4D Space
Critical Design Review

University of Oslo
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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
Mission Overview: Action Items from PDR

• Mechanical (24/11/2017)
  – Weight of skin: 6.61 kg
  – Total weight: 14.78 kg (33.58 lbs)
  – Height skin: 228.60 mm
  – ASC mech. engineer is also in direct contact with Wallops to secure correct mechanical design.

• Micro switch on daughter
  – Battery will be physically disconnected when switch is pressed.
  – Circuit always on when switch is not pressed.
  – There is currently now way to verify if switch has been activated during e.g. vibration test.
  – However, if activated, this should only be for a short time. Switch pressed by weight of module when resting.

• Pyro
  – Dedicated meeting with Wallops and ASC to discuss pyro on Oct. 26.
Mission Overview: Mission Statement

The experiment will demonstrate the feasibility of multipoint high-resolution electron density measurement using the 4DSPACES payload module:

- Multipoint measurement will facilitate the understanding in the ‘big picture’ of ionospheric plasma condition.

- Characterizing the plasma density at kinetic scale.

- The obtained data can be used to study plasma turbulence and instability for space weather forecast. And increase reliability of GNSS systems.
Mission Overview: Mission Objectives part I

Successfully release six sub-payload modules into space.

Successfully establish communication

- All daughter sub-payloads can communicate with the access point on the ‘mother’ payload section.
- Daughters contact each other for localization purpose.
Mission Overview: Mission Objectives part II

Successfully measure electron density using Langmuir probe systems:
- multi-Needle Langmuir probe (m-NLP) or single Needle Langmuir probe (NLP) systems are used to characterize plasma structures with high sampling rate up to several kHz.
- Measure platform potential of the daughters after being released.
- Electron emitter to mitigate the sub-payload modules charging effect.
- Measured data is transmitted to the control board on the mother payload section.

Post-flight data analysis to study plasma turbulence and instability:
- The in-situ measurement can then be compared with other indirect measurement.
Mission Overview: Theory and Concepts

Positioning and attitude:
- Localization in a wireless network of the six daughters will be based on Time Off Flight (TOF). RSSI not available for current version of radio chip
- by onboard gyro, magnetometer and accelerometer

Multi-Needle Langmuir probe (m-NLP) system:
- Has long been developed and deployed on more than 7 sounding rockets.
- Measure absolute electron density at high sampling rates (several kHz) - high spatial resolution (up to meters)
- Determine the spacecraft floating potential.

Spacecraft charging mitigation by electron emitter:
- The daughter platforms likely charge to a negative potential as a result of the current balance in ionosphere. The more collected electrons by the onboard probe system, the more negative the spacecraft floating potential, that deteriorates the electron density measurement performance.
- Electron emitter is deployed to shoot out ‘redundant’ electrons, and/or strips of metal foil are used to increase the conductive area of the daughters.
Mission Overview: Concept of Operations

1. Launch
   Power/Telemetry begins

2. Launch to Apogee
   Power/Telemetry continues
   Daughters released
   Min release time ~ 10 s
   Daughter flight time ~ 275 s
   Max separation ~ 1200 m
   Separation speed ~ 4.4 m/s

3. Apogee
   Nose cone separation
   Skin separation
   De-spin to TBD rate
   Power/Telemetry continues
   Daughter separation at apogee ~ 500 m

4. Descent
   Power off at TBD time
   Telemetry continues

5. Splashdown
   Telemetry terminates

Pending updated time line!
## Concept of Operations: Timer Events Matrix

<table>
<thead>
<tr>
<th>Event</th>
<th>Time On</th>
<th>Units</th>
<th>Dwell Time</th>
<th>Units</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSE 1</td>
<td>-300 (T-X) (sec)</td>
<td>900 (sec)</td>
<td>Main power</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSE 2</td>
<td>(T-X) sec</td>
<td>(sec)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TE-R</td>
<td>(T+X) (sec)</td>
<td>(sec)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TE-1</td>
<td>62 (T+X) (sec)</td>
<td>20 (sec)</td>
<td>Deployment signal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TE-2</td>
<td>60 (T+X) (sec)</td>
<td>0,1 (sec)</td>
<td>Pyro ignition Pending confirmation on whether controlled by TE-2 or other dedicated line.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TE-3</td>
<td>(T+X) (sec)</td>
<td>(sec)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pending update on mission time line!

Release of sub-payloads some time after burnout but before de-spin.
Mission Overview: Expected Results

We expect to see that all six daughter sub-payloads are released well.

If everything works as designed, each of the daughter modules should execute its measurement mission and transmit data to the control board on the mother payload section, then the data can be transmitted to the ground station via telemetry in real-time.

- We expect to receive transmitted data that includes measured currents by the probe system (which then give ambient electron density and daughter platform potential), attitude information given by the gyro, magnetic field and acceleration sensors, and TOF information for daughter localization purpose.

- And that multipoint electron density measurement would be able to provide the separation of temporal and spatial variations in electron density, as well as provide bases to study plasma turbulence and instability.
Mission Overview: Success Criteria

Minimum Success Criteria:
– Deliver and qualify 4DSPACE module and sub-modules for flight (educational objective)
– Release of the daughters and establish communication to the rocket and further to ground

Comprehensive Success Criteria:
– Continuous data retrieval for whole traveling path of the daughters,
– Retrieve valid data for calculation of electron density and platform potential
– Retrieve valid housekeeping data and TOF for calculation of the daughter’s position/path
2.0 System Overview

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No major system changes since PDR

**Daughter payload:**
- RSSI not supported by nRF24L01 → Plan to try TOF method.
- Direct communication from Hercules microcontroller to ADC has been demonstrated. Intermediate Igloo FPGA can be removed.

**Main payload**
- Use of serial interface
  - Due to limited bandwidth (150 kbits/s) on the parallel interface it is desirable to use the serial interface for housekeeping data.

Do not impact mission objective.
System Overview: Science Design Overview

Main payload (4DSPACE module):
- Mother payload section consists of six sub-payload modules, a.k.a daughters.
- ‘Puck’ shaped daughters are released by the mother payload section to measure temporal and spatial variations of ambient plasma density.

Sub-payload Instrumentation:
- Each of the daughters accommodates an instrumentation section, which runs either multi-Needle Langmuir probe (m-NLP) or single Needle Langmuir probe (NLP) system to characterize ambient plasma with high sampling rate up to several kHz.
System Overview: Main Payload Overview

Main payload (responsible: ASC):

- Main payload design will be done by Andøya Space Center.
- The design has heritage from the previous Maxidusty project and will modified to the RockSat-X platform
System Overview: Sub-payload Overview

**Sub-payload:**

**Science Instrument (UiO)**
- The probe system design has heritage from our sounding rocket and satellite versions of the probe instrumentation.
- Daughters will employ electron emitter with tungsten filament taken from light-bulb to control the sub-payload potential.
- A probe of m-NLP (4 probes) or NLP has a length of few centimeters, together with its bootstrap section. Where each probe is supported by a spring-loaded boom.

**Communication and power board (ASC)**
- Each daughter sub-payload will be powered by 1 cell 500mAh Lipo battery and have a transceiver system with around 2 Mbits data speed. Attitude information of the daughters will be given by onboard gyro, magnetic field and acceleration sensors.
System Overview: Main payload block diagram

ASC responsible for design.
System Overview: Sub-payload block diagram

ASC responsible for design.
System Overview: mNLP Instrument block diagram

- Langmuir Probe
- Microcontroller (TI Hercules)
- ADC
- Electron Emitter
- Voltage regulator

To ASC microcontroller board (Communication and power)
Regulated 5V from ASC uC board
Payload mechanical development is done by Andøya Space Center.
Sub-payload cross-section (E-gun implementation)

- **Lid**
- **MCX**
  - **Analog board**
  - **Digital board**
  - **Ring**
  - **Andøya board**
- **Antenna**

**Cross-section**

- All dimensions given in mm
- Analog Board thickness may be changed to 0.8mm to correspond with current EGUN design.
System Overview: Electrical Design (mNLP)
System Overview: Software design (mNLP)

Data flow through the hardware:

- 4 channels of data runs from ADC to High Energy Timer (HET)
- HET stores the data in a sample buffer using Direct Memory Access (DMA)
- The Software takes the data and process and create packets from the data
- These packets are sent to the radio module
System Overview: Software design (mNLP)

Sample Packet with raw data from HET

![Diagram of sample packet structure:]
- Total Size of Sample Packet: 18 Byte
- 16 Bit Counter
- 32 Bit Channel 1
- 32 Bit Channel 2
- 32 Bit Channel 3
- 32 Bit Channel 4

![Diagram details:]
- 8 Bit Header
- 16 Bit Data
- 8 Bit Dummy Data
System Overview: Software design (mNLP)

Data Packet for Radio Module

Total Size of Data packet for the radio module, 28 byte

- 3 Byte Sample Counter
- Status Byte
- 24 Byte Data

2 byte of raw data for each Channel

ch1 ch2 ch3 ch4 ch1 ch2 ch3 ch4 ch1 ch2 ch3 ch4
System Overview: Software design (mNLP)

**Software flow:**
- Initialize
- Check and change bias of probes
- Get data and average from Direct Memory Access buffer
- Send raw data
- Create packets and store in buffer
- Send packets to radio module
Description of Partnerships

ASC:
- Mechanical design of main payload
  - in direct communication with Wallops to secure correct integration
- Mechanical design of daughter module
- Electrical and SW design for radio board on daughter module

Penn State University:
- Characterization and possible improvements of antennas
System Overview: Special Requests

- Separate section on RockSat-XN. Not standard instrument deck.
  - To fit 4DSPACE module.

- Auroral activity as desired launch condition
3.0 Subsystem Design

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Subsystem Design: Detailed Weight Budget

- Weight of full 4DSPACE module is estimated to ~32.6 lbs.

- Weight of skin: 14.6 lbs

- The weight of one sub-module is ~0.77 lbs (350 g)

- These estimates are subject to change due to redesign.

<table>
<thead>
<tr>
<th>ExampleSat Weight Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subsystem</strong></td>
</tr>
<tr>
<td>4DSPACE module (excl. sub-module)</td>
</tr>
<tr>
<td>1 Sub-payload</td>
</tr>
<tr>
<td>...</td>
</tr>
<tr>
<td>...</td>
</tr>
<tr>
<td>...</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
<tr>
<td><strong>Over/Under</strong></td>
</tr>
</tbody>
</table>
Subsystem Design: Detailed Power Budget

- Sub-payloads are not included as they run independently on battery and will not affect the power consumption of the main modules connected to the rocket.
- These numbers are estimates based on most recent test.
- We are well within the available power budget

### University of Oslo - Power Budget

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Voltage (V)</th>
<th>Max Current (A)</th>
<th>Start Time (min)</th>
<th>Time On (min)</th>
<th>Watts</th>
<th>Ah</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary electronics</td>
<td>28,0</td>
<td>0,30</td>
<td>-5</td>
<td>15</td>
<td>8,40</td>
<td>0,08</td>
</tr>
<tr>
<td>Deployment motor</td>
<td>28,0</td>
<td>0,20</td>
<td>1</td>
<td>0,3</td>
<td>5,60</td>
<td>0,00</td>
</tr>
</tbody>
</table>

| Total                  | 0,50        | 14,00           | 0,08             |
| Total Power Capacity   | 1,00        |                 |                  |
| Over/Under             | 0,92        |                 |                  |

# of Flights Margin: 13,2
Subsystem Design: Structures

- The 4DSPACE system consists of
  - 1 Main payload
  - 6 Sub-/daughter payload (communication board + mNLP)

- Weight balance of main payload is estimated to be near the spin axis and about 6 cm from the top.
  - Can be spin balanced if necessary.

- Sub-payload has static balancing while 4D-space module is estimated to be near spin-axis and ca 6 cm from the top of the module, If necessary it could be spin-balanced
Subsystem Design: Structures Main module

Mechanical drawings provided as pdf
Subsystem Design: Structures Sub-payload
Subsystem Design: Main payload

- Power

Microcontroller
CPLD, Radio
Motor control / light sensor
Subsystem Design: Main payload

Interfaces:
- **Main payload to rocket:**
  - Electrical interface for main module to rocket is currently under re-design to fit power and telemetry interface/connectors (ASC responsible)

- **Main payload to sub-payload:**
  - Wireless 2.5 GHz (nRF24 radio module)
  - Standard S-band blade antenna on module

Weight:
- 14.78 kg (skin 6.61 kg)
Subsystem Design: Sub-payload

Power (ASC):
- Power is provided by the communication board.
- Each sub payload is powered by a one cell 500mAh LiPo battery, charged at 250mA outside of the 4DSpace module, not possible to charge while installed to the module.
- The batteries are charged by standard USB-mini, and charging is controlled by IC MCP73831 as shown in the picture below. The charge circuit is USB powered so the circuit is dead when there is no charging.
- No need for charging after installation, due to low self discharging.
- mNLP voltages is 5V.
Subsystem Design: Sub-payload

Interfaces:
- **Main payload to sub-payload:**
  - Wireless 2.5 GHz (nRF24 radio module)
  - Planar inverted-F antenna (PIFA)
- **Communication board to Instrument:**
  - SPI

Weight:
- Approx. 350 g. To be updated when new prototype has been built
Multi-Needle Langmuir Probe (m-NLP)*
- 4 fixed biased needle probes
- kHz sampling rate (~m resolution)
- Design heritage from MaxiDusty & QB50
- Communication link & mechanical design by ASC
Subsystem Design: Sub-payload - Instrument

System Overview: Sub-payload - Instrument

First prototype of Hercules-based mNLP

CubeSat version
- Parallel development for different project

Is currently being modified to sub-payload form factor and to accommodate E-Gun.

Integrates analog and digital on single board
Subsystem Design: Sub-payload - Instrument
Subsystem Design: Antennas

Standard S-band blade antenna on module

Planar inverted-F antenna (PIFA) on sub-payloads
Subsystem Design: Command and Data Handling

- All command and data handling will be conducted by onboard microcontrollers.

- Takes raw data from instrument on sub payloads and transmit to main payload in data windows of 20ms, so that no sub payload will transmit data at the same time. Each data window will send a package with housekeeping from each sub payload (IMU data, current/voltage, temp, time) and the rest of the window will be sensor data
  - Radio: nRF24L01+PA+LNA

- Communication between main payload and rocket is planned to be done through 16 bit-parallel data line (a redesign is needed to adapt to NASA interface)

- ASC is still evaluating need for serial interface for housekeeping data due to lower bandwidth on parallel interface. (desirable / optional)
Risk Matrix: Main payload

MP.R1: Mission objectives aren’t met IF daughters won’t release
MP.R2: Mission objectives aren’t met IF communication with main payload isn’t established
Risk Matrix: Sub-payload

SP.R1: Mission objectives aren’t met IF communication with main payload isn’t established
SP.R2: The m-NLP does not release
SP.R3: Current drawn from the battery before launch
4.0 Prototyping/Analysis Results/Plans

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Prototyping Results/Plan:

The 4DSPACE system has already been flown on MaxiDusty 1b:

- Doors ejected too early
- Design has been improved

mNLP instrument is flying on Norsat and is successfully providing data

4DSPACE module is re-design to fit RockSat-XN platform

mNLP instrument re-design for G-CHASER:

- Main controller based on Hercules TMS570 (previous MAX10 FPGA + STM microcontroller, or ProASIC FPGA + M1 core for sat. version)
- Electron emitter will be added

2 sub-payloads and 1 main payload (electronics) will be built/prototyped to validate functionality in lab.
Analysis Results/Plans:

• Penn State University will characterize antennas in anechoic chamber (maybe also contribute to link budget analysis)

• 4DSPACE module is short with relatively thick walls, considered over dimensioned so no stress/strain analysis have been done

• NASTRAN FEM analysis to solve for modal frequencies and tip deflection for different lengths of the probe
  • Estimate max. length given vibration load

• Bandwidth/data-link analysis needs to be done in order to set correct sampling rate for mNLP instrument (limited to 150 kbits/s for parallel interface)
5.0 Manufacturing Plan

Name of Presenter
Mechanical Elements

What will be manufactured:
- Parts for carousel deck (ASC)
- Skin and doors (NASA)
- Sub-payload (ASC)

What will be purchased:
- The carousel deck (ASC)

• All hardware needs to be completed by March 1st, 2018.
• Spin-release test in March
Electrical Elements

Currently all PCB’s need to be manufactured/soldered

UiO:
- Sub-payload mNLP instrument
- Anticipate 2 revisions. First revision to be submitted for production in December 2017.
- Components not in stock needs to be purchased

ASC
- Sub-payload communication board (re-used old design)
- Main payload electronics board (revision ongoing to accommodate RockSat-XN power and telemetry interface)
  - Update of CPLD design is currently ongoing.
- Motor and motor controller has been ordered
- RF-filter has been ordered
- Components not in stock needs to be purchased

Hardware needs to be completed by March 1st, 2018.
Software Elements

Sub-payload mNLP
- Software design is currently being ported from MaxiDusty hardware to G-CHASER hardware.
  - MAX10 FPGA + STM uC → Hercules TMS570
  - New external ADC → interface verified → needs to be integrated
  - I/V monitored through TMS570 internal ADC (interface verified → needs to be integrated)

Sub-payload communication board / Main payload
- Software design can be reused, but needs to be updated with TOF feature (ASC + UiO)

All software needs to be completed by March 1st, 2018.
6.0 Testing Plan

Name of Presenter
Test/Prototyping Plan

Test plan for sub-payloads (Completed by March 1st):
- Electrical test of PCBs when produced and components are mounted (Jan-18)
- Functional test of software/hardware (Jan-18)
- Communication test between sub and main payload (Feb-18)
- Battery test (how long does the battery last) (Feb 18)
- Test electron gun in vacuum chamber (March 18)
- Verify correct mechanical release of probes (March 18)

Test plan for main payload (Completed by March 1st):
- Electrical test of PCBs when produced and components are mounted (Feb-18)
- Functional test of software/hardware (Feb-18)
- Spin - Release of Sub-Payloads (March 2017)

Full system test (Completed by April 1st):
- Test probes and full readout of data for full mission time line (source current to probe)
  - Read data from probes with mNLP instrument,
  - send data to communication board,
  - Send data to main payload via wireless link
  - Monitor data sent over telemetry interface (simple GSE to be prepared)
- Calibration of probes
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>N/A</td>
</tr>
<tr>
<td>Weight 30.0+/- 1.0 (15.0 +/- 0.5) lbs?</td>
<td>37.2</td>
</tr>
<tr>
<td>Max Height &lt; 10.75&quot; (5.13&quot;)</td>
<td>9&quot;</td>
</tr>
<tr>
<td>Bottom of deck has flush mount hardware?</td>
<td>N/A</td>
</tr>
<tr>
<td>Within Keep-Out Zone</td>
<td>N/A</td>
</tr>
<tr>
<td>Using &lt; 10 A/D Lines</td>
<td>Using 2 lines</td>
</tr>
<tr>
<td>Using/Understand Parallel Line</td>
<td>Yes</td>
</tr>
<tr>
<td>Using/Understand Asynchronous Line</td>
<td>Yes (desirable/optional)</td>
</tr>
<tr>
<td>Using X GSE Line(s)</td>
<td>GSE-1</td>
</tr>
<tr>
<td>Using X Non-Redundant PWR Lines (TE-1, TE-2, TE-3)</td>
<td>TE-1 (deployment)/ TE-2 (pyro)</td>
</tr>
<tr>
<td>Using X Redundant Power Lines (TE-R)</td>
<td>no</td>
</tr>
<tr>
<td>Using &lt; 1 Ah (.5 Ah for half payload)</td>
<td>0.08 Ah</td>
</tr>
<tr>
<td>Using &lt;= 28 V</td>
<td>Yes</td>
</tr>
<tr>
<td>Using RF (If yes, list frequency and TX Power)</td>
<td>Yes, 2.5 GHz at &lt;130mW</td>
</tr>
<tr>
<td>Using deployable?</td>
<td>Yes, 6 deployable circular «pucks»</td>
</tr>
<tr>
<td>Using ITAR and/or Export Controlled hardware</td>
<td>Holex 2800, provided by NSROC</td>
</tr>
</tbody>
</table>
# User Guide Compliance: Power Interface

<table>
<thead>
<tr>
<th>Power Pin</th>
<th>Function</th>
<th>Intended Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GSE 1</td>
<td>Main Power</td>
</tr>
<tr>
<td>2</td>
<td>Timer Event Redundant (TE-RA)</td>
<td>N/C</td>
</tr>
<tr>
<td>3</td>
<td>Timer Event Redundant (TE-RB)</td>
<td>N/C</td>
</tr>
<tr>
<td>4</td>
<td>Timer Event 1 (TE-1)</td>
<td>Deployment signal</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>GND</td>
</tr>
<tr>
<td>6</td>
<td>GND</td>
<td>GND</td>
</tr>
<tr>
<td>7</td>
<td>GND</td>
<td>GND</td>
</tr>
<tr>
<td>8</td>
<td>GND</td>
<td>N/C</td>
</tr>
<tr>
<td>9</td>
<td>GSE 2</td>
<td>N/C</td>
</tr>
<tr>
<td>10</td>
<td>Timer Event 2 (TE-2)</td>
<td>Pyro ignition?</td>
</tr>
<tr>
<td>11</td>
<td>Timer Event 3 (TE-3)</td>
<td>N/C</td>
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<tr>
<td>12</td>
<td>GND</td>
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<tr>
<td>14</td>
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<td>N/C</td>
</tr>
<tr>
<td>15</td>
<td>GND</td>
<td>N/C</td>
</tr>
</tbody>
</table>
# User Guide Compliance: Telemetry Interface

<table>
<thead>
<tr>
<th>Telemetry</th>
<th>Function</th>
<th>Intended Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Analog 1</td>
<td>Ligh sensor 1</td>
</tr>
<tr>
<td>2</td>
<td>Analog 2</td>
<td>Ligh sensor 2</td>
</tr>
<tr>
<td>3</td>
<td>Analog 3</td>
<td>N/C</td>
</tr>
<tr>
<td>4</td>
<td>Analog 4</td>
<td>N/C</td>
</tr>
<tr>
<td>5</td>
<td>Analog 5</td>
<td>N/C</td>
</tr>
<tr>
<td>6</td>
<td>Analog 6</td>
<td>N/C</td>
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<tr>
<td>7</td>
<td>Analog 7</td>
<td>N/C</td>
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<td>8</td>
<td>Analog 8</td>
<td>N/C</td>
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<td>9</td>
<td>Analog 9</td>
<td>N/C</td>
</tr>
<tr>
<td>10</td>
<td>Analog 10</td>
<td>N/C</td>
</tr>
<tr>
<td>11</td>
<td>Parallel Bit 1 (MSB)</td>
<td>Parallel Bit 1 (MSB)</td>
</tr>
<tr>
<td>12</td>
<td>Parallel Bit 2</td>
<td>Parallel Bit 2</td>
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<tr>
<td>13</td>
<td>Parallel Bit 3</td>
<td>Parallel Bit 3</td>
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<tr>
<td>14</td>
<td>Parallel Bit 4</td>
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<td>Parallel Bit 6</td>
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<td>17</td>
<td>N/C</td>
<td>N/C</td>
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8.0 Project Management Plan (PMP)

Name of Presenter
Management: Team Organization

Team supervisor
Ketil Røed

Senior engineer
Espen Trondsen

Team members
Fredrik Lindseth Winje (*)
Henrik Bjoner Lie (Science)
Andrei Costescu (Instrumentation)
Ole Martin Vister (Positioning)
Huy Minh Hoang (Instrumentation, Science)
Tom Morten Berge (Communication, pos.)
Eirik Nobuki Kosaka (Software)
Yassine Elfarri (Software, Instrumentation)
Simen Sørensen (Instrumentation)

(*) Team lead

Technical support
UiO ELAB

Collaborators
Andøya Space Center
Penn State University

(688x24 to 739x77)
(64x19 to 243x71)
(331x39 to 435x125)
Team

Front row: Fredrik L Winje
Middle row from the left: Huy Minh Hoang, Tom Morten Berge, Eirik Nobuki Kosaka, Ole-Martin Vister
Back row: Henrik Bjorner Lie
## Management: Preliminary schedule (PDR)

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</table>

*Note: The schedule is marked with blue for completion.*
Management: Budget

**Funding has been secured from the Norwegian Space Center (NRS)**
- to cover engineering of payload module at Andøya Space Center
- to cover the RockSat-XN program fee

- Students can apply for 50% coverage of travel and registration fee costs from NRS
- Students may look for sponsoring options
- Instrument expected to be covered by associated research projects at UiO. Strong overlap with parallel development for e.g. ICI5 and ongoing CubeSat activities.

- Funding to support student exchange with US has been applied for through the Norwegian Centre for International Collaboration in Education (SiU). If successful, parts of this funding can be used to cover remaining travel costs.
# Management: Contact Matrix

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
<th>Day Phone</th>
<th>Cell Phone</th>
<th>Receive Texts?</th>
<th>Email</th>
<th>Citizenship</th>
<th>Add to mailing list?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervisor</td>
<td>Ketil Raed</td>
<td>+4722858632</td>
<td>+4798865163</td>
<td></td>
<td><a href="mailto:ketil.roed@fys.uio.no">ketil.roed@fys.uio.no</a></td>
<td>Norway</td>
<td>Yes</td>
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<tr>
<td>Senior Engineer</td>
<td>Espen Trondsen</td>
<td>+4722857371</td>
<td></td>
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<td><a href="mailto:espen.trondsen@fys.uio.no">espen.trondsen@fys.uio.no</a></td>
<td>Norway</td>
<td>Yes</td>
</tr>
<tr>
<td>Student</td>
<td>Fredrik Lindseth Winje</td>
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<td><a href="mailto:fredrikw@gmail.com">fredrikw@gmail.com</a></td>
<td>Norway</td>
<td>Yes</td>
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<tr>
<td>Student</td>
<td>Henrik Bjoner Lie</td>
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<td><a href="mailto:henrikbjonerlie@hotmail.com">henrikbjonerlie@hotmail.com</a></td>
<td>Norway</td>
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<tr>
<td>Student</td>
<td>Andrei Costescu</td>
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<td><a href="mailto:ancostescu@gmail.com">ancostescu@gmail.com</a></td>
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<td>Student</td>
<td>Ole Martin Vister</td>
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<tr>
<td>Student(PhD)</td>
<td>Huy Minh Hoang</td>
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<td><a href="mailto:huy.hoang@fys.uio.no">huy.hoang@fys.uio.no</a></td>
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<tr>
<td>Student(PhD)</td>
<td>Tom Morgen Berge</td>
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<td>Eirik Nobuki Kosaka</td>
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<td>Norway</td>
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</tr>
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</table>
Risks/Worries:

Communication between the six daughter payloads and the mother payload section.

If the communication link fails to establish, we would not get any measurement data from the daughters.
PMP: Conclusions

Address why your mission deserves to fly

– Multipoint high-resolution electron density measurement is significantly needed to understand the ‘big picture’ of ionospheric plasma condition by providing the separation of temporal and spatial variations in ambient electron density.

– Success of the program will enable us to deploy constellations of even more sub-payloads for multipoint scientific studies of ionospheric plasma, as well as to provide viable solutions to deal with spacecraft charging effect in tiny spacecraft.

Questions:

– Dedicated line for pyro trigger?
– Serial interface needs negative voltage?
– Updated mission time line
  • Time of spin stabilization?
  • Knowledge of spin before and after spin stabilization?
Questions

• Dedicated line for pyro trigger?
• Serial interface needs negative voltage?
• Updated mission time line
  – Time of spin stabilization?
  – Knowledge of spin before and after spin stabilization?
9.0 Appendix
# Top Level Requirements:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification Method</th>
<th>Description</th>
</tr>
</thead>
</table>
| Ejection of the daughters and correct release of probes.                    | **Test**            | Remove lid to demonstrate release of probes  
Spin test to verify release mechanisms                                         |
| Communication  
• between daughters and main payload  
• Between payload and RockSat-XN                                        | **Test**            | Test communication between daughters and main payload  
Test communication between main payload and RockSat-XN using the Equipment (GSE) suitcase. Can this be provided earlier than the first integration? E.g. in Norway? |
| The main payload shall fit on the RockSat-XN rocket.                        | **Inspection / Analysis** | Specification from Wallops used for CAD design. CAD design should be validated and approved by Wallops?  
Visual inspection during first integration                                    |
| The system shall survive the vibration, spinn characteristics prescribed by the RockSat-XN program. | **Test**            | The system will be subjected to these vibration, spin loads in June during testing week.                                                |