

New Results on Opto-Electronics

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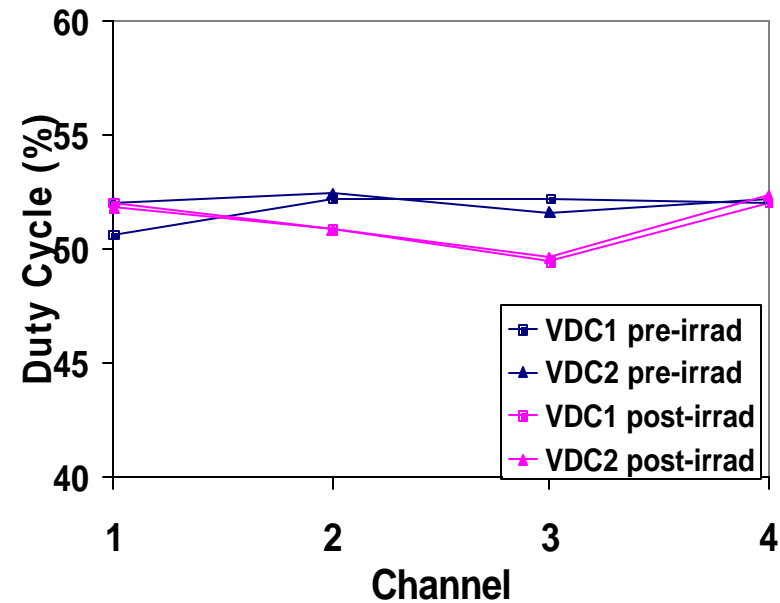
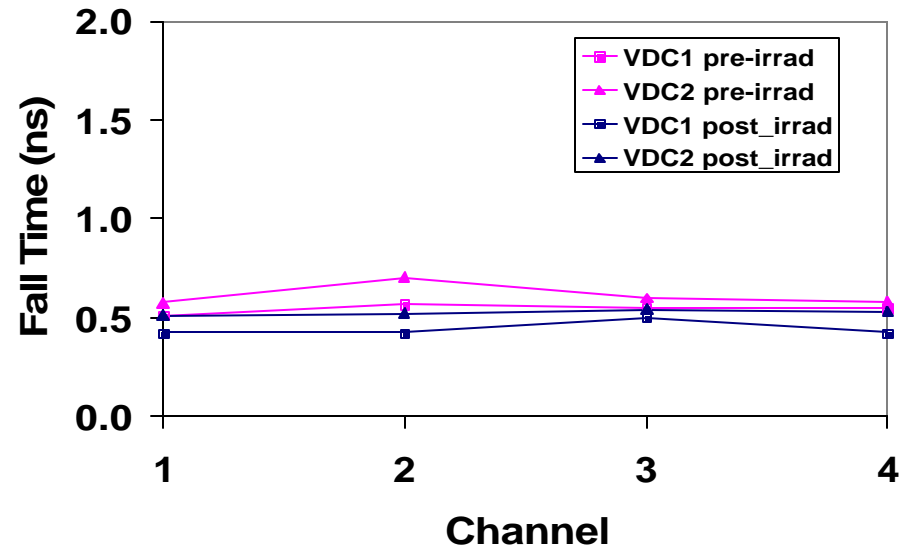
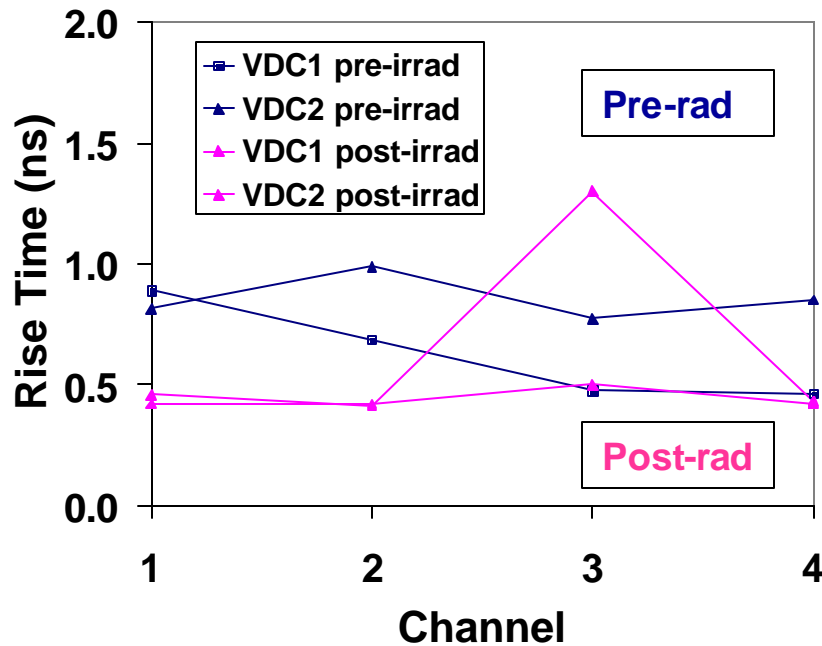
A. Coliox, M. Holder, S. Nderitu, M. Ziolkowski

B. Siegen University

Outline

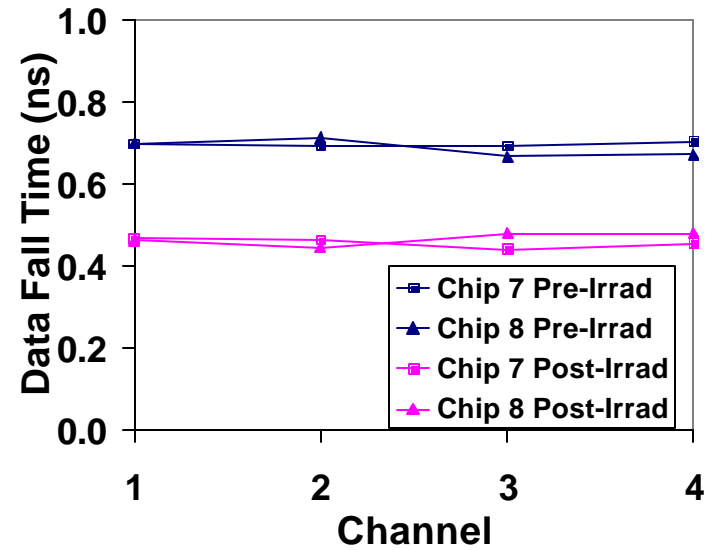
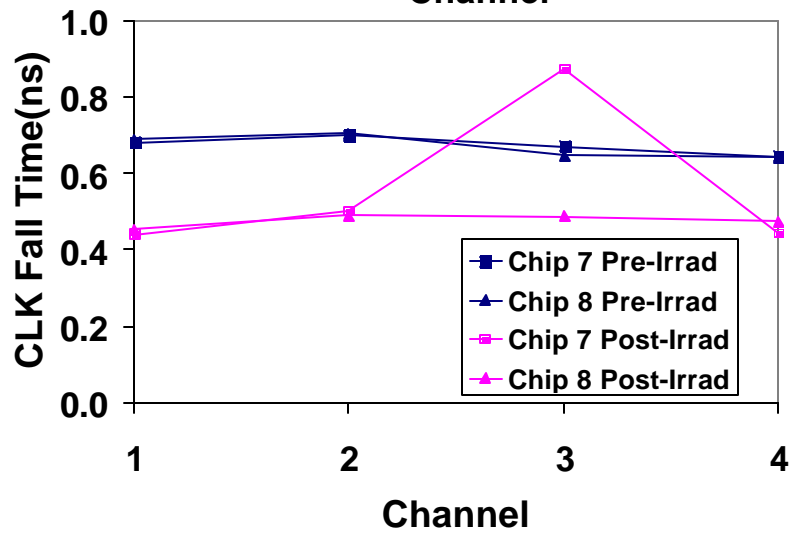
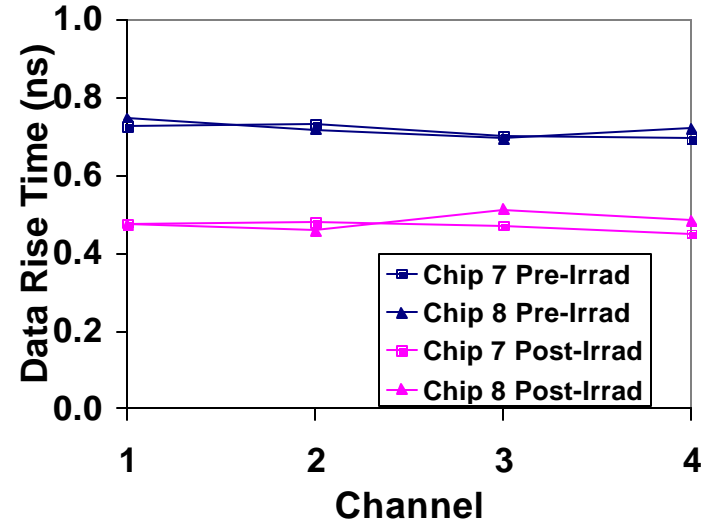
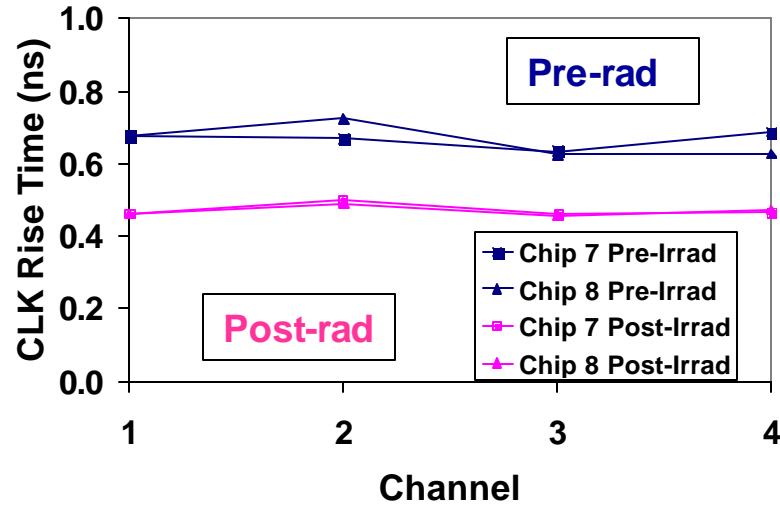
- Results of post irradiation QA
- Irradiation effects on VCSEL voltage and threshold current
- Fiber mismatch effects on power loss
- VCSEL/opto-board cooling and heating effects on optical power
- BeO5 and BeO6 results
- Summary

VDCI5e: Clock Rise/fall Time and + Duty Cycle



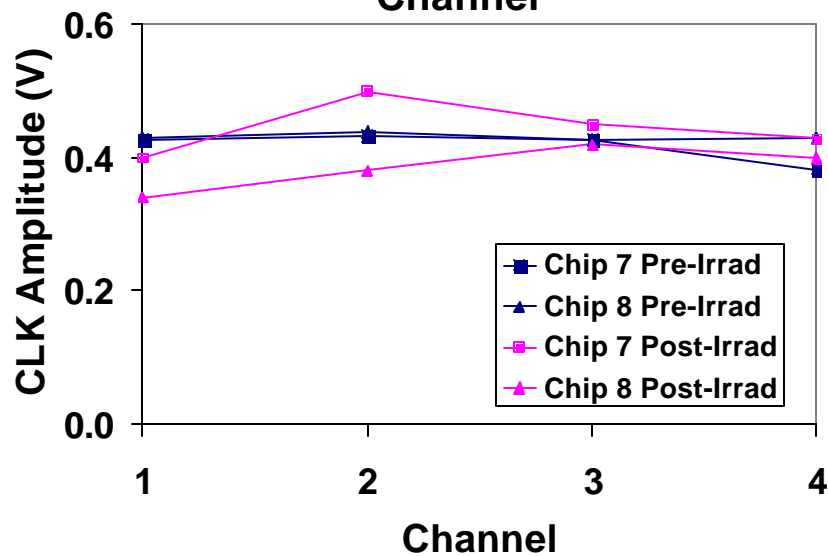
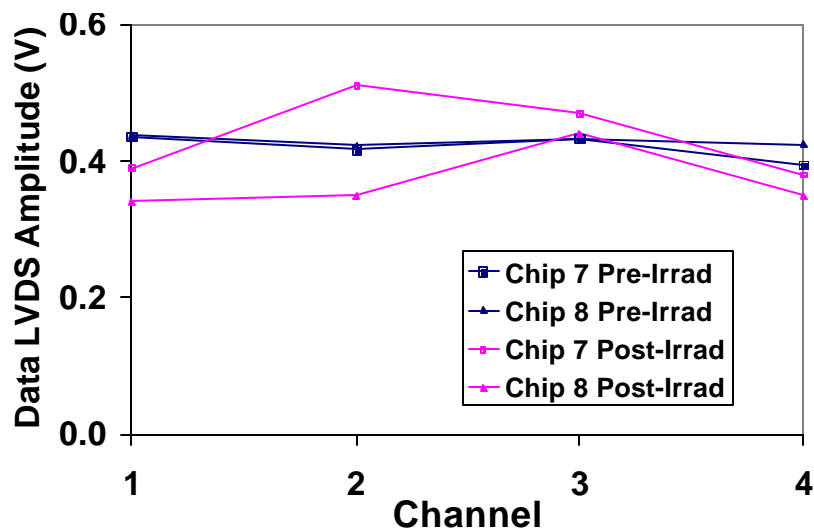
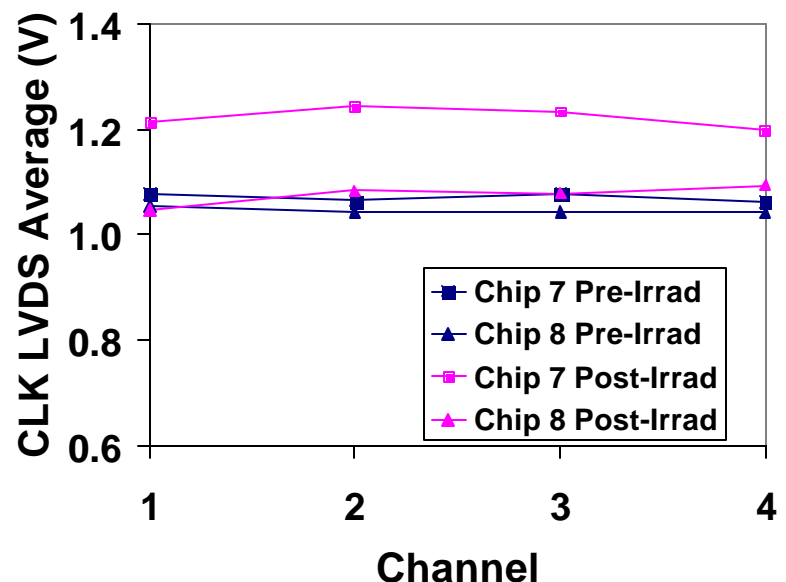
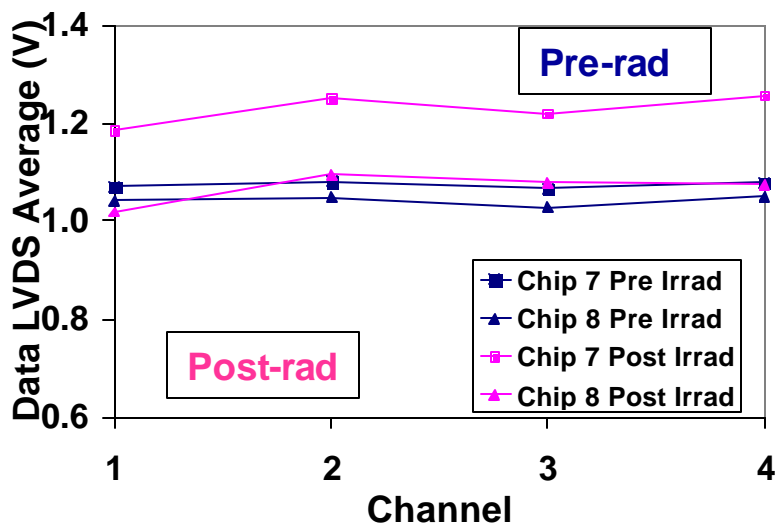
- ✓ Fall time < 1 ns
- ✗ Rise time < 1 ns
 - Measured with 44 PIN package
 - Faster rise time on opto-board
- ✓ Duty cycle: (50% ± 4)

DORICI5e: LVDS Rise and Fall Time



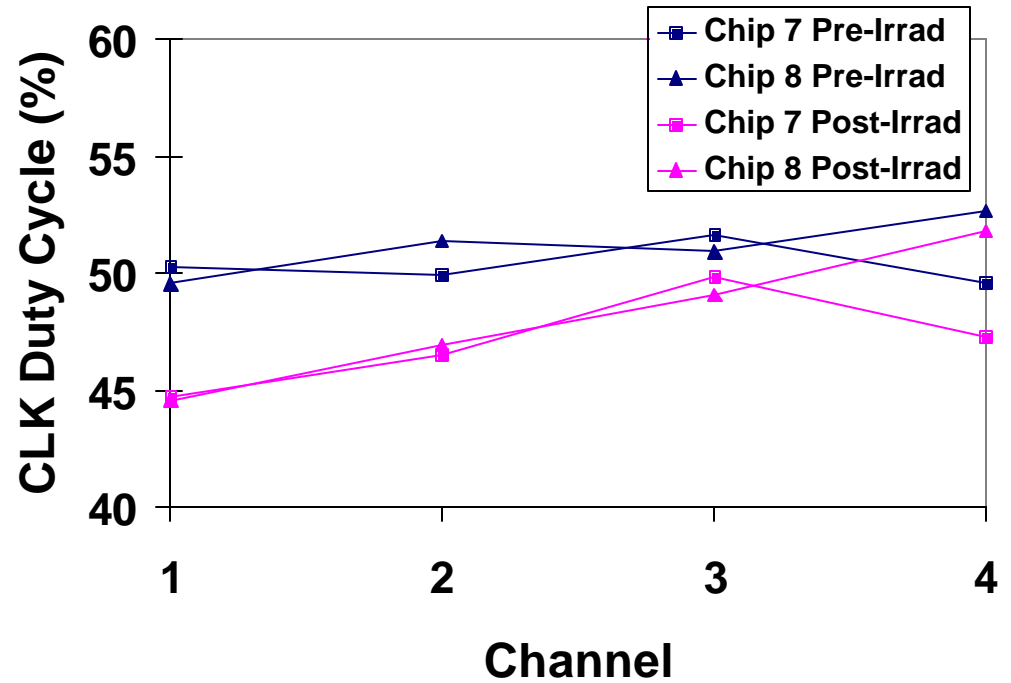
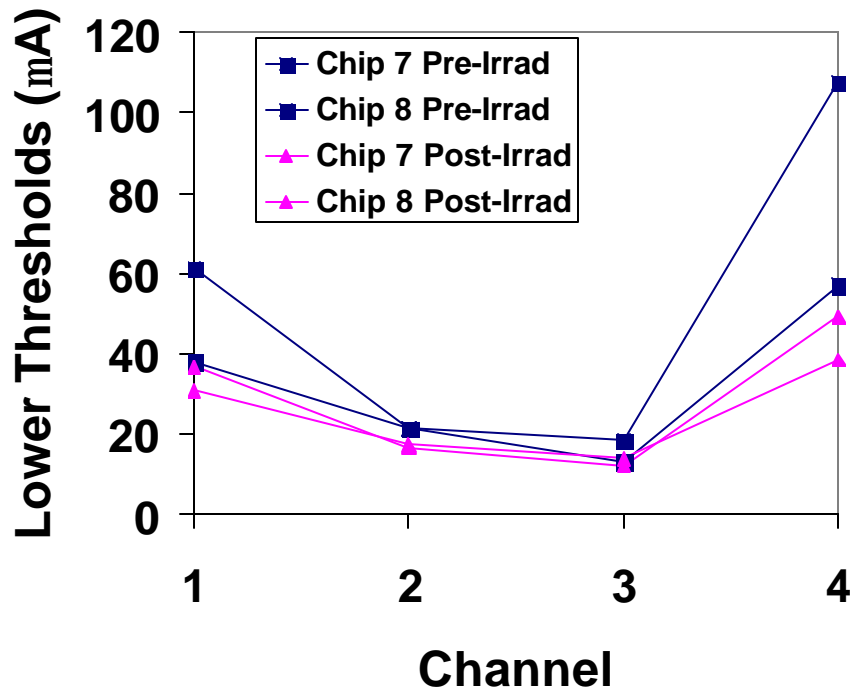
- ✓ Rise time < 1 ns
- ✓ Fall time < 1 ns

DORICI5e: LVDS Amplitude and Average



- ✓ Acceptable shift in LVDS average
- ✓ No change in clock and data LVDS amplitude

DORICI5e: +Duty Cycle and Threshold

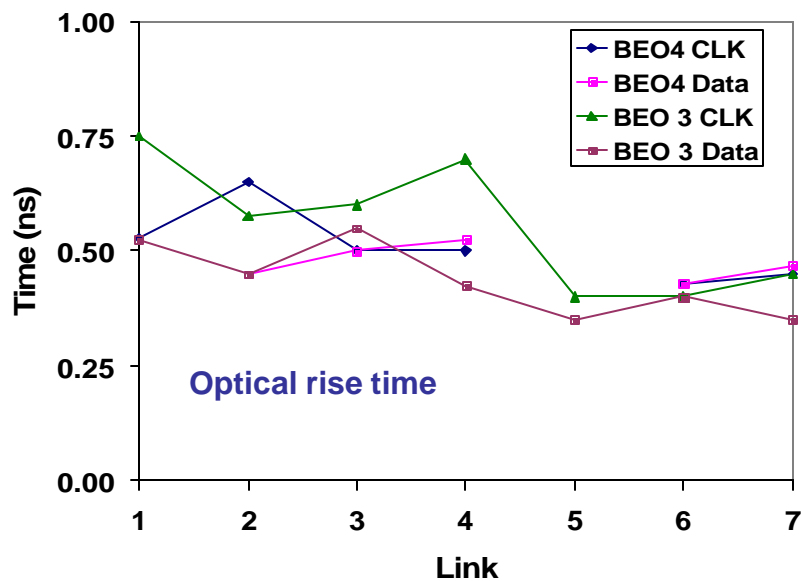
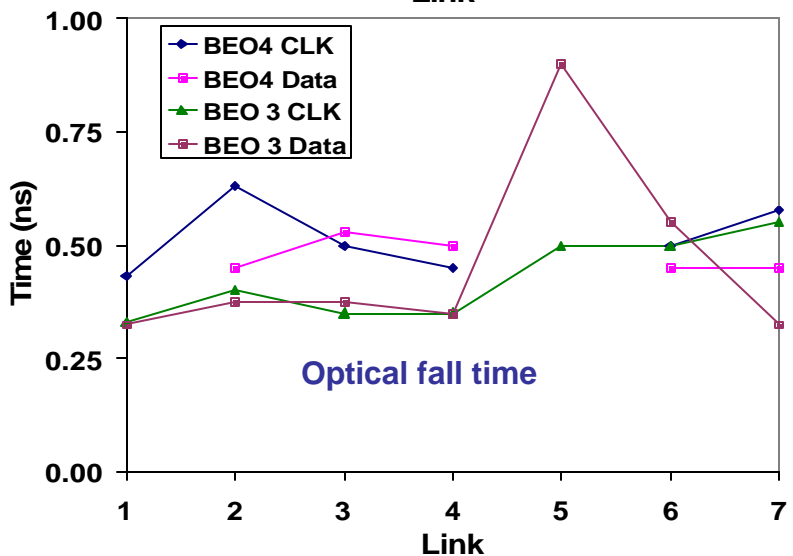
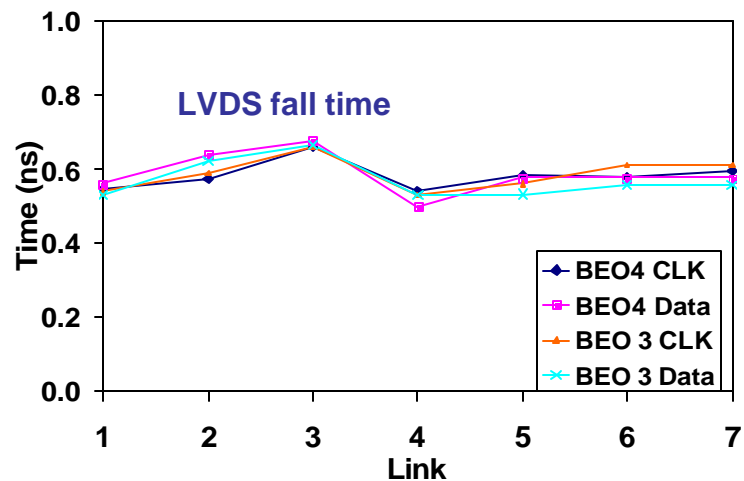
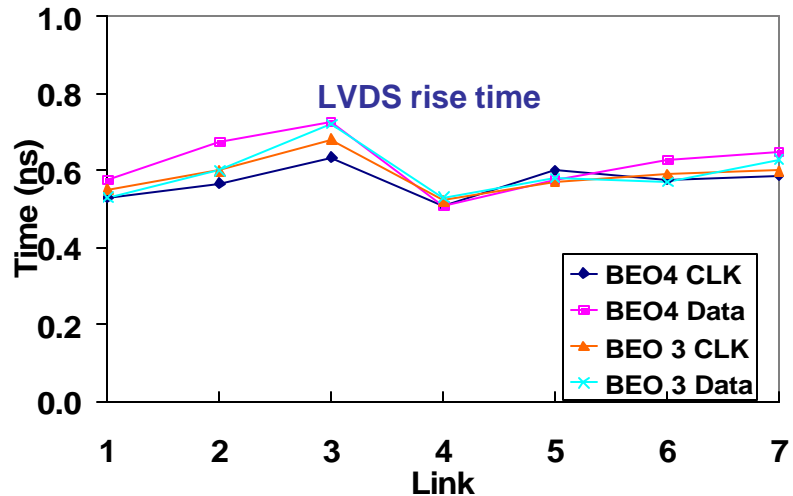


- Lower thresholds?
- ✗ Duty cycle
 - Min: 45%
 - Spec: (50% ± 4)
 - Close to 50% on opto-board

Summary of VDC/DORIC I5e

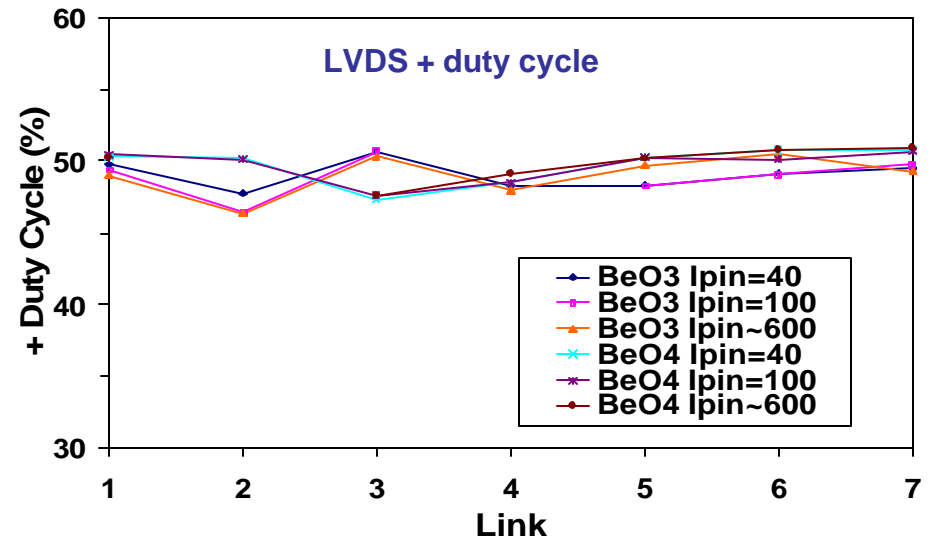
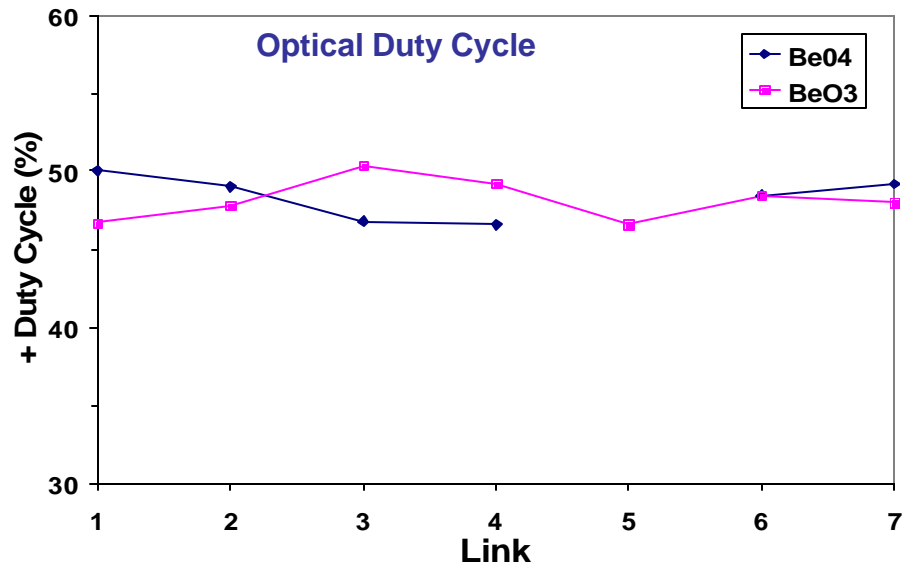
- Acceptable degradation in VDC and DORIC after 55 MRad

Opto-board: LVDS and Optical Rise and Fall Times

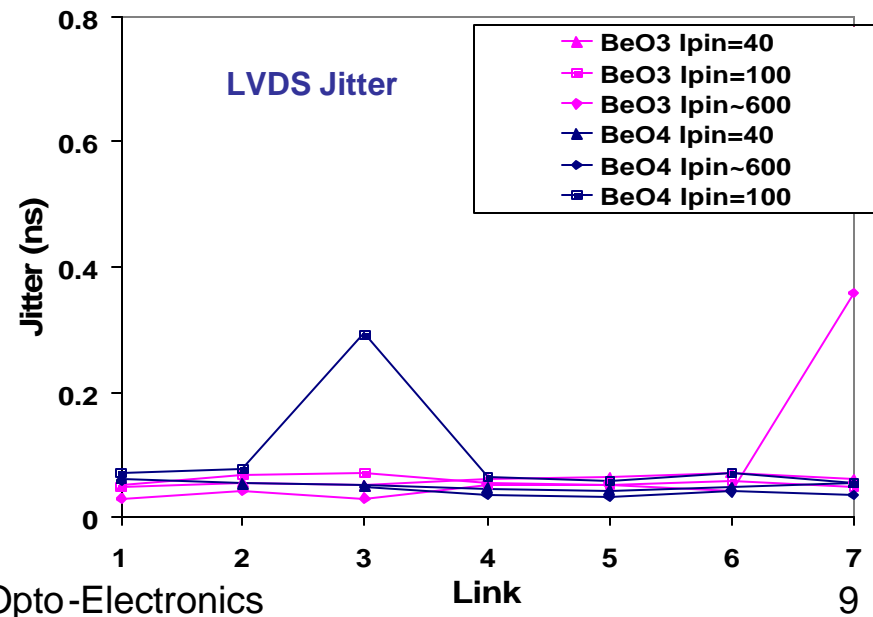


- ✓ LVDS fall and rise times < 1.0 ns
- ✓ Optical rise and fall times < 1.0 ns

Opto-board: Duty Cycle and Jitter



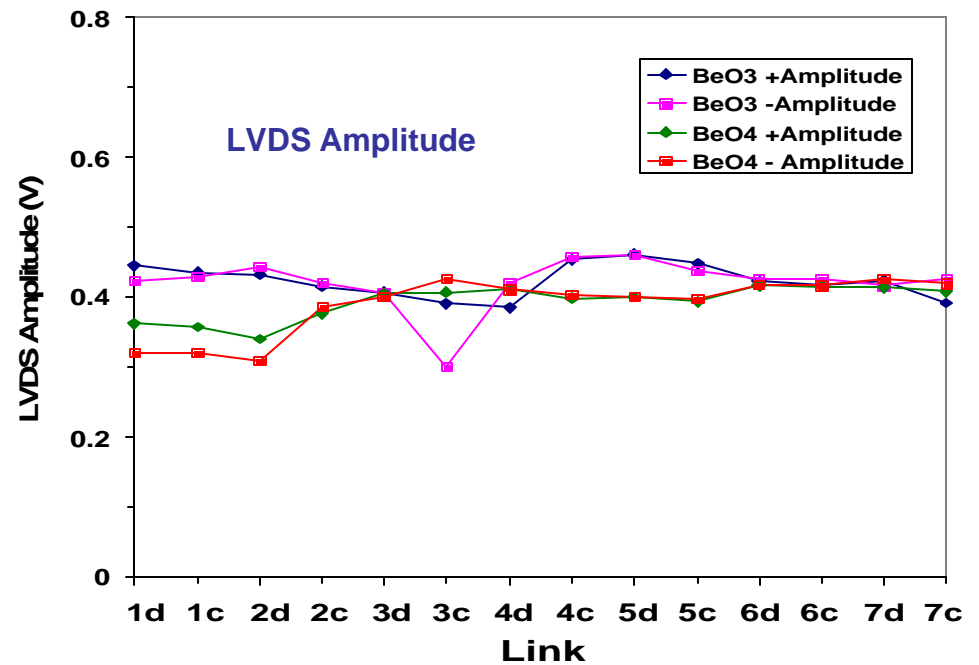
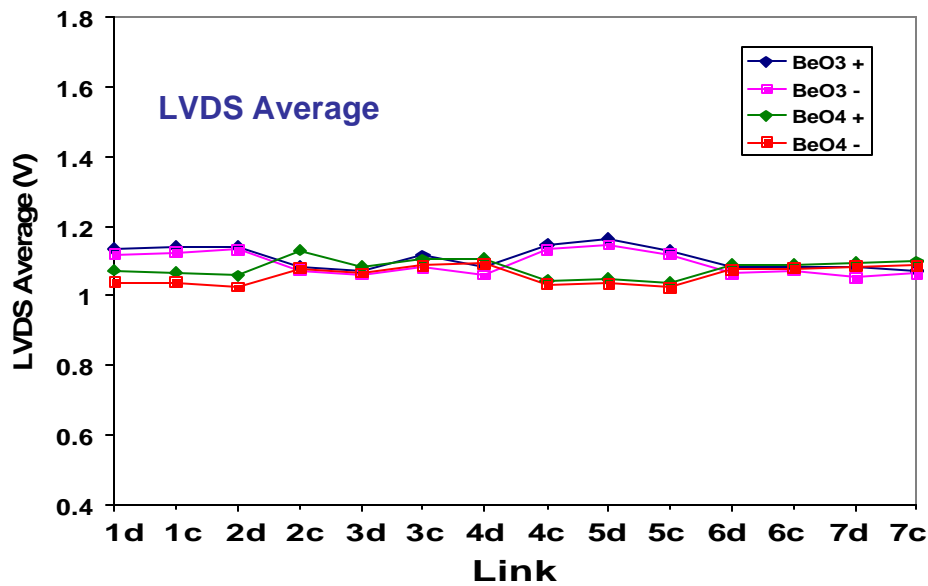
- ✓ Duty cycle: $(50 \pm 4 \%)$
- ✓ Jitter < 1 ns



A. Rahimi

ATLAS Pixel Opto-Electronics Meeting

Opto-board: LVDS +/- Clock and Command Average and Amplitude

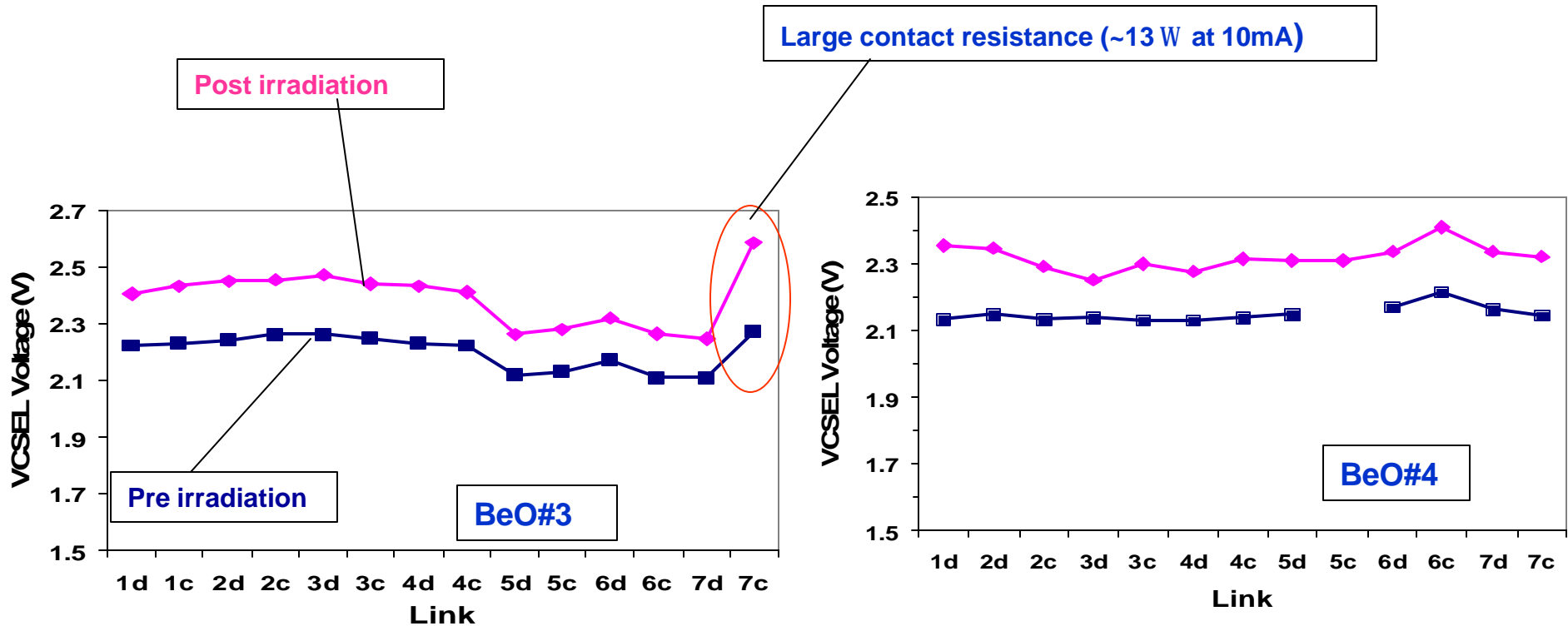


✓ LVDS average and amplitude are within spec.

Summary of BeO3 and 4 QA

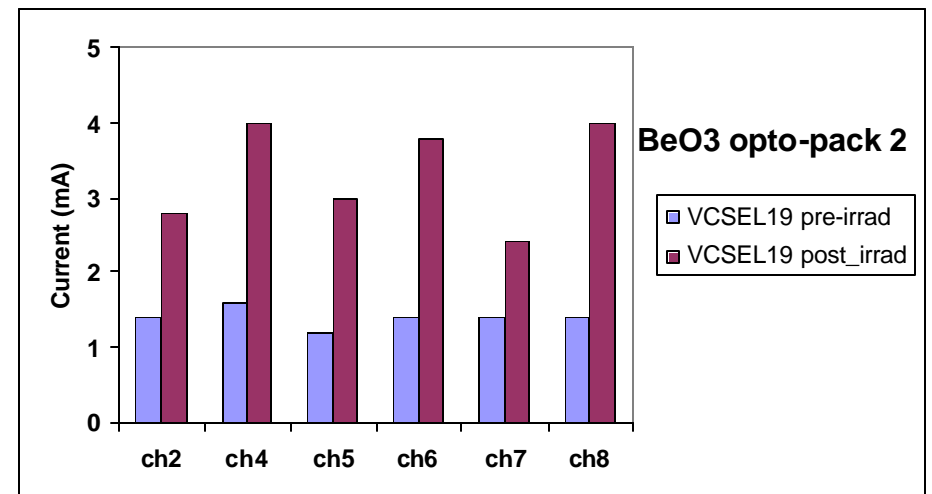
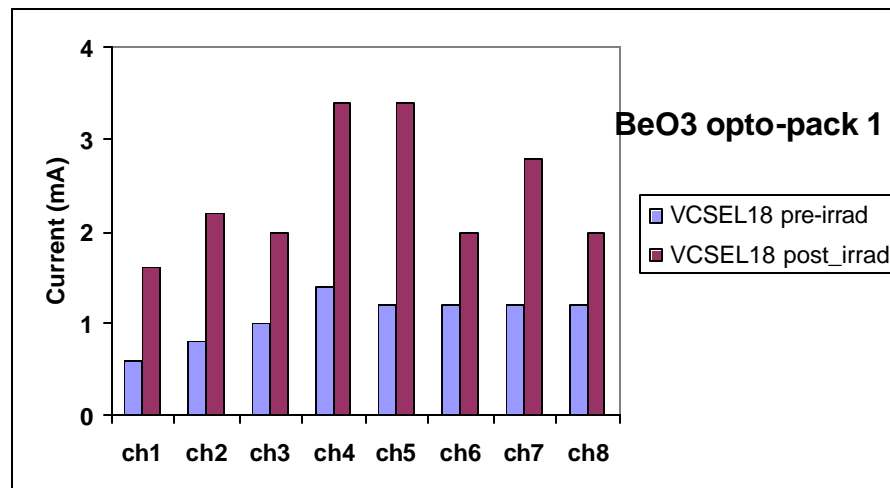
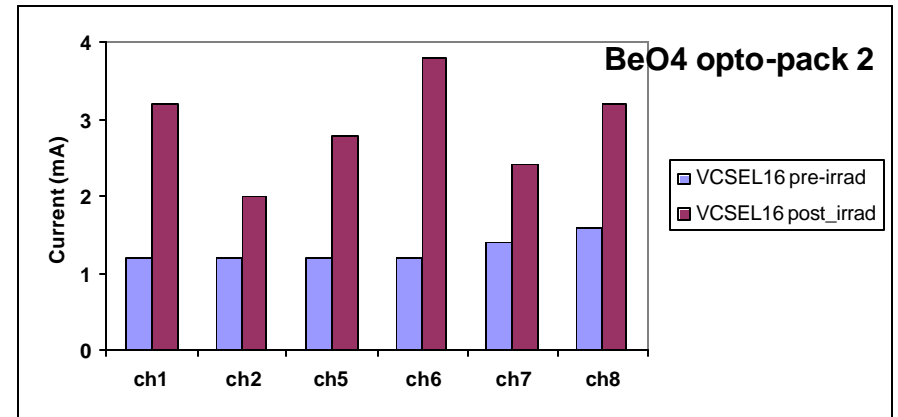
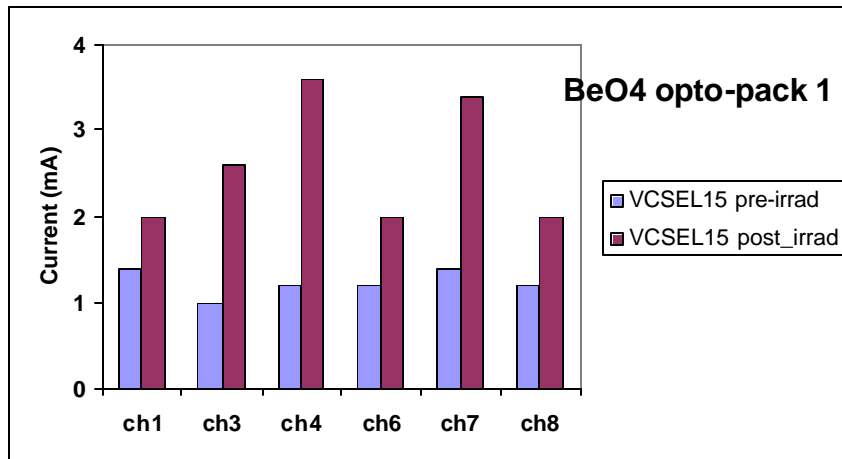
- Both boards pass the QA

VCSEL Forward Voltage after Irradiation/Annealing



- Compare pre and post irradiation V_{VCSEL} at $I_{VCSEL} = 10mA$
 - Average V_{VCSEL} increase of ~200mV

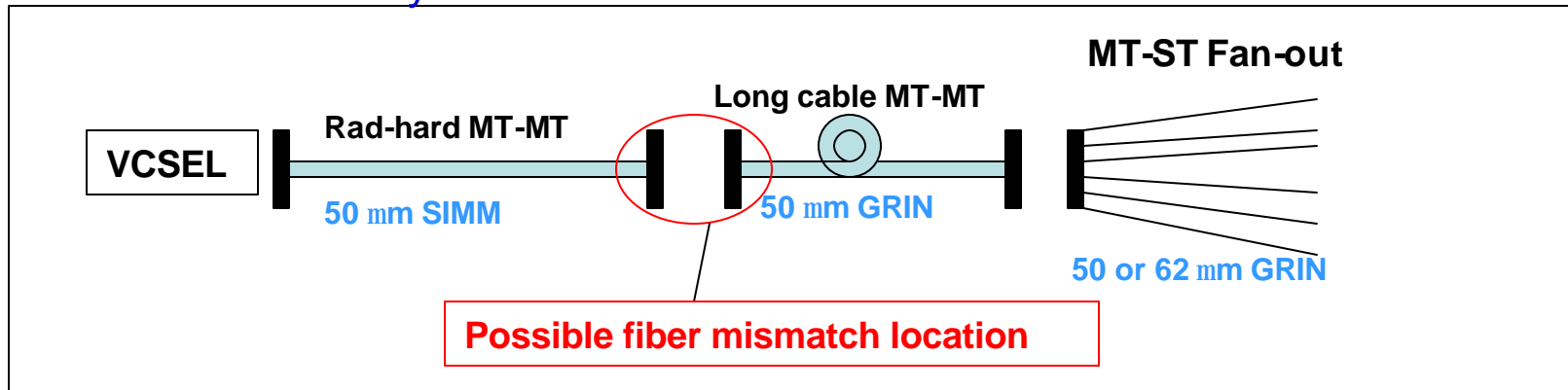
VCSEL Threshold Current after Irradiation/Annealing



- Approximate threshold current increase of ~ 1.6 mA
- Large channel to channel variations

Fiber Mismatch and Power Loss

Irradiation fiber layout



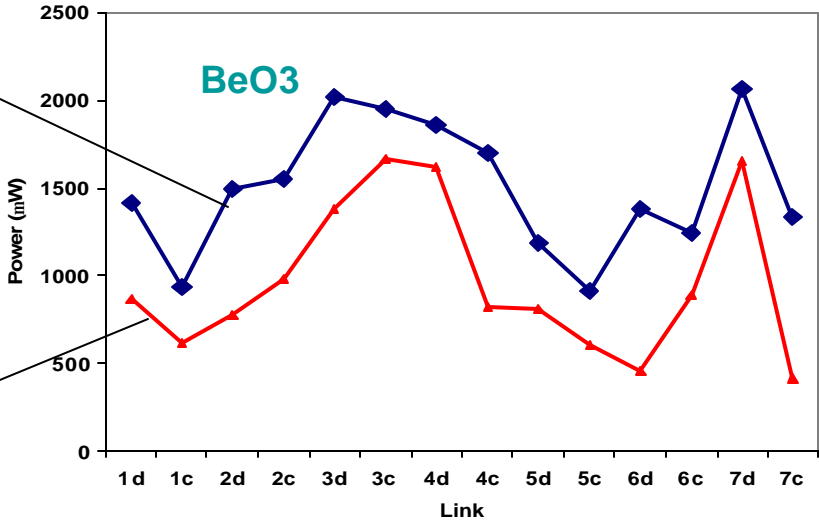
- Power is lost wherever light travels from small effective diameter fiber to a large one
- ~35% power loss with MT-MT -- Long cable

Fiber Connections	Loss
Rad-hard (50 μm SIMM) – Long cable (50 μm GRIN)	~35% loss due to mismatch
Rad-hard (50 μm SIMM) – Taiwan Fan-out (62 μm GRIN)	small
Rad-hard (50 μm SIMM) – Croning Fan-out (50 μm GRIN)	~23% loss due to mismatch
Long Cable (50 μm GRIN) - Croning Fan-out (50 μm GRIN)	small

BeO3 and BeO4 Optical Power

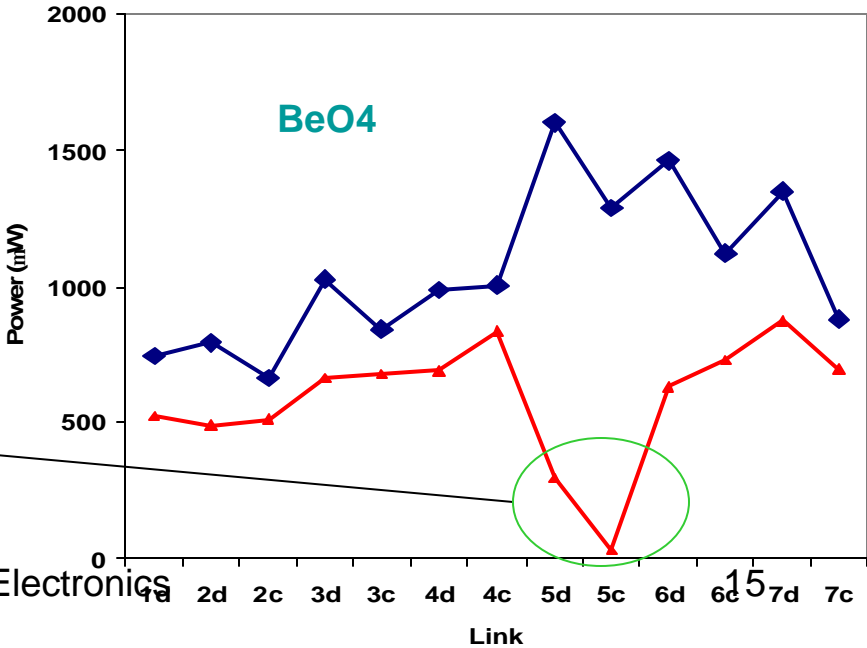
power with one link active at $I_{VCSEL} = 10\text{mA}$

power with VDC driving the VCSEL at $I_{set} = 0.6\text{mA}$ and all links active



- Significant decrease in optical power when driving the VCSEL with the VDC

Poor contact between VCSEL and VDC

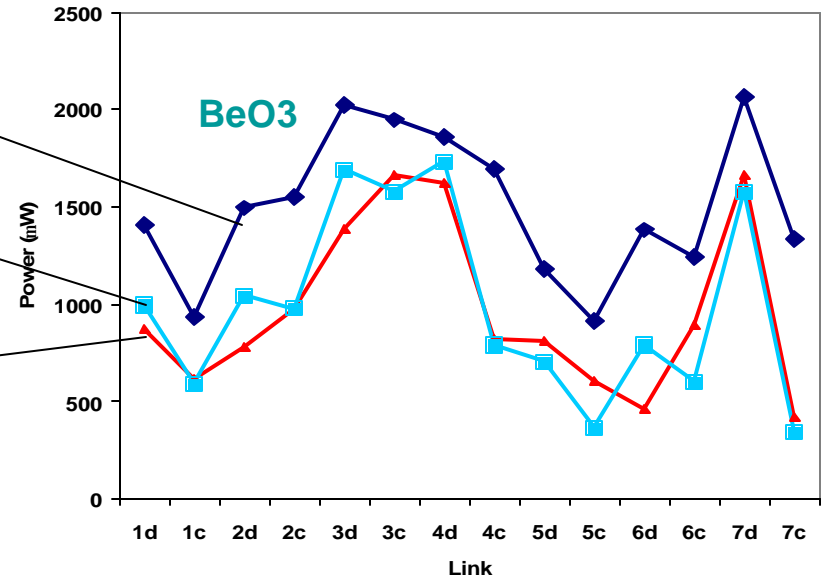


Is the Power Drop Due to VCSEL Heating?

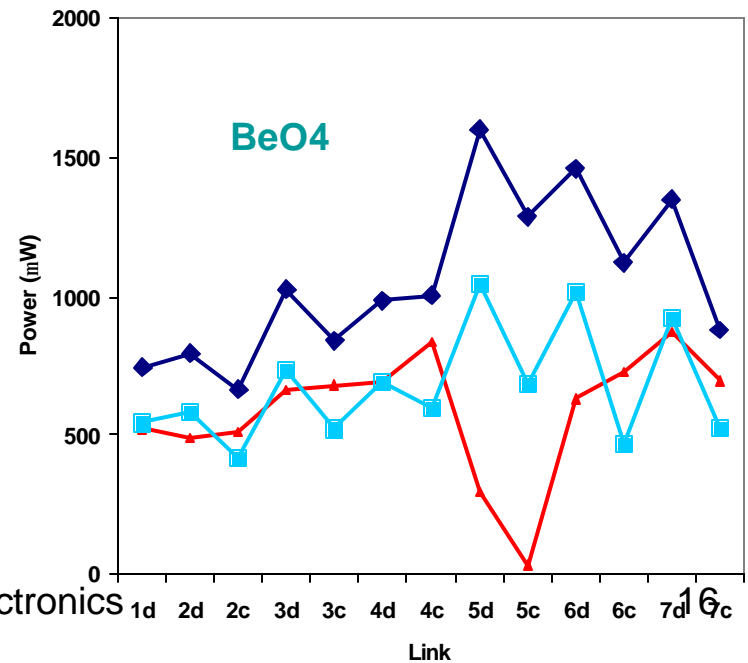
power with one link active at $I_{VCSEL} = 10\text{mA}$

power with 10mA per channel with all channels turned on

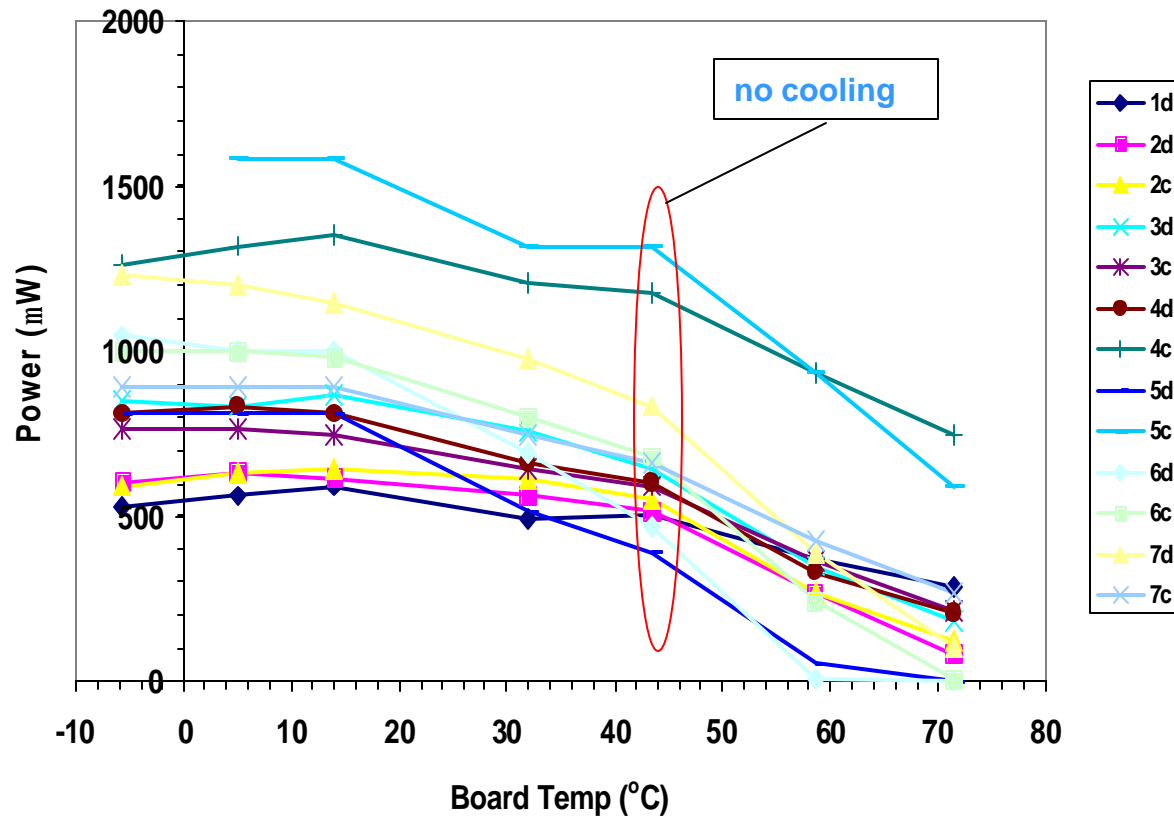
power with VDC driving the VCSEL at $I_{set} = 0.6\text{mA}$, all links active



- Power drops to the level consistent with $I_{set} = 0.6\text{mA}$
- Is the drop in power due to VCSEL heating?
 ⇒ Measure power vs. temperature

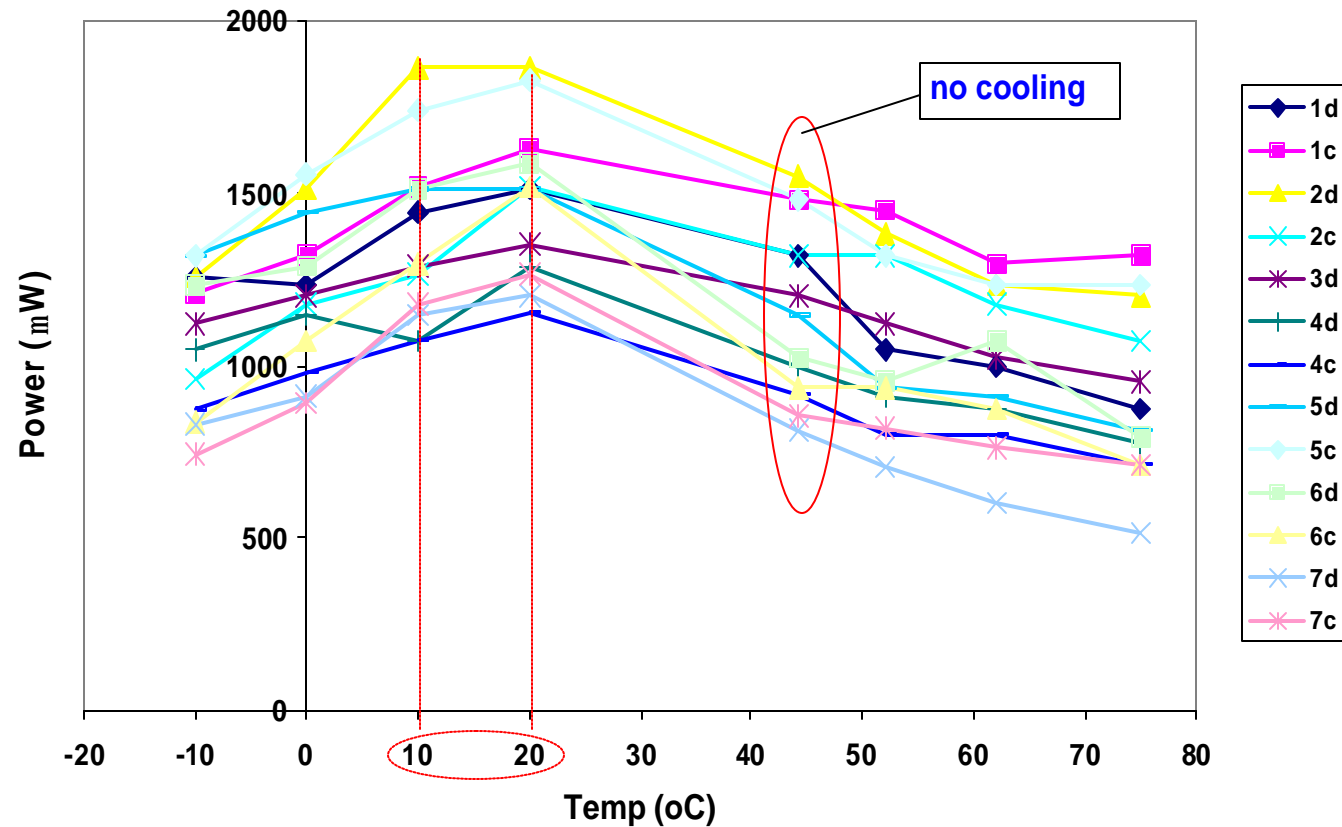


BeO4 Optical Power and Temperature



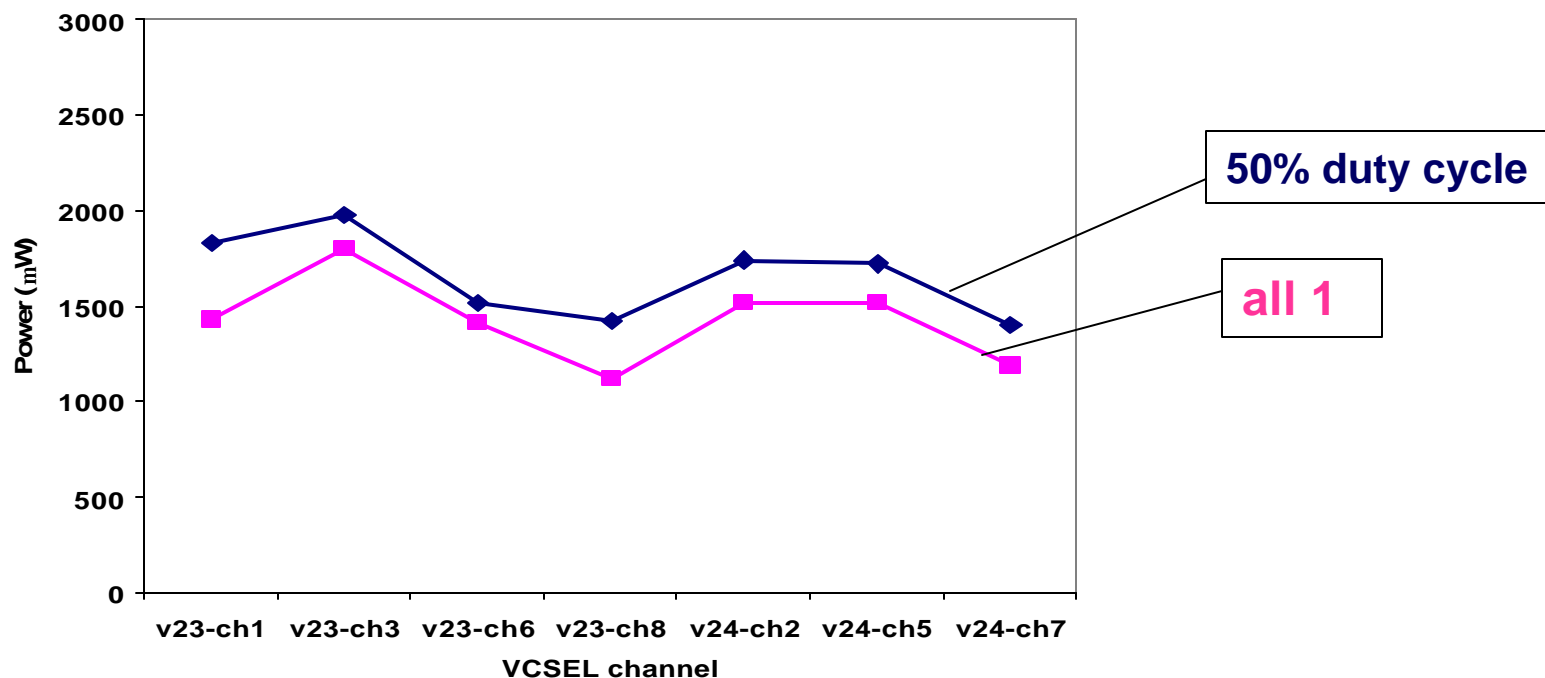
- BeO#4 mounted inside the TJR environmental chamber
- Thermo-couple attached to the opto-board for temperature monitoring
- Power decreases as the board temperature rises
- Favorable power at the cooling temperature of $\sim 10^{\circ}\text{C}$
- Opto-board power down by **$\sim 26\%$** with no cooling

BeO6 Optical Power and Temperature



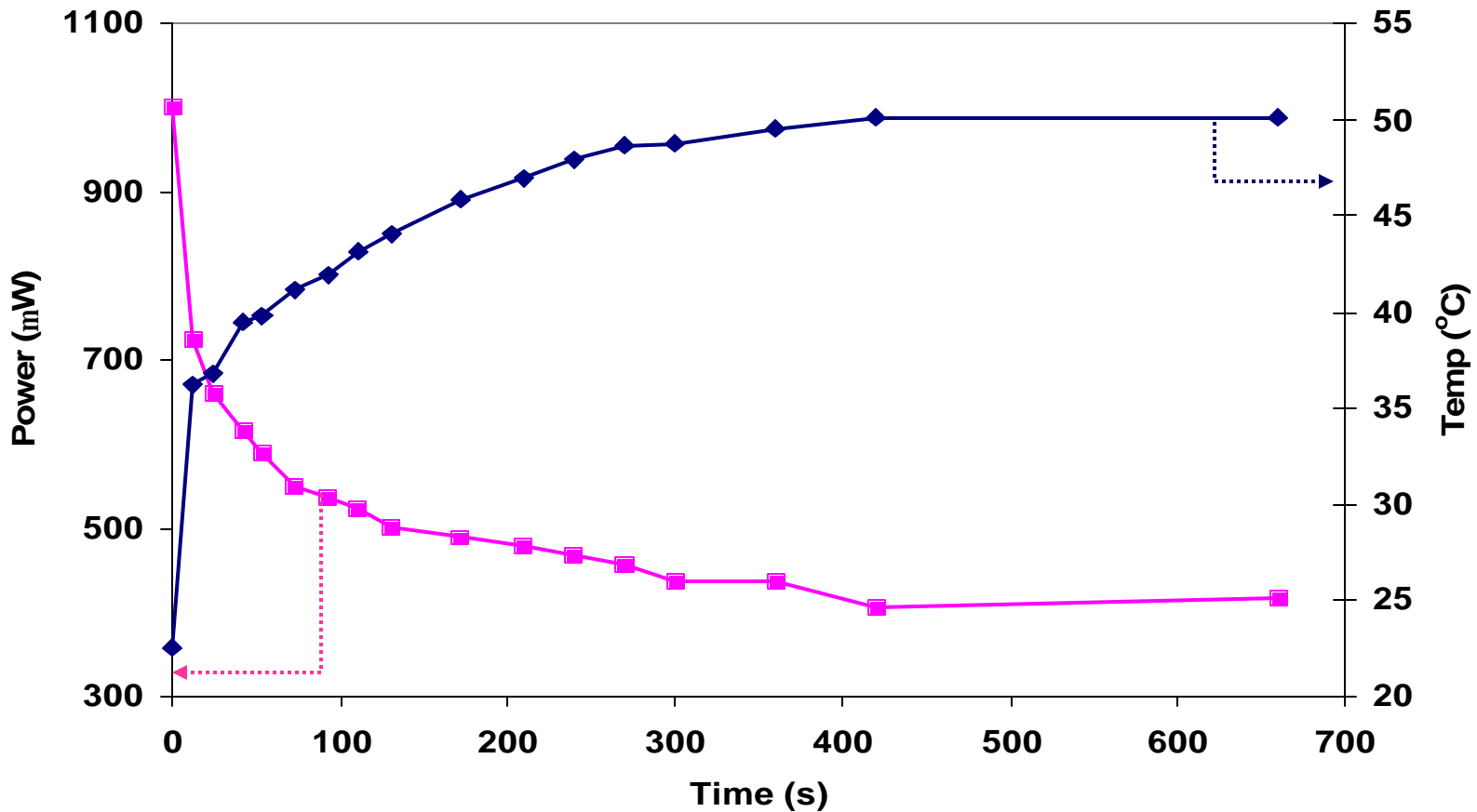
- Favorable power at $T_{\text{board}} = 10 - 20^{\circ}\text{C}$
- Power decreases at lower and higher temperatures

BeO6 Optical Power with 20MHz vs all 1 Signal



- Generate 20MHz (50% duty cycle) signal in the data channel
- ~17% Larger power with the 20MHz signal as compared to all 1
 - Possibly due to less VCSEL heating

VCSEL Power vs. Temperature

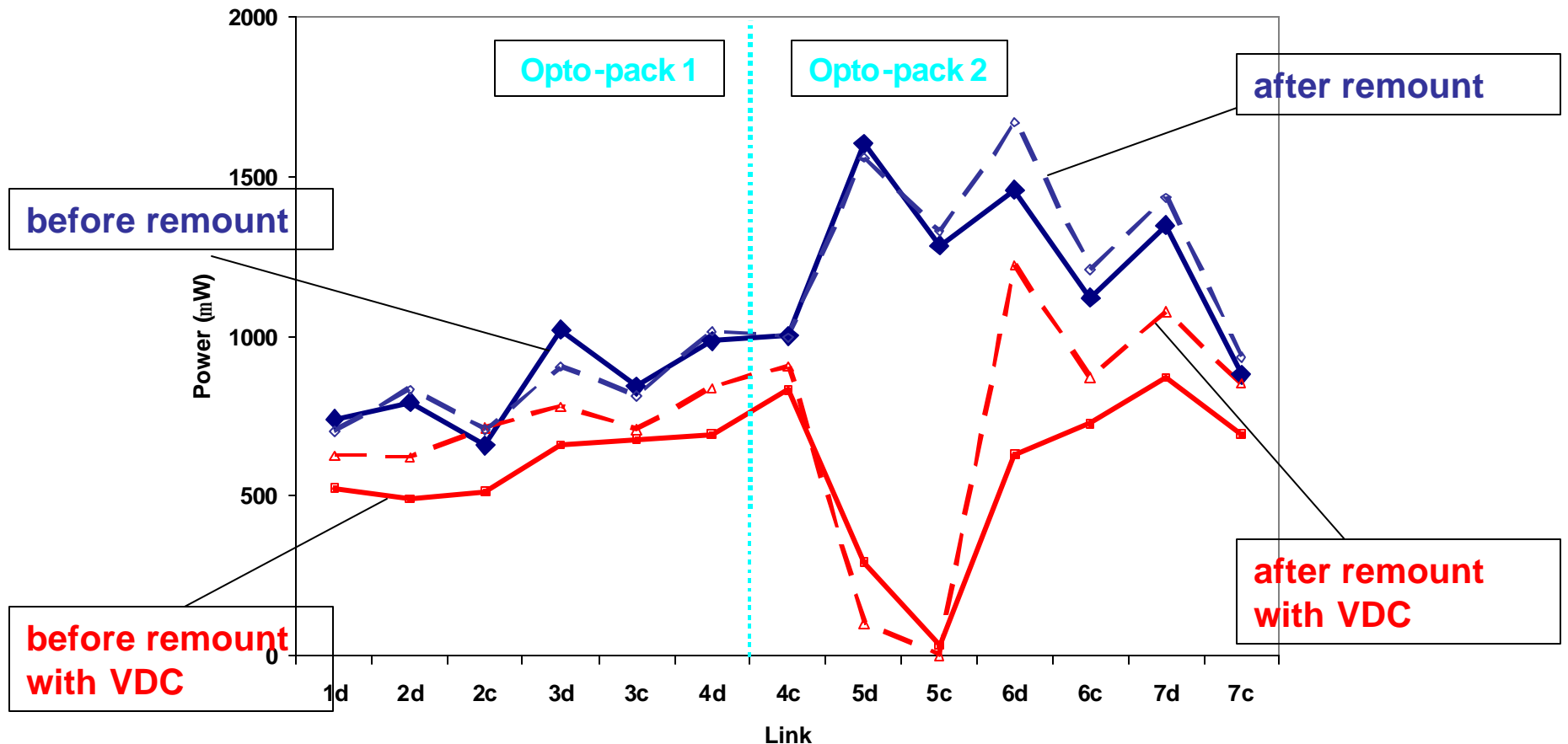


- All VCSELs channels at 20mA per channel
- Connect the thermo-couple to the opto-pack housing to monitor temperature
 - Power decreases by ~70% as T_{housing} rises from 25°C to 50°C

Summary of Opto-board/opto-pack Heating

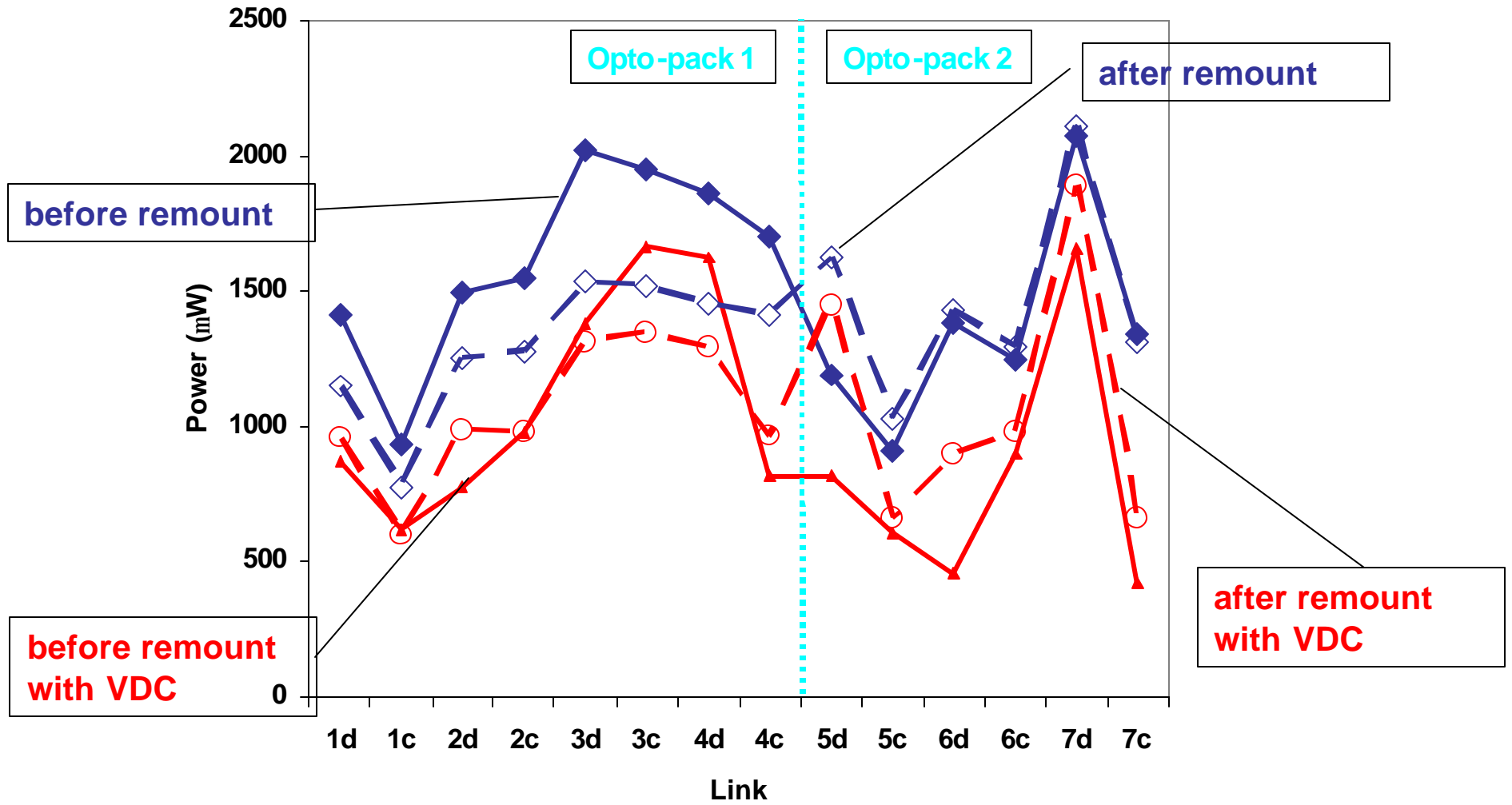
- BeO3 and 4 power decreases significantly when all VCSEL channels are powered
- Optical power decreases with heat
- Favorable power at T_{board} of $\sim 10 - 20$ °C

BeO4 Power after Remounting VCSEL Opto-packs



- Remount VCSELs with the improved procedure
 - Mount housing with MT ferrule to precisely define height
 - Apply adhesive in between opto-pack and opto-board
- Improved power and better agreement between with and without VD
- All channels above 500 μ W after remount

BeO3 Power after Remounting VCSEL Opto-packs

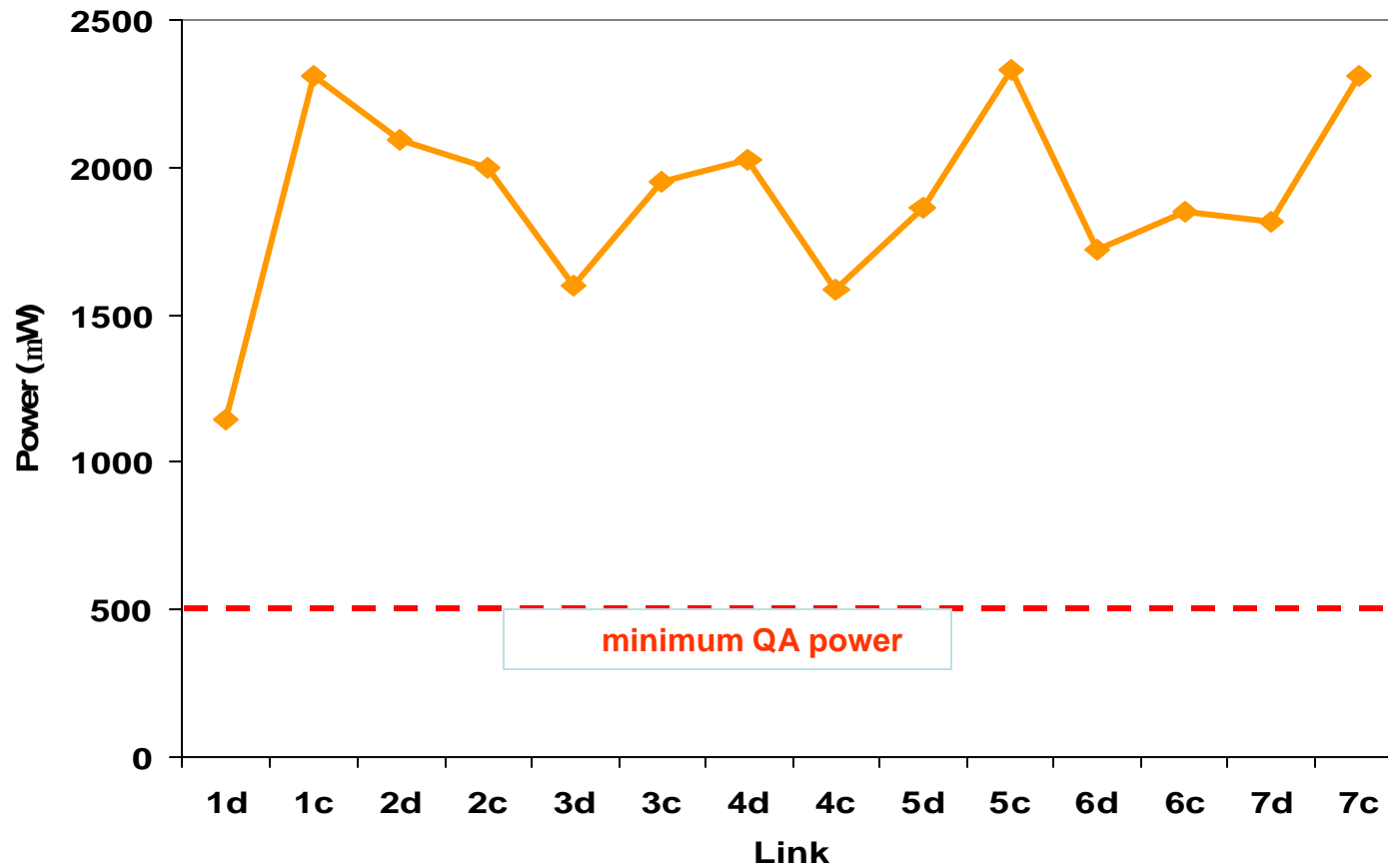


- Similar results as BeO4
 - All channels above 500 μ W after remount

BeO3 and 4 Optical Power Summary

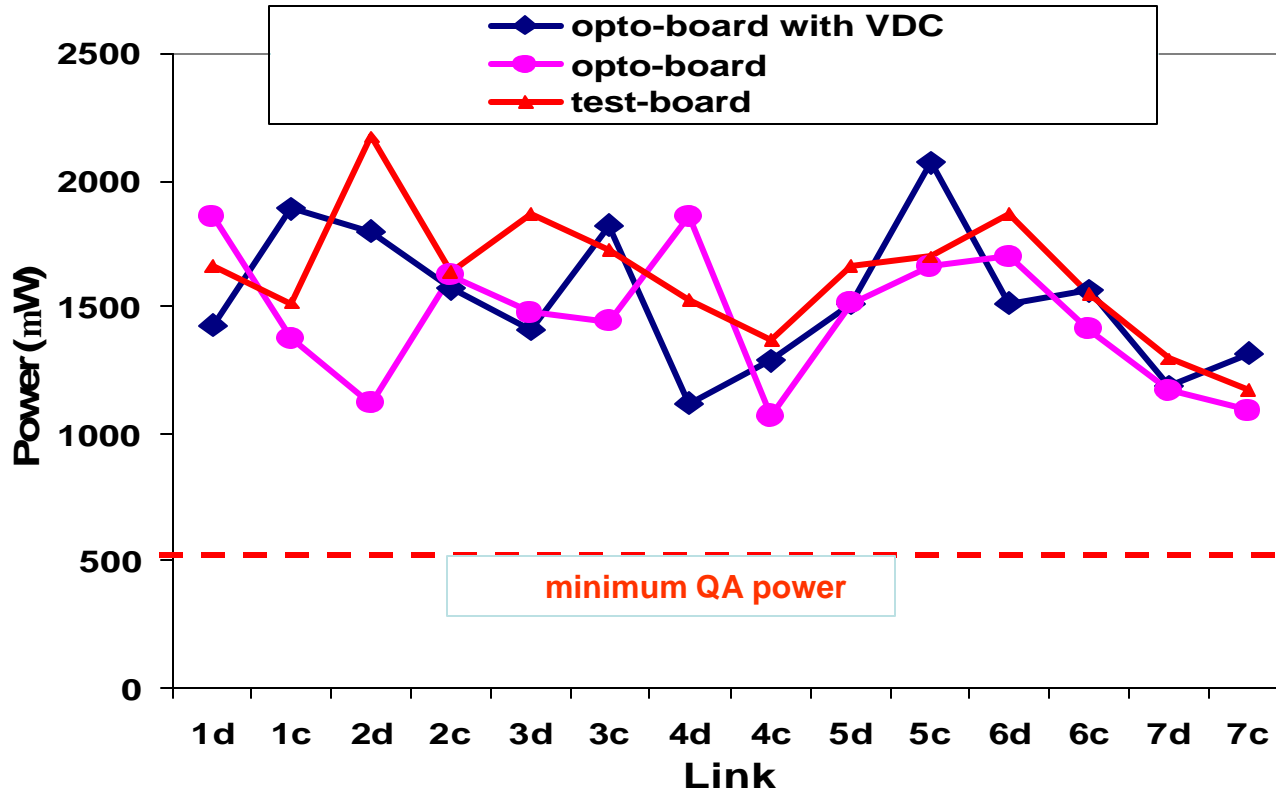
- Low power with all channels powered
- Cable mismatch
 - ~23% loss from 50 μ m SIMM to GRIN
 - ~35% with the long cable
- Opto-board/VCSEL heating
 - ~26% loss in BeO4 power with no cooling
 - Significant power loss at high temperature
- Better power with improved mounting procedure

BeO5



- Passed QA
- Very good optical power
 - All channels are above 1 mW
- Shipped to Wuppertal

BeO6



- Passed QA
- Three sets of power measurements
 - test-board
 - opto-board
 - opto-board with VDC
- Good powers, all channels higher than 1mW
- Some channels have larger than 20% variations between measurements

Summary

- Acceptable degradation in VDC and DORIC after 55 MRad
- BeO3 and 4 pass QA after ~32 MRad
- Forward V_{VCSEL} and threshold current increase after irradiation
- BeO3 and 4 power decrease significantly with heat
 - all channels above 500 μ W at room temp.
- SIMM to GRIN power loss ~23%
 - 35% loss with the long cable
- BeO5 and 6 pass QA
 - Optical power > 1mW in all channels