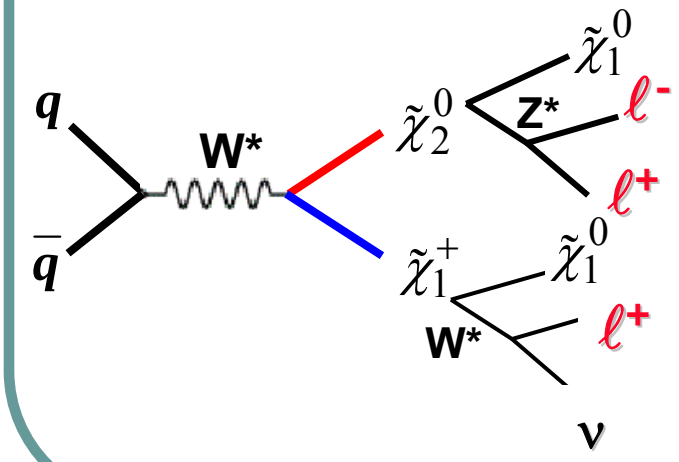
Search for chargino and neutralino associated production with multileptons



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Representing CDF

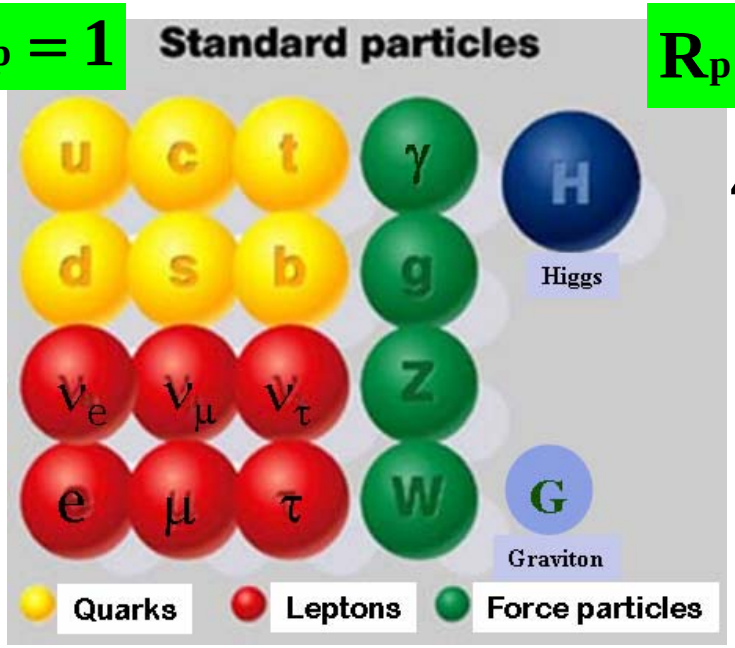
Joint meeting of Pacific Regional Particle Physics Communities

October 26- November 3, 2006

SUSY

- **New symmetry between bosons and fermions**
  - **Unifies gauge couplings**
  - **Solves "fine-tuning" problem (if M_{SUSY}<1 TeV)**
  - **Includes quantum gravity**

$R_p = 1$



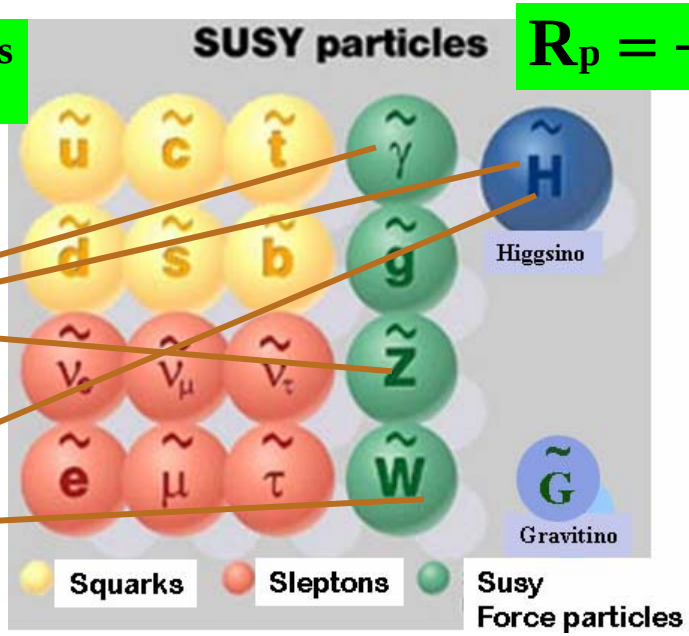
$R_p = (-1)^{B+L+2s}$

4 neutralinos

$\tilde{\chi}_i^0$

$\tilde{\chi}_i^\pm$

2 charginos

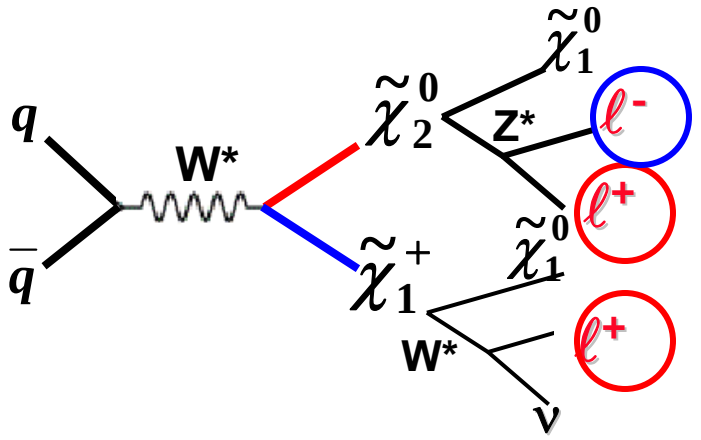


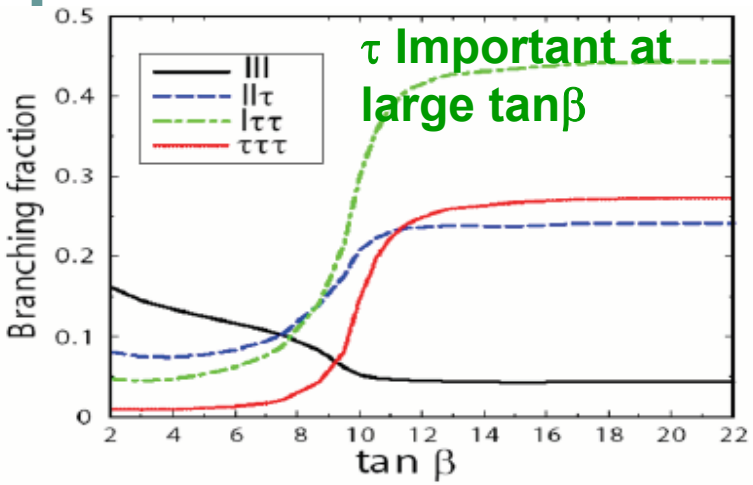
$R_p = -1$

- In many models the lightest SUSY particles are the spartners of the EW bosons: $\tilde{\chi}_i^0$, $\tilde{\chi}_i^\pm$
- $\tilde{\chi}_1^0$ is an excellent dark matter candidate

Chargino and neutralino

- **Chargino and neutralino associated production is a golden channel for SUSY:**
  - Final state with leptons and missing E_T
  - Easy to trigger
  - Final state depends on tan β

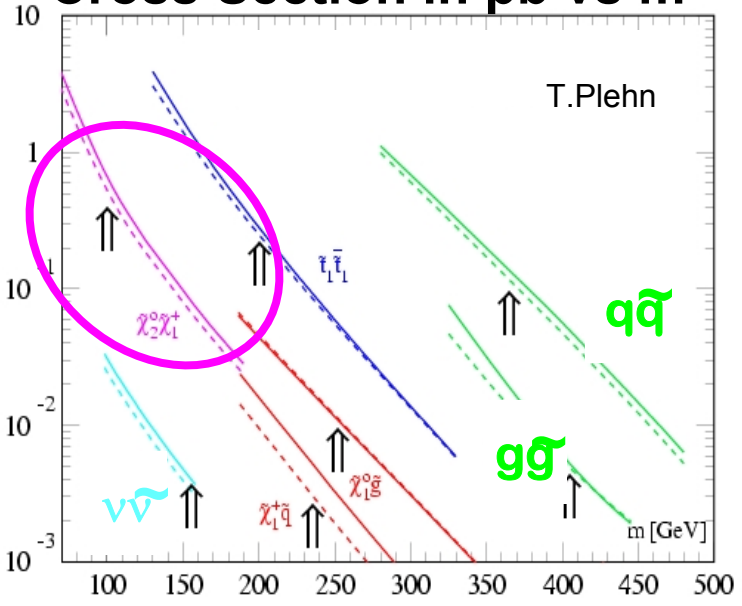




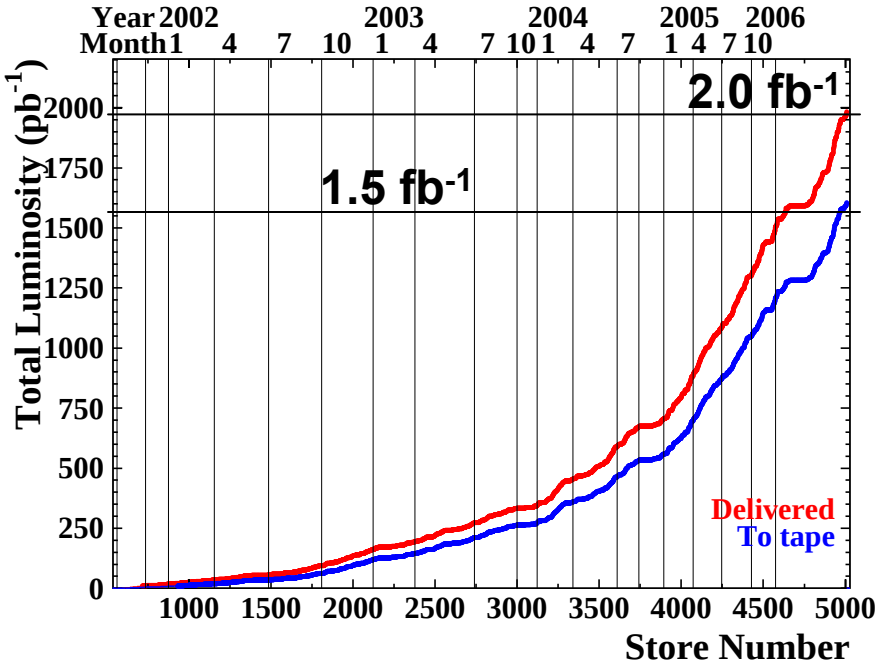
- **Low cross section**
- **Must reduce SM back-grounds**

tanβ= ratio of the higgs vev's

Cross Section in pb vs m



The Tevatron at Fermilab



Run II: about 2 fb^{-1} delivered to the experiments

Analysis presented are based on ≤1fb^{-1}

Overview

UNBIASED SEARCHES

CHANNEL	L (fb^{-1})	TRIGGER PATH
LS: $e^{\pm}e^{\pm}$,$e^{\pm}\mu^{\pm}$, $\mu^{\pm}\mu^{\pm}$ P_T>20,10 GeV	1	High p_T Single Lepton
$\mu\ell$ + e/μ P_T>20,5,5 GeV	0.75	High p_T Single Lepton
eℓ + e/μ P_T>20,8,5 GeV	1	High p_T Single Lepton
$\mu\mu$ + e/μ P_T>5, 5, 5	1	Low p_T Dilepton
ee + track P_T>15, 5, 4	1	Low p_T Dilepton

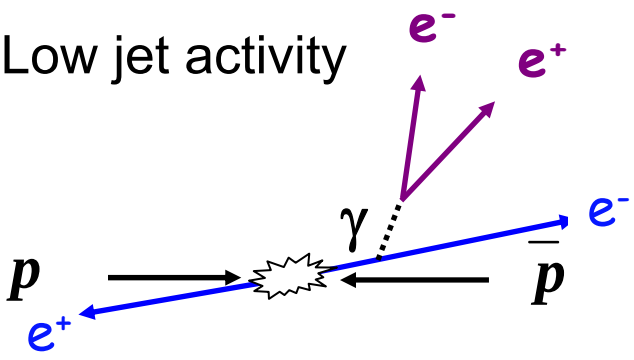
Like-sign dilepton: larger acceptance at low chargino mass mass

Use e/mu only Very small backgrounds

Dielectron + track: Sensitive to τ as 3rd lepton $\Rightarrow$ larger acceptance at large tanβ

Backgrounds

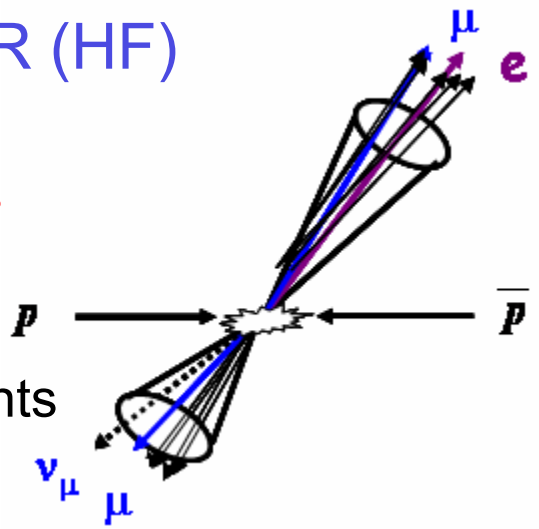
- DRELL YAN (DY)
  - Mainly high p_T leptons
  - Small MET
  - Low jet activity



- DIBOSON
  - Leptons have high p_T
  - Leptons are isolated
  - MET due to neutrinos

irreducible background

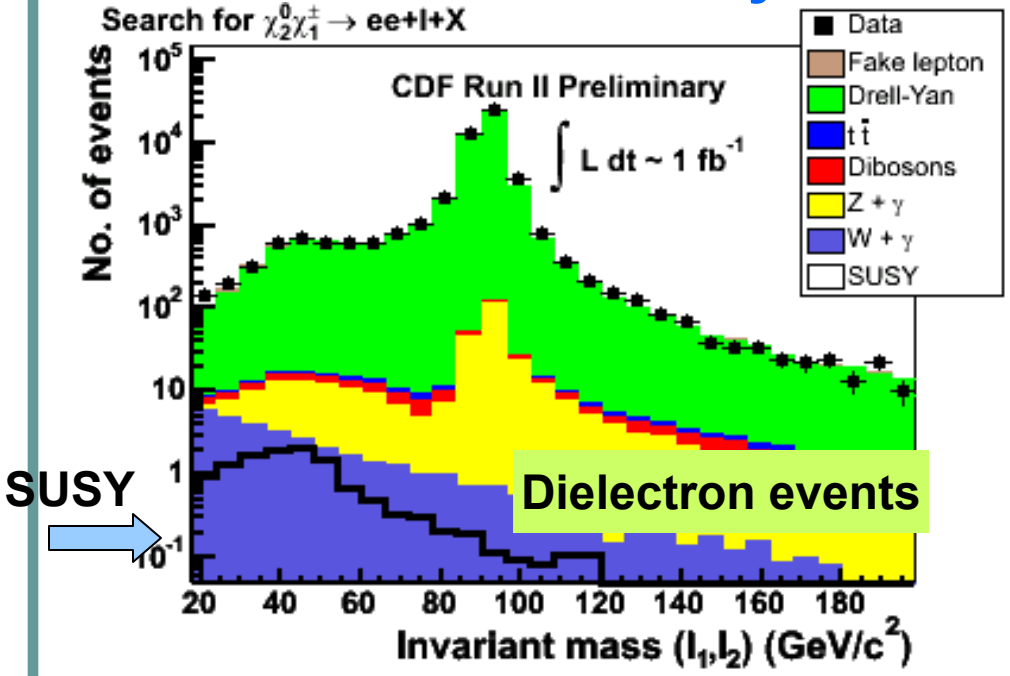
- HEAVY FLAVOUR (HF)
  - Lower P_T non isolated leptons
  - MET due to neutrinos or jet mis-measurements

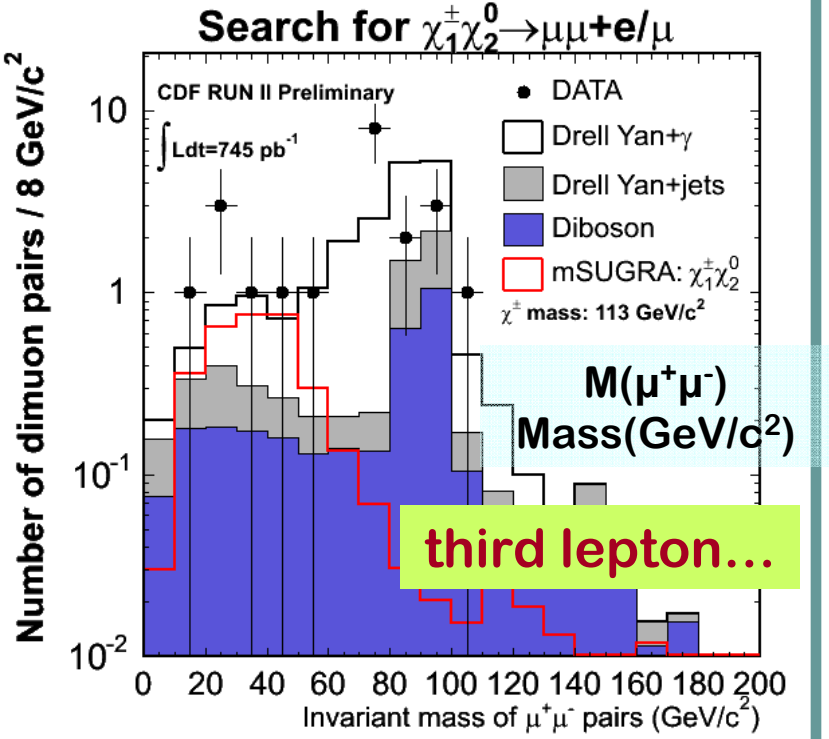


- **Lepton P_T to reject HF**
- **Veto resonances (J/Ψ, ϒ, Z)**
- **Large MET to reject DY, HF**
- **Low jet activity to reject ttbar,W+jets,Z+jets**
- **More kinematic selection for low P_T analysis**

Background reduction

- **SM background Z/γ^*, $W+\gamma$, diboson, $Z/\gamma^* \rightarrow \tau\tau$, $t\bar{t}$ overwhelms New Physics**



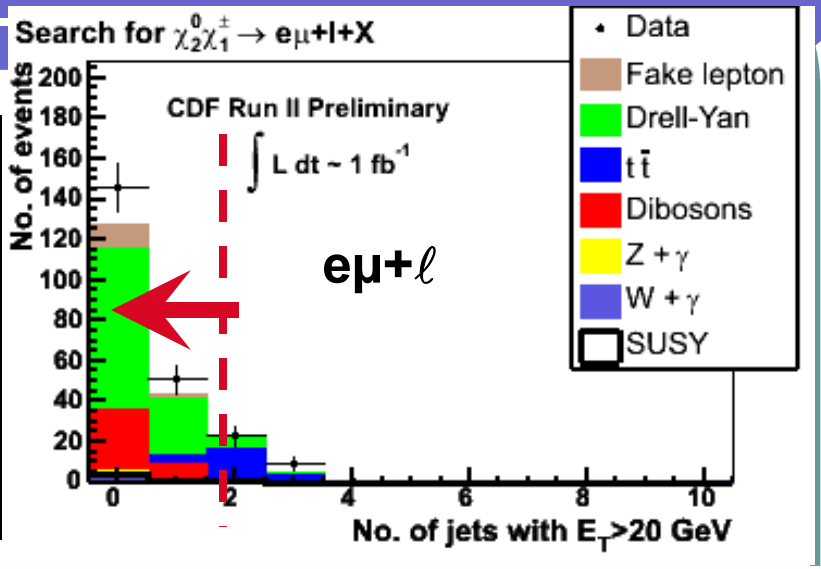


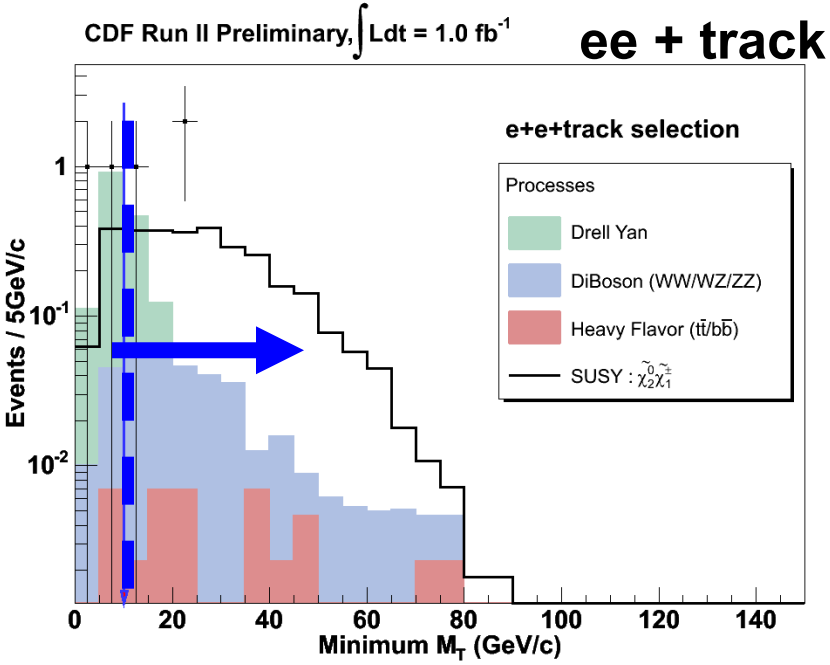
Rejection of J/Ψ, Υ and Z

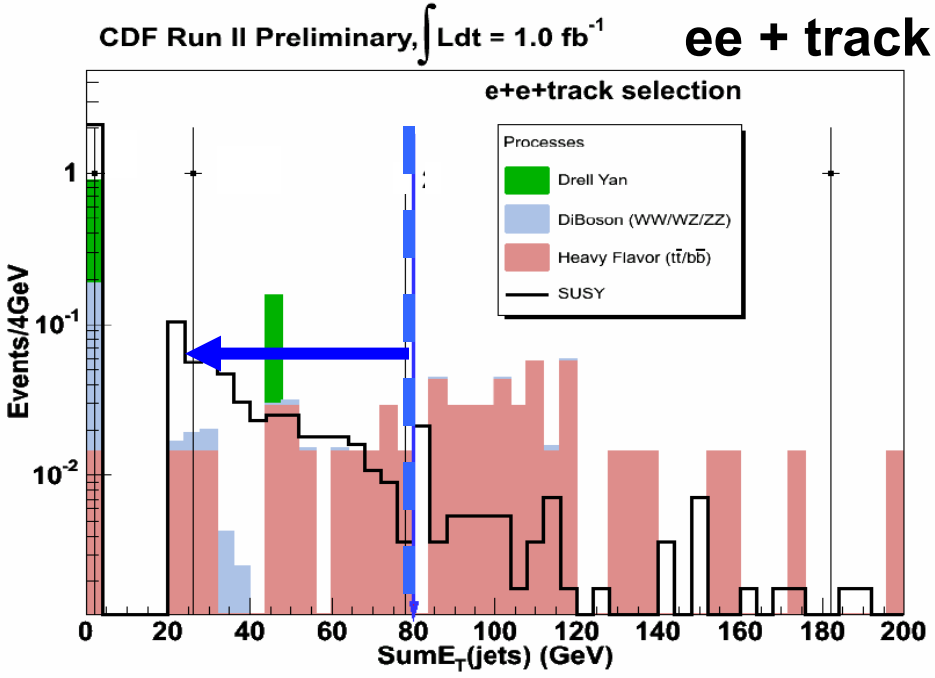
- $M_{\ell\ell}$<76 GeV & $M_{\ell\ell}$>106 GeV
- $M_{\ell\ell}$> 15 GeV (20 for dielectron + track, 25 for LS)
- min $M_{\ell\ell}$ < 60 GeV (dielectron+track)

Other selections

Analysis	Kinematic Selections
Trilepton	n. Jets(E_T>20 GeV) < 2
Dielectron + track	$H_T = \sum jet E_{Tj} < 80$ GeV
Dielectron+ track	$\Delta\phi(\ell\ell)<2.8$ rad
Dielectron+ track	Min MT(ℓ,MET)>10 GEV/c^2

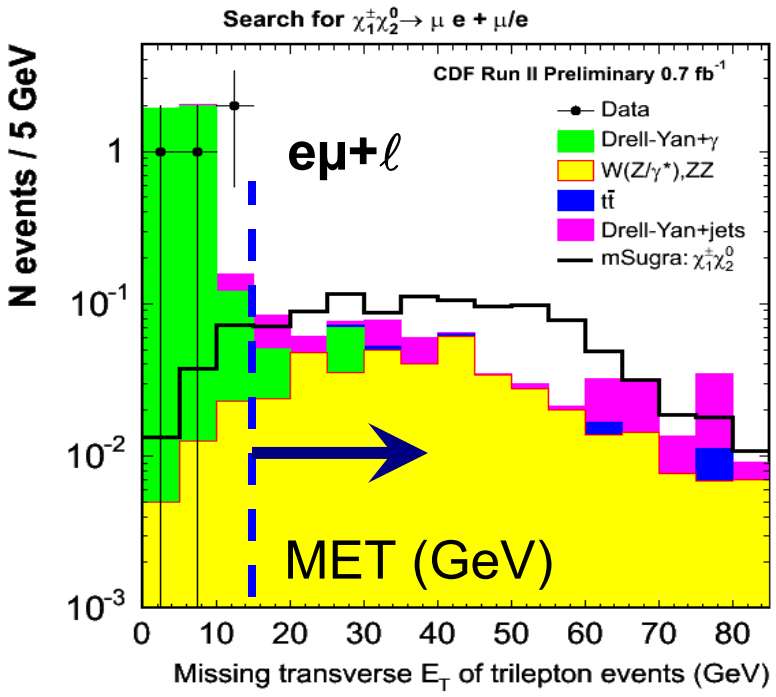


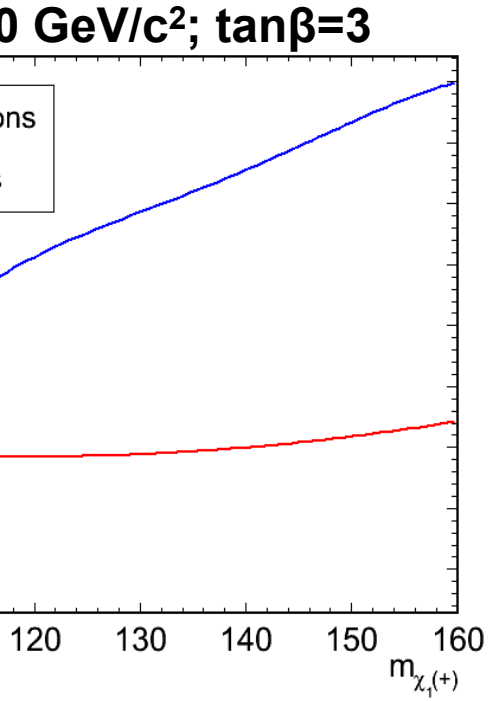




MET selection

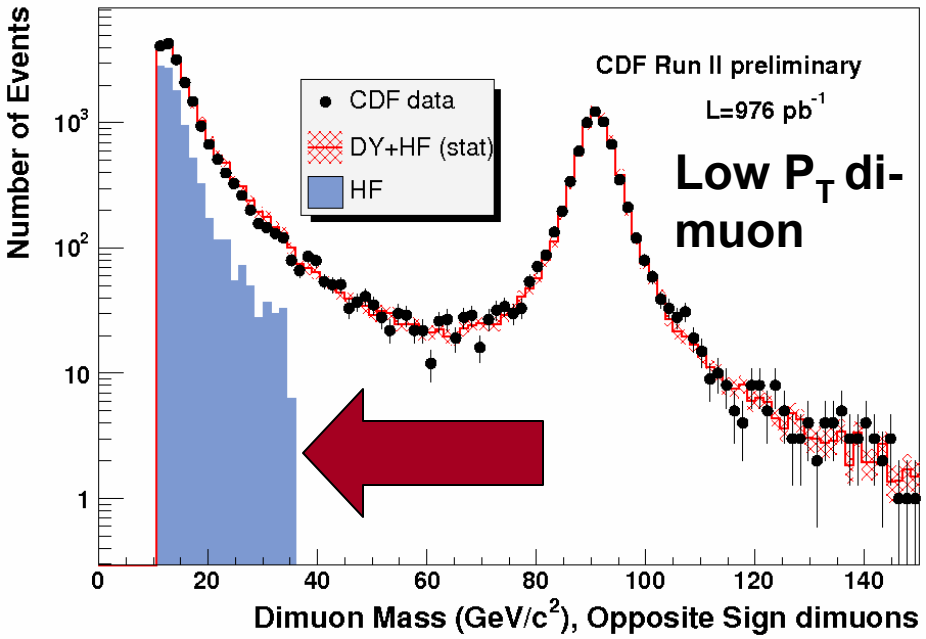
Further reducing DY by asking MET > 15 GeV
(MET>20GeV for di-electron + track)





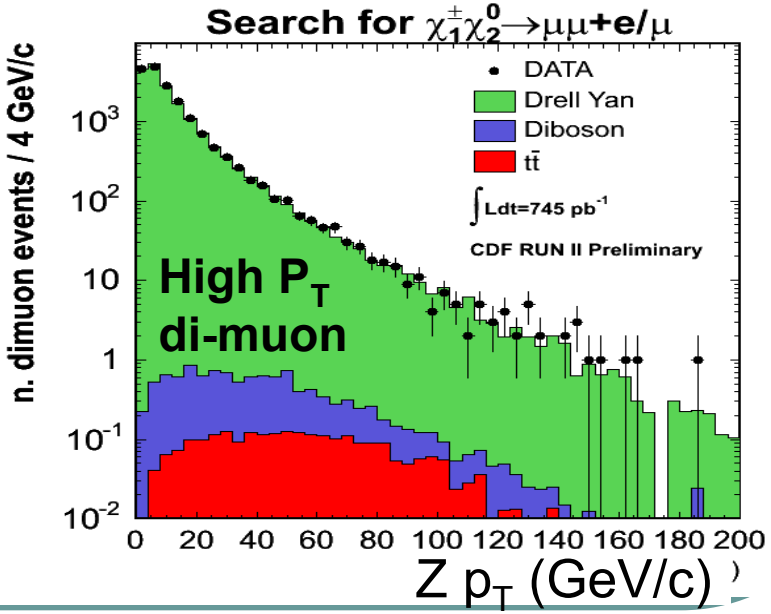
Chargino Mass (GeV/c^2)

Understanding the SM

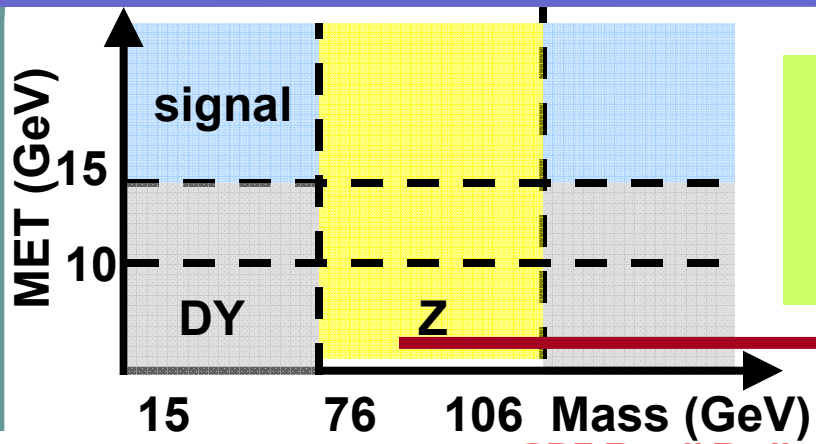


- **Major effort to investigate SM in control regions:**
  - **Dilepton**
  - **Tri-lepton (low statistic)**
  - **Combination of data (misidentified leptons, HF) and MC (PYTHIA,etc.)**

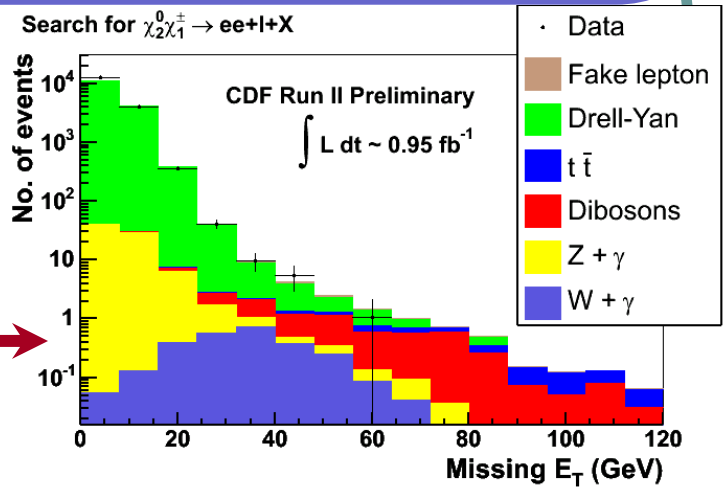
- **HF estimated from data using with large impact parameter muons $|d_0|$>0.2 cm (no) or $|d_0|$>0.02 cm(with silicon hits)**

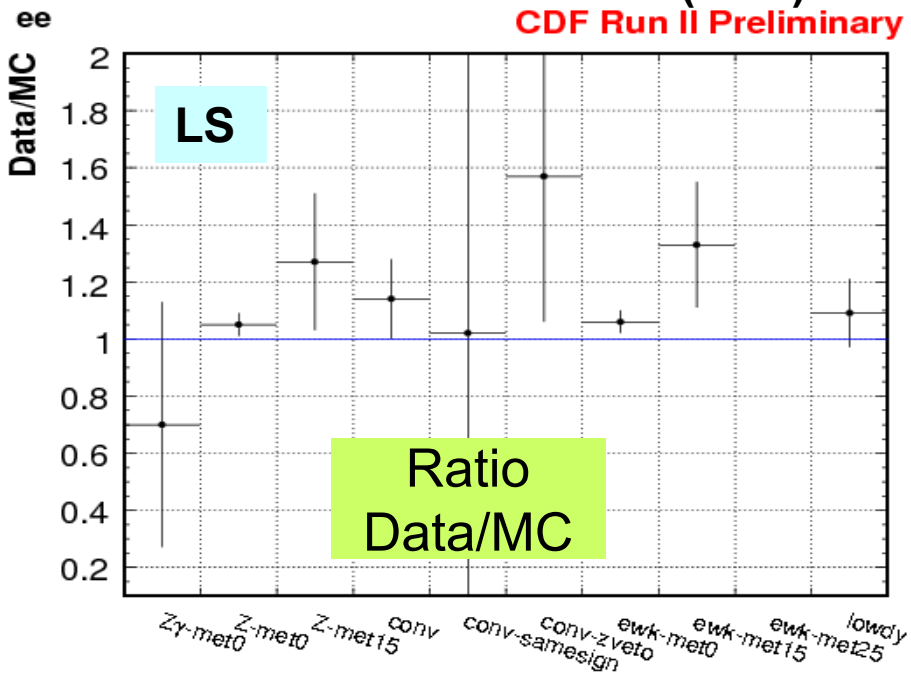


Background and systematics



Up to 19 "control regions"

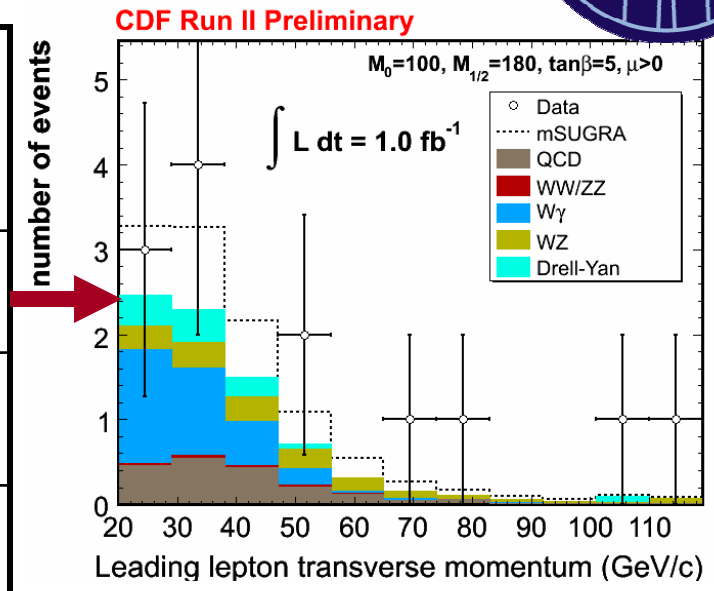


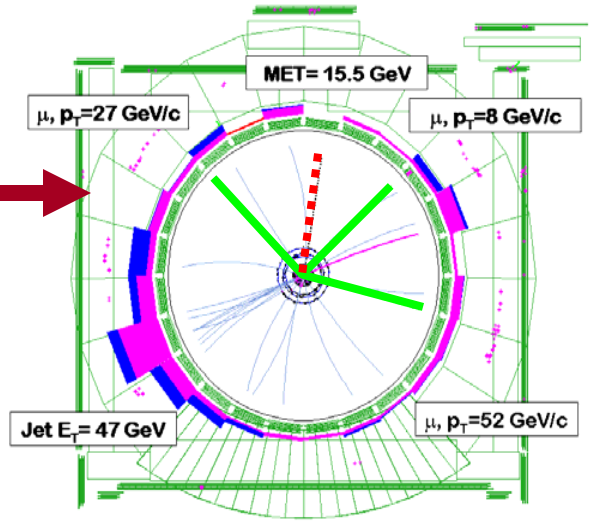


- **Systematic errors, example e$\ell\ell$:**
  - **Backgrounds:**
    - **Jet energy scale 5%**
    - **Fake rate 10%**
    - **MC stat 13%**
  - **Signal**
    - **Conversion scale factor 6%**
    - **Lepton ID 4%**
    - **Theor. cross section 7%**
  - **Luminosity 6%**

Results

Analysis	L (fb^{-1})	Total predicted background	Obs-erved data	L in limit
$e^{\pm}e^{\pm}$,$e^{\pm}\mu^{\pm}$, $\mu^{\pm}\mu^{\pm}$	1	7.5±0.3	13	0.71 (9)
μμ +e/μ (low-p_T)	1	0.4±0.1	1	0.31 (0)
ee+track	1	0.97 ± 0.28	3	0.61 (1)
eℓ + e/μ	1	0.73±0.09	0	0.35 (0)
μμ +e/μ	0.75	0.64±0.18	1	0.75 (1)
μe +e/μ	0.75	0.78±0.15	0	0.75 (0)





Combination is not yet available for the entire luminosity

Limit

- **Combine all analyses to obtain a limit on the mass of the chargino in a mSugra-like scenario :**
  - Equal slepton masses
  - **Observed limit:**

$M(\chi^{\pm}_1) \sim 127$ GeV/c^2

σxBR ~ 0.25 pb

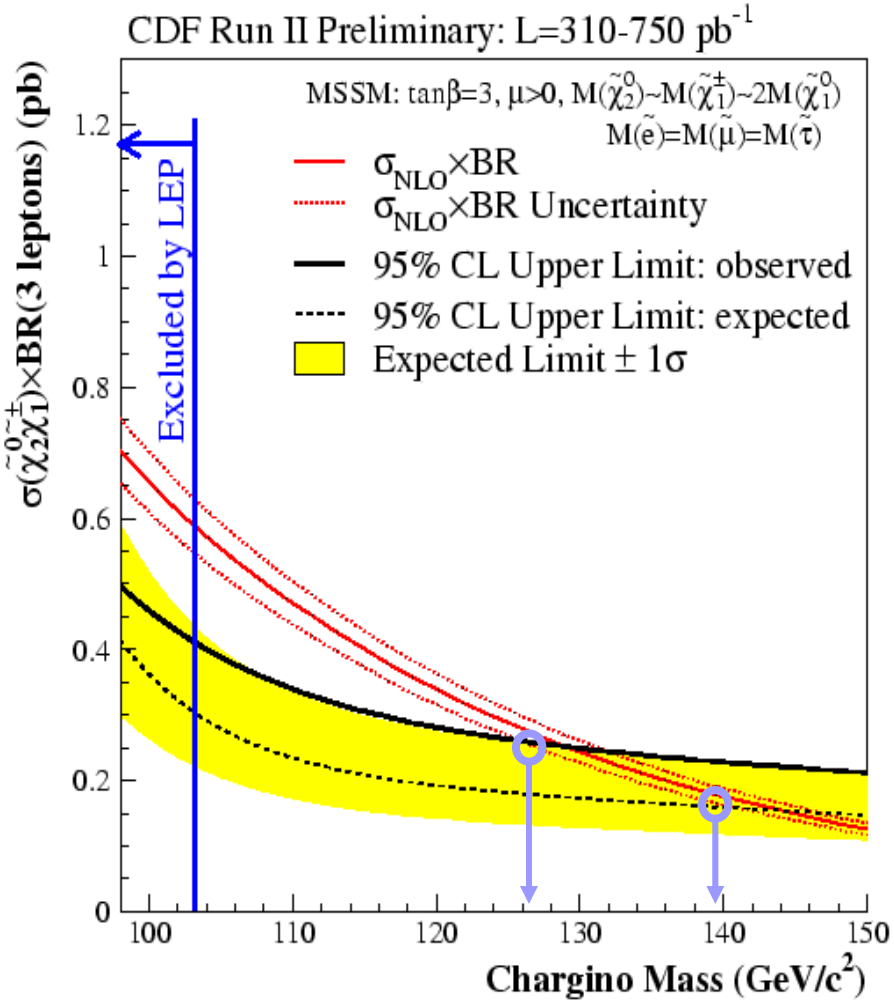
- **Sensitive up to masses**

$M(\chi^{\pm}_1) \sim 140$ GeV/c^2

σxBR ~ 0.2 pb

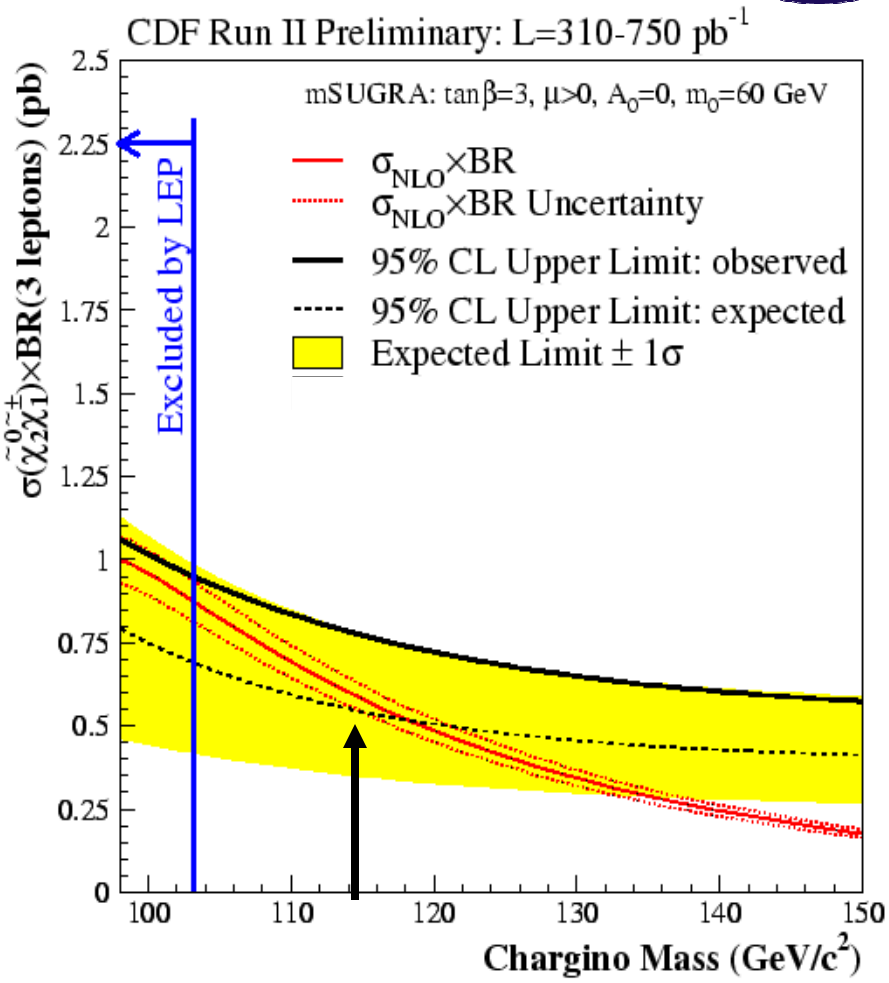
D0 limit in similar scenario:

$M(\chi^{\pm}_1) > 140$ GeV/c^2



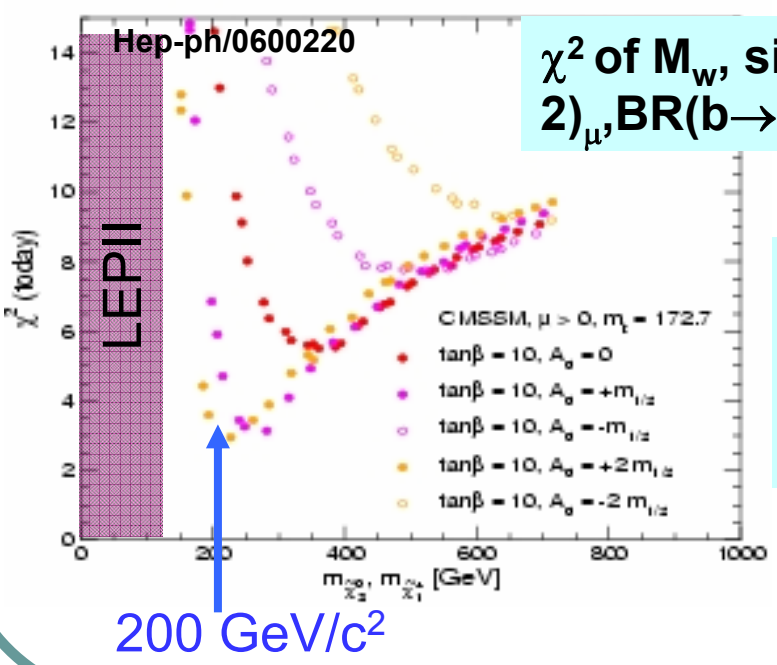
Limit in msugra

- mSugra :
  1. M_0=scalar mass at GUT scale=60 GeV/c^2
  2. $M_{1/2}$=Gaugino mass at GUT scale=160-200 GeV/c^2
  3. tanβ=ratio of Higgs vev's=3
  4. A_0=trilinear coupling term=0
  5. sign μ= sign of Higgs mixing parameter>0
- Sensitive to chargino masses of ~ 116 GeV/c^2
- Unable to exclude this region of parameter space with the current data
- In Standard mSugra the BR into taus is larger and the acceptance is lower



Conclusions

- Tevatron is starting to probe the region above LEP limit.
- Updated CDF combined limit almost ready
- Expect to probe chargino masses up to ~250 GeV/c^2 with ~8fb^{-1} of data
- Tevatron will provide direction to the LHC searches

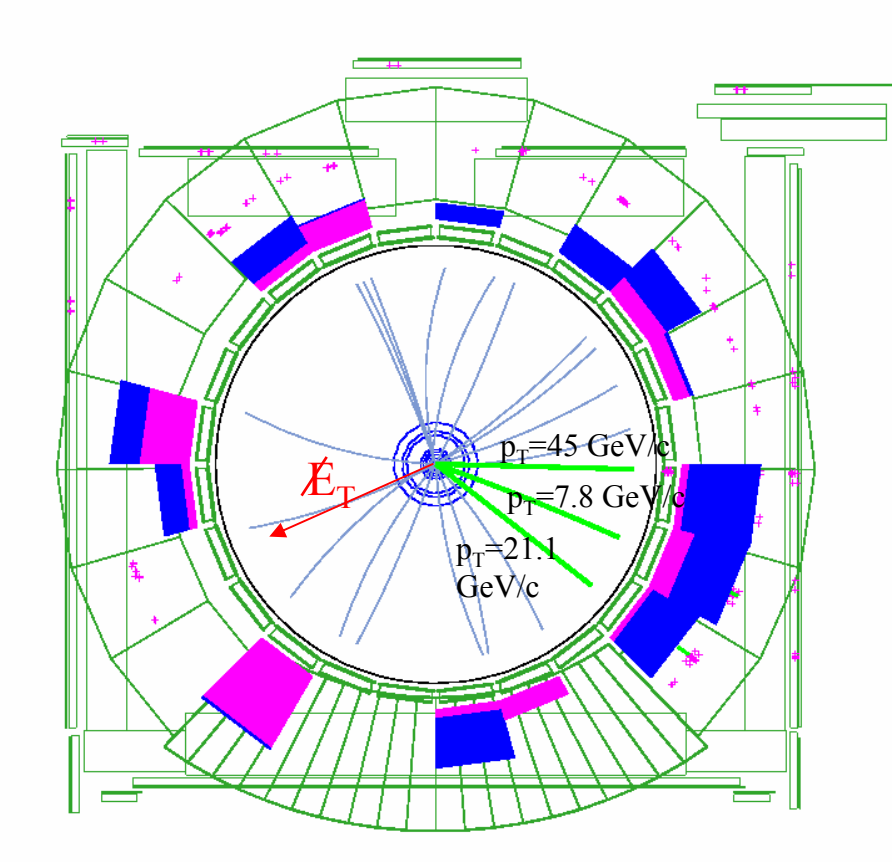


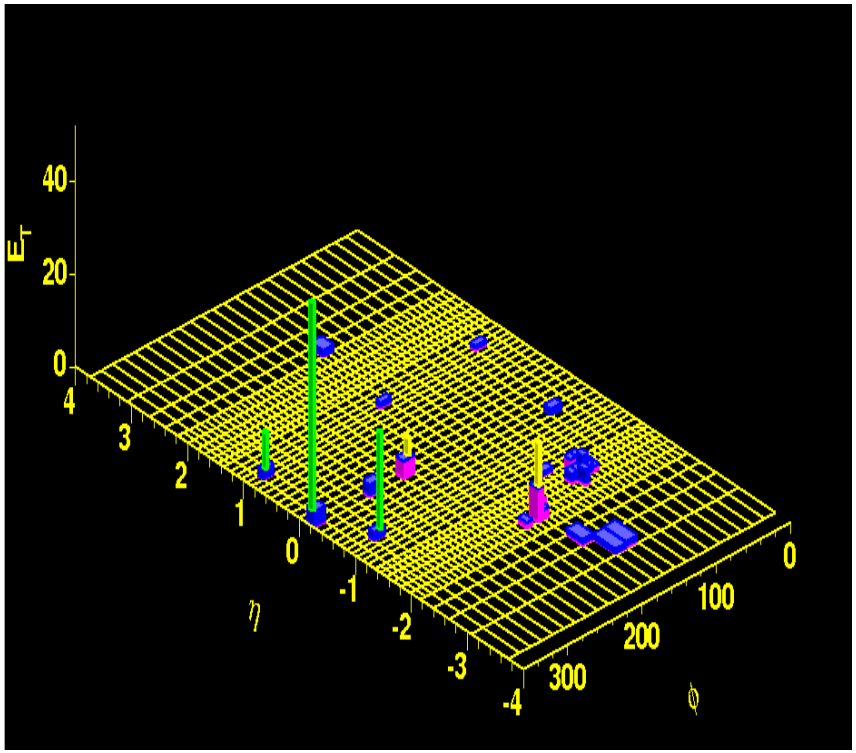
χ^2 of M_W, $\sin^2\theta_{eff}$, (g-2)$_\mu$,BR(b→sγ),m_h

More information about CDF analyses can be found at: http://www-cdf.fnal.gov/physics/exotic/exotic.html

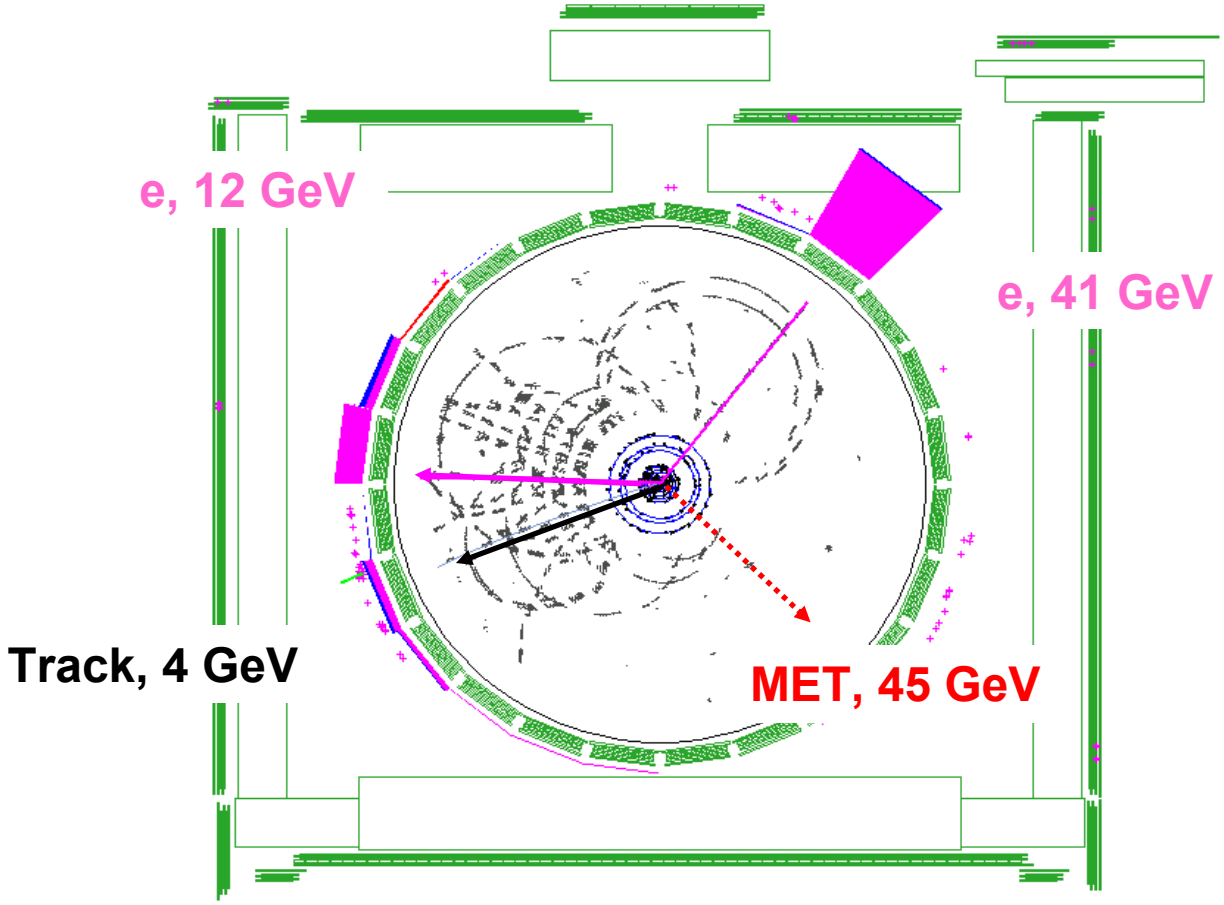
BACKUP

Low PT tri-muon



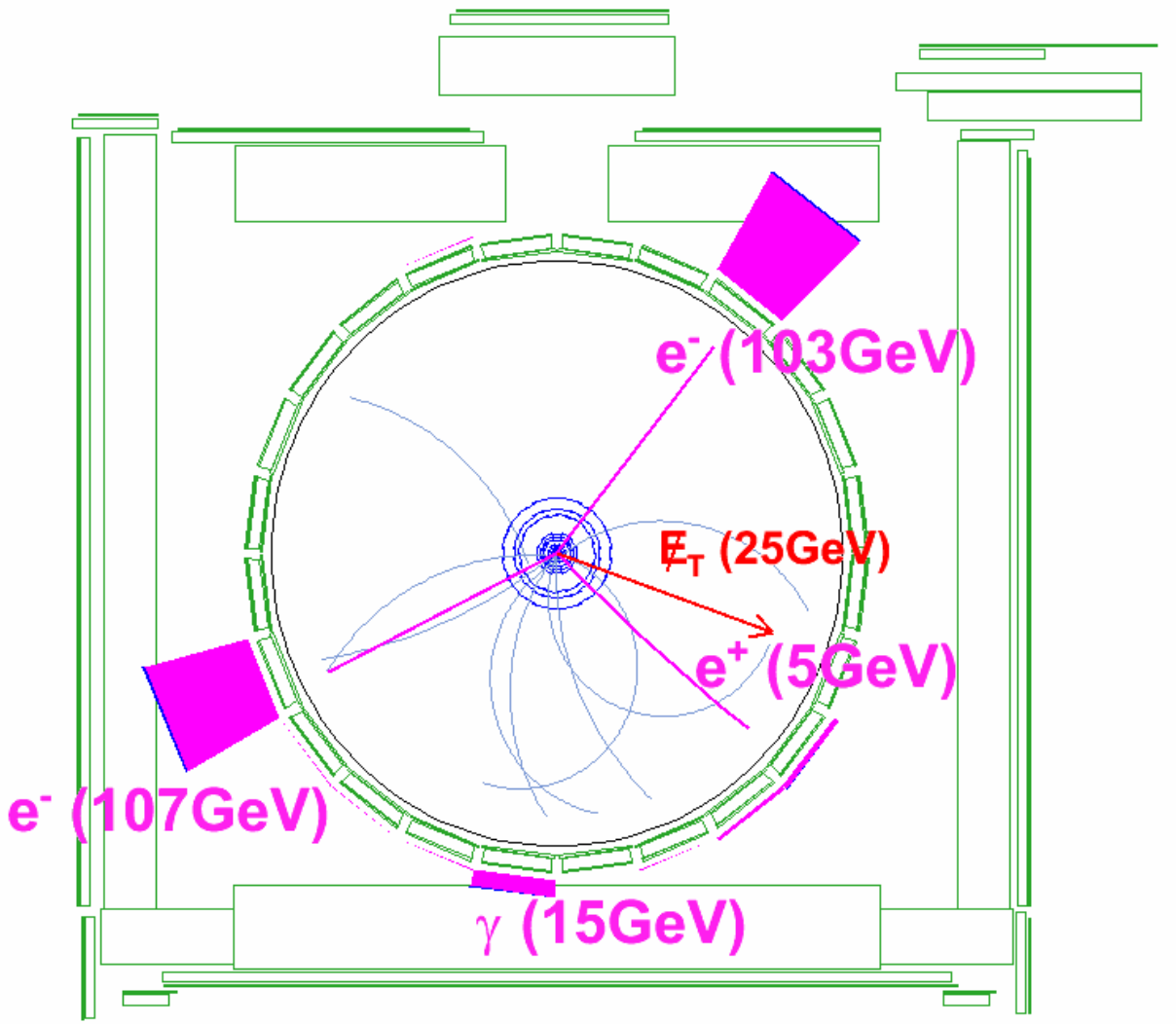


Di-lepton + track

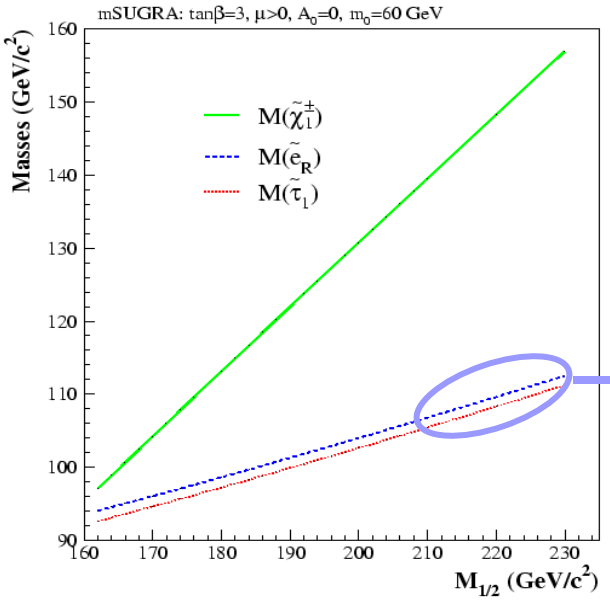


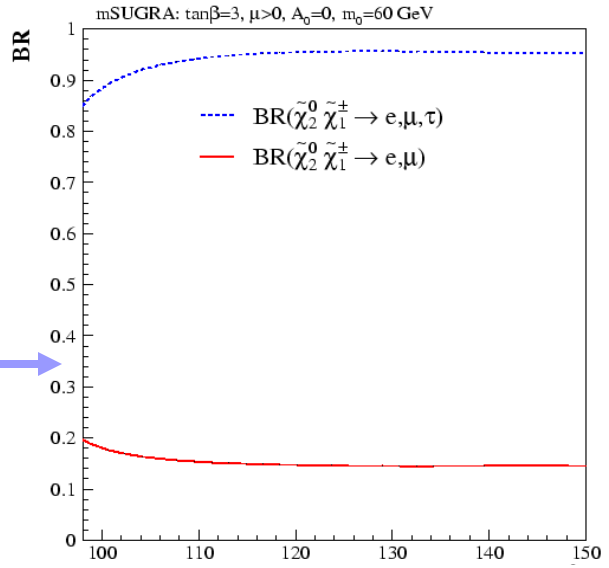
Mass OS1	41.6 GeV
Mass OS2	27.0 GeV

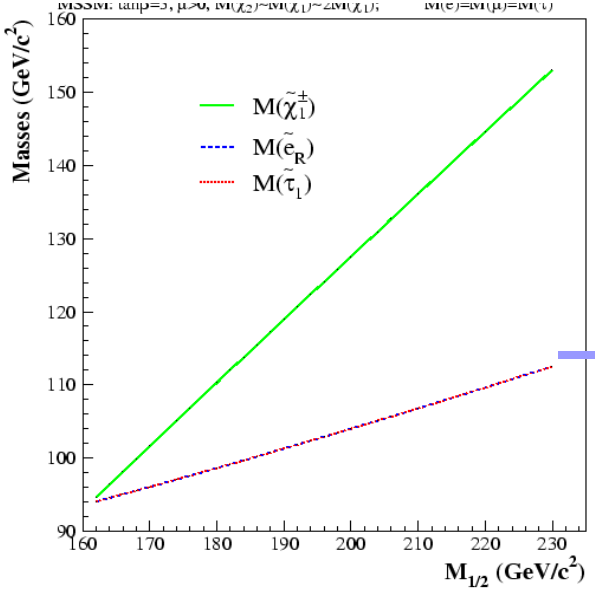
LS dilepton event

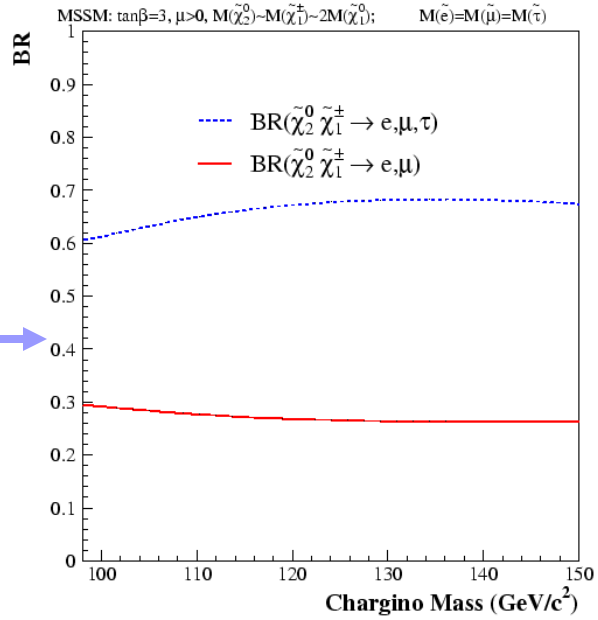


The differences in the models

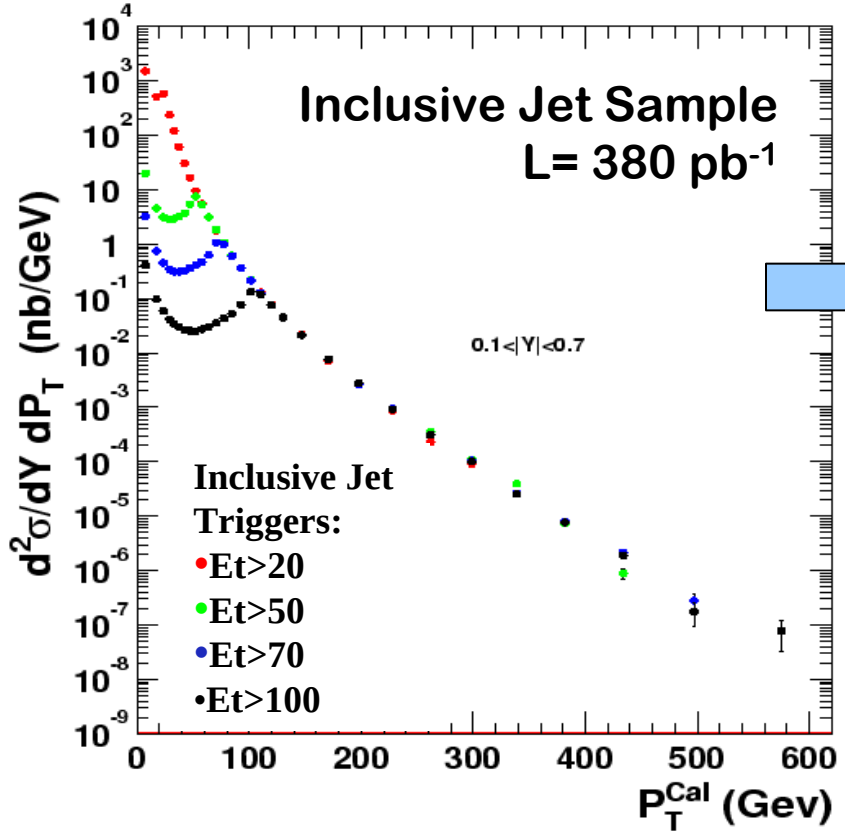


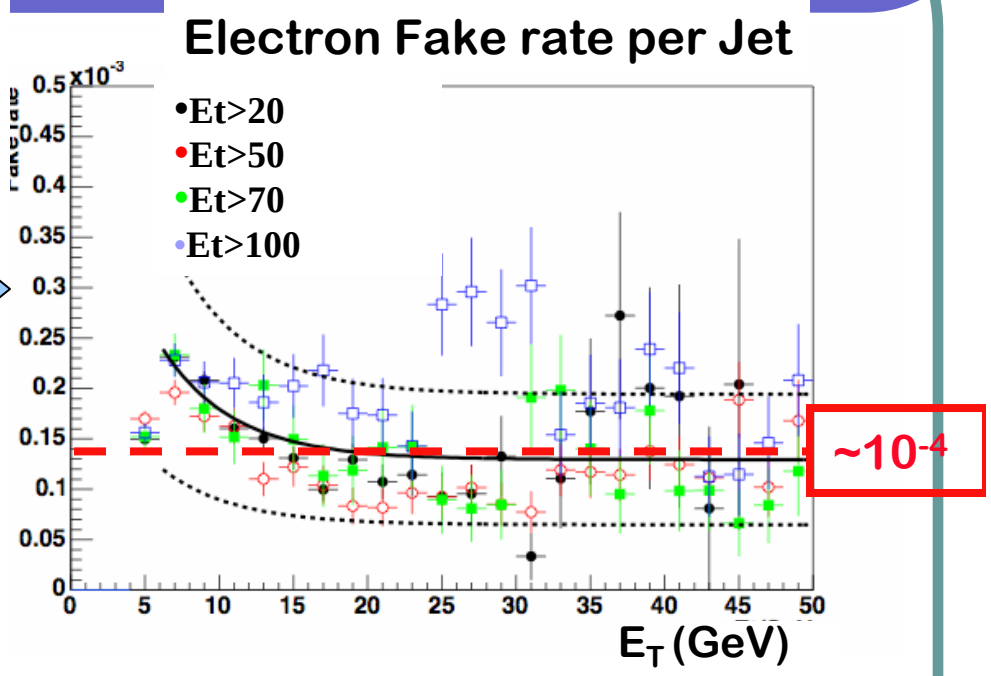






Jets Faking Leptons





Inclusive Jet Sample with different trigger thresholds used to extract Fake rates and test Jet Energy Scale