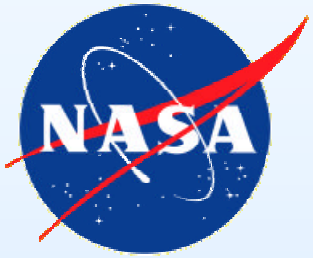

Single Event Transient (SET) in Linear Devices, Testing Guidelines

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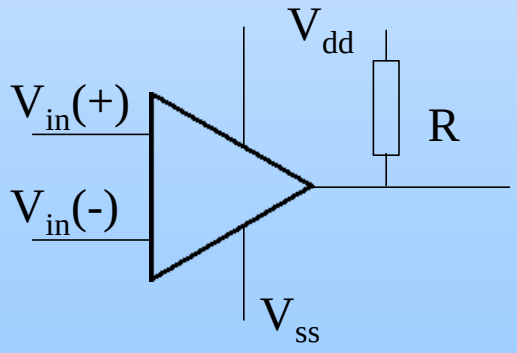
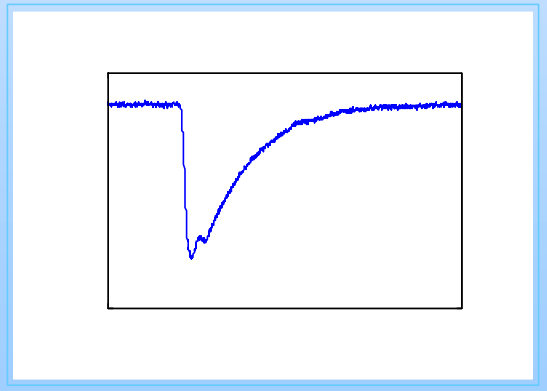
Outline

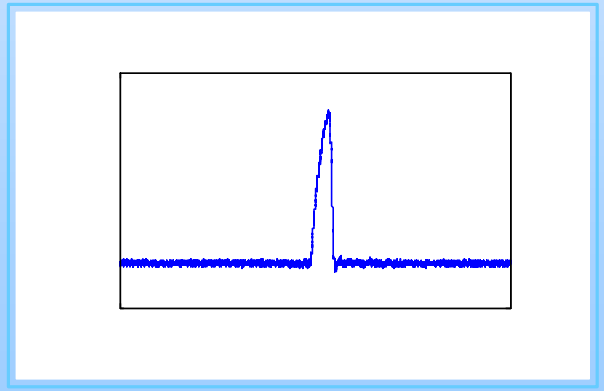
- Introduction
- Lessons learned
  - Irradiation conditions
  - Bias conditions
  - Test set-up
  - Data analysis and reporting
- Testing guidelines

Introduction

- SETs are momentary glitches in the output voltage of a circuit caused by ions passing through sensitive nodes in the circuit
- SETs can occur in both digital and analog circuits







Introduction

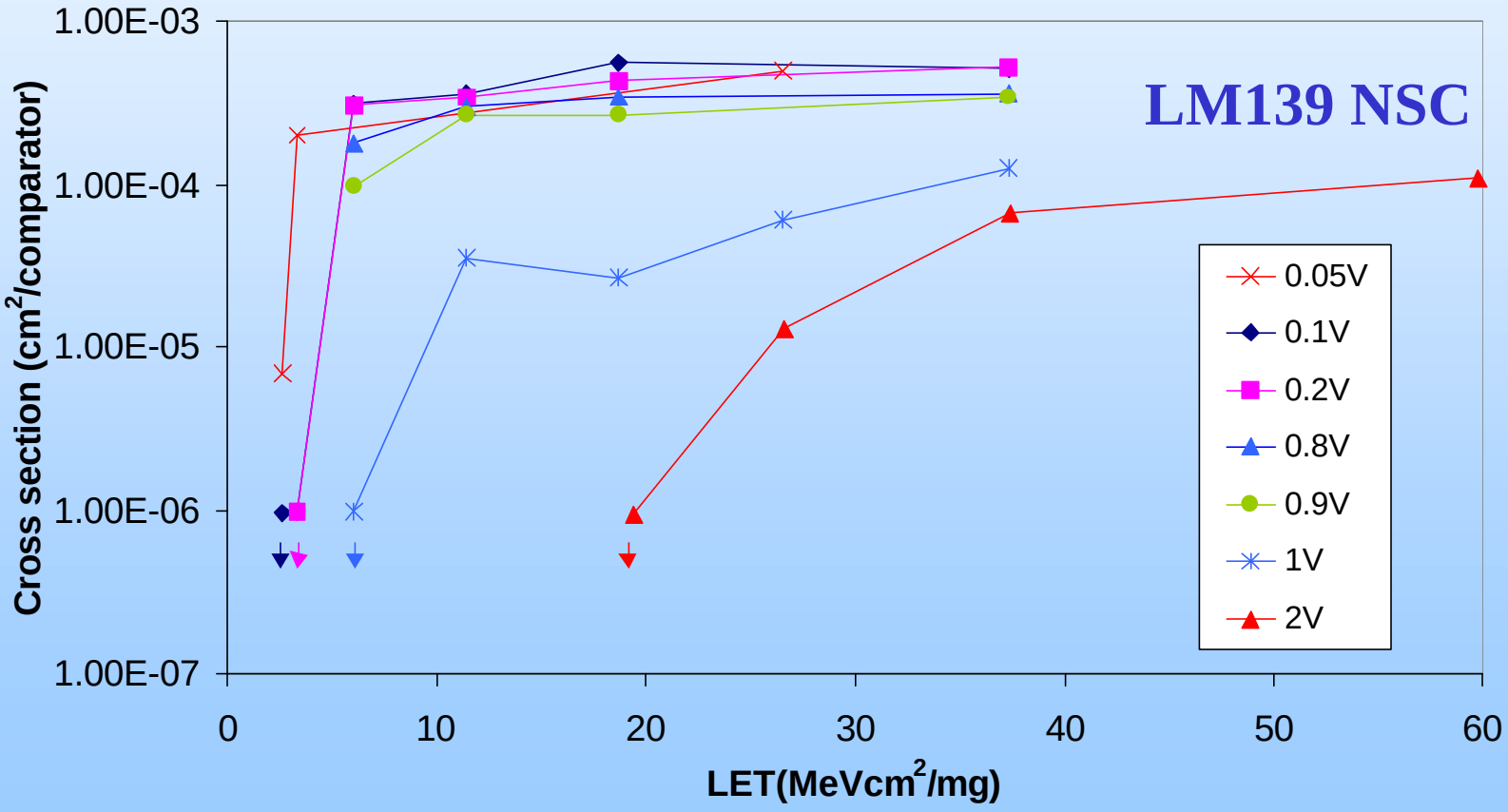
- Need for test guidelines is to ensure
  - that all SET testing of linear circuits be done by a test engineer who is fully aware of all conditions that affect the results
  - the results can become part of a radiation effects data base that can be used by others who also want to use the part in space.

Introduction

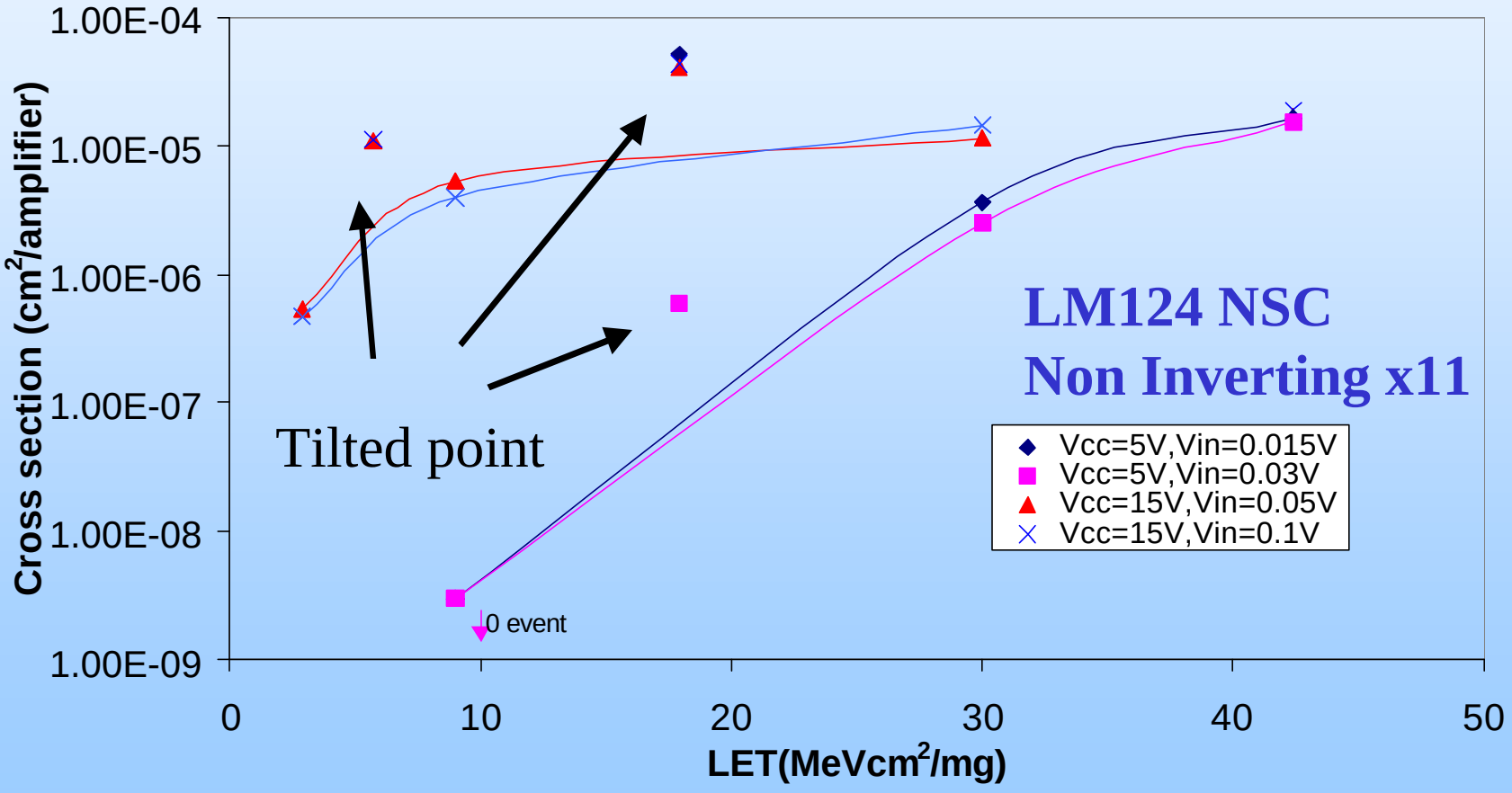
- Numerous SET tests have been performed during the last two years by NASA-GSFC in order to define a low cost conservative test methodology.

- This talk presents both the lessons learned during these tests and the proposed testing guidelines.

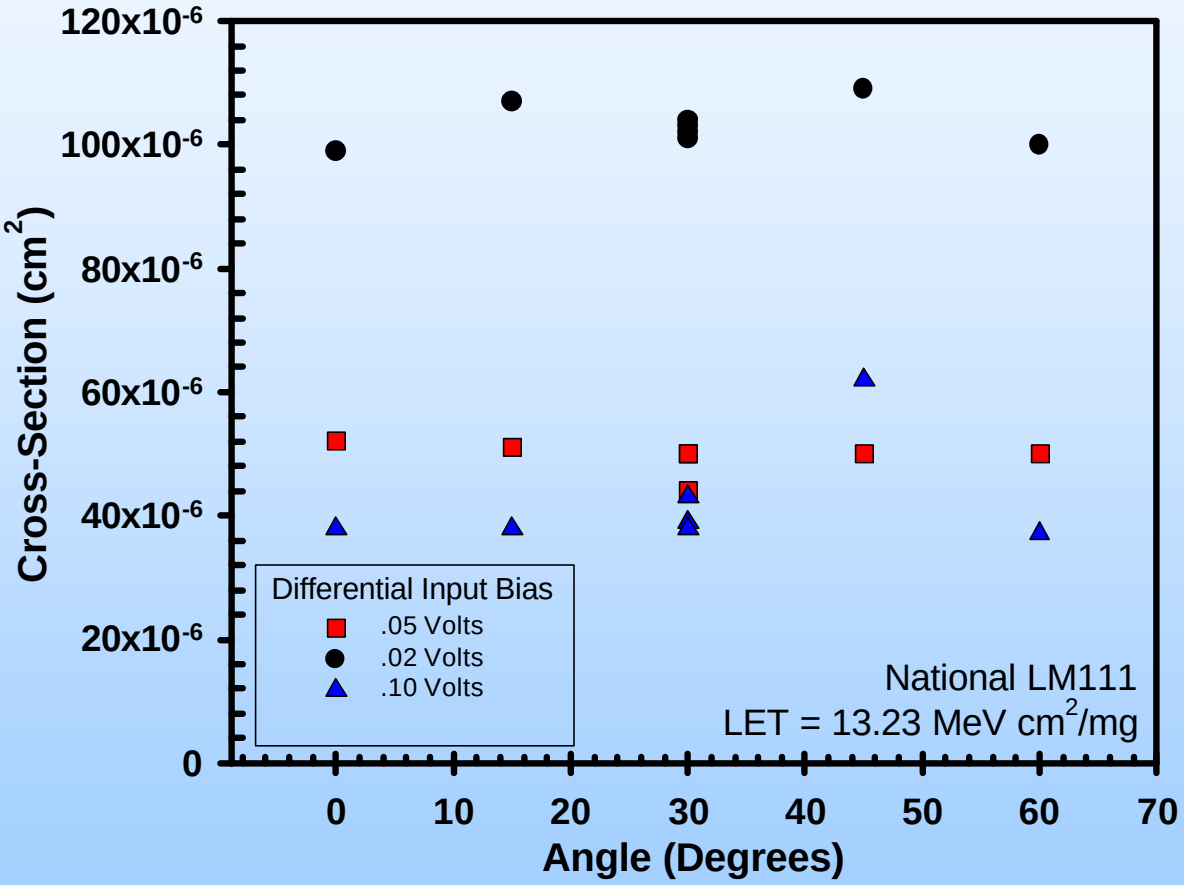
Bias conditions have a significant effect on device sensitivity
Input Voltage



Bias conditions have a significant effect on device sensitivity
Power Supply Voltage



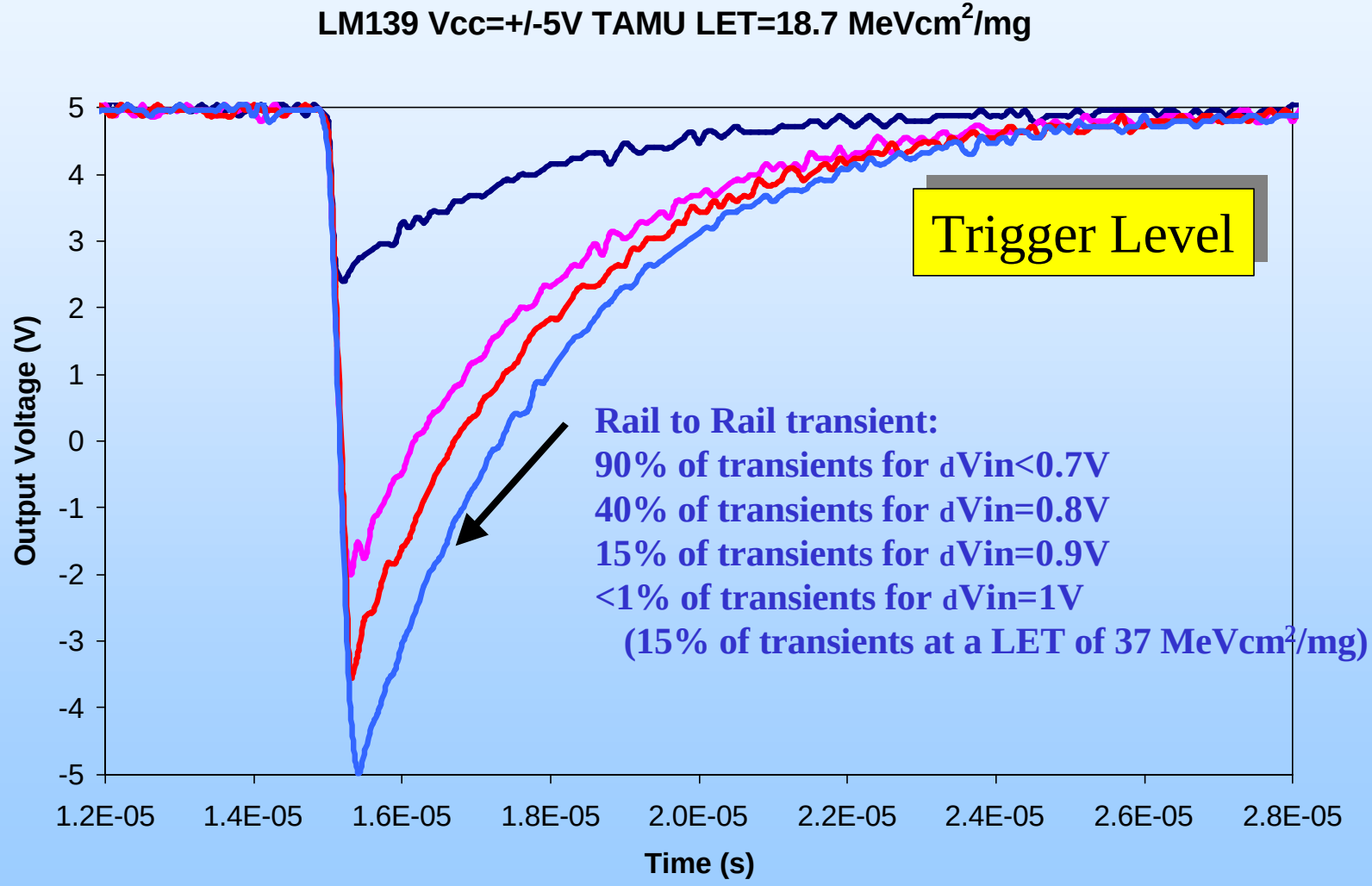
There is not always a dependence on tilt angle



RPP Method?

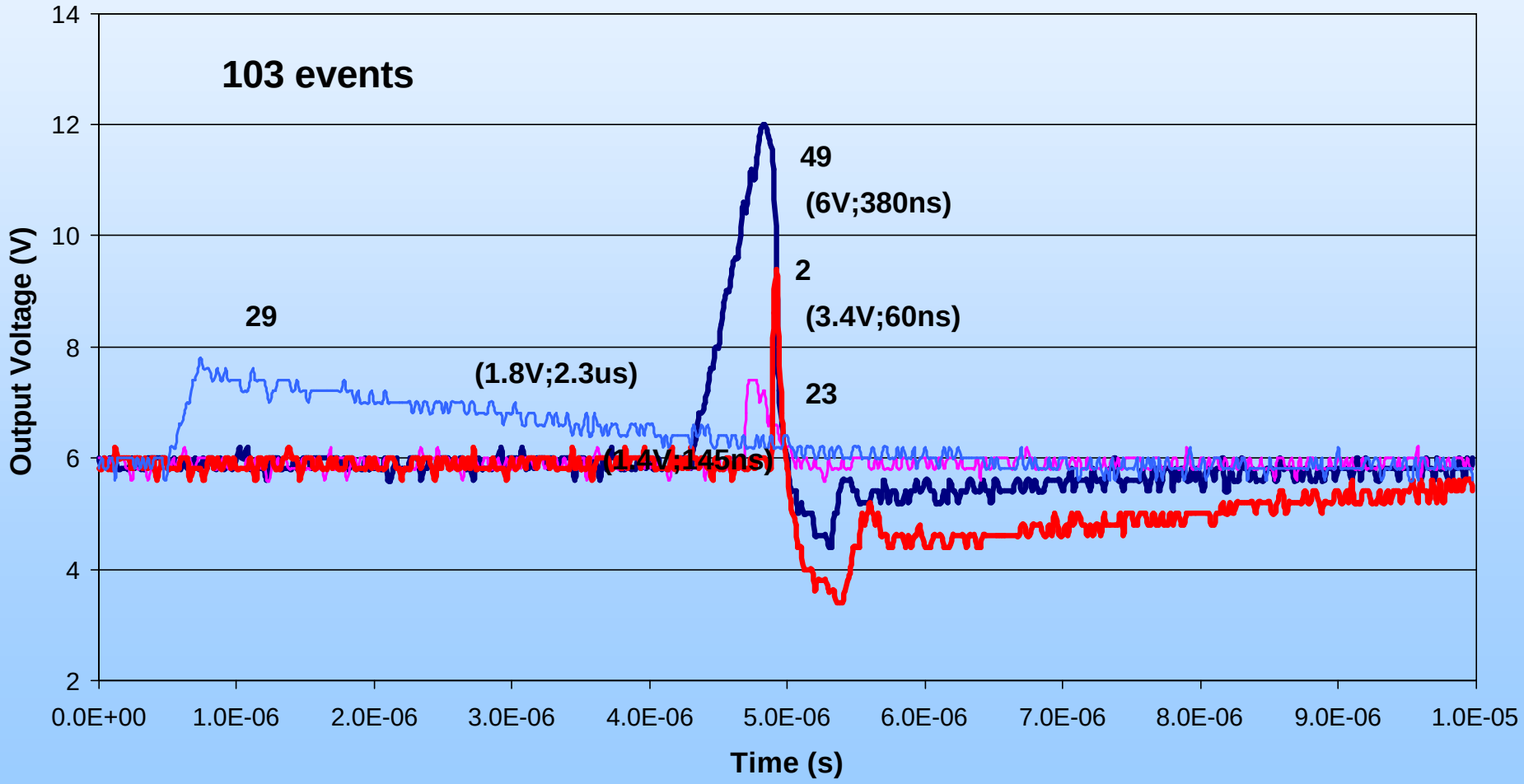
Data provided by M. Savage, NAVSEA CRANE

Bias conditions have a significant effects on transient waveform

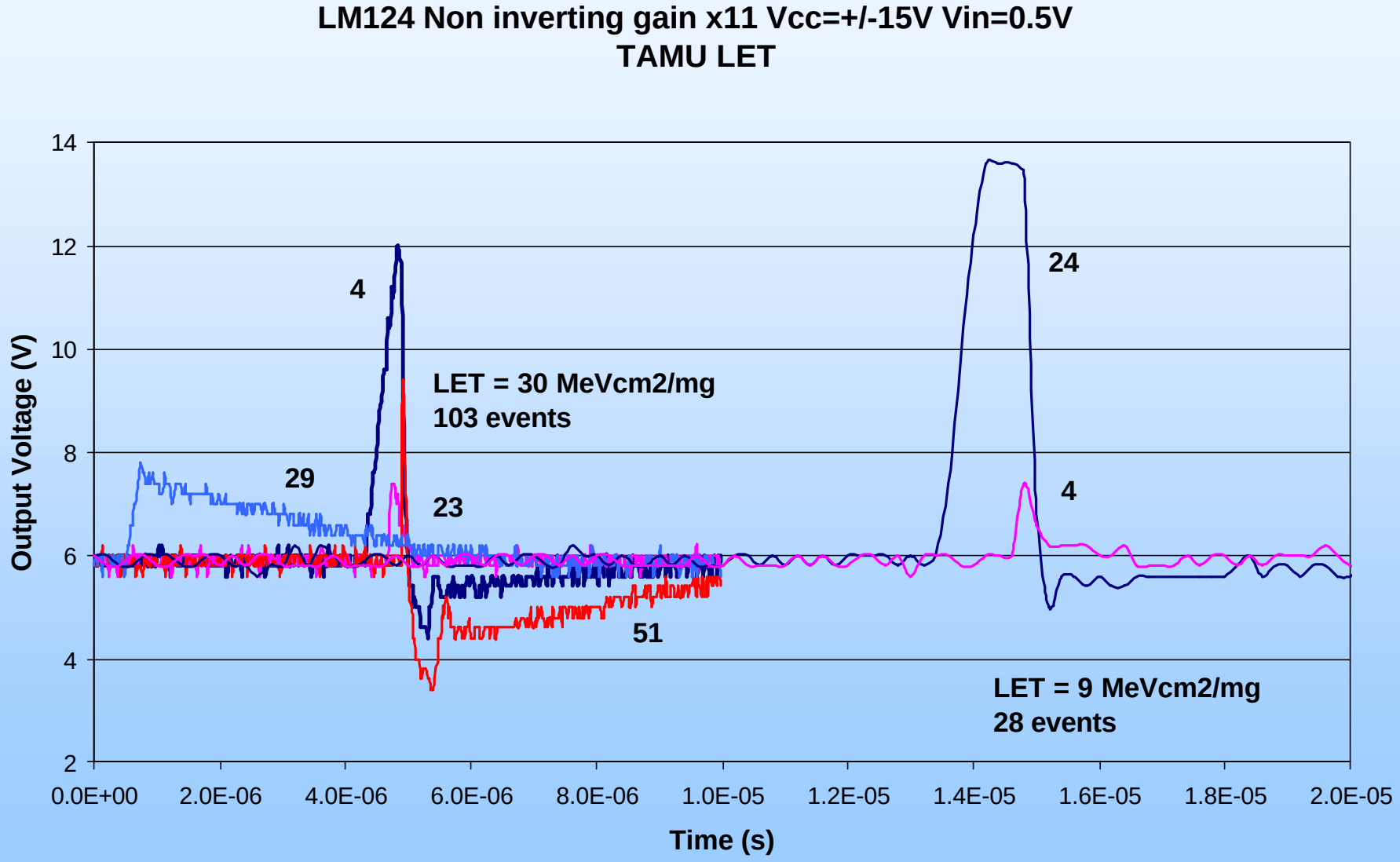


Various transient waveforms can be collected

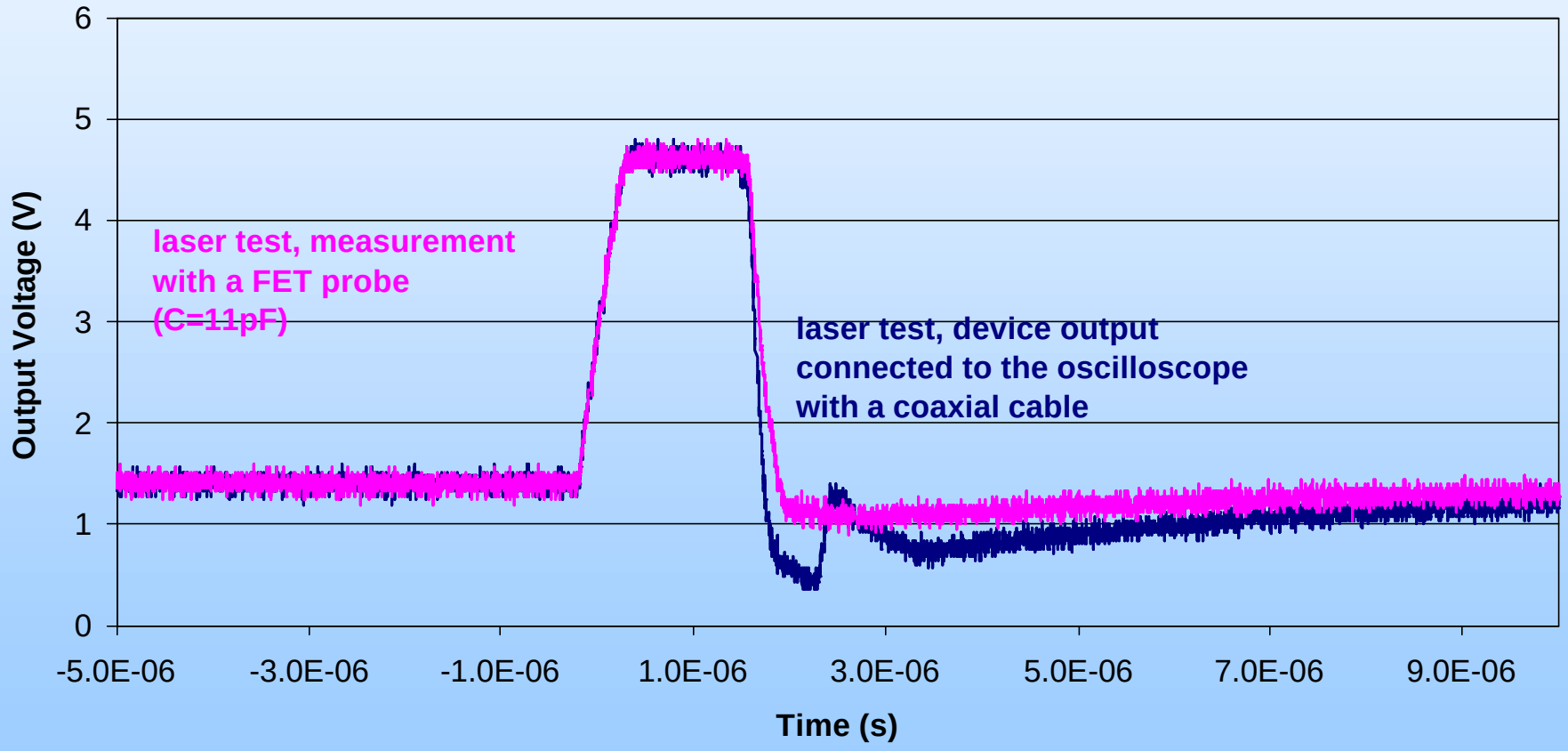
LM124 Non inverting gain x11 Vcc=+/-15V Vin=0.5V
TAMU LET= 30 MeVcm2/mg



Transient characteristics vary with LET



Test set-up may have significant effect on the collected transient waveforms



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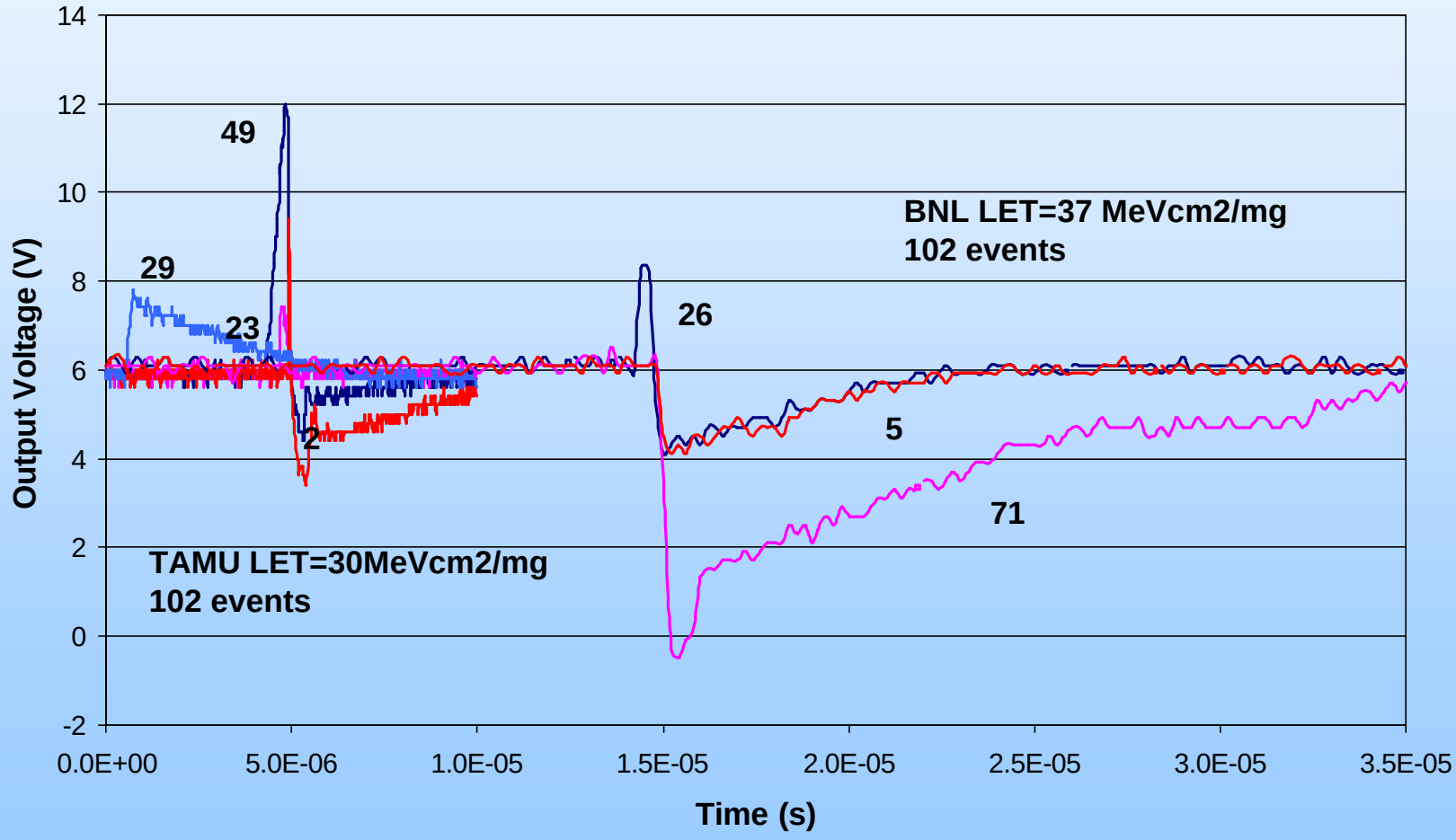
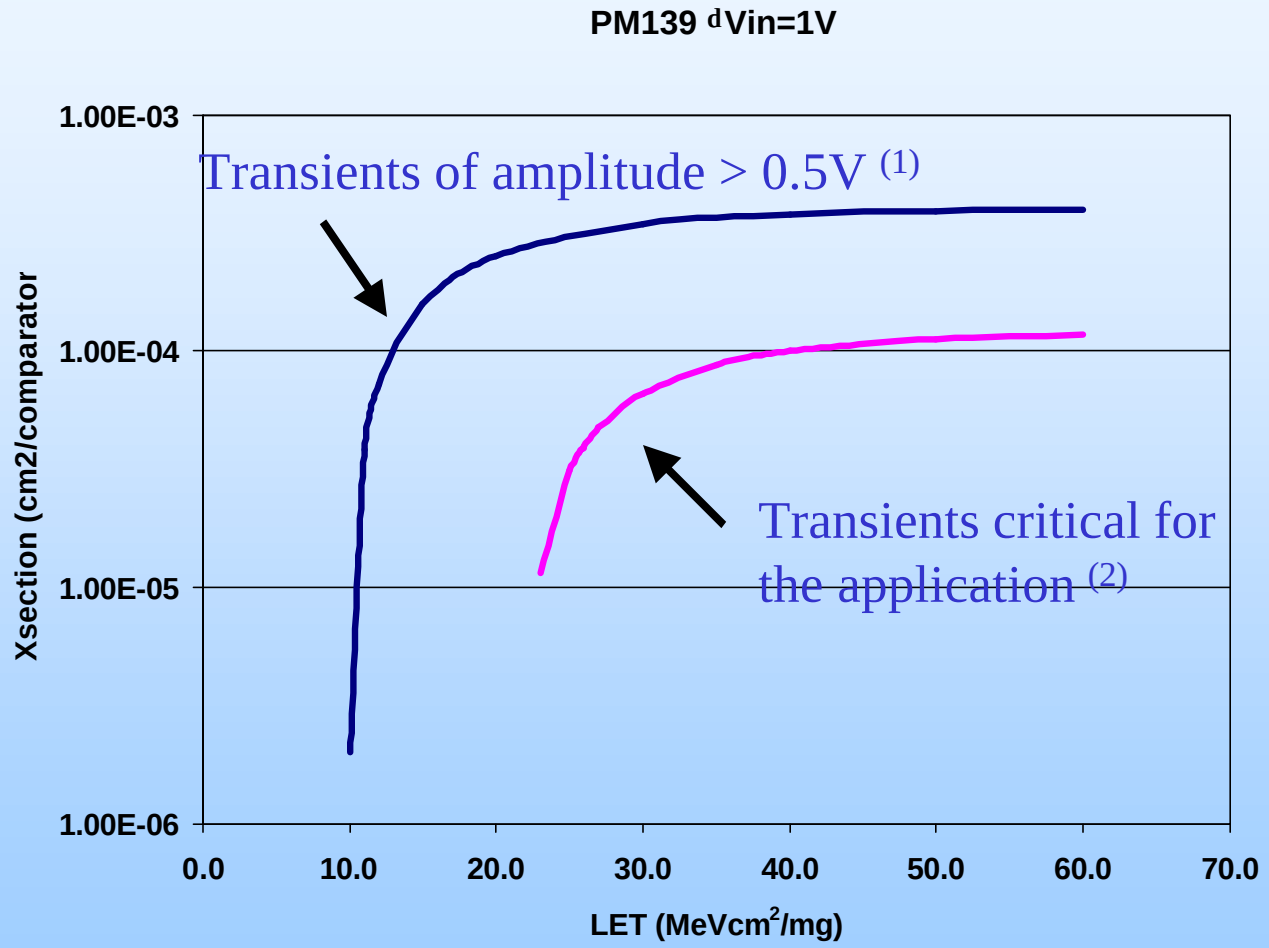


How good is the data to assess the SET impact on applications?



(1) After A. Johnston, IEEE Trans. on Nuc. Sci., vol. 47-6, p2624, Dec. 2000.
(2) After Boeing data.

Testing Guidelines
Irradiation Conditions

- Flux must remain low enough not to cause pile-up of data collection
- A sufficient number of transients needs to be collected to get a significant number of all the different transient waveforms:

  >400 events
- Minimum penetration range of ions:

  > 30 μm

Testing Guidelines
Bias Conditions

- A large set of different bias conditions is necessary to try to understand the device behavior and define worst case bias conditions.
- It is not often possible to define worst case bias conditions.
- It is often necessary to test the parts in their application conditions.
  - Laser testing and modeling may be useful to check other bias conditions.

Testing Guidelines
Data collection techniques

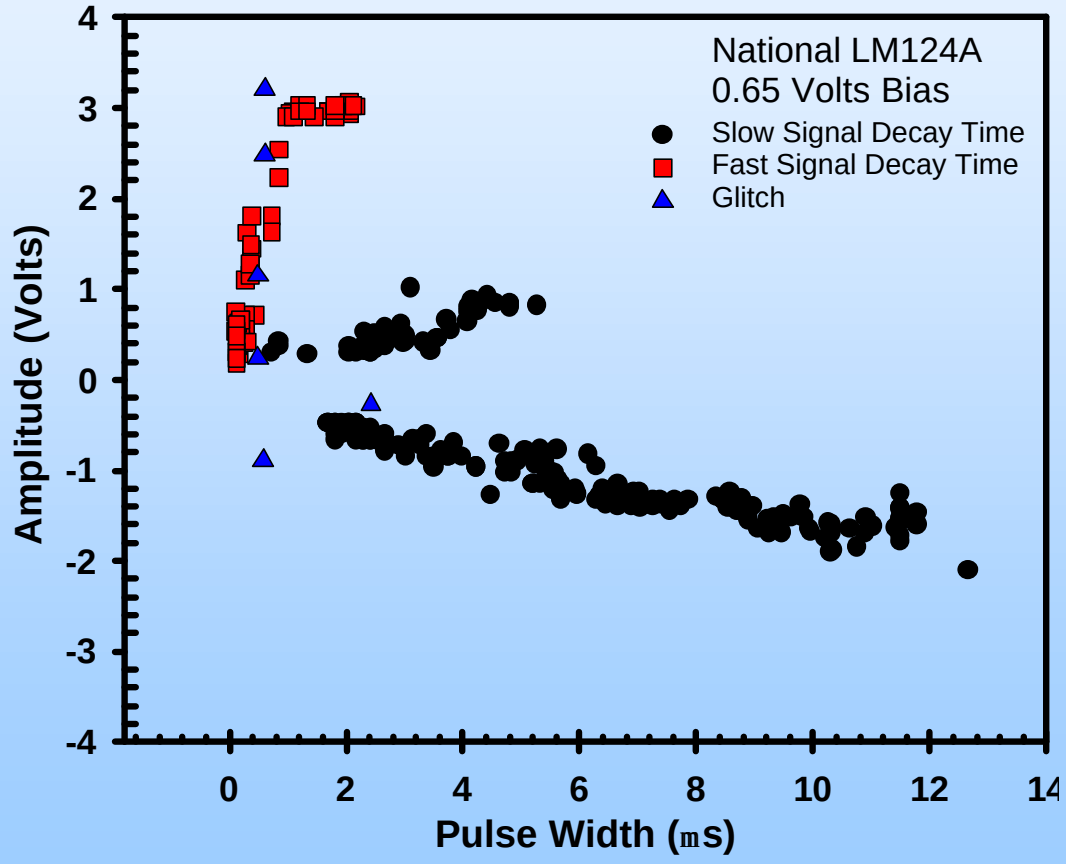
- Care must be taken in the selection of the type of oscilloscope probe used
  - Low capacitance active FET probe.

- All the transients collected need to be stored for further analysis.

Testing Guidelines
Data Analysis & Reporting

- At minimum the report should include:
  - bias conditions
  - measurements conditions (triggering conditions)
  - the total cross section curve
  - traces of the different types of waveforms collected with worst case characteristics (amplitude, duration) and how they contribute to the total cross section curve.

Testing Guidelines
Data Analysis & Reporting



Data provided by M. Savage, NAVSEA CRANE

Summary

- SETs are voltage transients that appear on the outputs linear devices exposed to ionizing particles in space.
- Unlike SETs in devices like memories, SETs in linears can vary significantly based on operating conditions.
- NASA/GSFC has produced a document that provides guidance to the community for SET testing of linear devices.

Data provided by M. Savage, NAVSEA CRANE