

LAB 3 - IMU Data Collection and Analysis

Purpose:

To collect the IMU data and analyze it while stationary for 10 min and 5hr to measure the actual sensor error.

Methodology:

In order to collect the linear acceleration, angular velocity, orientation and magnetic field a Vectornav VN-100 IMU sensor is used. A ros node is written for reading the IMU data and publishing it has /imu and /magnetometer topics and save it as a bag file.

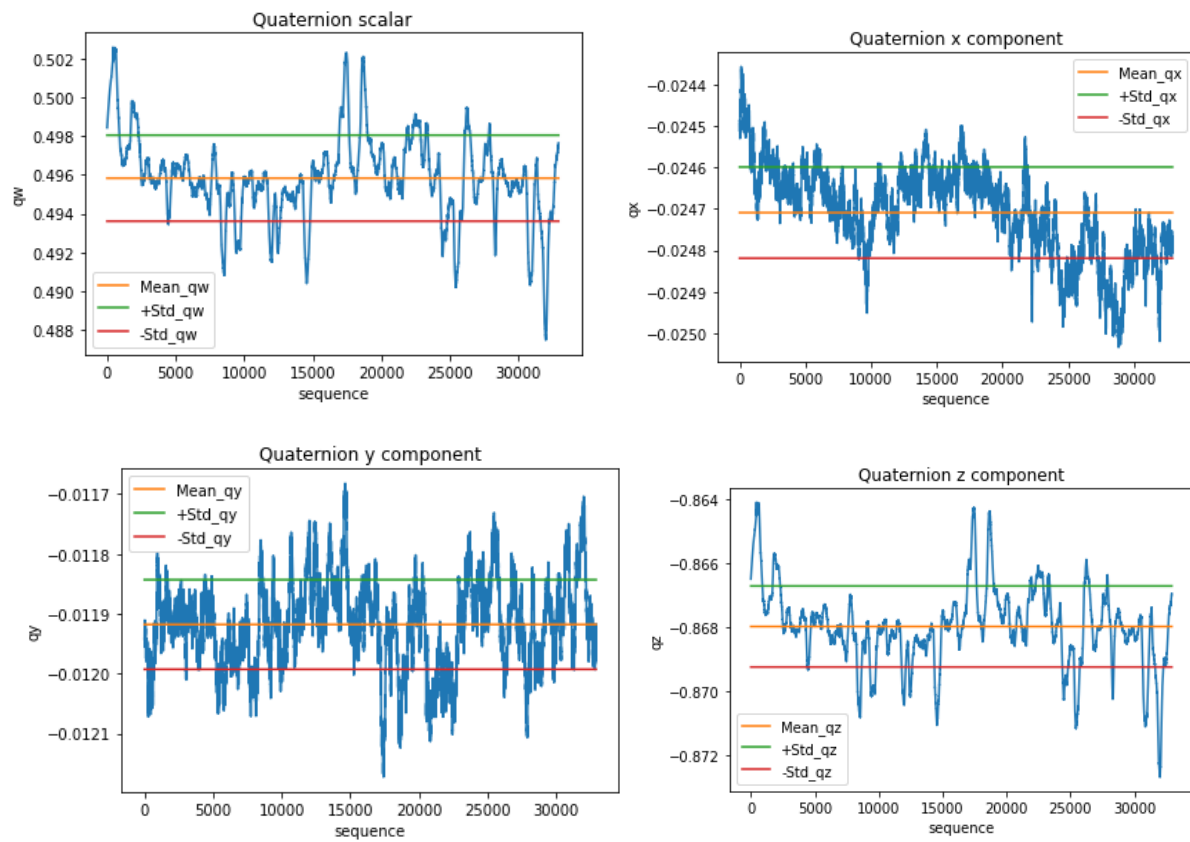
Data Collection:

Data is collected for 10 min and 5hr and parameters which are collected are

1. Orientation (quaternion x,y,z,w) - deg
2. Angular Velocity (wx,wy,wz) - rad/s
3. Linear Acceleration (ax,ay,az) - m/s²
4. Magnetic Field (mx,my,mz) - Gauss

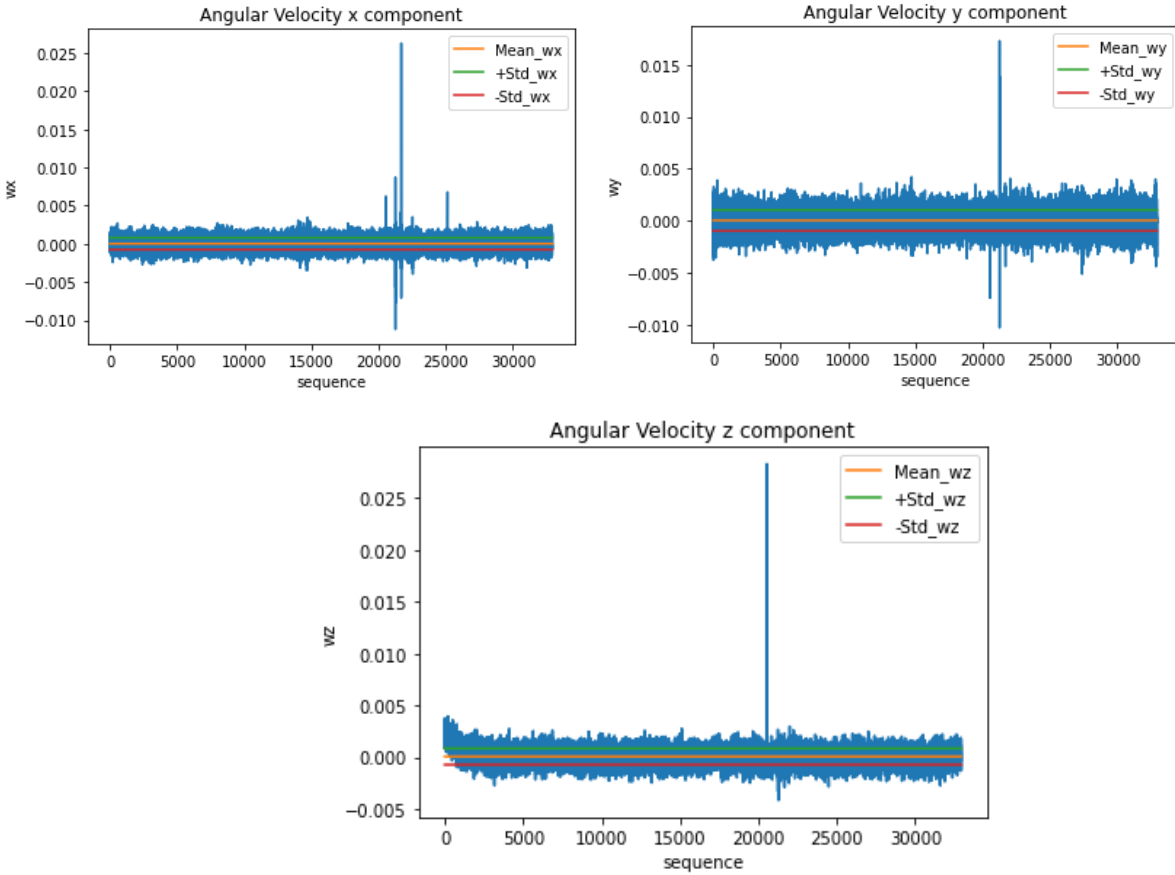
15 Min IMU Data Analysis:

1. Quaternions:



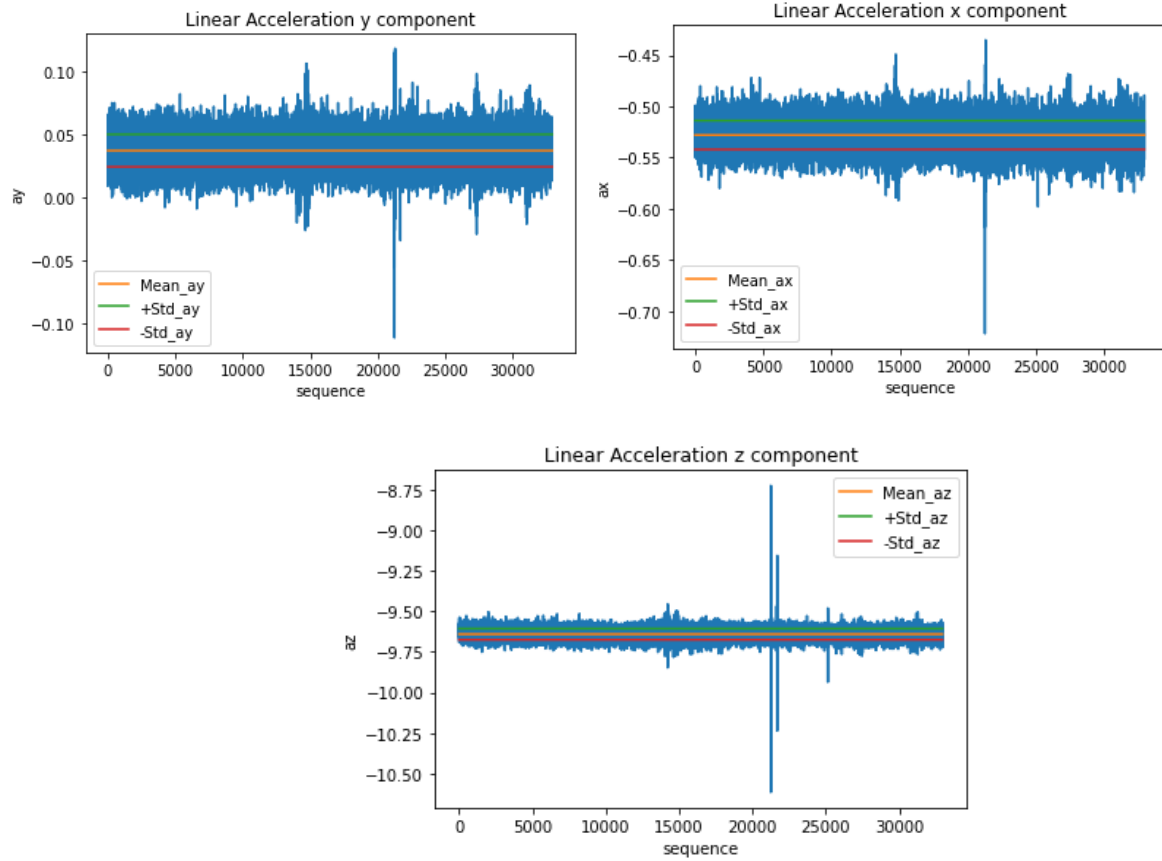
index	orientation.w	orientation.x	orientation.y	orientation.z
count	32932.00000	32932.00000	32932.00000	32932.00000
mean	0.49582	-0.02471	-0.01192	-0.86799
std	0.00222	0.00011	0.00007	0.00127
min	0.48748	-0.02503	-0.01217	-0.87270
25%	0.49491	-0.02478	-0.01197	-0.86851
50%	0.49577	-0.02469	-0.01192	-0.86802
75%	0.49682	-0.02463	-0.01187	-0.86742
max	0.50257	-0.02436	-0.01168	-0.86411

2. Angular Velocity :



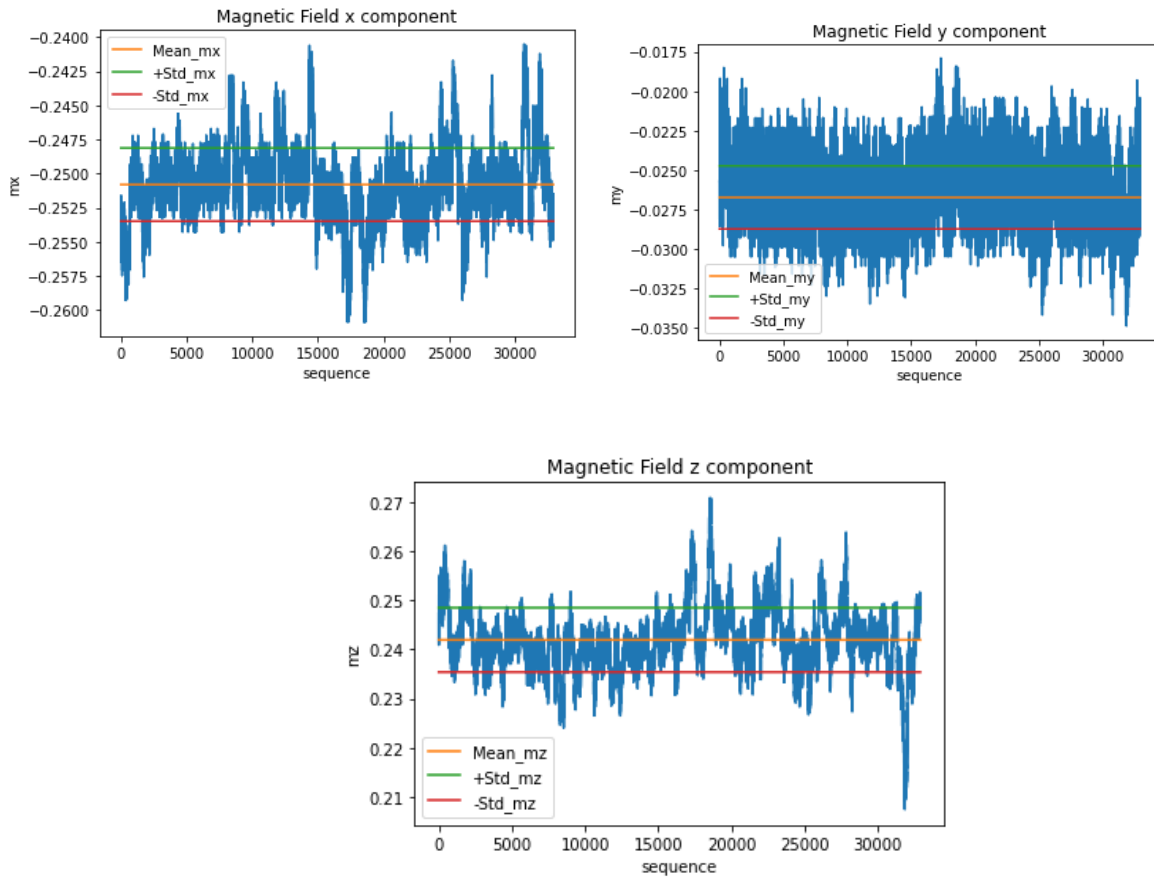
index	angular_velocity.x	angular_velocity.y	angular_velocity.z
count	32932.00000	32932.00000	32932.00000
mean	0.00002	-0.00001	0.00006
std	0.00077	0.00100	0.00078
min	-0.01121	-0.01031	-0.00416
25%	-0.00048	-0.00066	-0.00045
50%	0.00002	-0.00001	0.00004
75%	0.00052	0.00063	0.00054
max	0.02627	0.01730	0.02831

3. Linear Acceleration:



index	linear_acceleration.x	linear_acceleration.y	linear_acceleration.z
count	32932.000000	32932.000000	32932.000000
mean	-0.527939	0.037130	-9.640382
std	0.014091	0.012813	0.034178
min	-0.722000	-0.111000	-10.615000
25%	-0.537000	0.029000	-9.662000
50%	-0.528000	0.037000	-9.640000
75%	-0.519000	0.045000	-9.619000
max	-0.435000	0.118000	-8.724000

4. Magnetic Field:

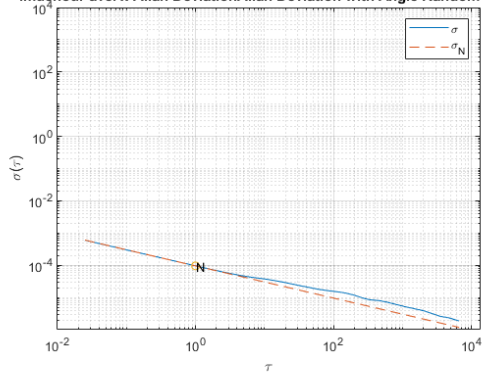


index	magnetic_field.x	magnetic_field.y	magnetic_field.z
count	32932.00000	32932.00000	32932.00000
mean	-0.25081	-0.02674	0.24195
std	0.00269	0.00200	0.00657
min	-0.26090	-0.03490	0.20740
25%	-0.25210	-0.02810	0.23840
50%	-0.25100	-0.02690	0.24160
75%	-0.24940	-0.02560	0.24540
max	-0.24050	-0.01790	0.27090

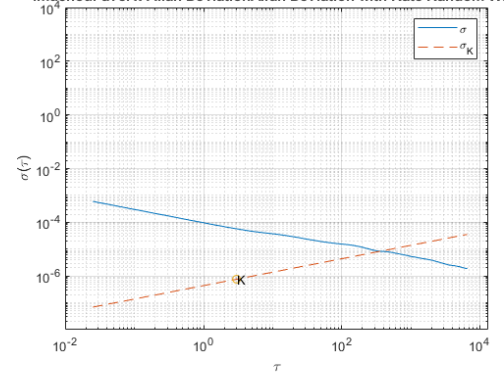
Allan Variance for 5hr Data:

Angular Velocity x:

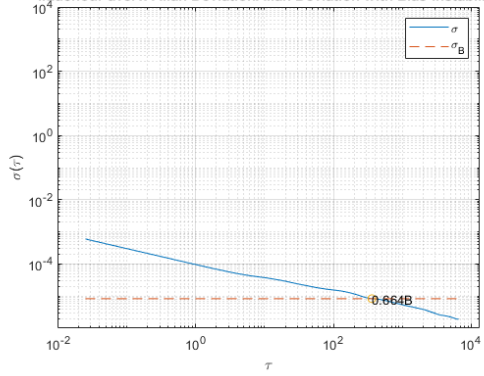
imu5hour avel x-Allan DeviationAllan Deviation with Angle Random Walk



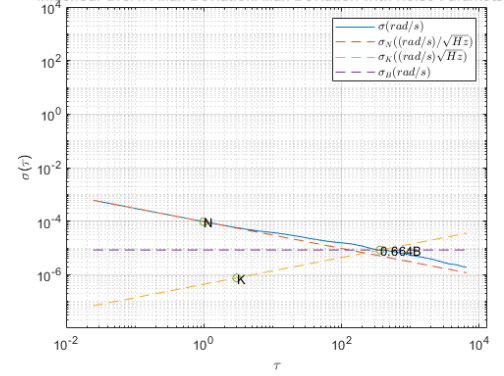
imu5hour avel x-Allan DeviationAllan Deviation with Rate Random Walk



imu5hour avel x-Allan DeviationAllan Deviation with Bias Instability



imu5hour avel x-Allan DeviationAllan Deviation with Noise Parameters

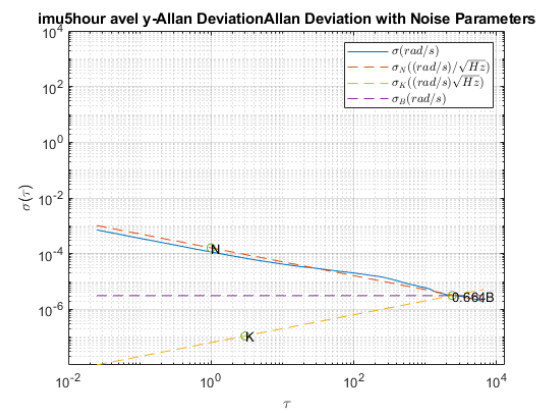
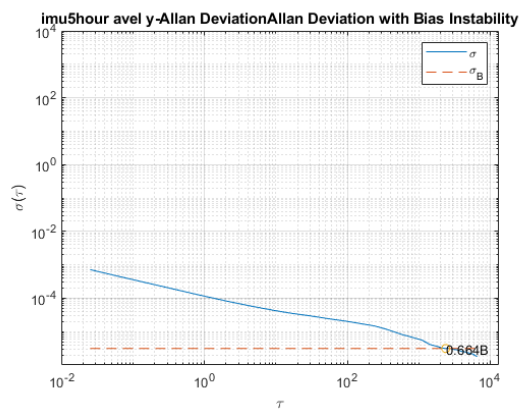
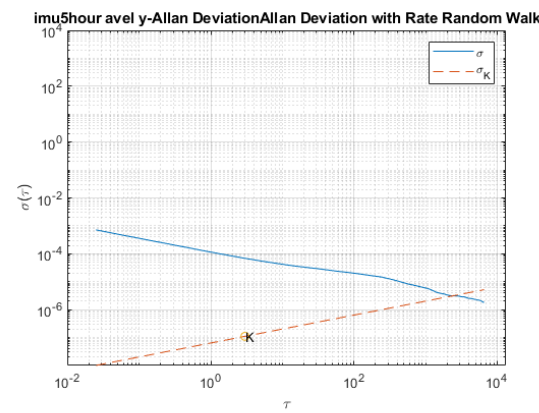
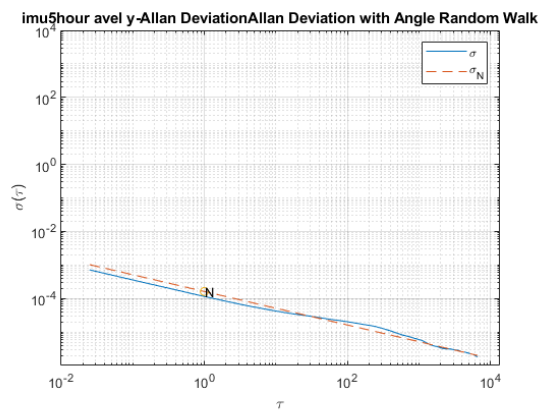


$$N = 9.5466 \times 10^{-5}$$

$$K = 7.5851 \times 10^{-7}$$

$$B = 1.2527 \times 10^{-5}$$

Angular velocity y:

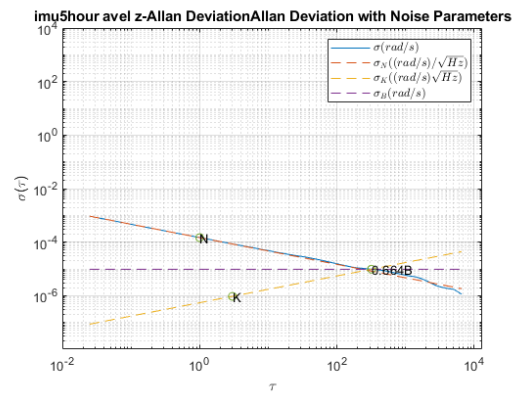
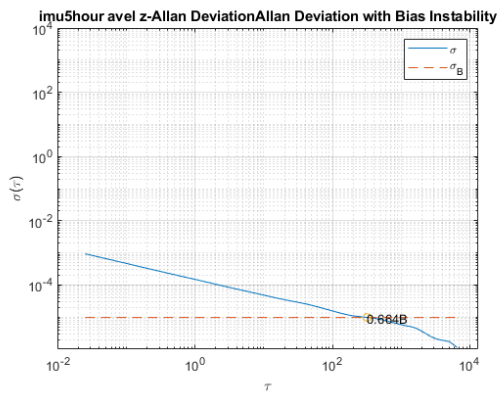
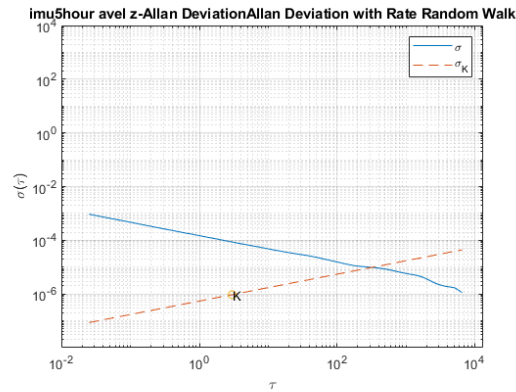
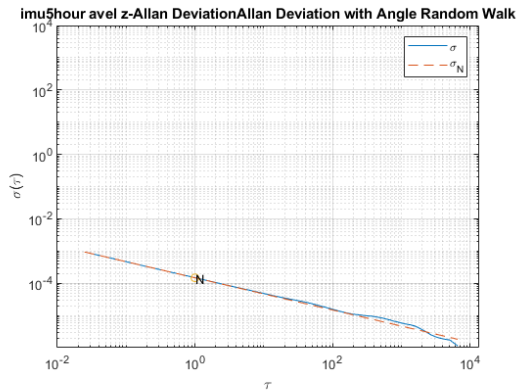


N =1.6150e-04

K =1.1057e-07

B =4.6995e-06

Angular Velocity Z:

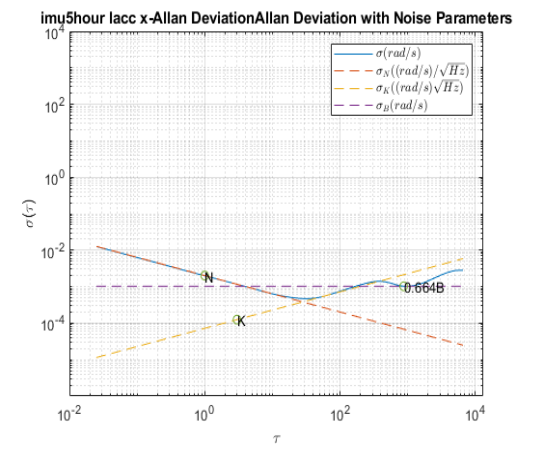
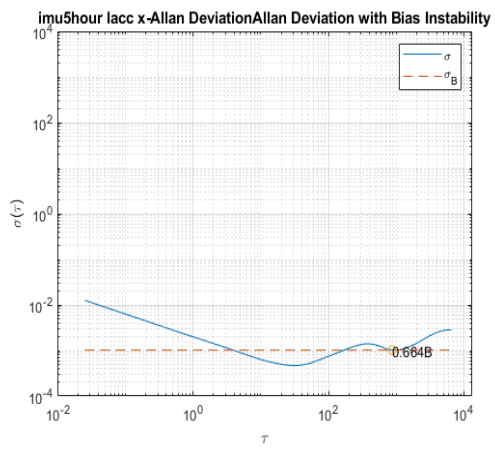
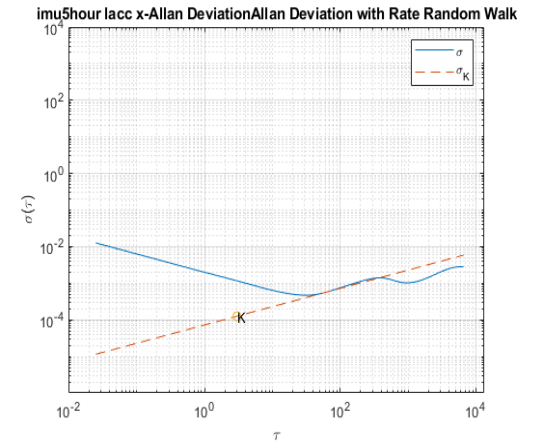
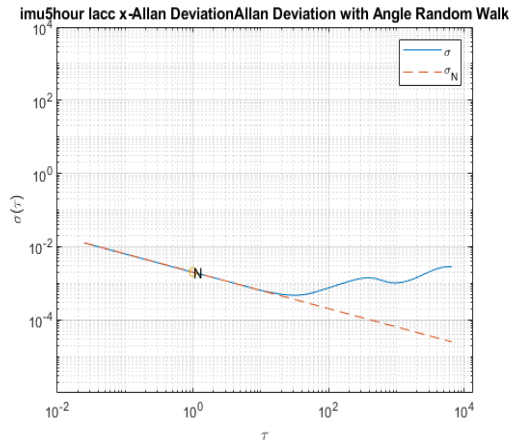


N =1.4754e-04

K =9.4467e-07

B =1.4649e-05

Linear Acceleration x :

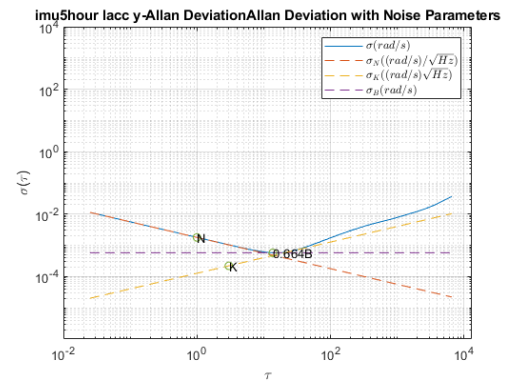
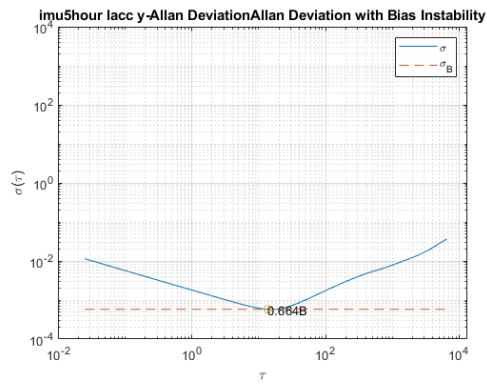
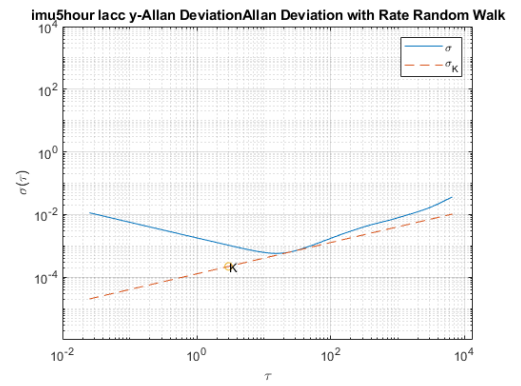
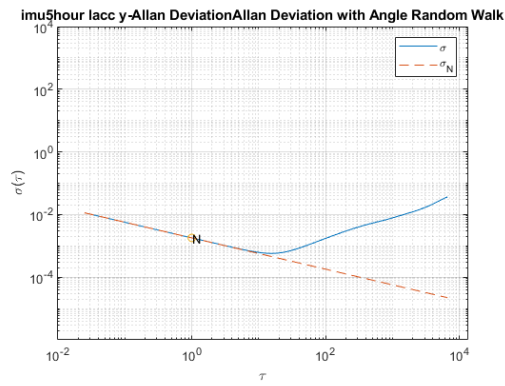


N = 0.0020

K = 1.2492e-04

B = 0.0015

Linear Acceleration Y:



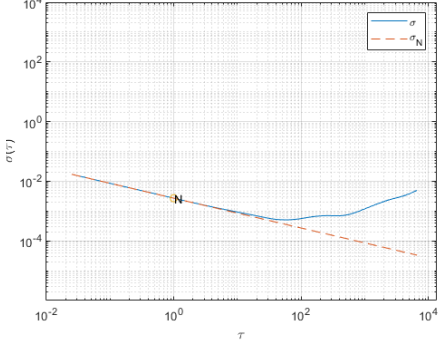
N =0.0018

K =2.2125e-04

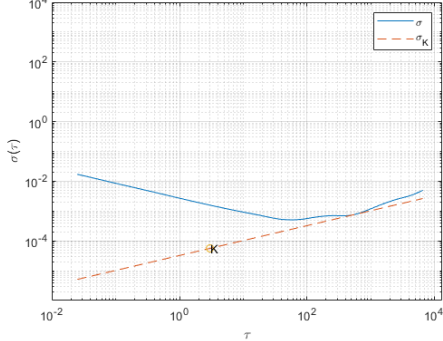
B =8.6861e-04

Linear Acceleration Z:

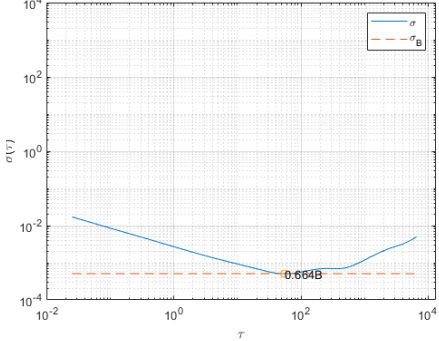
imu5hour lacc z-Allan DeviationAllan Deviation with Angle Random Walk



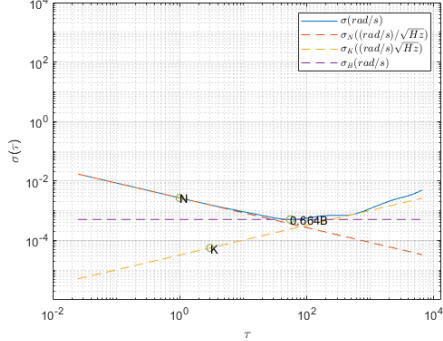
imu5hour lacc z-Allan DeviationAllan Deviation with Rate Random Walk



imu5hour lacc z-Allan DeviationAllan Deviation with Bias Instability



imu5hour lacc z-Allan DeviationAllan Deviation with Noise Parameters



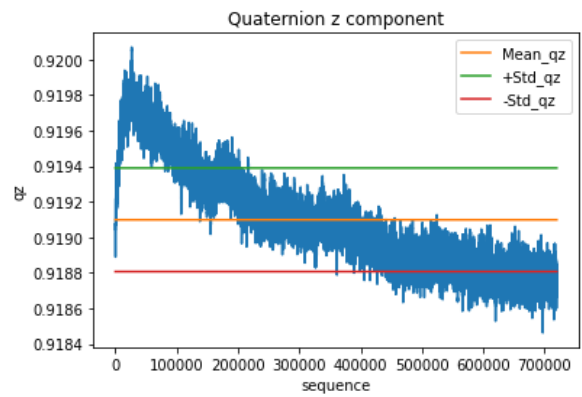
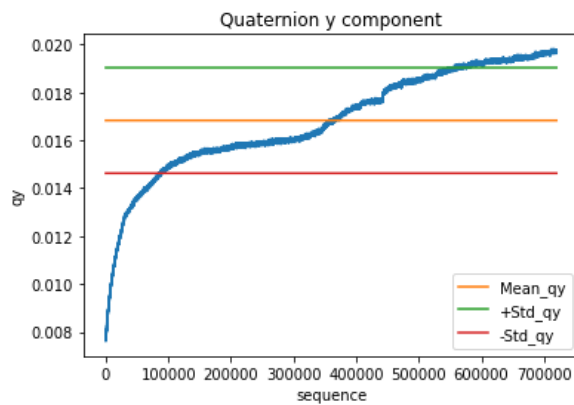
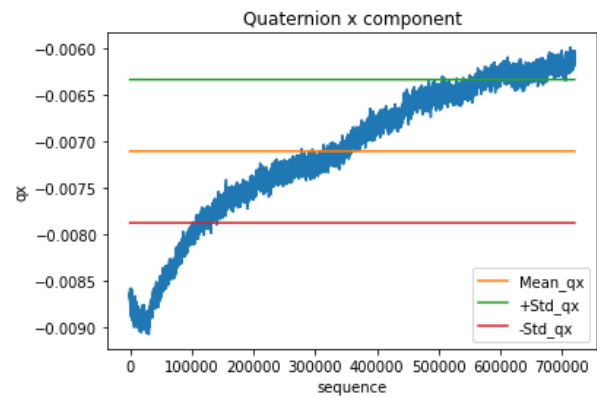
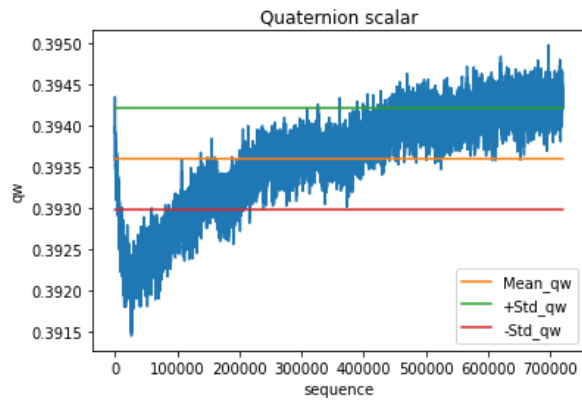
N =0.0027

K =5.6123e-05

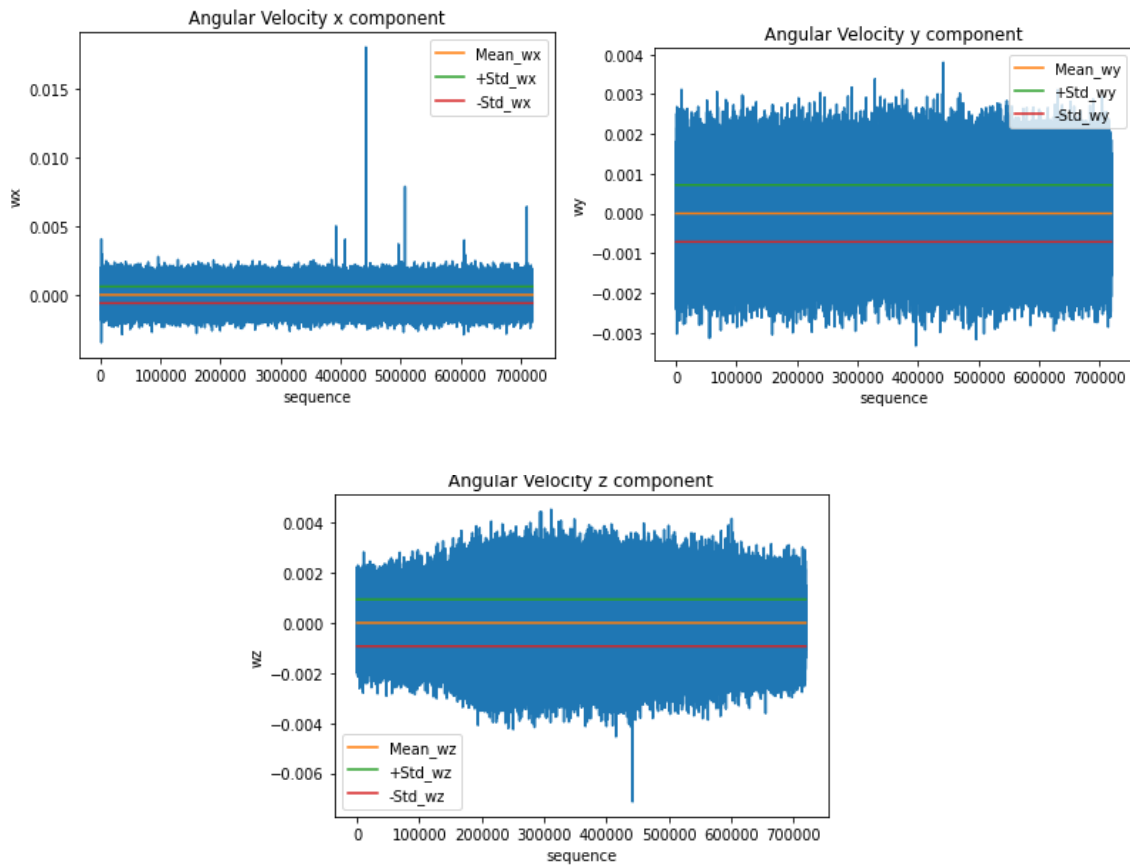
B =7.6522e-04

5hr IMU Data Analysis:

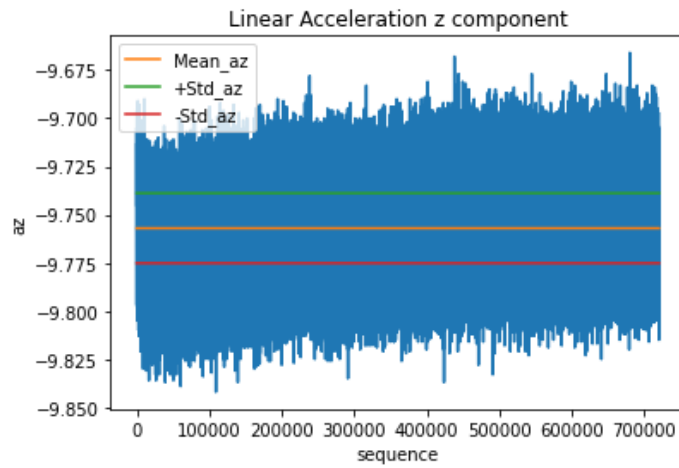
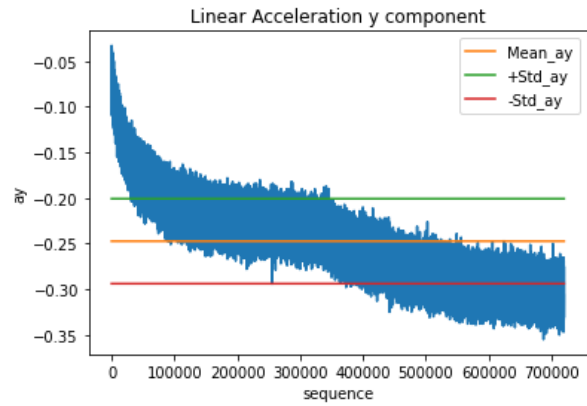
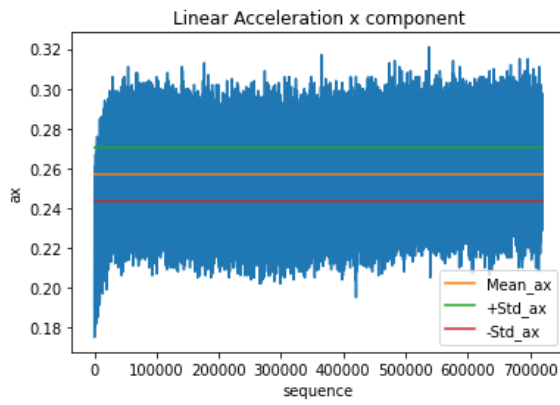
1. Quaternions:



2. Angular Velocity:



3. Linear Acceleration:



4. Magnetic Field:

