

National Aeronautics and  
Space Administration



# Space Technology FY 2013

Dr. Mason Peck,  
Office of the Chief Technologist

The Association of American Universities  
April 4, 2012

# Office of the Chief Technologist



Serves as Advisor to Administration



Direct Technology Management and Budget Authority for the Space Technology Program



Office of the Chief Technologist



Demonstrates and Communicates Societal Impacts of NASA Technology Investments



Advocates Externally NASA's R&D Programs



Integrates Technology Investment Across the Agency

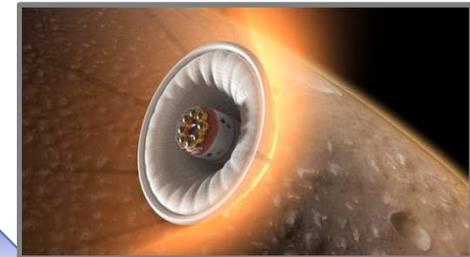


Leads Tech Transfer, Partnerships and Commercialization Activities Across the Agency

# Space Technology: Investments in Our Future



- **Enabling Our Future in Space:** By investing in high payoff, disruptive technology that industry cannot tackle today, *Space Technology* matures the technology required for NASA's future missions in science and exploration while proving the capabilities and lowering the cost for other government agencies and commercial space activities.
- **NASA at the Cutting Edge:** Pushing the boundaries of aerospace technology and seizing opportunities, *Space Technology* allows NASA and our Nation to remain at the cutting edge.

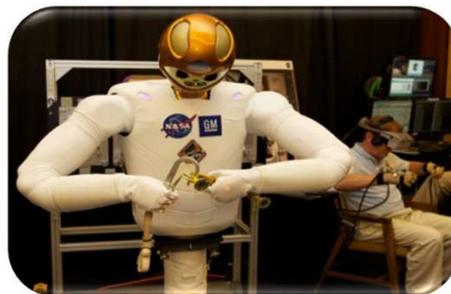


# Guiding Principles of the Space Technology Program



## OCT's Space Technology Program

- Advances broadly applicable technology to infuse solutions into applications for which there are multiple customers.
- Employs portfolio approach to capture the entire spectrum of technology readiness.
- Competitively selects research by academia, industry, and the NASA centers based on technical merit.
- Leverages the technology investments of our international, other government agency, academic and industrial partners.
- Coordinates with internal and external stakeholders, including academia, industry and other government agencies
- Results in new inventions, new capabilities and the creation of a pipeline of innovators aimed at serving future National needs
- Grows the Nation's innovation economy



# The Ten Programs of Space Technology



## Early Stage Innovation



Space Technology Research Fellowships & Grant Programs



NASA Innovative Advanced Concepts (NIAC) Program



Center Innovation Fund Program



Centennial Challenges Prize Program

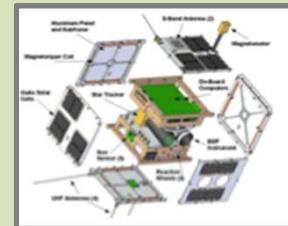


Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) Program

## Game Changing Technology



Game Changing Development

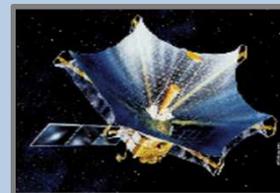


Franklin Small Satellite Subsystem Technology

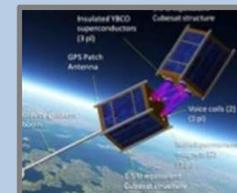
## Technology Capability Demonstrations



Flight Opportunities



Technology Demonstration Missions



Edison Small Satellite Demonstration Missions

# Space Technology FY 2013 President's Budget Request



Budget Authority (\$M)	FY 2012	FY 2013	Notional			
	Appropriation		FY 2014	FY 2015	FY 2016	FY 2017
<b>FY 2013 President's Budget Request</b>	<b>573.7</b>	<b>699.0</b>	<b>699.0</b>	<b>699.0</b>	<b>699.0</b>	<b>699.0</b>
<u>Partnership Development and Strategic Integration</u>	<u>29.5</u>	<u>29.5</u>	<u>29.5</u>	<u>29.5</u>	<u>29.5</u>	<u>29.5</u>
<u>SBIR/STTR</u>	<u>166.7</u>	<u>173.7</u>	<u>181.9</u>	<u>187.2</u>	<u>195.3</u>	<u>206.0</u>
<u>Crosscutting Space Technology Development</u>	<u>187.7</u>	<u>293.8</u>	<u>272.1</u>	<u>266.6</u>	<u>259.7</u>	<u>247.0</u>
Early Stage Innovation	39.8	59.0	61.0	61.0	61.0	61.0
CSTD Game Changing Technology	61.5	66.7	73.7	69.1	58.4	58.4
CSTD Technology Demonstration Missions	65.3	128.9	103.4	102.5	106.3	93.6
Edison/Franklin Small Satellites	11.2	24.2	19.0	19.0	19.0	19.0
Flight Opportunities	10.0	15.0	15.0	15.0	15.0	15.0
<u>Exploration Technology Development</u>	<u>189.9</u>	<u>202.0</u>	<u>215.5</u>	<u>215.7</u>	<u>214.5</u>	<u>216.5</u>
ETD Game Changing Technology	111.2	104.0	70.5	79.8	85.9	90.9
ETD Technology Demonstration Missions	78.7	98.0	145.0	135.9	128.6	125.6



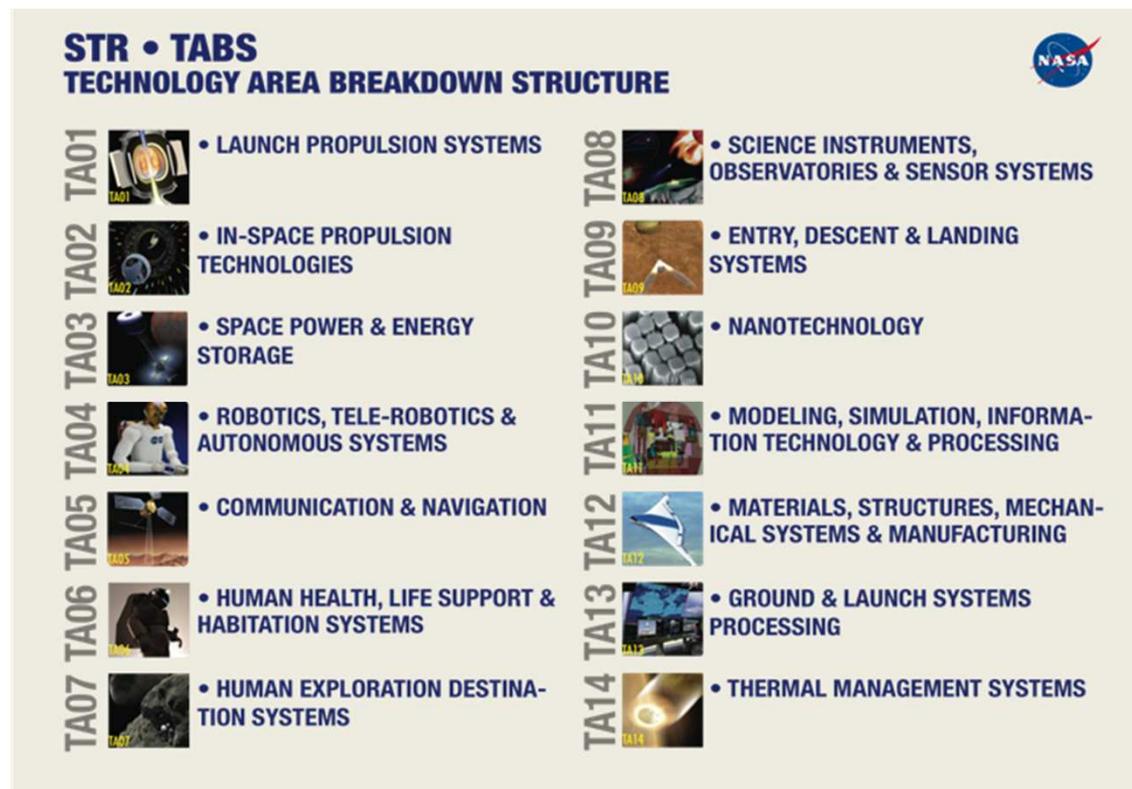
# FY 2011 Competitive Selections

- **NIAC** selected 30 advanced concept proposals from hundreds of submittals. Addresses early-stage concepts address challenging problems in space operations research and development.
- **STRF** selected inaugural class of 80, highly-qualified and talented graduate students from 37 universities and colleges.
- **Green Flight Challenge:** 14 teams registered for competition. Three teams met requirements and competed. First prize of \$1.35M awarded to Pipistrel-USA.com. Second place prize of \$120,000 awarded to team eGenius.
- **SBIR:** -Awarded 450 SBIR Phase 1 awards across 37 states      - Awarded 215 SBIR Phase 2 awards across 35 states  
-Awarded 24 SBIR Phase 2E awards
- **STTR:** - Awarded 45 STTR Phase I awards across 15 states      - Awarded 27 STTR Phase II awards across 18 states
- **Game Changing Development** is soliciting proposals for research and technology development for revolutionary improvements in America's space capabilities. Initial selections:
  - Lightweight Composite Cryogenic Propellant Tank – Boeing
  - Ultra-high energy density Silicon Nanowire Lithium Ion Batteries – Amprius
  - Ride the Light (Formulation Phase) – 9 companies/universities
- **Flight Opportunities** selected seven companies to integrate and fly technology payloads on commercial suborbital reusable platforms. The seven companies receiving IDIQ contracts are:
  - Armadillo Aerospace; Near Space Corp; Masten Space Systems; Up Aerospace; Virgin Galactic; Whittinghill Aerospace; XCOR.
  - Flight Opportunities made 25 Suborbital/Parabolic Payload Selections
- **Technology Demonstration Mission** proposals were sought in four areas:
  - High-bandwidth deep space communication, navigation and timing; orbital debris mitigation or removal systems; advanced in-space propulsion systems; autonomous rendezvous, docking, close proximity operations and formation flying
  - Selected three proposals for award: Solar Sail (L'Garde); Deep Space Atomic Clock (JPL); Laser Communications Relay Demo (GSFC)

# NRC Report on NASA's Space Technology Roadmaps



- At the end of 2010 NASA drafted roadmaps to guide Agency-wide technology investment. The National Research Council (NRC) led a year-long study to assess these roadmaps, prioritizing prospective technology-investment opportunities in terms of their value to NASA's future and the Nation as a whole.



# Space Technology Roadmap Development Process



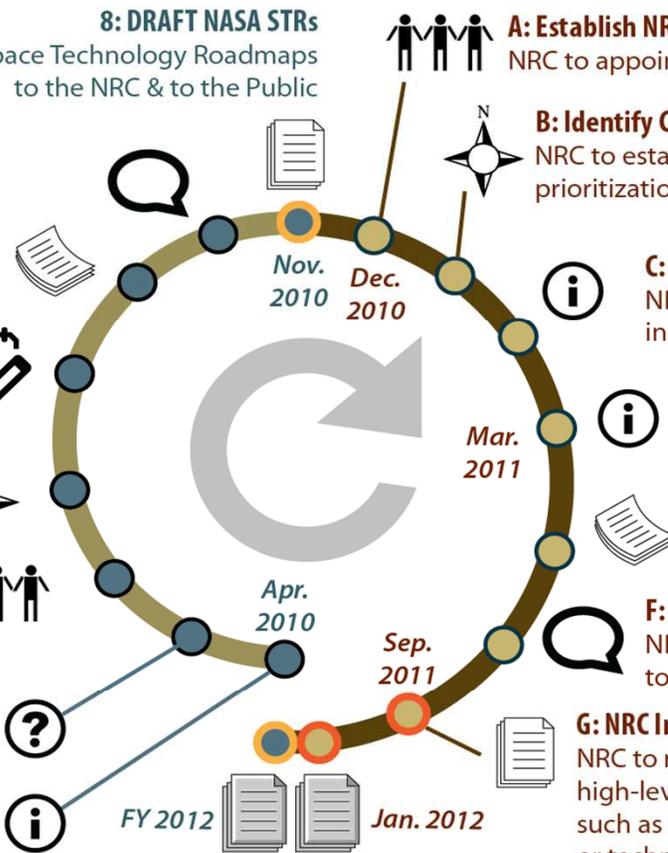
## NASA Process

- 1: START & Input from MDs & Center**  
Identified MD Goals, Missions, Architectures & Timelines; MD Technology Roadmaps & Prioritizations; Center Technology Focus Areas
- 2: Identify Technology Areas**  
Identified Technology Areas (TAs)
- 3: Establish TA Teams**  
OCT established NASA internal 6-member subject expert teams for each TA, with one or two chairs
- 4: Common Approach for TA Teams**  
Guidelines, assumptions, deliverables
- 5: Form Starting Point for TA Roadmaps**  
Assessed past roadmaps; MD & Center inputs
- 6: Roadmapping Process**  
Preliminary roadmaps for TA areas
- 7: Internal Reviews**  
Each TA Roadmap reviewed by OCT & extended teams of subject experts

## NRC Process

- 8: DRAFT NASA STRs**  
OCT released draft Space Technology Roadmaps to the NRC & to the Public
- 9: FINAL NASA STR REPORTS**  
NASA to release Roadmap Reports
- A: Establish NRC Teams**  
NRC to appoint steering committee and 6 panels
- B: Identify Common Assessment Approach**  
NRC to establish a set of criteria to enable prioritization within and among all TAs
- C: Initial Community Feedback**  
NRC to solicit external input from industry & academia
- D: Additional Community Feedback**  
NRC to conduct public workshops
- E: Deliberations by NRC Panels**  
NRC panels meet individually to prioritize technologies and suggest improvements to roadmaps
- F: Documentation by NRC Panels**  
NRC Panels to provide written summary to Steering Committee
- G: NRC Interim Findings**  
NRC to release a brief interim report that addresses high-level issues associated with the roadmaps, such as the advisability of modifying the number or technical focus of the draft NASA roadmaps
- H: FINAL NRC REPORT**  
With decisional information, including: summary of findings and recommendations for each of the roadmaps; integrated outputs from the workshops and panels; identify key common threads and issues; priorities, by group (e.g., high, medium, low), of the highest priority technologies from the TAs

## NASA Space Technology Roadmaps Process



# NRC Study: 16 Technologies in the Final Prioritization



Technologies included in the final prioritization,  
listed by TABS number

- 2.2.1 Electric Propulsion
- 2.2.3 (Nuclear) Thermal Propulsion
- 3.1.3 Solar Power Generation (Photovoltaic and Thermal)
- 3.1.5 Fission (Power)
- 4.2.1 Extreme Terrain Mobility
- 6.3.2 Long-Duration (Crew) Health
- 8.1.1 Detectors & Focal Planes
- 8.1.3 (Instrument and Sensor) Optical Systems
- 8.2.4 High-Contrast Imaging and Spectroscopy Technologies
- 8.3.3 In Situ (Instruments and Sensor)
- 14.1.2 Active Thermal Control of Cryogenic Systems
- X.1 Radiation Mitigation for Human Spaceflight
- X.2 Lightweight and Multifunctional Materials and Structures
- X.3 Environmental Control and Life Support System
- X.4 Guidance, Navigation, and Control
- X.5 Entry, Descent, and Landing Thermal Protection Systems

X = cross cuts several Technology Areas in the roadmaps

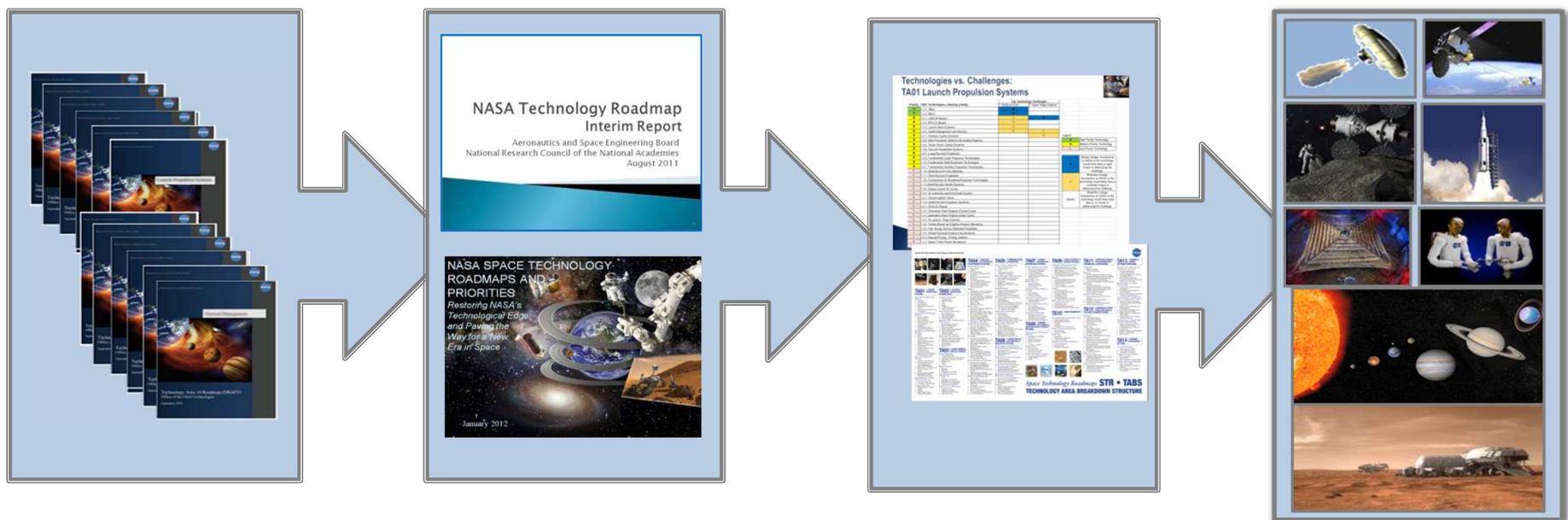
# NRC Report on NASA's Space Technology Roadmaps



- The NRC study was released on February 1. It is a comprehensive report with important observations, analyses and priorities, including
  - Currently, available technology is insufficient to accomplish many upcoming missions in Earth orbit and beyond.
  - Success in executing future NASA space missions will depend on advanced technology developments that should already be underway.
  - NASA's technology base is largely depleted. So, revitalizing technology investment at NASA is required if NASA is to achieve the challenges before it.
  - Technological breakthroughs have been the foundation of virtually every NASA success. In addition, technological advances have yielded benefits far beyond space itself in down-to-Earth applications.
  - Future U.S. leadership in space requires a foundation of sustained technology advances.
  - The NRC concurs with the design of NASA's new Space Technology Program, with its cross cutting technology projects that span a range of technical maturity and include flight demonstrations.
- The NRC study emphasized 16 high-priority technology areas. NASA is currently investing in all 16 at some level.
- This assessment will help guide NASA's technology investment priorities in the years to come, working across the agency to address the findings.



# Strategic Perspectives and Process



## What NASA could do

- Draft ST Roadmaps:**
- 140 technical challenges (10 per roadmap)
  - 320 technologies
  - 20 year horizon

## What NASA should do

- NRC ST Roadmaps Study:**
- Gives priority to:
- 100 top technical challenges
  - 83 high priority technologies (roadmap-specific)
  - 16 highest of high technologies (looking across all roadmaps)
  - Immediate 5 year horizon

## What NASA is doing

- Updated ST Roadmaps:**
- Incorporate NRC Study Results
  - Update with Mission Plans and Technological Developments
- Internal Assessment to create Strategic Plan:**
- Compare to Current Investments
  - Compare to Current Plans
  - Analyze Gaps

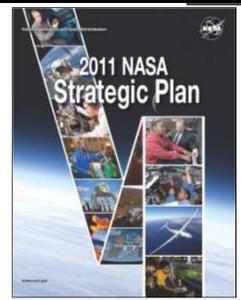
## What NASA will do

- Implement NASA Technology Portfolio Investments**
- Technology Developments (across full TRL spectrum)
  - Flight Demonstrations
- Must reflect:**
- Affordability
  - Technical Progress and Performance
  - Mission Needs and Commitments
  - Stakeholder Guidance



# Strategic Perspectives and Process

NASA Strategic Plan



NASA's

- Current Technology Investments
- MD Technology Priorities
- Budget Constraints
- Center Capabilities/Facilities

Strategic Technology-Investment Plan

NASA Space Technology Roadmaps



NRC Roadmap Analysis & Priorities



and Other Govt. Agency Partnership Opportunities



ations

HEOMD

SMD

STP



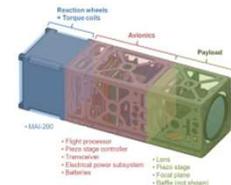
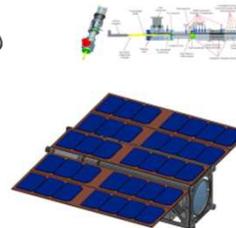
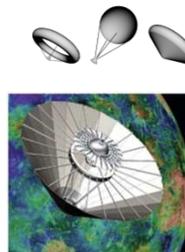
# Space Technology Research Grants Program Overview

**PROGRAM:** To accelerate the development of push technologies through innovative efforts with high risk/high payoff and develop the next generation of innovators through:

- **Space Technology Research Opportunities** – Early Stage Innovation (STRO-ESI): technology portfolio of groundbreaking research in advanced space technology
- **NASA Space Technology Research Fellowships (NSTRF):** Competitive selection of U.S Citizen / permanent resident graduate students developing promising technologies in support of future NASA missions and strategic goals

## ACCOMPLISHMENTS/MILESTONES (FY 2012/2013):

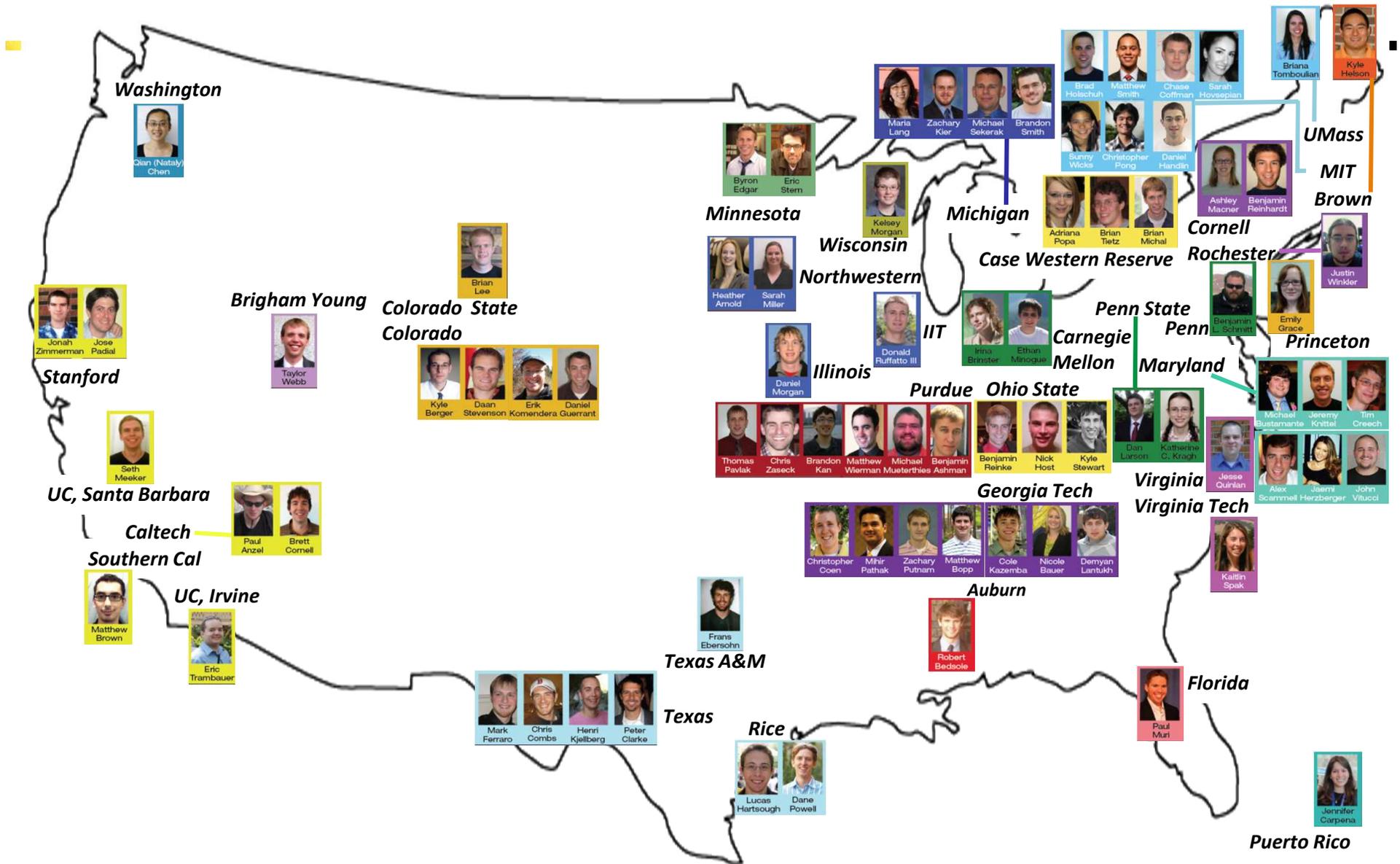
- STRO-ESI: One year awards with possible renewals; ~\$200K/year
- NSTRF: 80 Fellows in inaugural class; NSTRF12 class will be announced ~ August 2012



# National Asset: The Inaugural Class of NSTRF



80 Students - 37 Universities - 22 States and U.S. Territories



# The Solicitation – *Application Components*



*The student shall be the principal author of the Educational Research Area of Inquiry and Goals, with minimal assistance from the current/prospective faculty advisor.*

1

## **Educational Research Area of Inquiry and Goals**

- summary of educational program objectives
- research interests with associated relevant hypotheses and possible approaches
- benefits of proposed research
- benefits of on-site R&D lab experience



2

## **Schedule of degree program**

- proposed start and completion dates
- anticipated milestones

4

## **Statement from faculty advisor (one page)**

- planned use of faculty advisor allowance
- If applicable, brief description of ongoing or pending research awards from NASA that are related to the student's Educational Research Area of Inquiry and Goals.

6

## **Transcripts**

- undergraduate
- graduate

3

## **Curriculum Vitae (one page)**

- faculty advisor
- student

5

## **Three signed letters of recommendation**

- from academic advisor
- from other faculty members or professionals with detailed knowledge of student's abilities

7

## **GRE general test scores**

# Application Evaluation and Selection

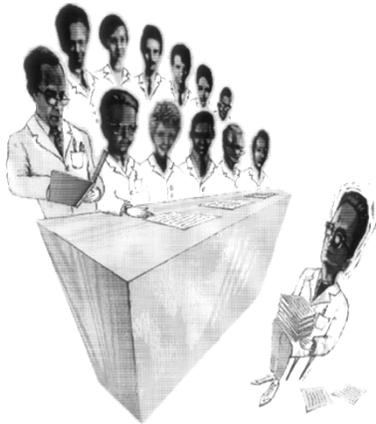


All eligible fellowship applications will undergo a review by technical experts.

## Criteria for Evaluation

**Merit** of the Applicant's Proposed Educational Research Area of Inquiry and Goals

- technical merit as appropriate to the candidate's educational level
- research area description, knowledge of relevant research literature and plans for student/advisor/mentor partnership



**Relevance** of the proposed research to NASA's Space Technology Roadmaps

**Academic excellence and Potential**

- Organizational and analytical skills
- scientific curiosity, creativity, acumen, and success in research appropriate to his/her educational level

**NOTE:** Subsequent to the technical review, candidates deemed excellent will be submitted to the Office of the Chief Technologist at NASA Headquarters for final consideration and selection.





# Annual Award Values



Category	Maximum value *
Student Stipend	\$36,000
Faculty Advisor Allowance	\$9,000
On-site NASA Center/R&D lab experience Allowance	\$10,000
Health Insurance Allowance	\$1,000
Tuition and Fees Allowance	\$10,000
<b>TOTAL</b>	<b>\$66,000</b>

\* from NSTRF12 solicitation



- A fellowship award is issued as a training grant to the student's host university.
- Separate from the awards, the Program has allocated resources to cover mentor time and costs associated with hosting/interacting with the Fellow.
- Open Opportunities are advertised via NSPIRES  
<http://nspires.nasaprs.com/external/>

# Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR)



- **PROGRAM:** Stimulate technological innovation and support NASA's innovative research to develop technologies for NASA projects while spurring economic growth through commercialization.
- **ACCOMPLISHMENTS/MILESTONES (FY 2012/2013):**
  - Selected 260 SBIR Phase 1 proposals selected across 37 states and 85 SBIR Phase 2 proposals selected across 26 states\*
  - Selected 40 STTR Phase I proposals selected across 18 states\*
  - STTR Phase 2 selections expected in April 2012
  - Expect to award Phase 2E awards in FY 2012
  - Working with Small Business Administration (SBA) to assess implementation of new requirements in recent SBIR/STTR Reauthorization. Expecting Policy Guidelines from SBA in accordance with schedule from reauthorization.

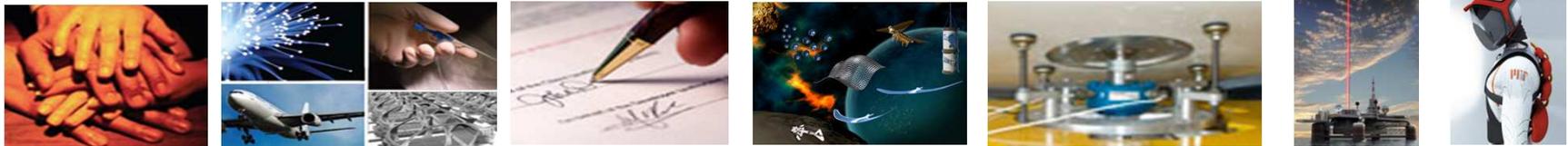


\*Selections still undergoing contract negotiations

# NASA Innovative Advanced Concepts (NIAC) Program Overview



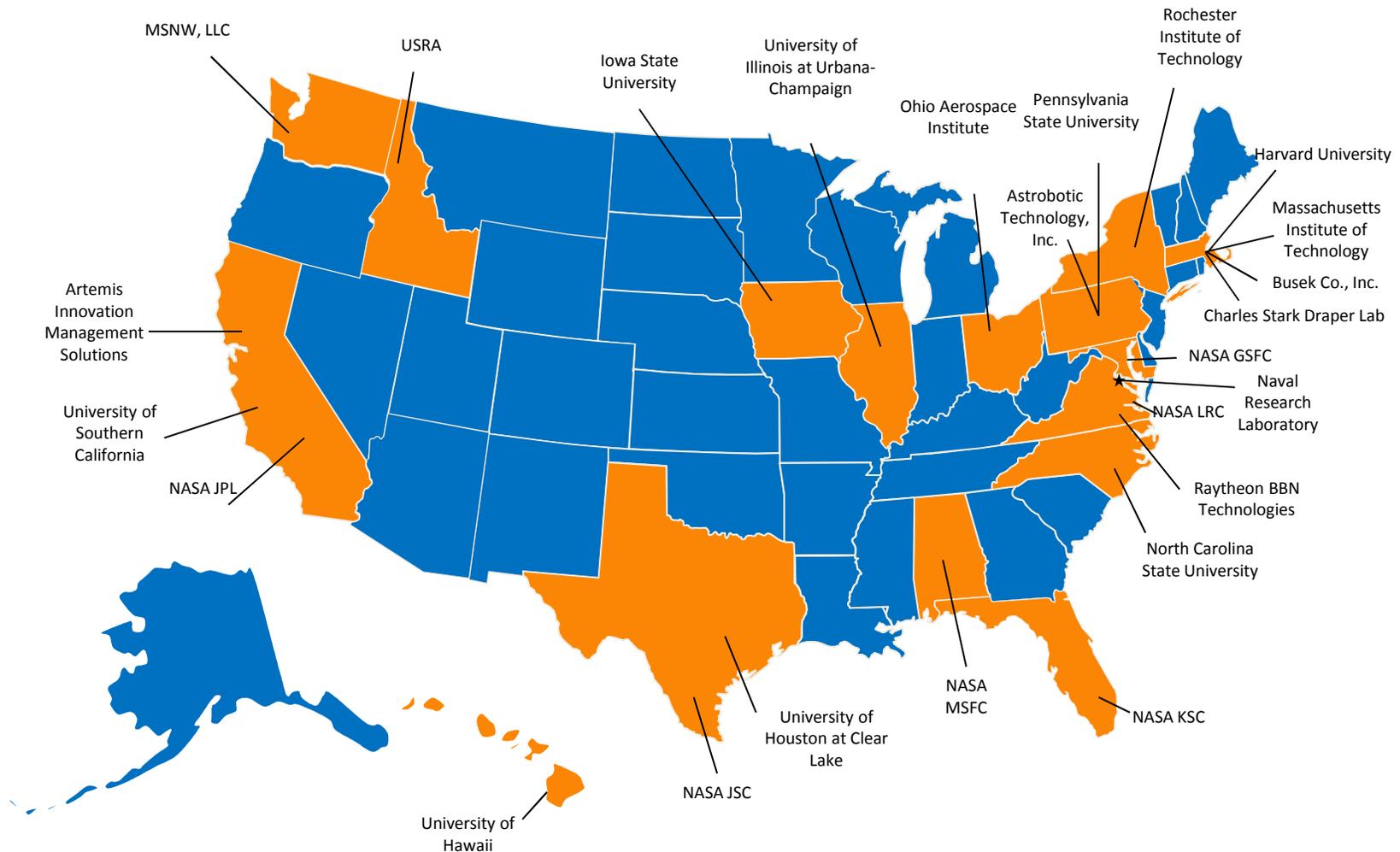
- **PROGRAM: NASA Innovative Advanced Concepts (NIAC)** funds early studies of visionary, long term concepts - aerospace architectures, systems, or missions (not focused technologies). The intended scope is very early concepts: Technology Readiness Level 1-2 or early 3; 10+ years focus
- **ACCOMPLISHMENTS/ MILESTONES (2012-2013):**
  - Jan 9 -- NIAC Phase I NRA released
  - March 27-29 -- NIAC Spring Symposium in Pasadena, CA
  - April 3 -- NIAC Phase II NRA released
  - July -- announce Phase I and II selections
  - Sept 1 -- FY12 studies (Phase I and II) commence
  - Sept 30 -- FY11 final reports due



# NIAC: Funding Innovation across the Nation



Exploring new concepts to expand aerospace possibilities



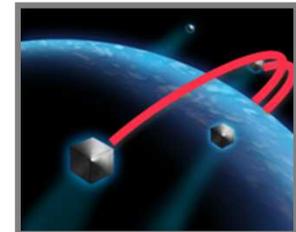
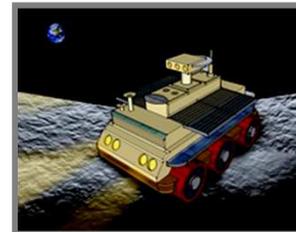


# Centennial Challenges

**PROGRAM:** The Centennial Challenge Program (CCP) directly engages non traditional sources advancing technologies of value to NASA's missions and to the aerospace community. CCP offers challenges set up as competitions that award prize money to the individuals or teams to achieve the specified technology challenge.

## **ACCOMPLISHMENTS/MILESTONES (FY 2012/2013):**

- Green Flight Challenge awarded the largest ever aviation prize for demonstration of over 400 mpg energy efficiency in a full scale, piloted, electric powered aircraft.
- Sample Return Robot Challenge will host a competition in June 2012 to demonstrate a that a robot that can locate and retrieve geologic samples from a wide and varied terrain without human control.
- In FY 2013 the Night Rover Challenge will have a competition to demonstrate a high energy density storage systems that will enable a rover to operate throughout lunar darkness cycle and the Nano-Satellite Challenge will have competitions to demonstrate placement of at least one small satellite into Earth orbit, twice within one week.



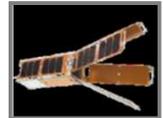
# Edison Small Satellite Demonstration Missions and Flight Opportunities Program Overview



**EDISON SMALL SATELLITE DEMONSTRATION MISSIONS PROGRAM:** Low-cost flight demonstrations of new capabilities and technologies for small spacecraft.

- **ACCOMPLISHMENTS/MILESTONES (FY 2012/2013):**

- Preparing PhoneSat 1.0 for launch in Summer 2012 demonstrating use of commercial smart phones for onboard satellite navigation, control and communications
- Began development of EtherSat mission to demonstrate capabilities of satellite swarms for a range of missions projected launch in 2013
- Released open solicitation for proposed small spacecraft demonstration missions for communications, propulsion and proximity operations
  - Selecting projects for award in August 2012
  - 2 to 3 year projects, up to \$15 million per project



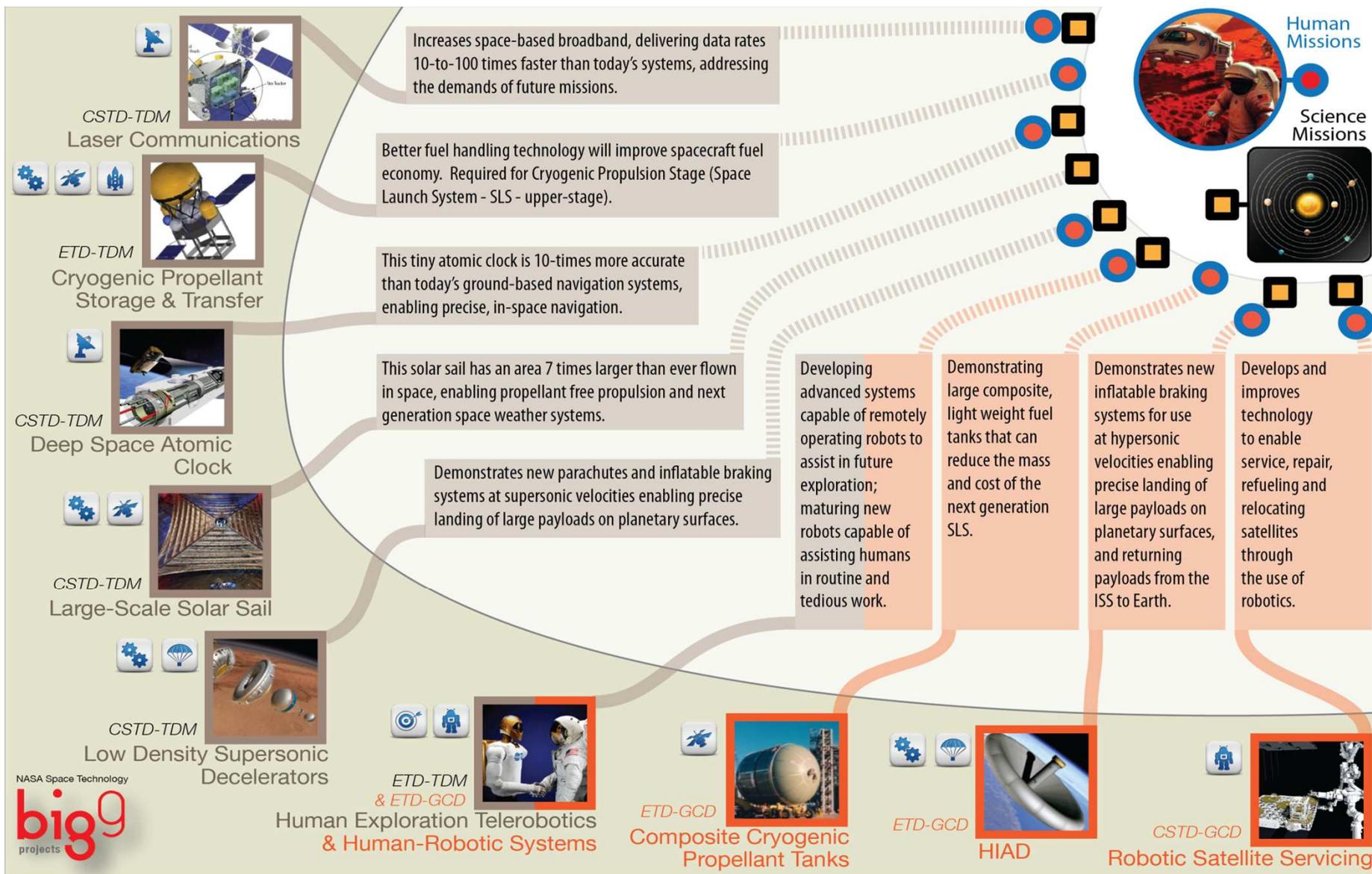
**FLIGHT OPPORTUNITIES PROGRAM:** Develops and provides opportunities for space technologies to be demonstrated and validated in relevant environments. Fosters the development of the commercial reusable suborbital transportation industry.

- **ACCOMPLISHMENTS/MILESTONES (FY 2012/2013):**

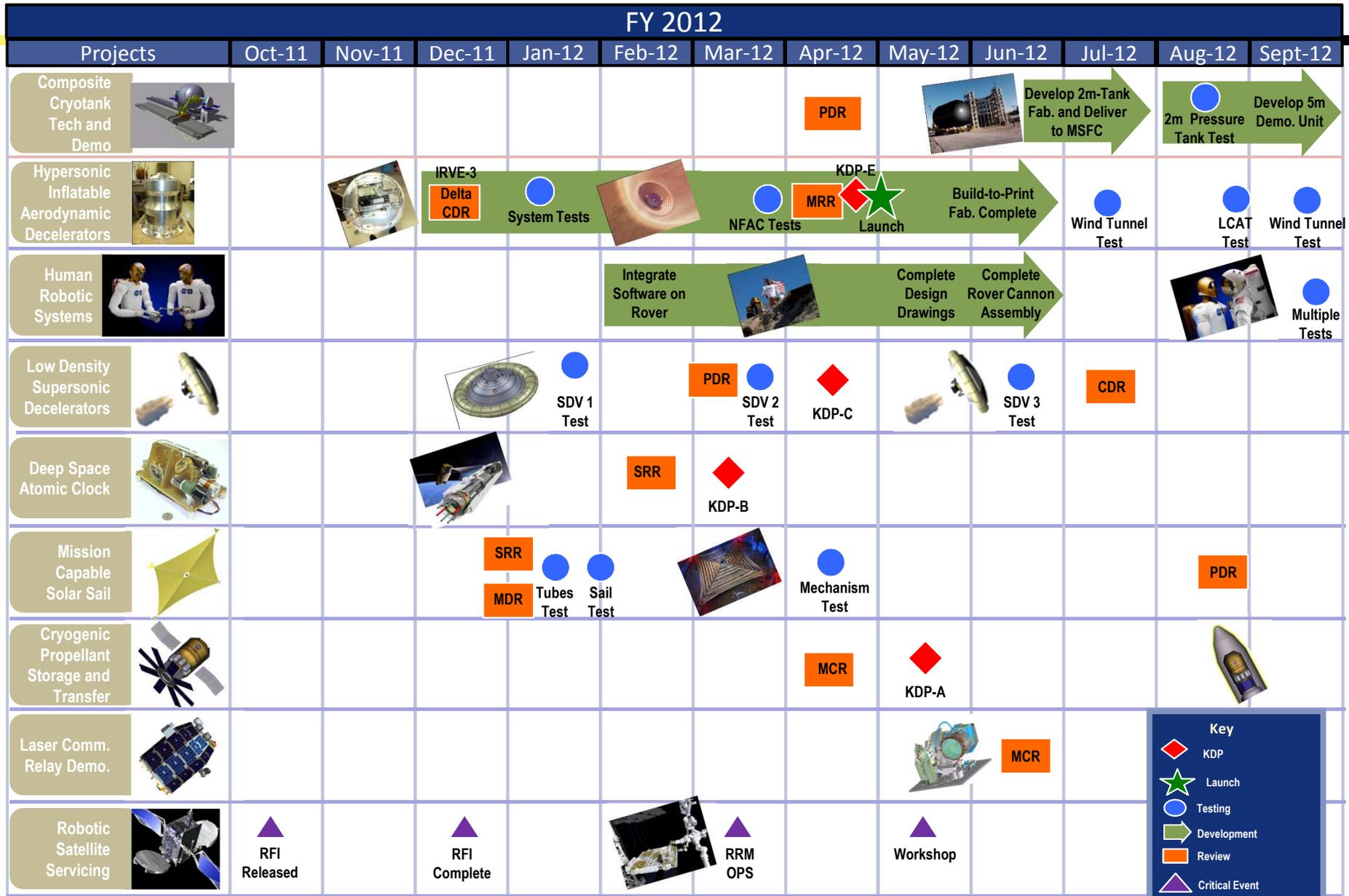
- Establishing a pipeline of technology payloads to utilize the anticipated commercial suborbital flight opportunities
  - Received 35 proposals for payloads in response to payload solicitation
  - Collaborating with Game-Changing Development Program to release NASA Research Announcement for payload development
- Planned commercial flight opportunities
  - Three Parabolic Flight Campaigns
  - Flights on Masten Space Systems, Near Space Corp, UP Aerospace, and Virgin Galactic
  - Qualification flights of Armadillo Aerospace, Whittinghill Aerospace, and XCOR Aerospace
- Formed Partnership with New Mexico Space Grants for flying Student Payloads
- Development of Commercial Vertical Testbed
  - Integration of Draper Labs Technology on Masten Space Systems' Vehicle
  - Successfully completed a free-flight demonstration



# Big Nine Projects



# "Big 9" FY 2012 Milestones



**Key**

-  KDP
-  Launch
-  Testing
-  Development
-  Review
-  Critical Event

National Aeronautics and  
Space Administration



[www.nasa.gov/oct](http://www.nasa.gov/oct)

Office of the Chief Technologist

# Acronyms



- CDR – Critical Design Review
- Comm. – Communications
- Demo. – Demonstration
- DVT – Design Verification Test
- Fab. – Fabrication
- KDP – Key Decision Point
- LCAT – Large Core Arc Tunnel
- M – Meter
- MCR – Mission Control Review
- MRR – Mission Readiness Review
- MSFC – Marshall Space Flight Center
- NFAC – National Full-Scale Aerodynamics Complex
- PDR – Preliminary Design Review
- RFI – Request For Information
- RRM – Robotic Refueling Mission
- SRR – Systems Requirements Review
- TBD – To Be Determined
- Tech. – Technologies