Study of invisible Higgs boson events at the LHC

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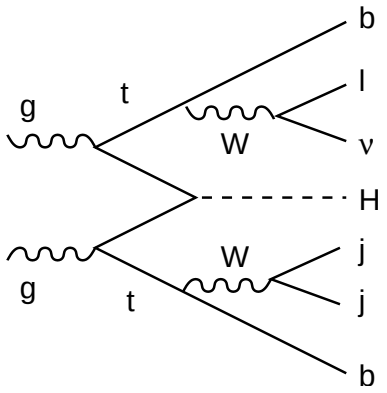
In some theoretical models the Higgs boson is allowed to decay invisibly. One of the search channels for the invisible Higgs at the Large Hadron Collider (LHC) is the channel

$$t\bar{t}H \rightarrow (b\ell\nu)\,(bjj) + \text{missing energy}$$

in which the Higgs particle is produced in association with two top quarks, whose decay products (with the exception of the ν) can be detected in an LHC detector such as ATLAS. The invisible Higgs boson escapes detection and contributes to almost all of the total missing energy ($\not{E}$).



The main background for this search is $t\bar{t} \rightarrow (b\ell\nu)\,(bjj)$ events.

The aim of this project is to study the feasibility of improving the discrimination between the $t\bar{t}H$ signal and the $t\bar{t}$ background, based on the reconstructed top masses in both types of event. More specifically, from the experimentally measured information in $t\bar{t} \rightarrow (b\ell\nu)\,(bjj)$ events it is possible to fully reconstruct the two top masses[1]. In the case of $t\bar{t}H$ events, it

is no longer possible to fully reconstruct *both* top masses. The aim of this project is to investigate whether this difference can be explored to improve the discrimination between the signal and the background.

The project is broken down in several parts:

- Familiarization with the search for the invisible Higgs search in the $t\bar{t}H$ channel. Application of the standard event selection to ntuples of the signal and background.

- Study of the method for reconstruction of the top quark mass in the non-trivial case when its decay includes a neutrino, which escapes detection: $t \to b\ell\nu$. Derivation of the corresponding equations for determining m_t^{rec} in terms of the experimentally available information.

- Determine all possible solutions for the pair of reconstructed top-quark masses in the selected events. There are four pairs of solutions, due to ambiguity in the determination of the neutrino momentum, and ambiguity in knowing which b-quark is associated to a given top-quark decay. Investigate if the information contained in the solutions can be used to discriminate between the signal and the background.

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References

[1] ATLAS Detector and Physics performance TDR, Vol. II, "Top quark physics" (Chapter 18), ATLAS Collaboration, May 1999.