

# Integration of LEDs as Alternative Communication System for CubeSats

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## Objectives:

- This research seeks to demonstrate the viability of LED payload for CubeSat as alternative communication system and optical tracking.
- Design and develop a 0.5U (0.5 cm x 0.5 cm) Light Emitting Diodes (LEDs) payload using COTS components for integration with the CubeSat developed by NPS.
- Design and develop a photodiode payload for the ground station to decode messages transmitted from the LED payload.



Figure 1. Operational Concept

## Results: Validation of optical link budget analysis

- $Link\ Margin\ (dB) = P_T - (P_R + G_R - L_a - L_e - L_{geom})$
- Irregular measurement as distance increase and affected by foggy weather condition
- Required at least five LEDs to achieve optical link between CubeSat in LEO @ 500 km altitude and ground stations (visibility > 10km)

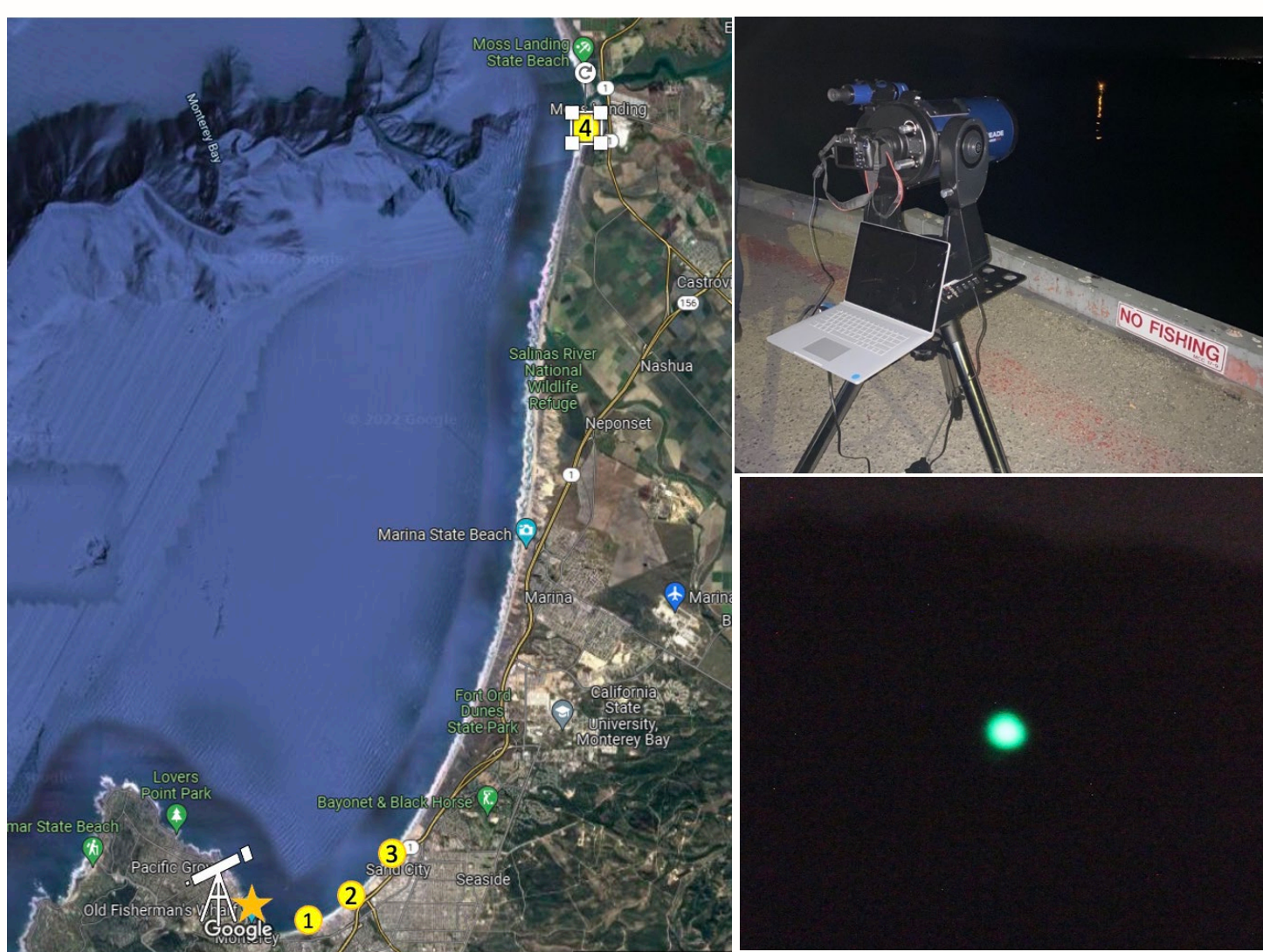


Figure 2. Test Locations and Setup

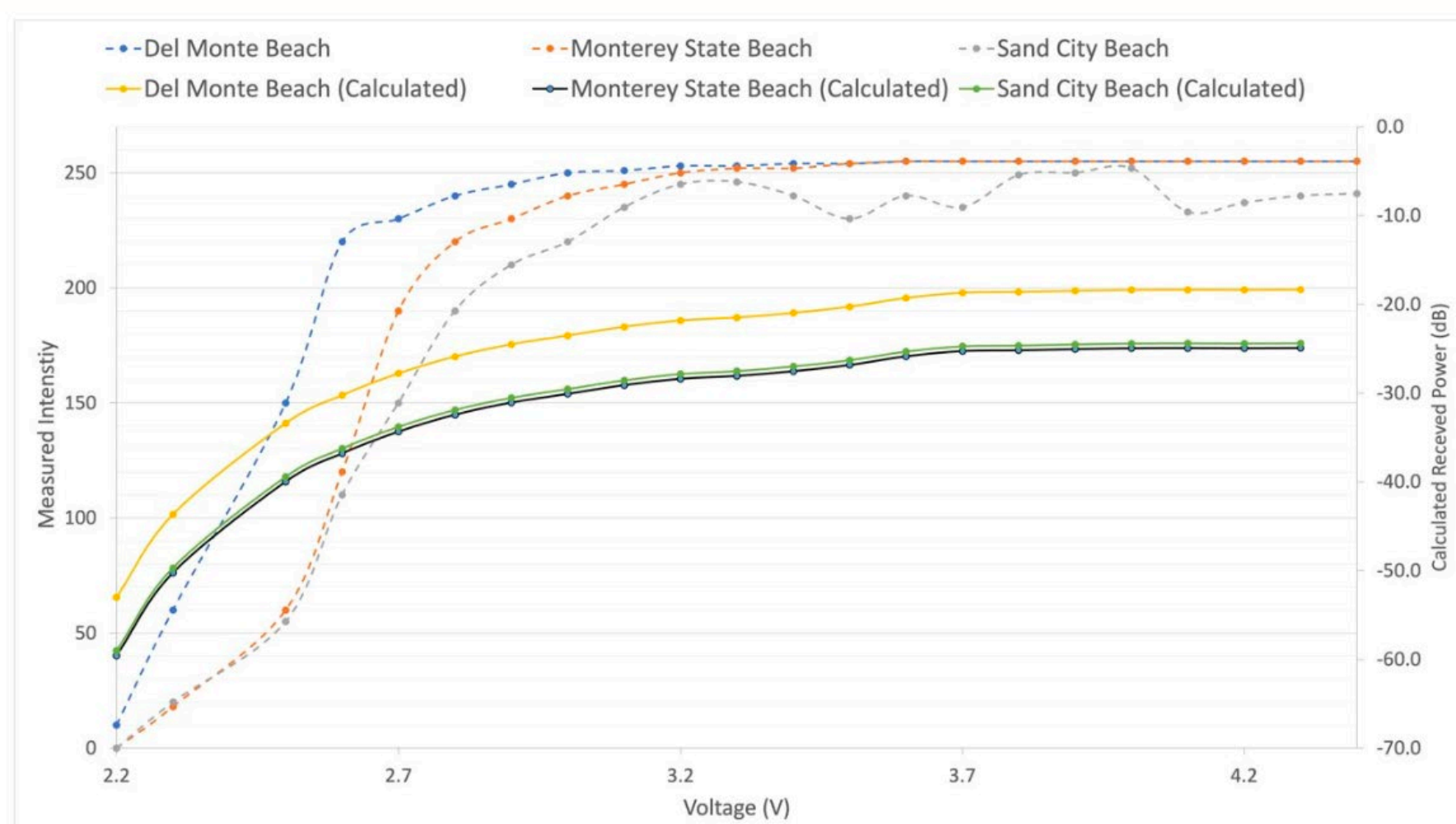


Figure 3. Correlation between theoretical and measured data

## Results: Message encoding and decoding

- Able to achieve data rate of 10 bits per second (bps) for short period (~10 messages)
- Existing design is an open loop communication system as LED and photodiode payload have individual internal clock
- Closed-loop system can be implemented by (1) adding a synchronisation LED in different wavelength, or (2) using GPS time

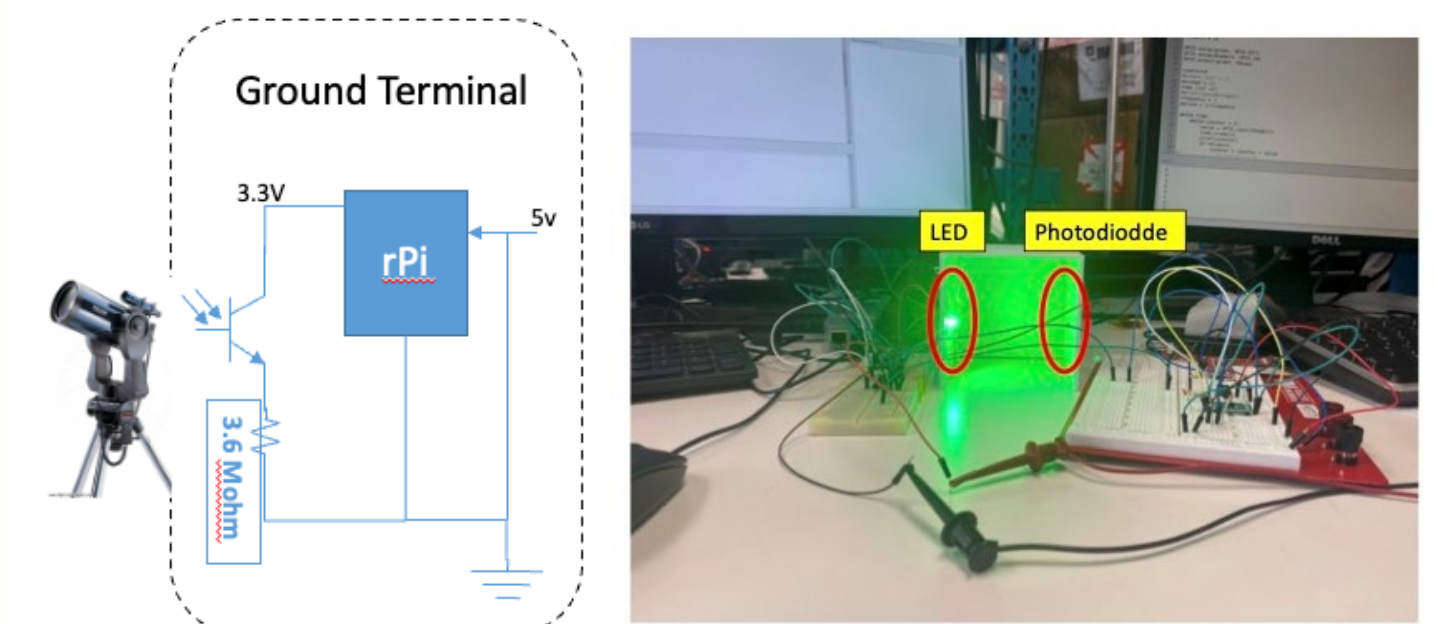


Figure 4. Photodiode payload and Test Setup

56	00110101
b'5'	00110110
['0', '0', '1', '1', '0', '1', '0', '1']	56
b'6'	['56']
['0', '0', '1', '1', '0', '1', '1', '0']	00110101
55	00110101
b'5'	55
['0', '0', '1', '1', '0', '1', '0', '1']	['56', '55']
b'5'	00110101
['0', '0', '1', '1', '0', '1', '0', '1']	00110101
55	55
b'5'	['56', '55', '55']
['0', '0', '1', '1', '0', '1', '0', '1']	

Figure 5. Encoded Message (LED Payload) and Decoded Message (Photodiode payload)

## Benefits of Research:

- Future research student could the optical link analysis using different components or configuration
- Potential operational application:
- (1) Optical tracking of CubeSat and backup communication system to RF communication
- (2) Optical communication between satellites (less susceptible to interference or jamming)