Galassia Nano-Satellite

National University of Singapore

Satellite and Airborne Radar Systems Laboratory

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Systems Engineer: Eugene Ee Wei Han

Presented by: Prof Goh Cher Hiang
@ 2nd Singapore Space Symposium 30 Sep 2015
Outline

- Missions Objectives
- Satellite Orbit
- System Overview
- Assembly, Integration & Test
- Schedule
Mission Objectives

➢ To acquire **Total Electron Count (TEC) data in the ionosphere above Singapore.**

\[ I = \int_0^R N \, ds \]

Where,

\[ N = 5.97 \times 10^5 \times \frac{f_c^3}{f_m^2} \Delta \Phi \]  (Electron Density)

- \( R \) is the vertical path between cubesat and ground station
- \( f_c \) and \( f_m \) are the carrier and modulation frequencies
- \( \Delta \Phi \) is the phase difference between of signals at ground station after mixing
Mission Objectives (cont’d)

➢ To acquire quantum correlation data in space for the concept verification of quantum-based communication by NUS Centre for Quantum Technologies (CQT). Its principle is based on Small Photon-Entangling Quantum Systems (SPEQS).

SPEQS Payload (EM Version)
**Satellite Orbit**

- **Galassia Orbital Parameters:**
  - **Near Equatorial Orbit**
  - **Altitude:** 550km
  - **Inclination:** 15 degrees
  - **Eccentricity:** <0.0003
  - **Average no. of access a day:** 8
  - **Longest access time:** 415.281 sec

- **Launch is based on piggyback opportunity on PSLV-C29**
# System Overview (Requirements)

## System Specifications

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bus</strong></td>
<td>2U Cubesat</td>
</tr>
<tr>
<td><strong>Dimension (mm)</strong></td>
<td>100 x 100 x 200</td>
</tr>
<tr>
<td><strong>Mass (kg)</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>UHF (436.4 MHz)</td>
</tr>
<tr>
<td><strong>Power (W)</strong></td>
<td>Max Consumption: 2</td>
</tr>
<tr>
<td><strong>Battery</strong></td>
<td>20 Whr (Li-Ion)</td>
</tr>
<tr>
<td><strong>Solar Panels</strong></td>
<td>GaAs Cells</td>
</tr>
<tr>
<td><strong>Flight Computer</strong></td>
<td>ARM 7</td>
</tr>
<tr>
<td><strong>Attitude Control</strong></td>
<td>Passive: Permanent Magnet &amp; Hysteresis Rods</td>
</tr>
<tr>
<td><strong>Orbit Altitude</strong></td>
<td>550 km, 15 deg Inclination Equatorial Orbit</td>
</tr>
</tbody>
</table>
System Overview (Configuration)

- ISIS Deployable Antenna
- Payload 1: TEC
- Payload 2: SPEQS Quantum Communication Payload
- Interstage Panel
- Nanohub
- Telemetry, Tracking & Command Subsystem (TT&C)
- Passive ADCS (Hysteresis Rods)
- Secondary Payload: ADCS-EP
- Electrical Power Subsystem (EPS)
- On Board Computer (OBC)
- Passive ADCS (Magnets)
- TT&C Deployable Antenna (Stowed)
Assembly, Integration & Test

- A Two-Model Philosophy is used:
  - Engineering Model ("FlatSat")
  - Flight Model (FM)
2015 Galassia Assembly Flow
• **Test Levels**
  
  • *Test done at Protoflight Model Levels (i.e. Qualification Level at Acceptance Duration)*

• **Tests Campaign (29th July – 09th Sept 2015)**
AIT (Facilities & Tests Planned)

• Flight Model Testing
  • Done at ST Satellite Systems
  • Shaker & Thermal Vacuum Chamber Class 100K cleanroom

• Tests Conducted
  • Vibration Test
    i. Sinusoidal Vibration
    ii. Random Vibration
  • Thermal Vacuum Test
Galassia in PPOD with mounted accelerometers on Shaker Table
AIT (Vibration Test Results)

- **Sinusoidal**
- **Measurement locations**

Mounting of Accelerometers for Vibration Tests

Sinusoidal Vibration Test Profile

Back Rail Measurement
AIT (Random Vibration Results)

- **Chan.no:** 3
- **Chan.type:** N
- **DOF:** 90
- **Level:** 0.0 dB
- **Resolution:** 5 Hz
- **Contr.strat.:** Average
- **Unit:** g²/Hz
- **RMS (act.):** 23.54 g
- **RMS (req.):** 6.705 g
- **Contr.strat.:** Closed loop

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**Measurement**

- **Input**

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**Back Rail**

- **[g²/Hz]**
  - 20 Hz: 0.0020 g²/Hz

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**[Hz]**

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**[g²/Hz]**

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**[Hz]**

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**C:\\VopNT\Daten\mp\NUS RANDOM_30 JULY 2015-VERTICAL_023.rmn**
AIT (Shock Test Results, Z-axis)
**AIT (Thermal Vacuum Test)**

- **TVC Facility**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Condition</th>
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</thead>
<tbody>
<tr>
<td><strong>Start Cycle</strong></td>
<td>Hot</td>
</tr>
<tr>
<td><strong>Ambient Temperature</strong></td>
<td>25 °C</td>
</tr>
<tr>
<td><strong>Vacuum Pressure</strong></td>
<td>$10^{-5}$ Torr</td>
</tr>
<tr>
<td><strong>No. of Cycles</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Dwell Time</strong></td>
<td>1 hour cold soak</td>
</tr>
<tr>
<td></td>
<td>1 hour hot soak</td>
</tr>
<tr>
<td><strong>Temperature Ramp</strong></td>
<td>1 °C/min</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>-15 °C to +35 °C</td>
</tr>
</tbody>
</table>

**Galassia in Thermal Vacuum Chamber**
**AIT (TVC Test Results)**

Thermal Vacuum Test Profile

- **Chamber’s pressure**
- **Jig/Base temperature**
- **Galassia temperatures**
## Schedule (Latest)

<table>
<thead>
<tr>
<th>Important Milestones</th>
<th>Planned Date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Kickoff</td>
<td>16 Aug 2013</td>
<td>Completed</td>
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<tr>
<td>Preliminary Design Review (PDR)</td>
<td>20 Sep 2013</td>
<td>Completed</td>
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<tr>
<td>Critical Design Review (CDR)</td>
<td>8 May 2014</td>
<td>Completed</td>
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<tr>
<td>Assembly Integration Test (AIT)</td>
<td>Jan to Sept 2015</td>
<td>Completed</td>
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<tr>
<td>Flight Readiness Review (FRR)</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt; Week Oct 2015</td>
<td></td>
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<tr>
<td>Shipment to Launch Site (Sriharikota)</td>
<td>Mid to End Oct 2015 (TBD)</td>
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<tr>
<td>Launch</td>
<td>Nov/Dec 2015</td>
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Thank You