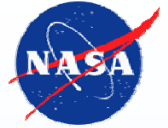


The Living With a Star Space Environment Testbed Payload

Mike Xapsos
NASA Goddard Space Flight Center

January 27, 2015

Acronyms

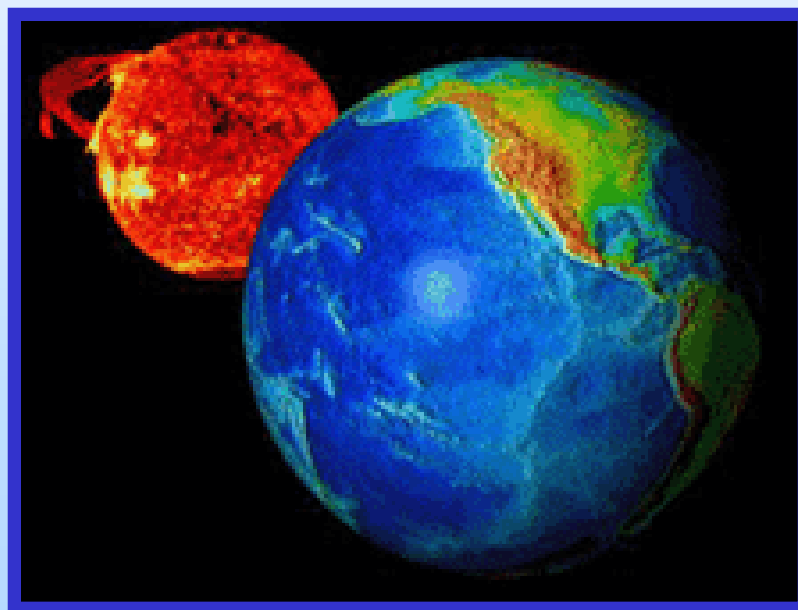


- ***LWS – Living With a Star***
- ***SET – Space Environment Testbed***
- ***SDO – Solar Dynamics Observatory***
- ***ESA – European Space Agency***
- ***JHU APL – Johns Hopkins University Applied Physics Laboratory***
- ***DSX – Demonstration and Science Experiments***
- ***BARREL – Balloon Array for 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***

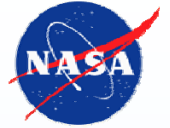
Outline



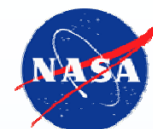
- *Living With a Star (LWS) Program*
- *Space Environment Testbed (SET) Payload*
 - *Space Weather Monitor*
 - *Carrier Containing 4 Board Experiments*



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

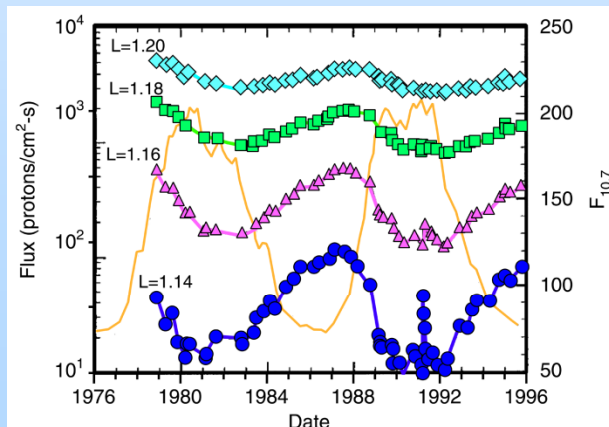
Investigators funded through NASA
Research Announcements (NRAs)

SET NRA #1 – Space Data Mining:

- 9 awards in FY01 totaling \$800 K
- Products available on SET web site

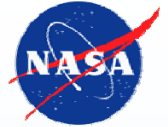
SET NRA #2 - Space Experiments:

- 7 awards in FY03 totaling \$1.5 M
- Selected experiments to be flown on AFRL's DSX Mission

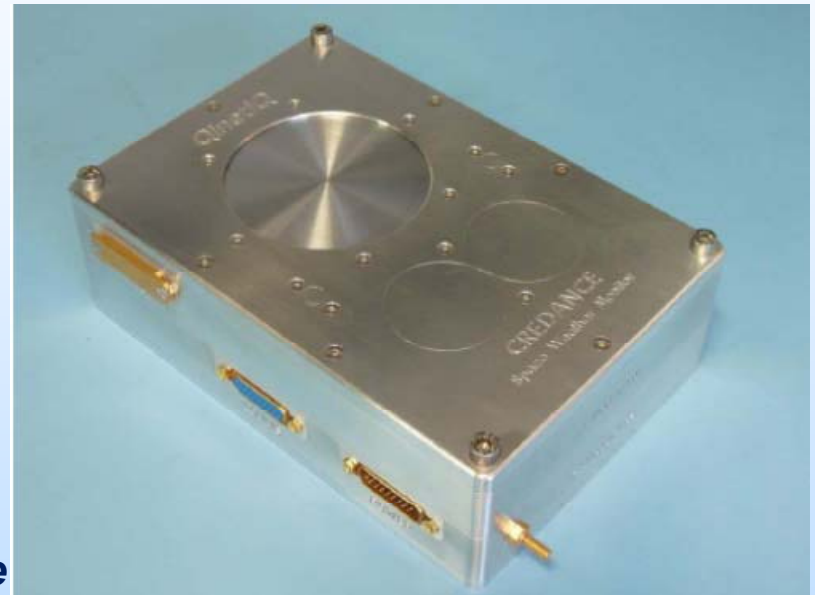


SET Payload:

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*

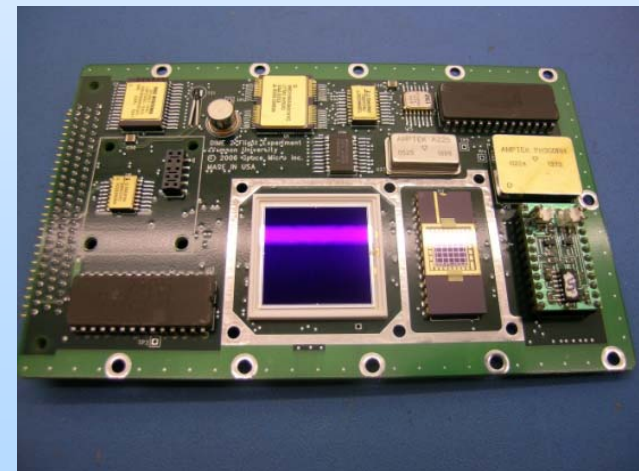
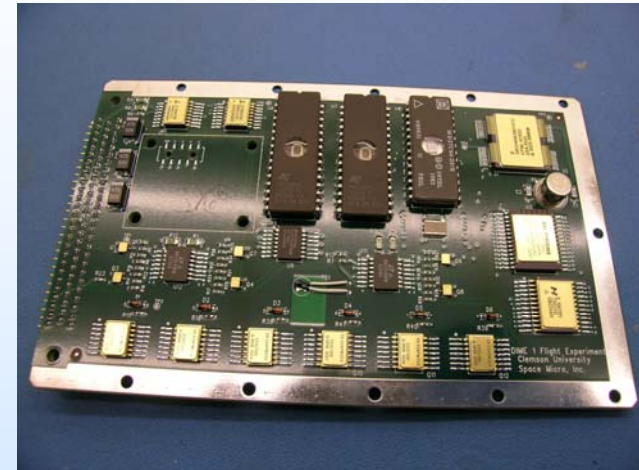


Credit: QinetiQ, United Kingdom
<http://lws-set.gsfc.nasa.gov>

SET Payload: Dosimetry Intercomparison and Miniaturization Experiment (DIME)

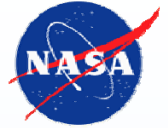


- **PI: Peter McNulty, Clemson**
- **Objectives:**
 - *Provide novel dosimetry data with Commercial Off the Shelf (COTS) microelectronic structures*
- **Measurements**
 - *Total dose from RADFETs, Erasable Programmable Read Only Memories (EPROMs) and Optically Stimulated Luminescence (OSL) films*
 - *Non-ionizing dose from Light Emitting Diode (LED) characteristics in OSL circuitry*
 - *LET spectra from p-type silicon/n-type silicon junction arrays*

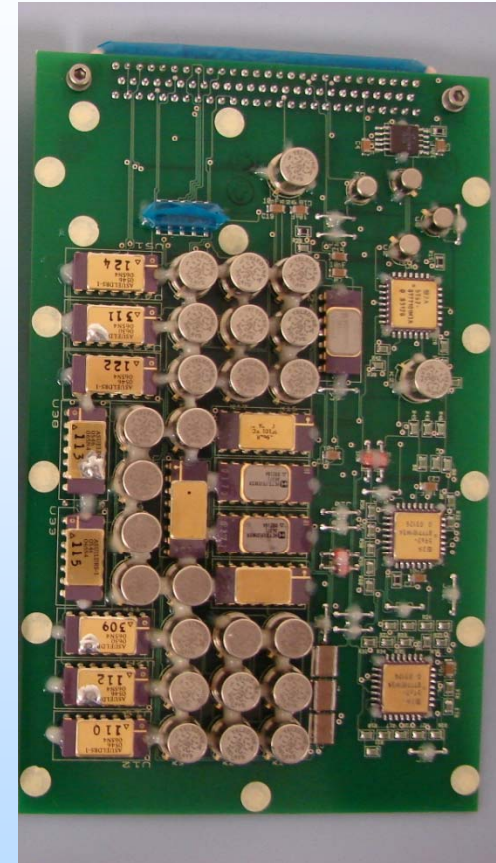


Credit: Clemson University; <http://lws-set.gsfc.nasa.gov>

SET Payload: Enhanced Low Dose Rate Sensitivity (ELDRS)

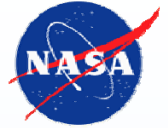


- *PI: Hugh Barnaby, Arizona State University*
- *Objective:*
 - *Improve understanding of the physics of the ELDRS effect in order to improve/validate ground test protocol for linear bipolar technologies and reduce design margins*
- *Space Measurements:*
 - *Transistor characteristics of 24 bipolar junction transistors with well-controlled, different processing characteristics:*
 - *Oxide thickness*
 - *Passivation layer*
 - *Hydrogen content*

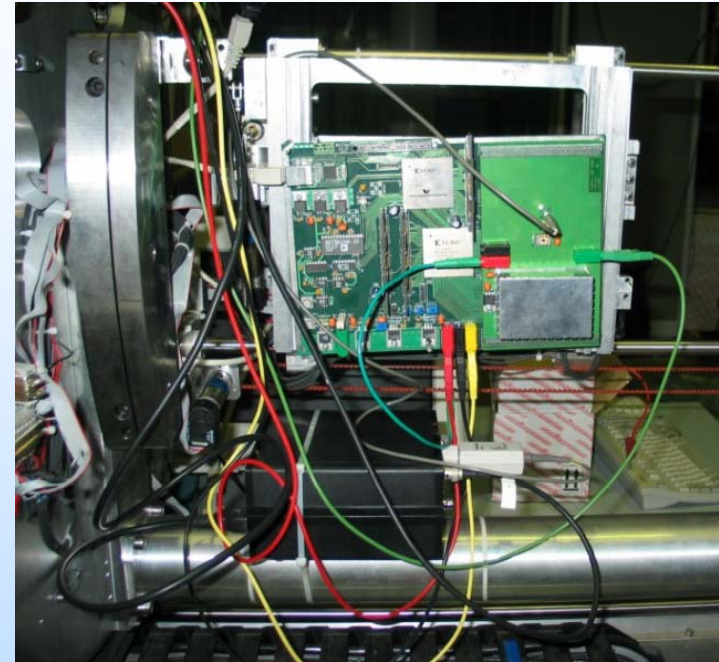


Credit: Arizona State University; <http://lws-set.gsfc.nasa.gov>

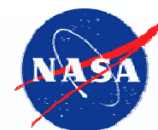
SET Payload: Commercial Off the Shelf-2 (COTS-2)



- *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)*

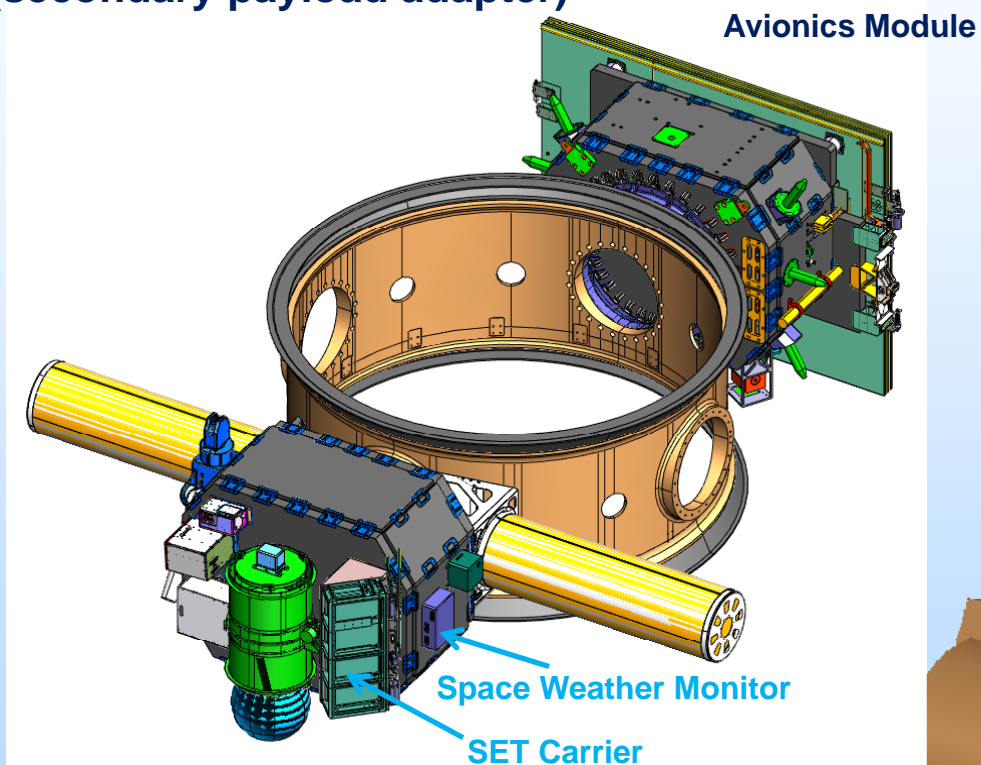


Credit: TIMA, France; <http://lws-set.gsfc.nasa.gov>

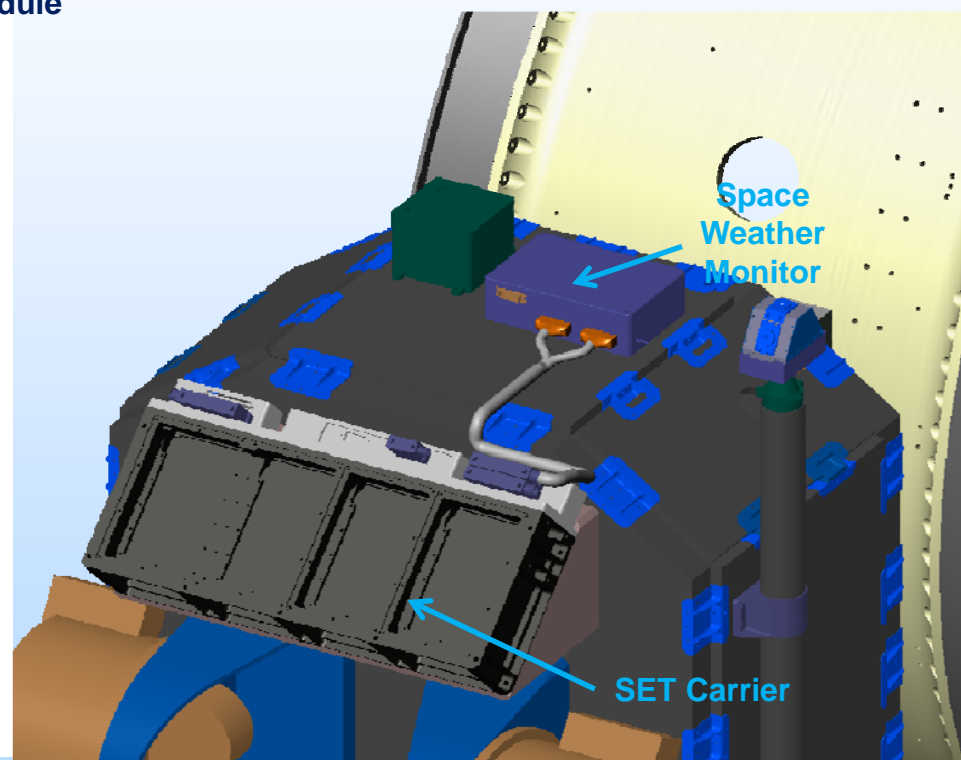


SET Payload on DSX

**DSX structure
(secondary payload adapter)**



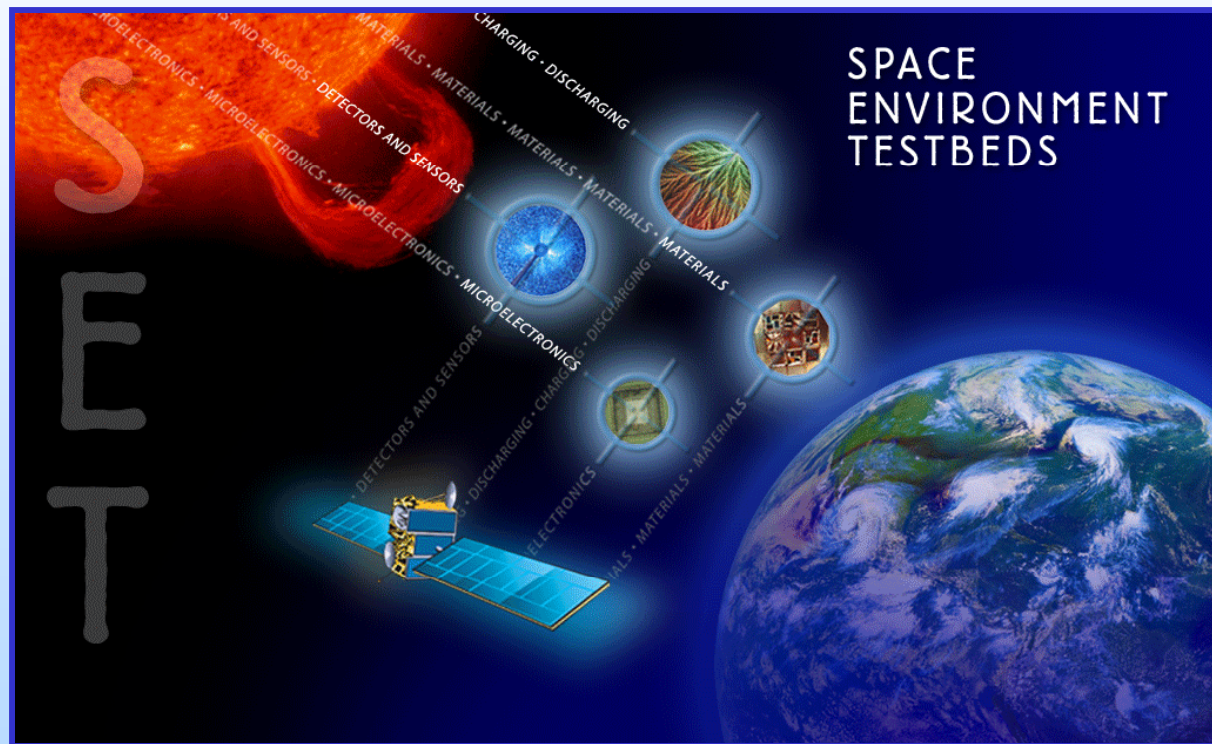
Payload Module



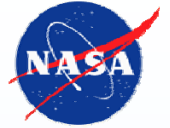


All space data will be publicly available on the SET website:

<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*