SEE Bulletin

Developing Tomorrow's Space Technologies Today

NASA's Space Environments and Effects Program — *Special Edition Issue*

SEE Program Update

By Jody Minor

We're still here! Even though its been a while since our last publication, we've been steadfastly working to meet our goals. The Program has gone through many changes over the last year, some you know about; others you may not. Here is a rundown of the changes that have been made within the past year:

- In 1999, Marshall Space Flight Center went through a major reorganization that affected our Program. Mr. Steve Pearson was promoted to Manager of the newly formed Engineering Technology Development Office (ETDO), in which the SEE Program is located. To fill this void in the SEE Program, Mr. Billy Kauffman was promoted to Manager of SEE and continues to execute his regular SEE duties as well. Most of the SEE personnel remained after the reorganization. Our ETDO duties now include technology development responsibilities for MSFC's Engineering Directorate as well as our usual responsibilities for SEE agency-level technology development. Ms. Donna Hardage came aboard to the ETDO and will handle SEE radiation issues as well as technology development for the ETDO.

- On a more important note, perhaps, is the reorganization that portions of NASA HQ have undergone. Our mother program, the Cross-Enterprise Technology Development Program, commonly known as CETDP, has been moved from the Office of Space Science (Code S) to the Office of Aerospace Technology (Code R) under the management of Sam Venneri. This move has resulted in a reorganization of the way NASA will handle technology development in the future but these details haven't yet been released. We tentatively expect to find out the new program guidelines within the next six months.

- The long-awaited CETDP NASA Research Announcement (NRA) was released in 1999. The initial feedback indicated that a record number of proposals would be submitted (over 2,000). Because of so many submissions, the proposal review process and results concerning who is selected is months away from completion. Reviews for SEE related proposals are scheduled for May 9-11, 2000, in Washington, D.C.

- It is still undetermined how the SEE Program is ultimately affected by the move to Code R, but we do have plans to maintain our position and talk with NASA management about our future. But, this will take time and we will let the community know of the results of our efforts.

If there are any questions concerning these issues, please call Mr. Jody Minor at 256-544-4041or email jody.minor@msfc.nasa.gov.

Bulletin Subscribers

If you have moved, changed Email addresses, etc., please inform the SEE Program Coordination Office so we may update our database. You may do this by emailing Jody Minor: jody.minor@msfc.nasa.gov

****NOTE** Because the SEE Program's activities are affected by changes within NASA, we won't be able to continue to publish the *SEE Bulletin* on a quarterly basis. The current schedule calls for publication every six months. We will revise this schedule when the need arises.**

Contents

Space Technology Research Vehicle (STRV)

NASA has prepared six experiments comprising the NASA Space Radiation and Electronics Testbed (NASRET) for flight aboard the Space Technology Research Vehicle-1d (STRV) to evaluate the effects of space radiation on electronics. NASA's Space Environments and Effects (SEE) Program, managed by the Marshall Space Flight Center, is leading this effort with major participation from:

- Goddard Space Flight Center,
- Jet Propulsion Laboratory,
- Langley Research Center,
- Aerospace Corporation, and
- NASA Headquarters.

The ultimate goals of the NASA experiments are to reduce size, weight, power, cost, and production time for future spacecraft as well as increasing reliability. In order to meet these goals, it is essential to obtain flight and ground test data for advanced and commercial off-the-shelf (COTS) microelectronic components in addition to on-orbit ionizing radiation environment data. The flight and ground data will be correlated to improve single event effects rate prediction models, determine the COTS response to single event effects and low dose rate exposure, and to improve ground test methodologies. Only flight experiments can provide the data necessary to improve performance predictive capabilities for future missions.

The NASA experiments, among others, will be located on the Electronics Test Bed (ETB) which will fly aboard the STRV-1d mission. The ETB effort is funded by the Ballistic Missile Defense Organization (BMDO) with the development and integration performed by the Air Force Research Laboratory (AFRL). The United Kingdom's Defence Evaluation and Research Agency (DERA) will launch STRV-1d, together with its sister spacecraft STRV-1c, on an Ariane 5 launch vehicle later this year, corresponding to solar maximum, which occurs every 11 years. In addition to the ETB, an additional 24 technology demonstration experiments sponsored by various international organizations, will be flown on the spacecraft for a nominal one year mission.

The satellite will be delivered to an elliptical orbit with perigee at 620 km and apogee at 36,000 km, an inclination of 7 degrees, and an orbital period of about 10.5 hours. This is an especially harsh orbit in terms of radiation. During each orbit, it will pass through the Van Allen Belts where it will encounter the trapped proton region and the inner and outer electron belts. The charged particles in these belts cause serious problems for satellite operations.

The six NASA experiments comprising the NASRET are: Dosimetry Experiment, COTS Analog Experiment, COTS Digital Experiment, two COTS Photonics Experiments, and Pulse Height Analysis (PHA) Experiment. The Dosimetry Experiment will measure the observed radiation environment and the effectiveness of composite material and conformal coating shielding technologies; the COTS Analog Experiment will measure the impact of low dose rate effects and transient single event effects on commercial analog devices; the COTS Digital Experiment will measure the impact of the radiation environment on commercial digital devices, such as stacked memories, ferroelectric memories, and Field Programmable Gate Arrays; the COTS Photonics Experiment will measure the enhanced proton displacement effects and transient single event effects on commerical optocouplers; and the Pulse Height Analysis (PHA) Experiment will measure the radiation environment in terms of the stopping power of charged particles for better single event effects rate predictions.

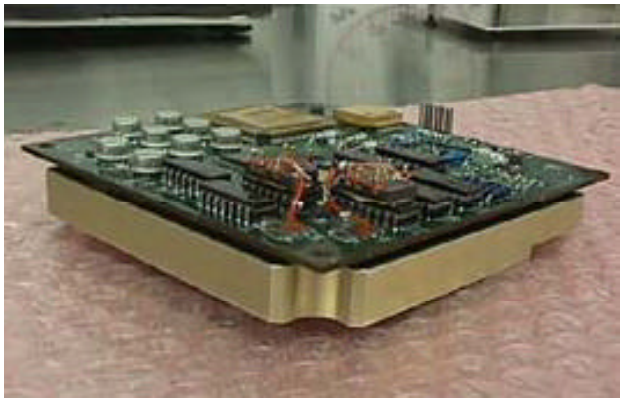
The results from this activity will culminate in the advanced radiation technology knowledge necessary to lead NASA into the 21st century. This is just one area that the NASA's SEE Program is focusing: developing advanced space environments technology in order to enable future NASA missions.

STRV-1d Undergoing Mass Property Measurements at DERT, Farnborough, UK

The Six NASA Experiments Comprising the NASA Space Radiation and Electronics Testbed (NASRET) are:

Dosimetry Experiment

This experiment will accurately measure the local radiation environment in proximity to devices under test in order to evaluate the space radiation effects on the microelectronics devices during mission life cycle. The parameters that will be measured include total ionizing dose, temperature, particle energy, and charging effects. In addition to these measurements, new shielding coatings and synergistic (TID/mixed environment) effects will be evaluated. p-FETs will be used to measure the total ionizing dose to 1 Mrad of total dose.



COTS 1 Analog Experiment

This experiment will measure the impact of low dose rates and single event transient effects of commercial analog devices to reduce the uncertainties regarding space radiation performance of these devices. This experiment will investigate and validate COTS analog microelectronic components and their response to the low dose rate environment of space. It will also help understand the impact of the space single-event-environment-induced transients and validate upset rate prediction modeling.

The sensitivity of analog microcircuits to heavy ions has been demonstrated in the laboratory and observed on-orbit in spacecraft. The single event upset (SEU) vulnerability of linear devices (operational amplifiers and voltage comparators) will be measured by detecting the occurrence of pulses and pulse heights. If an upset appears as a pulse in the output line of an analog microcircuit, it may affect other circuits (either digital or analog) connected to it. The device bias current, the input offset voltage, and the input bias current will be measured on the same test board to investigate the total dose degradation in space. The combined effects are correlated in order to study the synergistic effects.

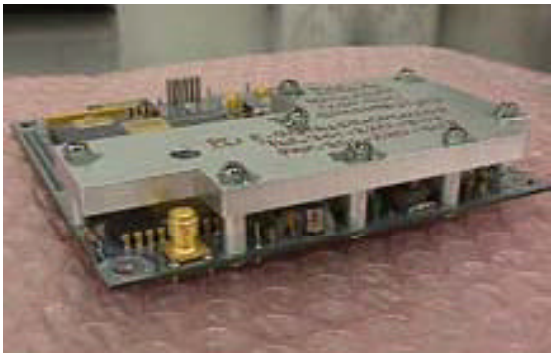
COTS 2 Digital Experiment

This experiment will aim to reduce the uncertainties regarding space radiation performance of commercial digital devices as well as increasing system performance with these types of components. It will measure the radiation effects on state-of-the-art emerging digital technology devices. In particular, it will measure the impact of low dose rate effects on commercial digital devices, such as stacked memories ferroelectric memories, flash EPROMS, and Field Programmable Gate Arrays (FPGA). Measurements will also be taken to identify single event effects and synergistic effects (TID/ SEU/Mixed environment). The objectives are to evaluate and validate these commercial off-the-shelf microelectronic components.

COTS 3 & 3b Photonics Experiments

These experiments will aim to reduce uncertainties regarding space radiation effects in commercial optocoupler devices, as well as increasing system performance with these types of components. They will investigate the single event transients (SET) and total ionizing dose/displacement damage effects of high rate, state-of-the-art, COTS optocouplers, in particular the HCPL 5631 used on the Hubble Space Telescope.

The SETs will be tracked and categorized by pulse width with a resolution ~ 20 nsec. SET hardening techniques will be utilized and their effectiveness will be quantified. The in-flight results will then be compared to the pre-flight predictions. The TID/displacement damage will also be measured in-flight and correlated to the in-flight dosimetry measurements and preflight ground tests.



Pulse Height Analysis (PHA) Exeriment

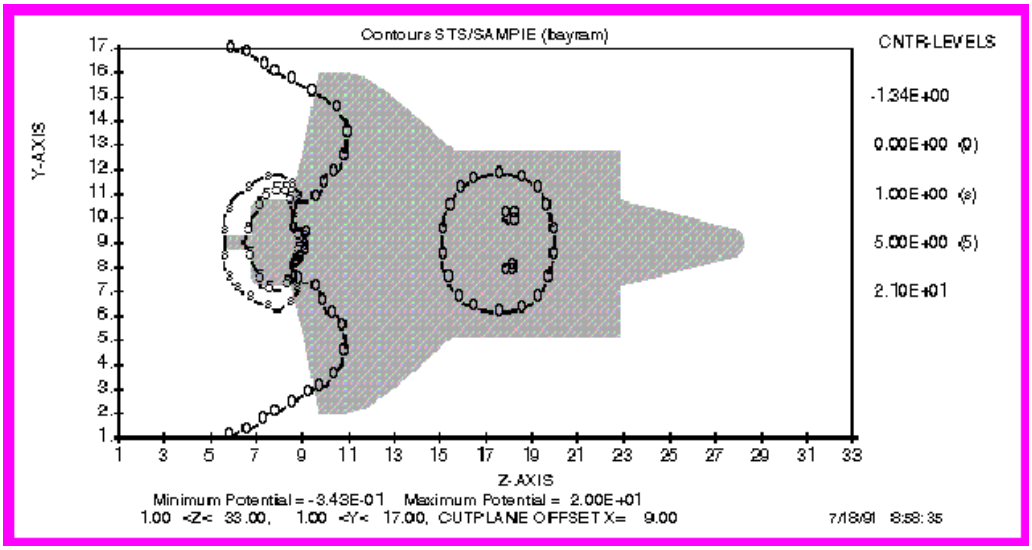
This experiment will measure the space radiation environment in terms of the stopping power (dE/dx) of the charged particles for better SEE rate predictions. The PHA instrument will measure the spacecraft incident energetic charged particles. It will provide the microelectronics investigators with an accurate definition of the measured single event radiation environment of the STRV satellite. Hazard warnings for solar proton events will also be provided. The PHA data will be used to verify and update the single event environment models and rate predictions. Failures, anomalies, and effects observed on the STRV electronics and ETB experiments will be correlated with the actual space radiation environment.

NASCAP 2K – Spacecraft Charging Analysis for the Future

The SEE Program is collaborating with the US Air Force Research Laboratory (AFRL) at Hanscom Air Force Base on a five-year development program of the next generation spacecraft charging analysis code – NASCAP 2K.

This new code will be a comprehensive revision to the current codes: NASCAP LEO, GEO, and POLAR and bring all three codes into one detailed package. It will incorporate updated algorithms, based upon the US Air Force's DynaPAC physics algorithms, add an expanded materials property database with new material electrical properties, and introduce a new user-friendly graphical user interface, including an all-new Object Definition Toolkit.

Development of the code is continuing with a tentative release of NASCAP 2K/GEO in 2002. The remaining LEO and POLAR codes will be added in subsequent years. For more information, please contact Jody Minor at 256-544-4041 or email jody.minor@msfc.nasa.gov.



First Announcement

7th Spacecraft Charging Technology Conference

2001: A Spacecraft Charging Odyssey

23-27 April 2001

Hosted by the

European Space Agency

at the

ESTEC Conference Centre, Noordwijk, The Netherlands

Sponsors:

ESA, NASA's SEE Program, BNSC, CNES

Spacecraft charging was arguably the first spacecraft-plasma interaction which caused problems for space systems. The major problems caused by this surface electrostatic charging process in the 1970's stimulated the start of this series of conferences. While spacecraft technology has progressed, spacecraft-plasma interactions in the broadest sense still cause an array of problems for space systems. Many other plasma and charged-particle interaction processes have been found to cause problems as well. The name "spacecraft charging" is maintained for this next conference in the series but it is clear that these other important aspects will also be key subjects.

The purpose of this 7th conference is to provide a forum to discuss all aspects of spacecraft plasma and charged particle interactions inasmuch as they have impacts on space systems technology. The conference will consist of several oral sessions organized around the main key topics. Each session will be completed by a poster session and discussion. The first day will consist of a course on spacecraft-plasma interactions including lectures and practical session on modeling and computational tools. This conference follows a highly successful 6th Spacecraft Charging Technology Conference held at the US Air Force's AFRL Science Center, Hanscom Air Force Base, in late 1998.

Examples of issues which will be included are:

- Spacecraft electrostatic charging and sheaths;
- Spacecraft charging environments including relationships to "space weather";
- In-flight investigations and instrumentation (monitoring of charging, discharging and environment);
- Spacecraft anomalies and other effects;
- Penetrating electrons and effects;
- Arcing, including "secondary arcs" and stimulated discharge;
- Active devices (e.g., tethers, high voltage systems, electric thrusters, plasma contactors...);
- Numerical and quantitative methods;
- Testing;
- Material characterization including passive charging control and new materials;
- Engineering procedures, standards & guidelines;
- Policy issues (business,collaboration, standardization,insurance, IP, technology transfer,...);

other related topics will be considered.

A second announcement, expected in June, will provide details of how to submit proposals for presentations. To register interest at this stage, please send an email to the ESTEC Conference Bureau (**confburo@estec.esa.nl**) with "Spacecraft Charging Technology Conference 2001" in the subject line. The conference will have access to networking and computational facilities so presentations and demonstrations making use of these facilities are encouraged. Presenters are required to make presentation material available for a conference web site. Proceedings will also be made available on the web site and CD, as well as in printed form.

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Coming in Next 2000 Issue...

SEE Program Activity Updates:

- **Spacecraft Charging**
- **Electromagnetic Effects**
- **Contamination**

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We are sending this issue to people we believe will be interested in the SEE Program. If you are not, please pass it on to someone else and let us know. Anyone interested in receiving the SEE Bulletin, may contact Ms. Gayle Brown at:

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Previous issues and current information can be found by visiting our homepage at:

http://see.msfc.nasa.gov/

Miscellaneous

Recent Website Additions:

- The SEE Program has added the new "Electromagnetic Toolkit for High School Teachers and Students" to the website. This toolkit presents educational materials on electricity and magnetism with a particular emphasis on electromagnetic interference (EMI) and shielding.
- The "Meteoroid and Orbital Debris Lesson Plan" is also available from the website.
- Version 2.1 of the Interactive Spacecraft Charging Handbook is now available on the website. This new version adds 3-D geometry capability.

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