Testing an active control device for bit flips in neutron and heavy ion radiation environments

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Effects of particle radiation can impair active implanted medical devices (AIMDs) such as pacemakers, or ICDs. Single event effects can affect the device memory and can ultimately lead to the pacemaker syndrome or unnecessary shocks of defibrillators. The assessment of the risk of malfunctions in those devices for defined radiation environments is a prerequisite for developing corresponding radiation protection measures. For this purpose, the devices are to be exposed to neutron and proton radiation fields to determine the cross sections for radiation related malfunctions. However, the AIMDs can only be read out after irradiation. Therefore, an active control device has been developed to assure a reasonable amount of bit flips in the particle energies to be examined. The set up contains 13 commercial-of-the-shelf SRAMs of different types and sizes which are connected to a microcontroller. A pattern of alternating bits is written on the chips and read out constantly during or cumulative after irradiation. Any variations from the original pattern are logged. Firstly, the device was exposed to an Am-Be source to investigate the response to neutrons and the effect of constant irradiation over several hours. Secondly, the set up was irradiated with 48 MeV/u carbon ions for testing an expected high rate of bit flips in a short amount of time. In both cases a reasonable amount of bit flips was logged for all SRAMs. However, a higher sensitivity to carbon ions than to neutrons has been observed. A balanced ratio between 1-0 and 0-1 bit flips has been found as well as an even distribution over all blocks of addresses. All in all, no permanent damage has been observed with the fluences used so far. The detection of bit flips was Poisson distributed and stable over time. Furthermore, the device has been demonstrated to process high numbers of bit flips in a short amount of time. In conclusion, the developed device can be used as an active control monitor for bit flips in neutron and heavy ion radiation environments