An Investigation Into The Susceptibility of Memory Cards to Neutron Damage

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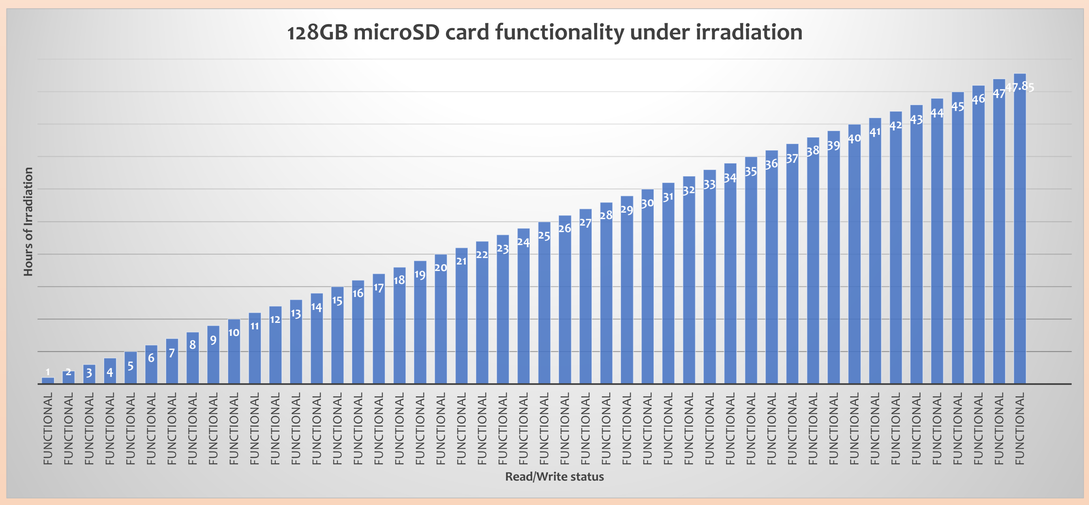
Abstract

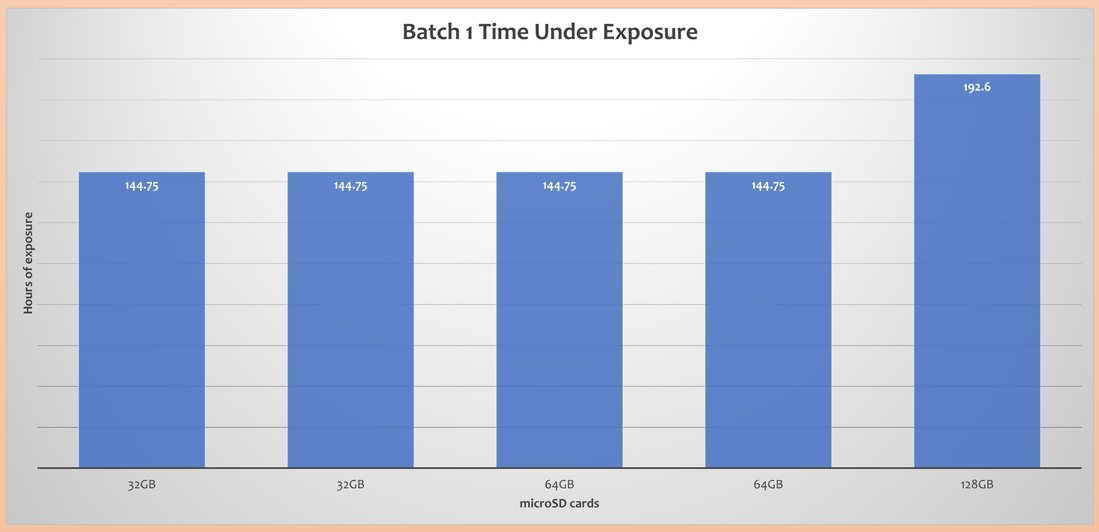
The safeguarding of nuclear materials and facilities is a global challenge. There are different methods to maintain nuclear safeguarding, with a primary method being the use of cameras. Therefore, it is fair to consider the vulnerabilities of the elements of this method of safeguarding. One of these vulnerabilities may be neutron damage to memory cards. This project aims to investigate whether a causal relationship exists between neutron damage and failure in memory cards. This investigation was carried out practically and experimentally, using the Lancaster University Californium-252 neutron source, which emits neutrons of between $1x10^{-10}$ – 1MeV, to irradiate microSD cards of three different storage sizes, 32 GB, 64 GB, and 128 GB, in batches of five. A read/write function check program was written using C++ and uploaded to an Arduino Uno that ran the program through a microSD breakout circuit. This project also aimed to assist in the calculation of the activity of the Lancaster University ^{252}Cf neutron source through the neutron activation of copper foils. This project has helped provide insight into the service life of memory cards in nuclear environments, contribute to the advancement of nuclear safeguarding and security, and influence the need for further research in this area, for example, the effect of higher energy neutrons on memory cards.

Results

After 47 hours and 51 minutes, the 128GB microSD card was still perfectly functional.



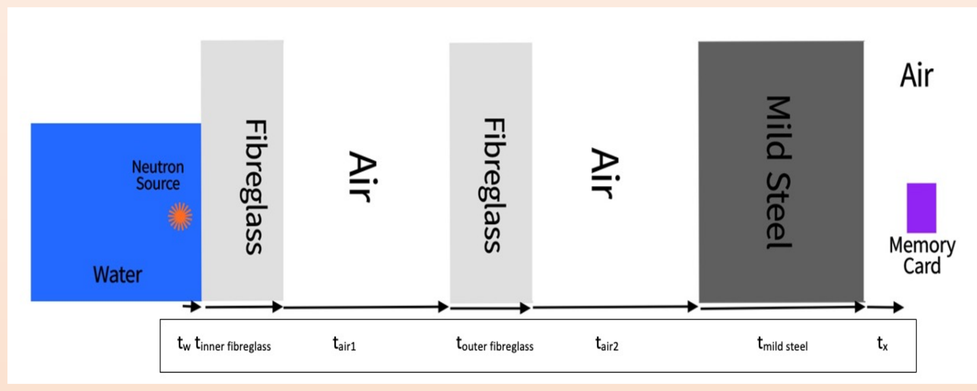
All microSD cards in batch 1 and batch 2 were still functional after exposure to the neutron source.



Methodology

The ^{252}Cf neutron source at Lancaster University was to be used in this project to irradiate memory cards. The tank is a double-hulled fibreglass tank, with the first tank containing water, and the second tank acting as a containment bund. External to the two open-top fibreglass tanks are eleven 3mm thick mild steel sheets.

Initially, one microSD card was placed in front of the tank where the source would be exposed, to try and ascertain the length of time under irradiation needed for a 128GB microSD card to fail.

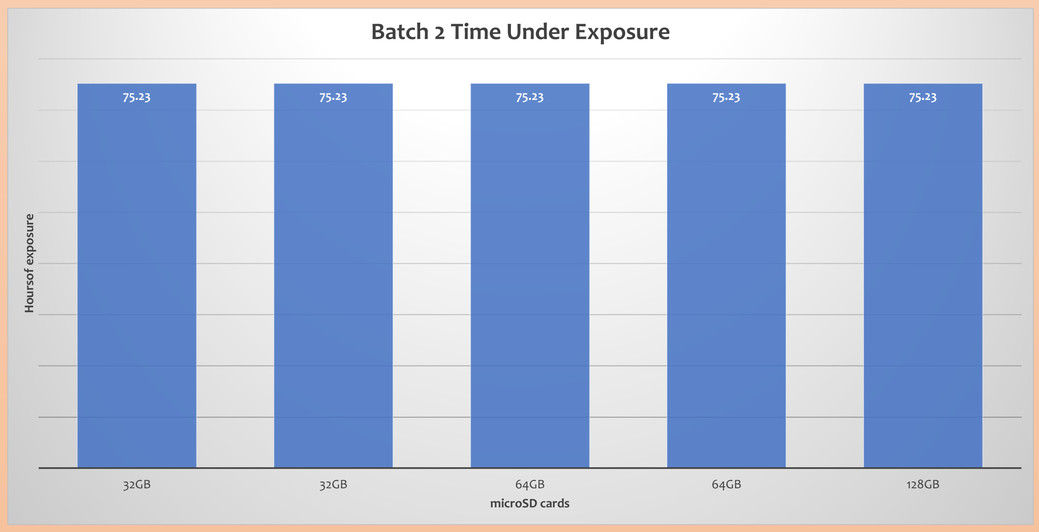


The 128GB card was exposed to the source for 47 hours and 51 minutes.

Then two batches of five microSD cards were tested. Each batch consisted of two 32GB cards, two 64GB cards, and one 128GB card.

The first batch was exposed for 144 hours and 45 minutes, but the 128GB in this batch was the same as previously used, so it has been exposed for 192 hours and 36 minutes. The second batch was exposed for 75 hours and 14 minutes.

The cards were tested using an Arduino Uno microcontroller connected to a microSD card breakout circuit, which separates the pins of the microSD cards. Using the Arduino IDE, code was written to analyse the read/write functions of the microSD card and output which function had failed.



Conclusion

This project discovered that, under exposure to a thermal neutron source, microSD cards are still able to function as required in the short term. Furthermore, varying the capacity of the microSD cards did not affect whether they would fail.

These results dictate a need for further experimentation, more specifically, the effect of fast neutrons on memory cards.

Experiments at ChipIR have been carried out to test the effects of a higher energy source against microSD cards, however, due to health and safety reasons, the microSD cards are yet to be released and the results are yet to be processed.

NuSec Nuclear Security Science Network