IDT-WG3 Topical Group: Higgs Properties

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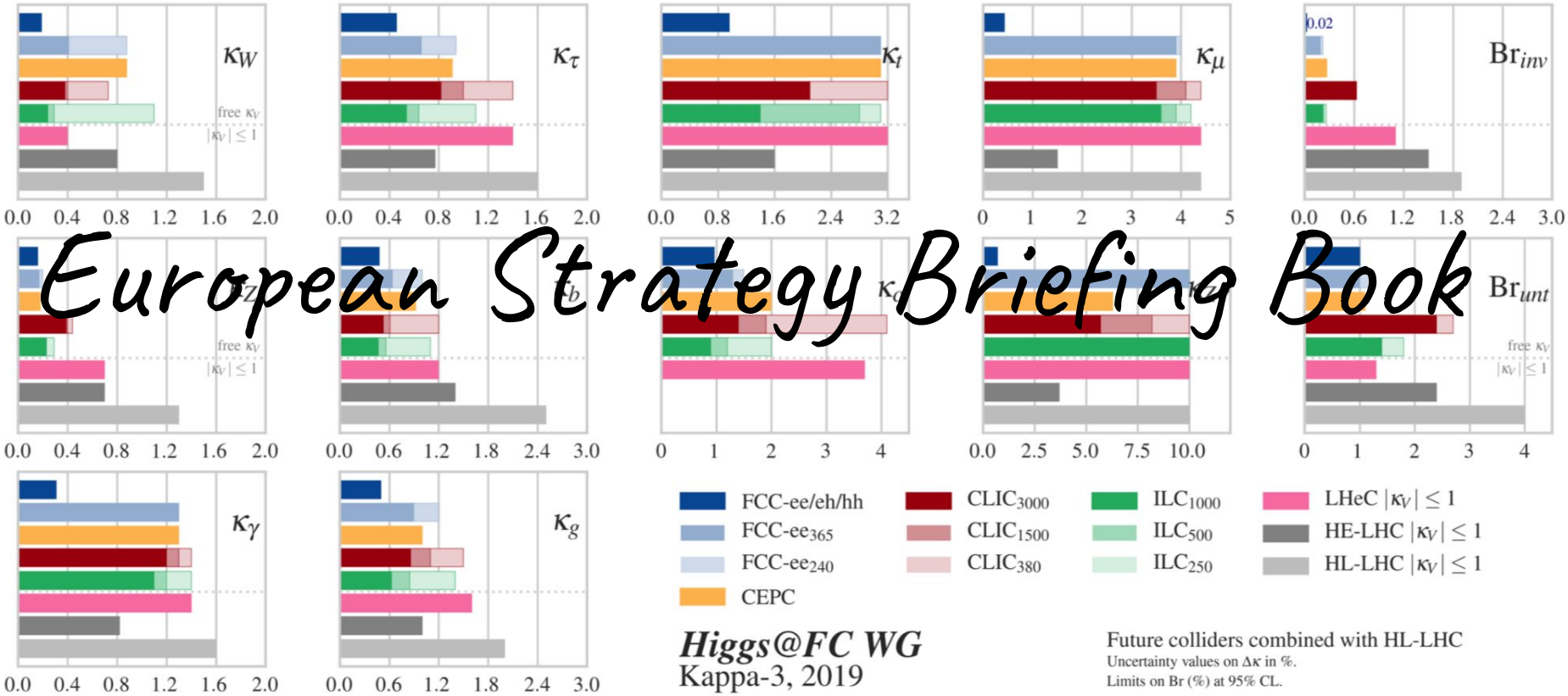
Vision for Topical Groups

from Aidan's talk at LCWS

Jenny List's Talk: Topical Group Convener's Meeting

- The *Topical Groups* will be the forum for discussions of physics goals and requirements for e^+e^- experiments, and for advancing the necessary theory
- In the next year these groups will operate in parallel with the Snowmass study in the US and the ECFA Higgs Factory Study in Europe. We anticipate close cooperation among these study groups
- Since the goals of all proposed e^+e^- Higgs factories are closely aligned, we welcome participation from all members of the community interested in these accelerators – collaboration will advance the Higgs factory concept
- We expect the work of the Topical groups will assist the formulation of experimental proposals (EoIs and LoIs) for the ILC or any future e^+e^- collider
- Longer term, we expect the Topical Groups will remain active for discussions across the experimental collaborations and for linking the theory and experimental communities

Already well studied...



European Strategy Briefing Book

Topical Group: Higgs properties

Aidan Robson's Talk: Topical Group Convener's Meeting

Higgs properties:

- For each production and decay process of the 125 GeV Higgs boson, evaluate the experimental prospects for high-precision measurements. What are the key observables, beyond the total cross section or branching ratio? What detector capabilities are especially important in reaching the ultimate performance?
- What BSM models are expected to produce the largest deviations from the SM in the various Higgs decay channels? What models provide the most important benchmarks for the program of Higgs boson measurements.
- What are the various methods for measuring the Higgs boson mass with high precision? What are the detector requirements? Is there a method to directly measure the Higgs boson width?
- What are the prospects for measuring the couplings of the Higgs boson to second- and even first-generation fermions? Can the decay $h \to$ light quarks be distinguished from the decay $h \to gg$?
- To what accuracy can possible CP-violating angles in the various Higgs couplings be measured?
- What is the sensitivity of ILC experiments to the various possible modes of Higgs decay that are forbidden in the SM? Possibilities include invisible and partially invisible decays, flavor-violating decays (both leptonic and hadronic), and decays to SM particles through exotic intermediate states. What are the key detector characteristics needed for this program?
- Study the strategies for the measurement of the Higgs boson self-coupling. What accuracy can the ILC achieve as a function of its CM energy?

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Higgs Self-Coupling at the ILC with the SiD Detector
(A Snowmass 2021 Leter of Interest)

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Abstract

Measuring the Higgs boson self-coupling λ_{hhh} with high precision is an important part of the program for particle physics in the coming decades. In the Standard Model (SM), $\lambda^{SM}_{hhh} = m_h^2/2v^2$ is determined by two parameters, $v = (\sqrt{2}G_F)^{1/2} \approx 246$ GeV and $m_h \approx 125$ GeV. In Beyond the SM (BSM) scenarios, new particles can enhance or diminish the self-coupling through mixing or in loops. In e^+e^- colliders λ_{hhh} is measured by measuring the cross section for double Higgs production in $e^+e^- \to ZHH$ or $e^+e^- \to \nu\bar{\nu}HH$. In this study we investigate the expected sensitivity to λ_{hhh} at ILC with the SiD detector.

Sensitivity to decays of long-lived dark photons at the ILC

Laura Jeanty, Laura Nosler, and Chris Potter
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(Dated: August 28, 2020)

I. INTRODUCTION

Searches for light, weakly coupled particles are an important component of the physics program at present and future colliders. New hidden or dark sectors around the electroweak scale which are weakly coupled to the Standard Model (SM) through mediators are well motivated by numerous theoretical and observational considerations, including naturalness, dark matter, and electroweak baryogenesis. A classic benchmark for a potential vector-boson mediator between the SM and dark sector is the hypothetical dark photon, γ_D, which interacts with the SM through kinematic mixing with the weak hypercharge field B with coupling strength ϵ. The dark sector could also have a dark Higgs boson, h_D, which in the general case will mix with the SM Higgs Boson [1]. This opens up a Higgs portal production mode for dark photons.

of long-lived γ_D as a benchmark to study the detector performance for detection of displaced decays.

II. QUESTIONS TO STUDY

We plan to focus on the proposed ILC dataset of 2 ab^{-1} at $\sqrt{s} = 250$ GeV. We are interested to use truth-level signal simulation samples to explore the full acceptance available to the ILC detectors. To explore the expected detector performance, we aim to use a benchmark signal sample reconstructed with full simulation of the SiD detector. The nominal SiD vertex detector [5] comprises five barrels closed by four disks one each side, together with three more forward disks further along the beamline on each side. Barrels and disks are instrumented with Silicon pixels with 5 μm or better hit resolution [5]. Comparisons of truth-level acceptance and full simulation with the standard recon-

Measuring the CP properties of the Higgs sector at electron-positron colliders

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August 31, 2020

Letter of Interest for SnowMass2021: Energy Frontier

The violation of the CP symmetry is one of Sakharov's conditions for the matter–anti-matter asymmetry of our universe. Currently known sources of CP violation in the quark and neutrino sectors are too small to account for this. Is CP also violated in the Higgs sector? Is the 125 GeV mass eigenstate a mixture of even and odd CP states of an extended Higgs sector, or is CP explicitly violated in Higgs interactions. With what precision could such effects be measured at future electron-positron colliders?

Several processes at e^-e^+ colliders are sensitive to the CP nature of the Higgs sector. Some are sensitive to CP-violating effects, others to anomalous couplings; they also require different centre-of-mass energies, as summarised below.

LOI - ILC/SiD Higgs to Invisible

Andrew White, Austin Prior, University of Texas at Arlington,
James Brau, Christopher Potter, Amanda Steinhebel, Makayla Massar, University of Oregon

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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.

Our Vision: What is new? What is our goal?

To further develop the physics case for using the ILC to investigate the Higgs

To understand if the ILC is particularly useful for learning things about the Higgs compared to other options

To understand the reach of the ILC as compared to the HL-LHC, to demonstrate the complementarity and to explore possible synergies between HL-LHC and ILC

Fingerprinting new physics direction via Higgs precision measurements at the ILC

To connect Higgs precision physics to the structure of the vacuum, to the thermal evolution of the universe and to the dark sector

To understand the impact of variations in detector design on the key Higgs measurements at the ILC

Planned Meetings

We expect meeting monthly (or so) and will observe the prescriptions for accommodating all relevant timezones

We understand there are two slots, 17 June and 15 July (?), allocated for Topical Group meetings

How do we reach the physicists most likely to be interested in contributing?

Our plan for meeting is a work in progress, please stay tuned and provide feedback.