

Searches for Physics Beyond the Standard Model at CDF Run II

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Outline

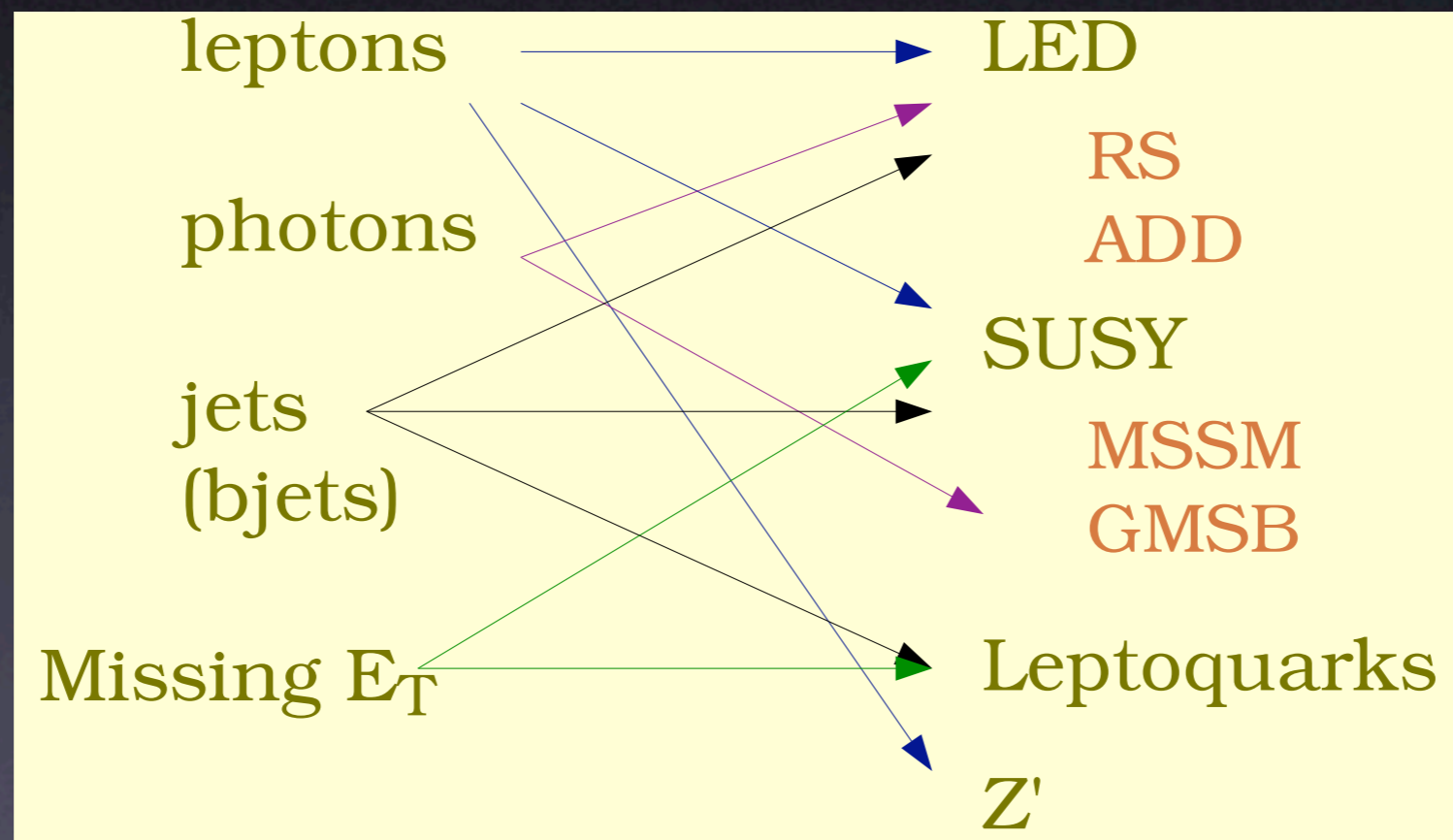
- Exotics domain and strategy
- Present CDF analyses
- Overview of other CDF Results
- Coming attractions

BSM: Subjects & Status

- Higgs: SM and SUSY (...and...)
- SUSY: SUGRA, RPV, GMSB, AMSB
- Leptoquarks
- Technicolor (little Higgs, etc...)
- Extra dimensions
- Heavy gauge bosons (Z' , W')
- Excited fermions

Beyond the SM: Strategy

- Signature-based searches
- then, apply to every model you can find!

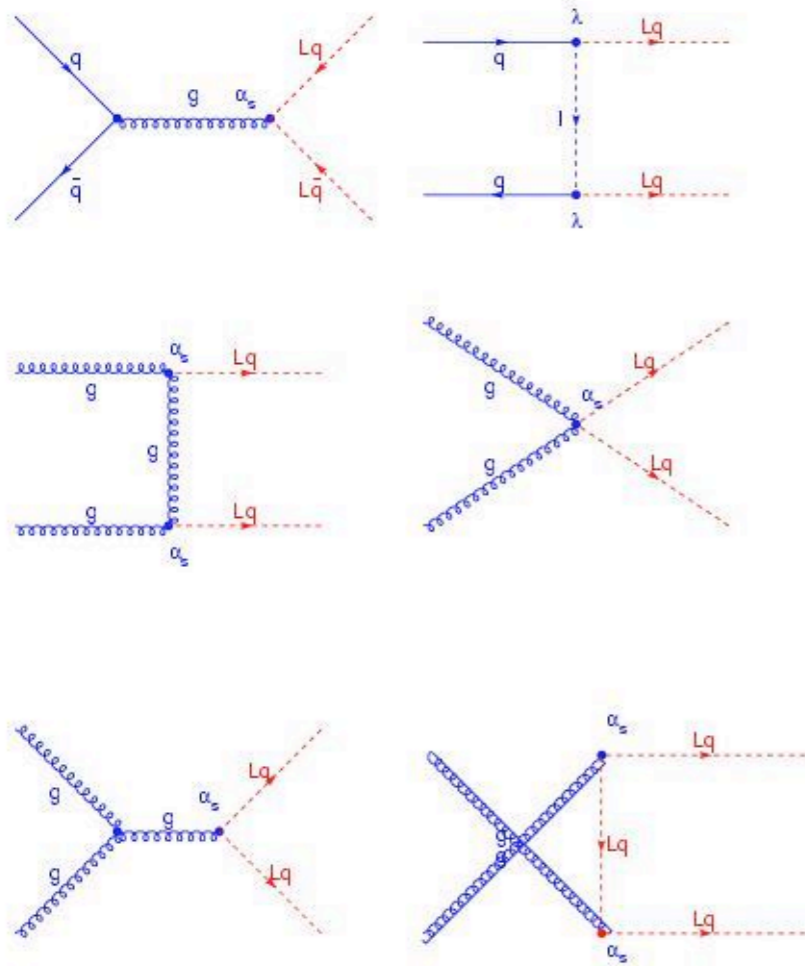


Run II enhancements: more data, higher \sqrt{s} ,
better detector and DAQ

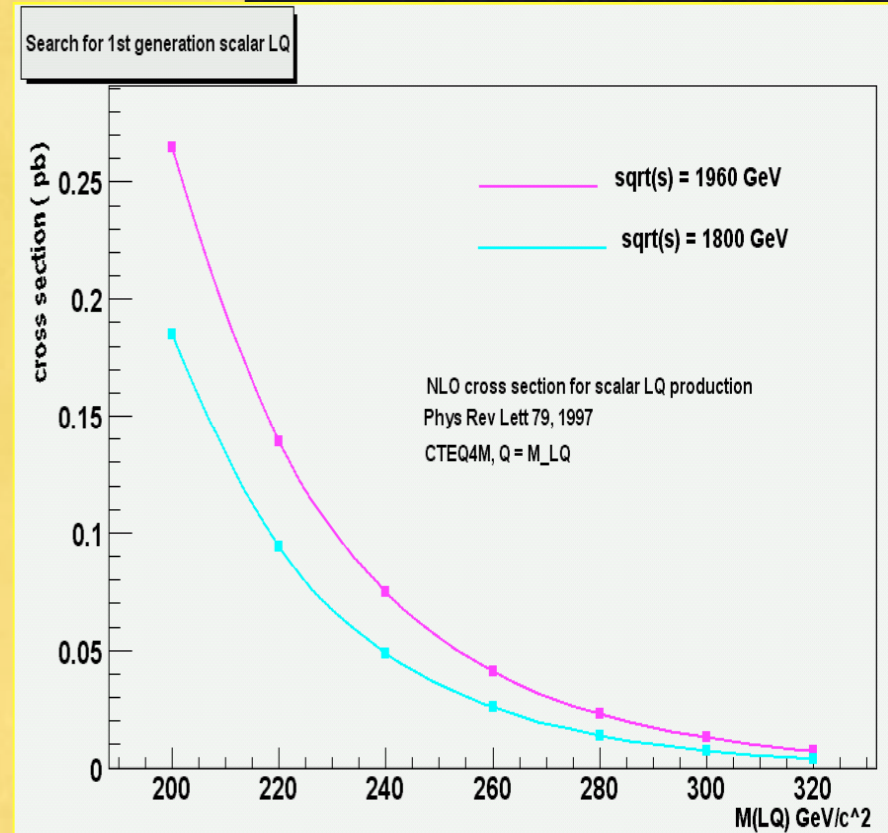
Leptoquarks @Tevatron

LQ : color-triplet bosons w/ both lepton and baryon quantum #s, predicted in various BSM theories: Grand Unification, Technicolor, SUSY

Strong pair-production, cross section independent of Yukawa coupling to l and q , assume generations don't mix



Feynman diagrams for pair production of leptoquarks at hadron colliders.



Search for LQI in Jets+MET

Assume $\text{Br}(\text{LQI} \rightarrow q\nu) = 1.0$

Signature:

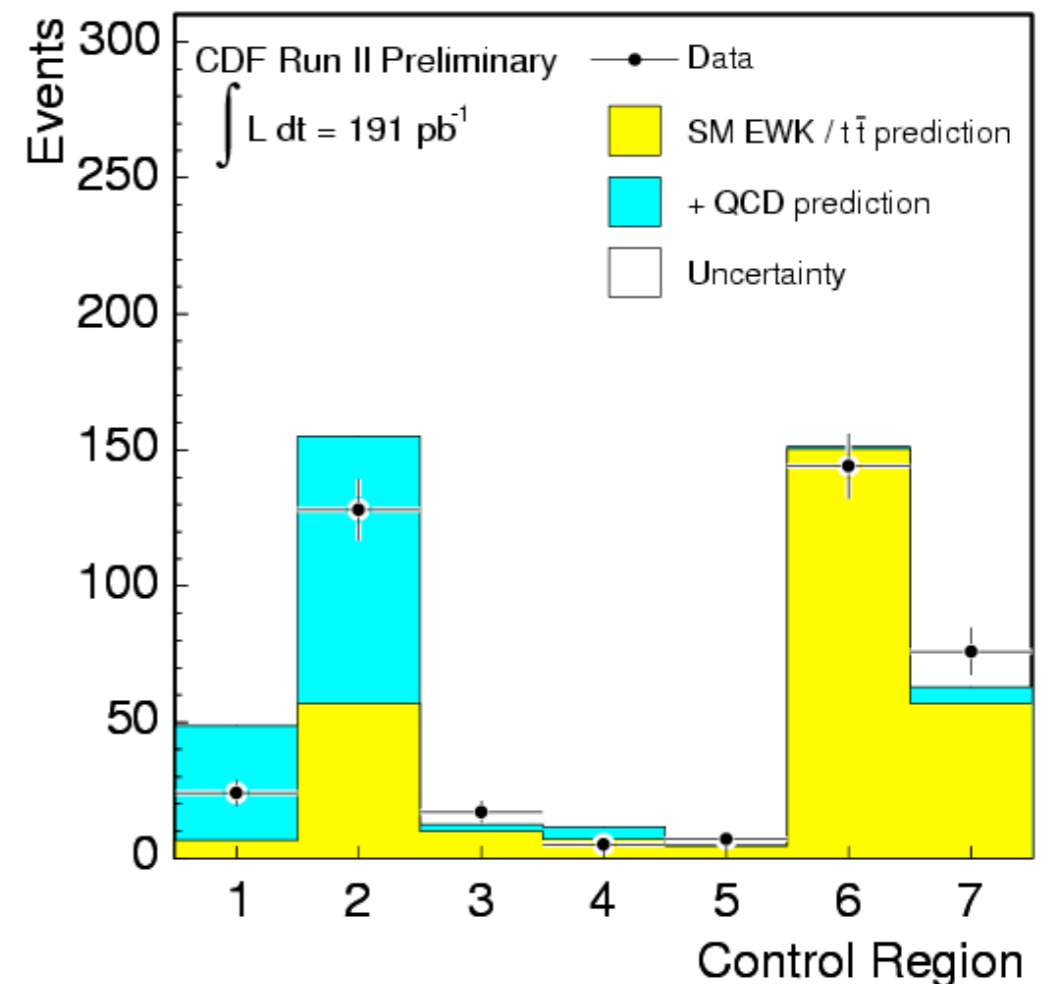
MET+2 high Et jets

Signal region: MET > 60,
 $80 < \Delta\phi(\text{jj}) < 165$, #lep = 0

Main backgrounds:
 W+jets, Z+jets

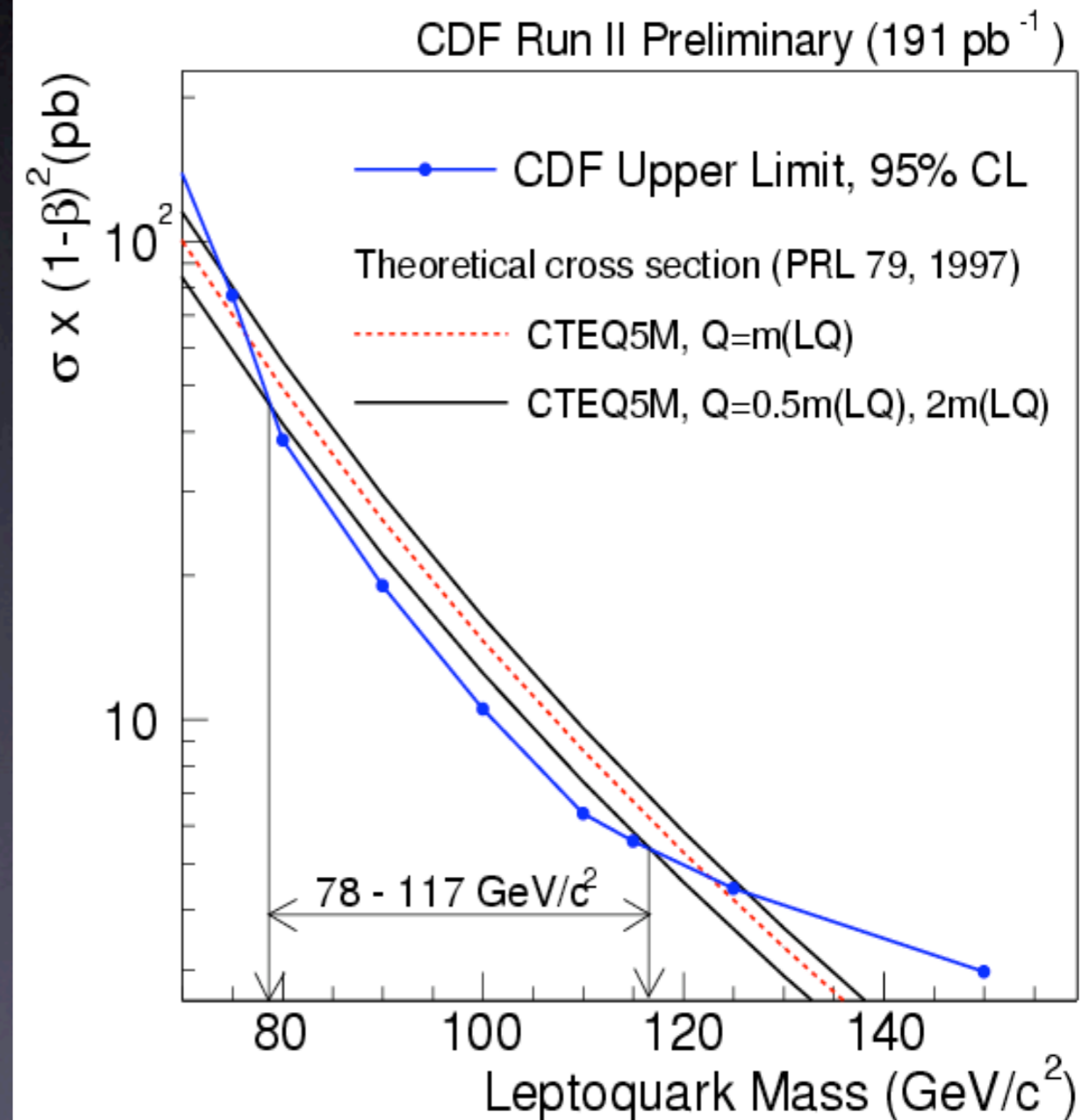
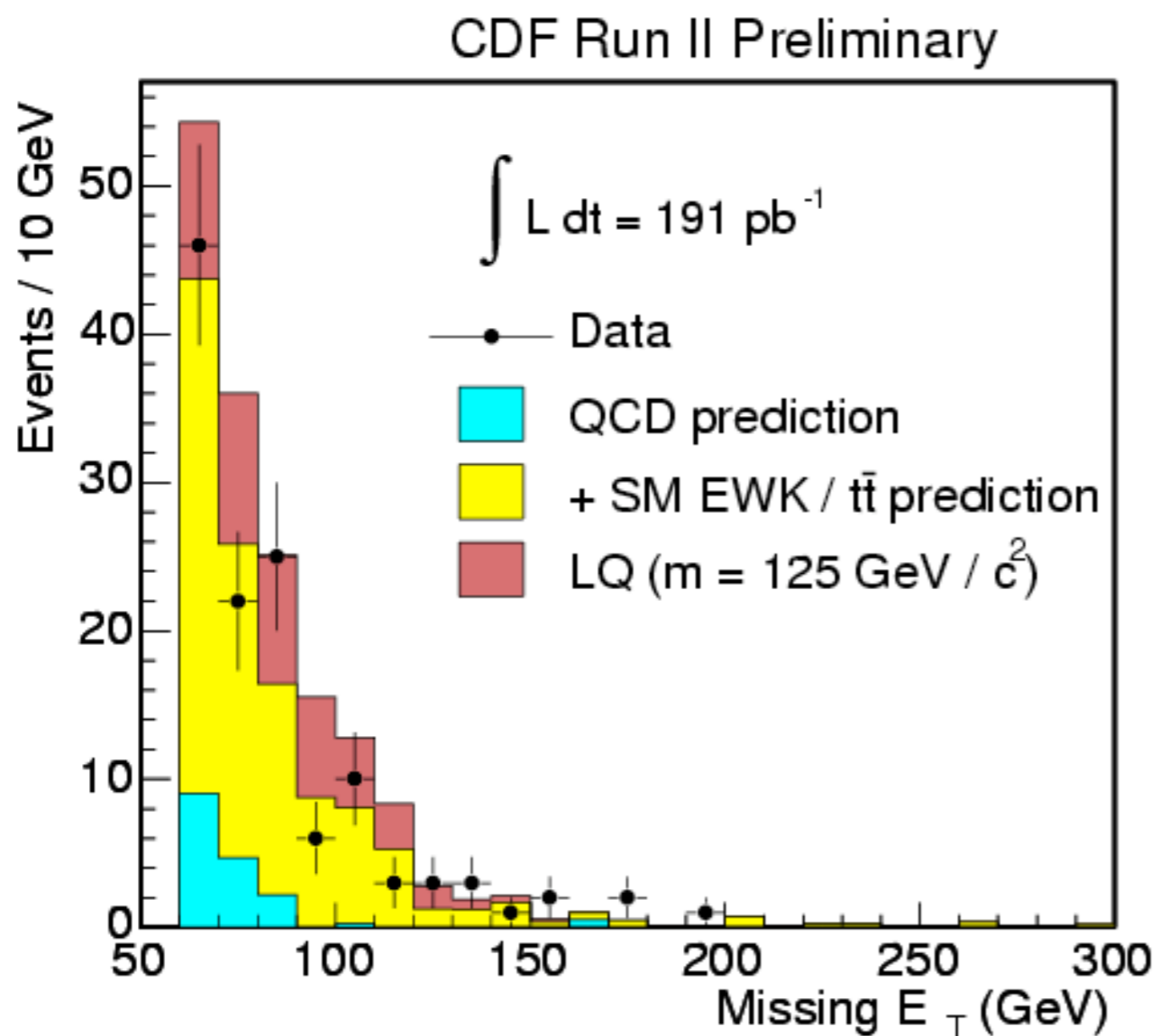
Region definition			
1)	$45 < \cancel{E}_T < 55 \text{ GeV}$,	$\Delta\phi(j_1, j_2) > 165^\circ$,	$N_l = 0$
2)	$45 < \cancel{E}_T < 55 \text{ GeV}$,	$\Delta\phi(j_1, j_2) < 165^\circ$,	$N_l = 0$
3)	$45 < \cancel{E}_T < 55 \text{ GeV}$,	$\Delta\phi(j_1, j_2) > 165^\circ$,	$N_l > 0$
4)	$\cancel{E}_T > 55 \text{ GeV}$,	$\Delta\phi(j_1, j_2) > 165^\circ$,	$N_l = 0$
5)	$\cancel{E}_T > 55 \text{ GeV}$,	$\Delta\phi(j_1, j_2) > 165^\circ$,	$N_l > 0$
6)	$\cancel{E}_T > 55 \text{ GeV}$,	$\Delta\phi(j_1, j_2) < 165^\circ$,	$N_l > 0$
7)	$45 < \cancel{E}_T < 55 \text{ GeV}$,	$\Delta\phi(j_1, j_2) < 165^\circ$,	$N_l > 0$

Background Predictions and Data Around The Signal Region



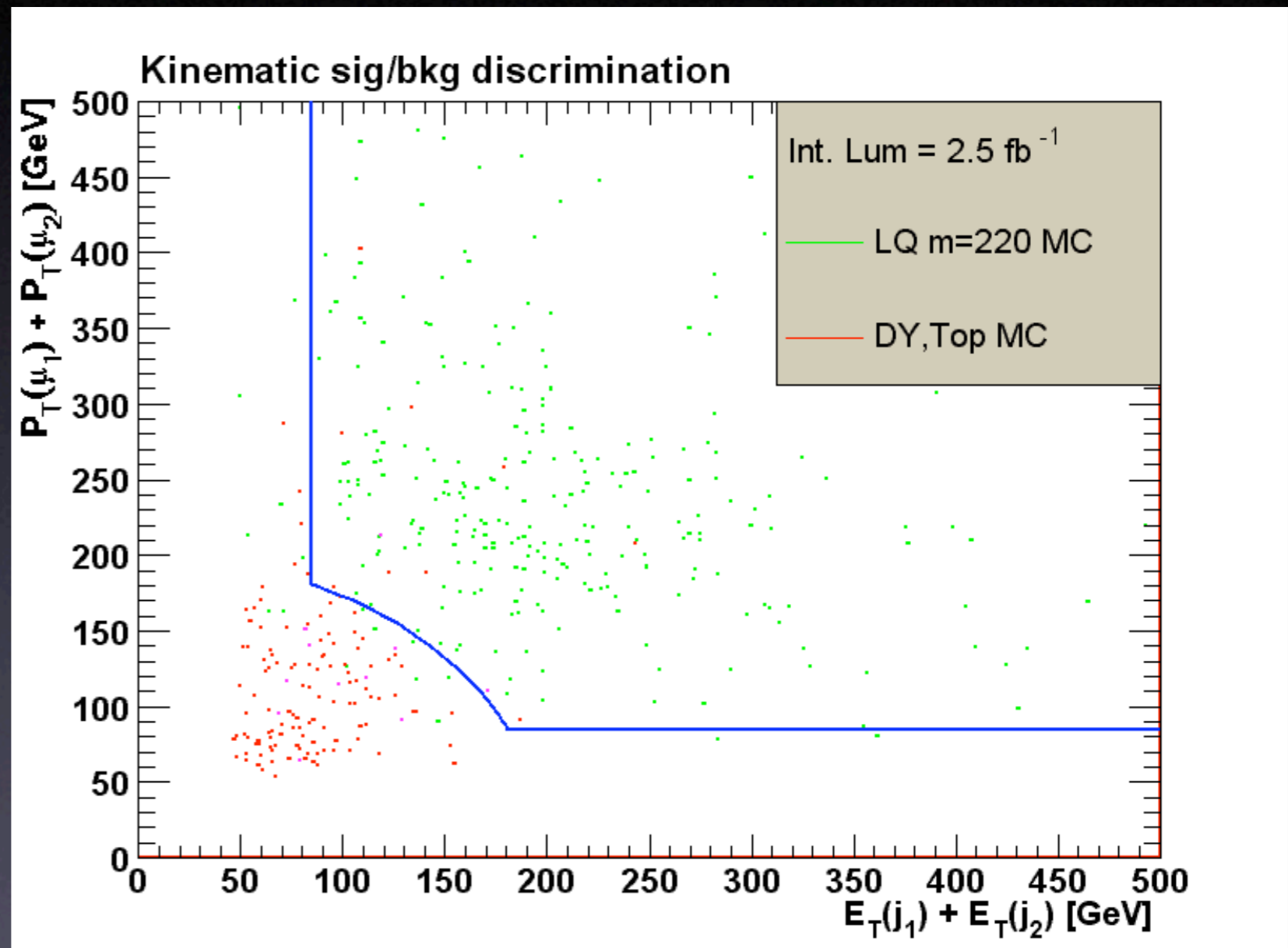
LQ I in Jets+MET (2)

Signal region: 118 ± 14 expected (bg), 124 observed
Compare with NLO prediction & set limits



Search for LQ2 in di- μ

- $\beta = \text{Br}(\text{LQ2} \rightarrow \mu q) = 1$
- Signature:
dimuons + dijets
- BG: $t\bar{t}$, $Z+2\text{jets}$



Kinematical cuts:

$$E_T(j_1) + E_T(j_2) > 85 \text{ GeV} \text{ AND } P_T(m_1) + P_T(m_2) > 85 \text{ GeV}$$

$$\sqrt{((E_T(j_1) + E_T(j_2))^2 + (P_T(m_1) + P_T(m_2))^2)} > 200 \text{ GeV}$$

Search for LQ2 in di- μ (2)

Predicted number of
CMUP/CMUP, CMUP/CMX,
CMX/CMX events in 126pb^{-1}

M(LQ)	$Q^2=M(LQ)^2/4$	$Q^2=4M(LQ)^2$
160	13.11	10.44
180	7.54	6.05
200	4.48	3.62
220	2.56	2.06
240	1.45	1.17
260	0.84	0.67
280	0.46	0.36
300	0.26	0.21
320	0.15	0.12

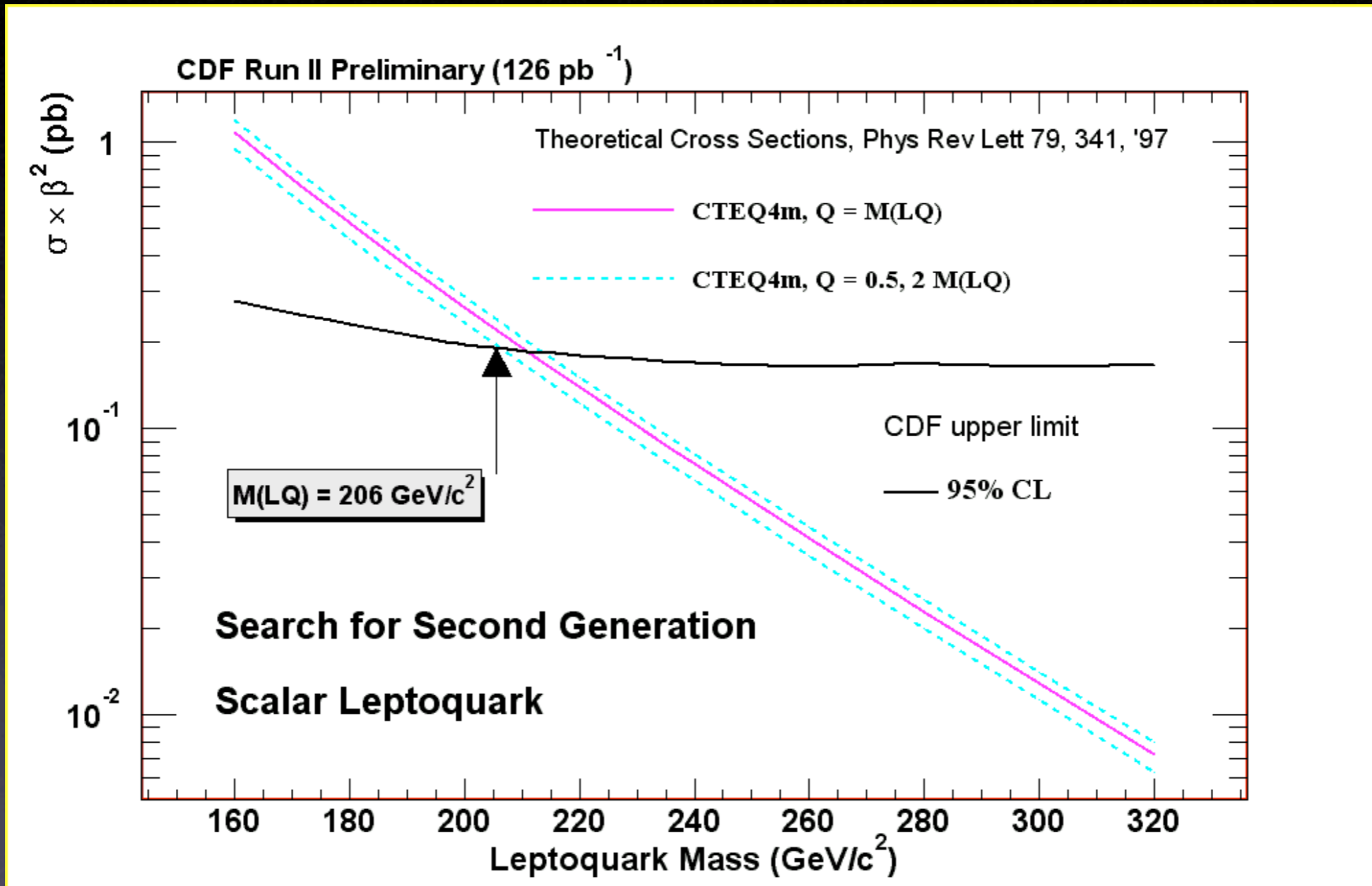
BG: tt, with both $W \rightarrow \mu\nu$: 0.09 events

DY+2jets: 0.34 events

Data

Type of Cut	Tot
Muon ID (2 tight)	1668
Pt_ μ 1 & Pt_ μ 2 > 25 GeV	1561
Et j1,j2 > 15,30 GeV	15
M $\mu\mu$ cut	4
Sum μ , Sumj > 85 GeV	1
Sqrt(Sum μ^2 +Sumj 2) > 200 GeV	0

LQ2 in di- μ Results

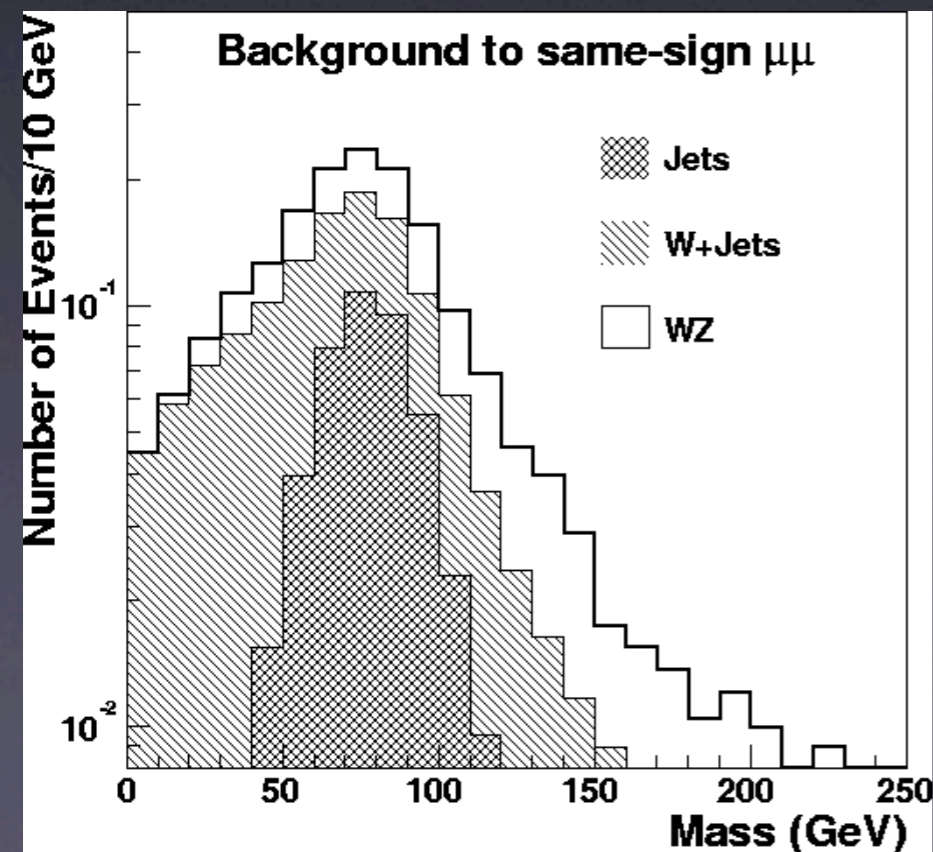
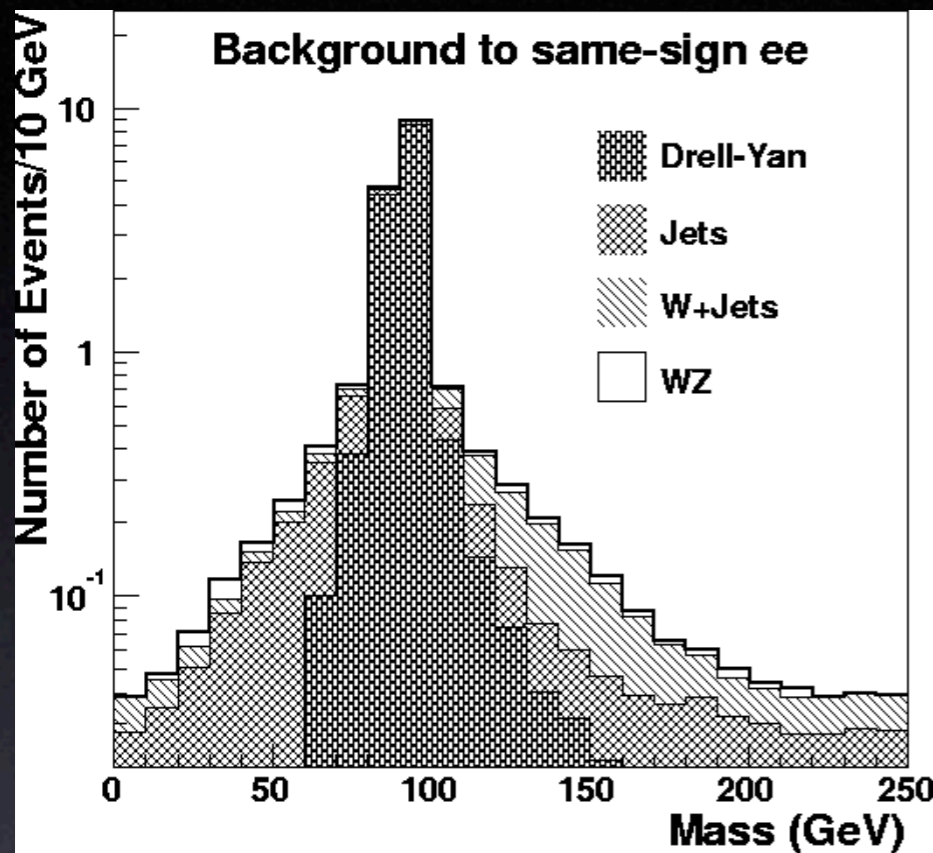


Run I limit: 202 GeV; Next: include MI tracks
to increase acceptance

Search for H^{++}

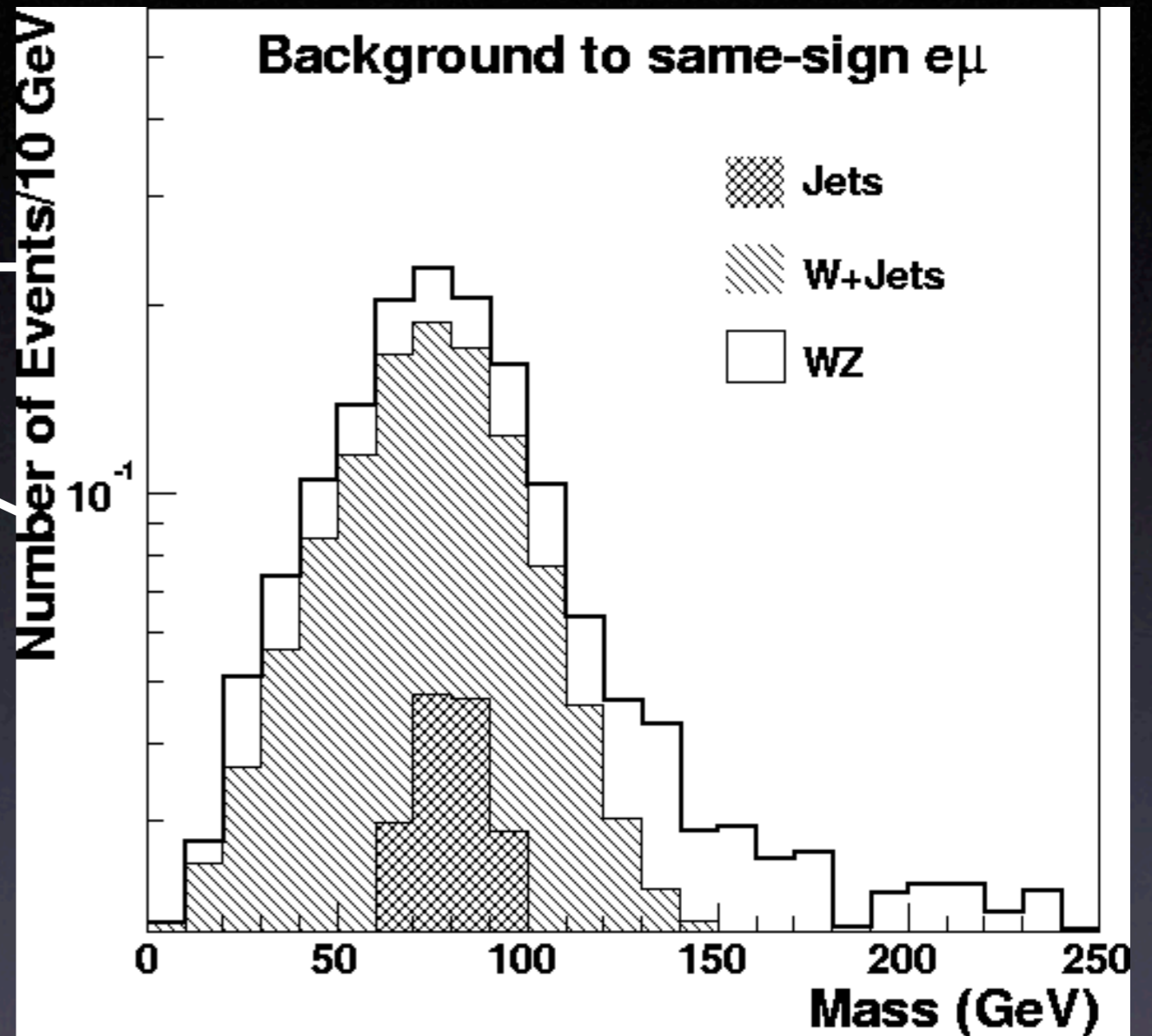
- Predicted in left-right symmetric models
- SUSY LR models predict $100\text{Gev} < M(H^{++}) < 1\text{TeV}$
- These decay to leptons!
- Search: 240 pb-1
- Strategy: LS dileptons, mass window of $10\% * M(H^{++})$

Search for H^{++} (2)



CDF Run 2

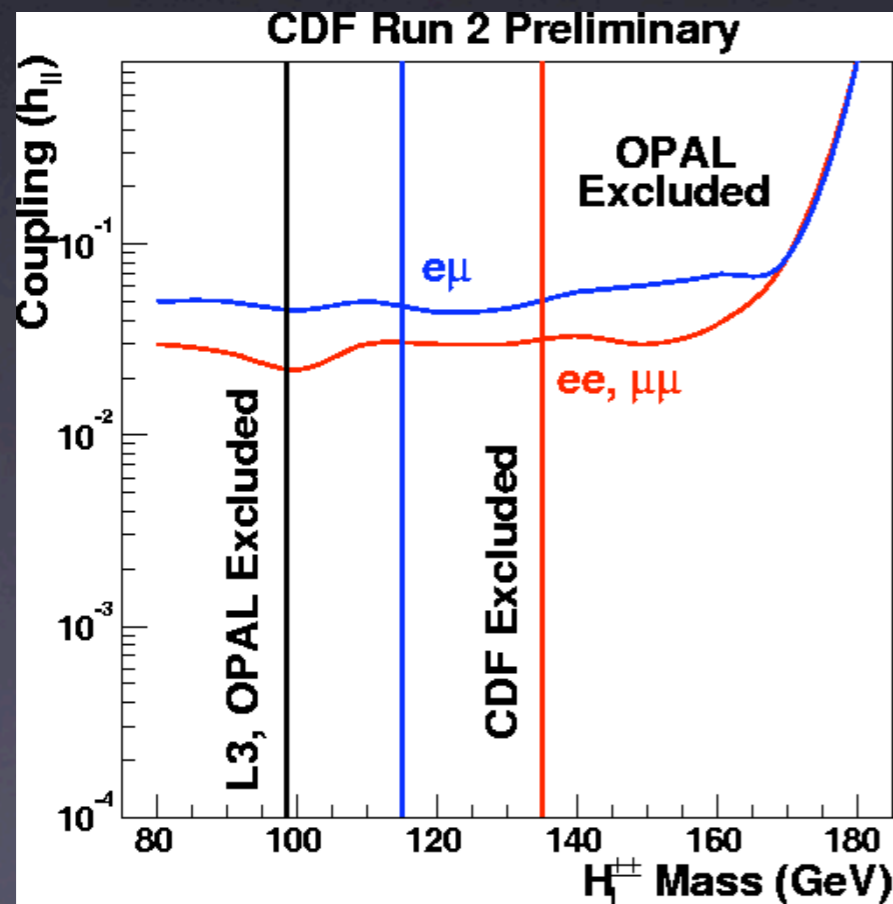
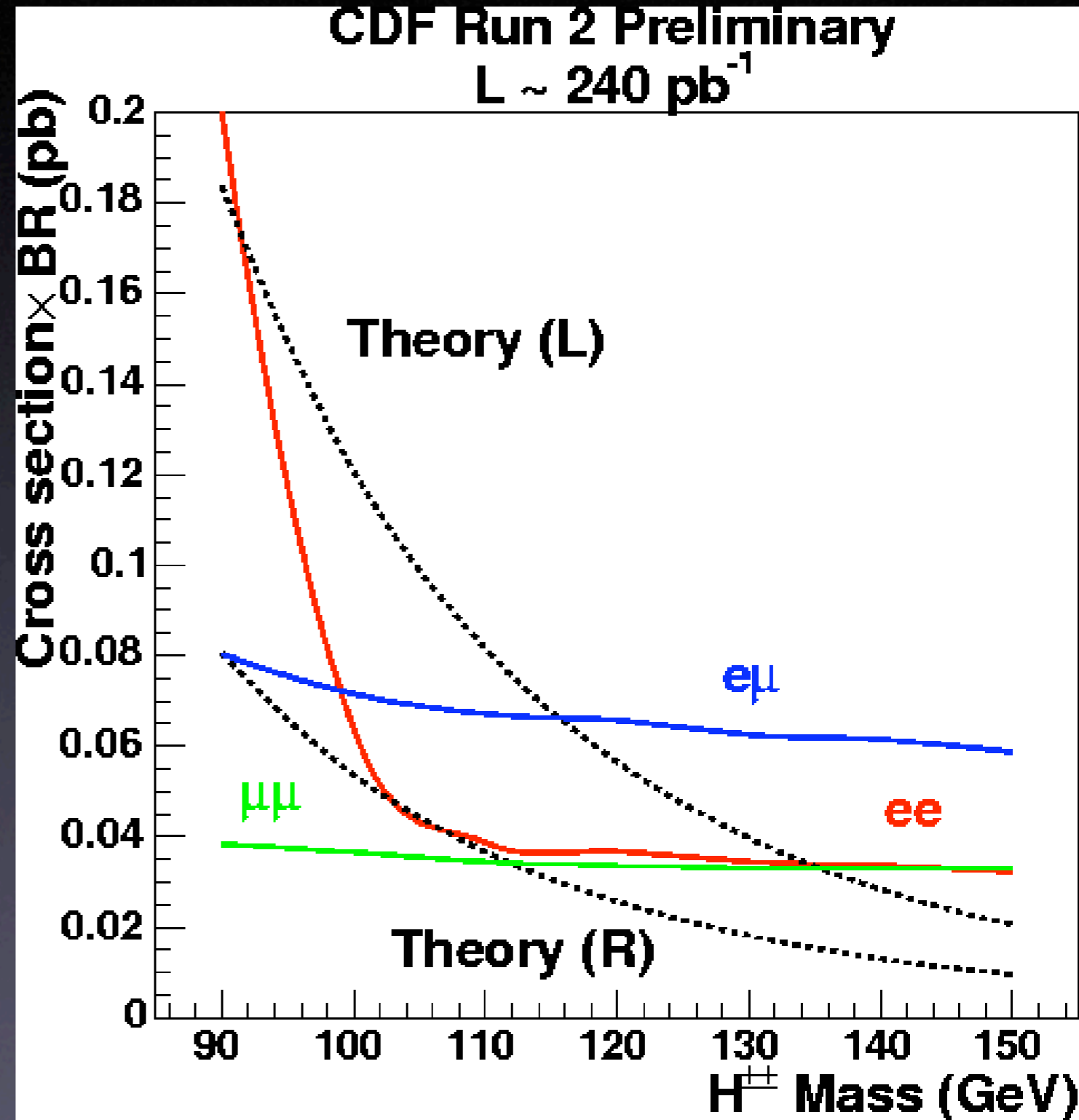
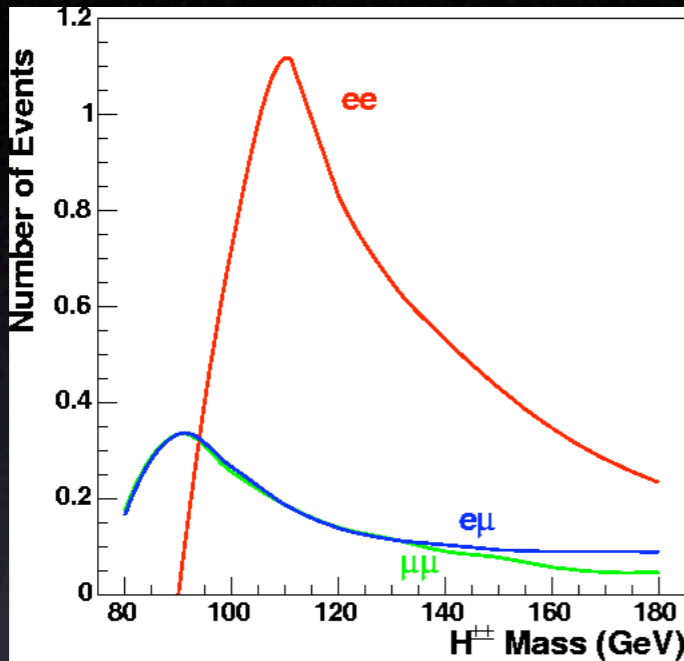
Preliminary 240 pb-1



Low mass region: predict 3.4 evts,
obs. 1 ee event

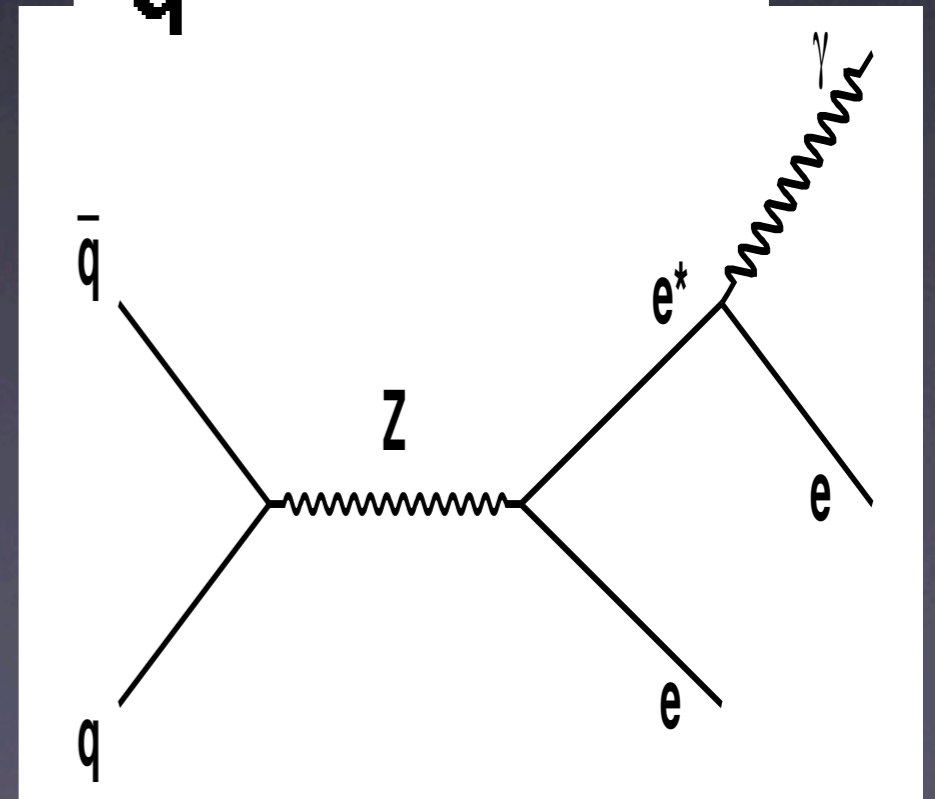
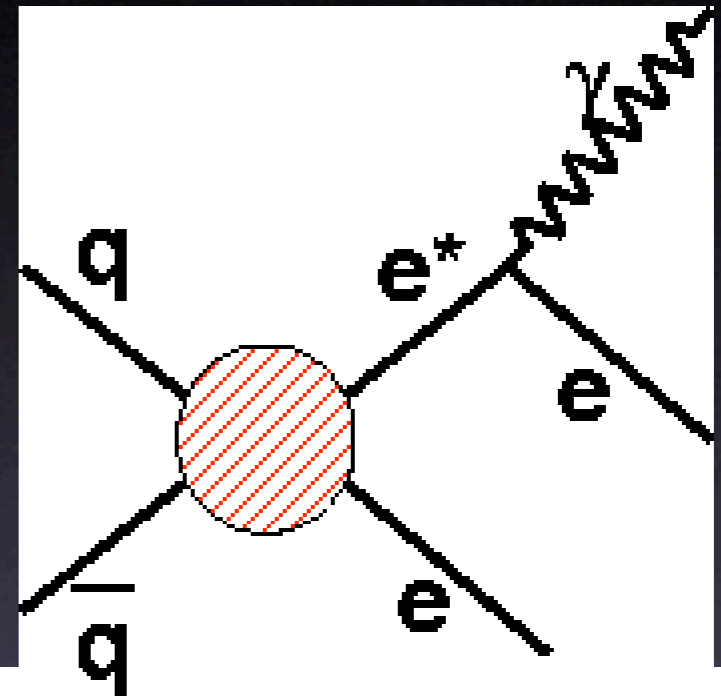
High mass (search) region: 0 obs.

Results for H^{++}



Search for excited electrons ($e^* \rightarrow e\gamma$)

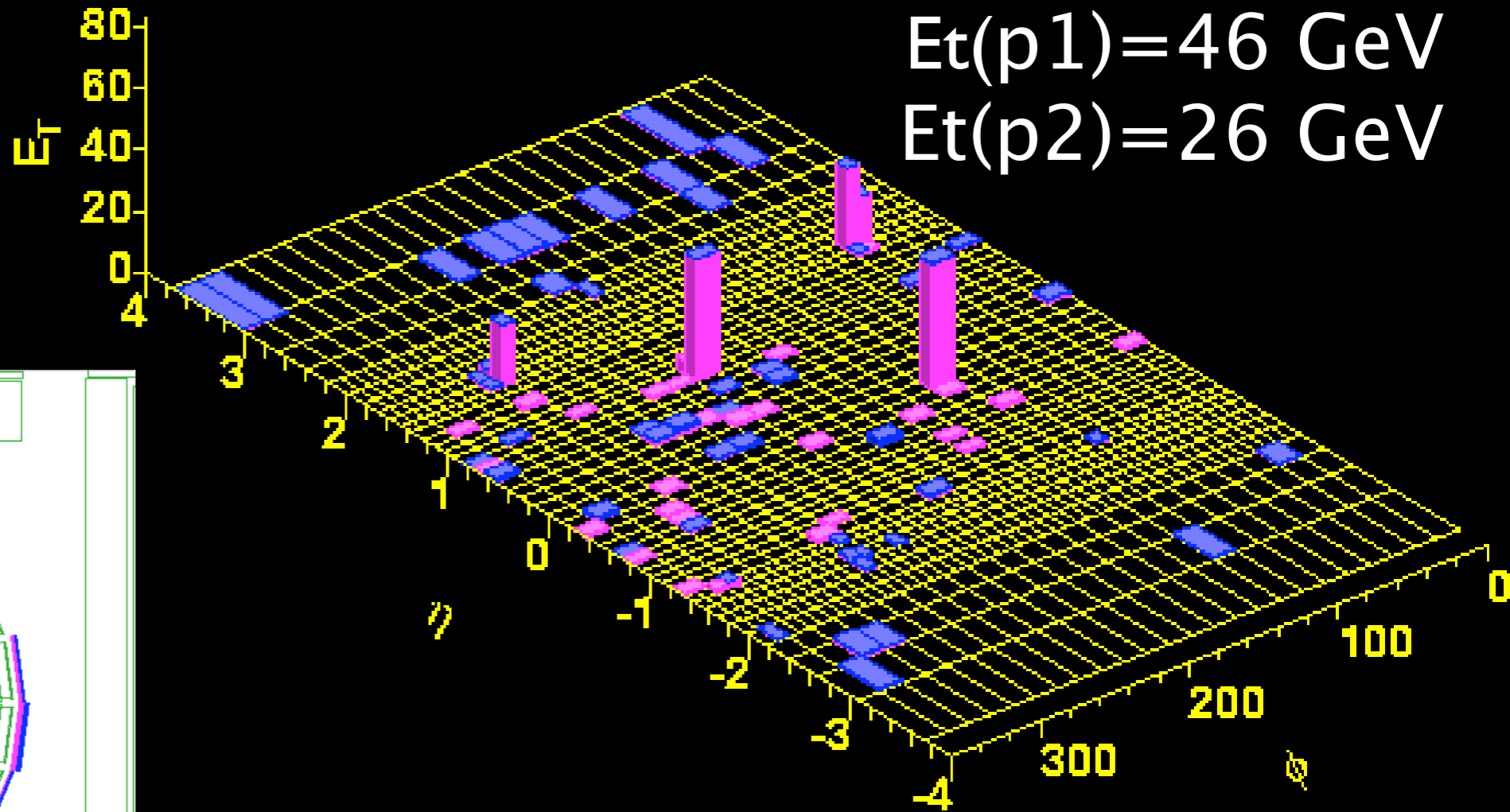
- Examine 200pb-1 data for resonance in $e\gamma$ channel
- Effective 4-f Lagrangian, GM e^* models (Baur, Phys Rev D42,3)
- XS depends on $M(e^*)$ and comp. scale Λ



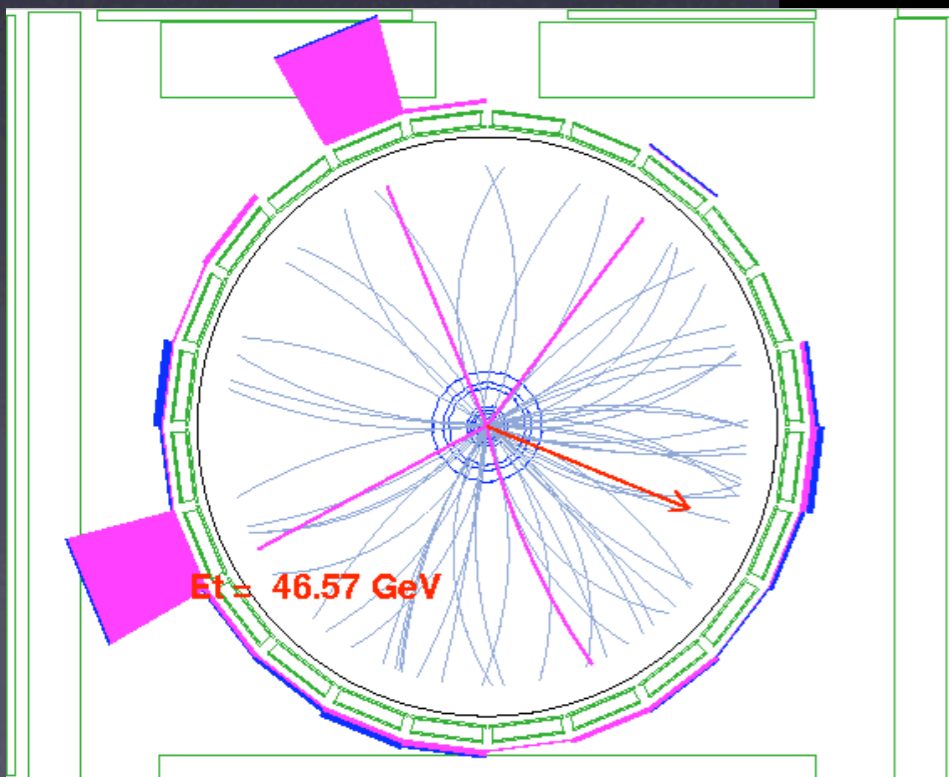
Candidate $ee-p$ event

Both p -
objects have
good tracks!
Inv. Masses:
this is ZZ !

$E_t(e1)=44$ GeV
 $E_t(e2)=42$ GeV
 $E_t(p1)=46$ GeV
 $E_t(p2)=26$ GeV

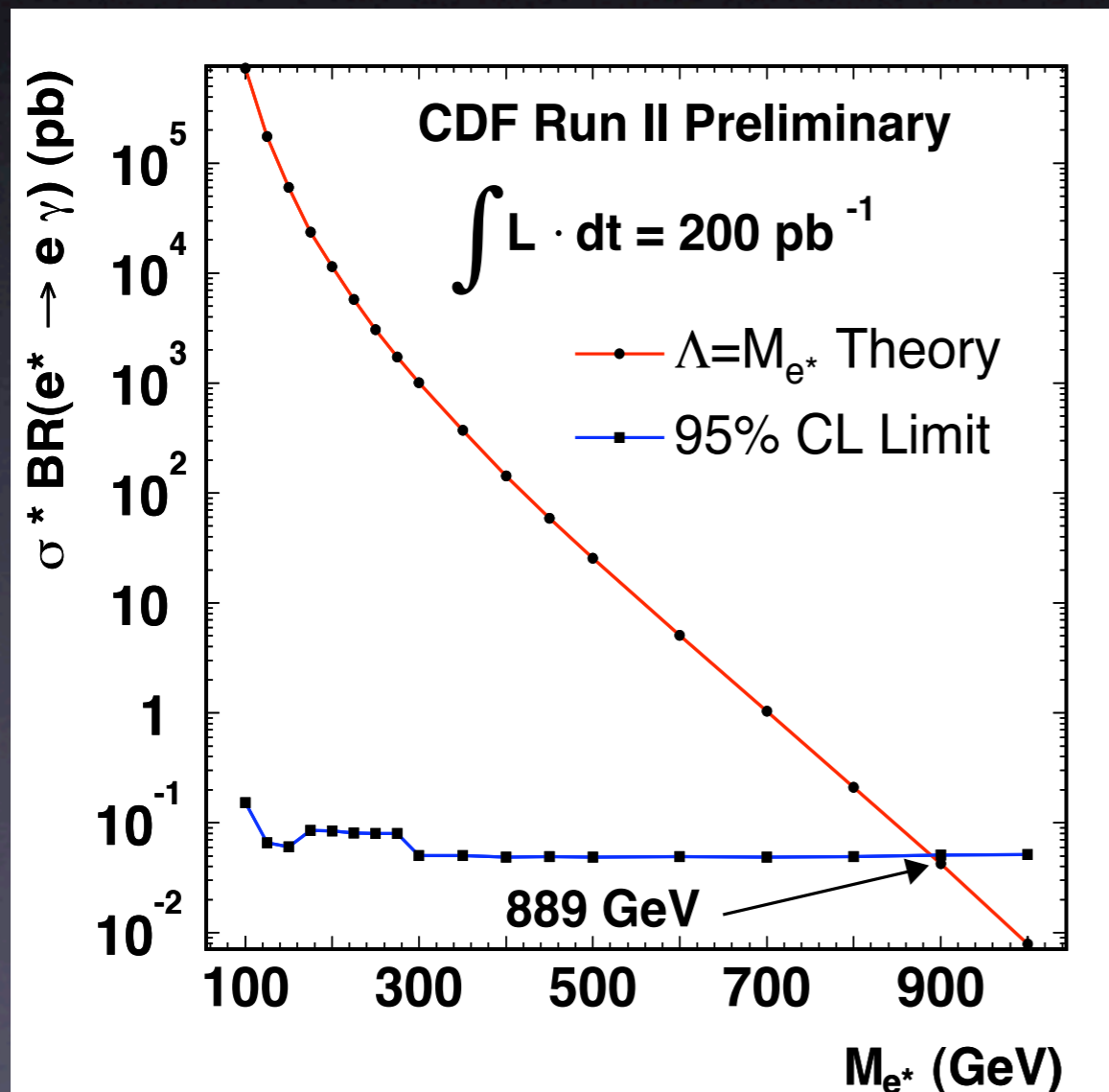


$MET = 13$ GeV

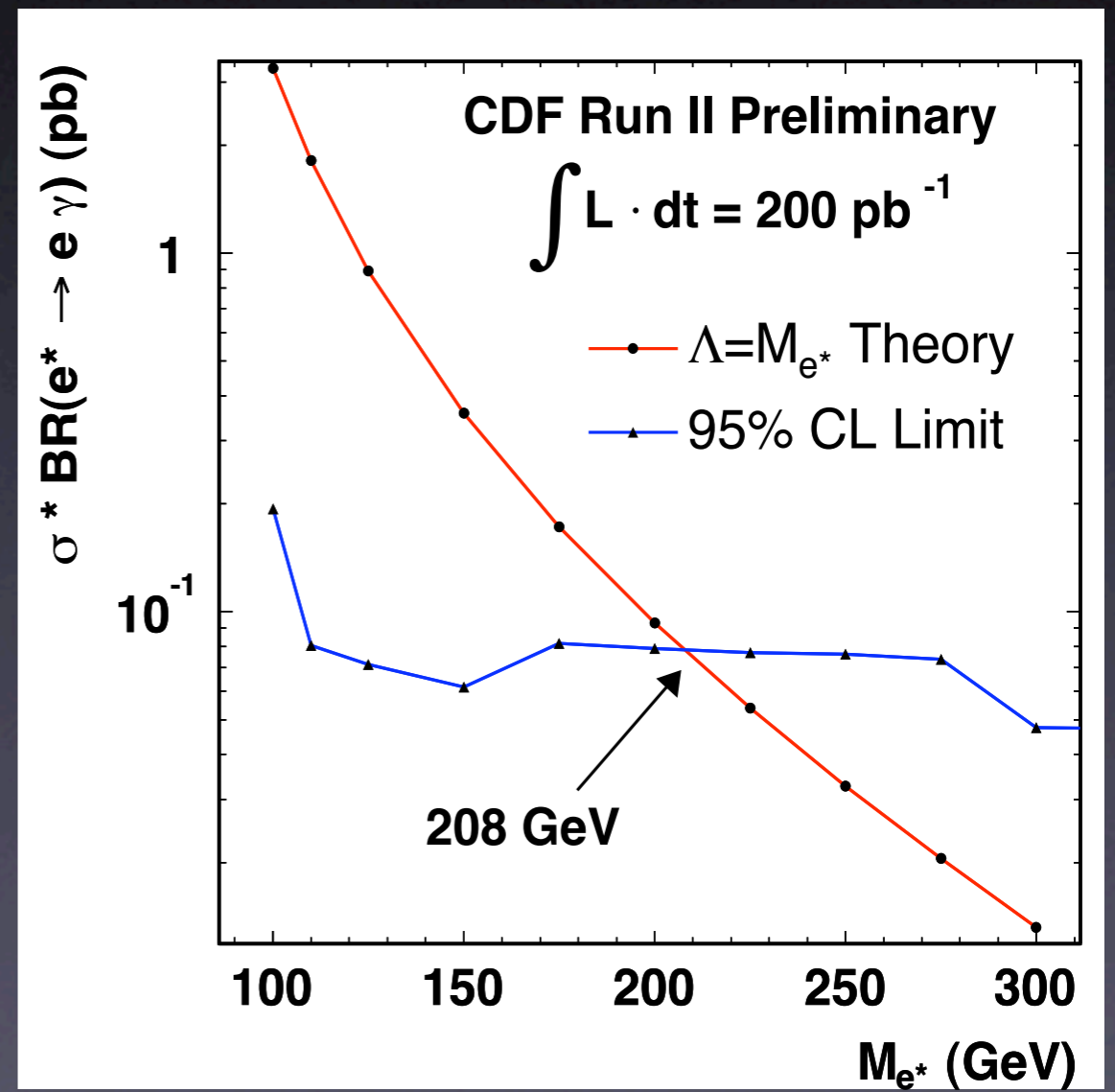


$e e \gamma$ Results

- Three events observed in 200 pb-1, total expected: 3 events! Set limits on CI, GM



Contact Interaction Model

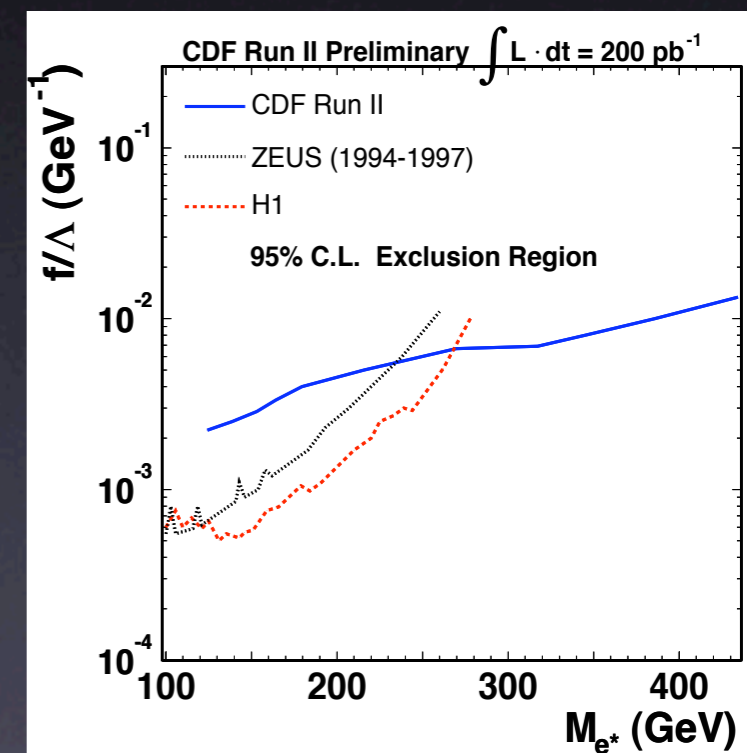
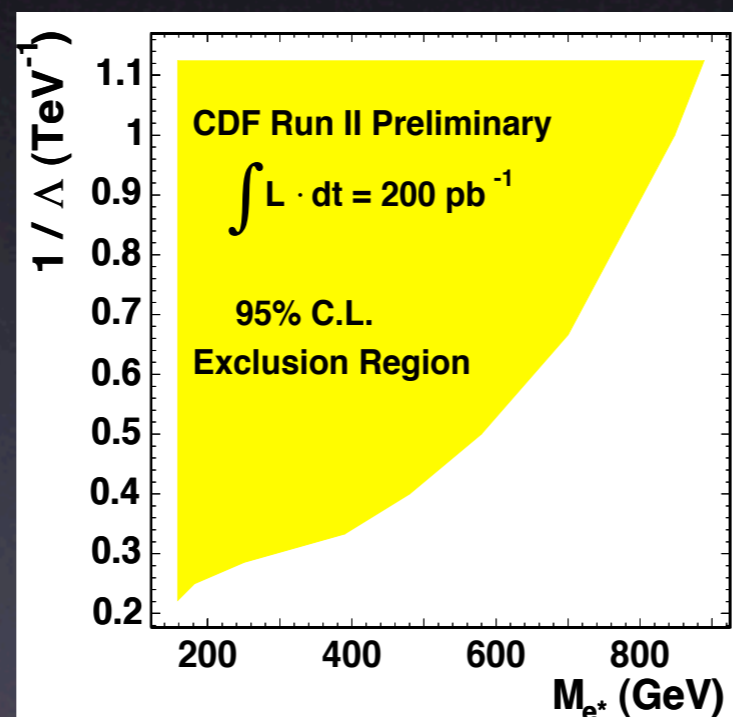
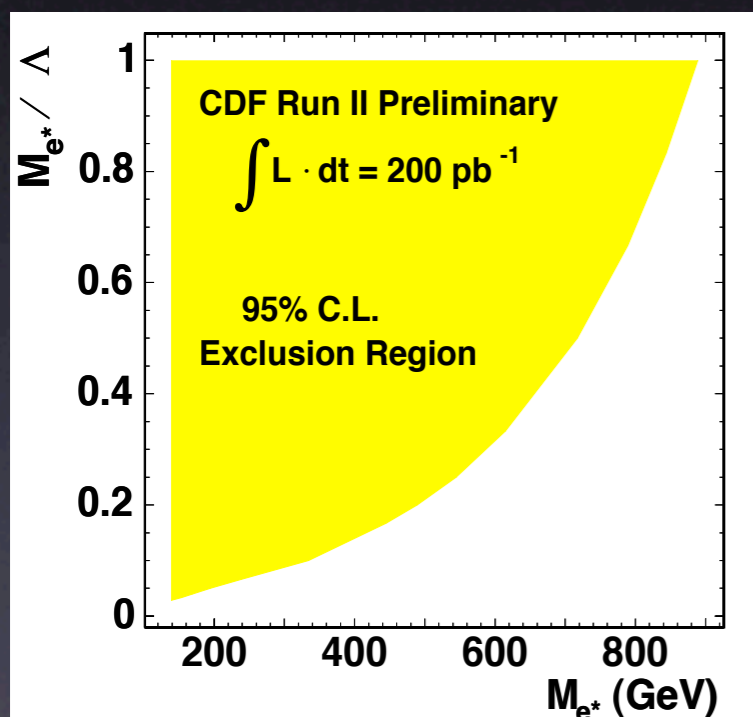


Gauge Mediated Model

$e e \gamma$ Results (2)

Contact Int. Limits

Gauge Mediated



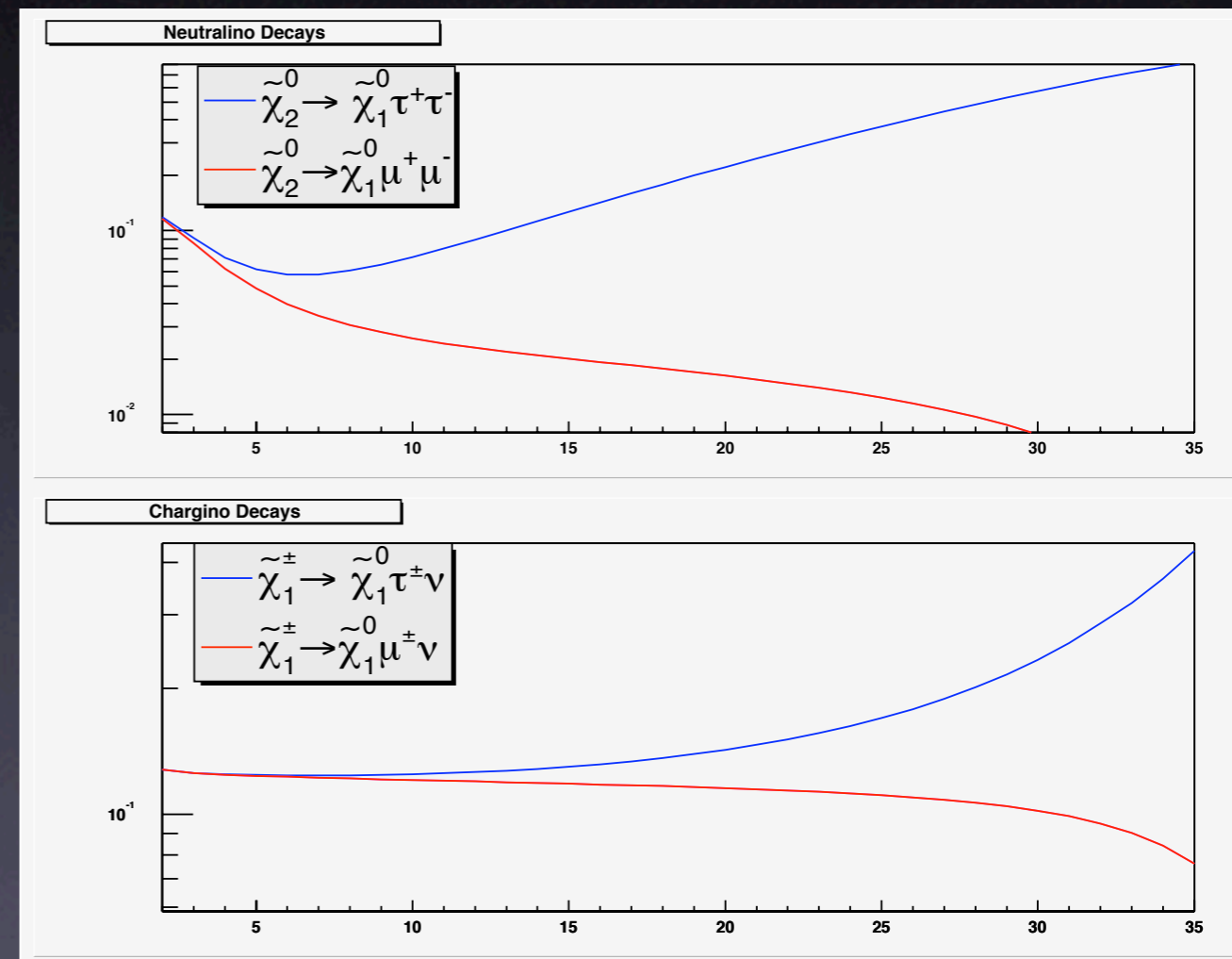
CDF μ^* Results are forthcoming

Other Recent CDF Results

- Z' (See D. Water's talk)
- $X \rightarrow$ di-jets
- scalar-b
- gamma + Missing Et, gamma-gamma
- gamma + heavy flavor
- $B_s \rightarrow \mu\mu$
- CHAMPs

Coming soon from a Collider Detector near you!

- Enhanced LQ2 search with full data set, other LQ decay modes
- Magnetic Monopoles
- $Z \rightarrow \tau\tau$ cross section, $Z' \rightarrow \tau\tau$ search
- SUSY with Tau Leptons!



$\tan \beta$
mSUGRA points: $m_0 = 150$, $m_{1/2} = 150$,
 $A_0 = 0$, $\text{sign}(\mu) = +1$