Venus Exploration Technologies and Opportunities through the NASA Small Business Innovative Research (SBIR) and Small Business Technology Transfer Research (STTR) Program B.R. Cogan NASA SBIR/STTR Program(bruce.rcogan@nasa.gov

Introduction: The NASA Small Business Innovative Research (SBIR) and Small Busines Technology Transfer (STTR) programs have awarded over $3.75 billion dollars to research-intensive American Small businesses. The primary mission of the SBIR/STTR program is to empower small businesses to deliver technological innovation that contributes to NASA's missions, provides societal benefit, and grows the U.S. economy.

The NASA SBIR/STTR program accomplishes its mission with an annual solicitation for new, innovative, technologies to support all of NASA's missions. Focus is on future mission needs that may not be currently funded by NASA. Small business success is defined as technology infusion into a NASA project and/or non-NASA commercialization of the technology.

Planetary Exploration has been a key focus of many SBIR/STTR solicitations, primary for the Science Mission Directorate (SMD) and STTR subtopics. Several technologies developed under the SBIR/STTR program are on the Perseverance Mars rover. Several previous SBIR technologies related to lunar exploration were granted additional funding under the SBIR Lunar sequentials program to enable rapid development to meet NASA Moon to Mars program, goals.

For missions in the more distant future such as Venus, Titan, Europa, Neptune, Pluto and others, the NASA SBIR programs allows technology development early in the process even prior to mission formation and funding Hostile environments, long distances, increased autonomy, sensors for new science goals and Earth based test environments may require long development cycles to raise technology readiness levels (TRL) so that the technology can be proposed for future missions.

Since 1994, over 50 SBIR/STTR contracts were awarded to small businesses to develop technologies for Venus exploration. Currently over 15 Venus related SBIRs are still active. Technologies being developed include sensors, UAVs, high temperature electronics, cooling systems, batteries, balloons, cameras, radios, insulation, landers, motors, and others. These are all funded by the NASA SBIR/STTR program and could be utilized on future Venus missions.

For future Venus and other planetary missions, the NASA SBIR/STTR program can be utilized in several ways including solicitation development, administration of Phase 1 and Phase 2 contracts, infusion into future missions and utilization of previously developed SBIR/STTR technologies.

Under solicitation development technologies required for future missions are identified and written into an SBIR/STTR subtopic. The solicitation will be sent to small businesses who will develop proposals addressing the technology needs. They are then reviewed and selected by NASA Subject Matter Experts who have identified the future technology needs.

Once a Phase 1 or Phase 2 contract is awarded, engagement of NASA and other planetary mission developers is critical in developing the end technology. Besides monitoring the progress of the contract, inputs on science goals and instrumentation, concepts of operations, information on test capabilities and new missions being developed.

Infusion of SBIR/STTR technologies into future missions will enable the technology development to continue. The NASA SBIR/STTR has several initiatives to provide matching funds to encourage infusion investments. Other NASA programs such as NASA Flight Opportunities also allow increase of TRL of SBIR/STTR technologies.

Finally, utilization of technologies developed under previous SBIR/STTR contracts should also be considered. These technologies may not have been infused at the time but could be relevant to more recent missions being developed. The NASA SBIR/STTR Program Office can provide information, reports, and points of contact for previous Phase 1 and Phase 2 contracts.

By utilizing the NASA SBIR/STTR program, technologies required to support future missions to Venus and other planets can be developed early on utilizing NASA SBIR/STTR resources. This will ensure the TRL of the required technology is high enough to be included during mission formulation.