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Analysis on CERN TB2022-06 Data

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CERN TB2022-06







- Sensors 0
 - 15 layers
 - 16 chips
 - 64 channel
 - 15,360 cells
- Active : Silicon 0 Absorb : Tungsten
- **CERN SPS Beam**
 - Energies 0
 - e : 10, 20, 40, 60, 80, 100, 150 GeV
 - μ : 50, 150 GeV
 - π : 10, 20, 70, 100, 150, 200 GeV





Datasets



Data Used

Electron Data

Run ID	
90320	
90378	
90375	
90372	
90367	
90365	
90355	

MC Used

• Simulation software provided by Fabricio <u>GitHub Link</u>

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- Run Setting
 - \circ Electron beam with same energy as Data
 - Single incoming electron per event
 - Same simulated detector setup as TB2022-06
- Not uploaded to eos or anything





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Energy	NEvents	NHits	Hits/Event
10	4999	826,350	165.303
20	4999	1,355,706	271.195
40	4999	2,164,765	433.040
60	4999	2,814,062	562.925
80	4999	3,371,195	674.374
100	4999	3,867,467	773.648
150	4999	4,903,946	980.985

Simulation

Energy	NEvents	NHits	Hits/Event
10	15120	1,813,628	119.949
20	81540	12,518,701	153.528
40	71698	16,537,826	230.660
60	47063	12,498,777	265.575
80	138585	56,395,730	406.940
100	38248	28,857,999	754.497
150	10750	10,132,062	942.517

Reconstruction



Masking Effect



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• There are 15 x 16 x 64 = 15,360 cells in overall SiWECAL

- Some of which were required to be **masked** due to:
 - Electrical cross talk
 - Wafer delamination
 - Connector to the SL board
- Notably, cell 37 has consistently been masked in each chip, representing a recurring anomaly.
- The cumulative effect of such masked cells is substantial and should not be underestimated.
- For an extended period, simulations did not incorporate the consideration of this masking effect.



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SlabAdd3





Procedure



Masking Simulation

- Masking patch was introduced by Fabricio in <u>SiWECAL-Sim</u>
- Each hit registered in the simulation is associated with the masking information based off the <u>Run_Settings</u> files.
- One need to retrieve and match the masking pattern, same as the one in the reconstruction.

Beam Position

- It is worth highlighting that, generated beam position and size significantly affects the final energy and hit distributions.
- The input beam position and size for the generator will not necessarily be identical to the final beam spot shape. One needs to play around with parameters to get them right.

Selection

- More than 13 coincidences
- Hit Energy > 1
- Hit SCA < 2





Masking in Action

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e-10 GeV simulation





Masking in Action

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e-10 GeV reconstruction



Hit XY e' 10 GeV slab 4

Hit XY e' 10 GeV slab 8



Hit XY e' 10 GeV slab 5

Hit XY e' 10 GeV slab 9

Hit XY e' 10 GeV slab



Hit XY e' 10 GeV slab 6

Hit XY e' 10 GeV slab 10





Hit XY e' 10 GeV slab 3



Hit XY e' 10 GeV slab 11



Hit XY e' 10 GeV slab 8

Hit XY e' 10 GeV slab

Hit XY e' 10 GeV slab 4



Hit XY e' 10 GeV slab 12

e-10 GeV simulation

EXY e' 10 GeV slab

Hit XY e' 10 GeV slab 5

Hit XY e' 10 GeV slab 9









Hit XY e' 10 GeV slab 3

Hit XY e' 10 GeV slab 6

Hit XY e' 10 GeV slab 10



Hit XY e' 10 GeV slab 7

Hit XY e' 10 GeV slab 11



Hit XY e' 10 GeV slab 14

Hit XY e' 10 GeV slab 12







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XY Hit Projections

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e- 10 GeV Hit Map X Projection





Hit Distribution e' 10 GeV slab 14



Hit Distribution e' 10 GeV slab 8

Hit Distribution e' 10 GeV slab 12





e-10 GeV Hit Map Y Projection





Hit Distribution e'10 GeV slab 13





Hit Distribution e' 10 GeV slab 3

Hit Distribution e' 10 GeV slab 7

Hit Distribution e 10 GeV slab 14

Hit Distribution e' 10 GeV slab 6

Gaussian fit was performed for the first few projection distribution to nurture the input parameter for the simulation

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Number of Total Hits



No mask



With mask





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- The simulated number of total hits now gets scaled down to more appropriate value
- Reconstruction now has better agreement with simulation. •



Total Hits per Slab

Number of total bits at 10 GeV in slab 1

Number of Intal hits at 10 GeV in siah 2

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Number of total hits at 10 GeV in slab 2

Number of total hits at 10 GeV in slab 10

- <u>i</u>.-



Number of total hits at 10 GeV in slab 8

Number of total hits at 10 GeV in slab 4

0.0

1.02

101

Number of total hits at 10 GeV in slab 9





Number of total hits at 10 GeV in slab 3



Number of total hits at 10 GeV in slab 12 Number of total hits at 10 GeV in slab 13





With mask Number of total hits at 10 GeV in slah 0





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Number of total hits at 10 GeV in slab 4







Number of total hits at 10 GeV in slab 8 Number of total hits at 10 GeV in slab 9





Number of total hits at 10 GeV in slab 12





Number of total hits at 10 GeV in slab 6

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Total Hits per Slab



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Number of total hits at 20 GeV in slab 2

Number of total hits at 20 GeV in slab 10





Number of total hits at 20 GeV in slah 1

Number of total bits at 20 GeV in slab 9



Number of total hits at 20 GeV in slab 8







Number of total hits at 20 GeV in slab 3









With mask







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Number of total hits at 20 GeV in slab 12









Hit Quality Checks

Hits per Layer

- Layer numbers of the deposited hits were plotted.
- The distribution should roughly correspond to the shower profile of the electron beam at 10 GeV.
- Shower maximum observed around slab 5-7.
- Some non-continuity in the distribution (e.g. layer 4), is caused by masking and wafer delamination, which leads to inability for the hit registration.



Hits per layer at 10 GeV

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Summary



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- Masking Studies
 - New features are now taken into account in simulation
 - Masking
 - Beam axis position
 - Beam axis width
 - They all significantly contribute to the final hit counts.
- Comparison
 - The total number of hits for 10 GeV do get closer to the generation, as the simulated distribution shift down.
 - Conquering another energy regime following the 1-6 GeV studies from DESY TB.
 - It is also clear that some slabs still lack in number hits. (20 GeV ~)
- Take home message
 - The masking effect and beam settings in both simulation and reconstruction must not be underestimated.
 - The simulation parameter should be adjusted for every runs (validate the simulation settings for each)



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Backup

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Hit Quality Checks (without mask)







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Electronic Circuit Layout for the SKIROC 2

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12 bit-ADC Ramp 12 bit-TDC Ramp ADC test Ch63... -----.... READ Sel ADC test ? (slow control) Ch0 =Depth=15 C2=1.6pF \mathbf{A} -~~ Slow Sh. G1 TDC ramp R2=100k out_adc signal Rf ◀ 1 or 10M R1=4k C1=45pF Г READ HOLD out_tdc M Cf Time, vref ss U Depth=15 ssh G1, x 400f.800f. 1.6p. 3.2pF ssh G10 Δ out_ssh_G1 C2=3pF conversion ΗH out ssh G10 Signal Slow shaper's Slow Sh. G10 ~~~ in PA R2=60k signal PAC R1=22k C1=8pF READ HOLD Gain_selection -mit Vth gs vref ss Depth=15 4 100f, 200f, 300f or 400fF Test Pulse TDC on ? in calib (slow control) Fast Shaper Gain10 ~~~ 300k 5p,10p, 15p or 20pF HOLD Auto Gain ? Forced Gain ? (slow control) Mask Trig_Ext, Val_Evt, 8-bit Delay Box : 100ns to 300ns vref_fs Vth_trigger Sel FlagTDCb Ext ? Forced FlagTDCb ? 4-bit DAC (slow control) adjustment out trigger FLAG TDC 10-bit DAC 10-bit DAC (from Digital ASIC)





Hold Scan



- Signal is needed to be read along the pulse that is generated by the slow shaper. This timing is managed by trigger delay.
 - Optimum trigger delay depends on the threshold.
- The delay-for-hold can be configured via DAQ software.
 - Inject the signal to row-by-row with signal amplitude of 1.2V
 - Hold scan was performed from the range of 20-160 in steps of 20.











Wafer Delamination



8 0

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0 1 2 3 4 3 6 7 6 9 10 11 12 13 State



Particle Identification



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beam composition (X=COG-Z (cm), Y= Nhits (div by 10)) 19 Raw Hitmap





Fig. AHCAL Pion 200 GeV



Wafer Delamination





Metrology and PCB Deformation

Setup of a device to measure the flatness of the PCB at different stages
PCBs will be out into cabling machine and dimensions will be monitored before and afterwards

Glue – Alternative agents and procedures

After discussion with Astronomy Institute of Paris and Epotek
Test glue of type H20E as alternative to Epotek J2189

Should have higher mechanical stability

Use EPOTEK 301-2 as underfill for mechanical stabilisation (proposal of Epotek)

This underfill has low viscosity that ensures mechanical stability by capillary effect
First tests carried out – Stay tuned for results

Alternative proposal EPOTEK 353ND-T

Epoxy for gluing electrical component, could be used to stabilise glued sensor at sensor boundaries
Data sheet in backup

Further alternatives will be studied

Pull tests

•IJCLab will prepare pull tests in order to get a quantitative picture of the mechanical stability

of the glue

•Maybe in combination with C2N - A CNRS Institute specialised for materials





New PCB Version

CULS

New FE boards

Improvements:

- Power distributions
 - Local power regulation
 - Local High Voltage filtering & Supply
- Signal distribution (buffering), data paths
- Monitoring (single ID, temp, probe analogue line)
- ASIC shielding/routing

Status:

- pre-version 2.0 tested, minor corrections needed
 - Noise uniformity dramatically improved (ex: outliers in thr. / 20 !)
- version 2.1 produced, ... in metrology
 - before cabling, 2nd metrology, gluing, ...
 - All material available : ASICs being tested

