

Low Energy electromagnetic showers with the SiW-ECAL tech. prototype

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Outline

- Testbeam setup
- Commissioning (optimize the self triggering capabilities)
- Single cell calibration
- Shower studies
 - Asked by the referee to be included in the paper (by 01/06).
 - Still in a quite preliminary but promising status

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Beam test performance of the highly granular SiW-ECAL technological prototype for the ILC.

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Abstract

The technological prototype of the CALICE highly granular silicon-tungsten electromagnetic calorimeter (SiW-ECAL) tested in beam at DESY in 2017. In this test the setup comprised seven layers of 1024 channels and a size of 18×18 cm² each. This article presents key performance results in terms of signal over noise ratios at different levels of the readout chain and a study of the uniformity of the detector response.

Keywords: Calorimeter methods, calorimeters, Si and pad detectors



Test Beam at DESY

> Setup :

- 6 FEV11, 1 FeV10 each equipped with 4 325um Si wafers and 16 Skiroc2
- **Power pulsing and ILC mode** (emulated ILC spill conditions)
- > Physics program:
 - **Calibration** run with 3 GeV positrons perpendicular beam without tungsten absorber plates
 - Electromagnetic showers program.
 - Calibration run with 3 GeV positrons in ~45 degrees (6 slabs)
 - Magnetic field tests with 1 slab (up to 1 T)







Commissioning

- > Masking of noisy channels (~6-8% in each slab except if other issues are present)
- > Self trigger optimization. Calibration (DAC to Energy) done only for one ASIC and assumed common for all.





Single cell calibration



Pedestal calculation and subtraction for all channels and memory cells (the ASIC is able to store up to 15 events per acquisition cycle)

- Calibration of all cells using 3GeV electron beam acting as MIPs.
 - Fit using a Landau function convoluted with a gaussian.



Pedestal & noise

> Pedestal and noise (pedestal distribution width) calculation for all layers using the calibration run



Very homogeneous noise response (6.6% dispersion)



Single cell calibration

- > MIP scan: Si ECAL (w/o the W)
 - Positrons of 3 GeV acting as MIPs
 - Pedestal correction done chip/channel/sca wise, Energy calibration done chip/channel wise





Performance for electromagnetic showers

> Tungsten program. All results are "work in progress"

- Scans of various energies (from 1-5.8 GeV).
- Scan using different tungsten configurations
- For all plots shown: Hit Energy > 0.5 MIP





 $w_0^j E_i$

i = cells, i = layer number

Raw shower barycenter maps

 $\overline{\mathbf{x}} = i = cells$, j = layer number

 $x'w_0^J E$

Shower containment



- > W-configuration 2.
- Looking at the z coordinate (in layer position) of the barycenter of the shower we expect large a,punt of leakage. For x and y, the shower is well contained.
- > To study events with minimal leakage, we select events with \overline{z} in $\langle \overline{z} \rangle \pm \text{Sigma}(\overline{z})$

Energy measurement

- Comparison of two energy beam runs with same tungsten configuration.
- Comparison of two selections of the showers:
 - All shower events vs
 - Showers with barycenter longitudinal value in the center of the z
 distribution → to reduce longitudinal fluctuations of the showers.





Shower profile



- > Ei>0.5 MIP in a event.
- > The cut in \overline{z} is applied





Comparisons to MC ?

- D. Jeans prepared a beam test simulation set of configuration files
 - Using dd4hep tools as used for ILD/SiD simulation easier transfer from TB → full det.
 - rather simple layered setup with no description of: supporting structure or individual sensors + cracks
- First files/distributions being produced during this meeting.
- The goal is not to perform a fully detailed shower analysis but to establish its basic perfomance.
 - While preparing the prototype for more beam tests (higher energy and combined with, at least, one HCAL)



Drawing by D. Jeans



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Conclusions + outlook

- > The SiW-ECAL technological prototype has shown good performance in beam test.
 - Good signal over noise capabilities.
 - Good single cell energy calibration uniformity
 - Stable performance
- > A paper on the commissioning and single cell calibration results has been submitted to NIMA.
 - The referee acknowledges the good quality of the study but strongly advices to include shower results.
- The shower results look promising but so far no MC has been used for comparison. Ongoing activity.





