Er1 High Speed test-chip Irradiation tests.

By Liam Godfrey

in collaboration with W.Helsby, M.Borri

UKRI Science and Technology Facilities Council

Aims + Overview

To irradiate a test chip to evaluate the breaking point by taking current measurements, eye-diagrams for signal /data communication analysis.

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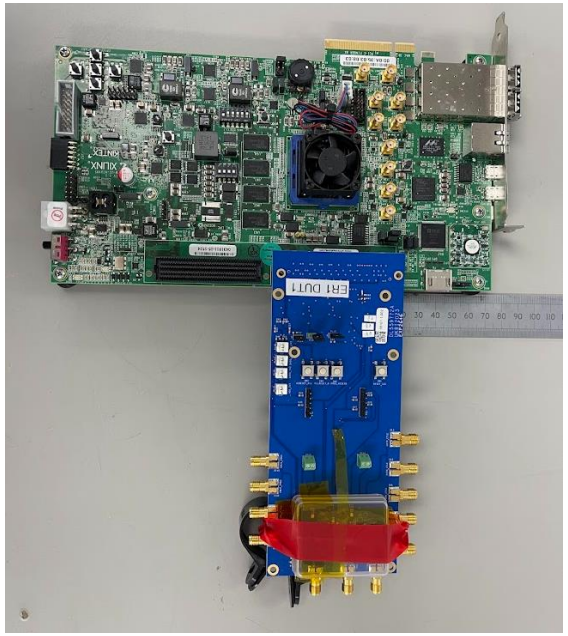
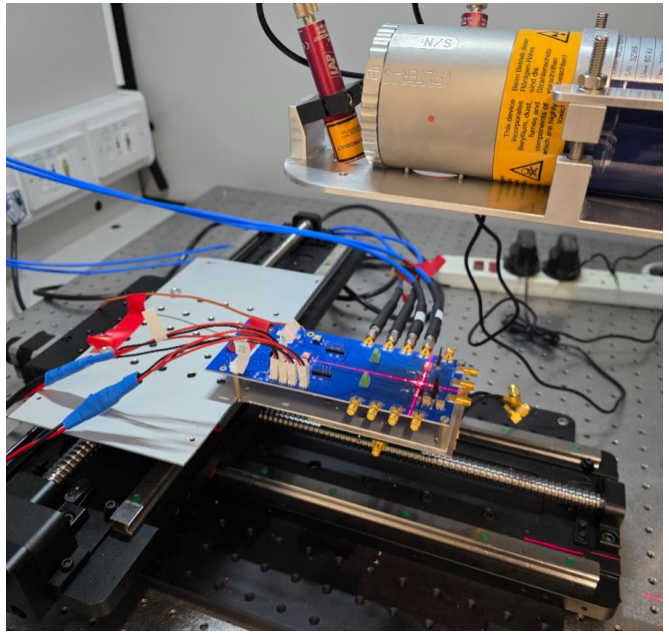
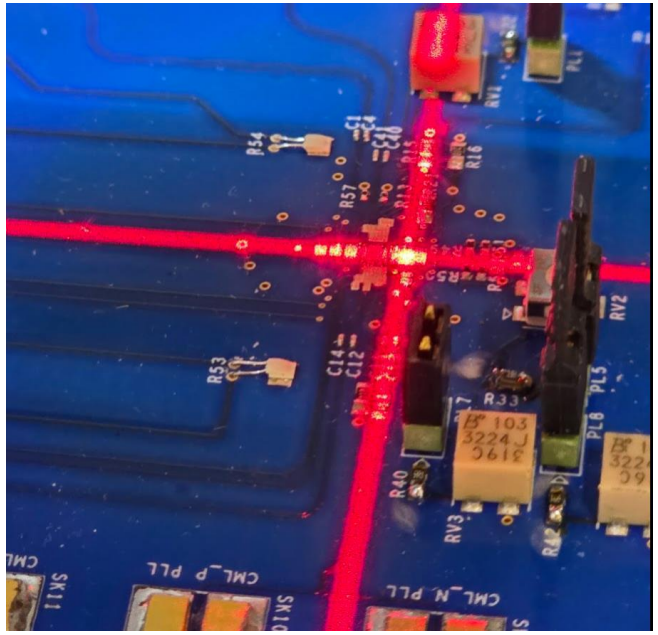
The test chip was wire-bonded onto a test board and loaded into the x-ray chamber, aligned and set to a height of 33mm







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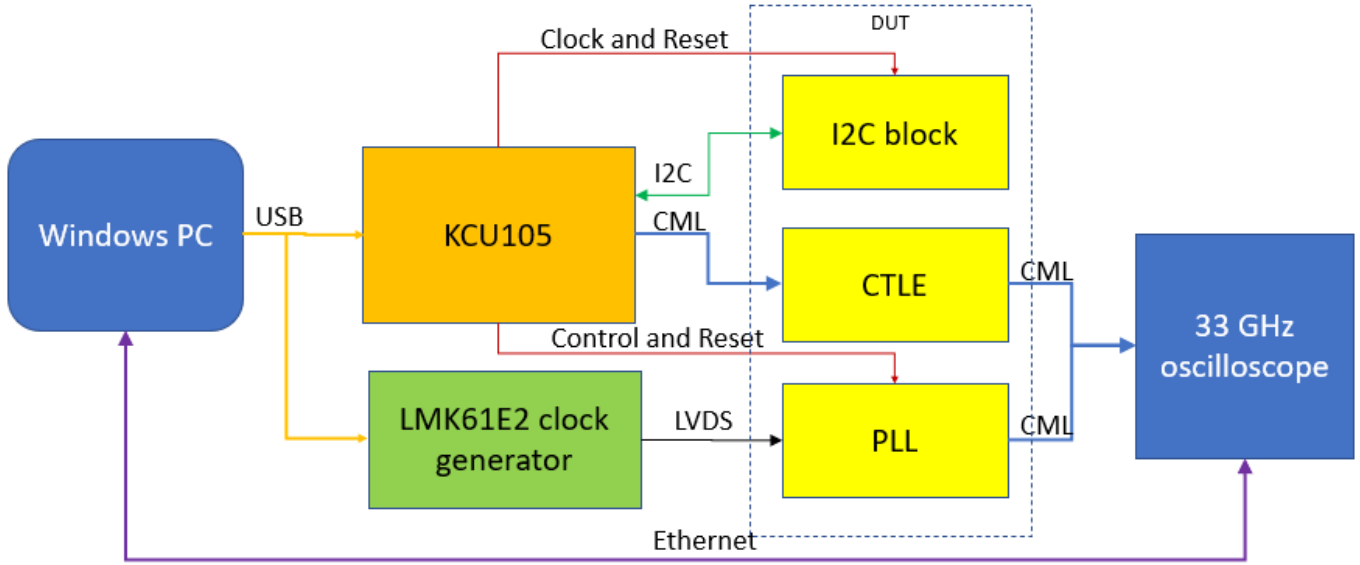
Set up for manual irradiations

4GBits/s 2GHz signal was inputted into the CTLE provided by the KCU105 via SMA cables. Programmed through Vivado.

This signal was measured using the oscilloscope and eye diagrams were generated after each irradiation step.



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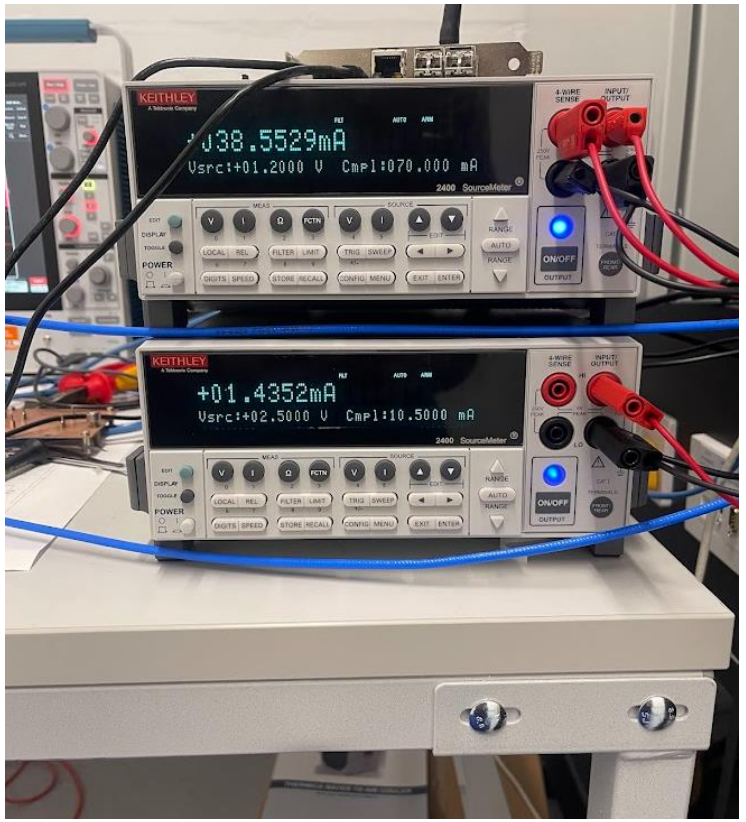
Source meters

Two Keithley 2400s providing 1.2V (compliance 70mA) and 2.5V (compliance 10.5mA).

Test board is powered through the entire experiment.

After each irradiation, the currents were manually recorded.



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Each irradiation step lasts 48.6 minutes. Equivalent to a TID of 5.0544 Mrad.

Manual restart and data taking.
Lead to large and inconsistent amounts of downtime resulting in annealing between irradiations (weekends, evenings and time off work).

Irradiations began on 2024/10/28 until Christmas break (2024/12/13).
When back from break done a final day of tests on 2025/01/08.

Overall the chip was irradiated to a TID of 667 Mrad.

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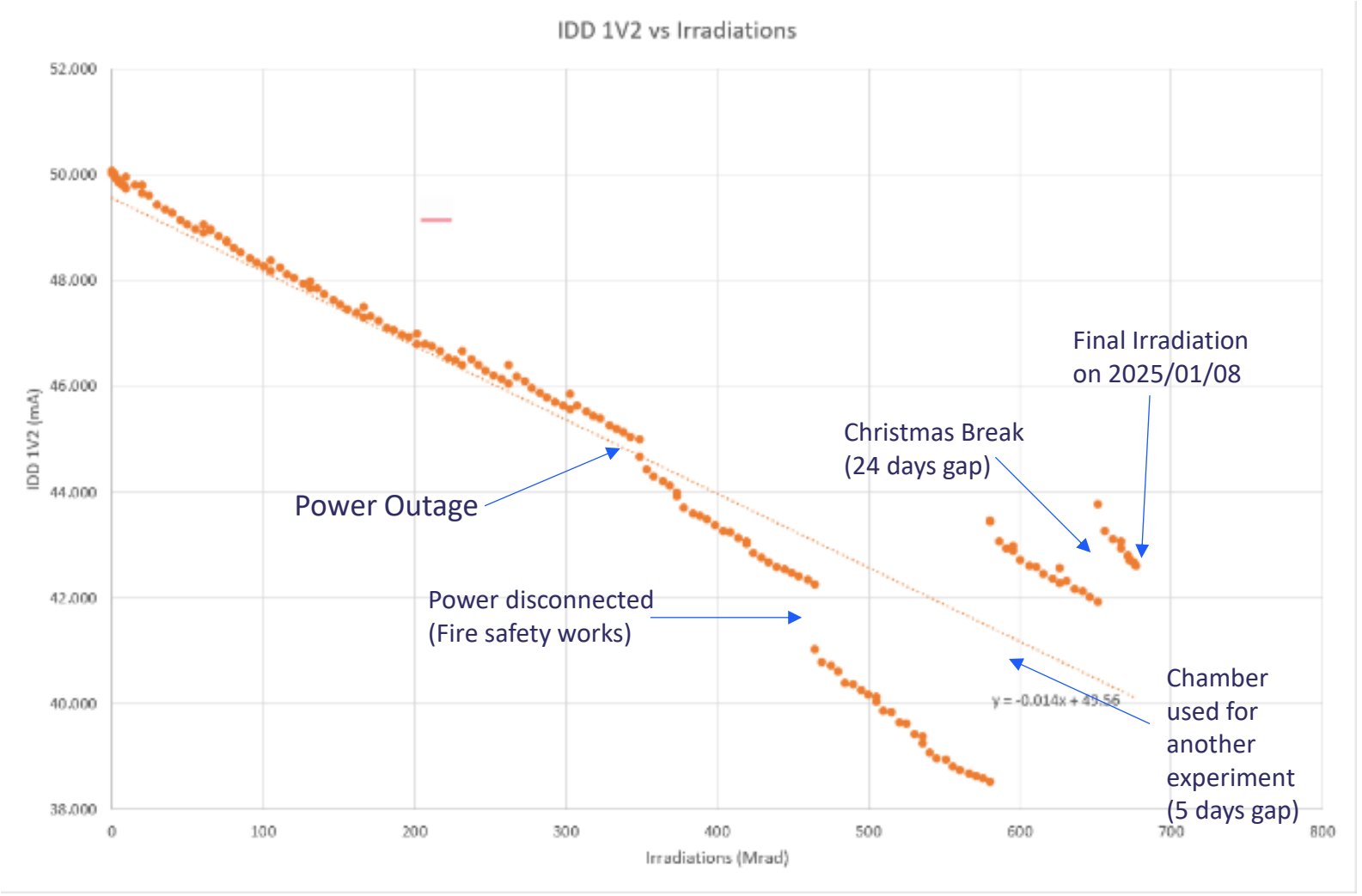
Manual Irradiations Current measurements

- A linear decrease was seen for the 1V2 rail.
- Between days a small increase was seen due to annealing.
- Discontinuity of measurements due to manual use.



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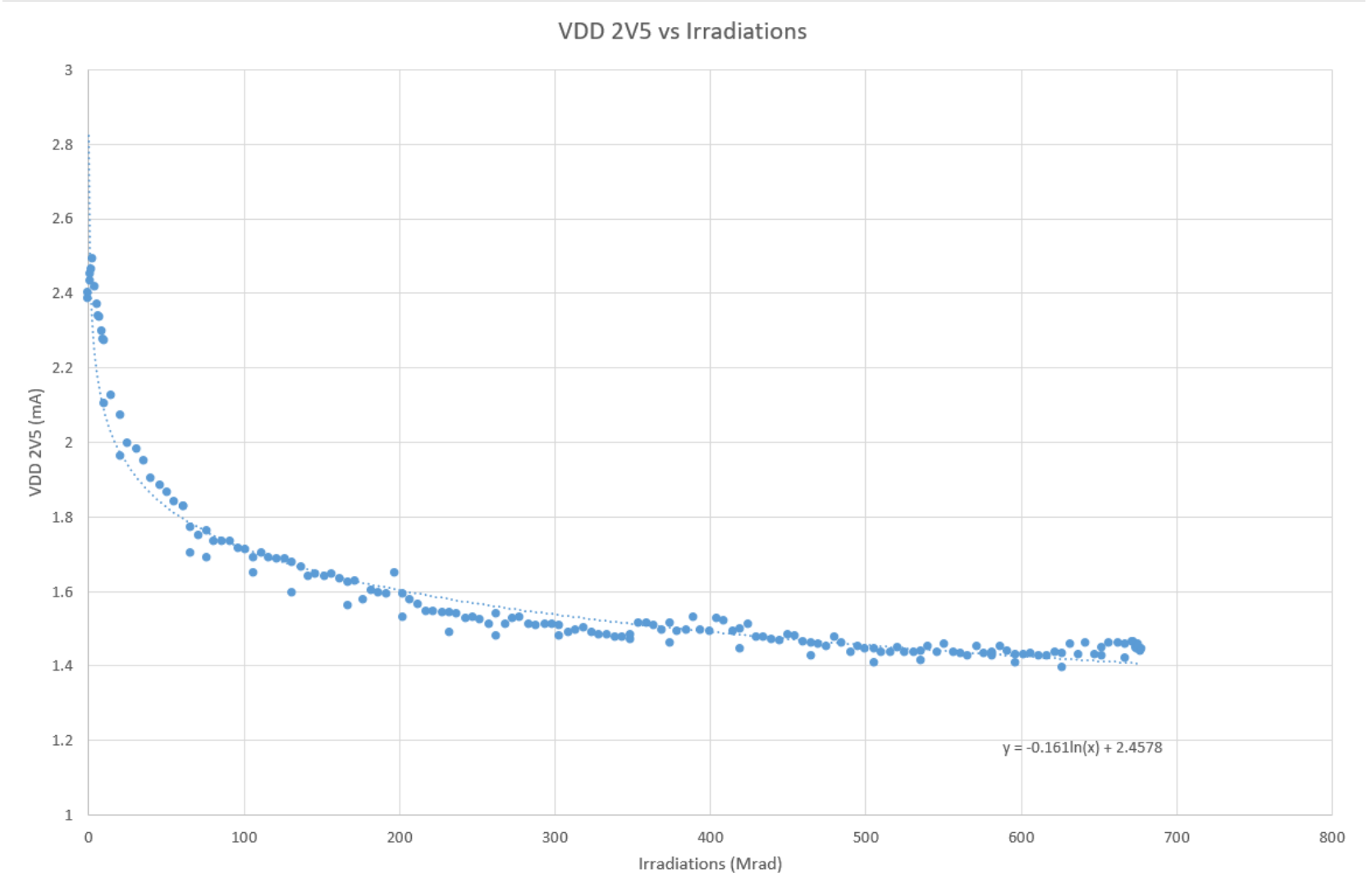
Manual Irradiations current measurements

- 2V5 rail
- The measured current decreased at a decreasing rate before ‘averaging’ at ~1.5mA



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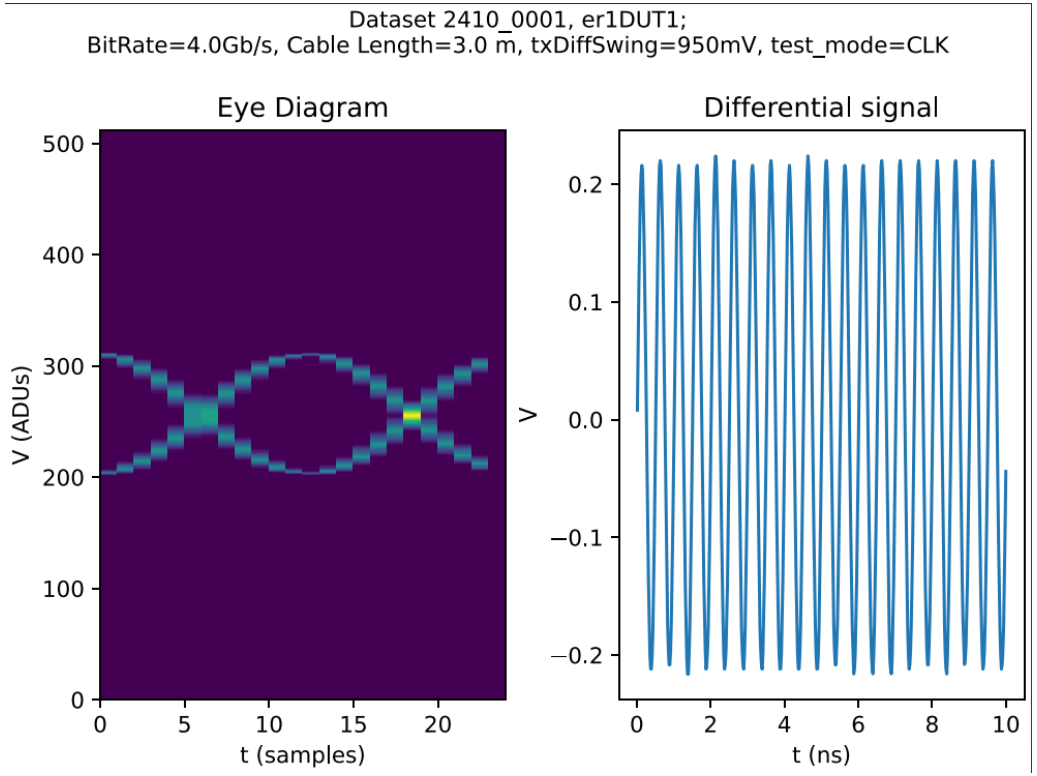
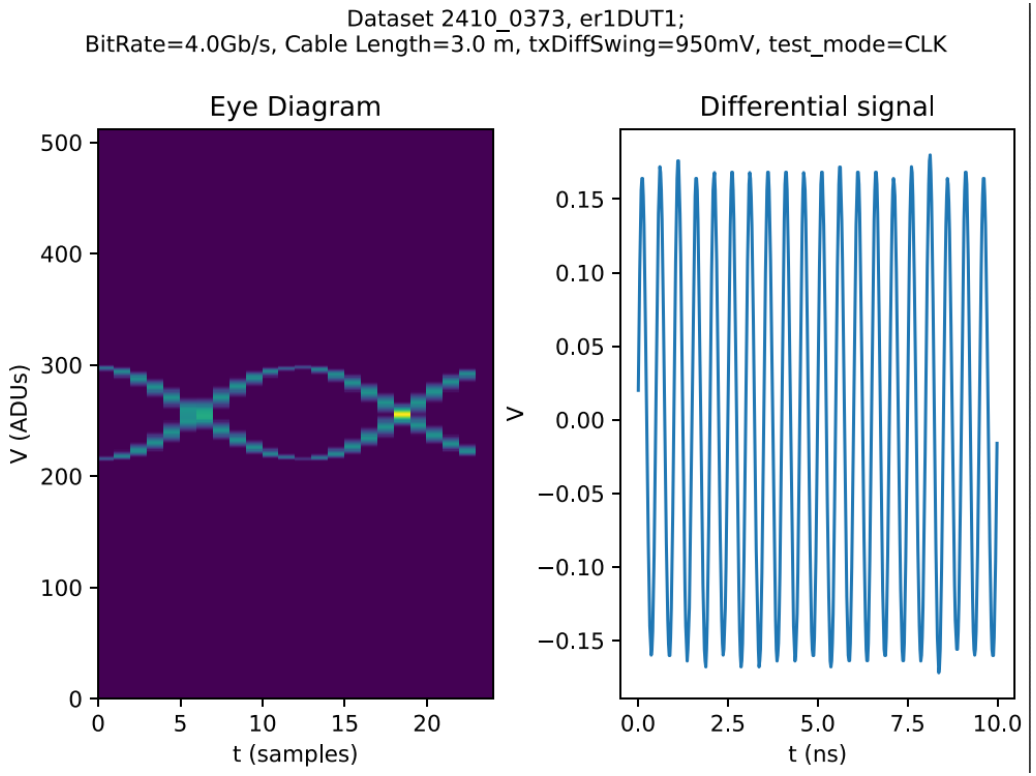
Eye Diagrams

Before first Irradiation



After 667 Mrad of TID Final data (date)



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Amplitudes of the signal expectedly decayed over applied TID.
Amplitude started at 0.4V and decreased to slightly more than 0.3V.

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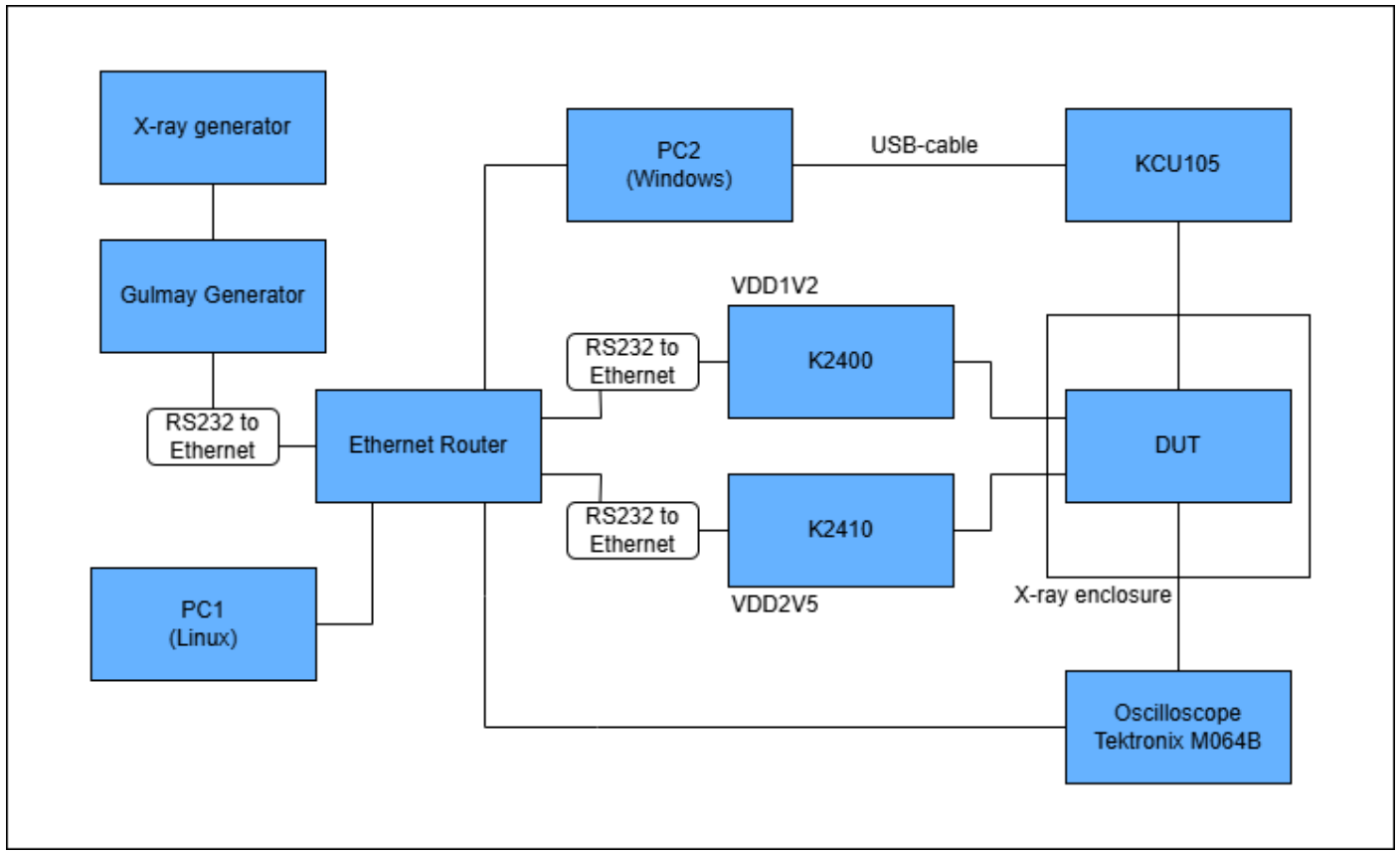
System was Automated

To decrease the amount of babysitting the system and measurement errors I used Python to automate the irradiations, measurement taking and analysis.
Can now set it and forget it and analyse the data throughout runs to check progress.

The same chip is being irradiated and we plan to irradiate until it breaks.



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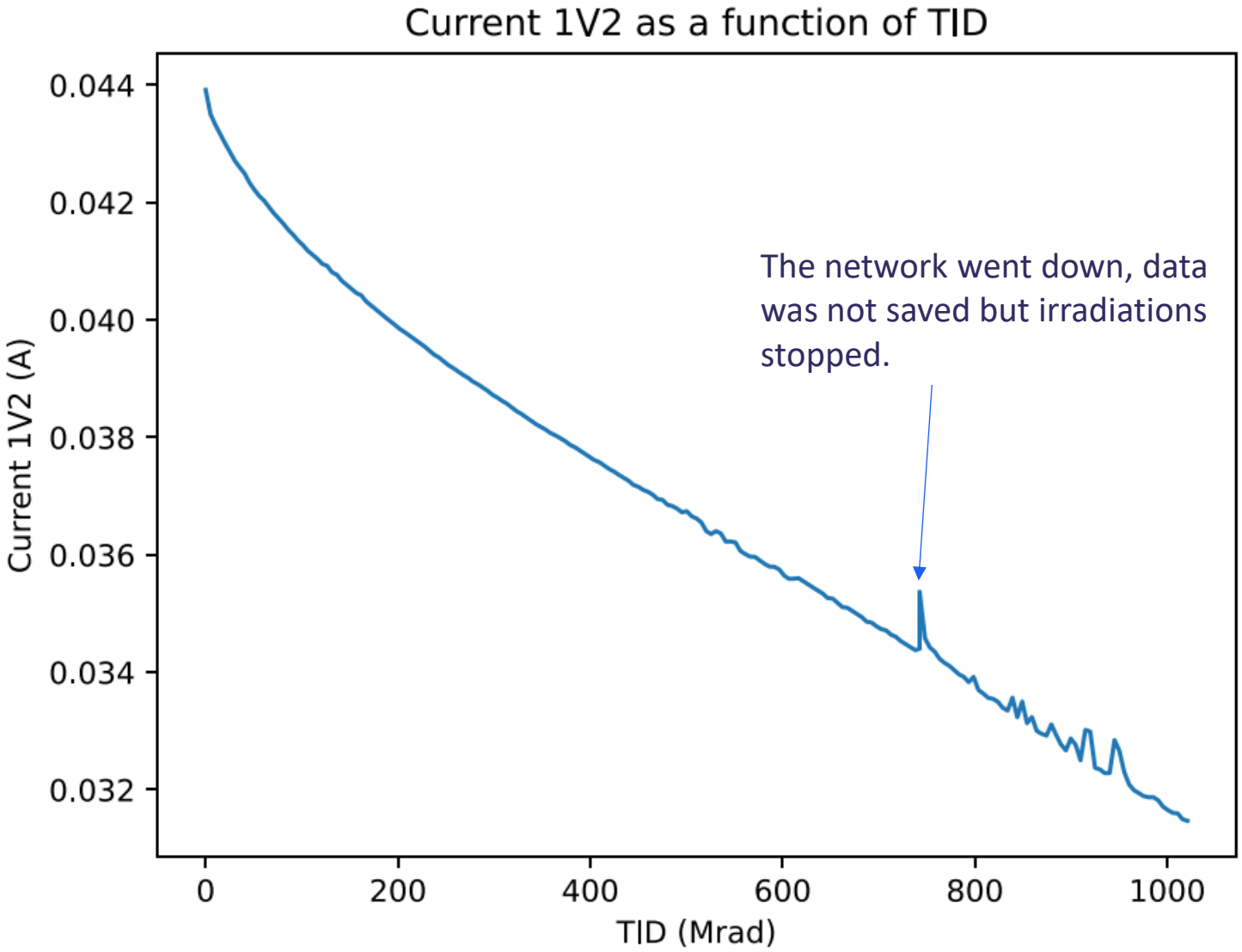
Results from Auto-Irradiations

- Follows the same trend as before.
- Chip has not been allowed to anneal.



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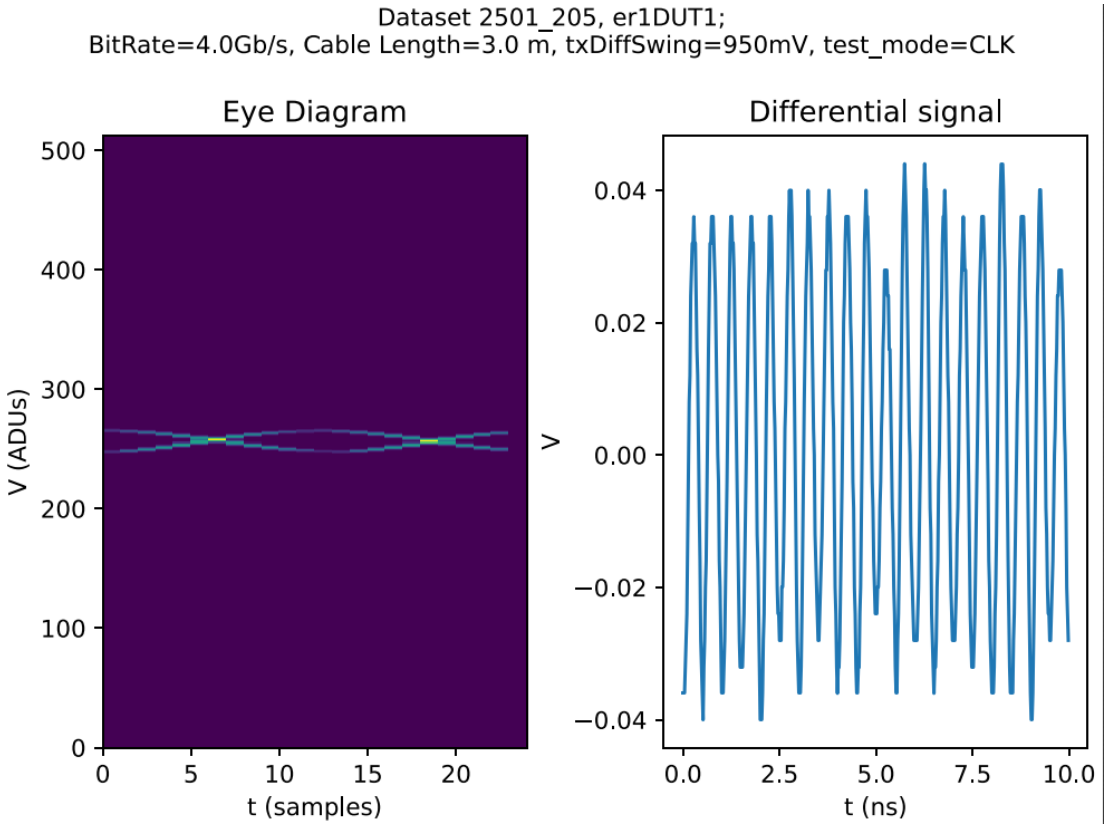
Eye Diagram and Channel Amplitude



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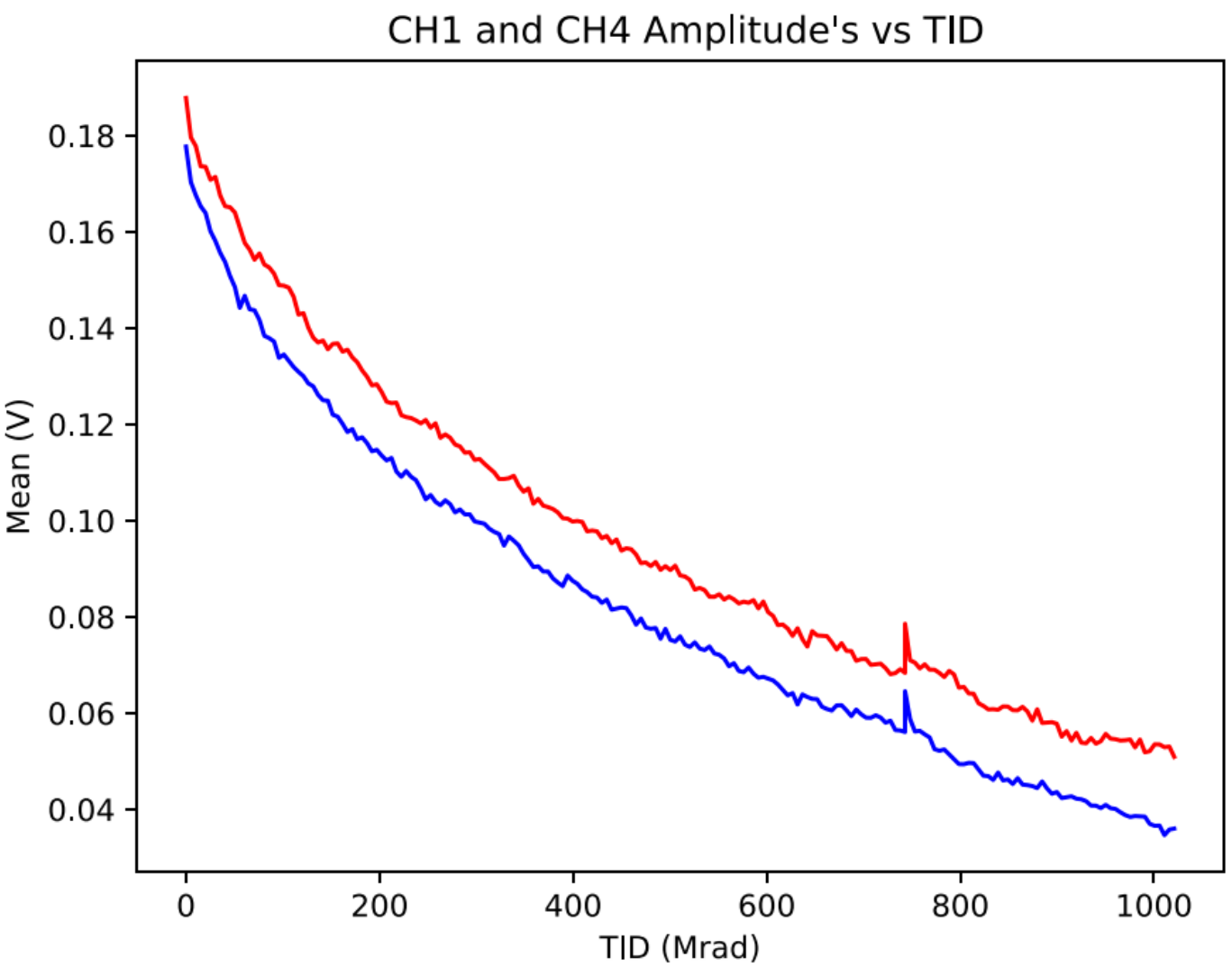

What comes next?

- Irradiate the current chip until it breaks.
- Classify and evaluate what this breaking point looks like.
- Irradiate 3+ chips with no interruptions and compare the results.

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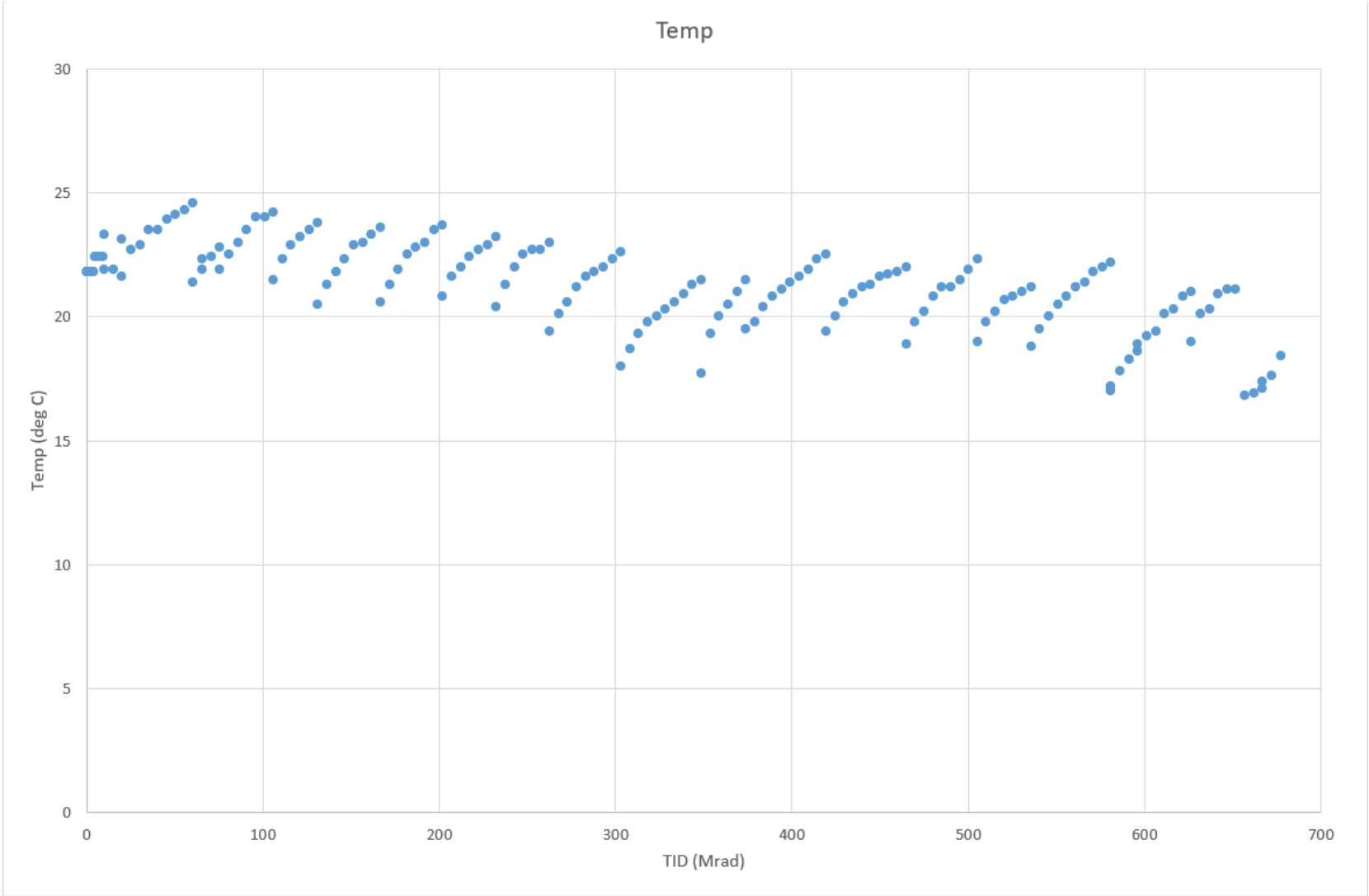
Temperature of Board measured throughout manual tests.



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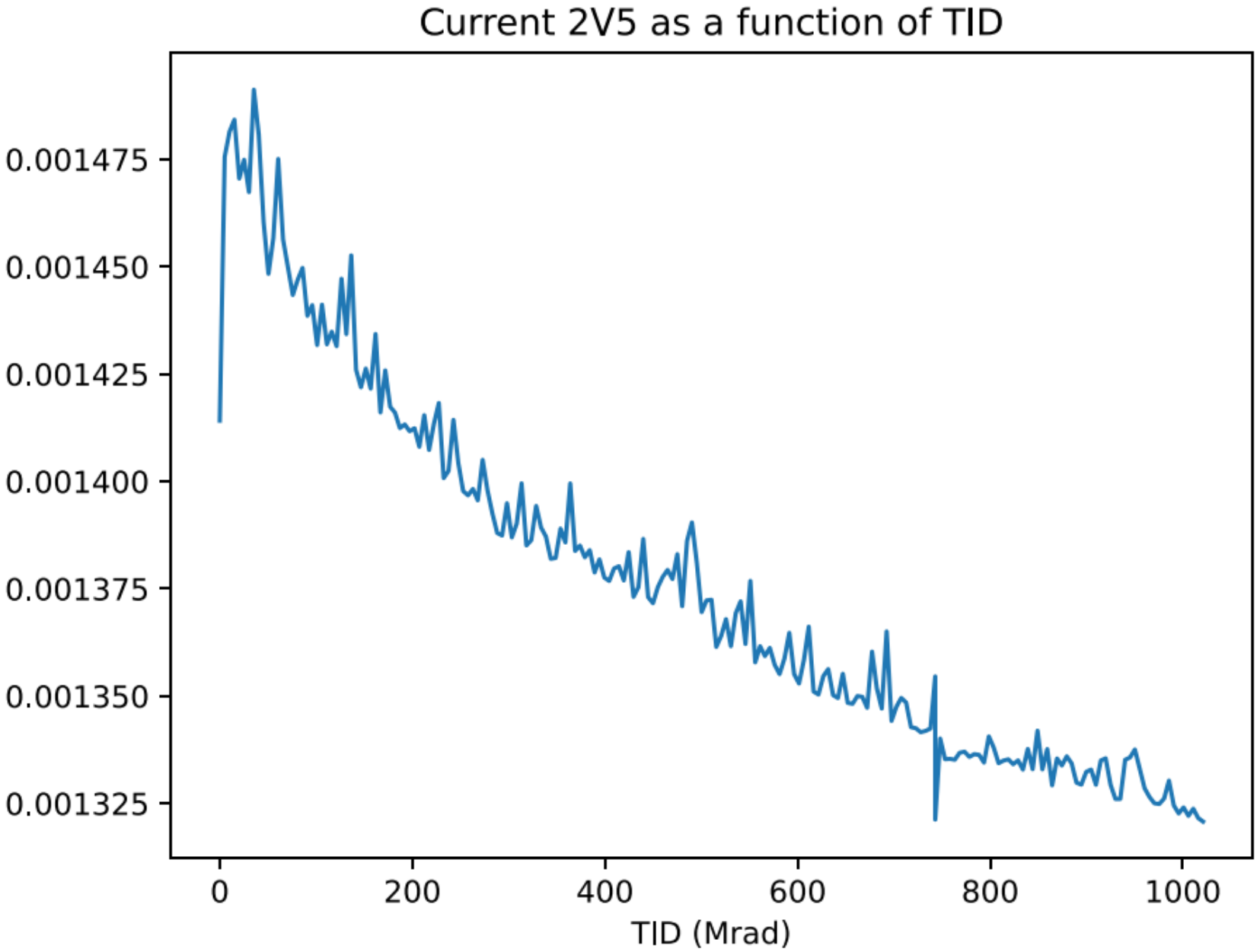

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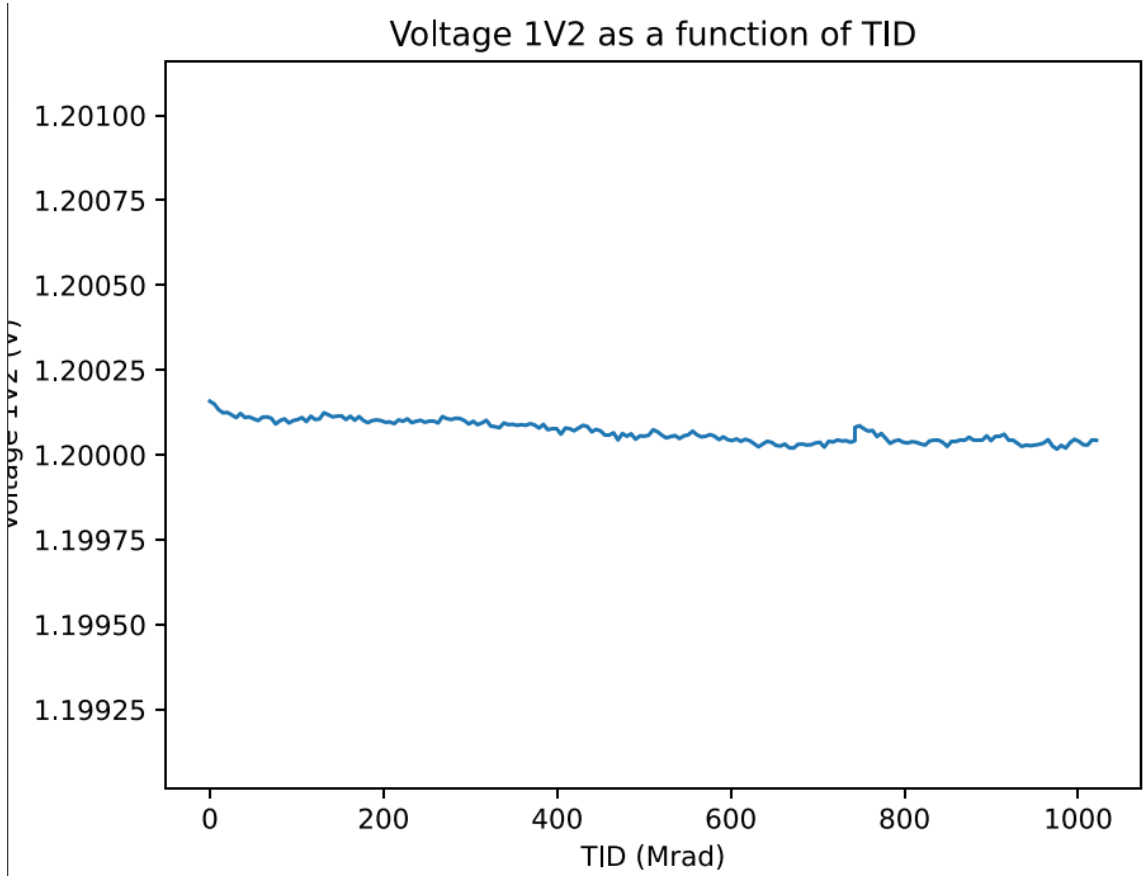
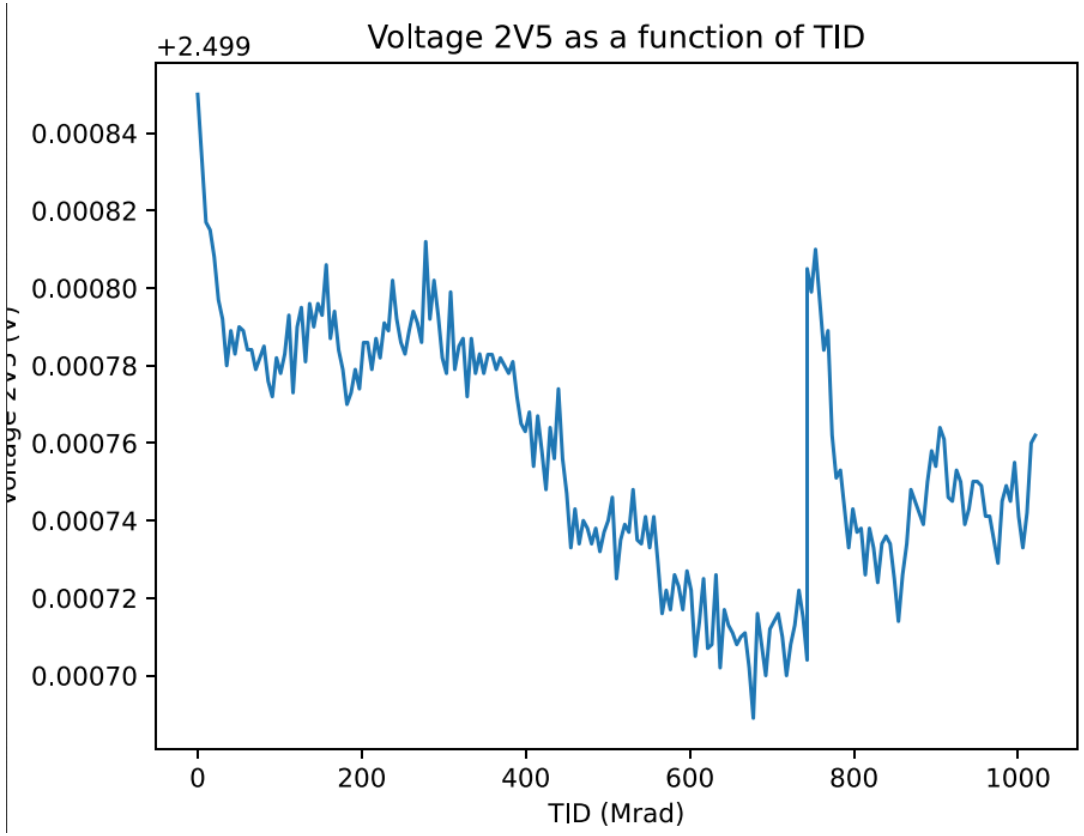
Supplied voltages plotted.





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