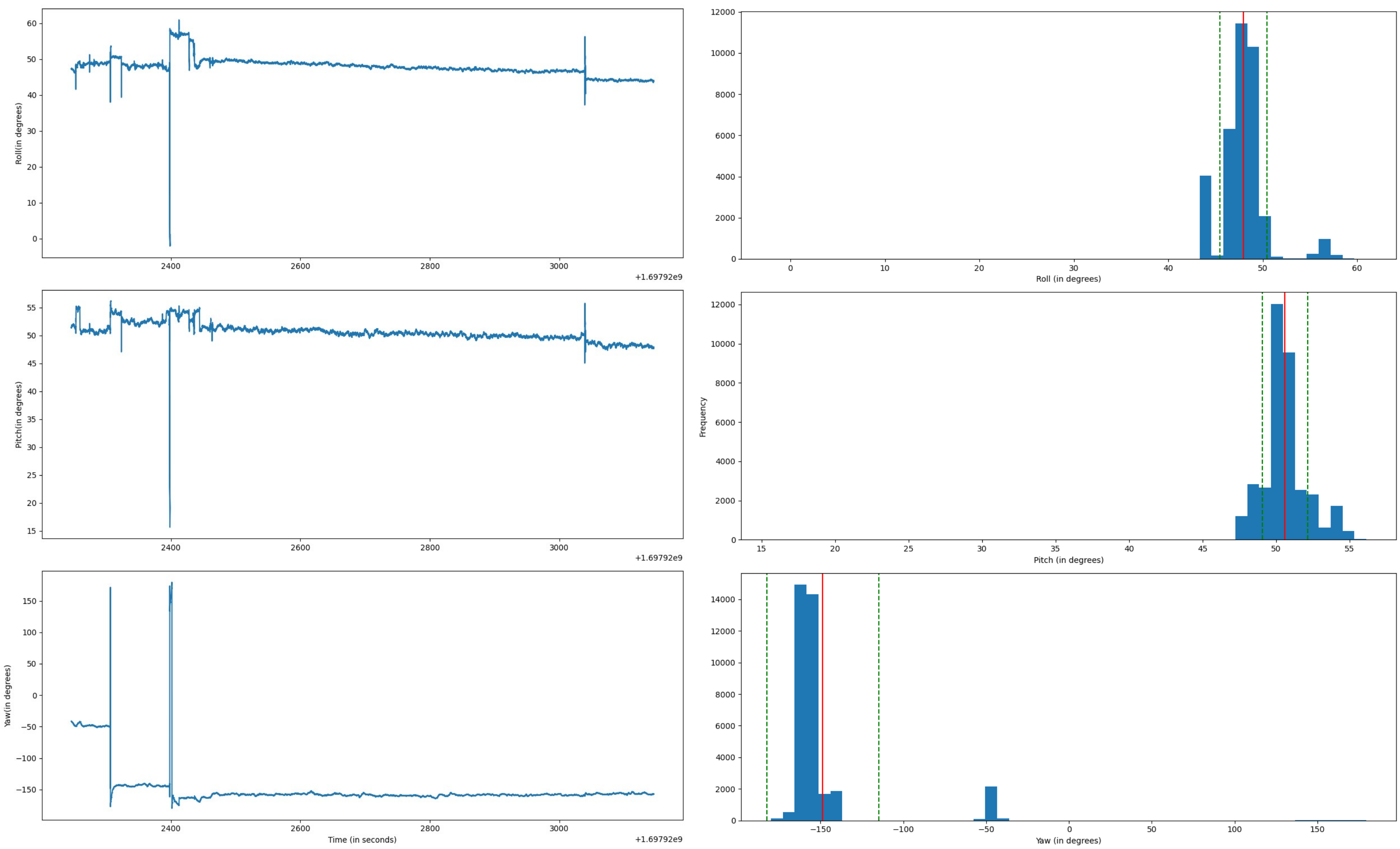
REPORT

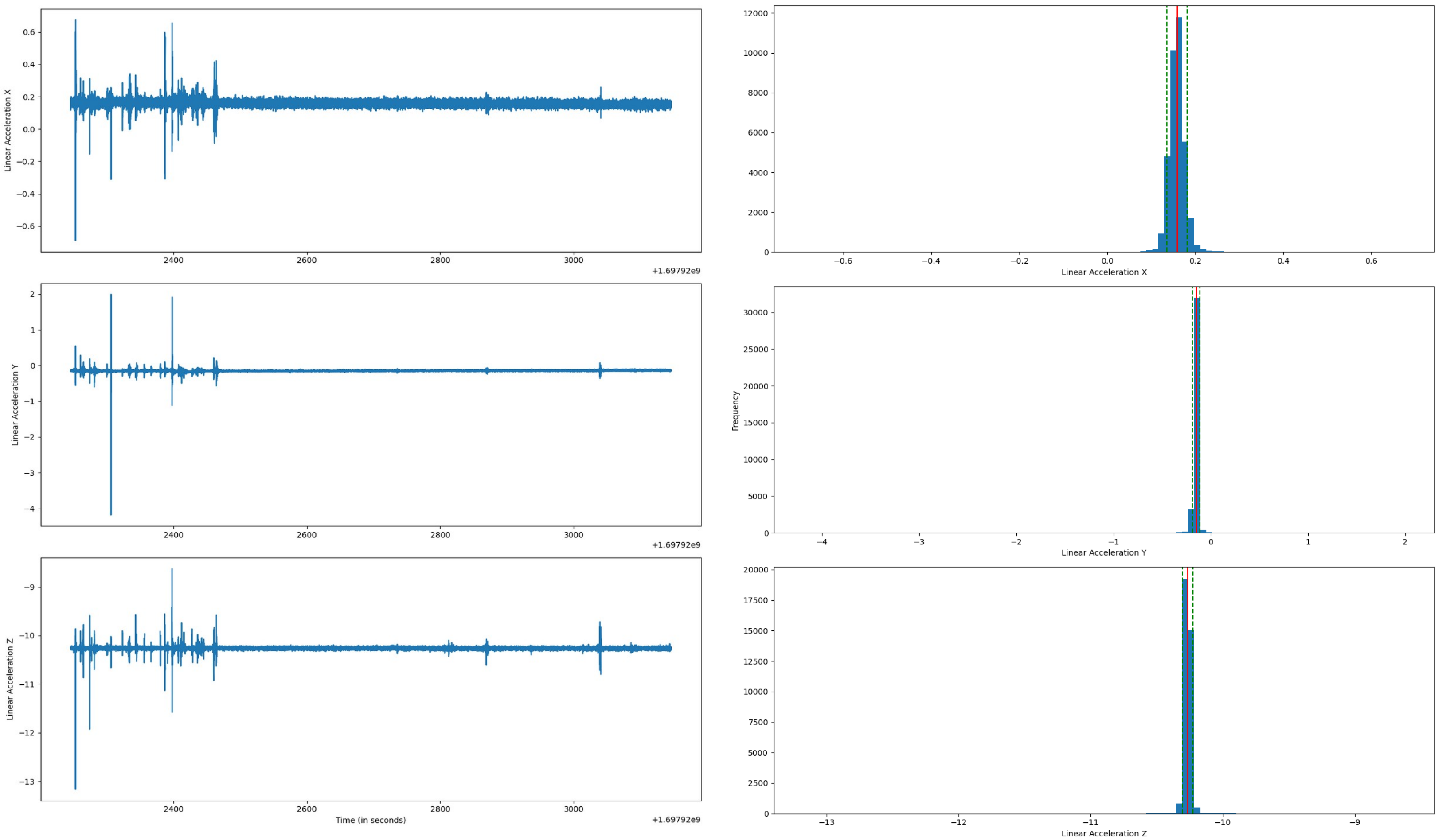
ABSTRACT: An inertial measurement unit (IMU) is an electronic device that measures and reports a body's specific forces, angular rate, and sometimes the orientation of the body, using a combination of accelerometer, gyrometer, and sometimes magnetometer.

INDIVIDUAL DATA:
a. Orientation plot.

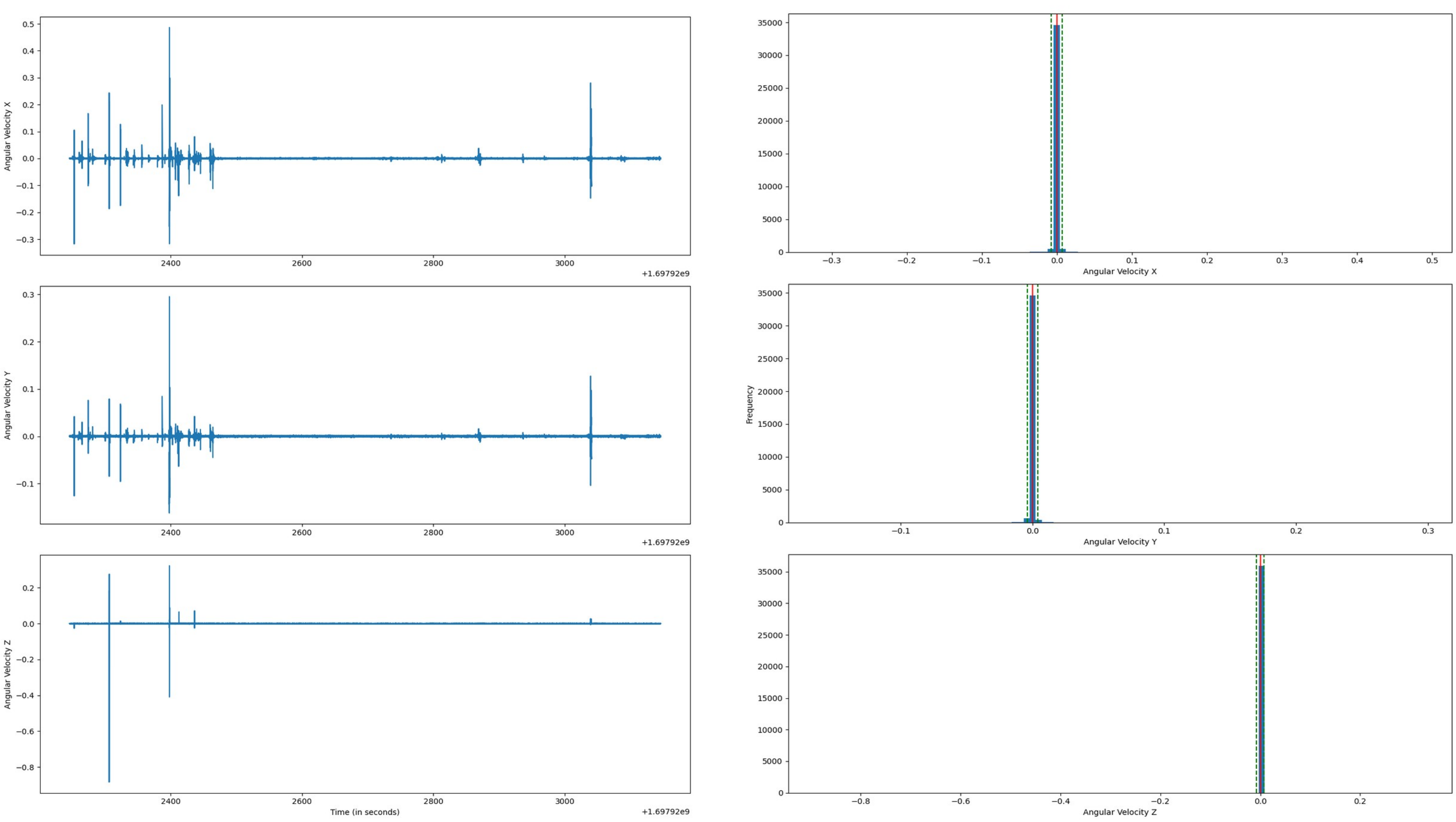


VectorNav VN-100 provides data for orientation, linear acceleartion, angular velocity and magnetic field. Roll, pitch and yaw are obtained in degrees therefore these values are then converted into quaternions which describes the orientation of the sensor in 3D space. Looking at the graphs, ideally, the imu sensor should transmit constant value for stationary imu sensor each axis in 3D space. But due to error sources, the data transmitted by the sensor causes fluctuations. Plots for linear acceleration, Angular velocity and magnetic field are displayed below.

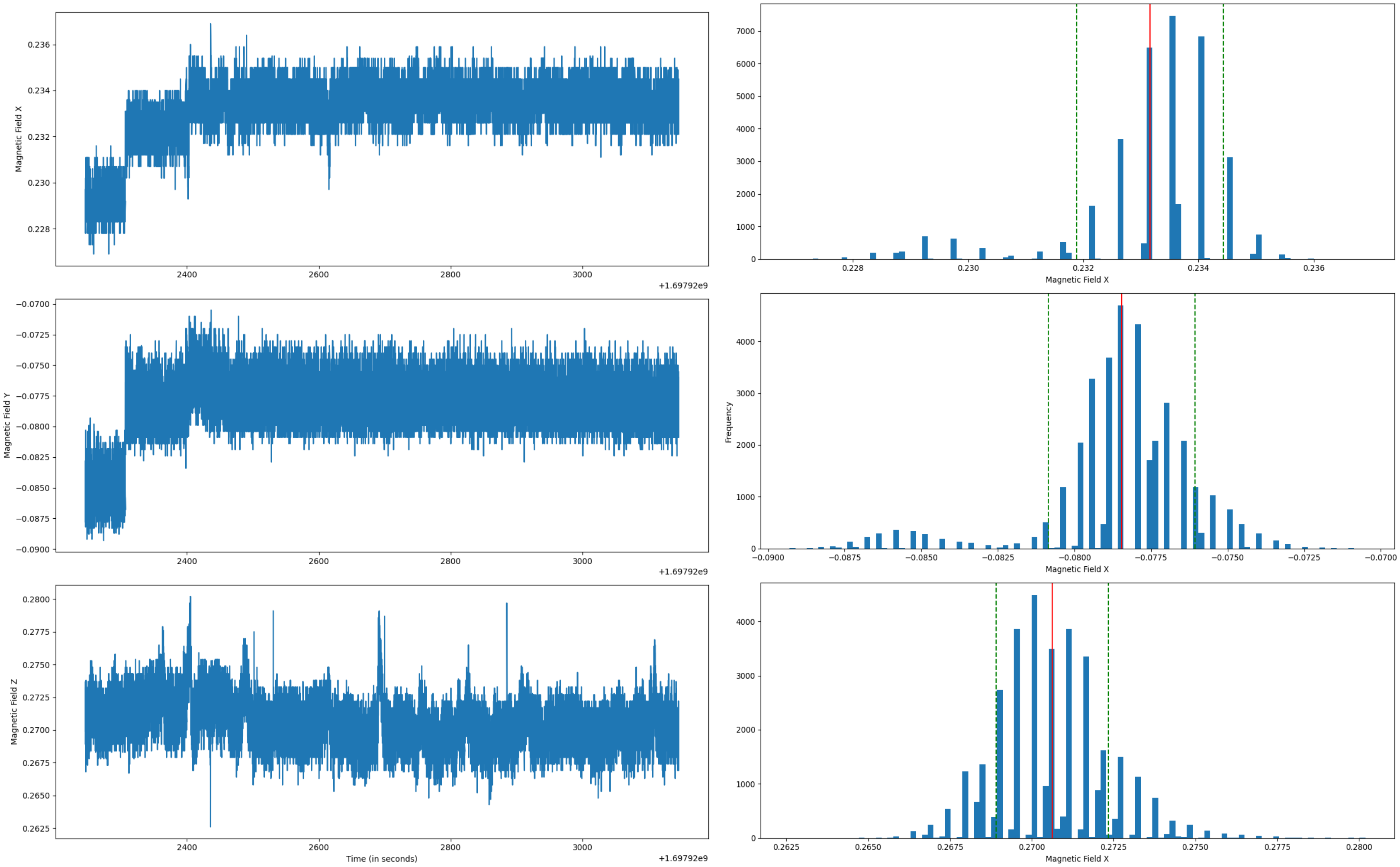
b. Linear Acceleration plot.



c. Angular Velocity plot.



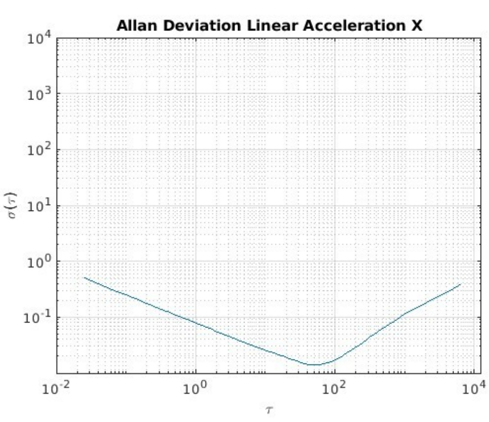
d.Magnetic Field

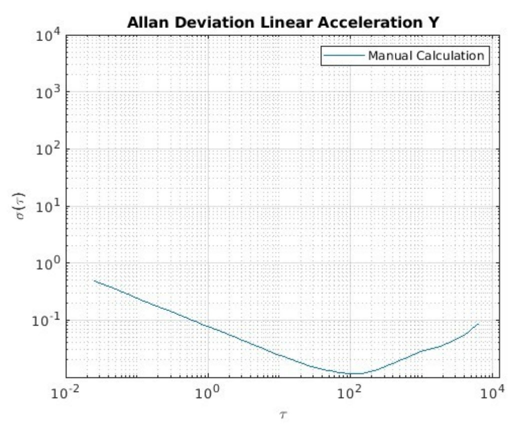


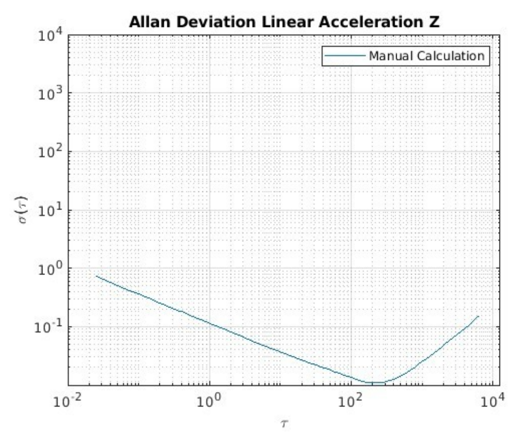
ALLAN VARIANCE:

Allan Variance test is a method used for identifying the noise properties of an inertial sensor.

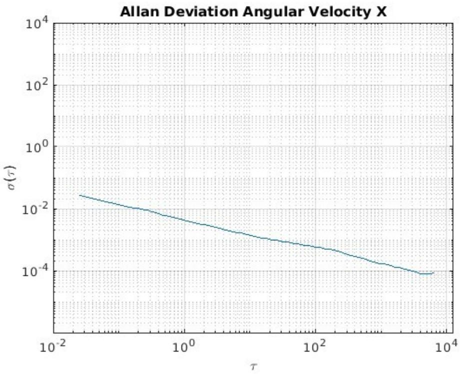
Linear Acceleration plot.

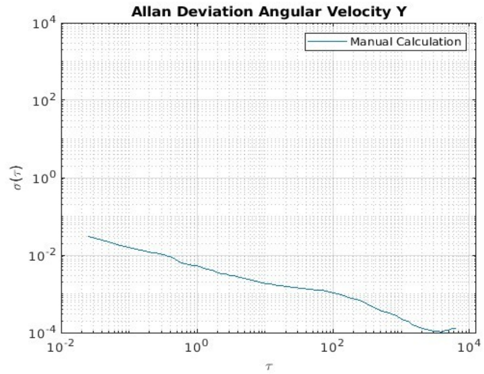


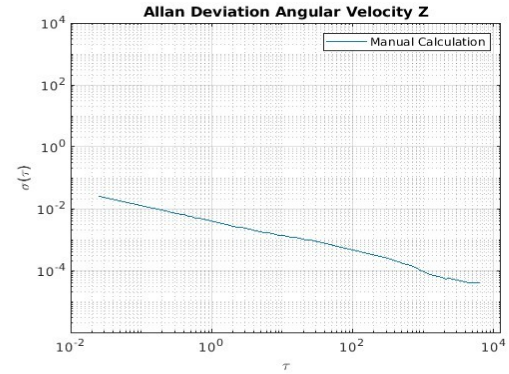




Anuglar Velocity plot.







Here are some common sources of error and noise in an IMU like the VN-100:
Gyroscopic Noise: Gyroscopes measure angular velocity, but they can have inherent noise due to the mechanical components or electronic components within the sensor. This noise can cause small, random fluctuations in the angular velocity readings.
Accelerometer Noise: Accelerometers measure linear acceleration and can also have noise, which may be due to electronic components, vibrations, or thermal effects. This noise can affect the accuracy of acceleration measurements.
Bias Drift: Over time, IMUs can experience bias drift, which is a slow change in the sensor's output when it's at rest. This can be caused by temperature variations or long-term wear and tear.
External Interference: External electromagnetic interference or radio frequency interference (EMI/RF) can affect the sensor's performance.

Modeling and Measuring errors:
Bias and Scale Factor Errors and Calibration: These errors can be modeled as constant offsets and scale factors applied to the raw sensor measurements. These parameters are often estimated during the calibration process. IMUs are typically calibrated to estimate and correct for bias and scale factor errors. This involves collecting data at various orientations and temperatures and then using calibration algorithms to determine the correction factors.
Bias Drift Measurement: Bias drift can be modeled as a slowly varying function of time or temperature. Models like random walks or Gauss-Markov processes are used to represent bias drift. Long-term monitoring of IMU data can help in estimating bias drift. By recording data at known orientations and comparing it over time, you can detect and measure drift.
External Interference Mitigation: Interference can be modeled as external noise sources with specific characteristics. Understanding the source of interference can help in modeling its effects. For external interference, you can measure the interference level using spectrum analyzers or specialized equipment. Shielding or distance from the interference source can be used to mitigate these effects.

The image below shows the data sheet specification of VN-100 imu sensor.

IMU Specifications	ACCELEROMETER	GYROSCOPE	MAGNETOMETER	BAROMETER
Range	±16 g	±2,000°/s	±2.5 Gauss	10 to 1200 mbar
In-Run Bias Stability (Allan Variance)	< 0.04 mg	< 10°/hr (5-7°/hr typ.)	-	-

The bias instability of Linear Acceleration as shown in the graph below is 0.00212 which satisfies the condition mentioned in the data sheet above. Similarly Bias instability plot of Angular velocity is also plotted below with Bias Instability of 0.0001162.