

# NASA Electronic Parts and Packaging (NEPP) Program COTS Metadata - FY18

**Gregory R. Allen**

[grallen@jpl.nasa.gov](mailto:grallen@jpl.nasa.gov)

818 393-7558

**Mark Hoffmann**

[mark.k.hoffmann@jpl.nasa.gov](mailto:mark.k.hoffmann@jpl.nasa.gov)

626 240-8521

**Wilson Parker**

[wilson.p.parker@jpl.nasa.gov](mailto:wilson.p.parker@jpl.nasa.gov)

818 354-2525

**Jet Propulsion Laboratory, California Institute of Technology**

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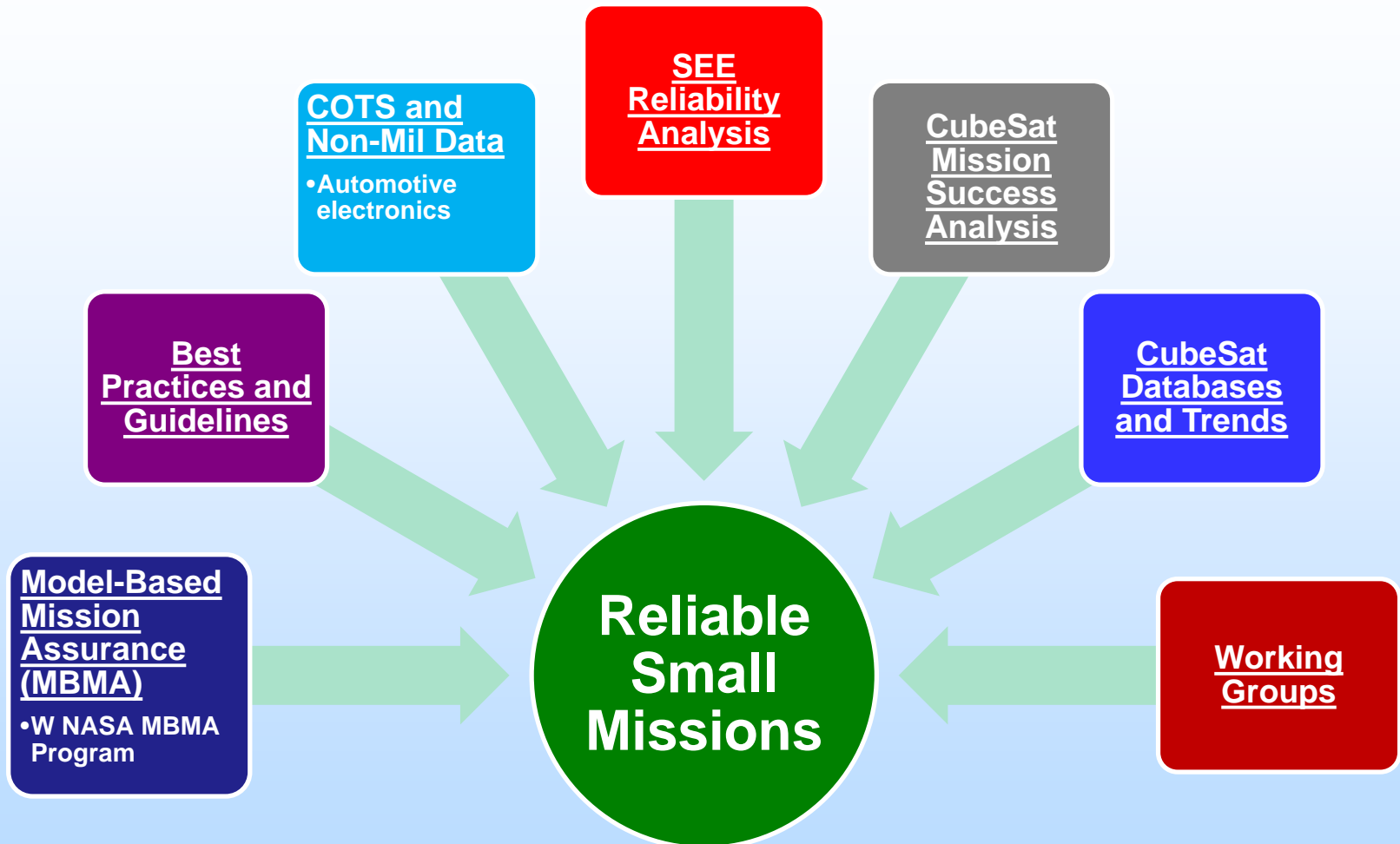
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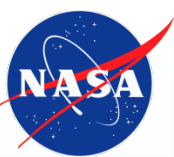
To be presented by Gregory R. Allen at the NEPP Electronics Technology Workshop, June 18<sup>th</sup>-21<sup>st</sup>.

***Unclassified***

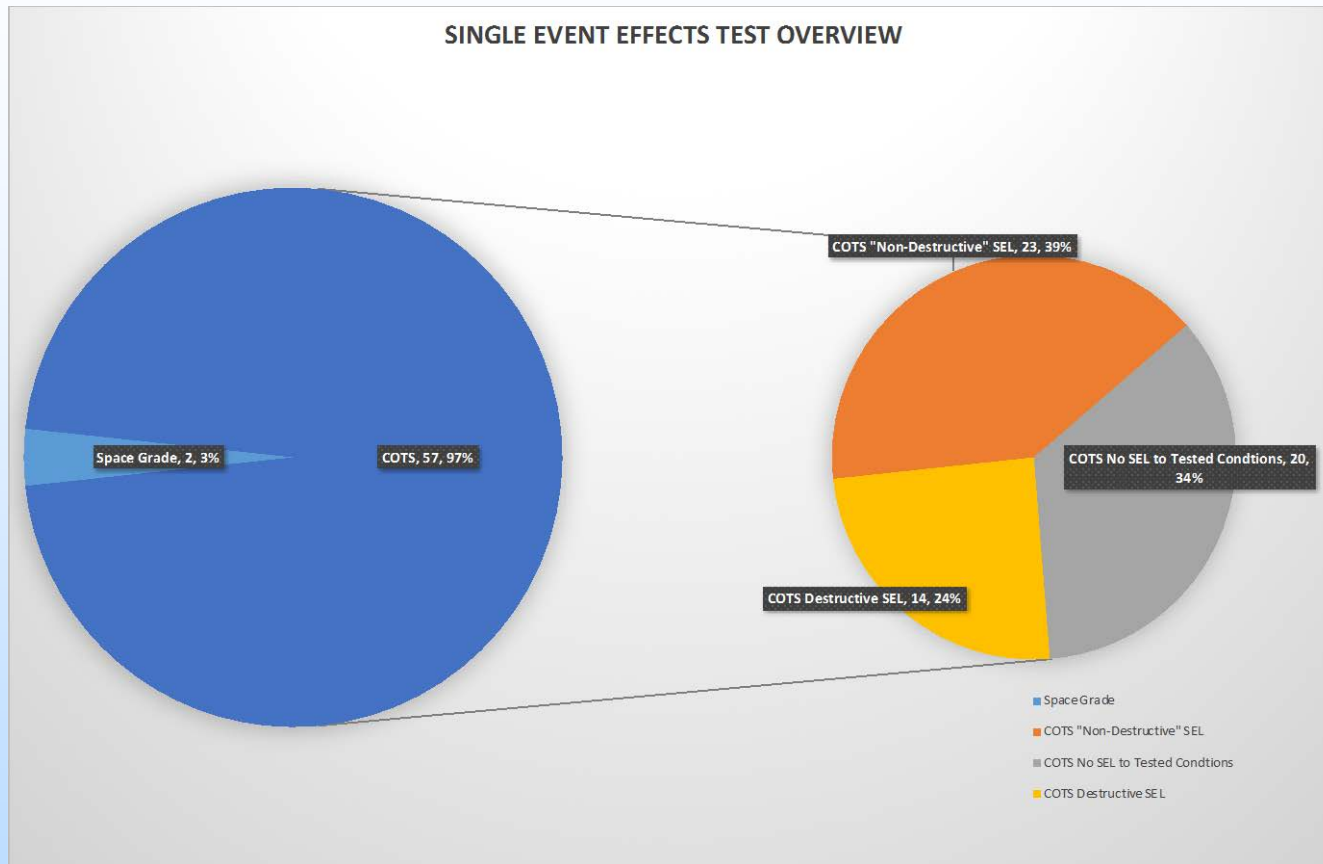


# NEPP - Small Mission and Emerging Architectures Efforts





# 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



# 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**



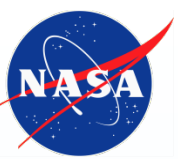
# Complete Objectives

- **Datasheet scraping tool completed**
  - Includes dynamic scraper
- **Developed V.2.0 model**
- **Developed UI V.1.0**
  - Dynamic model creation and scoring
  - Adding new data / reconciliation of existing tests
  - CRUD operations on test data
- **Added voltage and temperature as test levers**
- **Authentication system using JPL LDAP**
  - Ability for distinguishing between “Super” users that have permission to edit test data and “Normal” users that can look up parts



# Inputs to the Model

- **Device**
  - From the part number we extract everything we can
  - Future efforts to add inputs beyond the datasheet (doping profiles, die info, etc.)
- **Radiation results**
  - LET threshold
  - Test at voltage
  - Test at temperature
  - *Saturated cross-section*



# Target Transformations

– Don't have exact target LETth in many cases, however, since we were interested in predicting LETth, we had to make a couple of assumptions

- **Example Tests**

- $20 < \text{LETth} < 40$
- $\sim 25$
- $< 50$
- $> 75$

- **Transformation**

- 30 (contains uncertainty)
- 25
- 50 (high estimate)
- 75 (low estimate)





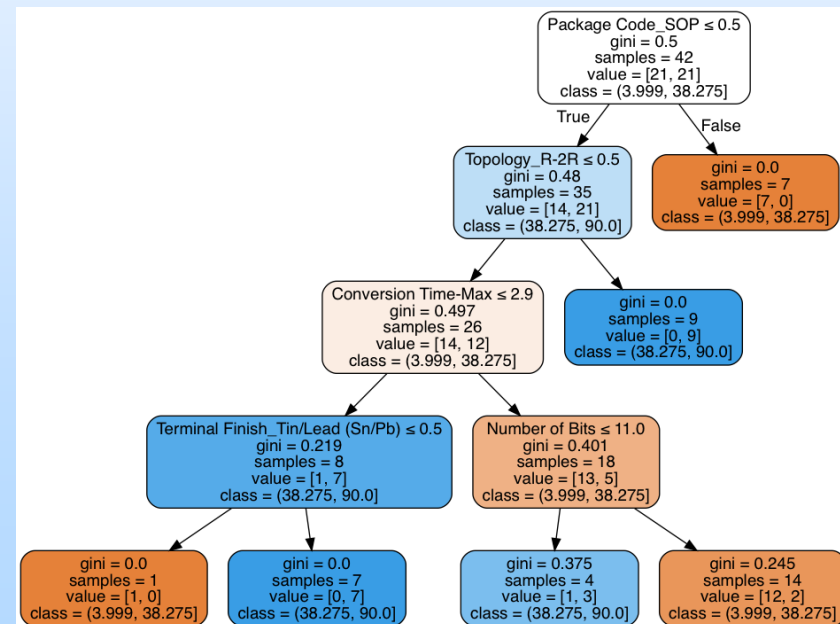
# Multiple Part Types

- **Each part contains a number of different “flavors” and can range from 5 to more than 60**
- **AD571**
  - **AD571JD**
  - **AD571SD**
  - **AD571JD/+**
  - **AD571SCHIPS**
  - **Etc....**



# Model Descriptions

- **Entropy based decision tree making predictions at various LET level splits**
  - This was chosen since models predicting a plain continuous variable were not able to fit very well based on the nature of the data with the sample size, but by doing these binary splits, we were able to get a much better fit for the sparse data
  - We are ultimately interested in a plain continuous variable prediction, the model V.2.0 attempts to transition smoothly from being weighted as mostly the step based decision tree and very little of a general linear predictor to leaning more on the linear predictor as it's uncertainty decreases.





# Logging In



## Radiation Metadata Tool

This tool is for the collection of testing data related to CMOS electrical components as well as assessing the risk associated with components for Single Event Latchup (SEL).

Login

LDAP Username


Password

Submit

- **Authentication via LDAP username and password**



# User Interface

**Jet Propulsion Laboratory**  
California Institute of Technology

**Radiation Metadata Tool**

This tool is for the collection of testing data related to CMOS electrical components as well as assessing the risk associated with components for Single Event Latchup (SEL).

Risk Profiling

Data Collection

**Risk Profiling**

Input a part number to see the risk associated with a SEL at different LETs. If we do not currently have the part number, in our records, we will go out and scrape the internet for the metadata, save it for future use, then make our predictions based on what we found.

**Input Part Number**



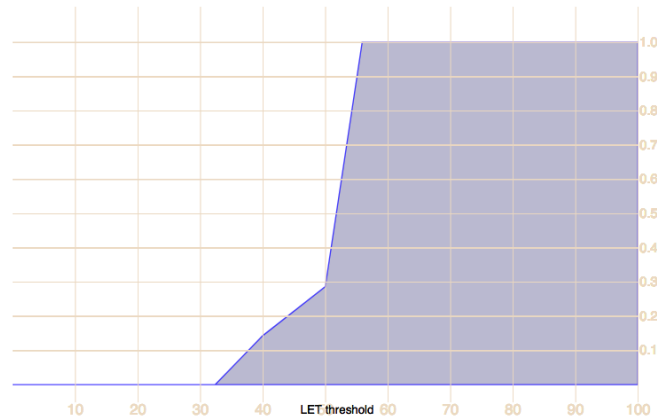
# Example of output from Model V.1.0

## IEEE Part Info

Mfr Package Description	PLASTIC, MSOP-10
REACH Compliant	Yes
Status	Active
Converter Type	ADC, PROPRIETARY METHOD
Analog Input Voltage-Min	0.0 V
Analog Input Voltage-Max	2.5 V
JESD-30 Code	S-PDSO-G10
JESD-609 Code	e0
Linearity Error-Max (EL)	0.0488 %
Moisture Sensitivity Level	1
Number of Analog In Channels	2
Number of Bits	12
Number of Functions	1
Number of Terminals	10
Operating Temperature-Min	0.0 Cel
Operating Temperature-Max	70.0 Cel
Output Bit Code	BINARY
Output Format	SERIAL
Package Body Material	PLASTIC/EPOXY
Package Code	HTSSOP
Package Equivalence Code	TSSOP10, 19,20
Package Shape	SQUARE
Package Style	SMALL OUTLINE, HEAT SINK/SLUG, THIN PROFILE, SHRINK PITCH
Peak Reflow Temperature (Cel)	235
Power Supplies (V)	3/3.3
Qualification Status	Not Qualified
Sample-and-Hold/Track-and-Hold	SAMPLE
Sample Rate	3.0 MHz
Seated Height-Max	1.1 mm
Sub Category	Analog to Digital Converters
Supply Voltage-Nom	3.0 V

Clear

## Risk Threshold



- Model output up until about LET of 55 MeV-cm<sup>2</sup>/mg then since we know a SEL occurred there from an existing test, it overrides as 100% probability above that.



# Example of Output from Model V.2.0



## Radiation Metadata Tool

This tool is for the collection of testing data related to CMOS electrical components as well as assessing the risk associated with components for Single Event Latchup (SEL).

Risk Profiling Data Collection

### Risk Profiling

Input a part number to see the risk associated with a SEL at different LETs. If we do not currently have the part number, in our records, we will go out and scrape the internet for the metadata, save it for future use, then make our predictions based on what we found.

Clear

### IEEE Part Info

Mfr Package Description	0.209 INCH, PLASTIC, SSOP-28
REACH Compliant	Yes
Status	Active
Converter Type	ADC, SUCCESSIVE APPROXIMATION
Analog Input Voltage-Min	-2.5 V
Analog Input Voltage-Max	2.5 V
Conversion Time-Max	1.15 $\mu$ s
JESD-30 Code	R-PDSO-G28
JESD-609 Code	e0
Linearity Error-Max (EL)	0.0122 %
Moisture Sensitivity Level	1
Negative Supply Voltage-Nom	-5.0 V
Number of Analog In Channels	1
Number of Bits	14
Number of Functions	1
Number of Terminals	28
Operating Temperature-Min	0.0 Cel
Operating Temperature-Max	70.0 Cel
Output Bit Code	2'S COMPLEMENT BINARY
Output Format	PARALLEL, WORD
Package Body Material	PLASTIC/EPPOXY
Package Code	SSOP
Package Equivalence Code	SSOP28_3
Package Shape	RECTANGULAR
Package Style	SMALL OUTLINE, SHRINK PITCH
Peak Reflow Temperature (Cel)	235
Power Supplies (V)	+5
Qualification Status	Not Qualified
Sample-and-Hold/Track-and-Hold	SAMPLE
Sample Rate	0.8 Mbit/s

### Temperature

25

### Voltage

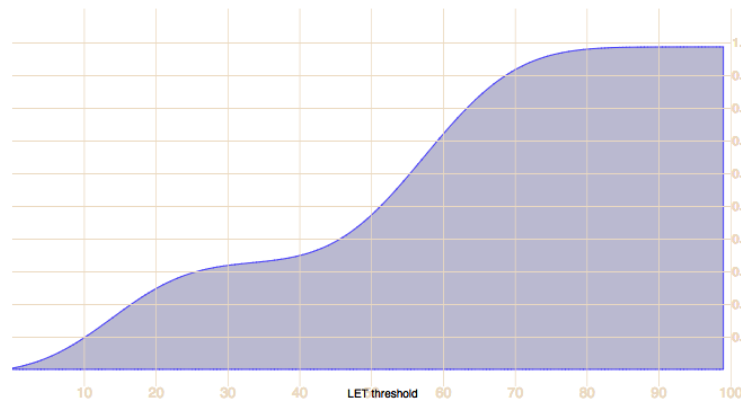
3

Update

### Test Info

Part	Temperature	Voltage	Details
LTC1419			84.0 < SEL < 68.3

### Risk Threshold



- Small UI updates allowing the user to see output of different Temperatures and Voltage levels.
- Displays historic test information
- Alpha of Model V.2.0 -- Still need to incorporate reconciling of existing tests for overriding predictions like with V.1.0.



# Existing Test Repository



## Radiation Metadata Tool

This tool is for the collection of testing data related to CMOS electrical components as well as assessing the risk associated with components for Single Event Latchup (SEL).

Risk Profiling | Data Collection

### Data Collection

Data collection to store information about tests and make our model stronger.

#### New Tests

Part Number

Temperature (Celsius)

Voltage (V)

LET Type

Select an option

Submit

#### Test Archive

Part ID	Temp.	Voltage	Comparator	LET_exact	LET_under_low	LET_over_high	LET_mid_low	LET_mid_high	Delete
AD571	24	3	EXACT	25					Delete
AD7821			RANGE				75	80	Delete
ADC1175			EXACT	23					Delete
LTC2297			RANGE				10	19	Delete
AD9200			BAD DATA						Delete
AD1674			GREATER THAN			37			Delete
AD7854			RANGE				6.7	11.4	Delete
AD7858			RANGE				11.4	22.8	Delete
AD7888			RANGE				16.7	22.8	Delete
AD7472			EXACT	12					Delete
AD7476			LESS THAN		60				Delete
AD9223			RANGE				11.4	20	Delete
LTC1272			LESS THAN		5.6				Delete
LTC1407			RANGE				32.4	55.9	Delete
AD9240			LESS THAN		19				Delete
LTC1417	82		GREATER THAN			75			Delete
LTC1419			RANGE				64	68.3	Delete
ADC14155			GREATER THAN			75			Delete
AD9259			GREATER THAN			32.4			Delete
LTC1604	85		RANGE				55	58	Delete

Previous

Page 1 of 3

20 rows

Next

Save Changes

- Add new tests with form on left  
It automatically looks up existing tests for the part and combines existing tests if necessary
- Edit / save / remove existing tests in table with verification if the data is filled out properly for each row

# Admin Management

[illegible]

- Since we are allowing access to to edit and remove test data, we manage "super" users to give access to data management





[Risk Profiling](#)
[Data Collection](#)
[Admin](#)

**A Place for Admin users to add or remove other admin users. Admins can View the Data Collection page along with adding and modifying existing tests.**

Cancel	Add as Super User?
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[illegible]

- **Connects into LDAP to pull information to verify it's the correct person before they are added**



# Future Work

- **Modeling v2 updates – Need to error handle all possible cases that could throw off new model since level of complexity has risen significantly from v1**
- **Better pruning of dynamic models based on class counts**
- **Model logging system**
- **Many to one flavor consolidation pipeline (information lookup + general part view) (Right now just taking first flavor and assuming it is very similar, which is not always the case)**
- **Better “smart” scraping of information for growing metadata repository faster vs. just looking up a single part as it is input**
- **Deployment**
- **Abstracting / refactoring code further for ease of future additions and portability of backend framework across other projects**