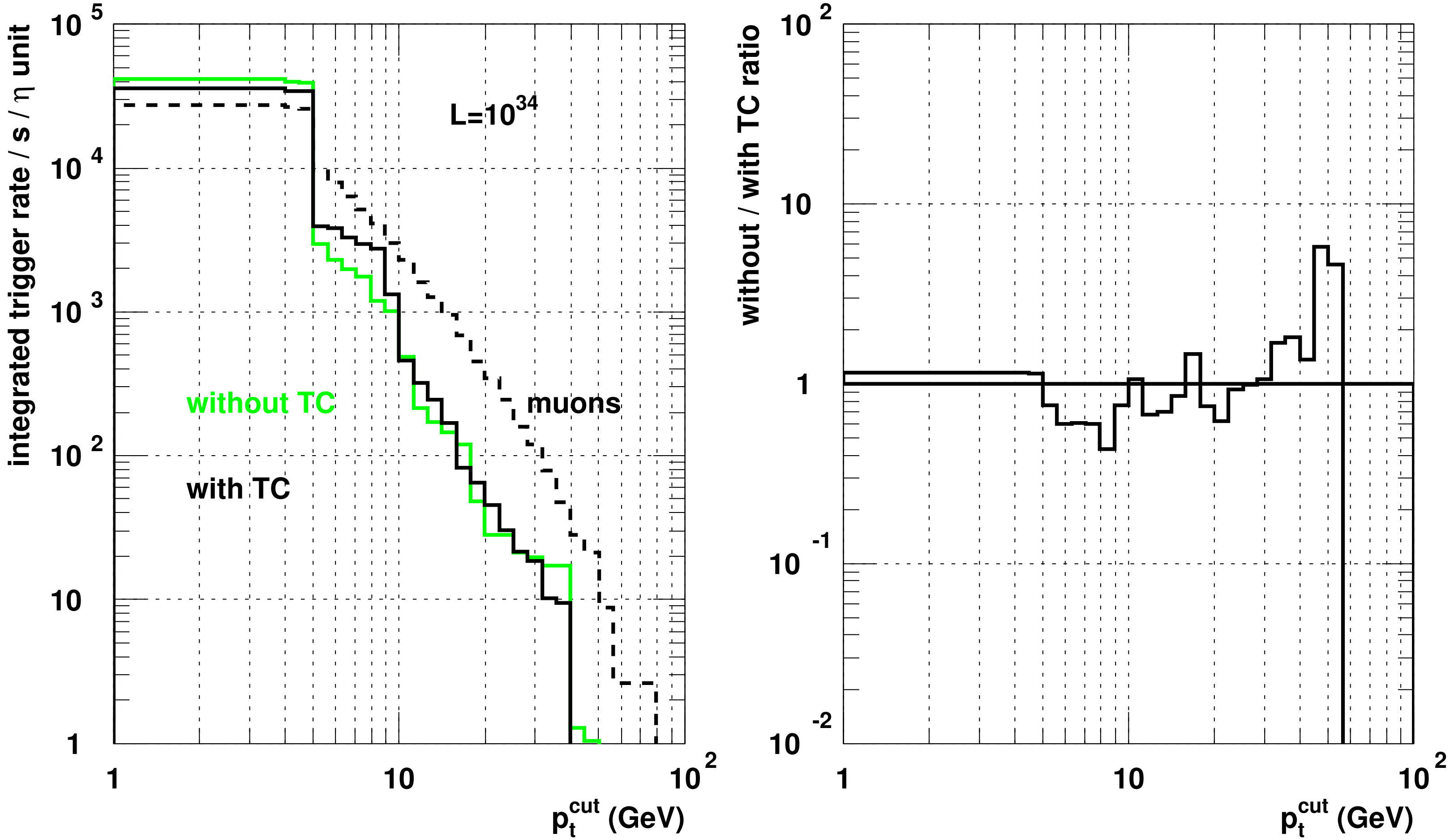




Weighted distributions [TN/95-105]



Single muon trigger rate vs p_t cut



Conclusions and plans

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

<u>To be done next:</u>

- **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

<u>Simulation should be done in three steps:</u>

- **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