

New Results on Opto-Electronics

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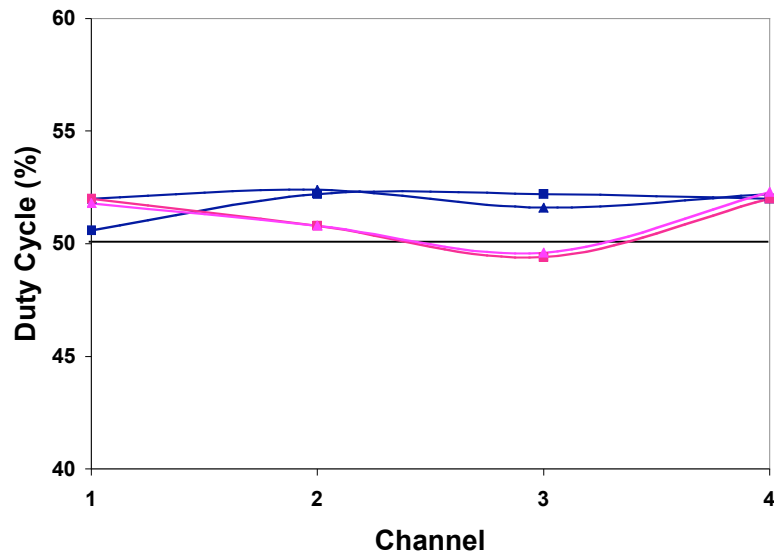
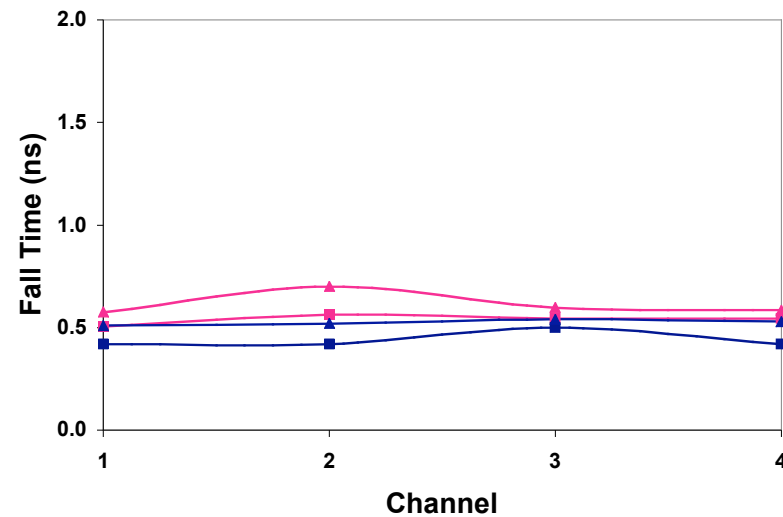
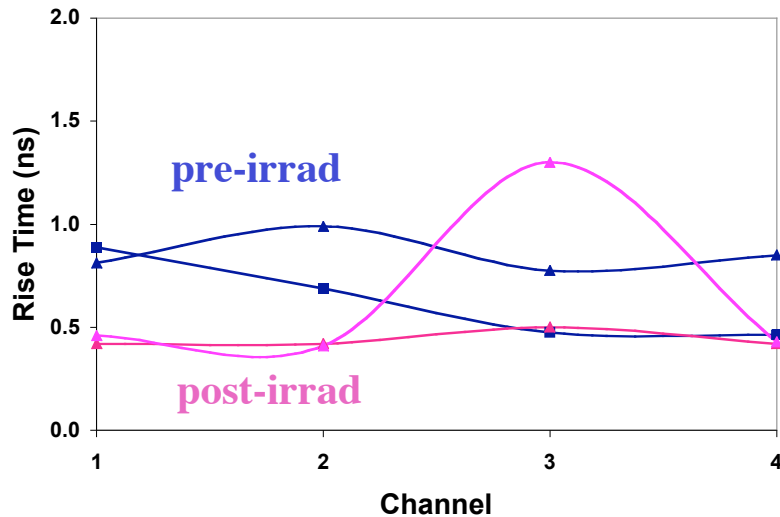
K. Arms, K.K. Gan, M.O. Johnson, H.P. Kagan, R.D. Kass,
A. Rahimi, C Rush, R. Ter-Antonian, M. Zoeller
The Ohio State University

A. Ciliox, M. Holder, S. Nderitu, M. Ziolkowski
Siegen University

Outline

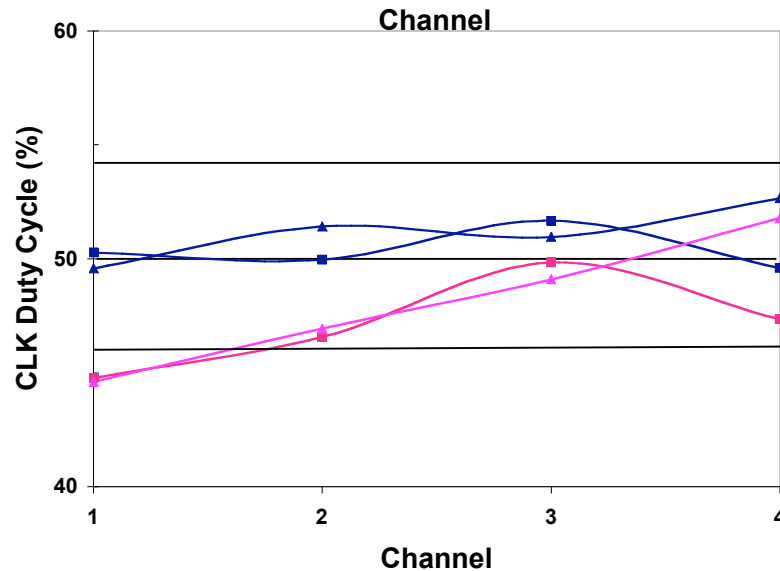
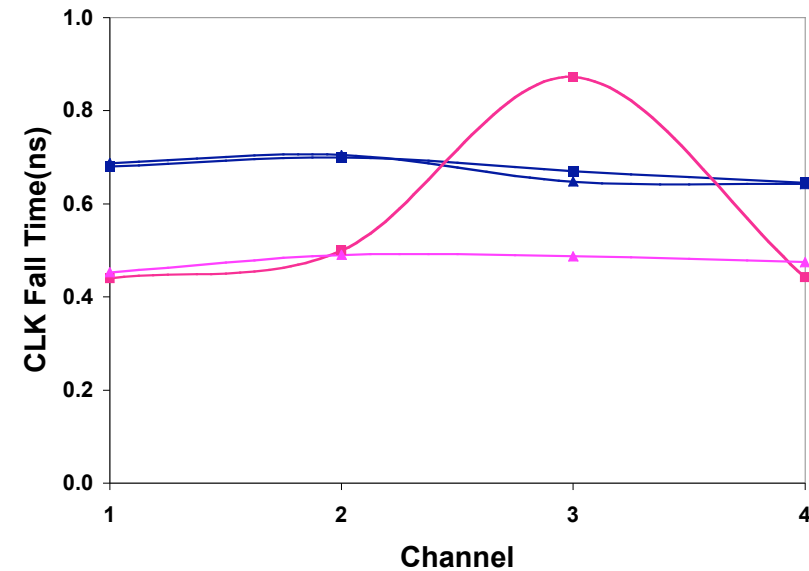
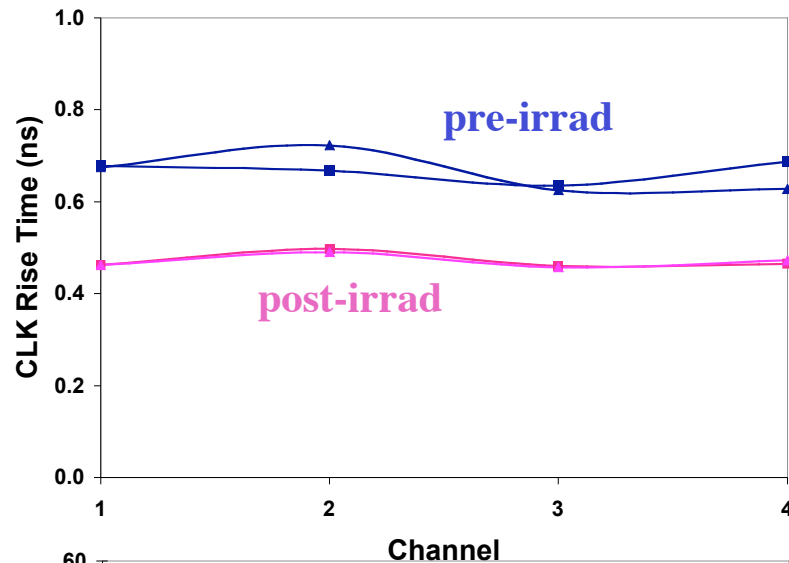
- Irradiated VDC/DORIC-I5e Results
- Results from New Opto-board
- Results from Irradiated Opto-boards
- Summary

VDC-I5e: Rise/Fall Time + Duty Cycle



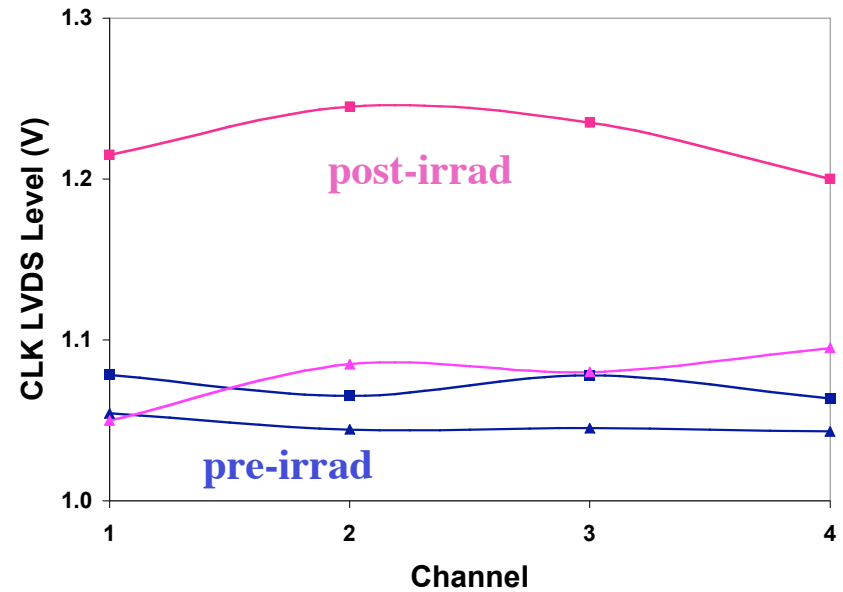
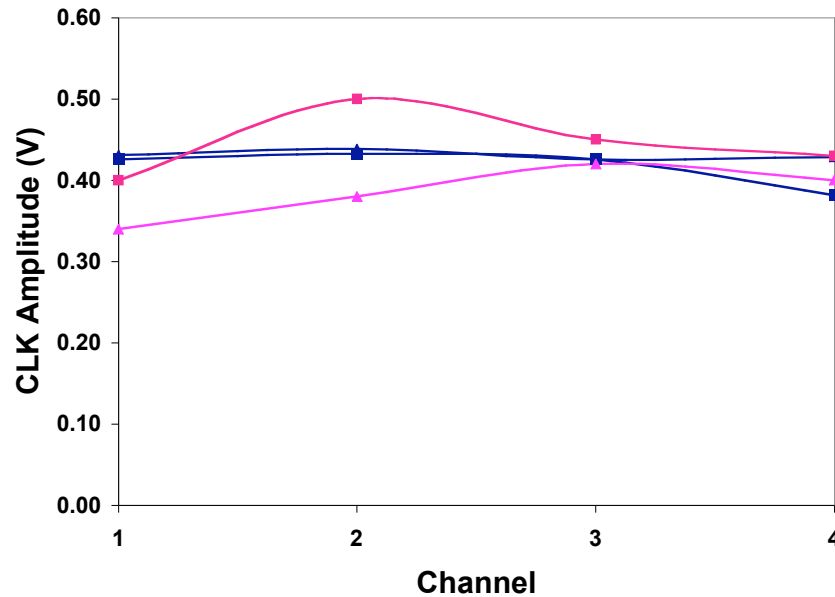
- ✗ rise time < 1 ns
- ◆ measured with 44-pin package
- ◆ faster rise time on opto-board
- ✓ fall time < 1 ns
- ✓ duty cycle < $(50 \pm 4)\%$

DORIC-I5e: Clock Rise/Fall Time + Duty Cycle



- ✓ rise time < 1 ns
- ✓ fall time < 1 ns
- ✗ duty cycle:
 - ◆ min: 45%
 - ◆ spec: $(50 \pm 4)\%$
 - ◆ close to 50% on opto-board

DORIC-I5e: Clock LVDS Output



- no change in clock LVDS amplitude
- acceptable shift in clock LVDS level

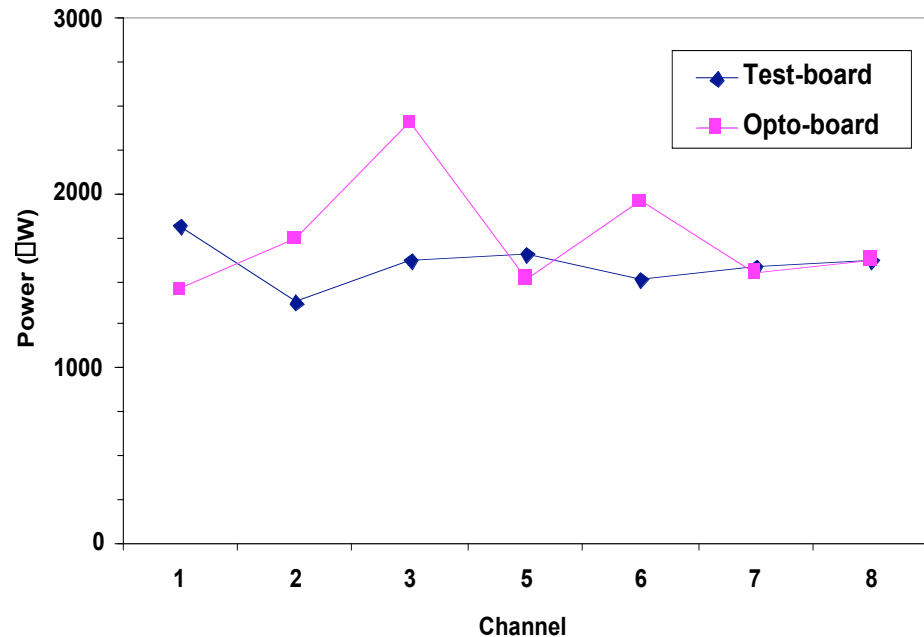
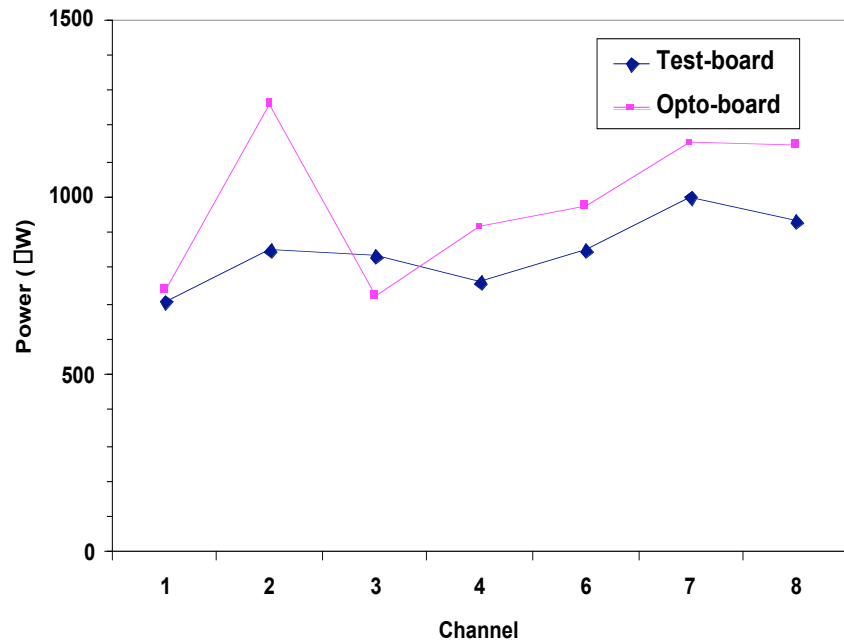
Summary of VDC/DORIC-I5e

- acceptable degradation in VDC and DORIC after 55 Mrad

Construction of New Opto-Board

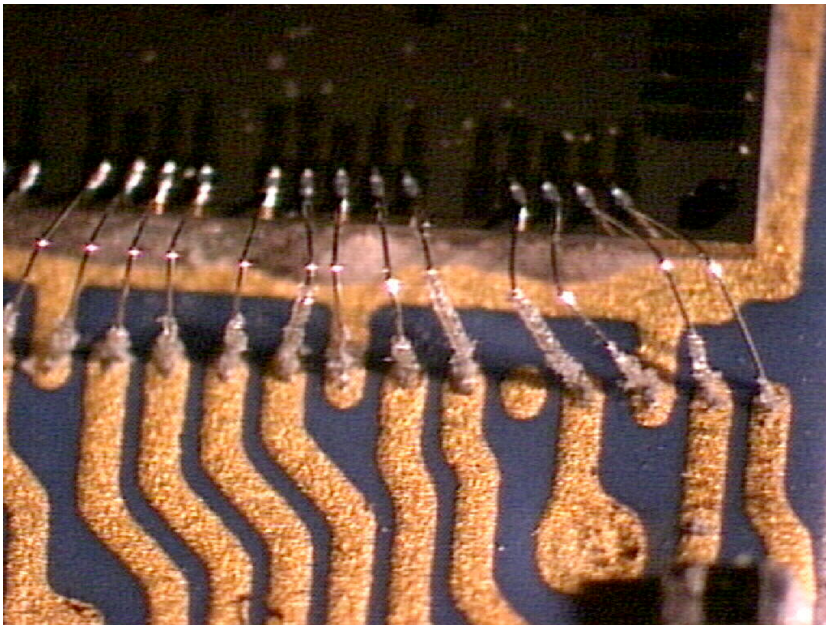
- traces of opto-packs connected to opto-board via wire bonds
- limit epoxy curing temperature to 80°C
 - ◆ curing temperature of previous two opto-boards: 100°C

Opto-Power of New Opto-Board



- both VCSEL opto-packs have good power on opto-board
- ◆ powers are comparable to those before mounting on opto-board

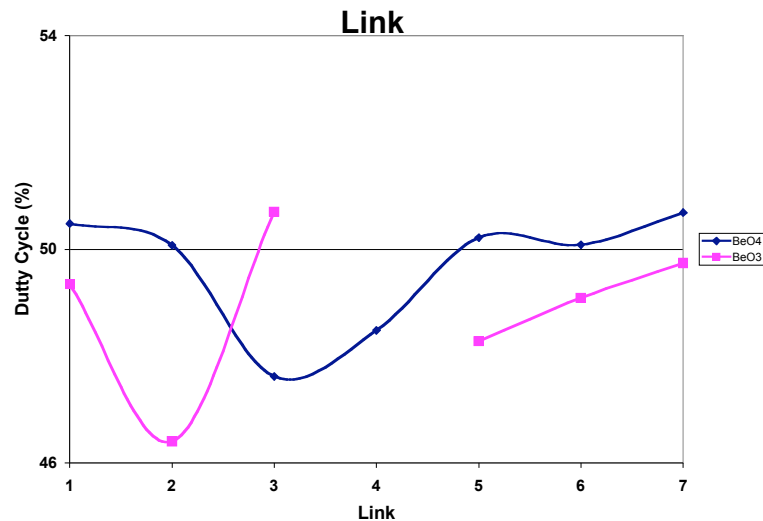
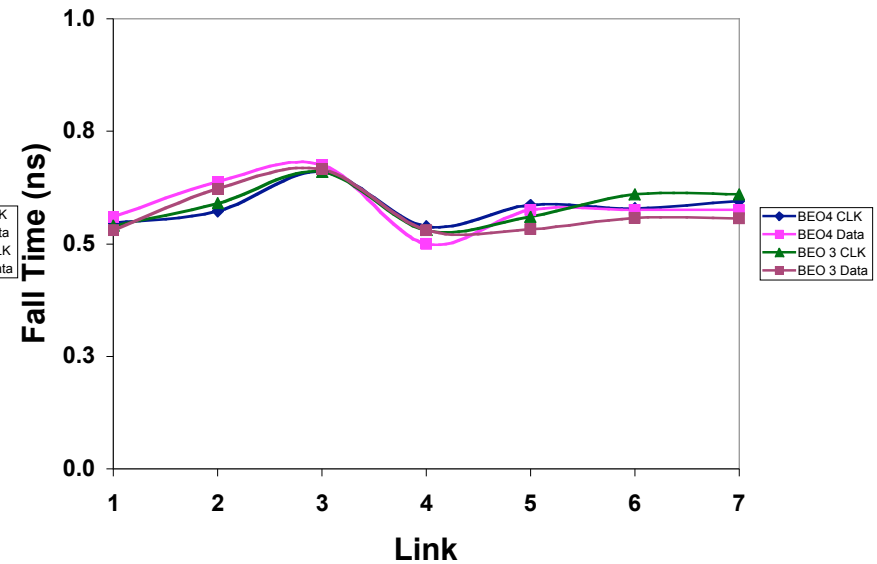
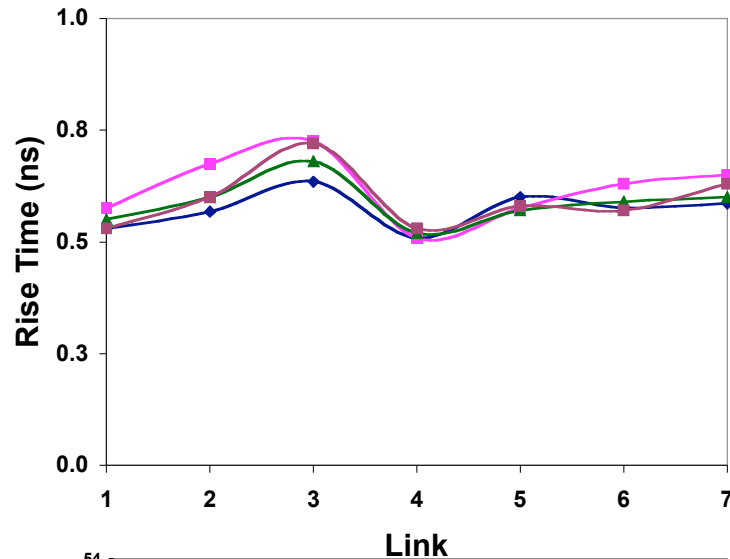
Corrosion on Opto-board Traces/MT Guide Pins?



Corrosion on Opto-board Traces/MT Guide Pins?

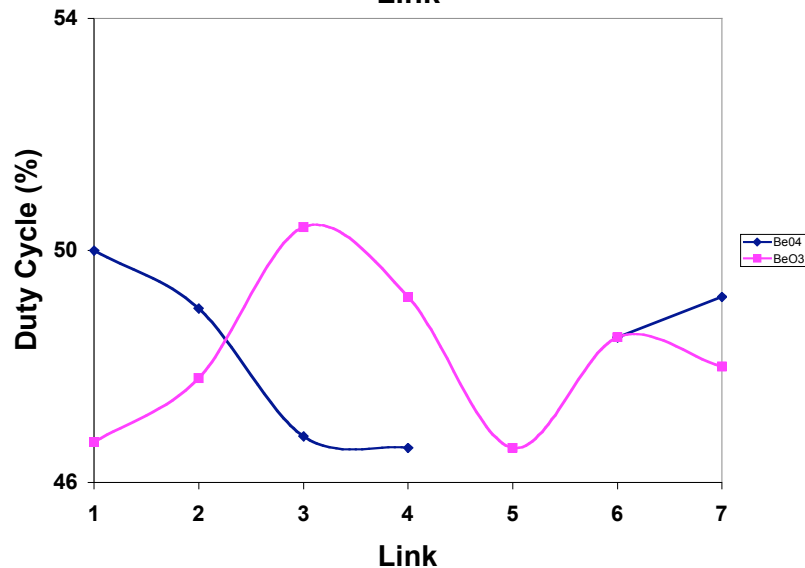
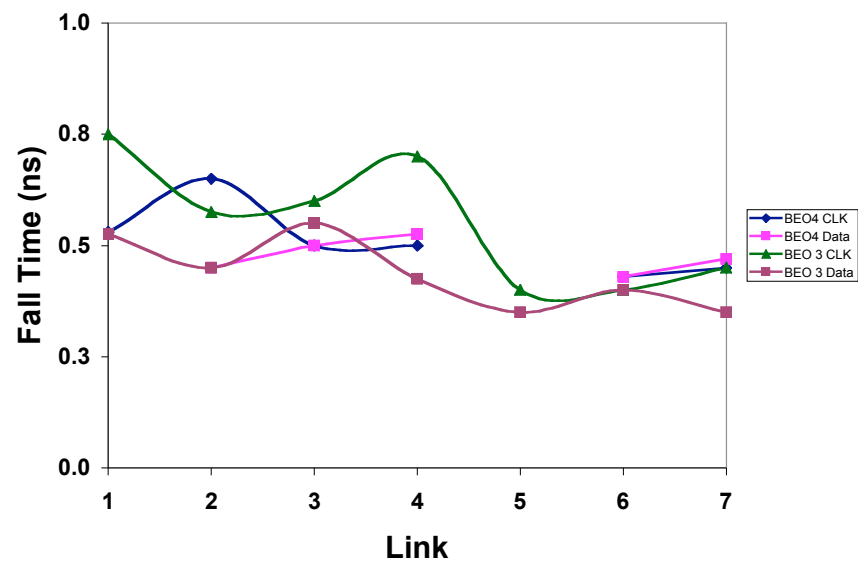
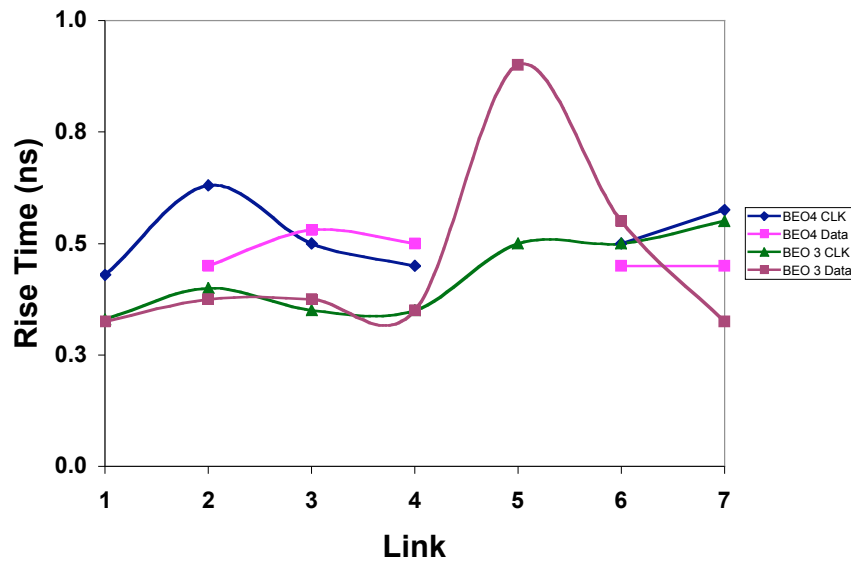
- brown whiskers on MT guide pins easily removable
 - ⇒ surface looks shiny after removal
- no whiskers on wire bonds connecting to chip pads
- white whiskers on wire bonds connecting to gold traces
 - ⇒ broken continuity between wire bonds and traces
 - ⇒ no whiskers on wire bonds protected with optical epoxy
- can grow whiskers for opto-board in moist environment within days
 - ◆ whiskers likely from condensation during cooling test at CERN
- no whiskers on opto-board after 6 days at 70°C
- no whiskers on opto-boards produced 6 months ago in lab environment
 - ⇒ protect wire bonds with optical epoxy?
 - ⇒ need to repeat tests with opto-boards from new vendor

Opto-board: LVDS Rise/Fall Time + Duty Cycle



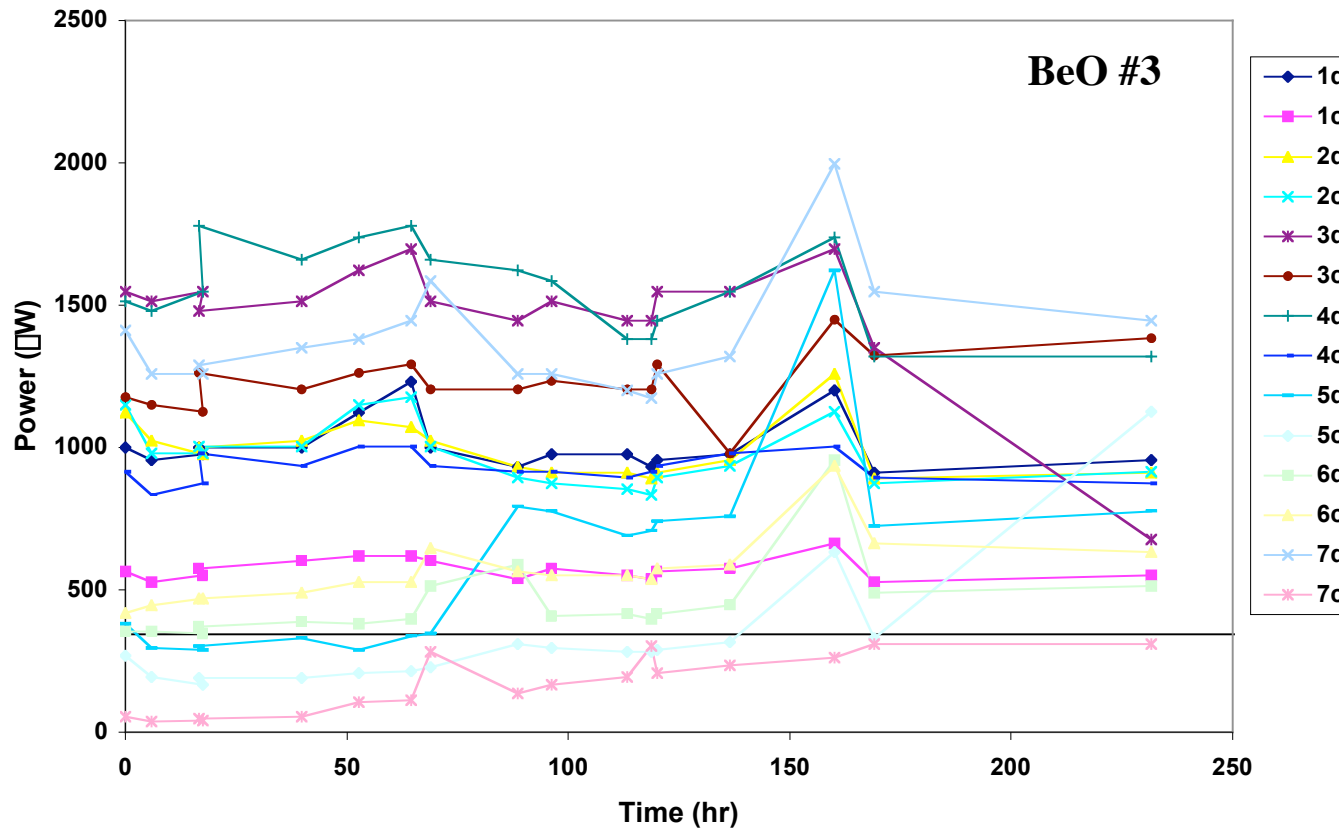
- ✓ rise time < 1 ns
- ✓ fall time < 1 ns
- ✓ duty cycle: $(50 \pm 4)\%$

Opto-board: Optical Rise/Fall Time + Duty Cycle



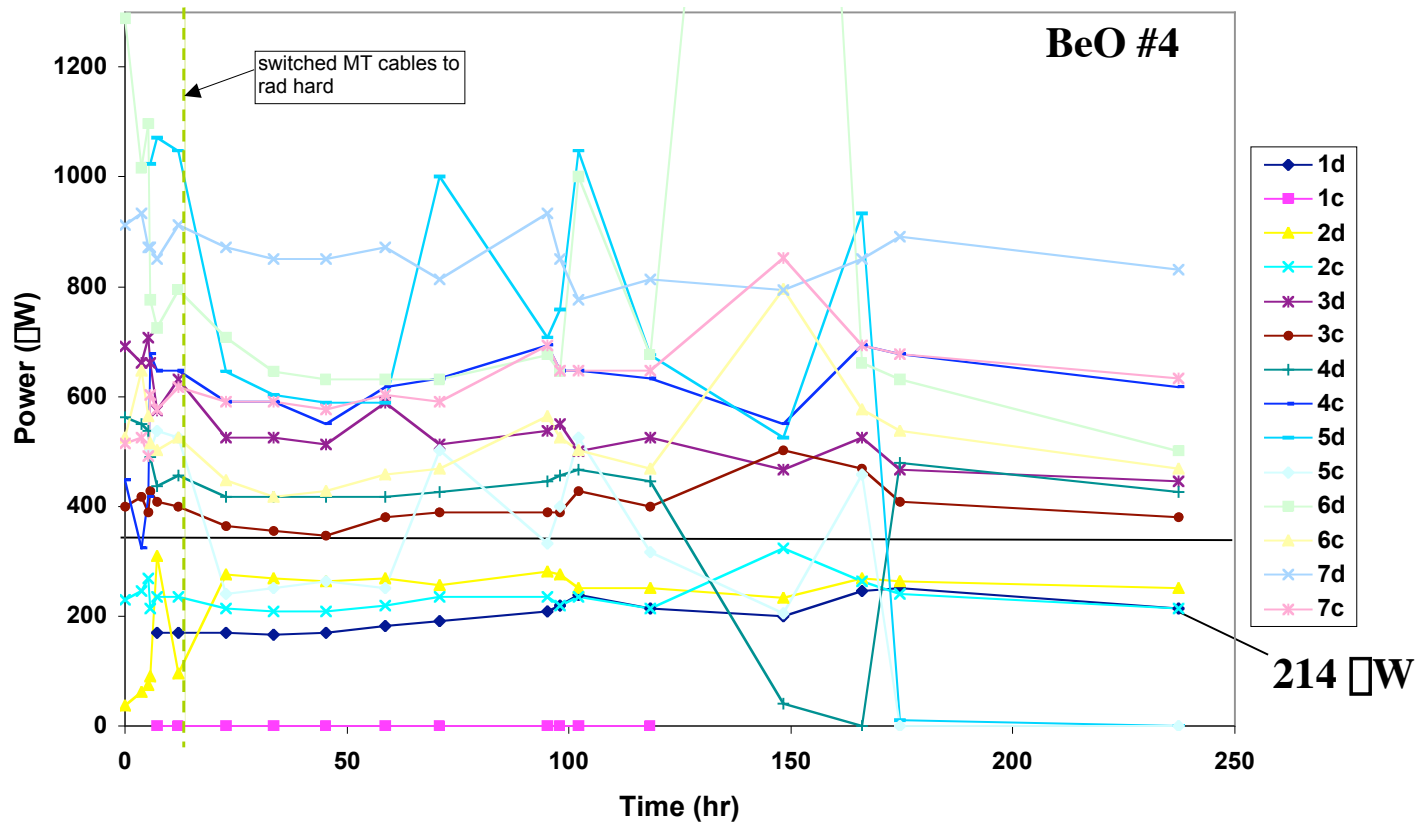
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Opto-power vs Annealing Time



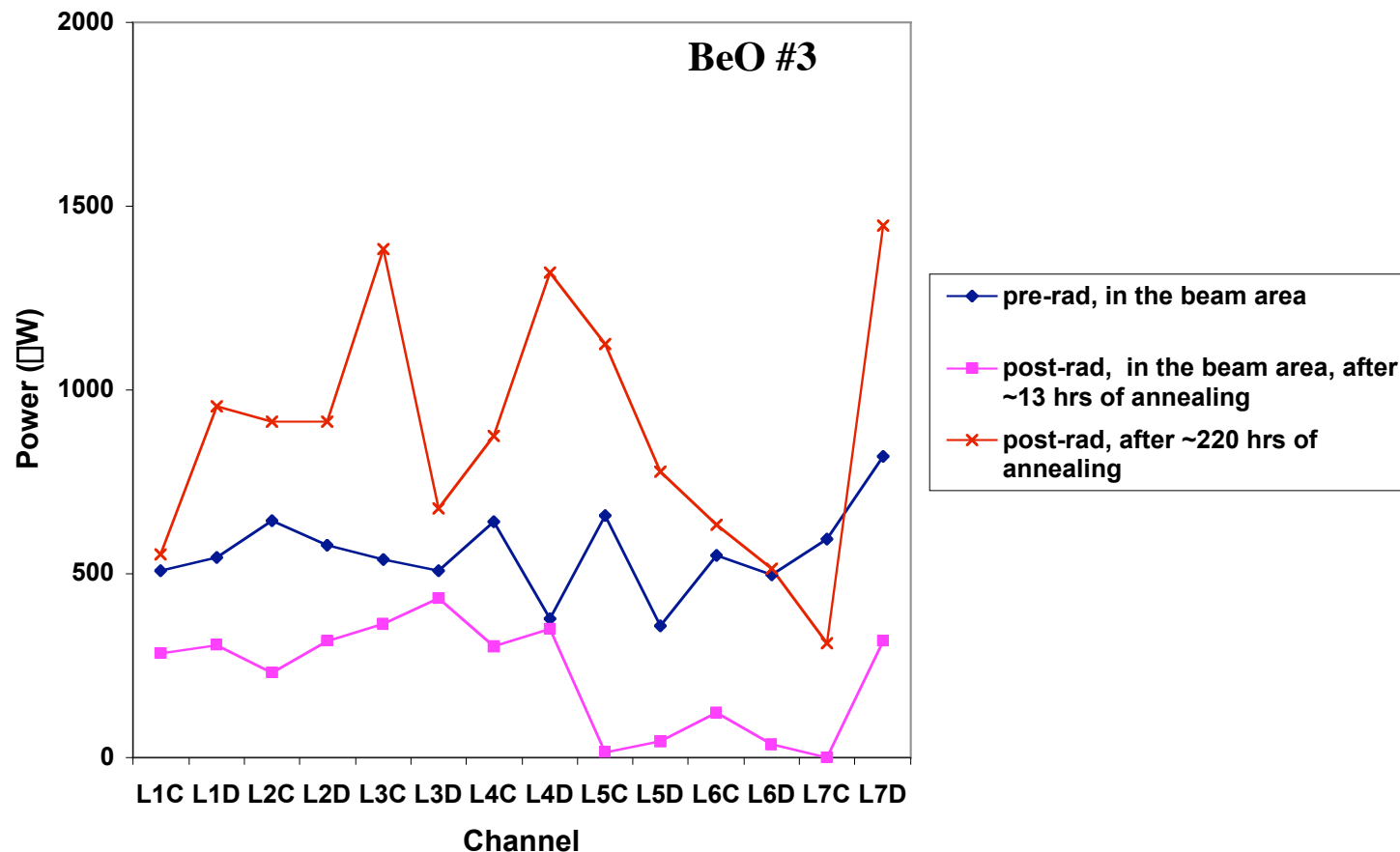
● lowest annealed power close to 350 W spec

Opto-power vs Annealing Time



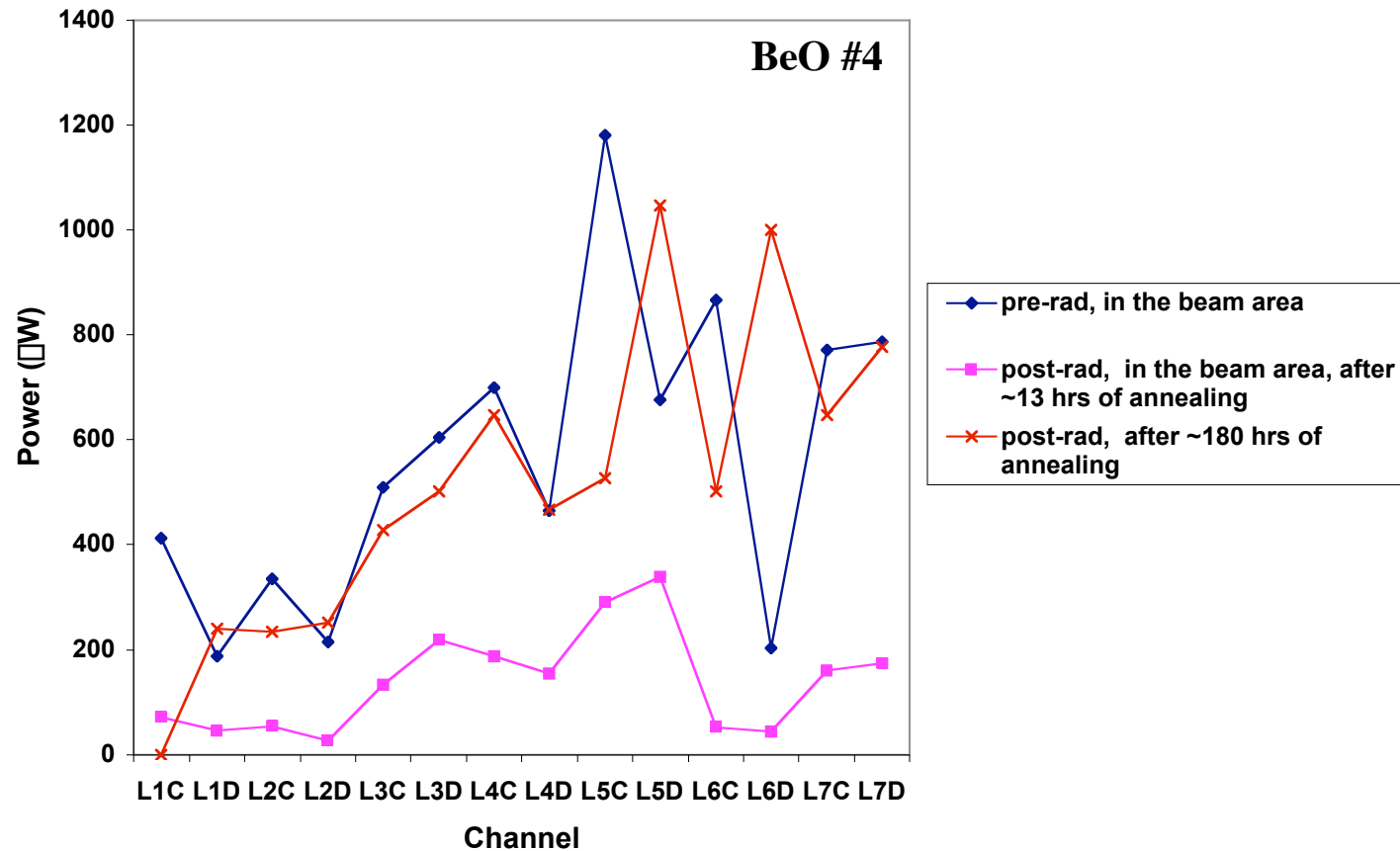
- lowest annealed power somewhat below 350 W spec

Opto-power Pre/Post-Irradiation



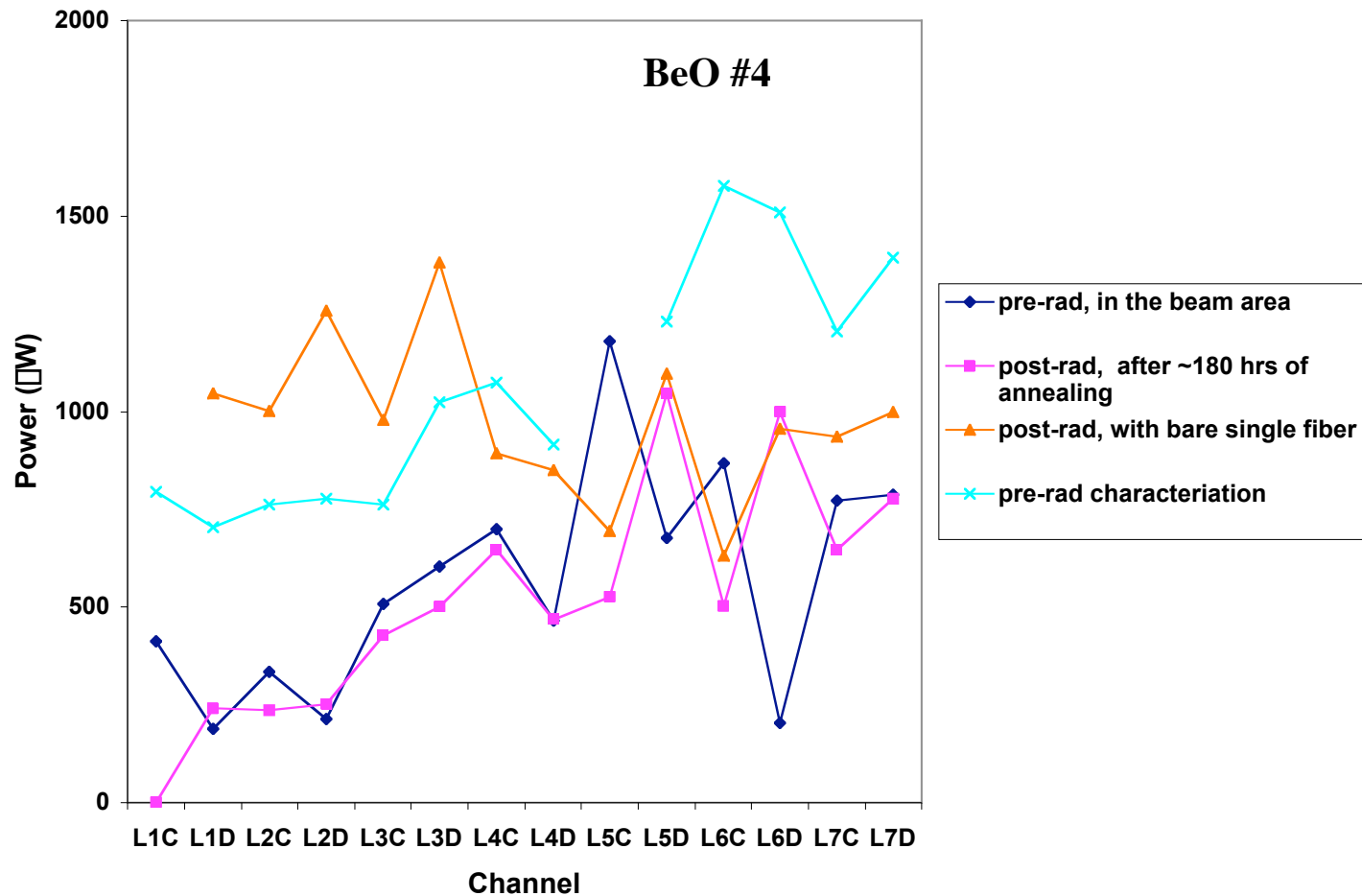
- recover most of lost power after annealing/with no long cable

Opto-power Pre/Post-Irradiation



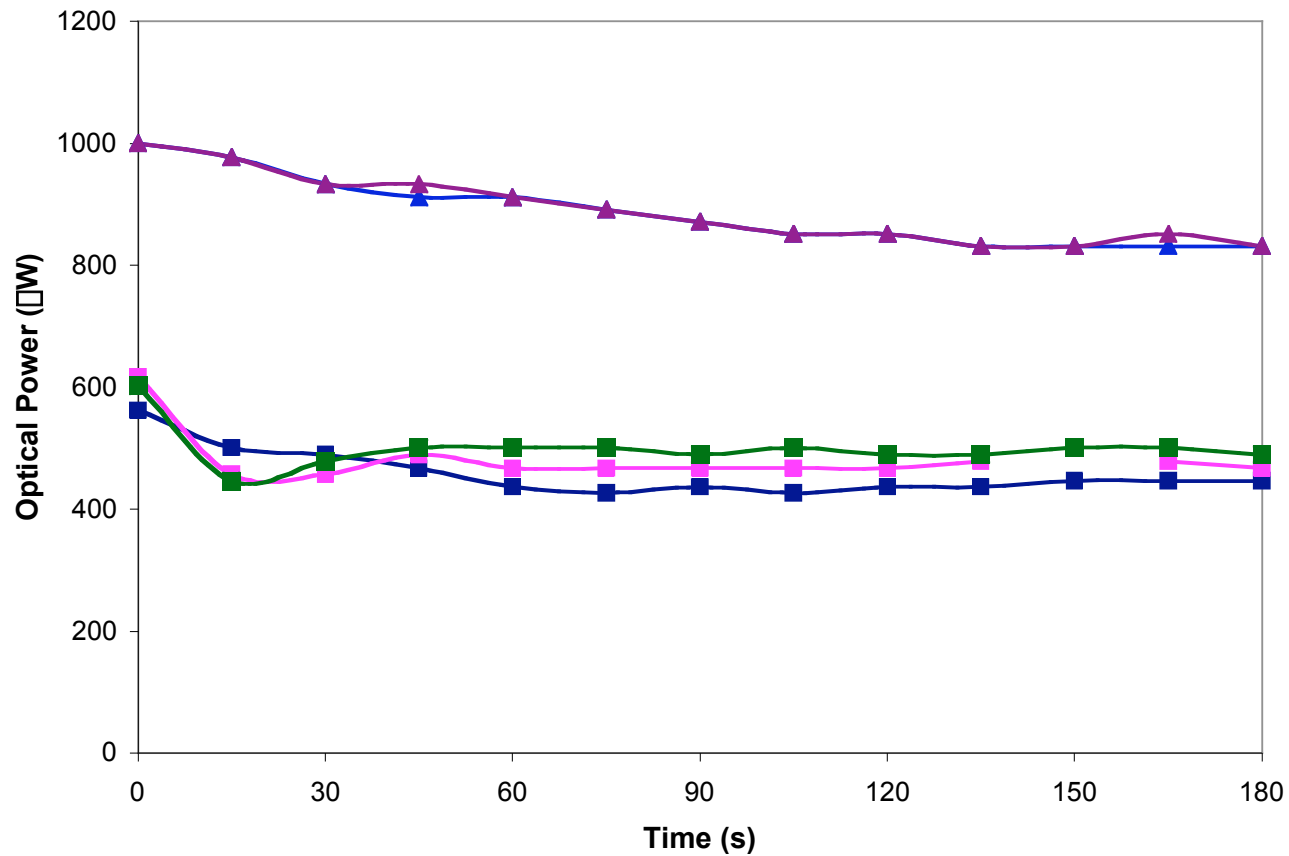
- recover most of lost power after annealing/with no long cable

Opto-power Pre/Post-Irradiation



- bare fiber measurements indicate VCSELs still produce large power

Opto-power vs Time



- 20% reduction in power due to heating of opto-board

Analysis of Power Loss

- no power loss for a VCSEL opto-pack after 1 week at 100°C
- SIMM (rad-hard) to GRIN cable: 20% (1.0 dB)
- thermal loss: 20%
- specs:
 - minimum power: 500 μ W
 - maximum radiation loss with annealing: 30%
- ⇒ minimum power after irradiation/annealing: 224 μ W
- observed lowest power: 214 μ W
- acceptable power loss?

VCSEL Mortality

- two channels died before irradiation:
 - one channel is open and one behaves like diode (1.4 V)
 - BeO #4: opto-packs salvaged from BeO #2
 - one channel died after irradiation: diode
 - two more channels have died
 - autopsy in progress...
- ⇒ infant mortality and/or radiation damage?

Summary

- acceptable degradation of VDC/DORIC-I5e after 55 Mrad
- lowest observed optical power after annealing consistent with expectation