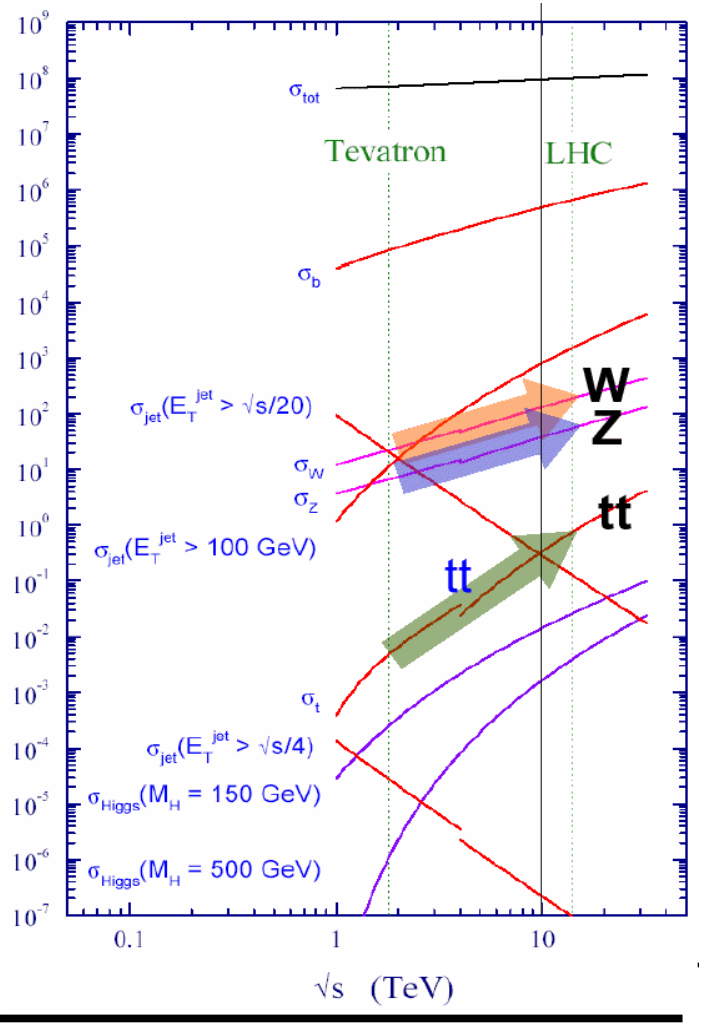
# Multi-jets background estimation from data

Aim : to estimate, from data, the number of multi-jet events in the context of searches for low mass ttbar resonances (< 1.5 TeV ) with 100 $pb^{-1}$

Outlines :

- Technicalities
- Standard ABCD method :
  - Principle
  - Aim and observables used
  - Results
- Conclusions
- More if we have times...



# Technicalities

- Customized CMSSW 2_2_7 + PAT
- Background and signal sample :
  - Multi-jet (PYTHIA) "ppMuPt20-15" :
    - Filtered at generator level for a muon with $p_T$>15GeV/c and $p_T$_hat >20GeV/c
    - LO $\sigma(pp \rightarrow \mu+X)$ = 121675 pb (~6M events = 49.7$pb^{-1}$, rescaled to 100$pb^{-1}$)
  - tt+jets (Alpgen)
    - NLO $\sigma(pp \rightarrow tt + jets)$ = 414 pb (~1M, rescaled to 100$pb^{-1}$)
  - W/Z+jets (Alpgen)
    - NLO $\sigma(pp \rightarrow W + jets)$ = 45600 pb (~1M, rescaled to 100$pb^{-1}$)
  - Leptophobic topcolor Z' (MG, provided by S. Perries, IPNL, Lyon)
    - Width = 1% mass
    - LO $\sigma(pp \rightarrow Z'$ @ 1 TeV $\rightarrow tt)$ = 6,04 pb

# Object selection

- Muon ID :
  - Global & Tracker muon (tracker track matching a segment in the muon system)
  - Chi²/Ndof (global track fit) < 10
  - Number of valid hits (tracker track) >10
  - Impact parameter < 2mm (corrected for beam position offset)
- Jet ID / Fake jet cleaning :
  - Not yet... (Question : is there a simple way to safely remove electrons faking jets ?)
  - For the moment : nb of constituents > 0
- Missing transverse energy :
  - No cut on MET
  - Corrections account for JES and muons passing the MUON ID

# Muon isolation

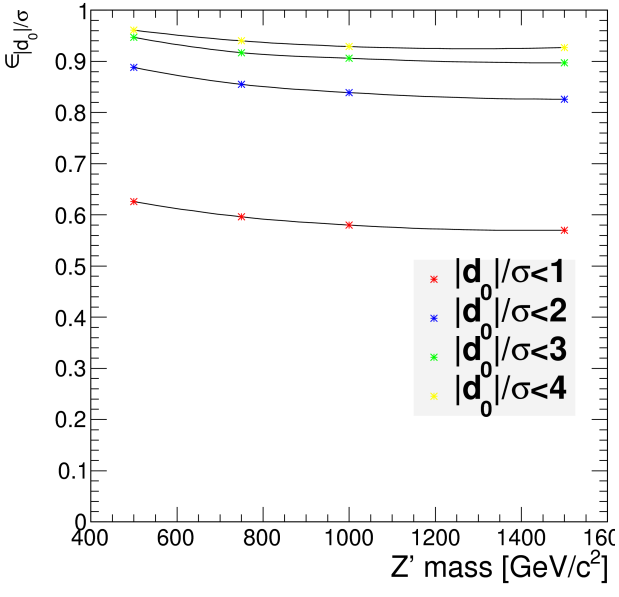
- Official Top/V+jets isolation variable :
  - RelIso = (CaloIso+TrackIso)/$p_T$
  - !! decreasing signal selection efficiency with increasing Z' mass !!
- Alternatives :
  - ΔR(μ,jet) : angle in eta,phi space between the selected muon and its closest jet
  - Ptrel : muon transverse momentum with respect the axis of this jet

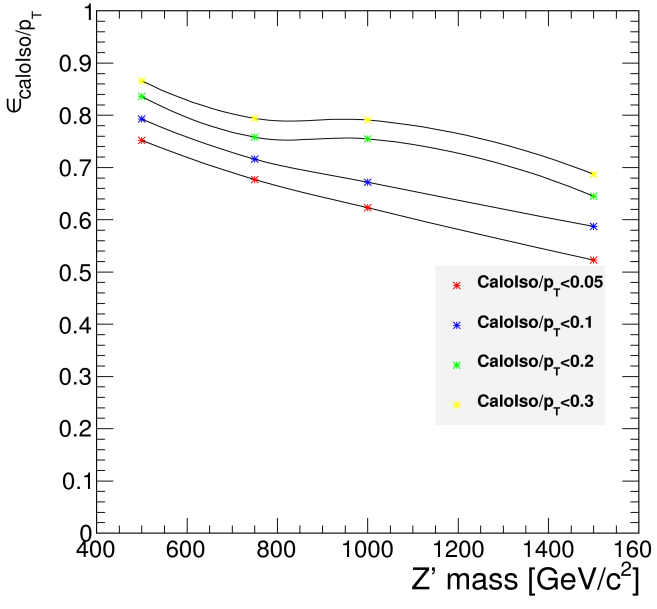
    NB : only jets with $p_T$ > 30 GeV/c are considered
  - RelCaloIso = CaloIso/$p_T$ and RelTrackIso = TrackIso/$p_T$
  - |d0|/σ, transverse impact parameter significance ($\sigma = \sqrt{\sigma_{d_0}^2 + width_{beam}^2}$)

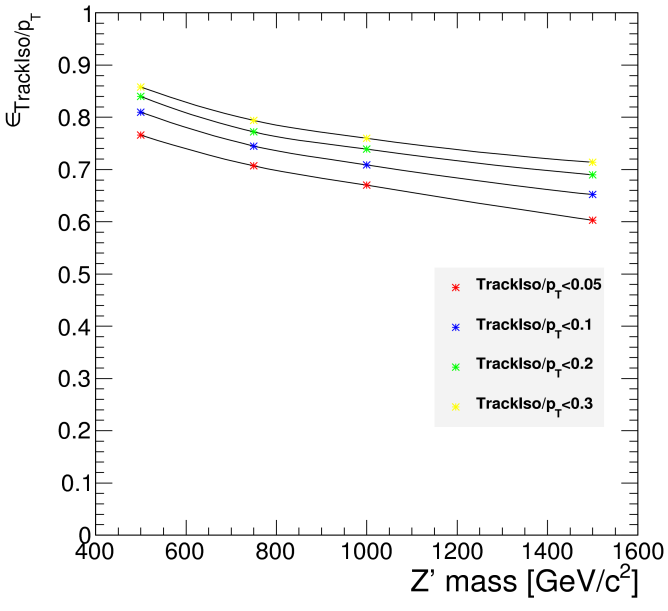
Proposed by Riverside's group. Used by Lyon's group for low mass resonances

# Signal selection efficiency

- Pre-selection :
  - At least one muon (passing the MuonId requirements) with $p^T$>30 GeV/c²
  - At least four jets with $p^T$>30 GeV/c²
- Selection efficiency $\varepsilon_X$ = Nb of events passing the isolation cut X / Nb of pre-selected events



# ABCD Method

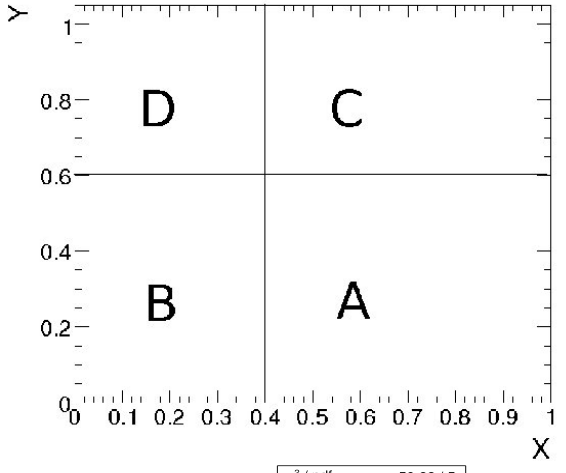
- Principle of the method :
  - If X and Y are uncorrelated :

$$N_C^{bckgd}/N_D^{bckgd} = N_A^{bckgd}/N_B^{bckgd}$$

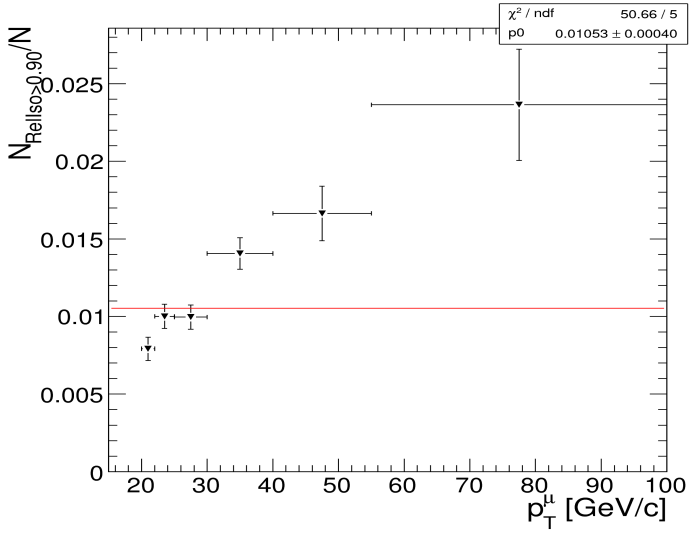
  - If the regions A, B and C are background dominated, then :

    $N_B^{bckgd} \sim N_b^{exp}$, number experimentally observed.

  - Therefore : $N_D^{exp} = N_B^{exp} * N_C^{exp}/N_A^{exp}$




- Control of the correlations :
  - Divide the X axis into N windows : $X^i$
  - For each $X^i$, calculate the ratio $N^i(y>y_0)/N^i_{tot}$
  - Perform the same calculation for the Y axis



# Event selection/reconstruction

Lyon's group :

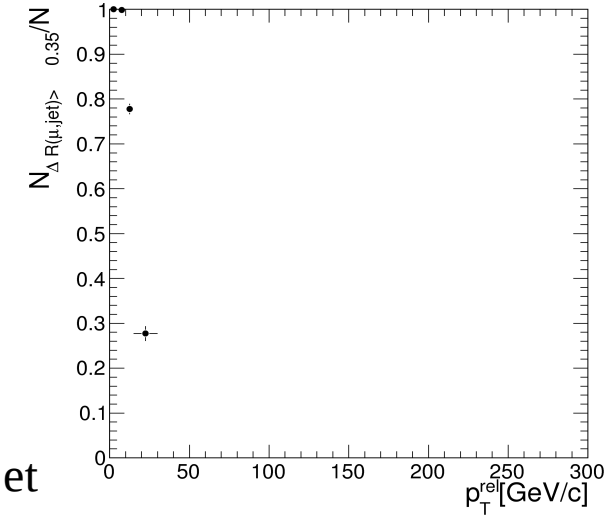
- Event selection for searches for low mass resonances :
  - HLTMu9
  - MuonID + $p_T$ > 30 GeV/c
  - $\Delta R(\mu,jet)$ > 0.4 & $p_T^{rel}$ > 35 GeV/c
  - Veto on a second high-$p_T$ lepton

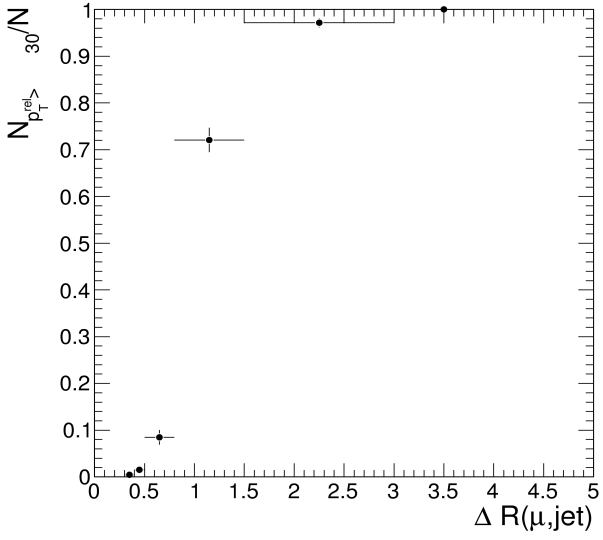
  (muon or electron, $p_T$ > 20 GeV/c and RelIso > 0.9)
  - At least 4 jets with $p_T$ > 30 GeV/c
- Event reconstruction :
  - $\chi^2$ based jet pairing
  - Kinematic fit
- Variables to play with :
  - $P_t^{\mu}$
  - $\Delta R(\mu,jet)$
  - $p_T^{rel}$
  - Number of jets
  - $p_T$ of the 4$^{th}$ highest jet

# Event selection/reconstruction

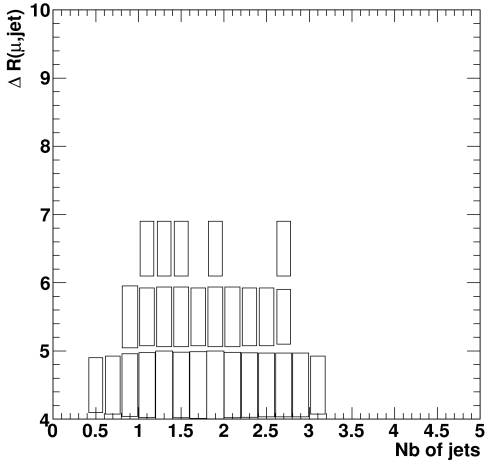
Lyon's group :

- Variables to play with :
  - $P_t^{\mu}$
  - $\Delta R(\mu,jet)$
  - $p_T^{rel}$
  - Nb jets / $p_T$ of the 4$^{th}$ highest jet




  - $\Delta R(\mu,jet)$ and $p_T^{rel}$, highly correlated...
  - If a cut at 35 GeV/c is applied on $p_T^{rel}$, the region $\Delta R(\mu,jet)<0.4$ is depleted...
  - Estimation is still under investigation...



# Event selection/reconstruction

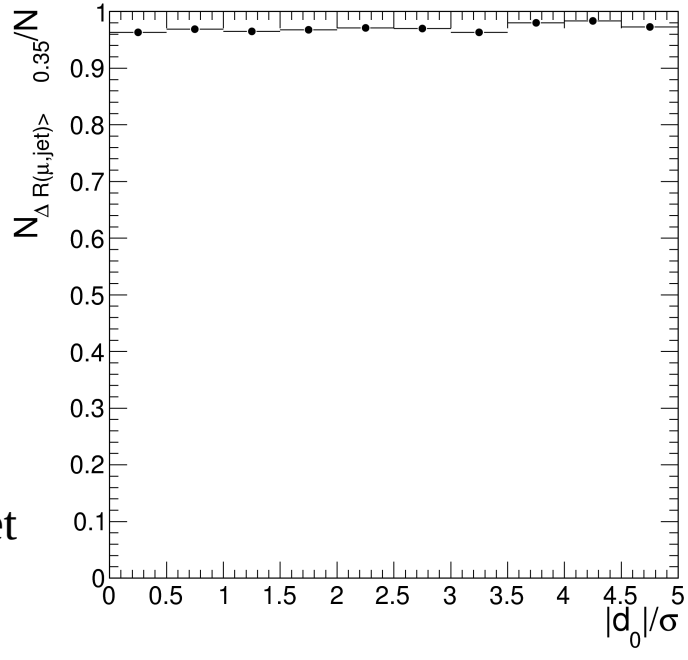
Brussels' group :

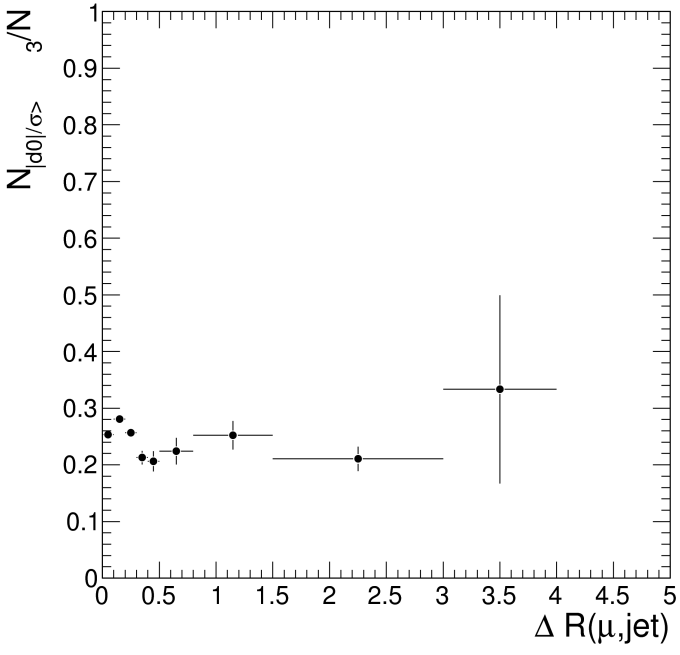
- Event pre-selection for searches for low mass resonances :
  - No trigger yet.
  - MuonID + $p_T$ > 15 GeV/c
  - At least 4 jets with $p_T$ > 30 GeV/c
- Event selection (to be defined) :
  - Muon $p_T$ > 30 GeV/c²
  - ΔR(μ,jet), |d0|/σ, RelCalo/TrackIso
- Event reconstruction :
  - No $\chi^2$ based jet pairing (studied but no yet applied) and no kinematic fit (so far...)
- Variables to play with :
  - $P_t^{\mu}$
  - ΔR(μ,jet)
  - |d0|/σ
  - RelCalo/TrackIso (not usable)
  - Number of jets
  - $p_T$ of the 4$^{th}$ highest jet

# Event selection/reconstruction

Brussels' group :

- Variables to play with :
  - $P_t^{\mu}$
  - $\Delta R(\mu,jet)$
  - $|d0|/\sigma$
  - Number of jets
  - $p_T$ of the 4$^{th}$ highest jet



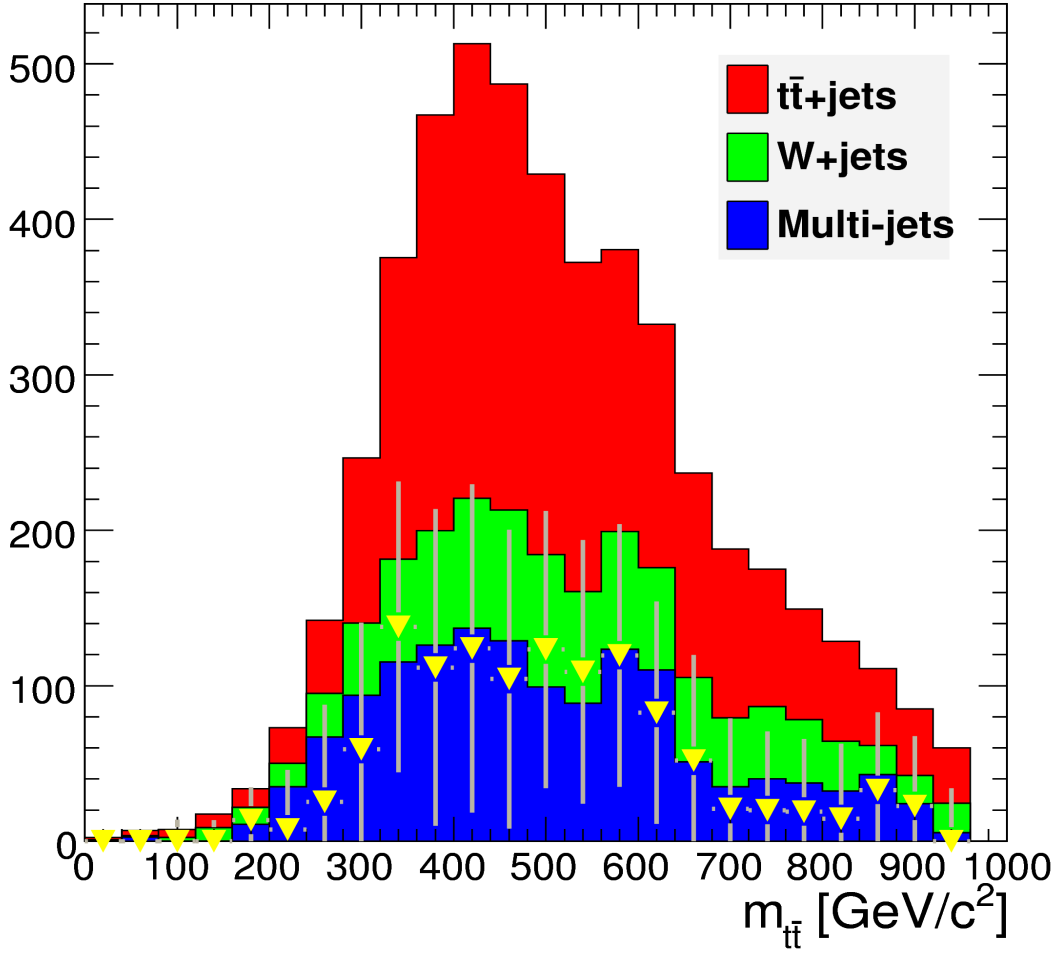




- Efficiency not really flat against $\Delta R(\mu,jet)$ but still reasonable...
- Impact on the estimate of the mtt shape : see next slide...

# Top quark pair invariant mass

Brussels' group :

- Illustration of the method :
  - Selected variables :
    - $\Delta R(\mu,jet) > 0.4$
    - $|d0|/\sigma < 3$
  - Multi-jet : 1055 ± 32 evts
  - Estimate : 977 ± 292 (!)
  - Errors have to be re-computed...
  - Impact on sensitivity to Z' resonances ?



# Conclusions

- A first step towards a multi-jet background estimate has been made in the context of a search for new physics...
- My « Want to do » list :
  - Finalize the event selection (trigger, event reconstruction...)
  - Check the stability of the result with multi-jet samples generated with MG (samples ready)
  - Produce an estimate for W+jets / tt+jets
  - Quantify the sensibility to new physics and apply it to topcolor Z' searches
  - ...