Background Estimation Methods
for the
Incl. Hadronic SUSY Analysis
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• QCD MET tails
• other backgrounds
Inclusive Hadronic SUSY Analysis:

• The object “jet”
  (jet efficiency, noise-fakes, energy scale, ...)

• The object “MET”
  (all corrections due to jets, calorimetry, ...)

• The Background
  QCD, ttbar, W, Z
Backgrounds (hadronic channel)

**QCD:**
- should have no real MET
- “fake MET” originates from badly measured jets (muon or neutrino contents, fluctuations, noise, etc.)
- high MET tails have to be understood → signal area

**Top / W background:**
- lepton is not identified, fakes a jet, or is a \( \tau \)
- ID efficiencies, fake-rates to be determined
- MET / jet spectra: Is the top-\( pT \) / W-\( pT \) distribution understood or does it need reweighting?

**Z background:**
- Z\( \rightarrow \nu\nu \) can be studied on Z\( \rightarrow ll \)
High MET tail in QCD events can be modeled using QCD with low MET (Atlas):

1. Obtain *jet-smearing function from QCD-events with high MET* (badly measured events/jets)

2. Apply smearing function *on events with low MET* (correct measured jets, high QCD statistics, low signal contamination)

3. Normalize the 'new' QCD sample

→ studies by Hamburg group in progress
1. Obtain jet smearing function

- **“Data-driven”:**
  
  Use jet nearest in $\phi$ to MET ($\Delta\phi$ modulo $\pi$) to calculate:
  
  \[ f(p_T) = 1 - \frac{p_T \cdot (p_T + MET)}{|p_T + MET|^2} \]

- **Use $\gamma$-jet instead of di-jet events**

- **MC-truth:**
  
  Use information of $\nu$-momenta from MC to calculate:
  
  \[ f(p_T) = \frac{p_T(\nu)}{p_T(jet)} \]
Advantages & Disadvantages of both methods 
(just my thoughts, has to be checked!)

Data-driven
+ Considers 'true' and 'fake' MET
- not clear which jet is badly measured, is $\Delta \phi$-criterion enough?
- signal contamination would result as largely overestimated background
  (no concern for $\gamma$-jet events)

First look: Torben Schum, [http://indico.cern.ch/conferenceDisplay.py?confId=29078](http://indico.cern.ch/conferenceDisplay.py?confId=29078)
Update: Benedikt Mura, Wed. 19.3. SUSY-meeting

MC truth
- Considers only MET from $\nu$'s
- To check: Depends the jet's $\nu$-content on jet-$p_T$, multiplicity, ... ?
+ No signal contamination
2. Apply smearing function

Smear events with low MET:
→ little signal contamination, high QCD statistics
→ check if one, two, or all (leading) jets are to be smeared
→ corrected MET for changed jet energies

The obtained (normalized) distribution has to be checked against an independent sample:

• Use events $x < \text{MET} < y$ to calc. smearing function, apply it on events with MET $< x$, and check against events with MET $> y$, OR
• Don't apply smearing to jets which contain leptons, check only against jets containing leptons
3. Normalize events

General method:

If 'variable 1' and 'variable 2' are uncorrelated (for the specific sample), then the following is true:

\[ C = D \cdot \frac{B}{A} \]

Avoid signal contamination in A, B, D!

We need to know the number of QCD events with MET > y → Which variable (for QCD) is uncorrelated to MET?
- (transversal) Inv. di-jet mass?
- minimal \( \Delta \phi(\text{MET, any jet}) \) ?
- ...?
Specific normalization (Atlas)

We can estimate the number of QCD BG in this region.

- We chose min $\Delta \phi = 0.4 \sim 0.6$ region to avoid QCD tail effect.
- The number of QCD BG after $\Delta \phi$ cut is obtained from this equation:

$$\frac{\text{# of QCD BG} (\min \Delta \phi > 0.2)}{\text{# of QCD BG} (\min \Delta \phi < 0.2)} \times \left[ \text{# of All BG} (\min \Delta \phi < 0.2) - \text{# of All BG} (0.4 < \min \Delta \phi < 0.6) \right]$$

= $\text{#QCD BG}(\min \Delta \phi > 0.2)$
ttbar / W - background

- (Semi-) leptonic ttbar/W: determination of lepton→jet fake rate
- Full-hadronic ttbar: Are the spectra of MET / jets understood? Compare with semi-leptonic channel?
- Full-hadronic W: Negligible? If not, check W-pT distribution by comparison to Z→ll

http://indico.cern.ch/conferenceDisplay.py?confId=29778
(for example: The DØ Matrix method)

More details from Michael Tytgat
Z - background

- $Z \rightarrow \tau \tau$ negligible?
- $Z \rightarrow \nu \nu$ study on $Z \rightarrow ll$ ($Z$-pT distribution)

Joe Incandela et al.?
Summary

• Jet & MET most important
• Understanding of QCD, ttbar, W, Z necessary
• QCD MET tail:
  - Estimate smearing function using MET or the ν-pT
  - Apply on low-MET events
  - Normalize