



Accelerated Lifetime Test Of Opto-Boards

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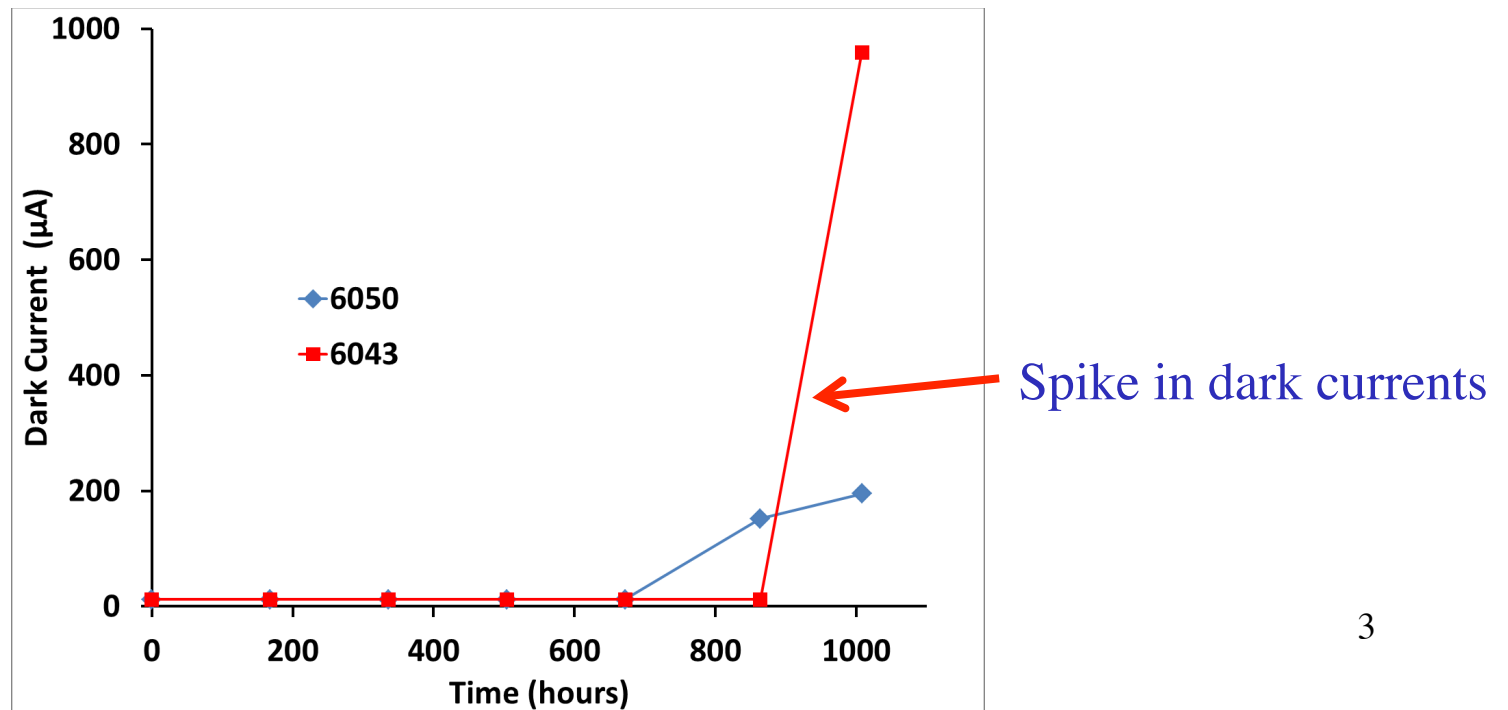
Accelerated Lifetime Test

- Industry standard: opto-boards should survive for 1,000 hours at 85°C/85% relative humidity
 - ◆ operate each VCSEL channel with 10 mA (pk-pk)
 - ◆ perform weekly measurements



Accelerated Lifetime Test-Phase I

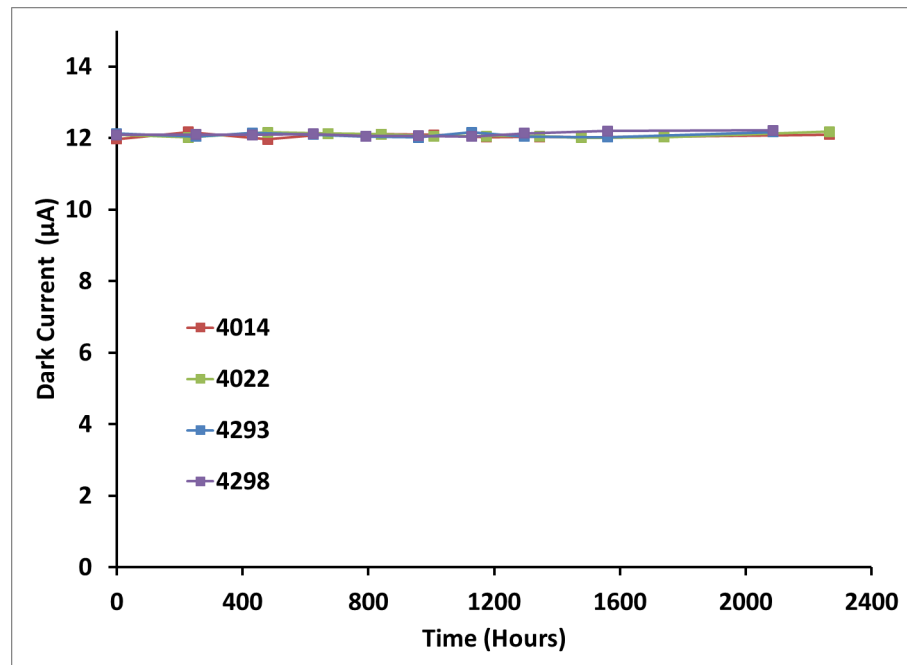
- Started the test with two IBL boards in Feb. 2014
- ◆ All VCSEL channels survived
- ◆ Both PIN arrays became leaky before 1,000 hours
 - PIN biased at 10 V
 - ULM photonics: recommend operating at 5 V even though spec. sheet lists bias as up to 10 V





Accelerated Lifetime Test-Phase II

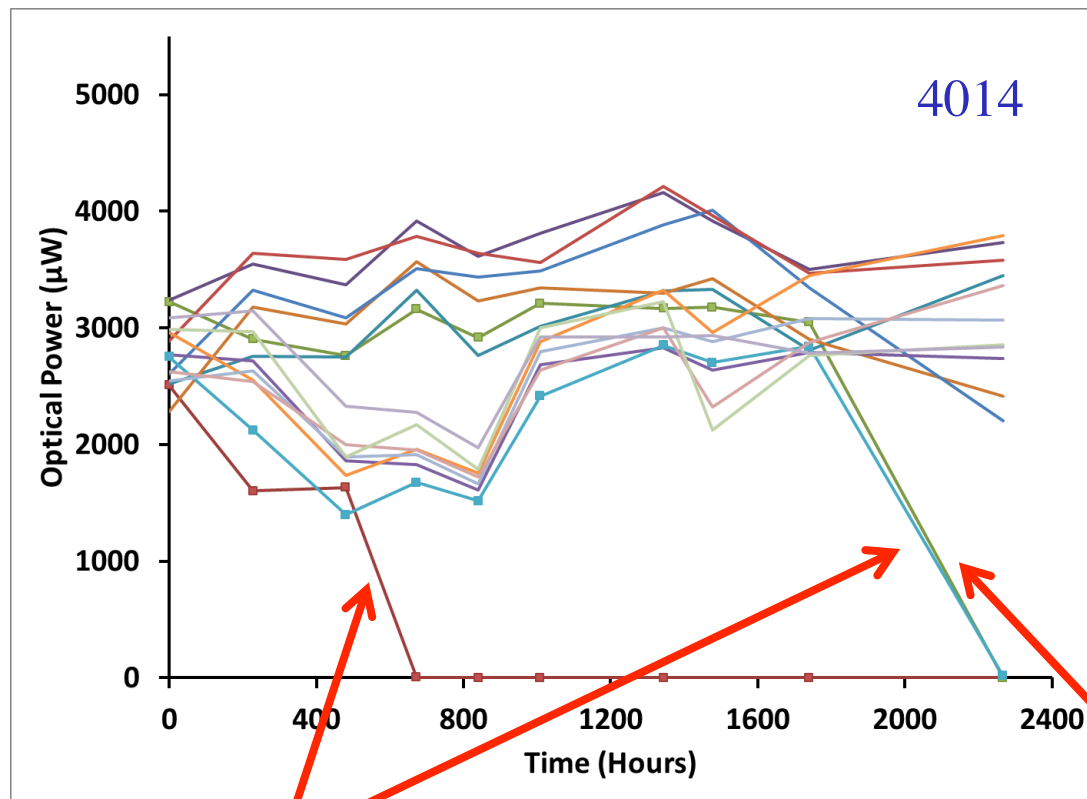
- June/July 2014: started four D opto-boards in 85°C/85% RH
 - ◆ 2 boards fabricated in 6/2013 (early production)
 - ◆ 2 boards fabricated in 12/2013 (late production)
 - ◆ PIN arrays biased at 10 V in ~4 days of burn-in/thermal cycle
 - No leaky PIN arrays for 5 V bias for over 2,000 hours!!



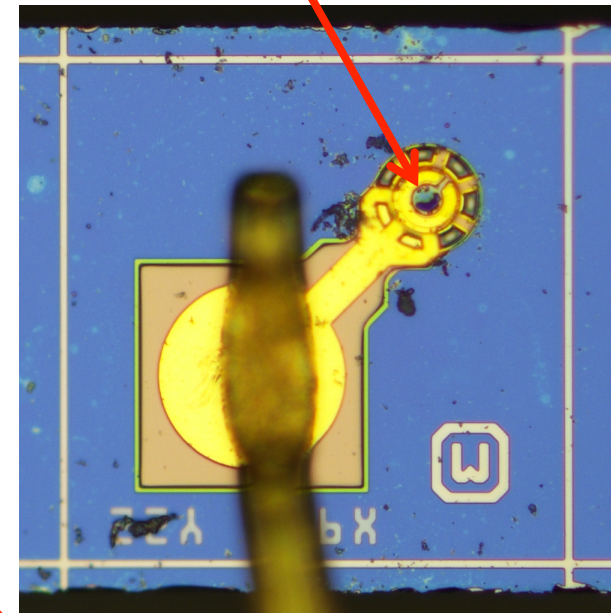


Accelerated Lifetime Test-Phase II

- One VCSEL on board 4014 failed between 1,740 and 2,266 hours



black spot in aperture
(not dirt)



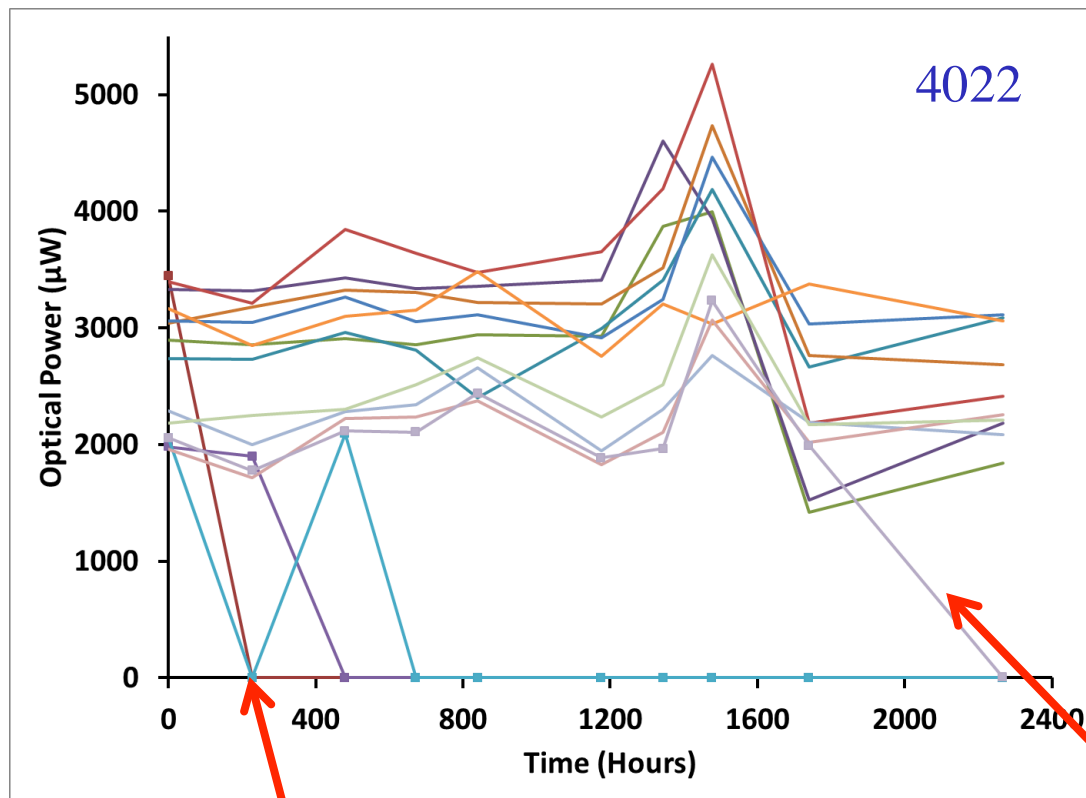
Wirebond broken during cleaning

One VCSEL failure



Accelerated Lifetime Test-Phase II

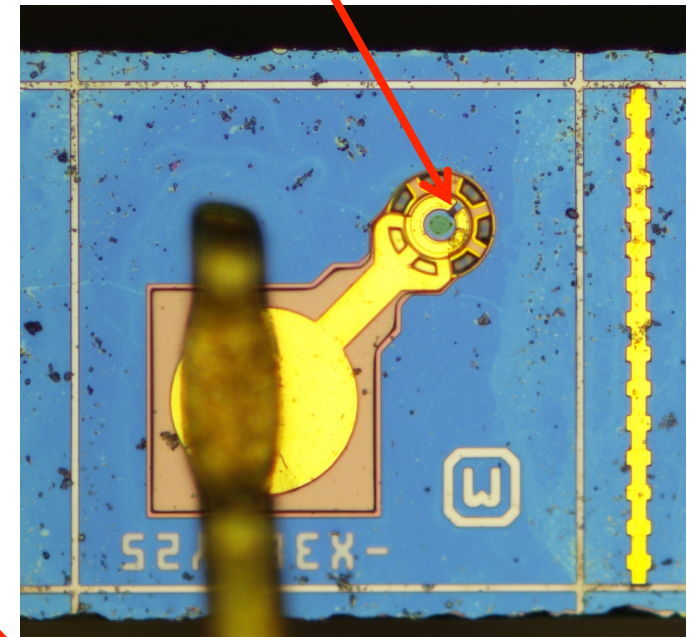
- One VCSEL on board 4022 died between 1,740 and 2,266 hours



Board dropped

K.K. Gan

black spot near aperture
(not dirt)



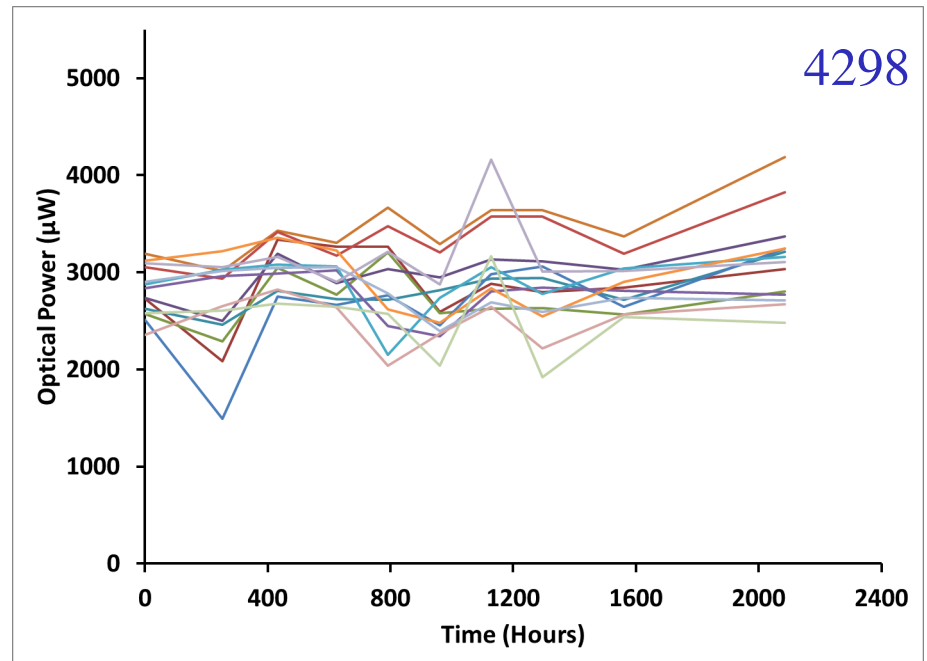
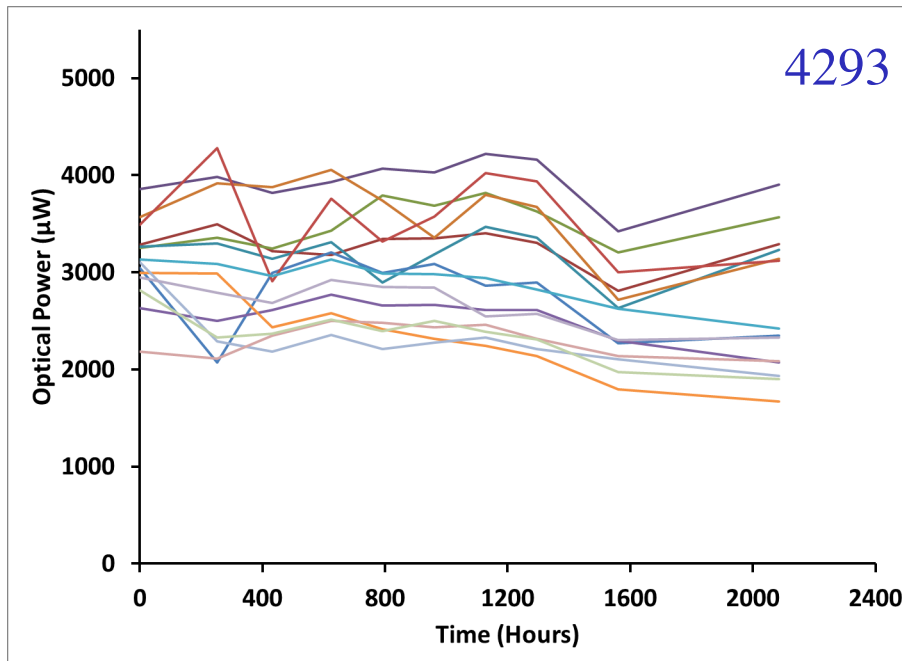
One VCSEL failure

Pixel Week



Accelerated Lifetime Test-Phase II

- VCSEL optical power OK up to 2,086 hours in 85°C/85% RH





Accelerated Lifetime Test-Phase III

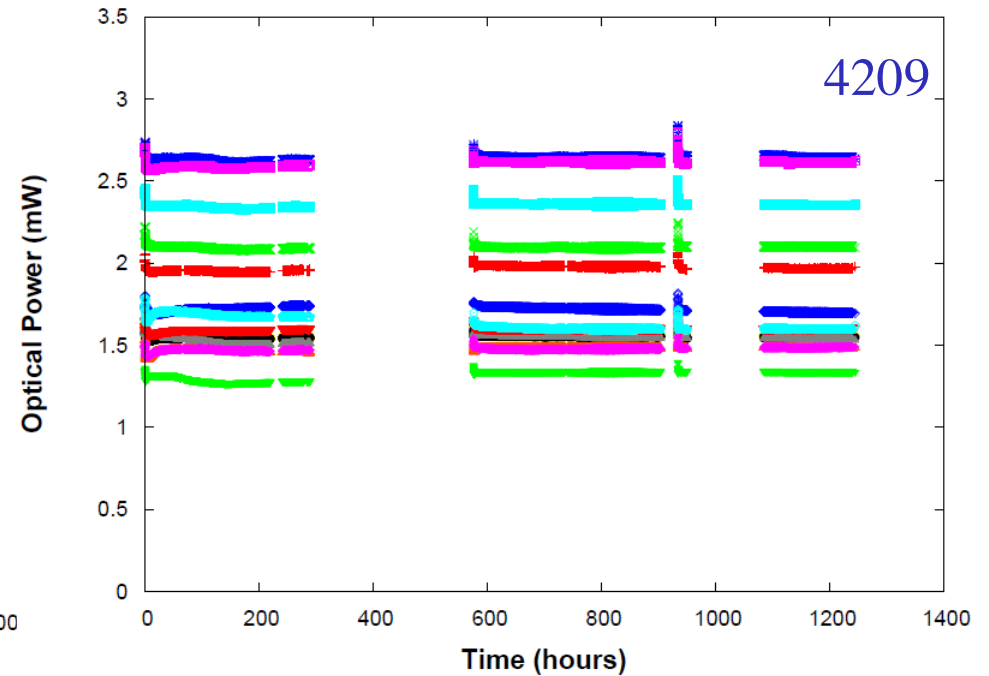
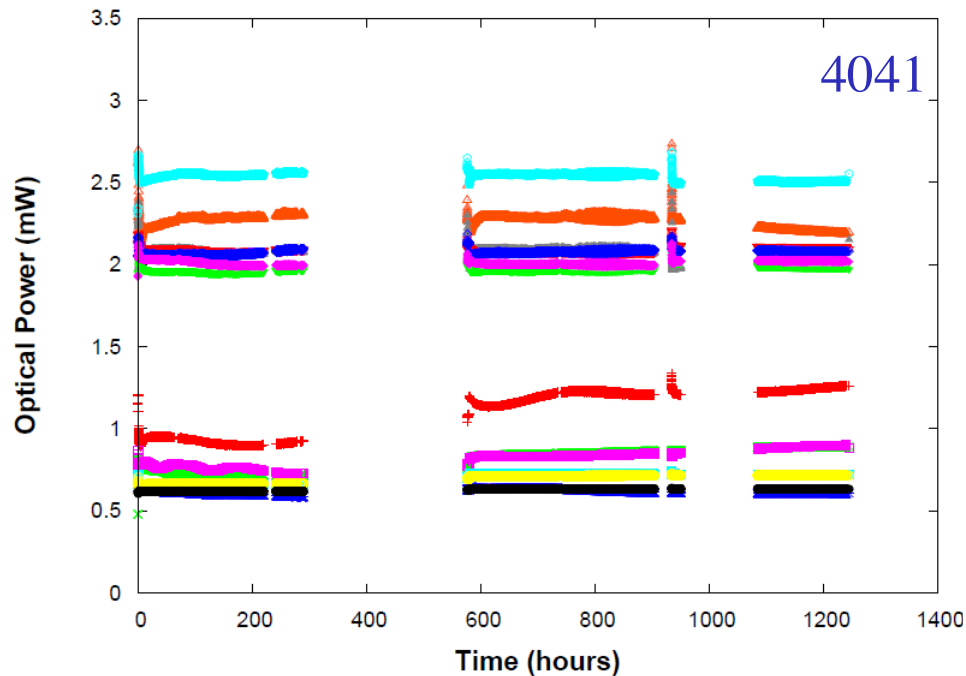
- November 2014: started four D opto-boards in 50°C/50% RH
 - ◆ Boards fabricated throughout production (4041, 4209, 4151, 4311)
 - ◆ Run VCSELs at 40 MHz (50% duty cycle), 10 mA pk-pk
 - ◆ Have accumulated 1,246 hours running time





Accelerated Lifetime Test-Phase III

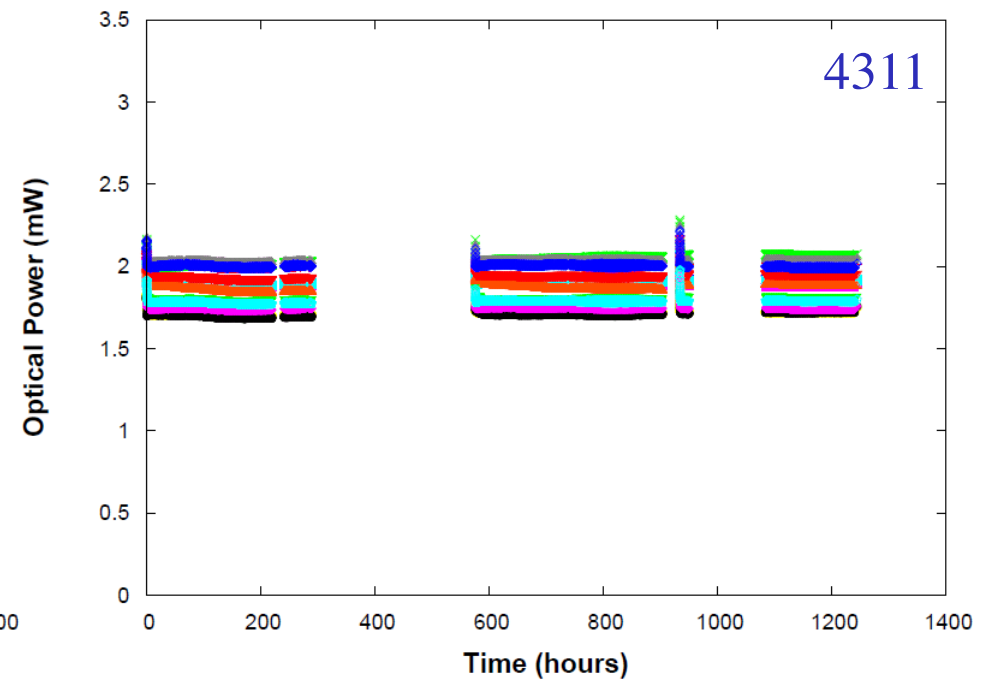
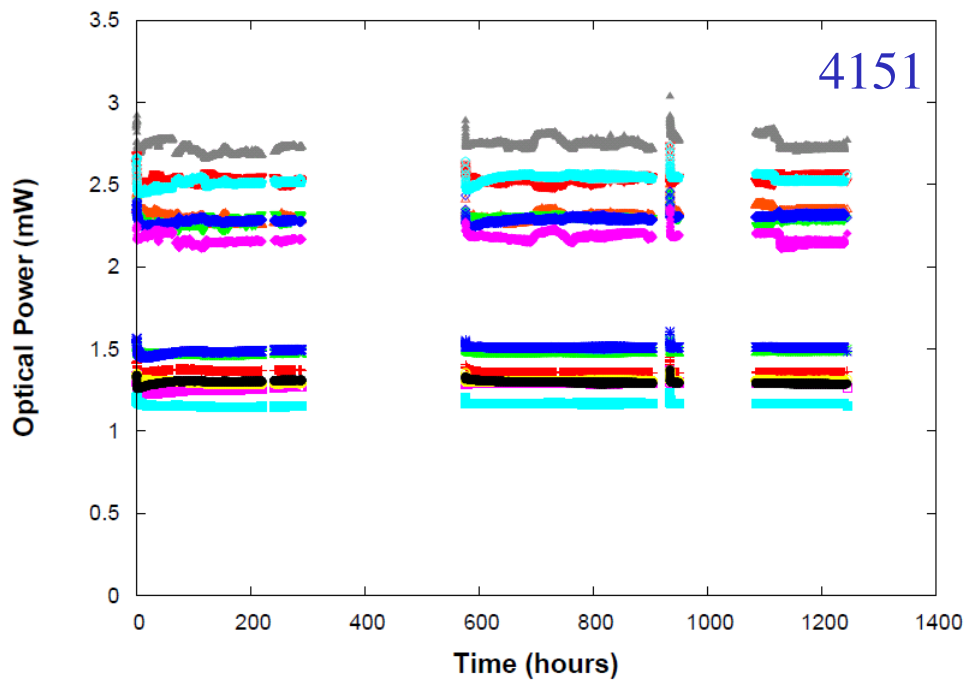
- VCSEL optical power stable during 1,246 hours in 50°C/50% RH





Accelerated Lifetime Test-Phase III

- VCSEL optical power stable during 1,246 hours in 50°C/50% RH





Summary

- production opto-boards passed accelerated lifetime test at 85°C/85% RH
 - ◆ VCSEL and PIN arrays survived for at least 1,740 hours
 - ◆ significantly longer than industrial minimum of 1,000 hours
- have accumulated 1,246 hours of test at 50°C/50% RH
 - ◆ will continue this study for at least two years