# TIWS Cubesat Mission

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IlliniSat

# 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

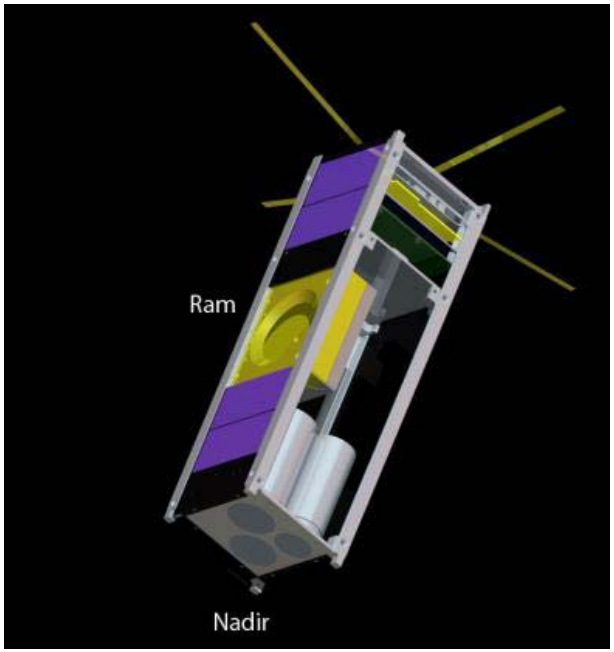
- Measurements of $O_2$ atmospheric (0-0) band airglow in mesosphere
  - Brightness perturbation
  - P-R branch ratio provides rotational temperature, wave amplitudes
- In-situ ion density measurements
- Large Waves or Bores (LWB) observations and correlated response in ionosphere

# 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

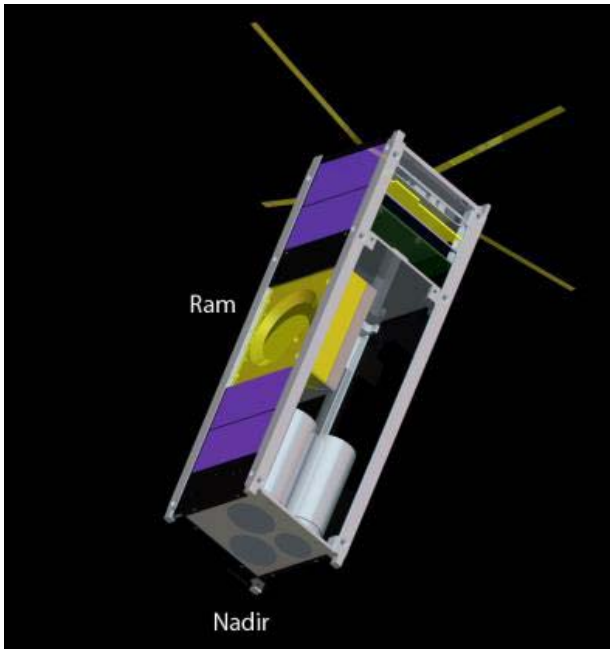
# TIWS Sensors

- 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

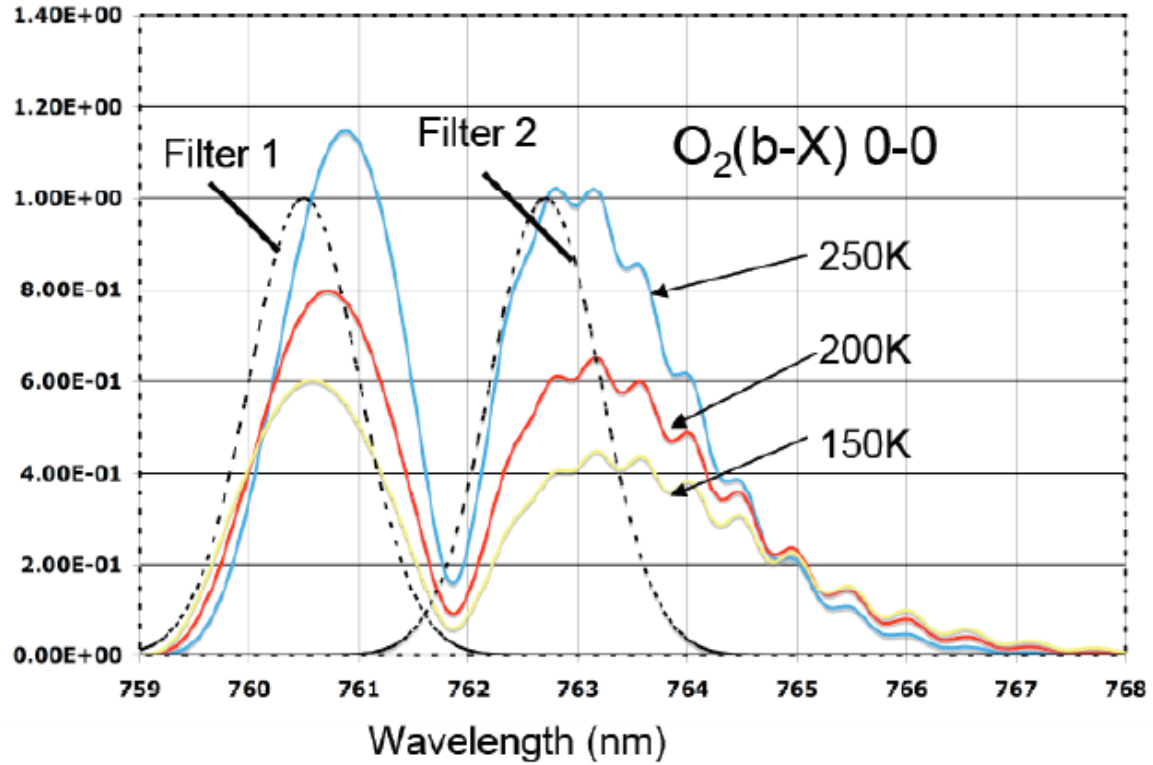


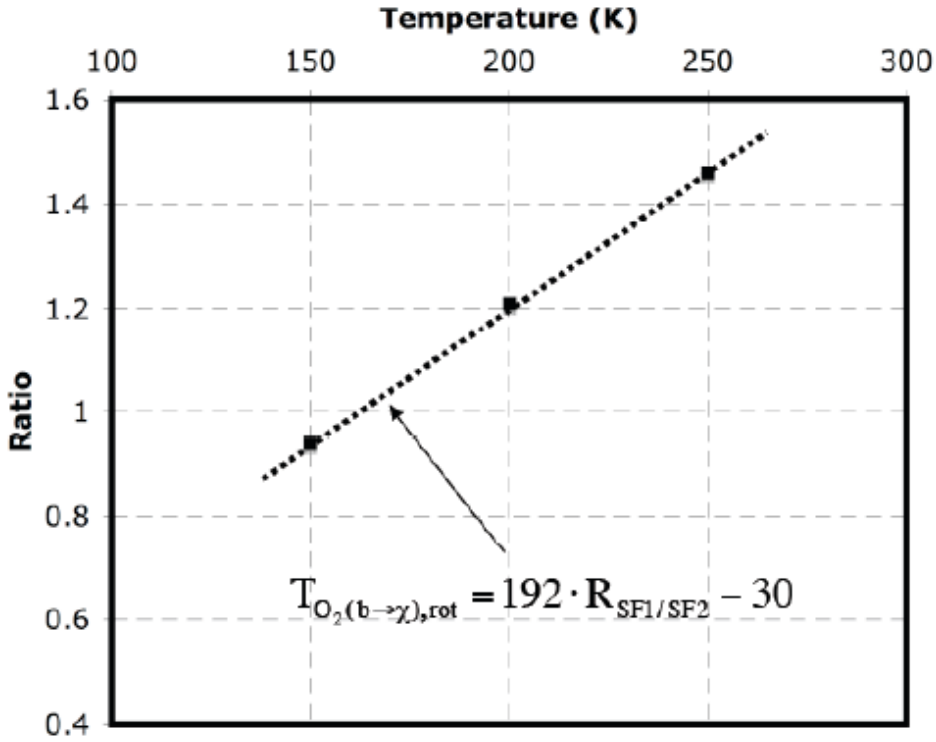
# TIWS Sensors

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



# TIWS Sensors



# 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