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Study of SEU effects in circuits developed in 110 nm UMC technology

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At INFN-Torino, ASICs for readout applications of detectors were designed in several technologies, and are now under development. The 110 nm CMOS UMC technology is applied too. This technology has been chosen for its lower cost with respect to IBM or TSMC, even if there was not a systematic characterization for what concerns the radiation tolerance. Obviously, it is important to know the behavior of this technology under radiation. For this reason, configuration registers of a full size prototype for the custom readout circuit of silicon double-sided microstrips of PANDA Micro Vertex Detector were tested with ion and proton beams.

Summary

The 110 nm CMOS UMC technology is one of the technologies used to develop ASICs for the readout of several detectors at INFN-Torino. In spite of its lower cost with respect to IBM or TSMC, its radiation tolerance has not been completely assessed.
First tests of Total Ionizing Dose for this technology have been done by the group of V. Re [E. De Riceputi et al., DOI:10.1109/PRIME.2017.7974152].
For that reason it is important to know the behavior of this technology under radiation and in particular to validate the use of the Triple Modular Redundancy (TMR) technique and Hamming Encoding (HE) to avoid the Single Event Upset (SEU) effects.
The circuit used to perform that evaluation is an ASIC prototype (named PASTA) developed for the readout of silicon double-sided micro-strips of the Micro Vertex Detector of PANDA experiment since it implements the two types of structures (TMR and Hamming Encoding) to be tested.
The full size prototype is a readout solution which uses the Time over Threshold (ToT) technique to determine the charge and time information.
It has 64 channels each containing three distinct building blocks: an analog front-end, an analog TDC and a digital TDC controller.
A fourth block, the global controller, is common to all channels and is used to collect the data from the channels and distribute the configuration.
A dedicated DAQ in LABView has been developed to configure the ASIC registers and acquire data.
The radiation tolerance of the configuration register is evaluated by the following procedure: a writing command is followed by a reading command until a SEU is detected showing an inefficiency of the protection circuit (TMR or Hamming Encoding technique), then the sequence starts again from the begin. The acquisition program counts the number of time when the bit changes its value (0-1, 1-0), allowing the estimation of errors which have been detected and corrected. A balanced sequence of 1 and 0 is used to evaluate also the different behavior of the circuits.
The configuration of each channel requires a sequence 42 bit long. The global configuration requires a sequence 172 bit long.
Two tests were performed, the first one at INFN-LNL using ions beams at the SIRAD facility and the second one at the experimental room of INFN-TIFPA, in the Centro di Protonterapia in Trento, with proton beam.
Several ions were used to obtain the cross section for SEU. Proton beams with different current intensities were used to investigate the SEU effects as a function of particle flux.

The results will be presented.

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