
Mission Initiation Conference
April 20, 2023 10:00 AM EDT
ANDØYA SPACE CENTER
Chris Koehler and Kolbjørn Blix

Presentation Outline

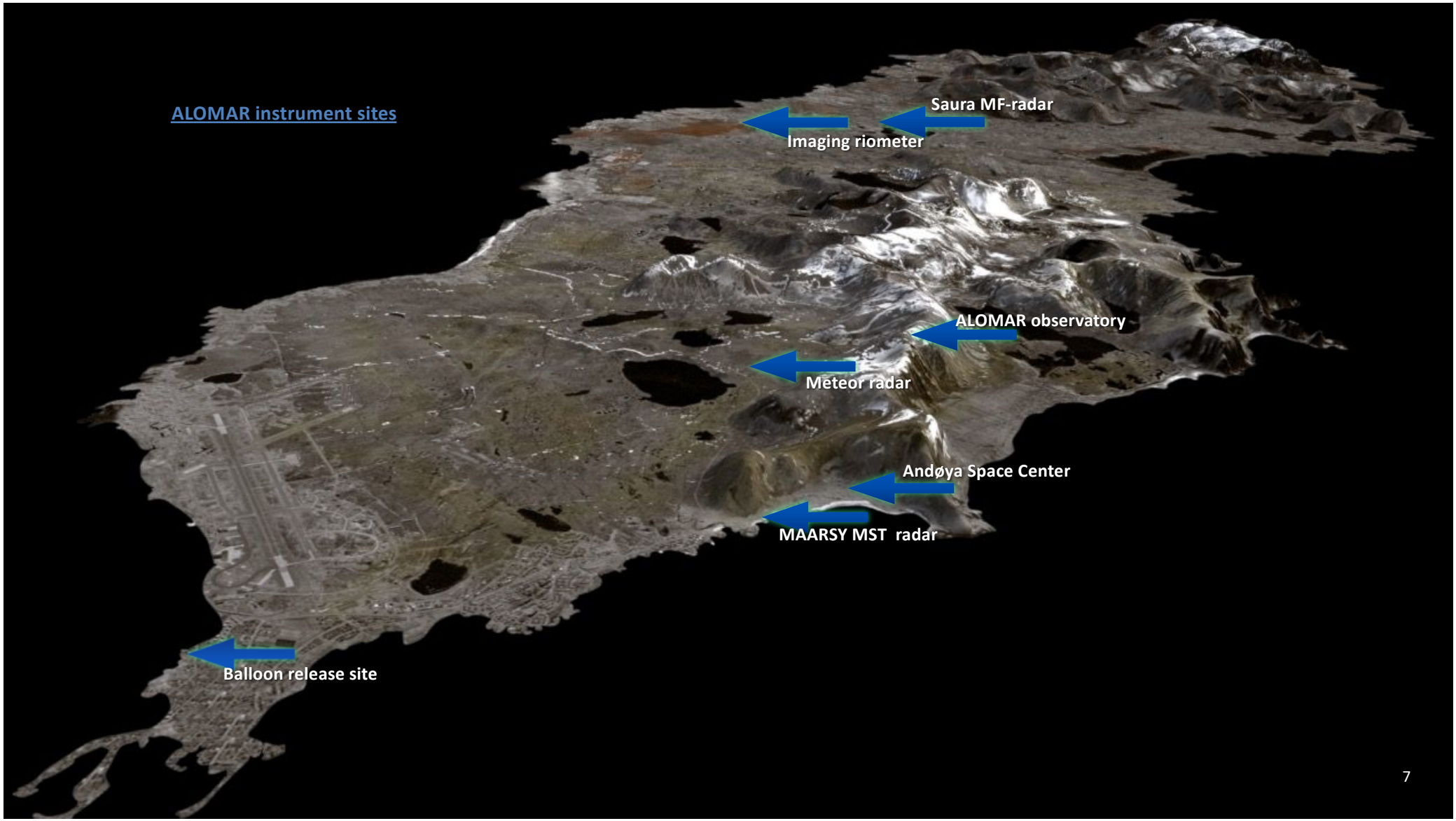
1. RockSat-X Program Introduction
2. GHOST Program Introduction
3. Interfaces
4. Experiment Section
5. Requests
6. Next Steps

GHOST Program Introduction

Grand Challenge Initiative – CUSP, M/LT and the proposed CUSP "Solar Max" projects

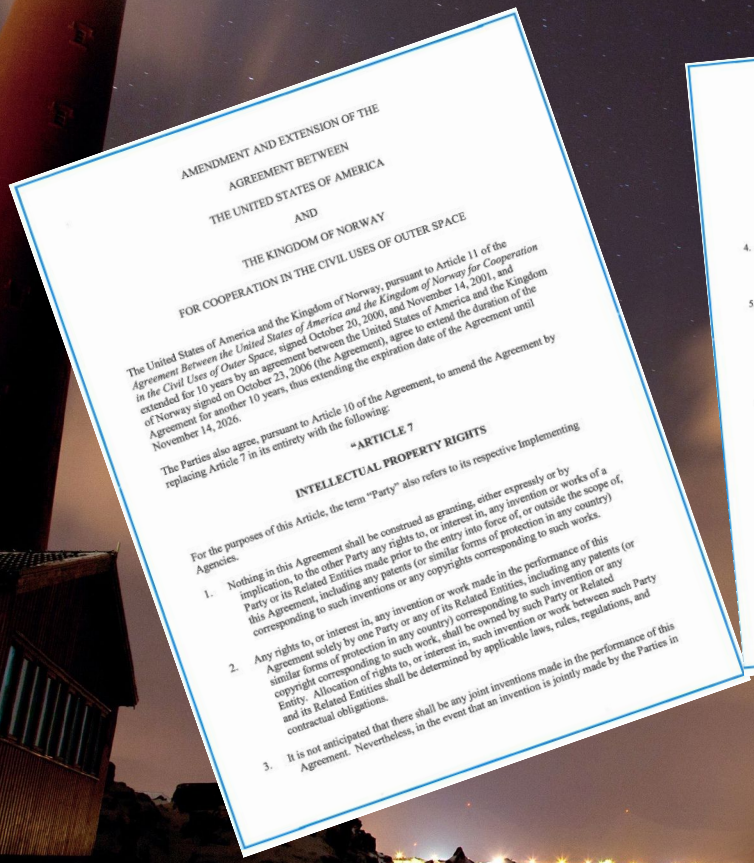
Andøya Space

Infrastructure at Andenes, Norway


ALOMAR instrument sites
Saura MF-radar
Imaging riometer
ALOMAR observatory
Meteor radar
Andøya Space Center
MAARSY MST radar
Balloon release site

USA-Norway agreement for ”Cooperation in the civil uses of outer space” 2006 –> 2016 -> 2026 + annex on sounding rockets

- an important agreement and reference document for all of our contracts and partnerships with NASA



AMENDMENT AND EXTENSION OF THE
AGREEMENT BETWEEN
THE UNITED STATES OF AMERICA
AND
THE KINGDOM OF NORWAY
FOR COOPERATION IN THE CIVIL USES OF OUTER SPACE

The United States of America and the Kingdom of Norway, pursuant to Article 11 of the *Agreement Between the United States of America and the Kingdom of Norway for Cooperation in the Civil Uses of Outer Space*, signed October 20, 2000, and November 14, 2001, and extended for 10 years by an agreement between the United States of America and the Kingdom of Norway signed on October 23, 2006 (the Agreement), agree to extend the duration of the Agreement for another 10 years, thus extending the expiration date of the Agreement until November 14, 2026.

The Parties also agree, pursuant to Article 10 of the Agreement, to amend the Agreement by replacing Article 7 in its entirety with the following:

"ARTICLE 7

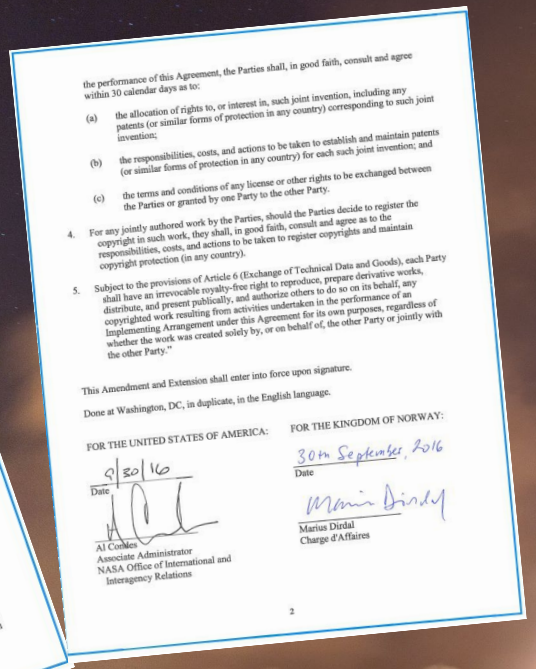
INTELLECTUAL PROPERTY RIGHTS

For the purposes of this Article, the term "Party" also refers to its respective Implementing Agencies.

1. Nothing in this Agreement shall be construed as granting, either expressly or by implication, to the other Party any rights to, or interest in, any invention or works of a Party or its Related Entities made prior to the entry into force of, or outside the scope of, this Agreement, including any patents (or similar forms of protection in any country) corresponding to such inventions or any copyrights corresponding to such works.

2. Any rights to, or interest in, any invention or work made in the performance of this Agreement solely by one Party or any of its Related Entities, including any patents (or similar forms of protection in any country) corresponding to such invention or any copyright corresponding to such work, shall be owned by such Party or Related Entity. Allocation of rights to, or interest in, such invention or any work between such Party and its Related Entities shall be determined by applicable laws, rules, regulations, and contractual obligations.

3. It is not anticipated that there shall be any joint inventions made in the performance of this Agreement. Nevertheless, in the event that an invention is jointly made by the Parties in



the performance of this Agreement, the Parties shall, in good faith, consult and agree within 30 calendar days as to:

(a) the allocation of rights to, or interest in, such joint invention, including any patents (or similar forms of protection in any country) corresponding to such joint invention;

(b) the responsibilities, costs, and actions to be taken to establish and maintain patents (or similar forms of protection in any country) for each such joint invention; and

(c) the terms and conditions of any license or other rights to be exchanged between the Parties or granted by one Party to the other Party.

4. For any jointly authored work by the Parties, should the Parties decide to register the copyright in such work, they shall, in good faith, consult and agree as to the responsibilities, costs, and actions to be taken to register copyrights and maintain copyright protection (in any country).

5. Subject to the provisions of Article 6 (Exchange of Technical Data and Goods), each Party shall have an irrevocable royalty-free right to reproduce, prepare derivative works, distribute, and present publically, and authorize others to do so on its behalf, any copyrighted work resulting from activities undertaken in the performance of an Implementing Arrangement under this Agreement for its own purposes, regardless of whether the work was created solely by, or on behalf of, the other Party or jointly with the other Party."

This Amendment and Extension shall enter into force upon signature.

Done at Washington, DC, in duplicate, in the English language.

FOR THE UNITED STATES OF AMERICA:

9/30/16
Date

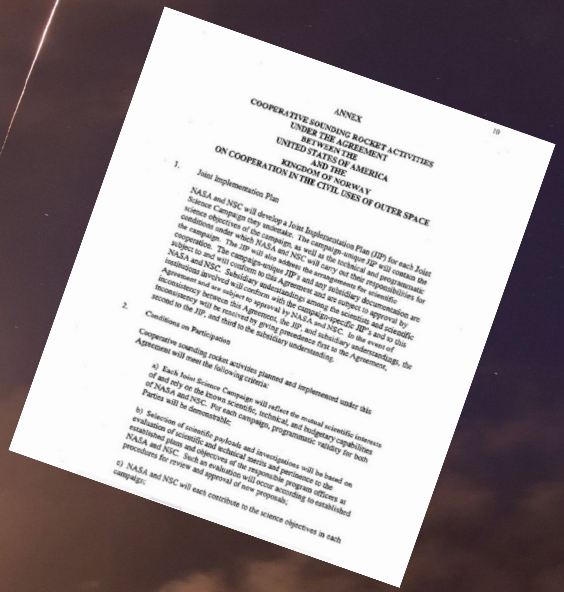
Al Conkles
Associate Administrator
NASA Office of International and Interagency Relations

FOR THE KINGDOM OF NORWAY:

30th September, 2016
Date

Marius Dirdal
Charge d'Affaires

2



ANNEX
COOPERATIVE SOUNDING ROCKET ACTIVITIES
UNDER THE AGREEMENT
BETWEEN THE
UNITED STATES OF AMERICA
AND THE
KINGDOM OF NORWAY
ON COOPERATION IN THE CIVIL USES OF OUTER SPACE

1. Joint Implementation Plan

NASA and NSC will develop a Joint Implementation Plan (JIP) for each Joint Science Campaign they undertake. The campaign-unique JIP will contain the science objectives of the campaign, as well as the technical and programmatic conditions under which NASA and NSC will carry out their responsibilities for the campaign. The JIP will also address the management of scientific cooperation. The campaign-unique JIP, and any subsidiary documentation are subject to and will conform to this Agreement, and any subsidiary documentation are NASA and NSC. Subsidiary understandings among and with respect to approved by NASA and NSC specific JIP's and to this Agreement, the Agreement and its subsidiary understandings, the JIP, and subsidiary understandings will be considered complementary to one another. In the event of inconsistency between this Agreement and the JIP, and third to the subsidiary understanding.

2. Conditions on Participation

Cooperative sounding rocket activities planned and implemented under this Agreement will meet the following criteria:

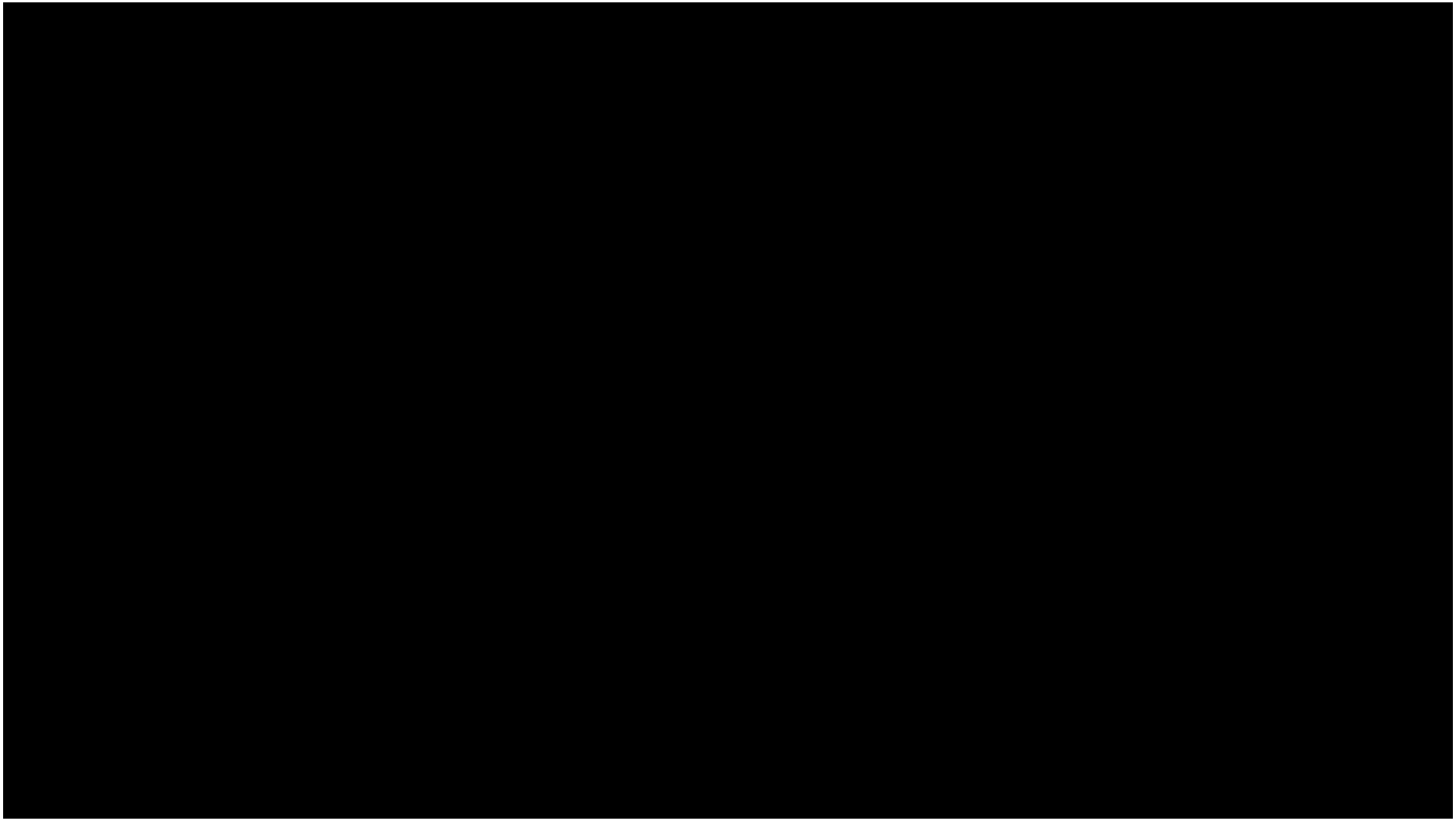
a) Each Joint Science Campaign will reflect the mutual scientific interests of and rely on the known scientific, technical, and budgetary capabilities of NASA and NSC. For each campaign, programmatic validity for both Parties will be demonstrable.

b) Selection of scientific payloads and investigations will be based on evaluation of scientific and technical merits and pertinence to the established plans and objectives of the respective program offices at NASA and NSC. Such an evaluation will occur according to established procedures for review and approval of new proposals.

c) NASA and NSC will each contribute to the science objectives in each campaign.

Photo: Kolbjørn Blix

Andøya Space



THE GRAND CHALLENGE INITIATIVE-CUSP

9 MISSIONS • 12 RO

Visualizing Ion Outflow via Neutral Atom Sensing-2

How do ions get 'boiled' off the atmosphere? VISIONS-2 observes ionized oxygen—a comparatively element—acquires enough energ escape our atmosphere. The miss the escape by visualizing the othe invisible atoms as they flow outw

Cusp-Region Experiment

C-REX-2 measures winds and velocity at around 400 km in a in the cusp to track causes of Increased density there. The r differentiates between possib causes such as changes in win temperature, or ion velocity.

SS-520-3

Atmospheric escape is a u phenomenon occurring on and other planets—but the vary case by case. The SS-5 investigates the wave-parti high in Earth's atmosphere particles to heat up and es

*TWO ROCKETS

MAGNETOSPHERE

AZURE* *Auroral Zone Upwelling Rocket Experiment*

How do auroras impact the total amount of

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5 months ago

Sounding Rockets

April 6, 2017

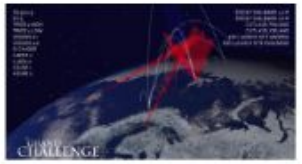
International Campaign to Explore Auroral Cusp

The United States, Norway and Japan signed a joint statement of scientific coordination on April 6, 2017, for participation in the Grand Challenge Initiative – Cusp – a series of international sounding rocket missions planned for launch in 2017-2019. The Grand Challenge will provide significant advances in understanding of near-Earth space beyond what each partners' independent projects could achieve individually.

The Grand Challenge studies the cusp, a region at each pole where the magnetic bubble surrounding Earth dips inward, allowing space particles to funnel in toward our planet. The missions will launch from two sites in Norway – Andoya Space Center and Svalbard Rocket Range. Sounding rockets launched from these sites are able to fly into the cusp and measure the solar particles streaming from the sun.

The joint statement outlines a framework for data sharing and future collaboration between current and future Grand Challenge partners. All participants will develop a plan to make their data publicly available. Combining data from multiple missions maximizes the partners' ability to research and understand this little-explored region of near-Earth space.

Ground-based sites will also provide valuable data during the missions. In some cases, launches will be conducted nearly simultaneously from Andoya and Svalbard, providing simultaneous observations



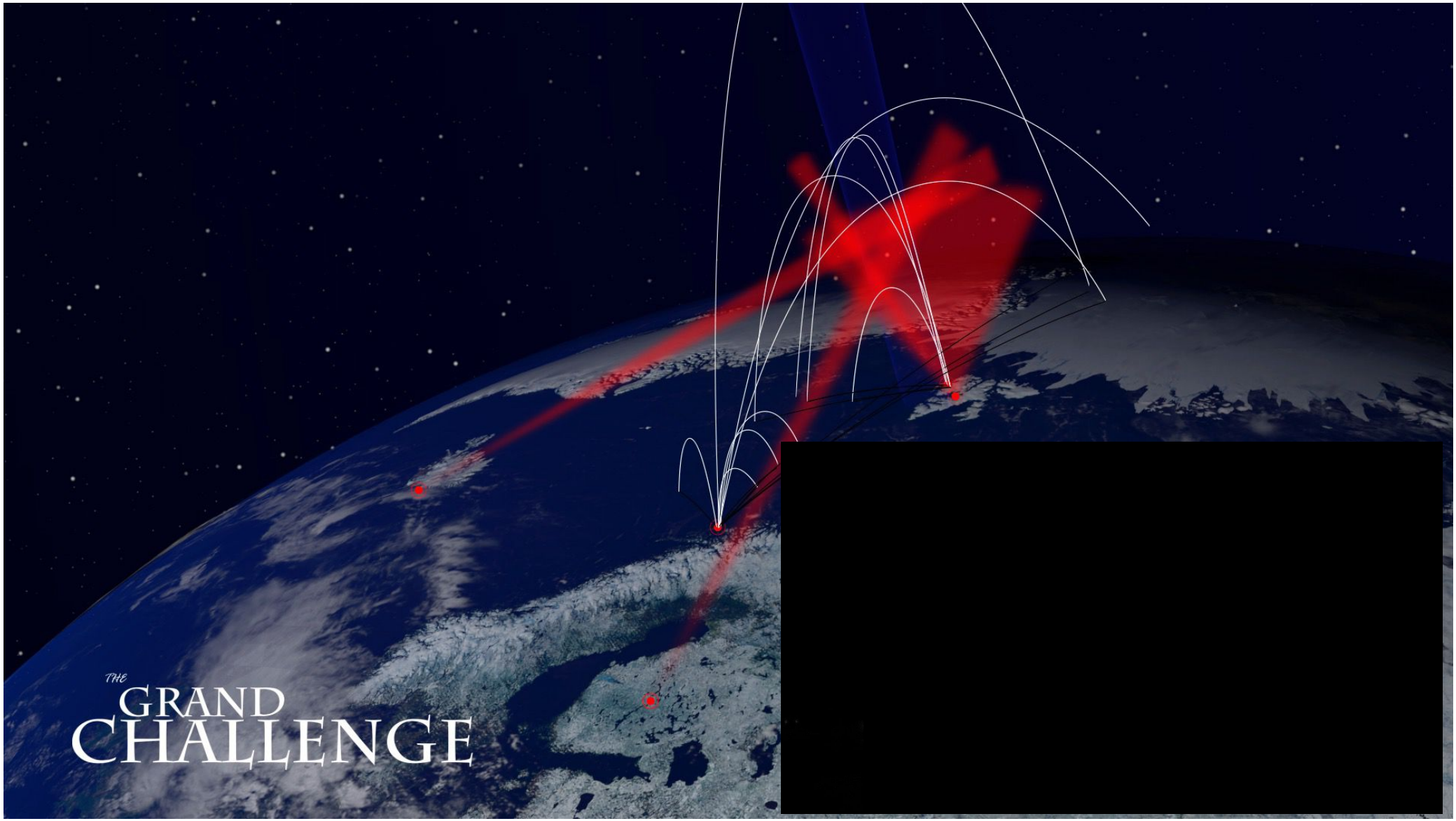
The illustration shows the flight paths of the suborbital sounding rockets being launched as part of the Grand Challenge Initiative. The red shows the areas covered by the ground-based instruments and the blue represents the cusp. On the left is the list of sounding rocket missions and on the right is a list of ground instruments.
Credit: Andoya Space Center/Trond Abrahamsen

THE SCIENCE OF THE CUSP:

The Grand Challenge Initiative - Cusp is an on to explore the polar agnetic field lines bend oles and particles from enter our atmosphere.

e information, please visit: //www.grandchallenge.no

NASA GSFC/WFF • Andøya Space Center • University of Oslo • JAXA • ISAS • Dartmouth College • University of Iowa • University of Alaska Fairbanks • Clemson University • University of Colorado


THE
GRAND
CHALLENGE

Andøya Space

G-CHASER student

G-CHASER launch, Jan 13th 2019

Andøya Space

GCI M/LT

Grand Challenge Initiative
M/LT Project
White Paper

Contents

Andøya Space

Current status GCI M/LT projects (Oct. 13th 2023):

- ~~**SpEED Demon***~~, a tech demo mission for SEED (Barjatya/Embry-Riddle) (launched Aug. 23rd, 2022 from NASA Wallops Flight Facility in Virginia)
- **SEED*** (Sporadic E Electrodynamics) (Barjatya/Embry-Riddle): −from Kwajalein Atoll ~2024 −PI Aroh Barjatya has more info at sail.erau.edu/seed
- **XENON** (Isotopic consentration of Xenon −Launched from Esrange in August 2021.
- ~~**PMWE 3 & 4**~~ (IAP, DLR Moraba) −Incl ~~2 Vipers~~ after the main rockets (same day) −Launched from Andøya Space, Oct 1st 2021
- ~~**VortEx***~~ (Lehmacher) − **2 of 4 rockets launched, March 22nd 2023**
- **ICI-5b* (4DSpace/DAEDALUS)** (Miloch/UiO/Norway) (winter 2024 from Andøya Space)
- **MaxiDusty-2*** (Mann/UiT/Norway) (summer 2024 from Andøya Space)
- **ORIGIN*** (Gumbel/MISU/Sweden) – launch spring 2025 from ESRANGE (same time as DEFINE)
- **DEFINE*** (Strelnikov/IAP/Germany) – launch spring 2025 from Andøya Space (same time as ORIGIN) ALOMAR Observatory measurements during ORIGIN & DEFINE
- **Turb3D** (Strelnikov/Lubken/IAP/Germany)
- **SYSTER** (IRF, Sweden) & **BROR*** (2023) (Ivchencko/KTH/Sweden)
- **ROMARA** (Stude/DLR/Germany)
- **ISAS/JAXA** (Abe)
- **B-SoLiTARe*** "Balloon Sodium Lidar to measure Tides in the Antarctic Region" (Janches, GSFC/NASA)
- **GHOST*** (Grand Challenge Mesosphere Student Rocket) (TBD) (NASA/Andøya Space)
- **NameNotDecided** (Conde/U Fairbanks/Alaska) – project in the works. 4 rockets from Andøya. More info to come in due time.

GHOST
(Grand cHallenge MesOsphere Student rockeT)

User Guide

A student rocket launch in partnership with NASA's Wallops Flight Facility (USA), Andøya Space (Norway), and the RockSat-X program

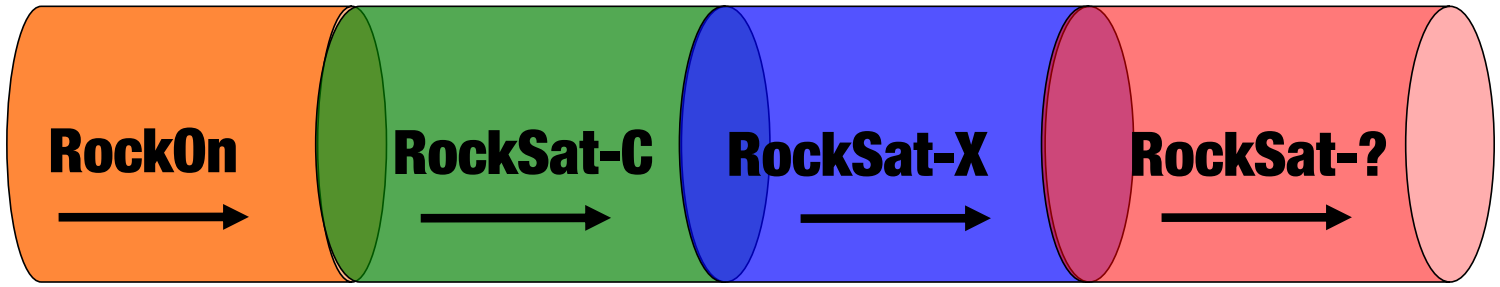
Wallops Flight Facility (WFF)
Wallop Island, Virginia

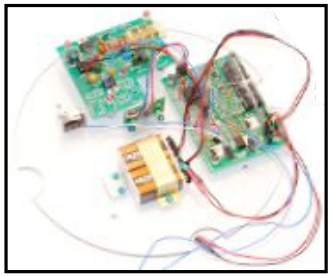
Andoya Space
Andoya, Norway

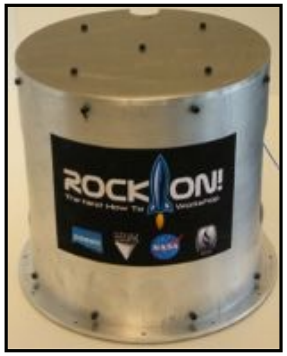
Program Introduction

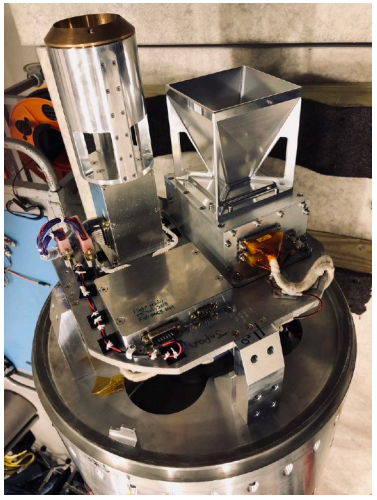
ROCKSAT-X

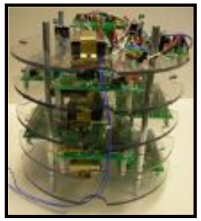
RockSat-X Program Introduction

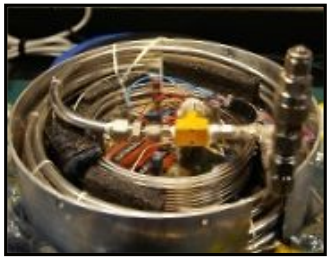




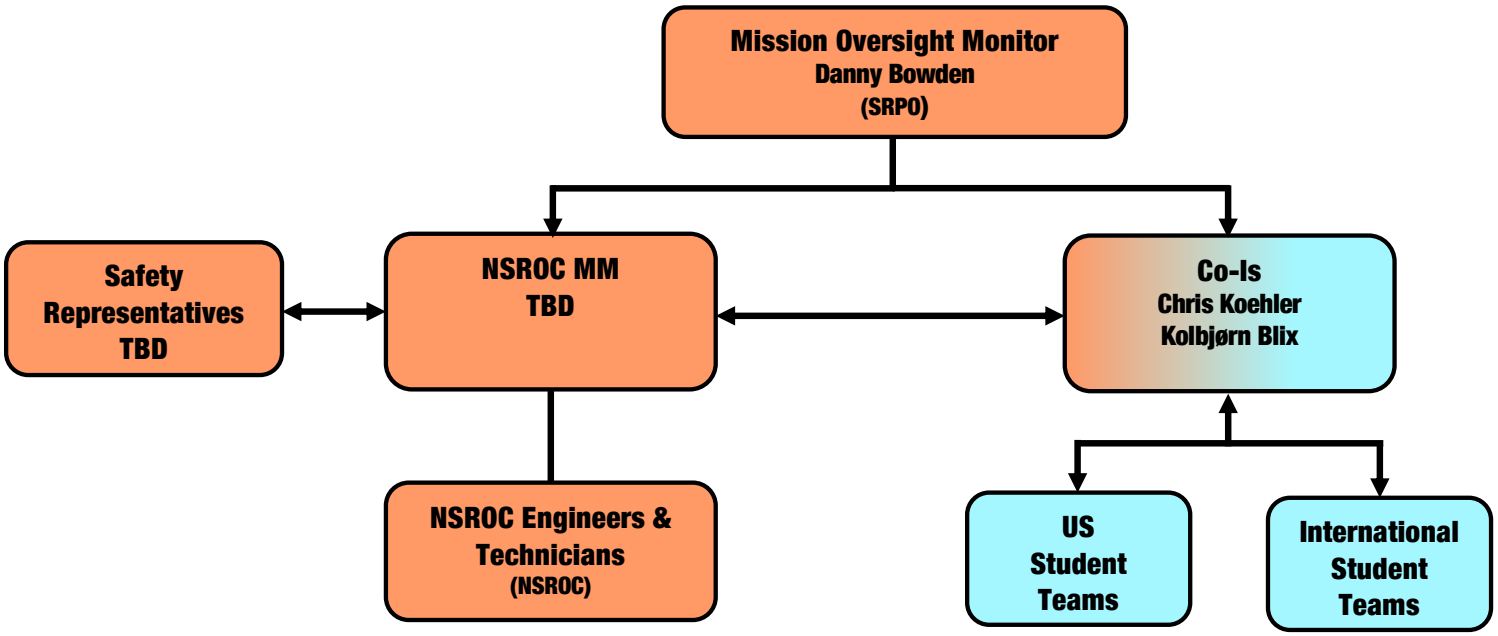








RockSat-X Program Organization



MOM Summary

Mission Oversight Monitor	
Flying a radioactive source?	NO
Radioactive source for ground calibration?	NO
Type of source and handling?	N/A
Responsible for handling?	N/A
Ground or flight high voltage systems?	TBD
Cryogenic systems including GSE	TBD
Desire to power during final vehicle preparations?	TBD
Foreign nationals' access to facilities?*	YES
Unique or hazardous systems, or environmental considerations?	TBD
Excess space available?	TBD

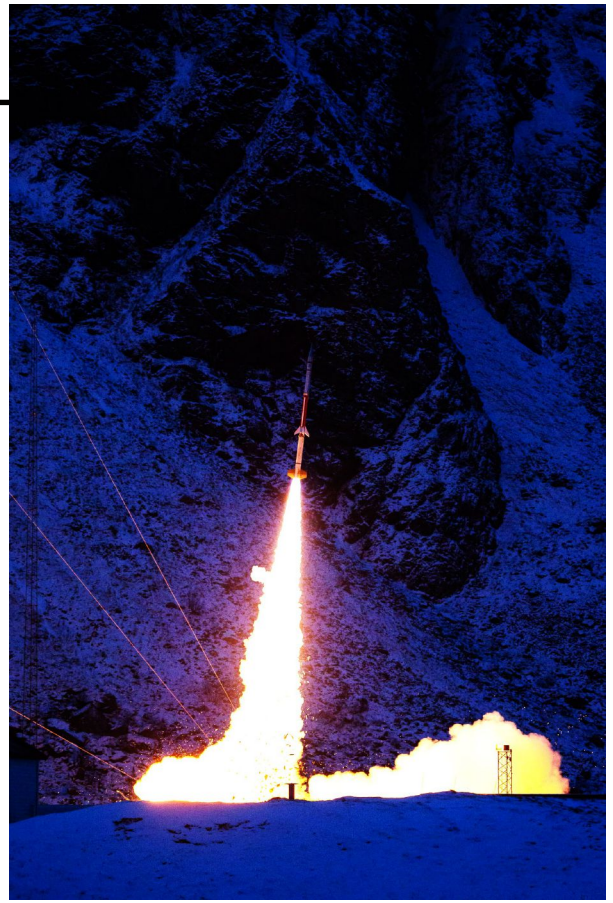
Mission Success Criteria

Minimum Success Criteria

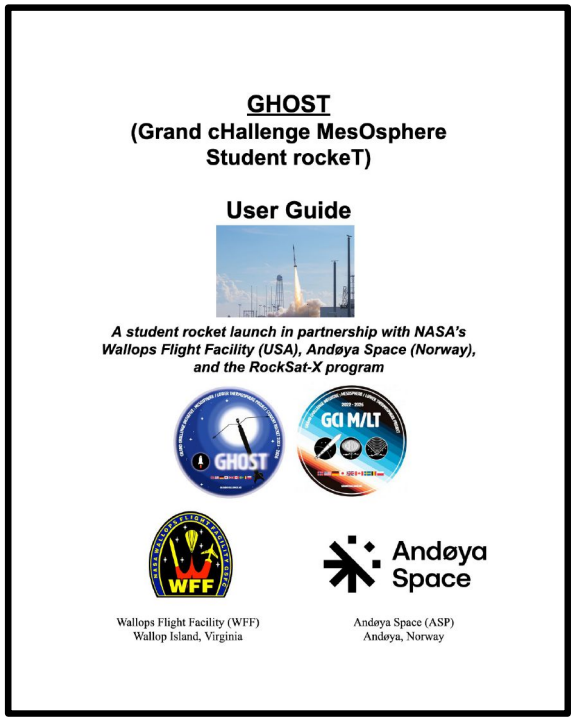
- At least one hot count is conducted for the RockSat-X mission.

Comprehensive Success Criteria

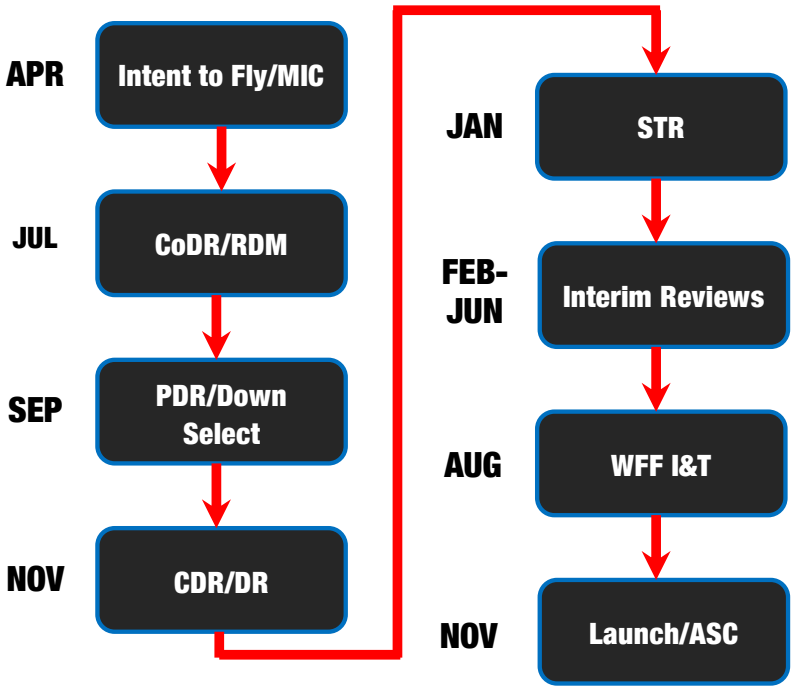
- Successful launch of the RockSat-X payload, including vehicle performance within 2 sigma of predictions
- All experiments successfully exposed to the space environment at an altitude within 2 sigma of the predicted nominal.
- Desired attitude achieved within 7 degrees.
- All individual deployment or ejection actuation impulses sent to each experiment at the programmed times
- Payload Recovery
- Data collected from a majority of the telemetered channels used by the participant-built experiments.



RockSat-X Program Introduction



GHOST User Guide 2023
Rev - DRAFT



Program Flow

RockSat-X Program Introduction

CoDR	JUL 5-10, 2023	
PDR	SEP 11-14, 2023	
CDR	NOV 13-17, 2023	
STR	JAN 22-26, 2024	
ISTR	MAR 25-29, 2024	
FMSR	MAY 20-24, 2024	
VVC	JUN 24-28, 2024	

WFF Integration and Test -> AUG 12-16, 2024*
ASC Launch -> NOV 11-15, 2024*

*** WFF/ASC confirmation needed**

Interfaces

ROCKSAT-X

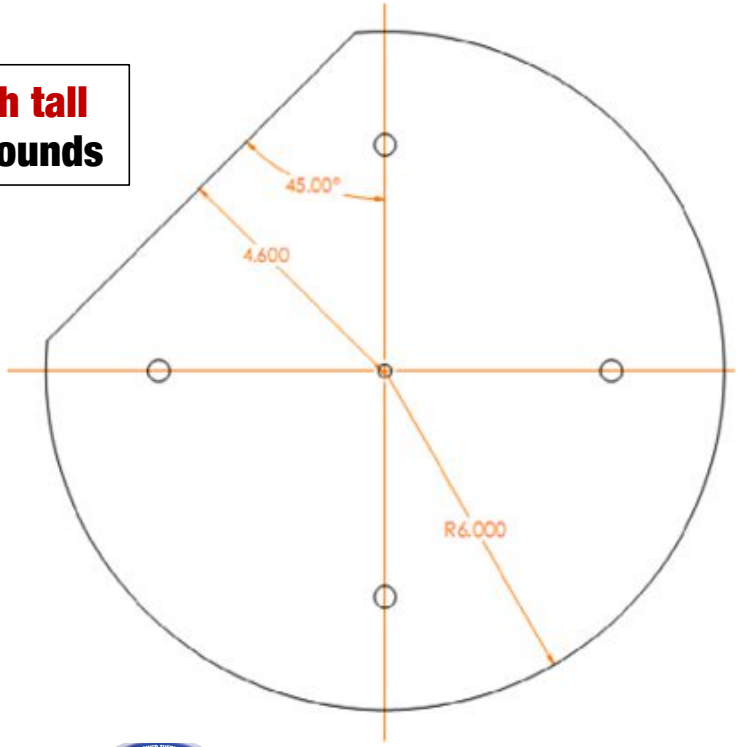
User Guide

Requirement
Center of gravity in 1" plane of plate
Weight 30.0+/- 1.0 (15.0 +/- 0.5 for shared) lbs.
Max Height < 10.75“ (5.13” for shared)
Bottom of deck has flush mount hardware
Within Keep-Out Zone
Using < 10 A/D Lines
Using/Understand Parallel Line
Using/Understand Asynchronous Line
Using X GSE Line(s)
Using X Redundant Power Lines (TE-1, TE-2, TE-3)
Using X Non-Redundant Power Lines (TE-R)
Using < 1 Ah (< 0.5 Ah for half payload)
Using <= 28 V
Using RF (If yes, list frequency and TX Power)
Using deployable?
Whole team consists of US Persons
Using ITAR and/or Export Controlled hardware

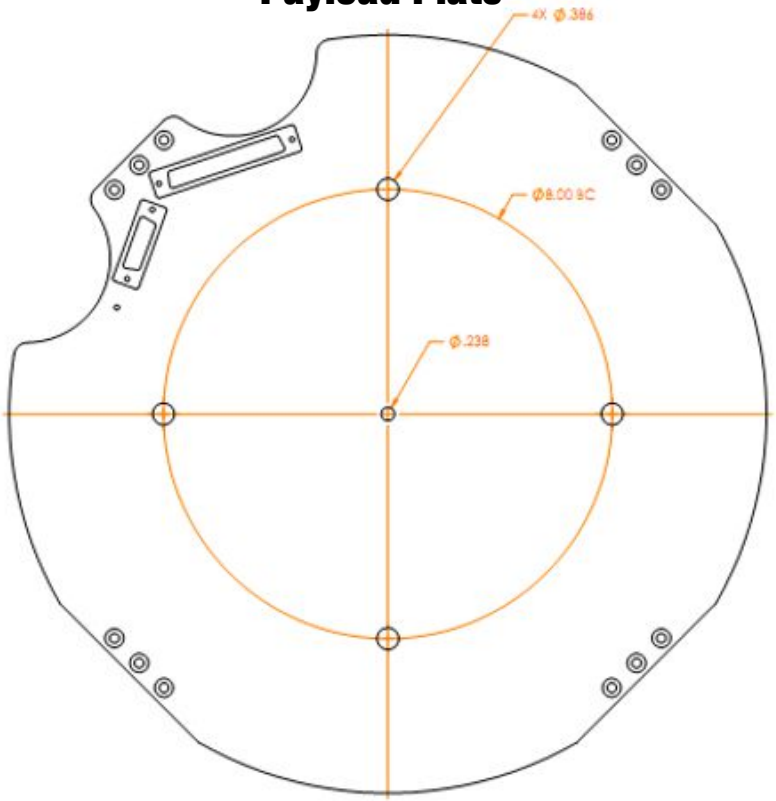
Mechanical Interface

10.75 inch tall
30 +/- 1 pounds

Payload Envelope

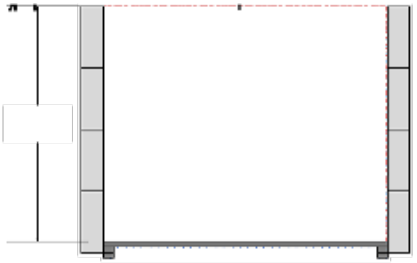
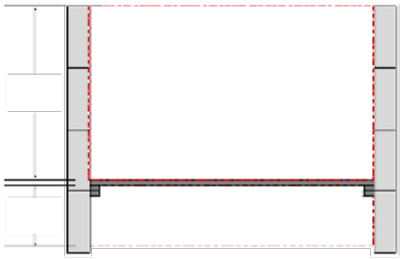
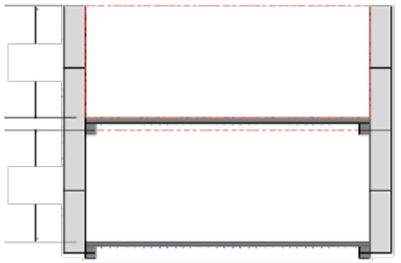
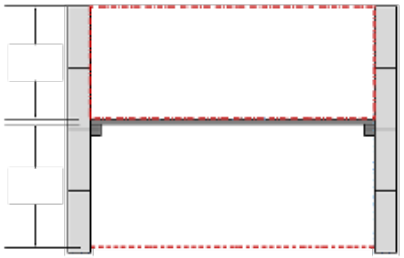
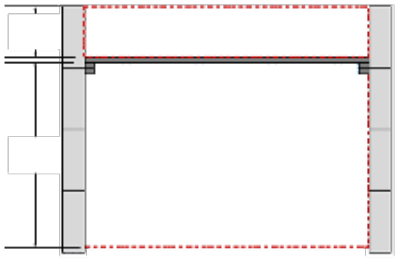


Payload Plate

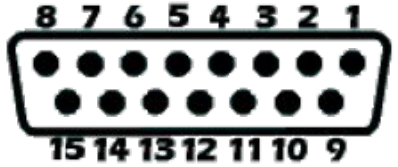


Mechanical Interface

- **Experiment height definitions to minimize chance of mechanical interference between payloads (0.25” margin)**

Power Interface



15 pin d-sub Connector
- **Experiment Side: (M)**
- **Wallops Side: (F)**

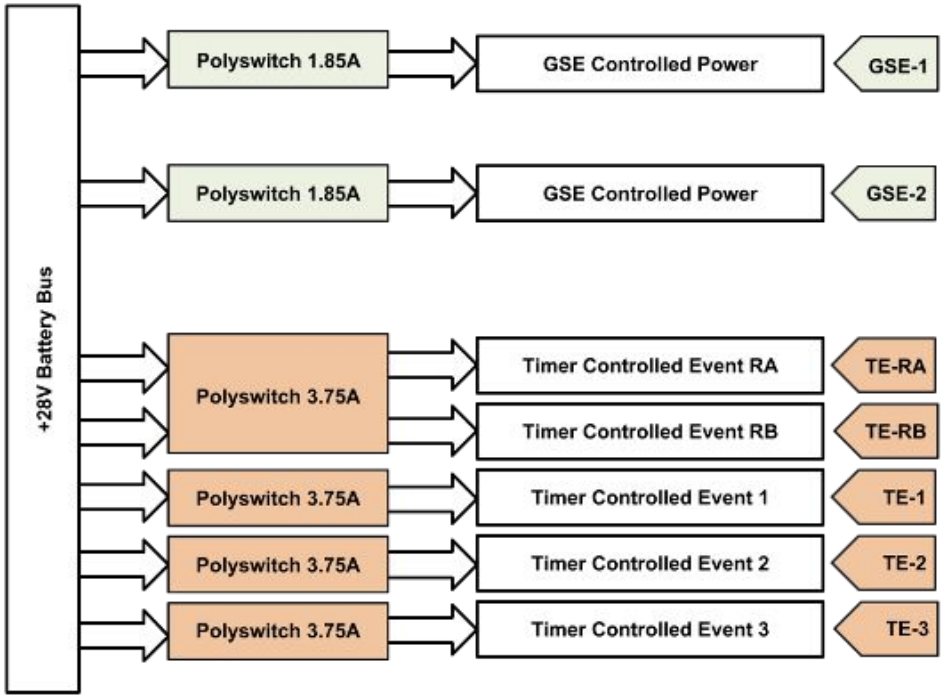
Pin	Function
1	GSE 1
2	Timer Event Redundant (TE-RA)
3	Timer Event Redundant (TE-RB)
4	Timer Event 1 (TE-1)
5	GND
6	GND
7	GND
8	GND
9	GSE 2
10	Timer Event 2 (TE-2)
11	Timer Event 3 (TE-3)
12	GND
13	GND
14	GND
15	GND

Each Standard Experiment Space Gets:

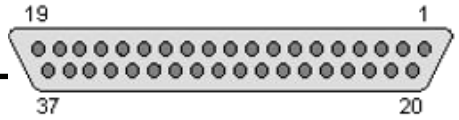
1. 2 Non-Redundant GSE Lines (GSE 1 and GSE 2)
   a) Pins 1 and 9, respectively
   b) 28V, 1.85 A (sum of both lines)
   c) Activation specified by payloads T-10:00 to T-3:00 with dwell time
   d) Automatically active after T-0:00
2. 3 Non-Redundant Timer Events (TE 1-3)
   a) Pins 4, 10, 11 respectively
   b) 28V, 3.75 A maximum (minus TE-R)
   c) Customer specifies On (T+0:01); dwell time
3. 1 Redundant Timer Event (TE-R)
   a) Pins 2 and 3 tied together
   b) 28V, 3.75 A maximum (minus TE 1-3)
   c) Customer specifies On (T+0:01); dwell time
4. 1.4 Ah /experiment space
5. Polyswitches – limited by harness

Power Interface

- Understand there are individual polyswitches
- RS-X GSE limits payload lines to the specs below
- Cumulative current draw is 3.75A for experiment



Telemetry Interface



37 pin d-sub Connector
- **Experiment Side: (F)**
- **Wallops Side: (M)**

Pin	Function	Pin	Function
1	Analog 1	20	Parallel Bit 7
2	Analog 2	21	Parallel Bit 8
3	Analog 3	22	Parallel Bit 9
4	Analog 4	23	Parallel Bit 10
5	Analog 5	24	Parallel Bit 11
6	Analog 6	25	Parallel Bit 12
7	Analog 7	26	Parallel Bit 13
8	Analog 8	27	Parallel Bit 14
9	Analog 9	28	Parallel Bit 15
10	Analog 10	29	Parallel Bit 16 (LSB)
11	Parallel Bit 1 (MSB)	30	Parallel Read Strobe
12	Parallel Bit 2	31	N/C
13	Parallel Bit 3	32	RS-232 Data (TP1)
14	Parallel Bit 4	33	RS-232 GND (TP2)
15	Parallel Bit 5	34	N/C
16	Parallel Bit 6	35	N/C
17	N/C	36	Ground
18	Ground	37	Ground
19	Ground		

Each Payload Space Gets:

1. 10 - 10 bit (16 bit word) A/D Lines
   a) Pins 1-10
   b) V = 0 – 5V (Continuous)
   c) Wallops side high impedance
   d) Sample rate = 1875 sps
2. 1 - 16 bit Parallel Line
   a) Pins 11-16; 20-29
   b) V = 0 (L) 5 (H)
   c) Sample rate = 9375 sps
3. 1 - Asynchronous Serial Line
   a) TX Pin 32, GND Pin 33
   b) Baud Rates (19200)
   c) RS-232 protocol
   d) 8-N-1
4. Based on a 3 Mbit/sec PCM Stack

RockSat-X GSE

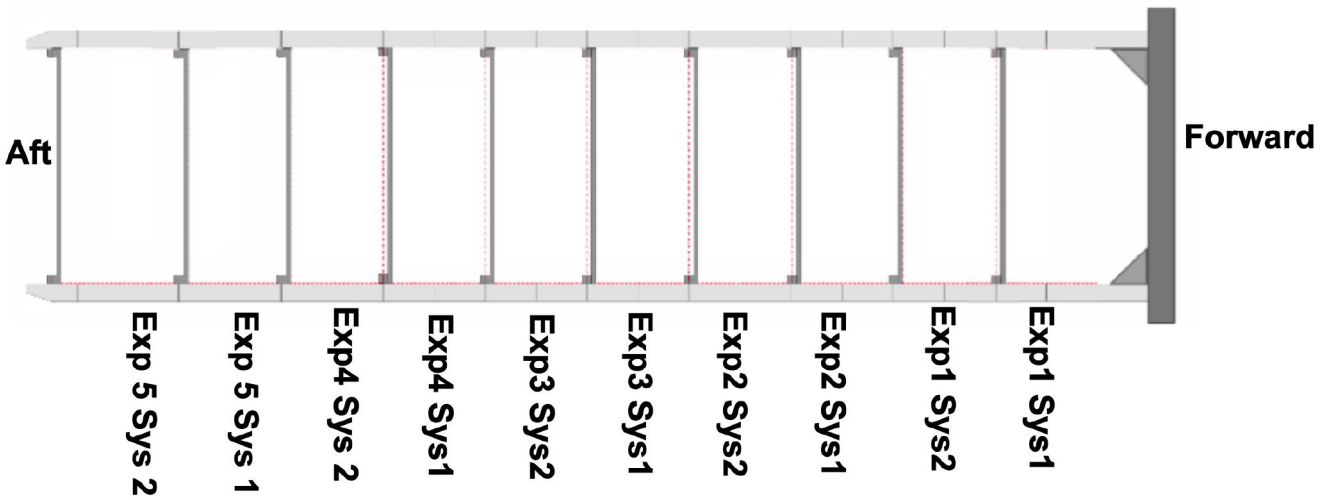
Purpose – RockSat-X GSE streamlines the integration and testing of all RS-X payloads upon arrival at Wallops

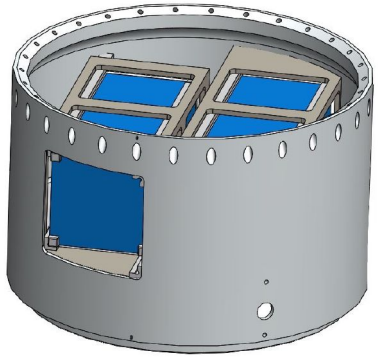
Experiment Plan

ROCKSAT-X

Experiment Plan

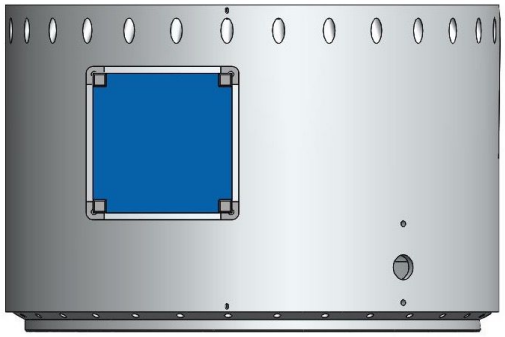
- 5 full spaces in aft requested with option to divide into 10 half spaces
  - Volume, weight, power, T/M would be split if half space used
- 1 full space in the nose cone like on G-Chaser
- 1 module for CubeSat Deployment (like on G-Chaser)

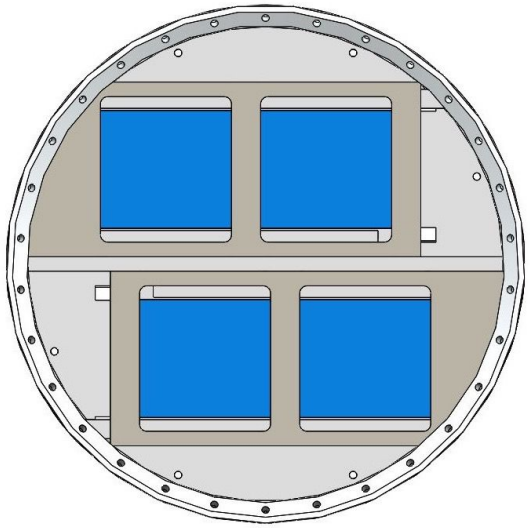


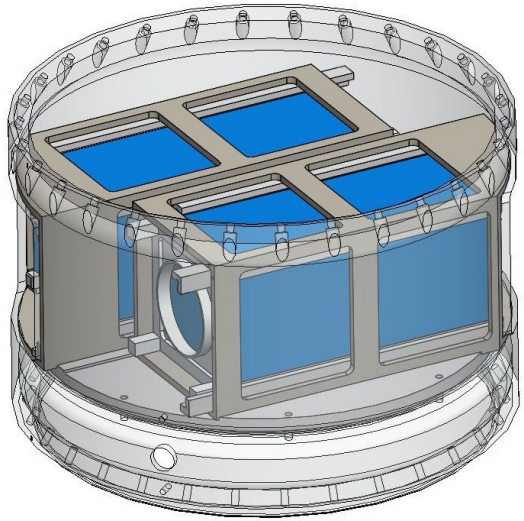


Experiment Plan

- Andøya Space CubeSat Eject Pod (CEP)
- Contains 4 x 1U CubeSats
- Decision on Andøya module (upscaled to 17 inches) or integrating into regular RockSat-X experiment deck
- No electrical connections between installed CubeSats and RockSat-X vehicle







Experiment Summaries

- **Only 4 teams have submitted IFFs so far**

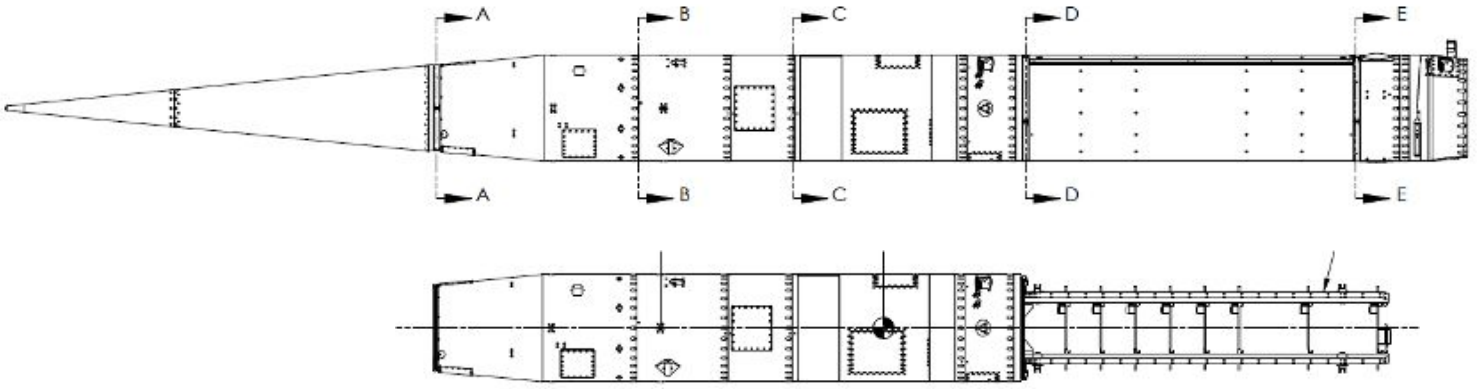
Half Experiment	Full Experiment
Lincoln University of the Commonwealth System of Higher Education, Founded 1854, Lincoln University, Pennsylvania	Clemson
University of Alberta	UPR

Requests

ROCKSAT-X

Vehicle Requests

- ~300 km apogee
- ~100 kg of experiment weight
- Full access to space environment
- Despin to ~0 hz
- Active ACS throughout flight
- Power and telemetry for experiments



Launch Requests

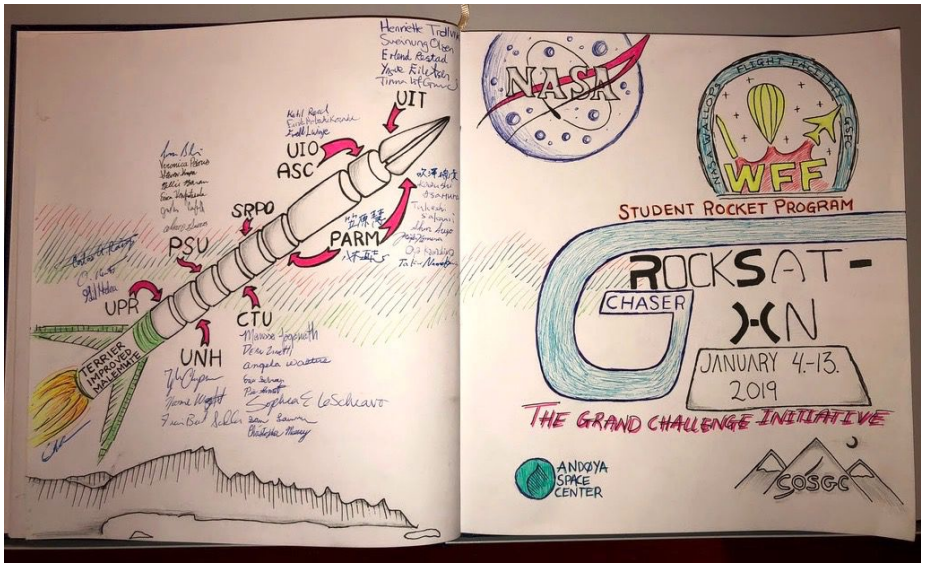
- Launch time = TBD
- Location = Andøya
- Recovery = Not required

Hardware Requests

- Up to 11 experiment decks
  - One may be different for nose cone experiment
- Connectors for flight decks (power and TM)
  - 10 TM (37 pin d-sub female)
  - 10 PWR (15 pin d-sub male)
  - Stand-offs and mounting hardware
- Help with CubeSat module

Next Steps

- **Conclude the Intent to Fly process (late April)**
- **Respond to action items discussed during this MIC**
- **Drive toward a CoDR and RDM in July 2023**



GHOST - Intent to Fly (IFF) Form

Complete the form below to officially indicate your team's Intent to Fly (IFF) on either the GHOST RockSat-X mission. The pdf version of this form should allow the user to enter the information, save the pdf, and then submit via email to rocksatprogram@gmail.com. The completion of this form is required to participate in GHOST 2024 mission and is due no later than April 17, 2023 at 5:00 PM MDT. It is expected to take ~20 minutes to complete this form. Although required, submission of the IFF does not mean that your team has been selected for flight on the GHOST 2024 program. Due to the limited experiment space on the launch vehicle, a down-selection process will be utilized after the successful completion of the GHOST Conceptual (CoDR) and Preliminary (PDR) design reviews in September 2023. If a team is down-selected, a full refund for their first payment will be issued minus a small processing fee. Launch date for GHOST is expected to be November 2024. You may send any questions about this form and/or the program to rocksatprogram@gmail.com.

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Questions?

ROCKSAT-X

Thank You

ROCKSAT-X