The Living With a Star Space Environment Testbed Experiments

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Outline

• **Living With a Star (LWS) Space Environment Testbed (SET)**
  – Objective & Scope
  – Investigations

• **SET Payload on the Air Force Research Laboratory (AFRL) Demonstration & Science Experiments (DSX) Spacecraft**
  – Space Weather Monitor
  – Carrier Containing 4 Board Experiments

Living With a Star
Space Environment Testbed

Objective

Improve the engineering approach to mitigate the effects of space weather on spacecraft design & operations

Scope

Spacecraft hardware & design / operations tools whose performance is affected by space weather, including:

- Radiation Environment Within Spacecraft,
- Microelectronics,
- Materials,
- Plasma & Charging Effects, and
- Detectors & Sensors.

Investigators funded through NASA Research Announcements (NRAs)

SET NRA #1 – Space Data Mining:
- 9 awards in FY01 totaling $800 K
- Products available on SET web site

SET NRA #2 - Space Experiments:
- 7 awards in FY03 totaling $1.5 M
- Selected experiments to be flown on AFRL’s DSX Mission

Objective
Space flight experiments designed to significantly enhance capability to operate in the harsh radiation environment of Medium Earth Orbit (MEO). View toward communication, surveillance and navigation capabilities.

Launch and Orbital Information
DSX is baselined for a 6000 x 12,000 km, 45° inclination orbit with 1 year of operations. Launch on SpaceX Falcon Heavy rocket in mid-2015 (2016?).

Three Types of Experiments
1. Wave Particle Interaction Experiment: Transmit Very Low Frequency (VLF) waves and understand effects on magnetospheric electrons.
2. Space Weather: Collect data and develop models for the highly variable Medium Earth Orbit (MEO) Slot Region.
3. Space Environment Effects: Rad effects on electronics, thermal materials and optical coatings.

SET on DSX

SET is one of nine payloads on DSX

DSX structure
(secondary payload adapter)

Avionics Module

Payload Module

SET Payload: Cosmic Radiation Environment Dosimetry and Charging Experiment (CREDANCE)

- **Principal Investigator:**
  - Clive Dyer, QinetiQ

- **Objectives:**
  - Demonstrate the value of a compact space weather monitor for spacecraft
    - 1 kg mass; 2.5 W power
  - Provide data to other experiments
  - Use data for trapped particle model development

- **Measurements:**
  - > 40 MeV proton flux
  - Electron charging current at 3 shielding depths
  - Ionizing dose at 2 shielding depths
  - Linear Energy Transfer (LET) spectra of heavy ions ranging from 0.1 to 25 MeV-cm$^2$/mg

Credit: QinetiQ, United Kingdom; http://lws-set.gsfc.nasa.gov

SET Payload: Dosimetry Intercomparison and Miniaturization Experiment (DIME)

- **Principal Investigator:**
  - Peter McNulty, Clemson

- **Objectives:**
  - Provide novel dosimetry data with Commercial Off the Shelf (COTS) microelectronic structures
  - “Back-up” environment data for other experiments

- **Measurements**
  - Total dose from Radiation-Sensing Field-Effect Transistors (RADFETs), Erasable Programmable Read Only Memories (EPROMs) and Optically Stimulated Luminescence (OSL) films
  - Non-ionizing dose from Light Emitting Diode (LED) characteristics in OSL circuitry
  - LET spectra from p-type silicon/n-type silicon junction arrays

SET Payload:
Enhanced Low Dose Rate Sensitivity (ELDRS)

- **Principal Investigator:**
  - Hugh Barnaby, Arizona State University

- **Objective:**
  - *Improve understanding of the physics of the Enhanced Low Dose Rate Sensitivity (ELDRS) effect in order to improve/validate ground test protocol for linear bipolar technologies and reduce design margins*

- **Space Measurements:**
  - *Transistor characteristics of 24 bipolar junction transistors with well-controlled, different processing characteristics:*
    - Oxide thickness
    - Passivation layer
    - Hydrogen content

Credit: Arizona State University; http://lws-set.gsfc.nasa.gov

SET Payload: Commercial Off the Shelf–2 (COTS-2)

- **Principal Investigator:**
  - Raoul Velazco, Techniques de l’Informatique et de la Microelectronique pour l’Architecture des systemes integres (TIMA), France

- **Objective:**
  - Validate approach to single event analysis in complex circuits with large phase space by combining measurements of static cross sections and fault injection techniques

- **Space Measurements:**
  - Single events in COTS Field Programmable Gate Arrays (FPGAs)

Credit: TIMA, France; http://lws-set.gsfc.nasa.gov

All space data will be publicly available on the SET website: 

http://lws-set.gsfc.nasa.gov

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  – Project Administrator/Education & Public Outreach Lead

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