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Petiroc and Citiroc : Front-end ASICs for SiPM read-out and ToF applications

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Petiroc and Citiroc are the two latest ASIC from Weeroc dedicated to SiPM read-out.

Petiroc is a 16-channel front-end ASIC designed to readout silicon photomultipliers (SiPMs) for particle time-of-flight measurement applications. It combines a very fast and low-jitter trigger with an accurate charge measurement.

Citiroc is a 32-channel front-end ASIC designed to readout silicon photo-multipliers (SiPM). It allows triggering down to 1/3 pe and provides the charge measurement with a good noise rejection. Moreover, Citiroc outputs the 32-channel triggers with a high accuracy (100 ps).

Each channel of both ASICs combines a trigger path with an accurate charge measurement path. An adjustment of the SiPM high voltage is possible using a channel-by-channel input DAC. That allows a fine SiPM gain and dark noise adjustment at the system level to correct for the non-uniformity of SiPMs.

Timing measurement down to 7 ps RMS jitter for Petiroc and 100ps RMS for Citiroc is possible along with 1 % linearity energy measurement up to 2500 pe. The power consumption is around 3.5 mW/channel for Petiroc and 2mW/channel for Citiroc, excluding ASICs outputting buffer.

Summary

Petiroc and Citiroc are the latest ASIC designed by Weeroc, a start-up company from the Omega microelectronics group of IN2P3/CNRS.

SiPM time resolution allows time-of-flight measurement with high accuracy. Petiroc is a 16-channel ASIC that features a front-end read-out chain composed of a fast DC-coupled amplifier, fast filtering and very low jitter discriminator for the time measurement and an optimized variable-gain shaper for high accuracy charge measurement. The main application of Petiroc is PET time-of-flight prototyping but can be used for any application that requires both sharp time resolution and precise energy measurement.

First measurement on Petiroc shows a time jitter around 7ps on 3 photoelectrons test pulses and 13ps on 1 photoelectron test pulses. Charge measurement has been measured and a 1% linearity has been measured up to 2500photoelectrons.

Citiroc is a 32-channel ASIC aimed to read-out SiPM without time of flight measurement. Each channel embeds a front-end read-out chain composed of two AC-coupled voltage low-noise preamplifier with variable-gain adjustment. The utility of the gain tuning on the preamplifiers is twofold. On the first hand it allows to compensate non-uniformity between channels by finely adjusting gain channel by channel, on the second hand, it allows to adjust the general gain of the amplification chain to adjust the read-out chain to the SiPM gain, allowing a large choice of SiPM on the system to be used.

Citiroc has a new channel-by-channel trigger chain composed of a fast shaper followed by two discriminators with individual channel-by-channel threshold adjustment to be able to trig on the first photo-electron and validate the trigger on the first few photoelectrons. That double trigger allows a great dark noise rejection at the first stage of the read-out chain and avoids saturating the DAQ with noise events. Each trigger channel can be masked in case of noisy channel, latched, or output the discriminator output as is depending on user needs. A general ASIC trigger is also outputted through a 32-input trigger OR.

A testboard with intuitive software is available for both Petiroc and Citiroc.

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