

Full Simulation of SUSY Events

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21 October 2002

Abstract

First results are presented for a sample of 500 SUSY events simulated with Atlsim and reconstructed with Athena.

The minimal SUGRA point

$$m_0 = 100 \text{ GeV}, \quad m_{1/2} = 300 \text{ GeV}, \quad A_0 = -300 \text{ GeV} \\ \tan\beta = 6, \quad \text{sgn}\mu = +$$

is qualitatively similar to TDR Point 5 but consistent with current bounds; in particular, $M_h = 114.8 \text{ GeV}$. SUSY production is dominated by gluinos and squarks, with the former decaying to the latter, which mainly decay via $\tilde{q}_L \rightarrow \tilde{\chi}_1^\pm q, \tilde{\chi}_2^0 q$ and $\tilde{q}_R \rightarrow \tilde{\chi}_1^0 q$. The main light gaugino decay modes are

$$B(\tilde{\chi}_1^\pm \rightarrow \tilde{\chi}_1^0 W^\pm) = 6.2\% \\ B(\tilde{\chi}_1^\pm \rightarrow \tilde{\chi}_2^0 W^\pm) = 28\% \\ B(\tilde{\chi}_1^\pm \rightarrow \tilde{\tau}_1^\pm \nu_\tau) = 68\% \\ B(\tilde{\chi}_2^0 \rightarrow \tilde{\ell}_R^\pm \ell^\mp) = 2 \times 8.8\% \\ B(\tilde{\chi}_2^0 \rightarrow \tilde{\tau}_1^\pm \tau^\mp) = 76\%$$

Thus this point has a $\ell^+ \ell^- + \text{jets}$ signature similar to Point 5 plus signatures involving τ 's. There is no significant $h \rightarrow b\bar{b}$ signal in SUSY events, but b tagging would be relevant for separating third-generation squarks.

A sample of 20k events for this point were generated using Herwig 6.4 with the SUSY spectrum and decays taken from Isajet 7.64. The full sample was analysed using Atfast; the resulting distributions appear reasonable. The response of ATLAS to 500 of these events was simulated using GEANT as implemented in the DC1 version of Atlsim, and these events were reconstructed using Athena. The events were divided among 10 jobs. Two of these gave ZEBRA errors.

The Athena reconstruction was run at BNL using Release 4.2.0 plus the following packages checked out on 20 October 2002:

- Calorimeter: CaloEvent, CaloNavProcessors, CaloProtoJetRec, CaloRec
- Event: ZebraTDR Cnv
- Reconstruction: CombinedJetRec, JetEvent, JetRec, KtJet, MissingET, NavigationRep, ProtoJetEvent, egammaRec, tauRec

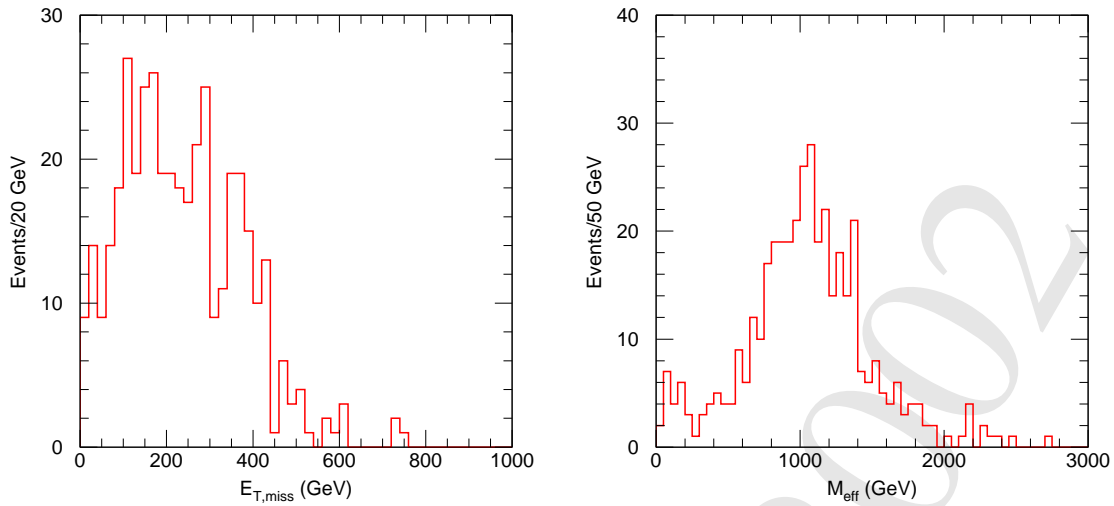


Figure 1: Missing energy E_T (left) and effective mass M_{eff} (right).

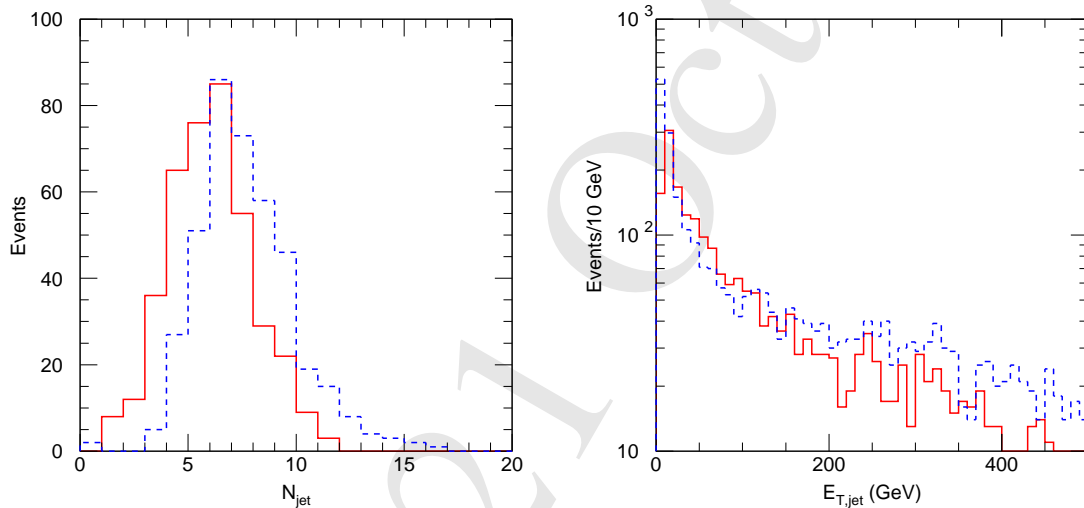


Figure 2: Jet multiplicity (left) and p_T distribution (right) for calorimeter (solid) and Monte Carlo (dashed).

All of these packages are identical to those included in Release 4.4.0; they build and run successfully against Release 4.3.0 at CERN but not at BNL.

Two ZEBRA files had an event with no Monte Carlo truth particles, causing a segmentation fault in `KtClusterAlg`. After this was fixed, a total of 400 events from 8 ZEBRA files were successfully reconstructed.

The jet reconstruction uses the K_T algorithm from Couchman with the default parameters and the latest version in CVS of the H1-style energy calibration. For comparison, the same jet algorithm

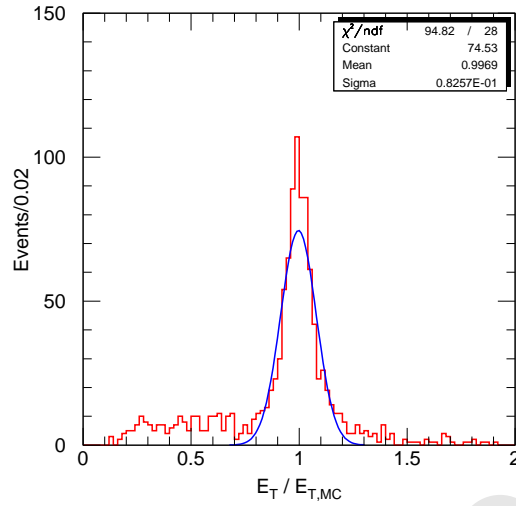


Figure 3: Jet resolution using default calibration.

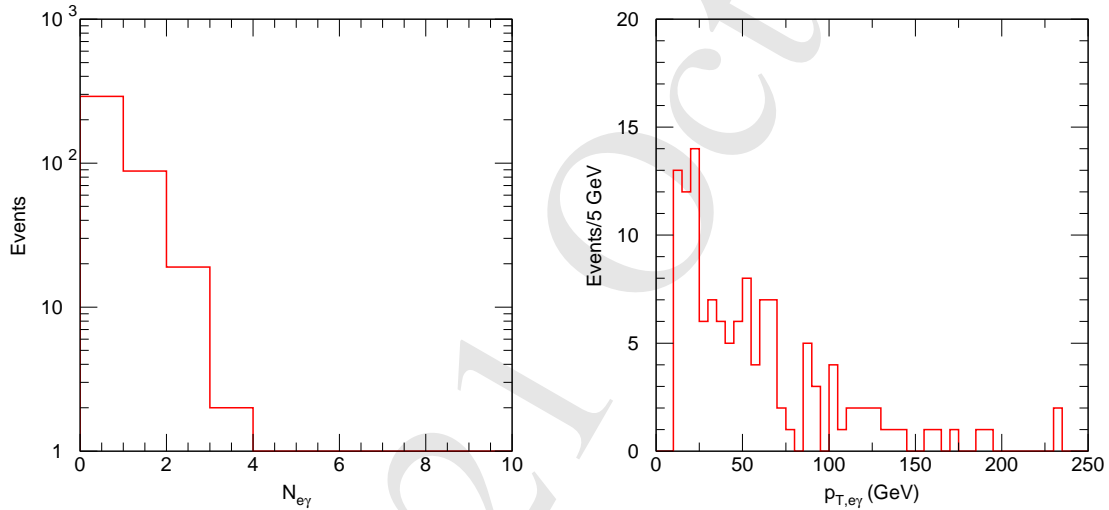


Figure 4: Multiplicity (left) and p_T (right) of $e\text{-}\gamma$ clusters.

is run on protojets formed from Monte Carlo particles. Figure 1 shows the missing energy and effective mass distributions with the default calibration. Figure 2 shows the jet multiplicity and p_T distributions for calorimeter and Monte Carlo jets. Figure 3 shows the ratio of the E_T of each calorimeter jet to that of the nearest Monte Carlo jet using the H1 weights in CVS. Evidently the mean is about right but there is a non-Gaussian tail that needs further study.

The multiplicity and p_T distributions of $e\text{-}\gamma$ clusters as reconstructed by Athena are shown in Figure 4. The EM objects are required to have $eg_IseM = 0$, meaning that they satisfy $|\eta| < 2.5$ and minimum isolation and HAD/EM cuts. The signs of electron candidates were obtained from

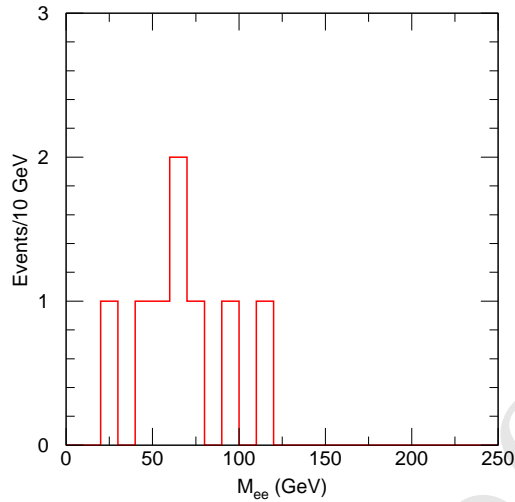


Figure 5: Mass distribution for e^+e^- pairs.

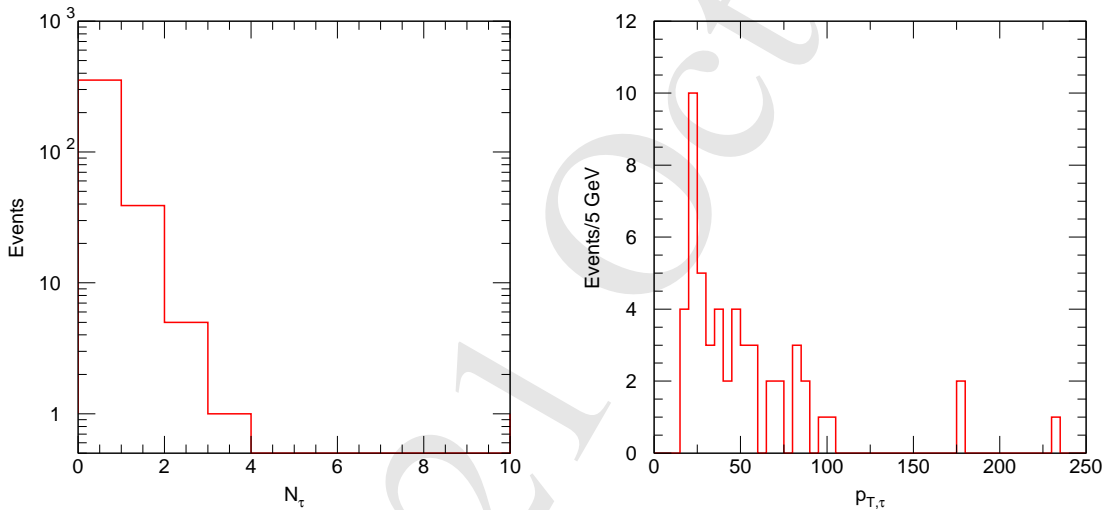


Figure 6: Multiplicity (left) and p_T (right) of hadronic τ decays reconstructed by Athena.

the sign of `eg_eoverp`, ignoring those with a value of -1000 . There is perhaps a hint of an endpoint in roughly the right place.

The multiplicity and p_T distributions of hadronic τ clusters as reconstructed by Athena are shown in Figure 6. The cuts are the defaults given in the τ reconstruction writeup; the cuts in the default `jobOptions` file are much looser. More work is needed to compare these distributions with those of the hadronic τ decays in the SUSY events.

All of the results given here are very preliminary, but they are quite reasonable and so indicate that the chain of event simulation, detector simulation, and reconstruction is workable for SUSY

events in Athena. Therefore, study of large samples seems warranted at this time.

Draft 21 Oct 2002