Evaluating sensitivity of the ILC to new extra scalar particles

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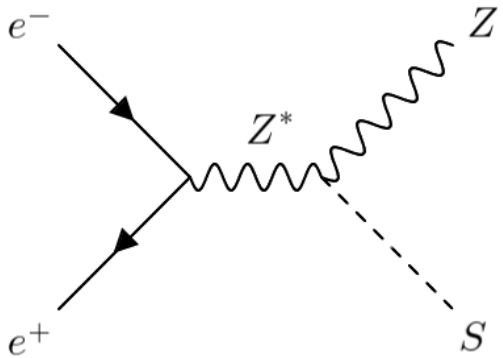
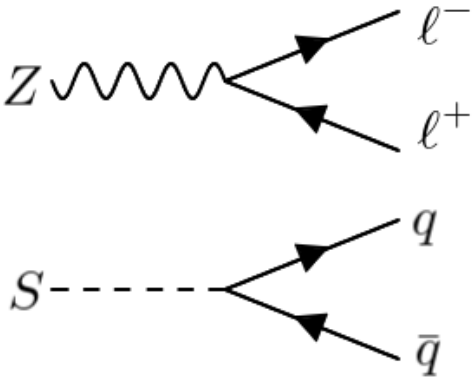
Introduction

There are many models containing a second scalar particle that is not currently excluded by the measurements.



- Cross section ratio of extra scalar particle production to SM Higgs production: $\sigma\left(e^+e^- \to ZS\right)/\sigma_{SM}$.
- The goal is to calculate 95% Central Limit on the cross section ratio.

Decay channels



- Z decays: $Z \to e^+e^-$ and $Z \to \mu^+\mu^-$.
- S decays: $S \to b\bar{b}$

Samples used

Background samples:

- 250 GeV center-of-mass energy,
- generated with Whizard v.2.8.5,
- SetA beam-spectrum,
- simulated and reconstructed with ILD_l5_o2_v02 model and ILCSoft v02-02-01.

Signal samples:

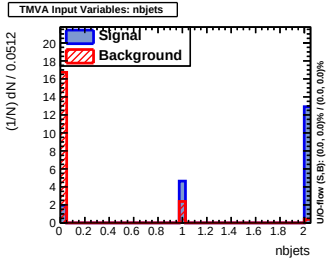
- 250 GeV center-of-mass energy,
- generated with Whizard v.2.8.5,
- SetA beam-spectrum,
- detector simulation done by SGV.

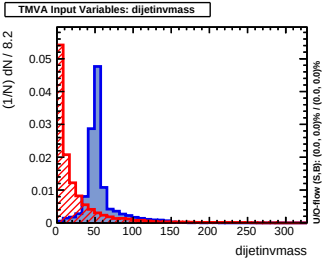
BDT classification

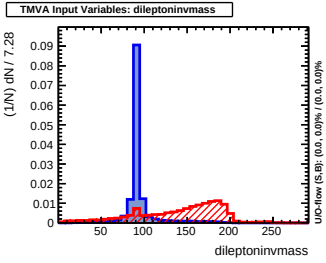
For classifying the events Boosted Decision Trees were used, implemented in ROOT under TMVA. There were 14 variables used:

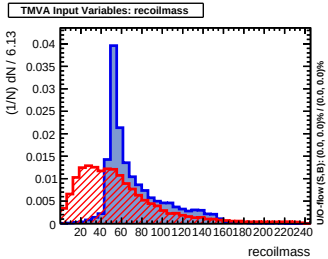
- number of b-jets according to certain B-Tag threshold,
- invariant mass of a jet pair,
- invariant mass of a lepton pair,
- recoil mass,
- B-Tag value for both jets,
- number of photons, electrons and muons,
- total energy,
- $cos(\theta)$ of one of the jets in the CM frame of the jet pair,
- transverse momentum of one of the jets,
- energy and transverse momentum of the jet pair.

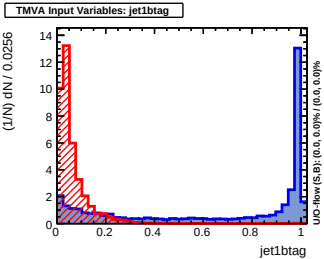
BDT classification

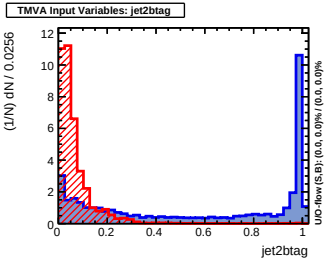




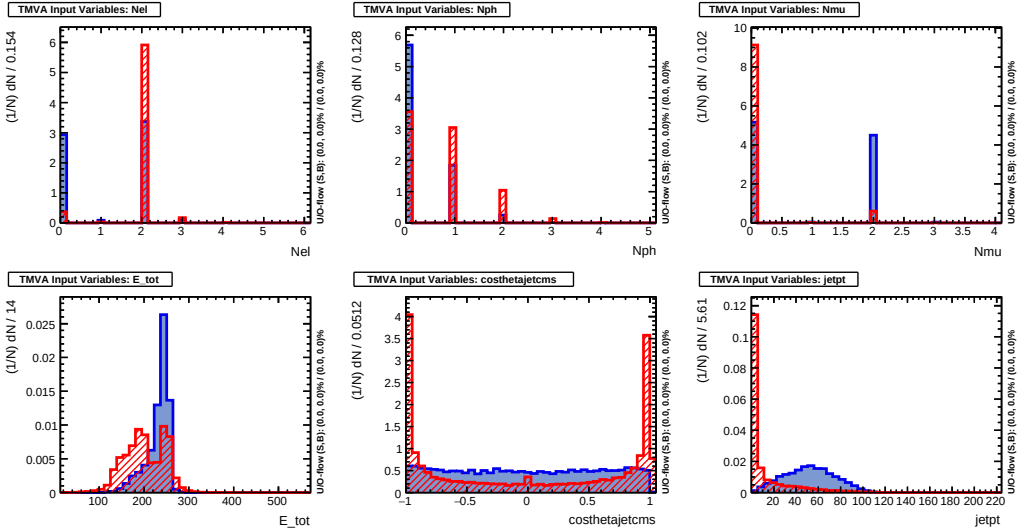




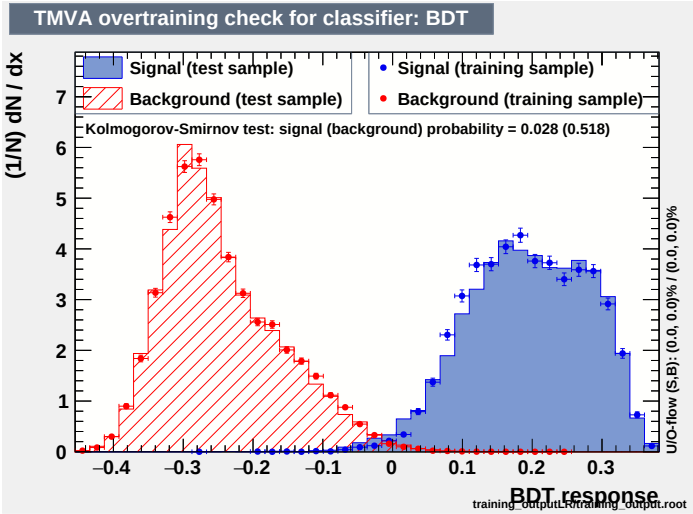




BDT classification

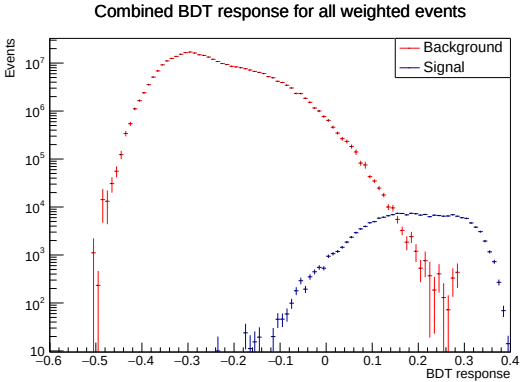


BDT classification - response



Limit calculations

After combining all polarizations and multiplying by appropriate weights output histogram is obtained.



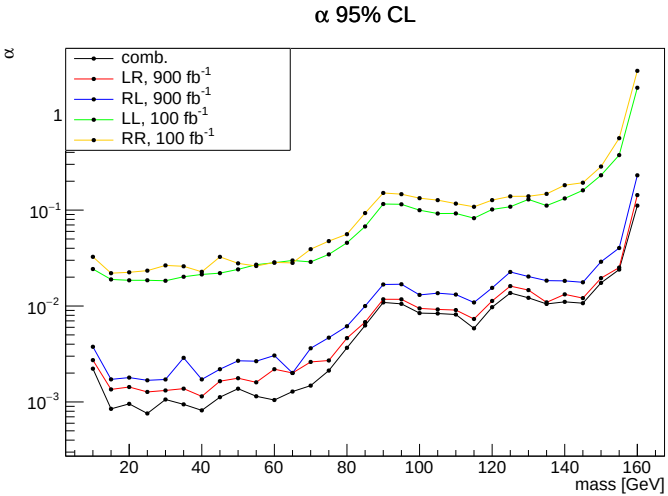
Limit calculations

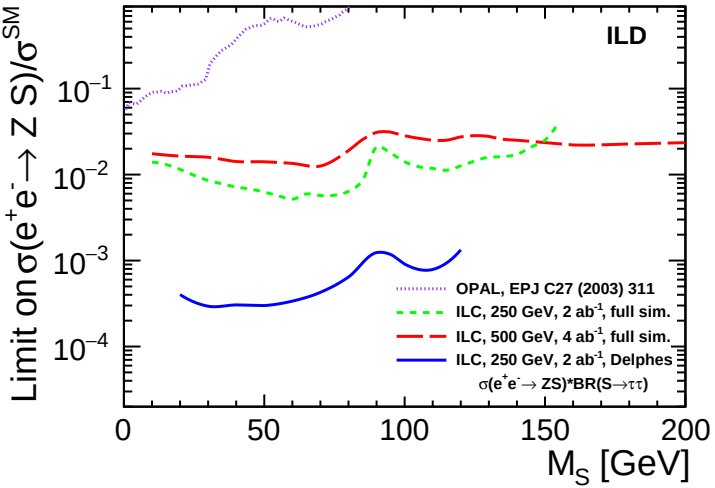
Limit formula:

$$\alpha_{95\%CL} = 1.64 \cdot \left(\sqrt{\sum_i \left(\frac{s_i^2}{b_i} \right)} \right)^{-1},$$

where $\alpha = \sigma\left(e^+e^- \to ZS\right) \cdot \mathcal{B}(S \to b\bar{b})/\sigma_{SM}$, s_i is the signal level in each bin and b_i is the background level.

Results


α 95% CL
α
comb.
LR, 900 fb-1
RL, 900 fb-1
LL, 100 fb-1
RR, 100 fb-1
1
10-1
10-2
10-3
20
40
60
80
100
120
140
160
mass [GeV]

Questions

Limit plot for comparison