

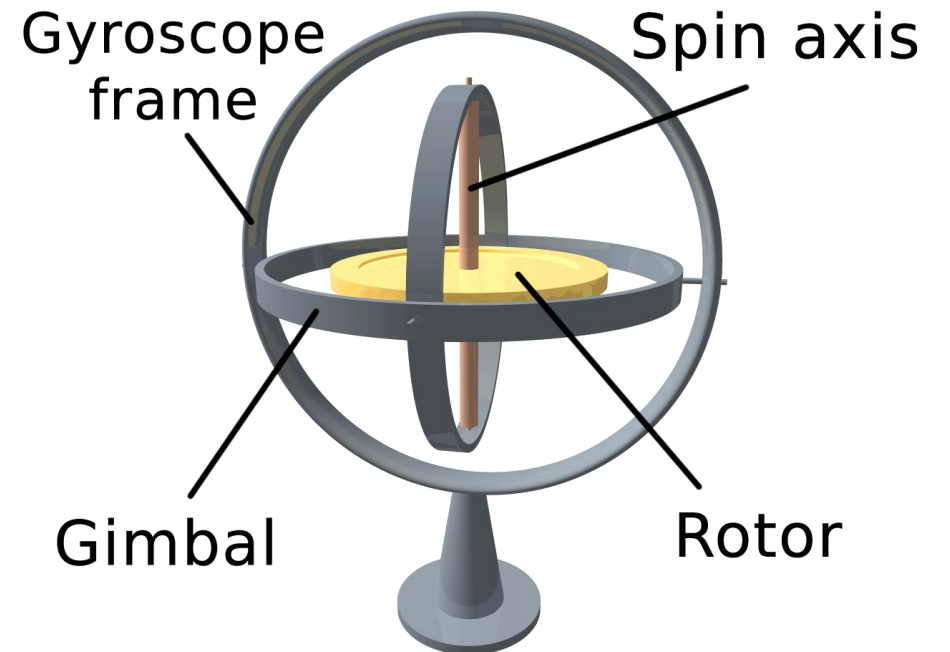
Simulation of a MEMS Gyroscope

ME237

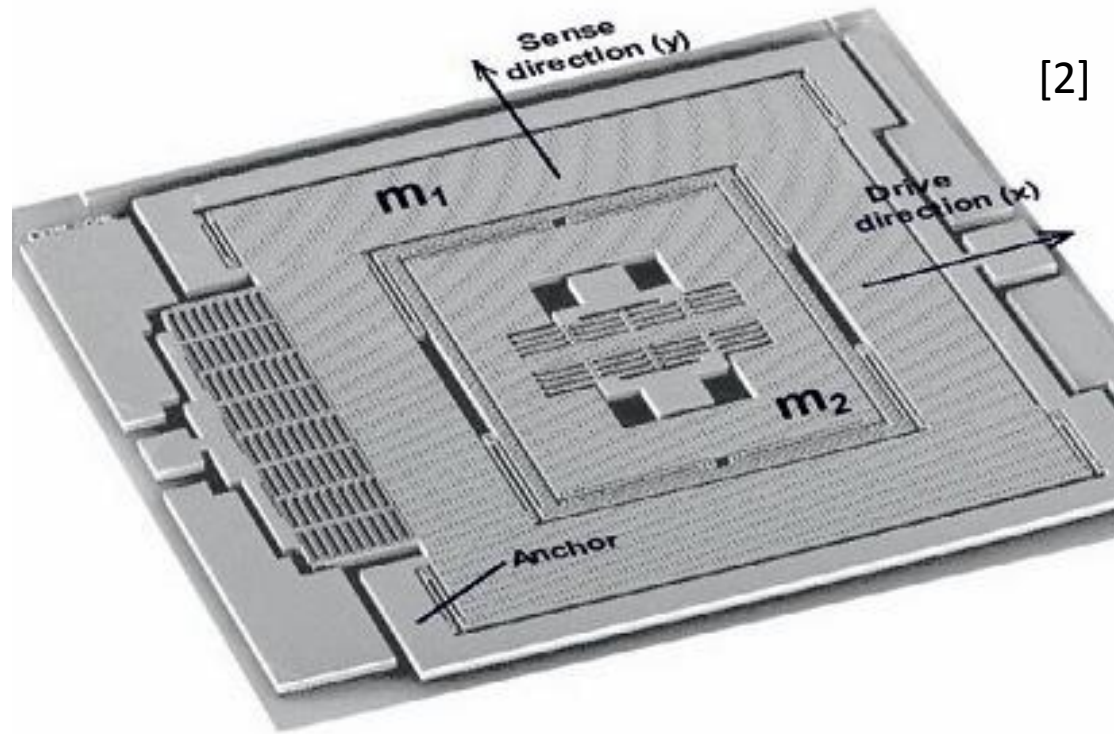
Project assignment

What is a Gyroscope?

- Gyroscope is a device that is used to measure orientation angular velocity and acceleration ,if possible, of a body.
- Principal of normal Gyroscope
 - Resisting the change of angular momentum vector.



MEMS Gyroscope



Working Principle

Works by transferring one mode of vibration to another.

Coriolis effect and angular acceleration is used as the method of transfer of energy.

Schematic of a mems Gyroscope

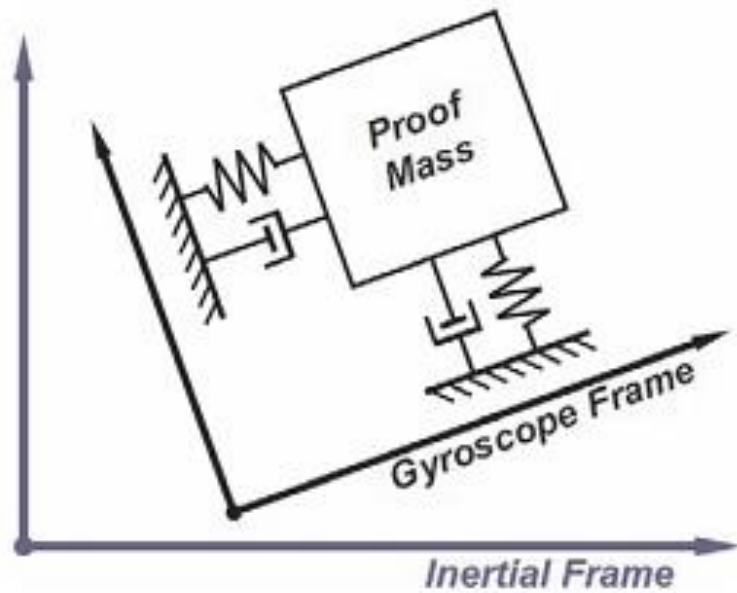


Fig:- Basic working schematic

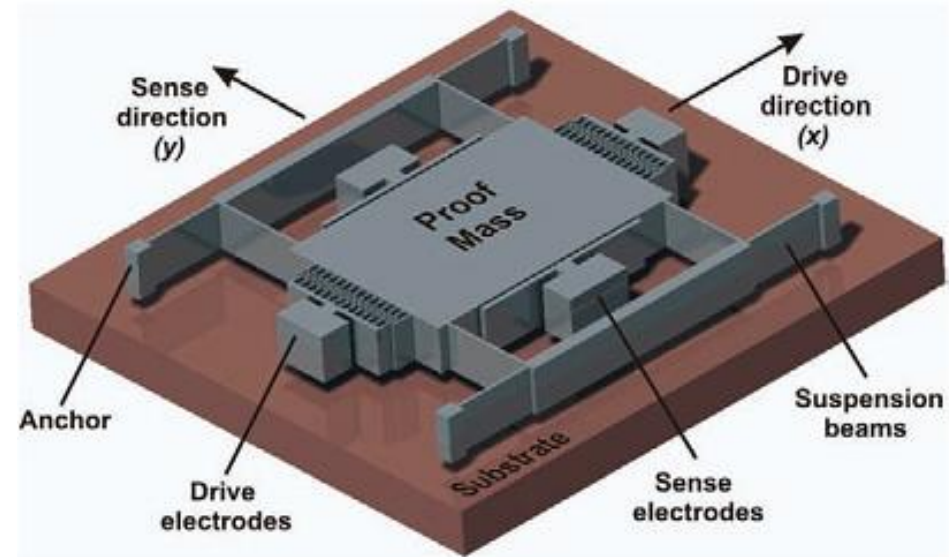
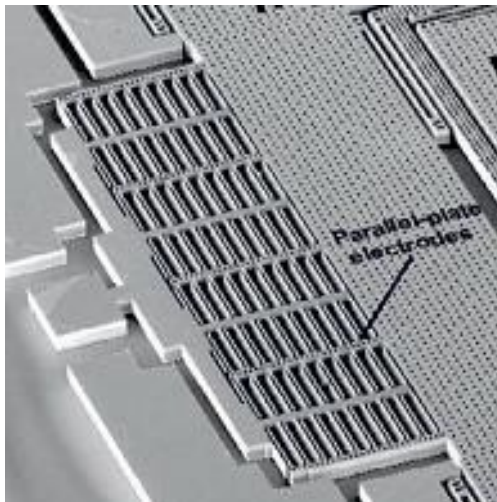


Fig: 3D view of a MEMS Gyro

Driving and sensing

Drive mode

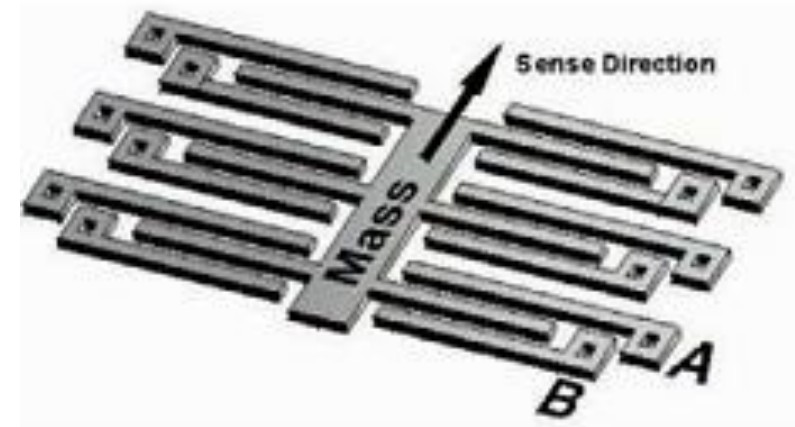
- Parallel plate capacitor as driving actuator.
- Comb drive



[2]

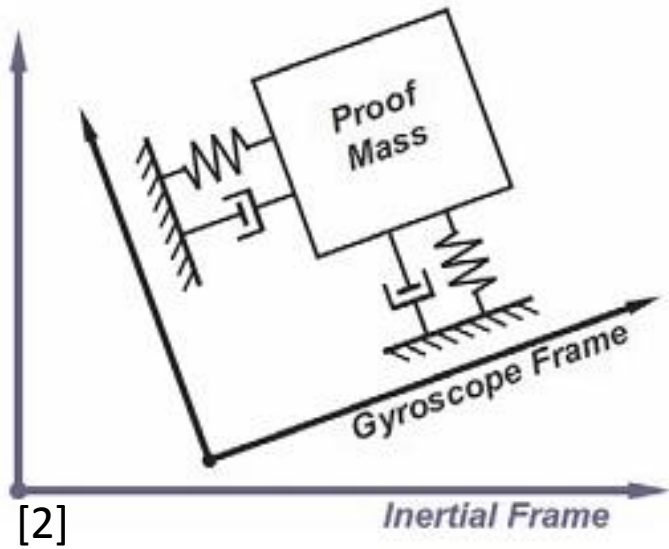
Sense mode

- Parallel plate capacitor as sensor
- Differential sensor



[2]Mems vibratory Gyroscopes, Cenk Acar and Andrei Shkel

Work done:-



For drive unit

$$m\ddot{x} + c\dot{x} + kx = F \sin(\omega t)$$
$$\therefore \ddot{x} + 2\xi\omega_n\dot{x} + \omega_n^2x = \frac{F}{m} \sin(\omega t) \dots (1)$$

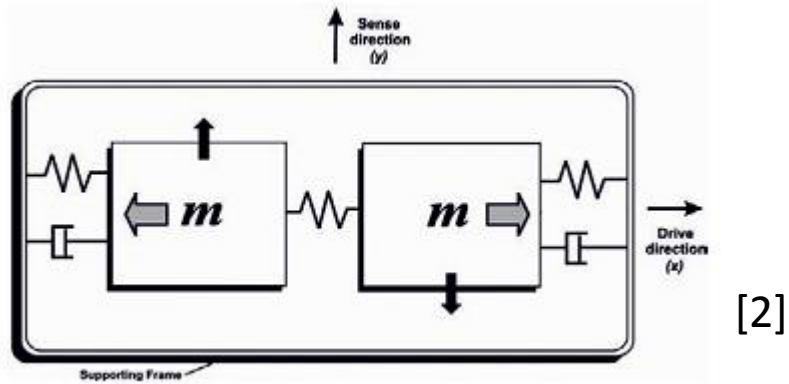
For sensing unit

$$m_1\ddot{y} + c_1\dot{y} + k_1y = m_1(2\Omega\dot{x} + \dot{\Omega}x)$$
$$\therefore \ddot{y} + 2\xi_1\omega_{n1}\dot{y} + \omega_{n1}^2y = 2\Omega\dot{x} + \dot{\Omega}x \dots (2)$$

$$\text{Ans: } \dot{x} \propto \omega x(\omega t + \frac{\pi}{2})$$

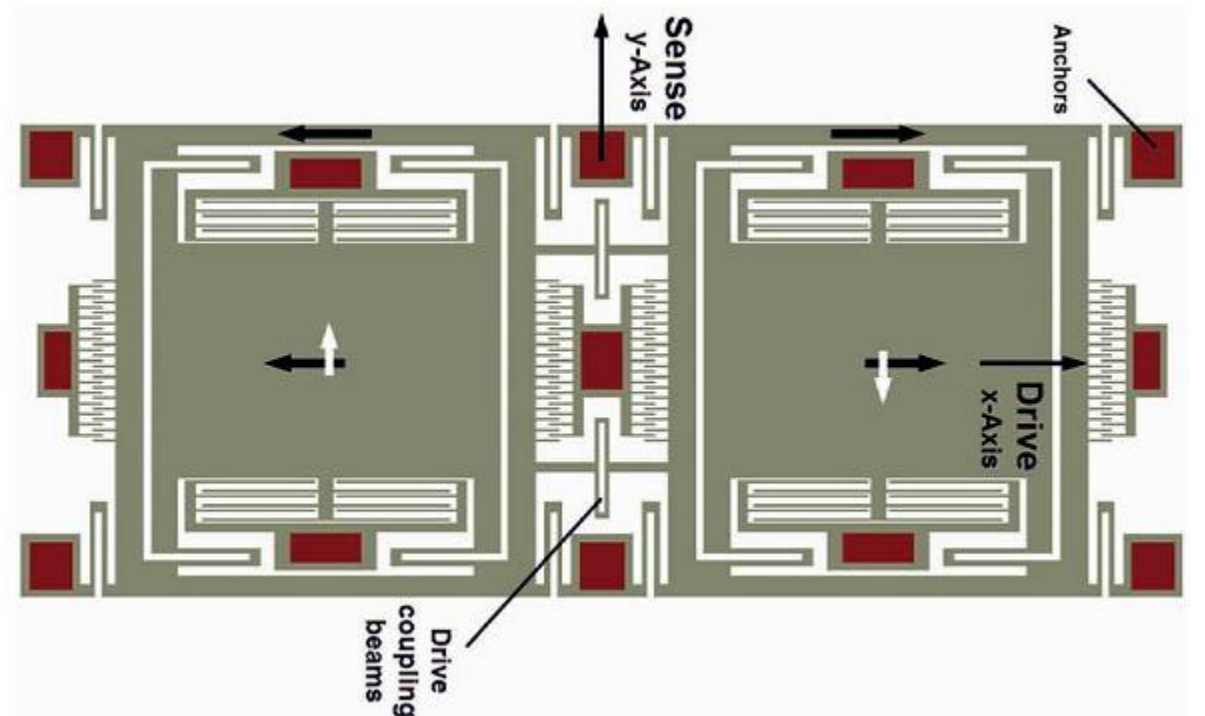
So for ease of calculation and better understanding of the system, we take the modified form of dynamic equation.

Anti-phase device

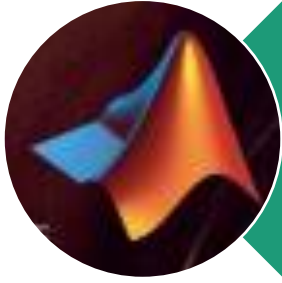


[2]

Used to remove platform noise from the system.



[2]



Simulink model

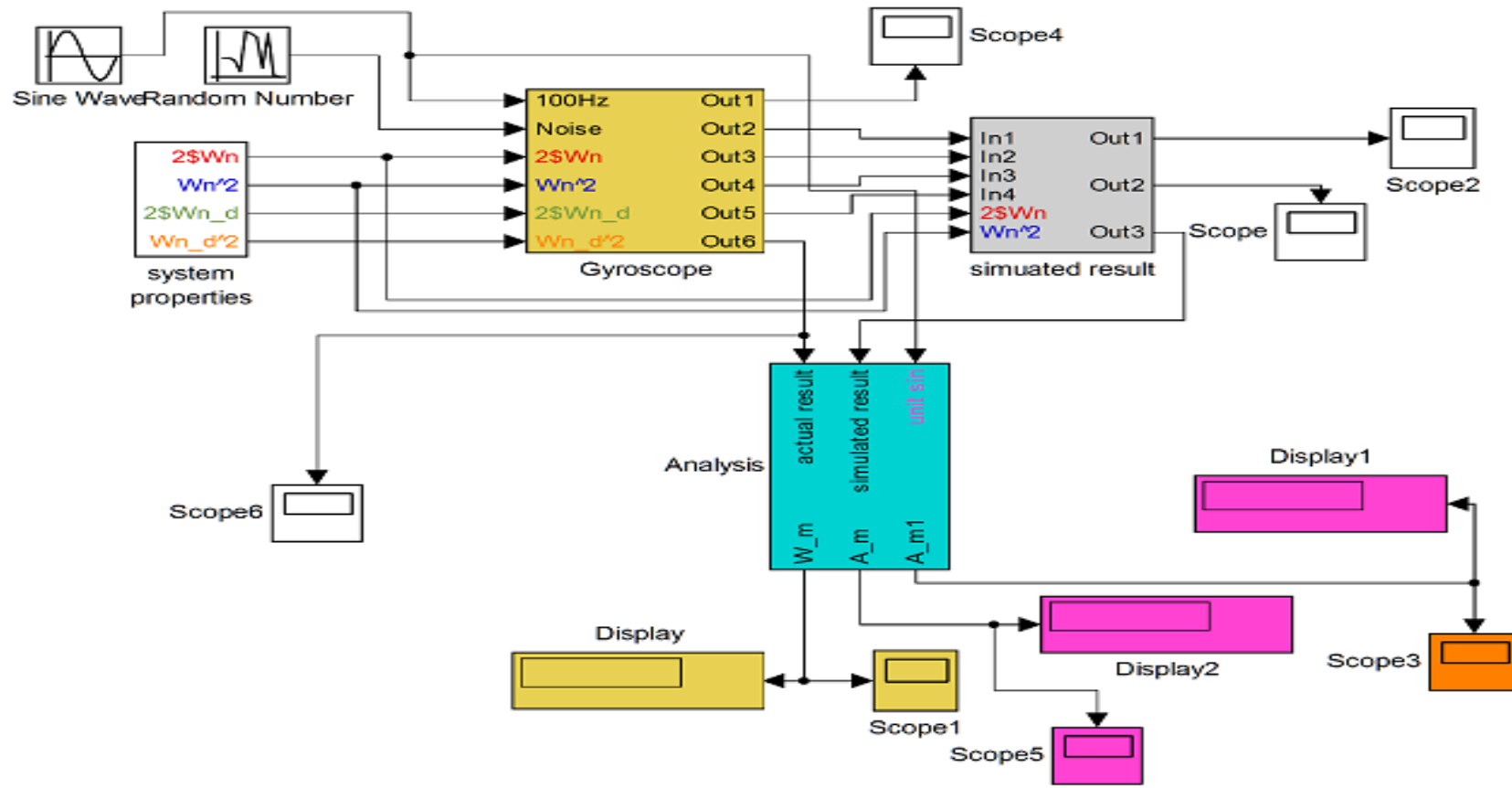


Fig: simulation of [gyroscope](#)

Results

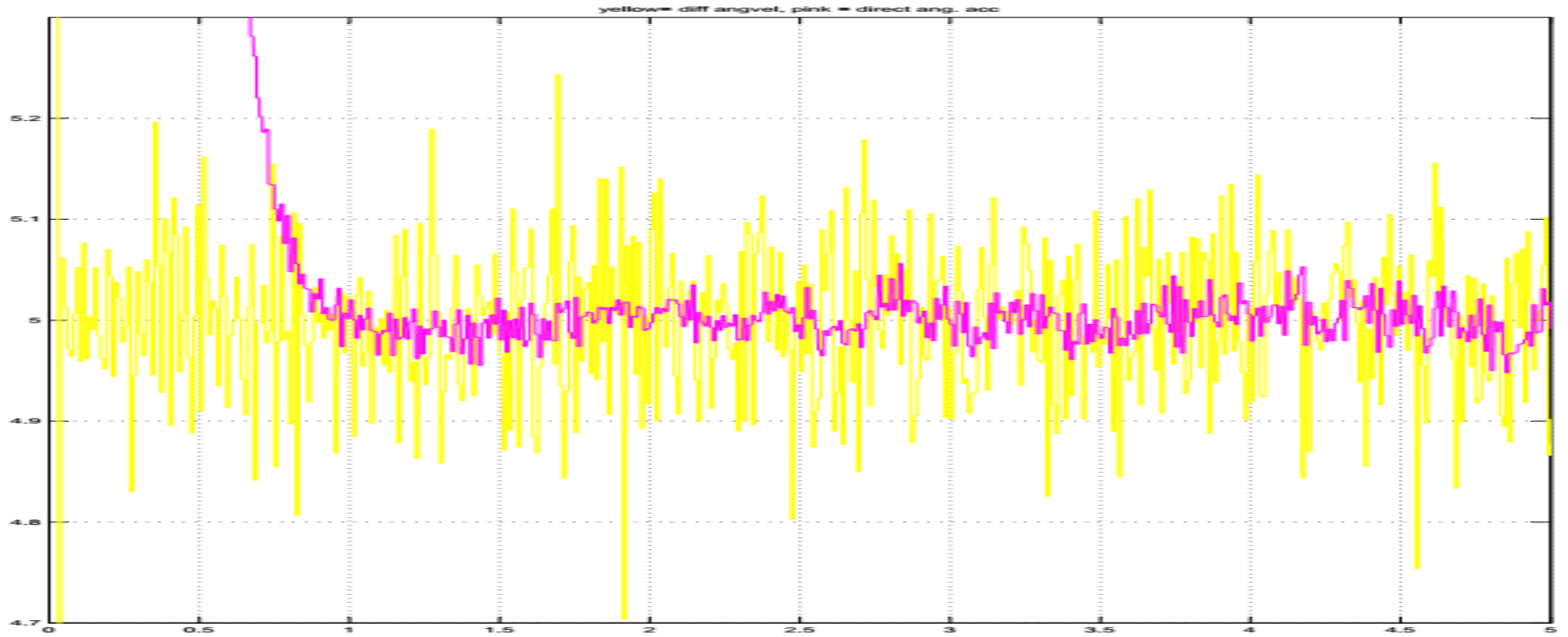


Fig:- comparing 2 simulated angular acc

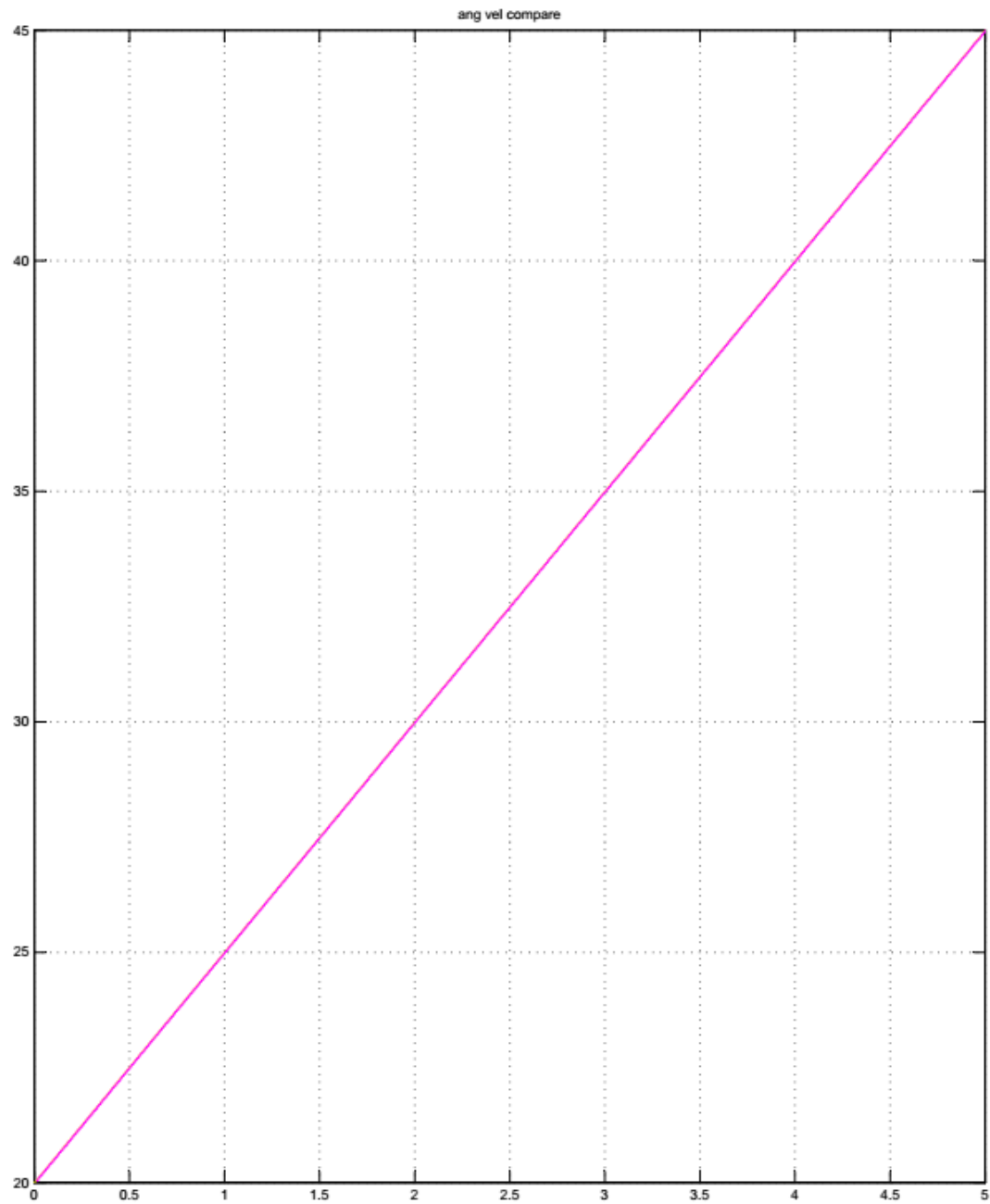


Fig: angular velocity comparison

As it turns out they are overlapping

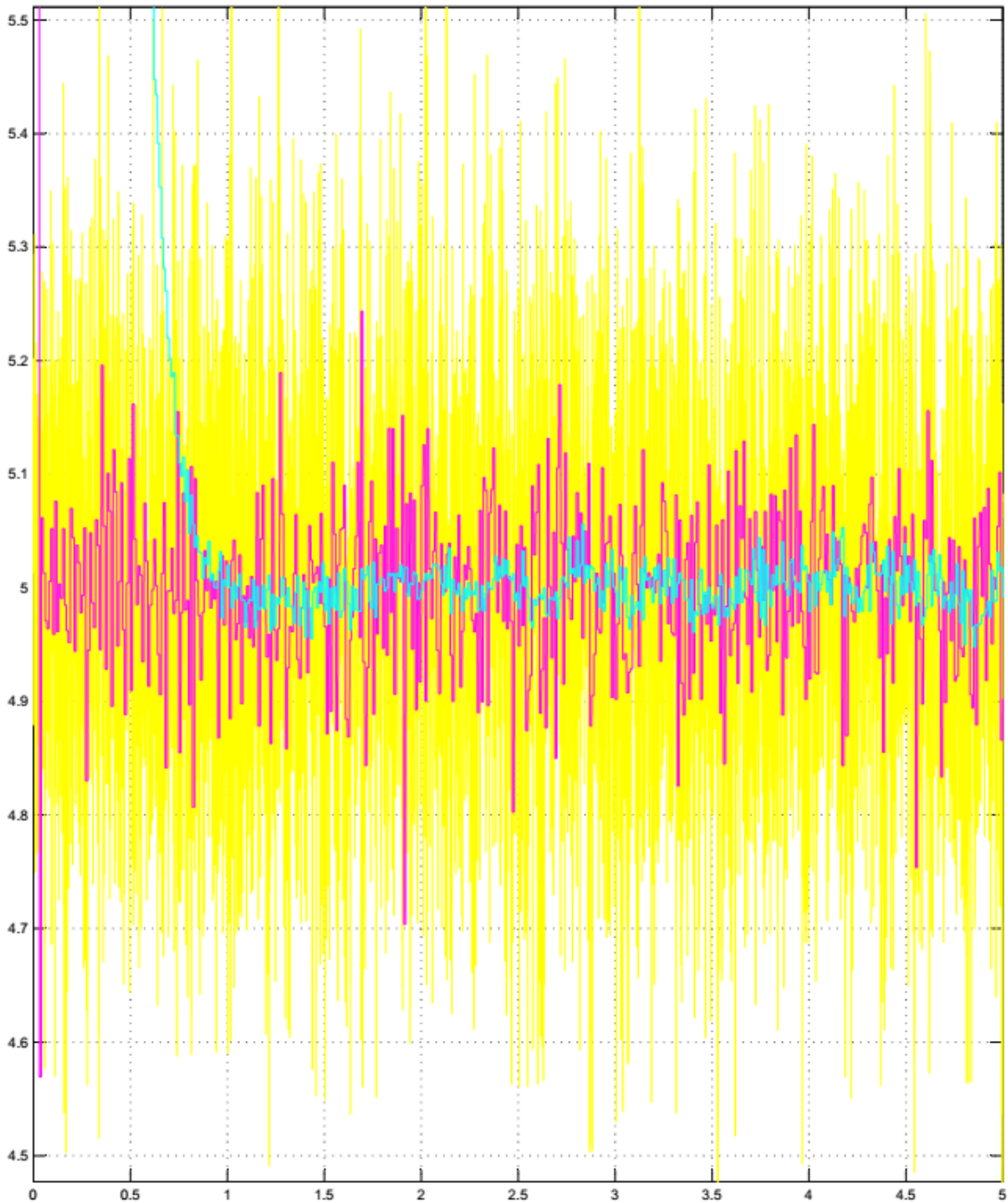


Fig: comparing all acceleration

Yellow= angular acceleration external

Pink= differential angular acceleration
measured

Light blue= direct angular acceleration
measured

Thank you

- Reference

- I. Mems vibratory Gyroscopes, Cenk Acar and Andrei Shkel
- II. Micro and Smart systems, G.k.Anandsuresh,k.j.vijoy