



# Status of On-Detector Opto-Links

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June 15, 2012





# Outline

- Results on prototype opto-board
- Analysis of accelerated lifetime test results
- Plan/summary





# Status of Opto-Board Prototyping

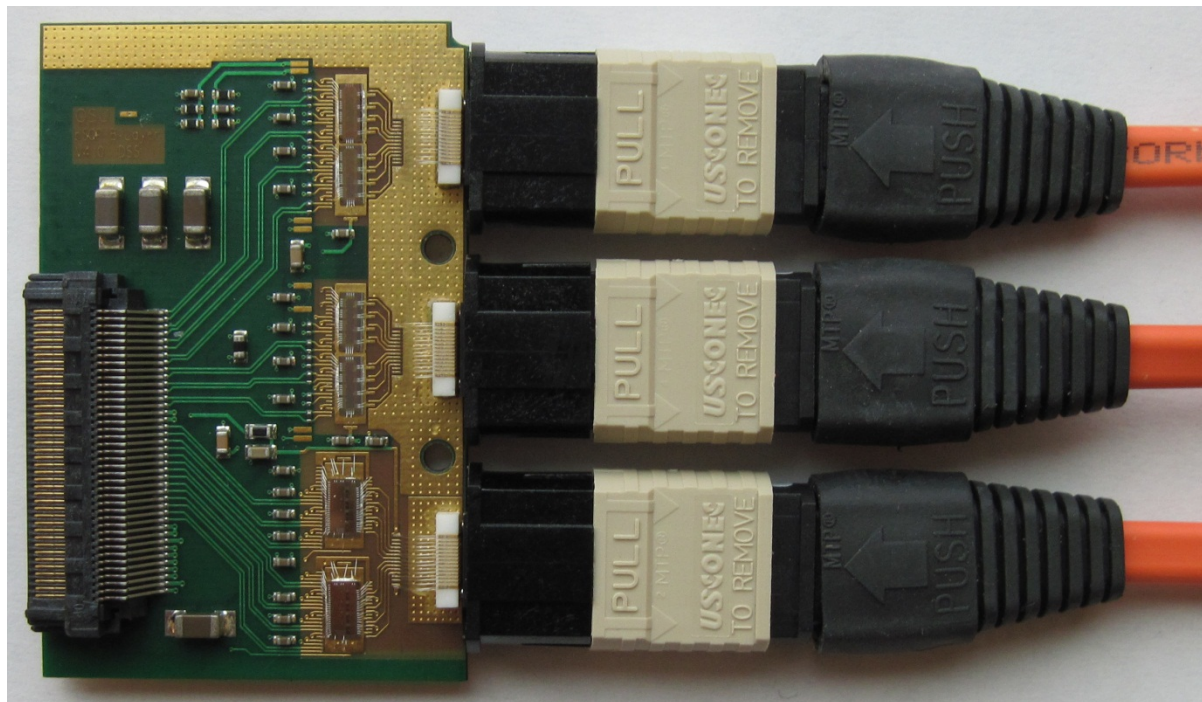
- 3 opto-board flavors
  - ◆ D opto-board (disk): 7 TTC + 7 data links (2 flavors)
  - ◆ B opto-board (B-layer): 7 TTC + 14 data links
  - ◆ IBL opto-board: 8 TTC + 16 data links
- October IBL GM:
  - ◆ PCBs for B opto-board (nSQP) were fabricated by CERN
    - 6 opto-boards fabricated/irradiated
      - ⇒ several design changes to ease the PCB fabrication





# Status of Opto-Board Prototyping

- 4 new B opto-board (nSQP) fabricated
  - ◆ 1<sup>st</sup> prototype PCB: SLAC
  - ◆ 2<sup>nd</sup> prototype PCB: Bern, CERN, Wuppertal



VCSEL  
→

VCSEL  
→

PIN  
←

← 3 cm →

K.K. Gan

IBL General Meeting





# IBL Opto-Board Submission

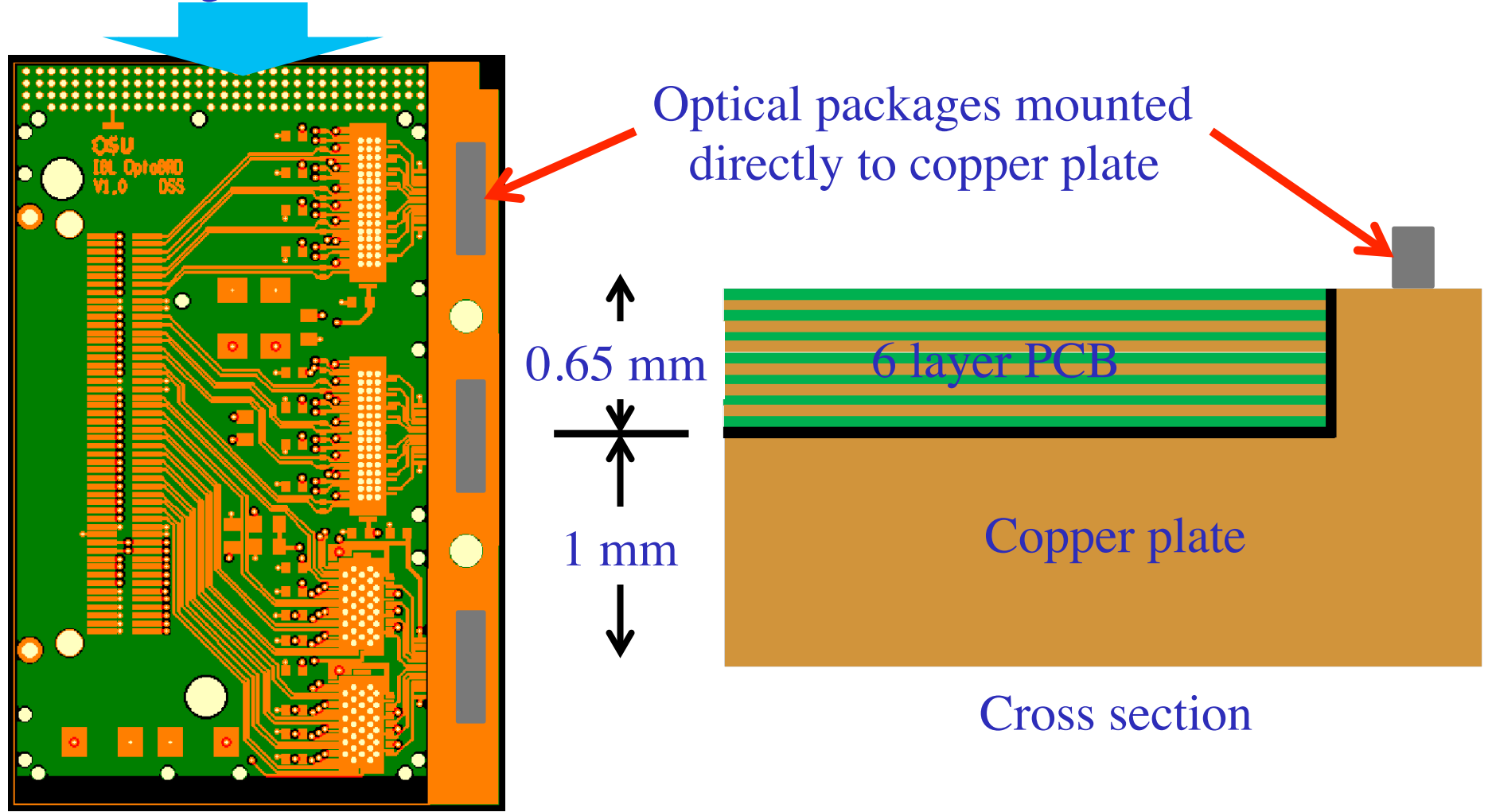
- IBL design submitted to the CERN PCB shop last week
  - ◆ special thanks to Steven Welch as liaison to the shop
  - ◆ should receive the boards in mid July
  - ◆ should have results by mid August





# Opto-Board Thermal Design

Cooling from here



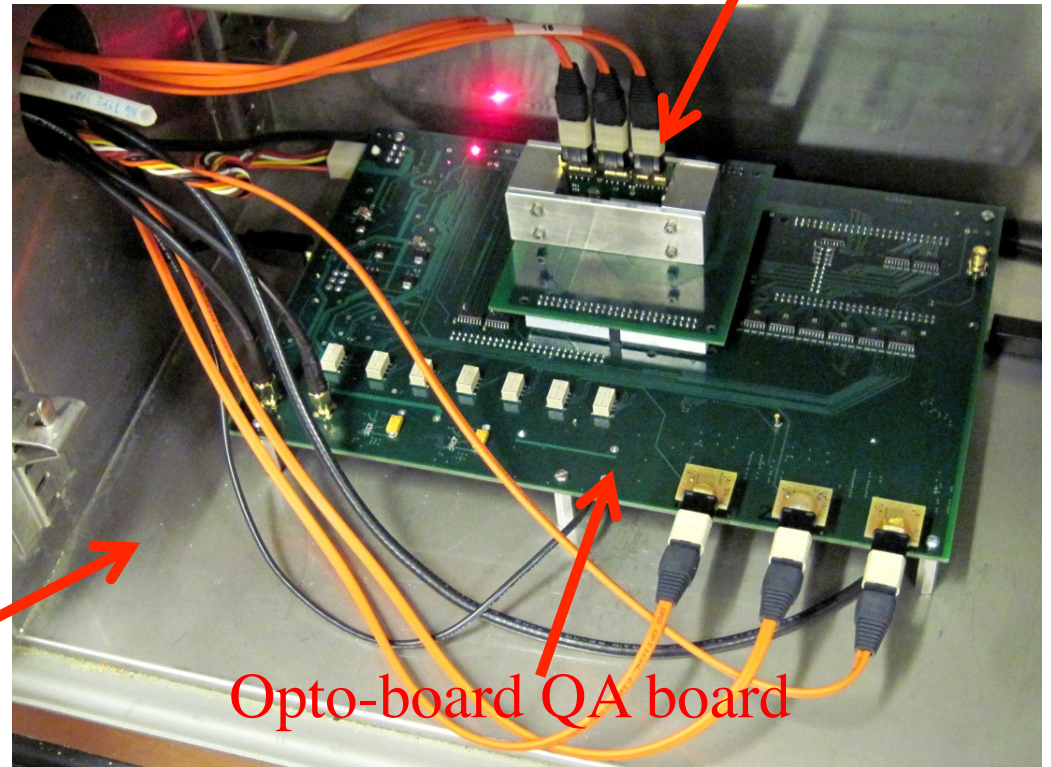




# Opto-Board Quality Assurance

- plan to perform QA test similar to present pixel opto-boards to validate constructed boards
  - ◆ burn in: 72 hours @ 50°C
  - ◆ 10 thermal cycles: -25°C  $\Rightarrow$  +50°C
    - 2 hours per cycle
    - 1 hour soak at 50°C
  - ◆ electrical and optical QA
- QA system exercised on fabricated opto-boards

Envirnoment chamber



Opto-board

Opto-board QA board





# Accelerated Lifetime Test

- Performed an accelerated lifetime test:
  - 20 VCSEL arrays from ULM (10 Gb/s)
  - mounted on OSU opto-packs
  - operated at 85°C and 85% relative humidity over extended time
  - all 240 channels continuously operated at 10 mA DC
  - aggregate VCSEL current/power from each array monitored with a wide area photo-diode
  - LIV (light-current-voltage) measurement every ~500 hours
- Test meant to qualify the use of ULM arrays mounted on the OSU opto-pack
  - believe that the arrays themselves are qualified





# Light-Current-Voltage Measurements

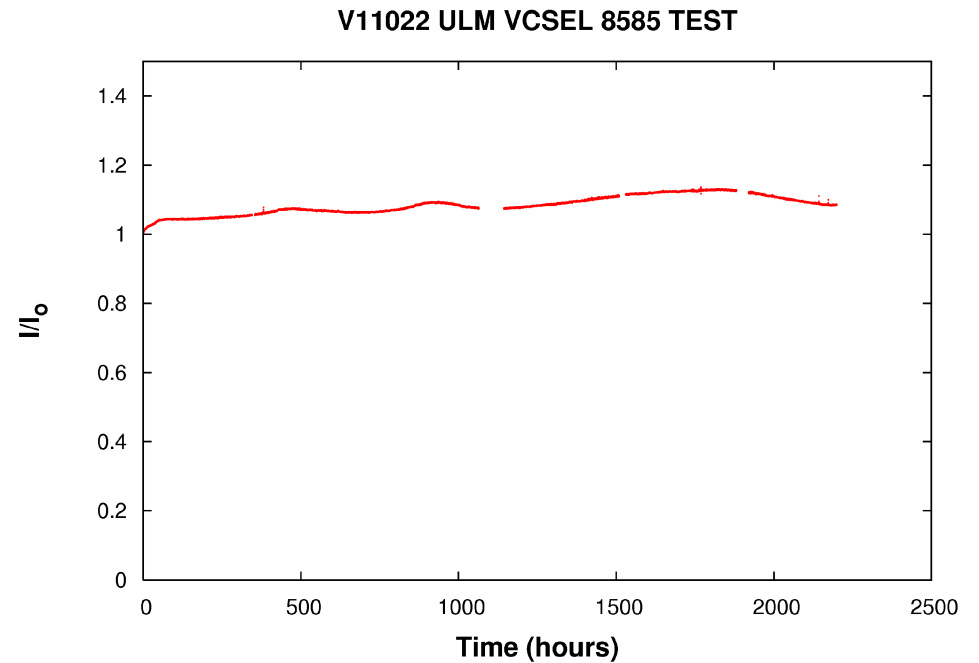
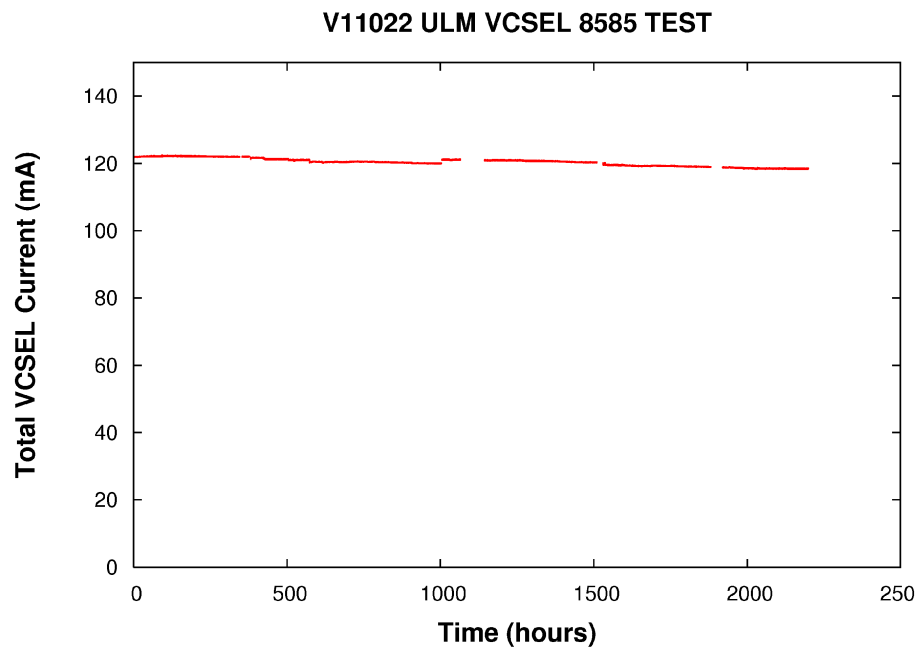
Date	Operating Hours
27/9	0
13/10	380
08/11	1,002
29/11	1,510
28/12	2,200





# VCSEL Current/Power

- Aggregate VCSEL current and light output for all arrays recorded continuously



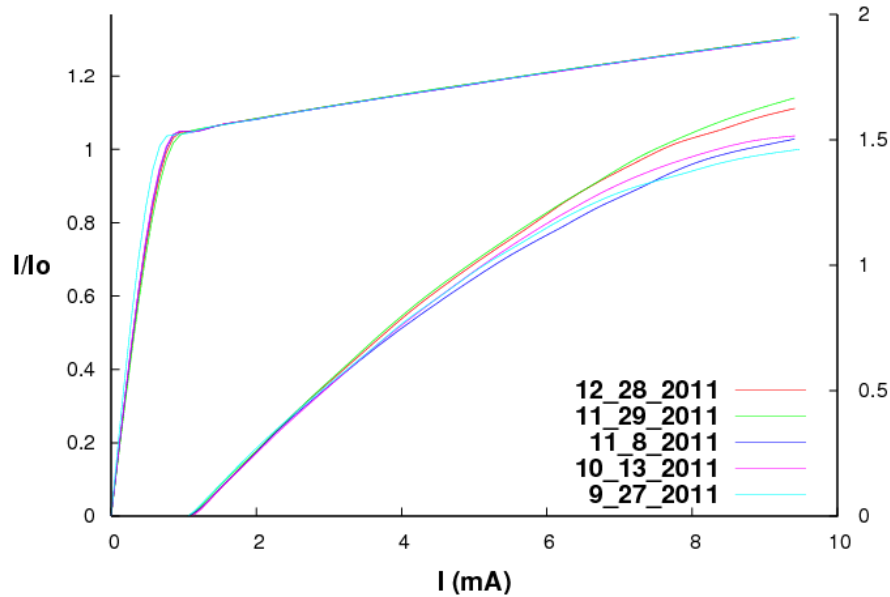




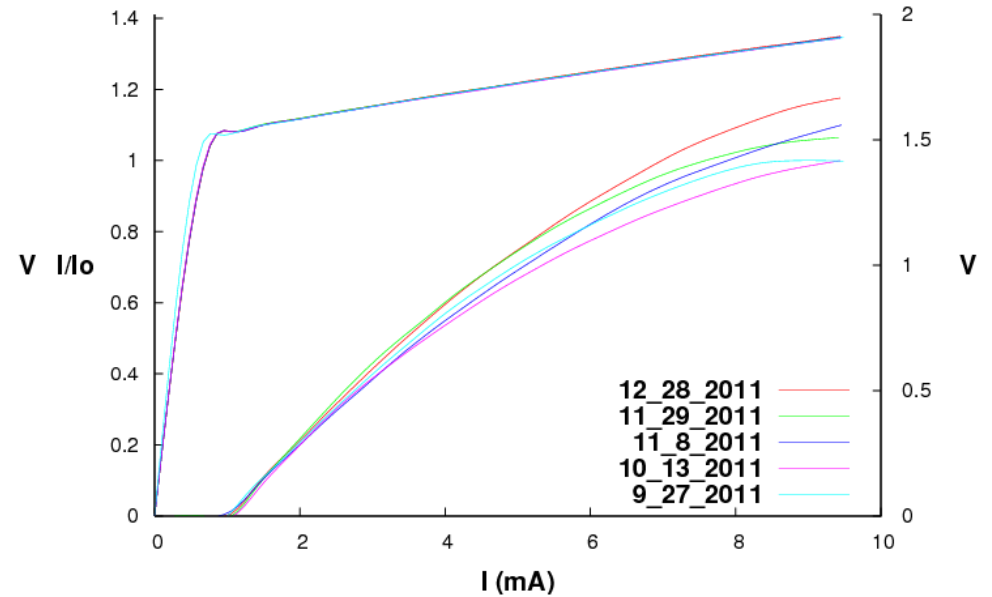
# LIV Measurements

- Performed periodic LIV measurement on each channel
- measured at 85°C

**V11022 Channel 1**



**V11022 Channel 2**







# Results

Hours	Failed Channels
1,002	0
1,510	2
2,200	19

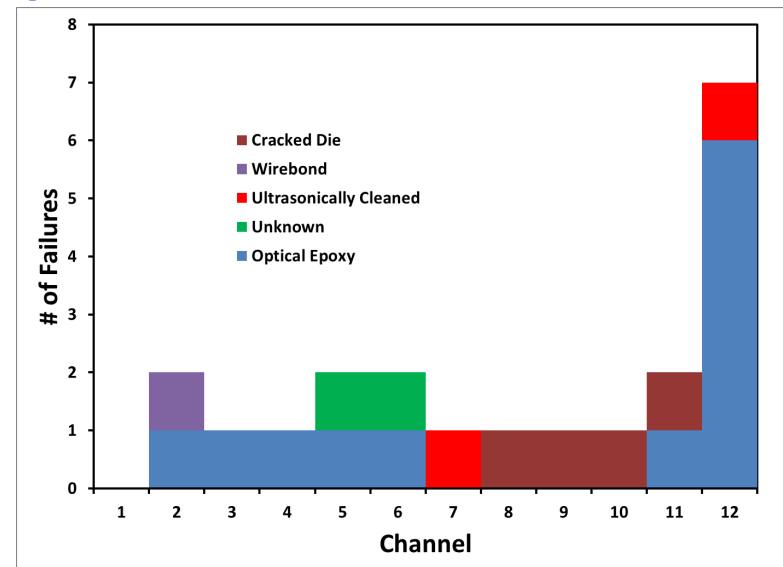
- Failure study:
  - ◆ visual inspection with microscopy
  - ◆ further measurements
  - ◆ discussion with ULM via Michal Ziolkowski





# Failure Analysis

- 16 - optical epoxy coverage/scraping
  - ◆ including 4 on a cracked die
- 2 - no obvious/correlated cause
  - ◆ discolored die
- 2 - ultrasonic cleaning of die before placement
- 1 - broken wire bond during test

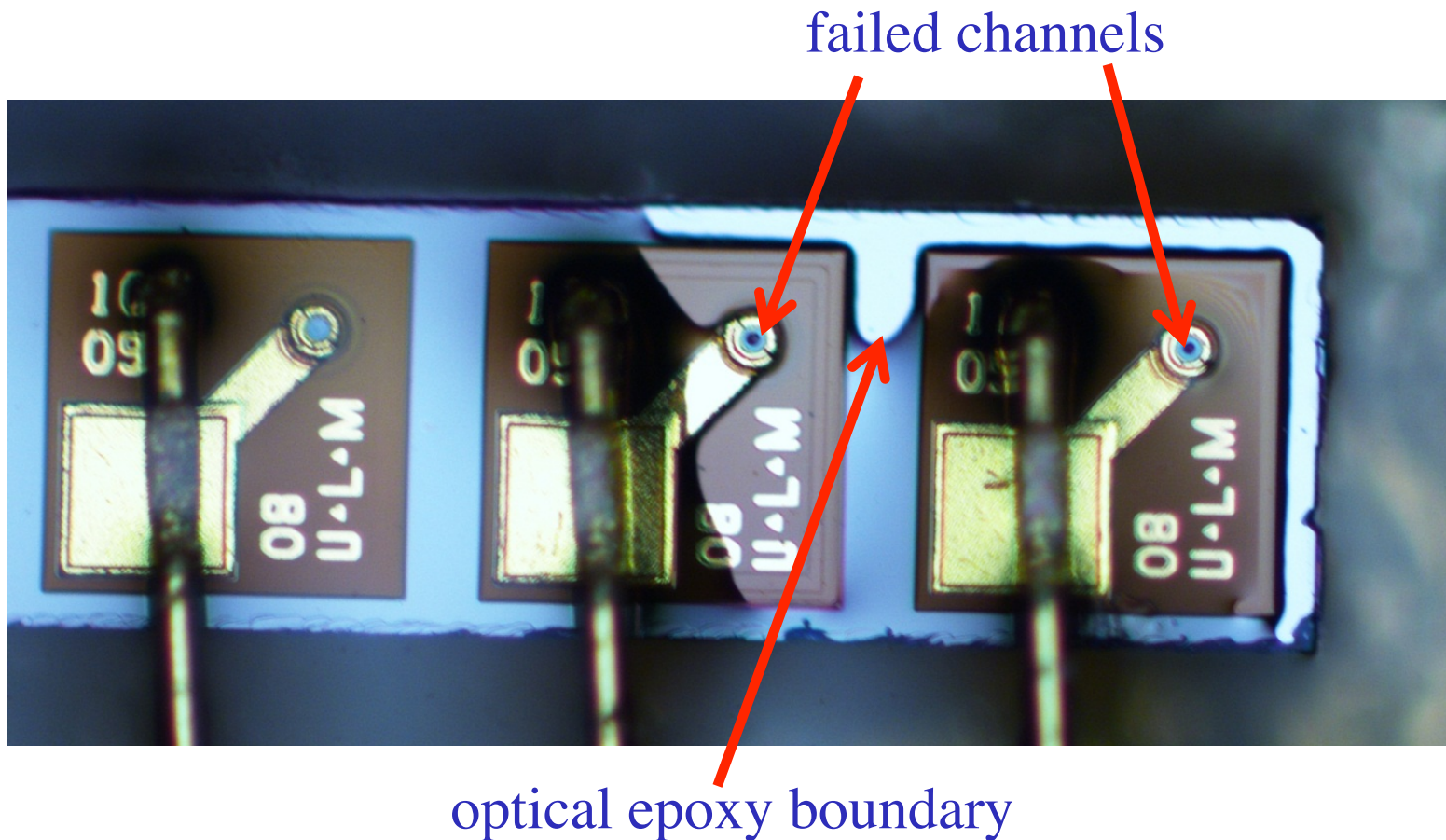






# Optical Epoxy Coverage Failures

- All channels with incomplete epoxy coverage failed







# Optical Epoxy Scraping Failures

- not possible to have complete epoxy coverage without epoxy around MT guide pins
  - ⇒ epoxy wick up the guide pins due to capillary effect
  - ⇒ scrape epoxy from guide pins to allow proper fiber coupling
  - ⇒ the accelerated lifetime study reveals that this might cause long term reliability issues:
    - ◆ cracked a die (which survived nearly the whole test)
    - ◆ introduced stress in a few arrays



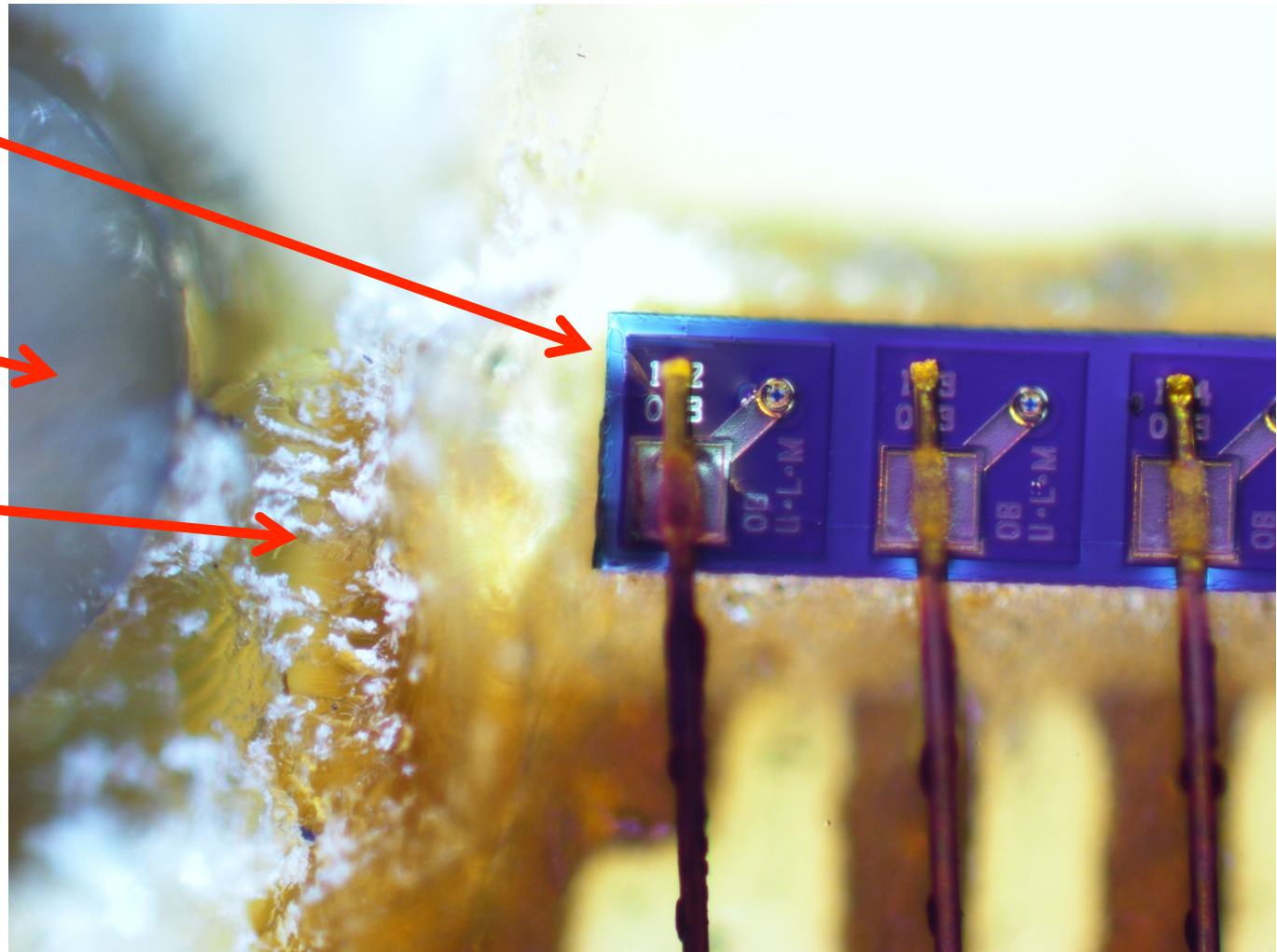


# Cracked Die

Crack in die  
(continues to  
channel 8)

MT guide pin

Scraped  
optical epoxy



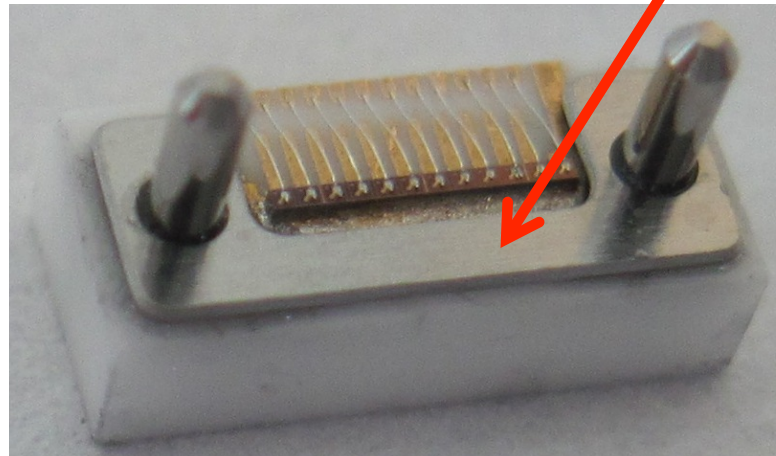




# Optical Epoxy Solution

- Add an optical epoxy dam
  - ◆ keeps epoxy from climbing the MT guide pins
    - ⇒ no optical epoxy scraping
  - ◆ adds reservoir to assist in complete epoxy coverage
  - ◆ doubles as MT ferrule bumper
- Presently constructing 20 Finisar arrays with the optical epoxy dam for next lifetime test
  - ◆ dam tested on 12 arrays
    - 6 good
    - 5 can be used in opto-boards for tests
    - 1 has too much epoxy

Optical epoxy  
dam







# Opto-Board Accelerated Lifetime Test

- working towards accelerated lifetime test on nSQP B-boards
- IBL board technology nearly identical
  - ⇒ test is extremely relevant
- will test 16 nSQP B-boards
- will test 4 IBL boards

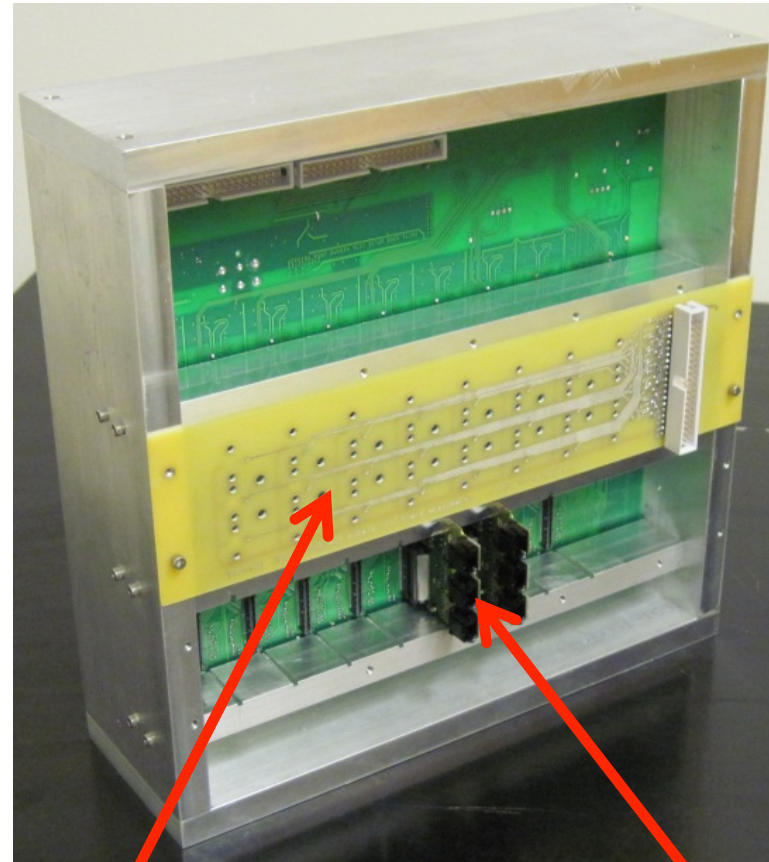




# Opto-Board Reliability Qualification

Back

Front



Mounting card for wide area photo-diodes

Opto-board





# Summary

- Four new B opto-board PCB (nSQP) fabricated
- IBL opto-board design submitted for fabrication
- QA test system fabricated and exercised
- Accelerated lifetime test reveals potential mechanical stress due to scrapping of optical epoxy from guide pins
  - ⇒ use epoxy dam to contain the epoxy