Status report of Jet + $\not{E}_T$ + τ Analysis

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OUTLINE:

- Introduction
- Simulation
- Preliminary Results
- Future Plans

SUSY Particle production at LHC ($\sqrt{s} = 14\text{TeV}$)

$$\text{p p} \rightarrow \underbrace{\tilde{g}\tilde{g}, \tilde{q}\tilde{g}, \tilde{q}\tilde{q}}_{dominant\ process} \quad \tilde{g}\widetilde{\chi}, \tilde{q}\widetilde{\chi}, \tilde{b}\tilde{b}, \tilde{b}\tilde{g}, \tilde{q}\tilde{b}, \widetilde{\chi}\widetilde{\chi}, \tilde{t}\tilde{t}, \tilde{l}\tilde{l}$$

Gluino and squarks undergo cascade decay

$$\text{pp} \rightarrow \text{SUSY particles} \rightarrow \widetilde{\chi}_1^{\pm},\ \widetilde{\chi}_2^0 + X (\equiv \text{jets} + \text{leptons})$$

$$\widetilde{\chi}_1^{\pm} \rightarrow \text{f}_1\ \text{f}_2\ \widetilde{\chi}_1^0$$
$$\widetilde{\chi}_2^0 \rightarrow \text{f}_3\ \text{f}_4\ \widetilde{\chi}_1^0$$

Classical SUSY signal : n leptons + m jets + $\not{E}_T$

$$\widetilde{\chi}_1^{\pm} \rightarrow \tilde{\tau}_1\ \nu_\tau$$
$$\widetilde{\chi}_2^0 \rightarrow \tilde{\tau}_1\ \tau$$

SIGNAL : jets + $\not{E}_T$ + τs

High $\tan\beta$ Regime

($\tan\beta$: ratio of vaccum expectation values of two higgs doublets)

- In SUSY model $\tilde{f}_L, \tilde{f}_R \Rightarrow \tilde{f}_1, \tilde{f}_2$
- Sfermion mixings are proportional to off diagonal mass term $m_f(\mu - A\tan\beta)$, Important for 3rd generation of sfermions, $\tilde{t}, \tilde{b}, \tilde{\tau}$
- For high $\tan\beta$ region, 3rd generation sfermions become light, $\tilde{\tau}_1, \tilde{b}_1, \tilde{t}_1$
- For certain region of parameter space (low m_0 or high $\tan\beta$), $\tilde{\tau}_1$ might turn out to be NLSP $\Rightarrow$

$$\tilde{\tau}_1 \rightarrow \tau\, \tilde{\chi}_1^0 \quad (100\ \%)$$

- Many τs are expected in the final state
- τs can be tagged as a narrow jet

SUSY parameter space

- Signal is analysed in the context of mSUGRA model
- Five parameters required to describe mSUGRA model are
  m_0 : common scalar mass
  $m_{1/2}$: common gaugino mass
  $tan\,\beta$: ratio of two Higgs v.e.vs
  A_0 : common trilinear coupling
  $sgn(\mu)$: sign of Higgsino mass parameter

- There are 9 benchmark mSUGRA points in CMS
- LM2 point (high $\tan\beta$ region)

m_0	$m_{1/2}$	$tan\,\beta$	A_0	$sgn(\mu)$
180 GeV	350 GeV	35	0	+

- ISASUGRA code is used to calculate the SUSY mass spectrum and the couplings

Mass Spectrum for mSUGRA point LM2

	$\widetilde{u}$	$\widetilde{d}$	$\widetilde{c}$	$\widetilde{s}$	$\widetilde{t}$	$\widetilde{b}$
L	777.16	781.54	781.54	777.16	666.47	666.47
R	753.06	751.31	751.31	753.07	679.20	589.08

	$\tilde{e}$	$\tilde{\mu}$	$\tilde{\tau}$	$\tilde{\nu}_e$	$\tilde{\nu}_\mu$	$\tilde{\nu}_\tau$
L	304.14	304.14	284.25	290.46	290.46	277.87
R	226.77	226.77	186.33			

	$\widetilde{b}$	$\widetilde{t}$	$\tilde{\tau}$
1	678.31	584.22	150.13
2	725.08	747.90	311.89

$\tilde{g}$	$\widetilde{\chi}_1^0$	$\widetilde{\chi}_2^0$	$\widetilde{\chi}_3^0$	$\widetilde{\chi}_4^0$	$\widetilde{\chi}_1^+$	$\widetilde{\chi}_2^+$
834.16	138.11	265.51	453.29	468.71	265.88	468.92

$\widetilde{\chi}_1^0$ is the Lightest Supersymmetric Particle

CMS framework Simulation Strategy

- SUSY events are generated using the event generator PYTHIA
- The detector effects are studied using GEANT4 in OSCAR framework. OSCAR provides CMS specific interfacing to GEANT4. It reads the ntuple provided by CMKIN and writes the output as SimHits
- In the Reconstruction and Analysis process, ORCA can
  - digitise starting from SimHits
  - reconstruct various reconstruction objects from digis
  - analyse events from the reconstruction results

  and can store if required
  - Digis at the end of digitisation
  - reconstructed objects as DSTs
  - root tuple at the end of analysis
- OSCAR370 and ORCA871 are used
- JetMetAnalysis package of ORCA is used in this analysis

- Started by trying to produce DSTs locally and did it successfully for a small event sample
- DSTs available from CERN production areas are finally used
- The information about all the DataSets produced can be obtained from

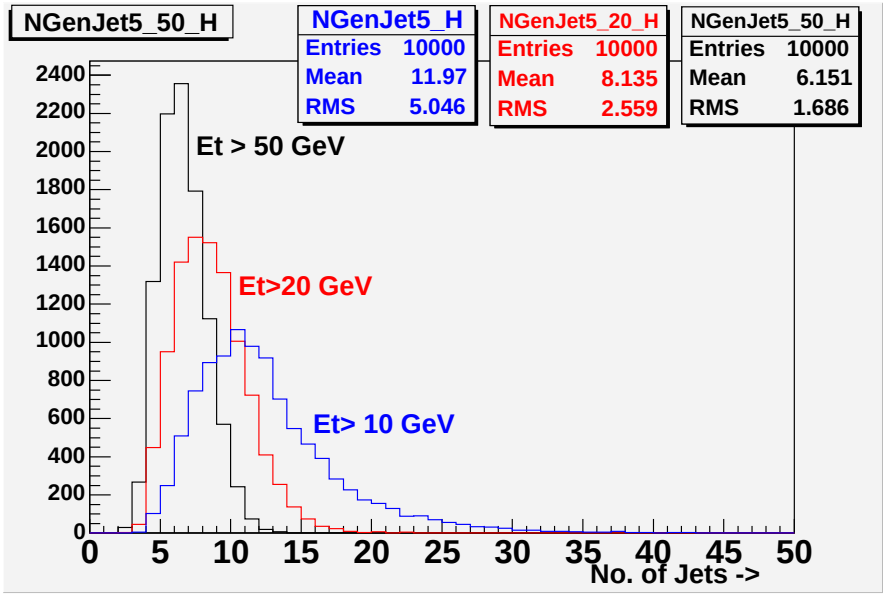
  http://cmsdoc.cern.ch/cms/production/www/PubDB/GetPublishedCollectionInfoFromRefDB.php

- All the DSTs are accessed from Castor area for analysis
- More information on how to access files from Castor is available at

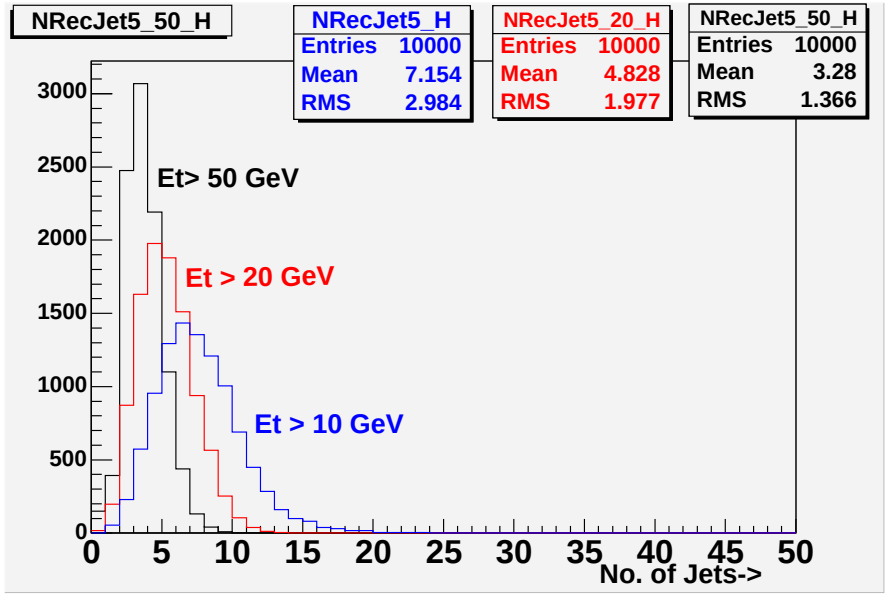
http://it-dep-fio-ds.web.cern.ch/it-dep-fio-ds/Documentation/userguide.html

Number of Jets

(Cone Algorithm $\Delta R = 0.5$)



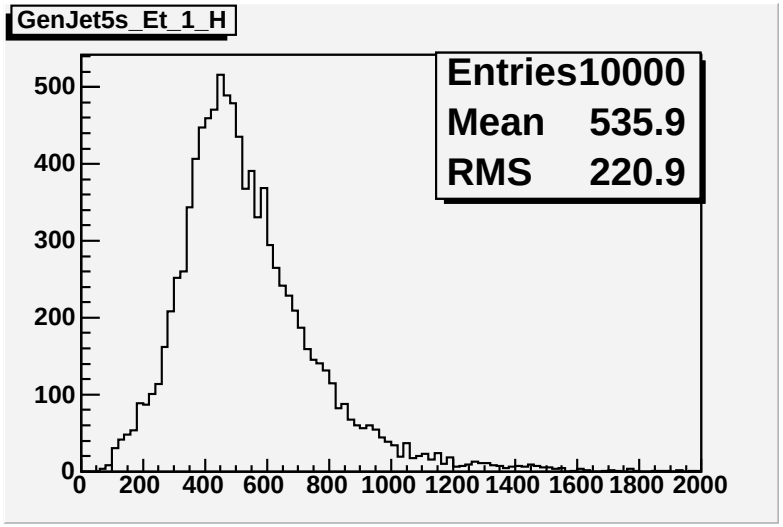
(Generator level)

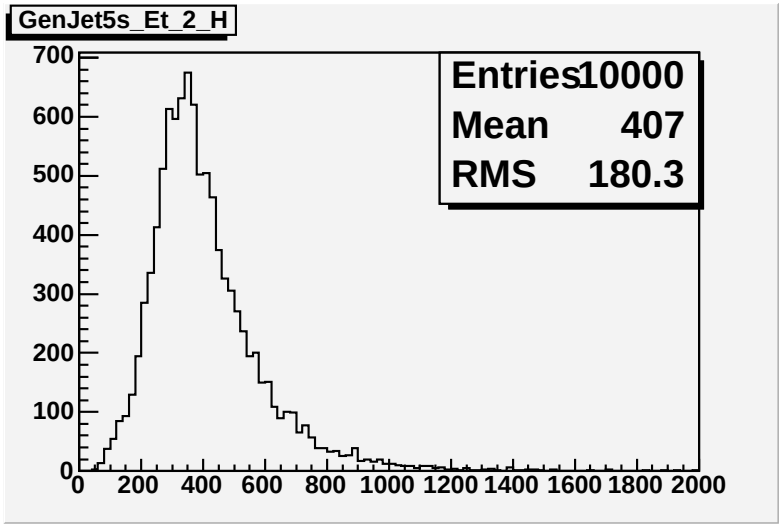


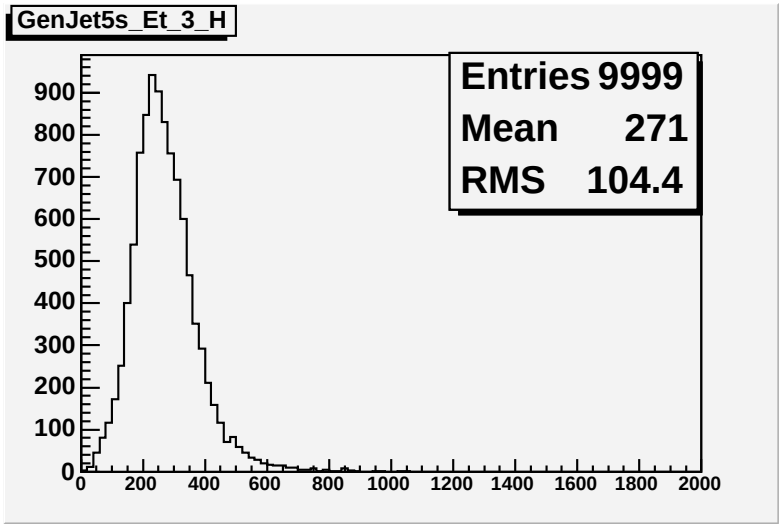
(Detector level)

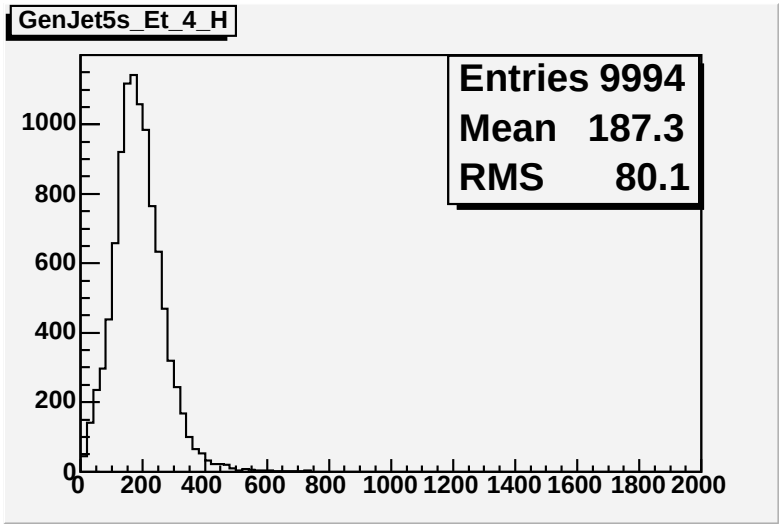
Transverse Energy for Four hardest Jets

(At generator level)





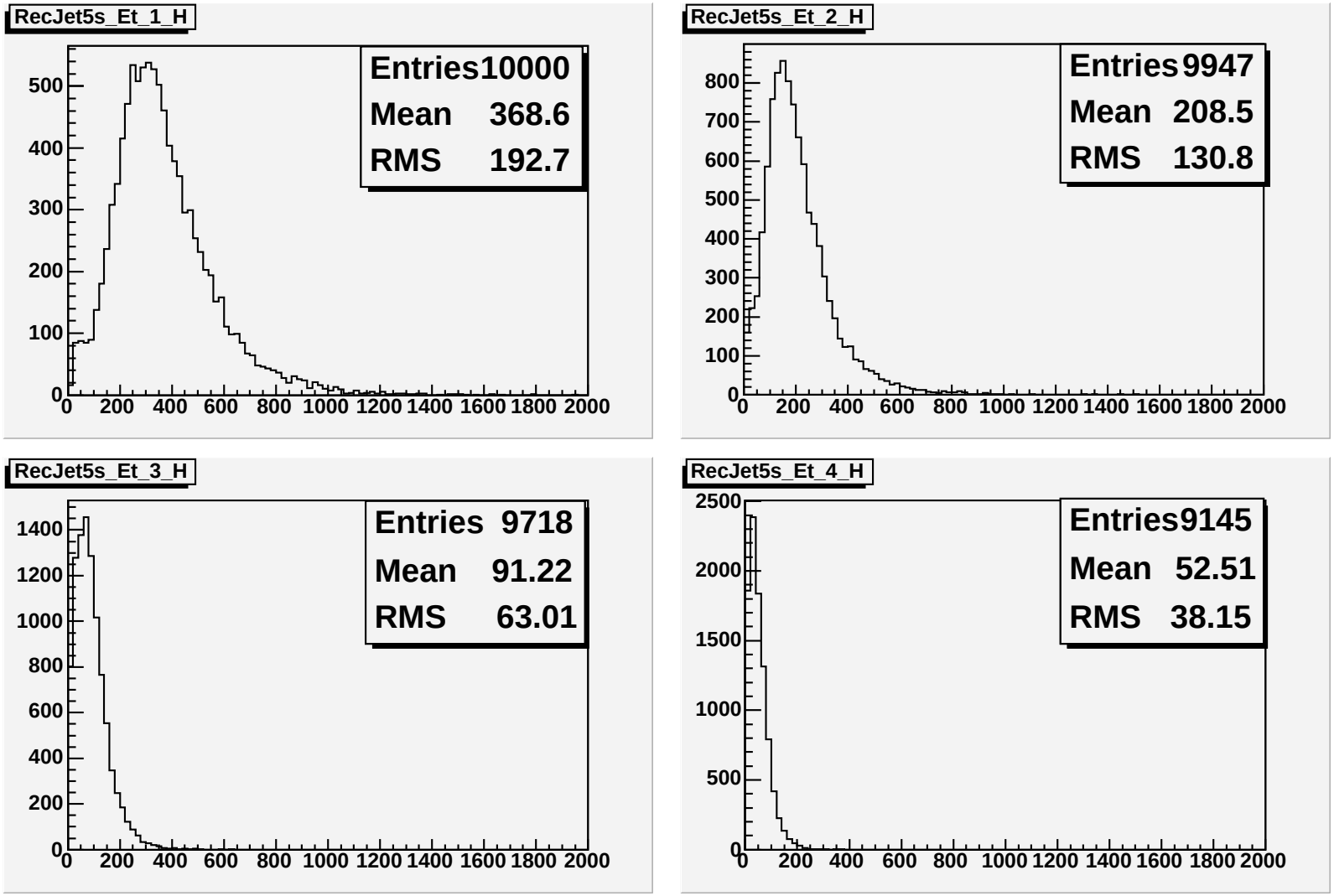




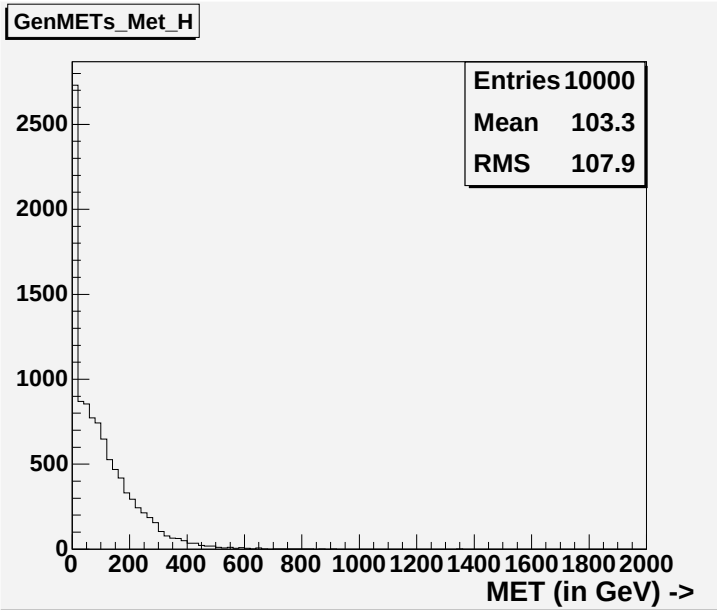
$\mathrm{E_T(inGeV)} \rightarrow$

Transverse Energy for Four hardest Jets

(After reconstruction)



Missing Tranverse Energy



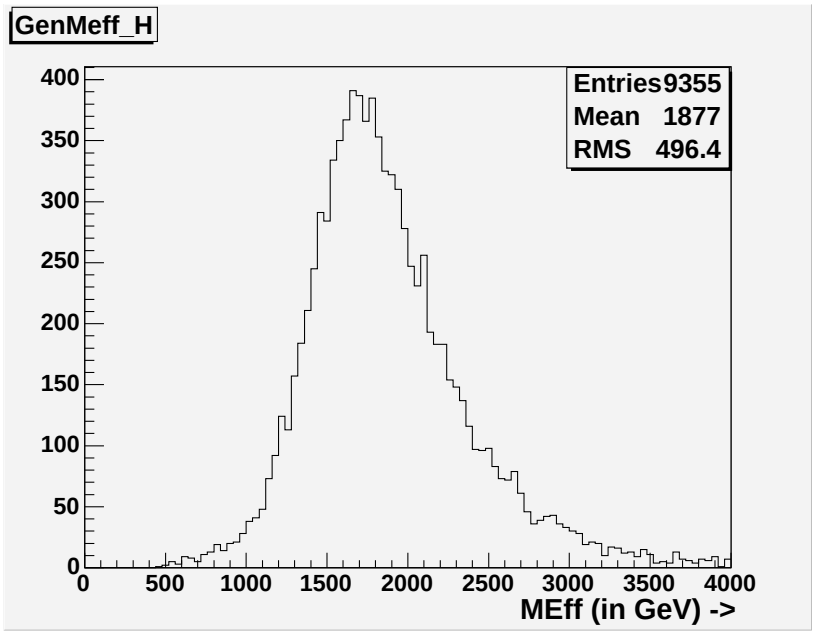
(Generator level)

(Detector level)

Calculated using Ecal + Hcal Towers and Iterative Cone Jet algorithm

Effective Mass ($M_{eff} = \sum^{j} E_T^j + \not{E}_T$)

with the cuts used $E_T^{j_1}$ >100 GeV and $E_T^{j_{2,3,4}} > 75$ GeV



(Generator level) (Detector level)

Future Plans

- Preliminary study is done using CMS Simulation Softwares
- Able to succesfully generate and analyse the DSTs produced on local machines
- Able to access and use the standard DSTs available from CMS production areas
- In the process to understand the nitty-gritties of Jet and MET reconstruction
- Tau tagging is not yet fully implemented in ORCA
  - Plan to plug-in the existing τ-identification code in JetMetAnalysis
  - Plan to use τ-polarisation in τ-jet tagging
- Background studies
- Plan to tune the cuts on the kinematic variables to reduce the background