

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

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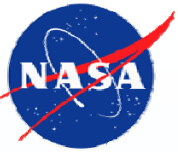
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**Co- Managers, NEPP Program**

**NASA/GSFC**

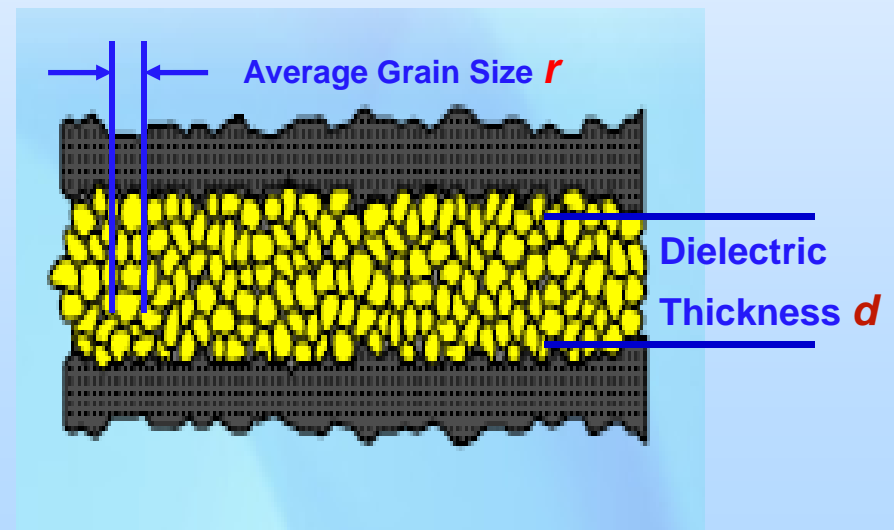
**<http://nepp.nasa.gov>**

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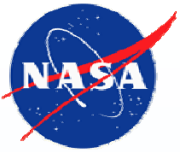


# Outline

- Acronym List
- Overview of NEPP
  - What We Do and Who We Are
  - Flight Projects
  - Technology
  - Working with Others
  - Working with HiREV
- Plans for FY14
- Summary



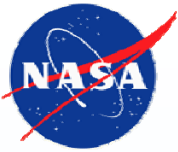
**Multi-Layer Ceramic Capacitor (MLCC)**



# Acronyms – 1 of 2

<b>3D</b>	<b>Three Dimensional</b>
<b>ADC</b>	<b>Analog to Digital Converter</b>
<b>Aero</b>	<b>Aerospace</b>
<b>AMRDEC</b>	<b>Aviation and Missile Research Development and Engineering Center</b>
<b>ARC</b>	<b>Ames Research Center</b>
<b>BME</b>	<b>Base Metal Electrode</b>
<b>BOK</b>	<b>Body of Knowledge</b>
<b>CALCE</b>	<b>Center for Advanced Life Cycle Engineering</b>
<b>CAVE</b>	<b>Center for Advanced Vehicle and Extreme Environment Electronics</b>
<b>CBRAM</b>	<b>Conductive Bridging Random Access Memory</b>
<b>CMOS</b>	<b>Complementary Metal Oxide Semiconductor</b>
<b>COP</b>	<b>Community of Practice</b>
<b>COTS</b>	<b>Commercial Off The Shelf</b>
<b>CSA</b>	<b>Canadian Space Agency</b>
<b>DAC</b>	<b>Digital to Analog Converter</b>
<b>DARPA</b>	<b>Defense Advanced Research Projects Agency</b>
<b>DC</b>	<b>Direct Current</b>
<b>DDR</b>	<b>Double Data Rate</b>
<b>DLA/DSCC</b>	<b>Defense Logistics Agency Land and Maritime</b>
<b>DoD</b>	<b>Department of Defense</b>
<b>DTRA</b>	<b>Defense Threat Reduction Agency</b>

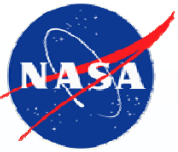
<b>EEE</b>	<b>Electrical, Electronic, and Electromechanical</b>
<b>ELDRS</b>	<b>Enhanced Low Dose Rate Sensitivity</b>
<b>EPARTS</b>	<b>NASA Electronic Parts Database</b>
<b>ESA</b>	<b>European Space Agency</b>
<b>FPGA</b>	<b>Field Programmable Gate Array</b>
<b>FY</b>	<b>Fiscal Year</b>
<b>G11</b>	<b>Component Parts Committee</b>
<b>G12</b>	<b>Solid State Devices Committee</b>
<b>GaAs</b>	<b>Gallium Arsenide</b>
<b>GaN</b>	<b>Gallium Nitride</b>
<b>GIDEP</b>	<b>Government Industry Data Exchange Program</b>
<b>GRC</b>	<b>Glenn Research Center</b>
<b>GSFC</b>	<b>Goddard Space Flight Center</b>
<b>HALT</b>	<b>Highly Accelerated Life Test</b>
<b>HiREV</b>	<b>High Reliability Virtual Electronics Center</b>
<b>IBM</b>	<b>International Business Machines</b>
<b>ICBM</b>	<b>Intercontinental Ballistic Missile</b>
<b>IP</b>	<b>Intellectual Property</b>
<b>JAXA</b>	<b>Japanese Space Agency</b>
<b>JEDEC</b>	<b>Joint Electron Device Engineering Council</b>



# Acronyms – 2 of 2

JPL	Jet Propulsion Laboratories
JSC	Johnson Space Center
KSC	Kennedy Space Center
LaRC	Langley Research Center
LEAP	Leading Edge Access Program
MDA	Missile Defense Agency
MEMS	Microelectromechanical Structure
MIL	Military
MLCC	Multi-Layer Ceramic Capacitor
MOSFET	Metal Oxide Semiconductor Field Effect Transistor
MRQW	Microelectronics Reliability and Qualification Working Meeting
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NAVSEA	Naval Sea Systems Command
NEPAG	NASA Electronic Parts Assurance Group
NEPP	NASA Electronic Parts and Packaging
NPSL	NASA Parts Selection List
NRO	National Reconnaissance Office
PBGA	Plastic Ball Grid Array
POF	Physics of Failure

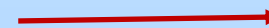
POL	Point of Load
QML	Qualified Manufacturer List
RERAM	Resistive Random Access Memory
RF	Radio Frequency
SAE	Society of Automotive Engineers
SAS	Supplier Assessment System
SEU	Single Event Upset
SMC	Space and Missile Command
SOC	Systems on a Chip
SW	Southwest
TI	Texas Instruments
TMR	Triple Modular Redundancy
TRL	Technology Readiness Level
US	United States
USAF	United States Air Force
USN	United States Navy
VCS	Voluntary Consensus Standards
VNAND	Vertical NAND

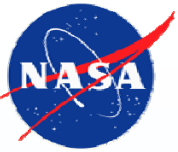


# NEPP – What We Do

- **NEPP provides two prime functions for NASA**
  - Assurance infrastructure for NASA
  - Research on advanced/new electronic devices and technologies
- **We work with**
  - Active and passive semiconductors
  - Electronic device packaging
  - Radiation effects on electronics
- **We collaborate with others in technical areas such as**
  - Workmanship
  - Alert systems
  - Standards development and maintenance
  - 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

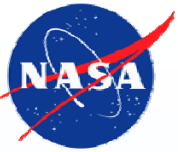




# NEPP's Two Functions

- **Assurance**
  - Customer: *Space systems in design and development*
  - **Issues applicable to currently available technologies (e.g., mature technologies)**
  - **Examples**
    - Cracked capacitors
    - Power converter reliability
  - **NASA Electronic Parts Assurance Group (NEPAG) - a subset of NEPP**
    - Communication infrastructure
    - Audit and review support
    - Investigation into reported failures (when of potential wide-reaching impact to NASA flight projects)
- **Advanced/new electronics technology research**
  - Customer: *Space systems in early design or conceptualization*
  - **Issues applicable to new technologies (or those with potential Mil/Aero applicability)**
  - **Examples**
    - Commercial field programmable gate arrays (FPGAs)
    - Sub 32nm electronics
  - **Technology evaluation**
  - **Development of test methods and qualification recommendations**





# 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

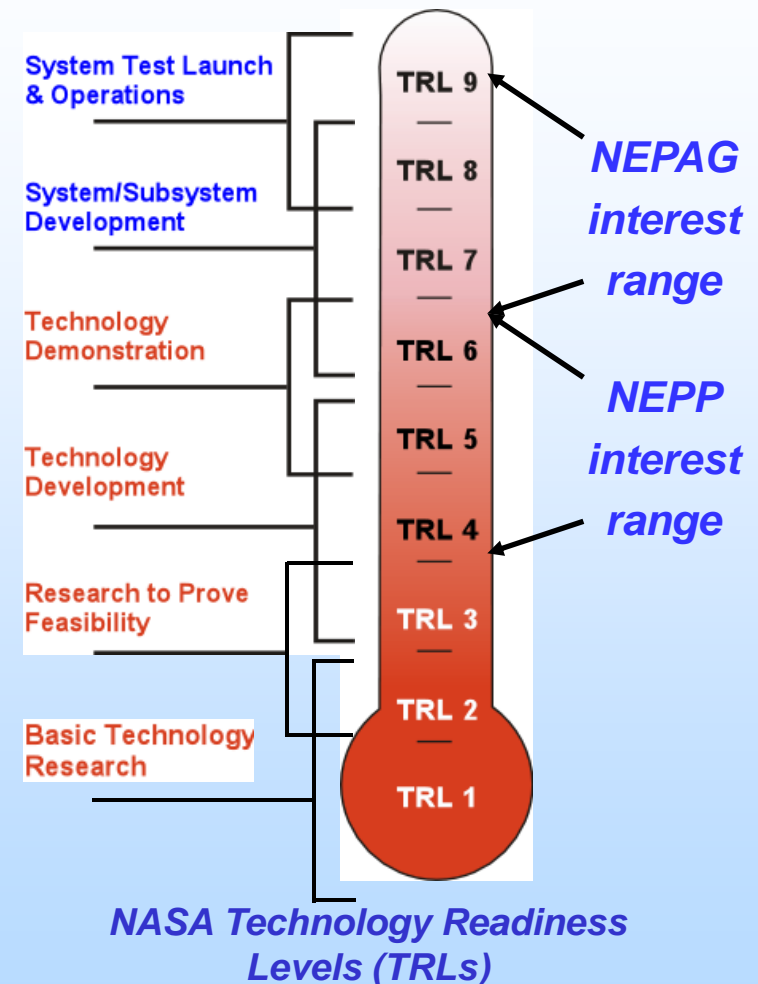
***NEPP provides products for use by flight projects***

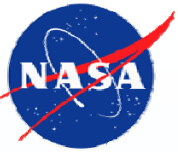




# Maturity of Technology – *The NEPP Model*

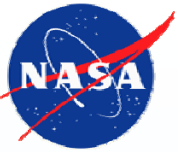
- NASA flight project timelines are insufficient to learn how to qualify a new technology device
  - Sufficient time may exist to qualify a device, but not to determine **HOW** to qualify
- For 2016 launch, technology freeze dates are typically 2013 or earlier
- Technology development and evaluation 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





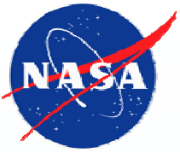
# Sharing NEPP Knowledge

- **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):** Week of June 2, 2014
    - HiREV day planned
  - Standards working groups
  - Telecons (NEPAG weekly and monthly international)
  - Documents such as Guidelines, Lessons Learned, Bodies of Knowledge (BOKs)
  - Technical papers

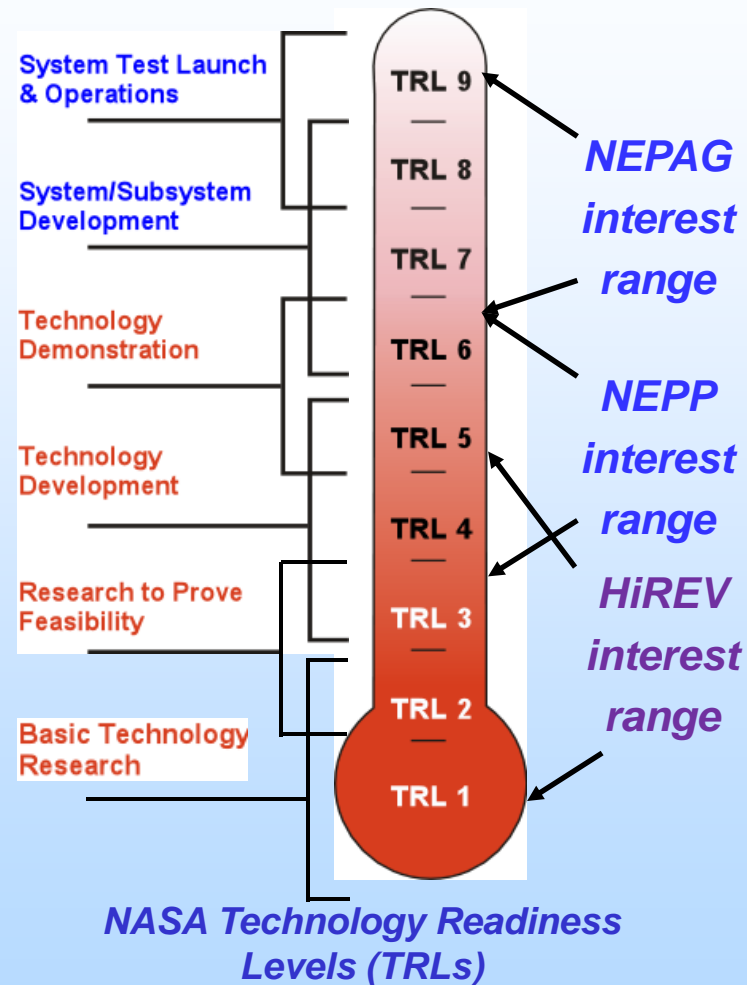


# Consortia and Working Groups

- **NEPP realizes the need to work in teams to provide better and more cost-effective solutions**
- **NEPP utilizes working 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**

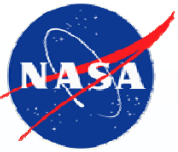


# HIREV and NEPP – NASA Perspective



**NASA has supported formation of the HiREV since it's beginning**

Presented by K. A. LaBel at the 2013 Microelectronics Reliability & Qualification Working Meeting and HiREV Industry Day, December 10-12, 2013 in El Segundo, CA and published on <https://nepp.nasa.gov/>.



# Alignment of NEPP and HiREV

## HiREV

- **Reliable Electronics**
  - Electronic technology  
Physics of Failure (POF)
- **Radiation Reliability of Electronics**
  - Modeling POF in new technologies

## NEPP

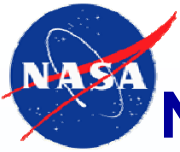
- **Reliable Electronics**
  - Applying POF to qualification/usage guidance
- **Radiation Reliability**
  - Testing for POF on new technologies
  - Support modeling/tools on new technologies
  - Qualification/usage guidance
- **Testing production devices**

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



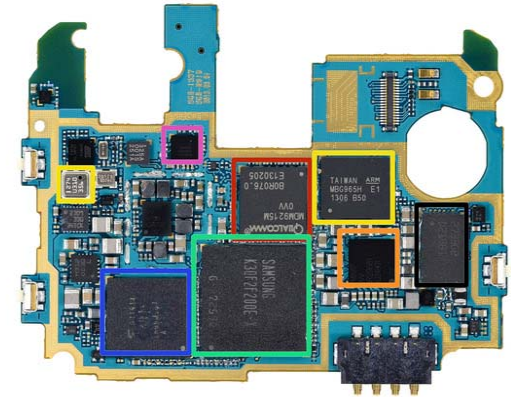
# NASA Expertise

- **Where NASA can provide specific added value**
  - Tie in to development of qualification and insertion guidance
  - Perspective on industry-wide insertion needs
  - Key discipline experts (e.g., FPGAs, capacitors, etc...)
  - Radiation effects on electronics
    - Emerging CMOS to Widebandgap to photonics to mixed signal to power electronics
    - Have been working with DoD (DTRA and NRO, co-funders, for example), universities (Vanderbilt & Georgia Tech), industry and international for nearly 20 years
    - Provides a clear adjoint to reliability POF, including efforts in combined effects (radiation/reliability)
  - Experience with dissemination via websites, conferences, and workshops



# Higher Risk Missions: NEPP Workshop on EEE Parts for Class D Missions and CubeSats

- One day agency-internal workshop held at NASA/GSFC on Sep 24, 2013
  - 160 attendees participated across the agency
    - Roughly 50% on-site, 50% via the web
  - Co-sponsored by NASA Offices of Safety and Mission Assurance and NASA Chief Engineer
  - Discussion and presentations on:
    - Examples from various Centers (GSFC, JPL, and ARC)
    - Discussion of electronics challenges and classes of electronics
    - Discussion of “go-forward” approaches, relevant guidance, and guidelines/policy
  - Post-workshop plans
    - Develop “rule of thumb” guidance in the near term (1Q FY14)
    - Develop more detailed guidelines/policy as appropriate in FY14
    - Organization of 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...)
    - Alternative part qualification evaluation focusing on effectiveness of board level test approaches

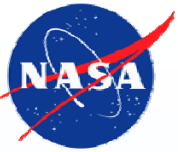


Galaxy S4 Phone Processor Board

[http://www.ifixit.com/Teardown/](http://www.ifixit.com/Teardown/Samsung+Galaxy+S4+Teardown/13947/2)

[Samsung+Galaxy+S4+Teardown/13947/2](http://www.ifixit.com/Teardown/Samsung+Galaxy+S4+Teardown/13947/2)

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.

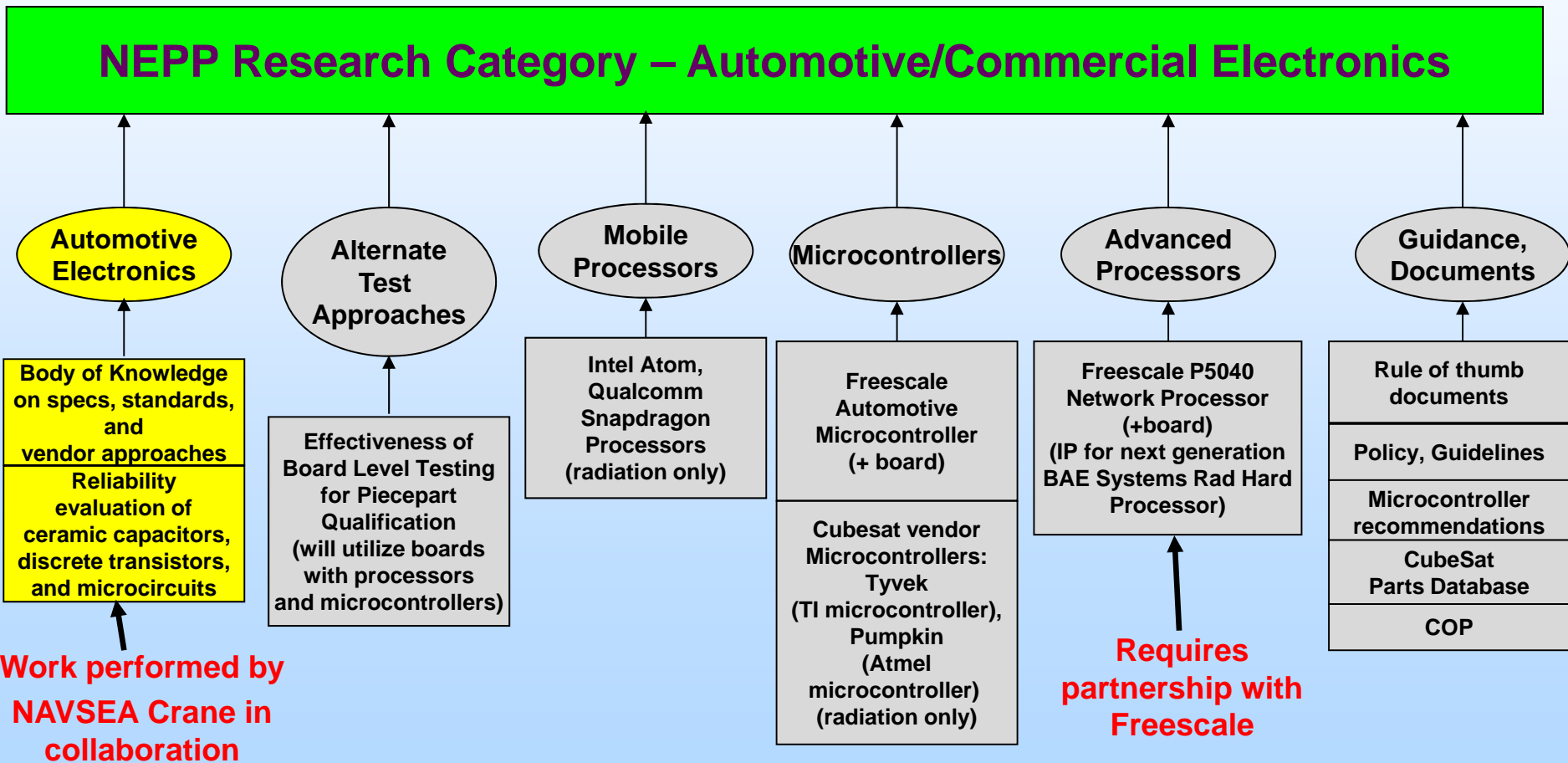
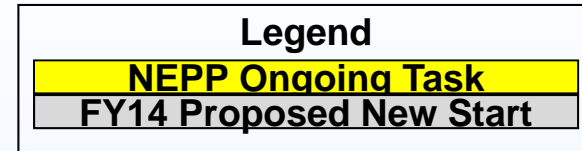


# FY14 NEPP Core –

## Automotive/Commercial Electronics (CubeSats to Class D)

Core Areas are **Bubbles**

Boxes underneath are variable tasks in each core



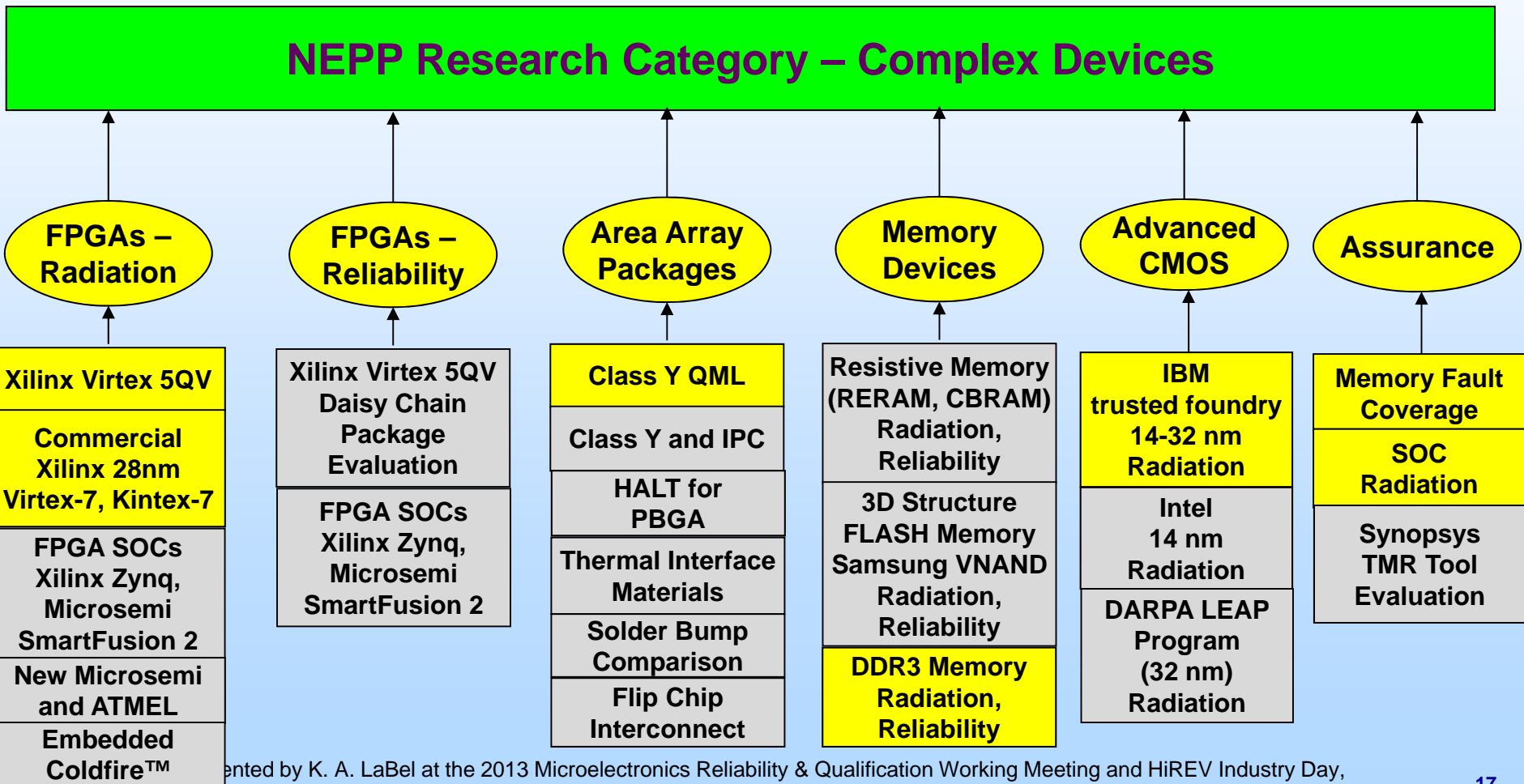




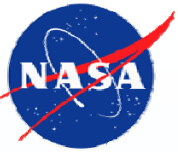
# FY14 NEPP Core - Complex Devices

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

Legend	
	NEPP Ongoing Task
	FY14 Proposed New Start

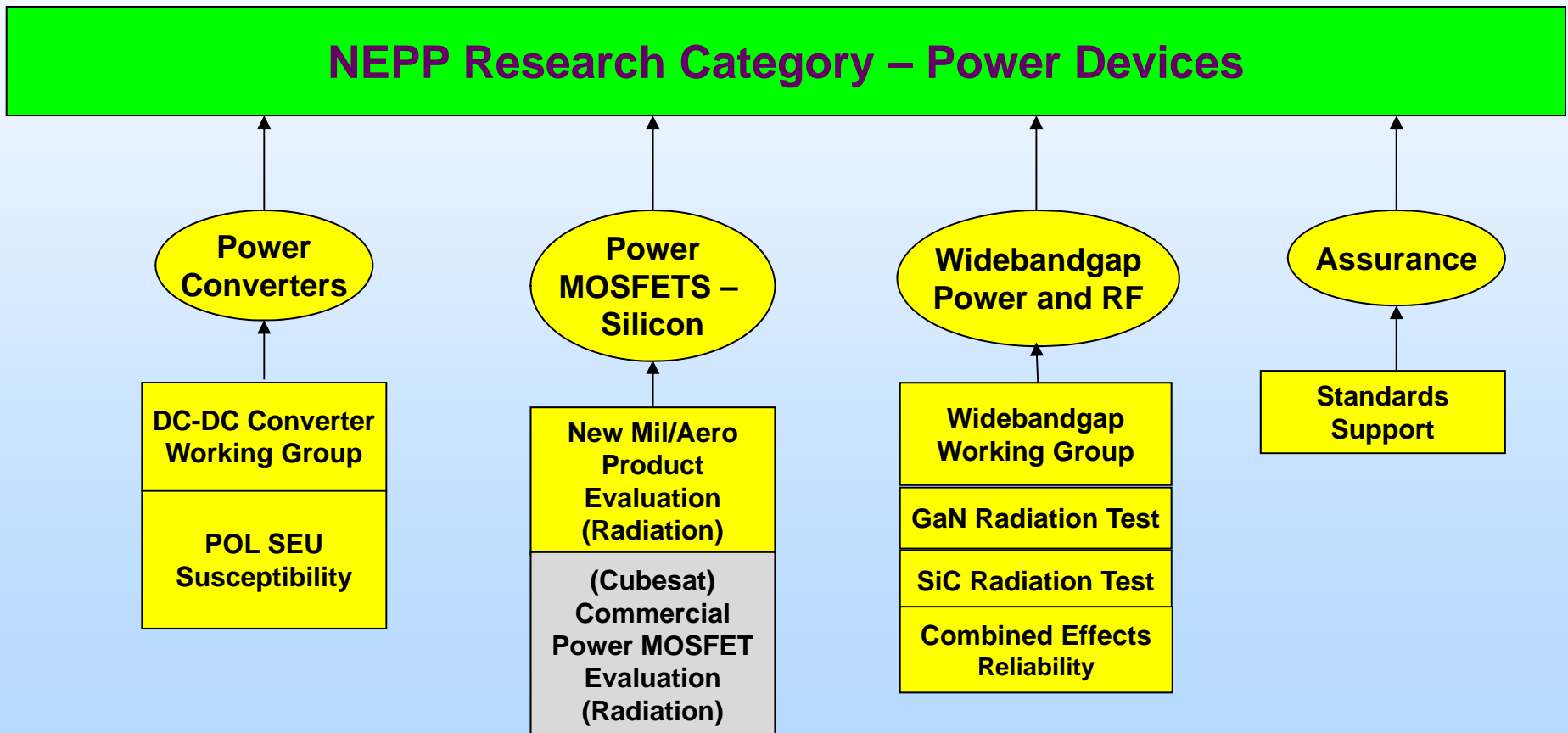
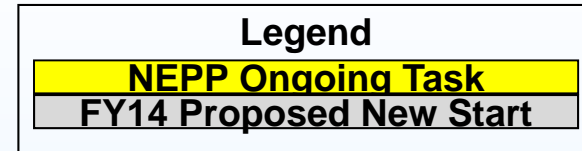


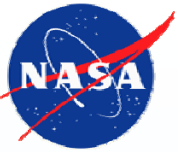
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# FY14 NEPP Core - Power Devices

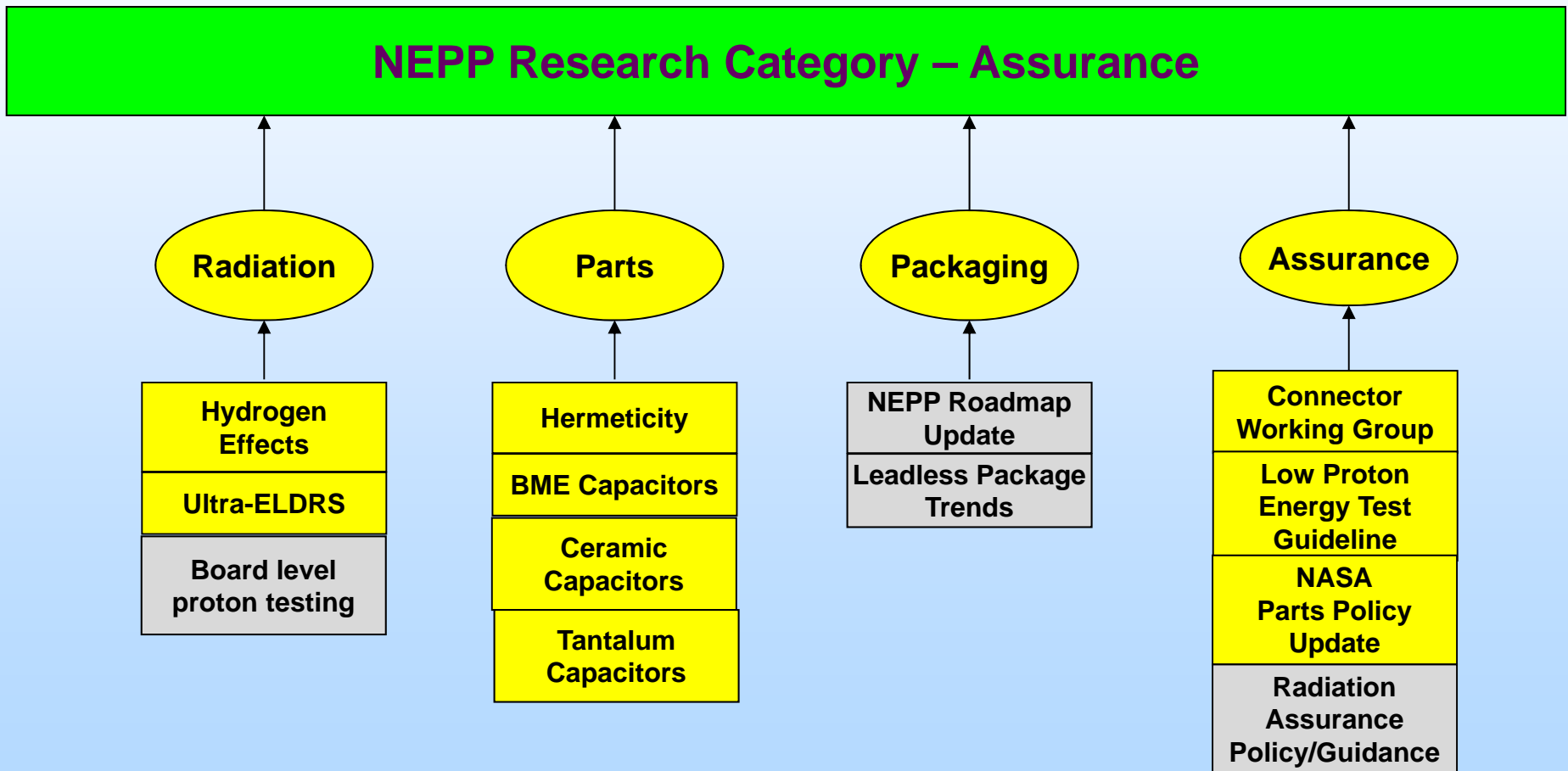
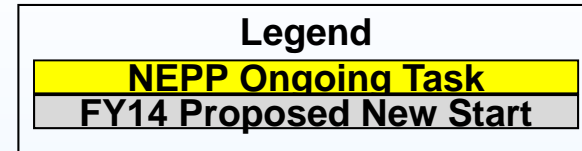
**Core Areas are Bubbles;**  
Boxes underneath are variable tasks in each core

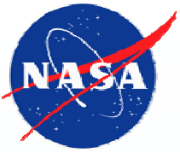




# FY14 NEPP Core - Assurance

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

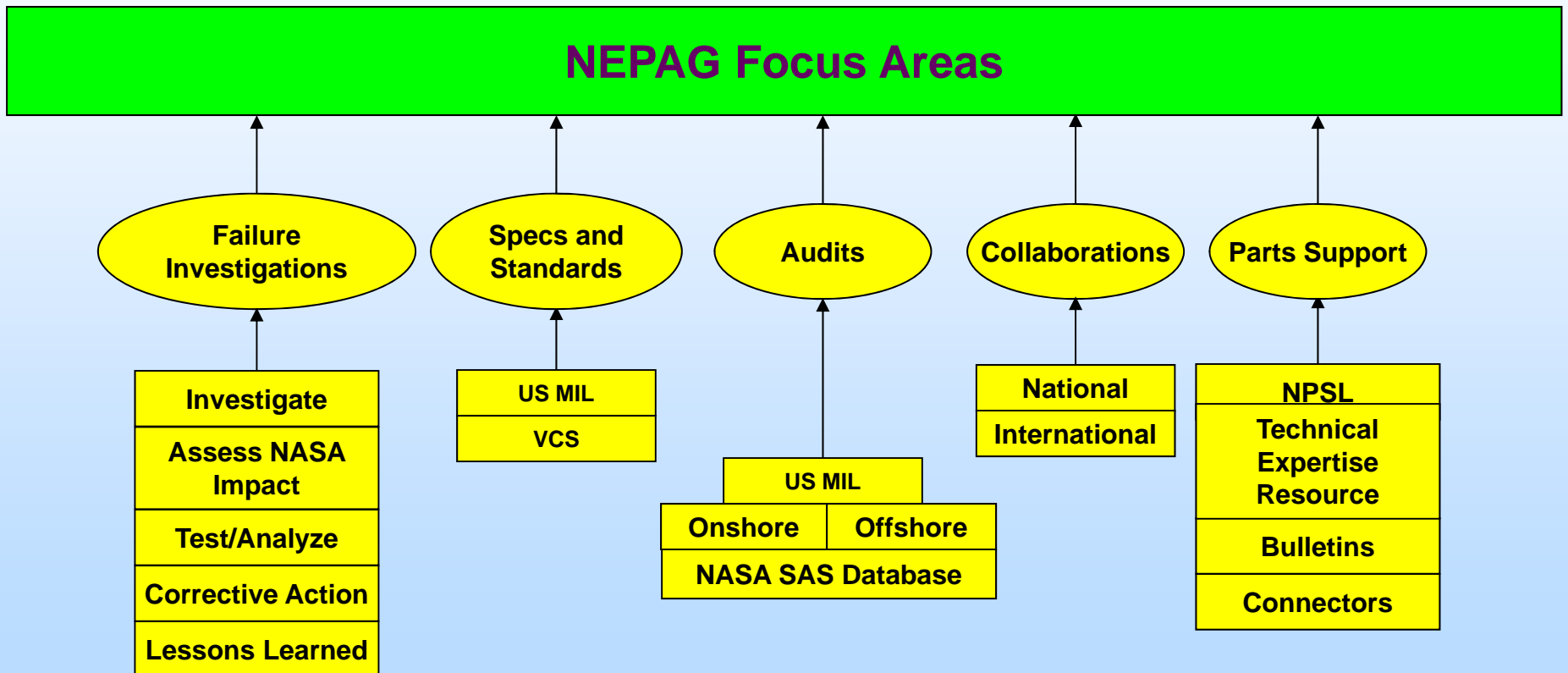


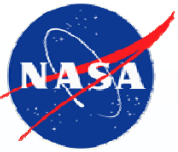


# NASA Electronic Parts Assurance Group (NEPAG)

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

Legend
NEPP Ongoing Task
FY14 Proposed New Start





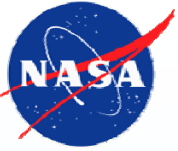
# Overguide/Approval Pending

- **Proposed tasks not yet approved**

- Long term storage guidelines
- Radiation/reliability 3<sup>rd</sup> 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?**