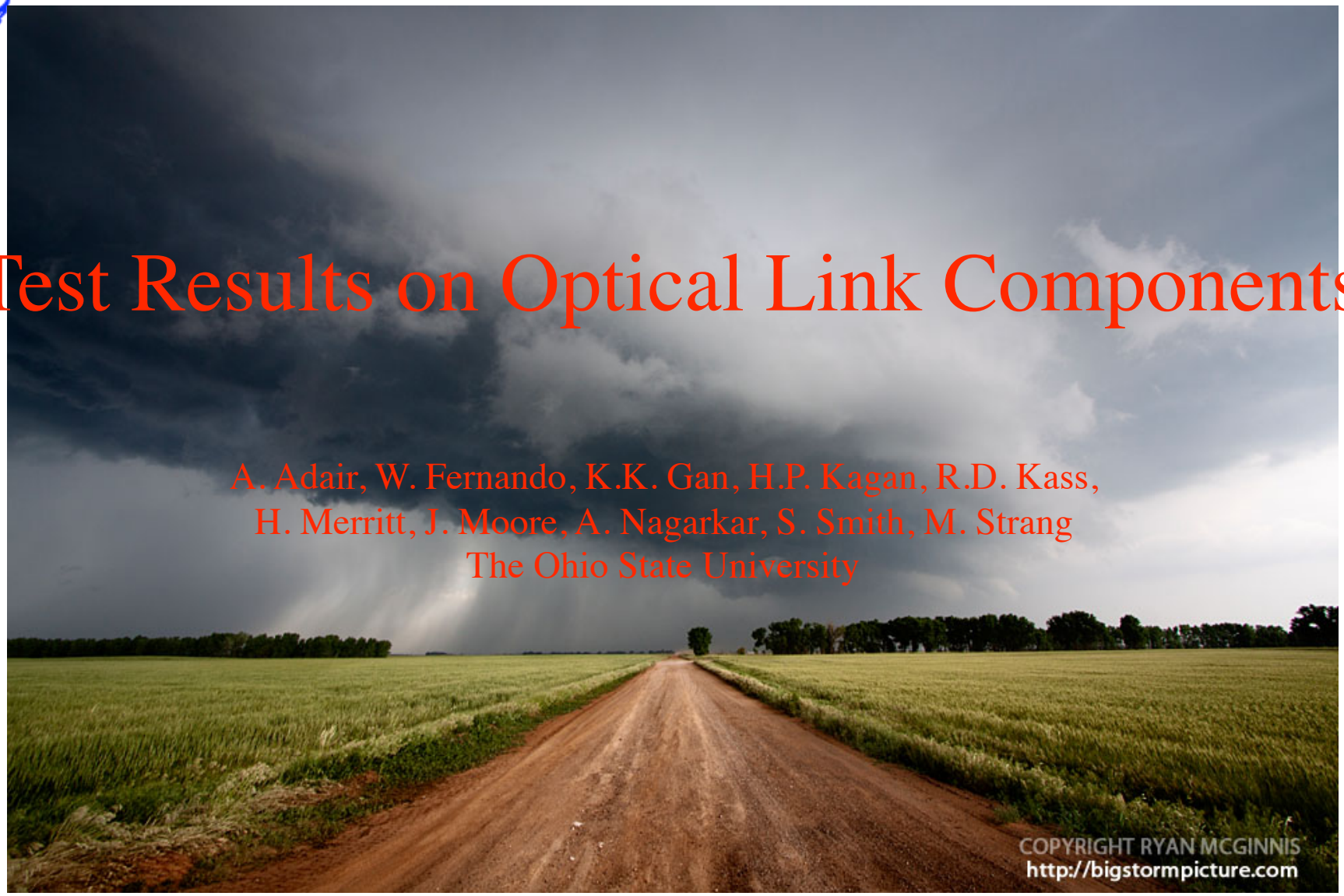
Test Results on Optical Link Components



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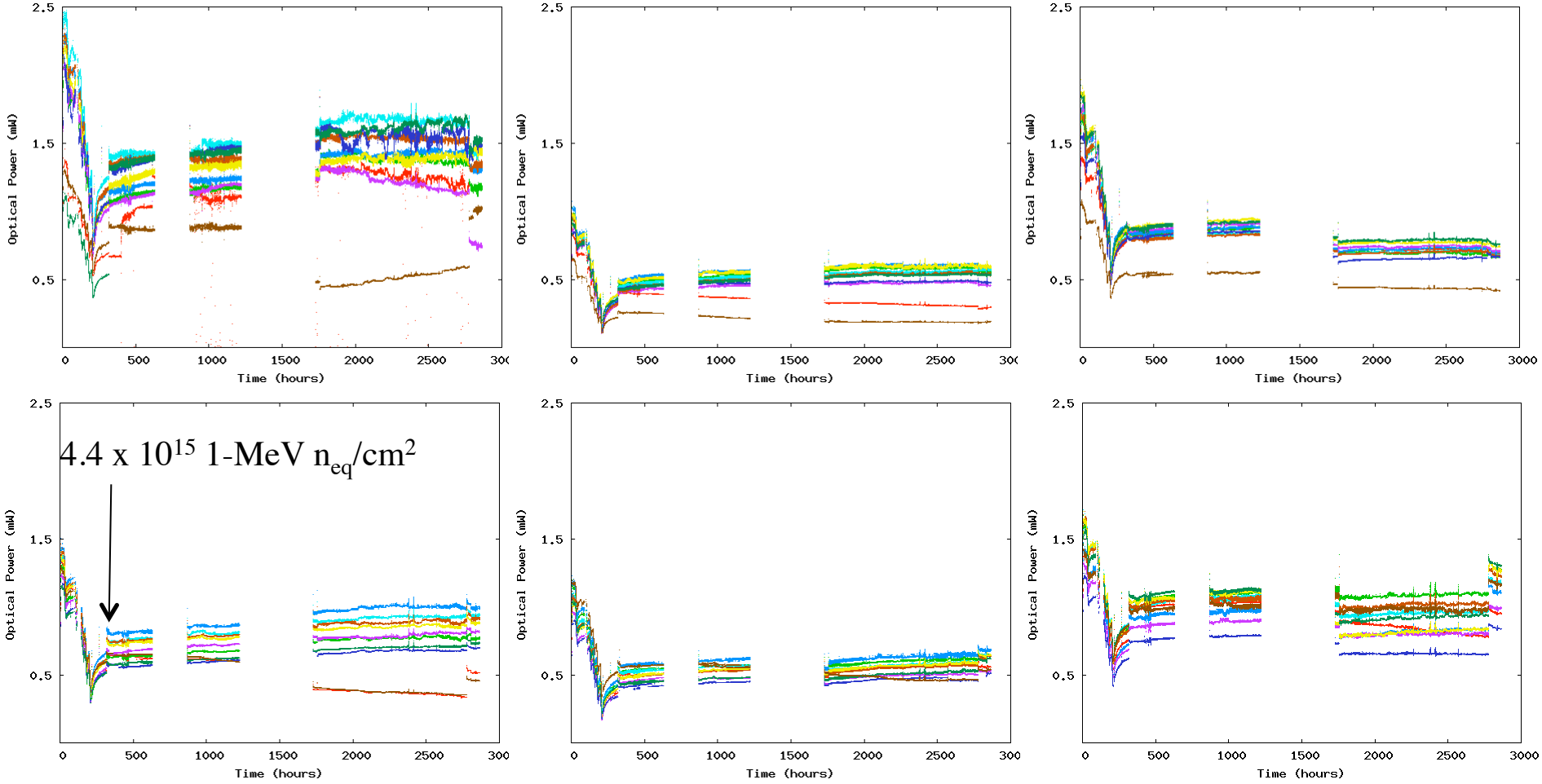
Outline

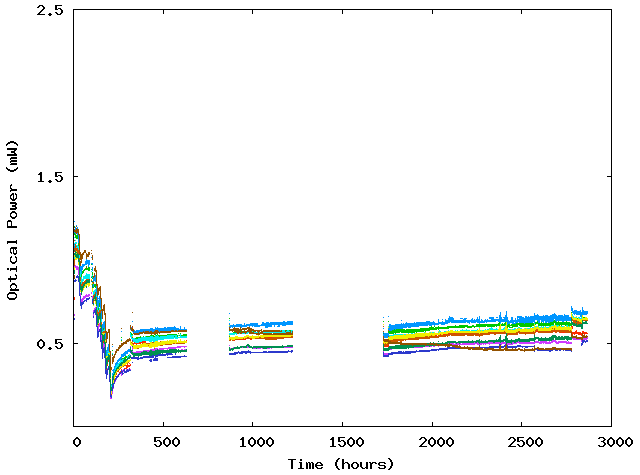
- Analysis of annealed VCSELs after irradiation
- Investigation of Optowell PINs leakage current problem
- Gathering storm on opto-boards of current pixel detector
- Summary

AOC 10 Gb/s VCSEL

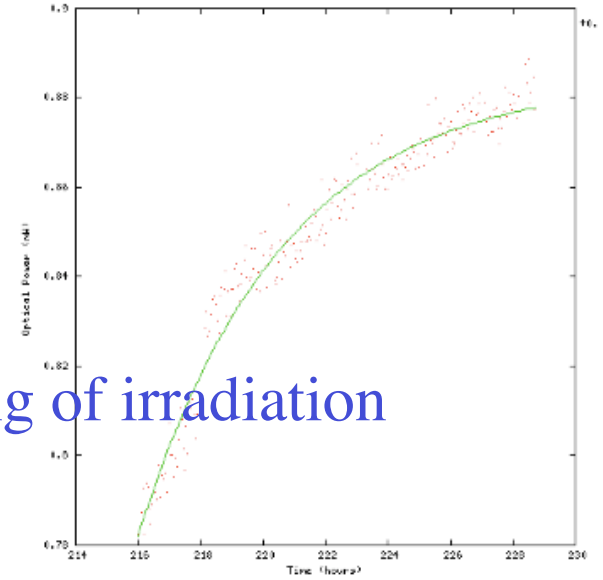


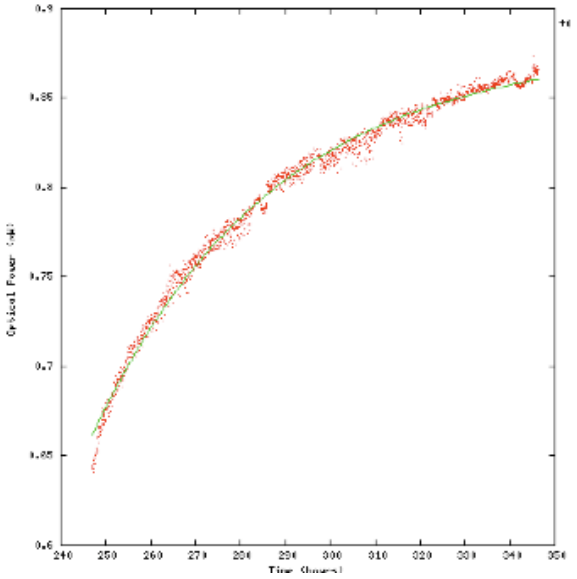
- Reasonable optical power for 6 arrays irradiated

Power Recovery Time vs Dosage



Near end of irradiation
$\tau \sim 40$ hours

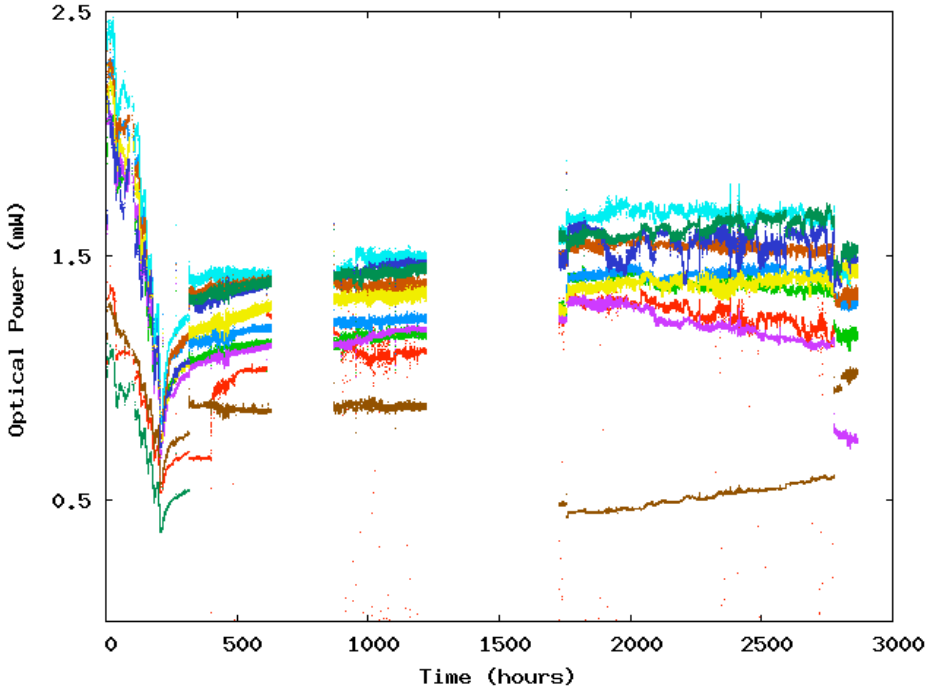




Near beginning of irradiation
$\tau \sim 4.6$ hours

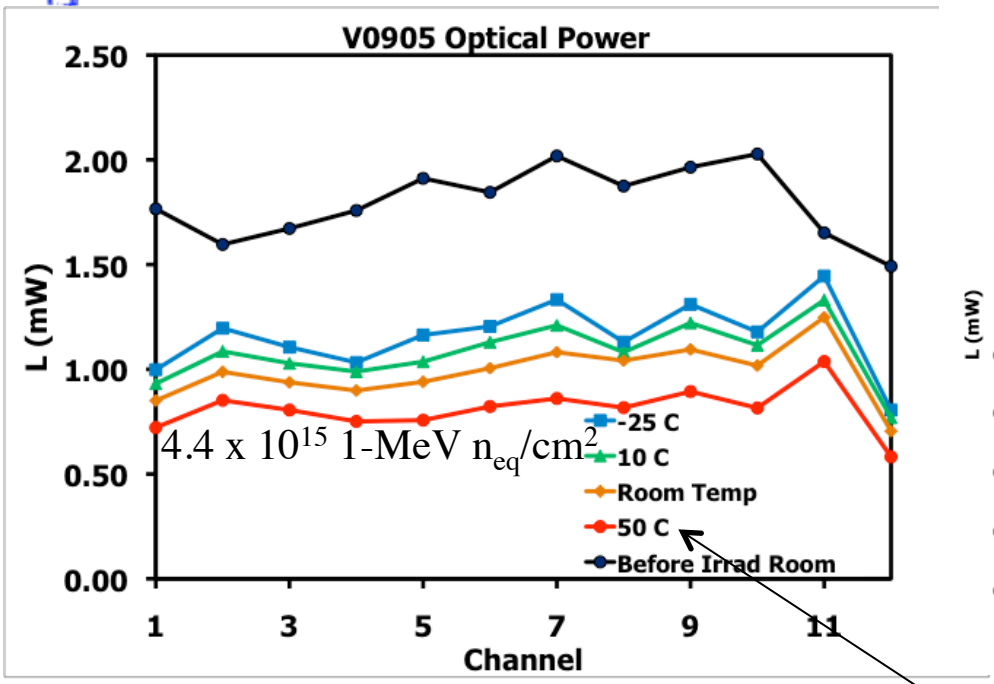
- Fit power vs time during annealing to exponential function
  - ⇨ recovery time increases with dosage
  - do not fully regain the lost power

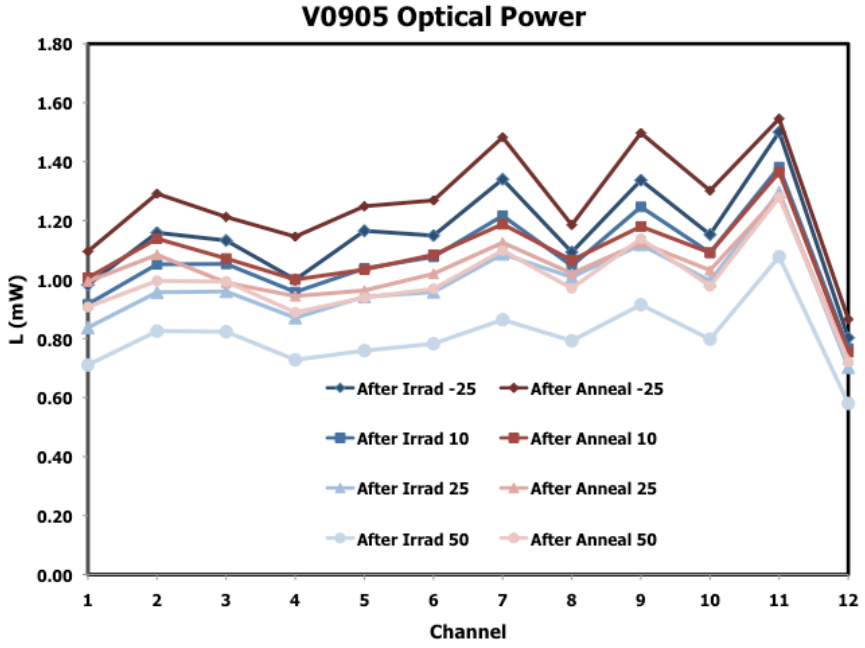
AOC 10 Gb/s VCSEL



- One channel produces no power
  - ⇨ need further investigation
- Power of several channels decrease with time
  - ⇨ need further investigation
- Plan to irradiate a sample of 20 arrays in August 2010

VCSEL Power vs Temperature





Ambient temperature
VCSEL temperature is 8 C higher

- Cooler VCSEL produces more optical power
  - Same characteristic after irradiation and annealing

PIN Leakage Current Problem

- Three out of 20 irradiated Optowell PIN arrays are inoperable due to high leakage current
- Study of 7 unirradiated arrays:
  - temperature cycling at 0, 20, and 50 C up to 20 V bias voltage
    - ⇨ no problem
  - temperature cycling at 0, 20, and 50 C up to 40 V bias voltage
    - ⇨ no problem
  - temperature cycling at -25, 0, 20, and 50 C up to 40 V bias voltage is in progress
- No response from vendor regarding the problem
- Purchased 20 ULM arrays for irradiation in August 2010

TX Problem

	Days after first	Pixel Deaths	Day after first	SCT Deaths	
	0d	1	-27d	1	
	3d	2	45d	2	
	16d	3	48d	3	
	26d	4	48d	4	
	33d	5	54d	5	
	39d	6	58d	6	
	40d	7	61d	7	
	42d	8	65d	8	
	47d	9	66d	9	
	47d	10	66d	10	
	49d	11	68d	11	
	51d	12	68d	12	
	52d	13		13	
	54d	14		14	
	56d	15		15	
	58d	16		16	
	58d	17		17	
	58d	18		18	
	62d	19		19	
	64d	20		20	
	65d	21		21	
	65d	22		22	
	66d	23		23	
		24		24	
		25		25	
		26		26	
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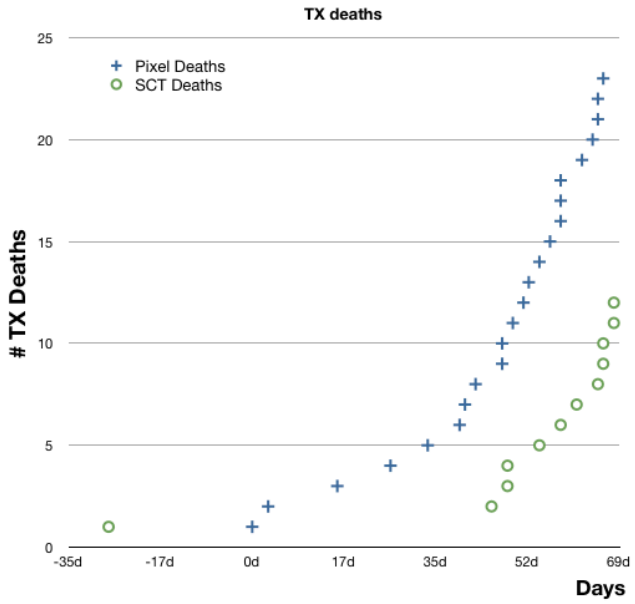
		32		32	
		33		33	



- VCSEL arrays on off-detector TX of Pixel and SCT are dying at alarming rate in 2008
  - ⇨ replacement of all TXs in 2009
  - ◆ new TXs starts to die again in April 2010

Implication for IBL Opto-board

- VCSEL arrays on opto-boards of current pixel detector are identical to TX arrays
  - hypothesis: failure starts after some livetime
    - ⇨ expect failure on opto-board VCSEL arrays starting in ~2015
    - ⇨ may need to extract pixel package to replace all opto-boards
- Current plan for IBL opto-boards
  - use AOC 10 Gb/s VCSEL arrays instead of Truelight arrays
  - use BeO optical package instead of FR4 for heat removal
  - need to understand the current VCSEL problem to see to see if the above changes are sufficient
  - if opto-boards of current pixel detector need replacement
    - ⇨ will attempt to unify the design of all opto-boards

Summary

- VCSEL arrays have plenty of power after irradiation
  but there are two problems that need to be understood
  - will irradiate 20 AOC VCSEL arrays in August 2010
- 3 out of 20 Optowell PIN arrays broken
  - problem not yet understood
  - will irradiate 20 ULM PIN arrays in August 2010
- TX problem has major implication for current pixel detector and IBL
  - need to understand this problem to build reliable opto-links