

Using top quarks to probe the Randall-Sundrum model

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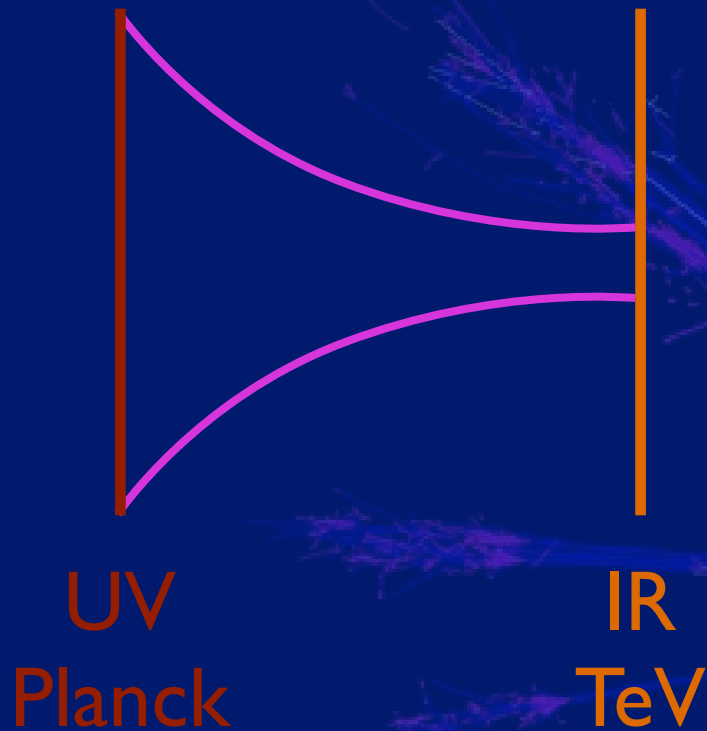
Outline

B. Lillie, L. Randall, L. Wang hep-ph/0701166

- Description of the RS model
- Importance of top quarks
- Top jets
- ILC channels?
- Outlook

The Randall-Sundrum model

L. Randall, R. Sundrum hep-ph/9905221



$$M \rightarrow e^{-\pi k r_c}$$

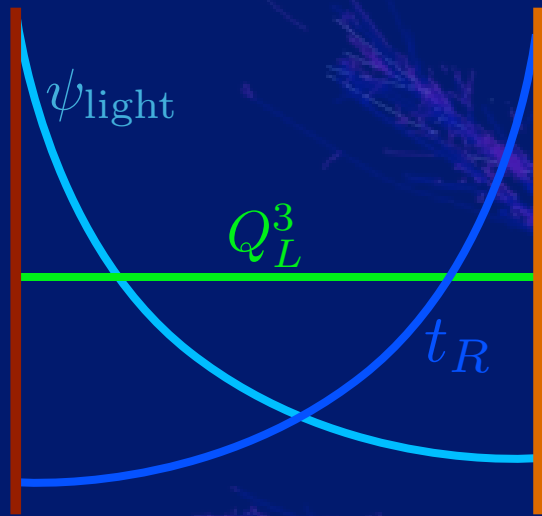
- Five dimensions
- Extra dimension is “warped”
- Warping scales masses, solving the hierarchy problem
- Parameters are natural

W. Goldberger and M. Wise hep-ph/9907447



Standard Model fields

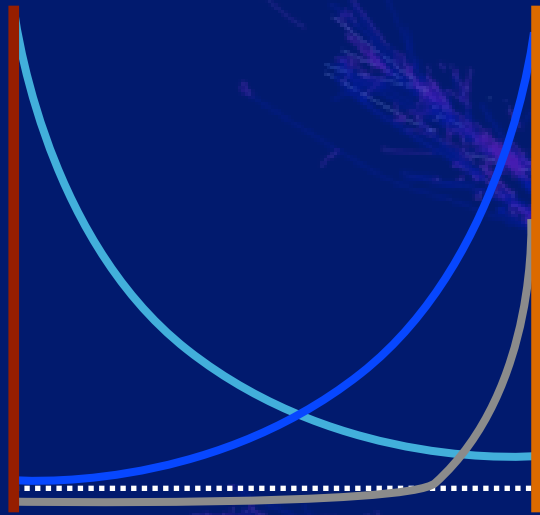
H. Davoudiasl, J. Hewett, T. Rizzo hep-ph/9911262
A. Pomarol hep-ph/9911294



- SM fields in bulk to suppress dangerous operators
 - Gauge fields must be in bulk
- Provides explanation of flavor hierarchy
- Structure constrained by SM precision observables
 - $Z \rightarrow b\bar{b}$ dominant constraint



Kaluza-Klein states



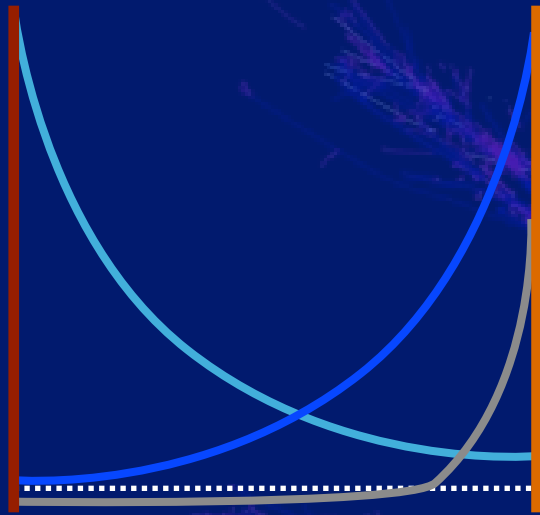
- KK states are IR localized
- Universal couplings to light fermions
- Large coupling to top

$$g_{f\bar{f}g^{(1)}} \sim 0.2g_s$$

$$g_{Q^3\bar{Q}^3g^{(1)}} \sim g_s$$

$$g_{t_R\bar{t}_Rg^{(1)}} \sim 4g_s$$

Kaluza-Klein states



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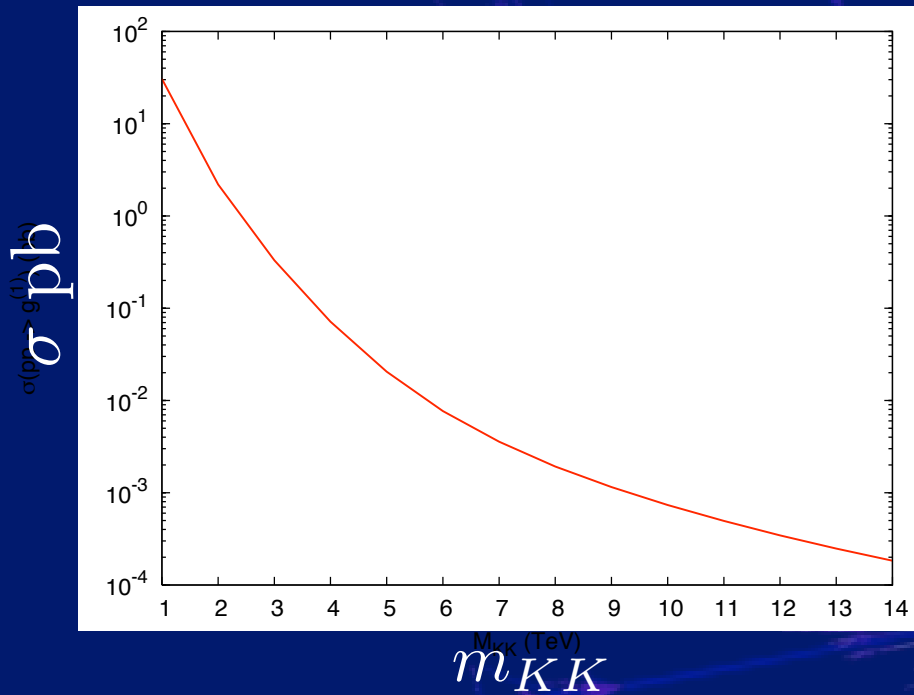
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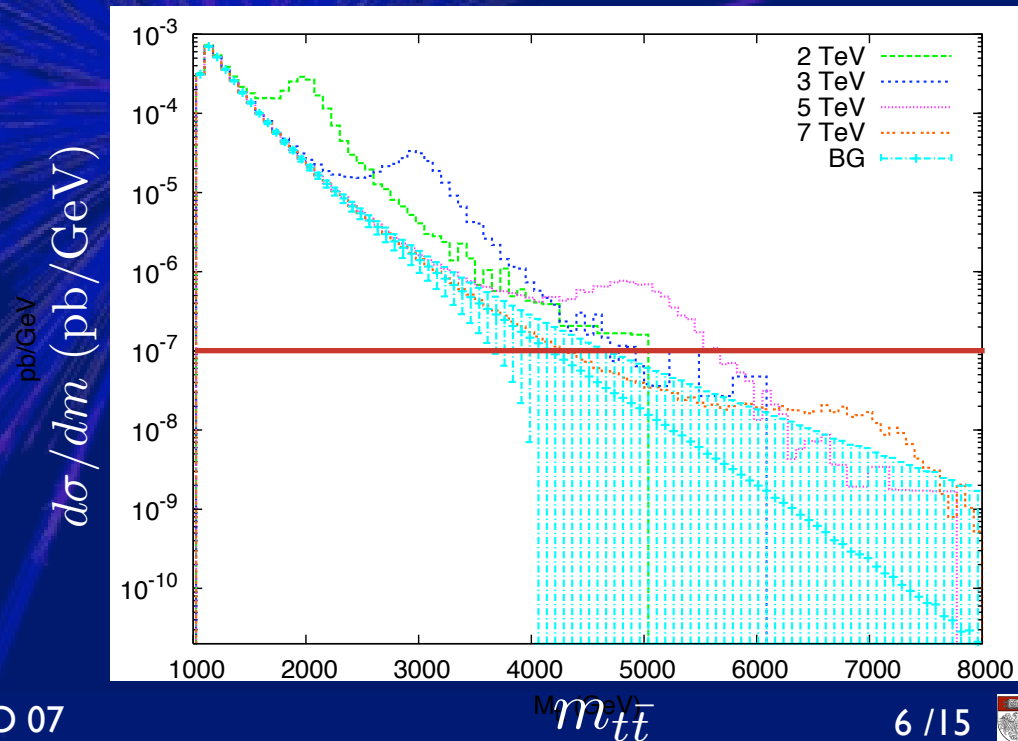
All gauge KK states decay predominantly to top pairs!

Top pairs from KK gluons



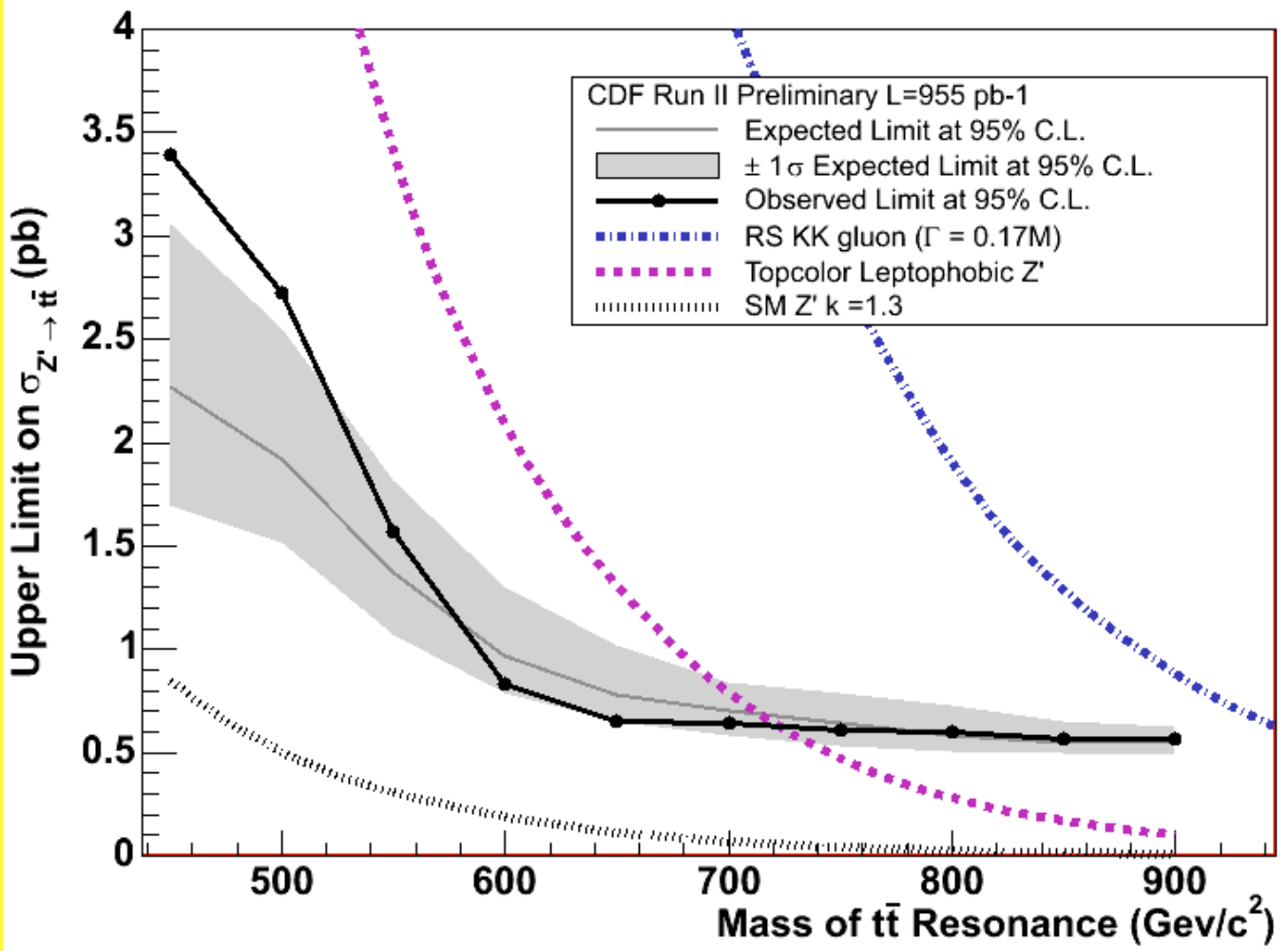
Cross-section at LHC reasonable, limited by small coupling to light fermions, and lack of glue-gluon coupling

- Nice signal above SM top production
- PDF and stat. errors shown, assuming 100 fb^{-1}
- Width/Mass $\sim 17\%$



Tevatron constraints

Upper Limit on Resonant $t\bar{t}$ Production at CDF

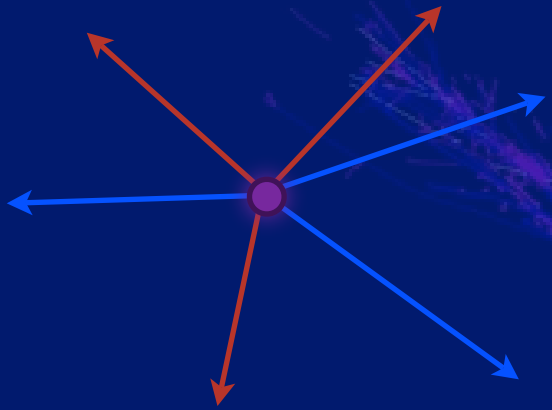


~ 950 GeV

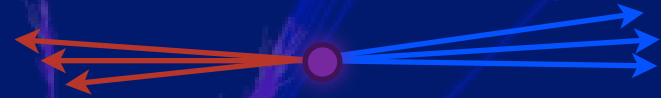
Used narrow-width approximation, so constraint is qualitative, but probably improves with proper treatment

M. Kagan, D. Amidei, C. Cully, T. Schwarz, M. Soderberg (Michigan)
http://www-cdf.fnal.gov/physics/new/top/2006/mass/mttb/pub_page.html

Top collimation

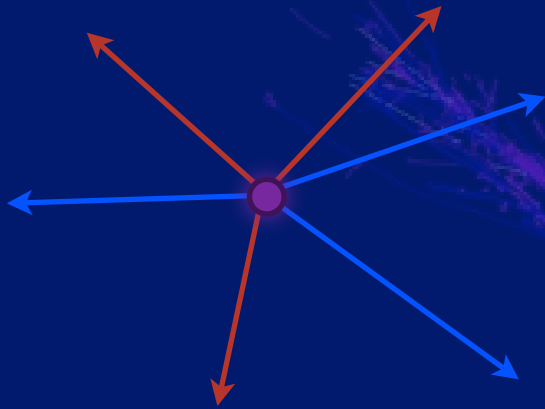


Threshold production

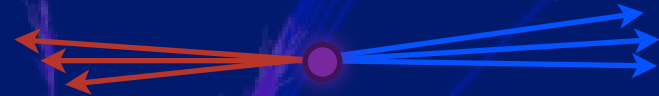


High mass production

Top collimation



Threshold production



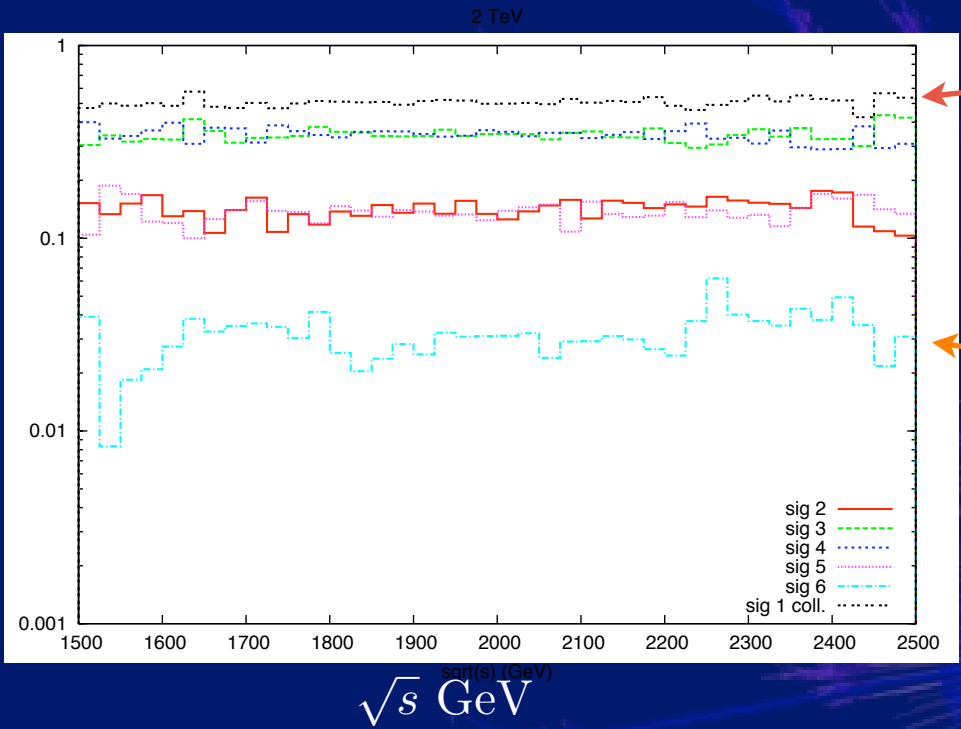
High mass production

- Tops can be highly boosted
- Can they be resolved into separate objects for top ID and reconstruction?

Top collimation (cont.)

2 TeV resonance

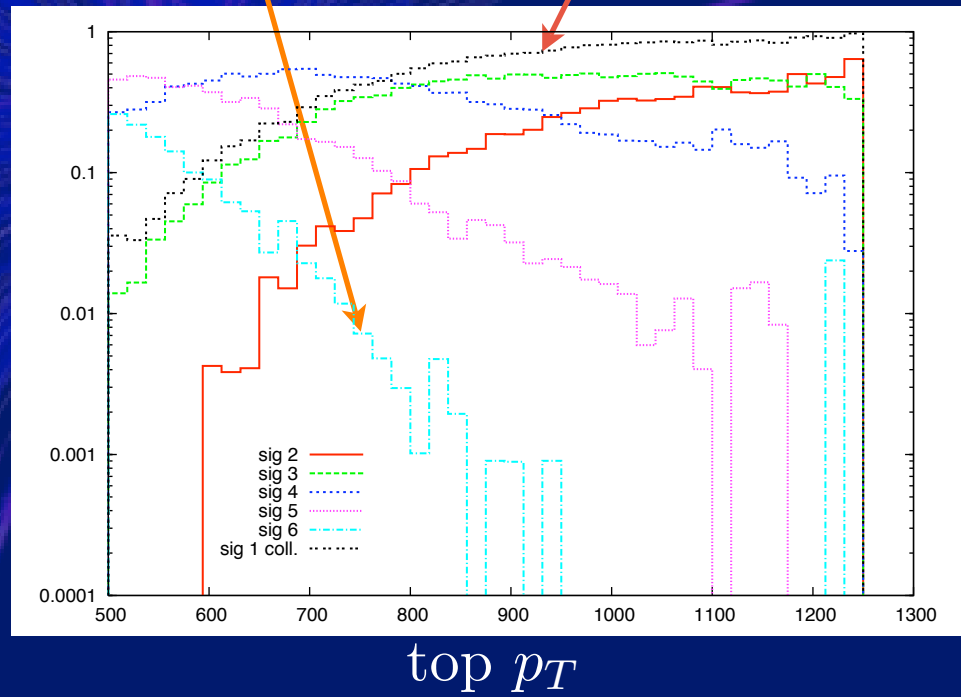
Fraction of events



One top completely collimated

6 isolated decay products

Fraction of events

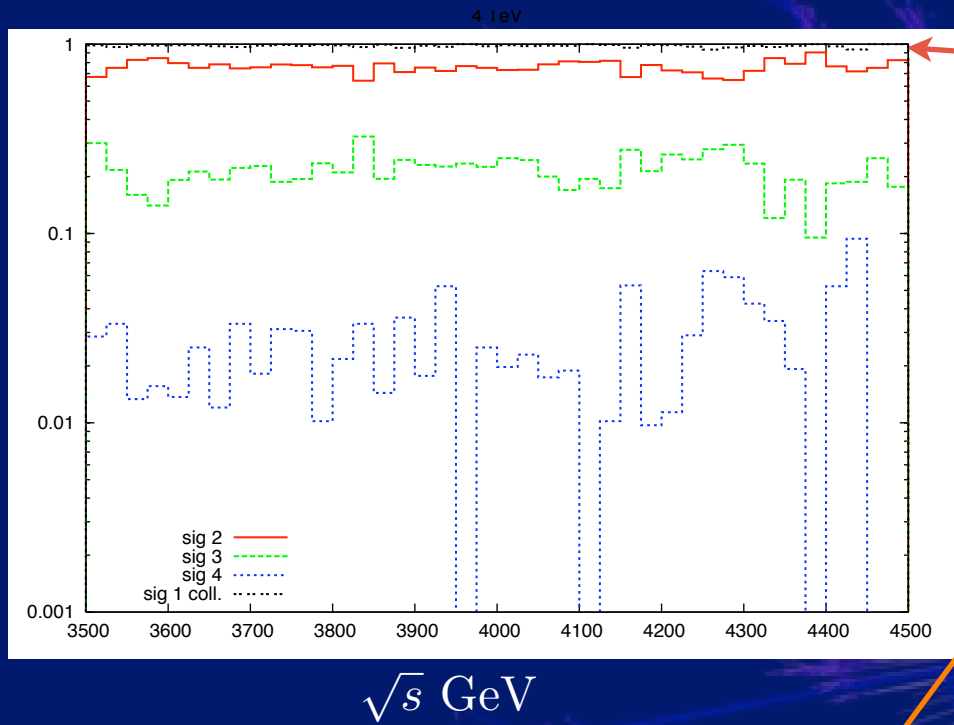


Separation: $\Delta R > 0.4$

Top collimation (cont.)

4 TeV resonance

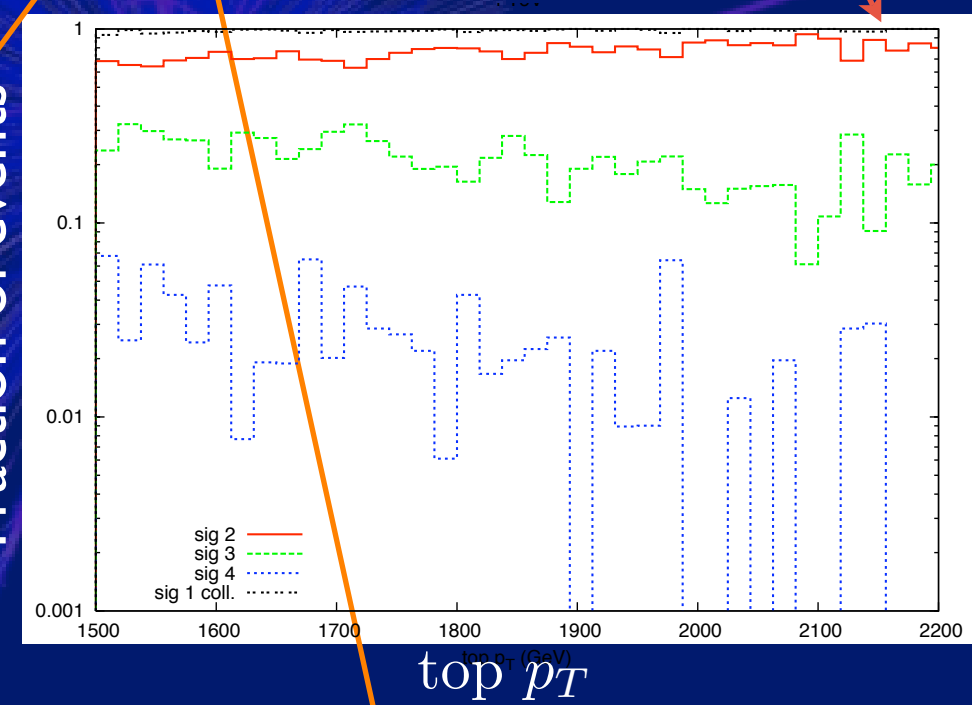
Fraction of events



One top completely collimated

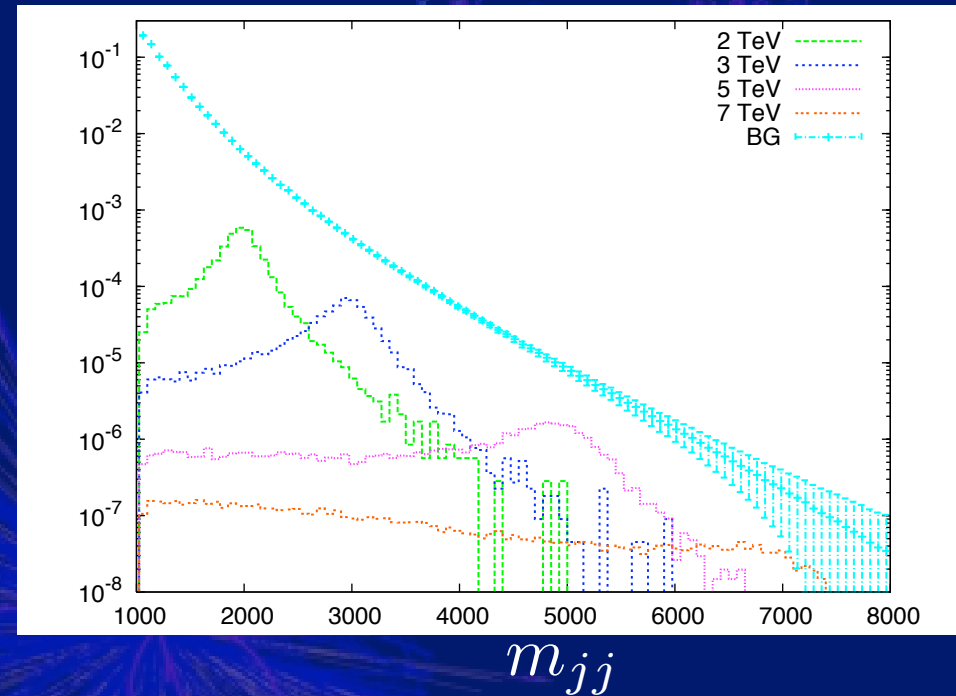
6 isolated decay products

Fraction of events



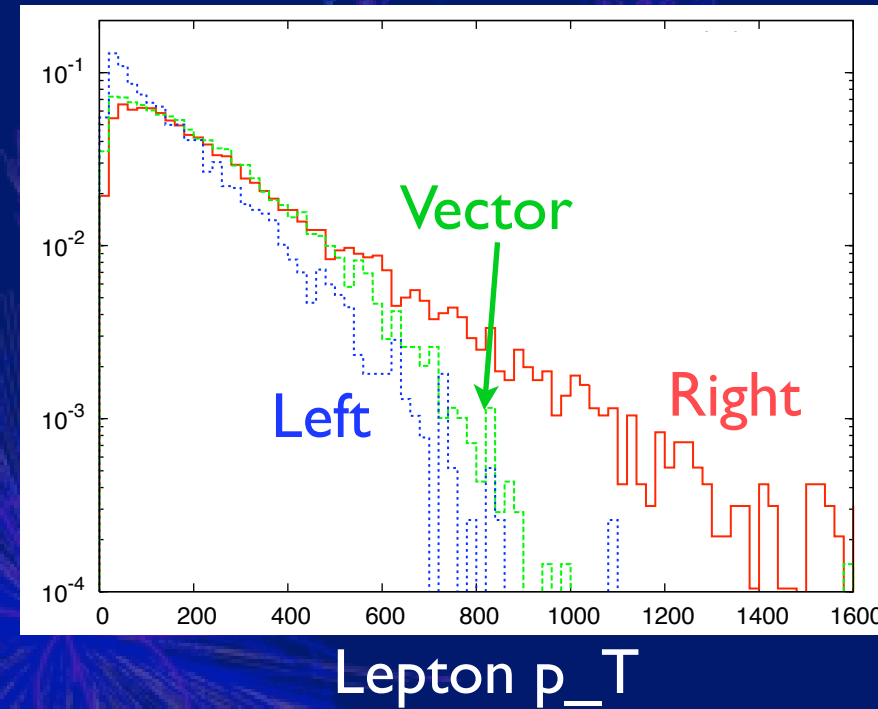
Compare to dijets?

- Possibly significant at lower masses (S/\sqrt{B})
- Still very challenging
- Would like a way to identify tops, even if collimated

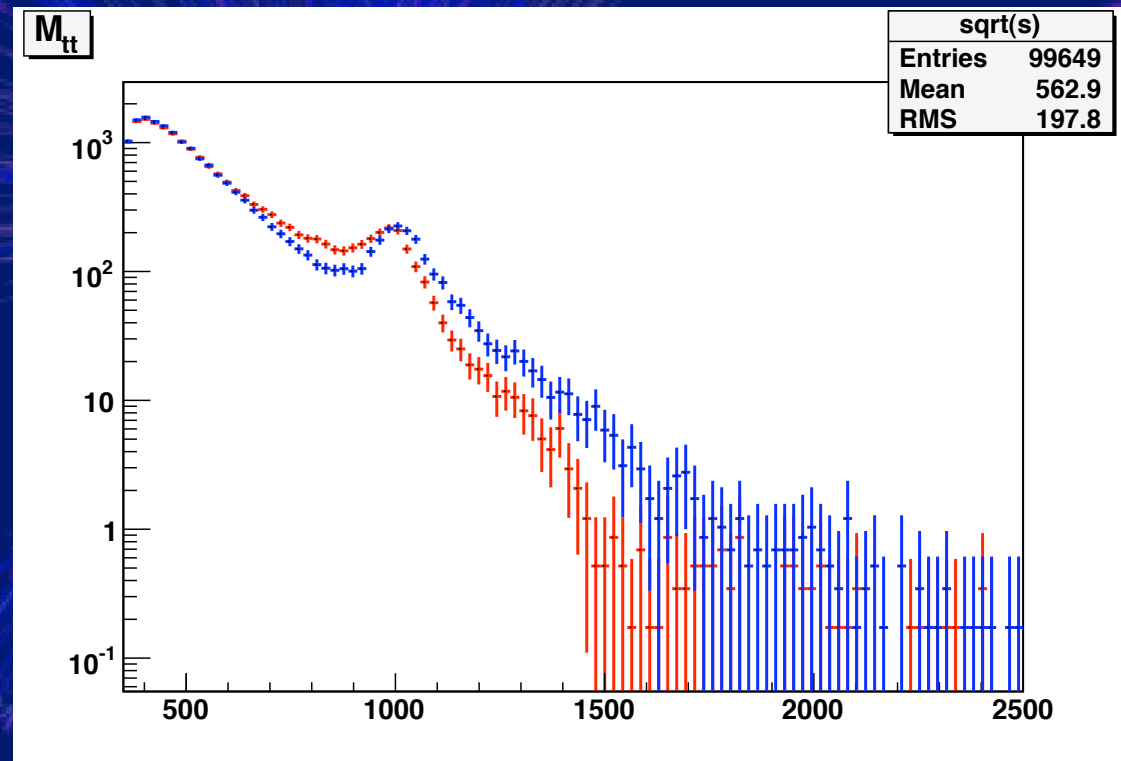
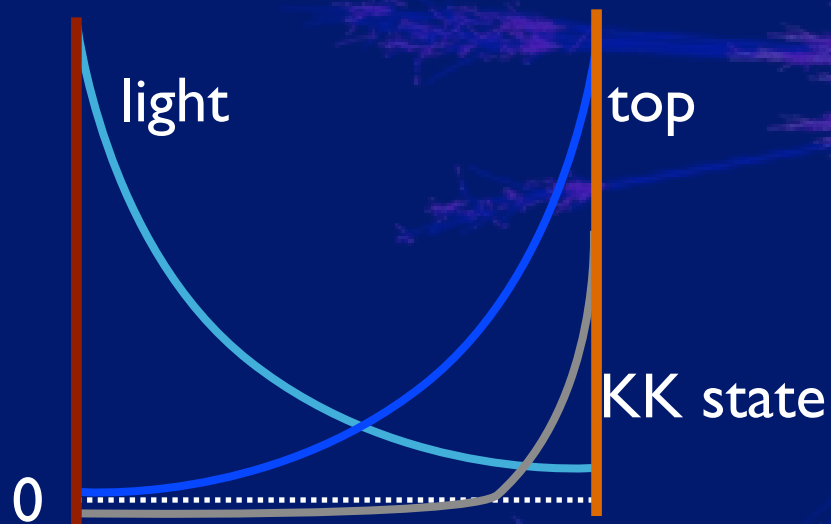
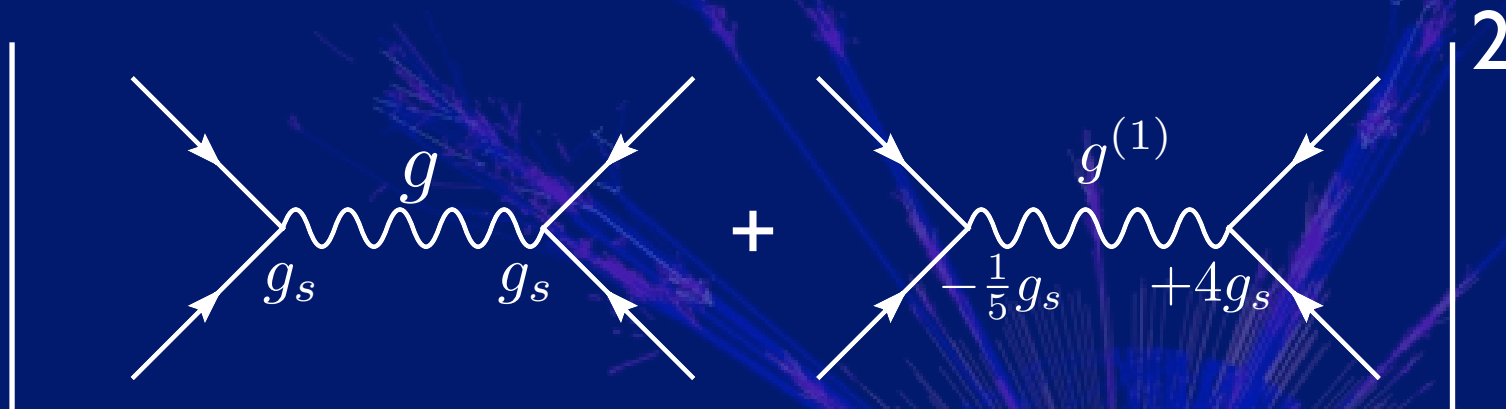


Top helicity

- Tops from KK decays are right-polarized
- Other models where they are left-polarized
 - e.g. Carena *et. al.* hep-ph/0607106



Sign of the couplings



Possibilities at the ILC

- No s-channel gluon production. Gives direct access to EW KK states
 - Disentangle KK gluons from EW bosons
- Unlikely to have on-shell production, but not necessarily problematic
 - See, e.g. TESLA TDR
- Better top helicity measurement?

Outlook

- Another reminder that large resonances can occur in models that solve the hierarchy problem
- Example of a model where almost all new physics appears in hadronic channels
- How well can KK gluon properties be measured? (mass, width, couplings,...)
- How much can be deduced about the theory by measuring those properties?