Space Technology Pipeline

Game Changing Development
- Game Changing Development Program
- SBIR Program Phase III

New Technology Partners
- Flight Opportunities Program
- Centennial Challenges Program
- Small Spacecraft Technologies Program

Early Stage
- NASA Innovative Adv Concepts Program
- Space Tech Research Grants Program
- Center Innovation Fund Program
- SBIR Program Phases I & II

Low TRL

Mid TRL

High TRL

Technology Demonstrations
- Technology Demonstration Missions Program
• Alignment with NASA mission needs
  – Human Exploration and Operations Mission Directorate near- and long-term priorities
  – Science Mission Directorate technology development partnerships
  – Aeronautics Research Mission Directorate technology investments

• Supporting commercial space technology needs
  – Cross-cutting technologies of significant benefit to industry
  – Potential for public / private partnerships

• Promoting early-stage technologies and innovations
  – Strengthening NASA relationships with academia
  – Leveraging small business and NASA center innovation

• Engaging emerging space technology partners and businesses
  – Challenge competitions and public / private partnerships with new partners
  – Partnerships with other government agencies
• NASA Innovative Advanced Concepts
  – System-level concept studies of visionary ideas for radically better or entirely new aerospace concepts

• Space Technology Research Grants
  – Engage academic researchers (students & faculty) in accelerating development of low-TRL technologies

• Small Business Innovation Research / Small Business Technology Transfer
  – Participation in government-sponsored R&D by small, high-tech companies and research institutions

• Center Innovation Fund
  – Stimulate and encourage creativity and innovation within NASA Centers

• Game Changing Development
  – Rapidly mature innovative, high-impact capabilities and technologies

• Centennial Challenges
  – Offer incentive prizes to generate revolutionary solutions from diverse sources to problems of interest

• Flight Opportunities
  – Develop and provide suborbital flight opportunities to validate technologies in relevant environments

• Small Spacecraft Technology
  – Develop and demonstrate new capabilities employing the unique features of small spacecraft

• Technology Demonstration Missions
  – Conduct subsystem-level ground and flight demonstrations validating technologies for mission infusion
Selected Current STMD Projects Potentially Related to Venus Exploration

• **Space Technology Research Grants**
  – Robust electrical contacts for sensors and electronics in space flight
  – Micro-scale gallium nitride pressure sensors for advanced harsh environment space technology
  – Guidance and control for entry vehicles with deployable hypersonic decelerators

• **Small Business Innovation Research / Small Business Technology Transfer**
  – Venus altitude cycling balloon
  – Measurement of trace gases in the atmosphere of Venus
  – High temperature Venus drill and sample delivery system
  – Low power nonvolatile memory for extreme environments
  – Harsh environment gas sensor array for Venus atmospheric measurements
  – Extreme environment sampling system deployment mechanism
  – Extreme environment hybrid gearbox technology
  – Extreme environment ceramic-to-metal seal
  – Wide temperature DC link capacitors for aerospace power electronics
  – Radiation / temperature hardened advanced readout array with dynamic power modes
  – Physics-based modeling tools for life prediction and durability assessment of advanced materials

• **Center Innovation Fund**
  – New power sources for Titan and Venus surface missions (JPL Workshop)

• **Game Changing Development**
  – Adaptive deployable entry and placement technology (ADEPT)
  – Heat shield for extreme entry environment technology (HEEET)
  – Hypersonic inflatable aerodynamic decelerator (HIAD)
  – Deep space optical communication
Selected Completed STMD Projects Potentially Related to Venus Exploration

• NASA Innovative Advanced Concepts
  – Venus landsailing rover

• Space Technology Research Grants
  – Robust electrical contacts for sensors and electronics in space flight
  – Micro-scale gallium nitride pressure sensors for advanced harsh environment space technology
  – Guidance and control for entry vehicles with deployable hypersonic decelerators

• Small Business Innovation Research / Small Business Technology Transfer
  – Aerogel insulation for the thermal protection of Venus spacecraft
  – Brushless DC motor and resolver for Venusian environment
  – Harsh environment gas sensor array for Venus atmospheric measurements
  – High temperature acid resistant balloon
  – High temperature all silicon carbide DC motor drives for Venus exploration vehicles
  – High temperature battery for in situ exploration of Venus
  – High Temperature capacitors for Venus exploration
  – High temperature telemetry transmitter for Venus exploration
  – Sapphire viewports for a Venus probe
  – Solid state vacuum device extreme temperature electronics for planned Venus missions
  – Thermal management system for long-lived Venus landers
  – Thermoacoustic duplex technology for cooling and powering a Venus lander

• Center Innovation Fund
  – Transformable entry system technology applicability to robotic Venus science missions
  – Innovative concept for Venus surface cooling system using atmospheric reformation
  – Woven TPS – a revolutionary approach to tailorable TPS design & manufacturing
Potential STMD Entry Points for Venus Exploration Community

• Engage STMD Principal Technologists in formulating new projects
  – Nine full-time technical experts and advocates covering nearly all of the space technology landscape
  – Their main role is developing and reviewing investment strategies across the full TRL pipeline

• Utilize Space Tech Research Grants program to engage the academic community
  – NASA Space Technology Research Fellowships for graduate students
  – Early Career Faculty awards via annual solicitations in specific topic areas
  – Early Stage Innovations awards via annual solicitations in specific topic areas

• Develop specific SBIR / STTR topics in conjunction with SMD and STMD

• Formulate targeted Centennial Challenge project focused on key capability

• Pursue Game Changing Development program solicitations on specific technologies

SMD advocacy for new Venus-related solicitations would be critical and co-funding would be highly desirable
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**Space Technology Strategic Themes**

**Get There**
Improve the ability to efficiently access and travel through space

**Land There**
Enable the capability of landing more mass, more accurately, in more locations throughout the solar system

**Live There**
Make it possible to live and work in deep space and on planetary bodies

**Observe There**
Transform the ability to observe the universe and answer the profound questions in Earth and space sciences

**Invest Here**
Enhance the nation’s aerospace capabilities and ensure its continued technological leadership