Total Ionizing Dose Effects on Single Event Transients in Linear Bipolar Systems

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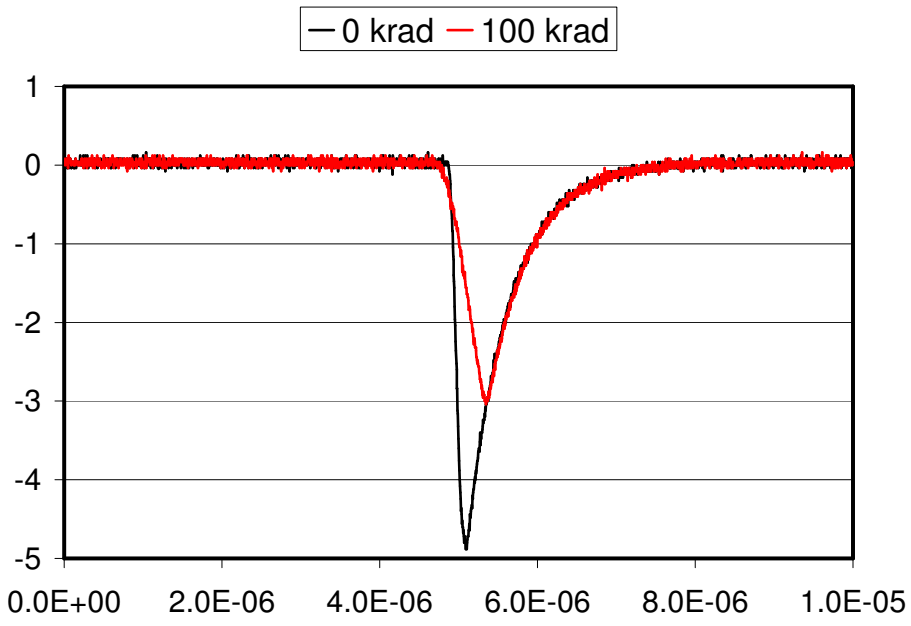
Introduction

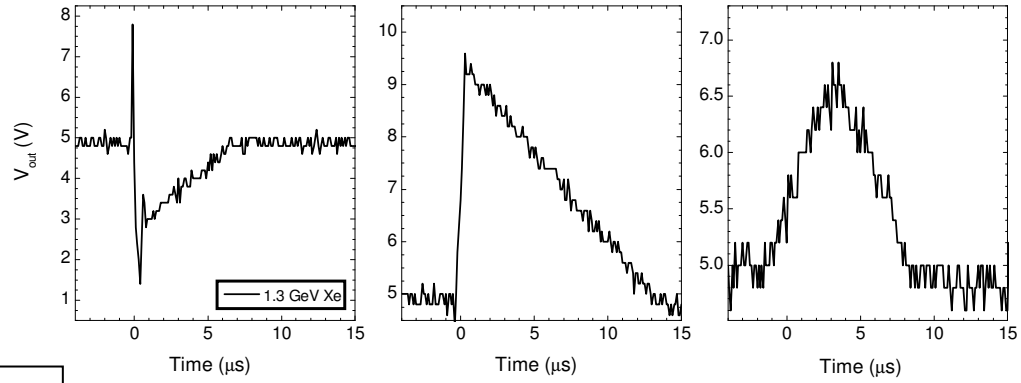
- Analog SETs (ASETs) can propagate through a system and cause a malfunction.
- Following radiation exposure, ASETs in LM139 become smaller ➔ System error rate decreases.



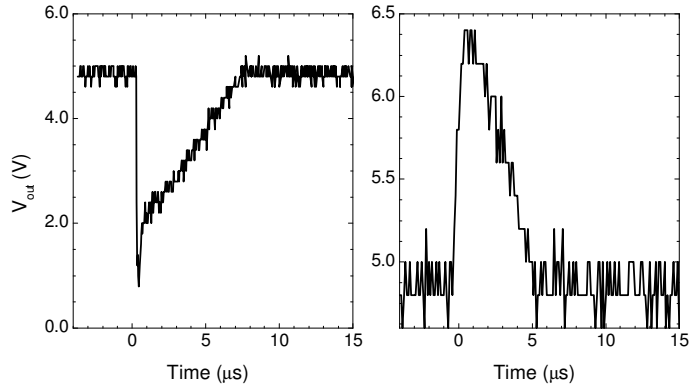
LM139
Voltage Comparator

Introduction

- LM124 is an op-amp with a much larger variety of SETs.

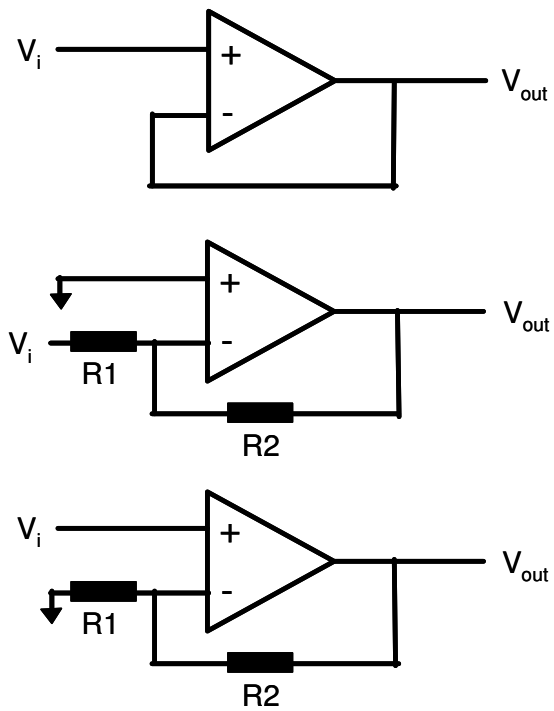


What happens to the SETs following TID irradiation?



LM124 Configuration

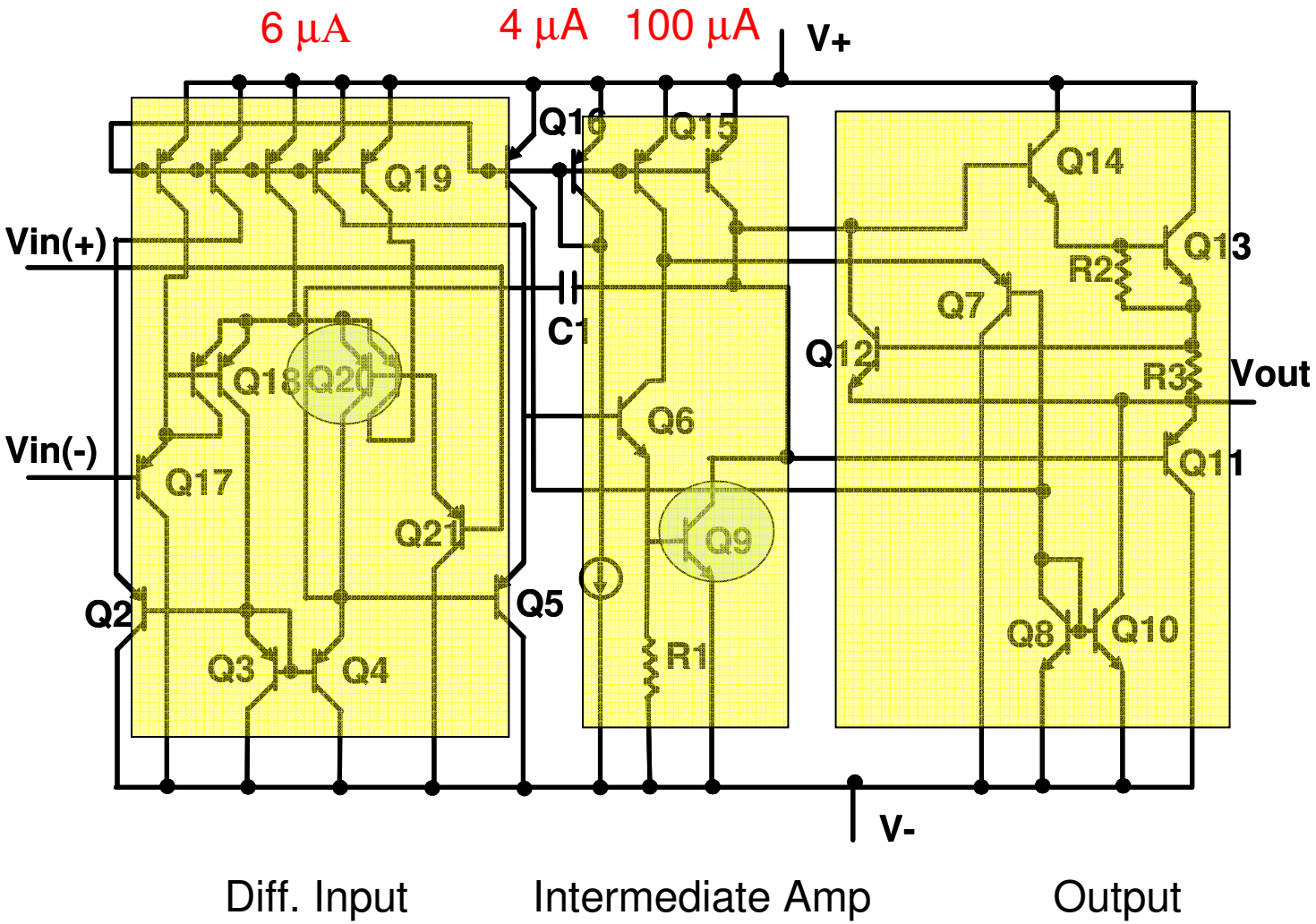
- LM124 is a quad op-amp. Configured in three ways: Voltage follower, Inverter, Non-Inverter.
- Irradiated to 150 krad(Si) under bias, i.e., V_{in} = 1V.



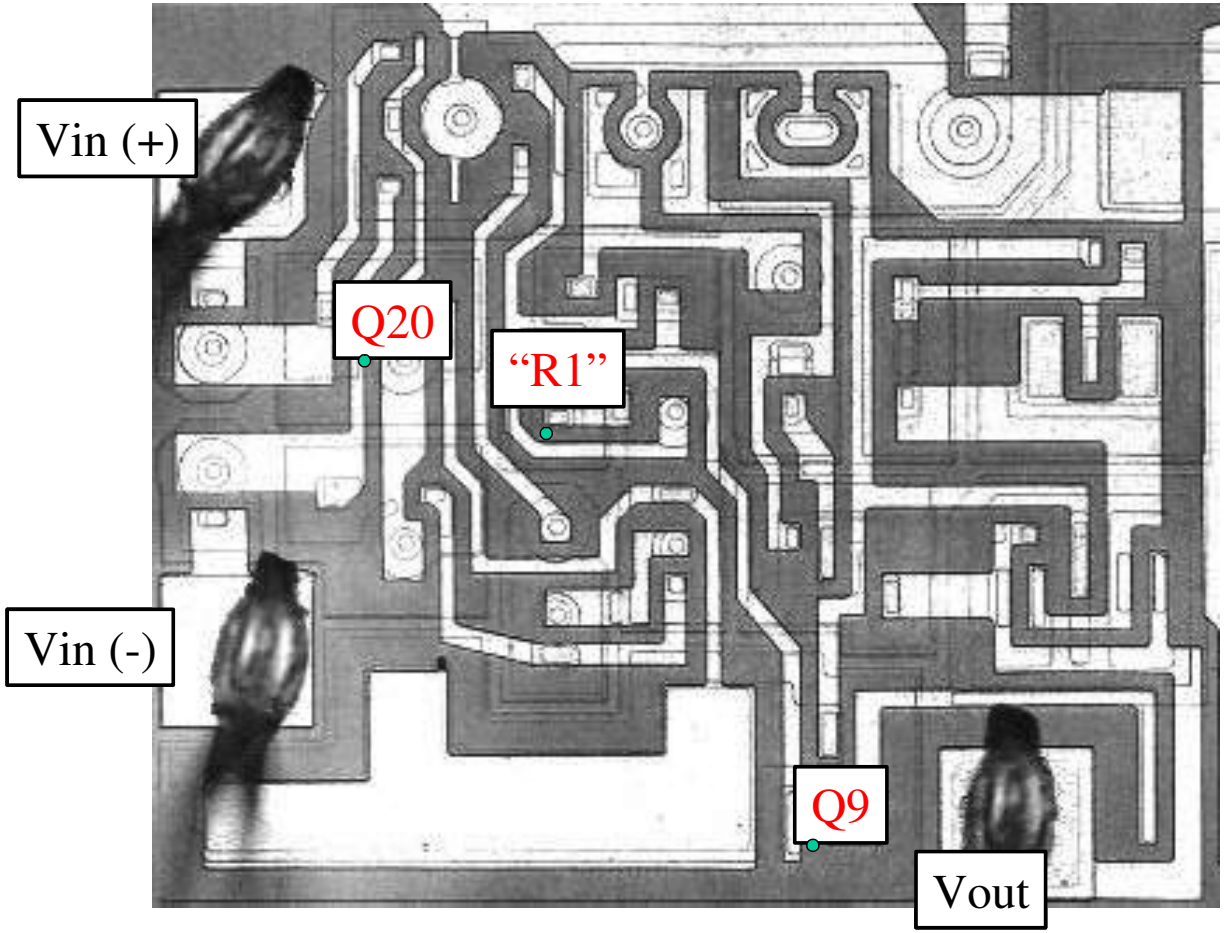
Radiation causes a reduction in transistor gain and a loss of transistor current drive.

Pulsed Laser Data

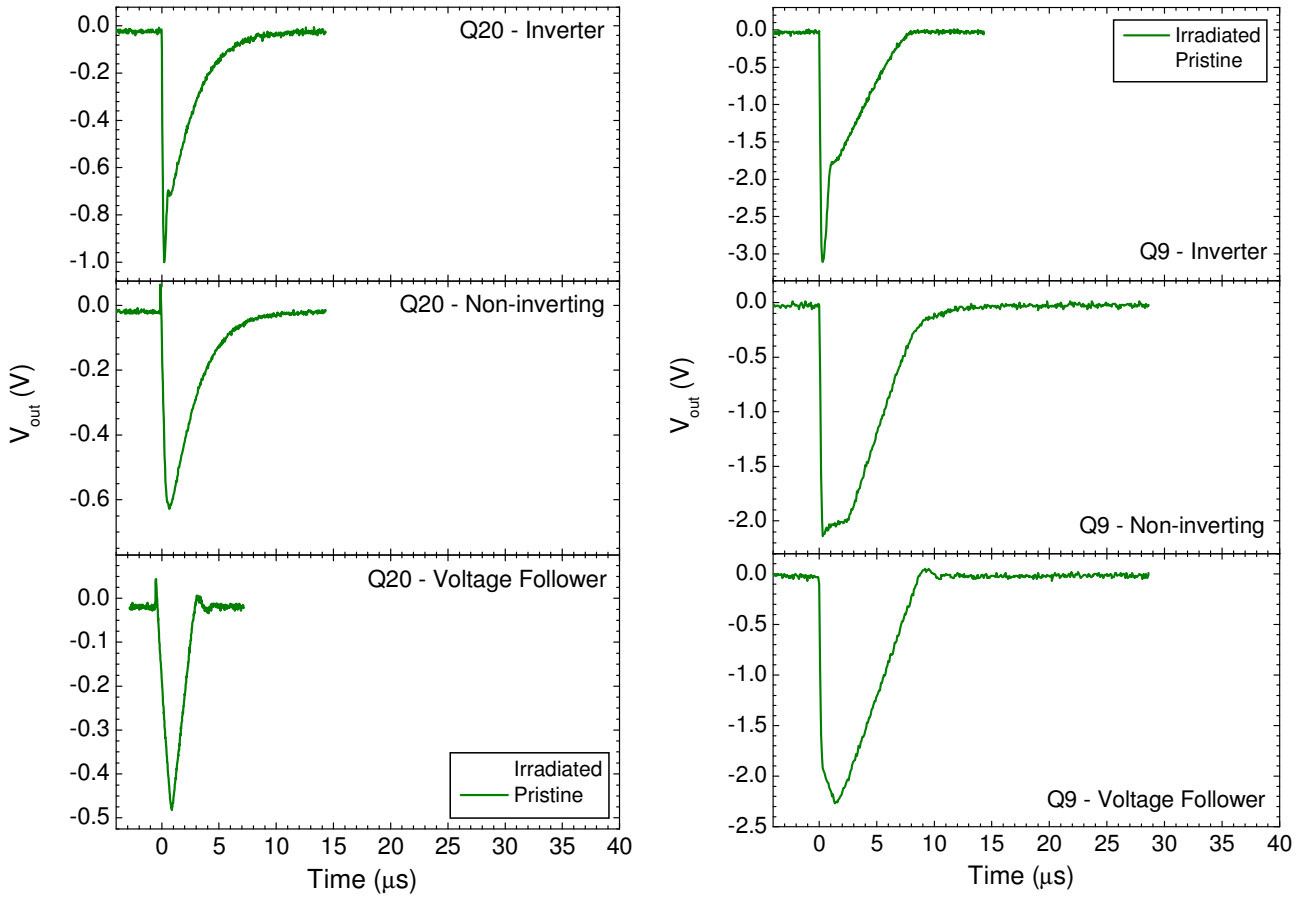
LM124 Circuit



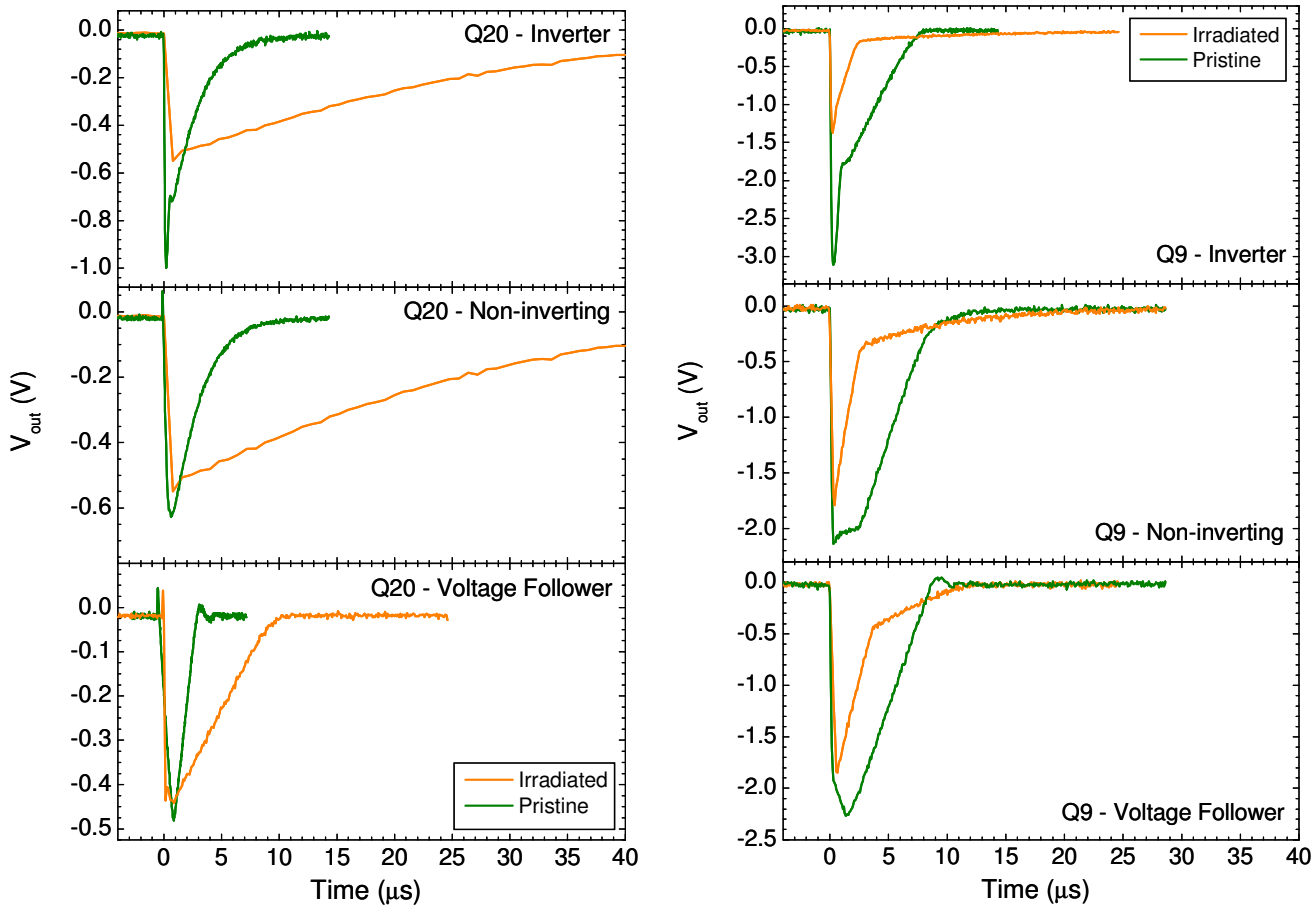
LM124 Photomicrograph



SETs in Pristine Device



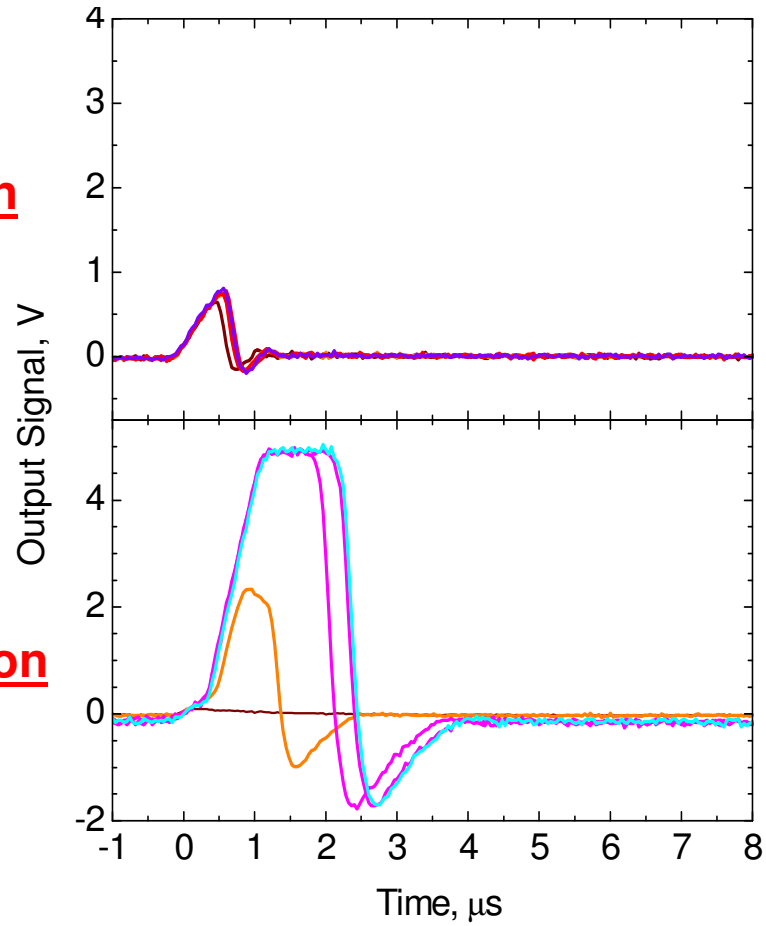
SETs Before and After Irradiation



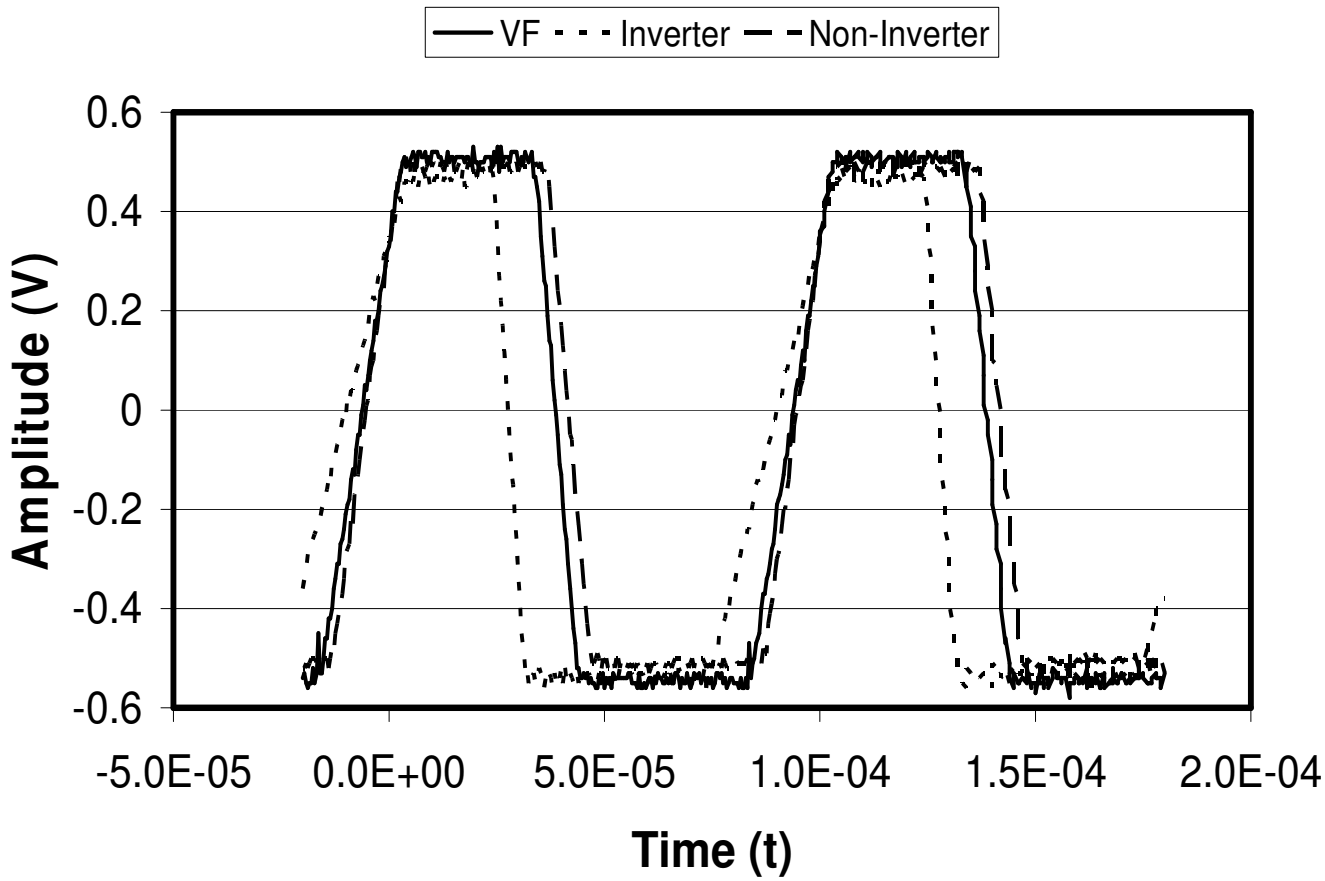
SETs in R1

After Irradiation

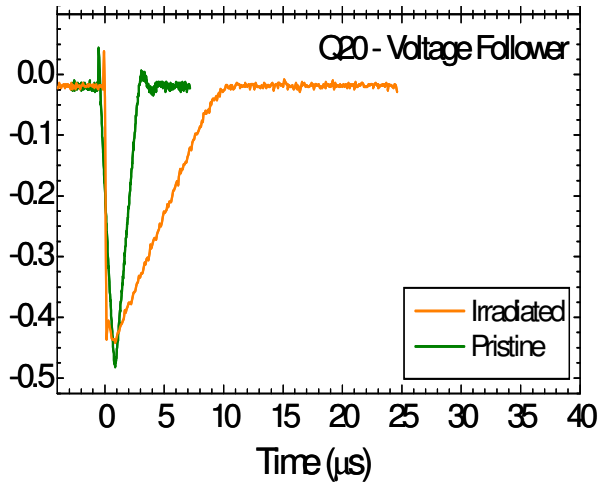
Before Irradiation

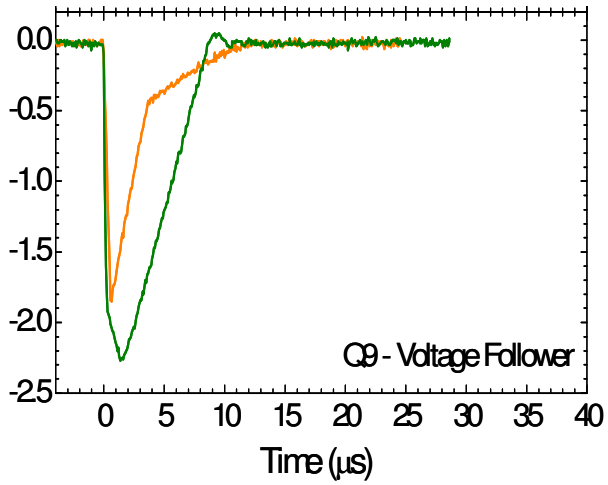


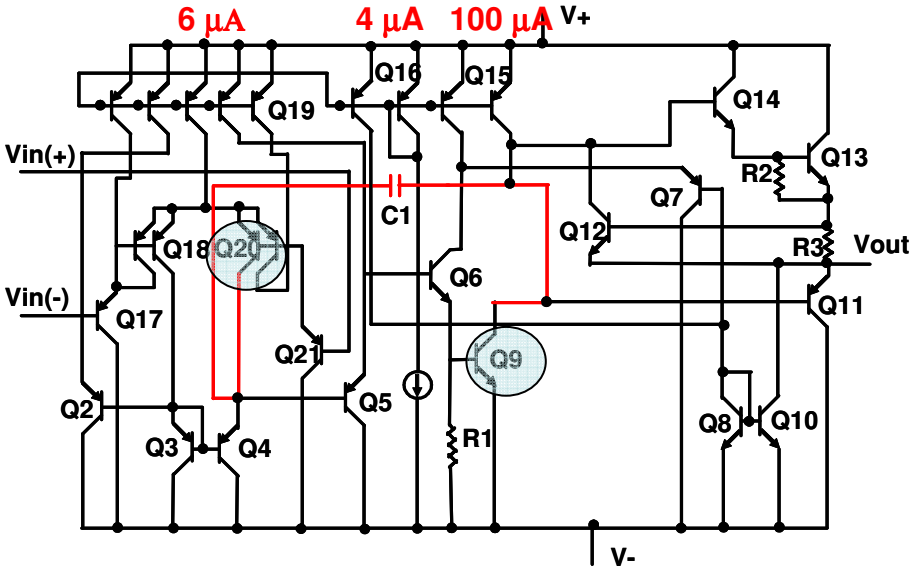
Slew Rate


VF
Inverter
Non-Inverter
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
Amplitude (V)
-5.0E-05
0.0E+00
5.0E-05
1.0E-04
1.5E-04
2.0E-04
Time (t)

Explanation for SETs on Q20 & Q9





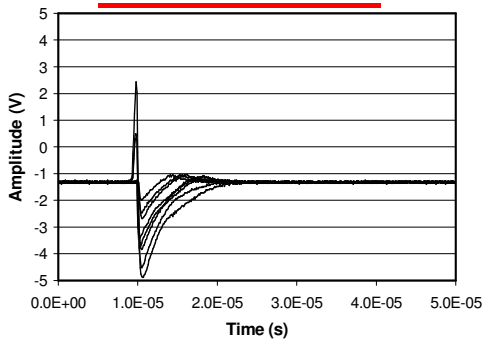


Heavy Ion Data

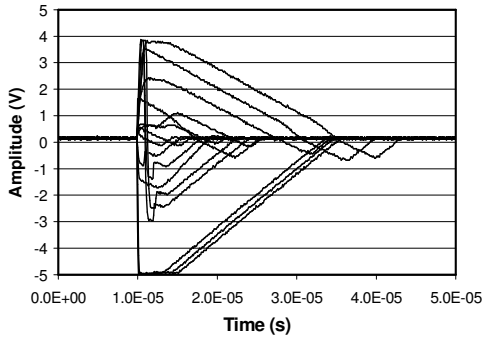
LET=54.8 MeV.cm^2/mg

Unirradiated

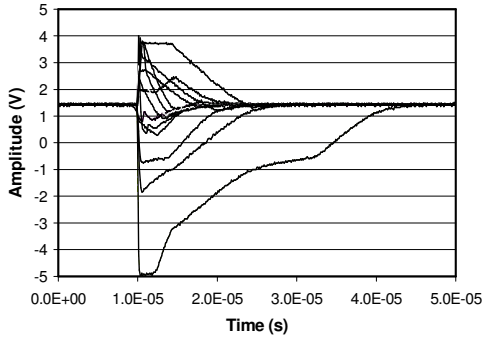
Inverter



Voltage Follower



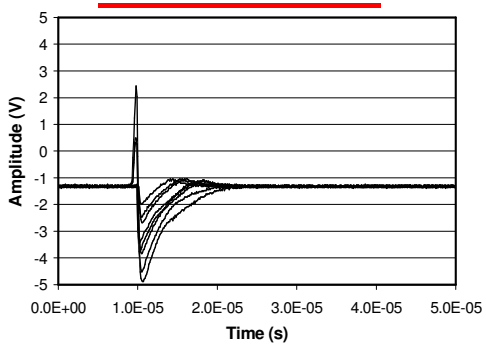
Non-Inverter

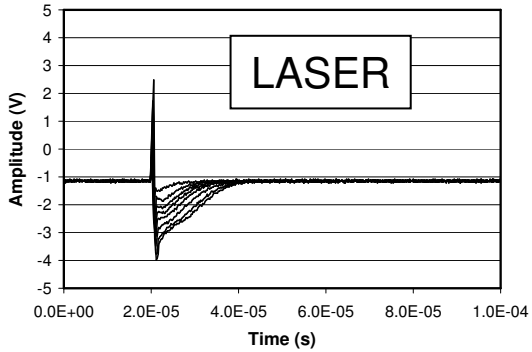


LET=54.8 MeV.cm^2/mg

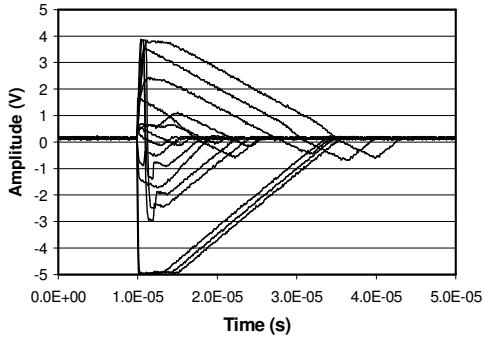
Unirradiated

Inverter

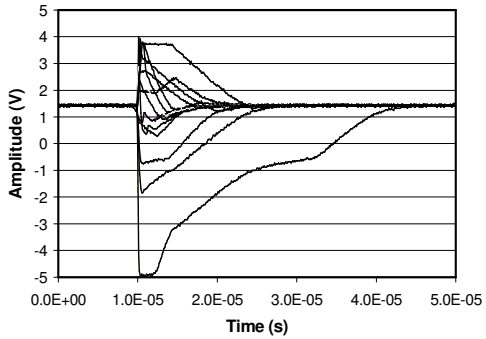




Voltage Follower



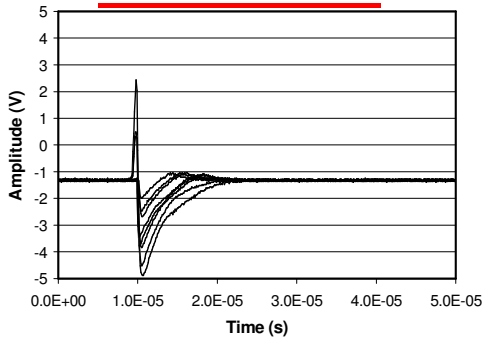
Non-Inverter

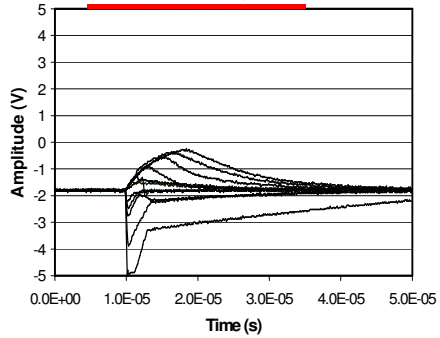


LET=54.8 MeV.cm^2/mg

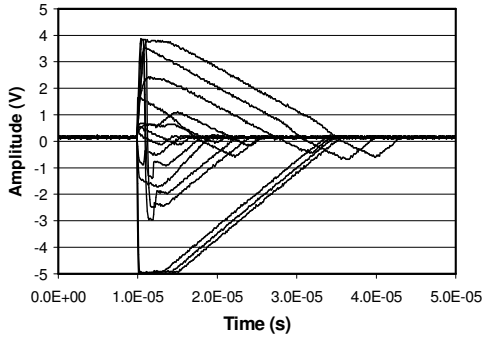
Unirradiated | **Irradiated**

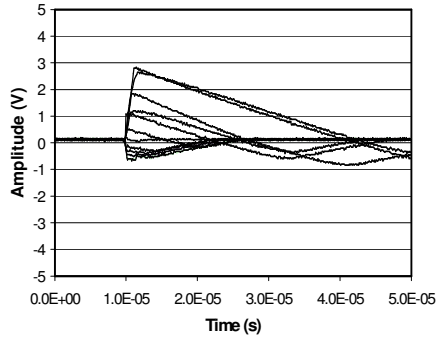
Inverter



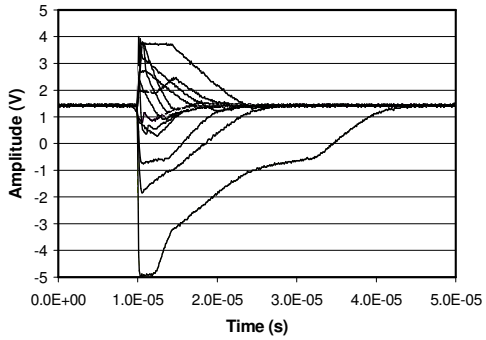


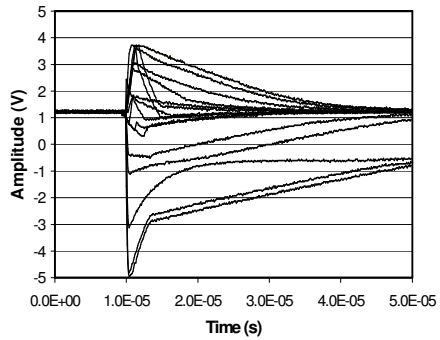
Voltage Follower



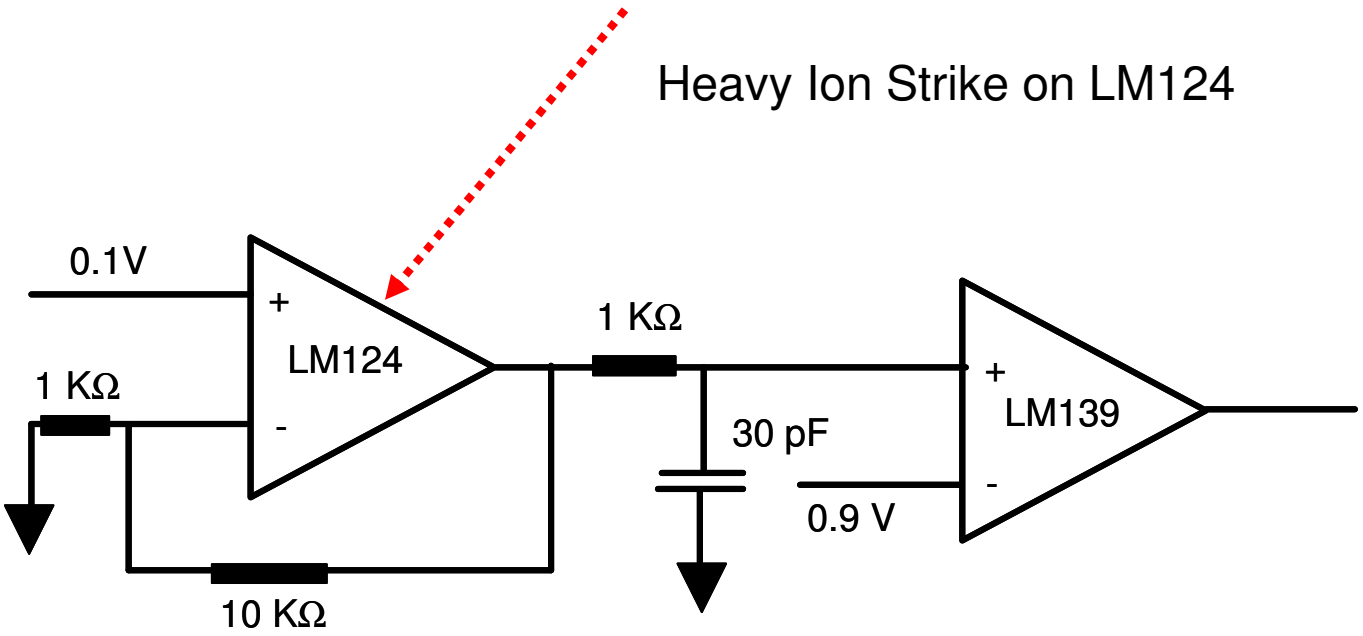


Non-Inverter



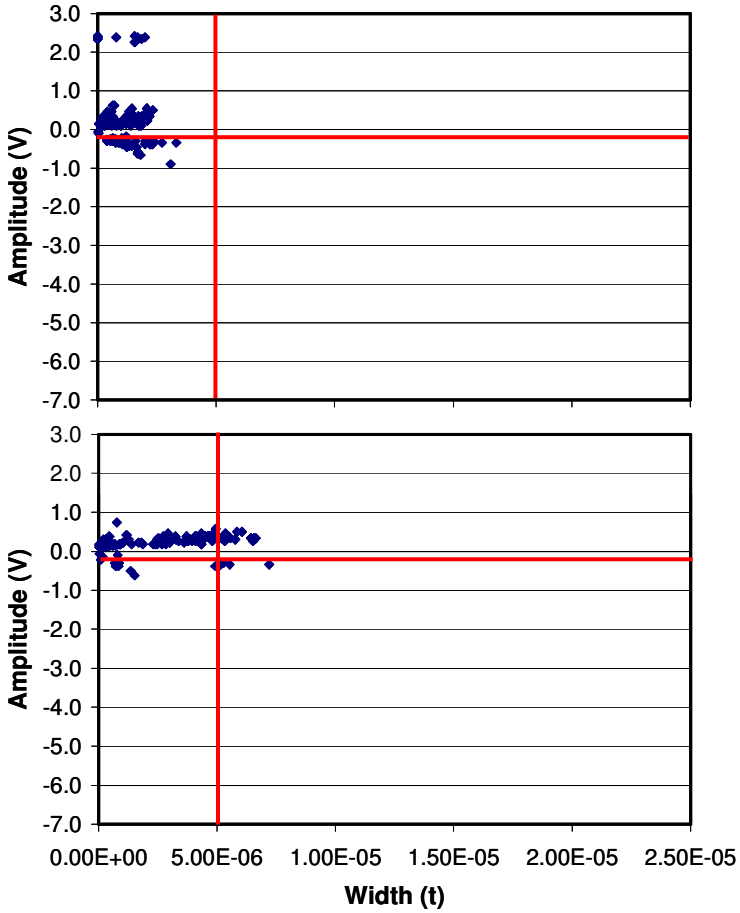


Application

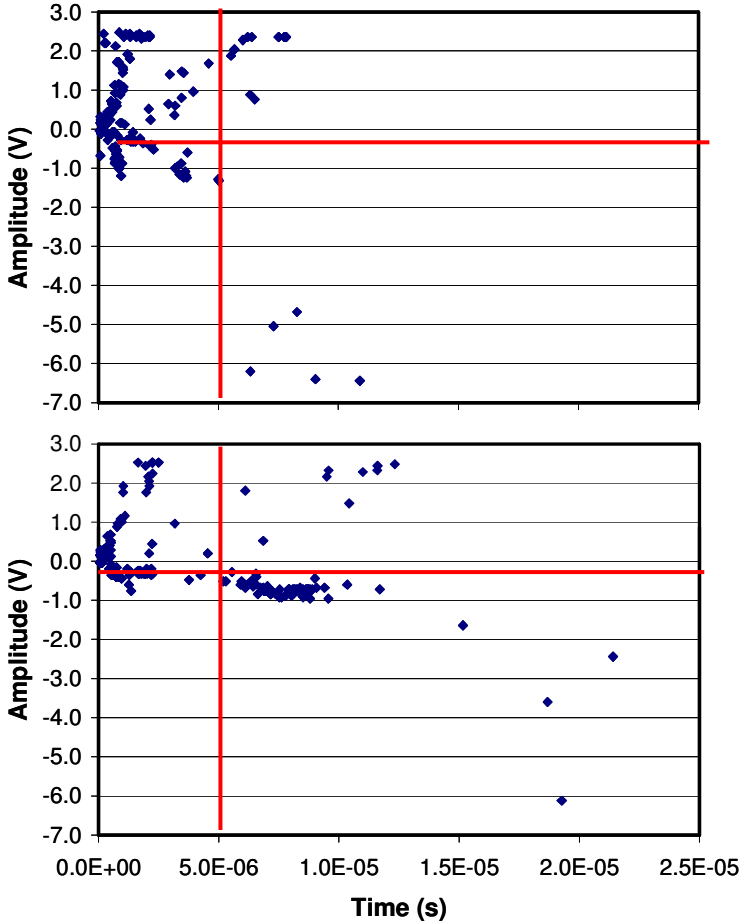


Plots of SET Amplitude vs Width

Non-Inverter

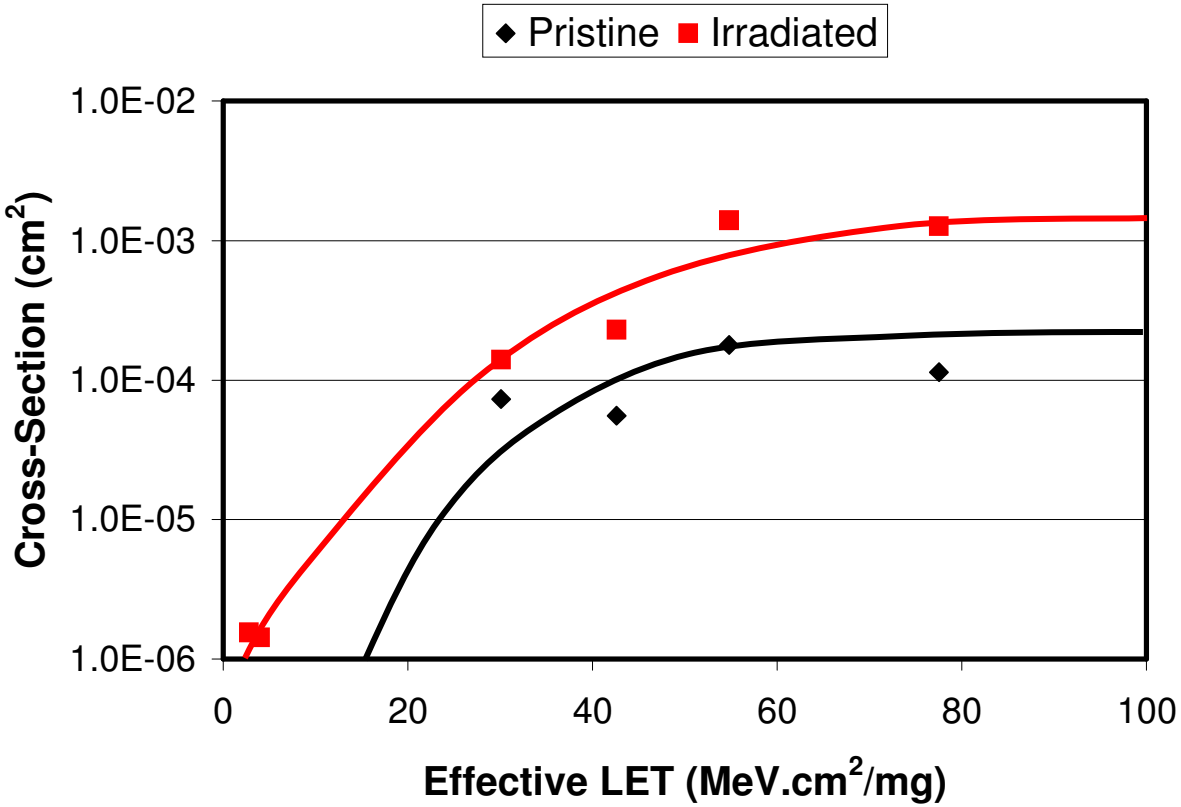


LET=2.8 MeV.cm^2/mg

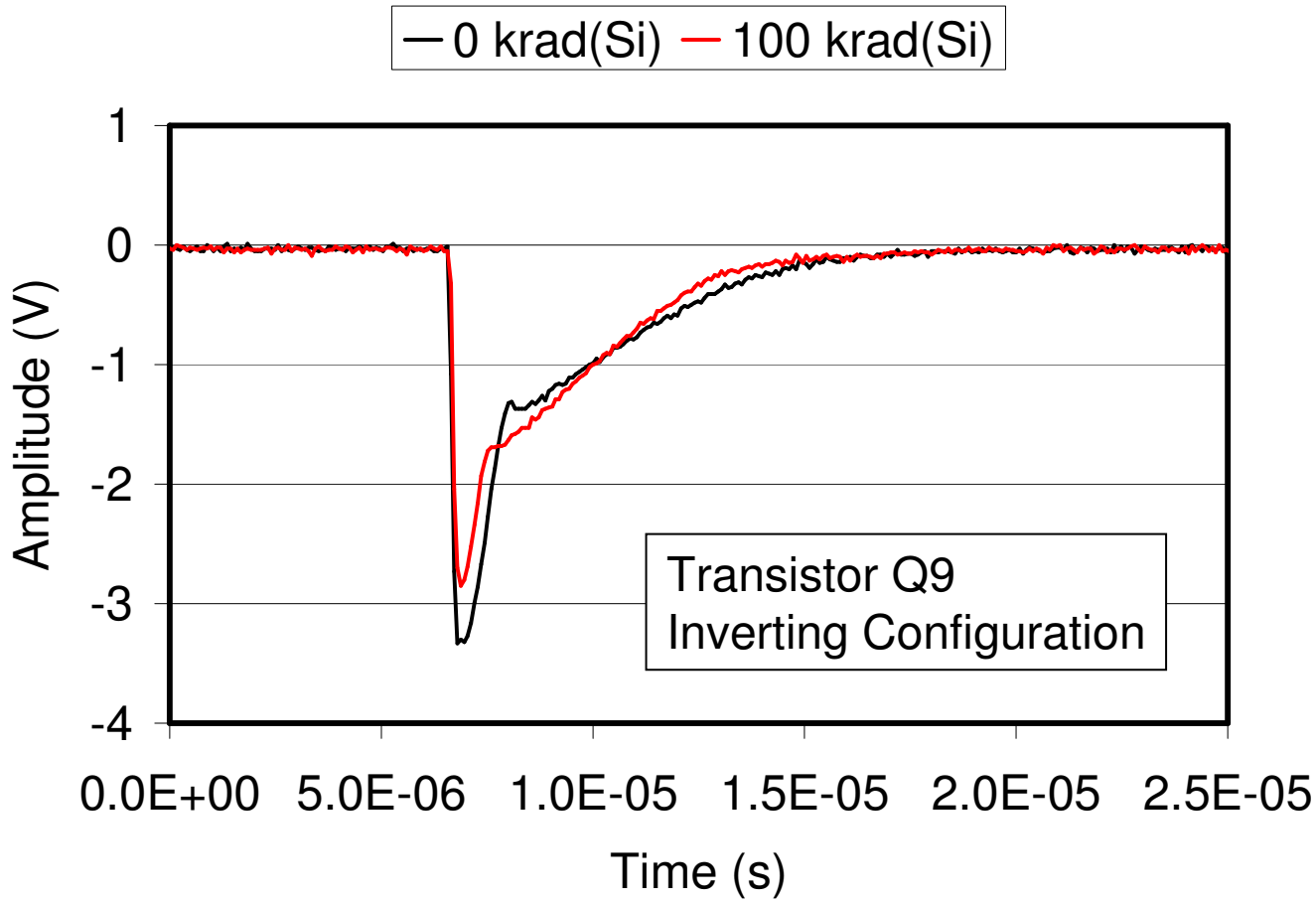


LET=54.8 MeV.cm^2/mg

LM124 Laser Induced Transients



RM124 Laser Induced Transients



Conclusions

- SET shapes depend on:
  - Configuration – different transistors sensitive
  - Radiation exposure – degrades gain and current drive
- Understanding of how TID affects transistor operation together with simple circuit analysis can explain changes in SET shapes with dose.
- Depending on origin, SET widths can increase or decrease following exposure.
- System SET rate can change with radiation exposure.
- Hardness assurance implications.