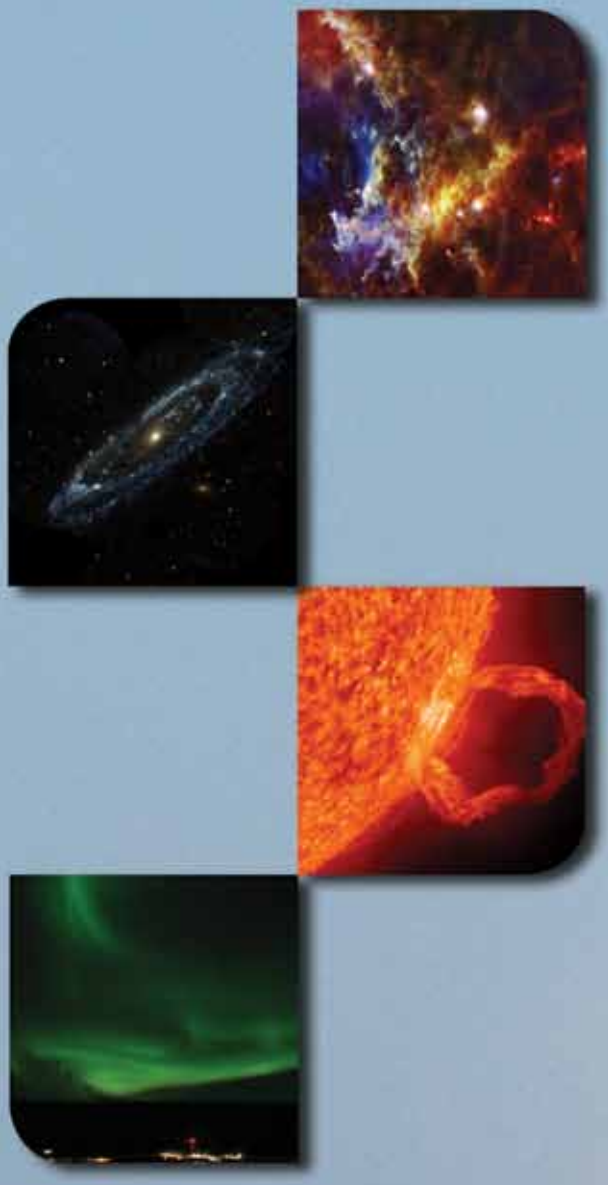
National Aeronautics and Space Administration



NASA Sounding Rockets 2010 Annual Report

Phil Eberspeaker
Chief, Sounding Rockets Program Office

Fiscal year 2010 was another exciting year for the NASA Sounding Rockets Program. As is typical, the program provided launch vehicle, payload subsystem, and mission support for numerous scientific investigations that have helped mankind expands its understanding of the Earth, Sun and Universe. These missions employed solar and astronomical telescopes, electric field detectors, particle detectors, and a host of other sophisticated instruments to accomplish their scientific objectives. The program also engaged in surplus vehicle and payload subsystem development efforts with the end goal of enabling the program to fulfill its vital role as NASA's provider of low cost access to space in an even more efficient and cost effective manner. Higher data rate telemetry allows for vast amounts of data to be collected, attitude control system enhancements allow for more efficient maneuvering which puts instruments on target sooner during the flight, and new vehicle stacks based on newly available surplus rocket motor assets result in lower cost launch vehicles. The program's unique expertise was also applied to other NASA missions that do not involve the actual use of sounding rocket launch vehicles. The program provided expertise in the areas of telemetry, power, attitude control, and rocket propulsion in support of entry, descent, and landing projects. The program continued to fulfill its commitment to STEM education by providing informative, fun, and inspirational outreach programs to local schools. The NSROC contractor and the Sounding Rocket Program Office hosted numerous interns and Co-Ops over the course of the year and the program's educational flight missions provided hands-on space flight experience to hundreds of university students and instructors. This unique educational "pipeline" helps the nation maintain leadership in science, engineering and technology. The NASA Sounding Rockets Program looks forward to continuing this world class support well into the future! This is made possible by the men and women, both civil servant and contractor, who make the program a reality.

The Chief

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The Sounding Rockets Program supports the NASA Science Mission Directorate's strategic vision and goals for Earth Science, Heliophysics and Astrophysics. The approximately 20 suborbital missions flown annually by the program provide researchers with unparalleled opportunities to build, test, and fly new instrument and sensor design concepts while simultaneously conducting world-class scientific research. Coupled with a hands-on approach to instrument design, integration and flight, the short mission life-cycle helps ensure that the next generation of space scientists receive the training and experience necessary to move on to NASA's larger, more complex space science missions. The cost structure and risk posture under which the program is managed stimulates innovation and technology maturation and enables rapid response to scientific events.

With the capability to fly higher than many low-Earth orbiting satellites and the ability to launch on demand, sounding rockets offer, in many instances, the only means to study specific scientific phenomena of interest to many researchers. Unlike instruments on board most orbital spacecraft or in ground-based observatories, sounding rockets can place instruments directly into regions where and when the science is occurring to enable direct, in-situ measurements. The mobile nature of the program enables researchers to conduct missions from strategic vantage points worldwide.

Telescopes and spectrometers to study solar and astrophysics are flown on sounding rockets to collect unique science data and to test prototype instruments for future satellite missions. An important aspect of most satellite missions is calibration of the space-based sensors. Sounding rockets offer calibration and validation flights for many space missions, particularly solar observatories such as NASA's latest probe, the Solar Dynamics Observatory (SDO).

Introduction

Executive Summary

Science with Sounding Rockets

Since their first use for space and atmospheric research in the 1950's, sounding rockets have continued to provide valuable data for scientists in several fields of study. Astrophysics, heliophysics, and geospace sciences all use sounding rockets for relevant research.

Missions 2010

Eighteen rocket missions supported science and technology disciplines, including geospacephysics, astrophysics, technology development and education. Several solarphysics missions were launched from White Sands, New Mexico, specifically to study the Sun's chromosphere and calibrate an instrument, the EUV Variability Experiment (EVE), on board the Solar Dynamics spacecraft. Two vehicle development test rounds were also flown this year.

Development & Enhancements

A new high data rate telemetry system was flown for the first time on the Labelle mission from Poker Flat, Alaska. New technologies are focused on recovery technologies such as novel flotation and location aids and parachutes. Work has continued on the Flight Termination System required for launches from White Sands Missile Range. The White Sands sounding rocket facility upgrades have been continued this year.

Education and Workforce Development

The NASA Sounding Rockets Operations Contract (NSROC) continued the highly successful internship program whereby university engineering interns participated in the various aspects of the Sounding Rockets Program. Additionally, the NSROC interns took part in a pilot program to evaluate a potential new High School rocket education effort. One dedicated education payload was flown in 2010 and two University CubeSats piggybacked on the Terrier-Improved Malemute vehicle test round. The Sounding Rockets Program Office (SRPO) supports NASA's workforce development objectives with the Hands-On Project Experience (HOPE) mission. The HOPE payload integration and testing have been completed. The employee profile of a long time sounding rocket engineer, Eric Johnson, highlights the many opportunities in the Sounding Rockets Program.

On the Horizon

International missions and campaigns will send sounding rocket teams to Australia, the Marshall Islands and Norway in the future. New astrophysics missions from Poker Flat, Alaska, are currently on the schedule for fiscal year 2011.

Statistics

Charts, graphs and metric analyses quantify the progress and success of the Sounding Rockets Program. These include launch history, launch sites, and vehicle and mission success statistics.

Science Highlight

Solar Ultraviolet Magnetograph Investigation (SUMI)
Principal Investigator: Dr. Jonathan Cirtain
Marshall Space Flight Center; NASA

Summary Statement:

The primary objective of the Solar Ultraviolet Magnetograph Investigation (SUMI) experiment is to test the technologies that have been developed for making magnetic field measurements in the upper chromosphere/ lower transition region. The transition region is a thin layer of the solar atmosphere tucked between the surface and its outermost level. Solar flares and coronal mass ejections can blast their way toward Earth, shorting out ground circuits and generating radiation capable of killing a space explorer. Such outbursts seriously impact humanity's ability to expand into space, so understanding and predicting them is critically important. In recent years, scientists have learned that the geometry of the magnetic field in the Transition Region directly relates to such solar activity. These important measurements are performed by observing magnetically sensitive lines that are in the ultraviolet and are therefore impossible to observe from the Earth. SUMI plans to make exploratory polarization measurements in this region to develop the scientific tools to analyze and convert our polarization data into vector magnetic field measurements and to use this data in determining the sensitivity requirements for space-based missions.

Figure 1: Marshall scientist Ed West assembles the optical system of the Solar Ultraviolet Magnetograph Investigation telescope.

Payload:

SUMI works by means of "Zeeman splitting." Dutch physicist Pieter Zeeman discovered the effect in the 19th century. When a glass tube filled with incandescent gas is dipped into a magnetic field, spectral lines emitted by the gas get split into two slightly different colors—the stronger the field, the bigger the splitting. The same thing happens on the sun. SUMI is comprised of a Cassegrain telescope and a spectrograph section (see Figure 1) that observes the Zeeman splitting and therefore the magnetic field strength. The telescope tested the new technology of a "cold mirror" coated to focus ultraviolet light off the front surface of the mirror, while allowing visible light to pass through the front optical surface of the mirror to then be reflected back out of the telescope on a parallel path. This concept lowers the energy transfer from the heat deposited by the solar visible radiation. Just short of the focal plane of the telescope is a waveplate that can rotate through different polarization positions to isolate linear or circular polarized light. At the prime focus of the telescope is a narrow slit, and the slit is etched into a highly polished surface. A 'slit-jaw' optical system generates an image from the telescope reflected off this polished metal surface. The light passing through the slit is split into two beams that fall separately onto individual gratings that disperse the light into the constituent spectra. In first order, the spectra of singly ionized Mg, formed at about 20,000K in the solar chromosphere, are imaged on two detectors, while the spectra of triply ionized C (100,000K) are captured by a single CCD. These emission lines are sensitive to the presence of a magnetic field, and the variability in emission at differing polarization positions is indicative of the inclination of the field along the line-of-sight and the strength of the magnetic field.

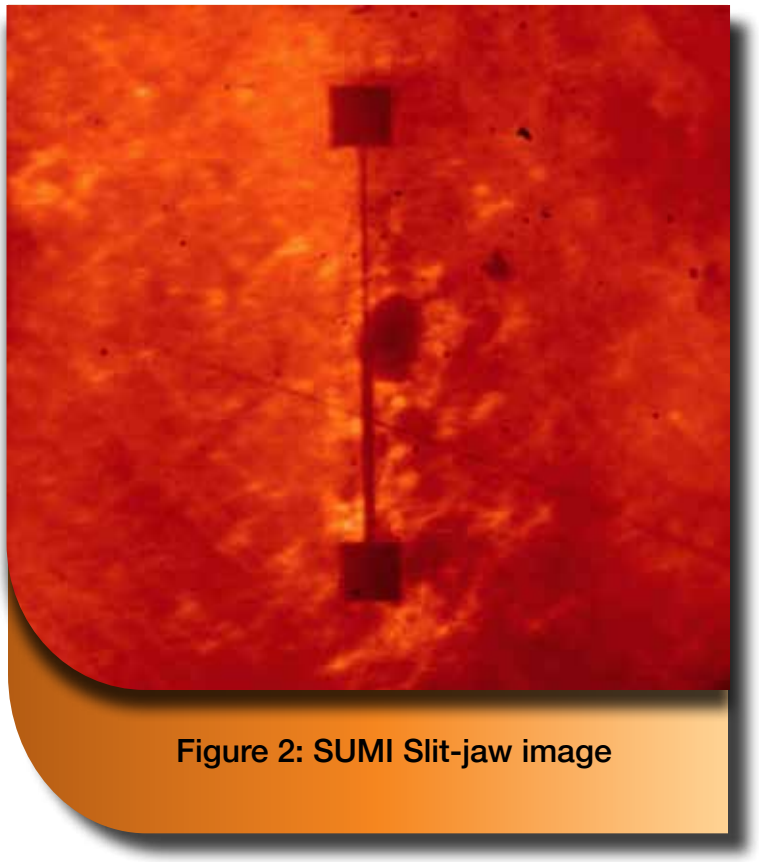


Figure 2: SUMI Slit-jaw image

Technology Development for NASA:

The SUMI instrument developed several new technologies relevant to NASA's Heliophysics Program.

- A "cold mirror" approach utilizing coatings on both the front and rear surfaces of the telescope optics provides an efficient system for rejection of out-of-band radiation while maximizing the in-band reflection.
- The spectrograph is a pair of torodial variable line-spaced gratings optimized for spectral dispersion over the range 280-320nm in first order and 145-160nm in second order. The optical system to image spectra at 280nm +/- 1.5nm and 155 +/-1.2nm was designed, fabricated and aligned for this range and maintained alignment through launch.

- The science target for SUMI is the UV chromosphere, a layer of the solar atmosphere inaccessible from within the atmosphere of Earth. SUMI demonstrated the scientific return for observations of this understudied layer of the sun.

Science

SUMI was successfully launched on a Black Brant IX on 30 July 2010 from White Sand Missile Range. The target for the observations was a sunspot near the north-east limb. An image of the sunspot with the SUMI slit is shown in Figure 2. For ~400 seconds SUMI collected spectral intensities for both spectrograph channels and analysis of the data indicate SUMI, in fact, did measure linear polarized light within the spot penumbra confirming the design of the instrument. Indications within the data that observed variations in the self-reversal of the Mg II emission line may be used to measure the propagation of waves in the chromosphere. This result will be a fruitful area of investigation for the upcoming NASA Small Explorer mission IRIS (Interface Region Imaging Spectrograph). A sample of the SUMI spectra is shown in Figure 3.

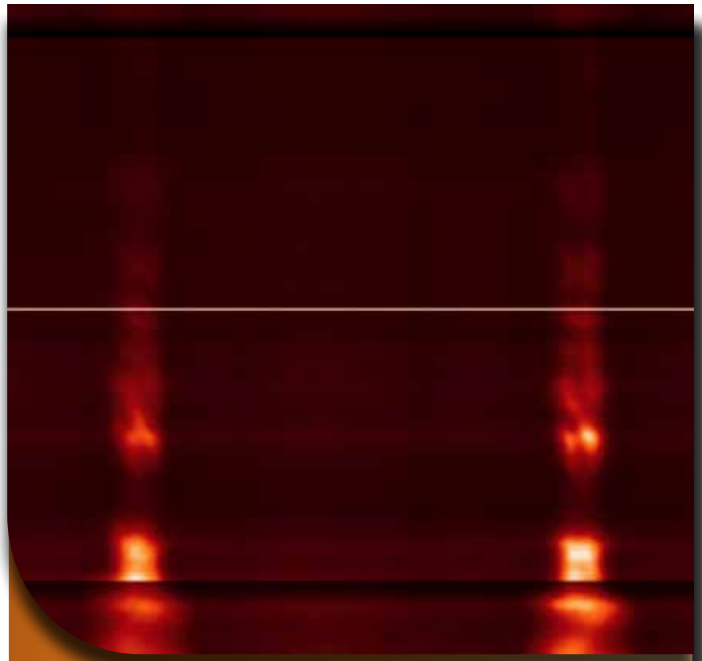


Figure 3:Mg II spectra are the two bright features running vertically in the image. Mg II H is on the left and Mg II K is on the right

Education

Then instrument development and design incorporated the use of several education initiatives within NASA. Engineering interns from the University of Alabama and Auburn contributed to the mechanical and electrical design, while NASA Post Doctorial awards funded scientist support. Many of the engineers and scientists that worked on the SUMI program had never worked on a science payload before and used the experience with SUMI as a professional education activity.

Continuation of Program

The initial successes of the observations from SUMI warrant a second flight in order to better constrain the measurements. A re-flight proposal will be submitted to the LCAS opportunity in March 2011. If selected for a second flight, SUMI will fly again in summer 2012.

The contributions of the highly capable engineers and support personnel from Wallops and NSROC at White Sands deserve special acknowledgement for the contributions and accommodations they made that insured the success of our program. We are deeply grateful for their professionalism and grace.

Payload ready for vibration testing.

Mission Support

Mission Support

The NASA Sounding Rockets Program provides comprehensive mission support and management services from concept through post-flight data distribution. This end-to-end support capability enables the Principal Investigator (PI) to focus on the research aspect of the mission. Extensive experience-over 2,500 missions flown-has led to streamlined processes and efficient design, manufacturing and assembly techniques. Management and technical support are provided for all facets of a mission and include engineering design, manufacturing, integration, and testing and evaluation. Periodic reviews are conducted to ensure mission requirements are being met on time and on budget.

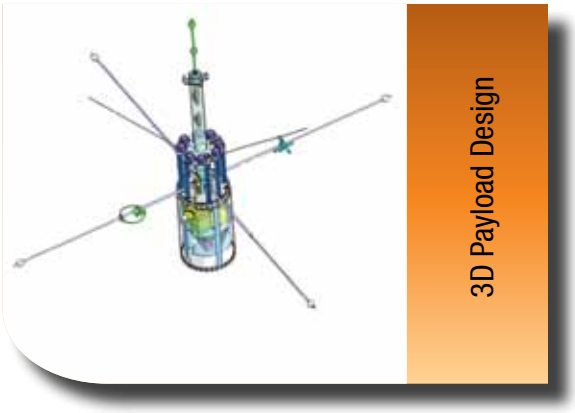
Terrier–Improved Malemute

Launch Vehicles

The Sounding Rockets Program offers multiple proven launch vehicles to meet the needs of most researchers.

Payload Design

All payload components, mechanical and electrical systems, telemetry, recovery and other subsystems are designed using state-of-the-art software, modeling and analysis tools. Three-dimensional (3-D) visualization tools facilitate the iterative design process by allowing flexibility in design updates and changes.



3D Payload Design

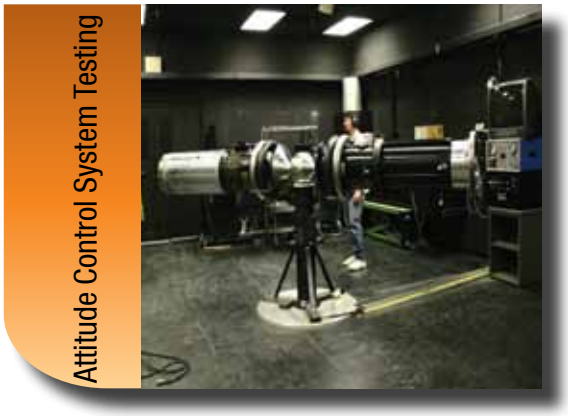
Manufacturing

Extensive in-house manufacturing capability is vital in a program with many customization requirements. The machine shop includes a vast assortment of machinery such as Computer Numerical Controlled (CNC) milling machines, lathes, welders, sheet metal breaks/shears/rollers and additional tools and processes to support the mechanical needs of the program.

Manufacturing

Subsystems

The Sounding Rockets Program provides standard subsystems such as recovery, attitude control systems, and the S-19 boost guidance system as required by the mission profile. Custom systems, such as telemetry based on heritage components, are also available.


Attitude Control System Testing

Testing and Evaluation

The launch and flight phases of a sounding rocket mission are violent and stressful events for the scientific payload. A comprehensive preflight qualification process involves subjecting the complete payload, in its flight configuration, to a series of environmental elements such as vibration, bending, heating, spin, de-spin, and vacuum exposure.


Payload Vibration Testing

Launch Operations Support

Both established and temporary launch sites world wide are available to accommodate the needs of the PI. Established launch ranges exist in Alaska, New Mexico, Virginia, Norway, Sweden and Australia. Temporary sites in Greenland, the Marshall Islands, Puerto Rico and Brazil provide extensive access to phenomena of interest to the science community.

Sounding Rocket Program Risk Management Process

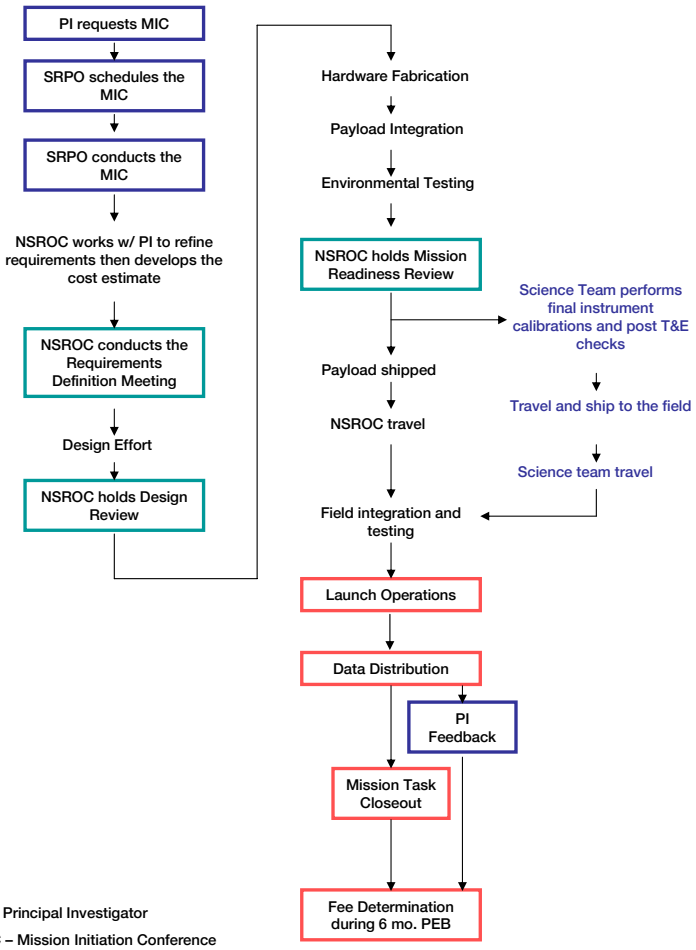
NSROC and the SRPO have a long, successful history of managing risk at all levels of each mission to an acceptable level in order to maximize probability of success. We do so by conducting detailed independent reviews of our designs and performing robust and thorough testing of our flight hardware. In an effort to better document and communicate what we already do, the SRPO and NSROC have developed a formalized Risk Management Process.


Launch Operations – Alaska

The process begins with NSROC mission team members communicating issues and problems that present mission risk to their mission manager and systems engineer. The systems engineer keeps a matrix of these items during the life cycle of the mission and tracks their progress throughout. On a monthly basis, NSROC systems engineers report a summary of these risks for all missions to the SRPO Payload Systems Manager. Mission risks are also discussed with the SRPO Chief during a monthly schedule review.

After the Mission Readiness Review for each individual mission, the assigned NSROC Systems Engineer will submit a list of residual risks to the SRPO Payload Systems Manager. Each risk item is accompanied by a mitigation statement and a recommendation from NSROC to either accept or further mitigate the risk. The SRPO Payload Systems Manager will iterate with appropriate NSROC and SRPO personnel until all risks are mitigated to an acceptable level. When this is satisfactorily completed, the Principal Investigator and SRPO Chief are briefed on the residual risks, and, subsequently, give their concurrence to proceed with launch.The additional attention given to the specific risks associated with each mission allows NSROC and SRPO management, as well as the PI, to make informed decisions regarding readiness to proceed with a mission. This risk management process also helps NSROC and the SRPO avoid, in the event of a mission anomaly, extensive after-the-fact reconstruction of decision making processes.

Sounding Rocket Mission Implementation Flow



PI – Principal Investigator
MIC – Mission Initiation Conference
NSROC – NASA Sounding Rocket Operations Contract

Labelle payload in the EMI chamber.

2010 Missions

CyXESS

Cygnus X-Ray Emission Spectroscopic Study

Mission:	36.252 UH
PI:	Dr. Webster Cash
Institution:	University of Colorado
Launch Site:	White Sands, NM
Launch Date:	November 14, 2009
PI Website:	http://casa.colorado.edu/

The scientific goal of this sounding rocket is to obtain X-ray spectral diagnostics of a nearby extended supernova remnant, the Cygnus Loop. The Cygnus X-ray Emission Spectroscopic Study (CyXESS) instrument addresses the structure and dynamics of supernova remnants and the hot phase of the interstellar medium. CyXESS can obtain physical diagnostics of the galactic halo and possibly even detect emission from the intergalactic medium.

The Cygnus Loop is the quintessential middle aged, shell structured supernova remnant. The morphology of this remnant results when the shock wave from the supernova blast encounters a shell of inhomogeneous medium. Interactions of this shock wave with clouds present in this structure create emission that dominates at all wavelengths including X-rays. The shell morphology is consistent with the idea of cavity explosion where the progenitor star wind creates a cavity and pushes out ambient medium to create a cavity in which the supernova occurs. The blast wave is now catching up to the outlying material. X-ray emission is indicative of the interaction of the blast wave with clouds.

The Cygnus Loop is an ideal probe of its surroundings. Understanding the relationship that supernovae have with their environments is crucial when considering everything from interfaces between different phases of the ISM to star formation to energy and matter feedback in galaxies and clusters.

Cash payload team at White Sands.

This was the third test flight of the Mesquito (M26/MLRS boosted dart). The purpose of this mission was to further evaluate the performance of this new vehicle system.

The Mesquito vehicle consists of a 4.5-inch dart propelled to 90-100 km with an US Army M26 Basic Multiple Launch System Rocket (MLRS) motor, and is intended for temporal and spatial measurements in the lower Mesosphere.

Mission:	12.068 GT
PI:	Mr. John Hickman
Institution:	NASA/Wallops Flight Facility
Launch Site:	Wallops Island, VA
Launch Date:	December 16, 2009
PI Website:	http://sites.wff.nasa.gov/code810/

Mesquito launch from Wallops Island, VA.

Mesquito

HAROH

High Altitude Resolution of Hydroxyl

In the Earth's Mesosphere, specifically the Meinel Airglow region, OH emits spectrally isolated radiation from specific upper vibrational states of OH Meinel emission bands. These bands are pervasive in the near-infrared, and dominate the terrestrial nightglow. The wide rotational line spacing of the individual vibrational bands allows spectrally resolving the individual rotational lines for many of these bands. Since the relative strengths of the rotational lines vary with temperature, they, in turn, provide an exceptionally useful thermometer for the upper mesospheric emission region.

The mission objectives are to collect radiated emissions from the Hydroxyl (OH) in the Meinel Airglow region from 50-90 km altitudes. The payload consists of an instrument with an array of 10 optical tubes (photometers) aligned parallel to the thrust axis.

The increased number of observations made of polar mesospheric clouds at high latitude, and observations of noctilucent clouds at mid latitudes, have raised the scientific importance of understanding this mesospheric region. Aeronomy of Ice in the Mesosphere (AIM) was recently launched to study it more in depth. The High Altitude Resolution of Hydroxyl (HAROH) experiment directly supports AIM's fundamental goal and will also aid in better understanding ground-based mesospheric temperature measurements that will be compared with those obtained from AIM.

Mission:	41.086 UE
PI:	Dr. Erdman
Institution:	Embry–Riddle University
Launch Site:	White Sands, NM
Launch Date:	December 17, 2009
PI Website:	http://daytonabeach.erau.edu/coas/physical–sciences/index.html

41.086 payload with Damon Burke.

Mission:	41.084 UE
PI:	Dr. Mark Conde
Institution:	University of Alaska
Launch Site:	Poker Flat, AK
Launch Date:	February 9, 2010
PI Website:	http://fulcrum.gi.alaska.edu/conde/

Dale Henderson with ampoules.

This mission was a test flight of a new TMA deployment technique. The payload included a constellation of 16 TMA ampoules designed to be deployed during flight. TMA releases are used to study wind gradients at altitude. This new technique, when perfected, allows the use of one payload and one vehicle to eject up to 48 TMA ampules throughout a three dimensional volume along a vehicle's flight path. Previous missions have required several launches in close sequence leading to complex operations scenarios to accomplish similar objectives. A second test flight is in planning to build on the excellent results obtained.

The ampoule detonation worked perfectly. The 41.084 mission successfully deployed 12 puffs of TMA chemical, all of which were from spring ejected sub-payloads.

41.084 ready to launch in Alaska.

Wind gradient study

CHARM

Correlation of High Frequency and Auroral Roar Measurements

Mission:	40.025 UE
PI:	Dr. Jim Labelle
Institution:	Dartmouth College
Launch Site:	Poker Flat, AK
Launch Date:	February 15, 2010
PI Website:	http://www.dartmouth.edu/~spacephy/labelle_group/

The Correlation of High Frequency and Auroral Roar Measurements (CHARM) II mission answers several outstanding questions about the physics of high frequency waves in the Earth's aurora, and directly tests theoretical predictions of wave growth, electron bunching, and resulting wave evolution.

The payload includes a new sophisticated all-digital receiver which, together with dedicated high frequency probes and amplifiers, will allow, for the first time on a sounding rocket, the detection of the relatively weak electromagnetic "auroral roar" signals emitted by auroral upper hybrid waves.

Karl Haugh working on the payload.

Preparing for EMI testing.

Terrier-Improved Malemute Testflight

Mission:	12.067 GT
PI:	Mr. Brian Hall
Institution:	NASA/WFF
Launch Site:	Wallops Island, VA
Launch Date:	March 27, 2010
PI Website:	http://sites.wff.nasa.gov/code810/

The first test flight of the Terrier-Improved Malemute occurred on March 27, 2010, when 12.067 GT Hall launched from Wallops Island. In addition to vehicle diagnostics the payload included CubeSats from Kentucky University and California Polytechnic Institute. Students from Kentucky Space and Cal Poly, San Luis Obispo, built CubeSats for this first-of-a-kind sounding rocket mission.

The Kentucky CubeSat, called ADAMASat, was developed by students to allow testing of hardware and software they intend to fly in an orbital CubeSat called KySat-1 to be launched with the NASA Glory mission no earlier than November 2010. The subsystems tested with the suborbital flight include an antenna deployment system and power conditioning circuitry.

Students monitoring incoming data.

The Cal Poly CubeSat, a test bed for Poly-Sat bus technologies, tested an attitude determination system. Students staffed several ground stations at Wallops, as well as stations at the University of Kentucky in Lexington, Morehead State University and at the U.S. Naval Academy in Annapolis, Maryland, to capture the telemetry during the flight. In addition, students distributed software packages for amateur radio enthusiasts to participate in the project.

Kentucky student with CubeSat.

12.067 Lift–off from Wallops Island.

EVE Calibration

Mission:	36.258 UE
PI:	Dr. Tom Woods
Institution:	University of Colorado
Launch Site:	White Sands, NM
Launch Date:	May 3, 2010
PI Website:	http://lasp.colorado.edu/rocket/

36.258 ready to launch.

Woods payload team.

This mission completed the first of five underflight calibrations of the EUV Variability Experiment (EVE) on board NASA's latest heliophysics spacecraft, the Solar Dynamics Observatory (SDO). Launched on February 11, 2010, from Cape Canaveral, Florida, the primary scientific goal of SDO is to enable us to better understand and predict solar variations that influcene life on Earth and humanity's technological systems. SDO will study how the Sun's magnetic field is generated and structured, and how the stored magnetic energy is converted and released into the heliosphere and geospace in the form of solar wind, energetic particles and variations in the solar irradiance.

The EVE measures the Sun's constantly changing ultraviolet brightness. Rapid changes in the ultraviolet radiation of the Sun can cause temporary outages in radio communications and electrical systems on satellites orbiting the Earth. EVE will take measurements of the Sun's brightness as often as every 10 seconds, providing space weather forecasters with warnings of possible outages that can be used to alert mission teams to take preventative measures to protect their electronic systems. By comparing EVE's measurements with pictures taken at the same time by AIA, scientists can learn where the change in brightness came from and whether it was a flare, a CME, or some other event. The HMI will then reveal the magnetic and plasma flow activities behind the event. The EVE instrument for SDO is provided by the University of Colorado, LASP, and the Principal Investigator is Dr. Tom Woods. The prototype EVE instrument was originally flown on a sounding rocket, 36.233, in 2006.

The Diffuse Interstellar Cloud Experiment (DICE) will record high resolution (R ~ 60,000) spectra of the O VI doublet (1032 Å, 1038 Å). The selected targets, □ Sco and ϖ Sco, separated by only ~ 10 parsecs, lie on opposite sides of a nearby hot/cold gas interface, evidenced by the increase in both Na I and O VI column densities between the two (Jenkins 1978, Hobbs 1974). DICE should be able to observe these targets with a velocity resolution of 5 km/s and signal-to-noise ratio (S/N) of 50-100, and allow us to fit profiles to individual components of the spectra, calculating column densities, centroid velocities, and Doppler broadening parameters. The Local Inter Stellar Medium (LISM) provides an excellent laboratory for studying interstellar gas dynamics and the distribution of energy and matter throughout the Galaxy. Understanding the role of O VI in our own neighborhood will aid in analyzing the ISM of galaxies through the universe.

DICE payload team at White Sands.

Mission:	36.270 UG
PI:	Dr. James Green
Institution:	University of Colorado
Launch Site:	White Sands, NM
Launch Date:	May 21, 2010
PI Website:	http://casa.colorado.edu/

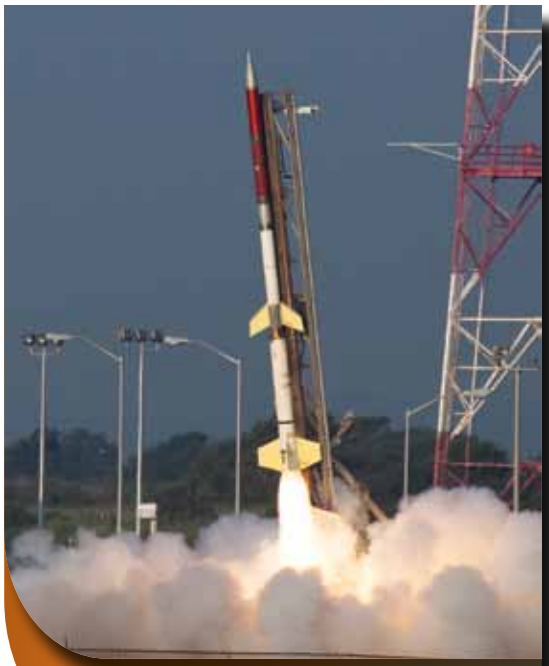
Recovery of 36.270.

Diffuse Interstellar Cloud Experiment

DICE

RockOn!

Mission:	41.088 UO
PI:	Mr. Chris Koehler
Institution:	University of Colorado
Launch Site:	Wallops Island, VA
Launch Date:	June 24, 2010
PI Website:	http://spacegrant.colorado.edu/rockon/



RockOn! lift–off from Wallops Island.

This mission was the third flight of the hands-on, University level rocket flight workshop known as "RockOn!," which is the collaborative effort of Colorado Space Grant Consortium (COSGC), the Virginia Space Grant Consortium (VSGC), and NASA Wallops Flight Facility. The primary objective of the RockOn! workshop is to provide university undergraduate students and instructors with a space flight opportunity that involves minimal cost, minimal amount of time invested, and a relative low level of complexity. Also, the program will be implemented at WFF with minimal impact to the NASA Sounding Rockets Program. The RockOn! workshop is intended to be an introductory flight opportunity to provide exposure to and spark the interest in space-based science missions. The long term goal of this program is to provide a low cost subsidized, self-sustaining, annual training program for the university community. This will be accomplished by flying two classes of experiments. The first time participants will fly the simpler kit experiments known as the RockSat-W experiments, and as they gain more experience, they will progress toward developing their own unique experiments known as the RockSat-C class experiments.

To find out more about this flight opportunity visit the Colorado Space Grant Consortium on the web at: http://spacegrant.colorado.edu/rockon/
or the Virginia Space Grant Consortium at: http://www.vsgc.odu.edu/

For information about the Space Grant program visit:
http://www.nasa.gov/offices/education/programs/national/spacegrant/home/index.html

The Cosmic Infrared Background Experiment (CIBER) will probe the absolute spectrum and spatial anisotropy of the extragalactic Infrared Background (IRB) in a search for signatures from first-light galaxies. CIBER will conduct a pioneering search for IRB anisotropies, and is specifically designed to measure fluctuations at wavelengths and spatial scales where a putative first-light galaxy signal can be best detected and discriminated from foregrounds. CIBER will be able to either confirm or refute the recent detection of IRB anisotropies in Spitzer IRAC bands, ascribed as infrared emission from clustered first-light galaxies.

Mission:	36.265 UG
PI:	Dr. Jamie Bock
Institution:	Calt Tech
Launch Site:	White Sands, NM
Launch Date:	July 11, 2010
PI Website:	http://science.jpl.nasa.gov/people/Bock/

Payload preparation.

CIBER payload team.

Cosmic Infrared Background Experiment

CIBER

SUMI

Solar Ultraviolet Magnetograph Investigation

Mission:	36.213 NS
PI:	Dr. John Davis
Institution:	NASA/MSFC
Launch Site:	White Sands, NM
Launch Date:	July 30, 2010
PI Website:	http://solarscience.msfc.nasa.gov/

The primary objective of the Solar Ultraviolet Magnetograph Investigation (SUMI) experiment is to test the technologies that have been developed for making magnetic field measurements in the upper chromosphere/lower transition region. While transition region magnetic field measurements are very important to our understanding of solar activity, the most important Zeeman sensitive lines at these heights are in the ultraviolet which are impossible to observe from the Earth. Therefore, the SUMI plans to make exploratory polarization measurements in this region to develop the scientific tools to analyze and convert our polarization data into vector magnetic field measurements and to use this data in determining the sensitivity requirements for space-based missions like the Magnetic TRAnsition Probe (MTRAP).

Payload recovery.

SUMI payload team.

The primary objective of this mission is to flight demonstrate the new production Nihka motor and ignition system in a dynamic environment that represents a nominal altitude. The secondary mission objectives include the flight demonstration of a White Sands Missile Range (WSMR) Black Brant IX (BB IX) ignition system and rocket propelled ampoule system.

Mission:	12.073 GT
PI:	Mr. Brian Hall
Institution:	NASA/WFF
Launch Site:	Wallops Island, VA
Launch Date:	August 4, 2010
PI Website:	http://sites.wff.nasa.gov/code810/

Flight Termination System (FTS)

NSROC is generating a new second stage igniter housing for BB IX missions launched from WSMR. This igniter housing will contain a redundant FTS as well as circuitry for second stage ignition, de-spin, and payload separation.

Payload in the ground station.

Aft-Looking Video Instrumentation System (ALVIS)

The ALVIS is a Black Brant video system configurable for multiple payloads and vehicles.

Rocket Powered Ampoule

The instruments are two ejectable sub-payloads carrying pyrotechnically detonated ampoules filled with gold-leaf metal chaff, together with a pair of video cameras monitoring their ignition and subsequent ejection. The ampoule system will be used for deployment of TMA in future missions.

12.073 Hall ready to launch.

Nihka testflight

RAISE

Rapid Acquisition Imaging Spectrograph Experiment

Mission:	36.219 US
PI:	Dr. Don Hassler
Institution:	SWRI
Launch Site:	White Sands, NM
Launch Date:	August 23, 2010
PI Website:	http://www.boulder.swri.edu/~hassler/

RAISE payload team.

The Rapid Acquisition Imaging Spectrograph Experiment (RAISE) sounding rocket payload is an extremely high speed scanning-slit imaging spectrograph designed to observe and analyze dynamics and heating of the solar chromosphere and corona on time scales as short as 100 ms, with TRACE-like spatial resolution and a velocity sensitivity of 1-2 km/s. RAISE will address three general topics that are accessible only with our instrument's unique capabilities: 1) Small-scale multithermal dynamics in active-region loops; 2) the strength, spectrum, and location of high frequency waves in the solar atmosphere; and 3) the nature of transient brightenings in the chromospheric network.

41.082 lift–off from Wallops Island.

The mission, Suborbital Technology Experiment Carrier (SubTEC) III, was designed to demonstrate multiple technologies, improve sounding rocket capabilities, and support range development initiatives. The SubTEC missions are intended to be low-cost missions using the two-stage Terrier-Orion launch vehicle.

The rocket's primary payload, the NASA Autonomous Flight Safety System (AFSS), is an autonomous onboard system that can enhance the function of the human ground command flight termination system. In the event of a deviance off the nominal flight path, the AFSS is designed to generate a flight termination system destruct command, causing the rocket to break apart and keeping the public safe.

Before the AFSS can be used as a real-time flight system, it must be proven to be worthy and ready for flight. This is the third successful flight of the AFSS. The first test flight dates back to 2006. The system will go through additional flights and testing on the path to becoming flight certified.

The Terrier-Orion rocket carried two additional payloads. The first was a NASA package of seven sensors to observe the rocket's performance. The third payload was a Federal Aviation Administration (FAA) payload designed to inform aircraft and air traffic control systems of the in-flight location and velocity of launch vehicles that could pose a collision hazard to aircraft.

Mission:	41.082 NP
PI:	Mr. Barton Bull
Institution:	NASA/WFF
Launch Site:	Wallops Island, VA
Launch Date:	September 21, 2010
PI Website:	http://sites.wff.nasa.gov/code598/

Suborbital Technology Experiment Carrier

SubTEC III

Development & Enhancements

12.073 Hall ready to launch.

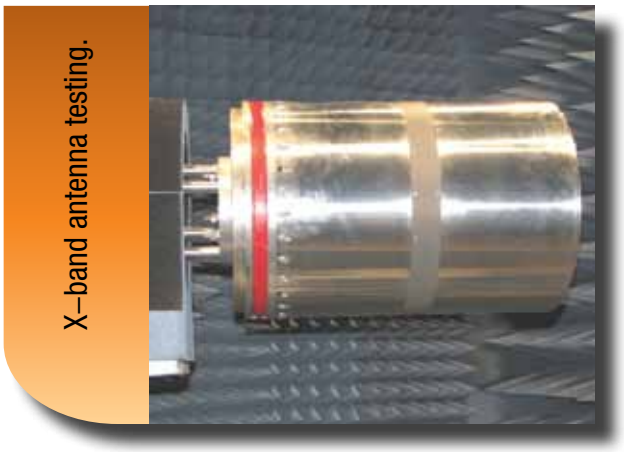
Technology Development

The Sounding Rockets Program Office is working closely with NSROC, NASA engineering, and other partners to sustain core capabilities and develop new technologies to enhance the sounding rockets program. The technology efforts underway and those under consideration span from component upgrades to new system developments to alternate vehicle configurations. 2010 was a busy year supporting many small scale developments, as well as the primary development efforts involving high speed telemetry, a new flight termination system, and the Nihka Mod II motor test and qualification.

X–band ground equipment.

High Data Rate Telemetry (TM)

Early this year the High Data Rate TM team, comprised of the SRPO, AETD, NSROC, and Range support personnel, successfully demonstrated the first high date rate X-band telemetry system. The system flew as a secondary experiment on the CHARM II mission (40.025 LaBelle) launched from Poker Flat Research Range in February 2010. This inaugural test flight was able to demonstrate a high rate data stream of 150 Mbits/sec, which is more than an order of magnitude increase in the current capability of 10 Mbits/sec. The system utilizes a X-band modulator built by Wallops AETD, which outputs a SQPSK modulate signal at 8212 MHz. The demonstration system also incorporated a COTS solid state amplifier and a linear polarized wrap-around antenna. In addition to the flight hardware development, the team upgraded the Poker Flat 11-meter tracking antenna system and developed ground support equipment to receive and process the high rate X-band data.



X–band antenna testing.

Building on the first flight demonstration, the High Data Rate team has been busy this year refining the design of the flight hardware and developing new operational plans for ground support systems. The team is currently building the next evolution of the system, which will be capable of transmitting a data stream at a rate of 385 Mbits/sec utilizing an alternate encoding scheme. In addition to the enhancements for transmitted data, the team is working with the GSFC SpaceCube as a potential flight processor and platform for onboard data recording at rates up to 1 Gbit/sec.

Another important aspect of the high data rate initiative is the upgrade of the ground tracking systems. This year the team has work closely with the Near Earth Network/Ground Network Team to develop plans for upgrading the 11-meter tracking antenna located at WFF. The asset is anticipated to be upgraded in early 2011, providing the capability to support the next X-band high data rate experiment on the SubTEC IV mission. In addition to the WFF 11-meter asset, AETD and the WFF Range are investigating the possibility of upgrading the Transportable Orbital Tracking System (TOTS) antenna at WFF and PFRR to provide additional high data rate X-band tracking capability.

Recovery Technologies

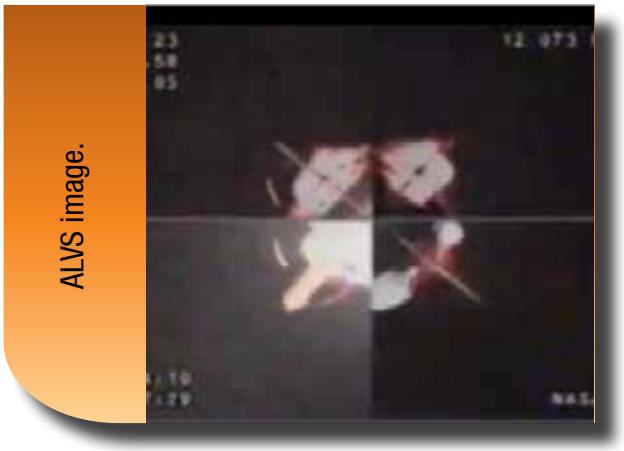
The Program is working closely with AETD to develop a modern water recovery system for sounding rocket payloads, comprised of an inflatable flotation device and including a global tracking beacon. This development effort sponsored jointly by the Program Office and a GSFC Internal Research and Development (IRAD) initiative kicked off in the third quarter of 2010. Traditionally, water recovered payloads have had to rely on sealing sections of small payloads and achieving payload buoyancy with free volume. This approach limits the ability to launch and recover larger and more complex payloads from water-based ranges, such as WFF. The new development effort will utilize inflatable chambers to provide the necessary payload buoyancy and will incorporate modern location aides for expedient recovery. Within the next year a prototype system will be designed, built, and subjected to lab and field testing.

FTS Status

NSROC continued efforts to develop the next generation Flight Termination System, which will yield a system compliant with current range safety requirements. NSROC is nearing completion of the second phase of the development with the operational readiness of the Hybrid II system anticipated at the beginning of CY2011. This year the development team transitioned from the design phase into the fabrication, assembly, and test phases for the Hybrid II system, with much of the efforts focused on completing the rigorous qualification testing for the components and subsystems. In parallel with the FTS development, NSROC developed a miniature Black Brant ignition system, which reduces the footprint of the heritage design allowing the additional FTS component, required for redundancy standards, to be housed in the standard size igniter housing.

Bench testing of the FTS ground system equipment.

Aft Looking Video System (ALVS)



ALVS image.

NSROC developed a unique onboard video system with the primary objective of monitoring Black Brant motor performance. The system was developed as a stand-alone system capable of transmitting video to the ground or recording video on board for retrieval after payload recovery. The system is built on a COTS Digital Video Recorder (DVR) which is utilized to combine the video streams of four aft-facing cameras mounted on the exterior of the ALVS skin. The system was successfully testing on the 12.074 Nihka Mod II qualification flight, providing stunning video of the Black Brant and Nihka motor plumes. The ALVS will continue to be flown on a non-interference basis on Brant missions and vehicle test flights as another tool to monitor the performance of vehicle systems.

ALVS image of Nihka plume.

SubTEC Program

The SubTEC technology initiative serves to improve technical capabilities of the Sounding Rockets Program and other users by providing a standardized carrier platform to flight demonstrate new technologies. SubTEC missions provide opportunities for multiple experiments and organizations to share the cost of a flight.

SubTEC III,Bull 41.082, launched September 21, 2010, providing critical flight demonstration of the Autonomous Flight Safety System (AFSS). The AFSS is a non-traditional Flight Termination System (FTS) designed to replace the traditional ground command destruct systems and uses rules-based decision software and onboard sensors to terminate a flight autonomously. This launch also provided an opportunity for the FAA to demonstrate an Automatic Dependent Surveillance-Broadcast system intended to aid air traffic control. Also, NSROC utilized the flight opportunity to gain valuable flight experience on several key components.

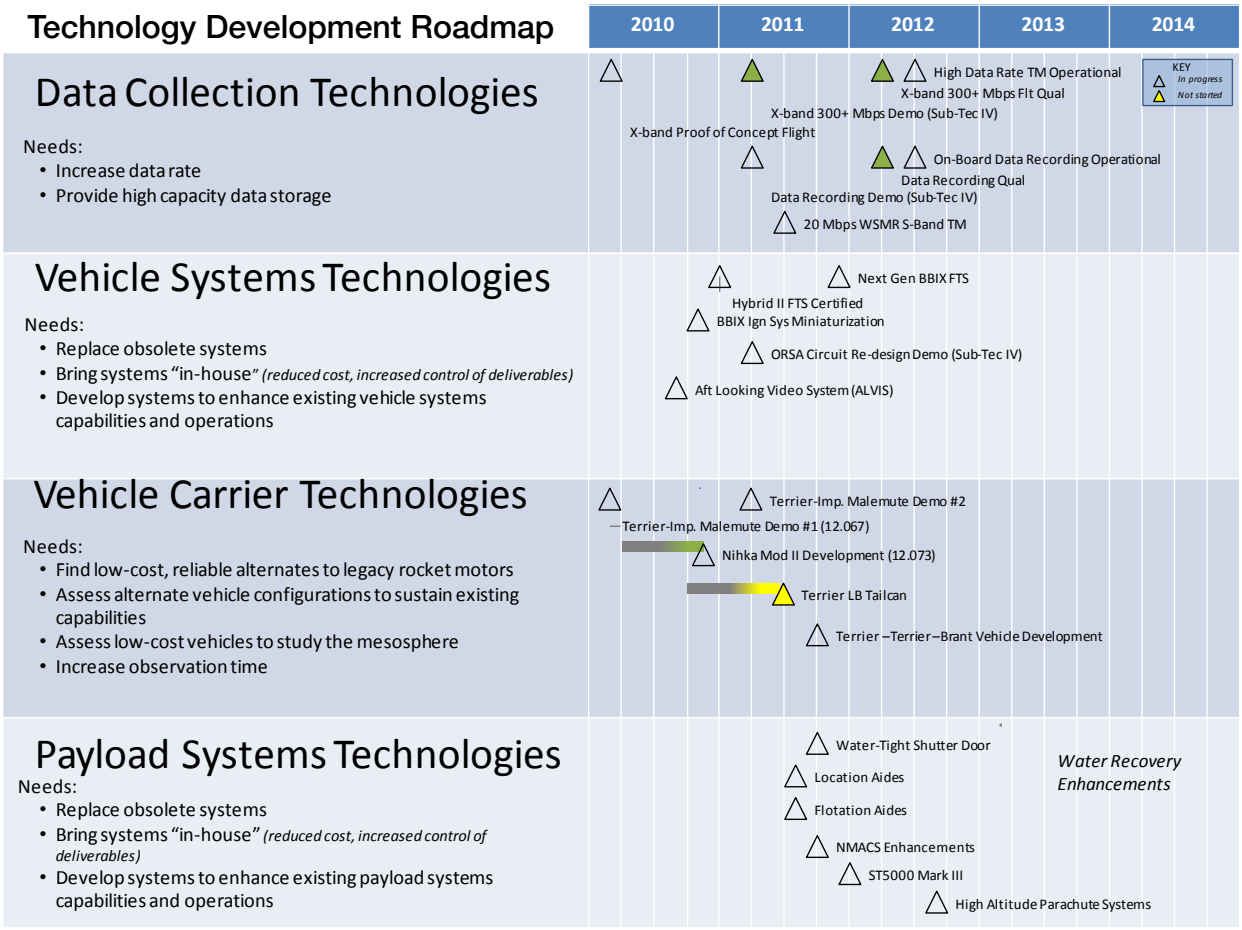
SubTEC IV, Hall 41.089, scheduled for flight in early 2011, carries two primary experiments: high data rate telemetry and Small Rocket/Spacecraft Technology (SMART). The High Data Rate Module experiment is designed to push the envelope on both data rate transmission and data recording to the maximum feasible rates given current cost effective technical solutions, i.e., provide a telemetry system capable of transmitting ~400 Mbps data to the ground using existing X-band

ground stations. System development will include the requirement to support direct downlink capability through existing telemetry stations for Geospace science missions. System development will include the requirement to support Astrophysics and/or Solar missions where utilization of high data rate telemetry systems are not feasible.

SMART contains basic components of a spacecraft prototype, including avionics, primary battery, optical sensors, thermal, pressure, inertial, and GPS-based position sensors. The main operational requirement for SMART is to be able to collect, record, and transmit subsystem (avionics primarily) performance data, including camera and sensor information. The system is based on the flight ready SpaceCube avionics. SpaceCube is a reconfigurable, high-performance system designed for space flight applications requiring onboard processing. Space Cube, developed by engineers at the NASA Goddard Space Flight Center, is a next-generation command and data handling system.

Preparing the SMART payload structure for vibration testing.

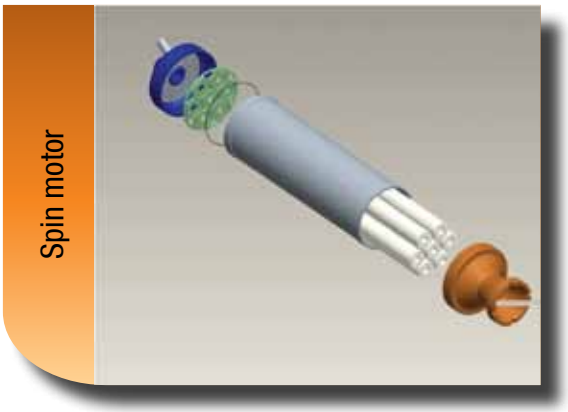
Technology Development Roadmap



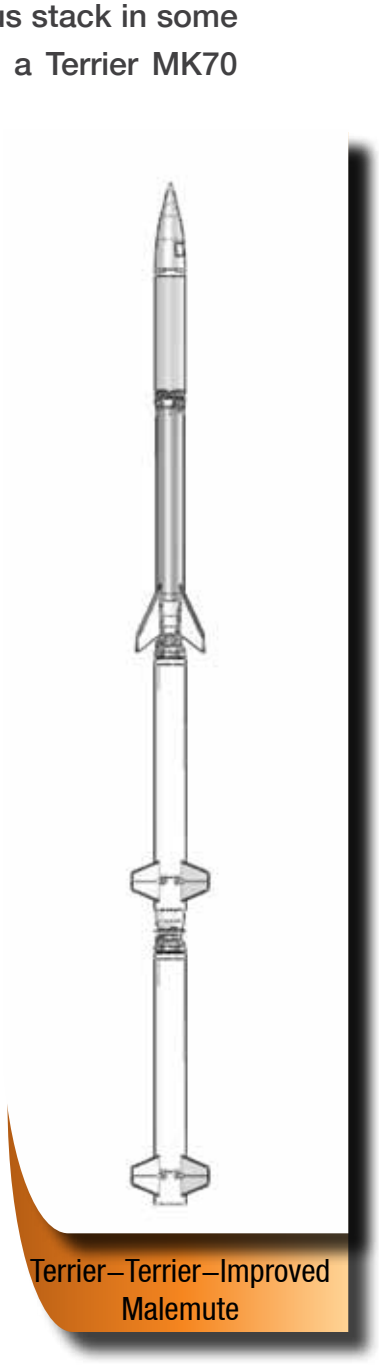
41.083 NP Bull - SubTEC III

New Vehicle Development

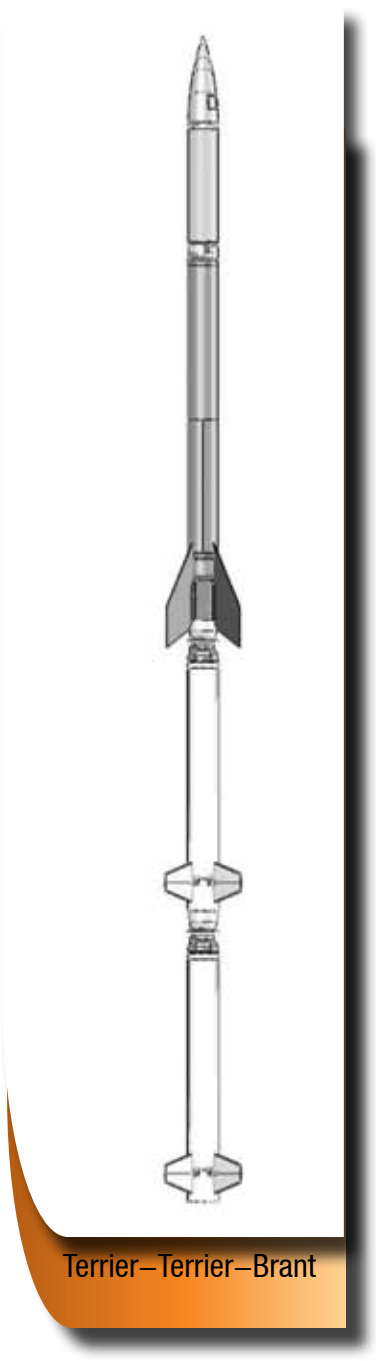
Good progress has been made on vehicle development efforts ranging from small spin motors to new multi-stage vehicle configurations. Development of the second test flight vehicle of the Terrier-Improved Malemute is underway. A new spin motor grain configuration is being developed with the Navy that will reduce hazard classification and provide reliable performance. A Booster study was conducted with the Air Force that investigated numerous vehicle stack configurations. The most promising performance combination consists of two Terrier MK 70 motors. This combination shows performance close to that of the Talos-Taurus stack in some configurations. Potential also exists to add a Terrier MK70 to the new Terrier-Improved Malemute, resulting in an "all surplus" three-stage high performing vehicle.



Spin motor



Terrier–Terrier–Improved Malemute



Terrier–Terrier–Brant

Testing & Evaluation Lab

A new Unholtz-Dickie 6,000-lbf Vibe System is now available in the Testing and Evaluation Lab. This 2-inch stroke shaker has improved component shock capabilities.

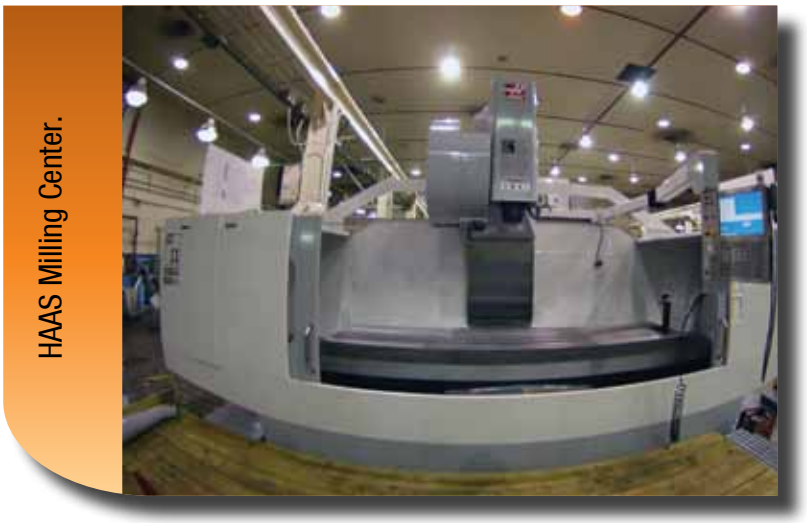
Upgrades also include a Data Physics Vibration Amplifier. The 330-KVA amplifier supports existing shakers and allows for shaker upgrades up to 40,000 lbf.

Unholtz–Dickie Vibe System.

Machine Shop

A HAAS Milling Center, with a 120” x 40” x 28” work space, has been added to assist with backlog of mill work. This machine is capable of complex parts via the MasterCAM interface.

The Clausing Manual Knee Mill, added this year, will off-load the larger mills and is used for smaller parts. It is also suitable for quick turn-around parts needed during T&E.



HAAS Milling Center.

Clausing Manual Knee Mill.

White Sands Missile Range, New Mexico


VAB construction at WSMR.


Dark room.

After many years of making the most with the least, a consolidated effort to upgrade the facilities at WSMR is now underway. The upgrade plan consists of a multi-year, three-phase project to provide new integration laboratories, technical work areas, additional office space, and a conference facility. Once complete, NASA plans to consolidate all operations at WSMR into one geographic location at Launch Complex 36. This will ultimately lead to greater operational efficiency and potential cost savings as older (Navy owned) facilities the SRPO uses at LC-35 can be abandoned.

A new storage facility was recently completed on the east side of the VAB which will provide both temperature controlled storage for critical space flight hardware and non-temperature controlled space for other hardware. The dark room in the VAB low bay recently completed a major rehab to make the area more efficient for dark room activities and also included a major HVAC upgrade that will help ensure cleanliness is maintained for critical optical instruments. The Phase I construction contract was awarded in late August and construction is underway. Phase I is a new 2-story addition on the northwest corner of the VAB that will house a new large integration laboratory on the first floor and office and conference space on the second floor to accommodate the NSROC staff permanently assigned to WSMR. The Phase II design is complete and currently being sent through procurement. It is anticipated construction will be begin in the second quarter of FY 2011. Phase II will consist of technical work areas for air bearing, optics, pneumatics, solar payload alignment, and electronics. Phase III is currently on the drawing board and will consist of a major facility rehab of the east side of the VAB, which houses mostly the Telemetry ground station.

RockOn! teams with payload.

Education & Worforce Development

RockOn!

In June the Colorado and Virginia Space Grant Consortia, supported by the NASA Sounding Rockets Program Office, the NASA Sounding Rocket Operations Contract (NSROC) and the NASA Space Grant Office at NASA Headquarters, arranged the third successful RockOn! mission. University students and faculty from around the country arrived at Wallops on Saturday, June 19th to participate in a weeklong space flight workshop. During the workshop participants learned how to build, test, integrate and fly an experiment on a NASA sounding rocket.


RockSat integration.

Working in teams of three or four, each group received an experiment kit consisting of an AVR microprocessor, various sensors, mounting hardware and programming software. From this box of hardware, by midweek, emerged a complete spaceflight experiment with datalogging capability.


RockSat integration.

Chris Koehler, Director of the Colorado Space Grant Consortium, is the instructor for the RockOn! workshop. He is assisted by several students from the University of Colorado. These students have been intimately involved in creating the experiment package and the software routines that enable collection of data during the flight.


RockOn! workshop.

The payload also contains seven RockSat-C canisters, which house custom built self-contained experiments provided by selected universities. Each experiment was selected for a flight opportunity as part of a competitive selection process. RockSat-C experiments are provided by University of Northern Colorado, Colorado State University College of Engineering, Temple University of Louisiana at Lafayette, University of Colorado at Boulder, University of Minnesota, West Virginia University, University of Puerto Rico, University of Wyoming, Virginia Tech, and College of Menominee Nation.

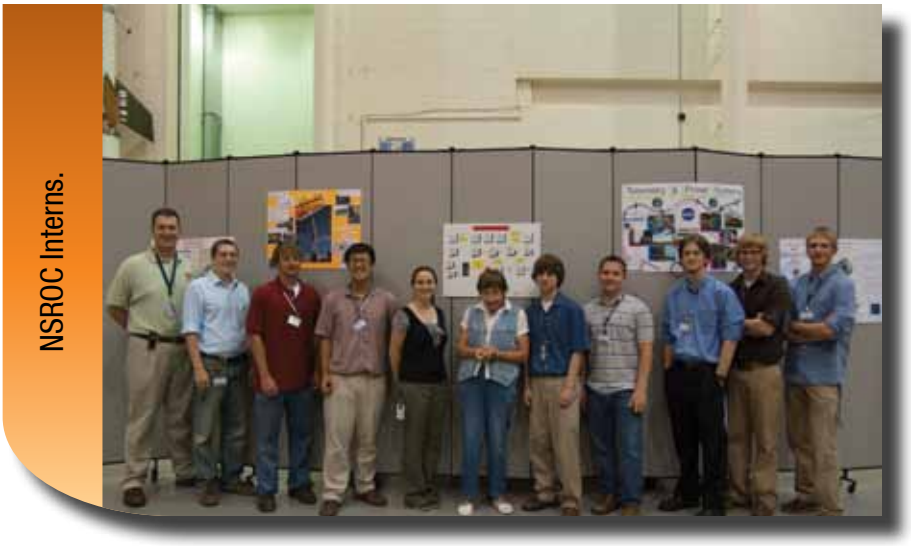

RockSat de–integration.

On launch day the teams headed out to Wallops Island early in the morning. The launch window opened at 6 a.m. and the countdown started a few hours before that. As the count neared zero, the crowd's excitement rose and the last 10 seconds were almost heart stopping. The viewers aided in the count and on T - 0, the Terrier booster ignited with a roar. A short burning booster, the Terrier burned out after about 5 seconds, and the Orion sustainer took over after a short coast phase. At an altitude of about 110 km the payload separated from the Orion and coasted to reach an apogee of 117 km. On the downleg a parachute was deployed to soften the impact of the payload. The payload was sealed and remained floating in the water until it was picked up by the recovery boat. Once the payload was back at Wallops Flight Facility the experiments were returned to the students and post-flight checks and data analysis began.

RockOn! launch viewing.

Interns

Over 120 students have participated in the internship program managed for the Sounding Rockets Program Office by the NASA Sounding Rocket Operations Contract. The program, now in its 11th year, provides internships and co-op opportunities for students studying engineering, computer science and electrical or mechanical technology. Students work side-by-side with experienced engineers and perform significant, valuable engineering tasks, leading to a better understanding of engineering, better grades and solid experience in a business environment.



NSROC Interns.

Almost 90 percent of undergraduate students who intern or participate in the co-op program return for additional employment prior to graduation. Participants in the program have gone on to pursue higher education and careers in the engineering and science fields; three participants have doctorate degrees, 18 have or are pursuing master's degrees, and 14 are full-time employees in the Sounding Rockets Program.

StepUP interns.

Additionally, two interns participating in the StepUP program were mentored by Sounding Rockets Program Office staff. The interns, both headed to college for engineering studies, had the opportunity to test model rockets in a wind tunnel, analyze drag models, and conduct a post-flight mission evaluation of a sounding rocket flight.

Hands-On Project Experience (HOPE) – NASA in-house training opportunity

In December 2008, NASA released the Hands-On Project Experience (HOPE) Training Opportunity (TO) to solicit NASA Center proposals to develop an in house payload to be launched on a sounding rocket. The short mission completion times and many existing subsystems, such as telemetry, recovery, and attitude control, make sounding rockets an optimal carrier vehicle option for the first HOPE payload.

Heyne payload team.

One goal of the TO is to provide hands-on flight project experience to enhance the technical, leadership and project skills for the selected NASA in-house project team. This opportunity includes experience in proposal development, and upon selection, development of a scientific investigation, payload integration and testing, integration of the payload with the launch vehicle, conducting flight operations including data collection and analysis, and project management.

The first HOPE project selected for flight is the Terrain Relative Navigation and Employee Development (TRaiNED), Jet Propulsion Laboratory's response to the request for proposals. The TRaiNED project will advance Terrain-Relative Navigation (TRN) technology by collecting a set of correlated ground imagery, Inertial Measurement Unit (IMU) and Global Positioning System (GPS) data during a sounding rocket flight and performing post-flight data analysis.

Heyne team after payload vibration testing.

Wallops Rocket Academy for Teachers and Students (WRATS)

With the increasing importance of Science, Technology, Engineering and Math education, the Sounding Rockets Program Office is interested in supporting the local education community by establishing a rocketry workshop program, the Wallops Rocket Academy for Teachers and Students. The pilot program was conducted in the summer of 2010 and collaboration with the Student Launch Initiative (SLI) at Marshall Space Flight Center is being investigated. Workshops lasting 3-5 days are envisioned as part of the WRATS program and would allow participants to build, test and fly model rockets, as well as explore basic principles of rocket flight. The intent of the workshops is to familiarize students and faculty with using model rockets as educational tools, and gain confidence to enter more advanced programs such as SLI.

WRATS launch.

WRATS construtution.

WRATS staging.

WRATS pre–launch check.

Employee Highlight - Eric Johnson

Eric Johnson, currently working in the Electrical Engineering department, has worn many hats in support of the Sounding Rockets Program.

How long have you been working with sounding rockets?

I have been working with different aspects of sounding rockets for 35 years. I began my career at Wallops as an electrical instrument maker in 1975. In the electrical shop we were responsible for the fabrication of printed circuit boards (which at that time were done entirely by hand), chassis fabrication for sounding rockets and any other projects on the base. After a program reorganization I was assigned as the shop lead. I served in this capacity, as well as working as an electronic technician on sounding rocket missions until 1985, at which time I transferred to mobile telemetry. After about a year in mobile telemetry I returned to the shop supervisor position where I remained until the NSROC I contract in 1999. I now work in the Electrical Engineering department.

Eric Johnson

Eric with the SubTEC payload.

What made you consider a career in aerospace?

When I came to Wallops in 1975 I had responded to a help wanted ad in the Baltimore Sun for someone with electronics background. I had no idea what the job entailed when I responded. I was intrigued by the fact the job was listed as working as a contractor for NASA. When coming to the Eastern Shore of Virginia and learning more about the job and being shown around the base, I knew I wanted to be a part of the Wallops team. At that time only a part of the sounding rocket program was handled by Wallops. The solar missions were managed by Goddard Space Flight Center in Greenbelt, Maryland. A few years later the solar payloads also were transferred to Wallops. Adding the solar missions increased the number of payloads flown and also broadened the base of experimenters. Some of those experimenters, both solar and plasma physics, are still flying sounding rocket payloads. I am glad to have a continuing working relationship with those experimenters and even some of the newer ones who were grad students when I began.

You have travelled to several remote locations to launch rockets. Could you describe the most memorable mission?

Eric in Kwajalein.

The most memorable mission I have is my first mission to Sweden in the winter of 1980. That was only my second time flying in an airplane and my first trip outside of North America. The rocket launches from Peru in 1983 are also unforgettable. Additionally, I've launched rockets from Norway, Marshall Islands, Alaska, Hawaii, and New Mexico.

Any recommendations for students thinking about a career in aerospace?

Get a good education and when offered an opportunity be ready to take it. Growing up as a poor farm boy, joining the Navy to see the world, but not getting to do much travelling while in the service, the sounding rocket program provided me all the thrill I could imagine. There are very few professions that provide opportunities to see the world. The experiences I have had while travelling to launch rockets are truly unique and very educational. Missions like the auroral studies take place in the winter at locations near the Arctic Circle. There is a lot of snow and generally it's pretty cold. It's been a life-long learning experience. As the saying goes; take the good with the bad.
For me there has always been a sense of pride and accomplishment with any mission I have been associated with. I cannot explain the feeling one gets when the rocket leaves the pad. That feeling gets me even more now in performing the launch officer duties at Poker Flat, Alaska. The rush that goes through me when the count hits zero and I push that button to send all that hard work skyward is incredible. It is a feeling few people ever get to experience. I am proud to be part of the work that takes place at Wallops and the team that brings to light new science and a new understanding of what goes on in the heavens.

Watching sea turtles in Kwaj.

Whirlpool Galaxy by Hubble.

On the Horizon

Astrophysics from Poker Flat, Alaska

Far-ultraviolet Imaging Rocket Experiment (FIRE) from University of Colorado is scheduled to be launched from Poker Flat, Alaska in February 2011. FIRE expands the science missions conducted from Poker Flat Research Range to include astrophysics. Additional unique requirements for this mission include new cleanroom facilities and recovery of the payload.

Scientist preparing instrument for testing.

FIRE will image a spectral region unexplored astronomically. The imaging band of FIRE (~900~1100 Å) will help fill the current wavelength imaging observation gap existing from ~620 Å to the Galaxy Evolution Explorer (GALEX) band near 1350 Å. Demonstration of the usefulness of the FIRE wavelength band will lead to the development of space-based missions that could find and study quasars, star forming regions and galaxies, and other UV bright objects.

The first flight of FIRE will image star forming regions within the Whirlpool galaxy (M51). Star formation typically produces the hottest, brightest types of stars, O stars, 30,000-50,000 °C. The emission peaks of O stars are within the FIRE waveband and constitute a majority of all the observed light emitted at these wavelengths. Therefore, the 900-1100 Å band provides the most sensitive indicator of young, massive stars. Combining this information with UV and visible wavelength data from other missions and comparing the spectral colors to stellar evolution models will help with the determination of the star formation history. Studying the light of a nearby galaxy will help us understand the redshifted light arriving from galaxies farther away. When performed over many galaxies at differing redshifts, the star formation history of the universe can be directly studied.

International Campaigns

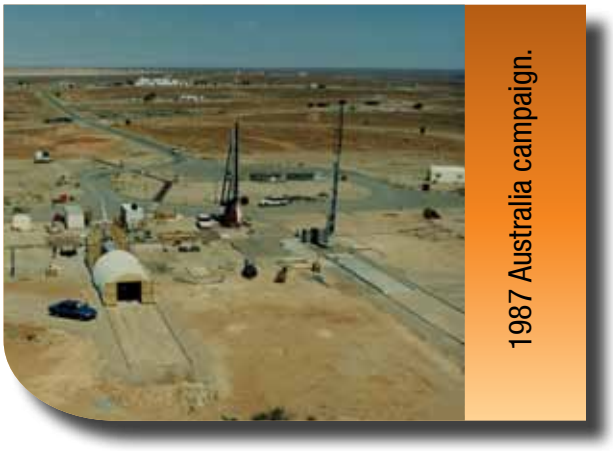
Proposals have been submitted to NASA Headquarters to conduct research missions from Kwajalein Atoll. The SRPO and NSROC employees are also investigating the possibility of a return to Woomera, Australia, with the added capability of launching Black Brant XIs. While these exciting new possibilities are currently in the planning stages, the campaigns would not likely begin before the 2012-2013 timeframe

2004 Kwajalein campaign.

Missions from Andoya Rocket Range, Norway

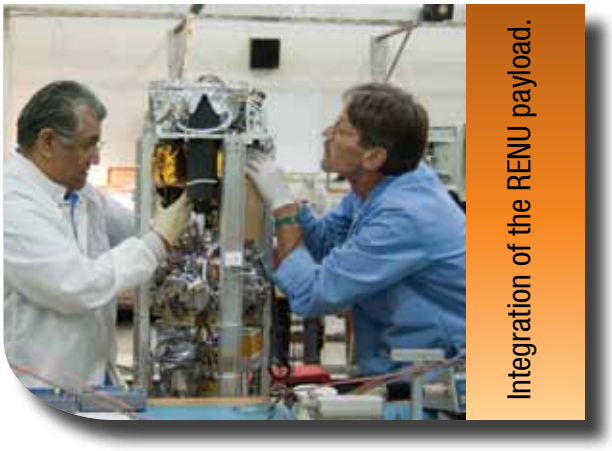
Lessard 40.026 UE - Rocket Experiment for Neutral Upwelling (RENU)

RENU has been designed to investigate further the phenomena associated with thermospheric upwelling in the cusp. This mission will launch the experiment to an apogee of about 600 km into the cusp from Andøya Rocket Range in Norway. RENU will transit the cusp region during a neutral upwelling event, equipped with a suite of instruments that will build on previous observations of this phenomenon, as well as acquire new types of data to provide a fresh perspective on this problem.The payload includes instruments to measure neutral gas, electric and magnetic fields, and precipitating particles.



1987 Australia campaign.

RENU ACS testing.



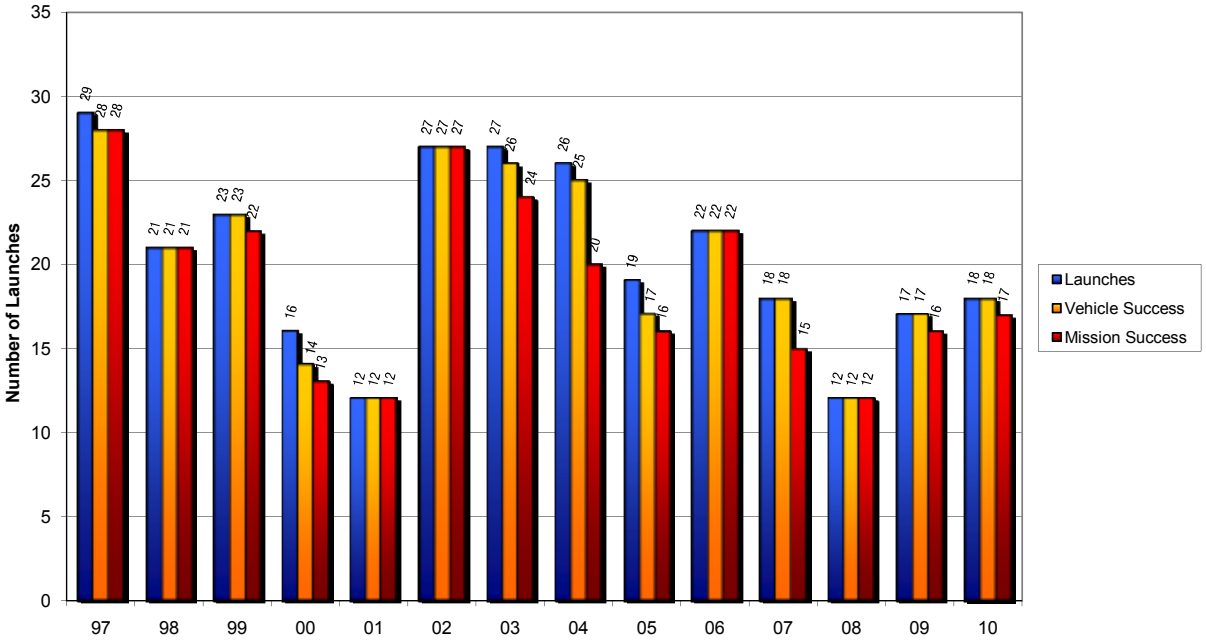
Integration of the RENU payload.

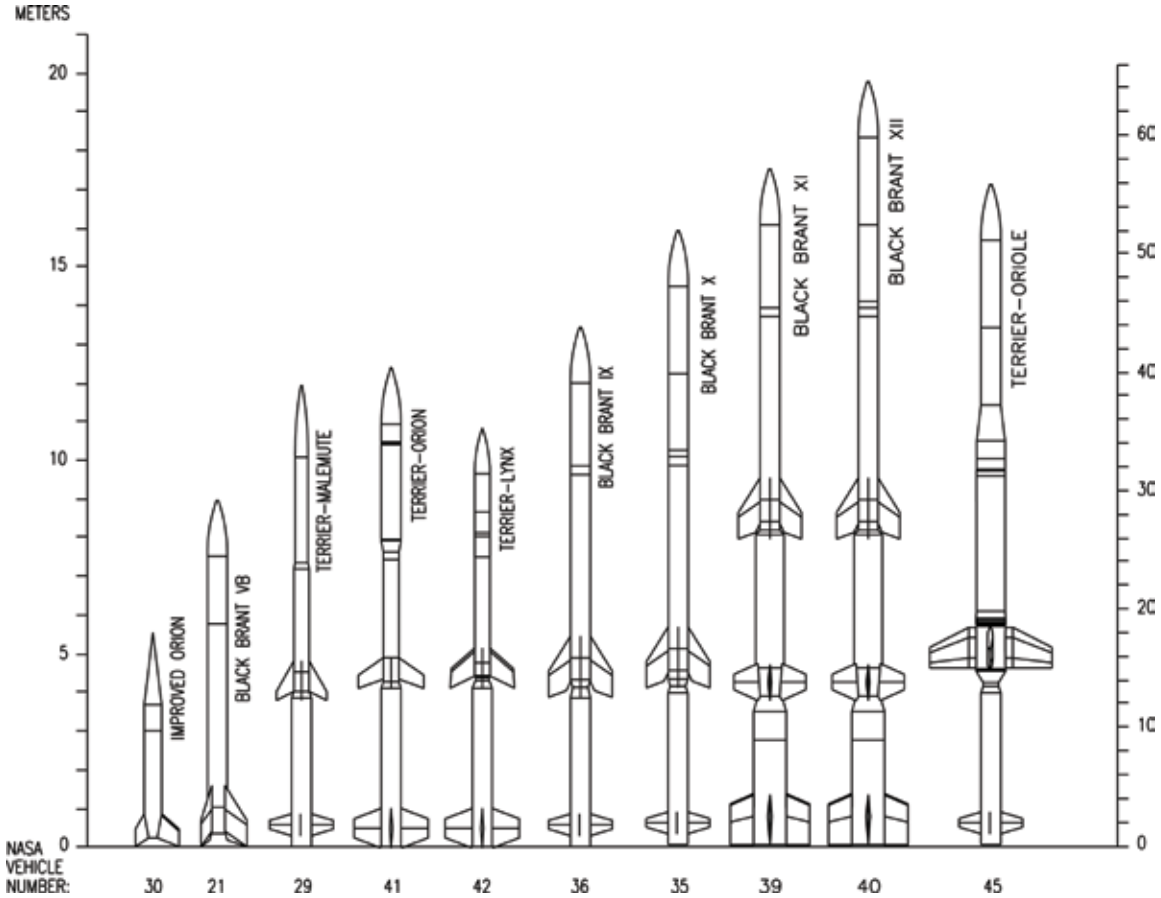
Robertson 41.093 & 41.094 - Charge and Mass of Meteoritic Smoke Particles (CHAMPS)

The scientific objectives of the two rockets are to detect and measure the meteoritic smoke particles in the Mesosphere that have long been thought to be the condensation nuclei for noctilucent clouds. The launches are from the Andøya Rocket Range in Norway in order to benefit from simultaneous meteor radar and lidar observations that will give a more comprehensive view of the state of the Mesosphere. The payloads will have the Mesospheric Aerosol Sampling Spectrometer (MASS) facing the ram direction, and additional instruments for particle impact, solar UV illumination, electron density, and ion density. Two payloads will be launched successively into daytime and nighttime conditions in the fall when NLC particles will not affect the data.

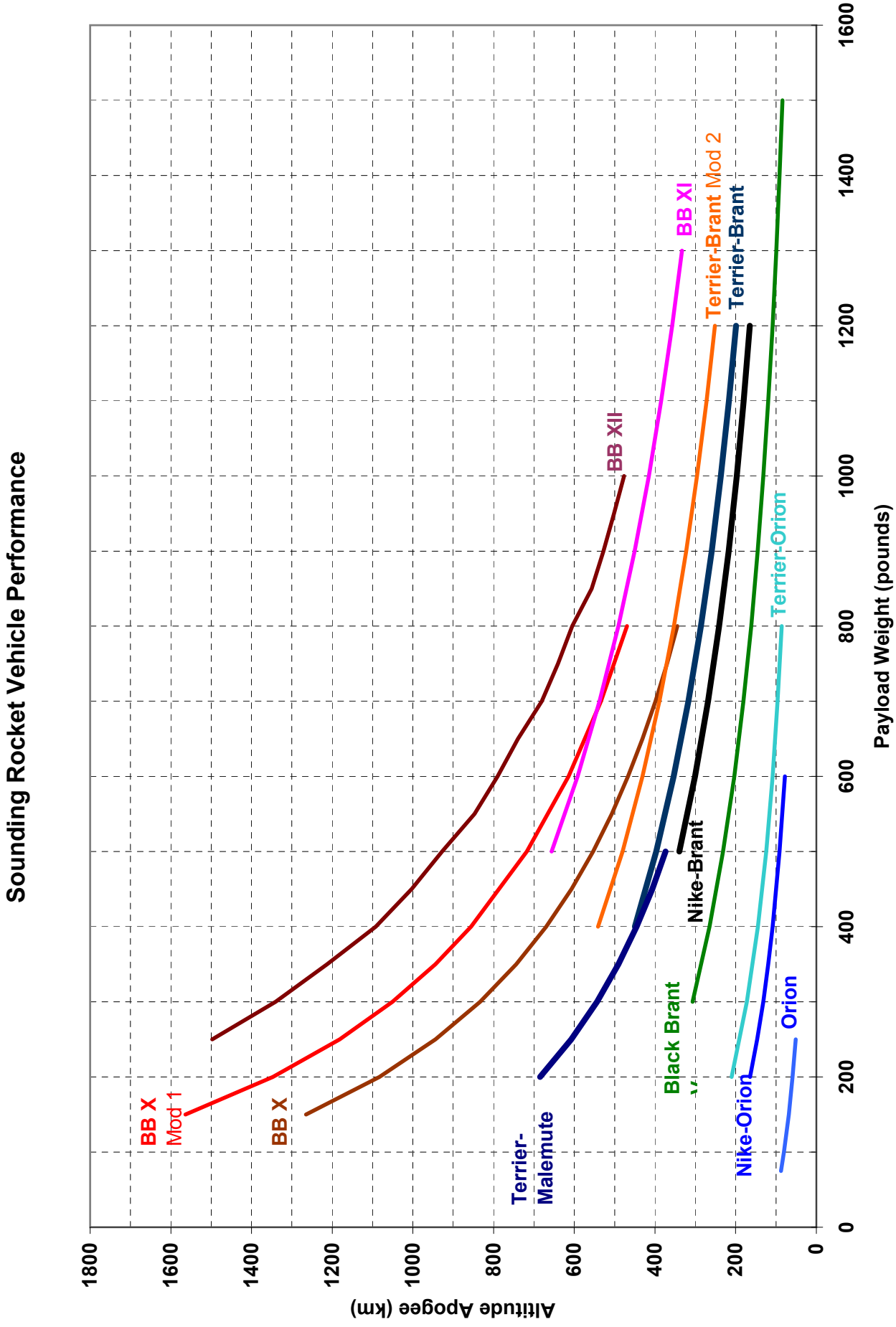
Statistics

Sounding Rocket Launches
FY 1997 - 2010
Total number of launches: 287





Ten vehicles ranging from a single stage Orion to a four stage Black Brant XII make up the core of the Sounding Rockets Program. New vehicles, the MLRS–Dart and Terrier–Improved Malemute will be added in the near future. Above: relative scale of the currently available vehicles. Below: Vehicle performance altitude vs. payload weight.


Sounding Rocket Vehicle Performance
Altitude Apogee (km)
Payload Weight (pounds)
0
200
400
600
800
1000
1200
1400
1600
1800
0
200
400
600
800
1000
1200
1400
1600
BB X
Mod 1
BB X
BB XII
BB XI
Terrier-Brant Mod 2
Terrier-Brant
Nike-Brant
Black Brant
Terrier-Orion
Nike-Orion
Orion
Terrier-
Malemute

Poker Flat, Alaska

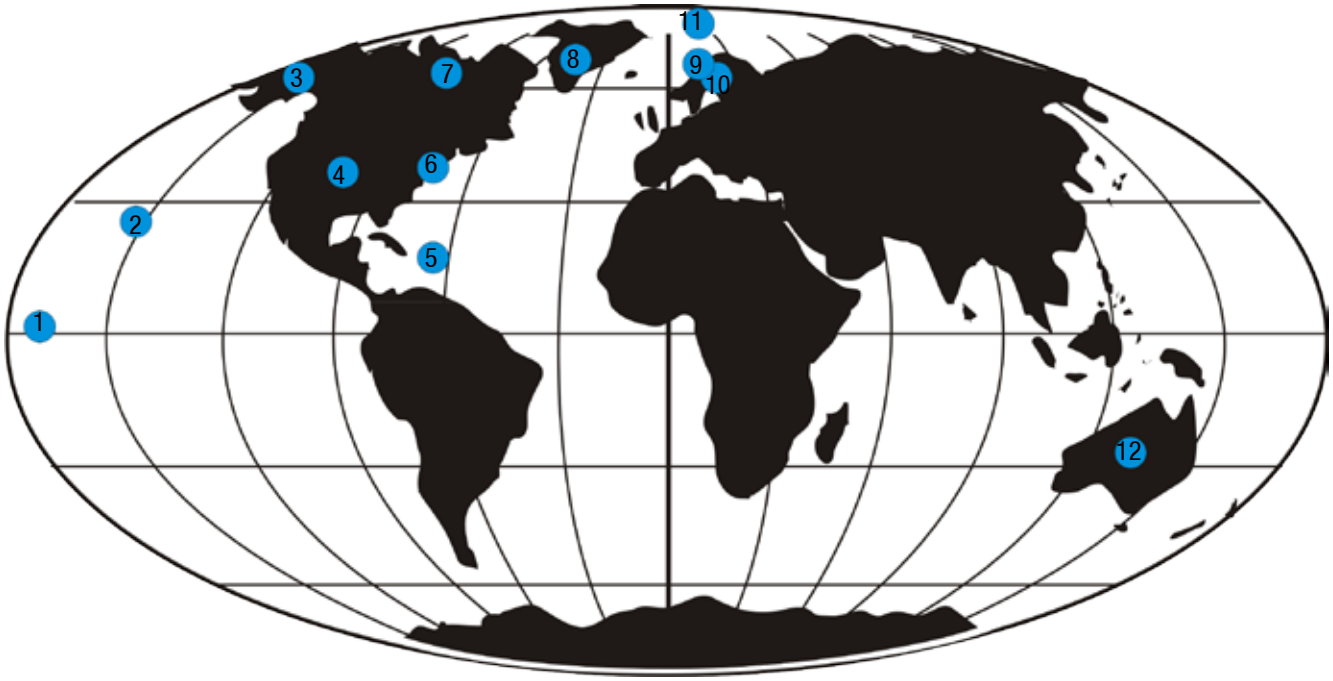
Esrange, Sweden

Kwajalein, Marshall Is.

Andoya, Norway

Woomera, Australia

Wallops Island, Virginia



Past and present world wide launch sites used by the Sounding Rockets Program to conduct scientific research:

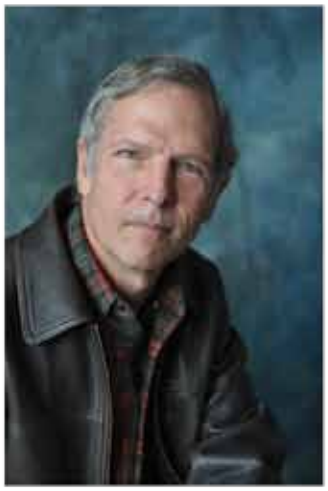
1. Kwajalein Atoll, Marshall Islands
2. Barking Sands, HI
3. Poker Flat, AK
4. White Sands, NM
5. Camp Tortuguero, Puerto Rico *
6. Wallops Island, VA
7. Fort Churchill, Canada *
8. Greenland (Thule & Sondre Stromfjord) *
9. Andoya, Norway
10. Esrange, Sweden
11. Svalbard, Norway
12. Woomera, Australia

* Inactive launch sites

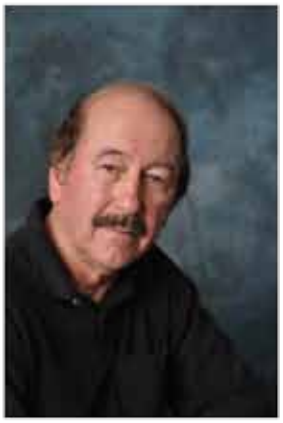
Sounding Rockets Program Office

Sharon H. Truitt
Secretary

Philip J. Eberspeaker
Chief



Emmet D. Ransone
Assistant Chief



John C. Brinton
Grants Manager

Charles L. Brodell
Vehicle Systems Manager

Brian A. Hall
Technology Manager

John C. Hickman
Operations Manager

Giovanni Rosanova
Payload Systems Manager

Norman E. Schultz
NSROC COTR

Elizabeth L. West
SRPO Projects Manager

Julie Bloxom
Resource Analyst

Contact Information

Philip J. Eberspeaker
Chief, Sounding Rockets Program Office
Ph: 757-824-2202
Email: Philip.J.Eberspeaker@nasa.gov

Emmett D. Ransone
Asst. Chief, Sounding Rockets Program Office
Ph: 757-824-1089
Email: Emmett.D.Ransone@nasa.gov

Sharon H. Truitt
Secretary
Ph: 757-824-1615
Email: Sharon.H.Truitt@nasa.gov

Norman E. Schultz
NSROC COTR
Ph: 757-824-1923
Email: Norman.E.Schultz@nasa.gov

John C. Brinton
Grants Manager
Ph: 757-824-1099
Email: John.C.Brinton@nasa.gov

John C. Hickman
Operations Manager
Ph: 757-824-2374
Email: John.C.Hickman@nasa.gov

Charles L. Brodell
Vehicle Systems Manager
Ph: 757-824-1827
Email: Charles.L.Brodell@nasa.gov

Elizabeth L. West
SRPO Projects Manager
Ph: 757-824-2440
Email: Libby.West@nasa.gov

Brian A. Hall
Technology Manager
Ph: 757-824-1477
Email: Brian.A.Hall@nasa.gov

Giovanni Rosanova
Payload Systems Manager
Ph: 757-824-1916
Email: Giovanni.Rosanova@nasa.gov

References

Design Review and Mission Initiation Conference documents for the following missions:
36.252 UH Cash/Univ. of Colorado
12.068 GT Hickman/NASA-Wff
41.086 UE Erdman/Embry-Riddle Univ.
41.084 UE Conde/University of Alaska
40.025 UE Labelle/Dartmouth College
12.067 GT Hall/NASA-Wff
36.258 UE Woods/Univ. of Colorado
36.270 UG Green/Univ. of Colorado
41.088 UO Koehler/Univ. of Colorado
36.265 UG Bock/Cal Tech
36.213 NS Davis/MSFC
12.073 GT Hall/NASA-Wff
36.219 US Hassler/SWRI
41.087 NT Heyne/JPL
41.082 NP Bull/NASA WFF
Information from the SDO website: http://sdo.gsfc.nasa.gov/
Colorado EVE website: http://lasp.colorado.edu/eve/index.htm and the GSFC NEWS Tech Transfer, Vol 7, No.3 Winter 2009

Credits

Cover launch photo of the Terrier-Improved Malemute by Jacob Owen/NASA Wallops Imaging Lab. Insert photos see credit for page 4 below.

Photos by Berit Bland/BBCO except as noted below.

2 – John Brinton/SRPO

4 – Sun - Image Credit: SOHO; Rosette Nebula - ESA and the PACS, SPIRE & HSC consortia, F. Motte (AIM Saclay,CEA/IRFU - CNRS/INSU - U.ParisDidedrot) for the HOBYS key programme; Aurora –Scott Hesh; Andromeda Galaxy – NASA JPL/Caltech

7 – Emmett Given/NASA Marshall Space Flight Center

8 - NASA/TRACE

11 -Terrier-Improved Malemute launch – Jacob Owen/Wallops Imaging Lab
Payload rendering – Shane Thompson/NSROC

12 - Staging motors – Lee Wingfield/Wallops Imaging Lab

15 –Visual Information Branch/White Sands Missile Range

16 – Launch photos - Jacob Owen/Wallops Imaging Lab

18 – Rocket on the pad - Lee Wingfield/Wallops Imaging Lab

20 – Rocket launch photo - Jacob Owen/Wallops Imaging Lab

21 - Visual Information Branch/White Sands Missile Range

22 - Visual Information Branch/White Sands Missile Range

23 - Jacob Owen/Wallops Imaging Lab

24 - Visual Information Branch/White Sands Missile Range

25 - Visual Information Branch/White Sands Missile Range

26 – Rocket on the pad - Jacob Owen/Wallops Imaging Lab

27 - Visual Information Branch/White Sands Missile Range

28 - Jacob Owen/Wallops Imaging Lab

29 - Jacob Owen/Wallops Imaging Lab

30 - X-band antenna testing- Steve Bundick/AETD

32 - ALVS system

37 - Visual Information Branch/White Sands Missile Range

45 – Bruce Scott/NSROC

42 - Whirlpool Galaxy – NASA, ESA, S. Beckwith (STScI), and The Hubble Heritage Team (STScI/AURA)

48 – Kwajalein rockets – BruceScott/NSROC
Australia Range – Wallops Imaging Lab

54 - John Brinton/SRPO

58 - Jacob Owen/Wallops Imaging Lab

Report Design by Berit Bland/BBCO
Editor Micaela Barnhill/CSC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Notes

National Aeronautics and Space Administration

Goddard Space Flight Center
Wallops Flight Facility
34200 Fulton Street
Wallops Island, VA 23337
www.nasa.gov/centers/wallops

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