National Aeronautics and
Space Administration

Technology & Innovation Committee

NAC Advisory Council

Dr. Bill Ballhaus, Chair
November 30, 2012

Technology & Innovation Committee

"The scope of the Committee includes all NASA programs that could benefit from technology, research and innovation."

T&I Committee Meeting Participants
November 15, 2012

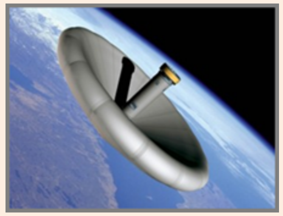
- Dr. William Ballhaus, Chair
- Dr. Erik Antonsson, Northrop Grumman
- Dr. Randall Correll, Consultant
- Dr. Dava Newman, MIT
- Mr. Gordon Eichhorst, Aperious Partners, LLC
- Dr. Matt Mountain, HST Institute
- Dr. Mary Ellen Weber, Stellar Strategies, LLC
- Dr. Susan Ying, The Boeing Company

T&I Committee Meeting Presentations

- Update on Advance Exploration Systems Program (AES) – Mr. Jason Crusan, Director, AES, HEOMD
- Update and Discussion of Space Technology Program – Dr. Michael Gazarik, Director, NASA Space Technology Program
- Office of the Chief Technologist Update – Dr. Mason Peck, NASA Chief Technologist
- Briefing on Mars Science Lab (MSL) and overview of technology's role in the mission – Dr. Dave Lavery, Program Executive, MSL
- Update on Space Technology Research Grants program – Ms. Claudia Meyer, Program Executive
- Hypersonic Inflatable Aerodynamic Decelerator, with focus on the MSL Entry, Descent, and Landing Instrumentation (MEDLI) and Inflatable Reentry Vehicle Experiment 3 (IRVE-3) – Dr. Neil Cheatwood, IRVE-3 Principal Investigator

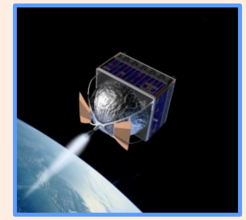
Space Technology Programs

Transformative & Crosscutting Technology Breakthroughs



Game Changing Development

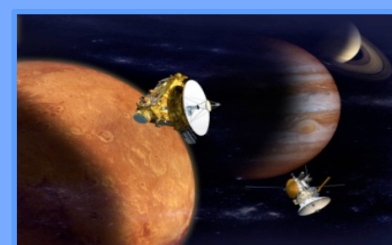
Technology Demonstration Missions



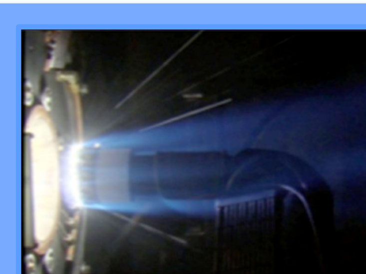
Small Spacecraft Technology

Pioneering Concepts/ Developing Innovation Community

Space Technology Research Grants



NASA Innovative Advanced Concepts (NIAC)



Center Innovation Fund

Creating Markets & Growing Innovation Economy

Centennial Challenges

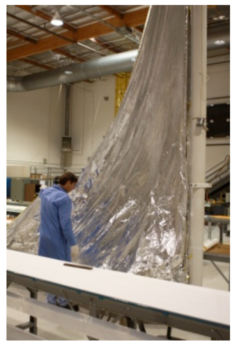
Small Business Innovation Research & Small Business Technology Transfer (SBIR/STTR)

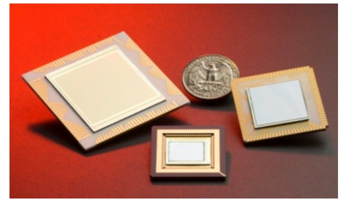
Flight Opportunities

Space Technology Hardware & Testing

BOOM Fabrication

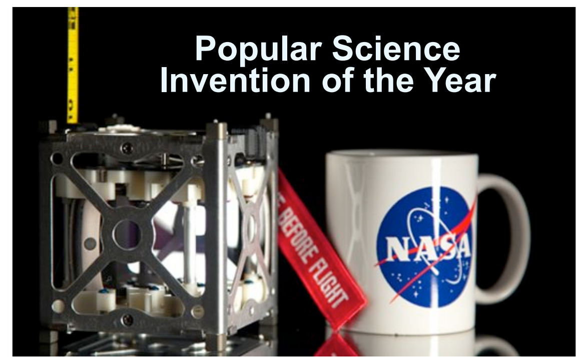
SAIL Fabrication

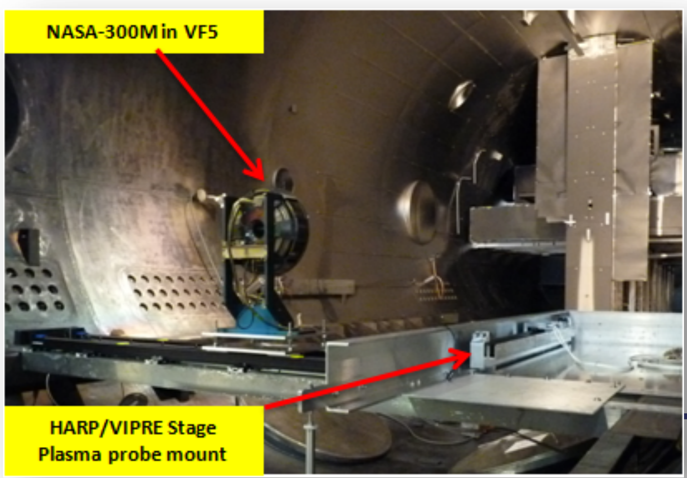


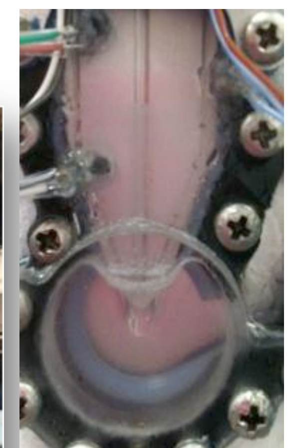


BIRD focal plane arrays

Model of 3-kW Non-Flow-Through Fuel Cell



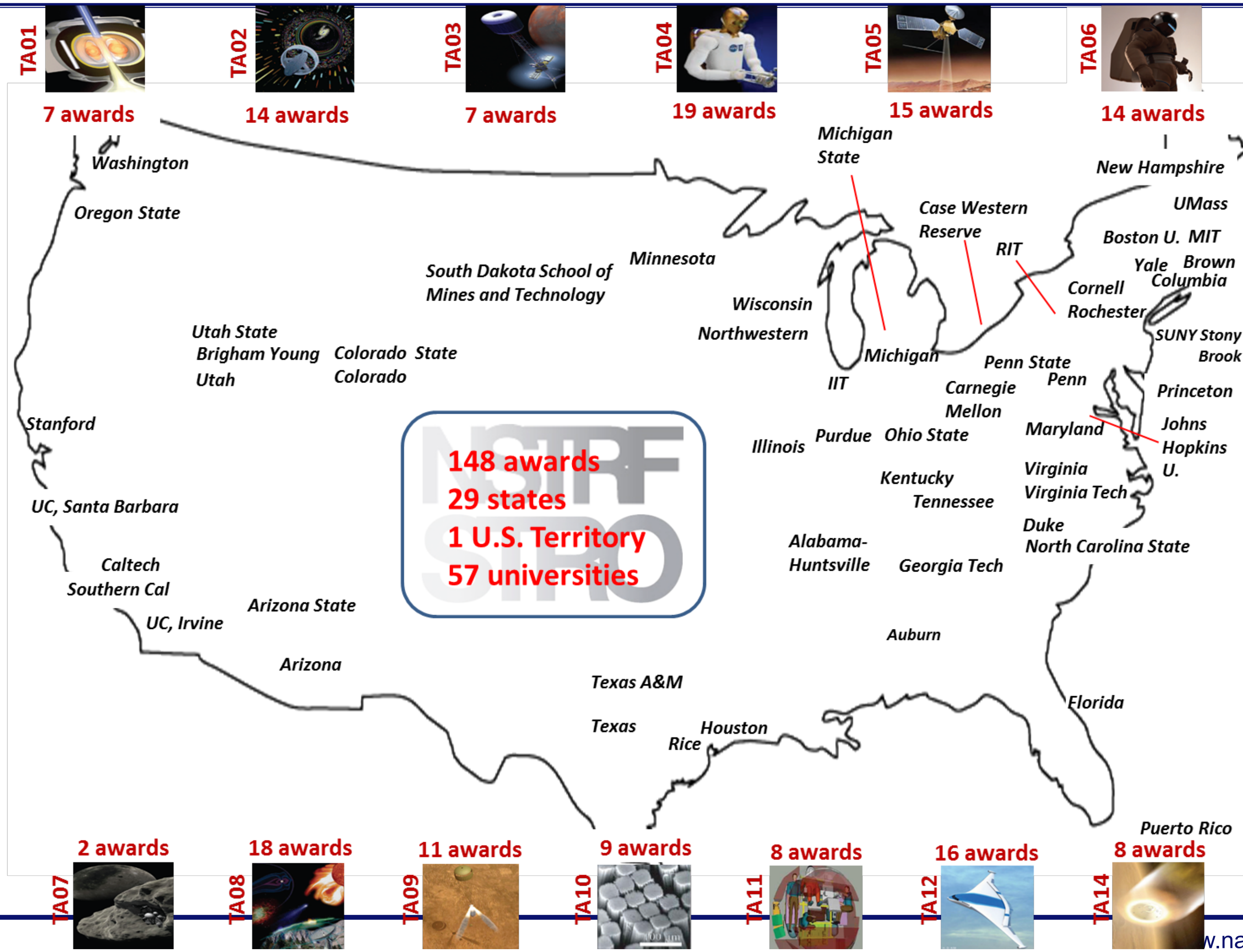




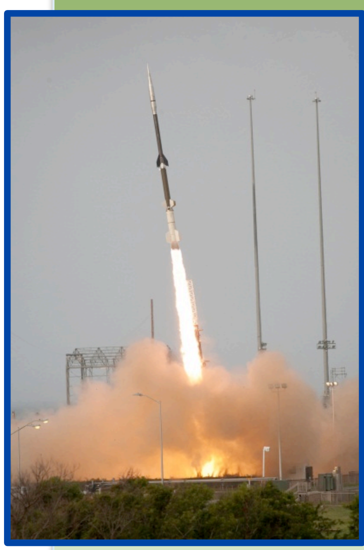
Water Droplet Visualization Test

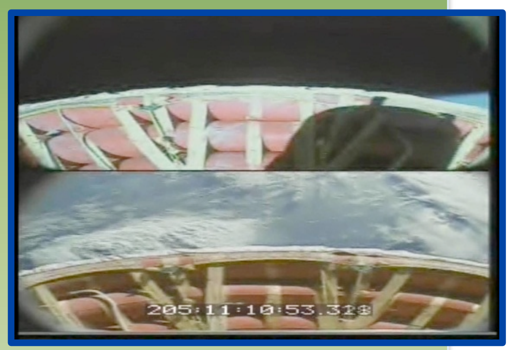
Exoskeleton

Space Technology Research Grant Program
Engaging the Nation's Universities



Technology Success: HIAD





Top left, Technicians at NASA's Wallops Flight Facility mated the components of the Inflatable Reentry Vehicle Experiment-3 (IRVE-3) into the nosecone and sounding rocket. **Bottom right**, Images of IRVE-3 successfully inflated, reconfigured to generate lift prior to atmospheric entry, and demonstrated re-entry steering capability.

Project Summary: NASA's Hypersonic Inflatable Aerodynamic Decelerator project (HIAD) focuses on the development and demonstration of hypersonic inflatable heat shield technologies through analysis, ground-based testing and flight tests.

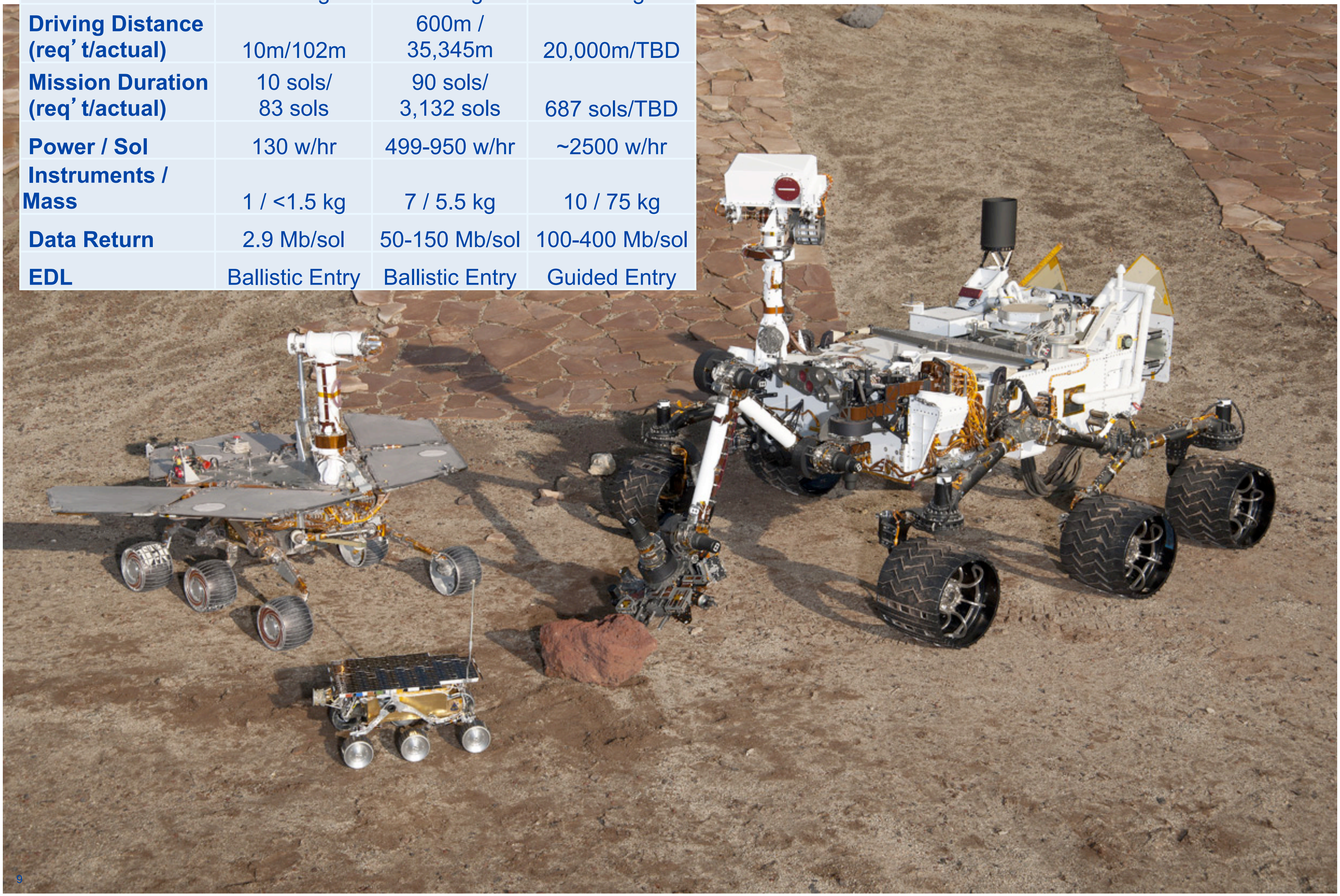
FY 2012 Milestone: On July 23, 2012, the Inflatable Reentry Vehicle Experiment (IRVE-3) successfully demonstrated key technologies, including flexible TPS materials for hypersonic entry conditions, attachment, and inflation mechanisms, along with high-strength, lightweight, inflatable bladder materials capable of withstanding high temperatures.

NASA/Government/Commercial Application: IRVE-3 will provide foundational data to develop and integrate HIAD technology, enabling future missions that require delivering larger mass/payloads to destinations with sizable atmospheres, or accessing Mars at higher elevations.

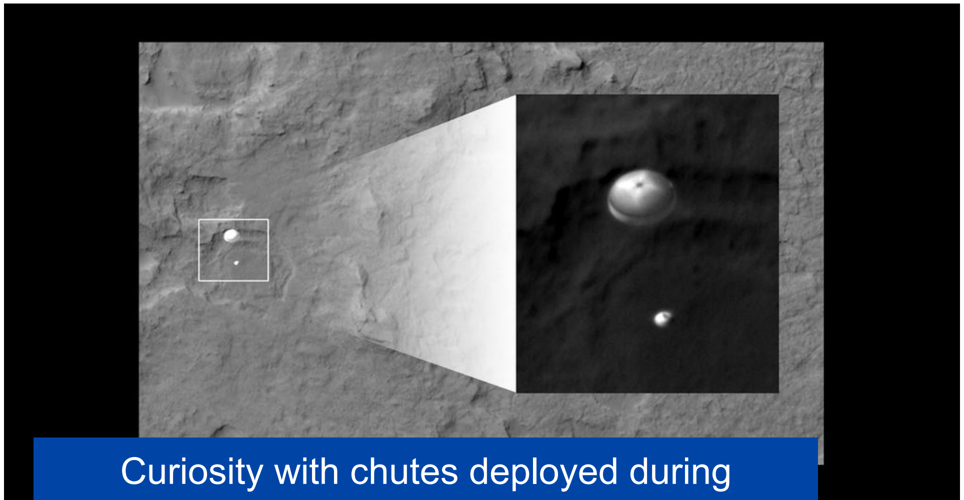
Partnerships: NASA is working with Airborne Systems/HDT Global, Oceaneering and Bristol Aerospace on this project. NASA, as well as other industry partners, could incorporate this technology for future ISS or LEO down mass applications or planetary science and exploration missions.

Rover Family Portrait

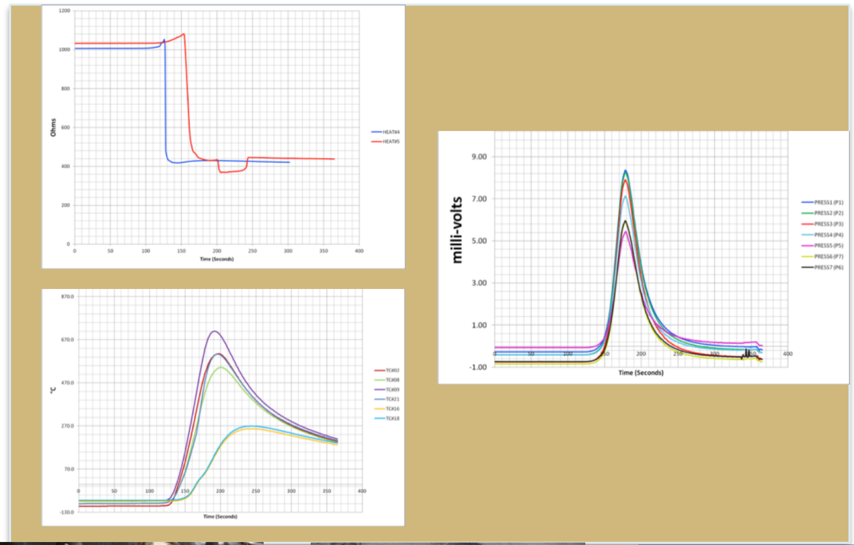
	Pathfinder	MER	MSL
Rover Mass	10.5 kg	174 kg	950 kg
Driving Distance (req’t/actual)	10m/102m	600m / 35,345m	20,000m/TBD
Mission Duration (req’t/actual)	10 sols/ 83 sols	90 sols/ 3,132 sols	687 sols/TBD
Power / Sol	130 w/hr	499-950 w/hr	~2500 w/hr
Instruments / Mass	1 / <1.5 kg	7 / 5.5 kg	10 / 75 kg
Data Return	2.9 Mb/sol	50-150 Mb/sol	100-400 Mb/sol
EDL	Ballistic Entry	Ballistic Entry	Guided Entry



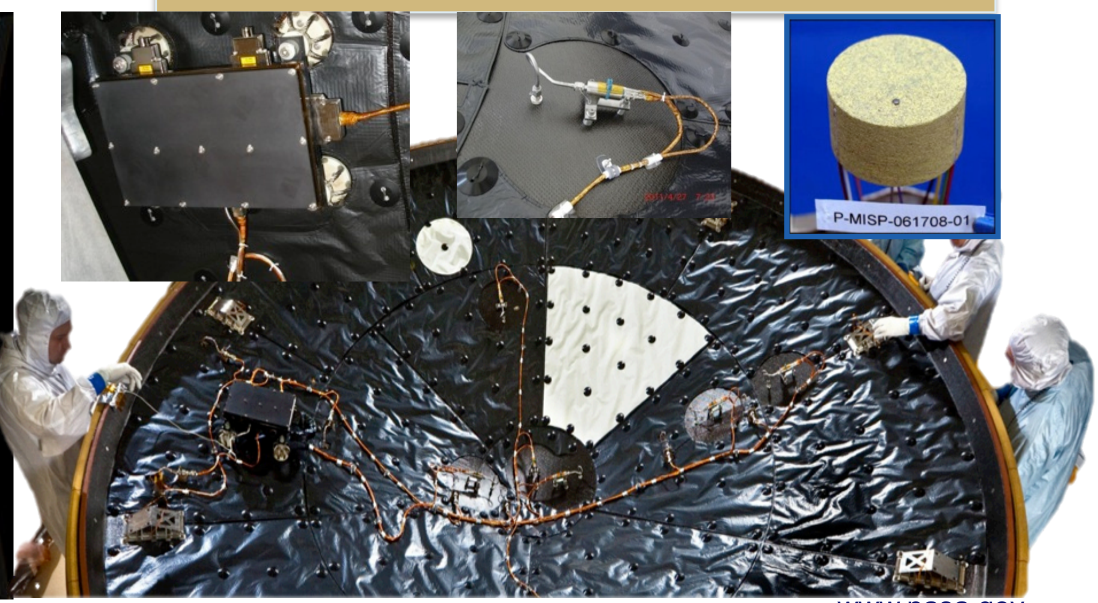
Technology Success: One of Many on Mars



Curiosity with chutes deployed during descent to Mars surface



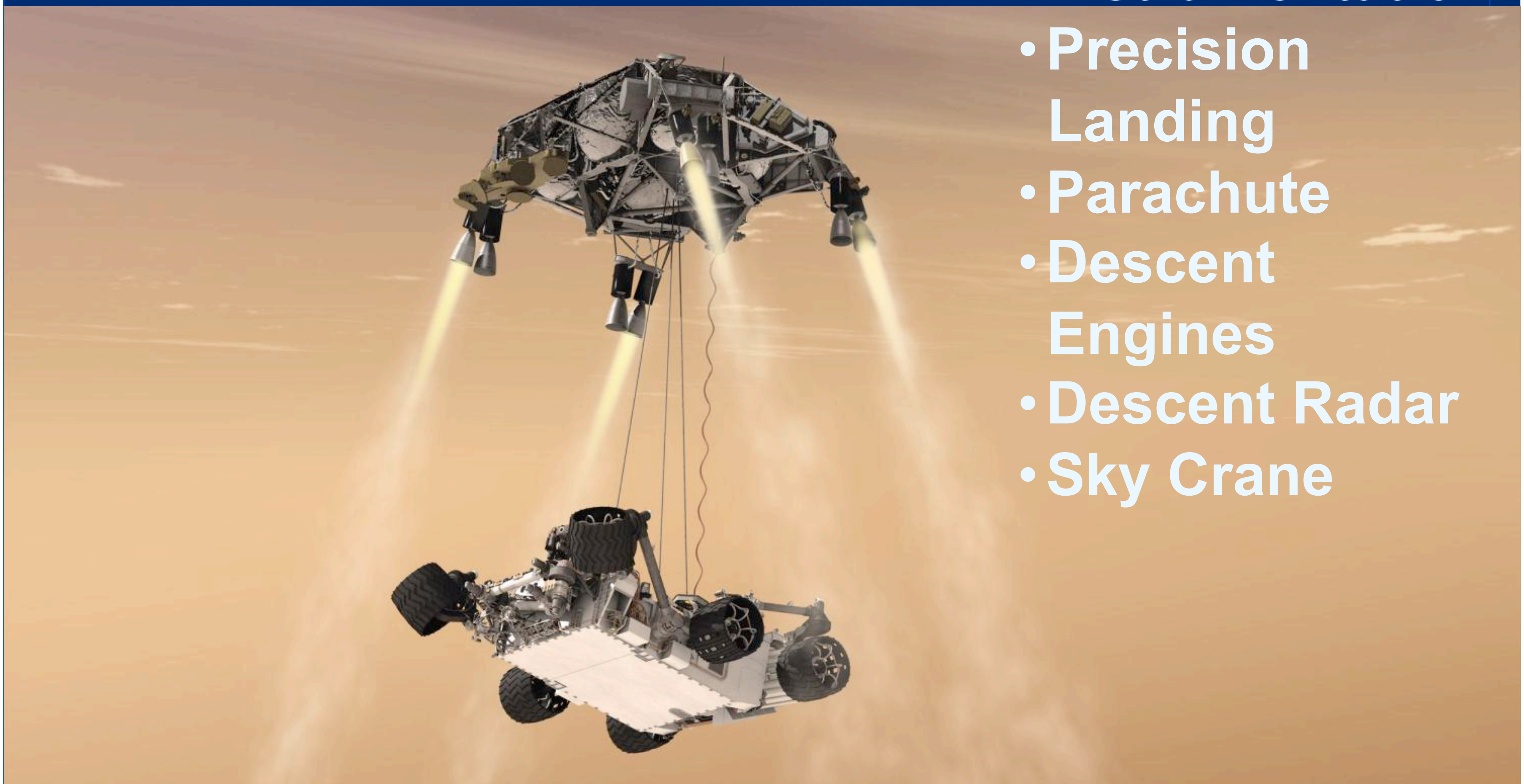
Curiosity's heat shield during descent



MSL Technology Advancements: Mars Technology Program Heritage

EDL Technologies:

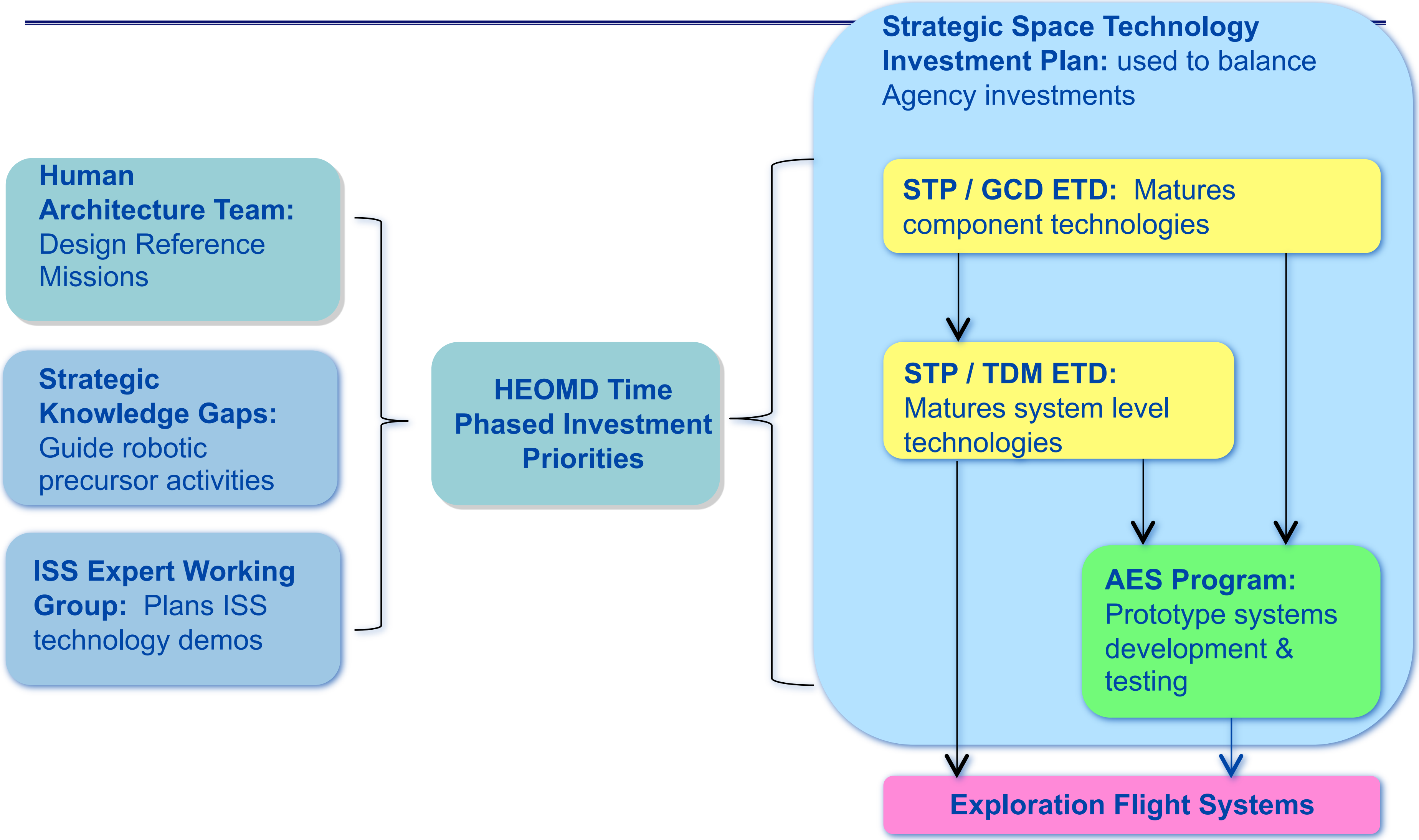
- PICA TPS
- Heat shield Instrumentation
- Precision Landing
- Parachute
- Descent Engines
- Descent Radar
- Sky Crane



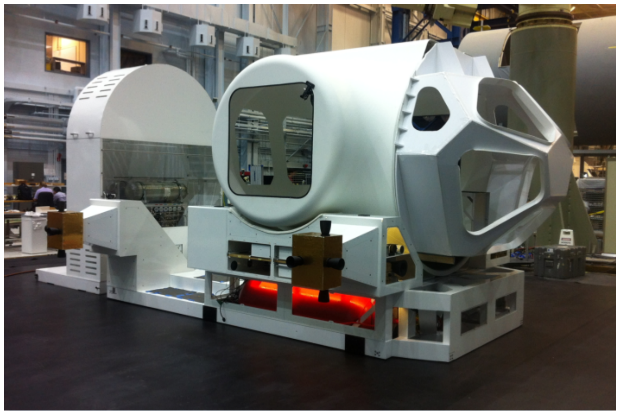
Artist's Concept. NASA/JPL-Caltech

Multi-Mission Radioisotope Thermal Generator

Defining the Combined AES/STP Portfolio



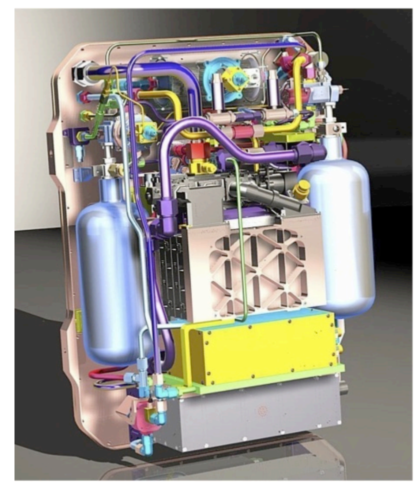
FY12 Accomplishments
Crew Mobility Systems Domain



MMSEV: Evaluated habitability and mobility during tests on air bearing floor

EVA: Assessed mobility of Z-1 space suit in partial gravity aircraft flight tests.

Suitport: Conducted differential pressure tests of two suitport concepts with Z-1 spacesuit.

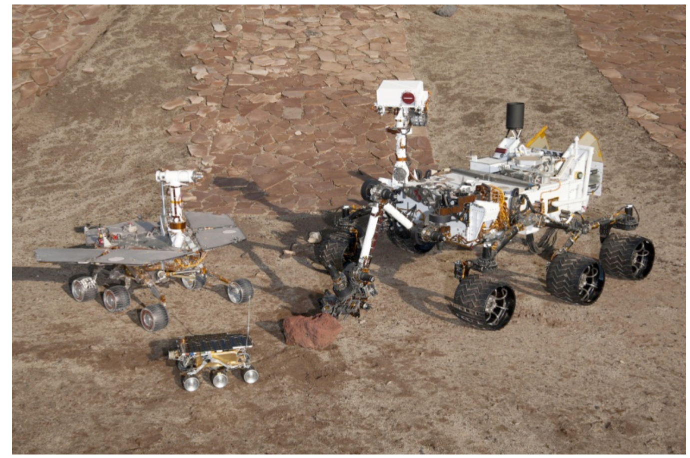


EVA: Designed prototype Portable Life Support System for advanced spacesuit.

Strategic Space Technology Investment Plan (SSTIP) Summary

- 20-year horizon, investment guidance for the next four years
- Framework:
  - Goals
  - Capability Objectives
  - Technical Challenges
- Four-year investment approach
  - 70% - 8 Core technologies represent 12 of 16 NRC top priority recommendations
  - 20% - Adjacent Technologies: Not part of the Core but are part of the NRC's 83 high priorities
  - 10% - Seeding Innovation: Smaller Investments in remaining technologies in the roadmaps that were not part of the NRC's 83 high priorities.

T&I Committee Findings for the NASA Advisory Council



- Major missions we're flying today (e.g MSL) dependent on technology investments made years ago.
  - Enabled by a rich base of technologies developed over a 20 year period
    - Sojourner to Spirit/Opportunity, to Curiosity
    - Many other examples on MSL and JWST
  - NASA should maintain a corporate memory on technology infusion into key missions to justify future investments to OMB/Congressional decision makers.

T&I Committee Findings for the NASA Advisory Council

- NASA technology shelf depleted over the last decade due to a lack of investment. NASA has begun to correct this over the last three years (e.g., Space Technology Program (STP)).

T&I Committee Findings for the NASA Advisory Council

- Committee is impressed with progress in the STP
  - Two years ago—just talking process
  - Today—program executing, achieving milestones and delivering technologies
  - STP has maturity, momentum and some budget stability
  - Need to enhance engagement with commercial space
  - Question: if 85% of milestones being met on tech demos, are we setting the right risk posture for advancing technologies? If we increase risk, the stakeholder community must be conditioned to accept some failures.

T&I Committee Findings for the NASA Advisory Council

- When NASA executes key missions, it should be enriching the Nation's technology base.
  - Question to ask in program formulation—what new technologies are we advancing by this mission?

T&I Committee Findings for the NASA Advisory Council

- In spite of the challenges, it is advantageous to insert technology measurement into flight missions to sharpen engineering analysis/design tools
  - MEDLI on MSL
  - OEX on Shuttle

T&I Committee Findings for the NASA Advisory Council

- Success of the Space Technology Research Grants program is encouraging
  - Mentorship has been a key to success
  - However, lack of hiring slots impedes refreshing of NASA technical workforce

T&I Committee Findings for the NASA Advisory Council

- The organizational construct of STMD and OCT makes sense to the committee
  - Separation of line and staff responsibilities