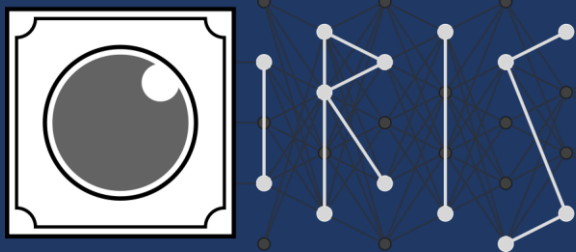


Internet of Things (IoT) Payload in IRIS CubeSat

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I . Introduction

IRIS-A is one of CubeSats in IRIS project which is designed, and still developing by NCKU, Taiwan. The mission objective of it is to demonstrate Internet of Things (IoT) communication technology in space. Techniques are developed to compensate for the significant attenuation and Doppler shift in the mission so that ground measurements can be uplinked, stored, and forwarded. To achieve this, there would need the following devices to cooperate in IoT payload, including the LoRa receiver, a reference clock board, a chip-scale atomic clock (CSAC) and a GPS receiver (GPSR).

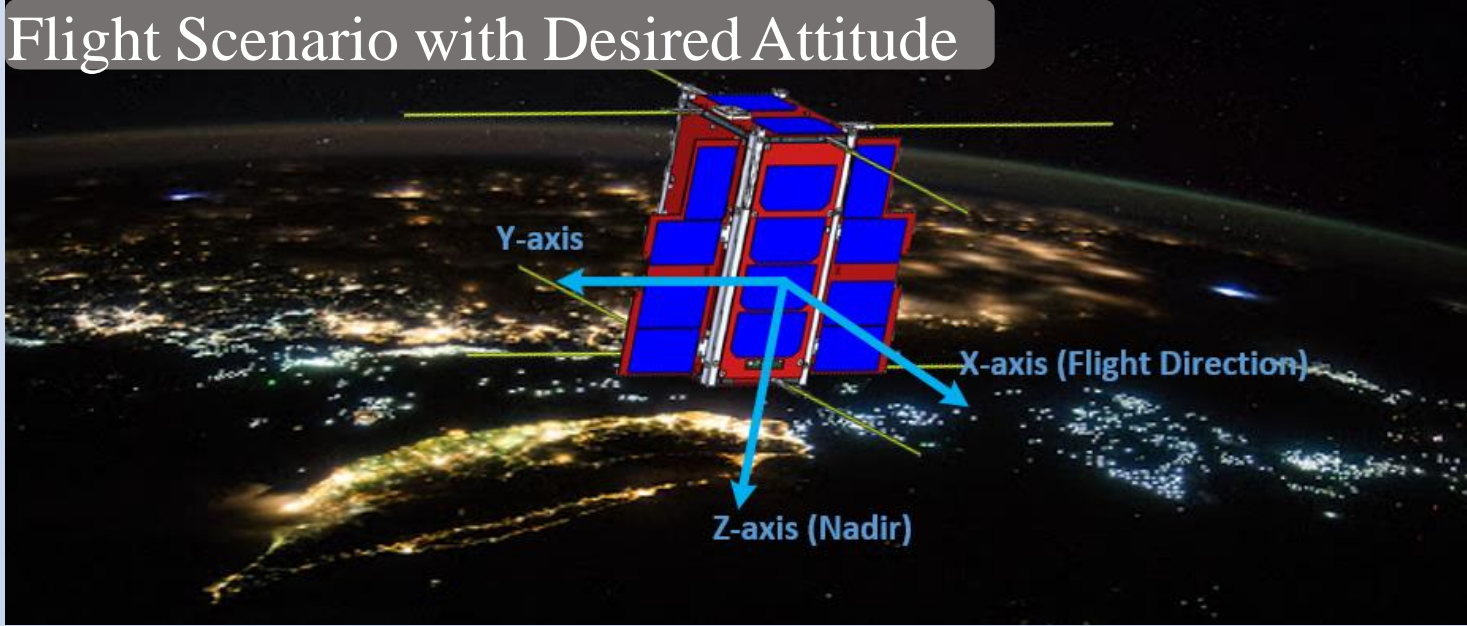
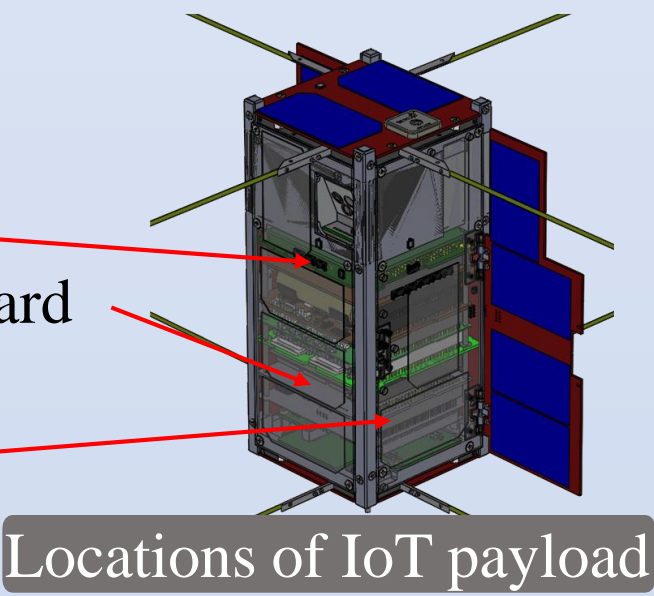
II. Overview of IRIS-A CubeSat

Subsystems

- Antenna
- ADCS
- COM
- OBDH
- EPS
- Camera
- Motherboard
- Daughterboard
- GPS Antenna

IoT Payload

- GPS Receiver
- Reference Clock Board
 - CSAC
- LoRa Receiver



III. IoT Payload

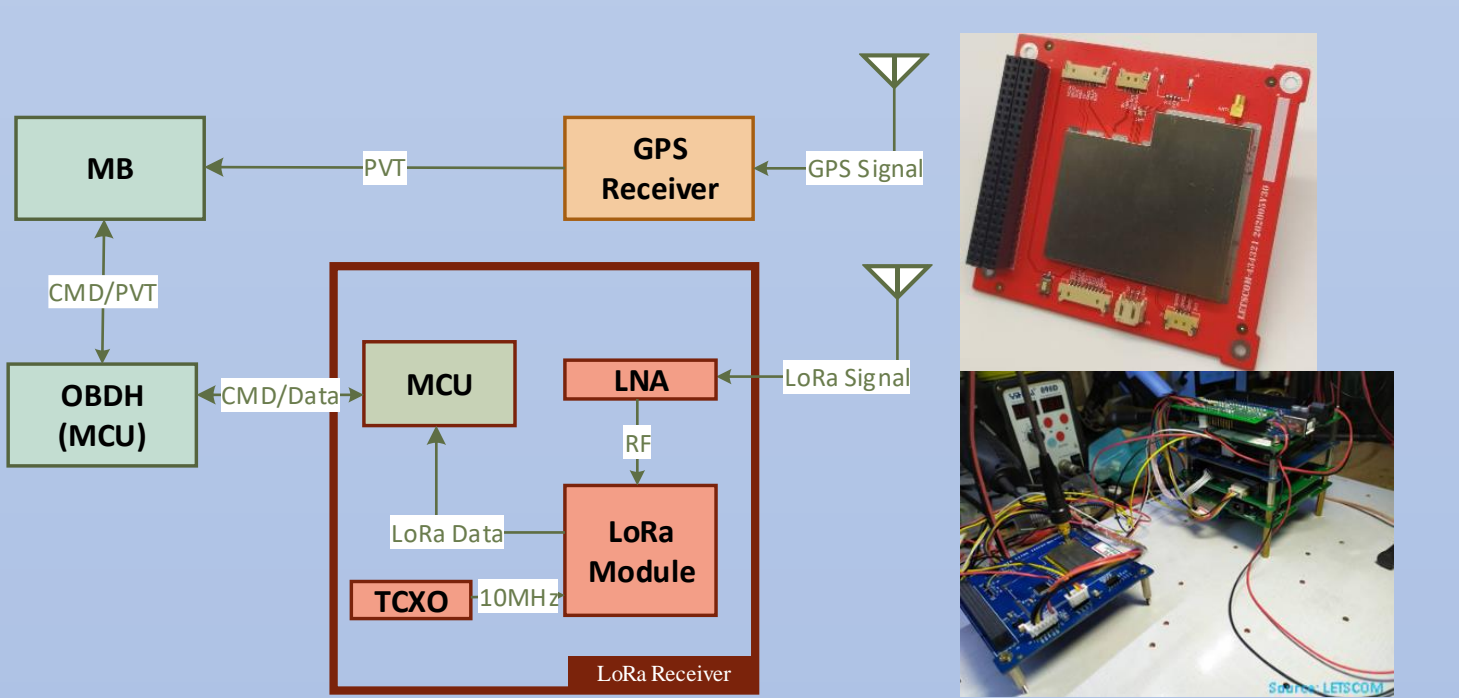
A. LoRa Receiver & S&F Mission

LoRa is a spread spectrum modulation (SSM) scheme that uses the chirp spread spectrum (CSS) technique where the information is encoded by a wideband chirp signal in which the frequency linearly increases or decreases with time.

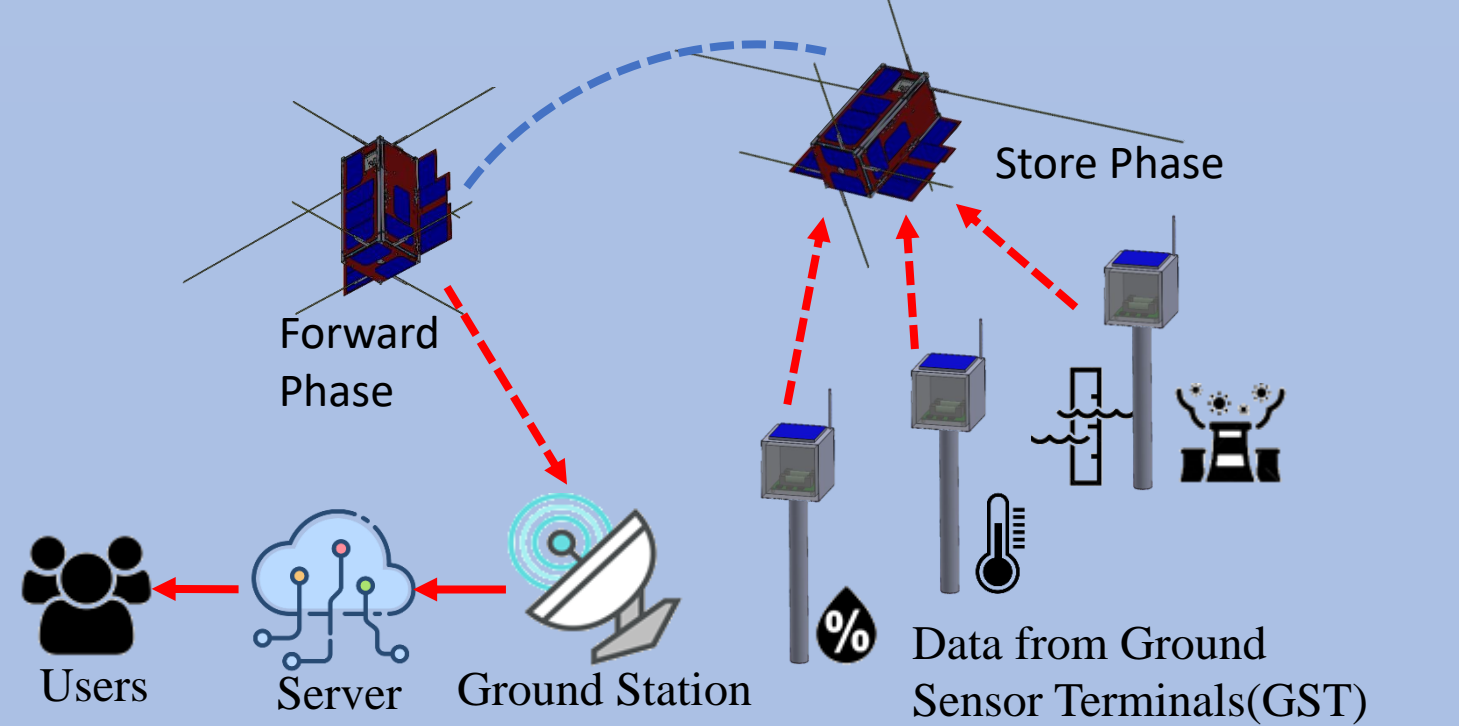
Characteristics

- Long Range
- Lower Bandwidth
- Low Power
- Lower Data Rate

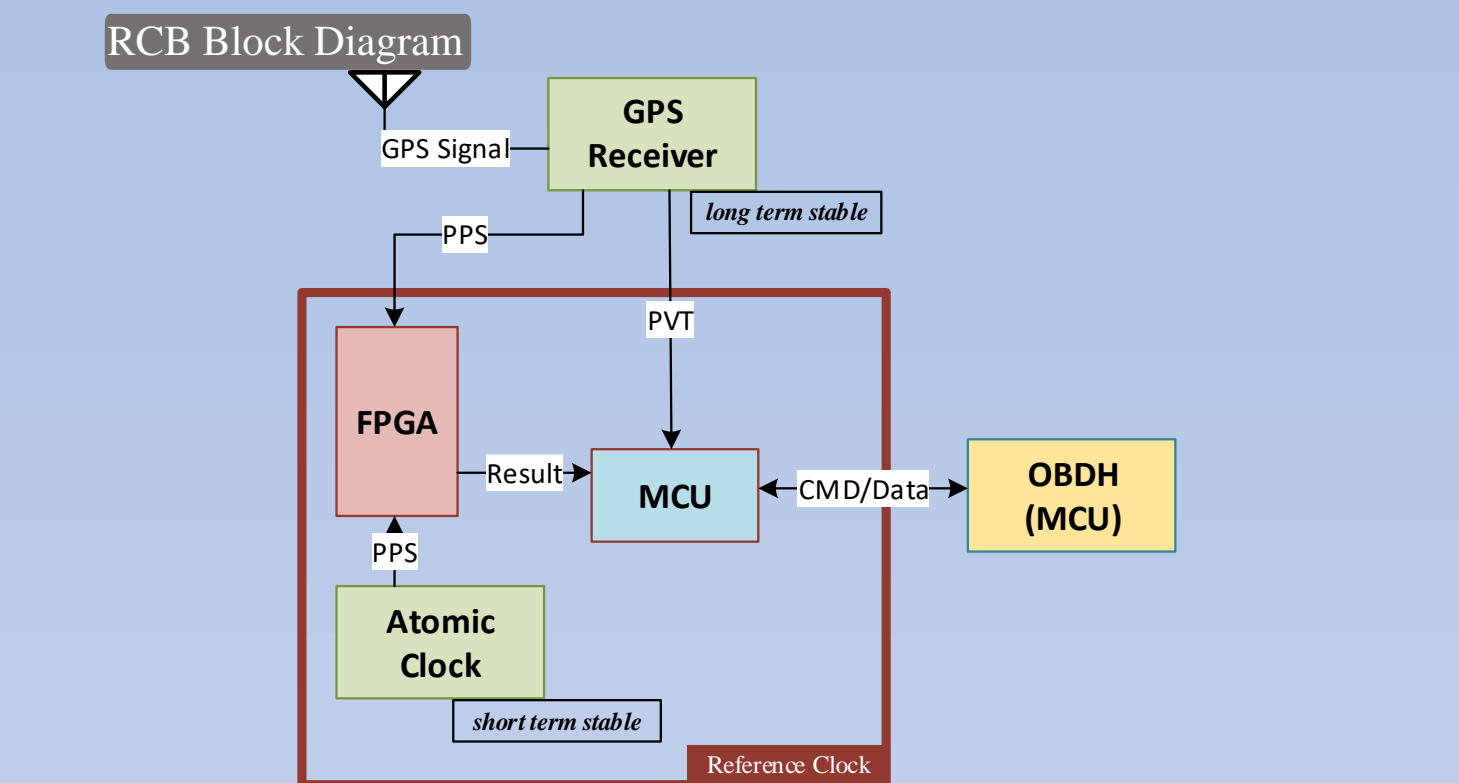
LoRa Receiver System Block Diagram



• Store & Forward (S&F) Mission



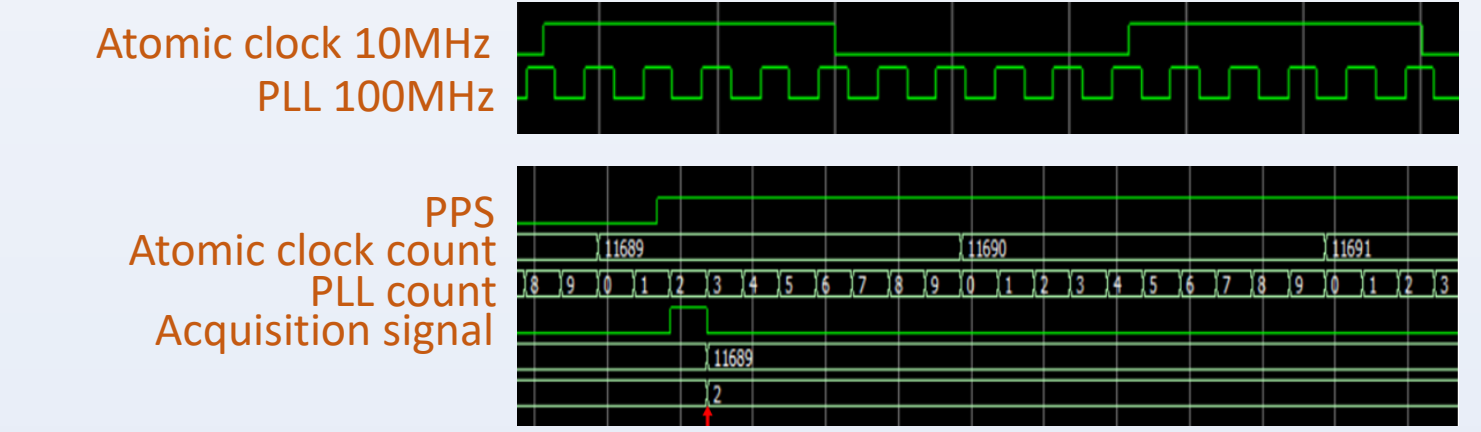
B. Reference Clock Board



a) GPSR Performance Demonstration

- Time to First Fix (TTFF)
- Receiver Sensitivity

b) CSAC Performance Analysis

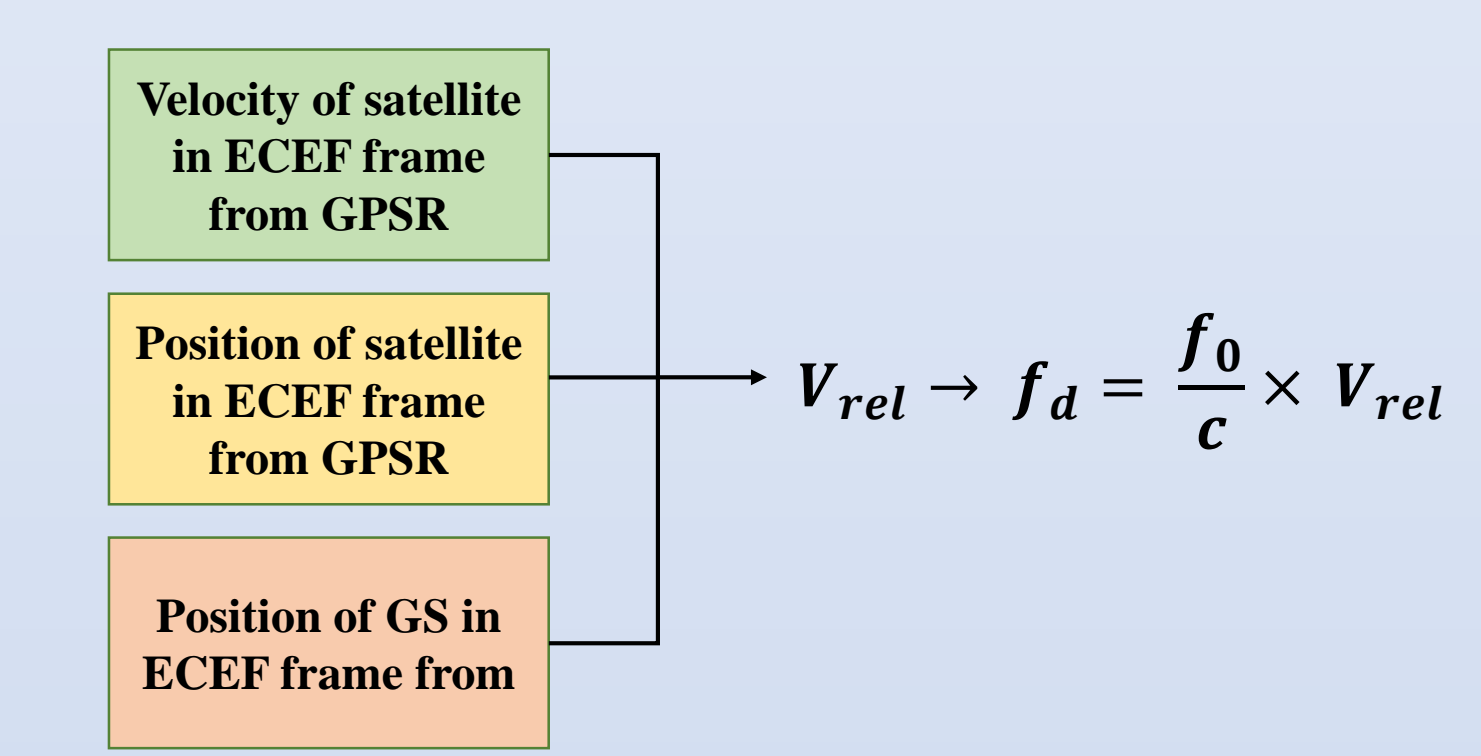


- PPS count = atomic clock count×10 + PLL count
- PPS differential(n) = PPS count - atomic clock per sec (constant)
- PPS phase differential (n) = PPS differential(n) - PPS differential(n-1)

c) Real Time Clock Function

- Function delay
- Transmission delay

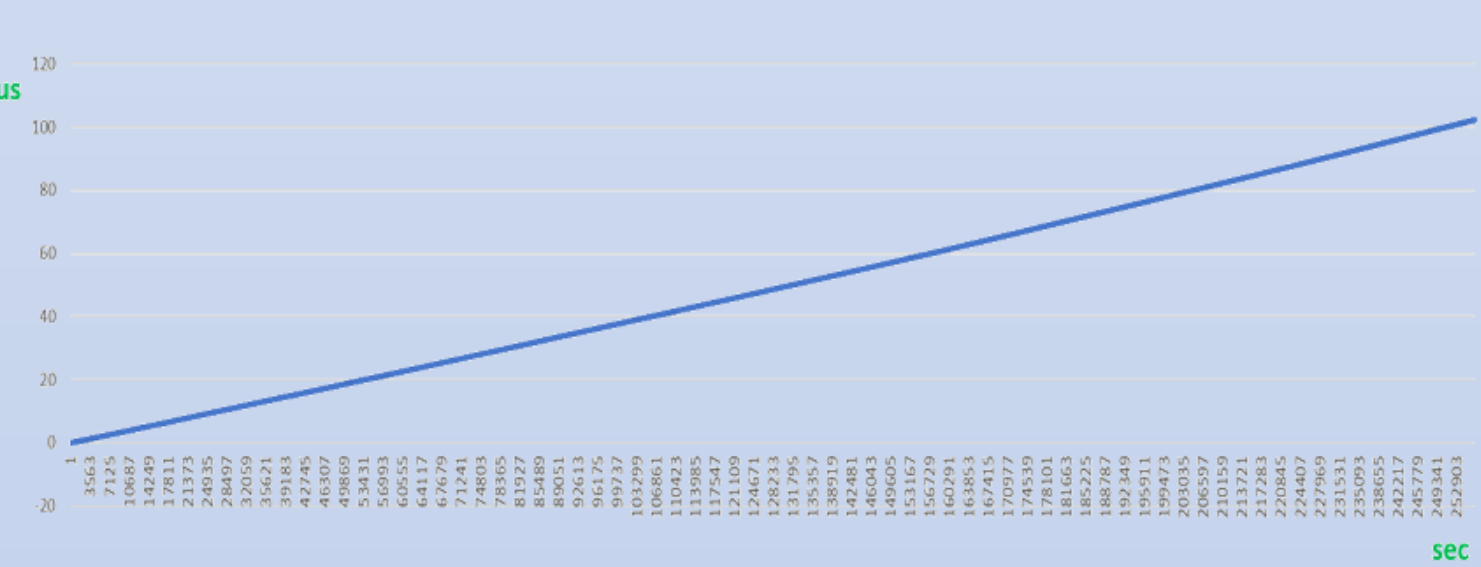
d) Doppler Estimation



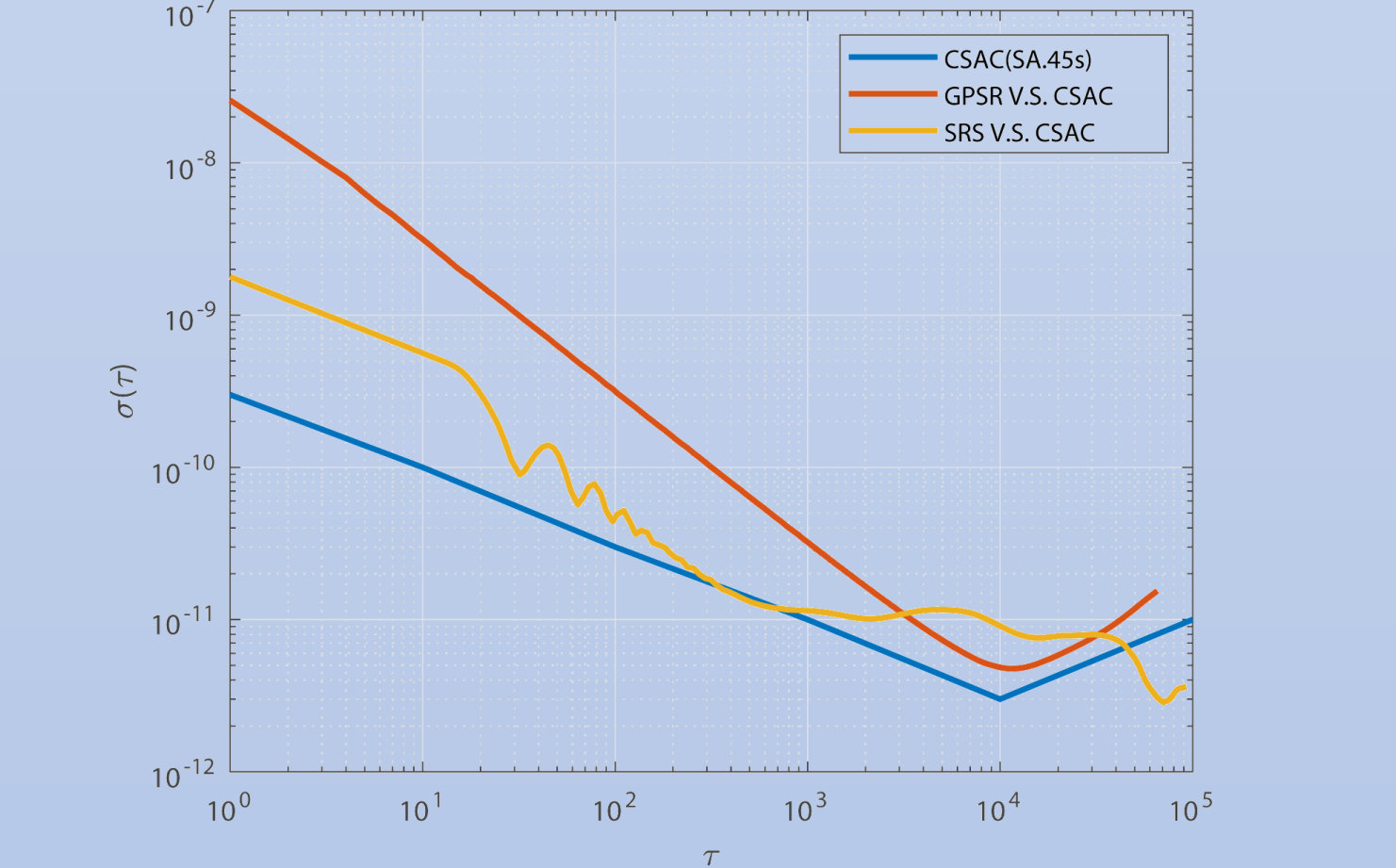
IV. Experiment & Analysis

■ Clock Performance Analysis

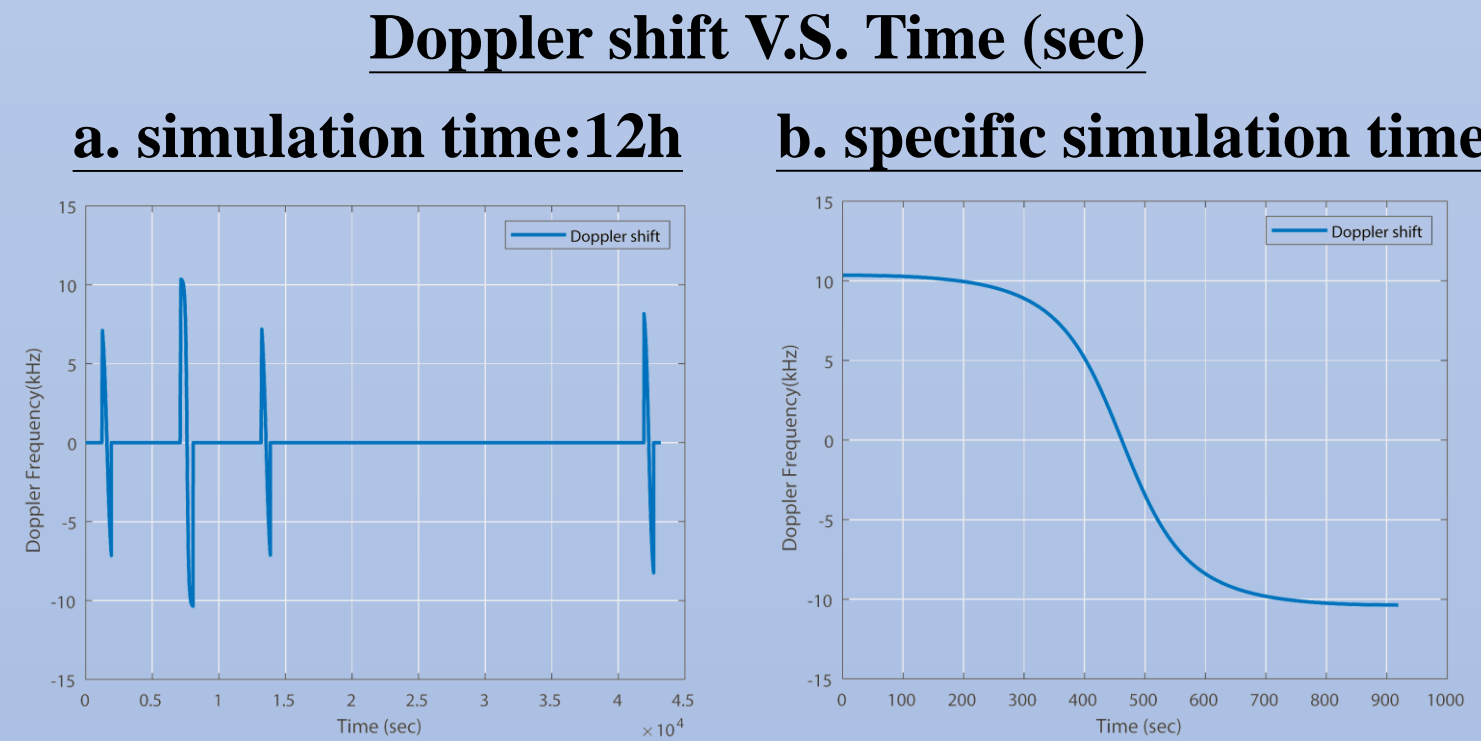
- Experiment time: 2 day 23 hour 14 min 5 sec
- Average phase accumulation: **1.44 μs/hour**



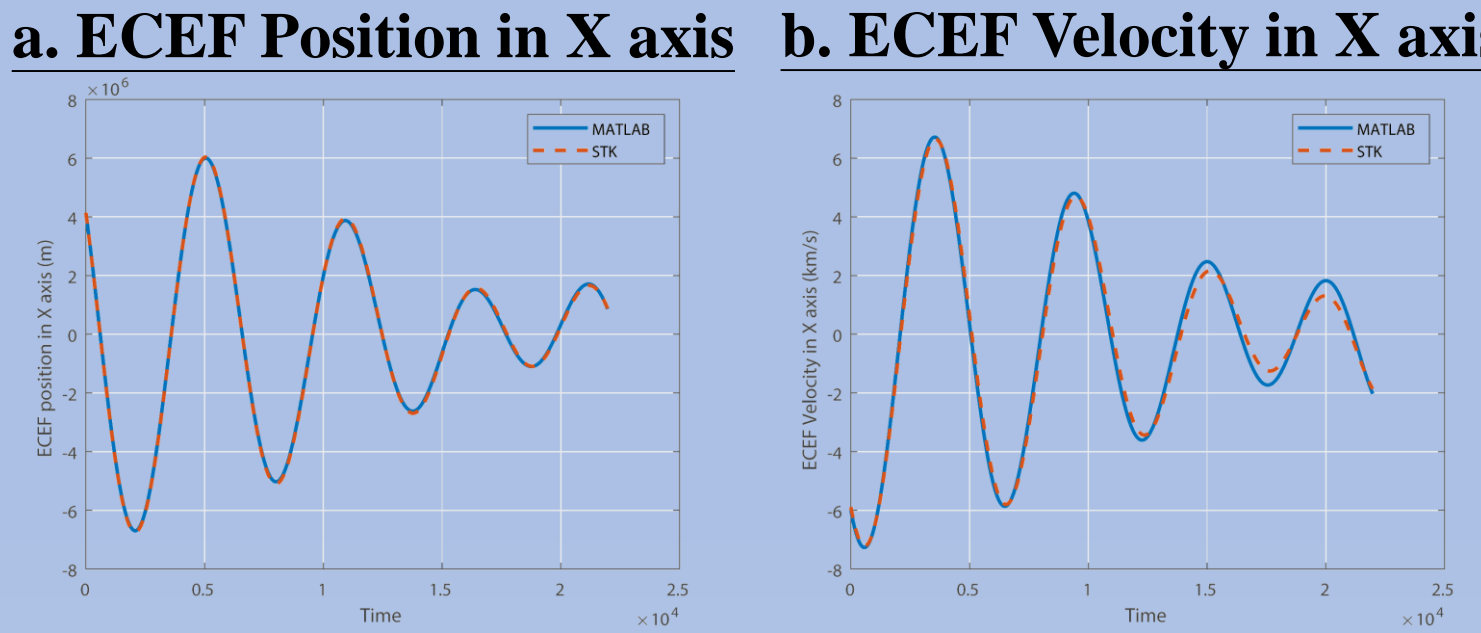
Allan Deviation



■ Doppler Estimation



Matlab V.S. STK



V. Conclusions & Future Work

➤ LoRa Receiver & S&F Mission

- LoRa module & GST are in progress.
- Communication experiments and validation of S&F mission

➤ Reference Clock Board

- Clock performance analysis under different temperature
- Compensation of Doppler effect at the satellite side