EECE5554 – ROBOTIC SENSING AND NAVIGATION

LAB -3 REPORT

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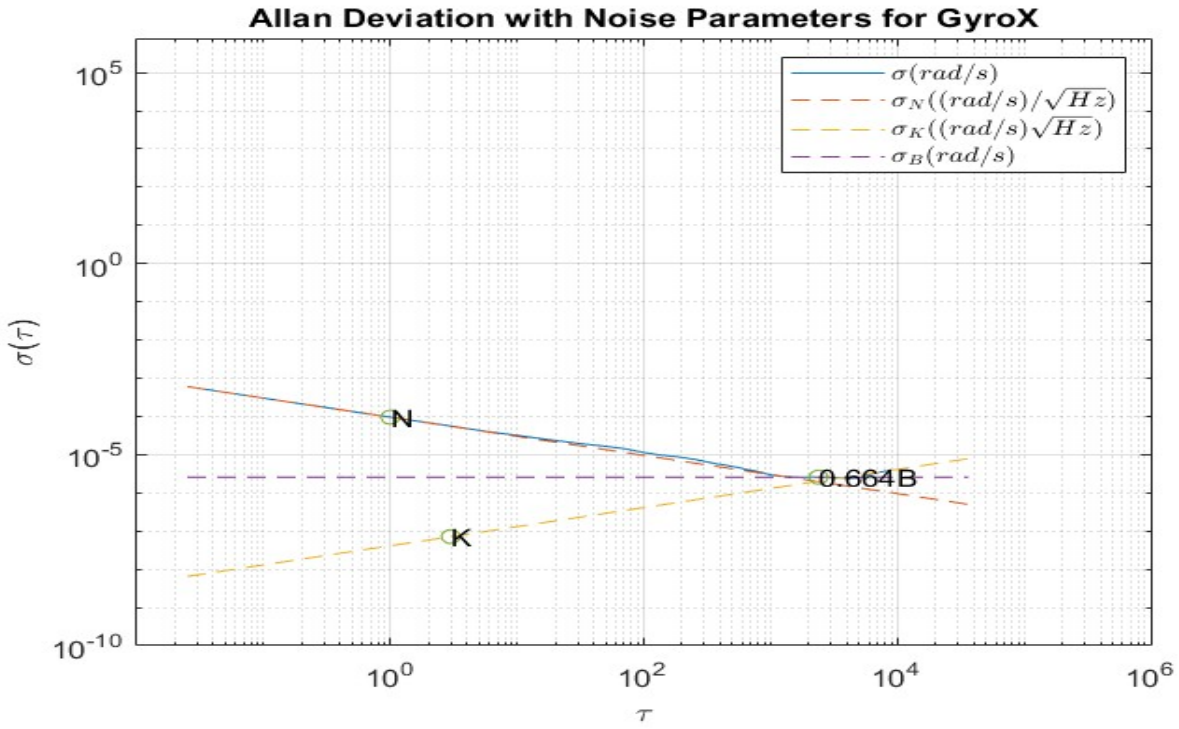
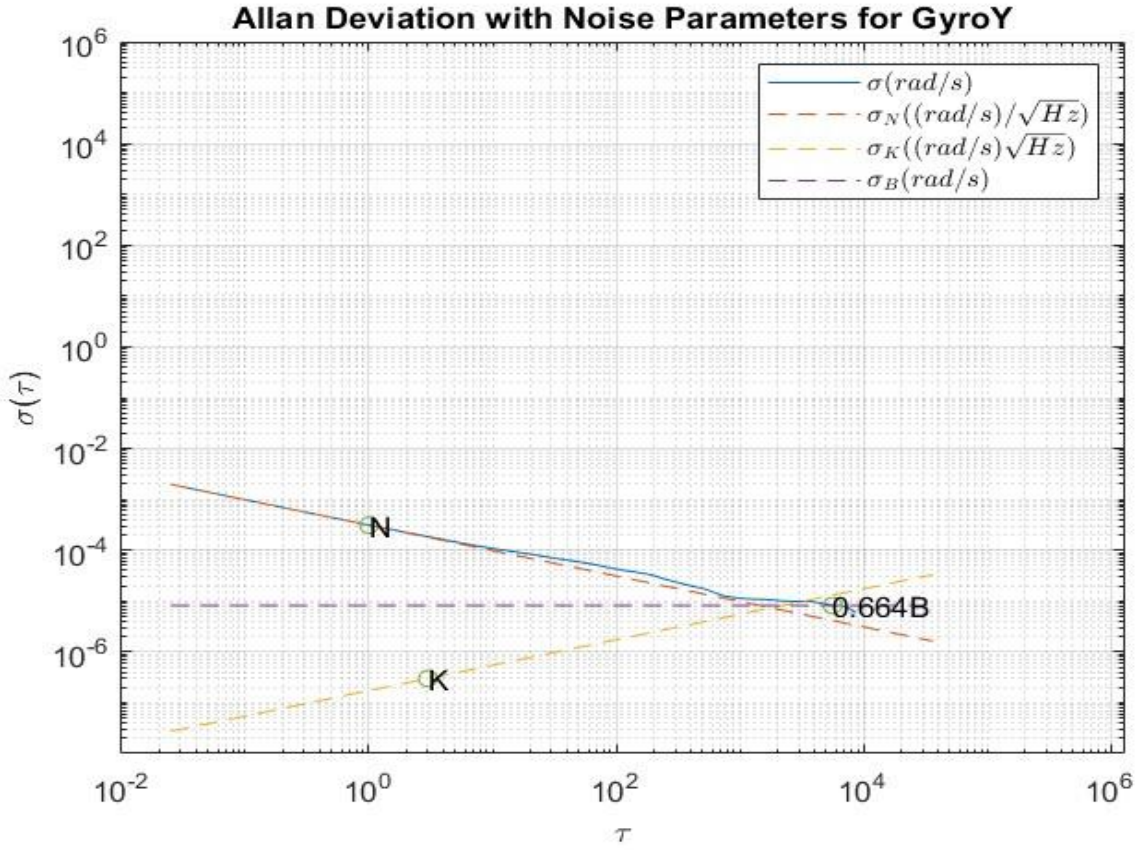
Lab Background

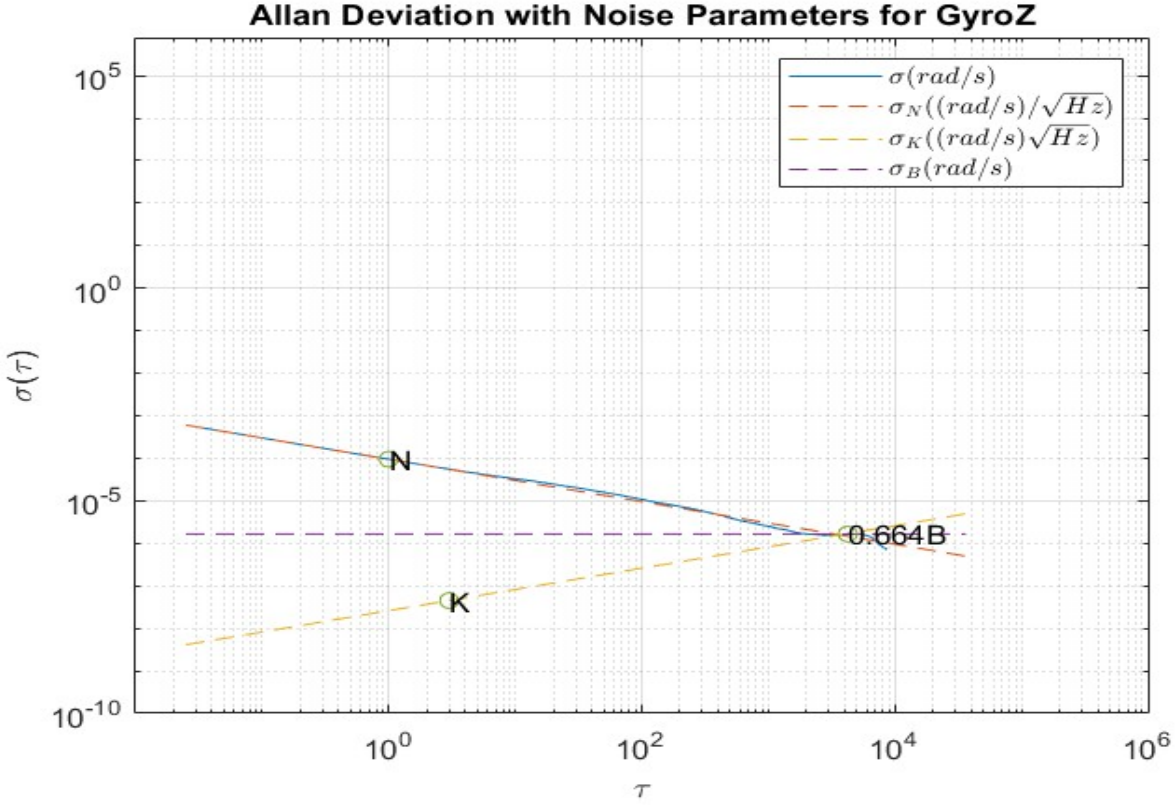
For this lab two separate data collections were measured to get the error of the IMU device. One data set consists about 10 minutes of data while the other for around 5 hours. The smaller dataset gives us some insight on the short term errors the sensor may pick up while the larger dataset is tested for long term drift done by computing the Allan Variance of the sensor data.

Five Hour Data

By plotting Allan Variance for the 3 axes of Angular Velocity, the noise of the system can be found. The data was collected from an underground bunker with little to no environmental interference. However, small deviations can be found, indicating that some environmental disturbances were present. The three noise parameters N (angle random walk), K (rate random walk), and B (bias instability) are estimated using data logged from a stationary gyroscope.

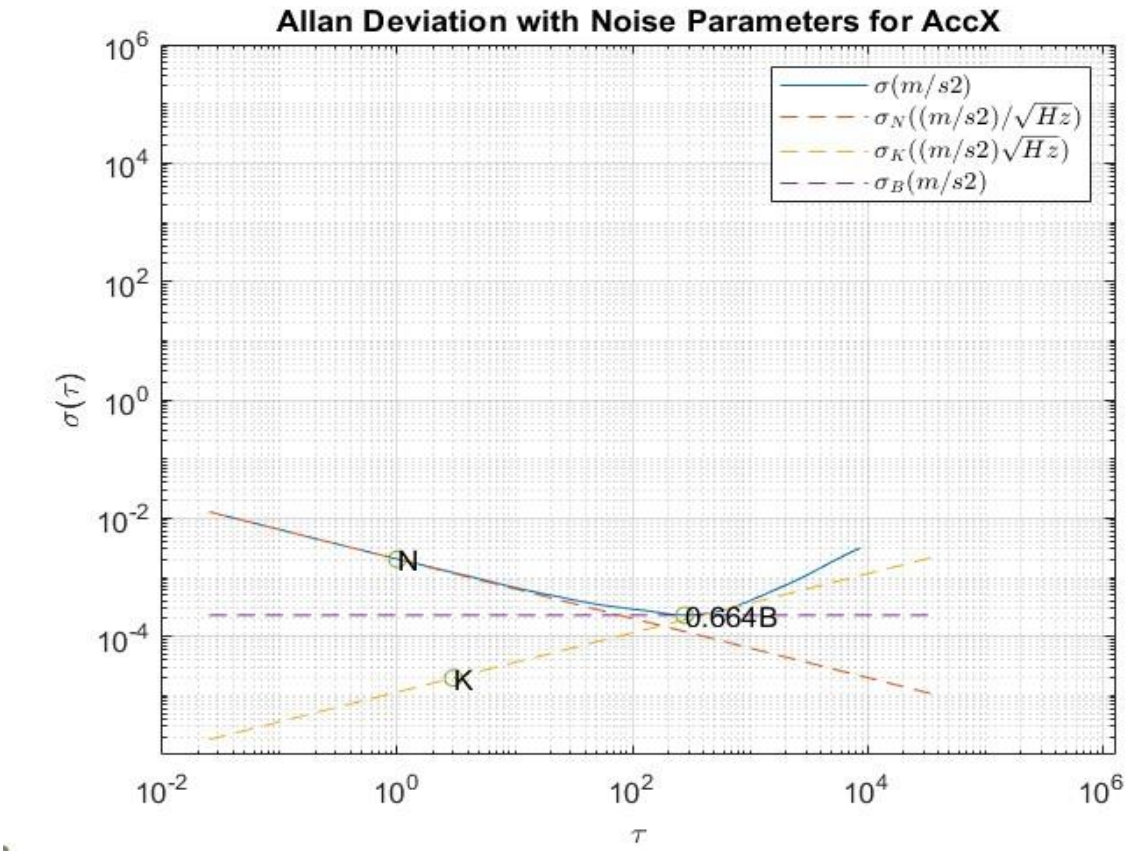


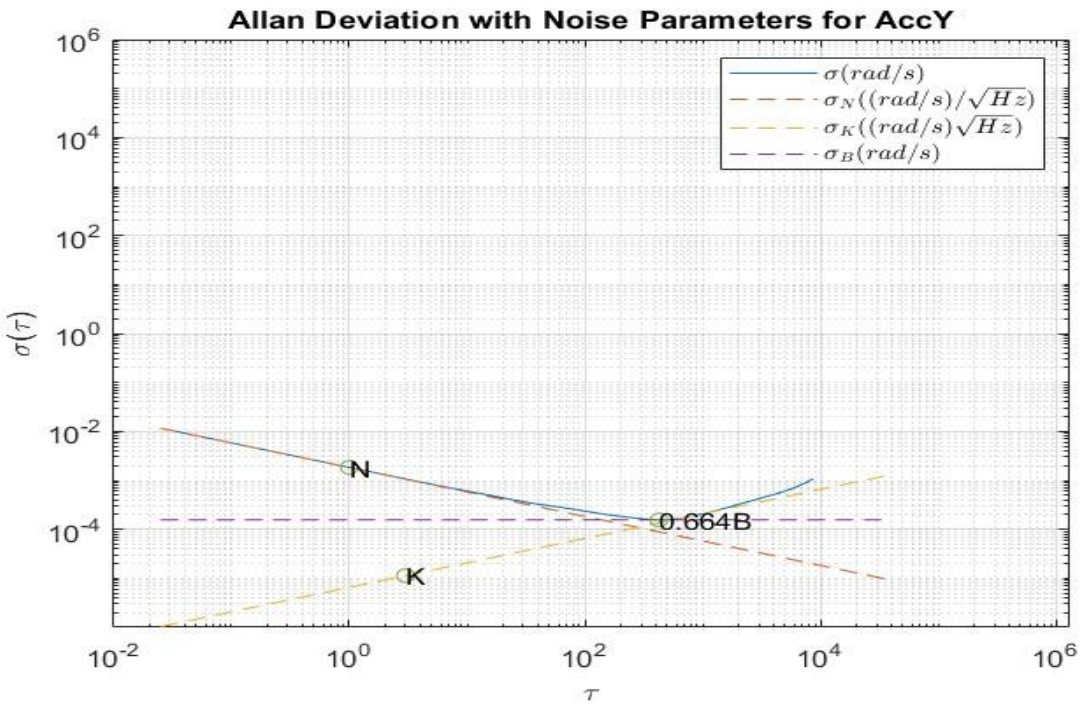

Allan Deviation with Noise Parameters for GyroY
$\sigma(rad/s)$
$\sigma_N((rad/s)/\sqrt{Hz})$
$\sigma_K((rad/s)\sqrt{Hz})$
$\sigma_B(rad/s)$
N
K
0.664B
$\sigma(\tau)$
τ

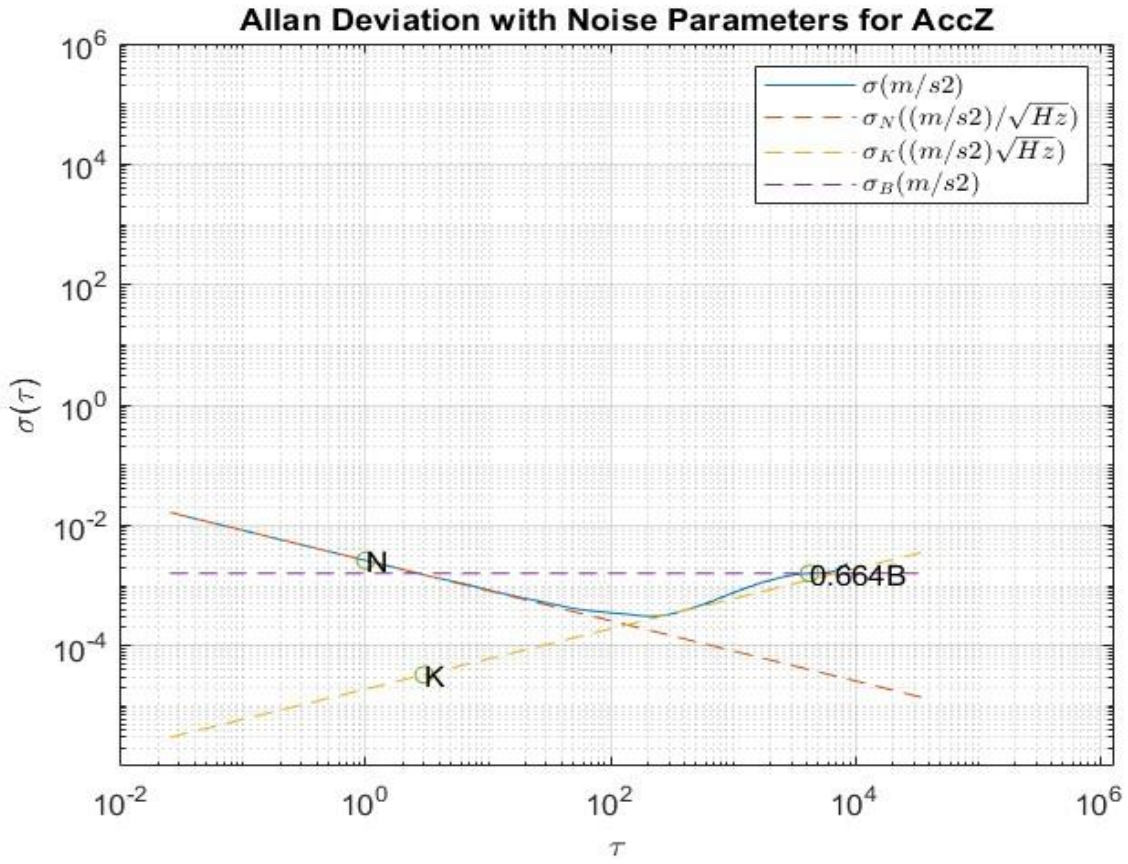

Allan Deviation with Noise Parameters for GyroZ
$\sigma(rad/s)$
$\sigma_N((rad/s)/\sqrt{Hz})$
$\sigma_K((rad/s)\sqrt{Hz})$
$\sigma_B(rad/s)$
N
K
0.664B
$\sigma(\tau)$
τ

Gyroscope Error Statistics			
	X-Axis	Y-Axis	Z-Axis
Angle Random Walk(N)	9.5422e-05	3.1056e-04	9.5207e-05
Rate Random Walk(K)	7.1429e-08	2.9993e-07	4.5078e-08
Bias Instability(B)	3.8712e-06	1.2286e-05	2.4907e-06

As shown in the figures above we can see there is no large spike against the straight line meaning there is little drift in the gyroscope output even over a long time period.

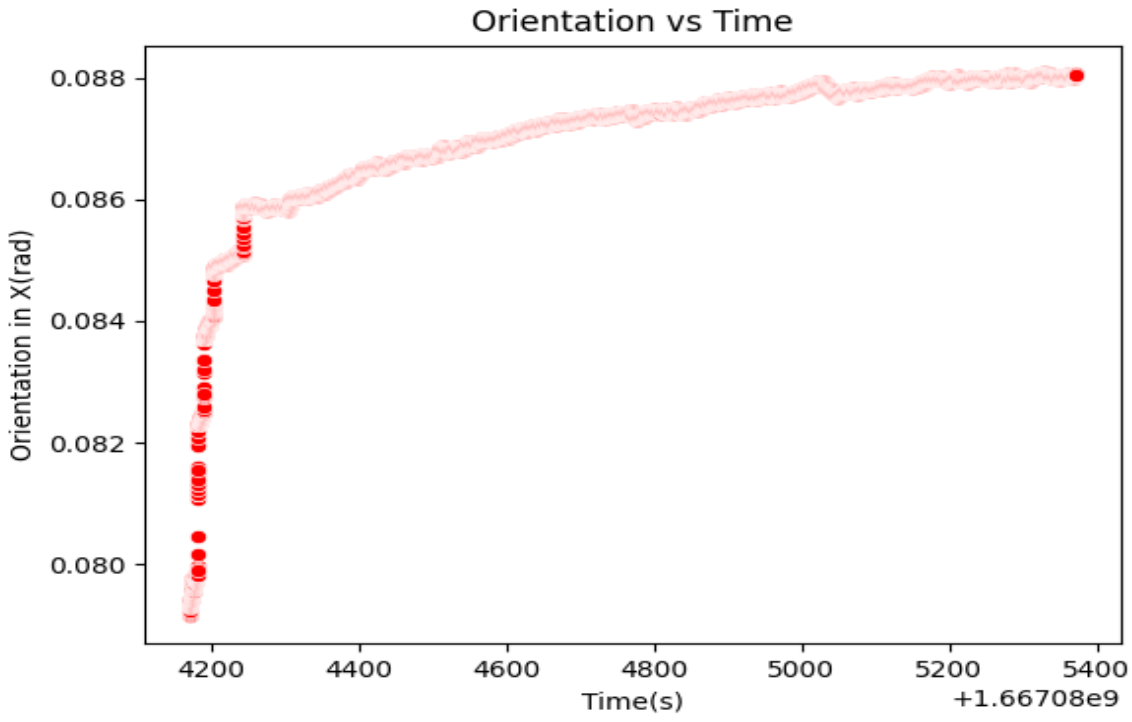


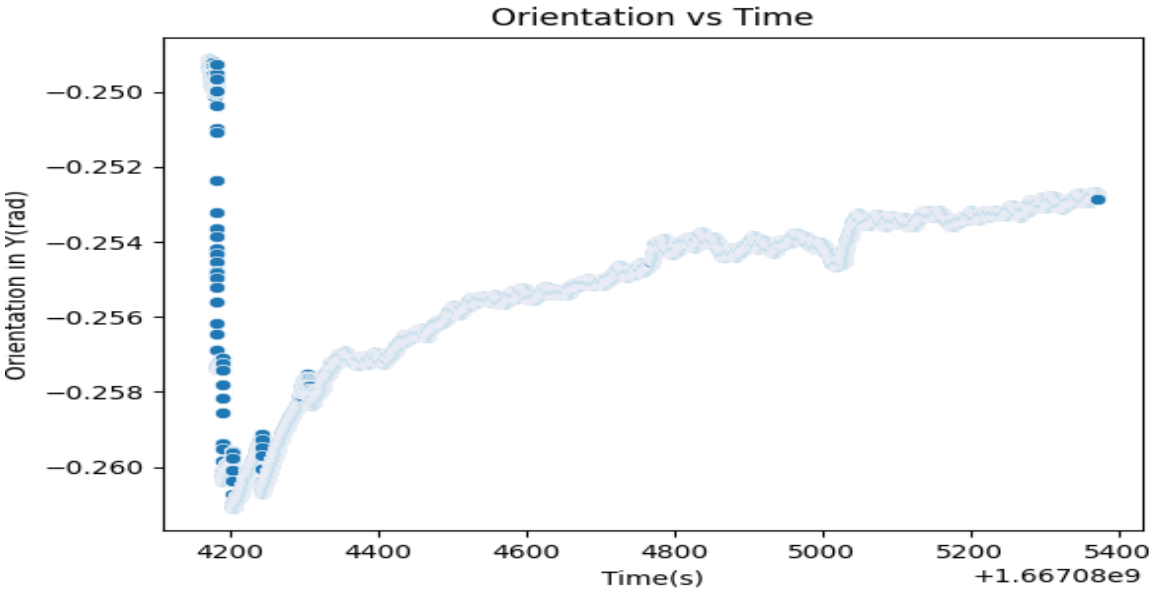

Allan Deviation with Noise Parameters for AccY
$\sigma(rad/s)$
$\sigma_N((rad/s)/\sqrt{Hz})$
$\sigma_K((rad/s)\sqrt{Hz})$
$\sigma_B(rad/s)$
N
K
0.664B
$\sigma(\tau)$
τ

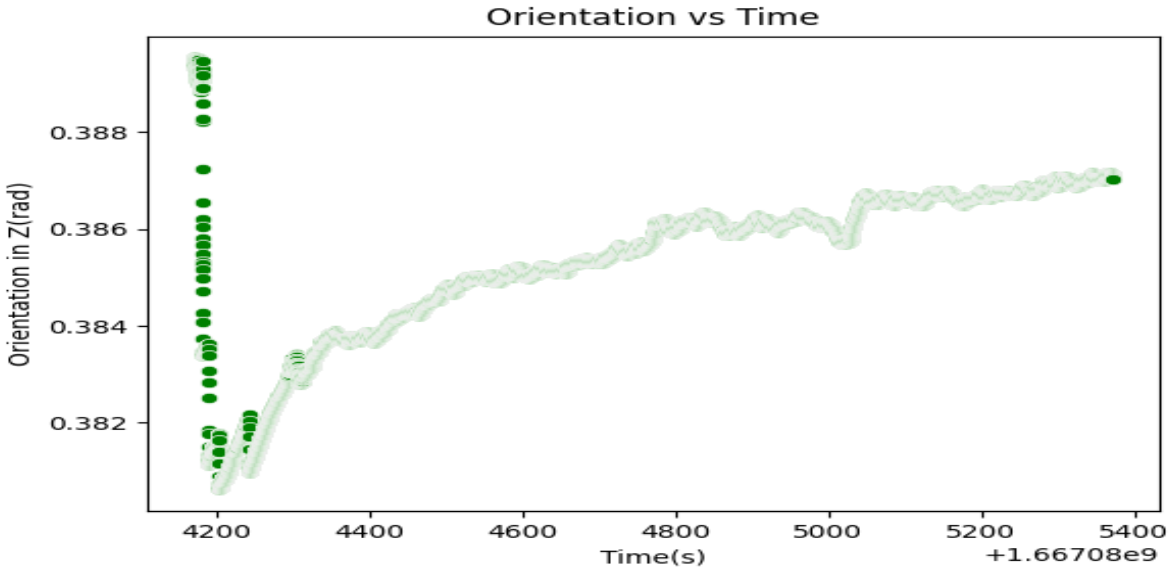

Allan Deviation with Noise Parameters for AccZ
$\sigma(m/s2)$
$\sigma_N((m/s2)/\sqrt{Hz})$
$\sigma_K((m/s2)\sqrt{Hz})$
$\sigma_B(m/s2)$
N
K
0.664B
$\sigma(\tau)$
τ

Accelerometer Error Statistics			
	X-Axis	Y-Axis	Z-Axis
Angle Random Walk(N)	0.0020	0.0018	0.0026
Rate Random Walk(K)	1.9847e-05	1.1349e-05	3.2970e-05
Bias Instability(B)	3.4348e-04	2.3539e-04	0.0024

Ten Minute Data

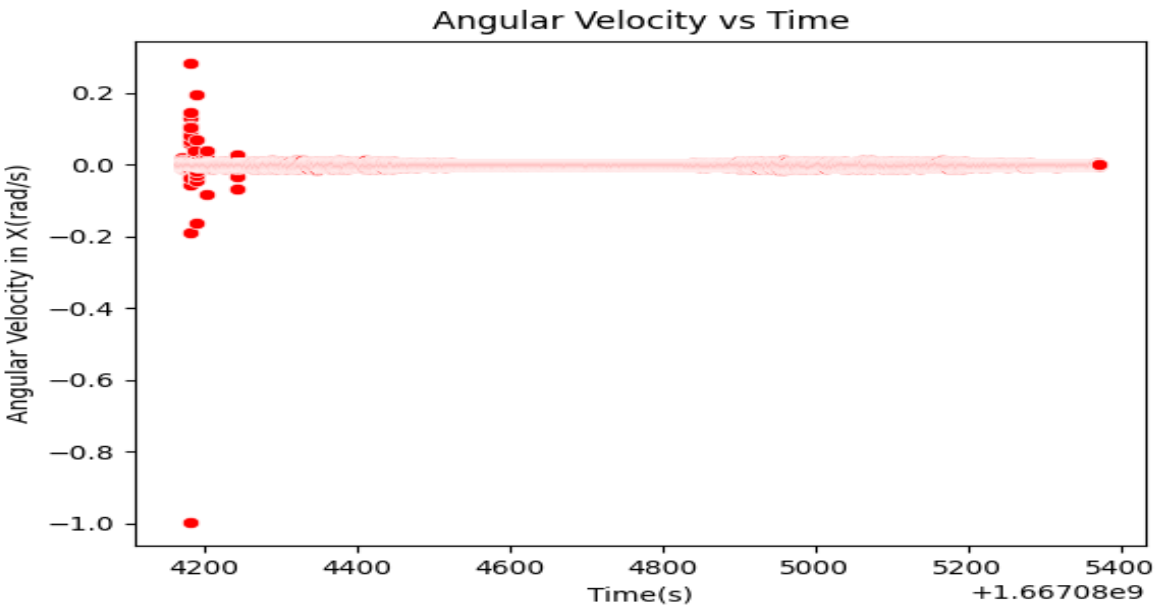


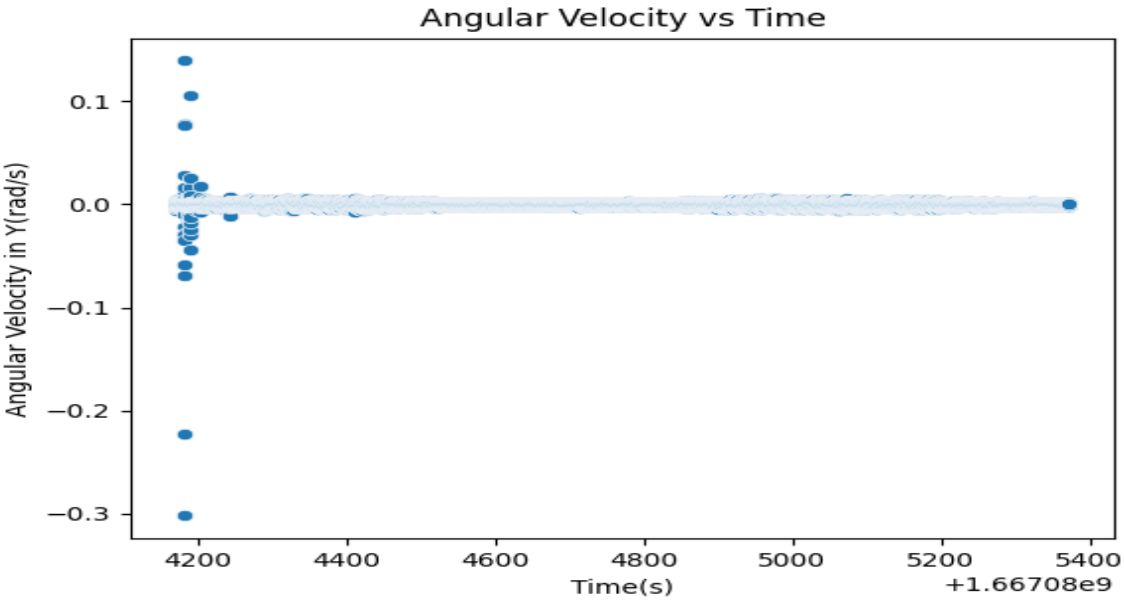


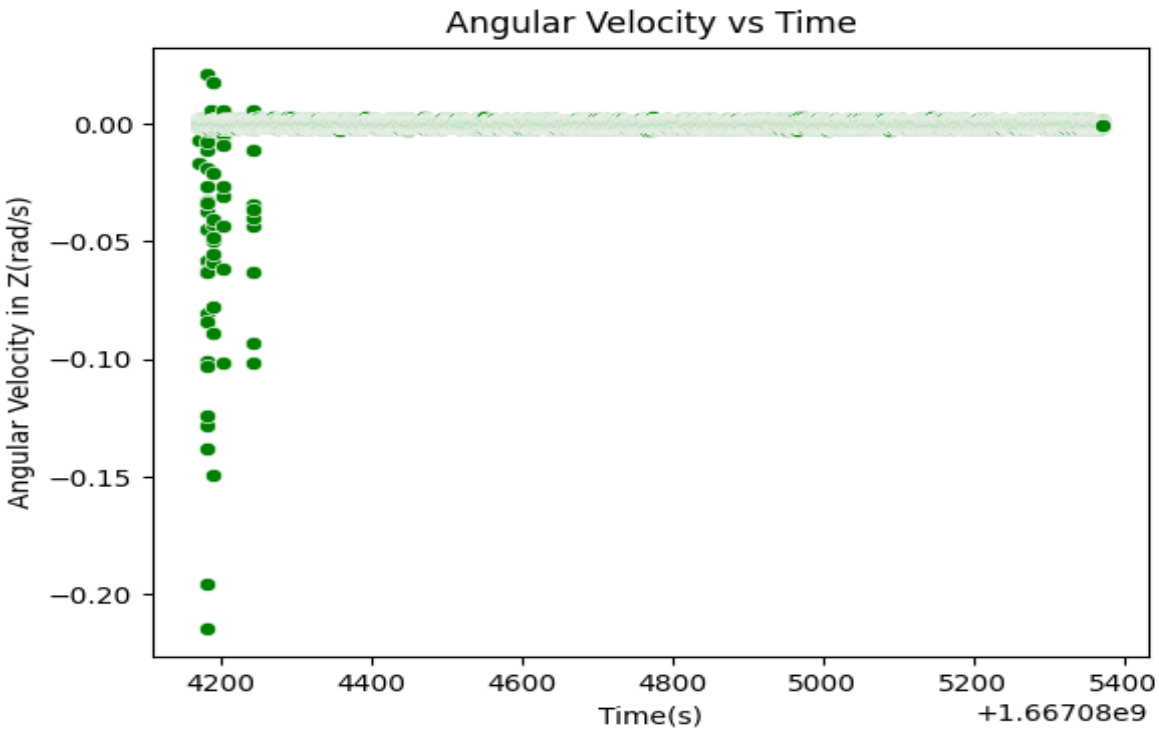


Orientation Statistics(rad)		
	Mean	Standard Deviation
X - Axis	0.0870	0.0011
Y- Axis	0.2550	0.0020
Z - Axis	0.3853	0.0015

Gyroscope Data

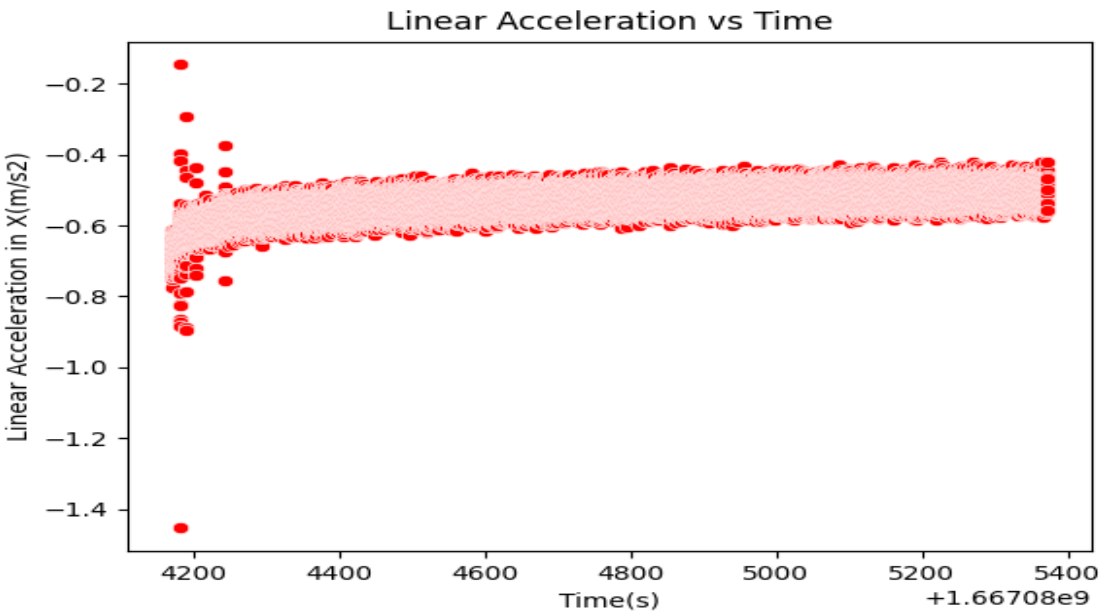


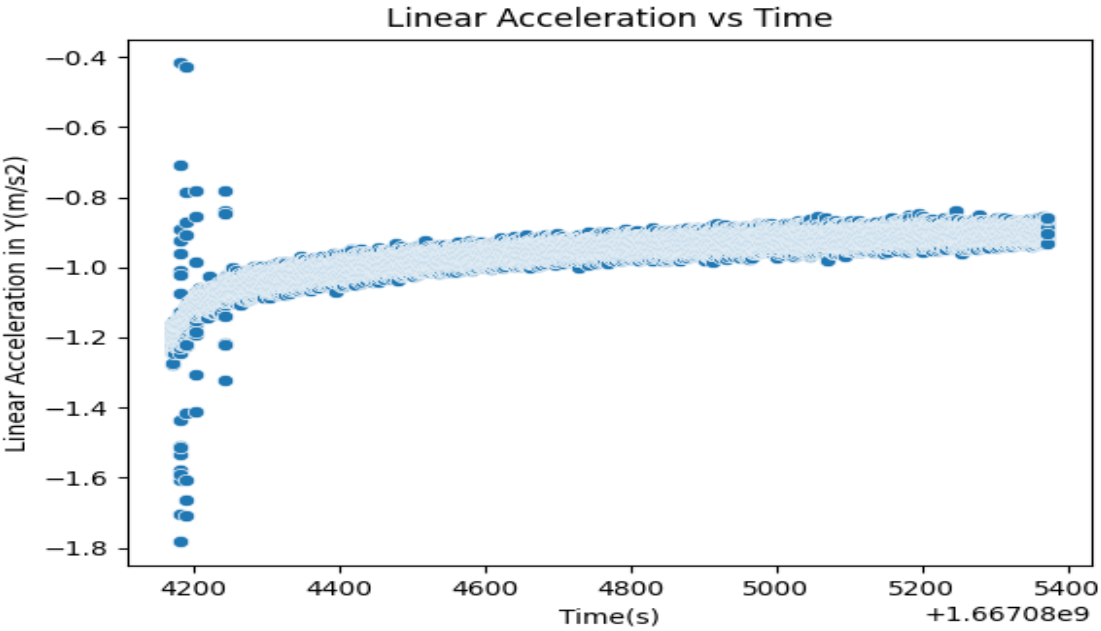


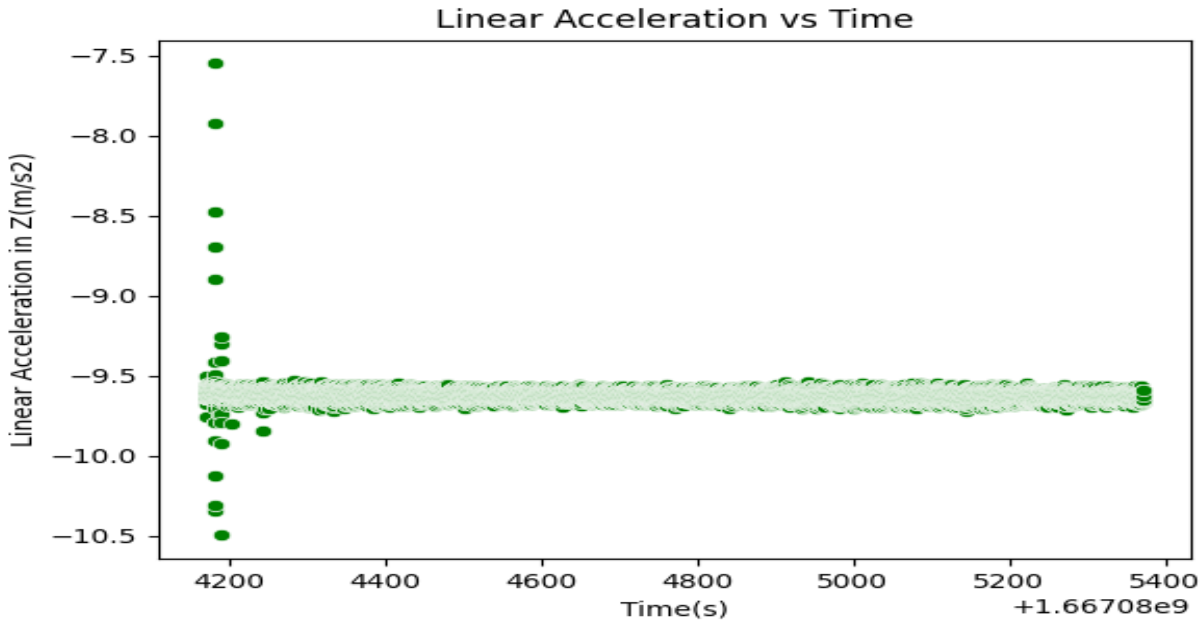


Angular Velocity Statistics(rad/s)		
	Mean	Standard Deviation
X - Axis	-4.6049e-05	0.00571
Y- Axis	2.24456e-05	0.00237
Z - Axis	-9.7632e-06	0.00255

Linear Acceleration Data

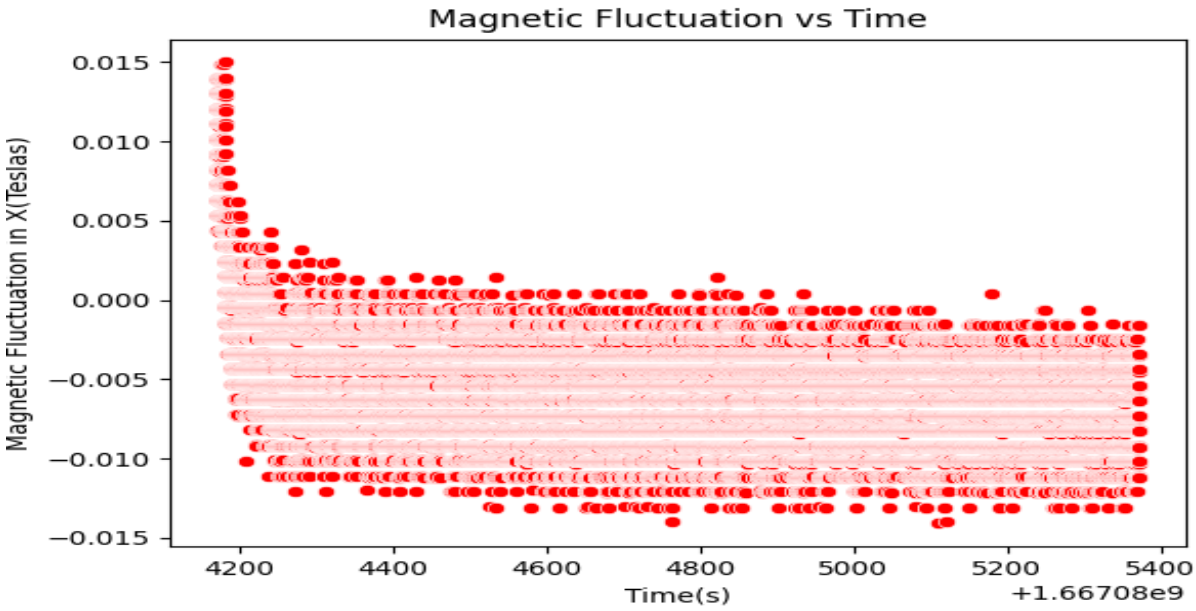


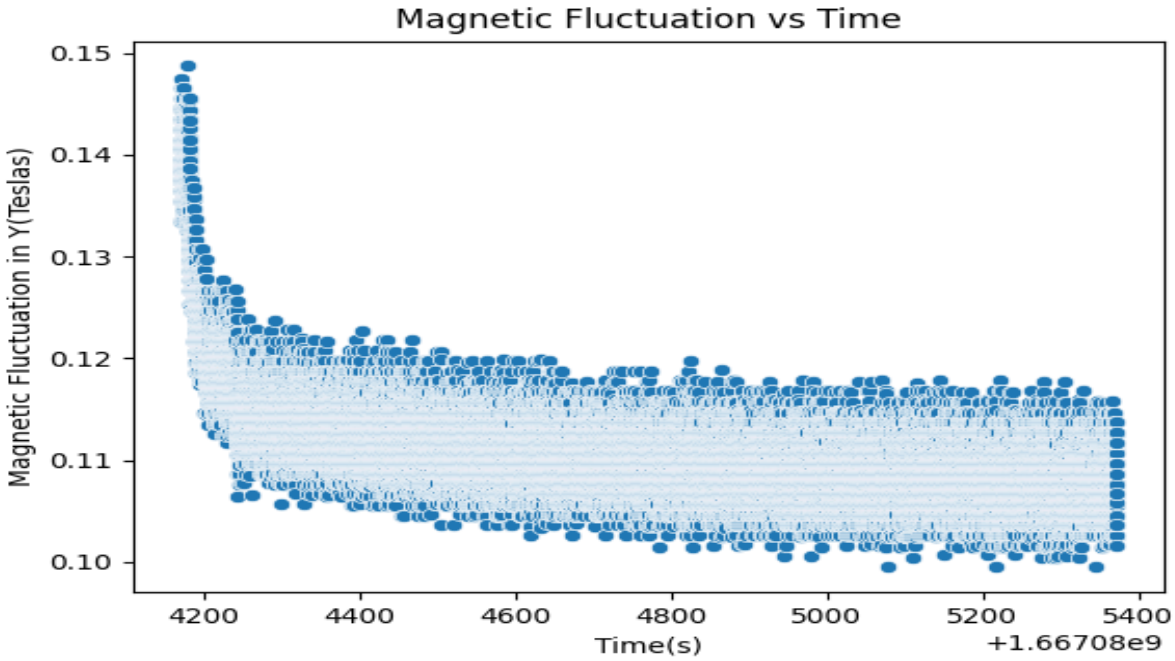


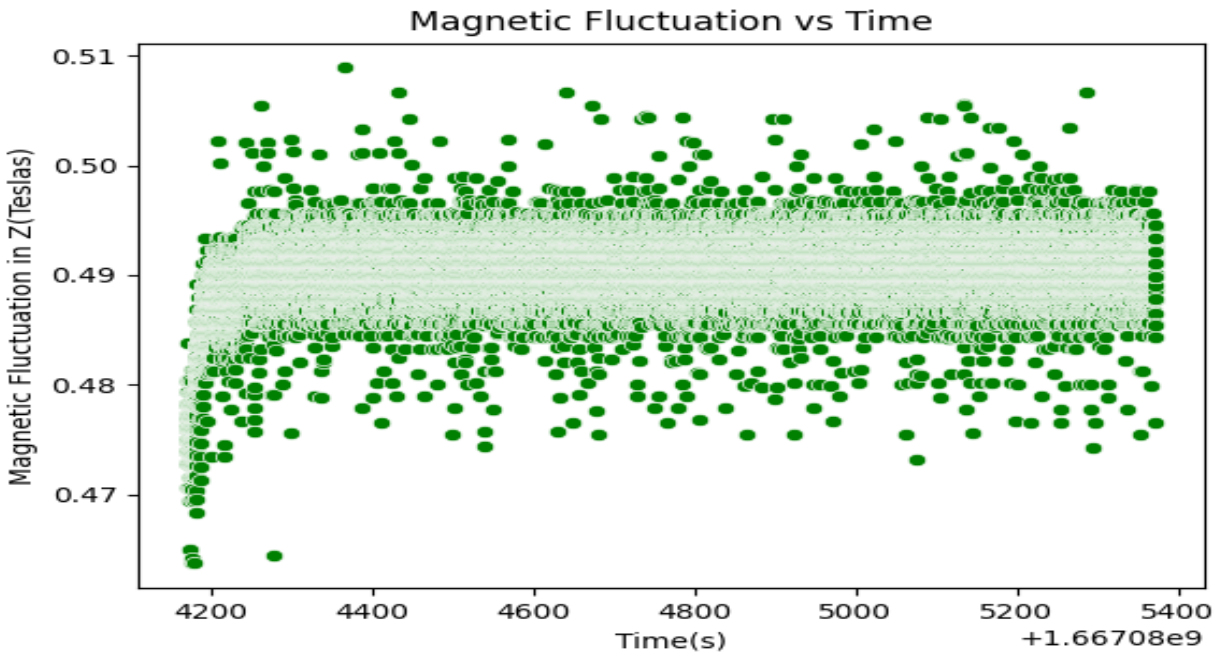


Linear Acceleration Statistics(m/s^2)		
	Mean	Standard Deviation
X - Axis	-0.53278	0.04239
Y- Axis	-0.960436	0.06273
Z - Axis	-9.622933	0.02680

Magnetometer Data







Magnetometer Statistics(Tesla)		
	Mean	Standard Deviation
X - Axis	-0.00588	0.00319
Y- Axis	0.11087	0.00502
Z - Axis	0.49050	0.00288

Analysis

After the plots were generated, it was found that they closely resemble a standard Allan Variance plot. The Angle Random Walk coefficient (White Noise) N were determined by finding the area of the Allan Variance graph with a slope of -0.5, fitting a line to it, and finding the value of that line at tau = 1. The fit-lines on all graphs were plotted and the N-value was calculated. The Rate Random Walk Coefficient K was found similarly by finding an area of the graph with a slope of 0.5 and fitting a line to it, then finding the value at tau =3. Finally, the Bias Instability coefficient B was found by plotting a horizontal line to the flat region near the minimum. The VN-100 user manual gives a bias stability of 0.04 for the accelerometer and 10 for the gyroscope, close in magnitude to values above. The manual also gives noise density values of 0.14 for the accelerometer and 0.0035 for the gyroscope, close in magnitude to the values above.