Production Experience of New Opto-Boards

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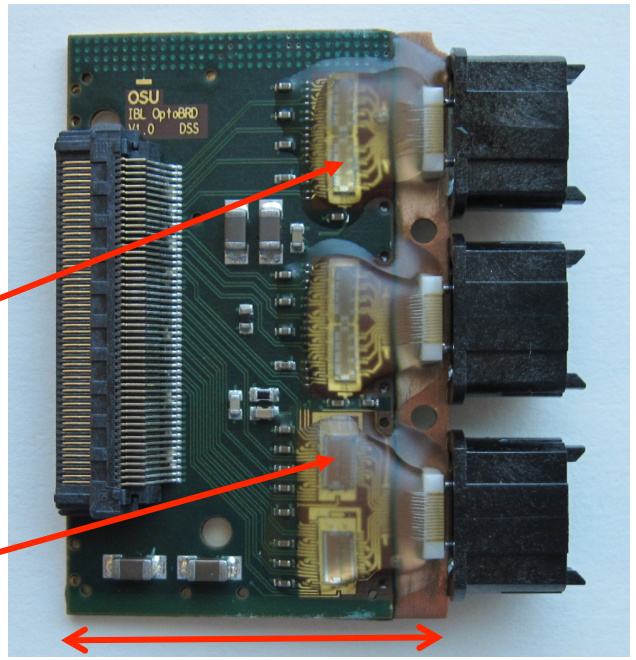
March 21, 2014

Outline

- Introduction
- Opto-board design
- Long-term reliability study
- Summary of failures after burn-in/thermal cycles
- Summary

Introduction

- 3 opto-board flavors
  - nSQP D opto-board (disk, L1, L2): 7 TTC + 14 data links
  - nSQP B opto-board (B-layer): 7 TTC + 14 data links
  - IBL opto-board: 8 TTC + 16 data links
- 300 boards needed
  - will produce ~400 boards or ~8,500 links



Opto-Board Improvements

- Implemented several improvements based on experience gained from production of 1st generation opto-boards:
  - replace custom optical connector with MPO to ease the mating/de-mating
  - mount array on BeO instead of PCB for efficient heat removal
  - connect optical package to opto-board by wire bonding instead of soldering micro-leads to BeO
    - soldering was major challenge in previous opto-board production
      - too much heat cause lead detachments
      - too little heat produces cold solder
    - cold solder is a major cause of opto-link failures
    - opto-boards built by OSU have ~0.1% broken links

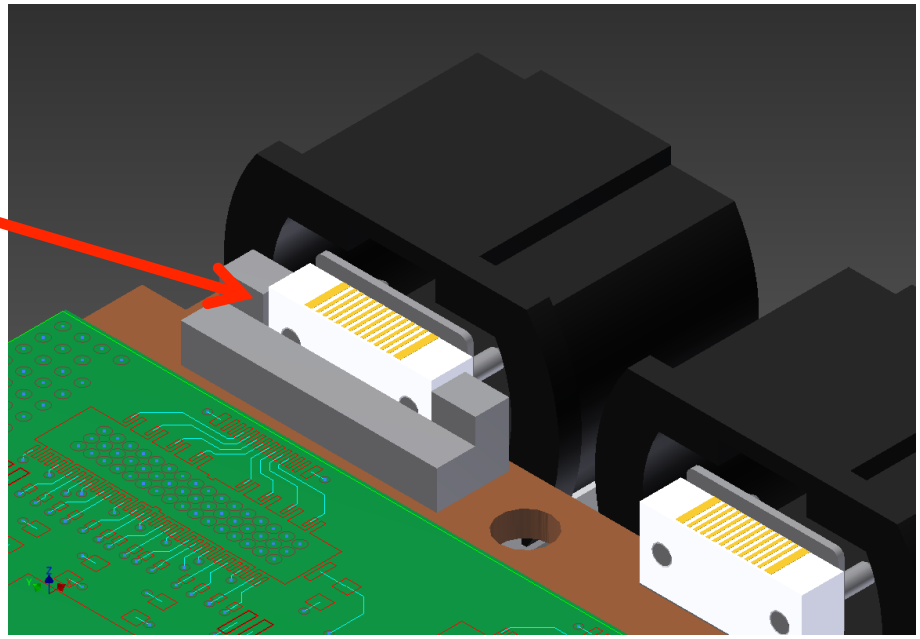
Opto-Board Quality Assurance

- perform QA test similar to 1st generation opto-boards to validate constructed boards
  - burn in: 72 hours @ 50°C
  - 10 thermal cycles: 0°C ⇨ +50°C
    - 2 hours per cycle
    - 1 hour soak at 50°C
  - electrical and optical QA

Opto-Pack Enforcement

- Several opto-packs detached during initial production
  - ⇨ two improvements:
    - scoring of PCB surface to improve adhesion
    - add aluminum brace to greatly increase epoxy contact area
      - ⇨ cannot remove opto-pack without destroying opto-pack

Sandblasted surfaces
to improve adhesion

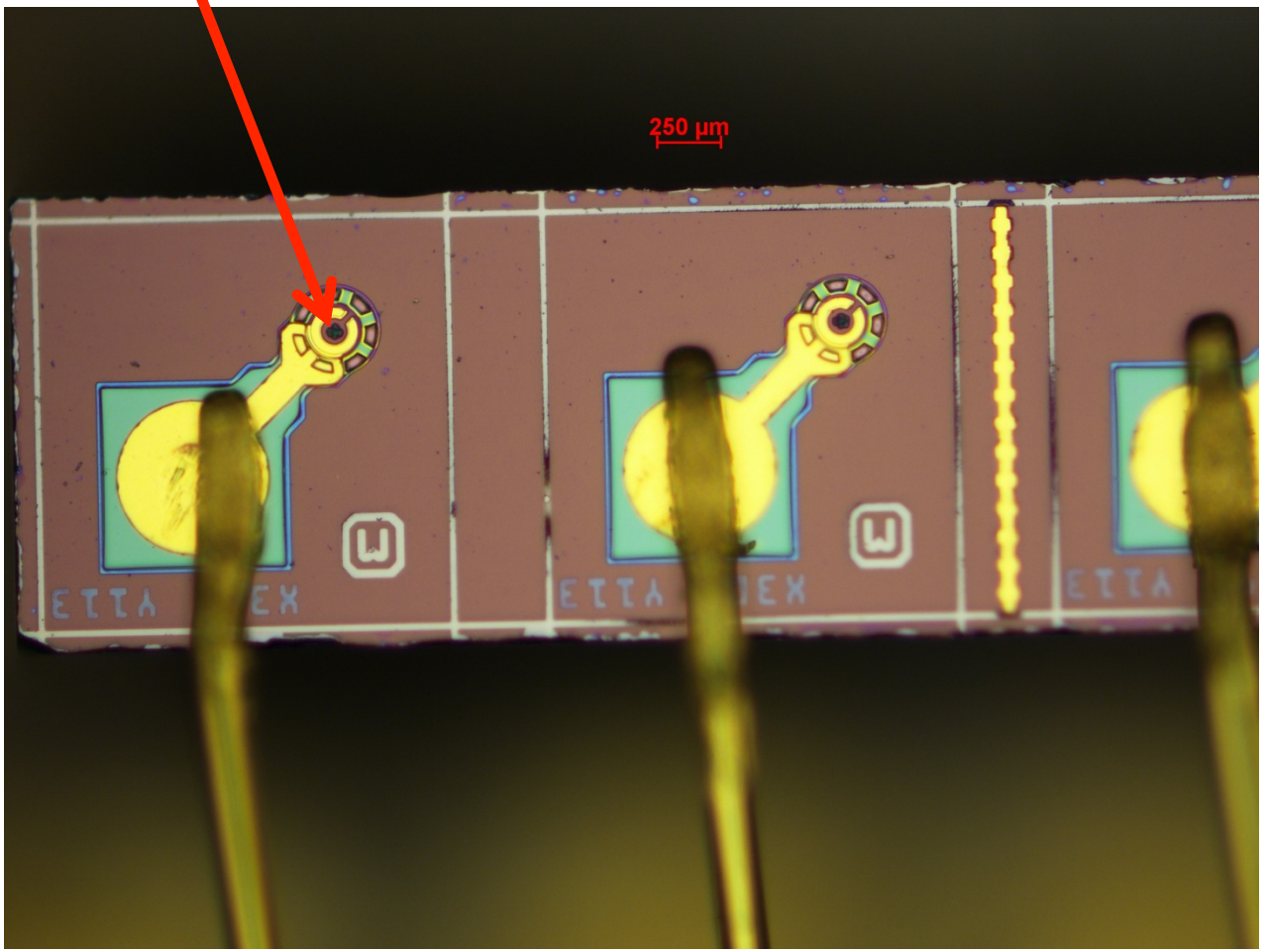


Accelerated Lifetime Test

- 21 Finisar 12-channel VCSEL arrays were operated at 10 mA DC in an 85°C and 85% relative humidity environment
  - 1 channel died after < 4 hours and array removed from test
    - infant mortality?
  - 1 array was broken due to an operator error during an in-situ LIV measurement at 1,650 hours
  - 3 channels (out of 228) had shifted IV curves at 2,500 hours
  - 15 out of the 19 arrays produce increasing output optical power during the test

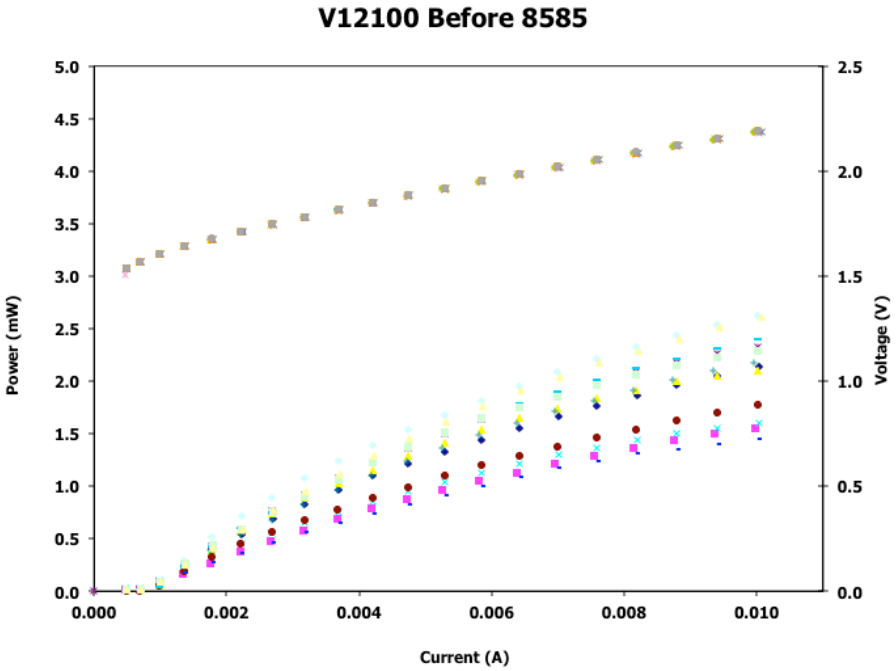
VCSEL 12100

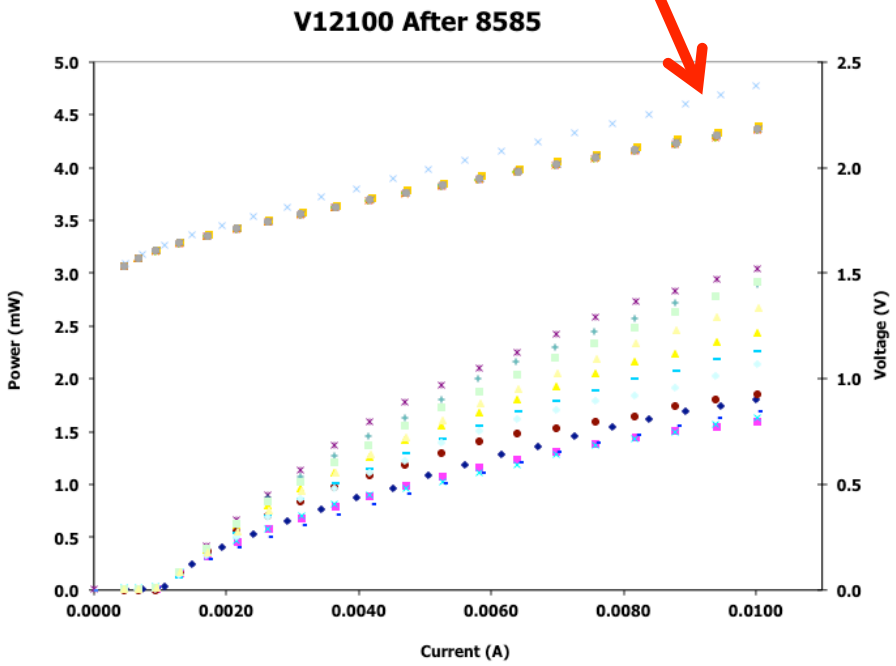
Channel 1 has shifted IV curve after 85/85 test



VCSEL 12100

Channel 1 has shifted IV curve after 85/85 test

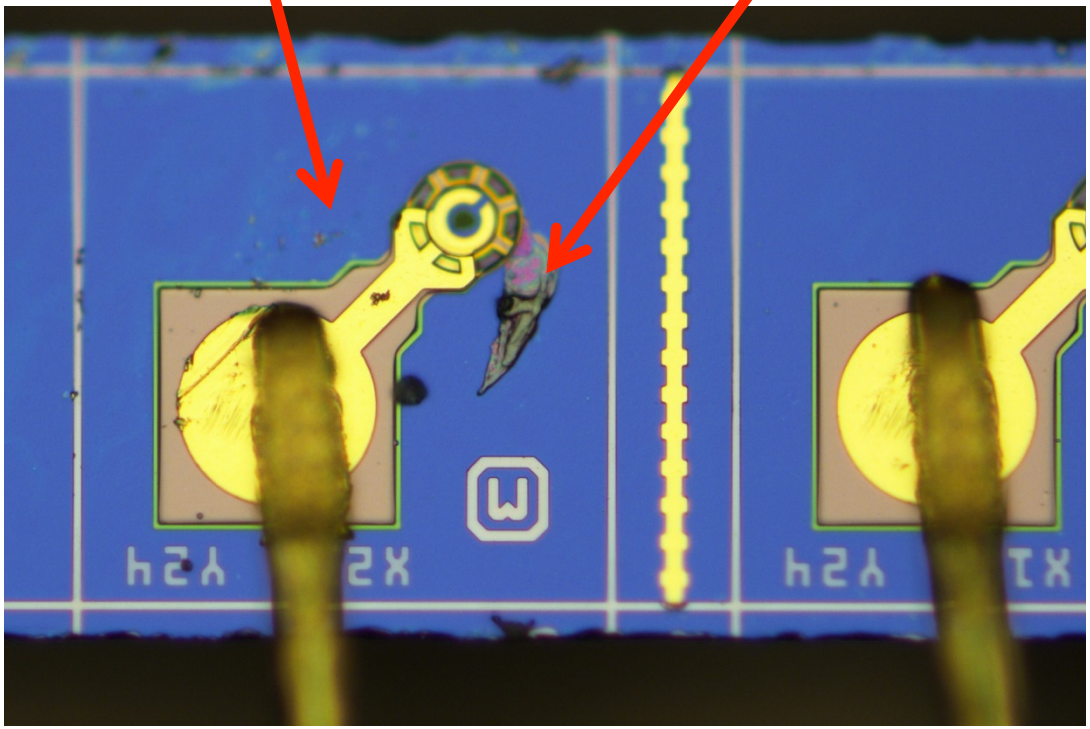




VCSEL 12126

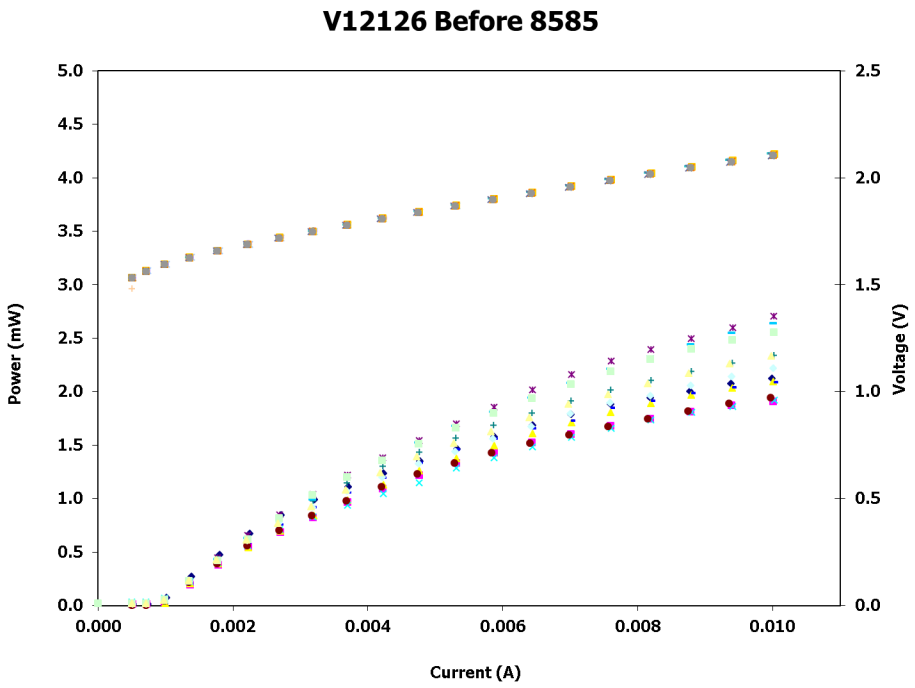
Channel 6 has shifted IV curve after 85/85 test

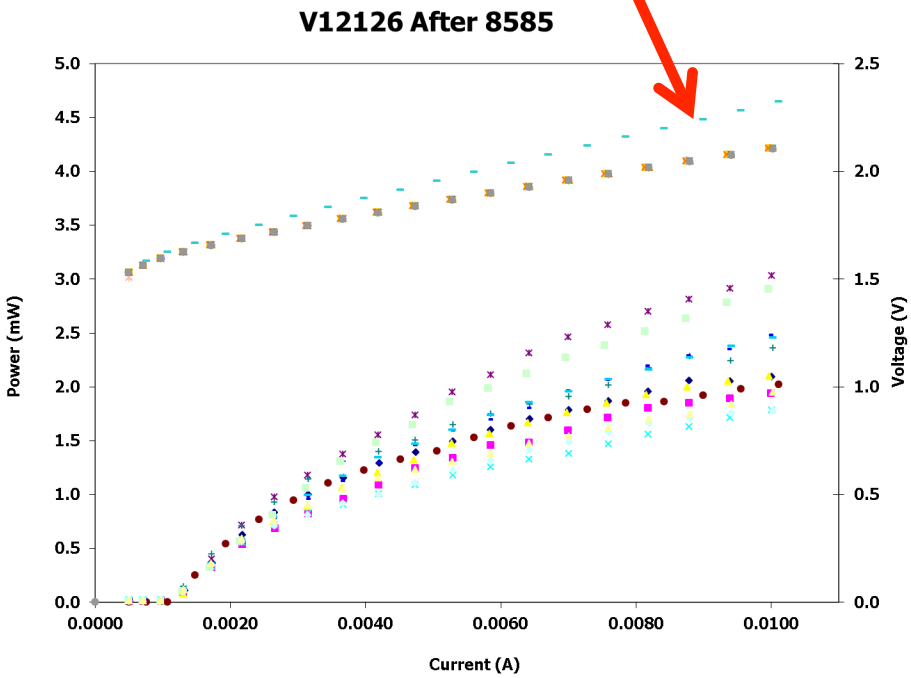
Mechanical damage?



VCSEL 12126

Channel 6 has shifted IV curve after 85/85 test



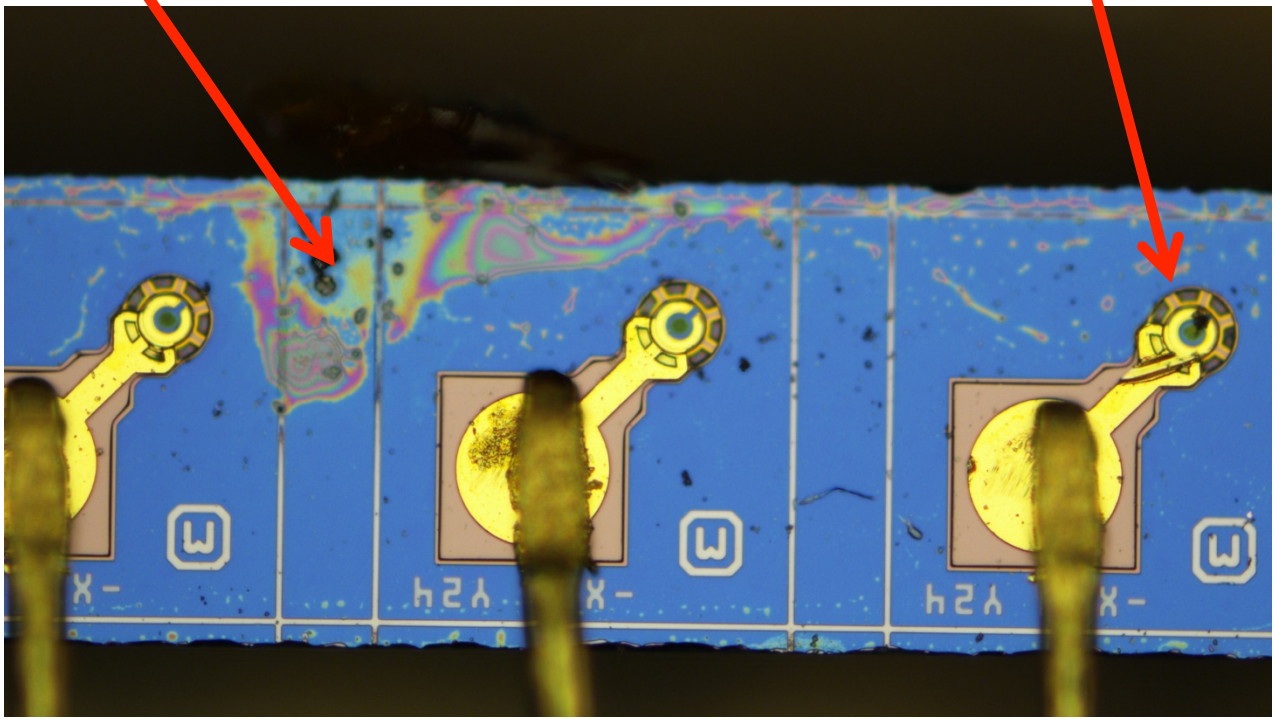


VCSEL 12127

Channel 6 has shifted IV curve after 85/85 test

Finisar: IV shifts can also be caused by thin film contamination

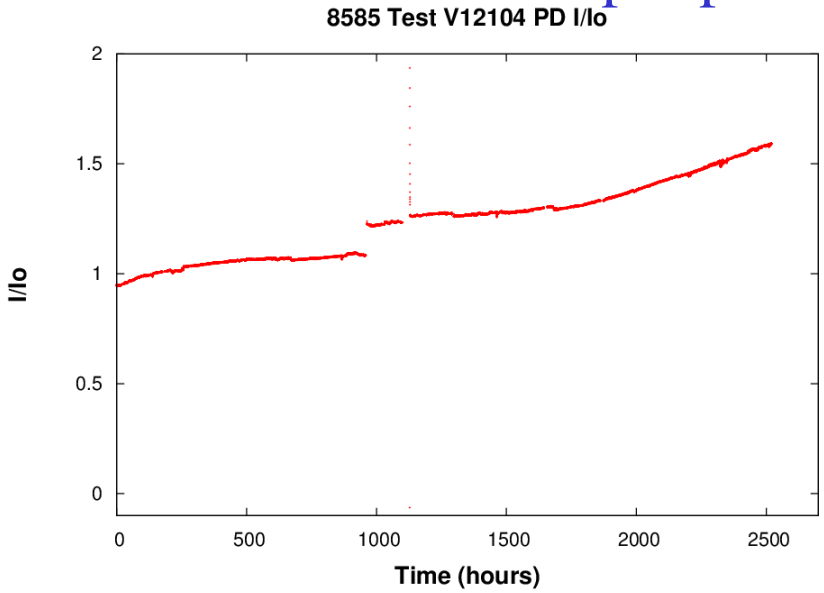
"dirt" that could be cleaned off…

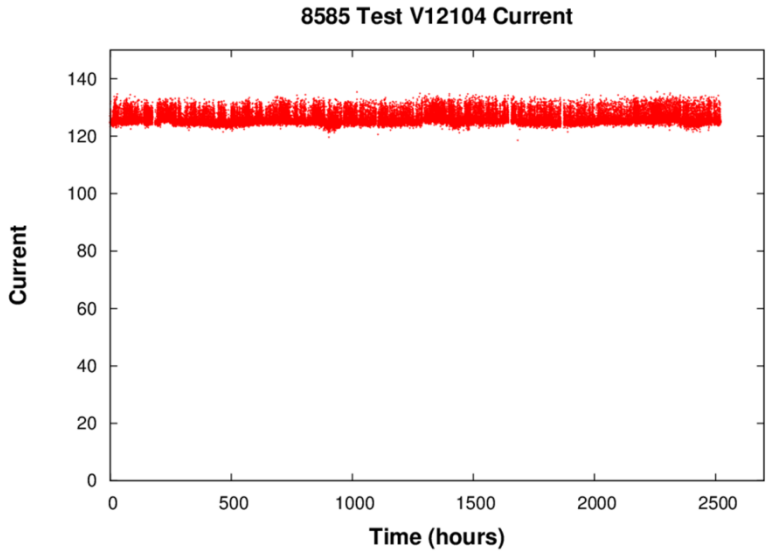


VCSEL 12104

PD current increases during 85/85 test

Finisar: we have seen output power increase as you are seeing

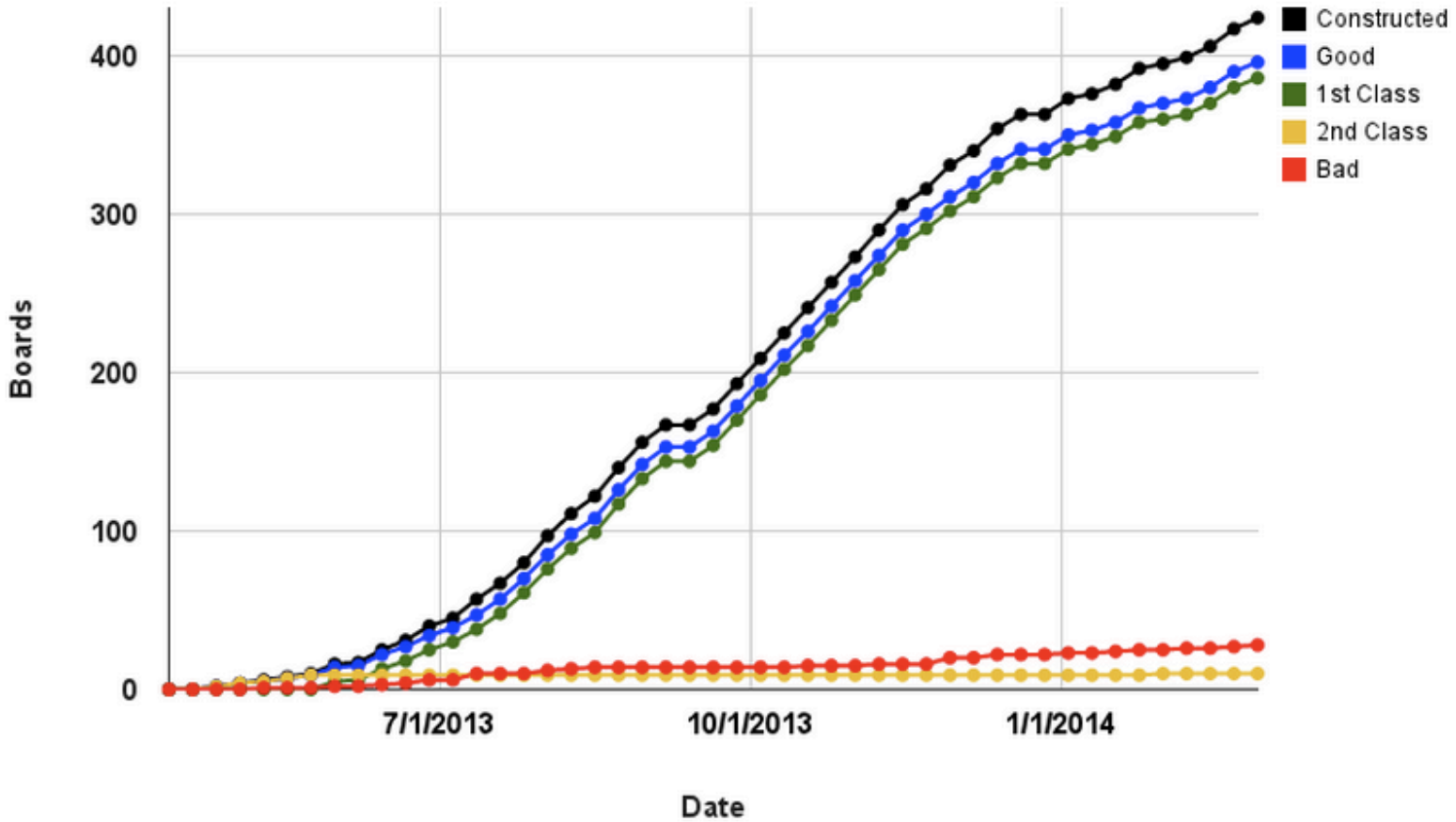




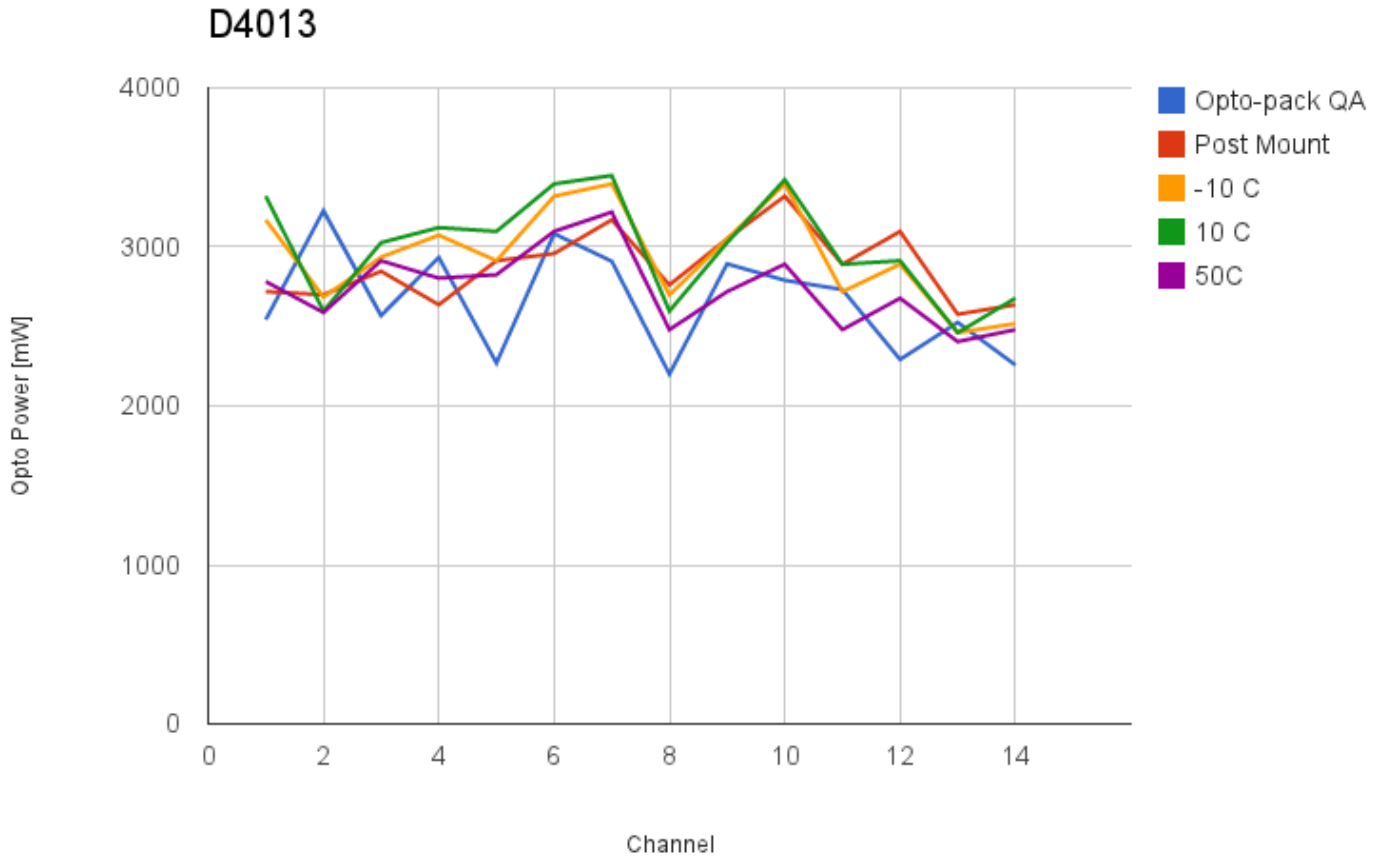
VCSEL current constant during 85/85 test

Production Rate

- Total fabricated: 424
  - Good: 396 (1st class: 386, 2nd class: 10)
  - Bad: 28

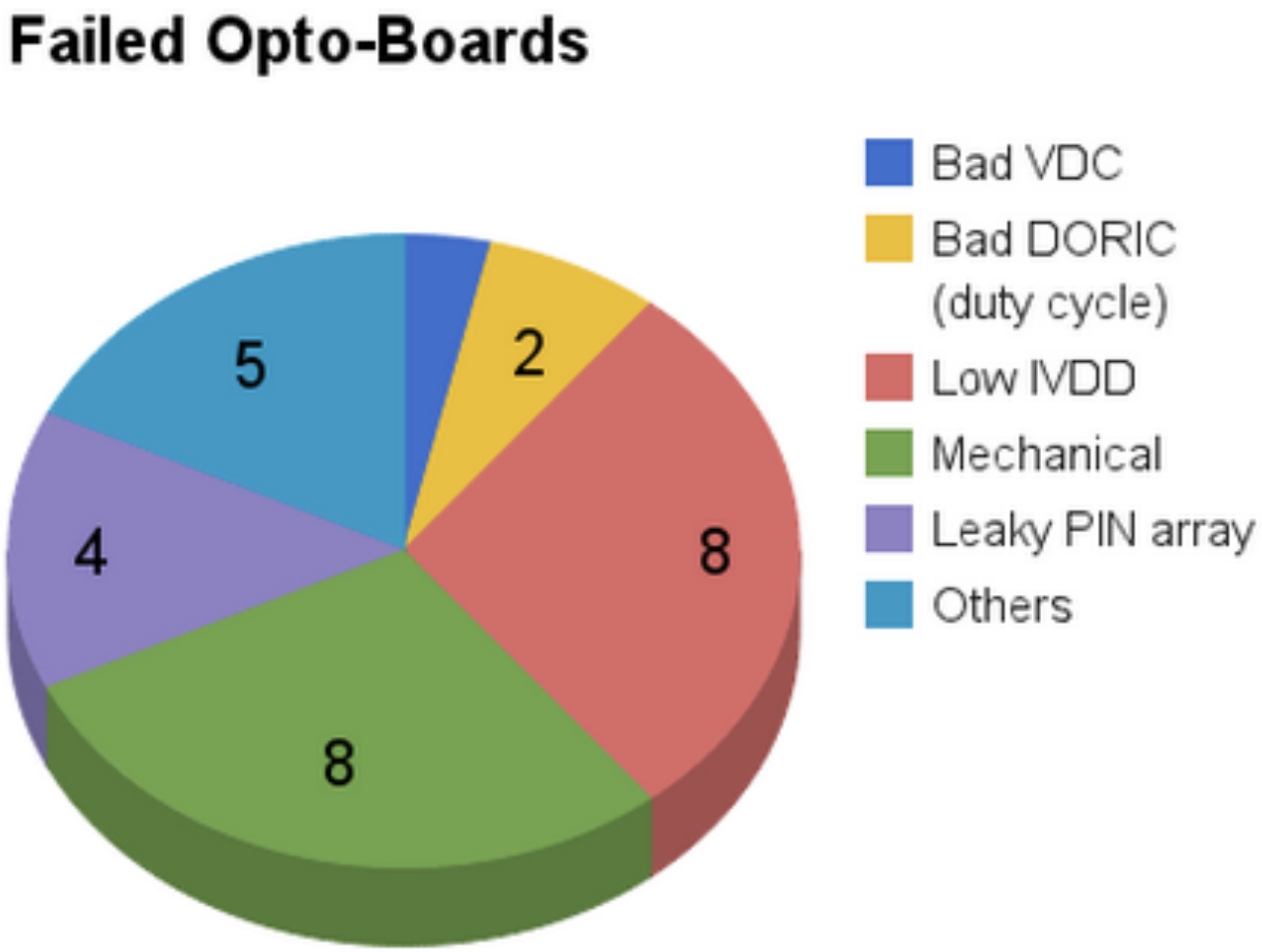


Optical Power



- Excellent optical power

Summary of Failed Boards



Summary of Failed Boards

- Few of the 400 boards have problems after burn-in/thermal cycles:
  - 1 VDC: cannot adjust drive current
  - 8 VCSEL arrays have low power
    - 3 failed for thermal cycle outside Finisar spec: -25 C
      - ⇨ thermal cycle: 0-50 C
    - 5 arrays not properly glued to BeO substrate
  - 4 leaky PIN arrays

Stress Test on Opto-Boards

- Industry standard: opto-boards should survive for 1,000 hours at 85°C/85% relative humidity
- Started the test on two IBL boards (100 hours so far)
  - D and B boards will be added soon
- After 2,000 hours, repeat the test on new boards at 50/50 for months

Summary

- Much improved 2nd generation opto-boards produced
- 19 12-channel opto-packs survive to 2,600 hours at 85/85
- Some opto-boards will be tested in 85/85 environment