High p_T photon studies from Randall-Sundrum graviton simulations

Student Sessions 18/08/10

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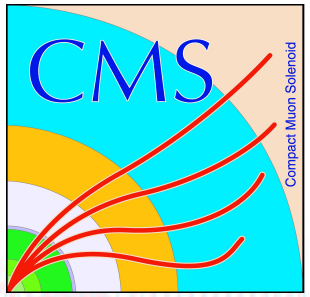
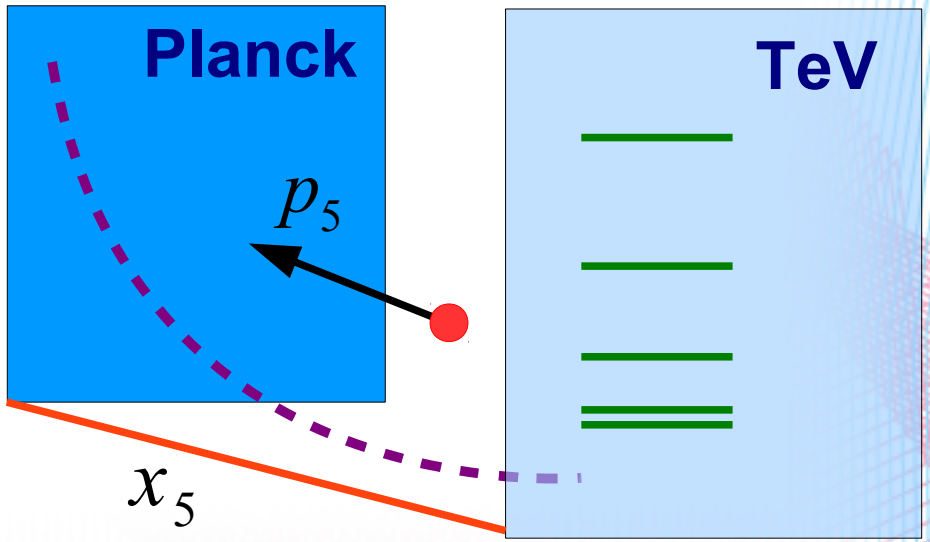


The Randall-Sundrum (RS) model

- One warped extra spatial dimension



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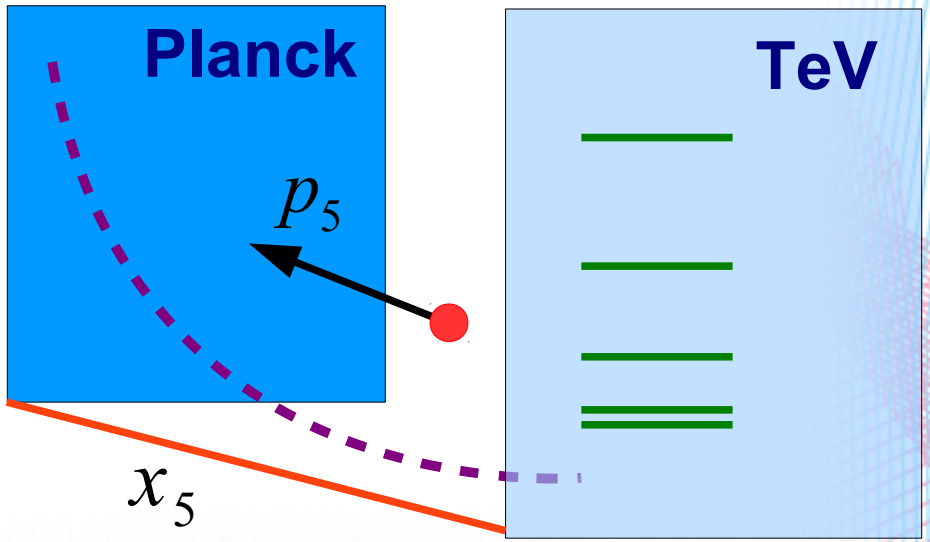
- One warped extra spatial dimension
- Solves the hierarchy problem ($M_{Pl} \gg TeV$)



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- ***5-space***: massless gravitons with p_5

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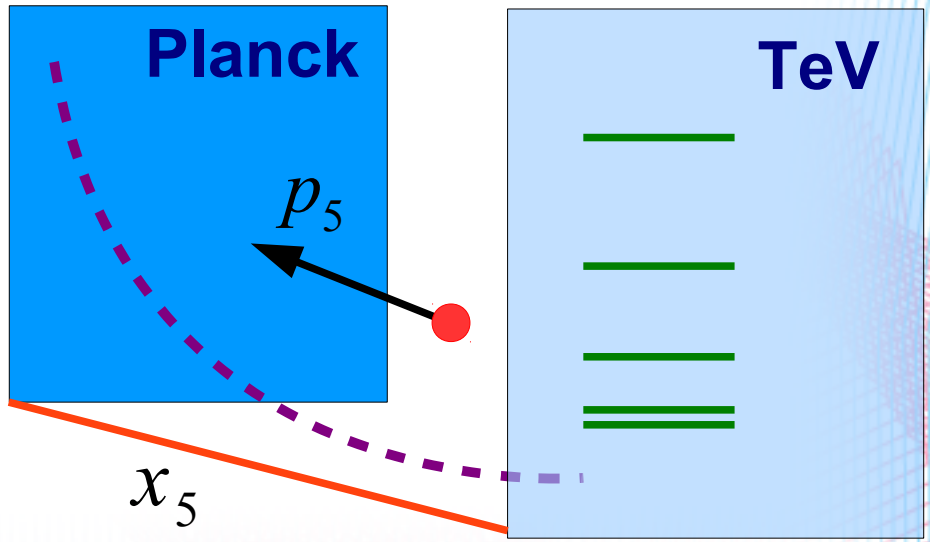

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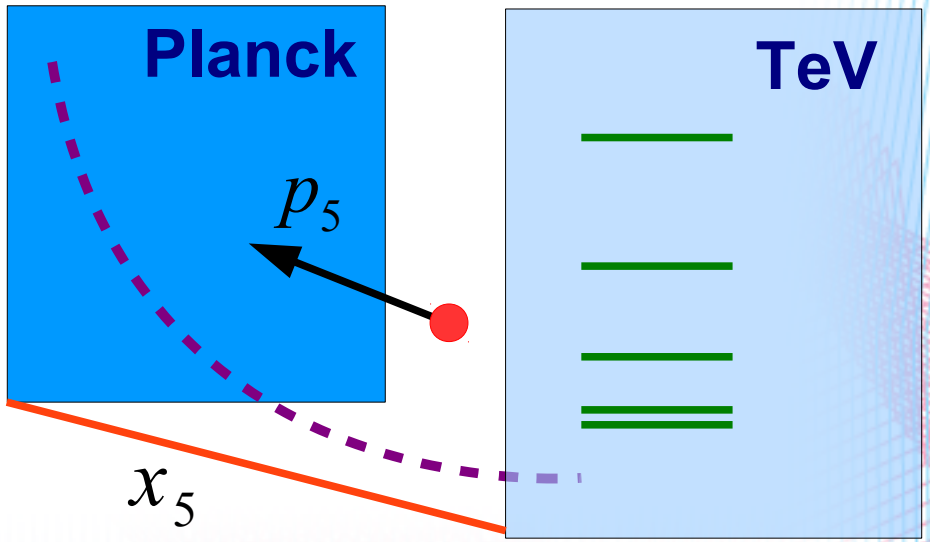

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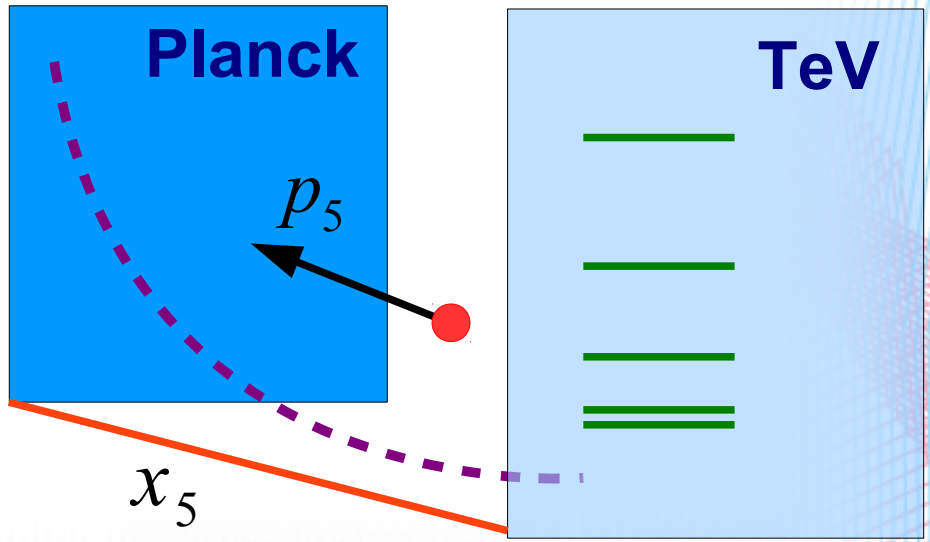
Two free parameters:

M_G 1st KK graviton mass

k/M_{Pl} Coupling constant



The Randall-Sundrum (RS) model

- One warped extra spatial dimension
- ***5-space***: massless gravitons with p_5

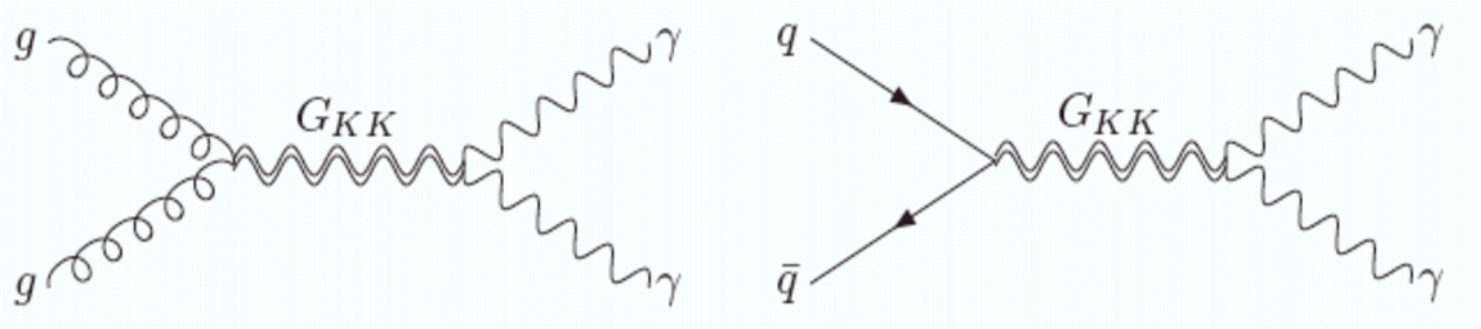
Two free parameters:

M_G ~ TeV scale

k/M_{Pl} from 0.01 - 0.10

- Solves the hierarchy problem ($M_{Pl} \gg TeV$)
- ***4-space***: tower of massive KK excitations
- Possible resonance at LHC energies
- Probe $G \to \gamma\gamma$ channel

Diphoton decay of RS graviton



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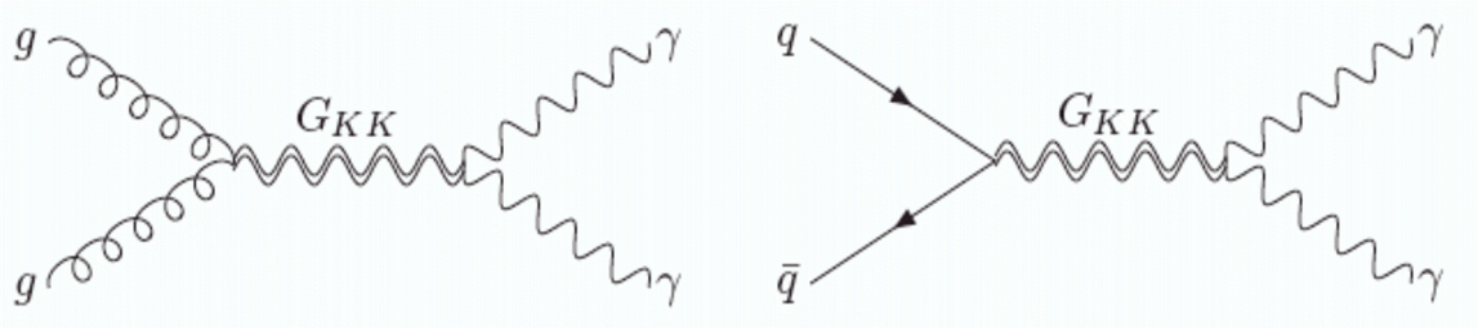
- ✔ Narrow width at resonance for $k/M_{Pl} < 0.1$

Diphoton decay of RS graviton



- ✔ Advantage - larger BR of 4% (2% for dilepton channel)
- ✔ Narrow width at resonance for $k/M_{Pl} < 0.1$
- Primary backgrounds from **SM** $\gamma\gamma$ and **instrumental**:
  - quark annihilation (Born) & gluon fusion (Box)
  - QCD γ + jets , multijets and Drell-Yan

The concept of Isolation

- We have both real photons and fakes from jets
- Our task: keep real photons (from RS decay)

  remove fakes (from $jets \rightarrow \pi_0 \rightarrow \gamma\gamma$)

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Real photons EM shower in **ECAL only**

Jet fakes Activity **around** candidate, **HCAL** deposits

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Real photons EM shower in **ECAL only**

Jet fakes Activity **around** candidate, **HCAL** deposits

Look around candidate for extra energy and tracks

The concept of Isolation

- Ecal Iso - sum of ECAL E_T in region around candidate
- Hcal Iso
- Had/EM
- Track Iso
- Require No Pixel Seed

- Separate barrel and endcap p_T , η distributions

The concept of Isolation

- Ecal Iso
- Hcal Iso - sum of HCAL E_T in region around candidate
- Had/EM
- Track Iso
- Require No Pixel Seed

- Separate barrel and endcap p_T , η distributions

The concept of Isolation

- Ecal Iso
- Hcal Iso
- Had/EM - ratio of hadronic to EM energy
- Track Iso
- Require No Pixel Seed

- Separate barrel and endcap p_T , η distributions

The concept of Isolation

- Ecal Iso
- Hcal Iso
- Had/EM - rejects jets with large hadronic component
- Track Iso
- Require No Pixel Seed

- Separate barrel and endcap p_T , η distributions

The concept of Isolation

- Ecal Iso
- Hcal Iso
- Had/EM
- Track Iso - scalar sum of p_T in a cone around candidate
- Require No Pixel Seed

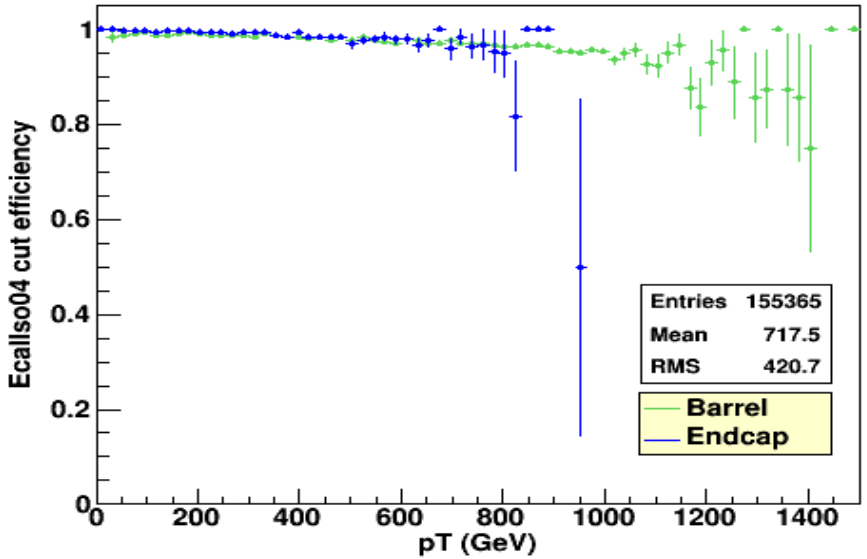
- Separate barrel and endcap p_T, η distributions

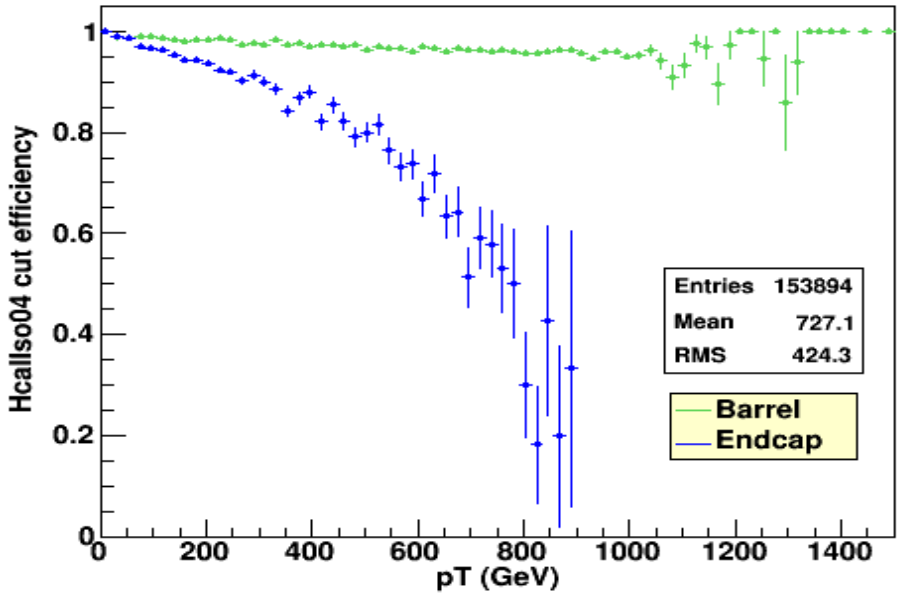
The concept of Isolation

- Ecal Iso
- Hcal Iso
- Had/EM
- Track Iso
- Require No Pixel Seed - differentiate e from γ in ECAL

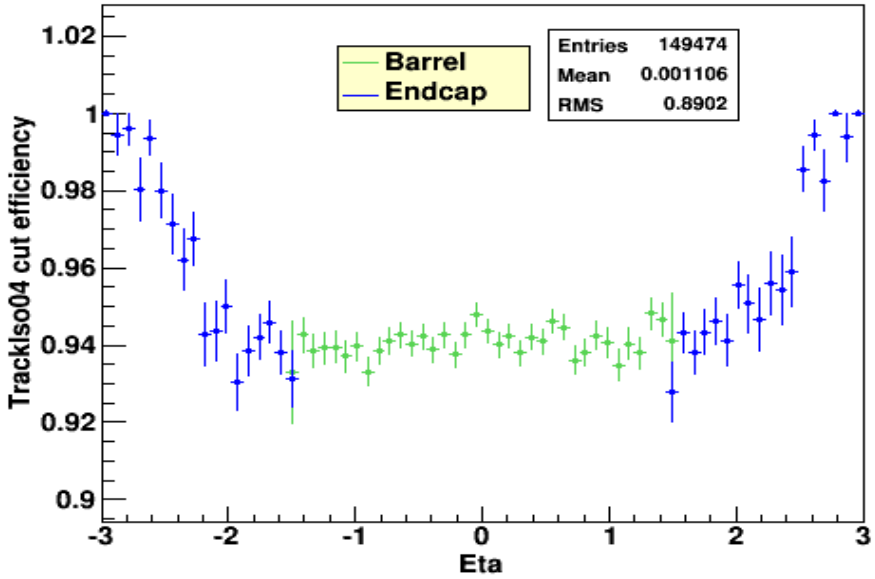
- Separate barrel and endcap p_T, η distributions

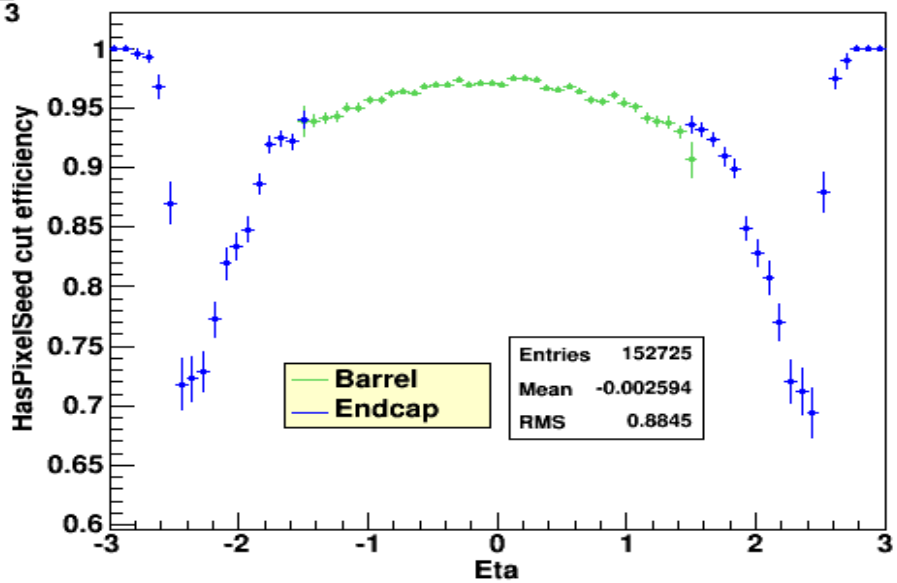
Efficiency v p_T examples



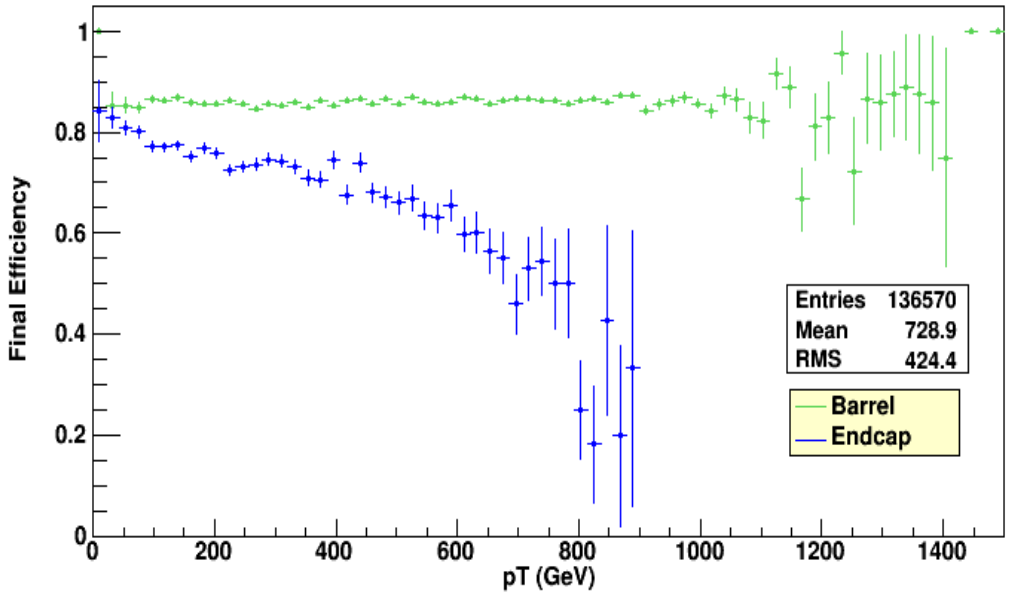


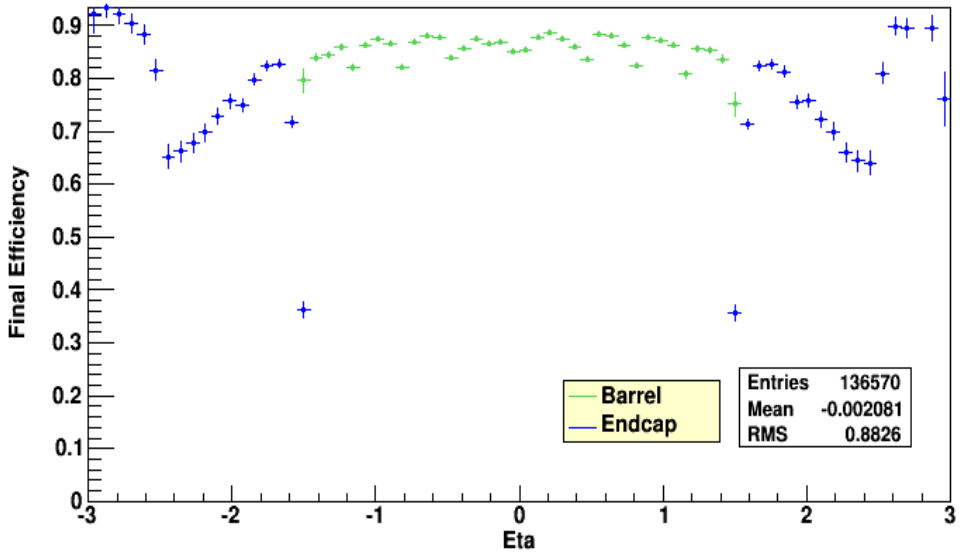
Efficiency v Eta examples



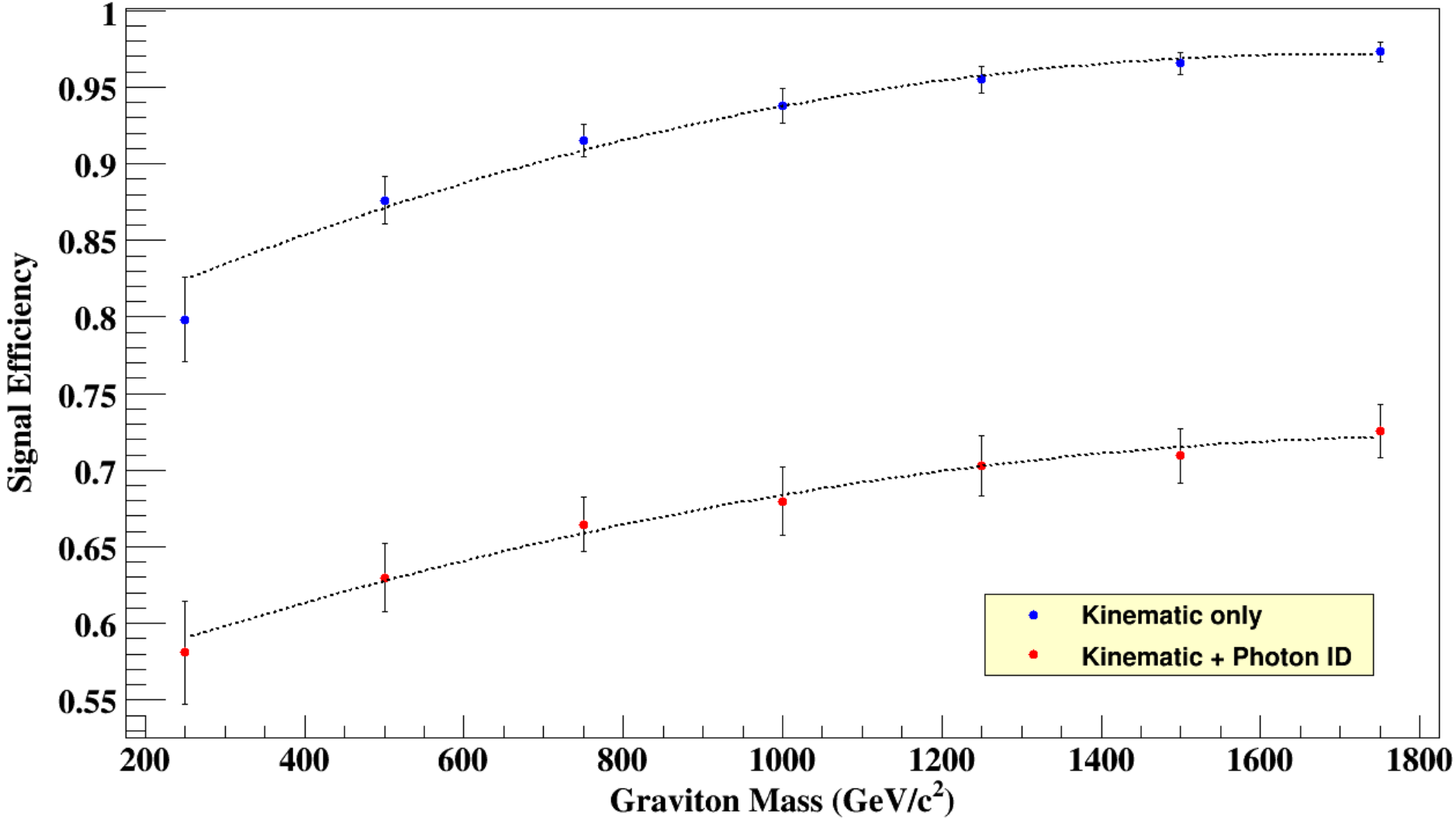


Final Efficiencies – dR + Photon ID cuts





Total diphoton signal efficiency



Sensitivity studies

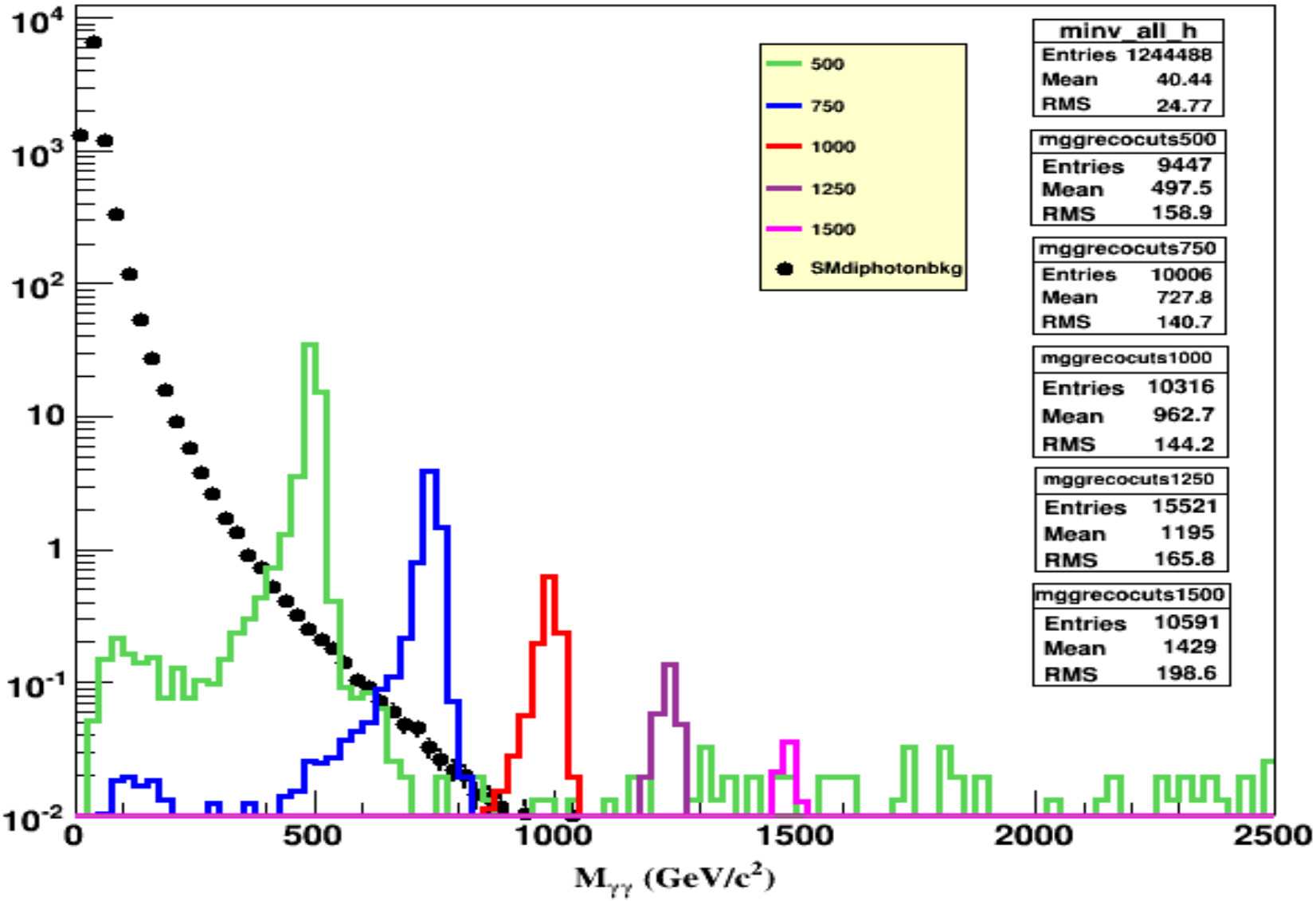
- Obtain a measure of expected sensitivity for:

i) Fixed M_G with variable k/M_{Pl}

ii) Fixed k/M_{Pl} with variable M_G

- Compare with SM diphoton background – include Born and Box contributions

$k / M_{Pl} = 0.05$


500
750
1000
1250
1500
SMdiphotonbkg
minv_all_h
Entries 1244488
Mean 40.44
RMS 24.77
mggrecocuts500
Entries 9447
Mean 497.5
RMS 158.9
mggrecocuts750
Entries 10006
Mean 727.8
RMS 140.7
mggrecocuts1000
Entries 10316
Mean 962.7
RMS 144.2
mggrecocuts1250
Entries 15521
Mean 1195
RMS 165.8
mggrecocuts1500
Entries 10591
Mean 1429
RMS 198.6
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
0
500
1000
1500
2000
2500
$M_{\gamma\gamma}$ (GeV/c^2)

$M_G\,(\mathrm{GeV}/c^2)$

k/M_{Pl}	250	500	750	1000	1250	1500	1750	2000
0.01	40.8	1.43	0.187	0.0348	0.00800	0.00210		
0.05		41.9	4.89	0.871	0.108	0.0641	0.0208	
0.10			19.4	3.70	0.425	0.256	0.0818	0.0154

Summary

- Photon ID cuts effective in high p_T regime
- High $G \to \gamma\gamma$ signal efficiencies across M_G range
- Sensitive across non-excluded M_G and k/M_{Pl} range – low mass, high coupling favoured
- Extensive background estimation required