Tracker Opto-Link R&D Results and Plan

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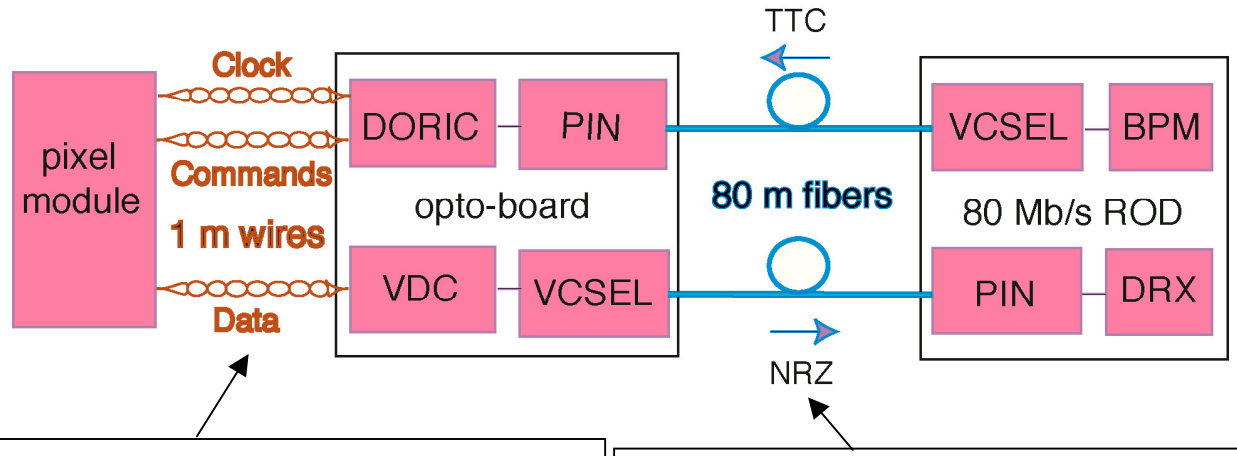
Outline

- Introduction
- Bandwidth of micro twisted-pair cables
- Bandwidth of fusion spliced SIMM-GRIN fibers
- Radiation hardness of PIN/VCSEL arrays
- Plan

ATLAS Pixel Opto-Link Architecture



micro twisted pairs decouple pixel and opto module production
⇨ simplify both design/production

8 m of rad-hard/low-bandwidth SIMM fiber fusion spliced to 70 m rad-tolerant/medium-bandwidth GRIN fiber

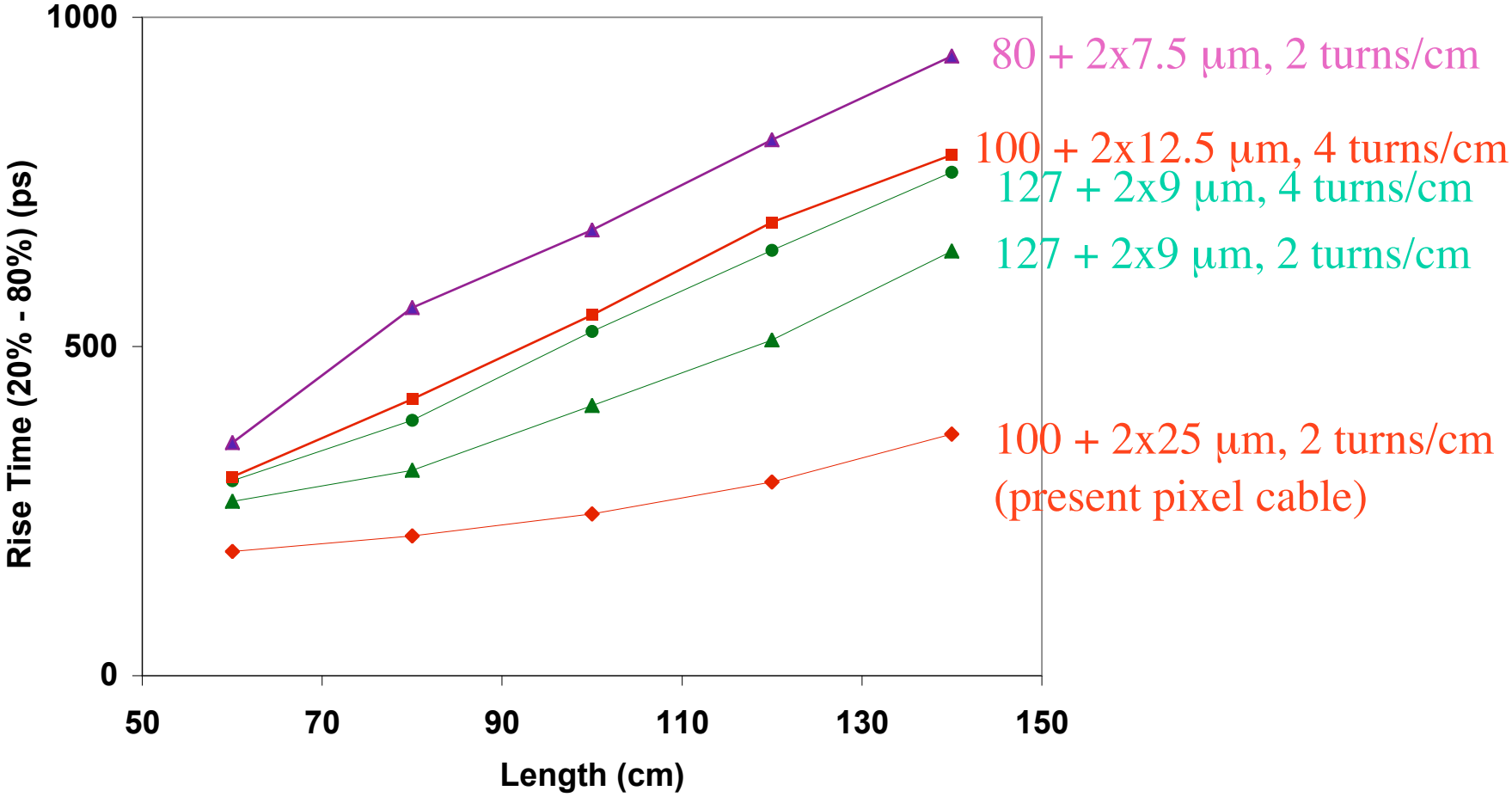
- upgrade based on current pixel opto-link architecture to take advantage of R&D effort and production experience?

⇨ can current pixel link infrastructure be operated at higher speed?

R&D Issues for SLHC

- bandwidth of ~ 1 Gb/s for pixel module is needed
  - can micro twisted pair transmit at this speed?
  - can fusion spliced SIMM/GRIN fiber transmit at this speed?
- can PIN/VCSEL arrays survive SLHC radiation dosage?
- upgraded version of driver/receiver chips are needed

Bandwidth of Micro Twisted Pairs

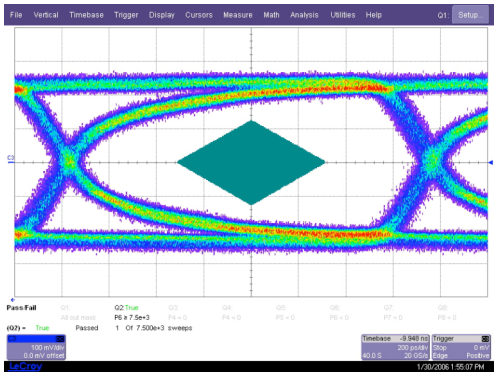


- current pixel cable is the best!
- thicker wires with 25 μm insulation have been ordered

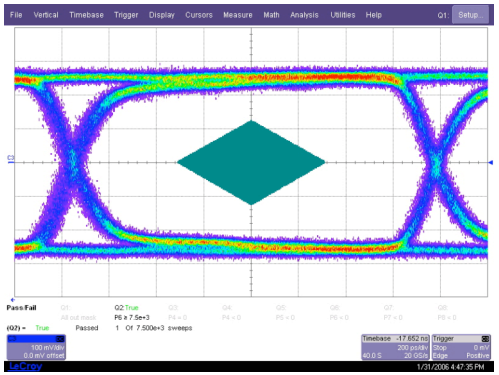
Eye Diagrams

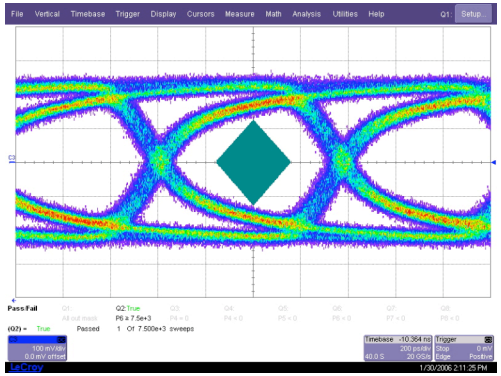
140 cm pixel cable

60 cm pixel cable

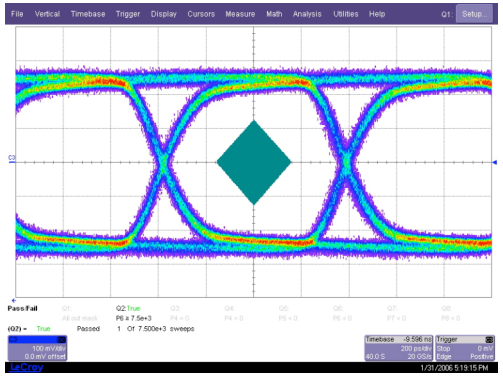


650 Mb/s





1.3 Gb/s

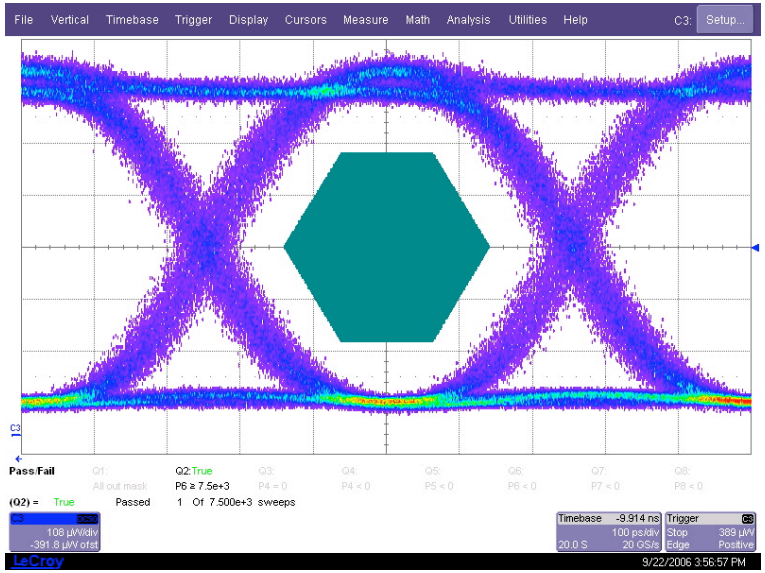


- transmission at 650 Mb/s is adequate
- transmission at 1.3 Gb/s may be acceptable

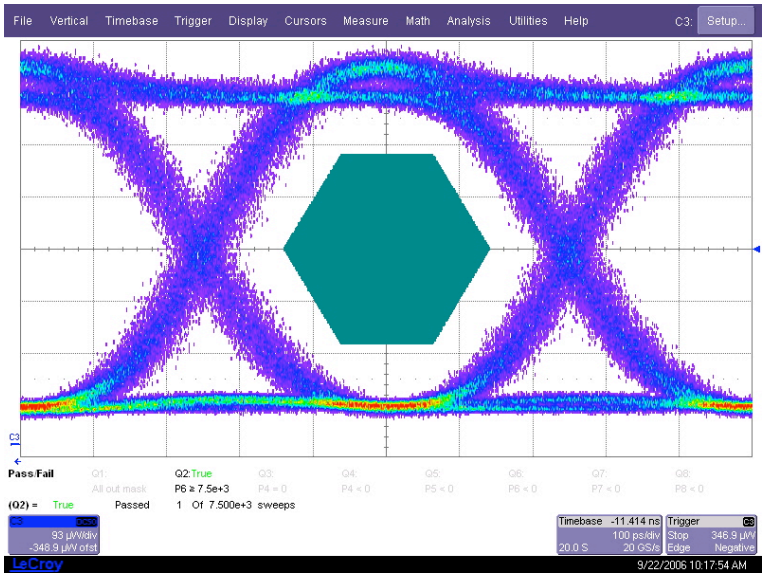
Bandwidth of Fusion Spliced Fiber

1 m GRIN fiber

8 + 80 m spliced SIMM/GRIN fiber



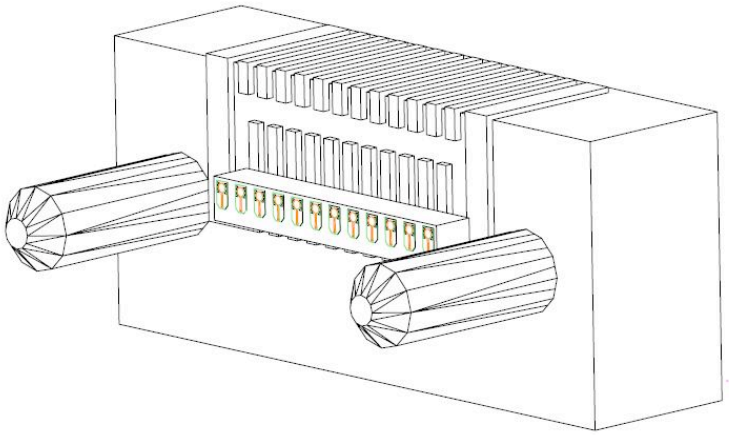
2 Gb/s

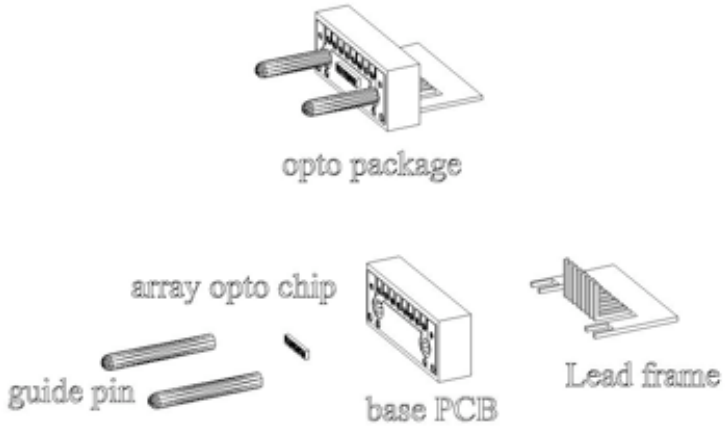


- transmission up to 2 Gb/s looks adequate

Opto-pack Development

- R&D plan assumed Taiwan will provide PIN/VCSEL packaging
  - micro soldering to 250 μm leads
  - Taiwan has not decided on whether to participate in SLHC
  - ⇨ Ohio State develops new opto-pack
    - uses BeO base with 3D traces for efficient heat removal
    - wire bond to driver/receiver chip instead



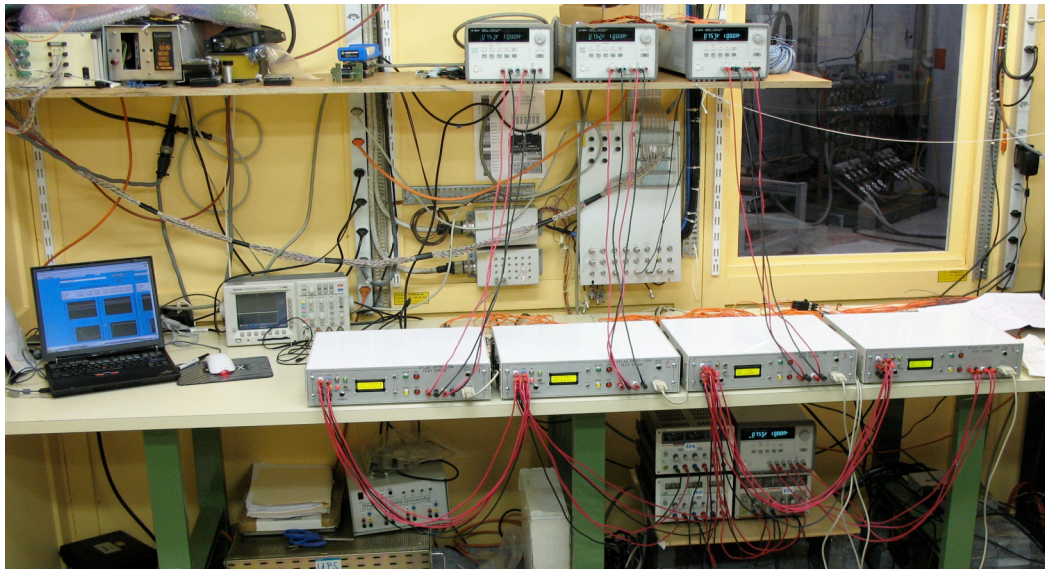


Opto-pack Development Status

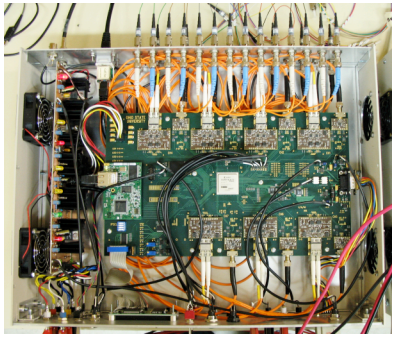
- opto-packs were prototyped from scrap alumina pieces
  - 4 VCSEL opto-packs were fabricated with good coupled power
  - ⇨ proof of principle
- 1st prototype with BeO substrate ordered in Spring 06
  - ~20 VCSEL/PIN opto-packs were fabricated
  - all VCSEL opto-packs have good coupled power
- 2nd prototype with small improvement recently ordered

Opto-Link Test System

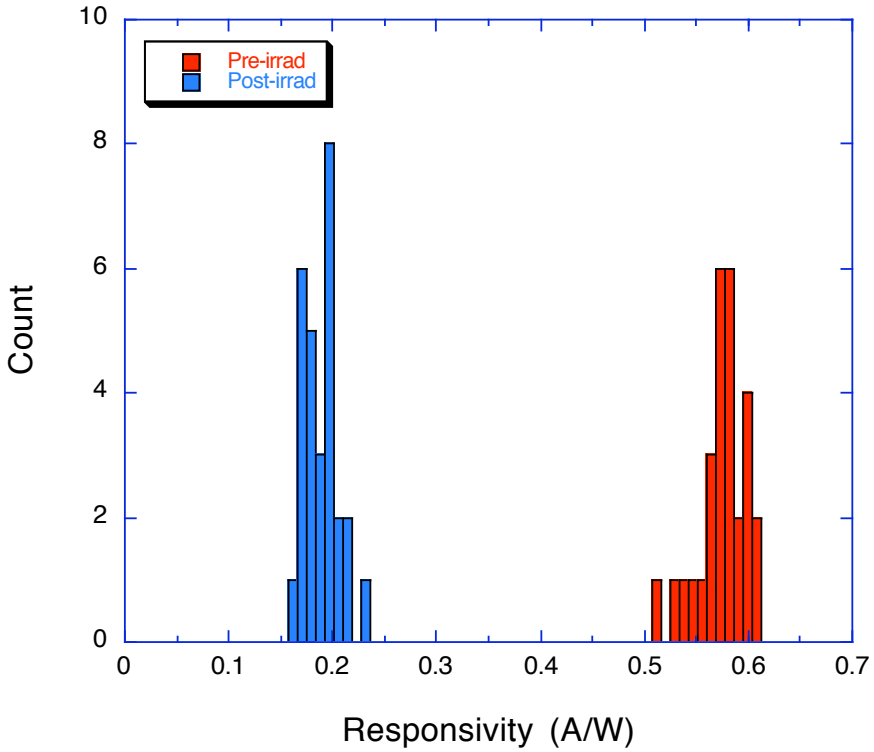
- a test system to evaluate VCSEL/PIN opto-packs and driver/receiver chips has been developed
  - system can be used in lab and irradiation
- system was used in summer 2006 irradiation
  - system was distributed to Oklahoma and Oklahoma State



CERN irradiation setup

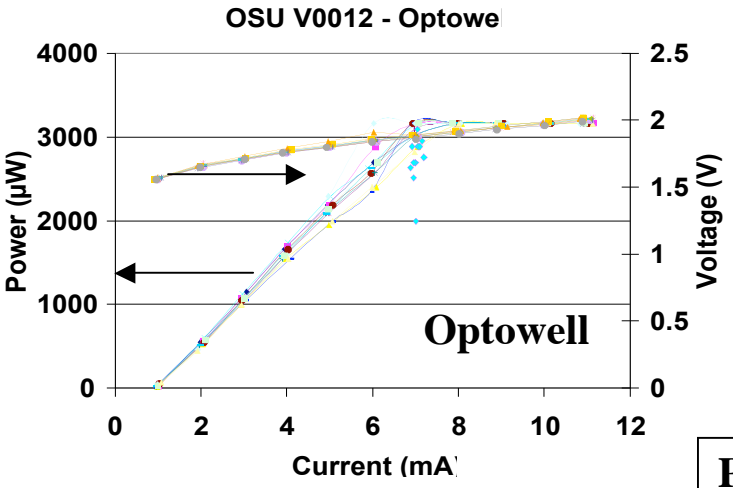


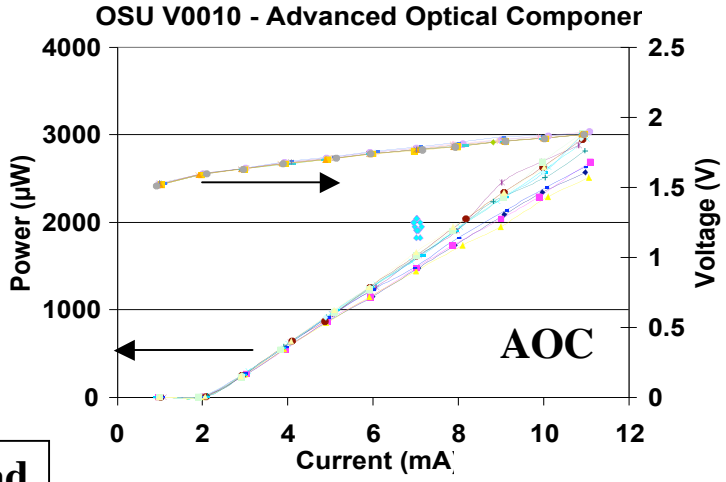
PIN Responsivity



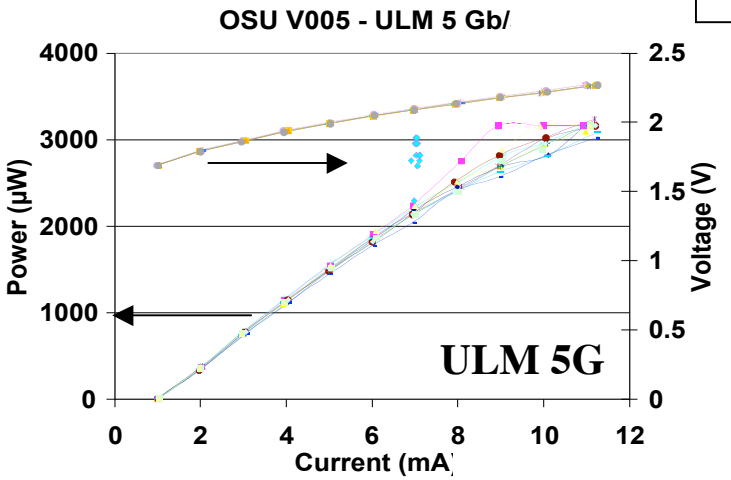
- silicon PIN responsivity decreases by ~65% after SLHC dosage
- lifetime studies of irradiated PIN in progress at Oklahoma
- will irradiate GaAs PIN arrays from 3 vendors in summer 2007

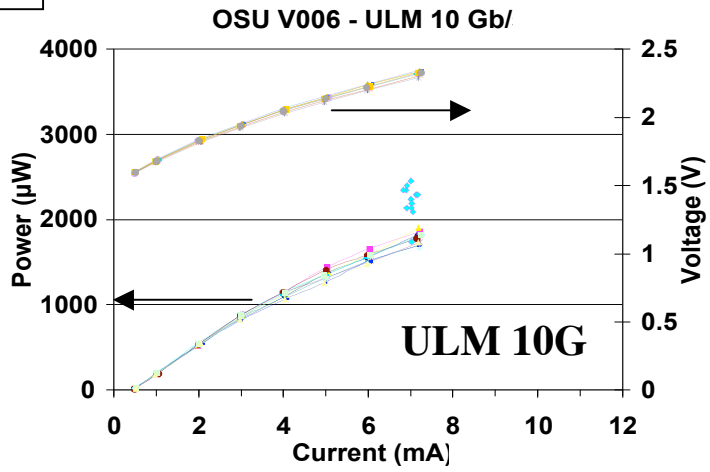
VCSEL LIV Characteristics





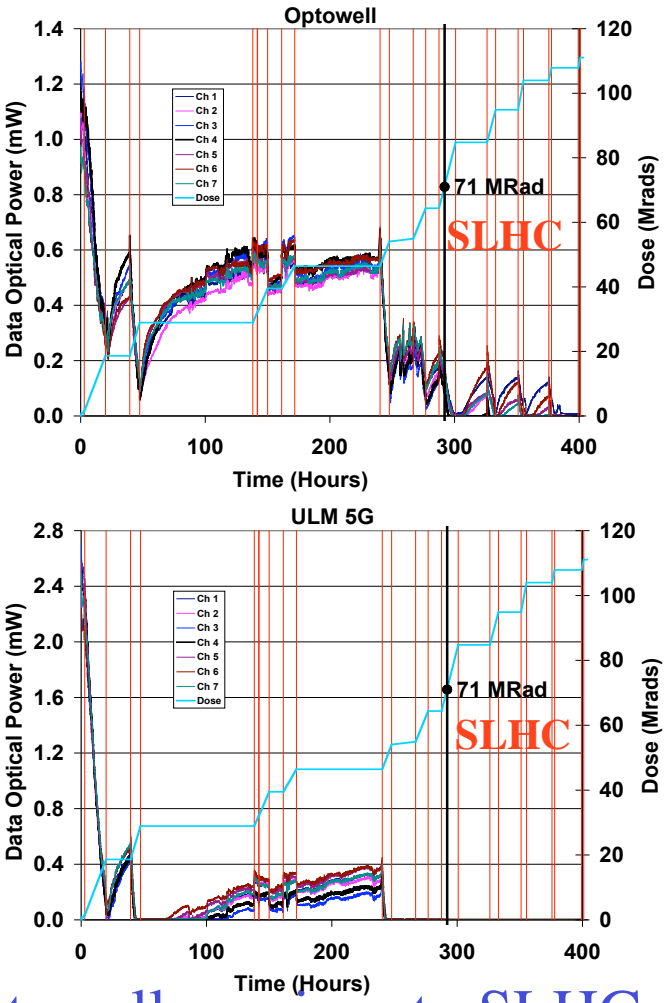
Pre-irrad

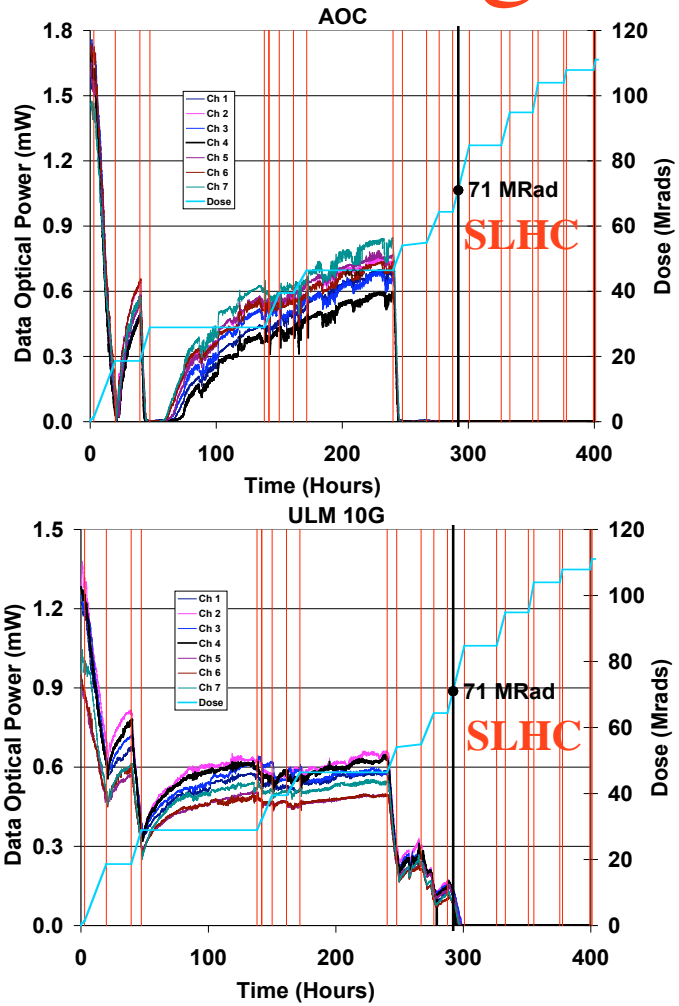




- ULM requires higher voltage to operate
- all arrays have very good optical power

VCSEL Power vs Dosage





- Optowell survives to SLHC dosage
- more VCSEL might survive with more annealing during irradiation

Summary

- micro twisted-pair cable of current ATLAS pixel detector can be used for transmission up to 1 Gb/s
- fusion spliced SIMM/GRIN fiber can transmit up to 2 Gb/s
- PIN responsivity decreases by 65% after SLHC dosage
- Optowell VCSEL survives SLHC dosage
- ⇨ current opto-link architecture satisfies SLHC requirements as a possible upgrade option

Driver/Receiver Chips

- VDC converted from 0.25 to 0.13 μm
  - can operate up to 2 Gb/s
- conversion of DORIC in progress
- plan to collaborate with developers of GBT driver/receiver chips

FY08 Plans

- more irradiation of VCSEL/PIN candidates from 1-2 vendors identified in FY07 irradiation
- continue development of driver/receiver chips in collaboration with GBT project
- irradiation of driver/receiver chips

FY08 Budget

- Ohio State:
  - FY07: $140K
    - 0.25 FTE E-engineer, 0.5 FTE E-tech
    - $9K for cables/fibers, VCSEL/PIN, BeO, M&S, irrad travel
  - FY08: $184K
    - 0.5 FTE E-engineer, 0.5 FTE E-tech
    - $18K for cables/fibers, VCSEL/PIN, BeO, M&S, irrad travel
- Oklahoma State:
  - FY08: $63K
    - grad. student, 0.5 FTE E-tech
- Oklahoma :
  - FY08: $29K
    - 0.5 EE-grad. student