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Title:

Novel GaAs and Silicon Sensor Planes for Compact Sampling Calorimeters

Finally we may subdivide into two papers, but many information is valid for both.

Abstract

Two samples of silicon pad sensors and two samples of GaAs sensors are studied in an electron beam of 5 GeV. The sensor size is 5x8 cm^2, the thickness 320 μm and 500 μm for the silicon and GaAs sensors, respectively. The pad size is 5x5 mm^2. The sensors are foreseen to be used in a compact electromagnetic sampling calorimeter. Therefore the readout of the pads is done via traces connected to the pads and to bond pads at the edges of the sensors. For the silicon sensors copper traces on a Kapton foil are used, connected to the sensor pads with conducting glue. The pads of the GaAs sensors are connected to the bond pads via aluminum traces on the sensor substrate. For the read out Flame front-end pre-amplifiers and ADCs are used. Pre-processing of the raw data and deconvolution is performed with FPGAs. The whole system is orchestrated by a Trigger Logic Unit TLU. Results are shown for the homogeneity of the response, edge effects at pads and sensors, and cross talk due to the readout traces.

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1 Introduction

For several applications of electromagnetic calorimeters the Moliere radius is a relevant parameter. Examples are luminometers in experiments at electron-positron colliders and an ECAL in laser-electron scattering. In the former Bhabha scattering is used as a gauge process. Using a highly compact calorimeter, i.e. with a small Moliere radius, the fiducial volume is well defined, and the space needed is relatively small. In addition, the measurement of the shower of

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2 Sensors

Silicon sensors, produced by Hamamatsu, are arrays of $5.5 \times 5.5 mm^2$, $p+$ on n substrate diodes. The thickness is $320 mum$ and the resistivity $3 k\Omega cm$, and the reverse bias voltage about $100 V$. Each sensor has a total area of

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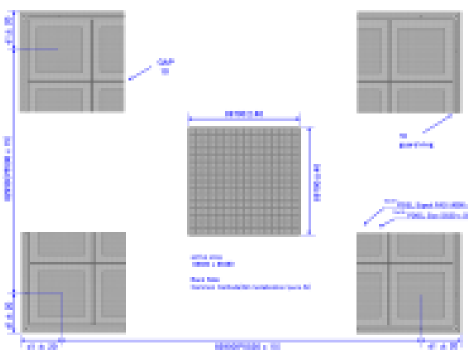


Fig. 1 Details of the geometry of the silicon sensor.

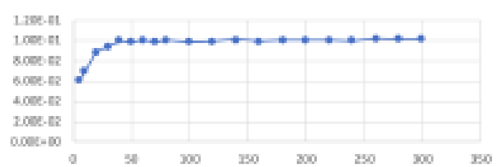
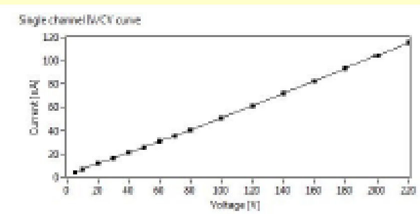


Fig. 2 Leakage current (in nA) as a function of the applied voltage (in V) for a selected pad.



he leakage current of a pad as a function of the bias voltage, measured at 20°C.

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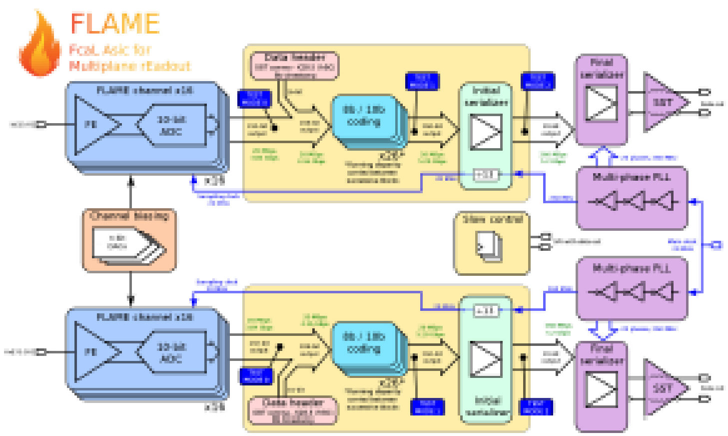
3 Front-End Electronics and Data Acquisition

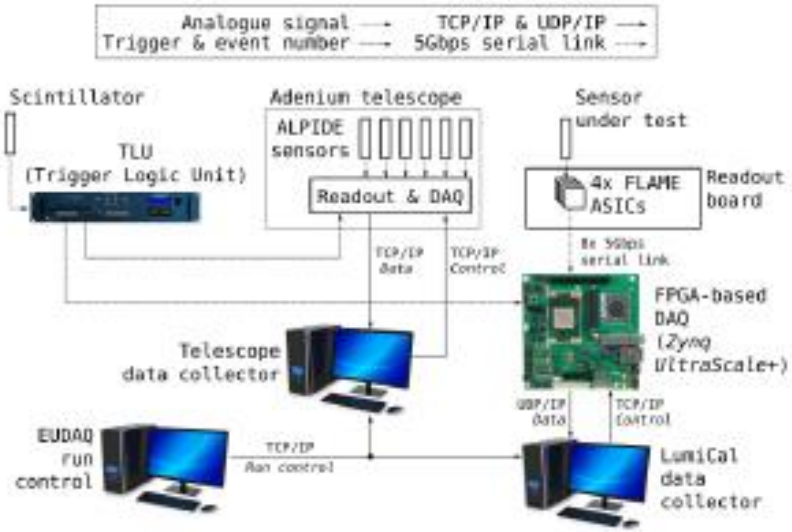
Each sensor plane is read out by FE ASICs called FLAME (FcaL Asic for Multiplane rEadout), designed for silicon-pad detectors of the LumiCal calorimeter for a future electron-positron linear collider experiment. The main



ck diagram of a 32-channel FLAME ASIC

Variable	Specification
Technology	TSMC CMOS 130 nm
Channels per ASIC	32
Power dissipation/channel	∼ 2 *mW*
Noise	∼1000 e⁻ @10 pF + 50e⁻/pF
Dynamic range	Input charge up to ∼ 6*pC*
Linearity	Within 5% over dynamic range
Pulse shape	T_{peak} ∼55 ns
ADC bits	10 bits
ADC sampling rate	up to ∼ 20 *MSps*
Calibration modes	Analogue test pulses, digital data loading
Output serialiser	serial Gb-link, up to 9 GBit/s
Slow controls interface	I^2C, interface single-ended

Table 1 Summary of the specifications of the FLAME ASIC.



Scheme of the read out. The TLU trigger is send both to the telesc
s. The FPGAs orchestrate the FE ASICS and perform the preprocessing
ta.

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4 Beam, Trigger and Beam Telescope

Electrons of 5 GeVproduced in the DESY3 facility are used in this study. The electrons pass a collimator of 12 x 12 mm^2 aperture. Two scintillation counters up- and downstream of the beam telescope are used to form a trigger signal in the TLU. The beam telescope comprises 6 planes of Alpide sensors of a

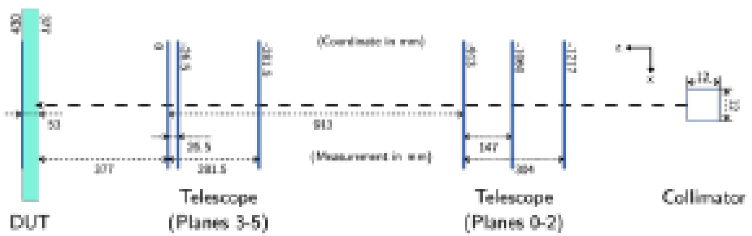
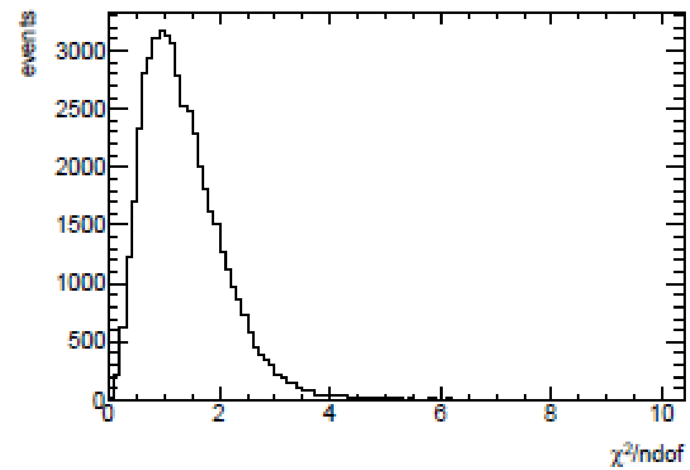


Fig. 7 Scheme of the test beam set-up. Electrons arrive from the right, pass the first scintillator, then six Alpide sensor plans, the second scintillator, and hit the sensor, denoted here as DUT (Detector under Test)



NDF distribution of electron trajectories fitted in the telescope.

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5 Data

6 Results

6.1 Response on Single Pads

Here the response of single pads should be shown and discussed, signal distribution example, compared with the results from raw data, simulation, homogeneity of the response (MPV as function of pad number)

6.2 Low and High Gain Comparison

compare signal sizes when FE electronics is set to high and low gain

6.3 Effects Near the Edges of a Pad

Scanning the signal size as a function of the local coordinate between the edges

6.4 Cross Talk Between Pads

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5 Data

5.1 Reconstruction

[SH: Alignment & integrity] [SH: Shan will summarise it! SH & ME]

6 Results

6.1 Monte Carlo simulation

[SH: Monte Carlo of sensor] [SH: Mihai & Kamil]

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6.2 Response on Single Pads

[SH: Dawid: calibration on channel] [SH: Melissa & Veta]

Here the response of single pads should be shown and discussed, signal distribution example, compared with the results from raw data, simulation, homogeneity of the response (MPV as function of pad number)

6.3 Low and High Gain Comparison

[SH: Dawid & Jakub] compare signal sizes when FE electronics is set to high and low gain

6.4 Effects Near the Edges of a Pad

[SH: Melissa & Dawid (raw data)] Scanning the signal size as a function of the local coordinate between the edges

6.5 Cross Talk Between Pads

[SH: Melissa & Dawid]

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Still Missing:

- Details for gluing the Kapton traces to the silicon pads

- Results, Results, Results……….

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