Sounding Rockets in the 21st Century – Strategic Enhancement of a Core Capability to Mitigate Risk and Cost in the NASA Vision for Space Exploration

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Stephan R. McCandliss – Ph.D.
Principal Research Scientist
Johns Hopkins University
3400 North Charles Street
Baltimore, MD 21218
Ph 410-516-5272
Fx 410-516-5494
stephan@pha.jhu.edu

This White Paper has been endorsed by:

Gregory Earle, Associate Professor of Phys. and E.E. – UT, earle@utdallas.edu
Philip J. Eberspeaker, Chief SRPO – WFF, Philip.J.Eberspeaker@nasa.gov
Paul D. Feldman, Professor of Physics and Astronomy – JHU, pdf@pha.jhu.edu
Dave Krause, Chief Engineer – NSROC/OSC, Krause_Dave@nsroc.net
Dan McCammon, Professor of Physics – UW, mccammon@wisp.physics.wisc.edu
Robert F. Pfaff, Jr, Ph.D. Chair SRWG – GSFC, Robert.F.Pfaff@nasa.gov
Douglas Rabin, Ph.D. Head Solar Physics Branch – GSFC, Douglas.Rabin@nasa.gov

As NASA embarks on its Vision for Space Exploration in the 21st century we wish to emphasize the role that sounding rockets have played in developing NASA science and technology programs of the 20th century and define the role they can play in the future.

Starting with Dr. Robert H. Goddard, sounding rockets have been used throughout the last century to provide small teams of experimenters with frequent low cost access to the upper atmosphere and lower reaches of space for science investigations utilizing innovative technology developed with an express purpose. These pioneering investigations served as the foundation for several new science disciplines that in turn became cornerstones of NASA's efforts to explore Earth and her Moon, the Sun and its planetary system, the stars, galaxies, and beyond.

Over the years a suite of highly reliable launch vehicles has been assembled with typical exo-atmospheric times on the order of 400 seconds. Similarly reliable modular support systems for providing telemetry, recovery, attitude-control, separation and despin, have been developed to streamline the process of payload flight qualification and to mitigate known risk. These systems are maintained by a commercial contractor with a willingness to enhance the current capability as the market demands. The ready availability of standardized and highly reliable support systems allows experimenters to concentrate on developing new science and the required technological innovations.

The relatively low costs of a suborbital mission (~ $2M) allow for the acceptance of risk in the development of the experiment, in exchange for experience that will produce flight tested hardware with high technology readiness levels (TRL of 7 or higher), and provide for an initial assessment of the science potential. These experiences work to speed the development of new technology and the attendant science return. The lessons learned from each flight become a valuable commodity in the later development of more sophisticated missions where the stakes are higher and risk is less acceptable.

Sounding rockets also provide unique opportunities for student participation in all phases of a NASA space mission, from concept to final analysis of the data, on a timescale commensurate with the length of a graduate education. Students who participate in the program, including undergraduates, are highly sought after. Their hands-on experience with cutting edge science and technology makes them extremely well suited to support and lead the next generation of NASA missions.

Explorer missions are often synergistic with sounding rocket programs. Explorers, with their 3 year development timescales and costs ~ $100M – 200M, are generally risk averse. They require hardware with TRL ≥ 7 and a ready pool of experienced personnel to be successful. The high costs associated with Explorer missions demand a focus on compelling new science, but these expensive opportunities are so few and far between that much compelling new science waits in the wings. It is often the case that Explorer missions are the only avenue for sounding rocket experimenters, who require more observing time than the seven minutes afforded by a typical flight, to fully realize the science potential of their new instrumentation. It is also often the case that much compelling new science can be accomplished in less than 3 years.

The heart of the problem is that improvements in the sophistication and capability of sounding rocket instrumentation have outpaced any effort to enhance the observing time provided by the delivery systems. Significant increases in science returned by sounding rockets could be achieved if a low cost means to increase observing time were available.

The Sounding Rocket Project Office (SRPO), in collaboration with the NASA Sounding Rocket Operations Contractor (NSROC), has undertaken a groundbreaking study where they identified a high altitude delivery system, costing ~ $5M, capable of delivering a 500 kg payload with a 1.25 m diameter to an altitude of 3000 km, and yield 40 minutes of exo-atmospheric time. For a relatively modest additional cost this system could be outfitted with a kick motor for placing a similar sized instrument into low-Earth orbit.

The SRPO, with its history of maintaining low costs through the use of standardized modular systems, in combination with the commercial interests of the NSROC, comprises an ideal partnership for developing an enhanced low cost delivery system. This team has already developed a technology roadmap to enable a test flight of a high altitude delivery system in three years, provided sufficient funding is made available.

It would be money well spent. A medium duration mission with an operational lifetime ~ an hour to weeks, would be an additional new tool for lowering the costs and risks associated with maturing space qualified science and technology. The acceptance of some risk in exchange for speeding the development of science and technical innovations will ultimately lower costs, while the use of a test-as-you-fly "proving space" will ultimately lower risk. This is as opposed to the current "proving ground" practice, which relies exclusively on exhaustive ground-based simulations to qualify flights systems.

Availability of a medium duration capability will allow for live space environmental testing of new mission critical systems required for facility class instruments like JWST, TPF, or SAFIR, which at present cannot be contemplated because of time constraints. Examples might include deployable segmented telescopes, formation flying interferometers, infrared cryogenic optics, or closed loop active optical systems.

A medium duration mission capability will lower development costs for the program's main customer, the Science Mission Directorate. It can perform the same service for the Exploration Mission Directorate, for example serving as a high velocity testbed for planetary aero-braking and landing systems, or crew escape vehicles.

The sounding rocket program is currently facing a budget shortfall and future cutbacks will greatly compromise the value of the program for space science and exploration. Failure to cover this shortfall will result in the loss to NASA of a core capability that has served it well in the past and can continue to do so in the future. We recommend that this program be provided funding to stabilize its current capability at a sustainable level. We further recommend that provision be made in the strategic roadmap to allow inclusion of a high altitude delivery system roadmap as defined by the SRPO and NSROC. We also suggest inclusion of a study for the migration of this system into a medium duration orbital delivery system. Now more than ever we need low cost access to space.