Search for Supersymmetry at CDF **using Trileptons**

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Wine and Cheese Seminar

FERMILAB, 8th February 2008

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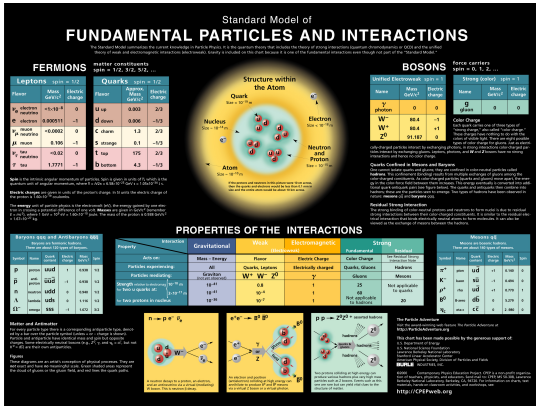
OUTLINE

- PART I : Introduction
- PART II : Data and Analysis
- PART III : Interpreting the Results

PART I
Introduction

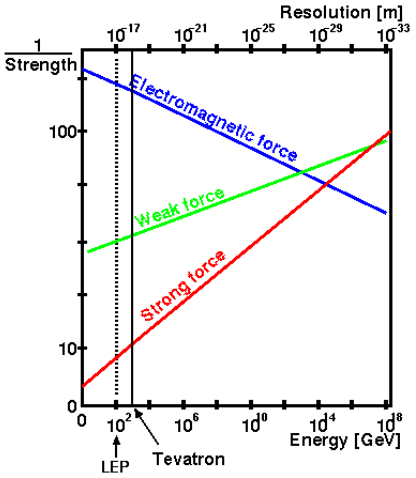
Beyond Standard Model

Standard Model does fantastic job of explaining our world (up to EWK scales)
Precision tests upto few parts per million confirm SM



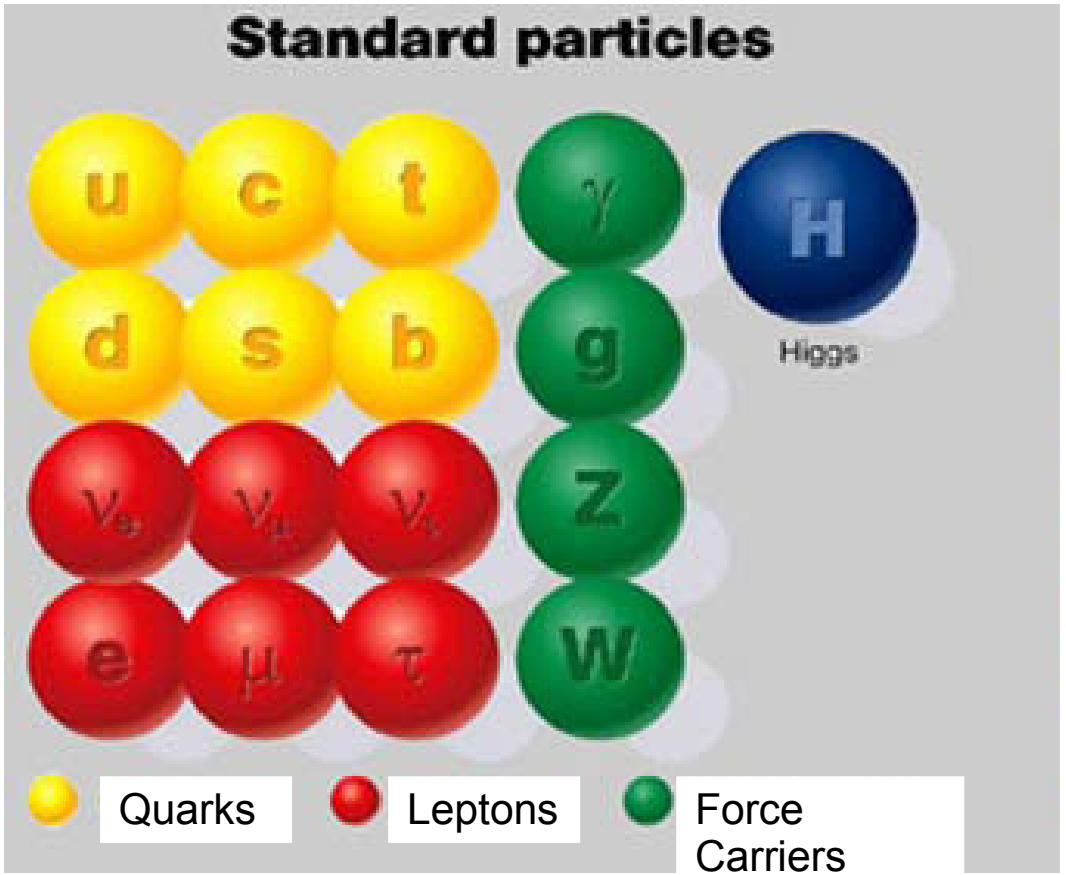
BUT,

- Including gravity
- What is Dark Matter/Dark Energy?
- Matter-Antimatter asymmetry in the universe
- Why three generations?
- Hierarchy problem



Supersymmetry

Proposes a new symmetry
Fermions ↔ Bosons

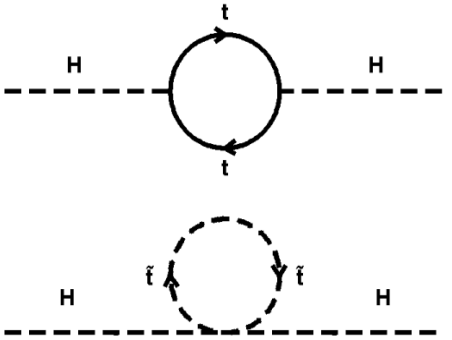


Every fermion has a boson superpartner & vice versa
R-parity : $R_p = (-1)^{B+L+2s}$

electron → selectron
R_p=1 R_p=-1

photon → photino
R_p=1 R_p=-1

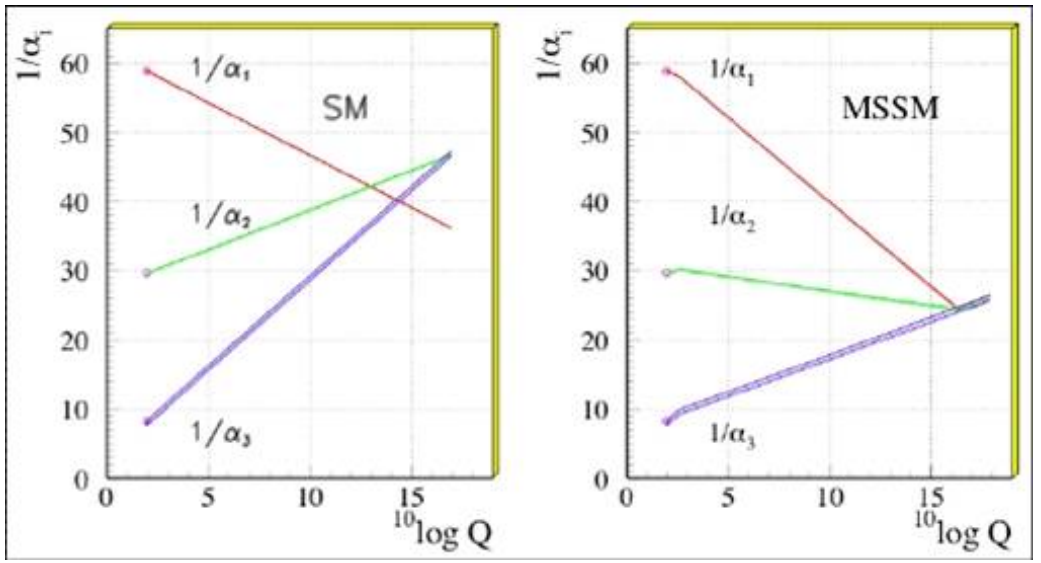
Supersymmetry



Supersymmetry solves the hierarchy problem

Also provides an excellent dark matter candidate (R_p conservation → LSP)

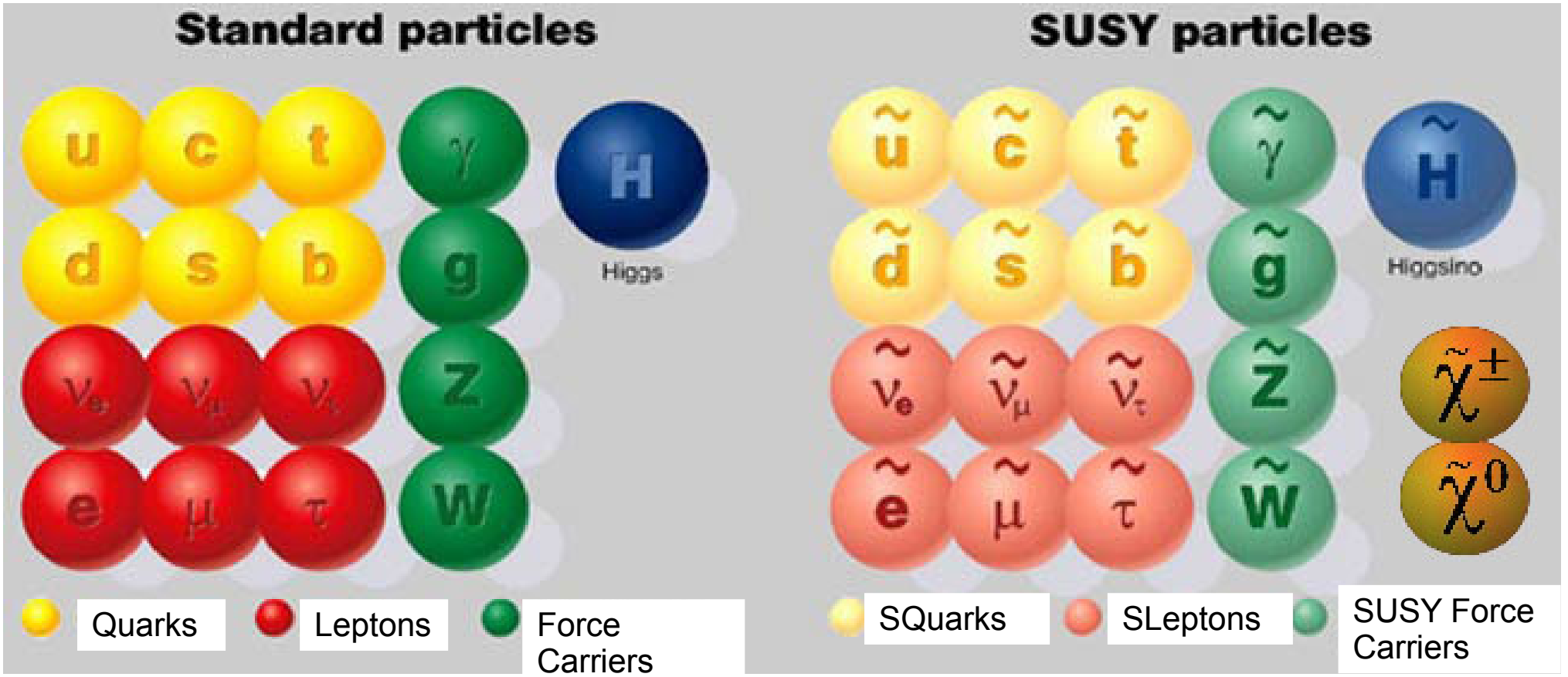
Gauge couplings are unified much better



27 down, 73 to go!!

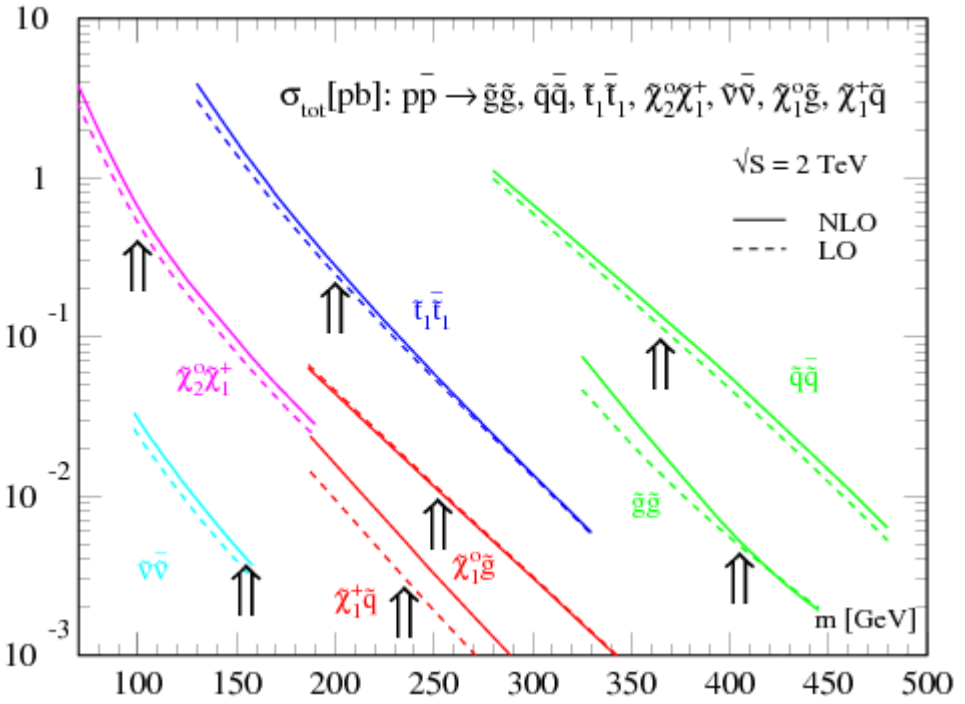
Particles x 2 Supersymmetry

Proposes a new symmetry
Fermions ↔ Bosons



Supersymmetric Particles

T. Plehn, PROSPINO



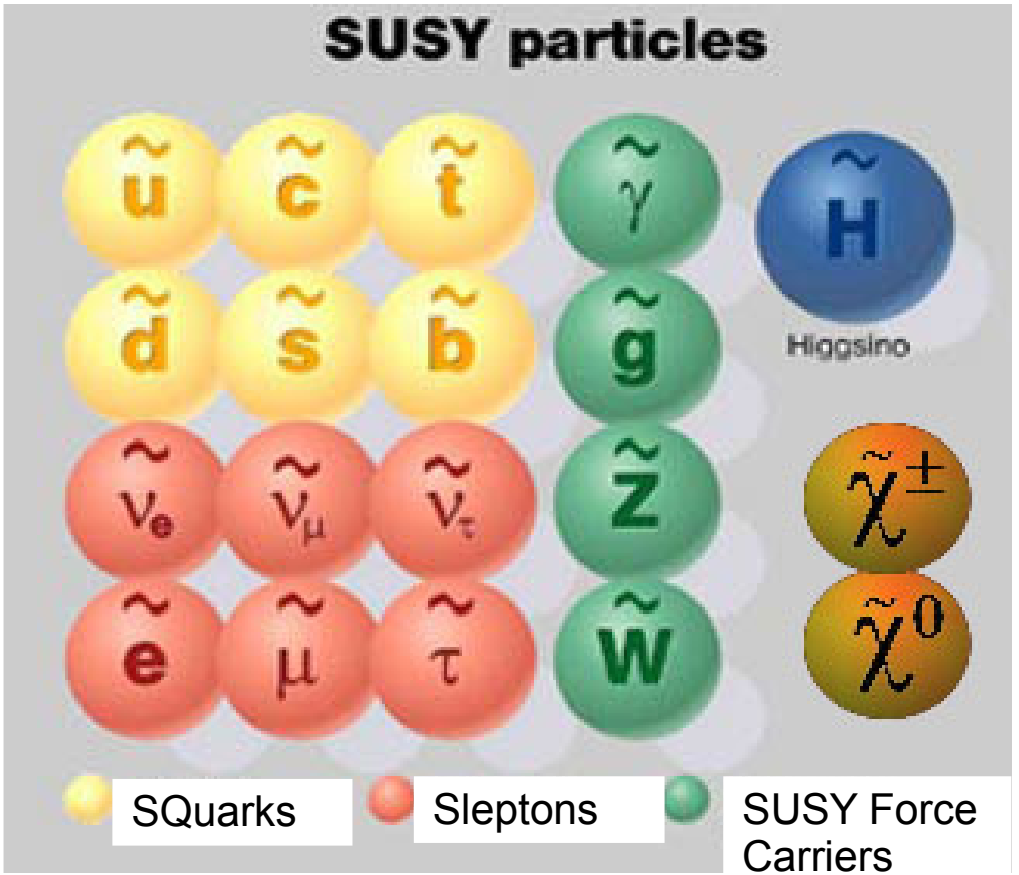
One can (and does) look for all types of supersymmetric particles :

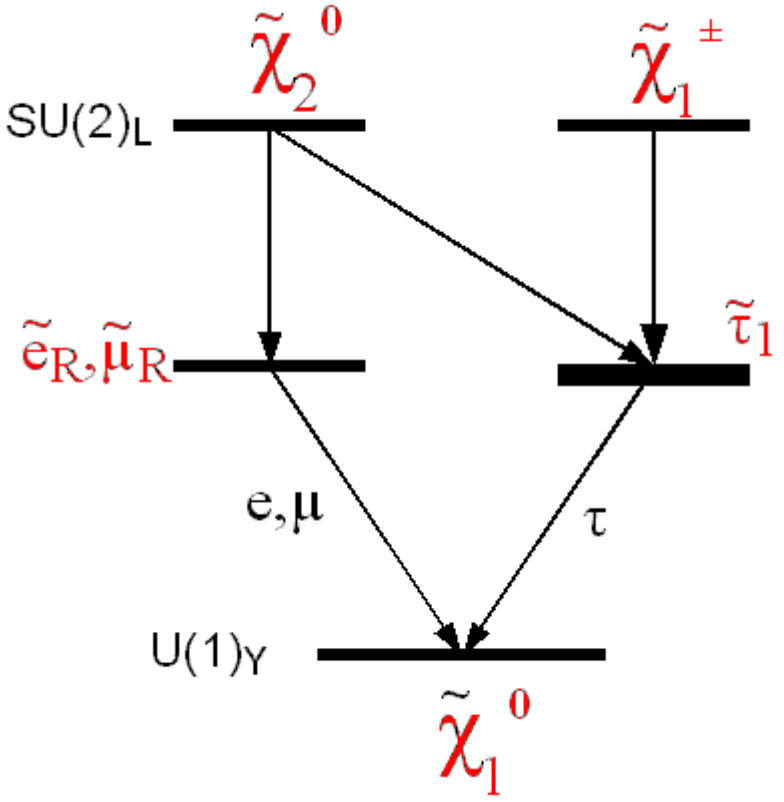
- Squarks (Stops and Sbottoms)
- Gluinos
- Chargino-Neutralinos

But Chargino-Neutralino decays are good experimentally because they **decay to leptons** (among other things) which makes identifying them easier .

Charginos and Neutralinos

- W's and Z's of Supersymmetry
- Charginos($\chi^{\pm}$) & Neutralinos (χ^0) are mixtures of the higgsino, binos and winos.
- There are four neutralinos and two charginos.





mSUGRA

mSUGRA -- minimal SUper GRAvity grand unification

why? a) Widely used as a standard candle by Run I, LHC TDR's etc.

b) Manageable due to five parameters

Defined by five parameters

m_0 : common scalar mass at GUT scale

$m_{1/2}$: common gaugino mass at GUT scale

$M_1(GUT)=M_2(GUT)=M_3(GUT)= m_{1/2}$

$\tan(\beta)$: ratio of Higgs vacuum expectation values

A_0 : common trilinear scalar interaction at the GUT scale (Higgs-sfermionR-sfermionL)

sign(μ) : μ is the Higgsino mass parameter ($|\mu^2|$ determined by EWSB)

Signal Benchmark Point (BP) with parameters :
mSUGRA m_0=60, $m_{1/2}$=190, $\tan(\beta)$=3, A_0=0, μ>0

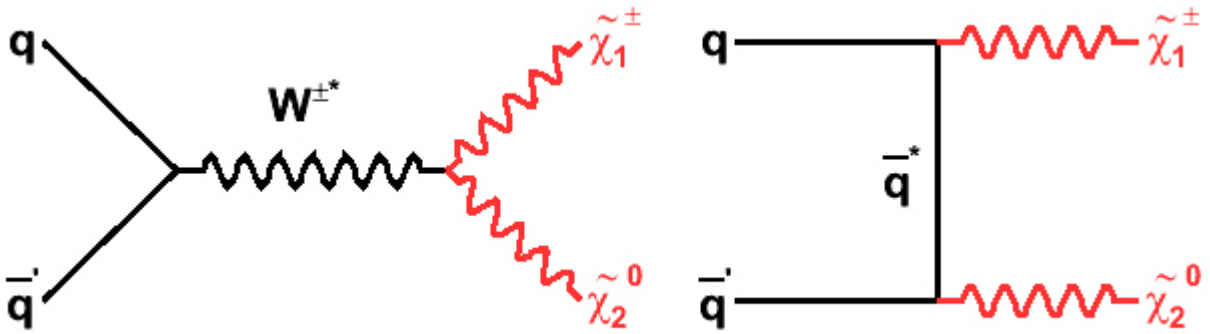
Spectrum (at BP) GeV

$\tilde{\chi}_2$	124
$\tilde{\chi}_1^{\pm}$	122
$\tilde{\chi}_1^0$	66
$\tilde{e}_L$	149
$\tilde{e}_R$	101
$\tilde{\tau}_1$	100
$\tilde{\tau}_2$	150
$\tilde{g}$	477
$\tilde{u}_R$	421
$\tilde{d}_L$	439

Chargino/Neutralino Production

We assume R_p is conserved –
SUSY particles are produced in pairs.

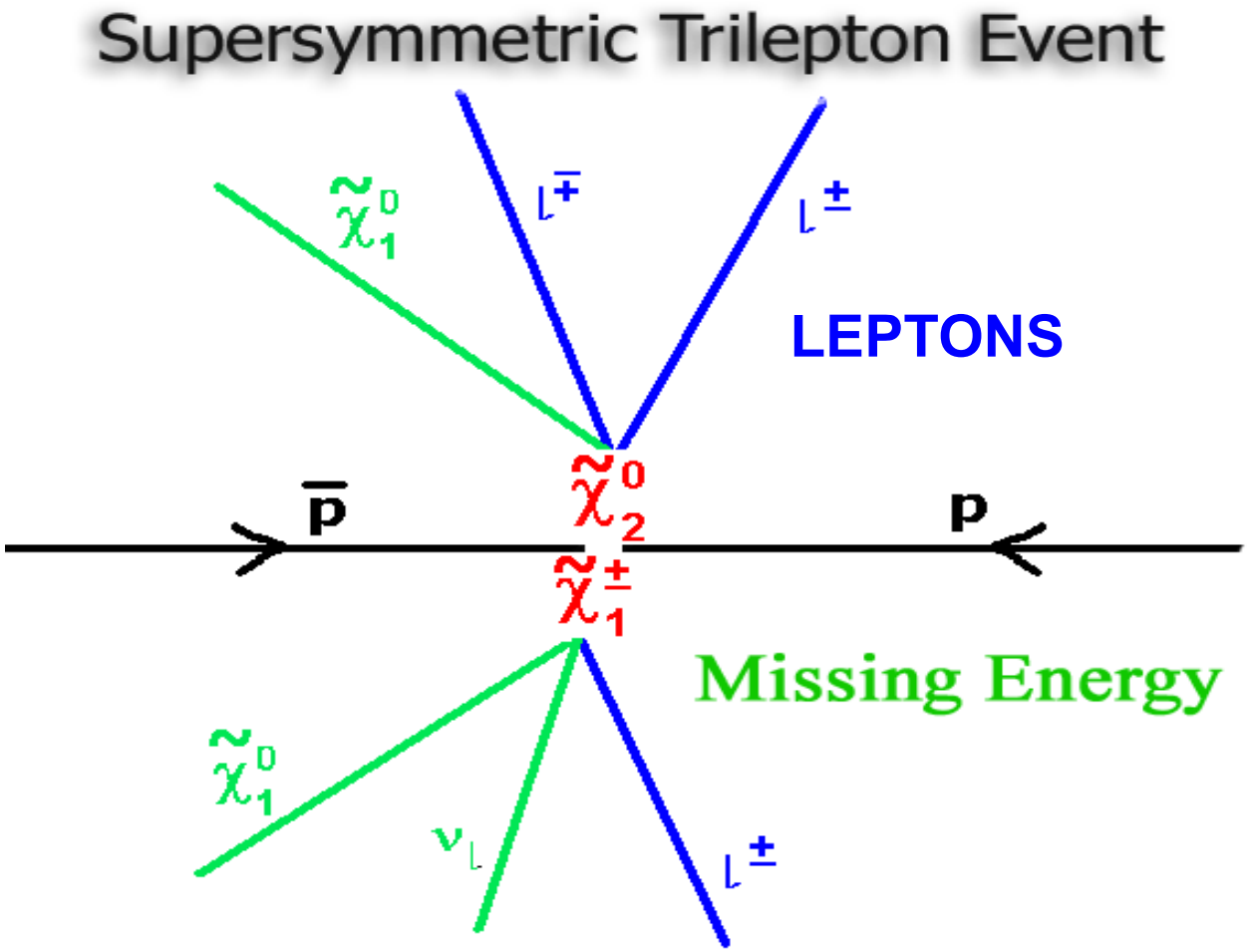
We have the associated production of chargino and neutralino



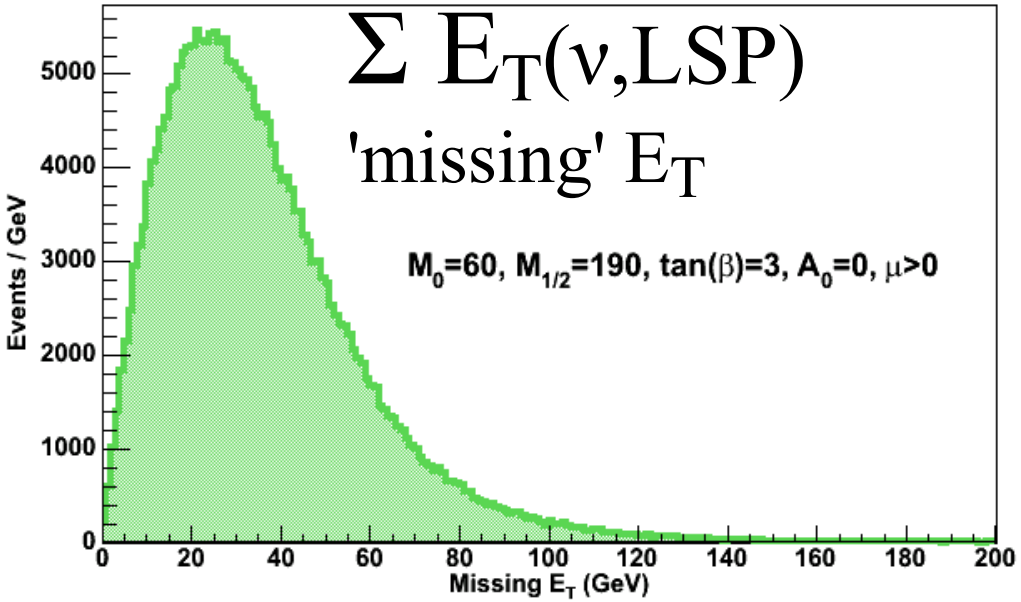
Chargino/Neutralino Trilepton Decay

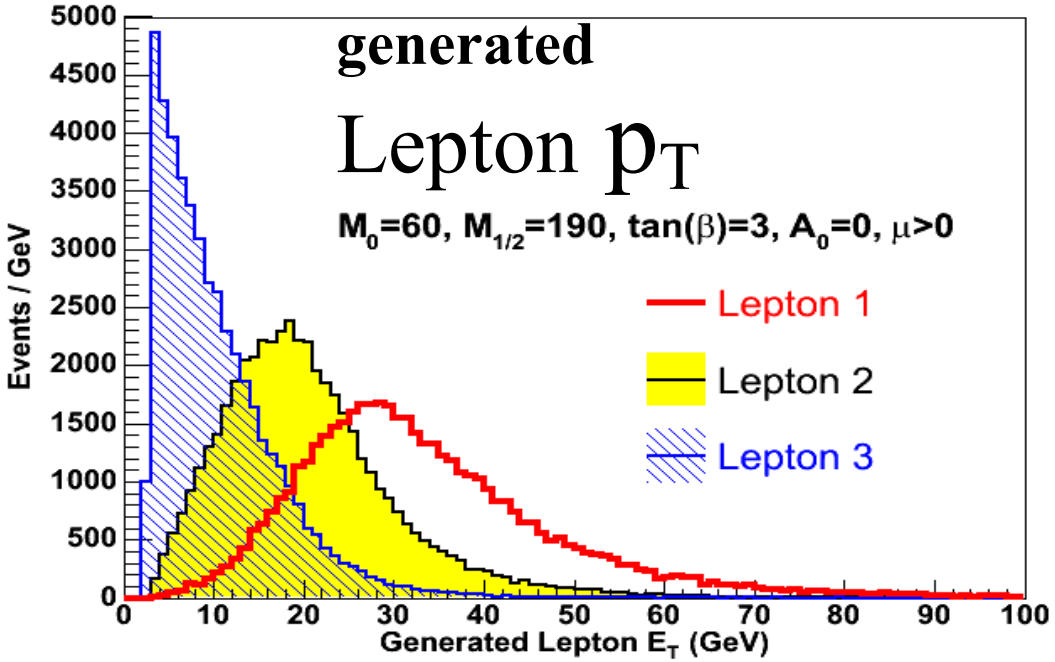
Charginos/Neutralinos decay via virtual W,Z or sleptons.

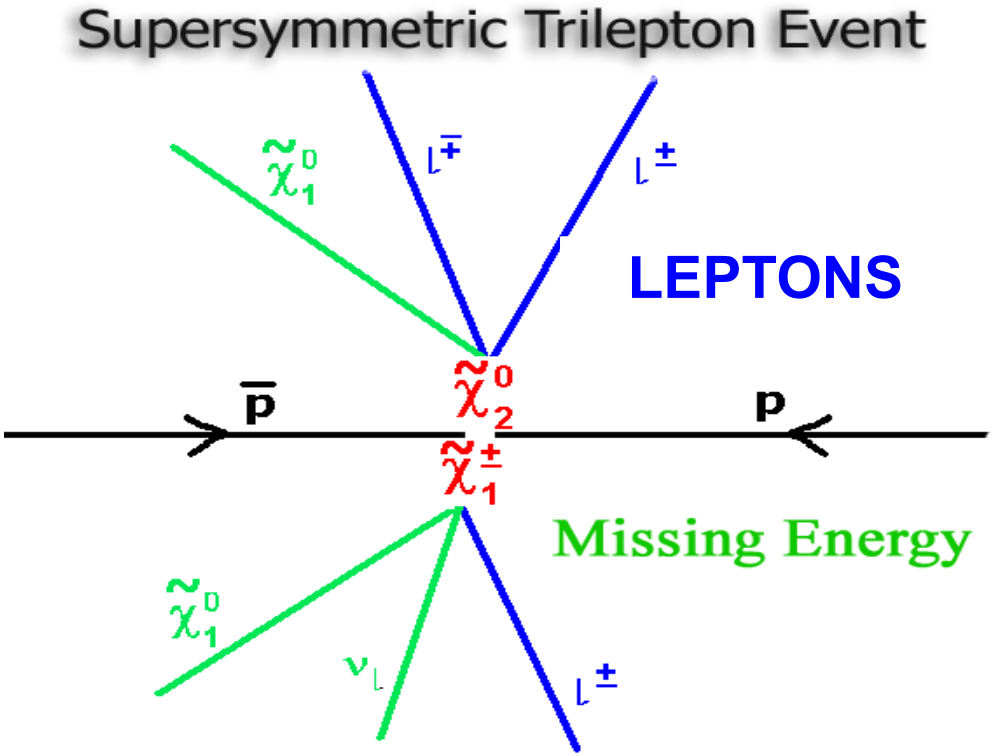
Observe three leptons + missing energy from decays of lightest Chargino $\tilde{\chi}^{\pm}_1$ and next-to-lightest Neutralino $\tilde{\chi}^{0}_2$



Signature of Interest







Signal and Background Cross sections

SIGNAL = 3 leptons + MET

σ(Signal)~0.5pb, for benchmark point Mass(Chargino) = 120 GeV/c^2

MET=missing transverse energy

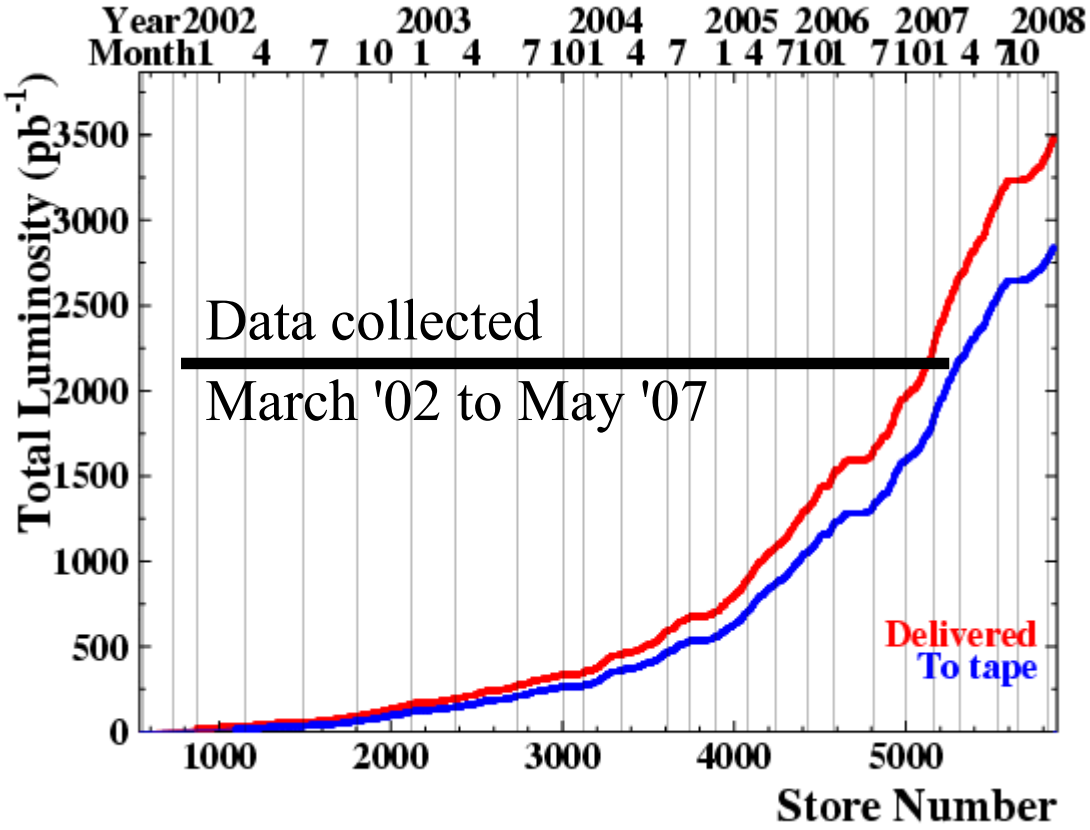
Process	σ(bkg)/σ(sig)	What it has	What it needs
WZ→lllυ	~ 1	3 leptons + MET	-
ZZ→llll		≥ 3 leptons	MET
WW→llυυ		2 leptons + MET	1 lepton
Top-pair	~ 10	3 leptons + MET	-
DY→ll	~ 1000	2 leptons	1 lepton + MET
Zγ→llγ	~ 30	≥ 3 leptons	MET
W→lυ	~ 5000	1 lepton + MET	2 leptons

PART II
Data and Analysis

Data

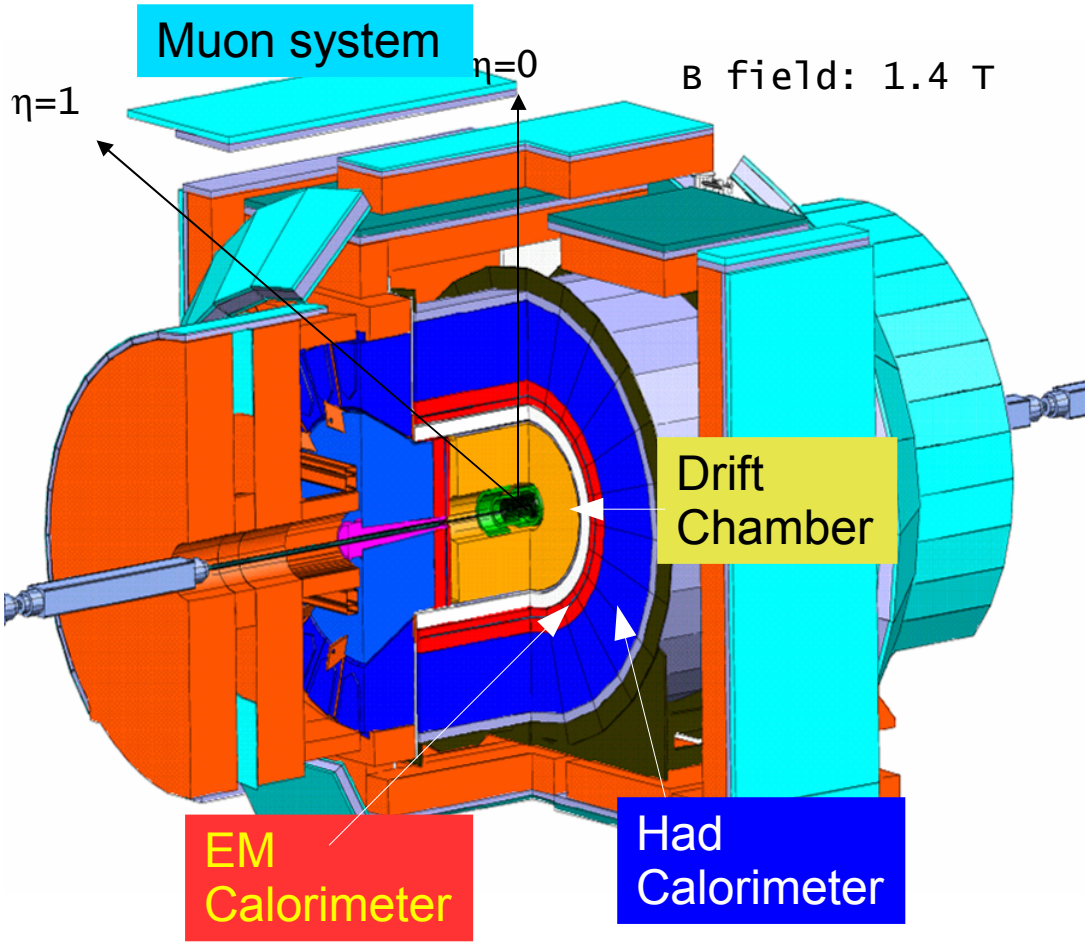
Proton-antiproton collisions at 1.96 TeV

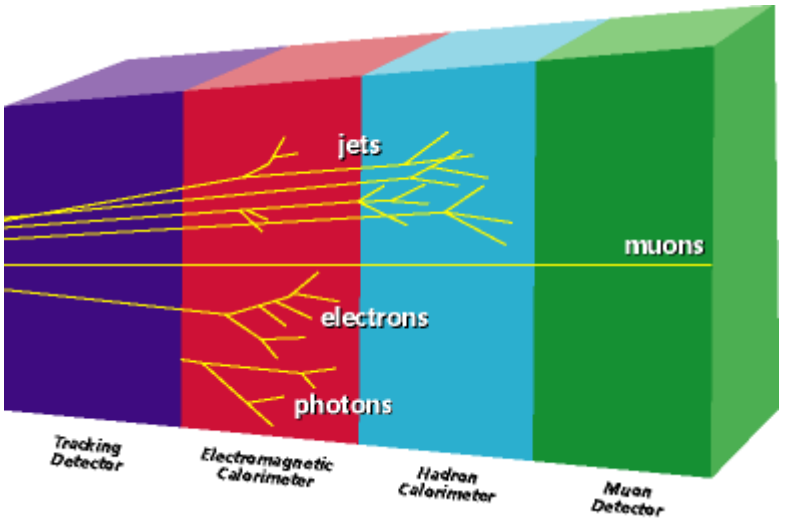
Thanks to Accelerator Division!!



Total Integrated Luminosity for this result is 2.0 fb^{-1}

CDF Detector





Multipurpose Detector :

radially outward – silicon detector, tracking chamber, EM and Had Calorimeters, Muon systems

Three Leptons : Types

Electrons are a track [charged particle] + EM shower

Muons are a track + no shower in CAL + signal in muon systems

Tau leptons decay to electrons or muons (see above) BR=35%

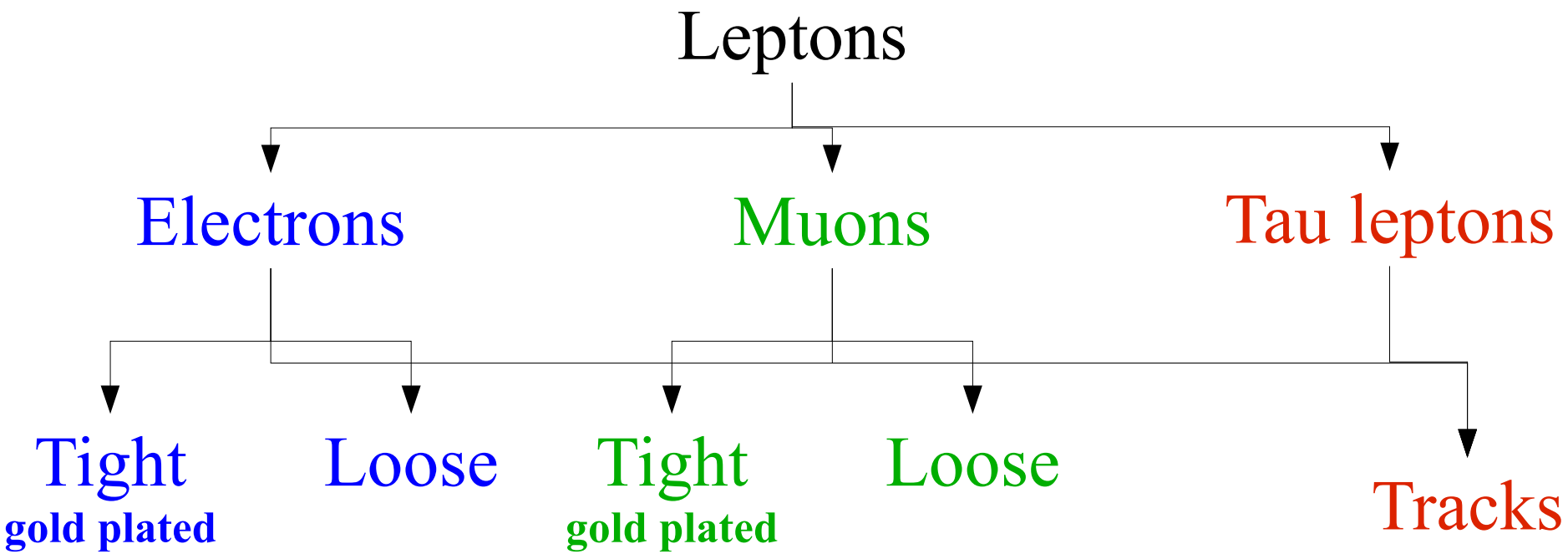
decay hadronically single-prong (1 charged particle) BR=50%

use an 'isolated' track to identify single-prong decays

(Not yet : decay hadronically three-prong (3 charged particle) BR=15%)

Use isolated tracks as a proxy for tau leptons.
But isolated *tracks also catch electrons or muons*
which are not gold-plated

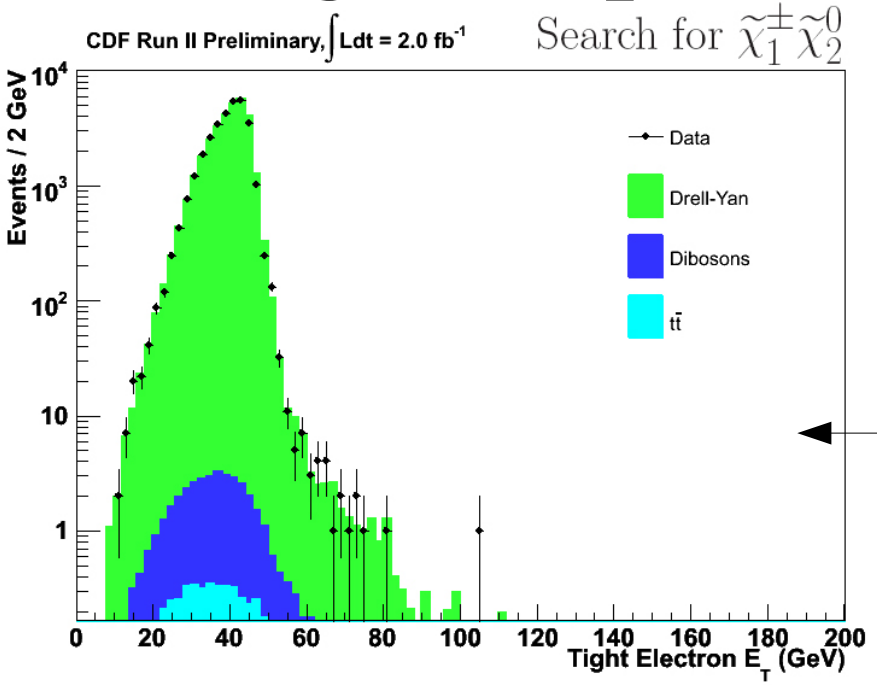
Three Leptons : Types



For example, Loose Electron has E/p < 2 and HadE/EmE < 5%
Tight Electron has additional requirements based on shower shape of electron in calorimeter, pointing of track to calorimeter shower etc.

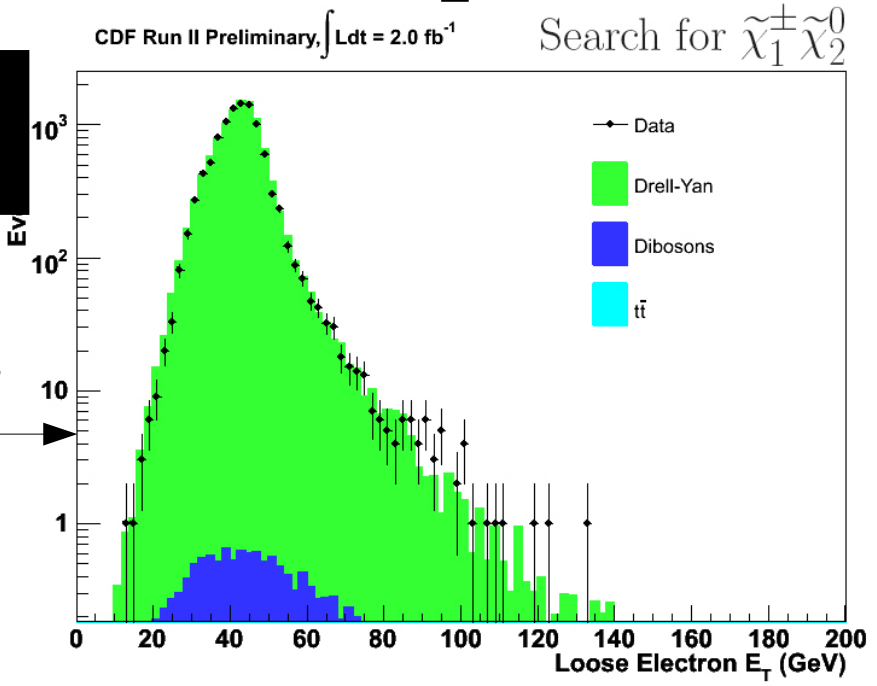
Tight Leptons

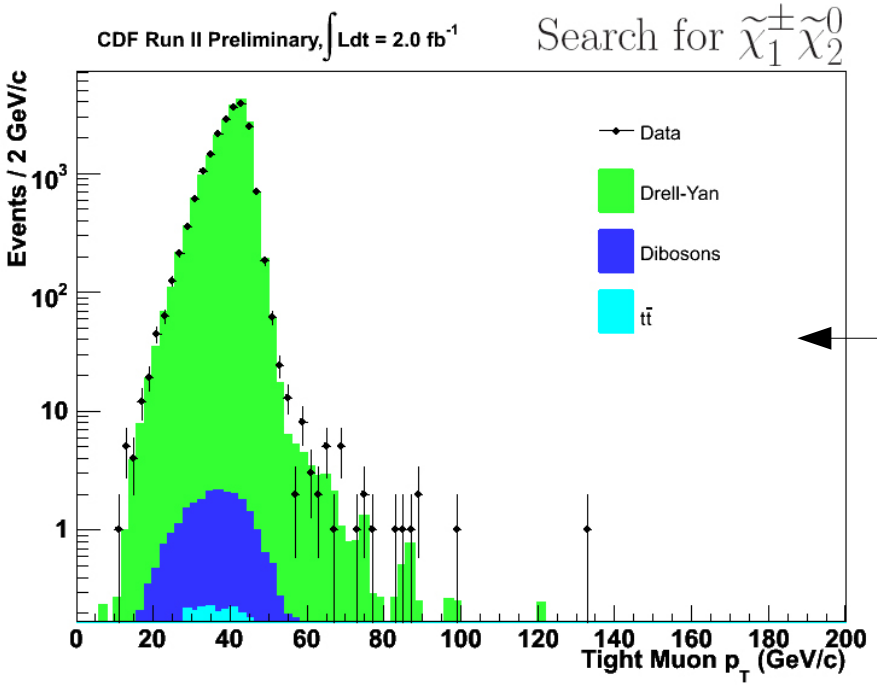
Loose Leptons



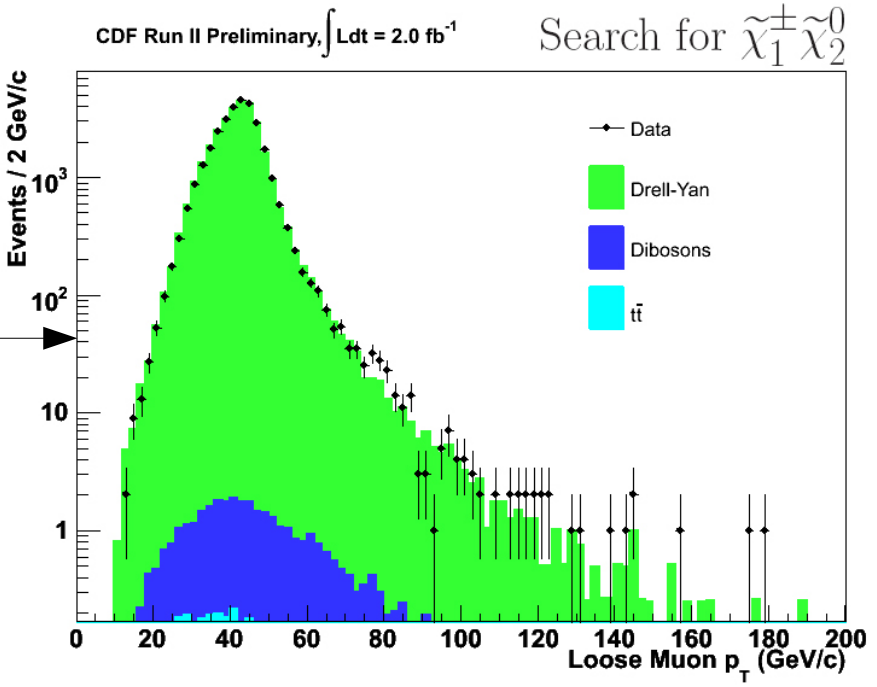
"Z" events

Electrons





Muons



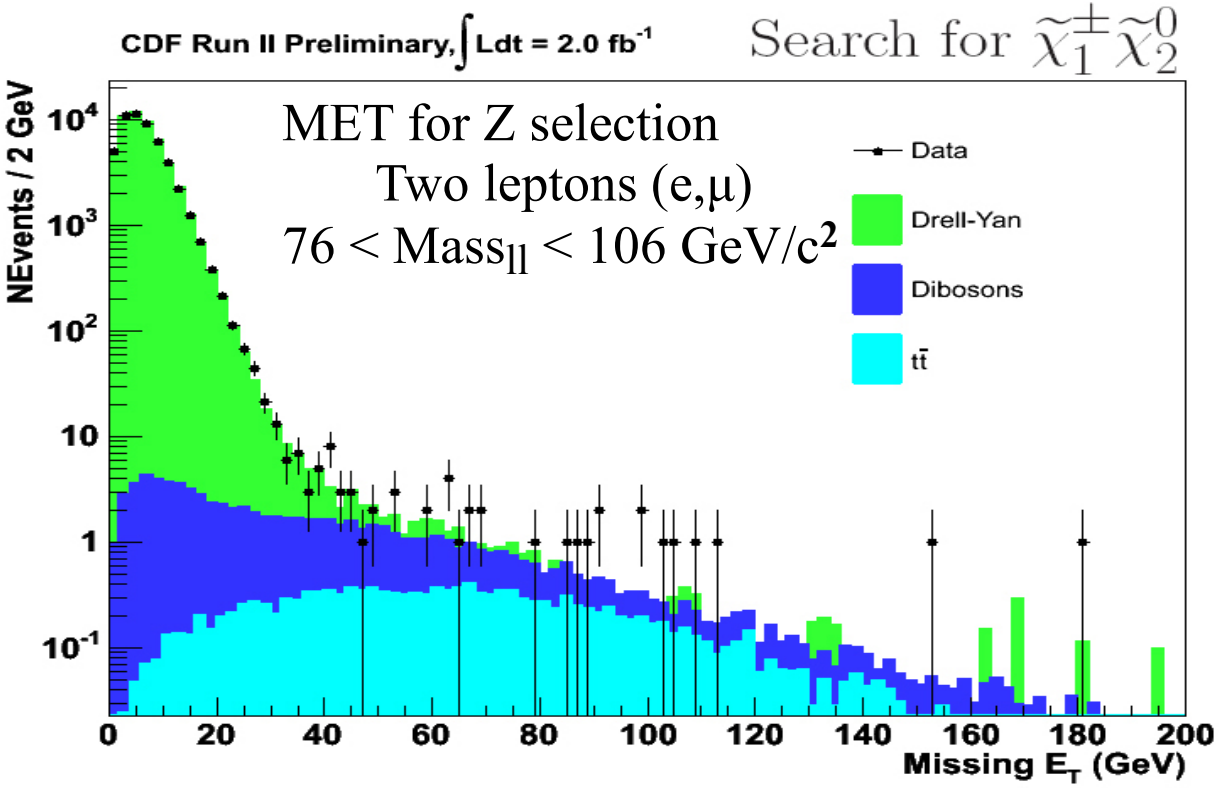
ube, Rutgers

Missing E_T

Missing energy known in transverse direction → missing E_T or MET

MET is calorimeter based

Real MET → Neutrinos (and SUSY particles, if they exist)



Instrumental MET →

- mismeasurement of jet energies
- not accounting for muons

We correct MET

✓ for jets

✓ for muons

SM Backgrounds

Our signature is three leptons + missing energy –
What SM processes also look like this?

Process	
WZ	3 leptons + missing E_T
ZZ	4 leptons
top-pair	3 leptons + missing E_T
DY	2 leptons
WW	2 leptons + missing E_T
	a) + γ conversion
	b) + track from underlying event
	c) + hadron misidentified as lepton
W+jets	1 lepton + missing E_T
	a) + track from jets
	b) + hadron misidentified as lepton

Three Real Leptons

Two Leptons + 'Fake'

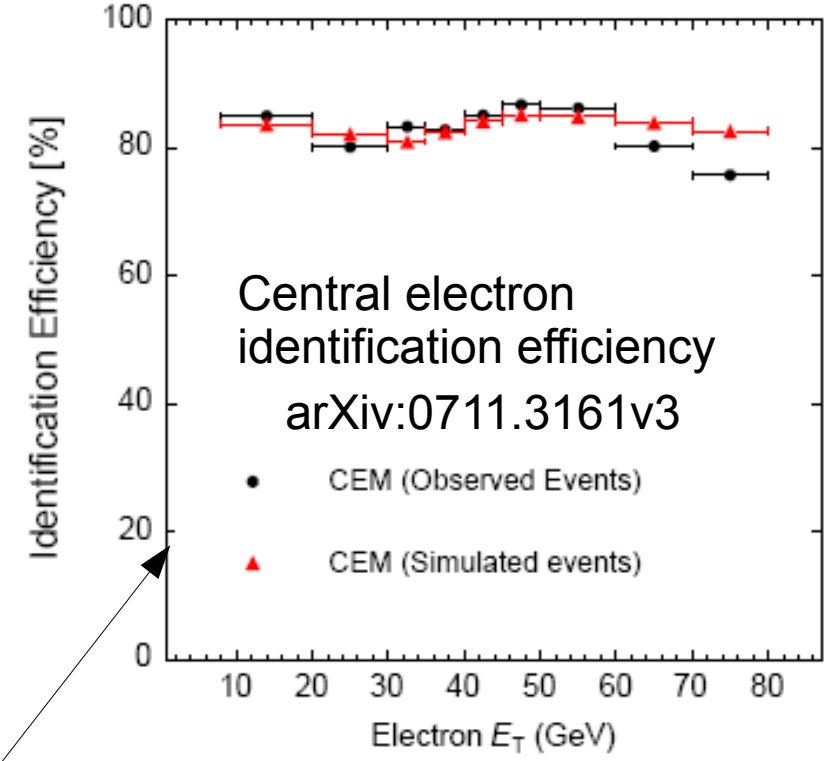
Estimating Backgrounds

Three real leptons :

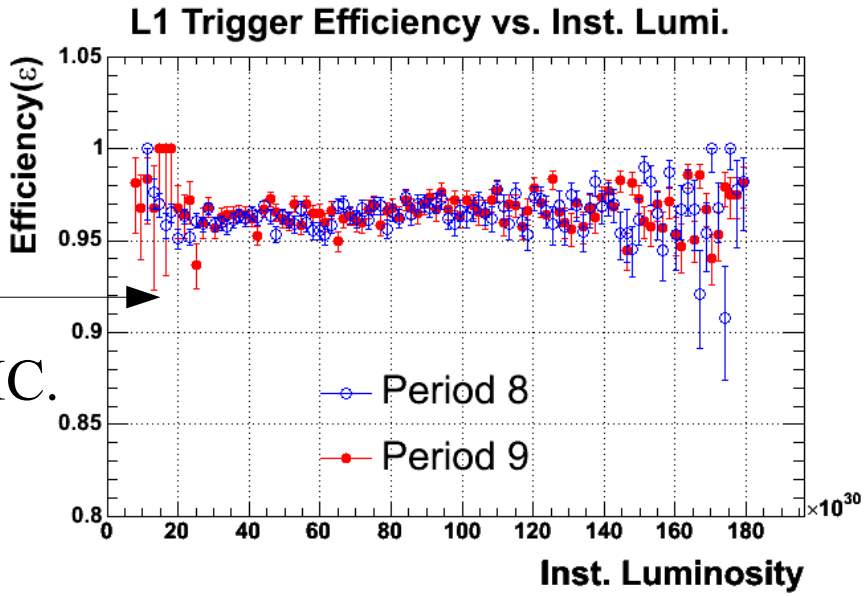
Backgrounds from WZ, ZZ, top-pair are obtained from Monte Carlo(MC) simulations.

DY + γ :

also obtained from MC simulations.



Lepton identification efficiencies and trigger efficiencies used to get correct predictions in MC.



Estimating Backgrounds

Rate for Leptons :

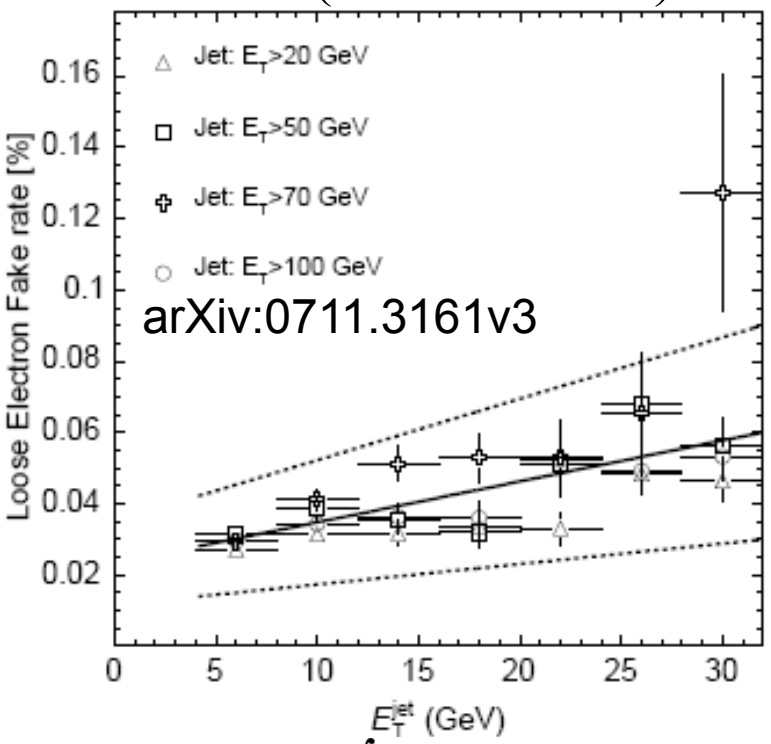
DY + (had→lep)

WW + (had→lep)

W+jets + (had→lep)

Estimated in **DATA**

Rate (Jet→Electron)



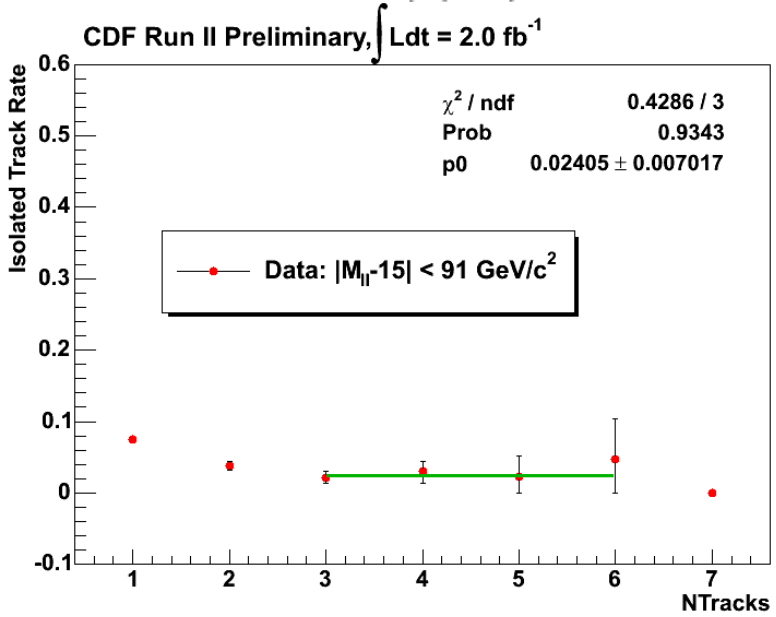
Rate for Candidate Tracks:

DY + track

WW + track

Estimated in **MC**

(but, normalized to data)



Setting up the Analysis

Perform an unbiased counting experiment :

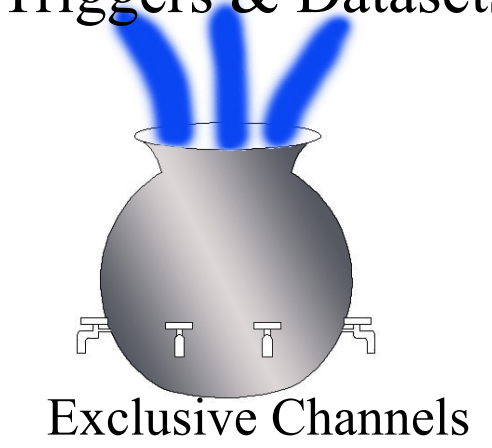
- Define event selection
- Test predictive ability in a set of control regions
- Predict number of events in signal box
- Look at data and claim discovery or set limit.

Setting up the Analysis

Challenge : Overlapping datasets with multiple trigger paths.

Channels in this analysis are

A) Mutually **exclusive** and,
B) Ordered in terms of purity (S/B).



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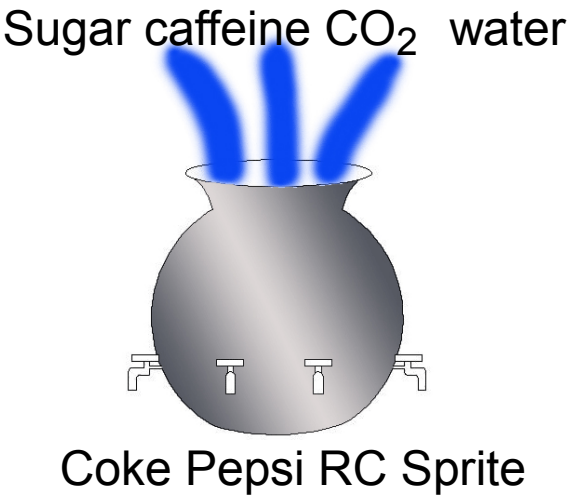


S/B

Find three tight leptons

Else, two tight leptons and a loose lepton.

Else, one tight and two loose leptons.

Else, two tight leptons and one isolated track.

Else, one tight, one loose lepton and one isolated track.

Setting up the Analysis

The five exclusive channels :

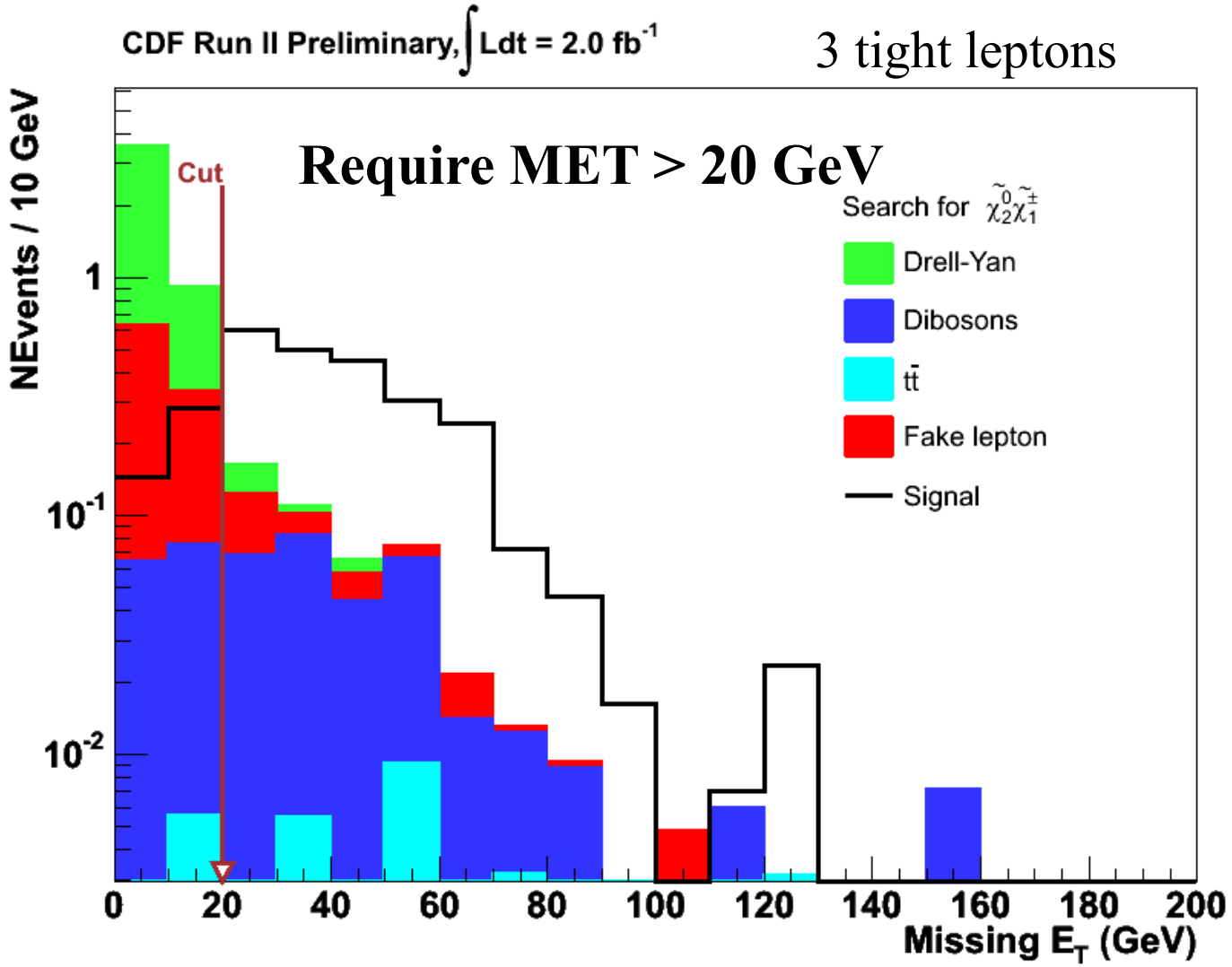
Channel	E_T (P_T) GeV
3 tight leptons OR 2 tight leptons + 1 loose electron	**15, 5, 5**
2 tight leptons + 1 loose muon	**15, 5, 10**
1 tight lepton + 2 loose leptons	**20, 8, 5 (10 if loose muon)**
2 tight leptons + 1 Track	**15, 5, 5**
1 tight lepton, 1loose lepton, 1 Track	**20, 8(10 if loose muon), 5**

The five exclusive channels constitute five independent experiments within CDF

Reducing Backgrounds

Process		How to reduce?
Drell-Yan + γ Drell-Yan + track	low missing E_T	make MET cut
top-pair production hadrons faking leptons	hadronic activity	require low hadronic activity
Dibosons : WZ,ZZ	on-shell contribution of Z can be removed by a invariant mass cut for the Z. off-shell contribution for ZZ → make MET cut *off-shell contribution is irreducible for WZ*	

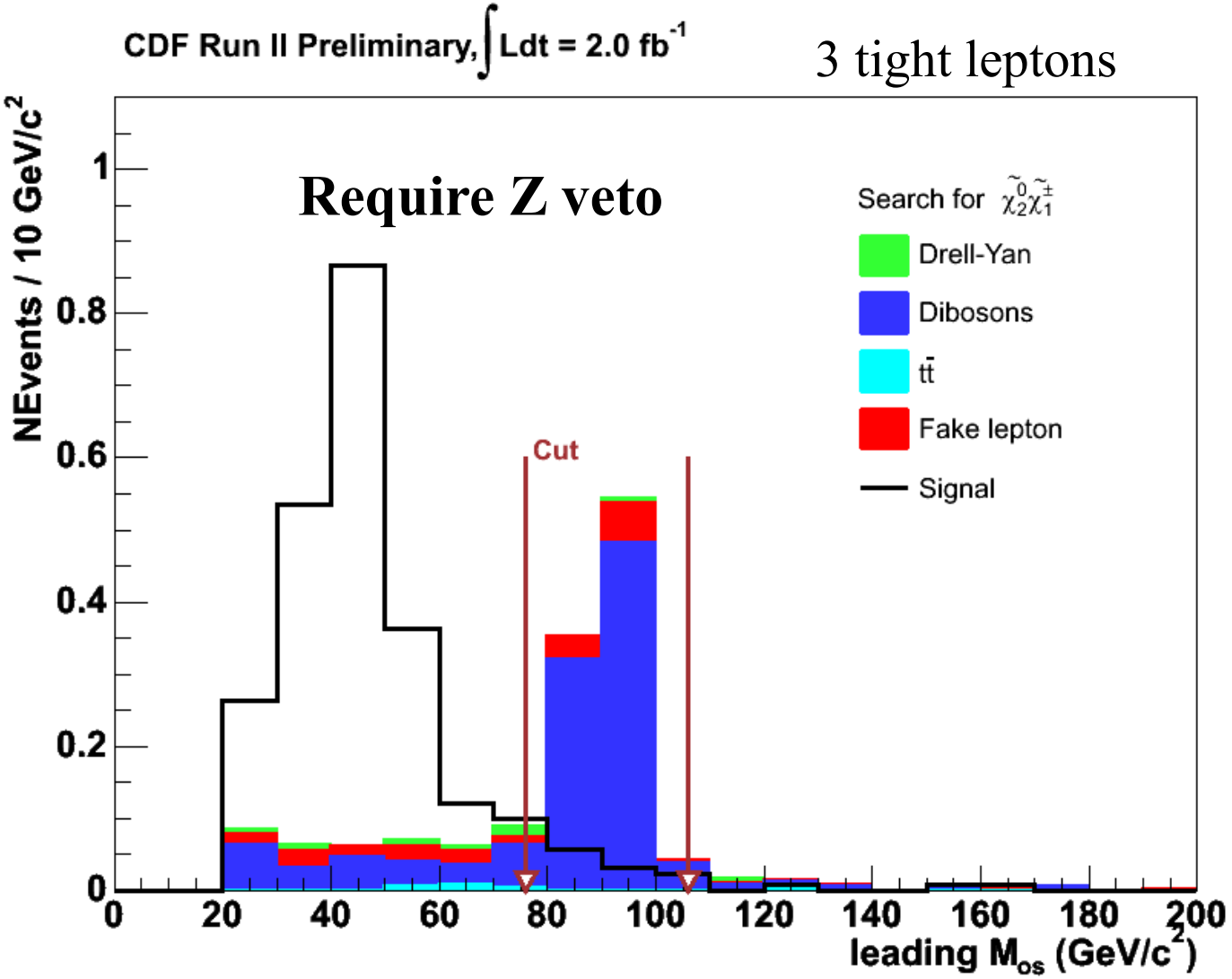
Reducing Backgrounds: Drell-Yan, ZZ



After all other selections are made

Signal : mSUGRA m_0=60, $m_{1/2}$=190, tan(β)=3, A_0=0, μ>0, M($\chi_1^\pm$)=120 GeV/c^2

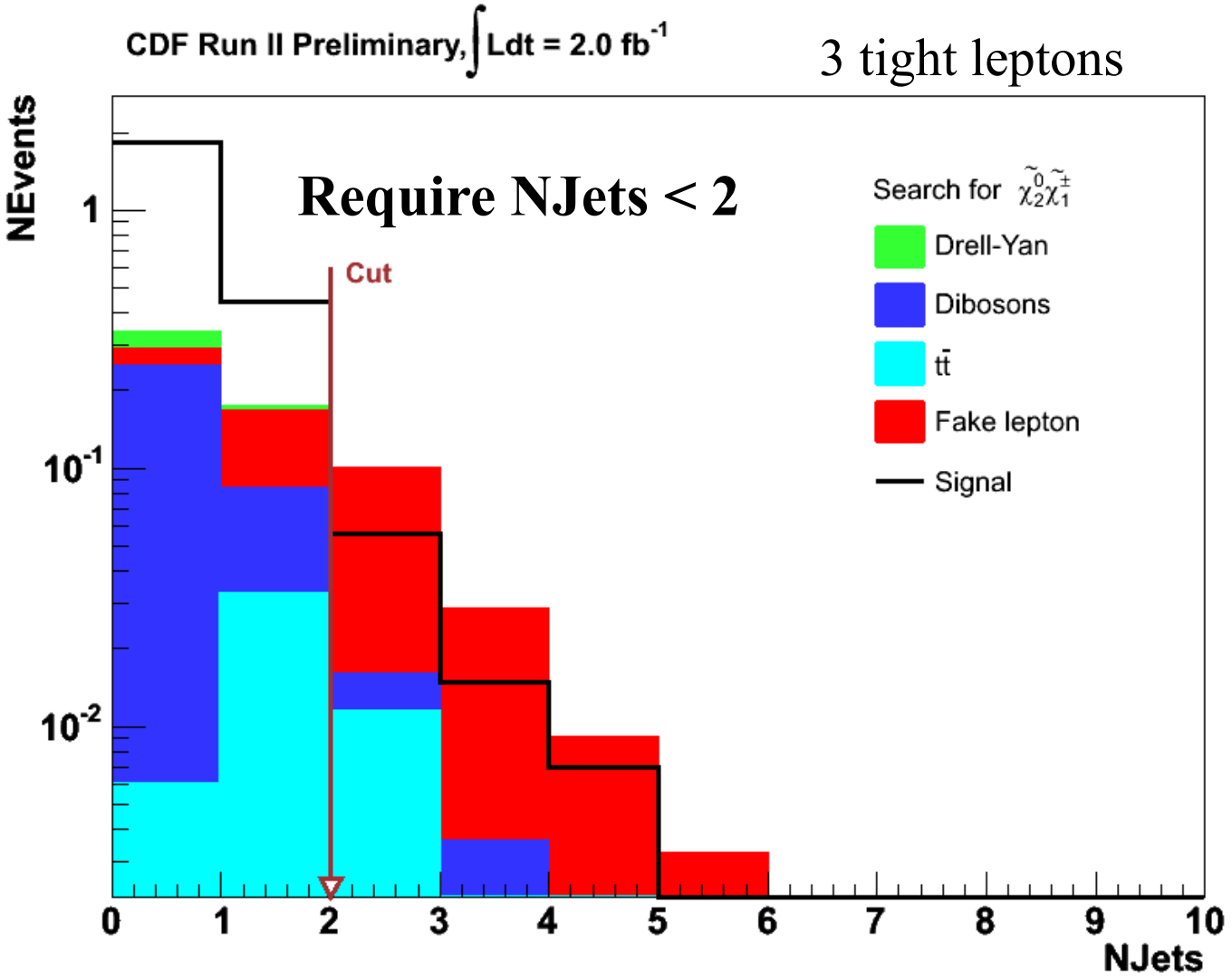
Reducing Backgrounds: WZ, ZZ on shell



After all other selections are made

Signal : mSUGRA m_0=60, $m_{1/2}$=190, tan(β)=3, A_0=0, μ>0, M($\chi_1^\pm$)=120 GeV/c²

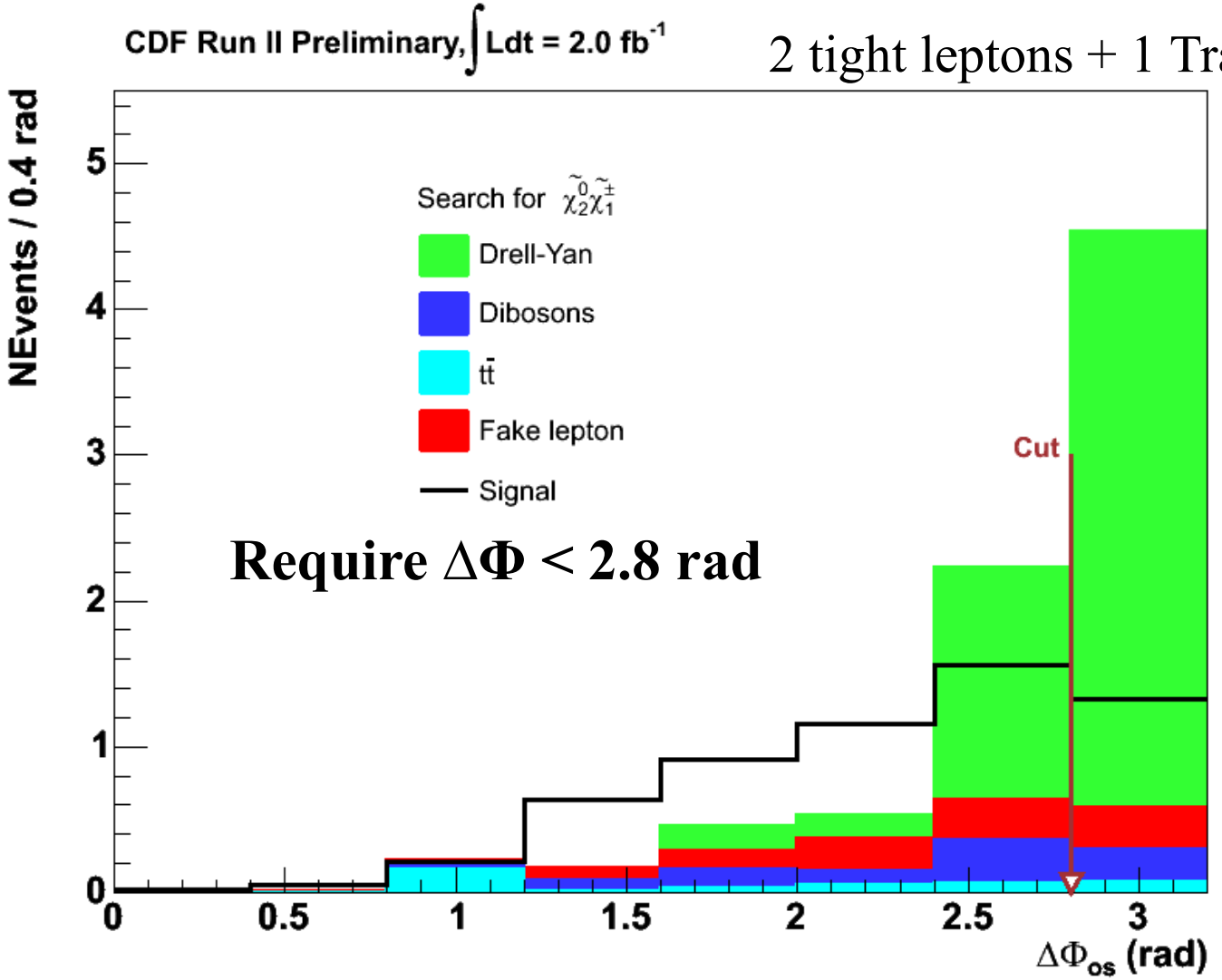
Reducing Backgrounds: top-pair, fakes



After all other selections are made

Signal : mSUGRA m_0=60, $m_{1/2}$=190, tan(β)=3, A_0=0, μ>0, M($\chi_1^\pm$)=120 GeV/c^2

Reducing Backgrounds: residual DY



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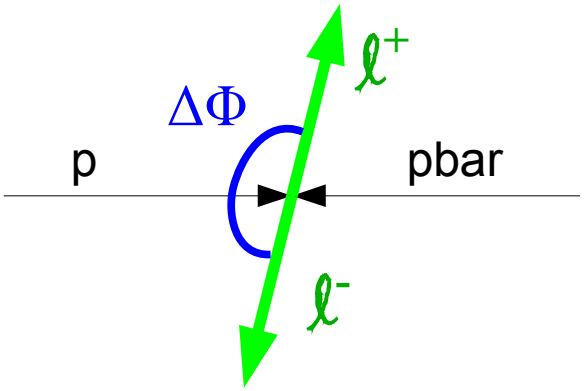

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Setting up the Analysis

Perform an unbiased counting experiment :

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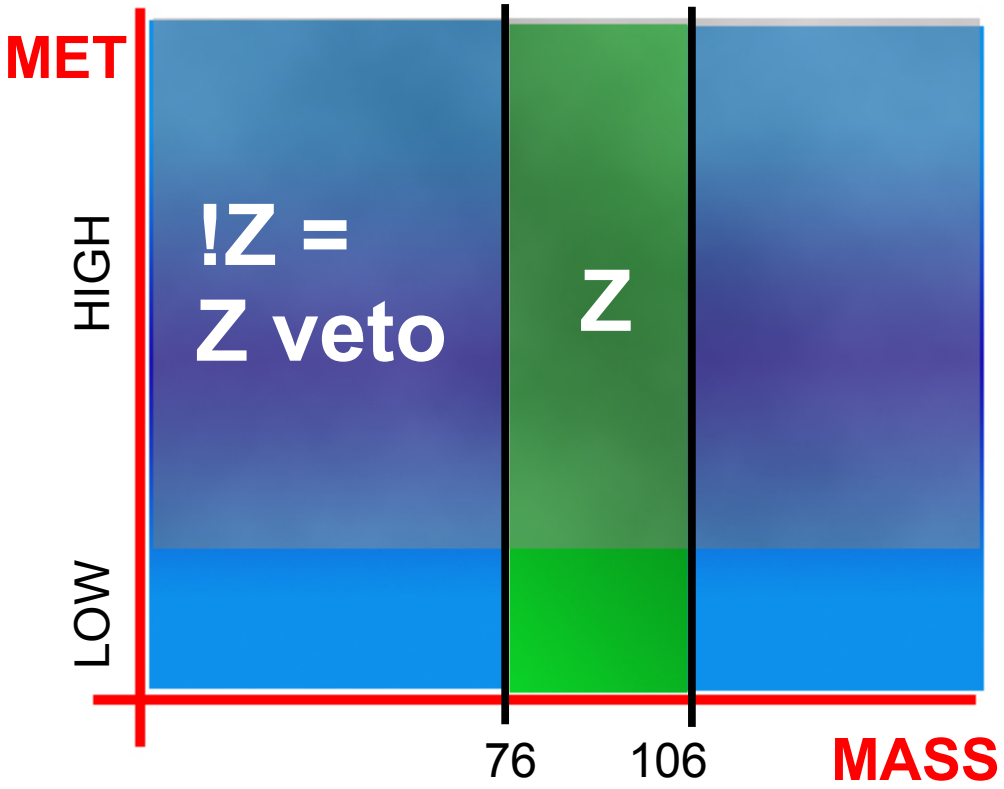
TEST WITH TWO LEPTONS FIRST
We will add third later in the talk

Two leptons before Three : High Stat Control Regions



Use Z events to test luminosity,

High P_T leptons,

Use Z-veto to test low mass DY,

Low P_T leptons

Z : $76 < M_{\ell\ell} < 106$ GeV/c^2

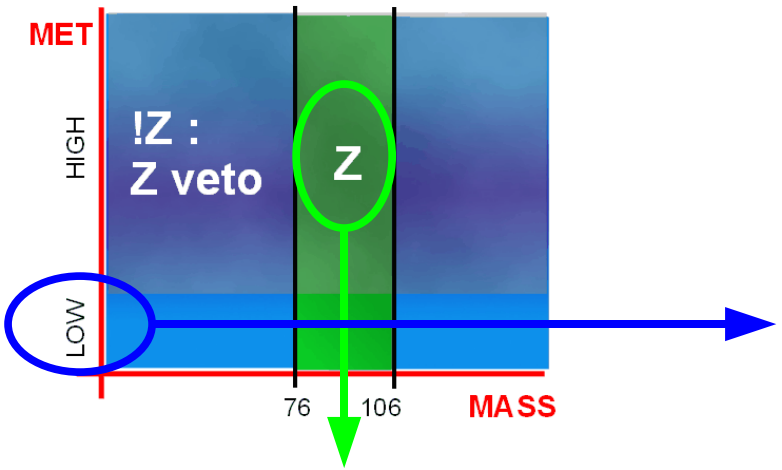
!Z : 'not' Z or Z veto

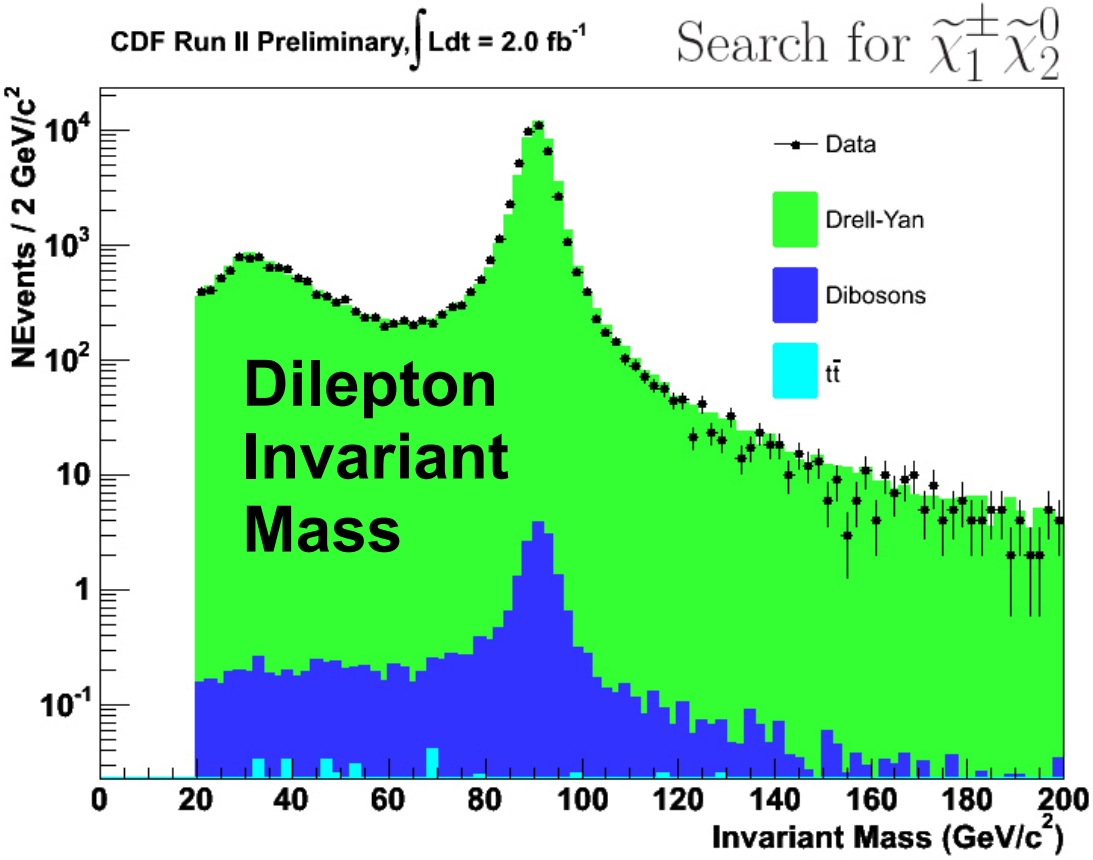
Use MET distributions to test corrections to missing E_T

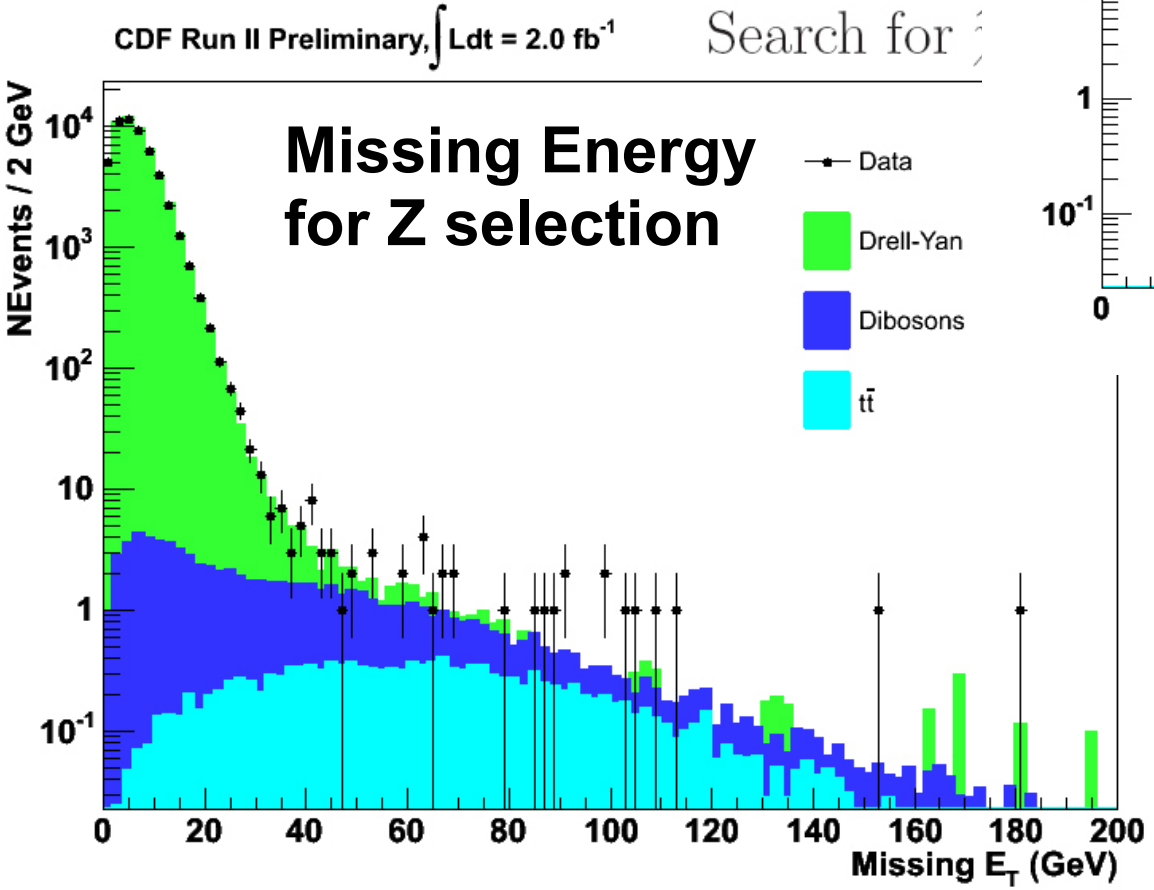
Use kinematic distributions to test agreements.

Split by flavor content (ee,μμ,eμ) to test agreements.

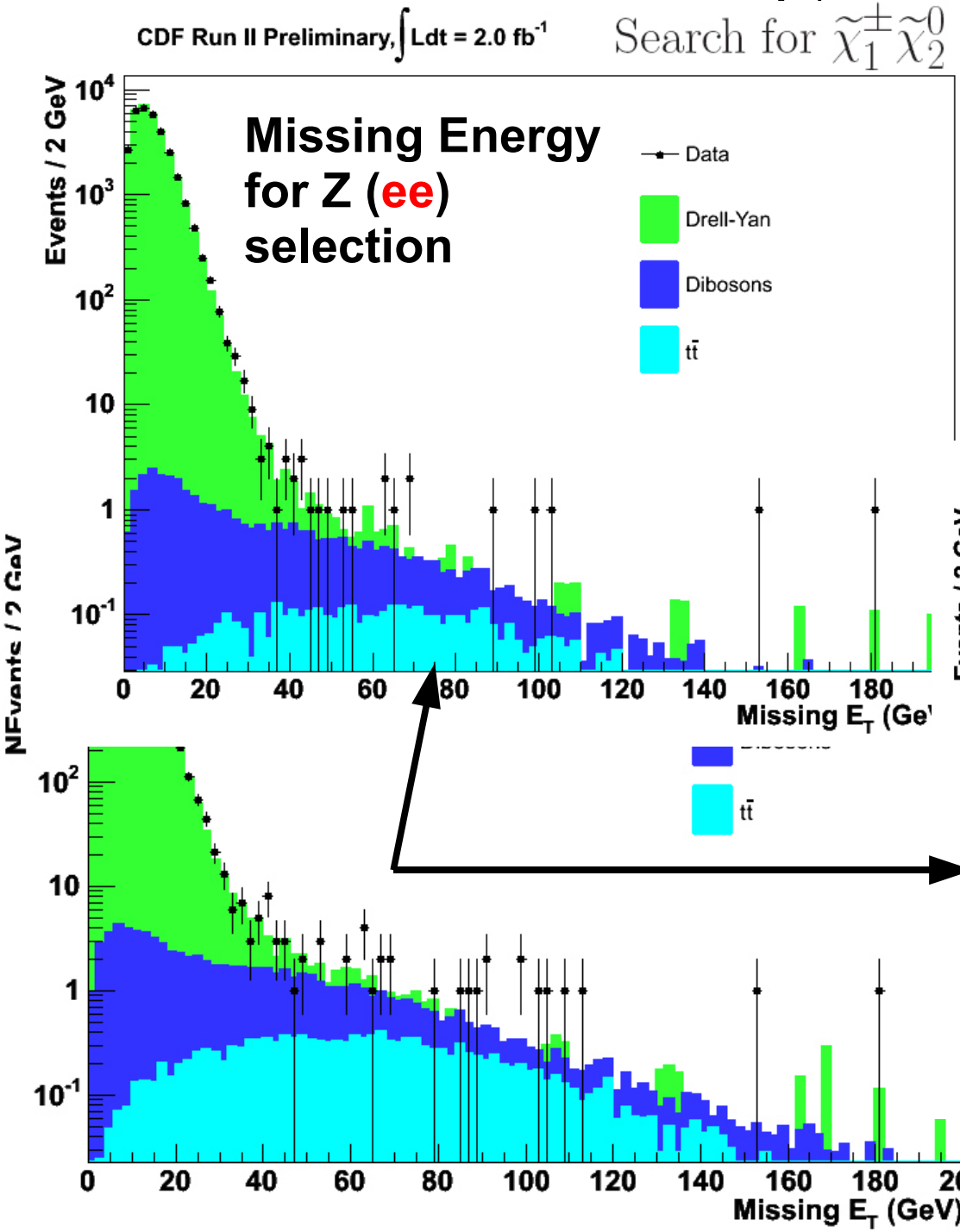
Control Regions : Dileptons

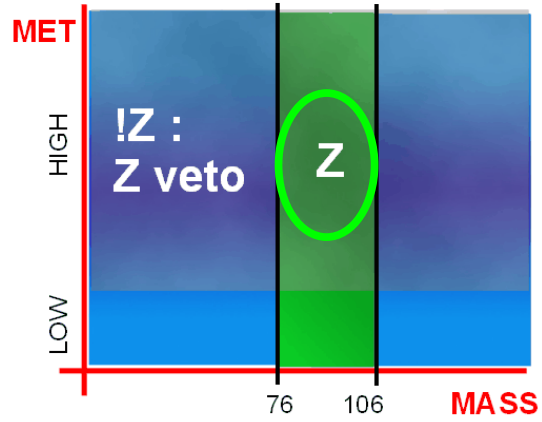


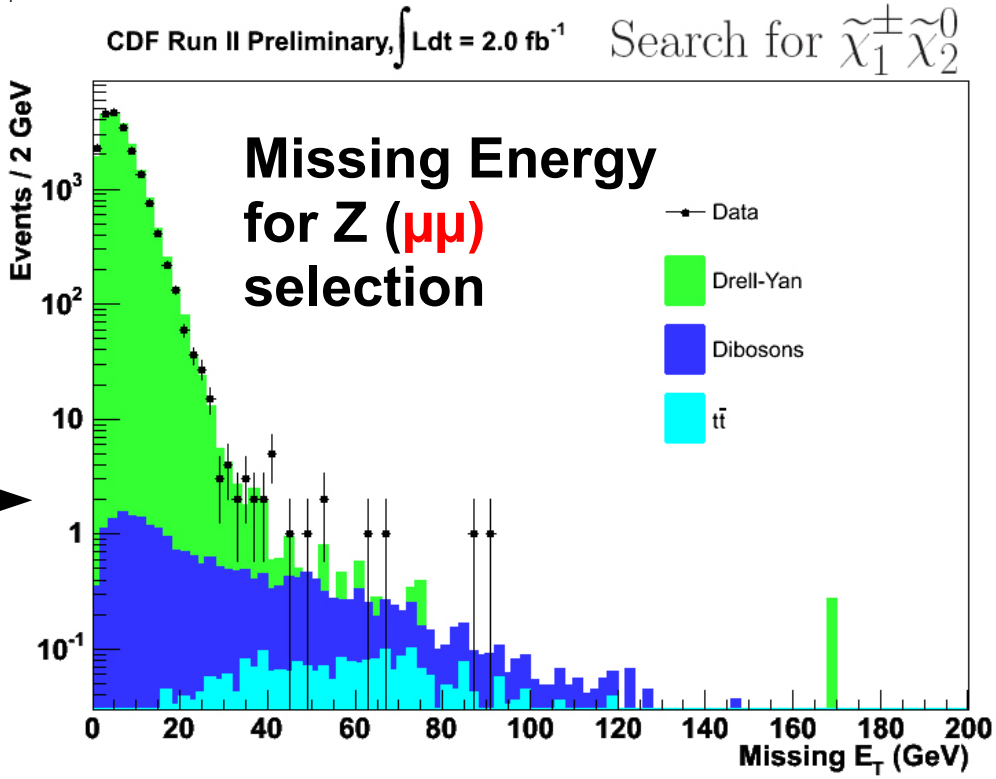




Control Regions : Dileptons

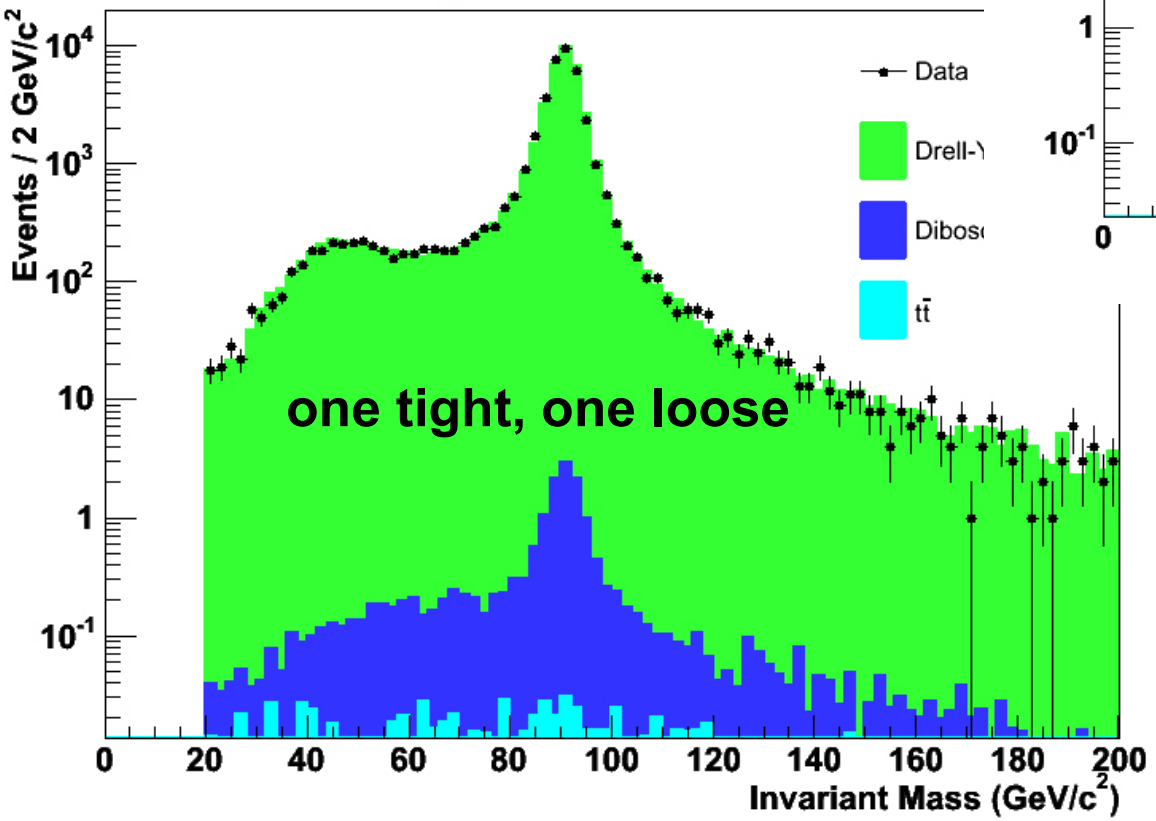


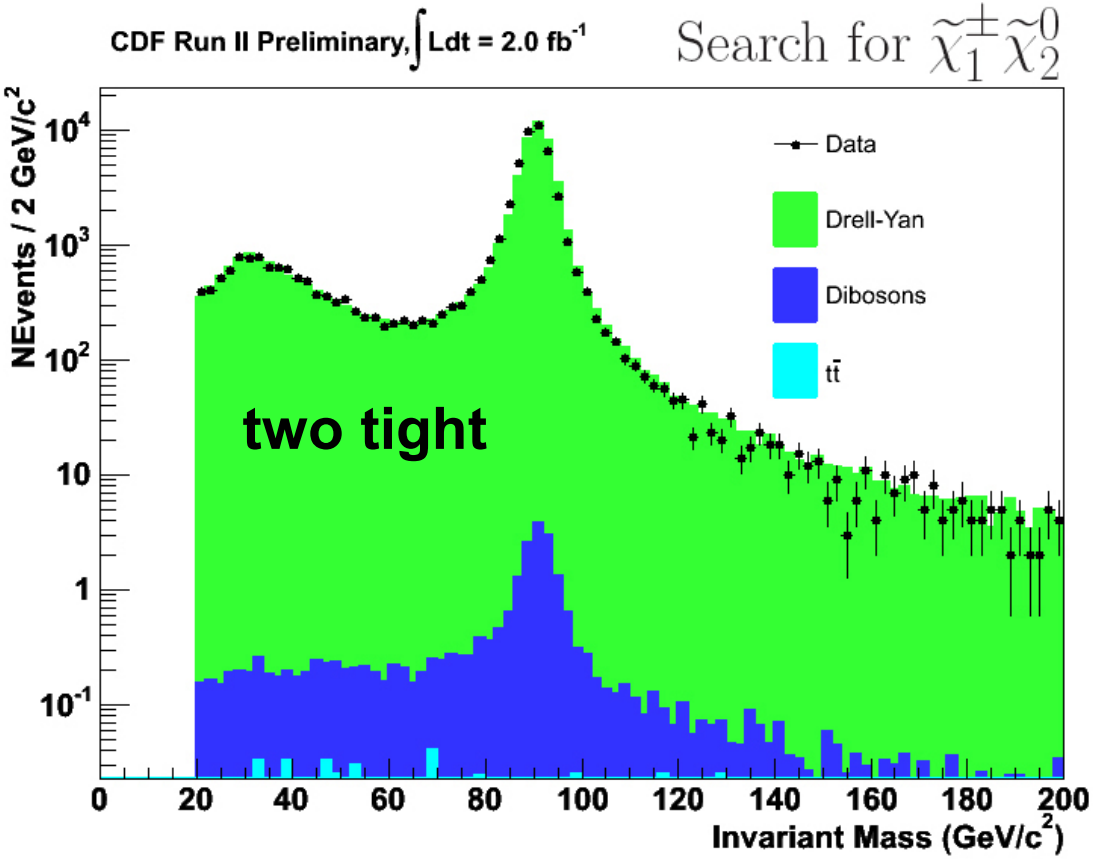


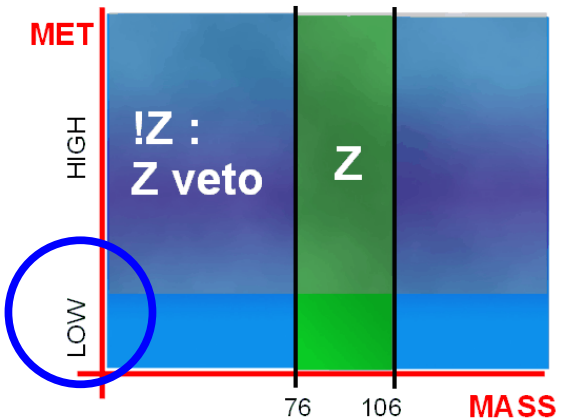


Control Regions : Dileptons

Dilepton Invariant Mass







Control Regions : Dileptons

CDF RUN II Preliminary $\int \mathcal{L}dt = 2.0$ fb^{-1} : Search for $\widetilde{\chi}_1^{\pm}\widetilde{\chi}_2^0$

Name	Z$\rightarrow ee$	Z$\rightarrow \mu\mu$	Z$\rightarrow \tau\tau$	WW	WZ	ZZ	$t\bar{t}$	Expected	Observed
				2tight					
!Z	9847.8	5034.7	1310.2	93.3	1.6	7.1	57.1	16352 $\pm$ 716	15966
!Zlo	7705.6	4240.6	477.7	4.7	0.1	2.3	1.0	12432 $\pm$ 569	12352
!Zhi	858.4	205.5	550.3	83.5	1.4	3.6	55.0	1758 $\pm$ 80	1612
Z	31178.2	19870.4	21.9	22.4	6.3	35.8	15.0	51150 $\pm$ 2034	51042
Zlo	25577.6	16665.6	11.1	1.6	0.2	13.4	0.2	42270 $\pm$ 1682	42093
Zhi	1261.1	741.5	6.4	19.0	5.8	15.9	14.4	2064 $\pm$ 92	2143
lo	33349.6	20903.9	488.7	6.3	0.3	15.7	1.2	54766 $\pm$ 2212	54445
Z(ee)	31178.3	0.0	6.7	6.5	4.0	21.9	4.7	31222 $\pm$ 1710	31074
Z($\mu\mu$)	0.0	19867.7	3.9	4.6	2.3	13.9	3.0	19895 $\pm$ 1102	19942
!Z(ee)	9847.9	0.0	497.8	29.9	1.1	4.3	18.3	10399 $\pm$ 617	10033
!Z($\mu\mu$)	0.0	5015.4	243.2	18.2	0.4	2.3	10.9	5290 $\pm$ 352	5198
eμ	0.0	21.9	580.4	56.5	0.1	0.5	35.1	694 $\pm$ 47	761

Control Regions : Dileptons

CDF RUN II Preliminary $\int \mathcal{L}dt = 2.0$ fb^{-1} : Search for $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$

Name	Z→ ee	Z→ $\mu\mu$	Z→ $\tau\tau$	WW	WZ	ZZ	$t\bar{t}$	Expected	Observed
				2tight					
!Z	**9848**	**5035**	**1310**	**93.3**	**1.6**	**7.1**	**57.1**	**16532 ± 716**	**15966**
!Zlo	7705.6	4240.6	477.7	4.7	0.1	2.3	1.0	12432 ± 569	12352
!Zhi	858.4	205.5	550.3	83.5	1.4	3.6	55.0	1758 ± 80	1612
Z	31178.2	19870.4	21.9	22.4	6.3	35.8	15.0	51150 ± 2034	51042
Zlo	25577.6	16665.6	11.1	1.6	0.2	13.4	0.2	42270 ± 1682	42093
Zhi	1261.1	741.5	6.4	19.0	5.8	15.9	14.4	2064 ± 92	2143
lo	33349.6	20903.9	488.7	6.3	0.3	15.7	1.2	54766 ± 2212	54445
Z(ee)	31178.3	0.0	6.7	6.5	4.0	21.9	4.7	31222 ± 1710	31074
Z($\mu\mu$)	0.0	19867.7	3.9	4.6	2.3	13.9	3.0	19895 ± 1102	19942
!Z(ee)	9847.9	0.0	497.8	29.9	1.1	4.3	18.3	10399 ± 617	10033
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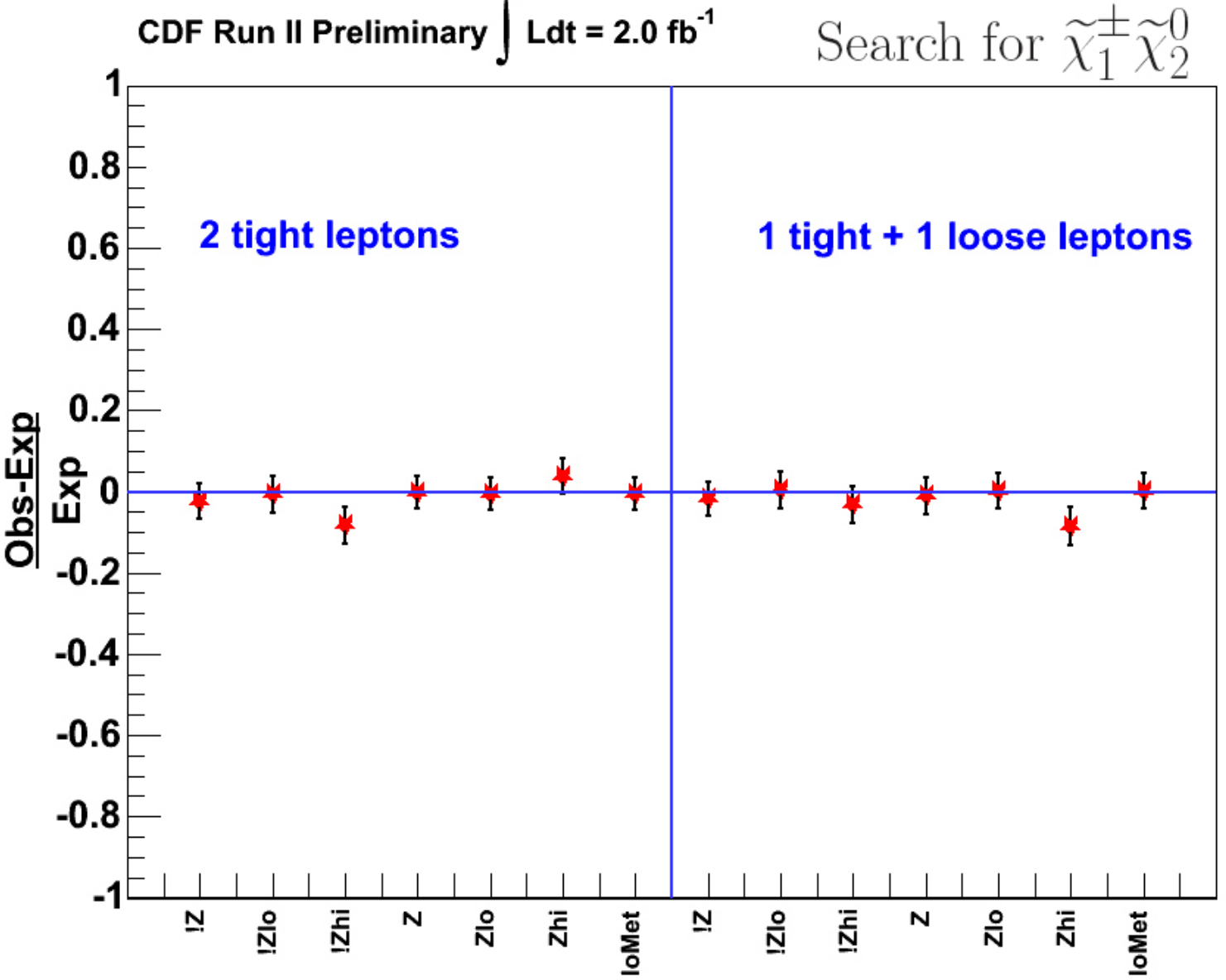
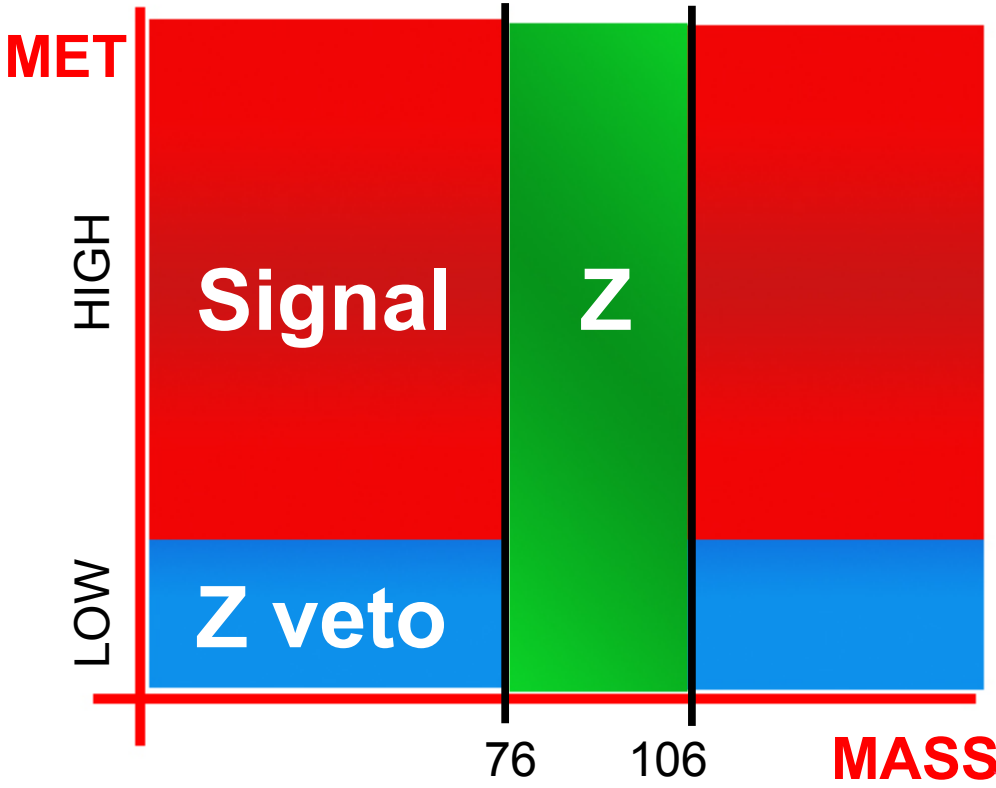
Control Regions : Dileptons



Ready for Three Leptons



High MET, Z-veto is now signal box

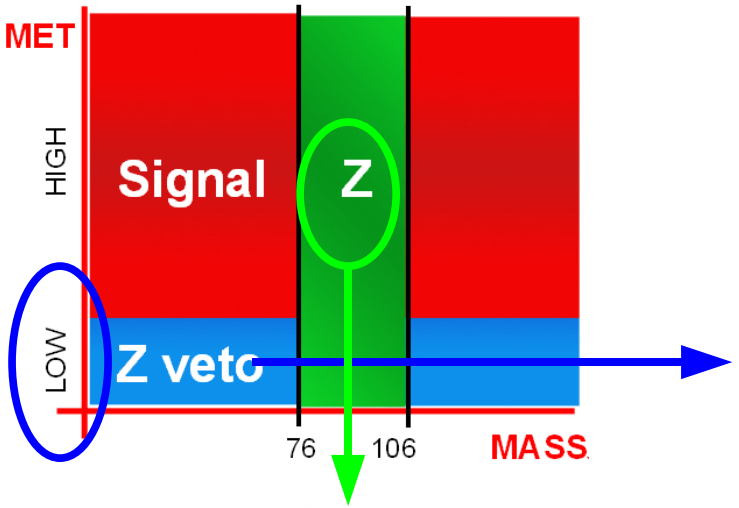
Use Z events to test MET

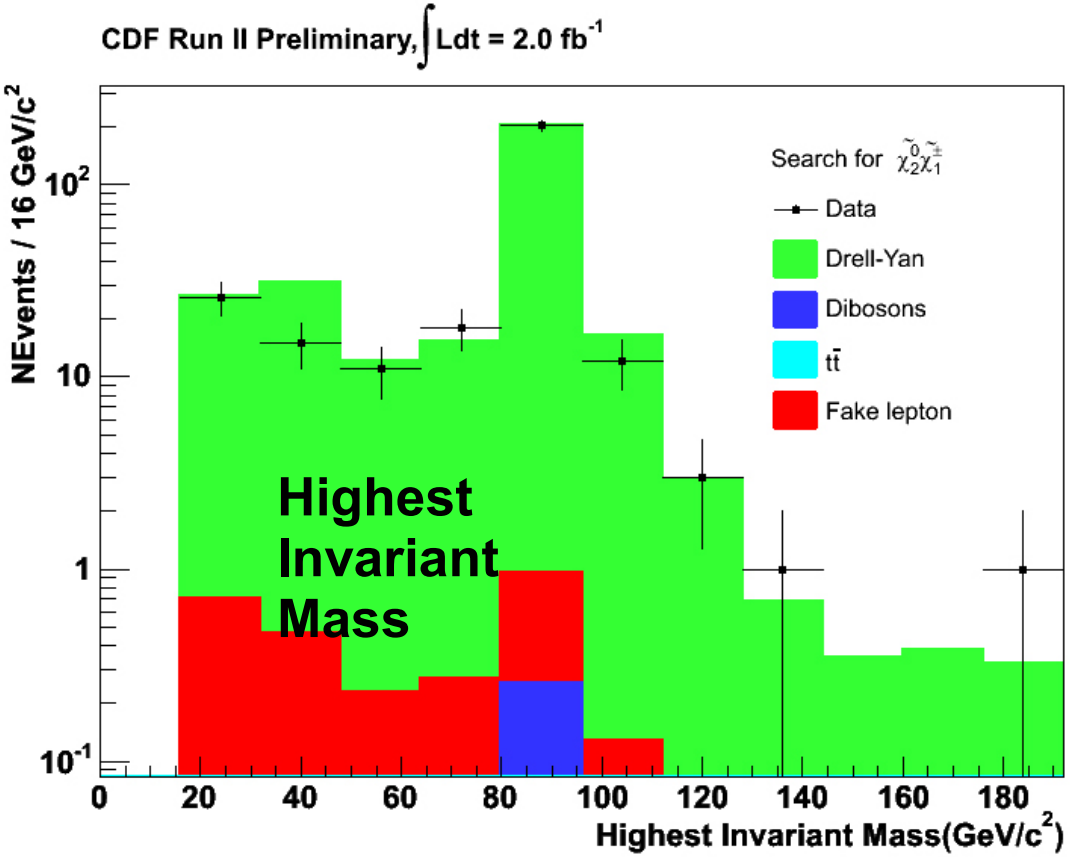
Use high MET Z region to test dibosons (WZ,WW)

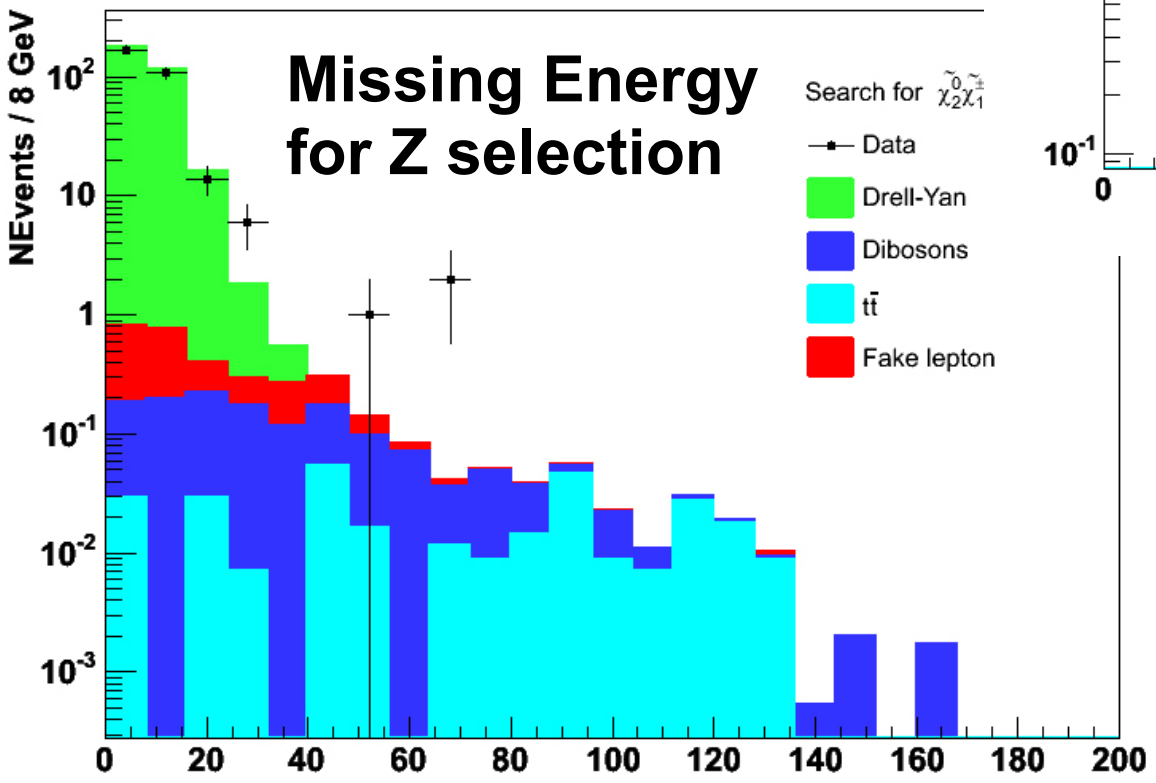
Test 'fake' estimations in Z events and low-mass, low-MET events.

Trileptons = two opposite charge pairs. Take higher to define control regions.

Control Regions : Trileptons

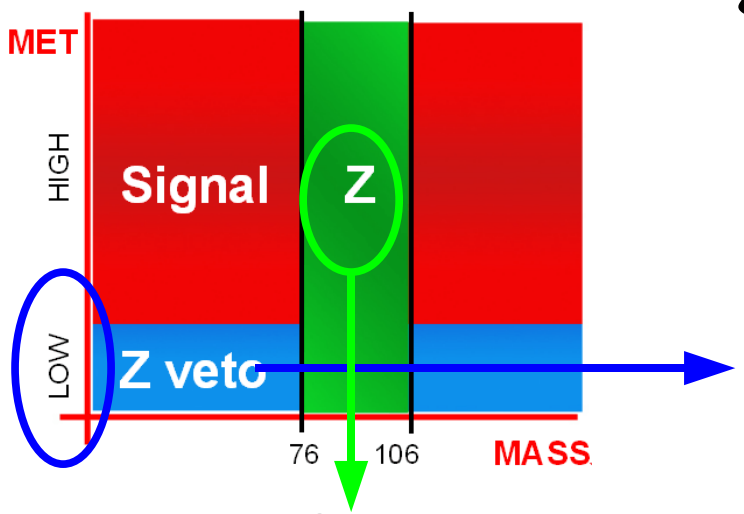


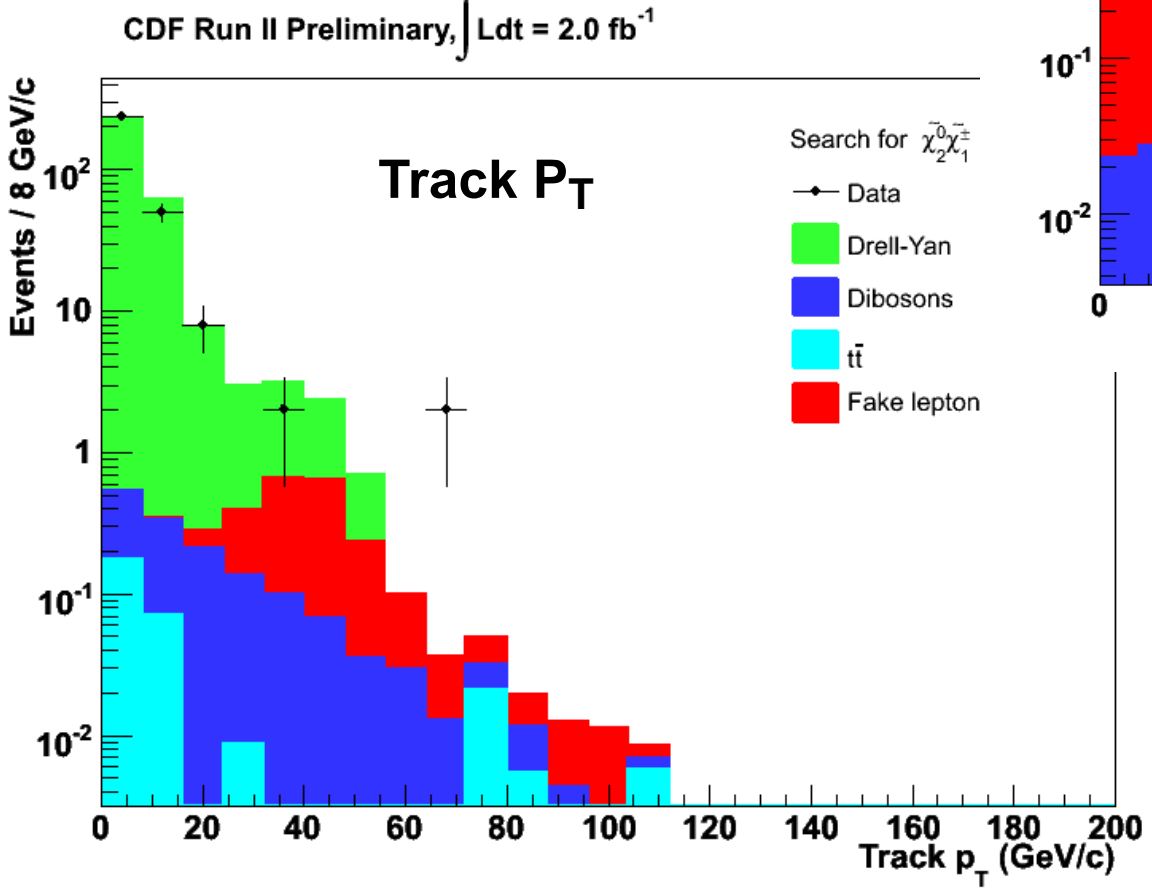


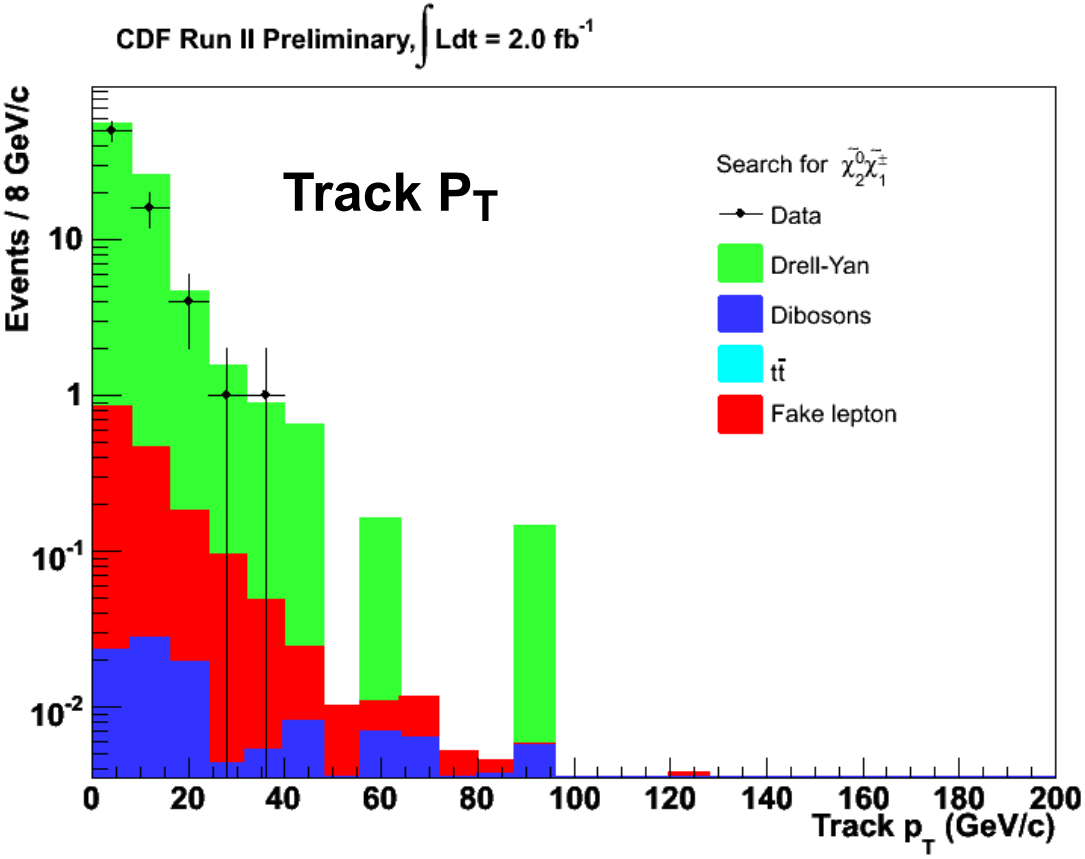


Selection :
2 tight leptons + 1 Track

Control Regions : Trileptons

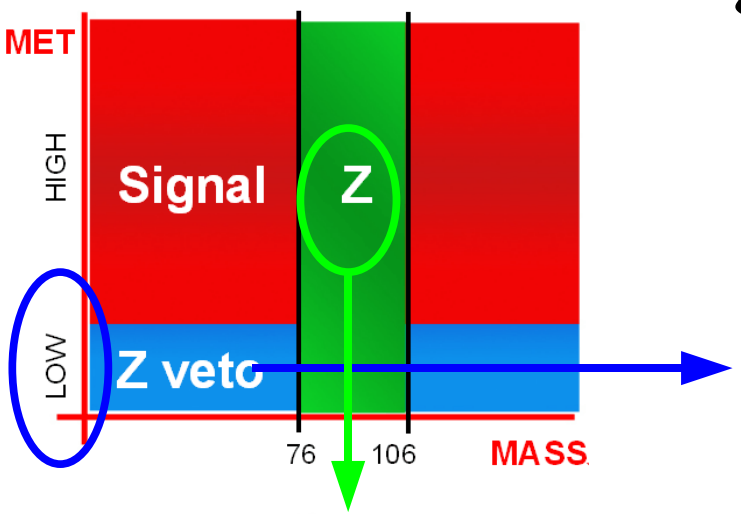


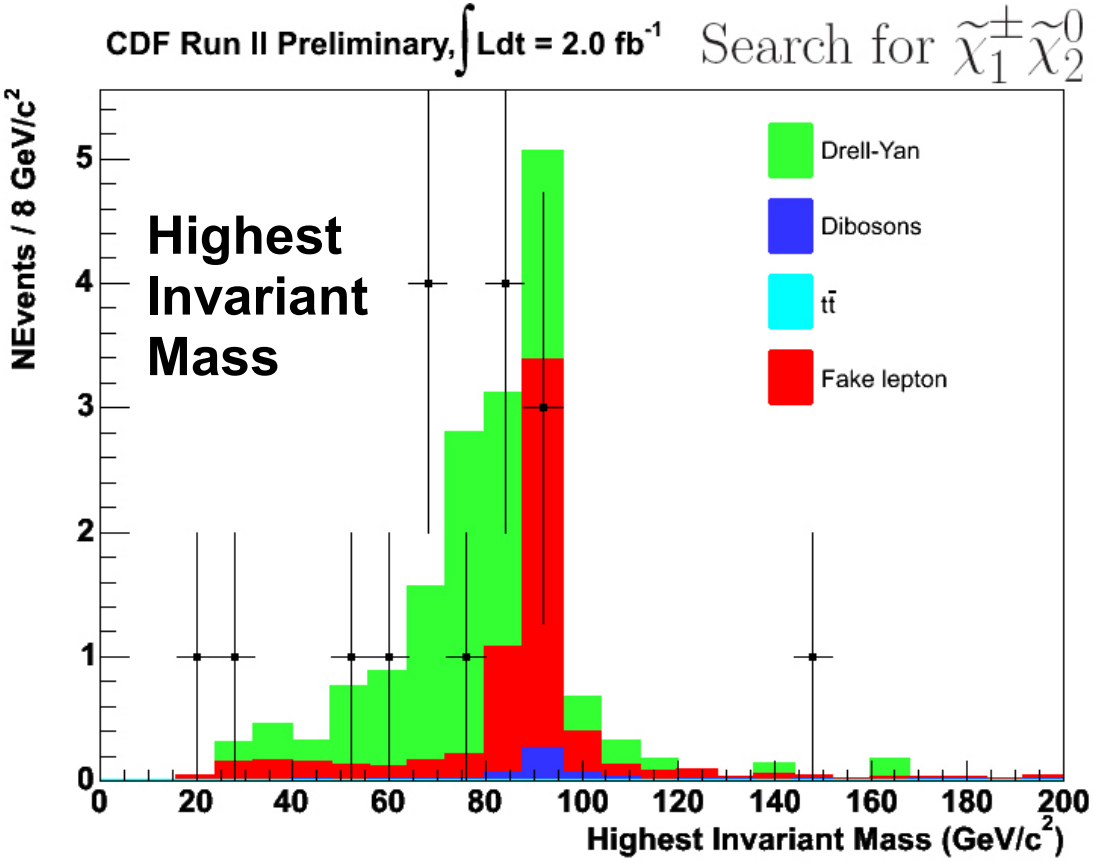


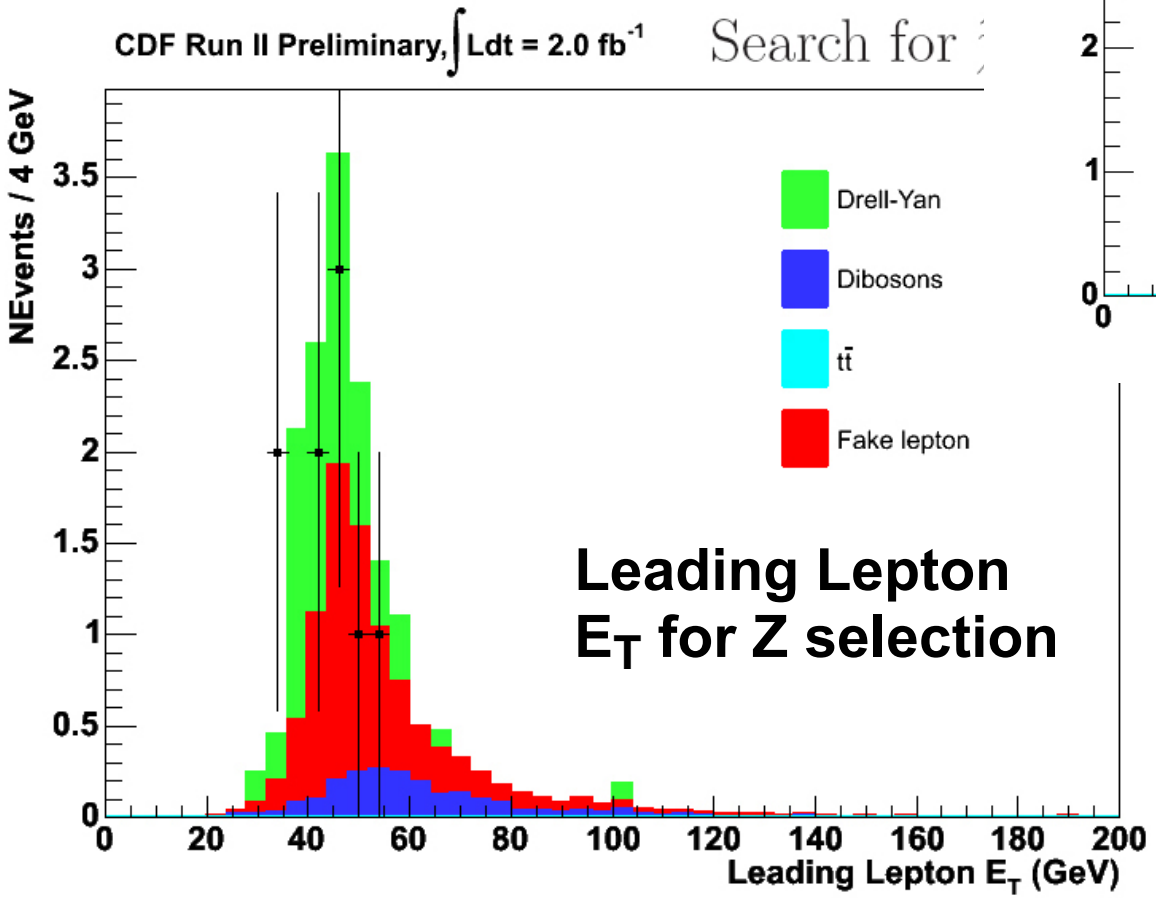


Selection :
2 tight leptons + 1 Track

Control Regions : Trileptons







Selection :
3 Tight Leptons

Control Regions : Trileptons

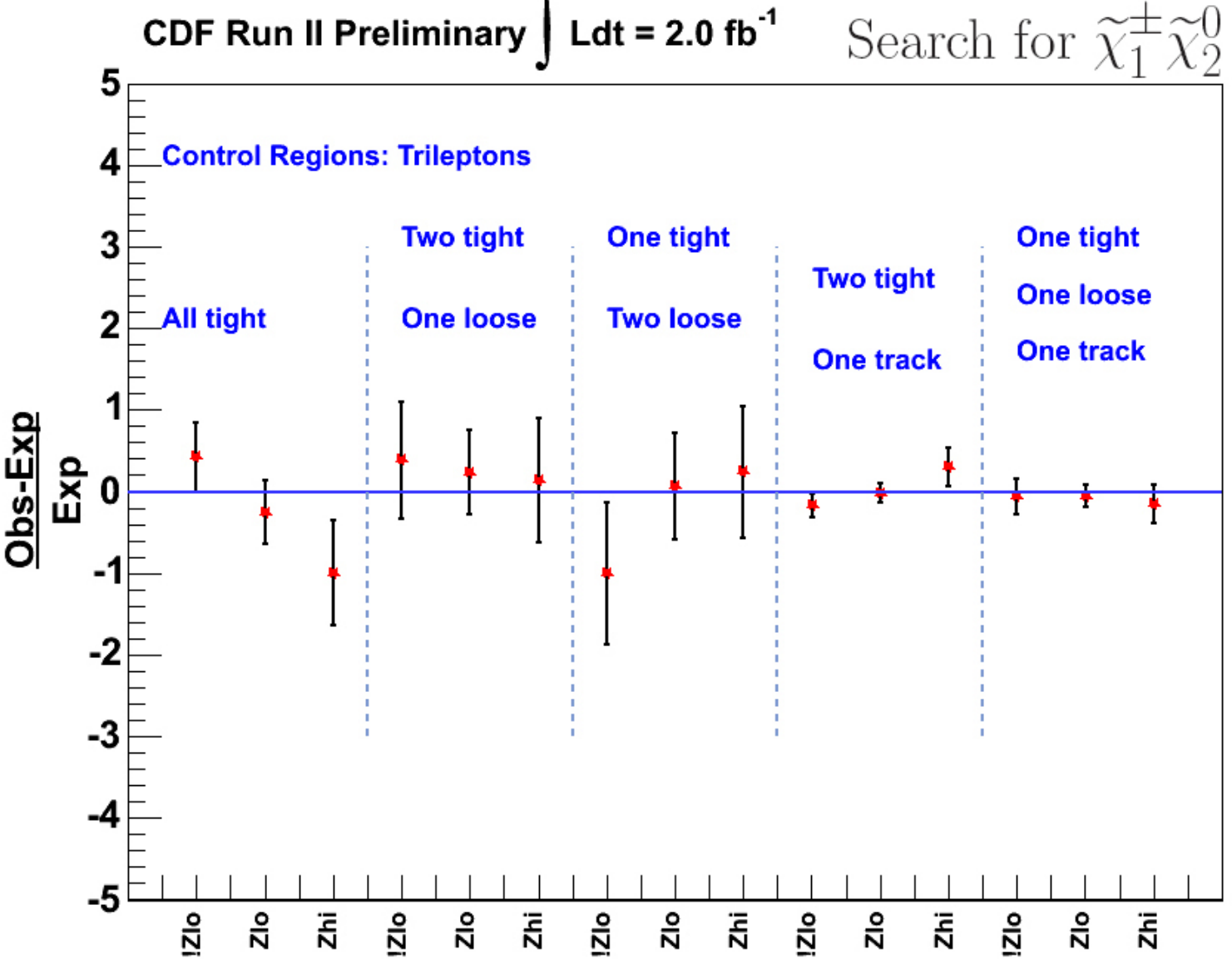
CDF RUN II Preliminary $\int \mathcal{L}dt = 2.0$ fb^{-1} : Search for $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$

Name	Z→ ee	Z→ $\mu\mu$	Z→ $\tau\tau$	WW	WZ	ZZ	$t\bar{t}$	Fakes	Expected	Observed
3tight										
lo	7.58	2.92	0.00	0.00	0.05	0.57	0.00	6.01	17.1 ± 5.3	17
!Zlo	3.73	1.25	0.00	0.00	0.04	0.17	0.00	1.14	6.3 ± 2.7	9
Z	4.67	2.17	0.00	0.01	1.30	0.82	0.02	7.68	16.7 ± 5.7	9
Zlo	3.86	1.67	0.00	0.00	0.01	0.40	0.00	4.87	10.8 ± 4.2	8
Zhi	0.00	0.09	0.00	0.01	1.23	0.30	0.02	1.06	2.7 ± 1.7	0
2tight,1loose										
lo	0.74	3.38	0.00	0.00	0.04	0.31	0.00	2.57	7.0 ± 3.0	9
!Zlo	0.64	1.09	0.00	0.00	0.02	0.10	0.00	0.33	2.2 ± 1.5	3
Z	0.10	2.69	0.00	0.00	1.09	0.64	0.01	3.13	7.7 ± 3.2	8
Zlo	0.10	2.29	0.00	0.00	0.02	0.21	0.00	2.24	4.9 ± 2.5	6
Zhi	0.00	0.08	0.00	0.00	1.05	0.34	0.01	0.28	1.8 ± 1.3	2
1tight,2loose										
lo	0.57	1.81	0.00	0.00	0.03	0.19	0.00	1.68	4.3 ± 2.3	3
!Zlo	0.12	0.96	0.00	0.00	0.00	0.07	0.00	0.29	1.4 ± 1.3	0
Z	0.64	1.09	0.00	0.00	0.70	0.32	0.02	2.63	5.4 ± 2.7	6
Zlo	0.45	0.84	0.00	0.00	0.03	0.12	0.00	1.39	2.8 ± 1.9	3
Zhi	0.19	0.09	0.00	0.00	0.62	0.14	0.02	0.57	1.6 ± 1.3	2

CDF RUN II Preliminary $\int \mathcal{L}dt = 2.0$ fb^{-1} : Search for $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$

Name	Z→ ee	Z→ $\mu\mu$	Z→ $\tau\tau$	WW	WZ	ZZ	$t\bar{t}$	Fakes	Expected	Observed
2tight,1Track										
lo	168.37	138.84	1.73	0.02	0.02	0.35	0.02	2.39	312 ± 35	290
!Zlo	49.31	35.84	1.61	0.01	0.01	0.10	0.00	1.57	88 ± 13	72
Z	166.42	140.97	0.12	0.13	0.32	0.77	0.29	1.82	311 ± 34	299
Zlo	119.06	103.00	0.12	0.01	0.01	0.25	0.02	0.83	223 ± 26	218
Zhi	14.67	10.40	0.00	0.09	0.30	0.41	0.27	0.67	27 ± 6	34
1tight,1loose,1Track										
lo	55.02	170.96	0.74	0.01	0.01	0.24	0.05	1.37	228 ± 30	214
!Zlo	6.64	25.38	0.74	0.00	0.00	0.08	0.03	0.90	34 ± 7	31
Z	69.45	202.01	0.15	0.11	0.27	0.56	0.30	1.13	274 ± 35	246
Zlo	48.38	145.58	0.00	0.01	0.00	0.15	0.02	0.47	195 ± 26	183
Zhi	8.59	17.69	0.00	0.10	0.27	0.32	0.28	0.48	28 ± 6	23

Control Regions : Trileptons



Control Region Summary

There are 51 (dilepton+trilepton) control regions, along with three lepton flavors, and hundreds of distributions....

This is where we spent most time and effort.

Bottomline : Excursions consistent with statistical fluctuations

Ready to open the Signal Box

Systematic Uncertainties

Backgrounds

hadrons faking leptons
underlying event → tracks ~ 10%

Lepton identification ~ 2%
Jet energy scale ~ 2 to 5 %
Process Cross-section ~ 5%

Signal

Signal cross section~ 10%

Lepton identification ~ 4%
Initial/Final State radiation ~ 4%

Common to both

Luminosity ~ 6%
PDF ~ 2%

FINAL PREDICTIONS

CDF Run II Preliminary, $\int Ldt = 2.0\ fb^{-1}$

Channel	Signal	Background	Observed
3tight	2.3±0.1±0.3	0.5±0.04±0.1	
2tight,1loose	1.6±0.1±0.2	0.3±0.03±0.03	
1tight,2loose	0.7±0.1±0.1	0.1±0.02±0.02	
Total trilepton	4.6±0.2±0.6	0.9±0.1±0.2	
2tight,1Track	4.4±0.2±0.6	3.2±0.5±0.5	
1tight,1loose,1Track	2.4±0.1±0.3	2.3±0.5±0.4	
Total dilepton+track	6.8±0.2±0.9	5.5±0.7±0.9	

TOTAL SIGNAL = 11.4 events

Signal : mSUGRA m_0=60, $m_{1/2}$=190, tan(β)=3, A_0=0, μ>0, $M(\chi_1^{\pm})$=120 GeV/c^2

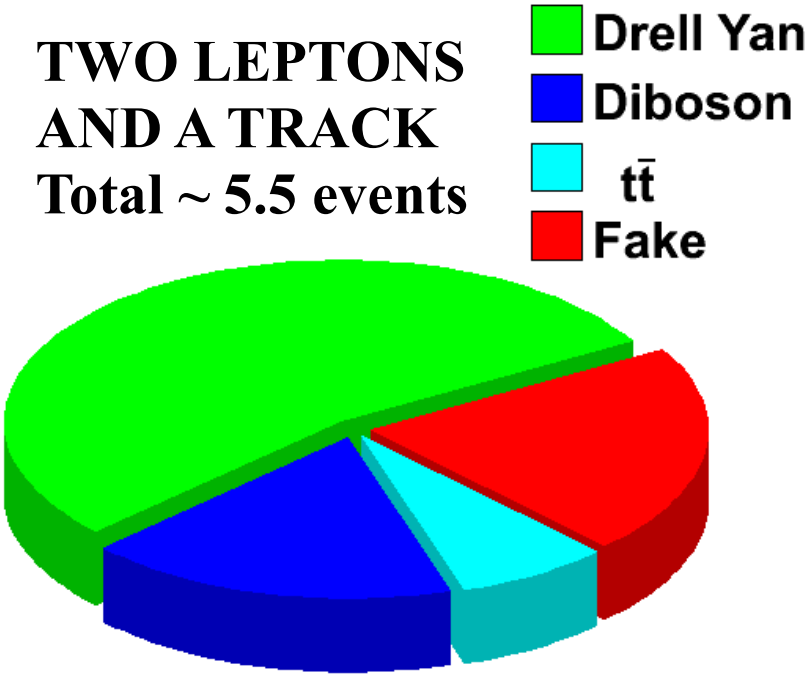
FINAL PREDICTIONS

Breakdown of Backgrounds

CDF Run II Preliminary, $\int Ldt = 2.0\ fb^{-1}$

ALL THREE LEPTONS
Total ~ 1 event

TWO LEPTONS AND A TRACK
Total ~ 5.5 events



FINAL PREDICTIONS

CDF Run II Preliminary, $\int Ldt = 2.0\ fb^{-1}$

Channel	Signal	Background	Observed
3tight	2.3±0.1±0.3	0.5±0.04±0.1	
2tight,1loose	1.6±0.1±0.2	0.3±0.03±0.03	
1tight,2loose	0.7±0.1±0.1	0.1±0.02±0.02	
Total trilepton	4.6±0.2±0.6	0.9±0.1±0.2	
2tight,1Track	4.4±0.2±0.6	3.2±0.5±0.5	
1tight,1loose,1Track	2.4±0.1±0.3	2.3±0.5±0.4	
Total dilepton+track	6.8±0.2±0.9	5.5±0.7±0.9	

TOTAL SIGNAL = 11.4 events

Signal : mSUGRA m_0=60, $m_{1/2}$=190, tan(β)=3, A_0=0, μ>0, $M(\chi_1^{\pm})$=120 GeV/c^2

FINAL PREDICTIONS

CDF Run II Preliminary, $\int Ldt = 2.0\ fb^{-1}$

Channel	Signal	Background	Observed
3tight	2.3±0.1±0.3	0.5±0.04±0.1	1
2tight,1loose	1.6±0.1±0.2	0.3±0.03±0.03	0
1tight,2loose	0.7±0.1±0.1	0.1±0.02±0.02	0
Total trilepton	4.6±0.2±0.6	0.9±0.1±0.2	1
2tight,1Track	4.4±0.2±0.6	3.2±0.5±0.5	
1tight,1loose,1Track	2.4±0.1±0.3	2.3±0.5±0.4	
Total dilepton+track	6.8±0.2±0.9	5.5±0.7±0.9	

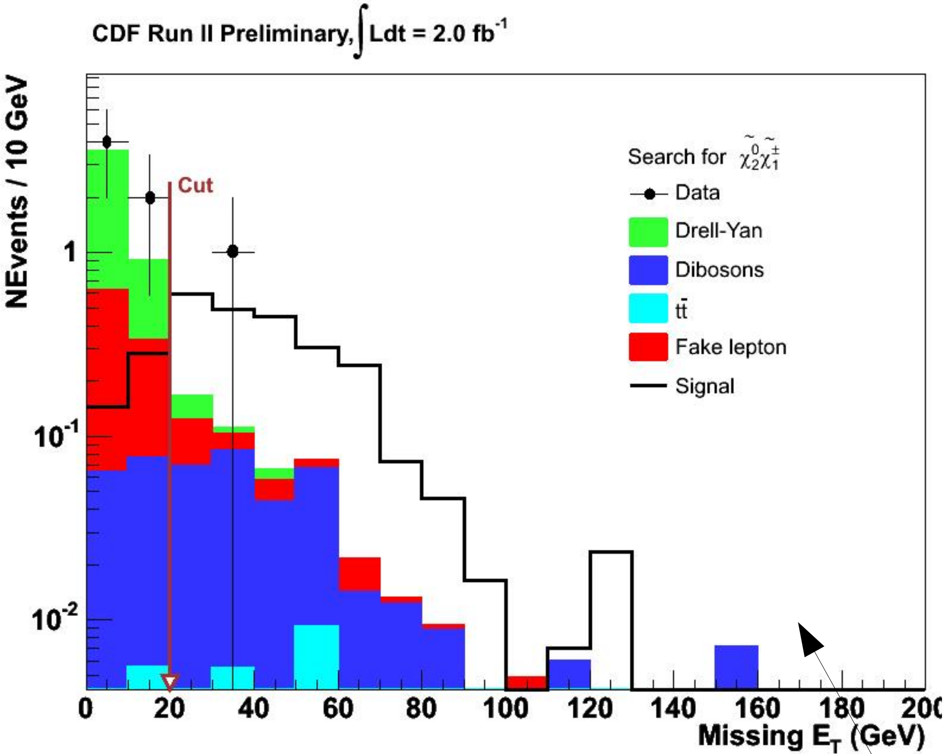
Signal : mSUGRA m_0=60, $m_{1/2}$=190, tan(β)=3, A_0=0, μ>0, $M(\chi_1^{\pm})$=120 GeV/c^2

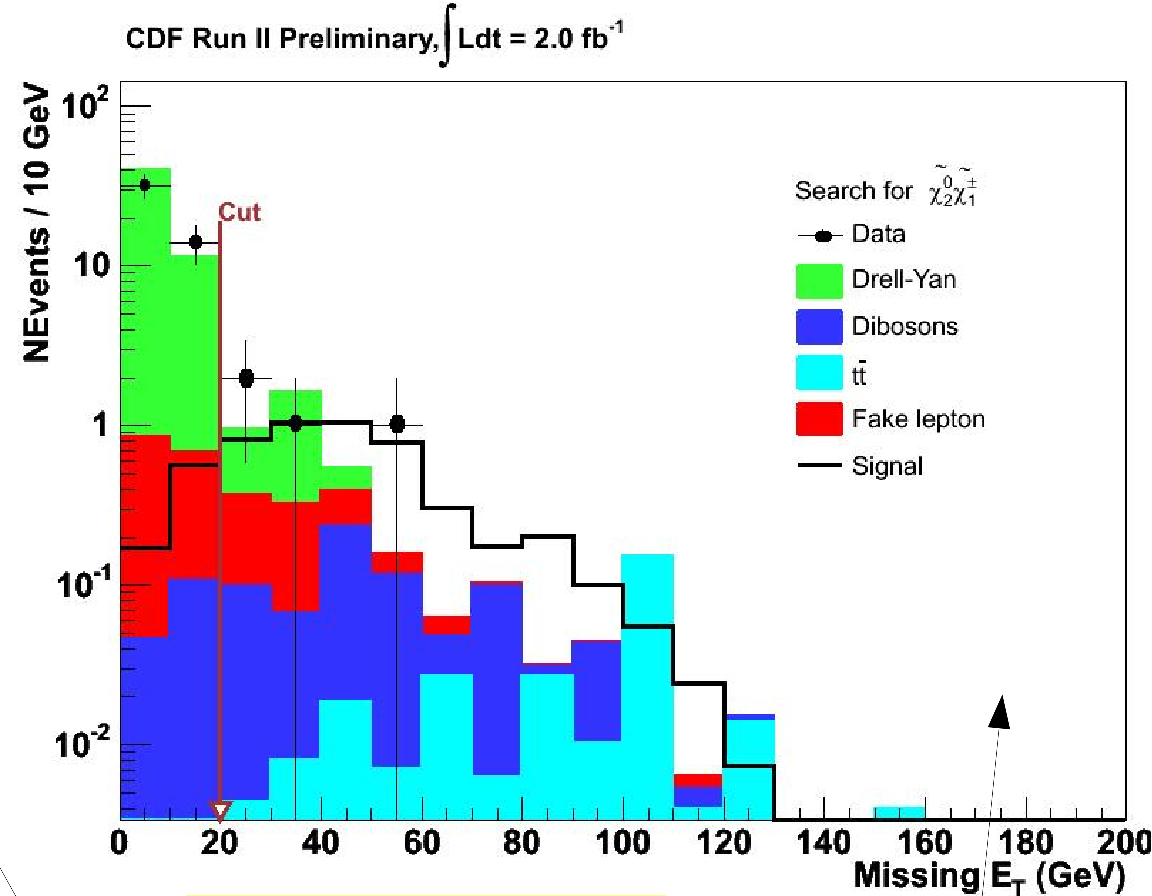
FINAL PREDICTIONS

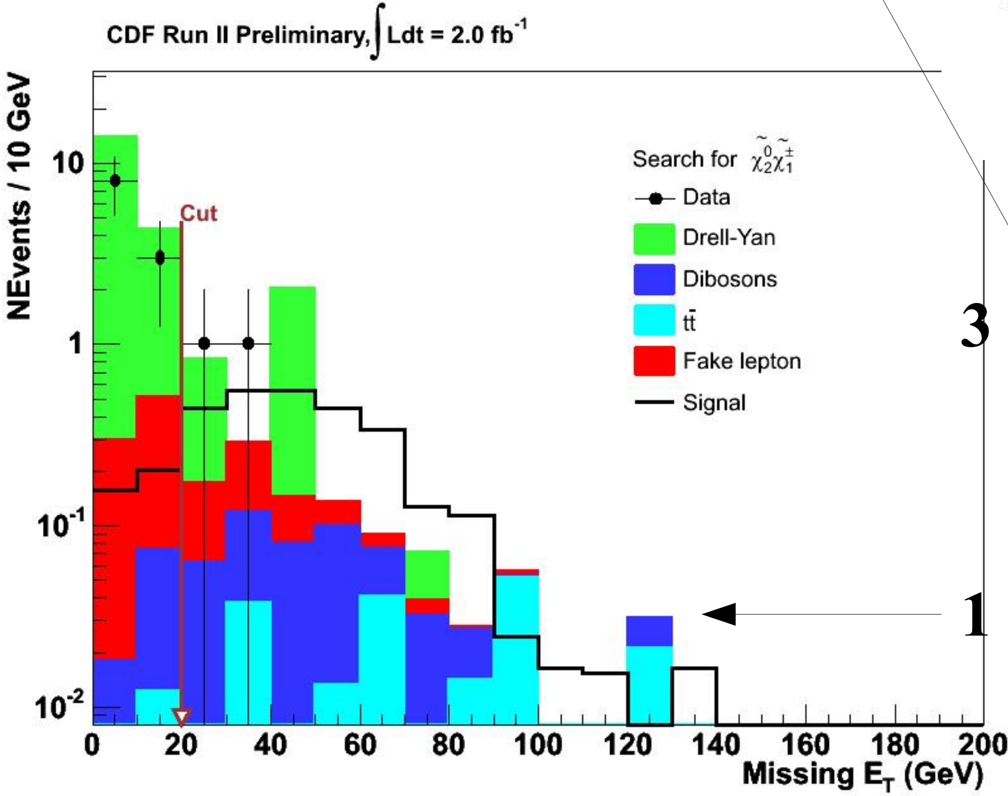
CDF Run II Preliminary, $\int Ldt = 2.0\ fb^{-1}$

Channel	Signal	Background	Observed
3tight	2.3±0.1±0.3	0.5±0.04±0.1	1
2tight,1loose	1.6±0.1±0.2	0.3±0.03±0.03	0
1tight,2loose	0.7±0.1±0.1	0.1±0.02±0.02	0
Total trilepton	4.6±0.2±0.6	0.9±0.1±0.2	1
2tight,1Track	4.4±0.2±0.6	3.2±0.5±0.5	4
1tight,1loose,1Track	2.4±0.1±0.3	2.3±0.5±0.4	2
Total dilepton+track	6.8±0.2±0.9	5.5±0.7±0.9	6

Signal : mSUGRA m_0=60, $m_{1/2}$=190, tan(β)=3, A_0=0, μ>0, $M(\chi_1^{\pm})$=120 GeV/c^2







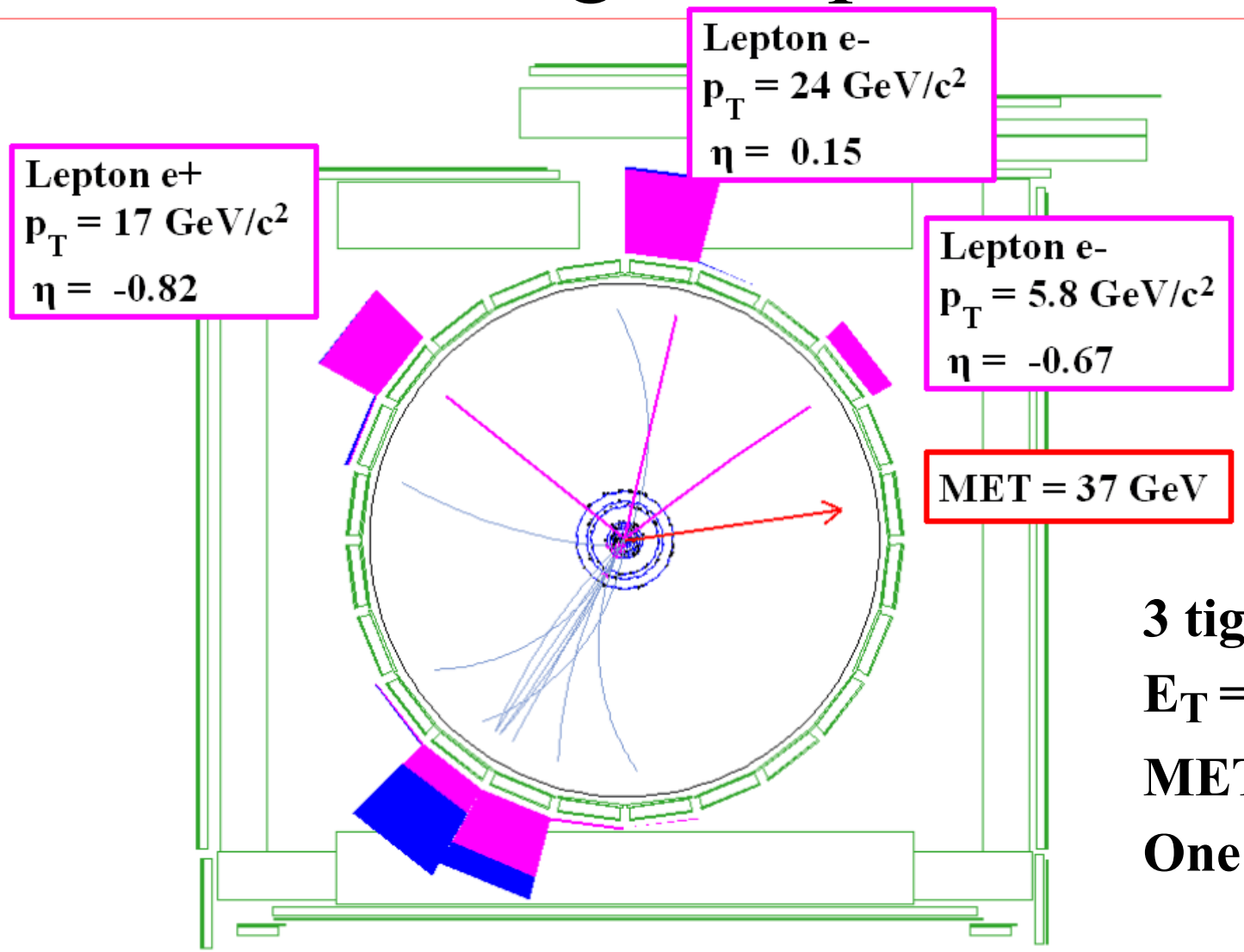
Missing E_T

3 tight → 1 event

2 tight, 1 Track → 4 events

1 tight, 1 loose, 1 Track → 2 events

3 Tight Lepton Event

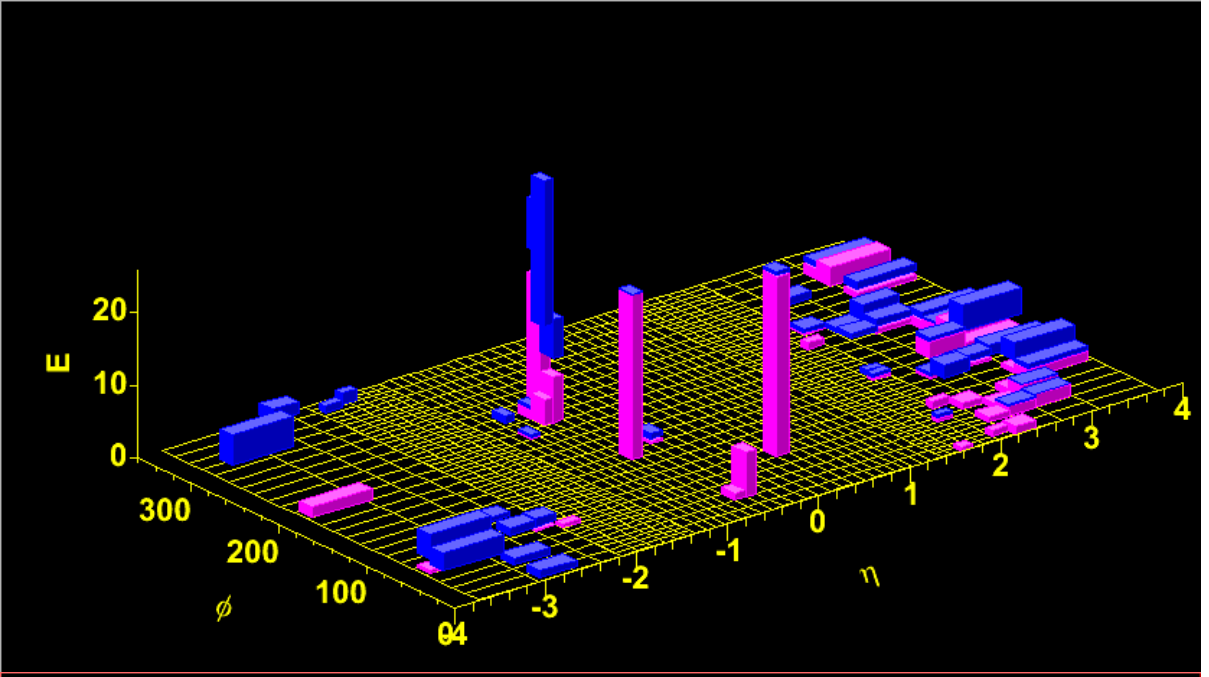


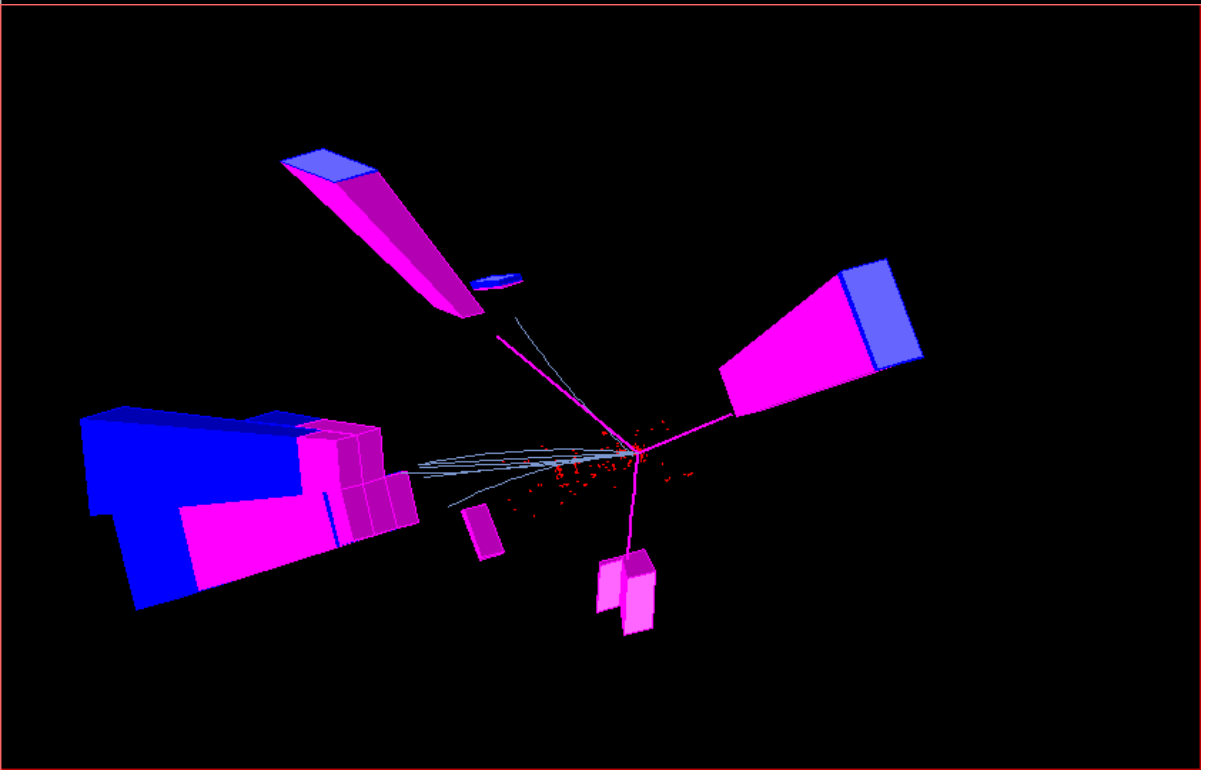
3 tight electron event

E_T = 24 , 17 , 6 GeV

MET = 37 GeV

One jet, Jet E_T = 60 GeV





3 tight electron event

E_T = 24 , 17 , 6 GeV

MET = 37 GeV

One jet, Jet E_T = 60 GeV

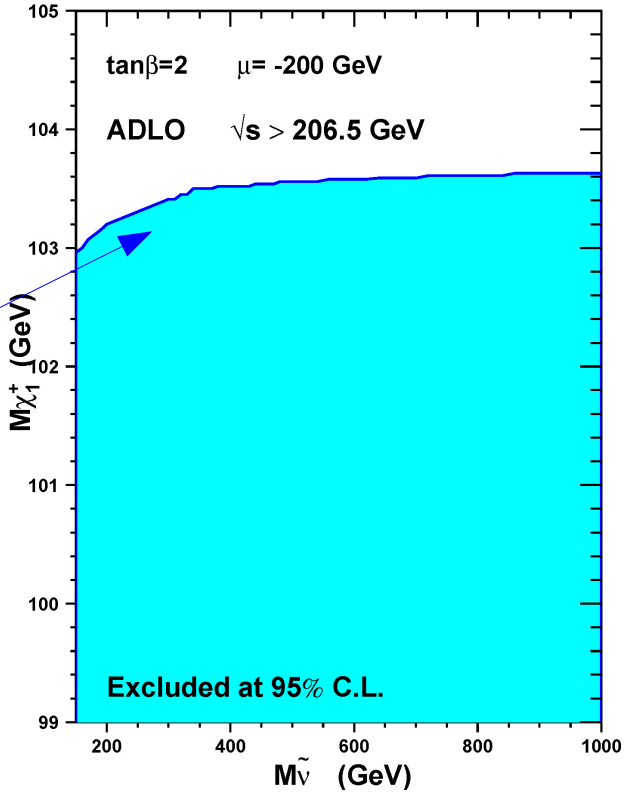
PART III
Interpreting the Results

Present State of Knowledge

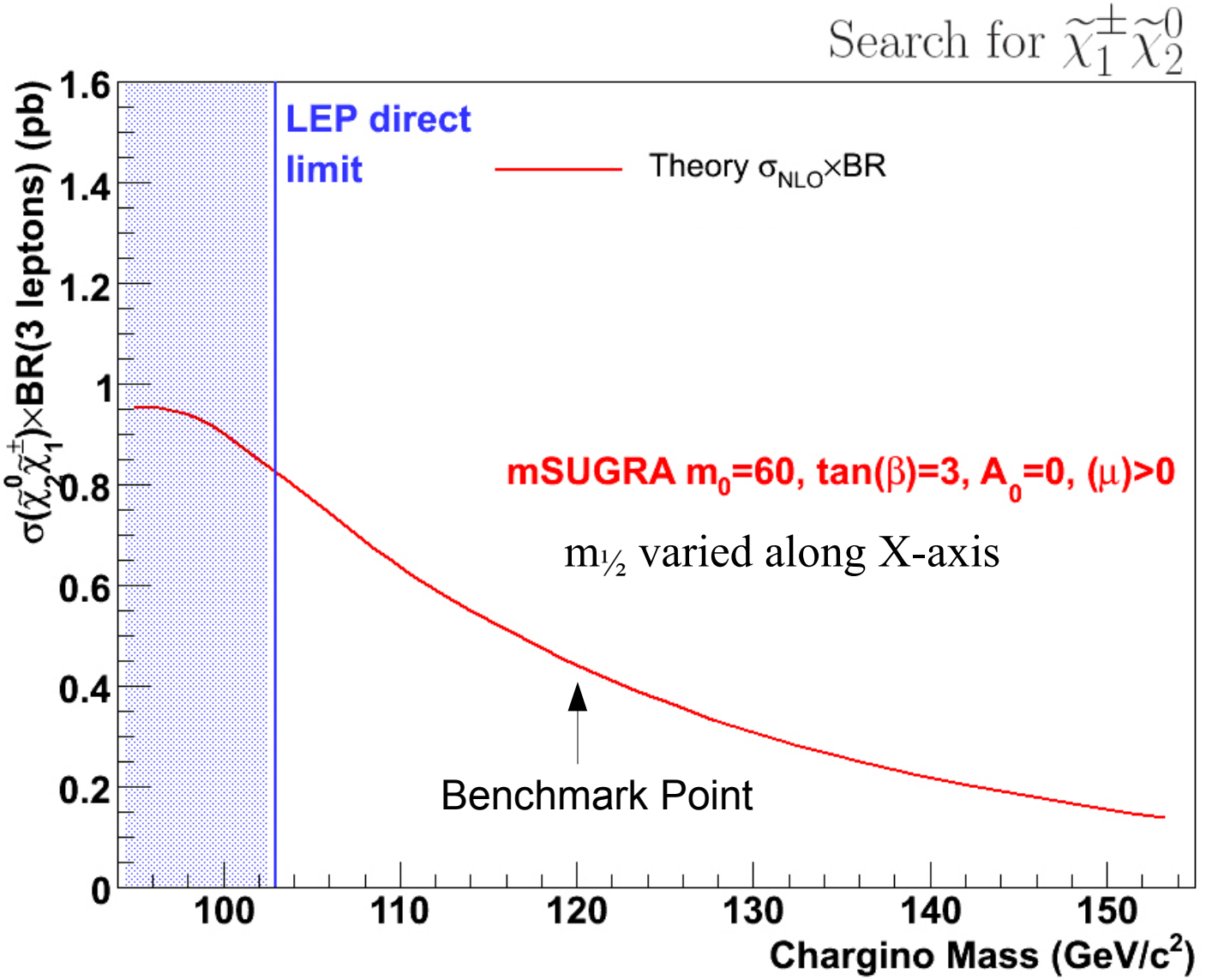
We can place limits on production cross section times branching ratio as a function of mass of the particle – in other words, rule out SUSY particles with masses below a threshold at 95% C.L.

LEP results : directly applicable

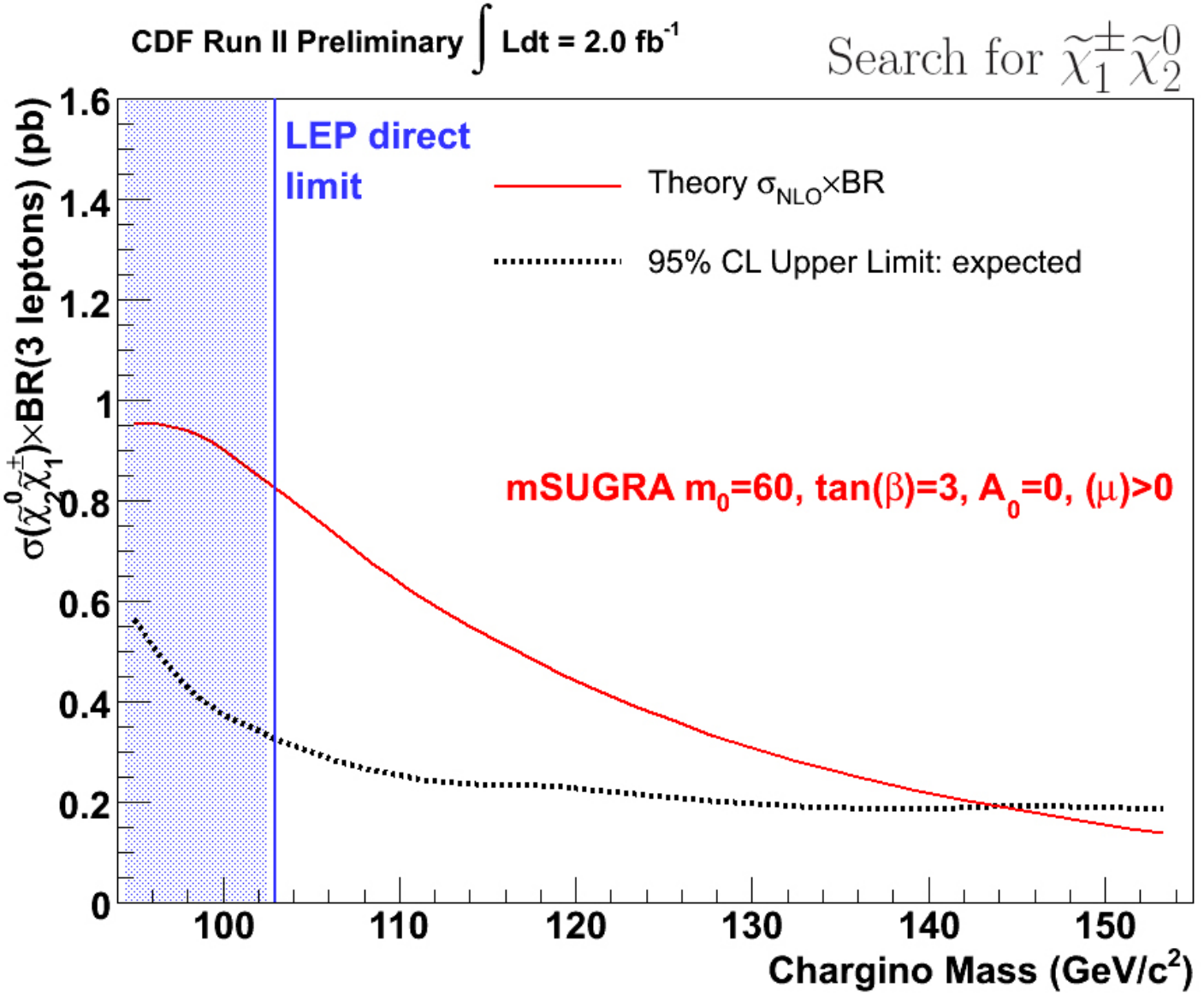
Charginos must have mass > 103.5 GeV/c^2



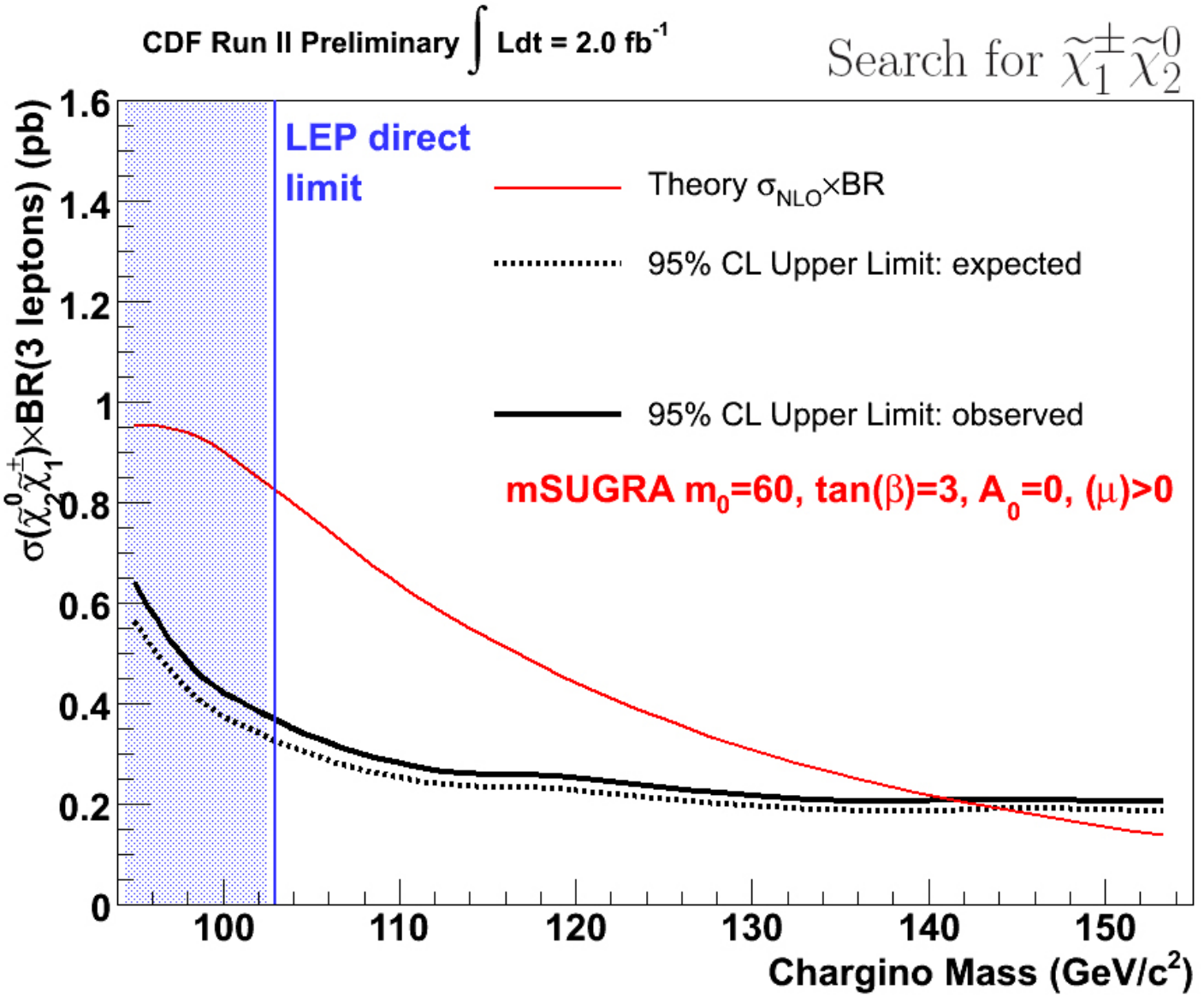
mSUGRA Signal Prediction



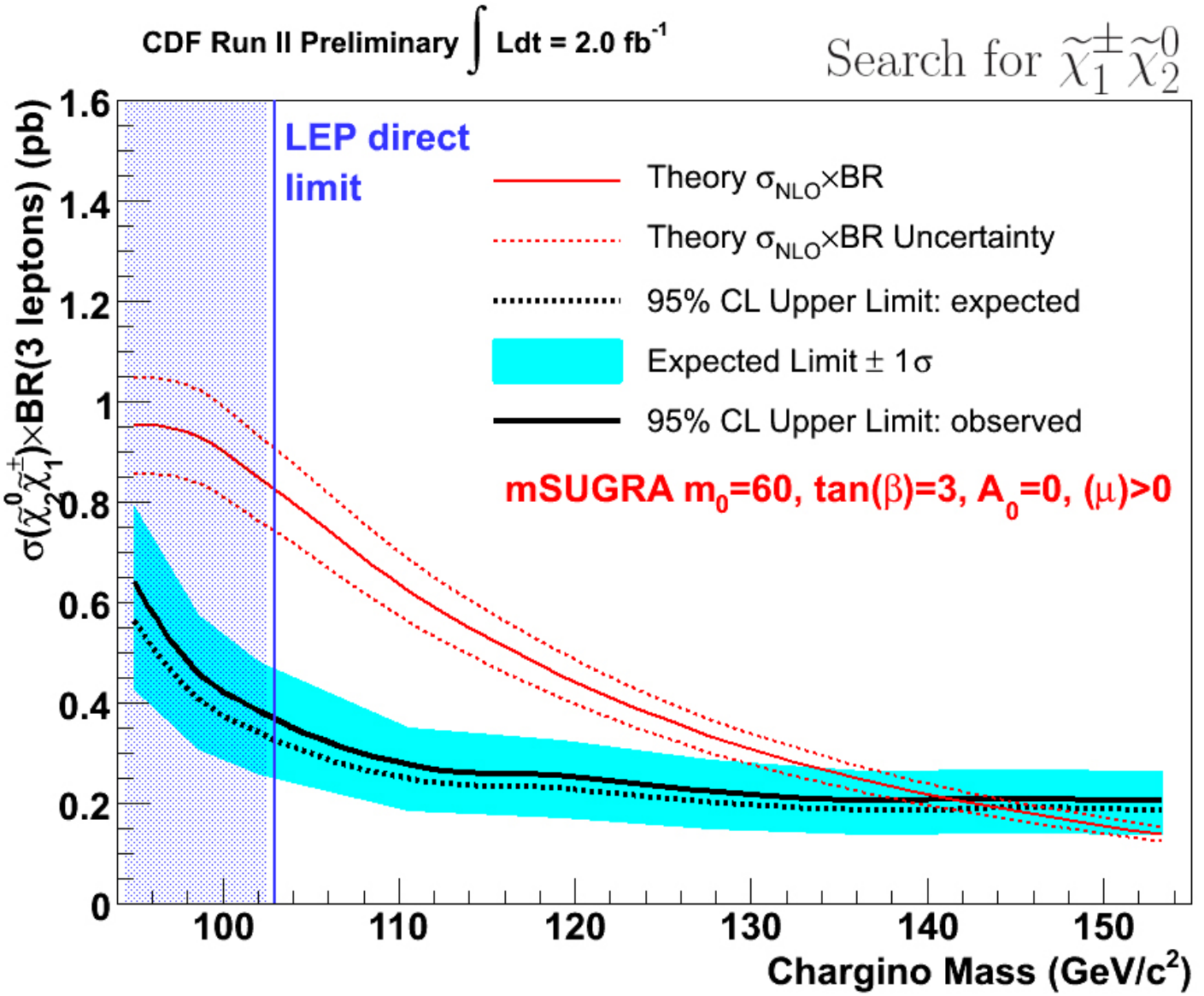
mSUGRA expected limit with 2 fb^{-1}



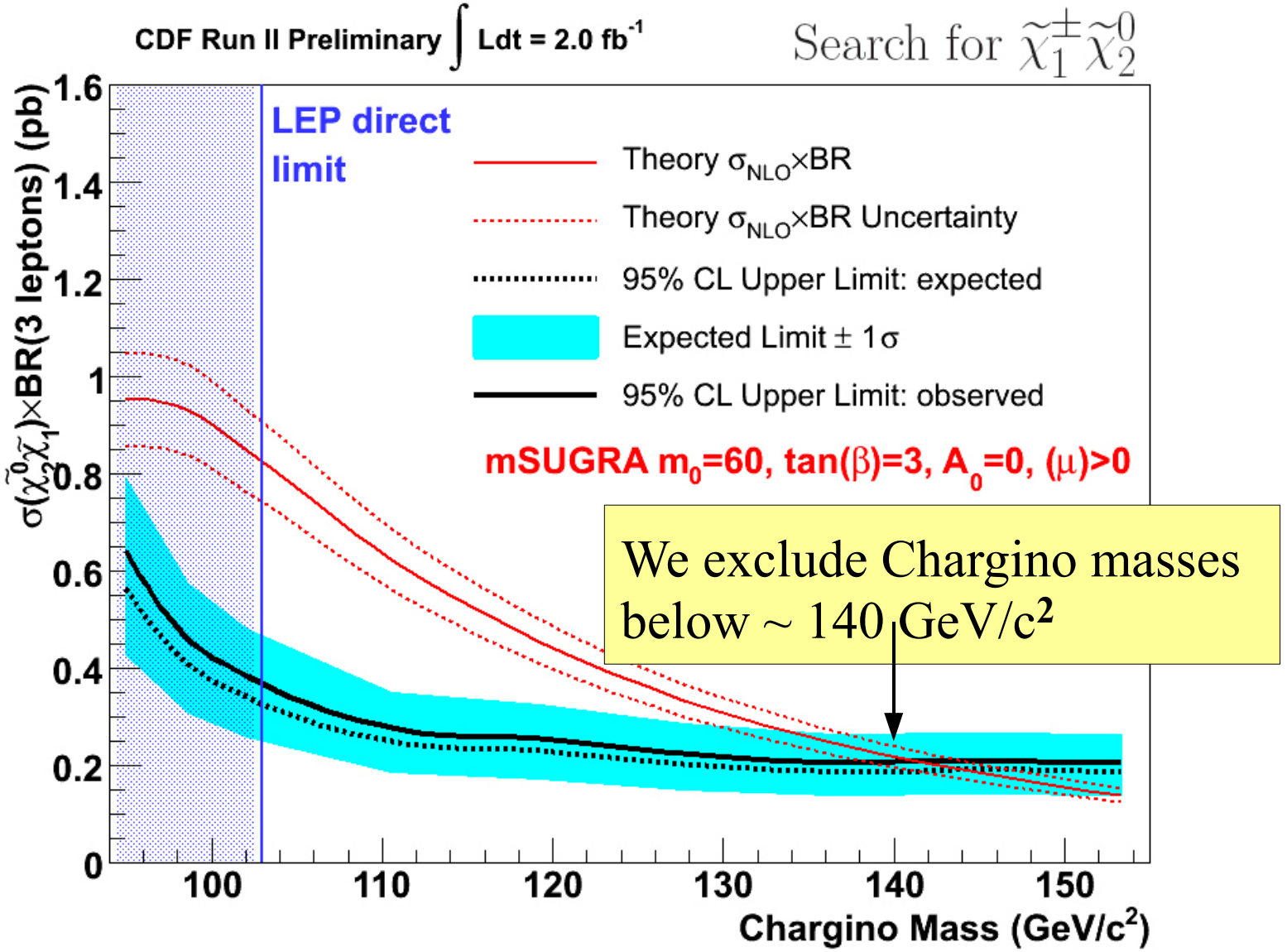
mSUGRA Limits : Observed



mSUGRA Limits



First mSUGRA Direct Limits since LEP!

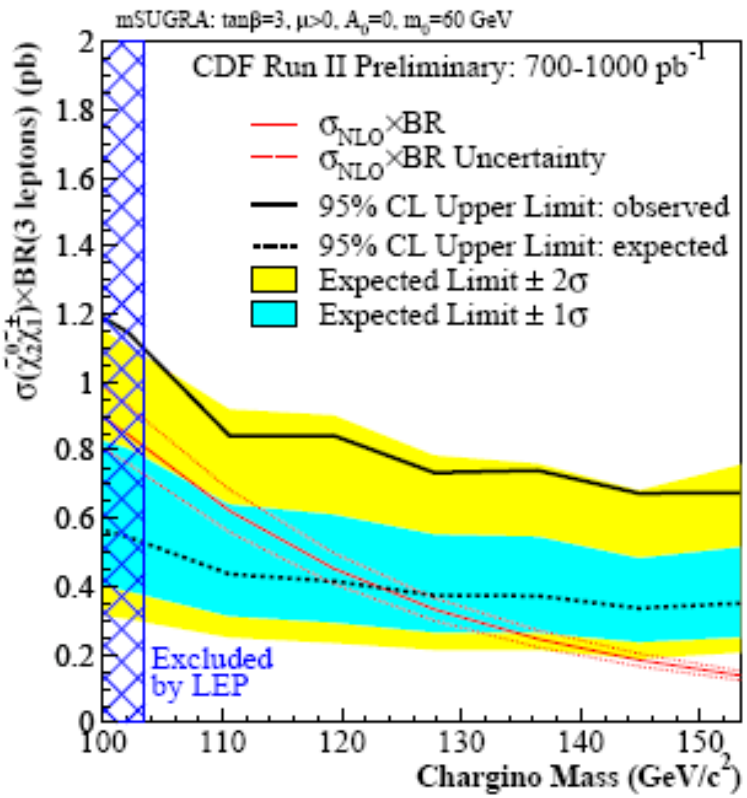


Improvements since 1 fb^{-1}

Expected limit improved 122 to 144 GeV/c^2

Observed limit : No exclusion before...

Now excluding ~140 GeV/c^2



Now with 2 fb^{-1}

- We have a unified search method – all channels for all lepton flavors in parallel.
- Our channels are defined exclusively – hence combining channels is straightforward.
- We added new categories of events such as dimuon+track to previous set.
- Bottomline :

  Being systematic allowed better optimization of selection

  Where we would've needed 2.5 fb^{-1}, now we can do it with 2 fb^{-1}

Summary and Outlook

- We analyzed 2 fb^{-1} of 1.96 TeV p-pbar collisions at CDF. For benchmark mSUGRA parameters, we expected ~12 SUSY events.
- Our observation of 7 events is consistent with the standard model expectation of 6.4 events.

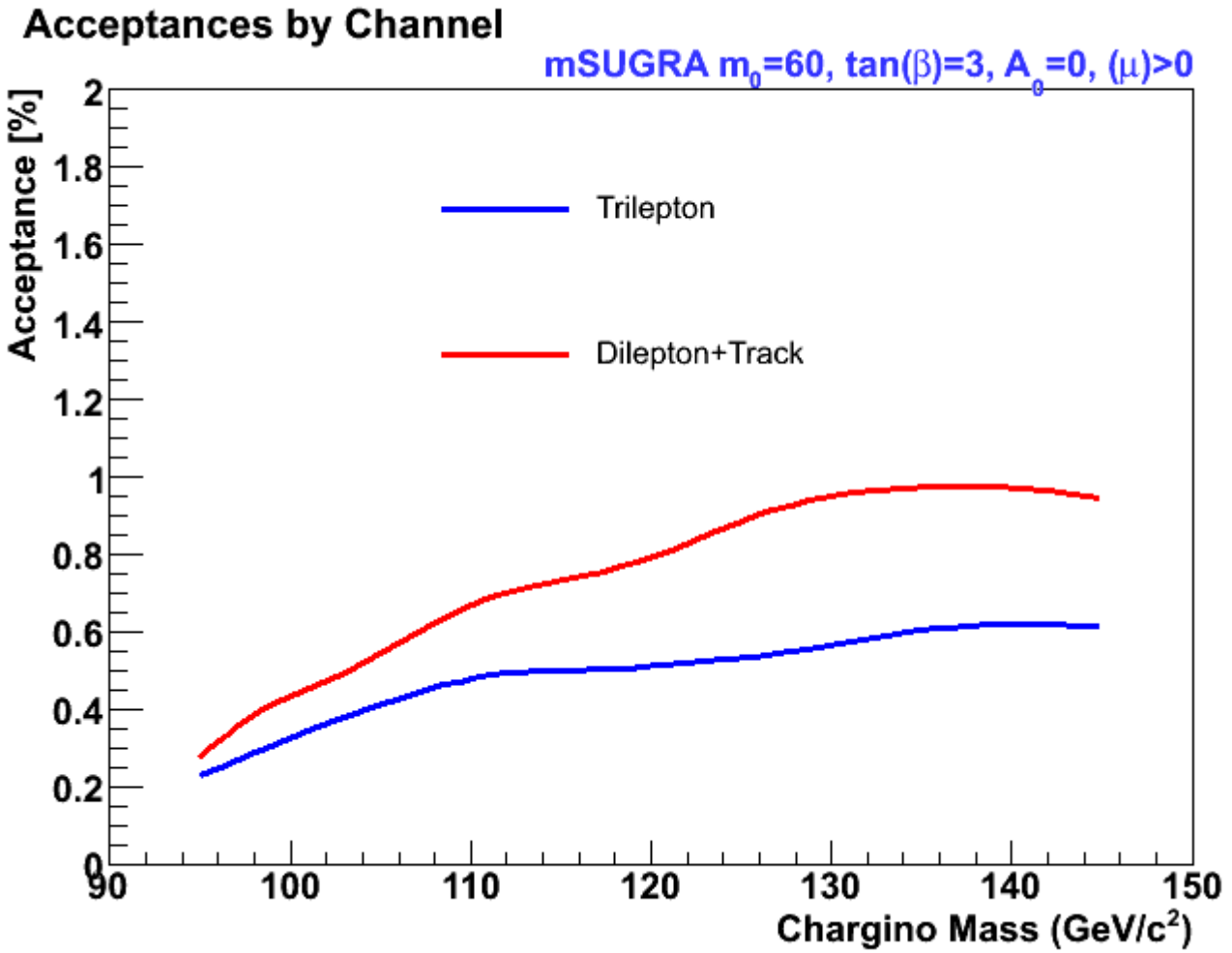
- We set limits on mSUGRA Chargino mass well beyond LEP for the first time. We are working on interpreting results in a model independent way.

- CDF has a mature trilepton analysis in place – all we need is more data.
- More and more data at the Tevatron will allow us to probe other regions in mSUGRA, and other models – we hope that SUSY is found there!

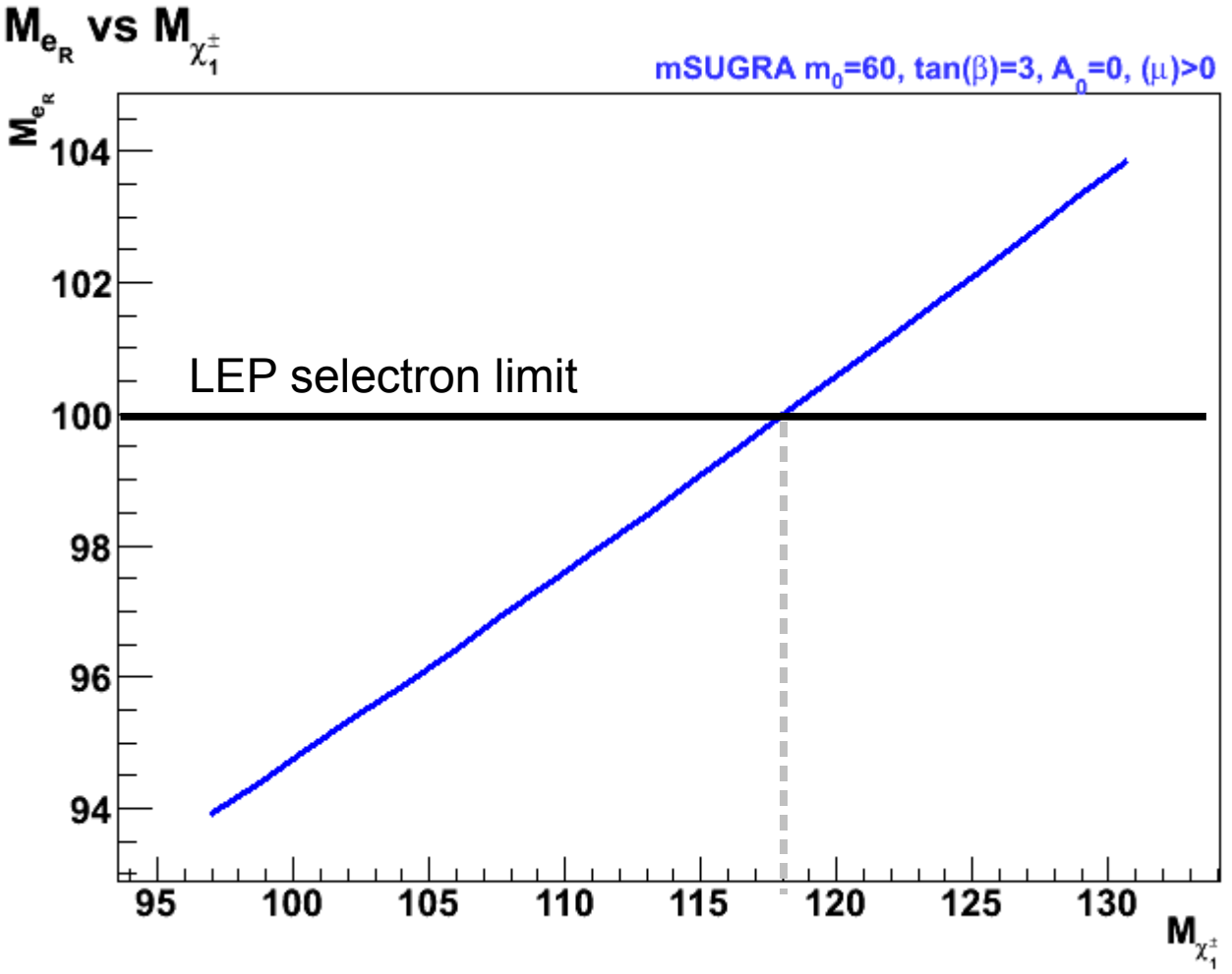
- If not, there is always the LHC.

BACKUP

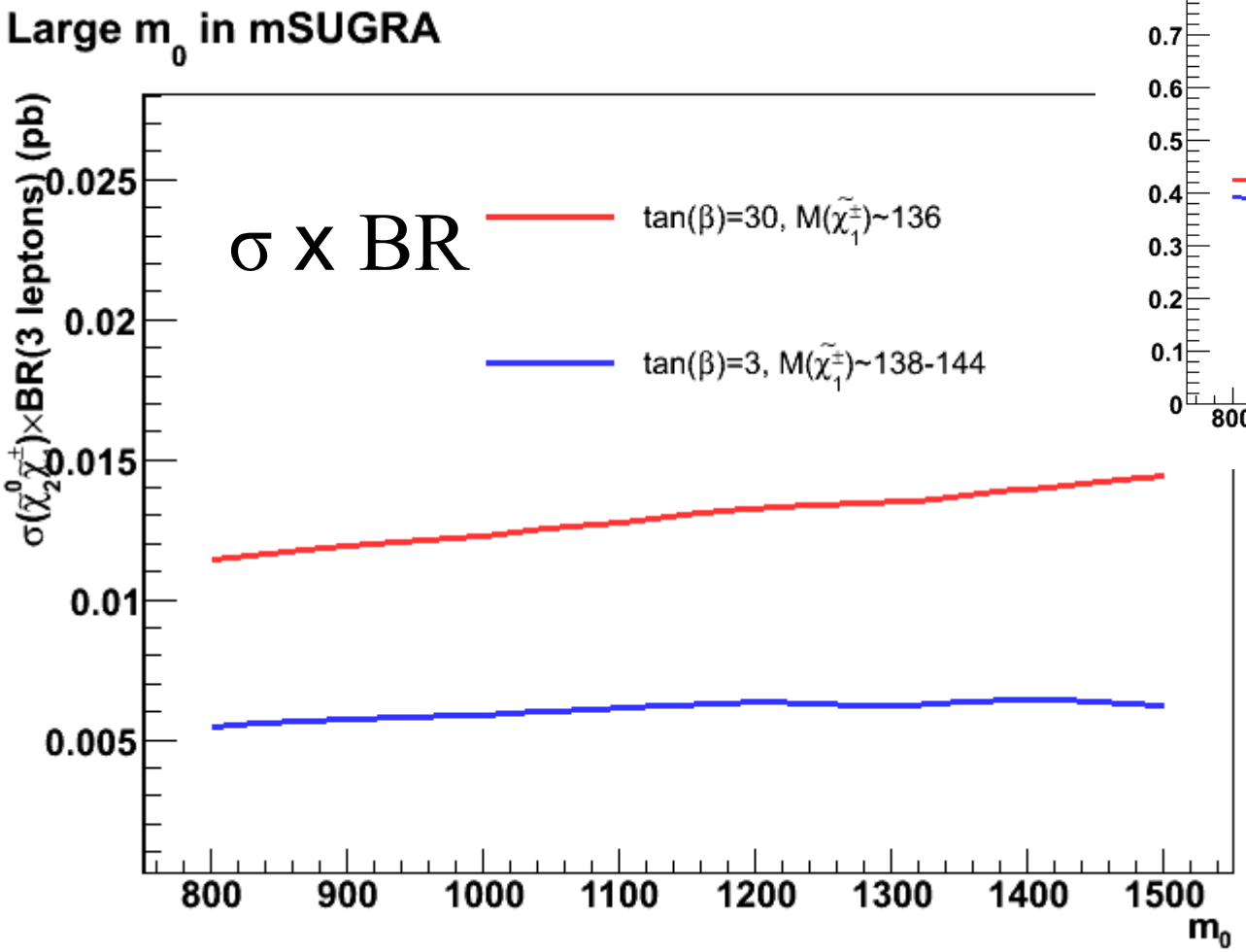
Signal Plots : Acceptances by Channel

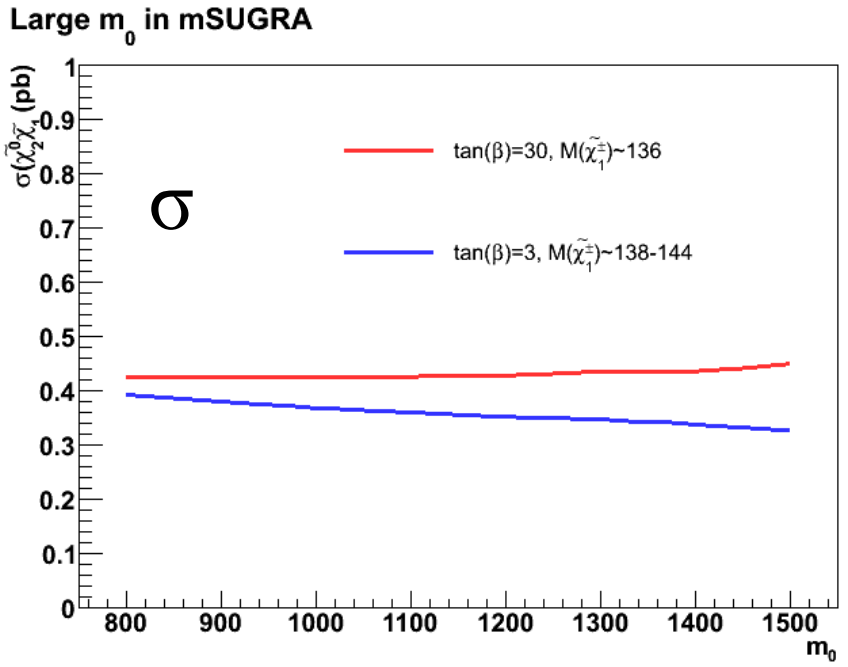


Signal Plots
M(selector) vs M(chargino)



Signal Plots : Large m_0



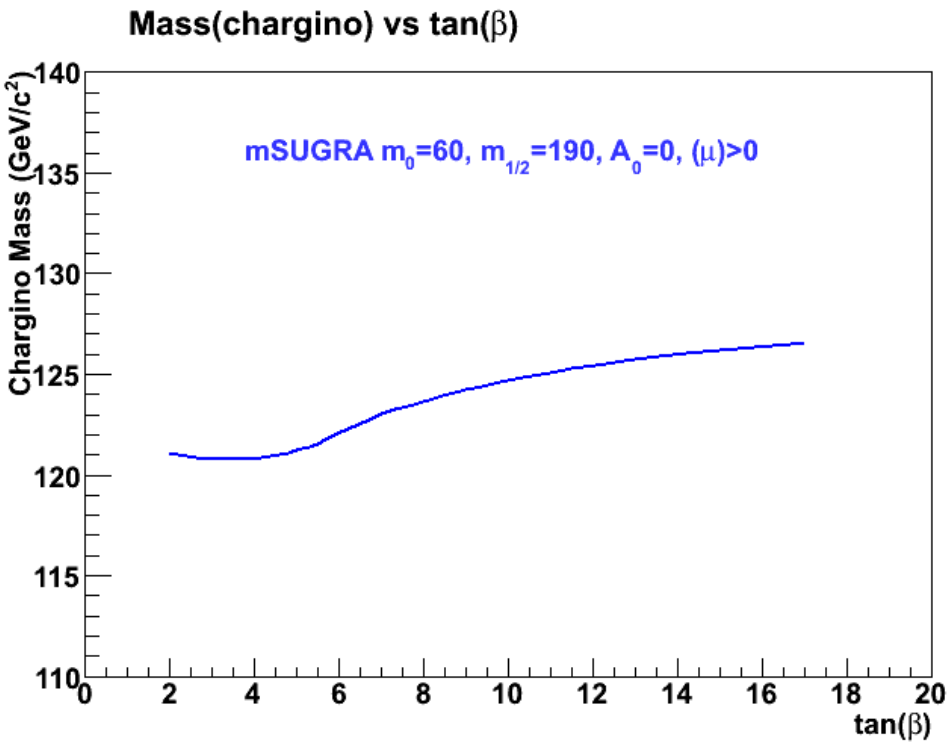


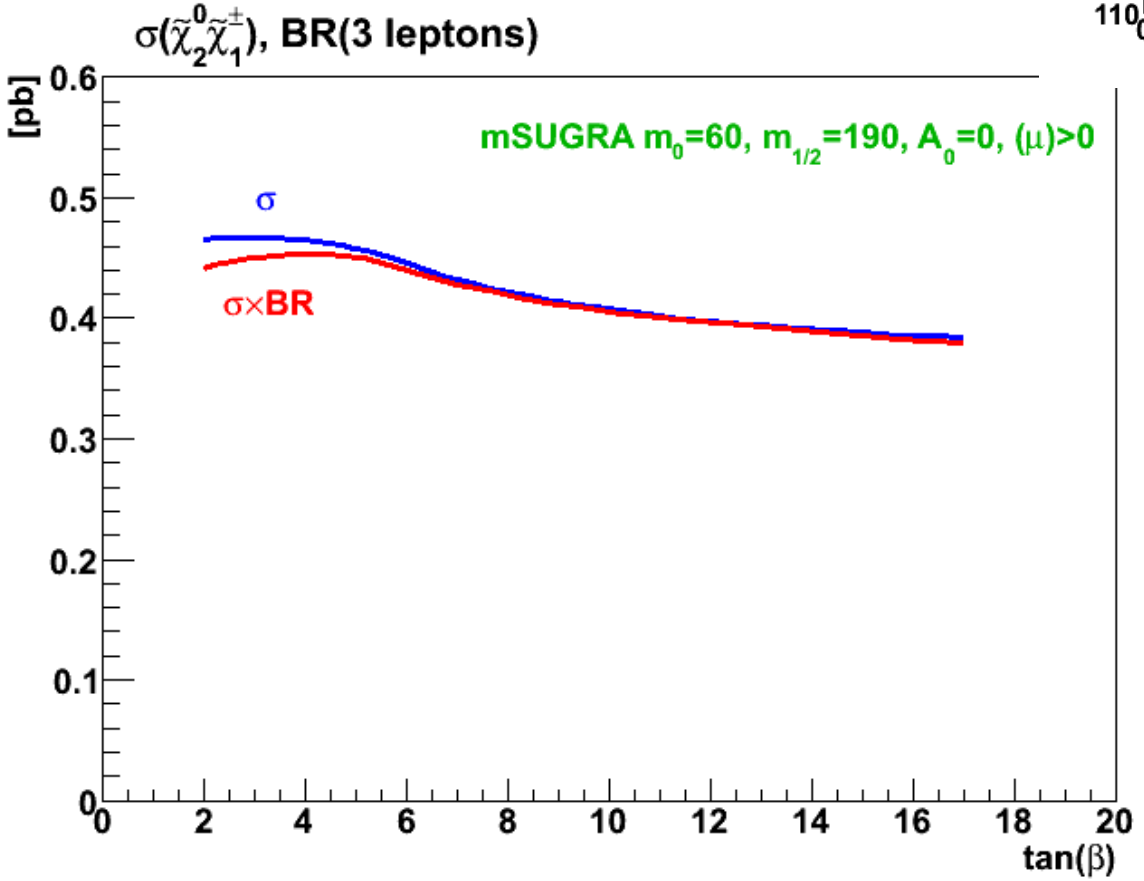
tan(β) = 30

tan(β) = 3

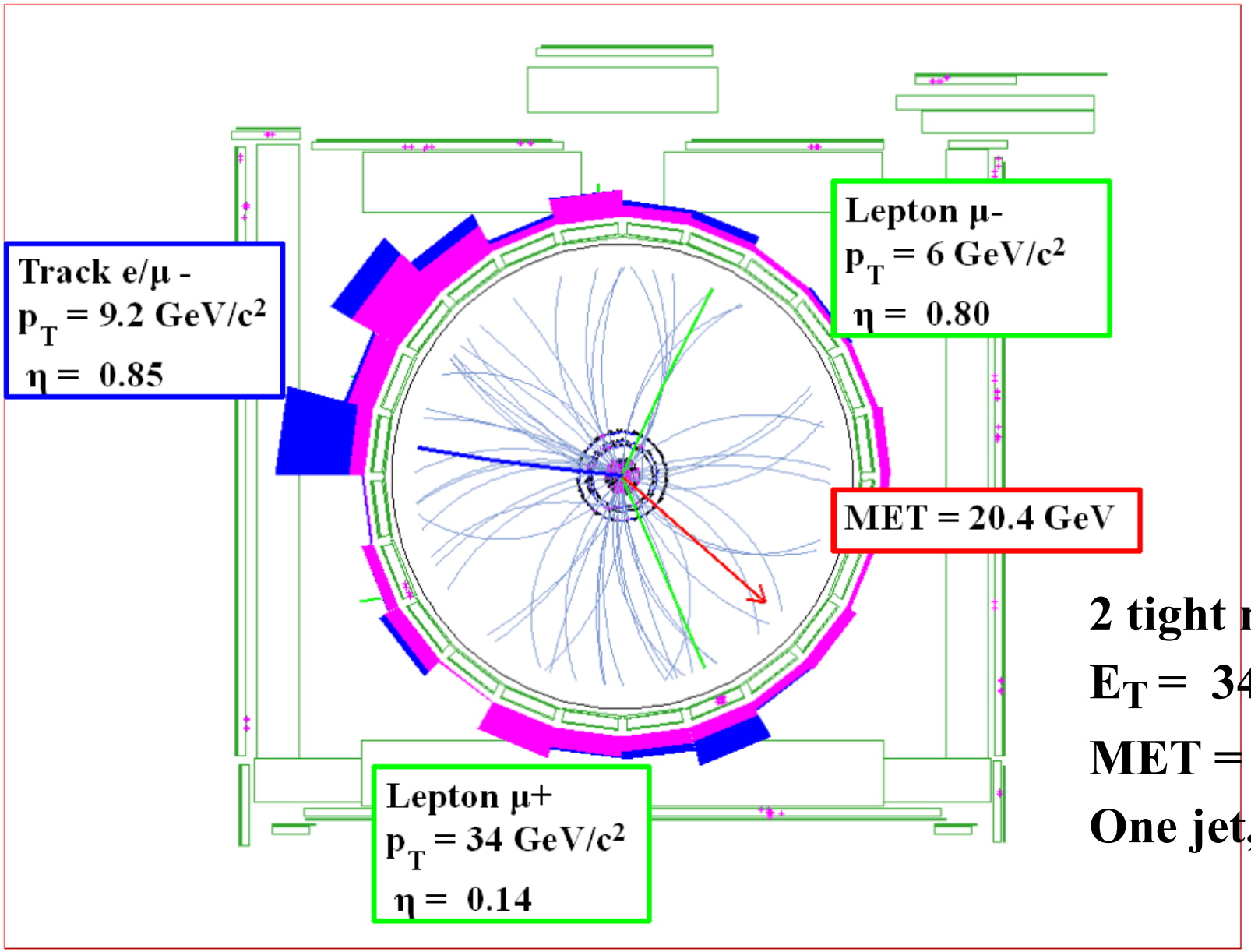
$m_{1/2}$ =190, A_0=0, μ>0

Signal Plots tan(β) variation





EVENTS



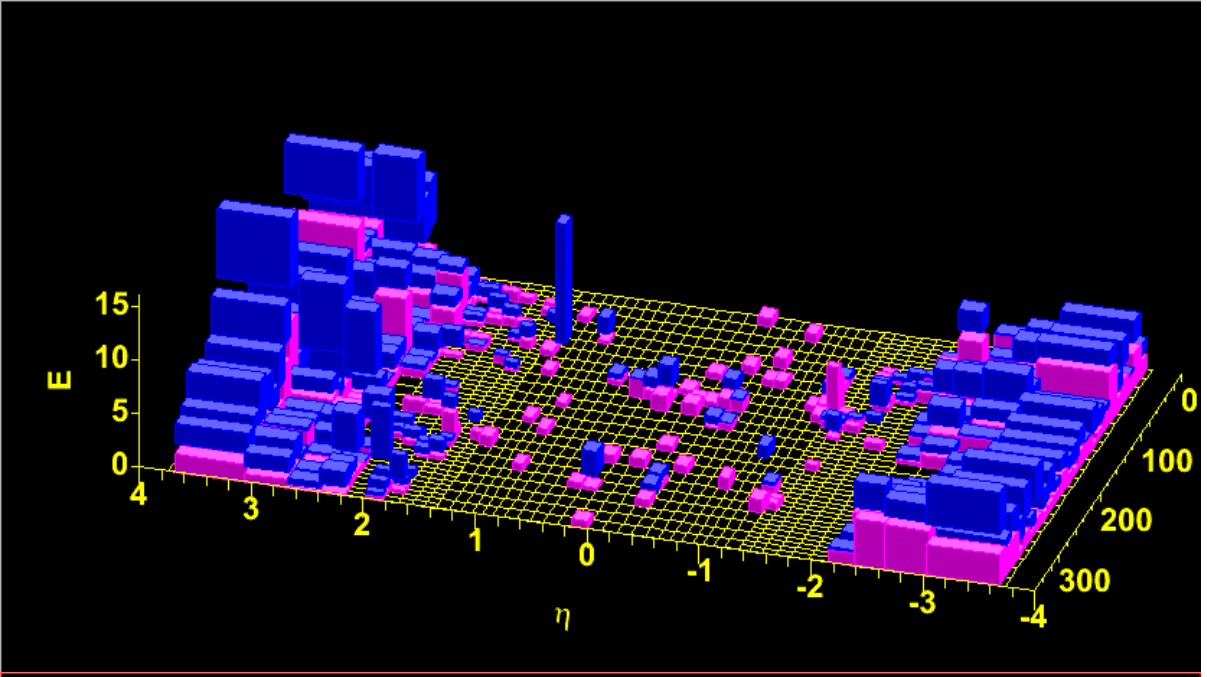
2 tight muons + 1 Track

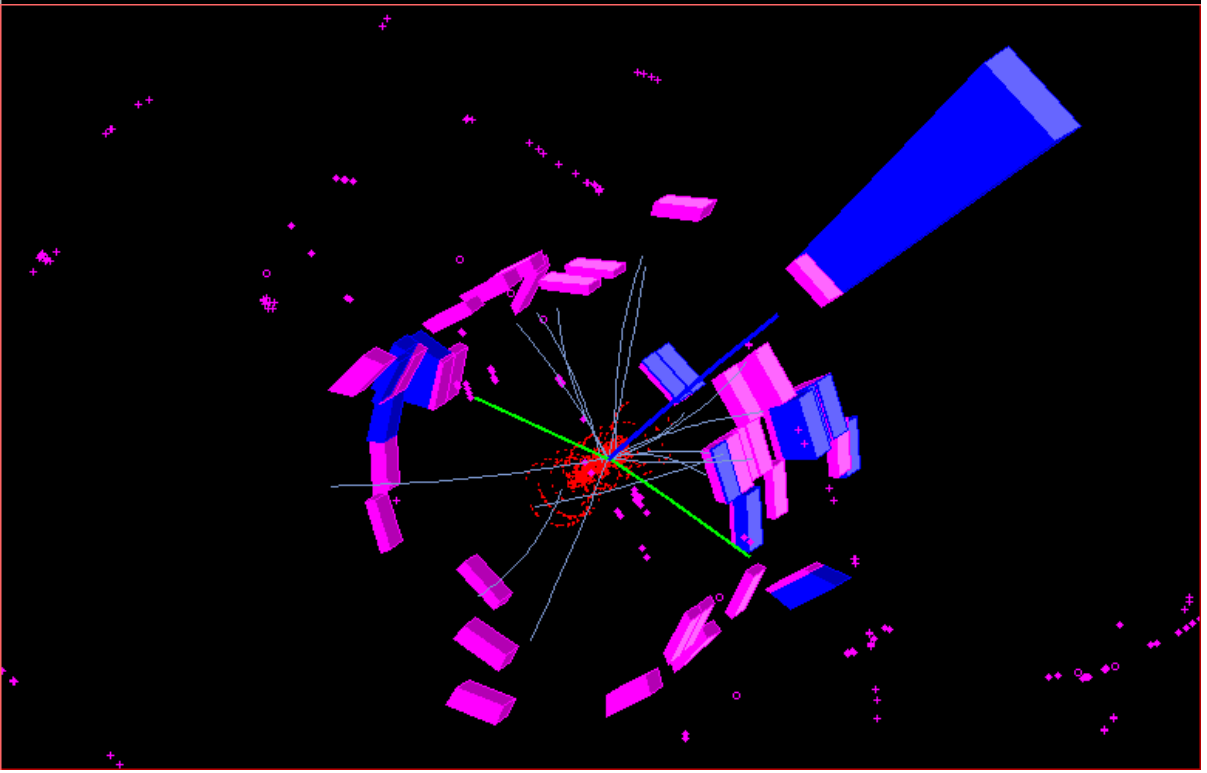
E_T = 34 , 6 , 9 GeV

MET = 20.4 GeV

One jet, Jet E_T = 22 GeV

EVENTS





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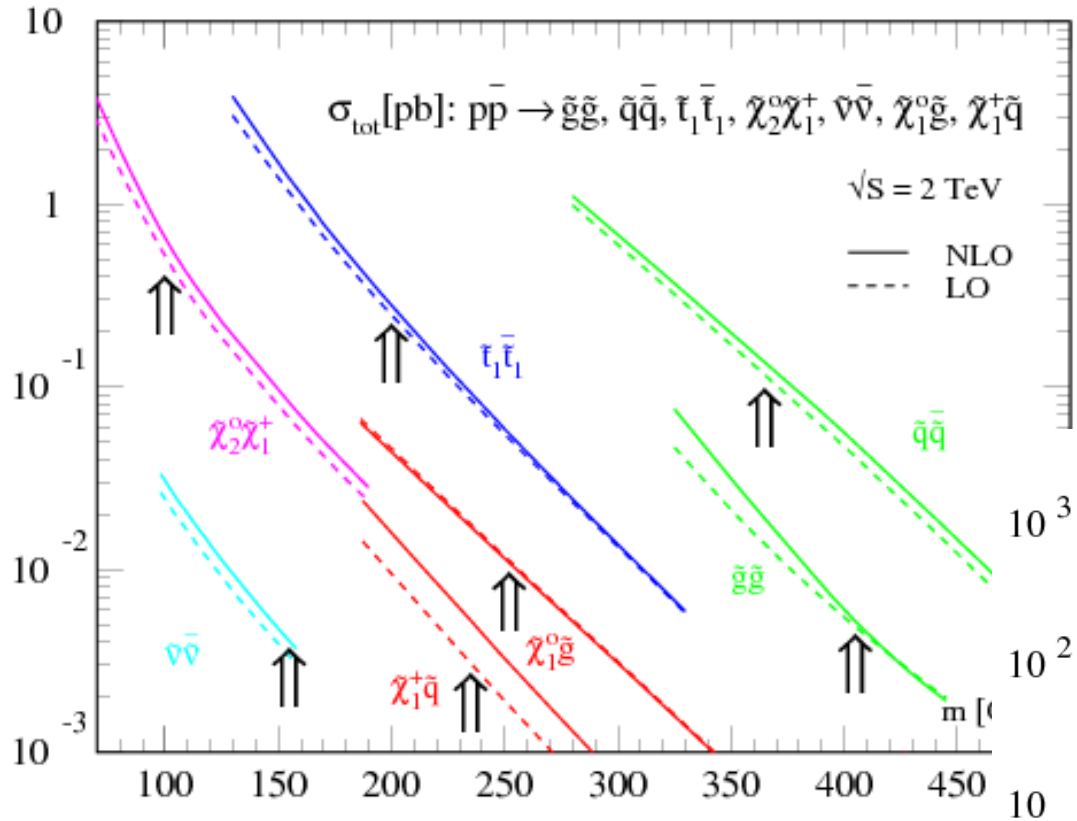
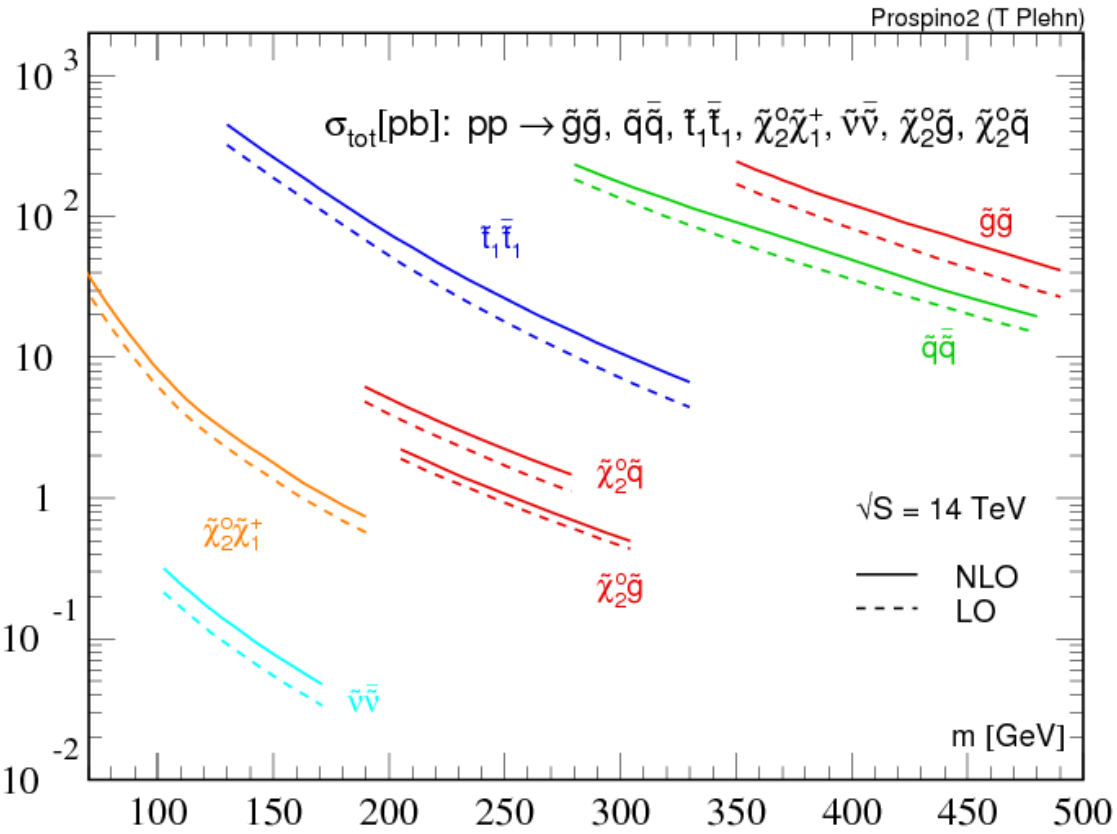
One jet, Jet E_T = 22 GeV

Cross Sections : Tevatron & LHC

T. Plehn, PROSPINO





DZero Limits