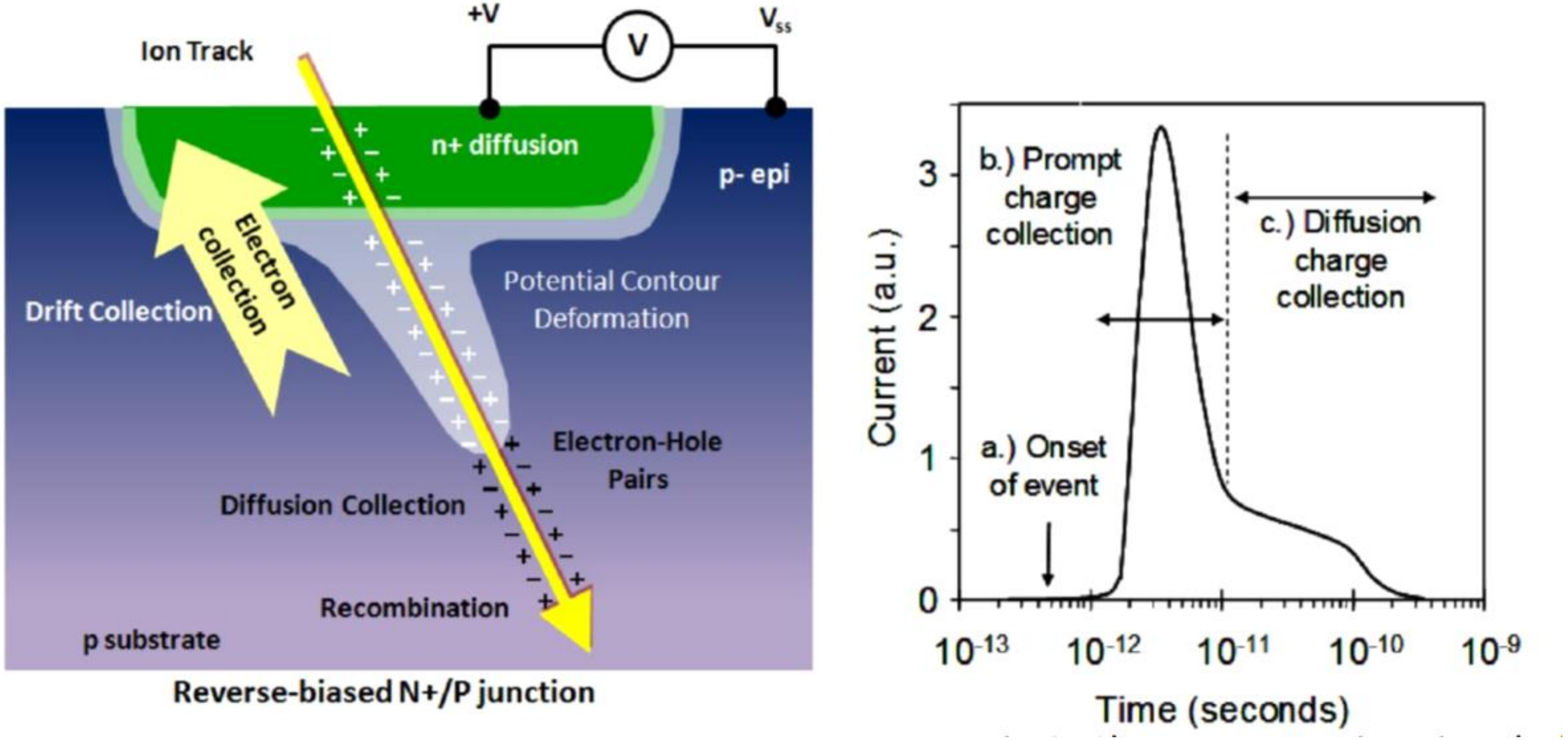
How pulsed laser SEE testing aids the space qualification of EEE components

Richard Sharp

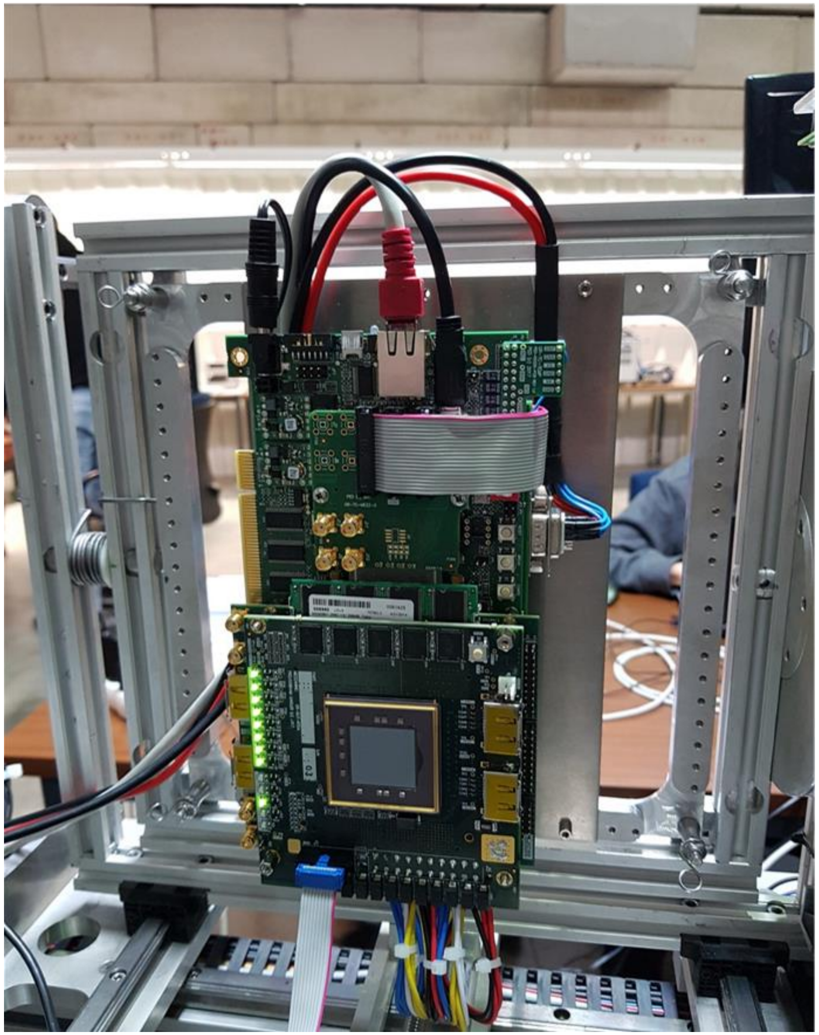
Carrier generation in semiconductors by the impact of a charged particle



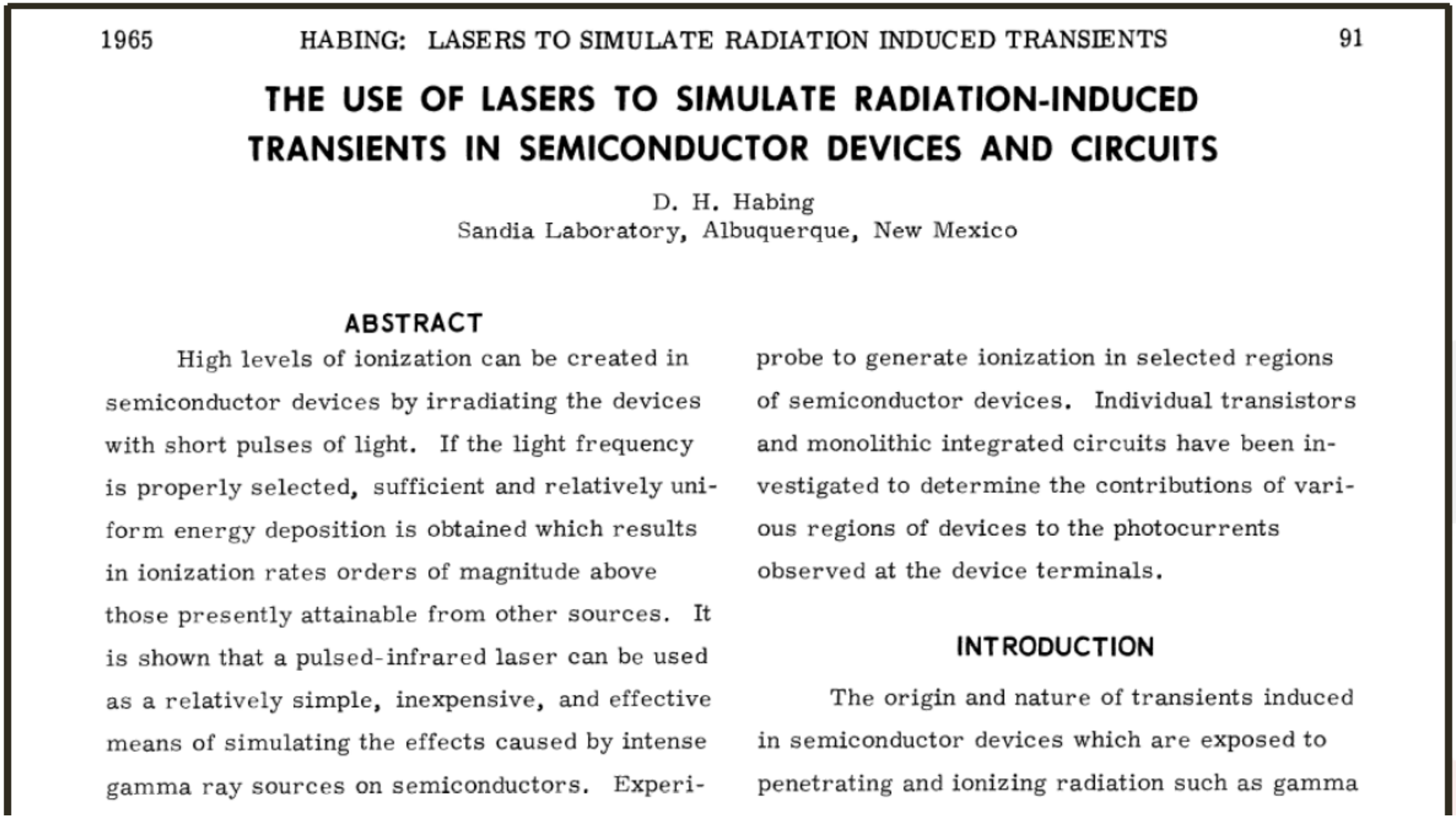
Baumann, “Landmarks in terrestrial single-event effects”, NSREC 2013 short course

Classic test facilities

Radtest Ltd



There is another way …



1965 HABING: LASERS TO SIMULATE RADIATION INDUCED TRANSIENTS 91

THE USE OF LASERS TO SIMULATE RADIATION-INDUCED TRANSIENTS IN SEMICONDUCTOR DEVICES AND CIRCUITS

D. H. Habing
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ABSTRACT

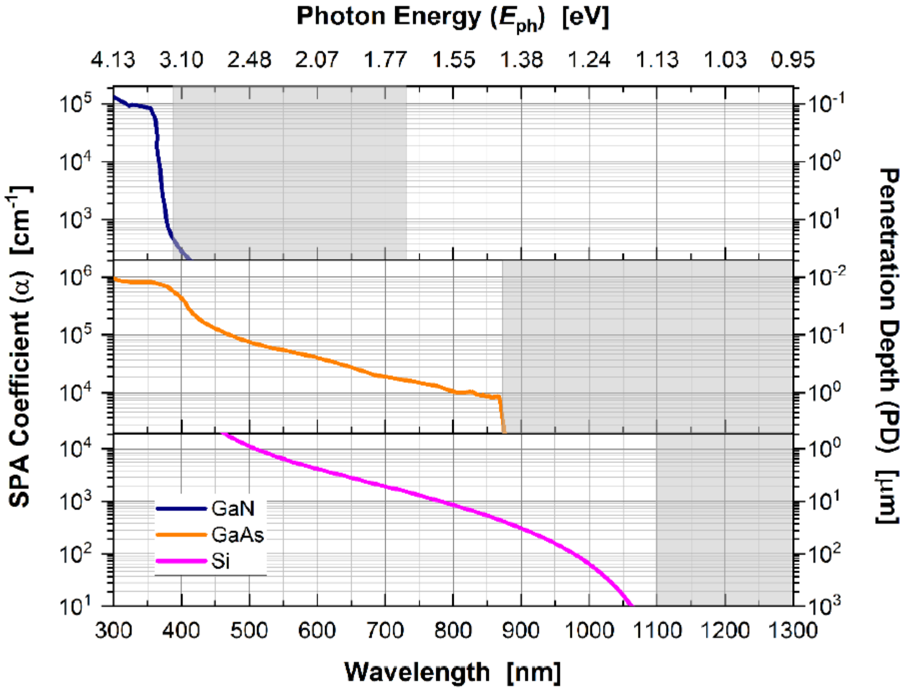
High levels of ionization can be created in semiconductor devices by irradiating the devices with short pulses of light. If the light frequency is properly selected, sufficient and relatively uniform energy deposition is obtained which results in ionization rates orders of magnitude above those presently attainable from other sources. It is shown that a pulsed-infrared laser can be used as a relatively simple, inexpensive, and effective means of simulating the effects caused by intense gamma ray sources on semiconductors. Experi-

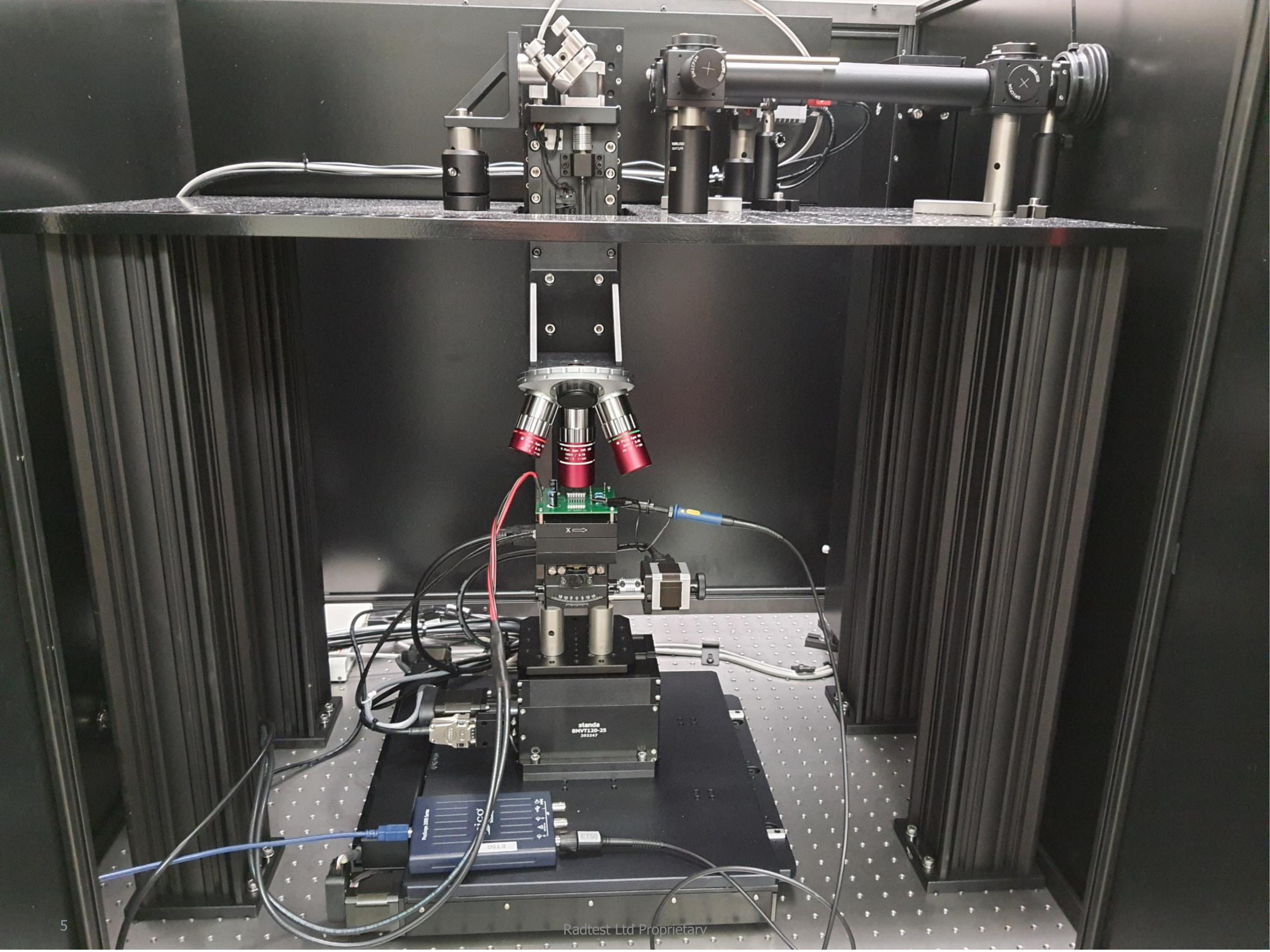
probe to generate ionization in selected regions of semiconductor devices. Individual transistors and monolithic integrated circuits have been investigated to determine the contributions of various regions of devices to the photocurrents observed at the device terminals.

INTRODUCTION

The origin and nature of transients induced in semiconductor devices which are exposed to penetrating and ionizing radiation such as gamma

SEREEL2 pulsed laser SEE test system

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How do they compare?

- Many studies have showed that HI and PL SEE testing give very similar results but a quantitative equivalence remains elusive
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- Factors influencing HI testing:
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  - Trajectory
  - Material composition/geometry

- Factors influencing PL testing:
  - Wavelength
  - Pulse duration
  - Material/doping
  - Metallisation
  - Pulse energy
  - Spot size
  - Surface preparation
  - Beam focus

Practical implications

- PL testing can reproduce nearly all types of single-event effect in silicon, except SEGR
- PL testing also replicates effects in WBG materials (SiC, GaN, etc)
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- PL v. HI as a screening tool
  - lower cost
  - better availability
  - higher throughput e.g. via unattended operation
  - consider effects seen under HI and not PL (and vice versa)

PL applications

What can I do?	Ion beam	Laser (SPA)	Laser (TPA)
Bulk screening of devices	x	✓✓	✓
Accurate cross-section v. LET	✓	x	x
Mapping SEE sensitivity	x	✓	✓✓
Rad hard product development	✓	✓✓	✓
Investigate deep charge collection phenomena	✓	✓	✓✓
Study rare events, e.g. SEFIs		✓✓	✓✓
Understand sensitive volumes in three dimensions			✓✓
Rapid SEL screening	x	✓✓	✓✓

SEL/'micro latch' effects

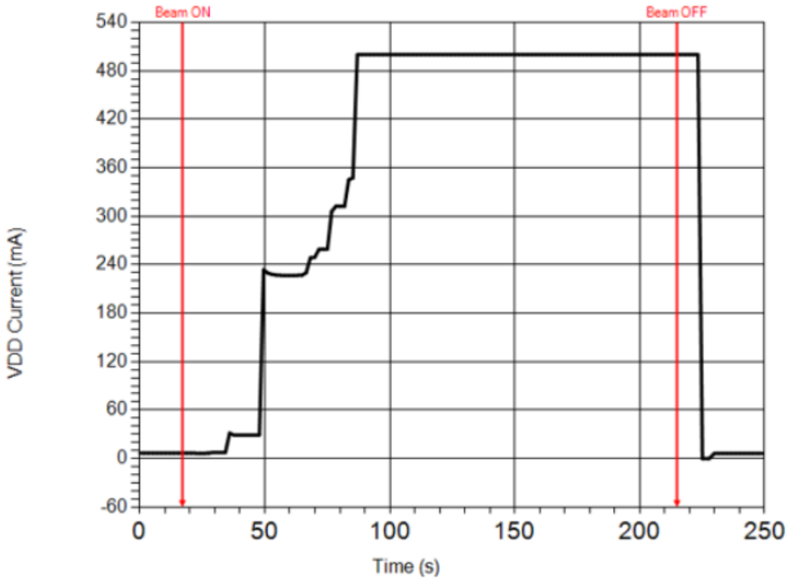


Fig. 21. MEMS Oscillator HI Exposure Current v. Time Plot

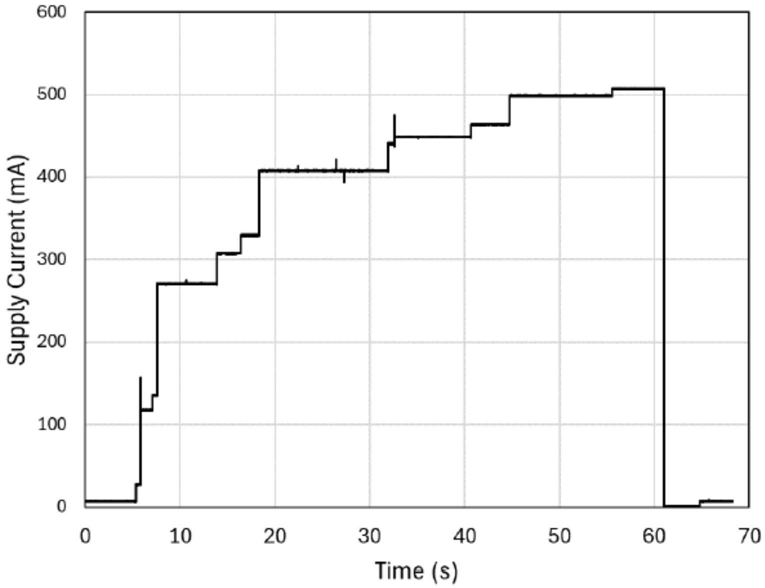
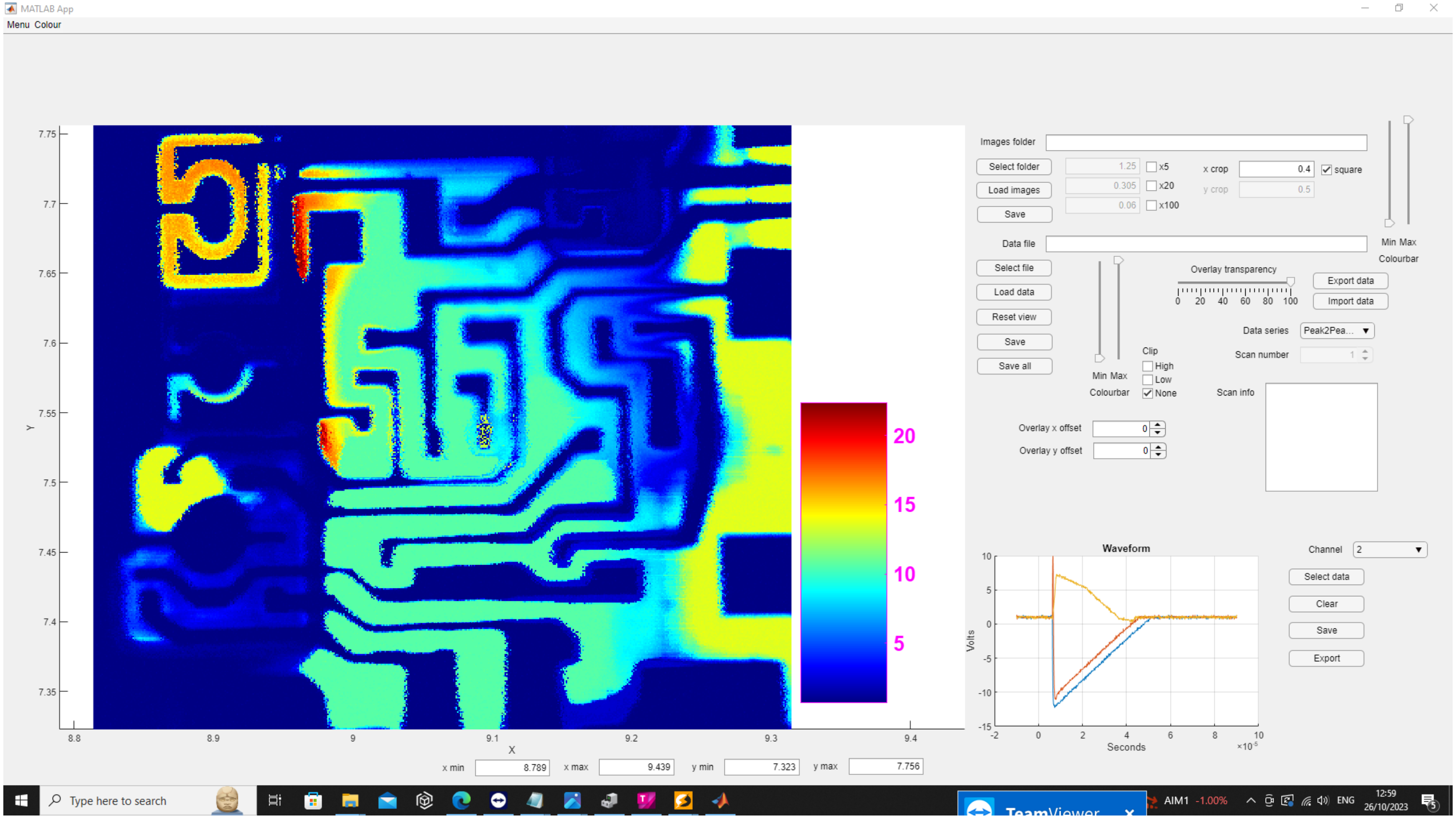


Fig. 22. MEMS Oscillator PL Exposure Current v. Time Plot

Ott, SEE/MAPLD, 2024

Heatmap of SET response



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y min 7.323
y max 7.756

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Use of PL testing for space qualification

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Bulk screening of devices	x	✓✓	✓
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