

The NASA Electronic Parts and Packaging (NEPP) Program for FY14 – Preliminary Plans

Kenneth A. LaBel
ken.label@nasa.gov
301-286-9936

Michael J. Sampson
michael.j.sampson@nasa.gov
301-614-6233

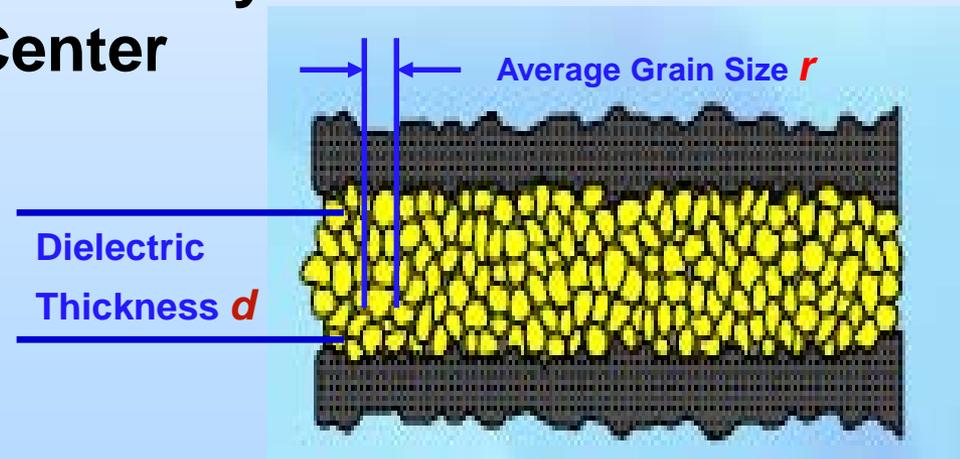
Co- Managers, NEPP Program
NASA Goddard Space Flight Center (GSFC)
<http://nepp.nasa.gov>

Unclassified



Outline

- Acronym List
- Overview of NEPP
 - What We Do and Who We Are
 - Flight Projects
 - Technology
 - Working with Others
 - Working with High Reliability Virtual Electronics Center (HiREV)
- Plans for FY14
- Summary



Multi-Layer Ceramic Capacitor (MLCC)



Acronyms

Acronym	Definition	First used on Page
3D	Three Dimensional	17
ADC	Analog to Digital Converter	21
Aero	Aerospace	18
AMRDEC	Aviation and Missile Research Development and Engineering Center	5
ARC	Ames Research Center	5
BME	Base Metal Electrode	13
BOK	Body of Knowledge	13
CALCE	Center for Advanced Life Cycle Engineering	21
CAVE	Center for Advanced Vehicle and Extreme Environment Electronics	21
CBRAM	Conductive Bridging Random Access Memory	17
CMOS	Complementary Metal Oxide Semiconductor	13
COP	Community of Practice	14
COTS	Commercial Off The Shelf	7
CSA	Canadian Space Agency	5
DAC	Digital to Analog Converter	21
DARPA	Defense Advanced Research Projects Agency	17
DC	Direct Current	9
DDR	Double Data Rate	17
DLA/DSCC	Defense Logistics Agency Land and Maritime	5
EEE	Electrical, Electronic, and Electromechanical	5
ELDRS	Enhanced Low Dose Rate Sensitivity	19
EPARTS	NASA Electronic Parts Database	14
ESA	European Space Agency	5
ETW	Electronics Technology Workshop	8
FPGA	Field Programmable Gate Array	13
FY	Fiscal Year	1
G11	Component Parts Committee	9
G12	Solid State Devices Committee	9
GaAs	Gallium Arsenide	21
GaN	Gallium Nitride	9
GIDEP	Government Industry Data Exchange Program	5
GRC	Glenn Research Center	5
GSFC	Goddard Space Flight Center	1
HALT	Highly Accelerated Life Test	17
HiREV	High Reliability Virtual Electronics Center	2
IBM	International Business Machines	17
ICBM	Intercontinental Ballistic Missile	5
IP	Intellectual Property	16
JAXA	Japanese Space Agency	5
JEDEC	Joint Electron Device Engineering Council	9
JHU-APL	Johns Hopkins University Applied Physics Laboratory	5

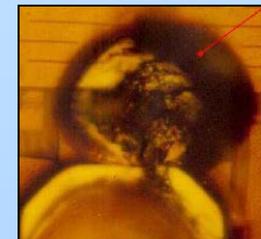
Acronym	Definition	First used on Page
JPL	Jet Propulsion Laboratories	14
JSC	Johnson Space Center	5
KSC	Kennedy Space Center	5
LaRC	Langley Research Center	5
LEAP	Leading Edge Access Program	17
MDA	Missile Defense Agency	5
MEMS	Microelectromechanical Structure	21
MIL	Military	15
MLCC	Multi-Layer Ceramic Capacitor	2
MOSFET	Metal Oxide Semiconductor Field Effect Transistor	18
MRQW	Microelectronics Reliability and Qualification Working Meeting	5
MSFC	Marshall Space Flight Center	5
NASA	National Aeronautics and Space Administration	1
NAVSEA	Naval Sea Systems Command	16
NEPAG	NASA Electronic Parts Assurance Group	5
NEPP	NASA Electronic Parts and Packaging	1
NGC	Northrop Grumman Corporation	5
NPSL	NASA Parts Selection List	20
NRO	National Reconnaissance Office	5
NSP	National Space Programs	10
NSWC	Naval Surface Warfare Center	15
PBGA	Plastic Ball Grid Array	17
POF	Physics of Failure	12
POL	Point of Load	18
QML	Qualified Manufacturer List	17
RERAM	Resistive Random Access Memory	17
RF	Radio Frequency	18
SAE	Society of Automotive Engineers	9
SAS	Supplier Assessment System	20
SEU	Single Event Upset	18
SiC	Silicon Carbide	13
SMC	Space and Missile Command	5
SOC	Systems on a Chip	17
SW	Southwest	5
TI	Texas Instruments	16
TMR	Triple Modular Redundancy	17
TRL	Technology Readiness Level	7
US	United States	13
USAF	United States Air Force	5
USN	United States Navy	5
VCS	Voluntary Consensus Standards	20
VNAND	Vertical NAND	17



NEPP – What We Do

- **NEPP provides two prime functions for NASA:**
 - Assurance infrastructure for NASA, and
 - Research on advanced/new electronic devices and technologies.
- **We work with**
 - Active and passive semiconductors,
 - Electronic device packaging, and
 - Radiation effects on electronics.
- **We collaborate with others in technical areas such as**
 - Workmanship,
 - Alert systems,
 - Standards development and maintenance, and
 - Engineering and technology development.
- **We provide an *independent* view for the safe use of electronic integrated circuits for NASA.**

Electrical overstress failure
in a commercial electronic device





NASA EEE Parts Assurance Group (NEPAG)

- **Subset of NEPP formed in 2000**
- **Weekly telecons**
 - Typical participation ~ 25
 - Share knowledge and experience
 - Address failures, requirements, test methods
 - Monthly international
- **Audit support**
- **Coordinate specification and standards changes**





NEPP and NASA Flight Projects

NEPP

- Works general device qualification standards
- Develops the knowledge-base on **HOW** to qualify a device used by flight projects
 - Test methods
 - Failure mode identification
 - User guidelines and lessons learned
- Works issues that are relevant across NASA

Flight Projects

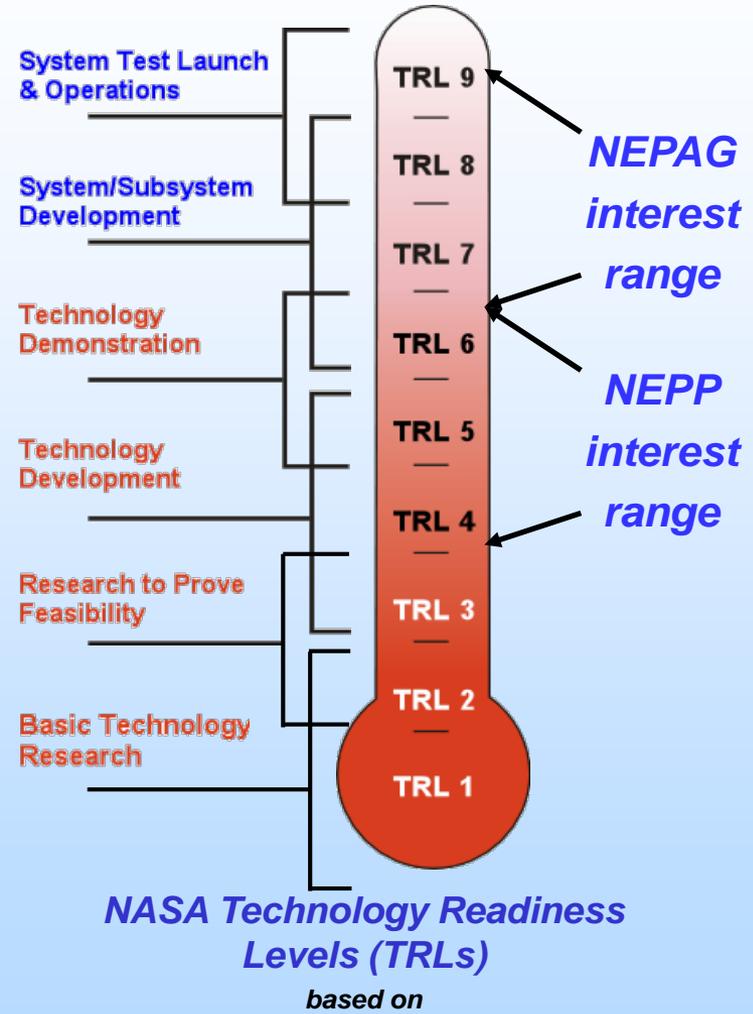
- Work mission specific requirements
- Qualify a device to mission requirements or to a standard
 - Uses NEPP knowledge to perform qualification
- Work issues relevant to a specific project

NEPP provides products for use by flight projects.



Maturity of Technology – The NEPP Model

- NASA flight project timelines are insufficient to learn how to qualify a new technology device.
 - Sufficient time may exist to qualify a device, but not to determine **HOW** to qualify.
- For 2016 launch, technology freeze dates are typically 2013 or earlier.
- Technology development and evaluation programs need to be in place prior to mission design.
 - NEPP’s strategic advanced planning on technology evaluation is critical to allow timely and safe flight project insertion of new technologies.
- With NASA’s increasing interest in COTS and automotive grade electronics, a different view of “readiness” may be developed.



<http://www.hq.nasa.gov/office/codeq/trl/trl.pdf>



Sharing NEPP Knowledge

- **NEPP success is based on providing appropriate guidance to NASA flight projects.**
 - Interaction with the aerospace community, other government agencies, universities, and flight projects is critical.
- **NEPP utilizes**
 - NEPP Website (<https://nepp.nasa.gov>),
 - NEPP 5th Annual **Electronics Technology Workshop (ETW):** June 17-19, 2014,
 - HiREV day planned
 - Standards working groups,
 - Telecons (NEPAG weekly and monthly international),
 - Documents such as Guidelines, Lessons Learned, Bodies of Knowledge (BOKs), and
 - Technical papers.



Consortia and Working Groups

- **NEPP realizes the need to work in teams to provide better and more cost-effective solutions.**
- **NEPP utilizes working and standards development groups for information exchange and product development.**
 - **External examples:**
 - **JEDEC commercial electronics and SAE G11/12 Government Users**
 - **Internal (NASA-only) examples:**
 - **DC-DC converters, point-of-load converters, GaN/SiC, and connectors**
- **NEPP supports university-based research when funds allow.**



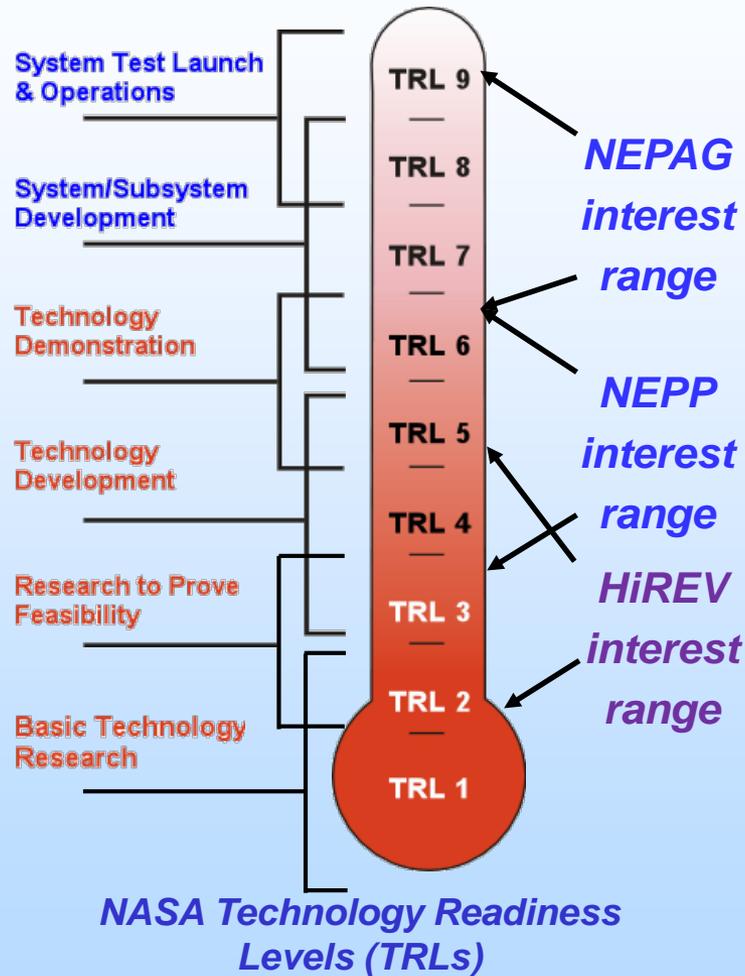
National High Reliability Virtual Electronics Center (HiReV)



- 1: Re-establish the government as the leader of emerging electronic device technology reliability for National Space Programs (NSP).**
- 2: Develop and implement a process to coordinate and communicate reliability research and knowledge across the NSP electronics community.**
- 3: Identify, prioritize and investigate device technologies that pose significant reliability challenges to NSPs.**



HIREV and NEPP – Mutual Interests



NASA has supported formation of the HiREV since it's inception.



Alignment of NEPP and HiREV

HiREV

- Utilizes detailed technology knowledge (materials, process, etc...) and detailed testing, physical analysis, etc... to enhance
 - Reliable Electronics
 - Electronic technology Physics of Failure (POF)
 - Radiation Reliability of Electronics
 - Modeling POF in new technologies
- Testing test structures
- “Buys down” risk
 - Required for National Space Programs (ultra-reliable)

NEPP

- Utilizes available technology knowledge coupled with selective testing and physical analysis
- Reliable Electronics
 - Applying POF to qualification/usage guidance
- Radiation Reliability
 - Testing for POF on new technologies
 - Support modeling/tools on new technologies
 - Qualification/usage guidance
- Testing production devices
- “Manages” risk

HiREV POF on early TRL's feeds NEPP focus on insertion/qualification.



How We Differ – Example Efforts

HiREV

- Technology forecasting (US Government needs)
- POF tools for Si and III-V electronics
- Pre-qualification efforts on
 - Base Metal Electrode (BME) capacitors
 - Class Y packages
 - 45 and 90nm CMOS trusted foundry technology
- Reliability science
 - GaN technology

NEPP

- Body of Knowledge (BOK) documents on new technologies
- Guideline on testing/qualification of FPGAs, memories, BME capacitors
- Evaluation of commercial products
 - BME capacitors
 - GaN/SiC devices
 - FPGAs
 - Automotive-grade electronics

HiREV utilizes test structures for detailed knowledge (model first).

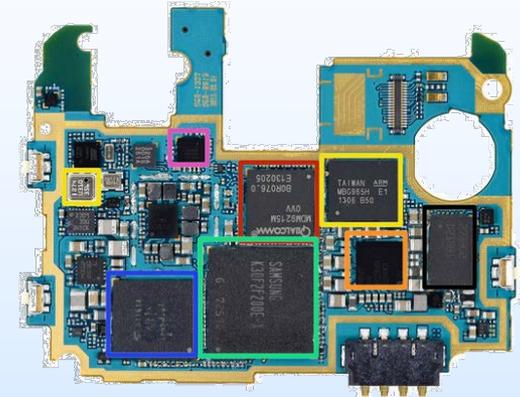
NEPP utilizes commercial product for general knowledge (test first).



How NASA is Changing:

NEPP Workshop on EEE Parts for Class D Missions and CubeSats

- NEPP held a one day agency-internal workshop at NASA/GSFC on Sep 24, 2013.
 - 160 attendees participated across the agency.
 - Roughly 50% on-site, 50% via the web
 - It was co-sponsored by NASA Offices of Safety and Mission Assurance and NASA Chief Engineer.
 - The workshop covered presentations on:
 - Examples from various Centers (GSFC, JPL, and ARC),
 - Electronics challenges and classes of electronics, and
 - Discussion of “go-forward” approaches, relevant guidance, and guidelines/policy.
 - Post-workshop plans include:
 - Develop “rule of thumb” guidance in the near term (1Q FY14),
 - Develop more detailed guidelines/policy as appropriate in FY14,
 - Organize a new Community of Practice (COP),
 - Coordinate with EPARTS database for features applicable to Class D/CubeSats,
 - Modify NEPP evaluation plans to more actively support CubeSat (generic) needs (i.e., use of automotive electronics, “standard” recommended parts, etc...), and
 - Consider alternative part qualification evaluation focusing on effectiveness of board level test approaches.



Galaxy S4 Phone Processor Board

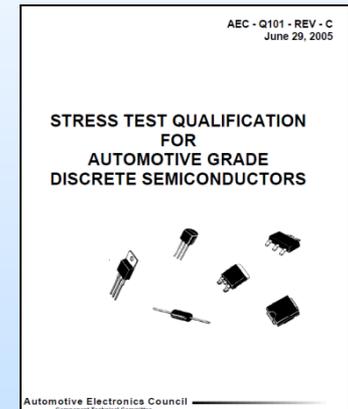
<http://www.ifixit.com/Teardown/Samsung+Galaxy+S4+Teardown/139472>

This small motherboard provides an order of magnitude more processing capability than a traditional military/radiation hardened option. Options like this have already been flown on CubeSats, but “rules” don’t exist on determining appropriate risk/reliability trades for specific needs.



NEPP Evaluation of Automotive Electronic Parts

- **Questions to be answered:**
 - What are automotive grade parts, who makes them, what standards exist, and can NASA leverage them for reliable use in space?
- **NEPP objectives:**
 - Develop a BOK on automotive grade parts,
 - Test a range of electronic parts (capacitors to transistors to processors), and
 - Develop a guideline for NASA usage.
- **Testing will be performed by NASA and NSWC Crane.**
- **Early results on selected automotive grade capacitors indicate aging/de-aging behavior variance.**
 - This behavior could be due to dielectric differences between military-grade parts and the selected test articles (higher volumetric efficiency).





FY14 NEPP Core –

Automotive/Commercial Electronics (CubeSats to Class D)

Core Areas are Bubbles;
Boxes underneath are variable tasks in each core

Legend

NEPP Ongoing Task
FY14 Proposed New Start

NEPP Research Category – Automotive/Commercial Electronics

Automotive Electronics

Body of Knowledge on specs, standards, and vendor approaches
Reliability evaluation of ceramic capacitors, discrete transistors, and microcircuits

Work performed by NAVSEA Crane in collaboration

Alternate Test Approaches

Effectiveness of Board Level Testing for Piecepart Qualification (will utilize boards with processors and microcontrollers)

Mobile Processors

Intel Atom, Qualcomm Snapdragon Processors (radiation only)

Microcontrollers

Freescle Automotive Microcontroller (+ board)
Cubesat vendor Microcontrollers: Tyvek (TI microcontroller), Pumpkin (Atmel microcontroller) (radiation only)

Advanced Processors

Freescle P5040 Network Processor (+board) (IP for next generation BAE Systems Rad Hard Processor)

Requires partnership with Freescle

Guidance, Documents

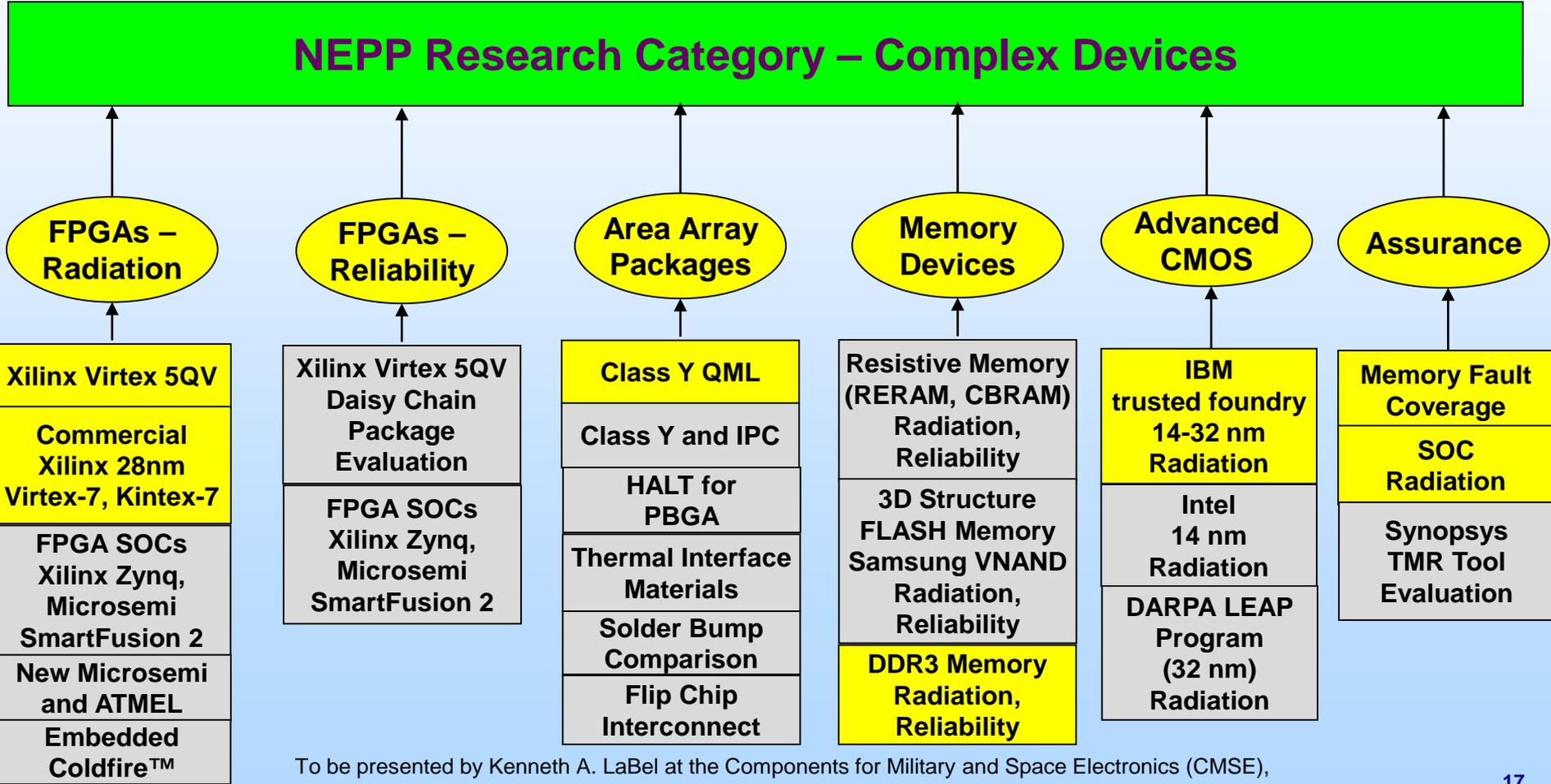
Rule of thumb documents
Policy, Guidelines
Microcontroller recommendations
CubeSat Parts Database
COP



FY14 NEPP Core - Complex Devices

Core Areas are Bubbles;
Boxes underneath are variable tasks in each core

Legend	
NEPP Ongoing Task	
FY14 Proposed New Start	



To be presented by Kenneth A. LaBel at the Components for Military and Space Electronics (CMSE), Los Angeles, CA, February 18-20, 2014 and published on <https://nepp.nasa.gov/>.

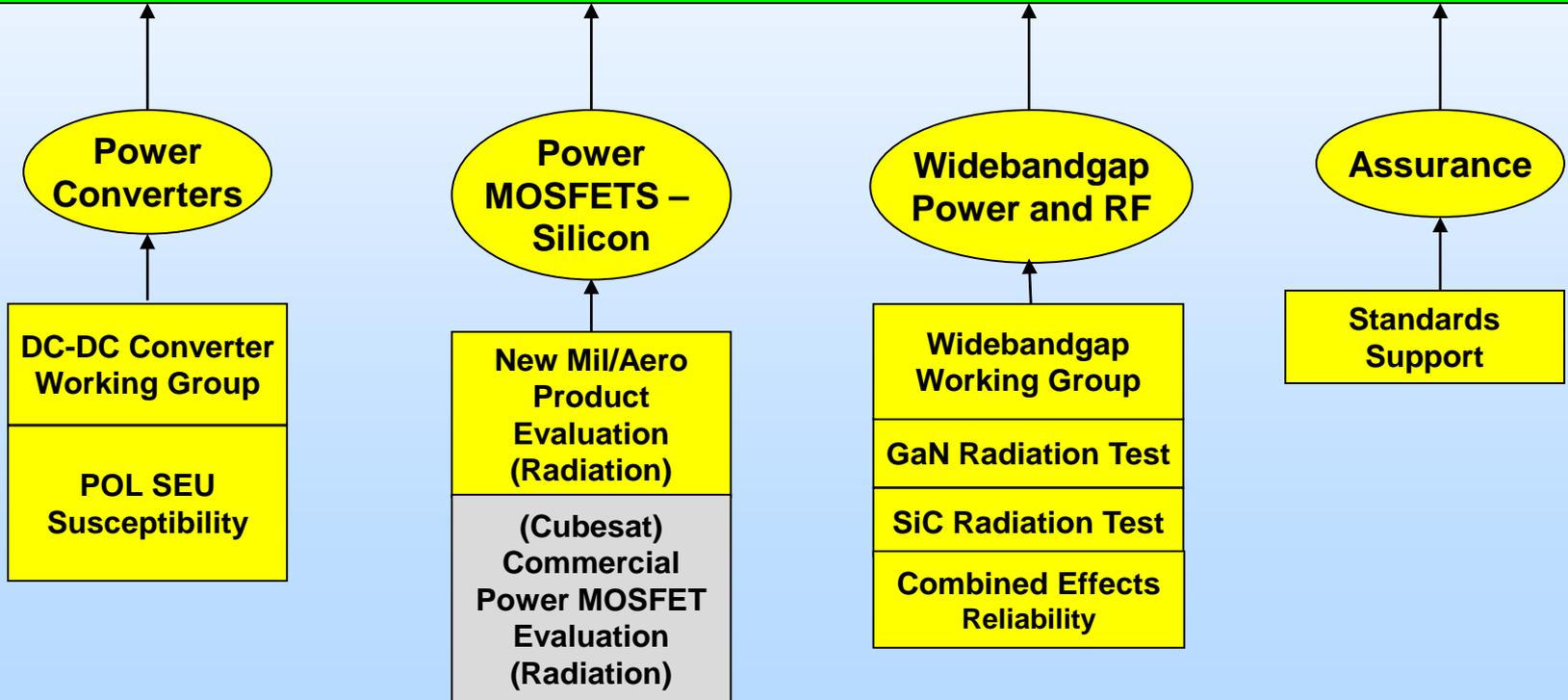


FY14 NEPP Core - Power Devices

Core Areas are Bubbles;
Boxes underneath are variable tasks in each core



NEPP Research Category – Power Devices





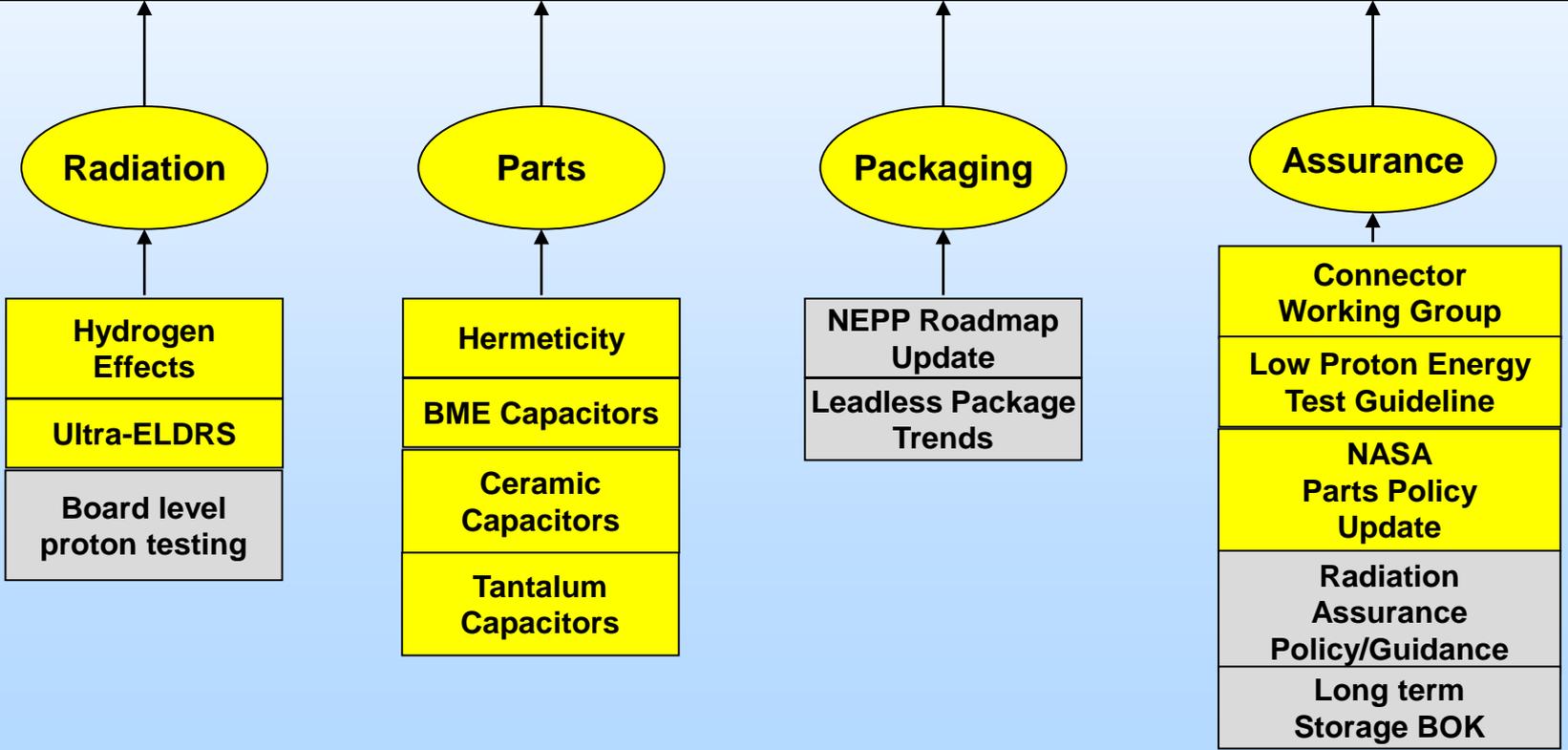
FY14 NEPP Core - Assurance

Core Areas are Bubbles;
Boxes underneath are variable tasks in each core

Legend

NEPP Ongoing Task
FY14 Proposed New Start

NEPP Research Category – Assurance



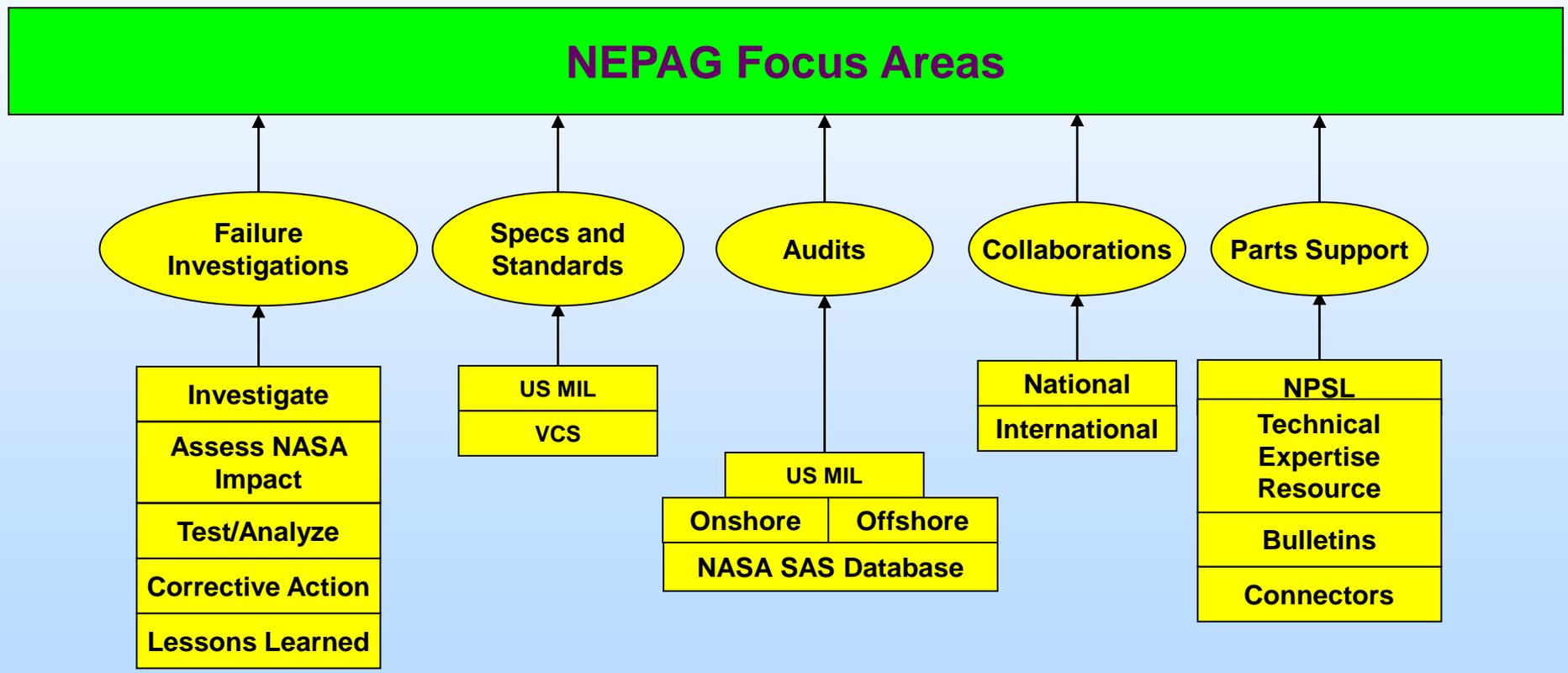


NASA Electronic Parts Assurance Group (NEPAG)

Core Areas are Bubbles;
Boxes underneath are elements in each core

Legend

NEPP Ongoing Task
FY14 Proposed New Start





Overguide/Approval Pending

- **Proposed tasks not yet approved (funding limited):**
 - Radiation/reliability 3rd generation parts
 - Qualification strategies for COTS
 - Reliability of Commercial Smartphones
 - 18-24 bit ADC/DAC radiation/evaluation
 - Qualification by similarity
- **Overguide task areas:**
 - Fiber Optics
 - SiGe Advanced Mixed Signal
 - GaAs Electronics
 - Connector Evaluation
 - 3D Packages
 - Flexible Electronics
 - MEMS
 - University Research
 - CAVE/CALCE Memberships



Summary

- **NEPP is an agency-wide program that endeavors to provide added-value to the greater aerospace community.**
 - Always looking at the big picture (widest potential space use of evaluated technologies),
 - Never forgetting our partners, and
 - Attempting to do “less with less” (static budget versus rising costs).
- **We invite your feedback and collaboration. Please visit our website (<https://nepp.nasa.gov>).**
- **Join us at our annual meeting in June at NASA/GSFC.**
- **Questions?**