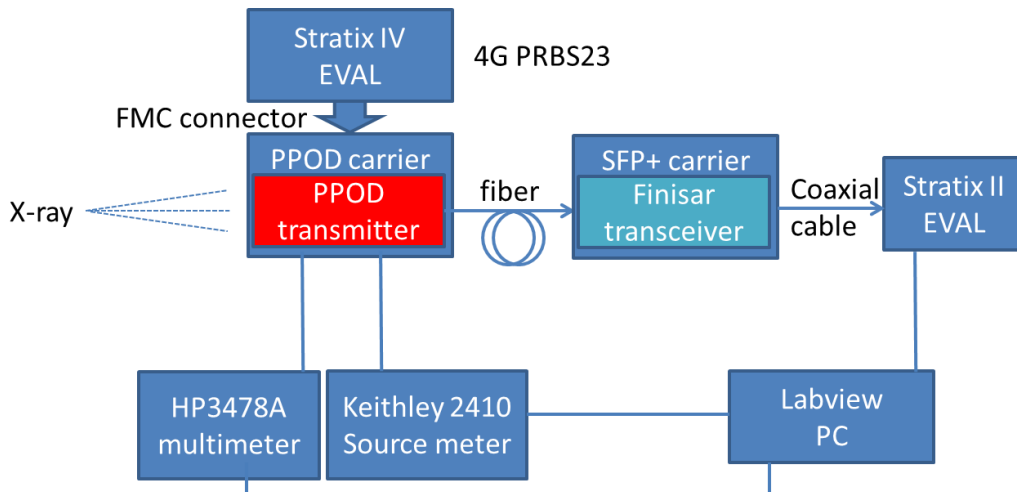


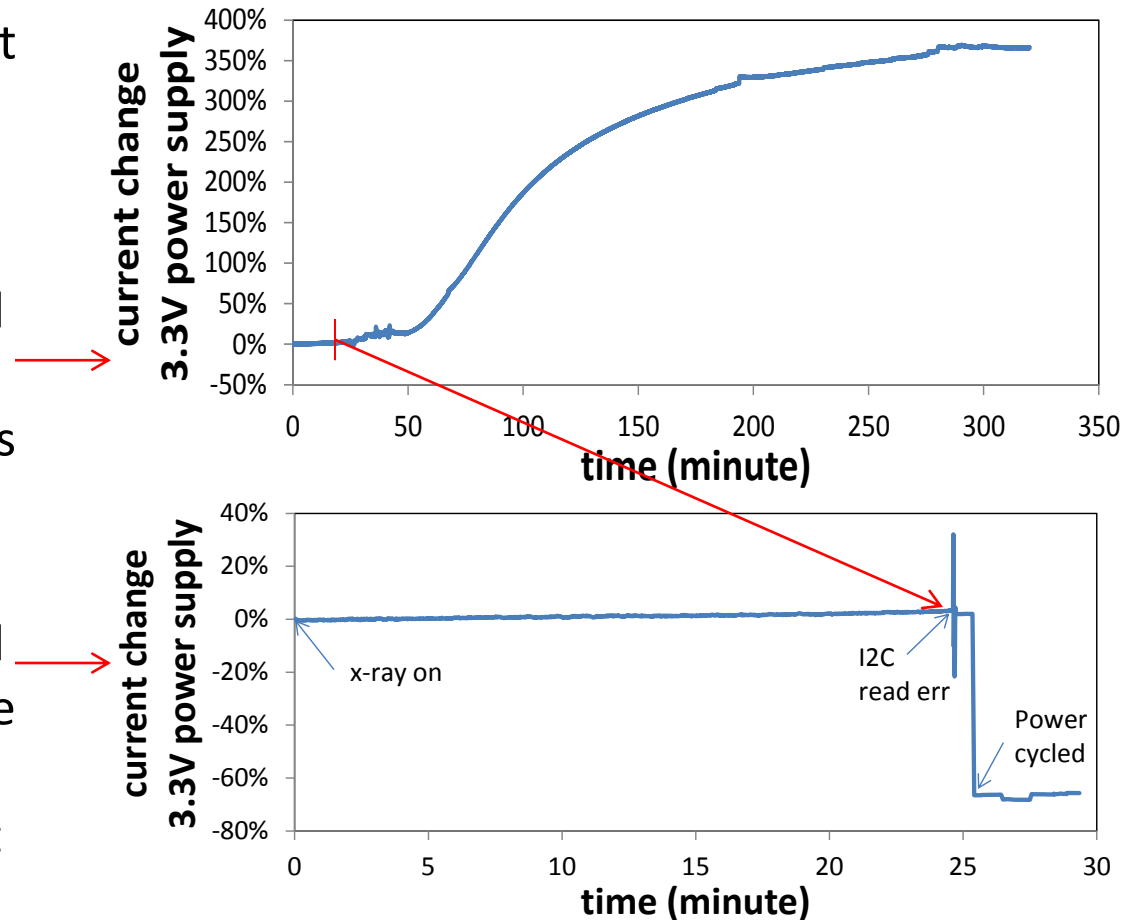
# Irradiation Test of PPOD

- Three optical transmitters (Part# **AFBR-810EPZ** manufactured by **AVAGO**), have been tested with **x-rays**.
- The dose rate of the x-rays is **360 krad(SiO<sub>2</sub>)/hour**.
- In lab x-ray tube X-RAD iR-160. The maximum energy of x-rays is 160 keV.
- During the tests, **2<sup>23</sup>-1 pseudo-random binary sequence (PRBS)** is sent through the module under test and checked errors with a Altera Statix IV GT FPGA. The data rate is **4 Gbps**.



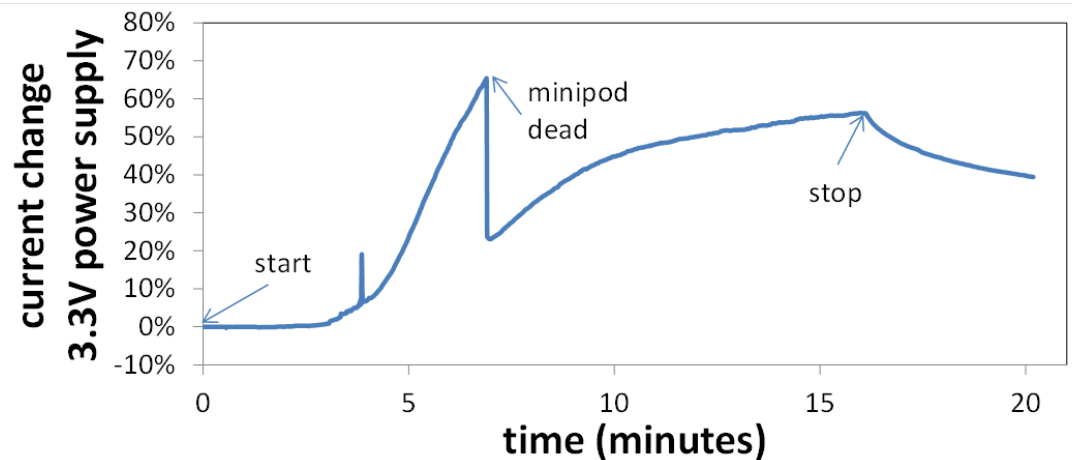
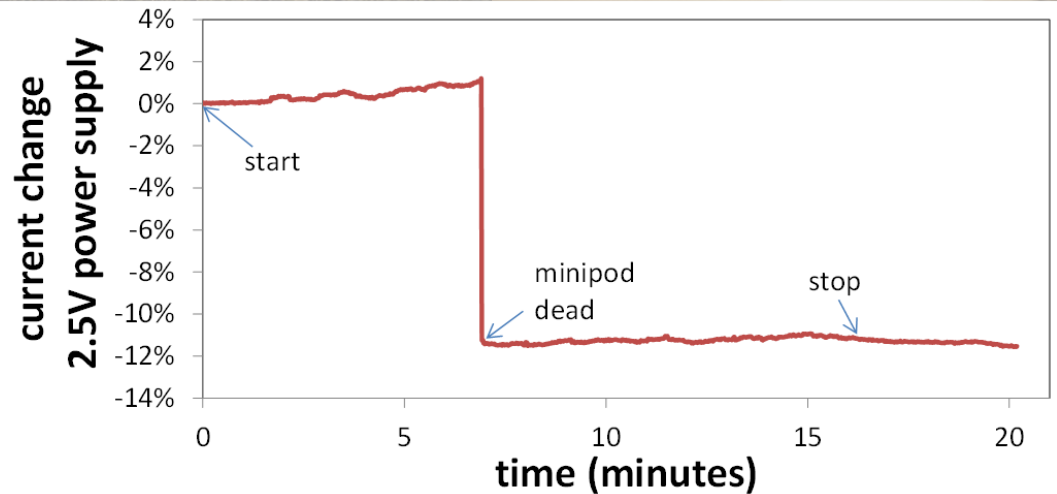
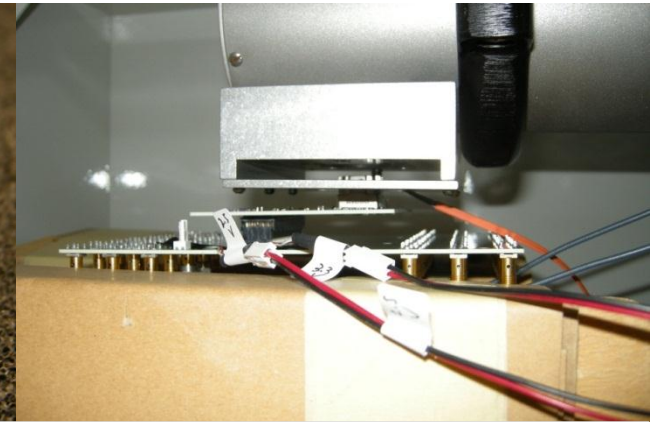
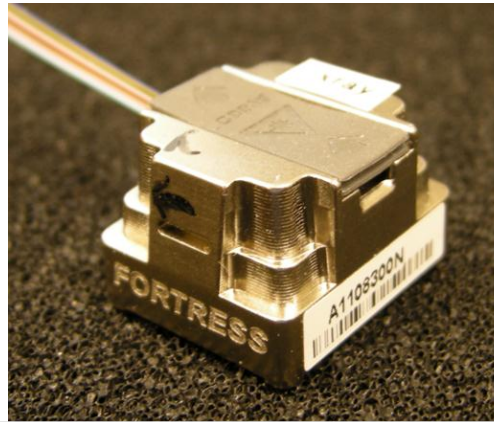
# Irradiation test of PPOD

- The first module survived **3.86 Mrad(SiO<sub>2</sub>)**. After all the test setup was moved to the lab, the module was found dead (no light).
- The second module survived **1.92 Mrad(SiO<sub>2</sub>)**. After a power cycle, the module was found dead, no light and no I2C access.
- The third module was tested with periodically power cycle and I2C write/read. The modules stopped working at **150 krad(SiO<sub>2</sub>)**.



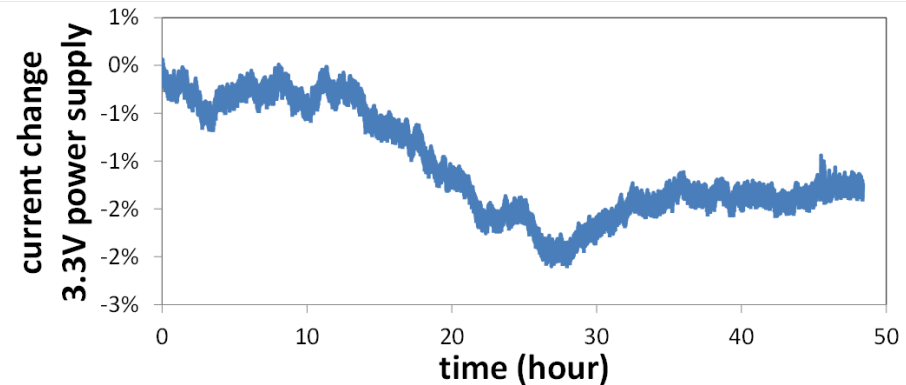
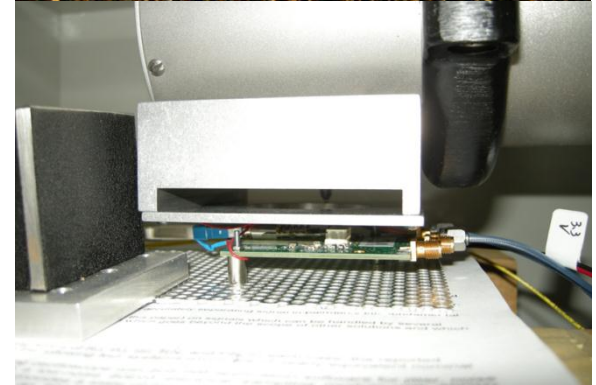
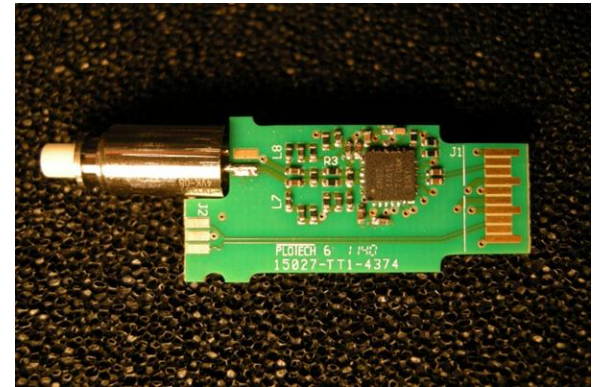
# Irradiation Test of miniPOD

- DUT Avago AFBR-811FN1Z
- The minipod transmitter worked for 11 minutes under x-ray before failed.
- The minipod transmitter was power cycled, but it didn't recover to work.
- **Dose rate is 360 krad/hour and total dose is 66 krad.**



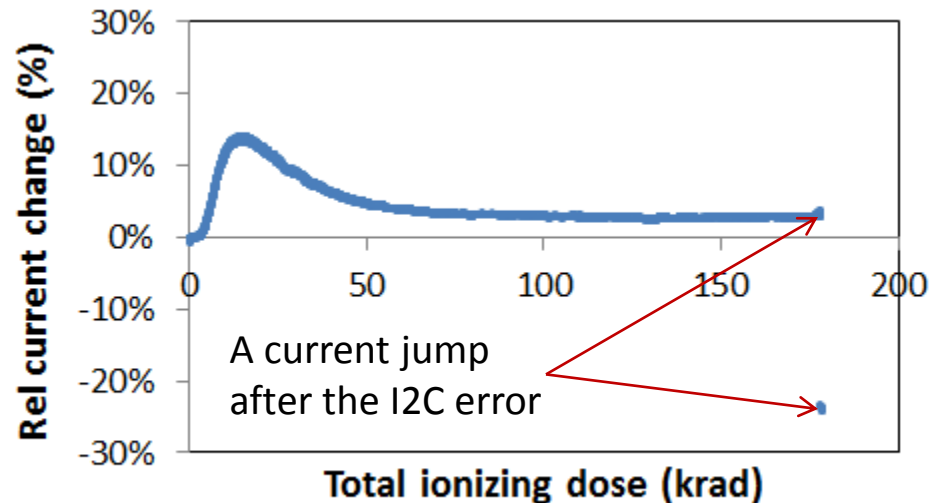
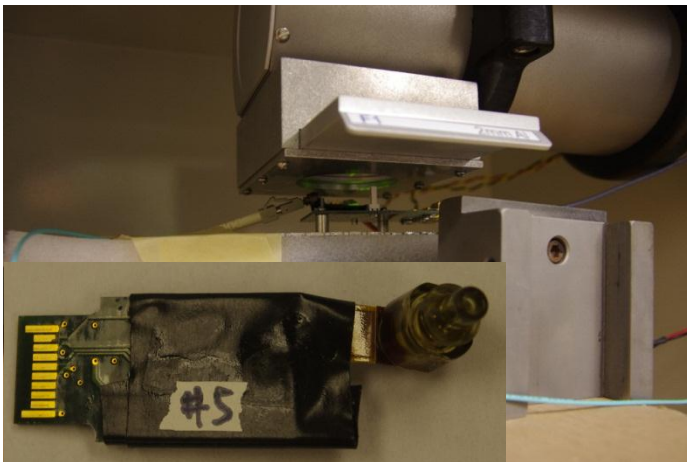
# Irradiation Test of ONET1101L

- DUT: ONET1101L from TI
- A modules survived **gamma rays up to 900 krad at 10 krad/hr** at BNL. After the setup was power cycled, the device stopped working (no light output).
- Another module was tested with power cycle and I2C read scheme. **Dose rate was 9.6krad/hour. The device stopped working at 464 krad.** The current changed up to -2.10%. Between the last configuration was readout successfully and the last power cycle, the current kept regular value and there was no error. After the last power cycle the ONET1101 couldn't be configured by I2C interface and the optical link lost link.



# Irradiation Test of ONET8501V

- DUT: ONET8501V from TI.
- **PRBS 2<sup>23</sup>-1 at 5 Gbps.**
- **X-ray machine X-RAD iR-160**
- The dose rate is **39 krad/hr**
- During the test, the power was **cycled every about 1.5 minutes**. After each power cycle, the ONET8501V was **configured** via the I<sup>2</sup>C interface and the configuration also was **read** back via the I<sup>2</sup>C interface.
- **The device stopped working at 178.0 krad.**



# COTS test result summary

- QSFP, miniPOD, PPOD, ONET8501V, ONET1101L have been tested with x-ray or gamma rays. None of them meet the calorimeter radiation requirement.
- A neutron beam have been booked at Los Alamos in October. Kintex 7, PPOD, and ONET8501 will be tested. A proton test will be done in December.

	Vendor	Part#	Data rate (gbps)	# of ch	Rad type	Dose rate (krad/hr)	Total dose (krad)
QSFP	Avago	AFBR-79EIDZ	10	4	$^{60}\text{Co } \gamma$	10	75
miniPOD	Avago	AFBR-810FN1Z	10	1	x-ray	360	66
PPOD	Avago	AFBR-810EPZ	10	12	x-ray	360	150
VCSEL driver	TI	ONET8501V	10	1	x-ray	39	178
F-P laser driver	TI	ONET1101L	10	1	x-ray	9.6	464
					$^{60}\text{Co } \gamma$	10	< 900