TIWS Cubesat Mission

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Illinisat-2 Overview

• Design Objectives:
  • Multi-mission capable bus
  • ~1U volume for bus
  • 2U, 3U cubesat capable (1-2U for payload)

• Mission types:
  • Remote sensing (Earth observing)
  • In-situ sensing (Thermosphere)
  • Technology demonstration
Illinisat-2 Subsystem Overview

- **Power:**
  - 5V, 3.3V regulated, 7.4V Li-ion battery pack
  - 4 solar panels and battery charger
  - 3.4W, 5.4W avg power for 2U, 3U designs

- **Communications:**
  - Amateur radio band
  - Yaesu VX-3R radio
  - Champaign, IL ground station
Illinisat-2 Subsystem Overview

- **ADCS:**
  - Determination (~1°): magnetometer, rate gyros, photodiodes
  - Control (~5°): 3-axis magnetic torquers

- **C&DH:**
  - TI OMAP5912 CPU running Linux kernel
  - IOND daemon-based software

- **Structures/Thermal:**
  - 1.5U, 2U, 3U designs
  - Carbon fiber side panels with integrated torque coils
TIWS Mission

• Mission Design:
  • 6-12 month lifetime
  • 300-450km altitude
  • 30°-60° inclination orbit

• Mission Objectives:
  • Remote observation of atmospheric gravity waves (AGW) in mesosphere
  • In-situ measurements of thermospheric ion density, temperature, composition
  • Educate and train young engineers at UIUC
TIWS Science

- Measurements of O\textsubscript{2} atmospheric (0-0) band airglow in mesosphere
  - Brightness perturbation
  - P-R branch ratio provides rotational temperature, wave amplitudes
- In-situ ion density measurements
- Large Waves or Bores (LWB) observations and correlated response in ionosphere
TIWS Science

• Science Goals:
  • Global measurements of medium-large scale (>150km wavelength) LWBs
  • Understand wave energy transport between mesosphere and ionosphere
  • Understanding of ionospheric irregularities

• Scientific Impact:
  • Plasma irregularities can affect radio wave propagation in ionosphere
  • Electron density gradients can degrade satellite-based navigation and communication systems
TIWS Sensors

• 2 Photomultiplier tubes (PMT)
  • Hamamastu H8259-02
  • 0.4 W power per sensor
  • Lens focal length: 37mm
  • Filter bands at 760.5, 762.8nm

• 1 Photodiode
  • Background (noise) observation
  • Lens focal length: 0.5”
  • Filter band at 777nm
TIWS Sensors

• Retarding Potential Analyzer (RPA)
  • University of Texas at Dallas
  • Ram-direction oriented
  • 0.8 W avg power
  • Ion-trap mode, Burst mode
TIWS Sensors

![Graph showing wavelength and temperature relationships for different filters and temperatures.]

\[ T_{\text{O}_2(b\rightarrow\gamma),\text{rot}} = 192 \cdot R_{\text{SF1/SF2}} - 30 \]
TIWS Sensors

• PMTs:
  • Integration time: 1-6s
  • 15x25km spatial resolution (footprint) for 1s integration
  • SNR = 24
  • 1000+ km target (AGWs)
TIWS Sensors

• RPA:
  • Ion density resolution: ~100cm$^{-3}$
  • Ion temperature resolution: ~50K
  • Ion trap mode:
    • 2 data samples per second
    • Ion density spatial resolution of 4km

• Burst mode:
  • 20 data samples per second
  • Sub-kilometer spatial resolution