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Monte Carlo Simulation of Radiation Effects in Microelectronics[1]

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Microelectronic devices are susceptible to disruption by ionizing radiation, and with the scaling of devices to ever-smaller dimensions they are increasingly vulnerable to single event effects. Single event effects are transient errors in active devices, usually although not exclusively in digital logic, that are caused by the interaction of ionizing particles with the materials from which the devices are made. This presentation describes a Monte Carlo approach for predicting the rate of single event effects from knowledge of radiation environments and device structure. The approach combines detailed physical modeling of discrete radiation events, semiconductor device simulation to estimate charge transport and collection, and circuit simulation to determine the macroscopic electrical effects of collected charge. Details of the Monte Carlo simulation will be presented, and a mathematical analysis that establishes its relationship to earlier single event rate prediction methods will be discussed. Recent experimental and computational results on the rate of single event effects in highly scaled devices will be reviewed.

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