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# **Validation of the GLAST Pre-production SSD -- Radiation Damage --**

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**Review of the GLAST SSD Specifications**



# Radiation Damage

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- **Radiation dose expected** : **1 krad / 5years**
- **x5 engineering margin** : **5 krad**
- **Our tests(x2 over requirement)** : **10 krad**
  
- **$^{60}\text{Co}$  gamma-ray irradiation at UCSC** : **10 krad**
- **$^{60}\text{Co}$  gamma-ray irradiation at Hiroshima** : **8 krad**



# Leakage Current

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- \* **150V bias voltage**
- \* **Temperature correction to 25 °C**



# Leakage Current

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## Specs

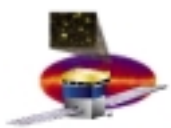
0 krad : average < 240nA ( 3.13nA/cm<sup>2</sup> )  
max < 800nA ( 10.4nA/cm<sup>2</sup> )

10 krad : < 9200nA ( 120nA/cm<sup>2</sup> )

## Results

0 krad : average ~ 230nA, max = 251nA

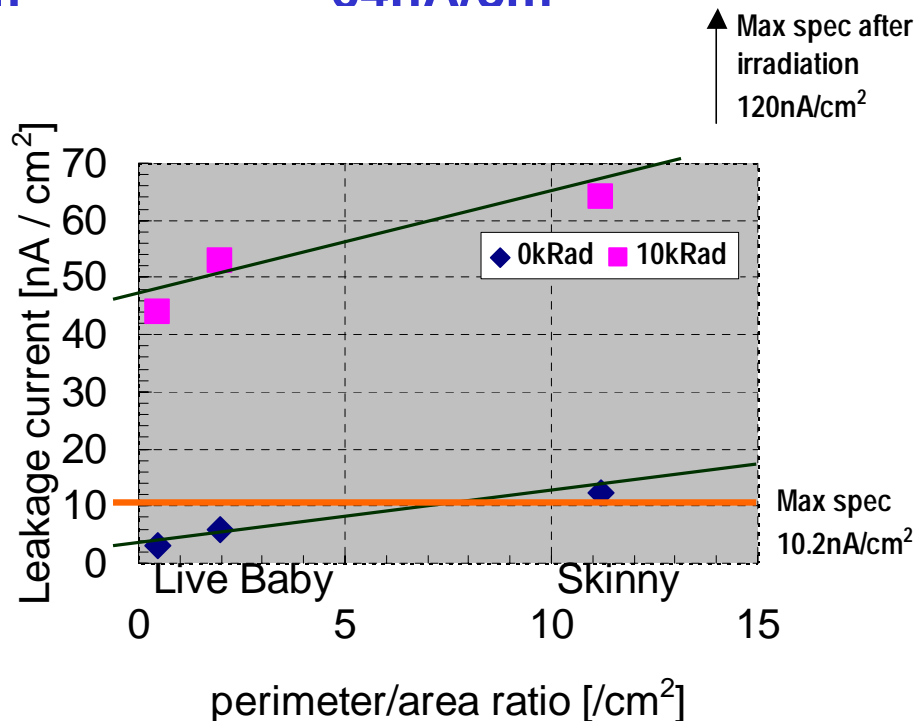
10 krad : 3360 nA



# Current/cm<sup>2</sup> Comparison

## Leakage current at 150V bias (corrected to 25 °C)

	<u>0 krad</u>	<u>10krad</u>
Live(76.7cm <sup>2</sup> )	3.0nA/cm <sup>2</sup>	44nA/cm <sup>2</sup>
Baby(4.82cm <sup>2</sup> )	5.9nA/cm <sup>2</sup>	53nA/cm <sup>2</sup>
Skinny(1.60cm <sup>2</sup> )	12.4nA/cm <sup>2</sup>	64nA/cm <sup>2</sup>





# Strip Capacitance

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Smaller total strip capacitance ( $C_{total}$ ) is favorable for lower readout noise

$$C_{total} = C_{inter-strip}(\text{all neighbor}) + C_{back-plane}$$

$$C_{inter-strip}(\text{all neighboring pair}) \\ = \underline{C_{inter-strip}(\text{one neighboring pair})} / 0.83$$

$$C_{back-plane} = 0.53 \text{ pF/cm}$$

We measured  $C_{inter-strip}(\text{one neighboring pair})$



# Strip Capacitance

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## Specs

0krad : < 1.5 pF/cm

10krad : < 1.6 pF/cm

## Results

0krad : 1.3 ~ 1.5 pF/cm (5.5~7.5 pF)

10krad : 1.2 ~ 1.3 pF/cm (4.7~5.8 pF)

( ) measured C\_inter-strip (one neighboring pair)



# Inter-strip Resistance

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## Strip isolation

### Specs

0 krad : > 1 G $\Omega$

10 krad : > 1 G $\Omega$

### Results

0 krad : ~ 1000 G $\Omega$

10 krad : ~ 1000 G $\Omega$





# Coupling Capacitance

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Bigger C coupling is better not to lose the signal charge

## Specs

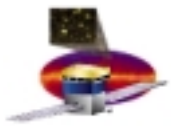
0krad : > 500 pF

10krad : > 500 pF

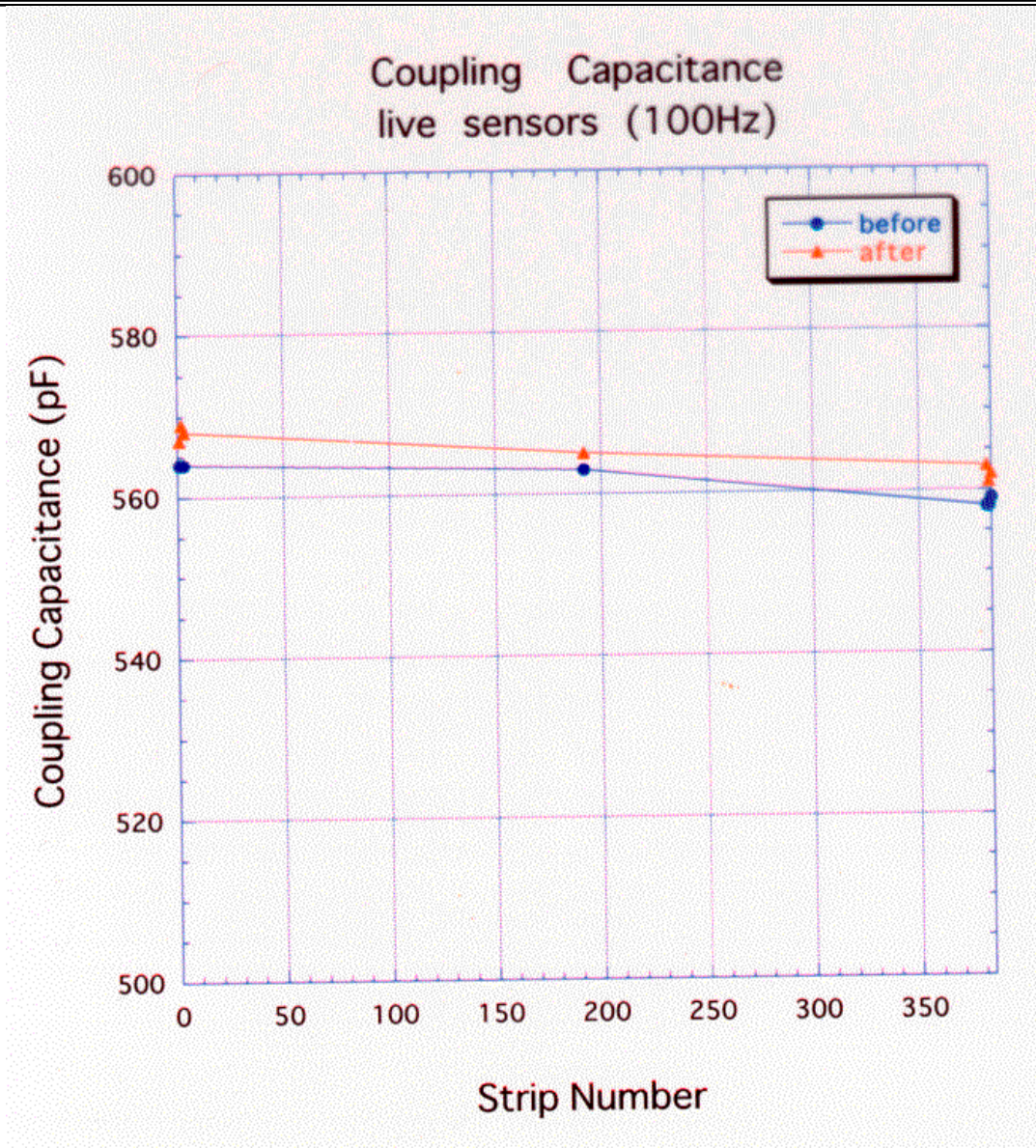
## Results

0krad : ~ 560 pF

10krad : ~ 565 pF



# Coupling Capacitance (Hiroshima)





# Summary

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**GLAST HPK pre-production detectors meet our specifications after 10krad gamma-ray irradiation on these parameters:**

**Leakage current**

**Inter-strip capacitance**

**Inter-strip resistance**

**Coupling capacitance**