PARM
Critical Design Review

Tohoku U. / U. Tokyo / Nagoya U. / U. Electro-Communications / JAXA

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Nov 28, 2017  Ver 2
CDR Presentation Outline

• Section 1: Mission Overview
• Section 2: System Overview
• Section 3: Subsystem Design
• Section 4: Prototyping/Analysis/Results/Plans
• Section 5: Manufacturing Plan
• Section 6: Testing Plan
• Section 7: User Guide Compliance
• Section 8: Project Management Plan (PMP)
• Section 9: Appendix (not presented)
1.0 Mission Overview

Name of Presenter
2018 CDR N

Status of PDR Questions (1/2):

1. PARM has checkout connectors on the instruments. Are these checkout connectors accessible from outside when PARM is assembled in the rocket (in case of the nose cone open)?
   -> Closed. Yes
2. Should we consider the instantaneous power cut? If so, how long?
   -> Closed. It is not necessary.
3. If we make unit-level vibration testing, what level should we take? The level shown in Appendix B of RockSat users manual is that for assembled rocket (payload).
   -> Closed. We have received the example level.
4. Temperature testing: Could you tell us possible temperature range the RockSat payload will experience?
   -> Open
5. We need a GSE which can act as Rocket (Wallops) system for testing COMMON-E. Can we borrow it from the Rocket. If so, when? How?
   -> Open. Possibly it will be brought to Japan temporarily.
6. GSE (QL hardware and software) is necessary when PARM is installed on the Rocket. Currently, TLM distribution interface is unclear. What/How/When do we prepare? Could you send us interface docs and information about available hardware for us?

-> Open.

6. Timing of nose cone jettison. When is it occur during flight? Can it be jettisoned below 70km altitude at upleg?

-> Closed. It will be ok. There is another team which wants to open the nose cone in even lower altitude. We have to continue requesting.

8. Length of harnesses. How can we estimate the length between COMMON-E and HEP? They will be mounted on different decks.

-> Open.

9. Can we use a gluing agent to fix the harnesses on the deck by ourselves? We prefer to glue a mounting base onto the deck, and tie the harnesses to it.

-> Closed. Gluing is ok to use.
Major changes after PDR

- AFG (magnetometer) is added: to identify the layer of electric current associated with PsA, which are necessary to confirm the minimum altitude of PsA as well as optical measurements by AIC.
Mission Overview: Mission Statement

The PARM mission will transit a region of Pulsating Aurora (PsA) with instruments that provide high-time resolution observations:

To understand:
the loss of the Earth’s radiation belts due to precipitation of high-energy magnetospheric electrons through the wave-particle interaction during PsA

To imply:
the impact of high-energy electrons on the Earth’s atmosphere, in particular, the possible change of ion chemistry including ozone (O₃) due to precipitation of MeV electrons during PsA
Mission Overview: Mission Statement

• **What is Pulsating Aurora (PsA)?**
  Diffuse aurora which changes its luminosity quasi-periodically. Pulsating frequency ranges from a few to a few tens of sec.

• **PsA is caused by periodic precipitation of tens of keV electrons** from the magnetosphere along the magnetic field line

• **Strong current flows** in the conducting layer at around 100 km altitude during PsA

Observations of PsA in the Scandinavian sector
Mission Overview: Mission Statement

- Recently, ionization at ~70 km altitude during PsA was discovered, which infers precipitation of very high-energy (sub-relativistic) electrons of radiation belt origin during PsA.

Contribute to the loss of the radiation belts?

Radar observations of the electron density during PsA

Miyoshi et al. [2015]
Mission Overview: Mission Statement

- If the radiation belt electrons precipitate deep into the middle atmosphere, significant ionization takes place.
- As a result, destruction of O$_3$ can be expected.

The impact of high-energy electrons on the Earth’s middle atmosphere.
Mission Overview: Mission Statement

Who will this benefit/what will your data be used for?

PARM will contribute:

1. To the understanding of the loss of the Earth’s radiation belts due to precipitation of high-energy magnetospheric electrons through the wave-particle interaction during PsA

2. To the understanding of the impact of high-energy electrons on the Earth’s atmosphere, in particular, the possible change of ion chemistry including ozone (O$_3$) due to precipitation of MeV electrons during PsA
Mission Overview: Mission Statement

*Why this mission should fly on this rocket*

There are two strong reasons:

• High time resolution optical instruments (>100 fps) are operative in Scandinavia by Japanese scientists including graduate students for PsA observations

• Japanese Arase satellite launched in December 2016 will also be operative during the planned launch window of G-CHASER for radiation belt observation at magnetosphere
Mission Overview: Mission Objectives

We aim at understanding:

Relationship between the loss of high-energy electrons in the Earth’s radiation belts and PsA

The mission objectives are:

• To observe the incoming PsA electrons in a wide energy range from a few tens of keV to a few MeV by onboard particle detectors
• To observe the temporal/spatial variations of PsA and minimum altitude of PsA by an onboard camera and magnetometer which is essential for studying PsA

Then we imply:

The impact of high-energy radiation belt electrons on the Earth’s atmosphere associated with PsA
Mission Overview: Mission Objectives

Planned instruments:

1. Two electron detectors (HEP and MED) which seamlessly cover the high-energy part of PsA electrons from 20 keV to 2 MeV

Observations of PsA electrons by REIMEI satellite

Miyoshi et al. [2015]
Mission Overview: Mission Objectives

Planned instruments:

1. Two electron detectors (HEP and MED) which seamlessly cover the high-energy part of PsA electrons from 20 keV to 2 MeV

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Observations of PsA electrons by REIMEI satellite
Miyoshi et al. [2015]
Mission Overview: Mission Objectives

Planned instruments:

2. An auroral camera (wide-FOV camera: AIC) and magnetometer (AFG) which can identify the spatial distribution of PsA and associated electric current from space.

AIC can observe not only the vertical thickness of the PsA but also horizontal 2D structure of PsA, which can be compared with the particle observations.
Mission Overview: Mission Objectives

Addition of magnetometer (AFG)

• To confirm the minimum altitude of PsA determined by the onboard camera, a magnetometer is added to observe magnetic field variation caused by electric currents flowing within the emission layer.
• The magnetometer is also able to detect pulsation in the current intensity within the layer of PsA.
Mission Overview: Mission Objectives

*What do you expect to discover or prove?*

We expect to discover:

- Simultaneous precipitation of high-energy (sub-relativistic) electrons during PsA

If we discover this signature by using data from the experiment we will be able to prove/imply:

- Simultaneous precipitation of MeV electrons of radiation belts during intervals of PsA
- Possible destruction of ozone due to the radiation belt electrons
Requirement from Science Side: Launch Conditions

It would be better to identify PsA clearly from the ground by using all-sky camera at Andøya at the time of launch:

To meet this launch criteria, we expect the following possible launch conditions which will be discussed with the project manager:

1. **New moon periods** to prevent contamination from moonlight
   (New moon in Jan 2019 is “Jan 4 – Jan 11”)

2. **Active geomagnetic condition** (just after aurora substorm)

3. **Morning side**, which is a hotspot of PsA

4. **Good weather conditions**, i.e., clear sky, to observe PsA optically at one of our ground-based optical observation sites (clear sky is not always necessary at Andøya)
Mission Overview: Concept of Operations

- Start of HEP / MED
- Right after the open of nose cone at ~70 km alt.
- Precipitating electrons along the magnetic field-line
- Emission layer of PsA (ranges from 95 to 105 km)
- Magnetic field lines
- Electric current caused by PsA observed by the AFG
- Field-of-view of AIC
- Ground-based supporting all-sky aurora camera

The Arase satellite measures magnetosphere
# Concept of Operations: Timer event

<table>
<thead>
<tr>
<th>Event</th>
<th>Time On</th>
<th>Dwell</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSE 1</td>
<td>T-600 sec</td>
<td>1200sec</td>
<td>Start on the instruments.</td>
</tr>
<tr>
<td>GSE 2</td>
<td>T-600 sec</td>
<td>1200sec</td>
<td>Start on the instruments.</td>
</tr>
<tr>
<td>TE-1</td>
<td>T+30 sec</td>
<td>10 sec</td>
<td>PARM sequence timer start</td>
</tr>
<tr>
<td>TE-2</td>
<td>T+55 sec</td>
<td>10 sec</td>
<td>MED HVPS ramp up</td>
</tr>
<tr>
<td>TE-3</td>
<td></td>
<td></td>
<td>Currently not used</td>
</tr>
<tr>
<td>TE-R</td>
<td>T+60 sec</td>
<td>10 sec</td>
<td>HEP HVPS ramp up</td>
</tr>
</tbody>
</table>
What are the minimum and comprehensive success criteria?

Minimum Success:
• Identification of temporal variations of precipitating electrons, optical emissions and electric current during PsA (Note that good weather condition at Andøya is not always necessary).

Nominal Success:
• Identification of temporal modulations of precipitating electrons in a wide energy range from tens keV to MeV energy during PsA

Extra Success:
• Identification of inverse energy dispersion that is a definitive evidence for the electron precipitation in the wide energy range
• Identification of the minimum altitude of PsA
2.0 System Overview

Name of Presenter
Major changes after PDR

- AFG (magnetometer) is added: to identify the layer of electric current associated with PsA, which are necessary to confirm the minimum altitude of PsA together with optical measurements by AIC.
System Overview: Science Design Overview

PARM includes four scientific instruments: HEP, AIC, MED, and AFG.

**HEP and MED**

HEP and MED are electron detectors which cover the high-energy part of PsA electrons from 20 keV to 2 MeV.

**AIC and AFG**

An auroral camera (wide-FOV camera: AIC) and magnetometer (AFG) can identify the spatial distribution of PsA and associated electric current in space.
System Overview: Science Design Overview

- The Arase satellite measures the magnetosphere.
- Precipitating electrons along the magnetic field-line.
- Emission layer of PsA (ranges from 95 to 105 km).
- Electric current caused by PsA observed by the AFG.
- Field-of-view of AIC.
- Magnetic field lines.
- Ground-based supporting all-sky aurora camera.
- Start of HEP / MED right after the open of nose cone at ~70 km alt.
• PARM consists of four instruments: HEP, AIC, MED, and AFG
• They are controlled by COMMON electronics unit which has electrical interfaces to the Wallops system
Design Overview: Functional Block Diagram

Inter-instrument interface:
Communication: LVDS
Power: bus

Diagram includes:
- AFG
- AIC
- Power block
- HEP
- COMMON-E
- Timer IF
- LVDS
- TLM IF
- MED
- Wallops system

Connections indicated with colored lines:
- GSE-1
- GSE-2
- TE_R1/TE_R2/TE_1/TE_2/TE_3
- Parallel
Proposed instrument accommodation

PARM lower deck

AIC-E

COMMON-E

FOV (AIC)

MED

FOV (MED)
Proposed instrument accommodation

PARM lower deck
Proposed instrument accommodation

• Is it possible for the tip of AIC (lens hood) to go beyond the stay out zone for 10 mm?

PARM takes ‘middle mount’ option.

The lowest possible location of deck next to PARM lower deck

The highest possible location of deck next to PARM lower deck
Instrument accommodation (MED FOV interference)

It seems interference exists, (A) and (B).
For (A), is it possible to arrange the accommodations to avoid FOV interferences?

PARM takes ‘middle mount’ option.

Notch is necessary to avoid interference of MED FOV with the deck.
Proposed instrument accommodation (Notch)

PARM lower deck

Unit: mm

Notch for MED FOV

Notch for AIC FOV
Proposed instrument accommodation

Top deck

Dimension of the deck supports may not be correct. Please tell us correct dimension.
Proposed instrument accommodation

Top deck
In PARM, COMMON-E is the only subsystem which has electrical interface to the Wallops system.

**Function of COMMON-E**
- To provide power, timer, and timing information to the other subsystem (sensors)
- To receive observation and status data from the subsystem and send to Wallops system as PARM TLM data.
System Overview: Software Design: Common_E

Power on GSE-1

Common_E on and Config fpga

Fifo Clear
Teleme timing Gen

Mission Data Save

If 1block Ready

Yes

Mission Data Telemetry out

HEP Power on

AFG Power on

Power on GSE-2

Power on AIC

AIC Power on

MED Power on

Timer TE-1

Time Information Initialize

Timer Event from GSE

TE-RA: Through to HEP (HV On)
TE-RB: Through to HEP (HV On)
TE-1: All Instruments (Time Information Initialize)
TE-2: Through to MED (HV On)
TE-3: Future
System Overview: Electrical Design: Common_E

“Common_E” Block Diagram
System Overview: Electrical Design: Common_E

Power Line Interface

- GSE_1/2 Power Input
- Connect to DCDC_Converter

Timer Line Interface

- TE-RA,-RB
- TE-1,-2,-3
System Overview: Electrical Design: Common_E

Parallel Read Strobe

Parallel Data Interface

Telemetry
Parallel Data
(Parallel Bit 1 (MSB) to Bit 16 (LSB))

1-B9 to 1-B16
System Overview: Electrical Design (HEP)

✓ Requirements:
Identification of temporal modulations of precipitating electrons in a energy range from 100 keV to MeV energy during PsA

<table>
<thead>
<tr>
<th>Item</th>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy range</td>
<td>100 keV – 2 MeV</td>
<td>• Eight layers of 600 µm thick silicon detectors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The amount of charge from each detector is estimated to be 4 - 80 fC</td>
</tr>
<tr>
<td>Energy resolution</td>
<td>about 20%</td>
<td>• Noise level at the input of preamplifier: less than 0.8 fC (5000 electrons)</td>
</tr>
<tr>
<td>Field of view</td>
<td>Geometrical factor: about 1 cm² sr</td>
<td>• Effective area of silicon detector is 2cm x 2cm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Mechanical design of HEP hood (opening angle is about 40 degrees x 40 degrees)</td>
</tr>
<tr>
<td>Count rate</td>
<td>100 counts per 0.05 sec</td>
<td>• Time to process an event: less than 20 µsec</td>
</tr>
</tbody>
</table>
System Overview: Electrical Design: HEP

HEP-S
- SSDx8
- Temperature Sensor

HEP-E
- Bias voltage (300V)
- FET SW
- Cal generator
- Discri Control

FPGA
- A/D
- D/A

PreAmp
- Shaping amplifier
- Vth

Peak Hold

COMMON ELEC.
- Timer
- TLM

HV safety
- Cont.
- F/S connector
- C/O connector

DC/DC (3.3V)
DC/DC (12V)

28V

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System Overview: Software Design: HEP

Power on HEP
- FPGA initialization (Load parameters from EEPROM)
- Analog board Power On
- Observation mode
  - Wait a trigger signal from a silicon detector
    - Readout all layer of the detectors and A/D
      - Event packet generation

Timer Event TE-R
- External pin HIGH
- High voltage Power ON/Ramp up

Timer Event TE-1
- External pin HIGH
- Sequence start
System Overview: Electrical Design: AIC

✓ Requirements:

• To detect pulsating auroral emission at wavelength in the range of 650 nm to near IR(N2 1st positive band) an accuracy better than 1000 Rayleigh, a time resolution better than 1s and wide field-of-view greater than 60°x 60°.

<table>
<thead>
<tr>
<th>item</th>
<th>requirement</th>
<th>specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength</td>
<td>650 nm to near IR</td>
<td>• Andover RG665 filter (bass band 650 to near IR)</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>Better than 1000R</td>
<td>• Estimated S/N = 6.3 for 1000R N2 1st positive band aurora(assuming read noise with 2000 rms electrons)</td>
</tr>
<tr>
<td>Time resolution</td>
<td>Better than 1s</td>
<td>• 0.1 s</td>
</tr>
<tr>
<td>Field of view</td>
<td>Wider than 60°x 60°.</td>
<td>• 75.0°(H) x 96.4°(V) using an objective lens (SPACE HF3.5M-2, f=3.5mm, Fno=.6) combined with 1/2 inch CCD (Watec WAT-910BD, pix: 494(H) x 768(V))</td>
</tr>
<tr>
<td>Angle resolution</td>
<td>100 counts per 0.05 sec</td>
<td>• 4.7°(H) x 3.0°(V) for 1 bin, whose pixel size is 30(H) x 24(V)(16 x 32 bins for a CCD frama)</td>
</tr>
</tbody>
</table>
System Overview: Electrical Design: AIC

AIC-S

CCD Electronics

Analog video

12V power

Digital (BT656)

Control (SPI)

AIC-E

Binning Double_Buffer

Time

FPGA

DC/DC

5V/3.3V power

28V

Common electronics

GSE-2

Power Timer TE_1

CHECKOUT BOX (non flight)

Connectors

TLM

TE_1

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System Overview: Software Design (AIC)

1. **Power on GSE-2**
2. **Power on AIC**
3. **Initialize AIC-S**
4. **Take photo**
5. **Binning an image**
6. **Store binned image**
7. **Timer event (Sequence start)**

No software control

**Sequence:**
- Power on GSE-2
- Power on AIC
- Initialize AIC-S
- Take photo
- Binning an image
- Store binned image
- Timer event (Sequence start)
**System Overview: Electrical Design: MED**

**MED observes the electrons responsible for pulsating patch illumination**

<table>
<thead>
<tr>
<th>Items</th>
<th>Requirements</th>
<th>Specifications</th>
</tr>
</thead>
</table>
| Energy range   | 20-100 keV   | • 20-100 keV  
• The lower limit is determined by the thickness of the Solar-EUV blocking filter on the incident surface  
• The upper limit is determined by the thickness of the APD’s depletion layer |
| Energy resolution | ~20%         | • Noise level is mostly determined by the energy straggling at the incident surface (for the lower energy) and the randomness of signal-multiplication (for the higher energy) |
| Sensitivity    | Count rates: | • Geometrical factor = 2e-5 cm²-sr  
• Pinhole size: 0.5mm DIA |< 5e3 cps @1e8 keV/cm²-sr-keV,  
> 10 cps @1e6 keV/cm²-sr-keV  
→ Geometrical factor: 1e-5 - 5e-5 cm²/sr |
System Overview: Electrical Design: MED

- **APD board**
  - APD
  - Temp. sensor

- **Analog board**
  - CSA
  - Shaper
  - Lower discr.
  - P/H

- **FPGA board**
  - ADC

- **HV board incl. LVPS (DC/DC)**

---

MED

- HV distrib. board
- FPGA board
- Analog board
- HV board incl. LVPS (DC/DC)
- APD board

---

3.3V +/- 12V

+28V

+28V

CMD

TLM

PARM Common Elec.

FPGA

GSE

TLM

LVDS

C/O connector

Temp. sensor

RST x5

SGNL x5

Discr. Level x5

FPGA

ADC

DAC
System Overview: Software Design: MED

**Power on MED**
- FPGA initialization (Load parameters from EEPROM)
- Analog board Power On

Wait a trigger signal
- Readout
- Counter increment

While major frame synch. (MFS) pulses are sent from Common-E
- Send Telemetry

Telemetry start

**TE-1**
- Preset timer counter

**TE-2**
- High voltage Power ON/Ramp up

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System Overview: Electrical Design: AFG

✔ Requirements:
Identification of spatial distributions of the magnetic field accompanying the electric currents caused by PsA.

<table>
<thead>
<tr>
<th>Items</th>
<th>Requirements</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>~ ±70000nT</td>
<td>• For the geomagnetic field observation</td>
</tr>
<tr>
<td>Resolution</td>
<td>~ 20bit (~0.013nT/digit)</td>
<td>• The vertical resolution of AFG is <strong>200 samples/km</strong> when the rocket crosses the current layer with a speed of 1km/s and a sampling rate of 200Hz.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The vertical spatial variation of the magnetic field expected to be 10nT/km associated with the current layer of PsA.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The 20 bit resolution is enough to resolve Δ10nT/200samples.</td>
</tr>
<tr>
<td>Sampling rate</td>
<td>200Hz</td>
<td>• The vertical resolution of AFG is <strong>200 samples/km</strong> when the rocket across the current layer with a speed of 1km/s and a sampling rate of 200Hz.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The vertical thickness of the current layer of PsA expected to be about several tens km.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The temporal resolution of 200 samples/km is enough to resolve the current layer.</td>
</tr>
</tbody>
</table>
System Overview: Electrical Design (AFG)

AFG

- Check out connector
- Cal in
- Excitation: f
- Feedback: 2f
- Sensor x3
- AMP
- BFP
- Phase detection
- ASIC chip
- A/D
- FPGA
- DATA
- COMMON ELEC.
  - TE_1
  - TLM
  - DC/DC 12V
  - DC/DC 3.3V
  - DC/DC 1.25V
  - 28V
System Overview: Software Design (AFG)

Power on GSE-1

Power on AFG

observe

A/D

Telem live stream

Store data

Timer event (Sequence start)

While AFG is on
System Overview: Software Design

PARM has no onboard software.
System Overview: Description of Partnerships

**JAXA, Japan**
Role: development of HEP, AFG, and COMMON-E project management

<table>
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<tr>
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<th>Interaction with PARM team</th>
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<tr>
<td>Electronics design / component selection</td>
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**Tohoku Univ., Japan**
Role: development of AIC

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**Univ. of Tokyo, Japan**
Role: development of MED

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</tr>
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</table>
De-Scopes and Off-Ramps

- All of the PARM subsystems (HEP, AIC, MED, AFG, and COMMON-E) have their own heritages for flight in space.
- We believe there is no serious risks to build the instruments.
- The necessary budget to develop the PARM subsystems that includes launch fee, travel expense, hardware development, and environmental testings have been authorized by Japanese government (JSPS).
- Therefore, de-scopes and off-ramps on schedule/budget constraints have not been considered at this time.
System Overview: Special Requests

- **Telemetry**
  - 300kbps for PARM is necessary

- **Field of view (FOV)**
  - FOV of HEP shall include upward direction (topward in reference frame of the rocket)
  - There shall be no obstacles in FOV of AIC and MED
    - We would like to have the tip of AIC (lens hood) located beyond the stay out zone for 10 mm.
    - It seems there are interferences for MED FOV. Please tell us related dimensions.

- **Electrical connection between the decks**
  - Electrical connection (dedicated harness) is necessary between the top deck (where HEP and AFG are mounted) and PARM lower deck. Twisted pairing of communication lines are necessary, since PARM inter-subsystem communication uses LVDS-based serial data transfer with a little bit high bit rate.

- **Use of high voltage**
  - HEP and MED use high voltages during the observation
    - Maximum output voltage: 300V
    - Typical / maximum output current: 0.0 / 2.5mA.

- **Nose cone jettison**
  - Lower than altitude of 70km is necessary

- **Non-magnetized material for the top deck**
  - AFG wants to have non-magnetized material for the deck where AFG is mounted. For example, aluminum alloy is preferred material.
System Overview: Special Requests

Attitude of the rocket during the flight
- In order to capture the geomagnetic field direction (upward) in FOV of HEP, the spin axis direction of the rocket should point almost upward throughout the mission (almost unchanged during the flight).

Non-flight item
- HEP, AIC, and MED have non-flight items (dust covers). They shall be removed just before nose cone integration to the rocket.
- HEP, AIC, MED, and AFG have F/S and/or check-out connectors. Flight connectors shall be mated to all of them during flight.

Heater control at ground tests when there is a risk of dew condensation

Verification of PARM functions in Wallops and the launch site
- TLM data of PARM is generated based on our own packet format. (Observed data of HEP, AIC, MED, and AFG are packed in one single data stream and it does not follow number of TLM word of Wallops TLM frame format.) Therefore it will be necessary to apply data decoding system dedicated for PARM, i.e., it will be difficult to check the TLM data just by watching specific words of TLM with simple data display system. If you show us specification etc. of Wallops data distribution and display system, we may consider about our own data display system to be connected to the Wallops system.
System Overview: Special Requests

Test after integration of the instruments to RockSatXN system at Wallops

- HEP
  * In order to measure noise level in the flight configuration, F/S connector should be set to ‘flight’ mode once in ground test configuration. Only a very small current of the order of micro-ampere flows in the HEP system.

- MED
  * In order to measure noise level in the flight configuration, F/S connector should be set to ‘flight’ mode once in ground test configuration. Only a very small current of the order of micro-ampere flows in the MED system.

- AIC
  * To get video, the checkout connector on AIC-E is used in the integration test.
  * Noise check will be carried out. For dark current noise test, we will use the lens cap but it may be necessary to make the room dark.
  * Image quality test (focus and alignment check) will be performed.
System Overview: Special Requests

Health check of AFG after system environmental tests at Wallops
Function test will be done with the calibration signal input using the checkout connector.
- at least once after system environmental tests
- with signal inputs by Signal Generator through the additional electric board (Cal-Box)

![Diagram]

AFG-E → Cal-box → SG

- Calibration signal input with the checkout connector

Power
System Overview: Special Requests

- **Test at the launch site**
  - **HEP**
    - In order to measure noise level in the flight configuration, F/S connector should be set to ‘flight’ mode once in ground test configuration. Only a very small current of the order of micro-ampere flows in the HEP system.
  - **MED**
    - In order to measure noise level in the flight configuration, F/S connector should be set to ‘flight’ mode once in ground test configuration. Only a very small current of the order of micro-ampere flows in the MED system.
  - **AIC**
    - Image quality (focus and alignment check) with room light will be performed using TLM data.
  - **AFG**
    - Function test will be done with the calibration signal input using the checkout connector.
      - at least once after system environmental tests
      - with signal inputs by Signal Generator through the additional electric board (Cal-Box)

![Diagram of AFG-E, Cal-box, SG, and Power connections with calibration signal input with the checkout connector]
3.0 Subsystem Design

Name of Presenter
Subsystem Design: Detailed Weight Budget

- Values are preliminary
- Full payload spaces must = 30+/-1.0 lbs.
- Shared payload spaces must = 15+/-0.5 lbs.
  - Weight of payload deck is 3.425 lbs.

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Total Weight (lbf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIC-S</td>
<td>1 kg (2.2 lbs)</td>
</tr>
<tr>
<td>AIC-E</td>
<td>1.5 kg (3.3 lbs)</td>
</tr>
<tr>
<td>MED</td>
<td>3.5 kg (7.7 lbs)</td>
</tr>
<tr>
<td>COMMON-E</td>
<td>1 kg (2.2 lbs)</td>
</tr>
<tr>
<td>Harness</td>
<td>1 kg (2.2 lbs)</td>
</tr>
<tr>
<td>Deck plate</td>
<td>1.6 kg (3.425 lbs)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>9.6 kg (21.2 lbs)</strong></td>
</tr>
<tr>
<td><strong>Over/Under</strong></td>
<td><strong>3.9 kg (8.8 lbs)</strong></td>
</tr>
</tbody>
</table>

Harness weight is very rough.
Subsystem Design: Detailed Weight Budget

- Values are preliminary
- Full payload spaces must = 30+/-1.0 lbs.
- Shared payload spaces must = 15+/-0.5 lbs.
  - Weight of payload deck is 3.425 lbs.

<table>
<thead>
<tr>
<th>Weight Budget</th>
<th>PARM on the top deck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsystem</td>
<td>Total Weight (lbf)</td>
</tr>
<tr>
<td>HEP-S</td>
<td>1.5 kg (3.3 lbs)</td>
</tr>
<tr>
<td>HEP-E</td>
<td>1 kg (2.2 lbs)</td>
</tr>
<tr>
<td>AFG</td>
<td>2 kg (4.4 lbs)</td>
</tr>
<tr>
<td>Harness</td>
<td>1 kg (2.2 lbs)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5.5 kg (12.1 lbs)</strong></td>
</tr>
<tr>
<td><strong>Over/Under</strong></td>
<td></td>
</tr>
</tbody>
</table>

Deck weight is NOT included.
Harness weight is very rough.
**Subsystem Design: Detailed Power Budget**

- Preliminary estimates on power usage for each subsystem
- Voltages and currents should also be included where possible

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Voltage (V)</th>
<th>Current (A)</th>
<th>Time On (min)</th>
<th>Amp-Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEP</td>
<td>28</td>
<td>0.3</td>
<td>20</td>
<td>0.1</td>
</tr>
<tr>
<td>AFG</td>
<td>28</td>
<td>0.15</td>
<td>20</td>
<td>0.05</td>
</tr>
<tr>
<td>AIC</td>
<td>28</td>
<td>0.35</td>
<td>20</td>
<td>0.12</td>
</tr>
<tr>
<td>MED</td>
<td>28</td>
<td>0.25</td>
<td>20</td>
<td>0.08</td>
</tr>
<tr>
<td>COMMON-E</td>
<td>28</td>
<td>0.2</td>
<td>20</td>
<td>0.07</td>
</tr>
</tbody>
</table>

Total (A*hr): 0.42

**Over/Under** 0.58
Subsystem Design:

Subsystem list

- HEP
- AIC
- MED
- AFG
- COMMON-E
Subsystem Design: HEP

• Power and data of subsystem
  – 8.4 W (28V x 0.3A)
  – 150 kbps
    = 85 count x (8 energy (num of SSDs) x 8bit + 1 time x 24bit) / 0.05s
    + 440bit(HK) / 1s
• Hardware used
  – Silicon detectors
  – Charge sensitive preamplifier (Hybrid IC)
• Subsystem Weight: Total 2.5 kg
  – HEP-S: 1.5 kg
  – HEP-E: 1.0 kg
• Other
  – HEP design is near FINAL.
  – Weight and power consumption are estimated values. Only minor changes could be expected.
Subsystem Design: HEP-S drawings
Subsystem Design: HEP-E drawings
Subsystem Design: AIC

✓ Drawing/model/sketch of subsystem

AIC-S with non-flight item (cap)

AIC-S back view

AIC-S without non-flight item (cap)

AIC-E
Subsystem Design: AIC

✓ Mechanical and Electrical Interfaces with other subsystems/Wallops
Subsystem Design: Subsystem Name (AIC)

✓ Power: 10 W
✓ Data rate: 81.92 kbps (science data) + 0.512 bps (HK data)
  Science data 16 x 32 bins for 1 frame, 16bit/bin, 10fps=81.92kpgs
  HK: time, temperature, etc 512bit/1sec
✓ Hardware used (include where possible pictures of hardware to be ordered or on hand)

✓ Subsystem Weight: 2.5 kg (1 kg for AIC-cam, 1.5kg for AIC-electronics)
✓ The design here is drawing as a FINAL version, but it may be have a very minor modification
  which have no impact to other system.
• Power of AIC is an estimated value at maximum case, and this might be more small.
• Weight of AIC is an estimated value at maximum case, and this might be more small.

CCD electronics
Objective wide-FOV lens
Subsystem Design: MED

- Power and data of subsystem
  - 7.0 W (2.5W/amp + 2W/Digital + 2.5W/PS, incl. DC/DC efficiency)
  - 25.6 kbps (science data) + 0.512 bps (HK data)
    - Science data: (16-energy bin x 5-detectors x 8-bit (counter depth) + 32-bit (Time) / (0.625-ms x (40 + 2))
    - HK: Time, temperature, HV-monitor, etc, at 512bit/1sec

- Hardware used
  - Avalanche Photo-diodes
  - Amp boards (HIC charge-amp, shaper, peak holder, etc)
  - Digital boards (FPGA, ADC, etc)
  - Power boards (DC/DC, HV, etc)

- Subsystem Weight: Total 3.5 kg

- Other
  - MED design is assumed to be FINAL.
  - Minor changes is possible if any problems are found during assembly and tests
Subsystem Design: MED

Overview

APD

Amplifier board

Power board

Collimator
Subsystem Design: AFG (Drawings)
Subsystem Design: AFG (Drawings)
Subsystem Design: AFG

- Drawing/model/sketch of subsystem
- Power and data of subsystem
  - 4.2 W (28V x 0.15A)
  - 12.5 kbps
    - $1250 \text{(bit/0.1s)} = 26\text{bit(header)} + 24\text{bit(counter)} + 20\text{bit(data)} \times 3\text{(components)} \times 20\text{(samples/0.1s)}$
- Hardware used
  - sensors
- Subsystem Weight: Total 2.0 kg
  - AFG-S: 0.3 kg
  - AFG-E: 1.5 kg
  - Cable: 0.2 kg
- Other
  - AFG design is near FINAL.
  - Weight and power consumption are estimated values. Only minor changes could be expected.
PARM.RSK.1: Mission objectives may not be met IF COMMON-E can’t survive launch conditions.
HEP.RSK.1: HEP(silicon detectors and electronics) can’t survive launch conditions, and the mission objectives aren’t met,
HEP.RSK.2: HEP shipment may delay IF unexpected and significant problems are found during assembly and verification.
HEP.RSK.3: Mission objectives may not be met IF HVPS discharges in-flight
Risk Matrix: AIC

AIC.RSK.1: AIC system (optics and electronics) can’t survive launch conditions, and the mission objectives aren’t met,
AIC.RSK.2: Significant misalignment in focal position of optical system due to the vibration of launch may cause fatal degradation of data quality,
AIC.RSK3: Frost may occur on/in the optical system and cause significant degradation of data quality
AIC.RSK.4: The AIC shipment may delay IF unexpected and significant problems are found during AIC unit assembly and verification.
MED.RSK.1: The MED system cannot survive launch conditions, and the mission objectives are not met
MED.RSK.2: Mission objectives may not be met IF HVPS discharges in-flight
MED.RSK.3: The MED shipment may delay IF unexpected and significant problems are found during MED unit assembly and verification
Risk Matrix: (AFG)

AFG.RSK.1: AFG (sensors and electronics) can’t survive launch conditions, and the mission objectives aren’t met,

AFG.RSK.2: AFG shipment may delay IF unexpected and significant problems are found during assembly and verification.

AFG.RSK.3: Mission objectives may not be met IF AFG cannot measure the magnetic field because of a significant magnetic disturbance from other instruments.
4.0 Prototyping/Analysis Results/Plans

Name of Presenter
Prototyping Results/Plan: HEP

- Silicon detector was evaluated with a general readout system.
- Results: noise level meet the requirement
  → Energy of an electron can be measured with the required level.

Radioactive isotope (²⁴¹Am)

Gamma-ray

600 μm thick silicon detector

Measured spectrum

60 keV gamma-ray

Calibration pulse to measure electrical noise level

ΔE ≃ 4 keV

✓ Energy resolution is ~ 4 keV and meets the requirement.
Analysis Results/Plans: HEP

- Energy deposited to silicon detectors was simulated by Geant4 library.
- Amount of charge from a silicon detector is determined: 4 – 80 fC
- Based on this range, amplifiers gain are designed

Distribution of energy deposit when $10^4$ electrons are input to a 600 µm thick silicon detector.
Prototyping Results/Plan: AIC

- Heritage of satellite camera: Reimei/MAC, Raijing-1, Dowata
- Heritage of ground-based camera for pulsating aurora using this Watec camera
- Prototype CCD electronics, objective lens, frame grabber board for PC were procured.
Analysis Results/Plans: AIC

- Heritage of satellite camera → Experienced fabrications of optics and electronics for space missions.
- Heritage of ground-based camera for pulsating aurora
  → Confirmed AIC-S electronics (WAT-910BD) capabilities, such as sensitivity for faint pulsating aurora and space/time resolution.
- Prototype CCD electronics, objective lens, frame grabber board for PC were procured.
  → Confirmed electrical interfaces, such as initialization and parameter setting, and digital and vide data outputs for AIC-S (WAT-910 BD CCD camera,
  → Confirmed precise shape and dimensions of objective lens (i.e., SPACE HF3.5m-2).
Prototyping Results/Plan: MED

• Heritage:
  • APD, Amp, HV (MEP-e/ERG)
  • MEP-e is successfully observing magnetospheric electrons as of Mar/2017

• The above heritage ensures MED functions
  • Energy coverage and resolution
Prototyping Results/Plan: AFG

- Heritage of satellite/sounding rockets magnetometer: ERG satellite /SS-520-3 sounding rocket
- Prototype electronics onboard ASIC chip was procured.
Analysis Results/Plans: AFG

- Heritage of magnetometers installed on a satellite/sounding rockets
  - Experienced fabrications of sensors and electronics for space missions.
  - Confirmed AFG electronics for observations of the geomagnetic field and its temporal and spatial variations with a resolution of several nT under the good EMC environment.

- Prototype onboard ASIC chip electronics was procured.
  - Confirmed electrical interfaces, such as external parts for ASIC chips.
5.0 Manufacturing Plan

Name of Presenter
## Schedule

### Schedule in RockSat-XN user’s guide ver 1

- **28 Nov 2017**
  - Critical Design Review (CDR)
- **Dec 21, 2017**
  - Final Down Select—Flights Awarded
- **Feb 2018**
  - Subsystem Testing Review (STR)
  - First Installment Due  
    - What shall be done until this due?
- **Mar 2018**
  - Experiment Decks and Connectors Sent to Teams
  - Integrated Subsystem Testing Review (ISTR)
- **Apr 20, 2018**
  - Second Installment Due  
    - What shall be done until this due?
- **Apr-May 2018**
  - Full Mission Simulation Review (FMSR)
- **May 2018**
  - Weekly Teleconferences Begin

### PARM schedule

- **Dec 2017 - Jan 2018**
  - Collection of parts
  - Manufacturing of chassis and electronics
- **Jan - Feb 2018**
  - Fit check and assembling of subsystem

- **Mar - Apr 2018**
  - Function and performance check
  - PARM-level testing

- **Apr - May 2018**
  - Environmental testing

- **End of May 2018**
  - Delivery of PARM to Wallops
Schedule

Schedule in RockSat-XN user’s guide ver 1

Jun 2018
  Integration Readiness Review (IRR) Teleconferences
Jun 2018
  GSE Checkouts at Refuge Inn
Jun 2018
  Testing and Environmental with Wallops
Jul 2018
  Weekly Teleconferences Resume
Jul 2018
  Launch Readiness Review Packages (LRR) DUE
Aug 2018
  GSE Checkouts at Refuge Inn
Aug 2018
  Final Integration at Wallops
Sep 2018
  Rocket shipped to ASC
Jan 2019
  Launch from ASC
Mechanical Elements (COMMON-E)

- Purchased component
  - Chassis parts
- Schedule
  - Dec, 2017 to Jan, 2018: Collection of chassis parts
  - Feb, 2018: Fit check with electronics and assembling
Mechanical Elements (HEP)

• Purchased component
  • Chassis parts
• Schedule
  • Dec, 2017 to Jan, 2018: Collection of chassis parts
  • Feb, 2018: Fit check with electronics and assembling
Mechanical Elements: AIC

- Done: Procurement of WAT-910BD and prototype of lens SPACE HF3.5M-2 and a frame grabber board for PC.

PLAN

- Dec/2017-Mar/2018: Function test and calibration with proto-type model, Fabrication of cases and electronics, component tests, and assembly
- Mar-May/2018: Unit test (sensor performance, environment tests)
- Jun/2018: Integration test at Wallops
Mechanical Elements: MED

- Manufactured component
  - Chassis parts
- Schedule
  - Dec, 2017 to Jan, 2018: Sensor ASSY and function tests
Mechanical Elements (AFG)

- Purchased component
  - Chassis parts
- Schedule
  - Dec, 2017 to Jan, 2018: Collection of chassis parts
  - Feb, 2018: Fit check with electronics and assembling
Electrical Elements (COMMON-E)

- Purchased components
  - Electronics parts
  - Soldering
- Anticipated revisions
  - 1-2 times
- Schedule
  - Dec, 2017 - Jan, 2018
    - Correction of electronics parts and soldering
  - Feb, 2018
    - Fit check with mechanical parts and assembling
  - Mar - Apr, 2018
    - Function check, interface check with other PARM subcomponents
  - Apr – May, 2018
    - Environmental testing
  - Jun, 2018
    - Testing at Wallops
Electrical Elements (HEP)

- Purchased components
  - Electronics parts
    - DC/DC convertors, Charge sensitive preamplifier, high voltage power supply, FPGA, op-amps, passive components
  - Soldering
- Anticipated revisions
  - 1-2 times
- Schedule
  Dec, 2017 - Jan, 2018: Collection of electronics parts and soldering
  Feb, 2018: Fit check with mechanical parts and assembling
  Mar - Apr, 2018:
    - Evaluation of silicon detectors with manufactured analog boards.
    - function check, interface check with COMMON-E
  Apr – May, 2018
    - Environmental testing
  Jun, 2018
    - Testing at Wallops
Electrical Elements: AIC

- **Done:** Procurement of WAT-910BD and a frame grabber board for PC for prototype test purpose.

**PLAN**

- **Dec/2017-Mar/2018:** Function test and calibration with proto-type model (by an integrated sphere facility in NIPR), Fabrication, component tests, and assembly (Procurement of lens an filters, Fabrication of AIC-E electronics, Fabrications of AIC-S and AIC-E cases and cables)
- **Mar-May/2018:** Unit test (sensor performance, environment tests) by an integrated sphere facility in NIPR and vibration facility in ISAS/JAXA
- **June/2018:** Integration test at Wallops
Electrical Elements: MED

- Manufactured
  - Digital board
    - FPGA, op-amps, passive components are procured
- Soldering
  - Passive components and temperature sensor around APD
- Anticipated revisions
  - 1-2 times
- Schedule
  - Dec, 2017 - Jan, 2018: Collection of electronics parts and soldering
  - Jan, 2018: Sensor ASSY
  - Feb - Mar, 2018:
    - Evaluation of electron measurement performances
    - function check, interface check with COMMON-E
  - Apr – May, 2018
    - Environmental testing
  - Jun, 2018
    - Testing at Wallops
Electrical Elements (AFG)

- Purchased components
  - Electronics parts
    - DC/DC convertors, FPGA, op-amps, passive components
    - Soldering
- Anticipated revisions
  - 1-2 times
- Schedule
  
  Dec, 2017 - Jan, 2018: Collection of electronics parts and soldering
  
  Feb, 2018: Fit check with mechanical parts and assembling
  
  Mar - Apr, 2018:
  
  - Evaluation of the magnetic sensor with manufactured analog boards.
  
  - function check, interface check with COMMON-E
  
  Apr – May, 2018
  
  - Environmental testing
  
  Jun, 2018
  
  - Testing at Wallops
Software Elements

PARM has no onboard software.
6.0 Testing Plan

Name of Presenter
Testing Plan: Testing Overview (HEP)

• HEP Unit level:
  – Function tests
    • Silicon detector test with radioactive isotope (RI)
    • Analog board (preamp+shaper) test with calibration pulse
    • TLM/TE tests for digital board
    • Combination test analog board and digital board
    • TLM/TE tests for the assembled sensor
  – Performance tests
    • Gamma-ray measurements with RI
    • Electron measurements in the vacuum
  – Environmental tests
    • Vibration (sine, random)
    • Temperature test
    • Function (TLM/TE) tests after vibration./temperature tests

• PARM level:
  – Function tests (PWR/TIMER/TLM)
Subsystem Design: Verification Matrix (AIC)

• AIC Unit level:
  – Function tests (Mar. 2018)
    • Power supply, settings of binning, pre-amp gain, frame rate, etc.
    • Calibration with integrated sphere
    • TLM/TE tests for digital board
    • TLM/TE tests for the assembled sensor
  – Performance tests (Mar. - Apr. 2018)
    • Calibration with integrated sphere and monochromatic light source
    • Focus adjustment in atmosphere
    • Function (TLM/TE) tests in vacuum
    • Focus check in vacuum
  – Environmental tests (May. 2018)
    • Vibration (sine, random)
    • Temperature test (down to -30 degC)
    • Function (TLM/TE) tests after vib./tmp. tests in vacuum
    • Focus check before and after environmental tests

• PARM level: Jun 2018-
  Function tests (PWR/TIMER/TLM)
  Focus check
  – Alignment test
Subsystem Design: Verification Matrix (MED)

- MED Unit level:
  - Function tests
    - Amp board test (test pulse, X-ray measurements etc.)
    - HVPS performance and calibration
    - TLM/TE tests for digital board
    - TLM/TE tests for the assembled sensor
  - Performance tests
    - X-ray measurements in the atmosphere
    - Function (TLM/TE) tests in the vacuum
    - Electron measurements in the vacuum
  - Environmental tests
    - Vibration (sine, random)
    - Temperature test (down to -30 degC)
    - Function (TLM/TE) tests after vib./tmp. tests in the vac.
- PARM level:
  - Function tests (PWR/TIMER/TLM)
## Testing Plan: Testing Overview (AFG)

- **AFG Unit level:**
  - **Function tests**
    - Combination test sensor and board
    - TLM/TE tests for digital board
    - Sensitivity/noise test with calibration signals
    - Frequency/linearity response measurement
    - TLM/TE tests for the assembled sensor
  - **Performance tests**
    - Sensitivity/offset/alignment/noise measurements under zero-magnetic field environment
    - Frequency/linearity response measurement
  - **Environmental tests**
    - Vibration (sine, random)
    - Temperature test
    - Function (TLM/TE) tests after vibration./temperature tests

- **PARM level:**
  - Function tests (PWR/TIMER/TLM)
Testing Plan: System Level Testing (HEP)

• In order to measure noise level in the flight configuration, HEP F/S connector should be set to ‘flight’ mode once in the ground test configuration at Wallops.
Testing Plan: System Level Testing (AIC)

• FOV interference: There should be no obstacle in the FOV of AIC.
• In Wallops system test, the check out output will be used to monitor video in addition to TLM data. Image quality test will be carried out under room light conditions with lens cap removed. In addition, dark noise test will be also carried out with lens cap on. After these tests, put on the lens cap.
• At the launch site, TLM data will be used to check the AIC data. Image will be taken with room light. Lens cap will be removed at the last timing we can to access AIC.
Testing Plan: System Level Testing (MED)

• In order to measure the noise level in the flight configuration, MED F/S connector should be set to ‘flight’ mode at least once in the ground test configuration at Wallops/Andøya.
  Testing with HV nominal output (~-150V)
  Testing at the earliest opportunity (e.g., at the first integration test) is preferred
Testing Plan: System Level Testing (AFG)

Function test will be done with the calibration signal input using the checkout connector.
- at least once after system environmental tests
- with signal inputs by Signal Generator through the additional electric board (Cal-Box)
Testing Plan: System Level Testing (anticipated issues)

• Verification of PARM functions in Wallops and the launch site

- TLM data of PARM is generated based on our own packet format. (Observed data of HEP, AIC, MED, and AFG are packed in one single data stream and it does not follow the number of TLM word of Wallops TLM frame format.) Therefore it will be necessary to apply data decoding system dedicated for PARM, i.e., it will be difficult to check the TLM data just by watching specific words of TLM with simple data display system.
- If you show us specification etc. of the Wallops data distribution and display system, we may consider about our own data display system to be connected to the Wallops system.
7.0 User Guide Compliance

Name of Presenter
## User Guide Compliance: Summary

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Status/Reason (if needed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center of gravity in 1&quot; plane of plate?</td>
<td>TBC (we need clarification of this requirement)</td>
</tr>
<tr>
<td>Weight 30.0+/ - 1.0 (15.0 +/- 0.5) lbs?</td>
<td>~30 lbs</td>
</tr>
<tr>
<td>Max Height &lt; 10.75&quot; (5.13&quot;)</td>
<td>245 mm (9.65”) excl. deck thickness for the PARM lower plate</td>
</tr>
<tr>
<td></td>
<td>285 mm (11.22”) for the top plate</td>
</tr>
<tr>
<td>Bottom of deck has flush mount hardware?</td>
<td>Yes</td>
</tr>
<tr>
<td>Within Keep-Out Zone</td>
<td>Yes</td>
</tr>
<tr>
<td>Using &lt; 10 A/D Lines</td>
<td>No</td>
</tr>
<tr>
<td>Using/Understand Parallel Line</td>
<td>Yes, 300kbps</td>
</tr>
<tr>
<td>Using/Understand Asynchronous Line</td>
<td>No</td>
</tr>
<tr>
<td>Using X GSE Line(s)</td>
<td>Yes, GSE-1 and GSE-2</td>
</tr>
<tr>
<td>Using X Non-Redundant PWR Lines (TE-1, TE-2, TE-3)</td>
<td>Yes, TE-1 and TE-2</td>
</tr>
<tr>
<td>Using X Redundant Power Lines (TE-R)</td>
<td>Yes, TE-R</td>
</tr>
<tr>
<td>Using &lt; 1 Ah (.5 Ah for half payload)</td>
<td>Yes, 0.42Ah</td>
</tr>
<tr>
<td>Using &lt;= 28 V</td>
<td>Yes (300V)</td>
</tr>
<tr>
<td>Using RF (If yes, list frequency and TX Power)</td>
<td>No</td>
</tr>
<tr>
<td>Using deployable?</td>
<td>No</td>
</tr>
<tr>
<td>Using ITAR and/or Export Controlled hardware</td>
<td>No</td>
</tr>
</tbody>
</table>
### User Guide Compliance: Power Interface

<table>
<thead>
<tr>
<th>Power Connector--Customer Side</th>
<th>Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>GSE 1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Timer Event Redundant (TE-RA)</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Timer Event Redundant (TE-RB)</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Timer Event 1 (TE-1)</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>GND</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>GND</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>GND</td>
</tr>
<tr>
<td></td>
<td>8</td>
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<td></td>
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<td></td>
<td>10</td>
<td>Timer Event 2 (TE-2)</td>
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<td></td>
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<td>Timer Event 3 (TE-3)</td>
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<td></td>
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<tr>
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</table>

- USE Pin Assignment xls file
- Include a screenshot in your presentation and the actual excel file with your CDR package
- Fill-in the function side for your payload
- Check for consistency with User’s Guide
## User Guide Compliance: Telemetry Interface

<table>
<thead>
<tr>
<th><strong>Telemetry Connector--Customer Side</strong></th>
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<tr>
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<td>N/C</td>
<td>25</td>
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<tr>
<td>7</td>
<td>N/C</td>
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<tr>
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<td>28</td>
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<tr>
<td>10</td>
<td>N/C</td>
<td>29</td>
</tr>
<tr>
<td>11</td>
<td>Parallel Bit 1 (MSB)</td>
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<td>17</td>
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<td>36</td>
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<td>18</td>
<td>Ground</td>
<td>37</td>
</tr>
<tr>
<td>19</td>
<td>Ground</td>
<td></td>
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</table>

- USE Pin Assignment ICD xls file
- Fill-in the function side for your payload
- Include a screenshot in your presentation and the actual excel file with your CDR package
- Check for consistency with User’s Guide
8.0 Project Management Plan (PMP)

Name of Presenter
Management

Team organization chart:

- **PI**
  - Asamura

- **Supervisor**
  - Fujii

- **Science**
  - Miyoshi

- **HEP**
  - Mitani
  - Namekawa
  - Hasegawa
  - Saito

- **AIC**
  - Sakano
  - Fukizawa
  - Yagi
  - Hino

- **MED**
  - Kasahara
  - Okitsu

- **AFG**
  - Nomura
  - Teramoto

- **COMMON-E**
  - Asamura

- **Ground observation**
  - Hosokawa
## Schedule

**Schedule in RockSat-XN user’s guide ver 1**

28 Nov 2017
- Critical Design Review (CDR)

Dec 21, 2017
- Final Down Select—Flights Awarded

Feb 2018
- Subsystem Testing Review (STR)

Feb 21, 2018
- First Installment Due
  - What shall be done until this due?

Mar 2018
- Experiment Decks and Connectors Sent to Teams
  - Integrated Subsystem Testing Review (ISTR)

Apr 20, 2018
- Second Installment Due
  - What shall be done until this due?

Apr-May 2018
- Full Mission Simulation Review (FMSR)

May 2018
- Weekly Teleconferences Begin

**PARM schedule**

Dec 2017 - Jan 2018
- Collection of parts
  - Manufacturing of chassis and electronics

Jan - Feb 2018
- Fit check and assembling of subsystem

Mar - Apr 2018
- Function and performance check
  - PARM-level testing

Apr - May 2018
- Environmental testing

End of May 2018
- Delivery of PARM to Wallops
Schedule

Schedule in RockSat-XN user’s guide ver 1

Jun 2018
  Integration Readiness Review (IRR) Teleconferences
Jun 2018
  GSE Checkouts at Refuge Inn
Jun 2018
  Testing and Environmental with Wallops
Jul 2018
  Weekly Teleconferences Resume
Jul 2018
  Launch Readiness Review Packages (LRR) DUE
Aug 2018
  GSE Checkouts at Refuge Inn
Aug 2018
  Final Integration at Wallops
Sep 2018
  Rocket shipped to ASC
Jan 2019
  Launch from ASC
Team mentors

Experts on sounding rocket experiments at ISAS/JAXA will give the PARM team useful comments at any phase of this project as team mentors.
Monetary budget

We have a fund from Japanese Government (JSPS) which covers until March 2020, including launch fee, travel expense, hardware development, and environmental testings.

Deposit:
USD2,000 has been paid.

Remaining sum of RockSat-XN program fee:
We need to establish a contract between JAXA and RockSat-XN (University of Colorado?) in order to proceed the payment. It may take rather long time (a few months, according to JAXA administration office). Please tell us the point of contact at RockSat-SN side for this issue as soon as possible.
PMP: Latest Contact Matrix

• You can copy and paste your contact spreadsheet here
• Times should be in Mountain Time
### PMP: Latest Contact Matrix

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principle Investigator</td>
<td>Kazushi Asamura</td>
<td>+81-50-3362-2136</td>
<td><a href="mailto:asamura@stp.isas.jaxa.jp">asamura@stp.isas.jaxa.jp</a></td>
</tr>
<tr>
<td>Supervisor</td>
<td>Ryoichi Fujii</td>
<td>+81-3-6402-6201</td>
<td><a href="mailto:eiscatfujii@gmail.com">eiscatfujii@gmail.com</a></td>
</tr>
<tr>
<td>Science</td>
<td>Yoshizumi Miyoshi</td>
<td>+81-52-747-6340</td>
<td><a href="mailto:miyoshi@isee.nagoya-u.ac.jp">miyoshi@isee.nagoya-u.ac.jp</a></td>
</tr>
<tr>
<td>Ground Observation Lead</td>
<td>Keisuke Hosokawa</td>
<td>+81-42-443-5299</td>
<td><a href="mailto:keisuke.hosokawa@uec.ac.jp">keisuke.hosokawa@uec.ac.jp</a></td>
</tr>
<tr>
<td>High-energy electron analyzer (HEP)</td>
<td>Takefumi Mitani</td>
<td>+81-50-3362-4161</td>
<td><a href="mailto:mitani@planeta.sci.isas.jaxa.jp">mitani@planeta.sci.isas.jaxa.jp</a></td>
</tr>
<tr>
<td>High-energy electron analyzer (HEP)</td>
<td>Tatsuya Hesegawa</td>
<td>+81-50-3362-4179</td>
<td><a href="mailto:t.hesegawa@stp.isas.jaxa.jp">t.hesegawa@stp.isas.jaxa.jp</a></td>
</tr>
<tr>
<td>High-energy electron analyzer (HEP)</td>
<td>Taku Namekawa</td>
<td>+81-50-3362-4179</td>
<td><a href="mailto:namekawa@stp.isas.jaxa.jp">namekawa@stp.isas.jaxa.jp</a></td>
</tr>
<tr>
<td>High-energy electron analyzer (HEP)</td>
<td>Yoshifumi Saito</td>
<td>+81-50-3362-4632</td>
<td><a href="mailto:saito@stp.isas.jaxa.jp">saito@stp.isas.jaxa.jp</a></td>
</tr>
<tr>
<td>Auroral camera (AIC)</td>
<td>Takeshi Sakanoi</td>
<td>+81-22-795-6609</td>
<td><a href="mailto:tsakano1@pparc.jp.tohoku.ac.jp">tsakano1@pparc.jp.tohoku.ac.jp</a></td>
</tr>
<tr>
<td>Auroral camera (AIC)</td>
<td>Mizuki Fukizawa</td>
<td>+81-22-795-6609</td>
<td><a href="mailto:fukizawa.m@pparc.jp.tohoku.ac.jp">fukizawa.m@pparc.jp.tohoku.ac.jp</a></td>
</tr>
<tr>
<td>Auroral camera (AIC)</td>
<td>Naoshi Yagi</td>
<td>+81-22-795-6609</td>
<td><a href="mailto:naoshi.yagi.s3@dc.tohoku.ac.jp">naoshi.yagi.s3@dc.tohoku.ac.jp</a></td>
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<td>Auroral camera (AIC)</td>
<td>Taiyo Hino</td>
<td>+81-22-795-6609</td>
<td><a href="mailto:hino.taiyo@gmail.com">hino.taiyo@gmail.com</a></td>
</tr>
<tr>
<td>Medium-energy electron detector (MED)</td>
<td>Satoshi Kasahara</td>
<td>+81-3-5841-4582</td>
<td><a href="mailto:s.kasahara@eps.s.u-tokyo.ac.jp">s.kasahara@eps.s.u-tokyo.ac.jp</a></td>
</tr>
<tr>
<td>Medium-energy electron detector (MED)</td>
<td>Yoshihisa Okitsu</td>
<td>+81-3-5841-4582</td>
<td><a href="mailto:okitsu@g.ecc.u-tokyo.ac.jp">okitsu@g.ecc.u-tokyo.ac.jp</a></td>
</tr>
<tr>
<td>Onboard ASIC Fluxgate magnetometer (AFG)</td>
<td>Reiko Nomura</td>
<td>+81-50-4462-7448</td>
<td><a href="mailto:nomura.reiko@jaxa.jp">nomura.reiko@jaxa.jp</a></td>
</tr>
<tr>
<td>Onboard ASIC Fluxgate magnetometer (AFG)</td>
<td>Mariko Teramoto</td>
<td>+81-52-788-6279</td>
<td><a href="mailto:teramoto@isee.nagoya-u.ac.jp">teramoto@isee.nagoya-u.ac.jp</a></td>
</tr>
</tbody>
</table>
**PMP: Worries**

**Interference of FOVs**
There should be no obstacles in FOV of HEP, AIC, and MED. Especially for AIC and MED, decks of other teams located next to the PARM lower deck may interfere. If so, we would like to discuss about this issue with corresponding teams.

**Data distribution and display at Wallops and the launch site**
TLM data of PARM is generated based on our own packet format. (Observed data of HEP, AIC, MED, and AFG are packed in one single data stream and it does not follow number of TLM word of Wallops TLM frame format.) Therefore it will be necessary to apply data decoding system dedicated for PARM, i.e., it will be difficult to check the TLM data just by watching specific words of TLM with simple data display system.

- If you show us specification etc. of Wallops data distribution and display system, we may consider about our own data display system to be connected to the Wallops system.
- If you send us TLM data during or just after testing, we will check them, although real-time checking is difficult. -- Please tell us TLM format to retrieve PARM data.
PMP: Conclusions

• Next steps for your team to get to STR (Subsystem Testing Review)
  – Check the FOVs available
  – Confirmation of mounting locations
  – Start manufacturing of components
  – Assembling of subsystem
  – Start function test of subsystem
PMP: Conclusions

- **Address why your mission deserves to fly**
  The particle detectors developed by ourselves can provide high time resolution observations of electrons in a wide energy range. Moreover, the optical imager and magnetometer provide detailed information on the height distribution of PsA layer. We believe that our instruments contribute to detailed understanding the deposition process of energetic electrons with tens keV - MeV energy range in the magnetosphere through the precipitation into the upper atmosphere.
Questions

1. We expect that delivery of PARM to RockSat-XN (Wallops) is end of May, 2018. Is this ok?
2. Please tell us status of HEP/AFG accommodation issue and how we should proceed.
3. In order to start manufacturing, accommodation issues of HEP, AFG, MED, and AIC shall be solved (mainly related to FOV interference issues). How should we proceed? We think discussion with other teams may be necessary.
4. Who is responsible for preparing harnesses between the PARM lower deck and the top deck where HEP and AFG is installed? If it is PARM side, we need length information.
5. Could you show us specification etc. of the Wallops data distribution and display system, we may consider about our own data display system to be connected to the Wallops system.
6. Is it possible for the tip of AIC (lens hood) to go beyond the stay out zone for 10 mm?
7. Could you show us location of decks next to the PARM lower deck?
8. What is the latest timing of payload access by PARM team (for removal of non-flight items) before launch?
9. We need to establish a contract between JAXA and RockSat-XN (University of Colorado?) in order to proceed the payment. It may take rather long time (a few months, according to JAXA administration office). Please tell us the point of contact at RockSat-SN side for this issue.
9.0 Appendix
Mission Overview: Theory and Concepts

- It has been widely believed that periodic electron precipitation during PsA is caused by the **cyclotron resonance** between **chorus waves** and energetic electrons in the magnetosphere.

Nishimura et al. [2010, Science]
Mission Overview: Theory and Concepts

- The resonance energy of the cyclotron resonance:

\[ E_R = \frac{B^2}{2\mu_0N} \frac{w_{ce}}{w} \left(1 - \frac{w}{w_{ce}}\right)^3 \]

- \( E_R \) increases when the chorus wave propagates closer to the Earth
- Higher-energy electrons (sub-relativistic) precipitate at the same time during intervals of PsA, so that wide-energy electron precipitations are expected.
Mission Overview: Theory and Concepts

• Recent computer simulation has predicted that inverse energy dispersion should be observed when electrons whose energy ranges from a few keV to a few MeV precipitate at the same time.

![Graph showing expected energy dispersion of precipitating electrons at the rocket altitude](image)

Expected energy dispersion of precipitating electrons at the rocket altitude

Saito, Miyoshi, and Seki [2012]

Travel time from the Magnetosphere
Mission Overview: Theory and Concepts

- Recent computer simulation has predicted that inverse energy dispersion should be observed when electrons whose energy ranges from a few keV to a few MeV precipitate due to chorus-electron interactions.

![Expected energy dispersion of precipitating electrons at the rocket altitude](image)

- Energy coverage of HEP
- Energy coverage of MED
- Travel time from the Magnetosphere

Saito, Miyoshi, Seki [2012, JGR]
Mission Overview: Expected Results

*What your data might look like*

- We expect to observe inverse energy dispersion, which is an evidence of simultaneous occurrence of cyclotron resonance in wide area along the magnetic field line.

![Graph showing energy coverage and travel time from the Magnetosphere](image-url)
Mission Overview: Expected Results

What your data might look like

We expect to observe inverse energy dispersion, which is an evidence of simultaneous occurrence of cyclotron resonance in wide area along the magnetic field line.

If observed, we are able to prove that:

Effective loss of radiation belt electrons occur during PsA which has a potential to affect the ion chemistry in the atmosphere.
Top Level Requirements:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEP FOV shall be upward. Also, no significant obstacles inside FOV of HEP, AIC, and MED.</td>
<td>Inspection</td>
<td>Upward FOV is necessary to measure precipitating electrons. Visual inspection will verify this requirement</td>
</tr>
<tr>
<td>Downlink bit rate of more than 300kbps is required.</td>
<td>Demonstration</td>
<td>To meet 50ms time resolution. This can be verified by testing on the ground.</td>
</tr>
<tr>
<td>The full system shall fit on RockSat-X including harnesses</td>
<td>Inspection</td>
<td>Visual inspection will verify this requirement</td>
</tr>
<tr>
<td>The system shall survive the vibration characteristics prescribed by the RockSat-X program.</td>
<td>Test</td>
<td>The system will be subjected to these vibration loads during testing week.</td>
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