Environmental Tests at SMU

Opto Workshop
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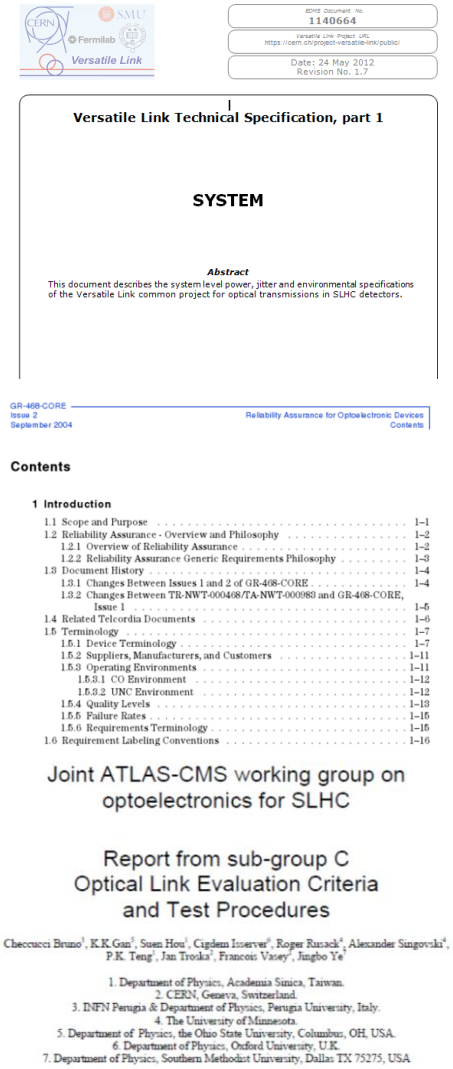
Outline

- Introduction
- Poor-man’s temperature chamber
- X-ray facility
- Summary and future Needs

Introduction

- Temperature tests required in standards
  - Functional tests
  - Reliability or accelerated life test
  - Production QA
- Radiation tolerance qualification
  - TID
  - SEU
- Application specific system margin exploration
  - High temperature back-end (Operating temperature tested from 0°C to 70°C)
  - Low temperature front-end (Operating temperature tested from -30°C to 50°C)
  - Radiation induced RIA (not to exceed assigned loss budget up to the cumulated fluence/dose)



Versatile Link

EDMS Document No. 1140664

Versatile Link Project URL https://cern.ch/project-versatile-link/public/

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Versatile Link Technical Specification, part 1

SYSTEM

Abstract

This document describes the system level power, jitter and environmental specifications of the Versatile Link common project for optical transmissions in SLHC detectors.

GR-468-CORE
Issue 2
September 2004

Reliability Assurance for Optoelectronic Devices
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Joint ATLAS-CMS working group on optoelectronics for SLHC

Report from sub-group C
Optical Link Evaluation Criteria and Test Procedures

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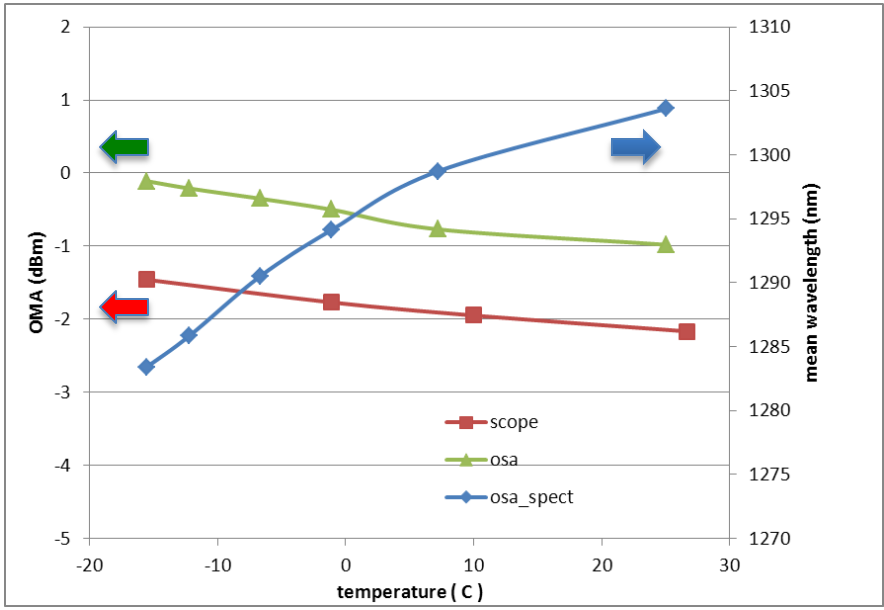
Temperature Tests

- Setup at SMU
  - Chest freezer with dry ice
  - Hot oven

- Temperature stability requirement
  - Enough time to calibrate temperature with wavelength
  - Enough time to run BER vs. OMA curve



Temperature Tests

- Downlink base: FINA1310Tx – VRx (room temperature), 2m fiber
- Downlink demo: FINA1310Tx (70 ° C) - VRx (-25 ° C), 150m fiber
- Less than 0.5 dB penalty observed

- Uplink base: VTx – FINA1310Rx (room temperature), 2m fiber
- Uplink demo: VTx (-25C) – FINA1310Rx(70C), 150m fiber
- Less than 0.5 dB penalty observed

- Downlink base: FINA1310Tx – VRx (room temperature), 2m fiber
- Downlink demo: FINA1310Tx (70 ° C) - VRx (-25 ° C), 150m fiber
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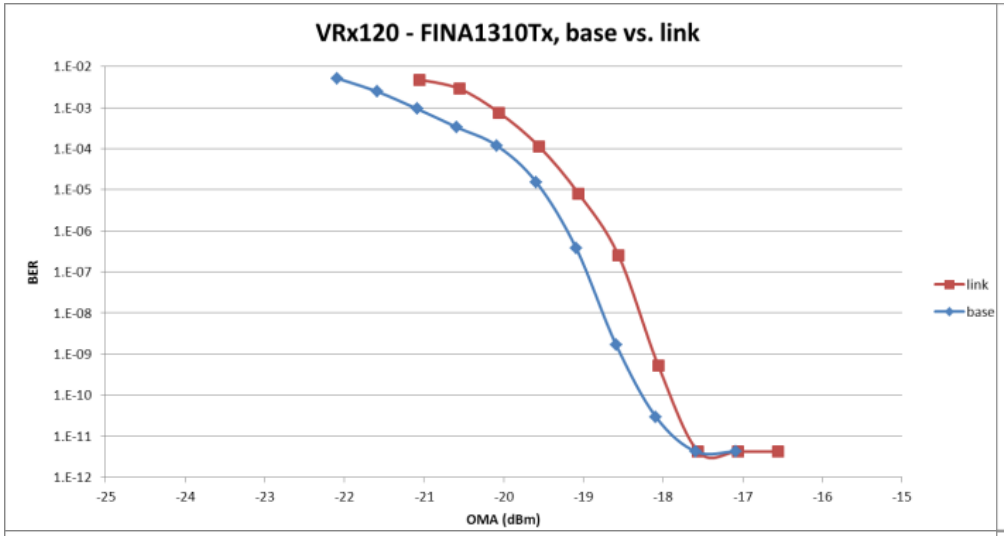
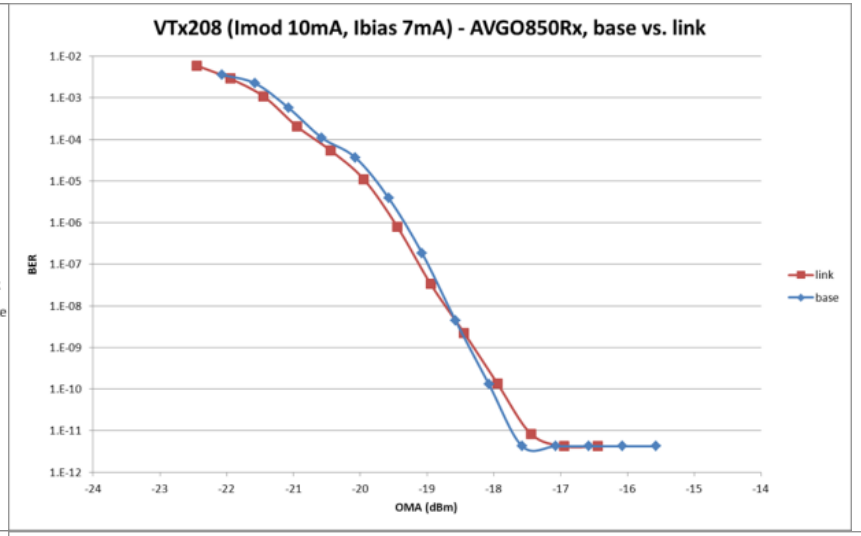
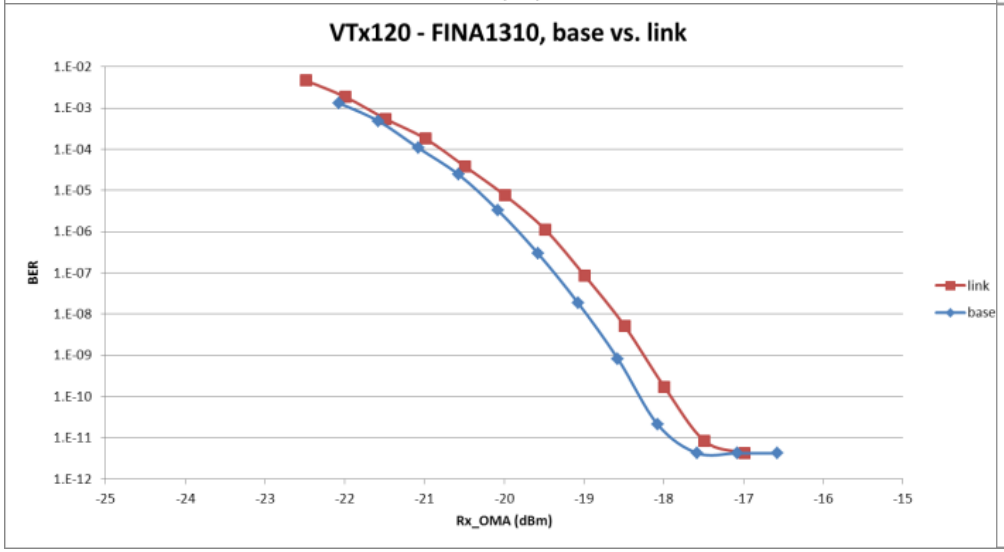
- Uplink base: VTx – FINA1310Rx (room temperature), 2m fiber
- Uplink demo: VTx (-25C) – FINA1310Rx(70C), 150m fiber
- Less than 0.5 dB penalty observed

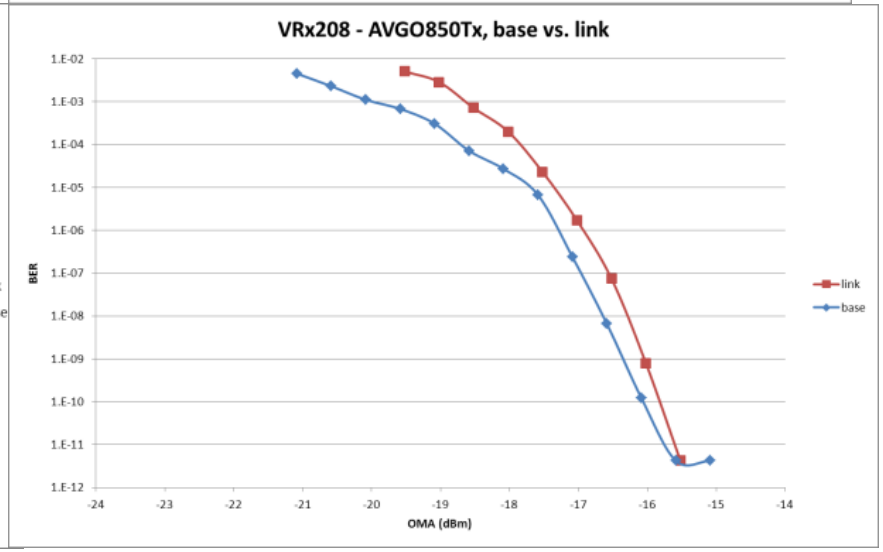
- Wavelength shifts impose minimal effect on power budget per link model simulation
- Less than 0.08dB is estimated for Rη change around 1310nm, and less than 0.06dB is estimated for Pattn change around 850 nm

Temperature Tests









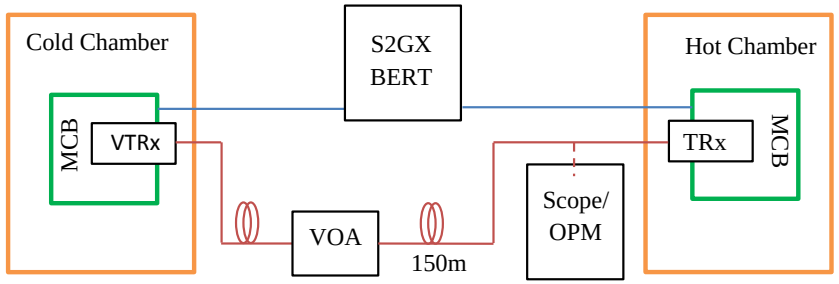
Temperature Tests

- Collaboration with FNAL and set up the demo link test with two environmental chambers

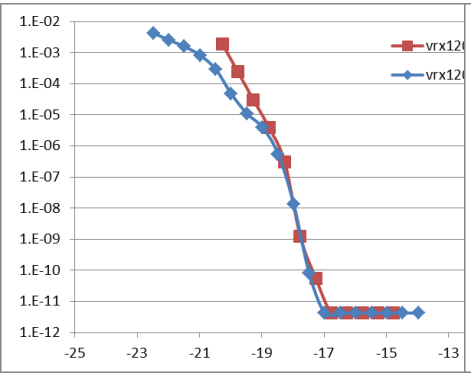
CSZ - neg 25C

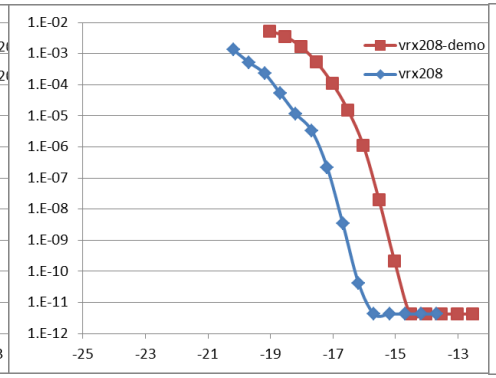
Fisher Scientific – 70C

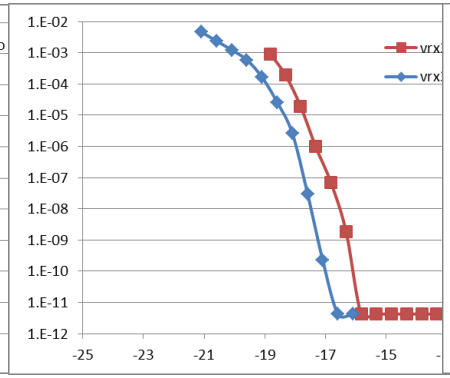
- VTRx 120, 208, 302, 408@ cold chamber
- Finisar 850, 1310 @ hot chamber

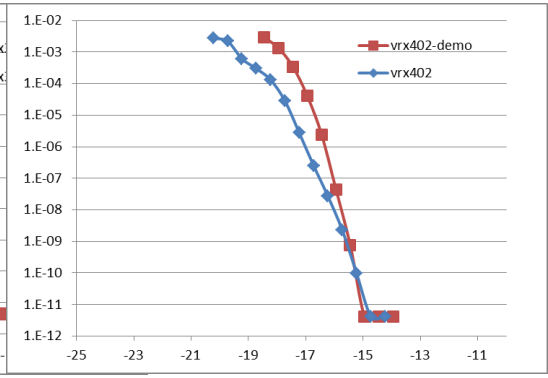


Temperature Tests

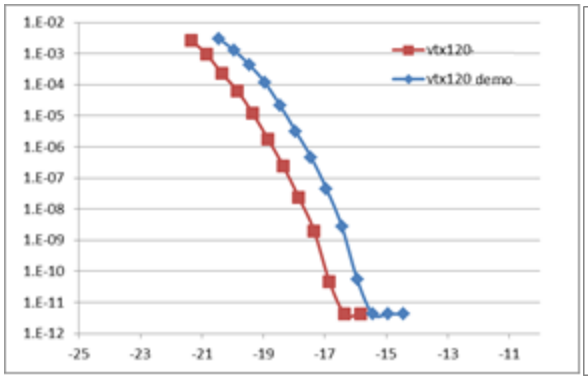


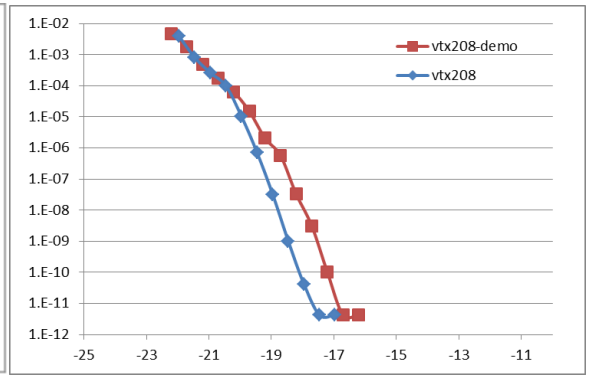






Ref_Tx to VRx 120, 208, 302, 402, base – blue, demo link - red





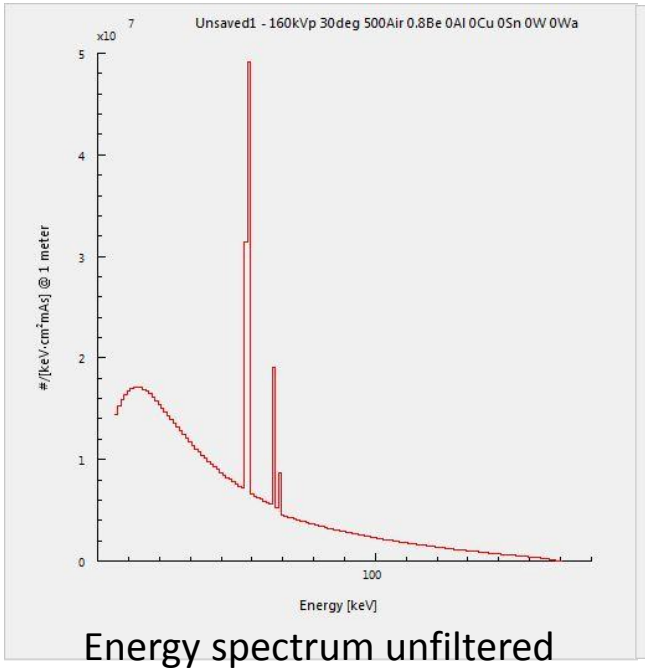
VTx 120, 208 to ref_Rx, base – blue, demo link - red

- Base: FINA1310TRX – VTRx (room temperature), 2m fiber
- Demo: FINA1310TRx (70 ° C) - VTRx (-25 ° C), 150m fiber
- Less than 1 dB penalty observed
- Note: VTRx302 Tx faulted, VTRx408 Tx suffer from insufficient FPGA drive amplitude.

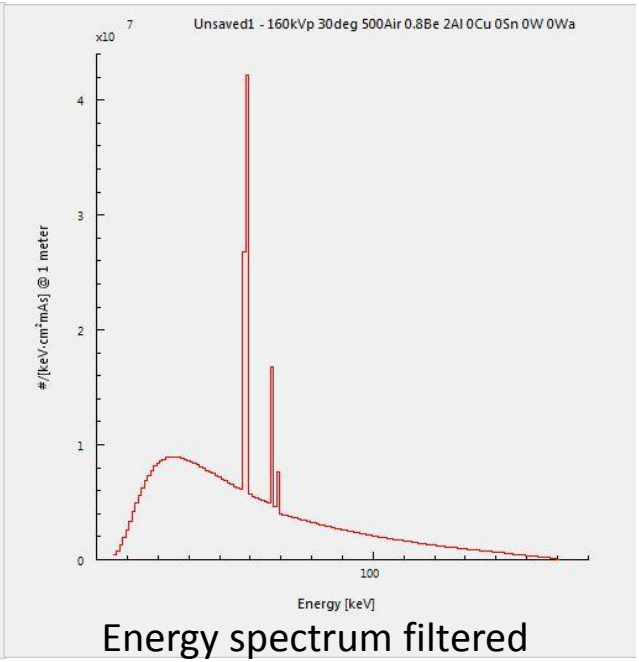
Extended operation temperature contribution to link penalty on surveyed links do not exceed specification

X-ray tests

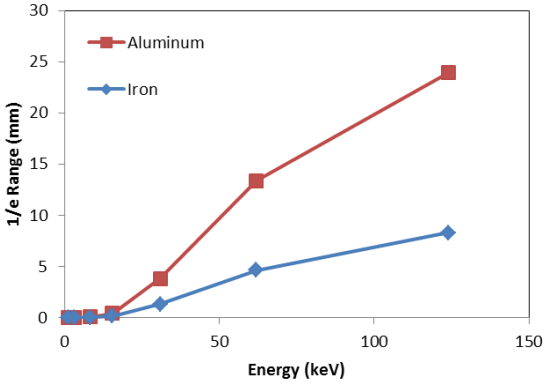
- X-ray chamber: X-RAD iR-160
- Raw Beam: >60 Gy/min at 160KV, 19mA, 30 cm SSD
- Vendor provided energy spectra indicates that the filtering factor over a wide energy range is acceptable.
- A dosimeter will be built in house (URA project).



Energy spectrum unfiltered

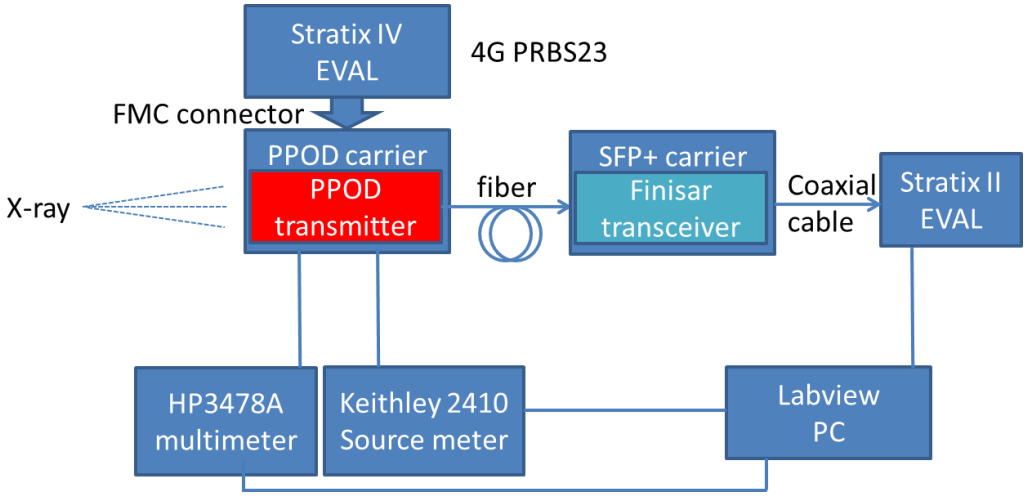


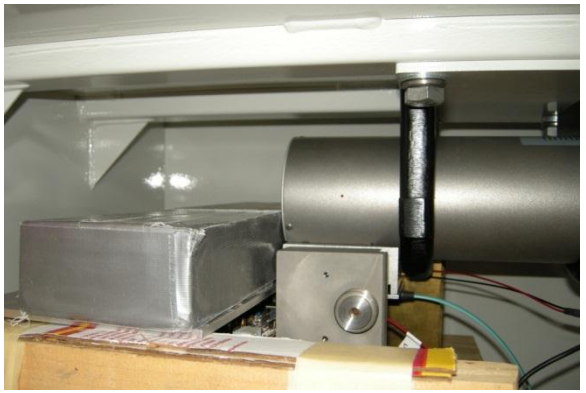
Energy spectrum filtered with 2-mm Aluminum



X-ray testing

- PPOD
- Avago part AFBR-810EPZ



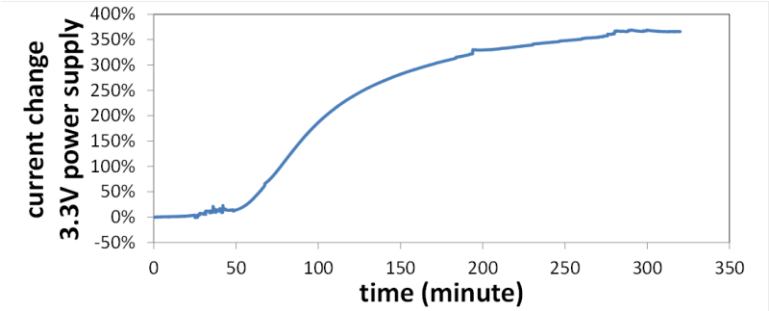


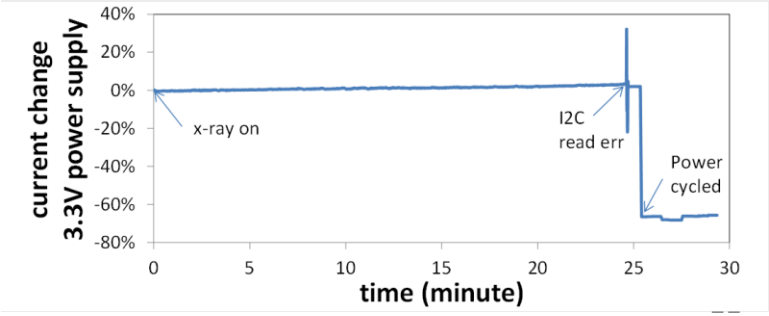
X-ray testing

- Test on 1st PPOD transmitter
- The first beam time lasted for 2 hours 29 minutes and was followed by annealing of 15 hour 42 minute. The second beam time lasted for 8 hours 15 minutes and was followed by annealing of 8 hours 7 minutes.
- **Dose rate is 360 krad/hour and total dose is 3.86 Mrad.**
- The currents of 2.5V and 3.3V power supply changed up to 0.65% and **465%** respectively.
- The transmitter kept running properly during the whole period of beam time and annealing time. But after **power cycling**, the transmitter does not work anymore.

- Test on 2nd PPOD transmitter
- The transmitter kept working during 5 hours and 20 minutes of beam time. But after power cycling, the transmitter does not work anymore.
- **Dose rate is 360 krad/hour and total dose is 1.92 Mrad.**
- The currents of 2.5V and 3.3V power supplies changed up to 0.04% and **369%** respectively.

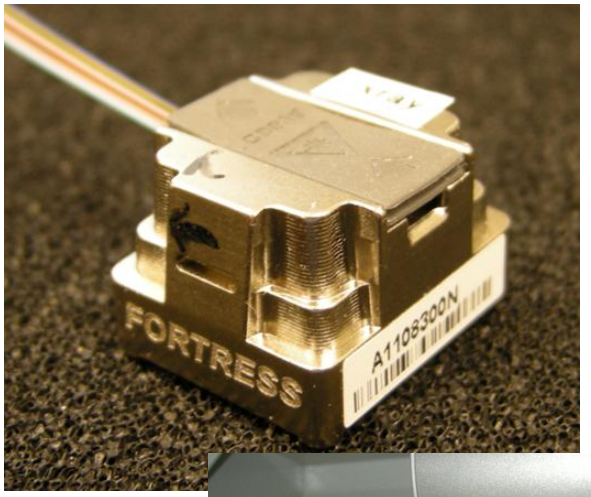
- Test on 3rd PPOD transmitter
- The power supplies of 2.5 V and 3.3 V were **power cycled every minute**. The memory contents were also **read out by the I^2C** interface every minute.
- There was a current fluctuation about 25 minutes. In half minutes after this fluctuation, I^2C readout failed, transmitter lost function upon next power cycle.
- **Dose rate was 360 krad/hour and total dose was 150 krad**.

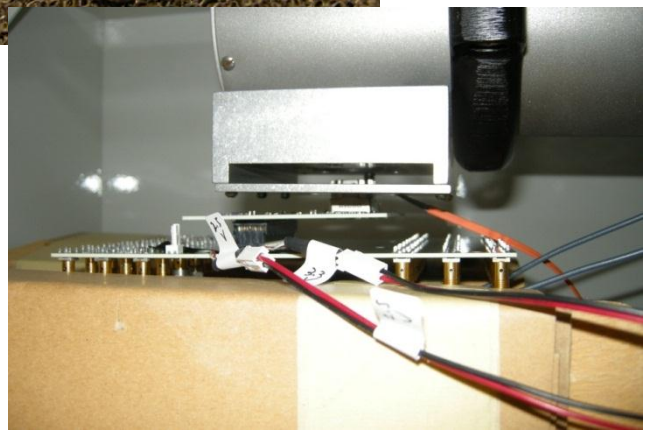


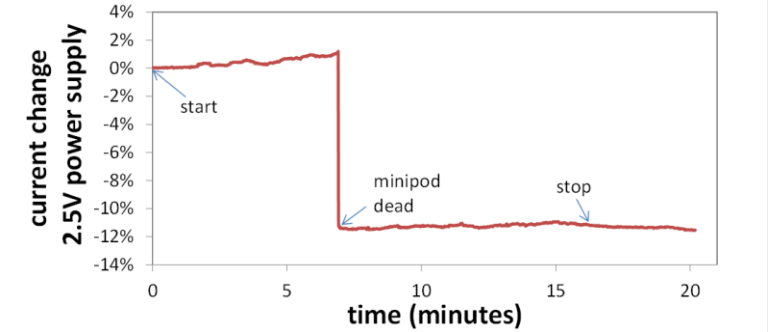


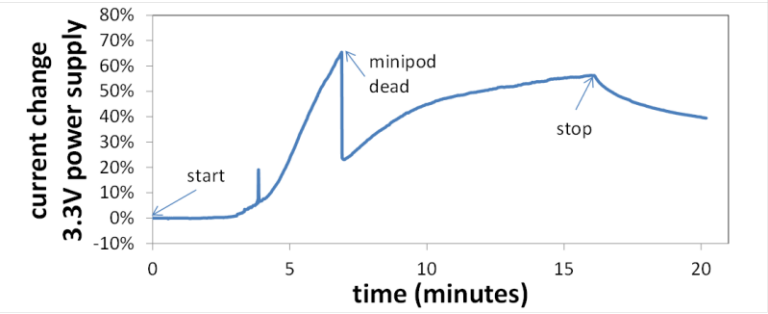
X-ray testing

- 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.**



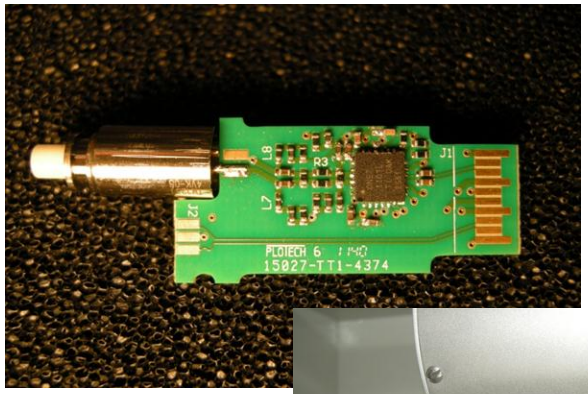




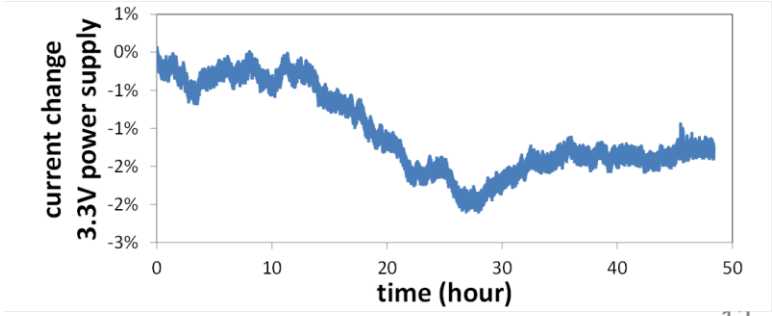


X-ray testing

- The ONET1101 is a 3.3V edge emitting laser driver at modulation rate up to 11.3 Gbps.
- Two modules were first tested. One lasted 51 minutes and the another one lasted 43 minutes without power cycle. The current changed up to 5.3%. I^2C readout failed.
- **Dose rate was 360 krad/hour and total dose was 306 krad and 258 krad respectively.**



- The ONET1101 was previously tested at BNL Gamma beam up to **900 krad**, at **10 krad/hr**.
- A third module was tested with power cycle and I^2C read scheme.
- **Dose rate was reduce to 9.6 krad/hour and total dose was 464 krad.**
- Between the last configuration was readout successfully and the last power cycle, the current kept regular value and there was no error observed. After the last power cycle the ONER1101 couldn't be configured by the I^2C interface and the optical link lost synch. The current changed up to -2.10%.



Other environmental tests and needs

- Wish list
  - A real environmental chamber with temperature and humidly
  - A fast pulsed laser for SEU

Summary

- A poor-man's temperature test setup is used to verify VTRx in cold.
- The in-house X-ray machine is found to be very useful.
- We will work on to getting an environment chamber that can provide temperature and humidity control, mostly for reliability tests.
- We will also try to find a pulsed laser at SMU for SEU tests.

Thanks for your attention