Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of June 3-4, 2015

Findings

1. Support for continuation of the Peregrine motor development

Summary

The development of NASA's Peregrine motor remains an extremely important activity for the program to pursue to completion. The SRWG believes that NASA should fully fund the continued development of the Peregrine. Full and successful completion of a new, cost effective, motor design including manufacture and test will secure NASA's future as the premier space agency for the launch of suborbital experiments, and minimize the susceptibility to mission failure due to motor combustion instabilities that exist with other motors.

Background

The Peregrine motor was initiated through a collaboration of the Marshall Space Flight Center, the NASA Engineering and Safety Center (NESC), the Wallops Flight Facility, and NASA Headquarters. This motor was developed on the premise that it would match the performance expectations of the Black Brant, attach to the same interfaces as the Black Brant, and eventually be a government furnished design to vendors that could bid on the development and manufacture of the motor. This initiative was meant to have several positive effects for the government: training of new personnel in the design, engineering, test and verification of rocket motors; development of a stable motor with a design owned by the U.S. government; and the availability of a suitable, cost effective alternative of the Black Brant motor for future sounding rocket missions.

The Peregrine motor has faced some substantial challenges during development. Most of these challenges were associated with contractor planning and delivery. The final system was tested in a static fire test that unfortunately ejected the aft end enclosure in a destructive failure for the launch system. This aft end enclosure failure was a noted concern for the system, as an aft end design was adopted from another motor system instead of developing a new enclosure for the Peregrine. This decision was made in an attempt to save development and test funds.

Despite this setback, the Peregrine motor remains a sound concept and prudent course of action for NASA. It is the finding of the SRWG that NASA fully fund the continued development of the Peregrine. Full and successful completion of a new cost-effective motor design, manufacture and test will secure NASA's future as the premier space agency for the launch of suborbital experiments, and minimize the susceptibility to mission failure due to motor combustion instabilities. Within limited additional expense, NASA can resolve the issues associated with the Peregrine aft end enclosure and develop the next generation of small payload test vehicle launch systems.

2. Initiation of rocket campaigns at non-standard launch sites

Summary

Non-standard launch ranges and mobile "campaigns" continue to be a hallmark of the sounding rocket program, enabling unique, important scientific investigations to be carried out in a variety of locations and launch conditions for which the data can not be obtained by any other means. The SRWG recommends that the procedure to decide upon and solicit proposals at non-standard ranges be clarified such that a larger group of investigators may propose for such campaigns and that no proposals are submitted "prematurely" for remote locations that are not yet approved or deemed feasible.

Background

Remote or mobile campaigns which include sounding rocket launches at non-standard ranges represent a signature feature of the sounding rocket program, enabling important scientific investigations to be carried out that cannot readily be pursued from the program's standard launch sites, such as Wallops Island, Va., White Sands Missile Range, New Mexico, and Poker Flat, Alaska. Scientific motivations for such remote campaigns typically including specific geospace investigations at different latitudes (e.g., the magnetic equator or the high latitude cusp) where the upper atmosphere and available sources of energy may differ significantly, astrophysical observations of southern hemisphere targets, launches in conjunction with powerful ground-based assets such as NSF's Arecibo Observatory, and ranges that provide unique locations for celestial events (e.g., launches in the path of totality of solar eclipses).

During the 50+ year history of NASA's sounding rocket program, numerous remote campaigns have been carried out at sites all over the world, including, but not limited to, sites located in Peru, Australia, Puerto Rico, India, Brazil, Argentina, Spain, Michigan, Greenland, Hawaii, Antarctica, and numerous remote sites in Canada. These locations were selected on the basis of input from the science community who articulate science drivers and candidate investigations in discussions with both NASA HQ and the Wallops Flight Facility. This input typically takes the form of workshop reports and other informal means of communication. Eventually, campaigns that are deemed feasible are encouraged by both NASA HQ and the Wallops Sounding Rocket Program Office (SRPO) after which individual proposals are then tenured and evaluated via the standard peer review process.

It should be noted that the remote sites may have special logistical, financial, and political aspects, and, in some cases, a high degree of flexibility is required for remote campaigns to succeed. Indeed, despite the best planning, in some cases, launch dates might need to be adjusted to accommodate unforeseen circumstances. Furthermore, in some cases, a "Campaign Scientist", who is typically one of the selected P.I.'s, is designated as the point of contact to lead the effort to help articulate the importance of, and potential science return from, the remote site campaign.

Despite their popularity and scientific advantages, at present, there are no well-established procedures for the initiation of such remote campaigns within the framework of NASA's sounding rocket program. The SRWG notes that the community is not well-served when PIs have insufficient advance warning to respond to opportunities to participate in remote campaigns, particularly campaigns that may not be publicized in the NASA Announcements of Opportunity. Further, the development of individual science investigations predicated on the availability of a given remote location is a waste of resources should the remote location turn out not to be available and the submitted proposals end up being disqualified without a detailed review. Although some uncertainty is inevitable, the effectiveness of the program overall would benefit from clearer procedures and signaling regarding remote campaign planning and projections.

The SRWG suggests that both NASA HQ and Wallops publicize their most up-to-date plans for remote campaigns in advance of the ROSES AO deadlines. Candidate sites for launches during the upcoming 3-5 years may be provided for which proposals may be submitted. The plans would be considered tentative and non-binding and would be in keeping with the ROSES AO instructions. The chief goal is to optimize the community awareness and streamline its participation in remote campaigns, as well as to prevent the generation and receipt of implausible sounding rocket proposals.

3. Continued interest in very high telemetry rates

Summary

Very high telemetry rates continue to provide exceptional scientific advantages for a wide variety of sounding rocket investigations that are not routinely available on any other experimental space platform. In a continuation of previous findings on this subject, the SRWG reiterates its enthusiasm for both very high telemetry rates via X-band and the inclusion of high capacity data recorders on recoverable flights.

Background

As sounding rocket instruments increase in complexity and resolution, the rate of data collection grows proportionately. Consequently, the scientific return of the rocket program cannot grow without major increases in telemetry bandwidth and data storage. The SRWG has been monitoring developments that would address this critical need. In particular:

(1) A commercial high speed, high capacity data recorder was under test by the program until the sole unit was destroyed in a mission mishap. It is our understanding that the program lacks funding for a replacement unit. The SRWG understands the concern over high unit cost, and we recognize that program resources are thin. However, we urge the SRPO to resume the data recorder effort or pursue a lower cost alternative. We note that PIs commonly develop their own onboard data storage capability out of necessity, using science funding. Repeatedly reinventing the wheel is not a good use of NASA funds. Moreover, it is possible that the elements of a good technical solution are available from the community. We urge Wallops to discuss such possibilities with cognizant

experimentalists.

(2) The program has been pursuing the adoption of an X-Band science telemetry system. We see this approach as an excellent fit both to experimenter needs and to existing range infrastructure. However, we are concerned by initial indications that NASA officials may decline to allocate the necessary bandwidth for sounding rocket usage. The committee urges NASA to authorize the use of X-band TM for sounding rockets on a non-interference basis.

4. Water recovery of high altitude, telescope payloads

Summary

The SRWG continues to encourage in the strongest terms the development of technologies for the water recovery of telescope payloads launched to high altitudes (400 km or greater.) The SRWG recommends the establishment of a water based recovery sub-committee consisting with members drawn from the SRWG, SRPO, NSROC, and the broader rocket community, to assist in defining technology developments in this area.

Background

The SRWG continues to encourage the development of technologies for recovering high altitude (> 400 km apogee) telescope payloads launched over water. Development of capabilities for telescope payload recovery in and over water is a necessary precursor effort towards routine access to new science targets, longer observation times, and long, low altitude trajectories. There are no landlocked launch ranges that can support long duration, recoverable experiments. Furthermore, recovery technologies have not been adequately developed for ranges that launch over water and could potentially support these high altitude missions. Studies of new hardware such as a hermetic shutter door design and gas pressurization systems can provide immediate incremental developments that would be beneficial to missions in the near future. Ultimately, however, it would be preferable to have a recovery system that does not expose the experiment or payload critical subsystems (e.g., ACS, telemetry) to water at all. Towards this end, we also recommend the investigation of powered paragliders and high altitude lifting bodies that can be flown to an offshore platform, or even back to land, as alternatives to water recovery.

Developments in payload recovery in and over water will enable “game-changing” science opportunities for the astrophysics and solar sounding rocket communities. For astrophysics, these developments will provide not only increased observation time, but access to unique targets located in the southern hemisphere. Currently, NASA has no capability to routinely launch south of the equator which severely limits science potential. For solar experiments, water based recovery is necessary to support investigations from next generation launch vehicles that can supply more than 10 minutes of exo-atmospheric observation, enabling the study of transient behavior tied to the 5 minute solar oscillation cycle. We also note that whereas water recovery has been successfully used for geospace payloads with limited ranges, this discipline could also benefit from water recovery for higher altitude rockets and those with tailored, long range, low altitude trajectories.

We appreciate the detailed studies performed by NSROC examining the potential increase in observing time provided by BBXI and BXII launches of a typical astrophysics payload outfitted to survive water recovery. The information provided was detailed, useful and sobering. The increase in time above 150 km from 337 seconds on a BBIX to 420 seconds on a BBXI, and to 475 seconds on a BBXII was found to be incremental. As such, SRWG recommends a study be undertaken to identify an advanced vehicle option to enable the game-changing science opportunities in astrophysics and solar as mentioned above. A delivery system capable of providing a factor-of-two gain in exo-atmospheric exposure time currently offered by a BBIX will be transformative for astrophysics. Moreover, such a system will also capture the time domain science necessary for key advancements in solar and can be used for long, low trajectory missions in support of geospace science. We encourage SRPO and NSROC to consider new vehicles or combinations of existing vehicles to fulfill the community's science requirements for longer duration recoverable experiments.

In addition to BBXI and BBXII payload studies, we urge continued discussion of water recovery for BBIX payloads both to enable new astronomical targets and as a stepping stone to recovery of payloads launched on advanced vehicles. This is a very important point as recovery of BBIX payloads from launch ranges such as Kwajalein (latitude = 9° N) enables partial access to the southern skies. This opens up a huge selection of astronomical targets that are unavailable from the standard ranges of WSMR, WFF, and Poker Flat, all of which are at latitudes northward of 30° N. Included in the deep southern sky are the nearest neighbor galaxies to the Milky Way (the Magellanic Clouds) and the nearest exoplanetary system (orbiting α Cen B); access to the southern hemisphere not only increases the number of available astronomical targets, but includes unique objects that cannot be accessed from standard northern launch sites. The impetus for water recovery enabling southern launch opportunities has increased with the delay and uncertainty in the Australia campaign. Water recovery of BBIXs from Kwajalein (possibly as part of the planned 2017 campaign) would enable new science objectives while concurrently testing key technologies such as a new shutter door and on-board experiment pressurization for future water recovery, acting as a stepping stone to recovery of payloads launched on advanced vehicles. We note a new shutter door design should not compromise aperture open area and gas pressurization systems must operate at ultra-high purity (both the gas and the delivery system). We also note that it may be cost effective to test both the BBIX and other Black Brant configurations such as the XI or XII at a more capable, potentially lower cost, launch site such as PMRF (Kauai) on an as-needed basis.

Recovery in water does come with its risks, however, and the eventual goal would be to develop a system that does not expose the payload. Critical subsystems such as the ACS, telemetry, and guidance are costly to replace, while experimenters are reluctant to drop expensive instrumentation into the ocean. Development of controlled descent mechanisms could remove these risks. Powered, shaped parachutes allow for tailored flight paths of the descending payload so that it can be flown to an autonomous recovery vehicle, an offshore platform, into the snare of an airplane, or even onto land. These approaches offer the developmental advantage of incorporation into existing BBIX payload systems designed for land-based recovery, reducing developmental risk. Such systems could also serve as an alternative to helicopter recovery at WSMR.

To help consolidate these efforts, SRWG recommends the establishment of a water based recovery subcommittee consisting with members drawn from the SRWG, SRPO, NSROC, and the broader rocket community, to assist in defining technology developments in this area.

NASA Sounding Rocket Working Group

Dr. Robert Pfaff, Jr. (Chair and Project Scientist)
NASA/Goddard Space Flight Center

Dr. Scott Porter (Deputy Project Scientist)
NASA/Goddard Space Flight Center

Committee Members:

Dr. Jonathan Cirtain
NASA/Marshall Space Flight Center

Dr. James Clemmons
Aerospace Corporation

Dr. Richard Collins
University of Alaska

Dr. Enectali Figueroa-Feliciano
Massachusetts Institute of Technology

Dr. Kevin France
University of Colorado, Boulder

Dr. David Hysell
Cornell University

Dr. Charles Kankelborg
Montana State University

Dr. Craig Kletzing
University of Iowa

Dr. Randall McEntaffer
University of Iowa

Dr. Marilia Samara
NASA/Goddard Space Flight Center