

A Year in the Life of the NASA Electronic Parts and Packaging (NEPP) Program

A NASA Office of Safety and Mission Assurance (OSMA) Program

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Acronyms

Acronym	Definition
3D	Three Dimensional (3D)
AF	Air Force (AF)
AF SMC	Air Force Space and Missile Systems Center (AF SMC)
AI	Artificial Intelligence (AI)
ARC	NASA Ames Research Center (ARC)
BAE	BAE Systems (BAE)
BN	Bayesian Networks (BN)
BOK	Body of Knowledge (BOK)
BYU	Brigham Young University (BYU)
CLTs	NASA CIO Leadership Teams (CLTs)
CMOS	Complementary Metal Oxide Semiconductor (CMOS)
COTS	Commercial Off The Shelf (COTS)
CRÈME	Cosmic Ray Effects on Micro Electronics
Cu	Copper
DDR	Double Data Rate (DDR) [DDR3 = Generation 3; DDR4 = Generation 4]
DiRAM	Dis-integrated Random Access Memory (DiRAM)
DLA	Defense Logistics Agency (DLA)
DMEA	Defense Microelectronics Activity (DMEA)
DoD	Department of Defense (DoD)
DOE	Department of Energy (DOE)
DRAM	Dynamic Random-Access Memory (DRAM)
EEE	Electrical, Electronic, and Electromechanical (EEE)
ESA	European Space Agency (ESA)
ETW	Electronics Technology Workshop (ETW)
FD-SOI	Fully-Depleted Silicon-On-Insulator (FD-SOI)
FinFETs	Fin Field Effect Transistors (FinFETs)
FPGA	Field Programmable Gate Array (FPGA)
GaN	Gallium Nitride (GaN)
GIDEP	Government-Industry Data Exchange Program (GIDEP)
GPU	Graphics Processing Unit (GPU)
GSN	Goal Structuring Notation (GSN)
HBM	High Bandwidth Memory (HBM)
HPSC	High Performance Spacecraft Computing (HPSC)
IC	Integrated Circuit (IC)

Acronym	Definition
IR	Infrared (IR)
JEDEC	Joint Electron Device Engineering Council (JEDEC)
LANL	Los Alamos National Laboratories (LANL)
MAIW	Military AI Works (MAIW)
MBMA	Model-Based Missions Assurance (MBMA)
Mil	Military (Mil)
MOSFET	Metal–Oxide–Semiconductor Field-Effect Transistor (MOSFET)
MPSOC	Multi-Processing System on Chip (MPSOC)
NASA	National Aeronautics and Space Administration (NASA)
Navy Crane	Naval Surface Warfare Center, Crane, Indiana (Navy Crane)
NEPAG	NASA EEE Parts Assurance Group (NEPAG)
NEPP	NASA Electronic Parts and Packaging (NEPP) Program
NESC	NASA National Electric Safety Code (NESC)
NRO	United States Navy National Reconnaissance Office (NRO)
OCE	Office of the Chief Engineer (OCE)
OSMA	NASA Office of Safety and Mission Assurance (OSMA) Program
PBGA	Plastic Ball Grid Array
PoP	Package-on-Package (PoP)
QFN	Quad-Flat No-Leads (QFN)
R&M	Reliability and Maintainability (R&M)
RH	Radiation Hardened (RH)
RHA	Radiation Hardness Assurance
SAE	Society of Automotive Engineers (SAE)
SAPP	Space Asset Protection Program (SAPP)
SEAM	Systems Engineering and Assurance Modeling (SEAM)
SEB	Single Event Burnout (SEB)
SEE	Single Event Effect (SEE)
SiC	Silicon Carbide (SiC)
SME	Small and Medium-sized Enterprises (SME)
SNL	Sandia National Laboratories (SNL)
SOC	Systems on a Chip (SOC)
STMD	NASA's Space Technology Mission Directorate (STMD)
SysML	System Modeling Language (SysML)
TOR	Technical Operating Report (TOR)



NEPP Mission Statement

Provide NASA's leadership for developing and maintaining guidance for the screening, qualification, test, and reliable usage of electrical, electronic, and electromechanical (EEE) parts by NASA, in collaboration with other government Agencies and industry.

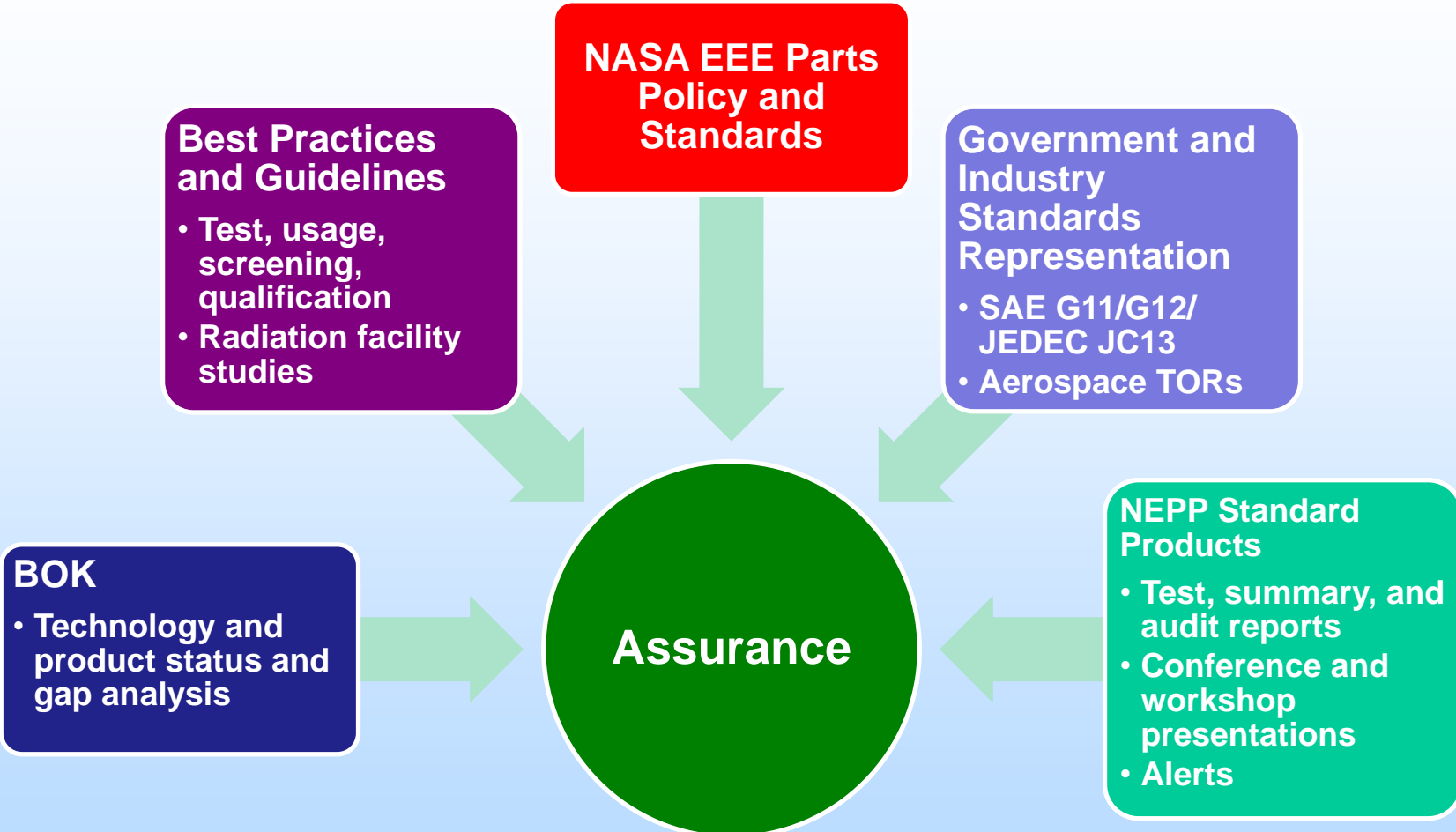


NEPP - Charter





NEPP – Product Delivery



Related task areas:

Technology/parts evaluations lead to new best practices, etc...

To be presented by Kenneth A. LaBel at the Radiation Hardened Electronics Technology (RHET) Conference, Colorado Springs, CO, November 6-8, 2017.



Body of Knowledge (BOK) Documents

- **What goes into a BOK**
 - An overview of the technology
 - An overview of technology applicability to space/aeronautics
 - An overview of technology maturity, produceability and/or commercial availability
 - Reliability, qualification, and/or radiation knowledge-base
 - Technology direction or extent of the reliability issue for the future Identification of experts, technology sources, test houses, etc.
 - Facilities/capabilities
 - Recommendation for follow-on NEPP task (if applicable)

BODY OF KNOWLEDGE FOR SILICON CARBIDE POWER ELECTRONICS



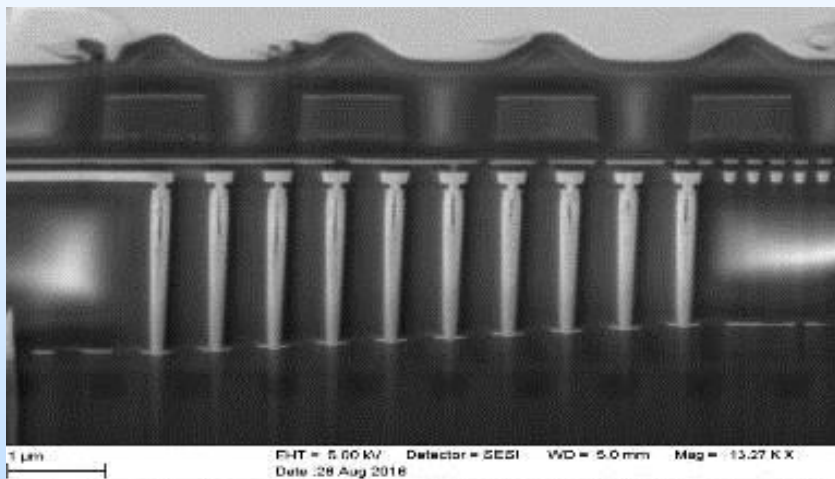
What's New for NEPP in FY18

- **Increased emphasis on needs of small missions such as CubeSats and model-based mission assurance (MBMA)**
 - Partnering with other NASA organizations, Agencies, and universities
- **More assurance products**
 - BOKs, Guidelines, Tools, Information Sharing, Training
- **Significant update of the NEPP website**
 - Easier to find guidance and search for data
 - New tie-ins to the SmallSat community
- **Support for Agency efforts for EEE Parts Consolidation, Radiation Beam Block Buys, and Capability Leadership Teams**

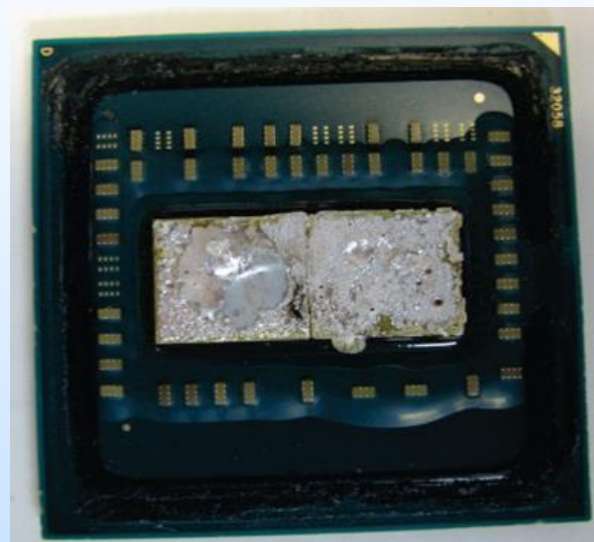


Advanced Technologies

- Technology/device evaluations with a nod to developing test methods and user guidance



Hynix 3D Flash Memory

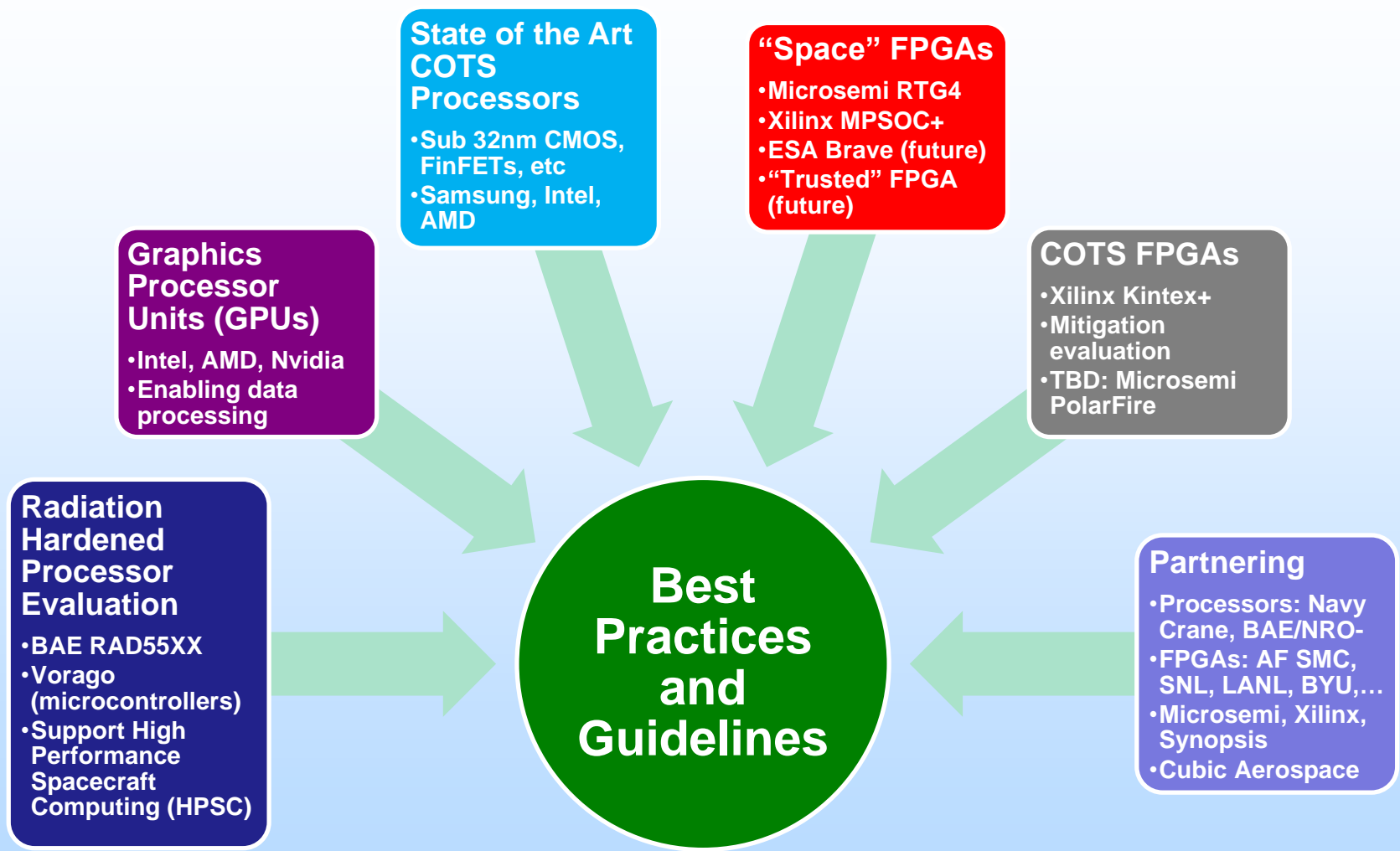


AMD Ryzen Processor

- New: collaboration with DMEA and GlobalFoundries on 22nm FD-SOI and 28nm bulk radiation evaluation



NEPP – Processors, Systems on a Chip (SOC), and Field Programmable Gate Arrays (FPGAs)



Potential task areas:

artificial intelligence (AI) hardware, Intel Stratix 10



NEPP – Memories

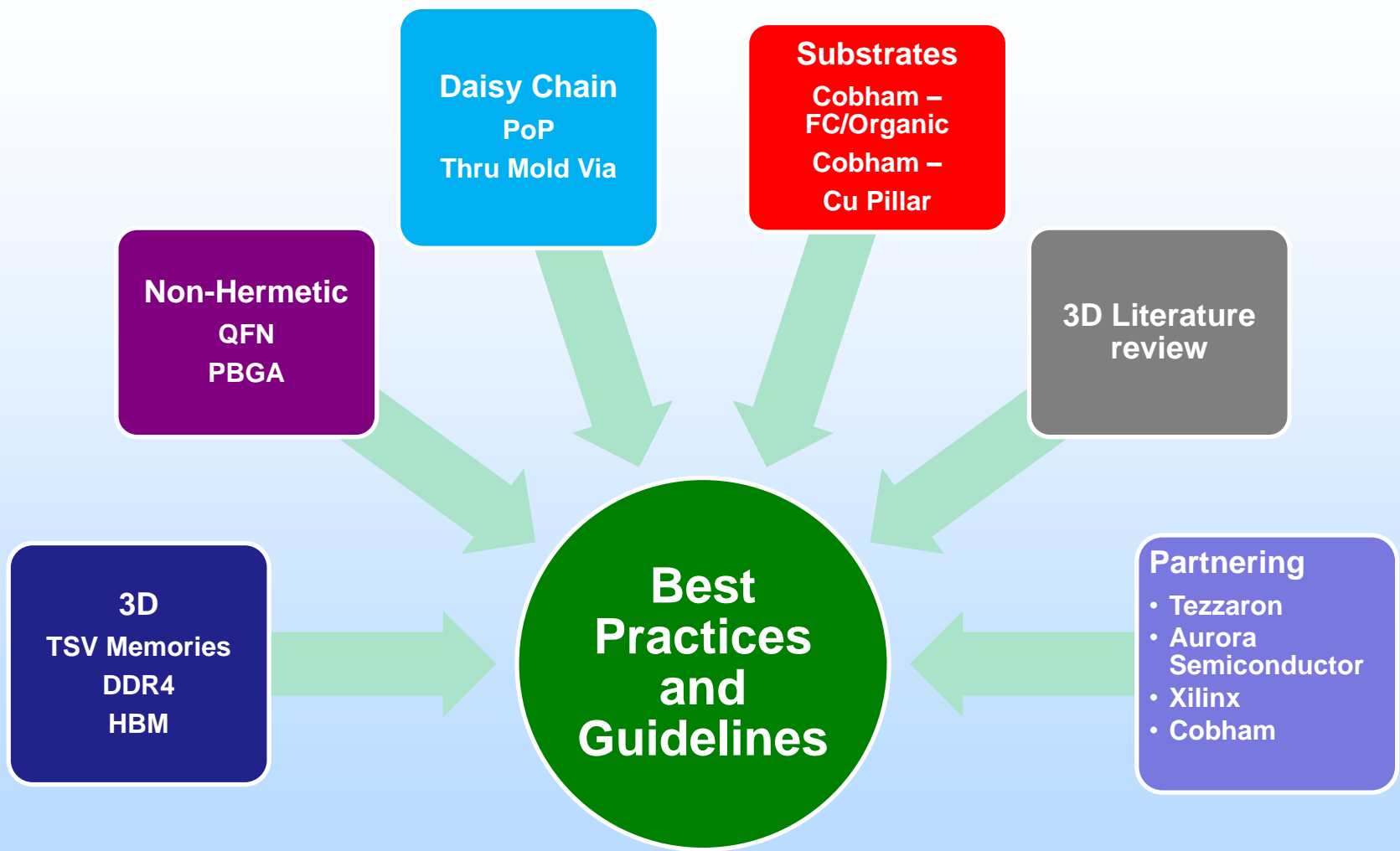


Related task areas:

Deprocessing for single event testing (also w/processors, FPGAs,...)

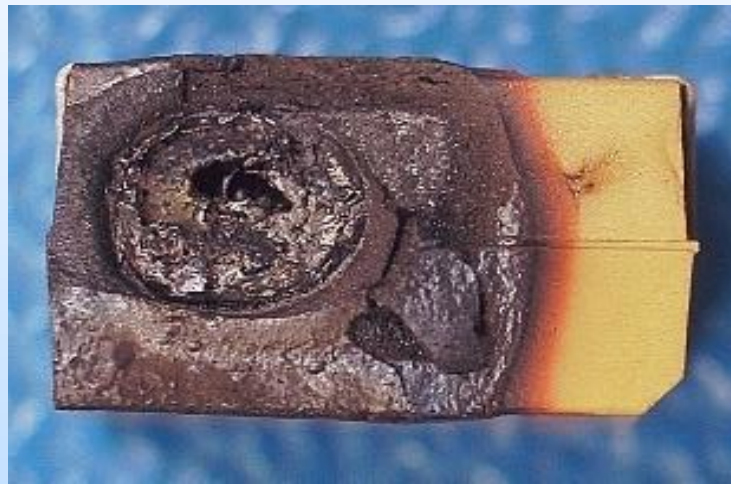


NEPP – Packaging



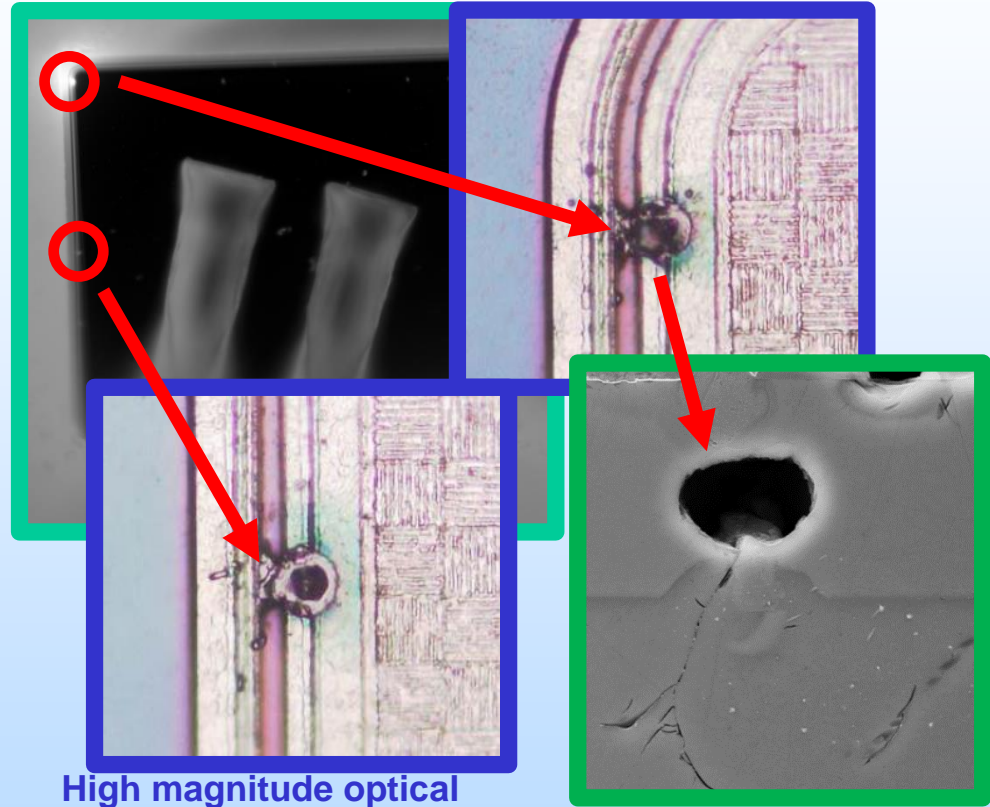


Working Industry/Agency-Wide Concerns



Tantalum capacitor failure

Thermal Image of failure locations



High magnitude optical images of failure locations

Cross-section of failure location

Failure analysis of Schottky diode radiation damage

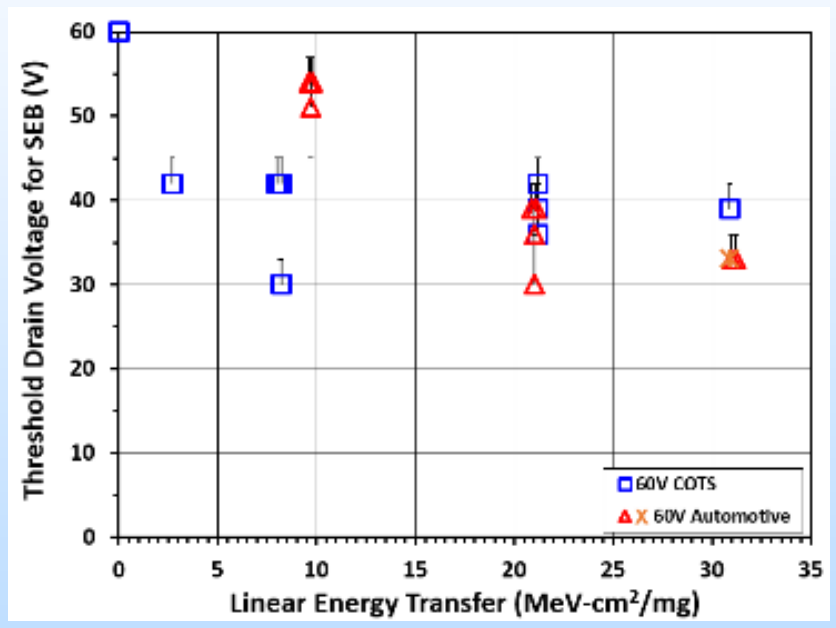


Vendor Validation Tests

- Photo-emission detects 2 leakage sites
- IR image
- Two damage sites from consecutive SEE

Optical image of device with failure sites superimposed. All failure occurred in the gate area. Failures appear randomly distributed.

GaN IC – radiation test analysis



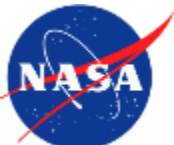
Comparison of n-type 60V trench MOSFET SEB thresholds



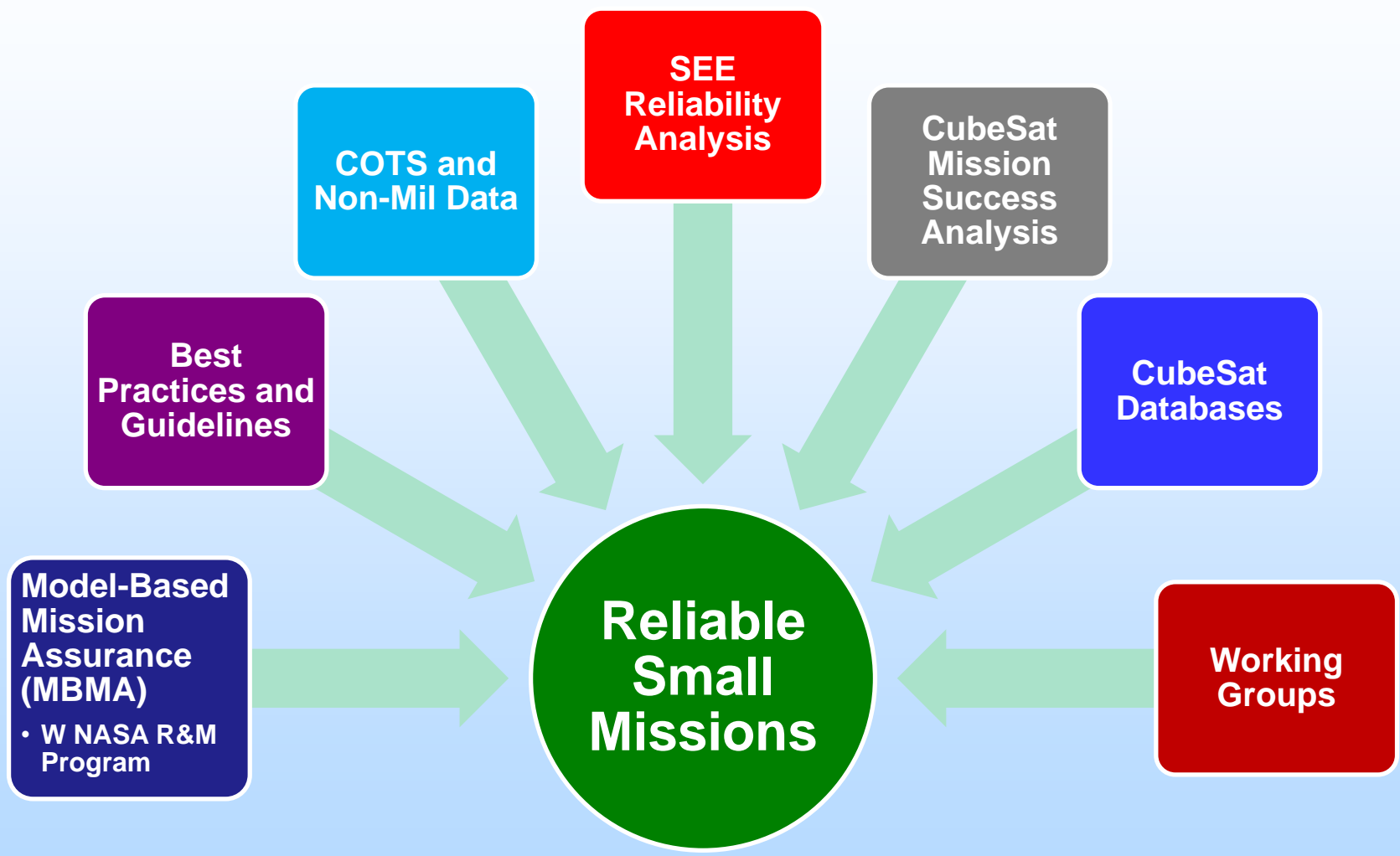
Infrastructure Challenges



*Using Proton Cancer Therapy Centers
for electronics testing*



NEPP - Small Mission Efforts



Potential future task areas: automotive and avionics resilience



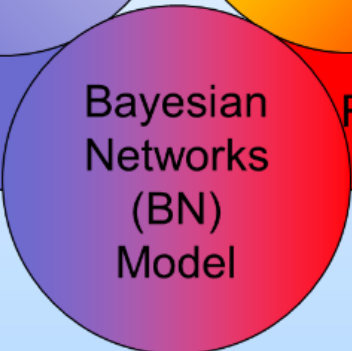
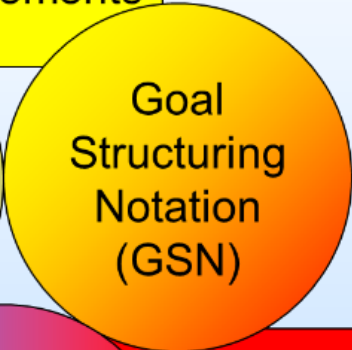
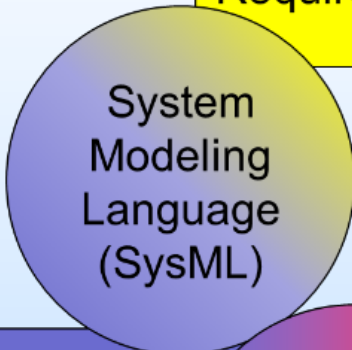
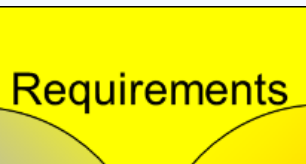
NEPP Small Mission Efforts and MBMA (w/ NASA MBMA Program)

NASA/GSFC (Campola)
Small Mission RHA
TBD

Small Mission EEE Parts Best Practices

NASA/GSFC (Xapsos)
RHA Confidence Approach

Aerospace (proposed)
CubeSat Kit Vendor Survey
“Mid-space” Grade Survey and
Requirements Definition



Vanderbilt University
GSN Exemplar (SEE) – complete
TBD
GSN Exemplar – EEE parts reliability

Saint Louis University
CubeSat Success Study

JPL
CubeSat EEE Parts Databases

TBD
CubeSat EEE Parts Testing

NASA/GSFC (Berg)
SEE Classic Reliability

Vanderbilt
CRÈME Toolsuite

TBD
Resilience, autonomy

Vanderbilt University
BN follow-on
BN integrated into SEAM

Other
Integration with Small
Spacecraft Virtual Institute
(NASA/ARC)
<https://www.nasa.gov/small-sat-institute>

Emerging Modeling
Vanderbilt University
Web-based tool (SEAM)
NASA/GSFC (Campola) - Vanderbilt
Notional RHA Tool (R-GENTIC)

Other
MAIW
SmallSat Reliability Initiative
(NASA/AF/ others)

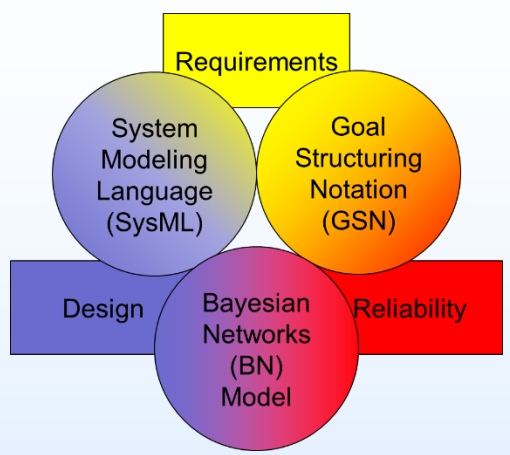
<https://modelbasedassurance.org/>



Partnering is key

- **Within**
 - **NASA**
- **With**
 - **Other government agencies**
 - **Industry**
 - **University**
 - **International**

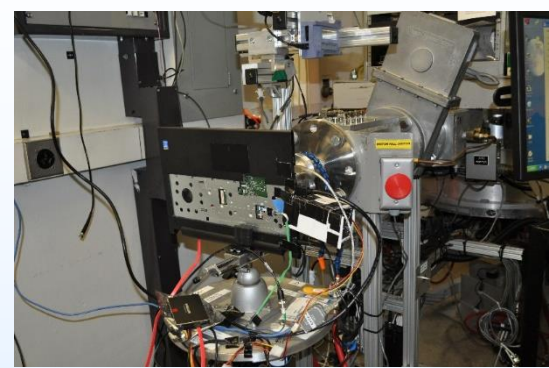




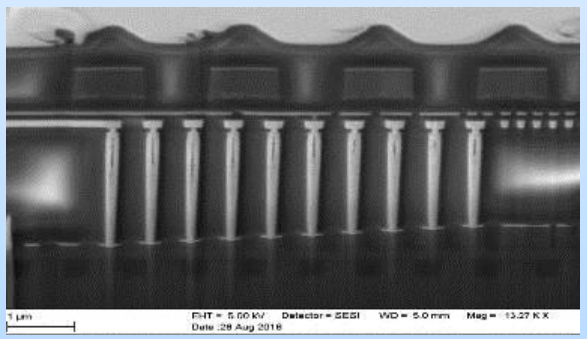
Emerging Assurance Methods
(Witulski, Vanderbilt University, NEPP ETW 2017)

9th Annual NEPP Electronics Technology Workshop (ETW)

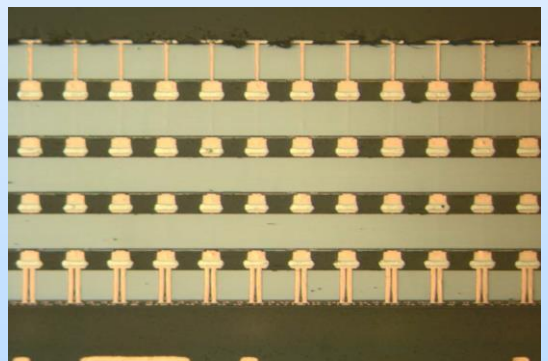
Scheduled dates:
June 18-21, 2018
NASA/GSFC and on-line



Radiation Testing



Advanced Technology Reliability



Commercial IC Packaging



<http://nepp.nasa.gov>