Analysis Plans for Jets + EtMiss Signatures

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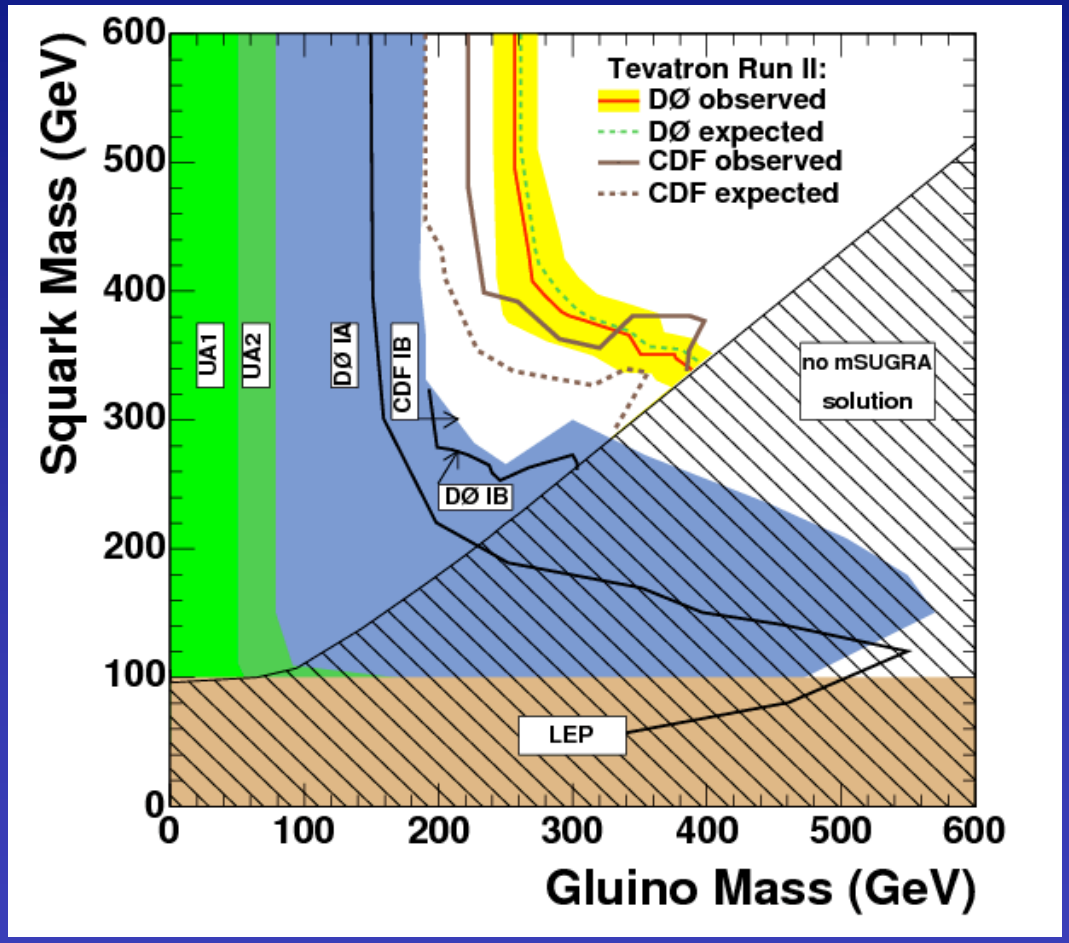
Outline

- History and Motivation
- Strategy
- Monojet Analysis on CDF
- Dijet Analysis on CDF
- ATLAS Analysis
  - Work done by Cristen et al
  - Differences between CDF and ATLAS analyses
- Future Plans

History and Motivation

- Result of after dinner discussions in 2004 aimed at answering two questions:
  - What have we not looked at with CDF data?
    - We have not looked at jets + missing energy with 1,2 jets
  - What physics do you want to do when LHC starts?
    - Dark Matter search, Resonances
  - So: do the CDF analyses, gain experience and apply it to ATLAS

mSUGRA Exclusion Plot



Strategy

- Start with simplest signature (1-jet) first, then move on to 2 jets, etc.
- Do a (mostly) model-independent search for all signatures. Why?:
  - Because we do not really believe any of the models that are out there. They are probably wrong, or just oversimplified.
  - Because we want to stay away from the model that is the flavour of the month. In the next few years interesting new ideas will be proposed and we should not always wait for theorists to tell us what to do
- Try to make the analysis as robust as possible by using data-driven background calculations.

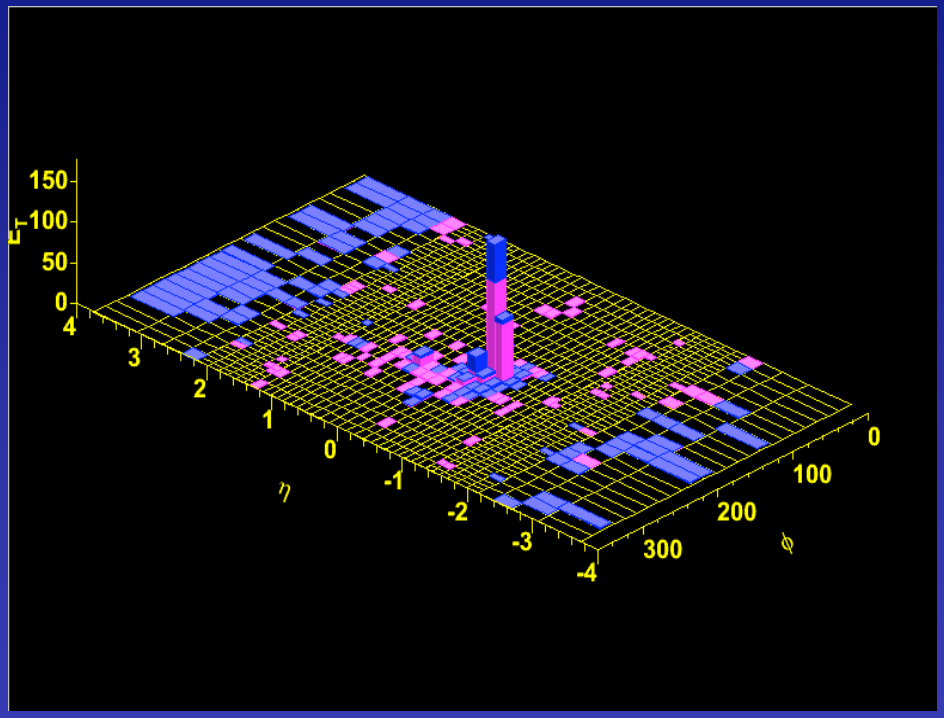
Monojet + missing Et Search

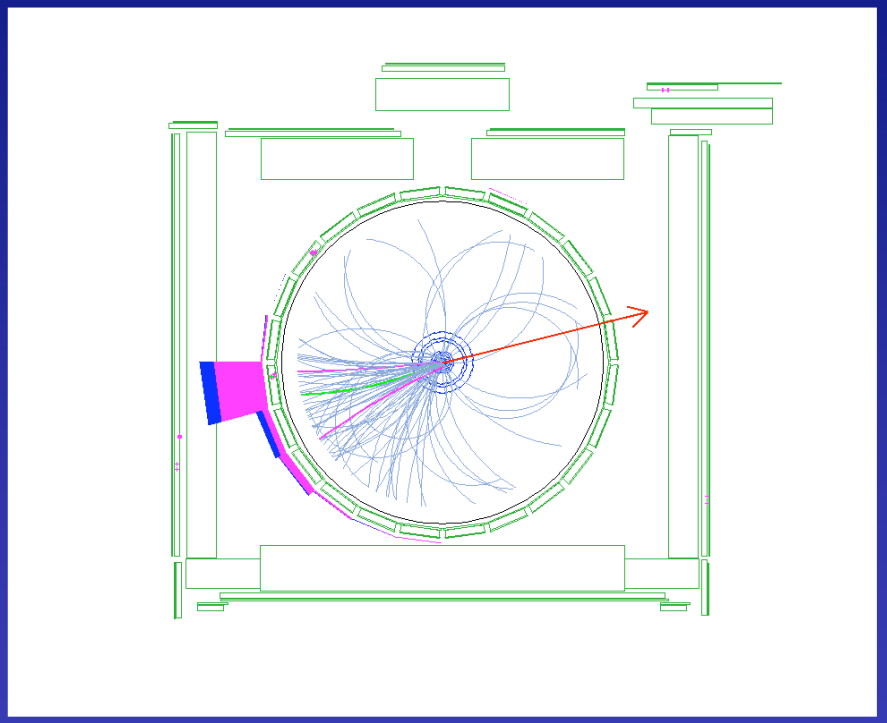
- Data sample of ~1.1 fb^{-1} collected using a jet trigger with a threshold of 100 GeV E_T
- The most important backgrounds are:
  - Electroweak:
    - 1-jet + $Z \rightarrow \nu\nu$
    - $W \rightarrow \ell\nu$: ℓ not identified (τ expected to be largest background)
  - QCD (badly measured jets) $\rightarrow$ expected to be small for the cuts we intend to use (next slide)

Monojet Event Selections

- The leading jet must have E_T(corr) > 150 GeV to ensure that the trigger is fully efficient;
- Large missing energy is expected from the escaping particle (missing transverse energy > 120 GeV);
- A 2nd jet of lower energy (E_T(2) < 60 GeV) is tolerated to increase the acceptance (ISR/FSR)
- To remove the charged lepton of W + jets events, we require no isolated tracks with P_T > 10 GeV/c and an Em fraction < 0.9
- To reduce QCD bkg, the MET must not be in the same azimuthal direction (ϕ) as any of the jets.

Example of Signature (most energetic event)

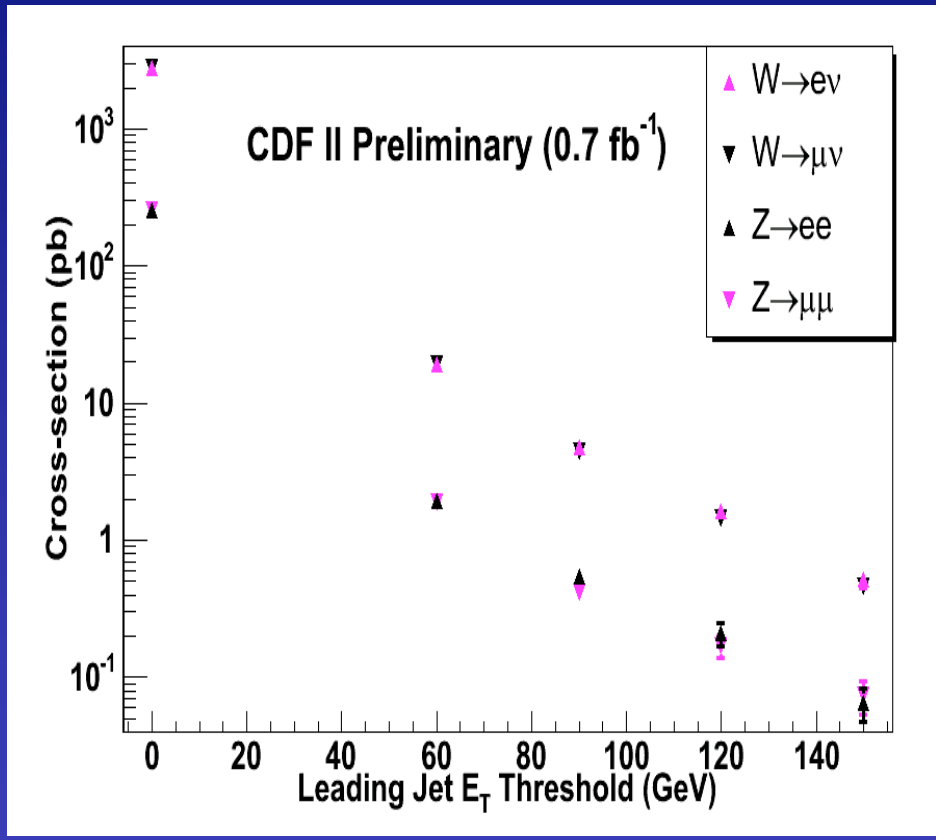




Jet E_T = 419 GeV, Missing E_T = 417 GeV

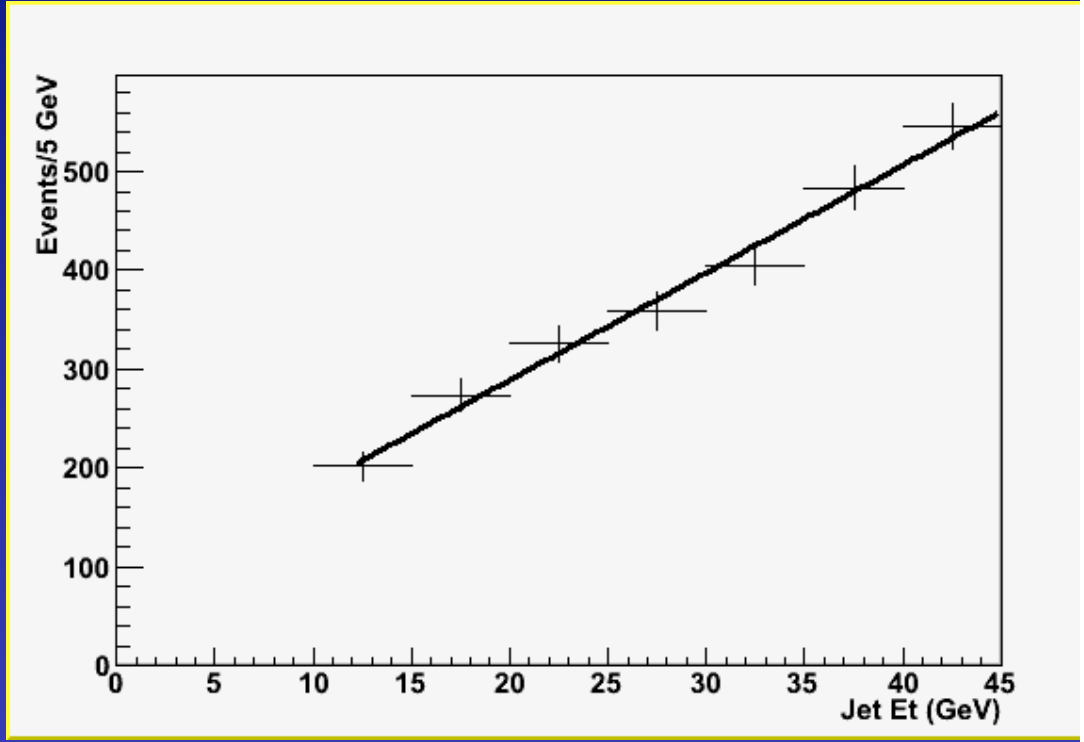
Electroweak Background Calculation

- To make a data-driven estimate of $Z \rightarrow \nu\nu$, $W \rightarrow \ell\nu$:
  - 1-jet+W/Z ($Z \rightarrow \ell\ell$, $W \rightarrow \ell\nu$, ℓ = e, μ) cross sections are measured with sample of identified leptons
  - W cross sections normalized to Z cross sections using theoretically robust ratio between $W \rightarrow \ell\nu$ and $Z \rightarrow \ell\ell$ cross sections.
  - $\sigma(Z \rightarrow \nu\nu + \text{jets}) = 6 \times \sigma(Z \rightarrow ll + \text{jets})$
    $\sigma(Z \rightarrow \nu\nu + \text{jets}) = 6 \times \sigma(W \rightarrow l\nu + \text{jets}) / R_{W/Z}$
  - Use simulation to estimate acceptance of missed lepton in $W \rightarrow \ell\nu$ (ℓ = e, μ, τ)



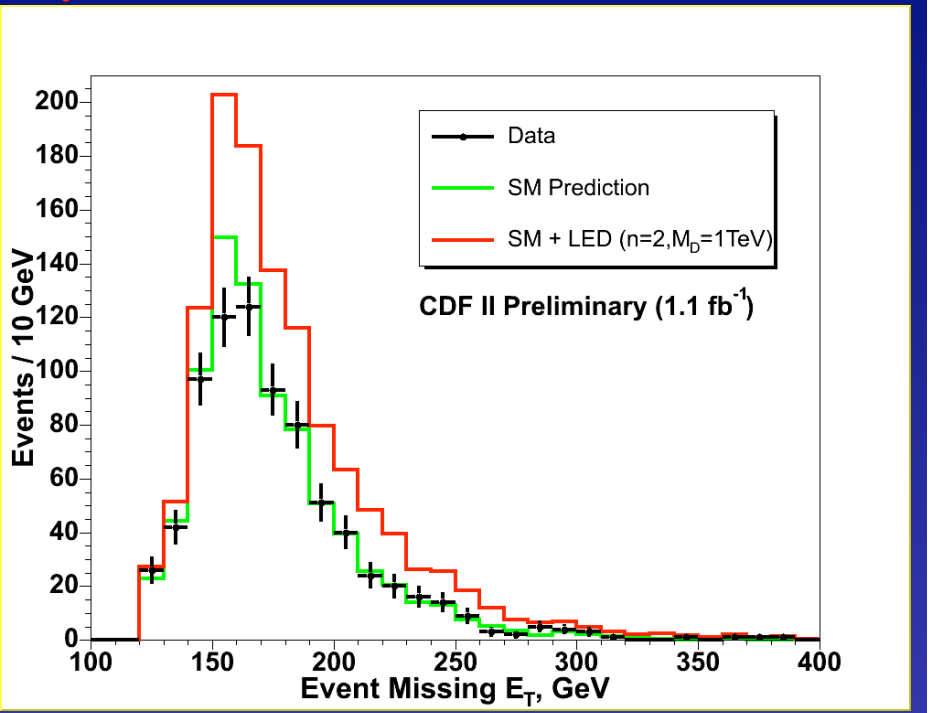
QCD Background Calculation

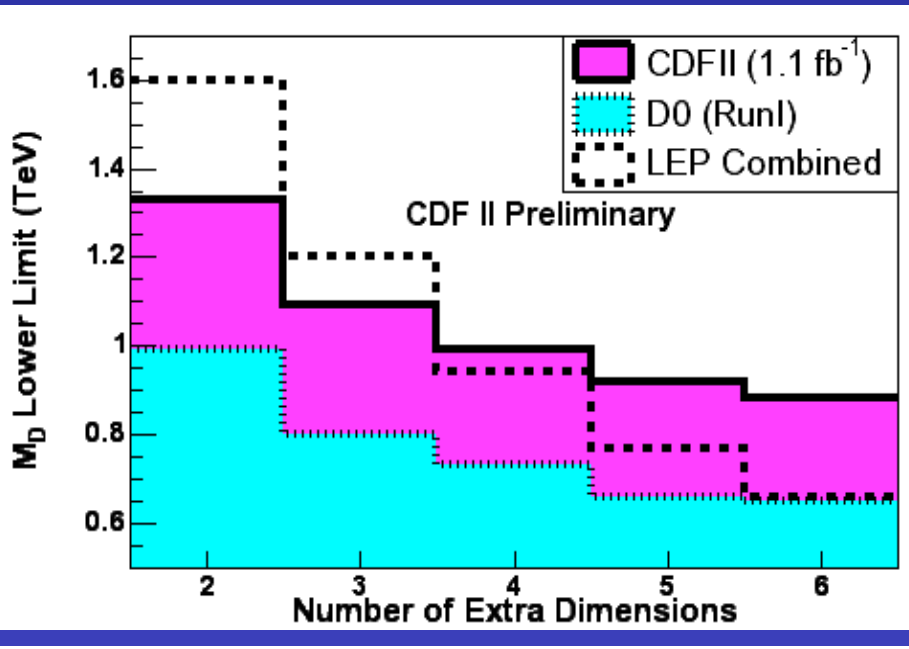
- Select data events where MET is within $\Delta\phi = 0.3$ of the lower E_T jet (reverse $\Delta\phi$ cut)
- Extrapolate to obtain number of events for which 2nd jet falls below $E_T > 20$ GeV threshold
- Estimate using MC fraction of events where 2 jets contribute to MET and we lose on of them: ~15%



Monojet Results, ADD Limits

Background	Expected Events
$Z \rightarrow \nu\nu$	398 ± 30
$W \rightarrow \tau\nu$	192 ± 20
$W \rightarrow \mu\nu$	119 ± 12
$W \rightarrow e\nu$	58 ± 6
$Z \rightarrow ll$	7 ± 1
QCD	39 ± 14
Non-Collision	6 ± 6
Total Predicted	819 ± 71
Data Observed	779





n	M_D (TeV/c^2) (K=1.3)	R(mm)
2	> 1.33	< 0.27
3	> 1.09	$< 3.1 \times 10^{-6}$
4	> 0.99	$< 9.9 \times 10^{-9}$
5	> 0.92	$< 3.2 \times 10^{-10}$
6	> 0.88	$< 3.1 \times 10^{-11}$

Dijet + Missing Et

- Most of the work already done in 1 jet analysis
- Electroweak backgrounds calculated the same way except that we need to calculate ratio "R" with two jets (calculate R as a function of invariant mass)
- QCD background: complexity of data-driven method increases with number of jets…

ATLAS Analysis

- Porting of simplified version of monojet analysis code and first checks and studies done by Cristen last year
- QCD background studies started by Ben Rifkind (NSERC student) last Summer
- Pier-Olivier (who did this on CDF) will soon get started on dijet + Etmiss analysis and extend to multijet case

Differences with CDF Analysis

- QCD background:
  - QCD/EWK cross sections larger at LHC :(
  - Better, more hermetic calorimeter :) but…
  - ttbar background is now huge for multijets :(
- EWK backgrounds:
  - Top background to W+jets affects our ability to use R! :(Need to find way to remove top from W+jets (?!?!!)

Plans

- Discussed short-term plans with SUSY conveners:
  - Contribute to CSC notes, focus on jets+Etmiss, no-lepton. Perhaps:
    - Find a way of using R by doing top reconstruction
    - Contribute to QCD estimate
    - Find more data-driven calculation for W->$\tau\nu$
  - Continue previous work on analysis software for background calculations and get ready to study first jets, Etmiss distributions (with Cristen, P-O, Summer student, anybody else? Get organized as a group?)
- Setup the computer and storage that will allow us to do this…