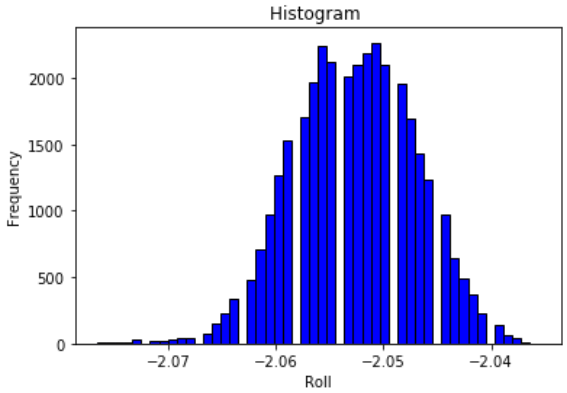
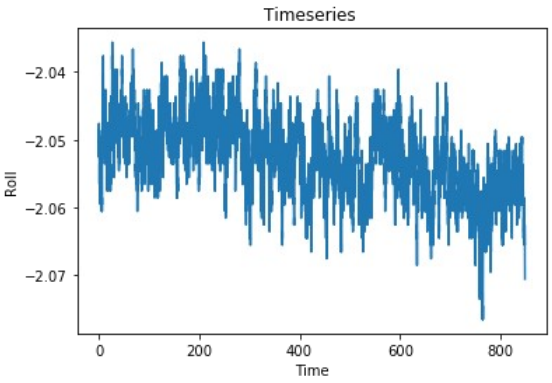
Individual data assessment

Orientation(in Euler)

ROLL

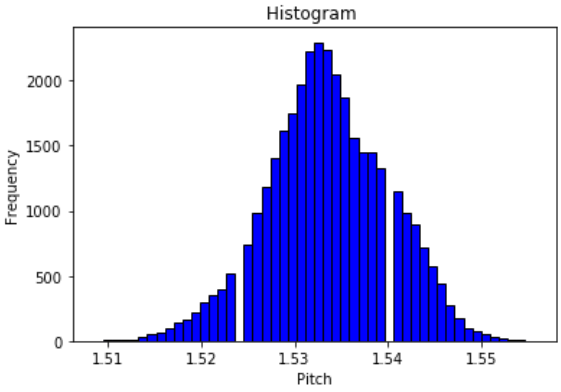


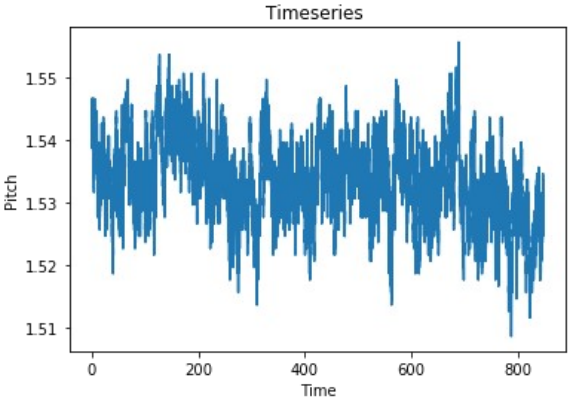


Mean: -2.0527107928232144

Standard deviation: 0.005631931611313559

PITCH

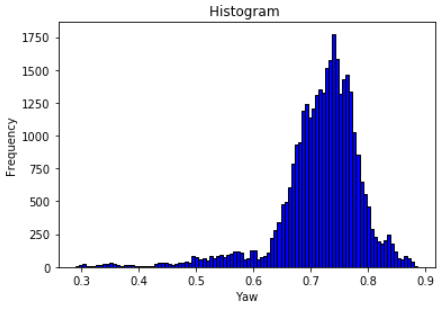


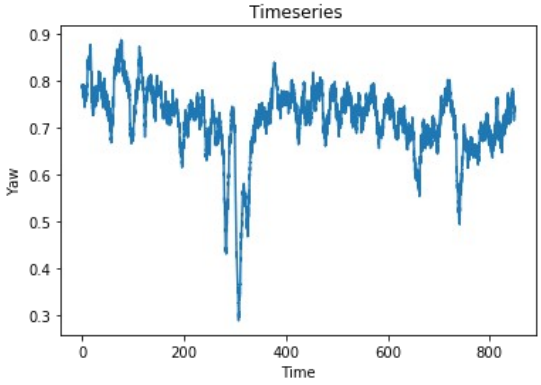


Mean: 1.5334600489290415

Standard deviation:0.006489009394327021

YAW





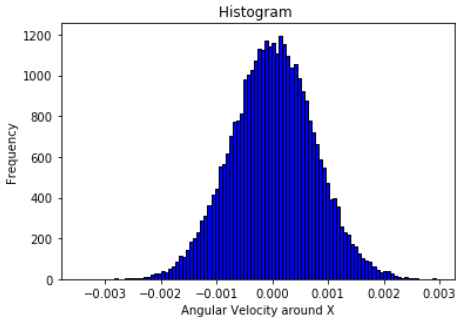
Mean:0.7164081782991557

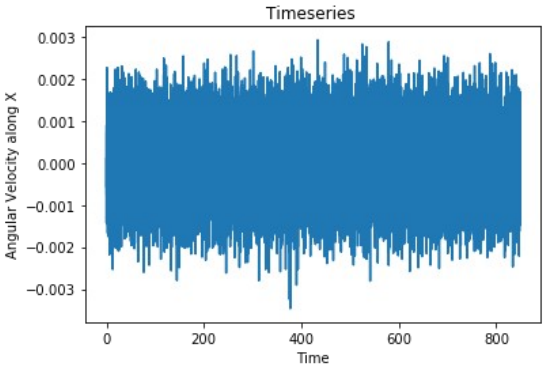
Standard deviation:0.07408497149274834

Analysis of orientation:
If we take an overall look at the histograms of each we can say that the distributions are mostly gaussians. A negative roll mean implies that maybe the floor(basement) where I took the readings was tilted(most of the houses in Huntington are tilted unfortunately). As the IMU was taped to the floor so we can expect it to have really low standard deviation also owing to its high sensitivity. Also, there is an anomaly in the data for yaw where a slight disturbance has been seen for a very short duration this could possibly be because of the wire moved a little because of some possible vibration, hence this might also have impacted the standard deviation of yaw and hence is less than pitch and roll.

3 Axis angular gyros(angular velocity)

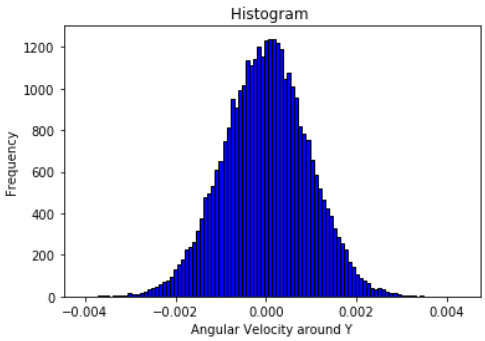
X Axis

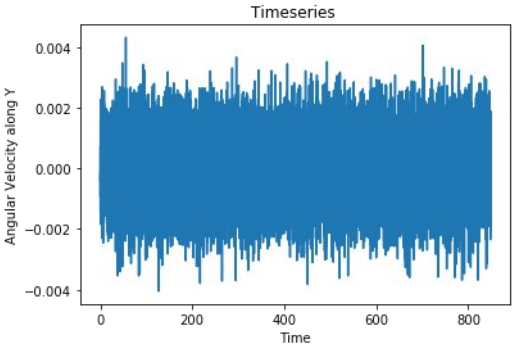




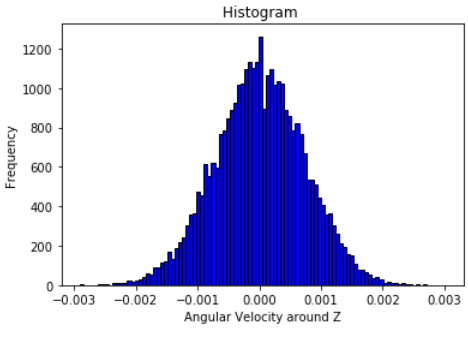
Mean:5.516262078717889e-06
Standard deviation:0.0007448542406968123

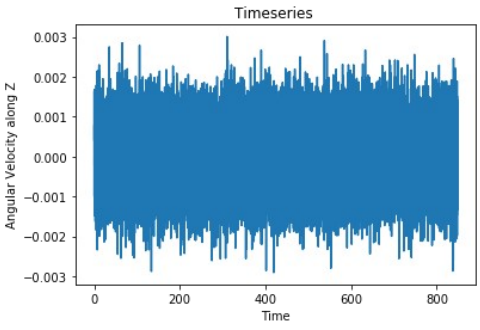
Y Axis





Mean:-3.428617723308979e-06
Standard deviation:0.000941141035379478
Z Axis

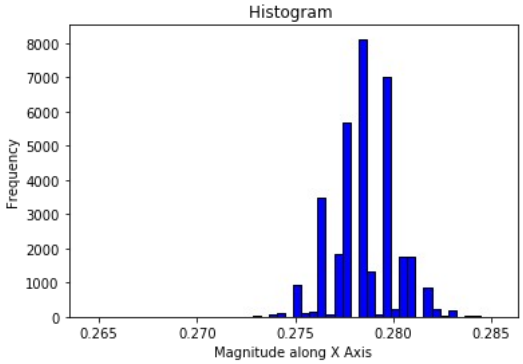


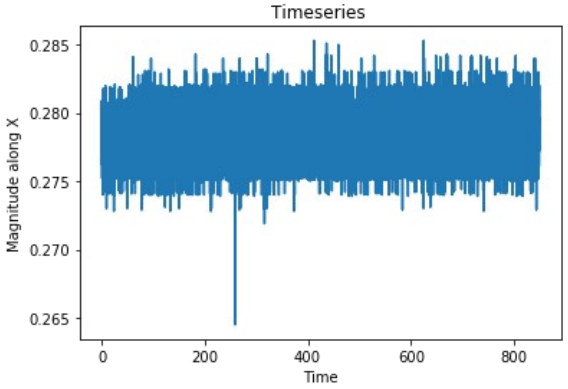


Mean:5.385635163799197e-06
Standard deviation:0.0007263771967508148

Analysis on angular gyros:
The values of each of these appear to be very close to an ideal gaussian distribution. The means are really low as the IMU was stuck to a table and was in a stationary place so obviously the angular velocity wouldnt change. The high sensitivity and precision of the device still managed to get some values but ideally the mean along all axis should be 0.

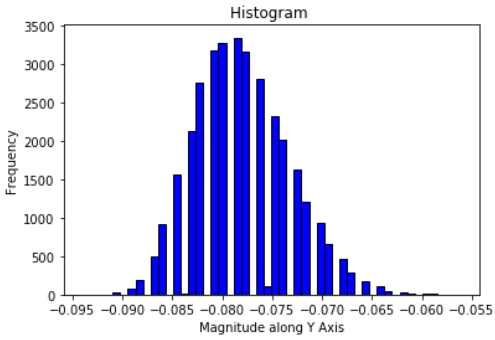
3 Axis magnetometer
X Axis

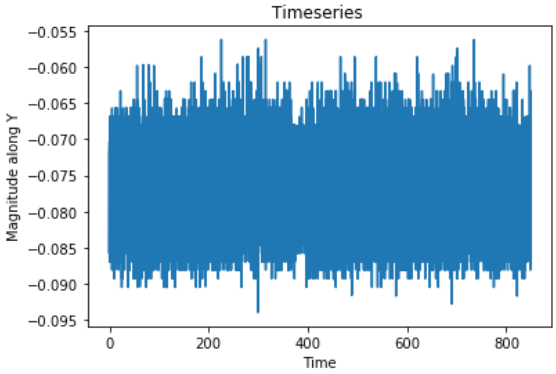




Mean:0.2785227610181475
Standard deviation:0.001595952513346805

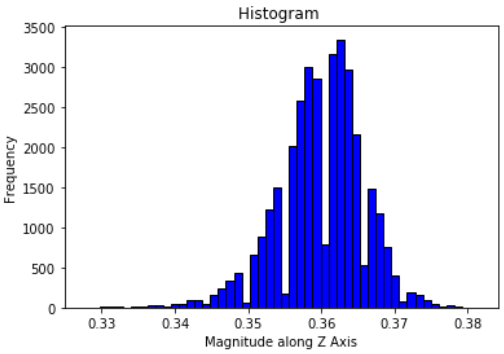
Y Axis

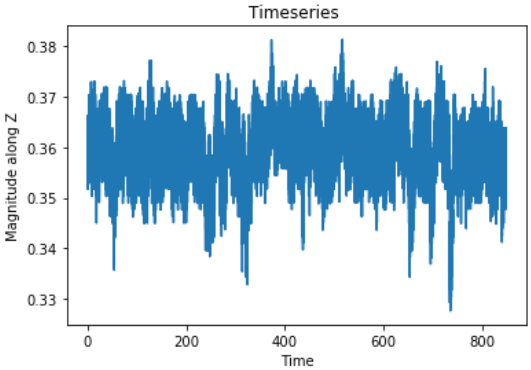




Mean:-0.07805647537119963
Standard deviation:0.004760813190172163

Z Axis





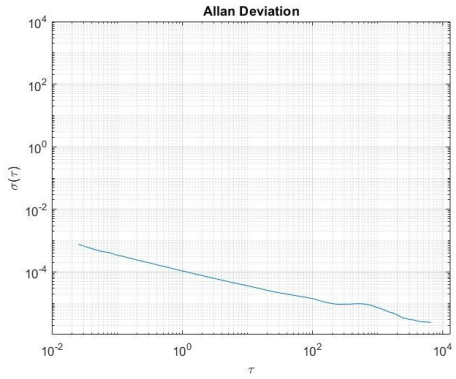
Mean:0.359950132571294
Standard deviation:0.0058395209303564325

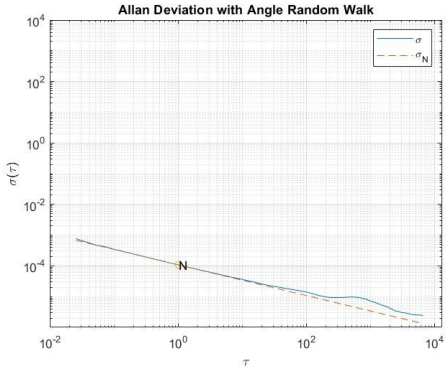
Analysis on magnetometer:

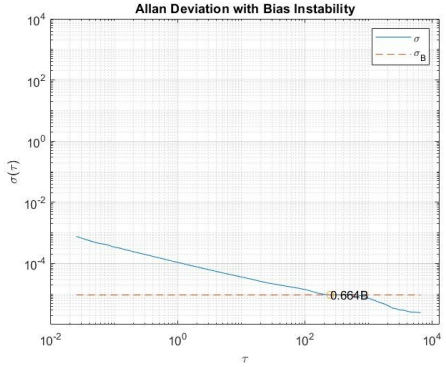
1. These are the only graphs which cant be called gaussian. The magnetic field that it would experience in a basement would be from the earth's magnetic field or from the magnetic waves produced by our devices. A magnetic spike along the X Axis is experienced almost at the same time when Yaw had a similar spike, this makes an interesting observation which can lead us to believe that it was because of some human or man made vibration(like a phone call?)

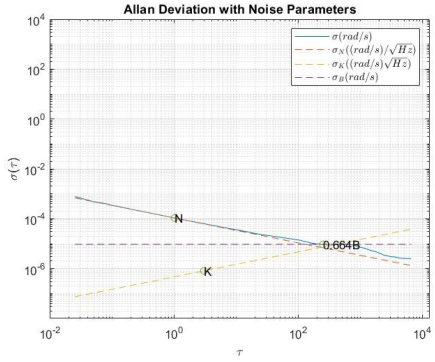
Allan Variance:

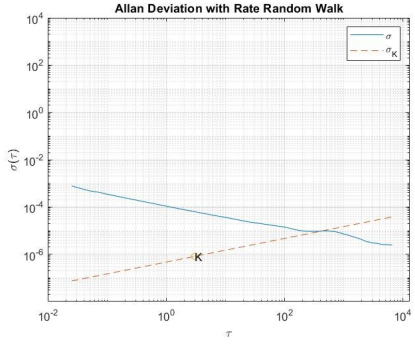
X

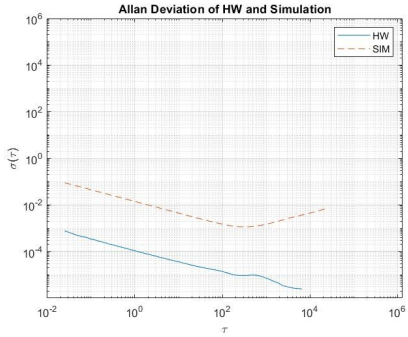




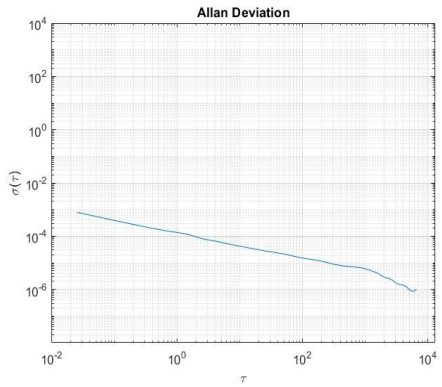


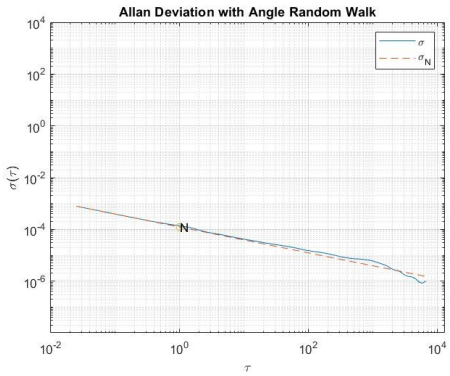


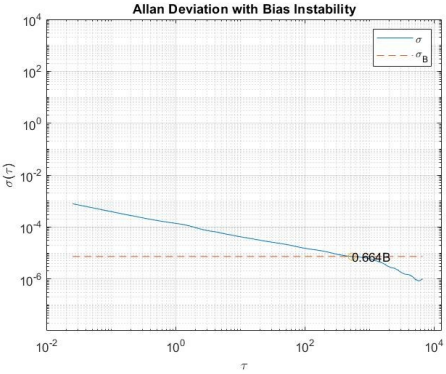


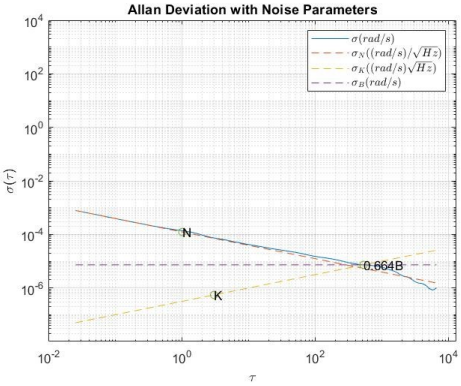


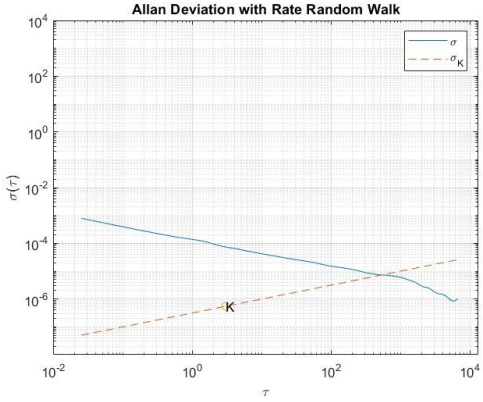
Y

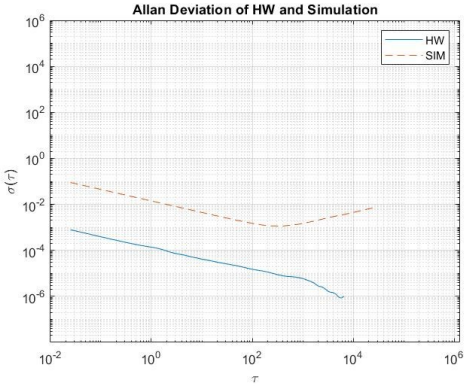

Allan Deviation
$\sigma(\tau)$
τ


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

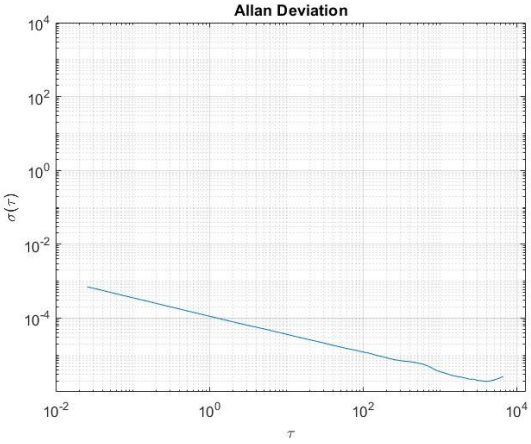

Allan Deviation with Bias Instability
σ
σ_B
0.664B
$\sigma(\tau)$
τ

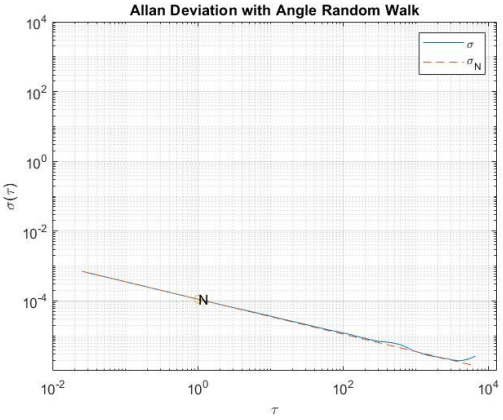

Allan Deviation with Noise Parameters
$\sigma(rad/s)$
$\sigma_N((rad/s)/\sqrt{Hz})$
$\sigma_K((rad/s)\sqrt{Hz})$
$\sigma_B(rad/s)$
N
0.664B
K
$\sigma(\tau)$
τ

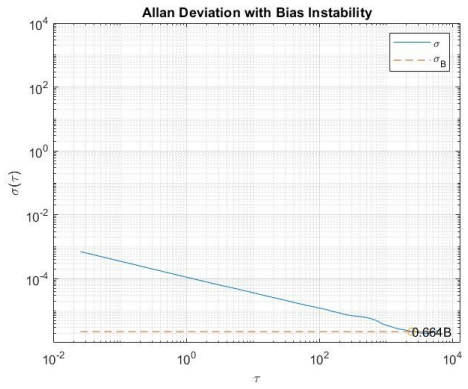

Allan Deviation with Rate Random Walk
σ
σ_K
K
$\sigma(\tau)$
τ

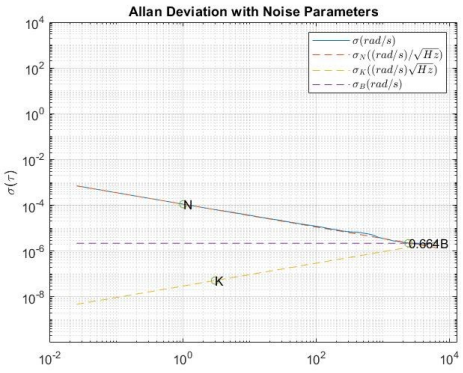

Allan Deviation of HW and Simulation
HW
SIM
$\sigma(\tau)$
τ

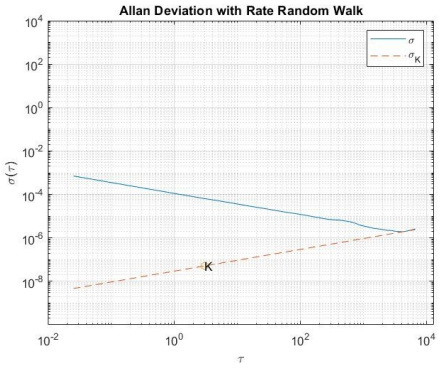
Z

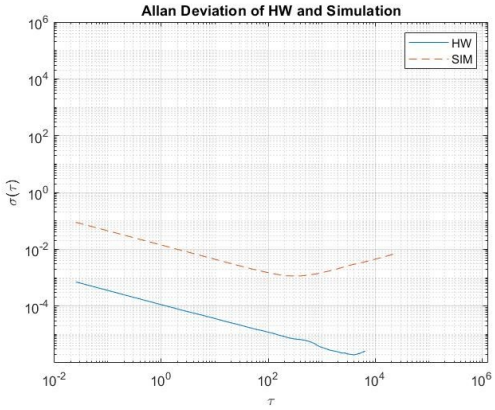

Allan Deviation
$\sigma(\tau)$
τ


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









What kind of errors and sources of noise are present?
Overtime the use of IMU sensors may introduce some Bias error which may effect the gyroscope and accelerometer readings. Uncalibrated equipments can also introduce some kind of errors in and hence proper scaling is required. Noise may creep from the surrounding through various electronic and environmental factors which would cause errors.

How do we model them?
Errors that are caused by bias can be removed by adding some constant value depending on the bias usually for the gyroscope readings. Device should be calibrated everytime we use or to introduce a scaling factor. Models like random walk is also used to remove bias by calculating the unpredictable and random variations. If a known variance is known, the noise can be added as white noise to remove errors from the sensor.

How do measurements compare to that of the datasheet?

Angle Random walk
N = 0.0199

Rate Random walk
K = 5.7350e-05

Bias
B =   0.0020
According to sensor grade for navigation given in the pdf:N=0.01 B=0.01

The errors are almost double of what has been provided, this maybe because of the errors caused over time.