The Living With a Star Space Environment Testbed Payload

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Acronyms

- LWS – Living With a Star
- SET – Space Environment Testbed
- SDO – Solar Dynamics Observatory
- ESA – European Space Agency
- JHU APL – Johns Hopkins University Applied Physics Laboratory
- DSX – Demonstration and Science Experiments
- BARREL – Balloon Array for Radiation-belt Relativistic Electron Losses
- AFRL – Air Force Research Laboratory
- AE9/AP9 – Aerospace Electron and Proton Models, Version 9
- MEO – Medium Earth Orbit
- GIOVE-A – Galileo In-Orbit Validation Element – A
- LET – Linear Energy Transfer
- RADFET – Radiation Sensing Field Effect Transistor
- PI – Principal Investigator
- TIMA - Techniques de l’Informatique et de la Microelectronique pour l’Architecture des systemes integres
Outline

- **Living With a Star (LWS) Program**
- **Space Environment Testbed (SET) Payload**
  - Space Weather Monitor
  - Carrier Containing 4 Board Experiments
Living With a Star Program

- **Provides missions to improve our understanding of space weather; how the Earth and Solar System respond; and how humanity is affected.**

- **LWS Missions:**
  - Solar Dynamics Observatory (SDO) – launched Feb. 2010
  - Solar Orbiter Collaboration with ESA – NASA providing 2 of 10 instruments for 2017 launch
  - Solar Probe Plus – developed by JHU APL and managed at GSFC for 2018 launch; measurements within solar corona
  - Van Allen Probes – launched August 2012; interest in collaborative work with DSX to extend both mission lifetimes
  - BARREL – balloon measurements of relativistic electron precipitation from belts; supplements Van Allen Probes data
  - Space Environment Testbed (SET)
Space Environment Testbed Investigations

Investigators funded through NASA Research Announcements (NRAs)

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

SET NRA #2 - Space Experiments:
- 7 awards in FY03 totaling $1.5M
- Selected experiments to be flown on AFRL’s DSX Mission
SET Payload: Cosmic Radiation Environment Dosimetry and Charging Experiment (CREDANCE)

- **PI:** Clive Dyer, QinetiQ

**Objectives:**
- Demonstrate the value of a compact space weather monitor for NASA spacecraft
  - 1 kg mass; 2.5 W power
- Provide data to board experiments
- Use proton and electron data for AE9/AP9 model development
  - Provide calibration to European MEO data taken on GIOVE-A satellite (23,260 km circular, 56° inclination)

**Measurements**
- 2 particle telescopes consisting of Si diode pairs
  - > 40 MeV proton flux
  - Heavy ion LET spectra: 0.1 to 25 MeV-cm²/mg
- Electrometers measuring electron charging current at 3 shielding depths
- RADFETs measuring ionizing dose at 2 shielding depths

Credit: QinetiQ, United Kingdom
http://lws-set.gsfc.nasa.gov
SET Payload:
Dosimetry Intercomparison and Miniaturization Experiment (DIME)

- **PI**: Peter McNulty, Clemson
- **Objectives**:
  - Provide novel dosimetry data with Commercial Off the Shelf (COTS) microelectronic structures
- **Measurements**
  - Total dose from 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

Credit: Clemson University; http://lws-set.gsfc.nasa.gov
SET Payload: Enhanced Low Dose Rate Sensitivity (ELDRS)

- **PI:** Hugh Barnaby, Arizona State University
- **Objective:**
  - Improve understanding of the physics of the 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)

- **PI:** Raoul Velazco, 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
SET Payload on DSX

DSX structure
(secondary payload adapter)

Payload Module

SET Carrier

Space Weather Monitor

Avionics Module

SET Carrier

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

http://lws-set.gsfc.nasa.gov
LWS SET Personnel

- **Reggie Eason**
  - Project Manager
- **Ron Mink**
  - Systems Engineer
- **Scott Appelbaum**
  - Mission Operations
- **Eve Rothenberg**
  - Ground Data
- **Karen Pham**
  - Integration & Testing