Photon + X Analysis at CDF

Ray Culbertson, FNAL,
for the CDF Collaboration

Search in the Diphoton Mass Spectrum, and New R-S Graviton Limits

Search for Anomalous Kinematics in Photon+jets Events

Measurement of the Diphoton Cross Section

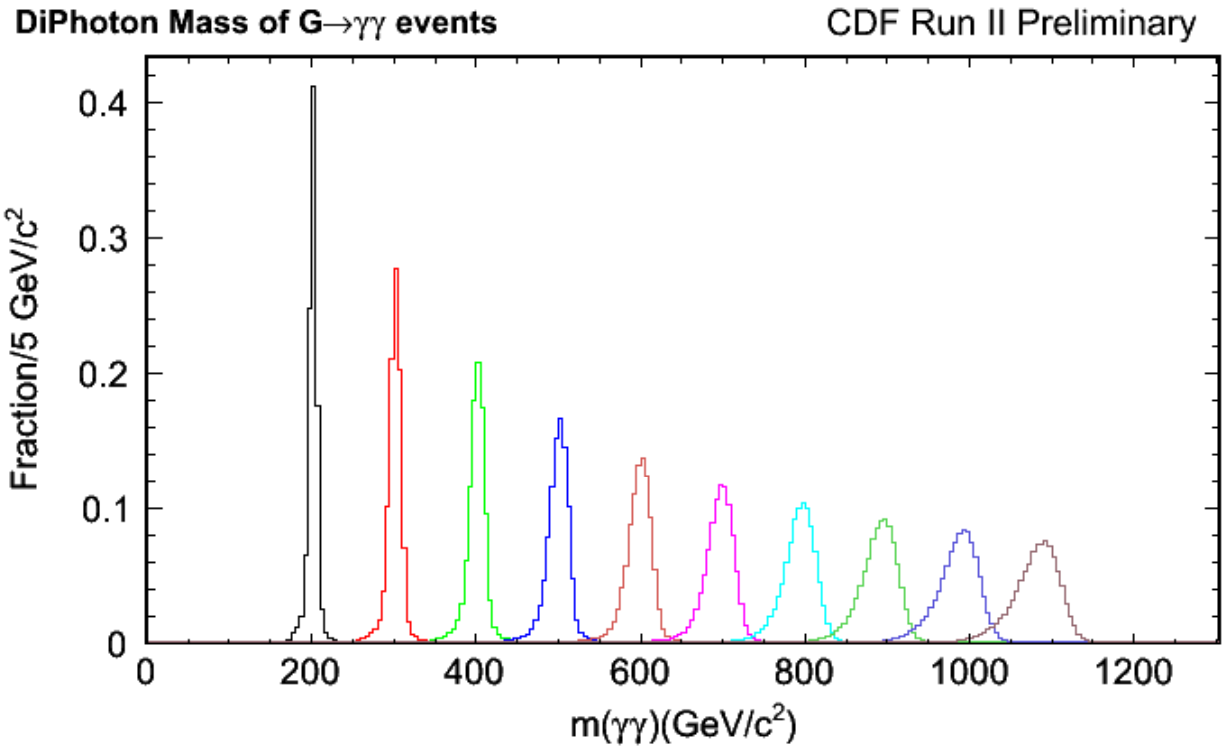
$\gamma\gamma$ Search

The Search

- Sensitive to narrow $X \rightarrow \gamma\gamma$
- Higgs,Technicolor
- other anomalous diphotons
- Set limits on LED Randall-Sundrum Gravitons

Event Selection

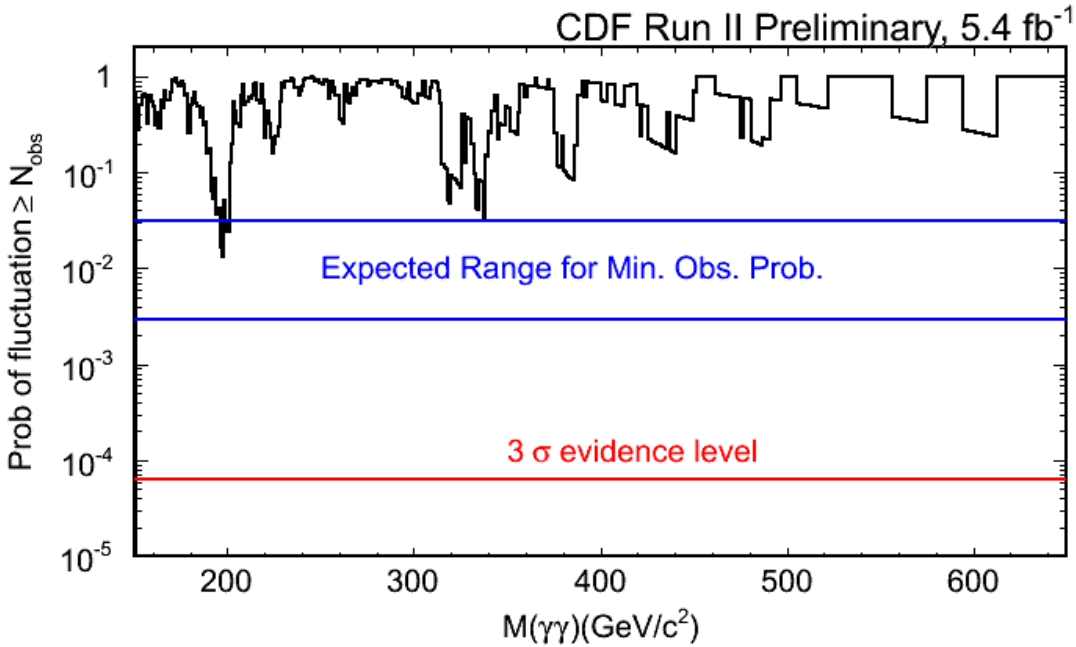
- 5.4 fb^{-1}
- Two photons
  E_T>15 GeV, $|\eta|$<1.1

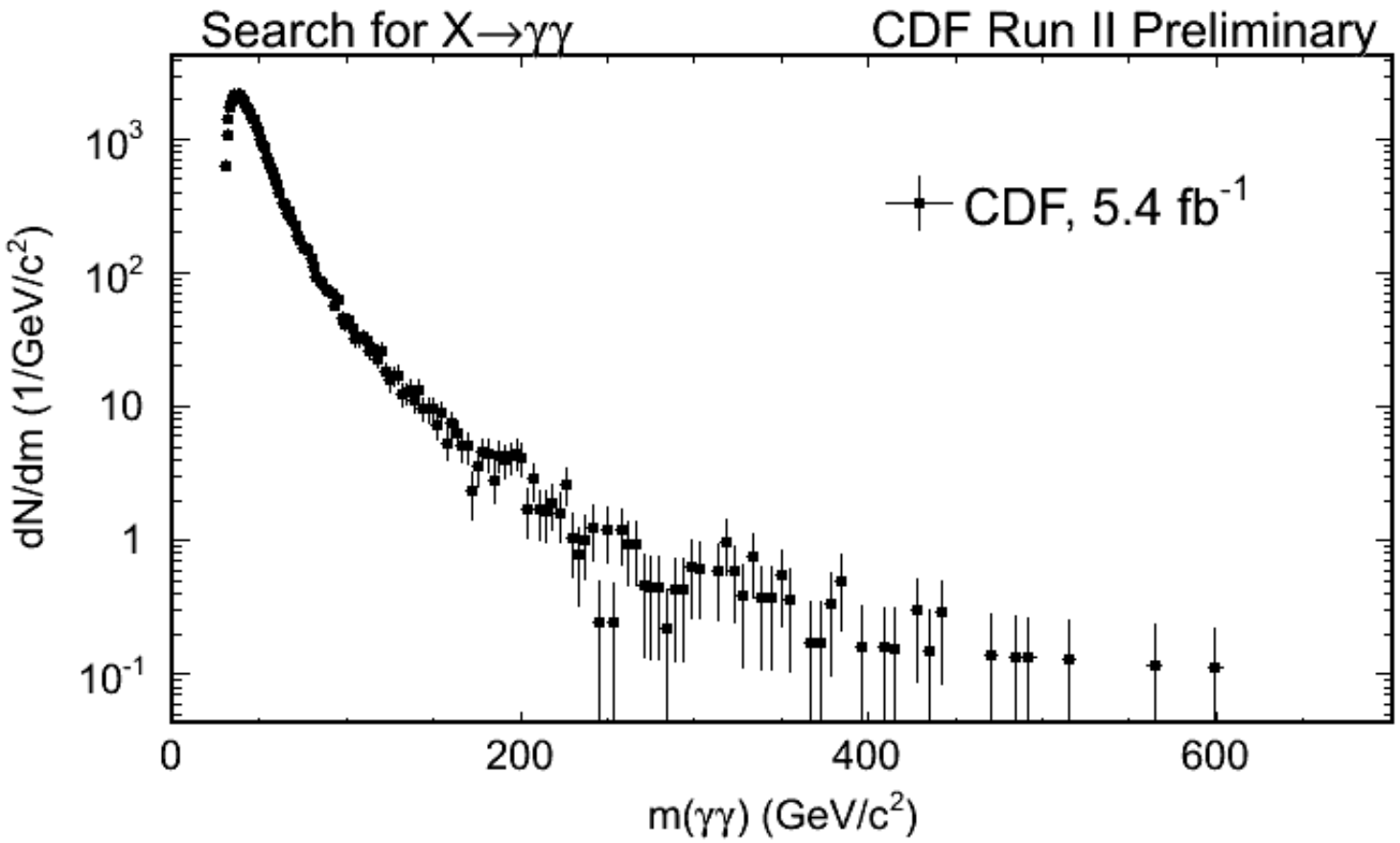


- R-S Gravitons, parameters: mass and k (coupling strength)
- calorimeter saturation not a issue

γγ Search

- spectrum in bins of resolution
- test for excesses,
  includes trials factor

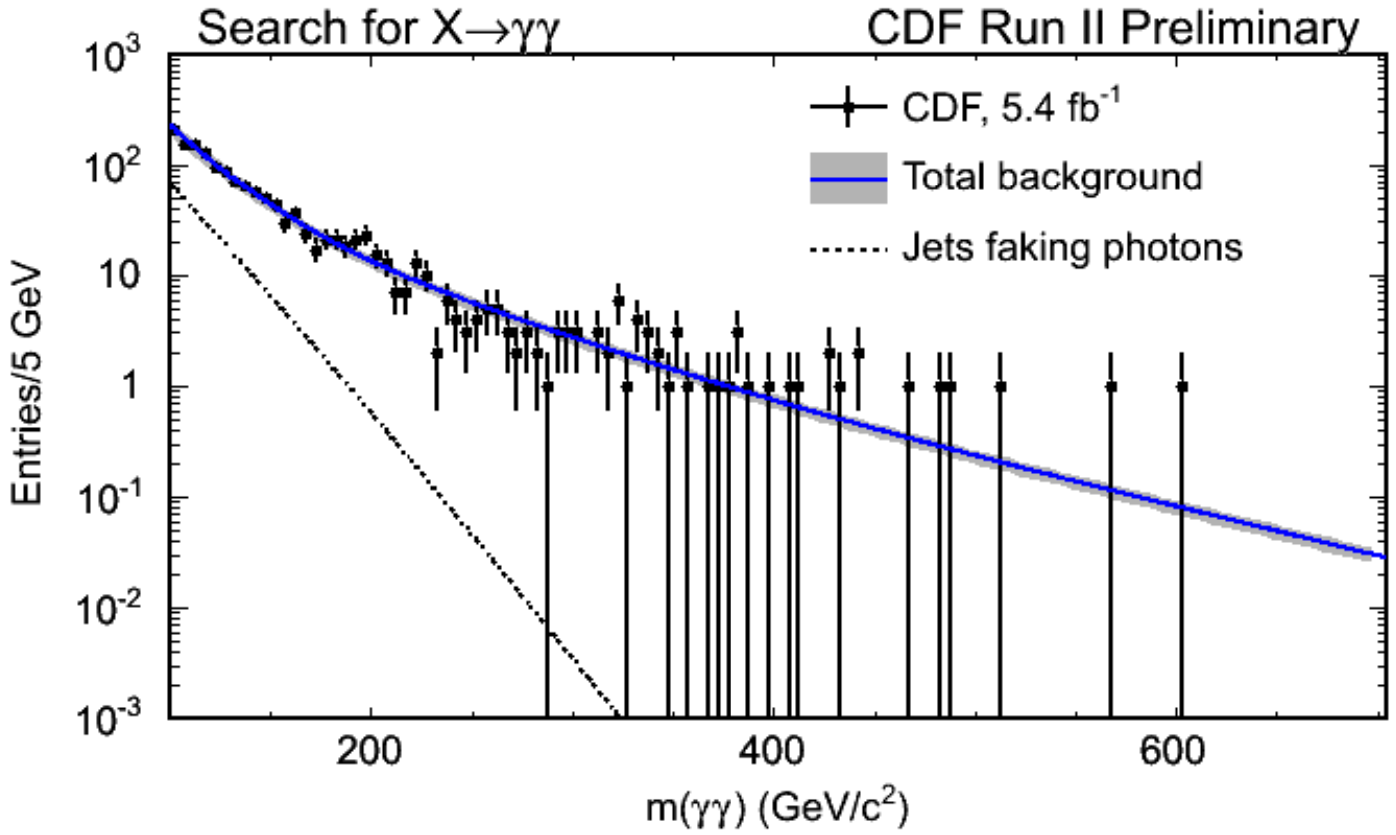




γγ Search

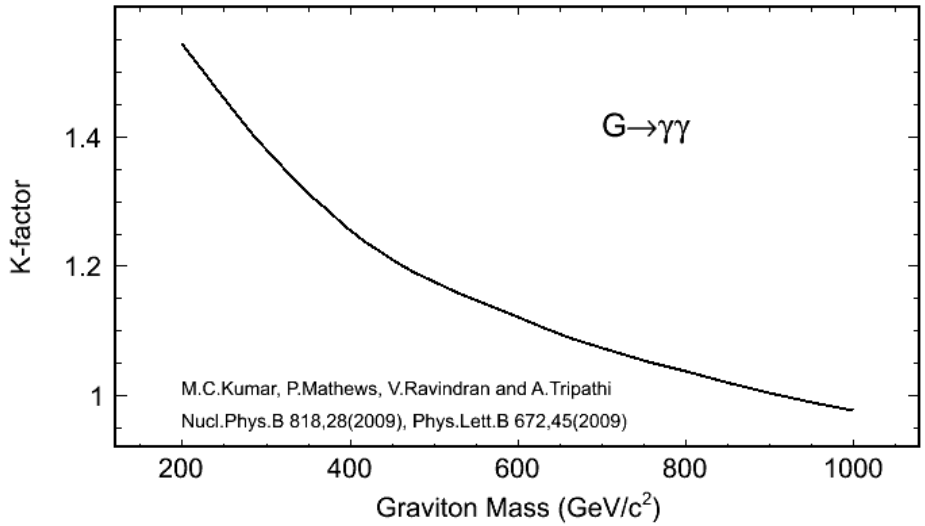
Background

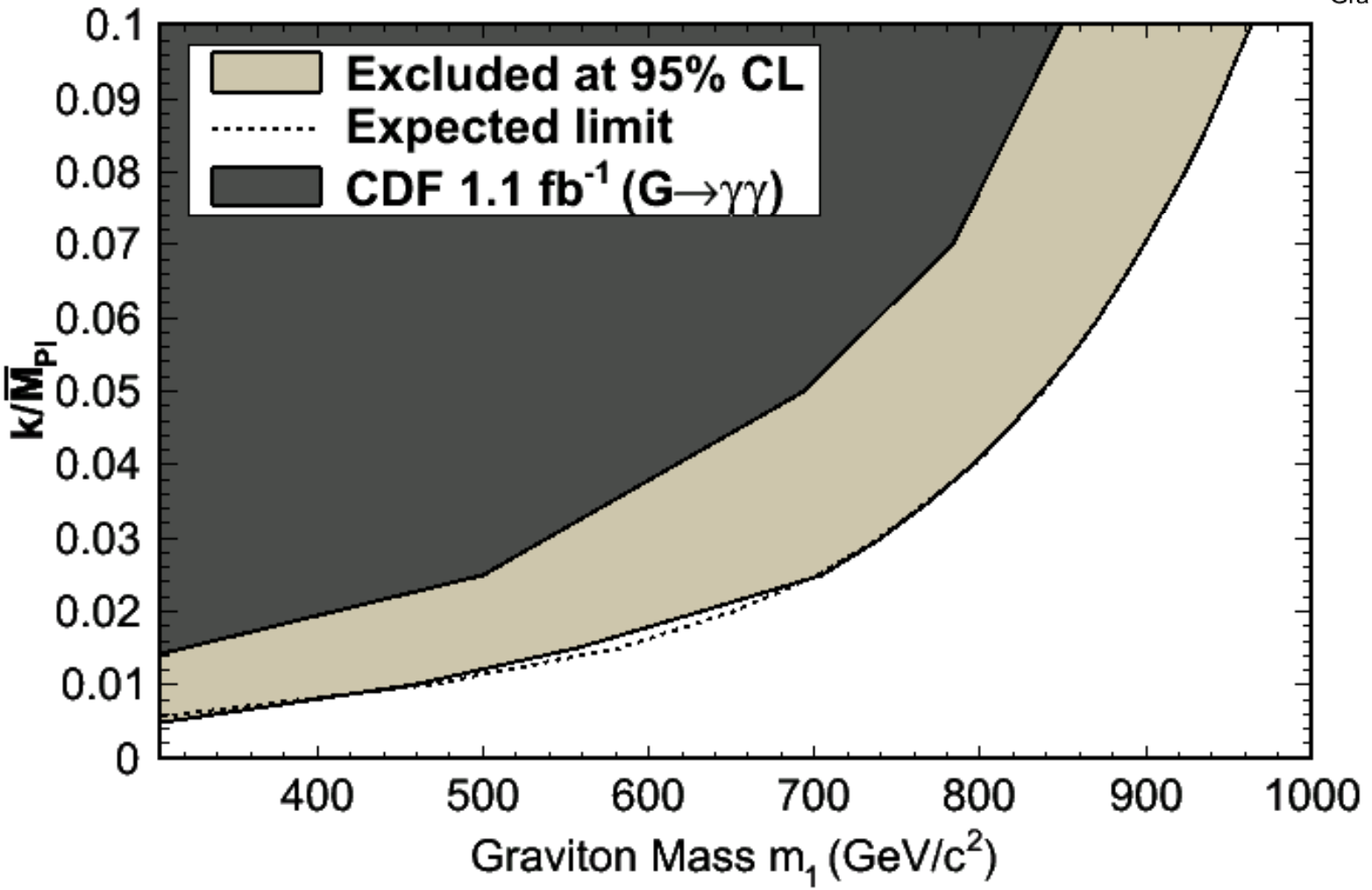
- fit DIPHOX NLO SM γγ spectrum
- fit data to DIPHOX + fake photon exponential form
- systematic:15-20% largest from PDF and efficiency



γγ Search

- mass-dependant k-factor
- limits in k/Mp_l vs M plane,
  k/Mp_l=0.1: **963 GeV**





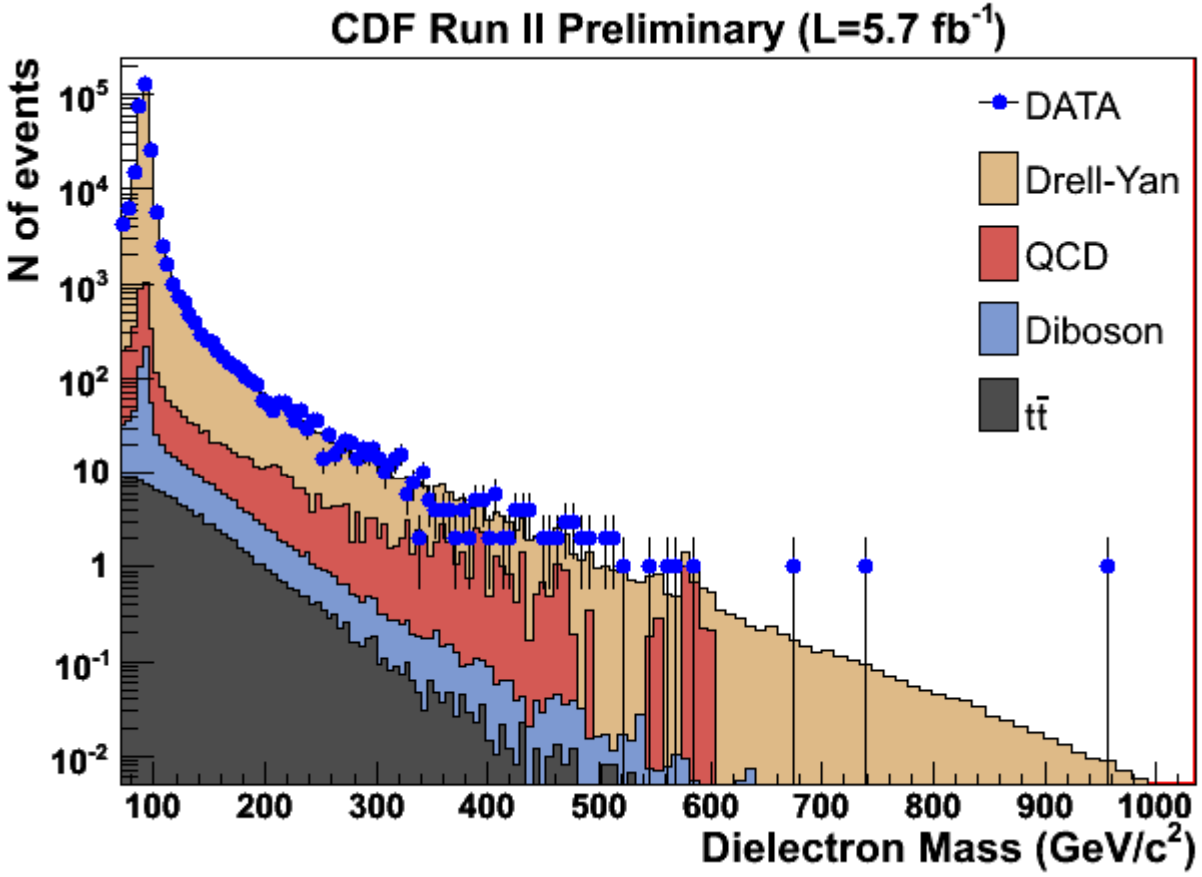
Ray Culbertson

di-electron Search

- 5.7 pb^{-1}
- two isolated electrons, central or forward, $|\eta|<2.8$

- backgrounds:
  - DY Monte Carlo
  - fakes through a fake rate measured in data
  - Ewk, top Monte Carlo

Worlds highest ee mass event: 960 Gev/c^2!



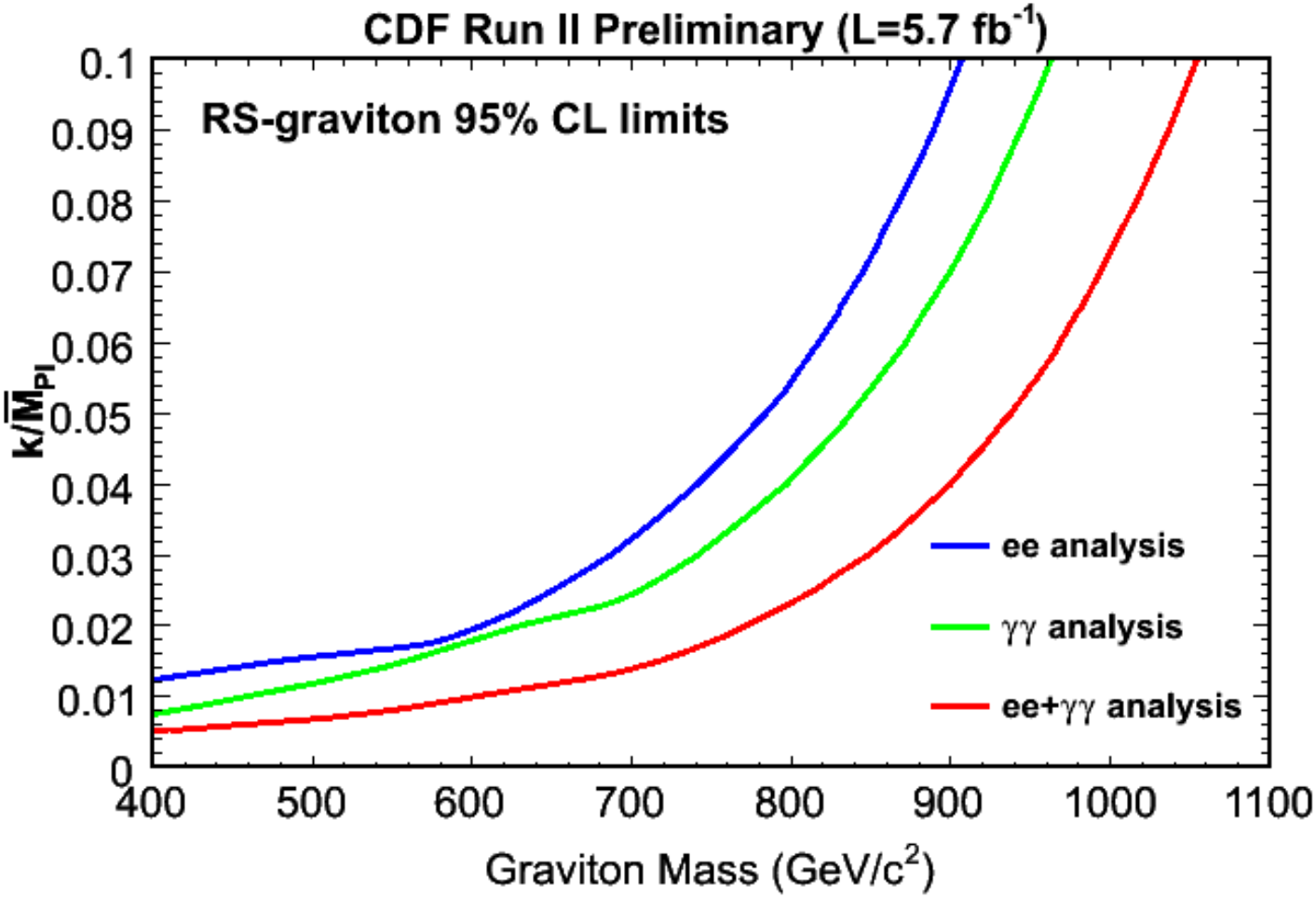
- no significant excesses
- 2.3 fb^{-1} hint at mass = 240 Gev/c^2 has decreased (Phys. Rev. Lett. 102, 031801 (2009))

$\gamma\gamma$ Search

combined $\gamma\gamma$ and ee R-S graviton limits

- mass-dependant k-factor
- **M>1055 GeV/c²** for $k/M_{pl}=0.1$

new world's best limit !



D0: 1050 GeV/c² with 5.4 pb^{-1} and k-factor=1.54 (P.R.L. 104 241802 (2010))

Search for Anomalous Kinematics in Photon+jets Events

γ+jets Search

first close look at this signature for CDF in Run II !

- sensitivity to GMSB SUSY, Technicolor, SUSY Higgs, X*
- chose to do this as a signature-based search
  - predict SM backgrounds
  - scan kinematic distributions for anomalies

- data sample
  - 4.8 fb^{-1} inclusive photon triggers
  - one central ($|\eta|<1$) isolated photon with $E_T > 30$ GeV
  - count jets with $E_T > 15$ GeV, require >= one jet
  - MET clean-up: $\Delta\varphi$(MET-jet) > 0.4 to any jet

- examine γ +j, γ+2j, with and without MET

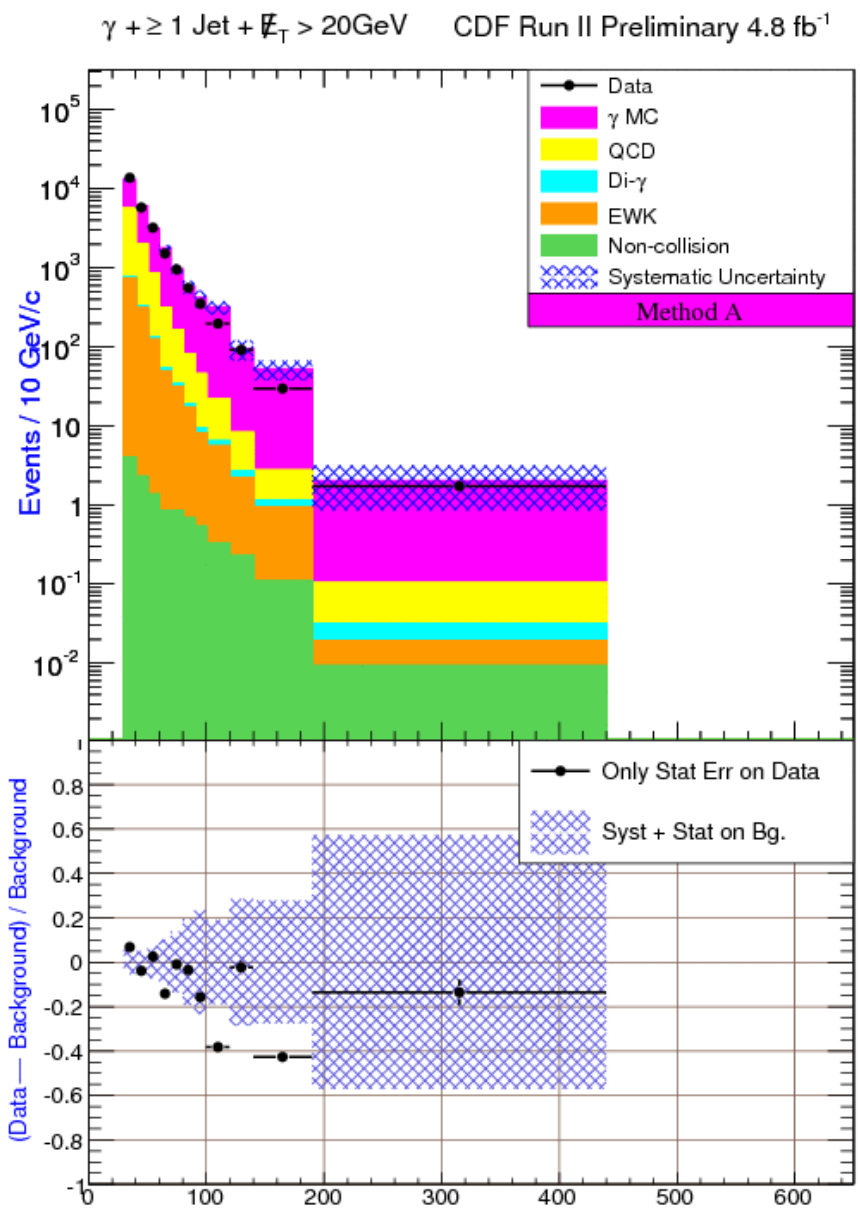
γ+jets Search

the challenge is in the background estimate

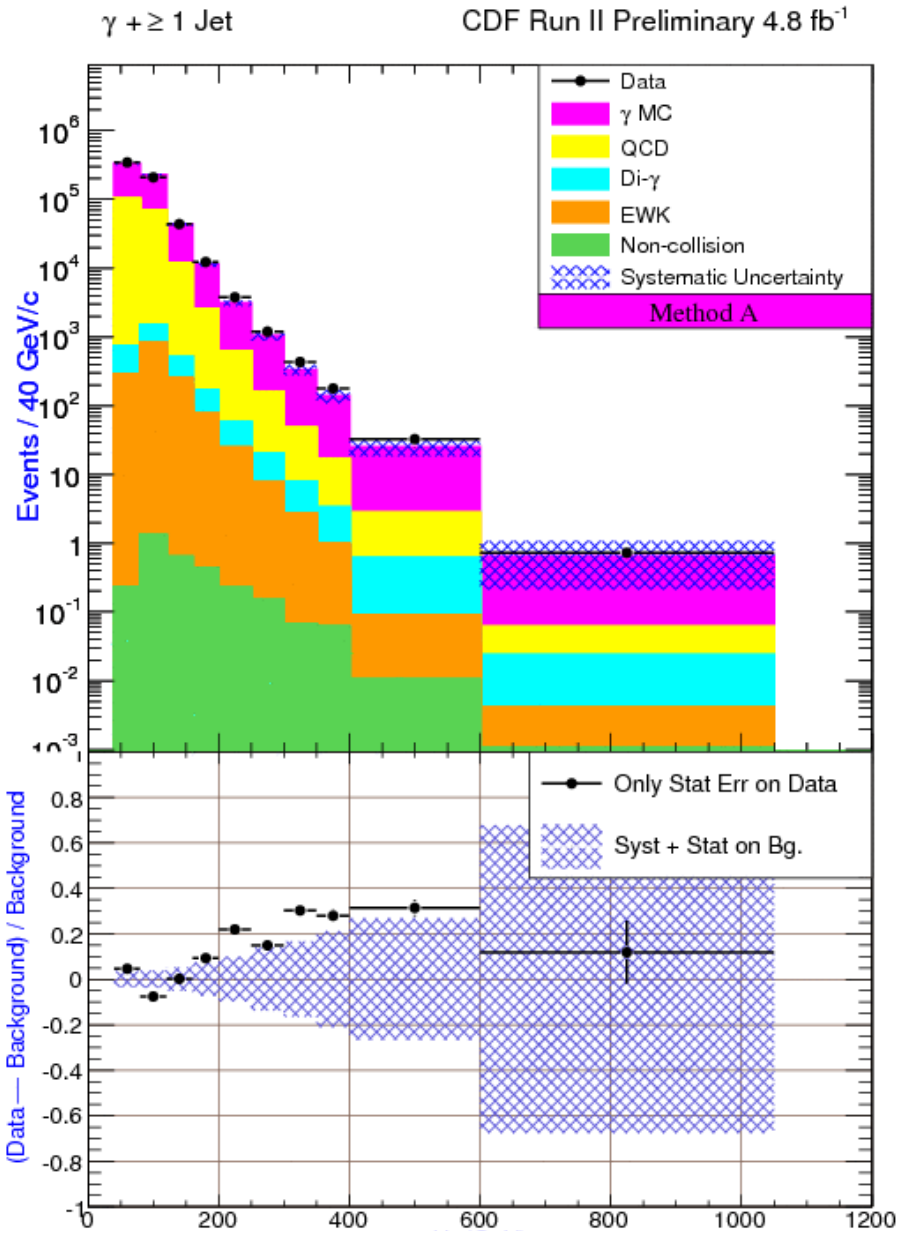
- Ingredients
  - PYTHIA inclusive photon/diphoton Monte Carlo + GEANT
  - "loose" photon sample, dominated by fakes, exclusive from signal
    - orthogonal measurement of the true/fake photon fraction
  - small components of cosmic showers and other pathologies
  - small EWK component from absolutely normalized Monte Carlo
    - total predicted background normalized to the observed total
- Method A
  - combine PYTHIA and loose sample in the known ratio
  - good for photon E_T ,H_T, but PYTHIA underestimates Njet
- Method B
  - reweight the photon E_T of the loose photon sample to Method A
  - entire prediction has data-based radiation, good for masses, Njet

γ+jets Search

♦ Method A (MC+loose)



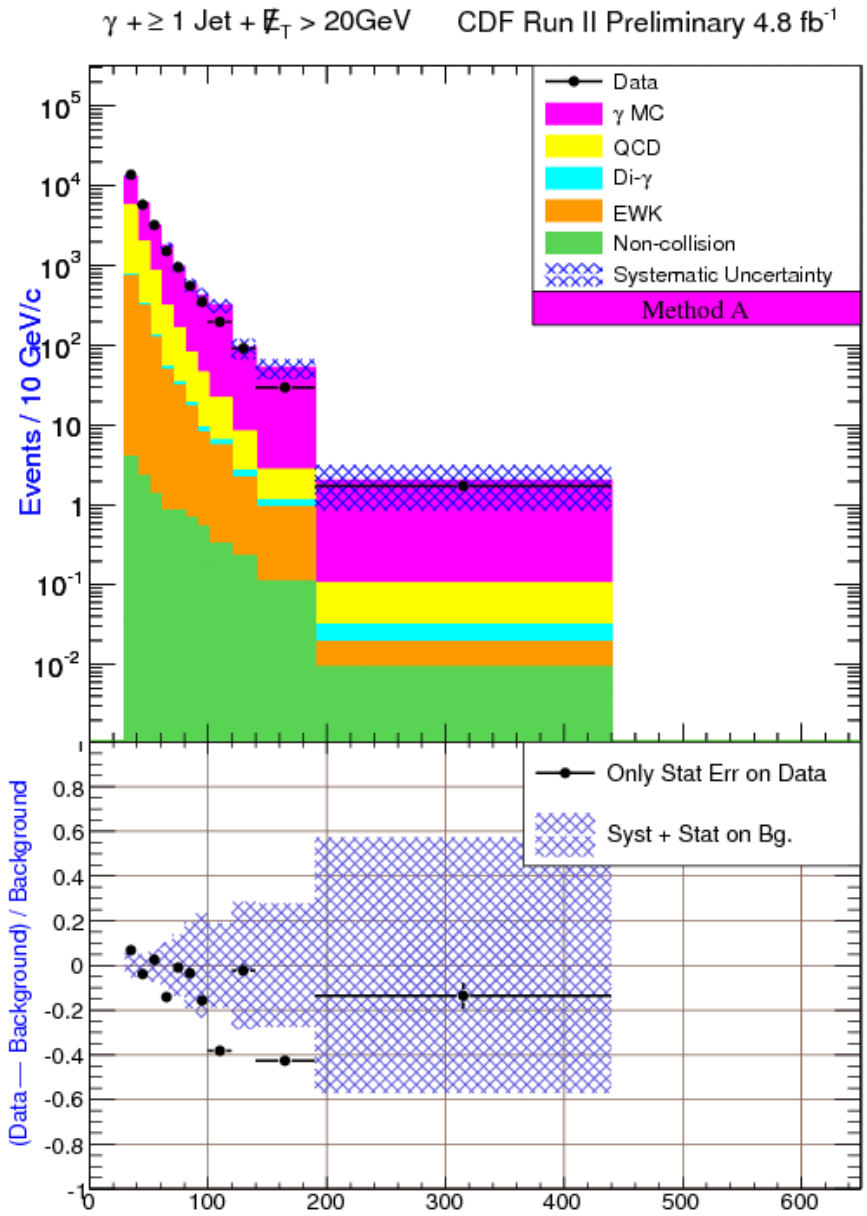
photon E_T



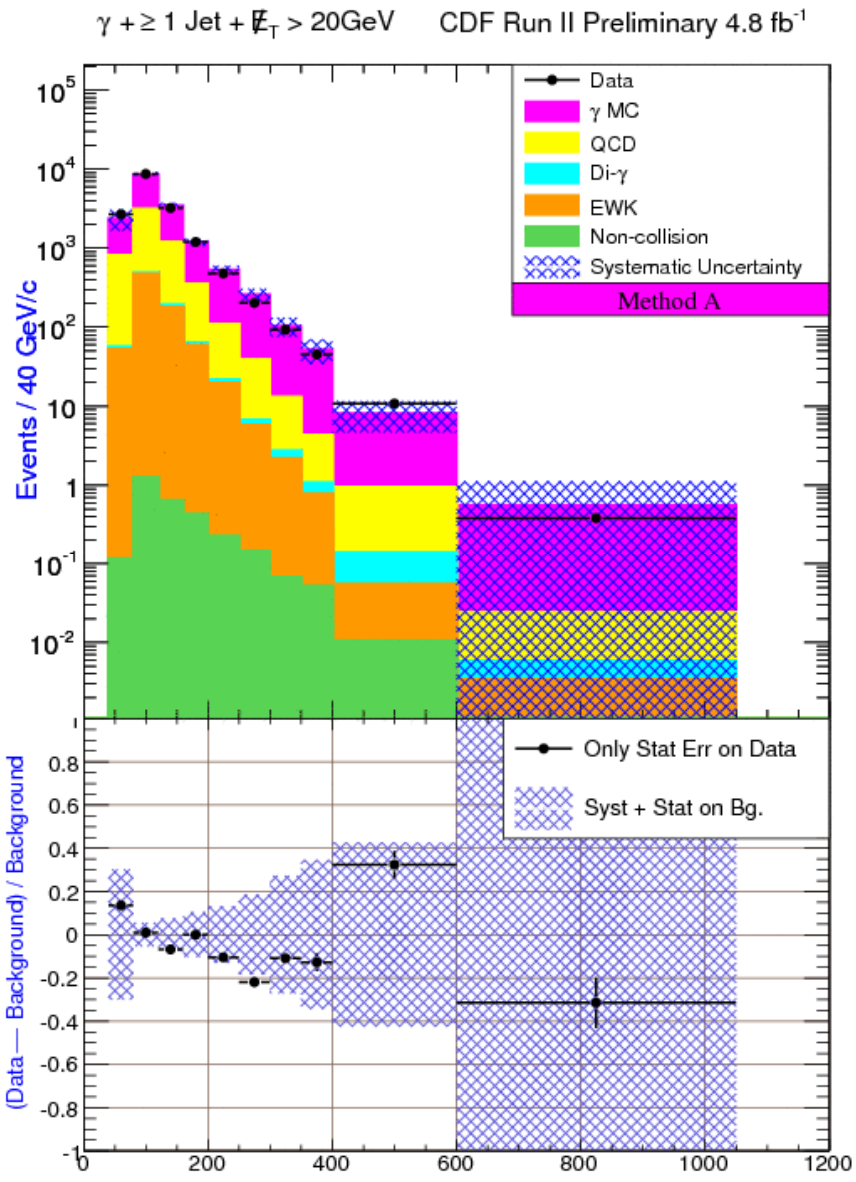
H_T

γ+jets Search

♦ Method A (MC+loose)



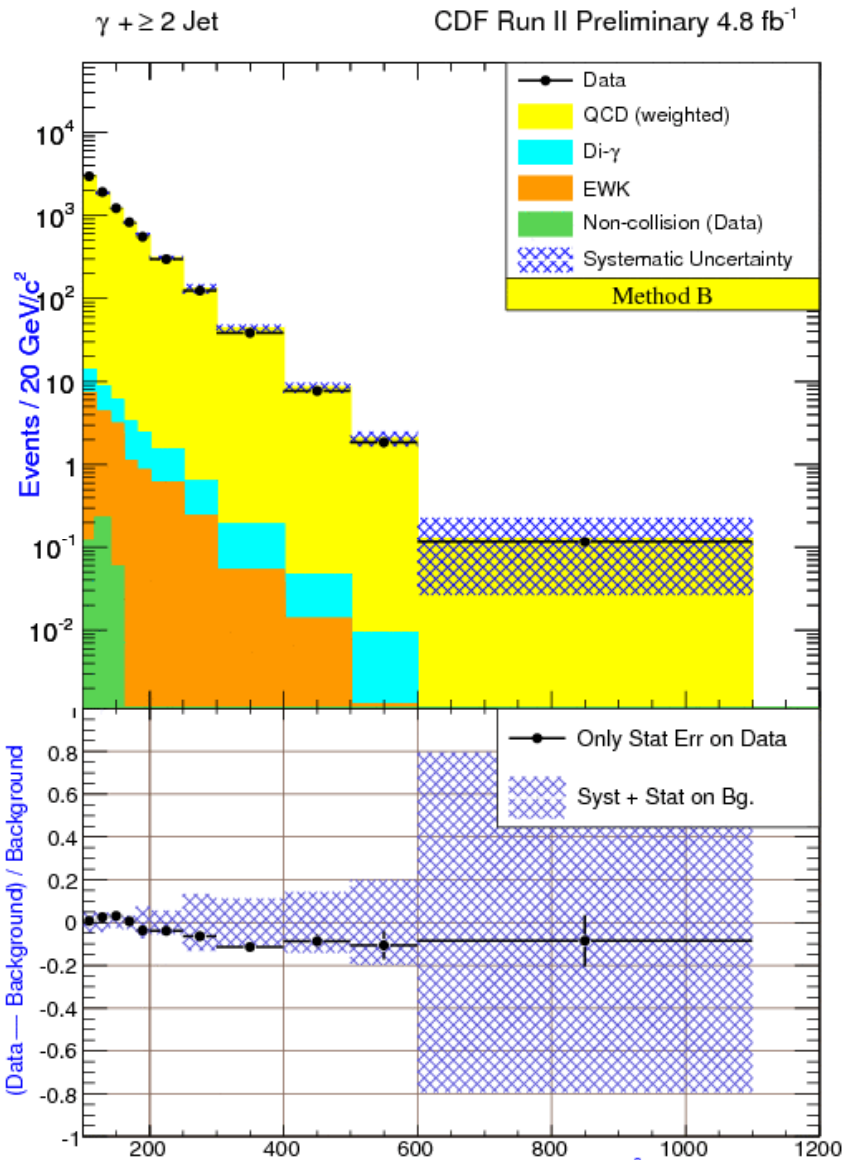
photon E_T for MET>20GeV



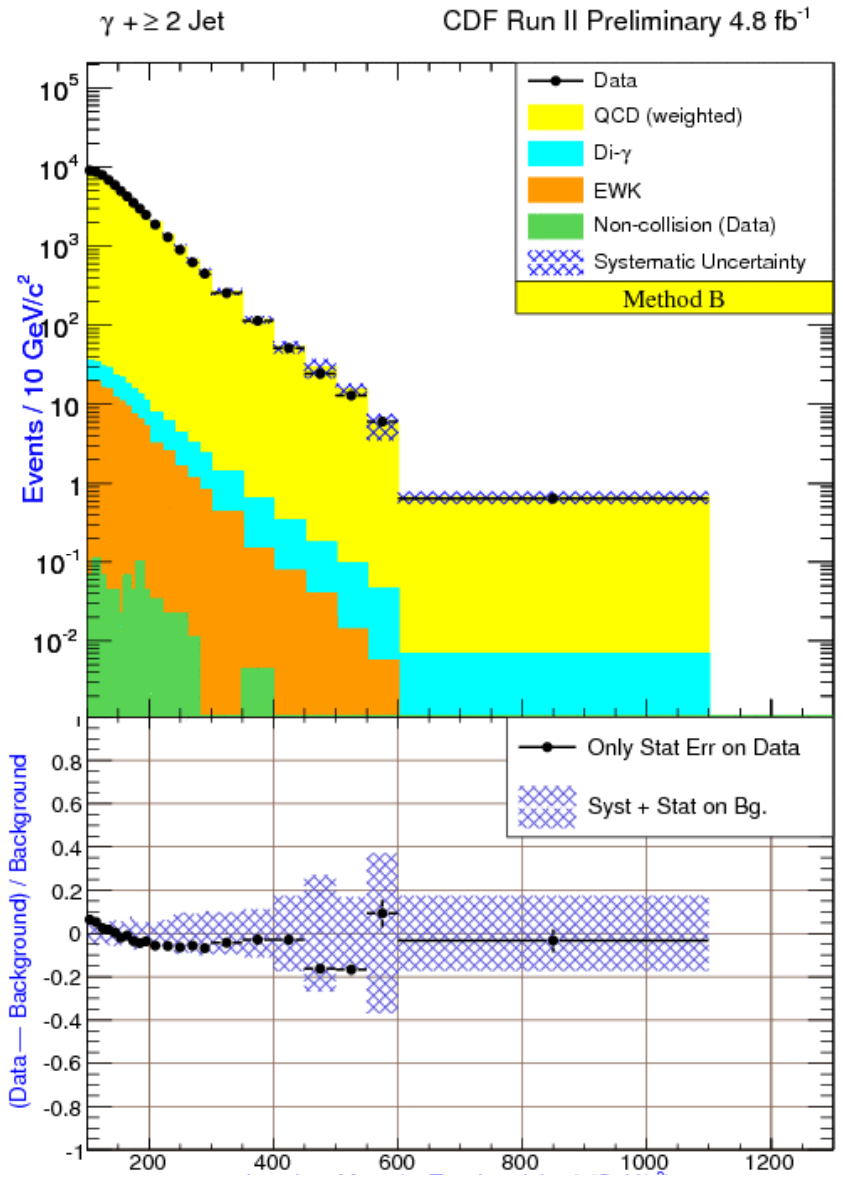
H_T for MET>20GeV

γ+jets Search

♦ Method B (loose)



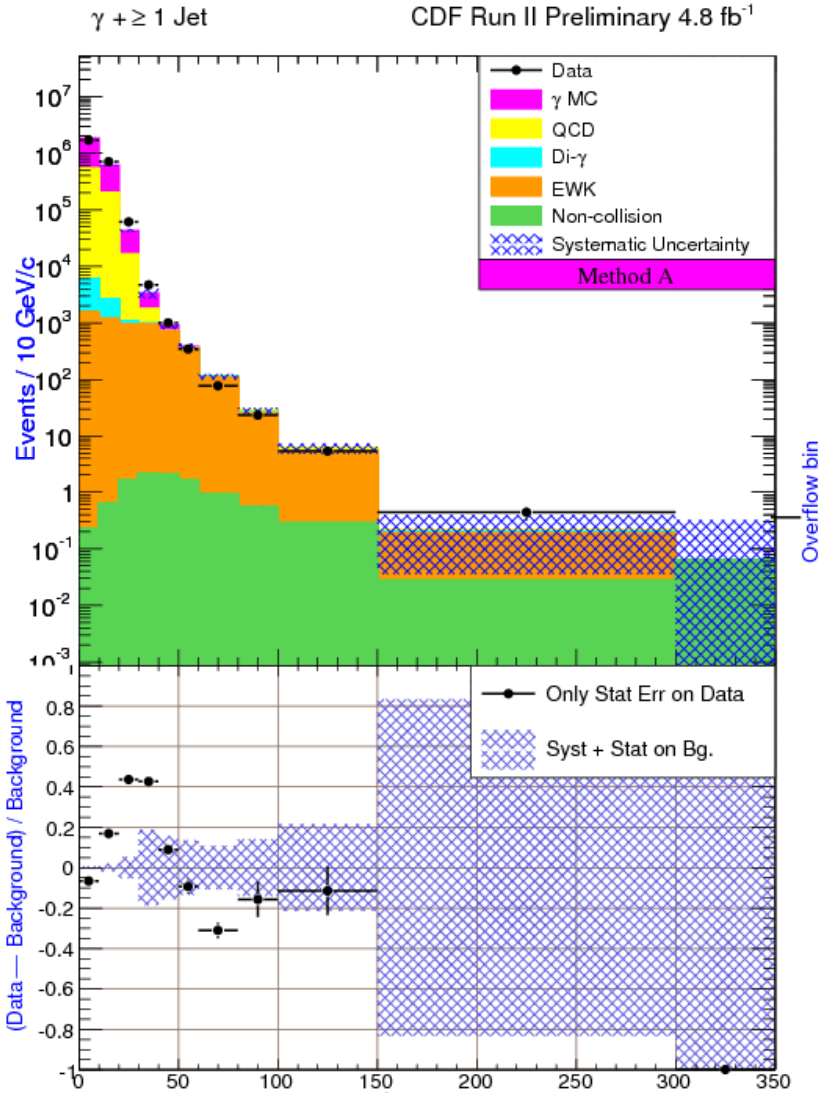
M(j1,j2)



M(photon,j1,j2)

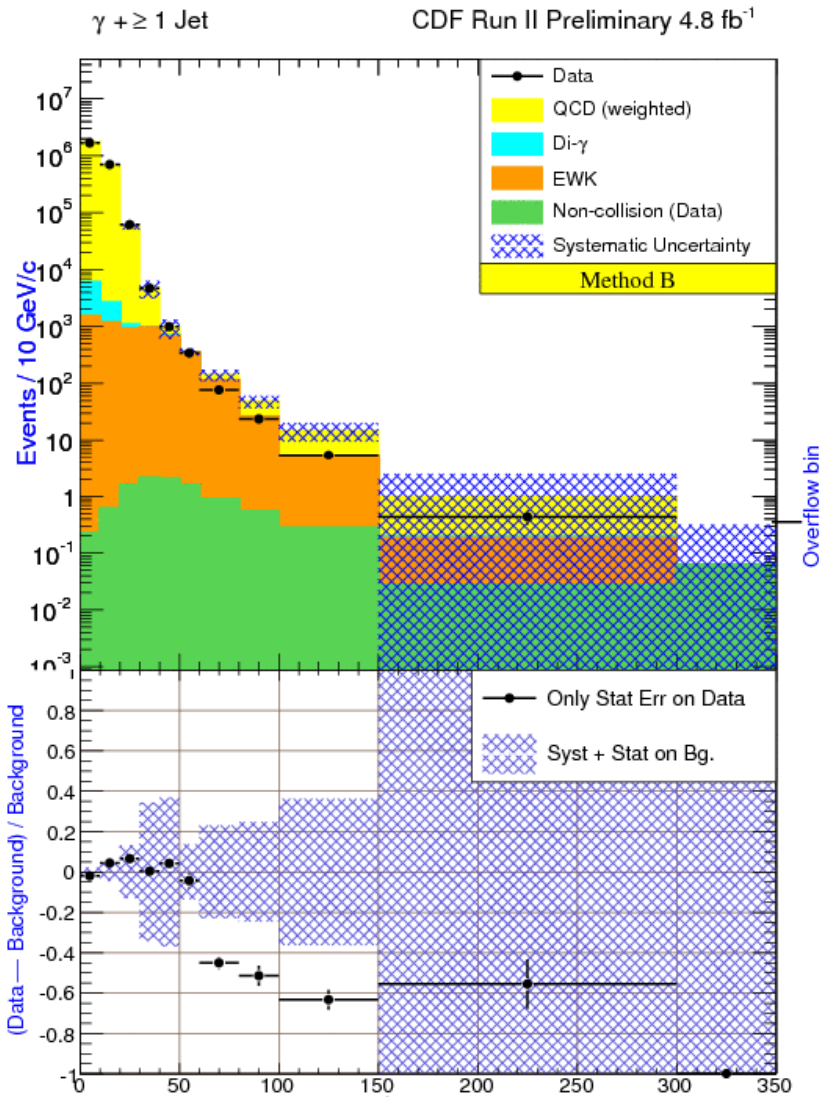
γ+jets Search

♦ Method A (MC+loose)



Missing E_T

♦ Method B (loose)



Missing E_T

Measurement of the Diphoton Cross Section

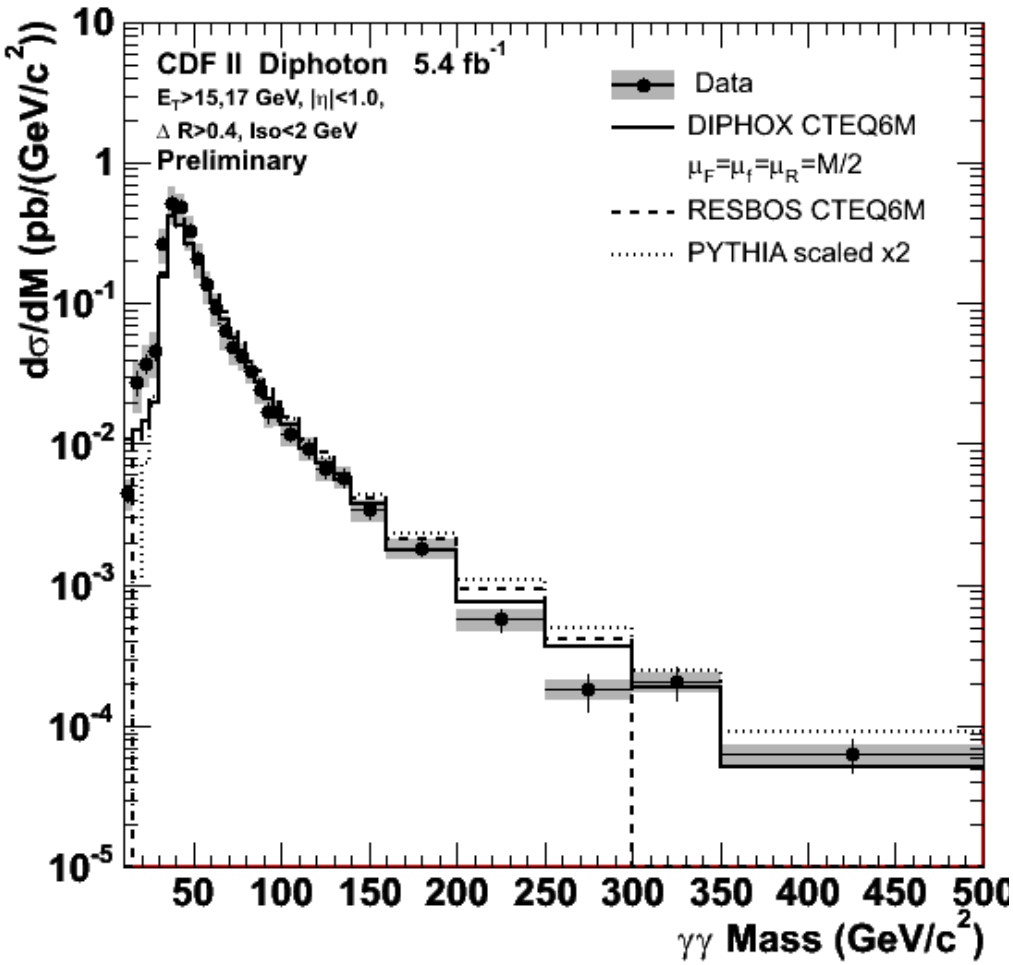
$\gamma\gamma$ Cross Section

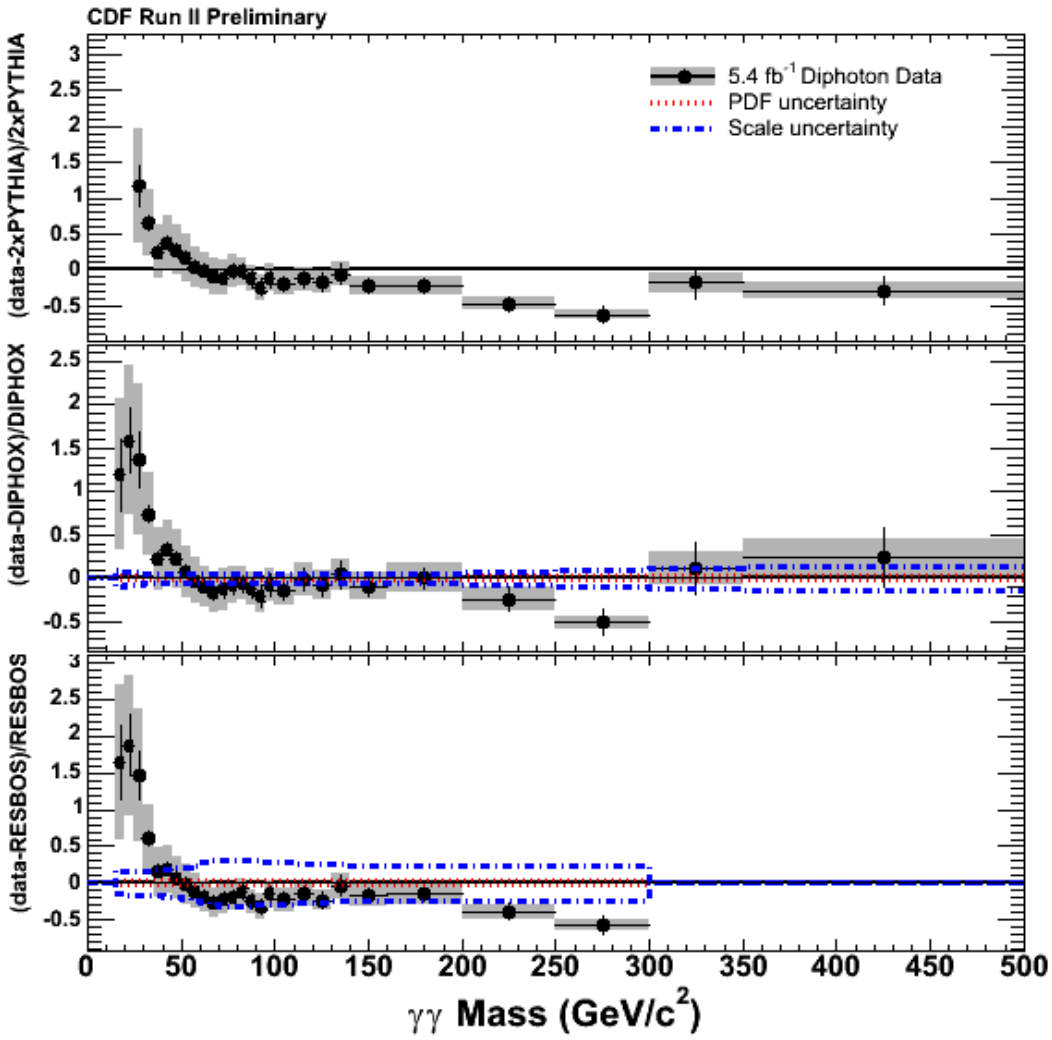
- 5.4 fb^{-1} of diphoton triggers
- $E_T > 15,17$ GeV, $|\eta|<1$
- Cal Iso < 2 GeV, cone 0.4
- $\Delta\varphi\ (\gamma\gamma) > 0.4$
- efficiency from PYTHIA + GEANT Monte Carlo
- efficiency iterated
- underlying event corrected to match theory
- background subtraction by track isolation distribution (systematic uncertainty: 15-20%)

Three Models:

- PYTHIA L.O. + I/FSR model scaled by a factor of 2
- DIPHOX N.L.O., including single and double fragmentation (quark catastrophic brem)
- RESBOS N.L.O. with resummed gluon emission

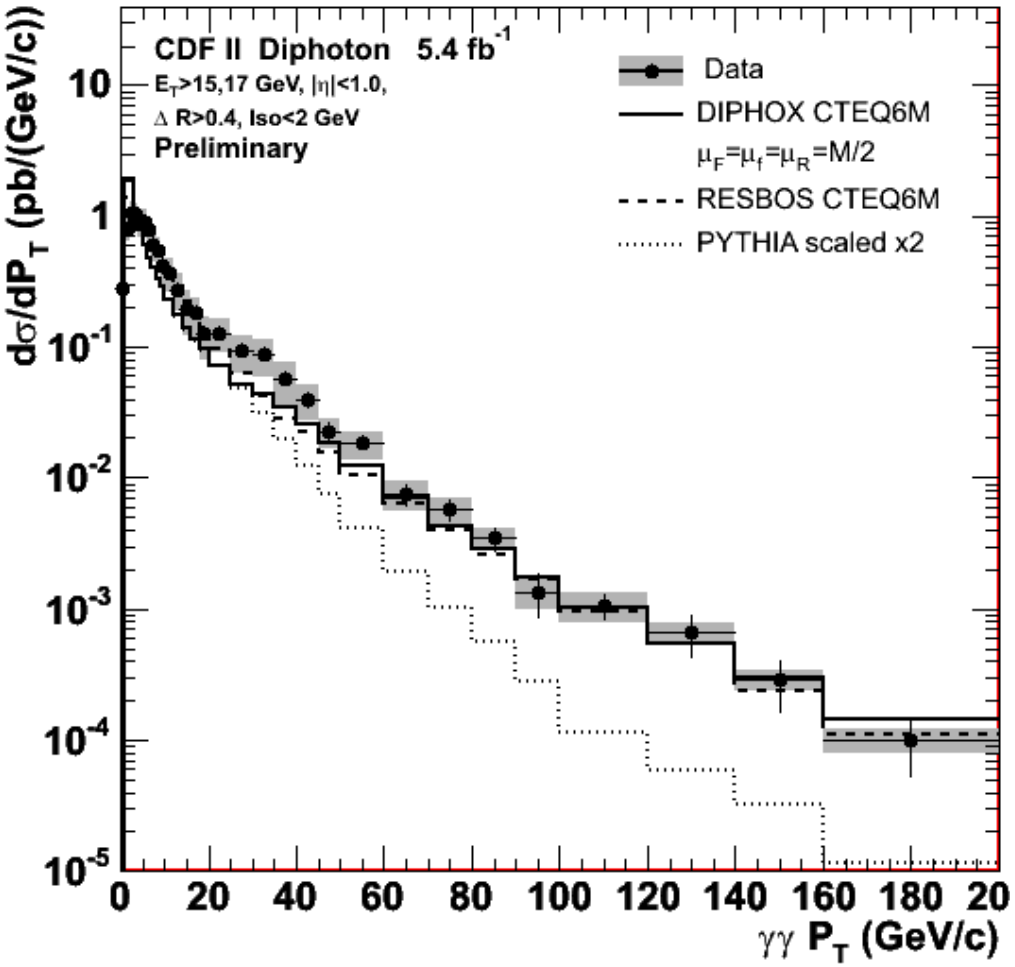
γγ Cross Section

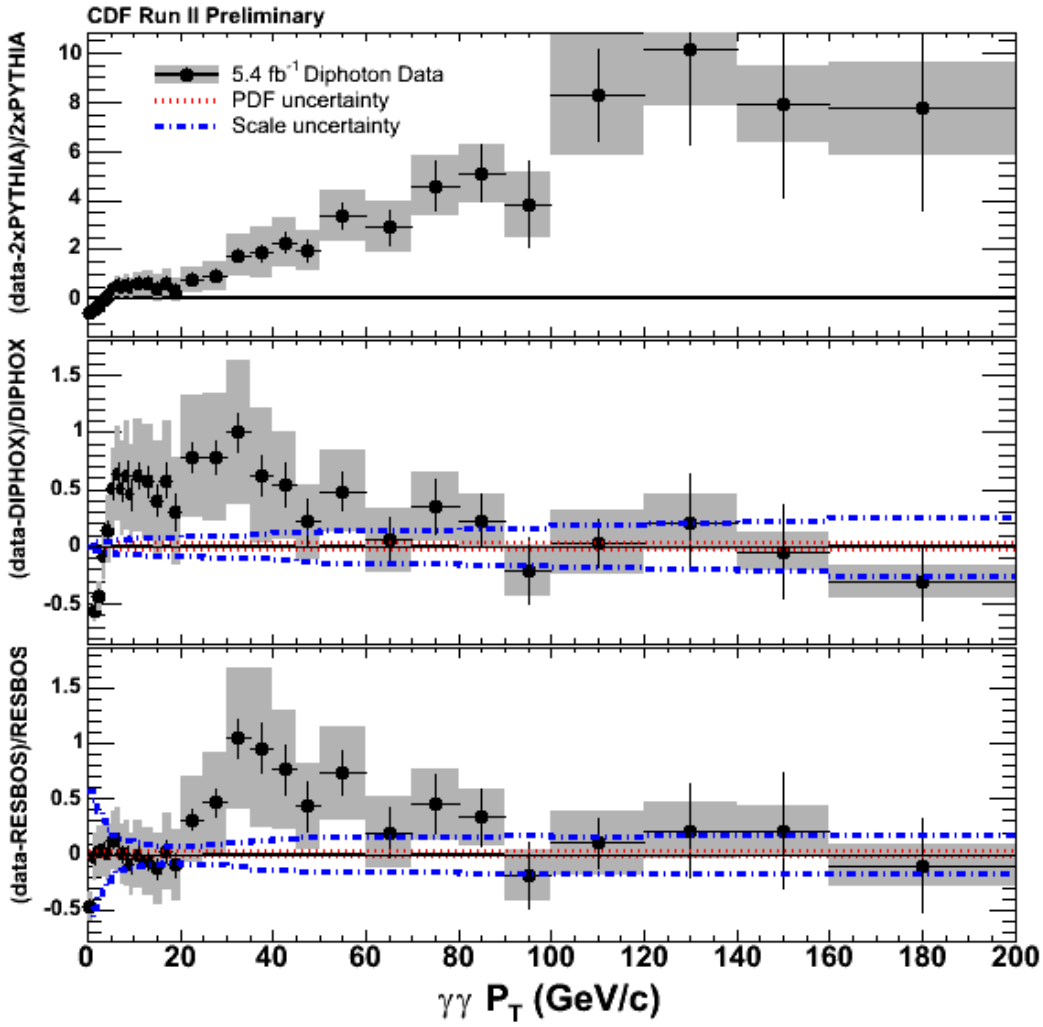




Diphoton Mass

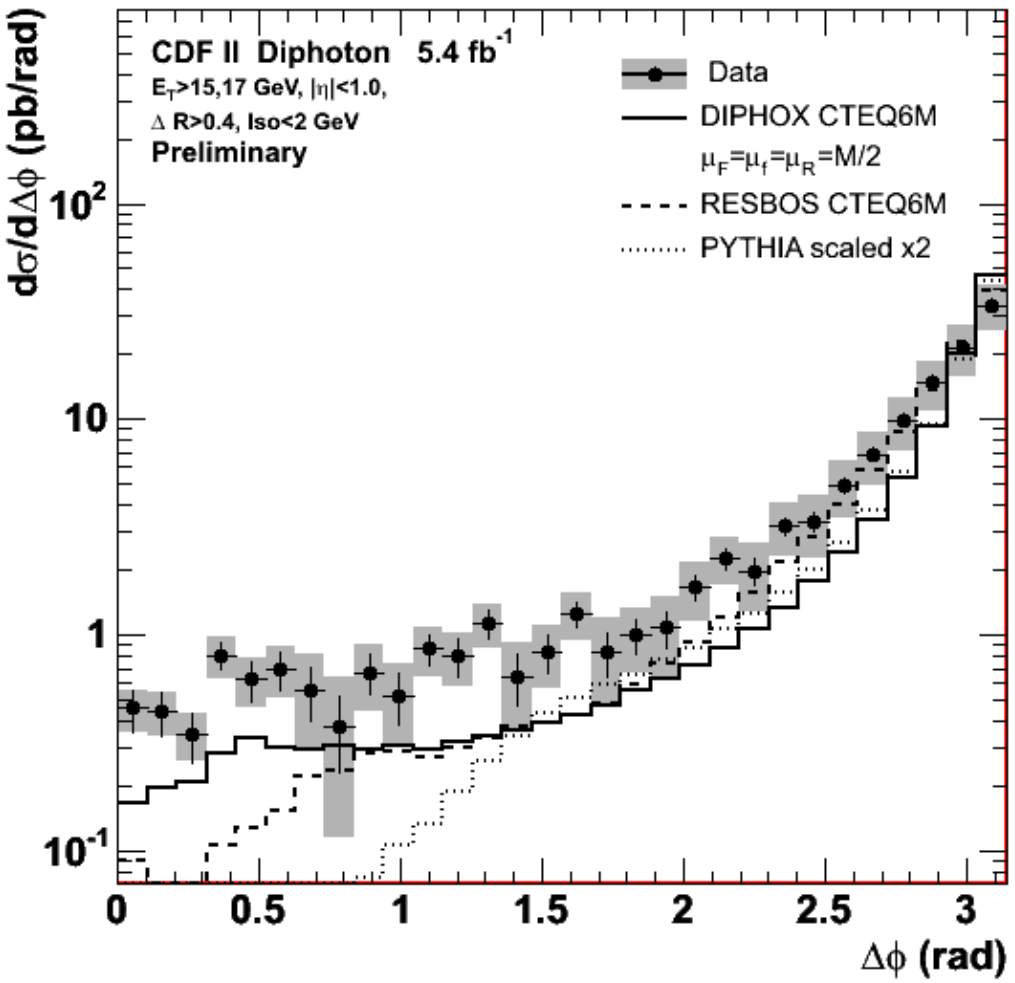
$\gamma\gamma$ Cross Section

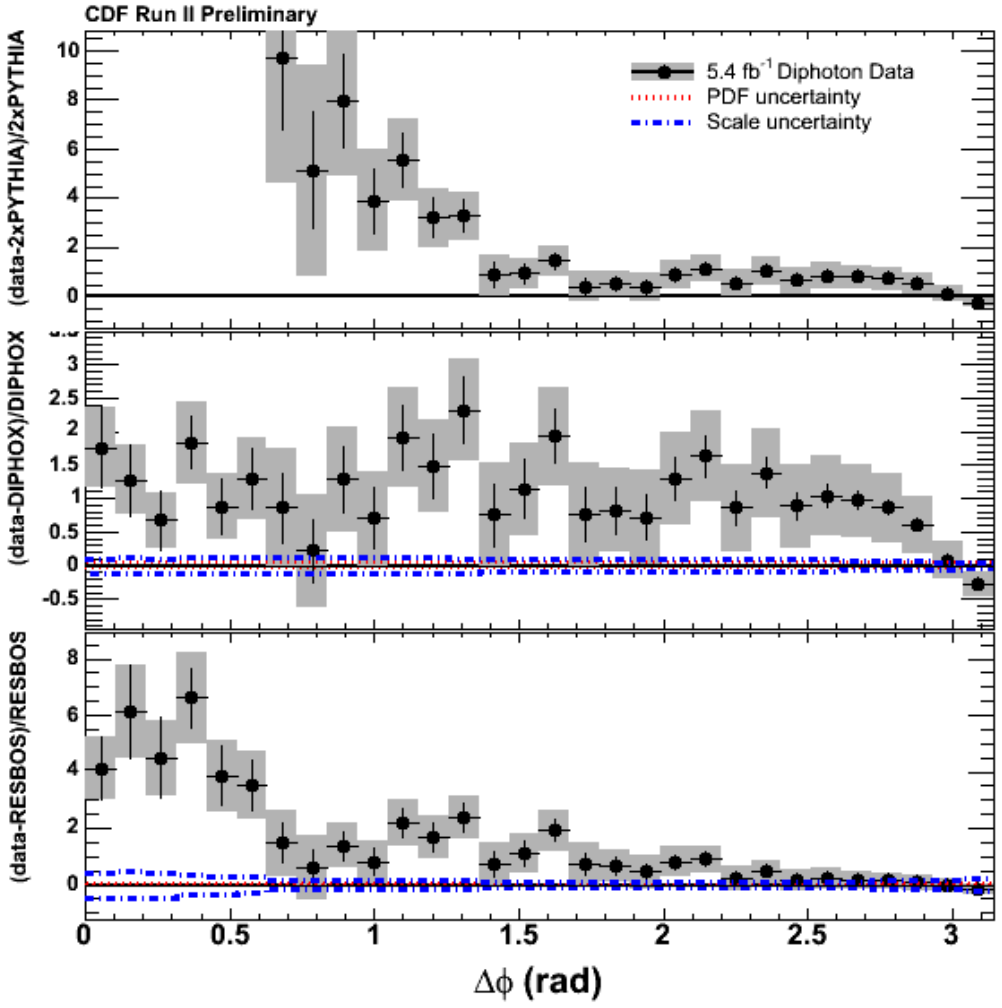




P_T of the Diphoton System

γγ Cross Section





Δφ Between Photons

Last Slide

- New Randall-Sundrum Graviton limits
  M>1055 GeV/c^2 for $k/M_{pl}=0.1$
- Searched photon+jets
- Measured the diphoton cross section

For complete sets of plots and analysis details, see
http://www-cdf.fnal.gov/physics/physics.html
Peruse the 27 published and 9 preliminary high-P_T photon results!

Thank you!