New Results on Opto-Electronics

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Introduction

- VCSEL Driver Chip (VDC):
  - convert LVDS signal into single-ended signal appropriate to drive VCSEL
- Digital Opto-Receiver Integrated Circuit (DORIC):
  - decode clock and command signals from PIN diode

Opto-electronics Team

- The Ohio State University:
  - ☆ Kregg Arms, K.K. Gan, Mark Johnson, Harris Kagan, Richard Kass, Chuck Rush, Rouben Ter-Antonian, Michael Zoeller
- Siegen University:
  - ☆ Michael Kraemer, Joachim Hausmann, Martin Holder, Michal Ziolkowski

Results on VDC/DORIC-D3

- VDC-D3: performance is satisfactory
- DORIC-D3:
  - 2 dice in packages + one die on opto-board III
  - 24 μA minimum PIN current for no bit errors
    - ➡ uniformly low PIN current thresholds
    - ➡ DC feedback is working

Opto-Board Prototype III

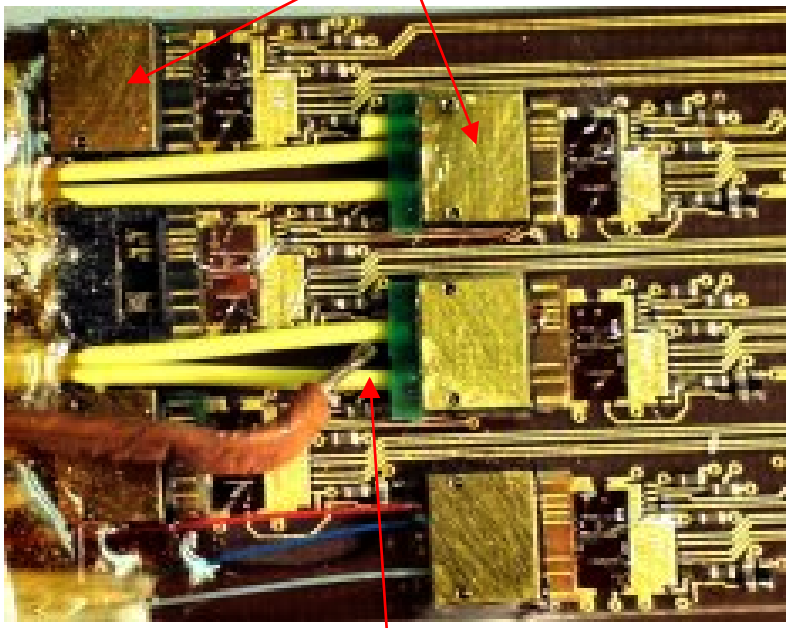
- design for VDC-D3/DORIC-D3
  and 4-channel VDC-I2/1-channel DORIC- I2
- compatible with VDC/DORIC-I3
- contain 7 opto-links for use in barrel and disk
- use SCT style opto-packs
- use 80-pin connector
- fabricated using FR4
- opto-board is working as designed
  - PIN current threshold for no bit errors
    is comparable with packaged dice

Opto-Board Prototype IV

- design for 4-channel VDC/DORIC-I4
- contain 7 opto-links for use in barrel and disk
- use 8-channel opto-packs
- use 80-pin connector
- last submission before using BeO
- to be designed for BeO but tested in FR4
- expect submission in summer 2002

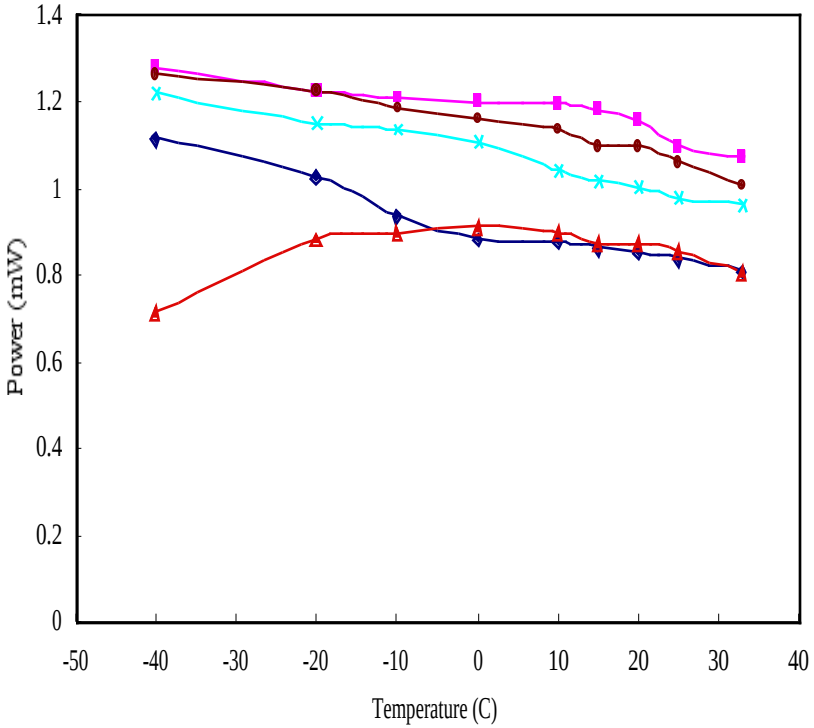
Irradiated Opto-Board with VDC/DORIC-I1

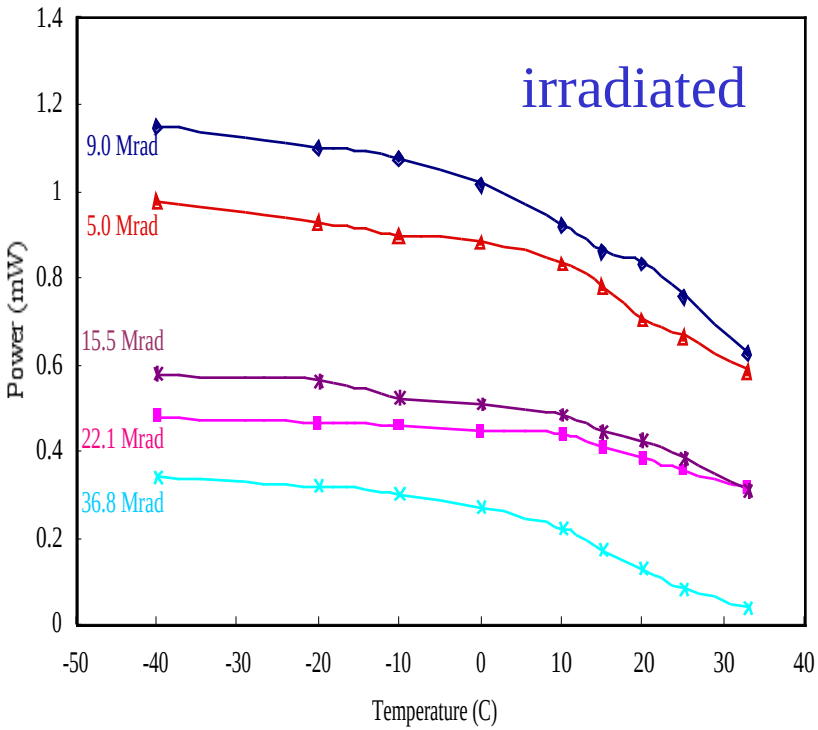
Opto-packs



Thermocouple

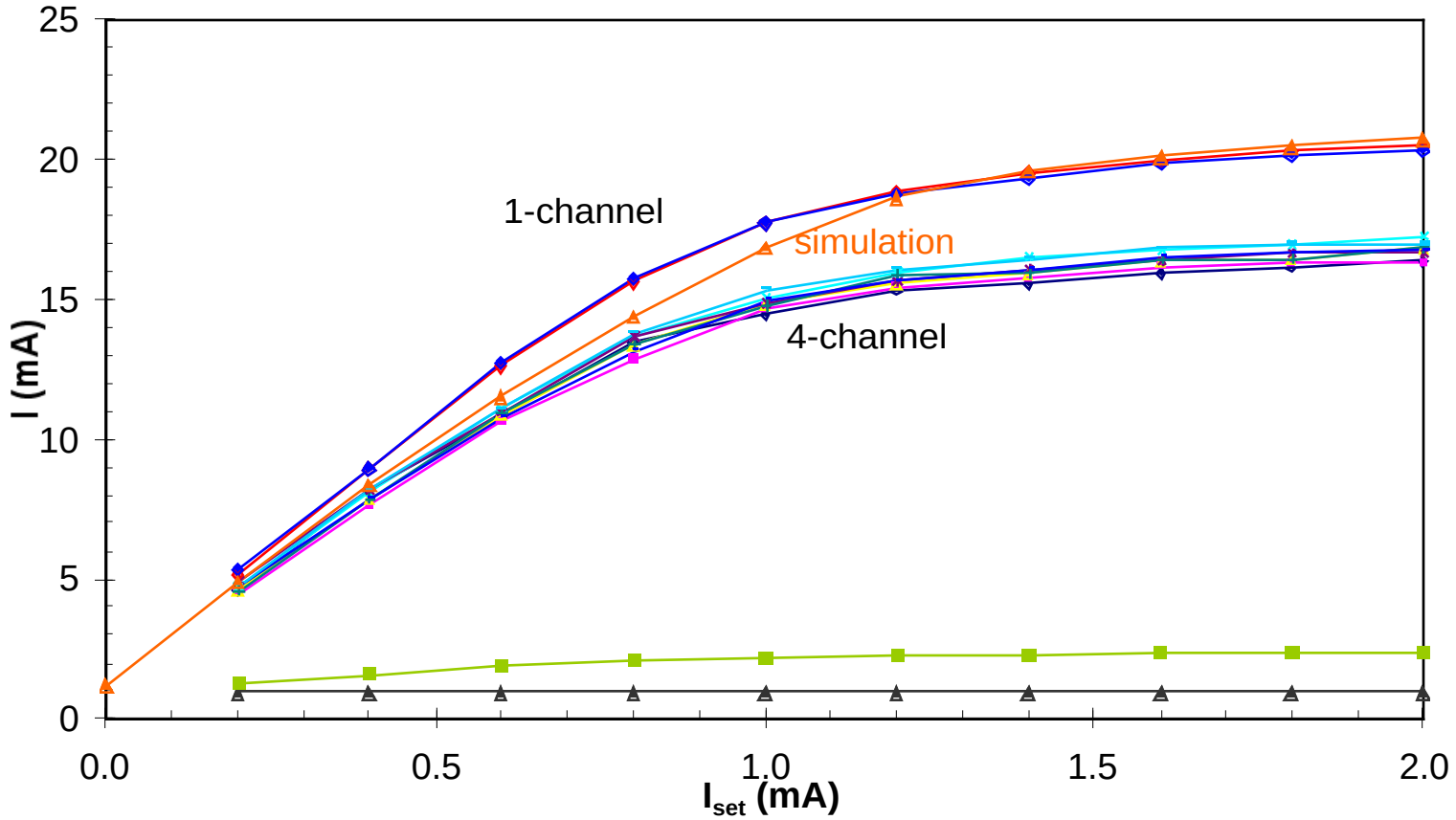
Optical Power vs. Temperature





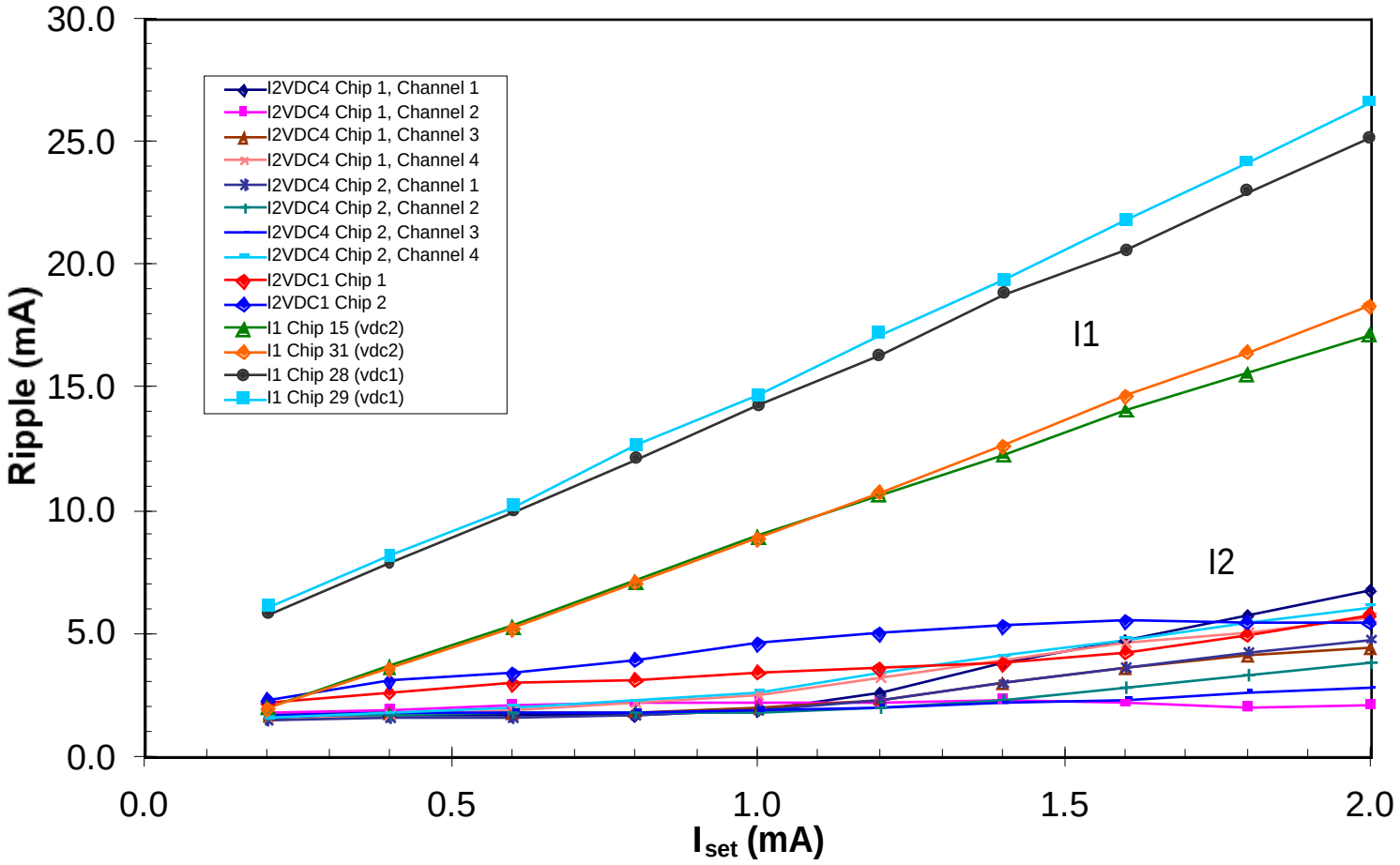
- Cold irradiated VCSELs produce much more light

Bright/Dim Currents vs I_{set}



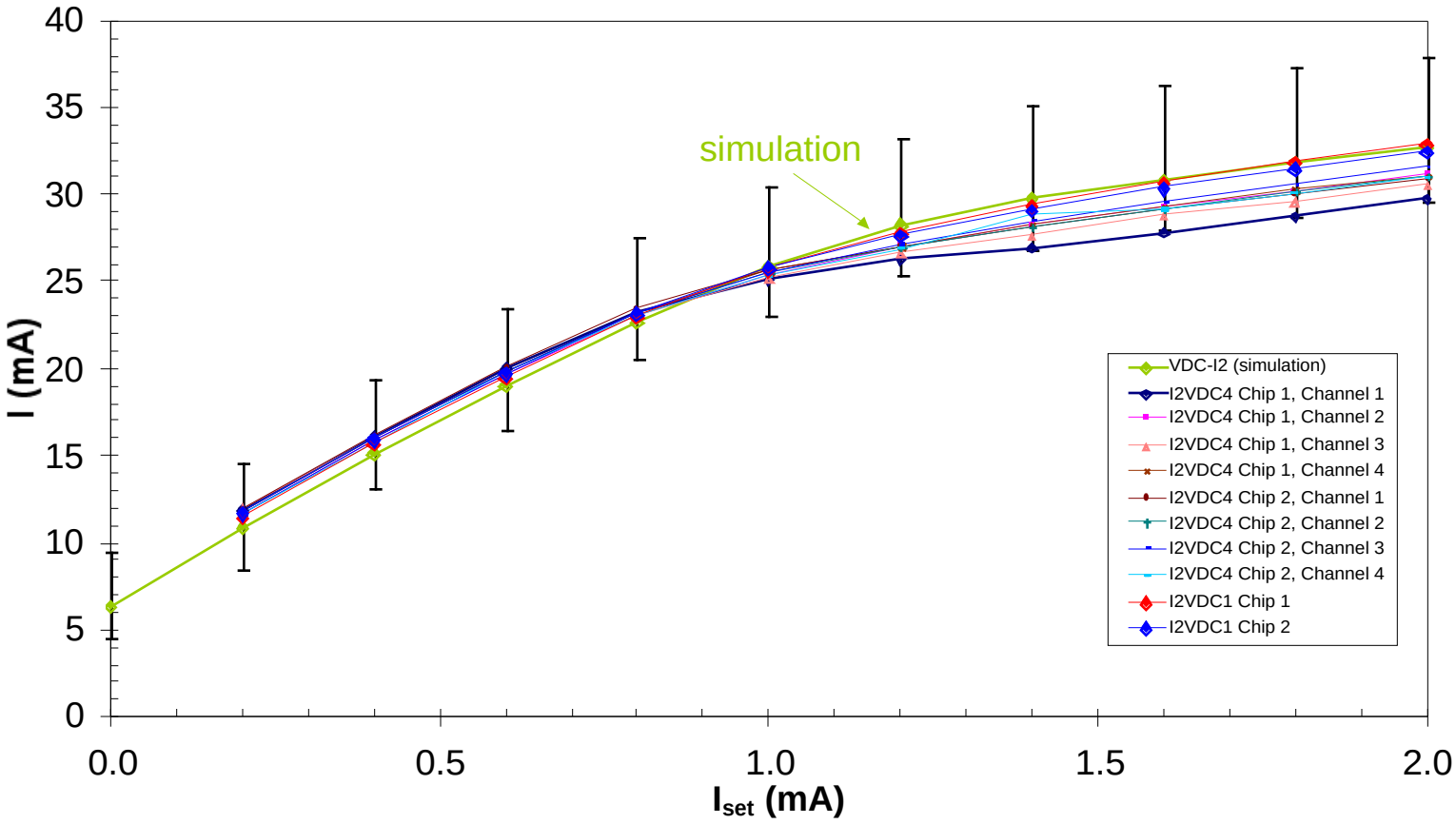
- turning over at high I_{set} is due to 10 Ω in series used in measurement
- dependence of bright current vs I_{set} is as expected

Ripple in VDC-I2 Current Consumption



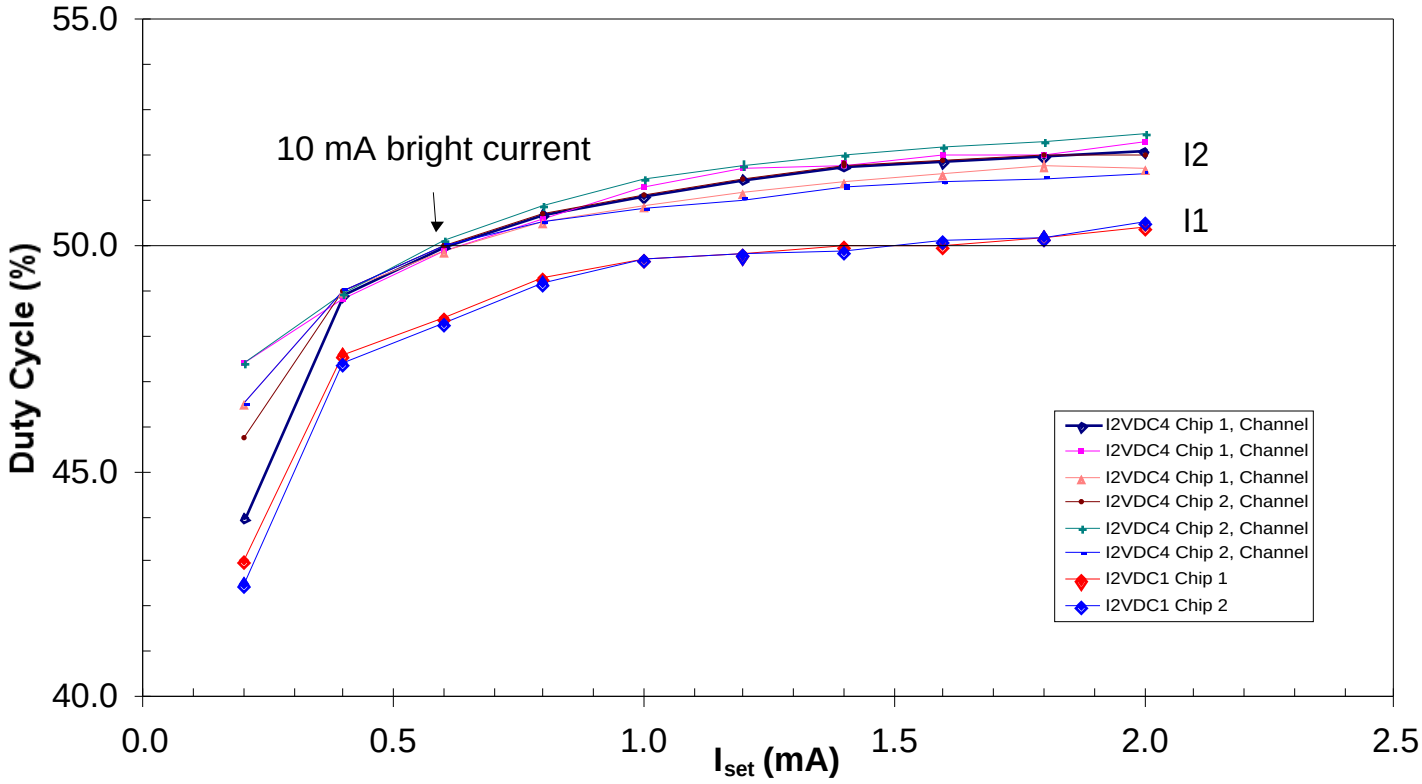
- VDC-I2 has more balance current consumption with VCSEL on and off

Current Consumption of VDC-I2



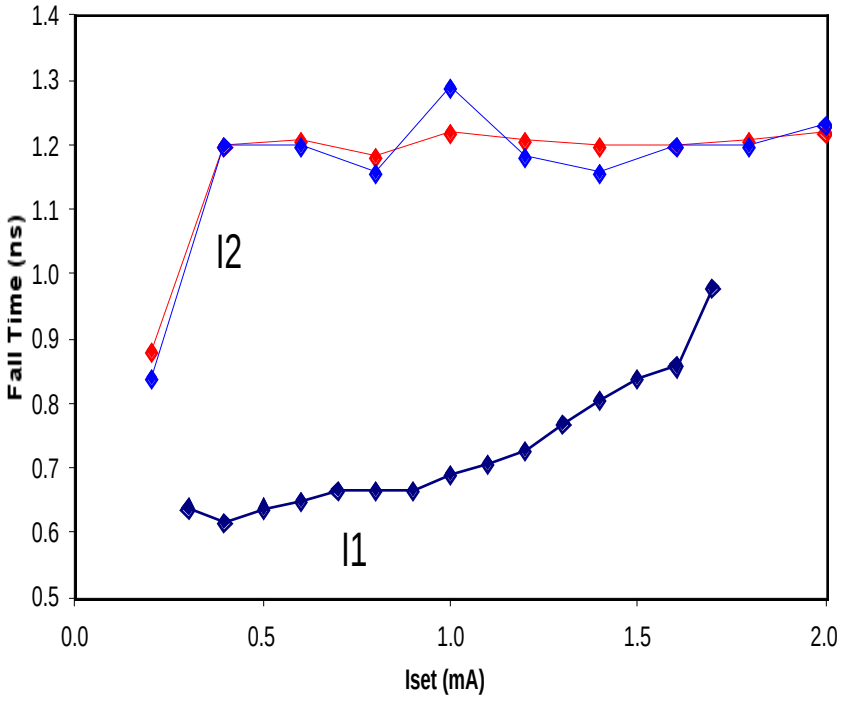
- current consumption of VDC-I2 is consistent with expectation

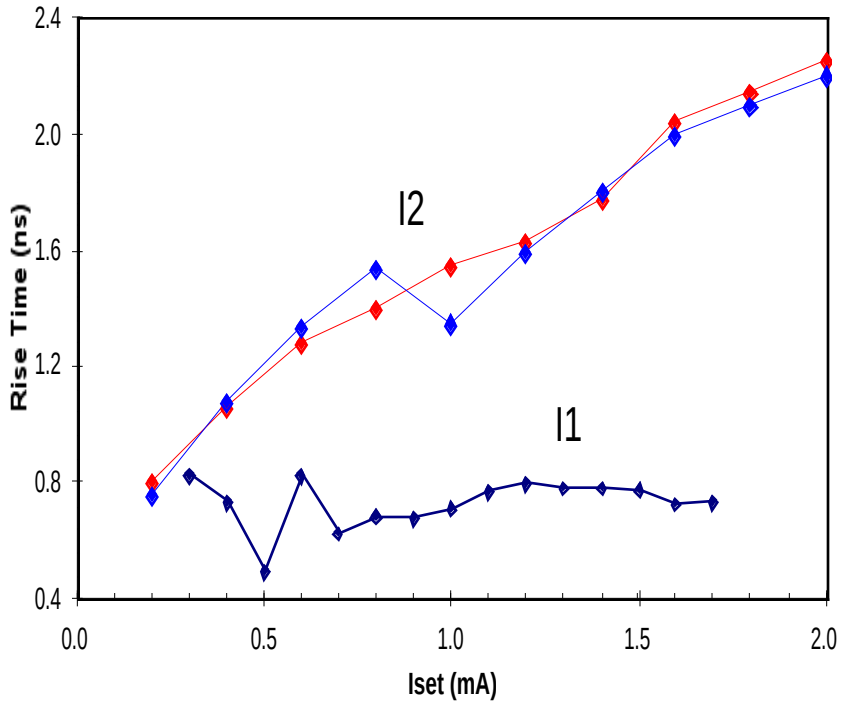
Clock Duty Cycle vs I_{set}



- clock duty cycle close to 50% at 10 mA bright current

Fall/Rise Time vs I_{set}





- fall/rise times somewhat above spec. (1 ns)

DORIC-I2

- minor bugs due to clamping/protection diodes:
  - VPIN is limited to 3.2 V
    - current in diode contribute to measured minimum PIN current for no bit errors
  - CMOS driver is powered at 1.7 V via diode to digital VDD
    - ➡ CMOS driver can't be turned off
    - ➡ contribute noise to pre-amp
      - minimum PIN current for no bit errors:

        27 μA vs 24 μA with diode blown
      - ☆ uniformly low PIN current thresholds
        - ➡ DC feedback is working!

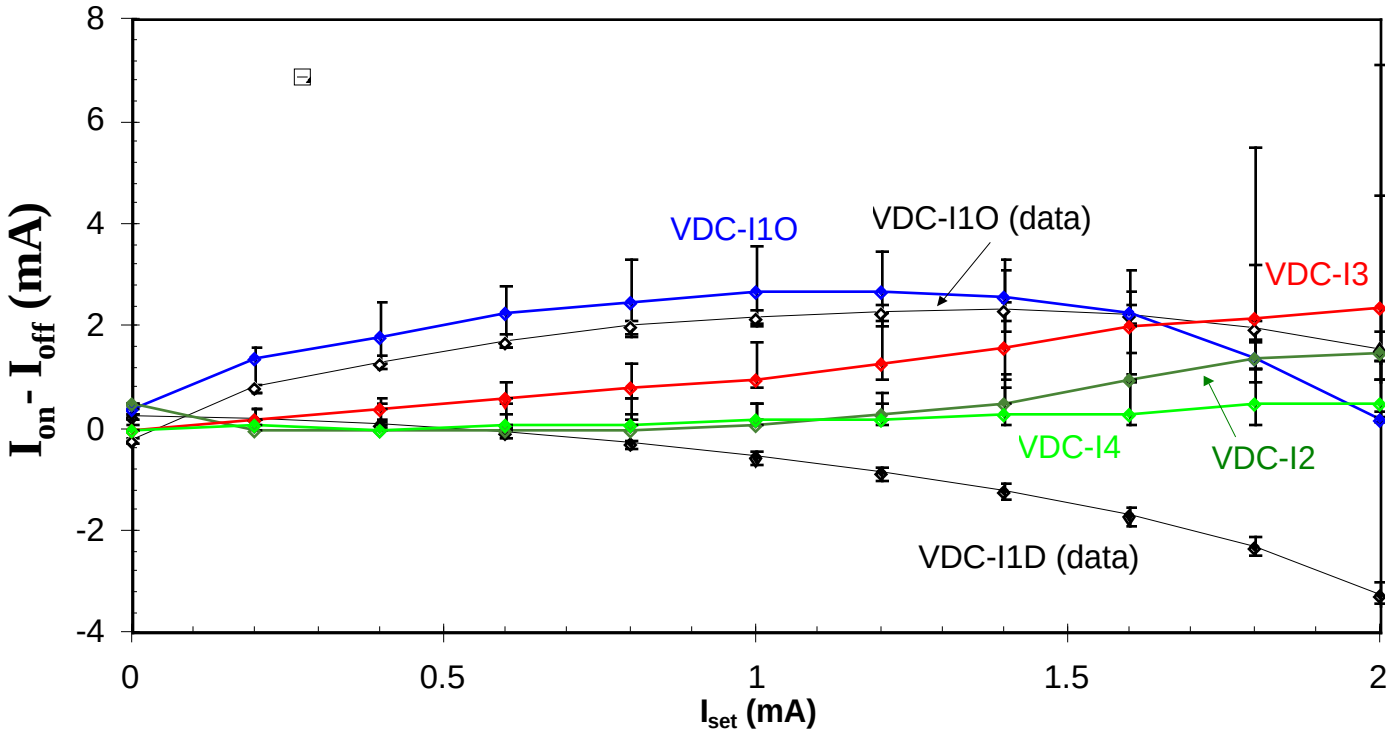
DORIC-I2

- larger time constant in pre-amp successful prevents feedback loop from oscillating even with no input!
- larger time constant in delay control circuit successful prevents delay control circuit from oscillating!
- clock duty cycle: 46/50% on two DORIC tested

Improvements in VDC-I4

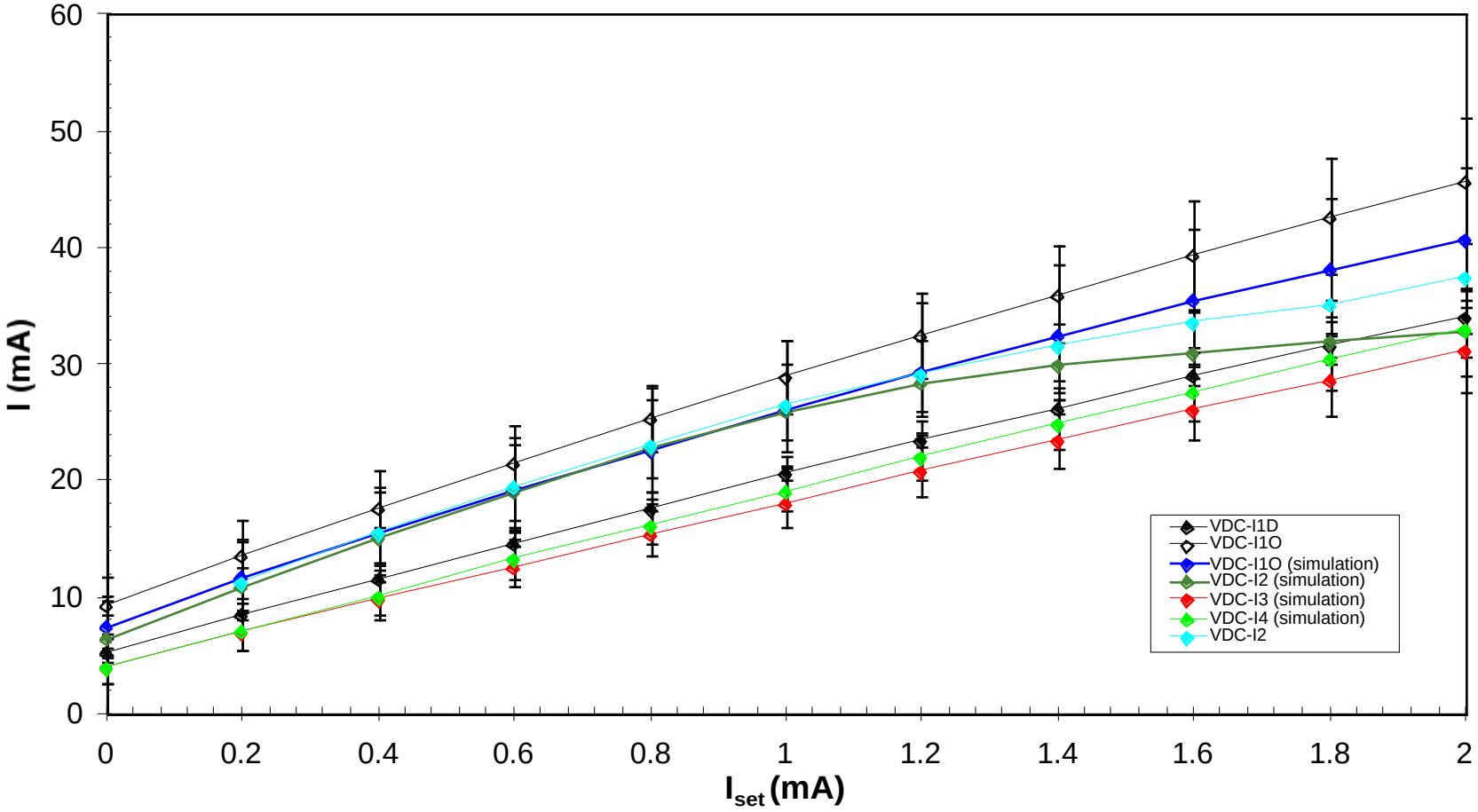
- convert VDC-I3 to be compatible with common cathode VCSEL array

Bright and Dim Current Consumption vs I_{set}



- VDC-I3/I4 has nearly equal current consumption

VDC Current Consumption



- simulations of VDC-I1/I2 reproduce observation
- VDC-I3/I4 consumes significantly less current

Improvements in DORIC-I4

- improved delay control circuit:
  - centers duty cycle of recovered clock at 50%
  - limits range of delays to prevent locking of recovered clock at half or twice frequency
  - add reset for slow and controlled recovery
- optimized timing:
  - two small delays added
- optimized internal digital signals:
  - change edge detector output buffer resistor from 20K to 10K
    - ⇨ smaller voltage swing
    - ⇨ symmetric threshold crossing for +/- signals
  - stronger exclusive OR output buffer for square recovered clock

Improvements in DORIC-I4 (cont.)

- improved pre-amp:
  - half the rise time
  - working on reducing noise
- optimize pre-amp design to be compatible with common anode PIN array
- submit a MPW run on April 15

Summary

- important to keep opto-board cold for maximum light output
- performance of VDC/DORIC-I2 is satisfactory