SATELLITE NAVIGATION
Workbook 4:
GPS Receiver Acquisition and Tracking Using C/A-Code

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Teaching material prepared by

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GPS Receiver Acquisition and Tracking Using C/A-Code

Laboratory experience overview

Università degli Studi di Padova

Main Objective

- Use RINEX and an almanac file to model the GPS constellation and generate a multi-satellite baseband waveform. Simulate the satellite scenario to get relative positions of satellites with respect to the modeled receiver. Impair the generated baseband signal with Doppler shift, delay, and noise.

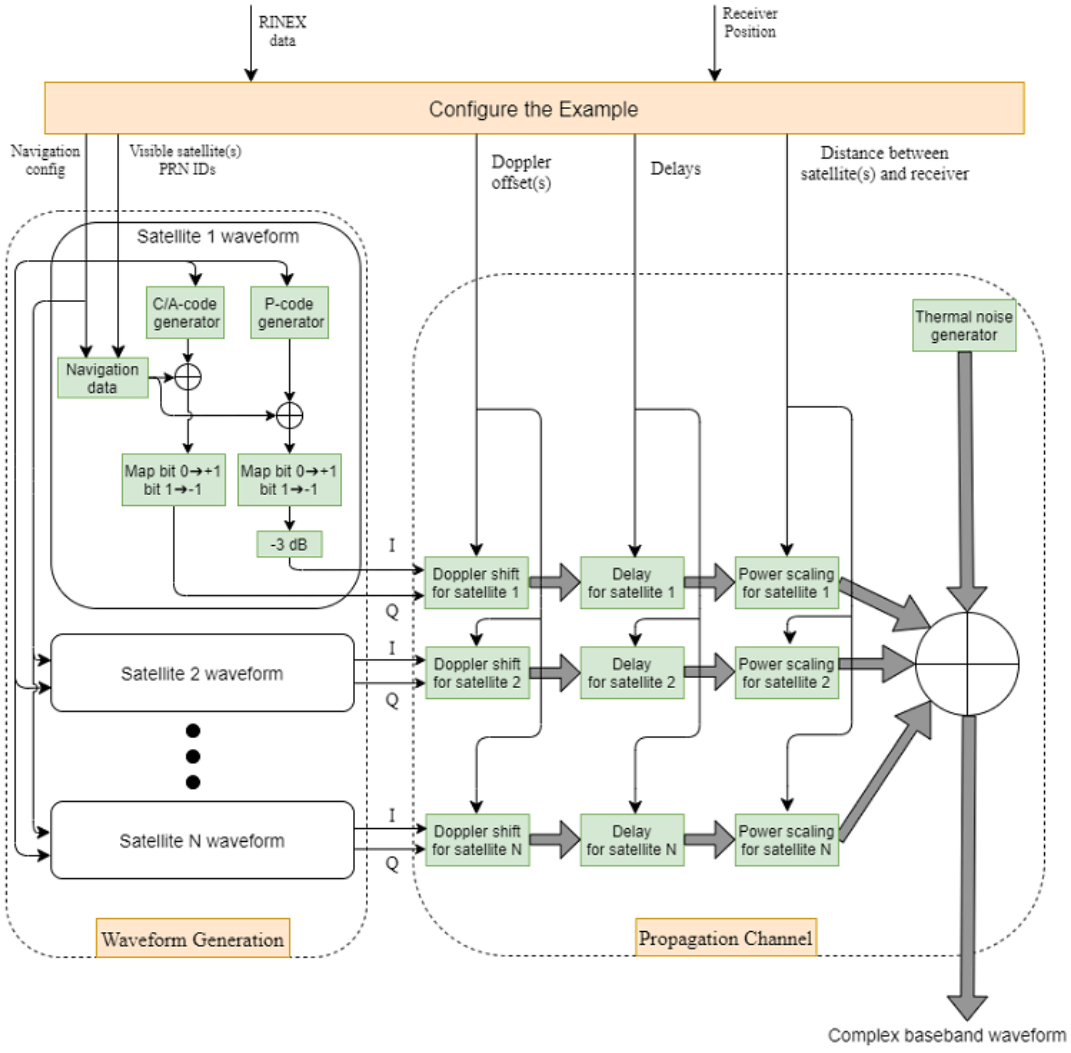
Software

- Matlab (R2023a or later) with Navigation Toolbox and Satellite Communication Toolbox.
- Matlab documentation: https://it.mathworks.com/help/satcom/ug/end-to-end-gps-legacy-navigation-receiver-using-cacode.html

GPS Receiver Acquisition and Tracking Using C/A-Code

GPS waveform generation

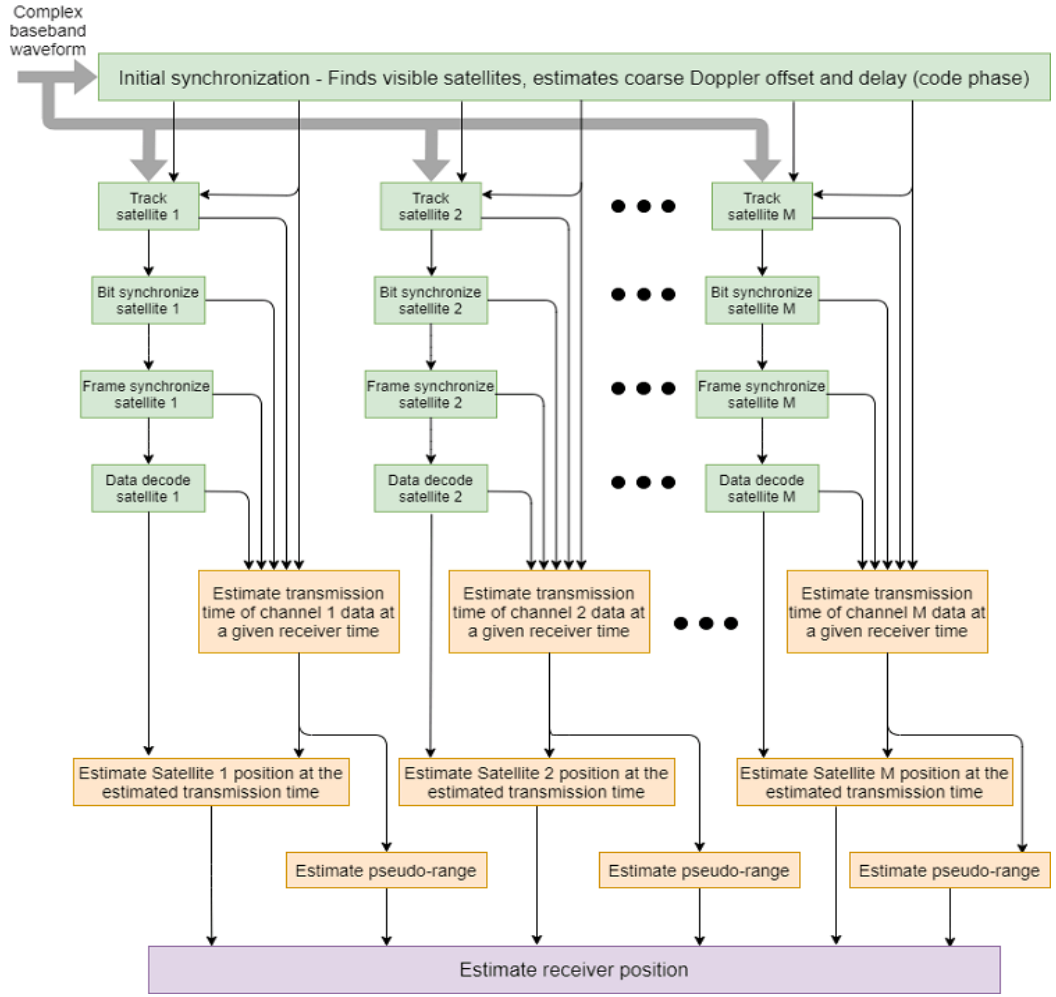
- Start with a RINEX file.
- Use rinexread to read the file.
- Provide input to satelliteScenario to simulate the GPS constellation.
- Calculate Doppler shift, delay, and signal path loss for each visible satellite to the receiver.
- Generate data bits according to the IS-GPS-200 standard using ephemeris and clock/almanac data.
- Generate coarse acquisition code (C/A-code) and precision code (P-code) for visible satellites.
- Place P-code on the in-phase (I) branch and C/A-code on the quadrature-phase (Q) branch of the baseband waveform.
- Attenuate the I-branch signal by 3 dB as specified in IS-GPS-200.
- Generate the baseband waveform for all visible satellites.
- Pass the baseband waveform through the propagation channel.
- Model propagation channel characteristics such as Doppler shift, delay, and scaling signal power based on propagation path loss.
- Add thermal noise to the composite signal.
- Provide the noisy signal as input to the GPS receiver.



GPS Receiver Acquisition and Tracking Using C/A-Code

Initial synchronization and tracking

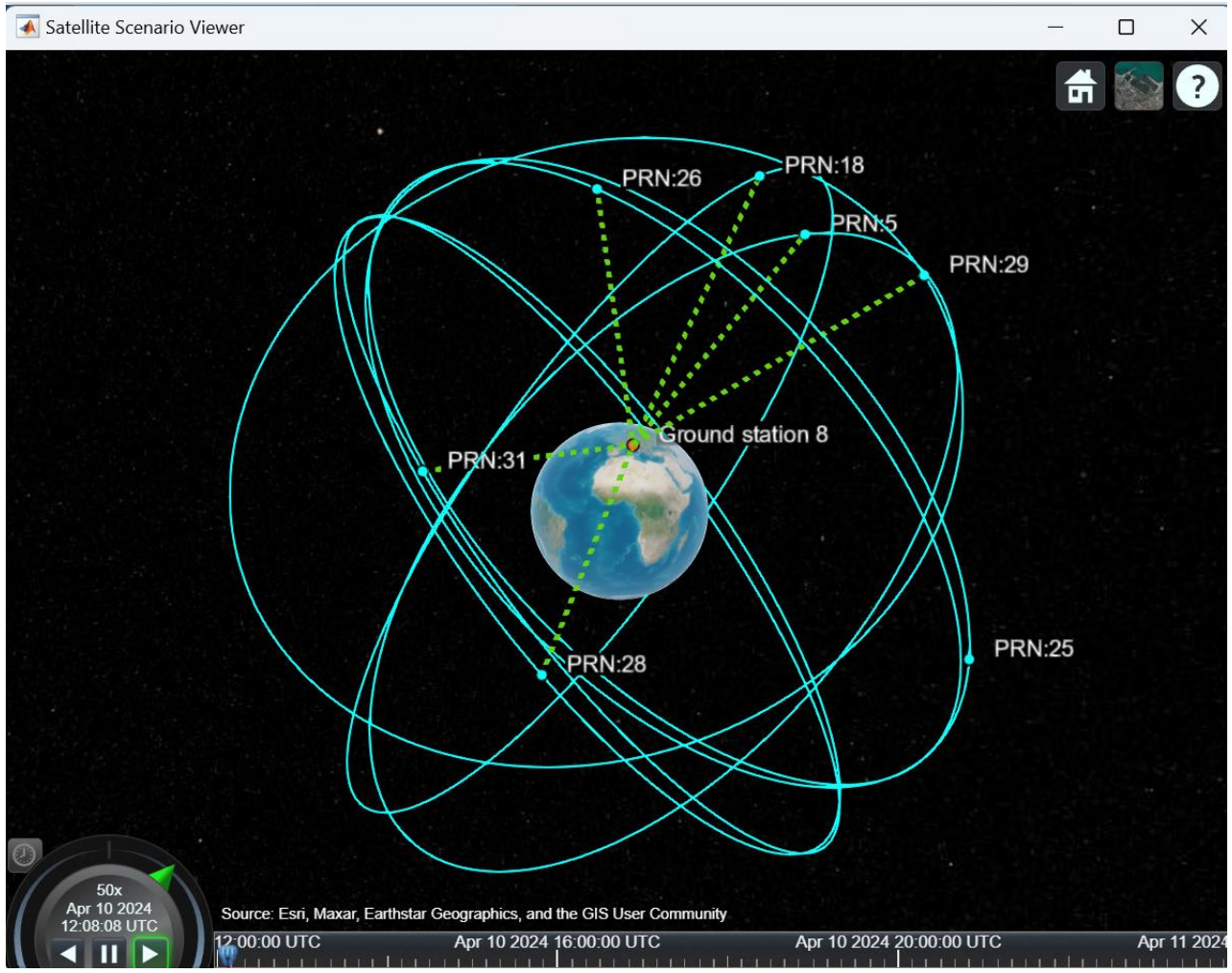
- Process the complex baseband waveform through a GPS receiver.
- The receiver consists of an initial synchronization module that detects visible satellites.
- Estimate coarse Doppler offset and delay values for visible satellites.
- Create separate receiver channels for each detected satellite.
- Each receiver channel performs tracking, bit synchronization, frame synchronization, data decoding, transmitted time estimation, satellite position estimation, and pseudo-ranges computation.
- Estimate satellite positions using decoded ephemeris data.
- Estimate distances from satellites to the receiver by computing propagation time and multiplying it with the speed of light.
- Estimate transmission time of each satellite signal by computing the difference between receiver time and transmission time.



GPS Receiver Acquisition and Tracking Using C/A-Code

Laboratory experience main objectives

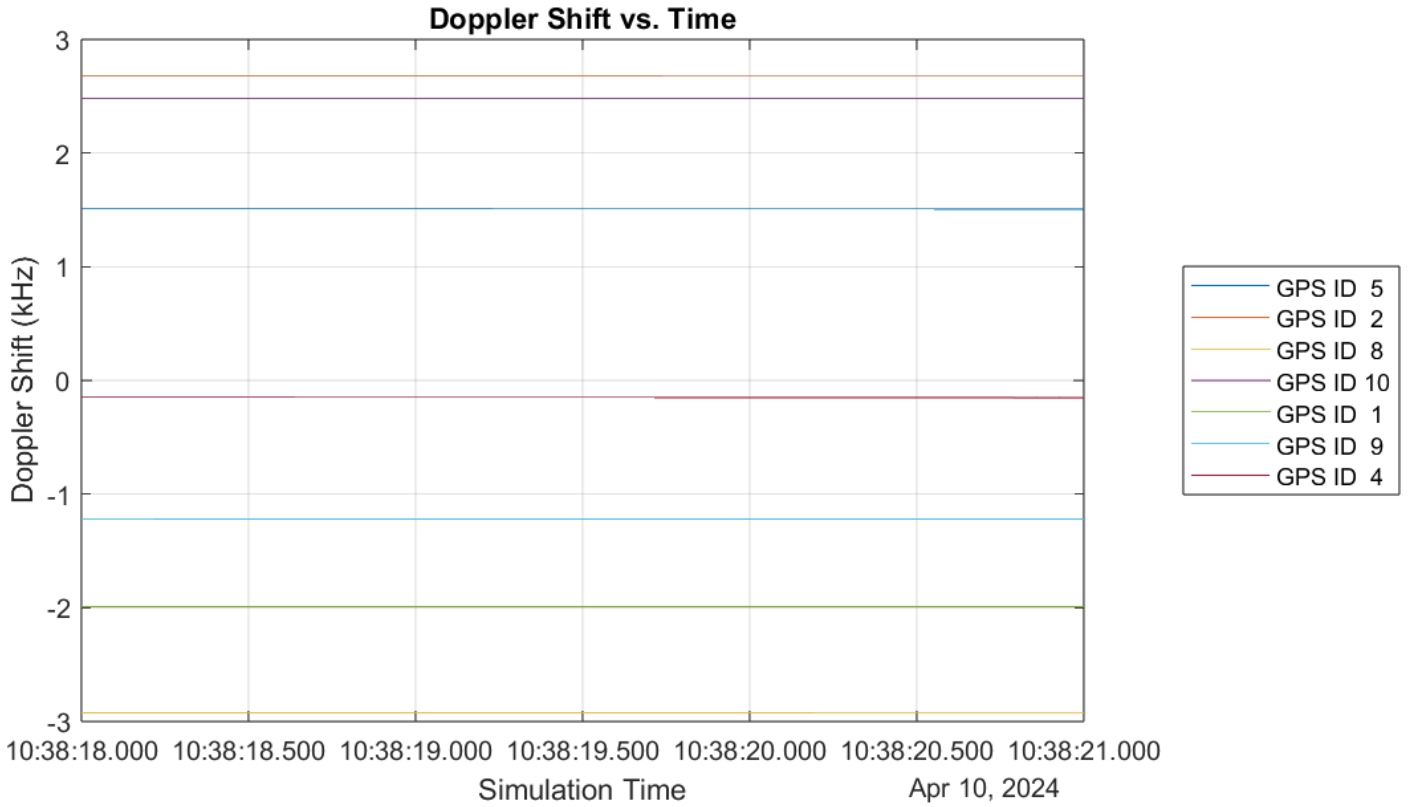
- Set up the satellite scenario based the RINEX file collected on 10 April 2024 and the corresponding receiver position.
- Download the SEM almanac file from NAVCEN website and parse it. Specify the date for which the file is to be downloaded.



GPS Receiver Acquisition and Tracking Using C/A-Code

Laboratory experience main objectives

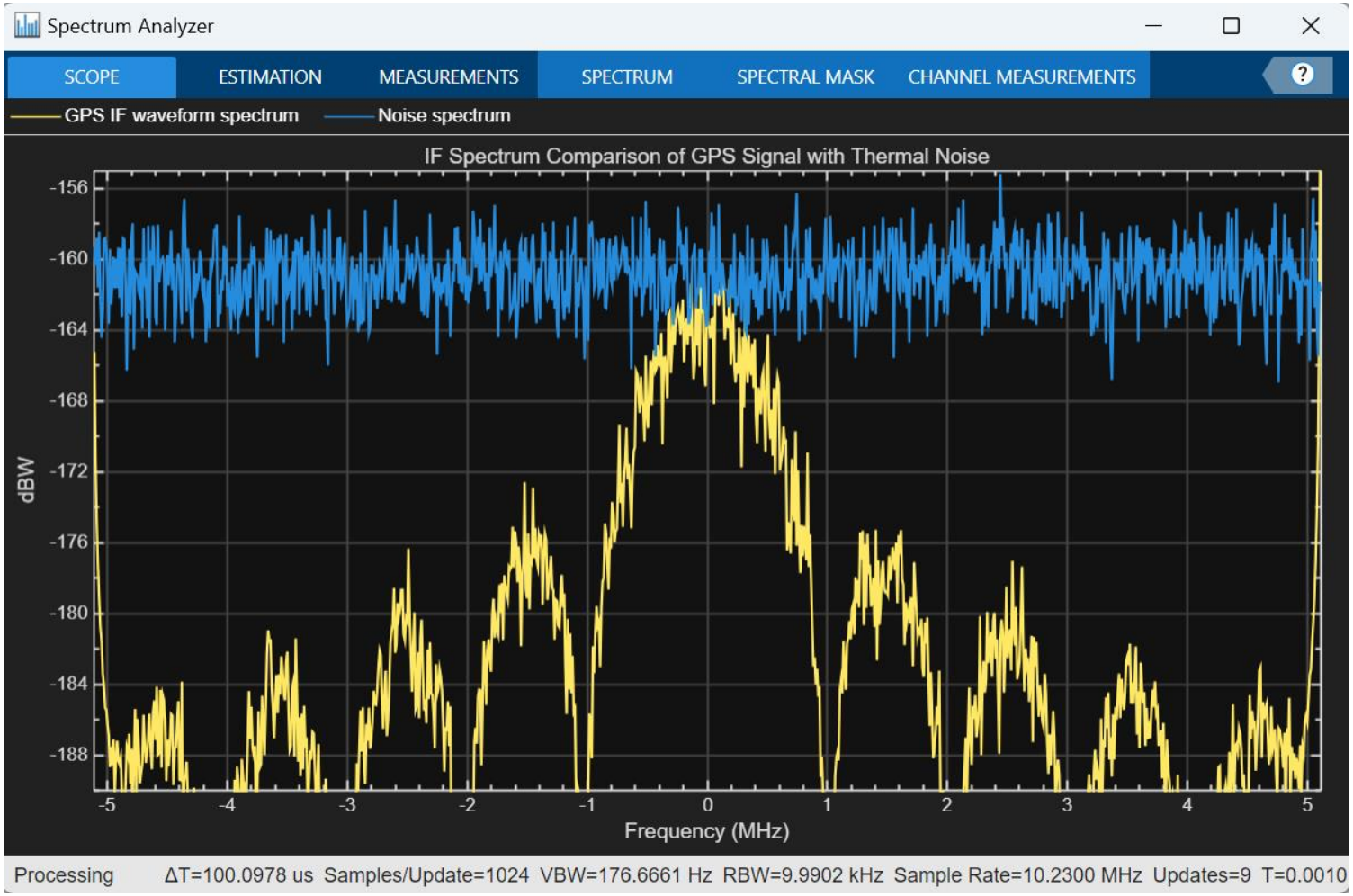
- Display Doppler shift over time for all the visible satellites.
- Display the distance between satellites and receiver over time.
- Display the C/A code of one of the visible satellites.



GPS Receiver Acquisition and Tracking Using C/A-Code

Laboratory experience main objectives

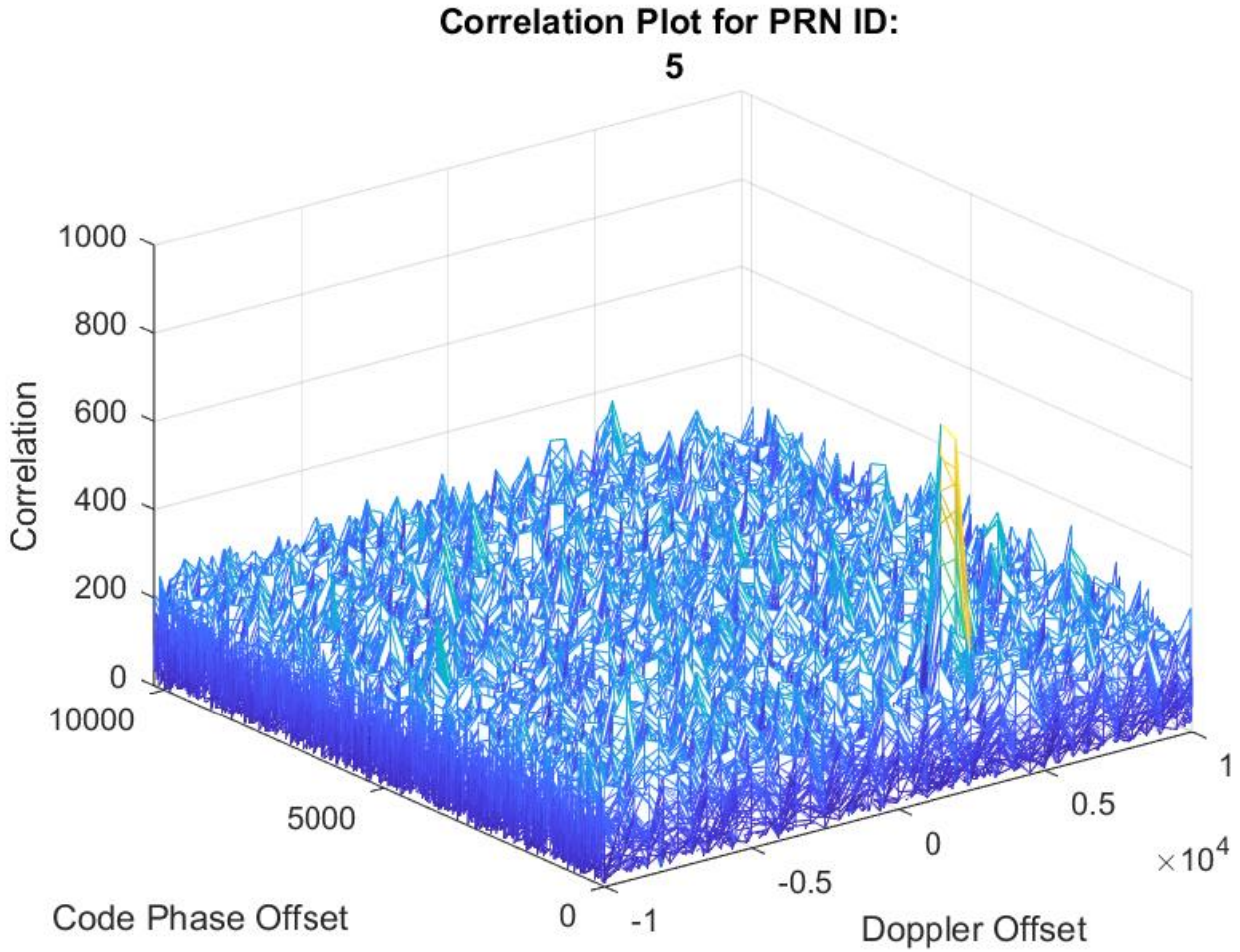
- Compare the GPS IF waveform spectrum with the Noise spectrum.



GPS Receiver Acquisition and Tracking Using C/A-Code

Laboratory experience main objectives

- Display the correlation plot for one of the satellites.



GPS Receiver Acquisition and Tracking Using C/A-Code

Laboratory experience main objectives

- Display the tracking loop results (PLL, FLL, DLL).