Preparation and operation of SiW-ECAL technological prototype for DESY test beam 2019

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Microelectronics

NHE

PARIS

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ILC (International Linear Collider)

- Collision of the electron and positron
- Center of mass energy : 250 GeV
- exploring new physics by precise measurement of the SM particle, especially higgs

- Two candidates of the detector
 - ILD (International Large Detector)
 - SiD (Silicon Detector)







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SiD



ILD (International Large Detector)

- ILD components
 - Vertex detector
 - Tracking detector
 - Electromagnetic calorimeter •
 - ScW-ECAL : using scintillator
 - SiW-ECAL : using Si semiconductor
 - Hadron calorimeter •
 - Muon detector



- Separation of the particles in jets
- - •
 - •



PFA (Particle Flow Algorithm)

SiW-ECAL

- The electromagnetic calorimeter in ILD is a sampling calorimeter with 20-30 layers
- SiW-ECAL
 - Tungsten (absorber)
 - Silicon (detector)
 - granularity requirement : 5 mm × 5 mm
 - silicon pad : 90 mm × 90 mm (256 pixels)
 - Si thickness : $320 \mu m$, $650 \mu m$



- ASICs (SKIROC2/2A) are used as the integrated circuit for data taking
- SKIROC2A
 - 64 channel
 - 15 memory cells
 - ADC mode
 - ADC high and low gain
 - TDC mode
 - TDC ullet
 - ADC high or low gain



ASIC



R&D of the SiW-ECAL

- The development phase is proceeding the following changes •
- The physics prototype •
 - Studying the Si detector satisfying ILD requirement
 - Development of the sensor and reading circuit •
- The technological prototype
 - Optimization of the DAQ systems for implementation to ILD
 - slab : just one layer of the SiW-ECAL
 - One slab has 4 silicon pads (1024 pixels)
 - read by 16 ASICs (1 ASIC : 64 ch)

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Assembly of the latest model (in Kyushu)

- 5 slabs are assembled in Kyushu University
- Gluing FEV and SMB to FPC
- Si thickness : 320 μ m (P3), 650 μ m (others)
- The difference between P and K
 - P : Flexible cable
 - K : Micro-coaxial cable



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gluing in Kyushu





- 2018 (DESY)
 - evaluation using the just one slab
 - particle : electron

- 2018 (CERN/SPS)
 - evaluation using the 5 slabs
 - particle : muon, electron, pion
 - 4 slabs had the problem in HV \rightarrow data taking is difficult using the older model's carbon plate

Previous Test Beam

with older carbon plate



Update from previous TB

- Replace the carbon plate on the backside and cover
 - New carbon plate :
 - cut the edge of the HV connector side
 - pushing with screw
 - leakage current •
- Temperature monitoring
 - It is the first time temperature measuring

New carbon plate







- S/N in the trigger line
 - defined by the study of the trigger line (fast shaper in SKIROC)
- threshold scans with charge injections
 - 1.4 mVpp : 1 MIP
 - 2.8 mVpp : 2 MIP
 - 5.6 mVpp : 4 MIP
- We can see the S curve (As the trigger line is higher, signal is decreasing)



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- Pedestal means for all channels are measured with thermal noise
- Each pedestal means are shown by following maps



[ADC counts]

- Data acquisition test with radiation sources

¹³³Ba : •

- 356 keV (62.1%)
 - Ee = 207.25 keV
- 81.0 keV (34.1%)
- ⁵⁷Co :
 - 122 keV (85.6%)
 - 136 keV (10.7%)

Data were measured using the ¹³³Ba and ⁵⁷Co as gamma radiation sources



		690
	Hit map (133Ba)	
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- ¹³³Ba ADC Histogram
- 0
 - Photoelectric peak
 - 81.0 keV
 - 64.8 ch
- . 2
 - Compton edge
 - 207.25 keV
 - 173.0 ch





⁵⁷Co ADC Histogram

- 0
 - Photoelectric peak •
 - 122 keV
 - 97.9 ch



Pedestal

noise from pedestal





- TDC mode operation test
- SKIROC2/2A has the ramp wave as one of the internal clocks
 - frequency : 2.5 MHz or 5 MHz (we can choose with rewriting firmware)
- The ramp wave can be measured with
 - synchronization of internal and external clock (injection signal)



Laboratory Test (4) TDC Ramp 3400 3200 3000 2800 2600 ₽ 2400 2200 2000

- using the following parameters
 - injection frequency : 200 kHz
 - injection voltage : 2.8 mVpp (2 MIP)
 - trigger : 230
 - ASIC channel : 13 channel
- TDC to real time conversion parameter
 - 0.127 ns / TDC count (up)
 - 0.066 ns / TDC count (down)



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Test Beam 2019 (1)

- Purpose :
 - Data acquisition with electron beam (MIP, Shower)
 - Operation test (TDC, Auto Gain, etc.)
- 25th June 2019 5th July 2019 (DESY)
- Beam Status : electron, 1 5 GeV
- Setup : 5 slabs (Kyushu) and 4 Chip-In-Board slabs (France)
 - MIP (without tungsten)
 - Shower (with tungsten)



Members





Test Beam 2019 (2)

- The following box was used in TB2019
 - 5 slabs (Kyushu) were installed to this box
 - 4 CIB slabs (France group) were also installed
- The order of slabs is shown by the picture
- In shower setup, We use two pattern thickness for tungsten 4.2 mm and 2.1 mm
- In detail explanation will be talked in analysis session







Temperature for all slabs

• Time variation of temperatures for all slabs



Temperature and Pedestal mean variation

Time dependance of the temperature and pedestal mean



ped_slab0_chip0_chn16_sca0 ped_slab0_chip0_chn17_sca0 ped_slab0_chip0_chn19_sca0 ped_slab0_chip0_chn20_sca0 ped_slab0_chip0_chn22_sca0 ped_slab0_chip0_chn23_sca0 Temperature of slab P1 Pedestal mean 19/07/01 19/06/30 19/07/02 19/07/03 19/07/04 19/07/05 09:00 09:00 09:00 09:00 09:00 Time [yy/mm/dd]

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Some issues (1)

- Some issues were happened for connections
- HDMI connection
 - HDMI connections are unstable and loose
- HV connector
 - HV connectors are too fragile
- Complicated cable connection
 - Three cables per a slab must be connected to outside of the box



Inner



- Some issues were found for reading circuit
- Re-triggering :
 - dummy hits after the hit
- Double pedestal
 - now studying •



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Summary and next plan

- Summary
 - Now, reading circuit for SiW-ECAL is optimized
 - We improved the slabs from the last Test Beam
 - We measured ADC data using gamma radiation sources
 - We calculated TDC convert parameter with charge injections
 - In detail analysis results are talked in the after talk

- Next plan
 - measurement of TDC for all channels



backup

Pedestal mean

slab P1









Measurement program

- MIP programs :
 - Position scan
 - Angle beam
 - TDC mode
 - Re-triggering / Double pedestal
- Shower programs :
 - TDC mode
 - Auto gain
 - Edge effect





Linearity of threshold





slabP1 chip15 ch56

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Update in this TB (1)

- Replace the carbon plate on the backside and cover
- New carbon plate :
 - cutting the edge of the HV connector side
 - pushing with screw
 - leakage current (imperfect insulation found)







