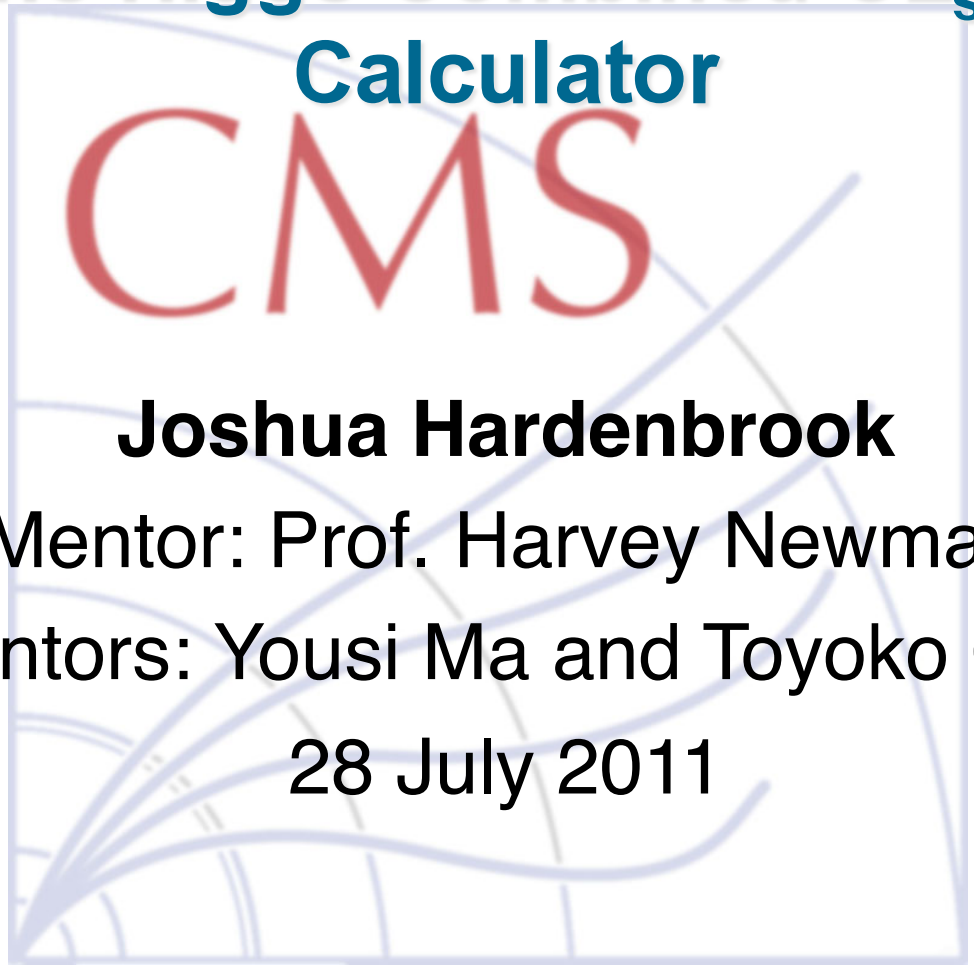
Search for Randall-Sundrum Gravitons and the Higgs Combined CL_s Limit Calculator



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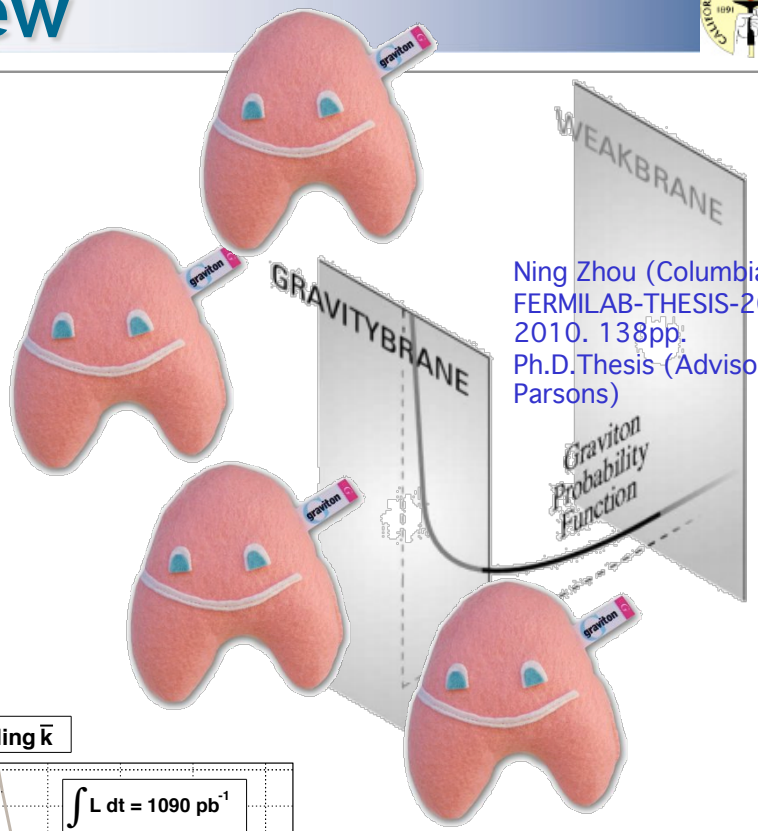
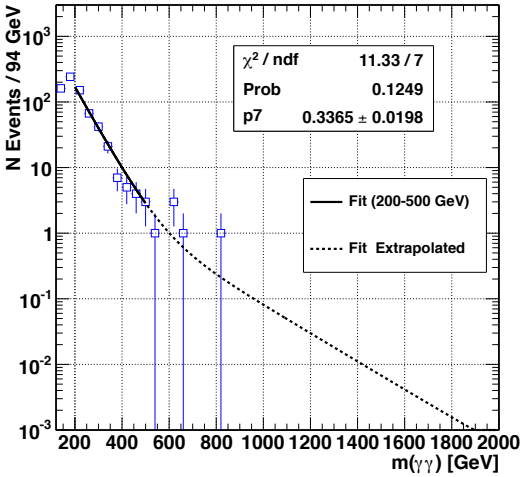
Review

- Searching for gravitons in the CMS Detector at the TeV scale
- Gravitons are separated from the standard model brane by an 4+1 dimensional space
- The gravitons are characterized by their warp factor k
- Determined expectations of signal and background

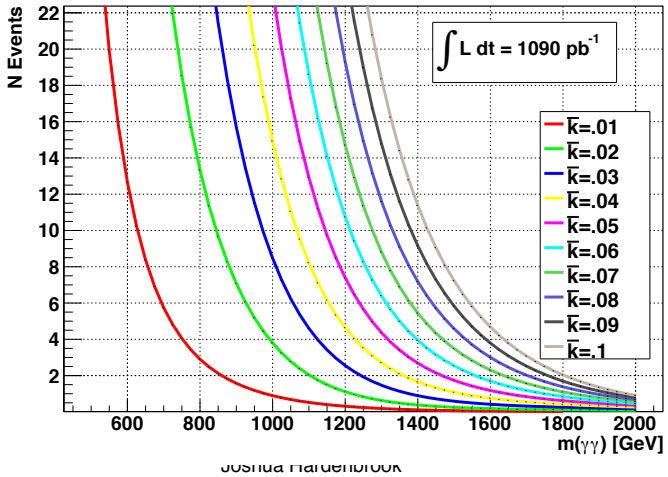


Ning Zhou (Columbia U.) . FERMILAB-THESIS-2010-14, Mar 2010. 138pp.
Ph.D.Thesis (Advisor: John Parsons)

Data Fit Normalization



Expected Signal Events by Coupling $\bar{k}$



Yield Calculations

$\tilde{k}$	M_1	Mass Window	Expected Signal	Expected Background	Data
0.01	500	469.6 to 530.3	32	4.5	4
0.01	750	707.1 to 792.8	4.0	0.71	0
0.01	1000	944.6 to 1055.3	0.89	0.23	0
0.01	1250	1182.2 to 1317.7	0.23	0.082	0
0.01	1500	1419.7 to 1580.2	0.066	0.028	0
0.01	1750	1657.2 to 1842.7	0.018	0.0097	0
0.01	2000	1894.7 to 2105.2	0.0053	0.0034	0
0.05	500	463.6 to 536.3	760	5.4	5
0.05	750	698.2 to 801.7	110	0.87	0
0.05	1000	932.7 to 1067.2	23	0.28	0
0.05	1250	1167.2 to 1332.7	5.6	0.10	0
0.05	1500	1401.8 to 1598.1	1.7	0.035	0
0.05	1750	1636.3 to 1863.6	0.71	0.012	0
0.05	2000	1870.9 to 2129.1	0.36	0.0042	0
0.10	750	668.8 to 831.1	410	1.4	1
0.10	1000	893.6 to 1106.4	90	0.46	0
0.10	1250	1118.3 to 1381.6	23	0.16	0
0.10	1500	1343.1 to 1656.9	7.2	0.059	0
0.10	1750	1567.8 to 1932.1	2.5	0.021	0
0.10	2000	1792.6 to 2207.4	0.91	0.0075	0

- Data is found in strong agreement with expectation (in the absence of signal)
- Where we expect more than one event we see the integer number of events
- Where we expect less than one event we see none
- Apply CLs method for Limits

CLs Method of Limit Calculation

- Determining significances in post selection mass windows by means of significance approximations i.e.

$$S = \frac{N_s}{\sqrt{N_s + N_b}}$$

only keeps track of counts of signal and background

- Instead, we break the histogram (for a single mass and warp factor) into i channels with events n_i and compute the test statistic q

$$q \equiv \ln Q \qquad Q = \prod_i^M \exp(-s_i) \left(\frac{s_i + b_i}{b_i} \right)^{n_i}$$

H. Prosper,"Calculating CLs Limits", Flordia State University

- Advantage: Take advantage of the power of the full mass window and the shape of the distribution in the S+B and B hypotheses

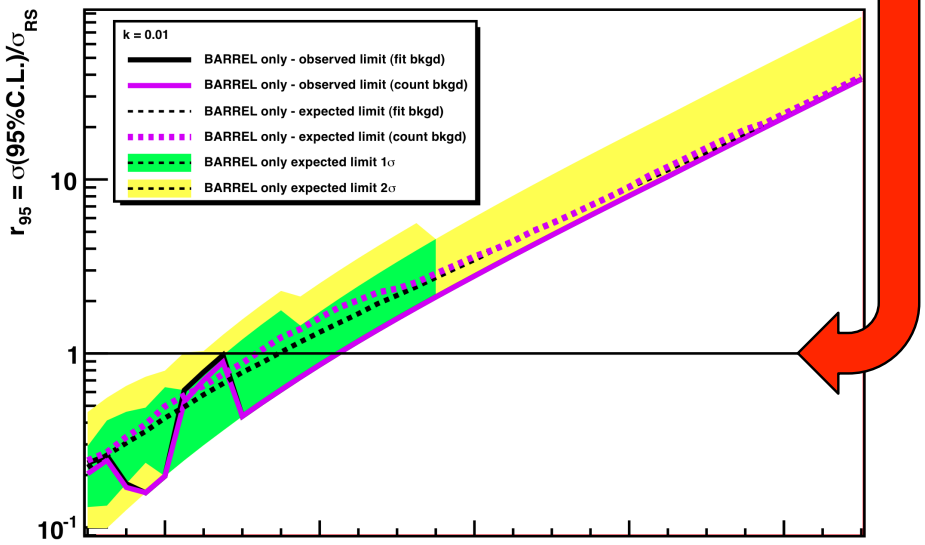
CLs Based Exclusions

- From this statistic we find the CLs by computing the ratio of the confidences of the S+B and B hypotheses at 95%
- From the CLs we can determine an upper limit on the cross section of the process
- 1 and 2 sigma errors on expected are calculated by throwing random seeded toy models at the redistribution in mass due to uncertainties (lumi, energy resolution, background estimation…etc.)

A. L. Read, " Modified Frequentist Analysis of Search Results (The CLs Method)", University of Oslo

$$CL_s = \frac{CL_{s+b}}{CL_b} \equiv \frac{P_{s+b}(q_{s+b} \leq q_{obs})}{P_b(q_b \leq q_{obs})}$$

$$\sigma(C.L.\ 95\%)/\sigma(SM) < 1$$



Higgs Combiner

- 8 categories distinct regions of the detector with its own signal, background, and systematics
- Applies the describes the CLs method in combination to all 8 categories
- I have successfully reproduced observed limits for $H \rightarrow \gamma\gamma$
- Running Expected limits requires approximately ~10^8 toy models PER mass/coupling point for accurate predictions (still running ……)
- Working with RooStats and RooFit to reproduce workspaces with new selection/catagories

FUN!

Questions?