

Fault-Tolerant Spaceborne Computing Employing New Technologies 2008



Exploration Technology Development Program's

Radiation Hardened Electronics for Space Environments (RHESE)

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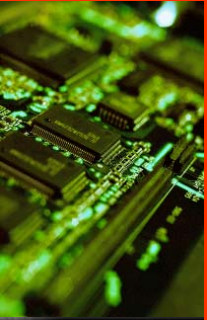
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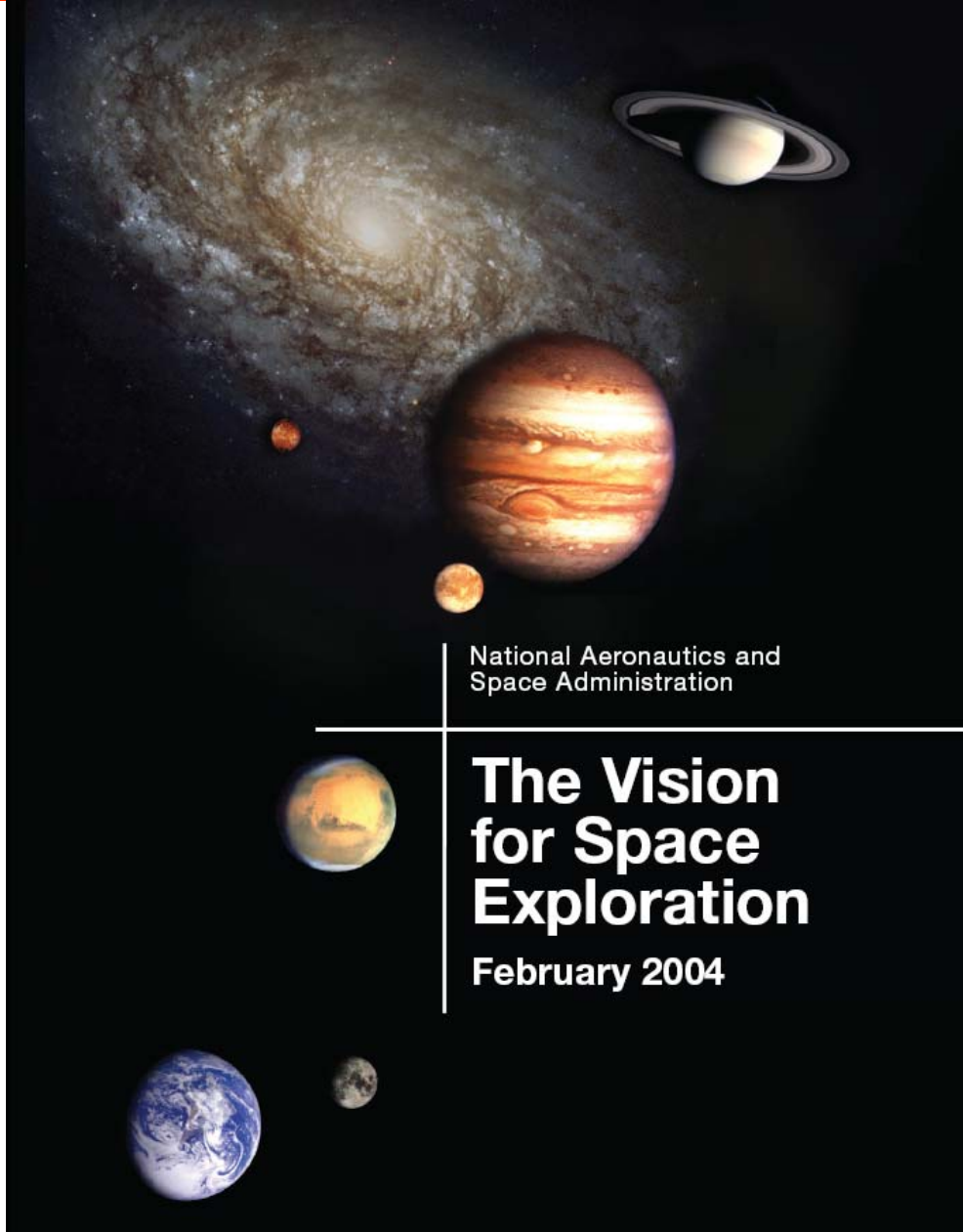


U.S. Space Exploration Policy (a.k.a. VSE)



- **The U.S. Space Exploration Policy directs NASA to pursue a long-term human and robotic program to explore the solar system.**
- **The policy is based on the following goals:**
 - Return the shuttle to flight (following the Columbia accident) and complete the International Space Station by 2010.
 - Develop a Crew Exploration Vehicle, test by 2008, first manned mission no later than 2014.
 - Return to the Moon as early as 2015 and no later than 2020.
 - Gain experience and knowledge for human missions to Mars.
 - Increase the use of robotic exploration to maximize our understanding of the solar system.

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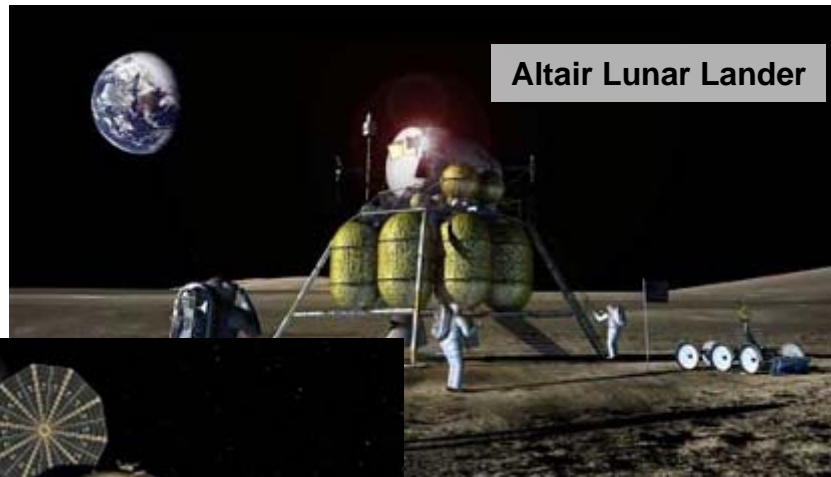
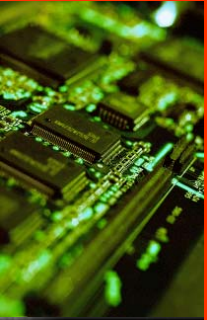
National Aeronautics and
Space Administration

The Vision for Space Exploration

February 2004

RHESE Supports Multiple Constellation Projects

- **RHESE's products are developed in response to the needs and requirements of multiple Constellation program elements, including:**
 - Ares V Crew Launch Vehicle (Earth Departure Stage),
 - Orion Crew Exploration Vehicle (Lunar Capability),
 - Altair Lunar Lander,
 - Lunar Surface Systems,
 - Extra Vehicular Activity (EVA) elements,
 - Future applications to Mars exploration architecture elements.



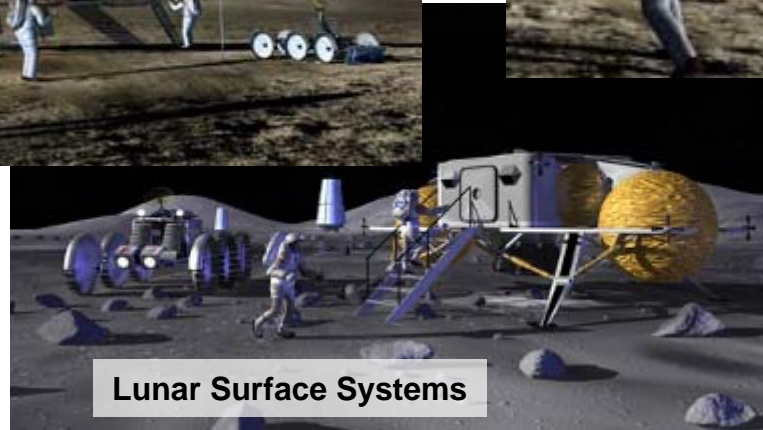
Altair Lunar Lander



EVA



Orion Crew Exploration Vehicle



Lunar Surface Systems

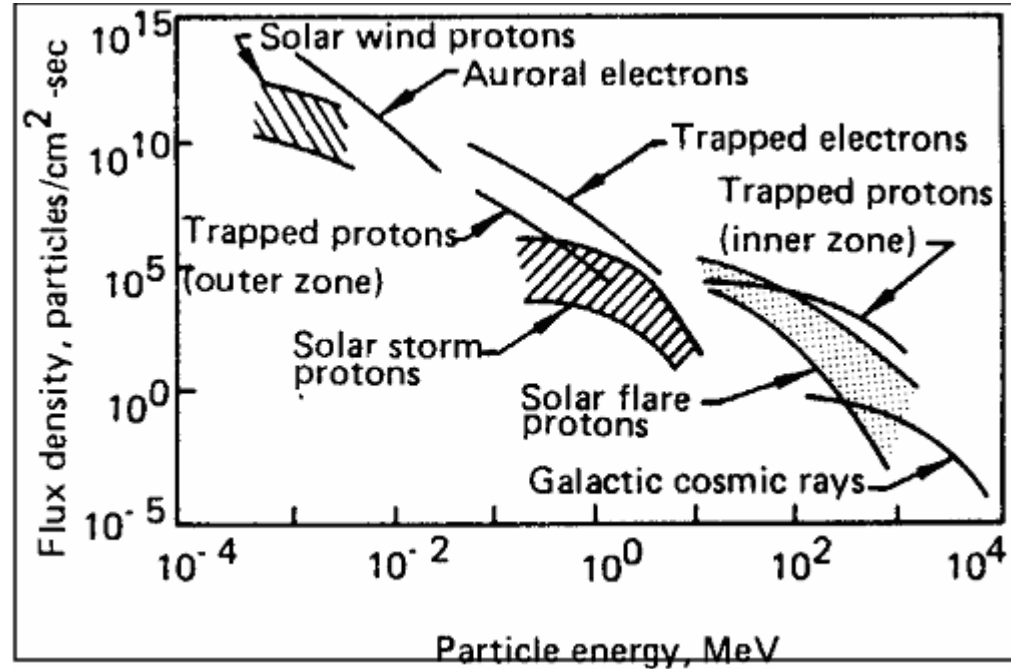


Ares V Launch Vehicle (EDS)

Surviving the Radiation Environment



- **Space Radiation affects all spacecraft.**
 - Spacecraft electronics have a long history of power resets, safing, and system failures due to:
 - Long duration exposures,
 - Unpredictable solar proton activity,
 - Ambient galactic cosmic ray environment.



The Radiation Hardened Electronics for Space Environments (RHESE) project expands the current state-of-the-art in radiation-hardened electronics to develop high performance devices robust enough to withstand the demanding radiation and thermal conditions encountered within the space and lunar environments.

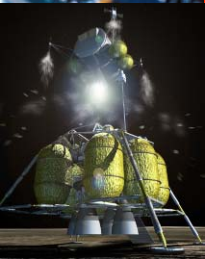
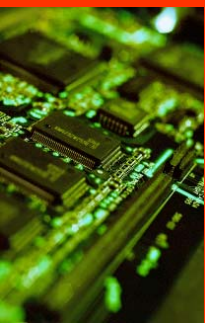
The specific goals of the RHESE project are to foster technology development efforts in radiation-hardened electronics possessing these associated capabilities:

- improved total ionization dose (TID) tolerance,
- reduced single event upset rates,
- increased threshold for single event latch-up,
- increased sustained processor performance,
- increased processor efficiency,
- increased speed of dynamic reconfigurability,
- reduced operating temperature range's lower bound,
- increased the available levels of redundancy and reconfigurability, and
- increased the reliability and accuracy of radiation effects modeling.

Customer Requirements and Needs



- RHESE is a “**requirements-pull**” technology development effort.
- RHESE is a “**cross-cutting**” technology, serving a broad base of multiple project customers within Constellation.
 - Every project requiring...
 - operation in an extreme space environment,
 - avionics, processors, automation, communications, etc....should include RHESE in its implementation trade space.
- Constellation Program requirements for avionics and electronics continue to evolve and become more defined.
- RHESE will develop products per **derived requirements** based on the Constellation Architecture’s Level I and Level II requirements defined to date.
- RHESE is actively working CSAs with all Constellation customers.



- **Specifically, the RHESE tasks for FY08 are:**
 - Model of Radiation Effects on Electronics (MREE),
 - Lead Center: MSFC
 - Participants: Vanderbilt University
 - Single Event Effects (SEE) Immune Reconfigurable Field Programmable Gate Array (FPGA) (SIRF),
 - Lead Center: GSFC
 - Participants: AFRL, Xilinx
 - Radiation Hardened High Performance Processors (HPP),
 - Lead Center: GSFC
 - Participants: LaRC, JPL, Multiple US Government Agencies
 - Reconfigurable Computing (RC),
 - Lead Center: MSFC
 - Silicon-Germanium (SiGe) Integrated Electronics for Extreme Environments.
 - Lead Center: LaRC
 - Participants: Georgia Tech. leads multiple commercial and academic participants.

...and (re)starting in FY09...

- Radiation-Hardened Volatile and Non-Volatile Memory
 - Lead Center: MSFC
 - Participants: LaRC, Multiple Vendors