Introduction and Data and Method

Although heavy-ion single-event effects (SEE) pose serious threats to space missions, evidence shows that proton SEE is a much less severe threat. This is mainly due to the high LET sensitivity of devices to heavy ions at low-energy ion fluences. Low-cost missions often forego testing with heavy ions, relying instead on testing with low-energy protons (LEP).

In this study, we examine whether testing with heavy ions or protons is the preferred strategy for minimizing SEE susceptibility in a variety of nuclear codes. We use the CRÈME-MC physics-based Monte Carlo package to calculate the effects of high-energy protons on sensitive volumes in space systems. We also compare the results of this study to previous work that used proton SEE data to constrain heavy-ion SEE susceptibility.

Destructive Mechanisms

Destructive SEE (DGSE) models are among the most serious threats to space missions. They are of great concern because high-energy protons can cause single-event burns and cause permanent damage to devices. In contrast, low-energy protons have a low LET and are not expected to cause much SEE.

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Results and Discussions

Figs. 6-7 illustrate the differences in the probability of SEEs between protons and heavy ions. For a given LET, the probability of SEEs is much lower for heavy ions than for protons. This is because heavy ions have a lower LET and are less likely to cause SEEs.

Hardness Assumptions

The hardness assumptions are based on the assumption that the LET of the incident ion is the same as the LET of the recoiled ion within the sensitive volume.

We have examined the effect on device SV geometry on the SEE cross section. We find that for device SV with depths greater than about 5 microns, the SEEs produced by heavy ions and protons are very similar. This is because the SEEs produced by heavy ions and protons are very similar.

Conclusion

We conclude that proton SEE data can be used as a proxy for bounding heavy-ion SEE susceptibility. This is because proton SEE data have a lower LET and are less likely to cause SEEs.

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References