Status of On-Detector Opto-Links

The Ohio State University

P. Buchholz, A. Wiese, M. Ziolkowski
Universität Siegen

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Outline

● Results on prototype opto-boards
● Results on prototype opto-board irradiation
● Results on iFlame optical packages
● Status of stress test
● Summary
Summary of Opto-Board Flavors

- 4 opto-board flavors
  - D opto-board (disk): 7 TTC + 7 data links (2 flavors)
  - B opto-board (B-layer): 7 TTC + 14 data links
  - IBL opto-board: 8 TTC + 16 data links
nSQP B Opto-Board

- In spring, decided to produce copper backed PCB over thick film BeO for cost saving
- CERN PCB shop fabricated 25 B-layer opto-boards
- PCB design/fabrication quality excellent
  - good passive/connector soldering
  - sharp etch patterns
    - easy wire-bond
  - no error found in schematic/layout
- Problems with copper backing plate
Fabrication Problems

- Shorts between VVDC, GND, and Cu plates
  - planes 125 \( \mu \text{m} \) from edge exposed after cut out
- Several boards were delaminated from Cu plate
- Cu plate too thin (< 200 \( \mu \text{m} \)) for good heat conduction
Design Changes

- Design modified to ease fabrication:
  - all artwork 250 μm from PCB edge
  - notches for opto-packs removed
  - PCB outline identical to Cu plate

- Mechanical/thermal improvements:
  - increase Cu plate thickness to 1 mm
  - add holes for extraction tool
  - exposed Cu on top layer for cooling of iFlame opto-pack (if used)

- Submitting to CERN PCB house this week for fabrication
  - also asking a US vendor to quote/fabricate PCB
Design Changes

First Prototype

V4.0 (new)

No cutouts for opto-packs, board is exact size as Cu plate

Added 2 mm extraction holes

Added exposed Cu on top layer
Prototype Opto-Board Irradiation

- Populated 6 prototype opto-boards:
  - used Finisar 5 Gb/s VCSELs and ULM PINs with OSU opto-packs
  - assembly was straightforward
  - wire-bonding went well

- Irradiated 4 opto-boards with 24 GeV protons at CERN:
  - 2 boards to $8 \times 10^{13}$ p/cm$^2$ or 1.8 Mrad (18 kGy)
  - 2 boards to $10 \times 10^{13}$ p/cm$^2$ or 2.3 Mrad (23 kGy)
  - no increase in PIN current thresholds for no bit errors
  - modest decrease in output optical power
Prototype Opto-Board Irradiation

- modest decrease in output optical power

![Graphs showing optical power over time for different rad levels](image-url)
iFlame Opto-packs

- Fabricated by Xloom
- Received 11 opto-packs with 4-channel VCSEL and PIN arrays
- Semi-hermetic sealed using optical epoxy similar to OSU/Taiwan opto-packs
- Optical power is somewhat low:
  - significant reflection loss due to design limitation
iFlame Opto-packs

- Channels on 3 opto-packs died during burn-in
- Xloom blamed the death on thermal stress
  - no heat sink attached during test
  - no heat sink required in OSU or Taiwan opto-packs
- 6 opto-packs were irradiated with 24 GeV protons at CERN
  - degradation is modest
- Learning to fabricate 12-channel opto-packs
  - encountered technical difficulties
  - expect delivery soon

Require heat sink attached to back of VCSEL array

K.K. Gan
IBL General Meeting
iFlame opto-pack image courtesy Tony Weidberg
85/85 Test

- Started stress test with 85% relative humidity @ 85°C
  - operate all 12 VCSEL channels with 10 mA DC
  - continuously monitor optical power and current consumption
  - good devices expected to survive at least 2,000 hours
85/85 Test

- 20 ULM VCSEL arrays:
  - no significant degradation after 500 hours
- 20 Finisar VCSEL arrays:
  - 15 arrays exhibited high common series resistance
  - problem worsen at 85°C
  - working with Finisar to find the cause
- Will test 20 iFlame opto-packs when available
- Will test 20 opto-boards once design settled
Summary

- Experience from nSQP prototype B opto-board has lead to improved design
  - new design submitted for fabrication
- Successful irradiation of 4 nSQP prototype B opto-boards
- 85/58 stress test started
- Will work on nSQP D board and IBL board once B boards validated