Space Radiation Analysis Group
Operational Tools

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OVERVIEW

- SRAG Operations
- Data and Measurements
- Technology Development
- SRAG Future
SRAG Operations
SRAG, est. 1962
- Real-time console operations
- Crew, ambient monitoring
- Pre-flight planning
- Design evaluations

Radiation Health Office
- Interpretation
- Record Keeping
- Risk Estimation
- Crew Selection

NASA Space Life Sciences (SLS) Reorganization combined SRAG and RHO. SLS changed names to Human Health and Performance (HH&P).
Radiation Monitoring for Crew and Space Vehicle

- **Console Operations Support**
  - 24 hours Contingency Support
  - 4 hour/day Nominal Support

- **Active Radiation Detectors**
  - Tissue Equivalent Proportional Counter (TEPC)
  - Charge Particle Directional Spectrometer (CPDS)
  - Intra-Vehicular TEPC (IV-TEPC)

- **Passive Radiation Detectors**
  - Crew Passive Dosimeter (CPD)
  - ISS Radiation Area Monitor (RAM)
Instrumentation

- **RAM** – Radiation Area Monitors
  - Passive dosimeters, 20+ locations on ISS

- **REM** – Radiation Environment Monitor
  - Active dosimeter with USB interface

- **TEPC** – Tissue Equivalent Proportional Counter
  - Located in ISS Service Module

- **IV-TEPC** – new TEPC detector
  - Moves about ISS every 4-6 weeks
Comparison to RAM Data
Comparison to RAM Data
A/L1-AD3
REM is based on a 256 x 256 pixel grid detector with total area of 2 cm². Low mass and power.
REM Instrument LET Measurements

LET Distribution

Number of Particles

Linear Energy Transfer [keV/μm]
Technology Development
Update to Advanced Radiation Protection Project

- MC-CAD: Radiation protection design through analysis of complex CAD geometries using Monte Carlo radiation transport codes.
- Both tasks are underway with expected operational products completed in Sept. 2014

- ARP was a casualty of sequestration on 3/1/2013
- Partial funding regained in April for ISEP to continue through September 2013
- MC-CAD remains unfunded by OCT
- ISEP will deliver models that need further verification and MC-CAD will deliver a prototype CAD-FLUKA interface
Technology Development

- **Active Shielding**
  - Research to determine if it is mass and/or power prohibitive
  - Technology development on system components that will improve shielding effectiveness and decrease mass and power needs

- **Measurements**
  - ISS Detailed Test Objective – REMs starting summer 2012
    - Actual: Launched in August began operations in October
  - Exploration Flight Test 1 (EFT-1) (RAMs and REMs) – 2014
  - Radiation Assessment Detector (RAD) with an added fast neutron detector channel – 2015
Collaboration with the University of Wisconsin has been established to make use of their existing DAG-MC (Direct Accelerated Geometry – Monte Carlo) tool as a universal geometry and navigation interface to radiation transport packages.

Teamed with FLUKA collaboration at CERN to make use of the FLUGG (FLUKA-GEANT4 interface) to link DAG-MC with FLUKA (FLU-DAG).
DAG-MC Overview

- Functioning version that currently works with MCNP. Used regularly for Fusion ITER project.
- CAD converted to MOAB (Mesh Oriented datABase)
- Fast binary search algorithms
- Material assignment, boundary conditions, source definition, tally/scoring
- Imprint and merge for touching surfaces (water tight)
- Navigation within CAD on complex geometry is only about 2.5 times slower than simplistic native quadric combinatorial geometry models
Space Weather Forecasting

- Historical database for identification of event trending/characteristics
- Probabilistic modeling for operational mission planning
- ISEP: integration of probabilistic spectral and SEP dose modeling
- Dose projection for in-event risk mitigation
- Forecasting of event onset and impact outside of low-earth orbit.

MAG4 Model

David Falconer University of Alabama

In Collaboration with CCMC and University of Alabama
Model Validation and Testing: All-Clear (Preliminary)

- Change in ‘All-Clear’ probability is sufficiently distinct for operational use.
- Thresholds for ‘go / no-go’ call will be user dependent and user-defined.
- Operational thresholds will be investigated in FY13.

A full assessment of forecast skill being performed by University of Alabama and JSC.
All-clear probability is cumulative over disk. However, time dependence of single-region growth correlates with region identified as producing flares and SEP.
SRAG Future
Future SRAG Instrumentation

- **ISS Radiation Assessment Detector**
  - Designed to measure neutrons and charged particles from protons through Iron
  - Will provide real-time data
  - Can be relocated within the habitable volume

- **MPCV Hybrid Electronic Radiation Assessor (HERA)**
  - Based on timepix technology and REM heritage
  - Will be integrated into MPCV
  - Will provide real-time data
Operational Toolset Next 5 Years

- SRAG expects to have the capability to do quick turnaround dose and risk assessments within complex vehicle geometry starting from CAD (months to week(s))

- SRAG expects to have forecasting models that give 24 hour all-clear probabilities for operating anywhere between the Earth and Mars

- SRAG expects to have models that predict overall radiation exposure early on during an SPE allowing go-no go decisions to be made

- SRAG expects to have instrumentation that continues to meet real-time data requirements that has reduced mass and power compared with today’s ops instruments