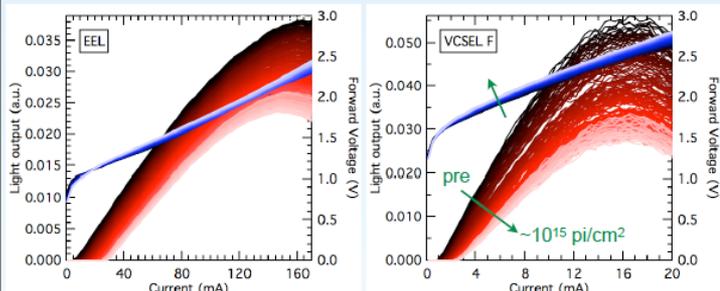


Optoelectronics Working Group Short Summary

- 1. Active Opto Devices: have we reached their radiation tolerance limits?
 - Jan Troska
- 2. Opto Packaging: how much can we do ourselves
 - Tony Weidberg
- 3. Opto modules: where can we safely use COTS?
 - Annie Xiang
- 4. Opto ASICs: Will we have 10G home-designed arrays?
 - Kock Kiam Gan

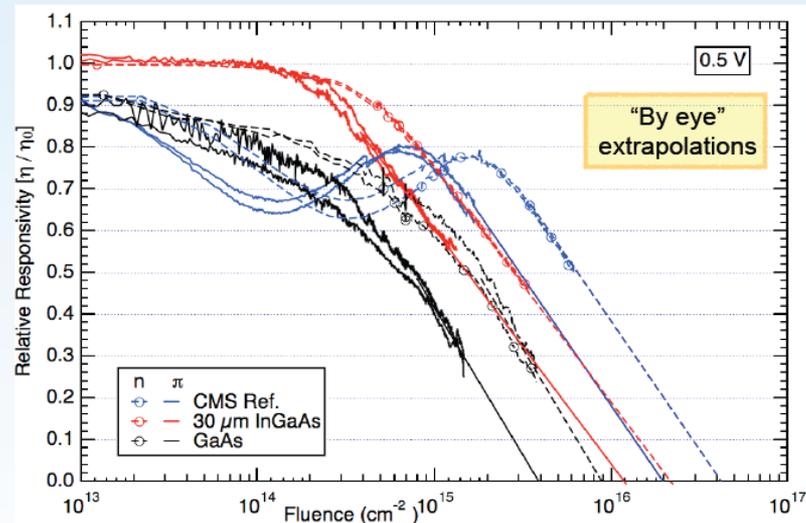
1. Active Opto Devices: have we reached their radiation tolerance limits?

Lasers



- Useable up to $<10^{16}$ p/cm²
- OK for HL-LHC strip-trackers
 - Not for pixel trackers
- Similar conclusions expected from different devices in same material systems

Impact of PD Responsivity loss



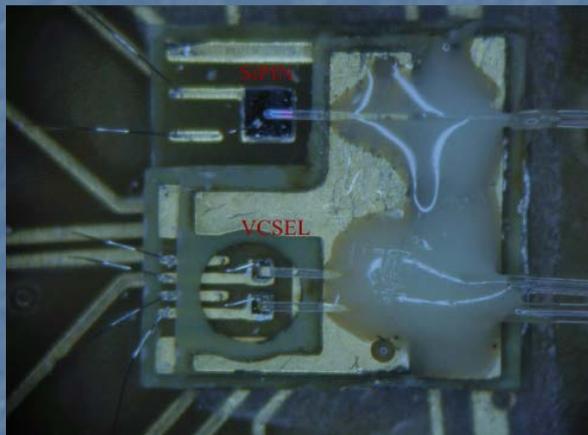
1. Active Opto Devices: have we reached their radiation tolerance limits?

- YES
- What do we do beyond 10^{16} p/cm²
 - Move opto away
 - Investigate new materials (quantum dots, Si, ...)
 - Introduce electronic mitigation schemes at backend
- No need to do better than the sensor

Tony Weidberg

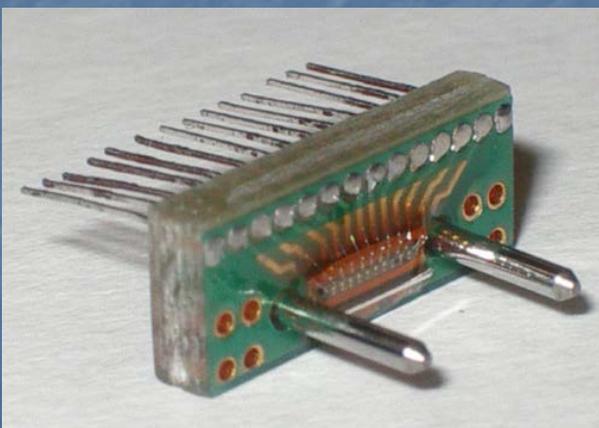
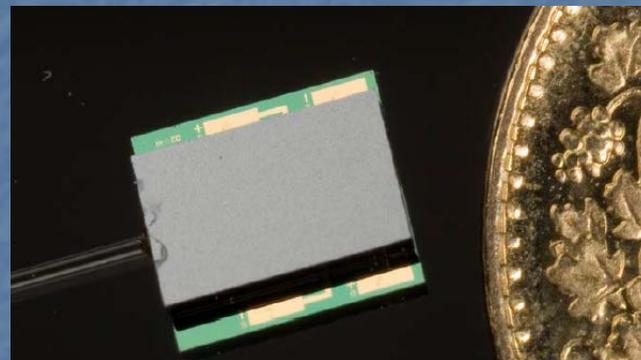
2. Opto Packaging: how much can we do ourselves? 1/3

Atlas SCT

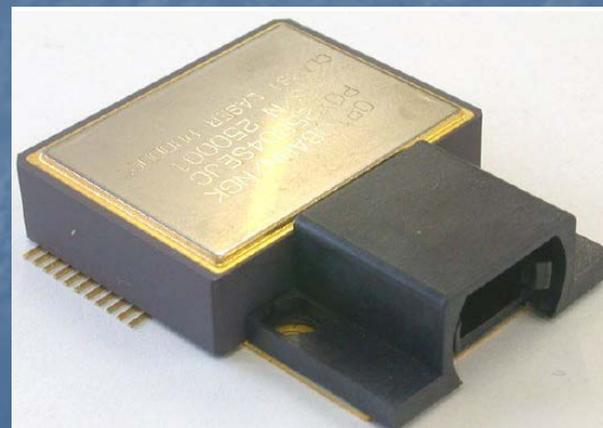


Front-End

CMS Tk



Back-End

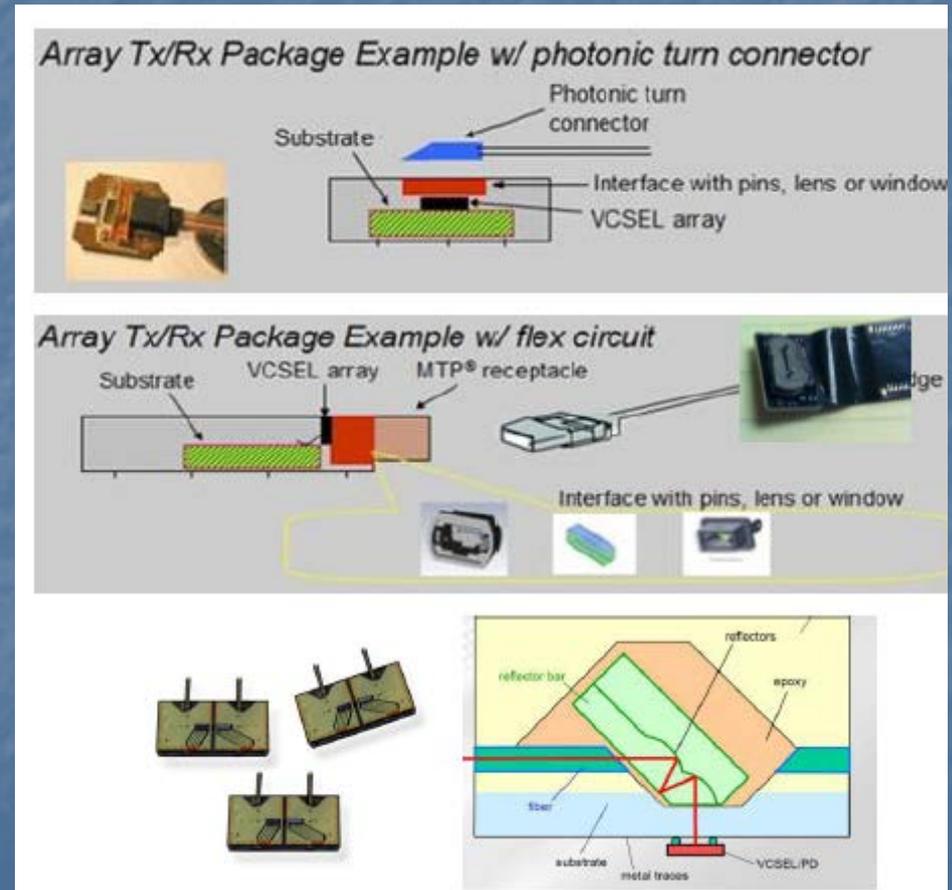
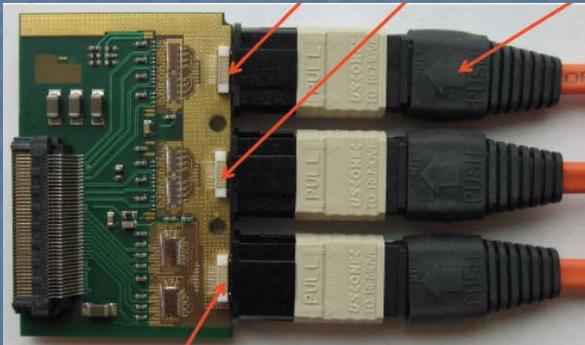


2. Opto Packaging: how much can we do ourselves? 2/3

- Back-End opto should be COTS
- Front-End constraints go beyond COTS specs
 - magnetic field tolerance, radiation resistance, low mass, *small footprint*, etc.
 - Customization is necessary, but the devil lies in the details (ESD, Hermeticity, CTE mismatch, etc.)
 - COTS means more than a few prototypes from a boutique shop
 - Reliability data must be available for the original product
 - Robust qualification for our environment is required
 - Limit customization to the necessary

2. Opto Packaging: how much can we do ourselves? 3/3

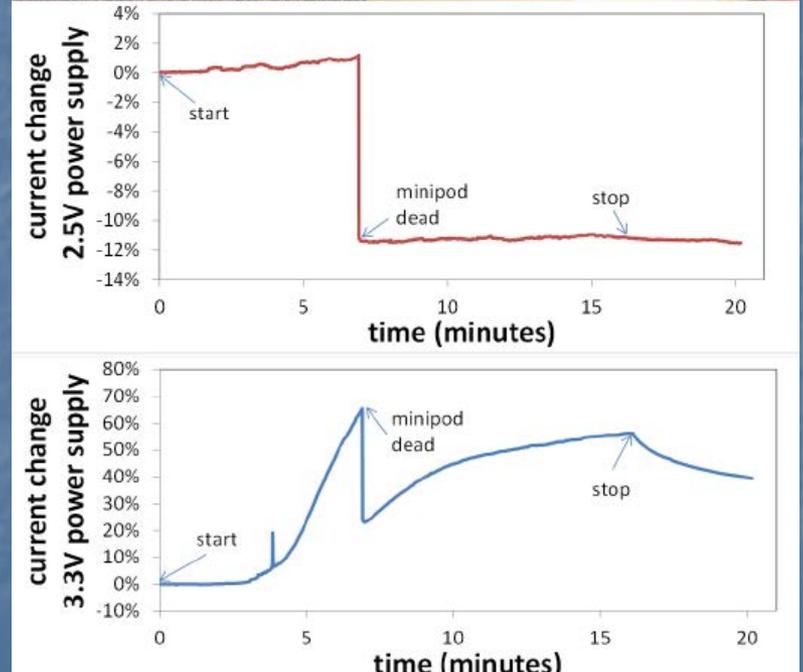
- Limit customization to the necessary
 - Subject to interpretation
 - Depends on environment
 - Several projects underway



3. Opto modules: where can we safely use COTS? 1/2

Annie Xiang

- Microcontroller fails first
- $O(10\text{kRad})$ TID
- Confirmed by several groups on several modules types



3. Opto modules: where can we safely use COTS? 2/2

- YES for $TID < 0(1\text{kRad})$
- After strict QA plan
- Taking SEU mitigation into consideration

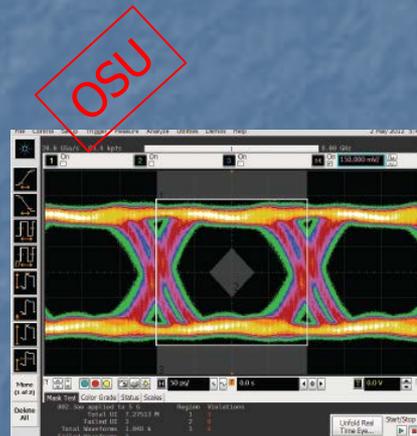
- Above $TID > 0(1\text{kRad})$
 - Use caution and sound engineering judgment
 - For instance: ATLAS TileCal
 - Si-Photonics COTS with bypassed microcontroller

4 Opto ASICs: Will we get 10G home-designed arrays? 1/2

K.K. Gan

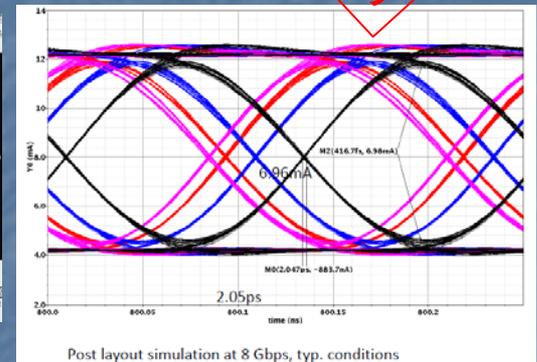
- From literature
 - 10G laser drivers demonstrated in:
 - 180 nm CMOS
 - 130 nm BiCMOS
 - 130 nm CMOS
 - 90 nm CMOS...

- TWEPP-12
 - 5G demonstrated
 - 8-10G announced



Array VCSEL

SMU



INFN



Single channel VCSEL & EEL

4. Opto ASICs: Will we get 10G home-designed arrays? 2/2

- Probably yes
 - Single channel and arrays
 - Final operating bitrate TBD
- Demand for arrays is $o(1000\text{pcs})$
 - Too small to justify concurrent developments

Summary of the summary

a personal view

- Wisdom is emerging



- We are (still) having fun



- Let's meet again next year and review progress
 - New technologies, new packages, new designs