



weeroc

High-end Microelectronics Design

Read-Out Chips Catalog





We are proud of the high quality of our products.

ISO 9001

ISO 9001:2015 approved quality system ensures all our internal processes.

From R&D to the registration of the incoming purchase orders, through:

- Resource Planning
- Scheduling
- Production

Our quality system is responsible for the proper functioning of all our internal processes and is subject to regular audits, carried out by the National Standards Authority.

From the initial product design and its development stages, till the delivery of the production batches, we follow documented procedures that cover every aspect of our business.

The quality of CAEN S.p.A. products is constantly monitored by the application of the UNI EN ISO 9001:2015 standard. CAEN S.p.A. is ISO 9001 certified since 1998.

ISO9001:2015
certified Company



ISO 9001:2015
cert. n. 9105.CAEN

Authorised
research laboratory
of the MIUR



 Small details
Great differences



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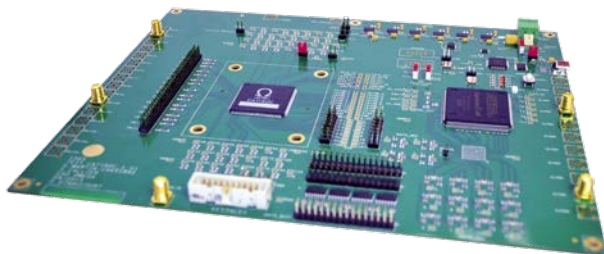
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WEEROC

Frontend analog and mixed ASICs for particle physics

CAEN SpA carries on its partnership with Weeroc, the microelectronics company designing and providing front-end read-out chips for most of the particle detector or photodetectors. Weeroc offers off-the-shelf programmable read-out chips and associated support for a fast and successful integration of the read-out chip in the final user system.

Readout ASICs



Testboard

For each of the available ASIC, Weeroc offers a testboard designed to test and characterize the chip. This tool is suited to easily evaluate the performances of the ASIC and, thanks to its features, allows a versatile use with real detectors.

CAEN-Weeroc synergy

CAEN has developed many complete readout systems based on Weeroc front-end ASICs. We are particularly proud to present the FERS-5200 board family for the readout of large detector arrays, with its first member being a 64-channel unit based on the Weeroc CITIROC1A for SiPM.



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Product lineup

About Weeroc

Weeroc is a fabless microelectronics company designing and providing front-end read-out chips for most of the particle detector or photodetectors. Weeroc offers off-the-shelf programmable read-out chips and associated support for a fast and successful integration of the read-out chip in user system.

Weeroc designs custom read-out chip on customer request for specific application not covered by programmable component off the shelf.

Weeroc's core of design expertise includes low noise and radiation-hardened mixed signal ASICs.

Weeroc is certified ISO9001 since 2015.



Application Domains

Weeroc ASICs are suitable for most industrial or research application involving photodetector or particle detector read-out.



**Aerospace
Industry**



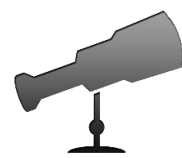
**Nuclear
Industry**



**Medical
Imaging**



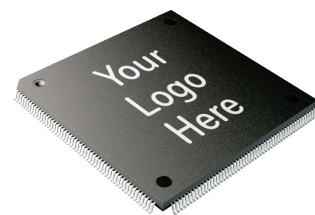
**Homeland
Security**



**Scientific
Instrumentation**

Dedicated Design

Weeroc can design dedicated ASIC for specific application. Non-recurrent design cost are paid by the final customer who have exclusive access to the design he ordered. Typical microelectronics design is 18 months from requirement specification to tested prototypes.





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Product lineup

Programmable read-out chip off the shelf

Weeroc offer a full range of product to read-out almost any kind of detectors. The table below describes which read-out chip is suitable for which kind of detectors. Weeroc application engineers can help you choose the best fit for your detector and application.

	SiPM	MA-PMT	PMT	APD	Pin diode	Silicon strips	RPCs	Micromegas GEMS
Maroc 3A	✓	✓	✓					
Catiroc 1	✓	✓	✓					
Citiroc 1A	✓							
Petiroc 2A	✓						✓ ¹	
Triroc 1A	✓							
Skiroc 2A				✓	✓	✓		
Gemroc 1				✗	✗	✗		✓

✓ Fully optimized readout - ✓ Compatibility - ✗ Compatibility not fully accessed

¹ Petiroc can read RPCs on the trigger line solely, no compatibility on the energy measurement line

Weeroc products maturity is ranged using technical readiness level (TRL) scale. The Weeroc definition of TRL is described below.

Technology Readiness Level	Description
TRL 1	ASIC project
TRL 2	ASIC in foundry
TRL 3	silicon available
TRL 4	First measurements, minor bug detected
TRL 5	First measurement, conclusive in lab
TRL 6	Application prototype available
TRL 7	Full system using ASIC available
TRL 8	Full system using ASIC running
TRL 9	Full system running ASIC, reliability proven



	Maroc	Catiroc	Gemroc
Prod. Version	3A	1	1
TRL	9	8	9
Package*	PQFP240 TFBGA353	TQFP208	PQFP160
Detector Compatibility	- MA-PMT, PMT - SiPM, SiPM array	- MA-PMT, PMT	- micromegas - GEMs
Optimized readout	MA-PMT	PMT	GEMs
Channel	64	16	64
Measurements and operations	- Free running trigger - External trigger - Charge (shaper) - Photon counting - Time (trigger)	- Free running trigger - Ext trigger - Charge (shaper) - Time (trigger) - Time (TDC)	- Free running trigger - Ext trigger - Charge (shaper) - Data 3-level trigger
Outputs	- 64 Triggers - Trigger OR - 1 analog multiplexer (charge) - ADC (8/10/12b)	- 16 Triggers - 16 Shapers - Trigger OR - ADC (10b) - TDC (10b)	- Trigger OR - 1 analog multiplexer (charge)
Input Polarity	Negative	Negative	Negative
Applications Main features	Energy meas. SPE application Photon counting rate < 30MHz MA-PMT gain adj.	Energy meas. Time stamping Low dead time Zero suppress data	Energy meas. Time stamping Data readout : 3-level trigger

*QFP packaging will be phased out and replaced with equivalent BGA packaging.

Glossary: ADC : Analog to Digital Converter – TDC : Time to Digital Converter

Product lineup

Skiroc	Citiroc	Petiroc	Triroc
2A	1A	2A	1A
8	9	6	8
BGA400	PQFP160 TFBGA353	TQFP208 TFBGA353	TFBGA353
- Si PIN diodes - Silicon strips	- SiPM - SiPM array	- SiPM - SiPM array	- SiPM - SiPM array
Si PIN diodes	SiPM	SiPM	SiPM
64	32	32	64
- Free running trigger - Ext trigger - Charge(shaper) - Time (TDC)	- Free running trigger - Ext trigger - Charge (shaper) - Time (trigger)	- Free running trigger - Charge (shaper) - Time (trigger) - Time (TDC)	- Free running trigger - Charge (shaper) - Time (TDC)
- Trigger OR - 1 analog multiplexer (charge) - ADC (10/12b) - TDC (10/12b)	- 32 triggers - Trigger OR - 1 analog multiplexer (charge)	- 32 triggers - Trigger OR - 1 analog multiplexer (charge) - 1 digital multiplexer (trigger) - ADC (10b) - TDC (10b)	- Trigger OR - analog multiplexer (charge) - 1 digital multiplexer (trigger) - ADC (10b) - TDC (10b)
Positive	Positive	Negative (optimized) Positive	Negative (optimized) Positive
Energy meas. Time stamping	Energy meas. Time of flight Photon counting Calibration input SPE spectrum Input DAC SiPM HV adjust.	Energy meas. Time of flight Time stamping Photon counting Input DAC SiPM HV adjust.	Energy meas. Time of flight Time stamping Zero suppress data Input DAC SiPM HV adjust.



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Maroc 3A

Photomultiplier-tubes read-out chip

MAROC3A is a 64-channel chip designed to readout negative fast input current pulses such as those provided by Multi Anode Photo Multipliers. Each channel provides a 100% trigger rate for signal greater than 1/3 photoelectron (50fC) and a charge measurement up to 30 photoelectrons (~ 5 pC) with a linearity of 2%. The gain of each channel can be tuned between 0 and 4 thanks to an 8-bit variable gain preamplifier allowing to compensate the non- uniformity between detector channels. A slow shaper combined with two Sample and Hold capacitors allows storing the charge up to 5 pC as well as the baseline. In parallel, 64 trigger outputs are obtained thanks to two possible trigger paths: one made of a bipolar or unipolar fast (15 ns) shaper followed by one discriminator for the photon counting and one made with a bipolar fast shaper (with a lower gain) followed by a discriminator to deliver triggers for larger input charges (> 1 pe). The discriminator thresholds are set by two internal 10-bit DACs. A digital charge output is provided by an integrated 8, 10 or 12 bit Wilkinson ADC.



Detector Read-Out	MAPMT, SiPM
Number of Channels	64
Signal Polarity	Negative
Sensitivity	Trigger on 1/3 photo-electron with a 10^6 PM gain or 50 fC
Timing Resolution	60ps RMS on single photo-electron, threshold 1/3 of photo-electron
Dynamic Range	5 pC (10^6 PM gain), Integral Non Linearity: 2% up to 5 pC
Packaging & Dimension	TFBGA353, PQFP240 discontinued
Power Consumption	3.5 mW /ch, power supply= 3.3V
Inputs	64 current inputs
Outputs	64 trigger outputs Wired OR of the 64 triggers for each of the 2 discriminators 1 multiplexed analog charge output that can be daisy chained 1 digital charge measurement (8, 10 or 12 bits)
Internal Programmable Features	gain adjustment between 0 and 2 over 8 bits for each input preamp, trigger threshold adjustment (10bits), analog and digital charge measurement, 64 trigger outputs, 64 trigger masks

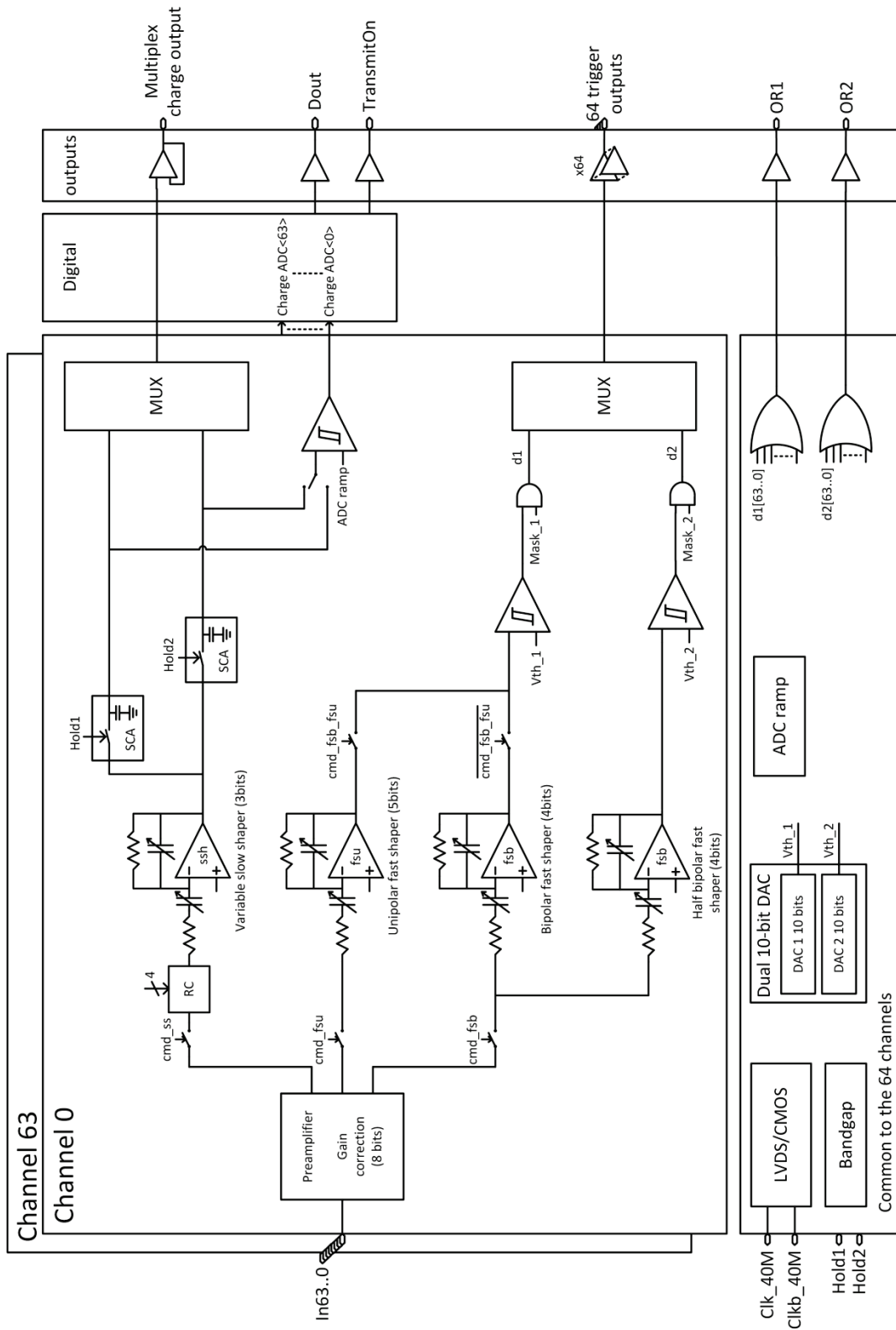
They are using Maroc 3A

CERN (ATLAS luminometer)
Jefferson lab (CLASS12)
Industrial applications under NDA

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More about Maroc 3A





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Catiroc 1

Large-Photomultiplier-Arrays Read-Out Chip

CATIROC 1 is a 16-channel front-end ASIC designed to readout photomultiplier tubes (PMTs) in large scale applications such as water Cerenkov experiments. The concept of the ASIC is to combine an auto-trigger chip to 16 PMTs to obtain an autonomous macro-cell for large area of detection.

An adjustment of the gain of each channel compensates for the gain variation of the PMTs and allows using only one HV cable for the 16 PMTs. In the ASIC, the 16 channels are totally independent. In each channel, the auto-trigger starts the charge and time measurements which are then converted and stored. Only the hit channels are read out by one serialized output. The time measurement is done by a 26-bit counter at 40 MHz for the coarse time and a Time to Amplitude Converter (TAC) for the fine time, giving a resolution of 200ps RMS. The charge measurement is done by a dual gain preamplifier followed by a shaper with variable shaping times (25 ns, 50 ns or 100 ns). Charge and fine time values are converted by a 10 bit ADC.

Moreover CATIROC 1 can be used as an analogue front-end ASIC for PMTs. The 16 triggers and 16 shapers output can be used in an application specific optimized front-end board.



Detector Read-Out	PMT, PMT array
Number of Channels	16
Signal Polarity	Negative
Sensitivity	Trigger on one third of photo-electron on each channel
Timing Resolution	200ps RMS on single photo-electron
Dynamic Range	400 photo-electrons (10^6 PMT gain) Integral Non Linearity 1% up to 400 p-e
Packaging & Dimension	TQFP208
Power Consumption	Power supply: 3.3V 21mW/ch.
Inputs	16 voltage inputs
Outputs	16 trigger outputs 16 shaper output 1 or of the 16 trigger output 1 serialized digital data output (50bits/channel)
Internal Programmable Features	16 channel gain adjustment (16x8bits), trigger and gain threshold adjustment (2x10bits), charge measurement tuning, 16 trigger masks, channel by channel trigger output enable.

They are using Catiroc 1

JUNO experiment
WA105 collaboration

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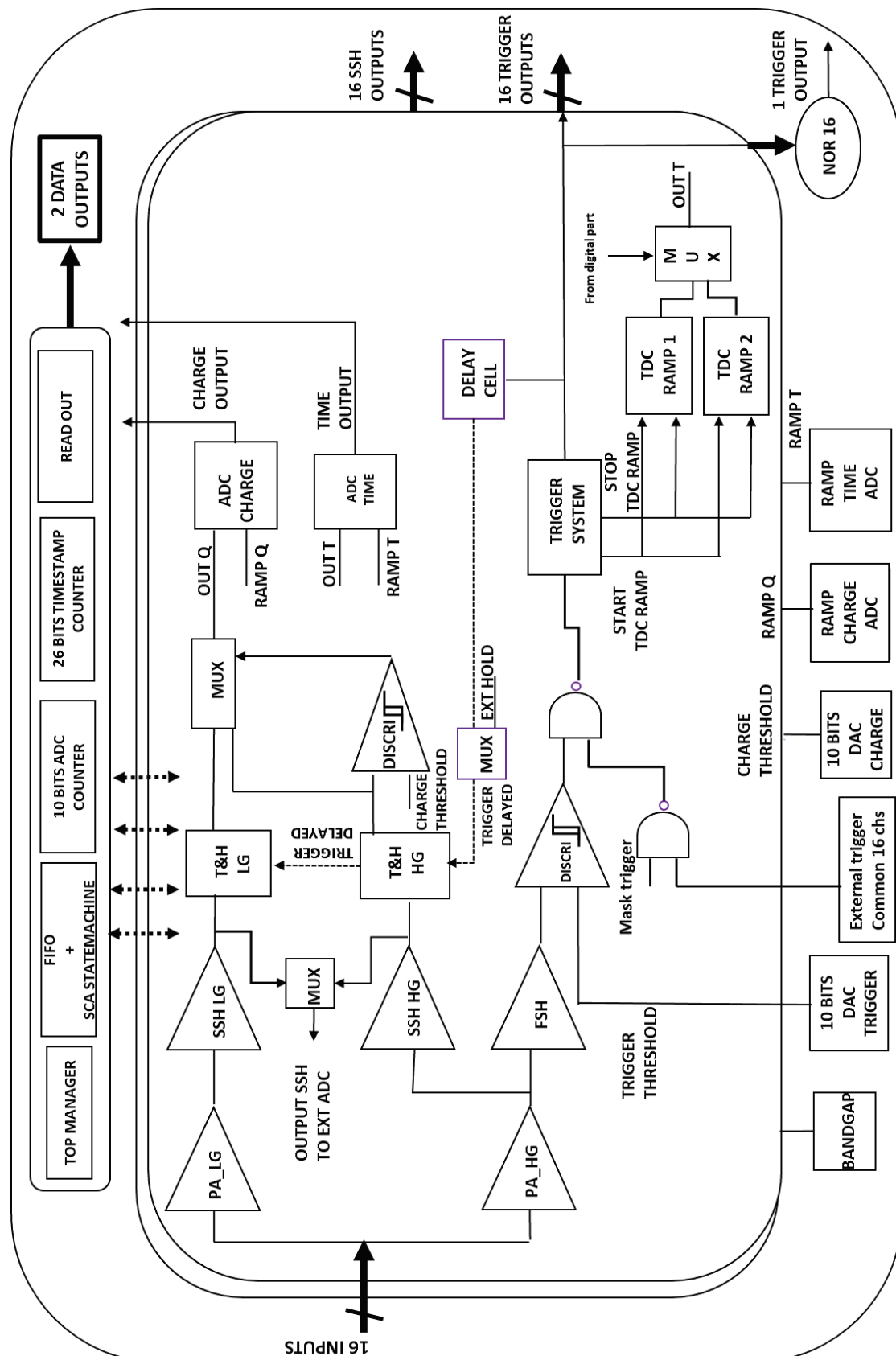
More about Catiroc 1



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Catiroc 1

Large-Photomultiplier-Arrays Read-Out Chip

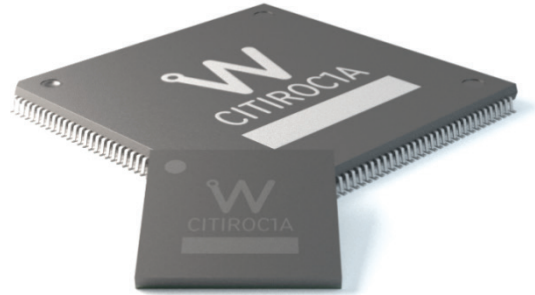


Citiroc 1A is a 32-channel front-end ASIC designed to readout silicon photo-multipliers (SiPM) for scientific instrumentation application.

Citiroc 1A allows triggering down to 1/3 pe and provides the charge measurement with a good noise rejection. Moreover, Citiroc 1A outputs the 32-channel triggers with a high accuracy (better than 100 ps).

An adjustment of the SiPM high-voltage is possible using a channel-by-channel DAC connected to the ASIC inputs. That allows a fine SiPM gain and dark noise adjustment at the system level to correct for the non-uniformity of SiPMs. Citiroc 1A can be calibrated using a unique calibration signal.

Timing measurement better than 100 ps RMS jitter is possible along with 1% linearity energy measurement up to 2500 p.e. The power consumption 225mW with all stages on.



Detector Read-Out	SiPM, SiPM array
Number of Channels	32
Signal Polarity	Positive
Sensitivity	Trigger on 1/3 of photo-electron
Timing Resolution	Better than 100 ps RMS on single photo-electron
Dynamic Range	0-400 pC i.e. 2500 photo-electrons @ 10^6 SiPM gain
Packaging & Dimension	TQFP 160 – TFBGA353
Power Consumption	225mW – Supply voltage : 3.3V
Inputs	32 voltage inputs with independent SiPM HV adjustments
Outputs	32 trigger outputs 2 multiplexed charge output, 1 multiplexed hit register 2 ASIC trigger output (Trigger OR)
Internal Programmable Features	32 HV adjustment for SiPM (32x8bits), Trigger Threshold Adjustment (10bits), channel by channel gain tuning, 32 Trigger Masks, Trigger Latch, internal temperature sensor

They are using Citiroc 1A

INAF – IASF (CTA experiment)
CERN (Baby mind experiment)

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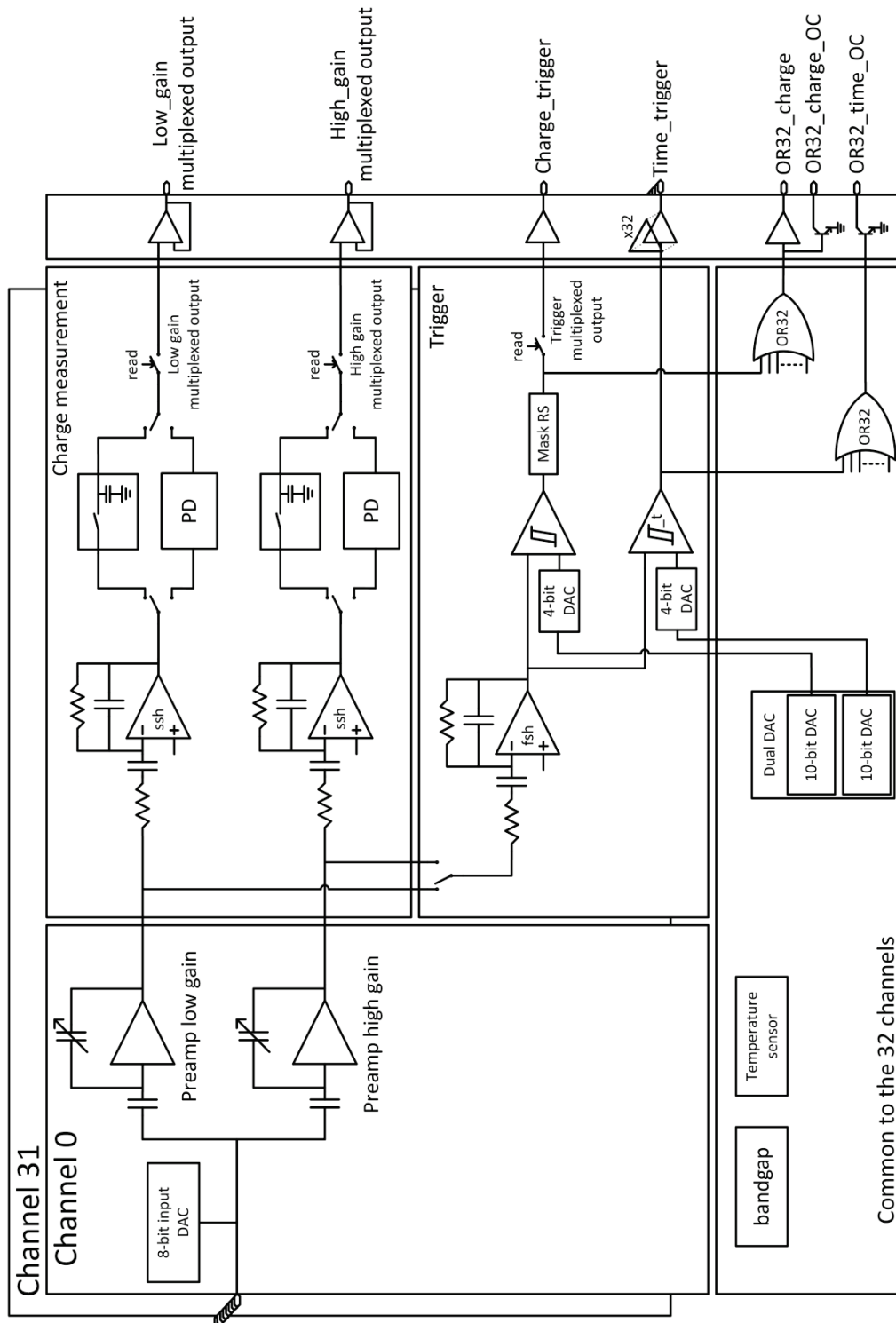
More about Citiroc 1A



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Citiroc 1A

Scientific instrumentation SiPM read-out chip



SSH – Slow Shaper ; FSH – Fast Shaper; PD – Peak Detector



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Petiroc 2A

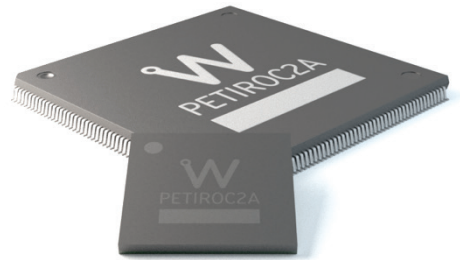
SiPM read-out for time-of-flight PET

Petiroc 2A is a 32-channel front-end ASIC designed to readout silicon photomultipliers (SiPMs) with both polarities for particle time-of-flight measurement applications. Petiroc 2A combines a very fast and low-jitter trigger with accurate charge and time measurements. Energy and time are digitized internally with a 10-bit ADC and 40ps-bin TDC.

The concept of the ASIC is to combine two measurement lines that won't interfere one with each other to measure both first incident photon timing measurement and whole crystal light charge integration.

An adjustment of the SiPM high voltage is possible using a channel-by-channel input DAC. It allows a fine SiPM gain and dark noise adjustment at the system level to correct for the non-uniformity of SiPMs.

The power consumption is 6 mW/channel, excluding buffers used to output the analogue signals. The main application of Petiroc 2A is PET time-of-flight prototyping but it can also be used for any application that requires both accurate time resolution and precise energy measurement.



Detector Read-Out	SiPM, SiPM array
Number of Channels	32
Signal Polarity	Positive or Negative
Sensitivity	Trigger on first photo-electron
Timing Resolution	~ 35 ps FWHM in analogue mode (2pe injected) - ~ 100 ps FWHM with internal TDC
Dynamic Range	3000 photo-electrons (10 ⁶ SiPM gain), Integral Non Linearity: 1% up to 2500 ph-e
Packaging & Dimension	TQFP208 – TFBGA353
Power Consumption	Power supply: 3.3V 192mW Analogue core (excluding analogue output buffer), 6mW/ch
Inputs	32 voltage inputs with DC adjustment for SiPM HV tuning
Outputs	Digital output (energy on 10 bit, time on 10 bit - 40ps bin) 32 trigger outputs 1 multiplexed charge output, 1 multiplexed hit register 2 ASIC trigger outputs (Trigger OR on 32 channels, 2 levels)
Internal Programmable Features	32 HV adjustment for SiPM (32x8b), trigger threshold adjustment (10b), charge measurement tuning, 32 trigger masks, internal temperature sensor, trigger latch

They are using Petiroc 2A

Industrial applications
Cannot be disclosed

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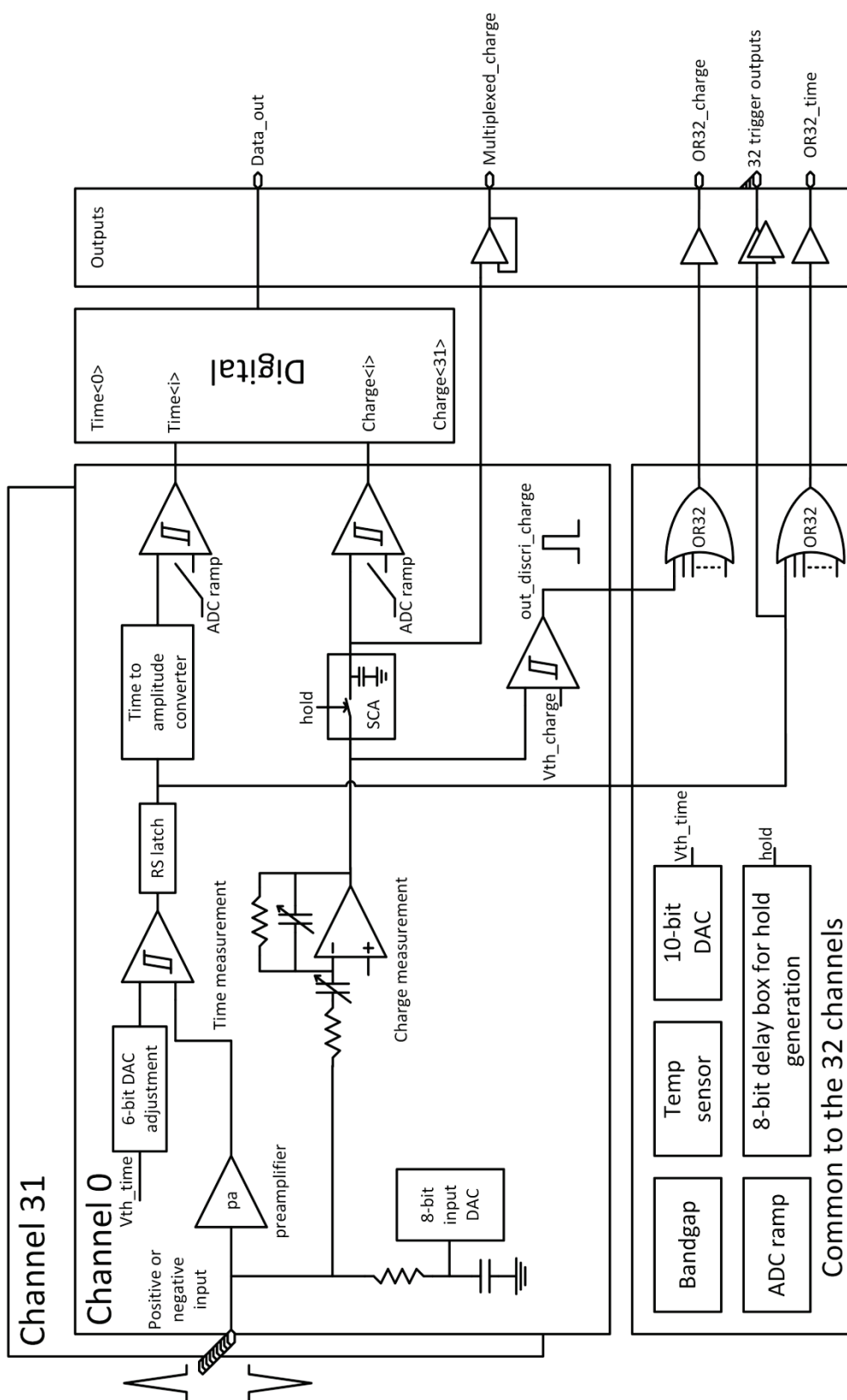
More about Petiroc 2



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Petiroc 2A

SiPM read-out for time-of-flight PET





Triroc 1A

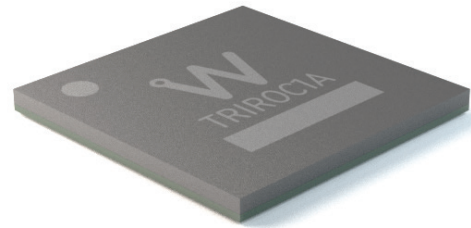
All-in-one SiPM read-out for multimodal PET
inserts

Triroc 1A is a 64-channel front-end ASIC designed to readout silicon photomultipliers (SiPMs) with both polarities for particle time-of-flight measurement applications. Triroc 1A combines a very fast and low-jitter trigger with accurate charge and time measurements. Energy and time are digitized internally with a 10-bit ADC and 30ps-bin TDC.

The concept of the ASIC is to combine two measurement lines that won't interfere one with each other to measure both first incident photon timing measurement and whole crystal light charge integration.

An adjustment of the SiPM high voltage is possible using a channel-by-channel input DAC. It allows a fine SiPM gain and dark noise adjustment at the system level to correct for the non-uniformity of SiPMs.

The power consumption is 10 mW/channel, excluding buffers used to output the signals. The main application of Triroc 1A is PET time-of-flight but it can also be used for any application that requires both accurate time resolution and precise energy measurement. Triroc 1A is available in naked dies or BGA packaging (12x12mm, 353 balls).



Detector Read-Out	SiPM, SiPM array
Number of Channels	64
Signal Polarity	Positive or Negative
Sensitivity	Trigger on first photo-electron
Timing Resolution	88 ps RMS
Dynamic Range	3000 photo-electrons (10^6 SiPM gain), Integral Non Linearity: 1% up to 2000 ph-e
Packaging	BGA (12x12mm, 353 balls)
Power Consumption	Power supply: 3.3V 10mW/ch
Inputs	64 voltage inputs with DC adjustment for SiPM HV tuning
Outputs	Digital output (energy on 10 bit, time on 10 bit - 30ps bin) 1 multiplexed time trigger output 2 ASIC trigger OR outputs (64 channels, 2 levels)
Internal Programmable Features	64 HV adjustment for SiPM (64x8bits), trigger threshold adjustment (10bits), charge measurement tuning, ADC Track & Hold/Peak Sensing, 64 trigger masks, internal temperature sensor, trigger latch, Power Pulsing

They are using Triroc 1A

Trimage collaboration (PET/IRM/EEG)
Industrial application
Cannot be disclosed

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More about Triroc 1A



All-in-one SiPM read-out for multimodal PET inserts



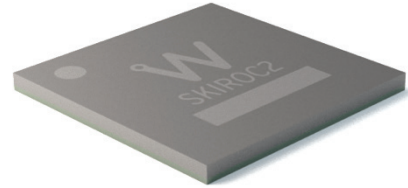


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Skiroc 2A

PIN Diode and Low Gain Silicon Detector Read-Out Chip

SKIROC 2A is a 64-channel front-end ASIC designed to readout silicon PIN diodes. Each channel is made of a variable-gain and low-noise charge preamplifier followed by two shapers – one with a gain of 1 and the other with a gain of 10 – to provide a charge measurement from 0.2 fC up to 10 pC. A time tagging is performed by a 12-bit TDC ramp. The charges and times are stored in a 15-depth Switched Capacitor Arrays (SCA), the values of which are converted by a multi-channel 12-bit Wilkinson ADC and sent to an integrated 4 Kbytes memory. The analog value of the charge is also available on an output pin. The trigger chain is composed of a high gain fast shaper and a discriminator and allows each channel to auto trigger down to 0.2 fC. Thresholds of the 64 discriminators are set by a common 10-bit DAC and an individual 4-bit DAC per channel. Each discriminator output is sent to an 8-bit delay cell (delay time tunable between 100 ns and 300 ns) to provide the Hold signal for the SCA cells of the slow channel. The power consumption is 6.2 mW/channel and each stage can be individually shut down when not used. 616 slow control parameters are available to set various configurations and ensure the versatility of the chip.



Detector Read-Out	Si PIN Diodes
Number of Channels	64
Signal Polarity	positive
Sensitivity	Trigger on 0.2fC
Timing Resolution	N/A
Dynamic Range	10 pC, Integral Non Linearity <1%
Packaging & Dimension	BGA 400 (17x17mm)
Power Consumption	6.2 mW /ch, power supply: 3.3V power pulsing
Inputs	64 current inputs
Outputs	1 multiplexed analog charge output 12-bit charge and time measurement Trigger OR of the 64 discriminators
Internal Programmable Features	Common gain adjustment for the input, common trigger threshold adjustment (10 bits) and individual threshold (4 b), 12-bit charge and time measurement, 64 trigger masks, multiplexed analog output

They are using Skiroc 2A

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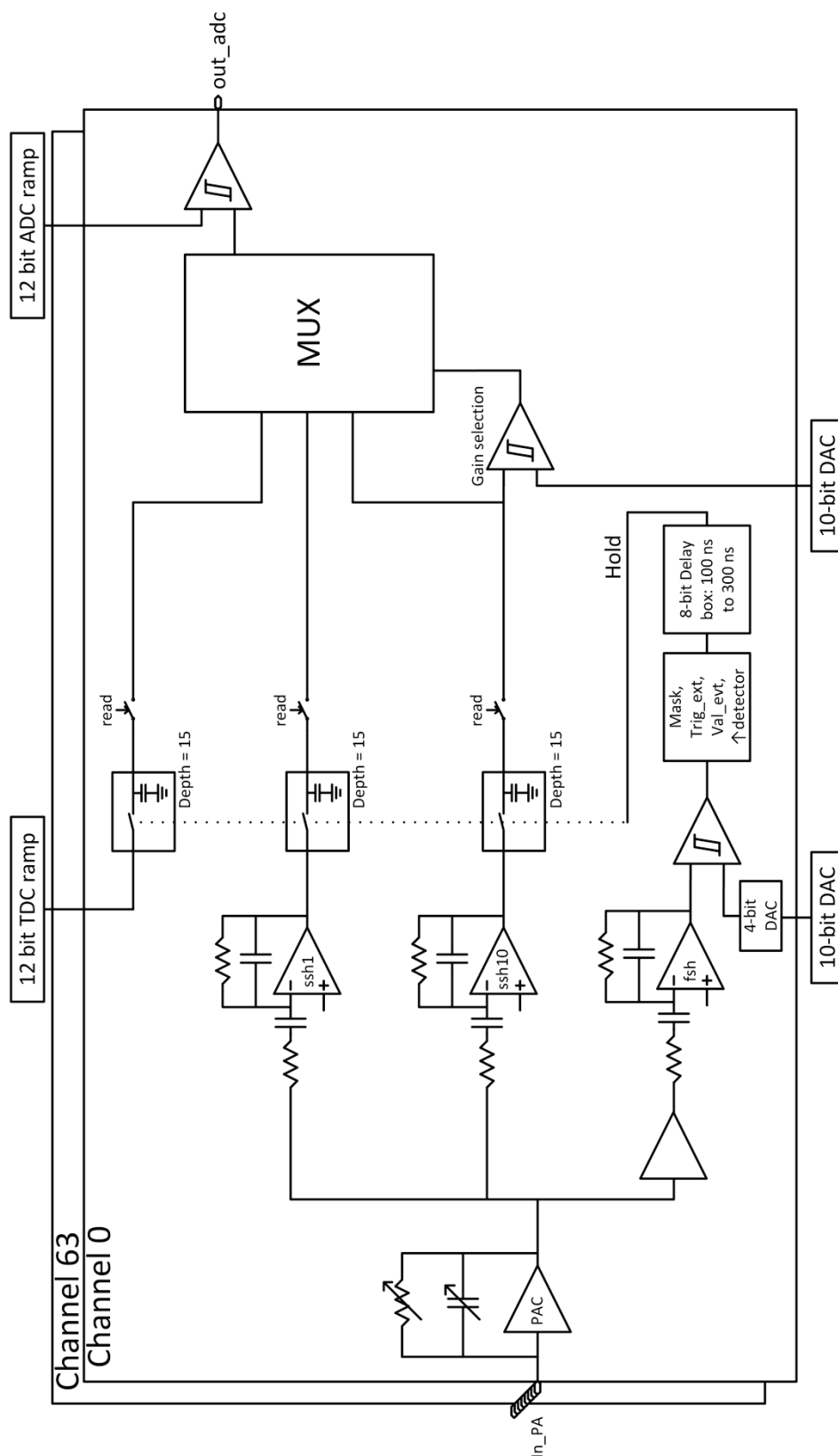
More about Skiroc 2A



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Skiroc 2A

PIN Diode and Low Gain Silicon Detector Read-Out Chip





Gemroc 1

Micromegas and GEMs semi-digital read-out chip

GEMROC 1 is a 64-channel front-end ASIC designed to readout negative fast ($<1\text{ns}$) and short ($<10\text{ns}$) current pulses from low gain detectors (GEMs, Micromegas, ...). GEMROC 1 provides a semi-digital readout with three thresholds tunable from 1 fC to 500 fC and integrates a 128-deep digital memory to store the 2 x 64 discriminator outputs as well as the timestamp from a 24b counter. The three thresholds are set internally by three 10-bit DACs. The gain of each channel can be tuned individually from 0 to 2 over 8 bits, allowing the compensation of non-uniformity between the 64 detector channels. Each channel can auto trigger down to 1 fC input charge. A multiplexed charge measurement up to 500fC is integrated.

The power consumption is 1.5 mW/channel and the chip can be fully power-pulsed allowing a significant power reduction by disabling unused blocks.



Detector Read-Out	Micromegas, GEM
Number of Channels	64
Signal Polarity	Negative
Sensitivity	Trigger 1 fC
Timing Resolution	N/A
Dynamic Range	500 fC
Packaging & Dimension	TQFP160
Power Consumption	1.5 mW /ch, power supply: 3.3V power pulsing
Inputs	64 current inputs
Outputs	2 encoded data outputs per channel streamed out in serial 1 multiplexed charge output 3 multiplexed trigger outputs or 3 trigger OR of the 64 channels
Internal Programmable Features	Trigger threshold adjustment (10bits), 3*64 trigger masks, multiplexed latched trigger or direct OR64 trigger outputs

They are using Gemroc 1

Industrial application (NDA)

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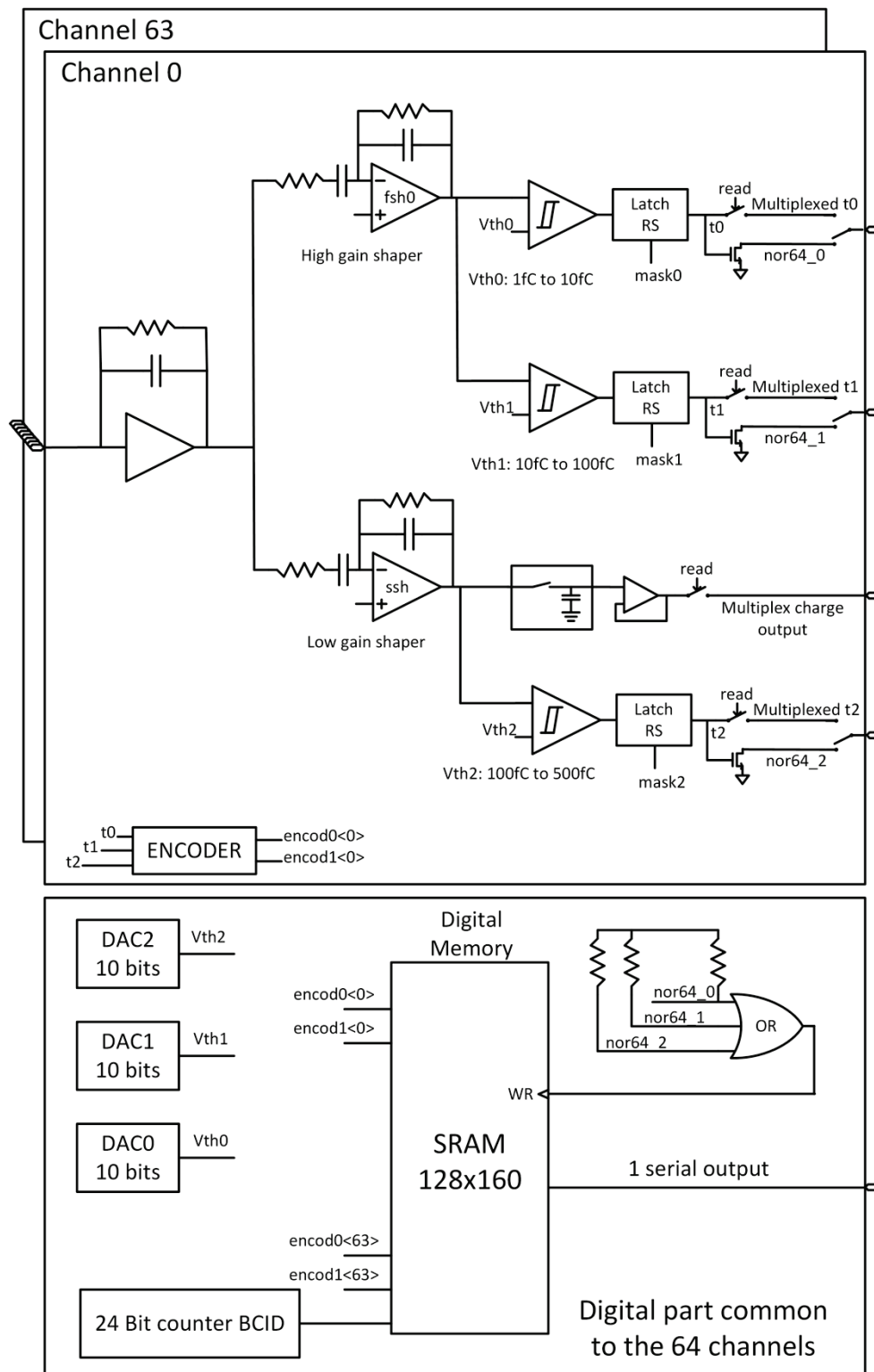
More about Gemroc 1



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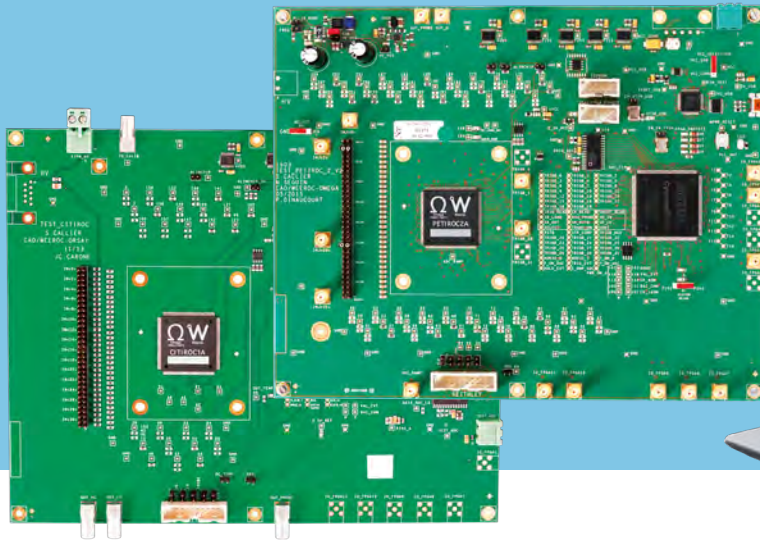
Gemroc 1

Micromegas and GEMs semi-digital read-out chip



Weeroc Testboards

Control Systems for Weeroc ASICs



A simple way to learn the use of Weeroc ASICs

Features

- Specific design for each Weeroc ASIC
- Hosting a small ASIC for easy DAQ management
- Easy characterization and debug of the ASIC
- Access to all ASIC's digital and analog I/Os
- ASIC internal signals monitor
- Data acquisition with real detectors
- Connections for an external High Voltage power supply
- Mini-USB for data transfer and board power supply
- Control and acquisition software for Windows OS (LabVIEW interface for TRIROC 1A board)

Overview

Weeroc Testboards are compact form factor platforms designed to control and read out Weeroc ASICs. This tool is suited to easily evaluate the characteristics of the ASIC and, thanks to its features, allows a versatile use with real detectors. The testboard provides easy access to all ASIC's digital and analog I/Os and implements a DAQ system consisting of an Altera Cyclone III FPGA and 12-bit ADCs.

The board hosts connections for detectors and the relative High Voltage distribution lines. Moreover, it provides the possibility to inject signals in the ASIC analog inputs using a generator.

A dedicated software for each different ASIC is available. It provides a simple GUI to set all the programmable parameters of the ASIC and allows the user to perform calibration and DAQ in an intuitive way. Some firmware options can also be set in order to manage DAQ within an experiment..

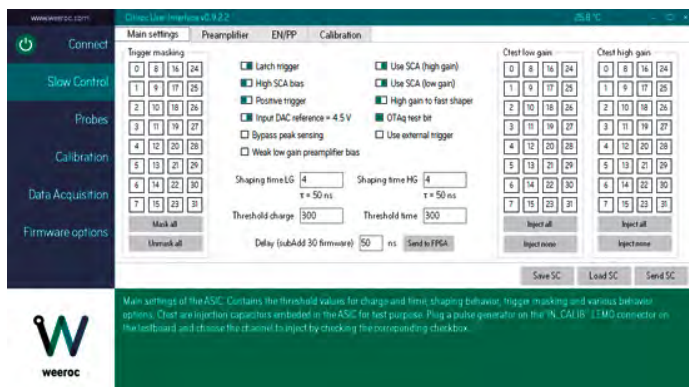
Software

Testboard Software



For each different testboard, a dedicated User Interface software for Windows OS is available for free download. It provides a simple GUI to set all the programmable parameters of the ASIC and allows the user to perform calibration and DAQ. Some firmware options can also be set.

The TRIROC testboard is equipped with a LabVIEW User Interface.

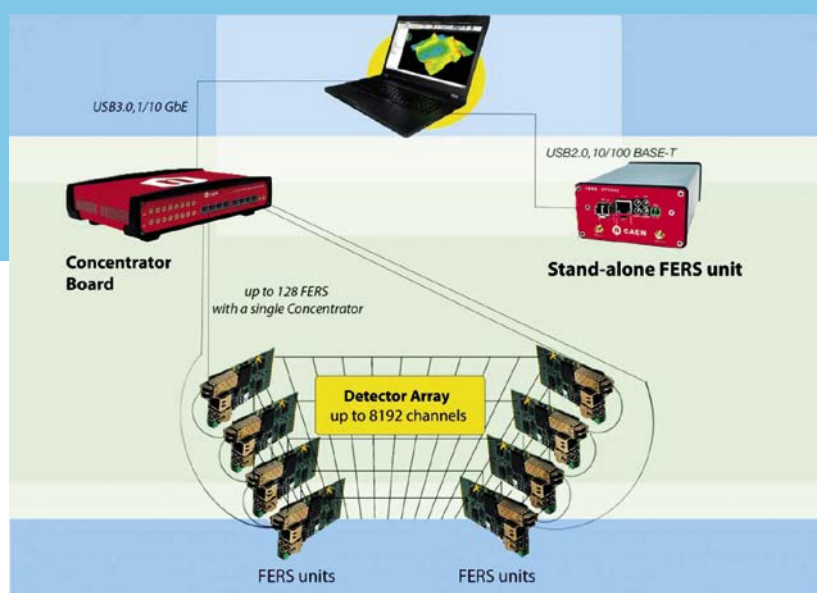


Ordering Option

Code	Description
WWTBCATIROC1	Testboard for CATIROC 1 chip
WWTBCITIROC1	Testboard for CITIROC 1A chip
WWTBGMROC1A	Testboard for GEMROC 1 chip
WWTBMAROC3AA	Testboard for MAROC 3A chip
WWTBPETIROC2	Testboard for PETIROC 2A chip
WWTBPHOTOC1	Testboard for PHOTOC 1A chip
WWTBTIROC1A	Testboard for TRIROC 1A chip

FERS-5200

Front End Readout System



A distributed and easy-scalable platform for the readout of large detector arrays

FERS-5200 is the CAEN solution to readout data from both small experimental setups and large experiments consisting of many thousands of detectors. The system was conceived to accomplish the present experimental necessity for high scalability, high channel density, and a reduced cost per acquisition channel.

Overview

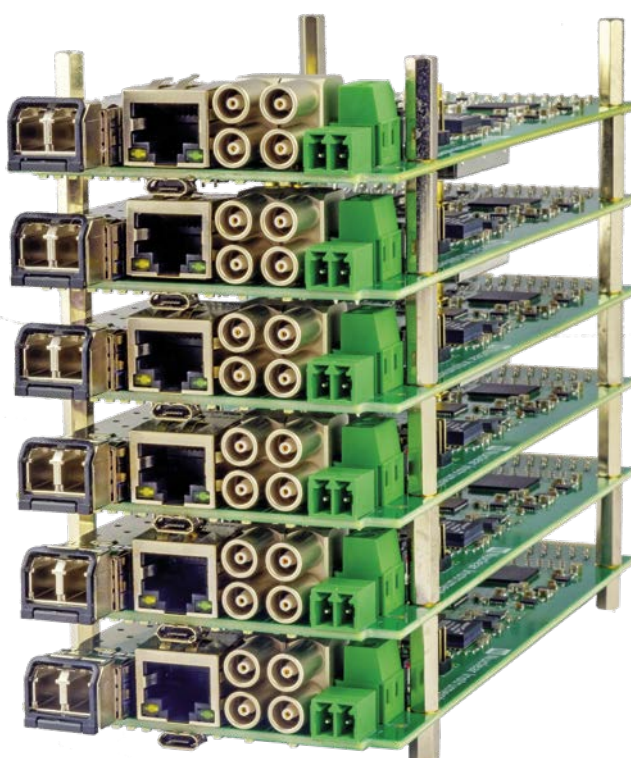
FERS-5200 is a Front-End Readout System designed for large detector arrays, such as SiPMs, multi-anode PMTs, Silicon Strip detectors, Wire Chambers, GEM, Gas Tubes, and others. FERS is a highly-scalable distributed platform. Each unit is a small card ($\sim 7 \times 17 \text{ cm}^2$) which houses 64 or 128 channels and includes Front End electronics, A/D converters, trigger logic, synchronization, local memory, and readout interface.

FERS is a synonym of flexibility: a single user-interface and readout infrastructure has been designed to support and perform a wide range of front-end tasks suitable for a large variety of detector types. In most cases, the front-end is based on ASIC chips. This design is perfect for large detector arrays, combining high density, cost-effective integration of multi-channel readout electronics with a small footprint, and low power draw.

This is the case of the first FERS-5200 model: A5202, based on the Citiroc-1A chip produced by Weeroc for SiPM readout.

Features

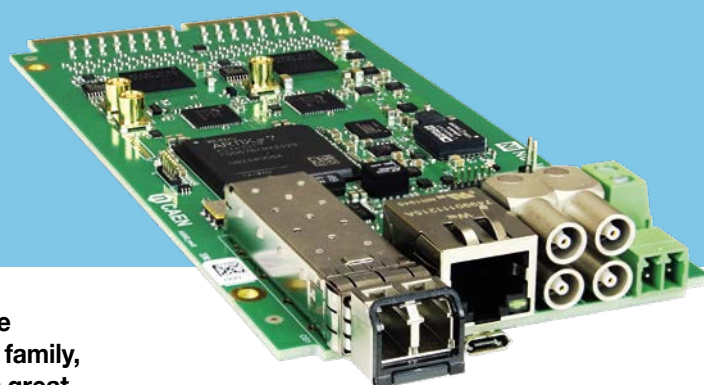
- **Scalability:** from a single standalone FERS unit for prototyping to thousands of channels (tree network structure)
- **Modularity:** multiple FERS units managed via a single Concentrator board
- **Flexibility:** FERS units can be tailored to specific detectors and applications
- **Compact size:** High-channel density FERS units



Ordering Option

Code	Description
WA5202XAAAA	A5202 - 64 Channel Citiroc unit for FERS-5200
WDT5202XAAAA	DT5202 - Desktop 64 Channel Citiroc unit for FERS-5200
WDT5215XAAAA	DT5215 - Collector Board for FERS-5200

The readout of large SiPM arrays has never been simpler and cost-effective



The A5202 module is the newborn FERS-5200 board for the readout of SiPM arrays. Being also the first member of the family, it constitutes a proof of concept for the system itself and a great starting point for other FERS-5200 board development.

ASIC Chip

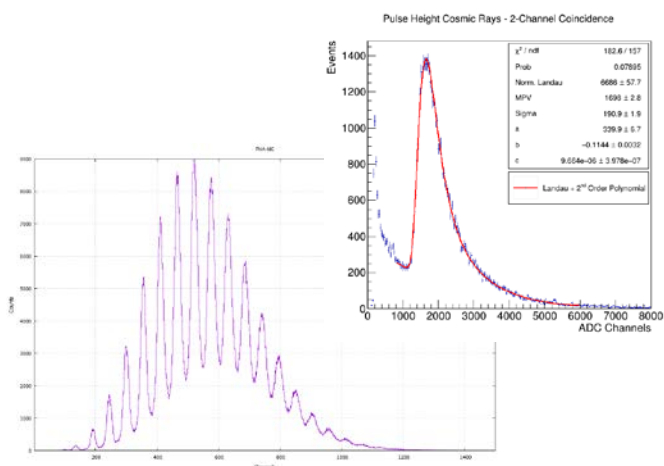


Features

- 64 channels (= 2 Citiroc-1A chips)
- Acquisition modes: spectroscopy (PHA), counting, time stamping with ToT
- Onboard power supply module for SiPM bias generation
- Up to 128 A5202 FERS units (up to 8192 SiPM pixels) can be managed and synchronized via optical link using a single Concentrator Board.

Overview

The first FERS-5200 unit being developed is the A5202 (DT5202 is the boxed version for desktop use) that uses the Citiroc-1A chip produced by WeeROC for SiPM readout. More precisely, the A5202 is a small board (~ 7 cm x 17 cm) housing two Citiroc-1A chips (64 readout channels). Each readout channel is composed of a Preamplifier, a Slow Shaper with pulse height detector, and a Fast Shaper followed by a discriminator. Pulse height values from each Citiroc-1A are converted sequentially by a 13-bit ADC to perform energy measurements. The 64 channel self-triggers (discriminator outputs) can be used for counting, time stamping, to determine the Time over Threshold (ToT) information, and also to generate the board bunch trigger that starts the ADC conversion. The A5202/DT5202 board also integrates the A7585D power supply module necessary for biasing the SiPMs, and the interfaces for readout, synchronization, and control.



DT5702 - A1702

32 Channel Silicon Photomultipliers Readout Front-End Board



A compact ASIC-based solution to readout SiPM arrays with coincidence trigger logic

Features

- Based on Weeroc CITIROC 1A ASIC
- Amplification and shaping of the SiPMs output pulse
- Provides bias voltage in the range of 20-90 V individually adjustable for each channel
- Discrimination of shaped signal at configurable level from 0 to 50 SiPMs photo-electrons
- Provides basic coincidence of signals from each pair of adjacent even-odd channels
- Timing resolution up to 1 ns
- Formation of two independent timestamps
- Lemo I/O for time reference and control signals
- DAQ and control software with data output in ROOT format
- Daisy chain of up to 256 boards into one network interface
- Multiple boards event validation
- Efficient back-end communication based on Ethernet standard
- Trigger-independent firmware available (NEW)

Overview

The DT5702/A1702 is a compact 32-channels Front-End Board (FEB) designed to perform energy and time measurements with SiPM arrays. Given the increasing use of SiPMs in physics experiments, this solution is a valid approach for a variety of applications thanks to its flexibility, compact form factor and channel density.

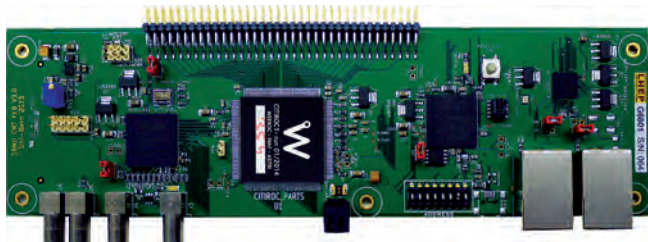
The board provides adjustable bias voltage to the detectors and is able to process and digitize the analog signals.

The analog input signal is processed by a Weeroc CITIROC 1A ASIC providing charge amplifier with configurable gain, fast shaping with the peaking time of 15 ns for trigger formation and slow shaping with configurable peaking time in the range of 12.5 ns to 87.5 ns for amplitude measurements. Thanks to these features the DT5702/A1702 has a wide range of possible applications: from veto systems of neutrino experiments to SiPM arrays imaging.

The triggering logic is realized by a XILINX Spartan-6 FPGA. A trigger independent firmware is available, useful to extract triggering pixel positional information, improve timing resolution and estimate the time walk.

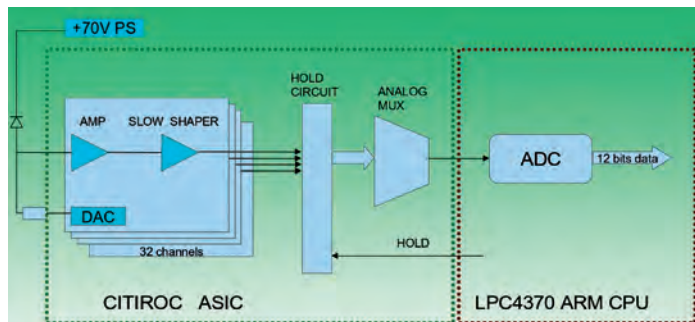
The communication interface of the board is a 3-port Ethernet switch, which allows connection to a host computer and daisy chain of multiple boards.

The board is available in boxed (DT5702) and naked (A1702) version.

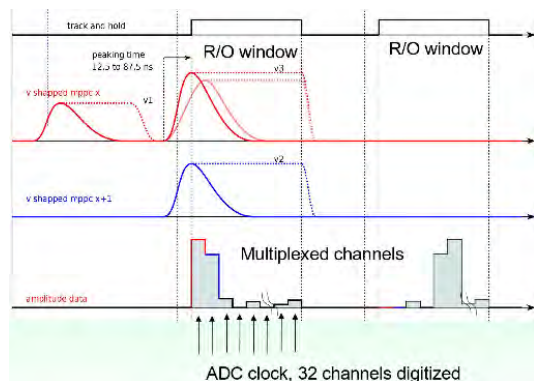


A1702 - Front-End Board.

DT5702 - A1702 Front-End Board is a custom design developed by the Albert Einstein Center for Fundamental Physics of the University of Bern for the readout of SiPM arrays used in the veto system of Liquid Argon Neutrino Experiment.



Block-scheme of analog signal processing circuit.



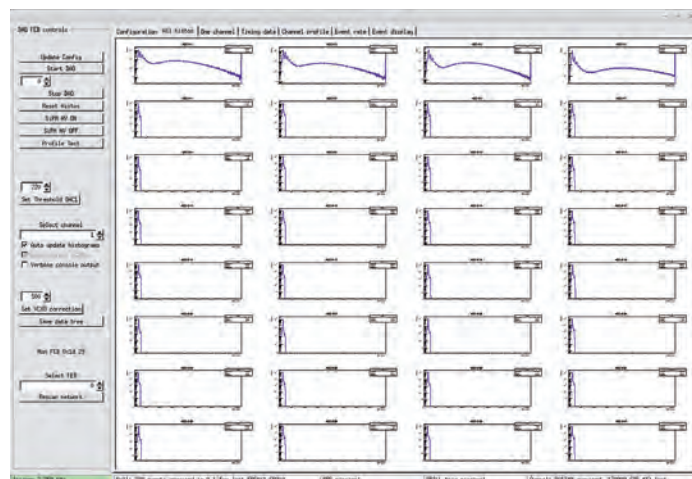
DT5702/A1702 readout of SiPM signals.

Software

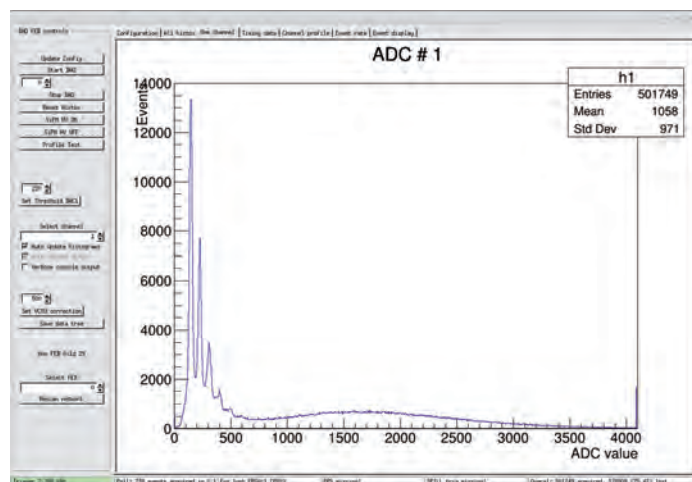


FEBDAQMULT

A data acquisition control software (FEBDAQMULT) with GUI is available in order to test the performances of DT5702/A1702 boards. The software is a C script based on Cern ROOT Data Analysis Framework and is tested on Linux OS. The code is open source and may serve as a template for more dedicated experiment-optimized DAQ software.



FEBDAQMULT GUI, 32-histograms per FEB summary.



FEBDAQMULT GUI, single histogram tab activated.

Ordering Option

Code	Description
WA1702XAAAAA	A1702 - 32-channel SiPM readout Front-End Board
WDT5702XAAAA	DT5702 - 32-channel SiPM readout Front-End Board BOXED

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