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H2GCROC: Design and Performance of a Dedicated Very Front-End ASIC for SiPM readout of the CMS High Granularity Calorimeter.

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The HGCROC ASICs are dedicated very front-end electronics designed to read out the High Granularity Calorimeter (HGCAL), which will replace the present end-cap calorimeters of the Large Hadron Collider (LHC) for the Compact Muon Solenoid collaboration (CMS). They are declined in two flavors: HGCROC to read out the Silicon pads of the electromagnetic and front hadronic sections and H2GCROC to readout out the SiPMs coupled to the scintillating tiles of the back hadronic sections, where the radiation constraints are less severe.
H2GCROC is a radiation-hardened 130nm CMOS chip with 78 channels (72 reading out standard cells, 2 reading out calibration cells, and 4 channels not connected to any sensor cells for common-mode noise estimation). The front-end preamplifier is adapted for the SiPM's higher signal level, expecting pC/MIP rather than fC/MIP ranges. A current conveyor at the FE ASIC's input modifies the signal to guarantee that the remainder of the chain is compatible with the one used to read the silicon sensors. Each channel also contains a low noise and high gain preamplifier and shapers connected to a 10-bit 40 MHz SAR-ADC allowing charge measurement over the preamplifier's linear range. A discriminator and TDC provide charge information from TOT (Time over Threshold) over a 200 ns dynamic range in the preamplifier's saturation zone. Additionally, timing information with an accuracy of 25 ps is produced via a fast discriminator and TDC. Finally, DRAM memory is used to store charge and timing data for later processing.
The chip was received end of 2020 and extensively tested since then, in the lab and in testbeam. This work examines the very front-end design and performance, including timing performance with the sensor.

Collaboration

CMS

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