Radiation Effects and Analysis (REA) Group and Space Radiation Physics Office (SRPO)

Ken LaBel, Group Leader REA
Janet Barth, Ass. Head SRPO

The Radiation Environment Radiation Effects

- Total Ionizing Dose (TID)
  - Trapped Protons & Electrons
  - Solar Protons
- Single Event Effects (SEE)
  - Protons
    - Trapped
    - Solar
  - Heavier Ions
    - Galactic Cosmic Rays
    - Solar Events
  - Neutrons

Total Ionizing Dose

- Cumulative long term ionizing damage due to protons & electrons
- Effects:
  - Threshold Shifts
  - Leakage Current
  - Timing Skew
  - Functional Failures
- Can reduce with shielding
  - Low energy protons
  - Electrons

Single Event Effects

- Event caused by a single charged particle
  - Heavy ions
  - Protons for some devices
- Effects:
  - Non-destructive: SEU, SET, MBU, SEBE, SHE
  - Destructive: SEL, SEGR, SEB
- Severity is dependent on
  - type of effect
  - system criticality
- Shielding has little effect

Displacement Damage

- Cumulative long term non-ionizing damage due to protons, electrons, and neutrons
- Effects
  - Production of defects which results in CTR degradation
  - Optocouplers, solar cells, CCDs, linear bipolar devices
- Shielding has some effect - depends on location of device
  - Can eliminate electron damage
  - Reduce some proton damage

REA/SRPO Objectives

- The objectives of the REA/SRPO are two-fold:
  - To provide NASA customers with critical support in the area of radiation hardness assurance (RHA), and,
  - To support NASA spacecraft designers and technology developers in the radiation evaluation of new and emerging technologies as well as radiation models and tools

Flight Project RHA

- Providing lead radiation engineer support to flight missions;
- Definition of mission radiation environment, both external to and internal to the spacecraft;
- Development of project specifications and requirements;
- Evaluation of component list for radiation concerns including recommendations for testing and/or alternative device selection;
- Radiation characterization of flight components;
- Calibration of flight instruments and detector technologies;
- Collaboration with spacecraft designers and system engineers on evaluating the system impact of radiation issues as well as mitigative options; and,
- Investigation of RHA issues that impact flight designs or are radiation-specific issues such as test methodology or dosimetry.

REA/SRPO Applied Research

- Provides characterization of new and commercial microelectronic and photonic technologies;
- Evaluates emerging leading edge microelectronic and photonic technologies;
- Develops models, characterization methods, and predictive tools for microelectronic and photonic technologies;
- Evaluates in-flight performance of microelectronic and photonic technologies;
- Develops radiation flight experiments and instrument monitors to evaluate radiation issues, to support technology developers, and to determine the radiation environment as it pertains to NASA designers and models;
- Supports flight opportunities for radiation flight experiments;
- Evaluates radiation environment models and determines applicability to NASA as well as development of new models; and,
- Supports technology developers in improving their products for radiation characteristics.

What is the Electronics Radiation Characterization (ERC) Project?

- A project under the NASA Electronic Parts and Packaging (NEPP) Program
  - Ken LaBel, Project Manager
  - Chuck Barnes (JPL), Deputy Project Manager
- Provides radiation evaluation of cross-cutting technologies
  - Examples: COTS, emerging microelectronics, photonics
- Provides guidelines for technology usage
  - Example: optocoupler usage
- Supports radiation-specific issues to provide increased reliability and reduced costs
  - Example: radiation test methods

ERC's Underlying Goal

- Aid NASA designers to meet *their challenges* such as
  - Performance
  - Reliability
  - Resources

ERC Tasks for FY00

- 24 GSFC Tasks
  - Many are joint with JPL
  - Tasks include
    - RADHOME Website
    - Emerging Microelectronic Technologies
      - SiGe, Ferroelectrics
    - Commercial Microelectronics
      - ADCs, DACs, DC-DC Converters, Memories
    - Flight Data Analysis
    - Optocouplers
    - Commercial Fiber Data Links
    - Radiation Impact on Reliability

Defense Threat Reduction Agency's (DTRA) Radiation Tolerant Microelectronics (RTM) Program

- Ken LaBel is program manager for NASA
  - Includes JPL tasks
- Tasks include
  - Development of fiber optic predictive tool
  - Characterization of Commercial Non-Volatile Memory Technologies
  - Proton Irradiation Test Guidelines
  - Radiation Effects in Optocouplers
  - SEE Response in SiGe and Other Emerging Technologies
  - Single Event Latchup (SEL) Reliability Impact

Orbiting Technology Testbed Initiative (OTTI)

- Space Science (Code S) Effort
  - Potentially part of Living With a Star (LWS) or New Millenium Program (NMP)
- Four Objectives
  - Technology Validations and Demonstrations
  - Technology Development
    - Models, Databases, Guidelines, Definitions
  - Flight Experiments
    - Enable operations in high radiation environments
  - Science Data Link

OTTI - GSFC Participation

- GSFC is likely the lead center for OTTI
- Janet Barth
  - Link to science team and LWS formulation
  - Environment models and tools
  - Possible lead for OTTI
- Ken LaBel
  - Link to technology experiments
  - Engineering interface

Flight Experiments

- Microelectronic and Photonics Testbed (MPTB)
  - Ken LaBel (and a cast of 1000s)
  - AS1773 Fiber Optic Bus
- Space Technology Research Vehicle -1d (STRV-1d)
  - Ken LaBel, Robert Reed, Rich Katz, Cheryl Marshall, E.G Stassinopoulus, et al
  - Optocouplers, state-of-the art digital electronics, pulse height analyzer (PHA) instrument, dosimetry
  - Co-PI with Aerospace Corp. on Analog SEE
- Others
  - CRUX, HOST, commercial airplane
  - Engineering data from SAMPEX, TOMS/Meteor, SeaStar, XTE, TRMM, et al