Searches for new physics at the Tevatron

David Stuart, UC Santa Barbara
for the CDF & D0 collaborations

PHENO'04, April 26, 2004

New physics has the same ingredients as bread & butter physics

Photons, MET, leptons, jets, b's

(massabetized to avoid any indication of bias)

Similar Combinations:

$\ell\ell$ $\Rightarrow$ Z or Z'

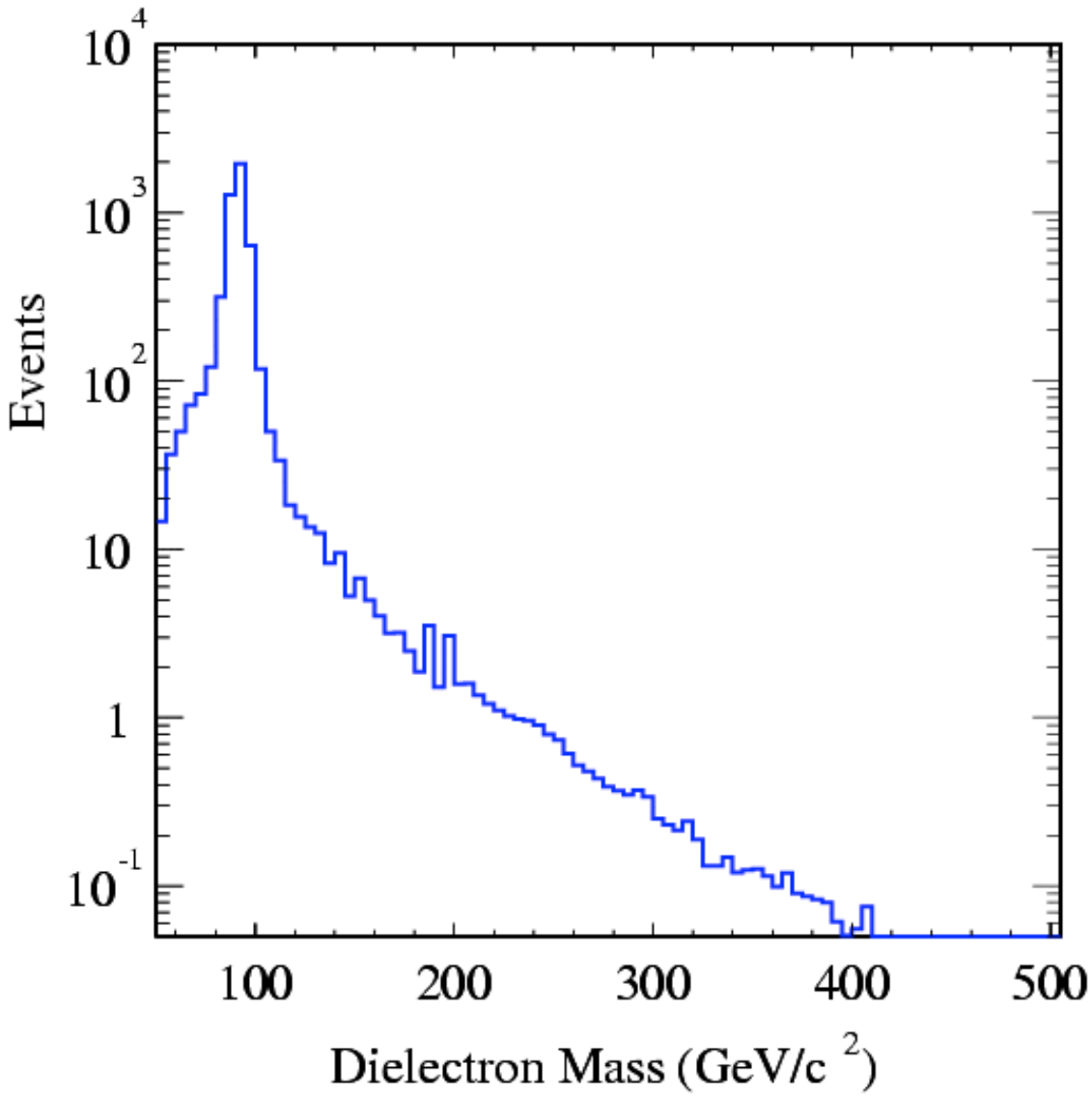
$\ell \not{E}_T$jets $\Rightarrow$ top or LQ or SUSY or Higgs

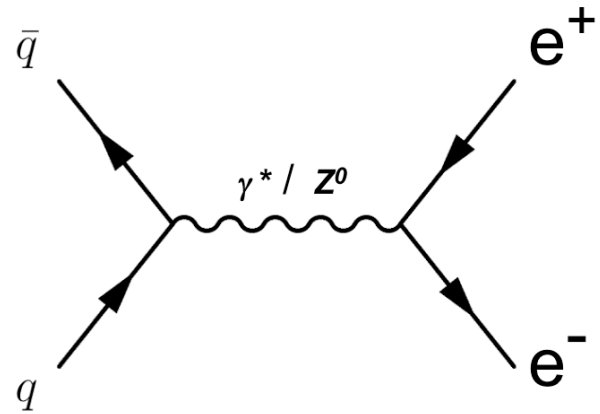
The experimental challenge is in defining and understanding the ingredients
CDF & D0 have done that as evidenced by the SM measurements
Combine the ingredients (with some reference to cookbook) for something new.

New physics has the same ingredients as bread & butter physics

Photons, MET, leptons, jets, b's

Search for high mass di-leptons





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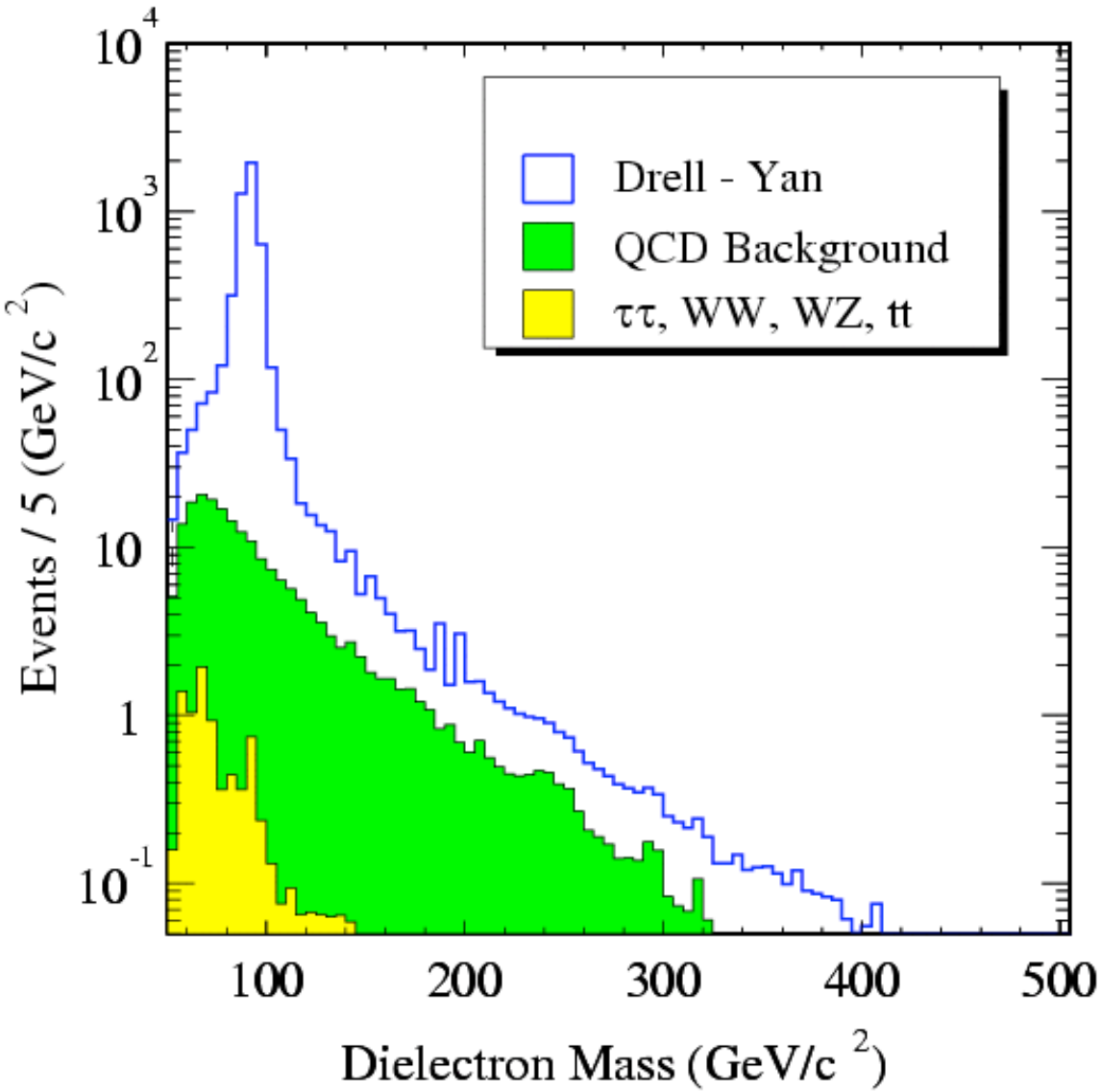

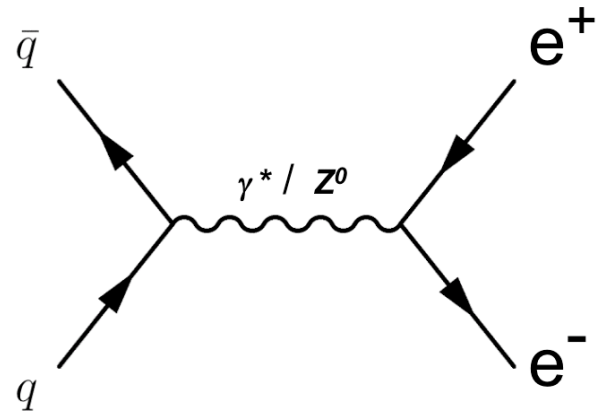

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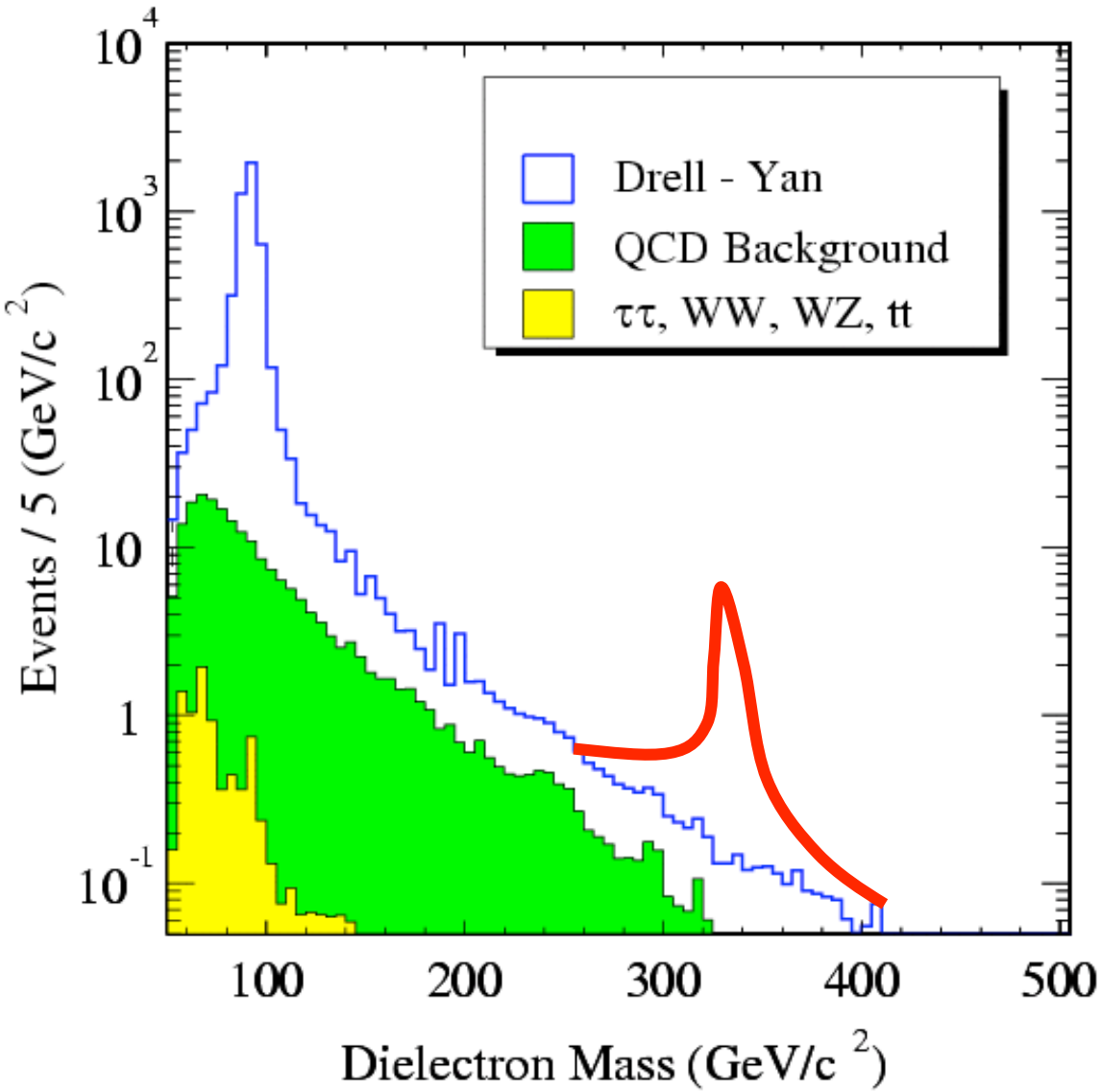

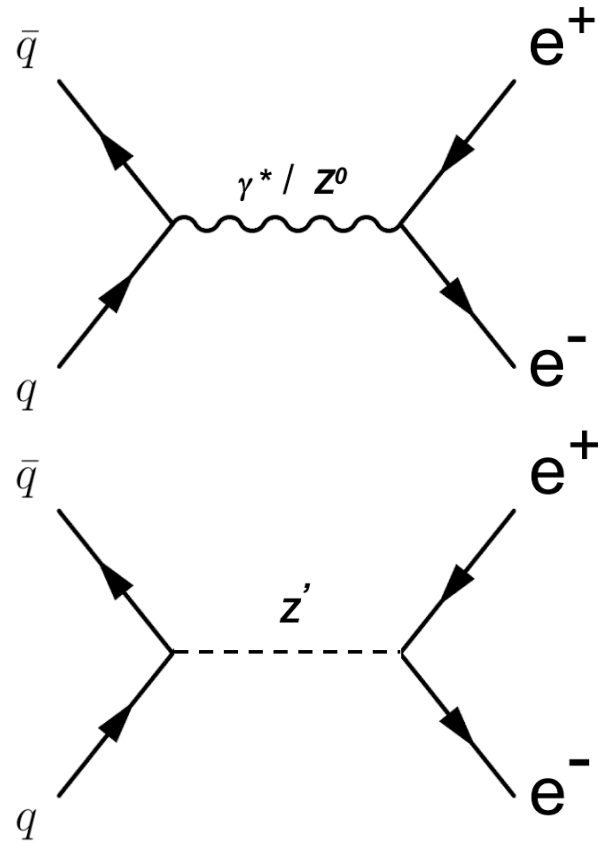

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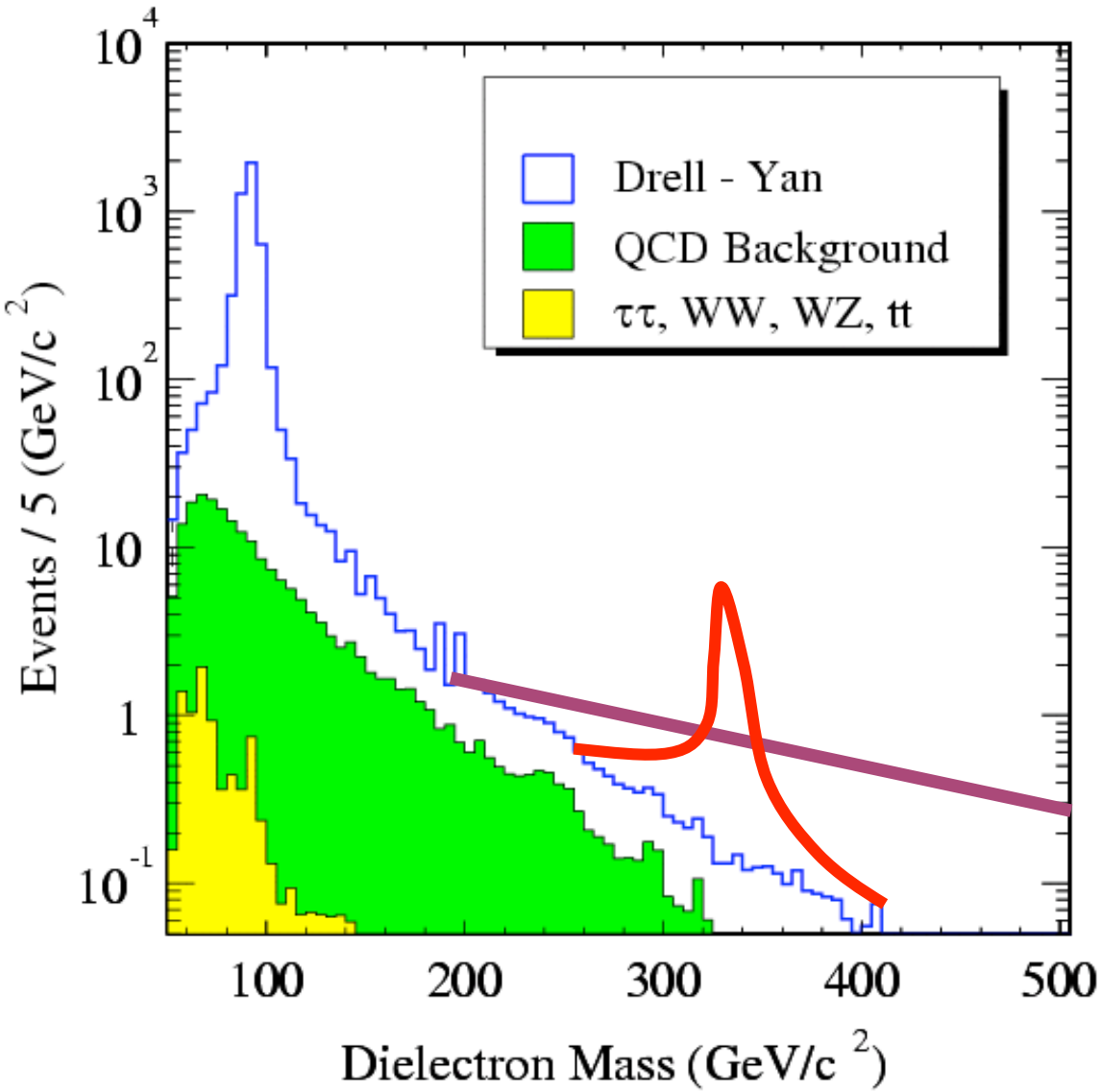

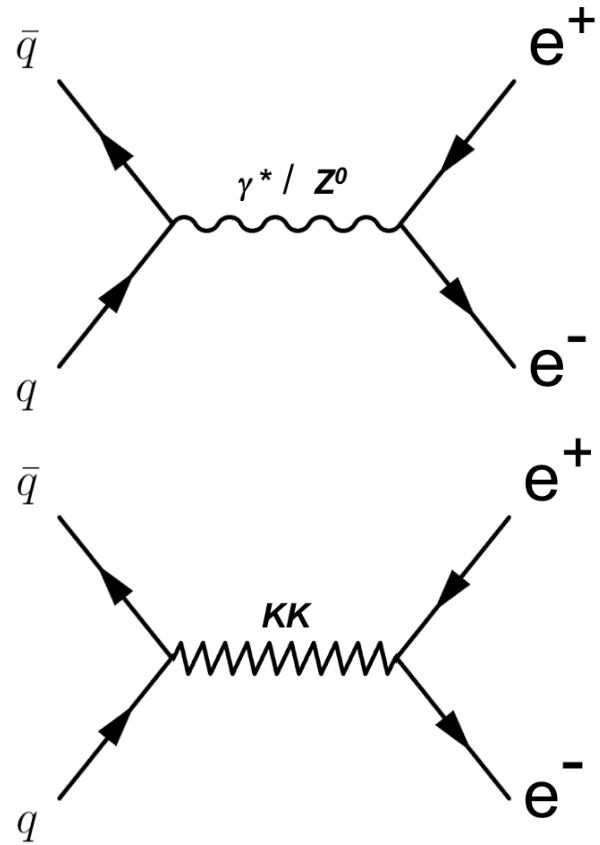

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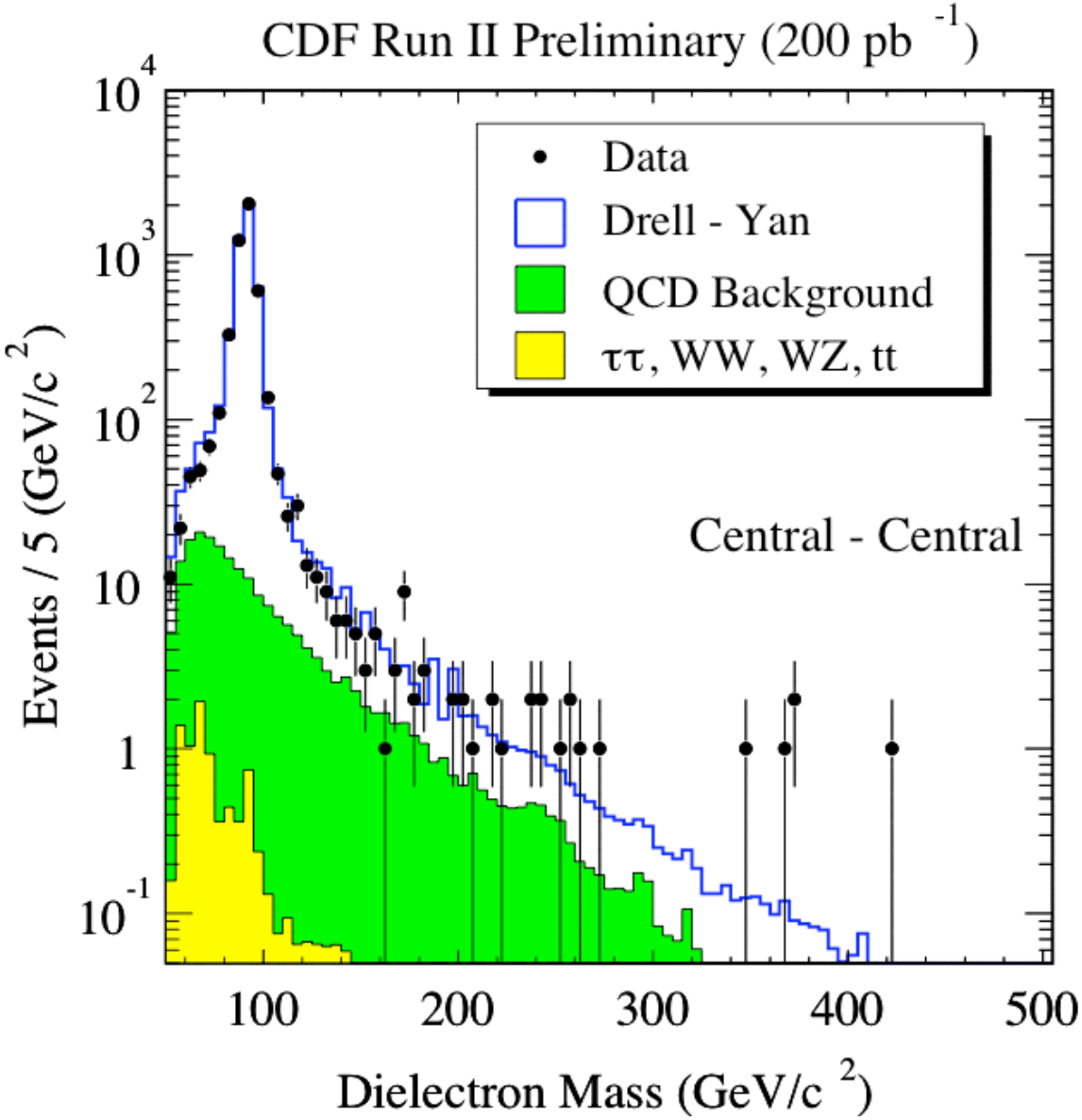

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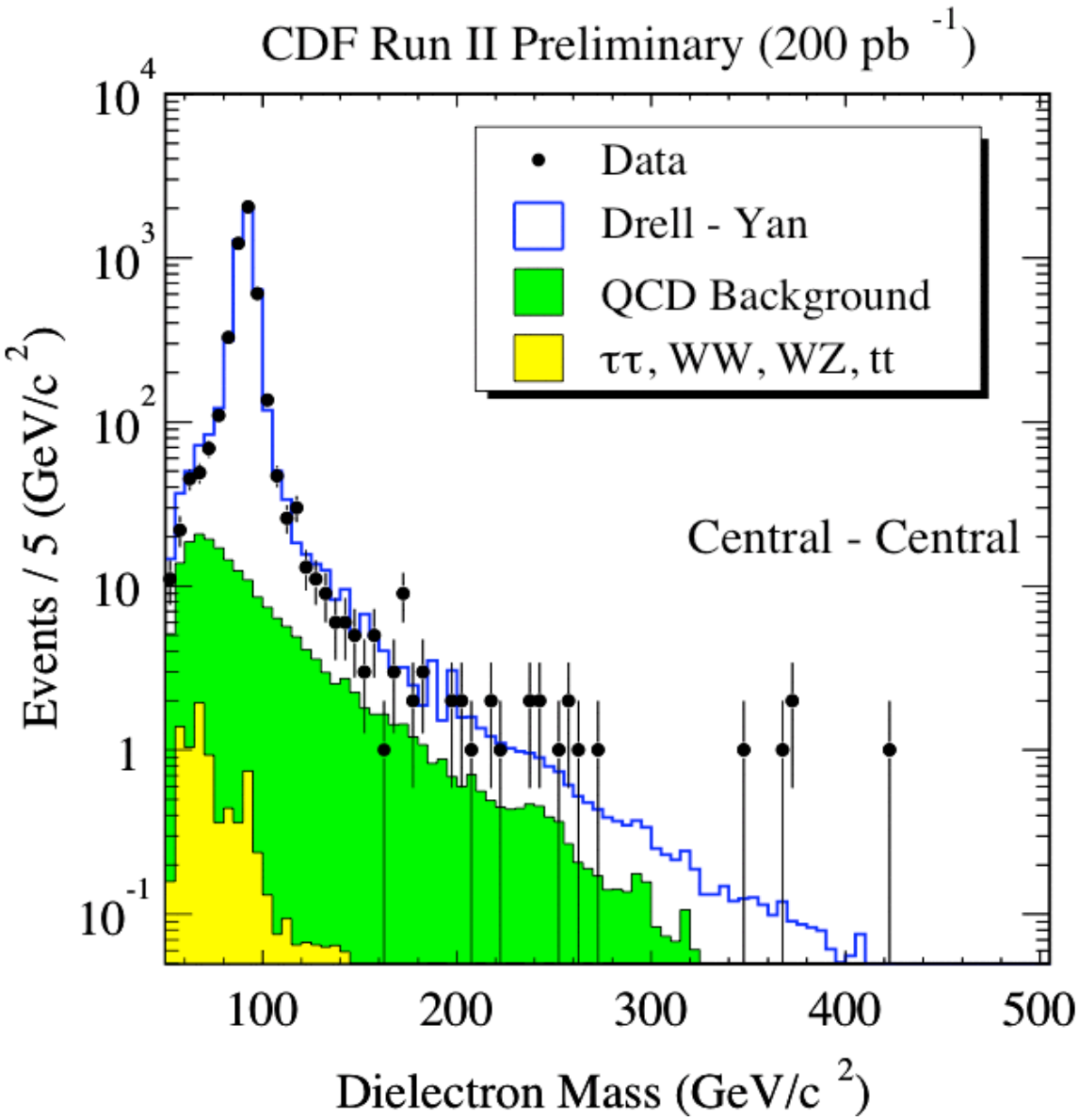

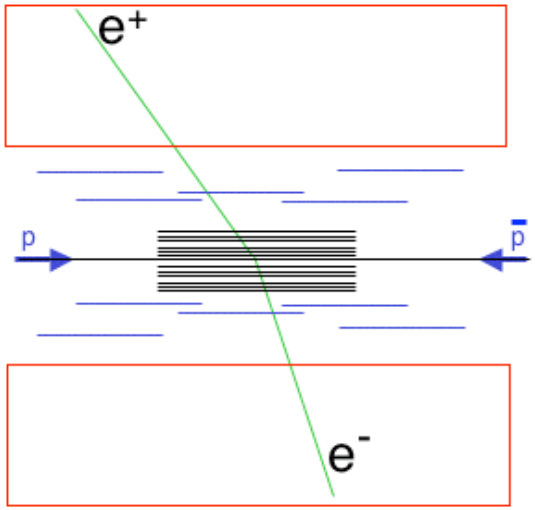

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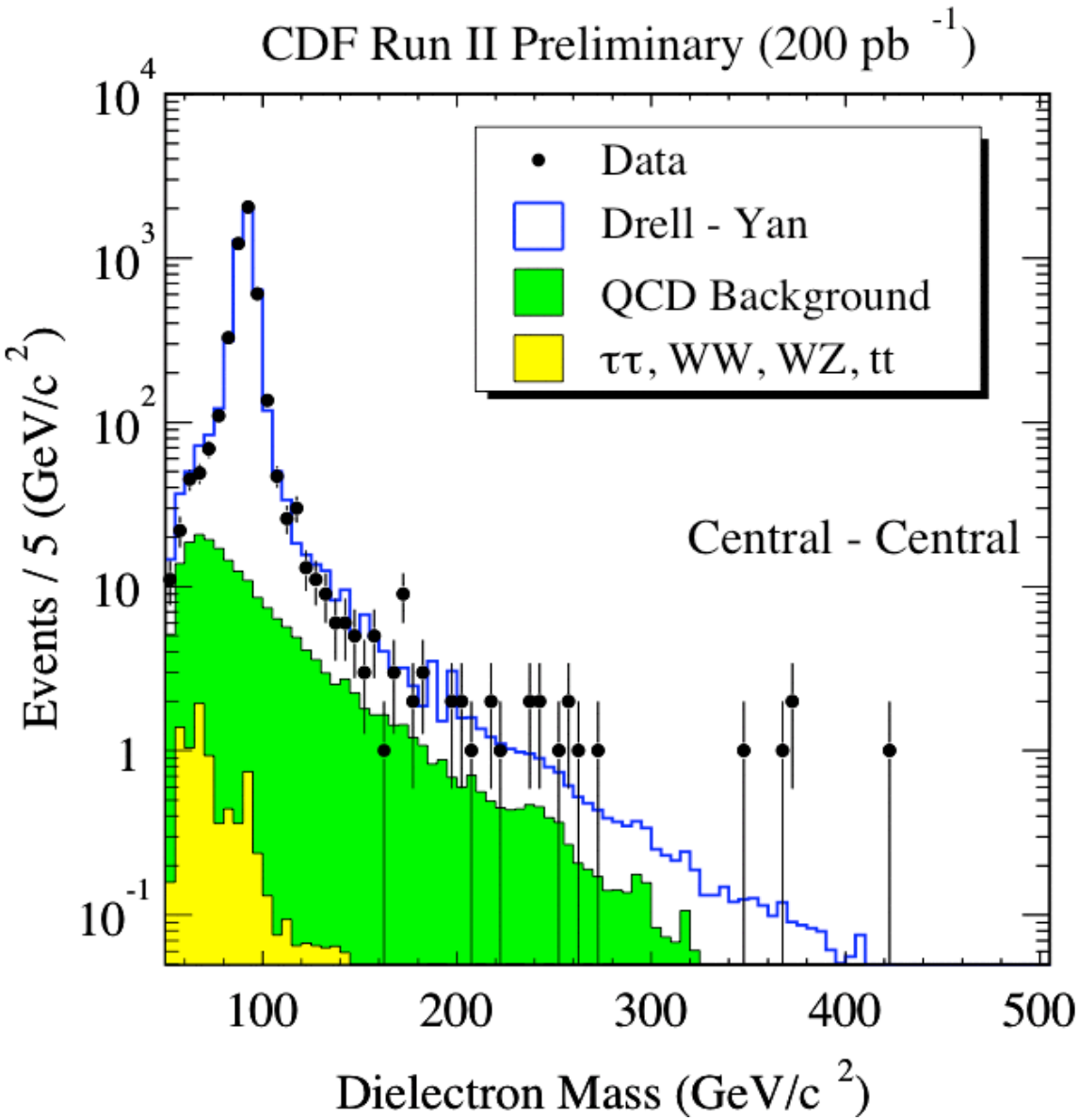

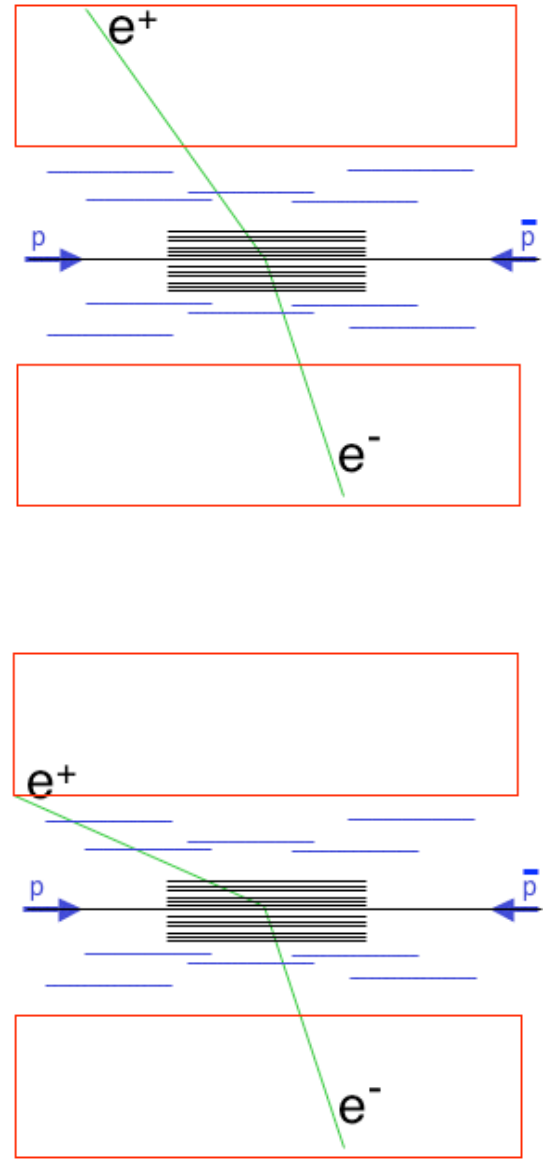

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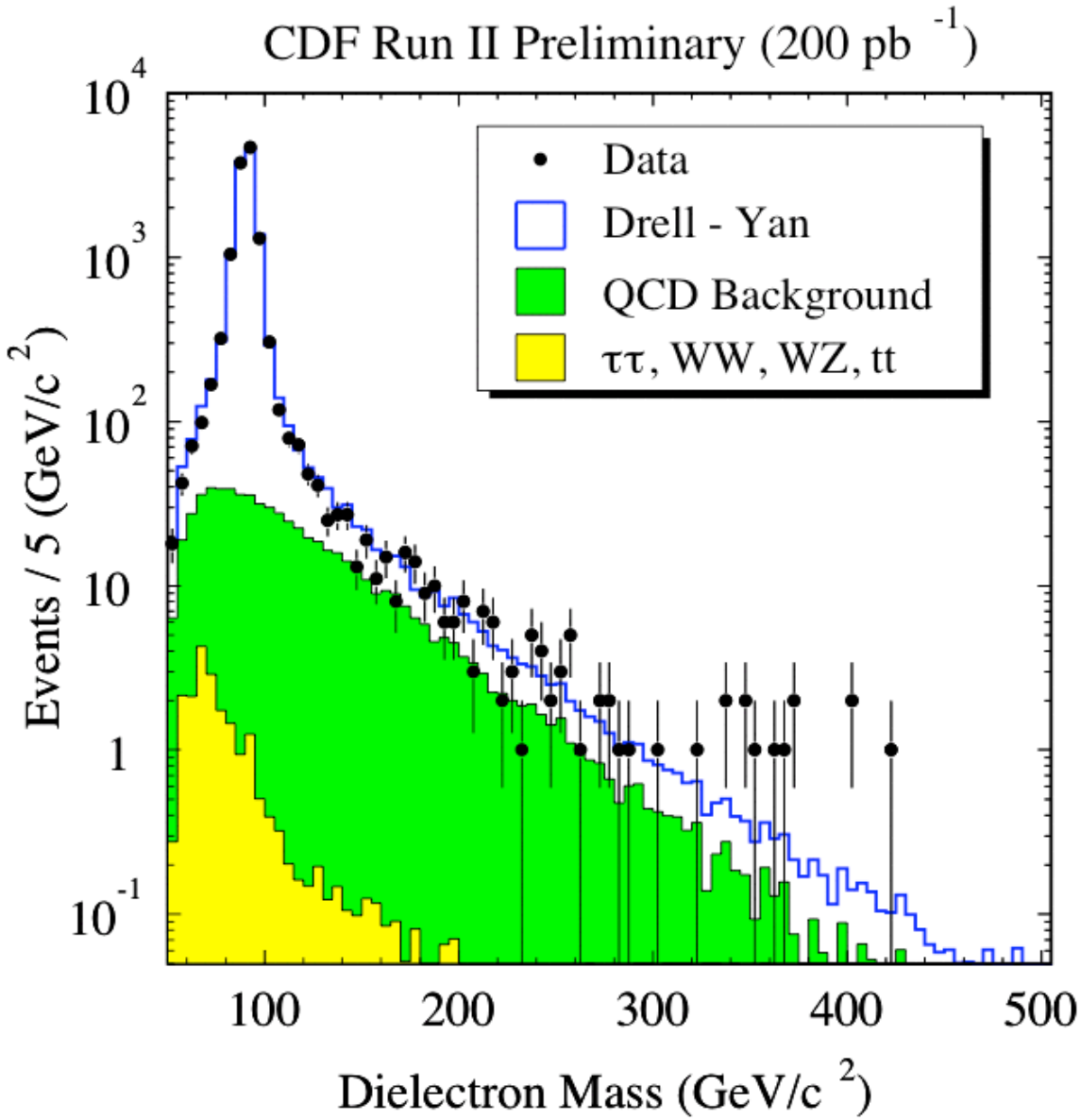

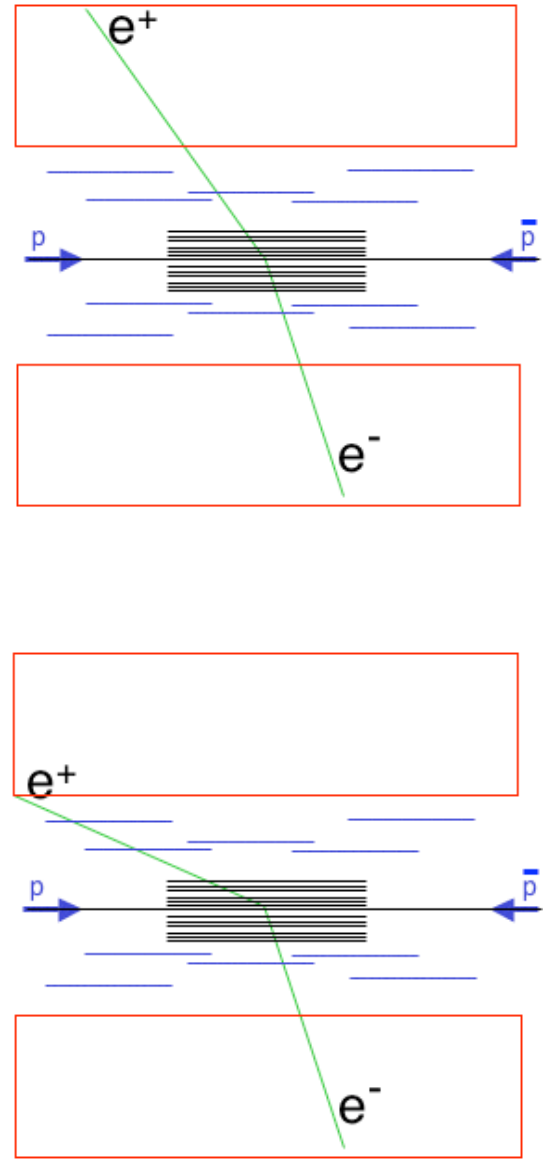

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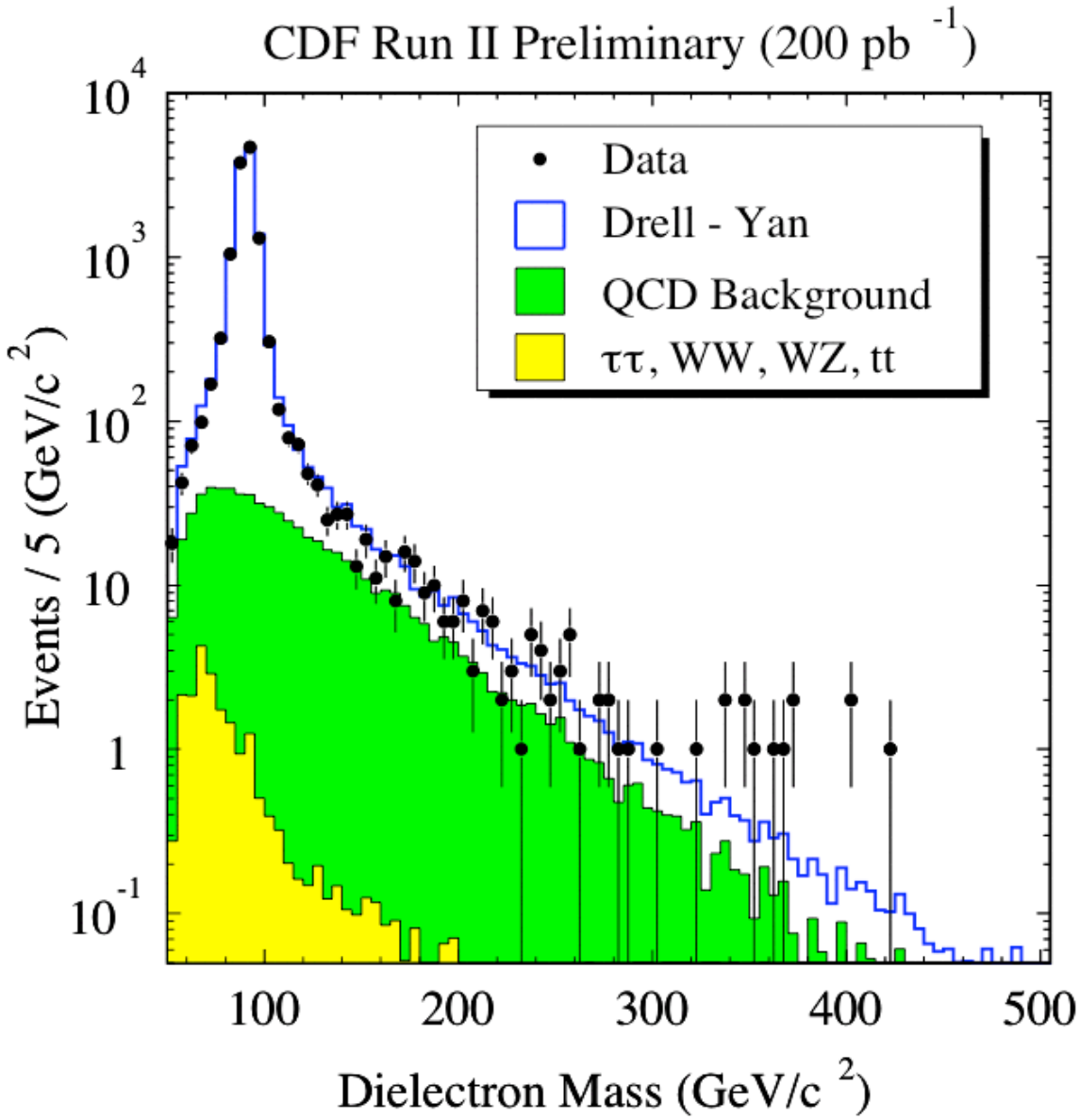

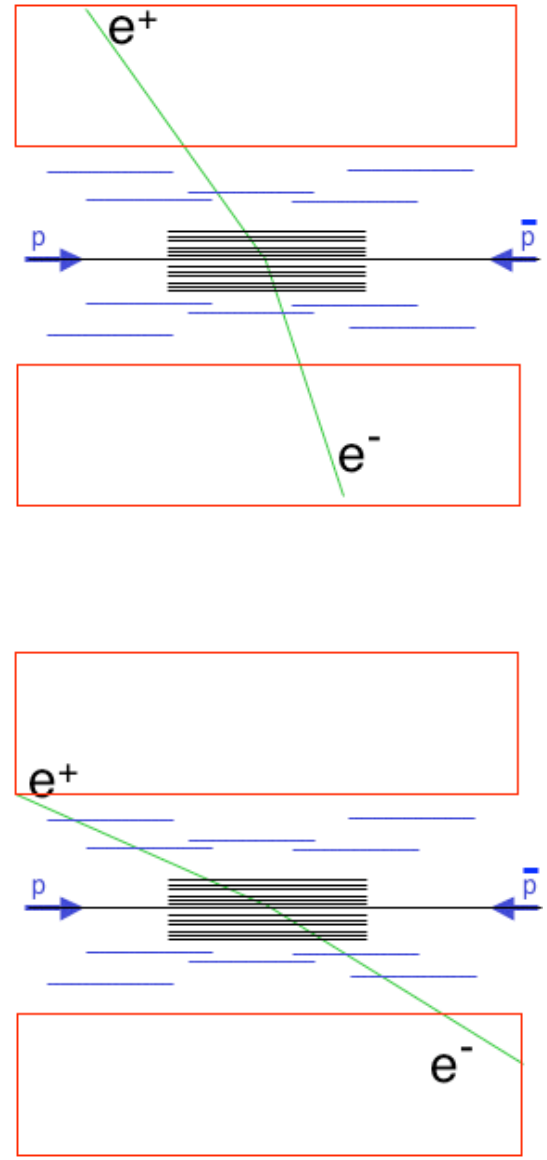

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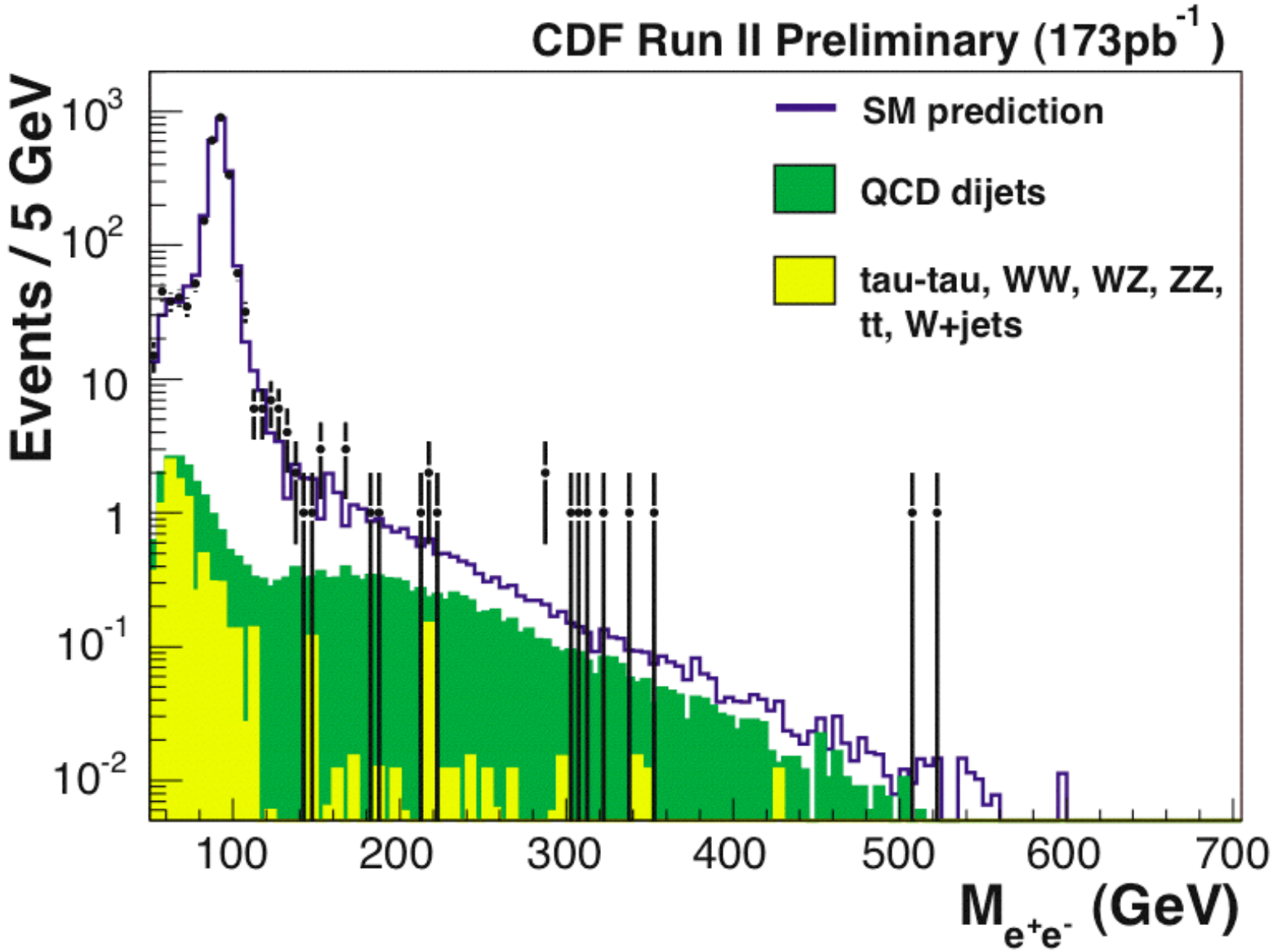

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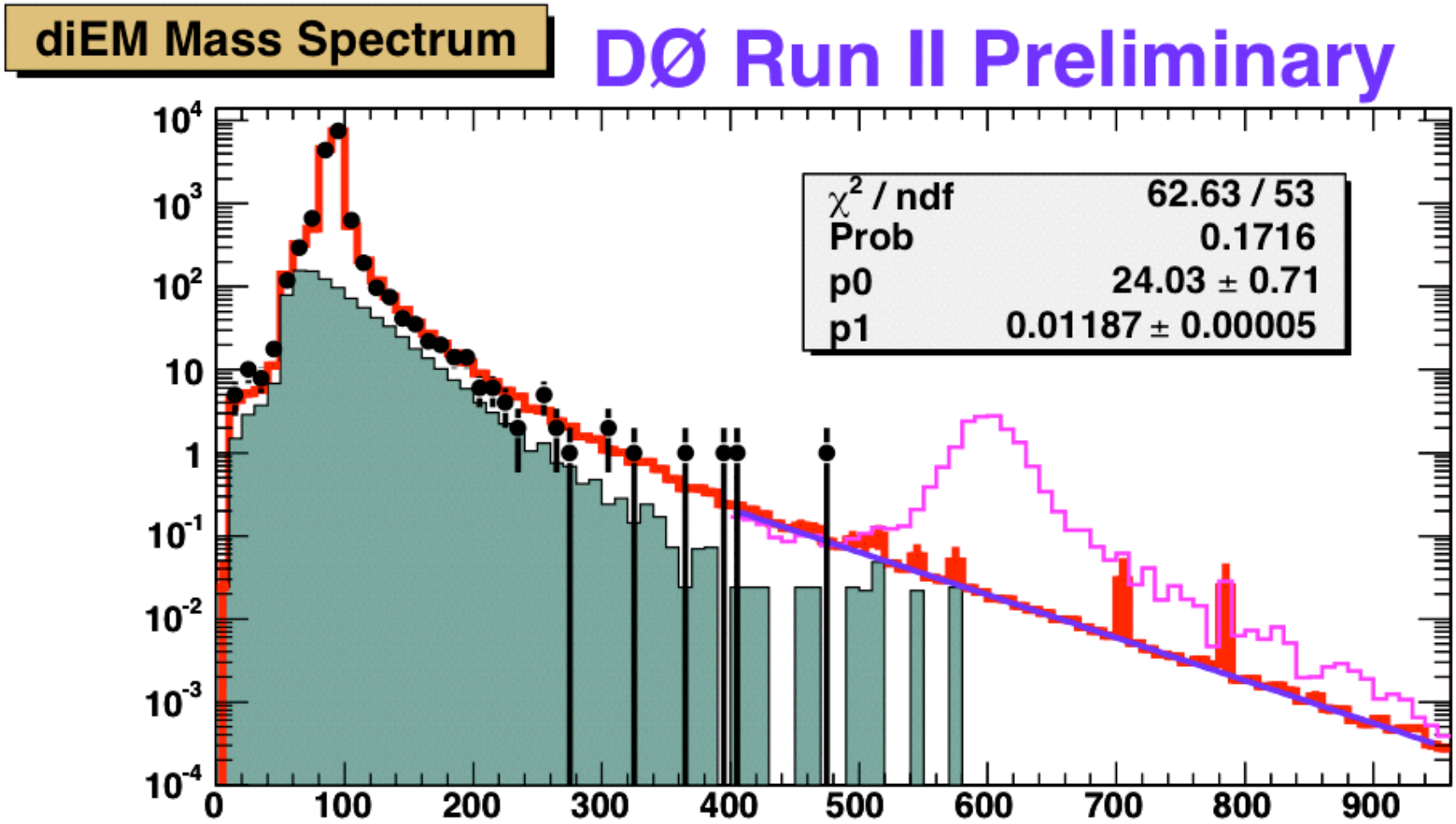

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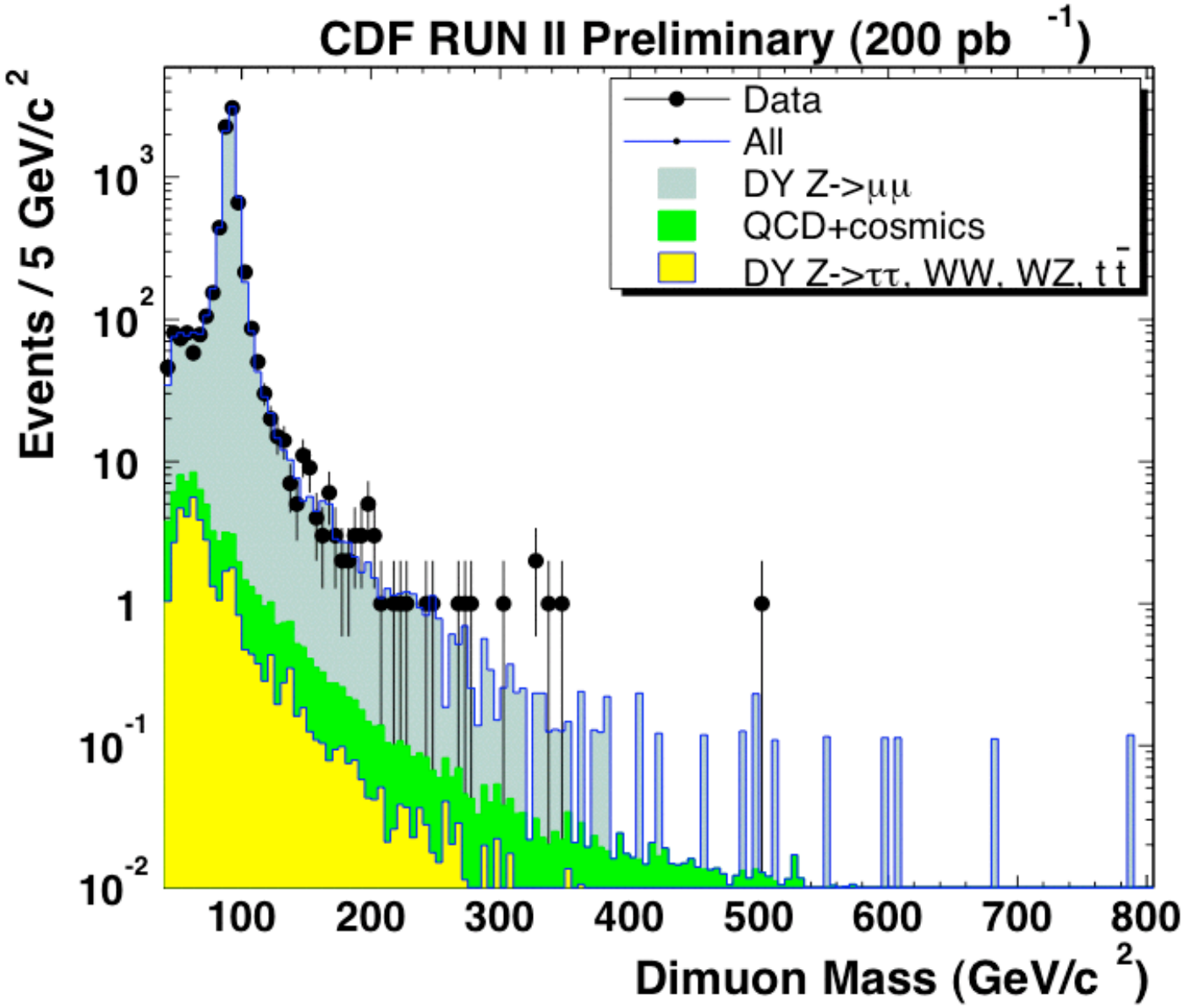

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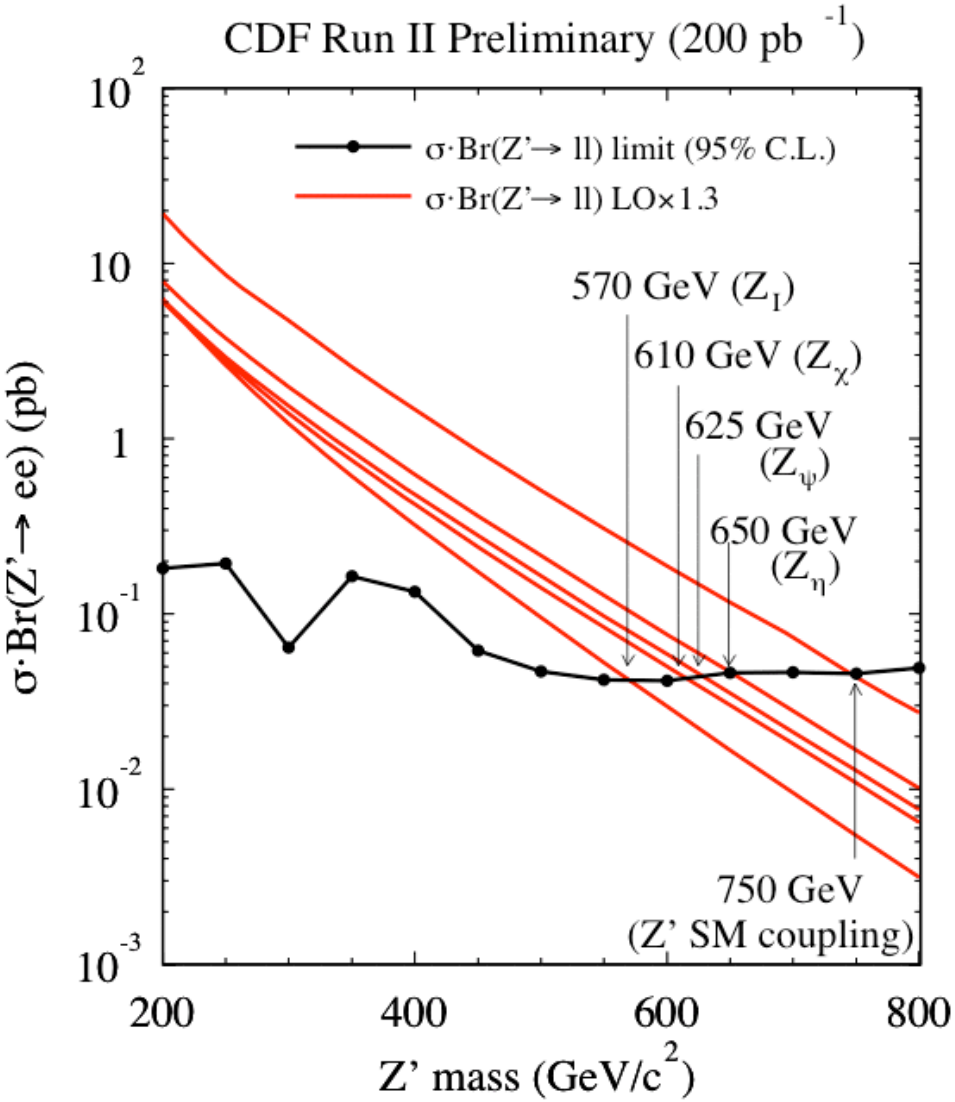
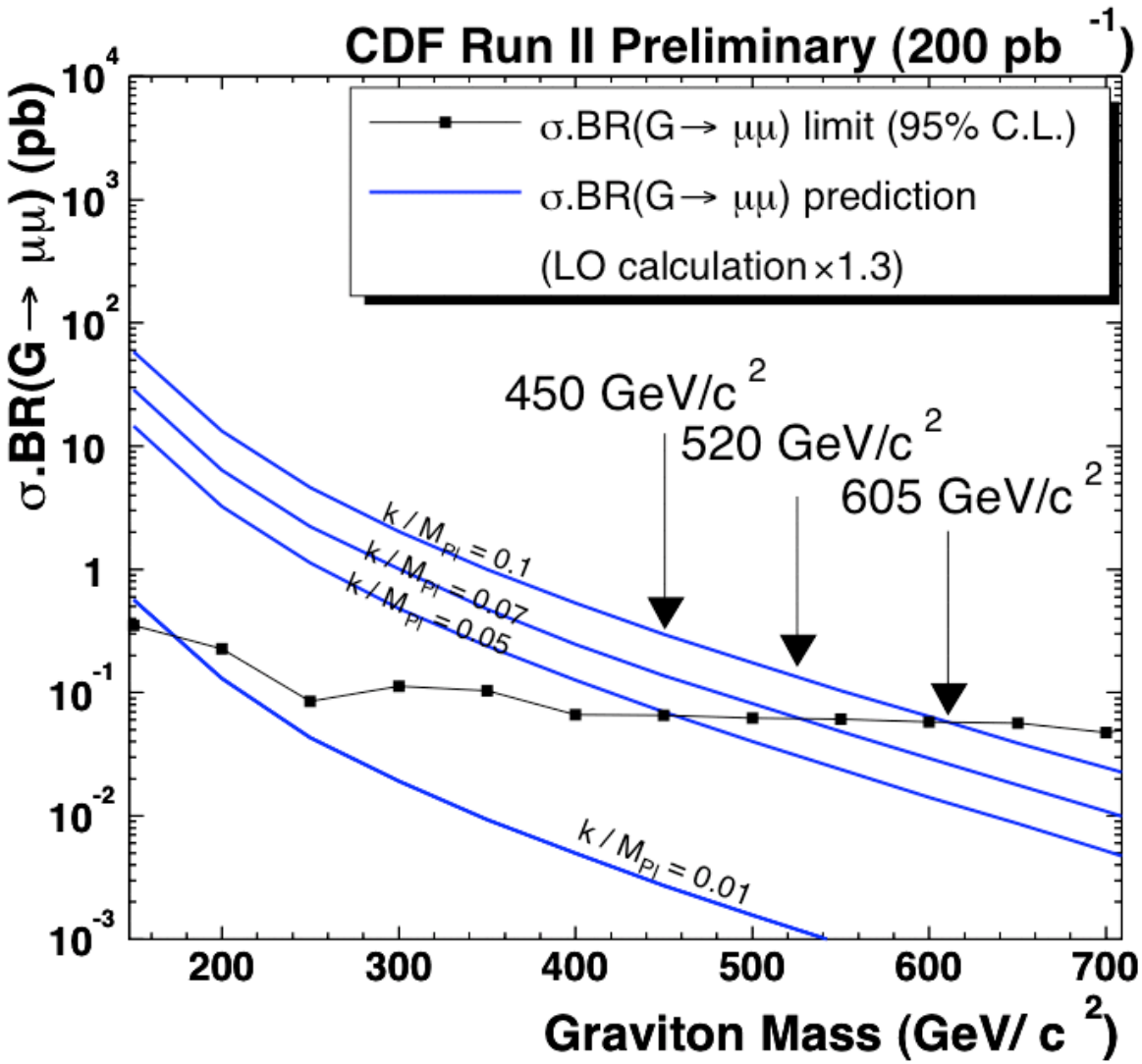


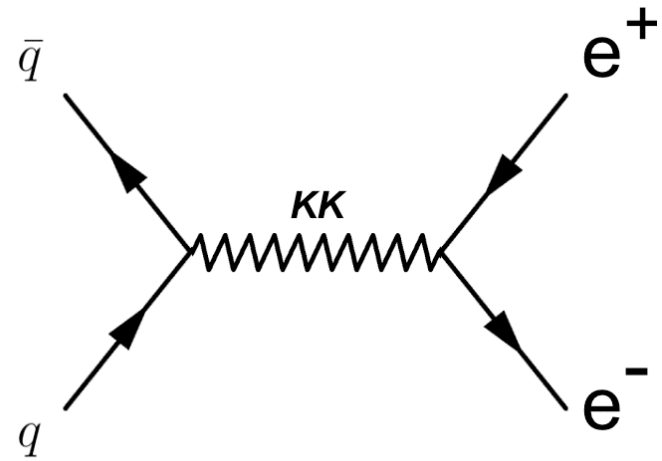
CDF and D0 obtain Z'

σ•Br limits of ≈50 fb

⇒M>750 GeV (with SM couplings)

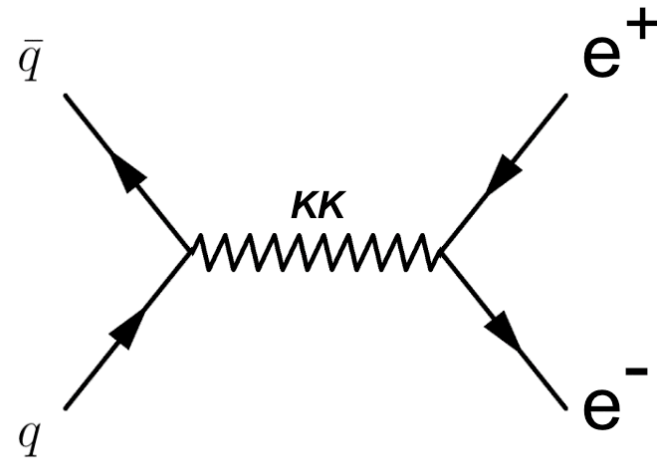
Search for high mass di-leptons

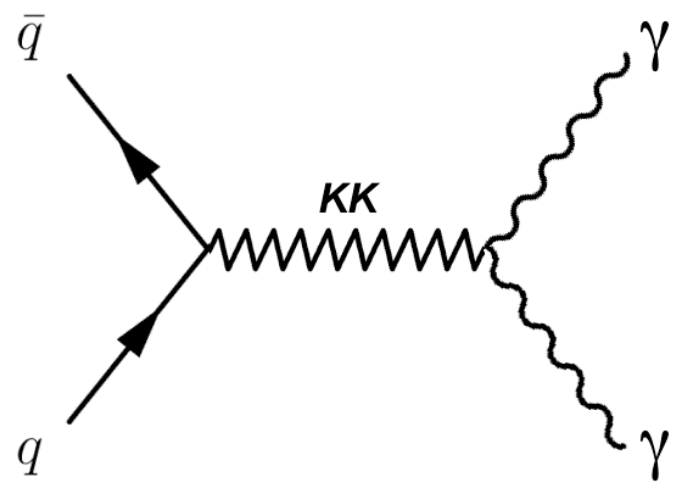




See talk by M.Karagoz Unel Tuesday at 3pm.

Search for high mass e^+e^- and $\gamma\gamma$





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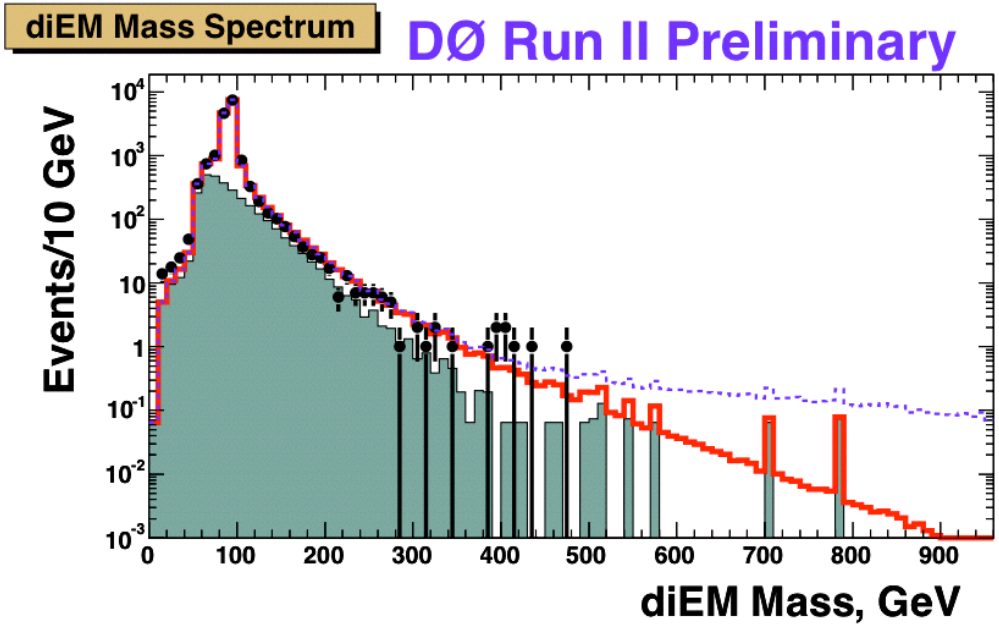
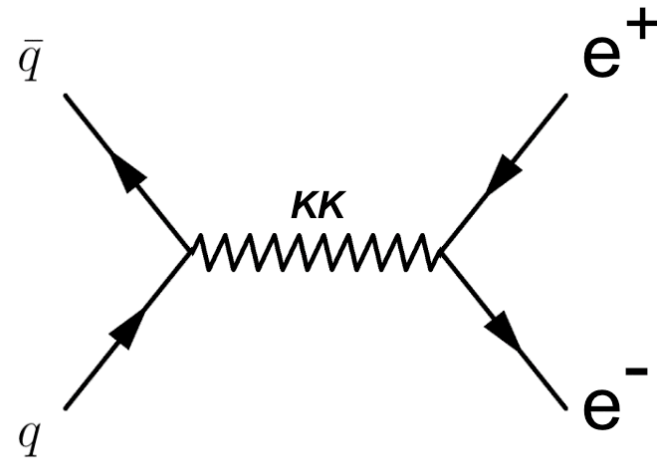
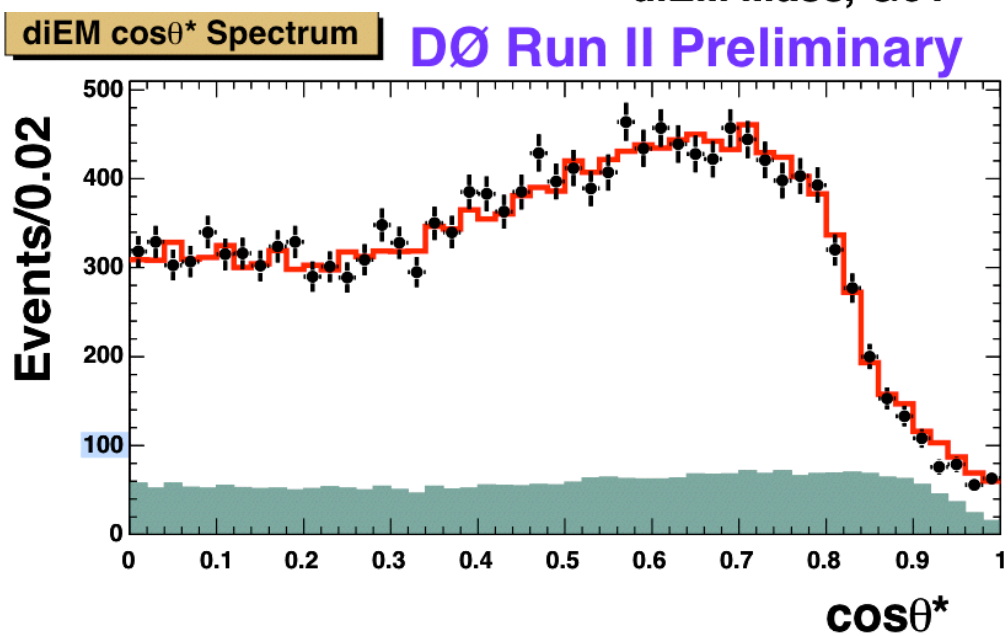
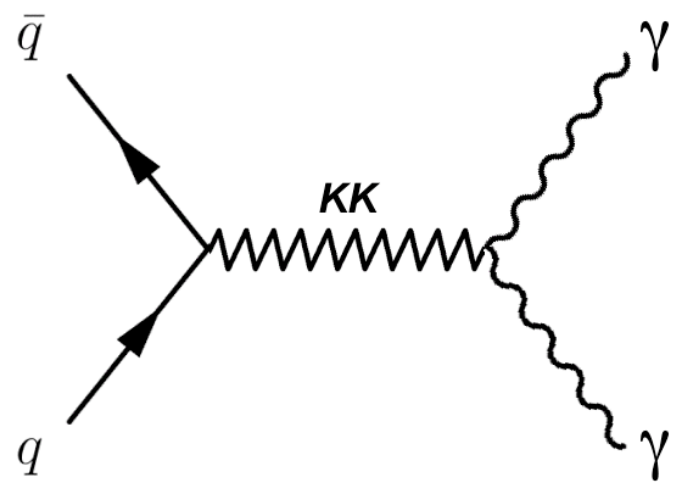






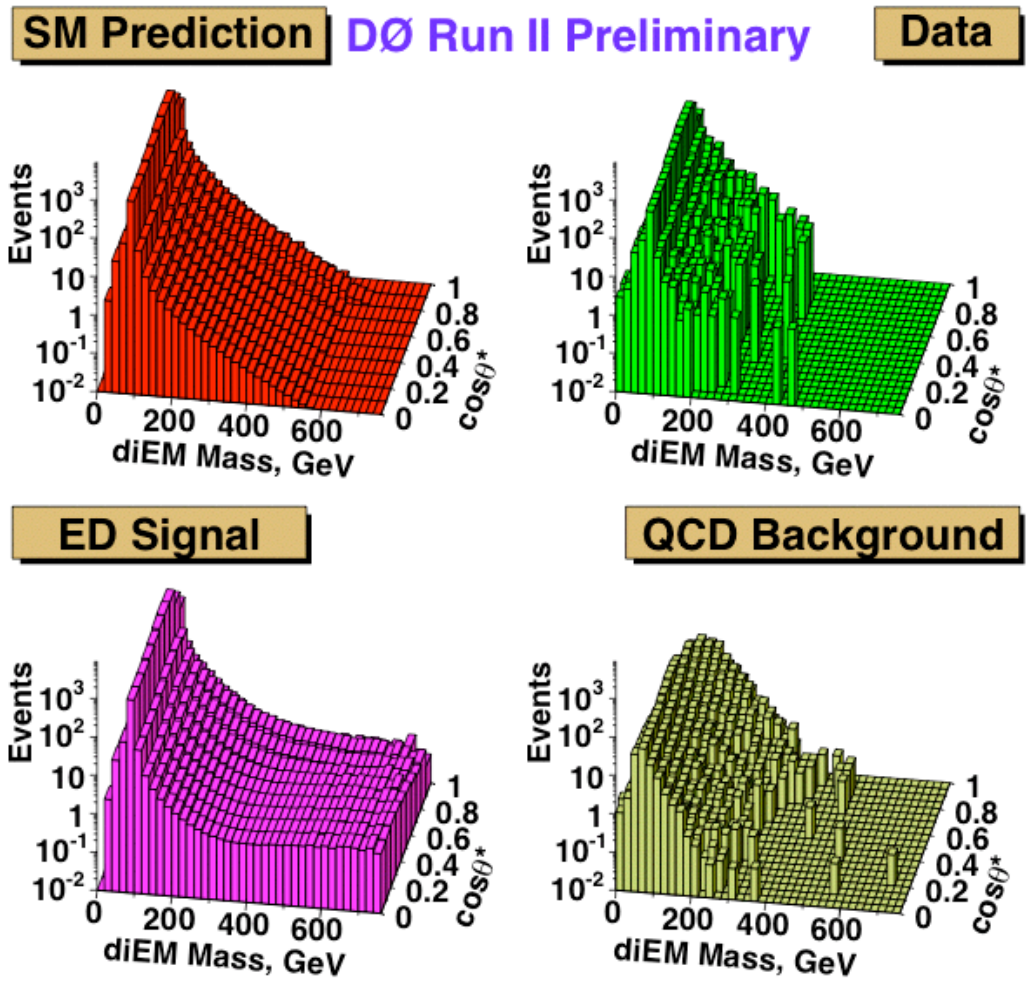


Search for high mass e^+e^- and $\gamma\gamma$

$$\frac{d^2\sigma}{dM\,d\cos\theta^*} = f_{SM} + f_{KK}\,\eta^2 + f_{int}\,\eta$$

$f = f(M, \cos\theta^*)$

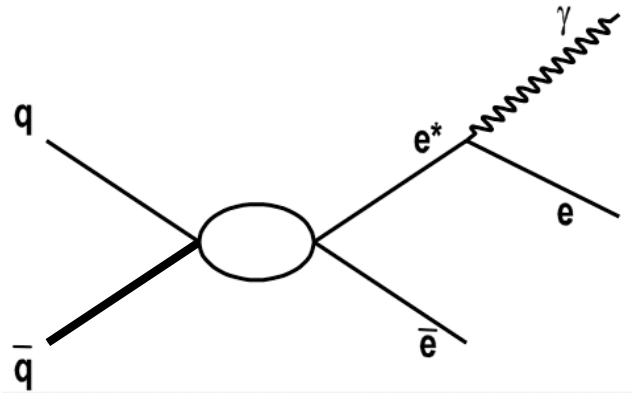
$$\eta = \pm\frac{2}{\pi M_S^4}$$

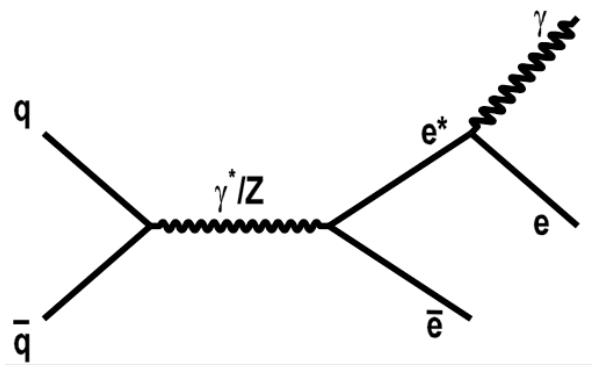


$M_s > 1.22$ TeV (+)

$M_s > 1.10$ TeV (-)

Excited electron search (ee$\gamma\gamma$)





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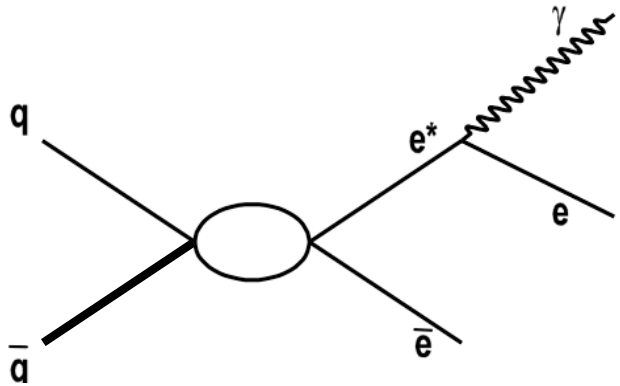
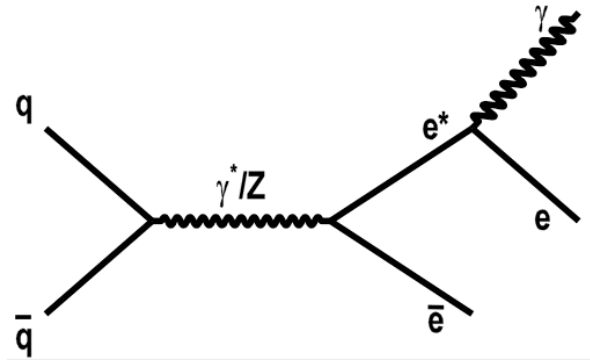
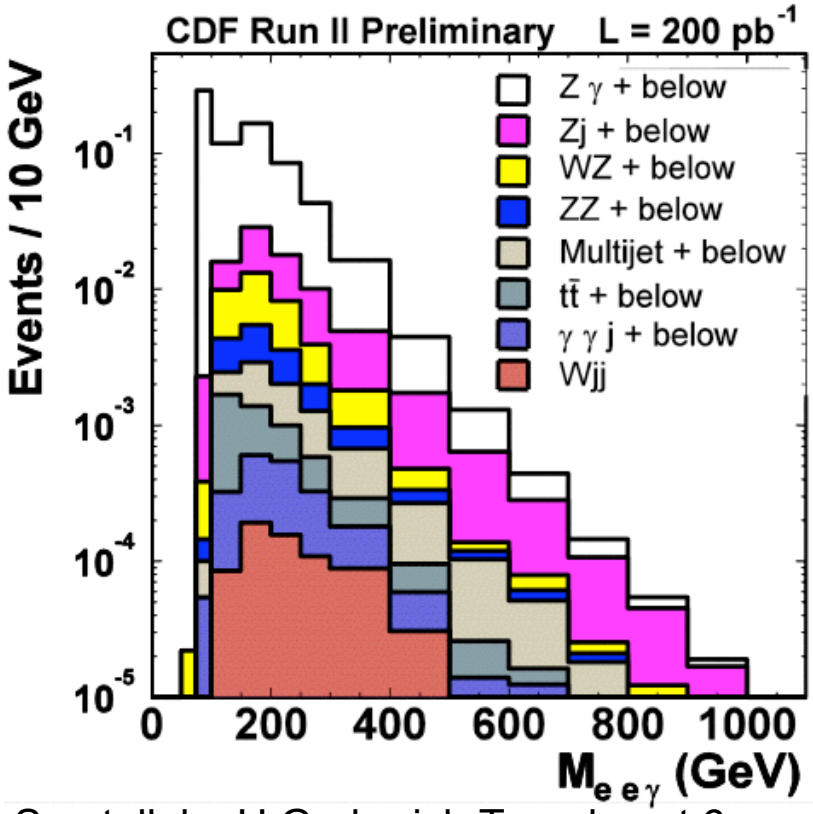
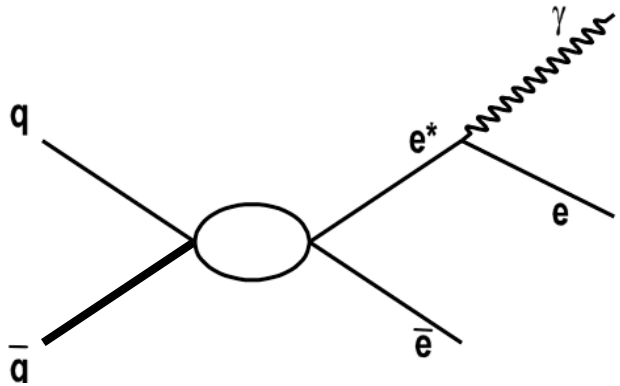


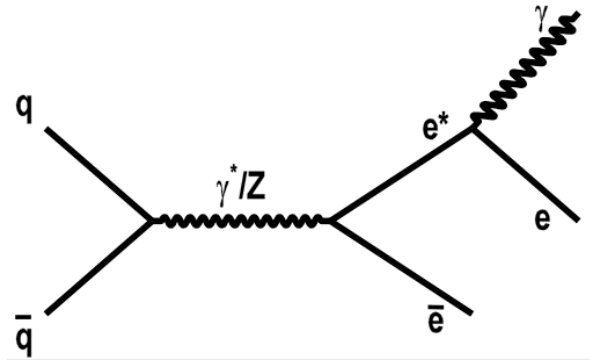


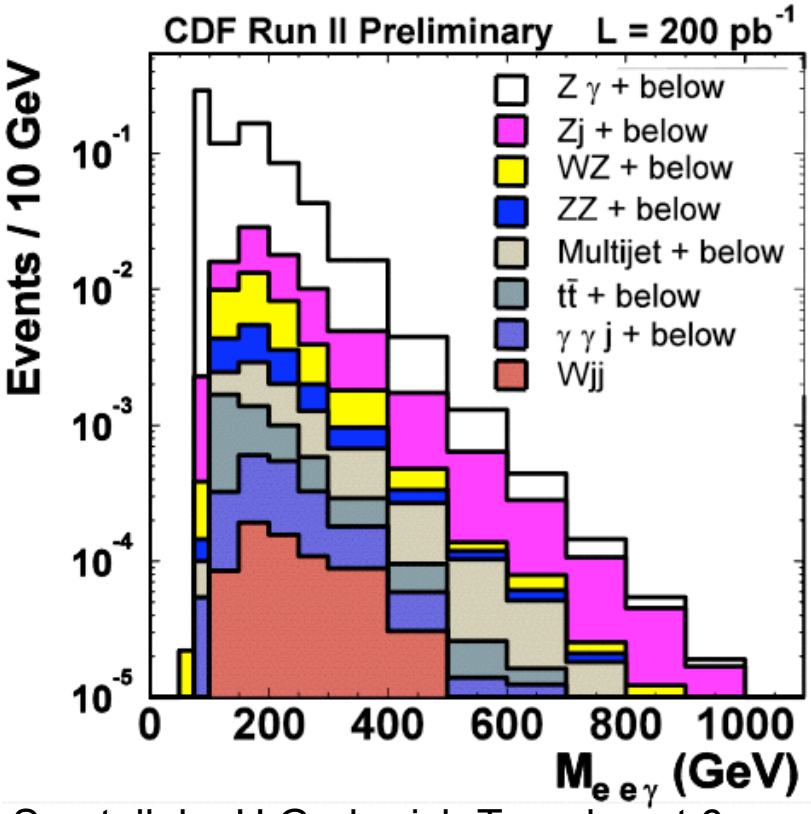


See talk by H.Gerberich Tuesday at 6pm.

Excited electron search (ee$\gamma\gamma$)





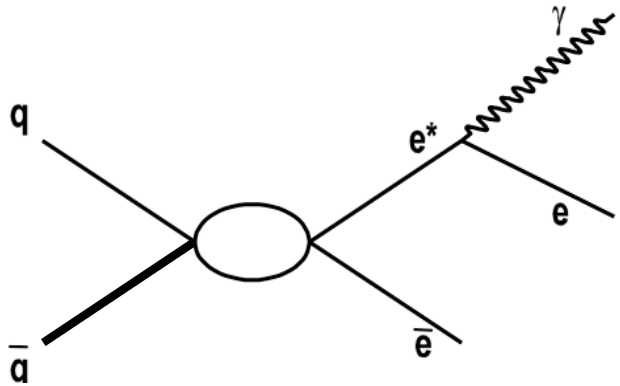


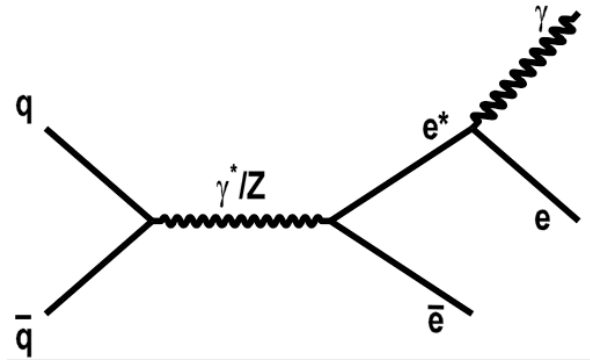
Expect 3 ± 0.4

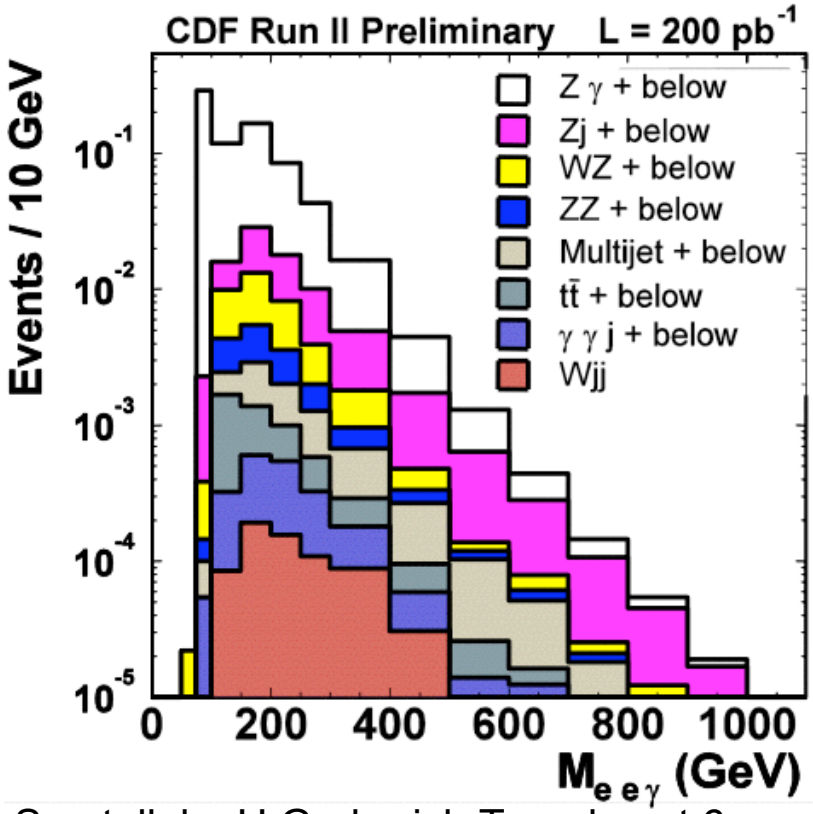
Observe 3

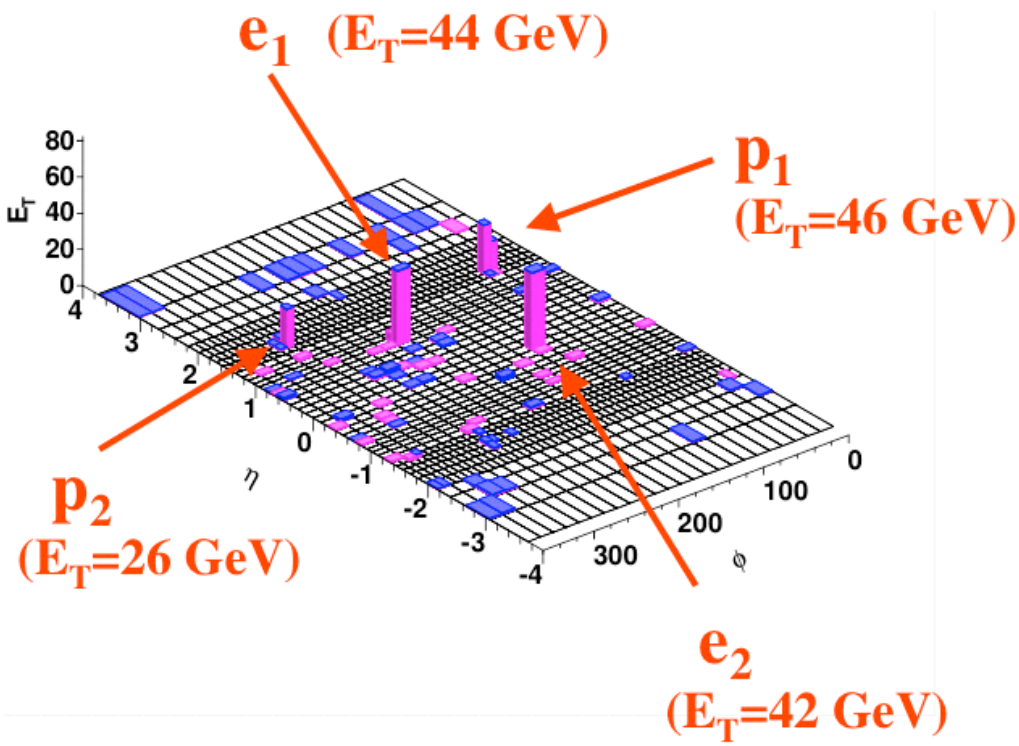
See talk by H.Gerberich Tuesday at 6pm.

Excited electron search (eeγγ)









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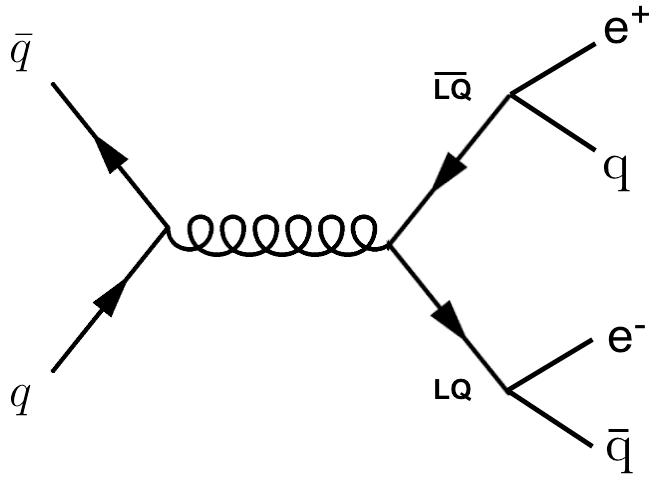
Leptoquark Searches (eejj)



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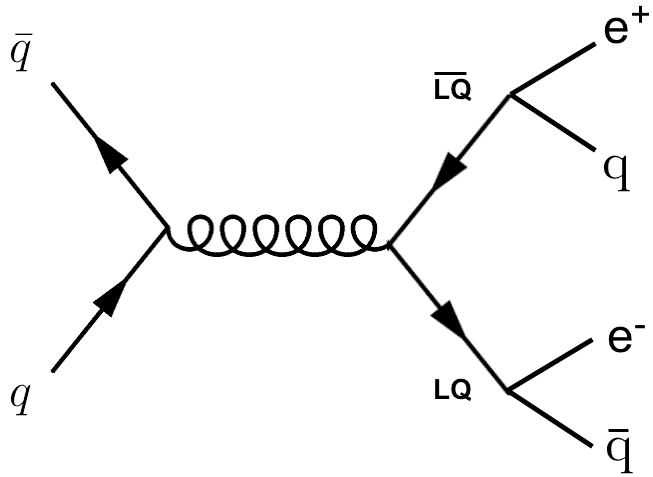
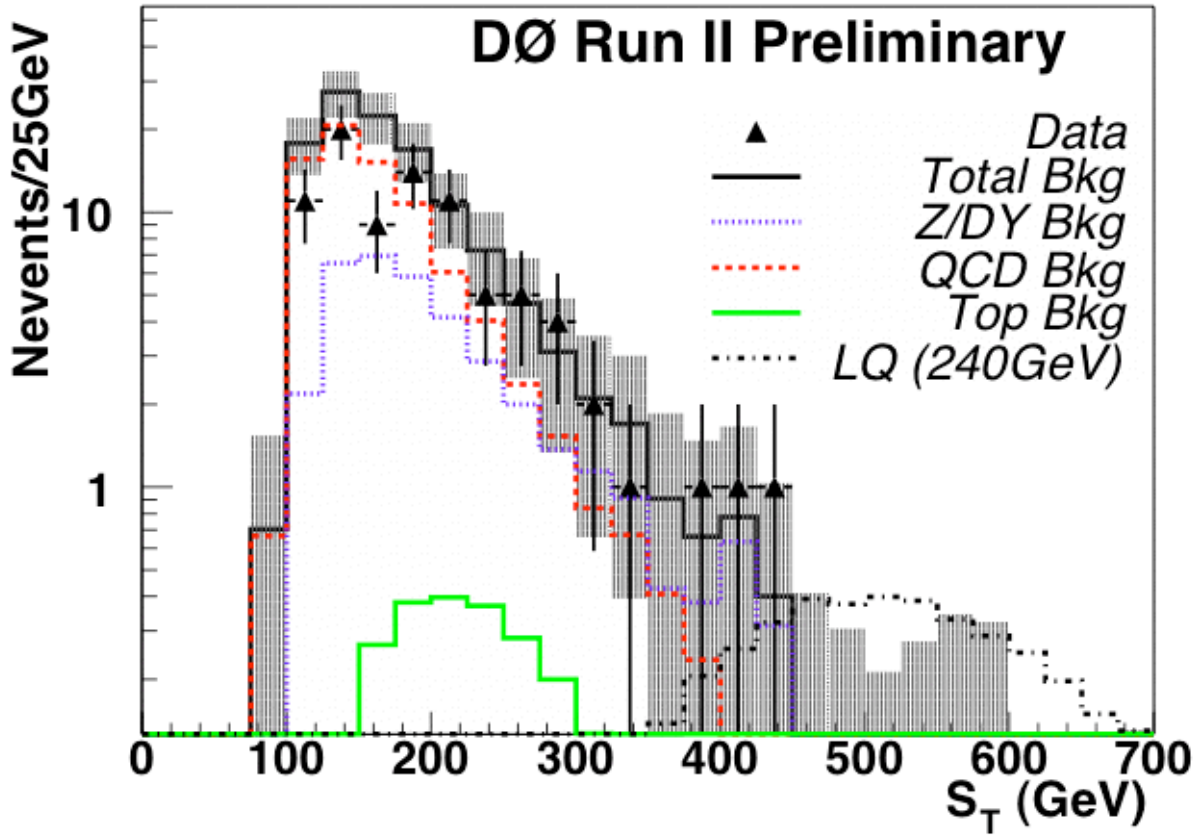
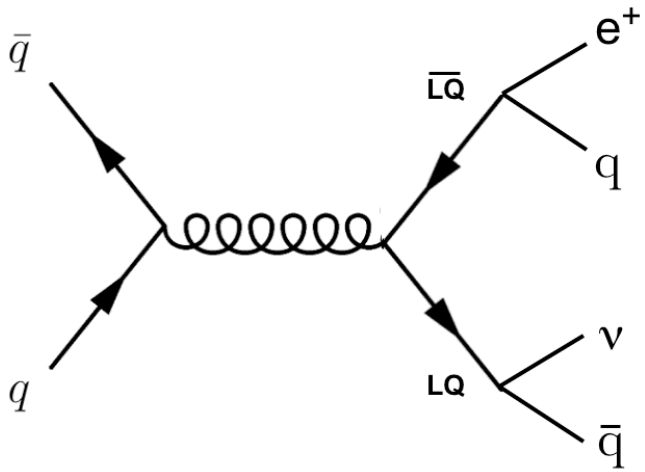


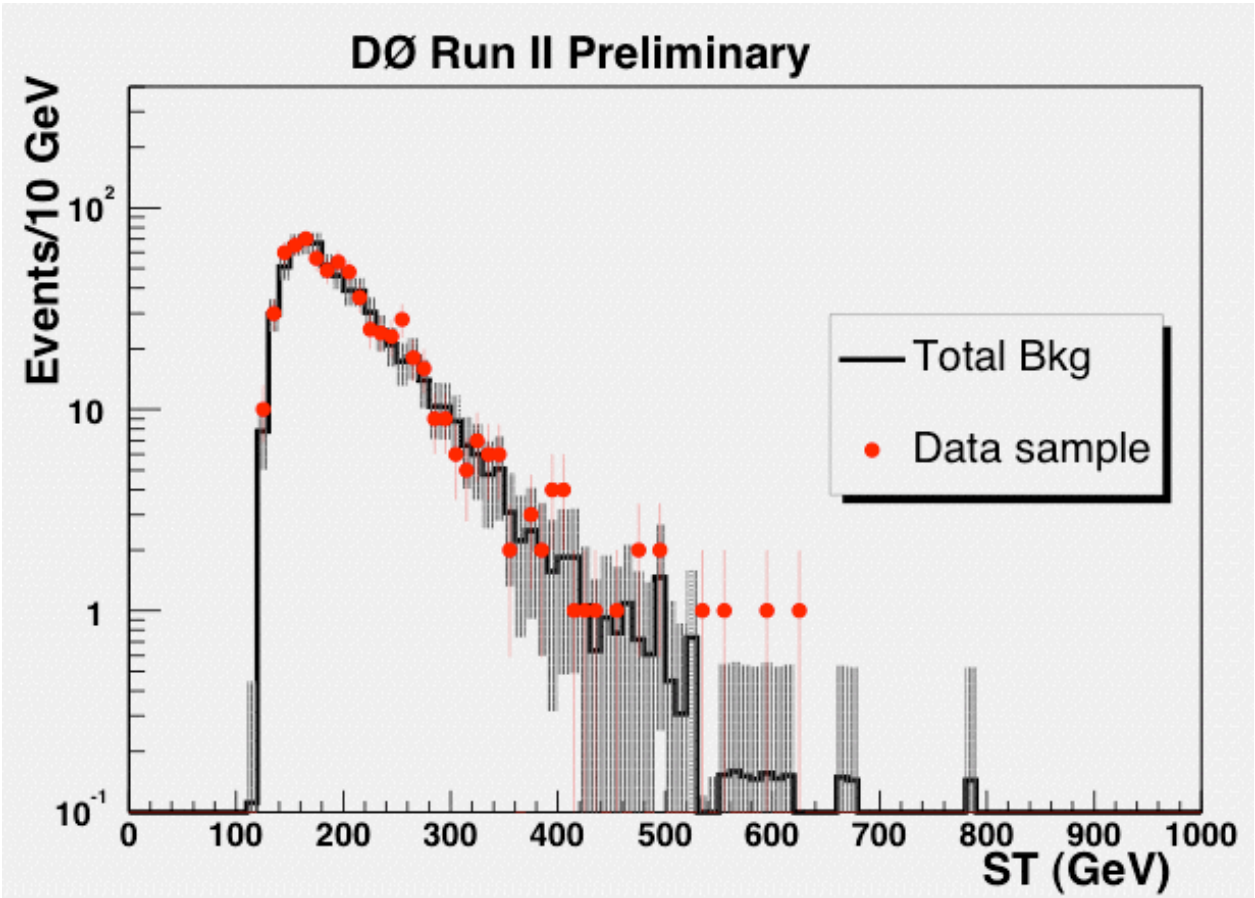


Require Scalar Sum of eejj E_T > 450 GeV

$\sigma \bullet Br < 60$ fb $\Rightarrow$ M > 238 GeV/c^2 if Br(LQ→eq)=1

Leptoquark Searches (eνjj)





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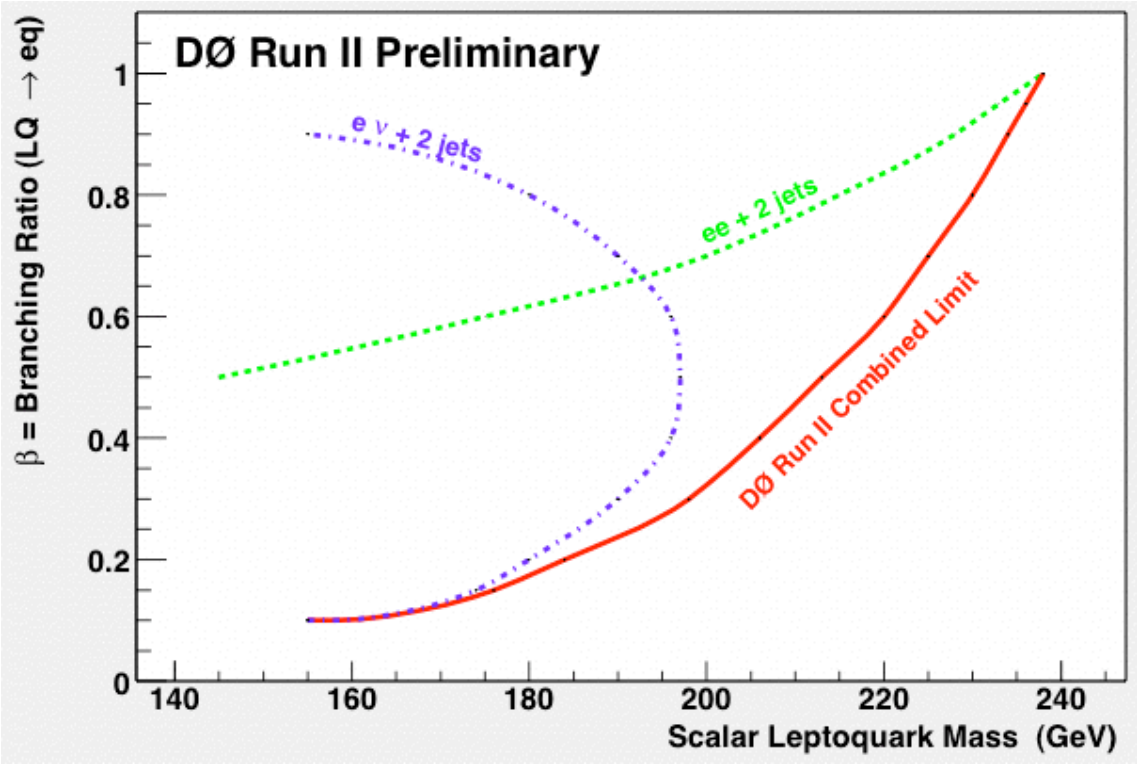

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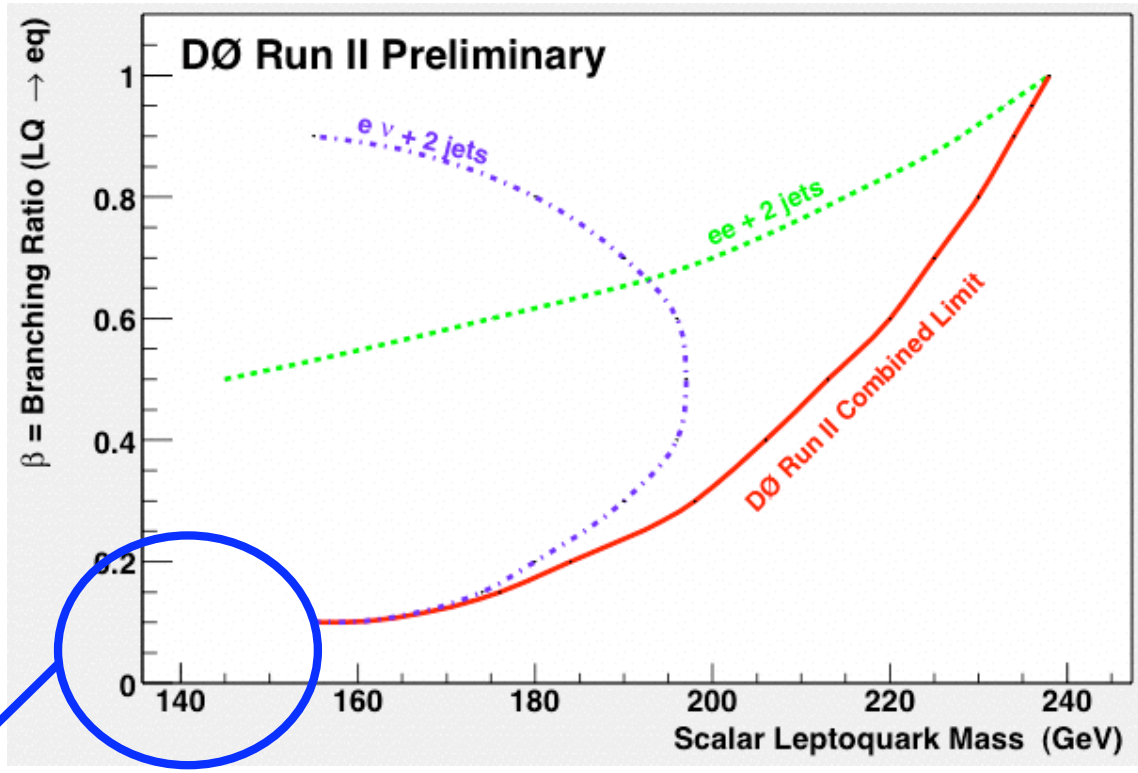
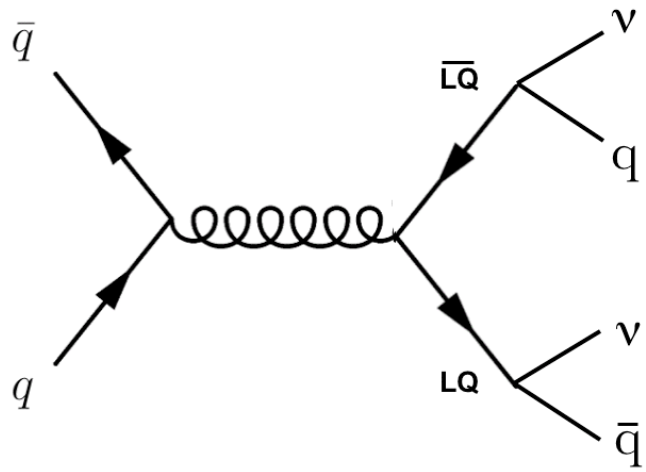


Low β ⇒



⇒ Jets + MET mode

Jets+MET is a classic signature of

<insert currently popular model name here>

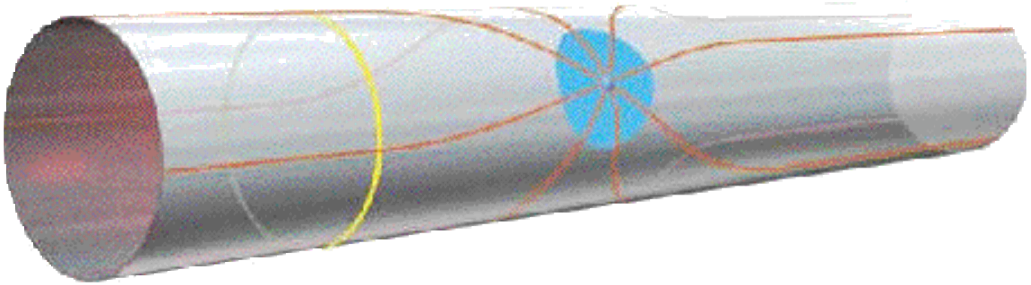
Jets+MET is a classic signature of

Large extra dimensions

Jets+MET is a classic signature of

Large extra dimensions

$$M_{Planck}^2 \sim R^\delta M_{Pl(4+\delta)}^{2+\delta}$$



Jets+MET is a classic signature of

Large extra dimensions

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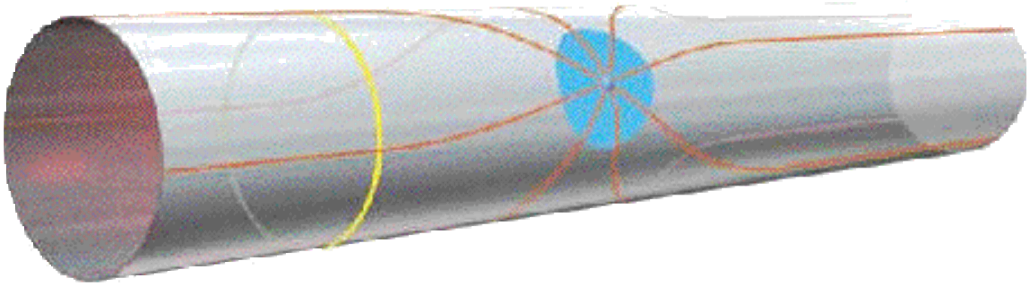

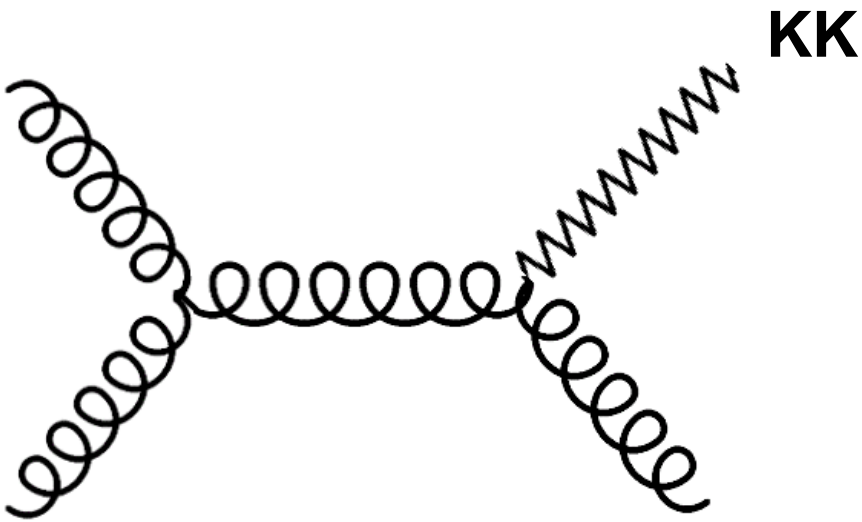

Jets+MET is a classic signature of

Supersymmetry

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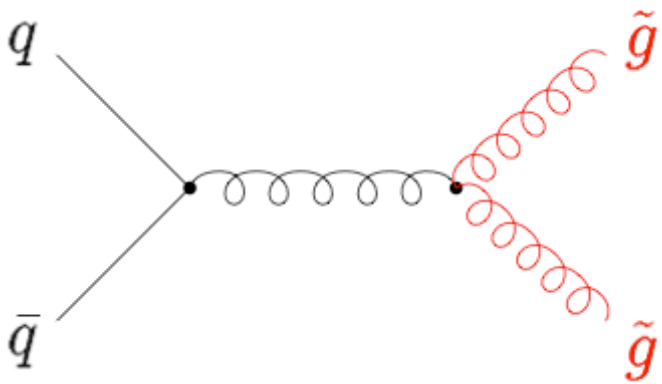

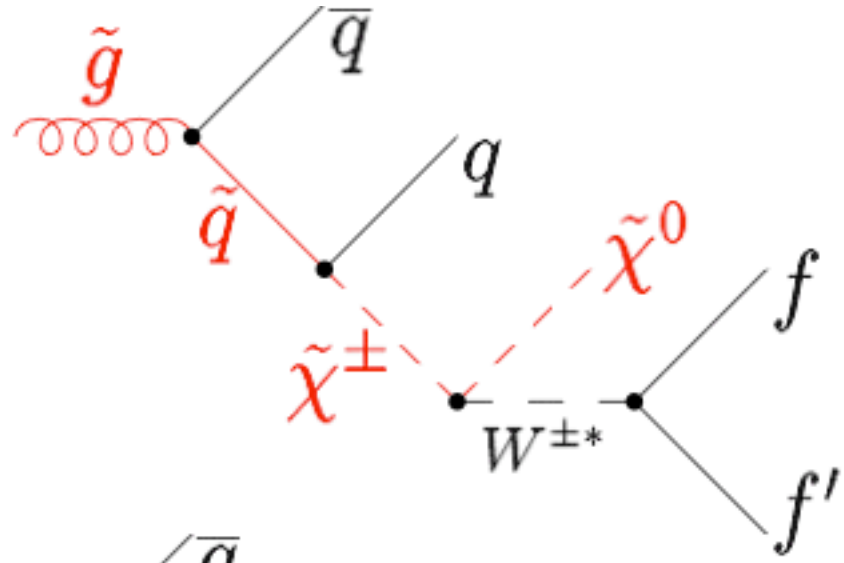

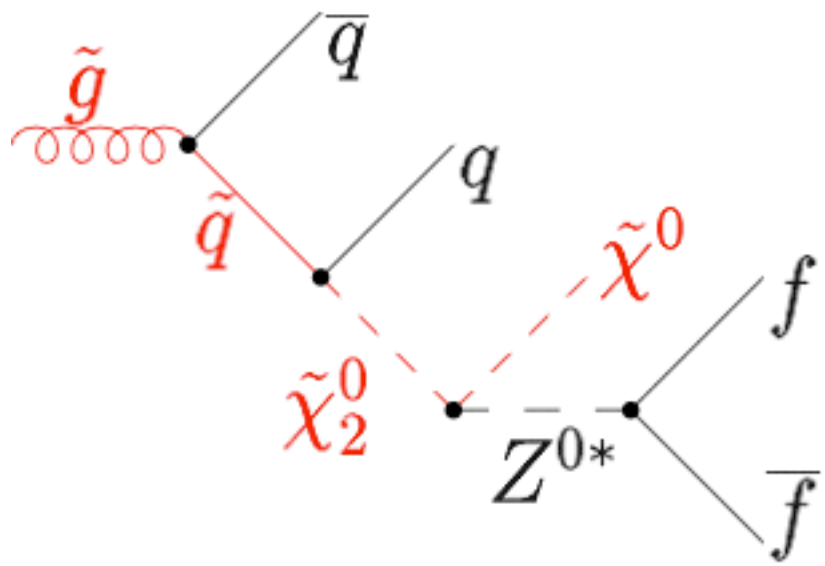

Jets+MET is a classic signature of

Quantum Chromodynamics

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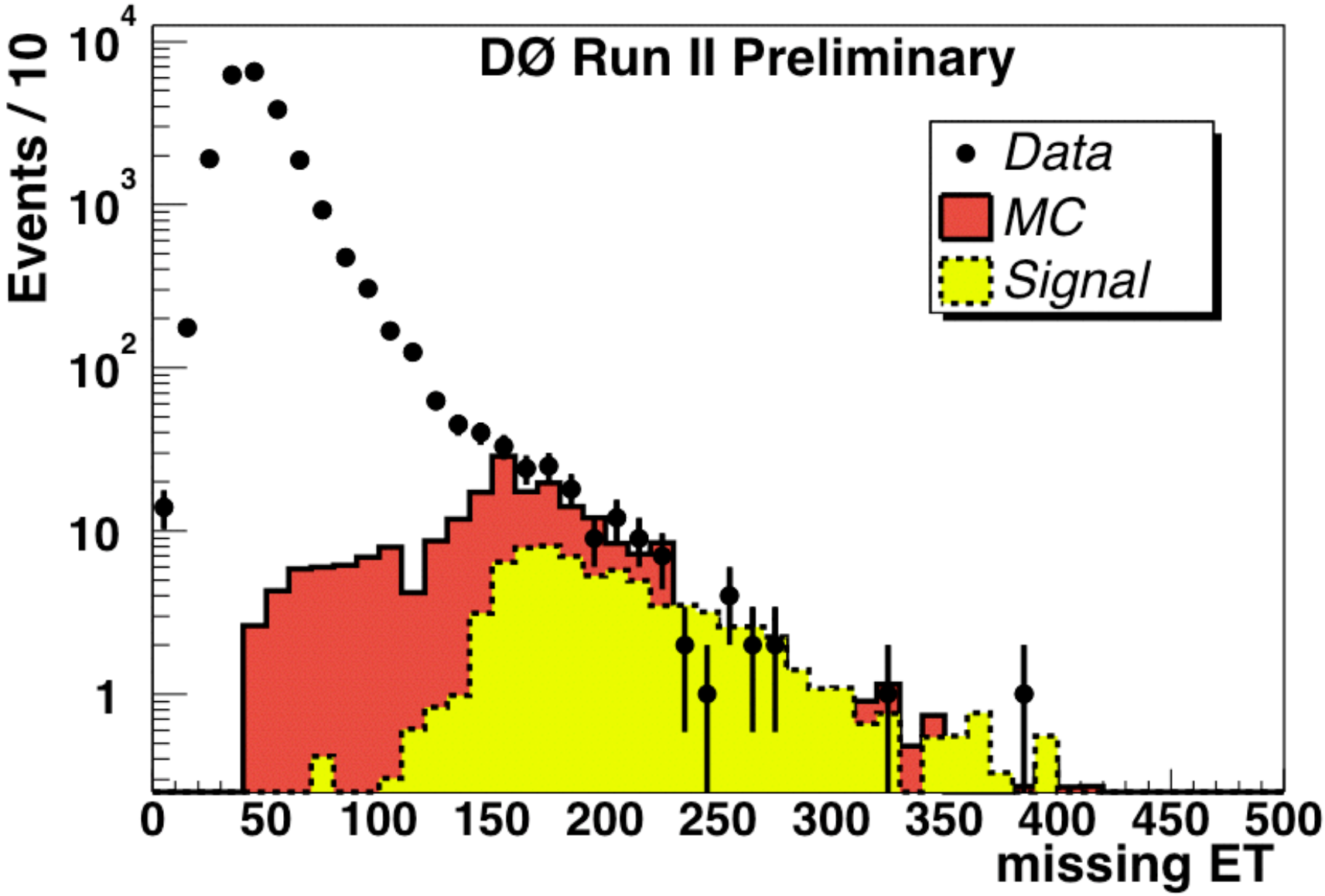
Quantum Chromodynamics



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QCD or beam splash or cosmics

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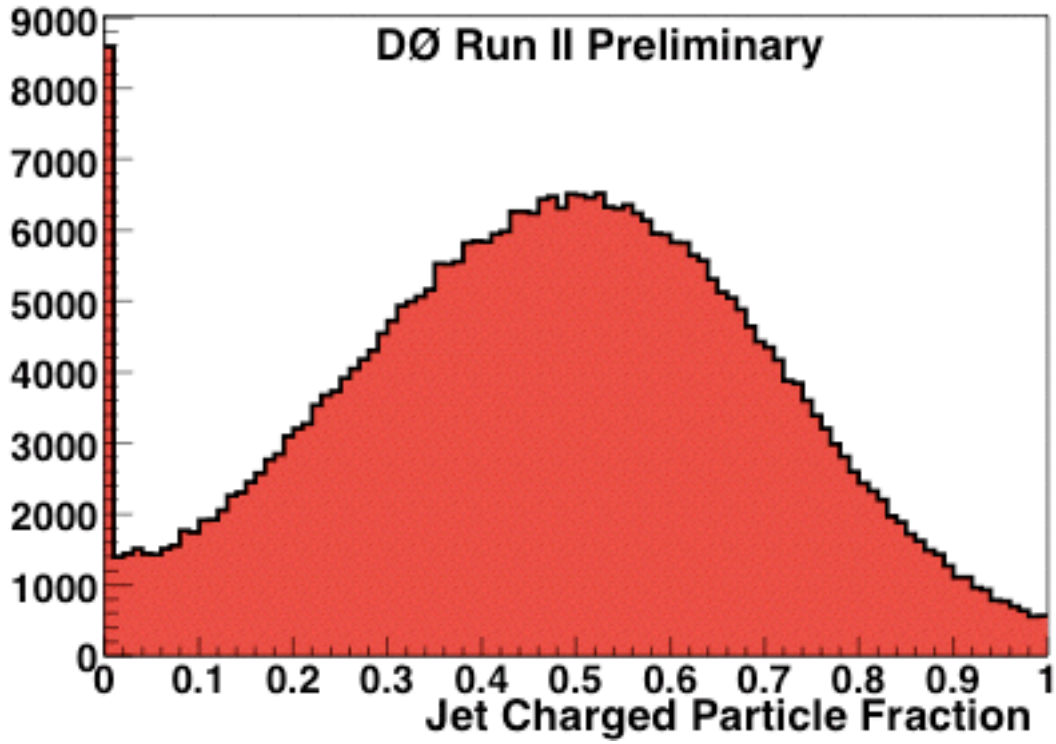
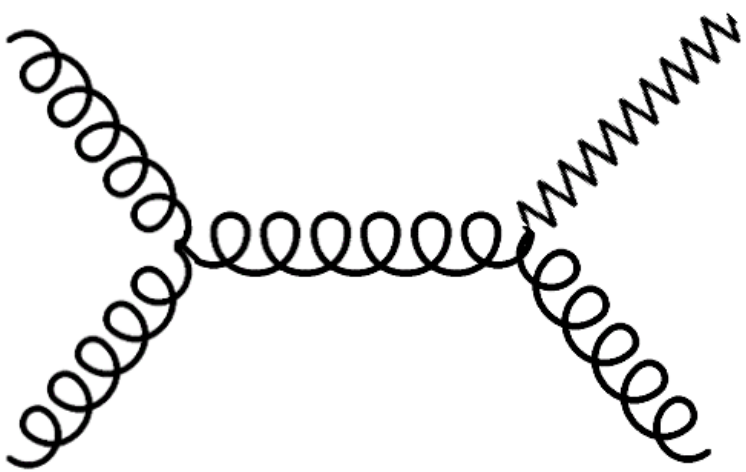


Confirm with track jets

Calorimeter timing cuts

Veto e and mu

Mono-Jets+MET results



KK

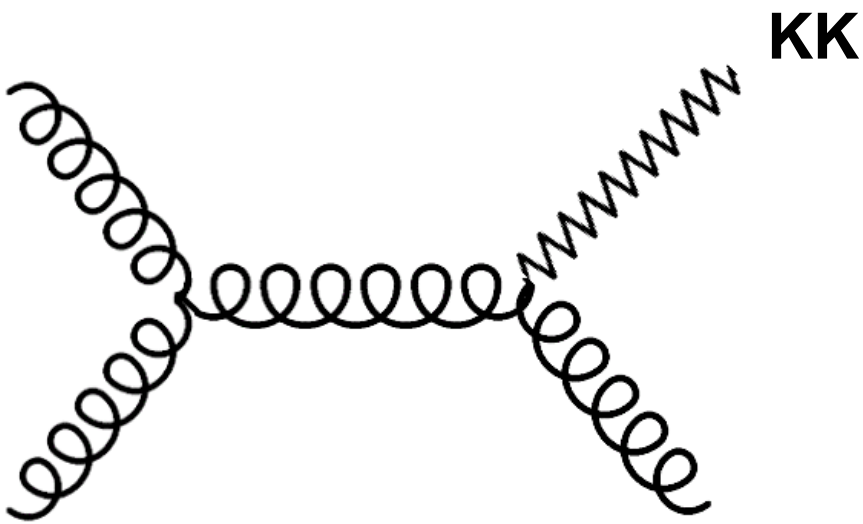
$E_T > 150$ GeV

no 2nd jet with $E_T > 50$ GeV

$\not{E}_T > 150$ GeV

$\Delta\phi > 30^o$

Mono-Jets+MET results



$E_T > 150$ GeV

no 2nd jet with $E_T > 50$ GeV

$\not{E}_T > 150$ GeV

$\Delta\phi > 30^o$

Predictions dominated by EWK backgrounds

$Z \rightarrow \nu\nu$ + jet

$W \rightarrow \tau\nu$ + jet

Signal shape is indistinguishable from background.

Mono-Jets+MET results

Predict 100 ± 10 Stat & $\delta\sigma$

Mono-Jets+MET results

Predict 100 ± 10 Stat & $\delta\sigma$

Observe 63

Mono-Jets+MET results

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Jet Energy scale is also a significant systematic on background and signal.

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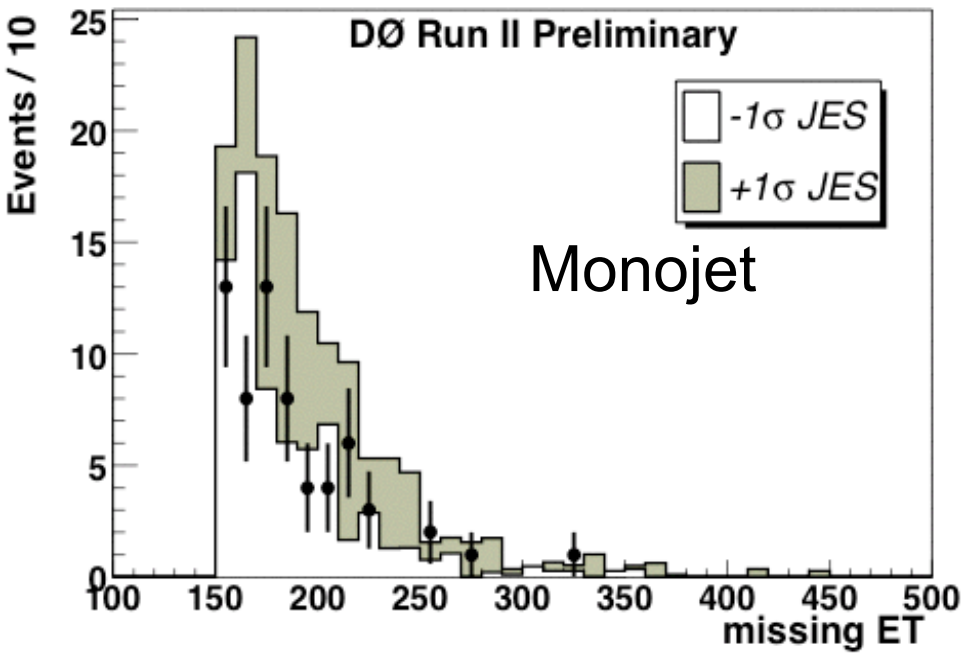

Mono-Jets+MET results

Predict 100 ± 10 Stat & $\delta\sigma$

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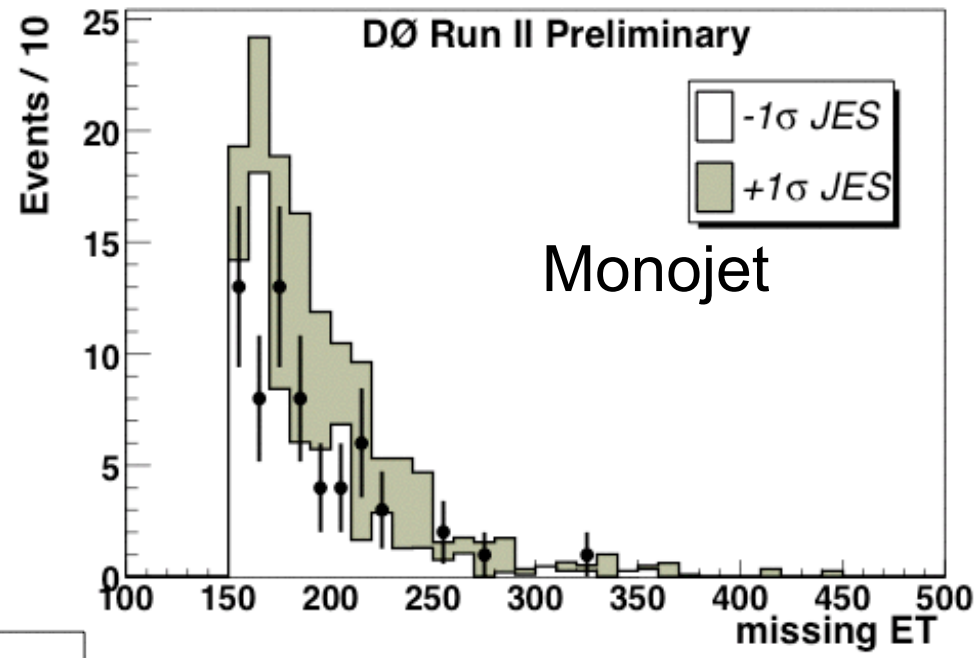
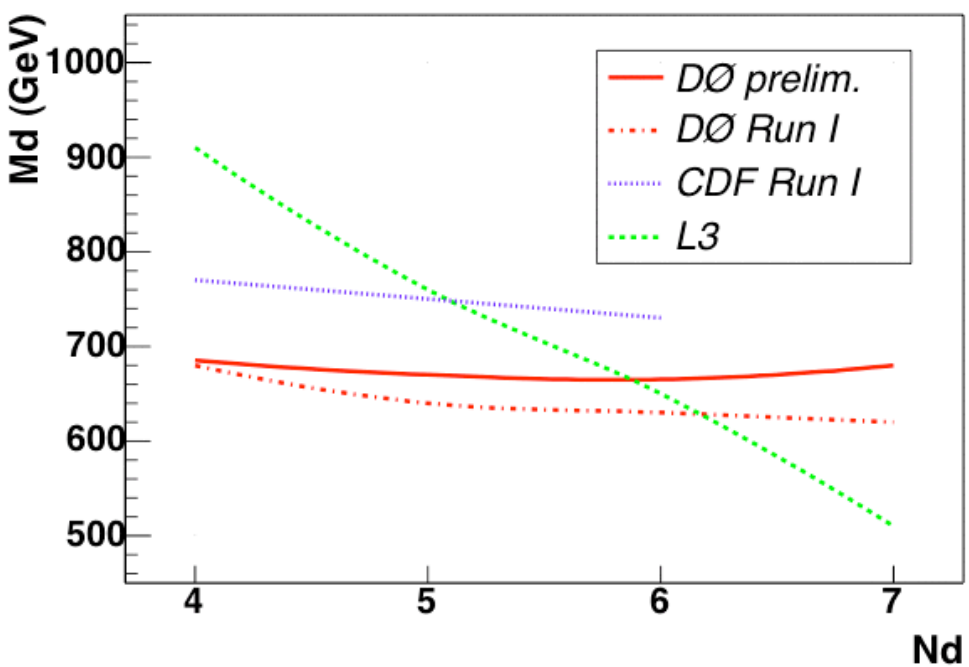
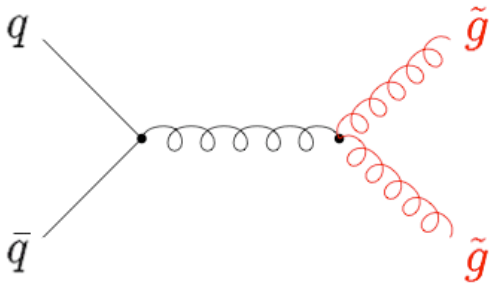
Jet Energy scale is also a significant systematic on background and signal.





Obtain limits of ≈700 GeV

Di-Jets+MET results



$E_{T1} > 60$ GeV, $E_{T2} > 50$ GeV

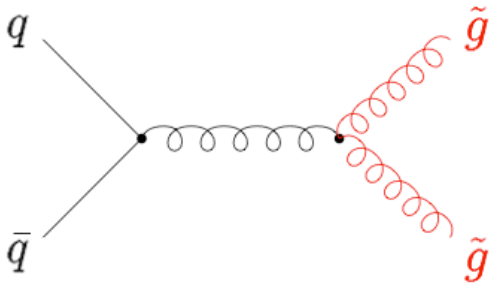
Veto e and μ

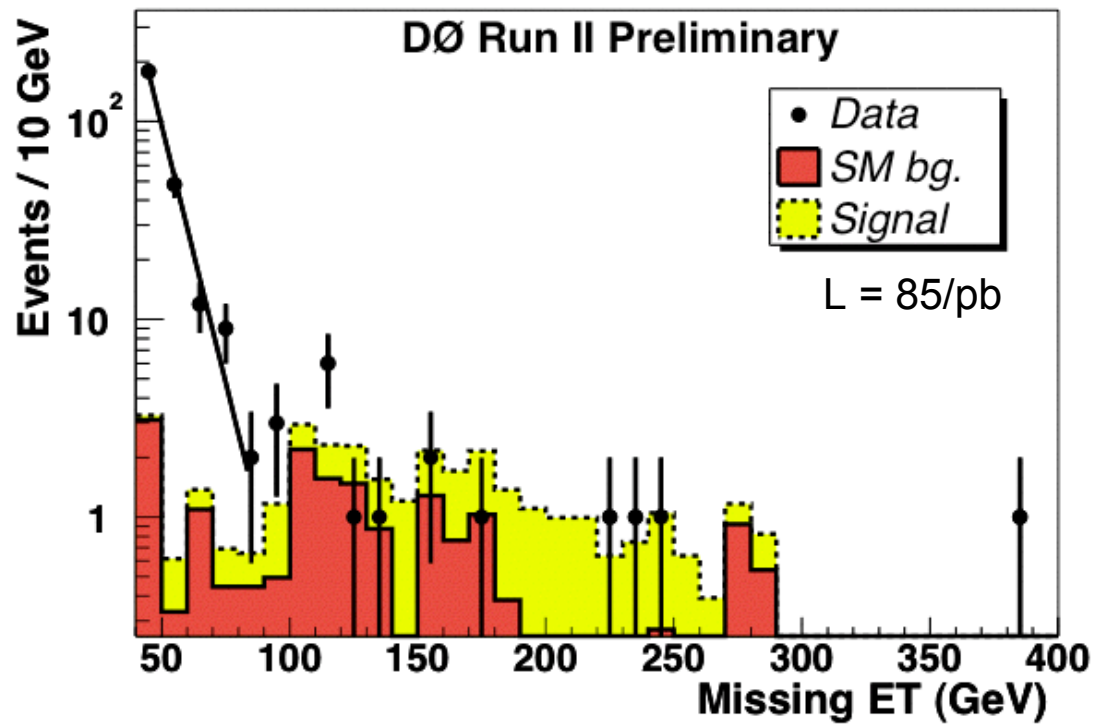
$30^o < \Delta\phi < 165^o$

$H_T > 275$

$\not{E}_T > 175$

Di-Jets+MET results





$E_{T1} > 60$ GeV, $E_{T2} > 50$ GeV

Veto e and μ

$30^\circ < \Delta\phi < 165^\circ$

$H_T > 275$

$\not{E}_T > 175$

Background predictions dominated by EWK not QCD

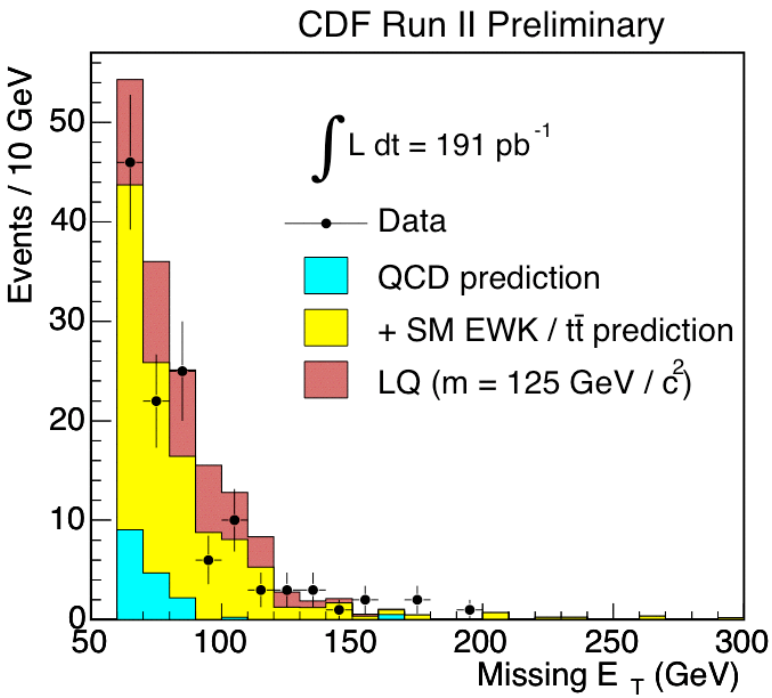
$Z \rightarrow \nu\nu$ + 2jets

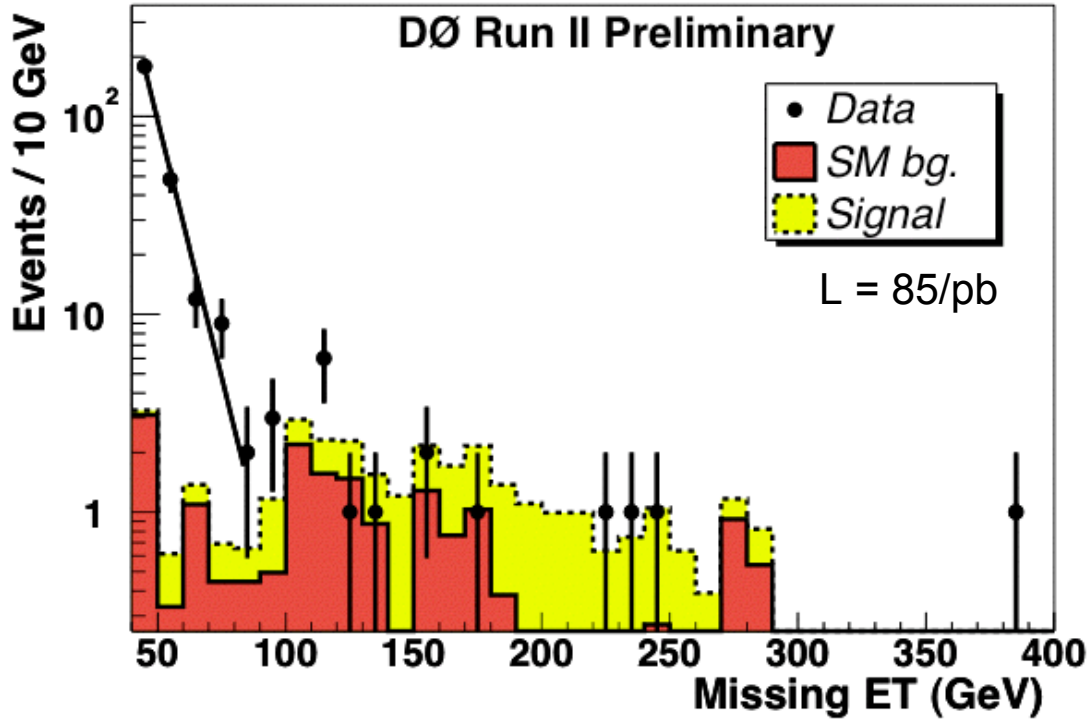
$W \rightarrow \tau\nu$ + jet

Expect 2.67 ± 0.95 events

Observe 4

Di-Jets+MET results





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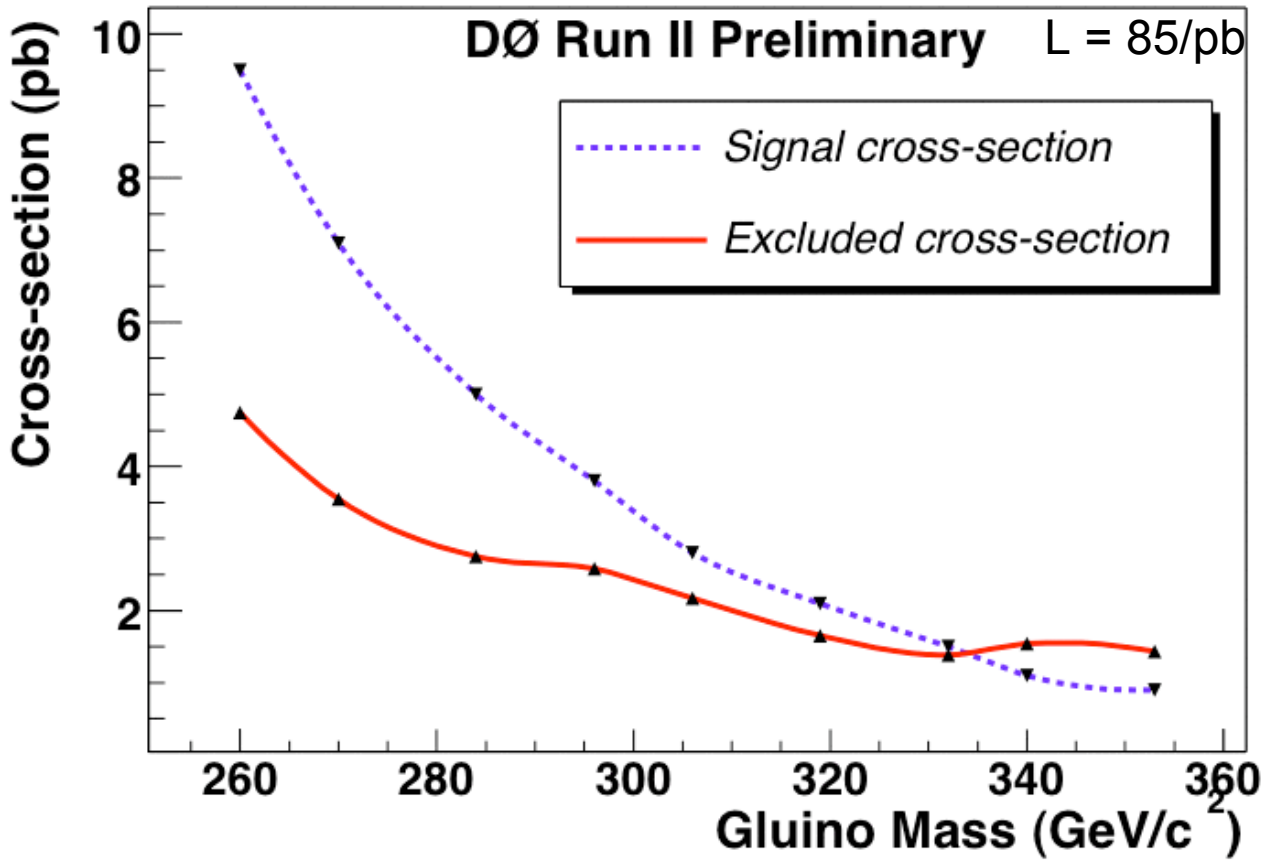
Observe 4

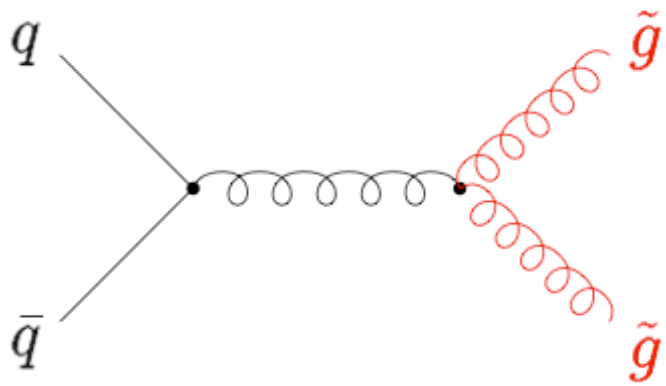
Di-Jets+MET results

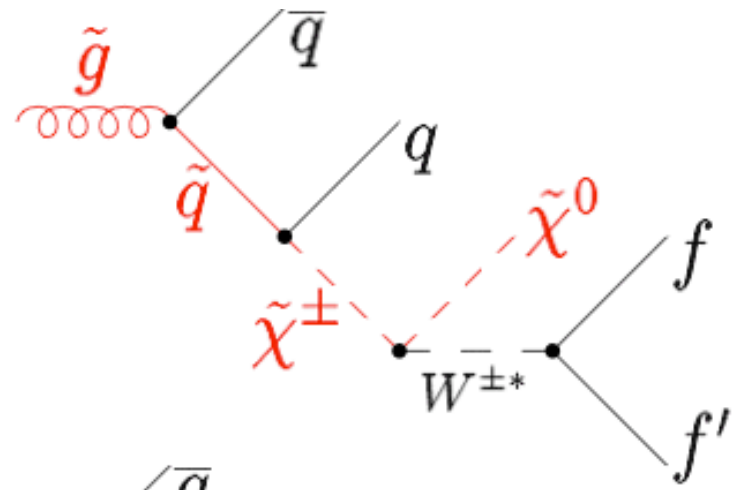


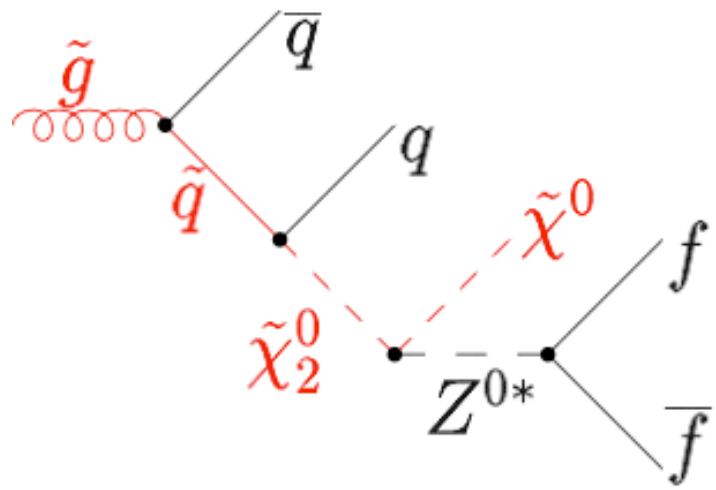
Prediction and acceptance for M_0 = 25 GeV/c^2, A_0=0, tan β = 3, μ<0, varying $M_{1/2}$

Di-Photons+MET

In GMSB models, gravitino is LSP $\Rightarrow$ $\tilde{\chi}_1^0 \rightarrow \gamma \tilde{G}$







Di-Photons+MET

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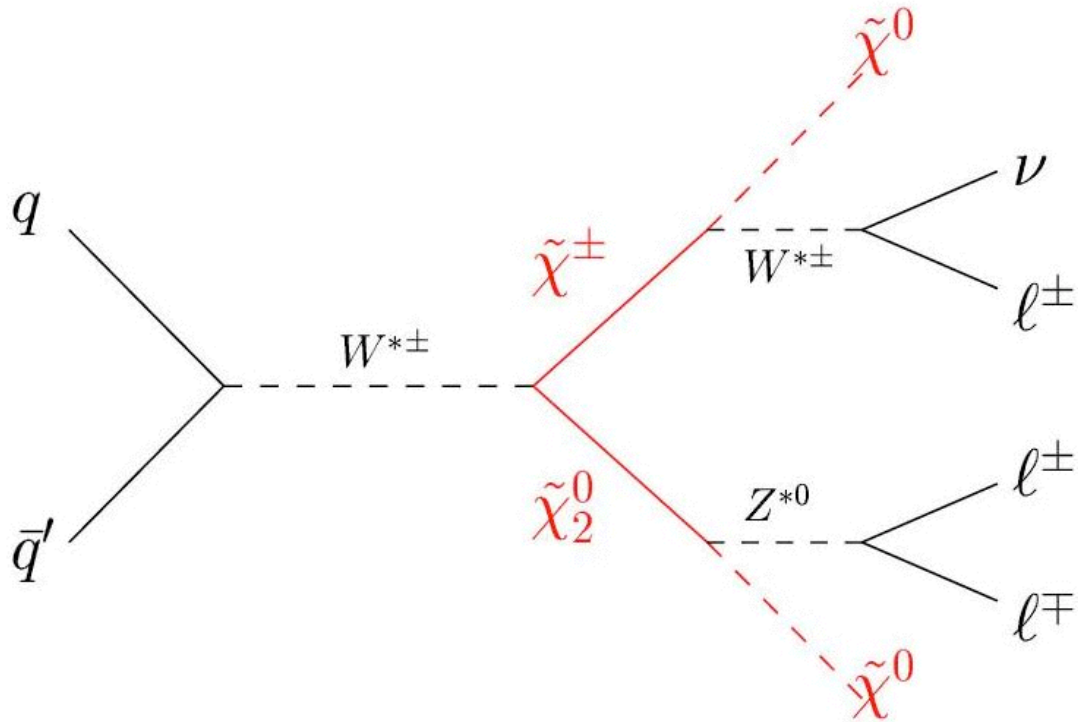
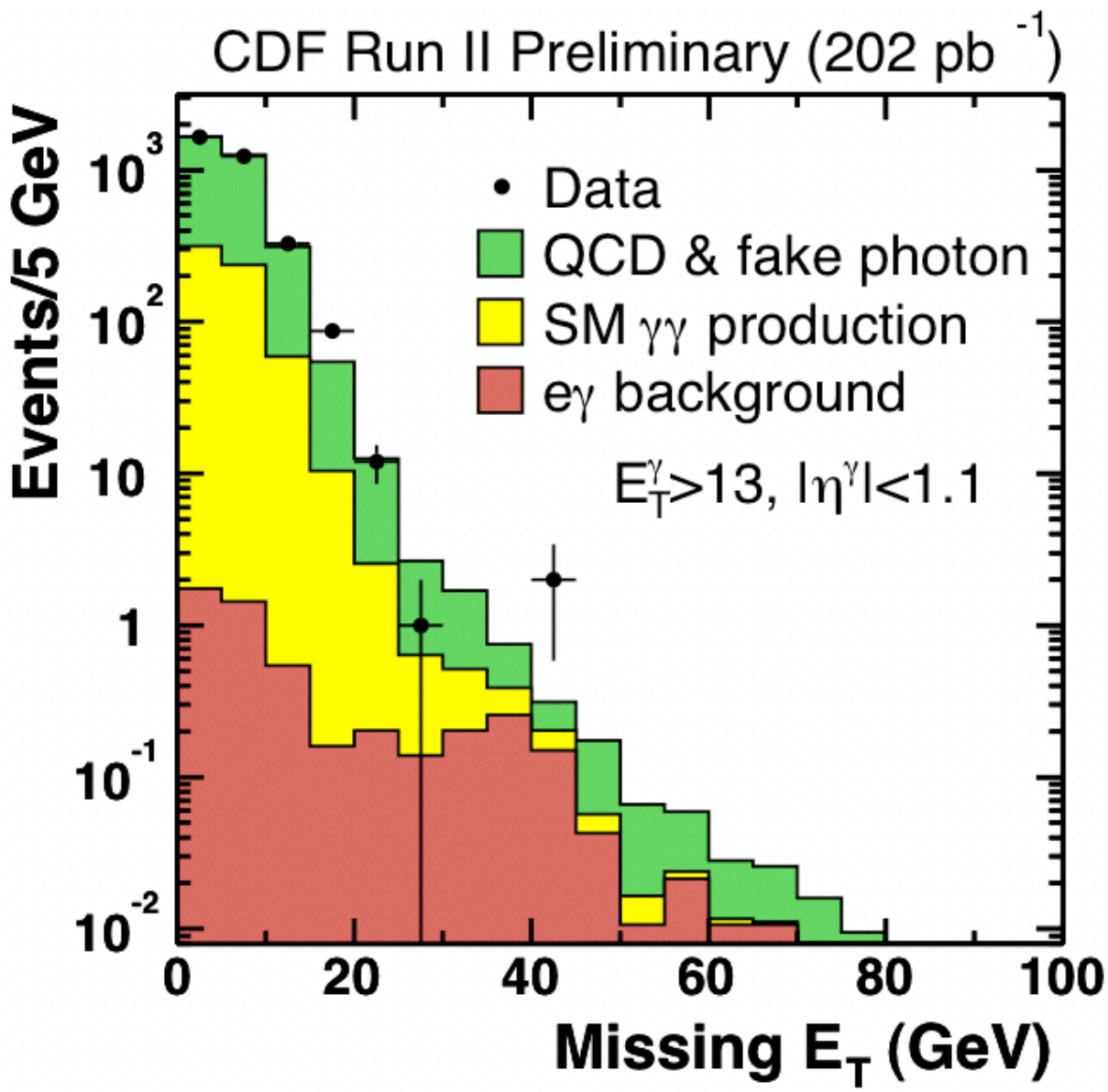


$\Rightarrow \gamma\gamma + \not{E}_T$ is a broadly sensitive signature for GMSB

Di-Photons+MET



E_T > 13 GeV

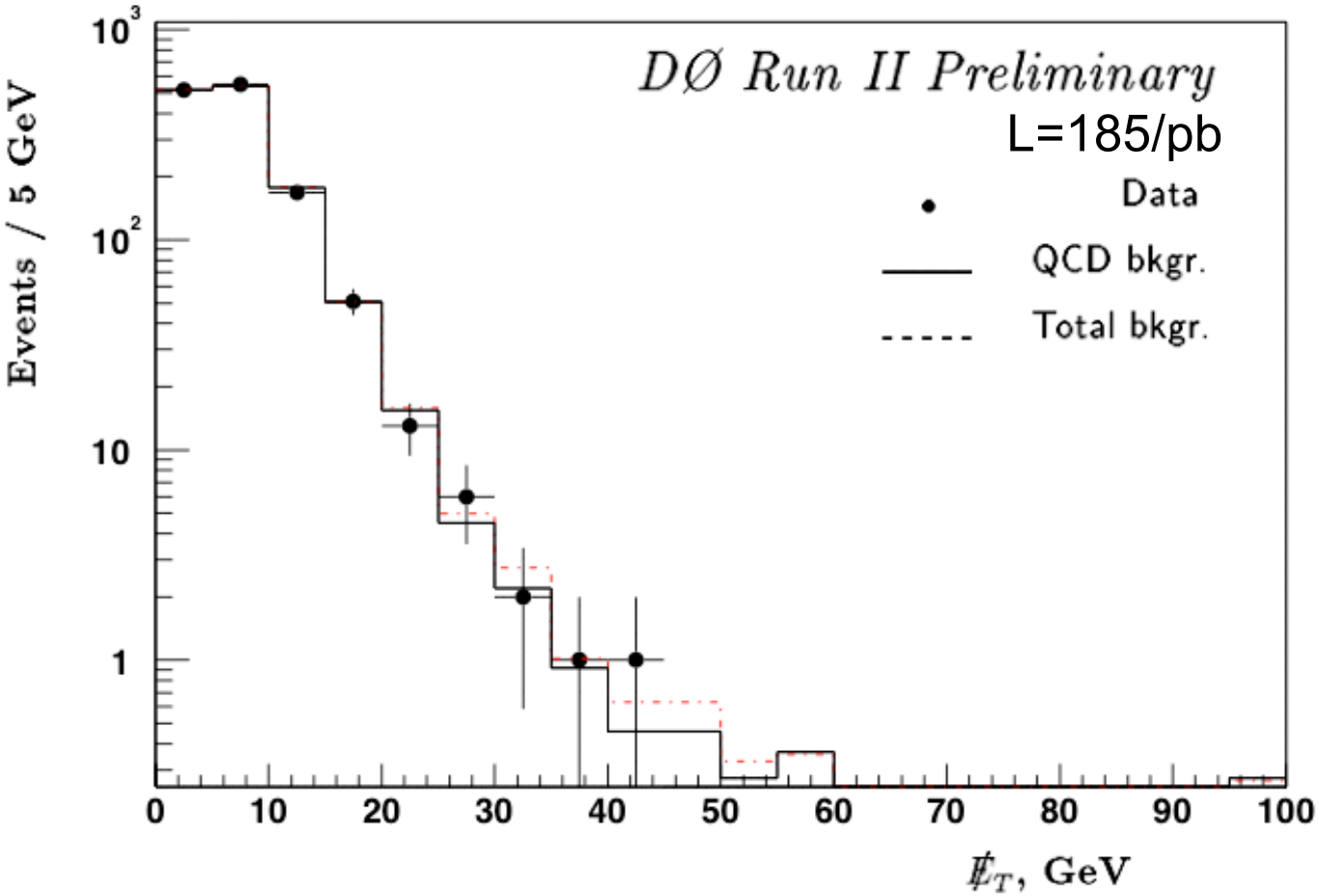
η<1.1

$\not{E}_T$ > 45 GeV

$10^o < \Delta\phi(\not{E}_T, j) < 170^o$

Calorimeter timing

Di-Photons+MET



$E_T > 20$ GeV

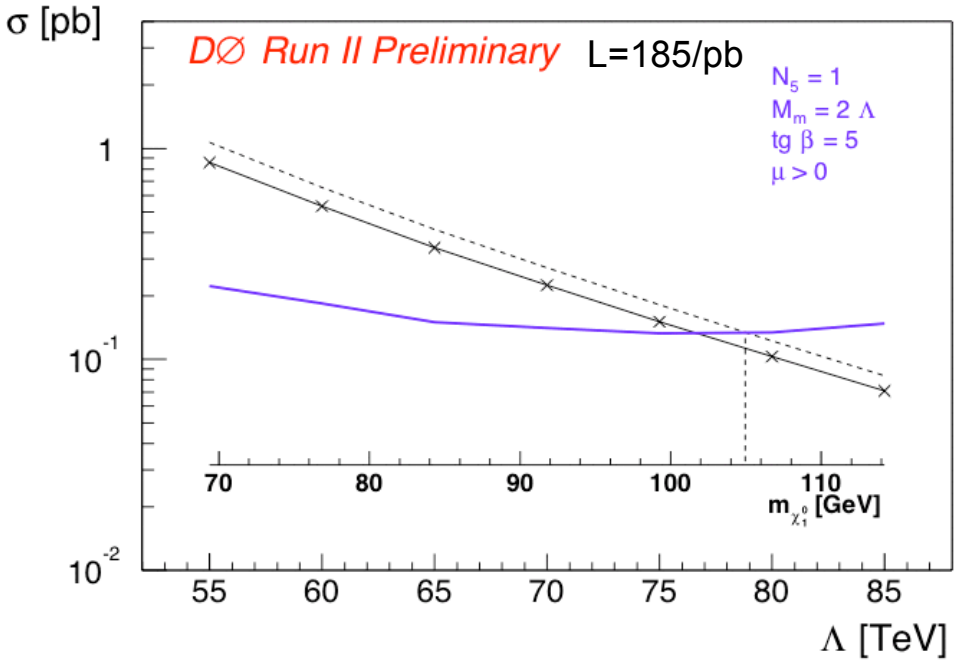
$\eta < 1.1$

$\not{E}_T > 40$ GeV

$\Delta\phi(\not{E}_T, \gamma) > 30^o$

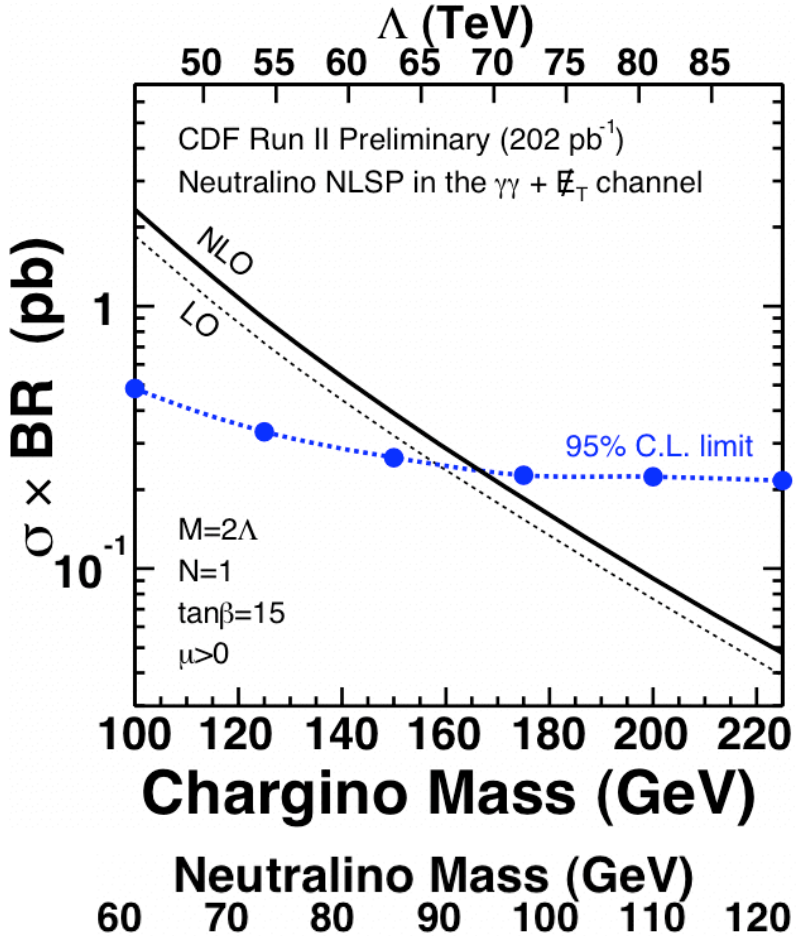
$\Delta\phi(E_T, j) < 145^o$

Di-Photons+MET



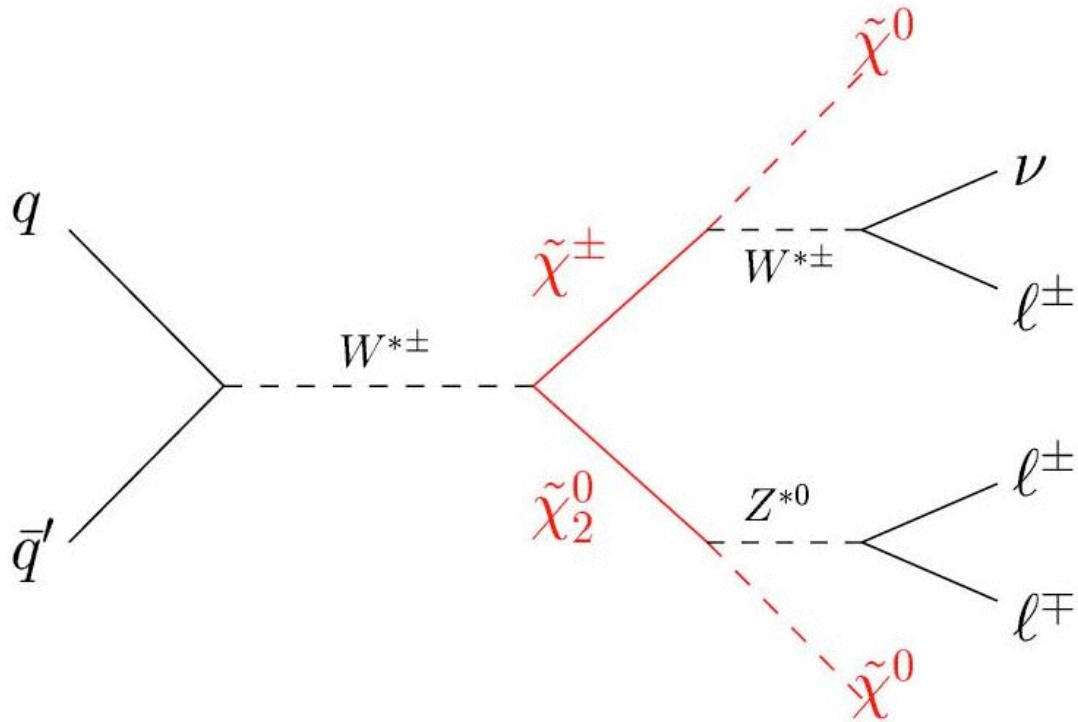
Neutralino mass limits

≈ 105 GeV



Di-leptons+MET

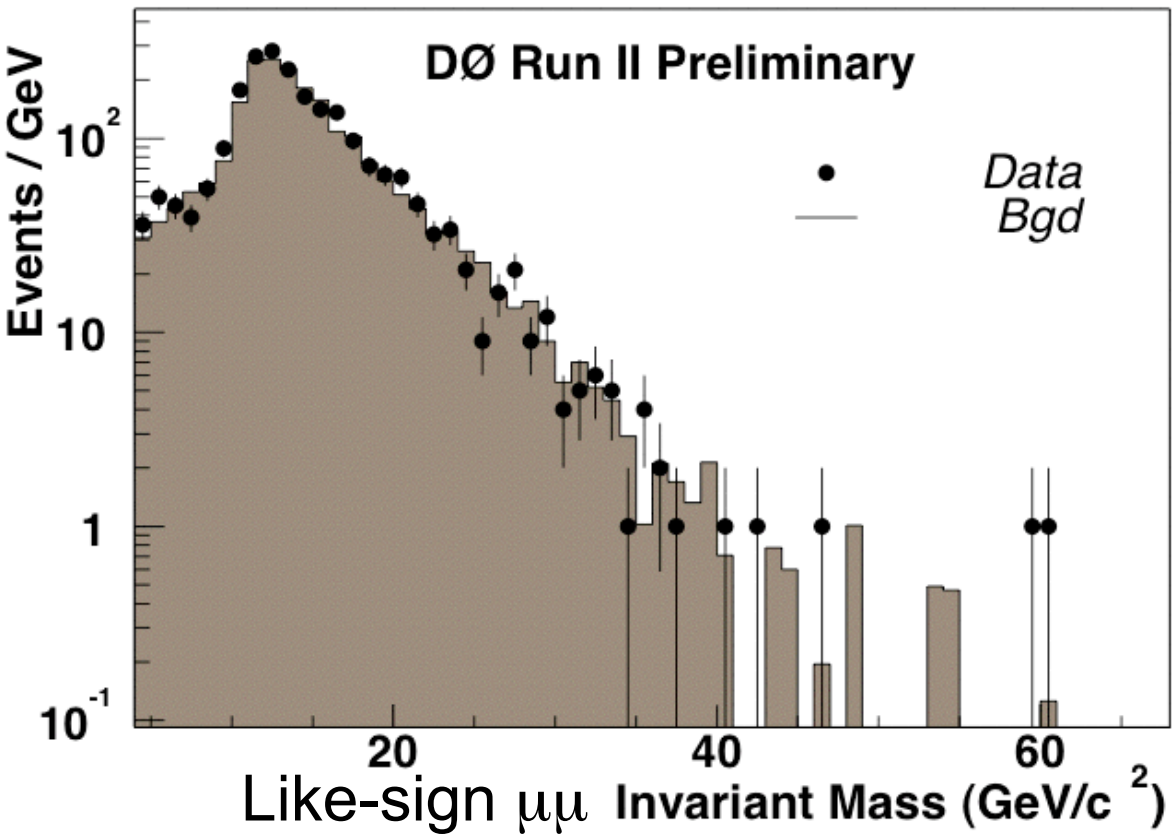
In MSUGRA models, neutralino LSP is stable



$\Rightarrow$trileptons+$\not{E}_T$ and di-leptons+$\not{E}_T$

D0 has searched in both modes.

Like-sign $\mu^{\pm}\mu^{\pm}$ *+MET*



Like-sign $\mu^{\pm}\mu^{\pm}$

p_{T1}>11 GeV/c

p_{T2}>5 GeV/c

$\Delta\phi(\not{E}_T,j)<145^o$

$30^o<\Delta\phi(\not{E}_T,\mu)<145^o$

$\not{E}_T$ > 40 GeV

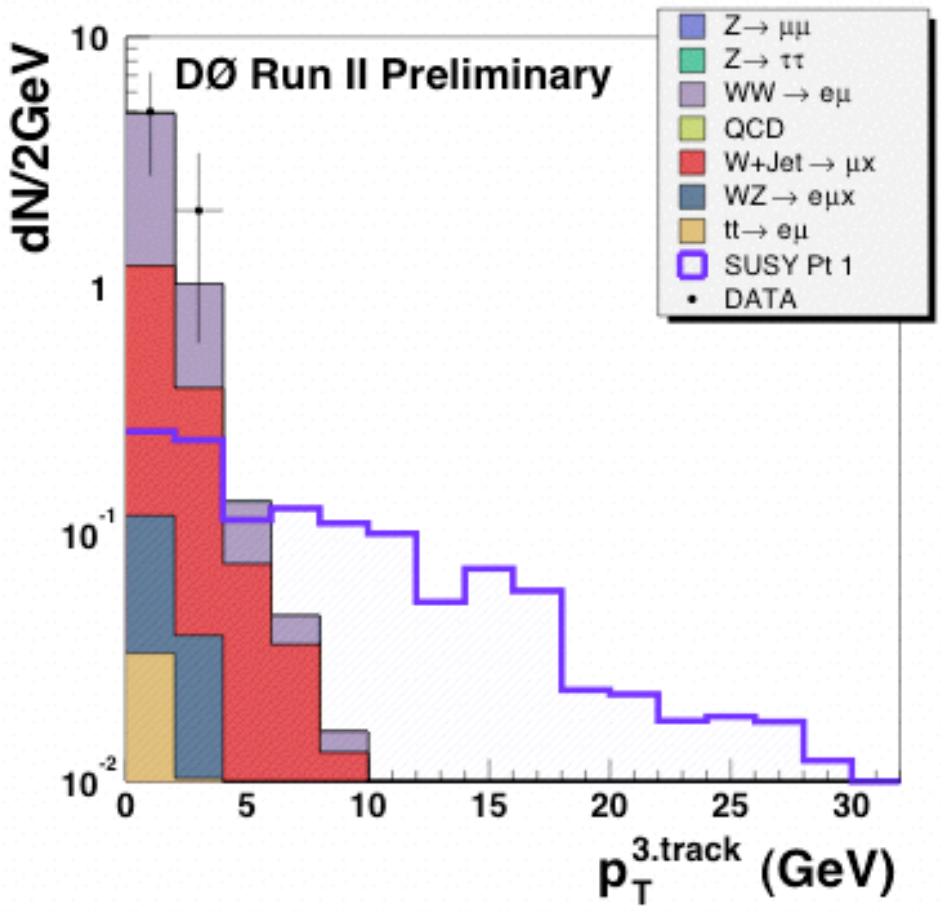
$M_{\mu\mu}$ < 80 GeV/c^2

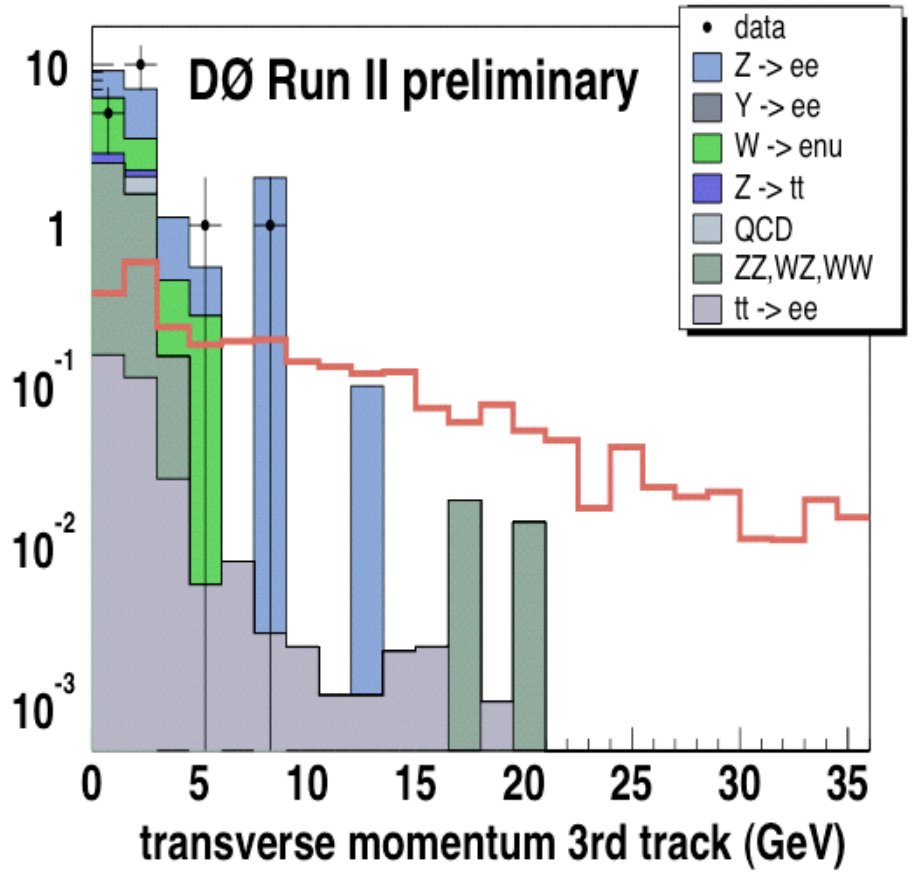
Predict 0.13 ± 0.06

Observe 1 event

Di-lepton +MET + Track

Select eμ or ee + $\not{E}_T$. Look for a 3rd, isolated track with $p_T > 3$

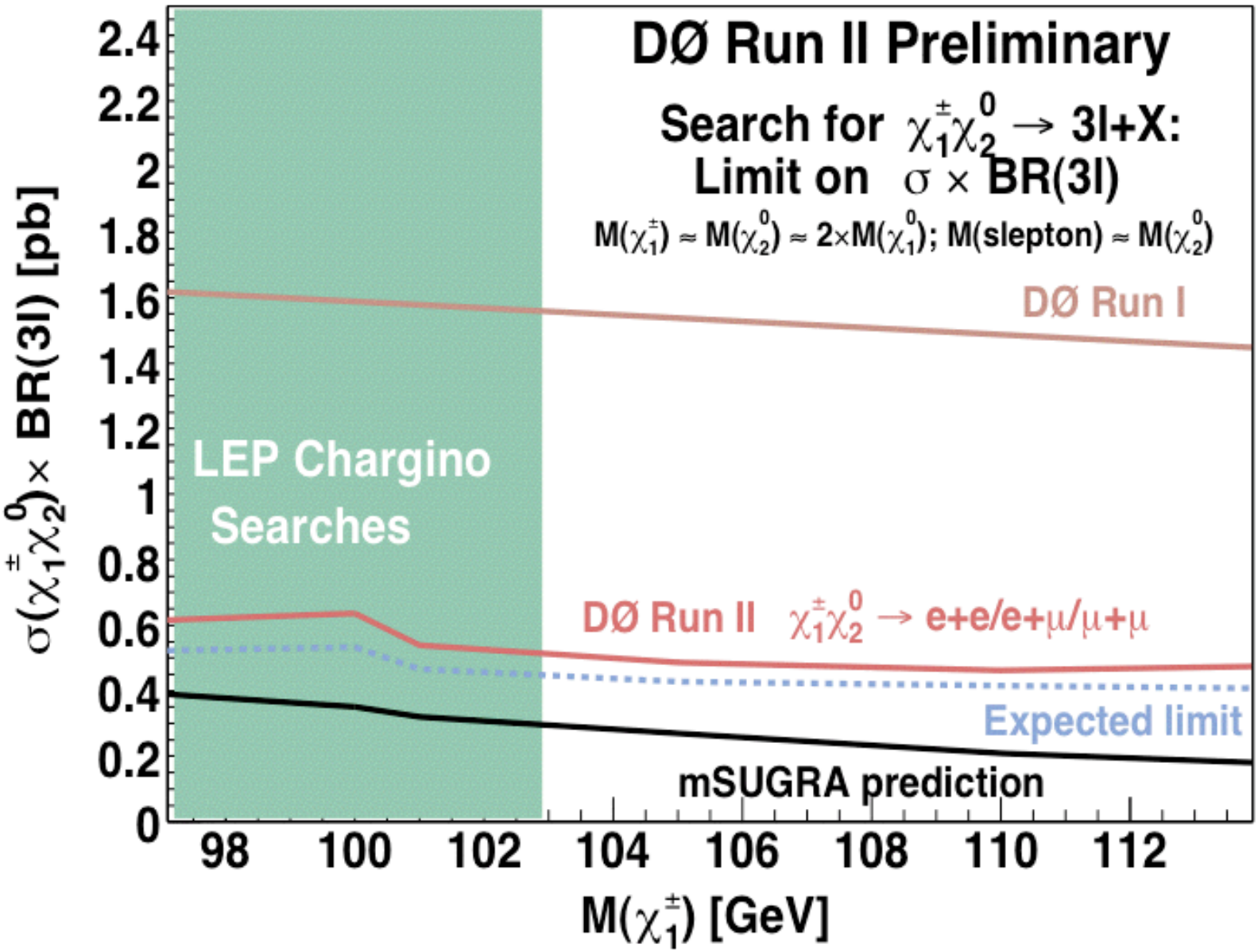




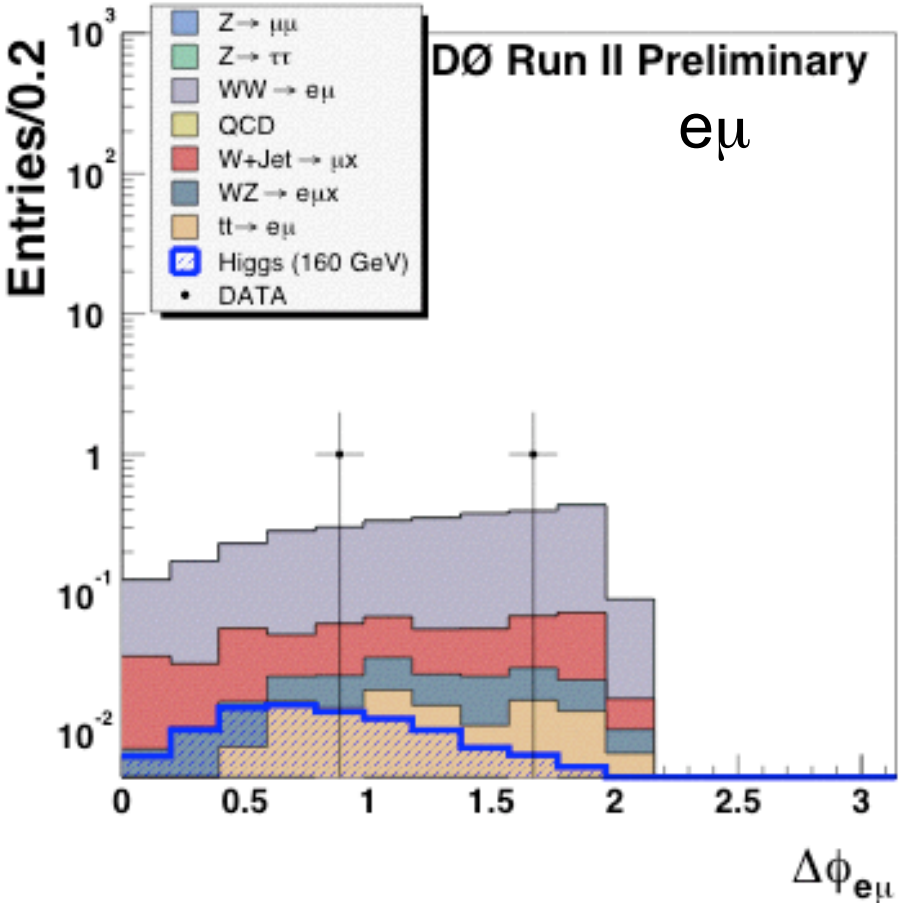
Expect 0.5 ± 0.2, see 0

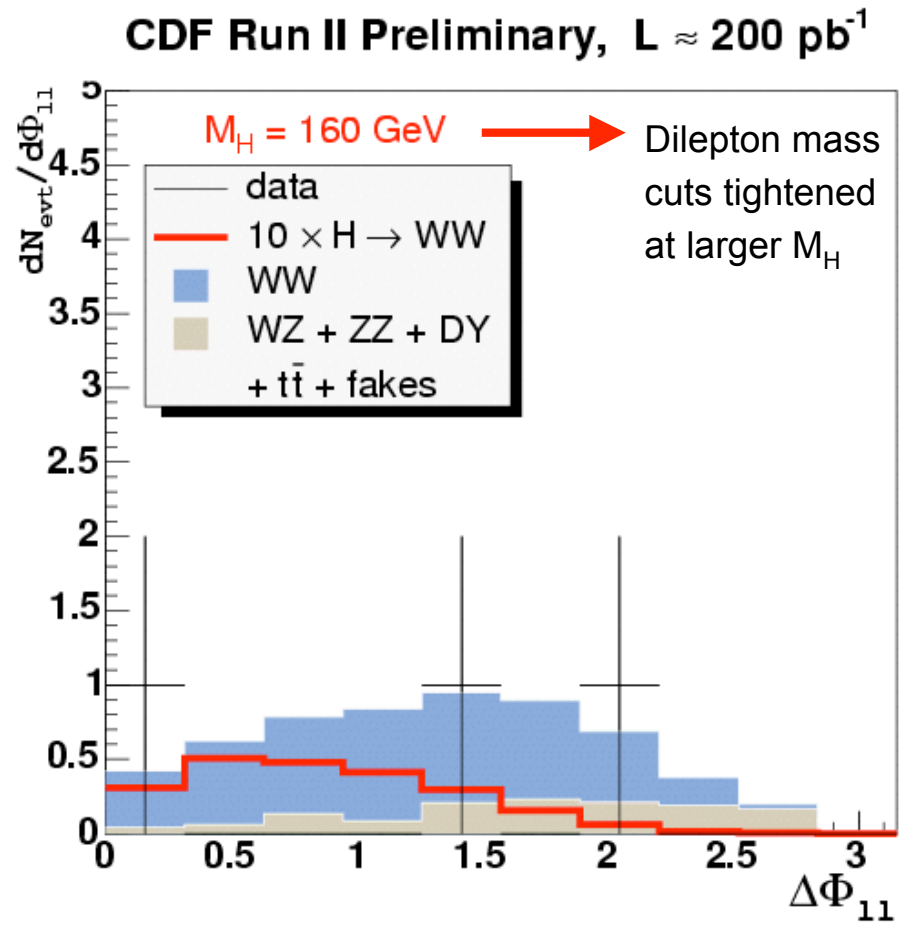
Expect 1.2 ± 0.4, see 1

Di-lepton +MET SUSY Limits



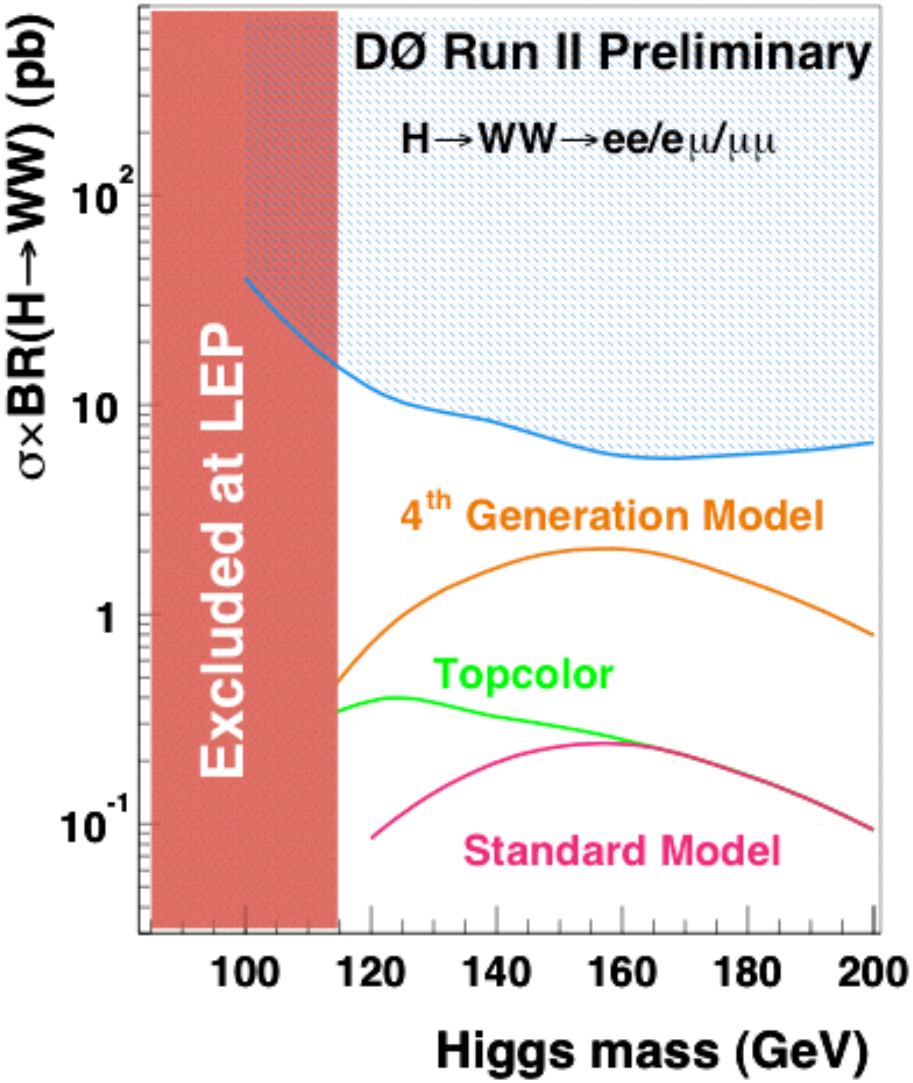
Di-lepton +MET Higgs Limits





See talks by P.Jonsson and S.Chuang Tuesday at 2pm.

Di-lepton +MET Higgs Limits



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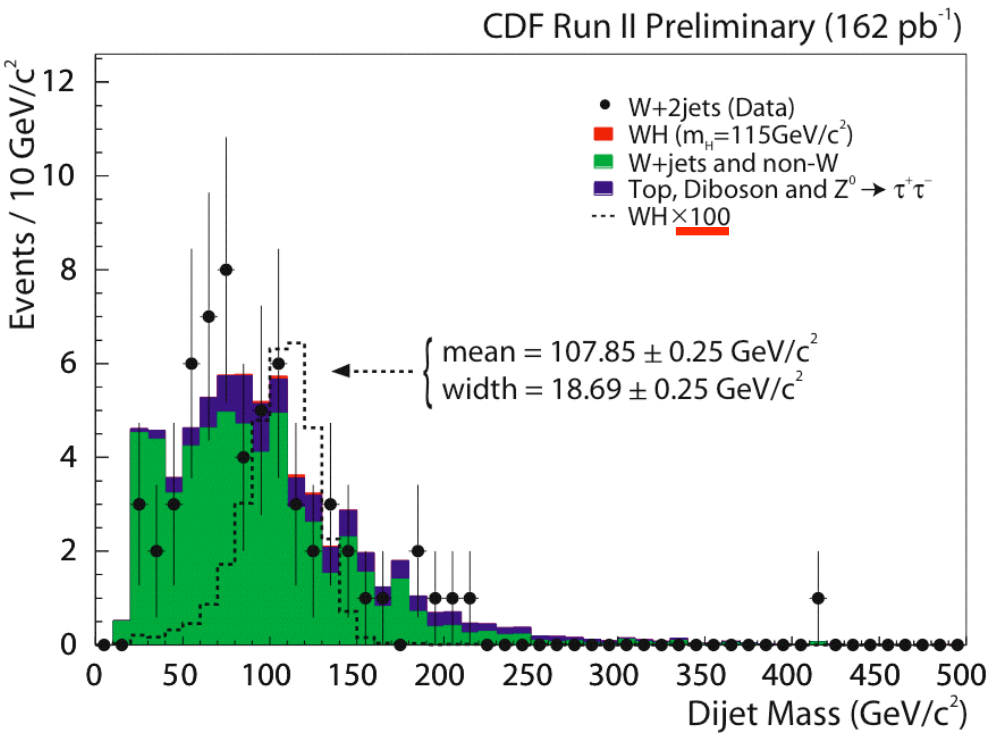
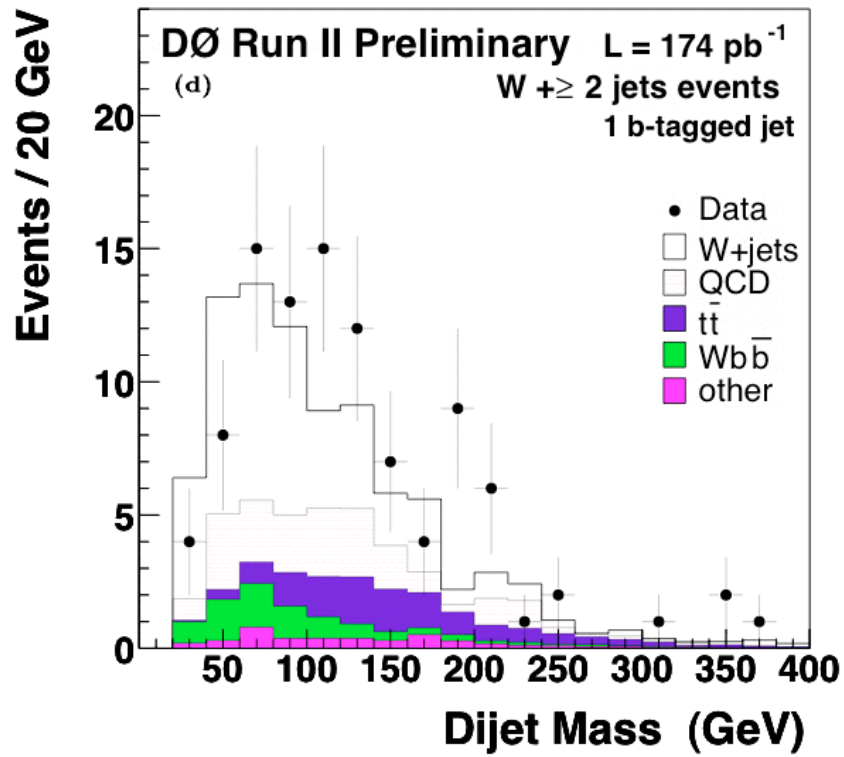
Lepton +MET + bb Higgs Limits





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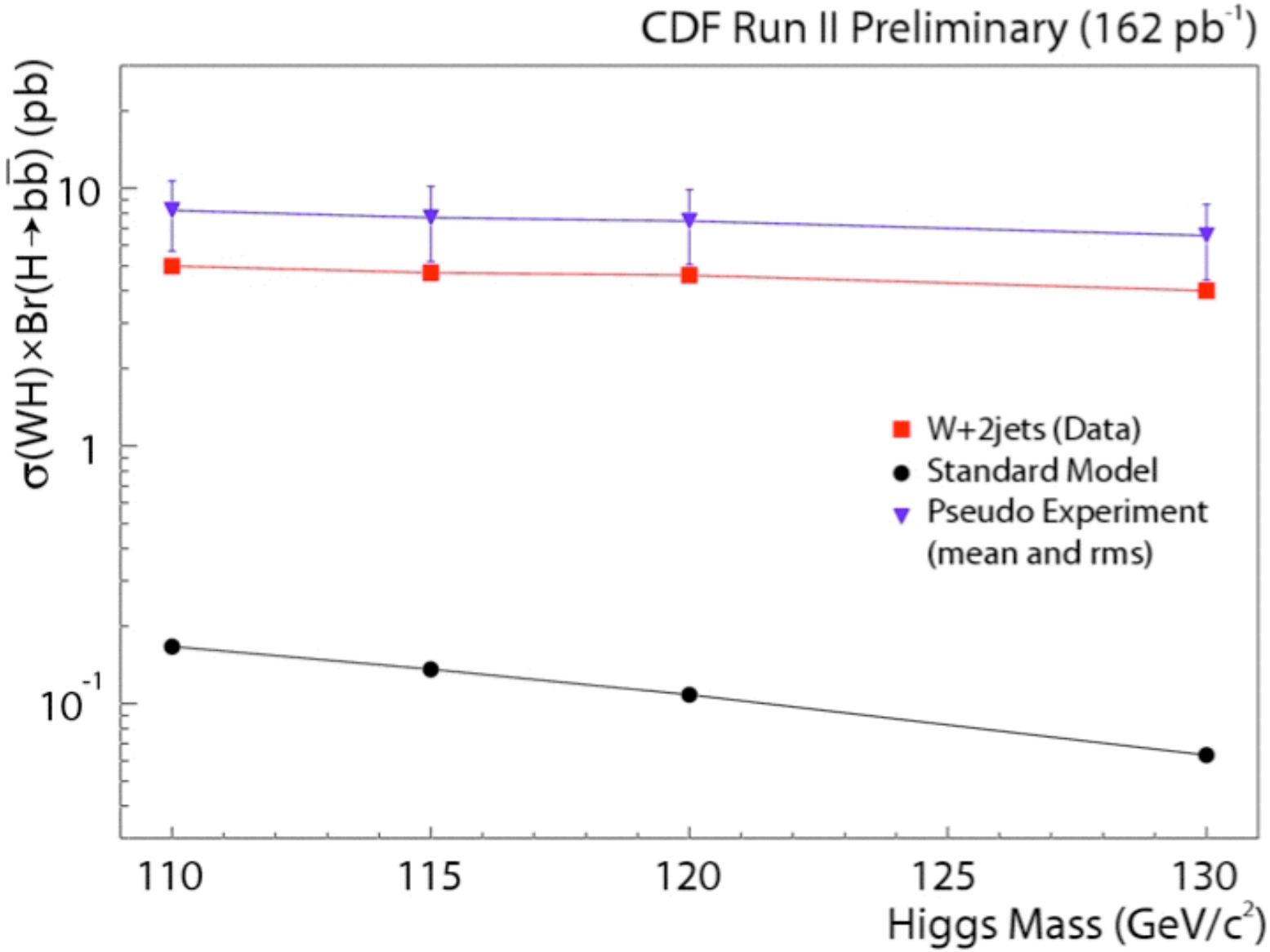
Lepton +MET + bb Higgs Limits



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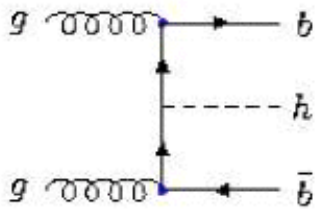
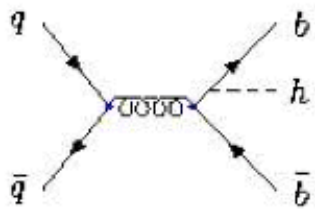
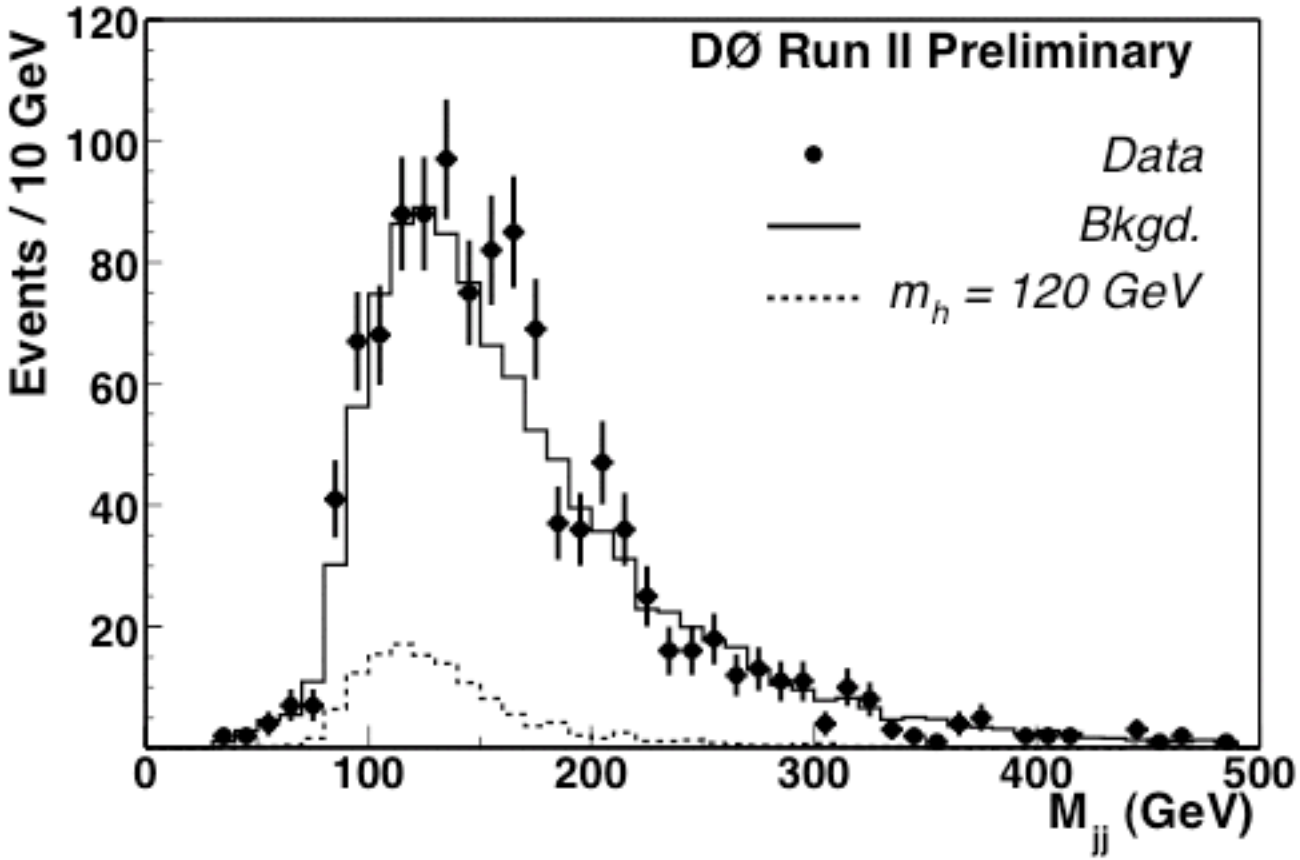
bbbb Higgs Search

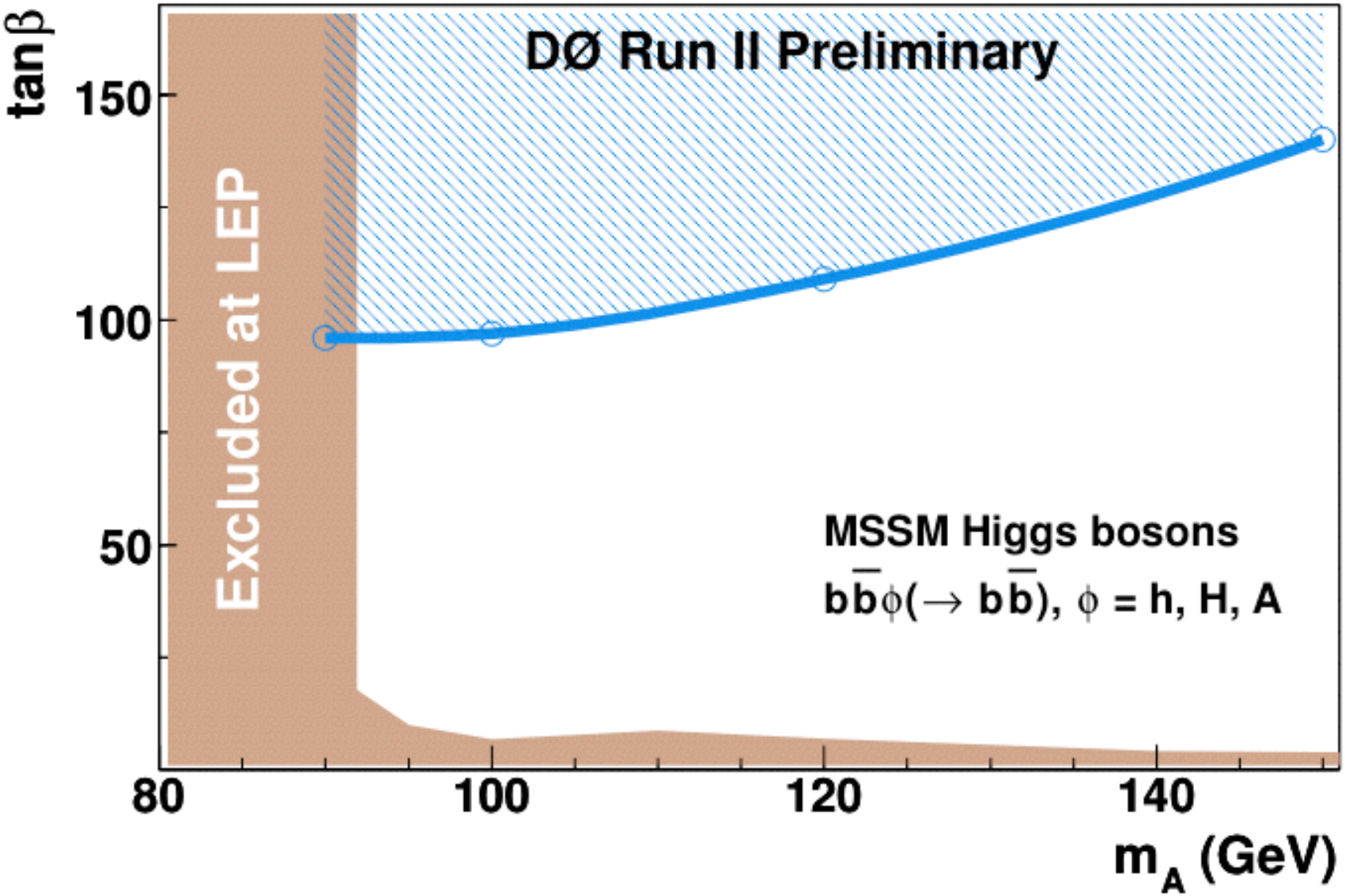




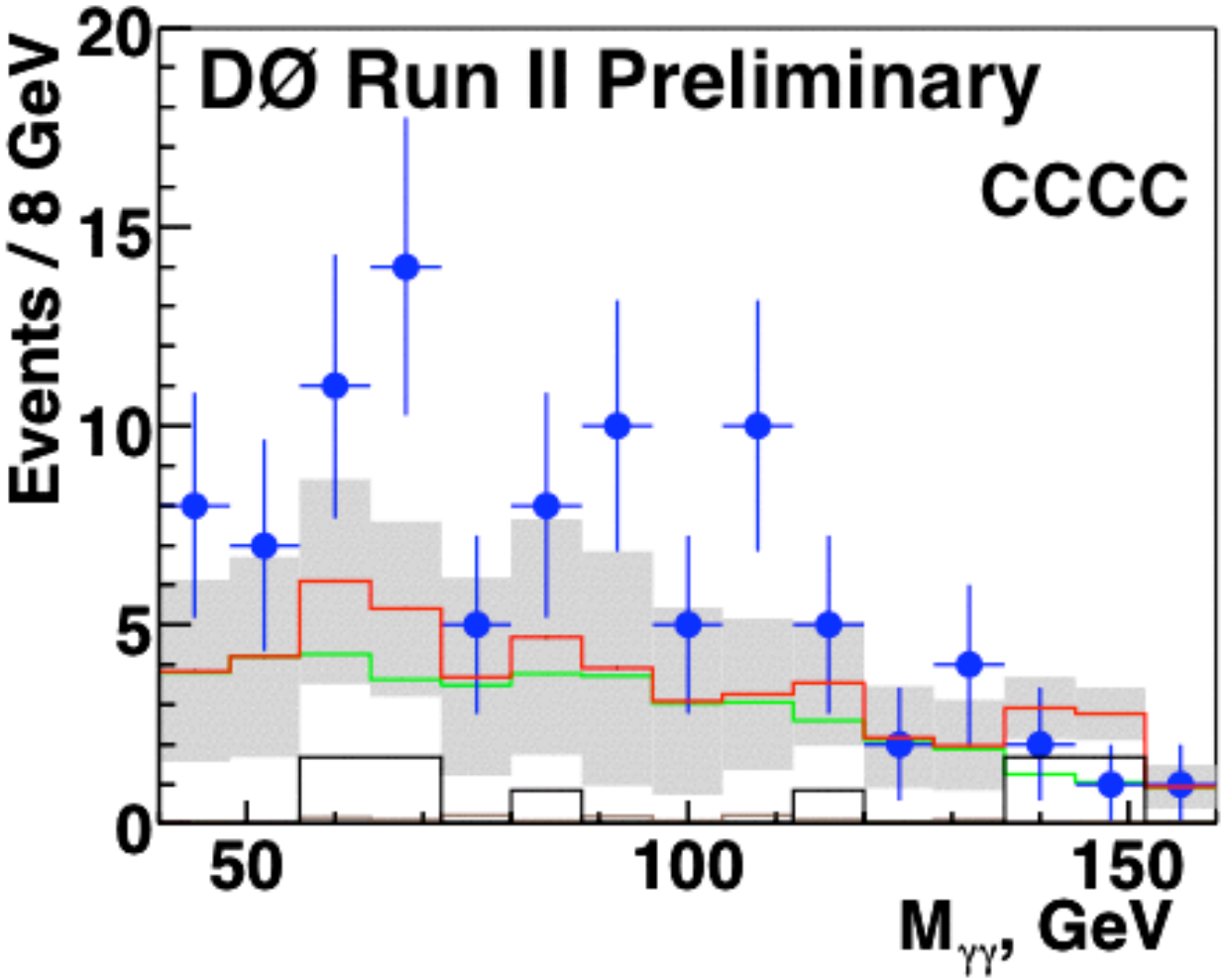
At least 3 tagged jets



bbbb Higgs Search



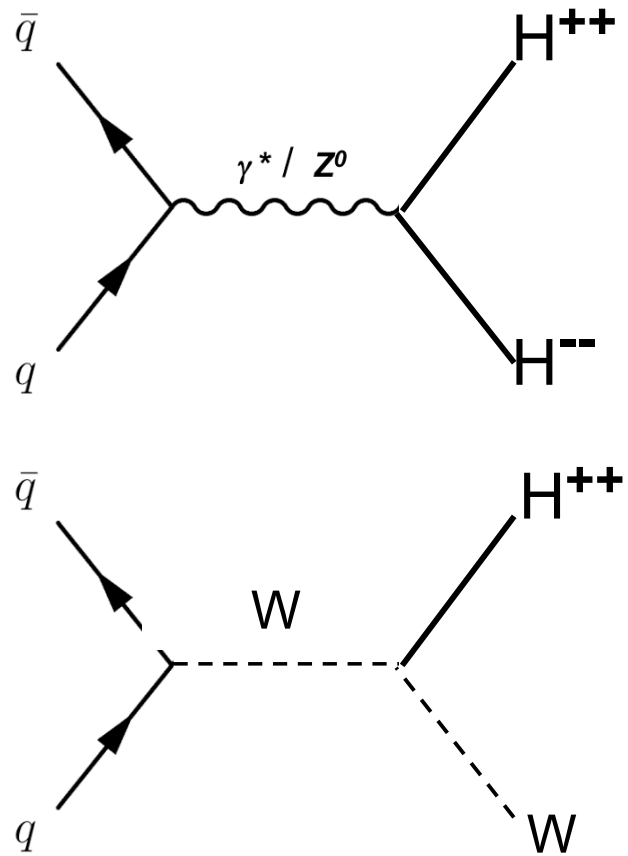
Search for $h \to \gamma\gamma$



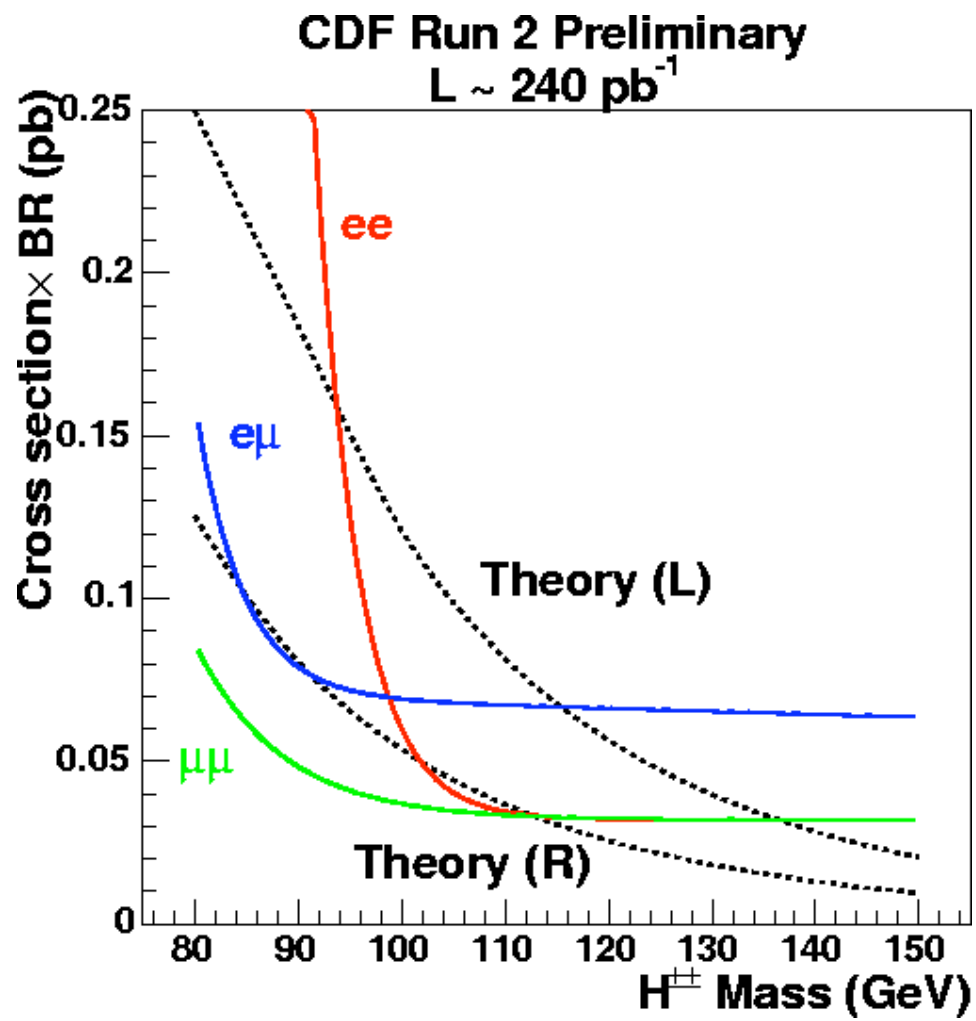
Limits on BR($h \to \gamma\gamma$) < ≈60%

Search for Doubly Charged Higgs

Predicted e.g., in LR symmetric models

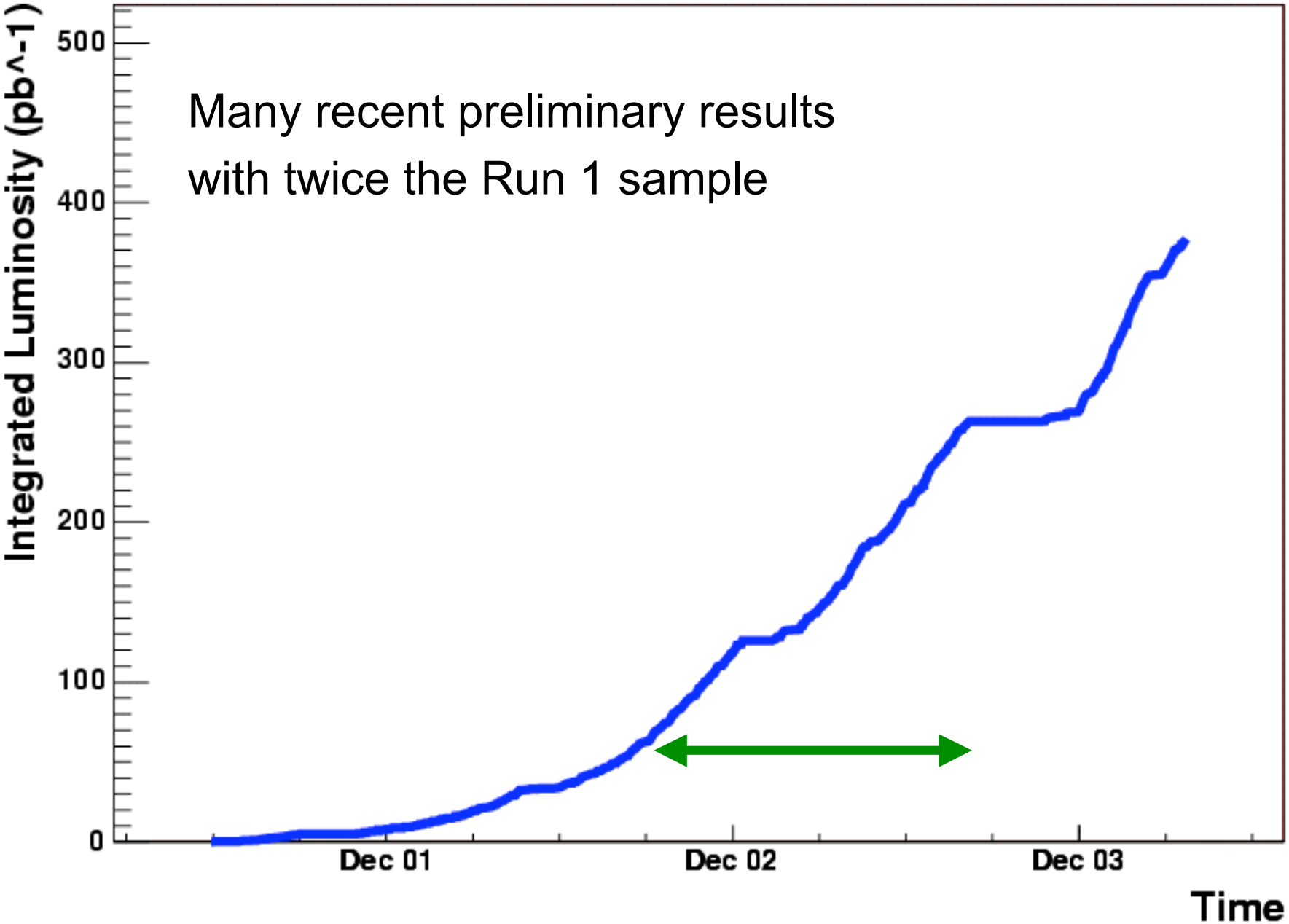


No events observed



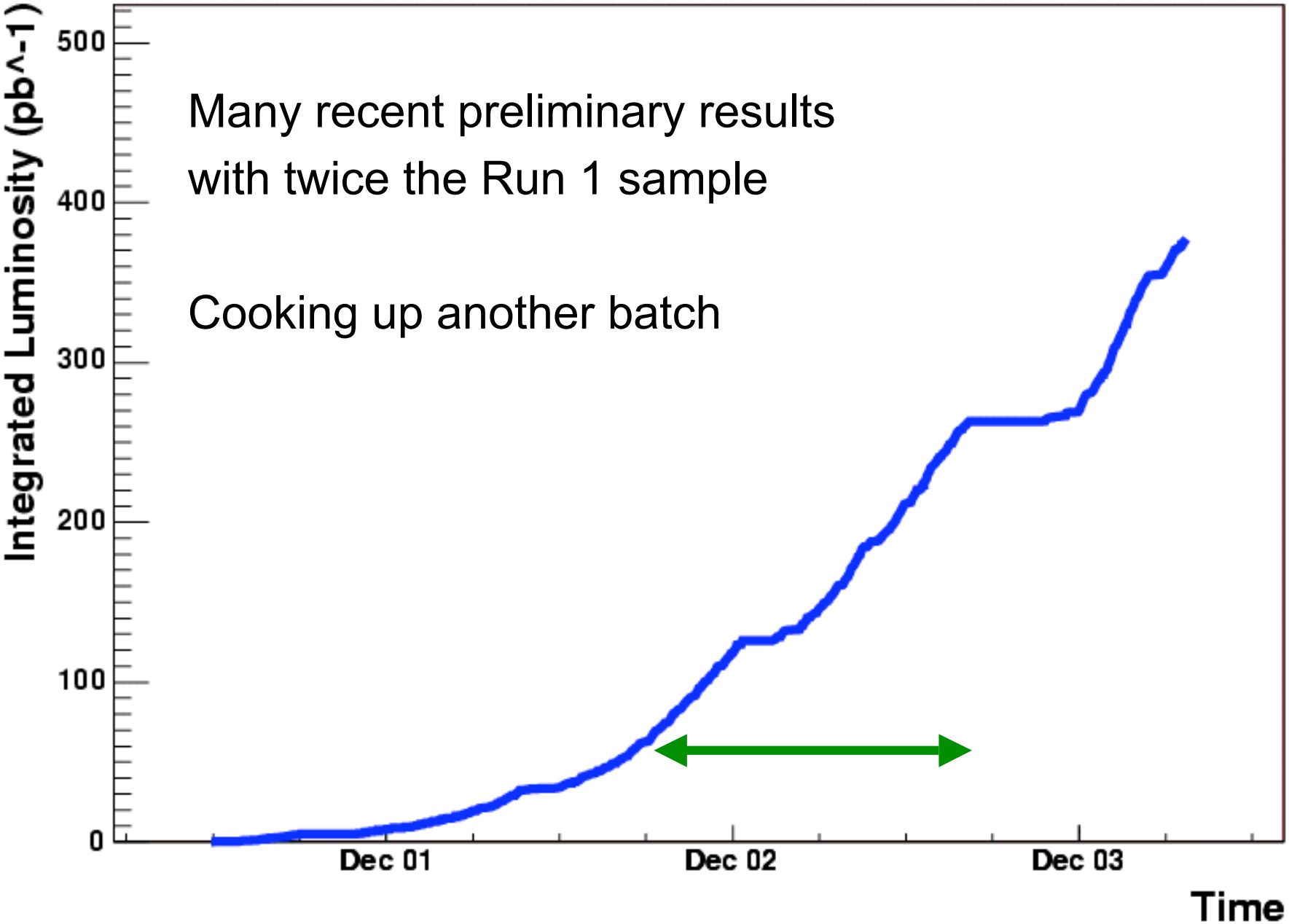
Same-sign dilepton signature

Summary



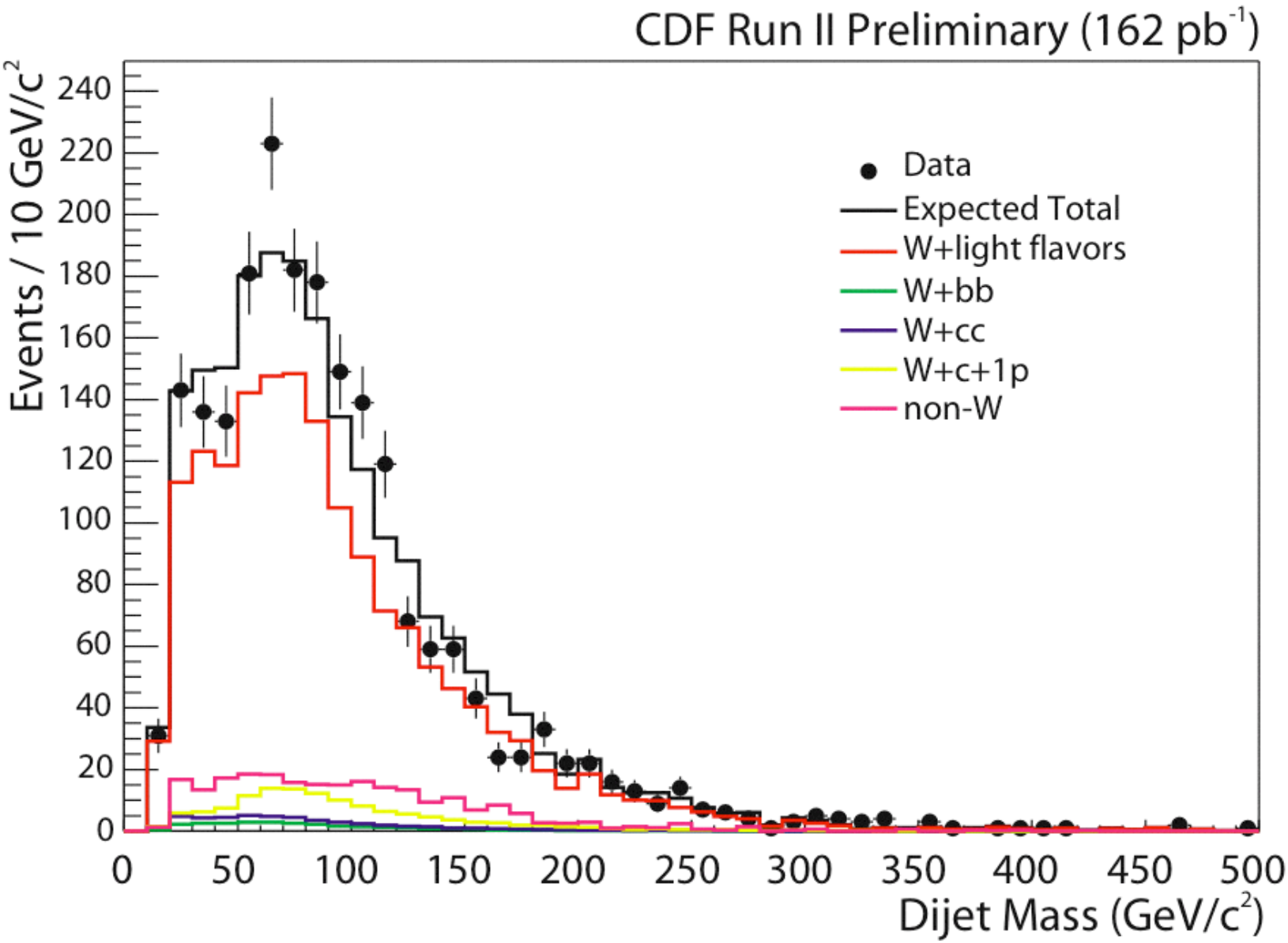
Many recent preliminary results
with twice the Run 1 sample

Summary

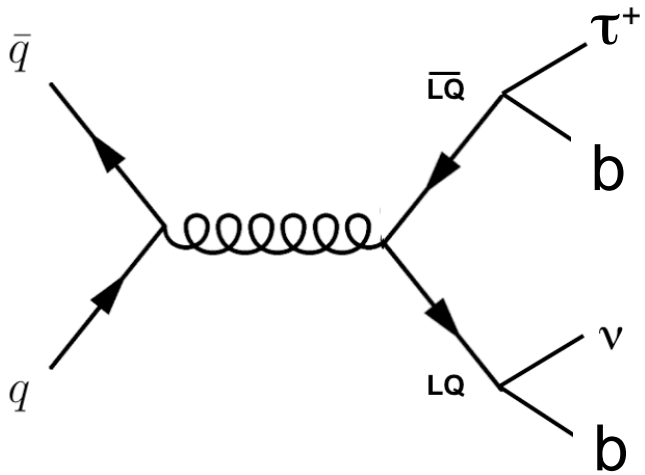


Many recent preliminary results with twice the Run 1 sample

Cooking up another batch


CDF Run II Preliminary (162 pb^{-1})
Events / 10 GeV/c^2
Dijet Mass (GeV/c^2)
Data
Expected Total
W+light flavors
W+bb
W+cc
W+c+1p
non-W
0
20
40
60
80
100
120
140
160
180
200
220
240
0
50
100
150
200
250
300
350
400
450
500

Lepton +MET + bb



Also a signature for
3rd generation leptoquarks