Characterization of Single-Event Transients in the LM119 Voltage Comparator

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- NASA Electronic Parts and Packaging (NEPP) Program's Electronic Radiation Characterization (ERC) Project
- DTRA RHM

Outline

- Introduction
- Comparison of Pulsed-Laser Data, Modeling and Heavy-Ion Data
  - Dependence on Differential Input Voltage
  - Negative vs Positive differential voltages
- Conclusions

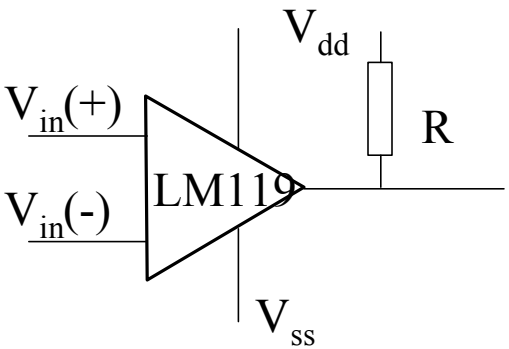
SETs in Linear Circuits

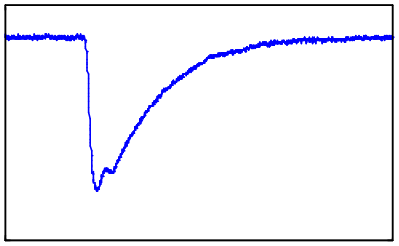
- SETs are momentary disturbances in the output voltage following an ion strike to a sensitive node in a circuit.

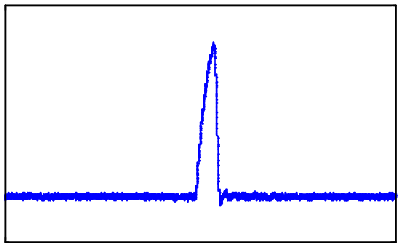
- SETs have been observed in
  - Voltage comparators (LM111, LM119, LM139)
  - Operational amplifiers (LM124)
  - Hybrids such as DC to DC Converters (2812)

SETs in Linear Circuits

- Depend on Operating Conditions:
  - Power supply
  - Output load
  - Input voltages
- SET Characteristics:
  - Amplitude
  - Width
  - Threshold

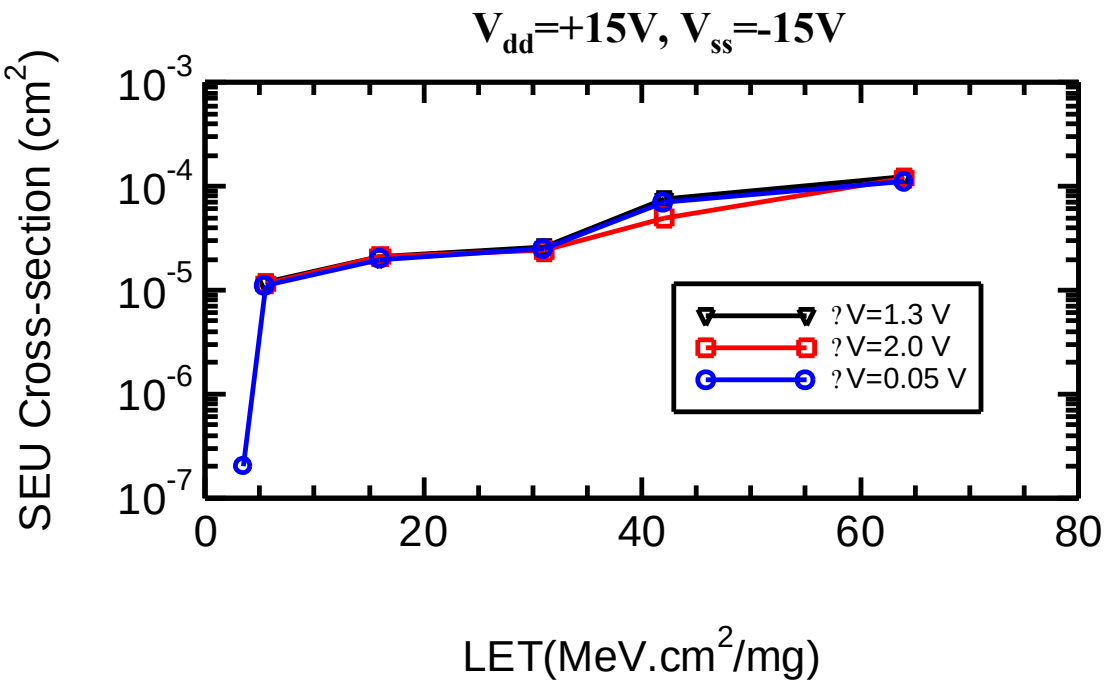






LM119 Heavy Ion Data

- Testing under limited set of conditions - results may not be applicable to another application

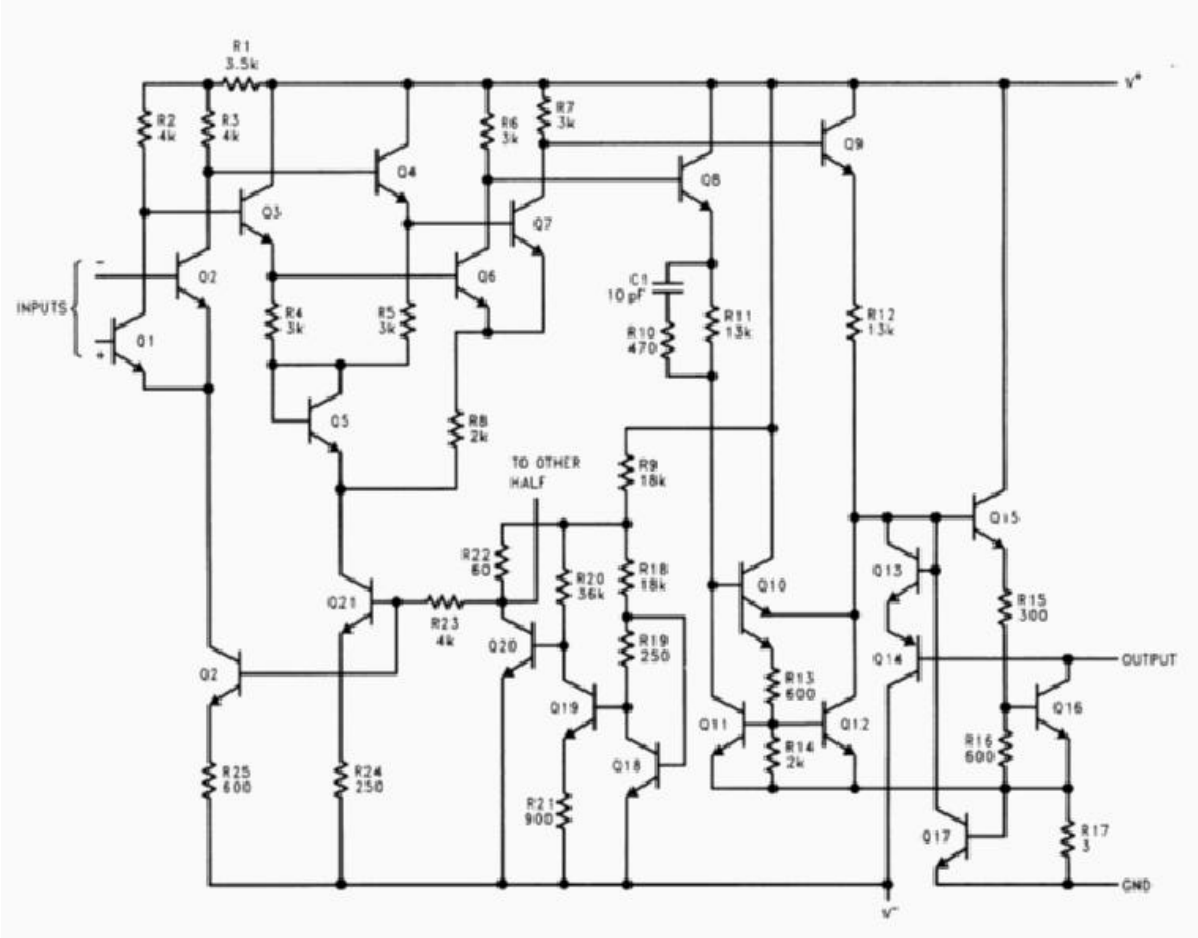


Koga et al. 1997

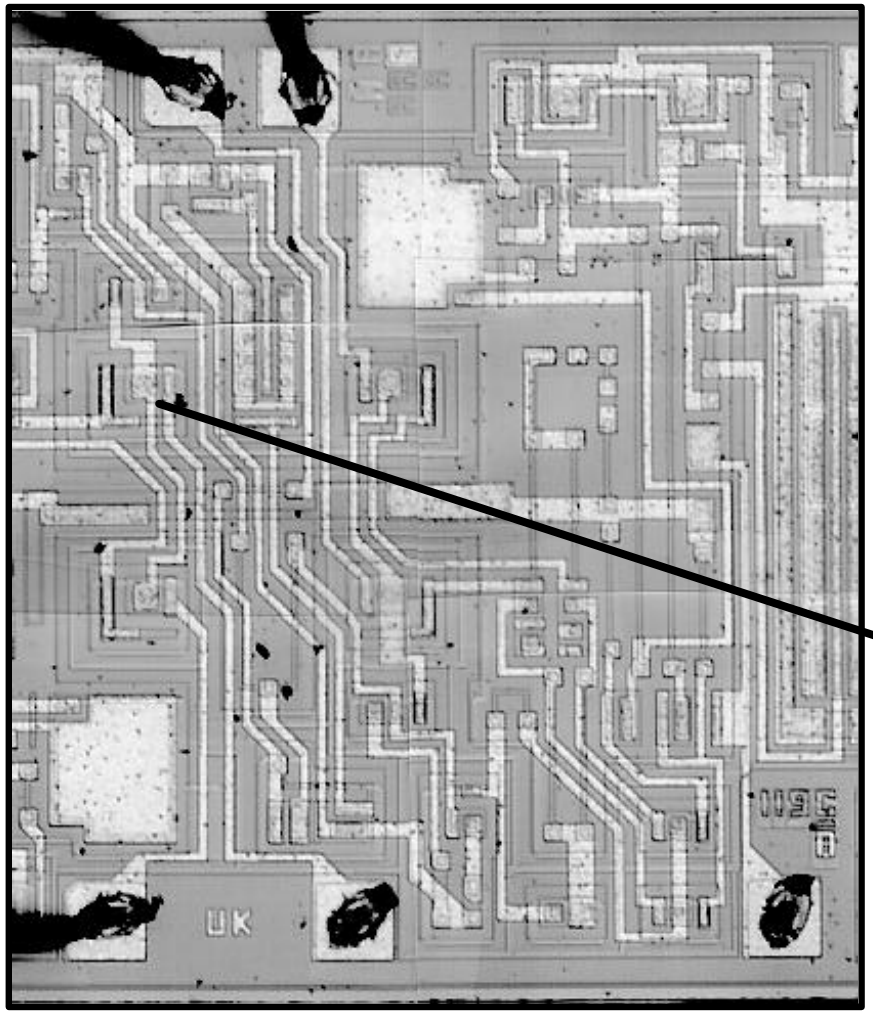
Characterization Approach

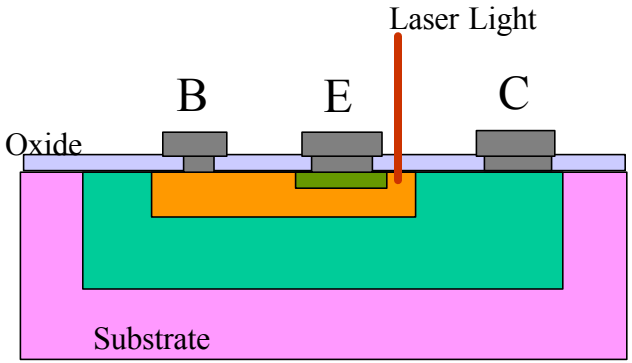
- To minimize costs of characterizing SET sensitivity of linear circuits, use a canonical set of data:
  - heavy-ion tests (Cross-section vs LET and transients waveforms)
  - modeling (device and circuit simulator programs)
  - ion microprobe (focused beam on known locations)
  - pulsed laser (focused beam of light)

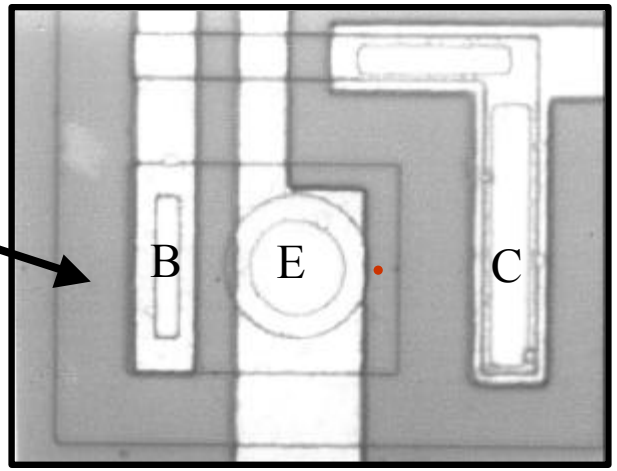
LM119 Circuit Diagram



LM119 Photomicrograph

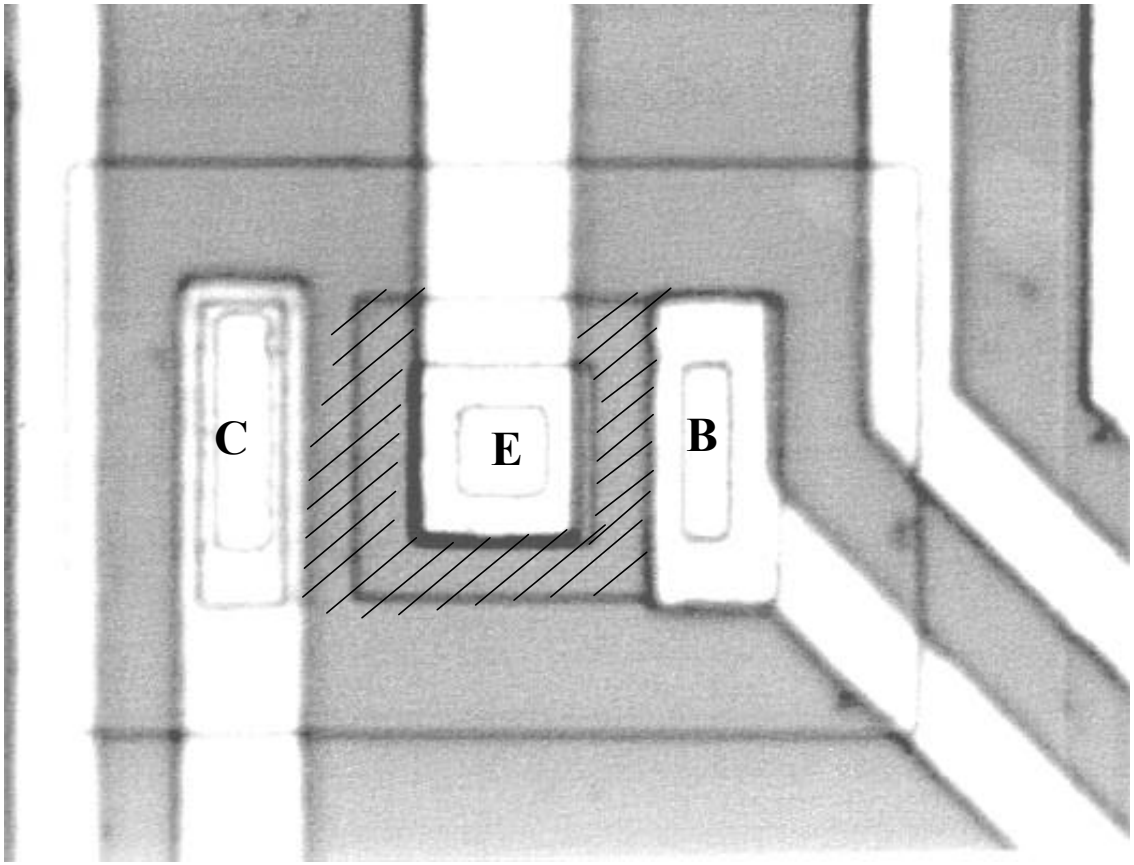




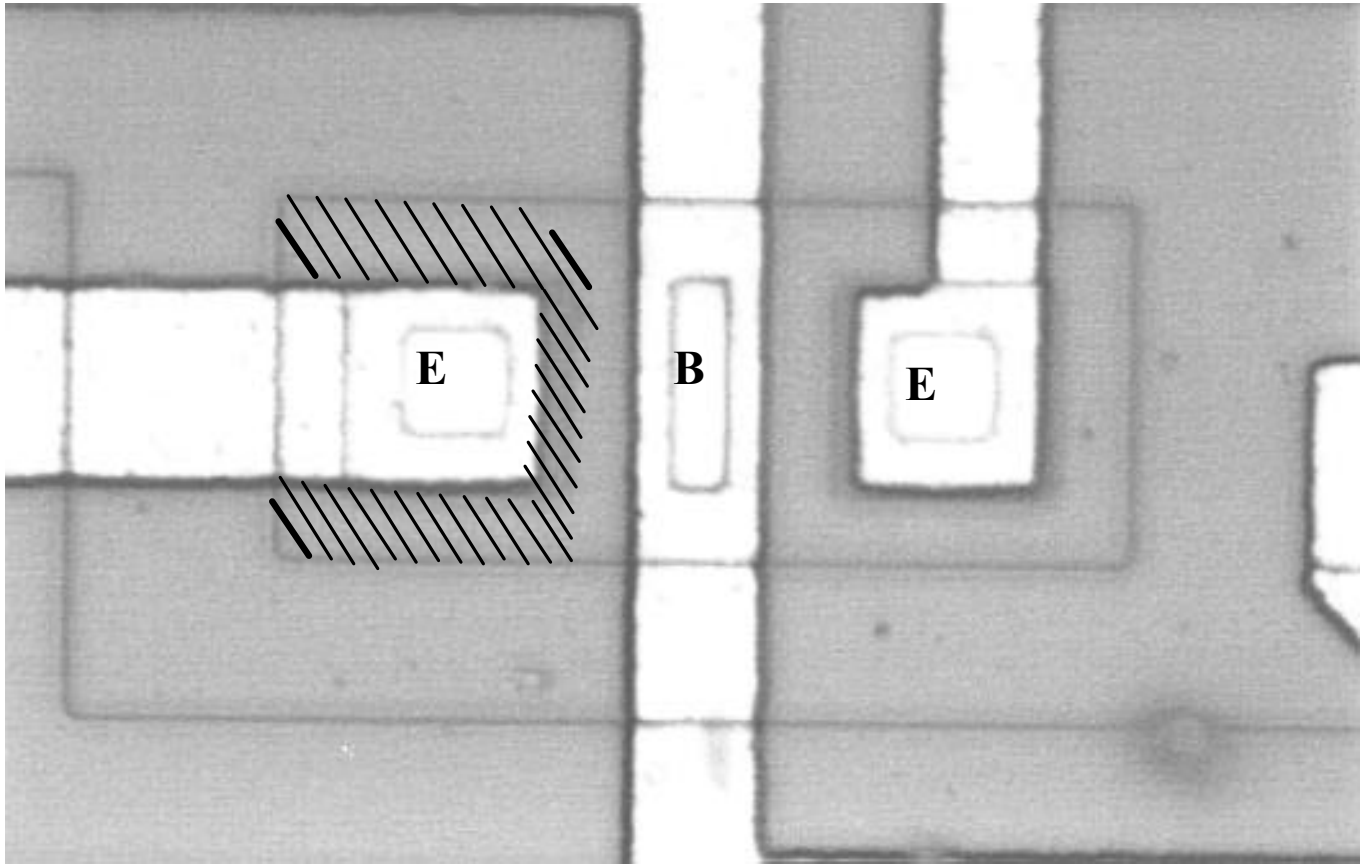


Q2

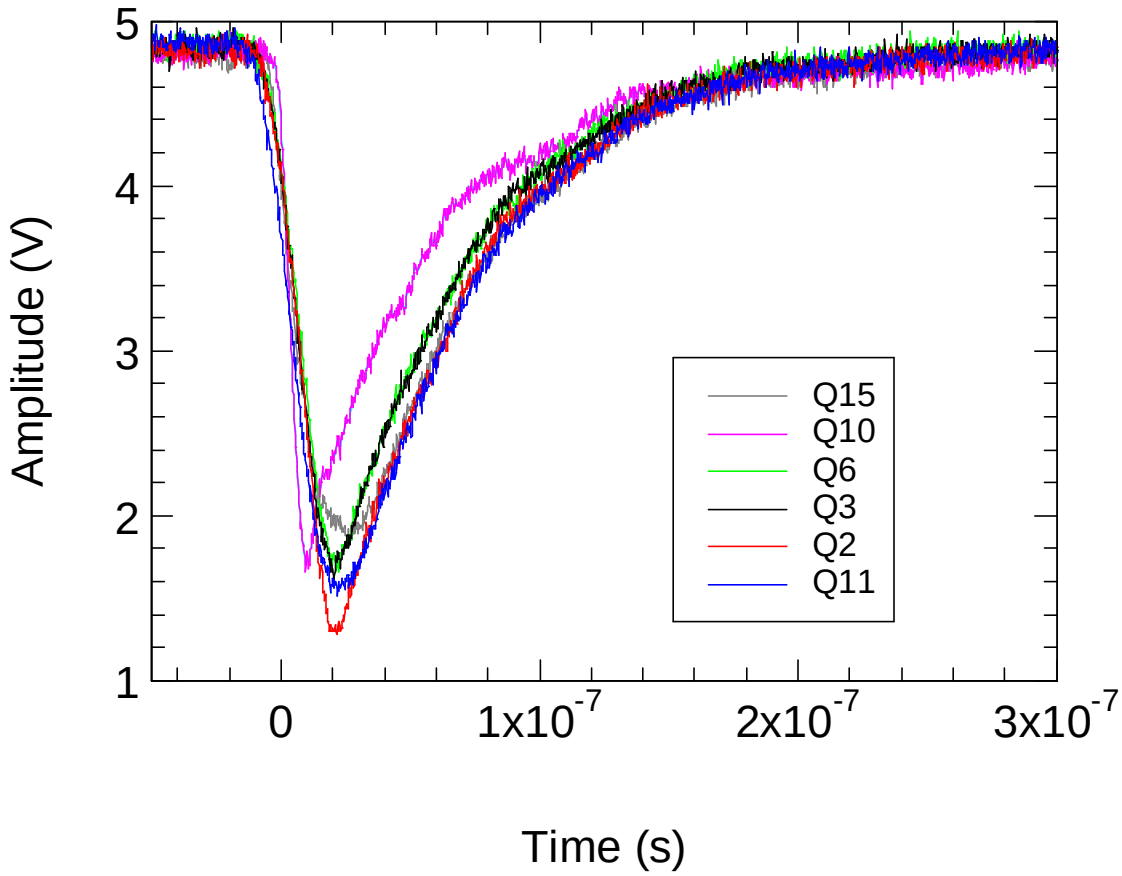
SET Sensitive Region for Q6



SET Sensitive Region for Q10



Pulsed-Laser Induced Transients



Pulsed-Laser Induced Transients

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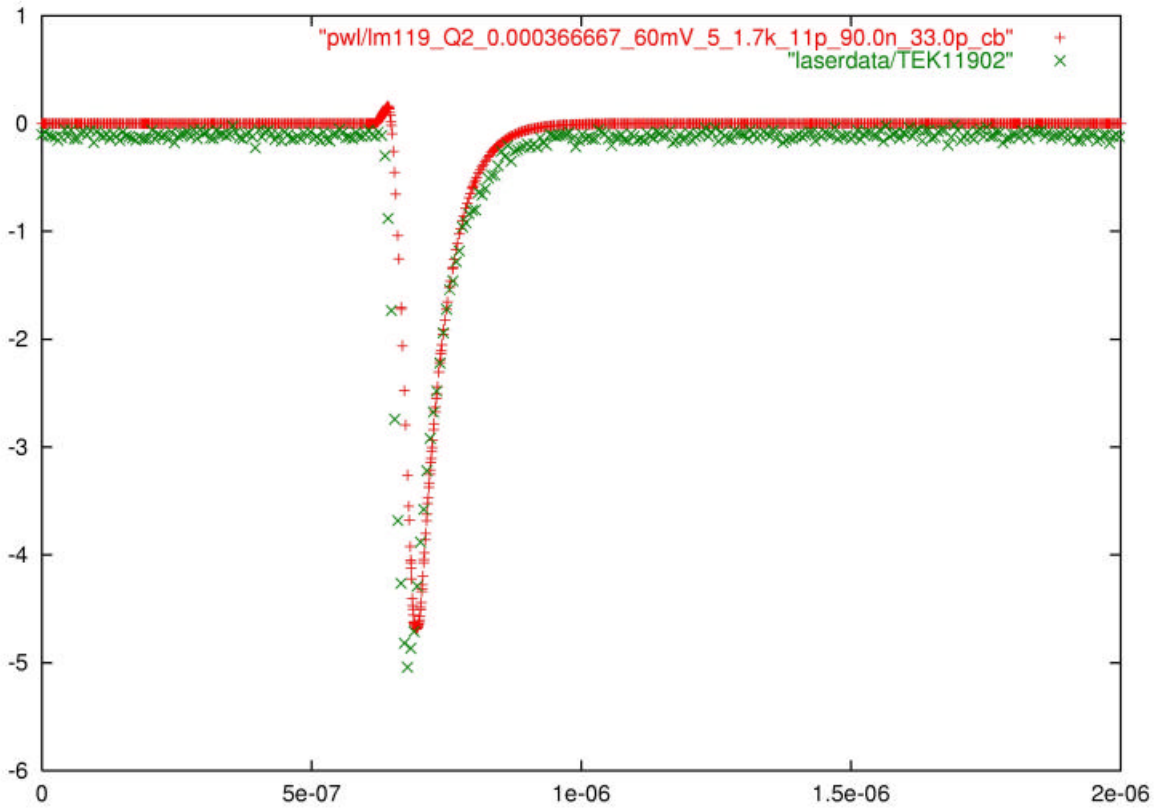


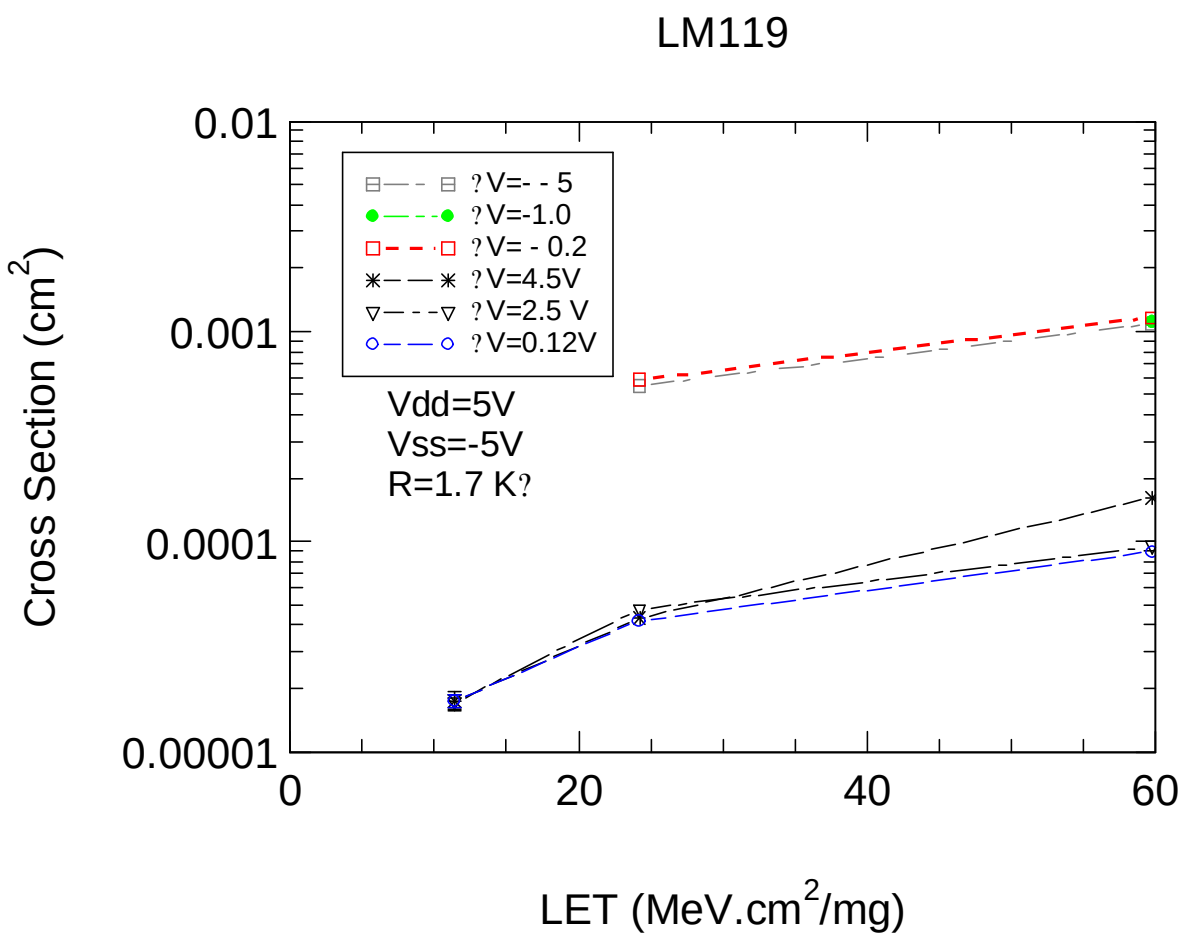
Comparison of Transistor Sensitivity to SEEs from Pulsed Laser Light and Modeling

Transistor	Delta V > 0			Delta V < 0	
	Laser	Modeling		Laser	Modeling
Q1	Y	Y		Y	Y
Q2	Y	Y		Y	Y
Q3	Y	Y		Y	Y
Q4	N	N		Y	Y
Q5	N	N		N	N
Q6	Y	Y		N	N
Q7	N	N		Y	Y
Q8	N	Y		Y	Y
Q9	Y	Y		N	Y
Q10	Y	Y		Y	Y
Q11	Y	Y		Y	Y
Q12	N	Y		Y	Y
Q13	N	N		Y	Y
Q14	Y	Y		N	N
Q15	Y	Y		Y	Y
Q16	Y	Y		Y	Y
Q17	Y	Y		Y	Y
Q18	N	N		Y	N
Q19	N	N		N	N
Q20	Y	Y		Y	Y
Q21	N	Y		Y	Y
Q22	Y	Y		Y	Y

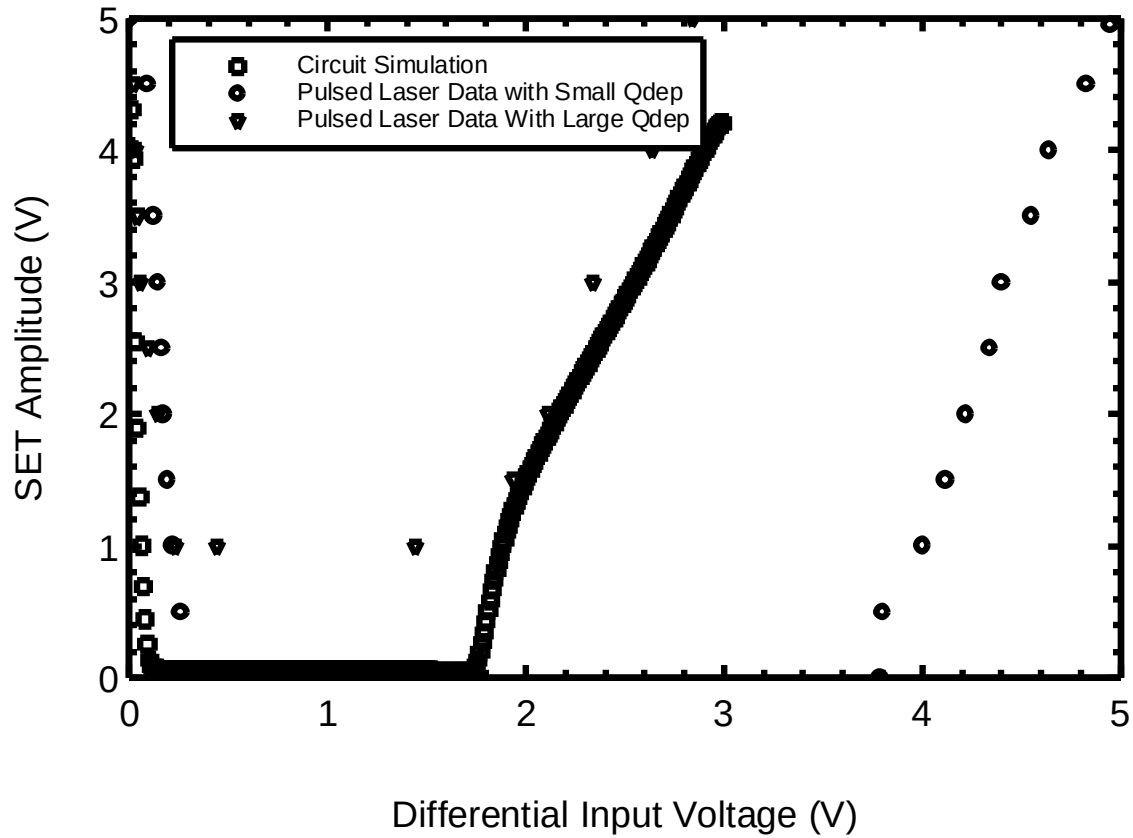
Pulsed Laser Results

Transistor	DeltaV=+60mV	DeltaV=-60mV
Q1		1
Q2	29	9
Q3	22	
Q4		7
Q6	18	
Q7		9
Q8		7
Q10	33	7
Q11	16	4
Q12		4
Q15	11	
Q16	7	
Q17		4
Q18		4
Q20		4

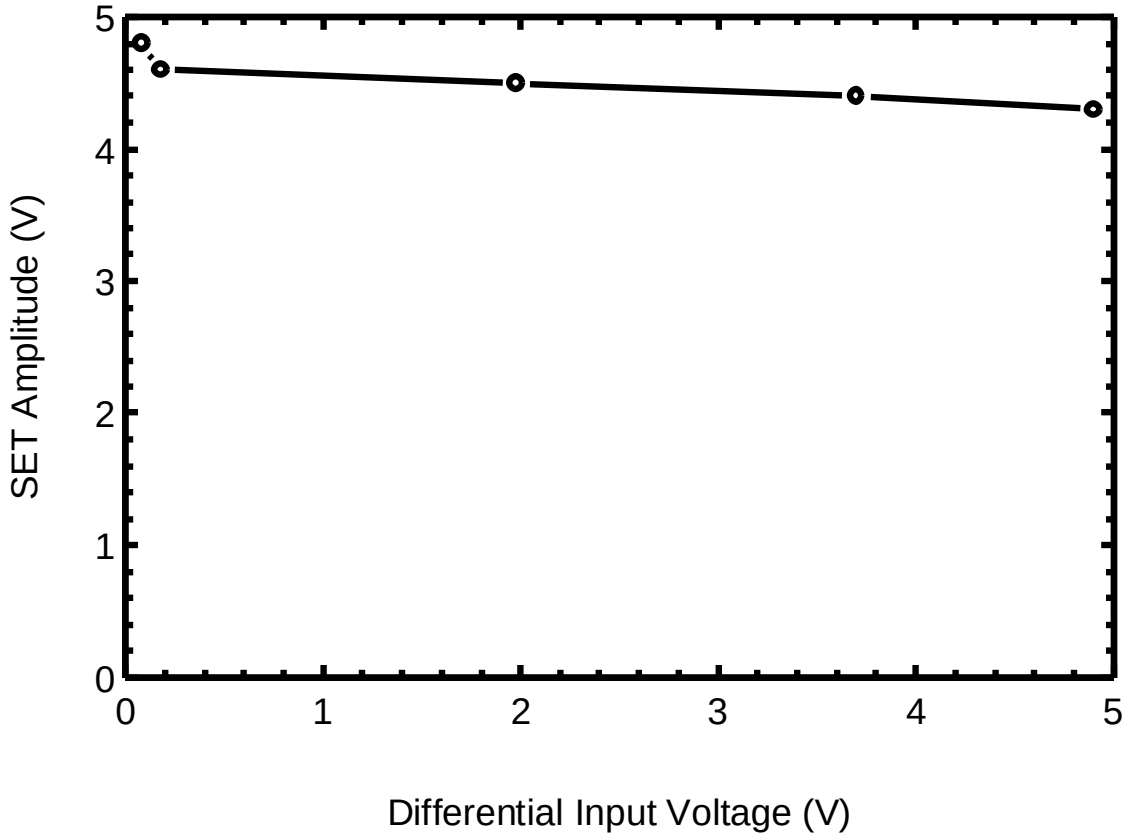
Heavy Ion Results



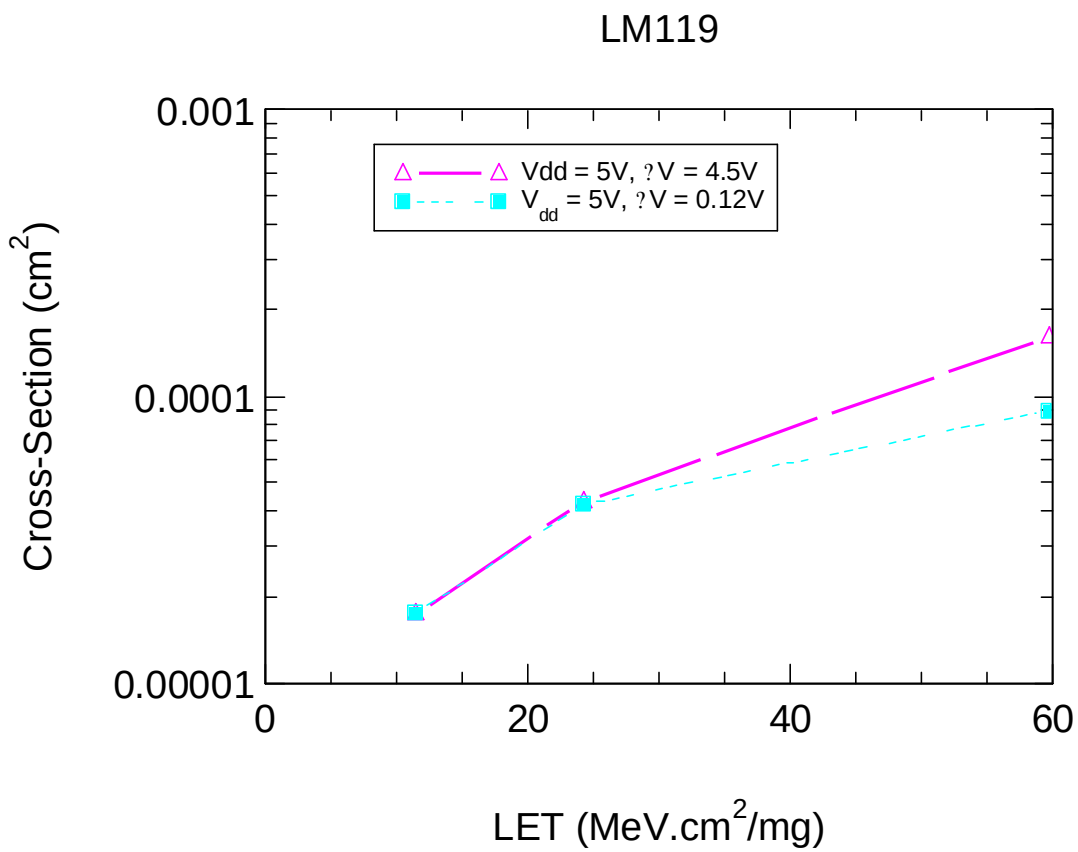
Pulsed Laser Results



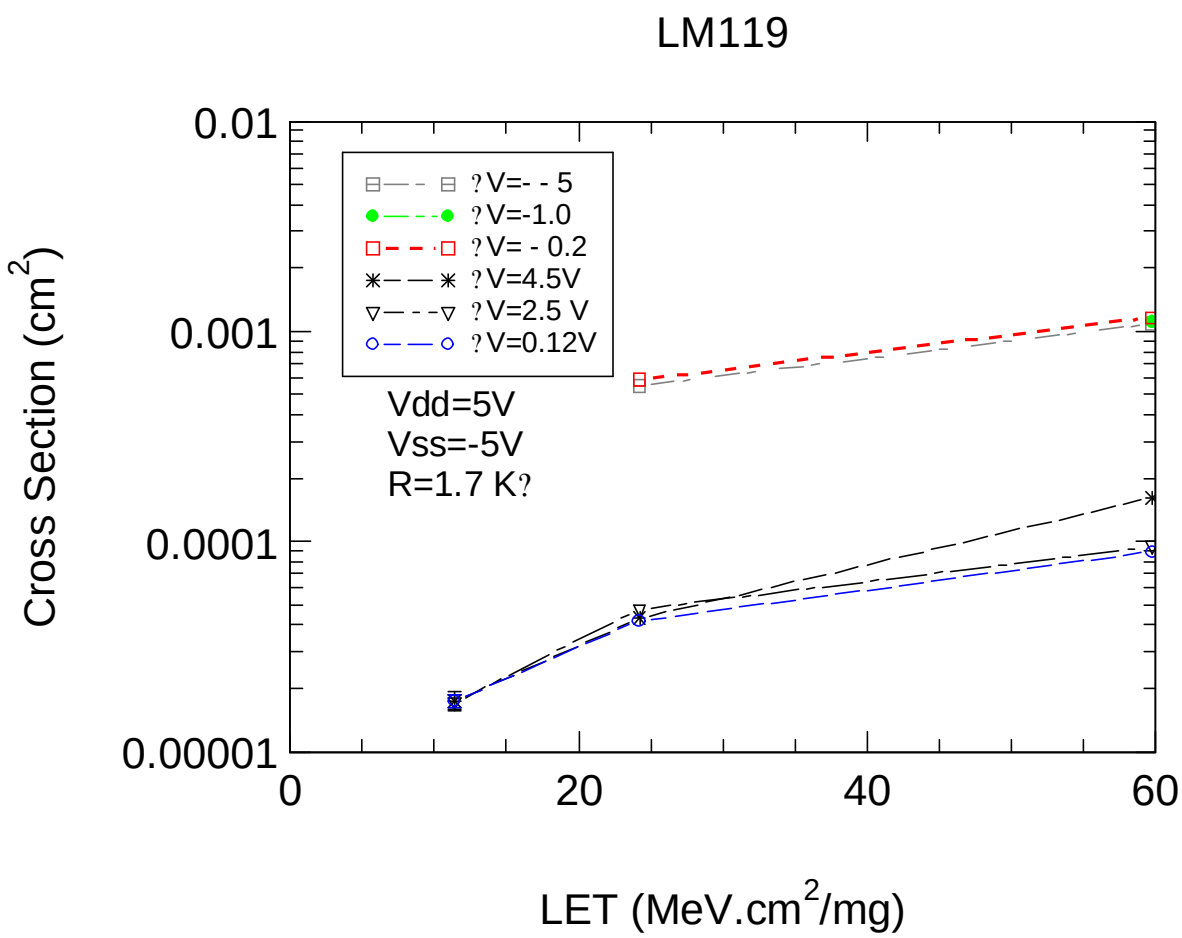
Pulsed Laser Results



Heavy Ion Results



Heavy Ion Results



Conclusions

- There is a wide parameter space for SETs in linears.
- Avoid heavy-ion testing for each condition by doing modeling.
- SPICE modeling requires a significant effort particularly if transistor parameters are not known.
- SET data from a pulsed laser can be used to validate SPICE models in a feedback mode.
- Ion microprobe is a valuable aid because of limitations of laser, i.e. metal coverage and penetration depth of the light.
- Pulsed laser can be used to check unique conditions rapidly.