

Er1 DUT2 High-Speed test-chip Irradiation tests.

By Liam Godfrey

Overview

- Overview of Er1 Chipllet
- Setup
- Irradiation parameters
- Results during TID irradiation
- Results during short term annealing
- Conclusion

Er1DUT2: tests only on CLTE block

The DUT contains 3 blocks:

- Dual-Mode Phase Locked Loop (PLL)
- I2C
- Continuous Time Linear Equaliser (CTLE)
(Tested HERE)

For CTLE, we measured:

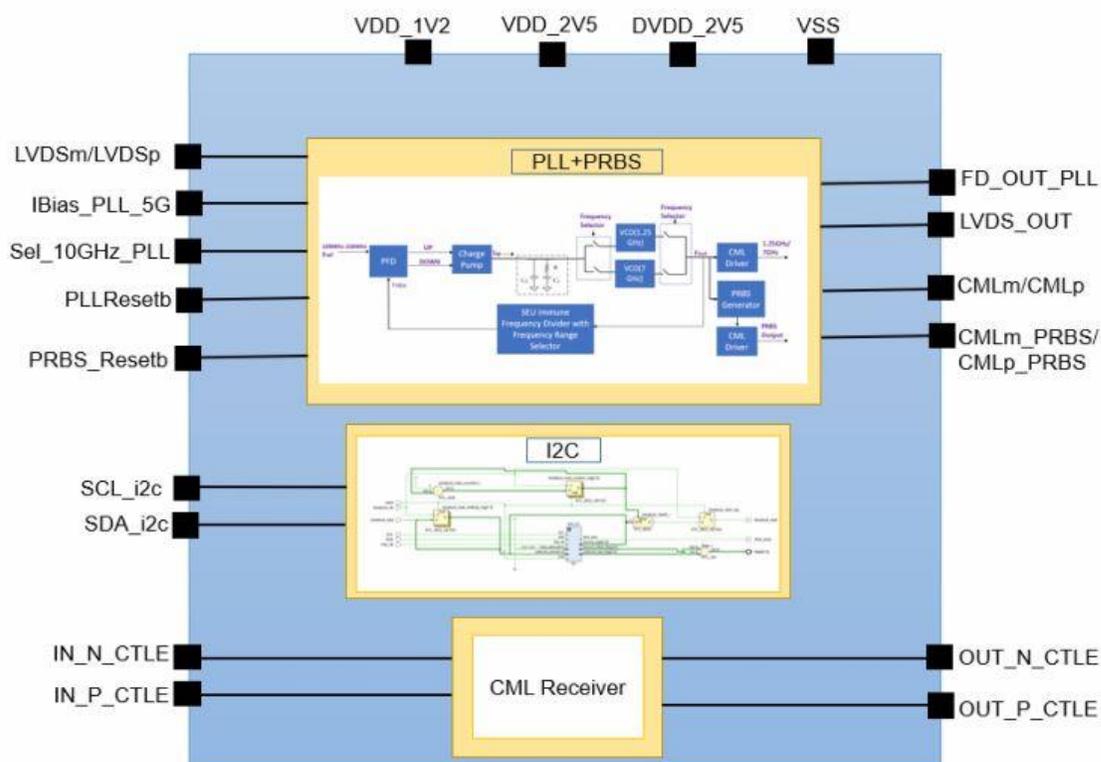
Supply currents Vs TID;

Eye amplitude Vs TID;

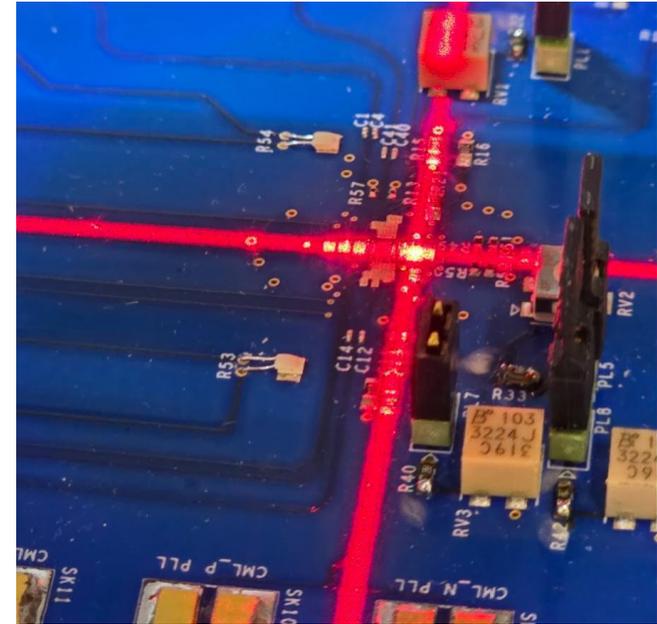
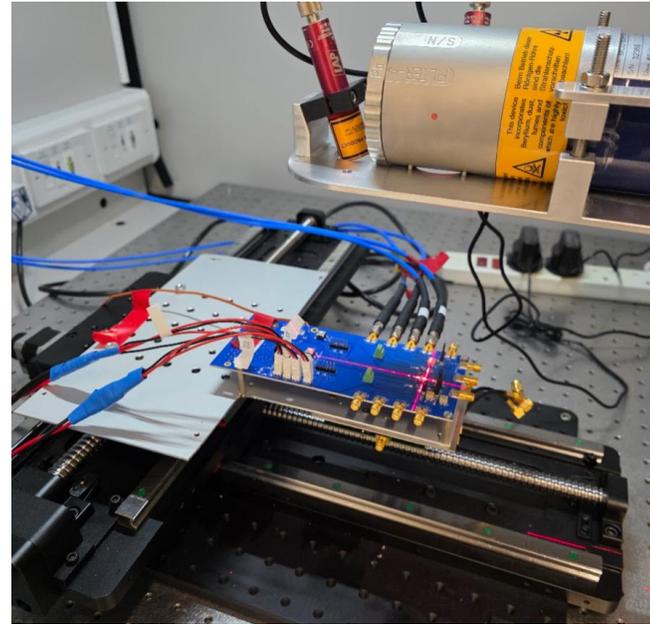
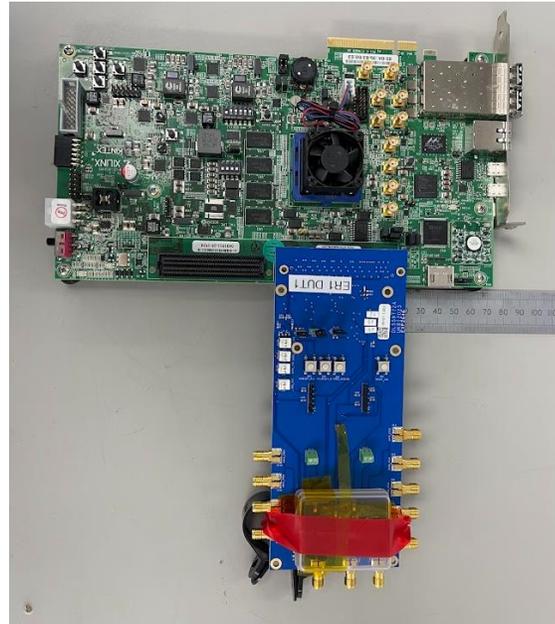
Irradiations went beyond the EPIC SVT TID requirements (~100s krad);

Irradiations explored the robustness of the 65nm process beyond the EPIC SVT requirements.

Functional Block Diagram:



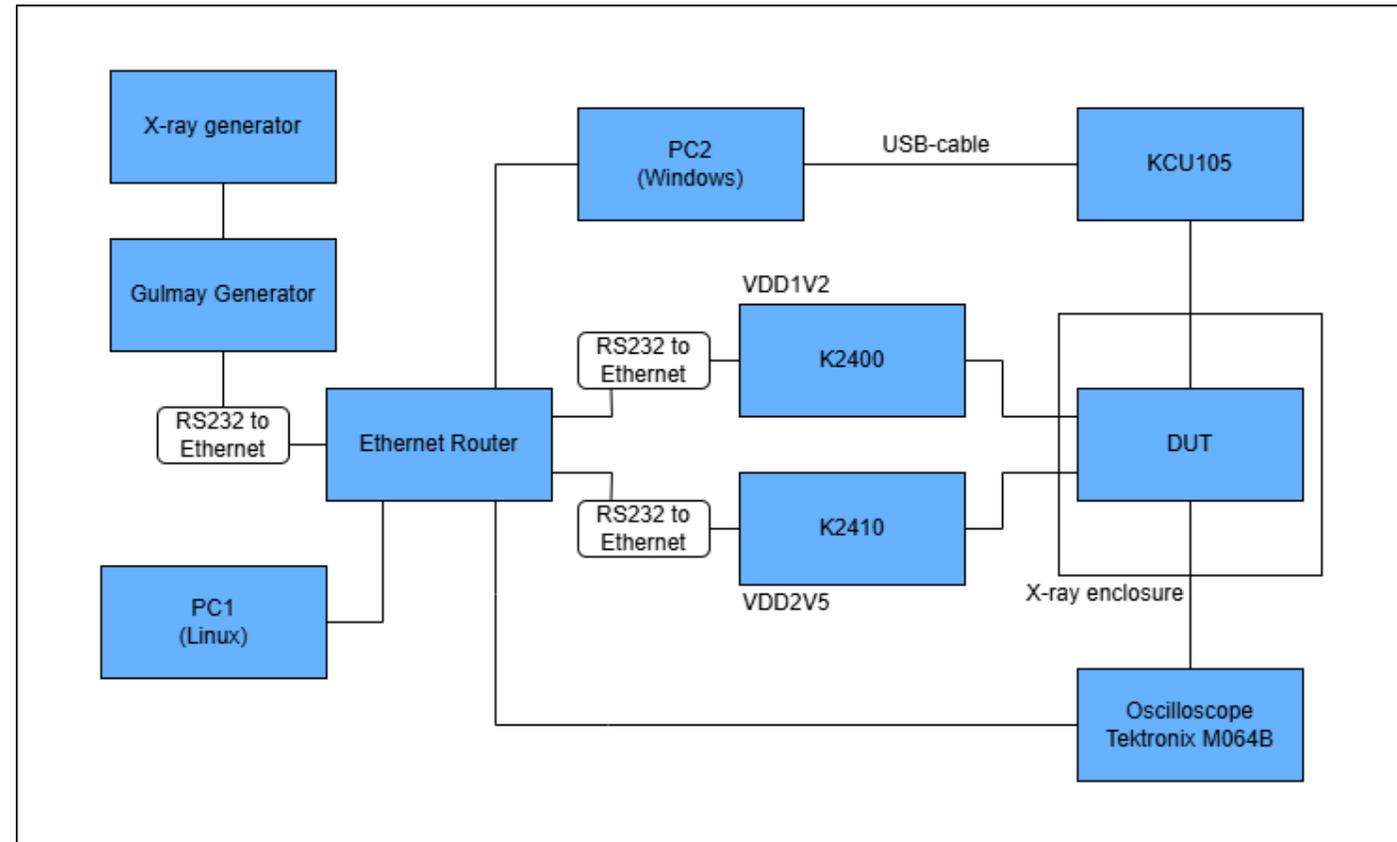
Er1 DUT2 was wire-bonded onto a test board and loaded into the x-ray chamber, aligned and set to a height of 33mm



Automated Irradiation and Measurements

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.

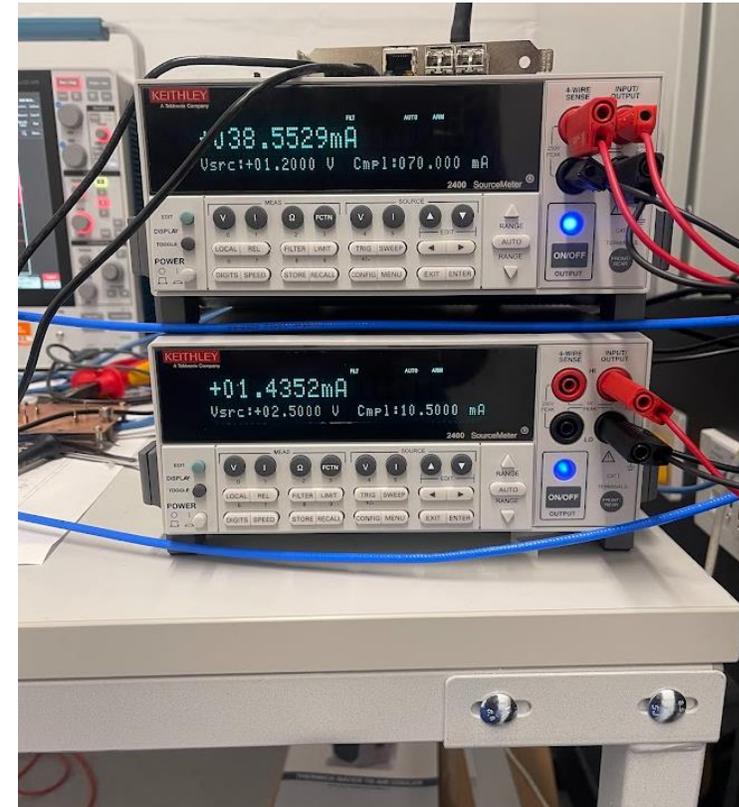


Source meters

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 recorded.



Dose Rate = 104 krad/min

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

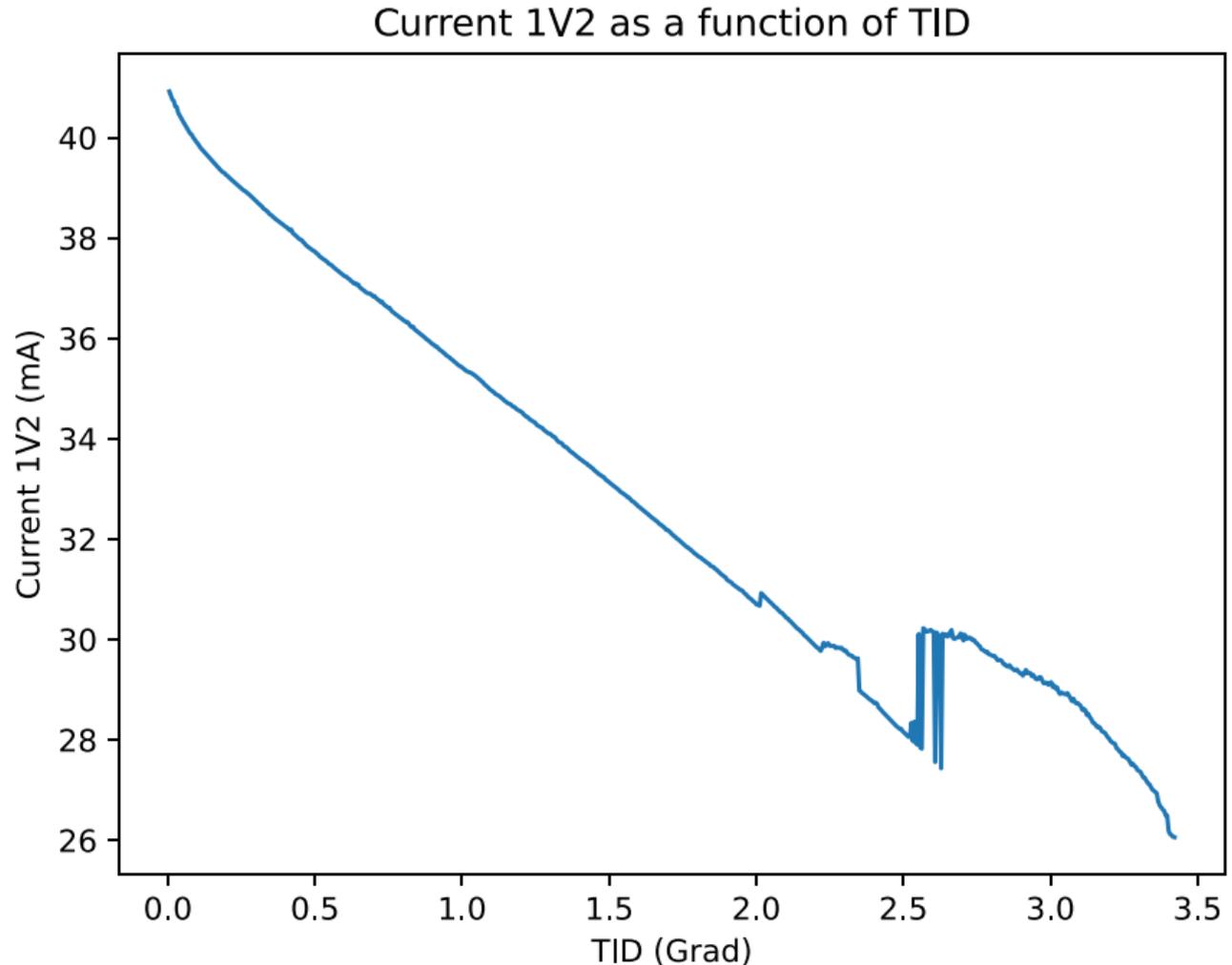
Irradiations began on 04/03/2025 at 12:43:55

Irradiations ended on 27/03/2025 at 16:42:45

ER1 DUT2 was irradiated to a TID of 3.421 Grad.

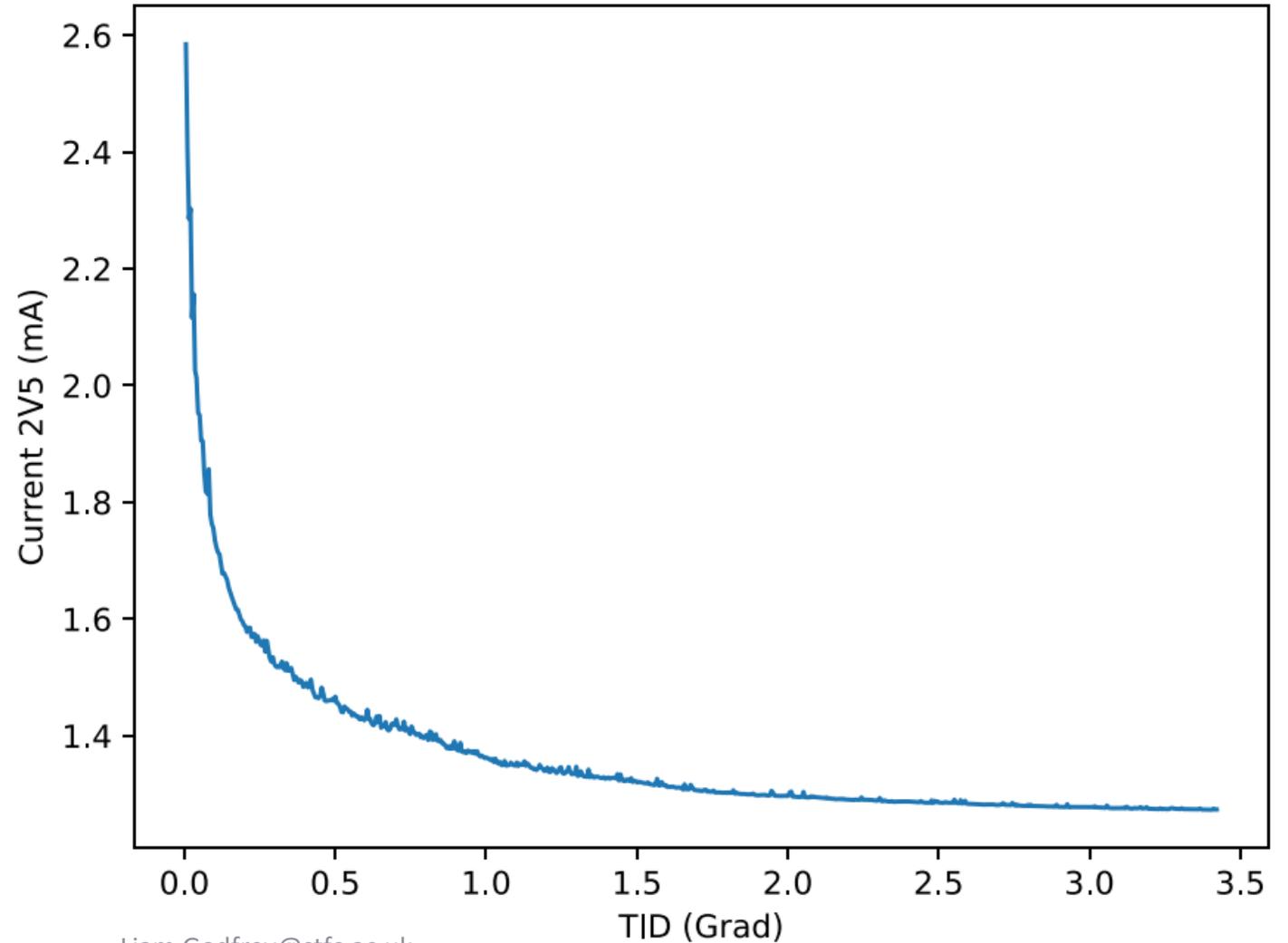
Irradiations 1V2 rail Current measurements

- A smooth linear decrease was seen for the 1V2 rail until ~2.5Grad
- Follows the same trend as DUT1.
- CTLE still working OK, possibly a fault on PLL or I2C.



Irradiations 2V5 rail Current measurements

Current 2V5 as a function of TID

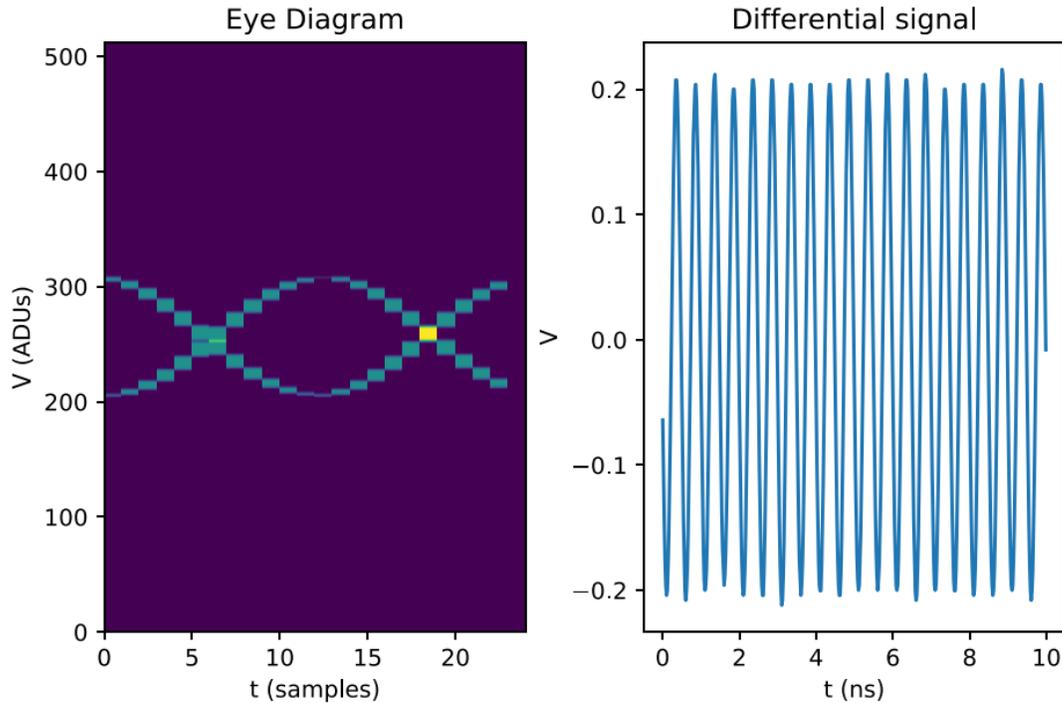


Liam.Godfrey@stfc.ac.uk

Eye Diagrams of Irradiated Chip

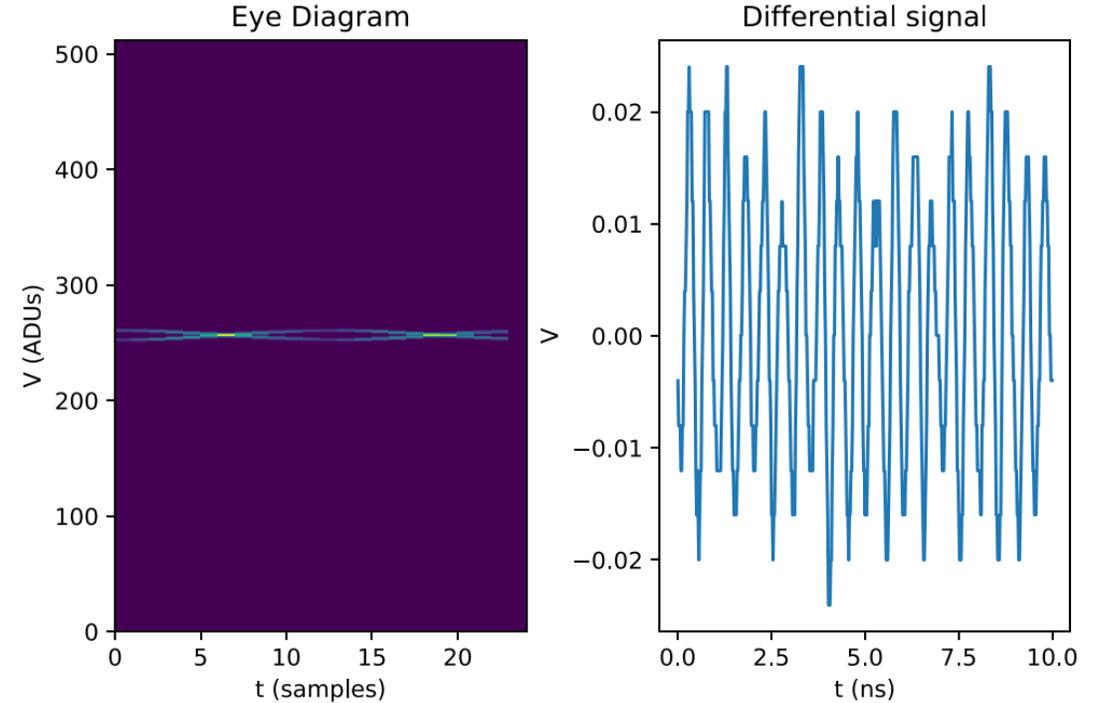
Before first Irradiation

Dataset 2503_001, er1DUT1;
BitRate=4.0Gb/s, Cable Length=3.0 m, txDiffSwing=950mV, test_mode=CLK



After 3.421 Grad of TID

Dataset 2503_687, er1DUT1;
BitRate=4.0Gb/s, Cable Length=3.0 m, txDiffSwing=950mV, test_mode=CLK

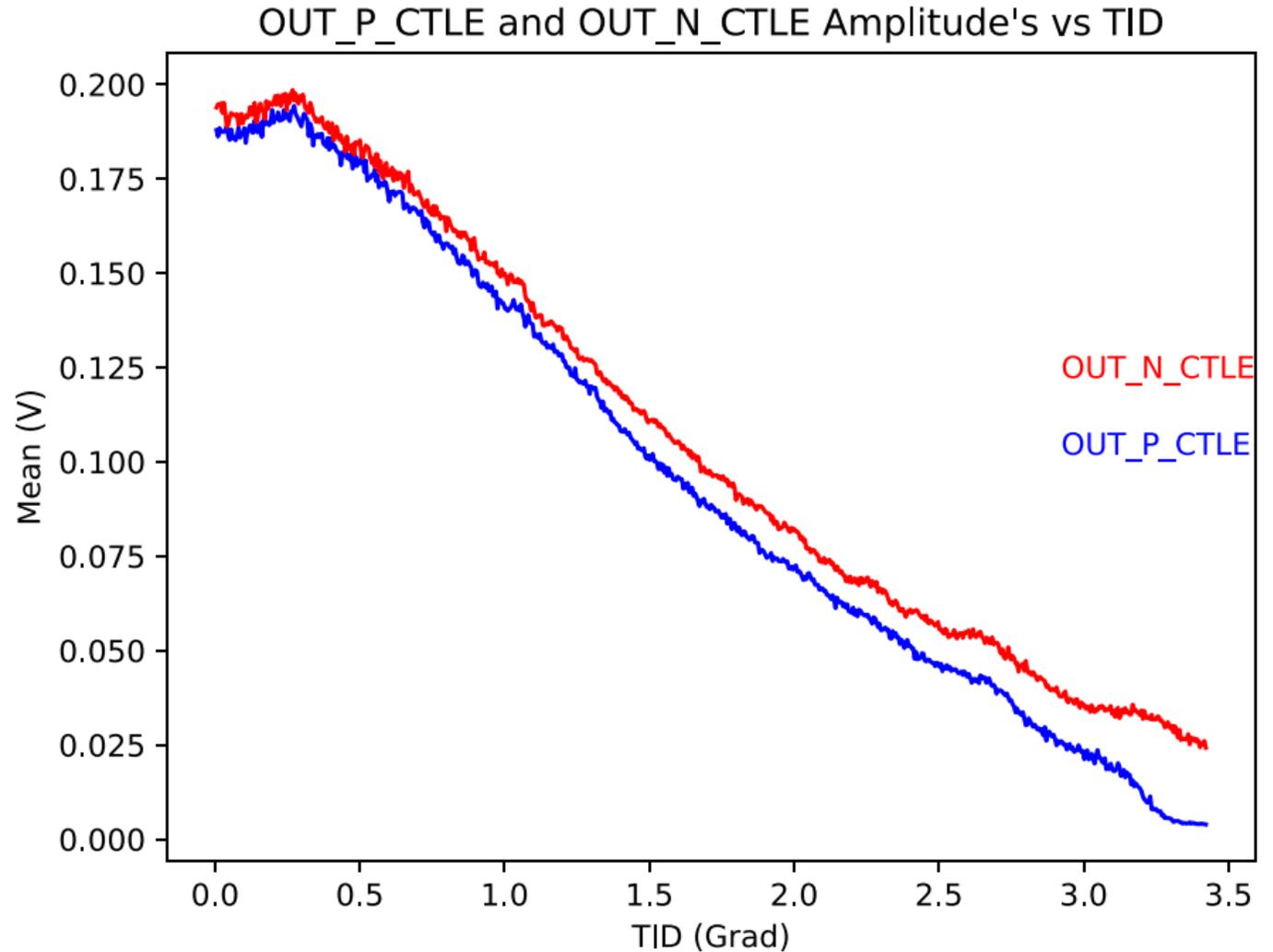


Amplitudes of the signal expectedly decayed over applied TID.
Amplitude started at 0.4V and decreased to 1/10 the initial.

Channel Amplitude Measurements

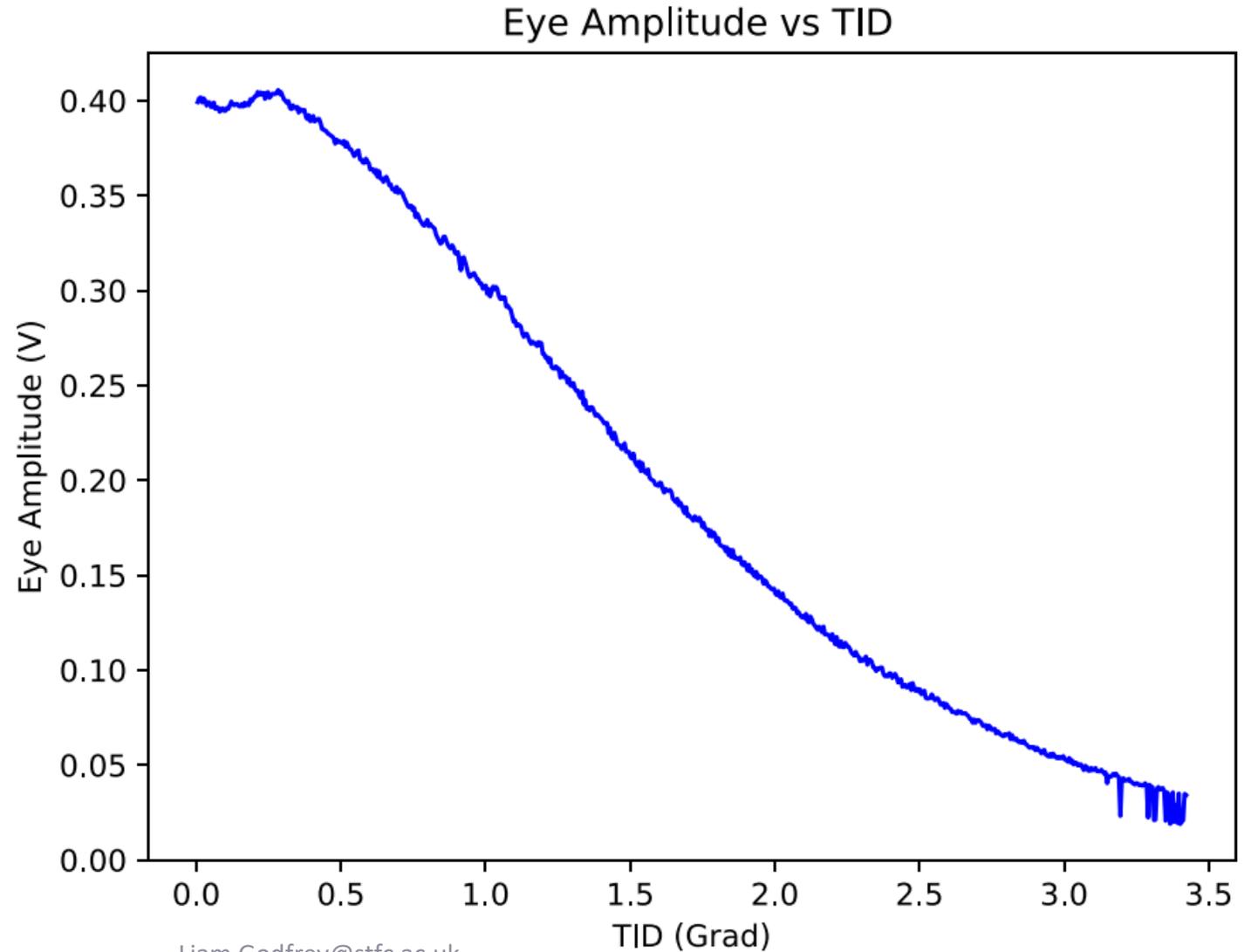
Positive and negative junctions of the differential signals. These depend on 1.2V supply.

CH1: OUT_P_CTLE
CH4: OUT_N_CTLE



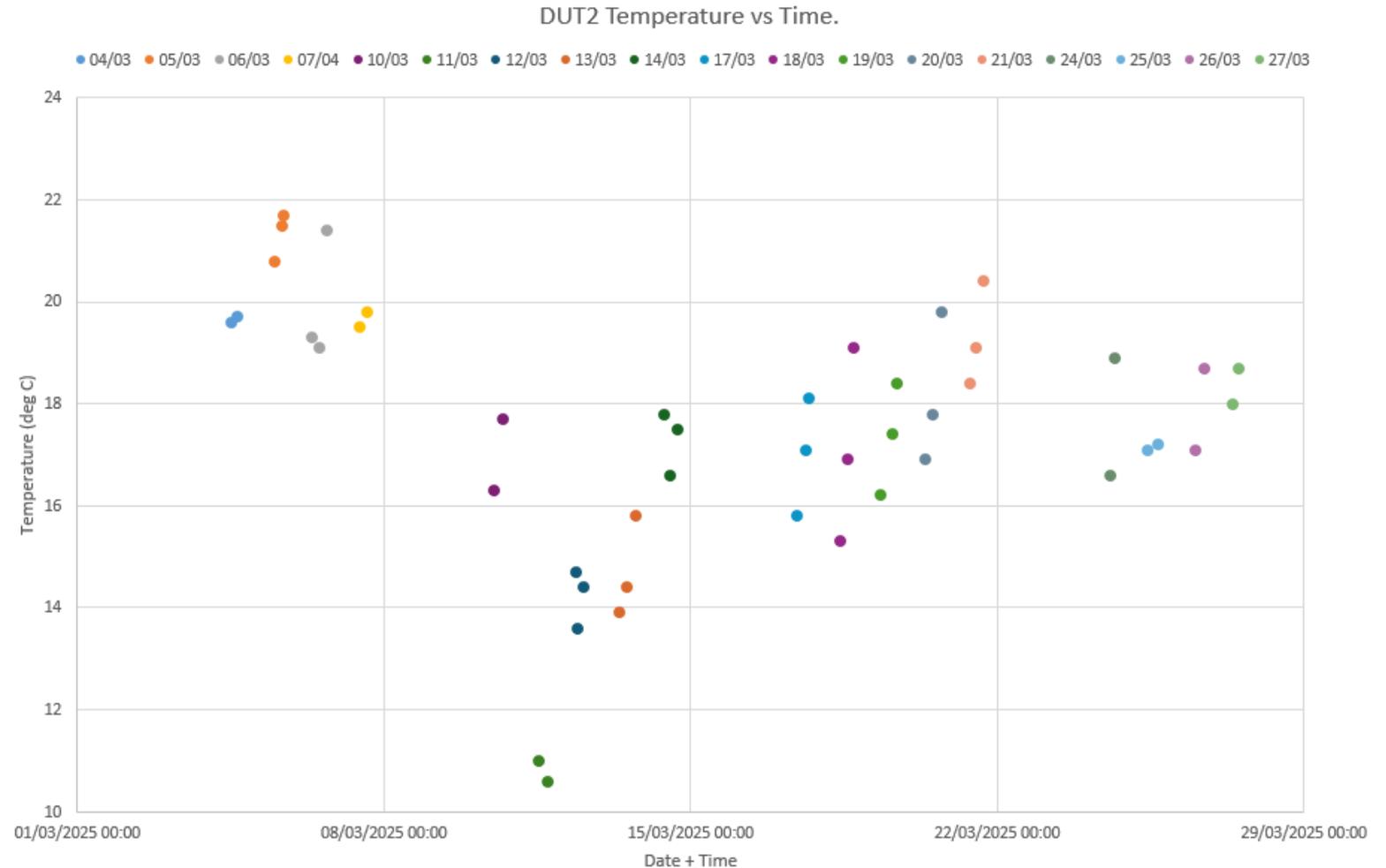
Amplitude of the Eye Diagram

- Difference between the top and bottom of the eye diagram



Board Temperature.

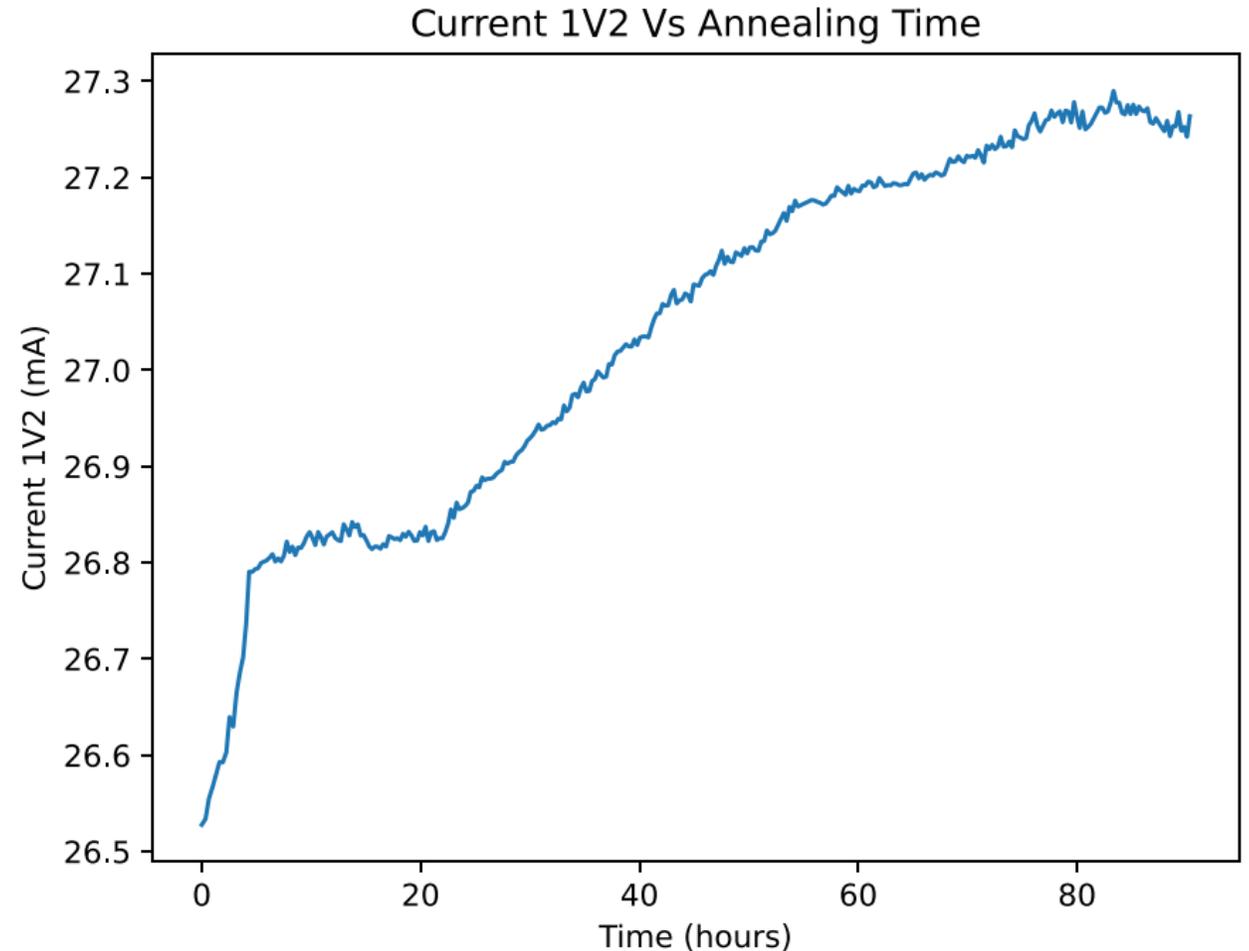
- The temperature of the board was checked 2-3 times a day.
- No correlation between irradiation results and temperature fluctuations



Annealing Effects

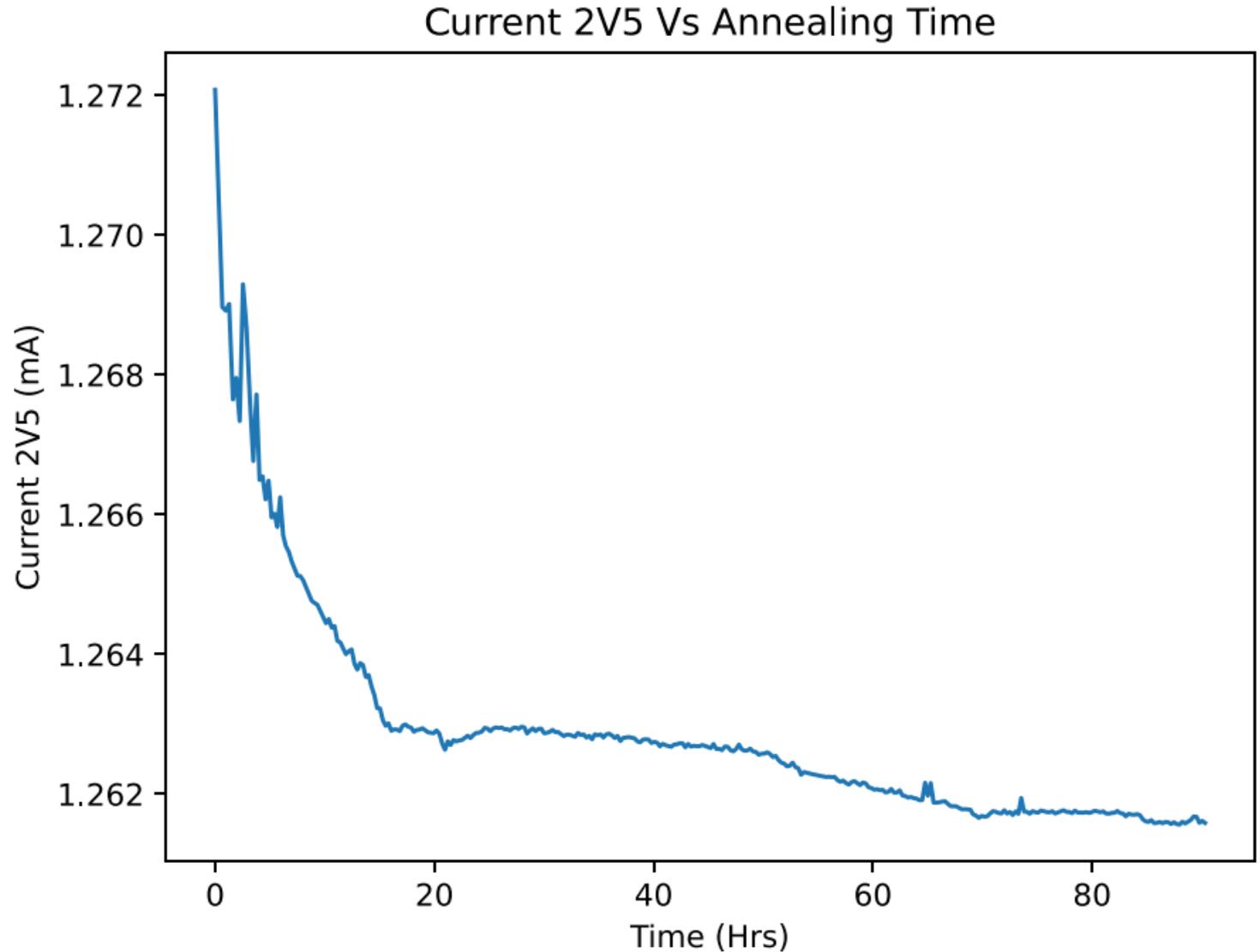
Annealing 1V2 rail Current Measurements

- Annealing measurements for **90** hours after irradiation.
- Expect the reverse to be seen after irradiation.
- Current 1V2 increased.



Annealing 2V5 rail Current Measurements

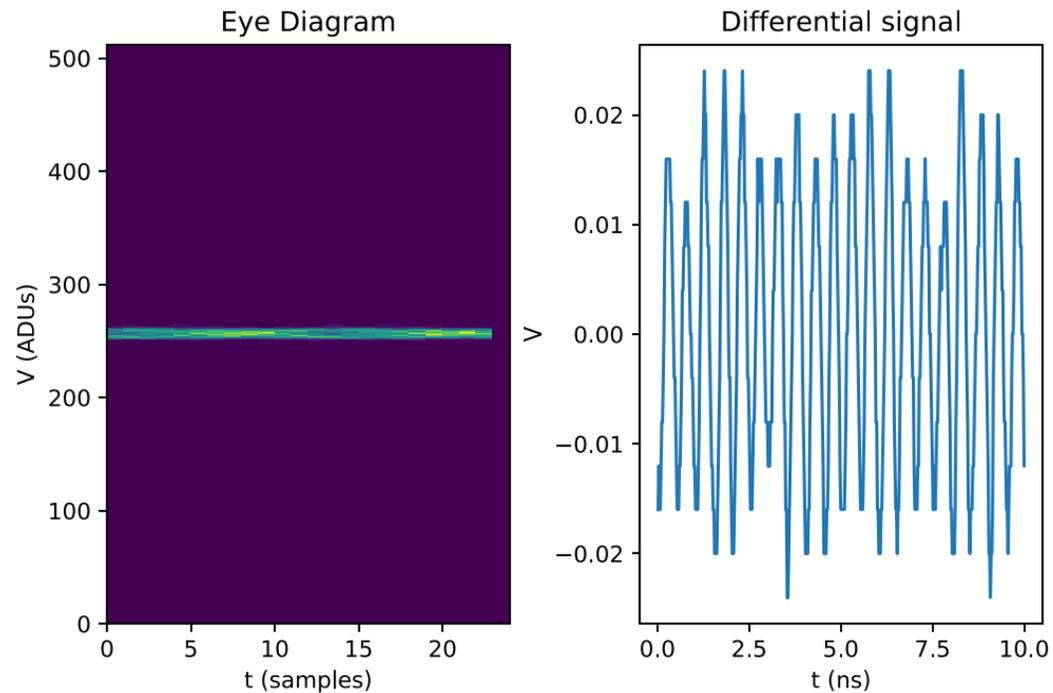
- Continued to decrease slightly.
- Was expected to recover but degraded.



Eye Diagrams throughout Annealing

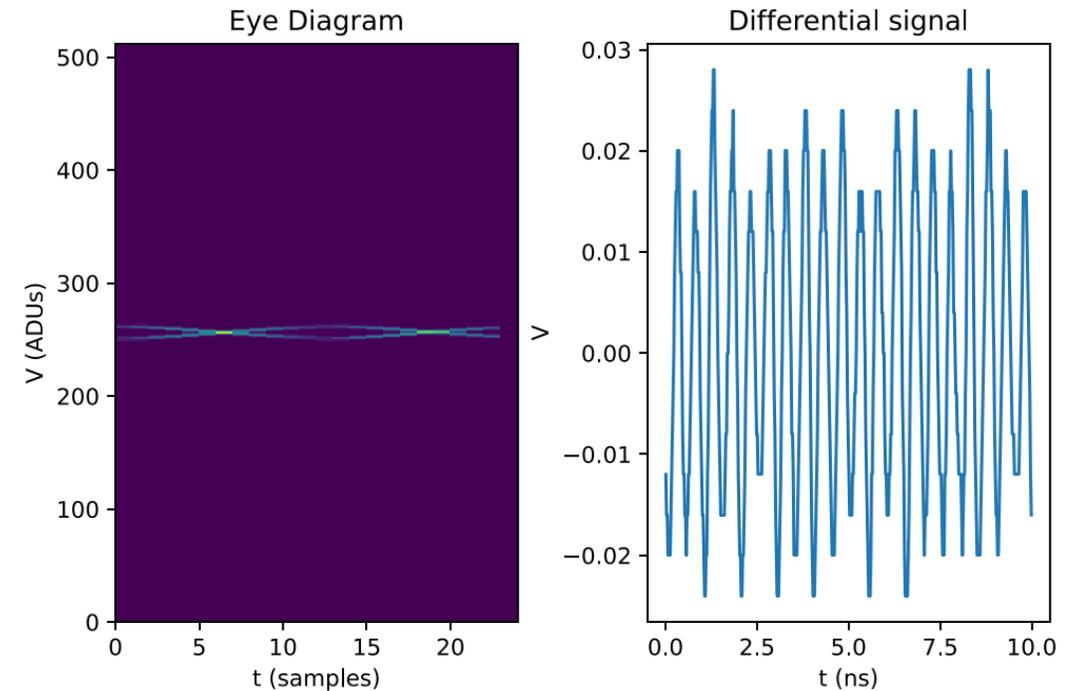
First annealing measurement.

Dataset 2503a_693, er1DUT1;
BitRate=4.0Gb/s, Cable Length=3.0 m, txDiffSwing=950mV, test_mode=CLK



Final annealing measurement.

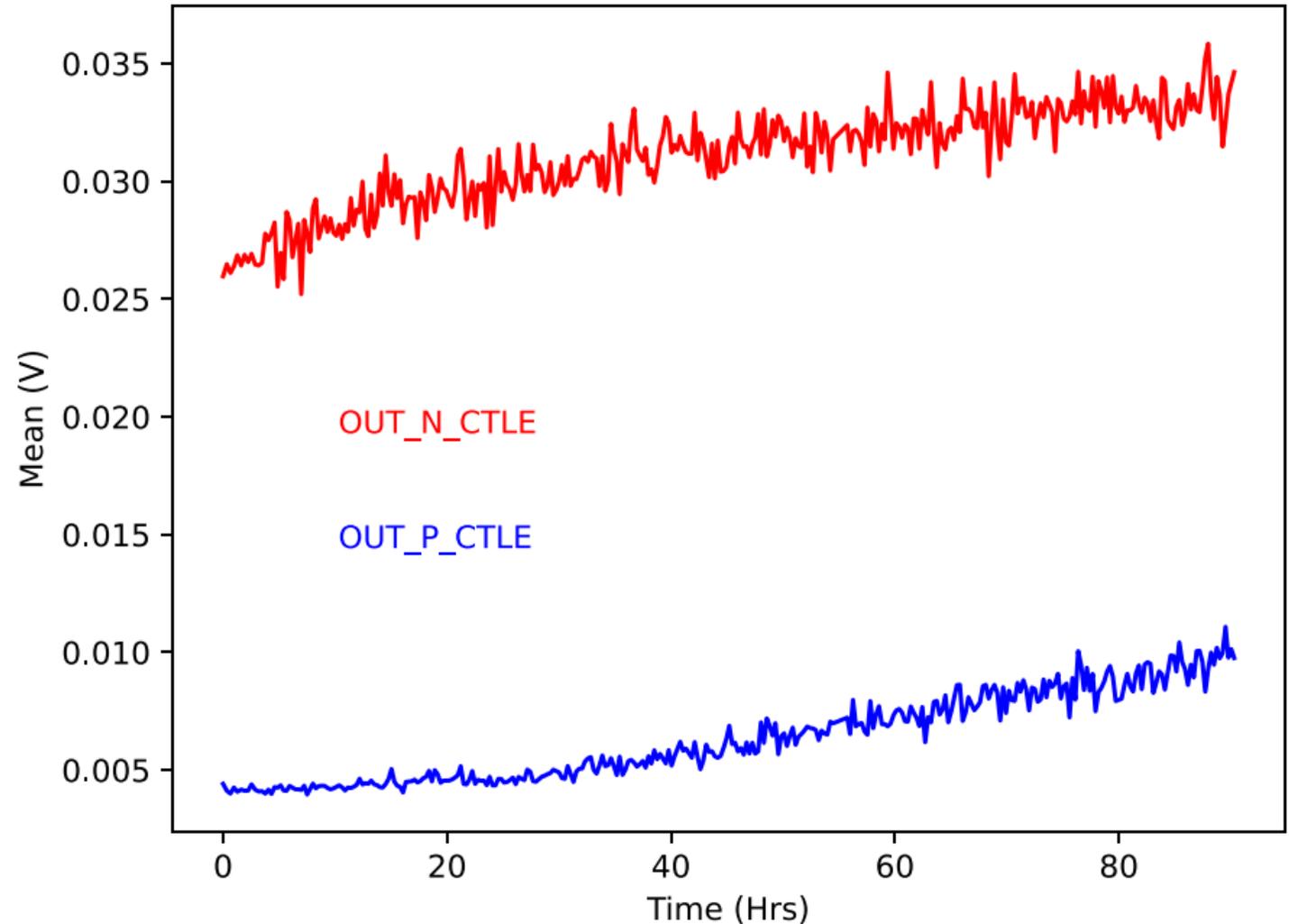
Dataset 2503a_1037, er1DUT1;
BitRate=4.0Gb/s, Cable Length=3.0 m, txDiffSwing=950mV, test_mode=CLK



Channel Amplitudes.

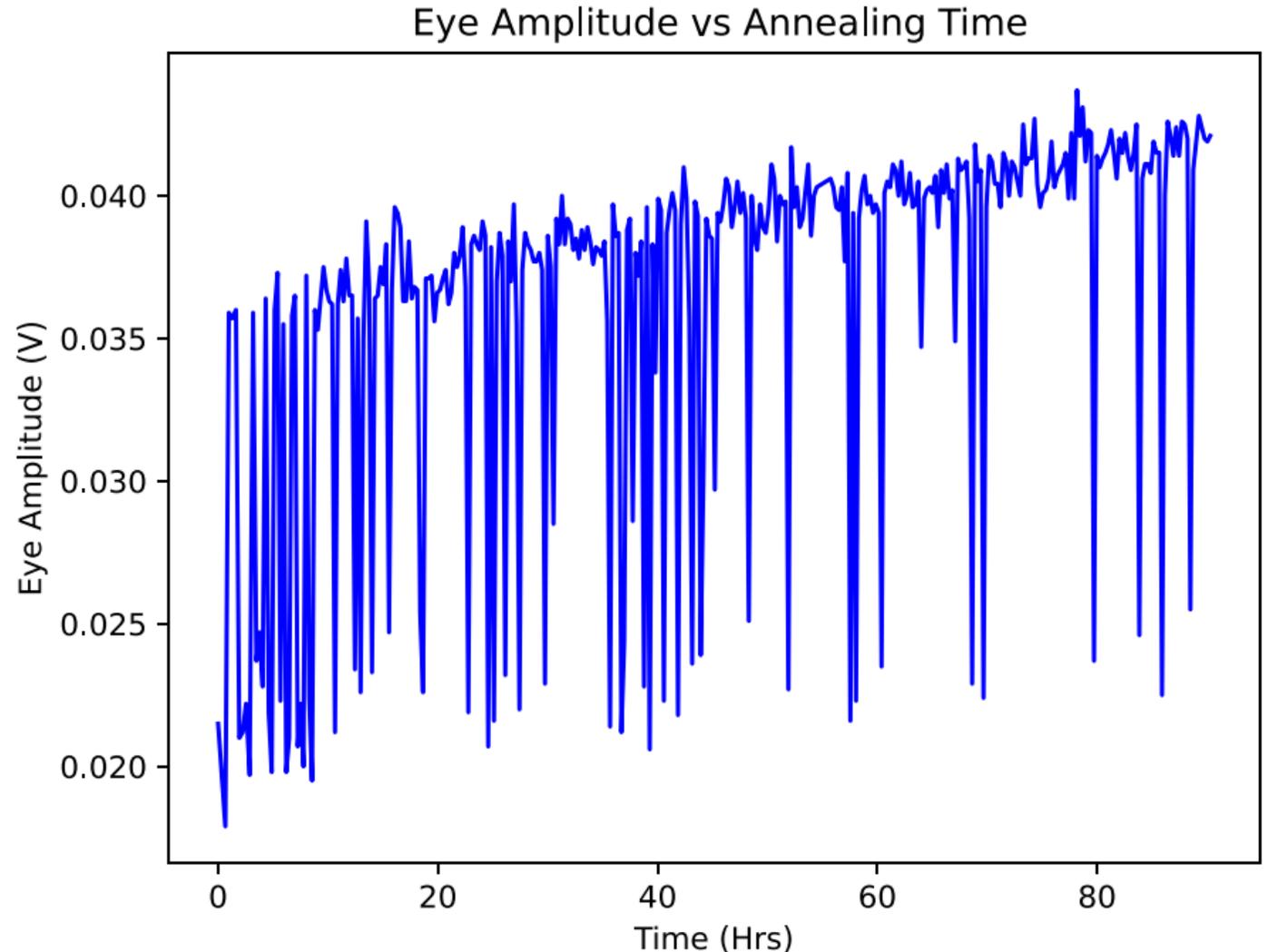
- Recovered over the annealing period

OUT_P_CTLE and OUT_N_CTLE Amplitude's vs Annealing Time



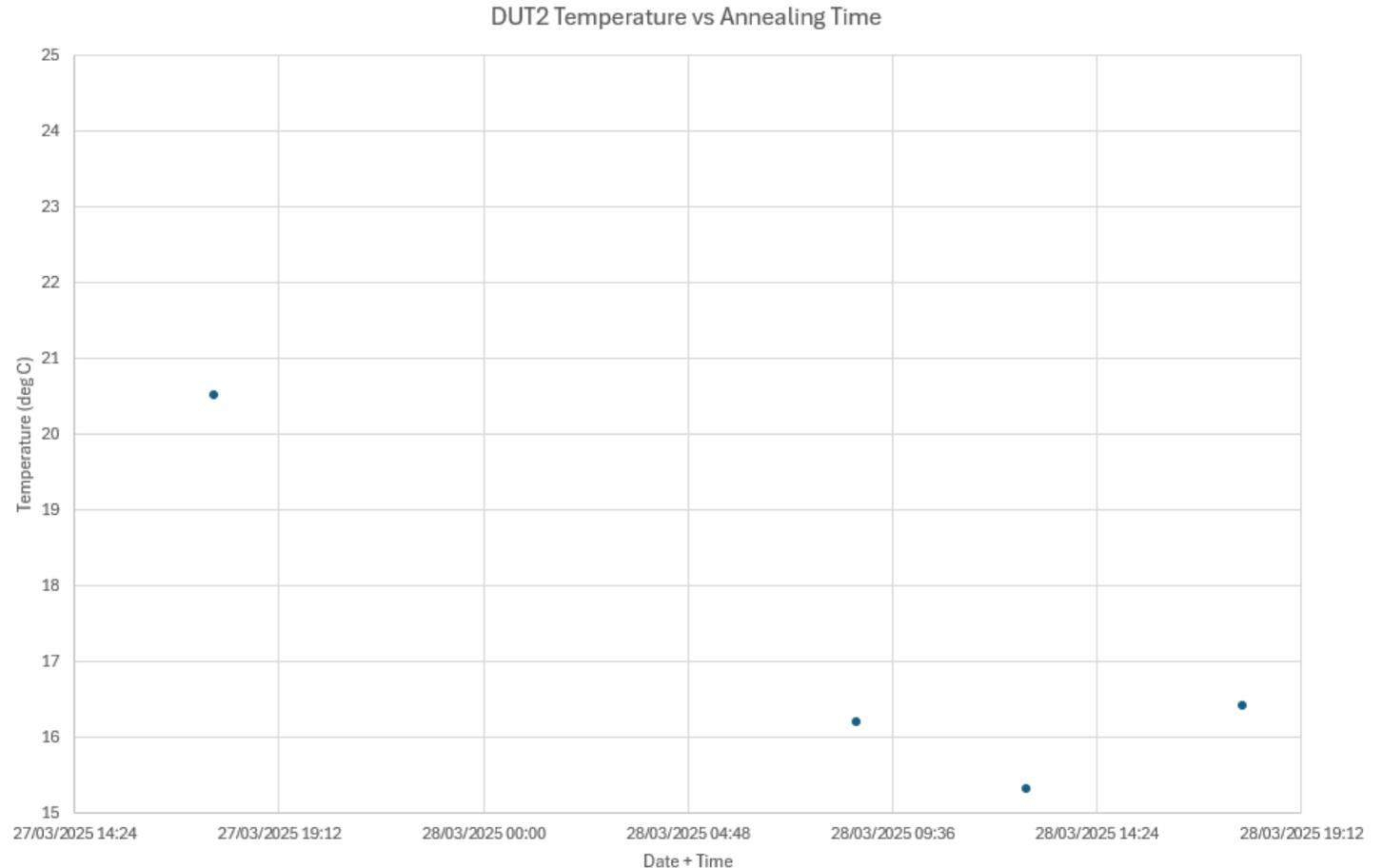
Amplitude of the Eye Diagram

- Slight increase over time.
- Many points plotted with much lower Amplitude. Shown in eye diagrams.



Board Temperature.

- The temperature of the board was checked when irradiation stopped and annealing started.
- Temperature was measured the following day.
- Following days of annealing Temp was not measured



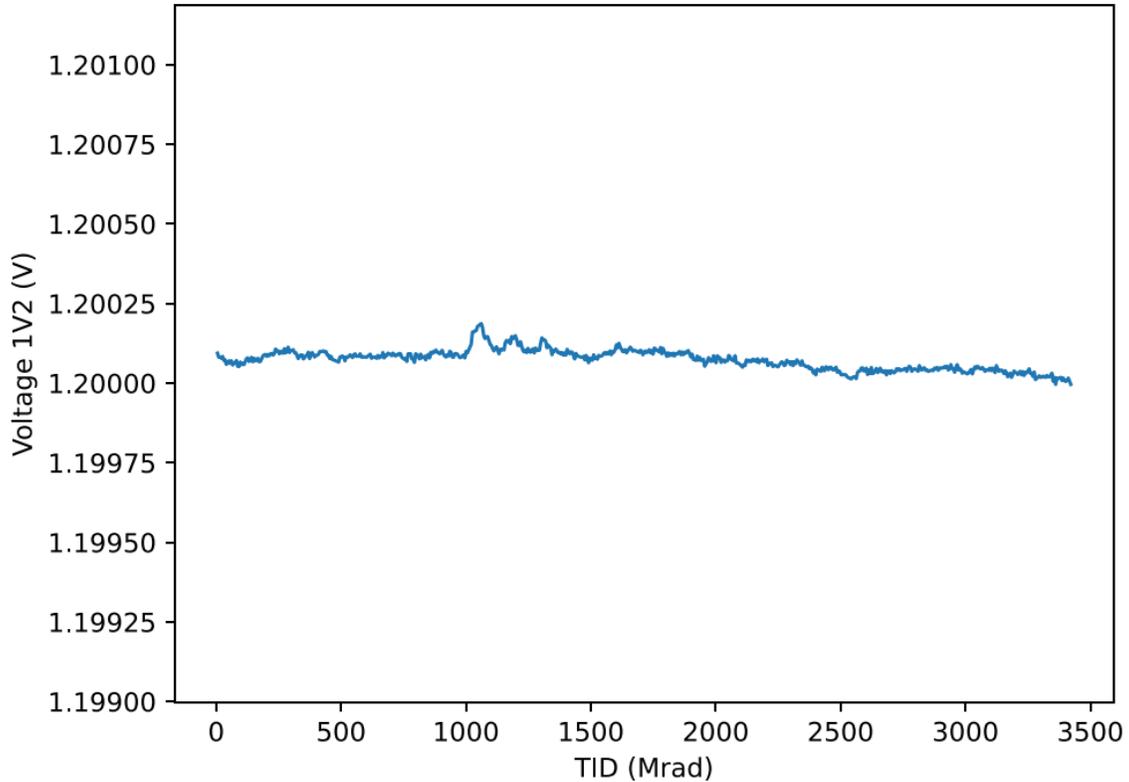
Conclusion

- Er1 DUT2 was irradiated up to ~3.4 Grad
- Tests performed only on CTLE block
- Measured degradation of supply currents and eye amplitude during irradiation
- Monitored annealing for ~90hrs

Back-up

Supplied Voltage.

Voltage 1V2 as a function of TID



Voltage 2V5 as a function of TID

