

Technology Development for Extreme Environments Systems

JPL Workshop

May 14, 2003

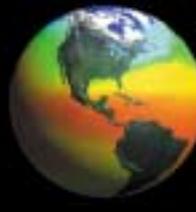
Dr. Chris Moore
ECT Program Manager
NASA Headquarters
Office of Aerospace Technology



6 Strategic Enterprises One NASA



Space
Science



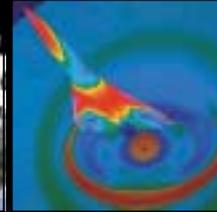
Earth
Science



Biological
& Physical
Research



Space
Flight



Aerospace
Technology



Education

NASA's Vision

- To improve life here
- To extend life to there
- To find life beyond

NASA's Mission

- To understand and protect our home planet
- To explore the universe and search for life
- To inspire the next generation of explorers
...as only NASA can



The Aerospace Technology Enterprise Contributes to the NASA Vision and Mission through Technology Development and Transfer

NASA Mission



**OGA & Industry
Partners**

**Space
Science**

**Earth
Science**

**Biological &
Physical
Research**



**Non Aerospace
Industry & Educators**



**Aerospace
Technology**



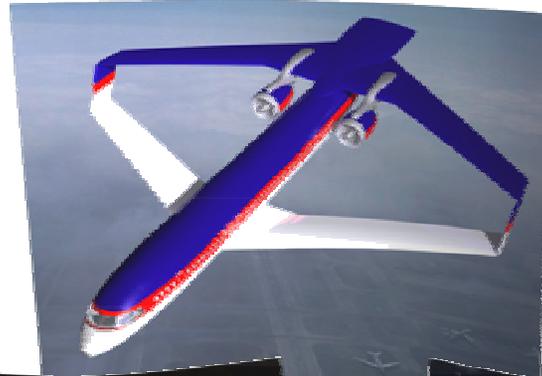
Space Flight

Aerospace Technology Enterprise

Strategic Themes



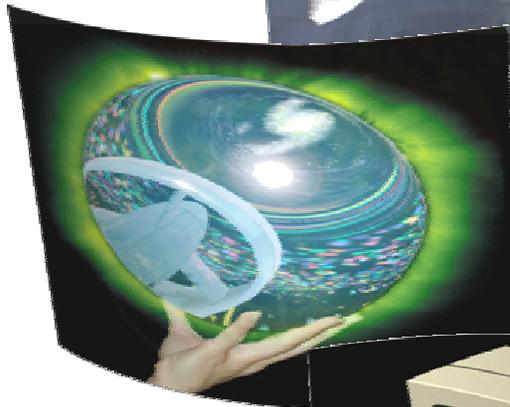
***Aeronautics
Technology***



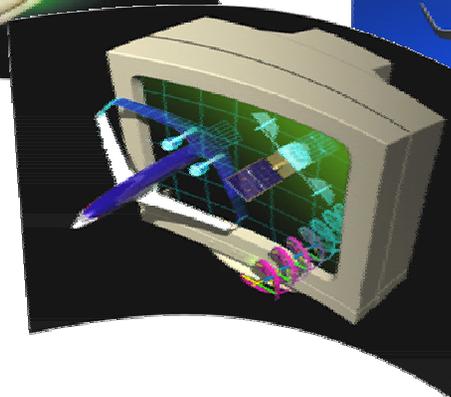
***Space Launch
Initiative***



***Mission and
Science
Measurement
Technology***



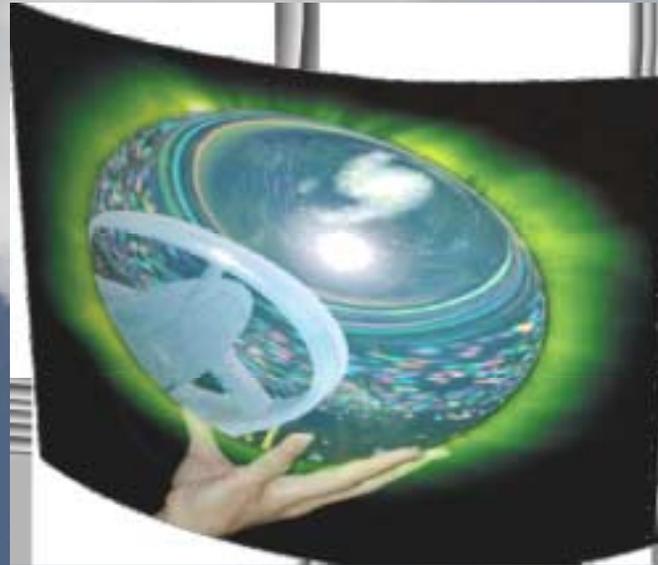
***Innovative Technology
Transfer Partnerships***





§ Mission and Science Measurement Technology

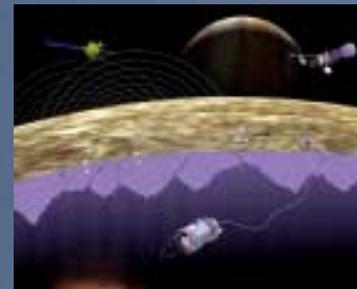
Theme



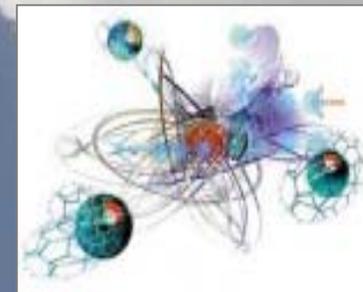
Programs



Engineering for
Complex
Systems



Enabling &
Concepts
Technologies



Computing,
Information, &
Communications
Technology

Enabling Concepts & Technologies Program

Objectives



NASA Mission

- To understand and protect our home planet
- To explore the universe and search for life
- To inspire the next generation of explorers

*MSM Theme
Strategic Goal*

GOAL 10: Enable revolutionary capabilities through new technology.

10.2 Create new system concepts and demonstrate new technologies that enable new science measurements.

Enabling Concepts and Technologies Program

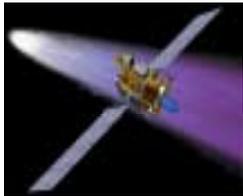
- Explore revolutionary aerospace system concepts to enable the grand challenges and strategic visions of the NASA Enterprises, and to expand the possibilities for future NASA missions.
- Develop advanced technology for sensing and spacecraft systems to enable bold new missions of exploration, and to provide increased scientific return at lower cost.
- Develop advanced energetics technology to provide low-cost power and propulsion for enhanced mission capabilities, and to enable missions beyond current horizons.

Enabling Concepts & Technologies Program Projects



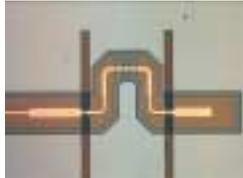
Advanced System Concepts

Conceptual studies and systems analysis of revolutionary aerospace system concepts that have the potential to leap well past current plans, or to enable new visions for NASA's strategic plans.



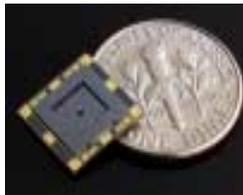
Energetics

Development of advanced power and propulsion technologies to enable lower-cost missions with increased capability, and to extend mission reach.



Advanced Measurement and Detection

Development of miniaturized, highly-integrated, and efficient instruments and sensors to provide increased scientific return.



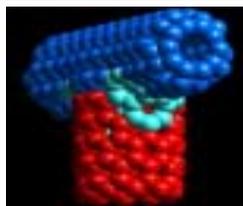
Revolutionary Spacecraft Systems

Development of revolutionary spacecraft systems and architectures to enable distributed science data collection, explore extreme environments, and lower mission costs.



Large Space Systems

Development of concepts for large, ultra-lightweight space structures and apertures to expand mission capabilities, and enable new visions of the Earth and the Universe.



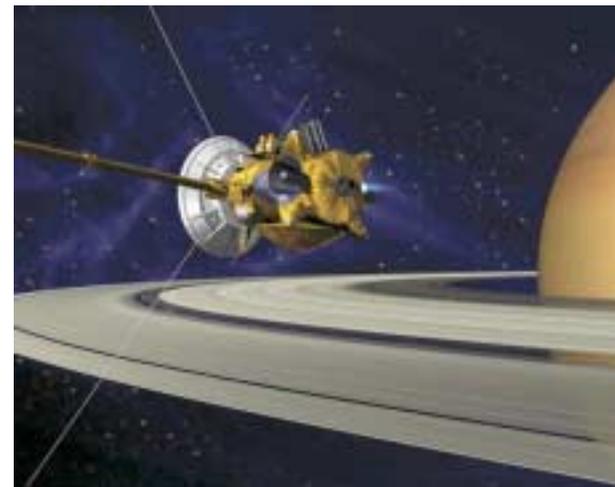
Space NRAs

Broadly announced peer-reviewed solicitations to capture innovative ideas from external organizations, to leverage high-payoff emerging technologies, and to complement NASA capabilities in critical areas.

Decadal Survey of Solar System Exploration



- National Academy of Sciences study to set direction of planetary exploration for next decade
- Solar System Missions 2003-2013
 - Cassini Extended
 - Kuiper Belt - Pluto Explorer
 - Lunar South Pole / Aitkin Basin Sample Return
 - Jupiter Polar Orbiter with Probes
 - Venus In-Situ Explorer
 - Comet Surface Sample Return
 - Europa Geophysical Explorer
- Mars Missions 2003-2013
 - Mars Scout
 - Mars Upper Atmosphere Orbiter
 - Mars Smart Lander
 - Mars Long-Lived Lander Network
 - Mars Sample Return
- Most of the recommended missions require new technologies to enable operations in extreme environments



Extreme Environments in Five Space Science Reference Missions

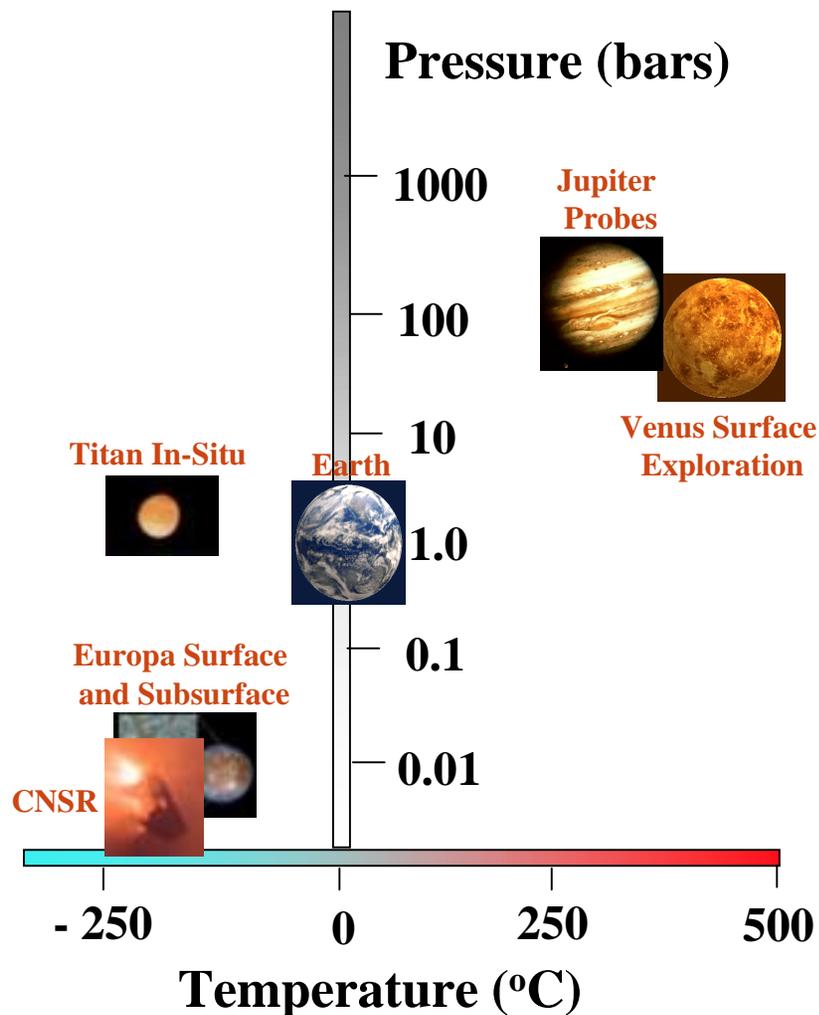


Mission	Low Temp.	High Temp.	High Radiation Levels	High Pressure	Other Environmental Conditions
Venus Surface Exploration and Sample Return		460C		90 bar	Sulphuric acid clouds at 50 km 97% CO2 at the surface
Giant Planets Deep Probes	-140 C	380C		100 bar	
Comets Nucleus Sample Return	-140 C				Dust
Titan In-Situ	-180 C			1.5 bar	2-10% Methane Clouds Solid/liquid surface
Europa Surface and Subsurface	-160 C		5 MRad		

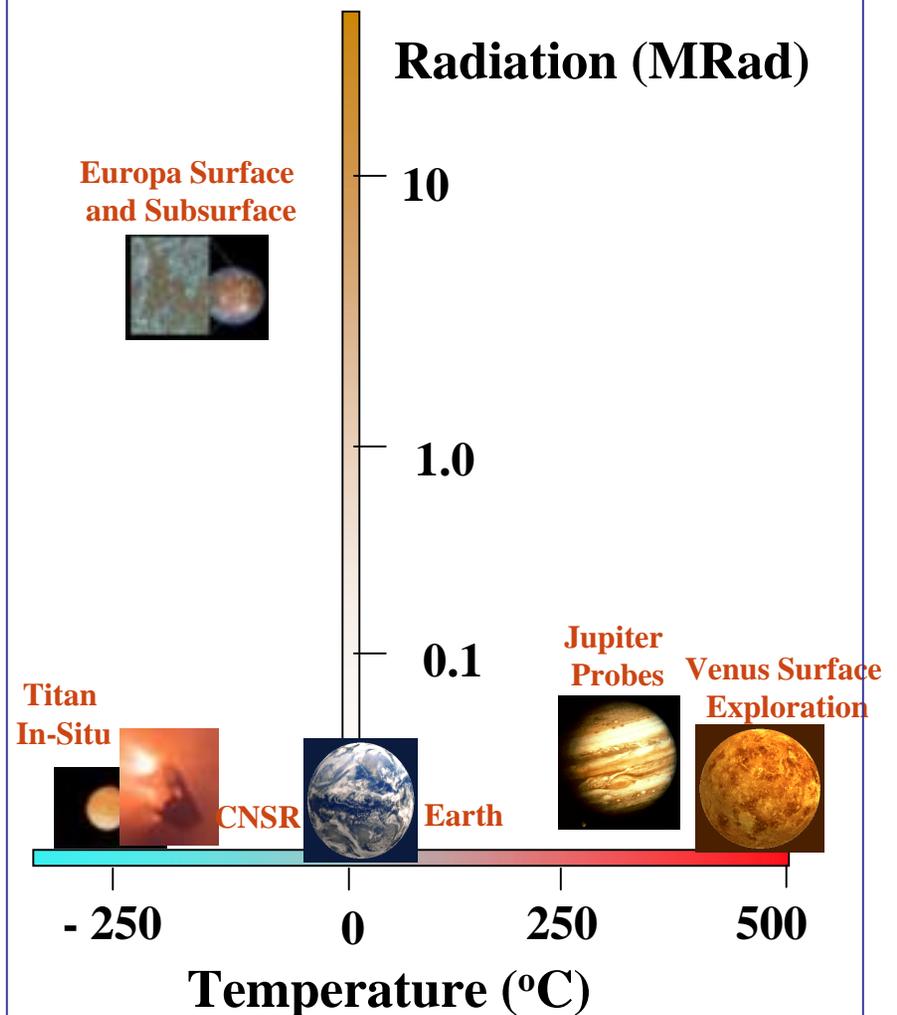
Challenge: All five reference missions have to survive in extreme temperature, pressure, and radiation environments.

Temperature, Pressure, and Radiation in Reference Missions

Pressure vs. Temperature



Radiation vs. Temperature



System Survival Technology Needs for Extreme Environment Missions



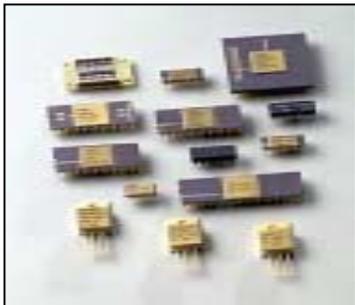
- Advanced thermal control and pressure vessel technology



- High temperature materials, electronics, packaging, sensors, actuators, energy storage, and corrosion protection materials and coatings



- Low temperature sensors, actuators, and interface electronics



- Radiation hard electronics and sensors

Project Prometheus

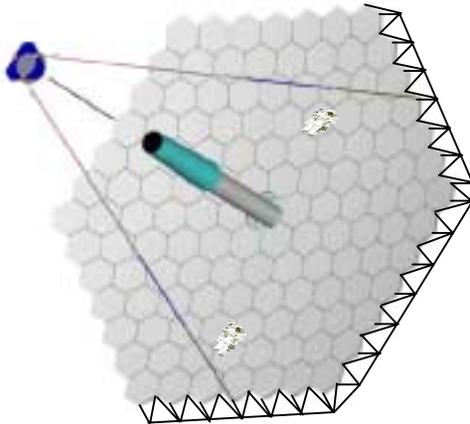
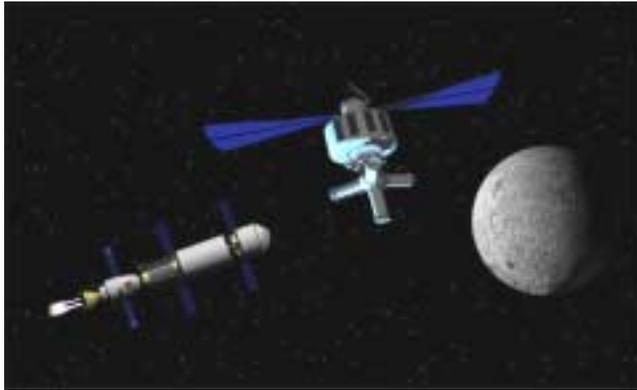
Office of Space Science



- Nuclear Power (Radioisotope Power System development)
 - Reestablish capability to fabricate space radioisotope power systems to support deep space and planetary surface exploration
- Nuclear Propulsion (advanced technology research and development)
 - Revolutionize solar system exploration through the research and development of advanced fission-based space propulsion and power technologies.
- Jupiter Icy Moons Orbiter (mission development)
 - Responsive to Decadal Survey recommendations, survey in unprecedented detail three icy moons of Jupiter, enabled by fission-based space propulsion and power technologies
- Rad hard systems required for operations near nuclear reactor and within Jovian radiation belts.



Stepping Stones Strategy for Future Human Exploration Missions

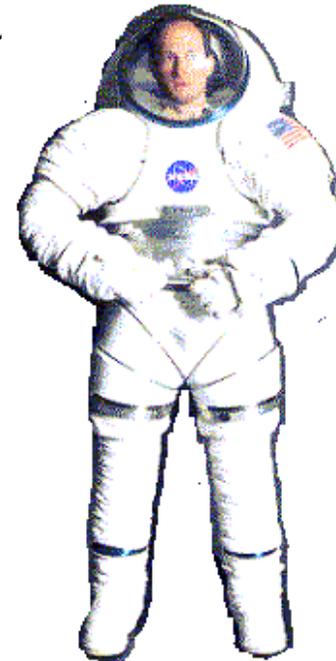


- International Space Station
- Earth-Moon L1 Gateways
- In-space assembly of large apertures
- Moon
- Near-Earth asteroids
- Mars

Human Protection Technology Needs for Extreme Environment Missions

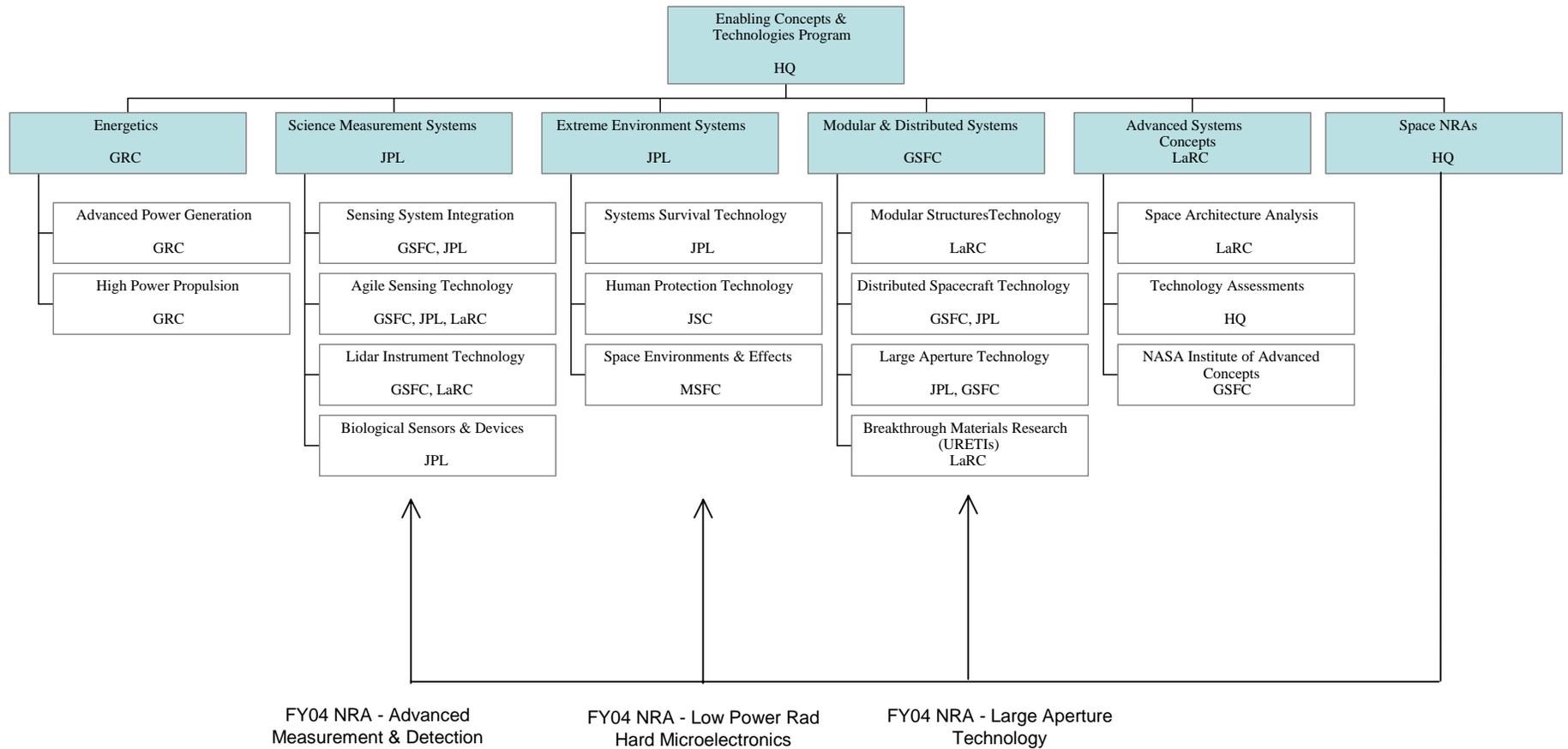


- Advanced Materials
 - Organic aerogel-fiber composite fabric for thermal insulation
 - Thermally conductive fabric for cooling garment application
 - New material for dust/soil protection of the spacesu
- Thermal Control
 - Heat pumps
 - Two-phase thermal control systems
 - Heat rejection technologies
 - Alternative heat transport fluids
- Advanced EVA Technology
 - Life support
 - Space suit garment
 - Instrumentation, information, & power systems
 - Robotic ergonomics
 - Design & analysis tools



Enabling Concepts & Technologies Program

FY05 Project Organization



Extreme Environment Systems

Project Elements



Systems Survival Technology

Proof-of-concept systems for exploration in extreme temperature, pressure, and radiation environments such as Jupiter, Venus, Europa, and Titan.



Human Protection Technology

Advanced habitation and EVA systems to enable human exploration in extreme environments.



Space Environments and Effects

Development of space environment models, and analytical tools for predicting the effects of space environments on spacecraft systems.

NASA Research Announcements



- NASA Research Announcements (NRAs) are openly competed, peer-reviewed solicitations for exploratory technology development activities.
- NRAs are open to proposals from industry, universities, non-profit organizations, NASA Centers, and other government agencies.
- The ECT Program plans to issue three NRAs in July for award in FY04:
 - Advanced Sensors & Instruments
 - Large Apertures
 - Low Power Rad Hard Electronics
- Typical funding awards are \$300K to \$500K per year for 3 years.
- \$3M Low Power Rad Hard Electronics NRA will support the Extreme Environment Systems project.
- Future NRA in Extreme Environment Systems technology may be issued in FY05.

Workshop Objectives



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- Assess state-of-the-art in technologies for extreme environments.
 - Help NASA plan its FY05 project in Extreme Environments Systems technology.

