

Activities for the stau search at IPHC

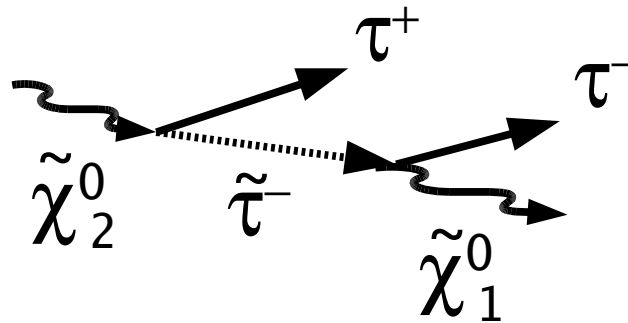
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CMS FRANCE at Strasbourg

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Outline: 1. Motivation and introductions
2. SUSY group's Reference Analysis
3. Current status (very preliminary)
4. Future prospect

Motivation

- A search for the **supersymmetric tau** events with an assumption of the decay chain:



- Large missing E_t events because of neutralinos in the final state.

Test points and mSUGRA parameter values

- Minimal Super GRAvity model of supersymmetry (mSUGRA) has 5 basic parameters. (m_0 , $m_{1/2}$, $\tan\beta$, $\text{sign}(\mu)$, A_0)

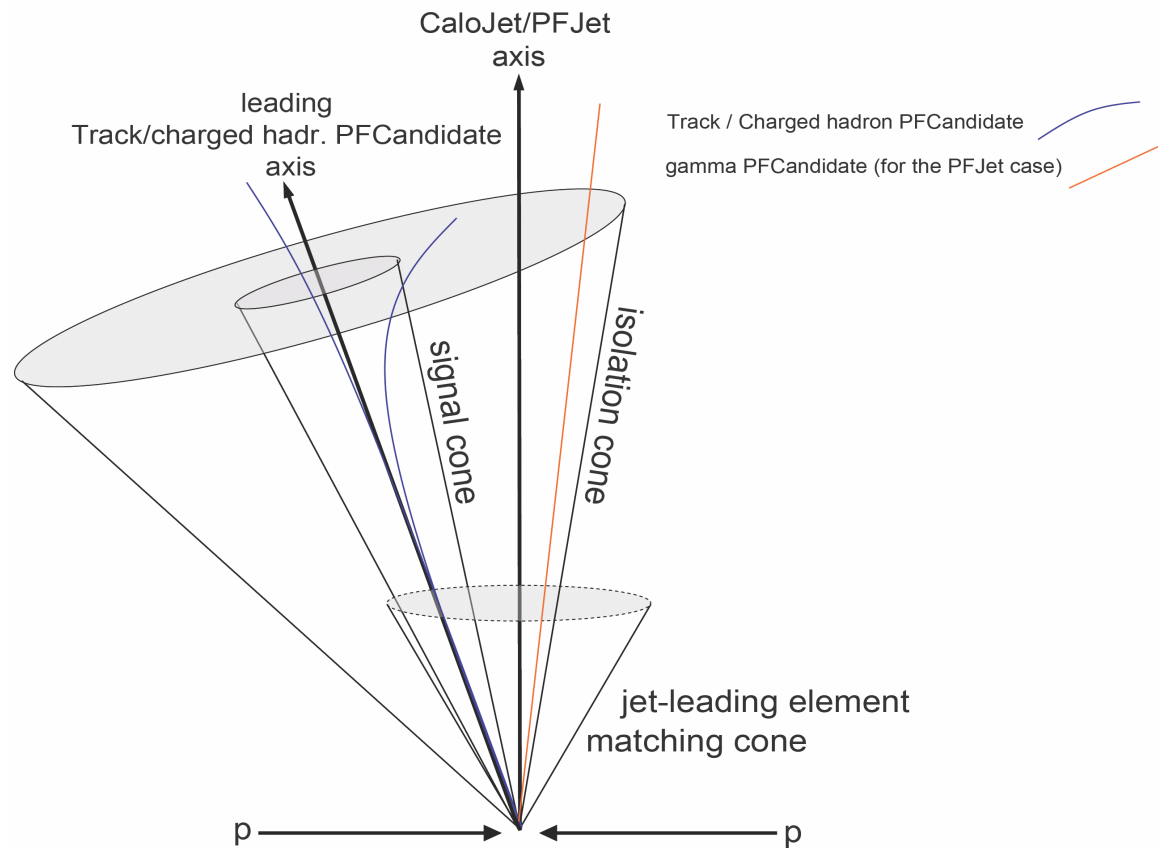
| Light Mass test points | m_0 | | $m_{1/2}$ | $\tan\beta$ | $\text{sign}(\mu)$ | A_0 |
|---------------------------|-------|----|-----------|-------------|--------------------|-------|
| LM1 | 60 | | 250 | 10 | + | 0 |
| LM2 | 185 | | 350 | 35 | + | 0 |
| LM6 | 85 | | 400 | 10 | + | 0 |
| LM7 | 3000 | >> | 230 | 10 | + | 0 |
| LM9 | 1450 | >> | 175 | 50 | + | 0 |

Note1. Masses are given in units of GeV/c^2

Note2. $\text{Br}(\tilde{\chi}_2^0 \rightarrow \tilde{\tau} \tau) = 96\%$ in LM2

τ reconstruction

- Standard τ identification is **from hadronic jet**.



1. Finding the leading track in the jet matching cone.
2. Requiring to be isolated from other high P_t tracks and photons.

SUSY Reference Analysis

SUSY hadronic reference analyses:

- RA1 : Exclusive n-jets analysis (e.g. Di-jet)
- RA2 : Inclusive ≥ 3 jets analysis (overlap with RA1)
- (RA3 : Di-photon + jets analysis)

Note1: Studying τ events (which are reconstructed from hadronic τ) is assigned in one of these categories.

Note2: First purpose of reference analysis is synchronization between different analysis group.

Reference Analysis 1

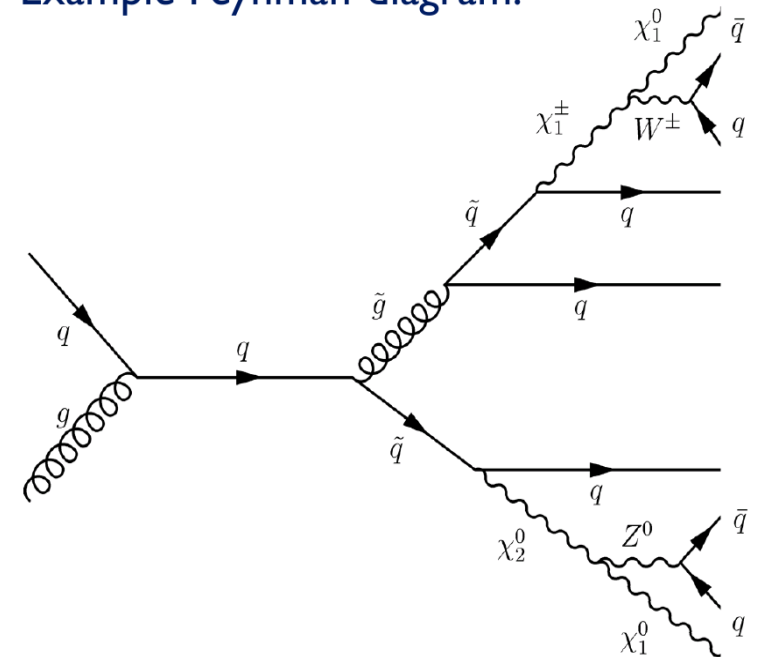
- RA1 (exclusive di-jet, exclusive 3 jets, and so on)
- Main pre-selection
 - The first and the second leading jets $P_t > 100 \text{ GeV}/c$
 - $|\eta| < 2$ for the leading jet
 - Electron and muon veto
 - No PAT-electron or global muon with $P_t > 10 \text{ GeV}/c$

Note: This e and μ veto is not proper for our particular stau study.

Reference Analysis 2

- RA2 (inclusive ≥ 3 jets)
- Main pre-selection
 - The first leading jet $P_t > 180$ GeV/c
 - The second leading jet $P_t > 150$ GeV/c
 - The third leading jet $P_t > 50$ GeV/c
 - The 1st, 2nd and 3rd jets $|\eta| < 2.5$
 - Veto on muons and electrons
 - Missing $E_t > 200$ GeV

Example Feynman-diagram:

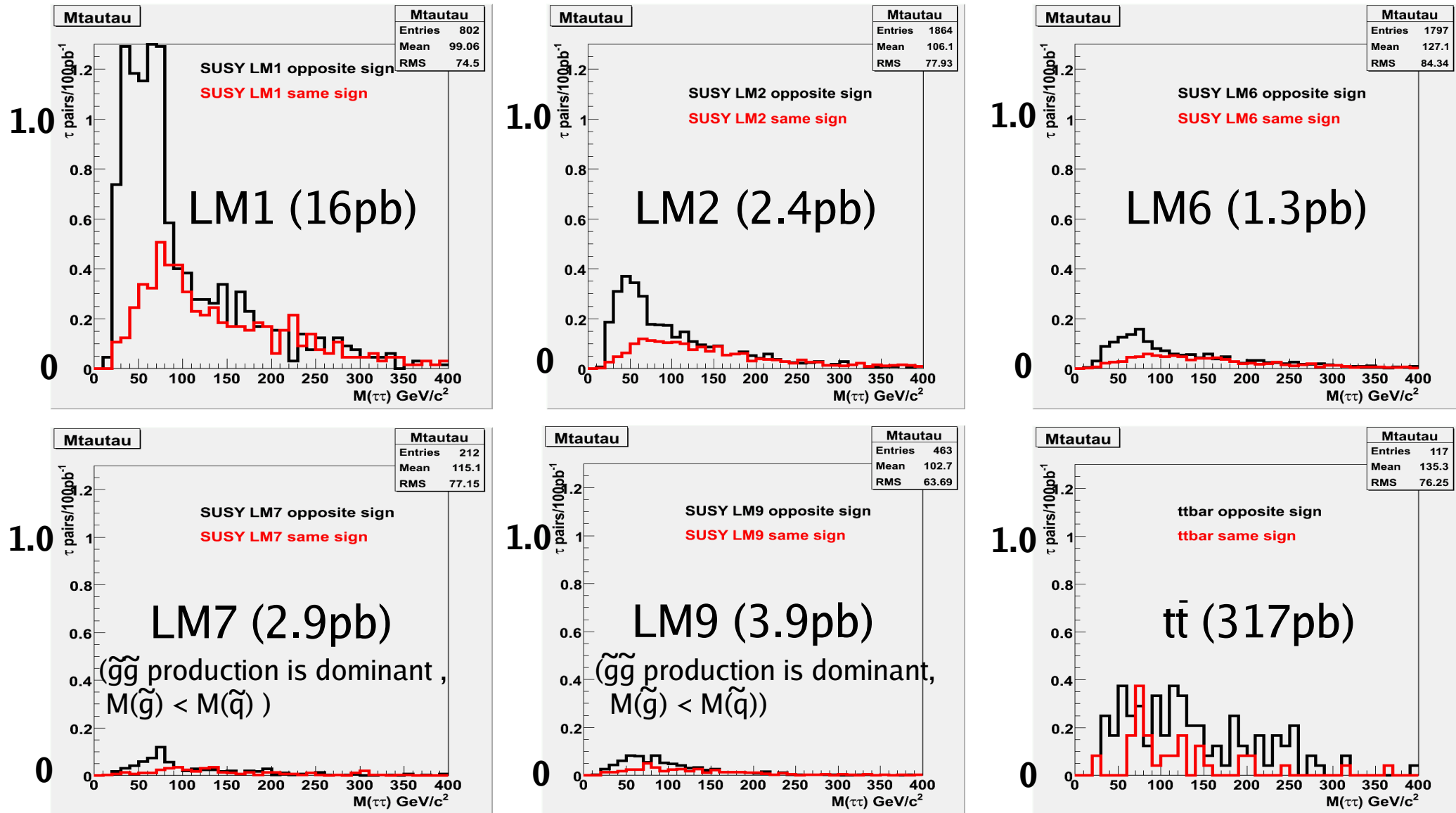


Note: This e and μ veto is not proper for our particular stau study as well.

Current status at IPHC

- David Bodin is studying the τ efficiency and the τ fake rate. (Please see Anne-Fleur's talk)
- Testing a basic signal selection criteria with available MCs.
- Studying some missing E_t related kinematic variables (e.g. $\alpha_t = E_t(2^{\text{nd}}) / M_t(1^{\text{st}}2^{\text{nd}})$ in di-jet system, α_t in n-jet system etc.)
 - Robustness against energy miss-measurements is under study.

Very preliminary $M(\tau^+\tau^-)$ tests plots at 100 pb^{-1}



Note1. Not yet final optimization : HT (jets Et sum) > 600 GeV, MET > 150 GeV, #Jets(Et > 50 GeV) > 2,
 Leading jet Et > 150 GeV, $|\eta(\tau)| < 2.5$, Pt(τ hard) > 40 GeV/c, Pt(τ soft) > 15 GeV/c

Note2. Summer08 10TeV MC samples (PYTHIA6 for LM points, MadGraph for $t\bar{t}$ MC)

Future prospect

- Synchronization efforts
 - Recently released MC version (SUSY-PAT Layer1 is partially available at this moment. e.g. Only for signal LMX etc.)
 - Testing the same basic criteria with reference analysis, afterward making it relax for our particular stau study.
 - Particle Flow will improve the τ energy resolution.
 - SUSY-PAT's 'cross-cleaning' (It removes double counts in jet.)
 - ➔ The 'cross-cleaning' will improve the resolution of MHT (missing E_t from jets).
- Data-driven systematic study
- Reference Analysis is for SUSY discovery in early data set.
 - Stau observation at 10TeV 100 pb⁻¹ is very challenging.
 - However, we are trying to do our best.

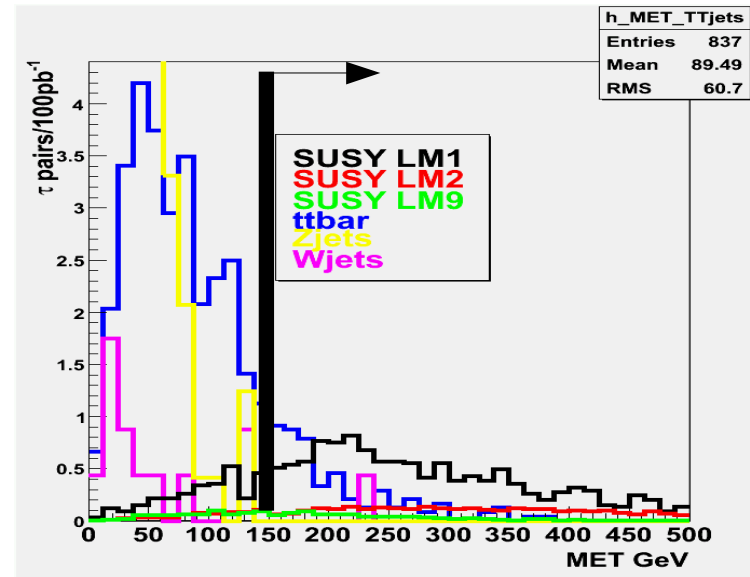
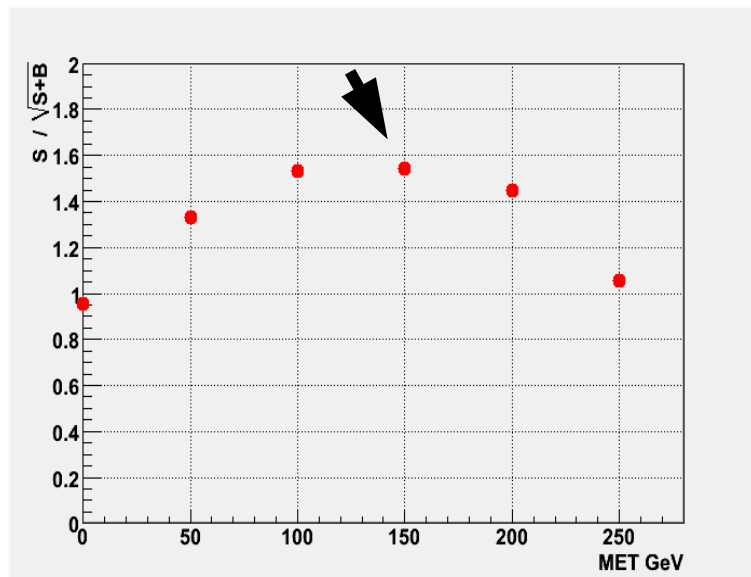
Backup: Selection optimization test

[under study]

$S = \#(\text{LM1 opposite sign } \tau \text{ pairs}) - \#(\text{LM1 same sign } \tau \text{ pairs})$

$B = \#(\text{ttbar}) + \#(\text{Wjets}) + \#(\text{Zjets}) + \#(\text{LM1 same sign } \tau \text{ pairs})$ [normalized with 100pb^{-1}]

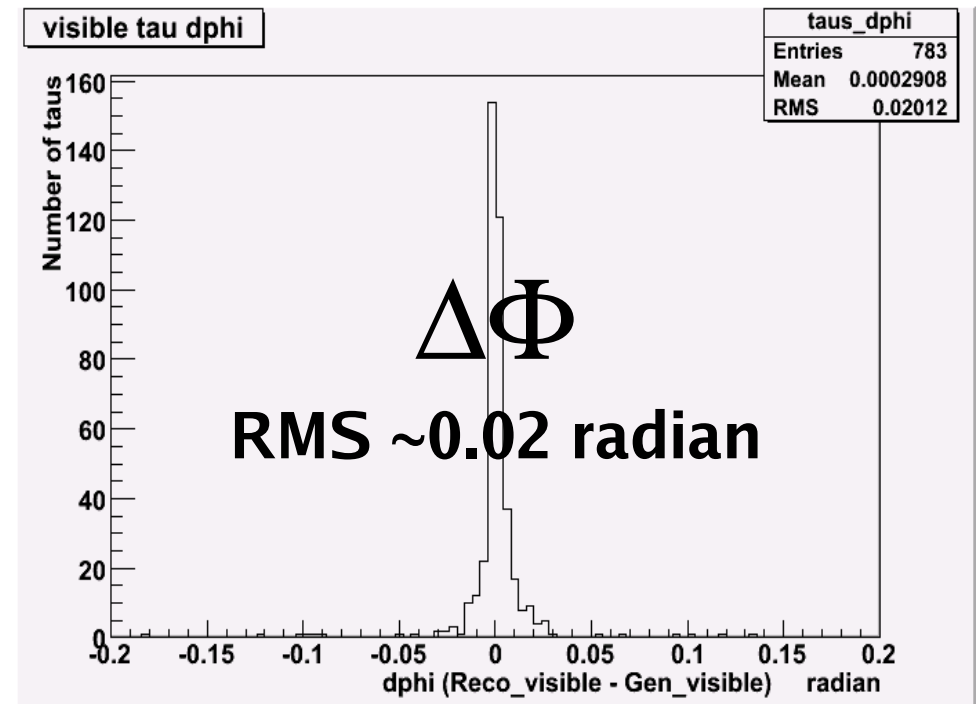
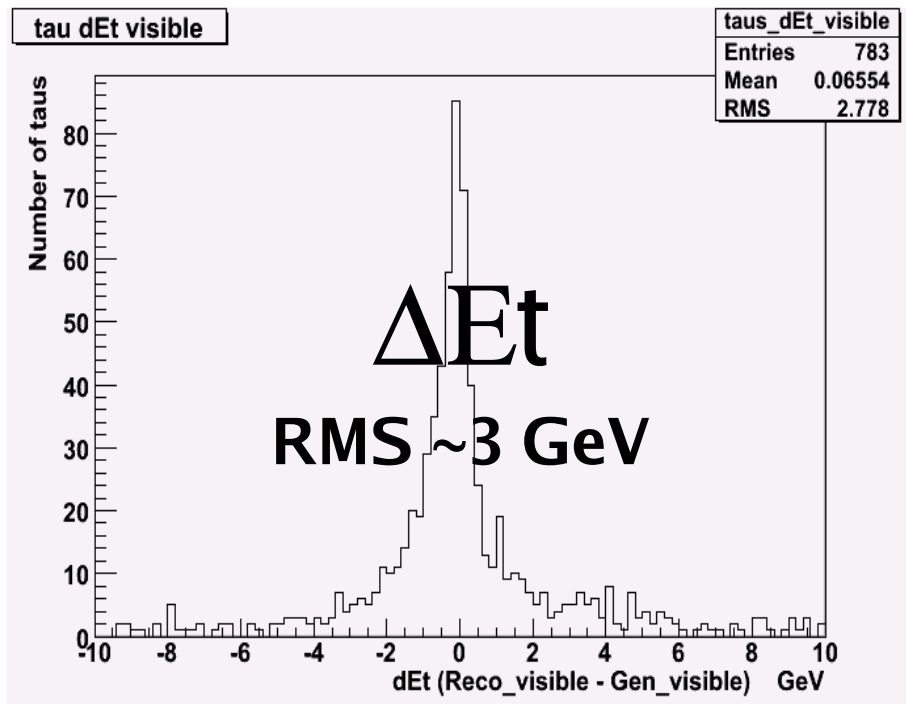
with basic test cuts: $|\eta(\tau)| < 2.5$, $Pt(\tau_1) > 40 \text{ GeV}/c$, $Pt(\tau_2) > 10 \text{ GeV}/c$,
Leading jet $E_t > 150 \text{ GeV}$, $\# \text{Jets}(E_t > 50 \text{ GeV}) \geq 2$,
 $HT(\text{jets } E_t \text{ sum}) > 600 \text{ GeV}$, $M(\tau\tau) < 100 \text{ GeV}/c^2$



(Note: QCD sample is still missing in this study.)

Backup: Particle Flow τ test

(single τ events with $Pt(\tau) = 50 \text{ GeV}/c$)



Good agreement with the CMS note (CMS PAS PFT-08-001)

MC samples

| Sample | Cross section | Events used | Luminosity correspond (fb^{-1}) |
|--------|---------------|-------------|--|
| LM1 | 16 pb | 104k | 6.5 |
| LM2 | 2.4 pb | 130k | 54 |
| LM6 | 1.3 pb | 131k | 103 |
| LM7 | 2.9 pb | 82k | 28 |
| LM9 | 3.9 pb | 213k | 55 |
| Wjets | 40 nb | 9.1M | 0.23 |
| Z jets | 3.7 nb | 0.9M | 0.24 |
| ttbar | 317 pb | 0.7M | 2.4 |

Note.1: Summer08 10TeV MC samples

Note.2: SUSY LMX MC are PYTHIA6, BG MC are MadGraph