NASA Parts Engineering School

NASA JPL – NASA GSFC Joint Task FY22

June 7, 2022

NASA JPL Team: Shri Agarwal, Dori Gallagher, Shayena Khandker, Nazia Ovee, Ramon Salallandia, Rowan Swain

Jet Propulsion Laboratory
California Institute of Technology

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NASA Parts Engineering Training

- Q2FY22 start
- Background work as part of Phase I
  - Summary of parts engineering disciplines at NASA JPL
  - Available training opportunities provided at JPL for new hires
  - Focused classes provided by NASA, JPL and outside organizations
  - Special projects for new hires
- Next phase: Review with JPL Component Engineering & Assurance section management and GSFC Parts management.
  - Define tasks for joint Parts Engineering School effort.
  - Determine individual tasks for JPL and GSFC and tasks to be worked jointly.

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First JPL-GSFC Meeting: May 25, 2022

- Determine a set of “must be learned” baseline courses focused on the fundamentals of EEE parts engineering.
- Identify specialty training for individual disciplines.
- Compliment with additional information as program matures.
- Discuss at bi-monthly meetings.
- Recognize and address that there are differences in the Parts Engineering activities across the NASA centers.
- Present summary at the F2F meeting on June 17, 2022.

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What is Involved in Parts Engineering?

Parts engineering is about supporting flight projects.

- Ensure parts meet project requirements.
- Resolve parts issues as quickly as possible.

Parts engineering is not taught in college.

- Learned on the job

Parts engineering is about staying current by

- Attending conferences, taking courses
- Networking with peers, suppliers, others

Parts engineering is dynamic.

- Prepare for / respond to paradigm shifts.

Parts engineering is exciting.

- Critically important for flight projects to be successful

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Knowledge Required for Parts Engineering

- Parts Performance Specifications and Technical Requirement Standards
  - Maintaining Current Standards
  - Developing New Standards
- Environmental and Material Concerns
  - Temperature, Shock/Vibration, Radiation, Packaging
- Manufacturing, Qualification, Screening Processes
  - MIL-STD
  - COTS
- Procurement Requirements
- Testing
- Quality Assurance
- Schedule/Budget Training
- Industry Partners and Product Lines
  - Space Agencies – Domestic and International
  - Requirements for commodities requiring special attention (e.g., ASICS, hybrids)
- Manufacturers
- Parts Handling
- NASA GSFC EEE-INST-002: Instructions for EEE Parts Selection, Screening, Qualification, and Derating (To be superseded by 8739.11)
- JPL PETS Project Level Requirements

Life of a Project with Component Engineering

- Proposal: Project Definition & Budget
- Project Requirements: SMAP/SMAR
- Part Selection
- Finalize Design
- Part Review
  - GIDEP, NASA or Industry Alert Review
  - Reliability
  - Radiation
- Part Procurement
  - Testing
  - Upscreening
  - Failure Analysis
- Part Receipt (Receiving Inspection and Flight Stores)
- Waiver Process
- Part Kitting to Production Floor
- GIDEP, NASA or Industry Alert Review of As-Built Assemblies

Parts Engineering and Reliability

Parts Engineering Specialist

- The Parts Specialists each have an area of expertise in specific technologies (e.g., passive components, transistors and diodes, magnetics, digital SSI, MSI and analog ICs, VLSI, RF components and Compound Semiconductors).
- Duties
  - Assisting flight projects in identifying parts that will meet the project's requirements
  - Identifying up-screening requirements for parts that do not inherently meet project requirements, and providing risk assessments for parts with non-compliances and no flight history
  - Supporting and leading investigations into part problems
  - Staying current with all the vendors and technology developments in their area of expertise
  - Attending conferences and symposia on the latest advances in manufacturing, quality and reliability

Part Type Categories

- Capacitors
- Connectors with EEE components
- Crystals
- Crystal Oscillators
- Fiber Optics, Passive
- Filters
- Fuses
- Heaters
- Magnetics
- Microcircuits
  - Hybrid
  - Monolithic
  - Plastic Encapsulated (PEMs)
- Relays, Electromagnetic
- Resistors
- Semiconductor Devices, Discrete
- Switches
- Thermistors including PRTs

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Parts Acquisition

Parts Acquisition Group

- Parts Representative Duties
  - Entering CogE submitted parts lists into the OEPE repository system for archiving parts requests in preparation for procurement
  - Initiating order requests
  - Initiating kit lists for use by flight stores
- Order Desk Duties
  - Initiates purchase of flight parts (EM and breadboard parts procurements are initiated as appropriate as part of the flight procurement effort
  - Flight parts can be procured directly by the Order Desk personnel when the value of the procurement is < $2500.
  - Larger value procurements are coordinated with Section 262 and tracked by the Order Desk until received by Flight Stores.
- Flight Stores Duties
  - Receiving flight and engineering model parts
  - Verifying that the proper part type and quantity has been received
  - Binning the parts into the appropriate Project stores
  - Implementing the kit request initiated by the Parts Representative
  - Maintaining the controlled temperature and humidity environment in the flight stores area
  - JPL Flight Stores facility has been completely re-done, and further information will be provided in the next update.

Project Support

Project Parts Engineer (PPE)

- Duties
  - Acts as the single point of contact for tailoring the Parts Program Requirements for the unique objectives of each mission
  - Provides component engineering resources (specialists, procurement and programmatic) to each project
  - Is responsible for the technical and programmatic management of the Parts Program implementation
    - Provides budget preparation and management
    - Oversees parts program lifecycle while maintaining schedule and EEE parts requirements
  - Provides technical, financial, schedule and programmatic reporting to both the Project Mission Assurance Manager and Line Management

Radiation Effects

Radiation Effects Engineer (REE)

- REEs have the responsibility of assuring all EEE components on JPL missions. These efforts include
  - Investigating the effect of radiation on EEE devices
  - Engineering mitigations for EEE parts applications
  - Ensuring the JPL processes are followed
- REEs participate in
  - EEE part selection for flight projects
  - Review of candidate parts for missions
  - Testing and analysis of EEE devices for gradual or prompt radiation effects
  - Use modeling tools on advanced technologies to advance JPL flight capabilities
  - Provide risk assessments
  - Support baseline designs to develop robust systems
- REEs also aid in technology development including
  - Radiation hardening by design (RHBD)
  - Vetting advanced technology for inclusion in future NASA missions
  - Performing fundamental research in radiation or solid-state physics
- REEs have expertise in
  - Electronics Engineering
  - Systems Engineering
  - Solid State Physics
  - Radiation Physics

Analysis and Test Laboratory

Analysis & Test Laboratory (ATL) Engineer

- The Analysis & Test Laboratory consists of characterization, testing and failure analysis experts serving JPL's project and technology customers, enabling JPL to remain at the forefront of space exploration while ensuring mission success.
- ATL staff conduct Parts Construction Analysis (PCA) to provide an early understanding of component construction.
- Parts screening (PS) is completed with Non-Destructive Evaluation (NDE) techniques such as X-Ray, C-SAM, Hermeticity and Particle Impact Noise Detection along with Destructive Physical Analysis (DPA) to ensure applicable requirements are met.
- Environmental and electrical reliability testing is executed to validate mission required performance is achieved.
- Failure Analysis engineers analyze components displaying anomalies appearing during assembly, build and test or during reliability tests intended to induce failure, enabling root cause understanding and ability to remedy issues prior to launch.
- The wide breadth of capabilities are available to the JPL & NASA community on a walk in basis.

Component Engineering and Assurance Office

Management and Technical Staff

- Technical Staff provides
  - Section wide technical support, including the NASA EEE Parts Assurance Group (NEPAG)
  - Complex risk analyses and assessments and other technical related tasks for the Section
    - Perform vendor audits and technical assessments
    - Support projects through parts problem resolution
    - Maintain the Section's command media
  - The Technical Staff also facilitates development of close relationships with parts organizations at other NASA centers.
- Lessons learned, including trends, issues with parts requirements or processes, etc., which flow up through management from Parts Engineering Specialists, the Parts Acquisition Group, Project Parts Engineers, Radiation Effects Engineers, and Analysis & Test Laboratory Engineers, are shared with the greater DLA, NASA, other space agencies and industry partner community.

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Training Opportunities for JPL New Hires

- Mentorship with senior parts engineers
- Hands on training (PARS Database, Parts Issues Resolution, QARS, Inventory Management)
- R&D Projects
- JPL Electronic Parts Engineering (CogE training)
  - Course unique to JPL is available, but not current.
  - Includes presentations from each discipline within EEE parts engineering and assurance
  - This is being updated to include any updates in requirements, processes and tools.
  - Completion anticipated in April 2022 timeframe.
- JPL Space Environments Course (513/Reliability Engineering and Mission Assurance)
- JPL Counterfeit Parts Training (512/Quality Assurance)
- JPL ESD Sensitivity Training (5142/Parts Acquisition and 5145/ATL)

Training Opportunities for JPL New Hires (cont.)

- JPL Critical Item Handling
  - (Anyone who moves flight hardware)
- JPL Pressure Vessel Safety
  - (Anyone who handles moisture sensitive parts - liquid nitrogen chambers in storage)
- Writing for Technical Professionals (NASA APPEL) https://appel.nasa.gov/course-catalog/appel-tw/
- NASA Lean Six Sigma Training (Process improvement methodology and leadership)
- Institutional Training Requirements
  - NASA - SATERN courses (Cybersecurity and Sensitive Unclassified Information Awareness)
  - JPL – (Ethics, Import/Export, Protective Services, Preventing Harassment, JPL Cybersecurity Differences)
- Courses taught by former JPL managers

Focused Classes and Seminars

- NASA SATERN Courses and NEPP Training Resources and Publications
- Courses in JPL Learning Management System (LMS) and Degreed
- Georgia Tech Packaging Seminar https://www.prc.gatech.edu/courses/
- TJ Green Associates Virtual Training Seminars https://www.tjgreenllc.com/
- Hi-Rel Laboratories Customer Training https://www.hrlabs.com/customer-area/training/
- Center for Advanced Life Cycle Engineering (A. James Clark School of Engineering, University of Maryland) https://calce.umd.edu/education
- Apogee Parts Engineering Training https://www.eeeparts.com/training/
- ESA EEE Component Training Opportunities https://escies.org/webdocument/showArticle?id=736&groupid=6

Focused Classes and Seminars (cont.)

- EEE Space Parts Training - Tesat Spacecom, Germany https://triasrnd.com/l/245-eee-space-parts-training
- EEE Components Engineering: Basics of EEE parts on Space projects - ALTER Technology, Spain https://academy.altertechnology.com/courses/course-v1:ALTERAcademy+CS004+2020_T6/about
- Manufacturer training opportunities
  - For example:
    - IRC https://www.ttelectronics.com/resources/,
    - Kemet https://ec.kemet.com/training/,
    - Vectron – Microchip University https://secure.microchip.com/mu
- Parts Supply Chain presentations at Learn at Lunches facilitated by NASA JPL NEPAG team

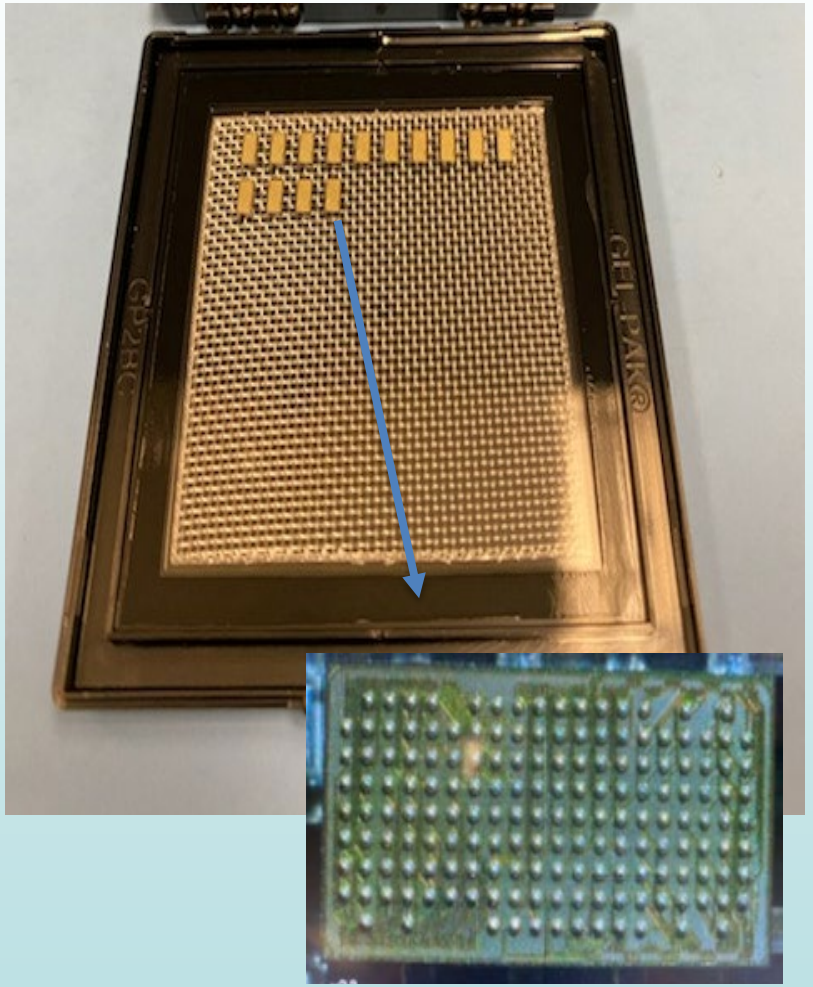
On The Job Learning Opportunities – New Hire Involvement in Special Projects

JPL Part Excess 2020 Project

- **Project Description**
  - Reduce the amount of parts both flight and destructive parts (ex. DPA/Qualification samples) in JPL stores (residuals) that have not been used and are not required on current projects in 10+ years.
  - Excel report was generated and sorted based on transaction history and requirements.
  - Destructive samples were sorted from the residual flight parts. All residual flight parts were sorted by FSC (Federal Supply Class) code.
  - Parts were pulled from flight stores, labeled in ESD packaging and put in labeled boxes.
  - Parts were offered to other NASA centers, and any remaining parts were shipped, recycled and destroyed.
- **Project Benefits**
  - Reduction in storage cost and space. Reduction in space was to account for a remodeled flight stores with new automated Kardex machines.
  - Substantial savings were achieved with removal of excess parts.
  - Of those excess parts, 5% were destructive parts (ex. DPA/Qualification samples).

514 and 3X Collaborative Research Project

- As the semiconductor industry moves towards smaller technology, JPL is analyzing the radiation effects on these new design libraries.
- A 22nm chip was designed, containing several test circuits.
  - Set up the 22nm Cadence directories in the JPL ASIC Server.
  - Design the test chip structures, then connect them to IO pads.
- The test circuits in the chip will undergo radiation testing and analysis:
  - Total Ionizing Dose (TID)
  - Single-Event Latch-up (SEL)
  - Single-Event Upset (SEU)
  - Single-Event Transient (SET)



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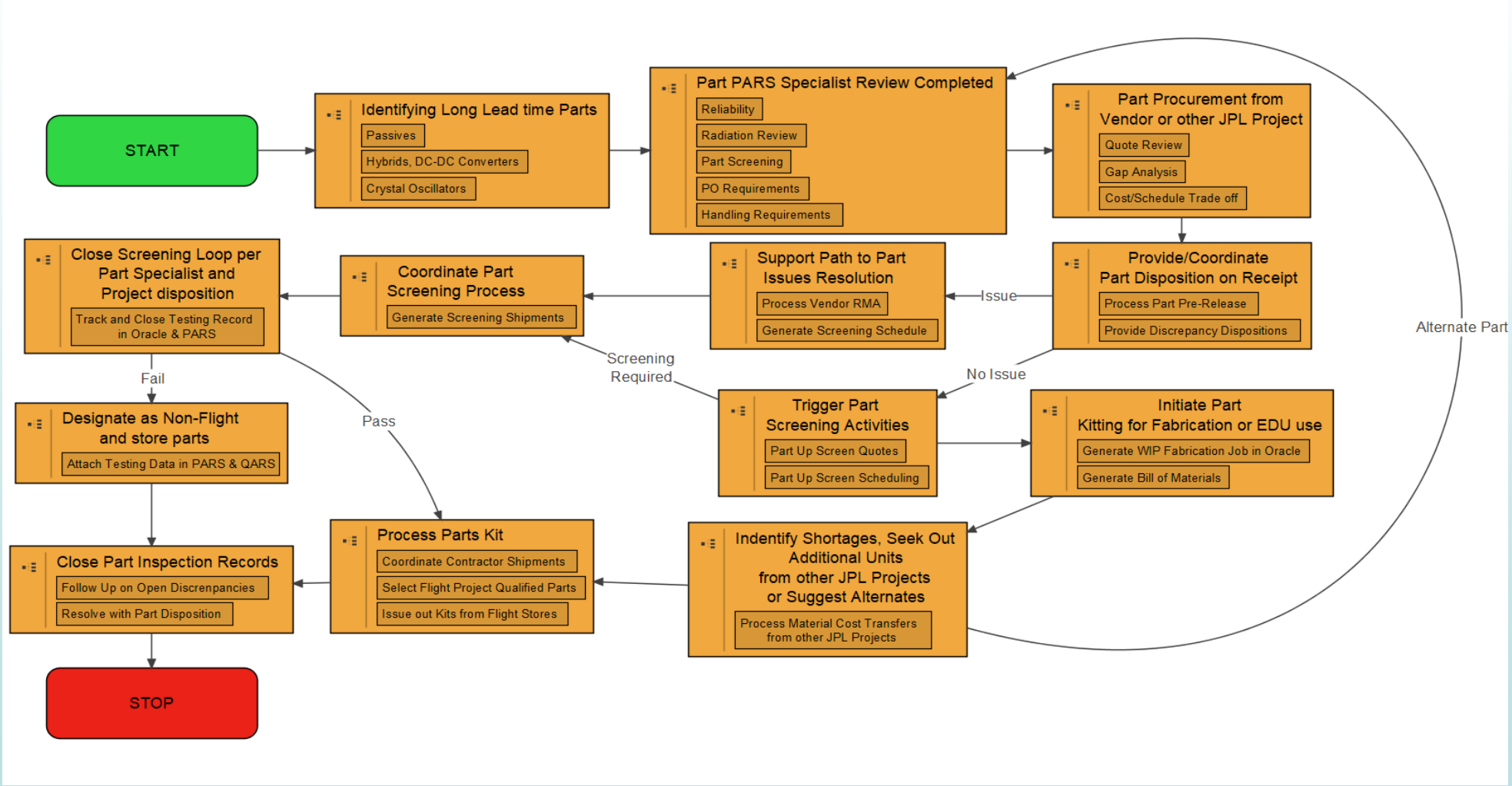
Xilinx Zynq System on a Chip (SoC)

Upscreening for EMIT project

- Zynq SoC is the most advanced and complex electronic part ever upscreened by JPL Parts Engineering and Reliability.
- Helped develop a test plan and test program to run on the SoC during burn-in, life test (Microblaze processor test)

Backup

High Level Parts Acquisition Responsibility and Activity Flow Diagram



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Section 514

COMPONENT ENGINEERING AND ASSURANCE (CEA)

Component Engineering and Assurance

The tiniest part on a spacecraft or instrument is as important as every other part, no matter how large or complex. Representatives of the Component Engineering and Assurance Office review EEE parts, advise JPL projects on part selection; conduct experiments or analyses to determine the physical behavior of parts in a space-like radiation environment; oversee procurement to ensure compliance with engineering requirements, and maintain inventories.

Parts Engineer — Identify high-reliability EEE parts for flight projects, quantify potential risk through technology analysis or characterization; and establish the physics of failure in support of failure analysis of EEE parts.

Parts Failure Analysis and Test Engineer — Perform testing and analysis of EEE parts, mechanisms and materials to determine deficiencies/ failure mechanisms or reliability characterizations.

Parts Acquisition Engineer — Manage the EEE parts supply chain including procurement, inventory, and kitting using the Manufacturing Resource Planning management system.

Project Parts Engineer — Works with the flight projects to ensure that all EEE parts meet the mission environment and reliability requirements, and establish and manage the schedule and budget.

Radiation Effects Engineer — Characterize the effects of radiation on EEE parts through testing or analysis, and apply this knowledge to support part selection and risk assessment for flight projects.

TYPICAL MAJORS

- Electrical/Electronics Engineering
- Applied Physics
- Computer Engineering
- Electronics Technology
- Engineering Technology

Contact:
parts.jpl.nasa.gov

Staffing@jpl.nasa.gov
(818)354-5150

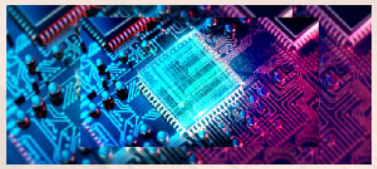
5140 OneSpace Community NEPAG

The 5140 Technical Staff provides:

- Section wide technical support, including the NASA EEE Parts Assurance Group (NEPAG)
- Complex risk analyses and assessments and other technical related tasks for the Section.

These include:

- Performing vendor audits and technical assessments
- Supporting projects through parts problem resolution
- Maintaining the Section's command media.
- The Technical Staff also facilitates development of close relationship with parts organizations at other NASA centers.



5141 PARTS ENGINEERING AND RELIABILITY

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5142 PARTS ACQUISITION

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5143 PROJECT SUPPORT

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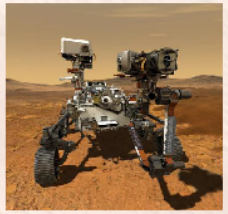

5144 RADIATION EFFECTS

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REEs participate in:

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- Review of candidate parts for missions
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- Use modeling tools on advanced technologies to advance JPL flight capabilities
- Provide risk assessments
- Support baseline designs to develop robust systems.

REEs also aid in technology development including:

- Radiation hardening by design (RHBD)
- Vetting advanced technology for inclusion in future NASA missions
- Performing fundamental research in radiation or solid-state physics.

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- Electronics Engineering
- Systems Engineering
- Solid State Physics
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5145 ANALYSIS AND TEST LABORATORY

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