CDF search for $\tilde{\chi}\tilde{\chi}$ pairs

SUSY07, Karlsruhe

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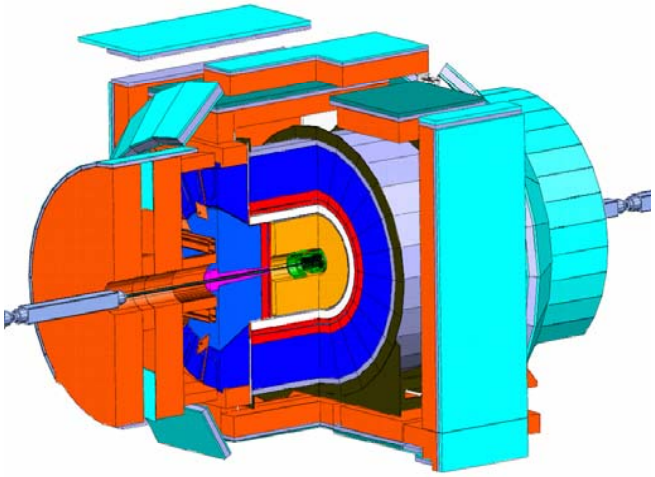
For the CDF collaboration

Outline

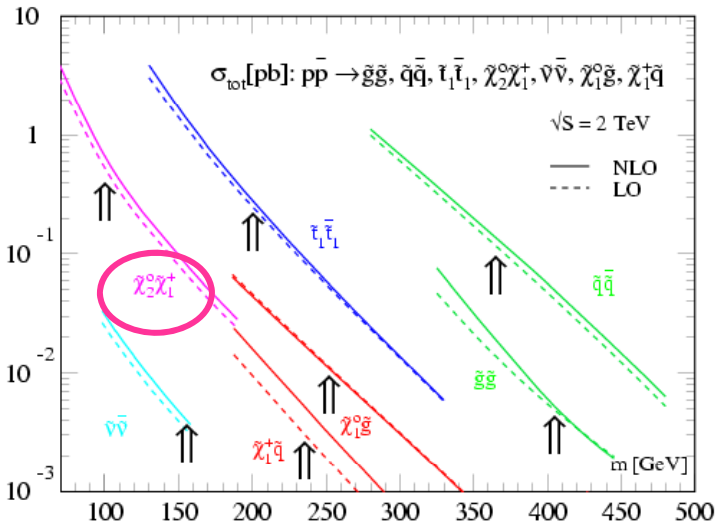
- $\tilde{\chi}\tilde{\chi} \rightarrow$ *trileptons + analysis strategy*
- *Backgrounds: rejection + validation*
- *Results with 1 fb^{-1}*
- *Interpretation + first projections*

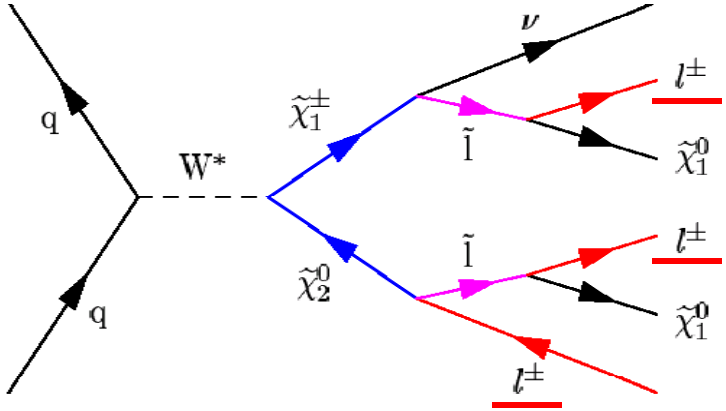


Why look for $\tilde{\chi}\tilde{\chi}$ at CDF?

Simple signature and relatively large production σ

$\sigma \times BR$(3 leptons) *low*





3 leptons

+

$\not\!\!E_T$*(MET)*

CDF strategy: Counting experiment

- *Combine several non-exclusive channels*
- *Test background estimates in control regions*

SUSY models used for interpretation

Generated with Pythia , NLO σ from Prospino

1) Low mass mSugra: m_0=60, tanβ = 3, A_0=0, μ >0

$\tilde{\chi}_2^0 \rightarrow \tilde{l}l$, *decays to* $\tilde{\tau}_1$ *favored*

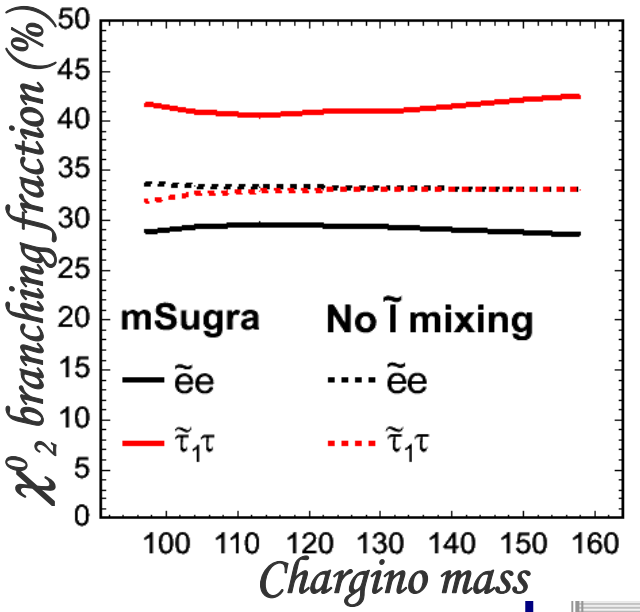
2) no slepton mixing, mSugra-inspired

Same mass range but $\tilde{l}$ *masses degenerate and mixing turned off.* *(SoftSusy)*

↳ *Less taus*

3) W/Z decay

Set $\tilde{\chi}_1^{\pm}$ *and* $\tilde{\chi}_2^0$ *decay BR's equal to those of W and Z. Pessimistic but less model dependence*



Analysis paths

Channels as combinations of $l = e, \mu$:

4 GeV + 4 GeV ee, μμ

μμ + l

ee + iso track *More sensitive to taus!*

High p_T triggers: 18 GeV e, μ

μ + ll

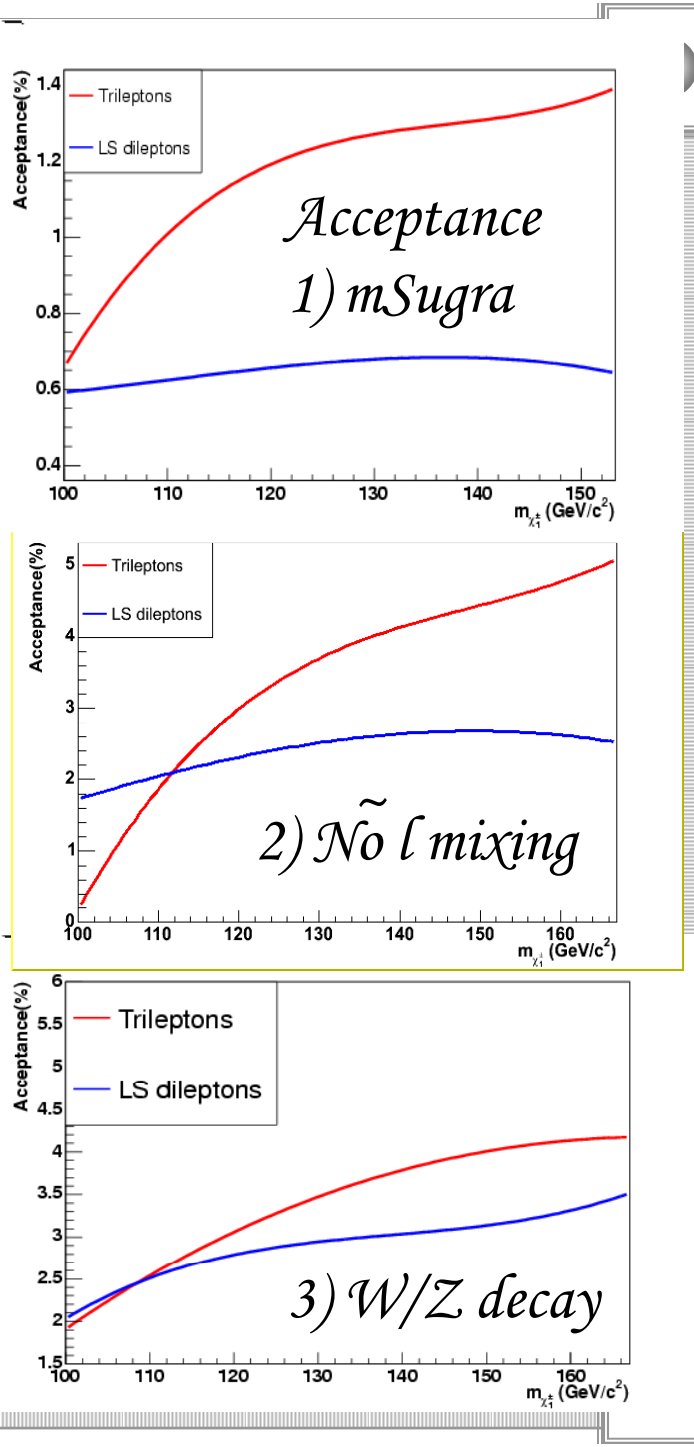
e + ll

l^+l^+, l^-l^- (like-sign, ee, eμ, μμ)

Higher acceptance!

Trigger leptons: $p_T \geq 5$ or 20 GeV

all leptons: $p_T \geq 4$ GeV



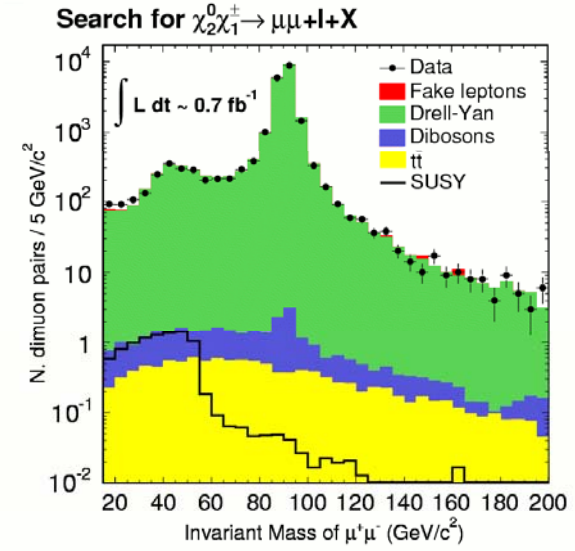
Backgrounds

Drell-Yan+γ/fake	Wγ	Diboson (WZ,ZZ)	$t\bar{t}, b\bar{b}$	Suppressed by:
✓	✓			Tight lepton selection
✓				missing Et
✓	✓			Conversion rejection
			✓	Isolation
✓		✓		Reject dileptons in Z window
			✓	jet veto

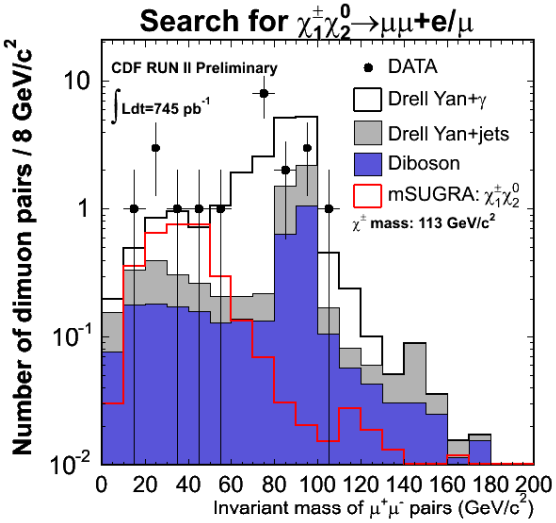
Generated with Pythia. $W\gamma^*$ and WZ/γ^*: ME + Pythia
Fake lepton and $b\bar{b}$ background estimated from data

Analysis cuts

Potential background greatly reduced by 3l requirement



Require 3rd lepton



Mass cut: $m_{l^+l^-} > 15\ (20)\ GeV/c^2$

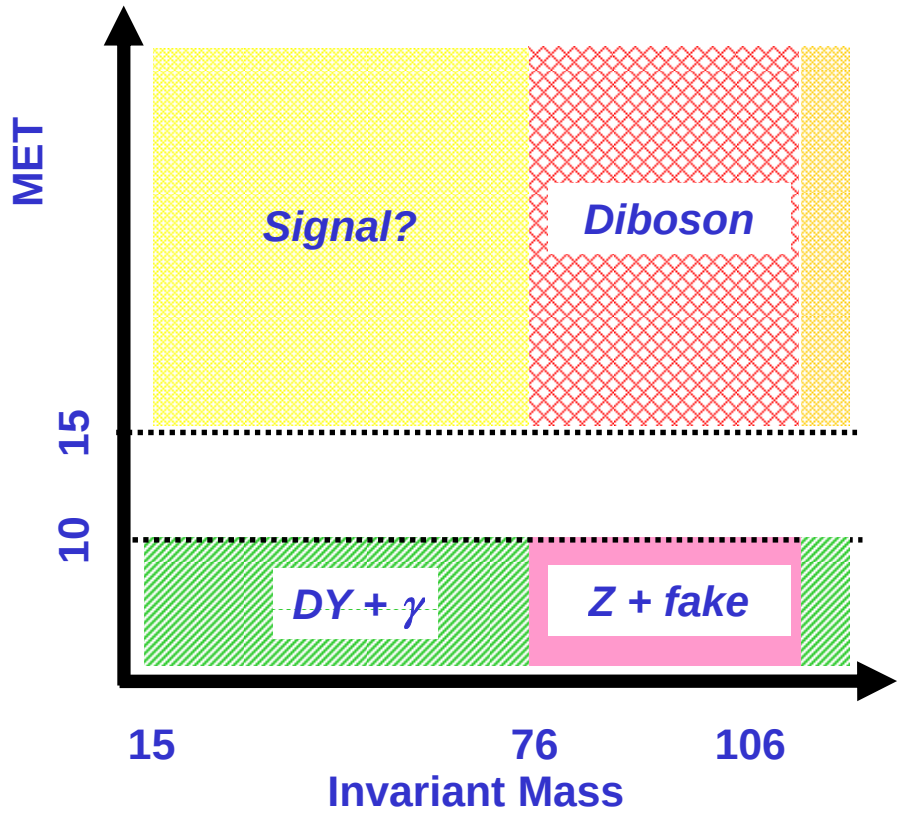
$m_{l^+l^-} \neq 76\text{-}106\ GeV/c^2$

MET $> 15\ (20)\ GeV$

+ jet suppression and angular cuts

Validating background estimates

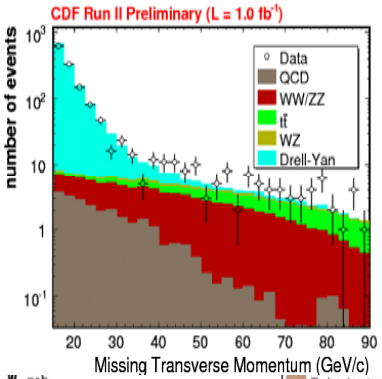
Based on these regions:

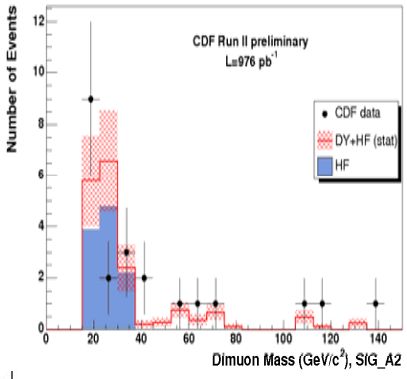


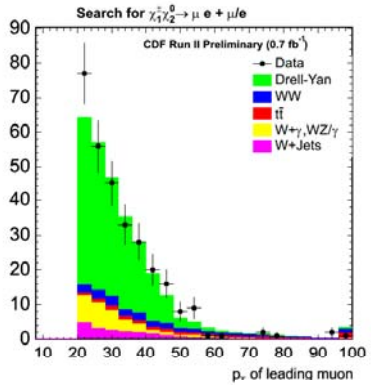
Additional dimensions:

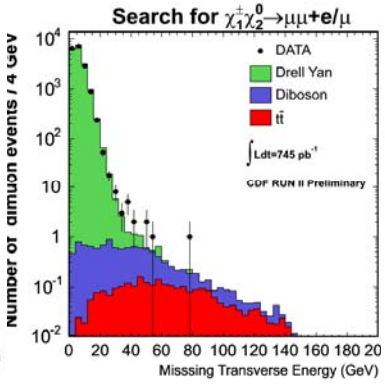
- *Similar regions with 2 leptons*
- *With or without jets*
- *LS dileptons check further conversion regions*
- *Z, Wγ cross section measurements*

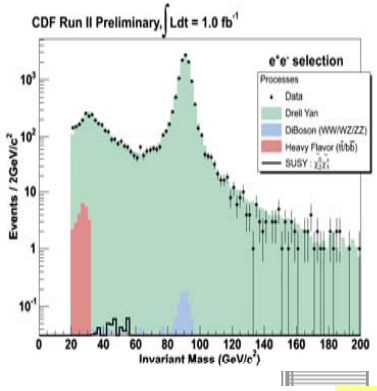
To be understood before looking at signal region!

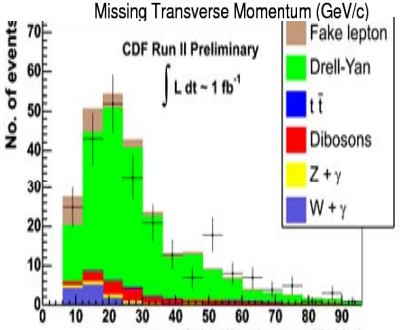


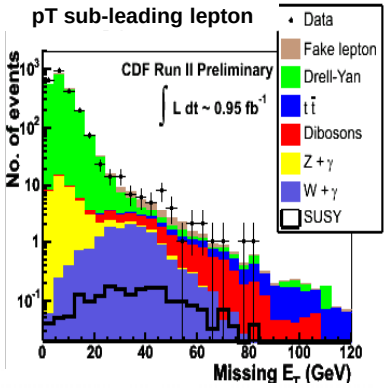








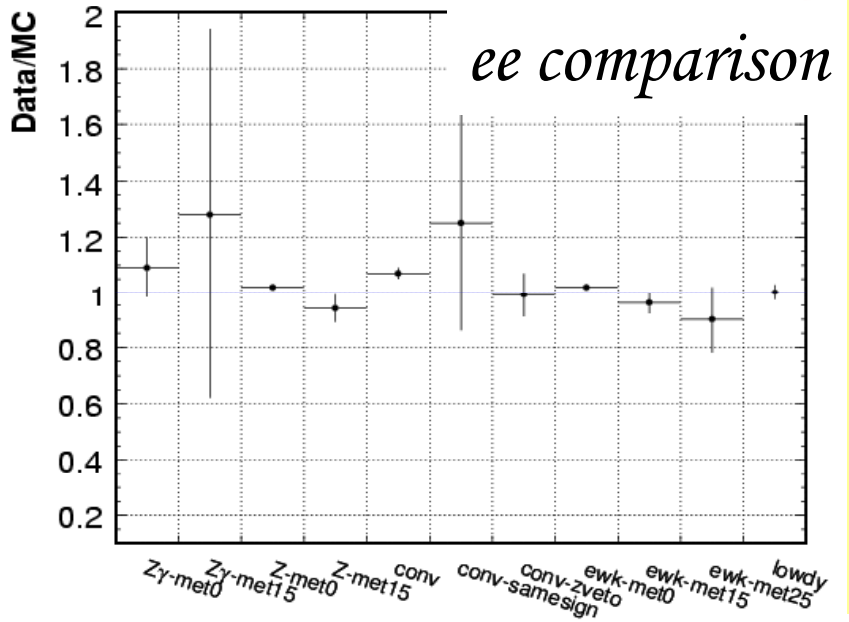


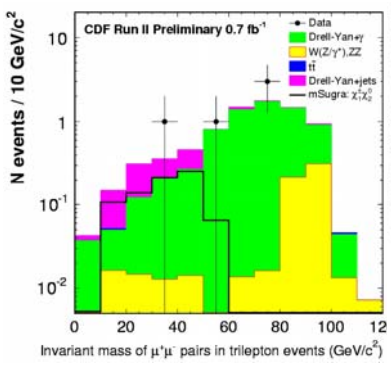


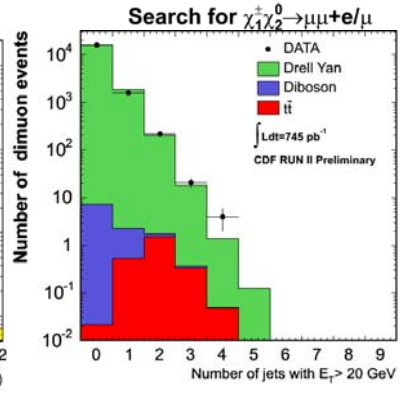
For each control region, compare:

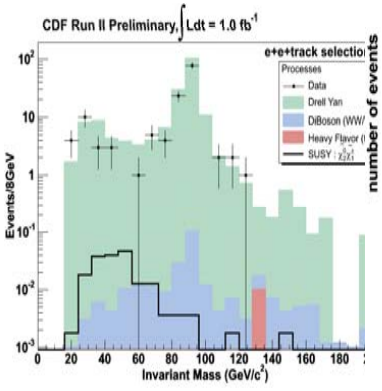
Number of events ✓

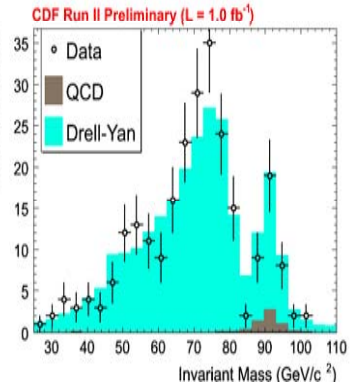
Background shape ✓

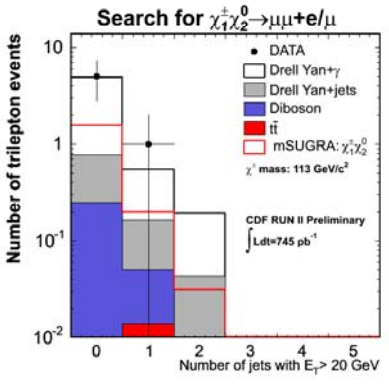








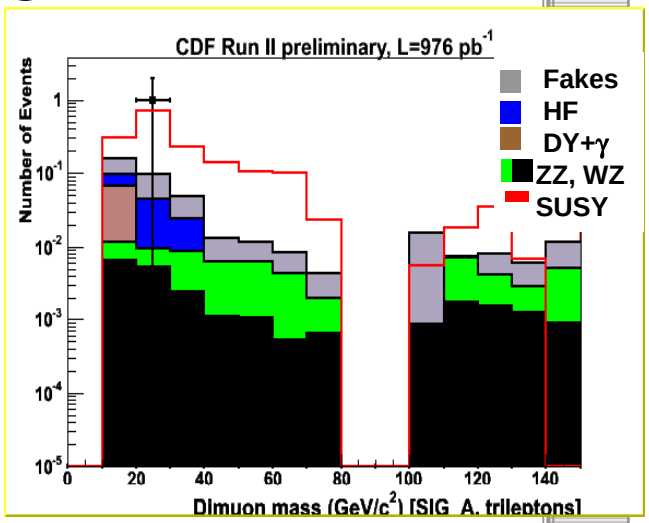


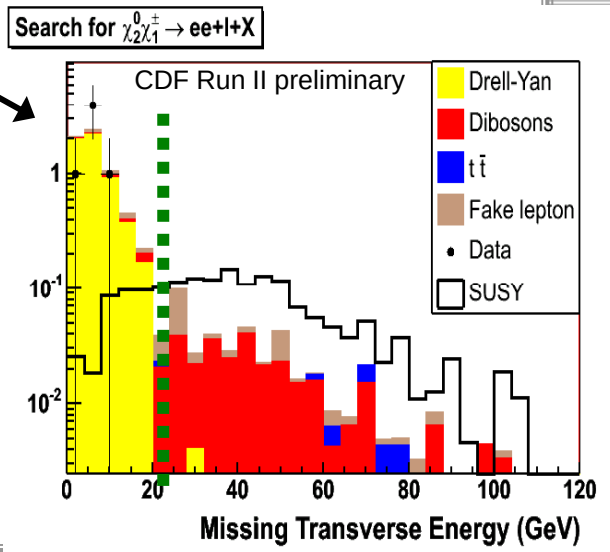


Results in signal region

~ 1 fb^{-1}

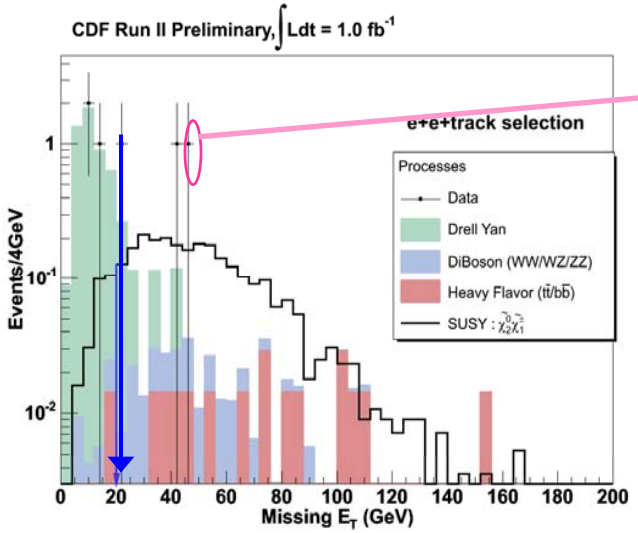
	Exp background	Ex. signal	Obs
Tri-leptons: $\mu\mu + \ell$ (low pt)	0.4 ± 0.1	0.6	1
ee+ track	1.0 ± 0.3	2.0	3
$\mu + \ell\ell$ (0.75 fb^{-1})	1.2 ± 0.2	2.3	1
$e + \ell\ell$	0.8 ± 0.4	2.1	0
Like-sign dileptons: ee	2.9 ± 0.5	0.6	4
$e\mu$	4.0 ± 0.6	1.7	8
$\mu\mu$	0.9 ± 0.1	1.0	1

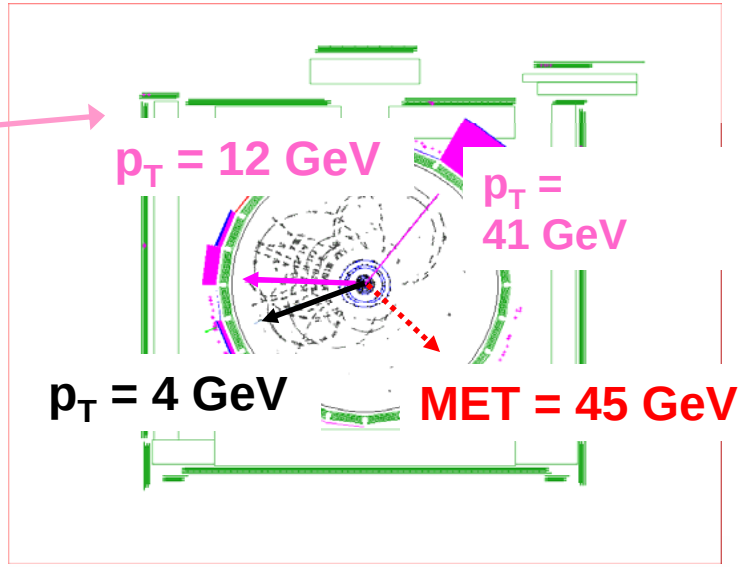




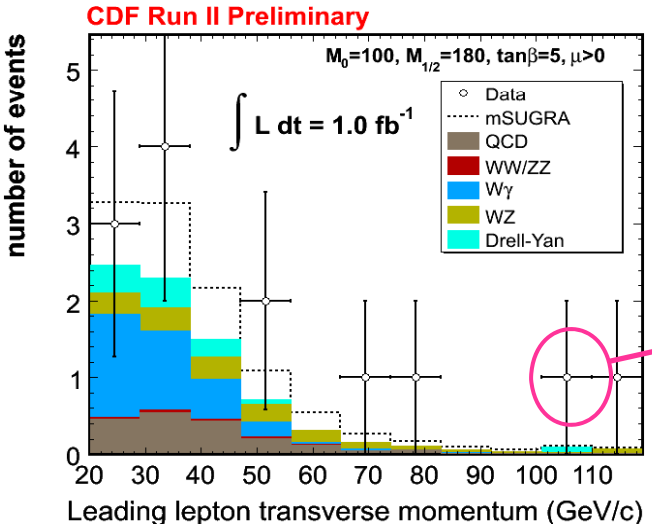
More examples:

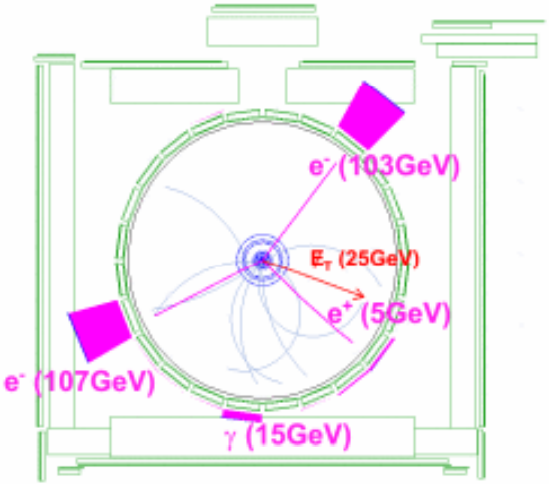
ee+track





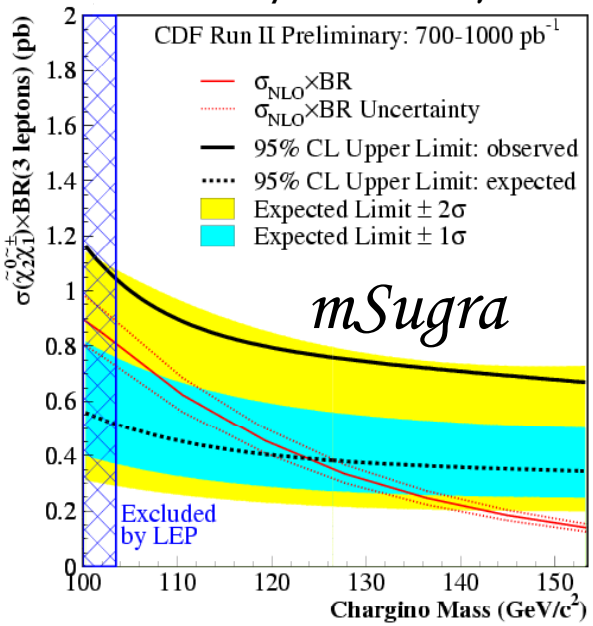
Like-sign dileptons

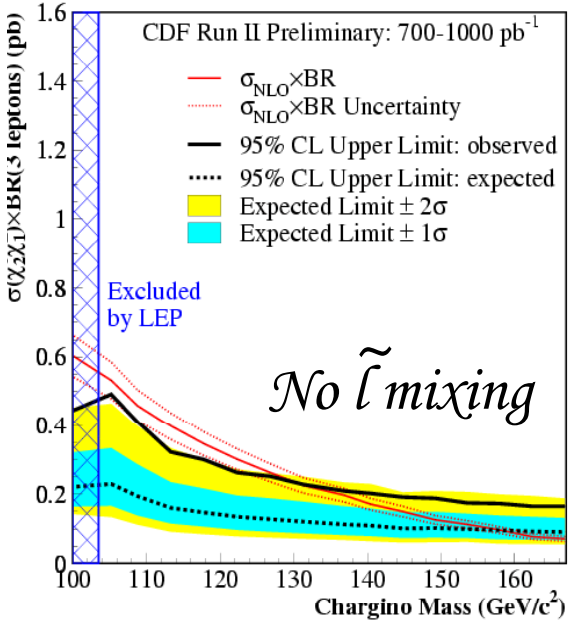


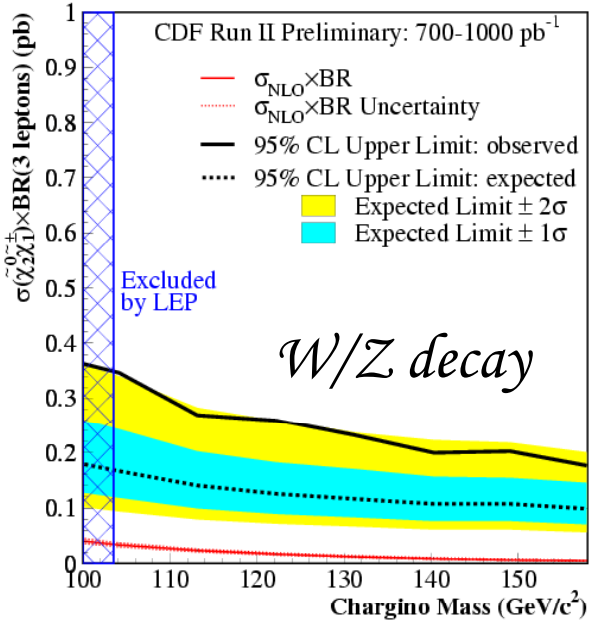


Limits set on $\tilde{\chi}\tilde{\chi}$ production

m0=60, tanβ = 3, A0=0, μ>0





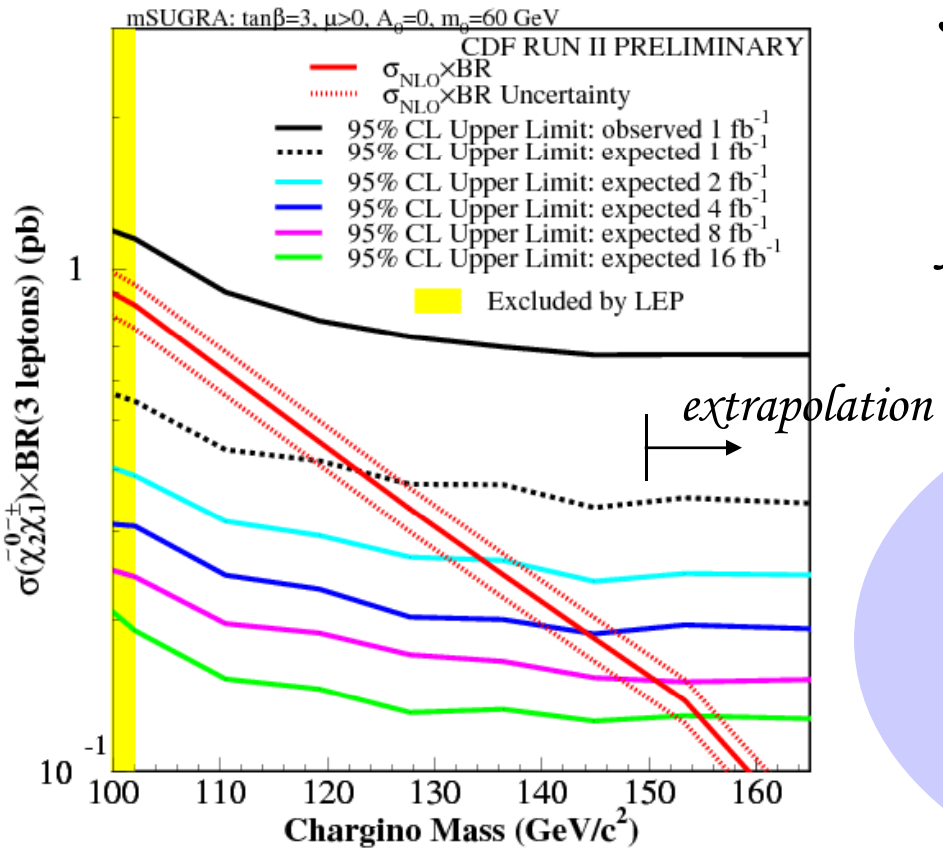


Chargino mass limits:

Exp:	*122 GeV/c²*	*157 GeV/c²*	*not sensitive*
Obs:	*no new limit*	*129 GeV/c²*	

Diff expected/observed limits due to small excesses for LS eμ and ee+track

mSugra: Projection



extrapolation

Simple projection: This is scaling the Acc. and background with L

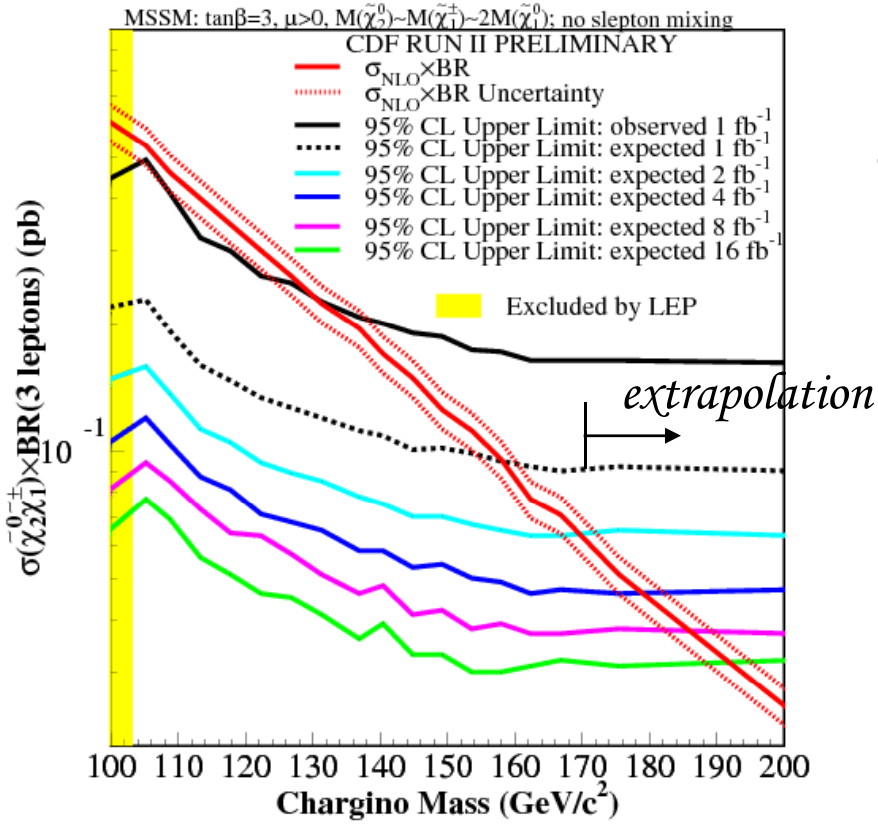
Assuming uncertainties stay the same

With no improvements (and no discovery)

can exclude up to 150 GeV/c² with 8 fb⁻¹

σ×BR(3l) < 0.20 pb

No slepton mixing: Projection



With no improvements:
Expected limit for 8 fb^{-1}
in this model ~185 GeV/c^2
σ×BR(3l) < 0.04pb

W/Z decay: not sensitive without improvements

Conclusion

- *No evidence of chargino-neutralino production*

  … but found several interesting events
- *With the first fb^{-1} CDF can exclude chargino masses up to 130 GeV /c^2 @95%CL in model with large number of electrons and muons*
- *Results shown here submitted to PRL: arXiv:0707.2362*

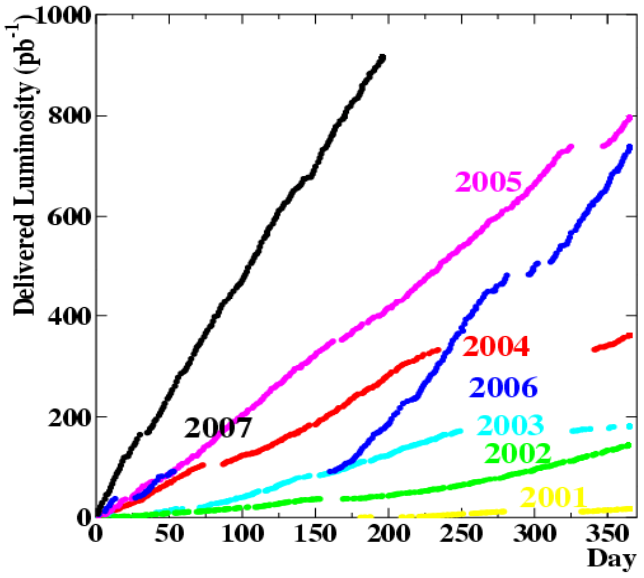
To come with 2 fb^{-1} on www-cdf.fnal.gov/physics/exotic/exotic.html :

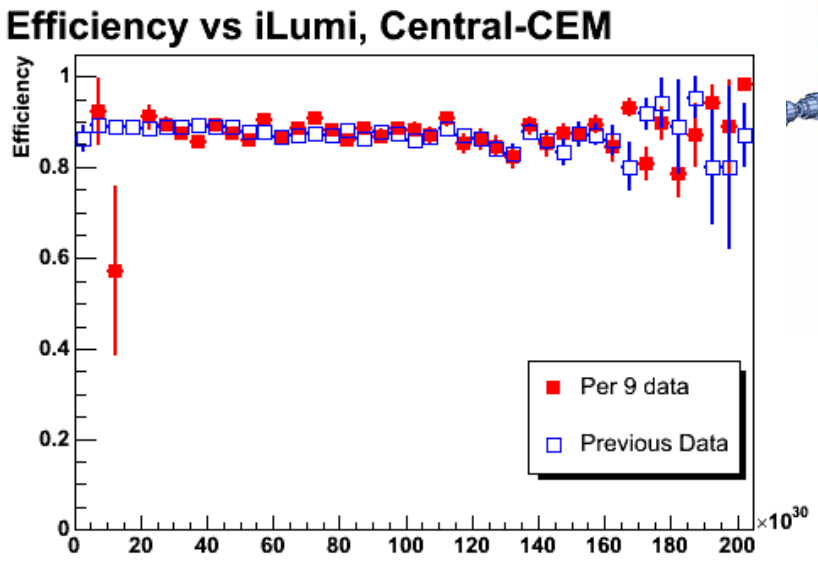
More models, more sensitivity to taus!

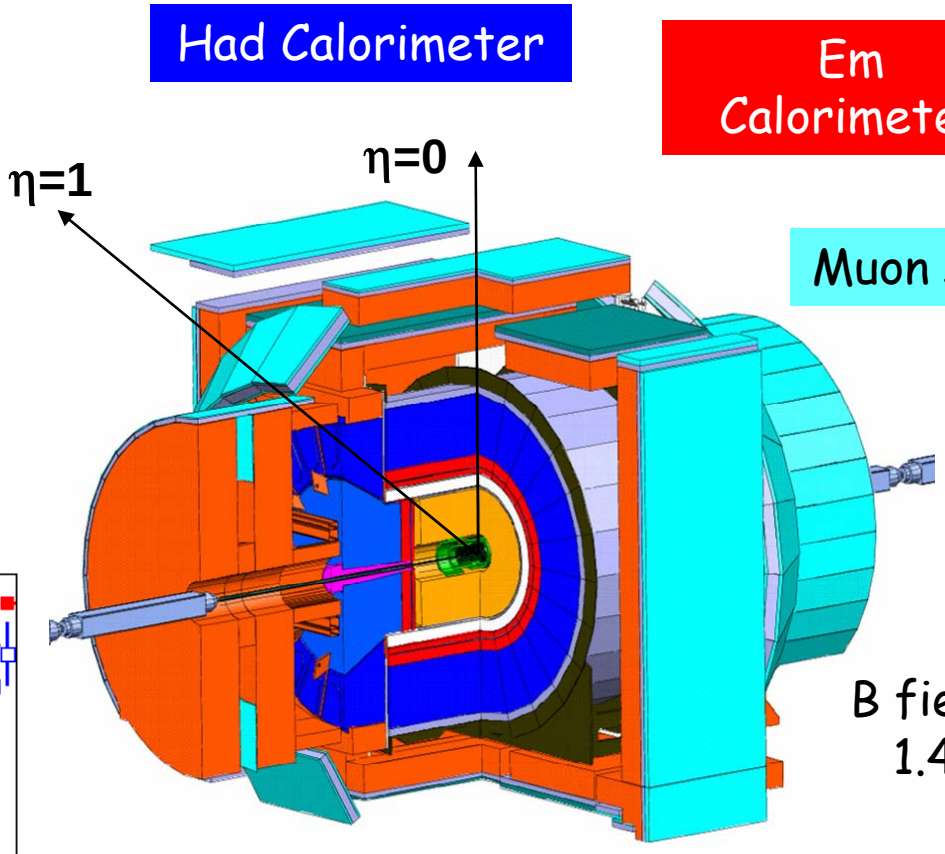
Backup

CDF Run II

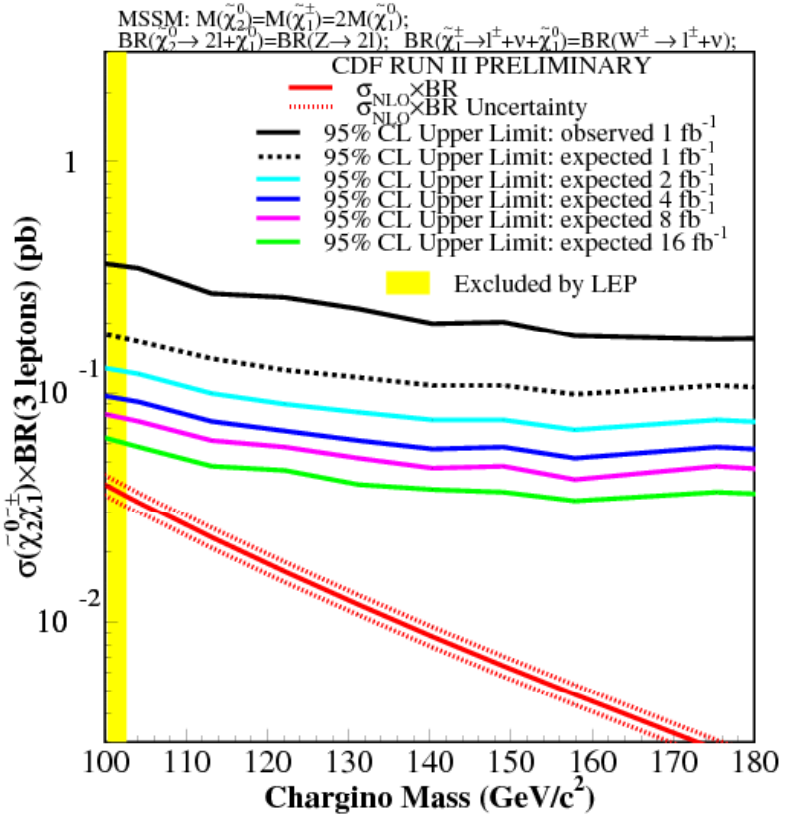
This analysis: ~ 1fb^{-1}







W/Z decay: Projection



Main systematic uncertainties

Signal:

Lepton ID

(typical ~few %, up to 14%)

Background:

MC statistics (up to 25%)

Conversion removal (5-15%)

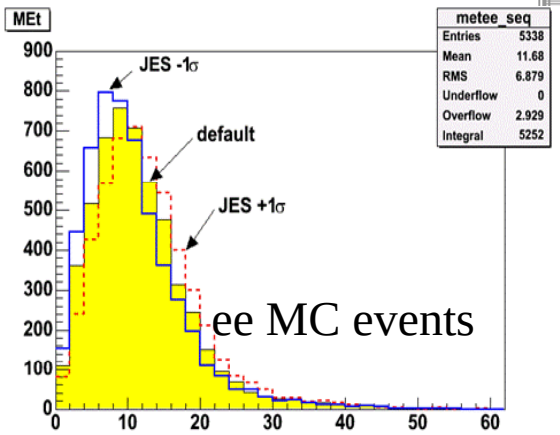
Fake estimation (10-15%)

Common:

Theory cross section (up to 10%)

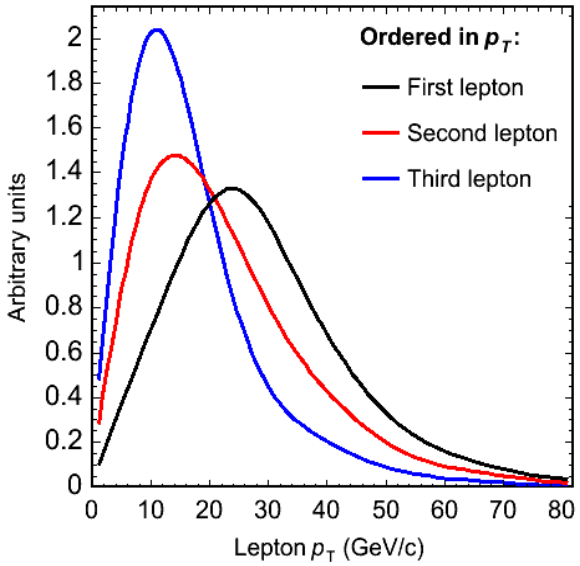
Luminosity (6%)

Jet Energy Scale
can have visible effect
via $\not{E}_T$ correction



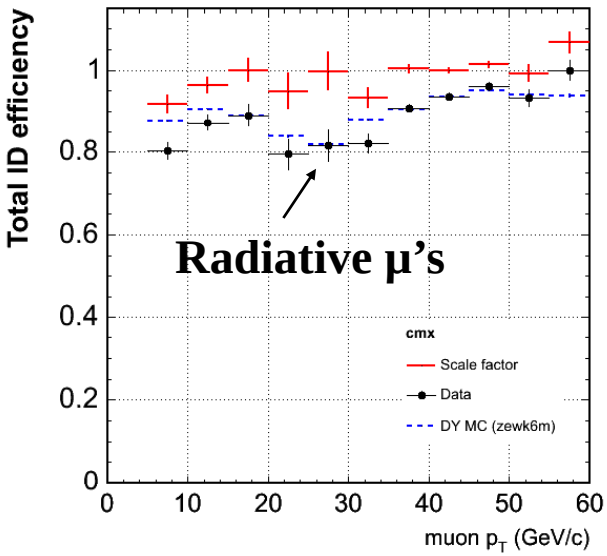
"Typical" systematics:
15% signal, 25% bkgr

Lepton ID cuts

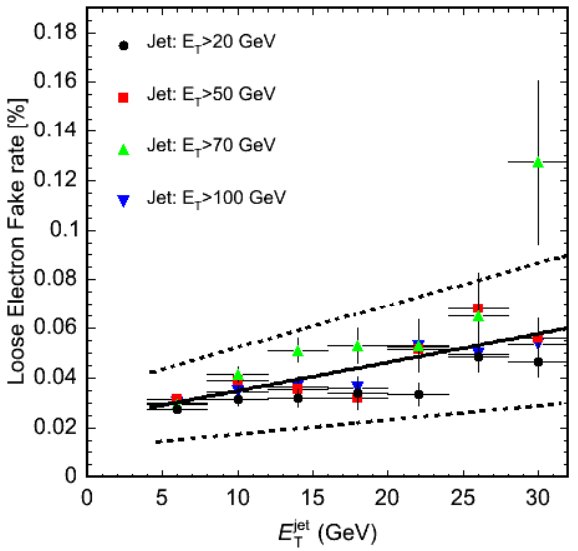


Pt range w/o cuts

ID efficiency

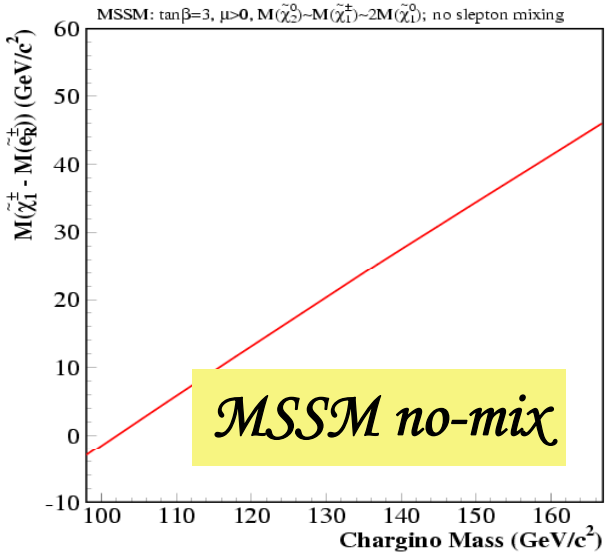


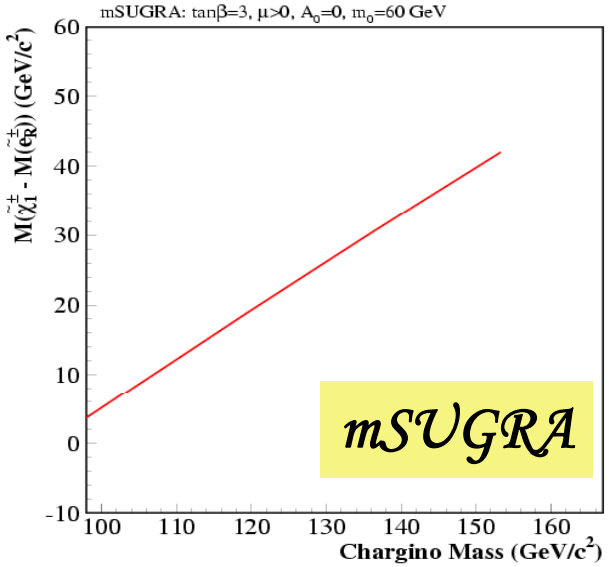
Fake rate

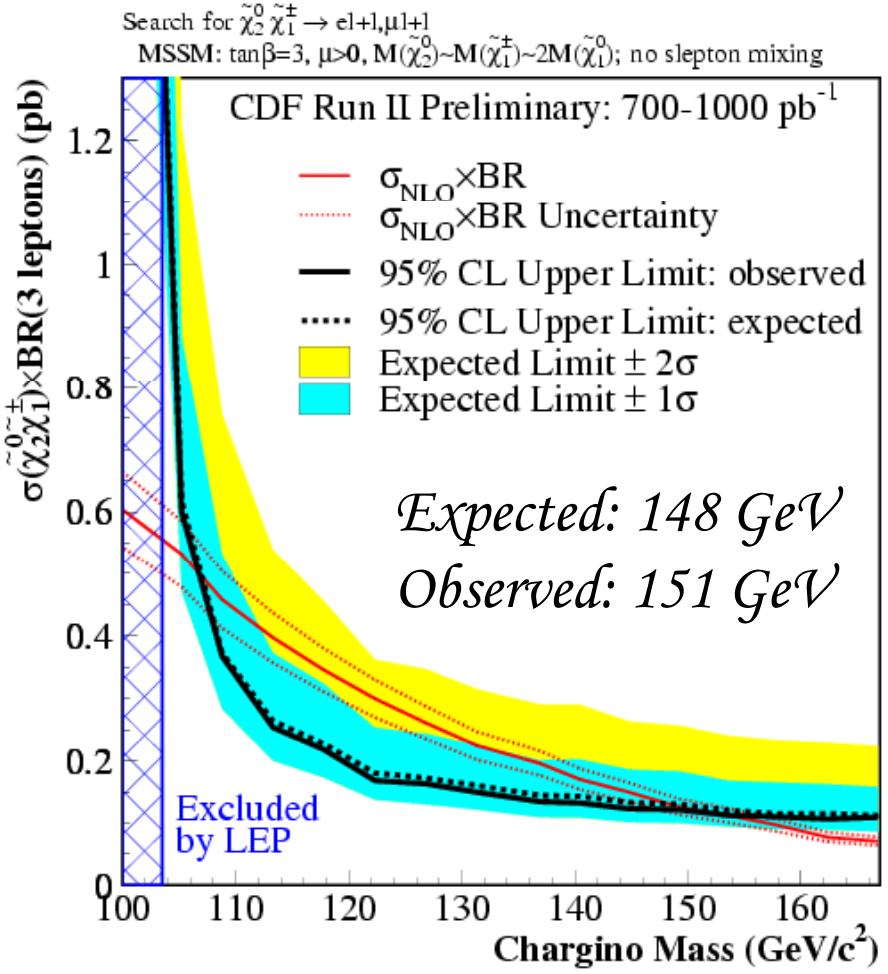


M(chargino) – M(slepton)

High-Pt analyses only

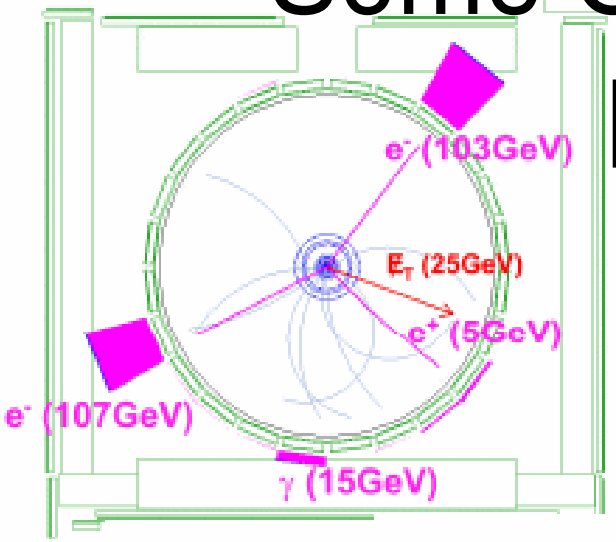


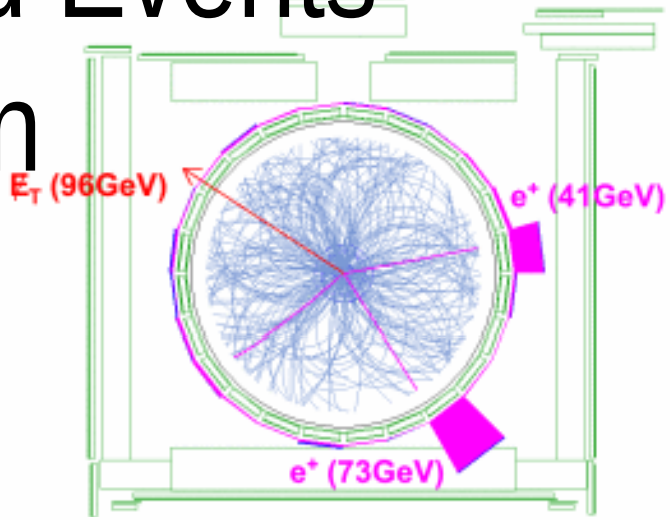


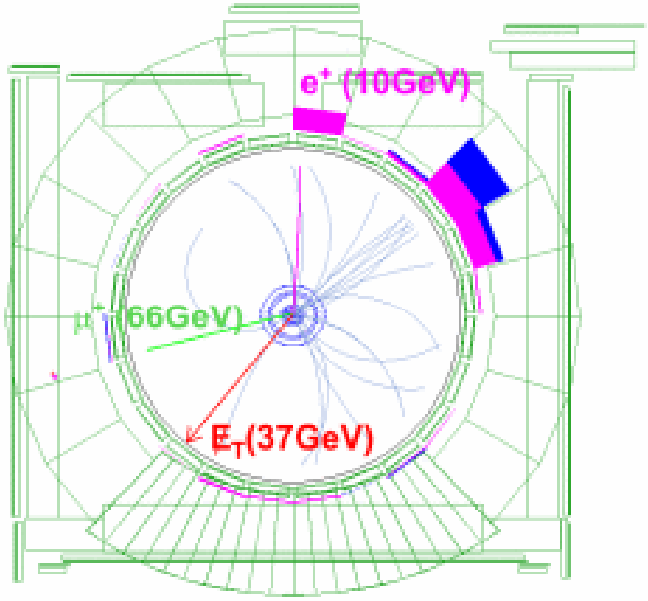


Some Observed Events

Like-Sign

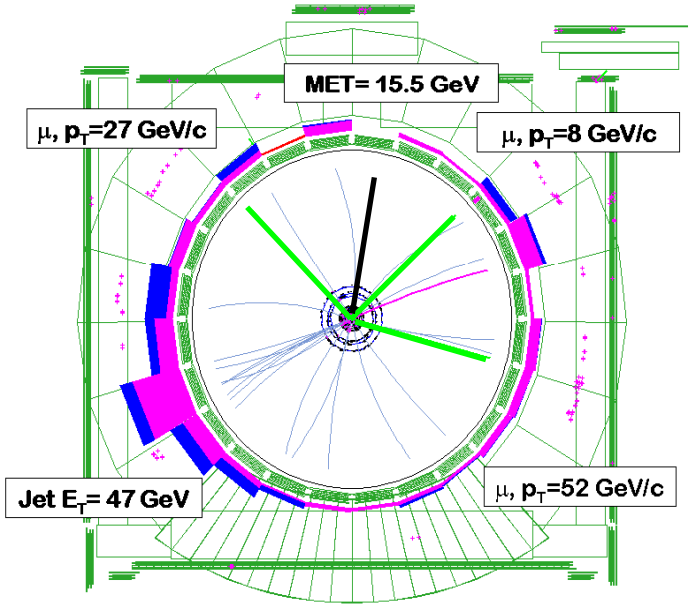




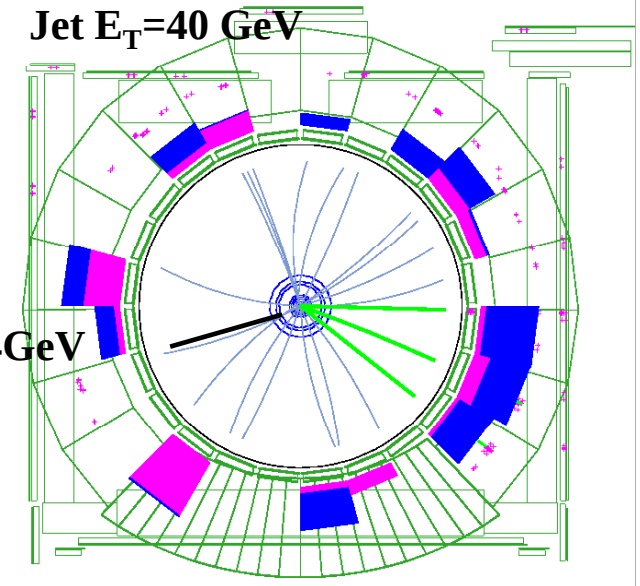


Some Observed Events

3 leptons

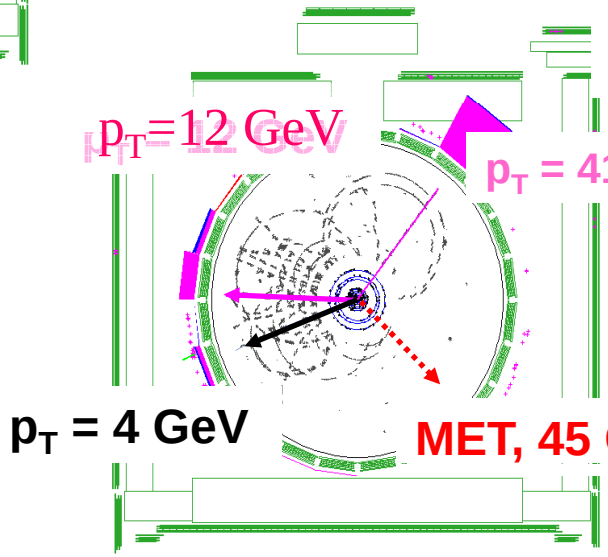


Max(Inv mass, OS) = 72 GeV



μ pt=8GeV
μ pt=21GeV
μ pt=45GeV

Max (Inv mass, OS) = 29 GeV



Max(Inv mass, OS) = 42 GeV