SUSY Searches at the TEVATRON

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Why Supersymmetry?

The Standard Model (SM) of particle physics is theoretically incomplete – there are many questions it cannot answer, and many aspects which are *ad hoc*.

We believe there is a better theory which rectifies at least some of the deficiencies of the SM, and which will also predict phenomena beyond the SM (BSM).

Probably the best candidate for the correct theory BSM is Supersymmetry (SUSY), though other very different theories are interesting and deserve attention. Today, however, SUSY!

There are many motivations for the theory of Supersymmetry, and there are reasons why it is so popular among speculations.

Motivation 1: Extend the Poincaré Group

We would like to unify all the forces of Nature, including gravity.

Spin-1 (gauge) bosons and spin-2 bosons (gravity) cannot be placed in the same representation, in general.

The only exception is: SUPERSYMMETRY.

If ***Q*** is a generator of SUSY algebra, then by definition

$$Q\ |fermion> \ = |boson> \qquad \text{and} \qquad Q\ |boson> \ = |fermion>$$

This allows the sequence

$$spin\,2 \ \rightarrow\ spin\,3/2 \ \rightarrow\ spin\,1 \ \rightarrow\ spin\,1/2 \ \rightarrow\ spin\,0$$

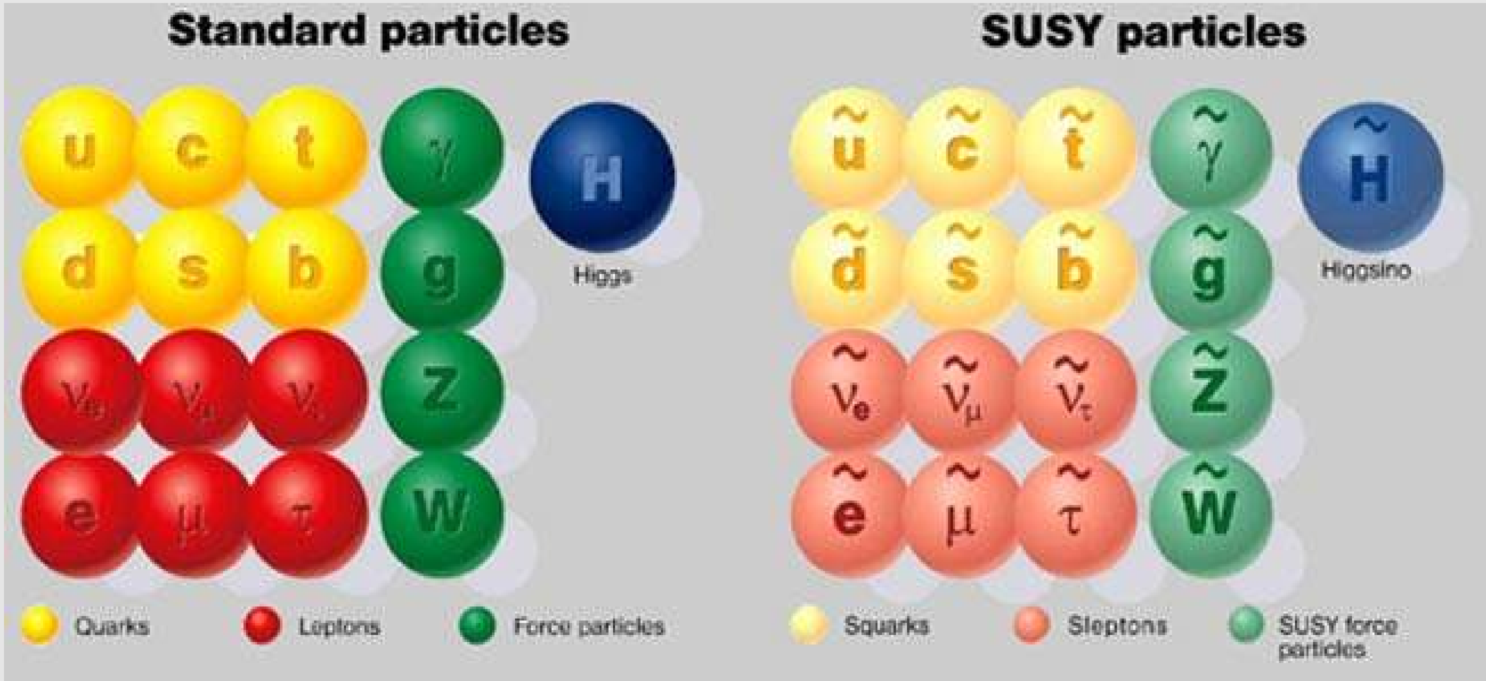
which shows that unification with gravity implies boson/fermion symmetry.

Taking infinitesimal transformations based on Q_α, and demanding that they be local, requires a theory like General Relativity.

This makes Supersymmetry mathematically unique, and valuable.

Finally, one should note that String Theories require Supersymmetry.

The particle mirror



For every SM fermion (the matter particles), there is a SUSY boson (spin-0).

For every SM boson (the force carriers), there is a SUSY fermion (spin-1/2).

SM and SUSY particles are distinguished by a new quantum number:

R-parity = +1 for SM particles
= −1 for SUSY particles
→ *prevents mixing among them, and the lightest SUSY particle ("LSP") is stable.*

We will assume that R-parity is exactly conserved.

sparticle mixing

SUSY particles mix to form mass states,
when not forbidden by some symmetry (conservation rule).

This has a major impact on the phenomenology.

Winos and charged Higgsinos mix to give two chargino states: $\widetilde{W}^{\pm}, \widetilde{H}^{\pm} \rightarrow \tilde{\chi}_i^{\pm}$

Zinos, photinos and neutral Higgsinos give four neutralino states: $\widetilde{Z}, \tilde{\gamma}, \widetilde{H}^0 \rightarrow \tilde{\chi}_i^0$

Flavor eigenstates mix to form mass eigenstates.
A particularly important case is the "stop" squark – the scalar partner of the top quark.
The left and right chiral states of the top quark have scalar partners which mix.
Due to the structure of the mixing matrix, this mixing may be large, resulting in a large splitting between the mass eigenstates.

$$\tilde{t}_L, \tilde{t}_R \rightarrow \tilde{t}_1, \tilde{t}_2$$

Paradoxically, the SUSY partner of the heaviest SM fermion could well be the lightest SUSY particle, aside from the neutralino (LSP).

Motivation 2: Dark Matter Candidate

The lightest supersymmetric particle (LSP), typically is neutral and interacts only weakly with matter. Of course it has mass, too...

If this LSP is stable (which has to be postulated) then there will be relic particles left over from the big bang.

It turns out that the density and mass of the LSP today easily matches that of dark matter!

There are a number of scenarios which have been carefully explored and calculated, which lead to a variety of related observations in colliders – should SUSY be the correct theory BSM!

Collider experiments will literally produce dark matter directly, if this speculation is correct and the colliders have enough energy.

** However, it may take the ILC to verify that the LSP can account for observed DM densities...*

Motivation 3: Unification of Forces

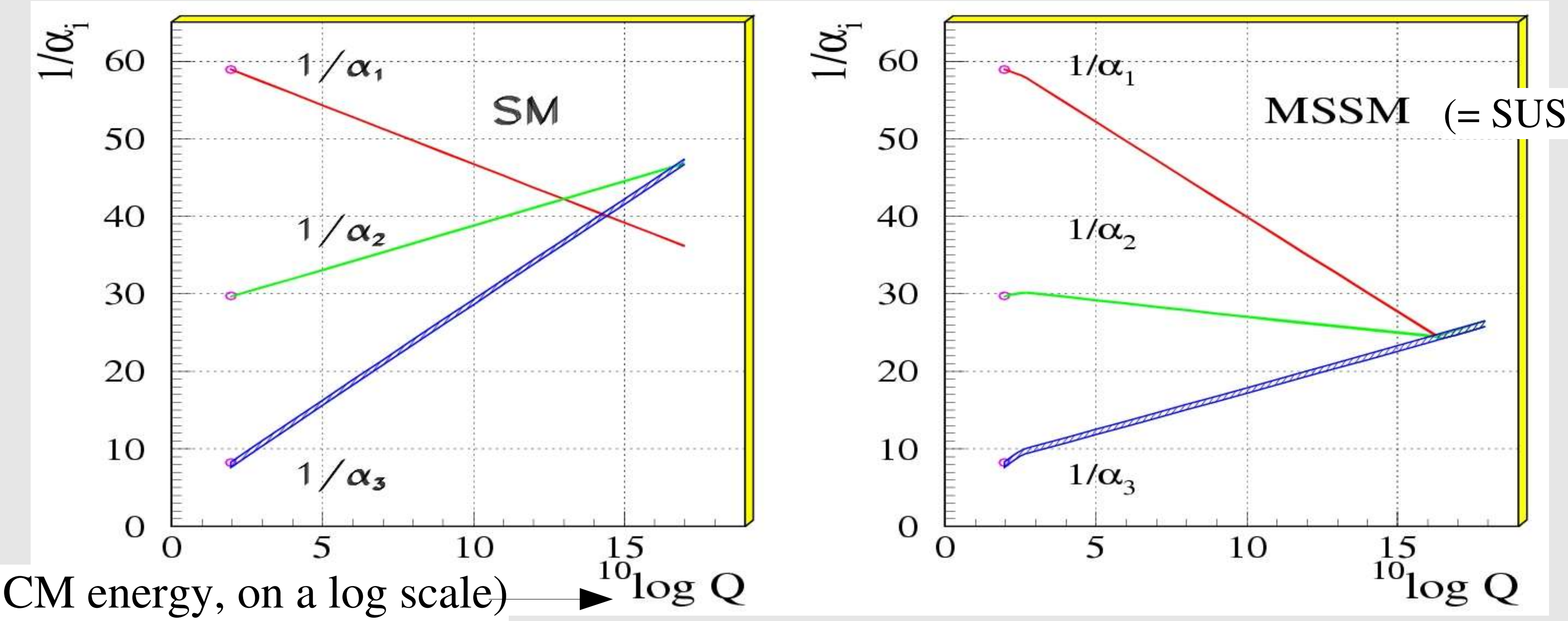
Unifying the known four forces has always been a goal – a paradigm – of particle physics. (These are the famous “GUTs”)

“Unifying” means that there is a mass scale (or interaction energy) at which the electromagnetic, weak, and strong interactions have the same strength.

(Gravity is left out of the picture most of the time.)

The way the forces change with energy is well known from precision measurements. The extrapolation to high energies depends on the particle content.

In the SM, the three forces do not unify at a common point.
In SUSY, they do!



(= SUSY)

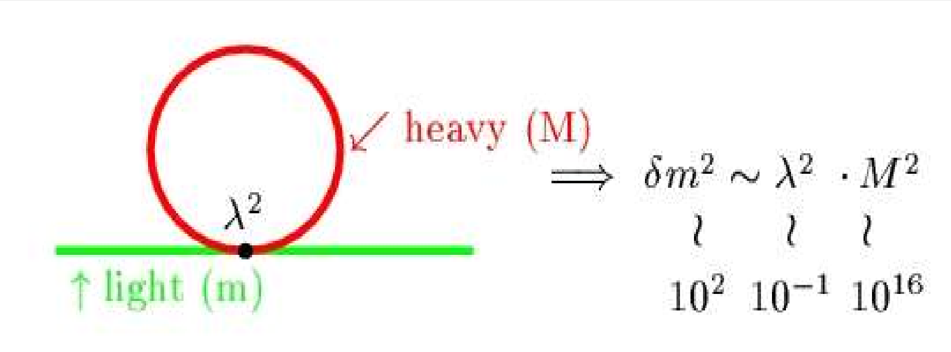
(mass, or CM energy, on a log scale) →

Motivation 4: Taming Higgs UV Divergence (also known as the “Hierarchy Problem”)

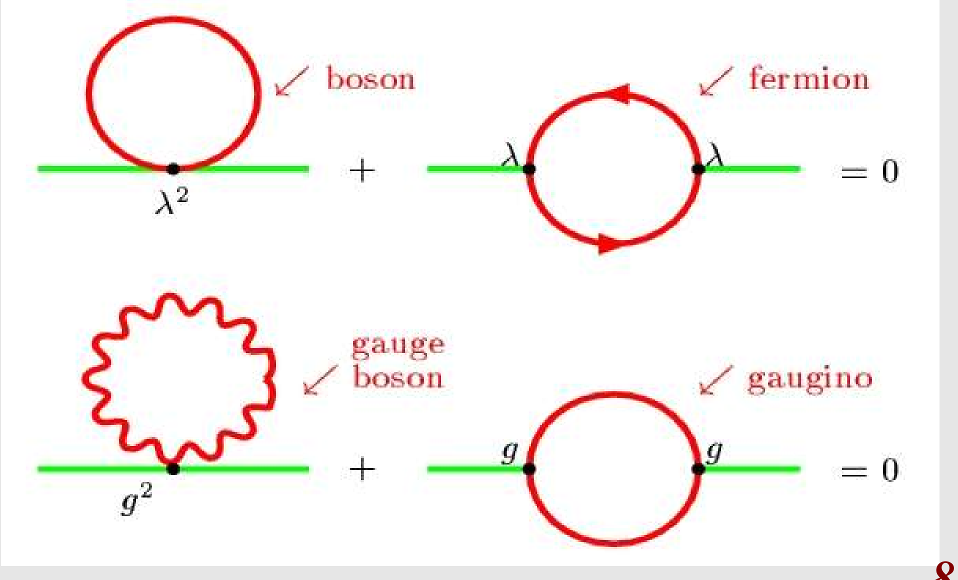
The Higgs mechanism provides an explanation for the masses of the gauge bosons (via “Electroweak Symmetry Breaking” - EWSB), and hence is a fundamental feature – and success – of the SM.

hep-ph/0012288

Unfortunately, if you calculate radiative corrections to the Higgs mass, you obtain divergent contributions which are many orders of magnitude larger (e.g., 10^{17} GeV) than the mass needed to provide EWSB (around 10^{2} GeV), and in the SM there is no good way to cure this.



It turns out that SUSY naturally solves this problem, since the boson contributions have opposite sign to the fermion contributions. Due to the symmetry between bosons and fermions, the sum of all contributions is strictly limited!



(“Little Higgs” models and models with extra dimensions also solve this problem.)

Why Colliders?

The symmetry between SM particles and their SUSY partners clearly is not maintained (otherwise we would have a light selectron, *etc.*, *etc.*)

It is fair to assume that sparticles must be heavy.
So, in order to observe and study them, we need high-energy collisions.

Hadron colliders provide the highest C.M. energies anywhere on earth. The **TEVATRON** collides proton and anti-proton beams of energy nearly 1 TeV = 1000 GeV.

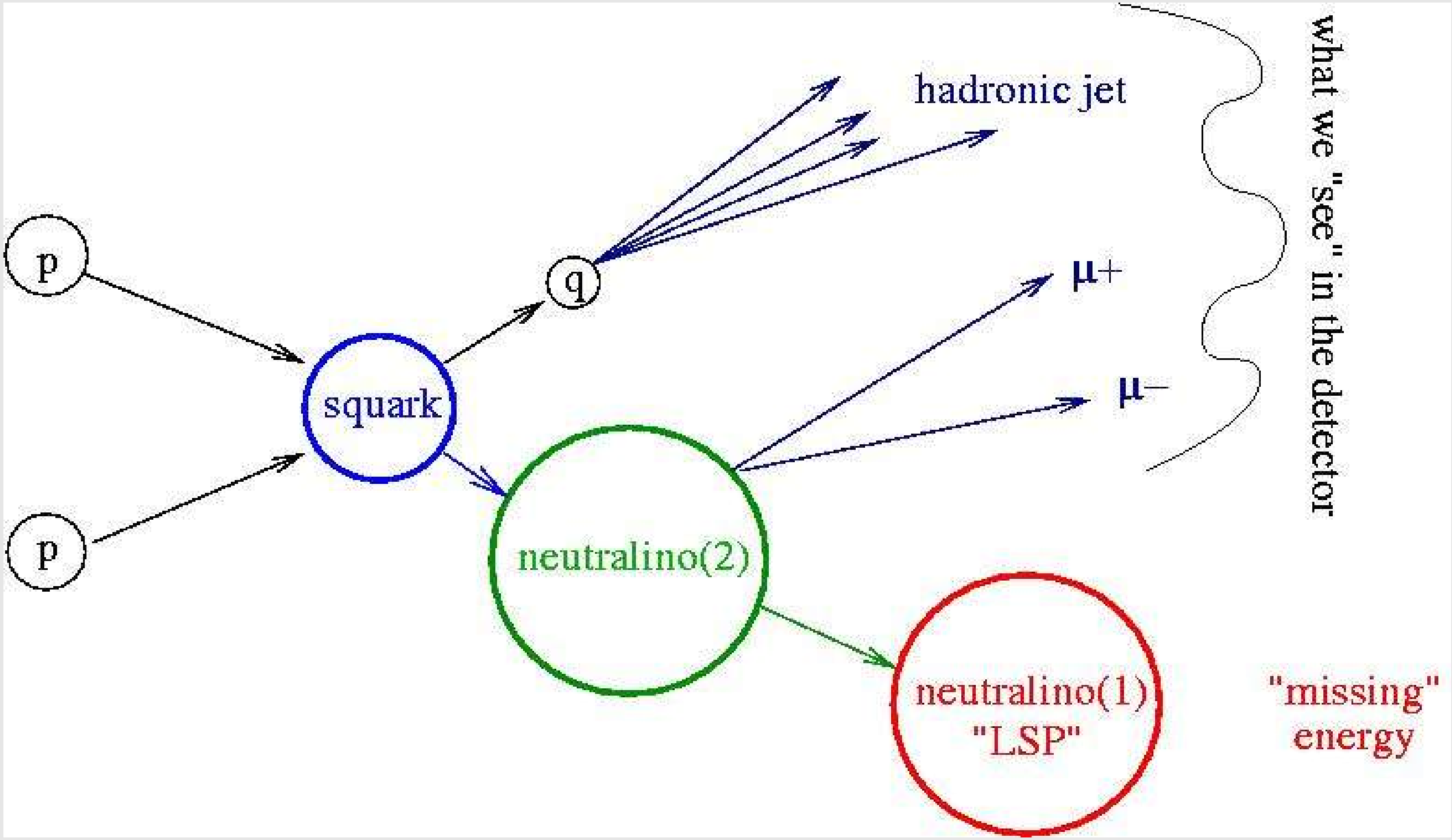
(The LHC will be seven times more energetic – more, later...)

Electron colliders have been limited by the power needed to accelerate electrons (which radiate away their energy too quickly).

Keep in mind that only the quarks and gluons inside the proton actually collide, so only a small fraction of the TeV energy is available for any given interaction, or “event.”

Experimenter's Toolkit

Any sparticle except the LSP will decay.



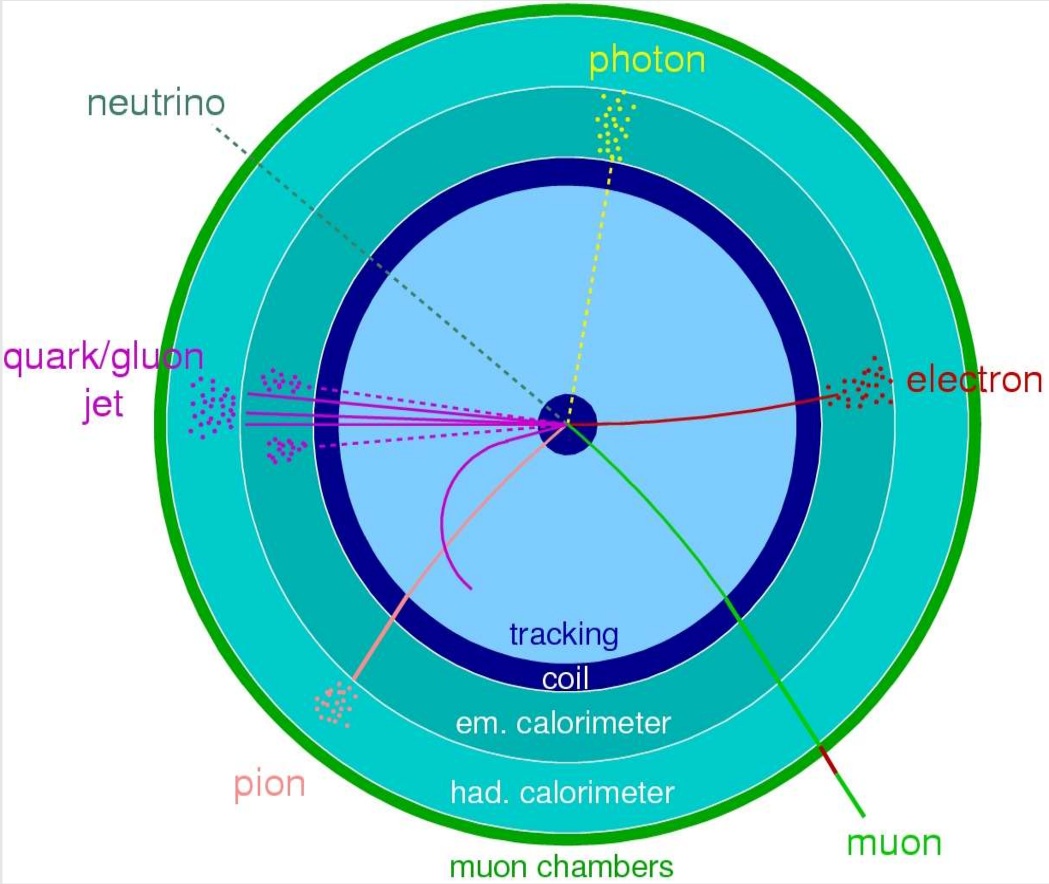
By and large, the decay products will be SM particles, which we need to detect, measure and correlate in order to reconstruct the sparticle that decayed.

The (quasi-)stable SM particles are the relevant ones: e, γ, μ and hadrons.

Collider Detectors

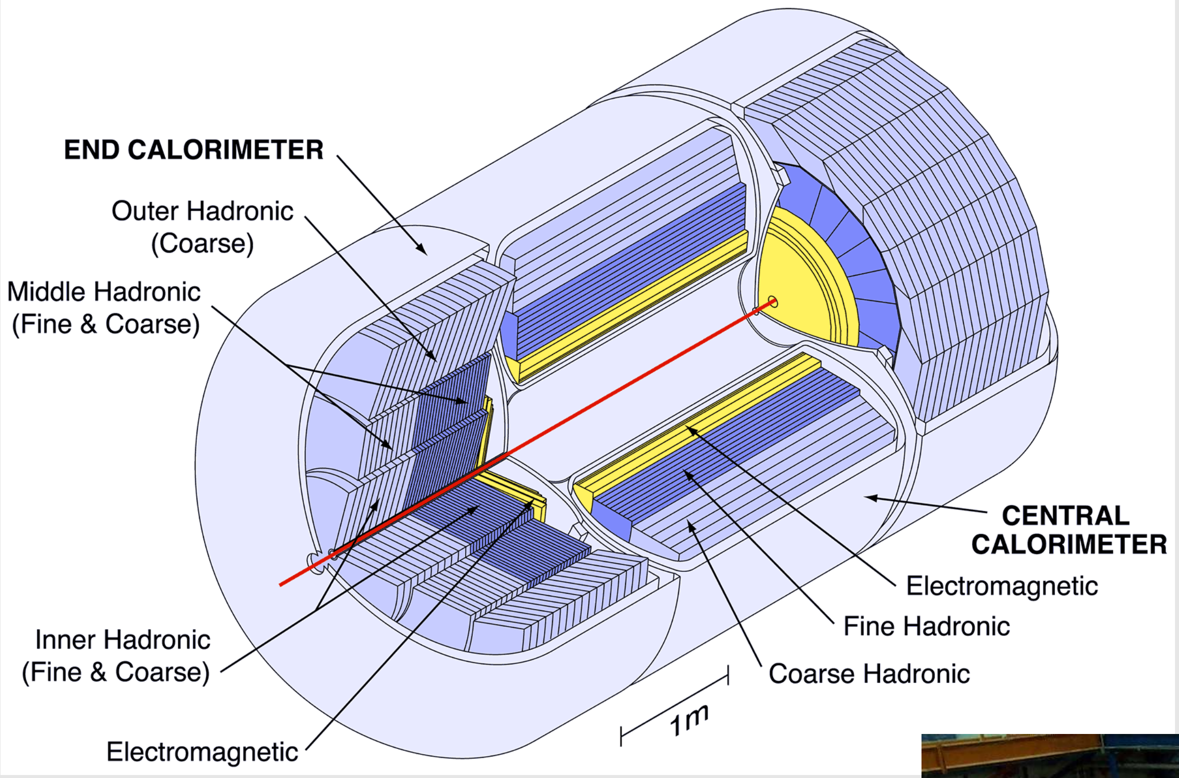
Collider detectors are like a set of nested Russian dolls, each of which tells us something useful.

With all that information, we decide what kind of particles were are detecting, and whether they might come from the decay of one or more SUSY particles.

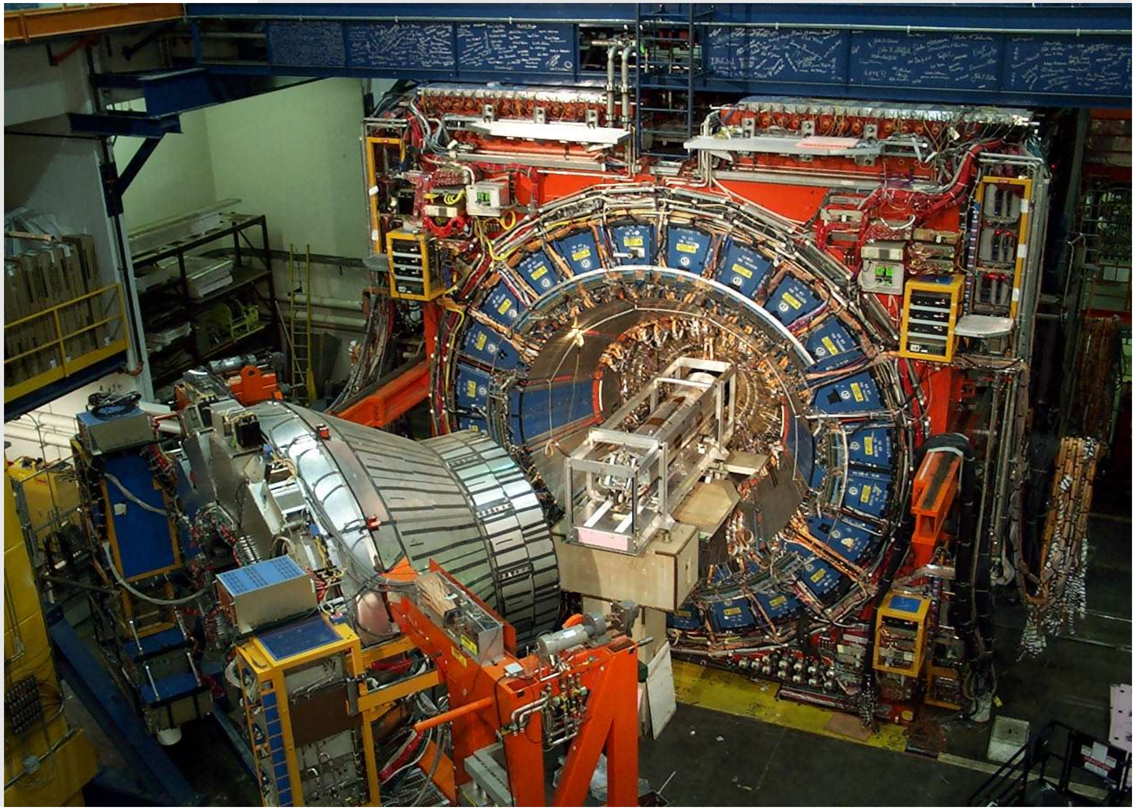


- charged particles leave tracks
- curvature (B-field) tells us p_T
- e & γ shower in the EM-CAL
- hadrons shower in the H-CAL
- μ don't shower and reach μ-det
- ν (and LSP's) are undetected

The D0 Detector



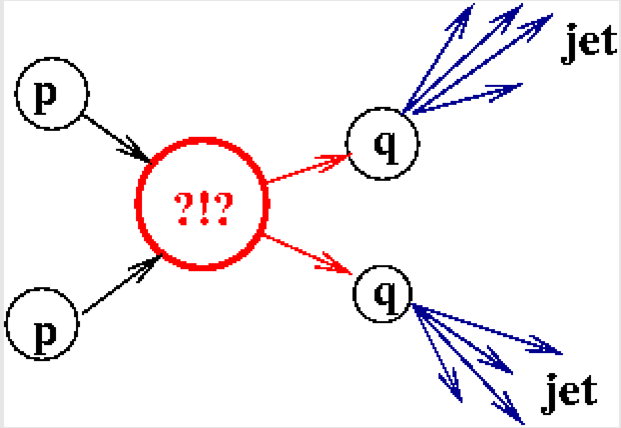
The CDF Detector

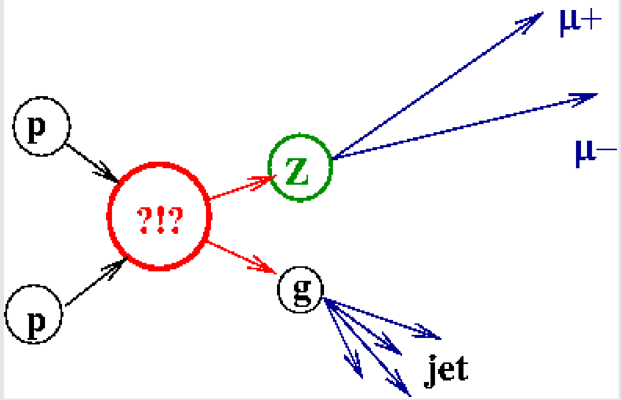


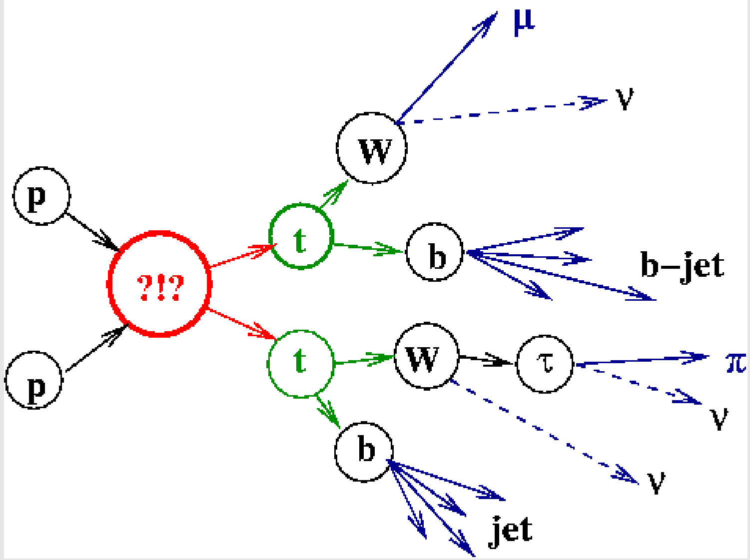
The SM is in the way!

Unfortunately (?!?), there are many SM processes which also produce e, γ, μ, and jets, and they obscure any SUSY process that might be present!

- the biggest source of events is *q-q* or *q-g* scattering, which leads to jets of hadrons occasionally with quite high energies.
- more interesting are the *W* and *Z* events which yield energetic (and isolated) electrons and muons, and sometimes neutrinos.
- the top quark (discovered with the TEVATRON in 1995) has a non-trivial decay pattern to *b*-quark jets, leptons and neutrinos
- boson pairs (*WW*, *WZ* & *ZZ*) are produced at very low levels, but are "interesting" because they mimic some of the most distinctive signals for SUSY particles.

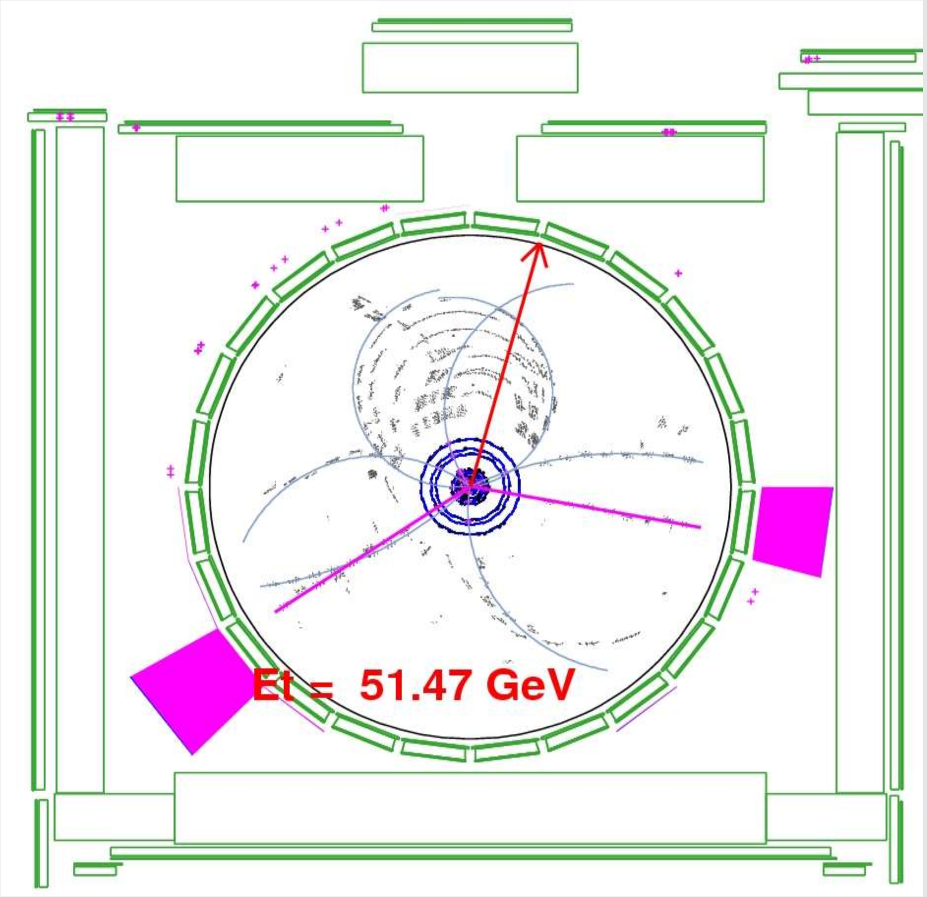






Examples of real events:

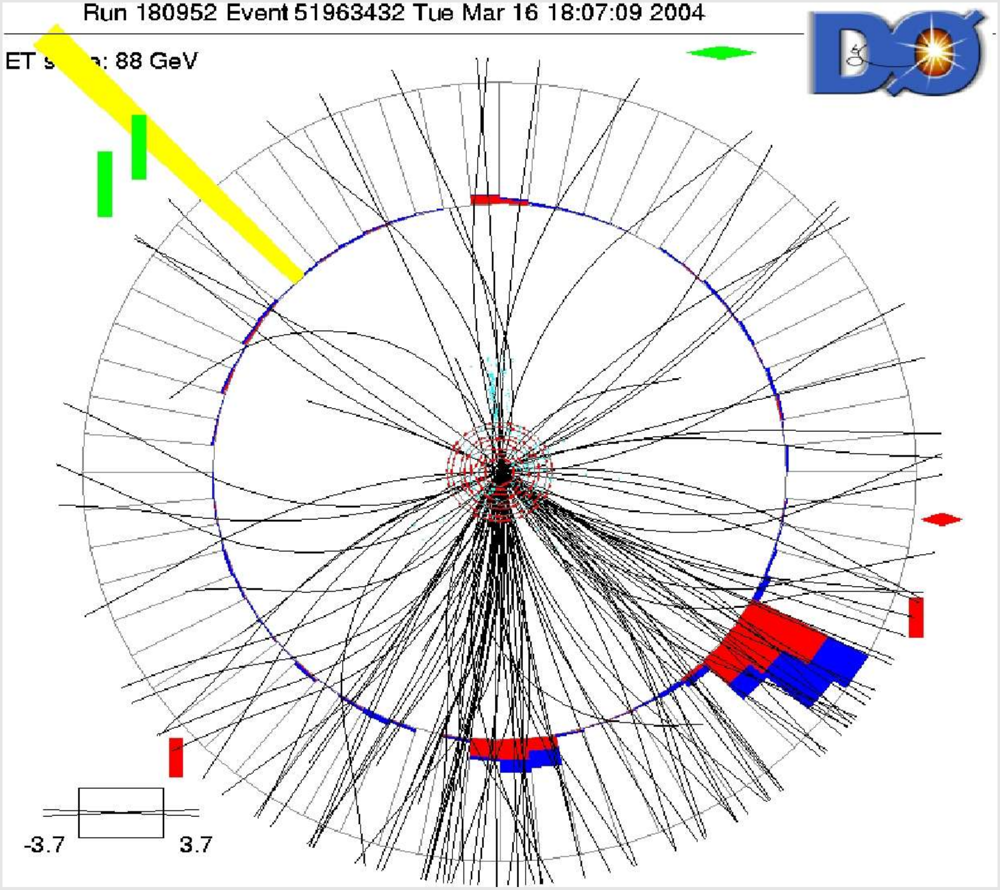
CDF



two electrons and
"missing" energy

(from search for di-boson production)

D0



two hadronic jets
and "missing" energy

(from search for SUSY)

Example 1: Jets and Missing Energy

Since the TEVATRON collides protons and anti-protons, which are made of quarks, anti-quarks and gluons, it makes a lot of sense to look for squarks and gluinos (the SUSY partners of quarks and gluons).

The task is to separate events with squarks and gluinos from ordinary SM events (which we call "QCD events" since they characteristically originate from strong-interaction processes).

The typical TEVATRON event consists of 2 or 3 energetic jets.

What would be different about an event with squarks or gluinos?

→ ***missing transverse energy (MET)*** $\vec{\not{E}}_T$

What is MET?

The calorimeters are segmented, so we know what energy is recorded where in any given event.

Since the incoming quark/gluon energy is not known event-by-event, we focus on kinematic quantities transverse to the beam direction.

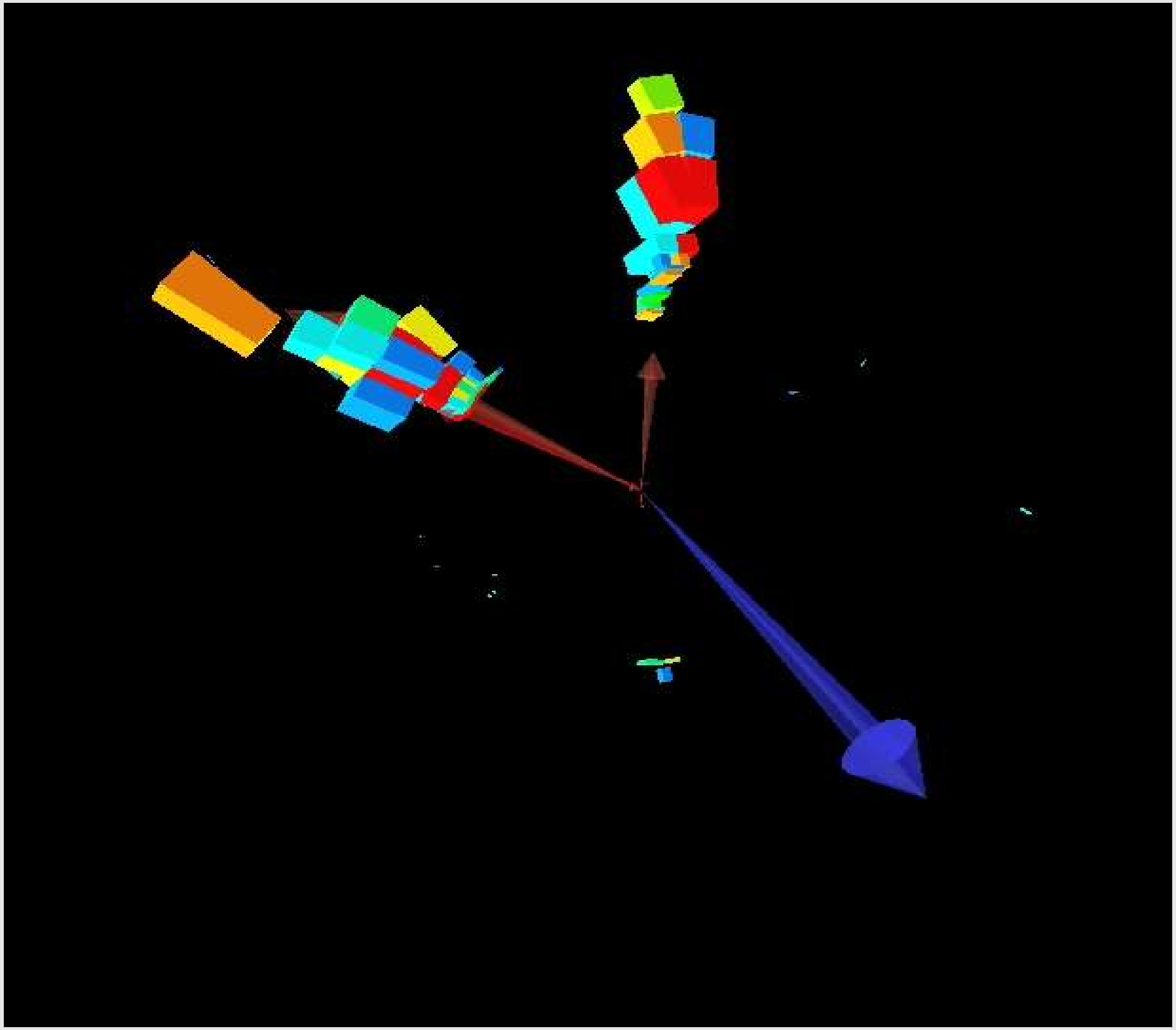
The vector sum of all transverse momenta must be zero!

If something invisible is produced (such as the LSP or a ν), then the sum of all transverse momenta will not be zero: it will be the opposite of the transverse momentum of the undetected particle(s).

This "missing transverse energy" (MET) is absent for most SM processes, but is the hallmark of most SUSY particles.

exploit this distinction!

Example of a real event with large MET, from DØ



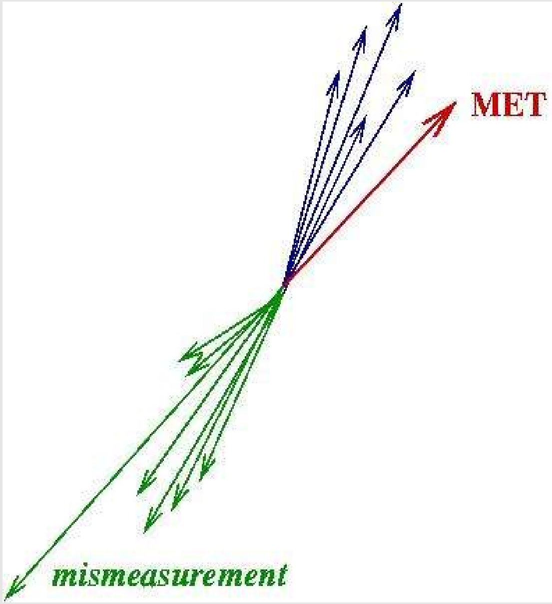
The colored boxes indicate energy deposits in the calorimeter.

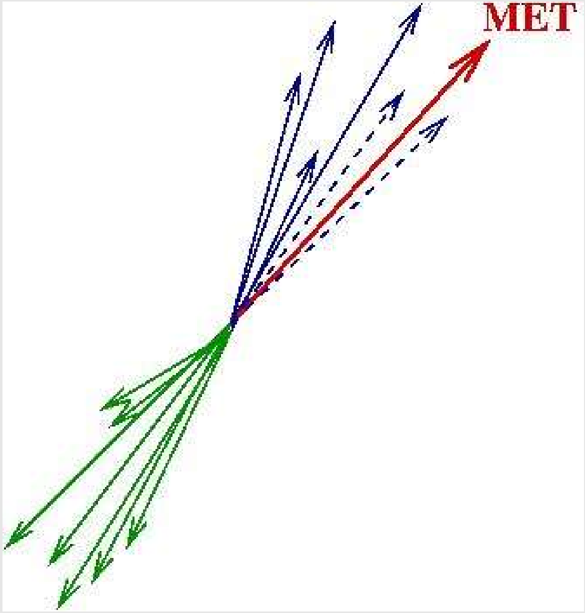
The blue arrow shows the direction & magnitude of MET.

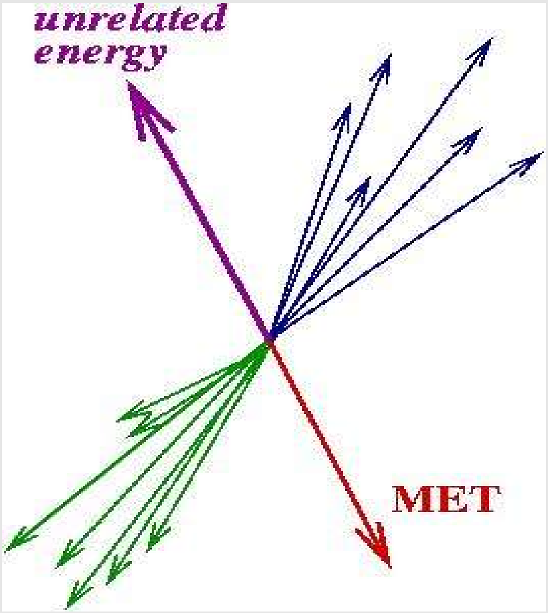
It is not so easy to “measure” the missing energy, due to difficult limitations in our instruments.

What are the sources of MET?

- calorimeter resolution on the jet energies
- losses of energy in uninstrumented regions (“cracks”)
- additional energy unrelated to the primary interaction
- neutrinos and also long-lived neutral kaons plus neutrons
- real LSP's (*e.g.* neutralinos), we hope....



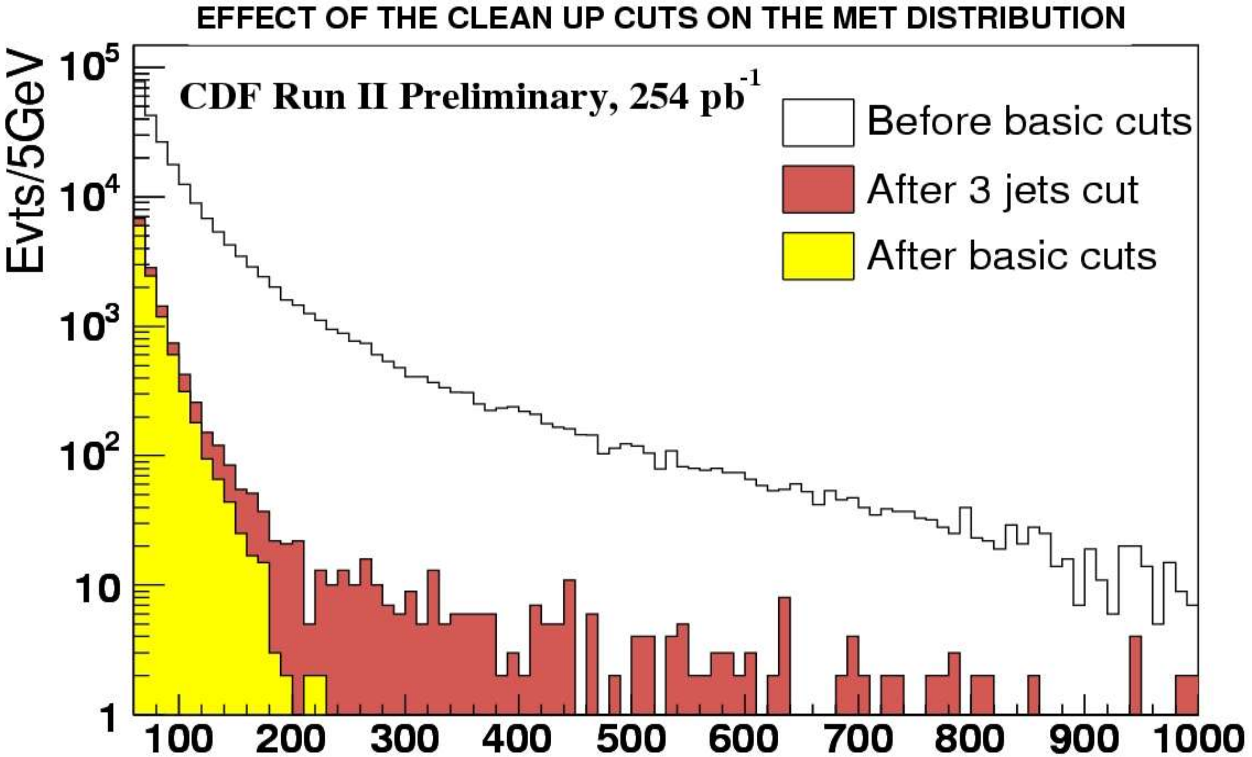


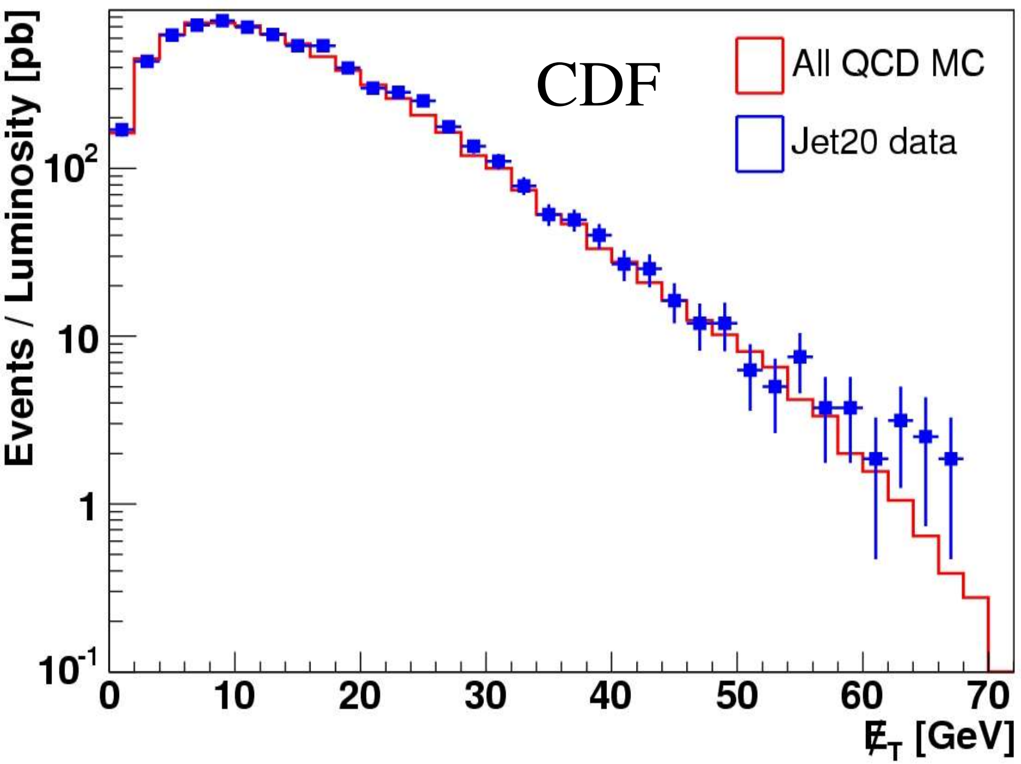


MET “clean-up”

After a lot or work, we learn how to remove “junk” from our data sample.

- *cosmic rays,*
- *beam halo,*
- *beam-gas events,*
- *calorimeter noise,*
- *etc.*





It is now possible to model the QCD backgrounds from simulation.

This is important as the QCD background is the most severe for this kind of search.

After you have your best measurement of **MET**, what then?

We need to think about the kinematic features of the SUSY events, and see how they might differ from ordinary QCD events.

- if **M(squarks) < M(gluinos)** then
  - ★ squarks decay to quarks and LSP's → *2 jets + MET*
  - gluinos decay to squarks and gluons
- if **M(squarks) > M(gluinos)** then
  - ★ gluinos decay to a pair of quarks and an LSP → *4 jets + MET*
  - squarks decay to a quark and a gluino

Note that we expect M(squarks), M(gluinos) to be > 300 GeV or so
(mainly because they have not been found for masses less than that).

The JETS that come from the SUSY decays will always be **energetic**, in distinction to ordinary jets which tend to have less energy.

→ Require high energies for the jets, and
require the sum of jet energies (H_T) to be high.

Both DØ and CDF pre-select events with >2 jets, and MET > 40 GeV or so...

(dictated by the experimental "trigger")

Actual cuts in the CDF selection:

- at least 3 jets, $E_T > 30$ GeV
- MET > *165* GeV
- $H_T > 350$ GeV

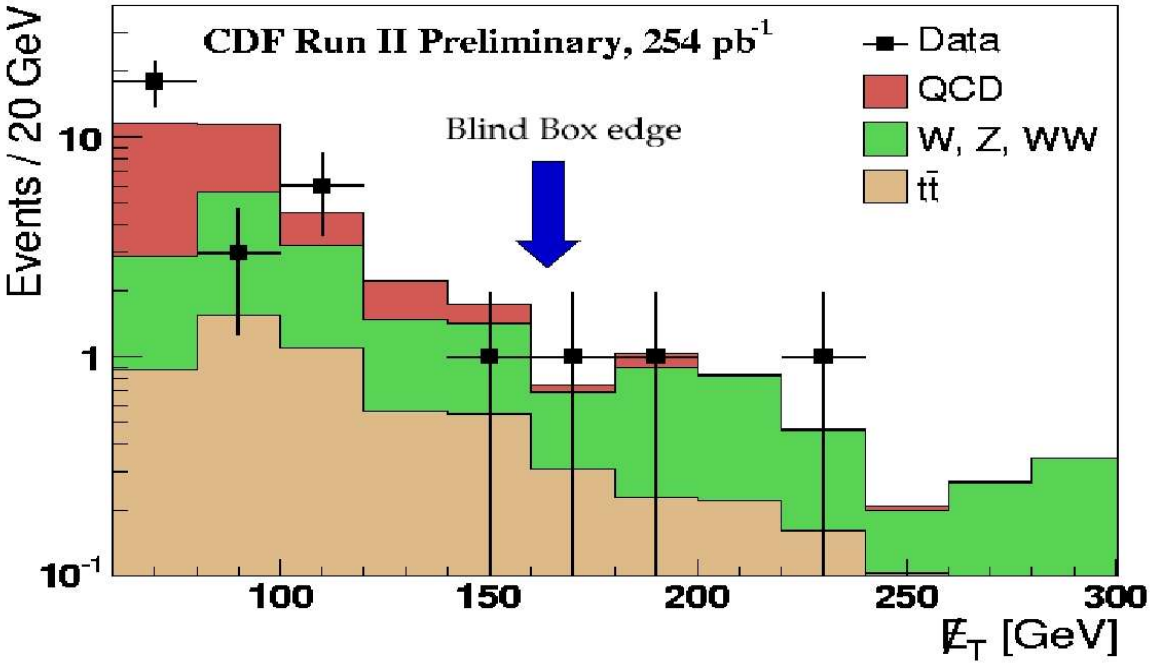
- expect 4.1 ± 1.4 events from SM
- observe 3 events

Actual cuts in the DØ selection:

The DØ cuts depend on the "scenario" - on the relative masses of squarks and gluinos.

- 2 Jets + MET: gluinos heavier than squarks MET > *175* GeV, $H_T > 250$ GeV
  expect 12.8 ± 5.4 events, observe 12 main background: $Z \rightarrow \nu\nu$
- 3 Jets + MET: gluinos close to squarks MET > *100* GeV, $H_T > 325$ GeV
  expect 6.1 ± 3.1 events, observe 5 main background: $W \rightarrow \tau\nu$ + jets
- 4 Jets + MET: gluinos lighter than squarks MET > *75* GeV, $H_T > 250$ GeV
  expect 7.1 ± 0.9 events, observe 10 main background: **t t**

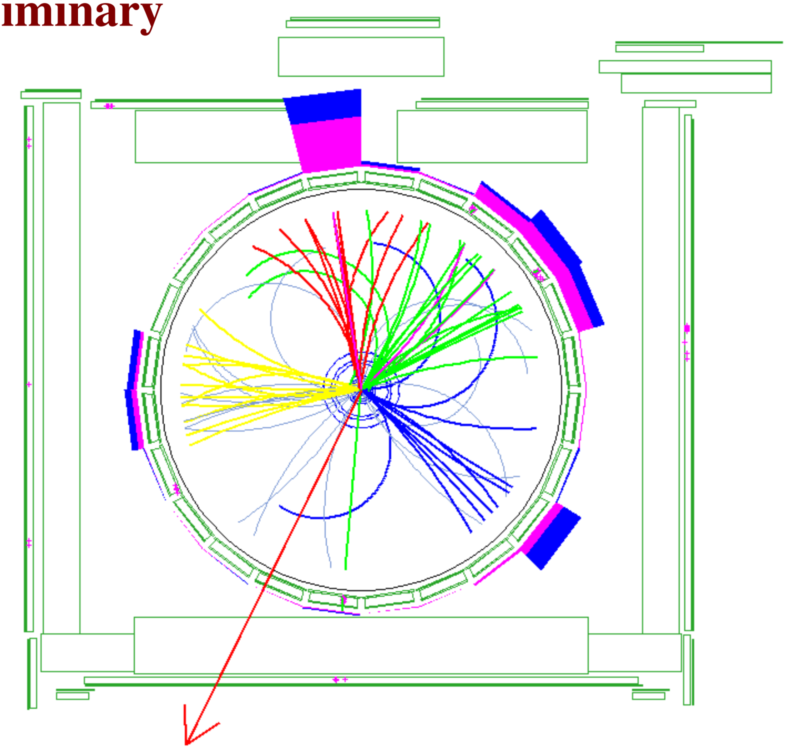
These results were obtained using about 300 pb^{-1} of data.



After lots of hard work, one can examine the last few events in the MET distribution.

We see no evidence for any excess of events above those expected from SM processes...

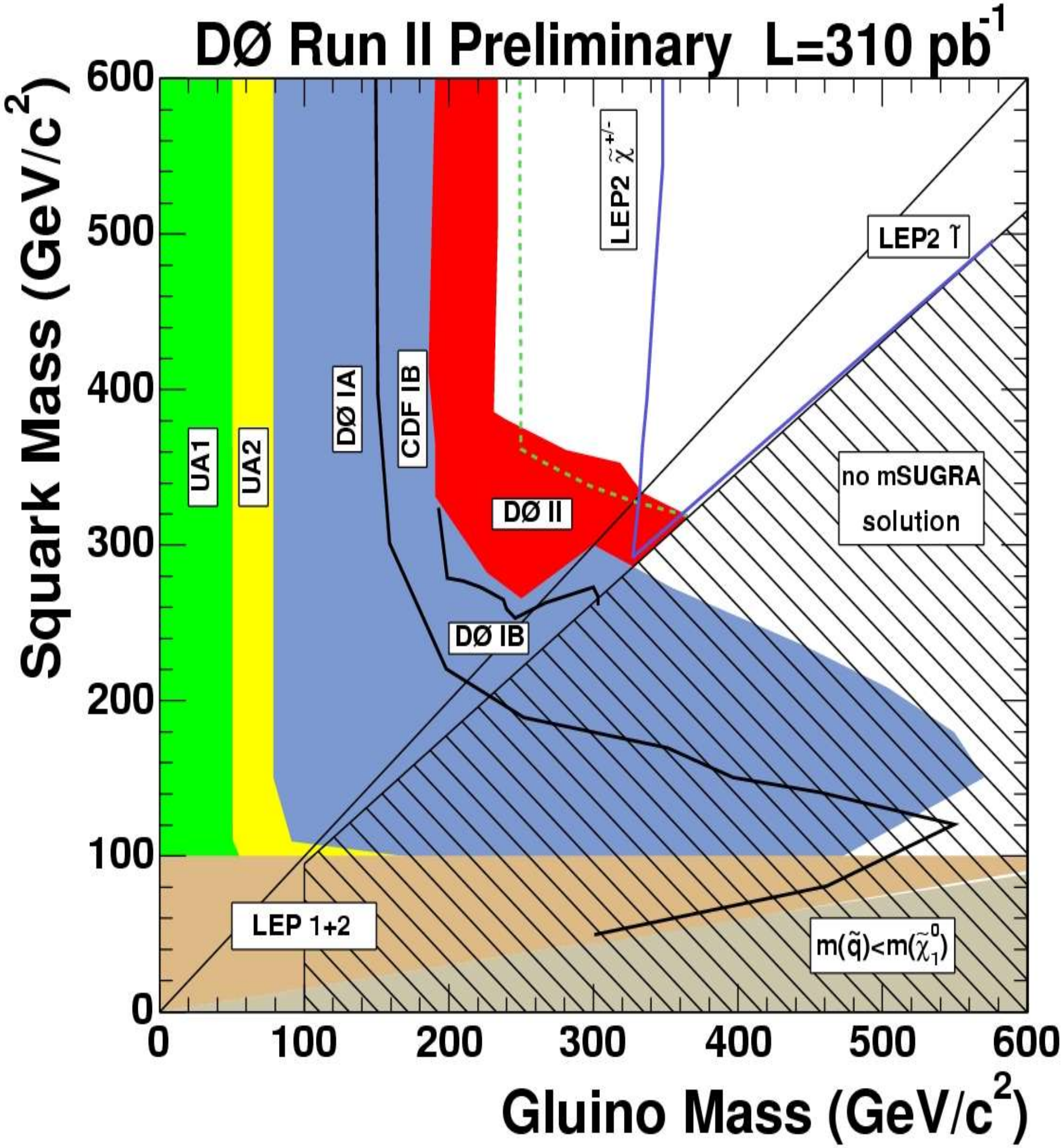
CDF preliminary

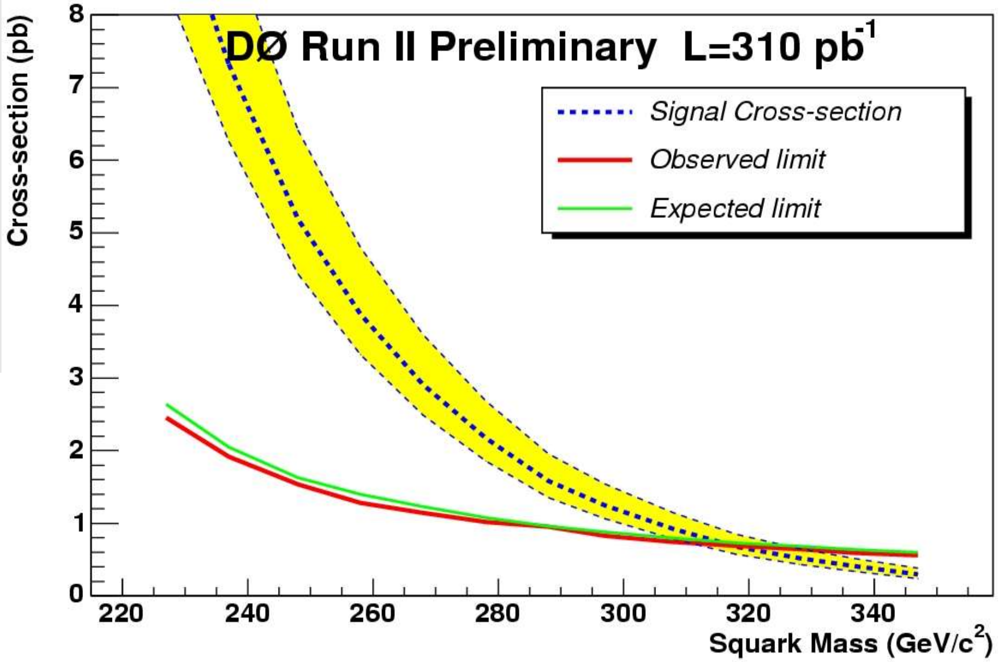


Here is the event with the highest missing energy.

One clearly sees four energetic jets, and a large MET (red arrow).

No evidence for squarks or gluinos.





In view of the negative results of these searches, one can only say that squarks and gluinos do not exist, provided they would have been produced at a rate which would have been visible...

In practice this is translated into excluded ranges for the squark and gluino masses.

$$M(\tilde{g}) > 233\,GeV \quad , \quad M(\tilde{q}) > 318\,GeV$$

Example 2: The “stops” Search

Perhaps in reality, the generic squarks are simply too heavy...

Stops (scalar top squarks) could be much lighter – is this the way to go?

If other SUSY particles are relatively heavy, then the decay will be

$$\tilde{t}_1 \to c + \tilde{\chi}_1^0$$

A pair of stops will appear as two (charm) jets and MET.

- select events with 2 or 3 jets ($E_T > 15$ GeV)
- apply a “loose” lifetime tag (a tight tag would not be efficient for charm jets)
- MET > 55 GeV
- throw away events with leptons (they would be coming from W bosons)

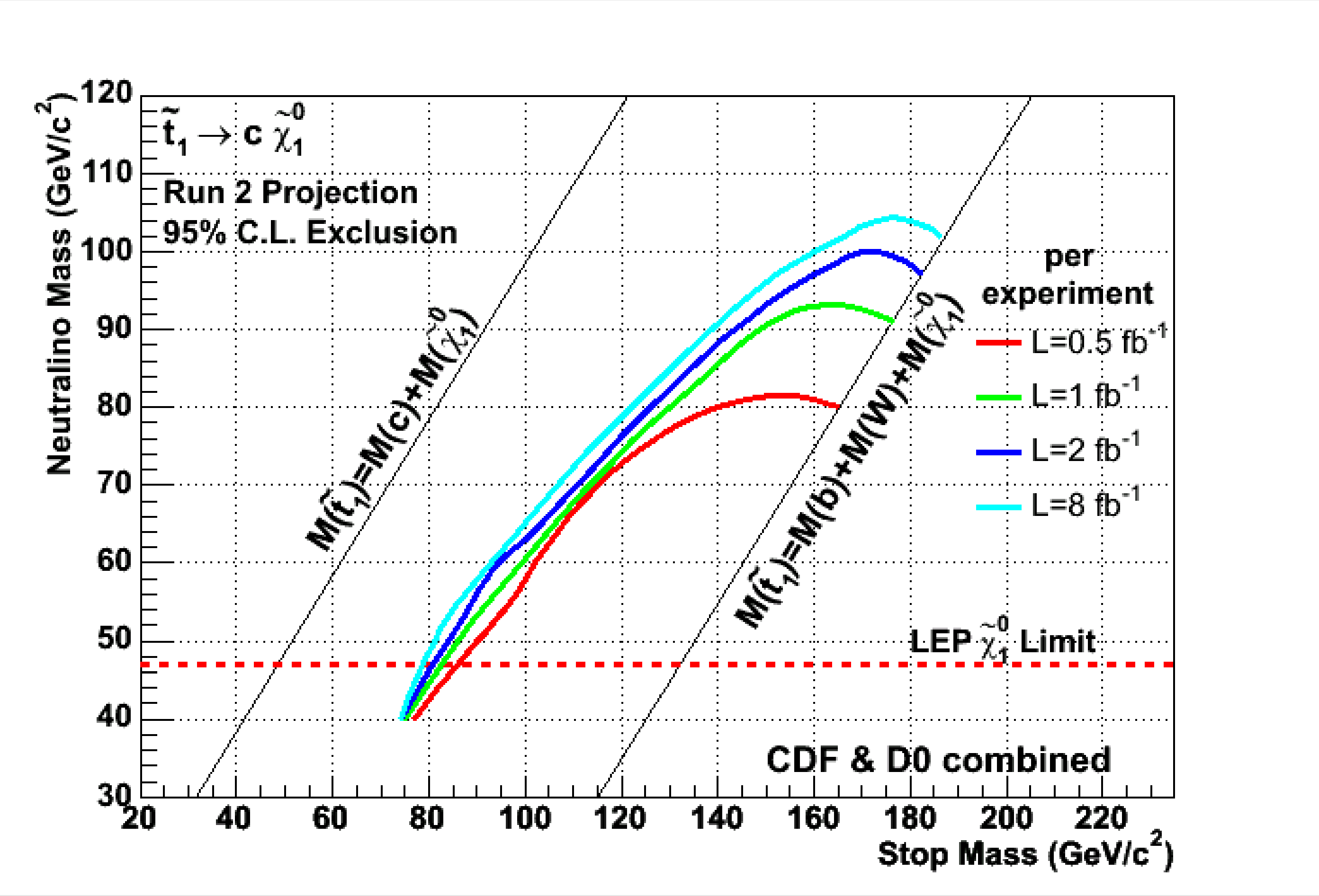
expect 8 ± 2 events, and observe 11 $\longrightarrow$ no signs of a signal

With about 160 pb^{-1}, limits are about the same as from Run I.

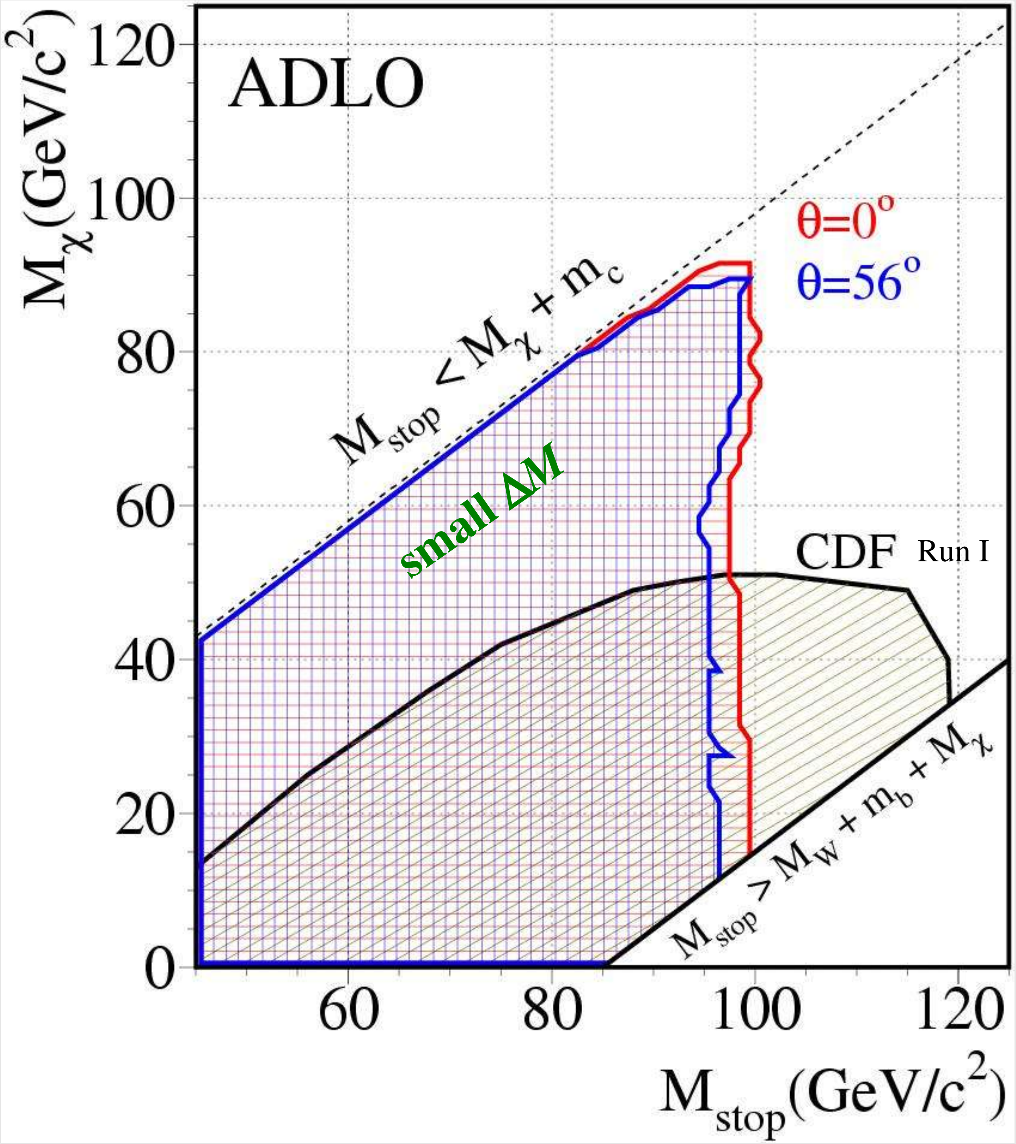
The problem is the MET cut.

The MET cut is needed in order to fight huge instrumental backgrounds swamping the trigger...

Even with a much larger data sample, sensitivity is quite limited:



It is instructive to compare to the LEP searches for stops:



This is the final result from LEP.

Notice that the exclusion extends all the way to within an “ε” of the boundary.

In e^+e^- experiments, there is a much starker contrast between acoplanar jets from stops and jets from two-photon interactions (which dominate the small-ΔM region).

Furthermore, one has control over all of the kinematics: there is no significant smearing of the longitudinal momentum.

This allows one to use variables such as the invisible mass and acollinearity to cut down background.

The maximum mass reach, however, will always be limited to about 100 GeV.

Notice the dependence on the stop mixing angle: this reflects a large variation of the signal cross section since $\tilde{t}_L$ and $\tilde{t}_R$ couple very differently to the Z boson.

Example 3: The “tri-Lepton” Search

Perhaps the problem is that **Jets+MET** is not distinctive enough.
Rare SM processes can be identified by the presence of leptons,
so let's try that strategy with SUSY processes, too.

Charginos and neutralinos are the spin-1/2 SUSY partners of (W and charged Higgs), and (γ, Z and neutral Higgs bosons).

Schematically speaking, their decays will resemble those of their SM partners, except for the “extra” LSP at the end of the decay chain.

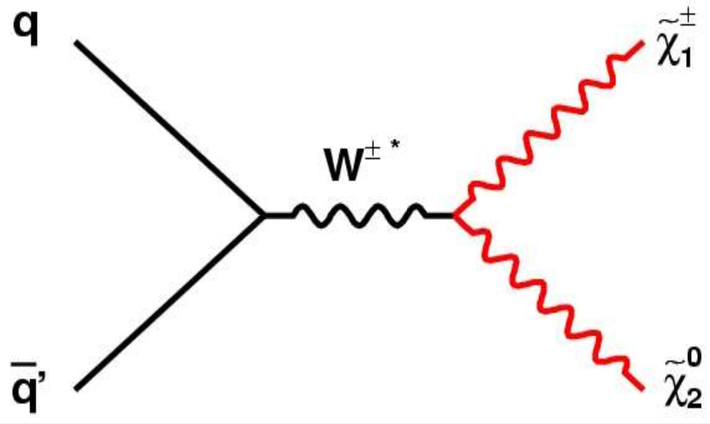
e.g., charginos decay to 2 fermions + LSP

- Single-lepton events come from inclusive *W* production and t-tbar.
- Double-lepton events come from inclusive *Z* (Drell-Yan) and t-tbar.
- So, ***look for triple-lepton events***...

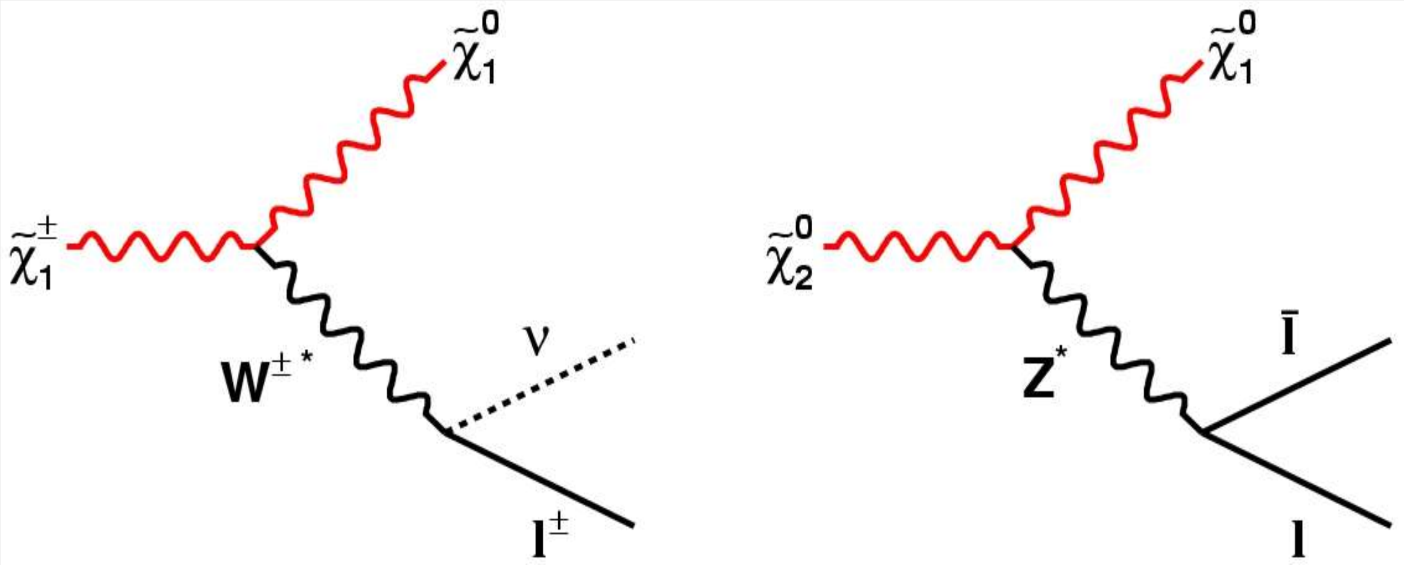
The tri-lepton Search

To be more specific, this is what we are after:

production:



decay:



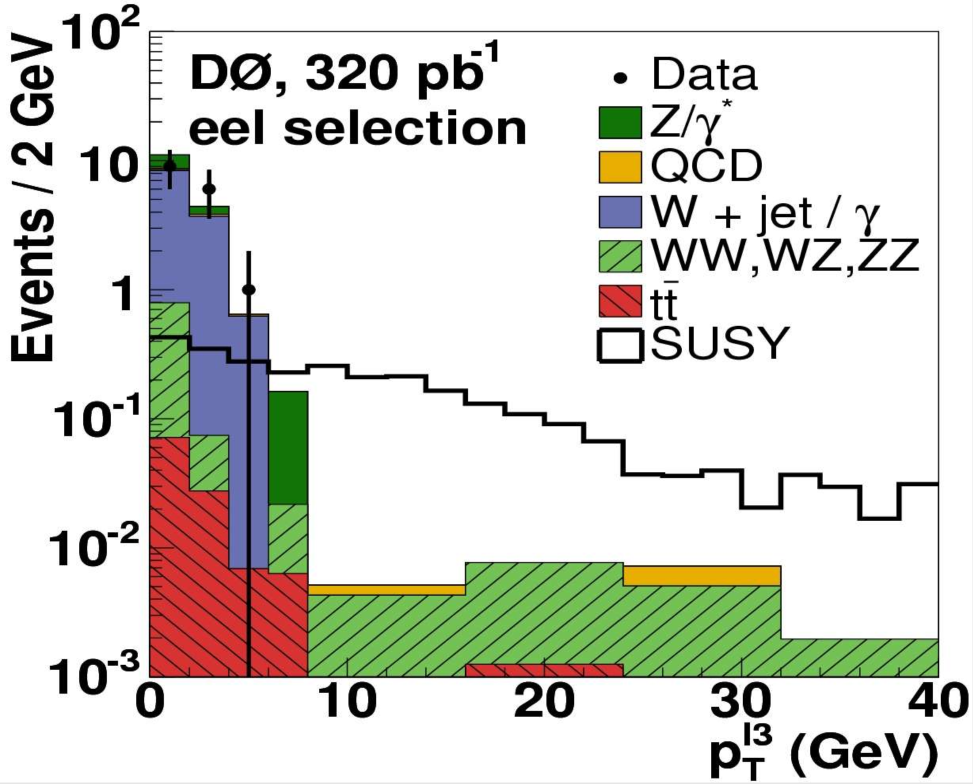
One lepton comes from the chargino, and two leptons come from the neutralino.
There is lots of missing transverse energy, too!

Again, we know that charginos and neutralinos are heavy (> 100 GeV).

This ensures that the leptons will be **energetic.**

They will also tend to be **isolated** in the sense that they will not be part of a jet.

(A troublesome source of leptons are jets with b-hadrons or c-hadrons, which sometimes decay semileptonically, giving us a lepton and a neutrino (=MET). The key point is that the leptons from b- or c-decays come associated with hadrons that are produced with the b- or c-quarks, and also in the b- and c-decays. So, we veto any leptons which have hadrons near by.)



This plot shows the discriminating power of the energy cuts (p_T) on the third lepton.

The SUSY curve corresponds to an optimistic but not crazy scenario.

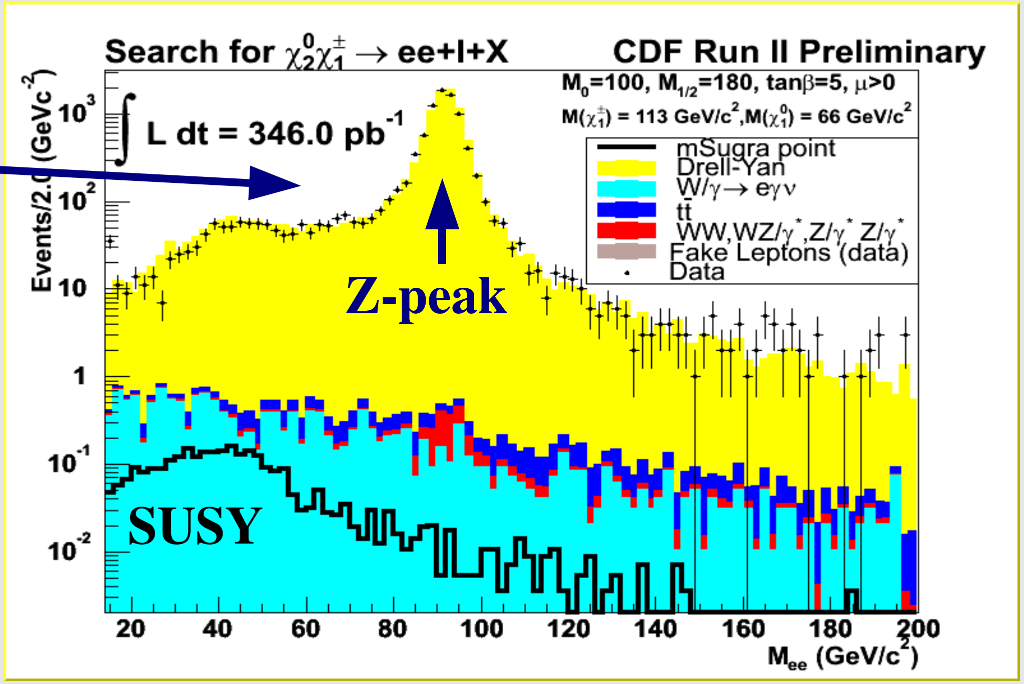
DØ published! hep-ex/0504032

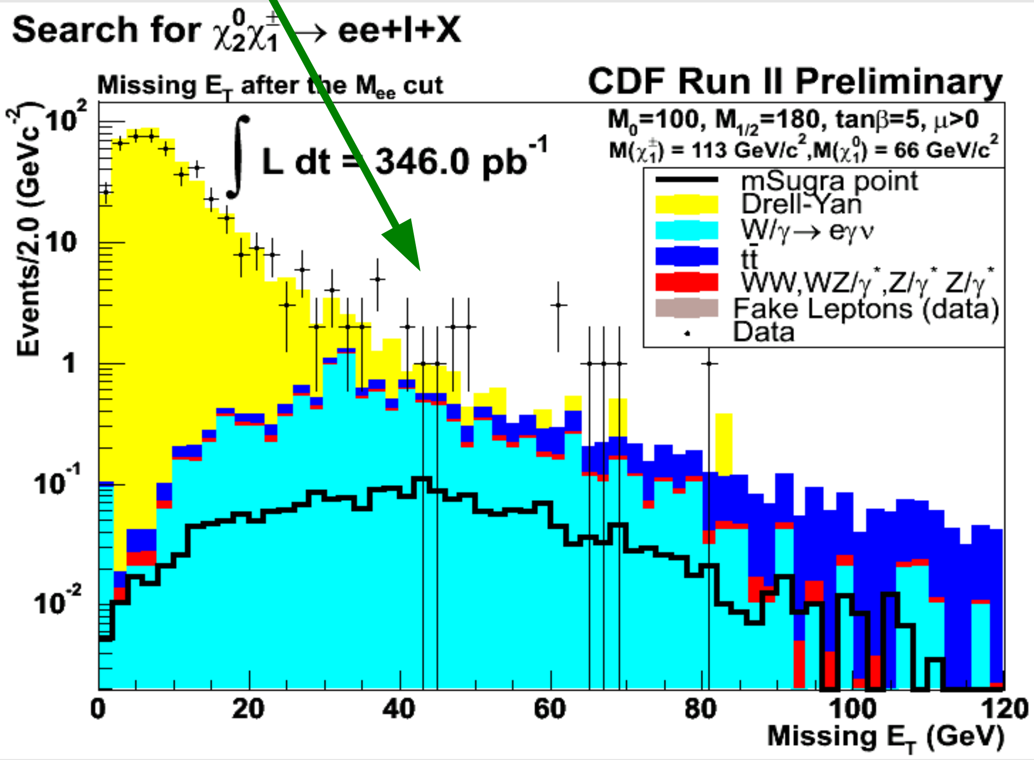
These plots show the power of the other cuts.

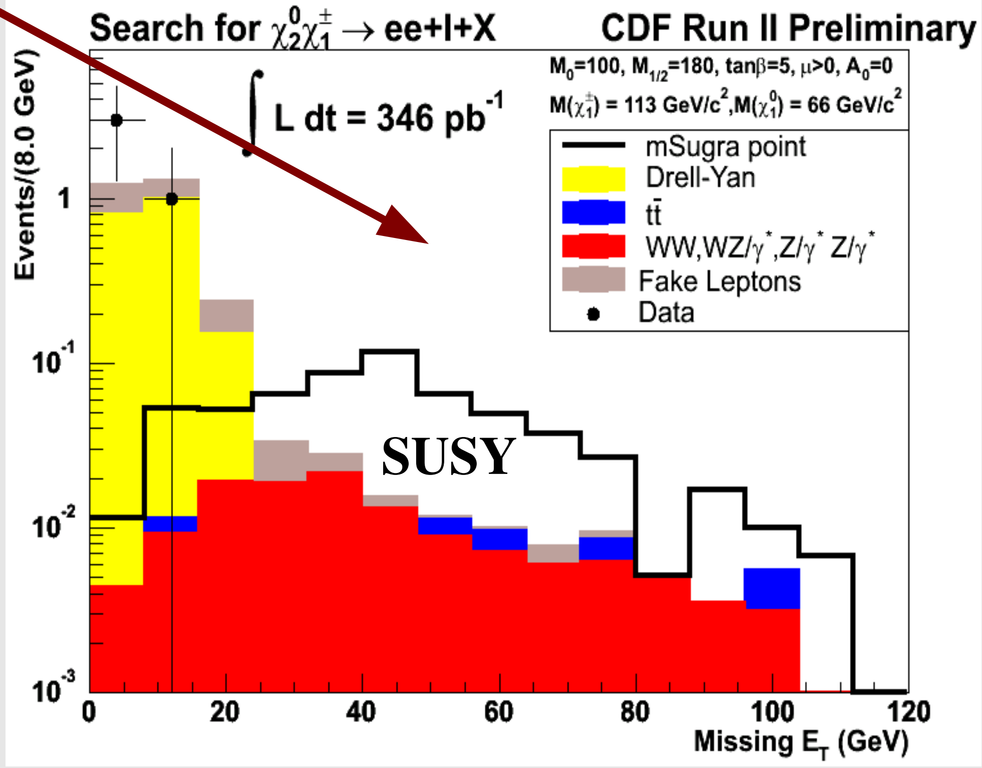
Overall di-electron mass spectrum.

MET distribution after cutting out the Z-peak.

MET distribution after all cuts.







In a little more detail, the CDF analysis runs like this:

- e^+e^- + (e or μ)
- $\mu^+\mu^-$ + (e or μ)
- e^+e^- + (isolated track)

these two have very low backgrounds

this one accepts some tau decays

The isolation of the leptons is crucial. There is a jet veto.

More than a dozen "control regions" (where no signal is expected) are scrutinized...

About 0.7 ± 0.1 events are expected, and 2 are selected. (346 pb^{-1})

And the DØ analysis is roughly as follows:

- e^+e^- + (isolated track)
- $e\mu$ + (isolated track)
- $\mu^+\mu^-$ + (isolated track)
- like-sign $\mu\mu$
- e + (hadronic τ) + (isolated track)
- μ + (hadronic τ) + (isolated track)

The kinematic selections are complex in order to reject surgically individual background sources.

The hadronic-τ selections help maintain good acceptance at moderate $\tan\beta$.

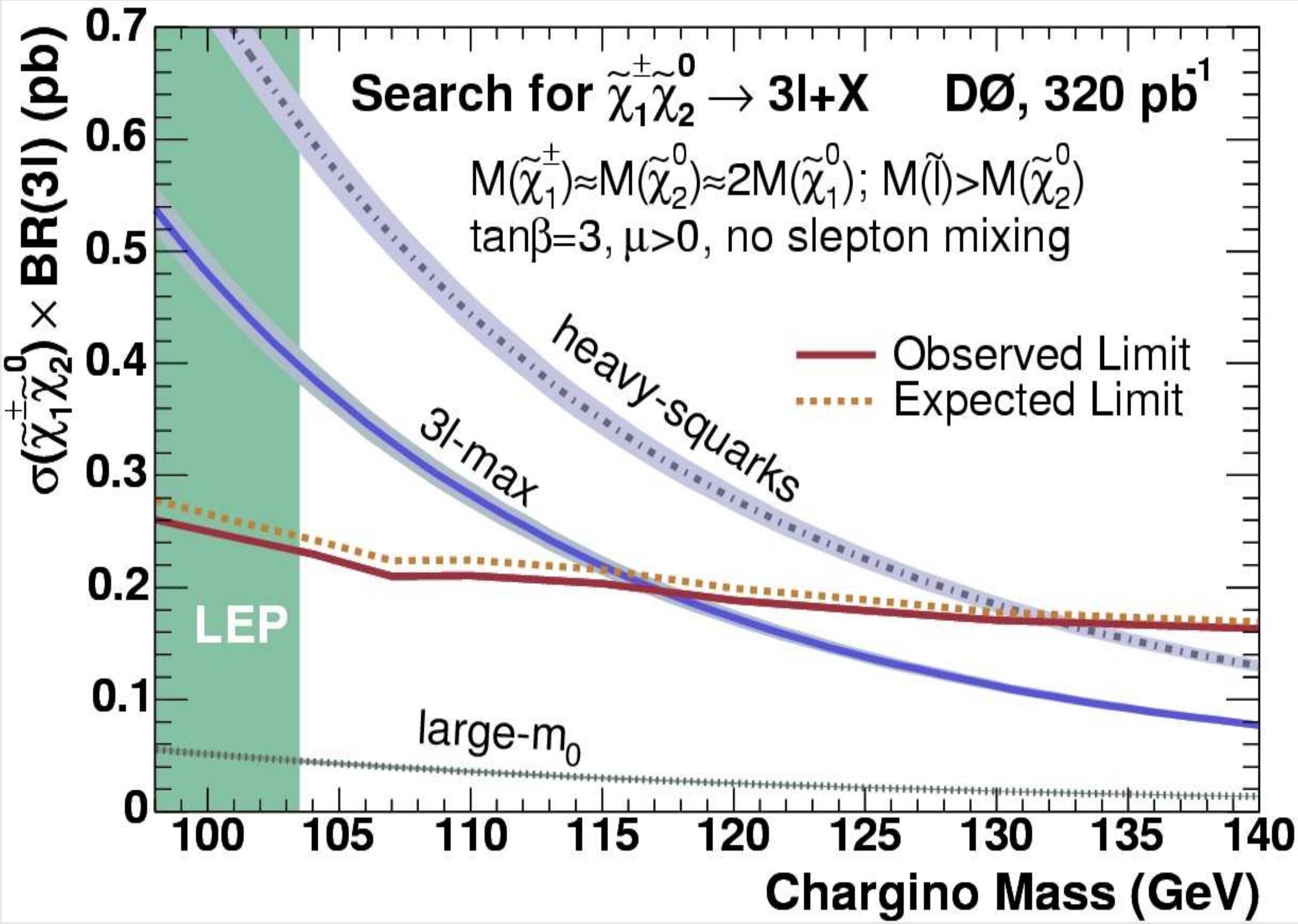
From these 6 selections, 3.8 ± 0.8 events are expected, and 4 are observed. (320 pb^{-1})

In both analyses, p_T thresholds are kept quite low. Remember these are 3-body decays...

And of course, significant MET (> 15 to 22 GeV) is required!

Limits from the tri-Lepton Search

Again, no evidence for any excess, so we can only place limits on SUSY cross sections, equivalently, masses.



Three scenarios are depicted:

all scalar masses large:

- cross section is maximal
- BR is not so optimistic
- very difficult to see a signal
- most realistic?

maximal leptonic BR:

- bring scalar masses down
- enhances BR
- but cross section reduced (*t*-channel)
- some extension of LEP bounds

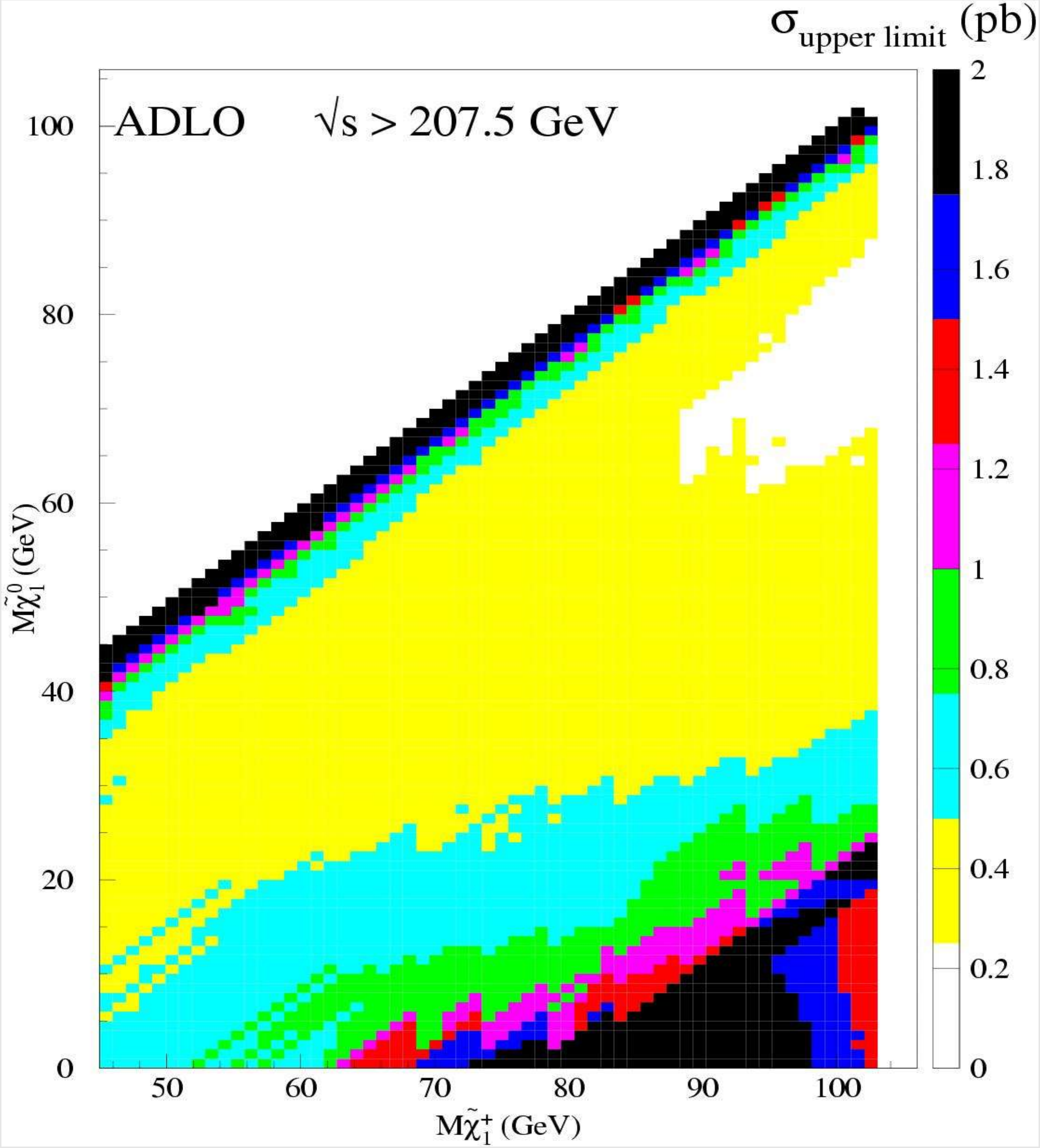
light leptons, heavy squarks:

- best of both worlds
- highly contrived ?
- would eventually cover past 200 GeV

hep-ex/0504032

$\sigma \times$ Br upper limits will improve by factor 20 by end of Run II.

Once again, let's make a quick comparison to LEP results:



Combined LEP final results:

upper limits on cross sections **regardless of decay mode!**

This is possible because the signal is not buried as it is at the Tevatron, and because kinematics are "sharper" and hence provide additional powerful handles.

- LL, HL, HH topologies taken together render results insensitive to H/L fractions
- good sensitivity at small DM
- robust at high tanβ where τ's dominate
- only a finely-tuned sneutrino mass can diminish these results, and only slightly.

In comparison, the "golden" tri-lepton channel appears rather special....

Example 4: "GMSB"

Most of the examples above are based on the MSSM with or without constraints coming from gravity mediation.

There are other variants of supersymmetry in which other mechanisms induce SUSY-breaking, and their phenomenology can be quite different.

One example is "gauge-mediated supersymmetry" (GMSB).

In these models, the LSP is the **gravitino** which is quite light.

Other SUSY particles can decay electromagnetically to the gravitino, and of particular importance is the lightest neutralino:

$$\tilde{\chi}_1^0 \rightarrow \tilde{G} + \gamma$$

(There are other scenarios in which the $\tilde{\tau}^{\pm}$ is lighter than the $\tilde{\chi}_1^0$.)

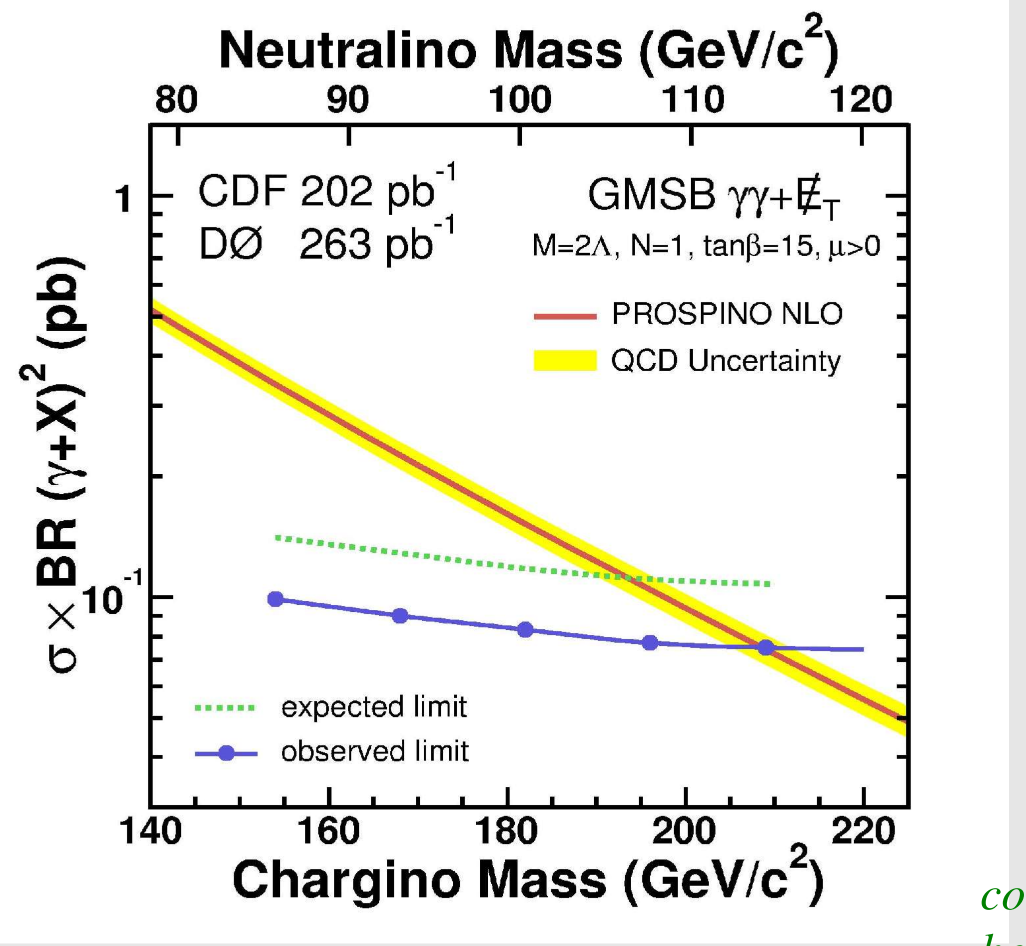
This leads to a very distinctive signature: high-energy photons and MET!

CDF and DØ have searched for charginos and neutralinos in this scenario.

$$p\,\bar{p} \;\rightarrow\; \tilde{\chi}_1^{\pm}\;\; \tilde{\chi}_2^{0} \;\rightarrow\; \gamma\,\gamma\,\vec{\not{E}}_T\,X$$

- ask for two high-ET photons (thresholds at 13 and 20 GeV, respectively)
- the photons have to be isolated
- ask for significant MET (45 and 40 GeV, respectively)

The signature is so distinctive that no other requirements are needed.



The reach in chargino mass is much higher than in the tri-leptons analysis.

This result is independent of the chargino and neutralino decay mode.

Clearly the Tevatron has access to much higher states than does LEP - the challenge is to dig the signal out from background.

There other model parameters which have to be specified – the cross section will be different for other values.

combined result from DØ and CDF
hep-ex/0504004

Example 5: Rare B_s Decays

Let's switch gears and look into the possibility of
virtual effects from Supersymmetry...

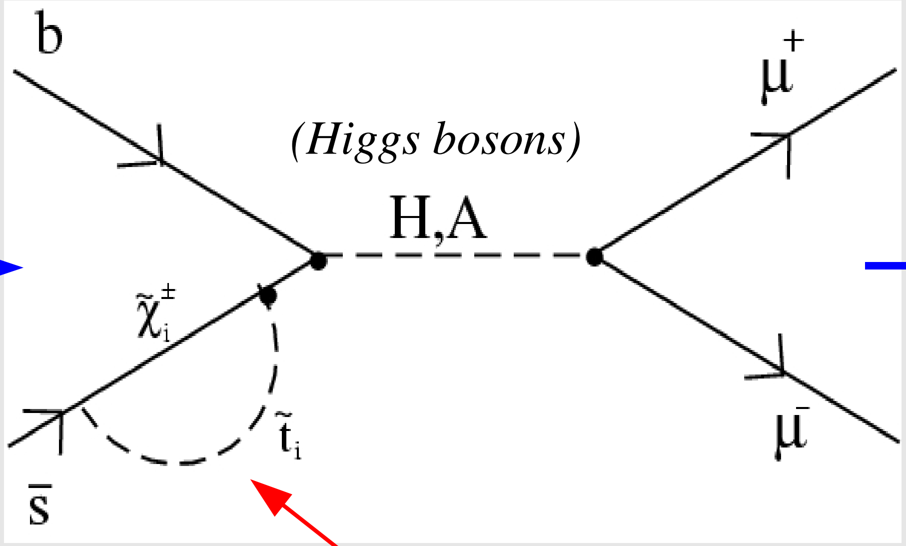
Particle physicists are expert in looking for and utilizing virtual effects from heavy particles.

For example, our knowledge of the Higgs boson comes mainly from the analysis of "precision electroweak observables" which are influenced by virtual Higgs bosons circulating in loops.

There have been many analyses of the possible impact of virtual SUSY particles, and there are several excellent examples:

- the Higgs boson mass itself (remember the "Hierarchy Problem")
- the same precision EWO are preserved by the structure of SUSY corrections
- the anomalous magnetic moment of the muon $(g-2)_\mu$
- enhancements to the rate of the $b \rightarrow s+\gamma$ transition (a FCNC)
- huge enhancements to the rate of $B_s \rightarrow \mu^+\mu^-$

The influence of SUSY particles on the $B_s \to \mu^+\mu^-$ decay rate comes through a complicated loop diagram as shown here:



B_s meson →

→ *$\mu^+\mu^-$ final state*

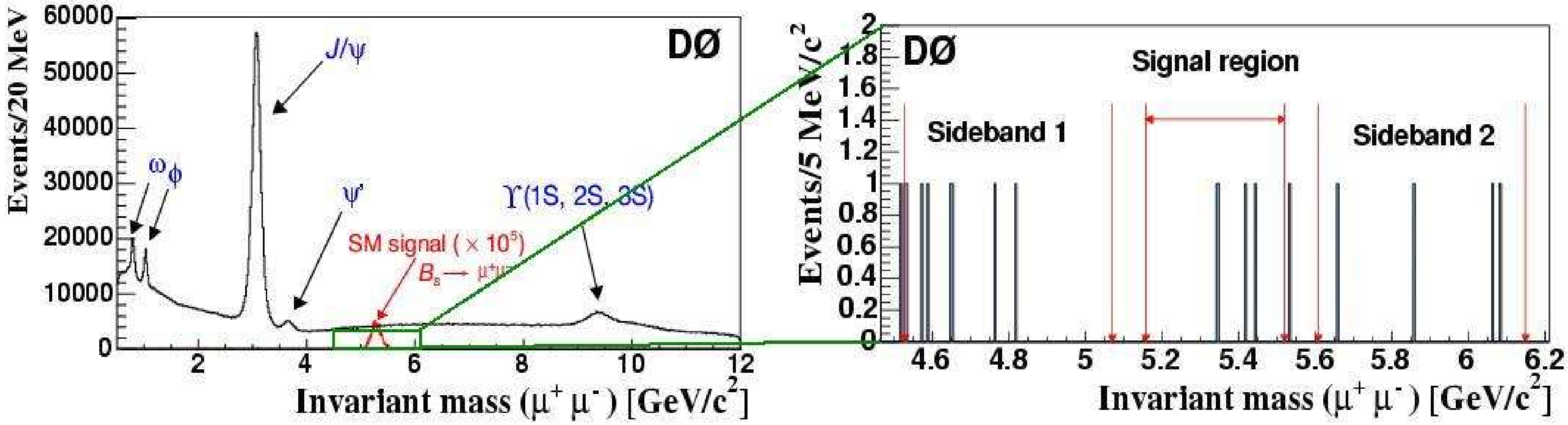
virtual SUSY particles in loops

This is extremely rare in the SM, since it constitutes a “flavor-changing neutral current” (FCNC) – which is forbidden at lowest order.
Hence, there is a special “window” onto virtual SUSY effects...

In the end, one sees that for *some* SUSY parameter choices (large tanβ), there is a **huge** enhancement for this decay. In fact, this enhancement occurs in regions where the tri-lepton searches tend to be weaker, so *the two searches are complementary*.

Once again we are using muons, but this time in a very direct and restricted way – we are looking for a bump in the $\mu^+\mu^-$ invariant mass spectrum.

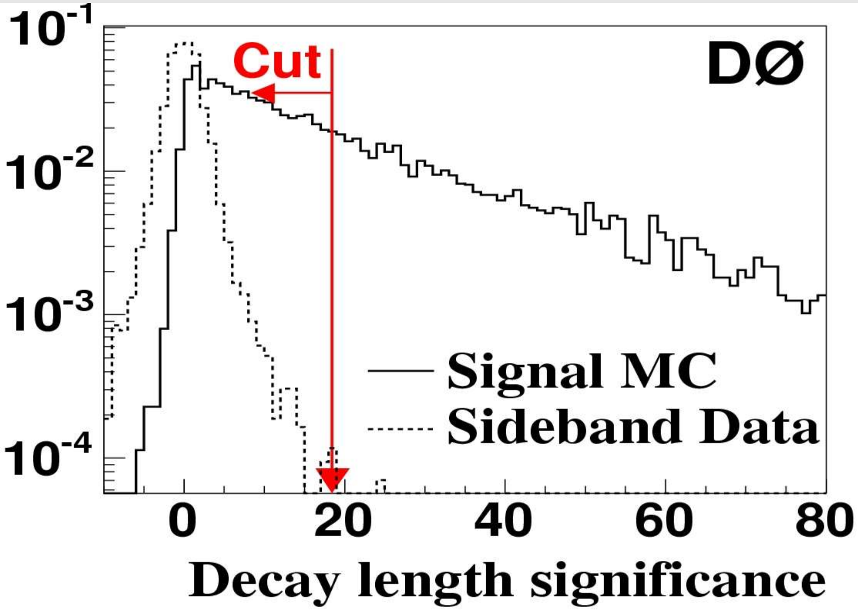
The signal is really tiny compared to SM production of $\mu^+\mu^-$ pairs, so one needs to be clever in isolating any possible signal.

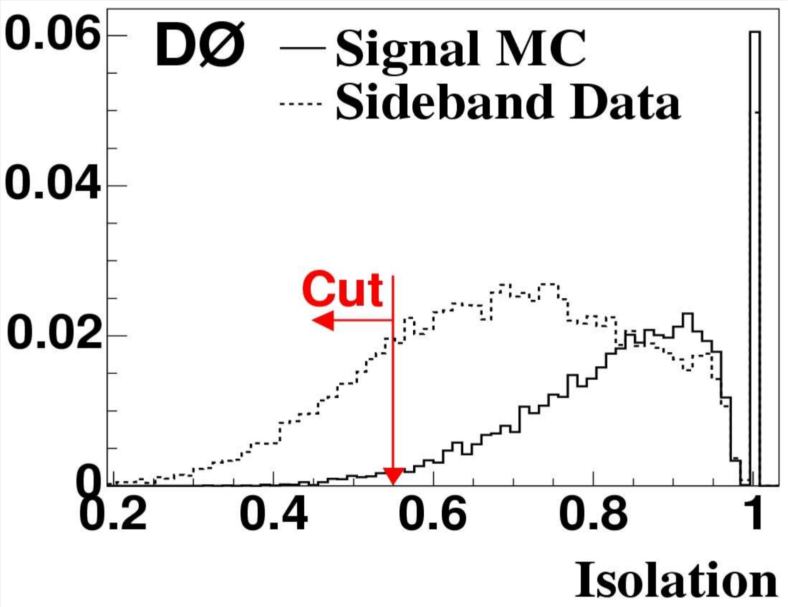


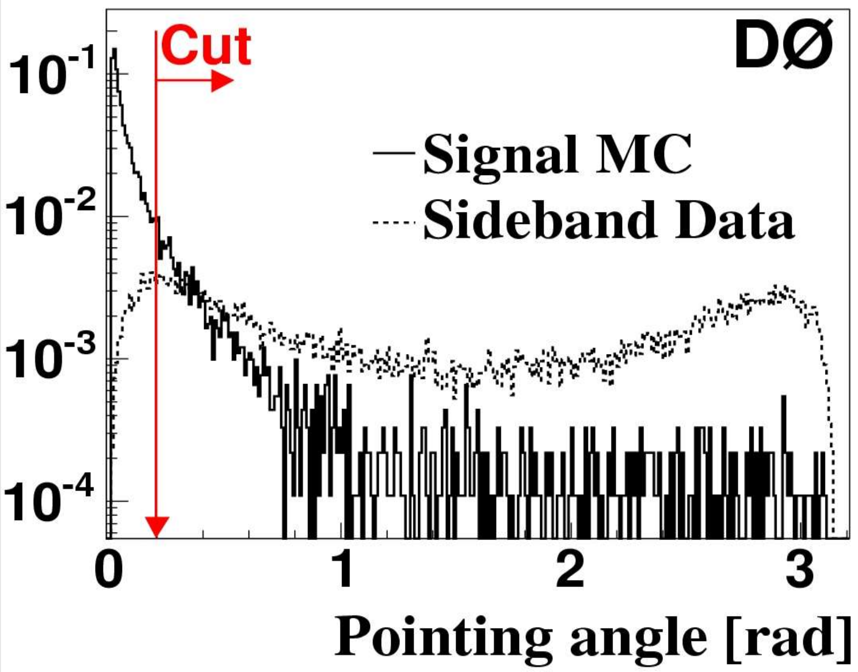
Clearly, having the narrowest possible mass peak is imperative.

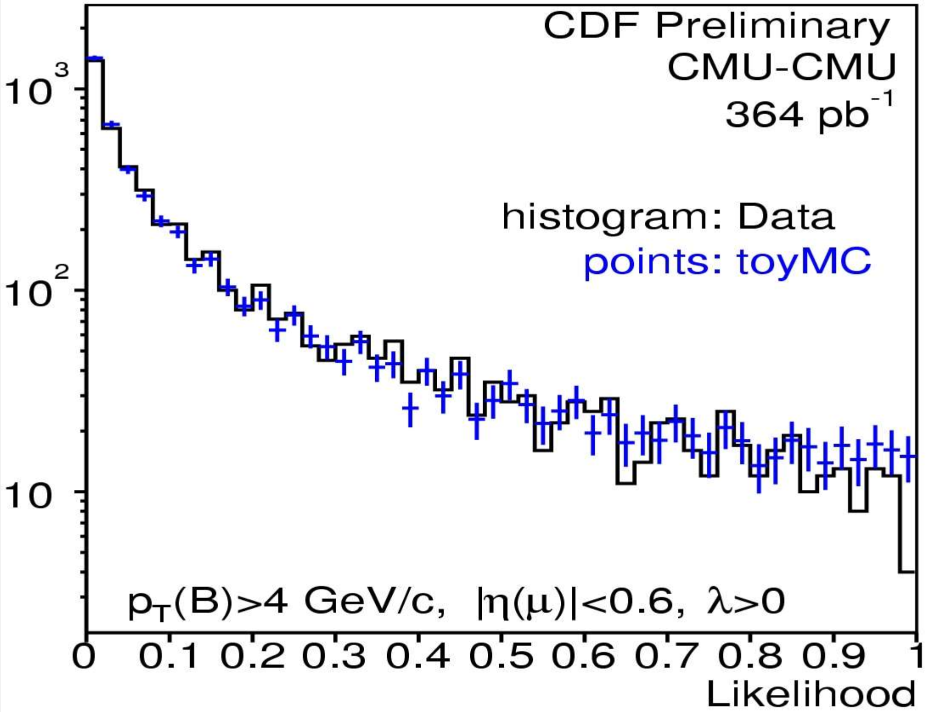
And more…

Some of the “handles” we can use to isolate any signal include:









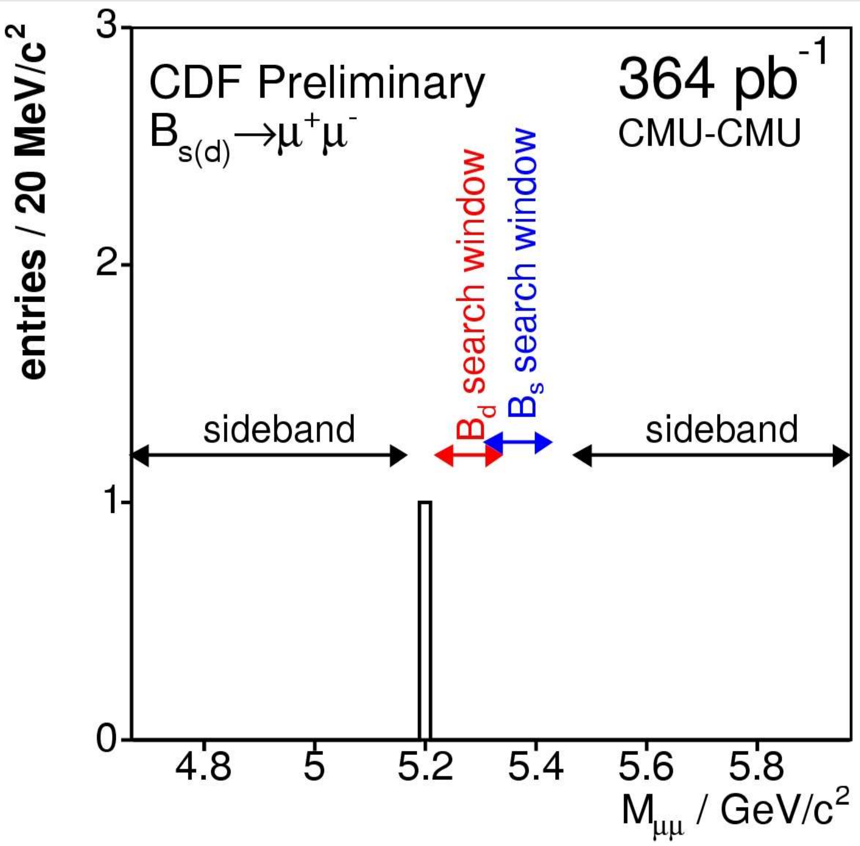
DØ and CDF results for $B_s \rightarrow \mu^+\mu^-$:

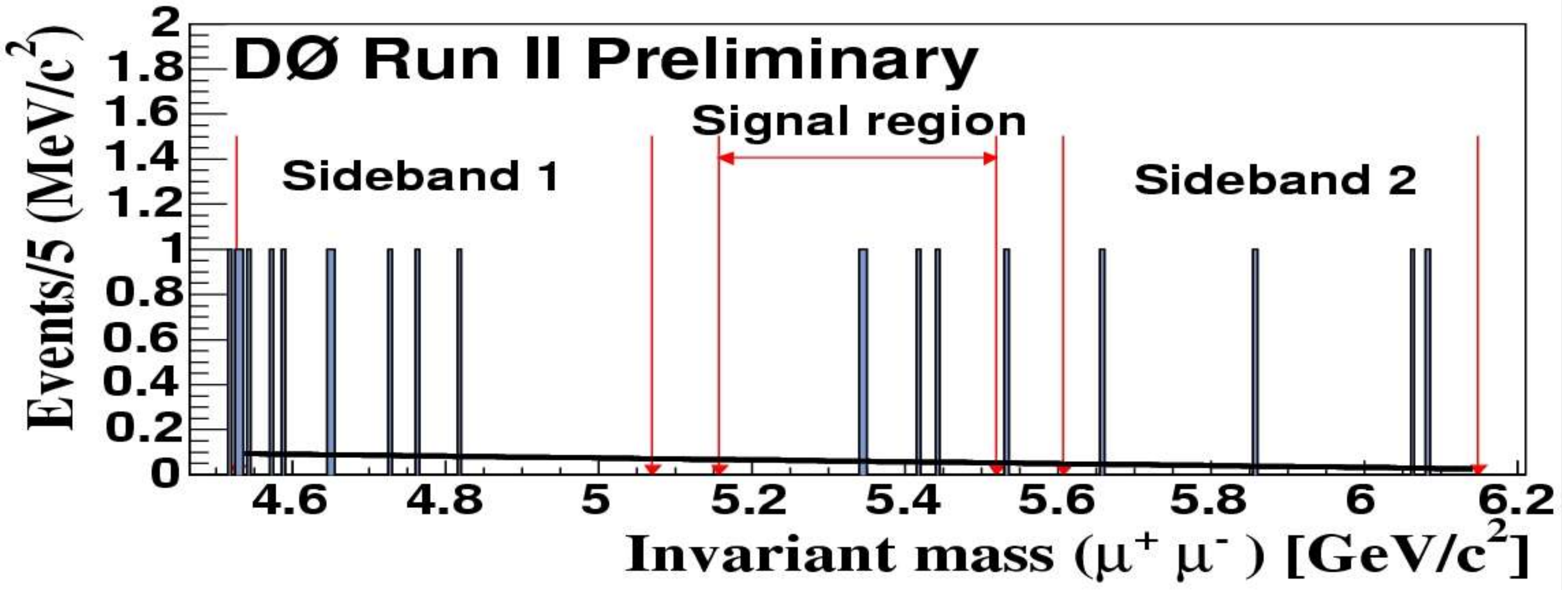
DØ: $Br(B_s \rightarrow \mu^+\mu^-) < 3.7\times10^{-7}$

CDF: $Br(B_s \rightarrow \mu^+\mu^-) < 2.0\times10^{-7}$

combined: $Br(B_s \rightarrow \mu^+\mu^-) < 1.5\times10^{-7}$

SUSY predictions range up to 5×10^{-8}.





After the TEVATRON: The LHC

We hope the TEVATRON will find the first evidence for SUSY.

However, it does not have the capability to study all SUSY particles in detail.

The **Large Hadron Collider (LHC)** will begin data taking in 2 – 3 years, at CERN in Geneva, Switzerland.

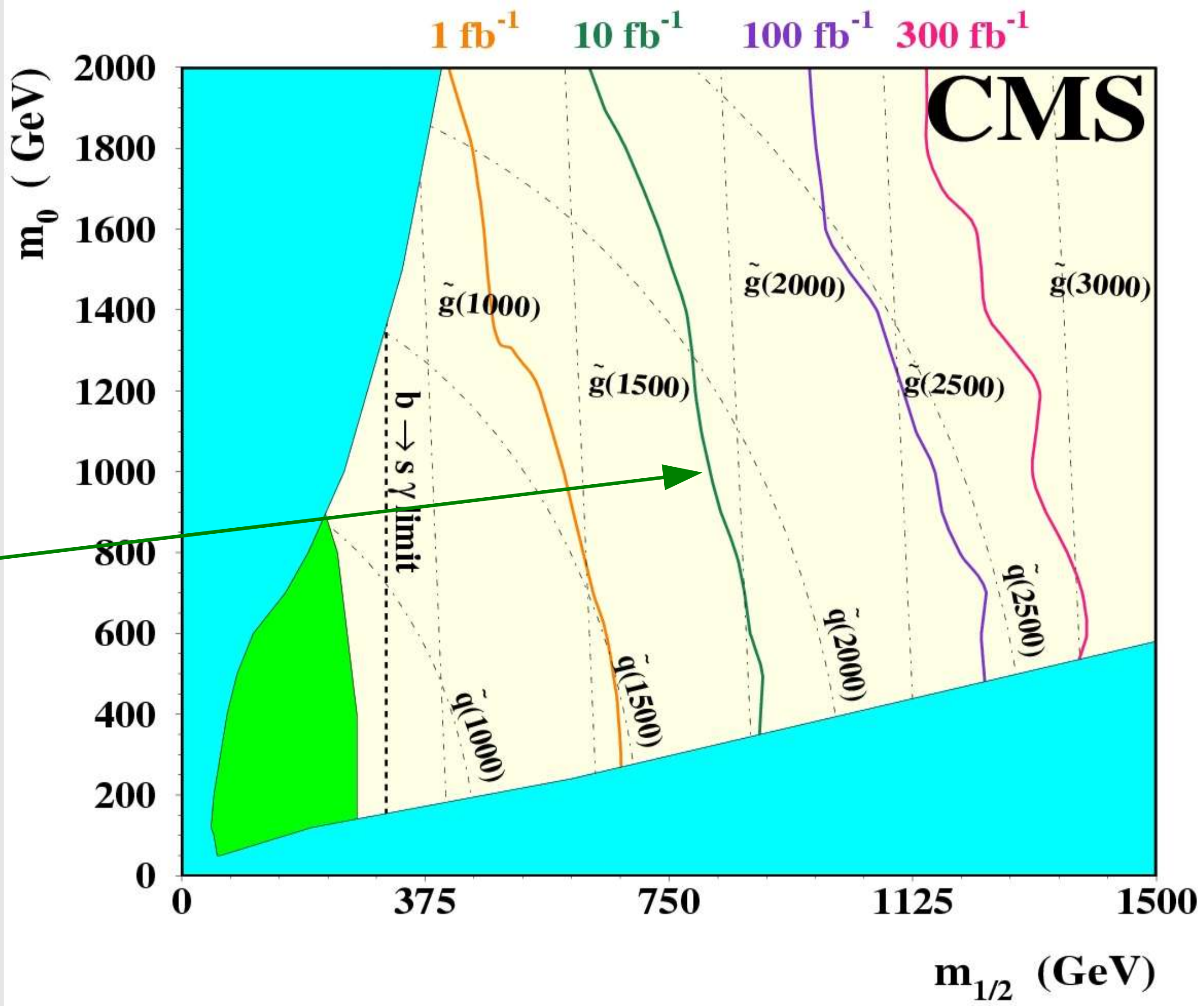
- collide protons and protons at **14 TeV** (Tevatron is 2 TeV)
- two experiments called **ATLAS** and **CMS**
- nominally "must" discover SUSY if it exists at "low" energy

As before, the *Experimenter's Toolkit* consists of leptons, jets, MET and photons, plus a bag of kinematic magic tricks.

We will consider two examples quickly to illustrate the promise of the LHC.

m_0 and $M_{1/2}$ are fundamental SUSY parameters (in the CMSSM version).
They control the masses of squarks and gluinos, and other particles.

This plot shows the reach of CMS as more and more data are collected.



Once the LHC is
up and running,
it will log a
luminosity $10\ \text{fb}^{-1}$
in one year.

(ATLAS has a very similar capability.)

Jets + MET at the LHC

Since the LHC has so much energy, one expects it will produce **all** squarks and gluinos.

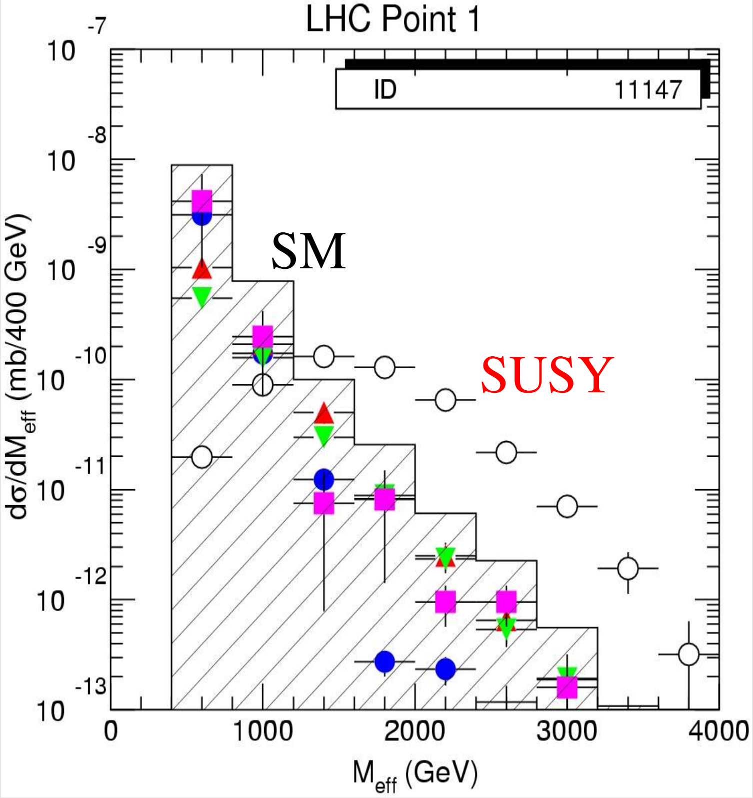
In our usual scenario, the decays of SUSY particles eventually yield two LSP's which results in large MET, and a number of energetic jets.

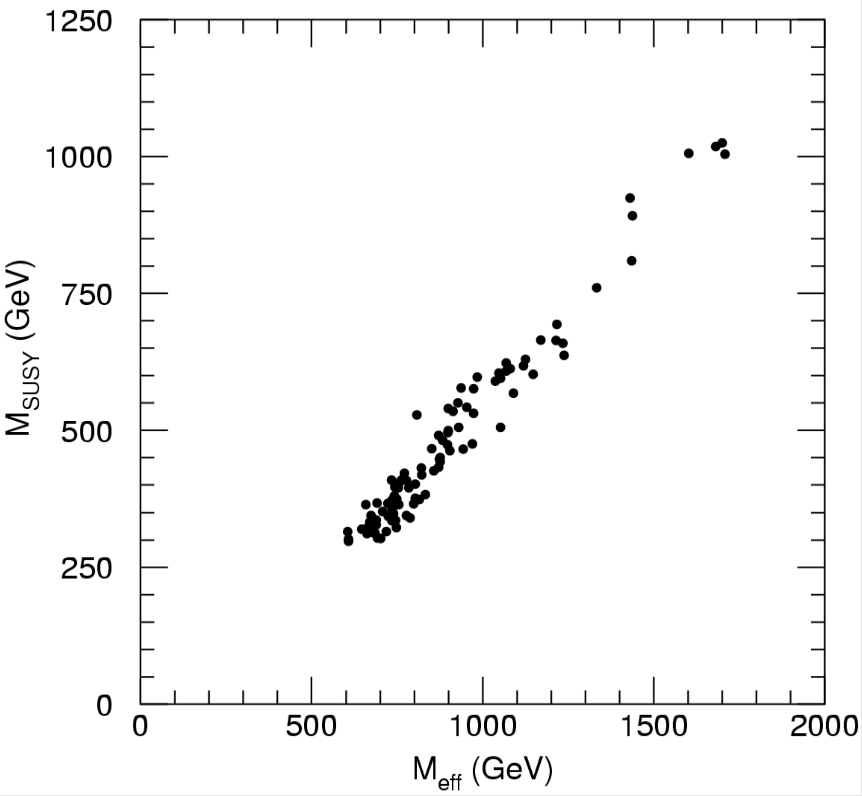
The production of squarks and gluons should be so copious that the simplest possible measure of “lots of energetic jets + MET” will already reveal SUSY beyond the SM.

$$M_{eff} = E_{T1} + E_{T2} + E_{T3} + E_{T4} + MET$$

correlates with SUSY mass scale!

hep-ph/9610544



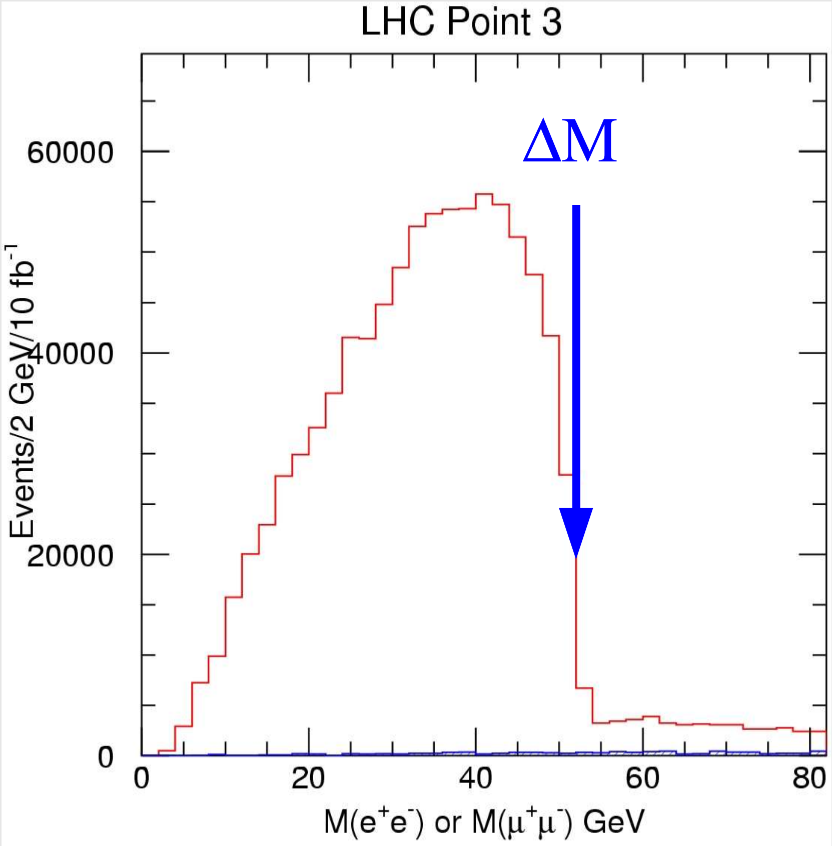


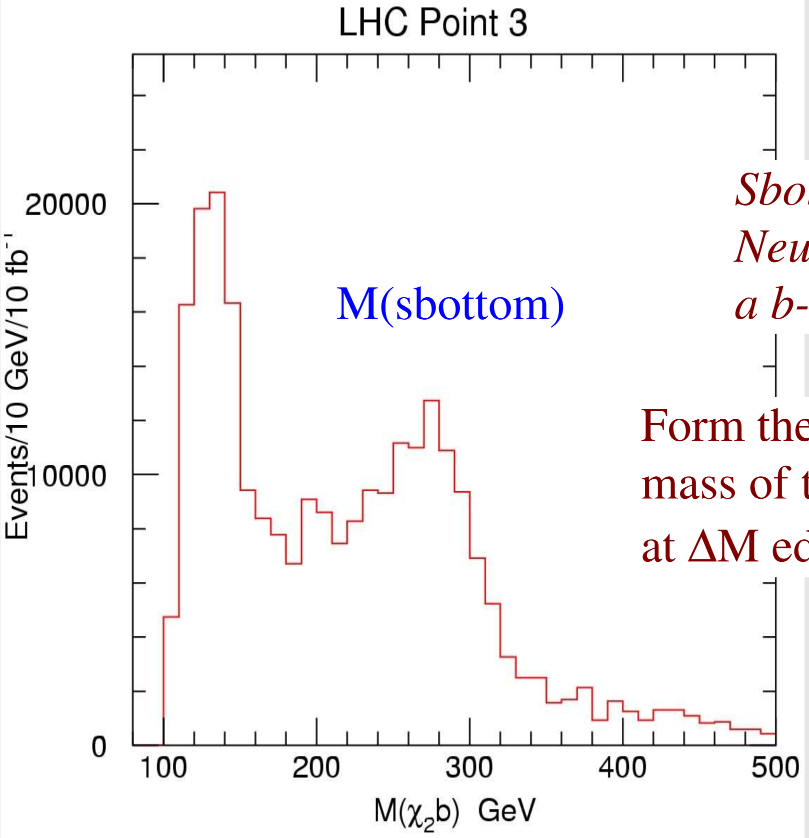
Lepton-based Searches at the LHC

Lepton-based signals could also be very impressive –
even the di-lepton + MET signature might be background-free!

With large distinctive signatures, we will be able to infer masses of SUSY particles (or combinations of SUSY particles).

Here is an example of a neutralino signal: $\tilde{\chi}_2^0 \rightarrow \mu^+ \mu^- \tilde{\chi}_1^0$





hep-ph/9610544

Sbottom decays to Neutralino(2) and a b-quark.

Form the invariant mass of the Neutralino(2) at ΔM edge, and a b-jet.

"Observation" of Dark Matter at the LHC

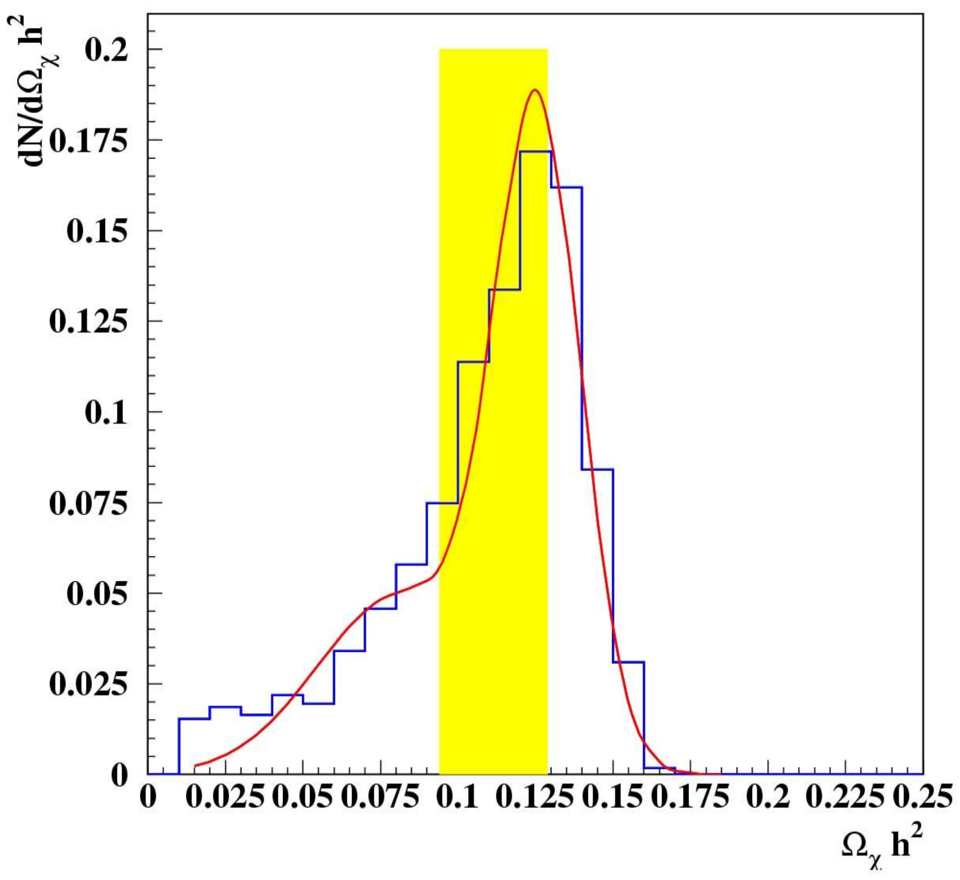
If SUSY is discovered and elucidated at the LHC,
can we confirm that it explains **Dark Matter**?

Yes!

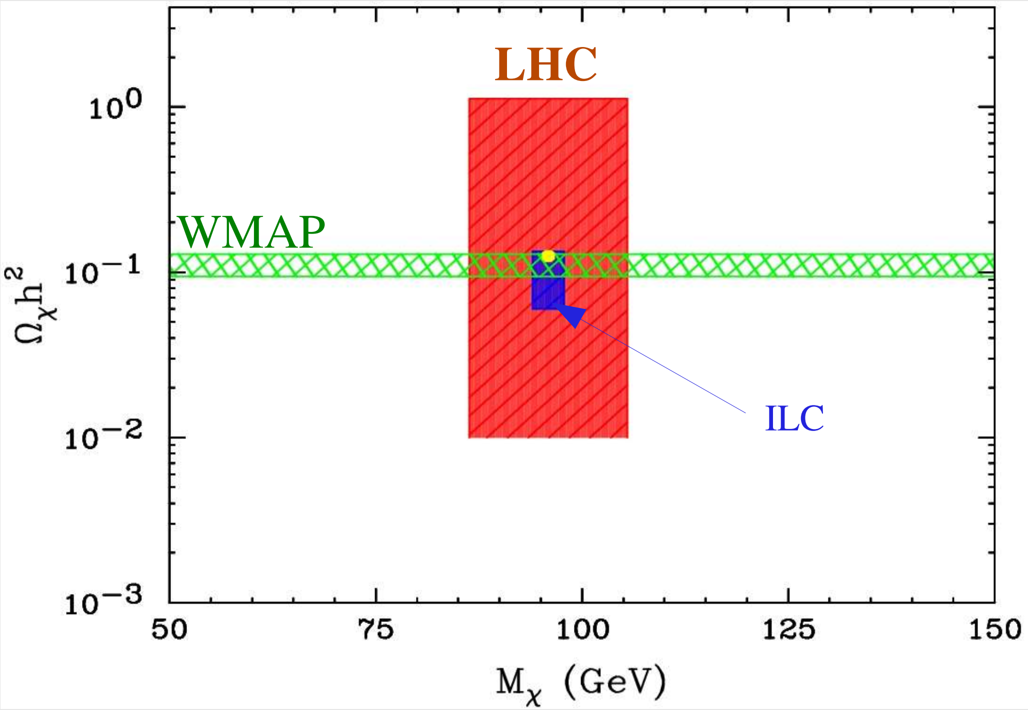
The fundamental SUSY parameters can be inferred with fairly good precision, and then used to calculate the DM relic density.

Finally, check the result against astrophysical observations:

hep-ph/0406147



hep-ph/0507214



(Assumed 10% measurements of some masses.)

Summary and Conclusions

- SUSY is a well-motivated theory, on theoretical grounds.
- SUSY predicts a variety of distinctive phenomena beyond the SM.
- Searches at the TEVATRON are under way, exploiting as much as possible the information coming from reconstructed jets, leptons and missing energy (MET).
- The LHC promises to be a SUSY factory, leaving a variety of signals to be studied.
- If so, we will begin to discern the correct form of SUSY and to fix fundamental parameters from judicious analyses of the data.

Of course, SUSY might not be the "right" theory, in which case we hope to discover whatever Nature has in store for us...

SUSY Review Articles

There are many excellent reviews of SUSY with a variety of perspectives.
Here is a limited list (no particular order) to get you started:

- D.I. Kazakov, *In Search of Supersymmetry*, hep-ph/0012288
- J. Ellis, *Supersymmetry for Alp Hikers,* hep-ph/0203114
- S. Dawson, *SUSY and Such*, hep-ph/9612229
- G. Kane, *Weak Scale Supersymmetry – a Top-motivated, Bottom-up Approach,* hep-ph/0202185
- S. Martin, *A Supersymmetry Primer,* hep-ph/9709356
- M. Carena et al., *Search for Supersymmetry at the Tevatron Collider,* hep-ex/9712022
- H. Murayama, *Supersymmetry Phenomenology*, hep-ph/0002232
- etc.