

Radiation Survivability of Micro-SD Cards in a Simulated Exposure to Prolonged Low Earth Orbit Space Environments

Achal Duhoon,¹ Jordan Lee,¹ JR Dennison,¹ Satoshi Takemori,² Takahiro Yatabe²

¹Materials Physics Group, Physics Department, Utah State University, USA
²Engineering Mechanics & Energy Department, University of Tsukuba, Japan

Introduction

Space environment is harsh. The objective of this research is to-

- Observe and understand the effects of radiation on variety of micro-SD cards.
- Help Get Away Special (GAS) team at USU, determine the best micro-SD card for their CubeSat mission.
- Perform recovery tests on the damaged micro-SD cards to check if the recovery was possible.

Radiation tests were conducted on a dozen of micro-SD Cards for a cumulative Total Ionizing Dose (TID) of **~1000 Gy** or **~50 times a typical annual dose (~20 Gy) received by a CubeSat in LEO**. Gray (Gy) is the SI unit to measure the amount of radiation absorbed by an object or person. *An individual at USU typically receives <0.001 Gy in a year.*

Methods

A. Pre-Radiation Tests-

The memory capacities of the micro-SD cards ranged from 4 GB to 32 GB with, low – and high-grade commercial multi-level cell (MLC) flash memory and industrial grade single-level cell (SLC) flash memory. Several different commercially available memory test software were used to check if the SD cards failed or if they slowed down.

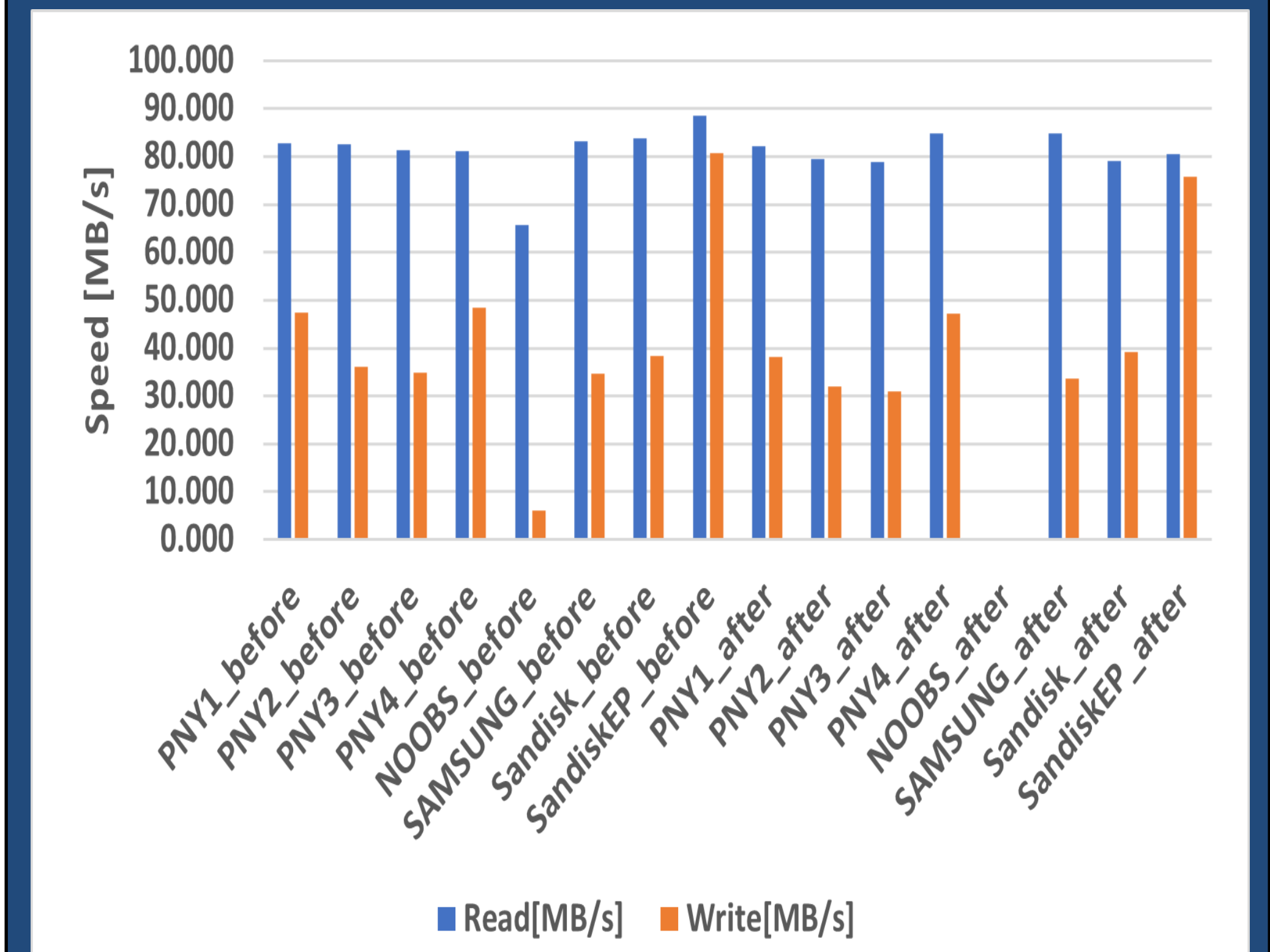
B. Radiation Tests –

These tests will be carried out in Space Survivability Test (SST) Chamber at USU at a dose rate of ~2.5 Gy/hr for 10 intervals ranging from 4 hrs to 400 hrs.

Results

- Preliminary tests performed by Japan at <340 Gy showed memory failures in cheap SD Cards.
- In the latest pre-radiation tests, using two different computers does not impact Read and Write Speeds of SD Cards. This is because the ratio of their speed is constant.
- This result would save a lot of time and we can use just one computer that can simultaneously test 13 SD cards at the same time.
- USB 3.0 adapters and USB 3.0 PCI cards will be used.
- This will be approximately 30 times faster than the previous tests.

Figure 2. Preliminary Results from Japan



Read and Write Speeds for Pre- and Post-Radiation Tests of micro-SD Cards. Notice that NOOBS broke after radiation.

Conclusions and Future Work

- Time plays a crucial factor in radiation.
- Testing a dozen SD cards simultaneously will also help in Recovery Tests.
- More USB 3.0 adapters and hubs will be purchased to speed up the testing process.
- These results will also give insight on the radiation tolerance of variety of micro-SD cards for future satellite projects.

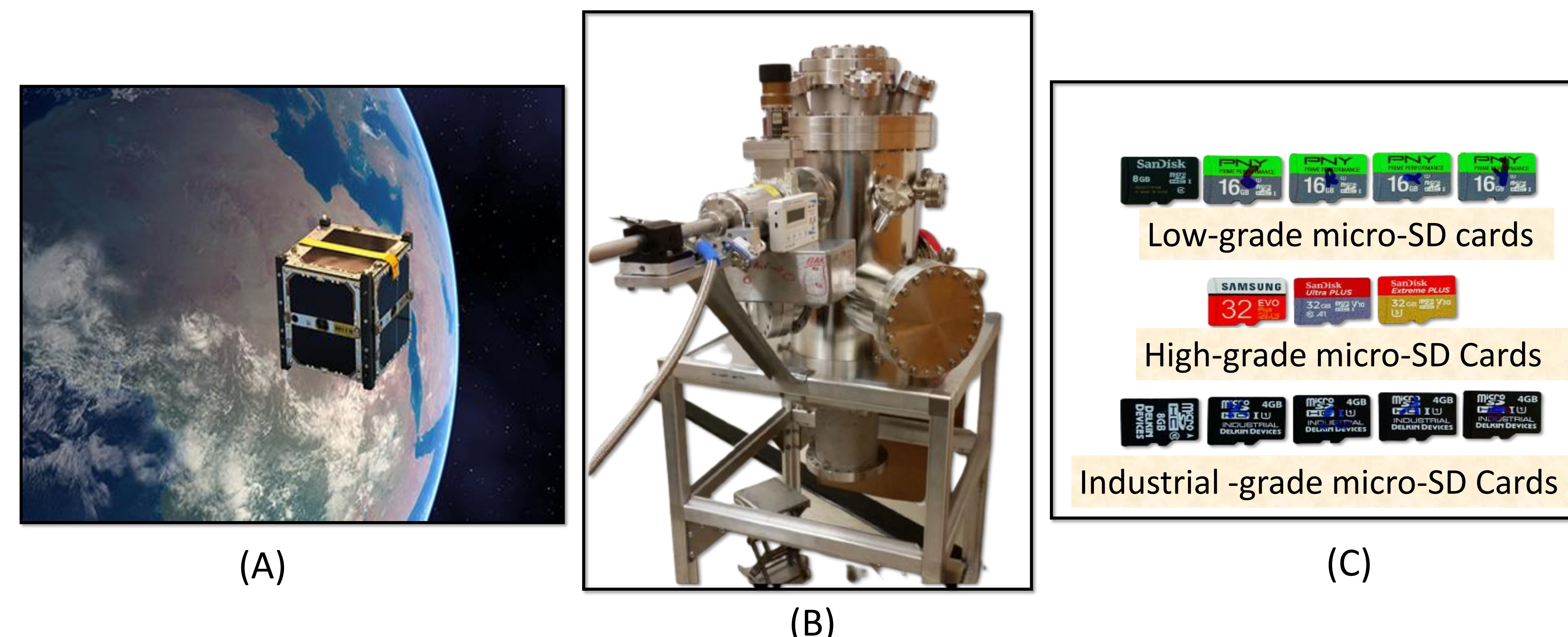


Figure 1. (A) Typical 1 U CubeSat in LEO (Image Courtesy : NASA). (B) Space Survivability Test Chamber at USU. (C) Categories of micro-SD Cards used in this experiment.

