Production Experience
of New Opto-Boards

K.K. Gan, R. Ishmukhametov, H. Kagan, R.D. Kass,
K. Looper, J. Moss, J. Moore, S. Smith, B. Tannenwald, Y. Yang
The Ohio State University

P. Buchholz, M. Ziolkowski
Universität Siegen

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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

VCSEL

VCSEL

PIN

driver

receiver

3 cm
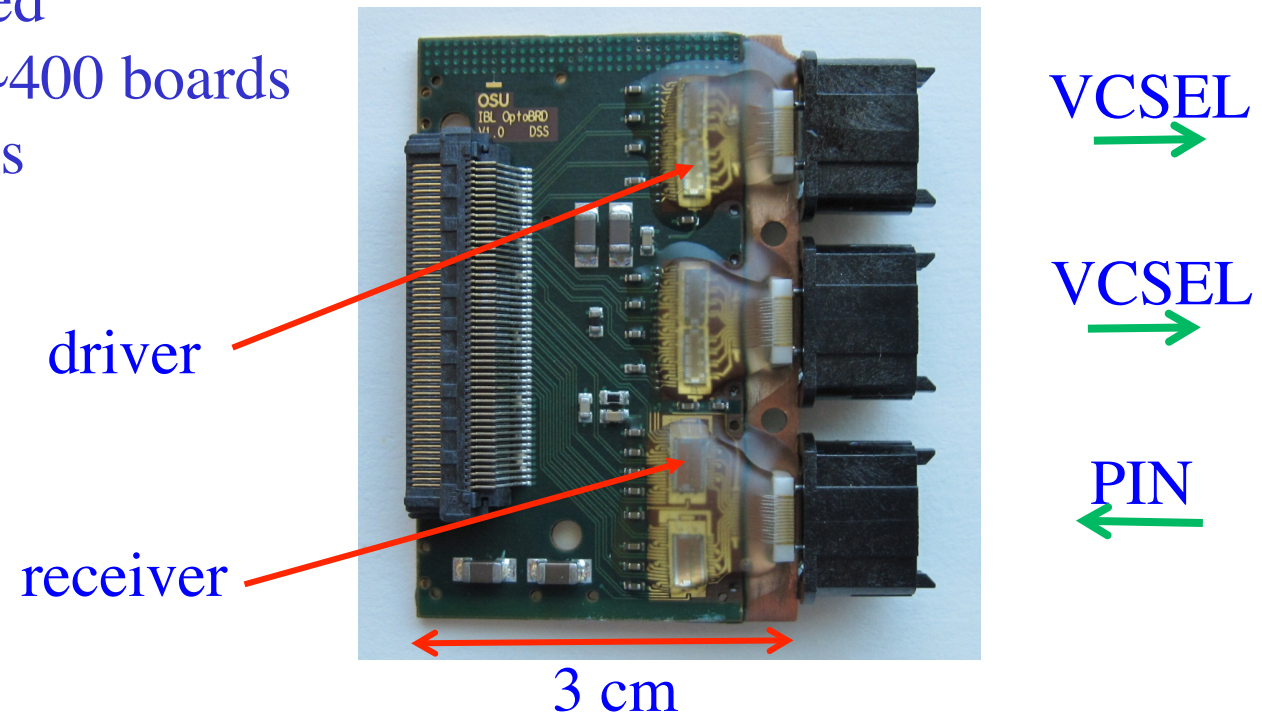
Opto-Board Improvements

- 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
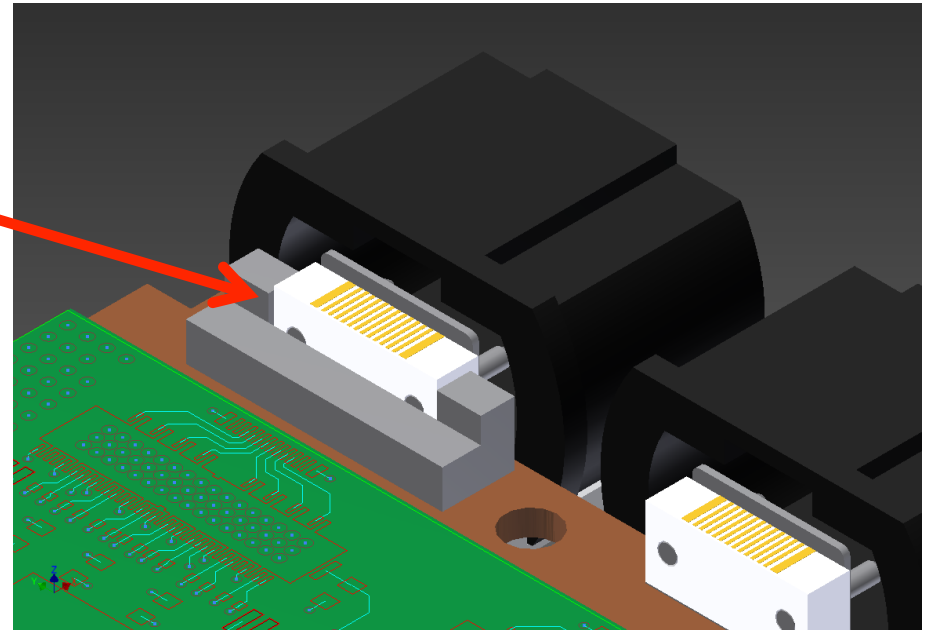
Accelerated Lifetime Test

● 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
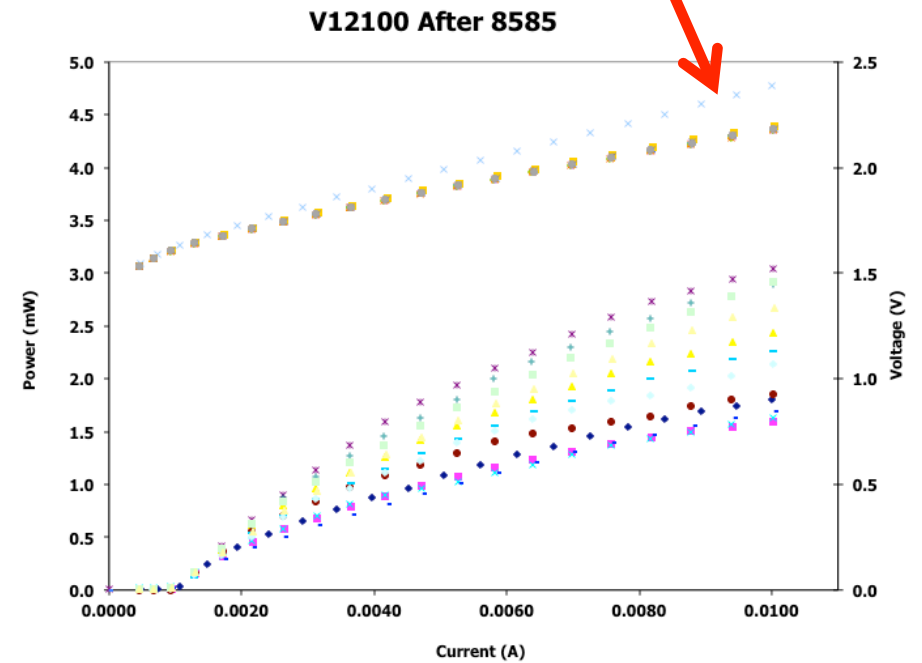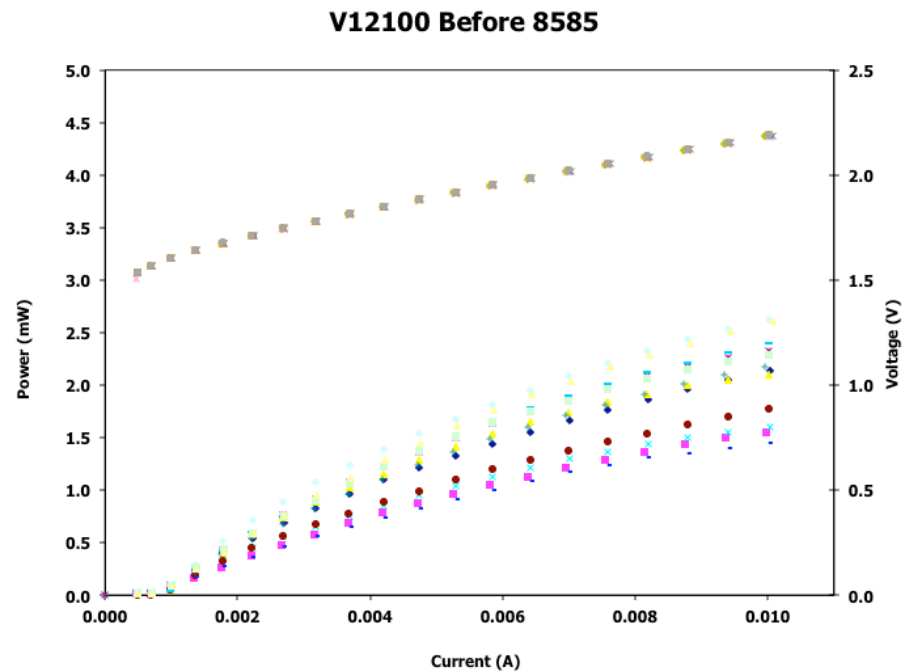   optical power during the test

VCSEL 12100
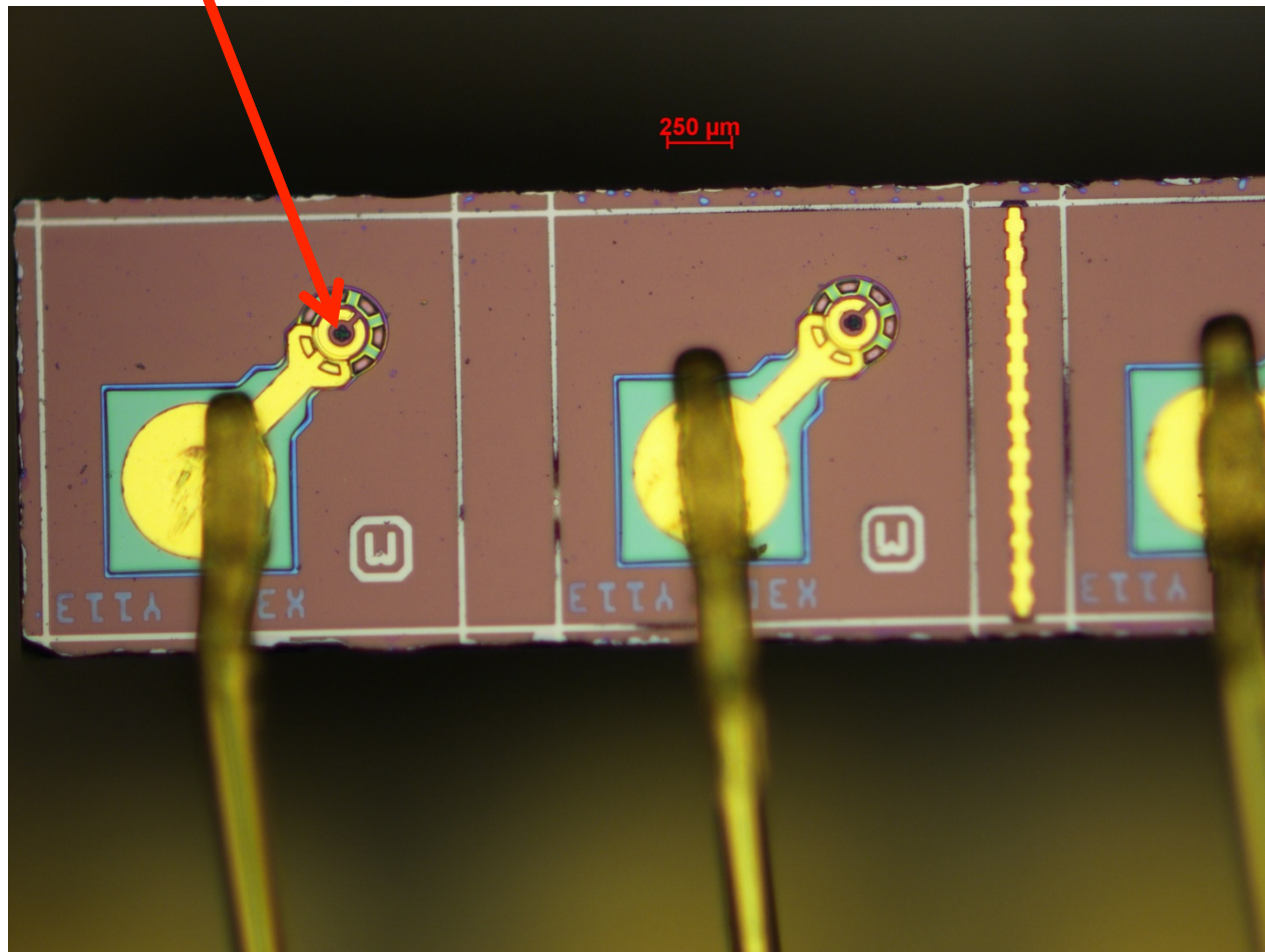
Channel 1 has shifted IV curve after 85/85 test

VCSEL 12100

Channel 1 has shifted IV curve after 85/85 test

V12100 Before 8585
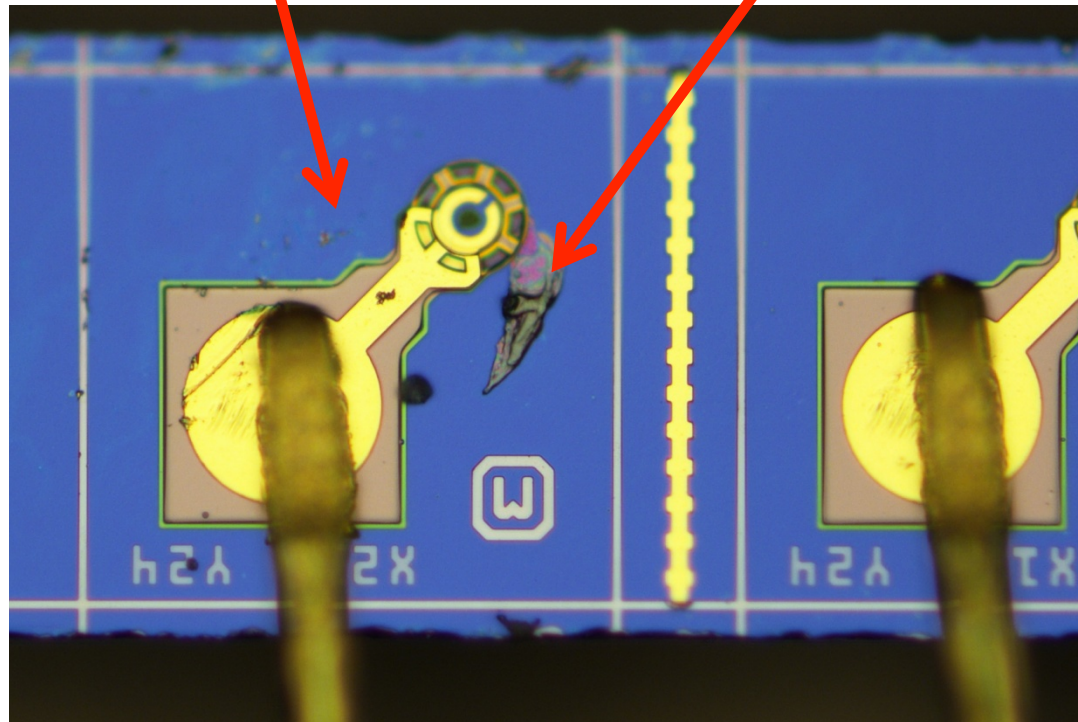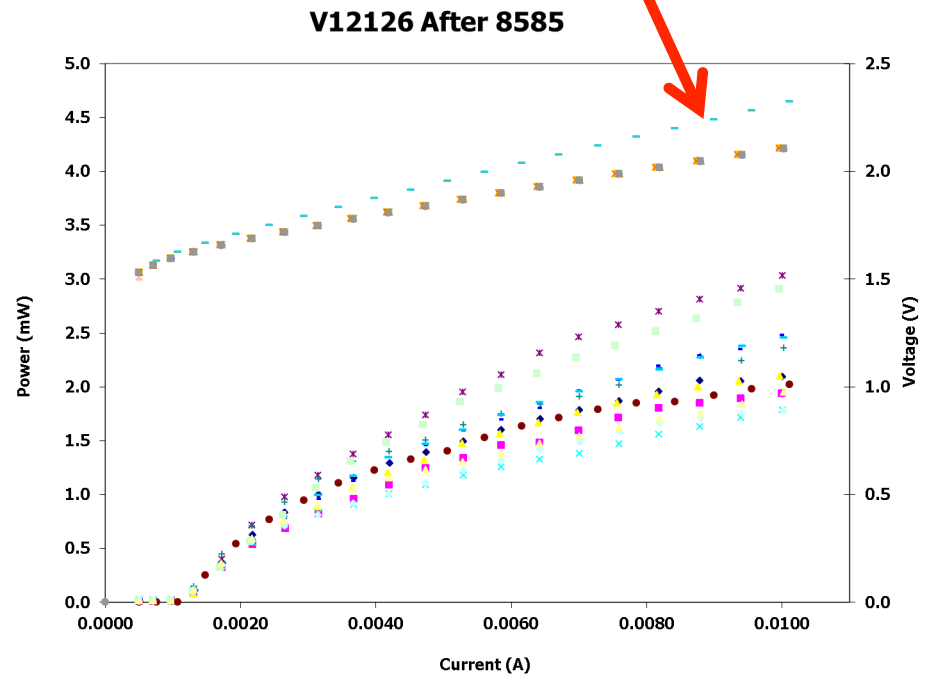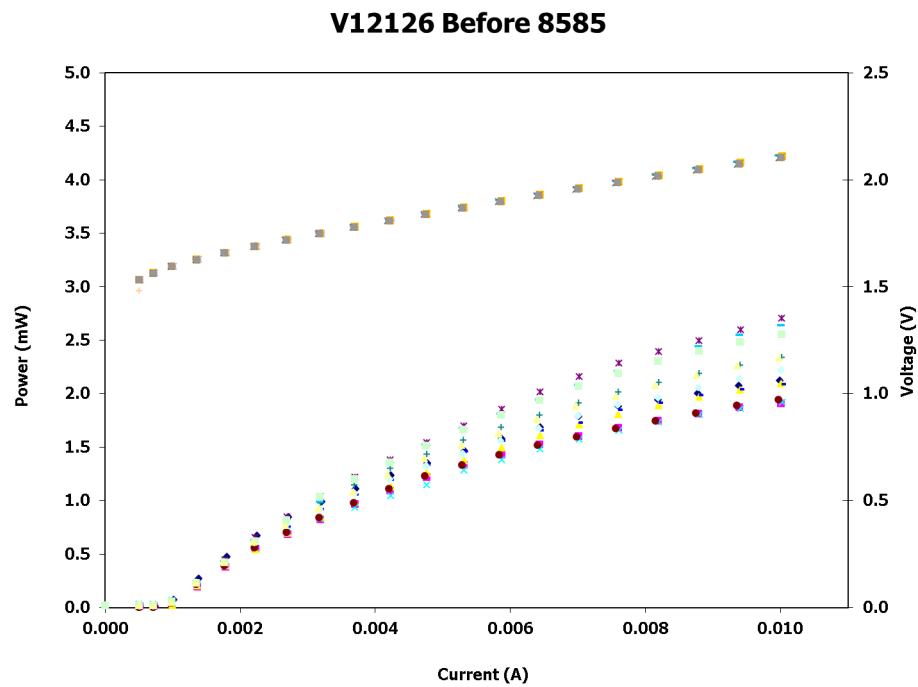
V12100 After 8585

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

V12126 Before 8585
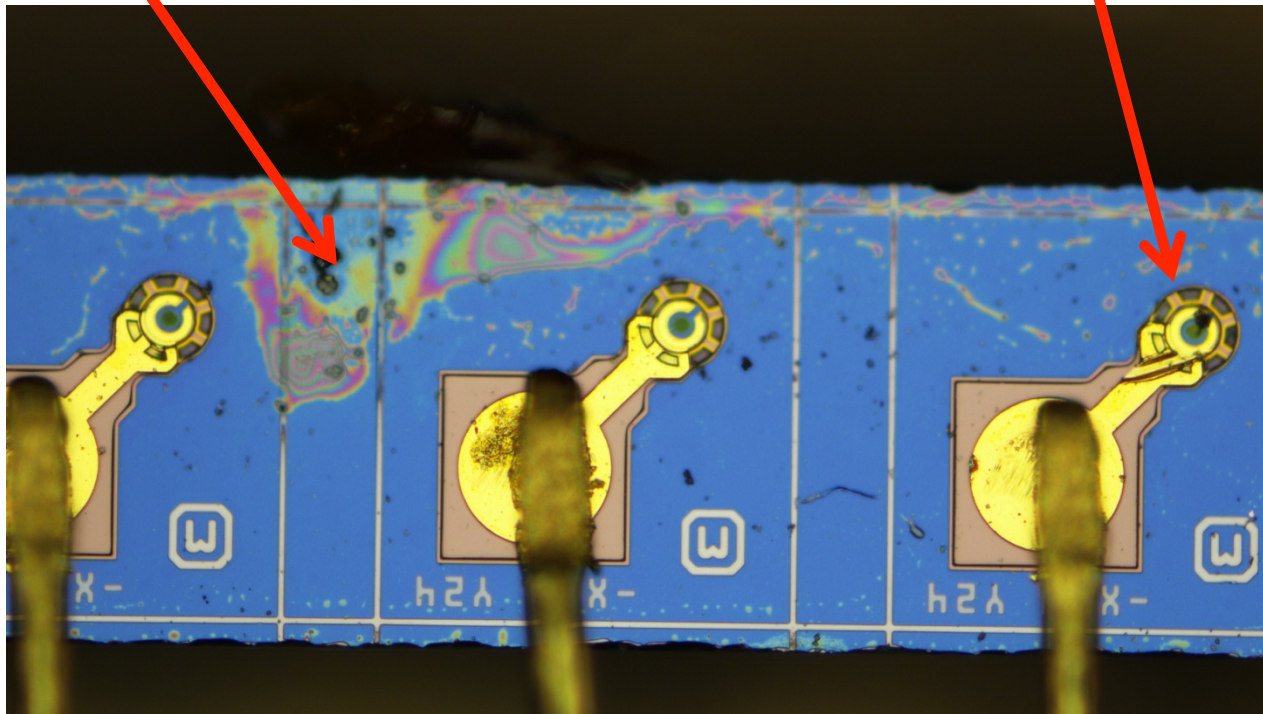
V12126 After 8585

VCSEL 12127

Channel 6 has shifted IV curve after 85/85 test
Finisar: IV shifts can also be caused by thin film contamination

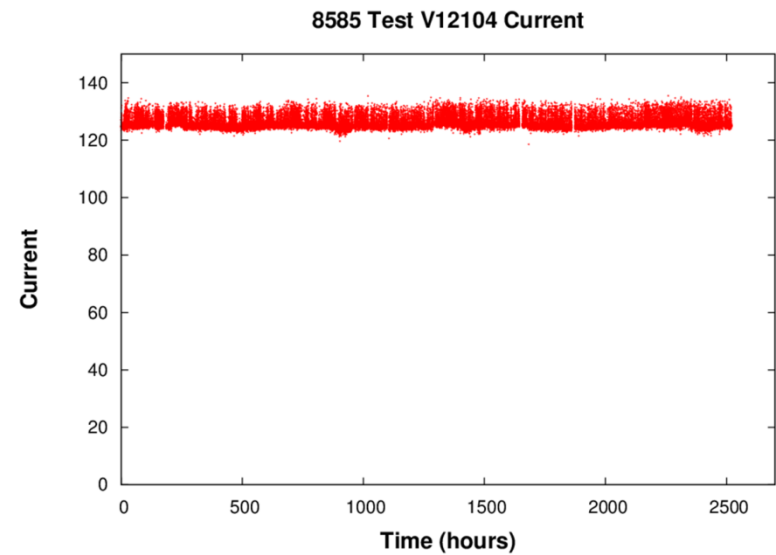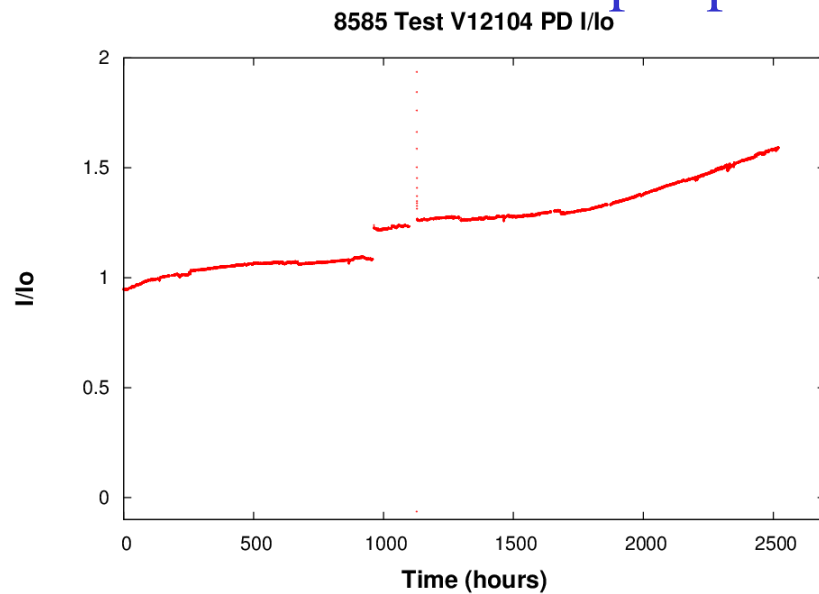"dirt" that could be cleaned off…

VCSEL 12104

PD current increases during 85/85 test

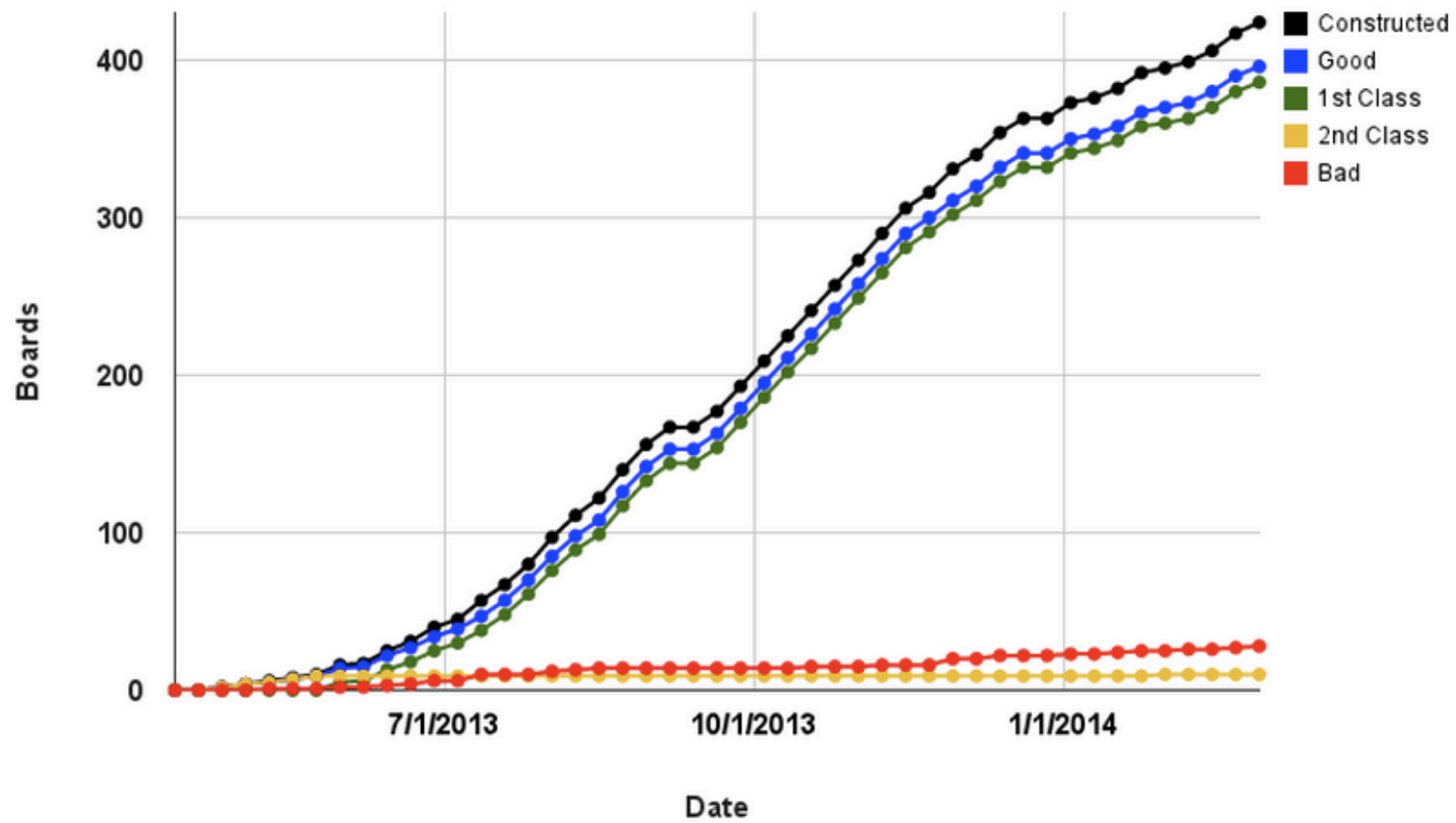Finisar: we have seen output power increase as you are seeing

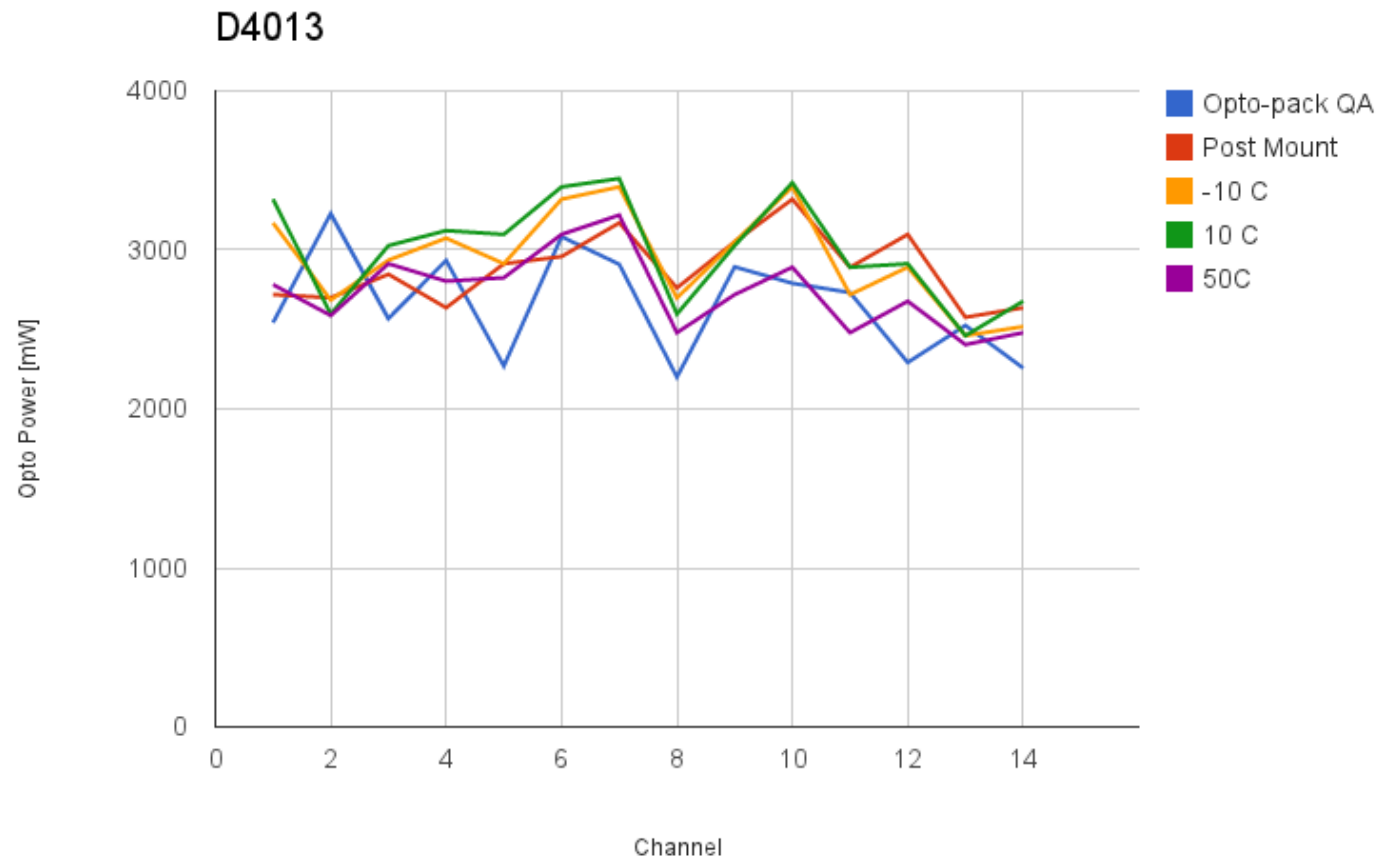VCSEL current constant during 85/85 test

Production Rate

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

Optical Power

D4013

- Opto-pack QA
- Post Mount
- -10 C
- 10 C
- 50C

- **Excellent optical power**

Summary of Failed Boards

Failed Opto-Boards

Legend:
- Bad VDC
- Bad DORIC (duty cycle)
- Low IVDD
- Mechanical
- Leaky PIN array
- Others

Values shown: 2, 8, 8, 4, 5
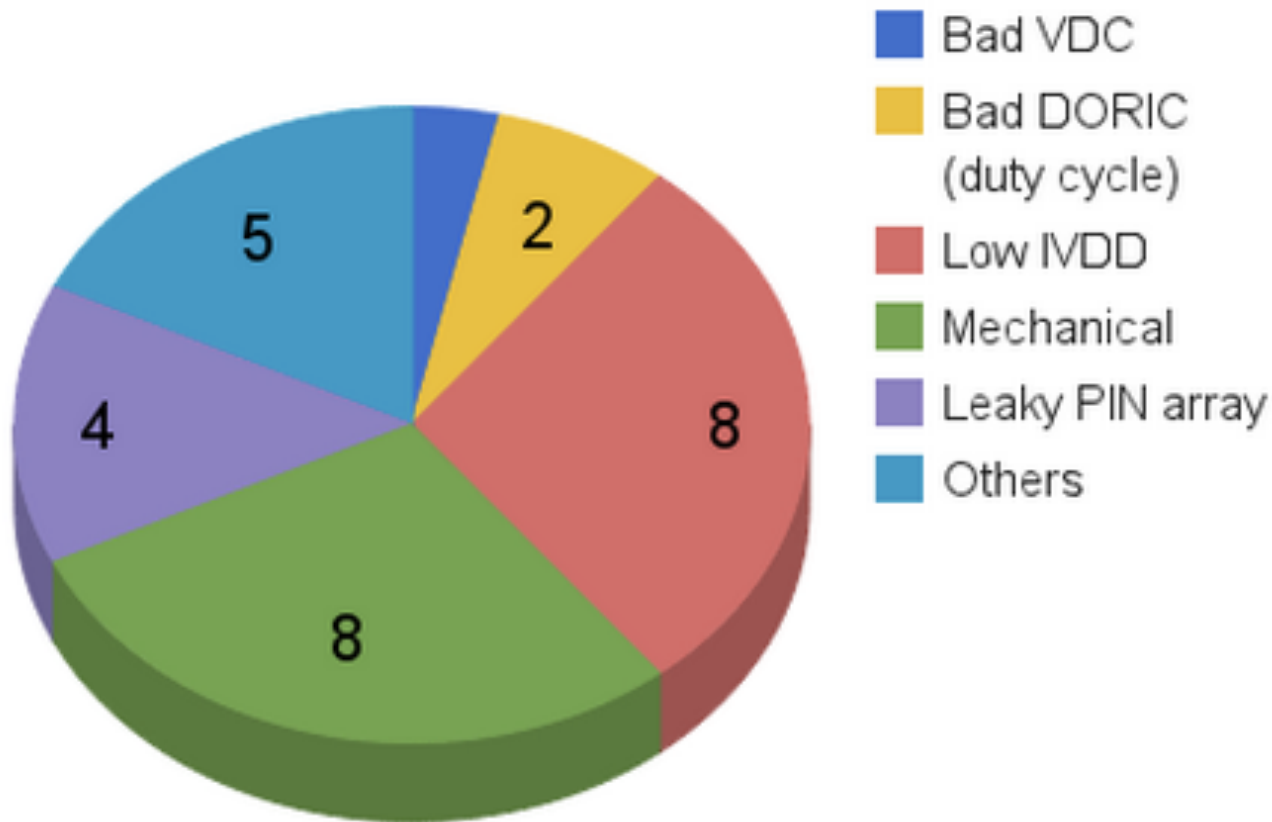
Summary of Failed Boards

- 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