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SPIROC and TRIROC, Design and Performance of Dedicated Very Front-End for SiPM

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The SPIROC and TRIROC chips are complete dedicated very front-end electronics for the readout of SiPM. Designed with AMS 0.35 μm SiGe technology, they enable to digitize and process signal over such a large dynamic range ADC.

SPIROC has been extensively used for calorimeters by different groups for ILC (International Linear Collider) HCAL and ECAL prototypes.

With its 64-channel readout, TRIROC targets Time-of-Flight Positron Emission Tomography (TOF-PET) application. TRIROC had been designed for TRIMAGE European project and includes compatibility with positive and negative SiPM signals and benefits from a TDC fine time binning of 40 ps.

Designs and measurements of both chips will be presented.

Summary

The SPIROC and TRIROC chips are two complete dedicated multichannel very front-end electronics to read out a prototype for Silicon Photomultiplier (SiPM).

They have been designed in 0.35 μm SiGe Austrian Micro System technology. The first one has been developed to match the specific ILC requirements of large dynamic range, low noise, low consumption, high precision and large number of readout channels needed and the second one is aimed for building a cost effective trimodal PET/MR/EEG brain scan within the TRIMAGE European project.

SPIROC is the first chip that integrates all the calorimeter readout, digitization and signal processing over such a large dynamic range. It has been extensively used by German and Japanese groups for ILC HCAL and ECAL calorimeter prototypes, where several thousand of channels have been operated in test beam. The latest results will be shown as well as design considerations for the 3rd generation that would be necessary for a final detector.

TRIROC is the latest addition to SiPM readout ASICs family developed at Weeroc, a start-up company from Omega microelectronics group of IN2P3/CNRS.

The low-noise, DC-coupled front-end amplifiers of this ASIC accept both negative and positive input signals thus making it suitable for reading out any SiPM in the market.

In each ASIC channel, the incoming signals will be sent into two different paths: for energy and time measurements. A variable gain semi-gaussian shaper is used for shaping the input signal in energy measurements. The energy conversion is handled by a 10-bit Wilkinson ADC. This ADC is a proven design and it is expected to be linear up to 2500 photoelectrons. Additionally, a charge trigger is available and can be used for events validation at required energy such as 511 keV.

Signal from high speed input pre-amplifier is fed into a discriminator in order to provide a fast trigger for time measurements. A TDC module with coarse and 40 ps fine time is used to time-stamp this trigger.

TRIROC can be operated with minimal external components, since most of the components for SiPM readout are packed internally. This feature makes TRIROC a good contender in compact multi-channel PET applications. TRIROC is designed by using AMS 0.35 μm SiGe technology and was submitted in March 2014. Test and measurements of this ASIC are expected to start around June 2014.

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