National Aeronautics and Space Administration

Sounding Rockets Program Office Quarterly Newsletter

Rocket Report

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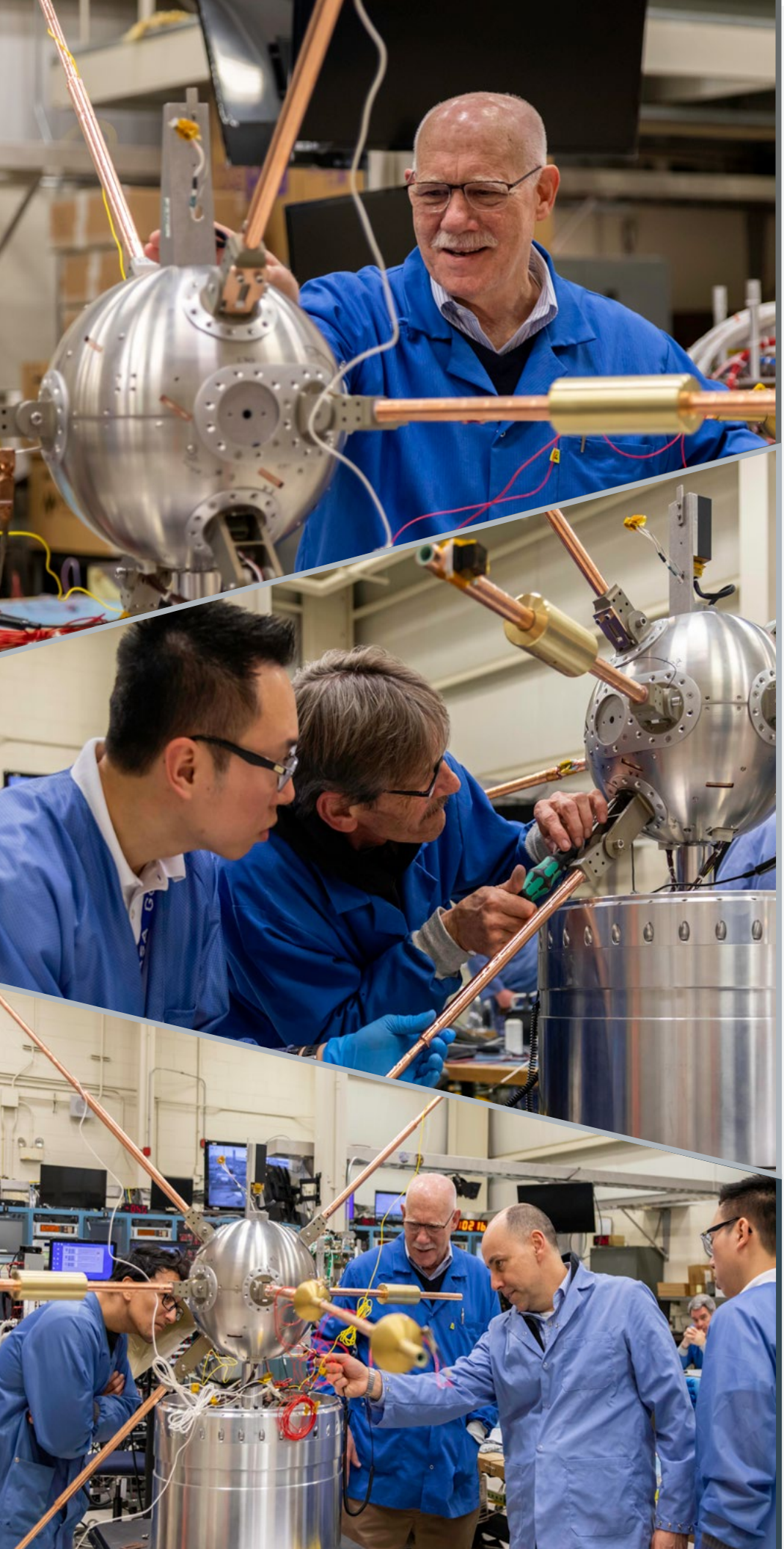
2021



INSIDE

Cover photo:
46.028 UE Bonnell launching from Wallops Island, VA. Credit: NASA photo/Terry Zaperach.

Pictures taken prior to Covid–19.

36.322 NS Daw on the launch pad at White Sands Missile Range, NM. Photo by: White Sands Missile Range.

Program Overview

Mission integration and testing activities have been scheduled in accordance with rules outlined in the program wide restart package. By keeping the total footprint in F–10 to a minimum, electrical and mechanical manufacturing have been able to continue to work onsite to help keep mission hardware moving forward. Payload teams involved in approved missions have returned to limited onsite work necessary to complete mission integration and testing.

Other mission preparations, such as mission milestone meetings, have been performed as scheduled for future flights. Facility inspections have also been performed on a regular basis.

A total of six launches were conducted this quarter, supporting Geospace Science, Solar Physics, Astrophysics, and Education.

36.324 US Harris/University of Arizona - Spatial Heterodyne Interferometric Emission Line Dynamics Spectrometer (SHIELDS)- launched April 19, 2021

The SHIELDS mission was successfully launched on April 19 from the White Sands Missile Range in New Mexico.

The purpose of this mission was to obtain a spatial map of scattered solar ultraviolet (UV) emission from interplanetary hydrogen (IPH) that has crossed, and been modified by, the ion pile–up along the outer edge of the heliosphere. The map will be constructed along multiple lines of sight over a 30° diameter region of the sky located near the location corresponding to the relative velocity vector between the Sun and the local interstellar medium (LISM).

Our solar system is located in an area called the Local Bubble, a cavity cleared by ancient supernova blasts and defined by lower neutral–hydrogen density than the surrounding Interstellar Medium. The Local Bubble is about 300 light–years long within the spiraling Orion arm of our Milky Way galaxy.

The heliosphere, a bubble inflated by plasma originating from the Sun, known as the solar wind, encases the solar system and travels through the Local Bubble at about 52,000 miles per hour (23 kilometers per second). Interstellar particles interact with and deform the heliopause, the boundary between the heliosphere and interstellar space. How and where the heliopause deforms shows the nature of the interstellar space outside it. Gathering data on this deformation was the primary goal of the SHIELDS mission.

SHIELDS measured emission from neutral hydrogen. How the wavelength from the emission stretches or contracts reveals the particles' speed. SHIELDS will produce a map to reconstruct the shape and varying density of matter at the heliopause.

SHIELDS on the launcher at WSMR. Credit: Visual Information Branch/WSMR.

SHIELDS team at WSMR. Credit: Visual Information Branch/WSMR.

52.007 UE Delamere/University of Alaska - Kinetic-scale Energy and momentum Transport eXperiment (KiNET-X) - launched May 7, 2021

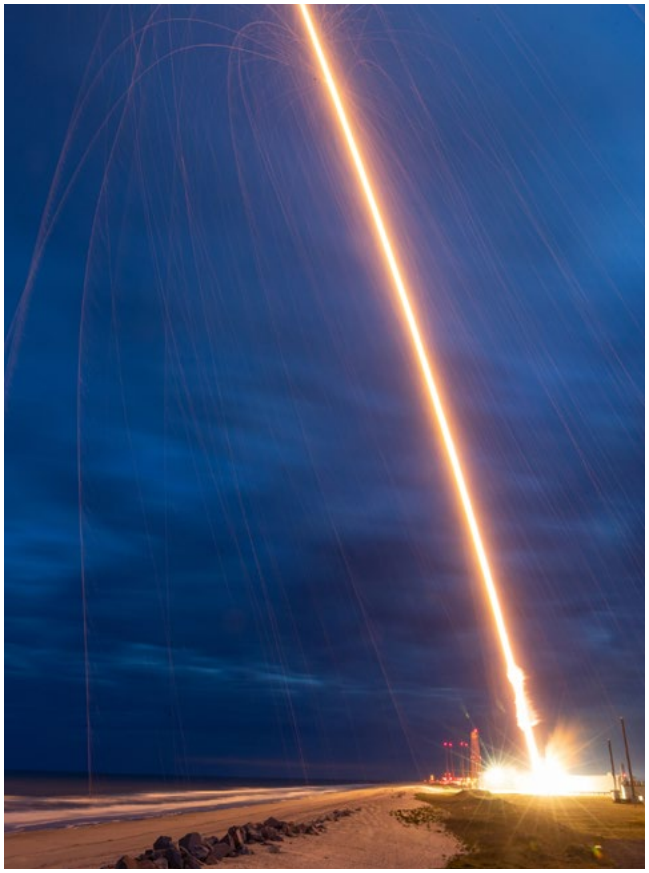
The KiNET–X mission was successfully launched on May 7 from Wallops Island, VA.

KiNET–X was designed to enhance our understanding of a key aspect of heliophysics and auroral physics: the energy and momentum coupling between spatially separate but magnetically linked plasma regimes. With known energy and momentum input, KiNET–X was designed to test the understanding of kinetic–scale transport. In particular, these questions are addressed: 1) how momentum transport is affected by ion kinetic–scale physics, 2) how electromagnetic energy is converted into plasma kinetic and thermal energy, 3) the interplay between fluid– and kinetic–scale processes.

The KiNet–X experiment was launched on a four stage Black Brant XII–A vehicle and consisted of seven separable payloads. Two barium vapor clouds emitted from the payload generated a magnetic field perturbation and caused electrons to be energized. Diagnostic instrumentation was carried on the main payload and four small subpayloads. This allowed for a multiple–point view of the disturbances created by the barium vapor releases. The four small subpayloads, also known as SWARM/Bob ejectables, made measurements of the space environment through which the barium–vapor–induced disturbance travels.

This was the first operational flight of the SWARM/Bob ejectables. Four Bobs were ejected for the constellation data collection. Several upgrades have been made to the SWARM system for this flight, including modular battery pack, for longer data collection times on the sub–payloads, and a miniature GPS package, for improved location information during flight. Additionally, a dual–channel "Marko" receiver for the main payload has been developed. This enables one receiver to track two ejectables, or two receivers to track four ejectables. The SWARM system is developed by NASA Engineering and Technology Directorate (ETD) and the Sounding Rockets Program Office (SRPO).

Barium vapor clouds from KiNET–X. Photo credit: Dr. Delamere



KiNET–X launch from Wallops Island, VA. Photo credit: NASA/Allson Stancil

36.322 GS Daw/NASA Goddard Space Flight Center - Extreme Ultraviolet Normal-Incidence Spectrograph (EUNIS)- launched May 18, 2021

The EUNIS mission was successfully launched on May 18 from the White Sands Missile Range in New Mexico.

EUNIS will contribute to explaining the mechanisms that maintain hot plasma (> 1 MK) in solar corona active regions, a longstanding unresolved question in solar physics. The widespread, faint line emission from superhot plasma predicted by the nanoflare model of coronal heating was observed by EUNIS during the 2013 sounding rocket flight.

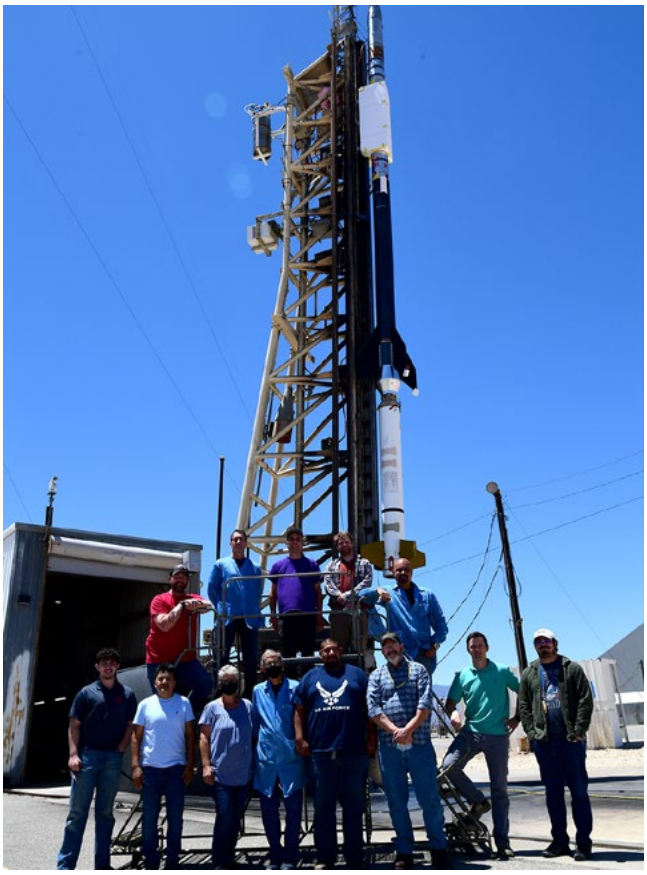
For EUNIS 2021, in addition to the 527–637 Å channel, a new 89–112 Å channel was flown. This new band had not been observed before with an imaging spectrograph.

This mission also aims to:

- Further test theories of coronal heating by quantifying the faint signature of subresolution impulsive events, using the brightest of the hot (4–10 MK) emission lines, Fe XVIII 93.93 Å and Fe XIX 108.36 Å.
- Derive accurate and reliable temperature response curves for the Solar Dynamics Observer (SDO), specifically, the shortest wavelength band (94 Å) of the Atmospheric Imaging Assembly (AIA).

This was the fourth flight of EUNIS.

EUNIS on the launcher at WSMR. Credit: Visual Information Branch/WSMR.



EUNIS team at WSMR. Credit: Visual Information Branch/WSMR.

46.028 UE Bonnell/University of Berkeley - Vlf trans-Ionospheric Propagation Experiment Rocket (VIPER) - launched May 27, 2021

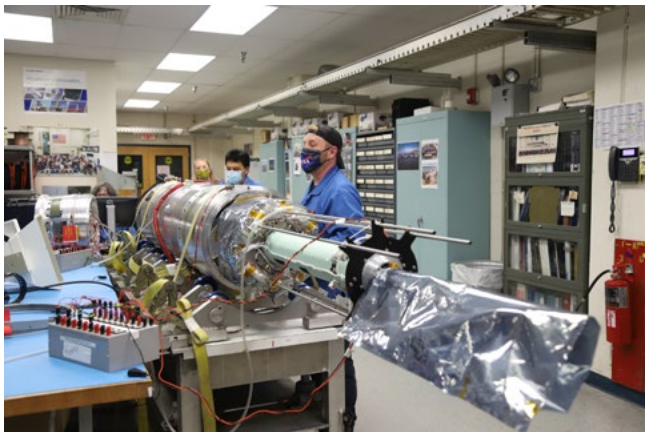
The VIPER mission was successfully launched on May 27 from Wallops Island, VA.

The VIPER mission was an observational and modeling effort to understand very low frequency (VLF) wave penetration through and propagation above the Earth's ionosphere

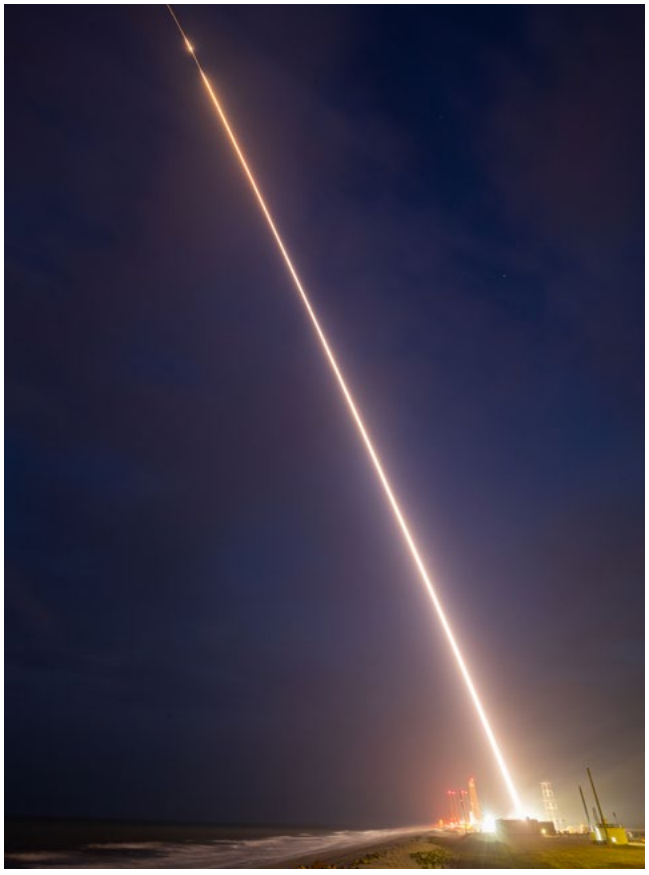
VIPER studied VLF radio waves produced by both natural phenomena, such as lightning, and human technology such as radio transmitters. Daytime conditions in the ionosphere (high plasma densities) reflect or absorb nearly all the VLF that impinges on the ionosphere from below. At night, however, as the ionospheric plasma recombines, reflection and absorption are reduced, and geo–physically significant amounts of VLF radiation can leak out along the Earth's magnetic field.

The Van Allen Radiation Belts, zones of intense energetic electron fluxes, cover a range of distances from the Earth, from as close as14,300 miles altitude (~4.4 Earth radii) out to 23,500 miles altitude (~7 Earth radii). The VLF frequencies and wavelengths studied by VIPER can scatter and accelerate energetic electrons in the Van Allen Radiation Belts. Such processes can efficiently drain the belts after magnetic storms or sub–storms have filled them up, and they have been described as producing, "an impenetrable shield" against such "killer electron fluxes" working their way into regions inside GeoSynch or GPS orbits.

By making accurate measurements of the VLF electromagnetic fields and the properties of the ionosphere below, at, and above the absorption and reflection layers in the ionosphere, VIPER provides a novel data set for comparison with existing numerical models of the fields and the ionosphere, as well as, observations made in the past of the escaping VLF radiation at higher altitudes and on the ground.



VIPER Sequence testing at Wallops.



VIPER launch from Wallops Island, VA. Photo credit: NASA/Allson Stancil

36.281 UG Zemcov/Rochester Institute of Technology - Cosmic Infrared Background Experiment (CIBER) 2 - launched June 7, 2021

CIBER–2 was successfully launched on a NASA sounding rocket on June 7 from the White Sands Missile Range in New Mexico.

The primary goal of the CIBER–2 mission was to measure near–infrared Extragalactic Background Light (EBL). CIBER–2 is a collaborative effort between the United States, Japan, South Korea, and Taiwan.

The EBL is the integrated light of all extragalactic sources of emission back to the early Universe and spans a range of wavelengths. At near–infrared wavelengths, measurement of the EBL is a promising way to detect the diffuse light from the first collapsed structures at redshift z~10, which are impossible to detect as individual sources. CIBER–2 will focus on a small portion called the cosmic infrared background, or CIB. Much of the CIB is thought to come from M and K dwarfs, the most common star types in the universe, though that is not the only contributor. CIBER–2 is designed to measure the total light, including from sources that haven't been identified yet.

CIBER–2 is a follow–on to CIBER, flown in 2009, 2010 and 2013. CIBER–2 is designed to be able to measure the spatial fluctuations in the EBL at much fainter levels than those detected in previous CIBER–1 experiments. Additionally, a linear variable filter is installed just above the detectors enabling a measurement of the absolute spectrum of the EBL.

CIBER–2 on the launcher at WSMR. Credit: Visual Information Branch/WSMR.

CIBER–2 team at WSMR. Credit: Visual Information Branch/WSMR.

41.130 UO Koehler/Colorado Space Grant - RockOn/RockSat-C- launched June 25, 2021

The RockOn/RockSat–C student payload was successfully launched on June 25 from Wallops Island, VA.

This mission was the 13th time the RockOn mission, carrying student experiments, was flown. Just like in years past, the payload included both RockOn workshop experiments, and, the more advanced, RockSat–C experiments. The 2021 workshop was completed using virtual tools developed by the PI institution, the Colorado Space Grant Consortium (CSGC). CSGC developed a complete set of videos to guide workshop participants in completing the experiments. All required materials were shipped to participating schools and students and faculty could work at their own pace to build the experiments. The experiments were then returned to Colorado for pre–flight checks and finally integrated at Wallops by the CSGC team. Integration activities were streamed to workshop particpants, and NASA provided a live stream of the launch. The RockOn workshop experiments measure acceleration, humidity, pressure,temperature and radiation counts.

The second part of this mission includes the RockSat–C experiments. These experiments are completely designed and built by the students during the school year. Students and faculy particpate in RockOn prior to designing their RockSat–C experiments.

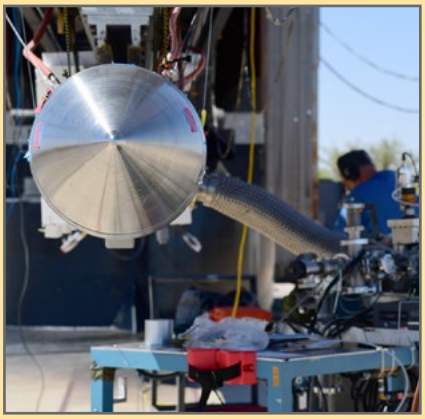
The payload was recovered off the coast of Wallops Island and the experiments are returned to the students for data analysis.

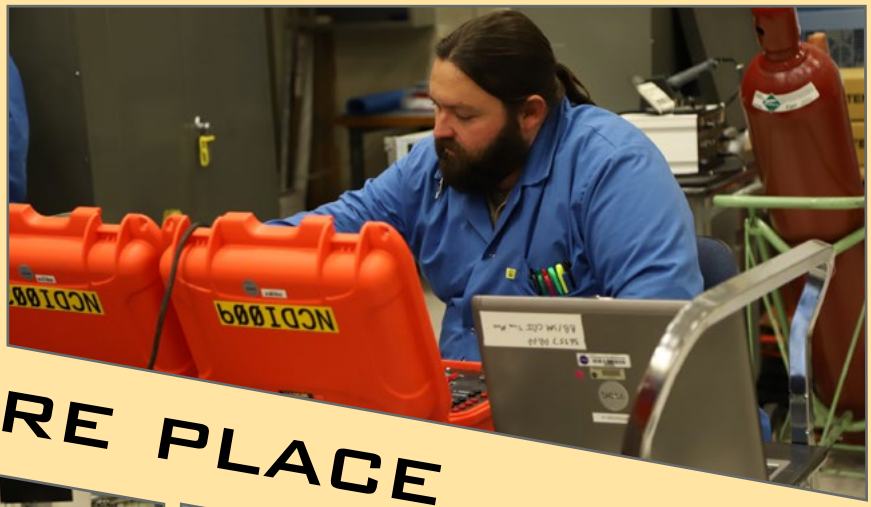
The next student mission, and the most advanced of the flight opportunities, RockSat–X, is scheduled for launch from Wallops Island on August 19, 2021.

For more information on these programs, visit the CSGC website:
https://spacegrant.colorado.edu/national–programs

CSGC team with RockOn cannisters during integration at Wallops.

RockOn launch from Wallops Island, VA. Photo credit: NASA/Allson Stancil





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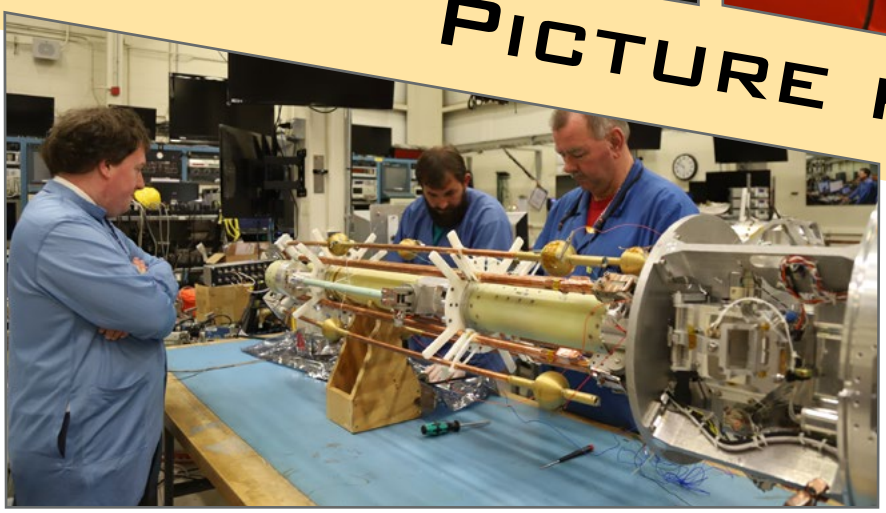
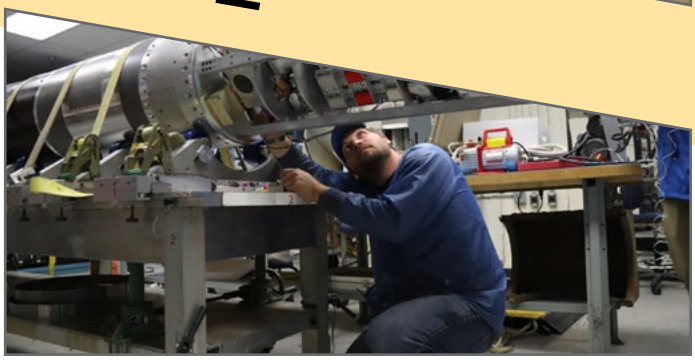




Integration and Testing

Sequence testing of Daytime Dynamo payload.

36.357 & 358 UE Pfaff/NASA Goddard Space Flight Center - Daytime Dynamo 2

Integration and testing continued through the 2nd quarter for these two payloads. The mission, Dyna–mos, Winds, and Electric Fields in the Daytime Low–er Ionosphere, will explore the ion–neutral coupling, winds, and electrodynamics that govern the global atmospheric dynamo which flows at the base of the daytime ionosphere during both quiet and disturbed conditions. Two Terrier–Black Brant vehicles carry identical payloads, one will be launched during quiet conditions, and the other during disturbed condi–tions.

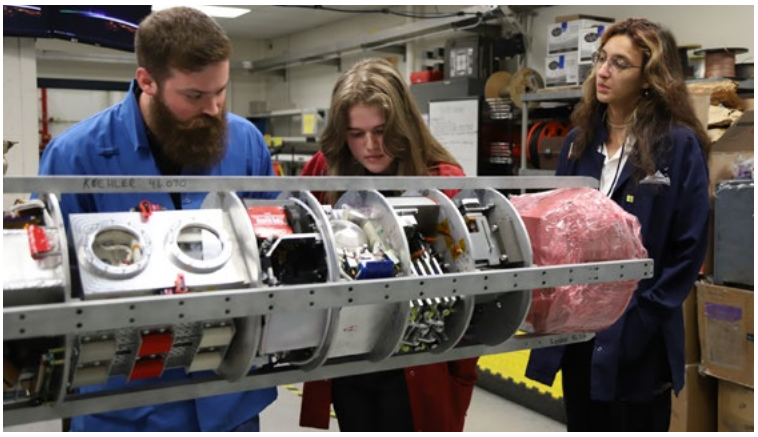
The mission is scheduled for launch from Wallops Island, VA in July 2021.

46.030 UO Koehler/Colorado Space Grant Consortium - RockSat-X

RockSat–X is the most advanced, of three, stu–dent flight opportunities arranged in collabora–tion with the Colorado Space Grant Consortium.

Thirteen schools from 5 states and Puerto Rico are participating in this year's opportunity.

For more information on this program, visit the CSGC website:
https://spacegrant.colorado.edu/national–programs



Sean with Colorado Team inspecting payload.

From the Archives: Launches from Barter Island, AK 1970

The ultimate rocket launch experience was provided by Barter Island, AK for Dr. Heppner from Goddard Space Fligth Center during the first, and so far only, sounding rocket launches from this remote spot.

Until the late nineteenth century, Barter Island was a major trade center for the Inupiat and was especially important as a bartering place for Inupiat from Alaska and Inuit from Canada. With the construction of a runway and a Distant Early Warning (DEW) site in the 1950s, permanent settlements were established on the island. The DEW was deactivated in 1990. After short and long range radars were installed at the site, it became part of the North Warning System (NWS). The City of Kaktovi was incorporated in 1971.

Barter Island photo by Rear Admiral Harley D. Nygren, NOAA, 1949.

In order to study neutral winds at high latitudes several launches were conducted from sites around the arctic. All launches released barium vapor trails for the studies.

Electrically neutral, luminous clouds are a by–product of chemical releases conducted to create barium ion clouds for the measurement of electric fields. Wind measurements provided by the motions of these clouds are particularly valuable in that the motions can be directly compared with convective, ion drift motions to test the importance of ion drag forces. The locations of the releases were divided into three regions, auroral belt, polar cap and at the transition between the auroral belt and the polar cap. The auroral belt measurements include launches from Norway in September of 1967 and 1968 and from Poker Flats, Alaska, in March 1970, the polar cap releases were carried out from the DEWLine site (Pin–Main) at Cape Parry, Canada, in March 1969, and the transition zone measurements from the DEWLine site (Bar–Main) at Barter Island, Alaska, in March 1970.

The Barter Island and Poker Flat launches in 1970, three from each site, used Nike–Tomahawk vehicles. These flights included two pairs of simultaneous launches: during evening twilight on March 2, 1970 and during morning twilight on March 4, 1970. Due to weather conditions the third set of simulatenous launches were not possible, and the last two rockets were flown on March 3 from Poker Flat and March 5 from Barter Island.

The scientific conclusions from these flights were that the observations in the evening and midnight hours at magnetic latitudes $\leq 65°$ strongly suggest that in these regions ion drag is the dominant force in driving neutral winds between 200 and 300 km.

Ref.
Neutral Winds Above 200 km at High Latitudes. Merriwehter, Heppner, Stolarik, Wescott, October 1972.

MISSION	DISCIPLINE	EXPERIMENTER	ORGANIZATION	PROJECT	RANGE	DATE
36.357 GE	GEOSPACE SCIENCES	PFAFF	GSFC	DYNAMO–2	WI	07/06/21*
36.358 GE	GEOSPACE SCIENCES	PFAFF	GSFC	DYNAMO–2	WI	07/06/21**
36.319 NS	SOLAR & HELIOSPHERIC	WINEBARGER	NASA/MSFC	MaGIXS	WS	07/30/21
46.030 UO	STUDENT OUTREACH	KOEHLER	COLORADO SPACE GRANT	ROCKSAT–X	WI	08/19/21
36.353 US	SOLAR & HELIOSPHERIC	WOODS	UNIV OF COLORADO	EVE	WS	09/09/21

* Launched July 11, 2021
** Launched July 7, 2021

Education Project

NSROC provided materials for science teacher, Shane Kio, Nandua Middle School, Accomack County, VA to allow his students to participate more actively in the Perserverance landing on Mars.

These photos show the outcome of the efforts.

Thanks to Valerie Gsell for providing the photos and supporting Shane Kio.