

Status of Opto-Board Development

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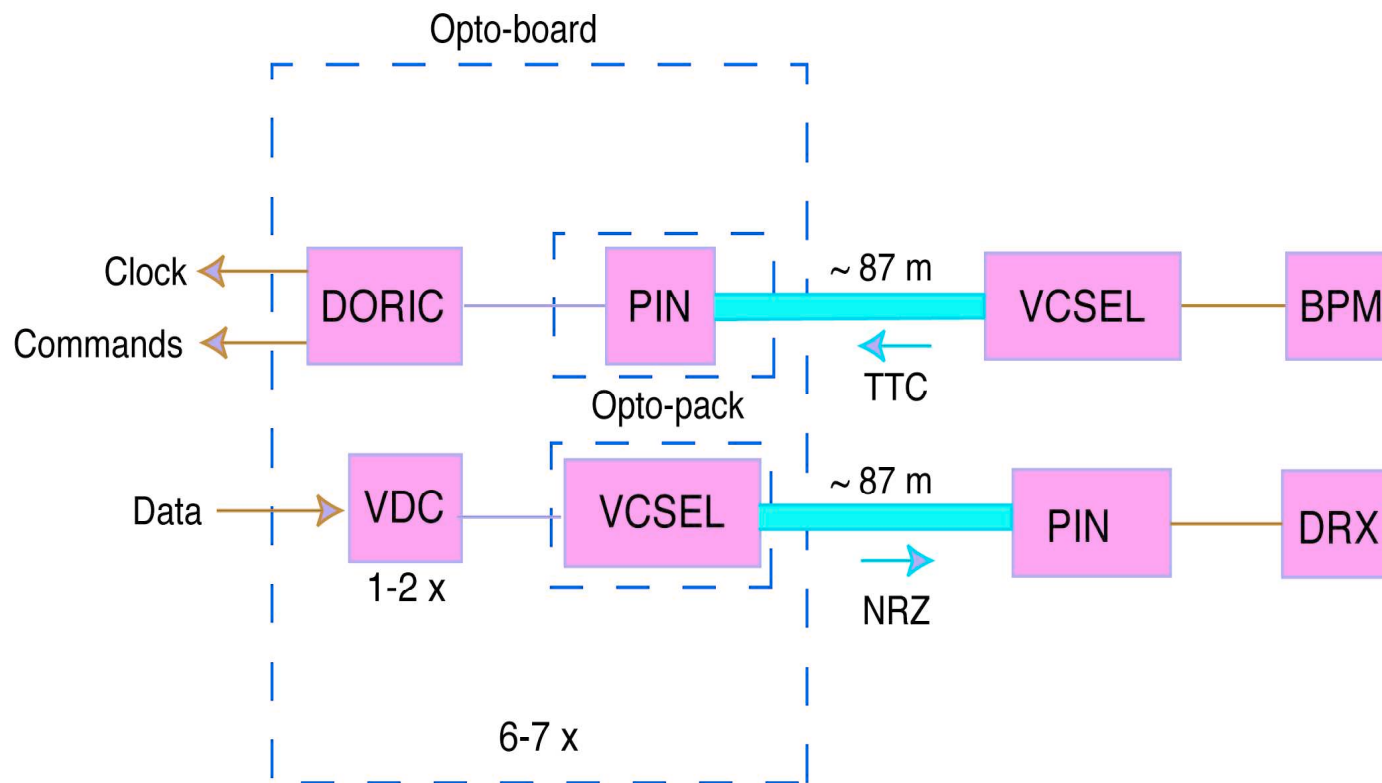
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Outline

- Introduction
- Opto-Board design
- Prototype Results
- Irradiation Results
- Conclusions

ATLAS Pixel Opto-link



Opto-Board

- converts: optical signal ↔ electrical signal
- single board design with 7 optical links:
 - ☆ disks and 50% of half-staves use 6 optical links
 - ☆ disk, layers 1 and 2 optical links:
 - ◆ 2 x 4-channel DORIC + 8-channel PIN opto-pack
 - ◆ 2 x 4-channel VDC + 8-channel VCSEL opto-pack
 - ☆ B layer optical links:
 - ◆ 2 x 4-channel DORIC + 8-channel PIN opto-pack
 - ◆ 4 x 4-channel VDC + 2 x 8-channel VCSEL opto-packs
- use BeO for heat management but prototype initially in FR4 for fast turnaround and cost saving
- quantity needed: 212 opto-boards for two-hit system

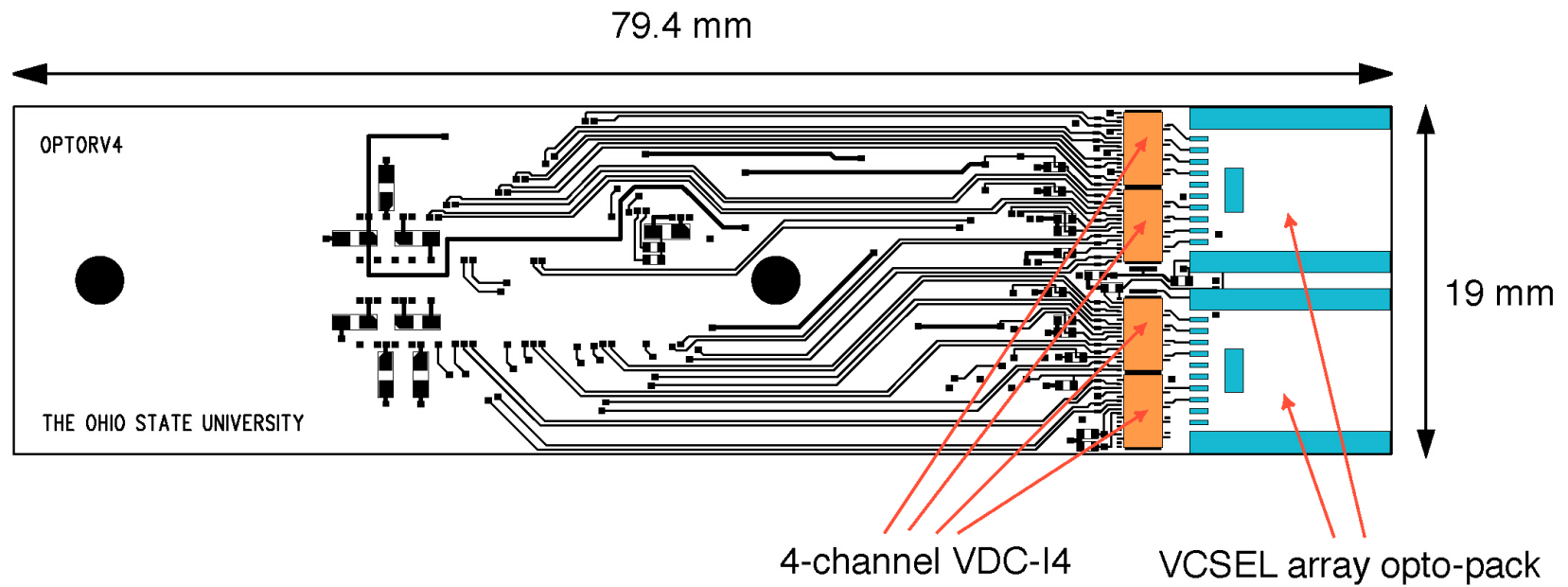
Opto-Board Prototypes

- opto-board prototype I:
 - ☆ designed for DORIC/VDC-D2
- opto-board prototype II:
 - ☆ designed for DORIC/VDC-I1
- opto-board prototype III:
 - ☆ designed for DORIC-I2/4-channel VDC-I2
 - ☆ contain 7 opto-links for use in barrel and disk
 - ☆ use SCT style opto-packs
 - ☆ use 80-pin connector

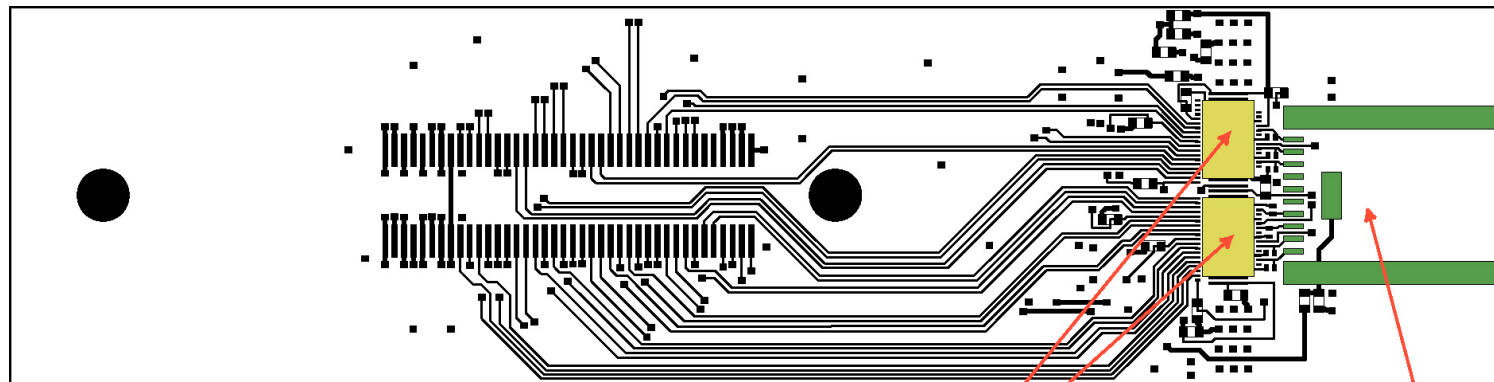
Opto-Board Prototype IV

- design for 4-channel DORIC-I4 and VDC-I4
- contain 7 opto-links for use in barrel and disk
- use 8-channel PIN/VCSEL array opto-packs
- use 80-pin connector
- last FR4 prototype before using BeO
- delivered in June 2002

Opto-Board Prototype IV (Top)



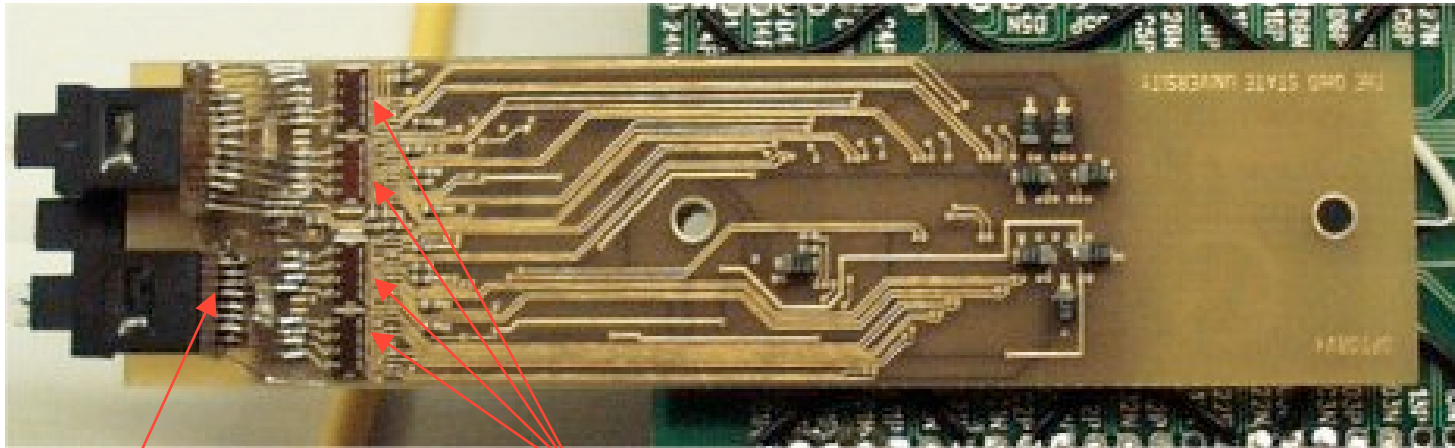
Opto-Board Prototype IV (Bottom)



4-channel DORIC-I4

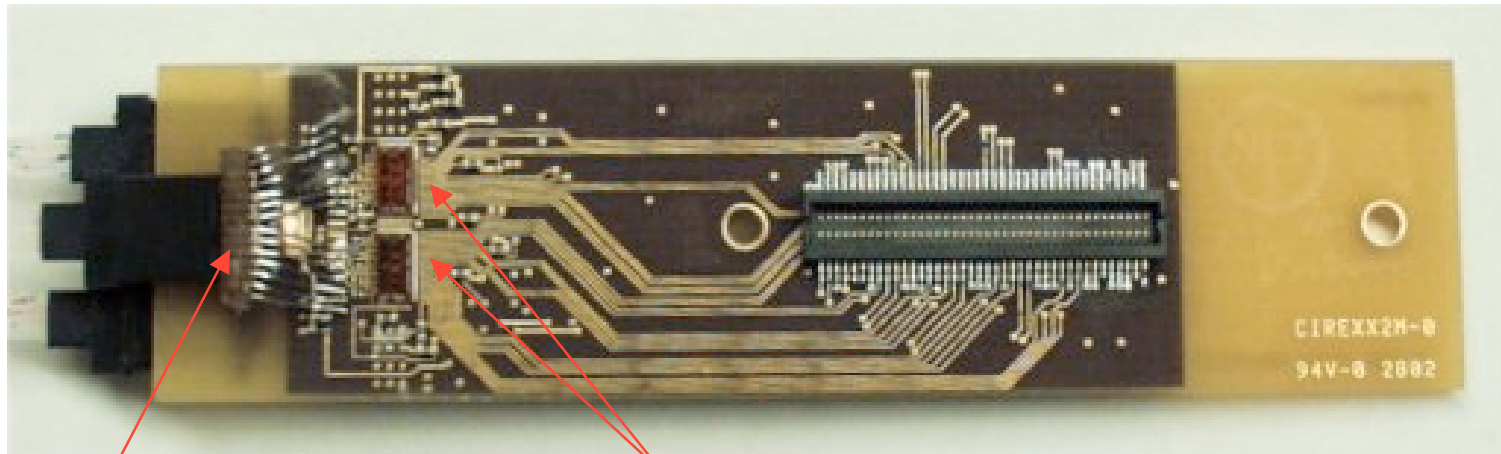
PIN array opto-pack

Opto-Board Prototype IV



VCSEL array

4-channel VDC-I4



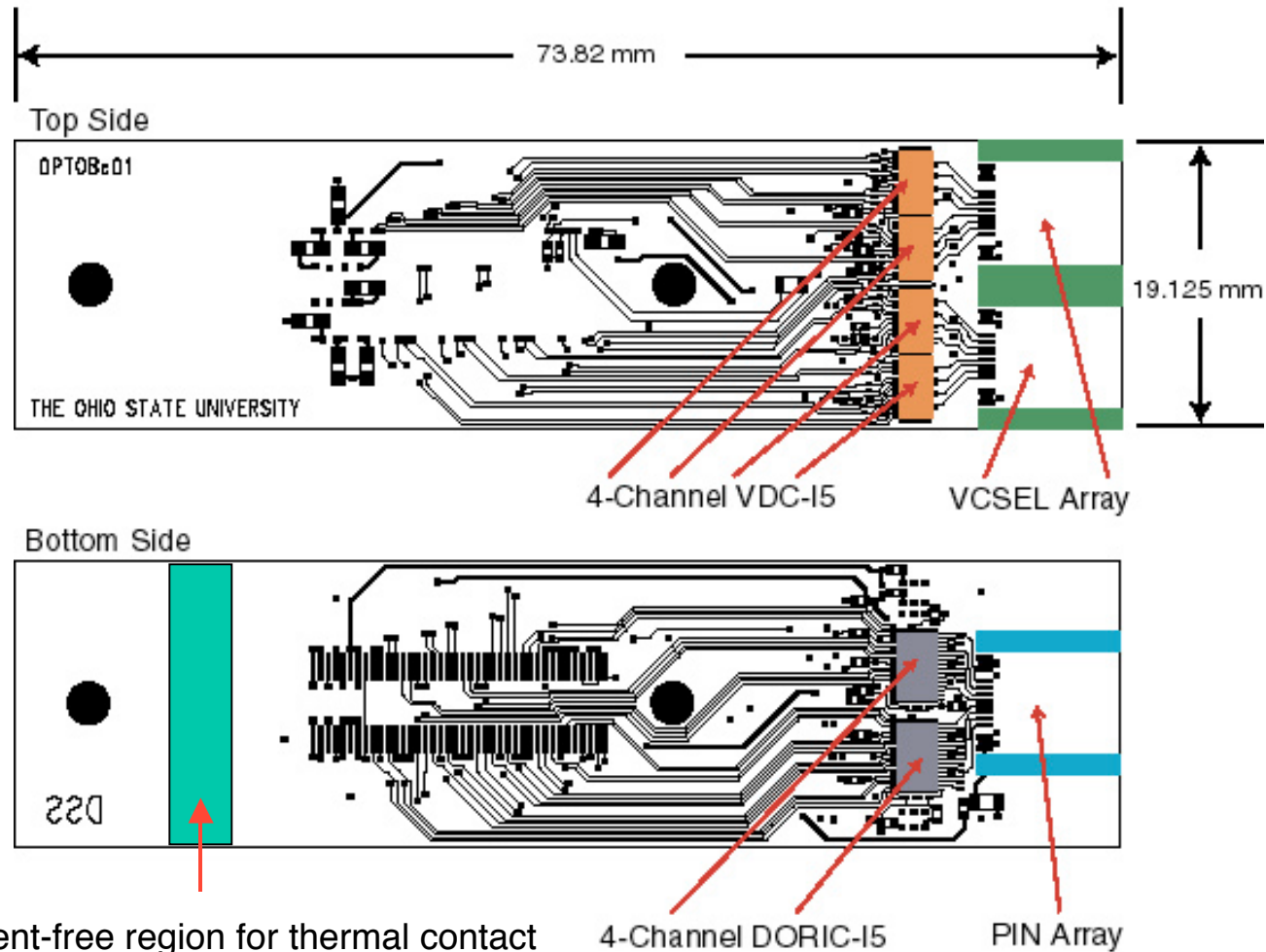
PIN array

4-channel DORIC-I4

Opto-Board Prototype V

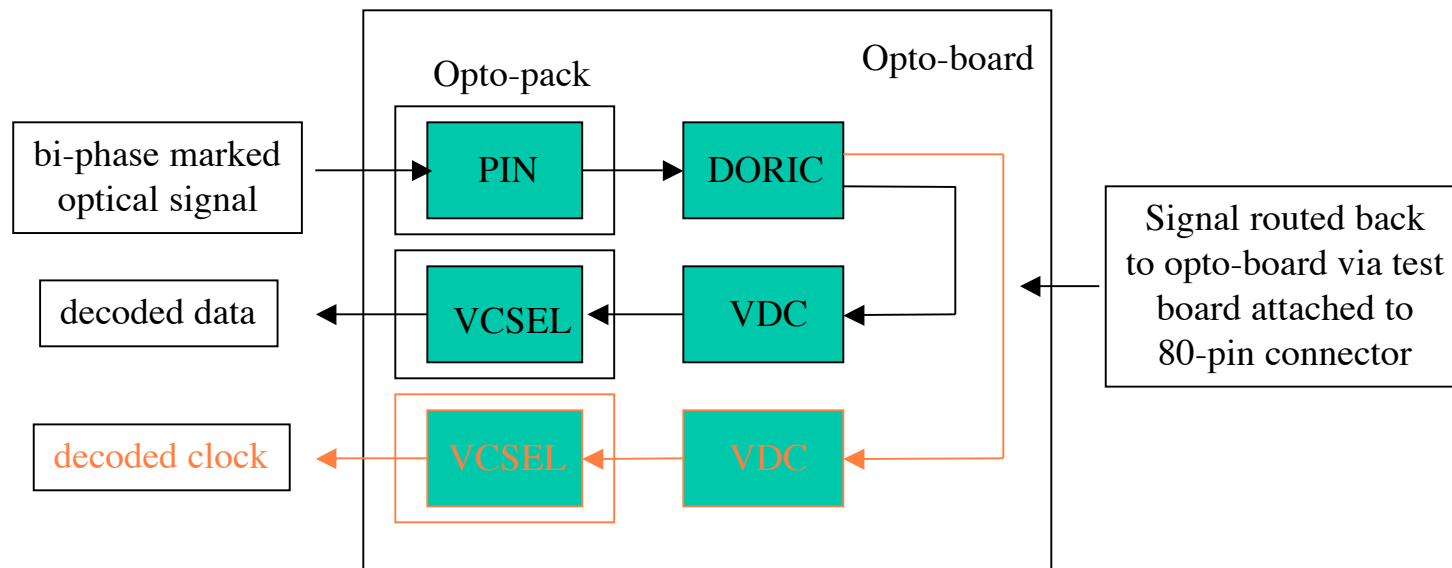
- design for 4-channel DORIC- I5 and VDC-I5
- first BeO prototype
- delivery expected in February 2003

Opto-Board Prototype V



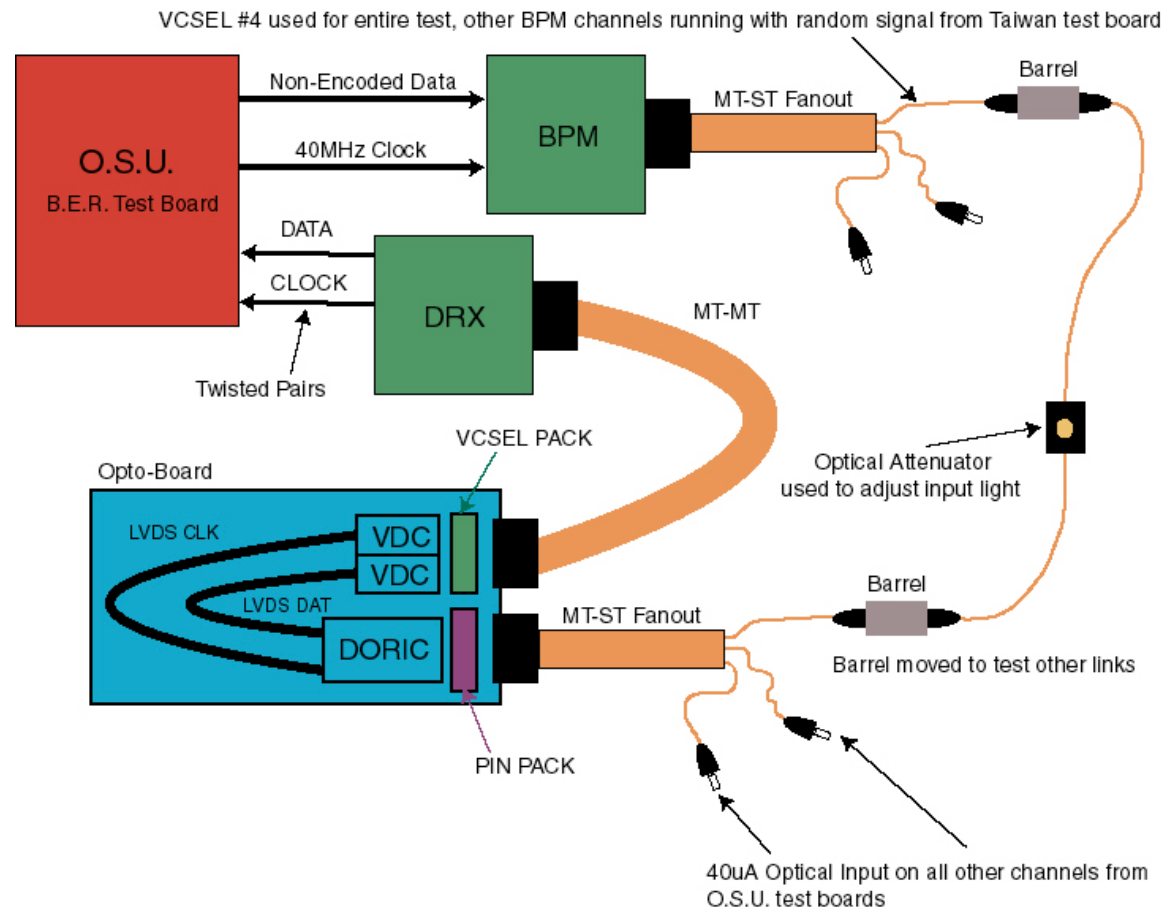
component-free region for thermal contact
expected opto-board temperature: $< 0^{\circ}\text{C}$

Opto-Board Testing

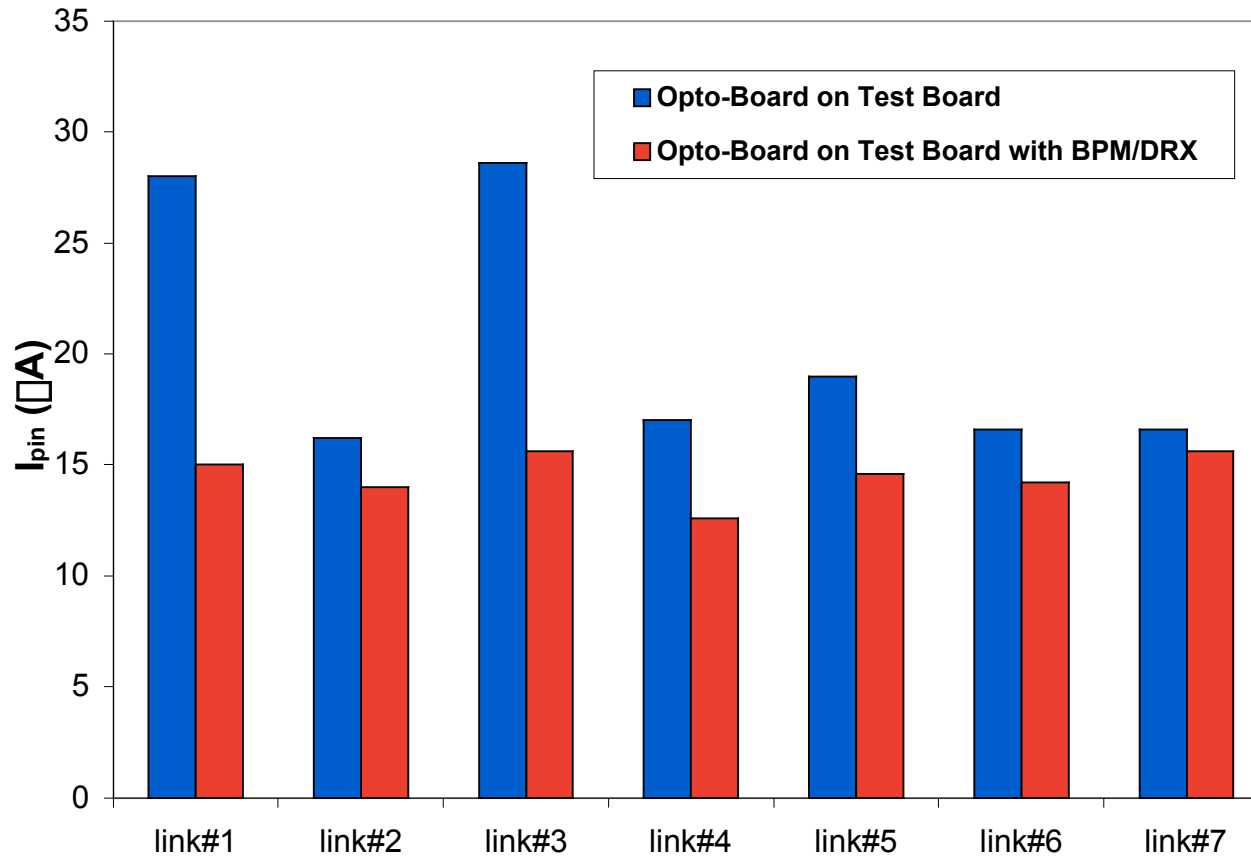


- compare transmitted and decoded data
 - ⇒ measure minimum PIN current for no bit errors

Opto-Board Testing with BPM/DRX

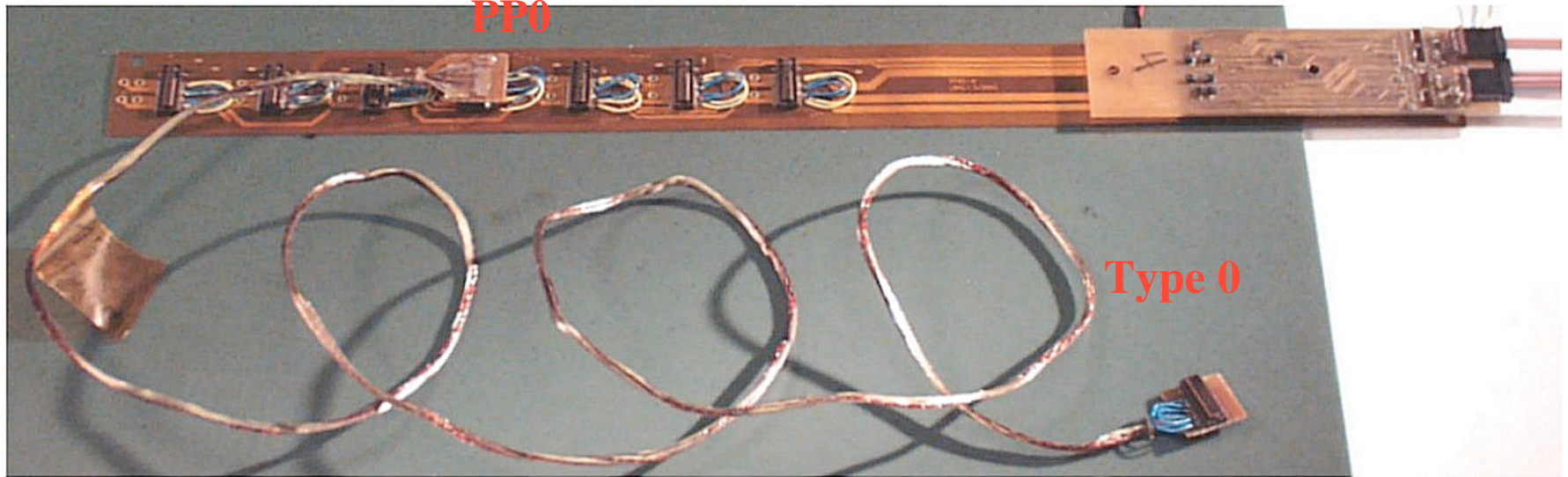


PIN Current Thresholds with Opto-Board



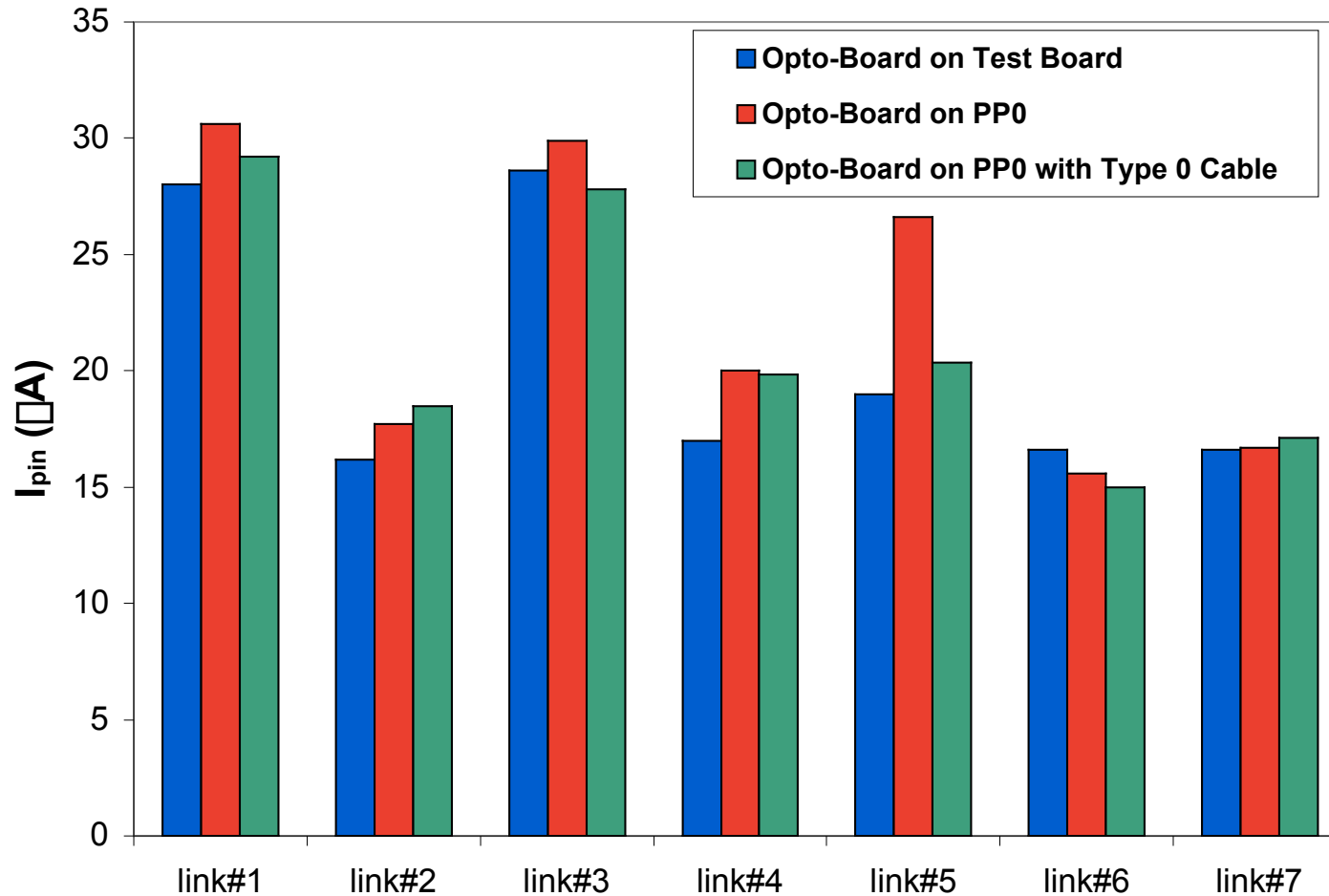
- thresholds for no bit error measured with other links running at 40 mA
- opto-board operates with low thresholds
- lower thresholds with BPM/DRX
 - ⇒ board design has low noise and compatible with BPM/DRX

Opto-Board with PP0 + Type 0 Cables



- data/clock from DORIC to VDC rerouted via PP0/Type 0 cables

PIN Current Thresholds with PP0/Type 0 Cables



- thresholds measured with other links running at 40 mA
- no increase in thresholds with PP0/Type 0 cables

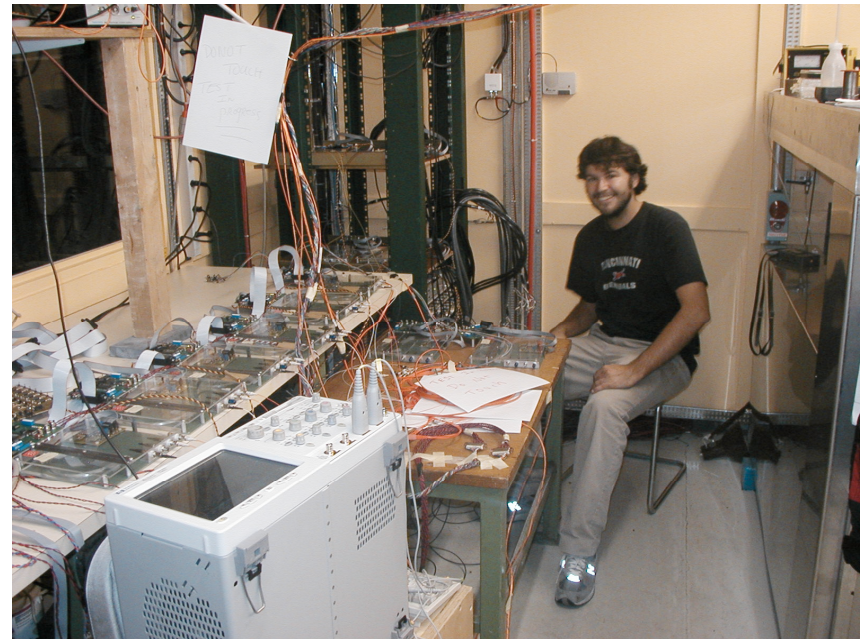
Proton Irradiation at CERN

- use 24 GeV protons at T7
- five irradiations since 1999:
 - ◆ last irradiation in August 2002
 - ☆ cold box: purely electrical testing
 - ☆ shuttle: opto-link testing
 - ◆ opto-board I: 5 working clock and data links
 - ◆ opto-board II: 4 working data links
 - ◆ opto-board III: 1 and 6 working clock and data links

Equipment Constructed for Irradiation



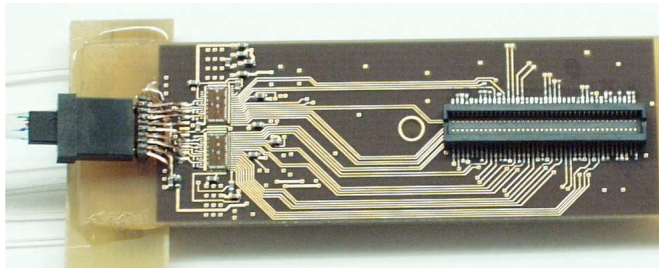
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Opto-Link FDR

Test Boards for Irradiation in Shuttle

Opto-board with 7 opto-links

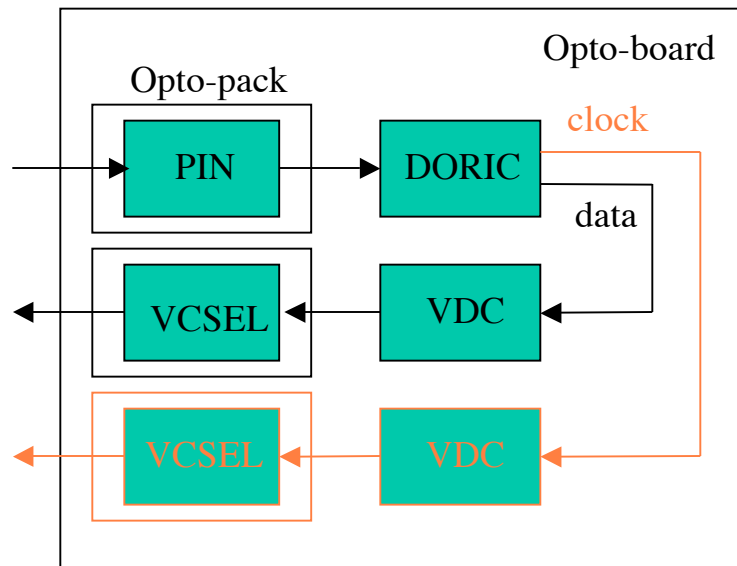
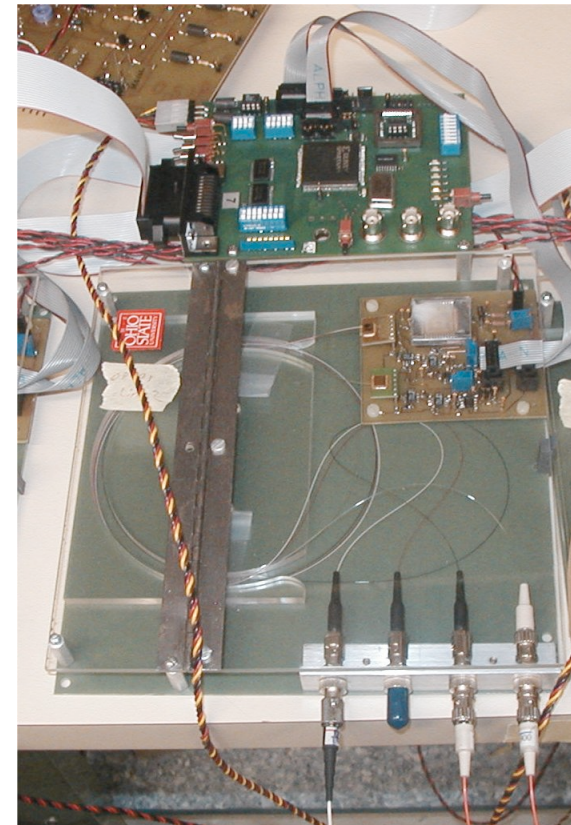


Bi-phase marked
optical signal

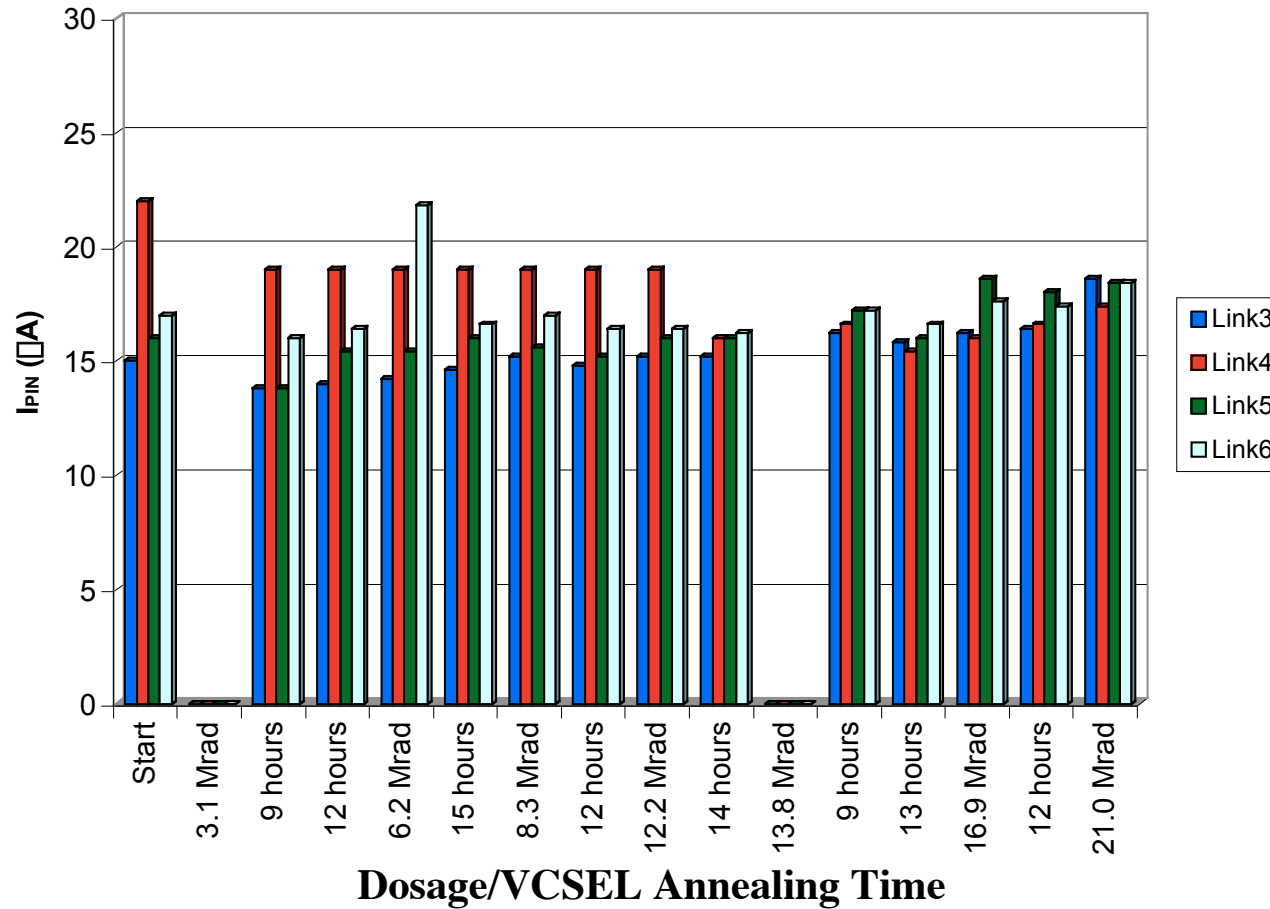
25 m fibers/wires

Decoded data

Bit error test boards in control room
(one per opto-link)

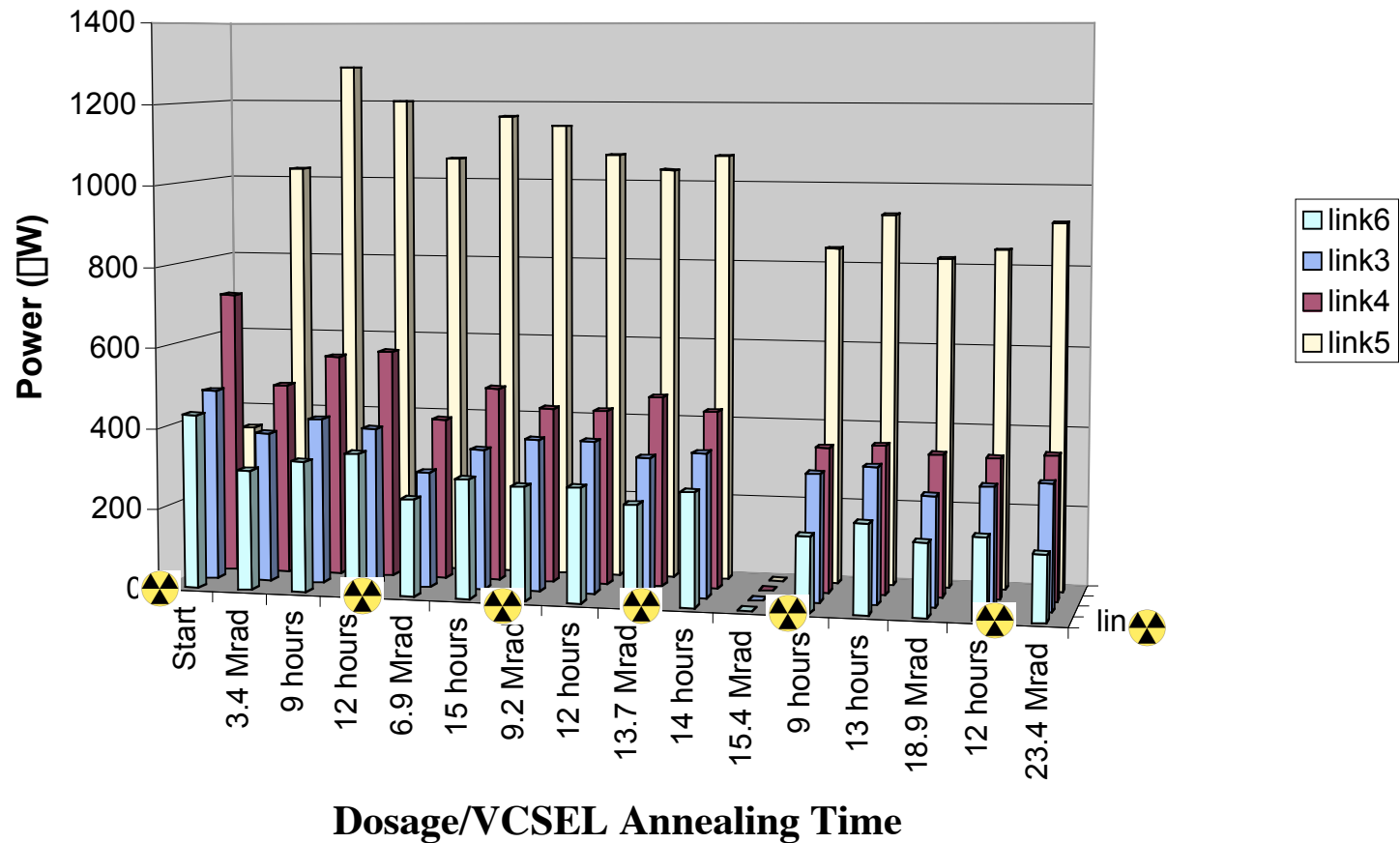


Opto-Board Bit Error Threshold vs. Dosage



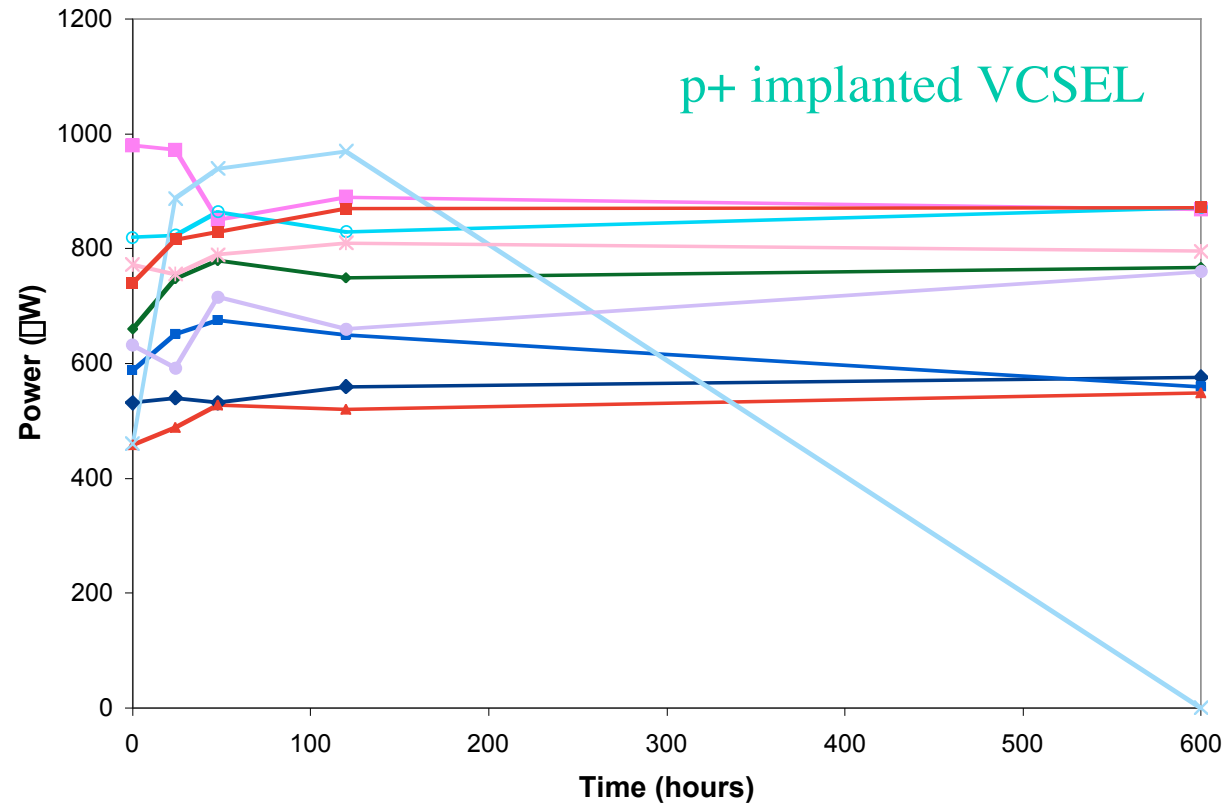
- VCSELs annealed with 20 mA during indicated periods
- bit error thresholds remain constant up to 21 Mrad

Opto-Board Optical Power vs. Dosage



- optical power decrease with dosage as expected

Optical Power of Irradiated Opto-boards after Annealing



- limited annealing during irradiation partially recovers optical power lost
 - ⇒ all links have good optical power before annealing
- one VCSEL has large radiation damage
 - ⇒ large improvement with annealing
 - ⇒ dead after > 100 hours of annealing

Irradiation Plans

- OSU research nuclear reactor can deliver 2×10^{15} n/cm² (1 MeV eq.) in one day
- OSU ⁶⁰Co source can deliver 5 Mrad in one day
 - ⇒ will irradiate BeO opto-boards with DORIC/VDC-I5 using neutrons and γ in March 2003
- will irradiate BeO opto-boards with DORIC/VDC-I5 using 24 GeV protons at CERN in August 2003

Summary

- opto-board prototype IV operates with low noise
- opto-board is compatible with BPM/DRX
- no change in PIN current thresholds for no bit errors with PP0/type 0 cables
- BeO opto-board has been submitted for fabrication
- no significant degradation of opto-electronics during proton irradiation
 - ☆ one irradiated VCSEL failed during annealing
- opto-pack MT latch and housing not yet tested