INCREASED SCIENCE INSTRUMENTATION FUNDING STRENGTHENS MARS PROGRAM

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Introduction: As the strategic knowledge gaps mature for the exploration of Mars, Mars sample return (MSR), and Phobos/Deimos missions, one approach that becomes more probable involves smaller science instrumentation and integrated science suites. Recent technological advances provide the foundation for a significant evolution of instrumentation; however, the funding support is currently too small to fully utilize these advances. We propose that an increase in funding for instrumentation development occur in the near-term so that these foundational technologies can be applied. These instruments would directly address the significant knowledge gaps for humans to Mars orbit, humans to the Martian surface, and humans to Phobos/Deimos. They would also address the topics covered by the Decadal Survey [1] and the Mars scientific goals, objectives, investigations and priorities as stated by the MEPAG [2].

While multiple new instrumentation funding paths used to exist, several key planetary science funding paths have been consolidated to a single one, the Planetary Instrument Definition and Development Program. The most common funding paths used to include:

1) Planetary Instrument Definition and Development Program (PIDDP)
2) Astrobiology Science and Technology for Instrument Development (ASTID) Program
3) Mission Concept Development for Astrobiology Small Payloads (replacing ASTID)
4) Mars Instrument Development Project
5) Planetary Major Equipment (PME) program

However, The Mars Instrument Development Project and the Mission Concept Development for Astrobiology Small Payloads have been combined with the PIDDP (Fig. 1). The PIDDP actively supports the advancement of spacecraft-based instrument technology that show promise for use in scientific investigations on future planetary missions. The program has a history of producing key instruments for planetary science. Since 1980, approximately 50% of the science instruments flown beyond Earth orbit originated in the PIDDP including the ChemCam and CheMin instruments [3]. Unfortunately, the FY12 PIDDP budget has only $10.9 M, spread across 3 years and with an expected 10-15 instrument selections [4].

There are three primary areas of technology development that have or could potentially have a significant positive impact on instrumentation development. These areas are carbon nanotubes (CNT), microelectromechanical systems (MEMS), and nanoelectromechanical systems (NEMS). These three technologies

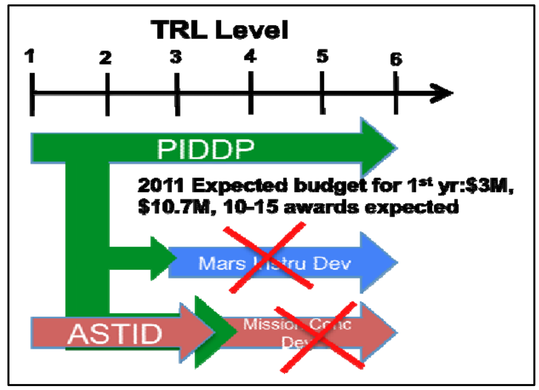

Figure 1: Planetary Science Instrumentation Development Programs and TRL Level

provide real opportunities for reduced size, mass, and power needs for the instruments themselves and, as a direct result, for the landing/orbiting vehicle and the size of the launch vehicle as well.

Some of these technologies have been successfully demonstrated in space, others such as NEMS, have yet to have significant experience in this environment. Future micro- or nano-instruments can thus be developed at the sub-millimeter level, or even smaller, and can either miniaturize current laboratory instrumentation or develop new instruments based on the functionality of the new technology. Application and demonstration of functions such as NEMS usage as a switch can thus become a reality.

There are 3 major reasons why an increase in scientific instrumentation development to the TRL 6 would be desirable.

1. Investigate specific scientific questions: Development of a variety of instrumentation allows for selection of a specific instrument or suite of complementary instruments to be flown to a selected landing site. This science analysis capability thus provides a "mix and match" approach to targeting specific questions for a site. The converse is also true. Other instrument(s) could be developed to provide a broad general investigation of the Mars environment, geology, compositional content, geophysical properties or even astrobiological questions.

Landed missions provide an excellent opportunity for discoveries such as detection of volatiles, identification of organic material, and detection of a biosignature. Appropriate science instrumentation on these missions allow for the identification of the best available samples for return to Earth or for discoveries that would interest and excite the general public.

2. Technology Development: Increasing funding for instrument development provides an excellent opportunity to develop a broad scope of new instruments, manufacturing methods, and technologies. Applications of these to terrestrial uses have the potential for benefit in many diverse areas and products.

An increase in development funding would also allow for broader participation from a more diverse group than currently exists. More organizations and/or teams of organizations would be interested in applying since the probability of selection may be increased.

3. Synergy with Human Exploration: Scientific investigations that directly address human exploration questions concerning Mars, Phobos, and Deimos would significantly reduce safety and mission success risks. Improved knowledge of the environment, operational constraints and *in-situ* demonstration would provide critical information to improve future crew safety and current mission success.

In addition, public interest in activities directly leading to human exploration of Mars, Phobos, and Deimos would also be a key benefit.

We argue that an increase of science instrumentation funding would be of great benefit to the Mars program as well as the potential for human exploration of the Mars system. If the total non-Earth-related planetary science instrumentation budget were increased 100% it would not add an appreciable amount to the overall NASA budget and would provide the real potential for future breakthroughs. If such an approach were implemented in the near-term, NASA would benefit greatly in terms of science knowledge of the Mars, Phobos/Deimos system, exploration risk mitigation, technology development, and public interest.

References: [1] Committee on the Planetary Science Decadal Survey N. R. C. (2011) Vision and Voyages for Planetary Science in the Decade 2013–2022. [2] MEPAG (2010) Mars scientific goals, objectives, investigations, and priorities: 2010. [3] Planetary Instrument Definition & Development Program (PIDDP), Johnathan Rall, May, 2008, [4] Technology Investments for Venus Exploration, Janice Buckner, Aug., 2012.