Update to Single Event Metadata Analysis Activities at JPL

Gregory R. Allen
grallen@jpl.nasa.gov
818 393-7558

Mark Hoffmann
mark.k.hoffmann@jpl.nasa.gov
626 240-8521

Wilson Parker
wilson.p.parker@jpl.nasa.gov
818 354-2525

Jet Propulsion Laboratory, California Institute of Technology

Acknowledgements:
This work was sponsored by:
The NASA Electronic Parts and Packaging Program (NEPP)

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement by the United States Government or the Jet Propulsion Laboratory, California Institute of Technology.


To be presented by Gregory R. Allen at the NEPP Electronics Technology Workshop, June 17th
To be presented by Gregory R. Allen at the NEPP Electronics Technology Workshop, June 17th.
Background
Task Objectives

• Due to the paradigm shift in spacecraft technology utilization, and the shift towards COTS technology, a plethora of COTS-based devices have been tested in recent years in addition to the decades of radiation data available in literature and online databases.

• We are developing an agency-level available database that attempts to expose radiation trends in the metadata.

• Our original focus will be on destructive effects (SEL, SEGR, etc.), but we will look beyond the standard voltage and temperature trends to manufacturer, technology process (not just node), device variables (e.g. for ADCs: number of bits, speed, architecture, etc).

• End goal is to expose buried trends to aid in part selection and MBSE analysis and guide bounding methodologies
Approach

- Assemble database of radiation results for a single part type
- Focus on one radiation effect (SEL screening)
- Use data scraping to automate database population of device parameters
- Employ predictive model for untested parts
- Employ machine learning to discover hidden trends
Previous Work - Example of Output from Model V.2.0

To be presented by Gregory R. Allen at the NEPP Electronics Technology Workshop, June 17th.
Metadata Analysis
Automatic Semantic Segmentation of Radiation Susceptible Electronics

• We attempt to build an automated system that can take the input of electronic die data and output the amount of susceptible area.

• The idea is that the greater the area of underlying components such as those that are CMOS is nature, is proportional to the susceptibility of the component undergoing various radiation effects.

![Plasma Etch of Linear Tech LTC1272-8CCSW#PBF](image)

Optical image showing the complete exposed die.

Optical image showing a detailed view of the die. Scratch in the die is an artifact from handling.
Methodology

• Data Collection
  – Electronic dies are consistently being made

• Labeling
  – Labeling of the electronic dies with the radiation susceptible areas vs. non radiation susceptible areas is a time consuming process. We label these images by drawing multiple bounding boxes on top of the die images so that we can generate ‘masks’ of areas of prediction

• Semantic Segmentation
  – We then build computer vision models that attempt to predict the class of every pixel on the die image one by one to determine total susceptibility of an electronic part

To be presented by Gregory R. Allen at the NEPP Electronics Technology Workshop, June 17th.
Semantic Segmentation

- Goal is to take raw pixels + pixel labels to predict the classes of the pixels.
- There are many popular methods for accomplishing this task, some of which include:
  - Fully Convolutional Models
  - Encoder – Decoder Models
  - Pyramid Based Network Models
  - R-CNN Based Models
  - DeepLab Based Models
  - Etc.

Example U-Net architecture that falls into the ‘Encoder-Decoder Models’ family.

To be presented by Gregory R. Allen at the NEPP Electronics Technology Workshop, June 17th.
High Image Resolution

Example Die Image and Mask (LTC1417)

Challenge of needing to properly splice the high resolution images into appropriate tiles to train, and then assemble back together.

To be presented by Gregory R. Allen at the NEPP Electronics Technology Workshop, June 17th.
Showing the Mask Overlay
Into Tile Transformation

data.show_batch(rows=2)
Conclusions & Future Work

• Continue to develop machine learning methodologies
• Repeat with spatially correlated SEL data from pulse laser
• Repeat with “fuller” database

To be presented by Gregory R. Allen at the NEPP Electronics Technology Workshop, June 17th.