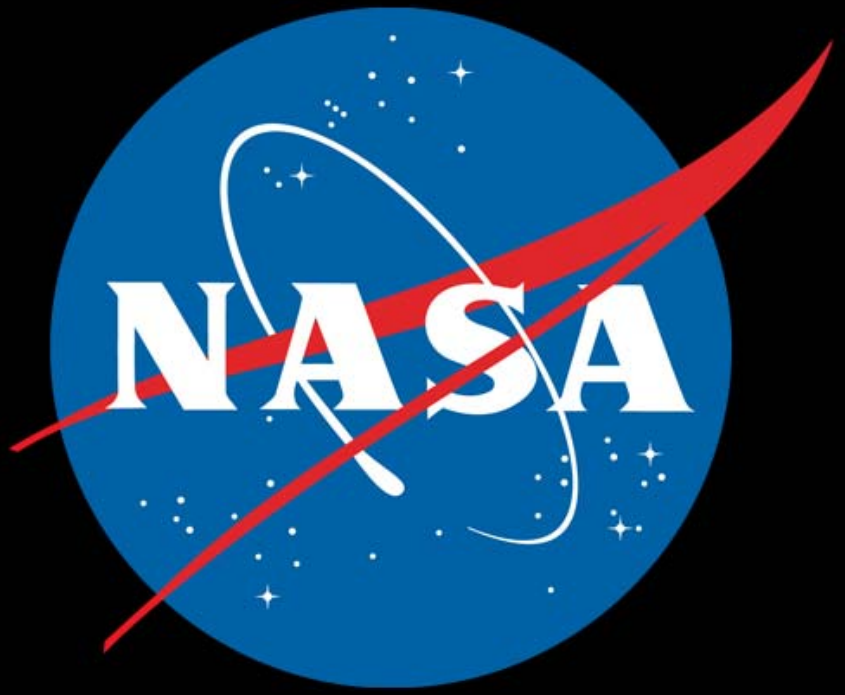
Meeting Technology Needs through Innovative Partnerships at NASA



Doug Comstock
Director, Innovative Partnerships Program Office - NASA

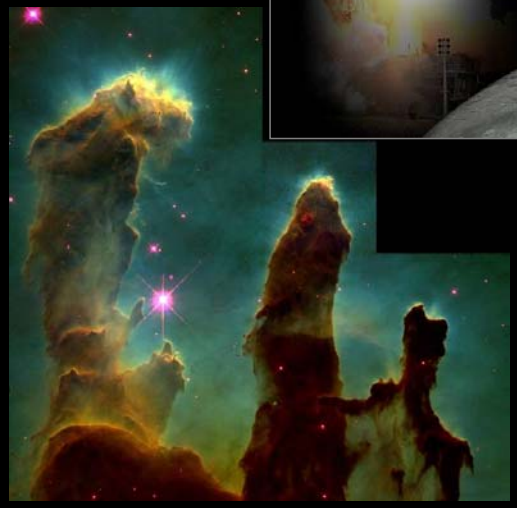
Military and Aerospace Programmable Logic Device (MAPLD) Conference 2008
September 17, 2008 Annapolis, Maryland

NASA Explores For Answers That Power Our Future

Inspire

Innovate

Discover



Inspiration + Innovation + Discovery = Future

Global Exploration Strategy

Human Civilization

Global Partnerships

Scientific Knowledge

Economic Expansion

Exploration Preparation

Public Engagement

Global Exploration Strategy

NASA Organizational Structure

Explorations Systems Mission Directorate

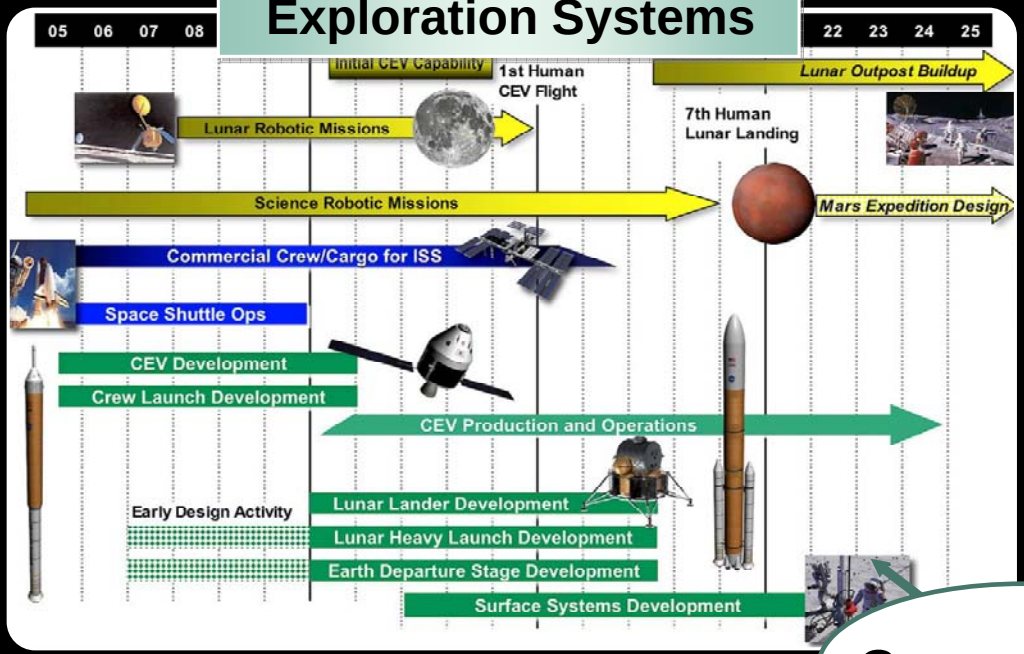
Space Operations Mission Directorate

Science Mission Directorate

Aeronautics Mission Directorate

Agency Capability Roadmap

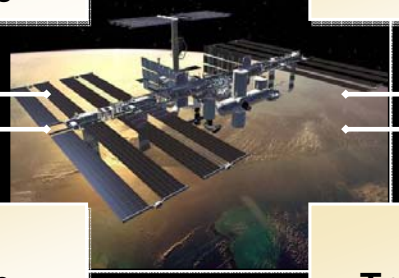
Exploration Systems



Space Operations

Space Shuttle: Return to Flight

Space Communications



ISS: Completion

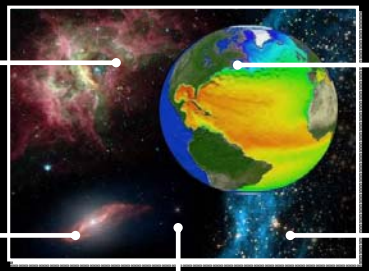
Space Transportation

Crosscutting

Science

Heliophysics

Earth Science



Planetary Science

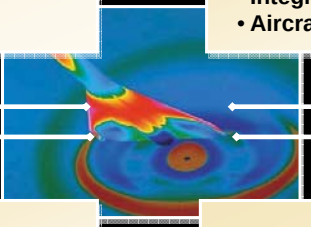
Astrophysics

Management & Policy

Aeronautics Research

Fundamental Aeronautics
- Subsonics: Fixed Wing
- Subsonics: Rotary Wing
- Supersonics
- Hypersonics

Aviation Safety
- Integrated Vehicle Health Mgmt.
- Integrated Intelligent Flight Deck
- Integrated Resilient Aircraft Control
- Aircraft Aging & Durability



Airspace Systems
- NGATS: Airspace
- NGATS: Airportal

Aeronautics Test
Protect and maintain key research and test facilities

Technology In Extreme Environments

High performance / weight

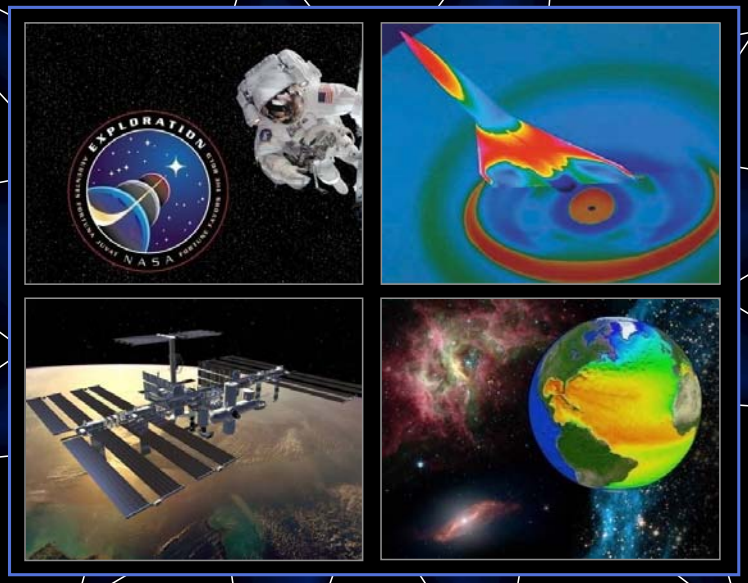
- Launch $
- Aeronautics Applications
- Human Habitats

Meteorite Impact & Dust Resistance

- Highly electrostatic
- Ultrafine
- Human Habitats

Multifunctional Intelligence

- Scientific Productivity
- Human “Amplifiers”
- IVHM



Extreme Radiation Resistance

- Mission to Europa: 1-5 Mrads

Ultra-sensitive Signal capture

- Voyager: Signal From 9.3 x 10^9 mi

Extreme Temperature Resistance

- Lunar Surface: -233 °C to 123 °C
- Mars Surface: -87 °C to -5 °C

Innovative Partnerships Program

Matching Technology Needs with Technology Capabilities

Innovative Partnerships Program Elements

- Small Business Innovation Research (SBIR)
- Small Business Technology Transfer Research (STTR)
- IPP Seed Fund

- Centennial Challenges
- FAST
- Innovation Transfusion
- New Business Models

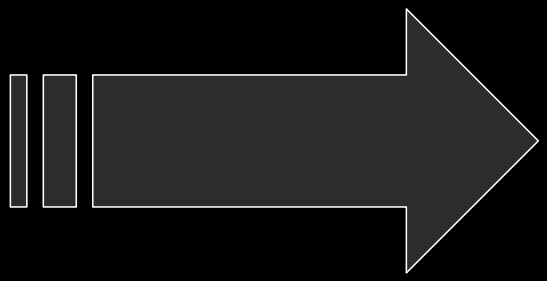
- Intellectual Property Management
- Technology Transfer
- New Innovative Partnerships

IPP Technology for Mission Directorates

Technology Needs
- Communication

Innovative Partnerships Program
- SBIR/STTR
- Centennial Challenges
- Seed Fund
- Partnerships

Executed at the Field Centers



Technology Infusion
- Bridging the “Valley of Death”
- Narrow the gap and reduce risk
- Begin building bridges early

Mission Directorates
- Programs
- Projects

Executed at the Field Centers

SBIR/STTR: 3-Phase Program

- **PHASE I**
  - Feasibility study
  - $100K award
  - 6 months duration (SBIR)
  - 12 months duration (STTR)
- **PHASE II**
  - Technology Development
  - 2-Year Award
  - Up to $750K (SBIR/STTR)
- **PHASE III**
  - Technology Infusion/Commercialization Stage.
  - Use of non-SBIR Funds.
  - Ability to award sole-source contracts without JOFOC based on specific SBIR authority – NASA and NASA primes.

SBIR	FY03	FY04	FY05	FY06	FY07	FY08
Millions of $	107.3	107.5	110.0	105.6	99.8	103.7
Phase 1 Awards	267	312	291	267	259	TBD
Phase 2 Awards	155	139	142	186	130	TBD

STTR	FY03	FY04	FY05	FY06	FY07	FY08
Millions of $	6.4	12.9	13.2	12.3	12.0	12.5
Phase 1 Awards	45	40	35	27	25	TBD
Phase 2 Awards	18	26	17	22	18	TBD

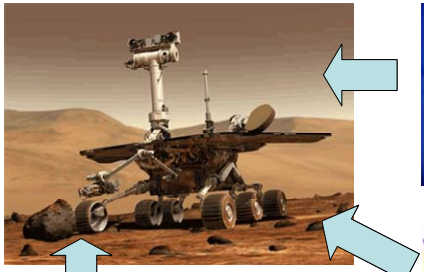
SBIR is 2.5% of extramural R&D, STTR is 0.3% of extramural R&D.

SBIR/STTR Taxonomy

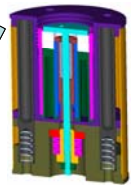
- Avionics and Astrionics
- Biotechnology
- Communications
- Cryogenics
- Education
- Electronics
- Extravehicular Activity
- Information
- Manufacturing
- Materials
- Microgravity
- Power and Energy
- Propulsion
- Robotics
- Sensors and Sources
- Structures
- Thermal
- Verification and Validation

SBIR Technology Infusion Examples

Mars Exploration Rovers



Lithium-ion batteries for battery packs.



Heat switches to control radiator for electronics package.

ASCII chip for memory modules and analog-to-digital converters.

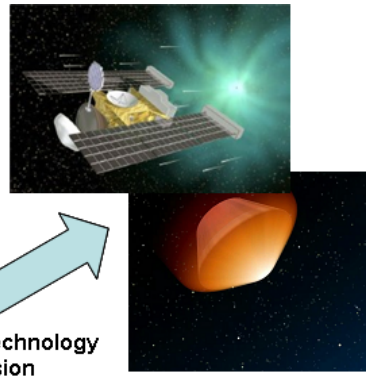
Stardust and Orion

ARC-invented heatshield technology Phenolic Impreg-nated Carbon Ablator (PICA)

SBIR awards to FMI advance manufacturing scalability of the technology

PICA selected as an enabling technology for successful STARDUST mission

STARDUST success leads to further application as heatshield on crewed reentry vehicles

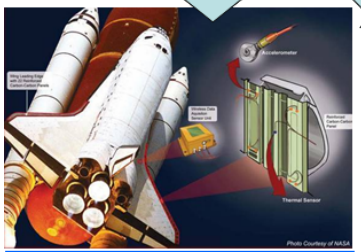


Space Shuttle and ISS

Sensor Control and Acquisition Telecommunications (SCAT)

Wireless Instrumentation Systems

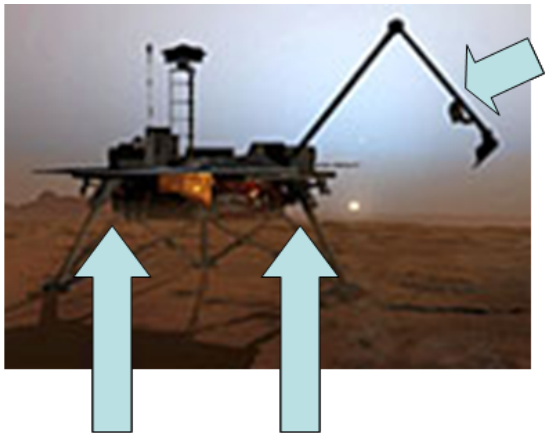
Microgravity Instrumention (And Structural Dynamics)



Wing Leading Edge Impact Detection System

IVHM Integrated Vehicle Health Monitoring

Mars Phoenix Lander

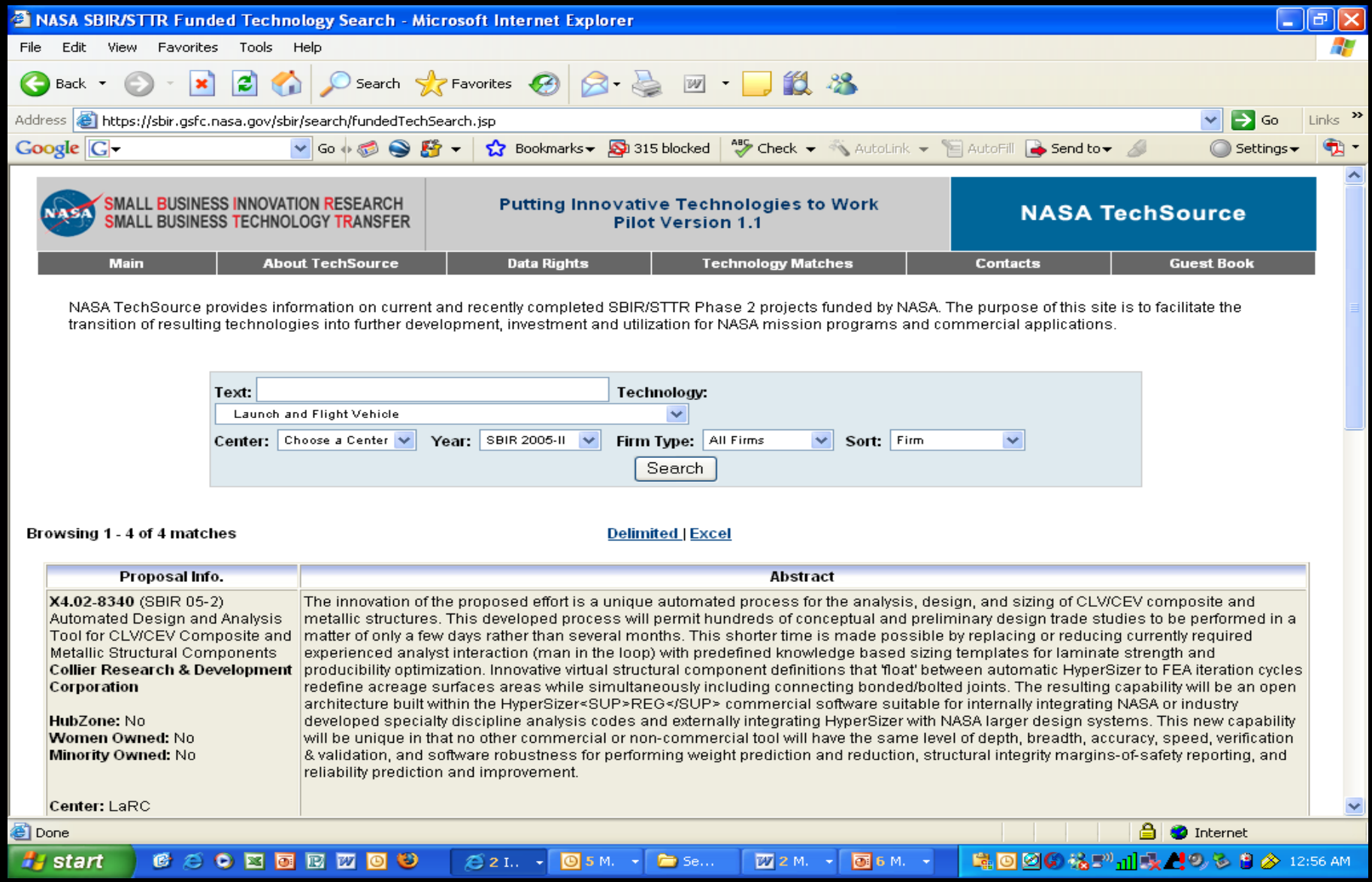


Icy Soil Acquisition Device supplied by Honeybee Robotics, Inc.

Lithium ion batteries supplied by Yardney Technical Products, Inc.

SpaceDev (formerly Starsys) contributed to the design of the Microscopy Electrochemistry and Conductivity Analyzer (MECA)

Technologies and Firms are Searchable

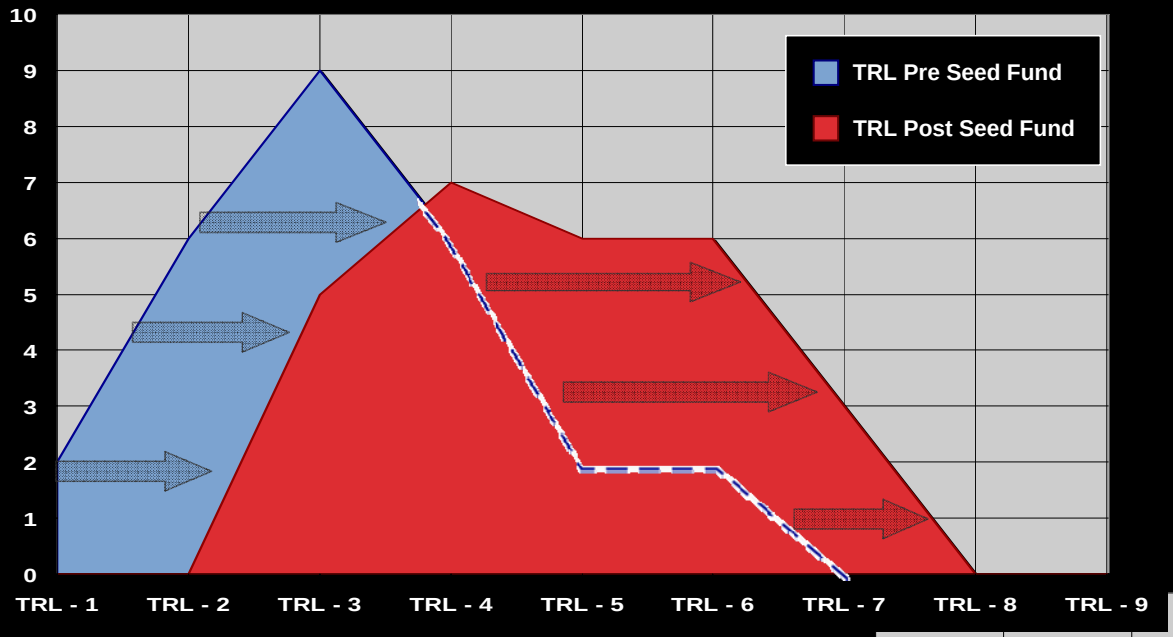


https://sbir.gsfc.nasa.gov/sbir/search/fundedTechSearch.jsp

IPP Seed Fund

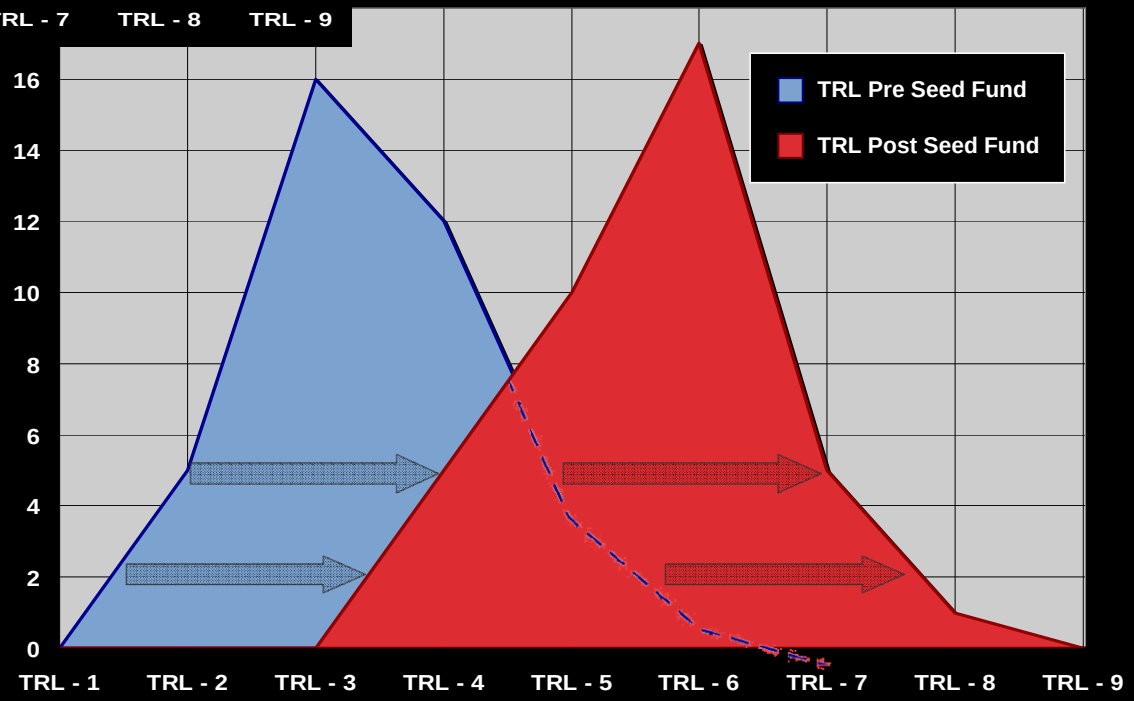
- **An annual process for selecting innovative partnerships to address technology barriers via cost-shared, joint-development projects.**
- **Enhances NASA's ability to meet the priority technology gaps of all four of NASA's Mission Directorates.**
- **The IPP Office at NASA HQ issues an annual Seed Fund call to all NASA Centers – they downselect and send to HQ for final selections.**
- **The Seed Fund operates through a collaboration of Center IPP Offices, NASA co-PI, and external co-PI.**
- **Proposals are evaluated against the following criteria:**
    - Relevance/Value to NASA Mission Directorates.
    - Scientific/Technical merit and feasibility.
    - Leveraging of resources.
- **In the last two years, an investment of $19 million by IPP facilitated the generation of 81 partnerships and was leveraged by nearly a factor of four, providing a total of $73 million for the advancement of critical technologies and capabilities for the Agency.**

Seed Fund TRL Advancement



FY06 Seed Fund Portfolio

FY07 Seed Fund Portfolio



Demonstration Highlights

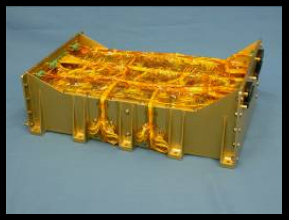
Technology Demos

Cryostable Low-cost Mirror
(Deep Space Missions)

Inflatable Human Habitat
(Human Lunar)

4D Flight Mgmt
(NGATS)

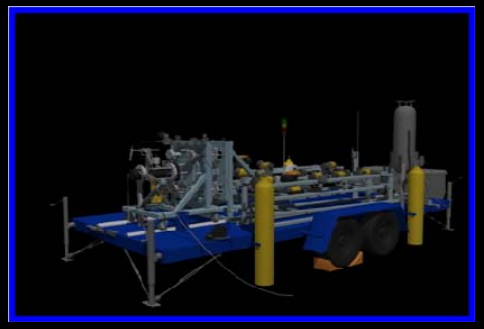
Li-Ion Battery for PLSS
(Human EVA)

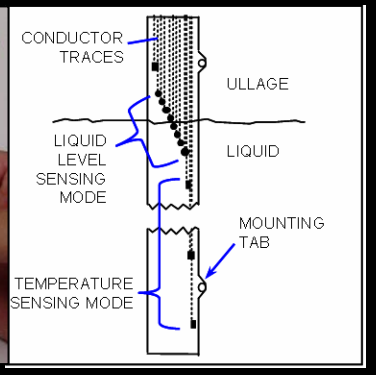


Inflatable Decelerator
(AFL MARS and COTS)

Cryo-tracker Flight Qualification
(Atlas/Centaur Launches)

ISHM - Test Stand and J2X Engine
(Aries 1 Upper Stage)





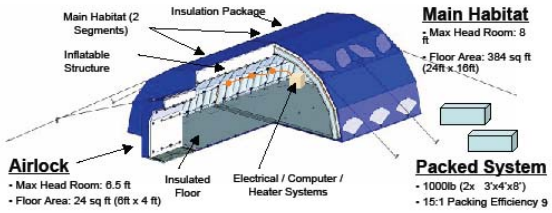
Antarctic Habitat Demonstrator

Antarctic Habitat Demonstrator

- NASA / NSF / ILC Dover Innovative Partnership Program (IPP)
- Test of expandable structures in Antarctic Analog to advance NASA knowledge base for lunar application
- Test of expandable structures to advance NSF knowledge and assess applicability to polar missions

System Requirements (NASA & NSF Combined) - Annotated

- Reconfigurable components
- Erected by 4 people in 4 hours
- Can withstand 100 mph winds
- High Packing Efficiency
- Can deploy on uneven ground
- Withstand the Antarctic winter
- Multiple cycle use
- Lighting/power/data acquisition
- Meet NSF building codes



Antarctic Habitat Demonstrator Study Goals

Large Expandable Structures:

- ☑ – Packing efficiency & shipping/handling survival
- ☑ – Deployment operability in a gravitational environment and in polar gear (representing space suits)
- ☑ – Adaptability to uneven and rugged surfaces representing the lunar surface
- ☑ – Reconfigurability
- Ongoing – Performance in a harsh environment
- Partial – Deployment with integrated electronics (power, lighting, sensors, etc.)
- ☑ – Remote structural health monitoring over long periods of time
- ☑ – Use of in-situ materials for shielding from radiation
- ☑ – Lunar dust mitigation practices

ILC DOVER 10

Reconfigurability Studies

Connections between sections were simple in ECWG + demonstrated reconfigurability

The system adapted well to the uneven ground due to compliant interfaces and structures

Packed & deployed system dozens of times

12

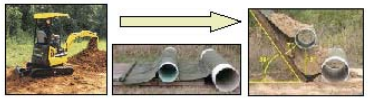
Radiation Protection Studies

Researching ways to apply regolith to the walls of a structure for radiation shielding

Bags Fill bags attached to structure

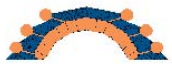
Blankets

Flexible PE blankets applied where required



Push regolith on deflated structure, inflate structure, capture regolith on walls

Regolith Lifter



13

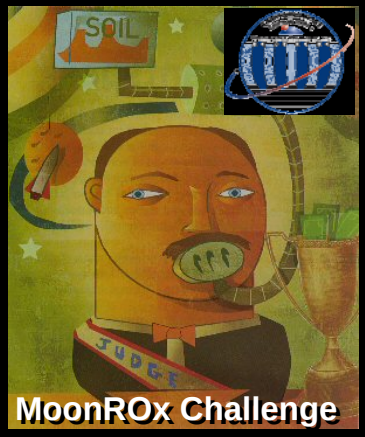
From briefing by Phil Spampinato, ILC Dover
At 3rd AIAA Space Exploration Conference, Feb. 27, 2008

How Do Prizes Benefit NASA?

- Increased Participation by New Sources of Innovation
- Leveraging of Tax-Payers' Dollars
- Innovative Technology Development to Meet NASA's Needs
- Increased Awareness of Science and Technology
- Hands-on Training for Future Workforce

Funded Centennial Challenge Competitions

Competition	Total	2006	2007	2008	2009	2010	2011
Astronaut Glove	$1M		250	350	400		
Regolith Excavation	$750 K		250	500			
Personal Air Vehicle	$2M		250	300	400	500	550
Beam Power	$2M	200	300	400	500	600	
Tether	$2M	200	300	400	500	600	
Lunar Lander	$2M	2,000					
MoonROx	$1M	250	750				



And The Winner Is...

...Peter Homer

Centennial Challenges - NASA Technology Prizes

RECENT COMPETITIONS

Regolith Excavation — August 2-3, 2008

Robotic devices to excavate simulated lunar soil.

Location: California Polytechnic State University, San Luis Obispo, CA

2008 Purse: $750K.

Managed by: California Space Education & Workforce Institute.

25 teams registered from 15 different states.

NASA Technologies/Center Interest: ISRU & Robotics - JSC, GRC, KSC, CxPO

General Aviation Technology — August 2-10, 2008

Safer, quieter & more efficient aircraft.

Location: Sonoma County Airport, Santa Rosa, CA.

2008 Purse: $300K.

Managed by: Comparative Aircraft Flight Efficiency Foundation.

The event will provide a forum for discussions on creation of a future Green Aviation Prize - intended to lead to a zero-emission airplane.

NASA Technologies/Center Interest: Aeronautics, energy systems, structures - LaRC, DFRC, GRC, ARC

Centennial Challenges - NASA Technology Prizes

UPCOMING COMPETITIONS

Lunar Lander **October 24-25, 2008**

Reusable rocket vehicles simulating lunar takeoff and landing.

Location: Holloman Air Force Base, NM.

2008 Purse: $2M.

Managed by: X PRIZE Foundation.

Near-winner from 2007 will return and other challengers are expected.

NASA Technologies/Center Interest: Propulsion, GN&C - CxPO-Altair, MSFC, JSC, GRC, SSC

Power Beaming & Tether **Fall 2008**

Wireless power transmission and super-strength materials.

Location: Western US.

2008 Purse: $2M for each.

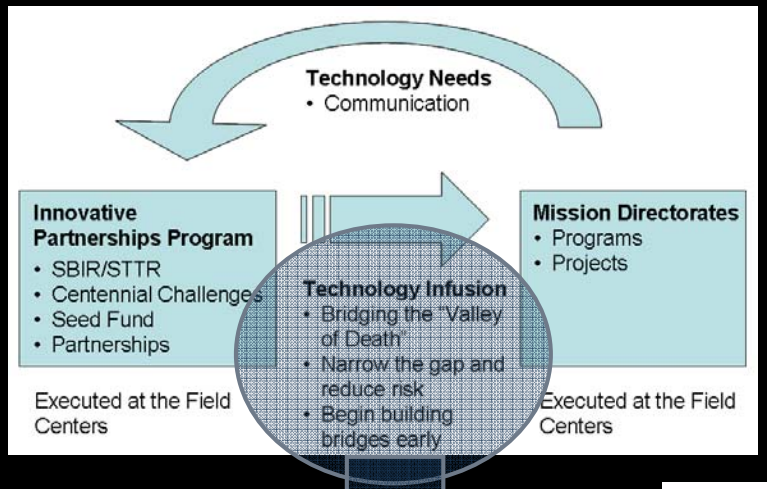
Managed by: Spaceward Foundation.

2008 Power Beaming event will require devices to climb one kilometer

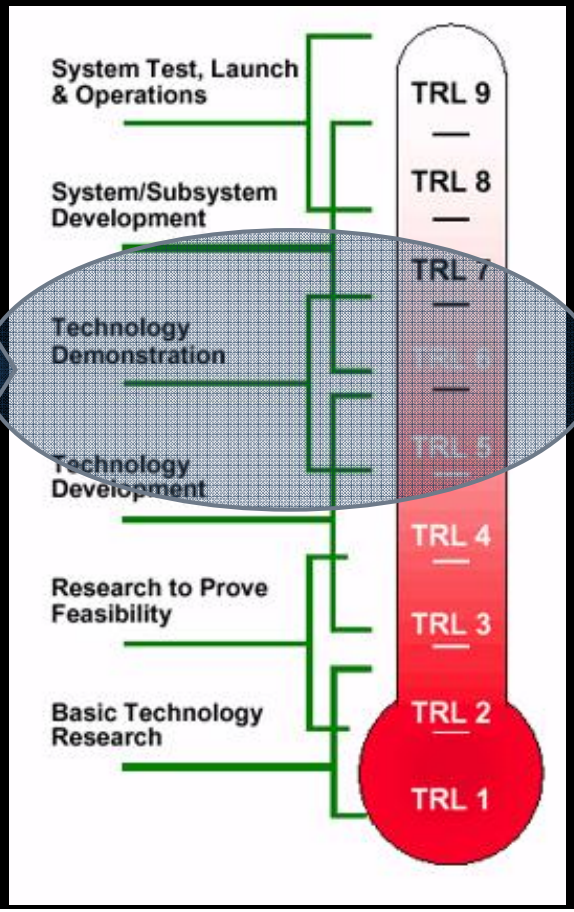
11 teams have entered.

NASA Technologies/Center Interest: Power systems, lasers, mechanisms, advanced materials - GRC, LaRC, CxPO

Technology Demonstration is critical to Infusion



- As a rule of thumb, projects like technology to be TRL-6 by PDR
- Technology Demonstration in relevant environments is critical



TRL 9	Actual system "flight proven" through successful mission operations.
TRL 8	Actual system completed and "flight qualified" through test and demonstration (ground or space).
TRL 7	System prototype demonstration in a ***space environment***.
TRL 6	System/subsystem model or prototype demonstration in a ***relevant environment*** (ground or space).
TRL 5	Component and/or breadboard validation in ***relevant environment***.
TRL 4	Component and/or breadboard validation in laboratory environment.
TRL 3	Analytical and experimental critical function and/or characteristic proof-of concept.
TRL 2	Technology concept and/or application formulated.
TRL 1	Basic principles observed and reported.

FAST

Facilitated Access to the Space Environment for Technology Development and Training

Objectives:

1) **Enable testing of emerging technologies in the space-environment such as zero and reduced-gravity conditions on parabolic aircraft flights.**
2) **Promote NASA use of commercial space-related services such as a commercially-operated parabolic aircraft.**

- **Modifications to the commercial aircraft to meet NASA requirements have been completed.**
- **Initial flight-weeks occurred August 25 and September 8.**
- **A broad call for proposals for flight weeks in FY09 will be issued in September for flights to occur in 2008 and 2009.**

FAST

Facilitated Access to the Space Environment for Technology Development and Training

SBIR firms tested five new technologies Sept. 9-10:

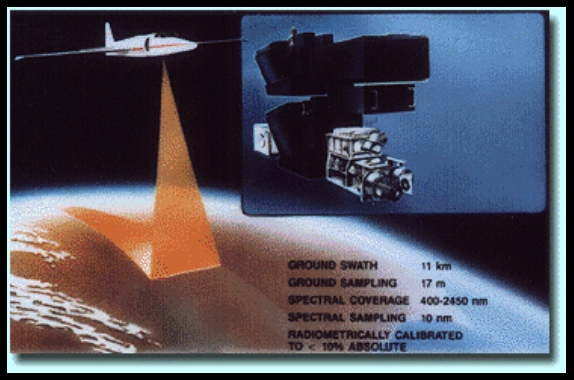
- Pneumatic mining under lunar gravity conditions (Honeybee Robotics of New York)
- Aircraft sensor-logger operations (Metis Design Corporation of Cambridge, Mass.)
- Microgravity flight testing of self-deploying shells (Mevicon Inc. of Sunnyvale, Calif.)
- Virtual sensor test instrumentation operations (Mobitrum Corporation of Silver Spring, Md.)
- Nanofluid coolant testing (nanoComposix, Inc. of San Diego, Calif.)

Four days of flights were scheduled in September, but the approach of Hurricane Ike caused those scheduled Sept. 11-12 to be suspended. An effort will be made to reschedule the flights in the future.

FASTRACK experiment module.

Spectral Imaging Partnerships

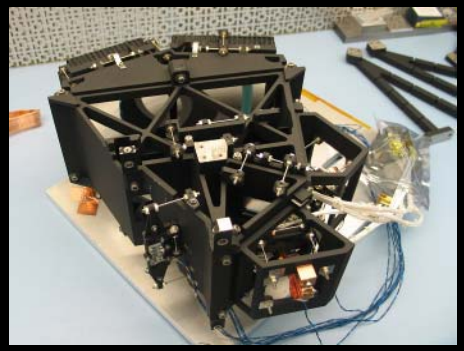
NASA Investment



Airborne AVIRIS Imager

- NASA funded airborne whisk broom spectrometer
- Built in 1989 and operated through present

Tech Transfer/Partnerships



Airborne Compact Imager

- Partnership with another agency to develop a new airborne spectrometer (MaRS)
- MaRS uses Offner and push broom design for improved performance metrics (radiometric precision, uniformity, simplicity, reliability)
- Partner provides $10M in funding to increase technology from TRL 3 to 7
- 24 month build
- Demonstrated in 2006

Benefits to NASA

Airborne Compact Imager

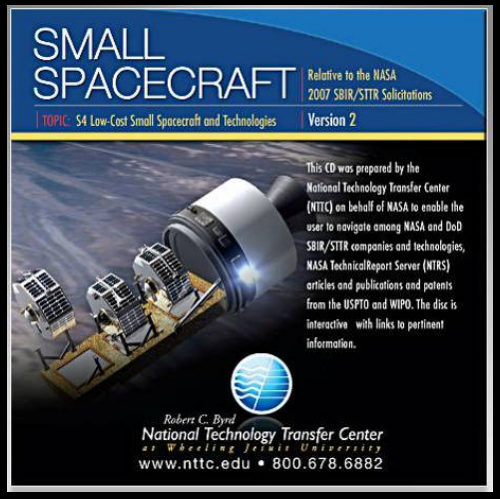
- NASA selects advanced push broom, compact spectrometer (Moon Mineralology Mapper) for joint NASA/ISRO experiment
- Based on MaRS design
- 24 month build
- Launch in 2008

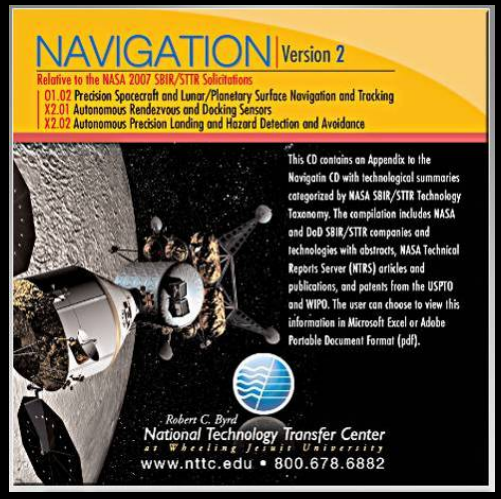
Finding Technologies

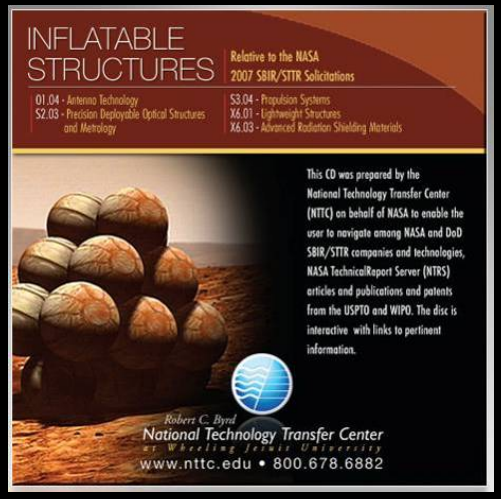
- **There are many technologies potentially available to address needs, and one of the challenges for connecting technologies with potential applications is the difficulty in navigating and filtering all the available data.**
    - Helping to make these connections is one of the key functions of the Technology Infusion Managers that IPP has at all ten field centers.
    - They are a great resource, and can be reached via http://www.ipp.nasa.gov/field_centers.htm.
- **There are also many searchable databases available to help identify technologies of interest. Some of these are summarized below:**
    - NASA TechFinder: http://technology.nasa.gov/
    - NASA TechBriefs: http://www.techbriefs.com/
    - NASA TechSource: https://sbir.gsfc.nasa.gov/sbir/search/fundedTechSearch.jsp
    - NASA SBIR/STTR Abstract Search : http://sbir.gsfc.nasa.gov/SBIR/sbirabssearch.html
    - Other databases: http://www.ipp.nasa.gov/databases.htm

Finding Technologies

- **IPP is working with the National Technology Transfer Center (NTTC) to develop a series of technology-specific resources for identifying available technology.**
- **These include relevant SBIR/STTR technology that has been funded by NASA or other agencies including DoD, and other sources of patented technology in the particular area of interest.**







- **The NTTC has developed several of these CDs for NASA, which IPP is making available to Mission Directorates, program/project staff at the field centers, prime contractors supporting NASA research and development activities, and other interested parties.**

Outreach & Publications

http://www.techbriefs.com/

Electronics & Computers
Semiconductors & ICs
Mechanics
Information Sciences
Materials Software
Manufacturing & Prototyping
Machinery & Automation
Physical Sciences
Bio-Medical Test & Measurement

http://www.sti.nasa.gov/tto/
http://www.sti.nasa.gov/spinoff/searchrecord

NASA @ Home & NASA City
http://www.nasa.gov/city

http://ipp.nasa.gov/innovation/index.html

Visit us at ipp.nasa.gov

What Can IPP Provide?

- **Funding or Leveraged Resources**
  - NASA SBIR/STTR funds several hundred small businesses
  - IPP Seed Fund seeks partnerships to leverage resources with the private sector and other Federal labs
  - Centennial Challenges offers millions in purses
- **Technology and Software**
  - Access through licensing or other partnerships
- **Access to Facilities and Test Capabilities**
  - Access to NASA's facilities through partnerships
  - Technology demonstration opportunities through FAST
- **Expertise**
  - Access to NASA's technical expertise through partnerships
- **Facilitation to enable partnerships**
- **Advocacy as a change agent to try new things**

Interested in partnering with NASA?

Contact the relevant IPP Center Chief(s):

Center	Name	Email	Phone
ARC	Lisa Lockyer	Lisa.L.Lockyer@nasa.gov	(650) 604-0149
DFRC	Gregory Poteat	Gregory.A.Poteat@nasa.gov	(661) 276-3872
GRC	Kathy Needham	Kathleen.K.Needham@nasa.gov	(216) 433-2802
GSFC	Nona Cheeks	Nona.K.Cheeks@nasa.gov	(301) 286-8504
JPL	Andrew Gray	Gray@jpl.nasa.gov	(818) 354-4906
JSC	Michele Brekke	Michele.A.Brekke@nasa.gov	(281) 483-4614
KSC	Dave Makufka	David.R.Makufka@nasa.gov	(321) 867-6227
LaRC	Brian Beaton	Brian.F.Beaton@nasa.gov	(757) 864-2192
MSFC	Jim Dowdy	Jim.Dowdy@nasa.gov	(256) 544-7604
SSC	Ramona Travis	Ramona.E.Travis@nasa.gov	(228) 688-1660

National Aeronautics and Space Administration

www.nasa.gov