Report on OSU Opto-Pack Prototypes

K.K. Gan

The Ohio State University

June 11, 2001

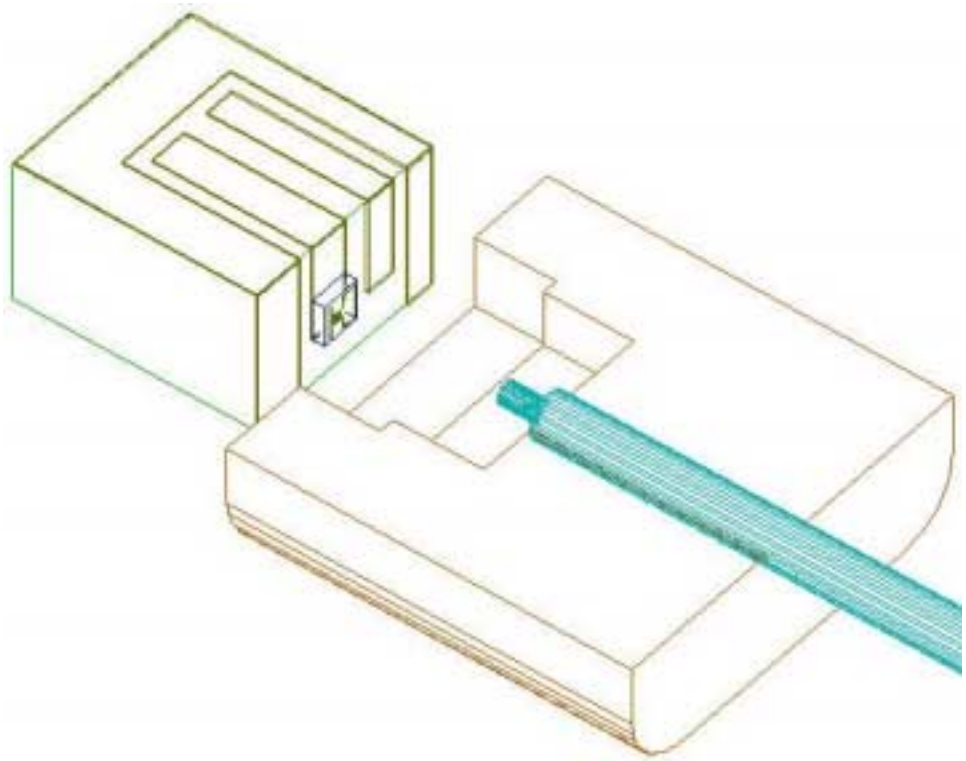
Outline

- Introduction
- Result on VCSEL opto-pack prototypes
- Result on PIN opto-pack prototypes
- Result on temperature cycling
- Result on test with opto-boards
- Production Plan
- Conclusions

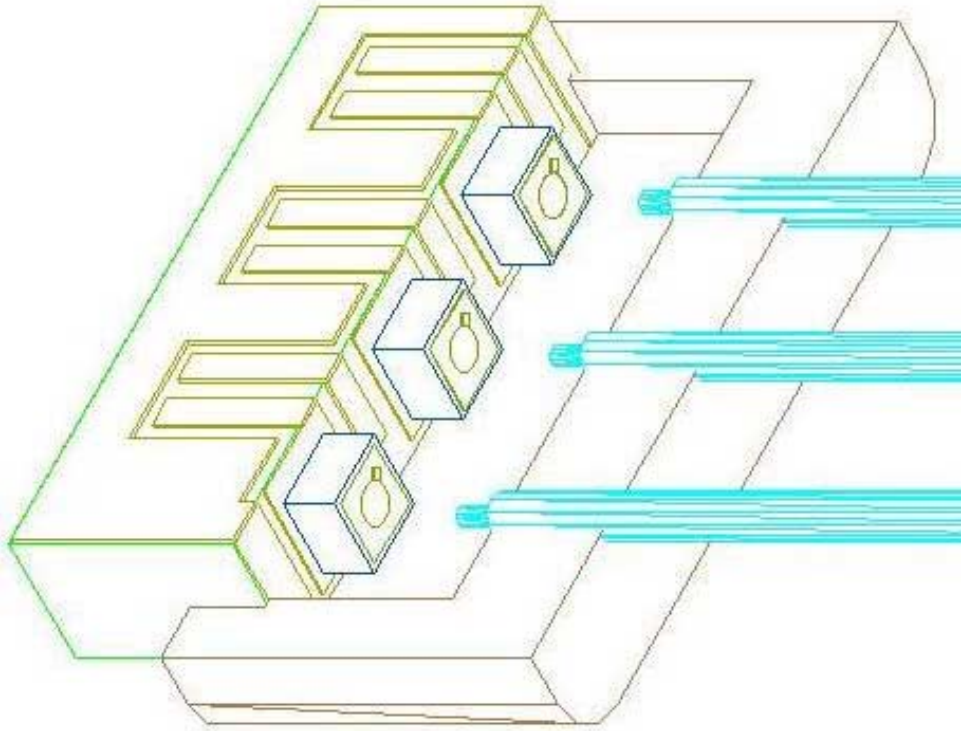
OSU Design

- connector concept design
  - ☆ use precisely fabricated cap and base for alignment
  - ☆ simple two-piece design for mass production
- cap
  - ☆ holes for fibers
- base
  - ☆ deposit gold traces for wire bonding, VCSEL and PIN placements

VCSEL Opto-Pack



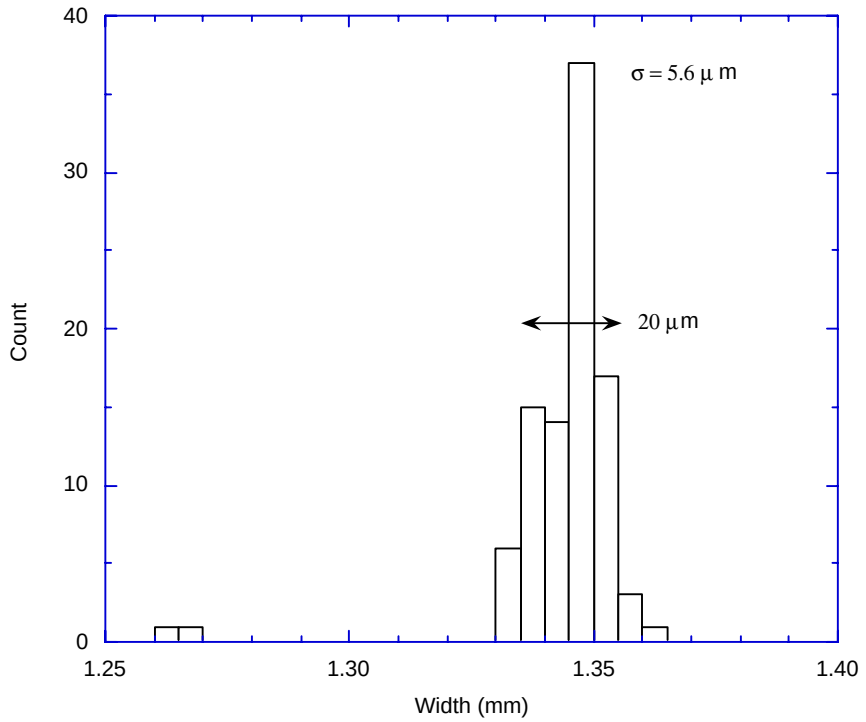
PIN Opto-Pack



Cap and Base Prototypes

- produced caps and bases with rounded corners using machinable ceramic
  - ☆ material tested: aluminum silicate and macor
  - ☆ difficult to obtain consistent precision
  - ⇨ redesign base with square corners for ease of fabrication by Hybrid-Tek
    - ☆ alumina sheet ground to proper thickness and cut into strips
    - ☆ strips cut into bases by American Dicing
    - ☆ can produce bases with precision within specification
    - ☆ 3D traces have good connectivity (~ 94%)
  - ⇨ fabricate cap with Ultem (polyetherimide) for radiation tolerance (10 Grad)
    - ☆ use manual micro mold injection to save development time
    - ☆ can fabricate ~ 10 caps per hour

VCSEL Base Width



- accept ~ 90% of bases

VCSEL Placement

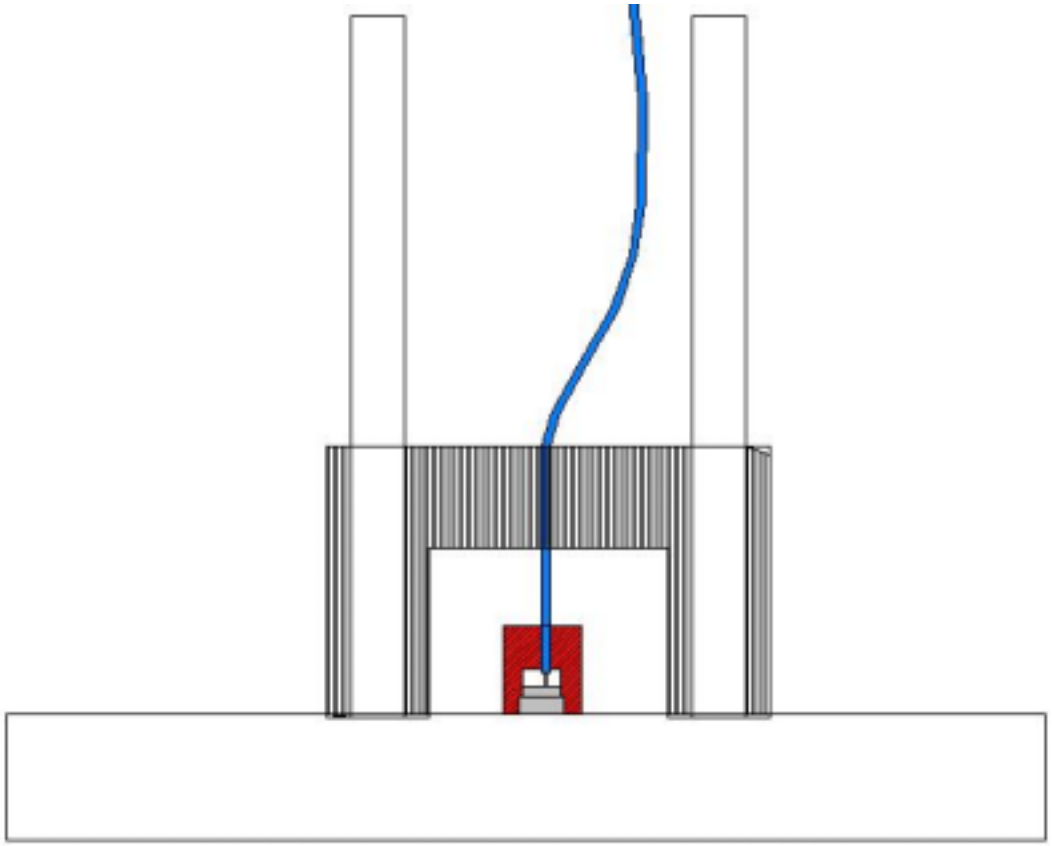
- VCSEL needs to be placed with a precision of 10 μm
  - ⇨ use precisely fabricate jig
    - ☆ precision base slot slightly larger than base
    - ☆ precisely located pocket for VCSEL
    - ☆ pocket slightly larger than VCSEL
      - ⇨ 3 contributions to placement uncertainty
      - ⇨ 12 out 18 bases fabricated satisfy power coupling spec.
      - ⇨ new VCSEL placement scheme

New VCSEL Placement Scheme

- measure location of pin in cap mold using comparator
  - ⇨ place VCSEL at expected fiber location
    - ☆ put base on comparator
    - ☆ move cross-hair to expected fiber location based on measured width
    - ☆ move VCSEL to cross-hair with micro-manipulator
      - ◆ operation time: ~ 5 minutes
- expect more precise pin location with CMM measurement
  - ⇨ should further improve coupled power

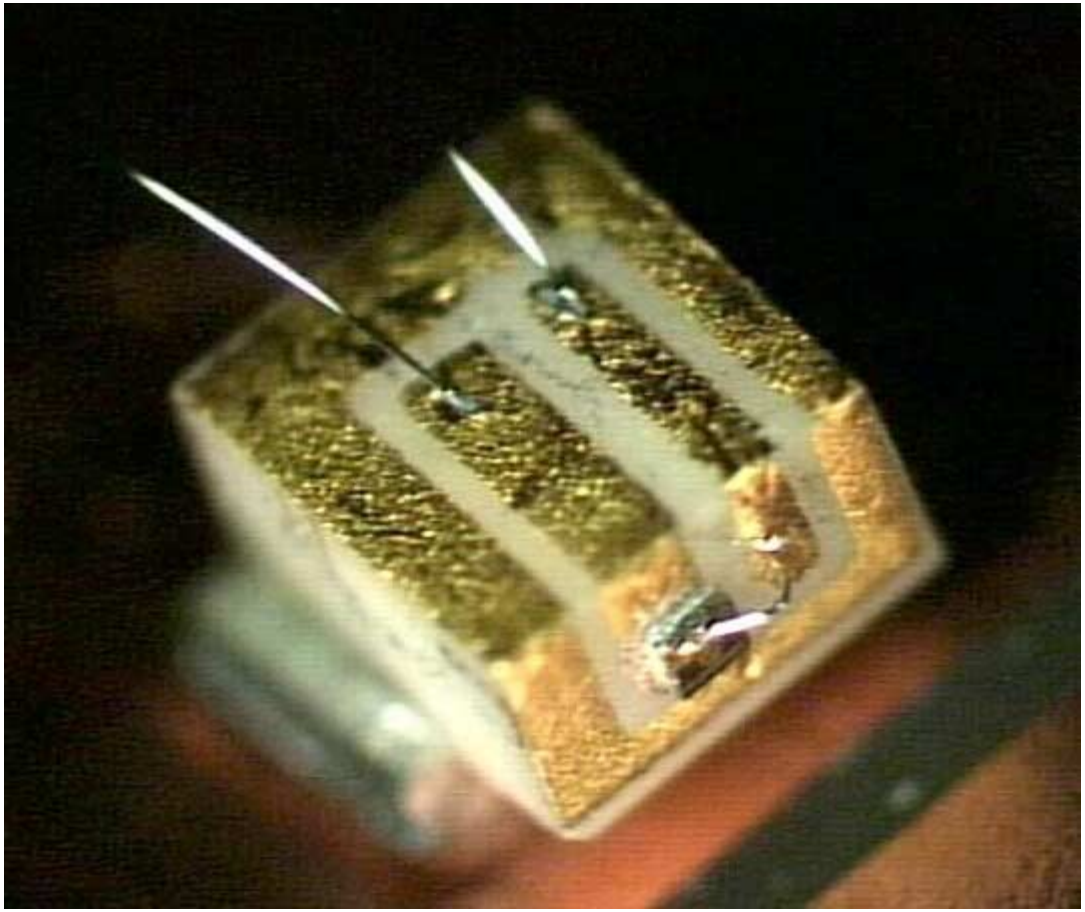
Cap Fabrication Mold

Fiber Placement Jig

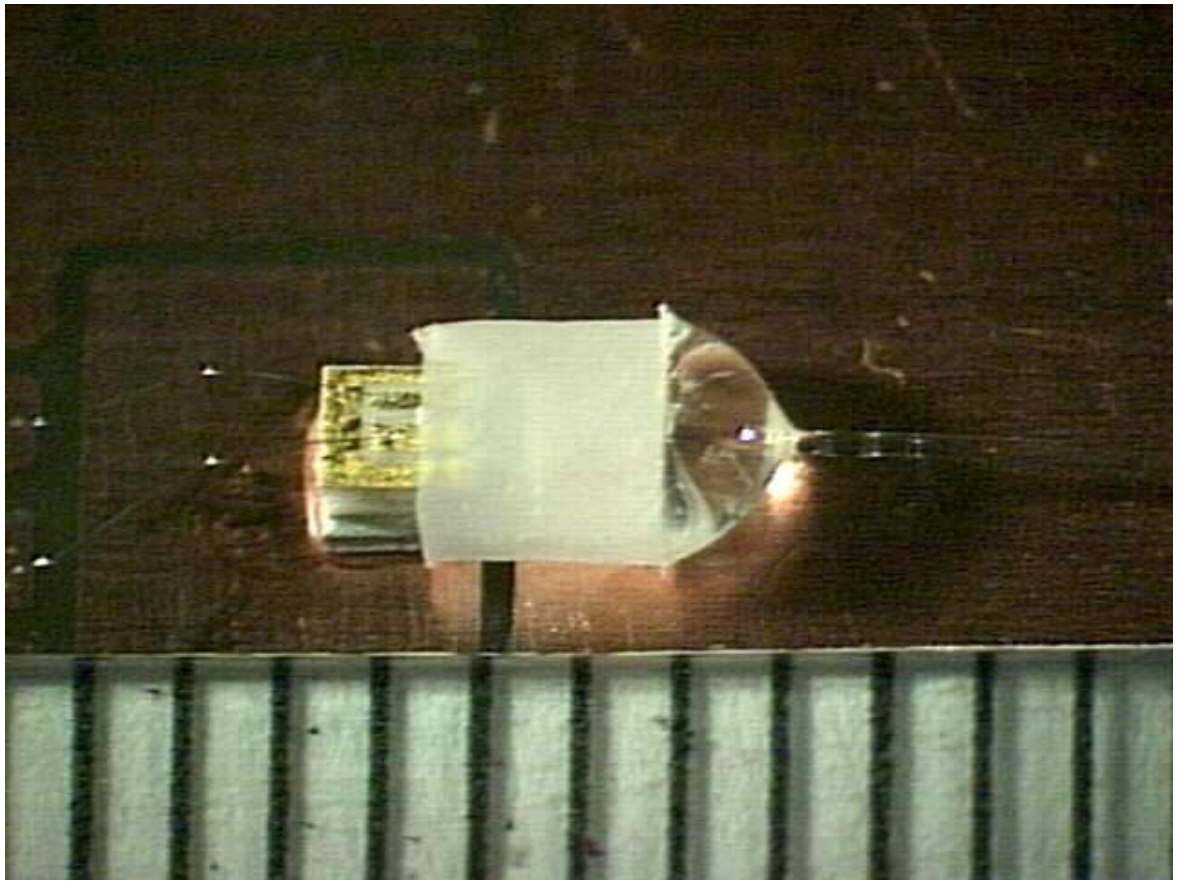


Cap with Precisely Fabricated Cavity

Base with VCSEL

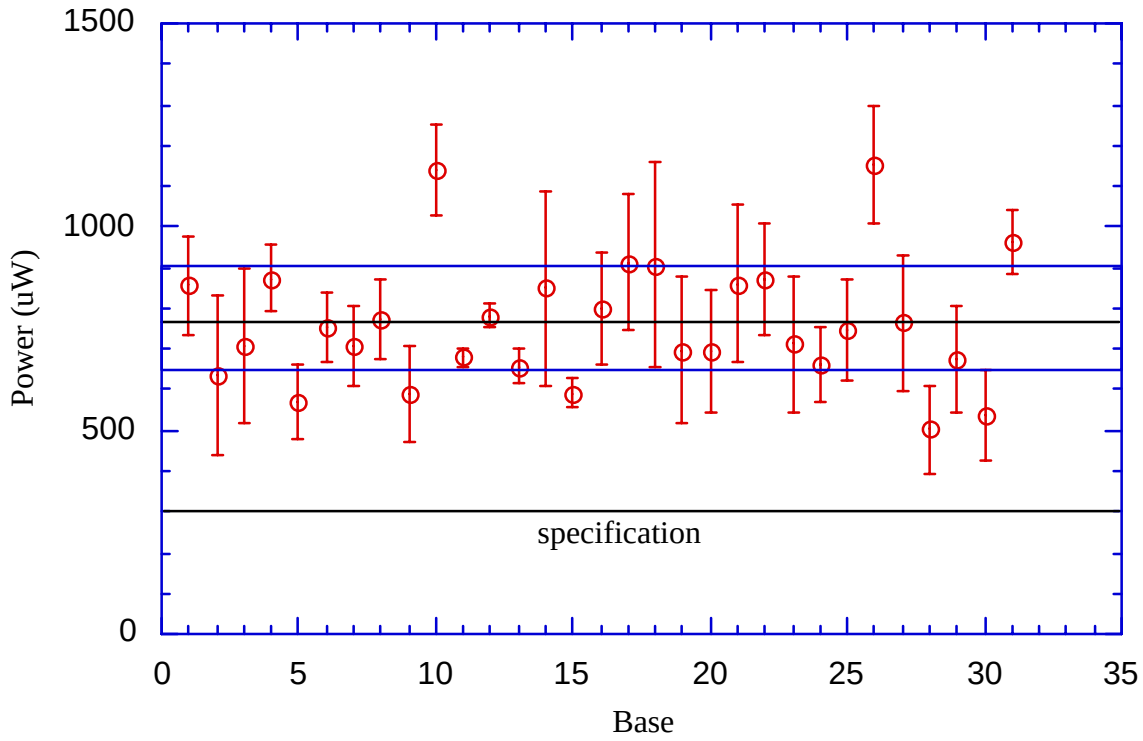


Completed VCSEL Opto-Pack



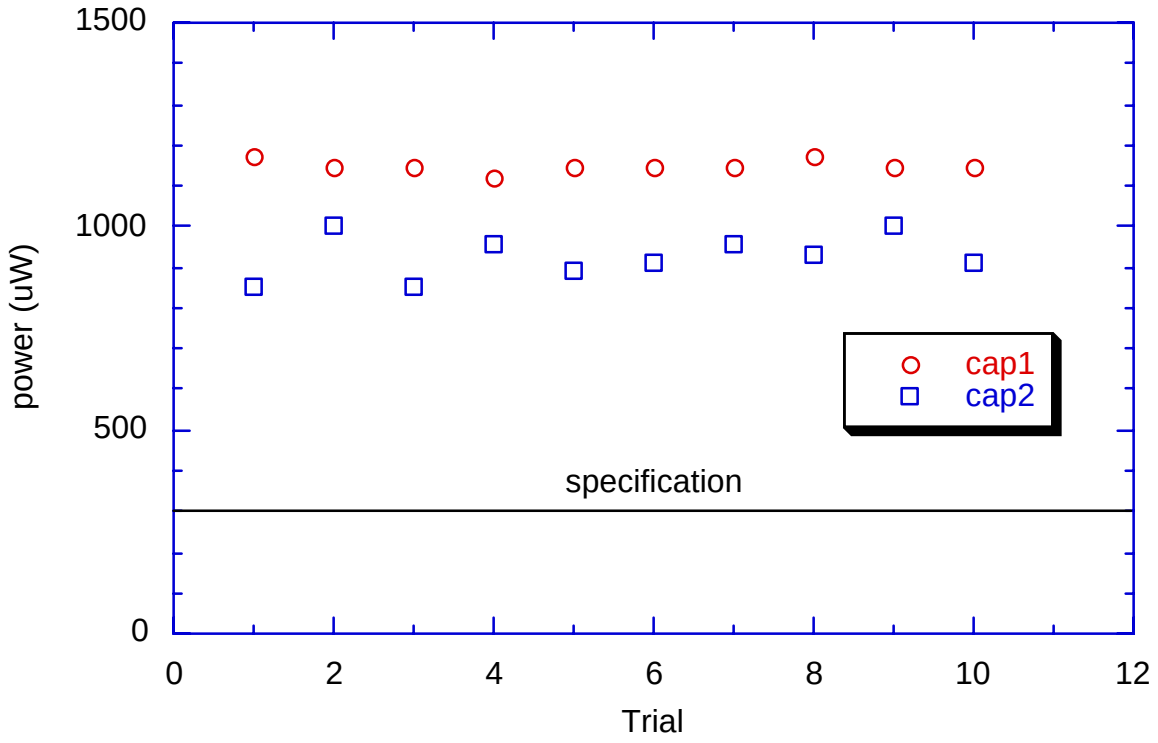
1 mm

Coupled VCSEL Power @ 10 mA



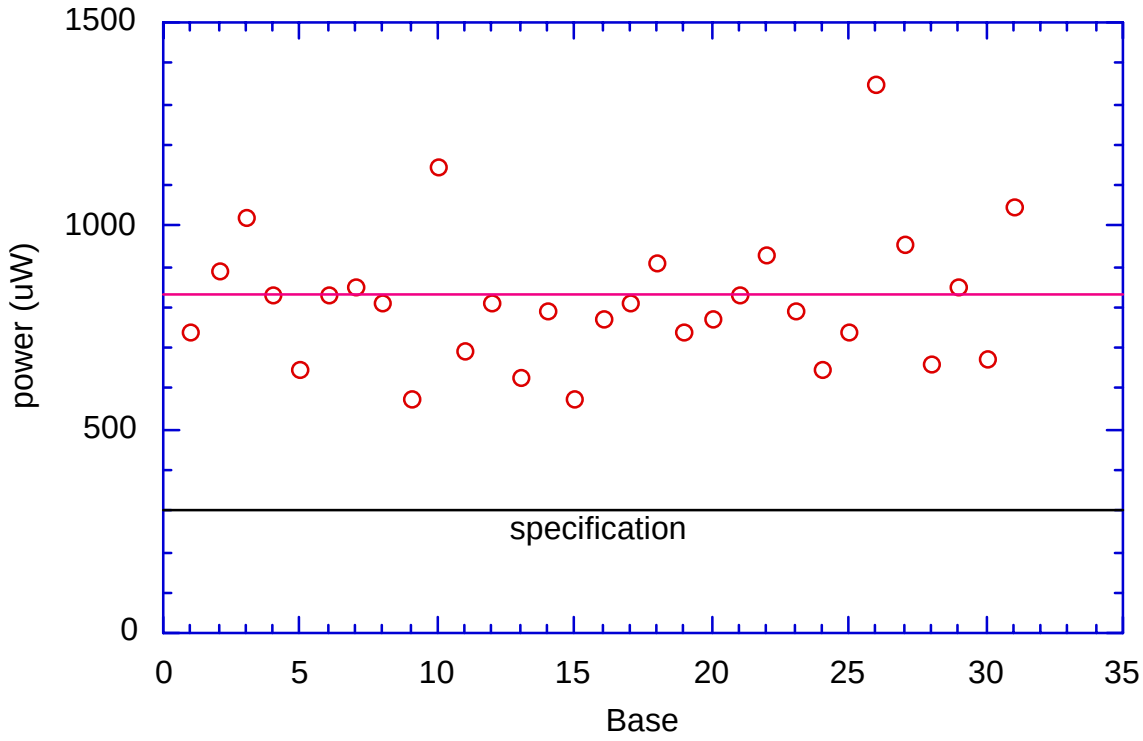
- all VCSEL opto-packs have coupled power well above spec.

Coupled VCSEL Power vs Usage



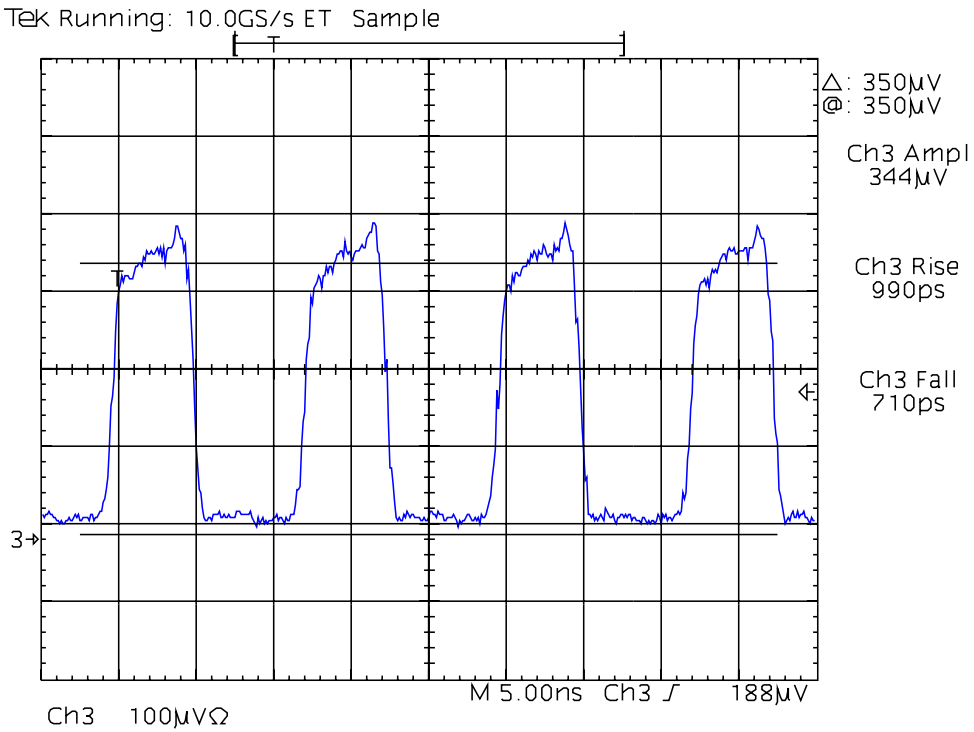
- caps can be used multiple times

Coupled VCSEL Power vs Usage



- same cap gives good power on 31 bases
  - ⇨ cap is reusable and inter-changeable

VCSEL Waveform

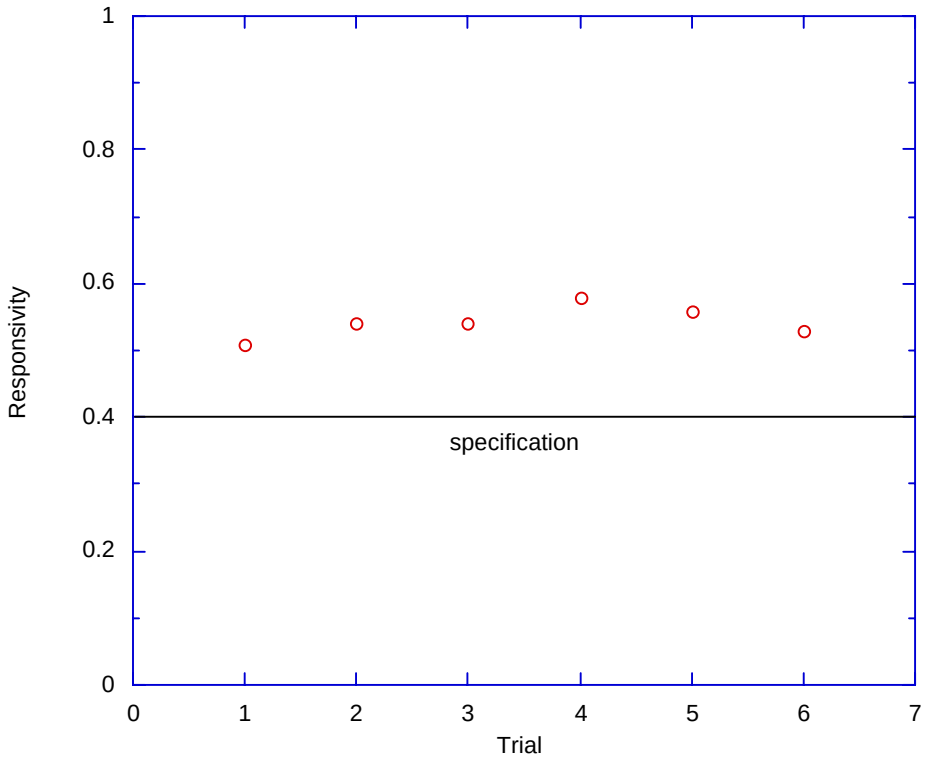


- VCSEL opto-pack has fast rise and fall times

Temperature Cycling

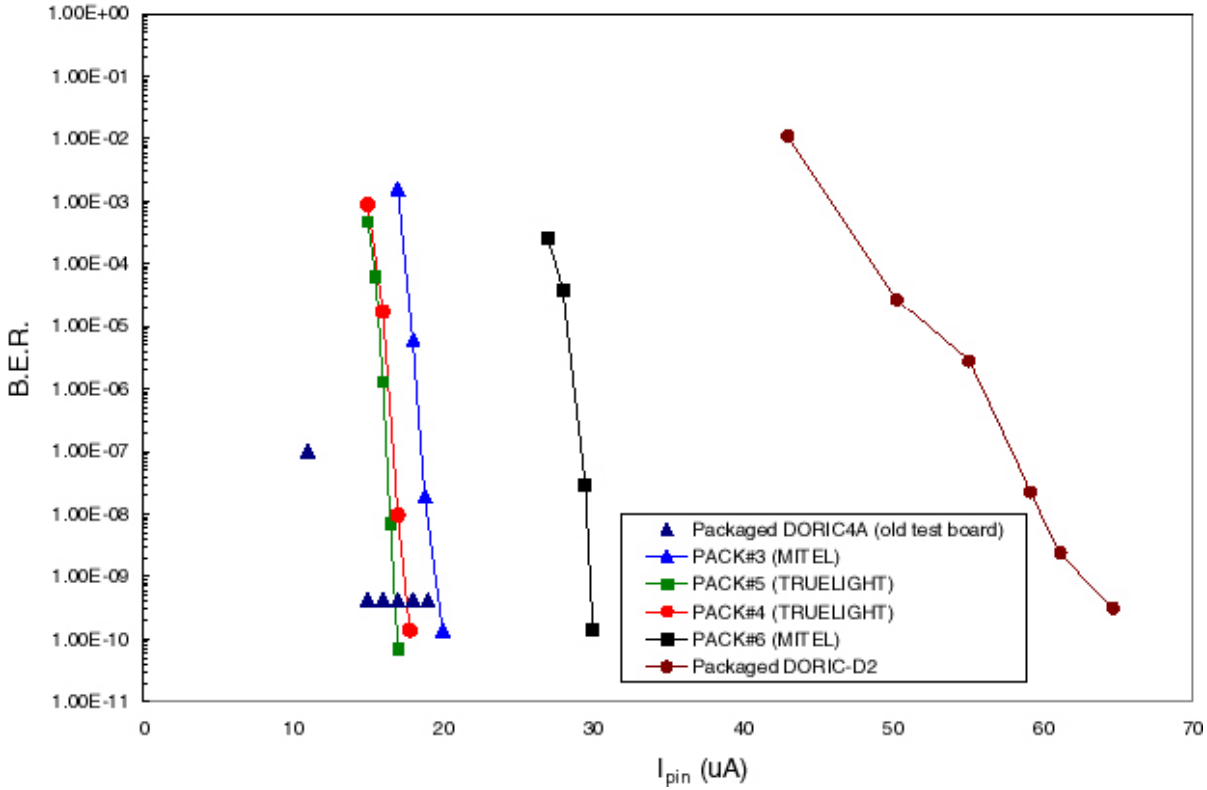
- 10 VCSEL opto-packs were temperature cycling:
  - ~ 300 cycles between -10^0C and 60^0C
  - no degradation observed

PIN Opto-pack Responsivity



- PIN opto-pack responsivity is above spec.

BER of Opto-packs on Opto-board



- opto-packs can run with low PIN current

Pro and Con of OSU Design

- disadvantages
  - need to fabricate more packages
  - extra time: 2000 caps x 10 min = 2 months of manpower
- advantages:
  - limited number of PIN/VCSEL per package to reduce loss
  - select VCSEL opto-packs of similar coupled power for appropriate I_{set}
  - opto-board without 21 long fibers is much easier to handle
  - cure epoxy on opto-board in oven without fibers for die replacement
  - cap with fibers can be attached to package at end of module assembly

Production Plan

- can transfer technology to any interested institution
  - ☆ OSU will provide jigs
- manpower need
  - ☆ assuming 30 minutes per VCSEL or PIN
  - ⇨ need 1.5 manpower-year to fabricate 3000 packages

Summary on OSU Opto-pack Prototype

- OSU prototype program successfully completed
  - ☆ can fabricate VCSEL opto-packs with good coupled power
  - ☆ can fabricate PIN opto-packs with good responsivity
  - ☆ opto-packs can run at low PIN current
- remountable caps offer maximum flexibility in opto-board assembly and repair