An Ionosphere Exploring Microsat

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INSPIRE Program and Organization

- **International Satellite Program in Research and Education**
- Nine partnering institutions ranging from first space involvement to developing several smallsats at once
- Four spacecraft currently under development
- Unique challenges and solutions to developing a spacecraft through an international cooperation
INSPIRE Program and Organization Continued

- Communication channels organized in a horizontal to vertical structure across institutions
- PM/SE students meet over telecon once a week and report up and disseminate action items down
- Summer workshop held in Boulder for 10 weeks for rapid development and design review checkpoints
- Google drive used for version control of documentation and central repository
- Slack used for instantaneous communications

INSPIRESat-1
Critical Design Review July 25, 2018
INSPIRESat-1 Introduction

- Microsat slated for launch in November 2019 with the Indian Space Research Organization
- Expected orbit of 500 km and 45° inclination
- Carrying the Compact Ionosphere Probe (CIP)
  - Ion Density
  - Ion Drift Velocity
  - Ion and Electron Temperature
  - Ion Composition
- Engineering structure at LASP or NTU tables during conference
INSPIRESat-1 Testing Status

- All subsystems have been tested and version two of EPS, CDH, and Interface have either been designed or are already on order.
- Successfully sent known bit stream from software defined radio to UHF and received correct bits at C&DH.
- Next steps include full flat sat tests with fully integrated flight software, as well as communications test with LASP UHF ground station.
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For more engineering, software, and testing information please see Ankit Verma and Duann Yi at their poster SSC18-PII-03 on August 8th.
## INSPIRESat-1 Science Motivation

### Science Traceability Matrix

<table>
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<th>Science Objective</th>
<th>Measurements</th>
<th>Instrument</th>
<th>Requirements</th>
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| 1) What are the occurrence rates and characteristics of plasma irregularities at low and mid latitudes? | Ion Density, Ion Velocity | Ion Trap Retarding Potential Analyzer, Ion Drift Meter | $10^3$ to $10^6$ cm$^{-3}$ ± 2.5 km s$^{-1}$  
7.5 ± 1 km s$^{-1}$ (ram) |
| 2) What are the spatial and temporal variations of the midnight temperature maximum (MTM)? | Ion Temperature        | Retarding Potential Analyzer        | 500 to 5000 K (Ti) |
| 3) What is the morphology of ion density and electric field in the nighttime ionosphere? | Ion Density, Ion Velocity | Ion Trap Retarding Potential Analyzer, Ion Drift Meter | $10^3$ to $10^6$ cm$^{-3}$ ± 2.5 km s$^{-1}$  
7.5 ± 1 km s$^{-1}$ (ram) |
INSPIRESat-1 Science Objective 1

Plasma Irregularities

- Plasma bubbles form around the magnetic equator in the early evening and propagate along magnetic field lines extending far from their initiation site (Kil, 2015).
- Bubbles can be hundreds of kilometers across and extend hundreds of kilometers up in altitude above the F-layer (>150 km) (Kil, 2015)

[Kil and Heelis, JGR, 1998]

Different types of irregularities

CNOFS/CINDI March 2, 2009
INSPIRESat-1 Science Objective 2
Midnight Temperature Maximum

• Around midnight at F region heights, the MTM is a neutral temperature increase which varies in season and solar activity

• Only a few models accurately capture the MTM including the coupled Whole Atmosphere Model (WAM) with the Global Ionosphere Plasmasphere (GIP) model.

• The MTM shows some seasonal variability in which it tends to maximize in the summer and weaken in the winter (Niranjan et al, 2006)

• The MTM is an understudied essential physics process that represents ion-neutral coupling

Fang et al, 2016
Akmaev et al, 2009
INSPIRESat-1 Science Objective 3  
Nighttime Ionospheric Morphology

Global coverage by the INSPIRESat-1 will allow for the study of background ionospheric states and their impact on science objectives 1 and 2.

[Kil et al., JGR, 2009]
INSPIRESat-1 Science Objective 3

Coordinated Measurements
References


QUESTIONS?
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