LOI - ILC/SiD Higgs to Invisible

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1 Introduction

The Higgs Boson, being the only true scalar particle yet discovered, is a fundamentally new entity in the world of high energy physics. As such, it imperative to explore every aspect of the Higgs properties. While, so far, experimental results are in line with the Higgs having the properties expected in the Standard Model, there is significant room for connections to new physics beyond the Standard Model. This LOI describes a study of possible decays of the Higgs into invisible particles, such as might comprise the Dark Matter.

2 The search for invisible decays of the Higgs

The ATLAS and CMS experiments at the LHC have searched for invisible decays of the Higgs in a variety of channels. The current best limit, from a single search, is from ATLAS in the vector boson fusion process [2]. The limit set is 13% at 95% c.l. This limit has, in turn, been used to set a limit as a function of mass on the dark matter-nucleon scattering cross-section, as seen in Figure 1.

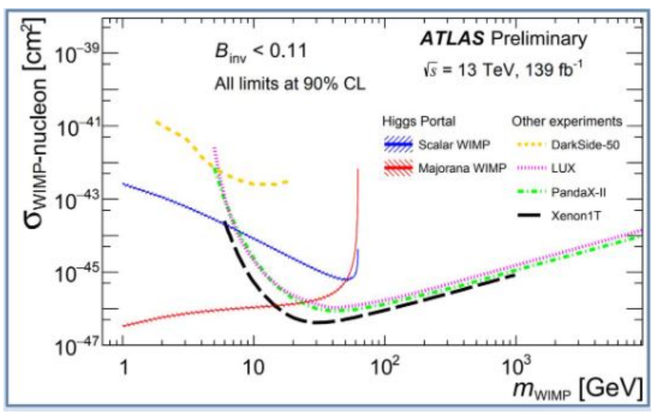

Figure 1: ATLAS limit on dark matter-nucleon scattering

Projections for the limit on Higgs to invisible decays at the HL-LHC lie in the few percent range, depending on assumptions regarding reduction of experimental and theoretical systematic errors - still under study. Theoretical studies [4] have set the range of 1% or better as the goal for detecting non-Standard Model decays of the Higgs. The indication from studies of future e+e- collider facilities is that model independent sensitivity in the 0.3% range can be achieved, as seen in Figure 2.

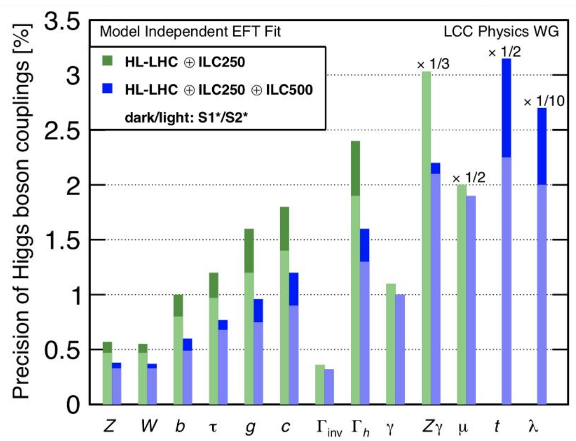

Figure 2: Projected future limits on Higgs decays - including invisible mode, LCC Physics Working Group [3]

3 Higgs to Invisible in e+e- at the ILC

The initial collision energy of the ILC will be 250 GeV. At this energy, the process e+e- → ZH exhibits a maximum cross-section. The Higgs boson recoils directly opposite the Z boson. While the Z → e+e-, $\mu+\mu-$ decay modes are very clean and efficient, the Z→qqbar mode provides the highest statistics. However, this latter mode requires excellent jet identification, reconstruction and measurement of jet energy resolution, along with tight control of experimental systematic errors.

4 Plan of work

4.1 Fast simulation study

Initial studies have begun using the DELPHES fast simulation with parameterized characteristics for the SiD detector. This study will establish the kinematics for signal and backgrounds and identify the optimal variables for separating the signal from the Standard Model backgrounds.

4.2 Full simulation study

The reconstruction of jets in the SiD detector using the particle flow approach requires excellent charged particle momentum measurement, and efficient identification and reconstruction of the various components of hadron showers in high granularity electromagnetic and hadronic calorimeter systems. Earlier studies [1] have shown that jet energy resolution in the 3-4% range can be achieved. However, as yet, the effects of systematic uncertainties arising from calorimeter design such as the number of layers, ratio of active to absorber layer thicknesses, calibrations within and between layers, transition regions between electromagnetic and hadronic systems and barrel and endcaps, and those deriving from e.g. confusion in the particle flow algorithm, have yet to be considered in terms of their influence on the ultimate limit on Higgs to invisible decays. These detailed effects can only be studied through the use of a full detector simulation which will be undertaken in the latter phase of this analysis.

References

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