【Grant-in-Aid for Scientific Research (S)】

Broad Section J

Title of Project： Muon-induced soft error evaluation platform: future prediction based on measurement and simulation

HASHIMOTO, Masanori
(Osaka University, Graduate School of Information Science and Technology, Professor)

Research Project Number：19H05664　Researcher Number：80335207
Keyword：soft error, muon, integrated system, VLSI, reliability

【Purpose and Background of the Research】

Soft error originating from cosmic ray is a serious concern for reliability demanding applications of integrated systems. According to device miniaturization, muon could become a major source of soft error, and the error rate may drastically elevate. This research aims to investigate whether muon would be the dominant error source in the future. For accurate prediction, this research will obtain fundamental physics data of muon-Si nuclear reaction and measure the error rate of state-of-the-art SRAM. With these, we will establish a simulation platform that reproduces physical phenomena and contributes to Society 5.0.

【Research Methods】

This research will establish a word-first simulation platform that accurately understands and evaluates muon-induced soft error and predicts the error rate of future devices. With fundamental physics data, which will be acquired by this research, and verification of hardware-simulation correlation, we will improve the accuracy and reliability of simulation technology.

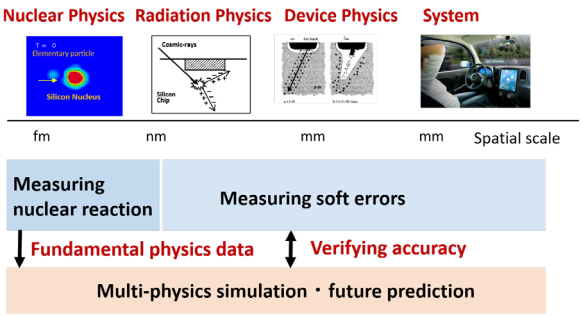

Figure 1 Organization of this research project

Figure 1 shows the organization of this research. Researchers who cover nuclear physics to system work together for this project. For establishing a reliable simulation platform that can be applied to future prediction, we will experimentally obtain muon-Si nuclear reaction data (Task 1: Niikura, Watanabe, Sato) and provide it to simulator developers. We will perform soft error measurement experiments with state-of-the-art SRAM, investigate physical phenomena contributing to soft error, and characterize its soft error rate (Task2: Hashimoto, Sato, Niikura). We will develop a multi-physics simulator that includes nuclear physics, radiation physics and device physics (Task 3: Abe, Kamakura, Niikura). The physics data obtained by Task 1 will be exploited in simulator development, and the hardware-simulation correlation will be verified with the soft error data measured by Task 2. Finally, we will predict soft error rate of future devices using the developed simulation platform and investigate the impact of muon-induced soft error on future information technology (Task 4: Hashimoto, Watanabe, Abe, Kamakura).

【Expected Research Achievements and Scientific Significance】

We will be able to correctly understand the physics of muon-induced soft error and reveal how serious muon-induced soft error would be and how urgent its countermeasure development is. This project develops an error evaluation platform, and distributes it to academia and industry so that countermeasures to muon-induced soft error can be developed.

Overall, this project prevents unexpected reliability degradation due to muon-induced soft error, and eliminates reliability degradation sources that prevent Society 5.0 from being actualized.

【Publications Relevant to the Project】

・W. Liao, M. Hashimoto, S. Manabe, Y. Watanabe, K. Nakano, H. Sato, T. Kin, K. Hamada, M. Tampo, and Y. Miyake, "Measurement and Mechanism Investigation of Negative and Positive Muon-Induced Upsets in 65-nm Bulk SRAMs," *IEEE Transactions on Nuclear Science*, 65(8), pp. 1734-1741, August 2018.
・S. Manabe, Y. Watanabe, W. Liao, M. Hashimoto, K. Nakano, H. Sato, T. Kin, S. Abe, K. Hamada, M. Tampo, and Y. Miyake, "Negative and Positive Muon-Induced Single Event Upsets in 65-nm UTBB SOI SRAMs," *IEEE Transactions on Nuclear Science*, 65(8), pp. 1742-1749, August 2018.

【Term of Project】

FY2019-2023

【Budget Allocation】

156,300 Thousand Yen

【Homepage Address and Other Contact Information】

http:// www-ise1.ist.osaka-u.ac.jp/
hasimoto@ist.osaka-u.ac.jp