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Chemistry and Dynamics of the Turbopause Region from 80 to 120 km: Mass Spectrometry of the Turbopause Region (MSTR)

The turbopause region, spanning altitudes of 80 to 120 km, is critical to our understanding of the thermosphere-ionosphere system. The turbopause's complex chemistry and variability influence high-altitude weather phenomena, which in turn can negatively impact space-based and terrestrial systems. However, this region remains poorly understood, largely due to the challenges of direct access – typically requiring suborbital rocket missions. To address these knowledge gaps and to directly measure the chemistry and dynamics of the region, the Mass Spectrometry of the Turbopause Region (MSTR) program was funded under a NASA HTIDS program, led by Orion Space Solutions (OSS) in collaboration with Southwest Research Institute (SwRI). MSTR's objective is to develop a compact, low SWAP, high-resolution (>2000), cryogenic Time-Of-Flight Mass Spectrometer (CTOF-OMS) capable of simultaneously measuring the composition of key species – O, O_2, N_2, NO, CO_2, H_2O, O_3, and Ar in the lower atmosphere. MSTR will help to answer several key scientific questions, including: what is the vertical chemical composition of the turbopause, how and to what extent is NO transported across the turbopause, and is CO2 an accurate tracer gas for mass transport across the turbopause. The MSTR instrument is tailored for integration with low-altitude sounding rockets and incorporates a cryogenically cooled nose cone to mitigate bow shock effects during supersonic flight. A future MSTR rocket flight will occur during polar night and will coordinate measurements with ground-based LIDAR temperature profiles and remote observations from SABER to resolve the temporal and spatial structure of the turbopause region. The resulting dataset will serve as a critical benchmark for validating Global Circulation Models (GCMs) such as WACCM, TIME-GCM, and the Whole Atmosphere Model (WAM).

Presentation DAY 4 September 11 15:45 | Session Geospace | Suborbital

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Characterization of Solar-Observing Instruments in the Extreme-Ultraviolet Spectral Range

For ~50 years, the Synchrotron Ultraviolet Radiation Facility (SURF) has been instrumental in characterizing solar-observing instruments across the extreme-ultraviolet and ultraviolet spectrum. In the late 1970s, NASA and the National Bureau of Standards (now NIST) collaborated to build a specialized facility for spacecraft characterization. At its heart is a large vacuum chamber designed for the precise alignment and manipulation of instruments. This chamber can move perpendicularly to the incoming synchrotron radiation, and an internal gimbal allows for pitch and yaw adjustments of the installed instrument. To prevent contamination of customer instruments, access to the chamber is provided via a class 1000 cleanroom. Synchrotron radiation is a broadband continuum spanning from microwave to X-ray regions. It's also highly collimated and polarized, and its absolute spectral irradiance can be calculated with exceptional accuracy. Furthermore, it's an incredibly clean light source, operating in an oil-free vacuum to prevent photo-activated polymerization of hydrocarbons. SURF III offers a flexible light source, allowing for special operating conditions tailored to customer requests. The storage ring can operate at electron energies between 100 MeV and 380 MeV, enabling customization of the radiation output based on calibration needs. The peak of the continuum emission shifts from 350 nm at 100 MeV to 5 nm at 416 MeV. Intensity can be scaled from a single electron (equivalent to about 0.1 pA electron beam current) to roughly 3·10^10 electrons at 300 mA. Recently, we implemented GPS-based time synchronization using the Precision Time Protocol. Now, customer and NIST data acquisition systems are synchronized at the microsecond level, significantly improving the accuracy and reliability of our calibrations.

Poster | HELIOTECH

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Development of Plastic Scintillator Loaded with CdTe QDs for Detection of Muons

This project presents the design and development of a polystyrene-based plastic scintillator doped with cadmium telluride (CdTe) quantum dots (QDs), optimized for the detection of minimum ionizing particles such as muons. The scintillator matrix incorporates PPO (0.4 wt%) as the primary fluor and POPOP (0.01 wt%) as the secondary fluor to shift the emission from ultraviolet to blue wavelengths (~420 nm). CdTe QDs are added at 0.2 wt% to further shift the emission spectrum to ~494 nm and enhance total light yield via quantum confinement effects. The synthesized CdTe nanoplatelets exhibit sharp absorption at 2.51 eV and fast photoluminescence decay, significantly improving optical coupling with photomultiplier tubes (PMTs). The scintillator dimensions are $10\times10\times4$ cm^3, chosen for an optimal balance between interaction volume and timing performance. To reduce corner light loss and improve internal reflectivity, the geometry is wrapped with Teflon and ESR film. The expected light output is approximately 8000–10000 photons/MeV, with sub-nanosecond timing resolution (<1 ns). Shielding is implemented using 5 cm thick lead for gamma attenuation, 6 cm boron-doped HDPE for neutron moderation, and inner aluminum layers (1 mm) to absorb secondary electrons. External layers include 0.5 mm aluminum for mechanical protection and optical containment, achieving ~92% reflectivity in the 400–600 nm range. Thermal expansion effects are accounted for in the mechanical design with appropriate tolerances. Overall, the system is designed to deliver high light yield, excellent timing and spectral compatibility with conventional PMTs, making it suitable for high-sensitivity charged particle detection applications.

Poster | HELIOTECH

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The Marshall Grazing Incidence X-ray Spectrometer (MaGIXS) Sounding Rockets

Addressing some of the outstanding heliophysics questions related to plasma heating in the solar corona requires observation of high temperature plasma (>4MK) that are both spatially and spectrally resolved simultaneously. The Marshall Grazing Incidence X-ray Spectrometer (MaGIXS) is a slitless spectrograph sounding rocket instrument uniquely designed to capture this critical data set. MaGIXS data are called spectroheliogram or overlappogram, which are spatially overlapped soft X-ray images. MaGIXS pioneers the unfolding of overlappograms and provides spatially resolved spectrally pure soft X-ray images. Till date, MaGIXS had two successful flights, 2021 and 2024 respectively, targeting to observe non-flaring solar active regions. In this talk, we will present an overview of the most recent MaGIXS-2 campaign, instrument details, data summary, and first results. In the end, we will also describe the plan and status update for the upcoming MaGIXS-3 a solar flare campaign, which is dedicated to observing a solar flare during its decay phase.

Presentation | DAY 5 | September 12 11:30 | Session: Solar and Lunar | Suborbital

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Sounding Rocket Observations of Thermospheric Nitric Oxide by Stellar Occultation

There is strong evidence that Nitric Oxide (NO) is a key coupling agent by which the magnetosphere channels solar energy into the polar winter upper atmosphere. NO is produced through a chain of events that begins with energetic particle precipitation (EPP), typically in the lower thermosphere. When NO is transported to lower altitudes, it participates in catalytic reactions that destroy ozone. Such transport becomes possible in the polar night where destruction of NO by photodissociation is not possible. While NO has long been understood as an important species in the upper atmosphere, its highly variable abundance throughout the thermosphere has primarily been measured during sunlit conditions. The relative lack of nighttime measurements is a crucial gap in our knowledge as there is a large and rapidly growing body of evidence that NO created by energetic precipitating particles EPP, after being transported to the lower atmosphere during polar night, has a significant effect on stratospheric ozone distributions. A January 27, 2020 sounding rocket mission measured a lower thermospheric NO profile using stellar occultation under solar minimum conditions. A moderately high-resolution spectral measurement of the NO gamma-bands near 215 nm was made while viewing the limb during the downleg segment of the rocket flight. Column NO densities were obtained from the observed atmospheric transmission and were used to calculate the volume density profile. The NO maximum retrieved from the rocket profile is significantly larger in abundance and lower in altitude than other observations on the same day at nearby latitudes just outside the polar night. A second such measurement is planned for January 2026 at what is expected to be significantly higher solar activity. We describe the rocket instrument and observations. We show that an instrument with appropriate light gathering ability for this measurement can be made with mass and dimensions appropriate for small satellites.

Presentation | DAY 4 | September 11 16:45 | Session: Geospace | Suborbital

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Low SWaP Fixed Bias Langmuir Probe Instrument for Orbital and Sub-orbital Platforms

One of the crucial measurements for characterizing any space weather event is absolute plasma density and plasma density fluctuations, both spatially and temporally. Among the various methods to perform in-situ plasma density measurements is a simple fixed bias Langmuir probe. This poster discusses the various implementations of a Langmuir probe and why a Planar Ion Probe (PIP) is the easiest and best method to measure high cadence absolute ion density in planetary ionospheres. We present the performance of the instrument from the NASA LLITED dual CubeSat mission which included two 1.5U CubeSats. The same instrument has also flown as part of sounding rocket dropsondes enabling simultaneous multi-point measurements of various mesosphere-lower-thermosphere phenomenon. We present data from SpEED Demon sounding rocket mission that flew into a mid-latitude sporadic-E layer. Due to its intended CubeSat platform, the designed instrument has extremely low size, weight, and power requirements and is intended to be flown as an innocuous hosted instrument on constellations of 100+ satellites.

Poster | Proposal: 18-HTIDS18_2-0030, 16-HTIDS16_2-0024 | HELIOTECH

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AERIS: Atmospheric Evaluation and Research at the Interface of Space

The Earth's sub-orbital atmosphere is an understudied region, as it lies between altitudes inaccessible by weather balloons and satellites. Traditionally, sounding rockets are used to probe this region, but they are expensive and unsuited for conducting repeated experiments. This project outlines a novel solution to gather in-situ atmospheric density measurements in this region using a payload, known as AERIS, that is deployed from a sub-orbital rideshare. AERIS allows for a more complete characterization of Earth's space transition zone at a low cost. The payload is deployed at the booster's apogee and descends through the region of interest (80-110 km) to collect density measurements. AERIS adopts a practical and robust measurement technique to derive atmospheric density from the net acceleration of the payload. This method circumvents the use of idealized gas models, which are susceptible to inaccuracies, and provides a cost-effective alternative to direct density measurements. A high-rate GNSS was selected to measure velocity and determine the acceleration of the payload, which avoids the sensor drift and noise associated with an IMU. Additionally, the spherical design of the payload minimizes uncertainty in the atmospheric density calculation by ensuring a predictable coefficient of drag and a constant cross-sectional area regardless of orientation. To account for tumbling during freefall, four GNSS antennas are arranged in a tetrahedral pattern on the inside of the spherical shell, guaranteeing at least one antenna always has a sky view and minimal signal noise. AERIS is expected to deliver atmospheric density measurements with 20% error, enabled by its high-rate GNSS receiver, spherical shape, and tetrahedral antenna arrangement.

Poster | HELIOTECH

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The Balloon-borne SUNRISE III Solar Mission

SUNRISE III is a balloon-borne stratospheric solar observatory dedicated to the investigation of the physics governing the evolution of the magnetic fields and the convective plasma flows in the lower solar atmosphere. In July 2024 it completed a 6.5 days stratospheric flight at 36 km altitude from Kiruna (Sweden) to Canada's Northwest Territories. It carried a 1-m-aperture solar telescope feeding a suite of 3 complementary science instruments observing different parts of the solar spectrum from the NUV to the NIR. The three instruments enable a comprehensive investigation of both the photosphere and the chromosphere in terms of sensitivity, height coverage and resolution. The gondola with its sophisticated attitude control system provided improved high precision and stability telescope pointing/tracking, which combined with an image stabilization system, part of the instruments package, produced a residual image jitter down to about 0.005 arcsec, maximizing the quality of the science data. During the flight Sunrise III observed a wide variety of features on the Sun including the quiet region, sunspots, plages, filaments, spicules, and new flux emergences, surpassing expectations in gathering high-quality scientific data. The nearly 240 TB of data, is currently being reduced and analyzed by the instruments teams and initial science research is being conducted. In this talk we will present a summary of the SUNRISE III mission, focusing on observatory characteristics, and in-flight performance, and will provide an overview of the scientific dataset acquired and status of the data analysis.

Presentation | DAY 5 | September 12 14:00 | Session: Balloon and Aircraft | Suborbital

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The Hi-LLITED Mission: Exploring Evolution of Coupled Neutral Plasma Density Structures

The High-Low Latitude Ionosphere/Thermosphere Enhancements in Density or Hi-LLITED CubeSat mission will build on the unique density structure observations made during the NASA LLITED CubeSat mission (2023-2024). The Hi-LLITED mission has two science goals: 1) Improve our understanding of the coupling physics between the Equatorial Temperature and Wind Anomaly (ETWA) and Equatorial Ionization Anomaly (EIA) as they evolve post-sunset and 2) Understand the interplay between plasma density, neutral winds and observed neutral density structures at high latitudes. Because of orbital placement, LLITED was unable to complete the EIA/ETWA study. However, Hi-LLITED will determine the mesoscale variability of the ETWA as function of season and lon/lat as well as its relationship to EIA heating. LLITED observed unexpected and significant structuring in the neutral density at high latitudes that could not be clearly linked to the observed plasma density structures. Hi-LLITED proposes to investigate in more detail both the evolution of the neutral density structure and the associated coupling between the thermosphere and ionosphere. The Hi-LLITED mission concept consists of two identical 3U CubeSats each hosting four sensors each. In addition to the in-situ neutral (MIGSI) and plasma (PIP) density sensors previously flown on LLITED, the mission will host a neutral wind sensor. The mission has a secondary technology demonstration goal to perform a head-to-head performance assessment of three different GPS receivers for radio occultation observations from a CubeSat platform while also providing larger-scale ionospheric contextual observations supporting the mission's science goals. The three receivers are a) JPL's CION receiver b) NovAtel commercial receiver, c) Aerospace's CubeSat bus integrated receiver. This presentation will describe in more detail the Hi-LLITED mission concept and enabling technologies.

Presentation | DAY 2 | September 9 16:15 | Session: Mission Concept | HELIOTECH

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MAGnetometers for Innovation and Capability Technology Demonstration Preliminary Results from the TRACERS Mission

MAGnetometers for Innovation and Capability (MAGIC), recently flown as a tech demo on the Tandem Reconnection And Cusp Electrodynamics Reconnaissance Satellites (TRACERS), aims to provide a platform for low-noise fluxgate magnetometers with scalable reproducibility. Two configurations were demonstrated on the TRACERS satellites; a 1-inch ring core intended as a replacement for the limited supply of Infinetics S1000 cores, and a new race-track geometry design with high magnetic stability. Fluxgate cores are manufactured at the University of Iowa Physics and Astronomy department via a tested and validated reverse-engineered process, allowing for scalable repeatability for spaceflight applications. MAGIC calibrations and data-product pipeline for the TRACERS launch followed lockstep with the heritage instrument teams, showcasing the MAGIC team's ability to provide a mature and spaceflight ready instrument platform. Initially intended for deployable booms, a technical issue required a design change to a shorter fixed non-magnetic bracket, placing MAGIC payloads ~20 cm from the TRACERS spacecraft skin. This change results in a significantly higher magnetic noise environment from the proximity to the main spacecraft payloads systems, presenting MAGIC with a magnetic interference and noise mitigation challenge. We present the preliminary results of the MAGIC payloads from the recent TRACERS launch, on-going challenges, and the future steps to showcase MAGICs ability to provide a matured spaceflight ready fluxgate magnetometer platform.

Presentation | DAY 1 | September 8 11:00 | Session: Fields | HELIOTECH

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H3SP: A High-Speed Space-grade Spectral Processor for Smallsat Radiometer Applications

This presentation describes H3SP: the High-Speed Space-grade Spectral Processor. H3SP, under development at JHU/APL, is a small, low-SWaP, scalable HW platform for processing and storing RF signals in environments ranging from LEO, to lunar to deep-space. Traditional THz and GHz radiometers have one RF front-end and one back-end spectrometer per channel. Modern technological advances have permitted the front-end receivers to be compact and operate non-cryogenic. Furthermore, current instrumentation concepts require a large number of channels to take phase-coherent simultaneous measurements or image spatially complex phenomena. To meet the needs of Ionospheric Thermospheric Mesopheric (ITM) and Magnetospheric-Ionospheric (M-I) coupling sciences, a scalable low-SWaP backend processor is necessary to easily accommodate different RF architectures without costly and time-consuming redesign. To meet this need a scalable backend processor was developed for <20 MHz signal bandwidths and channel capacity from 1 to 100. The processor is modular, using a space-grade FPGA-based System-on-Module (SoM) for the compute platform, and a carrier card that can be redesigned at low cost for specific analog interfaces. An 8-channel prototype has been built and configured to demonstrate real-time calculation of full Stokes parameters. To accommodate wider bandwidths for THz sensing, the modular architecture of this platform can be leveraged to update the ADCs on the carrier card without changing the compute platform, thus realizing a backend processor with 500-600 MHz analog bandwidth with minimal design changes.

Presentation | DAY 1 | September 8 16:30 | Proposal: HTIDS17_2-0074 | Session: Remote Sensing | HELIOTECH

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Echoes - Revealing the Origin of Equatorial 150 km Radar Echoes

Pending future funding of the NASA Peru sounding rocket campaign, the Echoes sounding rocket will launch from Punta Lobos rocket range into the near-equatorial ionosphere to solve the long-standing mystery of the cause of strong dayside radar echoes observed by low latitude radars. Though observed for over 60 years by the Jicamarca Radio Observatory, only recently has a hypothesis been published to explain echo formation and properties. The suggestion is that photoelectrons created in a narrow energy range near 20 eV drive high frequency (MHz) upper hybrid waves which cross-scale couple to 3m ion acoustic waves. The resulting ion acoustic "foam" strongly backscatters the 6m Jicamarca signals. Echoes will include an electromagnetic fields package, HF receiver, Langmuir probe suite, and a state-of-the-art photoelectron spectrometer to make the required measurements to test this hypothesis. Understanding the formation of the echoes will enhance the utilization of Jicamarca (and other radar) observations for remotely probing important near-equatorial dynamics of the critical upper atmosphere and lower ionosphere transition region.

Presentation | DAY 5 | September 12 15:50 | Session: Geospace | Suborbital

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Shuttered Plasma Instrument for Detecting Environmental Response (SPIDER)

Understanding how ionospheric plasma escapes into the magnetosphere remains a critical open question in heliophysics. Specifically, the composition of ionospheric outflows – particularly the relative abundance of heavy ions like N^+ and O^+ – strongly influences magnetospheric dynamics by altering parameters such as Alfvén velocity and reconnection rates. However, despite decades of observational campaigns, the mechanisms that energize ionospheric species to escape velocities, and how composition varies under different solar and geomagnetic conditions, remain poorly constrained. Previous missions have lacked sufficient mass resolution to distinguish closely spaced ion species, such as N^+ from O^+, which is essential for understanding their distinct roles in magnetospheric processes. The Plasma Instrument for Detecting Environmental Response (SPIDER), a compact, low-resource ion composition sensor capable of achieving a mass resolution of $M/\Delta M = 7$, is specifically designed to address this gap. SPIDER combines a novel high-speed electrostatic shutter, a cylindrical electrostatic analyzer (ESA), and a channel electron multiplier (CEM) detector to measure the time-of-flight and energy-per-charge of incident ions in the 10 eV to 5 keV range. This enables SPIDER to resolve key ion species (H^+, He^+, N^+, O^+) critical to understanding outflow dynamics. Designed to fit within a 3U CubeSat payload volume and operate at only 3W, SPIDER provides a highly configurable platform for deployment on CubeSats, sounding rockets, or as hosted payloads. By providing high mass-resolution measurements from a miniaturized platform, SPIDER enables transformative science on ion outflow composition and dynamics, meeting priorities of the Heliophysics Decadal Survey and advancing technology readiness for future distributed space missions. SPIDER is currently being supported by the Heliophysics Technology and Instrument Development for Science (HTIDS) program.

Presentation | Day 2 | September 9 9:00 | Proposal: 24-HTIDS24-0006 | Session: Dust and Debris | HELIOTECH

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Using the Decision Tree (DT) to Help Scientists and Technologists Navigate the Orbital, Suborbital, and Ground Qualification Platforms

The Decision Tree (DT) is a tool that uses a tree-like model of decisions and their possible consequences, including costs, schedule, risks, and performance. The paper applies the decision tree tool to the orbital, suborbital, and ground qualification options to help scientists and technologists select the best approach that meets their requirements. This paper describes the flight and non-flight qualification options, the DT process, and it provides the government and industry contacts for the different options.

Poster | Suborbital

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AstroPix: Monolithic Pixel Sensors for Suborbital and Balloon-Borne Gamma-Ray Observatories

AstroPix is a next-generation High-Voltage CMOS (HV-CMOS) monolithic active pixel sensor under development to enable precision gamma-ray imaging and spectroscopy in the medium-energy regime (~100 keV–100 MeV). AstroPix features a 500 µm pixel pitch, on-pixel amplification and digitization, and low power consumption (~1.5 mW/cm^2), making it scalable for large-area, multilayer telescope detector planes. The detectors have a designed dynamic range of 25 keV to 700 keV. Version 3 (v3) devices have demonstrated ~10 keV energy resolution at 59.5 keV in a 100 µm depleted substrate. AstroPix_v4 sensors have achieved performance across the 25–200 keV range, and fabrication is underway on version 5, which will achieve full depletion of the 500 µm substrate and realize the full dynamic range. Twelve v3 sensors are currently being integrated into the A-STEP sounding rocket payload – a compact demonstrator that will validate AstroPix performance in a suborbital environment. In parallel, we are developing ComPair-2, a balloon payload designed to carry ten layers of v5 detectors, with 380 AstroPix chips per layer, to demonstrate the scalability and high-granularity tracking needed for next-generation gamma-ray observatories. I will present recent progress in the design, characterization, and flight integration of AstroPix sensors as we prepare for upcoming suborbital and balloon-borne missions.

Presentation | DAY 5 | September 12 13:45 | Session: Balloon and Aircraft | Suborbital

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Globular Cluster FUV Observations With the OAxFORTIS Sounding Rocket

The Off-Axis Far-UV Off Rowland-circle Telescope for Imaging and Spectroscopy (OAxFORTIS) is a new off-axis reconfiguration of the sounding rocket experiment, FORTIS, designed in a "two bounce" Gregorian fashion with a diffractive secondary to conduct multi-object spectroscopy. OAxFORTIS enables us to field the first statistically significant exploration of the curious UV diversity of the hot horizontal branch (HHB) in the otherwise similar globular clusters M10, M13, and M3. HHB morphology is largely driven by metallicity, but these three clusters have nearly identical [Fe/H] abundance and age, and despite their similarities they exhibit significant differences in the thermal distribution of stars along the HHB. This issue is commonly referred to as the "second parameter problem" as researchers hunt for the additional parameter driving this diversity. In addition to the off-axis reconfiguration, high efficiency LiF/Al coatings were included in the changes implemented for the 1st launch of OAxFORTIS, which took place in August 2024 and resulted in the successful observation of M10. Future innovations include XeLiF coatings and a new Next Generation Microshutter Array. We plan to install these in preparation for the upcoming 2nd launch set for June 2026 to observe M13. The demonstration of these technologies in space systems such as OAxFORTIS supports the feasibility of future large-scale missions such as the Habitable Worlds Observatory by raising their technical readiness.

Poster | Suborbital

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Maturation and Validation of Imaging Technologies for Astrophysics and Heliophysics Applications aboard NASA High Altitude Balloons

We conducted a field test of the Compact Multichannel Imaging Camera (CoMIC) aboard a high-altitude balloon to explore the feasibility of suborbital probing of airglow and auroral emissions from the upper atmosphere. CoMIC used a set of Commercial Off the Shelf (COTS) bandpass filters probing aeronomically important red (OI 630 nm), green (OI 557.7 nm) and NIR (OI 777.4 nm) emission lines. Its 35 deg x 25 deg focal plane was shared by a mosaic of these filters and other ones probing background emissions. The balloon was launched from Fort Sumner, NM on September 28, 2022 and operated for 16.5 hours starting at 3:30 AM. Nightglow observations by CoMIC were found to be consistent with the GLOW model. Additionally, spatio-temporally variable, cloud-like structures were observed in the green and NIR filter panels. In addition, during the balloon flight the ground based High Throughput & Multi-slit Imaging Spectrograph (HiT&MIS), observed a 16 deg x 0.5 deg region of the sky from the ground. It recorded similar structures in the green emissions. These results demonstrated the suitability of a low-cost instrument like CoMIC for balloon-borne studies of airglow and aurora. We plan to extend CoMIC's nightglow observations to twilight and daytime conditions through modifications of the two instruments and conducting similar field tests in the near future.

Presentation | DAY 4 | September 11 14:30 | Session: Keynote | Suborbital

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Instrument Design and Laboratory Performance for a Photonic Imaging Spectrograph

We present a 6 baseline heterodyne interferometric imaging PIC design which can perform 1-D spectroscopy and telescope pointing. The Magnetograph using Interferometric and Computational imaging for Remote Observations (MICRO) design based in silicon photonics leverages the platform to drastically reduce the size, weight, and power (SWaP) of the optical frontend. We achieve 1-D measurement results by integrating the MICRO PIC with photodetectors and an FPGA to capture and compute the baseline pairs with minimal system size. This integrated telescope system greatly reduces the SWaP of the optical frontend, paving the way for compact high-resolution telescope systems. Furthermore, we present the first results of a 14-aperture, 2-D interferometric MICRO imaging PIC, capable of capturing data in 2-D. This lab demonstration uses point source functions (PSFs) to simulate stars to capture and image the PSFs at different spatial positions.

Presentation | DAY 2 | September 9 14:30 | Proposal: 19-HTIDES19-0002 | Session: Remote Sensing | HELIOTECH

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Low SWaP Sweeping Langmuir Probe for Orbital and Sub-orbital Platforms Mitigating Spacecraft Charging

Electron temperature (Te) is a fundamental plasma parameter that is critically important for understanding a variety of plasma phenomena. For thermal plasmas this is typically measured using a Sweeping Langmuir Probe (SLP). Operating a SLP on a spacecraft where the surface area ratio of spacecraft-to-probe is less than 1000 results not only in erroneous Te measurement, but it also dynamically swings the spacecraft floating potential (i.e. spacecraft charging) with every sweep and inadvertently affects other electrostatic instruments on the spacecraft. With the continued miniaturization of spacecraft, such as CubeSats, and the growing need to be able to do measurements from a constellation of such small spacecraft, it is now imperative to build an instrument that can circumvent the dynamic charging made by an SLP and yet accomplish accurate Te measurements. The Space and Atmospheric Instrumentation Laboratory at Embry-Riddle Aeronautical University has developed a small form factor miniature Double Langmuir Probe (mDLP) that enables high sample rate observations of plasma density and electron temperature from orbital and suborbital platforms. The instrument is a dual-sensor Langmuir probe that can be operated in high cadence fixed bias mode to give plasma density and also run in a swept bias mode to give electron temperature without swinging the payload floating potential. The circuit enforces equal and opposite current balance to each electrode to mitigate spacecraft charging. This is accomplished during a voltage sweep by biasing the electrodes with respect to each other, instead of a spacecraft ground, and allowing the bias voltages of the electrodes to float as needed to achieve current balance. The probe can be fitted with planar or cylindrical probes, of similar or asymmetric surface areas to increase the sampled regions of the I-V curve of the desired measurement. This work will present some bench and plasma chamber results of the novel instrument.

Poster | Proposal: 22-HTIDS22-0018 | HELIOTECH

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Low-resource Instrumentation for Scientific Measurements in Planetary Thermospheres: Development of the Thermo Series of in situ Sensors

Described is the Thermo series of instruments currently under development for measuring thermospheric parameters in situ from a cubesat-class platform. The instruments are based on mechanically modulating the rammed gas flow afforded by an orbiting host vehicle into an accommodation chamber instrumented with a sensitive pressure gauge. The series builds on the simplest of the sensors, Thermo1D, which has no modulation and returns only thermospheric density measurements. Thermo1D is essentially the same as the MIGSI sensor that flew on the LLITED cubesat constellation in 2023-2024. Addition of a scanning baffle creates Thermo3D, which additionally provides measurements of a single cross-track winds component and the thermal speed of the gas. Thermo4D adds a second scanning baffle to measure the other cross-track winds component. Finally, Thermo5D modulates the flow using a baffle and fast-actuating shutters to add the in-track winds component. The measurement principles of these systems are discussed, and development status for each is presented, including laboratory test data. Detailed specifications for spacecraft resource requirements are given, as are performance capabilities. The path to completion of each of the sensors is put forward, including the possibility of augmenting the capabilities to yield information on thermospheric composition. Plans for near-term flight tests are also presented.

Presentation | DAY 2 | September 9 10:30 | Proposal: 21-HTIDS21-0012 | Session: Neutrals/Neutrons | HELIOTECH

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The ETWA Sounding Rocket Mission: Revealing the Physics of the Equatorial Temperature and Wind Anomaly

Presented is a concept for a sounding rocket mission to investigate the physics of the Equatorial Temperature and Wind Anomaly (ETWA) in the dusk sector of the equatorial thermosphere. This phenomenon, which occurs commingled with the better-known Equatorial Ionization Anomaly (EIA) in the ionosphere, is the result of profound ion-neutral coupling between the ionosphere and thermosphere. It features strong, structured winds and enhanced neutral gas temperatures. The ETWA mission plans to explore how this Anomaly is established by flying an comprehensively-instrumented sounding rocket through the equatorial ionosphere-thermosphere system near dusk. The payload features a suite of instruments to measure the neutral and ionized components of the system, as well as its electromagnetic field. The measurements gathered from the experiment will be used to distinguish among three theorized physical scenarios that could potentially describe this interaction.

Presentation | DAY 5 | September 12 16:05 | Session: Geospace | Suborbital

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First Results from the TOMEXplus Sounding Rocket Mission

First results from the TOMEXplus sounding rocket mission are presented and discussed. As a follow-on to the Turbulent Oxygen Mixing Experiment (TOMEX), the mission sought to understand the turbulent environment at the mesopause. The centerpiece of the experiment was an instrumented rocket carrying a spaceborne sodium lidar system oriented on the spinning rocket such that sodium density was measured within a volume centered on the peak density. The lidar measurements were supported by a suite of in situ neutral gas instruments designed to measure the density, 3D winds, temperature, and compositional profiles through the region. Also measured was the atomic oxygen airglow as a function of altitude. Two vapor release rockets measured the winds and turbulent structure of the mesopause region near the trajectory of the instrumented rocket as context. A ground-based airglow imager was used to monitor the mesopause region before, during, and after the rocket flights, and images of the event launched into will also be presented.

Poster | Suborbital

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Solid-State Quantum Magnetometers for Space Science Applications

Magnetometry plays a vital role across numerous space applications, including planetary science, Earth science, and heliophysics. To reduce magnetic interference from other spacecraft components, magnetometers are typically mounted on long booms. However, modern spacecraft design is increasingly favoring the use of multiple small sensors distributed throughout the platform. This shift requires the development of novel sensors with extremely low size, weight, and power (SWaP) and the ability to measure magnetic fields in an absolute manner. In this presentation, we describe quantum magnetometers that use spin defects in solid-state systems to measure magnetic fields, with a particular focus on silicon carbide (SiC). The core principle is to maintain the resonance condition of the spin system by actively compensating for the external magnetic field using cancellation coils. This approach provides a robust method for vector magnetometry. We will present various readout mechanisms including electrically detected magnetic resonance (EDMR), optically detected magnetic resonance (ODMR), and RF-detected magnetic resonance (RFDMR). While ODMR offers higher sensitivity, EDMR provides a simpler, purely electrical readout that can be enhanced through optical pumping with UV light. Additionally, we introduce a novel hybrid method—RFDMR—based on a recently developed room-temperature maser using SiC. This approach combines the narrow linewidth of a maser with the practical advantages of electrical readout. Moreover, superradiance in the masing regime enables linewidth narrowing beyond state-of-the-art limits, and operation at frequencies well above the noise floor of modulation electronics. This work paves the way for the development of solid-state quantum magnetometers based on SiC, enhancing their appeal for next-generation space applications.

Presentation | DAY 1 | September 8 10:45 | Session: Fields | HELIOTECH

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Hailstorm Mission

Hailstorm will make multi-point measurements to enable the first-ever in-situ, 3D investigation of electrojet currents and horizontal neutral winds in the vicinity of an auroral arc. Hailstorm centers around the development of a modernized falling sphere sub-payload called "Hailstones," each equipped with a magnetometer and high-accuracy GNSS receiver. Using magnetic field and position measurements from an array of these new inflatable falling spheres, Hailstorm will explore the plasma and neutral dynamics in the largely under-sampled altitude range from ~80-160 km, which is critical for magnetosphere-ionosphere-thermosphere coupling. Altitudes in the approximate range from 80 to 160 km, which include the D- and E-regions of the ionosphere as well as the bottom of the F-region, represent a critical region where key aspects of the energy and momentum transport within the MIT system take place. This region is immensely important because it is the altitudinal crossroads where ionospheric electrodynamics, such as Joule heating and current closure, occur in concert with significant neutral densities and thermospheric processes, such as neutral winds. Accurate, first-principles measurement of the structure and intensity of ionospheric currents is fundamental because they play a major role in determining the transfer of heat and mechanical work between electromagnetic fields and neutrals in the thermosphere (e.g., Richmond, 2021, and references therein). Additionally, while observations of neutral winds have been obtained by chemical tracers, such as trimethyl aluminum (TMA), for decades, this approach is limited to two vertical profiles per rocket launch and only under clear-sky nighttime conditions. The lack of simultaneous 3D measurements of the winds and shears over the range of 10s to 100s of km in the lower thermosphere keeps the community from testing hypotheses surrounding the generation of instabilities in the lower thermosphere (e.g., Mesquita et al., 2020).

Presentation | DAY 4 | September 11 15:30 | Session: Geospace | Suborbital

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Plasma and Radiation Combined IN-situ Instrument (PRCINI)

The Plasma and Radiation Combined IN-situ Instrument (PRCINI) sensor integrates a modified version of the Parker Solar Probe/Energetic Particle Instrument (EPI)-Lo sensor (McComas et al., SSR, 2016) with a custom-designed electrostatic analyzer (ESA) to create a novel combined suprathermal and energetic ion instrument that measures energy, angular distribution, and compositional distributions from ~1 keV to ≥15 MeV, as well as ion charge-state composition from ~15 (protons) to ~220 keV/q, over co-planar fields-of-view; energetic electron measurements will also be made from 30 keV to ≥1 MeV. PRCINI incorporates this new "pumpkin" ESA into the self-contained electrostatic optics of EPI-Lo, providing the following benefits: 1) use of a shared MCP and energy detectors, which simplifies the number of gains and thresholds which must be considered during calibration and flight; 2) reduction and simplification in the number of electrical and mechanical interfaces; and 3) overall reduction on spacecraft resources. Strategically, PRCINI closes an energy gap from ~40 to ~130 keV for heavy ions (e.g., O+) that has plagued independent plasma and energetic particle instruments on recent missions such as Van Allen Probes (Mauk et al., 2013) and Magnetospheric Multiscale (MMS; Burch et al., 2016). This is especially important for magnetospheric investigations of transport in the plasma sheet, where the determination of ion-species-dependent processes requires measurements of O+ that fall right aforementioned energy gap. PRCINI is currently funded by the NASA Heliophysics Technology and Instrument Development for Science (HTIDS) program.

Presentation | DAY 1 | September 8 14:15 | Proposal: 20-HTIDS20-0009 | Session: Charged Particles | HELIOTECH

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Plasma Environment, Radiation, Structure, and Evolution of the Uranian System (PERSEUS): A Dedicated Orbiter Mission Concept to Study Space Physics at Uranus

Plasma Environment, Radiation, Structure, and Evolution of the Uranian System (PERSEUS) mission concept defines the feasibility and potential scope of a dedicated, standalone Heliophysics orbiter mission to study multiple space physics science objectives at Uranus. Uranus's complex and dynamic magnetosphere presents a unique laboratory to study magnetospheric physics as well as its coupling to the solar wind and the planet's atmosphere, satellites, and rings. From the planet's tilted and offset, rapidly-rotating non-dipolar magnetic field to its seasonally-extreme interactions with the solar wind to its unexpectedly intense electron radiation belts, Uranus hosts a range of outstanding and compelling mysteries relevant to the space physics community. While the exploration of planets other than Earth has largely fallen within the purview of NASA's Planetary Science Division, many targets, like Uranus, also hold immense scientific value and interest to NASA's Heliophysics Division. Exploring and understanding Uranus's magnetosphere is critical to make fundamental gains in magnetospheric physics and the understanding of potential exoplanetary systems and to test the validity of our knowledge of magnetospheric dynamics, moon-magnetosphere interactions, magnetosphere-ionosphere coupling, and solar wind-planetary coupling. The PERSEUS mission concept study, currently at Concept Maturity Level (CML) 4, comprises a feasible payload that provides closure to a range of space physics science objectives in a reliable and mature spacecraft and mission design architecture. The mission is able to close using only a single Mod-1 Next-Generation Radioisotope Thermoelectric Generator (NG-RTG) by leveraging a concept of operations that relies of a significant hibernation mode for a large portion of its 22-day orbit. The PERSEUS mission concept was funded by the NASA Heliophysics Flight Opportunities Studies (HFOS) program.

Poster | HELIOTECH

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The Clemson Rocket Ionospheric Software-defined-radio Platform (CRISP) Experiment

The Clemson Rocket Ionospheric Software-defined-radio Platform (CRISP) is a developmental instrument designed for suborbital sounding rockets, currently manifested for flight aboard SubTec-10. CRISP is a high-frequency (HF) receiver system uses commercial off-the-shelf Software-Defined Radio (SDR) components that measures Faraday rotation, differential Doppler, and differential absorption using ground-based transmitters. Building on earlier analog experiments by Friedrich and Seddon, CRISP introduces a more advanced digital system capable of leveraging signals of opportunity and using passive radar techniques to estimate in-situ ionospheric profile data, such as electron density. While earlier HF analog systems were limited to continuous wave (CW) transmitters in the lower HF band, CRISP can theoretically exploit a broader range of complex signals, including ROTHR, CODAR, and Digisonde transmissions, depending on their presence in the launch region. The system uses electrically short antennas with preamplifiers to feed circularly polarized signals to the onboard SDR and microcomputer. CRISP is configurable to match the expected RF environment at launch and can sample up to 30 MHz of bandwidth—covering the entire HF spectrum. It can further channelize this data into discrete datasets for onboard processing before transmission via telemetry. As suborbital platforms increasingly adopt more capable digital electronics, CRISP is positioned to offer substantial value to sounding rocket missions, especially as telemetry bandwidth and power budgets continue to improve with ongoing technological advancements.

Presentation | DAY 4 | September 11 16:15 | Session: Geospace | Suborbital

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Active Water Experiments in the Lower Thermosphere

Rocket traffic is expected to increase substantially and result in increased deposition of water vapor exhaust in the middle atmosphere. Individual polar mesospheric clouds (~ 82 km) have been attributed to exhaust from the Space Shuttle. The Super Soaker experiment employed a Terrier Improved Orion rocket that released 220 kg of pure water at 85 km. The experiment was conducted in January to when the ambient conditions are least favorable to formation of ice clouds. A cloud was detected by a ground-based lidar 18 s after the release. The cloud appeared to descend from 93 km to 78 km in 3 minutes. We interpret the geometry of the cloud as an expanding thin shell (~1.5 m) of pure water vapor (1 ppv) with a fine filamentary structure. The cloud release and formation was simulated with a microphysical model that included a water vapor radiative cooling. The simulation indicates that the rapid formation and descent of the cloud reflected that water exhaust not only acts as a reservoir for mesospheric cloud production but also actively cools the mesosphere to induce cloud formation. The cloud formed due to the combination of rapid radiative cooling (~25 K) and increase in frost point (~50 K). However, the Super Soaker experiment did not yield a direct measurement of this cooling. We discuss the rocket requirements to release a larger amount of water and yield a larger cloud with greater cooling and better characterize the effects of rocket exhaust on the thermodynamics of the middle atmosphere.

Presentation | DAY 4 | September 11 16:30 | Session: Geospace | Suborbital

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NASA's Resolute Sounding Rocket Mission

Resolute, a dual-sounding rocket mission spearheaded by NASA, is poised to answer a foundational question pivotal to the understanding of Earth's space environment: "How are heavy ions lofted from the ionosphere to the boundary with the magnetosphere?" The crux of this mission involves comprehensive investigation into two fundamental ion populations: (A) the heavy atomic ion group comprising N+ versus O+, and (B) the molecular ion group which includes ions such as N2+, O2+, and NO+. Importance: Understanding how these ions are propelled into the magnetosphere is essential not only for a deeper comprehension of Earth's atmospheric evolution and the conditions allowing life to thrive, but also for insightful knowledge into Earth's magnetospheric dynamics. The processes and amount of energy required to loft heavy ions from the ionosphere to outer magnetic boundaries represent significant gaps in current scientific understanding, posing challenges in magnetic coupling and energy distribution modeling across space environments. Current Knowledge and Challenges: Historically, very few missions have successfully distinguished N+ ions from O+ ions or resolved molecular ions at the required resolution. This deficiency in direct observational data has led to substantial gaps in our knowledge. Physics of ionospheric-ion lofting is crucial in contexts like atmospheric escape phenomena, space weather impacts on technological systems, and even analogs to exoplanetary atmospheres. Resolute's approach, grounded in both rocket-borne observatories and supportive ground-based observations, promises to bridge these gaps substantially. Mission Design and Objectives: Resolute's mission is strategically designed to tackle these challenges through localized examinations within Earth's geospace environment. Scheduled to launch from the Andoya Rocket Range in Norway in 2027, Resolute will take advantage of the perturbative conditions of a geomagnetic storm to derive unique insights into ion upwelling mechanisms. The low-flyer rocket is engineered to reach an apogee of 500 km, capturing up-close measurements of ions at their origin point. In parallel, the high-flyer rocket will target an apogee of 1,400 km to examine the dispersion and separation of ions at the critical magnetosphere boundary. Instrumentation and Measurement Strategy: Each of Resolute's rockets is equipped with an extensive suite of scientific sensors, fostering intricate examination and data collection. Instruments include a magnetometer (MAG) to map magnetic field variations, electric field instruments (EFI) for electrical parameter evaluations, electron spectrometers (E-ESA) for electron distribution analysis, Langmuir probes (FIELDS) to assess plasma properties, and the HYPERION ion spectrometer notable for its high-resolution capacity to delineate ion composition across masses up to 36 AMU. These instruments collectively assure a robust technique to measure the essential parameters and transitions impacting ion movement in space environments. Ground-Based Support and Complementary Technologies: To fully realize the aims of the Resolute mission, ground-based observational support plays a pivotal role. These auxiliary systems provide necessary correlational data to enhance rocket-derived insights. Coordination with tools such as the esteemed EISCAT 3D RADAR, pending its availability, would enable precise tracking of ionospheric disturbances, plasma flow variances, and cross-sectional energy dynamics critical to assessing heavy ion propulsion. Such collaboration amplifies the mission's investigative capability, aligning localized data sets with broader geophysical environmental contexts. Post-flight Modeling and Analysis: Following the mission, Resolute is structured to integrate post-flight numerical modeling techniques. This element of the mission is crafted to construct a comprehensive understanding of the mechanistic upwelling attributed to geomagnetic disturbances, magnetic reconnection processes, and ionospheric-magnetospheric coupling. Numerical models will assimilate observational data, predicting further ion behaviors and clarifying underlying physical interactions. Scientific and Societal Implications: Resolute's findings will offer unprecedented insights vital for predicting and mitigating space weather impacts on vital technological assets, including satellites and power grids, thereby informing protective strategies for national infrastructure. The examination of heavy ion dynamics provides a parallel understanding pertinent to planetary atmospheres beyond Earth, thus guiding future exploration missions and enhancing our grasp of potential habitable conditions in distant celestial systems. The Resolute mission will bring new insights in ionospheric science and magnetospheric dynamics at low cost. Its unique approach marries detailed ground-based observations with precision in-situ measurements to not only advance our understanding of ion upwelling processes but also safeguard technological infrastructure from the adverse effects of unpredictable space weather phenomena. The mission's comprehensive framework sets a foundation for profound scientific exploration, international collaboration, and the broad application of research outcomes.

Poster | Suborbital

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Measuring Local-scale Spatial and Temporal Gradients in the Vector Fields Describing Thermospheric Neutral Winds and Ion Drifts, Using Optical Tracking of 3D Tracer Cloud Constellations

In-situ sensors carried aboard a sounding rocket can only resolve structure in geophysical field variables along one spatial dimension, i.e., distance along the trajectory. Since around 2009, we have been working to expand the dimensionality of sounding rocket measurements, using ejected "constellations" of sub-payloads that instead collectively sample a 3D volume. Using small rocket motors, the sub-payloads can reach distances of up to around 50 km from the parent vehicle, allowing sample volumes spanning 100x100 km horizontally, and several times this vertically. Here we present wind measurements using constellations of vapor tracer clouds deployed this way during two recent missions: CREX2 (2021) and AWESOME (2025). Both missions ejected rocket-propelled sub-payloads early in their flight, that separated and, subsequently (on the way down), deployed a combination tracer clouds consisting of trimethyl-aluminum (TMA), strontium, and barium. The TMA tracers actually produced vertical trails, spanning heights in the range 85 to 160 km. Discrete Ba and Sr tracer clouds were deployed at heights above this, up to around 300 km. Motion of the Sr and TMA acts as a tracer for neutral winds. The Ba clouds ionize in sunlight and so provide tracers on ion drift motion. Both missions showed the now-familiar transition from winds driven by terrestrial meteorological processes below around 150 km altitude, to those driven at greater heights by space weather, processes acting via ion-neutral coupling. Below 150 km strong shears and signatures of waves and tides were observed. The mission's 3D sampling volumes allowed, for the first time, measurements to be made of horizontal divergence and vorticity that were resolved over both height and time. Also, tracers were tracked at heights below 150 km for long enough to measure accelerations. We report here on surprisingly large horizontal gradients and accelerations that were observed during both of these missions.

Presentation | DAY 4 | September 11 14:10 | Session: Keynotes | Suborbital

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First Imaging Spectroscopy of the 92-115A Sun Achieved by EUNIS

The Extreme Ultraviolet Normal Incidence Spectrograph (EUNIS) sounding rocket observed AR 12824 on 2021 May 18 in co-ordination with IRIS and Hinode, providing the first imaging spectroscopy in the 92-115 A soft X-ray range of the Sun. EUNIS comprises a pair of coaligned imaging spectrographs: one flown previously observed solar line emission in first order at wavelengths of 528-638 A, and the second observed emission in third order at wavelengths between 92-115 A, targeting the Fe XVIII 94 A and Fe XIX 108 A lines for implications/constraints on coronal heating models. The new grating was fabricated using holographic processes developed in industry for this mission that have since been used for the gratings on missions such as the MUlti-slit Solar Explorer (MUSE) MidEx and Solar eruptioN Integral Field Spectrograph (SNIFS) sounding rocket. EUNIS obtained Images of AR 12824, quiet-sun area, and off-limb area by scanning the 660"-long slit(s) over the selected targets. A DEM analysis shows that, for AR 12824, the observed Fe XIX comes from plasma around 4 MK, and is perhaps not the 'smoking gun' of super-hot plasma from nanoflares. This flight of EUNIS was supported by NASA awards HTIDS13_2-0074 and HTIDS17-0046.

Poster | Suborbital

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Lunar On-surface and Orbiting Neutron Spectrometer (LOONS)

As our nearest neighbor, the Moon offers an opportunity to advance our capabilities for human exploration of space, serving as both a platform for industrial and scientific research, but also a gateway to distant locations. The lunar south pole, in particular, possesses tangible advantages for a potential manned outpost, with regions of increased solar illumination that are in close proximity to permanently shadowed regions, offering a unique opportunity to explore the origin of surface volatiles. With persistent exposure to the Sun for long, uninterrupted periods, the south pole is also an ideal home for a solar neutron observatory, providing a much-needed missing perspective on particle acceleration. While the lunar surface affords a diverse laboratory for pioneering science, it is also home to an extreme environment including biologically harmful levels of radiation. Neutrons are a particularly egregious radiation constituent on the Moon's surface given their abundance and potent biological impact. The contribution to the total dose to astronauts from neutrons is significant and is mainly in the form of fast neutrons (> 0.5 MeV). We discuss the Lunar On-surface and Orbiting Neutron Spectrometer (LOONS), an agile deployed detector designed to measure thermal, epithermal and fast neutrons (0.015 eV-150 MeV), as well as γ-ray spectroscopy. LOONS has a robust compact design based on modern scintillators, miniature silicon-photomultipliers (SiPM), and state-of-the-art digital processing. With broadband neutron and γ-ray spectroscopy it will be possible to uniquely address fundamental science questions while also safeguarding our astronauts and space assets in this exciting era of exploration.

Poster | HELIOTECH

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Measuring the Alfvén wave Parametric Decay Instability Growth Rate in the Laboratory

Alfvén waves, a fundamental mode of magnetized plasmas, are ubiquitous in lab and space. The non-linear behavior of these modes is thought to play a key role in important problems in space plasma such as the heating of the solar corona and solar wind turbulence. In particular, theoretical predictions show that these Alfvén waves may be unstable to various parametric instabilities, but space observations of these processes are limited. I will present an experiment on the Large Plasma Device at UCLA aimed at measuring the Parametric Decay Instability (PDI) growth rate in the laboratory. In these experiments, a high amplitude $\delta B/B0 \sim 0.7\%$ pump Alfvén wave is launched from one end of the device and a smaller seed Alfvén wave is launched from the other side. When the frequency of the seed wave is chosen to match the backward wave expected from PDI, damping of the seed wave is reduced. We compare this reduction in damping to the theoretically expected PDI growth rate, carefully accounting for effects such as seed wave reflections and acoustic mode damping. Results show qualitative agreement between measurement and theoretical predictions. This may help validate PDI theories and establish signatures for future space observations. I will also briefly mention efforts to design a next generation laboratory facility to create $\beta i \gtrsim 1$, collisionless, magnetized plasma in the laboratory for the first time; such a device will allow for novel studies of energy transfer relevant to space and astrophysical plasmas, complementing and extending new and existing spacecraft missions.

Presentation | DAY 1 | September 8 16:00 | Proposal: 22-HTIDS22-0019 | Session: Laboratory Studies | HELIOTECH

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Self-Calibrating Coil Ensemble for Space Magnetometer Constellations

Magnetospheric constellation missions, consisting of multiple spacecraft working in tandem, require numerous accurate magnetometers to observe the global magnetosphere and understand auroral connections to field aligned current. As future missions scale up, the ability to build and test large numbers of research-quality magnetometers becomes essential. Most commercially available magnetometers lack the precision and consistency needed, and employ varying techniques to calibrate sensor bias and drift. Our solution, CHIME (Coiled Helmholtz and Inductive Magnetometer Ensemble), calibrates commercial PNI RM3100 magnetometers by surrounding them with ground-calibrated Helmholtz coils that measure and correct drift in calibrated biases. Helmholtz coils are standard tools for both ground and in-flight calibration, enabling known magnetic fields to be applied for correcting gain, orthogonality, and offset. CHIME's integrated coils perform this same function autonomously, enabling self-calibration of gain and orthogonality drift both on the ground and in-flight. CHIME prototypes have been built and tested to evaluate their calibration performance against standalone magnetometers. Laboratory demonstrations benchmark CHIME's ability to correct gain and orthogonality drift using both its integrated coils and a large reference Helmholtz coil. Thermal stability is assessed by tracking offset and gain variation across temperatures relevant to space environments. CHIME's in-flight calibration algorithm is simulated and compared to other techniques. It operates in parallel with standard two-step calibration algorithms to track and correct offset drift in the RM3100. The method is validated by introducing artificial scale factor errors into ESA Swarm magnetic data and using CHIME's algorithm to recover the original signal. Optimal geomagnetic regions for in-flight calibration are identified by simulating performance across different storm phases.

Presentation | DAY 1 | September 8 10:15 | Proposal: 22-HELIO22-0004 | Session: Fields | HELIOTECH

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TFIPS – A SWaP Efficient Solar Wind and Planetary Magnetosphere Time-of-Flight Plasma Spectrometer

We have developed a SWaP (size, weight, & power) efficient time-of-flight mass spectrometer to measure the heavy ions of the Solar Wind and planetary magnetospheres called TFIPS or the Triple Fast-Imaging Plasma Spectrometer. TFIPS will measure the trajectories of heavy ions (H^+, $He1\text{-}2^+$, $[C, N, O]^+$, $[Na, Mg, Si]^+$, $[S, Ar, Ca]^+$, and ions of H_2O, CO_2, NH_3, and CH_4) in deep space plasmas from 0.5 to 25 keV/e to determine answers to critical science questions such as tracing plasma source signatures to their origins or revealing elusive energization mechanisms. TFIPS is a triple-coincidence plasma spectrometer comprising a 1.4π field-of-view (FoV) electrostatic analyzer and time-of-flight telescope that leverages flight heritage from the MESSENGER mission with the inclusion of energy-resolving solid-state detectors. Critically, it is designed for SWaP efficiency at 5 kg mass, 5 W power consumption, and just over 6U in size. We have procured new detectors and begun manufacturing a new electrostatic analyzer and time-of-flight chamber; these included components are made with novel additive and subtractive manufacturing techniques. We report the results of our ion optical design, performance analysis, and ongoing calibration efforts.

Presentation | DAY 1 | September 8 13:45 | Session: Charged Particles | HELIOTECH

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Report on the Proceedings of the 2025 SHINE LWS Instrumentation Panel

On June 23rd, 2025, the Heliophysics community met for a townhall at the Solar, Heliospheric, and Interplanetary Environment (SHINE) workshop in Charleston, SC to discuss the instrumentation necessary for future NASA Living With a Star (LWS) and similar Heliophysics science missions. Discussions were led by a panel of scientists who led the primary research proposals that were consolidated to create the 2024 Heliophysics Decadal Survey LWS mission priority. The community discussions were forward-looking and action-oriented while engaging with the current uncertainty in budgeting for the Science Mission Directorate. The science objectives of the decadal survey are paramount and we are prepared to advocate for these while assisting NASA with new mission designs that are adaptable to various funding limitations. We report the results of the community discussion and the recommendations that were produced for NASA.

Poster | HELIOTECH

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Progress on MEGA-H: An Ultra-Wide-Field Camera for Heliophysics Applications

MEGA-H is a HESTO-sponsored program to develop a large-format, multi-detector, wide-field telescope system that produces 300 Mpixel images. The optical path employs pickoff mirrors that partition the image field onto three individual detectors. The detectors can be located conveniently apart from each other while preserving the whole FOV and producing a recombined image without any gaps. This architecture enables a scientist to choose the best detector for the task, which may have the good detection properties but insufficient number of pixels, and combine multiple detectors to achieve the desired pixel count. This camera system will initially be mounted behind a wide FOV white light imager and be capable of both wide FOV (10 degrees on diagonal) and high instantaneous field of view (iFOV) (1.5”) to observe the Sun’s corona. We describe our progress in assembling and testing the instrument, which is built around COTS telescope optics and camera heads. Alignment features facilitate fine positioning of the two pickoff mirrors and three camera heads. Stray light control features prevent ‘sneak path’ rays from falling on the wrong detector. The instrument is designed to work in an airborne environment. A thermal control subsystem incorporates four thermal zones, to maintain tight focus and alignment under dynamic environmental conditions, while a focus mechanism compensates for large changes in temperature. The data path is sized to store full-resolution data from three 127 Mpixel cameras, at a rate of 10 GB/s. A real time viewer produces fused images from the three cameras for monitoring of the image acquisition process.

Presentation | DAY 2 | September 9 14:00 | Proposal 23-HTIDS23-0025 | Session Remote Sensing | HELIOTECH

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Advancements in Lyot Filters for Space

Birefringent optical filters were first demonstrated by Bernard Lyot in 1933. They comprise multiple ‘optical stages’ where each stage consists of an input polarizer, a split birefringent element (e.g., calcite, quartz, $LiNbO_3$, etc.) and a half-wave retarding element. An early advancement of the basic Lyot filter was to add wavelength tunability by introducing variable retarding elements within each stage. Initially, these retarding elements were mechanically rotated while more recently, liquid crystal materials that can be electro-optically controlled are used. The two main challenges for developing space qualified tunable birefringent filters are (a) a strong dependence of a particular materials birefringence on temperature and (b) the need to reduce Fresnel losses between elements without the use of oils or gels. The Lyot Filter Demonstration Instrument (LFDI) project seeks to raise the technical readiness level (TRL) of a 3-stage Lyot filter, assembled using carefully selected optical bonding agents and which achieves wavelength transmission stability using a temperature compensated tuning architecture suitable for spaceborne missions. Assembly techniques will be discussed.

Presentation | DAY 2 | September 9 14:45 | Proposal 20-HTIDS20-0004 | Session Remote Sensing | HELIOTECH

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Balloon Facilities and Capabilities

The US NASA Balloon Program offers low-cost access to a near-space environment. As the science community's needs continue to evolve, the NASA Balloon Program adjusts to support the scientific community, providing enhanced capabilities across a spectrum of balloon-related disciplines. The disciplines supported by the NASA Balloon Program include astrophysics, heliophysics, planetary science, earth science, technology development, and education. A broad overview of the NASA Balloon Program that touches on critical highlights, including launch locations, standard systems, and development efforts will be presented. The period under review witnessed significant strides in balloon technology, payload instrumentation, and mission design, all aimed at enhancing the Program's scientific capabilities – the integration of cutting-edge technologies allowed for executing ambitious missions, and fostering collaboration with domestic and international partners. Specific information on commercial satellite communications with off-the-shelf hardware as well as the program's pursuit of optical communications will be provided. The Program's strategic goals, emphasizing its commitment to advancing atmospheric and astrophysical research, are highlighted via recent missions. Program support plans and technology development through the end of 2030 will be discussed with specific details for potential investigators to enable proposal submissions and lower the barrier of entry for new investigators. The program is also working to increase opportunities for technology maturation flights. The Program is vital in supporting educational and outreach activities, fostering the next generation of scientists and engineers. Collaborative efforts with educational institutions and outreach programs have expanded public engagement and inspired students to pursue careers in STEM fields. The Program's versatility and success in facilitating groundbreaking research underscore its continued significance in advancing our understanding of the Earth and the universe.

Presentation | DAY 4 | September 11 11:10 | Session: LCAS | Suborbital

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The XL-Calibur Balloon-borne Hard X-ray Polarimetry Telescope

X-ray polarimetry has become a vital addition to timing, spectral, and imaging studies of extreme astrophysical objects, such as stellar-mass black holes and pulsar wind nebulae. The XL-Calibur balloon-borne polarimetry telescope, complementing the polarimetry capabilities in the 2-8 keV range of the recently-launched IXPE, measures the polarization of 15-60 keV X-rays. XL-Calibur flew from Esrange, Sweden to northern Canada from in July 2024, observing the Cygnus X-1 Black Hole X-ray Binary and the Crab Pulsar/Pulsar Wind Nebula. In this talk, I will discuss the design of the XL-Calibur instrument and the results obtained for both astrophysical sources, highlighting the implications from jointly analyzing IXPE and XL-Calibur data. If time allows, we will also discuss the science objectives of planned future XL-Calibur flights.

Presentation | DAY 5 | September 12 13:30 | Session: Balloon and Aircraft | Suborbital

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OCTEA: Optics for Compact Two-dimensional Energetic Atom Imager for CubeSats

OCTEA is a NASA funded HTIDeS project to advance the technological readiness level (TRL) of the optics for a compact (1U-CubeSat-sized) two-dimensional ENA imager, capable of capturing the dynamics of low-altitude, precipitating RC ions. The OCTEA science goal is to determine the dynamics of stormtime ring current (RC) loss. Geomagnetic storms can pump petaJoules of energy into the RC and trigger space weather events affecting satellites, communications, power grids, or humans in space. RC losses regulate the strength and timing of the storm peak and recovery. OCTEA targets (S1) the space-dependent dynamics of low-altitude RC loss during storms, and (S2) the dynamic interplay between ions and neutrals during low altitude ion precipitation. OCTEA is a follow-up to a Southwest Research Institute (SwRI) funded Internal Research (IR) project that designed, fabricated, and built a 1U CubeSat volume, 0.6 kg energetic neutral atom (ENA) optics prototype. In Year 1 of the HTIDeS funded period of performance, we bench tested and documented the prototype instrument, updated the design of the detector anodes, and produced two anode design variations (micropixel and cross delay line) for testing and calibration. Year 2 achieves first-light and beam calibration. Year 3 will perform environmental testing and repeat calibration. OCTEA advances an ENA imager with great promise for use in scientific investigations on future Heliophysics missions. The OCTEA optics module has an ample geometric factor, low mass, and is compact. In conjunction with separate development of technology for compact ultraviolet and ion filters, the new OCTEA technology is the central component for a light, low-resource ENA imager that is well-suited for deployment on CubeSats and other resource-limited NASA missions, including the H-FORT program.

Presentation | DAY 2 | September 9 9:45 | Proposal: 23-HTIDS23-0004 | Session: Neutrals/Neutrons | HELIOTECH

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The Performance Impacts of Degaussing PNI RM3100 Magnetometers for Space Weather Missions

The geomagnetic field shields and protects Earth from solar and cosmic radiation that can otherwise strip the atmosphere. Measuring the magnetic field is an important task in many fields of study including geophysics, heliophysics, and planetary sciences. The PNI RM3100 is a low-cost and low-resource automotive grade commercial off-the-shelf magneto-inductive magnetometer, whose sensitivity and wide magnetic field detection range could enhance magnetic field measurements on boom-less satellites. Often, magnetometers are placed on booms that extend mounted sensors away from satellites and shield from the electrical components inducing magnetic noise in measurements. For the purpose of mitigating magnetic noise in the absence of a satellite boom, degaussing tests are performed to determine how to effectively minimize magnetization that introduces unwanted biases in magnetic field measurements. Degaussing is a method commonly used to wipe hard drives and magnetic memory by "resetting" the magnetic moments or domains of a ferromagnetic material. Results on the effect degaussing has on the magnetometer are presented to discuss system performance including offset and resolution of the sensor. The comparison between three degaussing methods will be made to infer the magnetometer's in-situ performance, including discussion on how degaussing advances the knowledge of the space environment in future missions.

Poster | Proposal: 80NSSC24K0641 | HELIOTECH

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MAGPRIME: Open-Source Magnetometer Signal Processing Algorithms for Low Cost Space Exploration

Magnetometers are indispensable for characterizing heliospheric plasmas and monitoring space weather effects, yet traditional boom-mounted sensors add mass, cost, and failure risk to spacecraft. We introduce MAGnetic signal Processing, Interference Mitigation, and Enhancement (MAGPRIME), an open source Python library that consolidates advanced magnetometer signal processing algorithms into a unified toolkit. MAGPRIME's toolkit includes Underdetermined Blind Source Separation, Wavelet Adaptive Interference Cancellation, rapid unsupervised anomaly detection, sensor calibration, and potential field modeling for region classification. We highlight previous applications on the Korean Pathfinder Lunar Orbiter mission and by developing agencies such as Nepal's Antarikchya CubeSat program, and explore applications to low cost CubeSat constellations, terrestrial geomagnetic surveys, and future mission concepts such as Magnetospheric Auroral Asymmetry Explorer. MAGPRIME's extensible code base invites community contributions and fosters a new era of scalable, precise, and open source magnetic field science.

Poster | HELIOTECH

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Enabling Future Heliophysics with CLASS: A Miniature Lyman-Alpha SHS for the FUV

Solar Energetic Particles (SEPs) with energies >10 MeV pose significant risks to spacecraft systems and astronaut safety, yet the mechanisms governing their acceleration remain unresolved. Detecting suprathermal ions near the Sun is critical for understanding how coronal mass ejection (CME) shocks generate SEPs, but current instruments are too large and resource-intensive for widespread deployment. The Compact Lyman-alpha Spatial Heterodyne Spectrometer (CLASS) is a miniature, ultra-sensitive FUV spectrometer designed to address this challenge. Based on Spatial Heterodyne Spectroscopy (SHS), CLASS delivers high-resolution ($\Delta\lambda R < 0.01$ Å) spectroscopy of the hydrogen Lyman-alpha line (121.6 nm) in a compact, low-power form factor (<2 kg). Its architecture dramatically reduces mass and volume compared to traditional coronagraph spectrometers, making it ideal for CubeSats and small spacecraft. CLASS is designed to resolve faint line wings and broadening signatures associated with suprathermal ions and outflow velocities in the extended solar atmosphere. Once space-validated, CLASS will enable transformative measurements of the inner heliosphere and contribute directly to science goals outlined in the Heliophysics Decadal Survey, including improved space weather forecasting and fundamental advances in SEP origin studies. Acknowledgments: This work was conducted at the Jet Propulsion Laboratory, California Institute of Technology, under contract with NASA.

Presentation | DAY 2 | September 9 15:15 | Proposal: NNH20ZDA001N-HTIDS | Session: Remote Sensing | HELIOTECH

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A High Throughput TES Microcalorimeter Sounding Rocket Payload for the Study of Diffuse X-ray Emission from Hot Gas

The "cosmic web" is dominated by diffuse filaments at temperatures around $1.0x10^6$ K and is thought to contain a large fraction of all baryons. Investigating the extended circumgalactic medium surrounding galaxies is critical to understanding galactic evolution. The virial temperature of our galaxy is also about $1.0x10^6$ K, so this should be a common temperature within the CGM. The Sun is embedded in a "local hot bubble" of ~100 pc extent containing tenuous gas at a similar temperature. Recent 3-D dust maps and kinematic Gaia data indicate that the LHB has played a major role in recent star formation in the Solar neighborhood, and that similar structures may occupy much of the Galactic disk. These important astrophysical investigations share a common set of technical obstacles related to studying diffuse gas at these temperatures. The LHB has the advantage that it is bright enough to observe on a rocket flight. So under our current grant we have been developing the needed technology for a rocket investigation of the LHB. I will discuss the problems and the solutions we've found for them. Spectral Resolution: Emission from gas near these temperatures is dominated by a dense forest of L-shell lines of multi-electron ions below 400 eV. Analysis requires 1-2 eV FWHM resolution. Throughput: Low surface brightness requires a large product of detector area and incident angles. Large detector area conflicts with energy resolution and large incident angles conflict with magnetic shielding. Magnetic Shielding: The gain of these detectors is very sensitive to ambient magnetic fields, but large opening angles tend to increase the size of magnetic shields and IR filters beyond what is practical for a rocket. Calibration: Interpreting these observations requires unprecedented calibration accuracy, and it is impractical to use the usual X-ray fluorescent lines that are much broader than the detector resolution. We have solved this problem with a pulsed laser.

Presentation | DAY 5 | September 12 9:20 | Session: Astro | Suborbital

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Comparative Study of Lower Hybrid Drift Waves During Magnetic Reconnection in the Laboratory and in Space

Kinetic plasma waves are considered to play important roles in the dissipation process during collisionless magnetic reconnection beyond its standard two-dimensional and laminar models. One of the candidate waves is lower hybrid drift waves (LHDW) which are often observed within or nearby the electron diffusion regions (EDR) both in the laboratory and in space. Here we present a series of investigations of LHDWs during reconnection in the laboratory based on Magnetic Reconnection Experiment; MRX), in space (based on Magnetospheric MultiScale, MMS mission), and the corresponding numerical simulations (based on VPIC code). Our analysis shows that there are two LHDW types, electromagnetic EM-LHDW and electrostatic ES-LHDW, depending on the local electron beta. The ES-LHDW can generate anomalous resistivity and heat electrons at low electron beta. Coordinated research across space and laboratory, facilitated by theory and numerical simulations, demonstrated its power to resolve complex nature of physics processes. The acceleration/heating is higher in electrostatic LHDWs and it is mostly in parallel direction, consistent with the recent results from the lab. The coordinated comparative research has been extended to turbulent magnetotail reconnection, 3D numerical simulations, and newly available Facility for Laboratory Reconnection Experiments (FLARE), which greatly expand the parameter space to be directly relevant to magnetic reconnection in space and on the sun.

Presentation | DAY 1 | September 8 16:15 | Proposal: 20-HTIDS20-0018 | Session: Laboratory Studies | HELIOTECH

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FOXSI-4 and FOXSI-5: Direct-Focusing X-ray Imaging Spectroscopy at the Heart of NASA's First Sounding-Rocket Flare Campaigns

NASA's Focusing Optics X-ray Solar Imager (FOXSI) program brings direct-focusing hard- and soft-X-ray imaging spectroscopy to the sounding-rocket platform. FOXSI-4, launched 17 April 2024, executed NASA's first solar-flare rocket campaign, observing a GOES-M1.0 flare. The payload blended several optic sets with three complementary detectors: CdTe strip sensors read over SpaceWire (4-20 keV), a Timepix hybrid-pixel CMOS imager, and large-area CMOS soft-X-ray cameras fitted with pixelated attenuators for on-the-fly dynamic-range control. FOXSI-5, targeted for early 2026 at White Sands Missile Range, re-flies this proven payload to maximize readiness and science return. Coordinated assets—including DKIST, Solar Orbiter/STIX, Parker Solar Probe, IRIS, Hinode, OVSA, and VLA—will focus on a >C5 flare to assemble the most complete multi-wavelength snapshot of flare energy release yet obtained. International partners from JAXA, Nagoya University, and ISAS continue to provide optics, detectors, and calibration. Beyond early-phase flare physics, the quick-response FOXSI architecture seeds suborbital missions that trace solar drivers to ionospheric consequences, enabling piggy-back geospace payloads on the same timeline. Flight-qualified optics, SpaceWire CdTe readout, and pixel attenuator heritage are feeding CubeSat concepts such as SHARP and baselining for future Explorer-class missions—advancing HELIOTECH's vision of low-cost, high-impact heliophysics technology.

Presentation | DAY 5 | September 12 11:15 | Session: Solar and Lunar | Suborbital

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Sounding Rocket Observations of the Coupled OH Meinel and O2 Atmospheric Band Nightglow Emissions

Nightglow emission signatures observed from space- and ground-based instruments are commonly used as proxies for atmospheric composition, especially for the altitude region around 100 km that cannot be easily studied in situ. Monitoring the intensity and temporal evolution of such proxies by remote sensing is often the method of choice to study a plethora of phenomena in this region of the atmosphere. Thus, the quantitative details relevant to the production and deactivation of excited atomic and molecular precursors responsible for prominent nightglow emissions are required to study atmospheric composition, radiative and energy balance, wave propagation and dissipation, as well as transport dynamics. Significant gaps and uncertainties exist in the understanding of the above processes and, as our recent studies on nightglow emissions revealed, substantial revisions of the relevant atmospheric models are warranted. We will present a progress report on investigations of the coupling between the OH Meinel and O2 Atmospheric band nightglow emissions, as revealed by extant sounding rocket observations. Research supported by NASA Heliophysics (LNAPP-80NSSC23K0694).

Poster | Suborbital

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A High Geometric Factor Spectrometer for Fast Plasma Measurements on Future Missions

In this paper, we report on the development of a novel space plasma analyzer providing instantaneous, multiple energy, wide field of view sampling in a compact, low-SWaP package. The analyzer uses nested cylindrical geometry as opposed to spherical geometry typical of top-hat like analyzers. Charged particle optics simulations of a representative geometry have been carried out and an early proof-of-concept prototype of the analyzer front-end has been built and tested. The current design achieves an angular coverage of 90 deg x ±45 deg and with a k-factor range between 46.7 to 76.7 for the outermost channel and 23.6 to 38.6 for the innermost, the analyzer samples an energy range of 5eV/q to 46keV/q with up to 1kV applied on the analyzer. Details of the geometry, preliminary simulation results and early test results from the prototype will be presented. The instrument has a geometric factor comparable to the DES sensors on MMS but at a significantly reduced size, weight and power (SWAP). As a comparison, the DES instrument, which consists of 4 dual analyzer head spherical top-hat sensors and a common DPU, is ~30 kgs. Configured to sample 4-Pi field-of-view, the nested geometry instrument is estimated to weigh under ~6 kgs. The low SWaP makes it very attractive for many future geophysics missions, particularly for nanosatellite and multi-satellite platforms and planetary missions. The front-end prototype developed for the project is compact enough to be flown on a CubeSat within a 2U resource envelope, including all its electronics. Besides fast (high cadence) measurements, the geometry factor enables several measurement capabilities and is also attractive as a space weather monitor. Some of these potential capabilities will also be discussed.

Presentation | DAY 1 | September 8 13:30 | Proposal: 24-HTIDS24-0039 | Session: Charged Particles | HELIOTECH

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High-altitude Airborne Observations of Thunderstorms and Gamma Rays

In July 2023, a field campaign called ALOFT used the NASA ER-2 high-altitude aircraft to overfly thunderstorms near Florida and Central America. This highly successful campaign used a suite of gamma-ray, lightning, and microwave instruments and observed well over 100 TGFs and hundreds of gamma-ray glows. The campaign also made important measurements relevant to the validation of spaceborne lightning detectors as well as measurements of physical processes within thunderstorms and atmospheric convection. This presentation will review the innovative sensor technology used in ALOFT and describe how it made game-changing discoveries in atmospheric and space electricity. The presentation will also discuss planned follow-on suborbital campaigns that will use modified versions of the ALOFT sensor payload on high-altitude aircraft to answer additional science questions related to thunderstorms, gamma rays, and related topics. ALOFT: Airborne Lightning Observatory for FEGS and TGFs. FEGS: Fly's Eye Geostationary Lightning Mapper (GLM) Simulator. TGFs: Terrestrial Gamma-ray Flashes.

Presentation | DAY 5 | September 12 14:30 | Session: Balloon and Aircraft | Suborbital

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Additively Manufactured Plastic Plasma Spectrometer (AMPPS) Prototype

We have built and tested a prototype instrument called AMPPS (Additively Manufactured Plastic Plasma Spectrometer). It is a "top-hat" electrostatic analyzer with a microchannel plate detector and supporting electronics. AMPPS measures the energies and arrival directions of electrons, particularly the range of ~10eV to 20keV. The entire electrostatic analyzer, the microchannel plate holder structure, and the electronics enclosure were all made using only 3D printed plastics. AMPPS fits within the 63mm diameter "tuna can" volume of a CubeSat, so it could be supported by a spacecraft as small as a 1-U CubeSat, or a sounding rocket's ejectable subpayload. Our recent test results with the printed electrically conductive plastic were promising, in terms of high voltage sweeping ability, thermal vacuum exposure, outgassing, and absorption of stray electrons and UV. Multi-material printing allows a single print to include portions with high and low conductivities, simplifying manufacturing and assembly, particularly for the detector stack. AMPPS uses MSP430 microcontrollers with FRAM memory, and a PADI-XII preamplifier-discriminator from Institute of Space Sciences-Romania for processing individual electron pulses. The high voltage power supply produces exponential energy spectrum sweeps 100 times per second at up to 4000 V. The current prototype is a relatively simple technology demonstration proof-of-concept. We believe a successful AMPPS demonstration would indicate relevance to larger Heliophysics missions, particularly constellations involving dozens or even hundreds of low-cost spacecraft.

Poster | Proposal: 19-HTIDS19-0030 | HELIOTECH

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Evolving Plasma Sensors for Future Measurements of Earth's Magnetospheric Cold Plasma

Routine measurements of Earth's magnetospheric cold plasma have not occurred on any recent space science mission. We will discuss common measurement artifacts that provide evidence of the systemic problems preventing routine and accurate characterization of magnetospheric cold plasma distributions. A discussion of instrument technology development occurring today will follow, to inform other instrument or mission developers of possible ways to improve acquisition of future cold plasma measurements needed for impactful scientific progress on these poorly understood magnetospheric plasma populations. This discussion of instrument technology development will include examples of how innovations in electrical or mechanical component manufacturing can find application across future space science sensors.

Poster | Proposal: 22-HTIDS22-0023 | HELIOTECH

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Lunar Vehicle Active Charge Control System Instrument

All surfaces immersed in a plasma charge to non-zero potentials. In very low-density plasmas (plasma densities < 100 cm-3), space vehicle charging can interfere with plasma probe measurements, degrade avionics performance, and cause system failures. Furthermore, contact charging builds quickly and dissipates slowly for space rover vehicles in these environments, impeding safe instrument operation and limiting mission performance. The Lunar Vehicle Active Charge Control System (LVACCS) is an instrument under development that will measure the electrical potential of a lunar vehicle, actively discharge negative charge, and safely charge the vehicle positively. LVACCS provides real-time in-situ space situational awareness that addresses these challenges in a small package. LVACCS has been awarded a NASA PICASSO grant to bring the instrument to technology readiness level 5 by late 2026. LVACCS consists of two main components: a Spacecraft Charge Detector (SCD) and a Collimated PhotoElectron Gun (CPEG). The SCD tracks positive and negative changes in potential over time with the ability to "reset," becoming equipotential with the vehicle frame. The CPEG can discharge negatively charged vehicle frames and actively charge them positively in a controlled manner. Monitoring charge build up on the lunar surface is a critical first step to understand hazards for crew, rovers, and instrumentation operating there. The LVACCS instrument is intended to fill this gap, providing robust lunar surface potential measurements and active charge dissipation. Instrument details, proposed concept of operations, and initial test results will be presented.

Presentation | DAY 1 | September 8 15:15 | Session: Charged Particles | HELIOTECH

Presenting Author: Leon, Omar | Affiliation: University of Michigan | Email: omarleon@umich.edu
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B-SPICE: The Beam-Spacecraft Plasma Interaction and Charging Experiment

The use of high-power electron beams in low-density space environments could open a wealth of new opportunities in magnetospheric science and help answer several fundamental, outstanding questions. However, emitting a sufficiently high-power electron beam in a low-density plasma environment would induce a charge on the spacecraft that would inevitably cause beam return (Lai, 1989). One promising solution is the use of a plasma contactor to produce a dense plasma cloud capable of emitting sufficient ion current and overcoming traditional space charge limits (Miars, 2020). Furthermore, numerical simulations have predicted scaling laws for spacecraft charge neutralization when operating a plasma source and electron beam simultaneously in a low-density plasma environment (Delzanno, 2015; Borovsky, 2020). The Beam-Spacecraft Plasma Interaction and Charging Experiment (B-SPICE) is a tethered rocket experiment that launched in November 2024 to investigate this plasma contactor mitigation strategy. B-SPICE studied the relationships between contactor ion current production, plasma plume expansion, expellant utilization, and mitigation effectiveness. Preliminary analysis of the experiment data, shows the capability of the ion plasma source to fully charge neutralize electron beam emission. However, a software racing condition prevented a full altitude scan of repeating science sequences. Additionally, while the tethered separation of the payloads (Main and Sub) reached just beyond minimum success of 30m, they slowly drifted back to about 10m separation by mission end, possibly affecting some instrument measurements. The successful completion of this experiment will ultimately raise the technological readiness level (TRL) of the described spacecraft-charging mitigation scheme for application to active experiments in the low-density magnetosphere. Mission details including a payload description, concept of operations, and initial findings from flight data will be presented.

Presentation | DAY 5 | September 12 16:20 | Session: Geospace | Suborbital

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Upcoming Rocket Experiment for Neutral Upwelling 3 (RENU-3) Sounding Rocket Mission

The RENU-3 sounding rocket is designed to measure the neutral gas, ions, and electrons in Poleward Moving Auroral Forms (PMAFs) in order to understand the neutral upwelling process that drives heating in the cusp of the magnetosphere. This mission requires a unique multi-payload configuration to accomplish this task. The spin stabilized main payload is equipped with a suite of instruments that can measure the particles and fields. The 3-axis stabilization will allow the instruments on the sub-payload to maintain a ram-facing orientation and for the imager to capture the PMAF region of space while on the upleg. In conjunction with the instruments on the rocket, there are several institutions that will collaborate with the mission to provide ground-based data to inform the launch conditions and the overall atmospheric conditions during the flight. These include All-Sky cameras provided by the Kjell Henriksen Observatory, the EISCAT radar that will observe ionospheric signatures of the PMAFs over Svalbard, the Scanning Doppler Imager and Fabry-Perot Interferometer that provides data about the dynamics of the neutral gas, and SuperDARN that provides measurements of ionospheric convection.

Poster | Suborbital

Presenting Author: Lu, Leo | Affiliation: Goeppert LLC | Email: zpleolu@gppert.com

Scalable Optically-tuned Lamellar cerAmic Reflective Intra-heliospheric Sail (SOLARIS)

We propose Scalable Optically-tuned Lamellar cerAmic Reflective Intra-heliospheric Sail (SOLARIS), an innovative solar sail designed to explore the inner heliosphere extremely close to the Sun (perihelion of 0.03 AU, or ~6.45 solar radii). SOLARIS employs a scalable, three-layer ceramic structure with honeycomb-corrugated geometry, optimized for thermal stability (up to 2000 K, 3-4 times higher than polymer solar sails), structural integrity, and constructive optical interference. At this distance (0.03 AU) and temperatures (~2000 K, assuming absorptivity of 0.007 and emissivity of 0.08), SOLARIS significantly improves thermal resilience compared to traditional polymer-based sails (e.g., aluminized polyimide), while maintaining low areal density, high broadband reflectivity, and ease of scaling beyond 1600 m2. Importantly, our scalable fabrication process does not require photo or e-beam lithography. SOLARIS provides critical capabilities for NASA's heliophysics and interplanetary science, especially for long-duration observational missions requiring a large Delta-v (through Oberth maneuver), such as (1) high-inclination solar imaging, (2) out-of-the-ecliptic maneuvering, (3) accessing hard-to-reach asteroids, and (4) fast transit to the solar gravity lens. For example, our technology aligns with NASA's Space Weather Explorers (SWEx) mission (placing a solar wind monitor at ~0.02 AU) and high orbital inclination Solar Orbiter (SO) mission (34° by 2030). In comparison, traditional aluminized polyimide sails (IKAROS) operate under 600 K and cannot safely approach within even 0.2 AU of the Sun. Our SOLARIS technology also offers several potential applications beyond NASA, including (1) fine attitude control for small satellites and CubeSats, (2) dynamic optimization for concentrated solar power (CSP) systems, (3) dynamic holography and displays, and (4) advanced aviation technologies.

Poster | HELIOTECH

Presenting Author: Malaspina, David | Affiliation: University of Colorado, Boulder (UCB) | Email: david.malaspina@colorado.edu
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Debris and meteoroid ENvironment Sensor (DENTS): An Instrument for Characterizing the Near-Earth Debris Environment and Spacecraft Hazards Caused by Hypervelocity Impacts

Spacecraft in Low Earth Orbit (LEO) are frequently struck by both natural meteoroids and anthropogenic debris. These hypervelocity impacts (> 1 km/s) produce a range of effects, including surface pitting and ablation, enhanced instrument noise, interruption of instrument operation, and degradation of spacecraft systems. Major effects such as full spacecraft incapacitation are also possible. The probability of collisions between spacecraft and anthropogenic debris is increasing sharply as the number and pace of space launches continue to increase. In this rapidly changing environment, there is a stark observational gap for small debris (< 3 mm). These particles cannot be efficiently detected from the ground, nor by current on-orbit optical systems. This observational gap motivates two primary questions: (i) How are the size distribution, orbital element distribution, and temporal variability of small debris particles in LEO changing with the recent proliferation of LEO spacecraft? (ii) What are the range and severity of effects that small impactors may have on spacecraft or instrumentation? This presentation describes an innovative instrument focused on addressing these questions: Debris and meteoroid ENvironment Sensor (DENTS). DENTS combines three well-established in-situ dust and debris measurement techniques into a single cohesive detector. DENTS detects impactors of any size and characterizes impactor velocity and mass for impactors between 1 and 100 microns with velocities between 1 and 70 km/s. DENTS evaluates the electromagnetic and plasma environment around a spacecraft following hypervelocity impacts, including clouds of impact-generated debris. DENTS is modular, deployable on platforms from cubesats to the International Space Station with minimal design modifications. This presentation describes the current DENTS status, including test readiness level (TRL) and testing in dust accelerator facilities.

Presentation: DAY 2 | September 9 9:15 | Proposal: 22-HTIDS22-0014 | Session: Dust and Debris | HELIOTECH

Presenting Author: Marshall, Robert | Affiliation: University of Colorado, Boulder (UCB) | Email: robert.marshall@colorado.edu
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Coded Aperture Imaging for X-rays and Energetic Electrons in Heliophysics Environments

Energetic electrons and X-rays are features of numerous regions of the space environment, and measurements of both are critical to advancing scientific understanding as well as space weather nowcasting. Both energetic electrons and X-rays can be measured by solid state detectors, but are similarly difficult to image, in order to determine source distributions in the case of X-rays, or pitch angle distributions in the case of electrons. In both cases, these angular distributions provide invaluable scientific information. This paper presents an instrument family that can image electrons and X-rays using pixelated solid state detectors and coded aperture imaging techniques. The first such instrument is the Atmospheric X-ray Imaging Spectrometer (AXIS) on the AEPEX CubeSat mission, scheduled to launch in early 2026. The instrument uses an array of pixelated CZT detectors, and a No-Two-Holes-Touching (NTHT) MURA coded aperture mask to provide imaging. The result is an instrument with 20 cm^2-str geometric factor and 90-degree field-of-view, to image X-rays emitted by Earth's atmosphere. This instrument has since evolved into two new variants that use a standard MURA pattern to increase the geometric factor while reducing the instrument size. Finally, the concept from the AXIS instrument has been adapted for energetic electron imaging, yielding direct measurements of pitch angle distributions. We present results of a concept design study that demonstrates the ability of such an instrument to measure electron distributions in the radiation belts or in the solar wind.

Presentation: DAY 2 | September 9 15:45 | Proposal: 18-HTIDS18_2-0023 | Session: Remote Sensing | HELIOTECH

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A Vectorized Rubidium Atomic Magnetometer for Low-Earth Orbit Field Monitoring

The Compact Spaceborne Magnetic Observatory (COSMO) is a 6U CubeSat mission launching in early 2026 to make continuous measurements of the Earth's magnetic field. COSMO carries a vectorized optical magnetometer to make precise and accurate vector and scalar measurements of the magnetic field in a single instrument. The magnetometer uses a rubidium optically-pumped scalar magnetometer from FieldLine, Inc., with <0.1 pT precision and <1 nT accuracy over the full range of Earth's magnetic field in LEO, sampled at 100 Hz. We extract vector components of the magnetic field using modulation coils wrapped around the scalar magnetometer in all three axes, following the methodology pioneered by the ASM-V instrument on Swarm. Vector components are extracted at 1 Hz with <3 nT precision and <5 nT accuracy. The flight instrument assembly has been completed, and calibration and characterization of the instrument and spacecraft have been performed at Goddard Space Flight Center's magnetic testing facility. Testing ensures that the magnetometer meets its design goals for precision, accuracy, stability, and thermal performance. This paper provides an overview of the magnetometer design and operation, calibration and characterization results, and an update on the COSMO mission design and timeline.

Presentation: DAY 1 | September 8 11:15 | Session: Fields | HELIOTECH

Presenting Author: Martínez-Ledesma, Miguel | Affiliation: NASA Goddard Space Flight Center (GSFC), Catholic University | Email: miguel.martinezledesma@nasa.gov
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Miniaturized Magnetometers: Vector Magnetometers for SmallSat Constellations

In recent years, SmallSats have transformed the space environment by broadening space access to multiple institutions. Multiple SmallSats are currently being launched in large constellations by commercial space companies and research organizations, allowing access to a number of flight opportunities not imagined before. Being able to integrate instrumentation on these new multi-satellite platforms would extremely advance our observation capabilities of the near space environment at multiple scales. Therefore, there is a pressing need for the development of new science-quality miniaturized technologies that allow the proliferation of measurement from SmallSats in Earth's space. To cope with the continuous and emerging requirement of instruments for constellations with low size, weight, power, and cost (SWAP-C), the Heliophysics division in NASA's Goddard Space Flight Center has developed the Miniaturized fluxgate Science Magnetometer (MSM). The MSM is a miniaturized, low-cost, high sensitivity and precision magnetometer that can support large constellations as well as rides of opportunity on missions without magnetic cleanliness standards or long magnetometer booms. The low SWAP of the MSM allows the capability of a distributed multi-sensor configuration to mitigate magnetic interference and produce reliable and clean scientific measurements. The instrument has obtained heritage through multiple sounding rocket test flights and the SPORT Cubesat in a single sensor configuration, and from the Dellingr CubeSat in a multi-sensor configuration. Here we discuss the general design of this magnetometer sensor and advantages of this technique compared to other space magnetometer suites.

Presentation | DAY 1 | September 8 10:30 | Session: Fields | HELIOTECH

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Waves, Instabilities, and Noise Spectrometer (WINS) for Earth's Ionosphere

The necessity to understand complicated interactions between ionosphere and its adjacent layers via description of waves is widely recognized as a one of the central problems in space exploration. For the daily cycling three-dimensional system, it is required to perform comprehensive mapping of plasma conditions over longitude, latitude, altitude, and local time, which is achievable only if the diagnostic equipment is affordable, energy efficient, and small in size. Waves, Instabilities & Noise Spectrometer (WINS) is a cost-effective, reproducible instrument built to operate within a 1U volume and capable of being deployed en mass. It performs accurate measurements of plasma density and temperature from MHz range electric field fluctuations via Quasi-Thermal Noise (QTN) spectroscopy. QTN spectroscopy has a half a century long record in solar wind observations but was not applied in the ionosphere before. WINS uses heritage of several solar wind missions and takes advantage of recent technological developments to accommodate the traditional solar wind setups to cold and dense ionospheric plasma. In parallel, DC regime electric field measurements enable in situ identification of plasma waves and instabilities. WINS antenna detectors, designed for deployment in an orthogonal basis geometry, characterize the electric field vector at the maximum 32 kHz cadence, sampling not just MHD, but also ion scale phenomena. The maturation of the instrument TRL from 2 to 5 will makes the instrument feasible for flight opportunities. WINS was originally developed au pair with Geospace Dynamics Constellation (GDC) Atmospheric Electrodynamics probe for THERmal plasma (AETHER) suite, aiming to aid in resolving potential observational issues early in the mission.

Presentation | DAY 1 | September 8 11:30 | Proposal: 22-HTIDS22-0013 | Session: Fields | HELIOTECH

Presenting Author: Mason, James | Affiliation: Johns Hopkins University Applied Physics Lab (JHU APL) | Email: james.mason@jhuapl.edu
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SunCET: The Sun Coronal Ejection Tracker

The Sun Coronal Ejection Tracker (SunCET) is a 6U CubeSat funded by NASA HFORT dedicated to figuring out how coronal mass ejections (CMEs) are accelerated. There are so many theories and models about how stored up magnetic energy can be released to force massive amounts of plasma to escape its magnetic confinement. Perhaps the background magnetic field falls with height just steeply enough that even a small random expansion of a flux rope is enough to let it fly free. Or perhaps the boiling motion at the surface of the star twists the coronal magnetic field so much that the flux rope crosses a critical threshold (448º) and it's suddenly kicked out. Magnetic energy release can continue to happen even after this initial phase, continuing to power the acceleration (e.g., varying velocity perturbations model). CMEs can also be deflected by the surrounding magnetic field they are passing through (e.g., ForeCAT model). All of these models produce unique predicted acceleration versus time profiles. The problem is we haven't had the ideal observations to discriminate between them. Enter SunCET, which solves the underlying technical hurdle that prevented prior observations from obtaining those complete acceleration profiles. The solar disk is 10 thousand to a billion times brighter than its surrounding corona, so prior observatories focused on only imaging one or the other, leaving a critical spatial gap between them in exactly the place CMEs experience the bulk of their acceleration. SunCET observes the whole thing, from 0-5 solar radii with no gap. Our new simultaneous high dynamic range detector algorithm is SunCET's enabling technology, which has broader applications for imaging and spectroscopy in astrophysics as well. The understanding we gain from SunCET CME observations and modeling efforts will inform our estimates of stellar CMEs and their impacts on the stellar environment. SunCET is expected to launch in early 2026.

Poster | Proposal: 20-HFORT20-0017 | HELIOTECH

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Development of a High Resolution Spectrograph in Lyman-a (HIRSL)

A currently funded H-TIDeS project is to develop a High Resolution Spectrograph in Lyman-a (HIRSL). HIRSL is. remote sensing instrument that uses a folded optical design with a micro-channel plate (MCP) to detect ultraviolet (UV) photons at the highest spectral resolution to date from space. The target investigation for our instrument is to measure the properties of interplanetary H. However, HIRSL can also be used to study H, D, & O UV emissions of the geocorona, planetary atmospheres, or cometary exospheres. Currently, HIRSL is in bench top development, preparing for the design of a future spaceflight capable system. This presentation is to inform the community of new hardware capabilities as well as to solicit input for future mission targets.

Presentation | DAY 2 | September 9 15:30 | Proposal: 22-HTIDS22-0007 | Session: Remote Sensing | HELIOTECH

Presenting Author: McCandliss, Stephan | Affiliation: Johns Hopkins University Applied Physics Lab (JHU APL) | Email: stephan@pha.jhu.edu

Astrophysical Sounding Rockets; Enabling the Future

Astrophysics sounding rockets have a long history in the nimble advancement of new science using new technologies and training the next generation of technically adept space scientists to carry the innovations forward into long duration missions. I will touch on examples from X-rays, UV and IR from the early days of sounding rocketry where space breaking efforts enabled or jumpstarted future advances. Highlights from some efforts by the JHU program to enable key developments in FarUV spectroscopy will also be presented.

Presentation | DAY 4 | September 11 13:30 | Session: Keynotes | Suborbital

Presenting Author: McEntaffer, Randall | Affiliation: Penn State University | Email: rlm90@psu.edu
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A Suborbital Rocket for High-Resolution X-ray Spectroscopy

The Off-plane Grating Rocket Experiment (OGRE) is a NASA suborbital rocket mission for high-performance X-ray spectroscopy. The nominal payload utilizes lightweight, polished-Si optics fabricated by NASA's Goddard Space Flight Center, a reflection grating array fabricated at Penn State with key industrial collaborations, and an EM-CCD-based camera fabricated by XCAM in collaboration with the Open University. In preparation for the nominal mission, we will fly a pathfinder rocket that swaps the polished-Si telescope out for the JET-X telescope being lent by the Italian Space Agency. This is one of three telescopes originally made for Spectrum-x-gamma with one currently flying on Swift and one slated for Pathfinder-OGRE. Here we report on the progress of the OGRE program, overview of the Pathfinder-OGRE mission, and updates on the nominal payload.

Presentation | DAY 5 | September 12 9:00 | Session: Astro | Suborbital

Presenting Author: Mehdi, Imran | Affiliation: NASA Jet Propulsion Laboratory (NASA JPL) | Email: imran.mehdi@jpl.nasa.gov
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TeraHz Limb Sounder (TLS) Technology for Remote Sensing of Global Thermospheric Wind, Temperature, and Density

Measurements of the neutral wind global profiles, during both day and night in an altitude region between ~100 km to ~400 km remains a key goal of future NASA heliophysics missions. In this region, most of the ion-neutral energy/momentum coupling takes place and the neutral atmosphere responds to external energy inputs, provides critical observational constraints to the complex dynamics in the coupled lower atmosphere /thermosphere/ionosphere/magnetosphere system. TeraHz Limb Sounder (TLS) is a low-mass, low-power, high spectral resolution heterodyne spectrometer system operating in the TeraHz (THz) frequency regime designed to remotely measure thermospheric wind velocity, temperature and atomic oxygen (O) density profiles from a low-earth orbit platform. It is envisioned to have two spectral channels that resolve the Doppler line shapes of the OI emissions at 2.06 THz (145 μm) and 4.7 THz (63 μm). This talk will describe recent progress made in developing an all-solid state 2.06 THz heterodyne receiver that has demonstrated Tsys<6000 K Double Side Band (DSB). This established a new world record for sensitivity at this wavelength and demonstrates the viability of a compact non-cryogenic receiver system that can be used in a space environment for 3D wind measurements.

Presentation | DAY 2 | September 9 11:00 | Proposal: 19-HTIDS19-0027 | Session: Remote Sensing | HELIOTECH

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The Spacecraft Charge Detector (SCD)

SCD is a novel spacecraft health and environment monitor with immense scientific and commercial potential. It monitors spacecraft surface charging, a major cause of satellite anomalies (i.e., failures) and a powerful indicator for the spacecraft environment (space weather, dust and debris impact, etc.). The SCD does not collect ambient plasma particles like state-of-the-art charging instruments, instead it tracks spacecraft potential changes using an isolated electrode. This novel approach enables a charging detector that is far smaller, cheaper, faster, and simpler than any available today. These advantages make the SCD the first spacecraft charging monitor feasible for widespread adoption, enabling a host of new missions and capabilities. In this talk we describe the SCD concept of operation, associated missions, development status (including the most recent testing from LVACCS), applications, and next steps. Heliophysics-specific applications to be discussed include unlocking orbital electric field and wave measurements in a low SWAP-C package (that does not need to be deployed). We will next address how the SCD enhances and enables traditional plasma instrument measurements by correcting for spacecraft charging (e.g. enabling electron measurements using Langmuir probes on small spacecraft). Finally, we will outline how distributed SCD measurements may be used for near-real time space environment warnings and space weather model validation via groups like the NOAA Space Weather Prediction Center.

Presentation DAY 1 September 8 15:30 | Session Charged Particles | HELIOTECH

Presenting Author Miles, David | Affiliation University of Iowa (UI) | Email david-miles@uiowa.edu
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The Capturing Ionospheric Coupling And Dynamic Aurora's (CICADA) Mission Concept

Connecting visible auroral signatures to wave-particle interactions and the conditions that drive them is a compelling piece of understanding energy transfer from space to Earth. Capturing Ionospheric Coupling And Dynamic Aurora's (CICADA) overall scientific goal is "Connecting auroral forms to precipitating electrons energized by Alfvénic wave-particle interactions." CICADA's instruments provide the key measurements to determine how Alfvénic wave-particle interactions and field aligned currents connect magnetospheric driving to ionospheric dynamics and the aurora. CICADA will also flight-demonstrate a powerful Alfvénic wave-particle correlator technique that enables future Mission-Of-Opportunity class investigations to the ~4,500 km auroral acceleration region to definitively establish the in-situ energy-transfer processes of Alfvénic aurora. CICADA defines three Science Objectives (SOs) that drive the mission and instrument design: SO1: What fraction of dynamic discrete arc aurora is associated with Alfvénic activity? SO2: What fraction of precipitating auroral electrons are causally related to Alfvén waves? SO3: What is the relationship between field aligned current and patches of pulsating Aurora?

Presentation DAY 2 September 9 16:30 | Proposal 8-HTIDS18_2-0010, 80GSFC18C0008 | Session Mission Concept | HELIOTECH

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Microwave and mm-wave Technologies and the EZIE Mission

The Electrojet Zeeman Imaging Explorer (EZIE) mission is a unique remote sensing mission for measuring the Auroral Electro-Jet currents in the Earth's ionosphere. EZIE launched recently illuminates the spatial and temporal structure of the AEJ by flying three pearls on a string 6U CubeSats within 2-10 minutes of each other. Each CubeSat carries the Microwave Electrojet Magnetometer (MEM) payload instrument, developed by NASA JPL. MEM carries 4 microwave polarimetric radiometers with a backend digital spectrometer. All radiometers cover a wide swath together, allowing spatial sampling. MEM operates at 118.75GHz, an oxygen absorption line. In the presence of a magnetic field, the oxygen line splits in frequency proportional to the strength of the field (Zeeman effect). MEM measures this frequency split that is a combination of the magnitude and direction of the background and electrojet induced magnetic field. MEM represents a prime example of technology innovation funded under NASA over decades, culminating in the EZIE mission. The MEM front-end technology was developed under NASA ESTO projects such as GeoSTAR and eventually validated with the TEMPEST-D mission. Similarly, the digital backend spectrometer was originally developed for Earth-based interference detection under the Agile Digital Detector program (developed at University of Michigan), eventually validated in space with the CubeRRT mission (led by Ohio State University, in partnership with JPL and NASA GSFC). MEM combined these low noise front-ends with backends capable of complex signal processing, developed originally for Earth applications and utilized successfully for a Heliophysics mission, led by JHU-APL and developed by NASA JPL. We will present recent EZIE-MEM results and on-board instrument performance. We will also present current and future technologies based on MEM like instrumentation that can aid and enable future Helio based missions and measurements.

Presentation DAY 2 September 9 11:15 | Session Remote Sensing | HELIOTECH

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Development of the Next-Generation SOlar Neutron TRACking (SONTRAC) Instrument

Solar eruptive events including solar flares and coronal mass ejections are known to accelerate charged particles to high energies. If those charged particles precipitate toward the solar surface, those accelerated ions can produce secondary neutrons via interactions with the dense plasma of the chromosphere and photosphere. Solar neutrons are among the least measured products of solar flare acceleration due to their low interaction cross sections and brief lifetime before they undergo beta decay. The SOlar Neutron TRACking (SONTRAC) instrument aims to fill this measurement gap. SONTRAC is a novel imaging neutron spectrometer utilizing a scintillating fiber hodoscope read out by miniature silicon photomultipliers. In this work we will describe the refinement and optimization of the next-generation SONTRAC instrument based on lessons learned from tests of the previous generation of SONTRAC. These refinements include a newly designed fiber bundle, the development of custom silicon photomultiplier arrays and newly designed readout electronics. Updates on the development of these technologies as well as future plans will be discussed.

Presentation | DAY 2 | September 9 16:00 | Proposal: 4-HTIDS24-0005 | Session: Remote Sensing | HELIOTECH

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The Quad-Mag Machine Learning Enabled Boom-less Magnetometer

The design, characteristics, and performance of a compact magnetometer board (Quad-Mag) equipped with four PNI RM3100 magnetometers and a Texas Instrument (TI) MSP430 microcontroller is presented. The low size, weight, power, and cost of the RM3100 enables the inclusion of four sensors on a single board, allowing a factor of two reduction in the noise floor and increase in the resolution established for an individual sensor via oversampling with multiple sensors. The PNI RM3100 experimentally achieved a noise floor of 12 nT at 150 Hz sampling rate. This results in a noise floor of 6 nT for the Quad-Mag at the same frequency after averaging, which meets theoretical expectations. A single on-board, TI MSP430 microcontroller handles synchronization of the magnetometers and facilitates data collection through a simple UART-based command interface to a host system. The Quad-Mag system has a mass of 59.05 g and total power consumption of 55 mW, while sampling and less than 5 mW while idle. The Quad-Mag enables < 1 nT magnetic field measurements at 1 Hz using commercial-off-the-shelf sensors for space applications. Combined with machine learning algorithms, the instrument allows boomless magnetic observations. The system will fly on the Resolute Rocket Investigation and proposed for other space missions. Research on significantly reducing the timeline for the manufacture and qualification of the system is being done for a commercial product to enable delivery of scores of units with lead times of a few months.

Presentation | DAY 1 | September 8 9:45 | Proposal: 23-HTIDS23-0001 | Session: Welcome/Keynote | HELIOTECH

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Development and Progress of SWIM Magnetometers for ICI-5bis Launch in 2026

ICI-5bis (investigation of cusp irregularities) is a University of Oslo sounding rocket mission that is currently set to launch out of the Andøya Space Suborbital range in Norway in May of 2026. The University of Iowa has the opportunity to conduct a technology demonstration of SWIM (space weather Iowa magnetometers) by providing inflight information about the magnetic field, with the goal of addressing the following questions: a) What is the role of Alfvén waves in auroral precipitation, b) How do turbulence and instabilities vary with different scales, and c) How does soft electron precipitation influence plasma structuring. The SWIM magnetometers each contain 3-axis 'racetrack' core magnetometers, of which the cores are made in house. SWIM development is based on an existing project, MAGnetometers for Innovation and Capability (MAGIC). Each will be mounted opposite the rocket to each other, and to their own deployable boom that extends outwards from the body of the rocket. These magnetometers will also be the University of Iowa's first digital magnetometers, which utilize digital demodulation instead of analog. Another developmental factor unique to this mission is building our magnetometers to be able to resolve measurements while at a maximum spin rate of 4 Hz. The challenge with a fast spin rate comes from reading the changing external field, and applying feedback fast enough to balance said field. As the graduate student PI on the project my goals include: understanding and supporting the build-up of the instrumentation, understanding and contributing to the calibration and characterization of magnetometer data, and contributing to and following the life cycle of a heliophysics suborbital rocket mission.

Poster | HELIOTECH

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Soft X-ray CMOS Detectors and the Development of the Solar Activity X-ray Imager Rocket (SSAXI-Rocket) and SmallSat (SSAXI-SmallSat)

Solar coronal plasma at temperatures greater than 1 megakelvin emit copious soft X-rays which encode diagnostic information on the plasma composition, plasma flows and aspects of the dominant heating mechanisms. The Solar Activity X-ray Imager program at the Harvard-Smithsonian Center for Astrophysics (CfA) has worked to develop X-ray CMOS detectors and X-ray multilayer coatings to enable new measurement capabilities via two separate capable instrument suites to measure the soft X-ray variations from the Solar coronal in the high time-cadence and spectral domains. This program has utilized HTIDS, LCAS, and HFOS funding to execute this vision. This talk will describe progress in the Swift Solar Activity X-ray Imager Rocket (SSAXI-Rocket) payload that was onboard the High-Resolution Coronal Imager (Hi-C) NASA sounding rocket for the Solar Flare Campaign. Hi-C Flare launched on April 17, 2024 and observed a solar flare. SSAXI-Rocket measured solar soft X-rays from 0.3-10 keV at 6 Hz time-cadence, which are some of the fastest to date of a solar flare. Additionally, The Scotopic Solar Activity X-ray Imager SmallSat (SSAXI-SmallSat) is designed to measure the solar soft X-ray spectrum from 0.5-7 keV during quiescent conditions. The dedicated spatially resolved full Sun observations are intended to decouple the heating mechanisms of the quiet Sun and active regions. Both SSAXI-Rocket and SSAXI-SmallSat instruments are compact, lightweight, and implement the latest grazing incidence optics and high-speed readout detector technologies.

Poster | Proposal: 19-HTIDS19-0017, 21-HLCAS21-0005, 24-HFOS24-0008 | HELIOTECH

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TeraHz Limb Sounder (TLS): Expected Performance for Retrieving Thermospheric Winds, Temperature, and Atomic Oxygen Density

TeraHz Limb Sounder (TLS) is a remote sensing radiometric instrument that collects light from Atmospheric Oxygen, O, emission lines that arise from transitions of the fine structure levels. The 2.06 THz OI emission (3P0->3P1) enables comprehensive remote sensing at altitudes between 100 and 250 km, while the 4.75 THz OI emission (3P1->3P2) extends the altitude range to >400km. The OI fine structure emission is present everywhere and is always in thermodynamic equilibrium with the ambient temperature at least up to 500 km altitude. As such, it is present at all local times and all latitudes and does not exhibit any space-time gradients over the terminators and within the aurora. Thereby, this is the only known thermospheric remote sensing technique that can measure the altitude profile of the thermospheric state at all local times and at all locations. The 2.06 THz implementation is proposed to fly on DYNAMIC as the DTLS instrument with 4 orthogonal look directions. We discuss the latest analyses into the space-time variability of the OI 2.06 THz and OI 4.7 THz emission strength over solar and geomagnetic conditions, latitudes and local times. We demonstrate that these emission lines are suitable for thermospheric retrievals everywhere because the emission lines are not modulated by external forces such as photoexitation and auroral precipitation. We discuss the expected retrieval performances as a function of receiver equivalent noise temperature and the thermodynamic state. We discuss the factors contributing to the accuracy of the estimated line-of-sight winds, how that compares to other remote sensing techniques, and the estimation of vector winds from multiple fields of view.

Poster | Proposal: 19-HTIDS19-0027 | HELIOTECH

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HBEE and POCCET; Sister New Shepard Payloads to Study Bubble Formation in Viscous Fluid and Pneumatic Regolith Trenching in Lunar Gravity

Understanding the behavior of gas-particle and gas-liquid systems in reduced gravity is critical for the advancement of planetary surface operations and in situ resource utilization (ISRU) technologies. Two suborbital rocket payload experiments – POCCET and HBEE – were developed to study pneumatic excavation of granular media and gas bubble dynamics in viscous fluid, respectively, under lunar gravity conditions. Both sister experiments were developed by Honeybee Robotics using shared designs and flew on Blue Origin's New Shepard NS-29 mission, which achieved two minutes of 1/6 g by rotating its crew capsule. The POCCET experiment demonstrated that pneumatic excavation in analog regolith (kinetic sand) under reduced gravity results in less stable trenches, increased particle lofting, and a 27% wider trench diameter compared to 1 g, indicating substantial differences in the mechanics of gas-driven regolith handling and rocket plume effects. The HBEE experiment used corn syrup as a molten regolith analog to show that bubble rise rate decreased to 1/6 under lunar gravity conditions, leading to enhanced bubble coalescence at the injection source, thus validating analytical models and emphasizing the importance of accounting for slower bubble movement in ISRU reactor designs. Together, these results contribute valuable data for the design of pneumatic excavation tools, management of rocket exhaust plume interactions, and optimization of gas-producing electrochemical processes for future lunar and planetary missions.

Presentation | DAY 5 | September 12 11:45 | Session: Solar and Lunar | Suborbital

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The EXoplanet Climate Infrared TElescope (EXCITE)

The EXoplanet Climate Infrared TElescope (EXCITE) is a 0.5m-class near-infrared spectrograph that flies from a stratospheric balloon platform. EXCITE is designed to perform phase-resolved spectroscopy -- continuous spectroscopic observations of a transiting exoplanet's entire orbit – of hot Jupiter-type exoplanets. This measurement requires excellent photometric precision over few day timescales, which in turn drives strict requirements on the instrument's optical, mechanical, and thermal stability. Consistent with the goals of NASA's suborbital program, in addition to being capable of cutting-edge science, EXCITE is also a testbed for advanced technologies, including detectors and readout electronics developed for the James Webb Space Telescope and the Roman Space Telescope, respectively. Here we present EXCITE's design, enabling technologies, and key results from its 2024 engineering flight from New Mexico. We show that the EXCITE instrument meets all requirements for its upcoming Antarctic long duration science flight, including the successful operation of all critical components in the stratospheric environment and a demonstration of milliarcsecond line-of-sight stability, setting the benchmark for a cryogenic balloon-based instrument.

Presentation | DAY 5 | September 12 13:15 | Session: Balloon and Aircraft | Suborbital

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Goddard Miniature Coronagraph

White light coronal observations are used to derive most of the basic properties of Coronal Mass Ejections (CMEs). They provide the ability to track their propagation and evolution and play a crucial role in forecasting CME geo-effectiveness. Observations from multiple lines-of-sight away from the Sun-Earth Line (SEL) reduce the ambiguities inherent in observing an optically thin medium. Multi-point observations of CMEs and heliospheric structures would be possible using missions out of the ecliptic plane and/or low-cost Smallsat platforms launched into various orbits off the SEL. For this ITD study, we will fully design and test on the ground a low Size, Weight, and Power (SWAP), miniature solar coronagraph, thus extremely cost/resource effective. While boom-deployed magnetometers have been successfully used on missions of varying sizes, the boom position and stability requirements for a coronagraph occulter are more severe and have not yet been tested. We will test the performance of a prototype coronagraph with a boom-deployed external occulter system to validate pointing, stability and stray light requirements. This ITD is an ideal opportunity to optimize performance and greatly enhance the probability of success on a future SWAP constrained coronagraph mission. The end result will be a full instrument design ready to be proposed and flown.

Presentation | DAY 2 | September 9 13:30 | Proposal: 22-HTIDS22-0004 | Session: Remote Sensing | HELIOTECH

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From Idea to Space Flight: Focus on Solar Wind Diagnostics; BITSE, CODEX

Developing a spaceflight science mission typically involves a methodical series of steps, starting out from an idea, through technology development and eventually leading to a full mission. The suborbital program is a key component of this stepwise approach for NASA. Our team has been developing the ability to obtain new observations of the solar wind in order to help solve one of solar physics biggest outstanding mysteries: What heats the solar corona to a million degrees hotter than the Sun's surface and sends it streaming out at almost a million miles per hour? The Coronal Diagnostic Experiment (CODEX) project is a prototypical example of this process. The theory of simultaneously measuring the solar corona and solar wind electron density, temperature, and speed was developed over several decades. This led to ground-based experiments during eclipses and then through a series of technological advances a scientific balloon (Balloon-borne Investigation of Temperature and Speed of Electrons in the corona (BITSE)) was successfully flown in 2019 to demonstrate the basic principles of this new diagnostic. This flight led to the development of CODEX, which was recently installed on the International Space Station. CODEX, that along with other observatories studying the solar corona will help shed light on the formation of the solar wind.

Presentation | DAY 3 | September 10 11:45 | Session: Keynote | Suborbital

Presenting Author: Newswander, Trent — Affiliation: Utah State University Space Dynamics Laboratory (USU SDL) — Email: trent.newswander@sdl.usu.edu
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Advanced Doppler Wind and Temperature Sounder

An advanced Doppler Wind and Temperature Sounder (DWTS) has been developed for flight on NASA's DYNAMIC (Dynamical Neutral Atmosphere-Ionosphere Coupling) satellite mission. DYNAMIC will explore the Space Atmosphere Interaction Region (SAIR), spanning the mesosphere and thermosphere, where Earth's atmosphere meets space. DWTS is a passive infrared radiometer that observes the atmospheric limb on both sides of the spacecraft. DWTS employs an onboard gas cell to detect the Doppler shifting of atmospheric emission lines, which yields wind and temperature measurements both day and night from 40 to 250 km altitude. This presentation introduces the DWTS science capabilities and applicability in heliophysics and space weather missions; describes the instrument design and performance; and reports results from subassembly prototype testing and maturation efforts.

Presentation: DAY 2 — September 9 10:00 — Session: Neutrals/Neutrons — HELIOTECH

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Small Orbital Debris Characterization with the Lightsheet Anomaly Resolution and Debris Observation (LARADO) Instrument

Objects in the size range of 0.1 mm to 3 cm are not currently trackable but have enough kinetic energy for lethal consequences to spacecraft. The detection of small orbital debris, potentially posing a risk to most space missions, requires a combination of a large sensor area and large time coverage. For example, a sensor with a time area product of 3 m^2-years is considered to be able to make a significant contribution to our understanding of the near-Earth small debris population. Deploying large sensors, however, is generally resource intensive, due to their size and weight. The light sheet sensor concept, allows the creation of a "virtual witness plate", which is created without any supporting physical structure and therefore presents an attractive opportunity for the detection small debris anywhere between low Earth orbit to interplanetary space. In this work, we will describe the dual sheet technique for the LARADO instrument, and the debris characterization work associated with the 22-HTIDS-06 effort, including laboratory data and analysis from multiple campaigns to the NASA Ames Vertical Gun Range. The orbital debris characterization work includes size, speed, direction and type.

Presentation: DAY 2 — September 9 9:30 — Proposal: 22-HTIDS22-06 — Session: Dust and Debris — HELIOTECH

Presenting Author: Ogasawara, Keiichi — Affiliation: Southwest Research Institute (SwRI) — Email: kogasawara@swri.org
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A Miniature Solar WInd Sensor (MSWIS) for Future Low-cost, Constellation, and Deep-space Missions

Providing solar wind parameters is critical to understanding the physical processes related to space weather and their impacts at Earth and other planets. CubeSats are now capable and flexible platforms that can be configured for a wide range of science mission profiles, either as a standalone platform, as a daughter spacecraft, or in swarms and constellations. A Miniature Solar WInd Sensor (MSWIS) is an extremely compact, low-power, and high-performance solar wind analyzer to measure ion velocity distribution functions (VDFs) and determine bulk solar wind moments with accuracies comparable to state-of-the-art solar-wind sensors with minimal resources (1 U, 1.5 kg, 4.7 W). The novel MSWIS design gives an energy per charge range of 100 eV/q to >10 keV/q with 5% resolution. The sensor total field of view covers 44° x 44° with 132, 4° x 4° sensor segments. Each segment points to different arrival directions, and MSWIS can instantaneously image the 2D (elevation x azimuth) distributions. Energy scan by sweeping a single internal electrode completes the 3D VDFs. In this presentation, we discuss the sensor concept, the proof-of-concept model of MSWIS with laboratory verification study results, and the sensor packaging efforts to achieve the goal of 1U size. A compact and versatile solar wind sensor like MSWIS is very attractive for many future Heliophysics or Planetary missions, particularly for nanosatellite/multi-satellite platforms. Such instruments are also attractive for space weather, for inputs to modeling the space environment variability all around the Solar System and understanding the interactions of the solar wind and/or the magnetospheric environments in which they are embedded.

Presentation: DAY 1 — September 8 14:00 — Proposal: 23-HTIDS23-0017 — Session: Charged Particles — HELIOTECH

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Dual Capability for a New Era in Airborne Science: Leveraging the C-130J-30 and Project Karman Line to Enable Heliophysics Research

Space Centre Australia LLC introduces two integrated mission capabilities that address current infrastructure gaps in airborne and suborbital science: (1) the acquisition and NASA-standard integration of a C-130J-30 aircraft platform, and (2) the development of Project Karman Line, a horizontal air-launch system deployable from the aircraft to support sounding rocket and suborbital trajectories. The C-130J-30, configured in accordance with NASA-STD-79191, is designed to support high-altitude atmospheric sampling, heliophysics payloads, and coordinated balloon or rocket campaigns. A key enhancement is the mitigation of “dirty air” from propeller wake and engine exhaust – resolved through forward-mounted instrumentation zones and an optional extended nose cone, ensuring clean laminar airflow for sensitive gas and aerosol sensors. Project Karman Line provides responsive suborbital access for microgravity, upper-atmosphere, and technology validation missions, with integration pathways supporting NASA, NOAA, NSF, and academic flight programs. The system is capable of rapid deployment from both U.S. and Australian airspace, including the emerging Atakani Space Centre in Cape York – offering dual-hemisphere science campaign capability. Together, these capabilities enable mobile, range-independent mission support for heliophysics and atmospheric science, complementing traditional suborbital research capabilities, while accelerating access for certification, research, and student flight projects.

Presentation	DAY 4	September 11 14:50	Session	Keynotes	Suborbital

Presenting Author	Palmer, Miles	Affiliation	University of California San Diego (UCSD)	Email	mppalmer@ucsd.edu

Rapid Fire Mach 8 Aircraft Ballistic Launch

Existing aircraft technologies are limited to roughly Mach 4 and 30 km altitudes. Previously demonstrated hypersonic aircraft like the X-15 have demonstrated capabilities to reach up to roughly 110 km. Development of such hypersonic aircraft is highly desired for both their speed and altitude capabilities. Such development to date has been expensive and slow. Two stage light gas guns first demonstrated hypersonic launch capability in the 1950s, but small payload size, extremely high accelerations, and long refurbishment intervals have limited their use to laboratory research. A new type of light gas launcher developed with commercial funding promises to greatly expand the payload size and launch frequency, and to reduce accelerations. Commercial scaleup and installation is planned to form the foundation of new low cost hypersonic research facilities for very frequent closed range and open ballistic flight tests to Mach 10 and 200 km altitudes. Engineering and programmatic information for the planned commercial facilities is presented.

Presentation	DAY 5	September 12 14:45	Session	Balloon and Aircraft	Suborbital

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Geospace Remote Sensing with the STORIE ISS Energetic Neutral Atom Imaging Instrument

Earth’s Geospace glows in Energetic Neutral Atoms (ENAs) when plasma ions charge exchange with the underlying cold hydrogen exosphere. Measuring the energy, composition, and angular distributions of these ENAs serves as a powerful remote sensing tool. The Storm Time O+ Ring Current Imaging Evolution (STORIE) mission scheduled for launch in 2026 will provide continuous inside-out global geospace weather imaging with its ENA instrument hosted on the International Space Station (ISS). The instrument leverages the abundant size, mass, power and telemetry resources of the space station. Basic specifications include FOV (4o x +/- 46o), large aperture (GF ~1.5 sr.cm^2), energy range ~1-200KeV, H, O composition, detailed time tagging and telemetry of each event. The instrument technology is based on HV charged particle rejection, electrostatic optics, foil/MCP/TOF, fast time of flight / delay line position sensing and HV electronics. Special UV filtering and tight quad time/ position coincidence is used for effective noise cancellation from UV geocorona, stars, even direct sunlight, and electronics. After successfully undergoing standalone environmental acoustic, vibration and TVAC the instrument was delivered to NASA/JSC for carrier level integration and environmental testing. We will present the instrument status update including test results from particle beam / UV validation. Based on the instrument capabilities we will discuss remote sensing of the ring current, dayside magnetopause / magneto sheath and the magnetotail. We will also discuss recent advances in using ML / AI for space weather prediction directly from the ENA images and upstream solar wind drivers.

Presentation	DAY 2	September 9 10:15	Session	Neutrals/Neutrons	HELIOTECH

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Vector Electric Field Booms with Dual Spheres for Use on Sounding Rockets

Electric field detectors have been flown on sounding rockets since the 1960's, providing fundamental measurements of DC and AC electric fields in a variety of geophysical conditions ranging from the high altitude auroral zone (e.g., 1450 km) to the equatorial electrojet to noctilucent clouds at 85 km. A key feature of double probe experiments is the boom system which deploys spatially separated electrodes between which the potential difference is measured. Fold-down electric field booms enable inner sensors to be included, providing plasma wave interferometry as well as measurements of electric fields associated with the payload sheath. We have developed spring-loaded, double-articulated fold-down booms flown on over a dozen payloads, providing tip-to-tip distances of 5m, with inner sphere separations of 75 cm. For some cases, the inner spacing is varied to permit a wider range of spatial attenuation measurements to characterize the short scale spectrum of electrostatic waves. Midway on the fold-down booms, we have extended search coil antenna, Langmuir probes, and "swivel" probes that provide an additional perpendicular double probe. This third electric field component completes the vector measurement when only spin plane booms are available and can be important for measuring Langmuir waves and electric fields parallel to the magnetic field direction. The third component has also been measured via fold-out booms deployed along the spin axis. Vector measurements have also been gathered with triaxial, identical fold-down booms of 2.4m tip-to-tip length on small (30 cm diameter) spherical payloads, originally developed at Goddard by Maynard to measure DC electric fields in the mesosphere, on which we include inner spheres to gather plasma wave interferometry. This talk reviews the key features of the different, fold-down electric field booms developed in our lab and successfully flown on a number of sounding rocket payloads.

Poster | HELIOTECH

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Exploring the Nighttime Equatorial Electrojet with Sounding Rockets

The equatorial electrojet is a critical feature of the Earth's global dynamo current system and one which is ideally suited for exploration with sounding rockets. Since the first rocket observation of the equatorial electrojet in 1949 from a US ship off the coast of Peru, sounding rockets have exposed fundamental processes associated with the electrojet current system including its electrodynamics and plasma instabilities. Despite over seven decades of probing the daytime electrojet with rocket probes, in situ measurements of the nighttime electrojet remain relatively rare. The nighttime electrojet is very weak because the plasma density in the lower ionosphere is considerably reduced compared to the daytime, and therefore it does not register a ground magnetic signature. Nevertheless, the electrojet current is expected to not only be present at night, but also to reverse direction, in concert with its associated, vertical DC electric field which is also expected to change sign. Such polarization electric fields are set up within the narrow altitude range (100-115 km) due to the Cowling conductivity at the magnetic equator where the magnetic field is precisely horizontal. Flux-gate magnetometers are sufficiently sensitive to measure this current on rocket platforms which, when flown with DC electric field and plasma density probes, will reveal the complete electrodynamic "picture" of the nighttime electrojet. Furthermore, from Jicamarca radar observations, the electrojet is known to be highly unstable at night, providing a seat for plasma instabilities that include both large amplitude, km-scale structures and shorter, meter-scale waves driven by the two-stream instability. In addition, at night, the plasma density may be characterized by jagged density layers and wind shears. This talk delineates the fundamental outstanding physical problems in the nighttime electrojet and the great promise of using probes on sounding rockets to resolve them.

Presentation | DAY 5 | September 12 15:35 | Session Geospace | Suborbital

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Metasurface-enabled Solar Polarimetry with SIMPol

Much of what is known about the sun's magnetic fields is owed to optical polarimetry, the measurement of light's polarization state. In most existing solar instrumentation, these measurements are enabled by a rotating waveplate retarder or a switching liquid crystal modulator. Not only do such active components present significant mission risk (especially in space), but instruments built around these technologies require multiple non-simultaneous image measurements to sense the polarization of light. Here, we present SIMPol (Solar Imaging Metasurface Polarimeter), a HESTO-funded project to realize solar polarimetry based on a new technology we call metasurface polarization splitters (MPSs). The MPS permits full-Stokes polarimetry of the sun with a single, passive nanofabricated component. We present the design of SIMPol, the fabrication, performance, and space qualification of a high-performance MPS, and the deployment of SIMPol to a major solar observatory facility where SIMPol was used to deduce solar magnetic fields based on Zeeman diagnostics. SIMPol demonstrates the unique advantages new photonic technologies can present to heliophysics and astronomy more broadly.

Presentation | DAY 1 | September 8 16:45 | Proposal 20-HTIDS20-0002 | Session Remote Sensing | HELIOTECH

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High-resolution Laboratory Measurements of M-shell Fe EUV Line Emission Using EBIT-I for Solar Physics

Solar physicists utilize EUV observations of M-shell Fe to study structures in the solar corona. Accurate atomic data for these ions are essential for correctly interpreting the observed solar spectra. One of the most powerful spectroscopic diagnostics for solar physics is the Ar-like Fe IX ion. Fe IX traces the cooler portions of the solar corona. Consequently, many solar imagers observe the bright Fe IX 171 A line, providing insights into the corona, coronal holes, flares, jets, coronal mass ejections, and other phenomena. Fe IX emission is routinely observed in the 180–260 A band which is diagnostic rich for these solar regions. As a result, it is a key observational target for the Extreme Ultraviolet Imaging Spectrometer on the Hinode satellite, and it will be a focus of instruments planned for future missions such as MUSE and Solar-C. Despite this, several bright lines in this wavelength region were only recently identified. Moreover, various calculations of Fe IX wavelengths have not yet converged to the same theoretical values or been experimentally verified, and there are many lines whose identifications are uncertain. In addition, the Fe IX 241.739 A / 244.909 A intensity ratio is predicted to be one of the most sensitive EUV electron density diagnostics in the solar spectrum. However, this diagnostic is not currently in use, in part due to disagreements between observations and theory. Such diagnostics can be very sensitive to uncertainties in atomic data and line blends. To benchmark this Fe IX density diagnostic, we have conducted high-resolution laboratory measurements of EUV line emission from Fe VII-X using EBIT-I at LLNL. We use our previously developed methods to calibrate density diagnostic line ratios to better than 20%. Our measurements also provide new line surveys of Fe M-shell emission covering the 40-100, 185-205, and 238–258 A wavelength ranges.

Presentation DAY 1 September 8 15:45 Proposal 24-HTIDS24-0002, 19-HTIDS19-0005 Session Laboratory Studies HELIOTECH

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Nitric Oxide Radiometer Development

SDL developed a small satellite payload to support the NICEcube mission concept capable of measuring vertical profiles of infrared radiance at 5.3 μm from nitric oxide (NO) in the atmospheric limb (100-250 km). These radiance measurements can be directly inverted to achieve vertical profiles of infrared cooling rates which are crucial to understanding the density response to the thermosphere in times of elevated geomagnetic activity. The payload was designed to fit on a 12U cube sat, function at low power and small mechanical envelope. Completed work includes building the telescope, integrating a representative detector, alignment, test planning, and initial testing. This paper discusses the payload concept, the payload build, how the payload fits into a common bus structure and briefly how technology development mitigates risk. The telescope is now ready to be integrated into a fully functional instrument with a larger format detector. This detailed prototype can then be assessed through environmental and performance testing in preparation for a flight instrument. Flight data, provided in near-real time, is envisioned to be a key component of emerging space weather forecasting models to be used to significantly improve space domain awareness in ever more crowded low earth orbit.

Presentation DAY 2 September 9 11:30 Session Remote Sensing HELIOTECH

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The Loss Through Auroral Microburst Pulsations Satellite (LAMPsat) Flight Opportunity Study

Electron precipitation into Earth's atmosphere profoundly impacts the geospace radiation environment. Lower-energy (1-10s keV) electrons create visible aurora, while hazardous relativistic (>500 keV) electrons generate X-rays. Despite evidence suggesting pulsating aurora and relativistic electron microbursts are linked, comprehensive simultaneous observations of both are elusive due to differing observational techniques. Recent studies, including the dedicated Loss Through Auroral Microburst Pulsations (LAMP) sounding rocket, hint that both microbursts and pulsating aurora are part of the same precipitating electron spectrum. To statistically understand when the precipitating electron distribution includes 10s keV pulsating aurora electrons and relativistic microburst electrons, we introduce the Loss Through Auroral Microburst Pulsations Satellite (LAMPsat). This mission concept is designed to fly in a polar low Earth orbit. There, its zenith-pointing particle detector will directly observe the precipitating relativistic electrons, while its nadir-pointing auroral imaging camera will observe the pulsating aurora light emitted by 10s keV electron precipitation. Over its five-month mission, LAMPsat will gather a statistically significant dataset of auroral images and electron spectra, allowing us to finally determine if microbursts and pulsating aurora are linked, and under what conditions does pulsating aurora include relativistic “killer” electrons.

Presentation DAY 2 September 9 16:45 Proposal 22-HFOS22-0007 Session Mission Concept HELIOTECH

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Tandem Ion Mass Spectrometer: High Efficiency Multi-Stop Design for M2M and Outer Planet Missions

We are developing a prototype of our Tandem IMS (TIMS) with the goal of working toward a fully operational instrument for future opportunities. TIMS is a state-of-the-art mass spectrometer with wide energy/charge range 1 V ≤ E/Q ≤ 50 kV, wide field-of-view (FOV) 360deg x 90deg and wide dynamic range by more than 10 decades in particle intensities for the M2M program including lunar lander, lunar orbiters, and for Mars orbiting missions with a MAVEN like science capability. During translunar space and cruise phase to Mars, TIMS would provide space weather measurements of the solar wind plasma ions including protons, 4He++ and the minor high charge state ions. In addition, TIMS can measure the interstellar pick-up ions up to mass-per-charge (M/Q) ~ 56 (i.e., 56Fe+) and possibly the noble gas krypton 84Kr+ (i.e., during solar minimum interstellar neutrals can penetrate deeper into the heliosphere). In addition, it has the potential to measure the high charge state noble gas ions 84Kr and 131Xe in the solar wind. TIMS uses a two-carbon foil (CF) time-of-flight (TOF) design with 3-stop coincidence detection for low noise measurements. By using an imaging technique, TIMS can correct for CF induced ion scattering and ion energy straggling so a high mass resolution 10 < M/dM < 60 capability can be achieved. The combination of dE/dX effects and TIMS high mass resolution ion TOF peaks can be separated. TIMS has the potential of making major discoveries for both heliospheric science and planetary science with emphasis on the M2M human exploration missions by providing space weather in situ measurements of the solar wind and solar storms and their impact on the safety of astronauts on the lunar and Mars surfaces, respectively. In addition, by measuring the composition of the solar wind during solar storms, it may provide important information about eventually predicting, for example, when a coronal mass ejection might occur when using spectral imaging measurements of the Sun.

Presentation | DAY 1 | September 8 13:15 | Session: Charged Particles | HELIOTECH

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Suborbital Activities and Capabilities at Esrange Space Center

Since the 1960’s and 70’s more than 600 sub-orbital rockets and close to 700 stratospheric ballons have been launched from northern Sweden. Being inside the auroral oval, the city of Kiruna has seen several important establishments within the area of space physics research develop in its vicinity. One of them, the ESRO (now ESA) Sounding Rocket Launching Range was built in 1964. In 1972, SSC was founded and took over ownership of the range under the name Esrange Space Center. SSC has been developing its capabilities ever since. Today activities include but are not limited to sounding rockets, stratospheric balloons, rocket motor testing, ground station services and the development of orbital capabilities. This paper will focus on current activities and capabilities within the spectrum of sounding rockets ranging from atmospheric and plasma physics to micro gravity and technology development. It will also briefly touch upon relevant permanent scientific ground instrumentation and stratospheric ballooning.

Poster | Suborbital

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The Relativistic Electron Atmospheric Loss (REAL) Energetic Electron Instrument

The REAL (Relativistic Electron Atmospheric Loss) CubeSat distinguishes between different modes of loss of energetic electrons to the atmosphere, by observing electrons at different pitch angles, simultaneously. It operates in low Earth orbit (LEO), where the atmospheric loss cone is larger (~60 deg) than at the equator (few degrees). The REAL instrument observes electrons in multiple look-directions, and over a wide energy range. It achieves this, in a 3U CubeSat, by making use of advances in sensor miniaturization. REAL observes from 100 eV to 2 MeV, incorporating low-, medium- and high-energy heads, with 2, 5 and 4 look-directions respectively, with time resolution sufficient to resolve electron microbursts. These pitch-angle resolved measurements will distinguish between precipitating, quasi-trapped, and trapped populations, thus more accurately quantifying the electron loss rate and the impact on Earth’s atmosphere. The medium- and high-energy heads consist of a multi-aperture collimator followed by stacked solid-state detectors (SSDs) The low-energy head is a miniature electrostatic analyzer (ESA) made up of titanium electrodes sandwiched between etched silicon wafers, and followed by a microchannel plate (MCP). The REAL instrument is made up of these three sensor heads integrated with four electronics boards that together take approximately one half of the 3U REAL spacecraft. This unparalleled capability enables high resolution observations, at high cadence, in a form factor suitable to multi-CubeSat missions.

Presentation | DAY 1 | September 8 14:30 | Proposal: 17-HTIDS17-0031 | Session: Charged Particles | HELIOTECH

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First Results of Suborbital in-situ In-Track Neutral Wind Measurements and Instrument Development of the Winds In-track (WIT) Instrument

The innovative Winds In-Track (WIT) is a time-of-flight in-situ instrument designed to measure the thermosphere neutral wind velocity in the ram direction. A rotating chopper wheel at the front of the instrument modulates the follow of thermospheric gas creating "puffs" of gas similar to molecular beam laboratory experiments (Scoles et al., 1988). These "puffs" travel a known distance through the instrument and are detected by a fast ionization gauge and microchannel plate at the back of the instrument. The 2021 Dynamo 2 sounding rocket mission was the first flight of the WIT with the wheel spinning. While flowing gas was clearly registered in laboratory tests, the Dynamo 2 flight data resulted in a low signal above the background gas, impeding efforts to extract wind speed. Modifications to the WIT geometry have been designed and simulated with 3D OpenFoam DSMC (White et al., 2018) that demonstrate the signal during flight will be measurable above the background. The updated WIT has successfully measured the laboratory wind beam and will fly in August 2025 on the TOMEX+ sounding rocket. The instrument development and first results of in-track neutral wind velocity from the TOMEX+ mission will be presented.

Presentation DAY 4 September 11 16:00 | Session Geospace | Suborbital

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A New HOPE for Accurate Solar Flare Prediction

Solar flares are among the most powerful explosions in the solar system, releasing electromagnetic radiation across a broad spectrum - from gamma rays to radio waves. Despite decades of research, the underlying physics of solar flare initiation remains to be completely understood. Predicting solar flares a few minutes in advance, known as nowcasting, continues to pose a major challenge in space weather forecasting. In this presentation we present an update on our current efforts for advancing solar flare nowcasting, through analysis of existing datasets and development of novel instrumentation. Our study leverages the recently identified Hot Onset Precursor Event (HOPE) of solar flares to provide early warnings of impending flares. Using soft X-ray irradiance data from the NASA-funded MinXSS-3 (DAXSS) instrument, alongside observations from the GOES-XRS instrument, we evaluate the statistical performance of our nowcasting algorithm across a wide range of flare magnitudes. Results indicate that the HOPE effect is present in most flares, and can provide an accurate flare alert 10-15 minutes prior to a solar flare. In addition, we introduce the concept and design of a new soft X-ray imaging instrument that aims to utilize the HOPE effect to further enhance nowcasting capabilities. This instrument is scheduled for launch aboard the Extreme-Ultraviolet Variability Experiment (EVE) calibration sounding rocket from White Sands Missile Range (WSMR) in April 2026. A successful demonstration on this sounding rocket platform could pave the way for future deployments on CubeSat or small-satellite missions.

Poster | HELIOTECH

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A Vacuum Ultraviolet Fourier Transform Spectrometer for Ultra-high Resolution Spectroscopy

In 2024, the NASA Heliophysics Technology and Instrument Development for Science (HTIDeS) program began funding the Laboratory for Atmospheric and Space Physics at the University of Colorado to develop a Vacuum Ultraviolet (VUV) Fourier Transform Spectrometer (FTS) that will bring unprecedented spectral resolution to space-based UV observations, and broad applicability to heliophysics observations including those of Earth's and planetary upper atmospheres and the solar chromosphere and corona. In addition to its unprecedented resolution, the VUV FTS design is inherently compact. Fourier transform spectroscopy is a powerful technique yielding unparalleled resolution at visible and Infrared (IR) wavelengths. Traditionally, a Fourier Transform Spectrometer (FTS) is based on a Michelson Interferometer, which has limited FTSs to wavelengths above ~140 nm. Recently, a new all-reflective FTS was developed at the SOLEIL Synchrotron. This spectrometer is broad-band, and capable of measuring down to 40 nm with a resolving power of 106 (e.g. 40 femtometers at 40 nm). The SOLEIL-FTS has been routinely used for over a decade for laboratory-based absorption spectroscopy, and has had a significant impact on Vacuum Ultraviolet (VUV) spectroscopy. LASP is ruggedizing the SOLEIL-FTS for spaceflight and optimizing the design to measure exospheric Hydrogen at 121.6 nm. This program is nearing completion of its first year. Designs are finalized and components are completed and in-production. In this presentation, we will present the LASP space-borne VUV FTS design and link instrument characteristics to measurement performance. Capabilities and limitations of the instrument will be presented in the context of current state-of-the-art grating UV spectrographs commonly used for heliophysics UV observations. We will also present recent performance test data on instrument sub-systems currently under development.

Poster | Proposal 23-HTIDS23-0022 | HELIOTECH

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Preliminary Development and Testing of the ComPair-2 Gamma-Ray Telescope

The Astro2020 Decadal Survey's highest priorities in gamma-ray and multi-messenger astrophysics focus on developing critical insight into the universe's most extreme objects, explosions, and particle accelerators. The Compton-Pair (ComPair)-2 gamma-ray telescope is a future balloon payload that will serve as a prototype for a proposed wide-field, medium-energy gamma-ray space observatory concept sensitive to 25 keV – 1 GeV that can deliver breakthrough discoveries in these areas. Currently being built at NASA's Goddard Space Flight Center and several partner institutions, the ComPair-2 instrument consists of a Tracker Module composed of AstroPix detectors – monolithic silicon high-voltage complementary metal-oxide-semiconductor (HVCMOS) active pixel sensors adapted from on-ground particle physics experiments – and a Calorimeter Module composed of cesium-iodide scintillator crystals coupled to custom dual-gain silicon photomultipliers. The mission will raise the technology readiness of both the instrument and its complex fabrication and assembly processes. Here, we present an overview of ComPair-2's preliminary instrument design, the fabrication and testing of the Tracker's engineering test units, upcoming efforts for the Tracker and Calorimeter, and plans for continued development towards a long-duration, high-altitude balloon flight.

Presentation | DAY 5 | September 12 14:15 | Session: Balloon and Aircraft | Suborbital

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Development of the Suprathermal Particle and Relativistic Electron Magnetic Spectrometer (SuPREMeS)

The Suprathermal Particle and Relativistic Electron Magnetic Spectrometer (SuPREMeS) is a novel and innovative instrument design that promises to deliver a next-generation, high-performance, and low-resource option for measurements of energetic particles in space. The goal of this effort is to advance the instrument design from Technology Readiness Level (TRL) 3 to 5/6 by the end of the effort, enabling a new instrument to address science related to Earth's and other planetary radiation belts, solar energetic particles (SEPs), and cosmic rays. The specific objectives to deliver on this goal include: optimizing the design of the detectors and sensor-head; finalizing the mechanical and electrical designs of the full instrument; procurement and preliminary testing of magnets and detectors; procurement and testing of key electronic components; field-programmable gate array (FPGA) design and testing; and manufacturing and testing a prototype (TRL 5/6) instrument. In this presentation, we introduce the instrument concept and report on progress made during Year-1 of the project, including the following key accomplishments: validation of the design and full simulated performance ranges; magnetics design and performance; details of the mechanical and electrical designs; and ongoing and future testing.

Poster | Proposal: 23-HTIDS23-0012 | HELIOTECH

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High-Resolution Wide-FOV Mapping of the Solar Corona and Inner Heliosphere

White light imaging of the solar corona and inner heliosphere provides key measurements for understanding solar transients and large-scale structures, including coronal mass ejections (CMEs). With conventional telescope designs for this application, there is a tradeoff between resolution and field of view (FOV); coronagraphs typically provide high-resolution measurements over a small region while heliospheric imagers sacrifice spatial resolution for larger FOVs. To address this measurement gap, we are developing the Scanning Coronal and Heliospheric Imager (SCHI), which employs achromatic hybrid metasurface Risley prisms to create high-resolution, wide-FOV maps of the corona and inner heliosphere in the visible light regime, all within a compact and versatile instrument package. This design enables rapid mapping of a large field of regard with a small instantaneous FOV, leading to improved spatial resolution and throughput, and features of interest (e.g., CMEs) can be tracked. Here we present on the instrument concept and early development through the NASA HTIDeS program.

Presentation | DAY 2 | September 9 13:45 | Proposal: 23-HTIDS23-0016 | Session: Remote Sensing | HELIOTECH

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Real-Time Early Flare Alert System for Sounding Rocket Solar Flare Campaigns

Understanding when and where a solar flare will occur continues to be an important goal for the heliophysics community, relevant to fundamental research, coordinated flare observations, and space weather applications. Flare forecasting products have typically included long-term probabilistic forecasts (e.g., probability that a flare of a given size will occur over a given time period) and flare alerts (e.g., notification when the flare flux has already reached a high level). For a variety of research and operational purposes, there is an additional need for an early flare alert system to anticipate large and long-lasting flares that is more actionable than long-term forecasts and provides earlier notice than current flare alerts. Such a tool would enable triggered observations of the early stages of solar flares, a crucial capability for demonstrating novel instrumentation optimized for solar flares via sounding rockets and other observing campaigns targeting flares. With this goal in mind, a collection of tools was developed and implemented for NASA's sounding rocket solar flare campaign in April 2024, which featured a suite of novel solar X-ray and EUV instruments onboard the FOXSI-4 and Hi-C Flare experiments. These tools leveraged near-real-time solar imaging and irradiance measurements from SDO/AIA, GOES/XRS, SDO/EVE/ESP, and EOVSA to determine when to launch to observe a large solar flare (>C5 class). Here we present on the real-time early flare alert system which supported these sounding rocket teams through a successful solar-flare-triggered sounding rocket launch and plans for continued development of these tools for upcoming campaigns.

Presentation: DAY 5 | September 12 10:45 | Session: Solar and Lunar | Suborbital

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Extreme Ultraviolet Snapshot Imaging Spectrograph 2 Mission

The Extreme Ultraviolet Snapshot Imaging Spectrograph (ESIS-2) sounding rocket mission is scheduled to launch in 2027 from White Sands Missile Range. Designed to investigate the role of magnetic reconnection in heating the solar corona, ESIS-2 uses advanced imaging spectroscopy to capture high-cadence, wide-FOV observations of the transition region and corona. Magnetic reconnection is believed to generate high-energy electron beams that heat the transition region and chromosphere, producing rapid (<20 s), localized brightenings and blue shifts. Capturing the frequency, timing, and location of these events requires observing spectral intensity and velocity across the full FOV—a challenge for traditional slit spectrographs. ESIS overcomes this by using Computed Tomography Imaging Spectrograph (CTIS), which acquire spectral and velocity data across the entire FOV in a single exposure. The first ESIS flight (2019) demonstrated the promise of this technique by recovering velocities from small-scale explosive events. ESIS-2 will observe the Ne VII 465.2 Å (0.5 MK) and Si XII 499.4 Å (2 MK) lines in active regions to determine: (1) the frequency and location of heating by electron beams, and (2) heating parameters for all such events. It also aims to validate inversion techniques for extended coronal structures, such as loops. The instrument retains the ESIS-1 optical design but adds new components and two more channels to improve inversion accuracy. The mission is led by Goddard Space Flight Center, in collaboration with Montana State University and Marshall Space Flight Center. This talk will provide an overview of ESIS-2's capabilities, current status, and upcoming milestones.

Presentation: DAY 5 | September 12 11:00 | Session: Solar and Lunar | Suborbital

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A-STEP: A Technology Demonstration Payload for Next-generation Gamma-ray Detectors

A medium-energy (100 keV to 100 MeV) gamma-ray telescope capable of spectroscopy, imaging, and polarization operating jointly with alternative messenger observatories (gravitational waves, cosmic rays, neutrinos) will deepen our understanding of various astrophysical phenomena and processes including compact object mergers, active galactic nuclei and gamma-ray bursts. AstroPix detectors are novel high voltage monolithic active pixel sensors (HV-MAPS) that will enable such gamma-ray telescopes by coupling a low-power and tileable design with high spatial and spectral resolution capabilities and on-chip signal digitization. The AstroPix Sounding rocket Technology dEmonstration Payload (A-STEP) is a prototype multi-layered instrument that will demonstrate the first operation of AstroPix detectors in a space environment. In this presentation I will detail A-STEP's design and mission parameters, discuss integration and test status of the payload, and outline the future of A-STEP and AstroPix.

Presentation: DAY 5 | September 12 9:50 | Session: Astro | Suborbital

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MiniCOR: Miniature Coronagraph for Heliophysics Research

Coronagraphs are the only instruments capable of capturing the development of coronal mass ejections (CMEs) in near-Sun space. Therefore, they provide critical information regarding the physics of CME evolution and propagation, which is essential for space weather forecasting. It is strategically important to reduce the technological and logistical barriers associated with maintaining space-based coronagraphic observations. MiniCOR is an innovative coronagraph designed to tackle these challenges. Its primary technical aim is to showcase that a cost-effective, miniaturized 6U CubeSat coronagraph can produce data with higher frequency and equal or superior sensitivity compared to both the full-sized, very successful LASCO instruments and the operational CCOR and its variants. Funded by NASA's HPD H-FORT program, MiniCOR is a collaborative effort between JHU Applied Physics Laboratory, the Naval Research Laboratory, and Argotec. Development commenced in 2024, targeting a launch into a Sun-Synchronous polar orbit in 2028. Building on the successful COR2 coronagraph from the STEREO mission, MiniCOR is closely integrated with a 'smart' bus from Argotec, utilizing on-board processing to optimize observations and data downlink, aiming to provide cutting-edge insights into the corona from 3 to 20 solar radii every 4 to 5 minutes. The success of MiniCOR will illustrate that 'big science' can indeed fit into 'small packages'.

Presentation | DAY 2 | September 9 14:15 | Proposal: 80NSSC24M0040 | Session: Remote Sensing | HELIOTECH

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NOAA's Space Weather Technology Development

The Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow (PROSWIFT) Act2020 directs NOAA to sustain and advance critical operational space weather observations and to collaborate and cooperate with other federal agencies to ensure efficient space weather knowledge transfer and information exchange. To execute space weather activities outlined in the PROSWIFT, NOAA has identified space weather as a new strategic priority. In 2023, NOAA NESDIS established an office of space weather observations (SWO) to manage NESDIS's space weather observations portfolios. SWO is actively involved in the partnerships and technology investments to advance NOAA's space weather observational and data system capabilities by collaborating with public and private sector partners. This allows NOAA to leverage external expertise and investments, enhancing our ability to meet mission goals and provide valuable space weather products and services. These efforts include increasing the emerging technologies developed by other agencies, industry, and academia that may be integrated into NOAA's operational environment, utilizing existing data sources and systems from partners to improve NOAA's space weather understanding and forecasting. In addition, NOAA supports innovation in the space weather sector through its SBIR program, which provides early-stage capital to small businesses developing new technologies. In this presentation, we will discuss some of the highlights from NOAA's technology development for space weather observations, data utilization to improve the understanding and forecasting of space weather.

Presentation | DAY 1 | September 8 9:30 | Session: Welcome/Keynote | HELIOTECH

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The NASA Goddard Space Flight Center Magnetometer Test and Calibration Program

At the Mario Acuna Magnetic Test Site, NASA Goddard Space Flight Center (GSFC) has one of the largest and most accurate magnetic test and calibration facilities in the world—one of only three with similar capabilities. First built in the 1960s as a spacecraft attitude control test site, within the last several years it has undergone a thorough rehabilitation to resume its peak operational capability. The facility is capable of producing a stable magnetic field while also nulling the local geomagnetic field, and the magnetic field it produces is homogeneous to within 0.5 nT over at least a 6-foot radius region. The Braunbek coils that produce the field are 42 feet in diameter and capable of producing a magnetic field pointing in any desired direction. It is ideal for testing and calibrating magnetometers as well as assessing the static and temporal magnetic signatures of spacecraft. Through the process of designing and executing a magnetometer test campaign on behalf of the National Geospatial Intelligence Agency's Magquest program, the operations, infrastructure, equipment, personnel, and procedures have evolved into a marketable well-oiled machine. We will present the facility's characteristics and capabilities as well as the suite of equipment, metrics, and test codes and procedures that are available for use with business, federal, and academic partners.

Poster | HELIOTECH

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Advancing Spectral Multiplexing in the FUV with the INFUSE and OAxFORTIS Sounding Rockets

The 2020 Decadal Survey has endorsed both an ultraviolet (UV) spectrograph and imager on the Habitable Worlds Observatory (HWO) including the need to achieve sensitivity at 100 nm. In order to achieve spectroscopic imaging in the far ultraviolet (FUV) regime, efficient methods of spectral multiplexing are required. This in turn requires the development and technology readiness level (TRL) advancement of mirror coatings and large-format detectors as well as new optical systems like microshutters and image slicers that permit multi-object or integral field spectroscopy. The first FUV integral field spectrograph (IFS) with access to the Lyman ultraviolet (100.0 – 121.6 nm), the INtegral Field Ultraviolet Spectroscopic Experiment (INFUSE), is a sounding rocket payload built and launched by the Colorado Ultraviolet Spectroscopy Program. An image slicer forms the basis for this IFS. Each reflective slice acts as a long-slit, creating 26 different channels. In an innovative new optical design, flown for the first time on INFUSE, each science channel is re-focused and dispersed by an individual holographic grating. Another sounding rocket, the Off-Axis FUV Off Rowland-circle Telescope for Imaging and Spectroscopy (OAxFORTIS) from the Sounding Rocket Group at Johns Hopkins University is a multi-object spectrograph (MOS) enabled by a NexGen Microshutter Array, a programmable slit mask that is an evolution of the array currently aboard the James Webb Space Telescope. Both sounding rockets include cutting edge FUV mirror coatings and large format microchannel plate detectors. By using these technologies, INFUSE and OAxFORTIS have driven the development of HWO-enabling technologies and rapidly advanced them from laboratory demonstrations to TRL 6 and above.

Presentation DAY 5 September 12 9:35 | Session Astro | Suborbital

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Design, Characterization, and Testing of HERT: A Miniaturized High-Energy-Resolution Relativistic Electronic Telescope for GTO

Earth's outer radiation belt contains relativistic electrons in the MeV energy range and beyond, which pose significant risks to spacecraft systems and humans in space. The miniaturized High-Energy-Resolution relativistic electron Telescope (HERT) is a compact telescope designed to provide high-energy-resolution (dE/E < 15%) measurements of 1 - 7 MeV electrons in GTO. These measurements will enable a novel method to distinguish between the two main acceleration mechanisms, inward radial diffusion and local acceleration, and solve the long-standing question of how radiation belt electrons are accelerated to relativistic energies. Building upon the heritage of REPT on the Van Allen Probes (Baker et al., 2012, 2021) and REPTile-2 on CIRBE (Khoo et al., 2022), HERT features a stack of nine solid-state silicon detectors in a telescope configuration, with a beryllium window to block lower energy electrons, and a tantalum collimator to enforce the required FOV (33°) (Krantz et al., 2023; Zhao et al., 2024). Geant4 simulations with a spherical particle source were conducted to characterize the instrument responses and evaluate the sensor shielding in GTO. Combined with Bow Tie analysis, HERT is projected to have an energy resolution of ~5% for 1.5 - 3 MeV electrons and < 15% for other energies. Radiation testing using a Cobalt-60 source indicates that HERT electronics can withstand a total ionizing dose of ~65 kRad, exceeding the 50 kRad requirement for a one-year nominal mission in GTO. Ongoing bench testing with muons and an SR-90/Y-90 radioactive source is validating instrument's functionality, with beam testing planned to further characterize instrument's performance. Environmental testing will follow to advance HERT to TRL6. By providing high-energy-resolution measurements with a miniaturized, radiation-tolerant design, HERT offers a low-cost, high-impact solution to advance our quantitative understanding of radiation belt electron dynamics.

Presentation DAY 1 September 8 14:45 | Proposal 80NSSC21K1041 | Session Charged Particles | HELIOTECH