Punchthrough of High Energetic Jets

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GEFÖRDERT VOM
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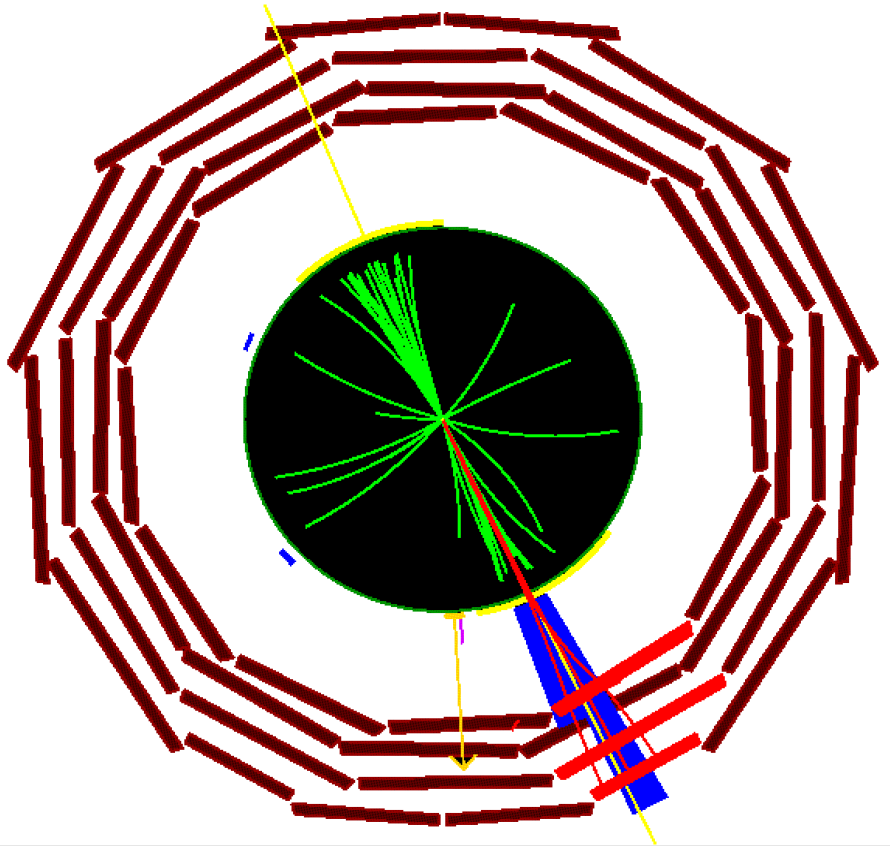
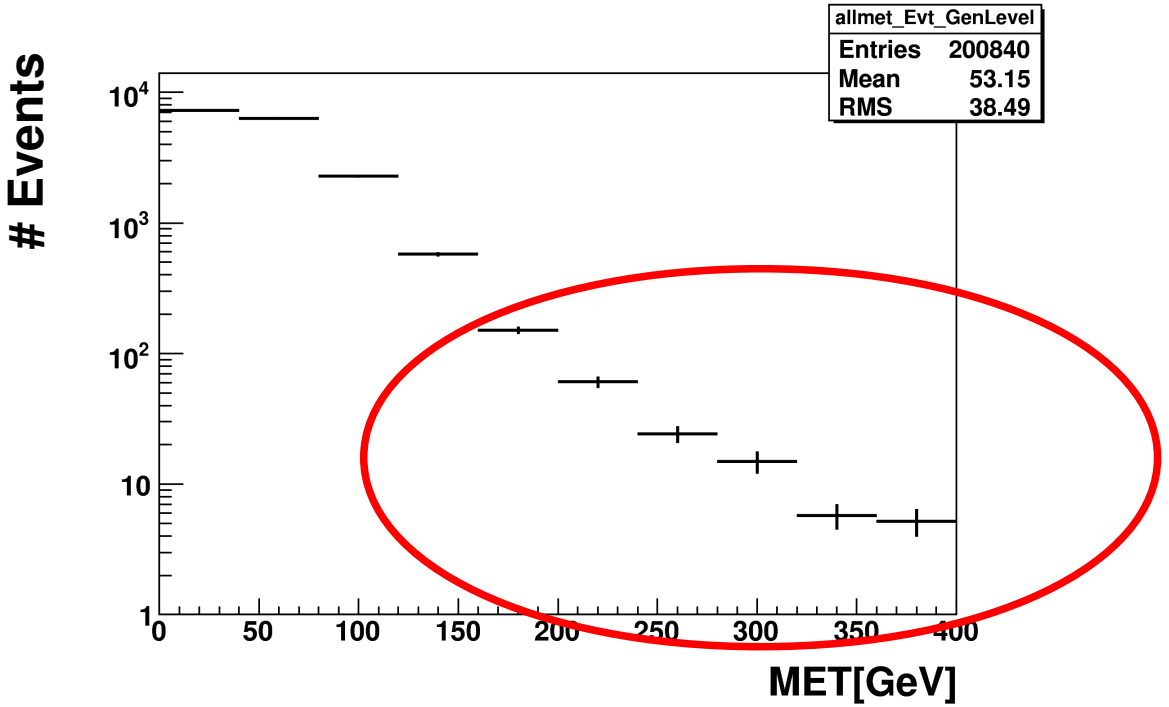
Overview

- Motivation
- Mismeasured high energetic jets
- Used variables
- Selection of heavy flavour jets
- Selection of punchthrough jets
- Implications for MET
- Summary & outlook



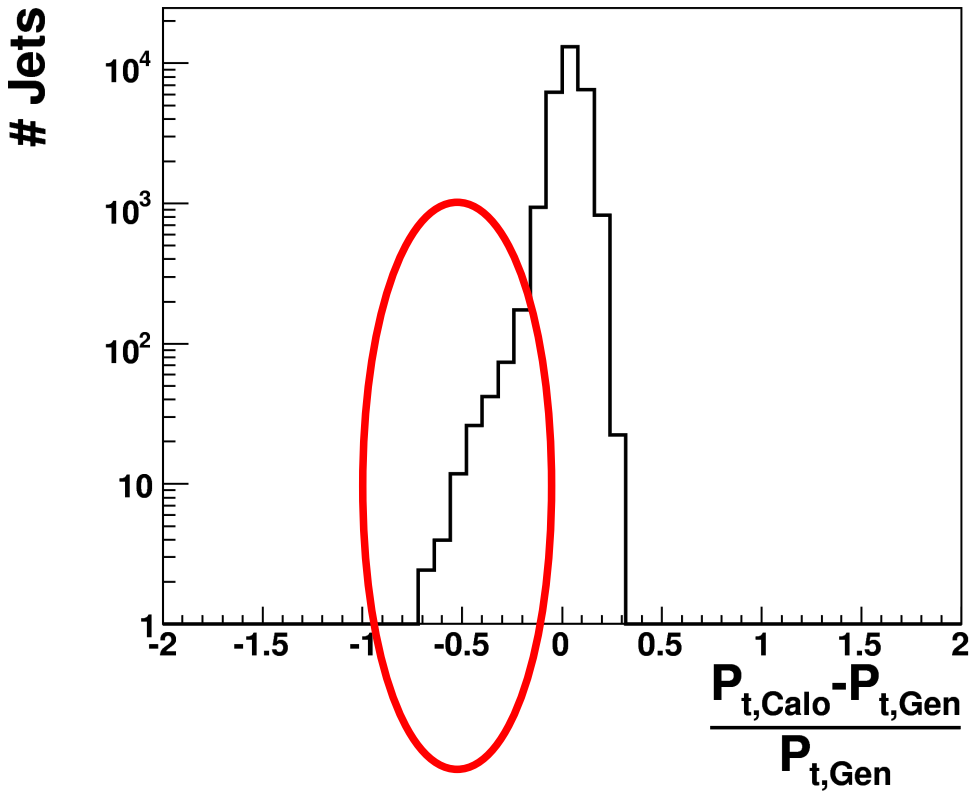
Event Selection

- QCDDijet events $\widehat{P}_t$120-Inf (Summer08, no redigi)
- Weighted to 100 pb^{-1}
- CMSSW 2_2_3 with updated muon selection (as in 3_1_X)
- Only events with at least one jet with $P_t > 500$ GeV and $|\eta| < 1.2$
- L2L3 - jet corrections
- Met corrected for jets and muons



Motivation

- Jet resolution of high energetic jets has tail with too low reconstructed jet energies



- Leads to better understanding of fake MET tails
- Understanding of these tails fundamental for SUSY/Exotica searches

Try to identify jets in tail according to effects (punchthrough, b/ jets) using hits in muon chambers

Mismeasured High Energetic Jets

1. B/C jets: jets with large fraction of energy in b-/c-quarks

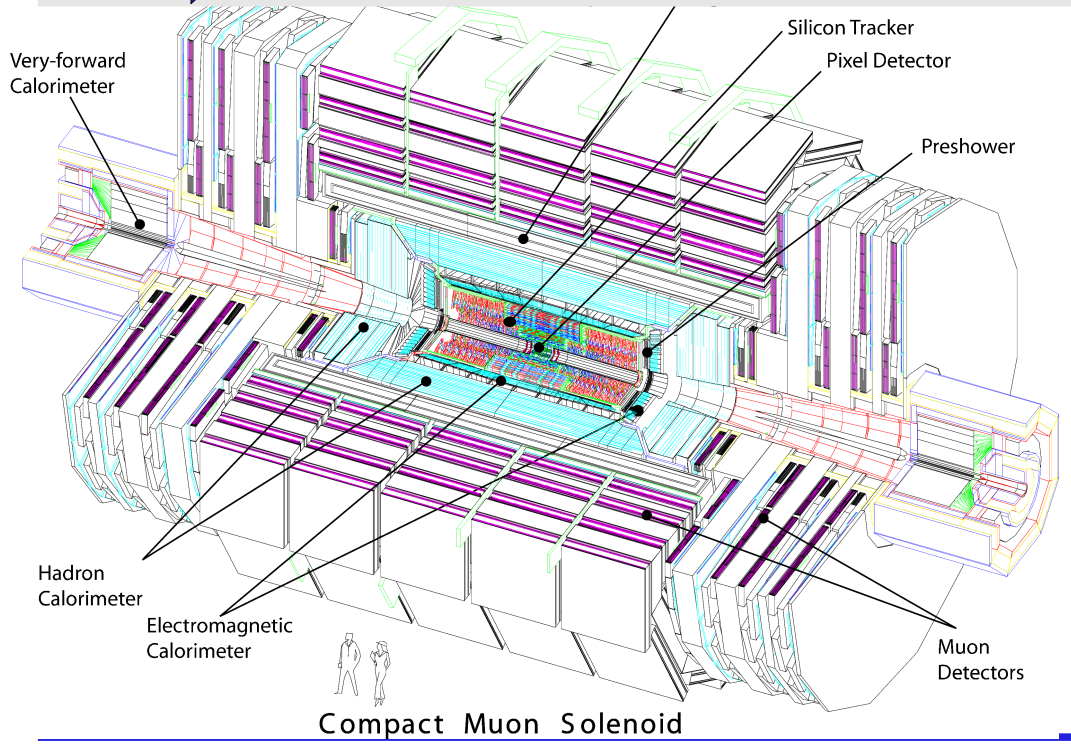
- B/C decays in muons and neutrinos invisible for calorimetry

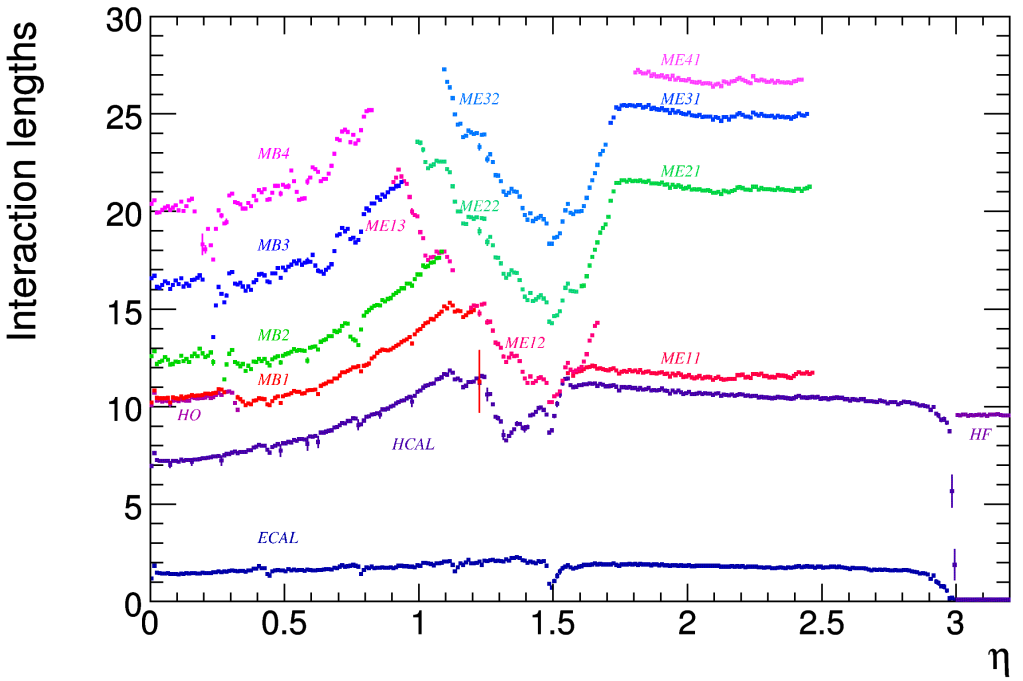
→ Muons from B/C jet decays should be measured in muon system

2. Punchthrough: only part of jet energy deposited inside calorimetry

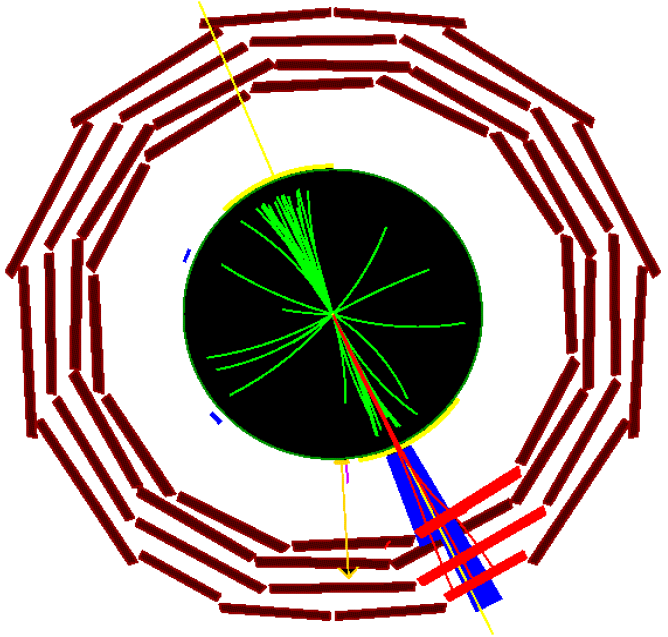
- Hadron calorimeter in barrel region ~7 interaction lengths (~10 with HO)
- Including the 4 muon chambers ~20 interaction lengths

→ Punchthrough jets should cause hits in muon system





Used Variables



Event display punchthrough:

- QCD Dijet Event (MC)
- Jets with 421 and 343 GeV
- $\not{E}_t$ 72 GeV

Idea:

- Use muon hits in jet cone and HO to measure energy not deposited in calorimeters (barrel)

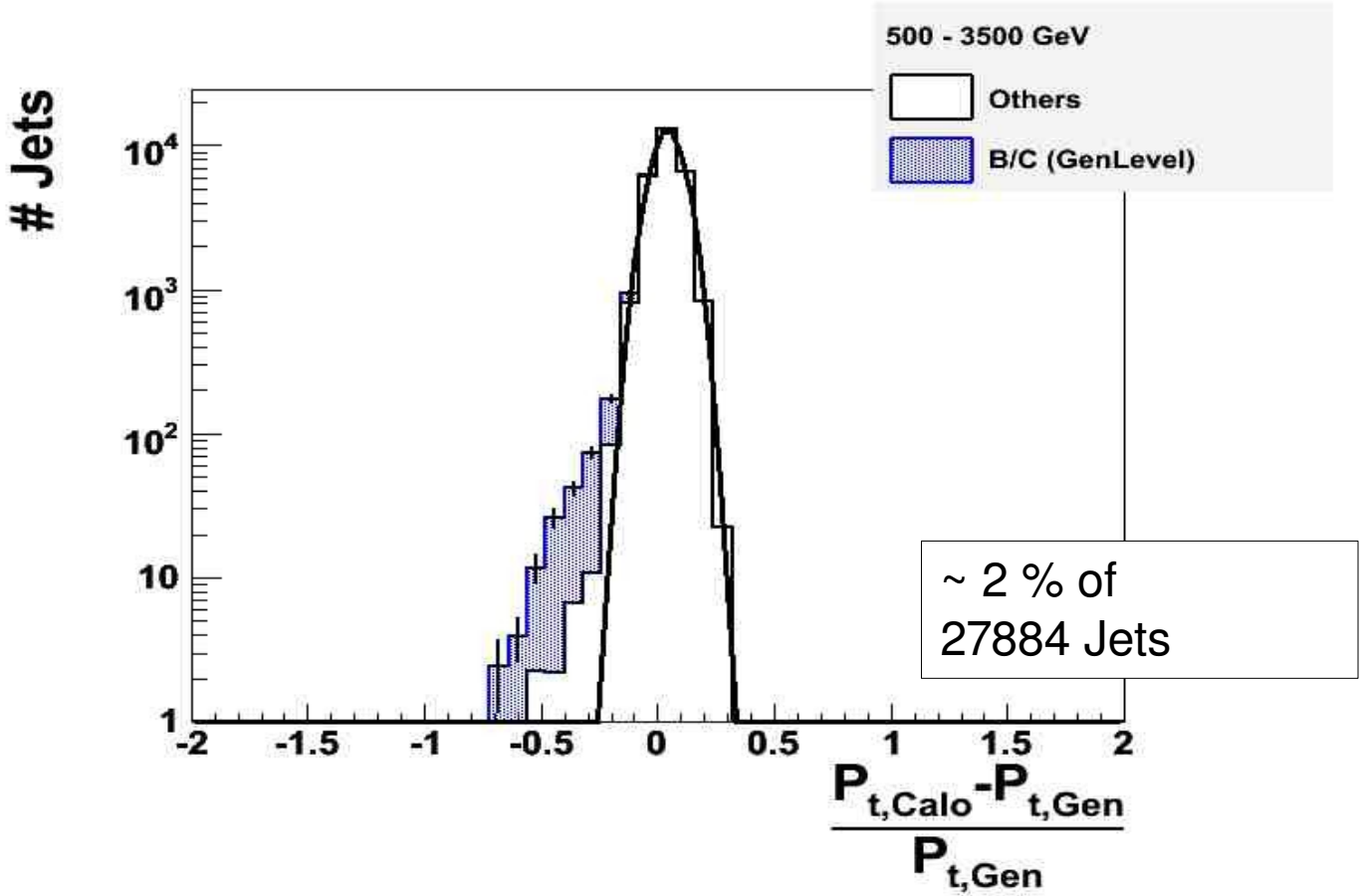
Variables:

- #Hits in DT/RPC in muon station 1, 2, 3, 4, 3+4, 1+2, 1+2/3+4
- HO-fraction of jet
- P_t of reconstructed muons behind jet (3_1_X definition of muons)

B/C Jets

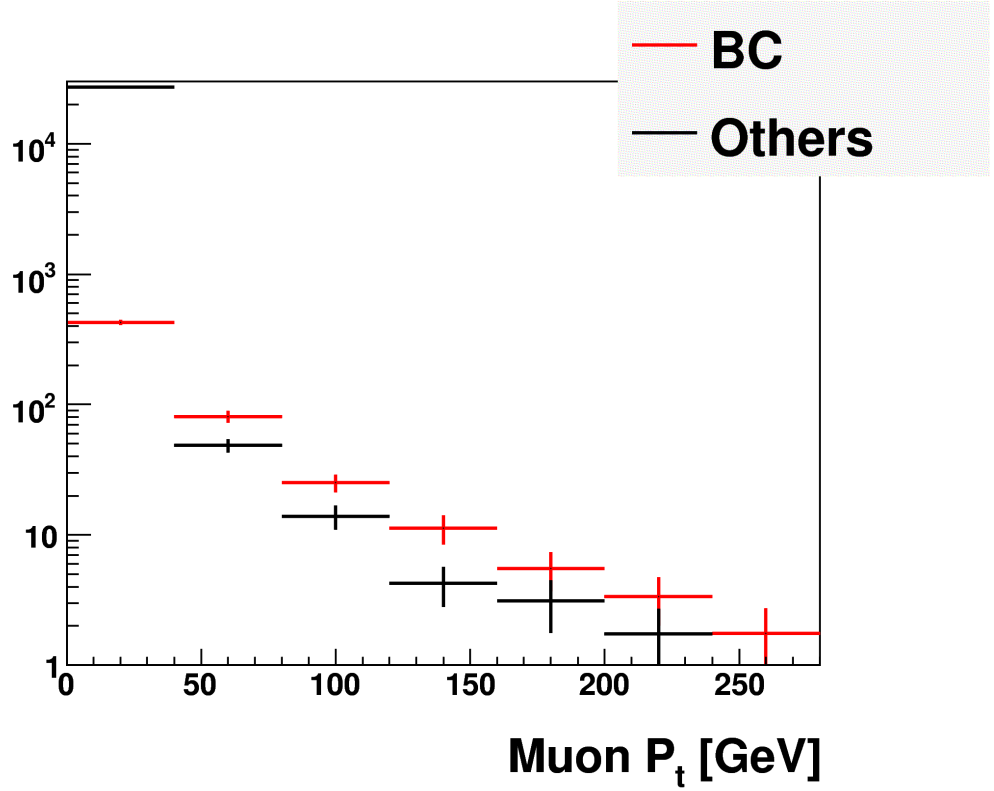
B/C s on gen level:

- Invisible fraction of jet > 10% and
- B/C-fraction >20% or b/c as matched generator particle (nearest)



Selection of B/C Jets on Data Level

- Try to separate b/c jets with muon variables on data level
- Compare B/C jets (gen level) with other jets for all variables



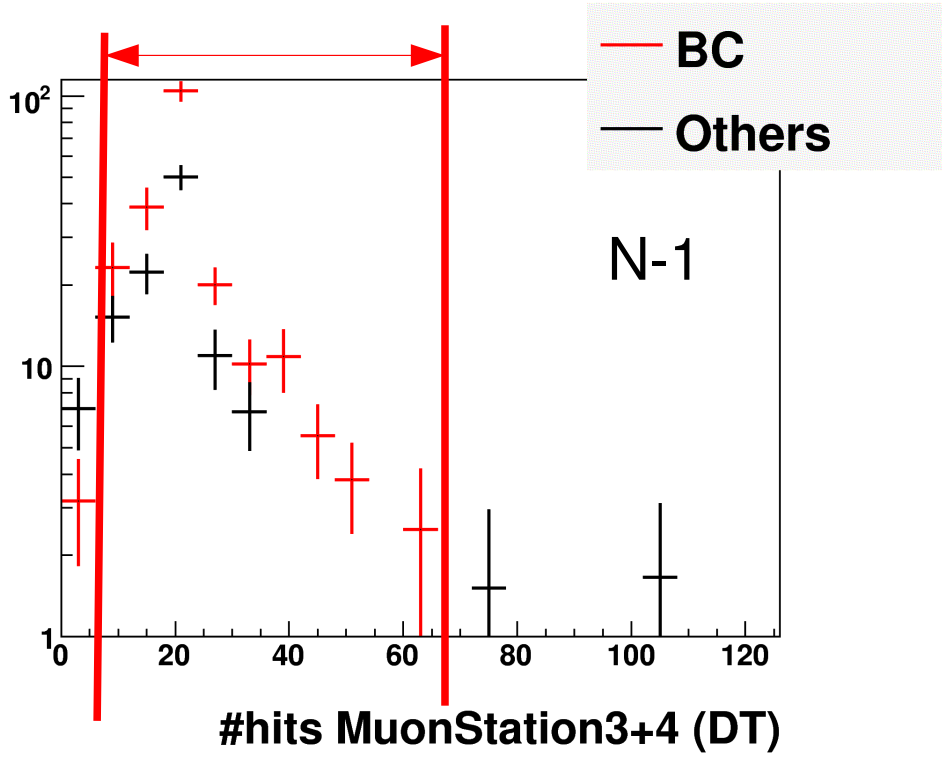
Select most separating variables:

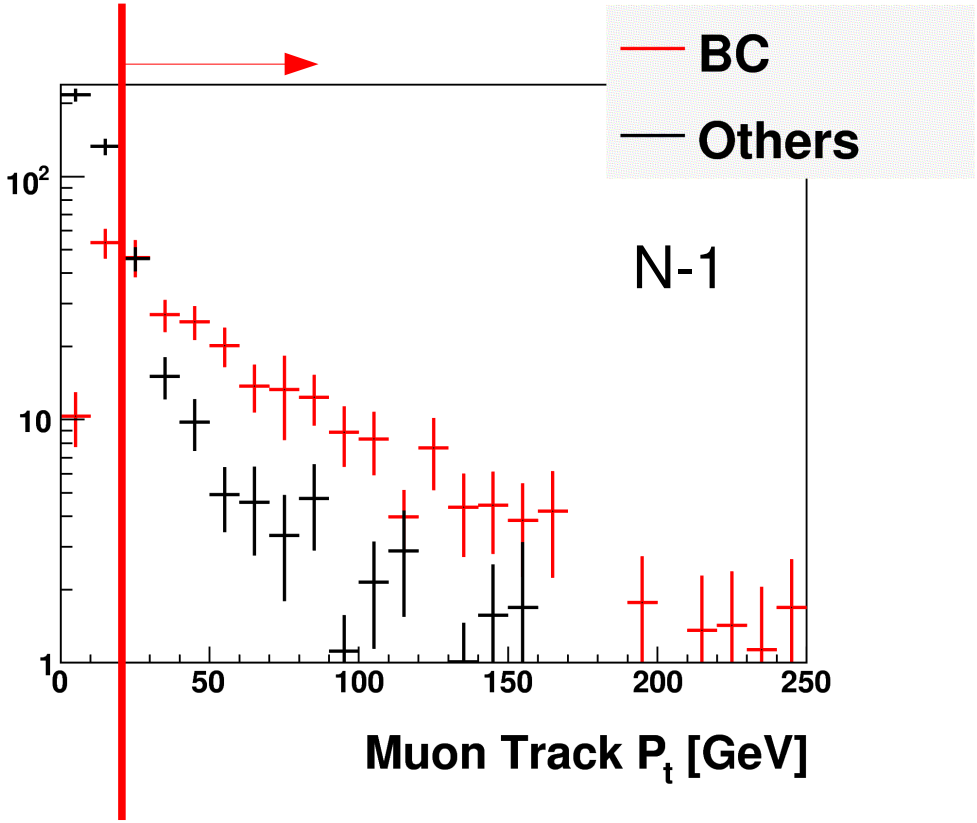
- Optimize $\frac{BC}{\sqrt{BC+Others}}$ for each variable/ variable combination
- Only simple cuts applied

Selection of B/C Jets on Data Level

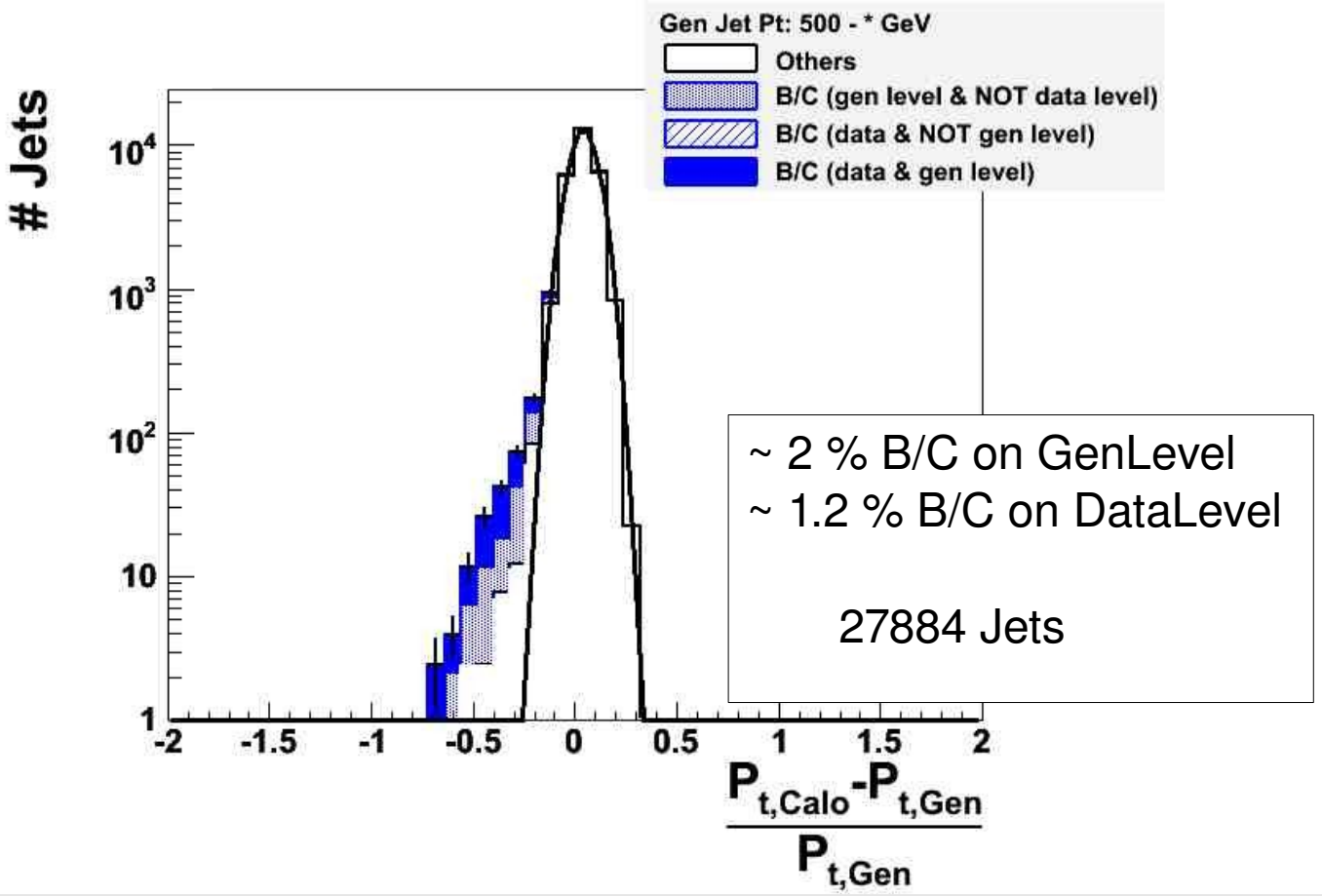
Selected variables:

- At least 1 track in muon station 4 with P_t>20 GeV
- #DT-hits in muon station 3 and 4 > 6 and < 66
- #DT-hits in muon station 4 < 60





Selection of B/C Jets on Data Level

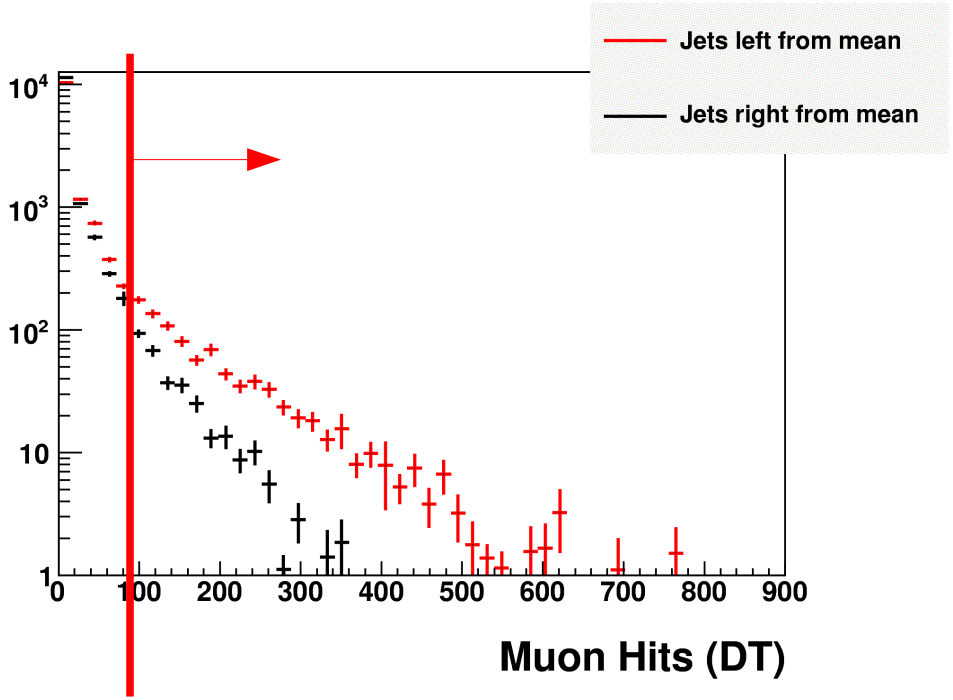


- ~39% of B/C jets on gen level are selected on data level

  → ~2/3 of B/C jets in tail are not sensitive to muon variables (as expected due to b/c decays in eν/τν)
- ~46% of selected B/C jets on data level are not B/C jets on gen level

Selection of Punchthrough Jets

- Ignore B/C jets selected on data level with the shown variables!
- Divide jets left/right from mean in $\frac{CaloJet\ Pt - GenJet\ Pt}{GenJet\ Pt}$ -distribution
- Assumption: Difference between 'L'-/'R' jets is punchthrough



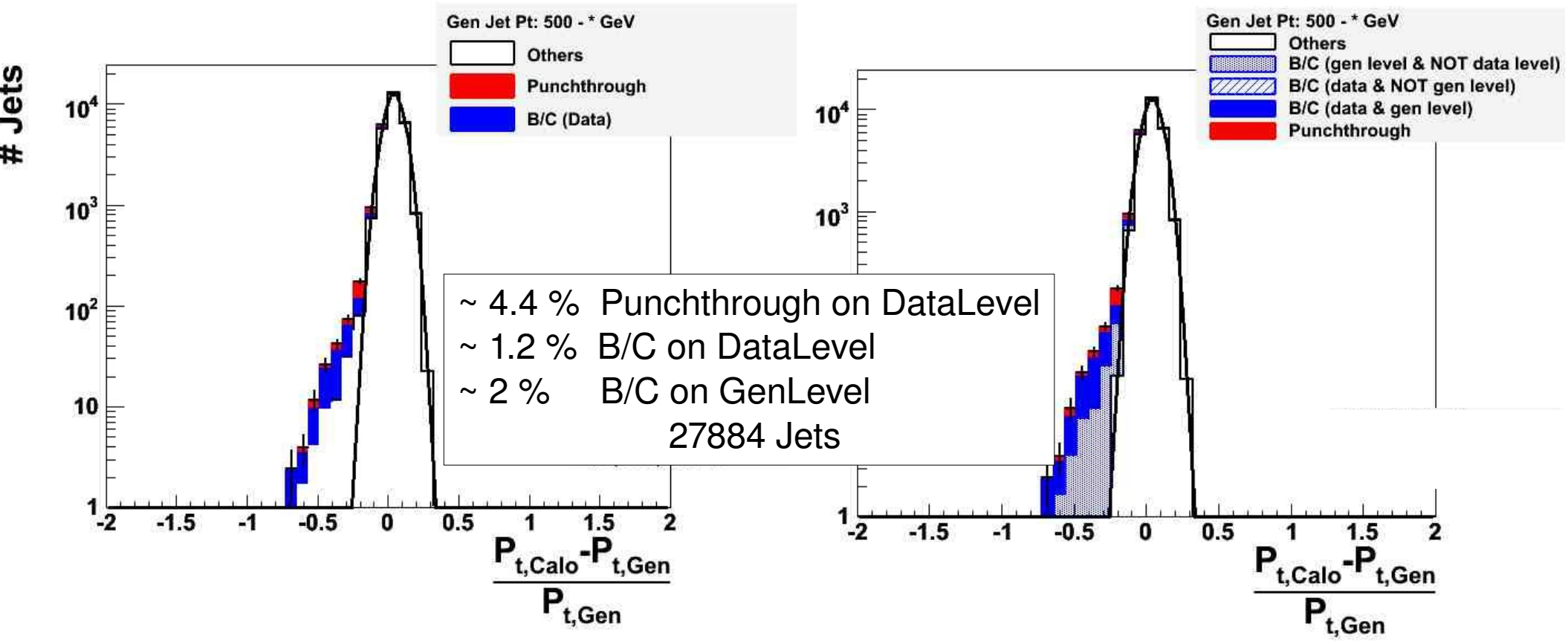
Select most separating variables:

- Optimize $\frac{L-R}{\sqrt{L+R}}$ for each variable/ variable combination

Best variable:

#DT-hits in muon stations >90

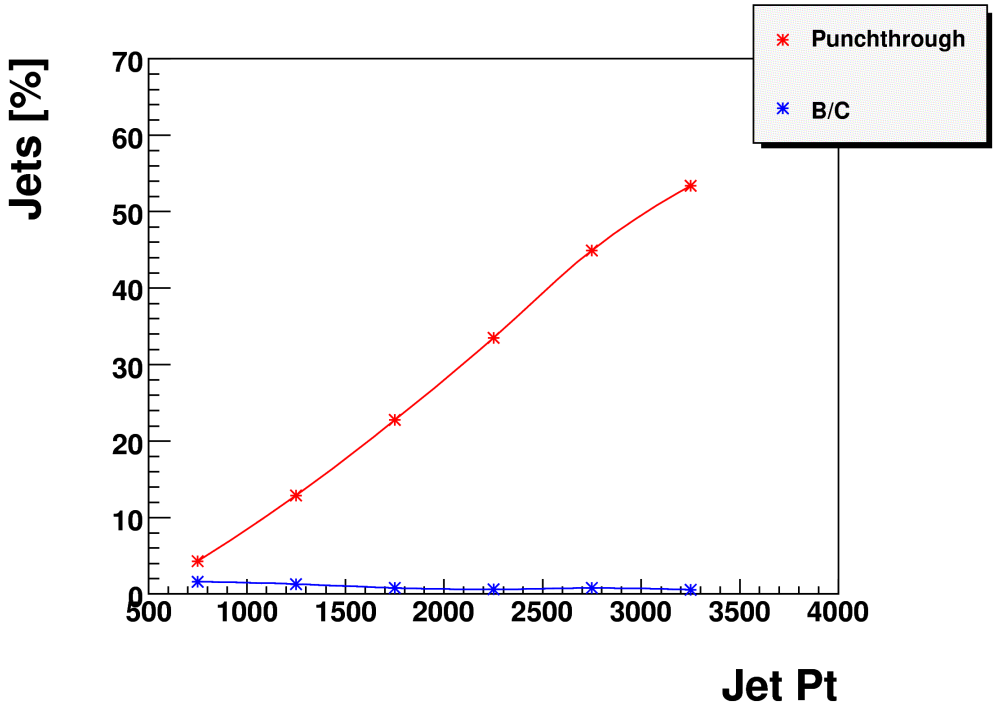
Selection of Punchthrough



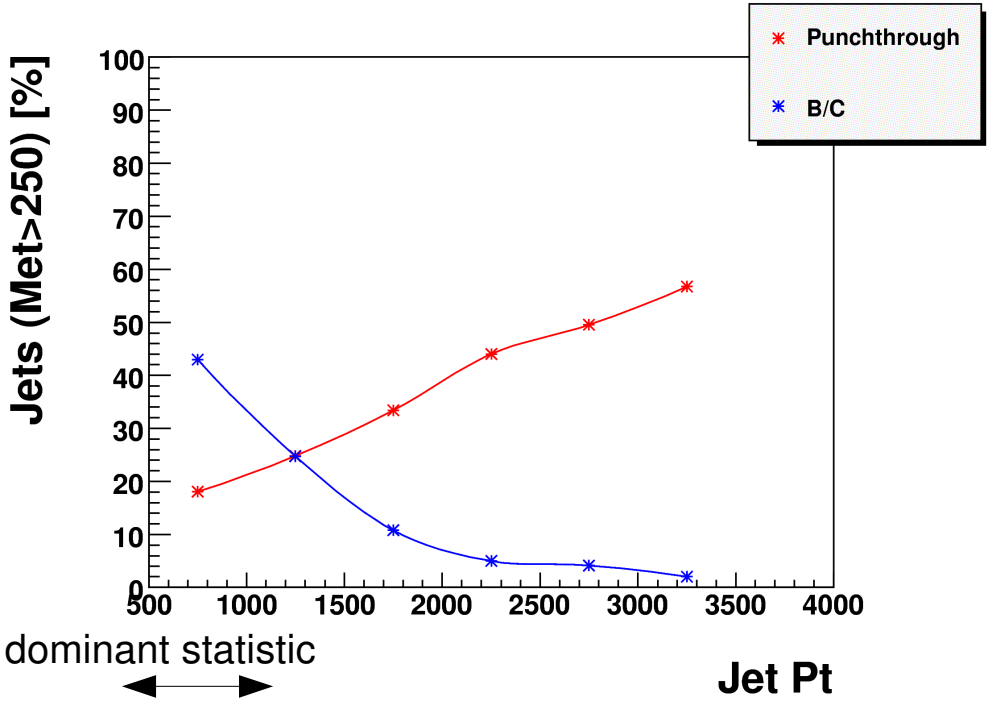
~ 4.4 % Punchthrough on DataLevel
~ 1.2 % B/C on DataLevel
~ 2 % B/C on GenLevel
27884 Jets

- Good description of tail
- Only small percentage of high energetic jets is mismeasured
- But jets in tail cause fake MET → implications for SUSY/Exotica searches

MET



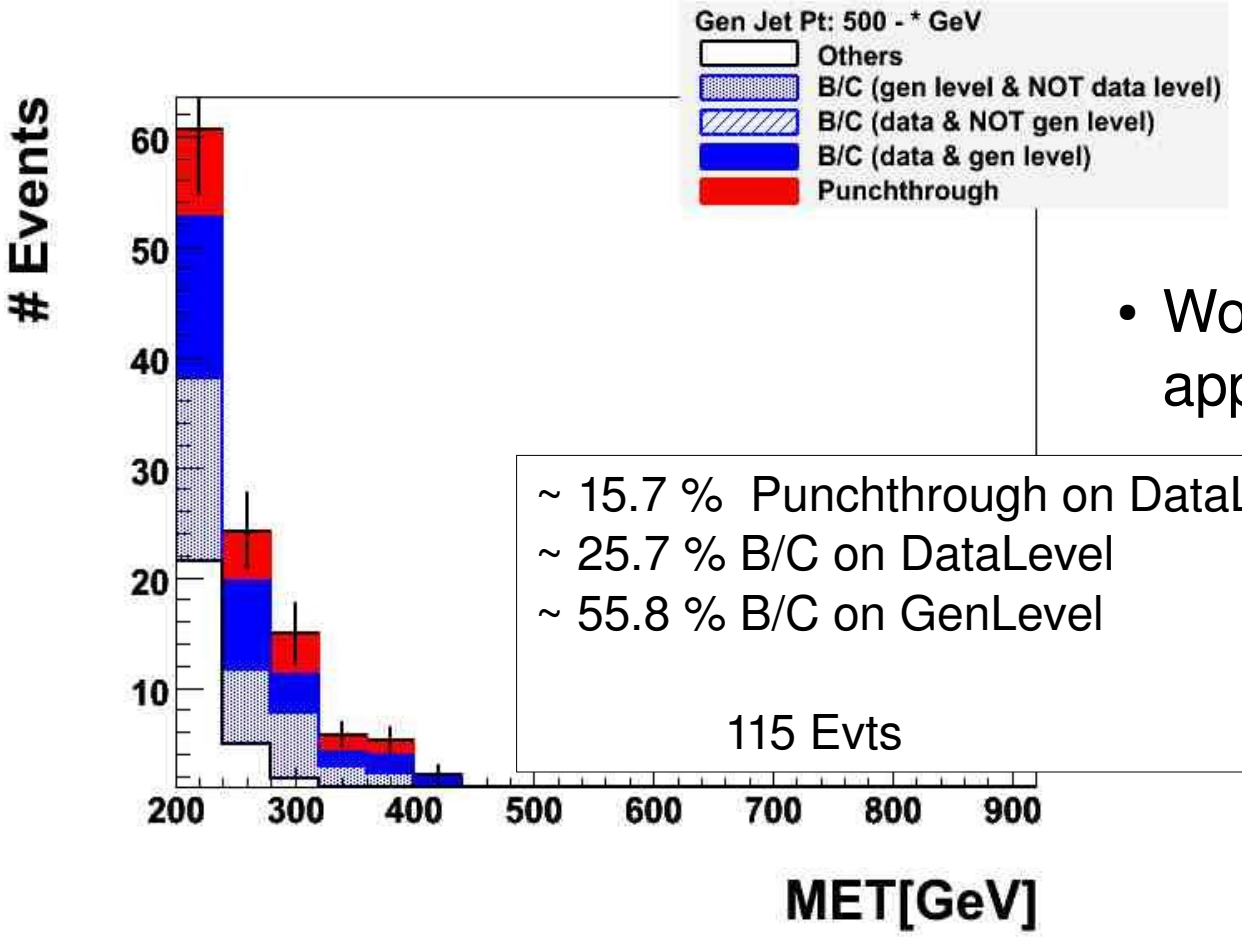
B/C on Gen Level



Punchthrough on Data Level

- Percentage of punchthrough increases with jet energy
- Percentage of B/C jets not strongly dependent on jet energy
- Both effects play an important role for studies with high energetic jets and high cuts on MET

MET



- Worst recoed jet appoints color

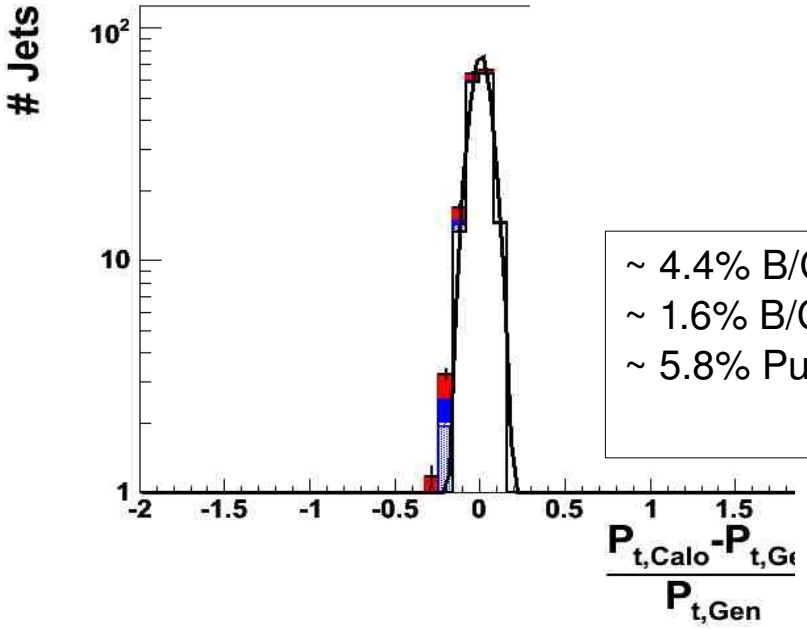
~ 15.7 % Punchthrough on DataLevel
~ 25.7 % B/C on DataLevel
~ 55.8 % B/C on GenLevel

115 Evts

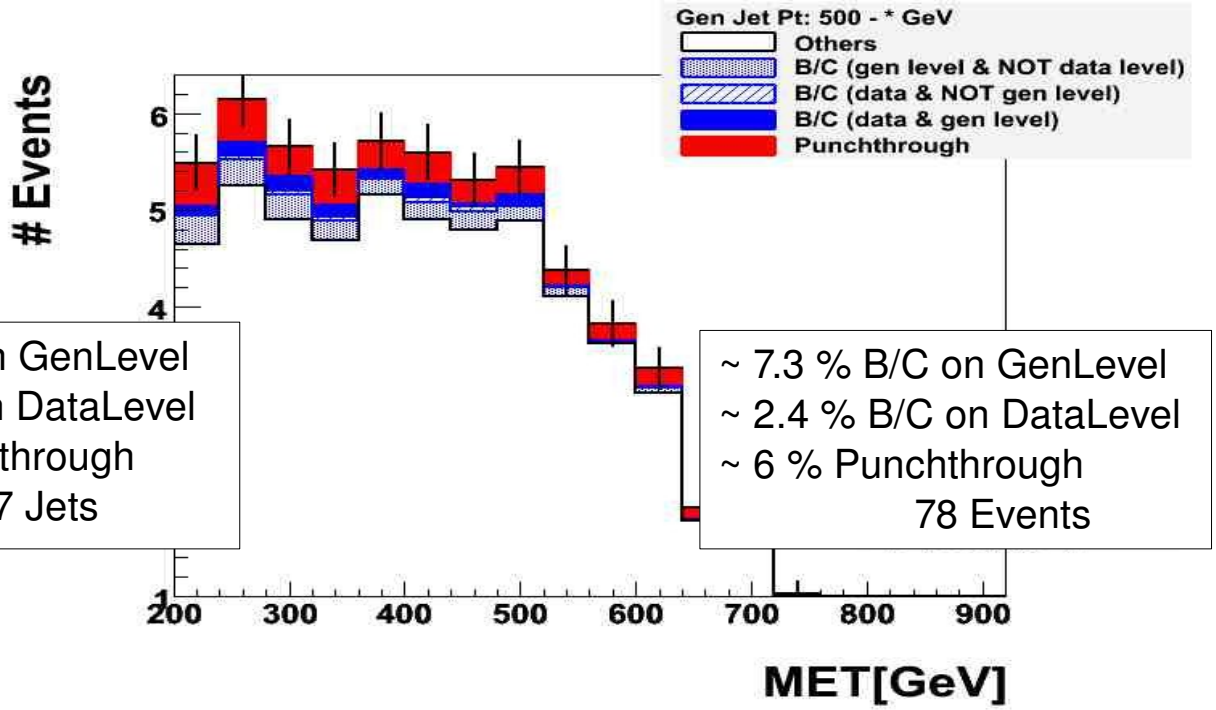
- QCDDijet Events → only fake MET
- On gen level ~71% of MET tail are tagged as punchthrouch or b/c
- On data level ~ 41% (due to b/c jets not sensitive to muon variables)

Implications on SUSY

- SUSY LM1 sample, Summer08 (redigi)
- Same event selection as for Dijet samples (jet P_t >500 GeV, etc.)



~ 4.4% B/C on GenLevel
~ 1.6% B/C on DataLevel
~ 5.8% Punchthrough
167 Jets

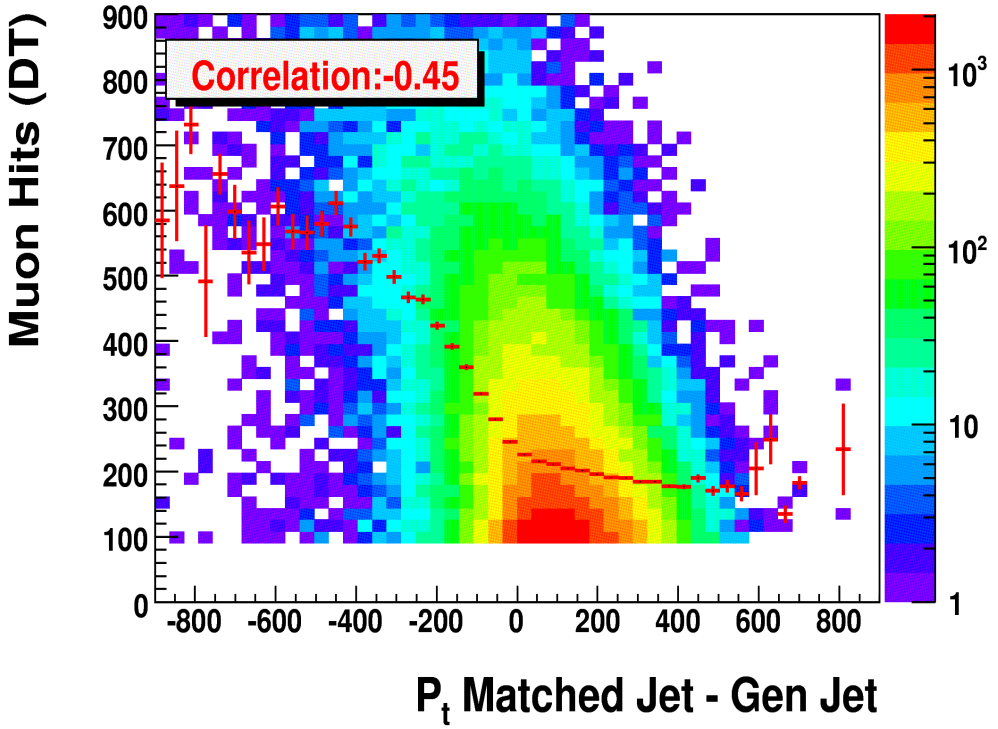


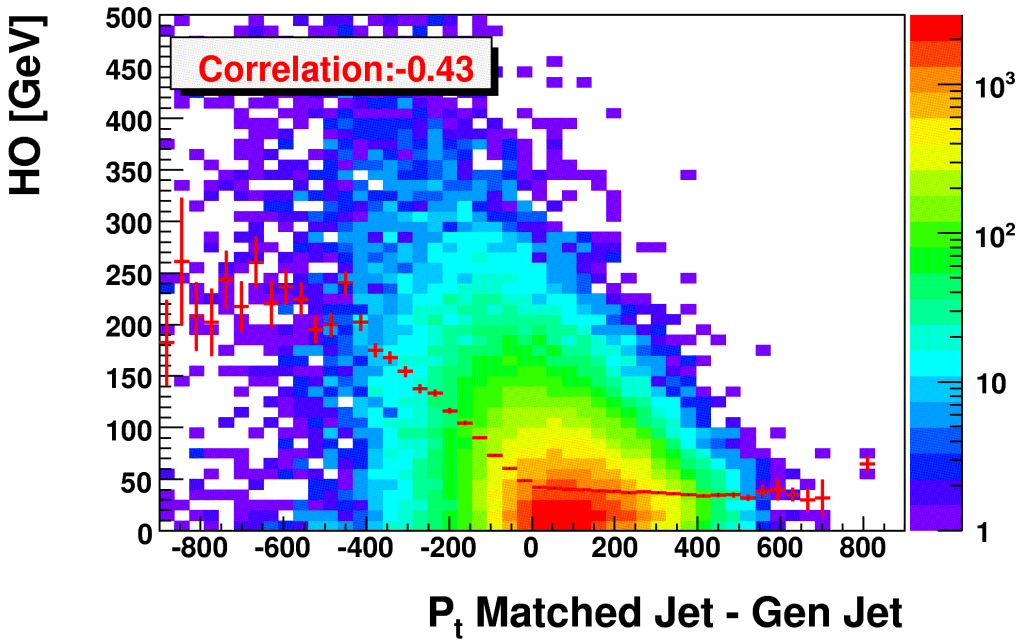
~ 7.3 % B/C on GenLevel
~ 2.4 % B/C on DataLevel
~ 6 % Punchthrough
78 Events

- Good description of mismeasured tail
- Selection efficiency of b/c jets comparable to dijet samples
- Percentage of tagged (fake) MET much smaller than in dijet samples (as expected due to high intrinsic MET in SUSY events)

Punchthrough: Correlations

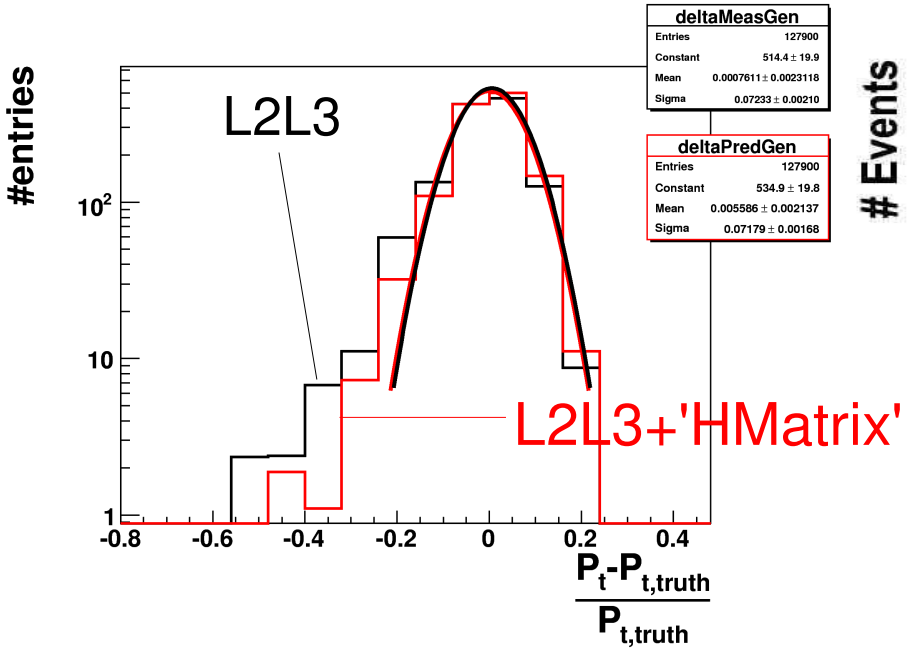
- Only jets tagged as punchthrough
- Strong correlation between mismeasurement and HO/Muon hits (and other muon system variables)

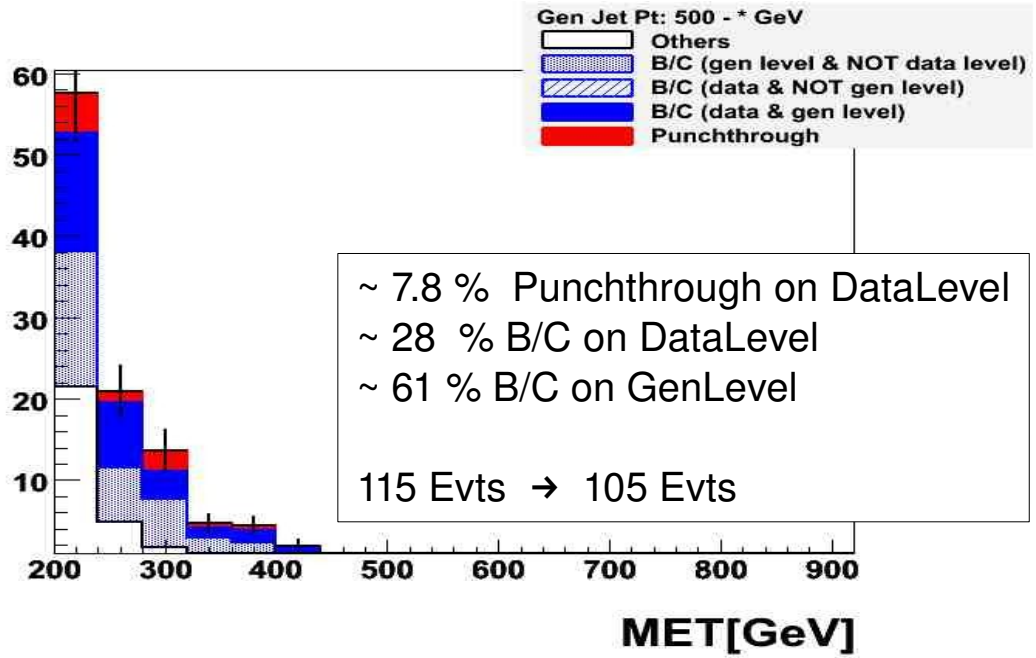




Outlook: Calibration of High Energetic Jets

- Use correlations to muon system variables to calibrate punchthrough jets
- Here: Consider only linear correlations (Hmatrix method)





- First very preliminary results show reduction of MET tail of ~ 9%
- Muon system variables can be used not only to tag punchthrough but also to correct high energetic jets

Summary & Outlook

- B/C jets and punchthrough give a good description of tail in resolution for high p_t jets
- B/C jets with large invisible fraction can be tagged with an efficiency ~1/3 on data level
- Muon system variables can be used to tag jets mismeasured due to punchthrough or b/c jets $(\mu\nu)$
- ~ 41% of MET tail (>200 GeV) are tagged as punchthrough or b/c

TODO:

- Study implications on searches for supersymmetry (QCD background)
- Derive mismeasurement from Dijetbalance not from MC
- Study correction of mismeasured jets with Hmatrix or more sophisticated methods using correlation to muon hits
- Compare selection with punchthrough on SimLevel

Hmatrix Method

- Idea: use linear correlations between observables ($X_{i=1\ldots M}$) and unknown variable (X_0) to determine X_0
- Covariance matrix with all correlations:

$$H_{i,j=0\ldots M} = \frac{1}{N}\sum_{n=1}^{N}(X_i^{(n)} - \overline{X}_i)(X_j^{(n)} - \overline{X}_j)$$

- Train HMatrix: With X_0 from Dijet balance (here: MC)
- Define χ^2 for single measurement

  →Minimization gives prediction for X_0 - $\overline{X_0}$

$$\Delta X_0^{(n)} = X_0^{(n)} - \overline{X}_0 = C^{(n)}/H_{00} \qquad \text{mit} \qquad C^{(n)} = -\sum_{k=1}^{M} H_{0k}\cdot\Delta X_k^{(n)}$$

e.g. R. Engelmann et al. NIM 216(1983) 45-56