Overview of NASA’s Space Technology Mission Directorate
to VEXAG

Presented by:
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Program Executive for the Game Changing Development Program

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Why invest in Space Technology?

- Enables a **new class of NASA missions** beyond low Earth Orbit.
- **Delivers innovative solutions** that dramatically improve technological capabilities for NASA and the Nation.
- Develops technologies and capabilities that make NASA’s missions **more affordable and more reliable**.
- Invests in the economy by **creating markets and spurring innovation** for traditional and emerging aerospace business.
- **Engages the brightest minds** from academia in solving NASA’s tough technological challenges.

**Value to NASA**

**Value to the Nation**

**Addresses National Needs**

A generation of studies and reports (40+ since 1980) document the need for regular investment in new, transformative space technologies.

**Who:**

- The NASA Workforce
- Academia
- Industry & Small Businesses
- Other Government Agencies
- The Broader Aerospace Enterprise
Challenges for Deep Space Exploration

- Communication
- Navigation
- Radiation Mitigation
- Environment Control & Life Supporting Systems
- Manufacturing In Space & For Space
- Power Generation & Storage
- Propulsion
- Logistics
- Entry, Descent & Landing
Trends in Space Technology

Small Spacecraft

Entry, Descent & Landing

Propulsion

Robotics

Manufacturing

Communications
## STMD Senior Leadership

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<td>Deputy Associate Administrator for Management</td>
<td>Dorothy Rasco</td>
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<td>Deputy Associate Administrator for Programs</td>
<td>James Reuther</td>
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<td>Director for Communications and Operations / Chief of Staff</td>
<td>G. Michael Green</td>
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<td>Director for Resource Management</td>
<td>Robert Carver</td>
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<td>Director for Strategic Integration and Analysis</td>
<td>Prasun Desai</td>
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<td>Senior Technical Officer</td>
<td>Harry Partridge</td>
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<td>Executive Officer</td>
<td>Natalie Simms</td>
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<td>Program</td>
<td>Program Executive</td>
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Space Technology Portfolio

- Game Changing Development (ETD/CSTD)
- Technology Demonstration Missions (ETD/CSTD)
- Small Spacecraft Technologies (CSTD)
- Space Technology Research Grant (CSTD)
- NASA Innovative Advanced Concepts (NIAC) (CSTD)
- Center Innovation Fund (CSTD)
- Centennial Challenges Prize (CSTD)
- Small Business Innovation Research & Small Business Technology Transfer (SBIR/STTR)
- Flight Opportunities Program (CSTD)
Space Technology Program Attributes

- **Adheres to a Stakeholder Based Investment Strategy**: NASA Strategic Plan, NASA Space Technology Roadmaps / NRC Report and Strategic Space Technology Investment Plan (SSTIP)
- **Invests in a Comprehensive Portfolio**: Covers low to high TRL, student fellowships, grants, prize competitions, prototype developments, and technology demonstrations
- **Advances Transformative and Crosscutting Technologies**: Enabling or broadly applicable technologies with direct infusion into future missions
- **Merit Based Competition**: Research, innovation and technology maturation open to academia, industry, NASA centers and other government agencies
- **Executes with Structured Projects**: Clear start and end dates, defined budgets and schedules, established milestones, and project authority and accountability.
- **Informed Risk Taking**: Rapid cadence of technology maturation and infusion, informed risk tolerance to infuse as quickly as possible
- **Positions NASA at the cutting edge of technology**: Results in new inventions, enables new capabilities and creates a pipeline of innovators for National needs
Space Technology Technical Areas

- LAUNCH PROPULSION SYSTEMS
- IN-SPACE PROPULSION TECHNOLOGIES
- SPACE POWER & ENERGY STORAGE
- ROBOTICS, TELE-ROBOTICS & AUTONOMOUS SYSTEMS
- COMMUNICATION & NAVIGATION
- HUMAN HEALTH, LIFE SUPPORT & HABITATION SYSTEMS
- HUMAN EXPLORATION DESTINATION SYSTEMS
- SCIENCE INSTRUMENTS, OBSERVATORIES & SENSOR SYSTEMS
- ENTRY, DESCENT & LANDING SYSTEMS
- NANOTECHNOLOGY
- MODELING, SIMULATION, INFORMATION TECHNOLOGY & PROCESSING
- MATERIALS, STRUCTURES, MECHANICAL SYSTEMS & MANUFACTURING
- GROUND & LAUNCH SYSTEMS PROCESSING
- THERMAL MANAGEMENT SYSTEMS
FY2014 Big Nine

Increases space-based broadband, delivering data rates 10- to 100-times faster than today's systems, addressing the demands of future missions.

Better fuel handling technology will improve spacecraft fuel economy. Required for Cryogenic Propulsion Stage (Space Launch System - SLS - upper-stage).

This tiny atomic clock is 10-times more accurate than today's ground-based navigation systems, enabling precise, in-space navigation.

This solar sail has an area 7 times larger than ever flown in space, enabling propellant-free propulsion and next generation space weather systems.

Develops and demonstrates green propellants, thus provides an alternative to highly corrosive and toxic hydrazine; consequently expanding the capabilities of small spacecraft systems.

Developing advanced systems capable of remotely operating robots to assist in future exploration; maturing new robots capable of assisting humans in routine and tedious work.

Develops large-scale solar array panels and deployment mechanisms. Critical step on the development path to a high-power solar electric propulsion system.

Demonstrating large composite, light weight fuel tanks that can reduce the mass and cost of the next generation SLS.

TDM Laser Communications
TDM Cryogenic Propellant Storage & Transfer
TDM Deep Space Atomic Clock
TDM Large-Scale Solar Sail
TDM Low Density Supersonic Decelerators
TDM Green Propellants
Human Exploration Telerobotics & Human-Robotic Systems
TDM Solar Electric Propulsion
GCD Composite Cryotank
Evaluating current STMD investments as recommended by the Strategic Space Technology Investment Plan (SSTIP)

- Initial evaluation is consistent with the Core, Adjacent, and Complementary recommendations
- Approximately > 65% of investments are in Core areas
- STMD has investments in all 14 TAs (Technology Areas)
- Approximately 10% of investments are low TRL (1-3) consistent with the recommendation by the National Research Council (NRC) Final Report on Space Technology Roadmaps and Priorities

STMD investments are consistent with the Strategic Space Technology Investment Plan (SSTIP)
Currently, significant engagements include:

- Green Propellant Infusion Mission partnership with Air Force Research Laboratory propellant and rideshare with DoD’s Space Test Program (STP)
- Solar Sail Demonstration partnership with NOAA and rideshare with Air Force
- Soldier-Warfighter Operationally Responsive Deployer for Space (SWORDS) low-cost nano-launch system with Army
- UAS Airspace Operations Prize Challenge coordinated with FAA
- Working with the USAF Operationally Responsive Space Office (ORS) for launch accommodations for the Edison Demonstration of Smallsat Networks (EDSN) mission.
- Partnership for Ohio’s first hydrogen generating fueling station with Greater Cleveland Regional Transit Authority to power city bus
- Partnership with DARPA on “Next Generation Humanoid for Disaster Response”
- In discussion with Department of Veteran Affairs for a collaborative project with “Exoskeleton” from our Human Robotics Systems Program
NASA Space Technology:  *Tapping into the future through student engineers and technologists across the Nation*

With over 350 activities in over 100 U.S. Academic Institutions, Space Technology is actively developing the Nation’s technological leadership.
Space Technology Mission Directorate

Technology Readiness Levels - Technology Maturation

- Technology Demonstration Missions (TDM)
- Small Spacecraft Technology (SST)
- Flight Opportunities (FO)
- Centennial Challenges (CC)
- Game Changing Development (GCD)

- SBIR/STTR
  - Center Innovation Fund (CIF)
  - NASA Innovative Advanced Concepts (NIAC)
  - Space Technology Research Grants (STRG)

TRL Ranges of Programs

TRL 1
TRL 2
TRL 3
TRL 4
TRL 5
TRL 6
TRL 7

GCD

TDM
SST
FO

SBIR CIF NIAC STRG
New Hardware in Advancing Space Technology

- Cryogenic tank
- Composite Strut Structural Testing
- Low Density Supersonic Decelerator Proof Test
- MSL heatshield with instrumentation
- Green Propellant 22N thruster
- Telerobotic Systems
- Additive Manufacturing
- Inflatable Re-entry Vehicle Experiment
- Solar Sail and Boom Fab
- Deep Space Atomic Clock
- BIRD focal plane arrays
- Exoskeleton
Technology Demonstration and Testing

- Reduced Liquid Hydrogen boil off test
- Mike Fossum with Smart SPHERES checkout
- R2 using air flow meter
- ARC Jet Testing
- Low Density Supersonic Decelerator Sled Test
- K10 rover deploying polyimide film
- LCAT Stagnation Test (50 W/cm²)
- MSL Launch and MEDLI measurements successfully completed
X1 or Exoskeleton will improve life on Earth and in space

Arrival and testing of 2.4m precursor tank, the largest out-of-autoclave tank fabricated in the world

Space Power Systems
First build of flight-like battery cells

SWORDs model for wind tunnel testing at NASA MSFC

Launch of IRVE-3 – successful suborbital test of 3m HIAD

Successful test of a hands-free jet pack

Nuclear Systems delivered the Fission Power System Technology Demonstration Unit (TDU) Reactor Simulator

Next Gen Life Support Engineer Marlon Cox, with one of the Variable Oxygen Regulators
• HIAD – Hypersonic Inflatable Aerodynamic Decelerators

• DACC – Deployable Aeroshell Concepts – Conformal TPS

• Woven TPS

• Hypersonics
Working Together to Innovate