SSC PHYSICS SIGNATURES AND TRIGGER REQUIREMENTS

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This working group considered strategies for triggering on new physics processes in the environment of the SSC, where interaction rates will be very high and most new physics processes quite rare. The quantities available for use in the trigger at various levels were related to the signatures of possible new physics. Two examples were investigated in some detail using the ISAJET Monte Carlo program: Higgs decays to W pairs and a missing energy trigger applied to gluino pair production. Other topics were investigated by subgroups and will be reported in separate contributions to these proceedings. In both of the examples studied in detail, it was found that workable strategies for reducing the trigger rate were obtainable which also produced acceptable efficiency for the processes of interest. In future work, it will be necessary to carry out such a program for the full spectrum of suggested new physics.

Introduction

The subject of triggering at the SSC has only begun to be considered by the various workshops that have been held[1,2]. Triggering is a particular concern at the SSC because the expected very small size of the cross sections for new physics has caused the machine designers to specify a very high luminosity: $10^{33} cm^{-2} sec^{-1}$. This should produce a total interaction rate of about $10^8/sec$. Since a practical rate for writing out data is probably more like $1/sec$, the trigger has the job of being very selective while retaining efficiency for a broad class of possible new physics, and further it has to do the job in a very short time. From a hardware point of view, the usual solution to the speed problem is to find some simple initial set of selections that can be made with data available from the detector very quickly after the interaction. With the rate reduced to no more than $10^4/sec$, subsequent stages of trigger (at least two more) can have the time to make increasingly complex selections based on more sophisticated combinations of data from the detector as they become available. At the first or second stage of the trigger, use will have to be made of fairly simple quantities such as

- total transverse energy
- local transverse energy in small groups of calorimeter cells
- Number and transverse energy of jets
- Number and transverse momenta of charged leptons
- Missing p_T

The fact that, as the machine is designed, there will be more than one interaction per bunch crossing or, more fundamentally, that there will be multiple interactions within the resolving time of most detector elements, is an added complication. The resulting overlap of events may make it easier for the data to satisfy a given set of trigger conditions and therefore harder to achieve a satisfactory trigger rate.

This working group was charged with devising strategies for triggering on specific physics processes that are consistent with the above considerations. In particular, it was important to determine, for at least a small number of representative cases, that a sufficiently selective and efficient trigger could be constructed out of the quantities plausibly available. This is a program which ought to be carried out rather generally for the physics expected to be studied or searched for at SSC, as part of the planning for utilization of the machine. We were only able to make a beginning to this program. It will be continued at other workshops, such as those already scheduled at UCLA, Madison, and Snowmass during the next year.

Topics Considered

Two main trigger scenarios were investigated in some detail by this group using the Monte Carlo program ISAJET[3]. The first scenario involved the search for a high mass neutral Higgs particle, using the decay to two W bosons. The second looked at triggering on events involving missing energy, specifically the production of two gluinos, with the gluino mass taken as either 100 GeV or 1 TeV, probably close to the extreme masses for such a search at the SSC. These calculations are described below.

One subgroup investigated the usefulness of diffraction as a trigger signature emphasizing hard scattering. They concluded that a signature combining the presence of a rapidity gap near the forward or backward directions with significant visible p_T would significantly enhance hard scattering processes relative to the background. Another subgroup considered the possible problems of analysis of the $H \longrightarrow WW$ signature investigated below and looked at the practicality of finding the Higgs particle using only leptonic decays of Z pairs. At standard SSC luminosities, they found this program to be barely possible for the lowest range of Higgs masses. Since the low rates for higher masses suggest a use for even higher luminosities, another subgroup considered the new problems presented by luminosities of $10^{34} cm^{-2} sec^{-1}$ or higher. Most of these subgroup investigations will be documented as contributions to these proceedings.

Monte Carlo Trigger Scenarios

These investigations were preliminary in a number of ways. An important limitation was the use of relatively low statistics in the Monte Carlo because of limited time. A second, and probably more important limitation, was the absence of all but the most rudimentary simulation of the detector. The "detector" used in the calculation consisted of a calorimeter with uniform cells accepting $\Delta y = 0.1$ and $\Delta\phi = 5\,\text{deg}$. The energy of each particle is confined to a single cell, but is smeared with resolutions

$$\frac{\Delta E}{E} = \frac{0.15}{\sqrt{E}} \qquad \text{for electrons and photons}$$
$$\frac{\Delta E}{E} = \frac{0.35}{\sqrt{E}} \qquad \text{for hadrons}$$

Hadronic and electromagnetic energy deposits are kept track of separately. No attempt is made to deal with the realities of cracks or other instrumental imperfections. Nor is an attempt made to apportion deposited energy between electromagnetic and hadronic sections of the calorimeter in a realistic way. No simulation of tracking is done. Early studies of triggering[2] found that multiple event overlap was not a serious problem. We have assumed this result and have not simulated multiple events. All Monte Carlo studies have been done for $\sqrt{s} = 40$ TeV. Most rates are reported in cross-section units, but the design luminosity of the SSC makes an easy conversion: 1 nb $\Rightarrow$ 1 Hz.

$H \longrightarrow W^+ + W^-$

(Monte Carlo study done by M. Goodman, F. Paige, L. Price, A. Savoy-Navarro, and B. Wicklund)

If the scalar Higgs particle of electroweak theory, or dynamics to take its place, has not been discovered at lower energy accelerators, it will represent one of the primary problems to be investigated with the SSC. Even if a light Higgs particle has been found, it will be necessary to study the TeV region in order to understand fully the Higgs sector. The mass range of interest at the SSC is that of the "heavy" Higgs, with mass greater than $2m_W$. Thus the primary decay mode to be expected is either to a pair of W's or to a pair of Z's. Each of the W's will then decay either to a lepton pair ($W \to l\nu$ or $Z \to l\bar{l}$) or to a quark pair. Since ordinary QCD reactions produce large numbers of events containing jets, even multiple jets, the triggering strategy must make some use of the leptonic decay modes. If both W's of a pair decay leptonically, the two missing neutrinos will make the W's unreconstructable. At the other extreme, the case of two Z's decaying leptonically is easily recognizable by the trigger, but has a very small rate. This case is discussed by Gunion and Soldate[4] in a contribution to these procedings. Of the remaining two possibilities, where one boson decays leptonically and the other hadronically, the case of $H \longrightarrow W^+ + W^-$ has been chosen for detailed investigation because of its substantially higher rate.

From the point of view of the trigger, the desired events are characterized by a lepton (we have specifically taken electrons) and associated missing E_T from one W and by two jets from the other W. The E_T scale for both leptons and jets will be set by typically 1/4 of the mass of the Higgs particle. The suggested trigger strategy is outlined in the following paragraphs.

At the first level of the trigger, it should be possible to recognize an electron candidate by selecting a calorimeter cell having at least 80% electromagnetic energy. The effect of this selection is shown in Fig. 1 which for standard model events plots E_T for all cells and for those cells with at least 80% electromagnetic energy. We also require that the cell have $E_T > 25$ GeV. The remaining cross-section after this selection is $3 \cdot 10^4 nb$. Also in the first trigger level, we require the event to have a missing $p_T > 40$ GeV. We have not simulated this cut with the Monte Carlo program because the fraction of QCD background events surviving it will depend principally on details of the detector resolution such as cracks which are not presently in the program. We estimate that the background will be reduced a

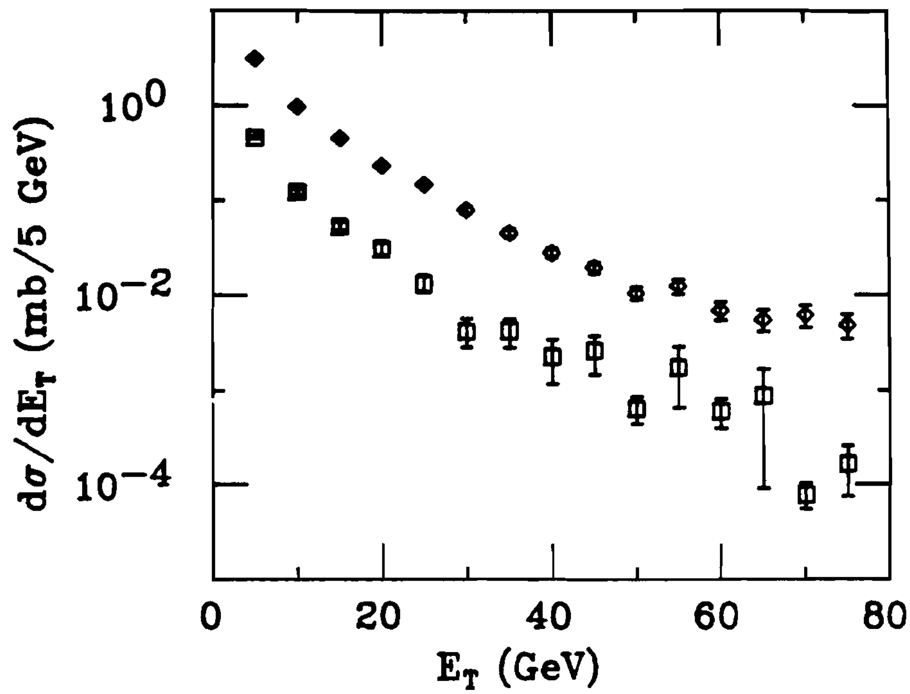

Fig. 1: Transverse energy in QCD events for all calorimeter cells (upper points) and for cells whose energy is at least 80% electromagnetic (lower points)

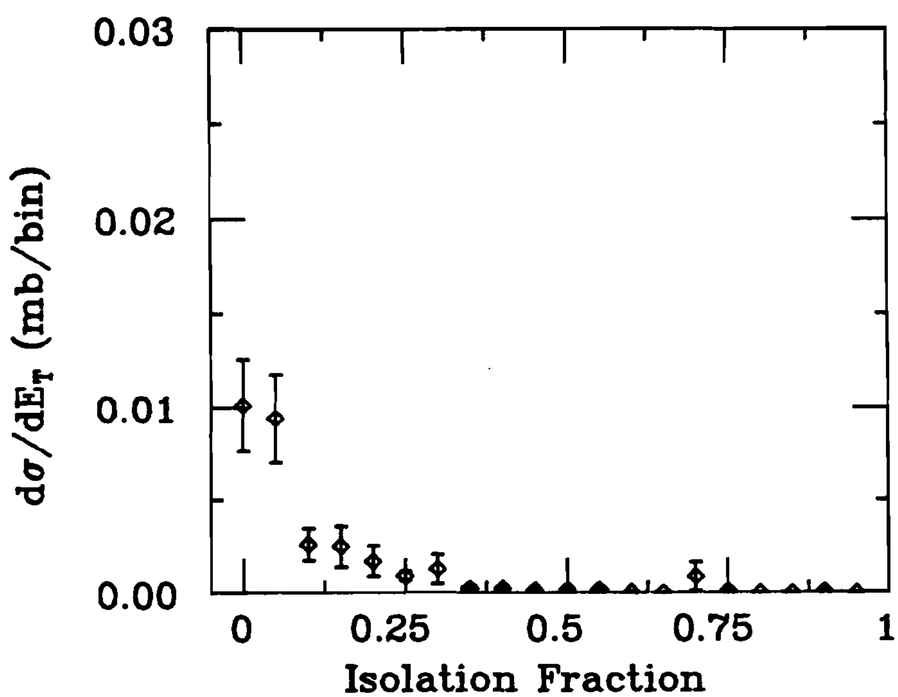

Fig. 2: Ratio of transverse energy in surrounding area to that in electron candidate cell

factor of 4 by this cut, based on an assumed $\sigma_{p_T} = 30$ GeV. The remaining QCD cross-section is then 7500 nb.

At the second trigger level, we impose the requirement that the electron candidate identified at the first level be isolated, as would be expected for an electron arising from a W decay and not from the leptonic decay of a heavy quark in a QCD jet. The specific requirement examines the E_T in a region of ± 5 calorimeter cells in both y and ϕ directions about the cell with the electron candidate and demands that E_T (surround)$< 0.2E_T$ (e candidate). The effect of this cut can be seen in Fig. 2, which plots the ratio E_T (surround)$/E_T$ (e candidate). The cut reduces the accepted cross-section by a factor of 1.3. Also at the second level, we make a requirement that jets be present, indicating the decay of the second W to a pair of quarks. We require either one jet with $E_T > 80$ GeV or two jets each having $E_T > 40$ GeV. Fig. 3 plots the E_T spectrum of the highest E_T jet and second highest E_T jet for events with candidate electrons. Jets are defined as the energy in groups of calorimeter cells with $\Delta y = 0.5$ and $\Delta\phi = 30\,\text{deg}$. The cross-section remaining after the second-level selections is 250 nb.

Finally, for the third level of triggering, we suppose that some results of tracking are available. Since the most likely background source of the calorimeter electron candidate signal is a neutral pion, we will have a much more powerful selection on an electron by requiring a fairly stiff charged track entering the calorimeter cell with the electron candidate. Fig. 4 plots the p_T spectrum for the stiffest charged track entering the electron candidate cell for events which pass the electron candidate cut of the first-level trigger. The p_T cut that can be put on the charged track will depend on the sophistication with which fits to tracking can be done in the time allowed for the third level of triggering. We have chosen a requirement of $p_T > 10$ GeV, which lowers the rate of events with electron candidates by a factor of 300. This cut is found to be somewhat correlated with the second-level isolation cut. When the isolation requirement has already been imposed, this tracking requirement produces an additional factor of 255, resulting in a final remaining accepted cross section of 1.1 nb or a trigger rate of 1.1 Hz at $L = 10^{33} cm^{-2} sec^{-1}$.

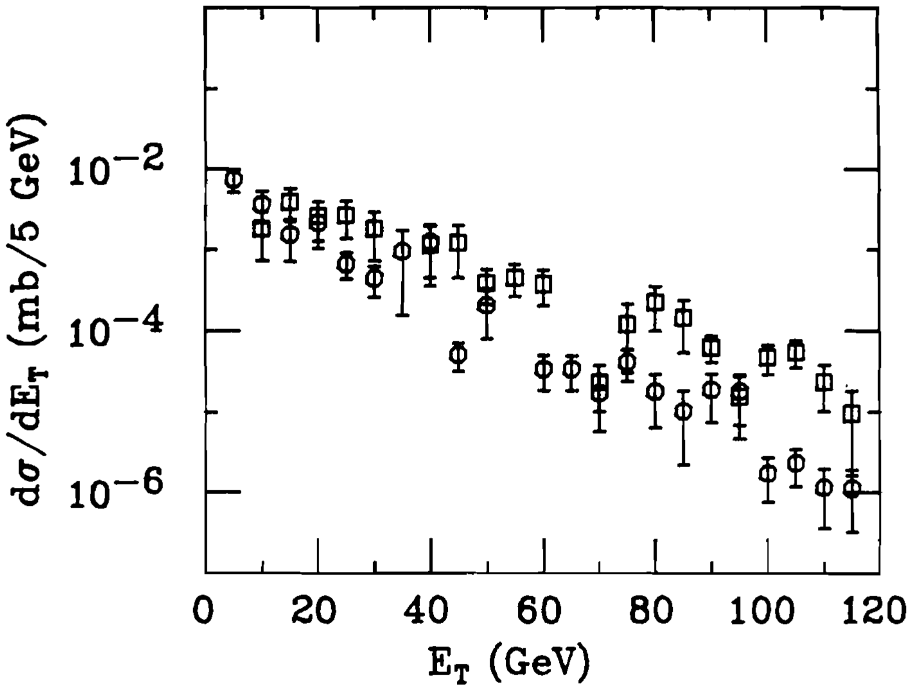

Fig. 3: Transverse energy of highest (squares) and second highest (circles) transverse energy jets in events with electron candidate

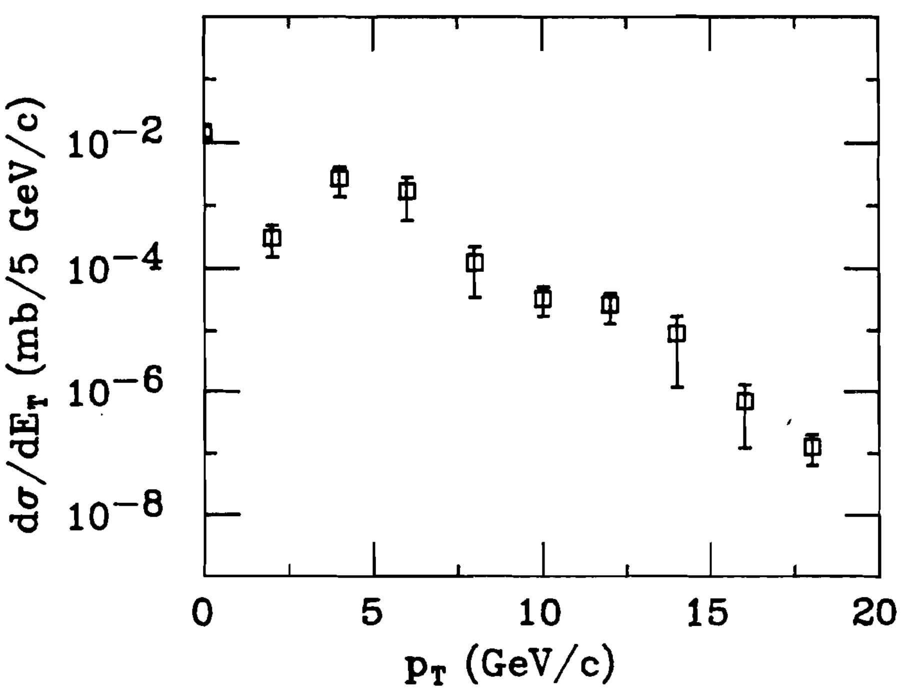

Fig. 4: Transverse momentum of stiffest charged track entering electron candidate cell for events passing level 1a trigger

Table 1 summarizes the trigger selections discussed above for $H \longrightarrow W^+ + W^-$. Efficiencies have been estimated for each of the trigger steps using the WW generator of ISAJET, with a p_T of 100 GeV, corresponding roughly to a Higgs mass of 200 GeV. These efficiencies are also shown in Table 1.

Table 1: Summary of trigger strategy and ISAJET results for $H \longrightarrow W^+ + W^-$. Note that the rejection factors apply to individual cuts while the efficiencies are cumulative.

Trigger Selections	Rejection Factor	Remaining Cross-Section(nb)	$H \longrightarrow WW$ Efficiency
First level:			
a) Select electron candidate as calorimeter cell with $E_T > 25 GeV$ and with at least 80% of the energy electromagnetic	700	$3 \cdot 10^4$	0.86
b) Require $p_T^{miss} > 40$ GeV for the event	4	7500	0.43
Second Level:			
a) Require the electron candidate to be isolated, with a surrounding region of $\pm$ 5 calorimeter cells in both y and ϕ containing less than 20% of the E_T of the electron candidate cell	1.3	5700	0.37
b) Make a jet requirement of either 1 jet having $E_T > 80$ GeV or 2 jets each having $E_T > 40$ GeV	20	290	0.32
Third level:			
Require that tracking show a charged particle with $p_T > 10$ GeV pointing to the candidate electron calorimeter cell	255	1.1	0.32

Missing Energy Trigger

(*Monte Carlo study done by A. Savoy-Navarro and Y. Takaiwa*)

Among the possible first level triggers, the one implying a minimal amount of missing transverse energy in an event is certainly a very rich source of Physics. It allows, in particular, a first filtering of events which could be due to the production and/or decay of Supersymmetric particles and more generally it opens the study of reactions of the following classes:

$$pp \longrightarrow X \longrightarrow \text{"}\nu\text{"} + Y \tag{1}$$

$$pp \longrightarrow X1 + X2 \tag{2}$$

where "ν" is a neutrino or a "neutrino-like" particle (for instance the photino if the photino is the lightest Supersymmetric [SUSY] particle); Y is a particle which will produce one or more leptons and/or additional "ν" or any combination of these three ingredients. X1 and X2 will behave like Y, so also producing missing transverse energy (E_T^{miss}). Finally, the processes (1) and (2) create topologies of events which are characterized by missing transverse energy + lepton(s), missing transverse energy+jet(s), or missing transverse energy+lepton(s)+jet(s). These signatures are satisfied by a rather large field of physics including $W \longrightarrow$ standard leptonic decays, QCD jets, and heavy quarks as well as non-standard physics such as Supersymmetric processes, heavy leptons, other heavy quarks, technicolor etc. The cross-section of the standard processes is in general higher than the non-standard ones, especially when the mass of the expected particles may vary from 100 GeV up to 1 TeV.

Let us assume that the mass of the Supersymmetric particles may lie between 100 GeV and 1 TeV. At the 1984 Snowmass Workshop, a complete set of different SUSY scenarios were studied[5] using events generated by the ISAJET Monte Carlo and a simple simulation of a fine grained calorimeter. The main characteristics of the events obtained in each different case are reported in Table 2. We will use it as a guideline for the discussion on the cuts we may apply at different levels of the trigger. We now develop, as a typical example, the study of a trigger for the reaction:

$$pp \longrightarrow \widetilde{g} + \widetilde{g} \tag{3}$$

where the gluino mass is equal to 100 GeV or 1 TeV and the gluino decays to $q + \overline{q} + \widetilde{\gamma}$.

Table 2: Main characteristics of SUSY events at $\sqrt{s} = 40$ TeV

Process	Masses	$< E_T^{miss} >$	$< E_T^{total} >$	$< \sharp\, jets >$	$< E_T^{fast} >$	$< E_T^{slow} >$
$pp \to \widetilde{g}\widetilde{g}$	$m_{\widetilde{g}} = 100$	47	208	2	87.5	59.4
$\widetilde{g} \to q\overline{q}\widetilde{\gamma}$	$m_{\widetilde{g}} = 1000$	424	1467	4	688	181
$pp \to \widetilde{g}\widetilde{\gamma}$	$m_{\widetilde{g}} = 100$	63.4	99	1	69	66.5
$\widetilde{g} \to q\overline{q}\widetilde{\gamma}$						
$pp \to \widetilde{g}\widetilde{q}$	$m_{\widetilde{g}} = 500$					
$\widetilde{g} \to q\overline{q}\widetilde{\gamma}$	$m_{\widetilde{q}} = 200$	187	557	3	267	109
	$m_{\widetilde{g}} = 200$					
	$m_{\widetilde{q}} = 500$	114	600	4	248	81
$pp \to \widetilde{W}\widetilde{g}$	$m_{\widetilde{W}} = 200$					
$\widetilde{g} \to q\overline{q}\widetilde{\gamma}$	$m_{\widetilde{g}} = 200$	118	303	2	159	87.2
$\widetilde{W} \to e\widetilde{\nu}$	$m_{\widetilde{W}} = 1000$					
$\widetilde{\nu} \to \nu\widetilde{\gamma}$	$m_{\widetilde{g}} = 1000$	534	1373	3	739	265

Among the possible supersymmetric reactions that could be produced by pp collisions, the process of Eqn. 3 is certainly the one with the highest expected rate. The main background that has to be overcome is the one due to the production of gluon pairs where one of the two gluons produces b $\overline{b}$ pairs and then one of the b-quarks decays semi-leptonically.

We have studied in detail the effect of a simple missing energy trigger on events generated according to Eqn. 3 and the corresponding background. We compare what happens in each case if we apply no cut on the missing total transverse energy and successively 50 GeV, 100 GeV and 200 GeV cuts on this quantity. We study in particular the number of events we retain, and how the various values of the threshold may affect the average value of the total missing transverse energy of the highest E_T jet in the event-topology (i.e. the number of jets in the events with $E_T > 50$ GeV). We summarize the results in Table 3.

Table 3: Effects of missing energy cut on the main characteristics of the events

Scenario	Cross-section (nb or pb)	$< E_T^{miss} >$ (GeV)	$< E_T^{fast\ jet} >$ (GeV)	$< \sharp jets >$
$pp \to \tilde{g}\tilde{g}$ ($m_{\tilde{g}} = 100$ GeV)				
All E_T^{miss}	26 nb	85	230	2.3
$E_T^{miss} > 50$ GeV	17	113	244	2.4
$E_T^{miss} > 100$ GeV	8.2	153	261	3.3
$E_T^{miss} > 200$ GeV	1.0	270	343	4.1
$pp \to \tilde{g}\tilde{g}$ ($m_{\tilde{g}} = 1$ TeV)				
All E_T^{miss}	22 pb	421	756	5.8
$E_T^{miss} > 50$ GeV	22	424	756	5.8
$E_T^{miss} > 100$ GeV	21	438	760	5.8
$E_T^{miss} > 200$ GeV	18	488	763	5.8
$pp \to u, d, s, g$				
All E_T^{miss}	10 μb	27	73	2.1
$E_T^{miss} > 50$ GeV	1.0	70	78	1.8
$E_T^{miss} > 100$ GeV	51 nb	121	170	2.5
$E_T^{miss} > 200$ GeV	0.6	238	339	6.0

We now discuss the results in Table 3 for each gluino mass separately. If the gluino mass is around 100 GeV, the characteristics of the signal (average missing energy, transverse energy of the trigger jet, jet-topology of the event) (Fig 5 a,b,c) are rather similar to those of the QCD background (Fig 6 a,b,c), even when vary-

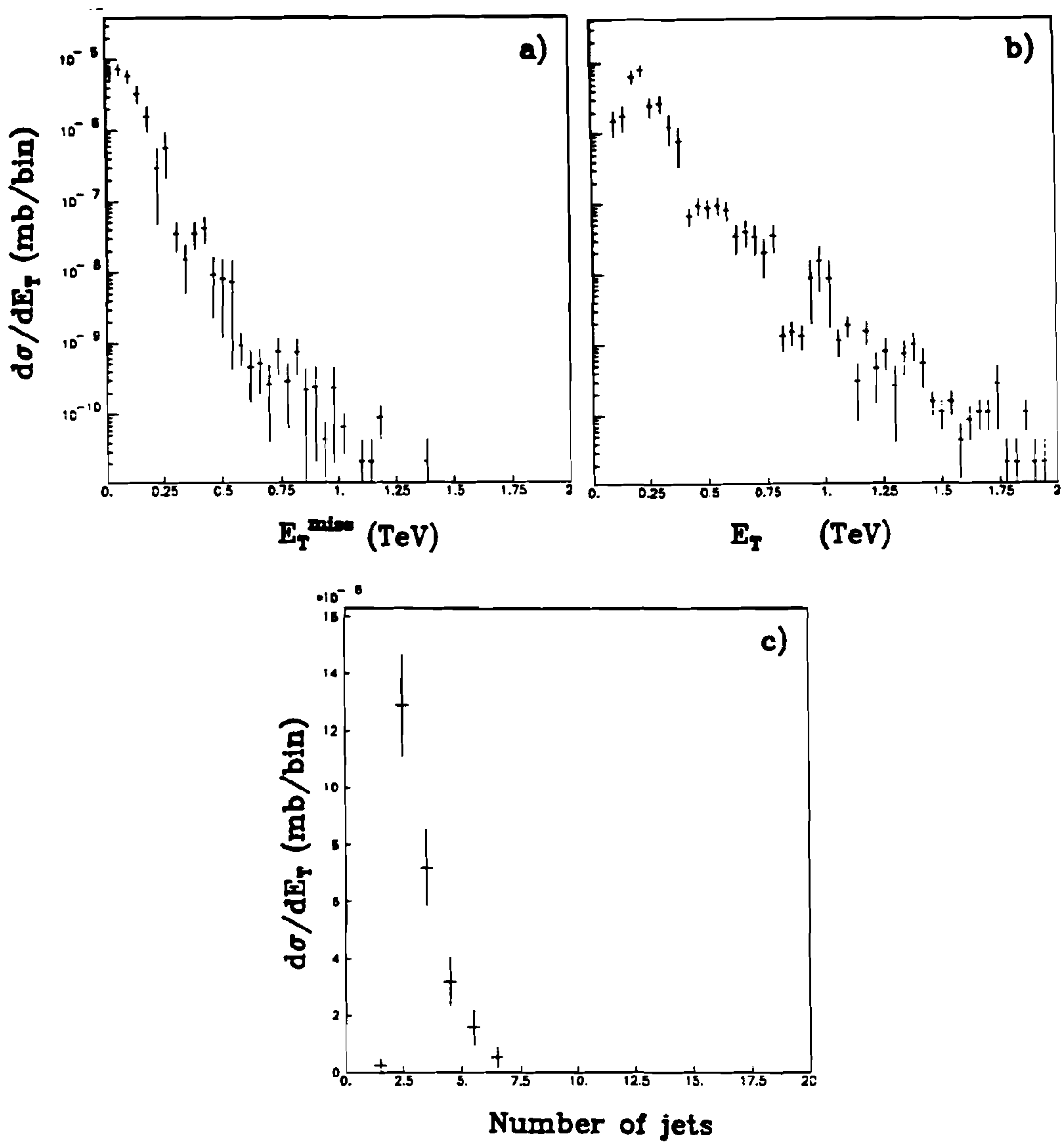

Fig. 5: Characteristics of gluino (mass 100 GeV) pair production: a) missing E_T spectrum; b) E_T spectrum of trigger jet; c) distribution of number of jets

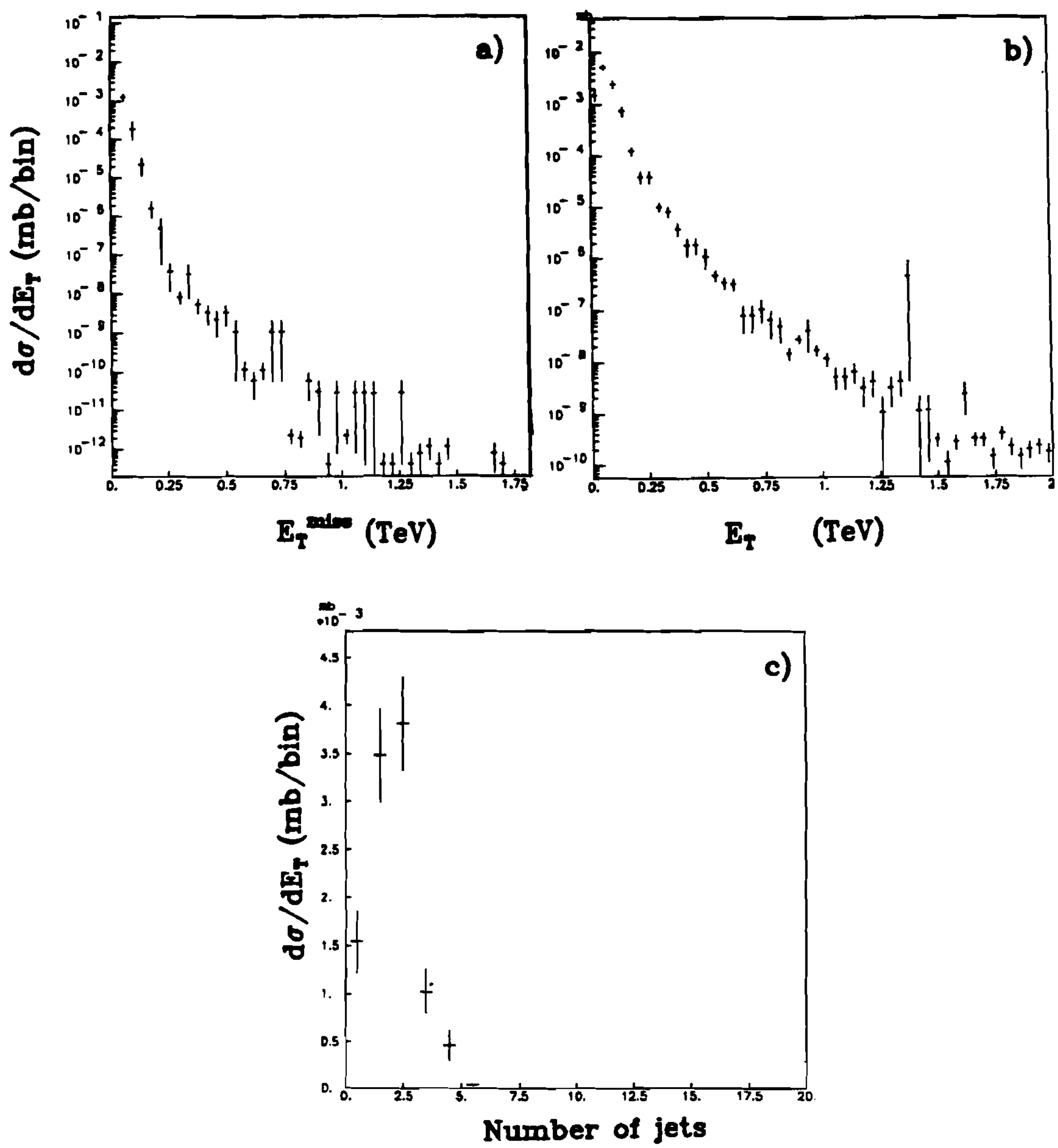

Fig. 6: Characteristics of QCD background events: a) missing E_T spectrum; b) E_T spectrum of trigger jet; c) distribution of number of jets

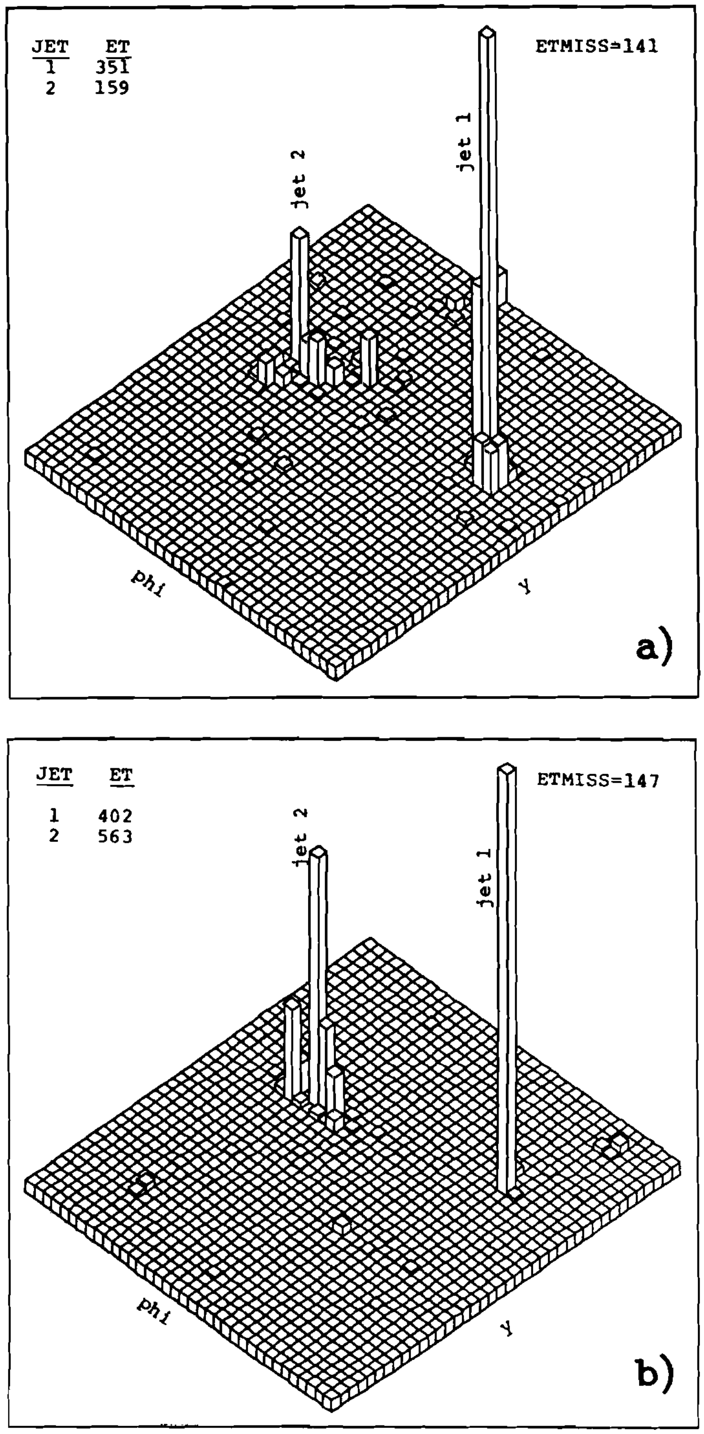

Fig. 7: Lego plots of typical events for a) gluino pair production and b) QCD background. Each plot shows the E_T values for each jet and missing E_T for the event

ing the threshold on the missing transverse energy from 0 to 200 GeV. This fact essentially says that the light constituent background tends to mimic pretty well the SUSY signal (Fig. 7 shows typical events). Another important remark is that the ratio of signal to background (S/B) increases from 10^{-3} to 1 as we vary the cut on the missing energy from 0 to 200 GeV. Finally, if we look at the absolute value of the rate of background due to QCD jets, we have 1 μb when we apply a cut of only 50 GeV; this corresponds to a trigger rate of 1000 Hz if we require this condition for the first level trigger. It is far too high for the final trigger and we need to go to a cut of 100 GeV, at least, if we want to remain at the level of 50 to 100 Hz for the second level trigger rate; in this case S/B is of the order of 12%. Alternatively, we could apply a higher cut on E_T^{miss} in order to enhance already at the first level trigger the ratio S/B. If, for instance we apply a cut at 200 GeV we will get a trigger rate of few Hz and a ratio S/B of about 1. But now, if we consider the results listed in Table 2, in particular for the low mass range case, we note that this cut on E_T^{miss} would kill also most of the other interesting SUSY signatures. We think then, that for relatively low mass particles, it is better to apply a cut at 100 GeV in the missing energy spectra and to enhance the signal at the second or even the third level trigger (see later).

If the gluino mass is around 1 TeV, the main remark is that the ratio S/B is tremendously small: it varies between $2.2 \cdot 10^{-6}$ to $3 \cdot 10^{-2}$ according to the value of the cut applied on the missing transverse energy (from 0 to 200 GeV). We note also that the characteristics of the events are rather different (see Table 3 and Fig. 8). So we have to apply a relatively high cut on E_T^{miss} to get a ratio S/B not too ridiculously small. In addition, if the cut on E_T^{miss} varies from 100 GeV to 200 GeV, the rate of the signal remains almost constant (21 to 18 pb) whereas the background rate falls by about a factor 100 (51 nb to 0.6 nb). We summarize the results of this discussion of a first level trigger based simply on a cut in missing energy in Table 4.

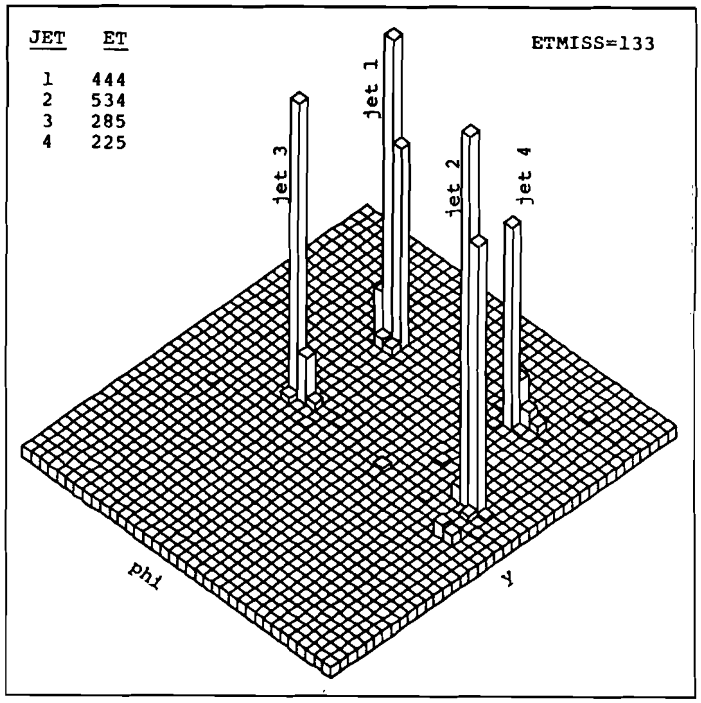

Fig. 8: Lego plot of a gluino (mass 1 TeV) pair production event

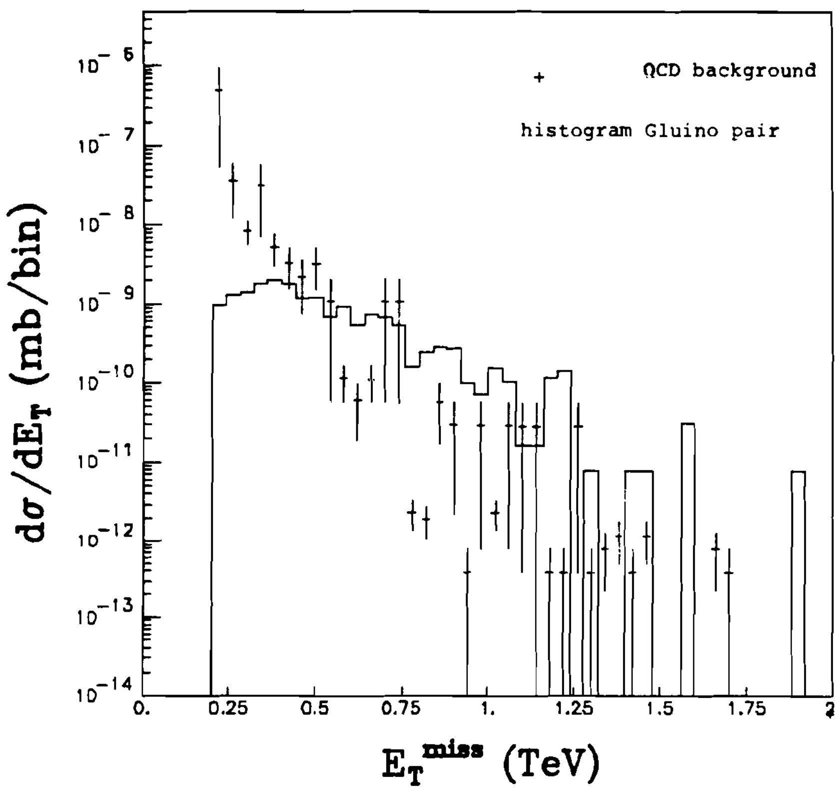

Fig. 9: Missing E_T distribution for gluino(mass 1 TeV) pair production (histogram) and QCD background (points)

Table 4: Main results for the E_T^{miss} trigger. Rates include both signal and background processes.

Process	E_T^{miss} threshold (GeV)	Total Cross Section (nb)	S/B
$pp \to \tilde{g}\tilde{g}$	50	O(1000)	$2.6 \cdot 10^{-3}$
$m_{\tilde{g}} = 100$ GeV	100	O(50-100)	0.12
	200	O(few)	1
$pp \to \tilde{g}\tilde{g}$	50	O(1000)	$2.2 \cdot 10^{-5}$
$m_{\tilde{g}} = 1$ TeV	100	O(50-100)	$0.4 \cdot 10^{-3}$
	200	O(few)	$3 \cdot 10^{-2}$

The conclusions are quite clear when looking at Table 4 and can be summarized as follows: For the first level trigger, a 50 GeV cut is attractive for E_T^{miss} because it preserves good efficiency all the way down to a gluino mass of 100 GeV while apparently producing a manageable rate for the second-level trigger to handle. As discussed above, however, for E_T^{miss} cuts in this range, we expect the measured value of E_T^{miss} to be dominated by instrumental resolution, so that in fact it is not reasonable to expect nearly such a low rate. Thus for the first level trigger, we believe that the right choice is to select $E_T^{miss} > 100$ GeV, and then to expect a remaining cross section of around 1000 nb. As seen in Table 3, this cut alone reduces the efficiency for detecting gluino pairs to about 30% when the gluino mass is 100 GeV. Since that is the lower end of the region of interest at the SSC, and much more efficiency is preserved at higher masses, we feel that $E_T^{miss} > 100$ GeV is the appropriate choice.

As in the case of $H \to WW$ discussed above, at the second trigger level it is appropriate to make a requirement on jets in the event. We have not had time to explore the jet requirement specifically for the SUSY investigation, but expect that it would have an effect on the surviving trigger rate comparable to what it produced earlier: around a factor of 20. The remaining cross-section after the second level would then be 50 nb. There is also an alternate sequence of cuts possible, namely using the jet cut as part of the first level trigger so that the E_T^{miss} cut can be set at 75 GeV, preserving greater efficiency for the lowest mass range. We leave this possibility unexplored for the moment, as we do not have numbers to present.

Also at the second level trigger, we propose to use a technique that was developed during the Snowmass meeting[5] of 1984. Let us explain it in the case which is the worst for the present example, namely when the mass of the gluino is 1 TeV. We notice from Table 3 and Fig. 9 that even applying a cut at 200 GeV on E_T^{miss}, the ratio S/B still remains at a value of $3 \cdot 10^{-2}$, rather small. If now we take the projected value (x_e) of the missing energy on the axis of the highest E_T jet in the event (i.e. the trigger jet) and the projected value (x_{out}) of the missing energy on the axis perpendicular to the axis of the trigger jet, we can find a reasonable optimization of the value of the cuts to be applied to the variables (x_e,x_{out}), namely, $x_e > 0.25$ and $x_{out} > 0.08$ (see Fig. 10 and Ref. 5), so that the ratio S/B increases to 10/1 (the signal remains at $5.4 \cdot 10^{-9}$ mb whereas the background drops to $2 \cdot 10^{-10}$ mb). In addition, the efficiency of such a "trigger" for the signal is 25%. So by applying this (x_e,x_{out}) technique, we still get 1/4 of the signal with the background really killed. Since it is not necessary to reduce the rate quite so low for triggering purposes, a somewhat lighter cut might be appropriate for the trigger, with the remainder left for analysis. This approach allows the background to be studied at the analysis stage.

We note that at the second level we have in a sense chosen to work with the same parameter as at the first level, namely the missing transverse energy, since x_e and x_{out} constitute an elaboration of the definition of E_T^{miss}. However, other methods can be used for the second and the third level trigger or added to the (x_e,x_{out}) recipe in order to enhance the signal. They imply mixing some of the main properties of the different types of signatures we want to study. Thus we could require some lepton recognition such as a muon or an electron requirement. These additional requirements will be useful for filtering and tagging events, e.g., for express-line or perhaps even on-line analysis.

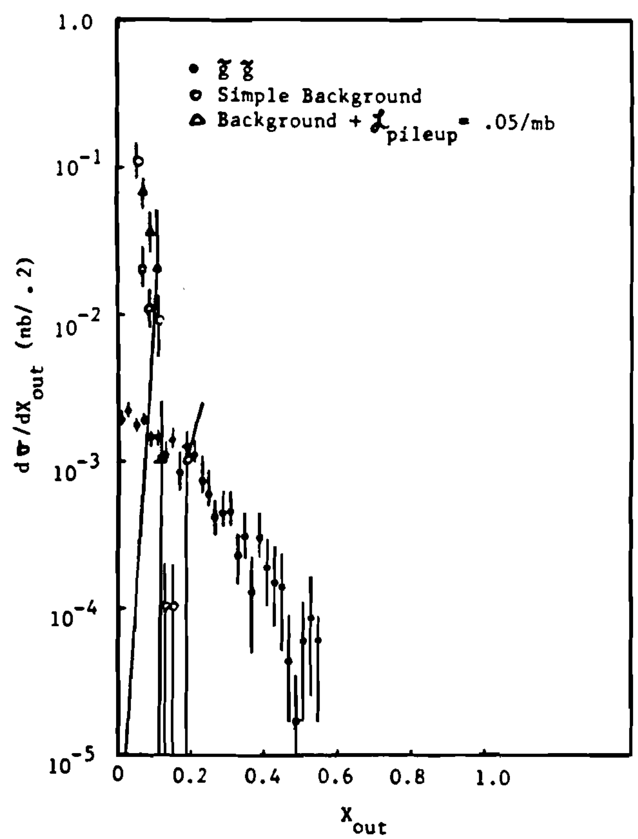

Fig. 10: x_{out} distribution

Summary

For the two examples considered we have found achievable sequences of trigger requirements that result in a final trigger rate of 1 Hz or below, while preserving a reasonable fraction of the suggested new physics in the data sample. While it will be important to repeat this exercise for the whole range of physics to be investigated with the new machine, this beginning already offers assurance that the unprecedented interaction rate does not render triggering unmanageable.

Several simplifications have been made in these calculations which should be removed as further work is done on simulating triggering for the SSC. Of primary importance among these future improvements is a realistic simulation of the detector. For the processes discussed here, the simulation of p_T^{miss} is particularly crucial, involving a detailed understanding of realistic calorimeter cracks and other contributions to calorimeter resolution. Electron identification and the separation of electromagnetic and hadronic energy are also important. The detector simulation will naturally become increasingly credible as detectors are outlined and then designed for the purpose, but initially the parameters of a realistic detector can be drawn from CERN and FNAL collider detectors. The effect of overlapping events in the various detector elements should also be examined in more detail.

Acknowledgement

The working group would like to thank Jean Rhoades for her extensive efforts to bring up a new version of ISAJET at FNAL during the workshop and to assist us in using it on both the CYBER and VAX computers.

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