Randall-Sundrum Model Search in High Mass Diphotons

Preblessing

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27th May 2004
Exotics meeting

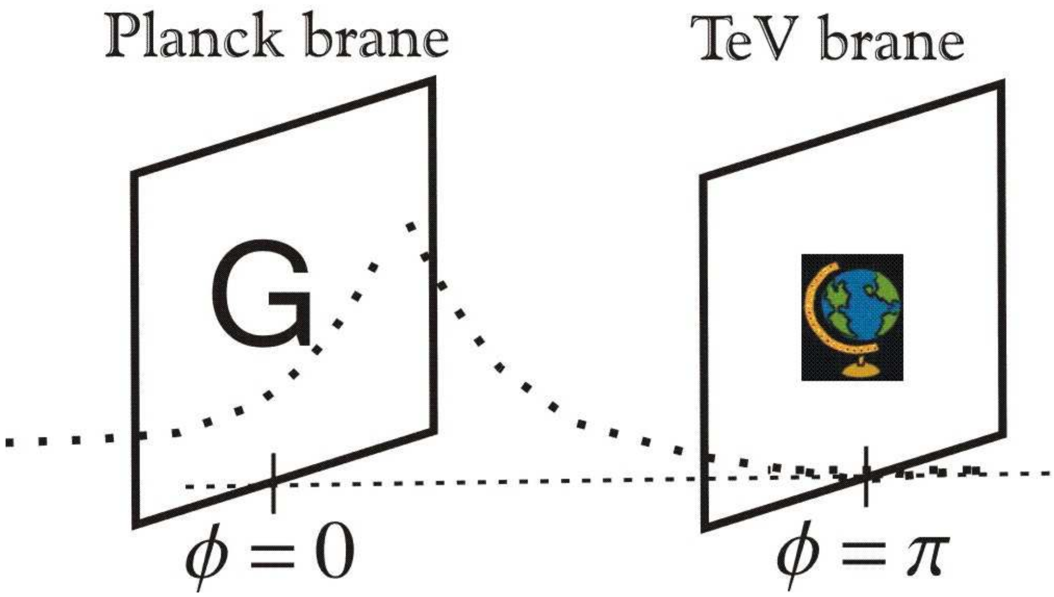
Overview

- RS model
- Dataset and Signal Sample Selection
- Signal Data Sample
- Acceptance and Efficiency Studies
- RS model Limit with no background
- Background Studies
  - SM NLO Diphoton Spectrum
  - Sideband Method
- RS model Limit with background
- Future plans

This work is described in cdf note 7024
Blessing Questions and Answers webpage:
http://home.fnal.gov/~pratt/Bless2004/BlessQA2004.html

Randall-Sundrum Model

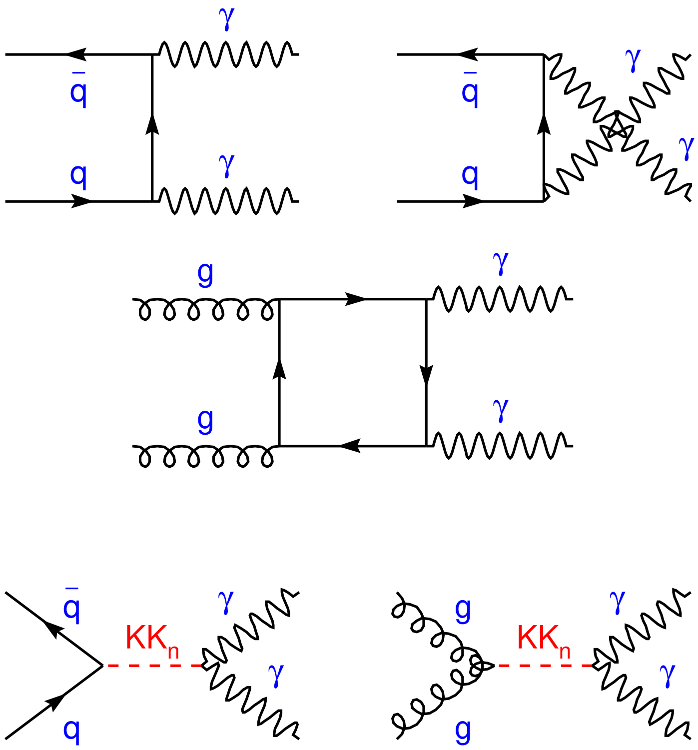
An Extra Dimensional model
with 1 Extra Dimension of finite size, in which gravity propagates
SM particles are confined to a brane (TeV) in the ED



Randall-Sundrum Model

Detect the ED via deviations to the SM diphoton production

Standard Model diphoton production and Graviton (KK) exchange



Search for peaks in the high mass diphoton spectrum

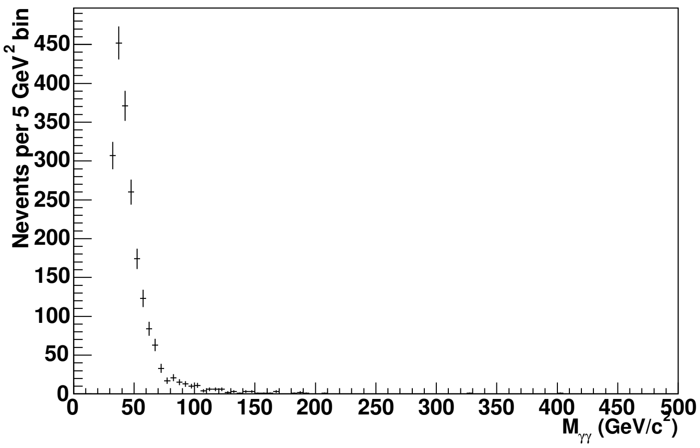
Dataset and Signal Sample Selection Criteria

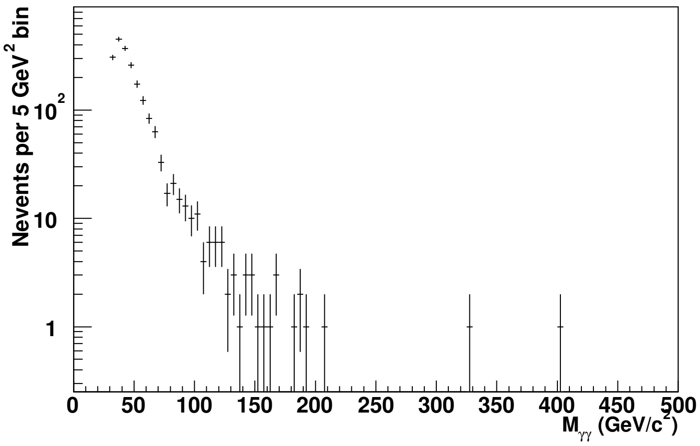
- Data used has 5.3.1 processing
- Stntuplised in version 5.3.1 dev 242
- Stripped 12 and 18GeV diphoton triggers from the cdip0d datasets
- in stntuple catalog: "stntuple/dev_242:cdip0d";
- Good runs were required: Same as for gg+met, based on DQM v4
  http://www-cdf.fnal.gov/internal/dqm/goodrun/v4/goodv4.html
  Good runs from 138819 to 168889
  Luminosity: 202 pb^{-1}
- Standard Photon cuts V2.1 applied to both photons

Event Cuts
trigger path: DIPHOTON 12 or DIPHOTON 18 ZVertex exists, $\lvert z\rvert < 60$ cm GOODRUN
Photon Cuts for both photons
Central CES strip and wire clusters present CES $\lvert x\rvert < 21.0$ cm CES $9.0 < \lvert z\rvert < 230.0$ cm
Had/EM$< 0.055 + 0.00045 * E$ CalIso(cone 0.4) $< 2.0 + 0.02 * (Et - 20 \text{ GeV})$ or $< 0.1Et$ if $Et < 20.0$ avg, scaled CES $\chi^2 < 20$ N3D$= 0$ || N3D$= 1$ and Pt$< 1.0 + 0.005 * Et$ SumPt (cone 0.4) $< 2.0 + 0.005Et$ Second CES cluster $E < 2.4 + 0.01 * Et$ or $E < 0.14 * Et$ if $Et < 18.0$

Signal Data Sample

After application of selection cuts and
Et > 15 GeV and $M_{\gamma\gamma}$ > 30 GeV : 2001 diphoton events



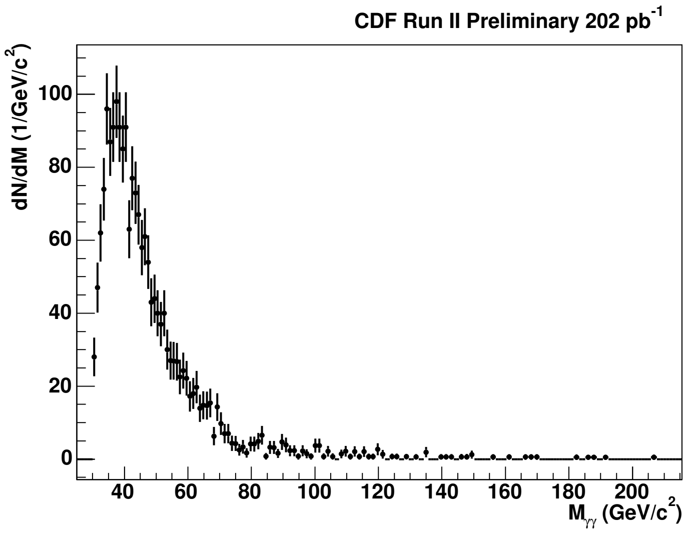


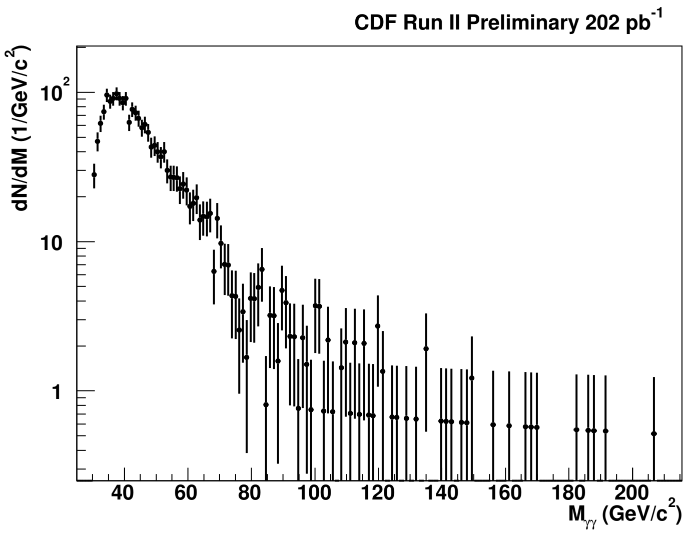
Three events above 200 GeV/c^2

run: event: 165271 : 2045232 Mass : 405 GeV/c^2 : Etc0 : 175 Etc1 : 172
run: event: 165435 : 446579 Mass : 329 GeV/c^2 : Etc0 : 170 Etc1 : 172
run: event: 166007 : 2285035 Mass : 207 GeV/c^2 : Etc0 : 110 Etc1 : 79

Search for bumps?!

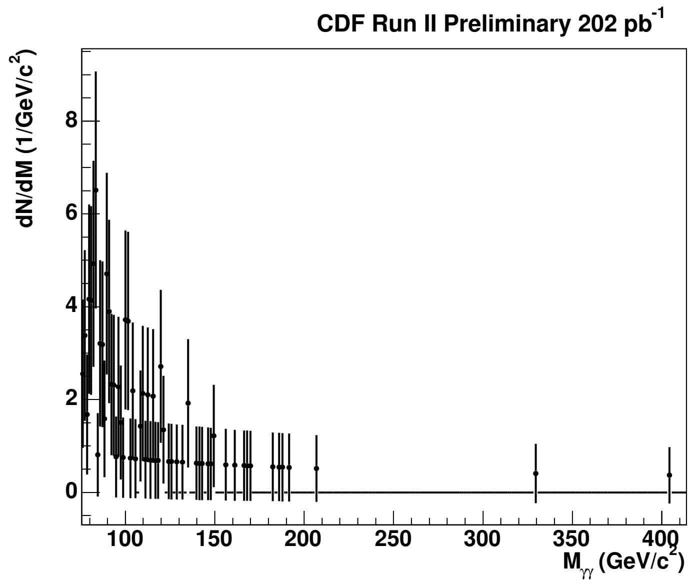
Diphoton spectrum in bins of 1 sigma mass resolution (minimum of 1GeV)

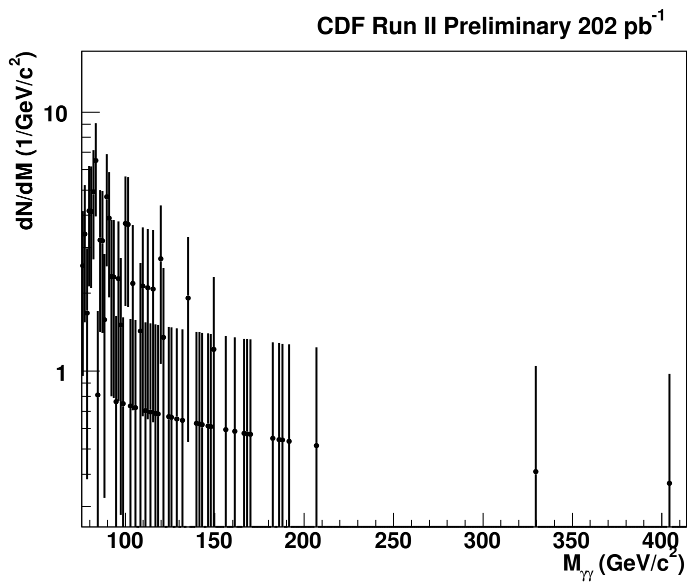




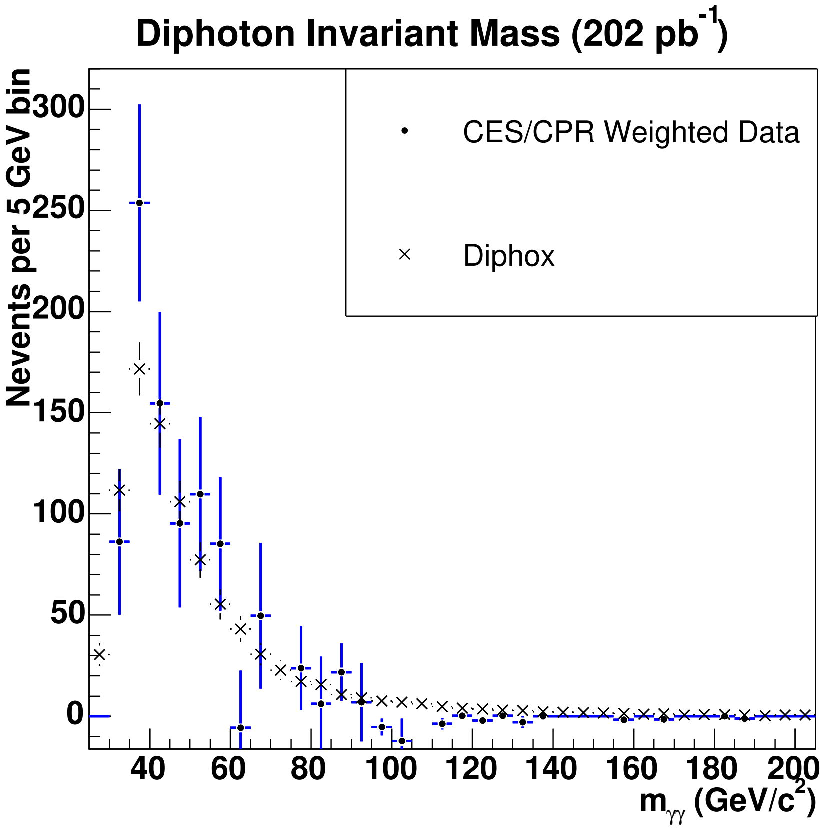
Search for bumps?!

Diphoton spectrum in bins of 1 sigma mass resolution (minimum of 1GeV)





Comparison with expectation



Acceptance and Efficiency for RS MC

RS Signal MC generated using Pythia 6.223 in version 4.9.1
Events weighted to correct for diphoton angular distribution (CDF 6560)
12000 events generated at M_G from 250 GeV to 1000 GeV in 50 GeV steps
PDF = CTEQ5L

Signal region are 3 σ around the reconstructed invariant mass for each M_G

Acceptance and Efficiency in signal window, from MC
MC corrections from comparisons of 4.9.1 data and MC to be added
And correction for 4.9.1 $\rightarrow$ 5.3.1 (presently estimated from MC)
(but plan to update using data $Z \rightarrow ee$ efficiency comaparisons of 4.9.1 to 5.3.1)

Mass Gev/c^2	Signal Range in	Region Gev/c^2	S. Width Gev/c^2	Acceptance	Efficiency*Acceptance
200	184	218	34	0.246 $\pm$ 0.003	0.125 $\pm$ 0.002
250	232	272	40	0.279 $\pm$ 0.003	0.144 $\pm$ 0.002
300	278	328	50	0.313 $\pm$ 0.003	0.162 $\pm$ 0.003
350	324	382	58	0.345 $\pm$ 0.004	0.179 $\pm$ 0.003
400	370	434	64	0.384 $\pm$ 0.005	0.201 $\pm$ 0.004
450	416	490	74	0.421 $\pm$ 0.004	0.225 $\pm$ 0.004
500	460	544	84	0.440 $\pm$ 0.004	0.239 $\pm$ 0.004
550	506	598	92	0.486 $\pm$ 0.005	0.270 $\pm$ 0.004
600	552	652	100	0.495 $\pm$ 0.005	0.269 $\pm$ 0.004
650	596	704	108	0.522 $\pm$ 0.005	0.290 $\pm$ 0.005
700	642	758	116	0.545 $\pm$ 0.005	0.297 $\pm$ 0.005
750	684	812	128	0.553 $\pm$ 0.005	0.295 $\pm$ 0.005
800	732	864	132	0.555 $\pm$ 0.005	0.292 $\pm$ 0.005
850	776	916	140	0.565 $\pm$ 0.006	0.302 $\pm$ 0.005
900	820	968	148	0.5620 $\pm$ 0.005	0.300 $\pm$ 0.005

Acceptance and Efficiency for RS MC

Corrections of MC to Data

Variable	Correction to MC	Rel.Syst.Unc.	Study
	(%)	(%)	
Had/Em	+2	1.0	UE and Z
Cal iso	-2	5.0	data/MC in UE & Z
Chi2 (Strips+Wires)/2.0	-3	2.0	Z study
N track (N3D)	-1	0.5	UE study
Track Pt	-1	1.0	UE study
Cone 0.4 Track Iso	-2	1.0	UE and Zee
2nd CES cluster	-	-	-
Fiducial	-	3.0	
Conversions	-3.7	1.2	E/p material
Trigger Efficiency	-	-	
Total per photon	-10.7	6.5	
Total per diphoton event	-21.4	13.0	

Acceptance and Efficiency for RS MC

To estimate uncertainty in efficiency due to versions 4.9.1 - 5.3.1

Compare RS MC 5.3.1 to 4.9.1

M_G GeV/c^2	Acceptance*Efficiency (A*ϵ) 4.9.1	5.3.1	Δ(A*ϵ)/(A*ϵ)
200	0.125 $\pm$ 0.002	0.121 $\pm$ 0.002	0.03
250	0.144 $\pm$ 0.002	0.142 $\pm$ 0.002	0.01
300	0.162 $\pm$ 0.003	0.156 $\pm$ 0.003	0.04
350	0.179 $\pm$ 0.003	0.181 $\pm$ 0.003	-0.01
400	0.201 $\pm$ 0.004	0.203 $\pm$ 0.003	-0.01
450	0.224 $\pm$ 0.004	0.210 $\pm$ 0.004	0.06
500	0.239 $\pm$ 0.004	0.235 $\pm$ 0.004	0.02
550	0.270 $\pm$ 0.004	0.252 $\pm$ 0.004	0.07
600	0.269 $\pm$ 0.004	0.270 $\pm$ 0.004	-0.004
650	0.290 $\pm$ 0.005	0.279 $\pm$ 0.004	0.04
700	0.297 $\pm$ 0.005	0.288 $\pm$ 0.004	0.03
750	0.295 $\pm$ 0.005	0.283 $\pm$ 0.004	0.04
800	0.292 $\pm$ 0.005	0.292 $\pm$ 0.004	0.00
850	0.302 $\pm$ 0.005	0.294 $\pm$ 0.005	0.03
900	0.301 $\pm$ 0.005	0.298 $\pm$ 0.004	0.01

Acceptanace*Efficiency generally higher in 4.9.1. This is probably due to the underestimation of the number of conversions in 4.9.1. To be verified

At present taken the uncertainty of version 4.9.1 $\rightarrow$ 5.3.1 as 0.034 independent of M_G. (From squaring each Δ(A*ϵ)/(A*ϵ) and dividing by the total number of masses generated.)
Plan to estimate any uncertainties from a change in efficiency between 4.9.1 to 5.3.1 using $Z \rightarrow ee$ data in future, rather than MC.

Uncertainties in Acceptance

Change in acceptance due to changing the pdf

M_G	Acceptance (%)					
(GeV/c^2)	CTEQ5L	MRST leading order Fit				
		Central	High Gluon	Low Gluon	High Alpha$_s$	Low Alpha$_s$
250	27.9 ± 0.3	27.5 ± 0.4	27 ± 0.5	26.7 ± 0.5	27.3 ± 0.4	26.3 ± 0.4
350	34.5 ± 0.4	33.6 ± 0.6	33.2 ± 0.5	34 ± 0.6	35 ± 0.6	35.2 ± 0.6
450	42.1 ± 0.4	40.7 ± 0.6	38.8 ± 0.7	40.5 ± 0.9	40.7 ± 0.6	41.2 ± 0.6
550	48.6 ± 0.5	46.3 ± 0.7	44.6 ± 0.7	47.4 ± 0.7	46.6 ± 0.9	47.3 ± 0.7
650	52.2 ± 0.5	50.8 ± 0.8	50.3 ± 0.8	51.4 ± 0.9	50.6 ± 0.8	50.9 ± 0.8
750	55.3 ± 0.5	54 ± 0.8	52.6 ± 0.8	54.4 ± 0.9	53.4 ± 0.8	54 ± 0.8
850	56.5 ± 0.6	54.4 ± 0.9	54.2 ± 0.8	55.7 ± 0.8	54.3 ± 1	55.5 ± 0.8
950	76.3 ± 0.4	76.7 ± 0.7	78 ± 0.7	79.7 ± 0.7	75.8 ± 0.9	75.1 ± 0.9

M_G	Average Deviation (%)	ΔA/A
250	1	0.04
350	0.8	0.02
450	2	0.05
550	2	0.05
650	1	0.03
750	2	0.03
850	2	0.03
950	2	0.02

To do: calculate uncertainty due to turning on and off FSR/ISR, at present this uncertainty is taken as 4%.

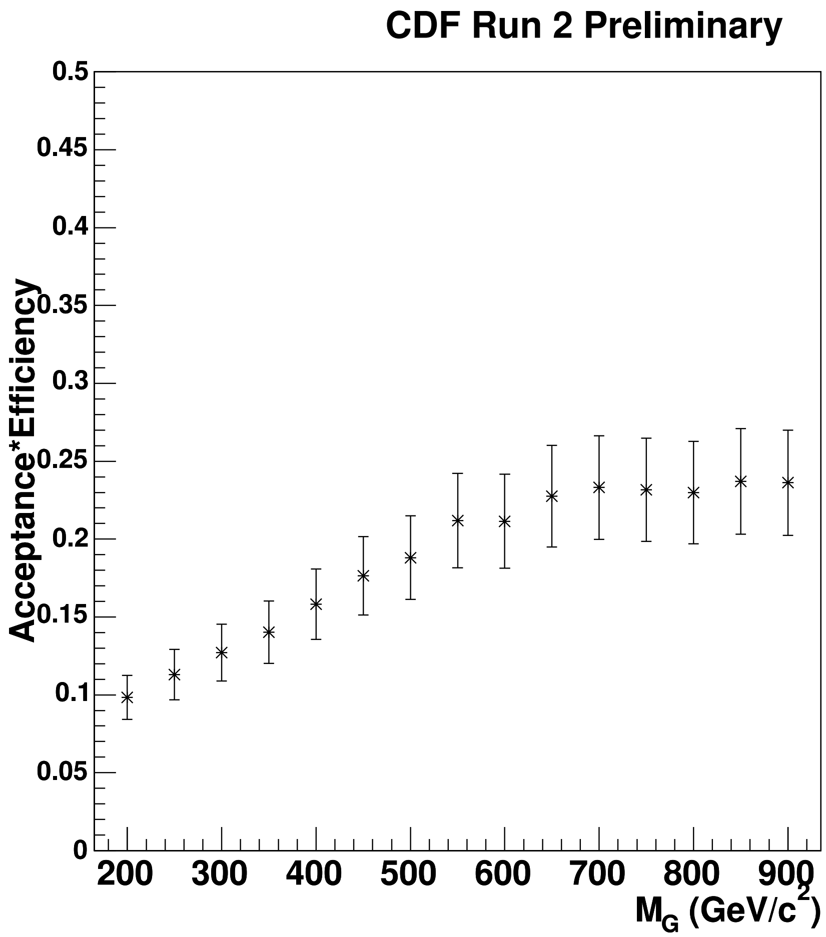
Change in Acceptance if signal region is shifted by 1%

M_G	$\Delta A/A$
200	0.009
250	0.004
300	0.004
350	0.003
400	0.004
450	0.004
500	0.003
550	0.003
600	0.004
650	0.003
700	0.003
750	0.002
800	0.003
850	0.003
900	0.003
950	0.003

Summary of the Acceptance*Efficiency uncertainties.

M_G GeV/c^2	Statistical	Systematic		Total
		Acceptance	Efficiency	
200	0.002	0.059	0.13	0.143
250	0.002	0.059	0.13	0.143
300	0.003	0.059	0.13	0.143
350	0.003	0.059	0.13	0.143
400	0.004	0.059	0.13	0.143
450	0.004	0.059	0.13	0.143
500	0.004	0.059	0.13	0.143
550	0.004	0.059	0.13	0.143
600	0.004	0.059	0.13	0.143
650	0.005	0.059	0.13	0.143
700	0.005	0.059	0.13	0.143
750	0.005	0.059	0.13	0.143
800	0.005	0.059	0.13	0.143
850	0.005	0.059	0.13	0.143
900	0.005	0.059	0.13	0.143
950	0.005	0.059	0.13	0.143

Acc*Eff corrected for MC $\rightarrow$ data corrections



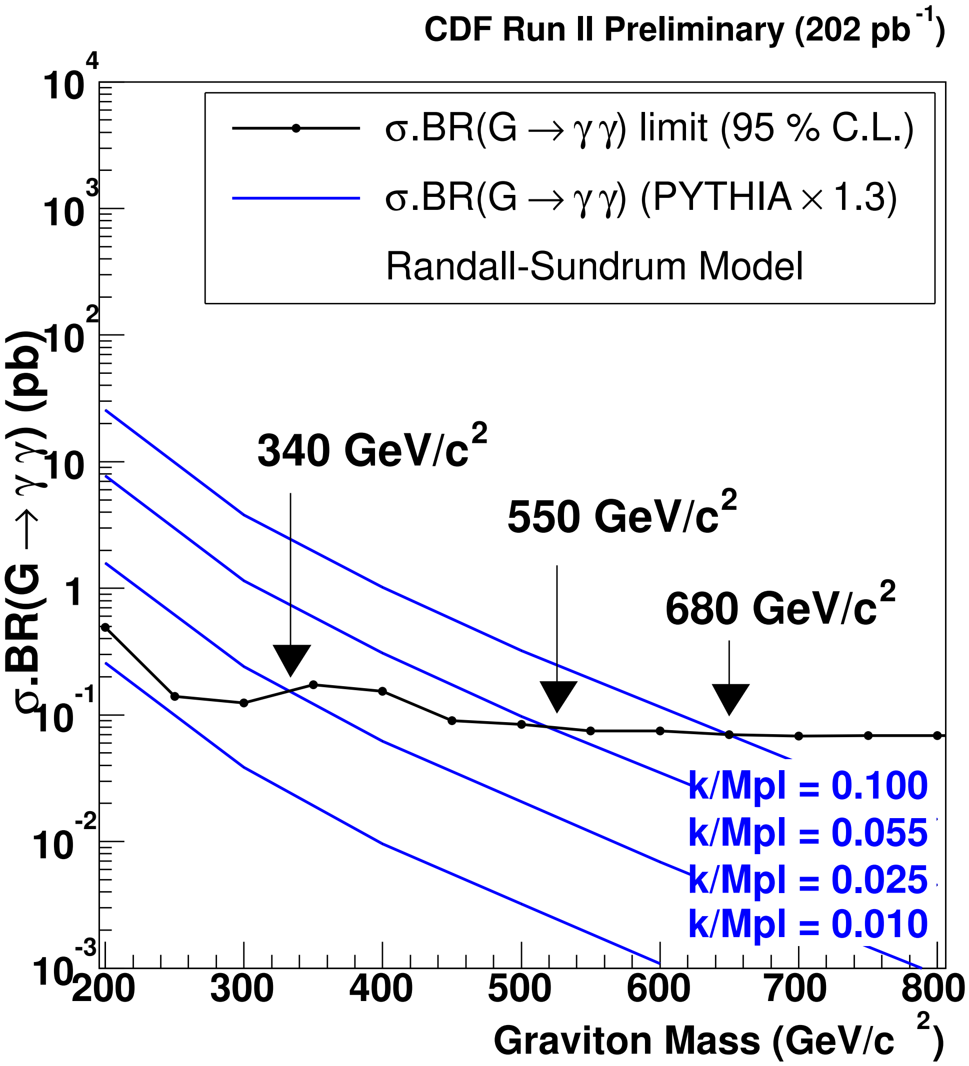
Limits in the Case of Zero Background

CDF Run II Preliminary (202 pb^{-1})

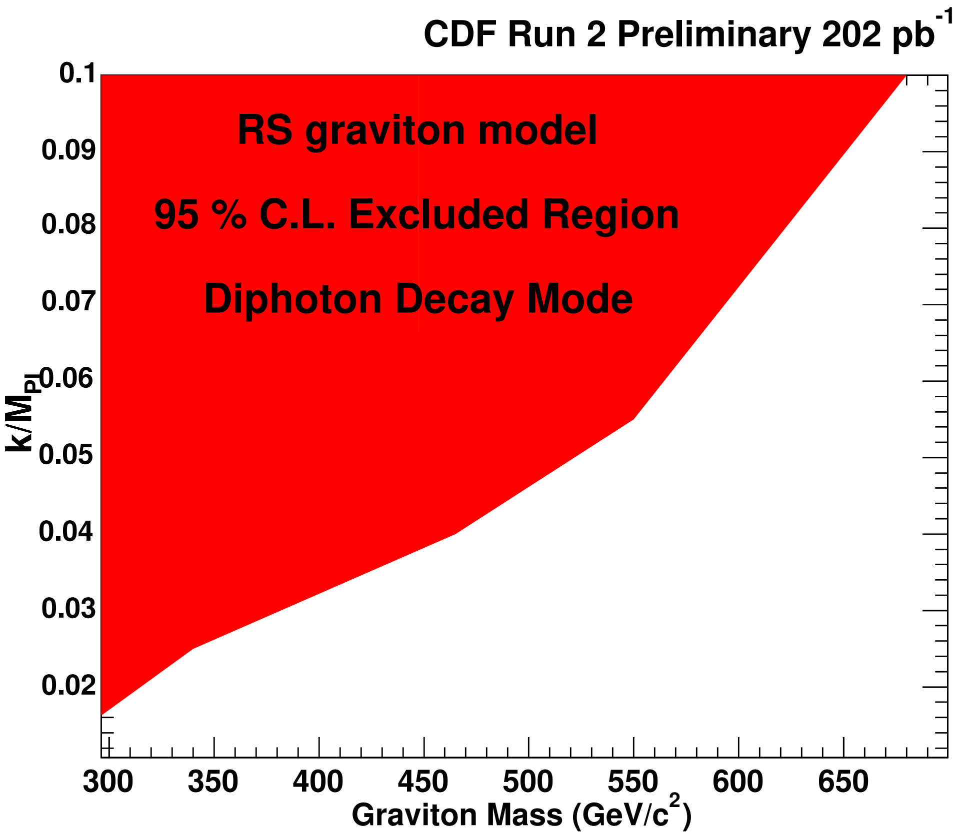
M_G	$3\times\sigma_{M_G}$	N_{data}	$N_{95\%}$	A*ϵ	$\sigma_{95\%}$
(GeV/c^2)	(GeV/c^2)			%	(pb)
200	34	4	9.8	0.0983 $\pm$ 0.002	0.49
250	40	0	3.2	0.113 $\pm$ 0.002	0.14
300	50	0	3.2	0.127 $\pm$ 0.003	0.12
350	58	1	4.9	0.140 $\pm$ 0.003	0.17
400	64	1	4.9	0.158 $\pm$ 0.004	0.15
450	74	0	3.2	0.176 $\pm$ 0.004	0.09
500	84	0	3.2	0.188 $\pm$ 0.004	0.084
550	92	0	3.2	0.212 $\pm$ 0.004	0.075
600	100	0	3.2	0.212 $\pm$ 0.004	0.075
650	108	0	3.2	0.228 $\pm$ 0.005	0.07
700	116	0	3.2	0.233 $\pm$ 0.005	0.068
750	128	0	3.2	0.232 $\pm$ 0.005	0.068
800	132	0	3.2	0.230 $\pm$ 0.005	0.069
850	140	0	3.2	0.237 $\pm$ 0.005	0.067
900	148	0	3.2	0.236 $\pm$ 0.005	0.067

(Would like to bless combined table, shown later)

Limits in the Case of Zero Background



Exclusion Plane in the Case of Zero Background



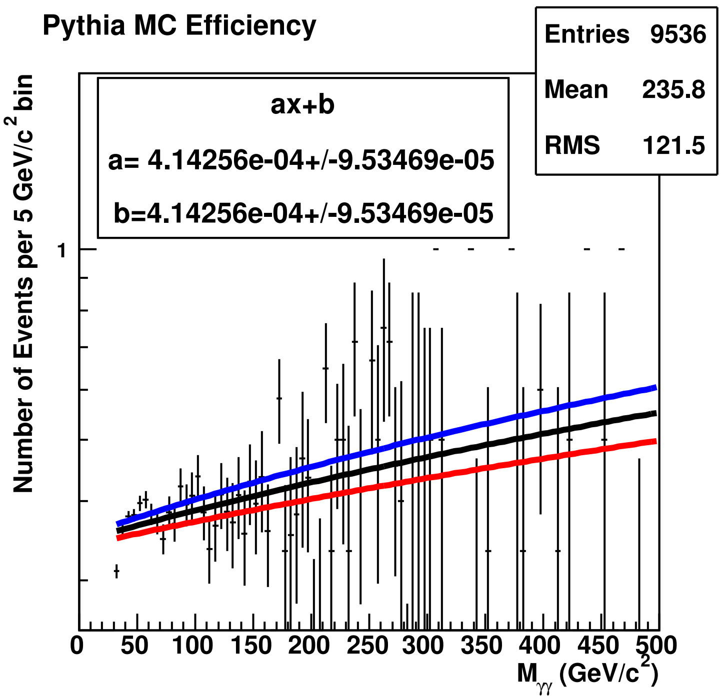
Diphoton Backgrounds

- SM
  Estimate SM background from Diphox
  Diphox is corrected for efficiency using Pythia MC and
  absolutely normalised to 202 pb^{-1}
  scale up to account for Diphox having $|\eta_\gamma|$<0.9 and data $|\eta_\gamma|$<1.04
  - scale factor from Pythia:
  33161.0/456898 $|\eta_\gamma|<$ 1.04 and 25617/456898 $|\eta_\gamma|<$ 0.9

- QCD background using Sideband spectrum

SM Diphoton Spectrum and Uncertainties

Diphox is corrected for efficiency using Pythia MC,
so uncertainty from the efficiency fit



M_G	Signal window	Diphox Background			Δ(Bkdg)/Bkdg
GeV/c^2	GeV/c^2	Eff	Eff L	Eff U	
200	184 - 218	3.8 ± 0.3	3.6 ± 0.3	4.1 ± 0.3	0.06
250	232 - 272	2 ± 0.2	1.9 ± 0.4	2.1 ± 0.4	0.07
300	278 - 328	1.6 ± 0.2	1.5 ± 0.4	1.7 ± 0.5	0.07
350	324 - 382	0.57 ± 0.2	0.52 ± 0.5	0.62 ± 0.5	0.08
400	370 - 434	0.35 ± 0.1	0.32 ± 0.5	0.38 ± 0.5	0.09
450	416 - 490	0.32 ± 0.1	0.29 ± 0.5	0.35 ± 0.5	0.09

SM Diphoton Spectrum and Uncertainties

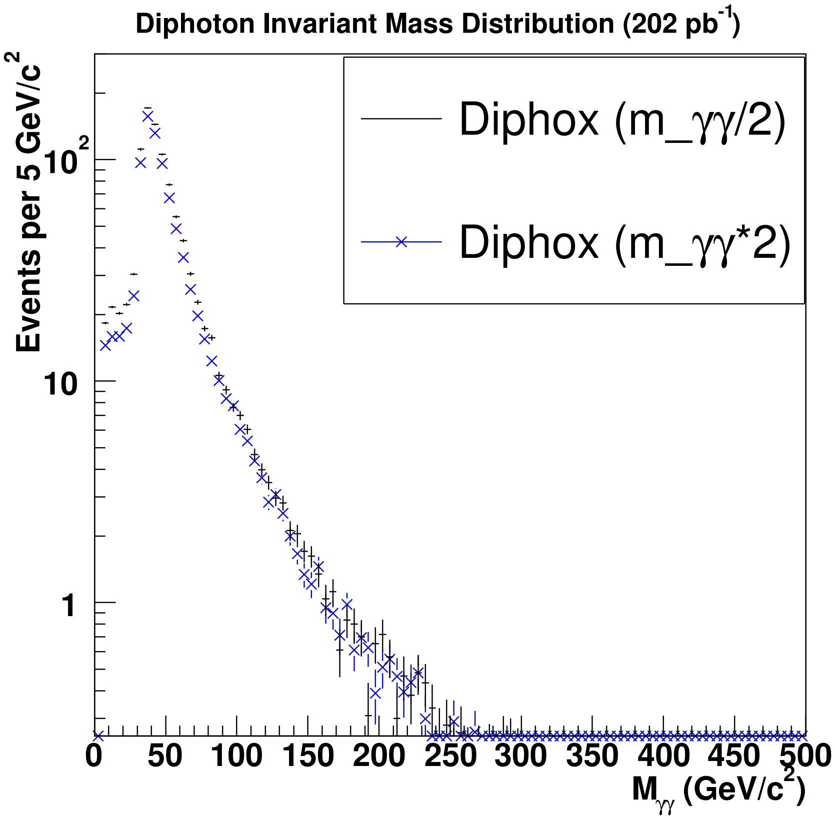
Uncertainty from choice of renormalisation scale in Diphox

Different scale choices used to calculate uncertainty

$\mu_F = \mu_R = m_{\gamma\gamma}/2$

$\mu_F = \mu_R = m_{\gamma\gamma}$*2

The former is the optimal choice by diphox.



M_G	Signal window	Diphox Background		Δ(Bkdg)/Bkdg
GeV/c^2	GeV/c^2	$m_{\gamma\gamma}/2$	$m_{\gamma\gamma}$*2	
200	184 - 218	3.8 $\pm$ 0.3	3.7 $\pm$ 0.3	-0.03
250	232 - 272	2 $\pm$ 0.2	1.4 $\pm$ 0.2	-0.3
300	278 - 328	1.6 $\pm$ 0.2	0.92 $\pm$ 0.2	-0.4
350	324 - 382	0.57 $\pm$ 0.2	0.35 $\pm$ 0.1	-0.4
400	370 - 434	0.35 $\pm$ 0.1	0.26 $\pm$ 0.1	-0.3
450	416 - 490	0.32 $\pm$ 0.1	0.18 $\pm$ 0.09	-0.4

SM Diphoton Spectrum and Uncertainties

- Uncertainty in scaling factor for eta correction of 0.008 (33161.0/456898 $|\eta_\gamma| < 1.04$ and 25617/456898 $|\eta_\gamma| < 0.9$

- Systematic uncertainty on the luminosity of 0.06

Total error on Standard Model Backgrounds

M_G	Signal window	Diphox Background
GeV/c^2	GeV/c^2	Diphotons
200	184 - 218	3.8 $\pm$ 1
250	232 - 272	2.0 $\pm$ 0.8
300	278 - 328	1.6 $\pm$ 0.7
350	324 - 382	0.57 $\pm$ 0.2
400	370 - 434	0.35 $\pm$ 0.1
450	416 - 490	0.32 $\pm$ 0.1

Non-SM Background: Sideband Data Sample

The events are required to be in good runs, have a good vertex and pass the diphoton 12 or 18 trigger
Both photons must pass the loose photon cuts:

- central detector
- looser iso cut of:
  float iso3 = IsoCorr(photon); // V2.1 cuts
  (etc<20.0 ? iso3<0.15*etc : iso3<3.0 + 0.02*(etc-20.0));
  rather than
  (etc<20.0 ? iso3<0.1*etc : iso3<2.0 + 0.02*(etc-20.0));
- Pt()<0.25*etc
- SumPt4()<5.0
- HadEm()<0.125

and have Et>15 GeV, and Mgg > 30 GeV
but the events which contain 2 or more gold photons are excluded
So this sample does not contain any of our signal events

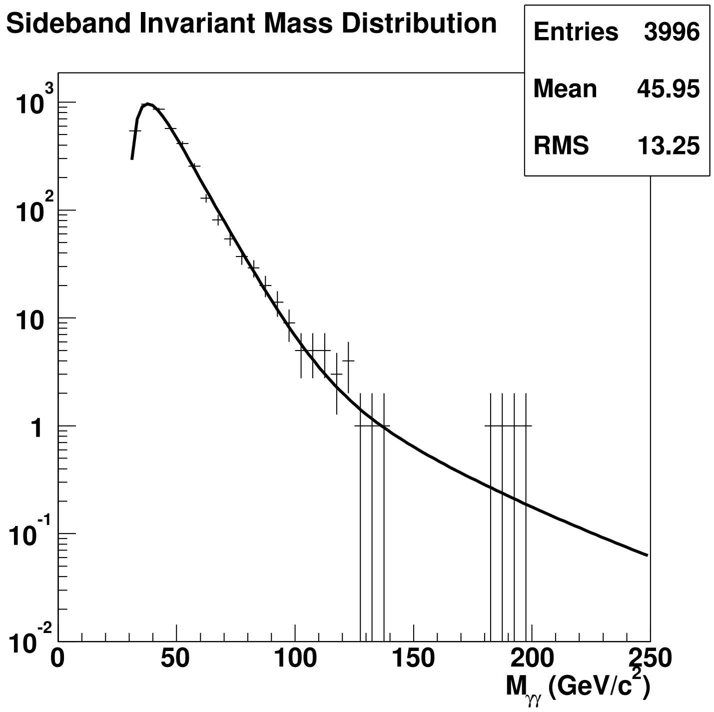
Signal : 2001 events
Sideband: 3996 (none above 200 GeV)
Sideband + iso (tighten cut, as applied to signal): 2693
Sideband + looser iso (et0<20.0 ? iso0<0.2*et0 : iso0<3.5): 4535
Sideband + N3d (applied to signal) : 2418
Sideband + Sumpt4 (applied to signal) : 1384
Sideband + 2nd CES (applied to signal) : 1927

Fits to Sidebands

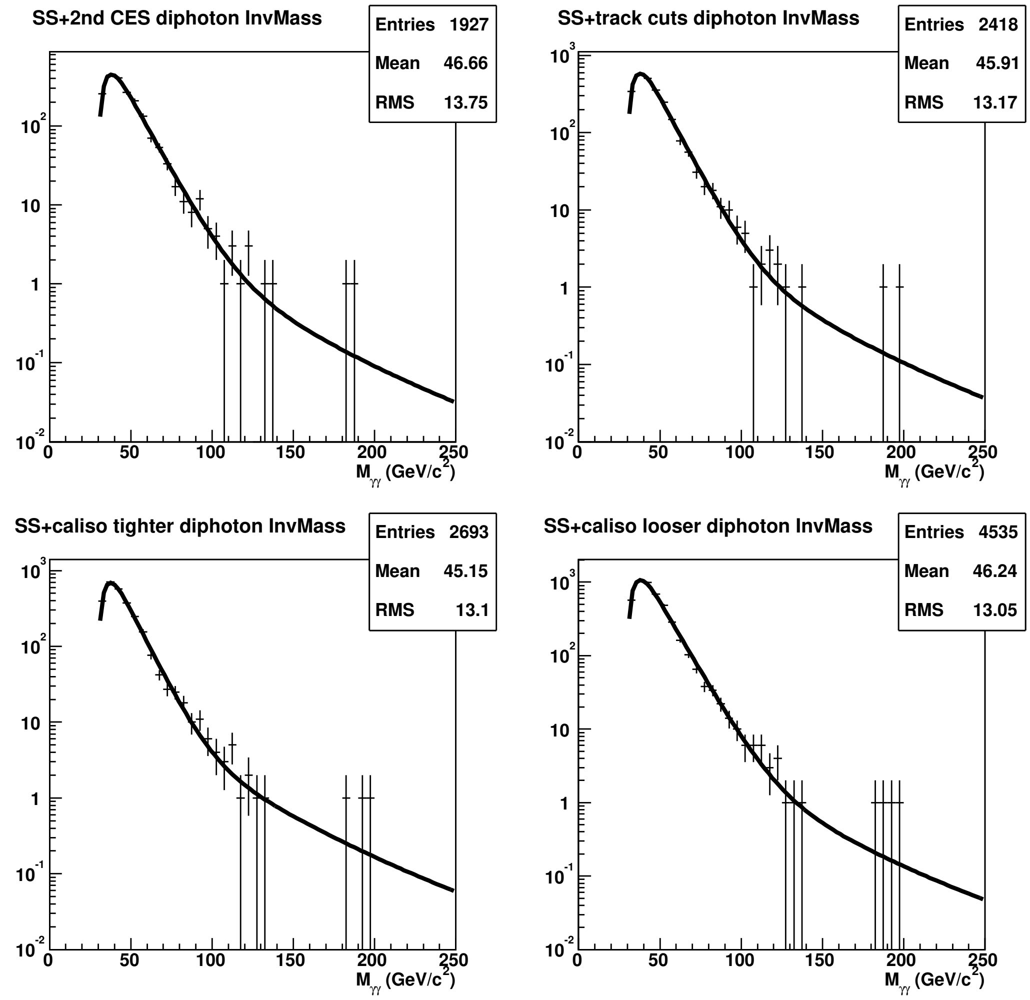
- The shape of the sidebands have been fitted with a threshold function times an exponential plus a fit to the Diphox spectrum, where the Diphox part is intended to account for a long-lived component in a controlled way. (Fitting two exponentials failed to fit these distributions.)

- Normalise the sideband shapes are normalised such that
$\int_{30}^{100} N_{data} = \int_{30}^{100} N_{diphox-202pb-1} + \int_{30}^{100} N_{sideband}$

- Find number of non-SM background in each signal region predicted by the sideband fit and take variation for the other sideband fits as the upper and lower uncertainty.



Fits to Variations of Sidebands



Non-SM Diphoton Background

M_G	Signal Region	SB	+2ndCES	+Track	+Caliso Tight	+Caliso Loose	Background Estimate
200	184-218	0.34	0.36	0.33	0.47	0.23	$0.34\ ^{+0.14}_{-0.11}$
250	232-272	0.14	0.14	0.13	0.19	0.092	$0.14\ ^{+0.055}_{-0.044}$
300	278-328	0.067	0.071	0.066	0.094	0.045	$0.067\ ^{+0.027}_{-0.022}$
350	324-382	0.033	0.035	0.032	0.046	0.022	$0.033\ ^{+0.013}_{-0.011}$
400	370-434	0.016	0.017	0.015	0.022	0.011	$0.016\ ^{+0.0063}_{-0.0051}$
450	416-490	0.0074	0.0079	0.0073	0.01	0.005	$0.0074\ ^{+0.003}_{-0.0024}$
500	460-544	0.0035	0.0037	0.0034	0.0049	0.0024	$0.0035\ ^{+0.0014}_{-0.0011}$
550	506-598	0.0015	0.0016	0.0015	0.0021	0.001	$0.0015\ ^{+0.00061}_{-0.00049}$
600	552-652	0.00063	0.00067	0.00062	0.00089	0.00043	$0.00063\ ^{+0.00025}_{-0.0002}$
650	596-704	0.00027	0.00028	0.00026	0.00037	0.00018	$0.00027\ ^{+0.00011}_{-8.6e-05}$
700	642-758	0.00011	0.00011	0.0001	0.00015	7.2e-05	$0.00011\ ^{+4.3e-05}_{-3.4e-05}$
750	684-812	4.5e-05	4.8e-05	4.4e-05	6.3e-05	3.1e-05	$4.5e\text{-}05\ ^{+1.8e-05}_{-1.5e-05}$
800	732-864	1.6e-05	1.7e-05	1.6e-05	2.3e-05	1.1e-05	$1.6e\text{-}05\ ^{+6.6e-06}_{-5.3e-06}$
850	776-916	6.4e-06	6.8e-06	6.3e-06	9e-06	4.3e-06	$6.4e\text{-}06\ ^{+2.6e-06}_{-2.1e-06}$
900	820-968	2.5e-06	2.6e-06	2.4e-06	3.5e-06	1.7e-06	$2.5e\text{-}06\ ^{+1e-06}_{-8e-07}$

Other Backgrounds

Diphoton backgrounds from other Standard Model processes are expected to be small.
Drell-Yan $\rightarrow ee$ can give $\gamma\gamma$ from radiation.

Generated 87000 events with $M_{\gamma\gamma}$>120 GeV/c^2,
using Pythia 6.203 and version 4.9.1 of the offline code.
2 events were observed with $M_{\gamma\gamma}$<50.
$\sigma(DY \rightarrow ee)$ ($M_{\gamma\gamma}$>120 GeV/c^2) = 2.2 pb
corresponds to a luminosity of 39545 pb^{-1}
So expect in datasample of 202 pb^{-1} : (202/39545)*2 = 0.010 events.
And these had $M_{\gamma\gamma}$<50 GeV/c^2

Also generated 59831 DY $\rightarrow ee$ events with $M_{\gamma\gamma}$>300 GeV/c^2
$\sigma(DY \rightarrow ee)$ ($M_{\gamma\gamma}$>300 GeV/c^2) = 0.59 pb
corresponds to a luminosity of 101408 pb^{-1}
Observed 7: 2 with $M_{\gamma\gamma}$>200 GeV/c^2: at 270 GeV/c^2 and 300 GeV/c^2
So expect in datasample of 202 pb^{-1} : (202/101408)*2 = 0.004 events with $M_{\gamma\gamma}$>200 GeV/c^2

Conclude that these backgrounds are negligible compared to the SM background and the non-SM diphoton background

Total Diphoton Background

Total Background = non-SM $\gamma\gamma$ (from sibeband) + SM $\gamma\gamma$ (from diphox)

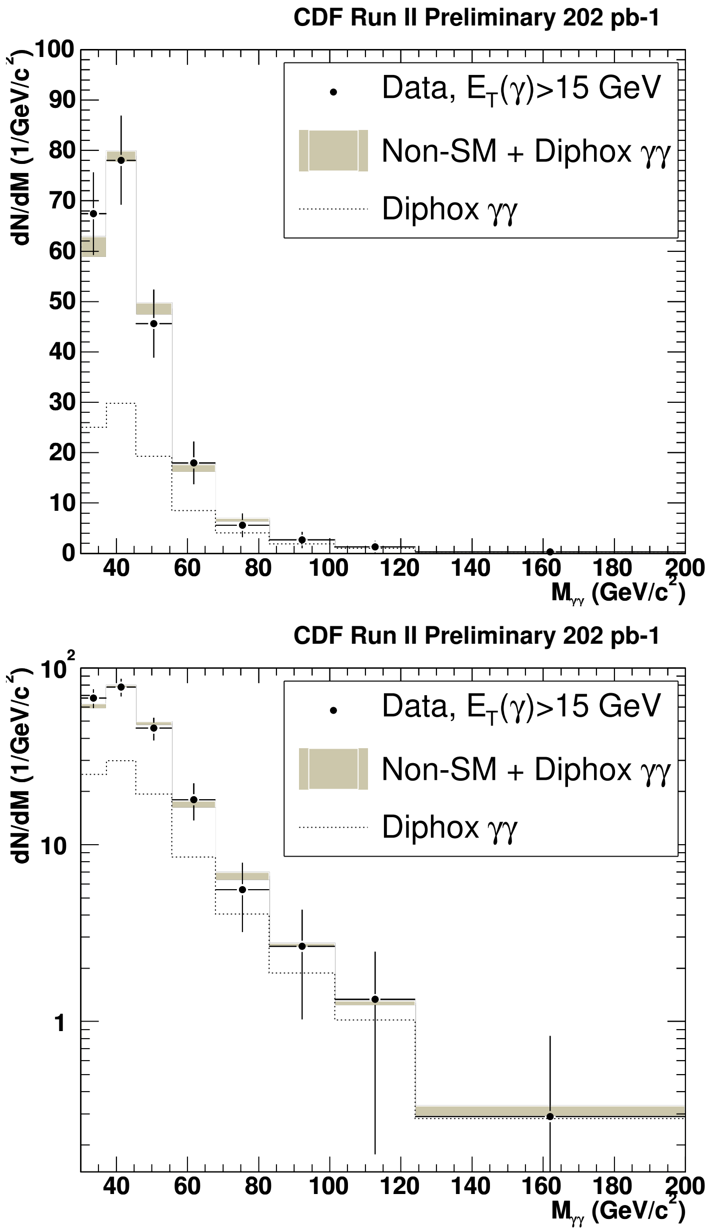
(For results above 450 GeV/c^2 this table is to be updated with SM estimates.)

M_G	Signal Region	Bkgd
200	184-218	4.1 ± 1.3
250	232-272	2.1 ± 0.82
300	278-328	1.7 ± 0.74
350	324-382	0.6 ± 0.24
400	370-434	0.37 ± 0.11
450	416-490	0.33 ± 0.15

Comparison of Expected/Observed Number of Events

Sideband shapes are normalised such that in the range from 30 to 100 GeV
$\int_{30}^{100} N_{data} = \int_{30}^{100} N_{diphox-202pb-1} + \int_{30}^{100} N_{sideband}$

Non-SM $\gamma\gamma$ from sidebands (average from sideband cuts and variation from rms of variations of the sidebands per bin)
(Need to add uncertainty from diphox)

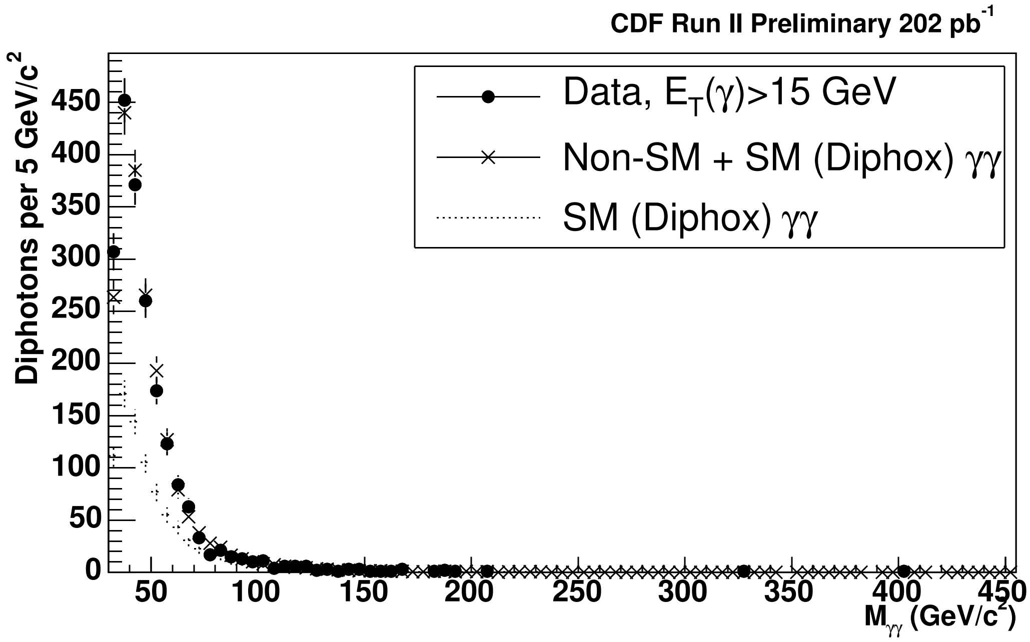


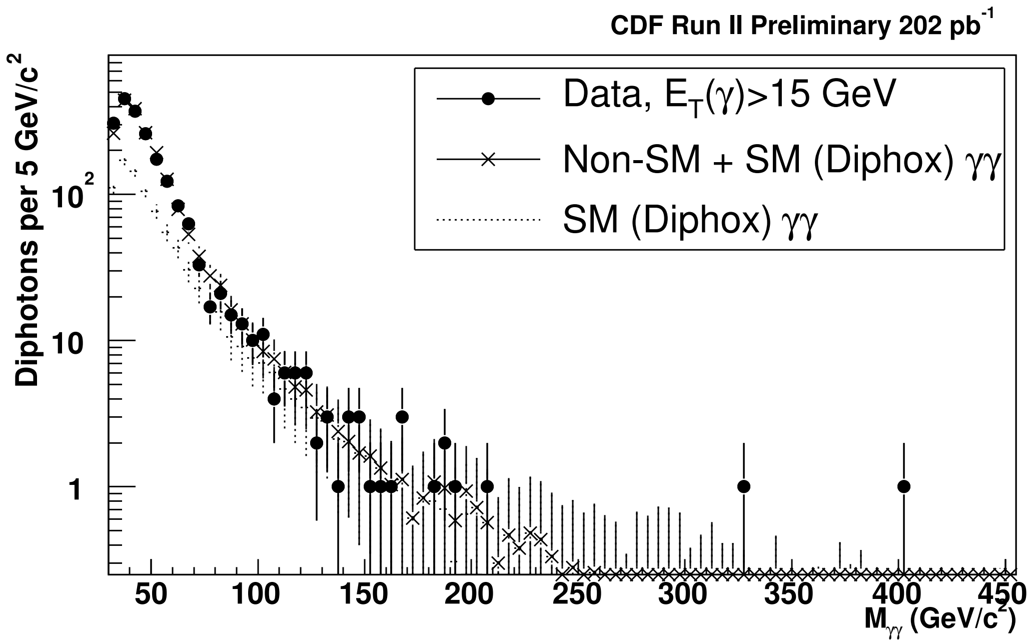
Comparison of Expected/Observed Number of Events

Sideband shapes are normalised such that in the range from 30 to 100 GeV

$\int_{30}^{100} N_{data} = \int_{30}^{100} N_{diphox-202pb-1} + \int_{30}^{100} N_{sideband}$

Errors are statistical errors - need to update





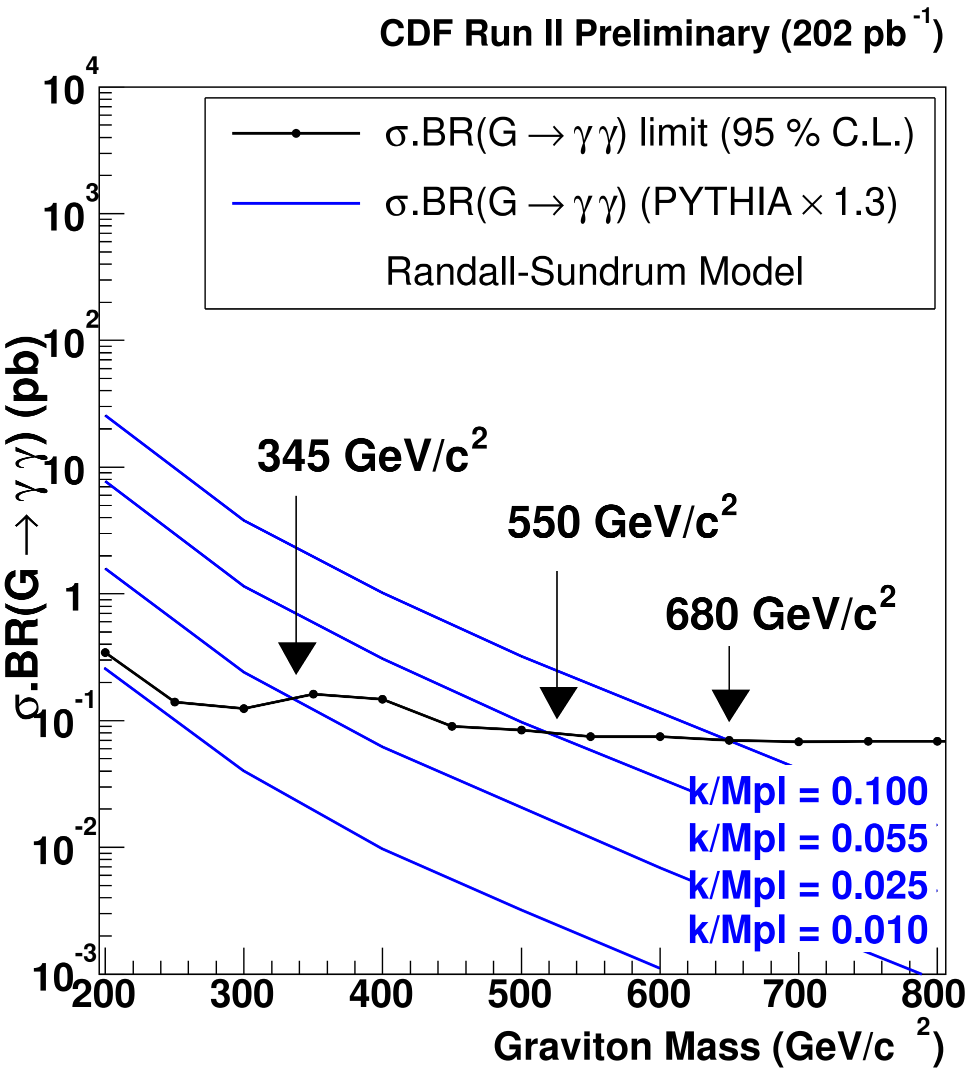
Randal-Sundrum Model Cross-Section Limits

CDF Run II Preliminary (202 pb^{-1})

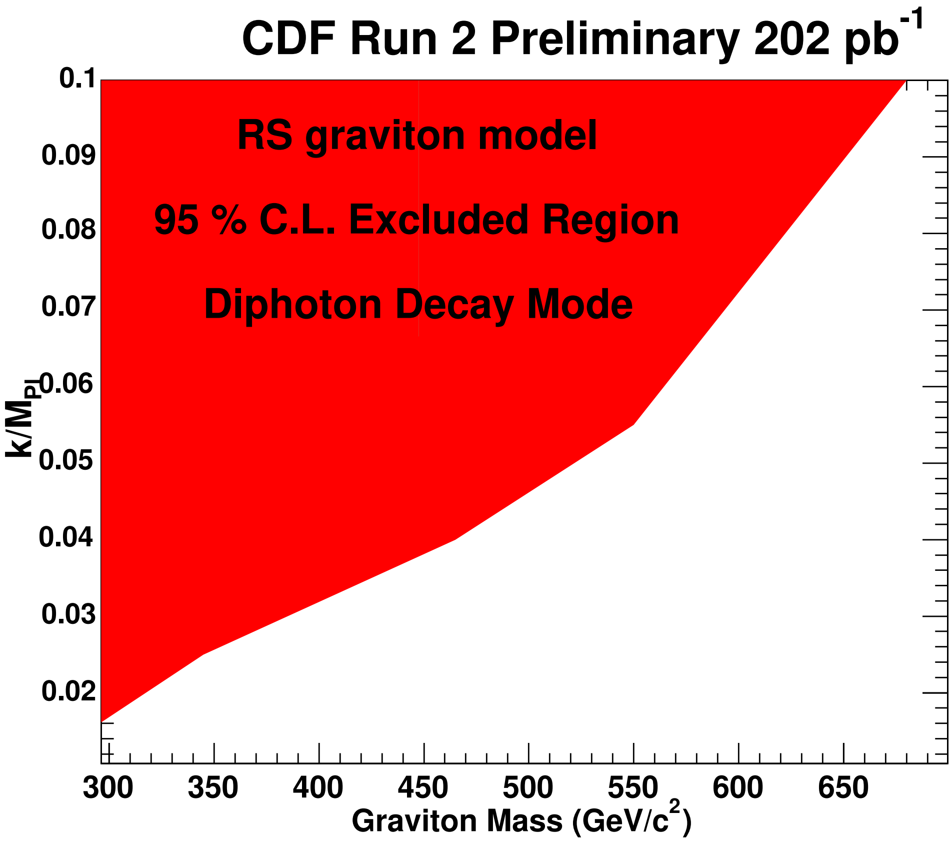
M_G	$3\times\sigma_{M_G}$	N_{bkdg}	N_{data}	$N_{95\%}$	A*ϵ	$\sigma_{95\%}$
GeV/c^2		Diphotons				pb
200	34	4.1 $\pm$ 1.3	4	6.8 *(9.8)*	0.0983 $\pm$ 0.0002	0.34 *(0.49)*
250	40	2.1 $\pm$ 0.82	0	3.2	0.113 $\pm$ 0.0003	0.14
300	50	1.7 $\pm$ 0.74	0	3.2	0.127 $\pm$ 0.0003	0.12
350	58	0.60 $\pm$ 0.24	1	4.6 *(4.6)*	0.14 $\pm$ 0.0004	0.16 *(0.17)*
400	64	0.37 $\pm$ 0.11	1	4.7 *(4.9)*	0.158 $\pm$ 0.0006	0.15 *(0.15)*
450	74	0.33 $\pm$ 0.15	0	3.2	0.176 $\pm$ 0.0007	0.09
500	84		0	3.2	0.188 $\pm$ 0.0007	0.084
550	92		0	3.2	0.212 $\pm$ 0.0009	0.075
600	100		0	3.2	0.212 $\pm$ 0.0009	0.075
650	108		0	3.2	0.228 $\pm$ 0.001	0.07
700	116		0	3.2	0.233 $\pm$ 0.001	0.068
750	128		0	3.2	0.232 $\pm$ 0.001	0.068
800	132		0	3.2	0.23 $\pm$ 0.001	0.069
850	140		0	3.2	0.237 $\pm$ 0.001	0.067
900	148		0	3.2	0.236 $\pm$ 0.001	0.067

N_{bkdg} column to be filled in! - won't affect final limits, since no events observed in the data sample.

Limits including Background



Exclusion Plane including Background



Future Plans

- Update systematic uncertainties on acceptance (ISR/FSR and new PDF method)
- Update the uncertainties to final invariant mass plots
- Hope to "bless" in 2 weeks to show at SUSY 2004