

SRAM DEVICES AND NEUTRONS

UTD, UD, and UT Austin Summer 2026 Research

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Mentors:

Dr. David Catlett and Dr. Will Flanagan

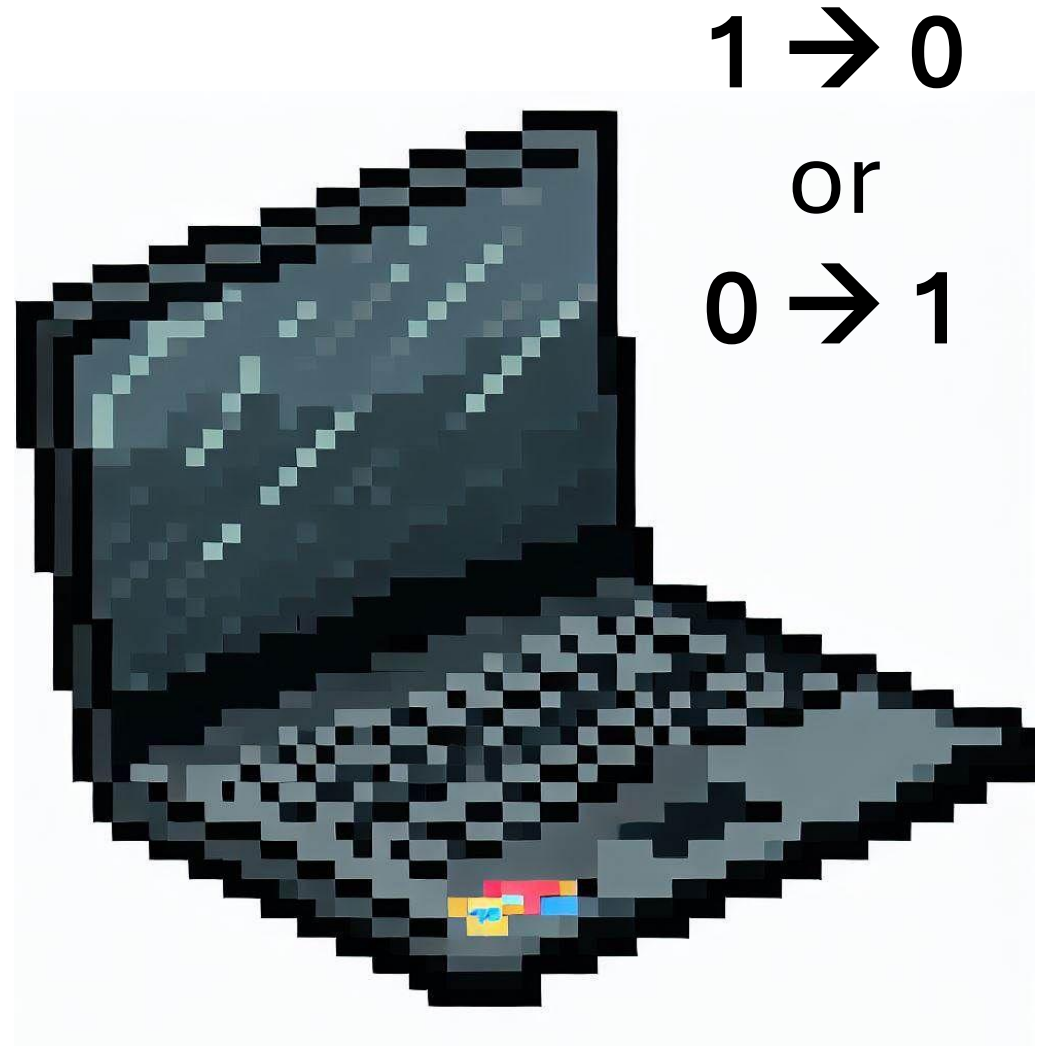
PROJECT ABSTRACT

- ❑ **Purpose:** To build on previous research on Neutron-Induced SEUs within SRAM devices.
- **UD** undergraduate research students.
- **UTD** undergraduate research students.
- **IMPROVING** the existing SEU-measuring device design.
- **EXPANDING** device capabilities.

INTRODUCTION

When a **NEUTRON** hits an electronic device, it can trigger a bit flip.

This is known as a **SINGLE EVENT UPSET (SEU)**.

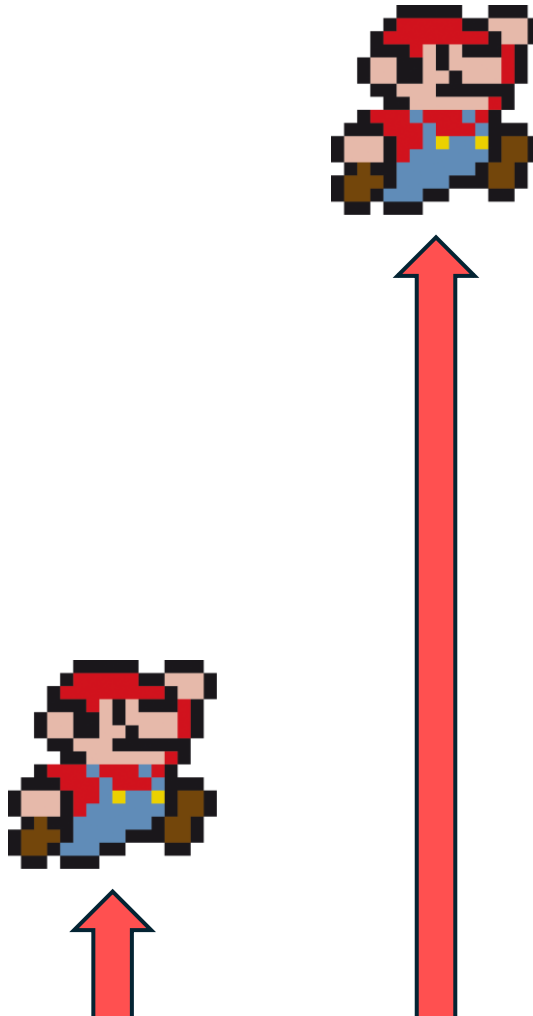


INTRODUCTION

Famous examples of this include...



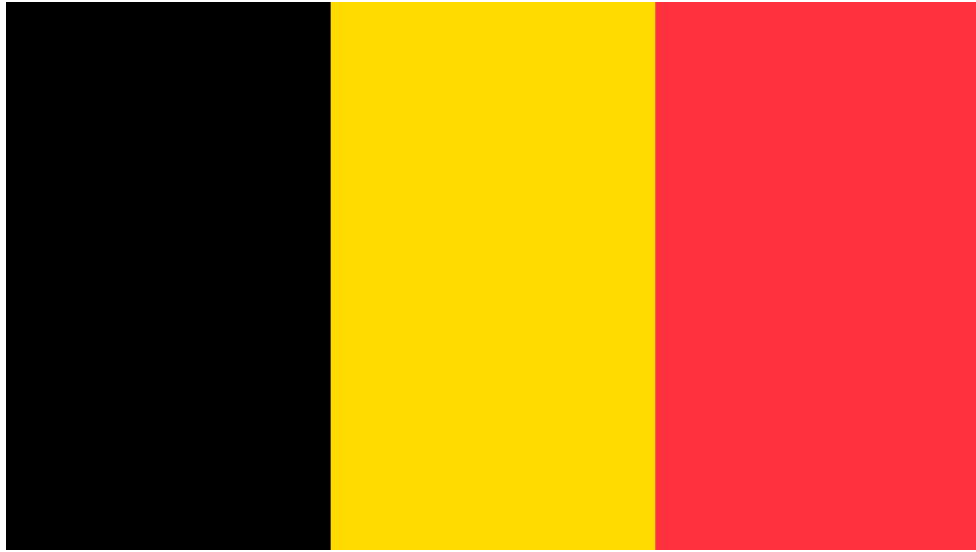
**Super Mario 64
Speedrun Glitch**



**It is believed
that this
glitch was
caused by an
SEU.**

INTRODUCTION

Famous examples of this include...



**2003 Belgium
Election Voting
Machine Glitch**

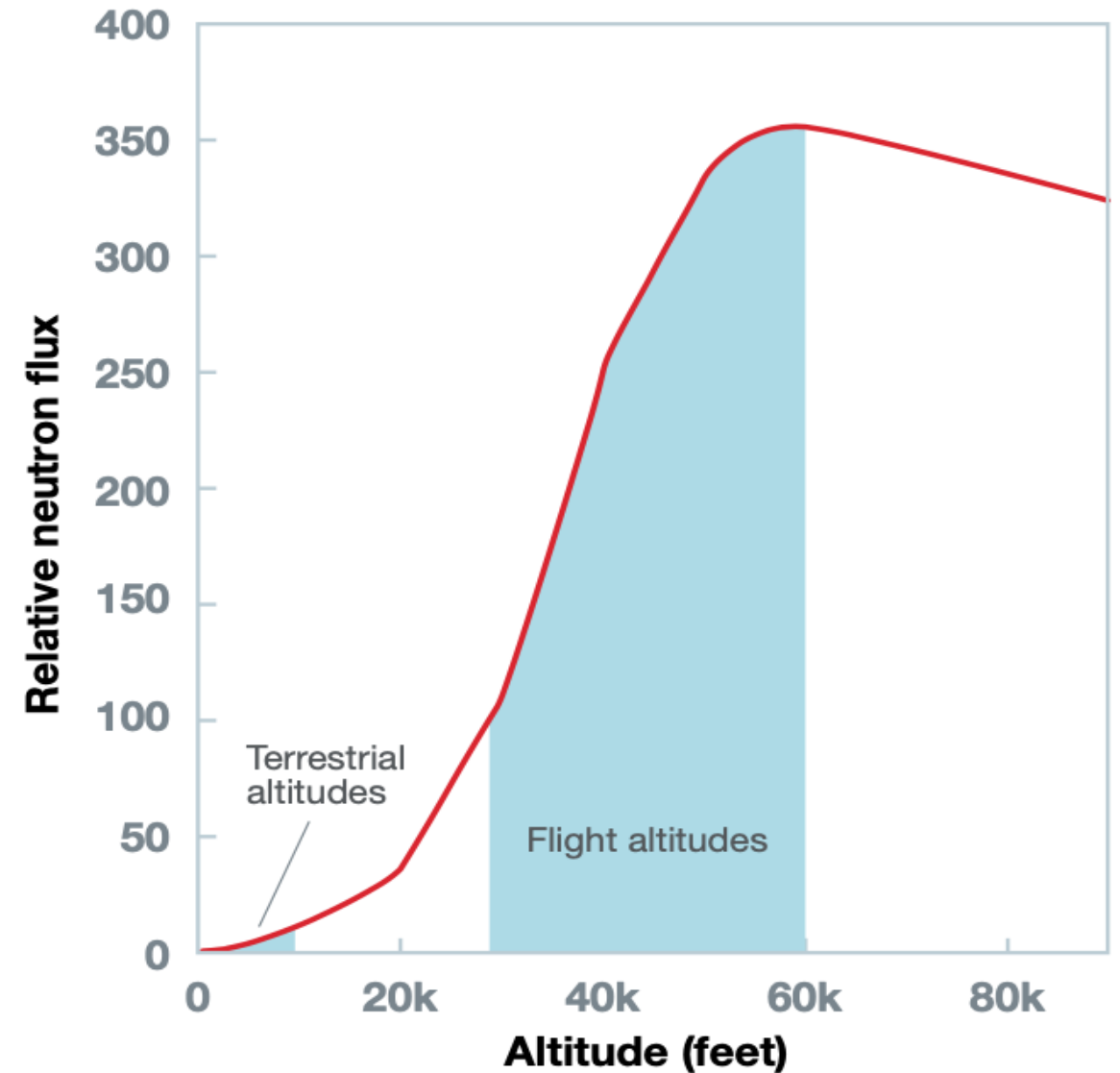
4096 Extra Votes!



INTRODUCTION

Neutrons make up a good portion of atmospheric radiation.

Aircraft software is at an even greater risk of experiencing SEUs.



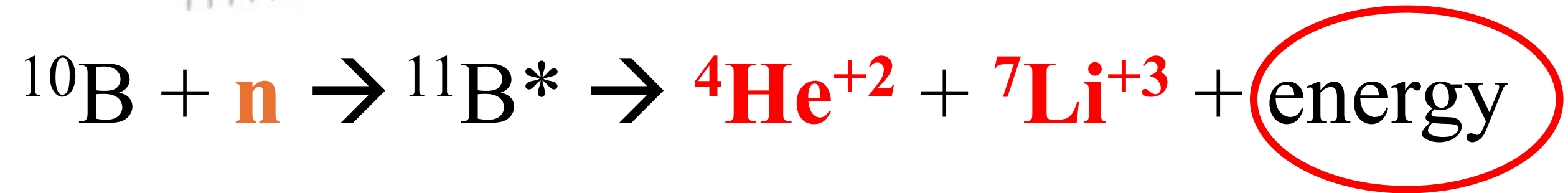
RESEARCH FOCUS

This research focuses on SRAM devices:

*Thermal Neutron Capture by **Boron-10***



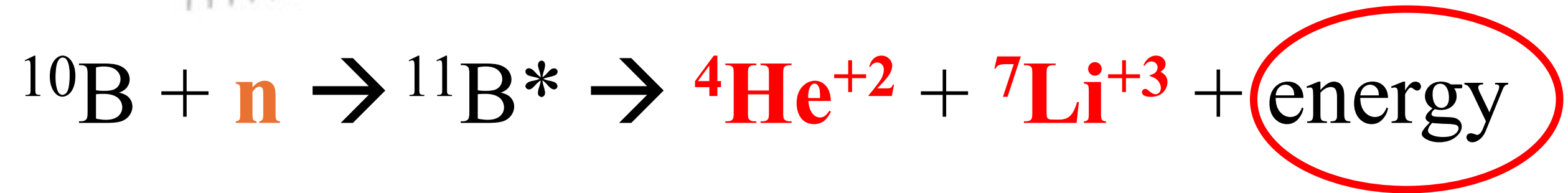
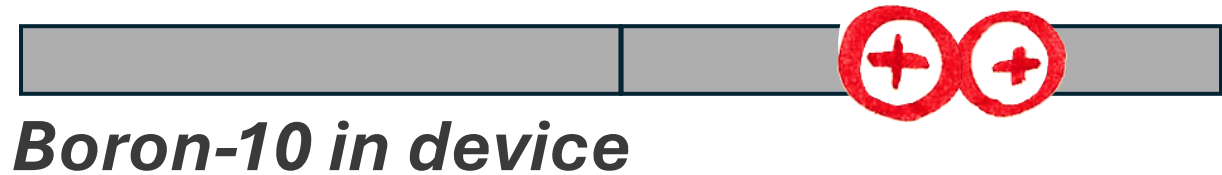
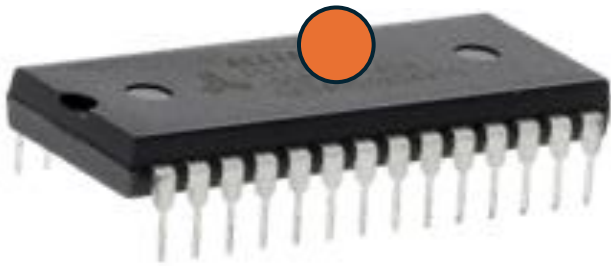
Boron-10 in device



RESEARCH FOCUS

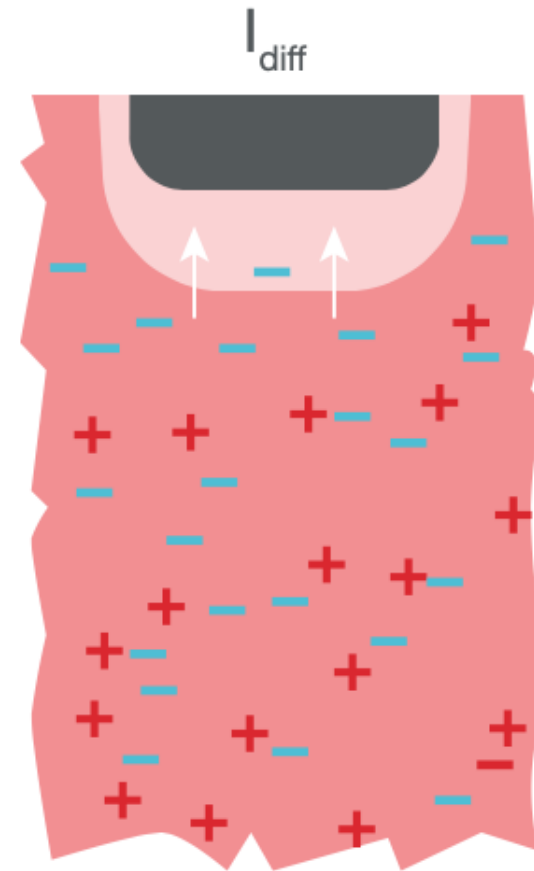
This research focuses on SRAM devices:

*Thermal Neutron Capture by **Boron-10***



RESEARCH FOCUS

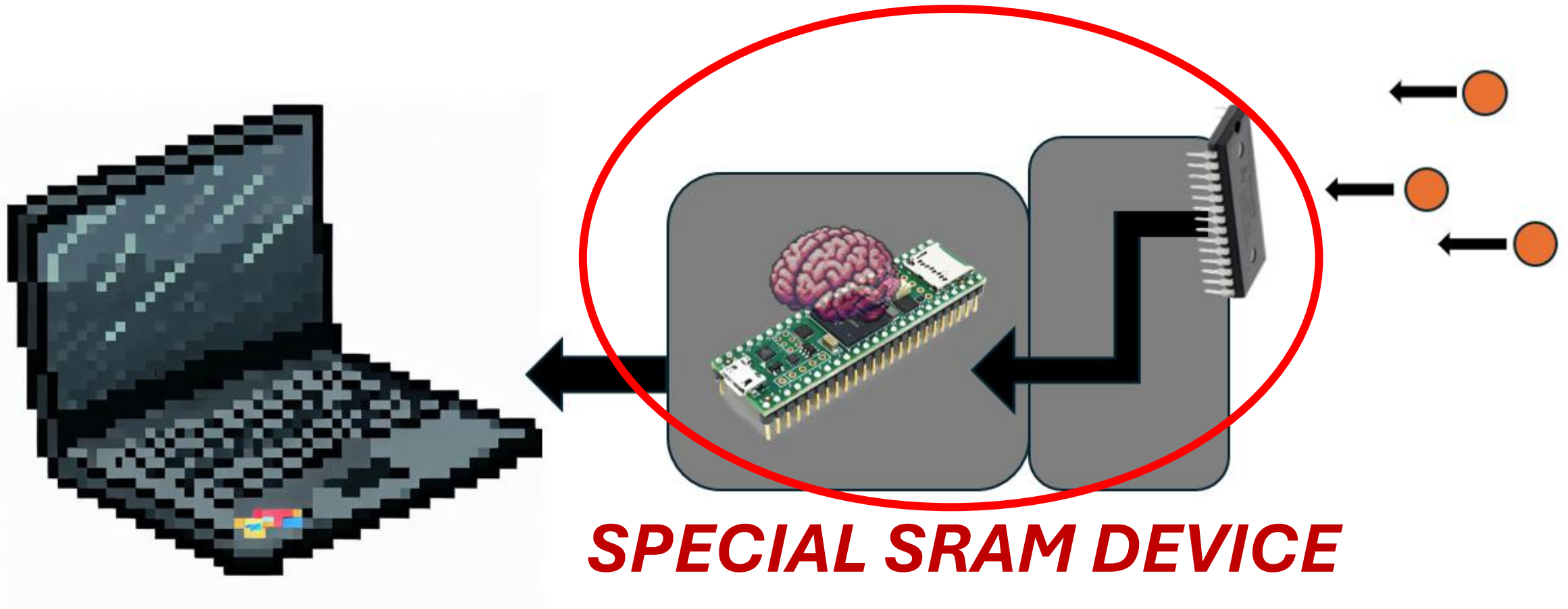
1. The ion strips electrons off the silicon atoms.
2. The voltage pulls the $(-)$ up and the $(+)$ down.
3. If the transient current pulse exceeds (Q_{crit}), it can trigger a change in the V_{node} .
4. Which causes an SEU.



c. Diffusion charge collection

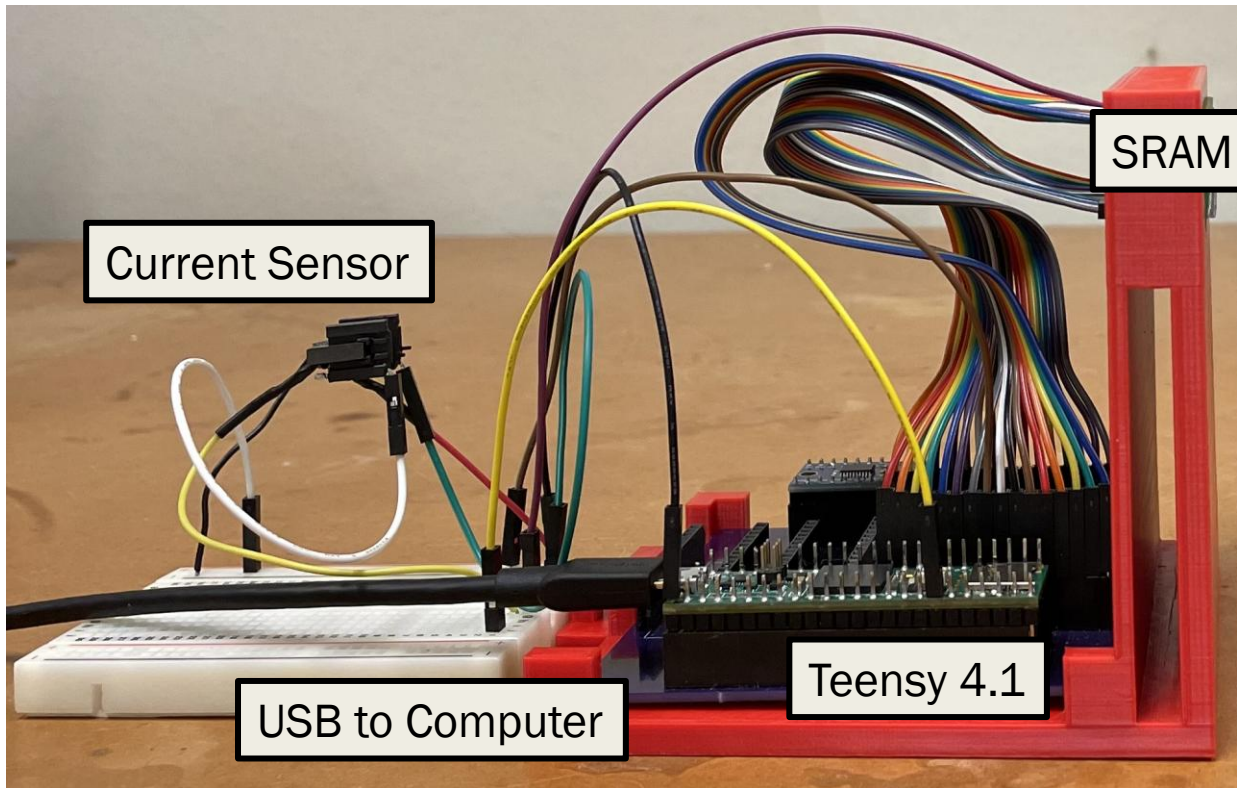
RESEARCH CONCEPT

The concept of this project:

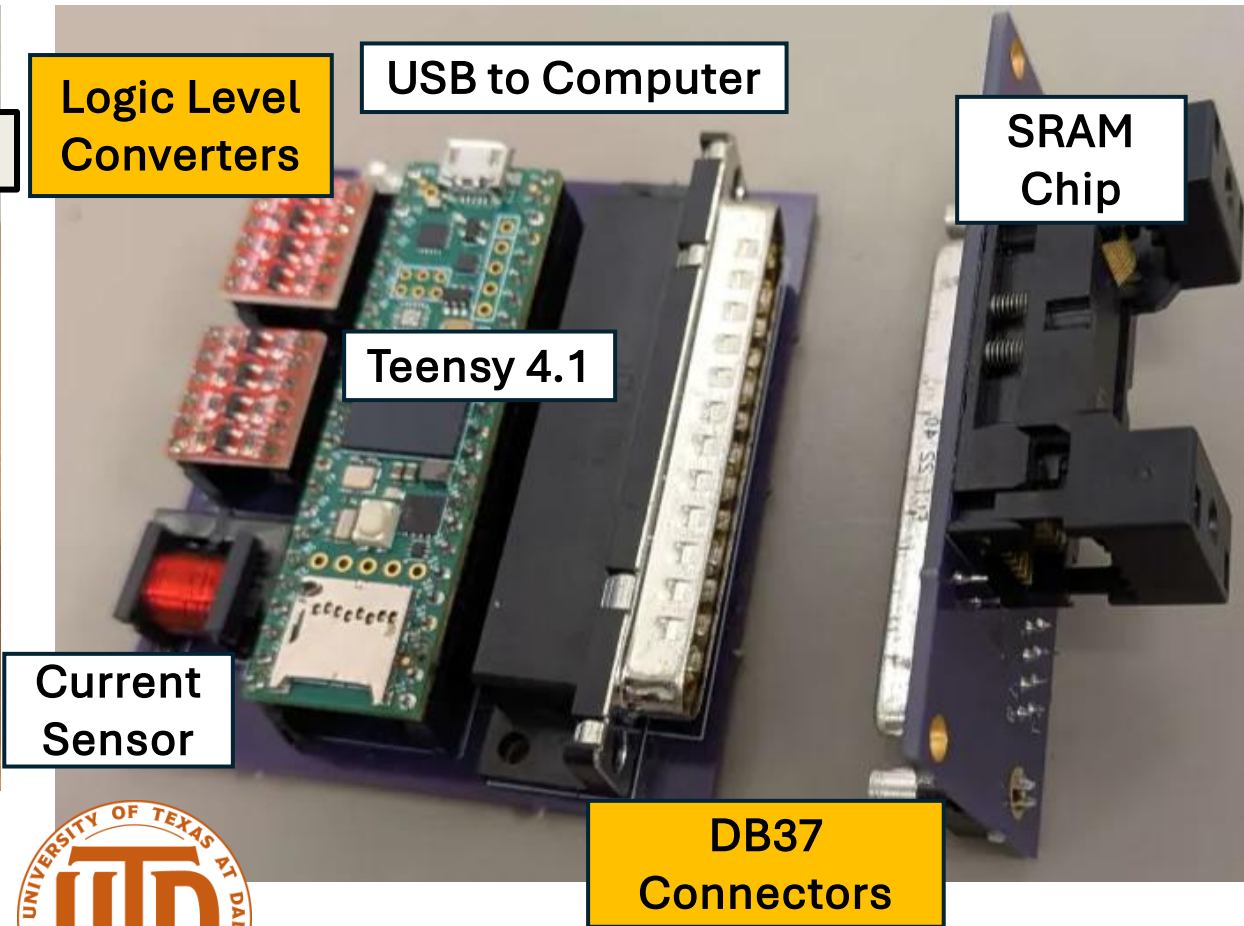


PREVIOUS RESEARCH

Summer 2023:

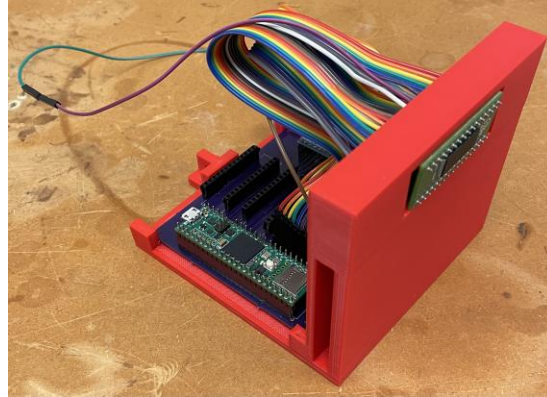


Fall 2023:

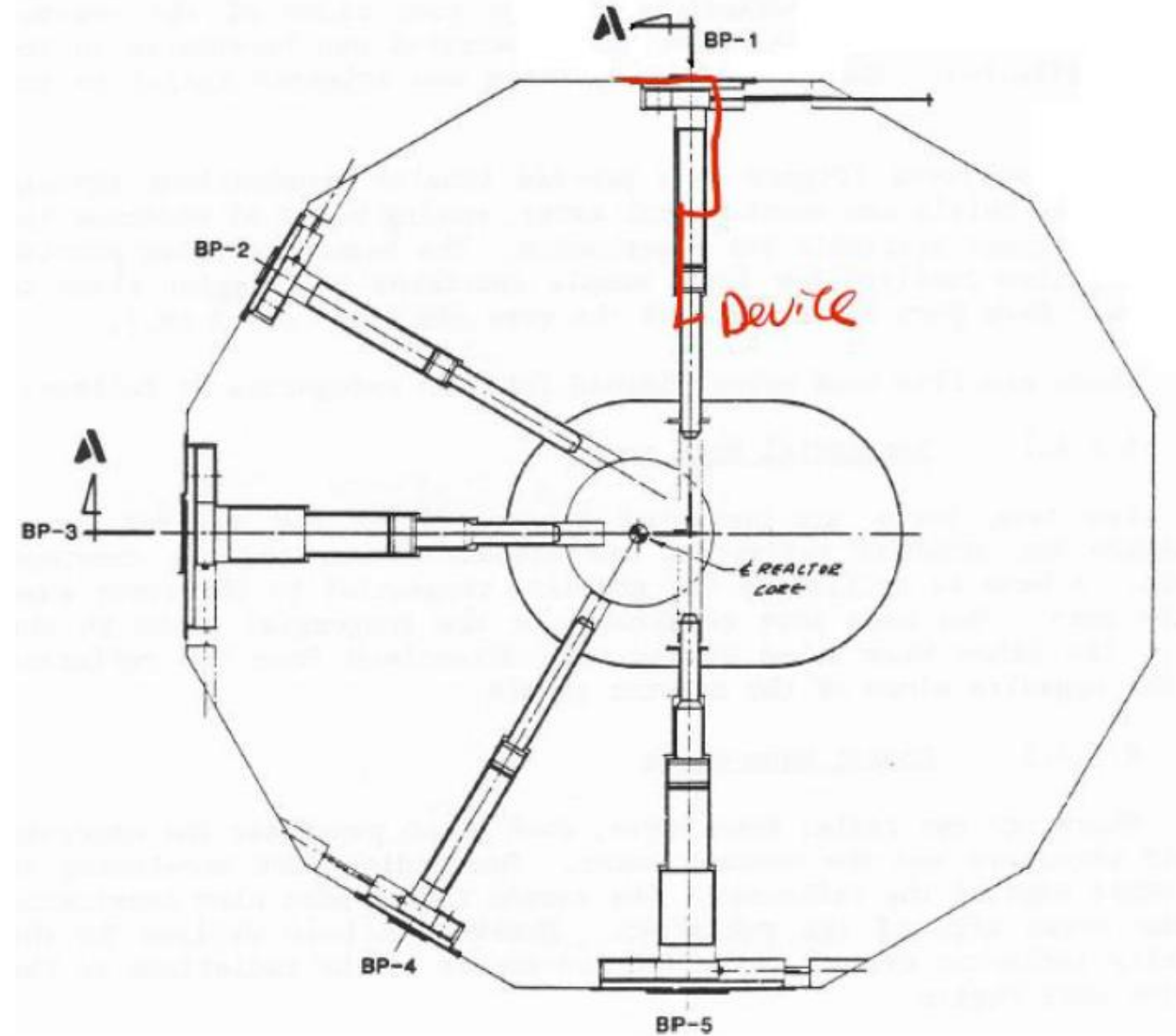
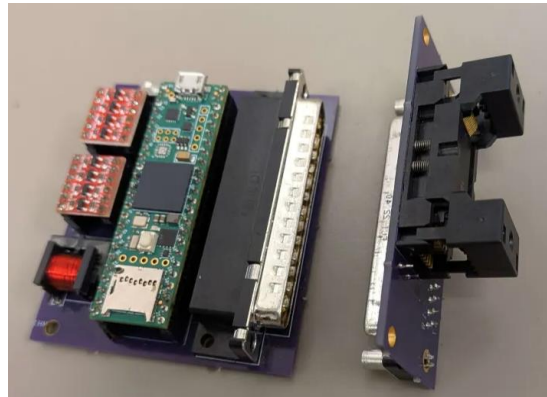


PREVIOUS RESEARCH

Summer
2023

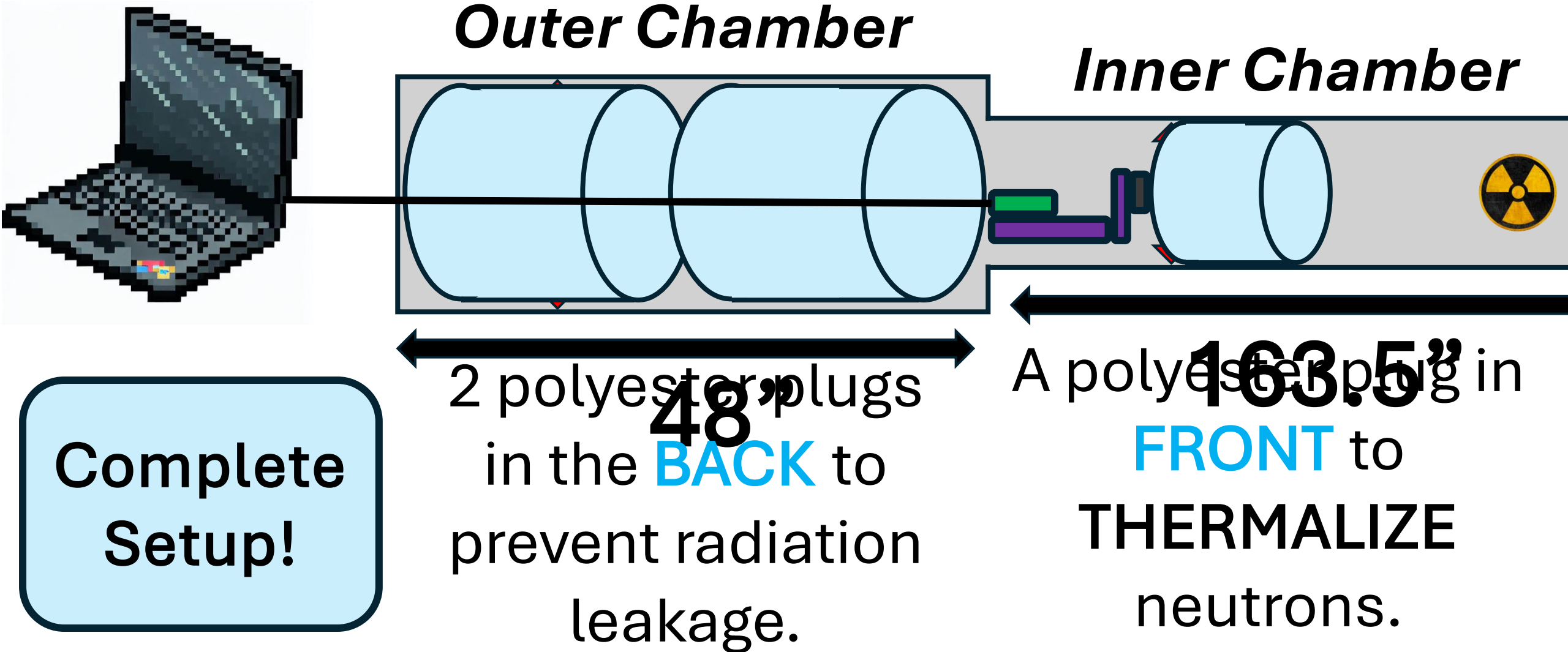


Fall 2023

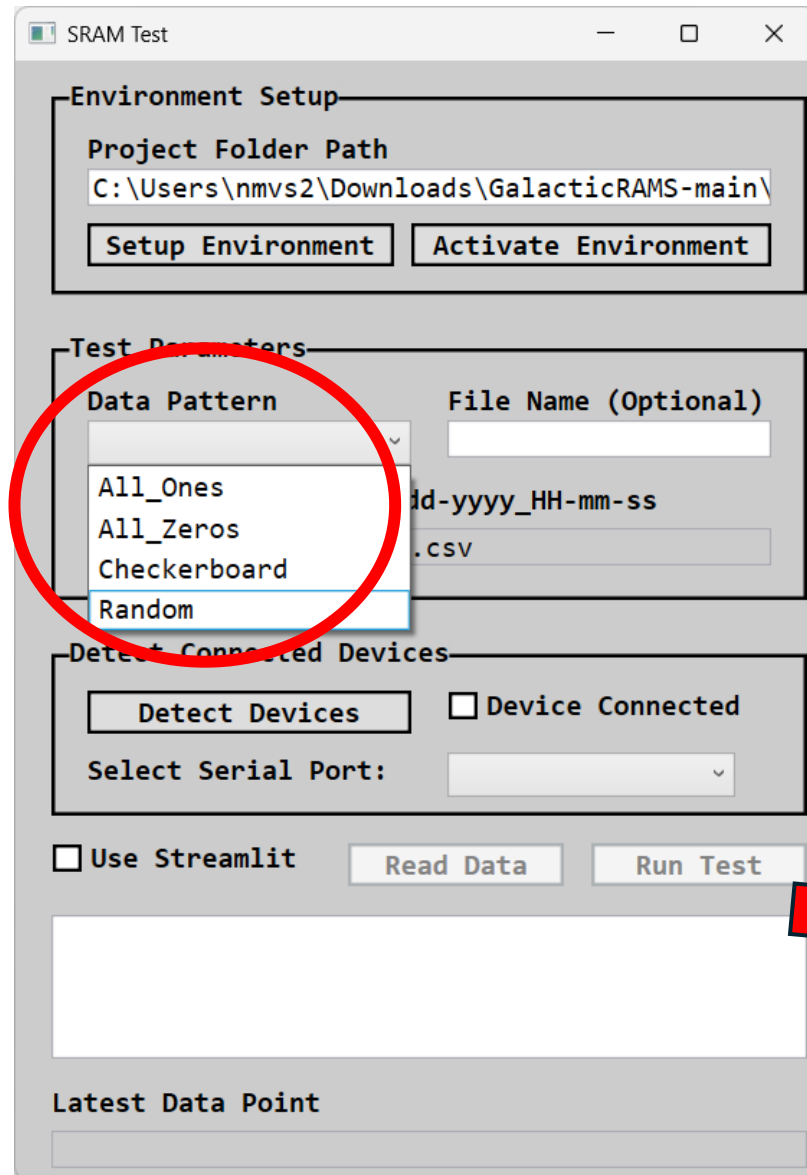


AT AUSTIN

PREVIOUS RESEARCH

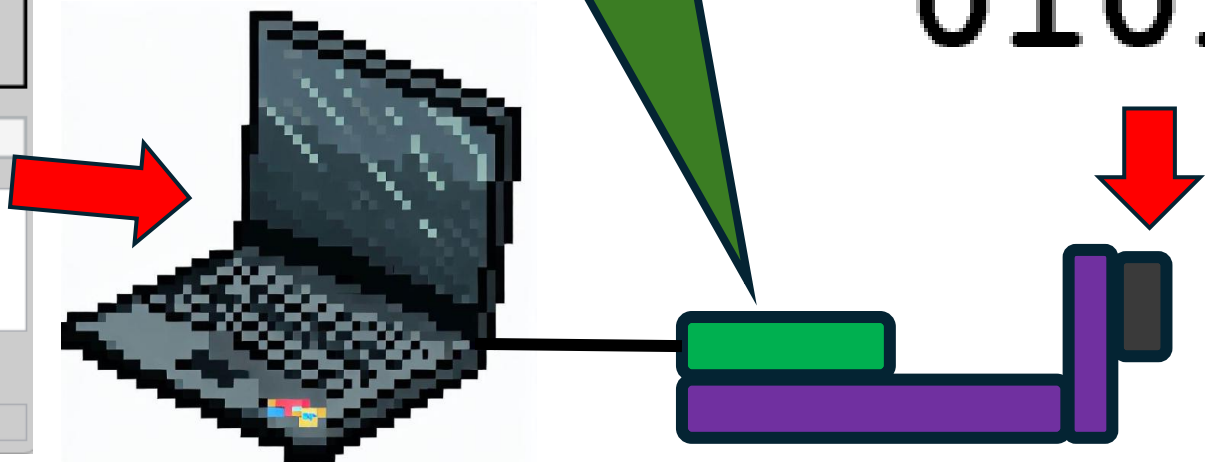


PREVIOUS RESEARCH



**ERRORS
RECORDED**

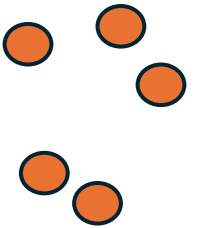
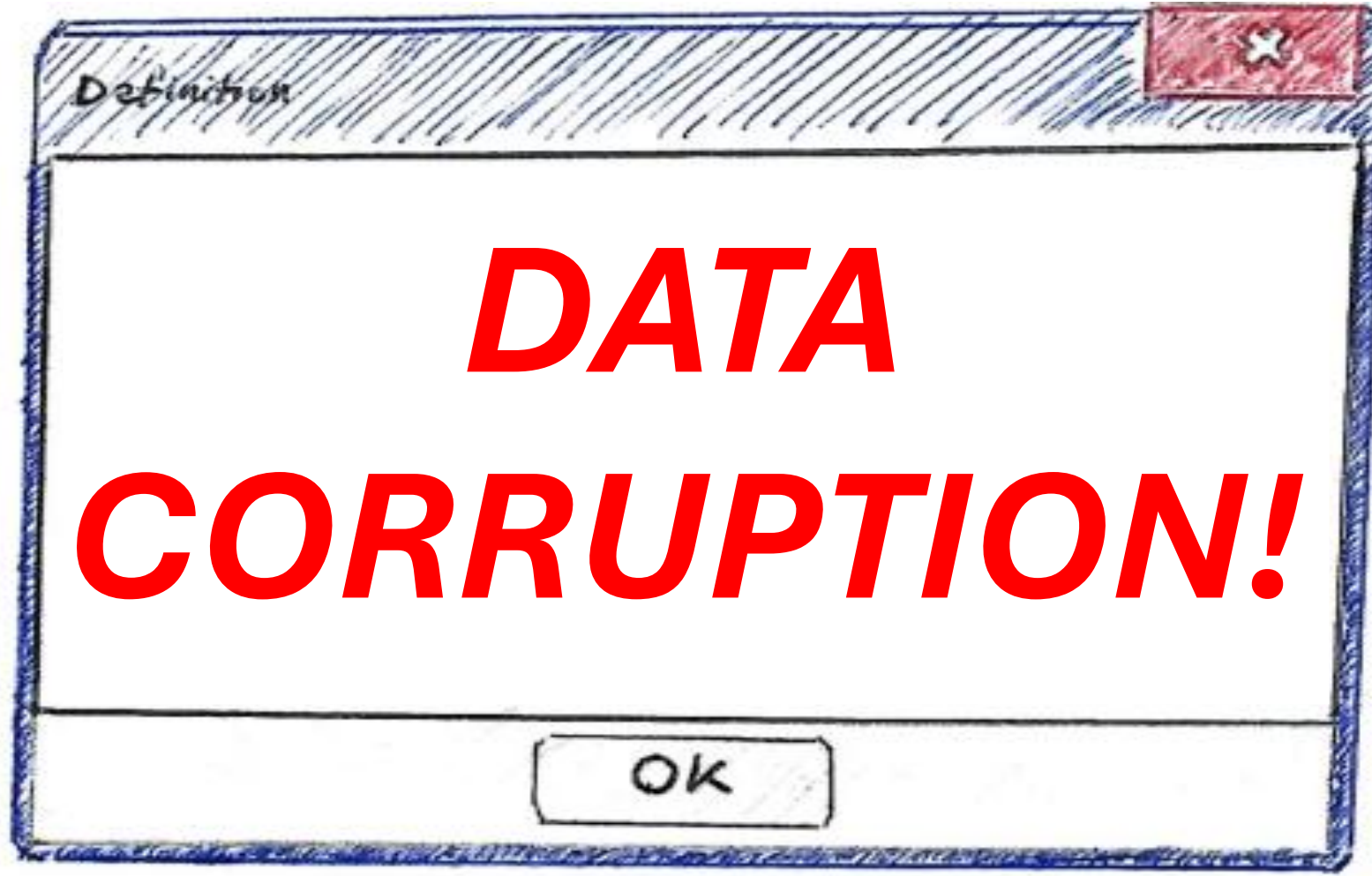
01010101
01010101
01010101
01010101



PREVIOUS RESEARCH

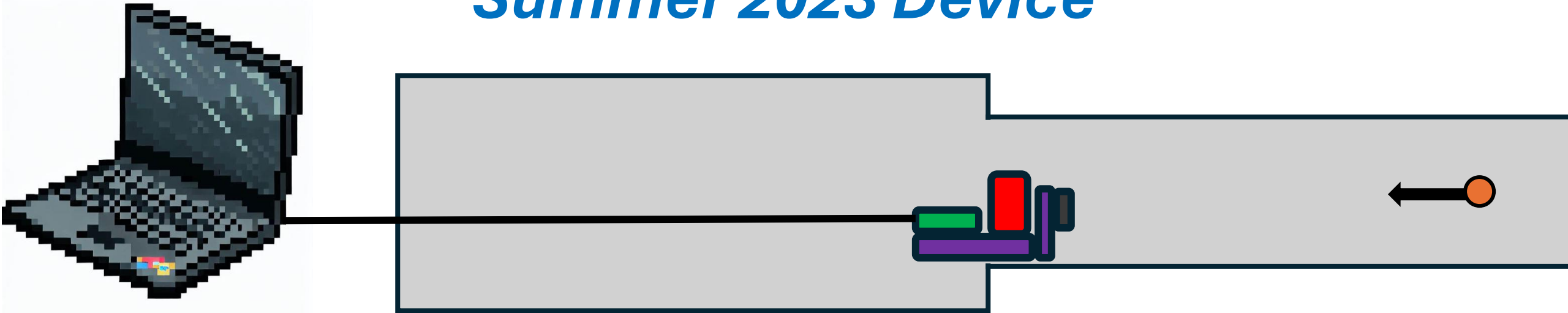


The neut
NOT the

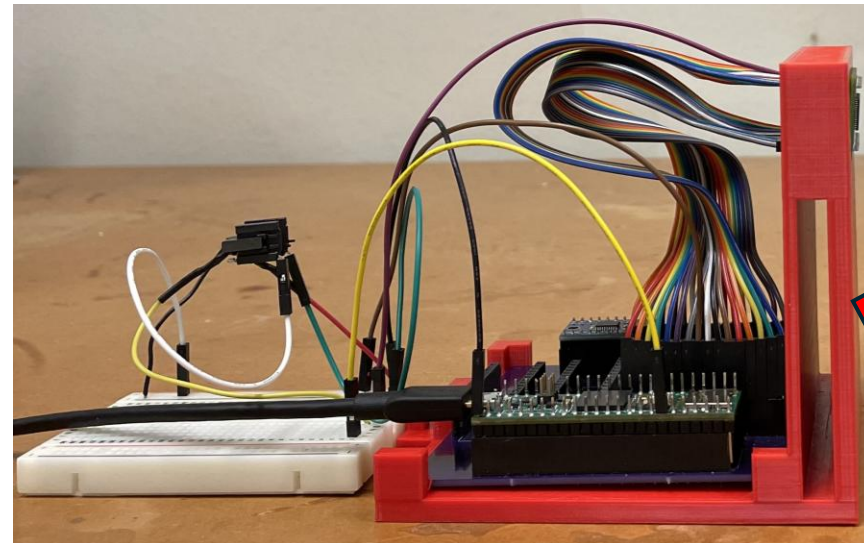


PREVIOUS RESEARCH

Summer 2023 Device



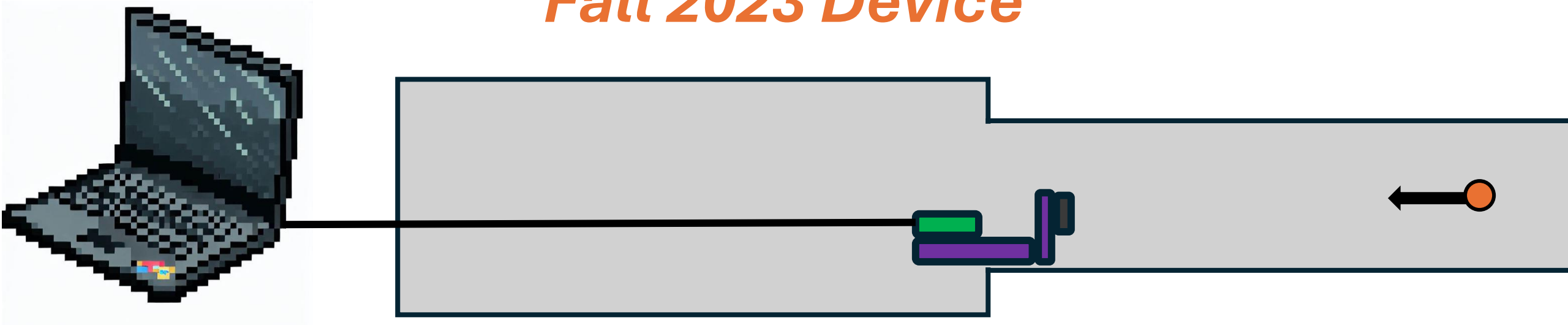
This device used a
Boron Carbide
SHIELD.



UNIVERSITY
of DALLAS

PREVIOUS RESEARCH

Fall 2023 Device



PREVIOUS RESEARCH

Fall 2023 Device



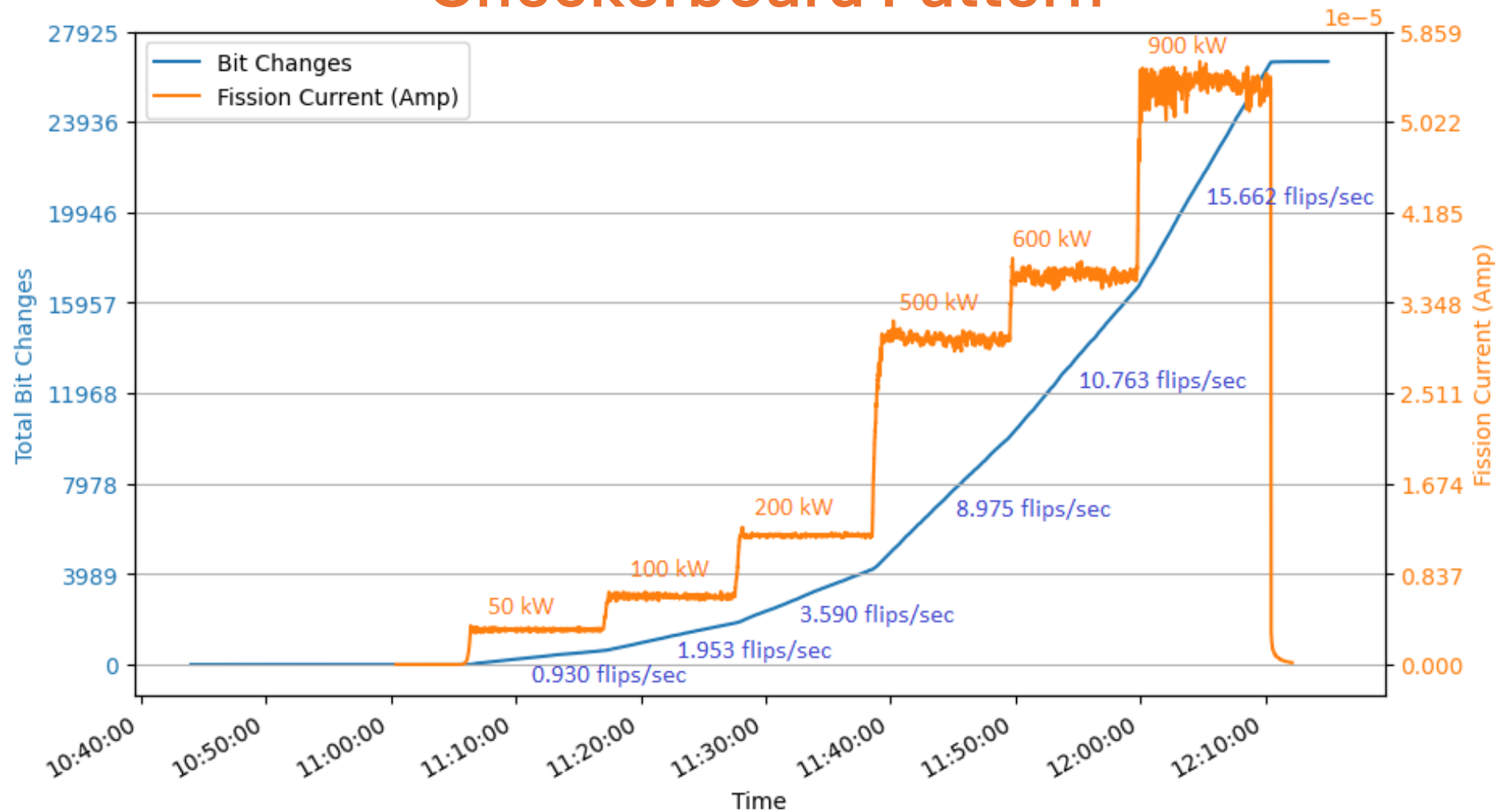
radiation
falls out
at $1/r^2$



6-ft long **DB-37 cable** to
maximize the distance.

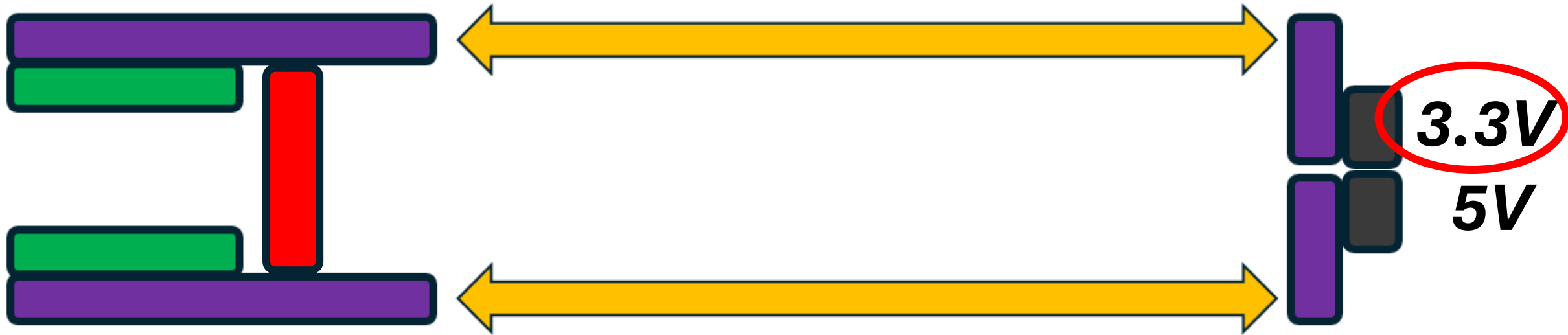
PREVIOUS RESEARCH

Commercially Available 5V SRAM with Checkerboard Pattern



SUMMER 2026 DEVICE EXPANSIONS

Project Expansion: testing 2 different SRAMs at once.

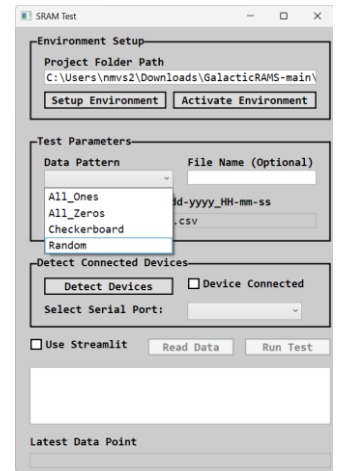
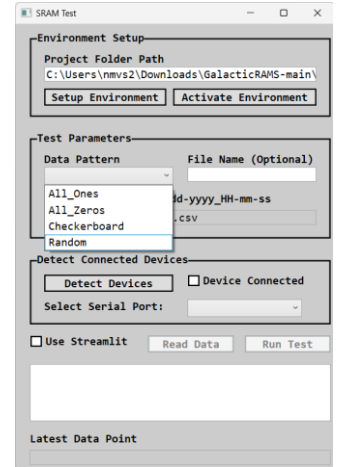


Radiation shielding:
Boron Carbide

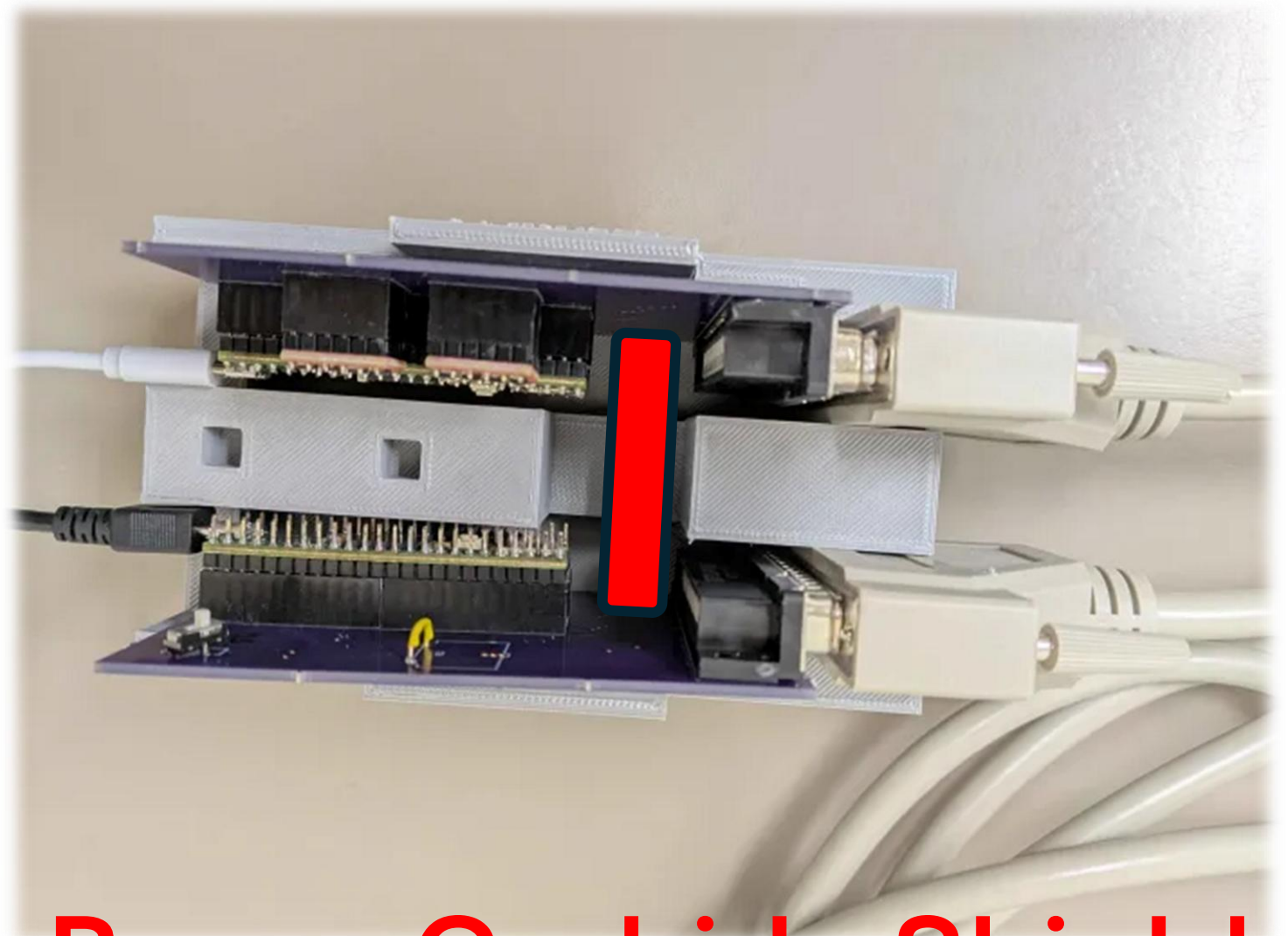
DB-37 Cable



SUMMER 2026 DEVICE EXPANSIONS



HARDWARE EXPANSIONS



Boron Carbide Shield

SOFTWARE EXPANSIONS

oooooooo
oooooooo
oooooooo
oooooooo

Write All 0's

Read x 10



Write

Checkerboard

Read x 10



Write ALL 1's

Read x 10



Repeat loop



All patterns
tested
automatically for
both SRAMs.



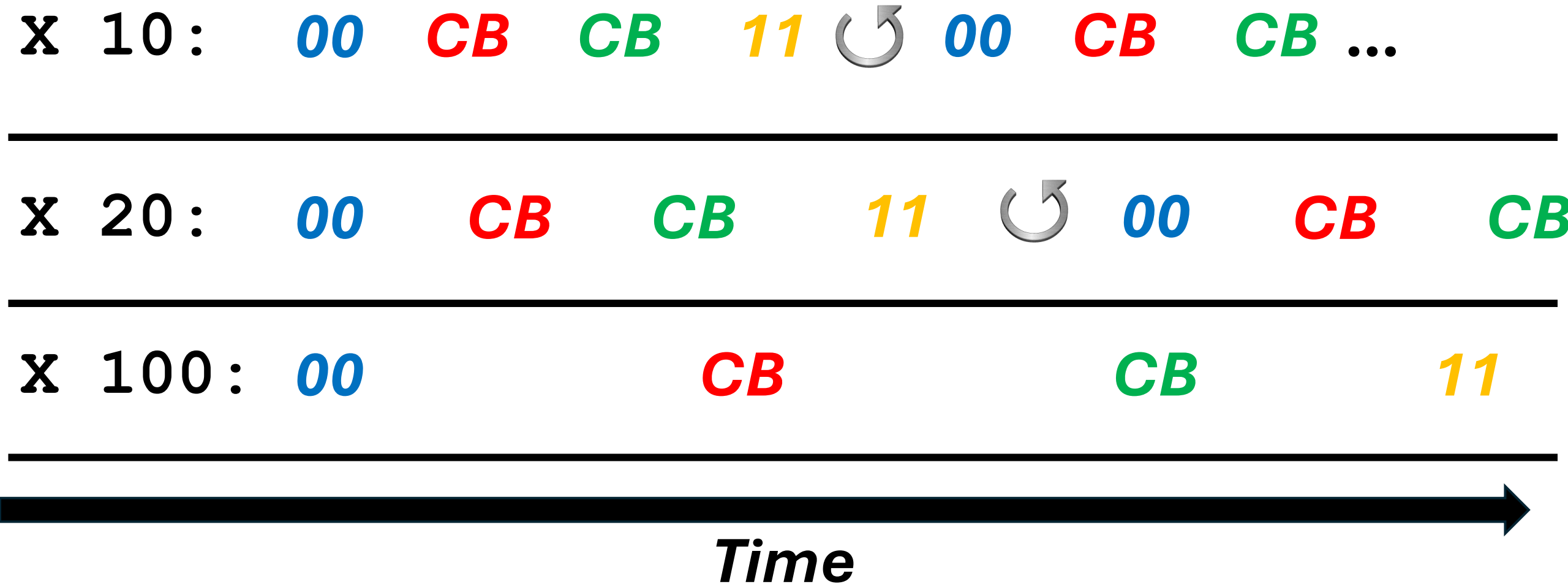
SOFTWARE EXPANSIONS

The “read” duration is VARIABLE.

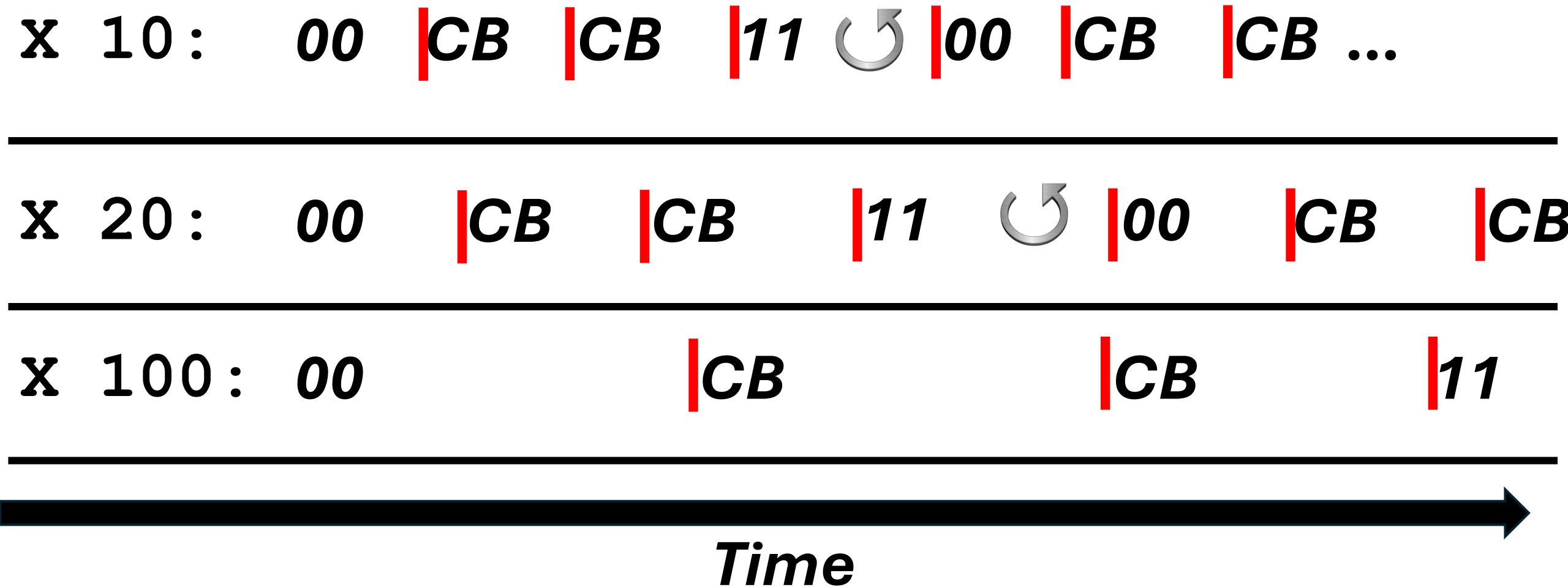
- Read x 10
- Read x 20
- Read x 100

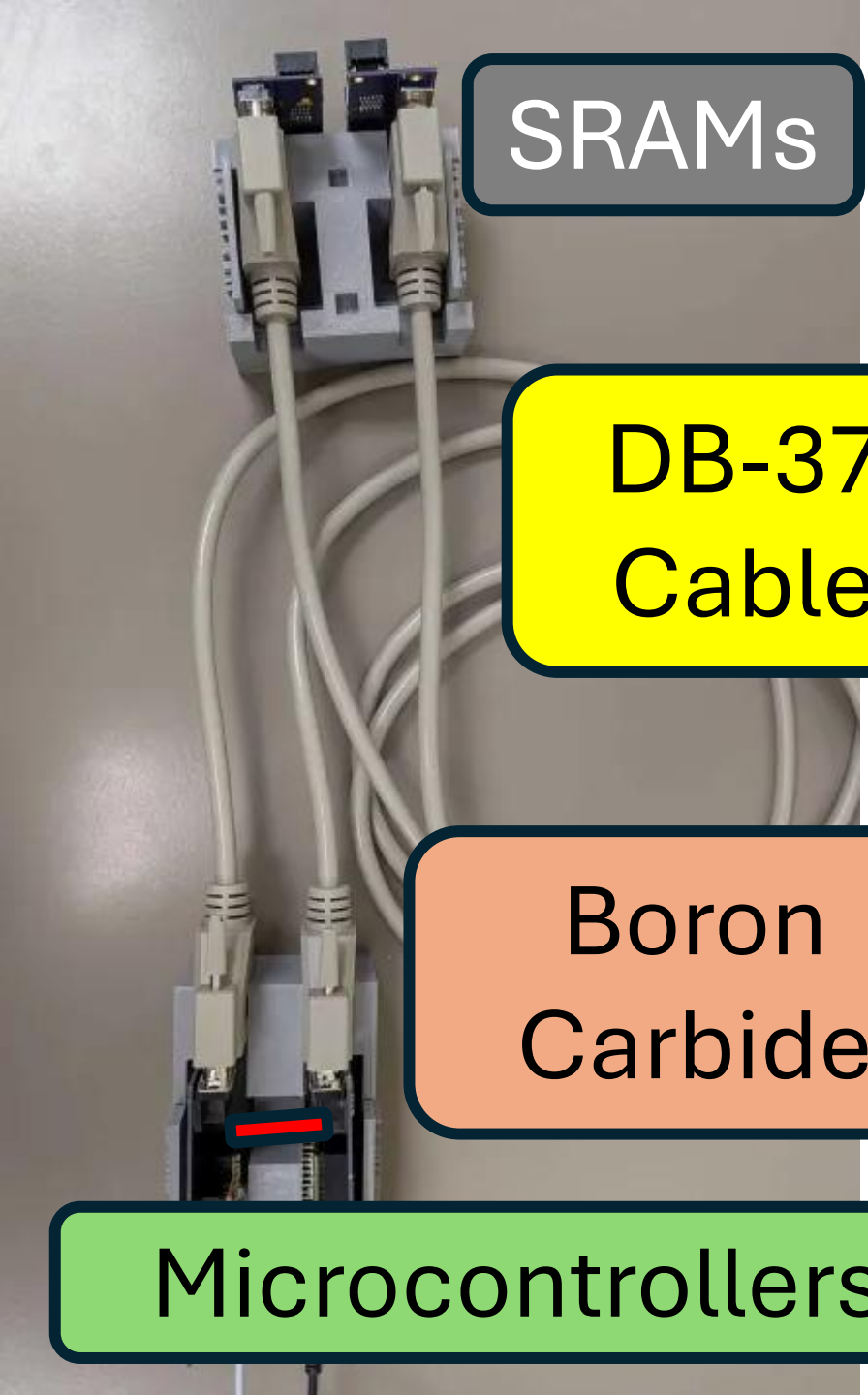


SOFTWARE EXPANSIONS



SOFTWARE EXPANSIONS





SRAMs

DB-37
Cable

Boron
Carbide

Microcontrollers

SUMMER 2026 DEVICE

IMPROVED the existing SEU-measuring device design:

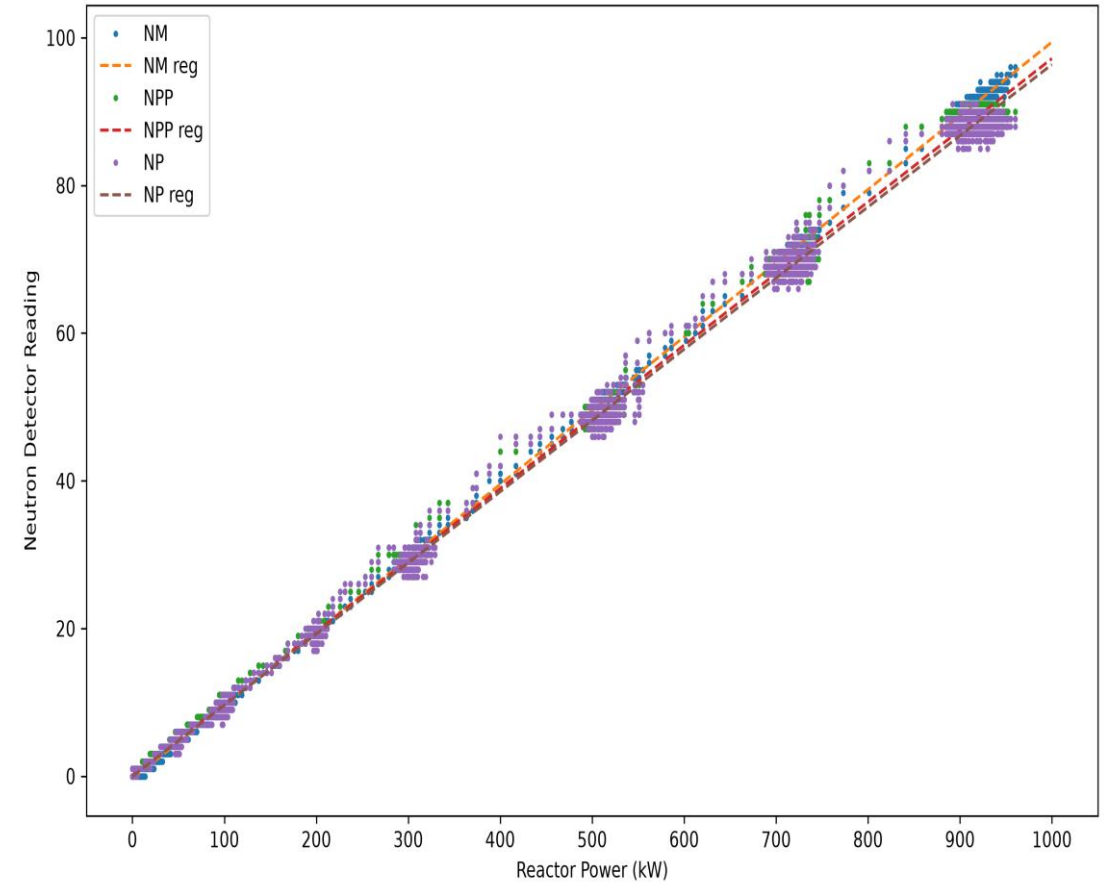
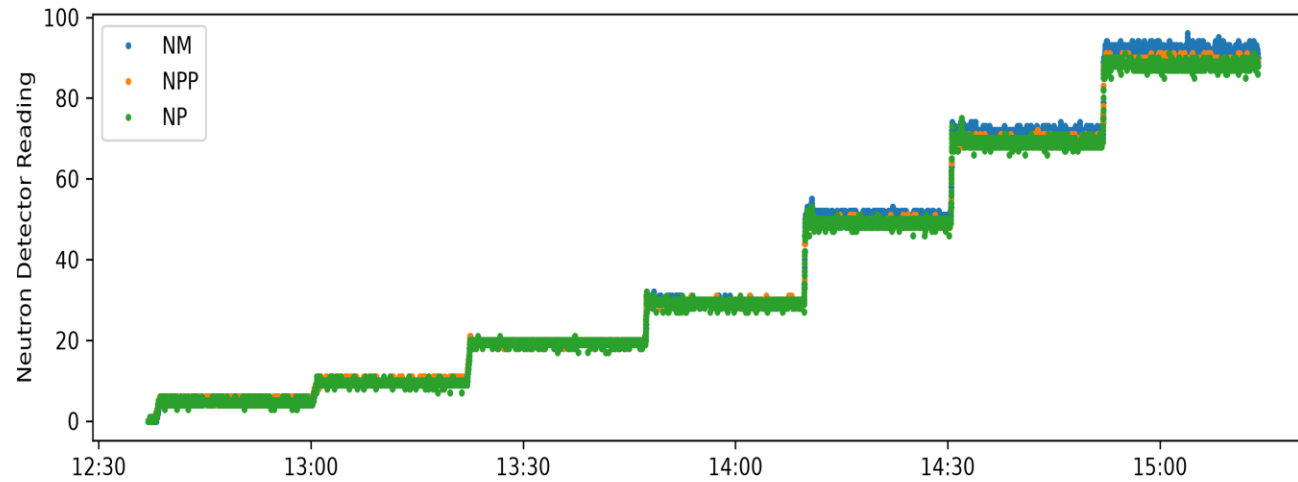
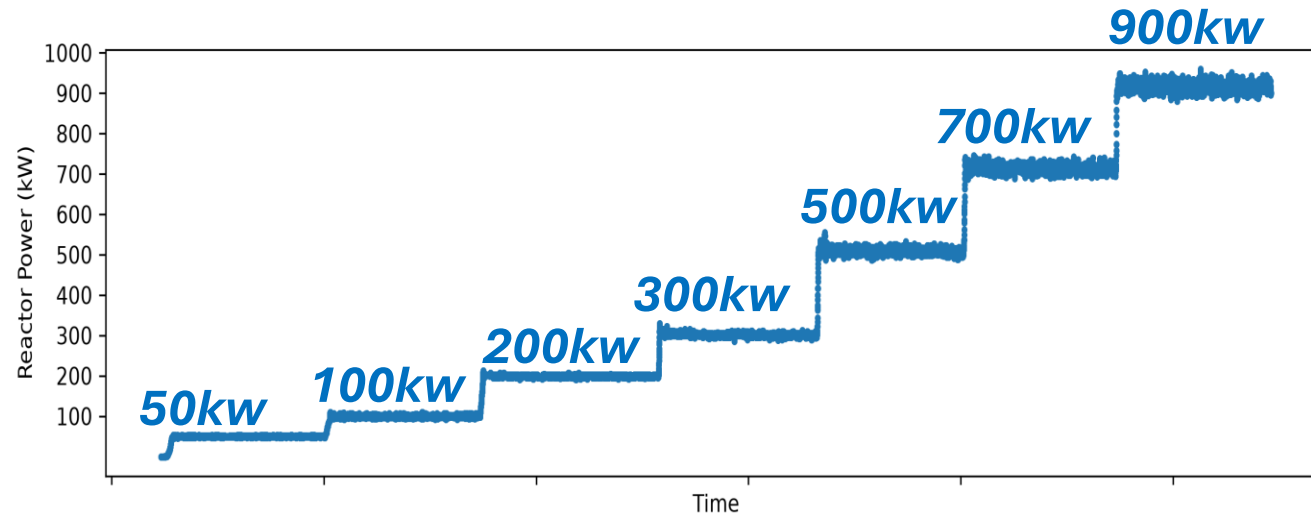
- Streamlined hardware.
- Better radiation shielding.

EXPANDED device capabilities:

- Tested multiple **chips**.
- Tested multiple **data patterns**.

SUMMER 2026 DATA

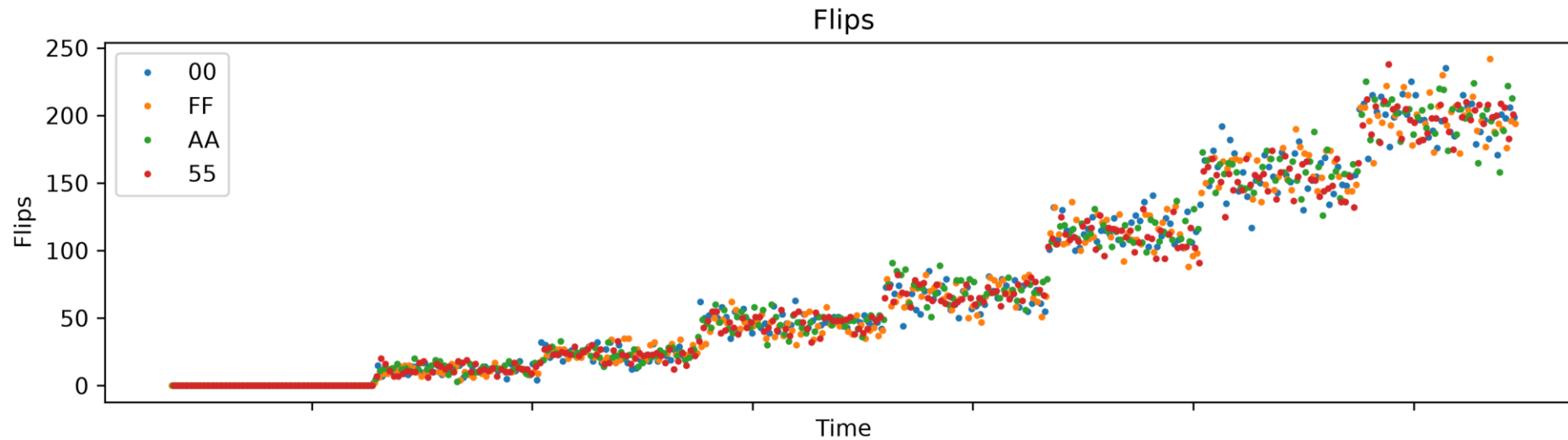
Reactor Power Graphs!



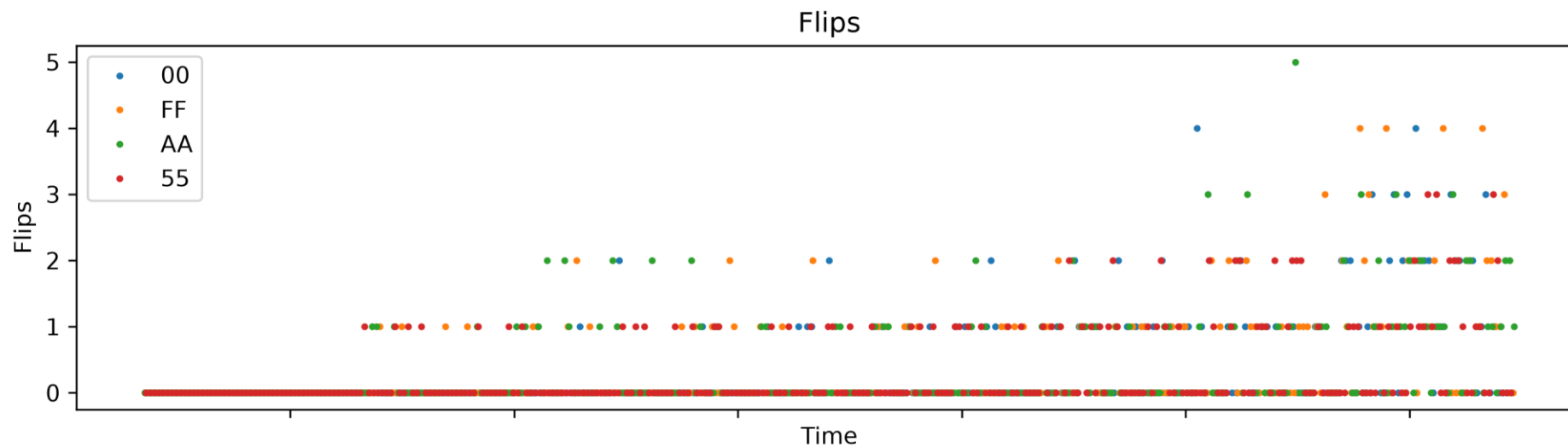
Neutron flux is proportional to reactor power.

SUMMER 2026 DATA

**SRAM SEU
Graphs!**



**5V
SRAM**

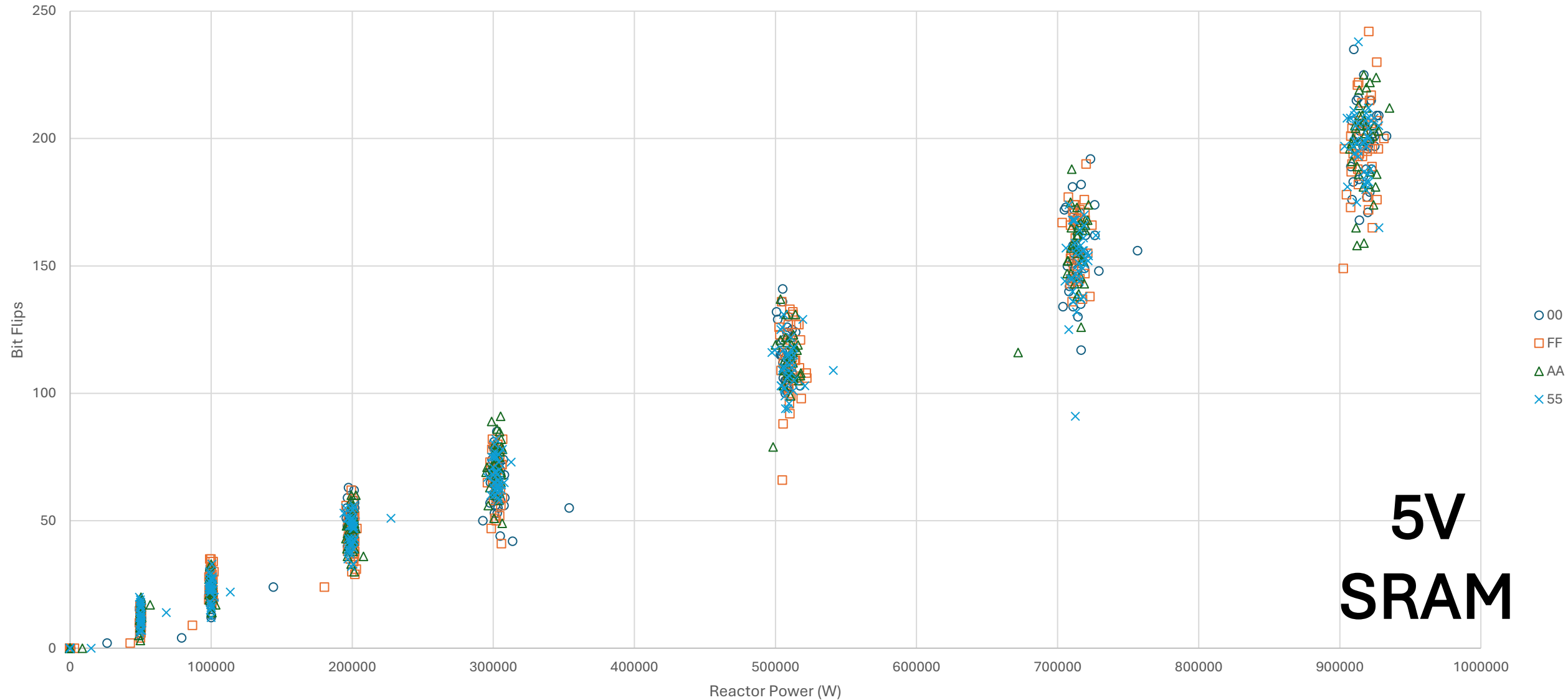


**3.3V
SRAM**

SUMMER 2026 DATA

Data Pattern
Differences!

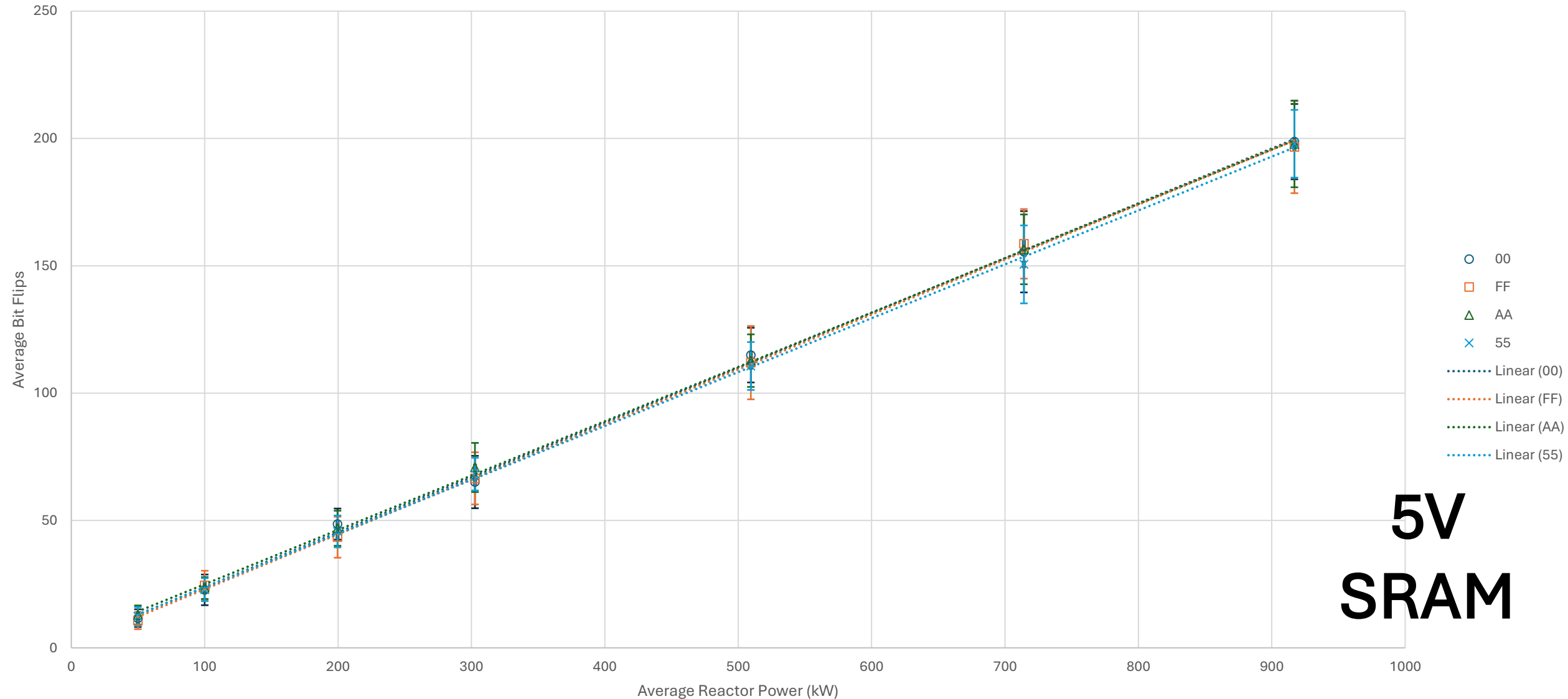
Total Bit Flips vs Reactor Power



SUMMER 2026 DATA

Data Pattern Differences!

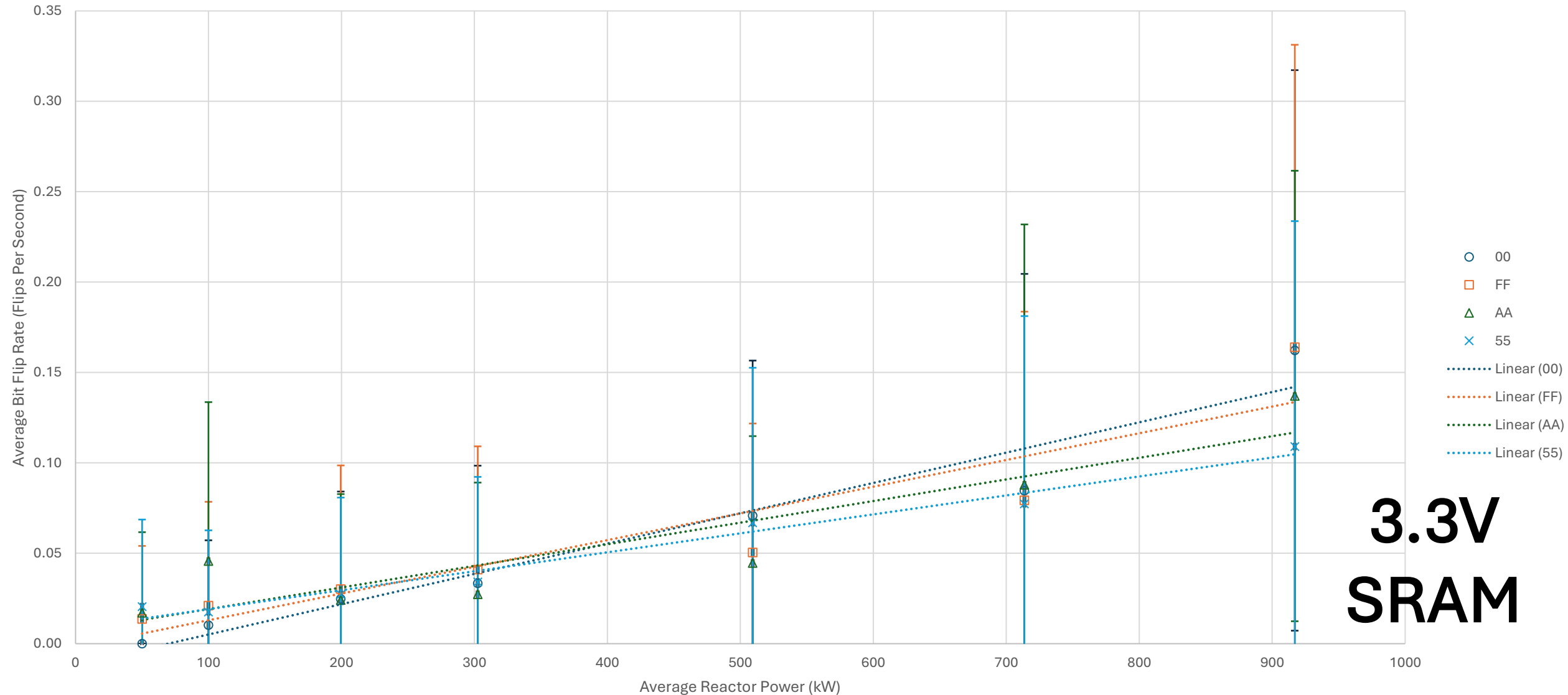
Bit Flips vs Reactor Power



SUMMER 2026 DATA

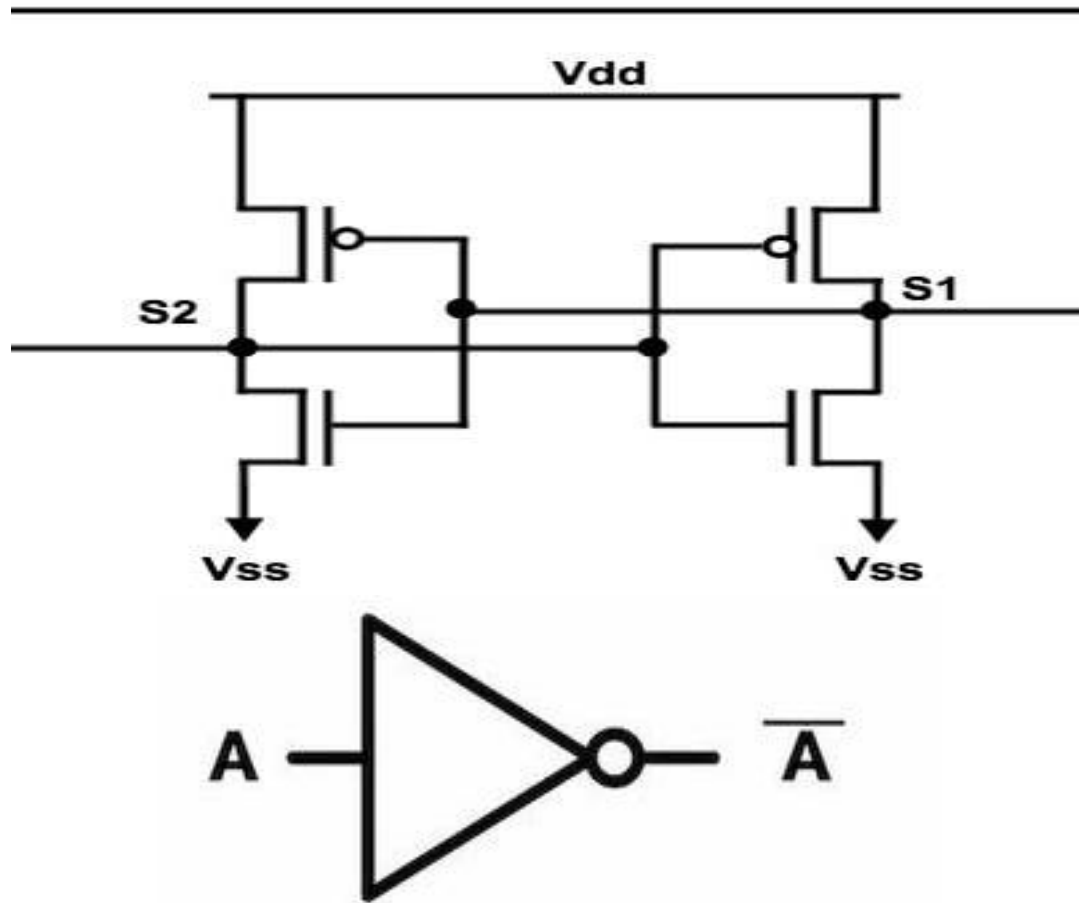
Data Pattern Differences!

Bit Flip Rate vs Reactor Power



SUMMER 2026 DATA

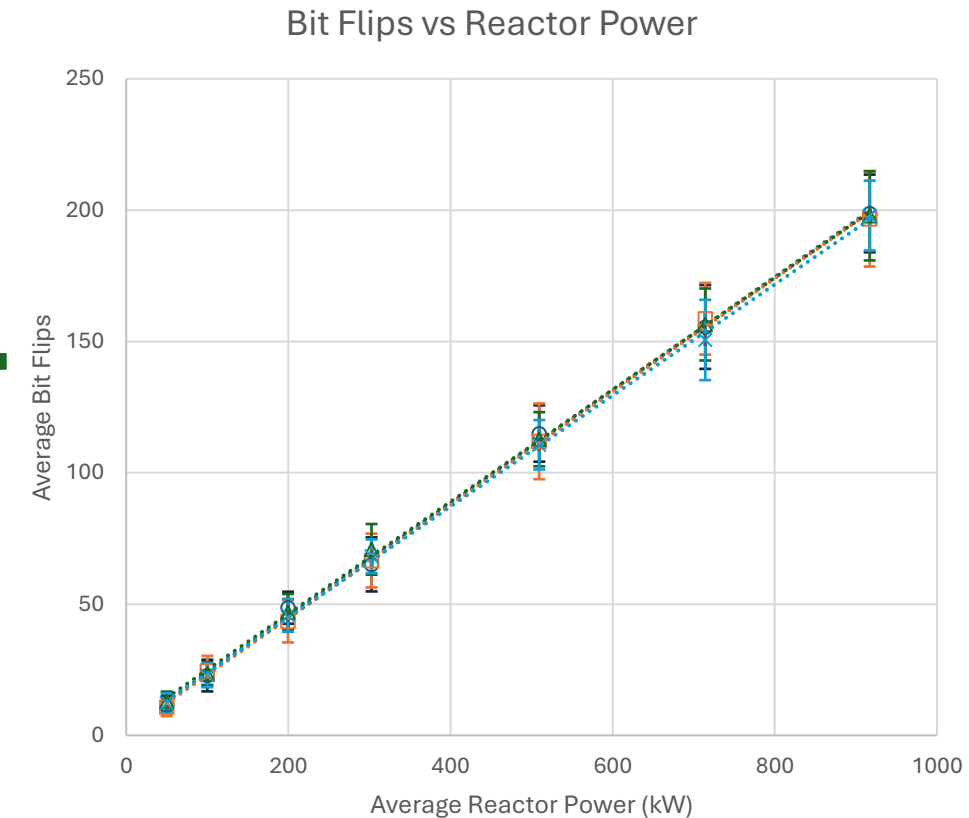
Data Pattern Differences!



00000000
00000000
00000000
00000000

01010101
01010101
01010101
01010101

11111111
11111111
11111111
11111111

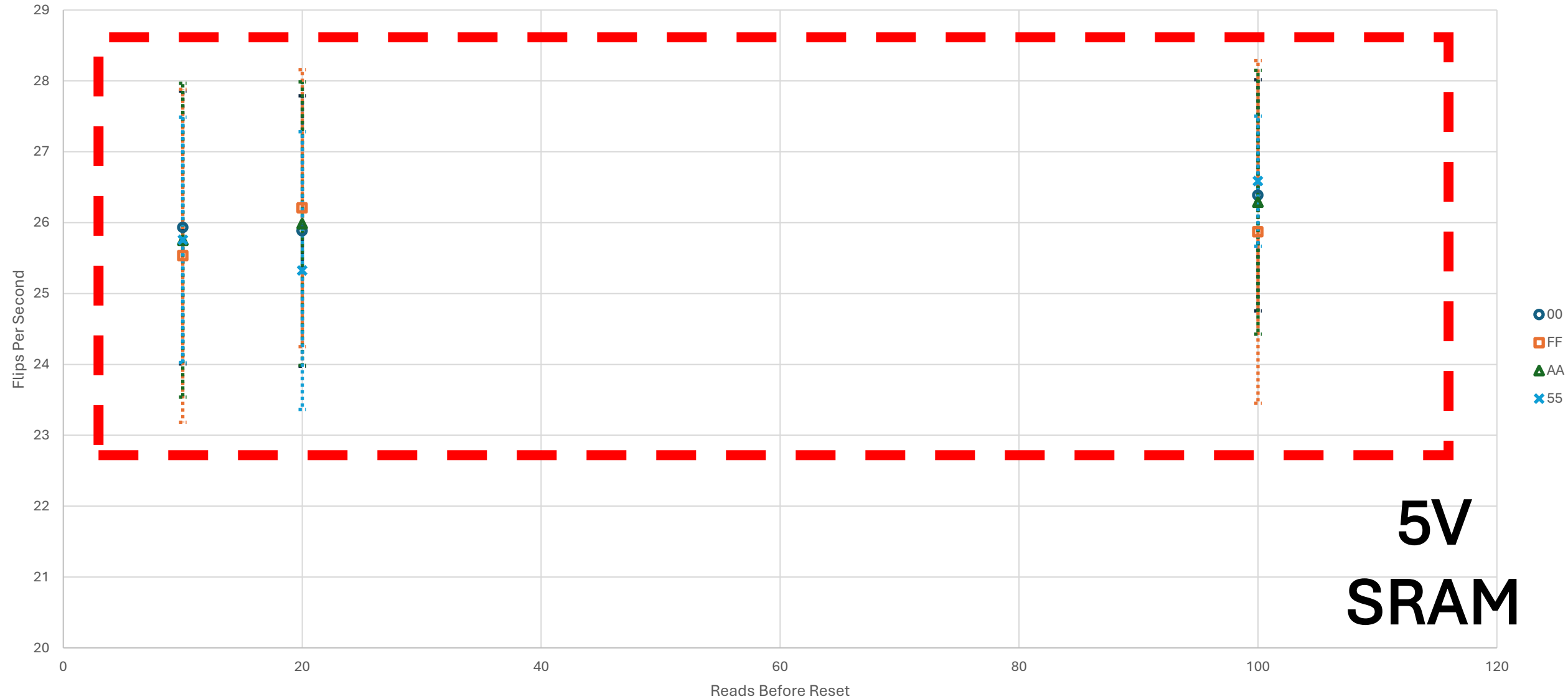


“0” has the same electrical charge as “1”.

SUMMER 2026 DATA

Read Cycle
Differences!

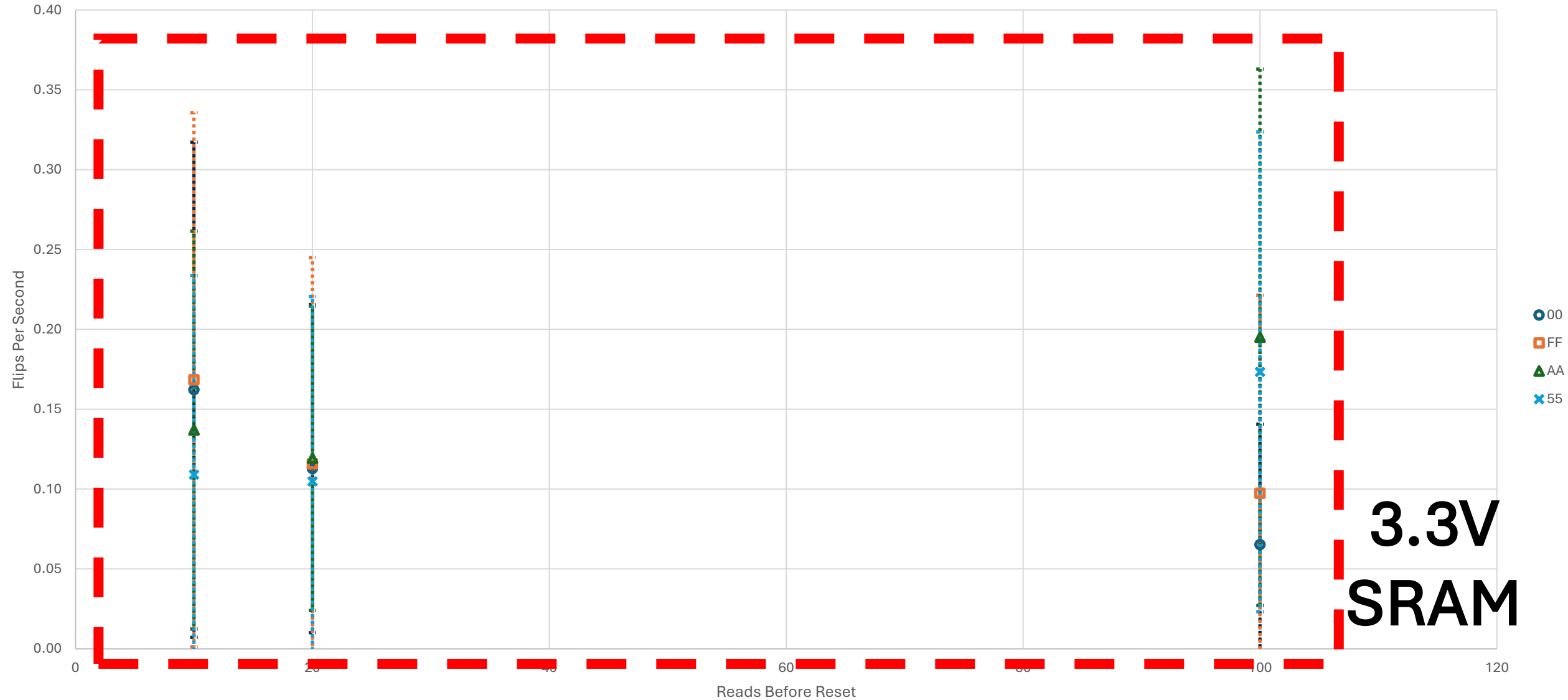
Average Flip Rate



SUMMER 2026 DATA

Read Cycle
Differences!

Average Flip Rate



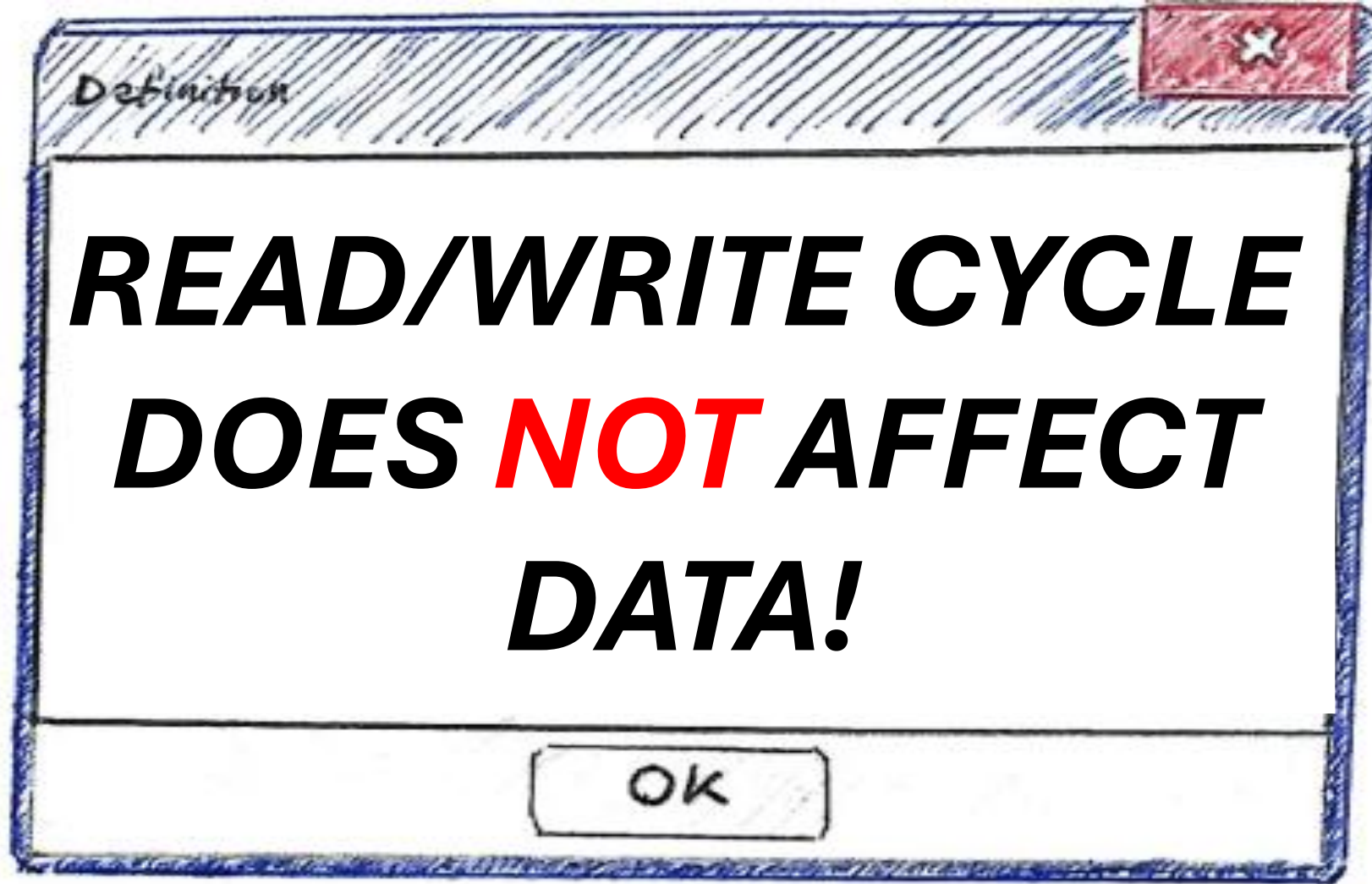
SUMMER 2026 DATA

Read Cycle
Differences!

X 10:

X 20:

X 100:



time

CB ...

|CB |CB

 |11

_____→

SUMMER 2026 CONCLUSIONS

- Improved device worked wonderfully!
- Expansions:
 - Multiple Data Patterns:
 - Data pattern **does not affect** the rate of SEUs.
 - Read/Write cycle duration **does not affect** data.
 - Multiple Chips:
 - 5V SRAM had many more SEUs than 3.3V SRAM.
 - Future research can be done on device layout and material of SRAMs.

ACKNOWLEDGEMENTS

Research Project Partner: Jaihan Utailawon

Mentors:

Dr. Catlett

Dr. Flanagan

Dr. Moldenhauer

Funding:

Department of Energy

University of Texas at Austin

Impact of Research Reactors to Education

DE-NE0009527

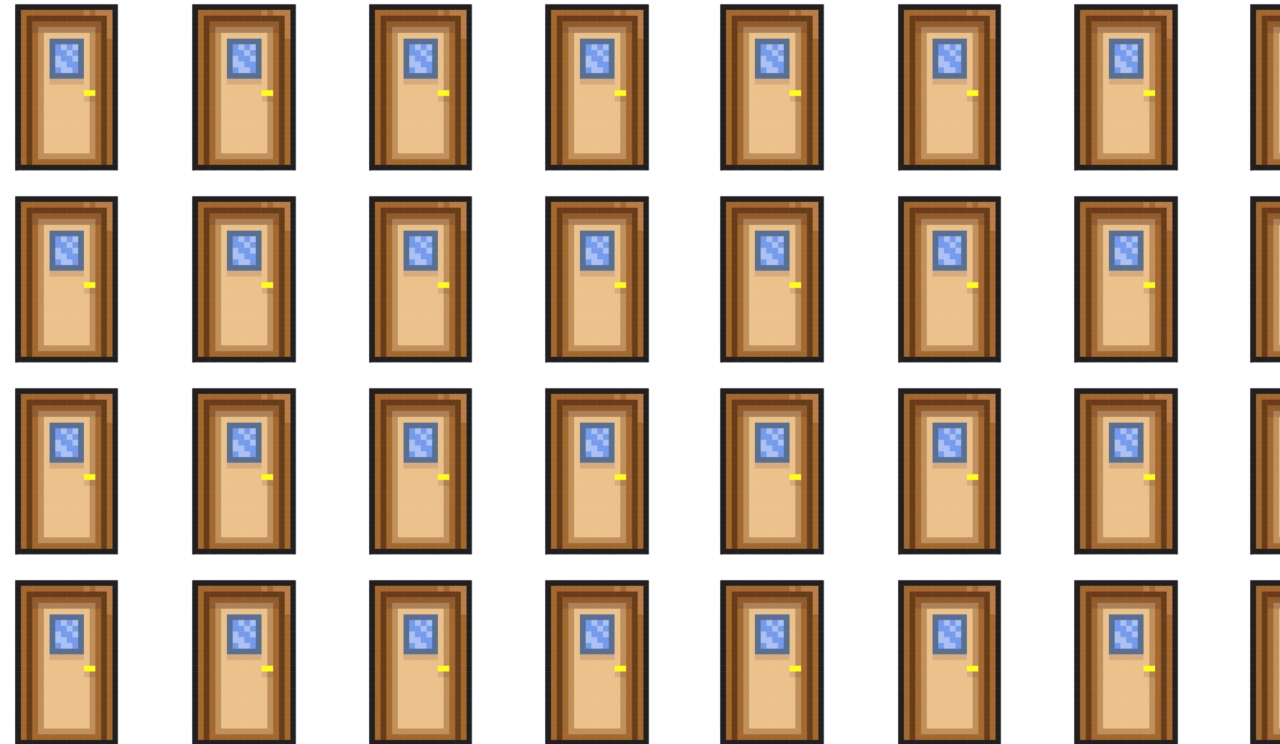
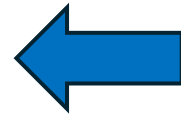


Thank you for your time!

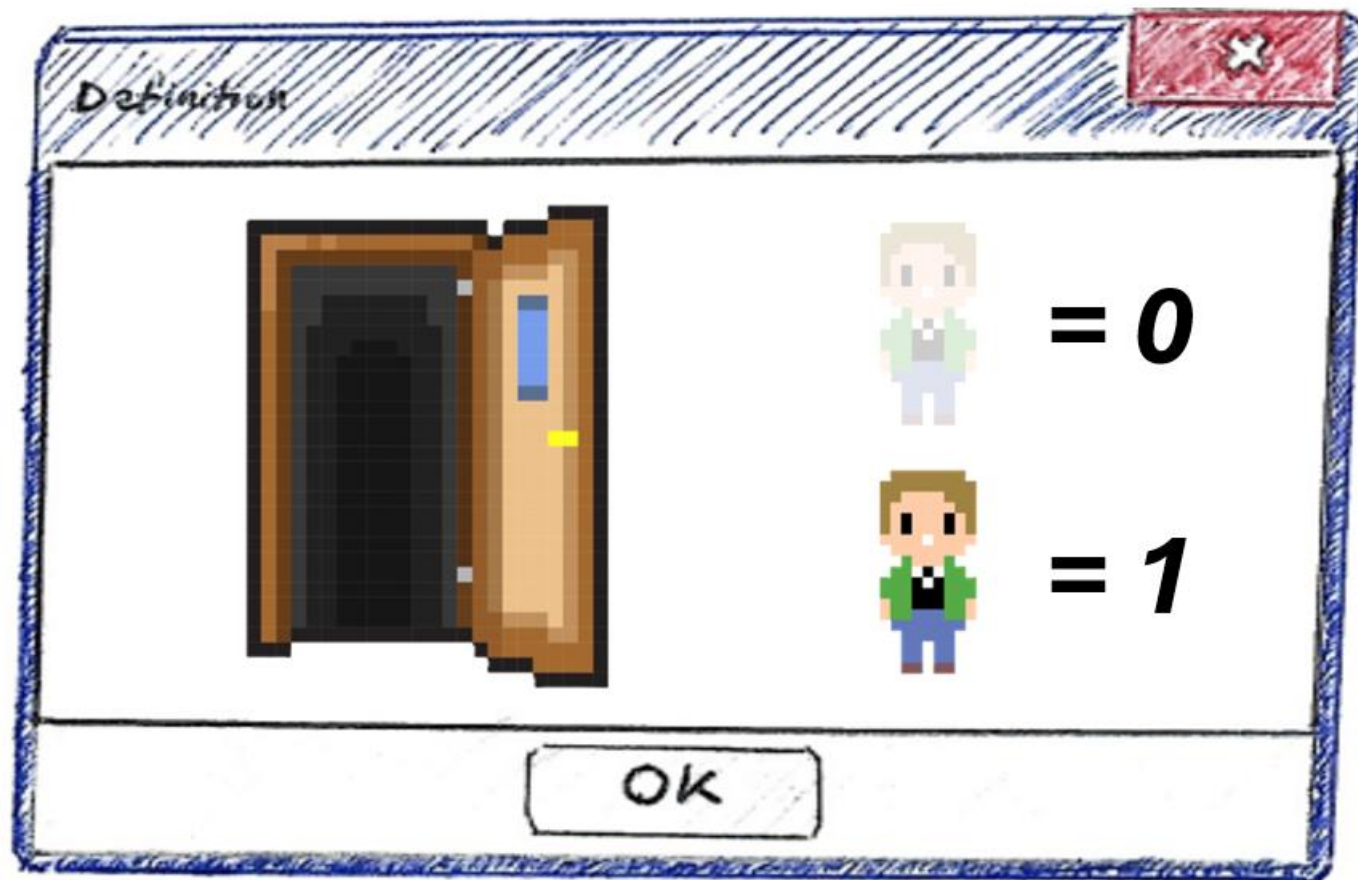
CODE EXPLAINED



Imagine the SRAM chip as a hotel with many doors!



CODE EXPLAINED



CODE EXPLAINED



SRAM Test

Environment Setup

Project Folder Path
C:\Users\nmvs2\Downloads\GalacticRAMS-main\

Setup Environment Activate Environment

Test Parameters

Data Pattern File Name (Optional)

All_Ones
All_Zeros
Checkerboard
Random

id-yyyy_HH-mm-ss
.csv

Detect Connected Devices

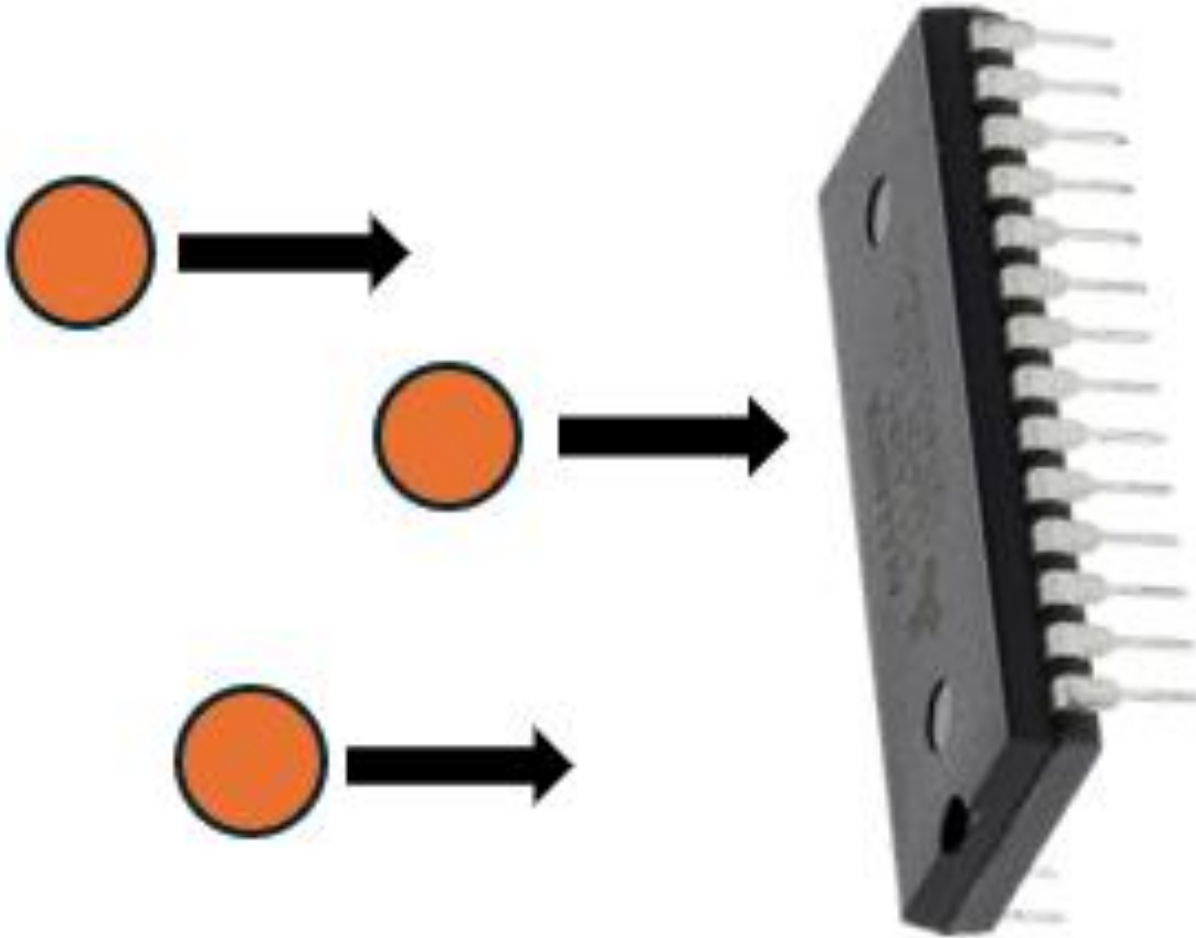
Detect Devices ☐ Device Connected

Select Serial Port:

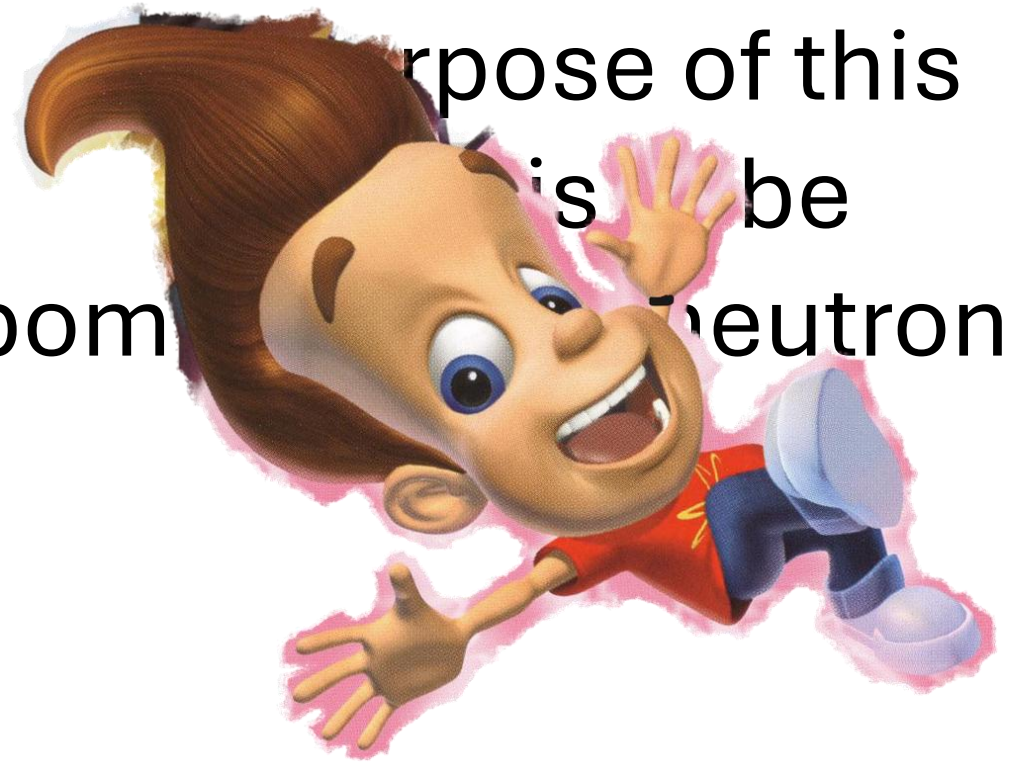
☐ Use Streamlit Read Data Run Test

Latest Data Point

CODE EXPLAINED



The purpose of this
bomb is to be
bombed by neutrons.



***So think of the neutrons
as troublemakers.***

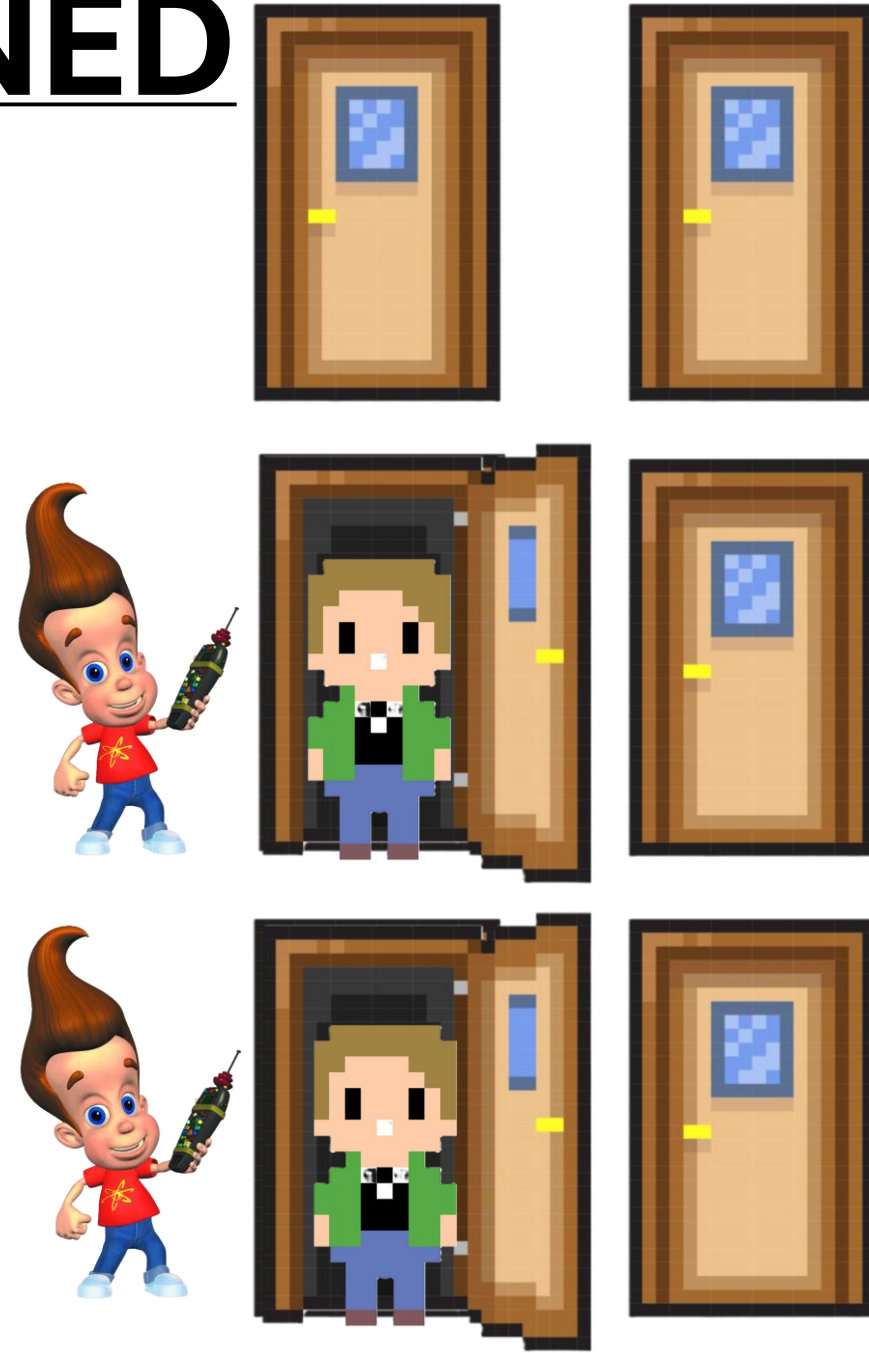
CODE EXPLAINED

Incoming neutrons
disrupt the SRAM's
memory by flipping bits:

$1 \rightarrow 0$

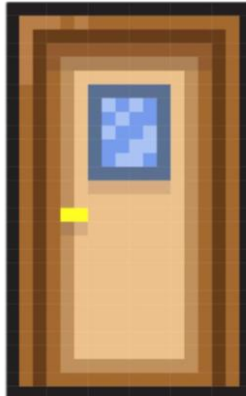
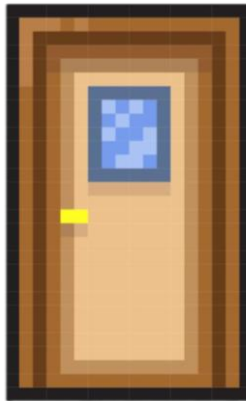
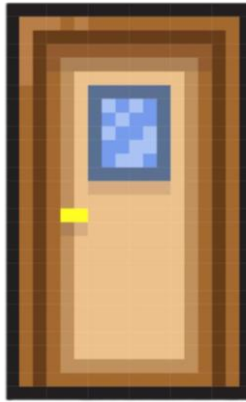
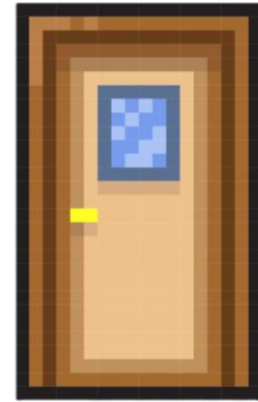
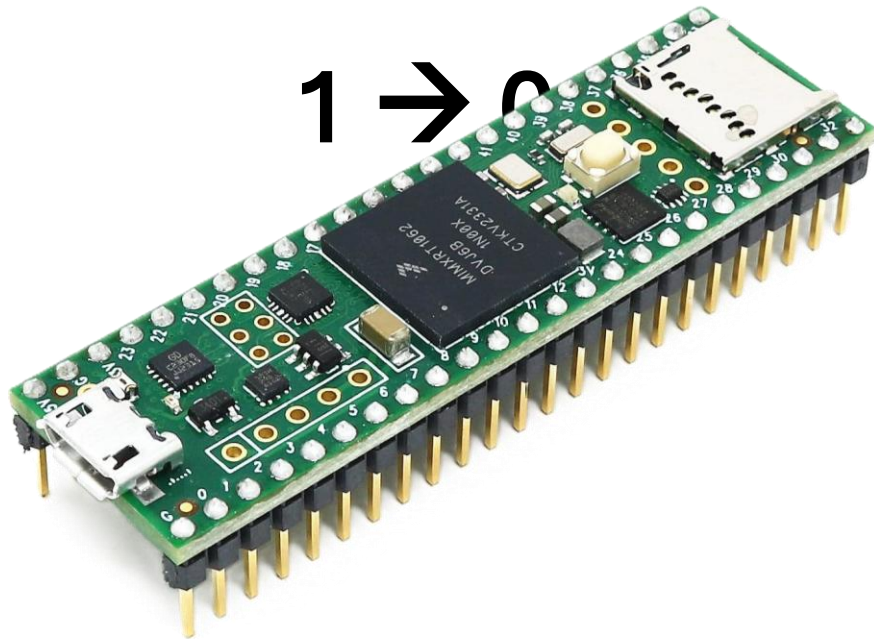
or

$0 \rightarrow 1$



CODE EXPLAINED

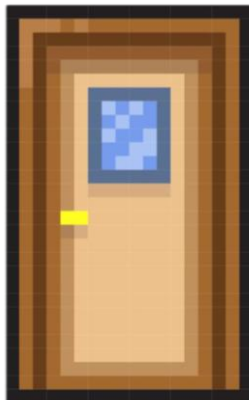
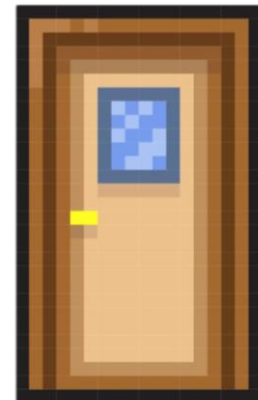
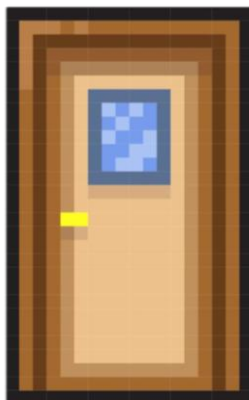
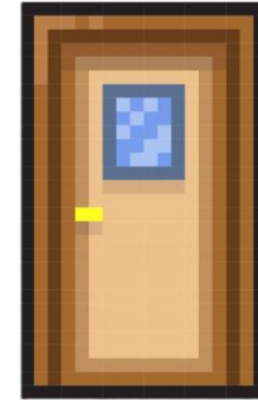
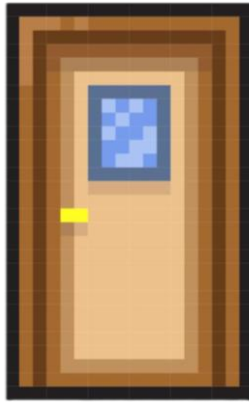
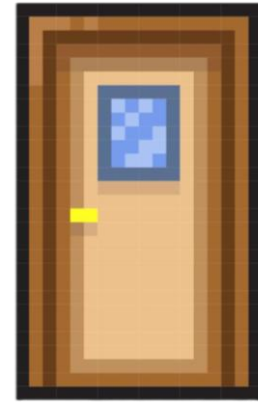
Incoming neutrons
Which is where the
disrupt the SRAM's
microcontroller
memory by flipping bits:
comes in...



CODE EXPLAINED



Imagine the
microcontroller as a
Hotel Inspector!



CODE EXPLAINED

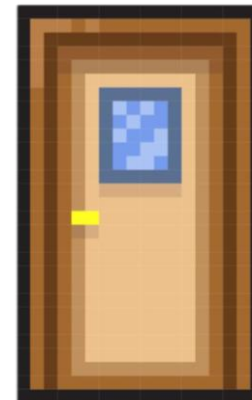
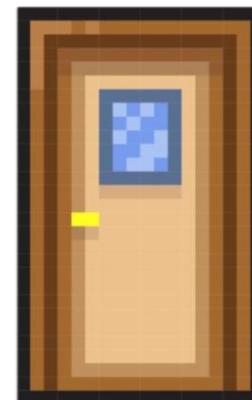
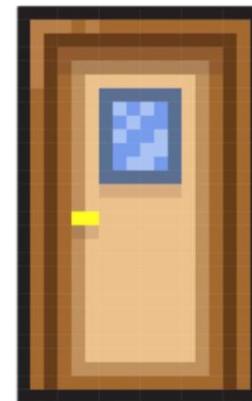
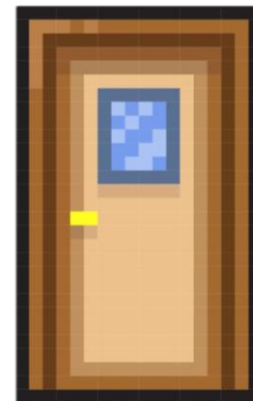
Expected:



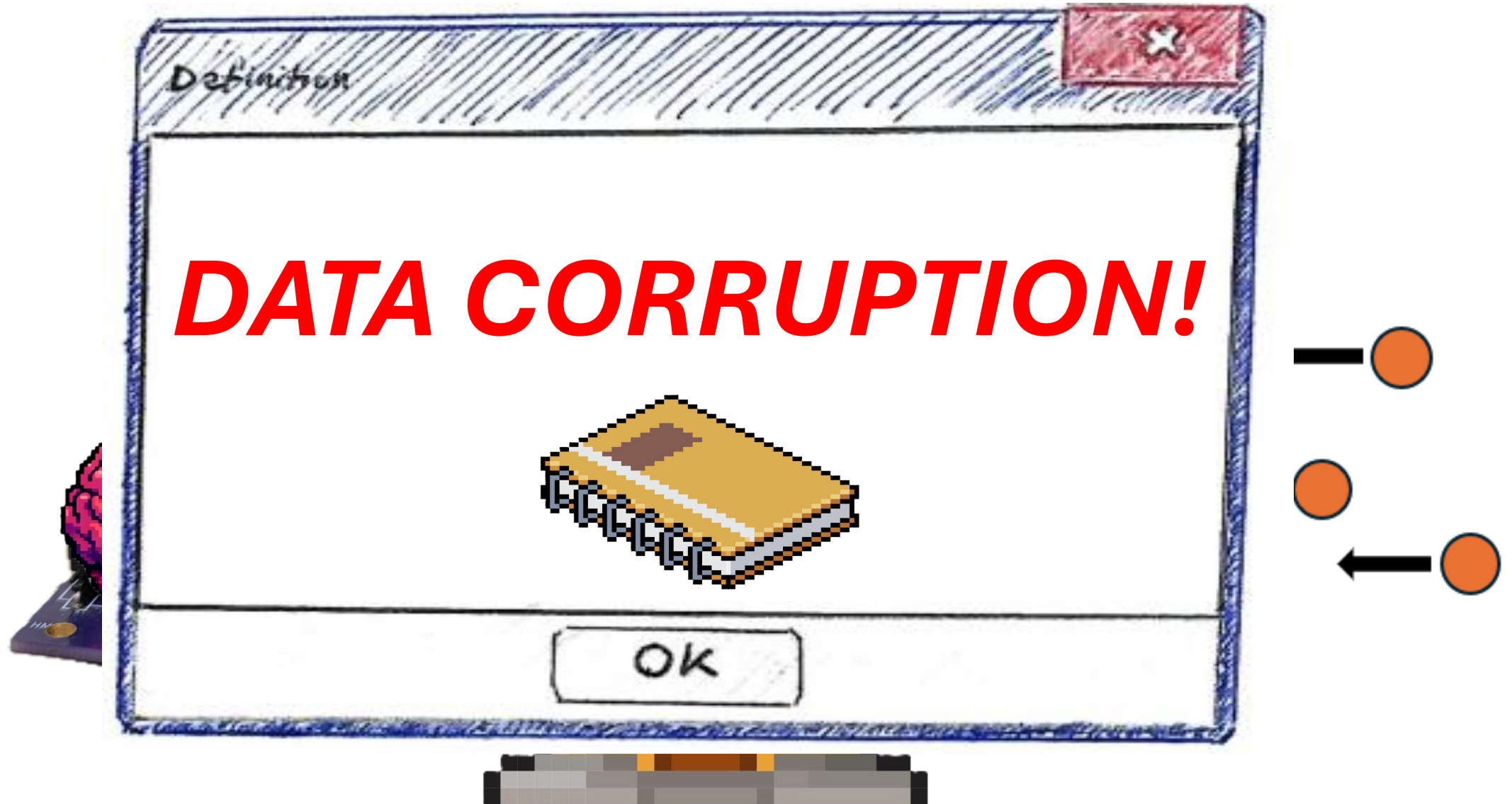
Observed:



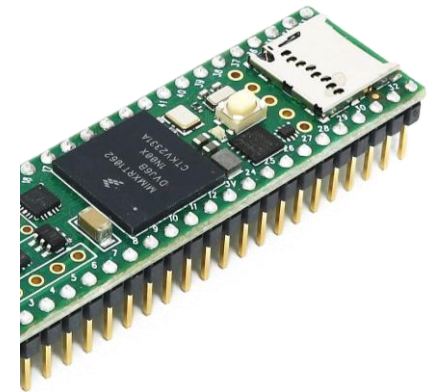
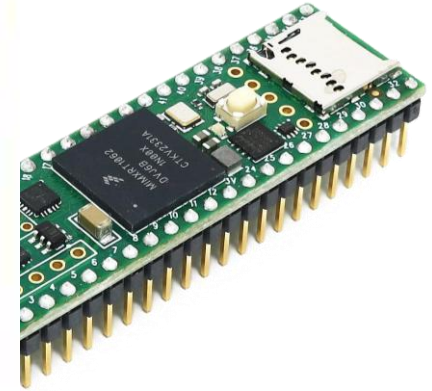
Total Errors: +2



HARDWARE



SUMMER 2026 DEVICE EXPANSIONS



RESEARCH FOCUS

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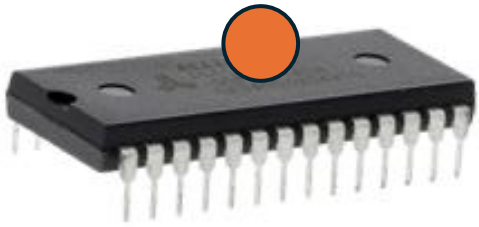
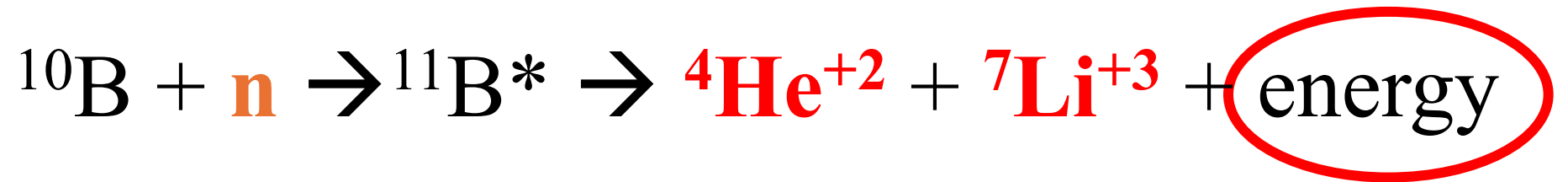


Boron-10 in device

RESEARCH FOCUS

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*Thermal Neutron Capture by **Boron-10***



Boron-10 in device