Superconducting Magnetic Bearing of EBEX experiment

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Supervisors

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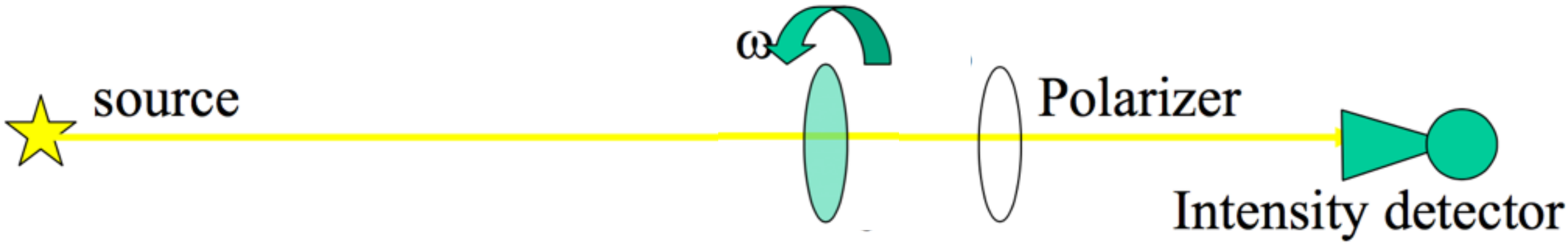
Michele Limon

Polarimeter with HWP



$$W = \tfrac{1}{2}\left(I + Q\cos^2 2\theta\right)$$

$$f = 4 f_o$$

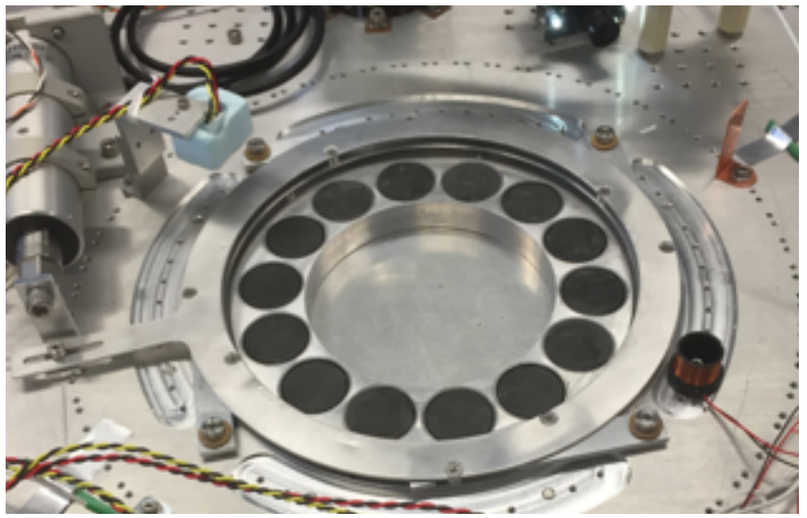
We have to rotate the HWP in order to:

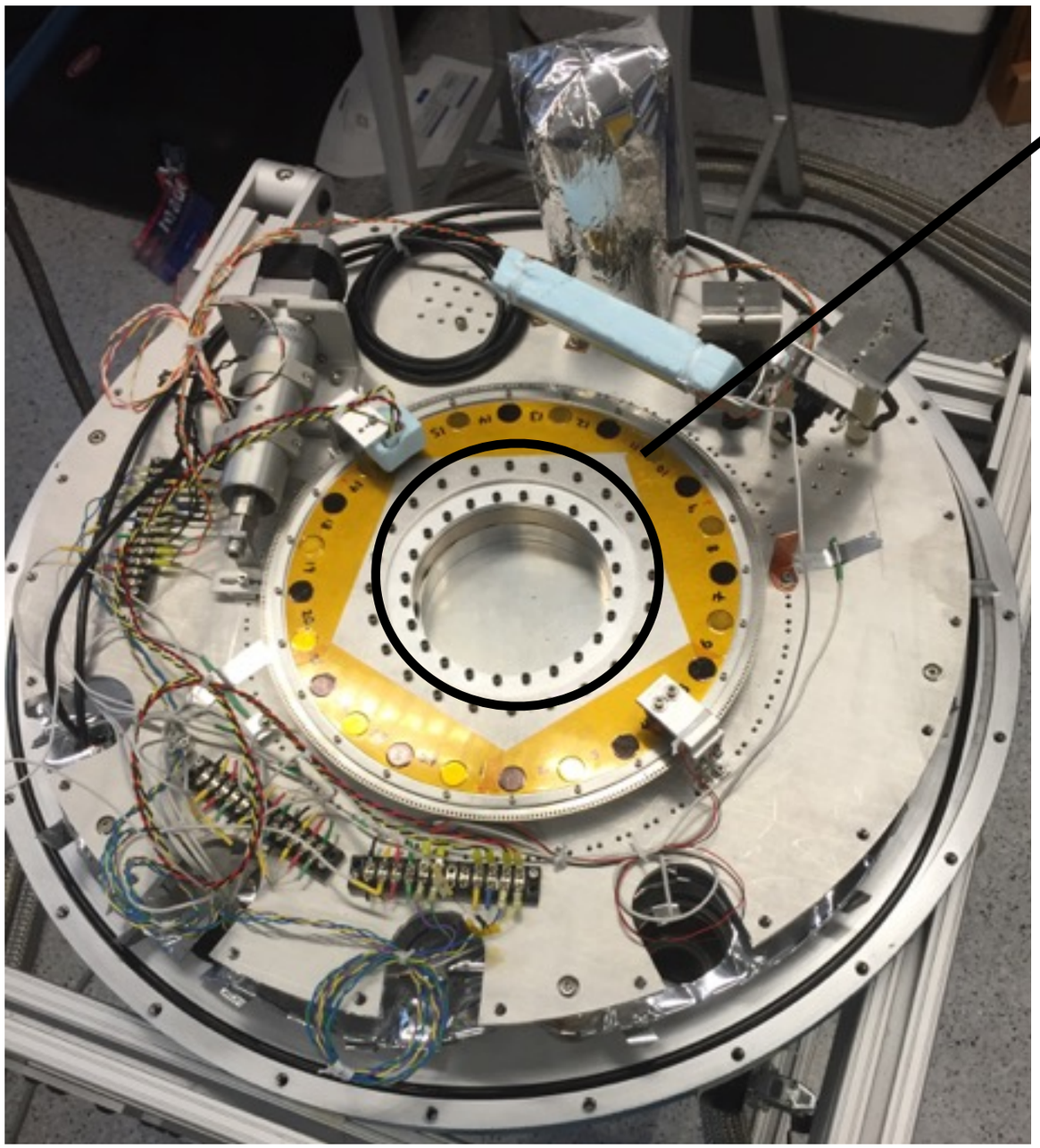
- reduce the effect of beam asymmetries and instrumental polarization of optical elements below the HWP
- modulate the signal
- reject atmospheric variations and 1/f noise.

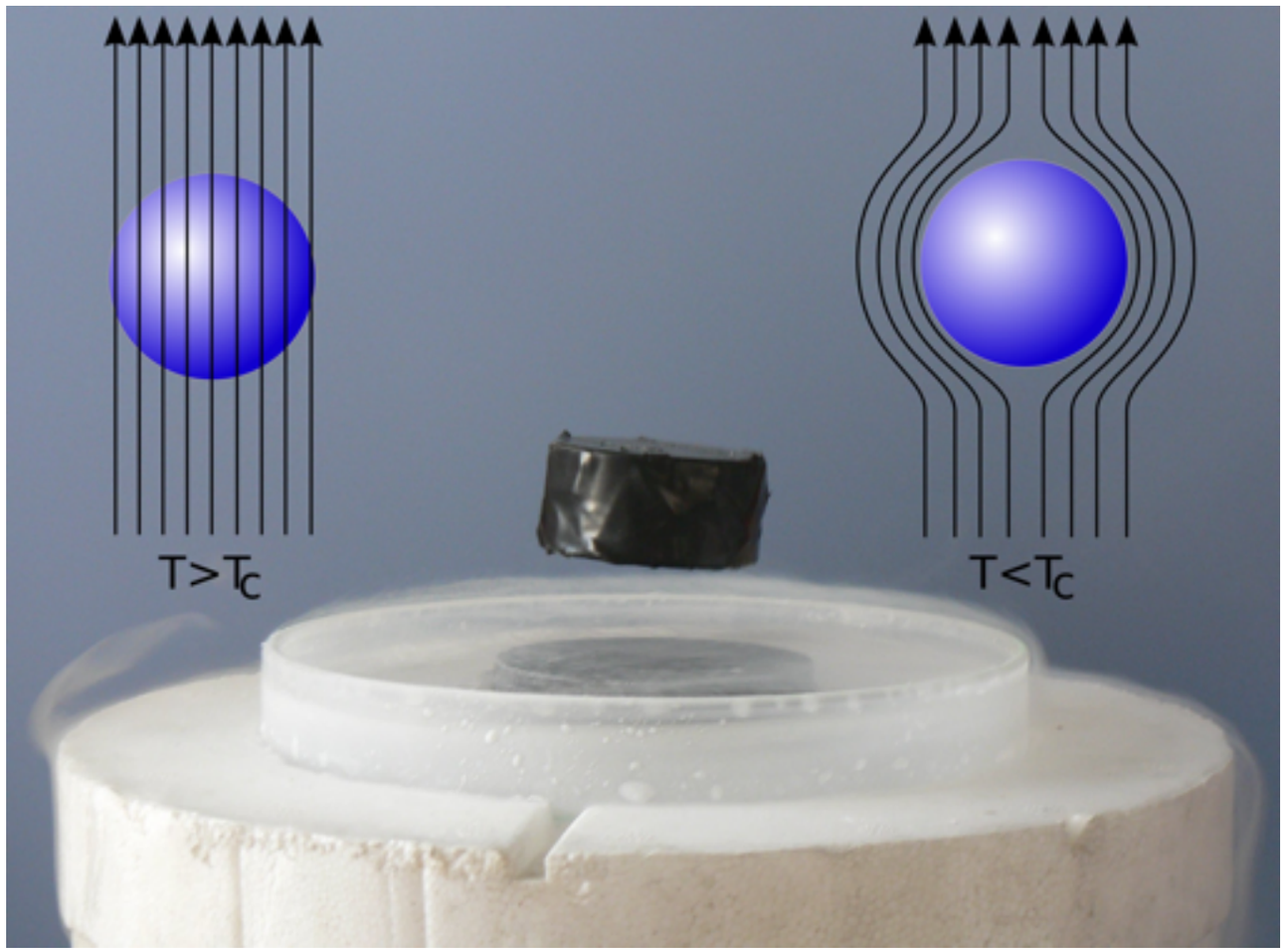
Superconducting magnetic bearing

YBCO

The material becomes
superconducting below 77K

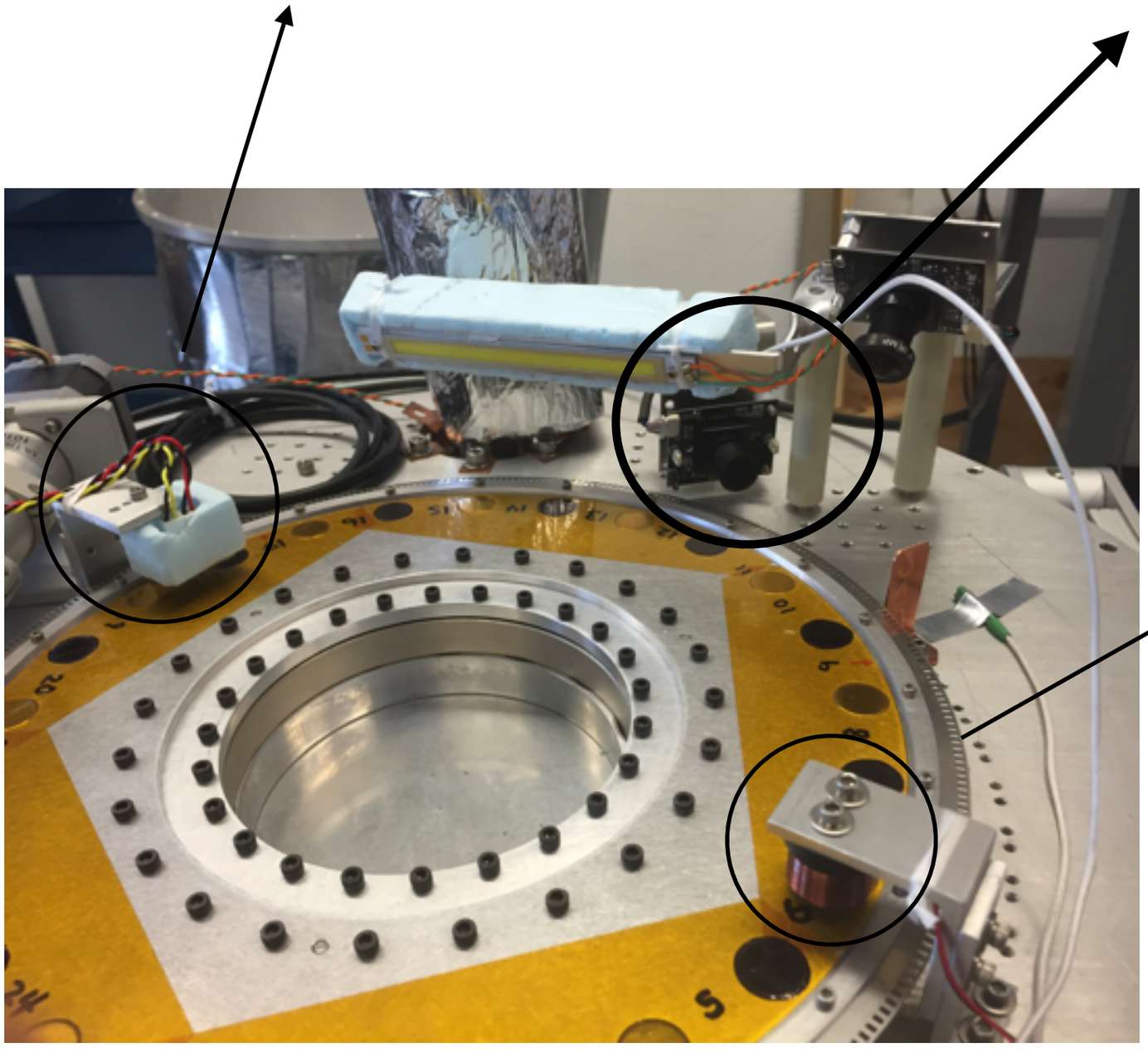




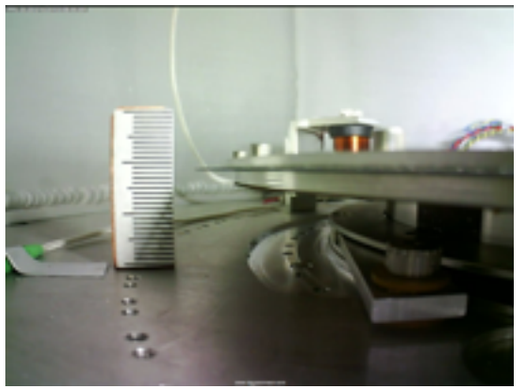


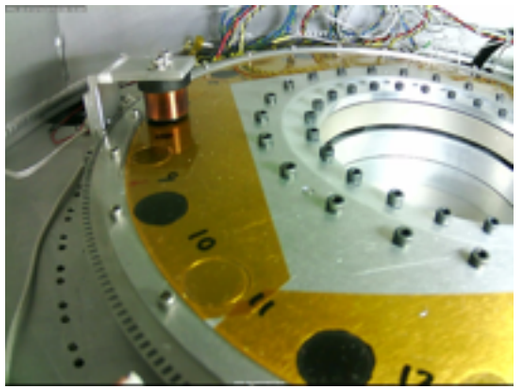
Superconducting magnetic bearing

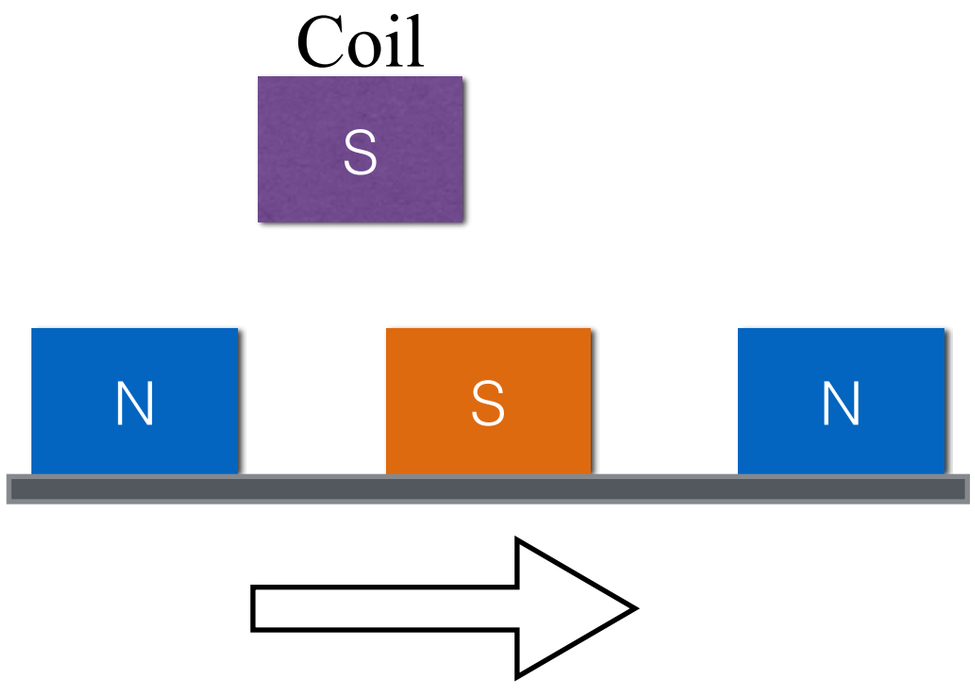
Hall Sensor



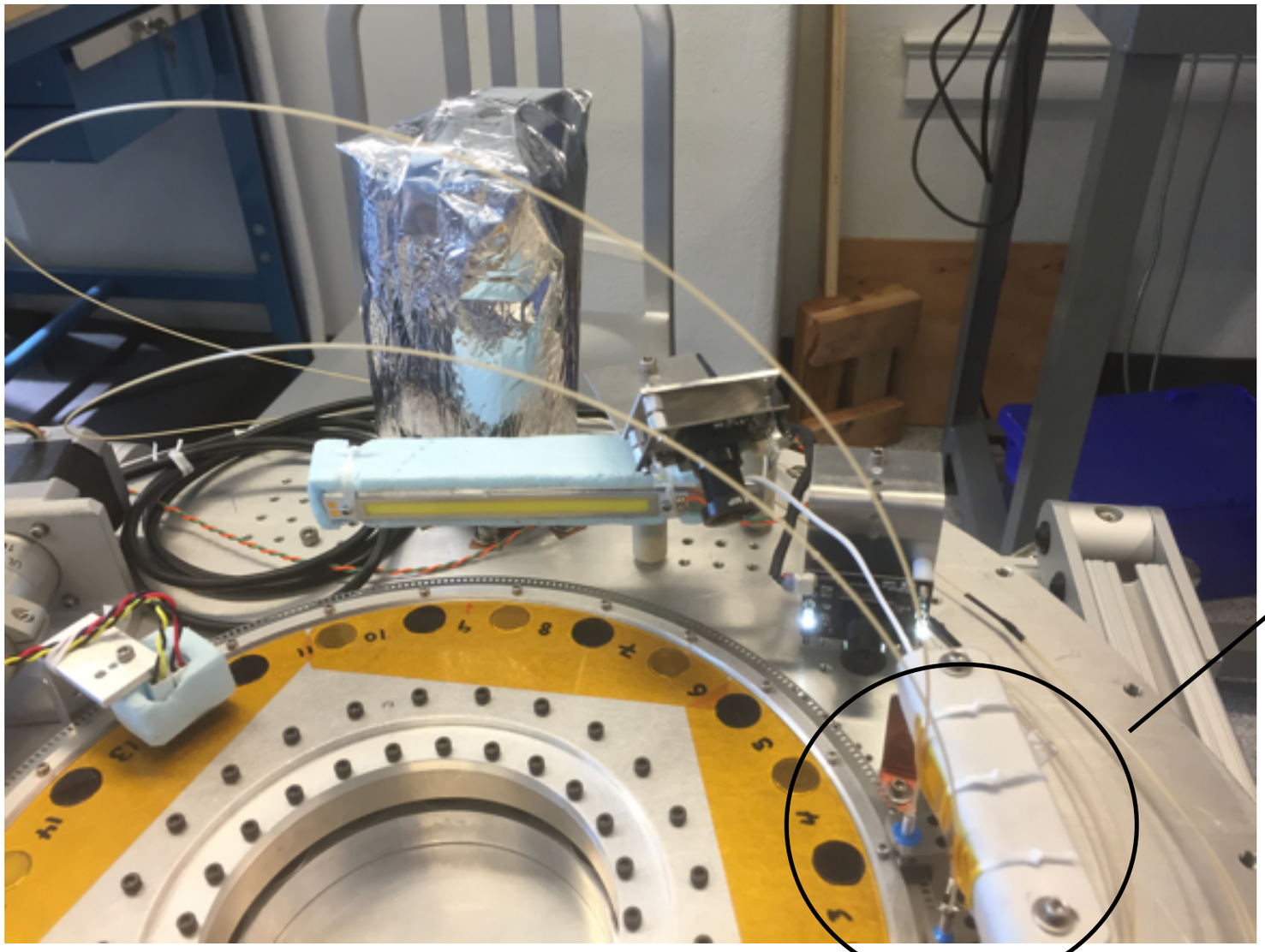
2 cameras

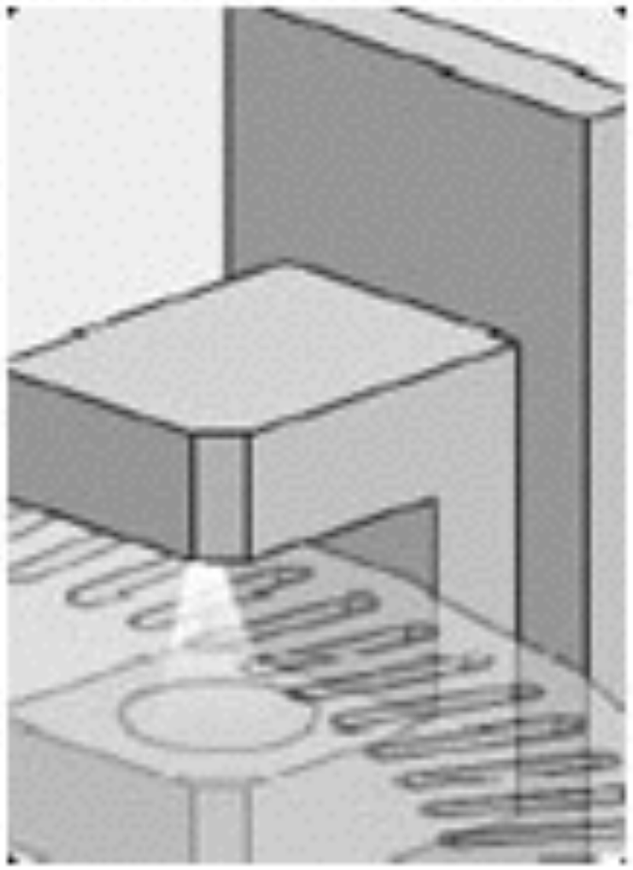


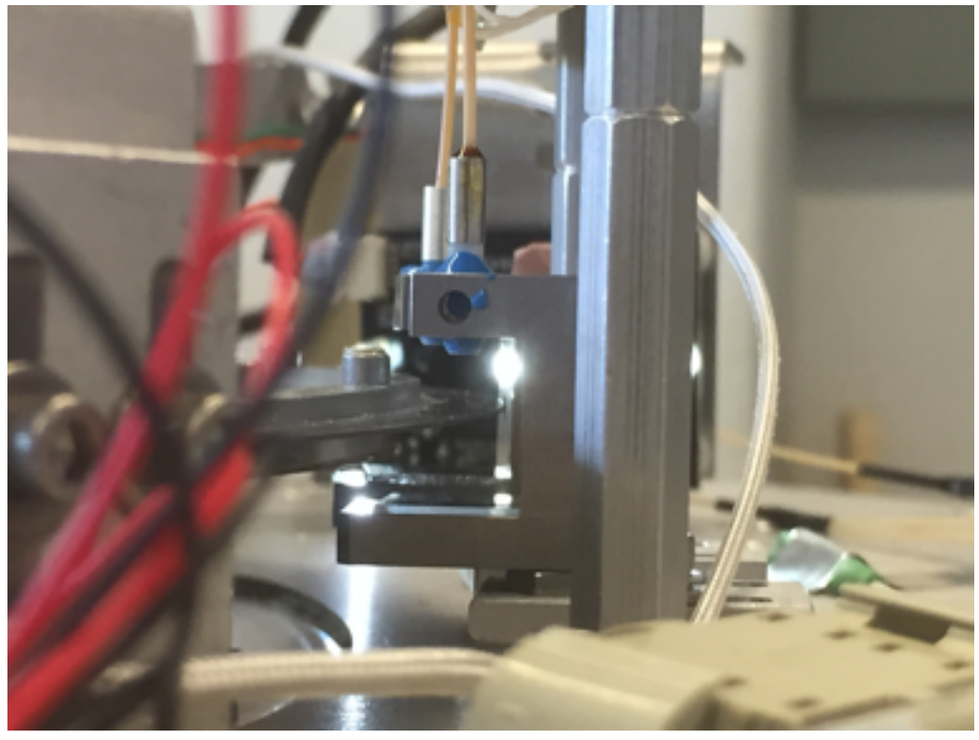




Superconducting magnetic bearing







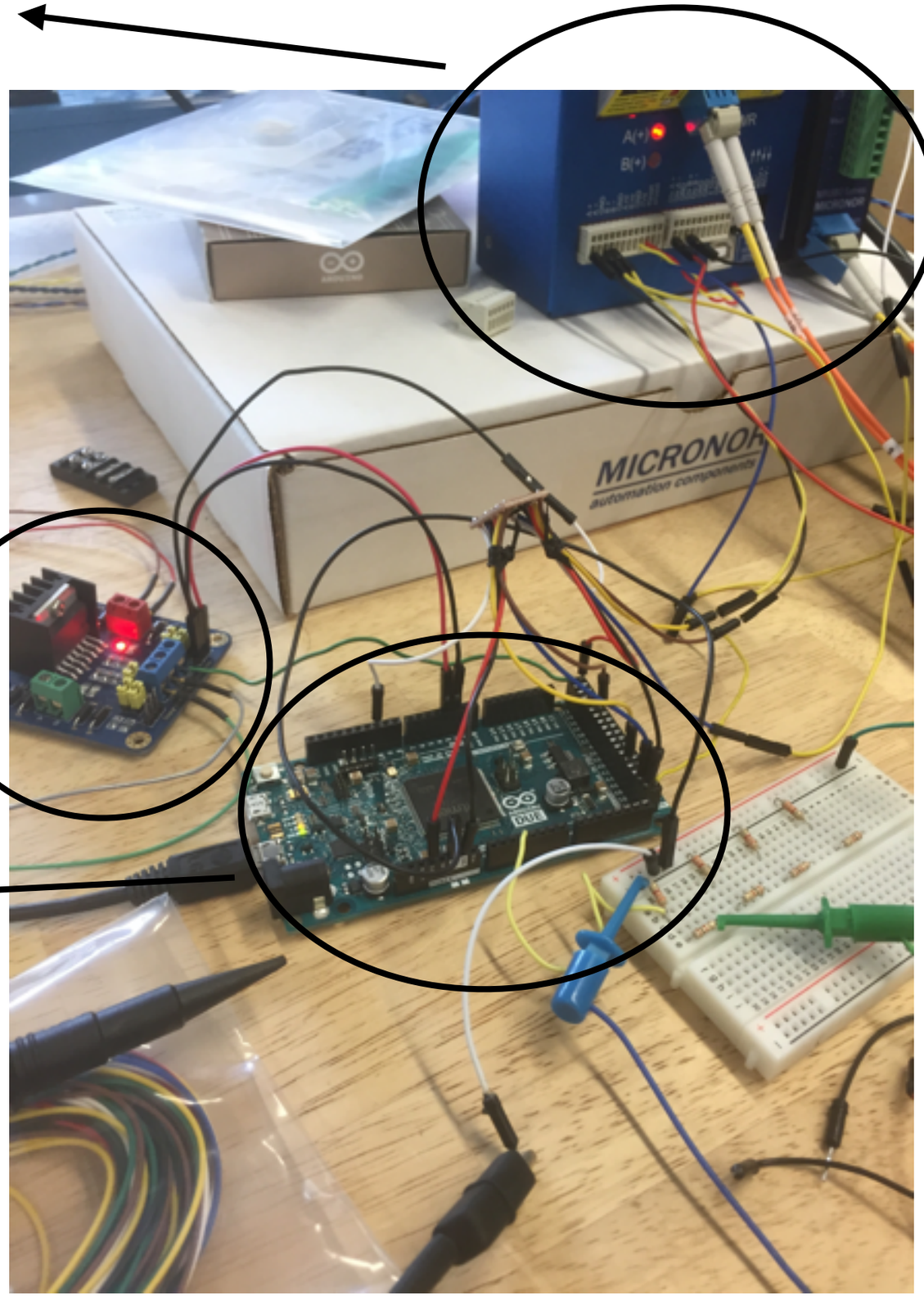
Hardware

Encoder controllers

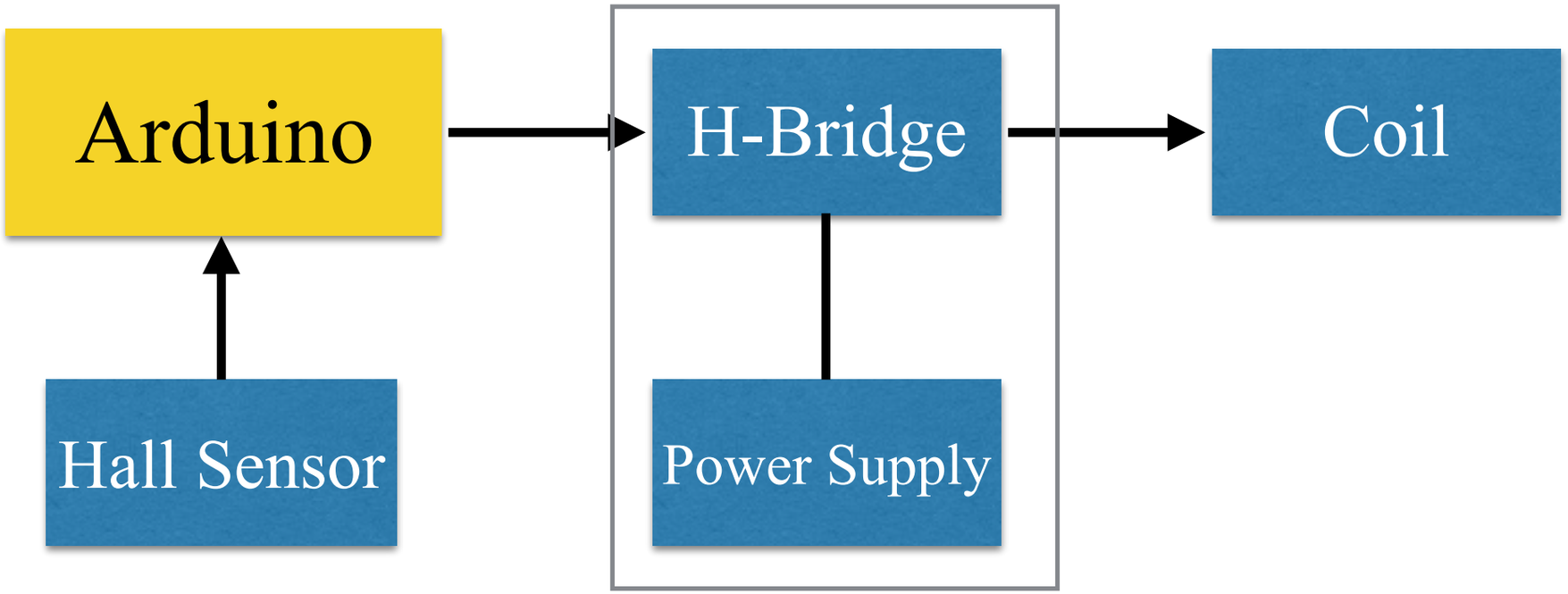
H-bridge

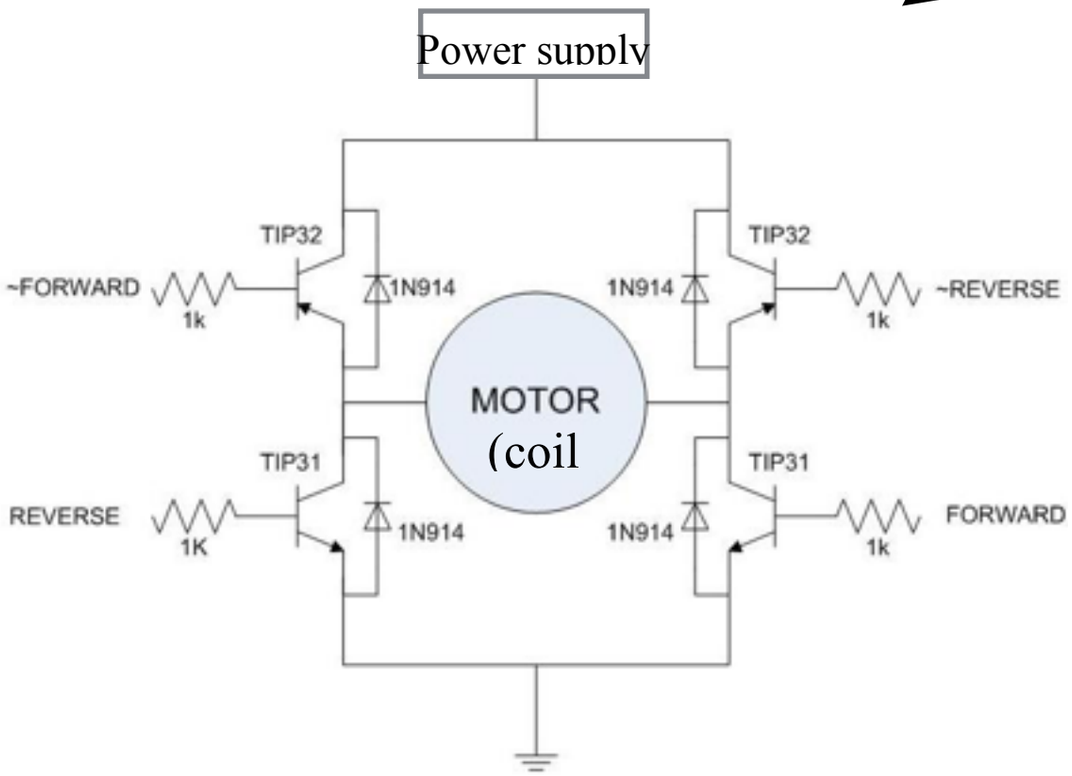
Arduino Due

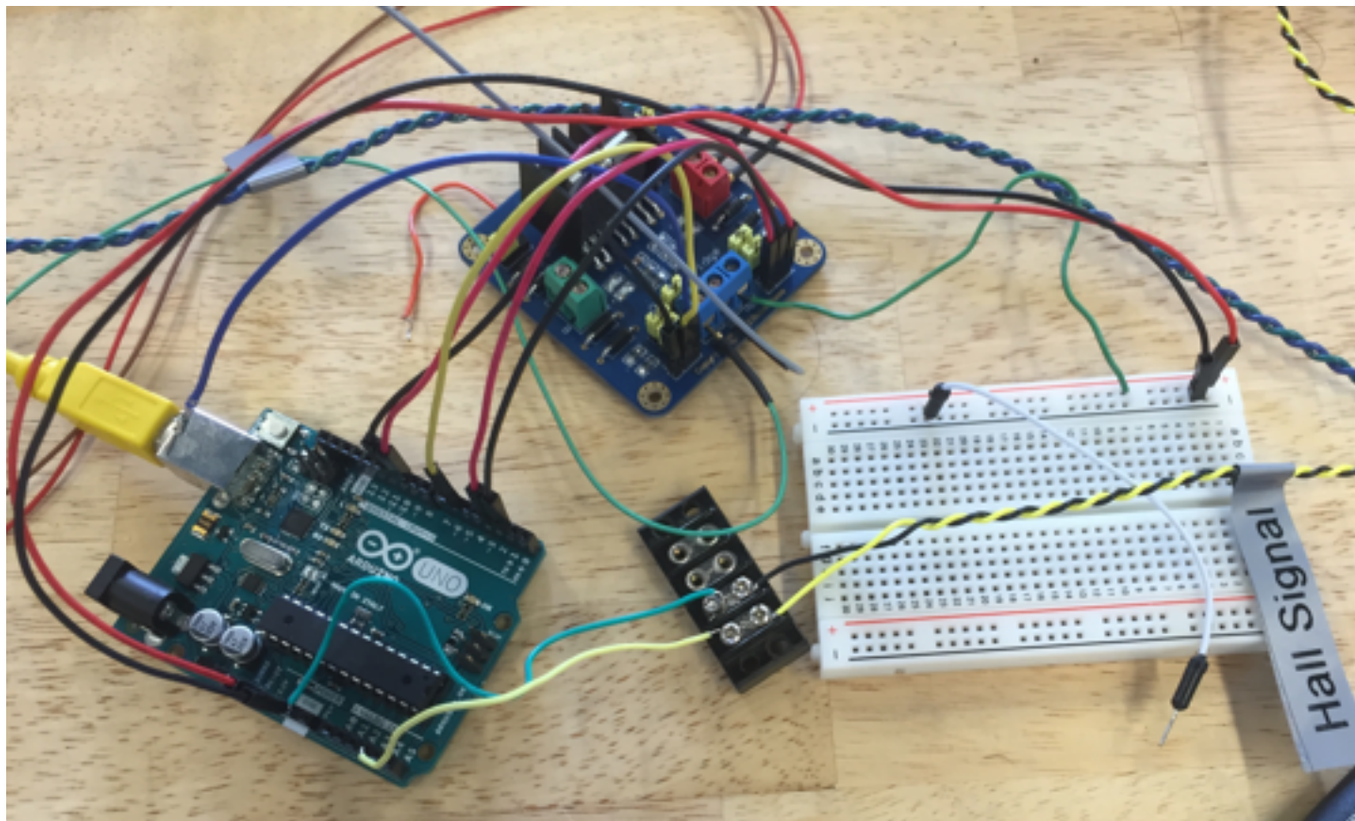
- Analog write: 12 bits of resolution
- Clock speed: 84MHz



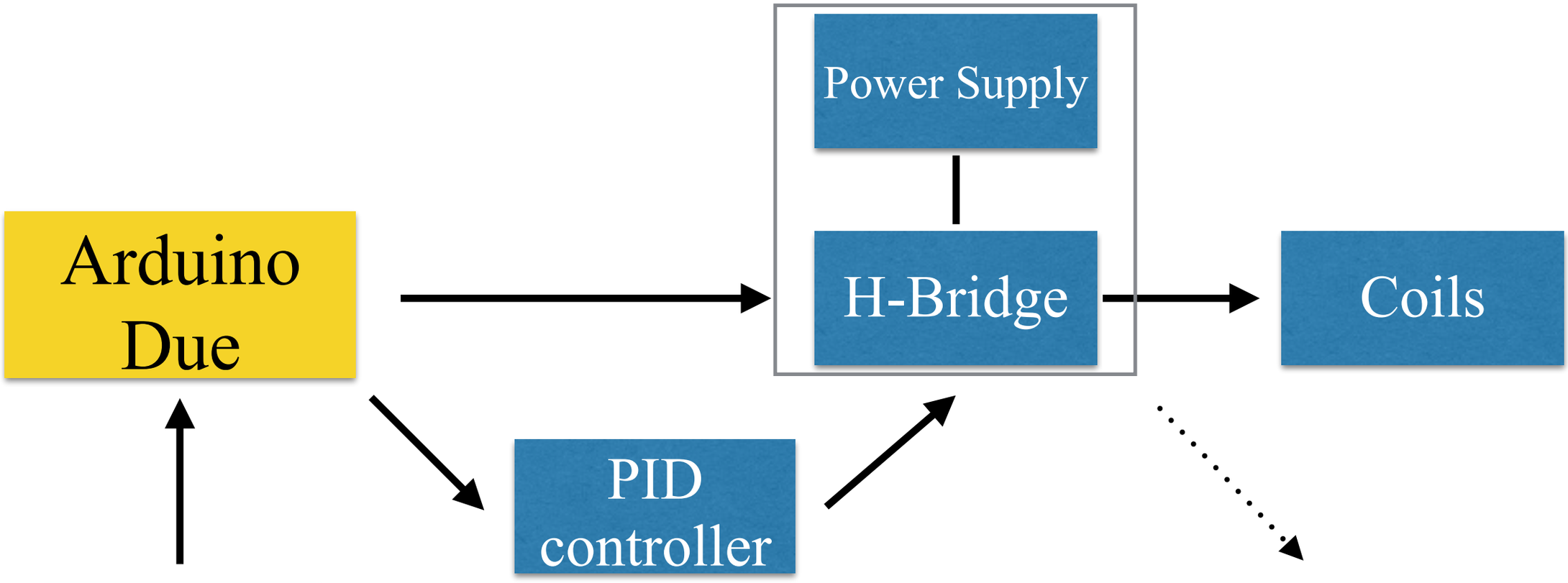
Hardware


Arduino
H-Bridge
Coil
Hall Sensor
Power Supply

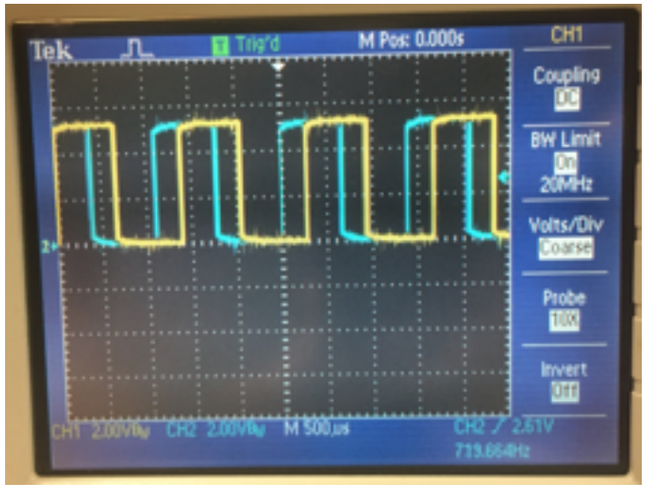

Power supply
TIP32
TIP32
~FORWARD
1k
1N914
1N914
~REVERSE
1k
MOTOR
(coil
TIP31
TIP31
REVERSE
1K
1N914
1N914
FORWARD
1k

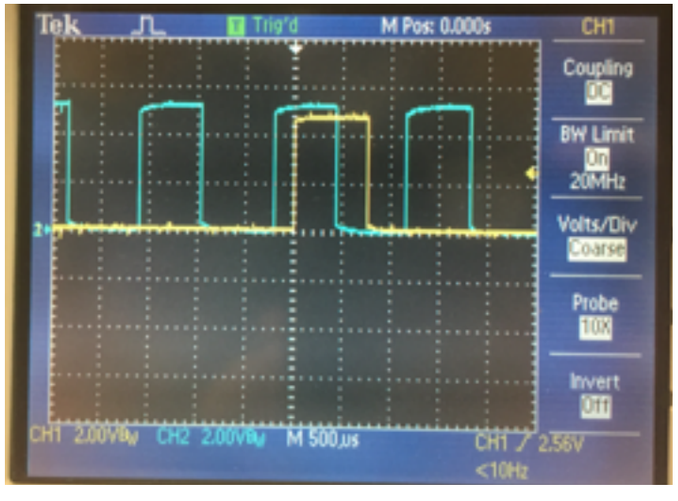

Hall Signal

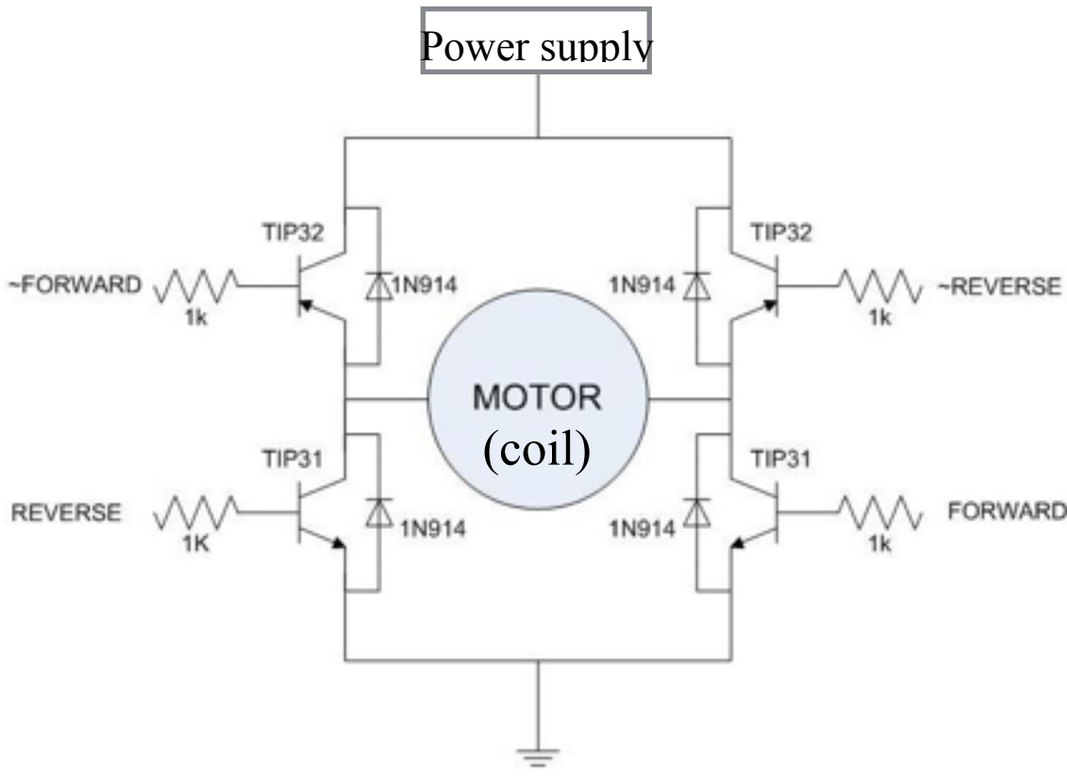
Hardware



Optical Encoders

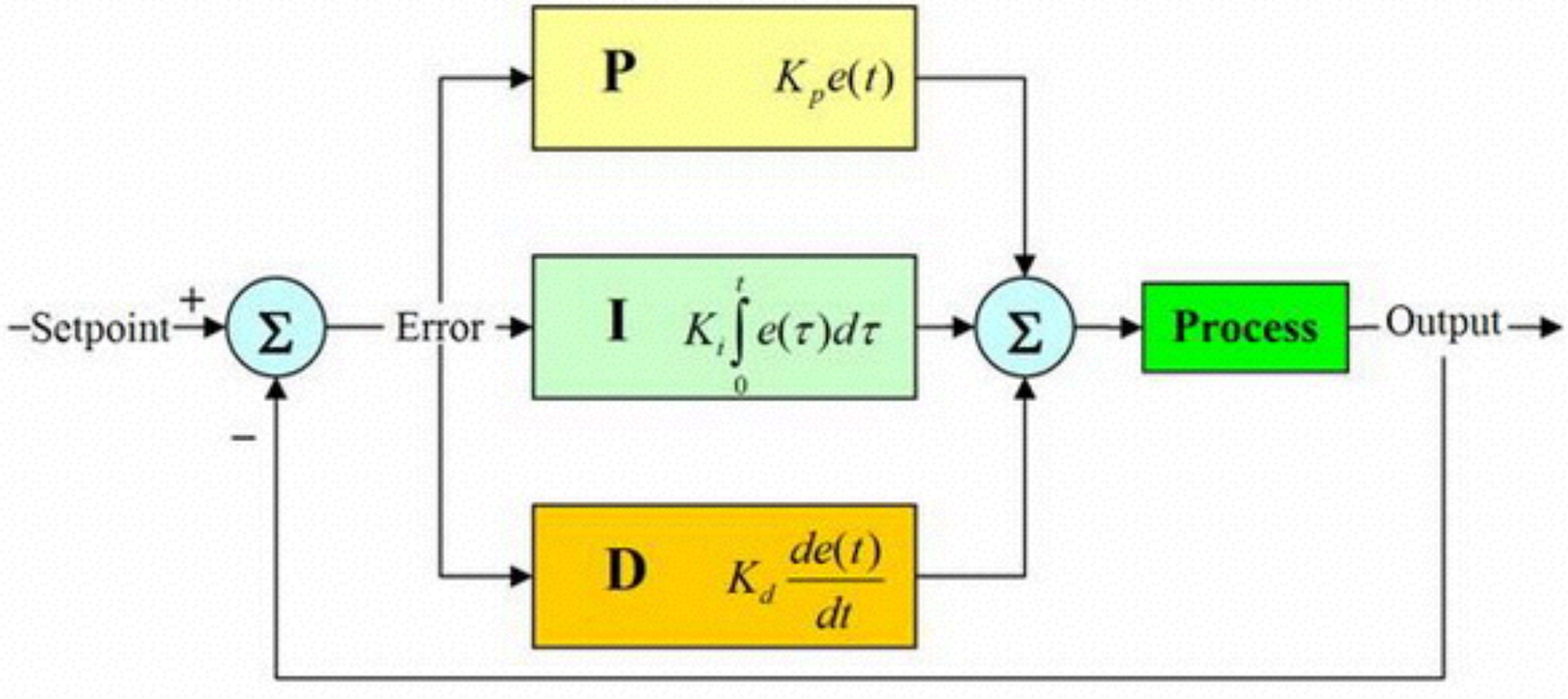




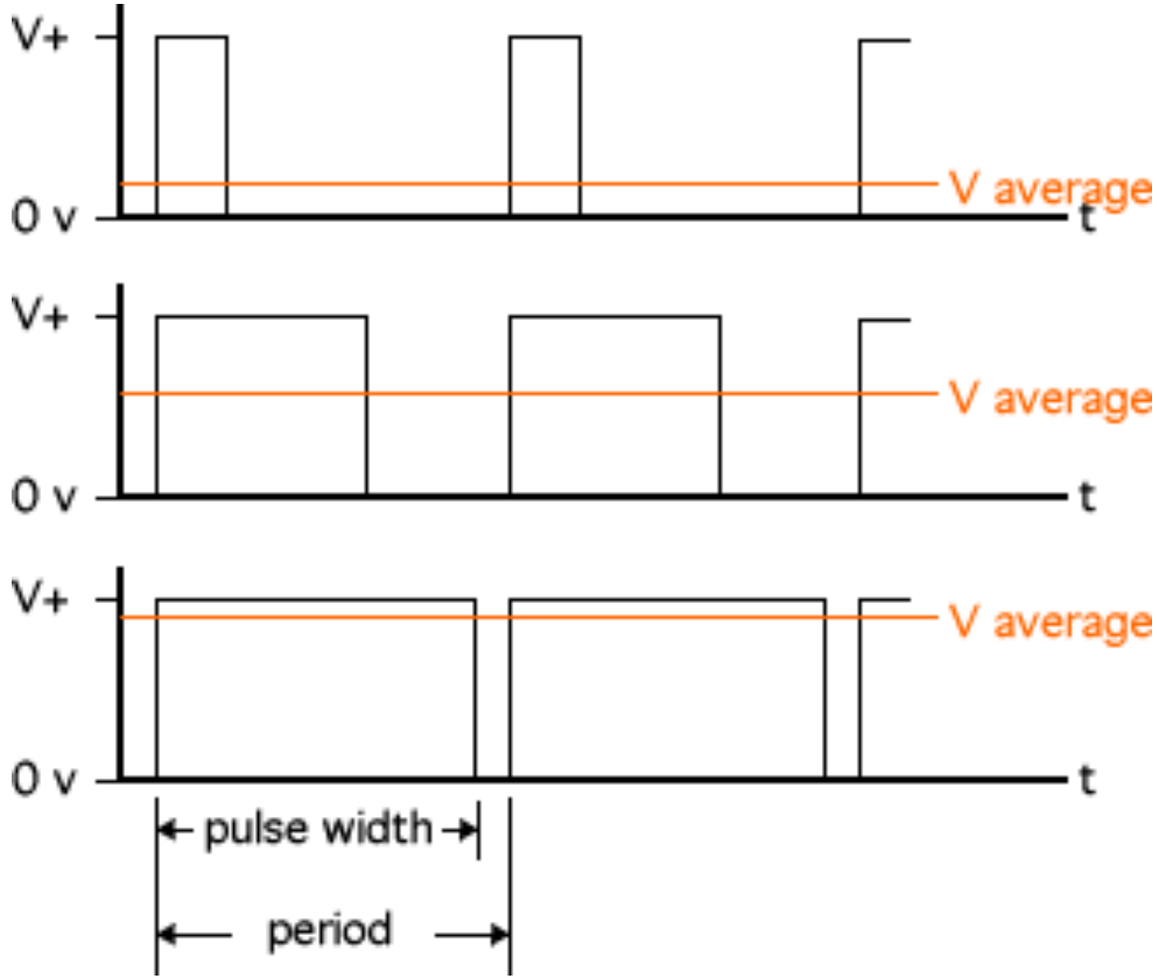


Software ??

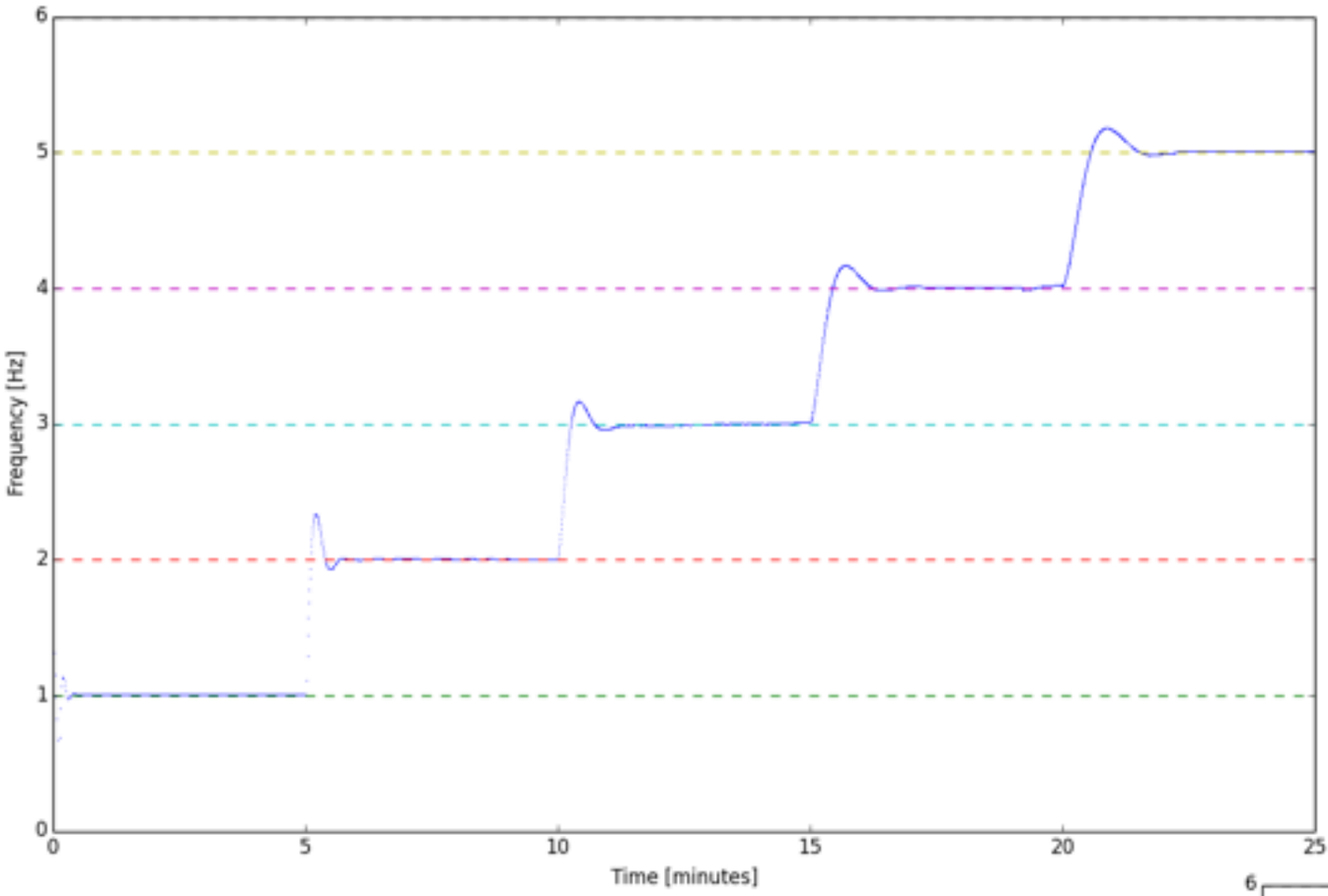
PID controller

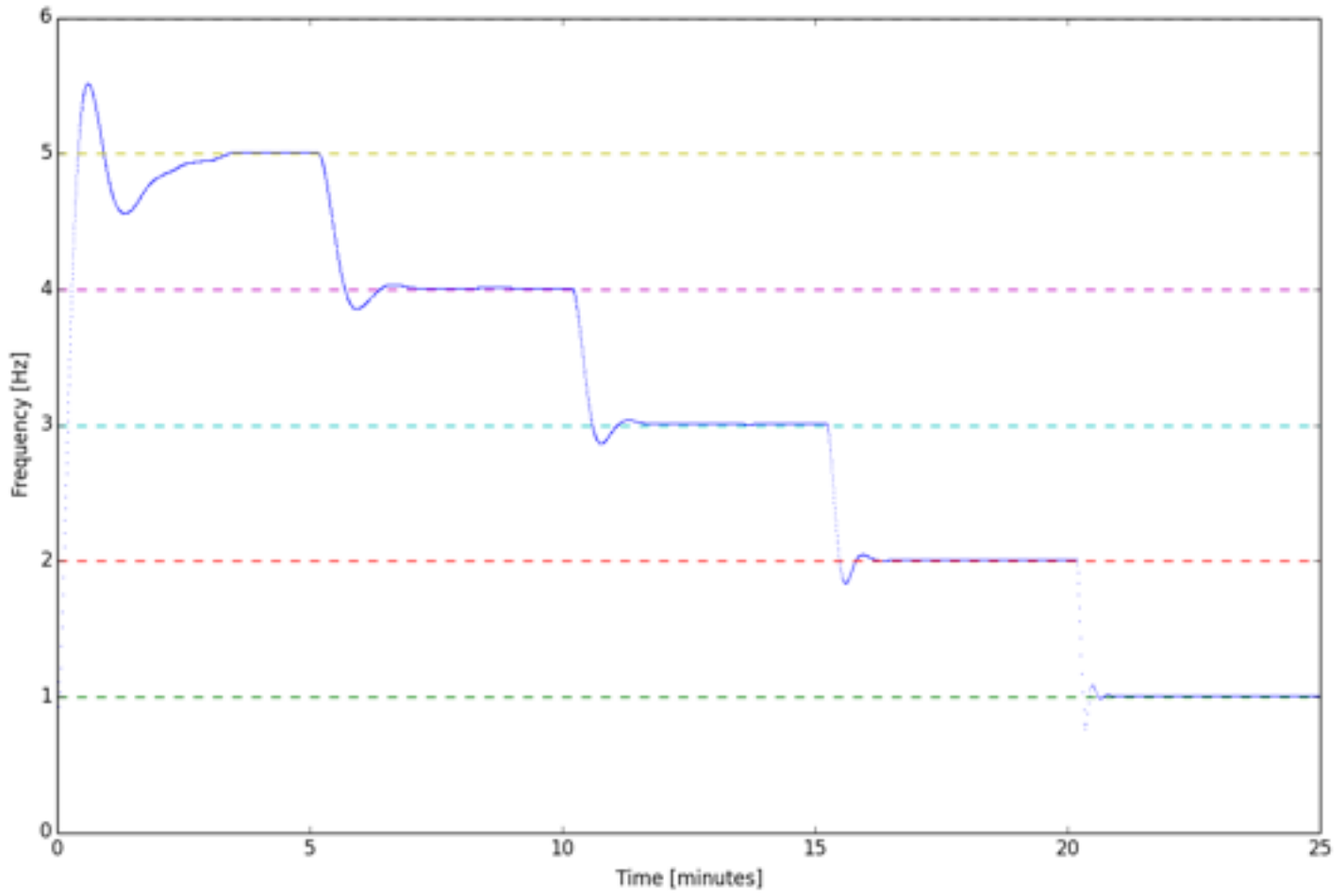


$$u(t) = K_p e(t) + K_i \int_0^t e(t)dt + K_d \frac{de(t)}{dt}$$



PID controller





Theoretical model

$$I\frac{d\omega}{dt} = M_m - M_D$$

M_m: Magnetic Force

M_D: Drag Force

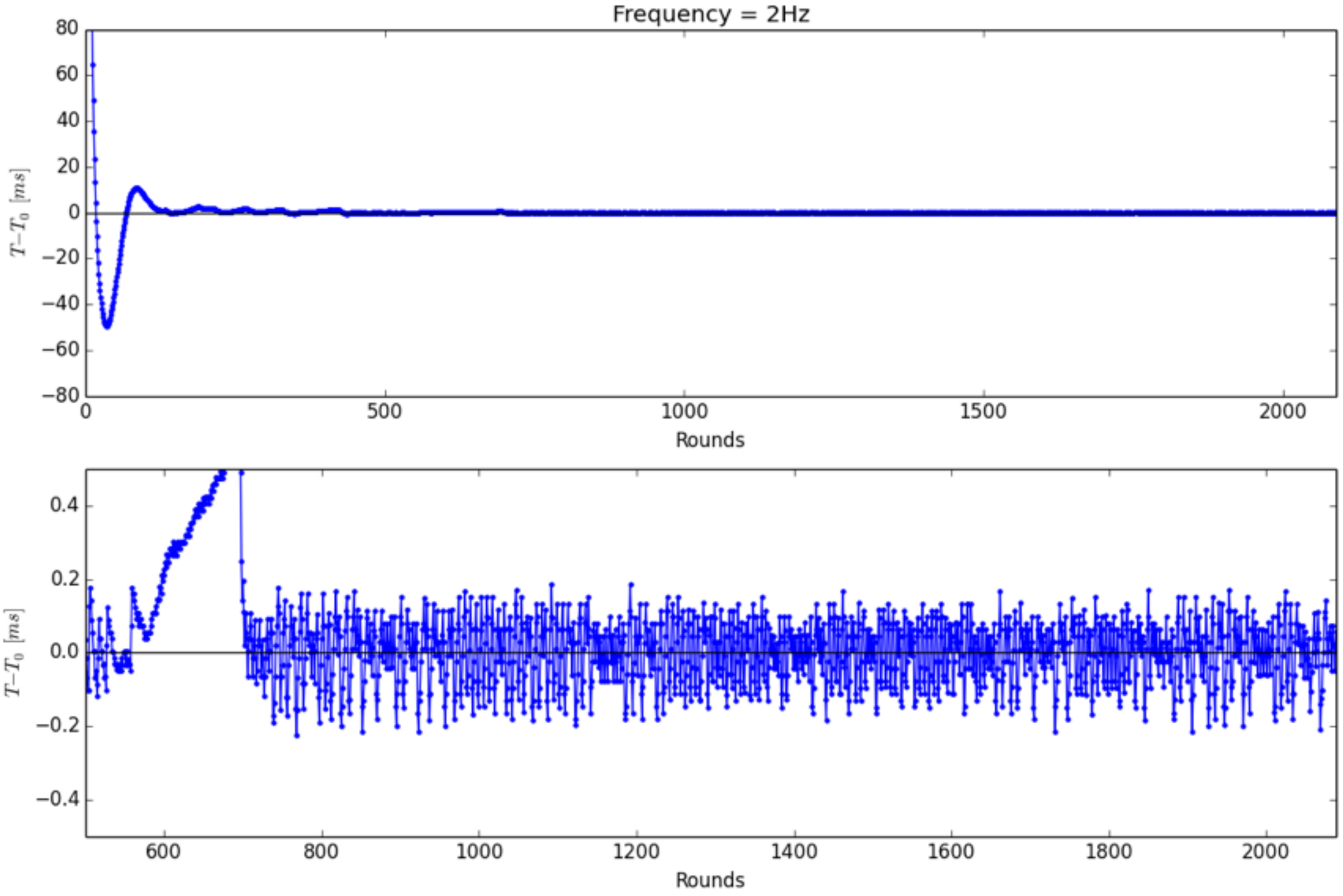
- NO acceleration

$$I\frac{d\omega}{dt} = 0 \longrightarrow M_m = M_D$$

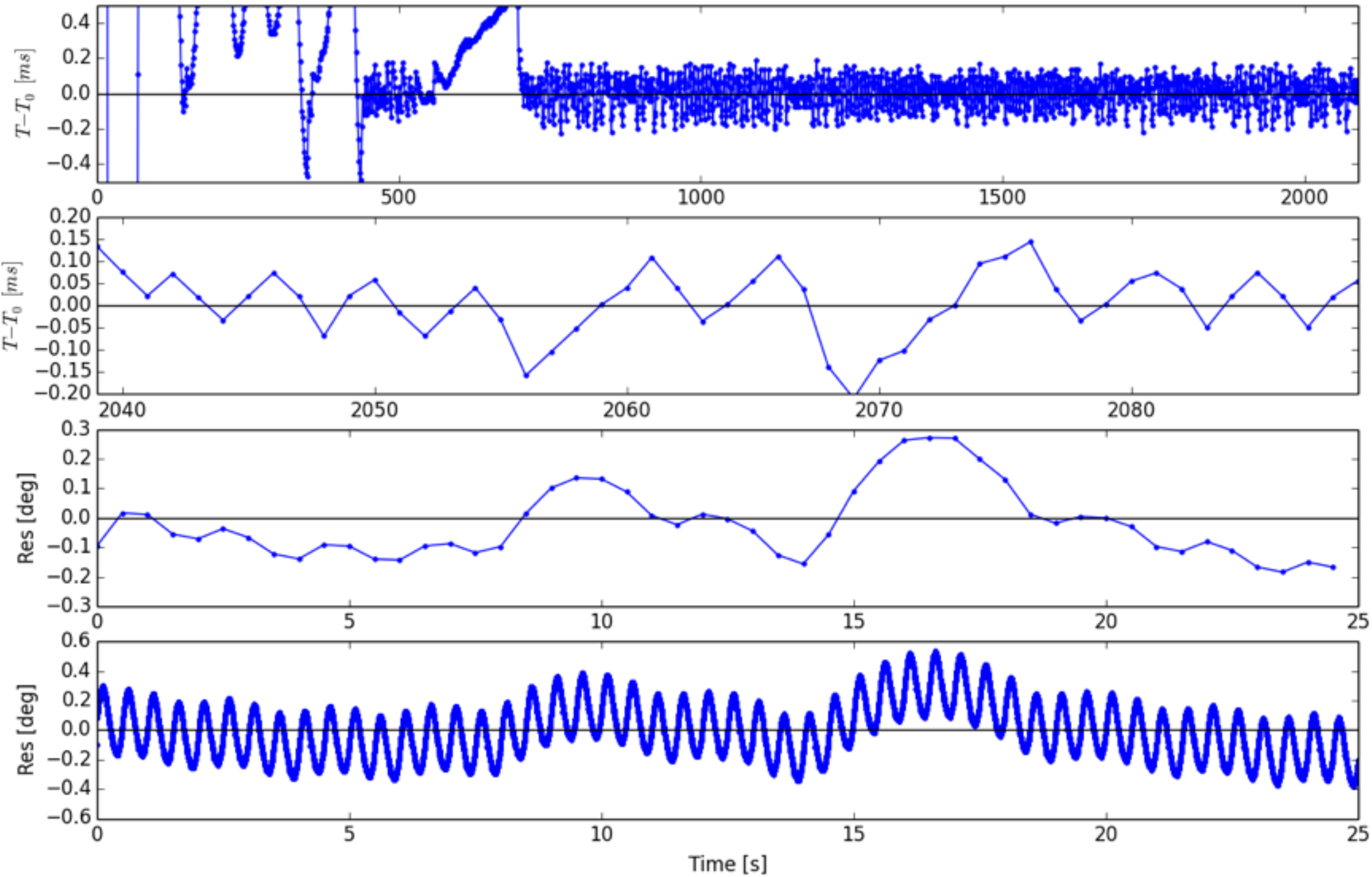
- NO magnetic force

$$I\frac{d\omega}{dt} = -M_D \longrightarrow \frac{d\omega}{dt} = -\frac{R}{I}F_D$$

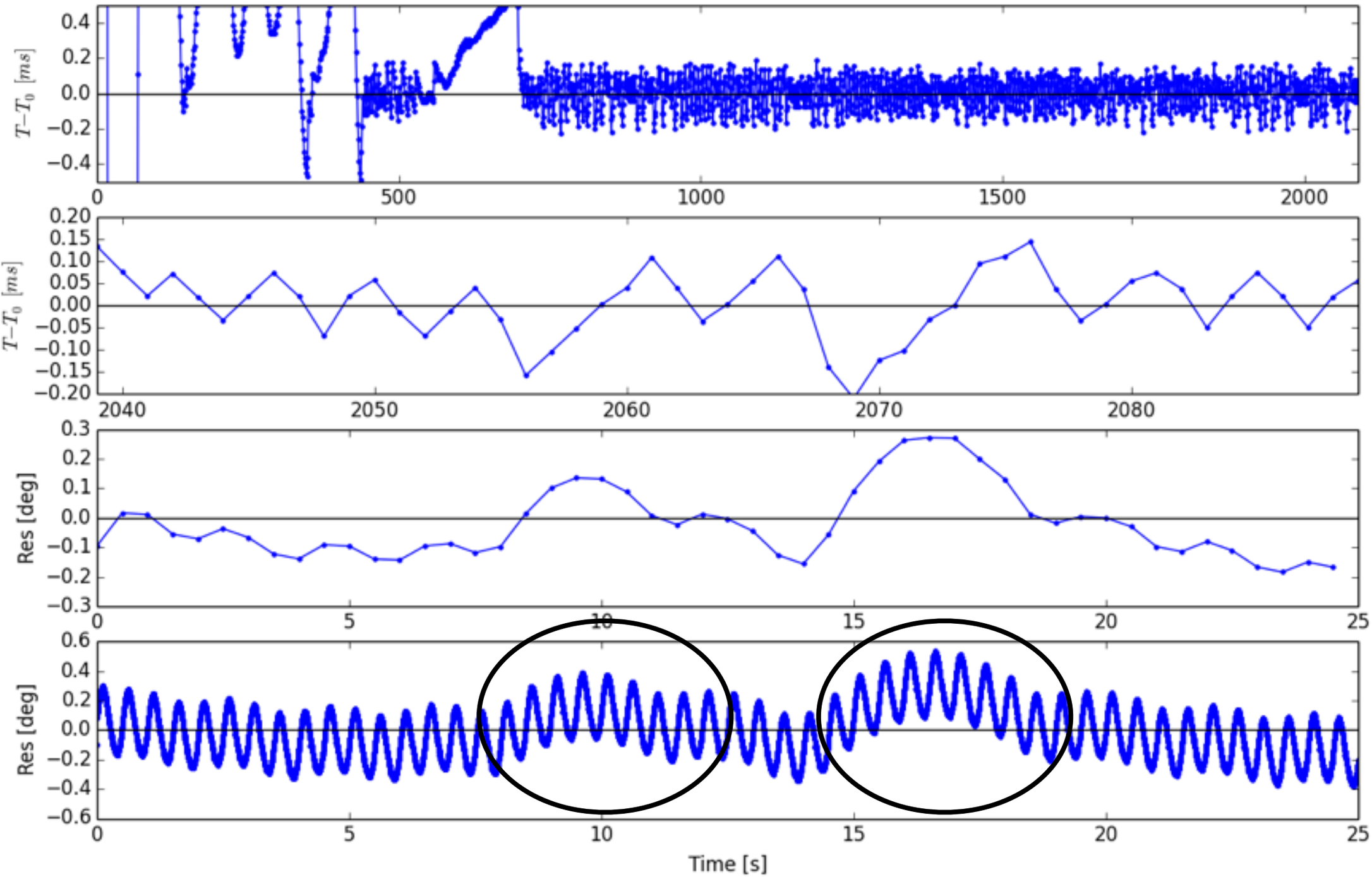
Data Analysis: 2Hz



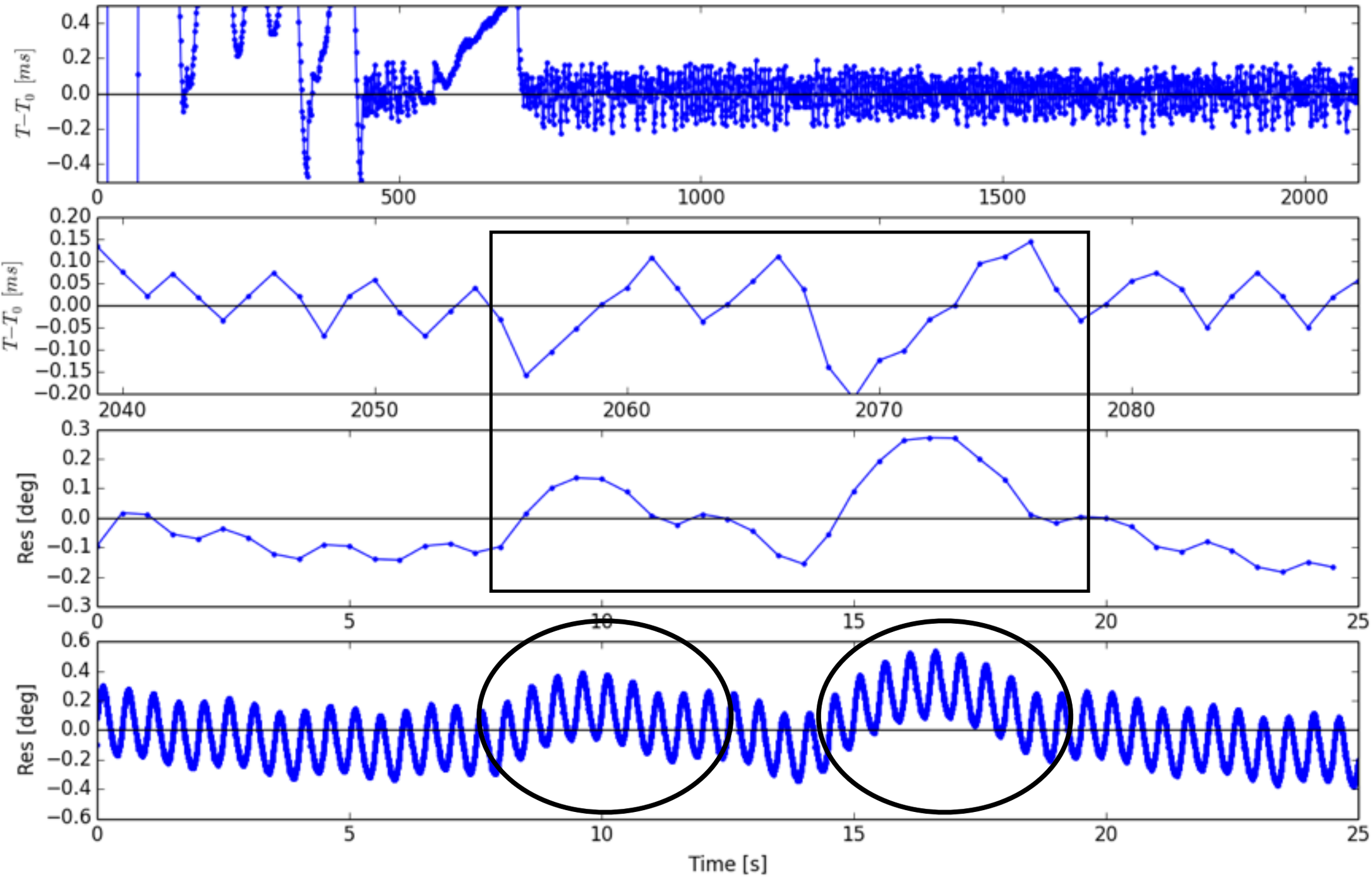
Data Analysis: 2Hz



Data Analysis: 2Hz



Data Analysis: 2Hz



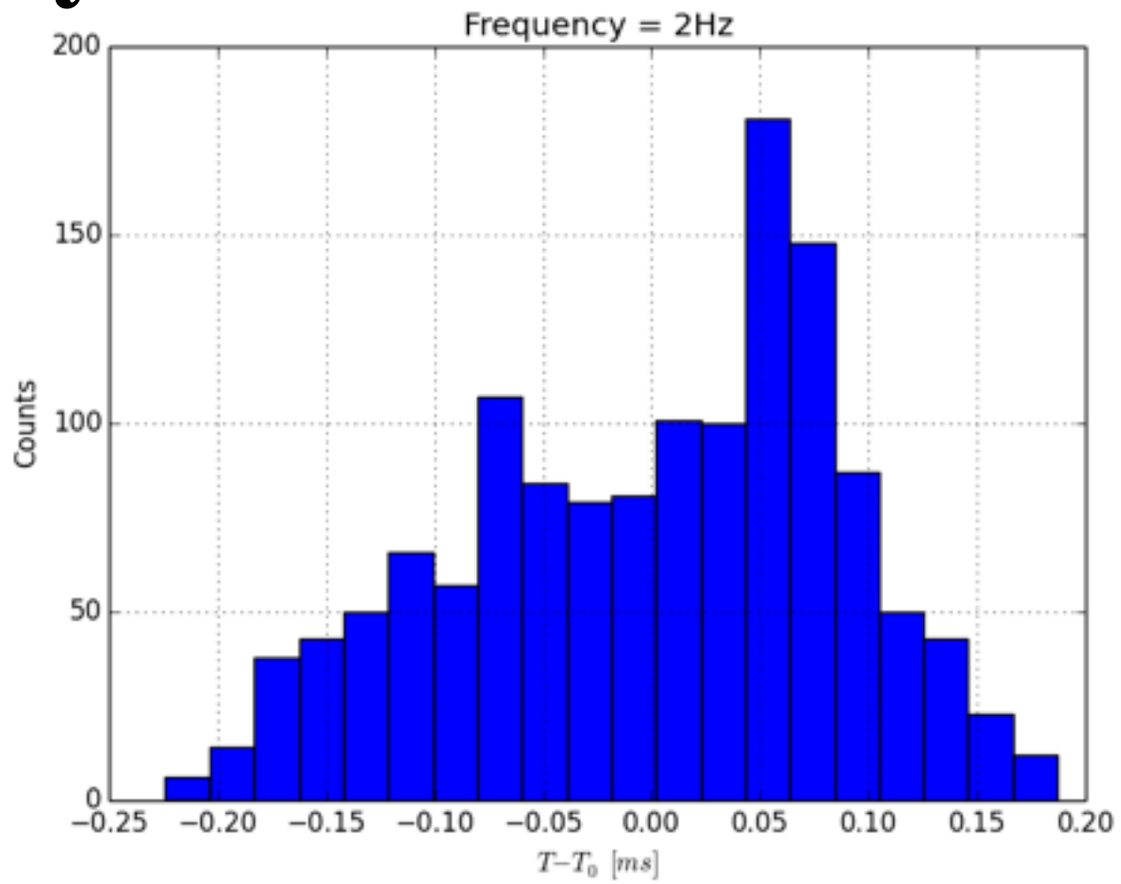
Data Analysis: 2Hz

- Frequency stability

$$\Delta t \approx 0.15ms$$

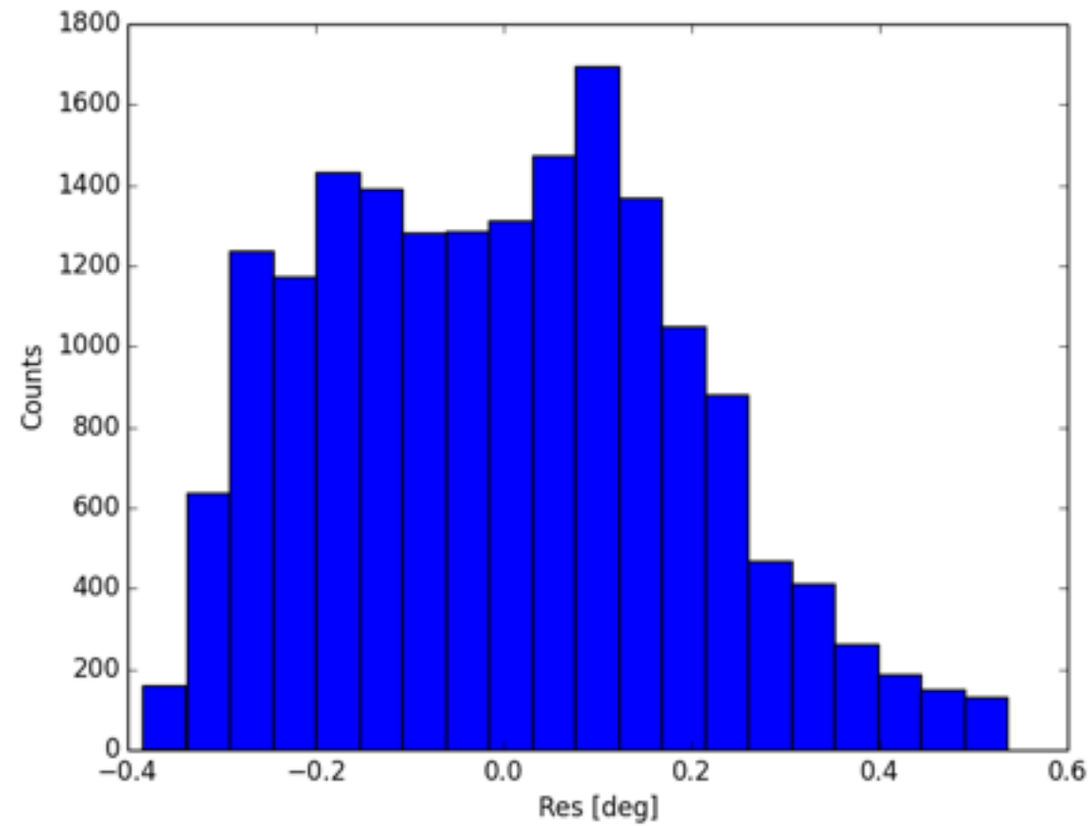
$$\downarrow$$

$$f = 2.0000 \pm 0.0006Hz$$

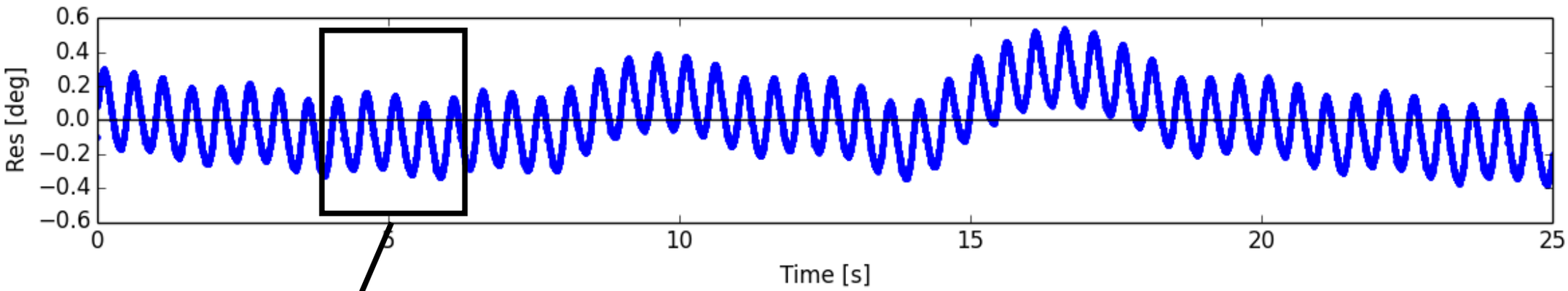


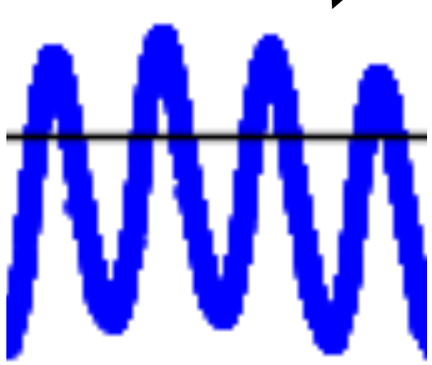
- Position accuracy

$$\Delta\theta \lesssim 0.3°$$



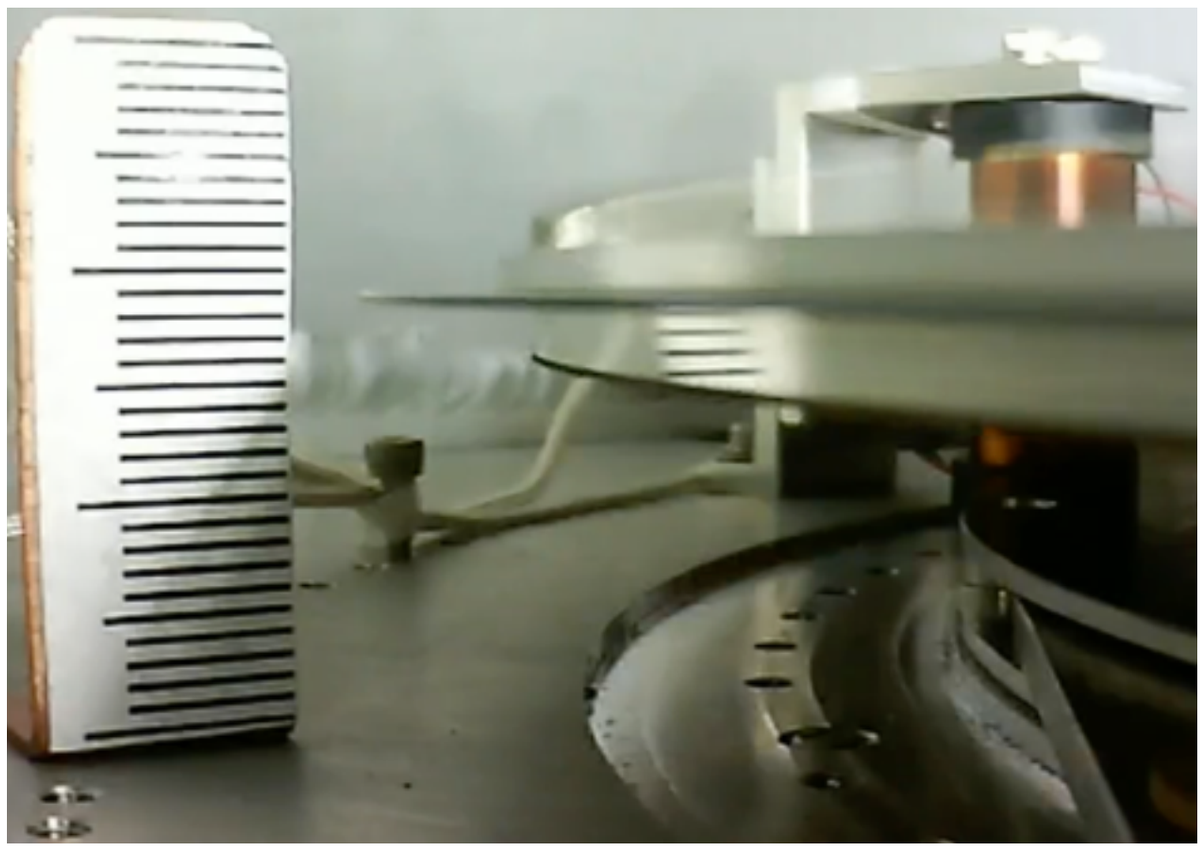
Wobbling motion





$\delta_x < 0.8mm$

$\delta_y < 0.2mm$



Plot discesa

Plot forza e corrente

Estrapolazione