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Twin Higgs from Left-Right Symmetry

Study of channel $W_H(1\,TeV/c^2) \rightarrow Tb$

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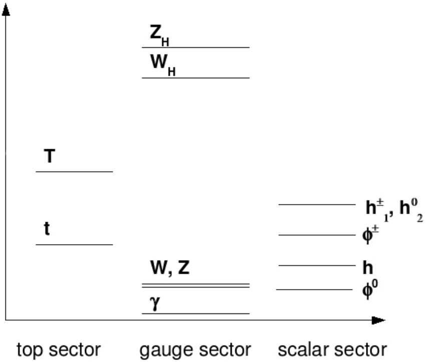
Twin Higgs from Left-Right Symmetry

- The *Left-Right Twin Symmetry* when broken adds new terms to the Lagrangian.
- This eliminates cuadratic divergences (at NLO) from Higgs boson's mass.



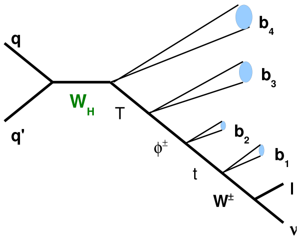
Mass is the only free parameter of the Twin Higgs model. Amongst its predictions, there are $SU(2)_R$ gauge bosons, vector-like quarks and a natural candidate to dark matter (h_2^0)

Z. Chacko, H.S. Goh, R. Harnik, A Twin Higgs model from left-right symmetry, JHEP 0601 (2006) 108, hep-ph/0512088

H.S. Goh, S. Su, Phenomenology of The Left-Right Twin Higgs Model, Phys. Rev. D 75 (2007) 075010

Study of channel $W_H(1 TeV/c^2) \rightarrow Tb$

$4b + l + E_T^{Miss}$ does not appear in *Little Higgs*



Particle	Mass (GeV)	Decay	BR
W_H	1000	$T_H b$	20%
T_H	500	$\phi^\pm b$	80%
$\phi^\pm$	200	tb	100%
t	175	$W^\pm b$	100%
$W^\pm$	80	$l\nu$	21%

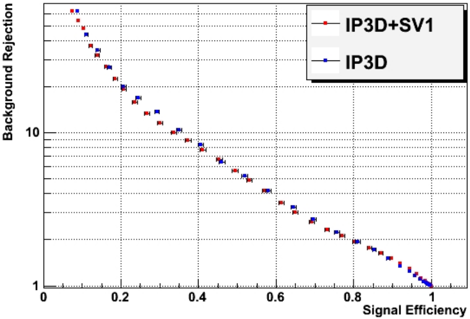
"New Physics at the LHC: A Les Houches Report. Physics at Tev Colliders 2007" – New Physics Working Group. Gustaaf H. Brooijmans et al. Feb 2008 arXiv:0802.3715 [hep-ph]

- $l + \nu \rightarrow W^\pm$
  - $p_Z^\nu // p_Z^l$ to reconstruct $W^\pm$.
  - $p_T^l > 25 GeV/c$
  - $E_T^{miss} > 25 GeV/c$.
  - $p_T^{W^\pm} > 25 GeV/c$.
- $W^\pm + b \rightarrow t$
  - $25 GeV/c < p_T^{jet} < 200 GeV/c$.
  - $M_t < 300 GeV/c$.
- $t + b \rightarrow \phi^\pm$
  - $25 GeV/c < p_T^{jet} < 100 Gev/c$
  - $M_{\phi^\pm} < 300 GeV/c$.
- $\phi^\pm + b \rightarrow T_H$
  - $p_T^{jet} > 100 GeV/c$.
  - $p_T^{T_H} > 120 GeV/c$
- $T_H + b \rightarrow W_H$
  - $p_T^{jet} > 150 GeV/c$.
- Always $|\eta| < 2.5$

B-tagging

- A sample of 20000 events of $W_H(1\,TeV/c^2) \rightarrow Tb$ was made with Athena v.12.0.6.1
  - Generation with Pythia v.6.4
  - Simulation with GEANT4
  - Reconstruction made including IPatRec info.
- Also 20000 events of background $t\bar{t}$ No Hadronic (Semileptonic + Dileptonic)
  - $\sqrt{s} > 500 GeV$
  - $p_T > 100 GeV$

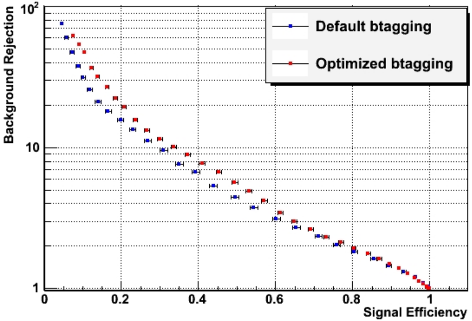
- Combination of IP3D and SV1 used.
- Paremeters of both algorithms have been optimized for a wider energy range jets.
- Although SV1 was found to have negligible efect.



This plot shows signal efficiency (4 b-jets) versus background rejection (2 b-jets) both for IP3D and IP3D+SV1.

B-tagging

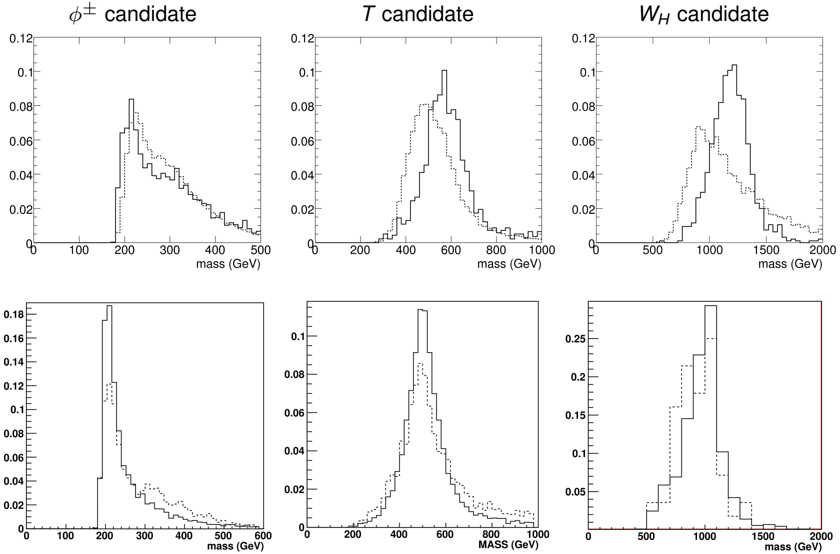
- Sarted with btagging algorithms optimized for high p_T jets shown in the following plot as "defalut"
- $W_H \to Tb$ has a wider energy range b-jets so we had to change algorithms' parameters in order to improve background rejection.



- Sum weights of the four jets used on W_H reconstruction.
- Use events with sum > 34 (20% signal efficiency and 95% background rejection)

More on high p_T btagging:
CSC book: the ATLAS collaboration, Expected Performance of the ATLAS Experiment - Detector, Trigger and Physics, arXiv:0901.0512

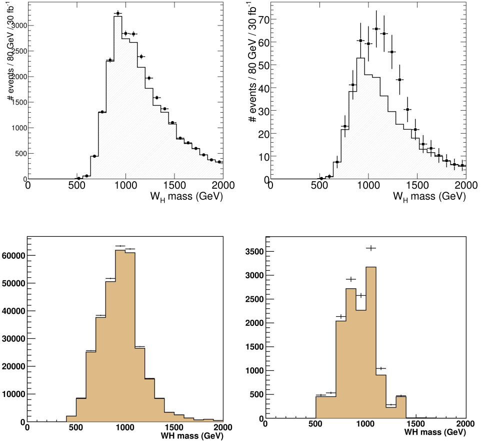
W_H invariant mass reconstruction.



Mass distributions for different steps of the reconstruction of the decay chain for signal events (full line) and the dominant $t\bar{t}$ background (dashed histogram) both for Atlfast (up) and Full simulation (down)

Btagging effect on W_H invariant mass reconstruction.

Before btagging After btagging



	Atlfast		Full	
selection	no b-tag	b-tag	no b-tag	b-tag
signal	1058	138	4414	917
$t\bar{t}$	23500	392	193537	7251
$S/\sqrt{B}$	6.9	7.0	10.0	10.8
S/B	0.05	0.4	0.02	0.13

Reconstructed mass distribution of W_H candidates (data points). The contribution of the $t\bar{t}$ and $W + jets$ backgrounds is indicated by the colored region. Results shown both for Atlfast (up) and Full simulation (down)

Conclusions and future steps.

Even though both kinematic reconstruction and btagging work worse in FULL than in FAST we still get statistic significance for $W_H(1\,TeV)$

To Do

- Use MC@NLO instead of Pythia and study heavier W_H (1.25 TeV, 2 TeV)
- Fine tune kinematic cuts and optimize btagging algorithms for them.
- Undestand better the excess of background we find compared with FAST study.
- Improve high p_T btagging using tracking on new versions of Athena.