NEPP/OSMA Perspective:
EEE Parts Data and Knowledge Repositories

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Outline

- **Electronics radiation databases**
- **NEPP's view of integrating knowledge**

NEPP has had discussions on data sharing in the past month with:

- **NASA S3VI**
- **AFRL (VSE)**
- **AF SMC**
- **The Aerospace Corp**
- **JPL**
- **ESA**

Violent agreement on need for better sharing!

EEE Parts Radiation Data - Status

- **NASA/NEPP – RADHOME and NEPP website (open access to both)**

- **JPL – RADNET – US only requiring login**

- **ESA – ESCIES – currently open access***

- **NRL – REDEX – no longer exists**

- **ERRIC/DASIAC – no longer exists**

- **RADCAT ™ - no longer exists**

- **JSC – unknown**

- **Pay for data: rad-data.net**

- **Under development/negotiation – searchable database of IEEE Radiation Effects Data Workshop (largest known repository of COTS rad data)**

  - **NEPP plans to have this on-line in a month or two**

  - **Caveat: This will require an IEEE Xplore membership to pull up actual data**

IEEE REDW Radiation Data

Radiation Effects Data Workshop Searchable Table -- Double Click on a Row to View Abstract or Full Text

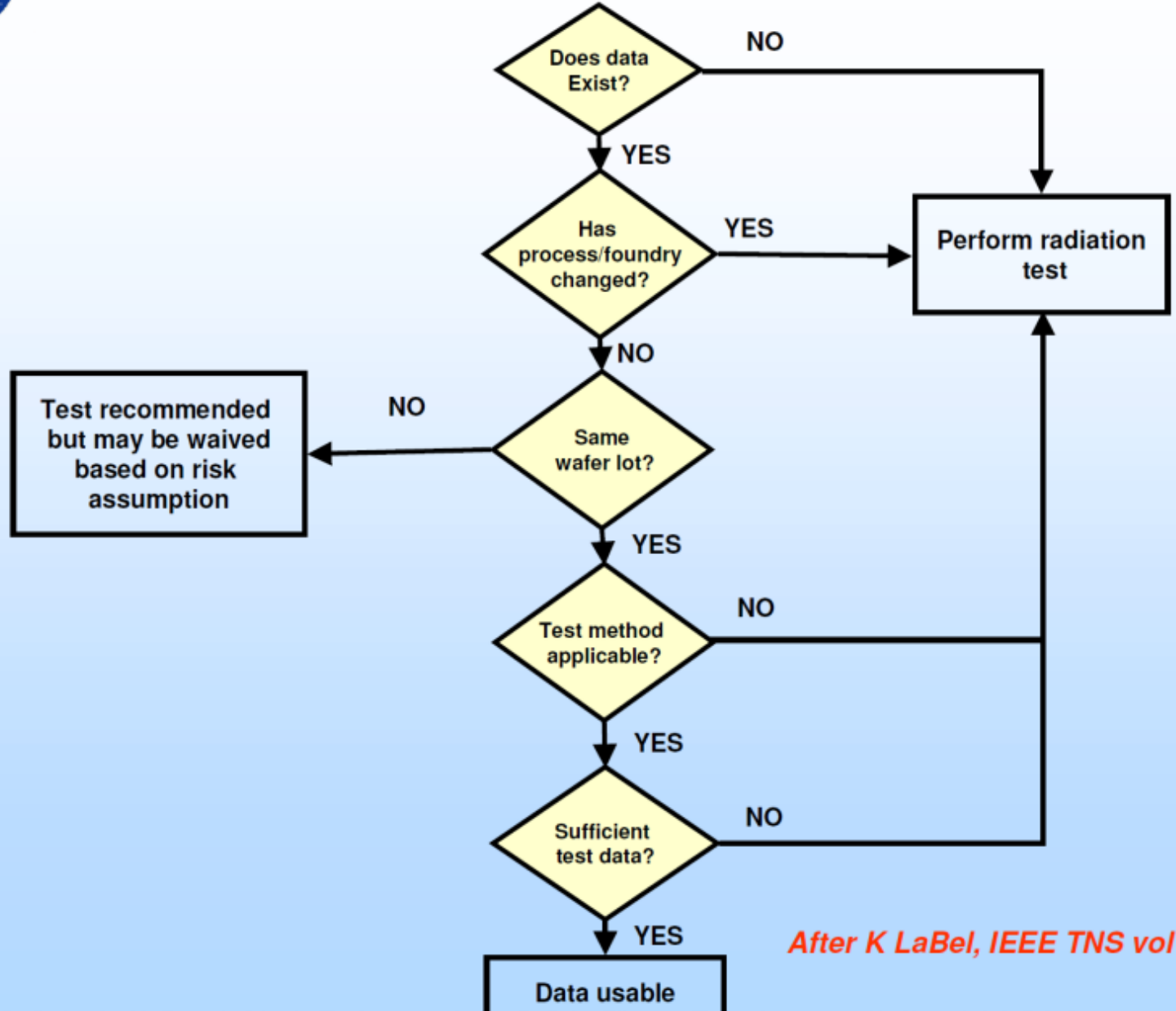CLEAR SEARCH and RESET TABLE to Display All Parts | Page 1 of 1,126 | 5 | Record 1 - 5 of 5,626

Year	Paper	Page(s)	First Auth	Part Num	Type	Manufact	Data	TID	SEU	SET	SEFI	SEL	SEB	SEGR	Dose Rat	Displacer	Facilities	Standard	Environm	Shielding
2012	1	1-6	D. Hiemst	--	Guide to	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2012	2	7-12	K. Scott	HCPL-523	Optocoup	Avago	Terrestria	--	--	--	--	--	--	--	--	Proton	--	--	--	--
2012	2	7-12	K. Scott	LM10	Operation	Texas Ins	Terrestria	ELDRS	--	--	--	--	--	--	--	Neutron	--	--	--	--
2012	2	7-12	K. Scott	OP484	Operation	Analog De	Terrestria	ELDRS	--	--	--	--	--	--	--	Neutron	--	--	--	--
2012	2	7-12	K. Scott	AD590	Temperat	Analog De	Terrestria	ELDRS	--	--	--	--	--	--	--	Neutron	--	--	--	--

Page 1 of 1,126 | 5 | Record 1 - 5 of 5,626

- **Based on yearly guideline published by David Hiemstra, MDA Corporation**
  - **He has kindly shared with us the spreadsheet he uses for the annual list of what data has been published in the REDW**
  - **~7000 records of radiation data on electronics**
- **Have discussed with IEEE Radiation Effects Steering Group (RESG)**
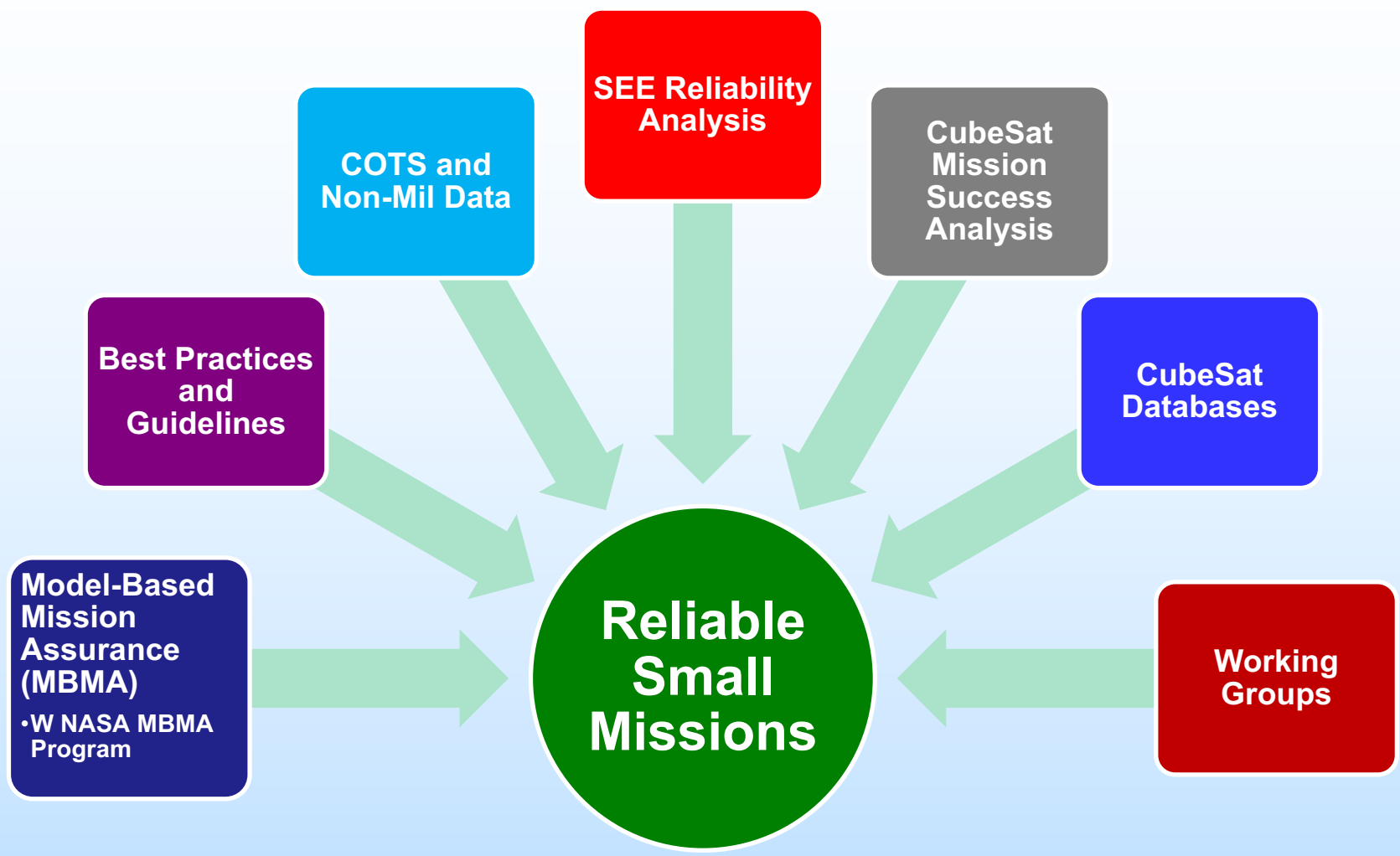 - **They concur with access to this searchable version**

Data Search and Definition of Data Usability Flow

Does data Exist? → NO → **Perform radiation test**

↓ YES

Has process/foundry changed? → YES → **Perform radiation test**

↓ NO

Same wafer lot? → NO → **Test recommended but may be waived based on risk assumption**

↓ YES

Test method applicable? → NO →

↓ YES

Sufficient test data? → NO →

↓ YES

Data usable

After K LaBel, IEEE TNS vol 45-6, 1998

Quality Leadership Forum in Orlando, Fl – Assurance Against Radiation Effects on Electronics presented by Kenneth A. LaBel– Sep 28, 2004

5

NEPP - Small Mission Efforts

SEE Reliability Analysis

COTS and Non-Mil Data

CubeSat Mission Success Analysis

Best Practices and Guidelines

CubeSat Databases

Model-Based Mission Assurance (MBMA)
•W NASA MBMA Program

Reliable Small Missions

Working Groups

FY18 possible extensions:

automotive, avionics, and autonomous vehicles resilience

To Be Clear:
NEPP's Big Three for Small Missions

- **Development of best practices/guidelines based on 3x3 risk matrix approach**

- **Increased sharing of COTS data**

- **MBMA and *integrated* risk evaluation tool infrastructure**
  - **Focus currently on radiation effects, but approach ports to POF, reliability, etc…**

Criticality	Environment/Lifetime		
High	Level 1 or 2 suggested. COTS upscreening/ testing recommended. Fault tolerant designs for COTS.	Level 1 or 2, rad hard suggested. Full upscreening for COTS. Fault tolerant designs for COTS.	Level 1 or 2, rad hard recommended. Full upscreening for COTS. Fault tolerant designs for COTS.
Medium	COTS upscreening/ testing recommended. Fault-tolerance suggested	COTS upscreening/ testing recommended. Fault-tolerance recommended	Level 1 or 2, rad hard suggested. Full upscreening for COTS. Fault tolerant designs for COTS.
Low	COTS upscreening/ testing optional. Do no harm (to others)	COTS upscreening/ testing recommended. Fault-tolerance suggested. Do no harm (to others)	Rad hard suggested. COTS upscreening/ testing recommended. Fault tolerance recommended
	Low	**Medium**	**High**

NEPP Notional EEE Parts Assurance

- Tailored Risk Acceptance

Model-Based Systems Engineering (MBSE) for Mission Assurance (MA) - aka MBMA

- **Led by NASA/OSMA Reliability and Maintainability (R&M) Program**
  - **NEPP co-funds efforts that are EEE parts related (tasks listed below)**
- **Completed tasks (assurance case)**
  - **Vanderbilt University: Goal structuring notation (GSN) exemplar for single event effects (SEE) in a CubeSat electronics board**
- **Current tasks**
  - **Vanderbilt University:**
    - **Bayesian nets for CubeSat electronics (radiation)**
    - **On-line sysML/GSN tool for CubeSat electronics**
      - **DEMOED on July 18, 2017 at IEEE NSREC conference**
    - **Multiple new tasks in FY18**
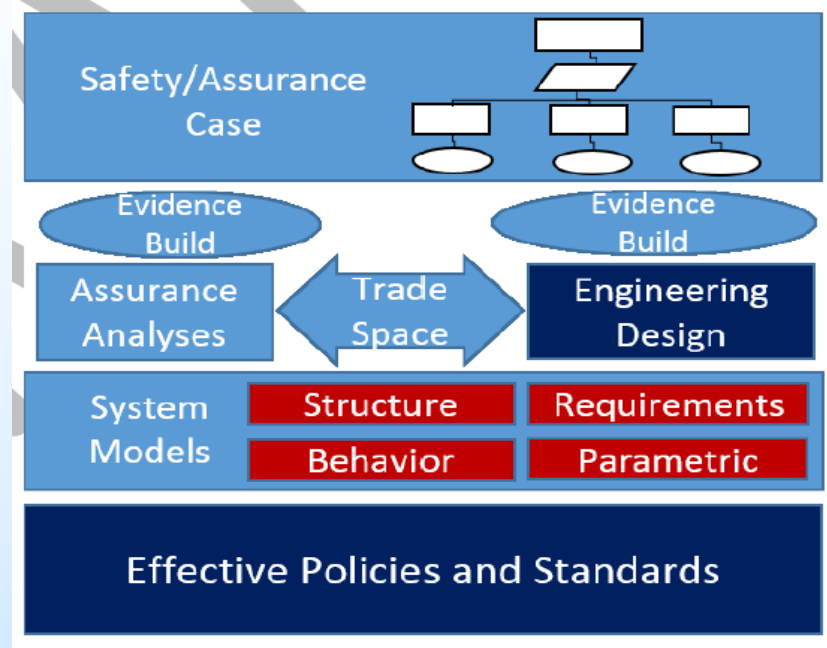
A Vision for Model Based Assurance

- John Evans, NASA/OSMA

"Knowledge may be power,

however, <u>integrated tools </u>allow the power to be applied" - *LaBel*

Vanderbilt's View of MBMA
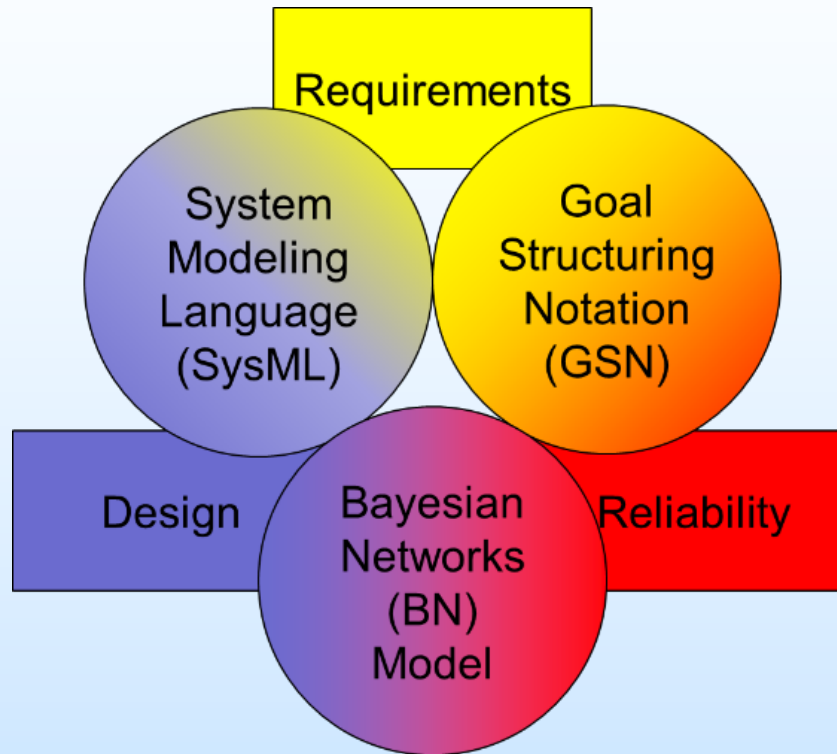
NEPP (w/ NASA MBMA Program)
Pieces to the puzzle (partial)

Emerging Architecture
Vanderbilt University
Web-based tool (SEAM)

Developing Requirements and Goals
NASA/GSFC (Campola) - Vanderbilt
Notional RHA Tool (R-GENTIC)
NASA/GSFC (Xapsos)
RHA Confidence Approach

Exemplars and Training for MBMA
Vanderbilt University
GSN Exemplar (SEE) – complete
TBD
GSN Exemplar – EEE parts reliability
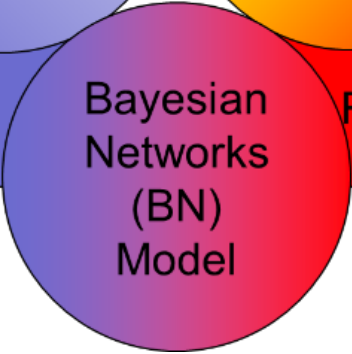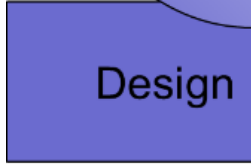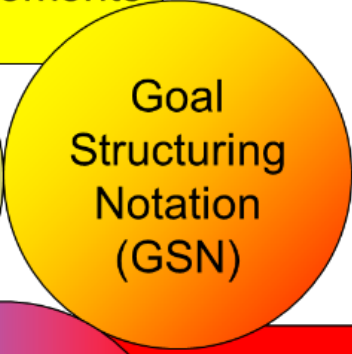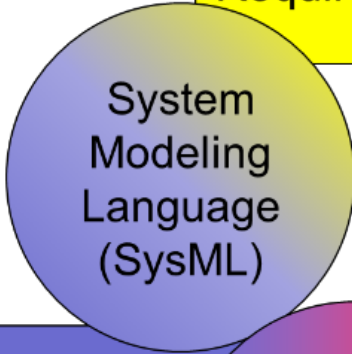
COTS Data
GSFC
NEPP/Radhome data
(+ collaborations)
GSFC
IEEE REDW access
GSFC/JPL (new data)
CubeSat EEE Parts Testing

Understanding the Small Mission Universe
Saint Louis University
CubeSat Success Study
JPL
CubeSat EEE Parts Database Studies
Aerospace (proposed)
CubeSat Kit Vendor Survey

Best Practices (Process and Test)
NASA/GSFC (Campola)
Small Mission RHA
NASA/GSFC
Small Mission EEE Parts Best Practices
NASA/GSFC (Xapsos)
RHA Confidence Approach
GSFC
Board Level Testing and EEE Part Reliability
JPL
Board Level Proton Testing

Requirements

System Modeling Language (SysML)

Goal Structuring Notation (GSN)

Design

Bayesian Networks (BN) Model

Reliability

Knowledge Sharing
Integration with S3VI
(NASA/ARC)
GSFC
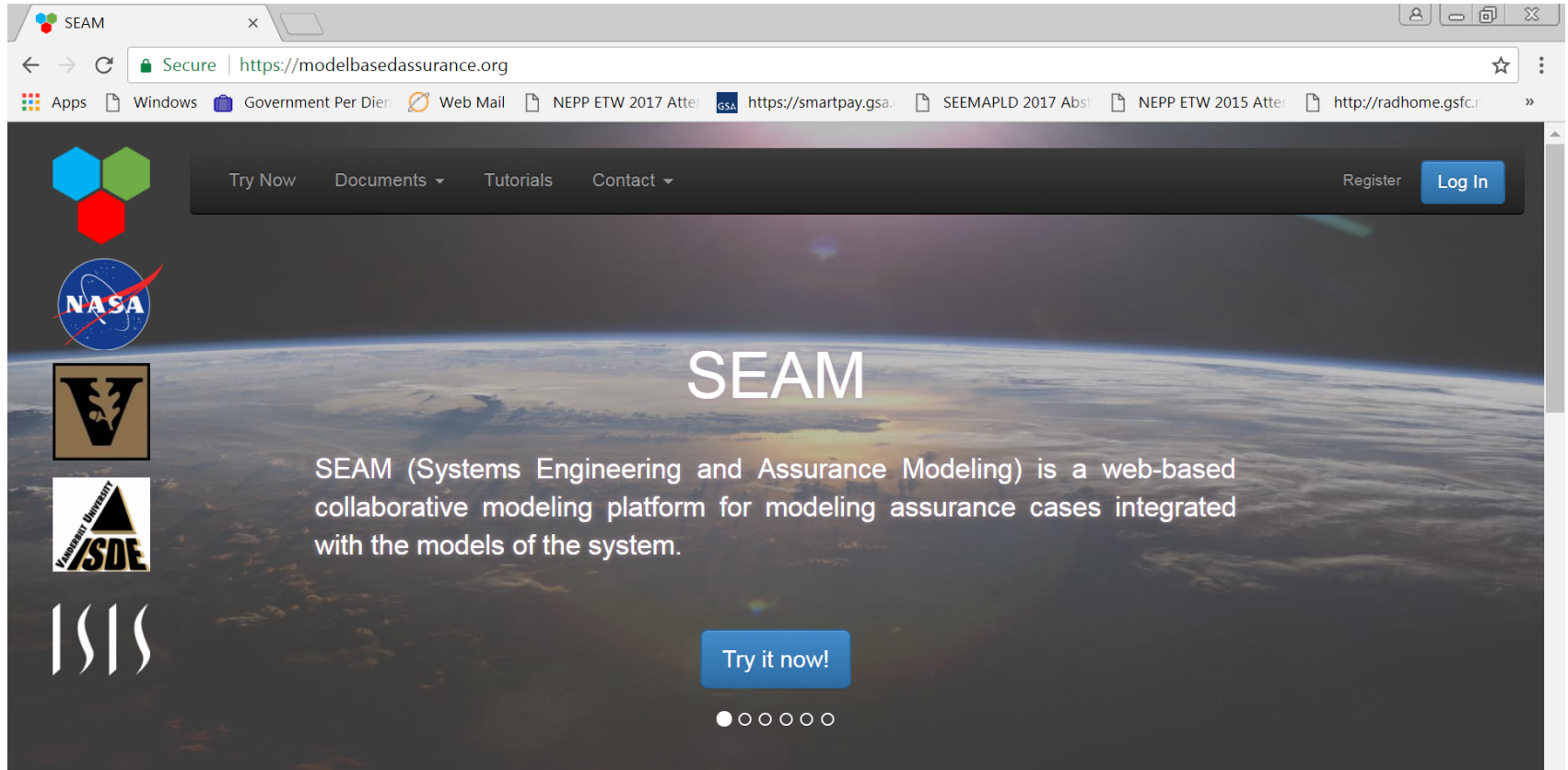ESA Small Mission RHA

Tools for Radiation Reliability
NASA/GSFC (Berg)
SEE Classic Reliability
Vanderbilt
CRÈME Toolsuite
Vanderbilt
BN Model + Integrating into SEAM
NASA/GSFC (Xapsos)
RHA Confidence Approach

TBD
Resilience, autonomy

Reliable less than MIL
Aerospace (proposed)
Space Enhanced Performance
(SEP) Electronics Grade Study

https://modelbasedassurance.org/

# https://modelbasedassurance.org

BACKUP

Best Practices and Guidelines

- **Current tasks**
  - **Radiation hardness assurance (RHA) for Small Missions**
    - NASA/GSFC: Michael Campola
  - **Board-level proton testing**
    - JPL: Steve Guertin
  - **Body of knowledge (BOK) on best practices for EEE part reliability via board testing**
    - NASA/GSFC (Lentech): Ed Wyrwas
- **Planned tasks**
  - **EEE Parts assurance for small missions**
    - TBD (overdue)
  - **Work with NASA/GSFC and NASA STMD for release of CubeSat tool**
    - R-GENTIC (Michael Campola)
      - R – Radiation GuidelinEs for Notional Threat Identification and Classification
    - *Plan is to make available via the web (NEPP website) and demo at IEEE NSREC*

Non-Mil/Aero EEE Parts

- **Automotive grade**
  - **Began FY15**
    - **Snapshot of representative part types under evaluation for reliability**
  - **Began FY16**
    - **Support of NASA Engineering Safety Center (NESC) automotive grade tests (limited electrical tests and a few radiation tests)**
  - **Plans**
    - **Guideline/lessons learned**
    - **Resilience/soft error rate – challenge in finding a partner**
    - **Have begun partnership with The Aerospace Corp**
- **COTS**
  - **Testing of COTS has been a cornerstone of the NEPP Program including processors, memories, FPGAs, power devices, etc…**
    - **Multiple on "CubeSat" class electronics - see presentations at weblinks on chart 2.**
      - **Example: radiation data on TI MSP430 processors**
  - **Plans**
    - **Discuss FY18 tasks for "CubeSat" class EEE parts**
    - **Plastic encapsulated device guideline**
- **NEPP radiation data can found at**
  - **http;//nepp.nasa.gov**
  - **http://radhome.gsfc.nasa.gov**
  - **Or via IEEE search**
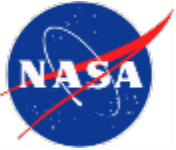
NEPP CubeSat Success and Databases

- **Mission Success Analysis (Prof. Michael Swartwout/SLU)**
  - **NEPP has been funding on-going tracking of CubeSat mission success with newer emphasis on root-cause (improved assurance practices)**
- **CubeSat Databases**
  - **JPL: two studies (need to update studies or tie into other studies)**
    - **Kit manufacturer EEE parts approaches**
    - **What EEE parts NASA (and JPL) are using in CubeSats**
  - **JPL: Limited evaluation of CubeSat kit electronics boards**
  - **JPL Action: integrate databases with The Aerospace Corp, SPOON database and with success study (if possible)**
    - **New: discuss with Ames (Small Spacecraft Virtual Institute)**

Radiation Reliability Analysis and Working Group

- **Single event effect (SEE) reliability analysis**
  - **NASA/GSFC (Melanie Berg/AS&D) - Current effort focused on developing model for treating SEE in a manner similar to reliability (i.e., how many 9's rather than a SEE rate)**
  - **Planned task is integration with MBMA tools approach**
- **Working groups**
  - **NEPP working group meets monthly on "CubeSat databases"**
    - **The Aerospace Corp and Prof. Swartwout participate**
  - **Support of MAIW (by invitation meetings with public document release)**
  - **Support of The Small Satellite Reliability Initiative- A Public-Private Collaboration (POC: Mike Johnson – NASA/GSFC)**