Multiple Cell Upsets Rate Estimation for 65 nm SRAM Bit-Cell in Space Radiation Environment

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Abstract

This report addresses the Multiple Cell Upsets in SRAM based on 65nm bulk CMOS technology node. Aggressive downscaling trends in CMOS technology has resulted in decrease of device feature size, power supply voltage and placement of MOS transistors in close proximity to substantially reduce the chip area. If 65nm SRAM bit-cell is struck by high LET particle in close proximity outside bit-cell area, it was found that stored information can be reversed due to charge sharing between the closely place MOS transistors in deep submicron technologies. Therefore, multiple memory cells can be affected by energetic single particle strike. We report Multiple Cell Upsets (MCUs) cross-section (Figure 1) and contribution of multiplicity of MCU events in Single Event Rate (SER) (Figure 2) calculated with MUSCA SEP3 toolkit with typical aluminum spot shielding of 2.54 mm physical mechanism simulation. In order to characterize the radiation hardness of scaled CMOS devices, EDA simulation tools such as MUSCA SEP3 was utilized for MCU rate prediction whereas space radiation environment was estimated with the help of OMERE-TRAD software. The contribution of different sources of space radiation into total SER is shown in Figure 3.

Acknowledgement

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Image

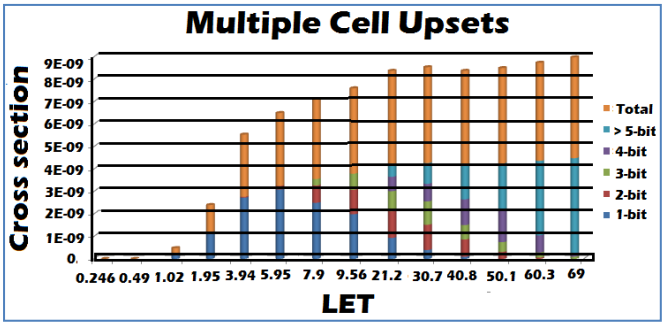

Figure 1. MCUs cross-section for 65nm SRAM device

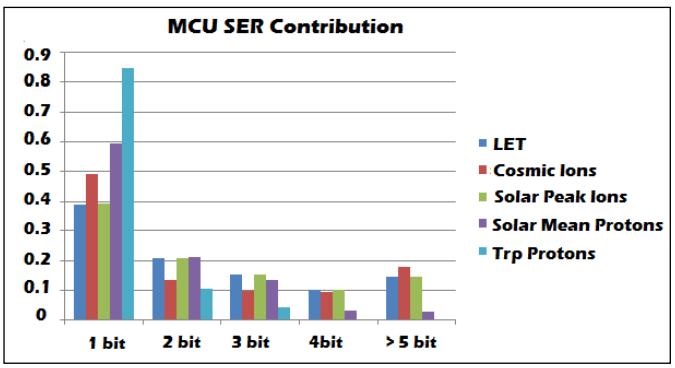

Figure 2. Multiplicity of events for MCU SER at LEO radiation environment for SRAM

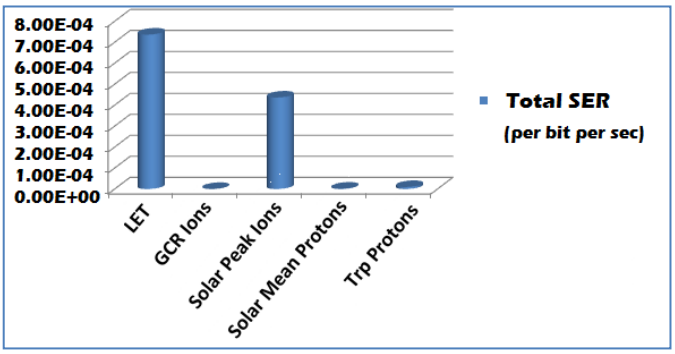

Fig. 3: Contribution of protons/heavy ions to MCUs SER at LEO for SRAMs

Recent Publications

[1] N. G. Chechenin, *et al.,* (2011) "Comparison of Experimental Data with Predictions of Various Models for Silicon and Aluminum Fragmentation under the Effect of High-Energy Cosmic Rays" *Physics of Atomic Nuclei*, 74: 1718–1724

[2] N. G. Chechenin, *et al.,* (2012). Impact of High-Energy Cosmic-Ray Protons and Ions on the Elements of Spacecraft On-Board Devices. *Journal of Surface Investigation. X_ray, Synchrotron and Neutron Techniques*, 6: 303–313.

[3] V. Ya. Chumanov, *et al.,* (2013). Ionization Effects of the Heavy Components of Cosmic Radiation in Protected Chips. J. of Surface Investigation. X ray, Synchrotron and Neutron Techniques, 7: 254–261.

[4] V. Ya. Chumanov, et al., (2014) Ionization Effects Coupled with the Residual Products of Nuclear Reactions Induced by Cosmic Protons in the Metallization Layers of Modern 3D Integrated-Circuit Assemblies. ISSN 102774510, Journal of Surface Investigation. X-ray, Synchrotron and Neutron Techniques, 8: 1265–1274.

[5] N. G. Chechenin, *et al.,* (2015) Tungsten Fragmentation in Nuclear Reactions Induced by High-Energy Cosmic-Ray Protons. *Physics of Atomic Nuclei,* 78: 159–166.

[6] M. Sajid, *et al.,* (2015), Space radiation environment prediction for VLSI microelectronics devices onboard a LEO satellite using OMERE-TRAD software, *Advances in Space Research* 56: 314–324.


Biography

Nikolay Chechenin, Dr. Sci, professor, is the head of Division of Atom and Nuclear Physics and Laboratory of Nanostructures and Radiation effects at Scobeltsyn Institute of Nuclear Physics of Lomonosov Moscow State University. He runs several projects, including effects of space radiation on on-board electronics.

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