A QUASI MODEL INDEPENDANT SEARCH FOR NEW HIGH P_T PHYSICS AT D0

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Supersymmetry has been searched for many years, but as it leads to numerous final states depending on the model and the set of parameters considered, only a small fraction of it has been explored. A quasi-model independant search is presented, which looks for any p_T excess in the data w.r.t standard model processes. This model has been validated and then applied to the 108 pb^{-1} D0 Run I data collected between 1992 and 1996. No evidence for new high p_T physics was found.

1 Introduction

Eventhough the Standard Model is a success, there are many clues that it would only be an effective model, valid at low energies. Other theoretical unification models have been developped, most of them based on the exitence of Supersymmetry.
Supersymmetry can be searched in many topologies, depending on the model (GMSB, mSUGRA, number of generators...) and the set of parameters considered, at most one of them beeing the correct description of Nature. Can one be sure that every model has been fully tested ? How can one interpret any event excess of events in terms of significance ?
In this spirit, the Sleuth algorithm has been developped to look for any deviation from the Standard Model processes, assuming that they will be signed by higher p_T events w.r.t known backgrounds. The search strategy will be presented, and after a validation step of the method, applied on the 108 pb^{-1} Run I data collected by the D0 detector. A more complete description of the algorithm and the analysis can be found in references [1,2,3,4]. It should be noted that some complex points have been skipped in order to fulfill the text length requirements.

2 The Sleuth Algorithm

We assume that the production and subsequent decay of massive Supersymmetric particles will lead to large transverse momentum final states.

2.1 Final State Definition

Using the detector information and its identification capabilities, events will be sorted depending on their contents in *objects* (electrons, muons, taus, photons, jets, transverse missing energy and when possible, W and Z bosons).
Then, all the Standard Model processes i leading to the same exclusive final states (i.e. having exactly the same number of objects) will be considered and the number of expected background events $\hat{b}_i \pm \delta\hat{b}_i$ will be computed.

2.2 Variable contruction rules

Given a final state, up to four variables per event will be built, following this prescription :

If the final state includes	then consider the variable
$\not{E}_T$	$\not{E}_T$
one or more charged leptons	$\sum p_T^{\ell}$
one or more electroweak bosons	$\sum p_T^{\gamma/W/Z}$
one or more jets	$\sum' p_T^{j}$

2.3 Variable transformation

Every background event is now associated to a set of up to four variables, which can be represented as a point in a d-dimensional space. A mathematical transformation[a] will be applied such that the d-dimensional space will turn into a *unit box* $[0, 1]^d$). The background points will be mapped following this transformation, and then will be *flatten* such that their projection on any of the d axis will be flat.
The main idea is now to fill this uniform unit box with the data events points following the transformation scheme set for the background. If a subset of the N_{data} points appear to cluster in a given part (*region*) of the box, then the p_T distributions differs from the Standard Model and the significance of the excess will be computed.

2.4 N-Regions and Probability Calculation

In the unit box, contigious data points will associated, defining a region. We will call a N-region a region containing N data points ($1 \leq N \leq N_{data}$).

[a]Details on this non-straight forward transformation can be found in the more detailed references.

For each N-region, the algorithm will compute the probability p_N^R that the underlying flat background events $\hat{b}_R$ has fluctuated at least up to the number of observed events N, and the best (i.e the smallest) probability for all N-regions $p_N = min_R(p_N^R)$ will be noted.
In order to test the significance of this fluctuation, we will generate hypothetical similar experiments *(hse)* by varying the expected background events according to the background distribution. We will then apply the previous algorithm to loop over N-regions and keep for each *hse* the lowest probability $p_N(hse)$, i.e. an excess as interesting as the one that was seen in the data. The fraction of *hse* which leads to a probability $p_N(hse) < p_N(data)$ will be the estimator of the fluctuation.
In other words, if most of *hse* have a lower probability than the one observed in the data sample, then our fluctuation is not significant. On the opposite, our observed excess should be examined with care if a small fraction of *hse* have a lower probability $p_N(hse)$.

3 Algorithm validation and Results

The Sleuth algorythm has been validated ignoring the $t\bar{t}$ production in the $e\mu X$ final states, i.e $t\bar{t} \rightarrow e\mu X$ processes were not included in the list of backgrounds. Eventhough Sleuth is not optimized for the $t\bar{t}$ analysis, Run I data points appear to be in excess w.r.t considered backgrounds with a $P_{e\mu \not{E}_T 2j} = 1.9\sigma$ significance.
Now including all known background processes, Sleuth was applied to the Run I data set over thirty exclusive final states. 89% of hse would lead to a lower probability, i.e. a more interesting fluctuation than the one observed in the data.

4 Conclusion

Sleuth, a quasi-model independant search, has been applied on the D0 Run I data set to search for new physics. Although no significant excess was found, this very promising tool will be used to look for new physics in the forthcoming Tevatron Run II data.

References

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