

Autonomous Solid-State Radiation Detector for Safety of Aerospace Systems

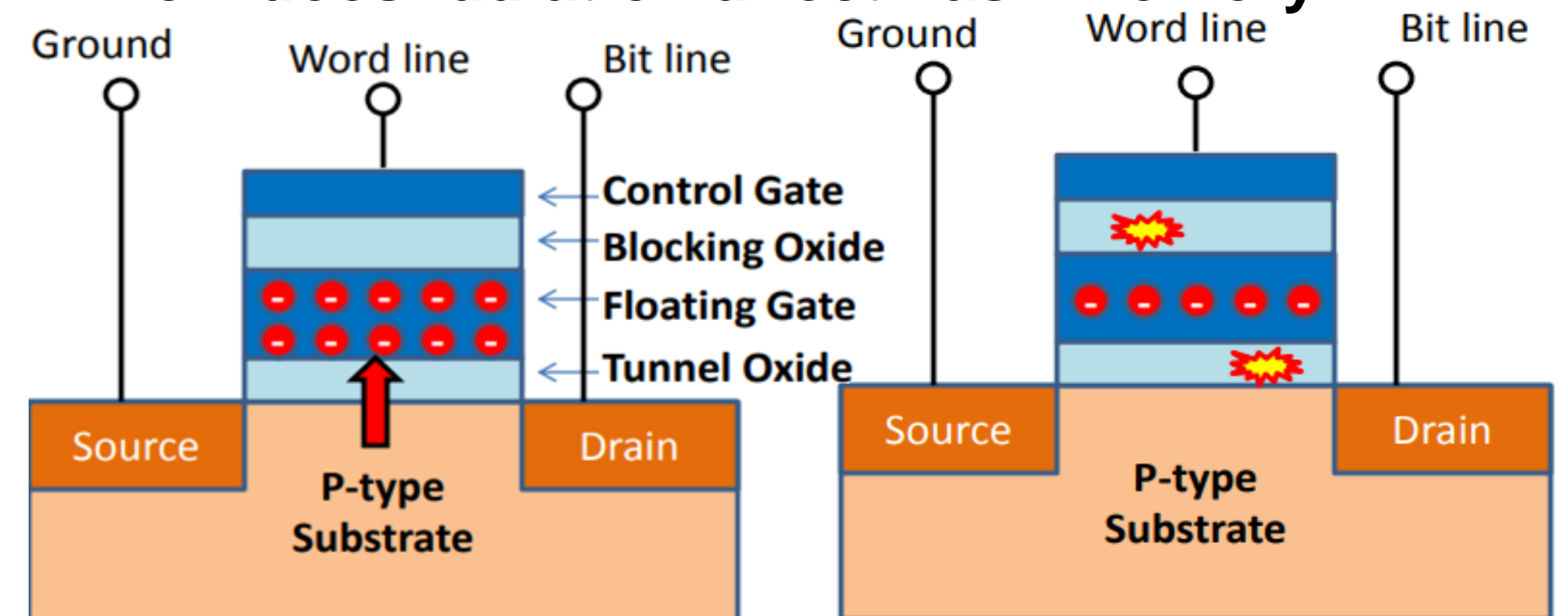
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Flash Memory as a Radiation Sensor

Benefits to the aero- and astronautical fields

- Availability: Flash memory already present in nearly all aerospace systems, dedicating portion for radiation detection easily done
- Increased Accuracy: Large memory densities, statistically reduced uncertainty
- Large Dynamic Range: Extensible Total Ionizing Dose measurement, kilorads to megarads

How does radiation affect flash memory?



High threshold voltage (V_T) Low threshold voltage (V_T)
 Incident radiation generates positive charge in oxides which shifts the V_T of a memory cell. Very few charges necessary for appreciably large shift in threshold voltage.

Conceptual Overview

Method 1: Bit Error Count

- Incident radiation shifts V_T of a cell, changes a “0” cell to a “1” cell
- After programming all cells “0”, apply incident radiation and count number of cells that now read “1”

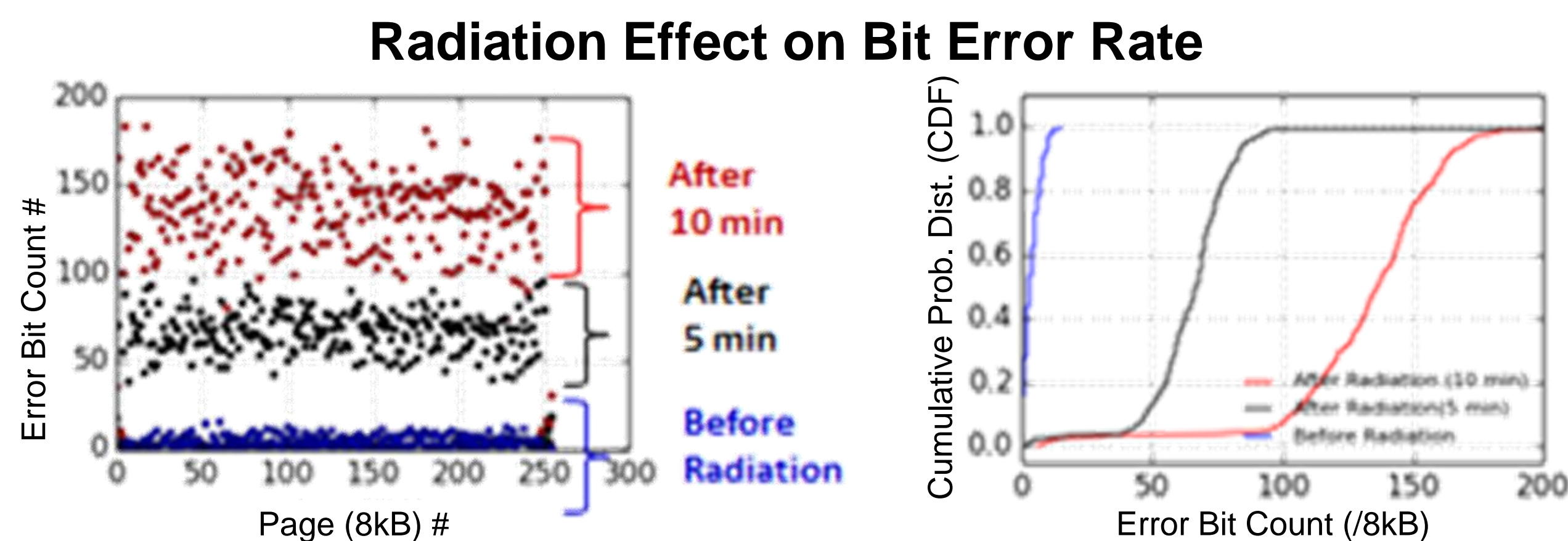
Method 2: Timings Statistical Analysis

- Bit error rate cannot always be measured (due to error correction)
- Error correction is not instantaneous, and a resultant increase in program, read, and delete time can be measured

Preliminary Results

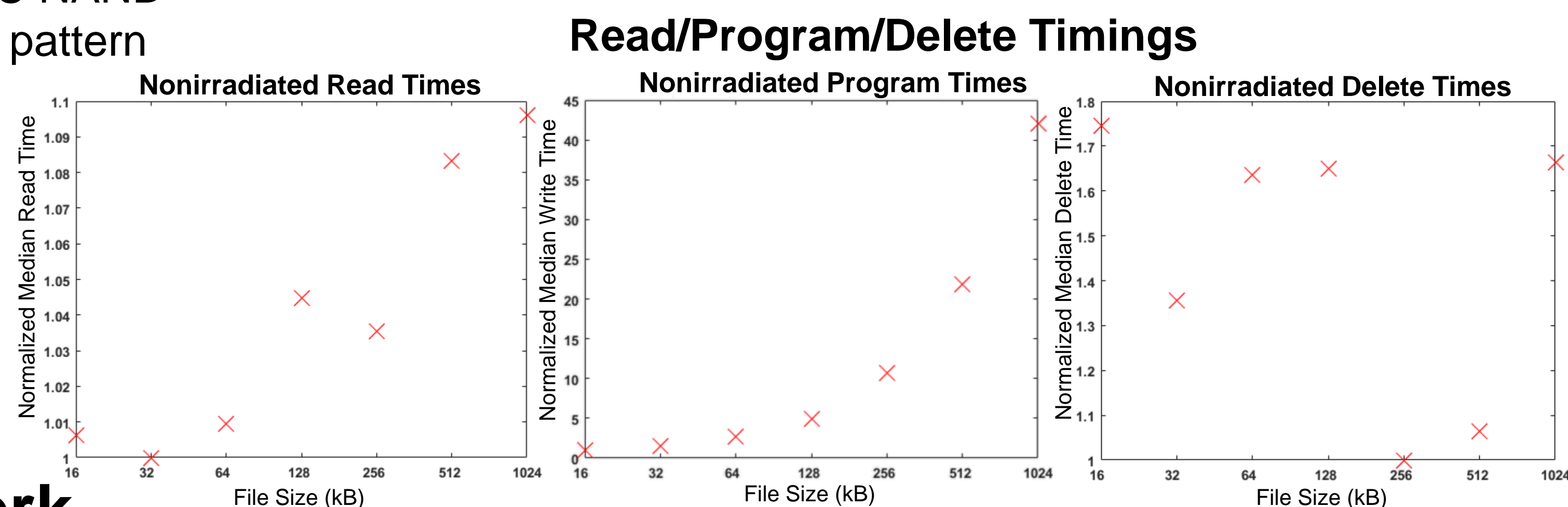
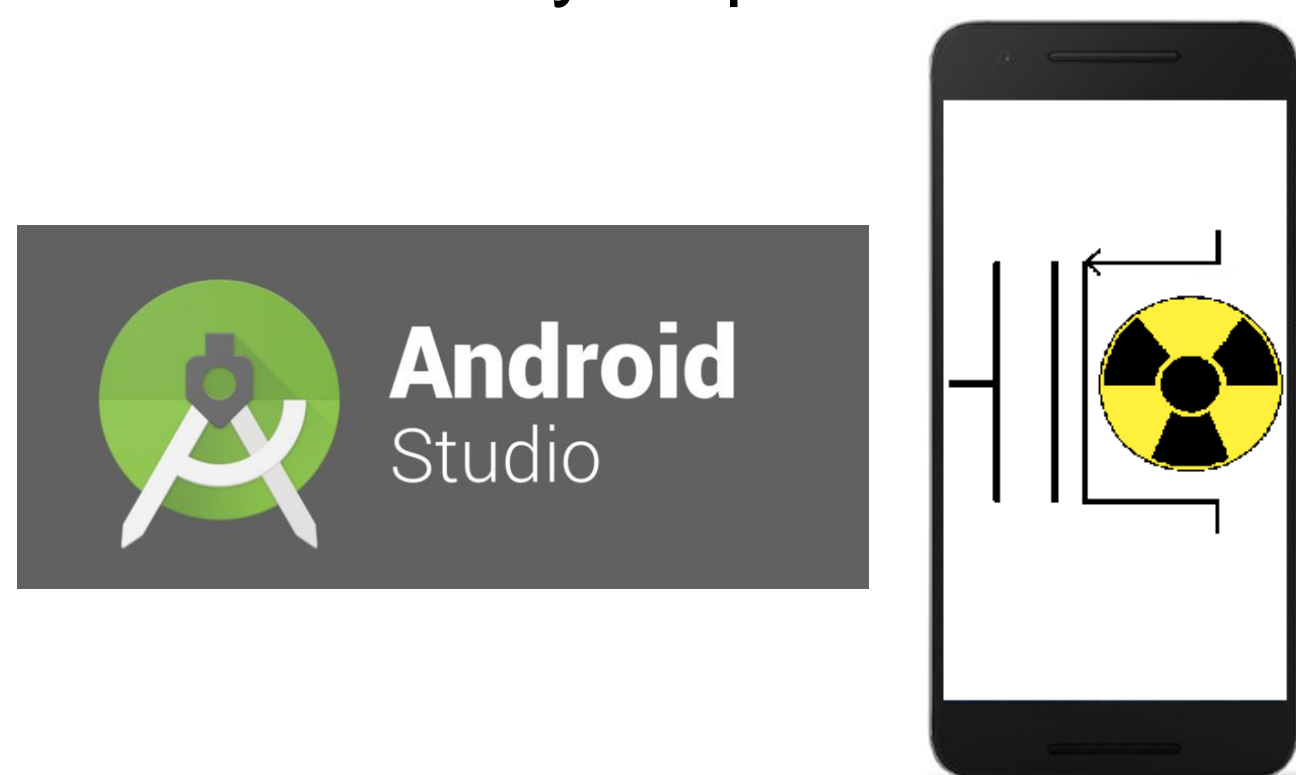
Bit Error Count

Experiment: Program a 64Gb MLC NAND Flash memory chip with all zero data pattern. Read the error bit count (or number of bit-flips) before and after X-Ray (70kV, 5min) exposure.



Timings Statistical Analysis

Experiment: Developed an Android App to program, read, and delete a 4Gb MLC NAND Flash memory chip with all zero data pattern



Conclusions/Future Work

Bit Error method is shown to detect radiation, and an algorithm can be developed to correlate number of flips to radiation dose with high fidelity.
 Timing method data is still being acquired, but the preliminary data is promising.

Acknowledgements

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