

CUBESAT DEVELOPER'S WORKSHOP

#CDW April 27 – 29, 2021 | Cal Poly, San Luis Obispo



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Tropical Cyclones Monitoring Solution using THz Technology Payload on a CubeSat

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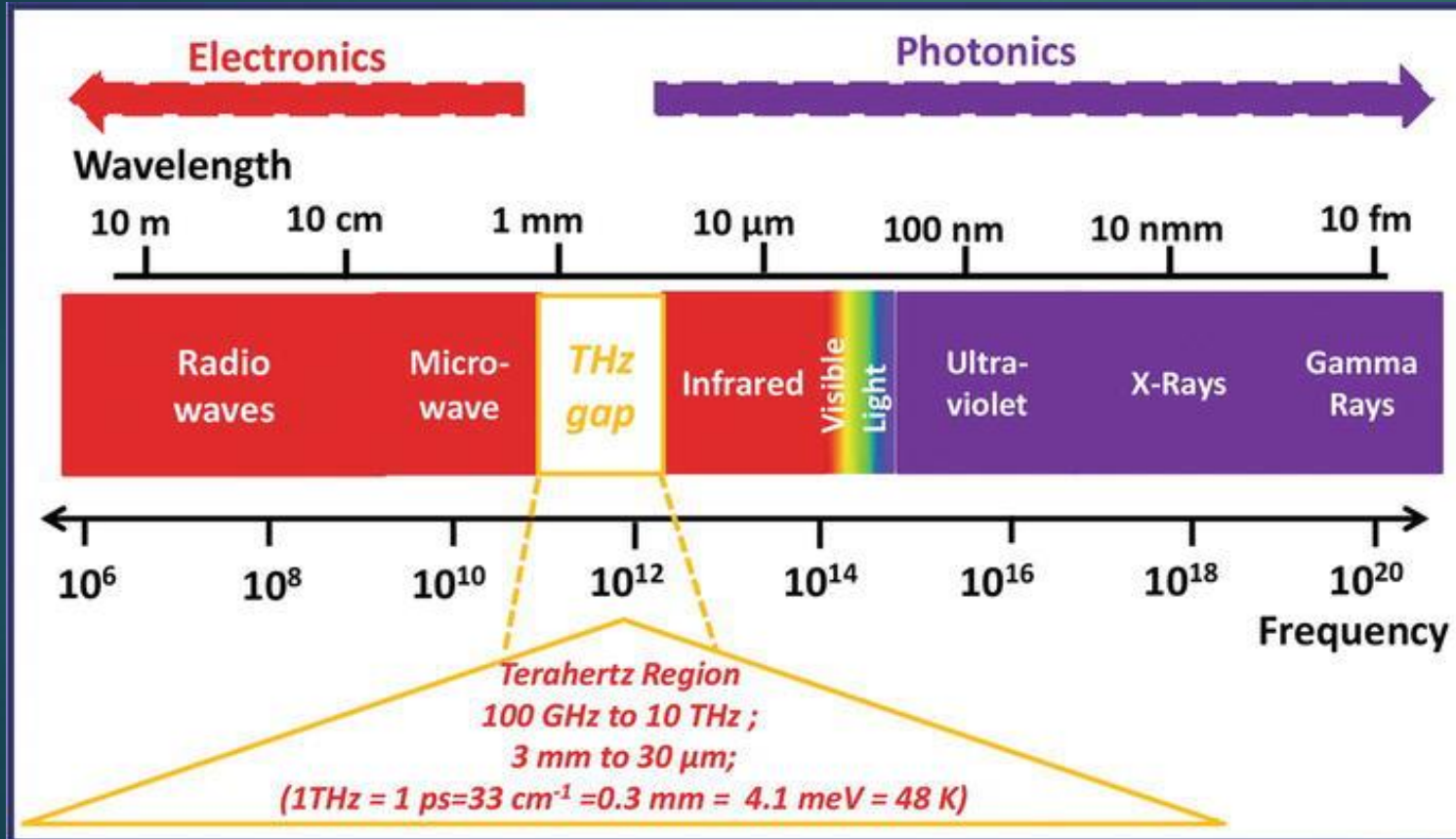
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[VIRTUAL]

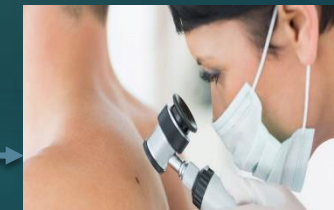
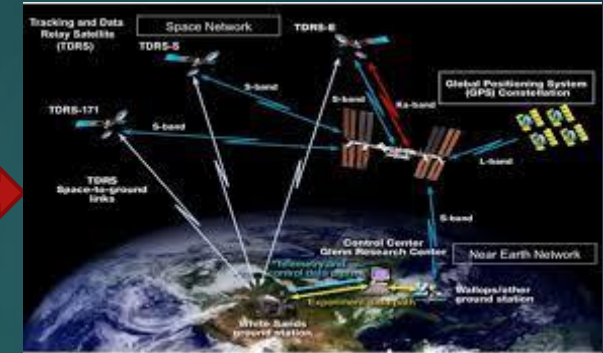
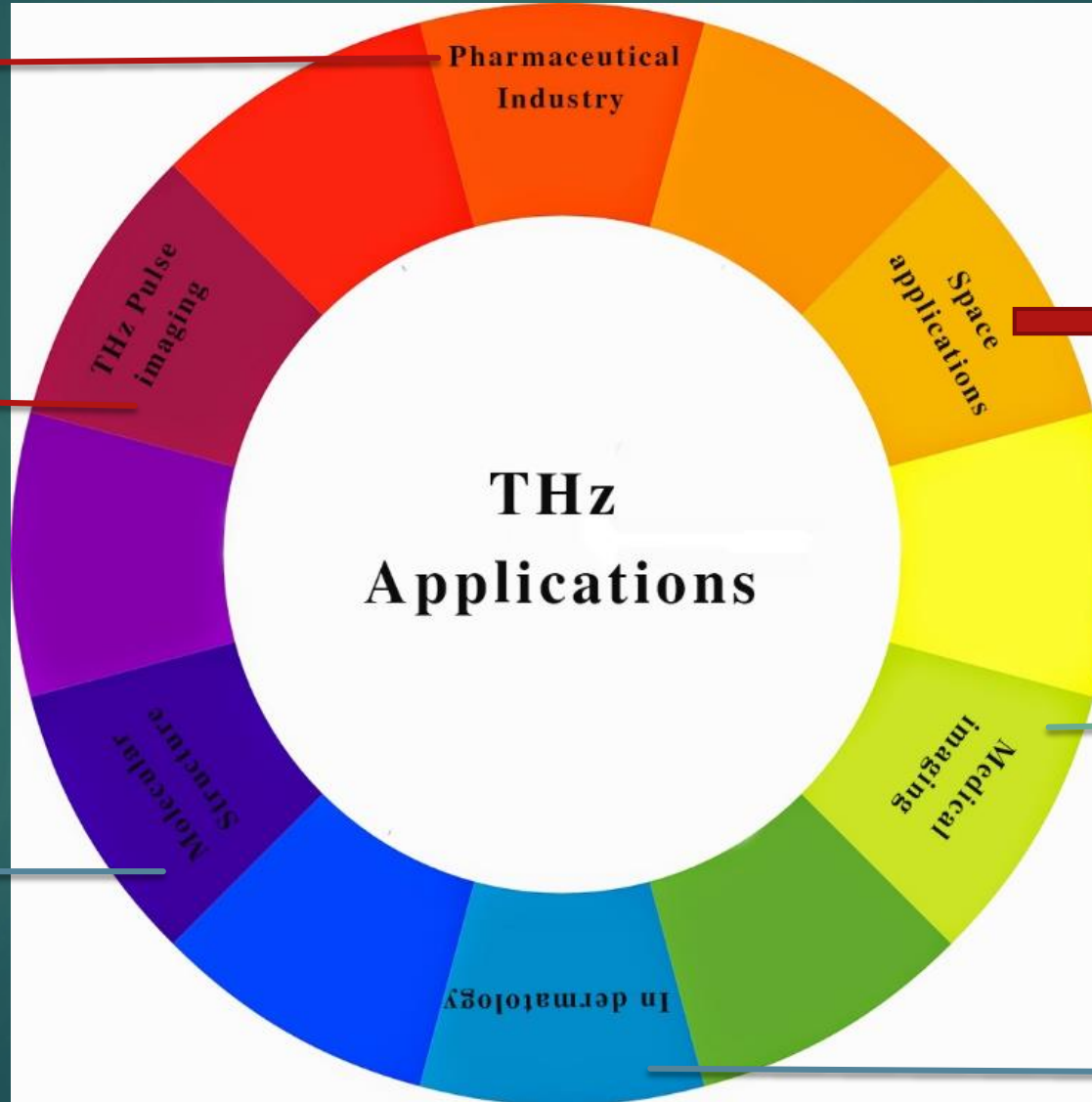
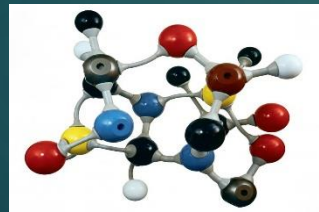
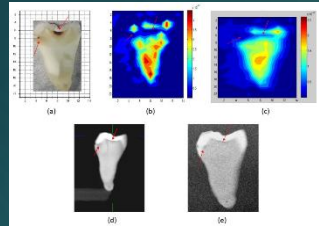
Presented from Cal Poly San Luis Obispo

Terahertz waves



- Terahertz radiation also known as Submillimeter radiation, Terahertz waves, Tremendously High Frequency (THF).
- Frequency range between 0.1-3 THz is considered as THz waves.
- THz is absorbed strongly by atmosphere and the signal strength reduces to zero after few meters.
- There are several THz applications both Terrestrial and Spatial items.

THz applications



THz space applications

- ▶ **Terrestrial applications:** 1) the use of THz wave for observation from geostationary have been one of the subject for both European and USA space agencies. The missions that millimeter-wave and sub millimeter-wave can do include total water vapor column, cloud motion vectors, possible ice profile, temperature and humidity profile. 2) Remote sensing of the surface of the earth is possible in foggy and cloudy condition. The applications of THz Remote sensing include imaging of sea ice and snow which the ice cloud is very detective with sub-mm instrument. 3) Climatology addresses several very important process taking place in the atmosphere and detecting what human's activities effect on it. One of the idea is to correlate the composition of the atmosphere. Millimeter and sub-millimeter frequency allow the use of radiometers for determination characteristics of Ozone and other greenhouse gasses such as CFCs.
- ▶ **Radio Astronomy:** observation of both interstellar and extragalactic regions with millimeter and sub-millimeter waves have been given us a great opportunity to understand our whole universe. This key technology has a great capability to see stars formation through clouds and dusts.
- ▶ **Planetary and Cometary science:** 1) another application for millimeter and sub-millimeter waves is monitoring third body or small planets such as moon, asteroids and comets etc. the target is to identify atmospheric characteristics and their compositions. 2) Martian, Venusian, Jovian atmospheres remote sensing. The proposed idea is about providing valuable data on composition, pressure, temperature wind velocity of referred planets which those data unaffected by atmosphere dust and independent sunlight conditions.

What we are going to do with THz

Tropical Cyclones Monitoring Solution using THz Technology Payload on a CubeSat

THz technology is a state-of-the-art technology for satellite remote sensing, with its tiny antenna size can be easily placed on a CubeSat surface. In addition, these tiny wavelengths can penetrate and identify small particles such as water vapor, ice, clouds, dusts, etc. Sweeping a target location at different times, this capability gives us a solution to monitor formation process of natural phenomenon, such as Tropical Cyclones. Yearly, Tropical Cyclones force billions of dollars of damages around the globe, takes lives, and bring homelessness, muddy water and even diseases. This mission is going to figure out how to predict Tropical Cyclones by Remote Sensing on THz technology by a CubeSat System and prevent irrecoverable financial and human losses.

Tropical cyclones are one of the biggest threats to life and humans sources. They include a number of different hazards that can individually cause significant impacts on life and property, such as storm surge, flooding, extreme winds, tornadoes and lighting. Combined, these hazards interact with one another and substantially increase the potential for loss of life and material damage.



forecasting Tropical cyclone a distractive phenomenon by satellite remote sensing

Forecasting tropical cyclones from space is high level trustable information which we can worn near habituated area when tropical cyclones are approaching. Fig (a) shows a tropical cyclones formation. A same location has been monitored at different times, this action provide capability to see the formation of the storm and if that threatens an area zone the area can be evacuated, subsequently, we prevent human and financial losses as much as possible.

Fig (b) shows a comprehensive storm map that it could show us which location the center of the phenomenon is so subsequently we can alarm the near effected area and, in addition, it can tell how much the capacity of the air pressure is. these kind of map very depends on the software we provide for ground station.

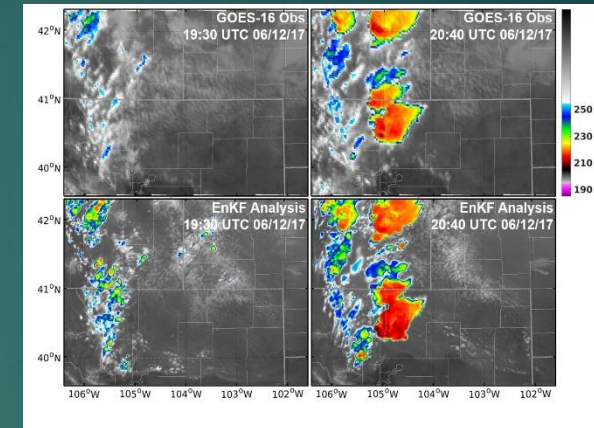


Fig (a)

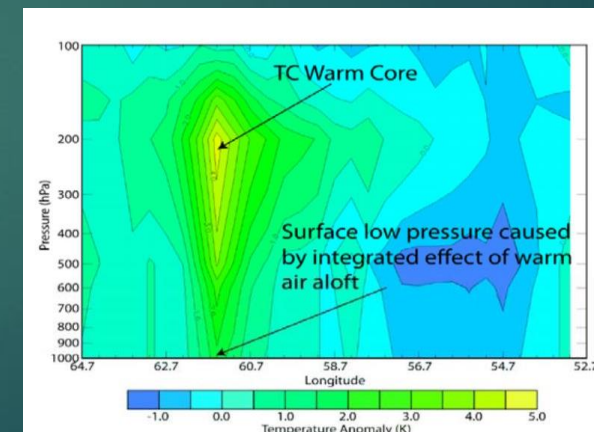


Fig (b)

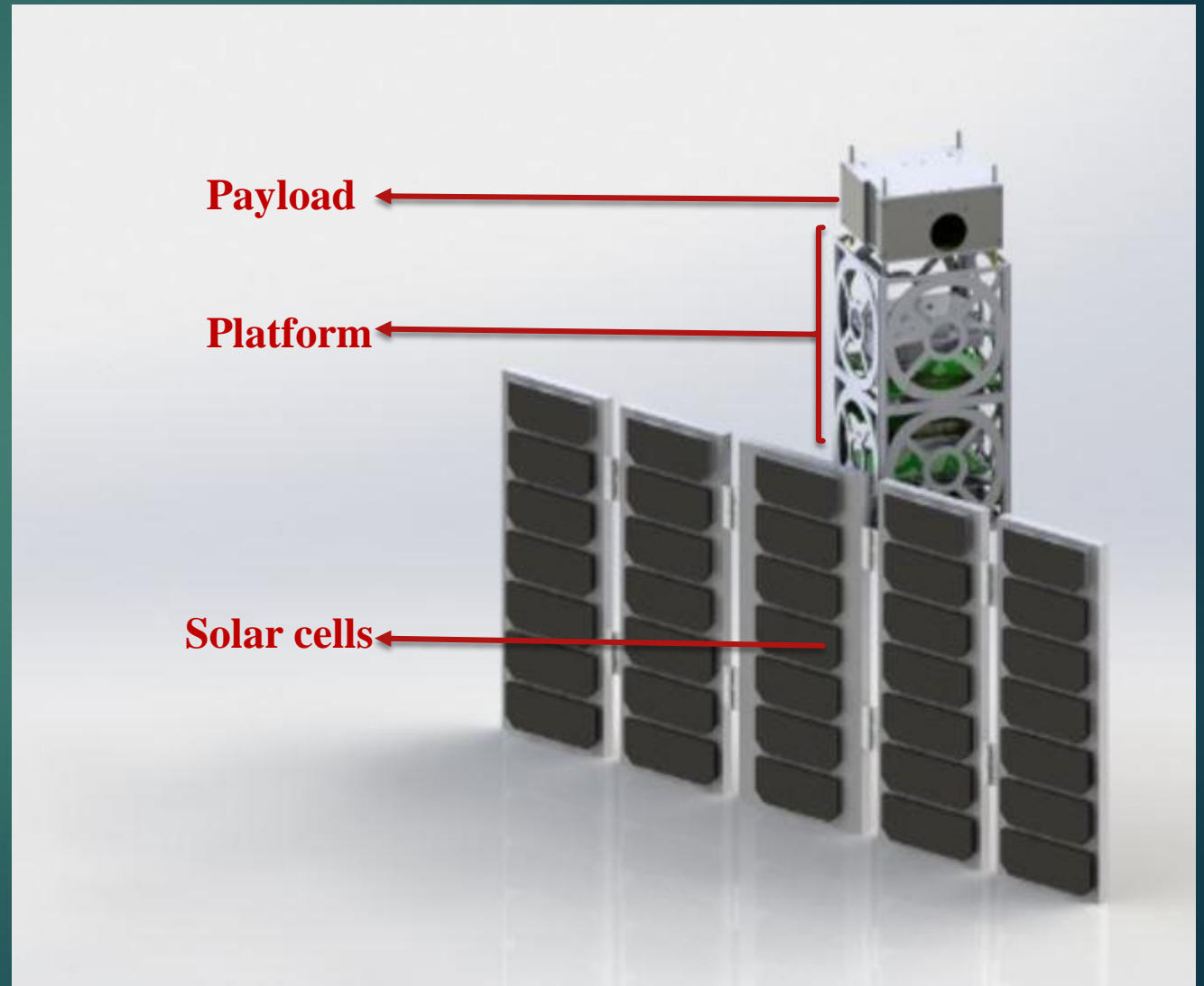
CubeSat system design

Here is the CubeSat first sketch. Totally this CubeSat contains three sections include payload, platform, solar cells.

The payload is proposed as a THz radio meter with center frequency 165GHz range. We have chosen this center frequency because the water vapor has strong signal strength at this frequency. This payload assists us to monitor cloud formations and subsequently, the tropical cyclones formation.

The platform contains subsystems to support the mission. We already have done the analysis such as link budget, mass budget, power budget etc. the platforms contains S-band for payload data transmission, UHF for Up & Down links, ARM based microcontroller for OBDH, 3-axis attitude control system with three magnetorquers and 45Wh battery capacity, all support the payload.

We consider a Maximum power tracker mechanism by ordering a connected servo motor with solar cells package. We consider this because the payload requires to point earth's atmosphere but the CubeSat power consumption is higher than we can consider a fixed body mounted solar cells to generate power.



Follows is CubeSat scenario, as it has been illustrated we can see that there are defined three targets. Those targets have been chosen relative to zones with high risk tropical cyclones capacity. Countries such as China, India, Bangladesh hit by tropical cyclones before. therefore, we chose targets near those countries. Meanwhile, there are zones near Australia and United state which is in the risked of tropical cyclones. On top right-hand the figure, we can see how THz radio meter will operate for presenting a tropical formation process. In fact, millimeter waves with its tiny wavelength can penetrate into clouds and detect the cloud will precipitate or as ice participate inside a storm. We suggest for better data accuracy utilize constellation, it enhances the covered areas and better real time data link.

