The SiD Detector for the International Linear Collider

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Introduction

The International Linear Collider (ILC) is a 34 km long accelerator colliding electrons and positrons with a center-of-mass energy of up to 500 GeV. There is a strong interest in Japan to host this machine and a potential site, the Kitakami mountains in the northern tip of Honshu, has been proposed by the Japanese scientific community. The ILC uses superconducting RF cavities, similar to the ones currently being installed at the European XFEL. The ILC has one interaction region, but hosts two detectors, SiD and ILD, which share the beam line using a push-pull scheme. In this summary we present an overview of the SiD detector and review the latest developments in optimizing its design.

The SiD detector

The SiD Detector for the ILC is designed to deliver high precision Higgs and Top measurements and will have excellent sensitivity to a wide range of possible new phenomena. The design of SiD is driven by the particle flow paradigm, combining information from both the tracker and the calorimeters to optimally reconstruct the events. This implies locating the calorimeters inside the coil as well, limiting also the total size of the coil.

SiD features a compact, cost-constrained design, with a robust silicon vertex and tracking system, which, combined with a five Tesla central solenoidal field, provides excellent momentum resolution. The vertex detector consists of five layers of silicon pixels with a pitch of 20 microns or less starting from a distance of 1.4 cm away from the beam pipe. This is complemented with a large silicon tracker using silicon strips with a pitch of 25 microns. The outer radius of the tracking system is 1.22 meters. The highly granular calorimeter system is optimized for Particle Flow application to achieve very good jet energy resolution over a wide range of energies. The electromagnetic calorimeter (ECAL) is a 30 layer Silicon-tungsten sandwich calorimeter with a pixel size of 3.5 mm and a total thickness of 15 cm. The hadronic calorimeter (HCAL) is a 40 layer scintillator-steel sandwich calorimeter using Silicon-PM's to read out. This is complemented by a muon system in the return yoke of the five Tesla solenoid. A cross-section through the SiD detector is shown in Figure 1. SiD has always had a well-defined baseline



Figure 1: Cross-section view of the SiD detector

design while at the same time looking at technological options which would deliver an improved performance at the same cost.

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Latest Results

SiD has focused its effort on optimizing its design for an optimal performance with reasonable costs and at the same time preparing for an assembly and installation at a site in the Kitakami mountains. In the following a short summary of the latest results is given.

HCAL technology decision

During the last year, SiD has reviewed the baseline technology for the HCAL. During the TDR³, SiD has proposed to use a "digital" HCAL using steel absorbers and RPCs for the readout. After a review, SiD has decided to switch the baseline technology to scintillator and SiPM-based readout. We present the conclusions of this review and present simulation results based on the new baseline.

Beam background studies

After the scientific decision for the Kitakami site, studies have started for a site-specific final focus region, including the move to a common L^* of 4.1 m and more refined layout. These changes have a big impact on the potential beam backgrounds and SiD has studied in detail the impact on the vertex detector and the forward systems. This was accompanied by studies to remove the Anti-DID magnet, which will significantly simplify the solenoid assembly. Equally, a detailed understanding of the backgrounds is essential for the design of the readout electronics.

Installation studies

One key issue for the installation in the Kitakami mountains is the weight limit of transports which is in the area of 30 metric tons. At the same time detailed studies of the stray fields of the solenoid magnet have indicated that the TDR design with a 0 degree transition between barrel and endcap may not be ideal. By moving to design with a 30 degree transition between barrel of endcap and changing from an octagon-shape to a dodecagon shape, SiD can address both these issues and will change the mechanical design accordingly (see Figure 2).

Beyond the Baseline

With the advances in technology, SiD has been looking into new

technologies, for example large-area MAPS-based sensors for the ECAL or 3D-integrated designs for the vertex detector. We will review a few technological approaches "beyond the baseline" and their impact on the performance of SiD.



Figure 2: The new mechanical design of the SiD return yoke

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