Sounding Rocket Working Group

National Aeronautics and Space Administration

Meeting of January 30-31, 2024

Findings

1. Wallops Engineering Support for Developing Innovative Science Instruments

Summary

The SRPO at Wallops and NASA HQ are very supportive of experimenters' efforts to develop new and innovative science instruments, with Wallops traditionally providing engineering support to help bring these new instrument capabilities to fruition. Given the success of this partnership, the SRWG asks that the program provide clarification regarding the best practices for this process. Responding to a question as part of the front matter of proposals regarding whether assistance from Wallops is requested may be an effective way forward.

Background

The Sounding Rocket Program Office (SRPO) at Wallops and NASA HQ continue to be very supportive of experimenters' efforts to develop new and innovative science instruments. To this end, Wallops engineering has provided infrastructure in parallel with the development of new and ongoing science instruments by P.I. teams at their home institutions that were approved via science-competed proposals. Indeed, some of the true engineering "marvels" of the rocket program grew from experimenter initiatives, including the ejectable sub-payloads recently employed by many different Geospace teams as well as the star camera with sub-arc second resolution that was spearheaded by Astrophysics P.I.'s at the University of Wisconsin. Importantly, these engineering achievements for which there was major development work provided by Wallops were subsequently made available to the entire science community for future flights.

Although this arrangement between P.I. teams and Wallops works well in general, there is some confusion regarding the degree by which support from Wallops might be expected for new initiatives. Accordingly, the SRWG asks that the program provide clarification regarding the best practices for this process, so that all PIs can be aware of what is reasonable and feasible to request.

From the standpoint of advancing such arrangements via the proposal process, it has been our understanding that as part of the competitive selection process at NASA HQ, proposals receive a top level, cursory review by the SRPO as a feasibility check prior to final selection though after science selection. In some recent instances, this process may not have been followed as rigorously as in the past. As a suggestion, perhaps proposers might respond to an explicit question as part of their proposal front matter regarding whether they seek assistance from Wallops for their proposed instrument/subsystem development. Indeed, current proposals do require a letter from Wallops regarding their feasibility if they wish to launch from non-standard rocket ranges or, at least for Astrophysics proposals, if they require a large amount of resources. The purpose of this letter is to ensure that proposed investigations are realistic, prior to their evaluation.

2. Optimizing Retention and Succession Plans for SRPO, NSROC Upper Management

Summary

The SRWG is concerned about the possible retirement of the long-term core senior engineering and management team at NSROC. We wonder about planned efforts to include mentoring, retention, training, and succession plans in the future. There is a growing team of recently hired engineering staff at NSROC who are young and diverse and who should see a path for themselves toward leadership in engineering and management of the program. The SRWG asks for clarification regarding NSROC's, as well as SRPO's, plans for retention, training, and mentoring of their workforce, as part of a broader succession plan.

Background

The SRWG is concerned about the possible retirement of the long-term core senior engineering and management team at NSROC. We wonder about planned efforts to include mentoring, retention, training, and succession plans in the future. There is a growing team of recently hired engineering staff at NSROC who are young and diverse and who should see a path for themselves toward leadership in engineering and management of the program.

Accordingly, the SRWG asks for clarification regarding NSROC's and SRPO's plans for retention, training, and mentoring of this NSROC engineering workforce, as part of a broader succession plan. The rocket community depends critically on its engineering team, and one of the biggest hurdles right now is personnel availability. Deliberate effort should be made to mentor, train, and retain the new engineering staff, and part of that is making clear that all of them have a path to the senior levels of engineering and management.

Mentoring is a significant aspect of most academic departments which is where most P.I.'s reside. Members of the SRWG are more than willing to help NSROC and SRPO identify best practices for mentoring within teams, specifically addressing minority groups within larger teams. Examples include: finding additional mentors outside the direct line of authority, recognizing minority cohorts within and across teams so that they have each other's backs, providing direct feedback and guidance for training and explicit advancement and succession plans. These practices help all team members understand their current and future roles.

The SRWG recognizes the difficulties of the current hiring environment, and lauds NSROC for the new hires that they have put in place. We wish to be constructive and share our lessons-learned, particularly from STEM academia, in terms of best practices for retention, training, and mentoring.

3. Civil Servant Mission Managers and Contractor Technical Task Leads

Summary

The SRWG requests clarification of the roles of the Mission Manager (MM) and the Technical Task Lead (TTL). The current setup has both a civil servant mission manager and a contractor technical task lead assigned to each payload, in which the TTL is a NSROC employee. For some Geospace payloads in the past, the mission manager also provided system engineering support. Are system engineering functions to be performed by the MM, the TTL, or perhaps another person?

Background

The intention of the sounding rocket program to require that mission managers be civil servants was to reduce turnover, particularly as the NSROC contract is constrained to be renewed every 5 years, as well as to ensure that the institutional knowledge gained over time by MM's working on numerous missions be readily available for future missions. This arrangement would also create a more efficient system that would enable new mission managers to be mentored by, and learn from, the more senior ones, creating a smoother succession for long term operations.

In the past, particularly for some Geospace payloads, the MM also provided system engineering support, which proved particularly efficacious in cases where the payloads were non-standard and had a completely new design. The current setup has both a civil servant mission manager (MM) and a contractor technical task lead (TTL) assigned to each payload, in which the TTL is a NSROC employee. In the new system in which a TTL has been added, it is not clear whether the MM or the TTL would act in this systems engineer role, or if these functions would be provided by someone else.

The SRWG requests clarification of the roles of the MM and the TTL. For example, who is going to act as the systems engineer who will form the backbone of the mission on the Wallops side and be the primary technical POC for the PI and the experiment team? Also, is this the long-term plan going forward for all future missions, or will new missions be assigned only a civil servant MM and not a TTL? We recognize that there are confusions during the implementation of this new system, so the questions address separately what is happening now, and what is the long-term goal.

4. Rail-Mounted Vacuum System for the Athena Launcher at WSMR

Summary

The SRWG is pleased to learn that designs are being developed for a rail-mounted vacuum system for the Athena launcher at WSMR. Such a system will enable pumping of evacuated payloads to much closer to T-0 than ground systems that have to be removed before final arming (roughly 2.5 hours prior to launch). There is significant challenges to creating "one-size-fits-all" options for all payloads, however. We support the continued development of this system, but suggest certain procedures and documentation be generated that will: (A) enable individual teams to supply their own hardware, if desired, (B) assist new payloads in designing for compatibility with the WFF pumps system, and (C) provide clarification on rules for electrical switching and operation of external pumps through final arming and launcher elevation.

Background

The SRWG appreciates the presentation at its most recent meeting pertaining to the development of the rail-mounted vacuum pump system. Such a proactive step by the WFF team continues the great tradition of collaboration that has made the sounding rocket program a success. However, during the meeting there was some concern that highly contamination-sensitive payloads may not be amenable to using a shared pump system for fear of contamination. Likewise, the diameter of the pump port is unlikely to deliver the capacity for high vacuum, which could limit usability for payloads requiring high voltage to test all systems during a rail-horizontal. There has been a lack of clarity of the rules surrounding operation of GSE during final arming that raise questions regarding how deep into the countdown the pump system can remain active.

Several ways to mitigate these concerns that would be aided by procedures and documentation being made readily available to payloads teams include the following:

1. For contamination-sensitive payloads, the foreline, bellows and fittings from the turbo-pump to the payload could be supplied by the payload team. This would require a well-defined ICD and the ability for the foreline system to have "swappable" parts.

2. For high-vacuum payloads, it could be possible to "hybridize" the pump scheme, with a ground-based pump system for the first several days on the rail that is then replaced by the rail-mounted system as part of the countdown on launch day. This would require a well-understood operations plan to avoid delays on launch day.

3. It was mentioned during the presentation that the valve on the payload-side could be "PI-chosen". While appreciated, as a skin-mounted system it would be valuable for a WFF validated/tested design to be provided as an option for payload teams.

4. A revised draft of ground safety rules specific to vacuum pump operation up to launch would enable payload teams to make the necessary trade study with respect to using either their own system or using/modifying the rail-mounted system.

In summary, the SRWG is pleased to learn of the plans to develop a rail mounted pump system. We urge Wallops management to continue to optimise the design and make documentation and specifications available to experiment teams.

5. Performance of Horizontal (spin-plane) Ejectable Payloads

Summary:

The recent development of small ejectable payloads on a number of Geospace rockets provides new and exciting opportunities for simultaneous, multi-point, distributed measurements using small platforms. While the performance of the ejectables typically meets minimum success, challenges remain which imply that meeting comprehensive success may continue to be elusive. The SRWG suggests a thorough design handover/training of the ejectables from the Engineering Test Directorate to NSROC, including a deeper understanding for the dynamics of ejection and coning, an alternate and more robust solution for battery design, and a treatment of various subsystems as standard so that they are well stocked. We further suggest that a sub-committee of users familiar with the ejectables share ideas with NSROC to find the best way to circumvent problems and ensure that this exciting new feature of the rocket program performs at its best.

Background:

Ejectable payloads in the spin plane (sometimes called "Swarm" or "Dallas") were developed by the Wallops Engineering and Technology Directorate (ETD) in 2018-19, culminating in a launch on the Subtec-8 payload. The basic design is intended to support both rocket-ejected (~50 m/s) and spring-ejected (~3 m/s) variants. This finding is mostly addressed to spring-eject instrumented sub-payloads. The design has since been handed off from ETD to NSROC and flown on multiple missions with limited success, including most recently: Delamere (52.007), SpEED Demon (46.025), and APEP (36.386, 387, 388).

Several issues/concerns have persisted regarding the ejectables which are discussed below:

1. Coning. There is no consistent coning pattern or behavior of the ejectables, even between units with the same experiment properties. Coning has varied from 10 deg half angle to as much as 45+ deg half angle, suggesting that there may be an unaccounted 'tip-off'. In general, meeting the +/-5 deg coning goal has been challenging. The current system uses Teflon strips to 'snuggle' the ejectables in the tube, a design which might be improved, perhaps with a redesign of the guide pins used in the launch tubes. We urge that the coning and potential tip-off be thoroughly studied. Perhaps the existing design envelope precludes such tight coning requirements. Nevertheless, it would be helpful for experimenters seeking to use this subsystem to be aware of its parameter space.

2. Design knowledge and hand-off from ETD to NSROC. Although the ETD design has been adapted by the program, it appears that implementation of the engineering is still being worked. For example, as recently as the APEP WSMR flights, new control cards designed by ETD were flown for the first time that required additional check out. There were also challenges with respect to recharging batteries. We suggest a more detailed design handoff be carried out, particularly as the Swarm ejectables become even more popular!

3. Build time and non-stocked items: For the most recent flights, the build-up and checkout of the ejectable units took longer than anticipated when preparing for I&T. This appears to have been due, in part, to mechanical and electrical tech support not being available, although another problem identified is that parts were not always available. We suggest that a large variety of sub systems (mechanical structure, panels, GPS system, control cards, etc.) be "auto stocked" to ensure that they are available when needed.

4. Battery system design: The current batteries are NiMH coin batteries assembled into a battery pack, which take considerable time to build as well as to cycle and checkout. We suggest that ETD/NSROC consider using improved Li-Ion or LiPo solutions. These batteries are routinely flown on LEO satellites. Furthermore, we note that millions of people ride in electric vehicles carrying similar batteries, showing that they are a safe system if charging and discharging protocols are followed.

6. Wind Weighting Challenges and Impacts to Science at Poker Flat

Summary

During the 2021/2022 season and the Fall 2023 season the timing and procedures for confirming wind-weighting status potentially impacted the science return of at least three missions – LAMP, Dissipation, and Beam-PIE. While the SRWG fully supports the safety requirements of launches, some of the reasons for the wind-weighting impacts could be easily remedied by upgrades to equipment or procedures. Accordingly, the SRWG requests that the SRPO examine means to: (1) fix or replace the existing 300-foot meteorological tower at Poker, (2) implement a lidar/sonar system to gather wind data, (3) reinstall the radar system that was previously used with balloons, and (4) develop another procedure or technology that measures high altitude winds that minimizes or eliminates the need to turn off PFISR during balloon flights during active counts and the science windows surrounding them.

Background

The inputs for wind weighting at Poker Flat have historically been a 300-foot meteorological tower (met-tower) for surface and low altitude winds and a sequence of balloons tracked by either radar reflector or GPS-sondes for medium and high-altitude winds. After an assessment of the 300-foot tower at Poker Flat (first installed in the 1970's) in 2019, it was deemed unfit to climb by the WFF safety group and the anemometers have not been serviced since that time. While the devices still send data, their calibration is not confirmed and therefore are not used as input to the wind-weighting software. For the 2021/2022 season and the Fall 2023 launch window, a portable 150-foot tower was located at PFRR. The shorter tower reduces the number of altitude levels which in turn increases the uncertainty in the wind-weighting solution, negatively constraining launch conditions and requiring more balloon launches to confirm that wind requirements are met. This resulted in delays for the desired PI launch times for both missions during the Fall 2023 launch season (Dissipation and Beam-PIE); it also provided serious holes in the night-long associated PFISR data record for the LAMP mission night, including much of the downleg portion of the flight itself.

In 2019, the NASA tracking radar at PFRR was moved to WFF which resulted in all balloon-based wind weighting relying on balloons carrying GPS sonde payloads to determine winds aloft. There have been several incidents where a GPS sonde has failed when near the beam pattern of the Poker Flat Incoherent Scatter Radar (PFISR). Based on this, the standard procedure now is to turn off PFISR when the local winds will direct the balloon sondes near the PFISR field of view. For most launches dealing with aurora and ionospheric physics, the data from PFISR are a key feature of operations at PFRR, and thus gaps in PFISR data have a significant impact on the science outcome of the mission, particularly as they typically occur near the time of the launch.

While not exhaustive, the SRWG discussed some solutions that we urge the SRPO to consider: (1) Re-furbish or replace the 300-foot met tower. This would improve the low altitude solutions, and potentially reduce the number of balloons required. (2) Implement new technology using sonar and lidar systems, which are currently and extensively used by wind power companies to examine the winds in the 100 to 300 meter altitude range. For example, a relatively low-cost lidar system (compared to a new tower) can provide high-rate (1Hz) wind fields at multiple (up to 50) altitudes to 300 meters (~ 1000 feet). (3) Re-install the radar system that was taken away in 2019 and use retro-reflective balloon payloads. This has the advantage that it would not require that PFISR be powered off when the balloons were sent aloft, ensuring that the collection of continuous, critical science data from the PFISR radar not be interrupted.

7. Support for Developing an Impulse Launcher for Mesosphere and Lower Ionosphere/Thermosphere Experiments

Summary

The SRWG is excited by the prospect of placing payloads in Earth's mesosphere and lower thermosphere via ground-based "Impulse Launchers" and encourages the SRPO to continue a dialog with potential providers to develop such new capabilities for scientific research.

Background

During the January 2024 SRWG meeting at Wallops, Dr. Todd Pederson of the Air-Force Research Laboratory presented recent work by AFRL and Green Launch to develop Impulse Launchers – systems that accelerate small (few to 10's of kg) payloads up to 100 + km altitude using mutli-stage H2 ignitions in a constrained tube (sometimes called a cannon). Dr. Pederson gave background on previous work and showed video of recent test launches (horizontal and vertical). Current estimates show that the systems can launch a payload of a few kg to well above 100 km altitude, as high as 140 km. The system is also capable of cycling to produce a sequence launches on a ~ 1 hour cadence. This capability would enable multiple launches within a several hour period for a ~ $1M price tag. This opens up the potential to create rapid time series measurements of mesosphere/thermosphere physics and dynamics that would be less practical using sounding rockets.

Two challenges that were presented regarding this technology are the high initial acceleration, up to 8000 g's, and the noise pollution produced by the launches. The acceleration for most components can be accommodated by embedding them in plastic or other material. The noise pollution created during launches are being examined by the providers (Green Launch), by using some H2 recapture technology, but there is no avoiding the sonic booms associated by the trans-sonic projectiles. This will limit where such a launcher could be located.

Although there are still technical and programmatic hurdles to overcome, the advantages that such a system could provide for some Geospace missions could result in transformative science, and we encourage SRPO and NASA Headquarters to keep an open line of communications in which they consider supporting the development of such launch and technologies and, when appropriate, include such capabilities in the stable of launch opportunities for NASA LCAS missions.

8. Including Senior Grad Students on the Sounding Rocket Working Group

Summary

The SRWG recognizes the significant contributions from graduate students to many payloads developed by university P.I.'s and to the program in general. Indeed, senior grad students often hold positions of responsibility and can be a critical reason for the success of a given mission. The SRWG would like include two senior grad students as part of its Working Group, perhaps to stay on the committee for 18 months (3 meetings) before rotating to new senior grad students.

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Furthermore, ideas from senior grad students tend to keep the program on its toes and bring in new and innovative solutions. Having a senior grad student on the working group helps foster new

P.I.'s with experience regarding the "inner workings" of the program not immediately transparent to those who are not part of the working group.
Finally, we note that several relevant NSF-sponsored community organizations, such as CEDAR and SHINE, include graduate student representatives on their program committees, which has worked out very well and can provide precedent and examples for making this work constructively for all concerned.

NASA Sounding Rocket Working Group

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