Searching for Graviton Resonances at the LHC

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- Extra dimension models can contain massive graviton resonances
- In some models, these resonances are well spaced in mass
- With universal couplings, the resonance could be detected in many channels (jet-jet, lepton-lepton, ZZ, WW etc)
- Model independent analysis: R-S type model used as test case.
- Graviton mass given by:

$$m_1 = kx_1 \exp(-kr_c\pi) = 3.83\frac{k}{\overline{\overline{M}}_{Pl}}\Lambda_\pi$$

Where: $$0.01 \le \frac{k}{\overline{\overline{M}}_{Pl}} \le 1$$

- Cross-section $\propto (k/M_{Pl})^2$

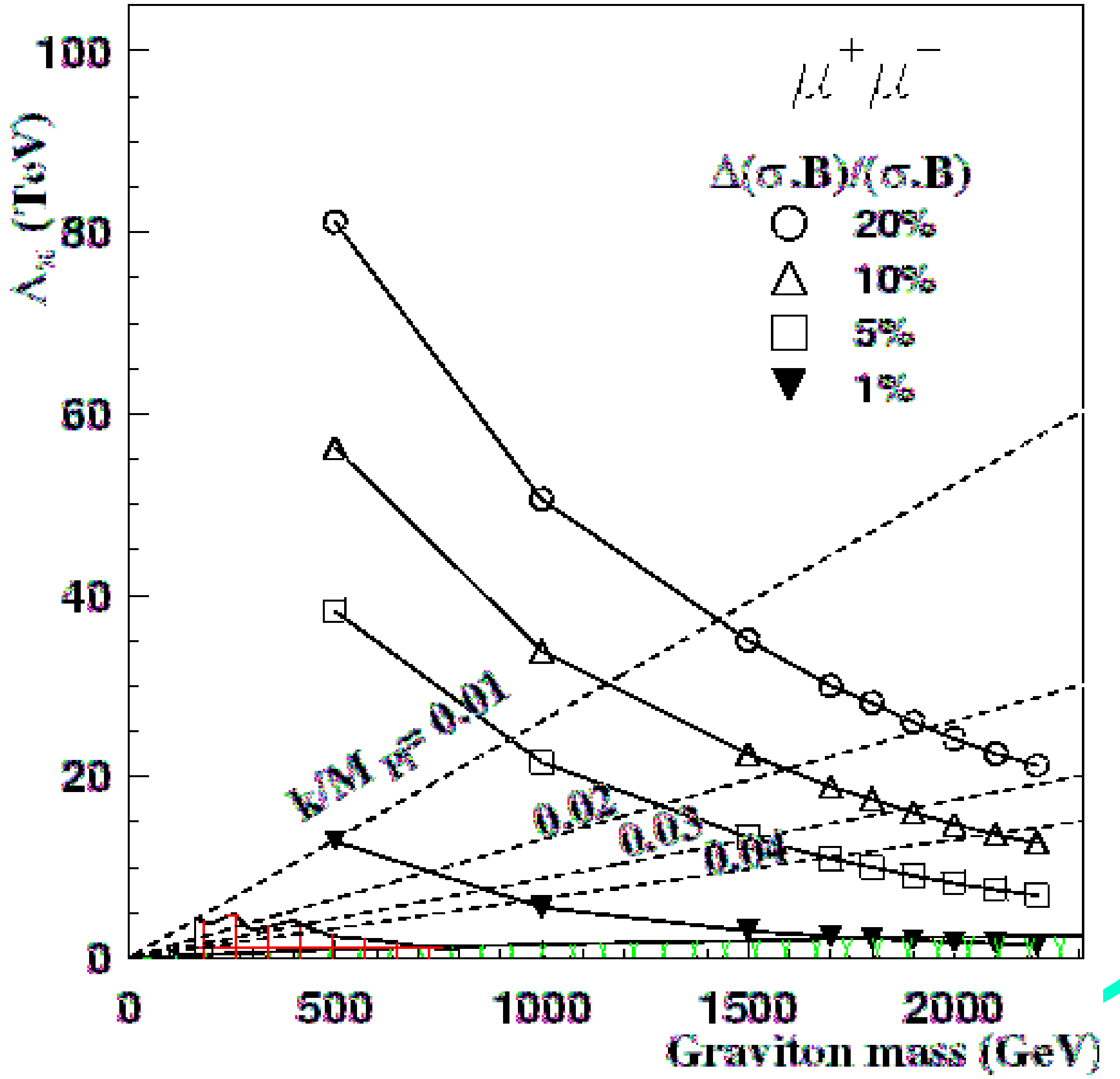
Results so far

In a paper last year, showed that Graviton can be detected in $G \to e^+e^-$ channel for masses up to 2080 GeV with $k/M_{pl}=0.01$

Showed that spin 2 nature can be detected up to 1700 GeV.

See *B.C. Allanach, K. Odagiri, M.A. Parker, B.R. Webber JHEP 09 (2000) 019*

Since then have looked at $G \to \mu^+\mu^-$, $\gamma\gamma$ and determined how well couplings can be measured.



G->WW channel

Signal:

Look at semi-leptonic channel: G->WW->lνjj

Difficulties:

- Determination of P_z ν
- W is strongly boosted so jets are close
- Jet algorithm is important

Backgrounds:

- W+jets
- ttbar
- Some background from WW production.
- WZ is neglible.

Analysis:

Events generated in Herwig

ATLFAST used to simulate detector response

Results calculated for 100fb^{-1} of luminosity

Default ATLFAST settings except where stated

Identification efficiencies included

Reconstruction Method

Require 1e or 1μ and 2 or more jets with $|\eta|<2$

Pt cuts:

- Pt miss > 50 GeV
- Pt lepton > 100 GeV
- Pt jets > 50 GeV

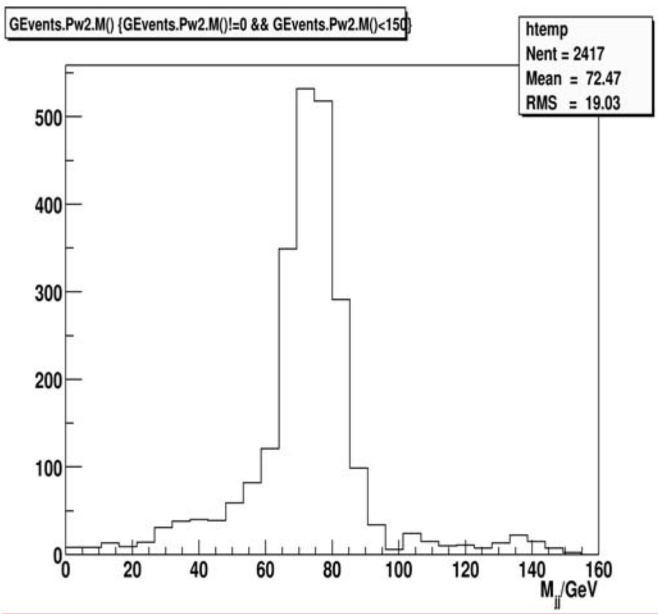
Pz ν :

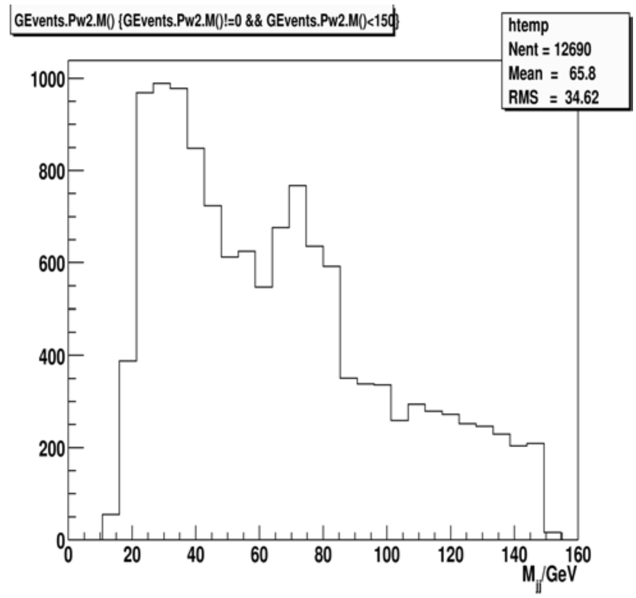
- Find by M_w constraint
- Gives 2 solutions
- Take average
- Require Pt W from l and ν > 200 GeV

Reconstruct W from jets:

- Use Mulguisin algorithm to find jets, $R_{min}=0.2$
- Require highest Pt jet
- Find a jet with $\Delta R < 1$
- Require $65<M_{jj}<85$ to be compatible with W
- Require Pt W > 250 GeV

Reconstruction Method continued





Cuts to reduce background:

- Try to reconstruct a top by searching for a jet that gives a top mass 150-200 GeV
- Central Jet veto: reject event if there are more than 2 additional jets with $|\eta| < 3$

Mass resolution, $\sigma_m/m = 5\%$

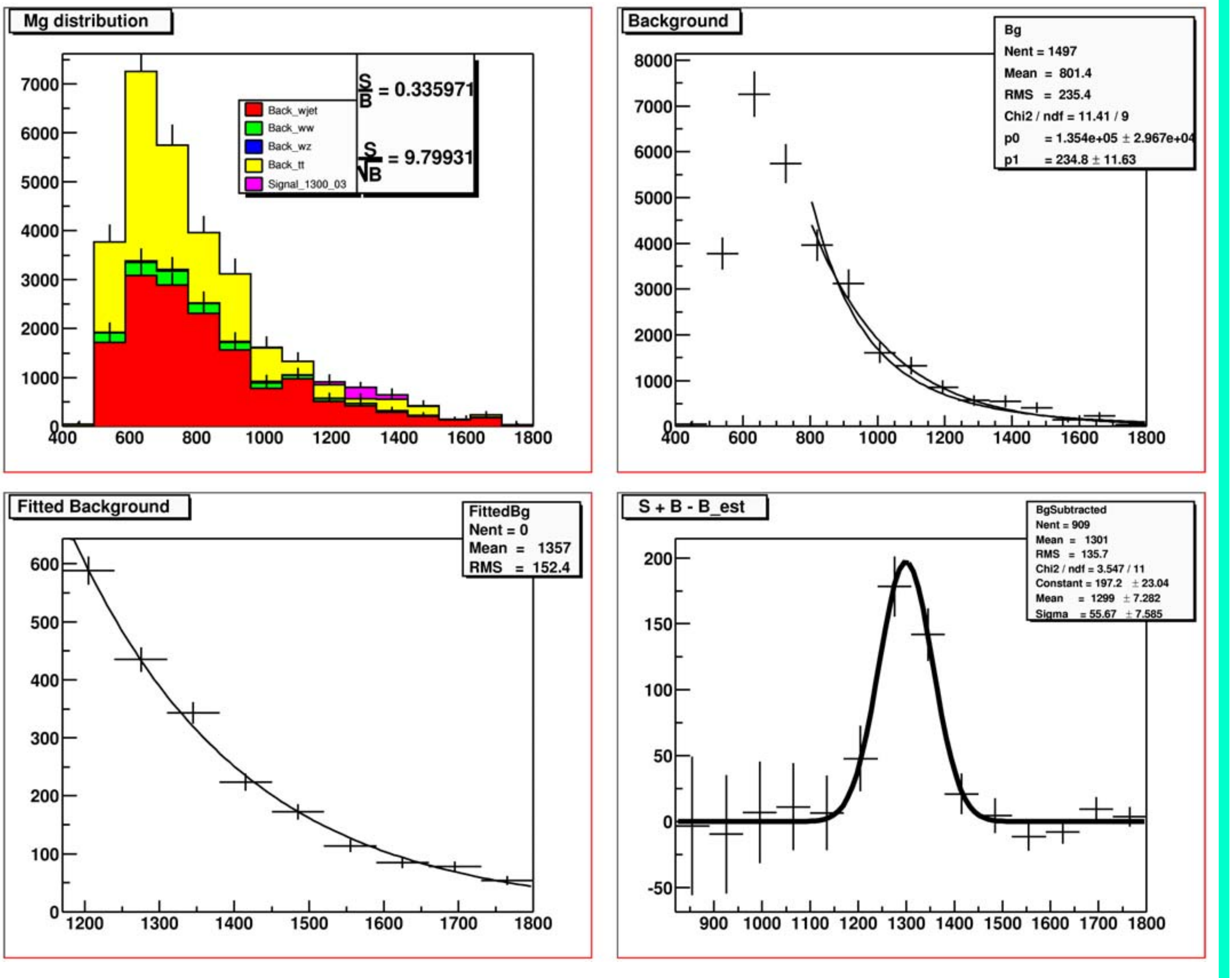
Overall efficiency is (mass = 1TeV): 13%

Compares well with Monte Carlo truth efficiency: 28%

Background efficiency is:

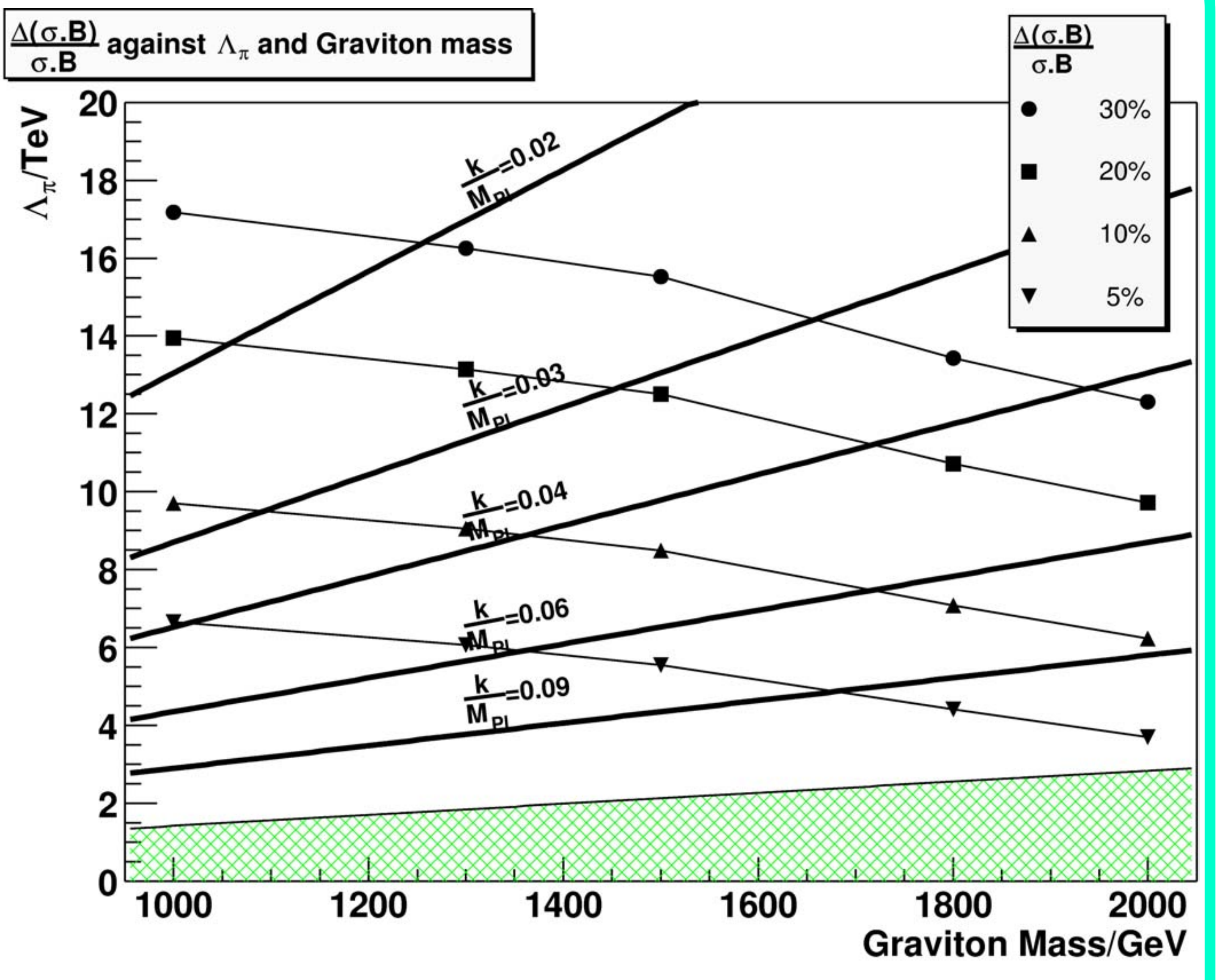
- W+jets: 0.07%
- ttbar: 0.03%

Results



- Background is dominated by simulation errors.
- To give a better idea of background, fit an exponential to it and add Poisson errors in each bin.
- Take this to be a representative ATLAS background.
- Background subtraction result shown.
- Will generate more background to check this.

Measurement of Graviton coupling to WW



Only statistical errors included at the moment.

Need to add in luminosity, acceptance etc errors

Green hatched region is where width≥resolution

(Analysis assumes width<<resolution)

Conclusion and Outlook

σ.B measurable to 30% or better for $k/M_{Pl} \geq 0.04$ and Graviton mass $\leq$ 1940 GeV

Hard to detect coupling to WW for k/M_{Pl}=0.01 and Graviton mass $\geq$ 1000 GeV

We've already investigated e^+e^-, $\mu^+\mu^-$, $\gamma\gamma$

Ali Sabet-Fakri is looking at jet-jet channel. Currently it looks like the background dominates: $S/\sqrt{B}$~0.3

Asa Briggs is looking at ZZ channel – no results yet but expect to be able to measure coupling for part of parameter space.

Expect to publish a paper on this within the next 3 months