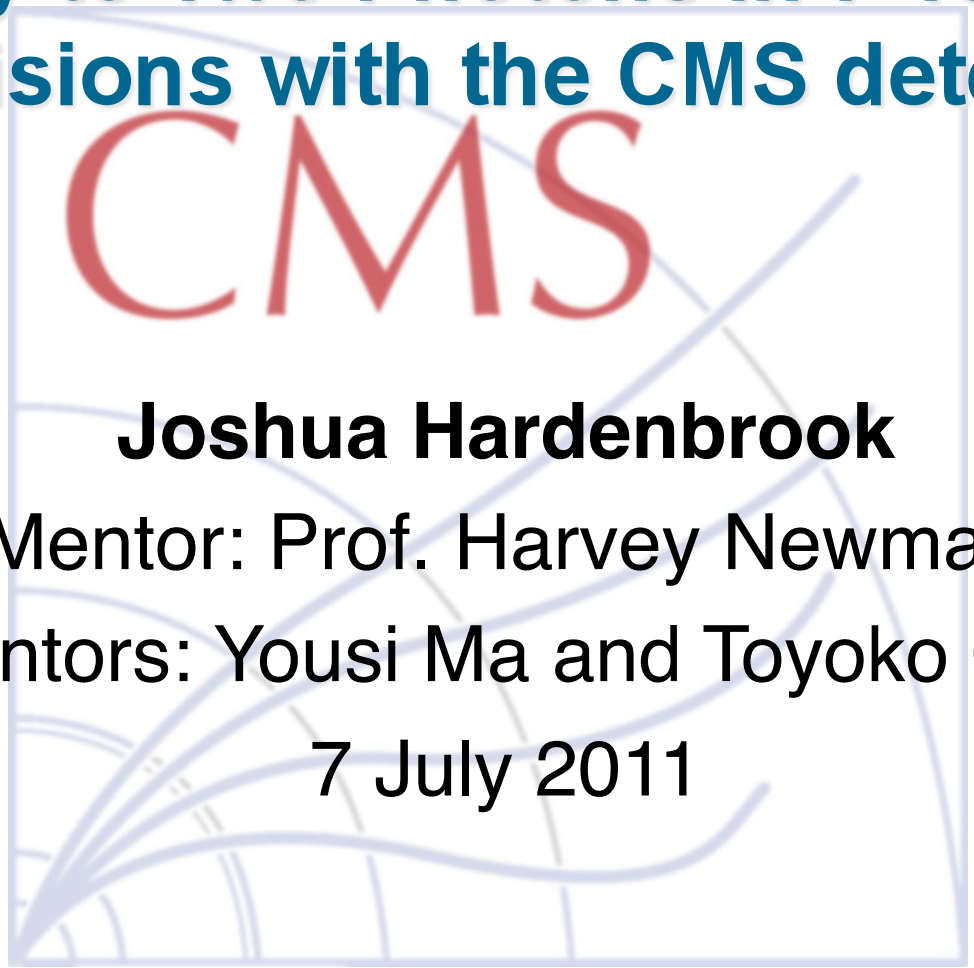
# Search for Randall-Sundrum Graviton's Decay to Two Photons in 7 TeV p-p collisions with the CMS detector

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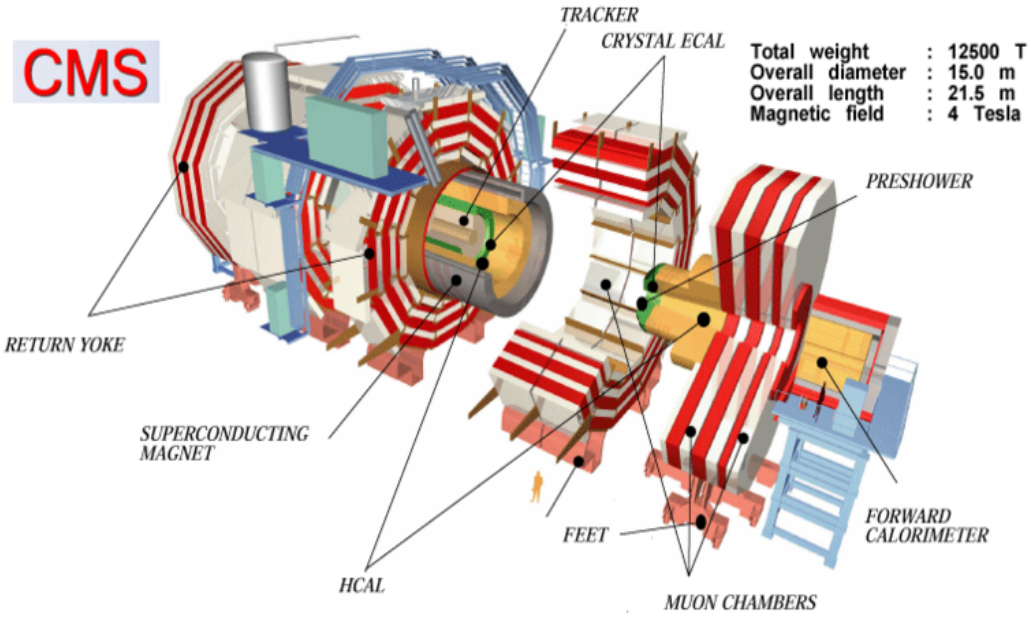
Mentor: Prof. Harvey Newman

Co-Mentors: Yousi Ma and Toyoko Orimoto

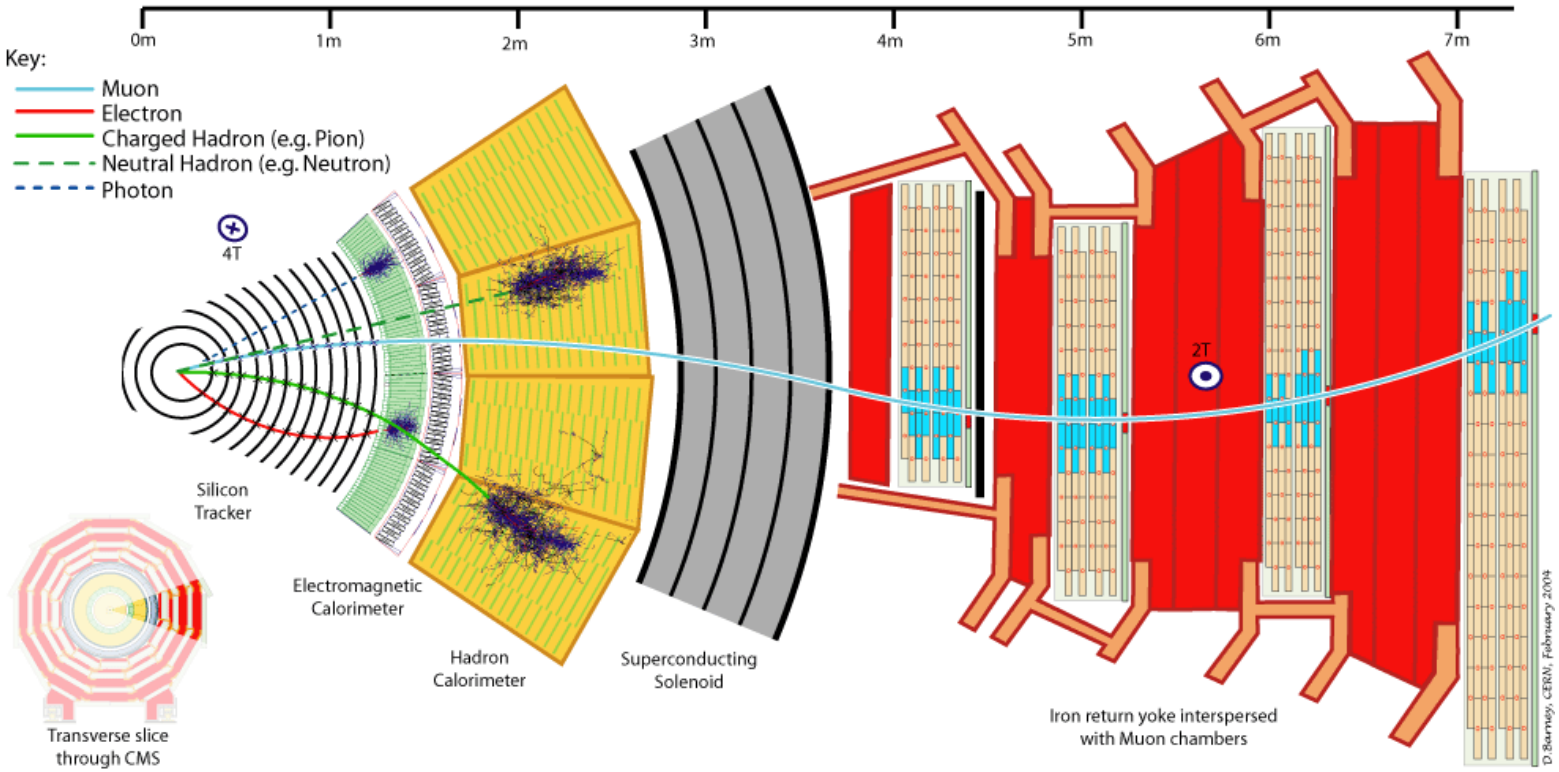
7 July 2011

# The Compact Muon Solenoid (CMS)

- One of the two general detectors at the LHC
- Main difference from ATLAS being its uniform magnetic 4 T magnetic field
- Prepared for both SM and beyond the SM physics
- Main Studies:
  - Supersymmetry
  - Probing TeV scale physics
  - Discovery of Higgs Boson
  - Extra Dimensions



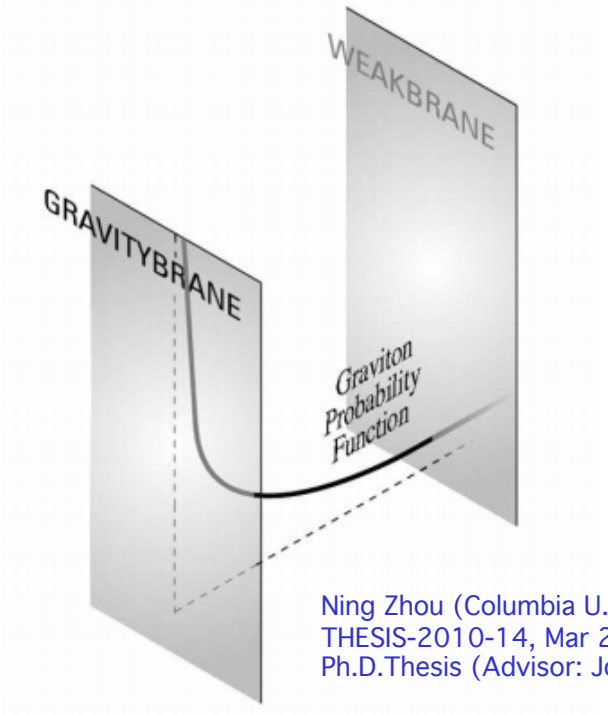
# Subdetectors




- 4 Main Subdetectors:
  - Tracker: 4 T solenoid outside the HCAL produces uniform magnetic field within. Knowing the charge of a particle we can calculate the momeeta due to curvature.
  - ECAL: Scintillating material measures energy of photons and electrons
  - HCAL: Measures energy of hadronic particles
  - Muon Chambers

# The Randall Sundrum Graviton (RS-1)

- In an attempt to solve the hierarchy problem (the large difference between the strength of the weak force and that of gravity) we introduce an extra dimension hence RS-1
- There are two (3+1)D branes separated by a (4+1)D “warped bulk”
- Gravitons exist mainly in one brane while “we” the standard model exist in the other
- The curvature of the bulk causes distance and mass to rescale exponentially causing gravity to appear weak



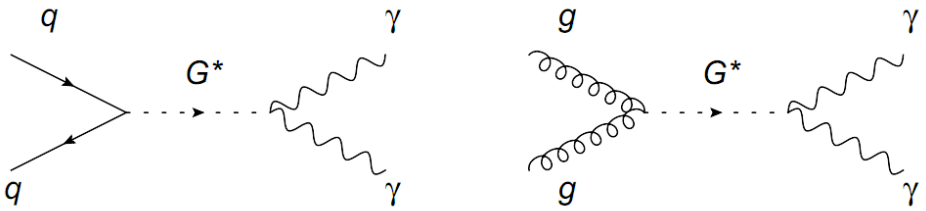

Ning Zhou (Columbia U.) . FERMILAB-THESIS-2010-14, Mar 2010. 138pp. Ph.D.Thesis (Advisor: John Parsons)

Two branes separated by “warped bulk”

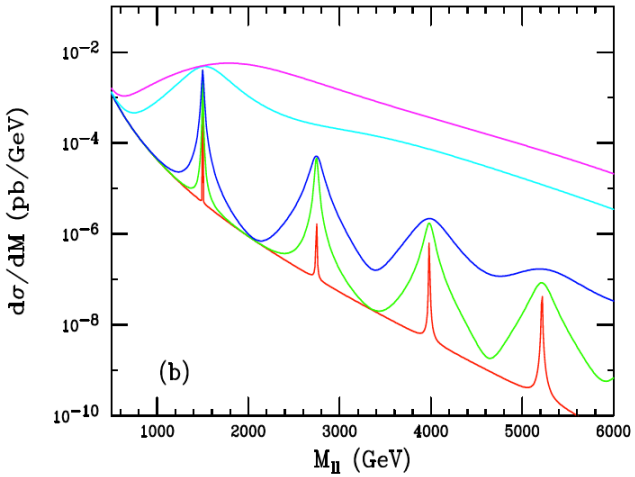
$$ds^2 = e^{-2kr_c y}\eta_{\mu\nu}dx^\mu dx^\nu - r_c^2 dy^2$$

RS-1 5 dimensional metric - note exponential warp factor described by k (the coupling of study in this search). $r_c$ is the compactification radius of the extra dimension, η is the usual minkowski-space time metric, and y is the coordinate in the extra dimension $0 < y < \pi$

# The Randall Sundrum Graviton (RS-1)




Graviton production and decay to diphotons
(dielectrons also a common study)



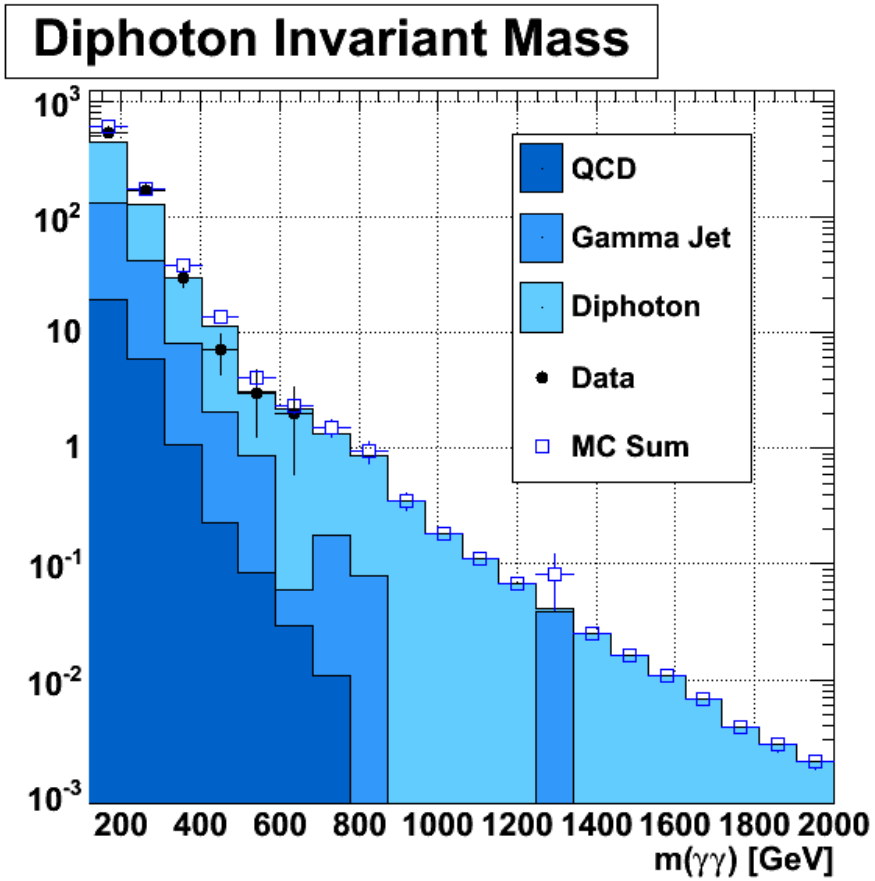

We look for the first (M1) Kaluza Klein excitation

H. Davoudiasl, J.L. Hewett, T.G. Rizzo
Phys.Rev.D63:075004,2001

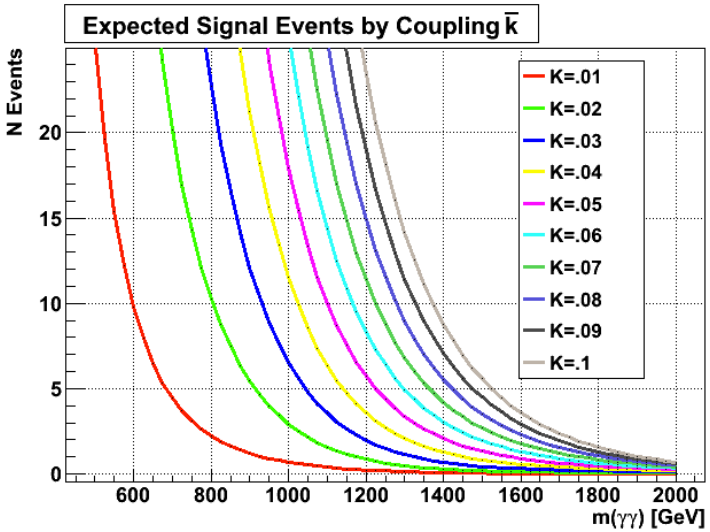
- We search for high mass resonances that would not have been seen at Tevatron at the level of ~1 TeV
- Gravitons appear as a tower of excitations
- The spacing and width of excitations is given by the coupling factor $k/M_{pl}$ constraining the search for resonances
- Theory/Experiment constrain this further to $.1 > k/M_{pl} > .01$
- Using official signal samples of coupling $k/M_{pl}$ for masses between 500 GeV and 2 TeV
- We apply an optimized selection and compute limits on the mass of the graviton and thus the cross section of $G_{KK} \rightarrow \gamma\gamma$

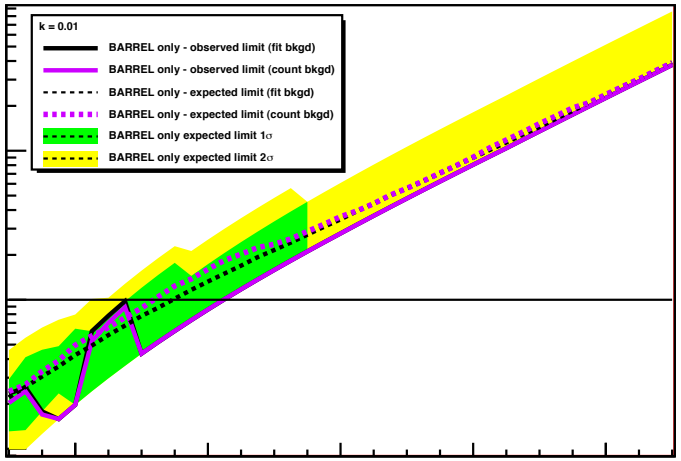
# Analysis

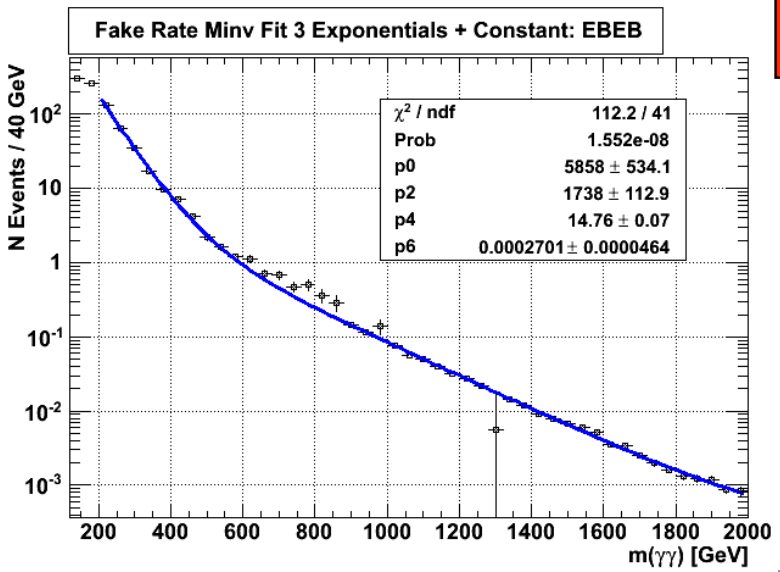
- My role has been understanding the post-selection expectations for signal and background as to compute limits on the coupling parameter, the graviton mass, and the diphoton production cross section
- I first compute expectations for each (mass, coupling) point in the mentioned official MC samples
  - Window acceptance, kinematic acceptance, selection, NLO k factors to MC, shape studies, etc…
- I then generalize (through functional forms and interpolation) the expectations to be calculated for any value of $k/M_{pl}$ and Graviton mass
- Limits are then computed and 95% confidence contours are made in $k/M_{pl}$ vs $m_G$ space

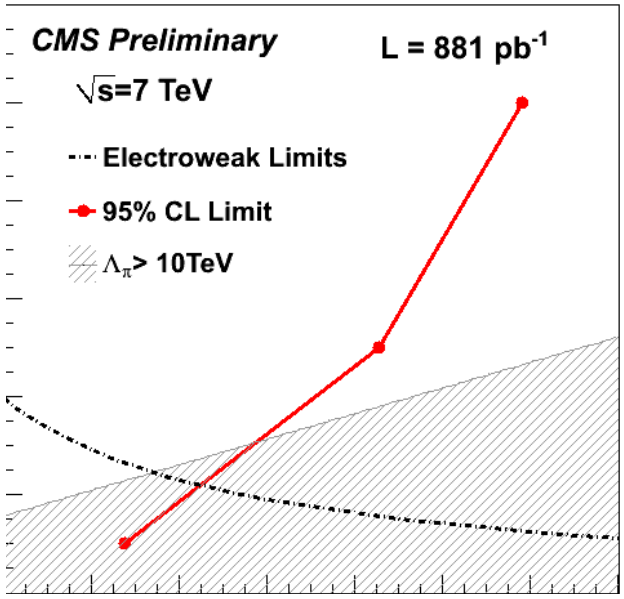


# Limit Calculation



# Ongoing Work

- Working on developing new categories for H→γγ analysis in the budget material of the tracker
- Photon r9 studies
- Vertex Selection Effects for RS Gravitons
- Currently pre-approved for the combined RS Graviton/ADD Extra dimensions analysis, working toward approval in the coming weeks for EPS

# Fun In Geneva/France





# Questions?