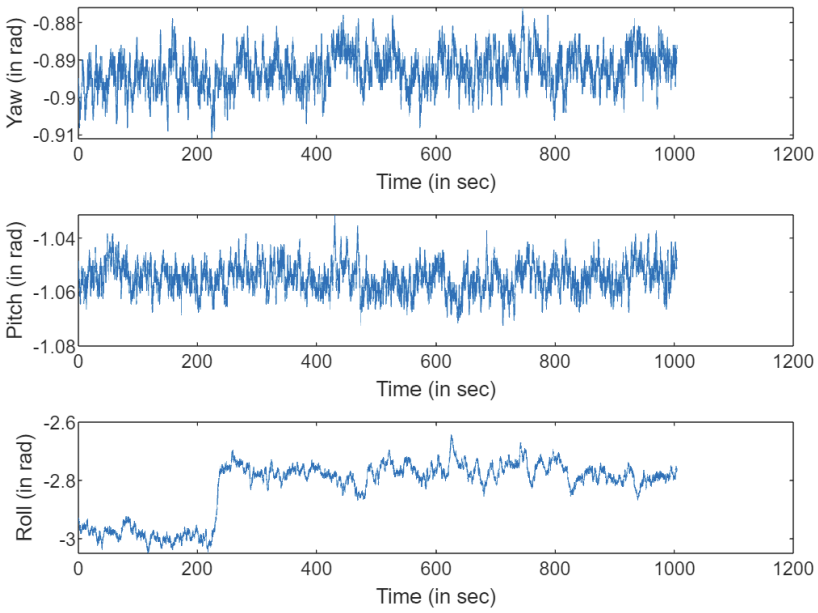
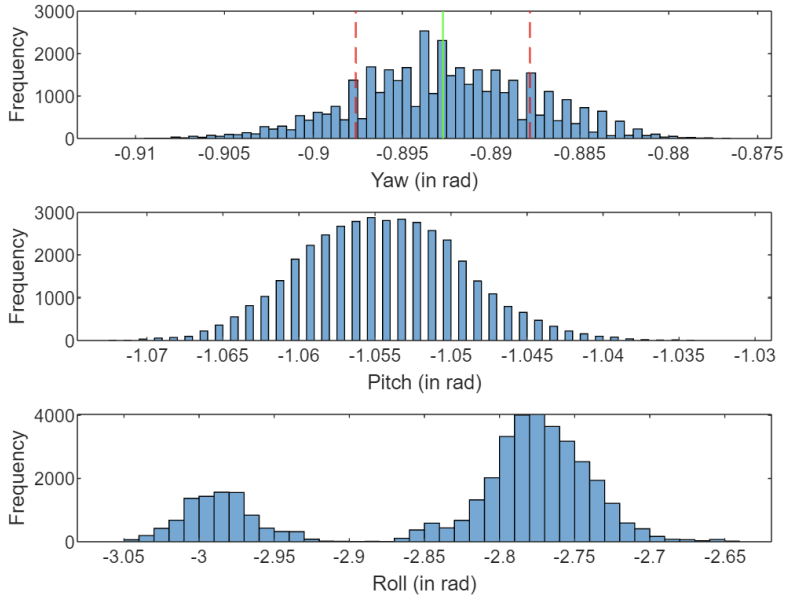
LAB-3
IMU

Stationary Noise Analysis

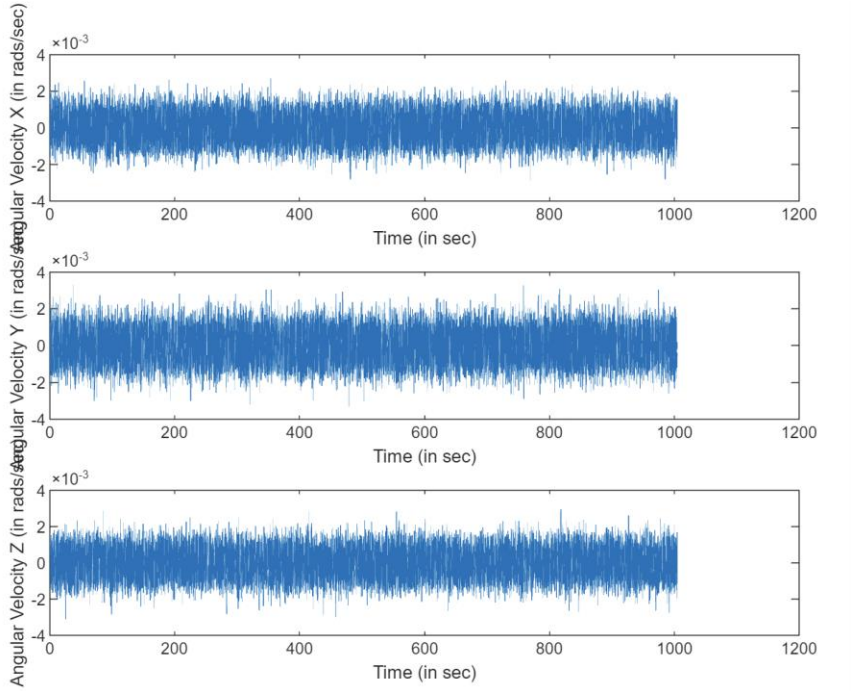
- Orientation Plots

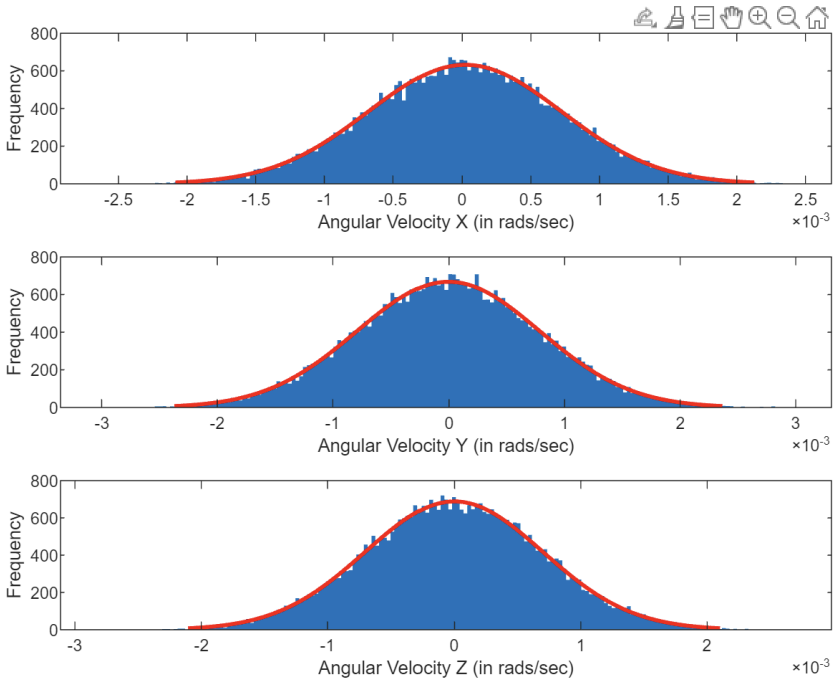




The mean and standard deviation of yaw is (-0.8927, 0.0049), pitch is (-1.0547, 0.0053) and roll is (-2.8221, 0.0951). The noise distribution of yaw and pitch are normal but that of roll is unevenly distributed, bimodal.

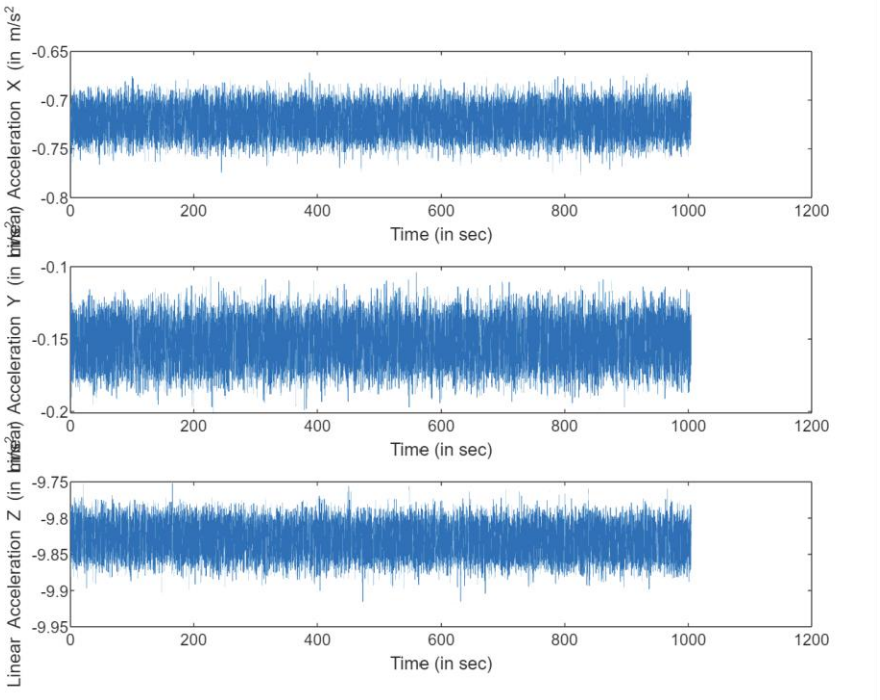
- Angular Velocity Plots

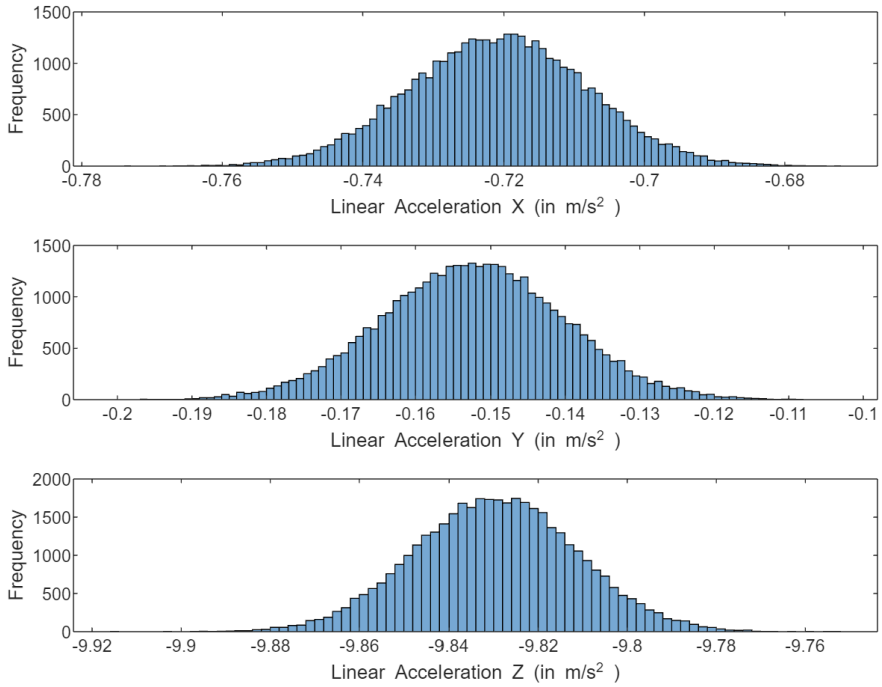




The mean and standard deviation of angular velocity x is (2.1834 x 10^-5, 7.0210 x 10^-4), angular velocity y is (-3.0297 x 10^-6, 7.8932 x 10^-4) and angular velocity z is (-1.1413 x 10^-6, 7.0091 x 10^-4). The noise distribution of the angular velocity along all axes is normal as it fits inside the gaussian bell curve.

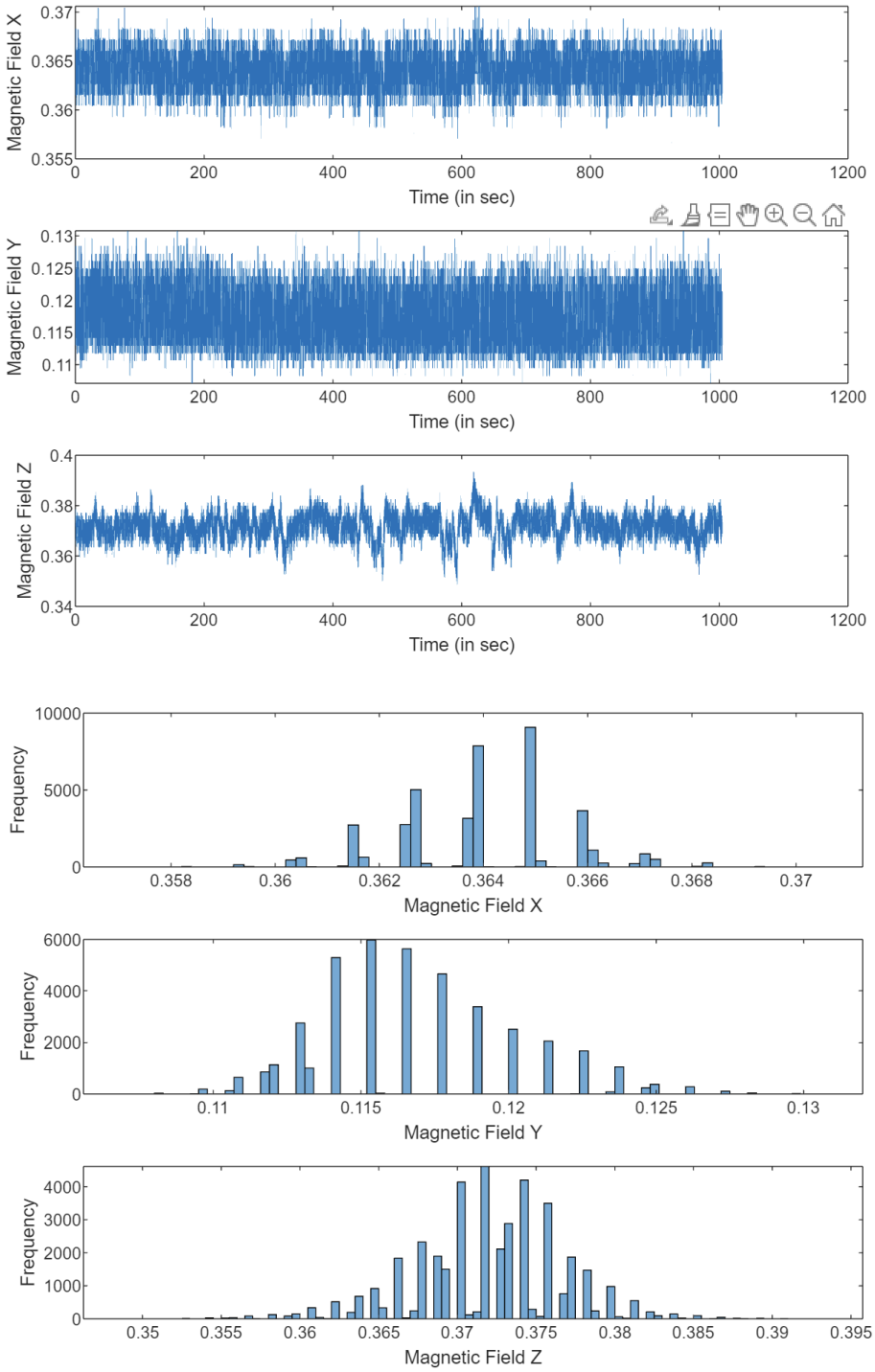
- Linear Acceleration Plots





The mean and standard deviation of linear acceleration x is (-0.7212, 0.0126), linear acceleration y is (-0.1529, 0.0121) and linear acceleration z is (-9.8301, 0.0182). The noise distribution of the linear acceleration along all axes is normal distribution.

- Magnetic Field Plots



The mean and standard deviation of magnetic field x is (0.3640, 0.0016), magnetic field y is (0.1169, 0.0034) and magnetic field z is (0.3720, 0.0048). The noise is unevenly distributed.

Allan Variance (5 hour)

Allan Variance is a time domain analysis technique designed for characterizing noise and stability. The technique can be applied to any signal to determine the character of the underlying noise processes. The Allan Variance of a signal is a function of averaging time.

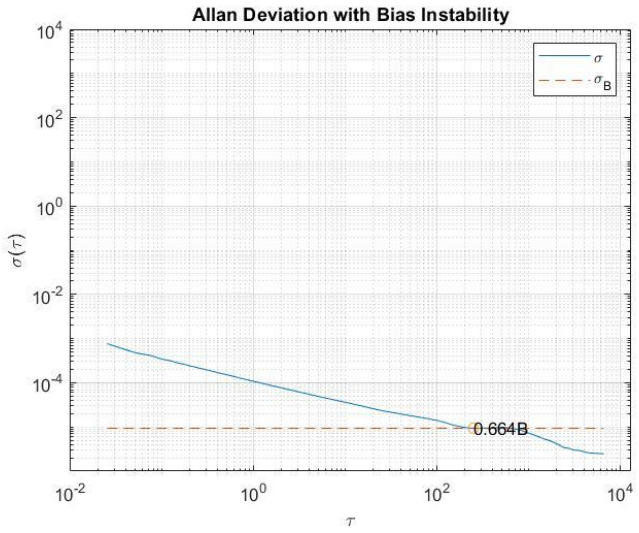
It helps us understand how the precision of a sensor changes as we average the measurements over different time spans.

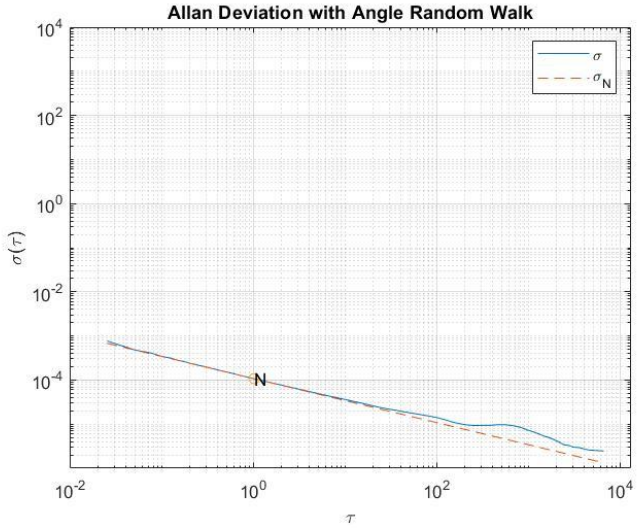
For our IMU, the important processes that we should measure are random walk, noise density and in run bias stability.

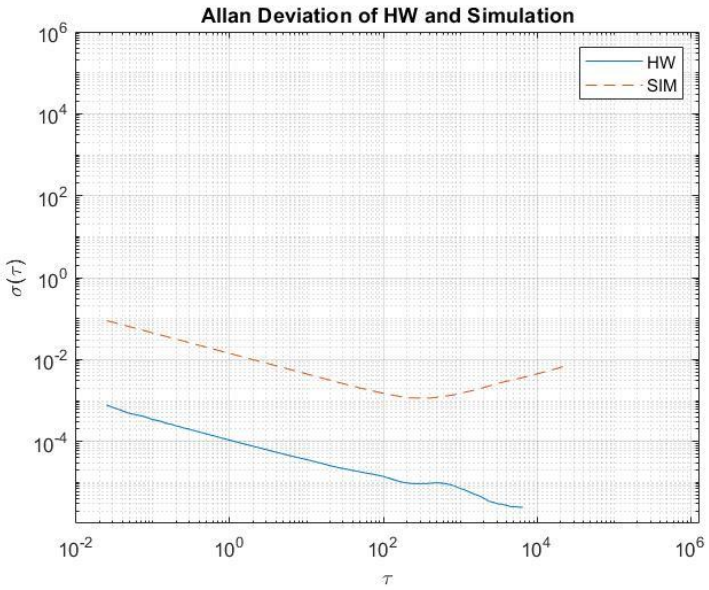
Bias stability is a measure of the long-term stability or drift in the output of an inertial sensor. It quantifies how the bias (or offset) of the sensor's readings changes over time.

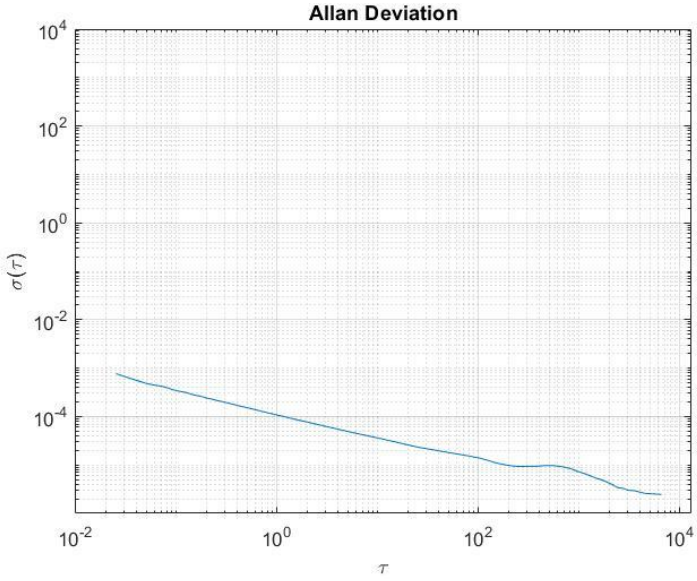
IMU Specifications	ACCELEROMETER	GYROSCOPE	MAGNETOMETER
Range	±16 g	±2,000°/s	±2.5 Gauss
In-Run Bias Stability (Allan Variance)	< 0.04 mg	< 10°/hr (5-7°/hr typ.)	-
Noise Density	0.14 mg/√Hz	0.0035 °/s /√Hz	140 µGauss/√Hz
Bandwidth	260 Hz	256 Hz	200 Hz
Cross-Axis Sensitivity	±0.05 °	< 0.05 °	±0.05 °

The bias stability of VN 100 is mentioned above.


Allan Deviation with Bias Instability
σ
σ_B
0.664B
$\sigma(\tau)$
τ


Allan Deviation with Angle Random Walk
σ
σ_N
N
$\sigma(\tau)$
τ





The sources of error are disturbance due to vibrations in the surroundings, noisy environment, bias error, scale factor ,installation error and random noise.