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Neutron Single Event Effects In Advanced Micro-Nano-Electronics - Tests Standards And Applications In Avionics, In Physics Or Fusion Research and Radiotherapy Facilities

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–Since the 80s and the 90s it is known that Terrestrial Cosmic Rays, mainly reported as ‘Atmospheric Neutrons’, as well as muons and protons, of cosmic origin, can penetrate the natural shielding of buildings, equipment and circuit package. Eg, flux of thermal to high-energy neutron of interest ranges between ~ 10 particles.cm-2.hour-1 at sea level to ~ 104 cm-2.hour-1 at typical airplanes flight altitude of 40000 feet. They eventually can trigger Soft Errors and Hard Errors such as Latch-up in integrated circuits and Breakdown of power devices. Besides, the elementary transistor device shrinking, pitch or gate length, affected the stored charge per bit of information, making devices more and more susceptible.

From a Real Time viewpoint, this evolution allowed gate delay down to some picoseconds and signal bandwidth to dramatically increase to Gbits/s and more. As a consequence, downscaling of device design affected signal integrity margins and rendered the single event effect more effective because more and more minute ionizing transients were captured as parasitic signals. We present a simple model resulting in an evolutionary diagram of the signal charge from micrometer and submicrometric to deca-nanometer compared to the transient charge induced by an ionization track.

The dramatic growth of the size of DRAM and SRAM memory (MB, GB, TB) caused the resulting Failure-In-Time and Soft Error Rate at circuit and system level to become unacceptable in standalone or embedded processors, FPGAs and System-on-Chips. Test standards and design solutions have been proposed to assess and maintain the reliability of commercial products and improve such as those used in stringent applications mainly in avionic flight computers, but also physics large hadron colliders fusion research facilities, and even some radiotherapy areas and high-end computing and routing the Internet.

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