Higgs pair production at a linear e+e- collider in models with large extra dimensions
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- Theoretical calculations
- Simulations
- Analysis
- Results

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Motivations

- Large Extra Dimensions are an alternative solution to the Gauge hierarchy problem

- Gravity with extra-dimensions would be characterized by KK graviton

- KK graviton interacts with SM very weakly but virtual KK graviton can mediate SM interactions.

- SM Higgs pair production is highly suppressed at the Linear Collider

- Clean signal with almost no SM background. Very characteristic spin 2 angular distribution.

- Channel well suited to identify KK graviton's signal

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Theoretical framework

- For more details, see Okada-san's lectures at http://www-jlc.kek.jp/information/index.html (Lecture 1 more specifically)

- Key points:

    - Need to introduce an ultraviolet cutoff M_s

    - @1 TeV cross section $(e^+e^- \rightarrow HH) = 8.6$fb for $M_s = 2$ TeV. (similar to $e^+e^- \rightarrow ZH$ in the SM)

    - Angular dependence of the cross section as a function of the scattering angle is characteristic

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Theoretical framework (2)
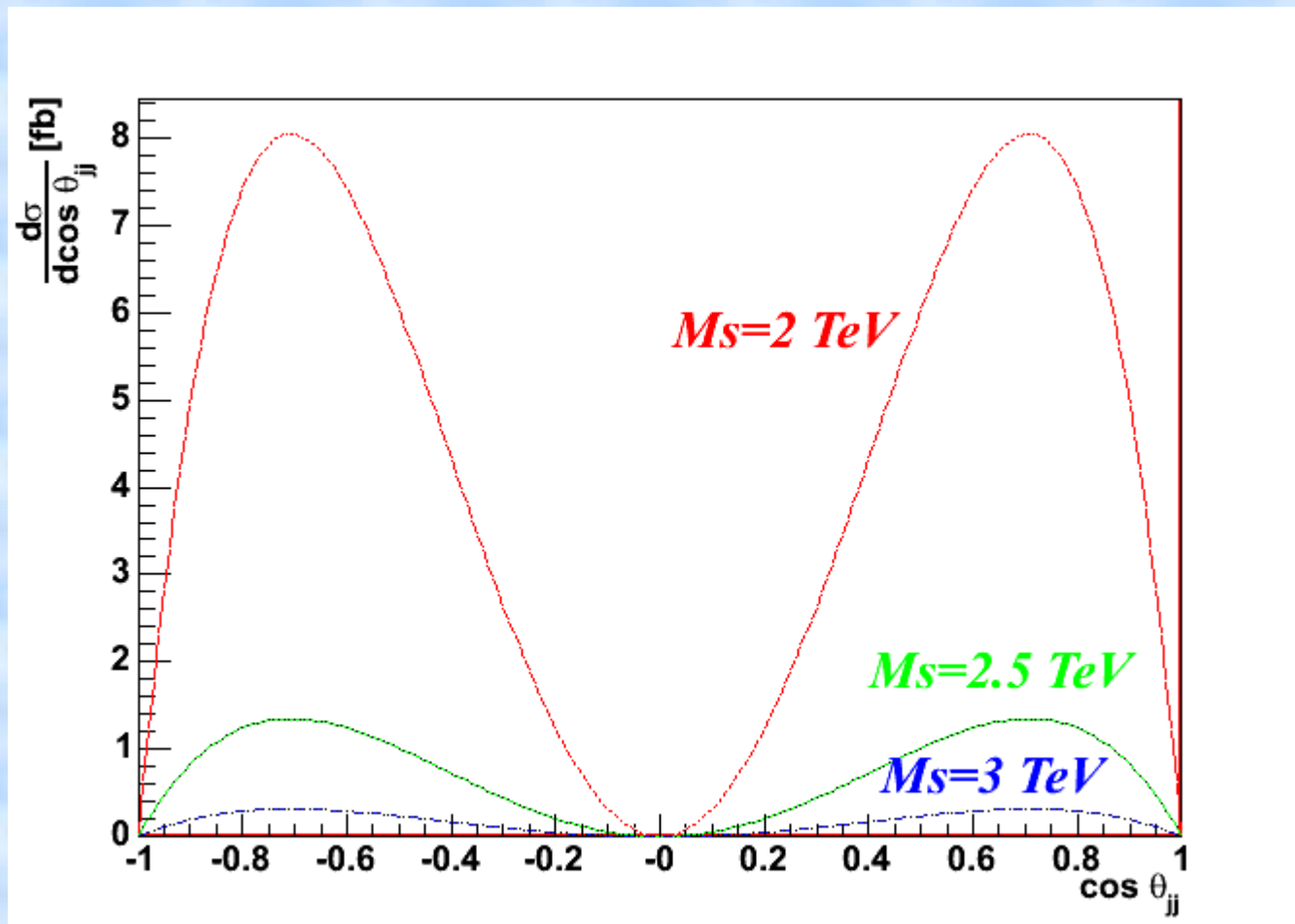
Angular dependence of the cross section as a function of the scattering angle.

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Monte-Carlo simulations

- The cross section formula has been used to write a Monte Carlo generator

- Use JSF's Hadronizer based on Pythia 6

- JSF quick simulator was then used.

- Signal's signature: 2 pairs of b-jets with Mass close from the Higgs.

- Background: WW, ZZ and ZH

- cm=1 TeV, Higgs Mass=120 GeV, M_s = 2 TeV

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Events selection

| Selection criteria	Signal	ZZ	ZH	WW
No cut	5.772 (10000)	206.666 (150000)	18.395 (20000)	3833.3 (60000)
$N_{\text{tracks}} > 25$	5.674 (9831)	164.330 (119272)	18.202 (19790)	2427.1 (37990)
$E_{\text{vis}} > 600$ GeV	5.471 (9479)	90.8559 (65944)	11.287 (12272)	1203.8 (18842)
$P_t \leq 50$ GeV	3.662 (6345)	79.9122 (58001)	8.9160 (9694)	939.61 (14707)
$N_{\text{jets}} \geq 4$ at $y_{\text{cut}} = 0.004$	3.481 (6031)	69.682 (50576)	8.6308 (9384)	644.89 (10094)
$|m_{jj} - m_H| \leq 16$ GeV	2.234 (3870)	0.136 (99)	0.174 (190)	0.319 (5)
b-tagging	1.313 (2275)	0.006 (4)	0.038 (41)	0.0 (0)

- After selection cuts, almost no background is left

- 1.3 events/fb^{-1} (0.04 background)

- Possible to see the characteristic distribution with 500fb^{-1}

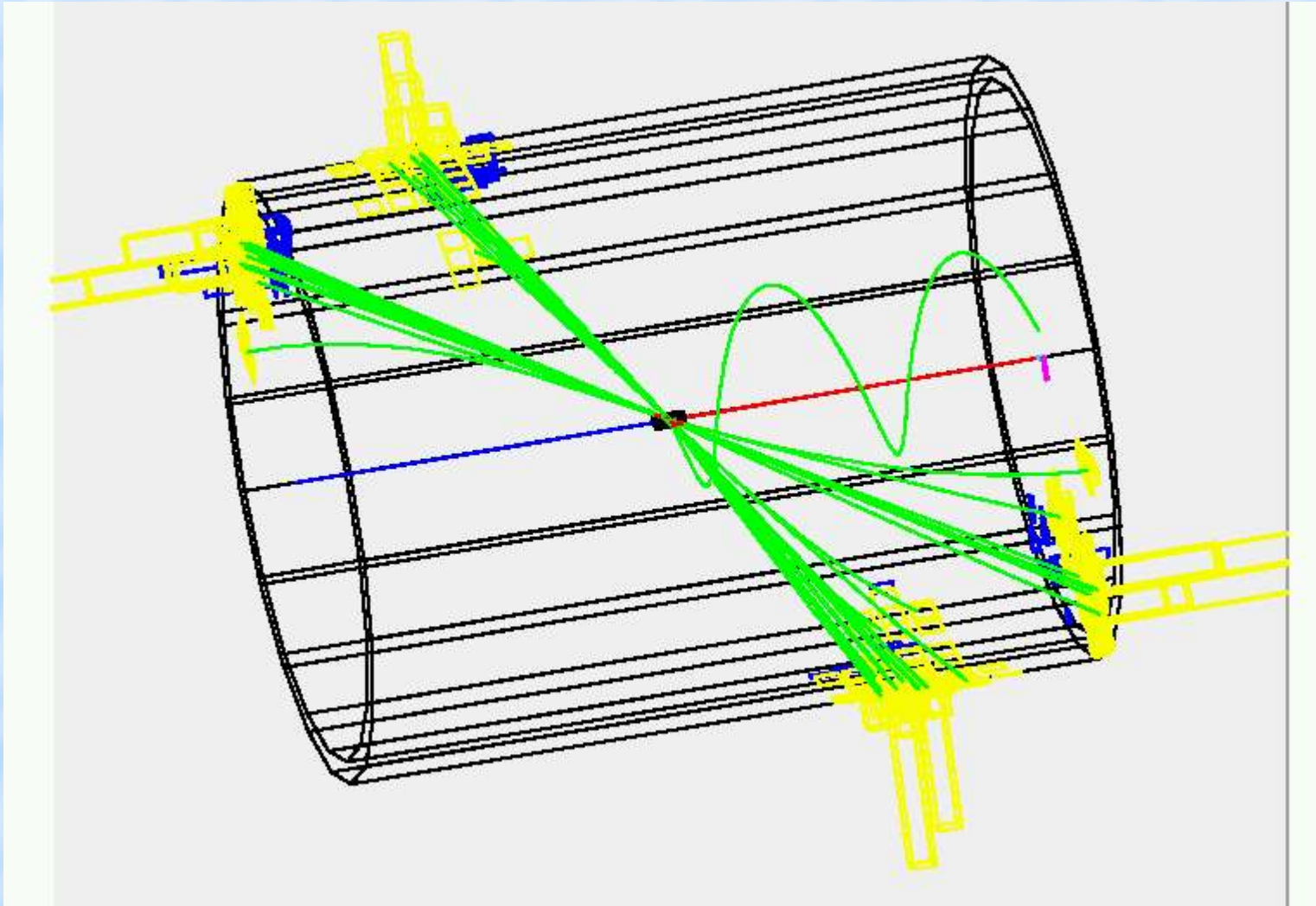GLC group Meeting 2.07.2004

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Dijets invariant mass (before mass cut)
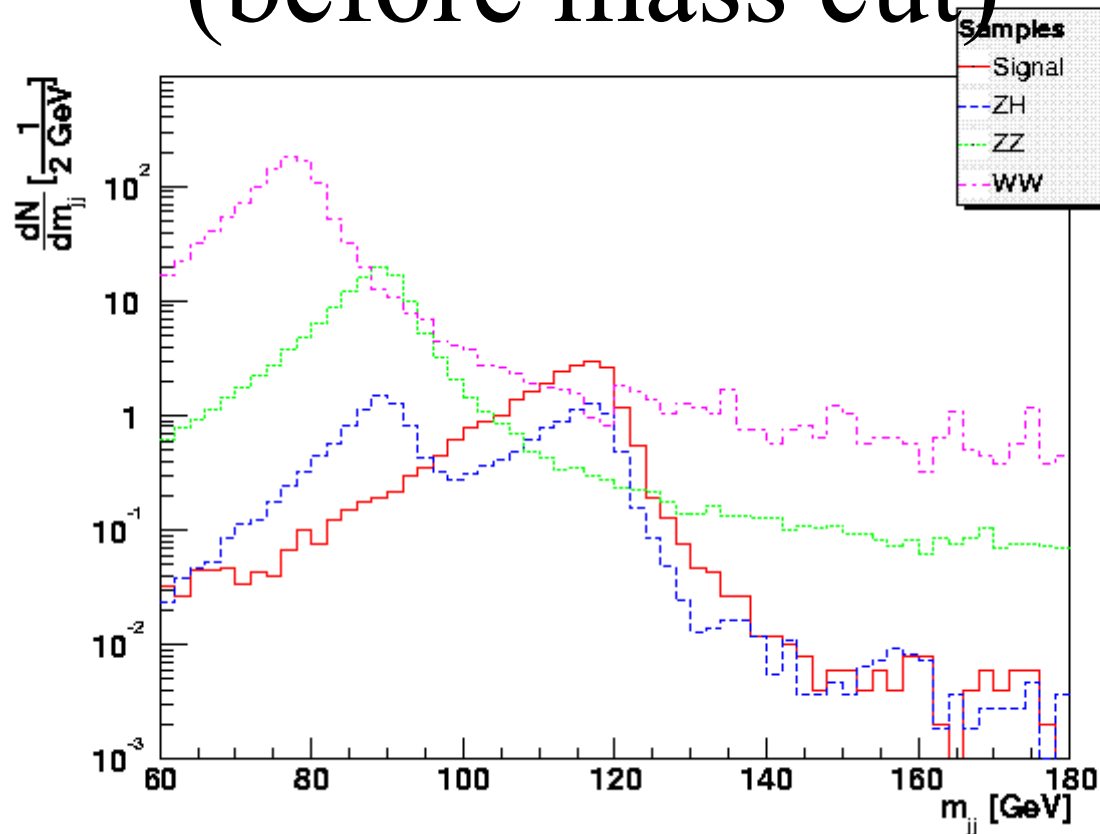
After mass cut almost all background removed (very unlikely to have 2 dijets near the Higgs mass in a single event)

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Cos theta distribution (500 fb^{-1})
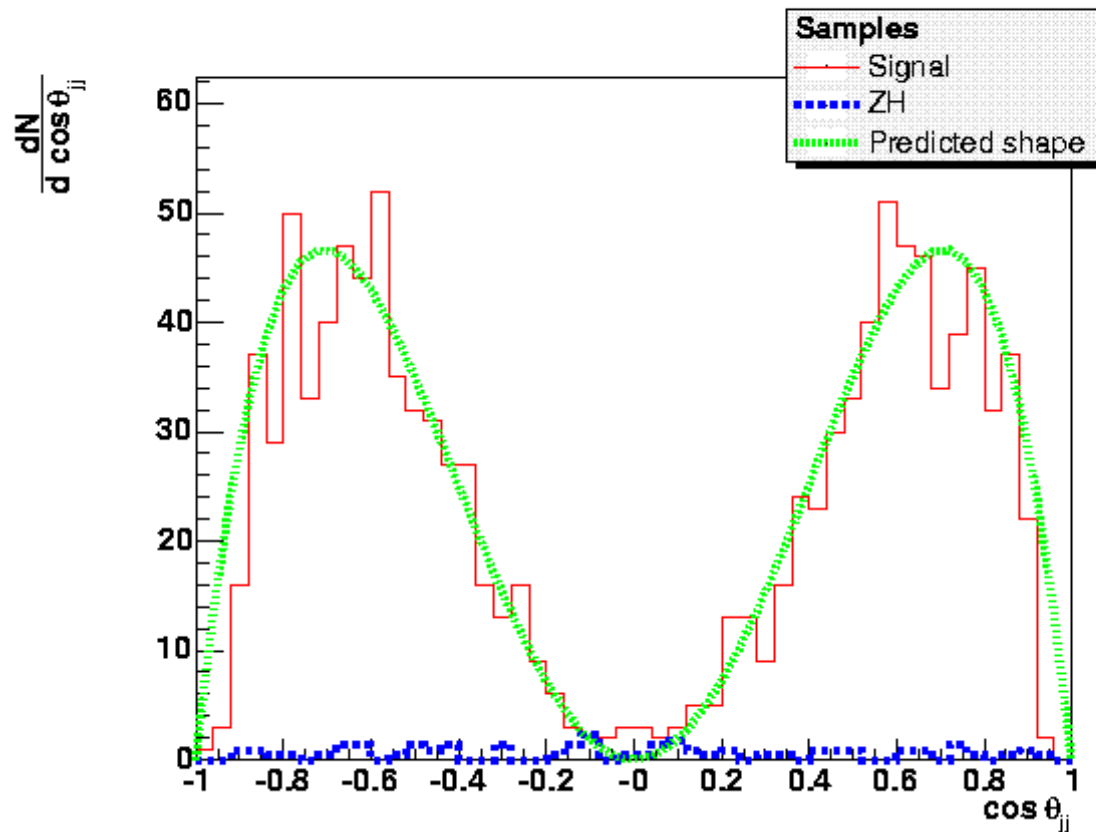
Spin 2 of the KK graviton can easily be verified

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Example of event

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Paper's conclusion

- @1TeV ZH and HH via KK graviton have cross sections of the same order, but HH has a characteristic signal distribution.

- Possible to obtain a very clean sample with 500fb^{-1}

- But ZH, ZZ and WW can also be mediated by KK graviton => Another paper is in progress

- *Submitted to PRD, rapid communictions*

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Referee's comments

- Sensitivity as a function of the Higgs mass should be discussed.
  (in progress)

- 4b background is missing.
  Cross section has been estimated with grc4f and is 3.7 fb, thus after invariant mass cut the number of remaining events should be negligible.

- Surprised by the distribution of the dijet invariant mass.
  2D plot available to justify the distribution

- Cross section of SM background modified
  Other paper in progress...

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