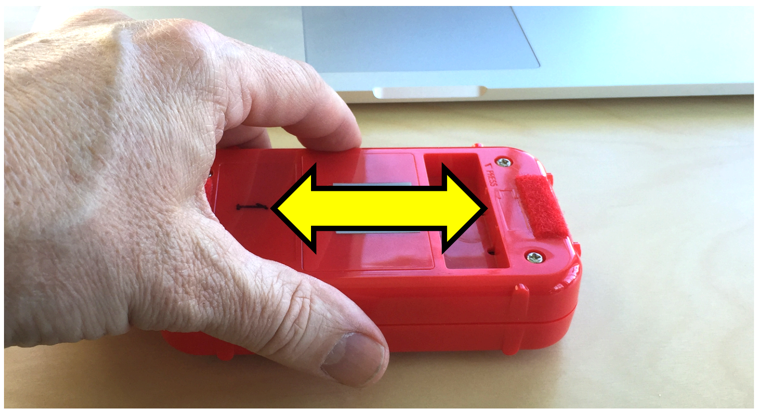
Mats Favorite IOLab Activities

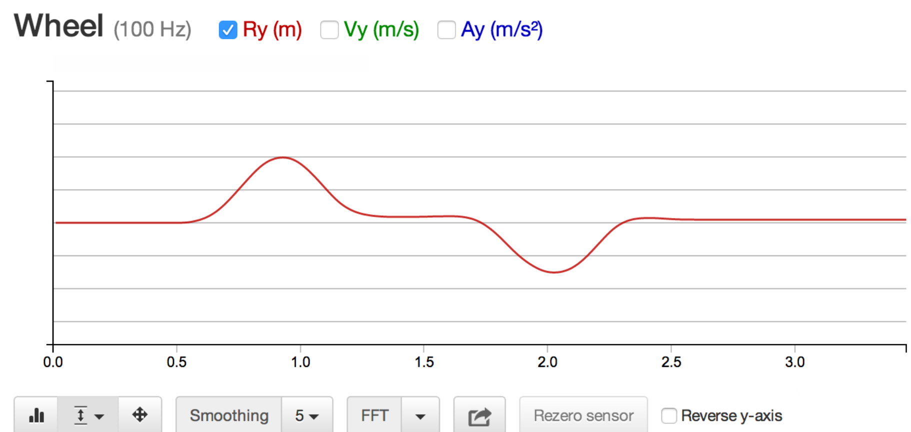
This is a growing list and is still very incomplete - I will add several more as I have time. This file was last updated on Feb/21/2016.

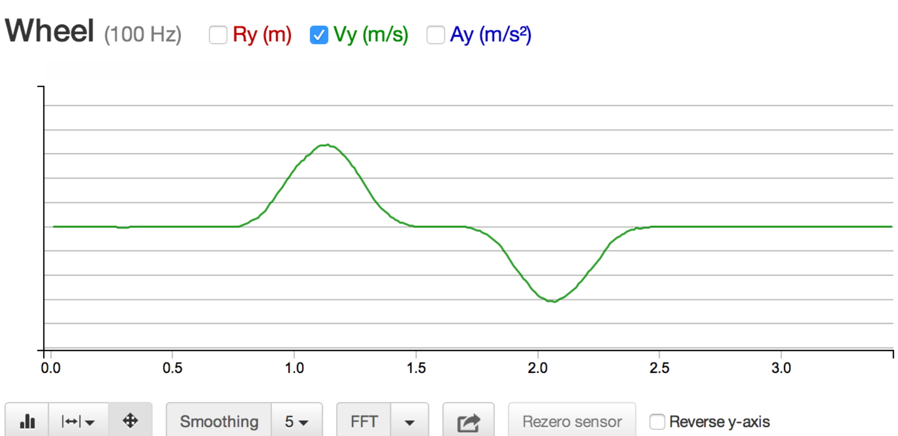
If you send me PowerPoint slides showing your own favorites in the same general format as these, I will be glad to add them and give you all the credit.

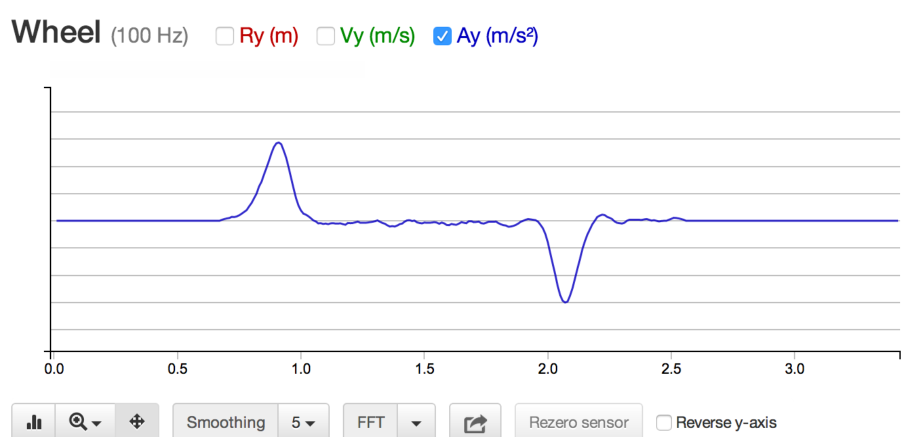
Kinematics
(Wheel Sensor)

Ask students to match the following plots by moving their own IOLab devices (acceleration is hardest)



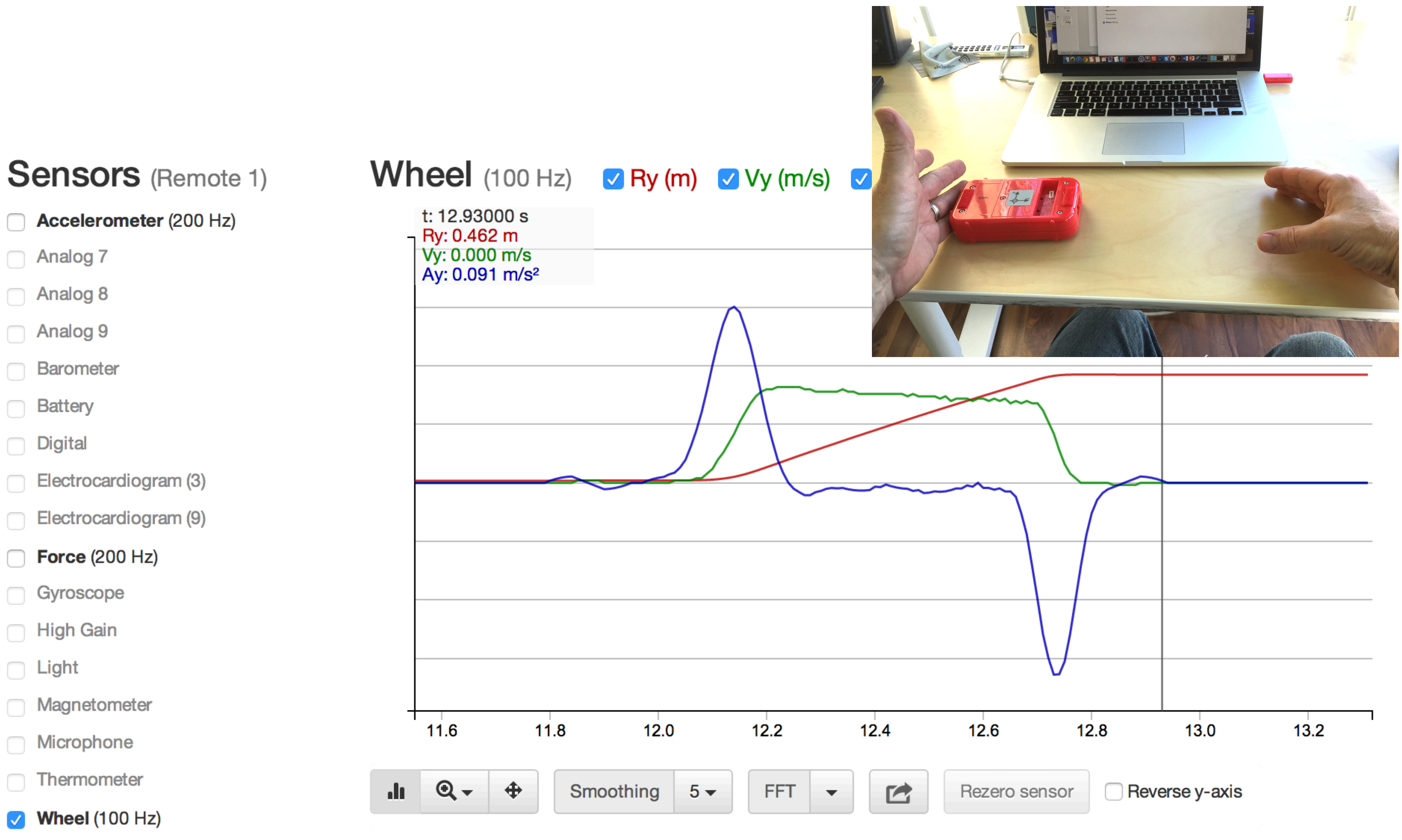






Kinematics
(Wheel Sensor)

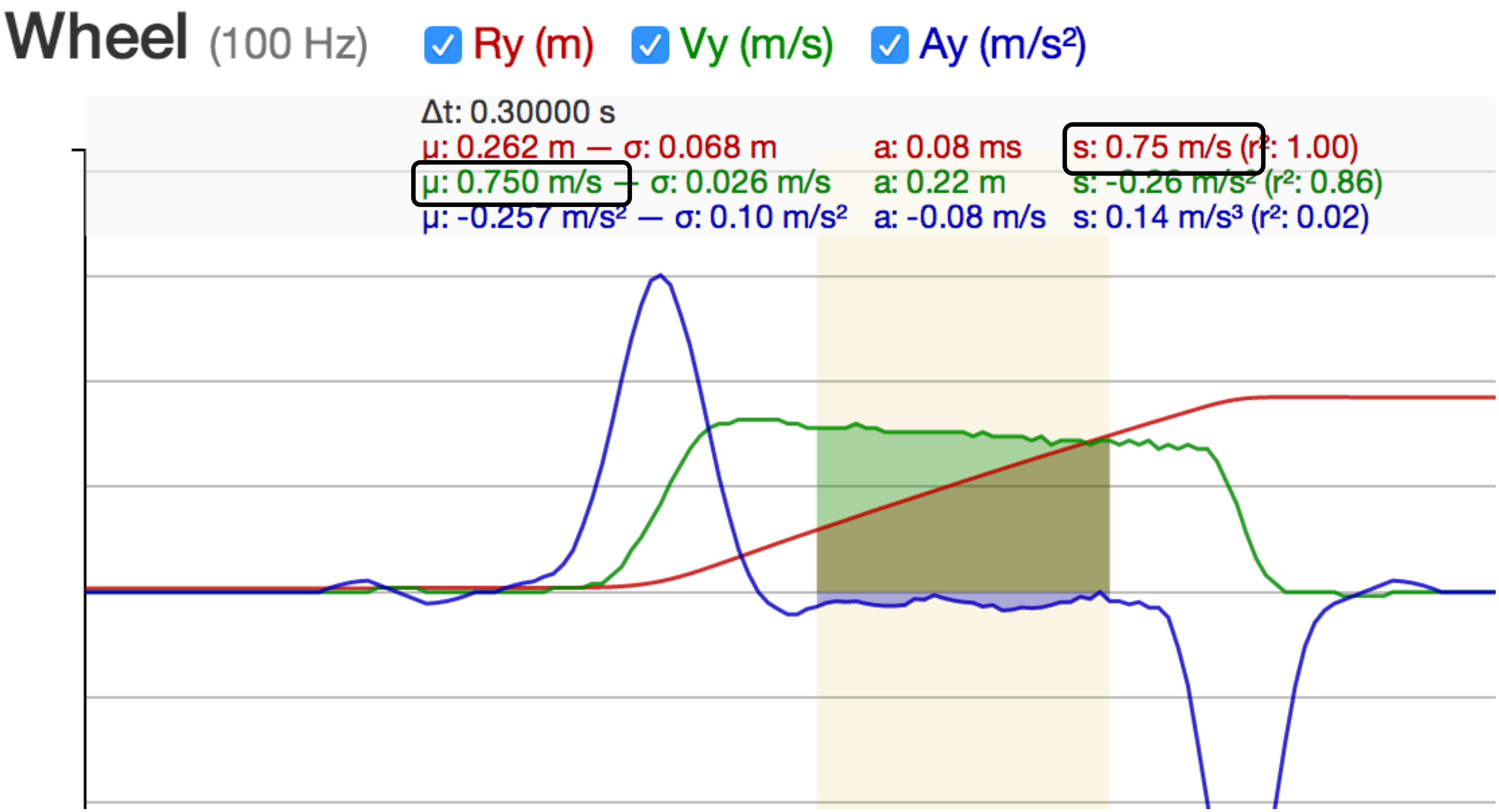
Roll from one hand to the other on horizontal desk



Kinematics
(Wheel Sensor)

Roll from one hand to the other on horizontal desk

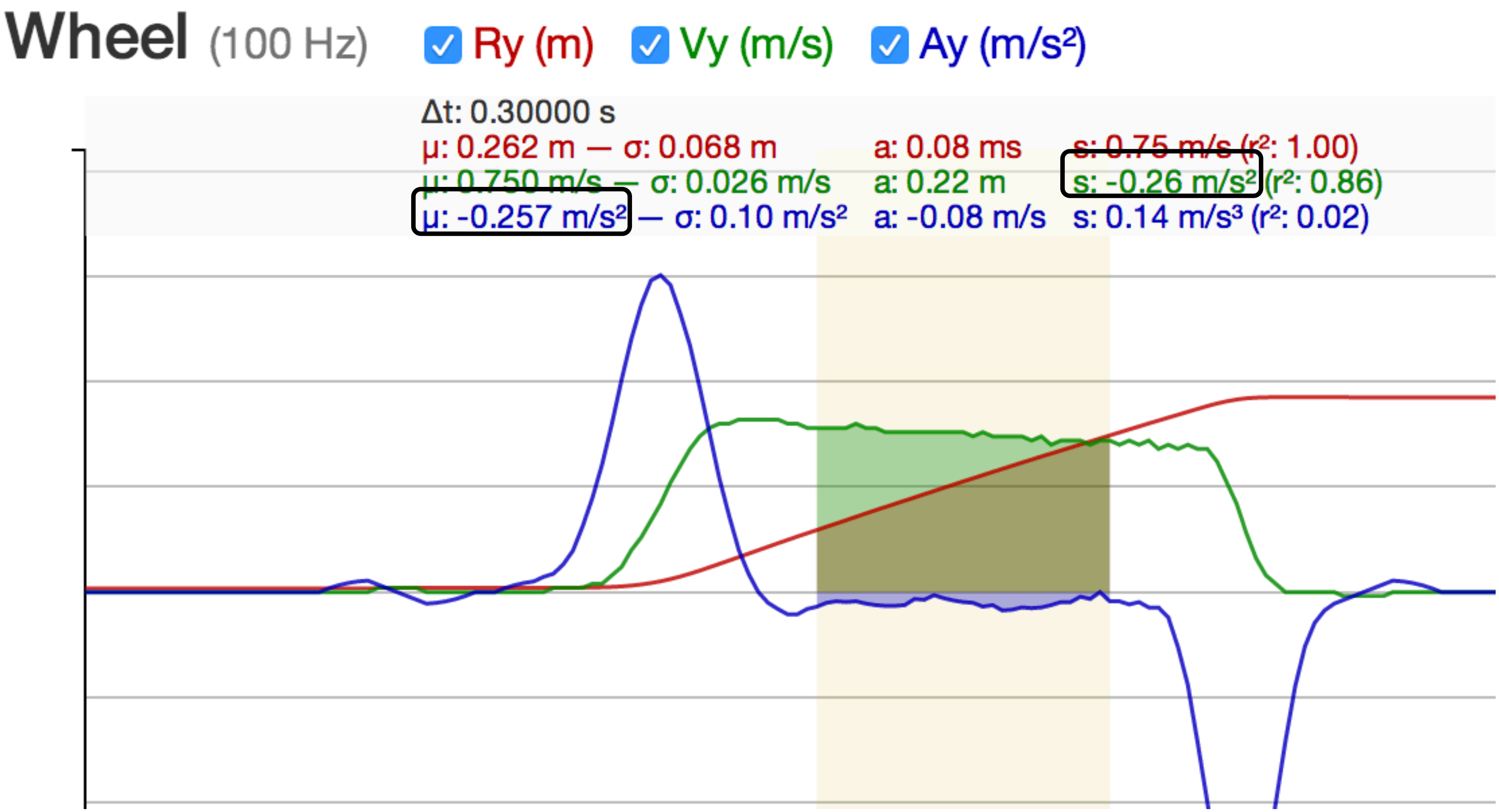
Slope of displacement = average velocity



Kinematics
(Wheel Sensor)

Roll from one hand to the other on horizontal desk

Slope of velocity = average acceleration

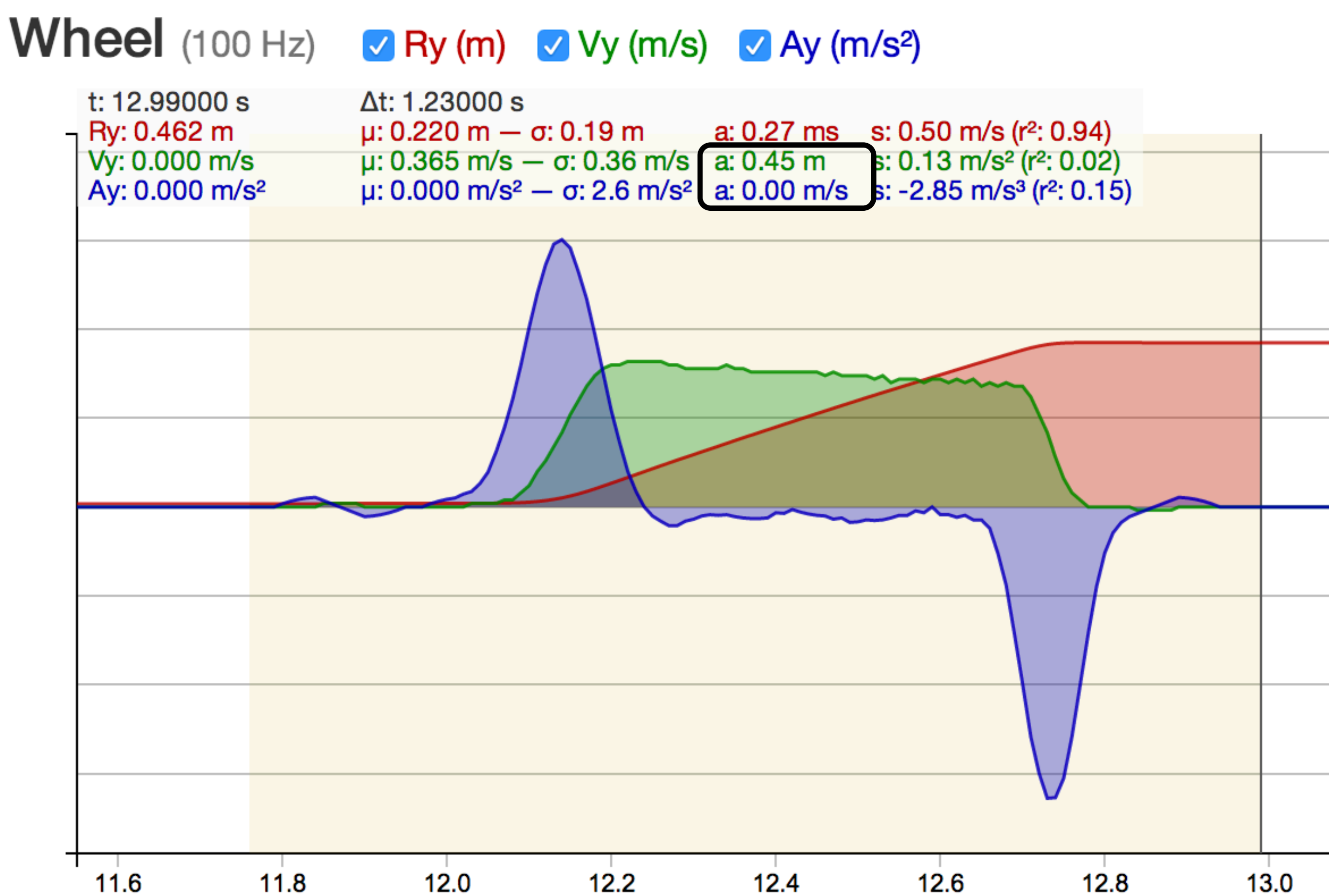


Kinematics
(Wheel Sensor)

Roll from one hand to the other on horizontal desk

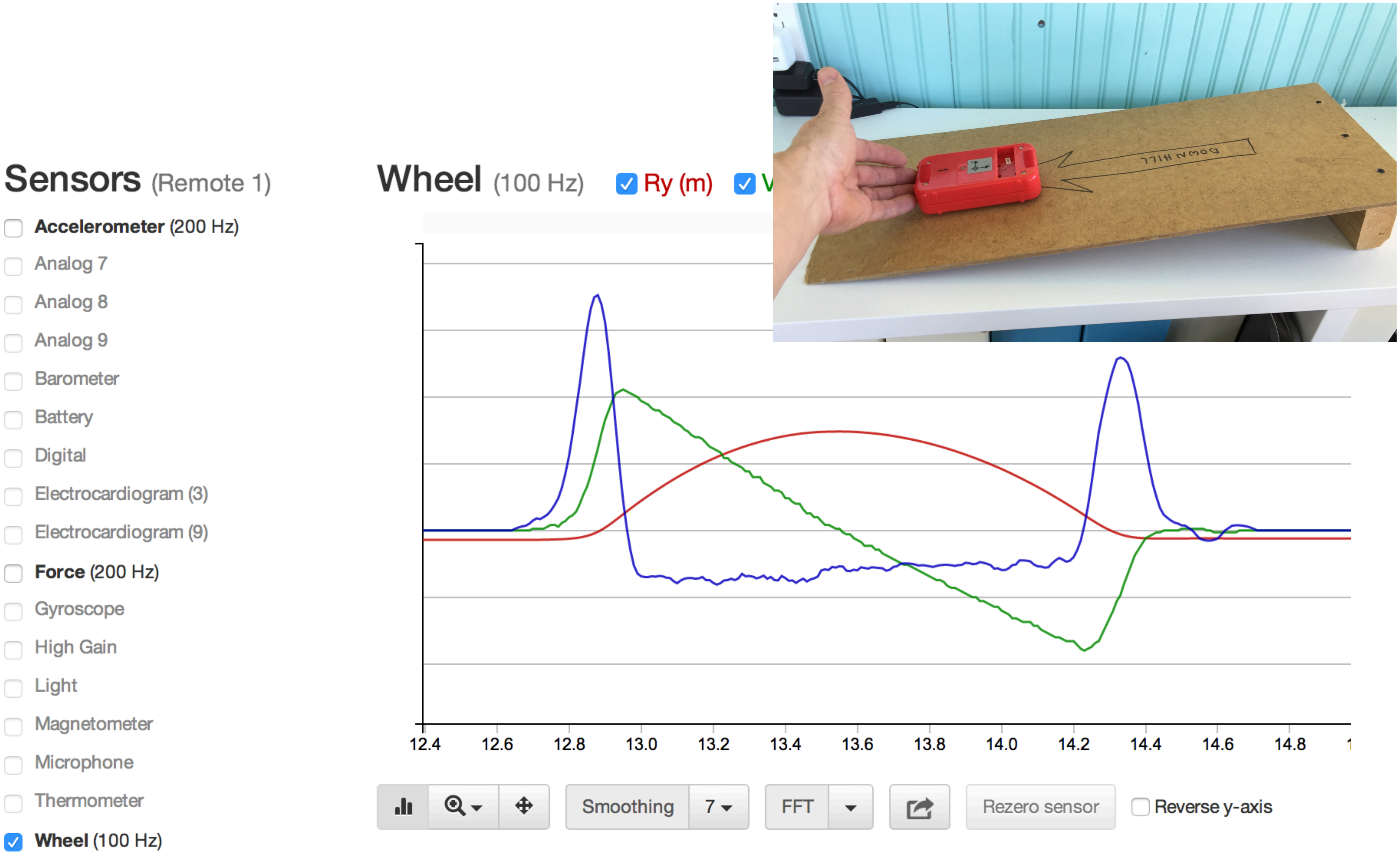
Area of velocity = change in position

Area of acceleration = change in velocity



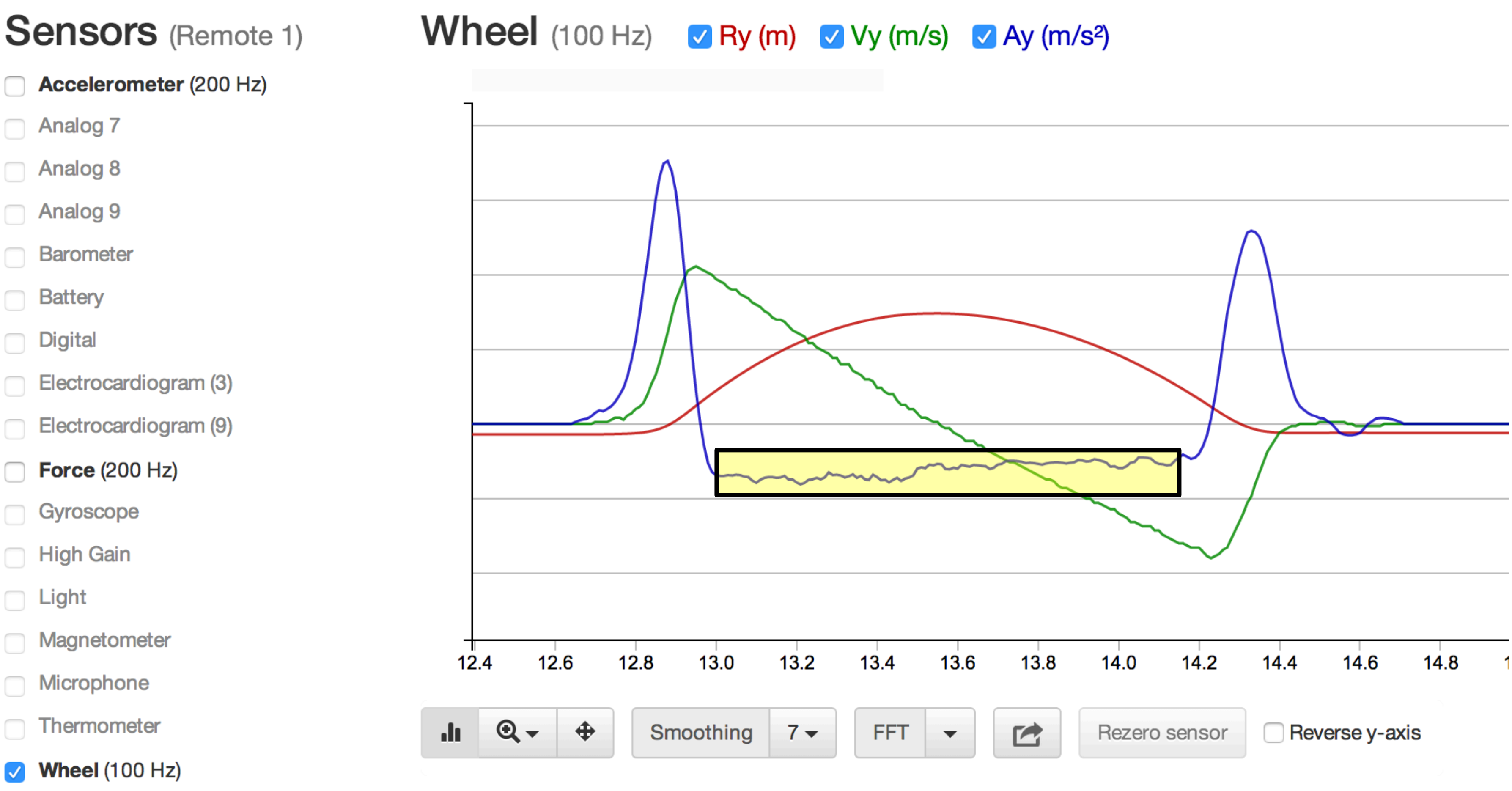
Kinematics
(Wheel Sensor)

Shove up a ramp and let it roll up then back down.



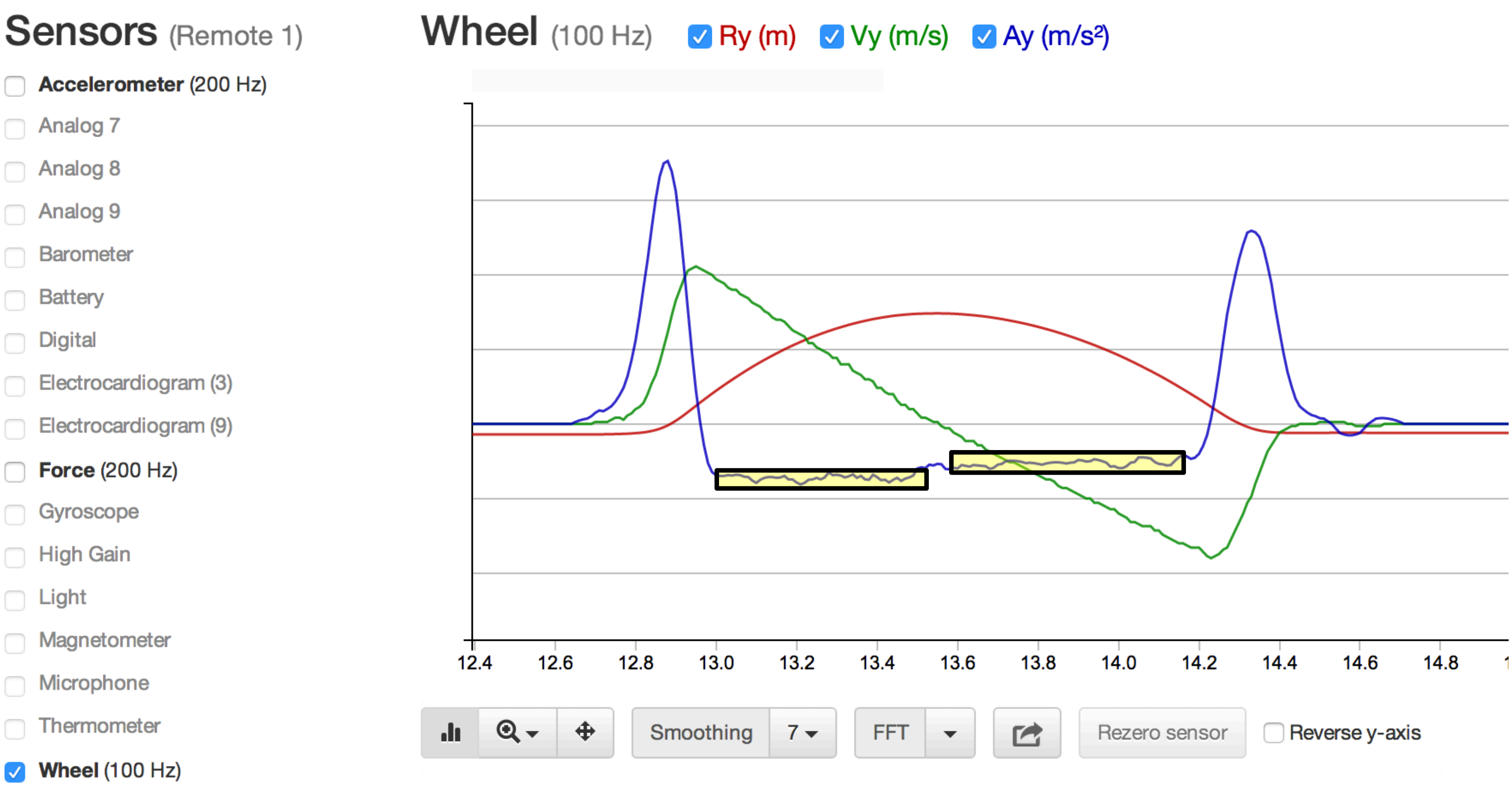
Kinematics
(Wheel Sensor)

Shove up a ramp and let it roll up then back down.
Understand why the acceleration has the
same sign even though velocity does not.



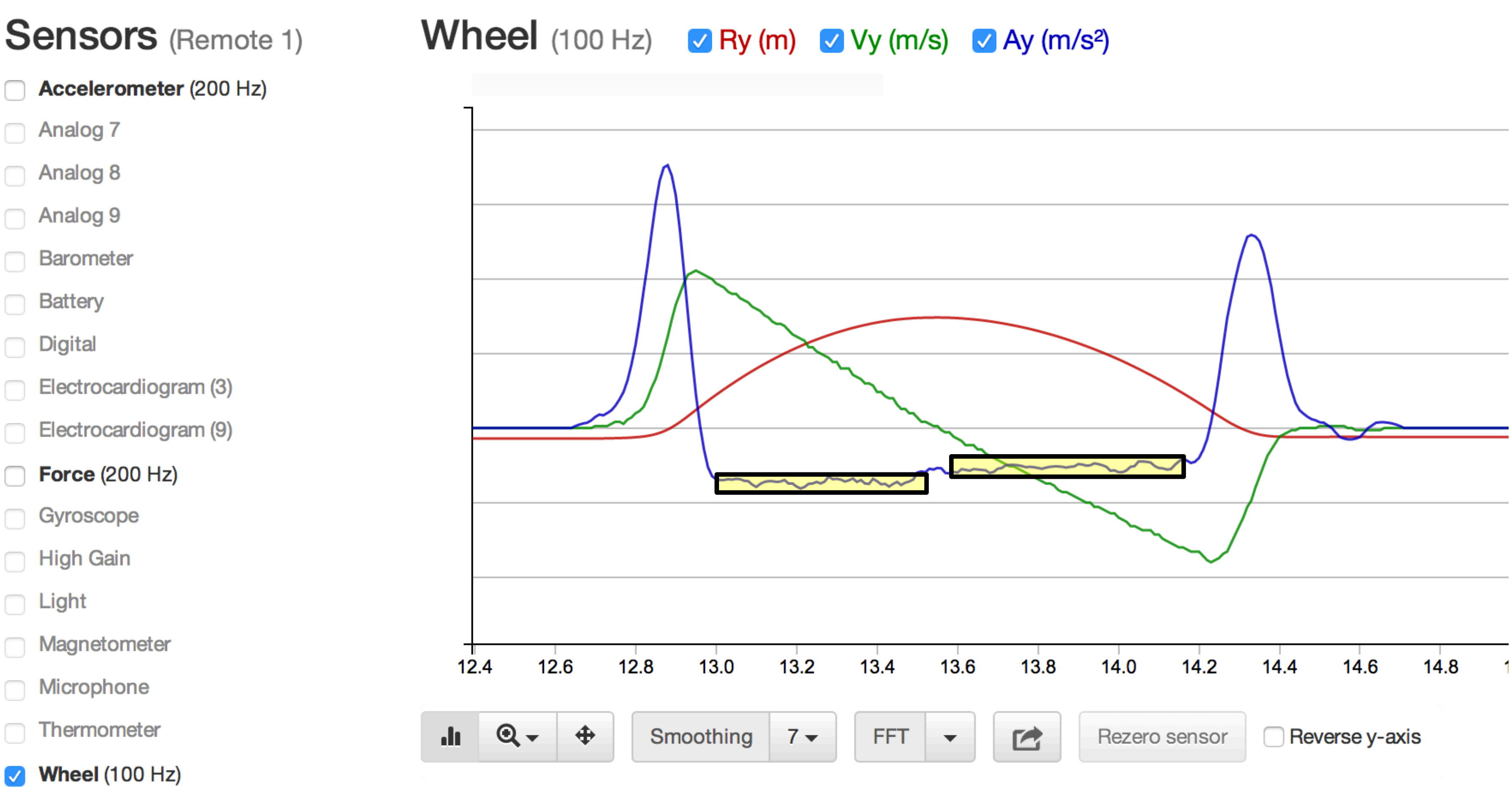
Kinematics
(Wheel Sensor)

Shove up a ramp and let it roll up then back down. Understand why the acceleration has a slightly different value on the way up and the way down.



Kinematics
(Wheel Sensor)

Shove up a ramp and let it roll up then back down. Calculate the angle of the ramp and the force of kinetic friction between the axle and the wheels.



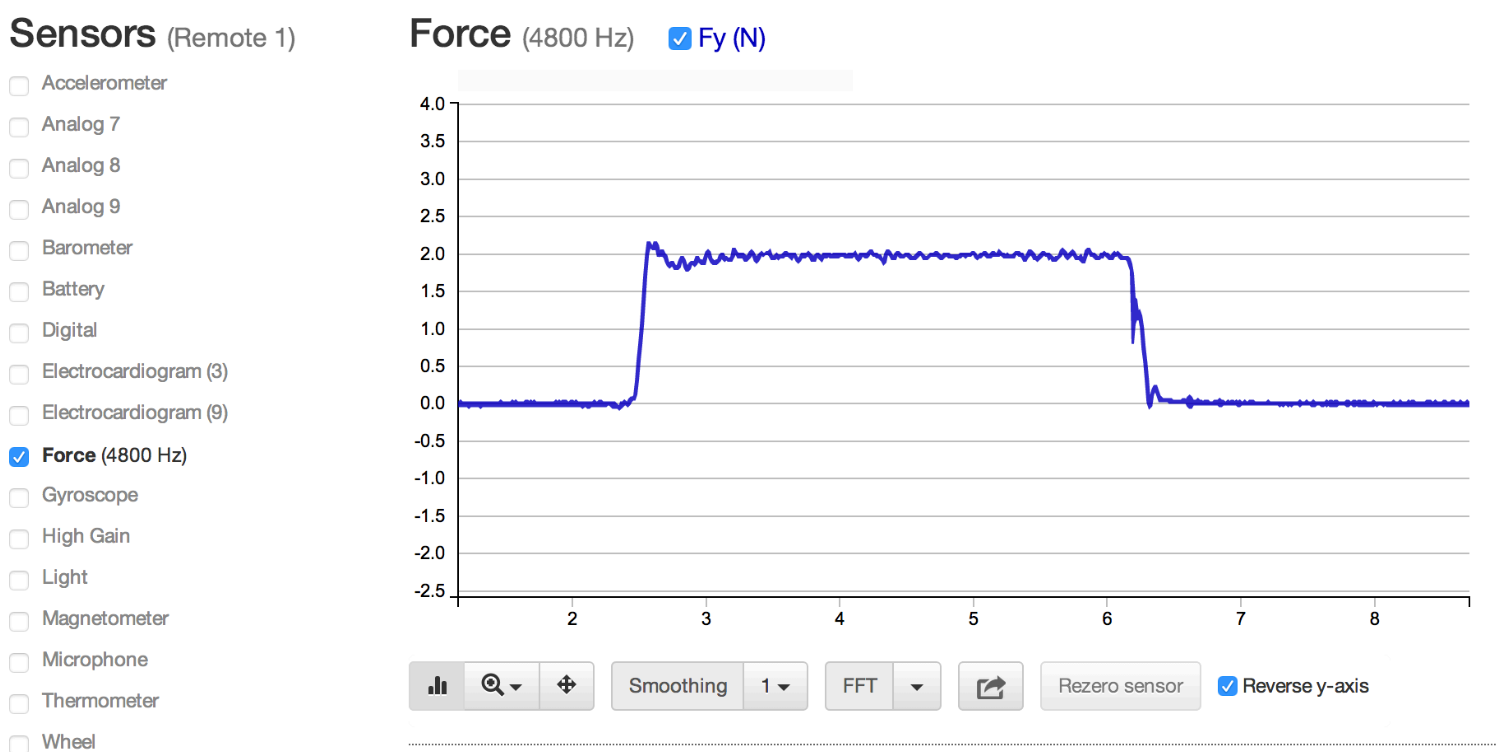
Newton's Laws

(Force sensor)

Lift device using force probe – hold still - put back down

Calculate mass of device from weight

(this is basically just a check that the calibration was done correctly and that students understand how to “zero” the force. The answer is 2 Newtons if they do this correctly)



Newton's Laws

(Force & Accelerometer sensors)

Hang device from force probe & move it up & down

Observe relationship between F and a

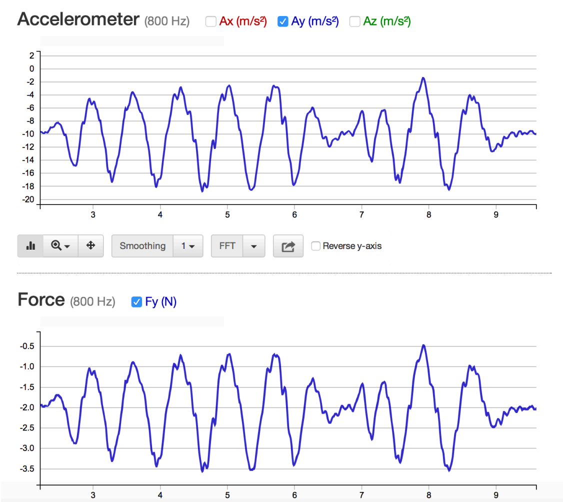
Newton's Laws

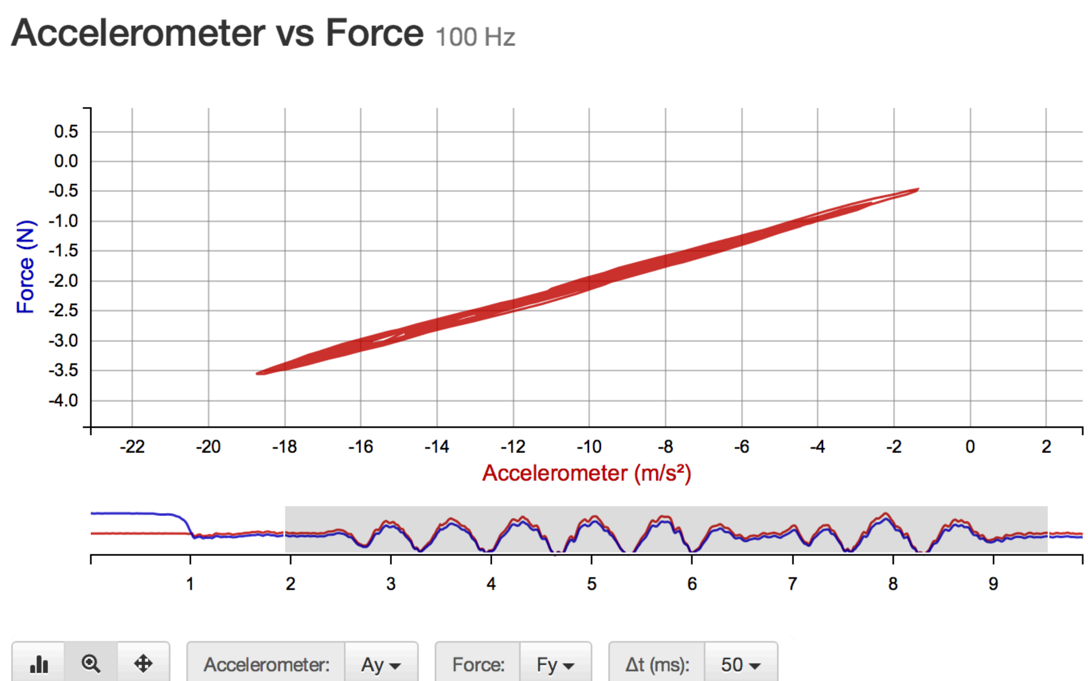
(Force & Accelerometer sensors)

Hang device from force probe – moving up & down

Calculate mass of device using

parametric plot of F vs a (slope = mass)

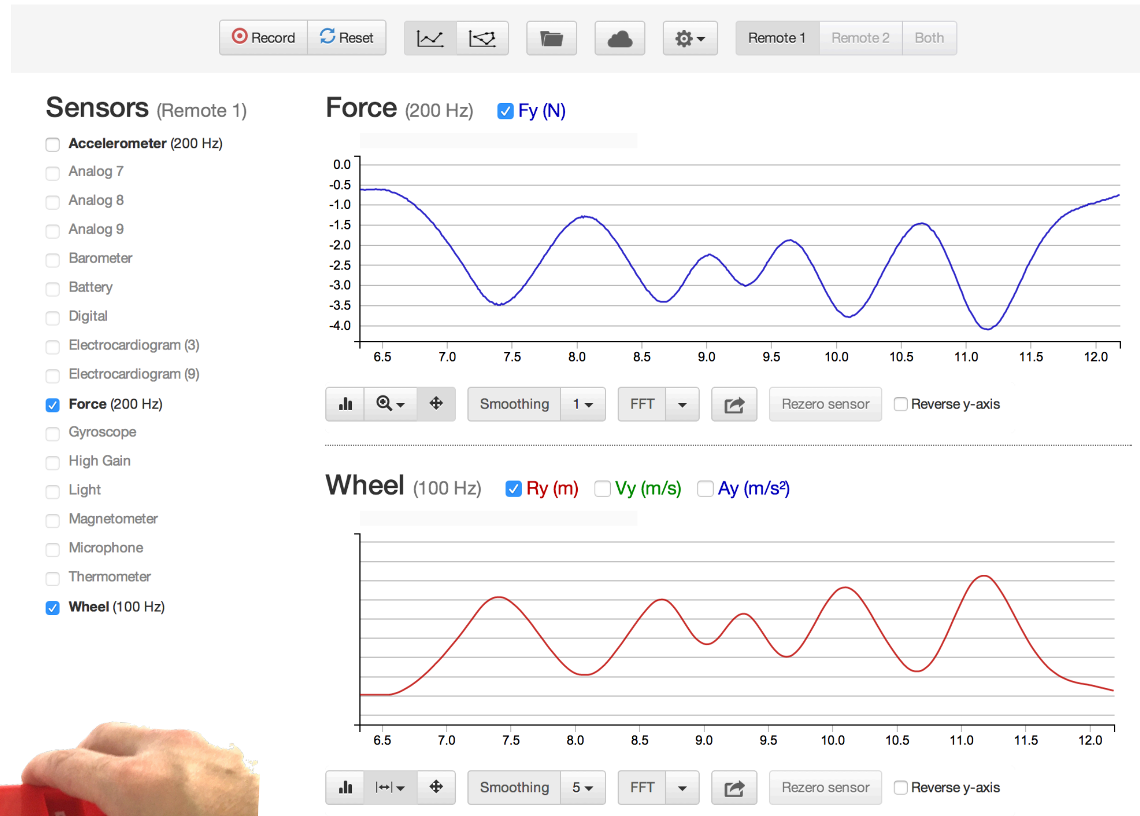


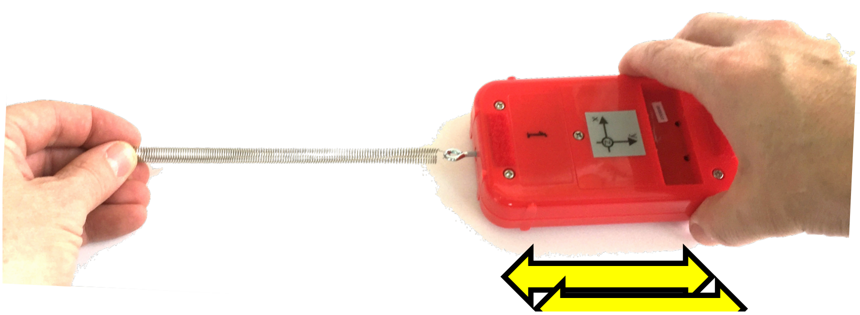


Newton's Laws

(Force & Wheel sensors)

Attach extension spring to force probe. Roll device while holding spring. Observe relationship between Displacement and Force

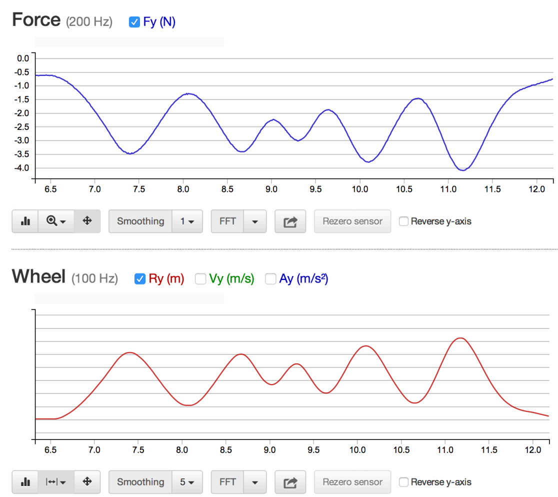


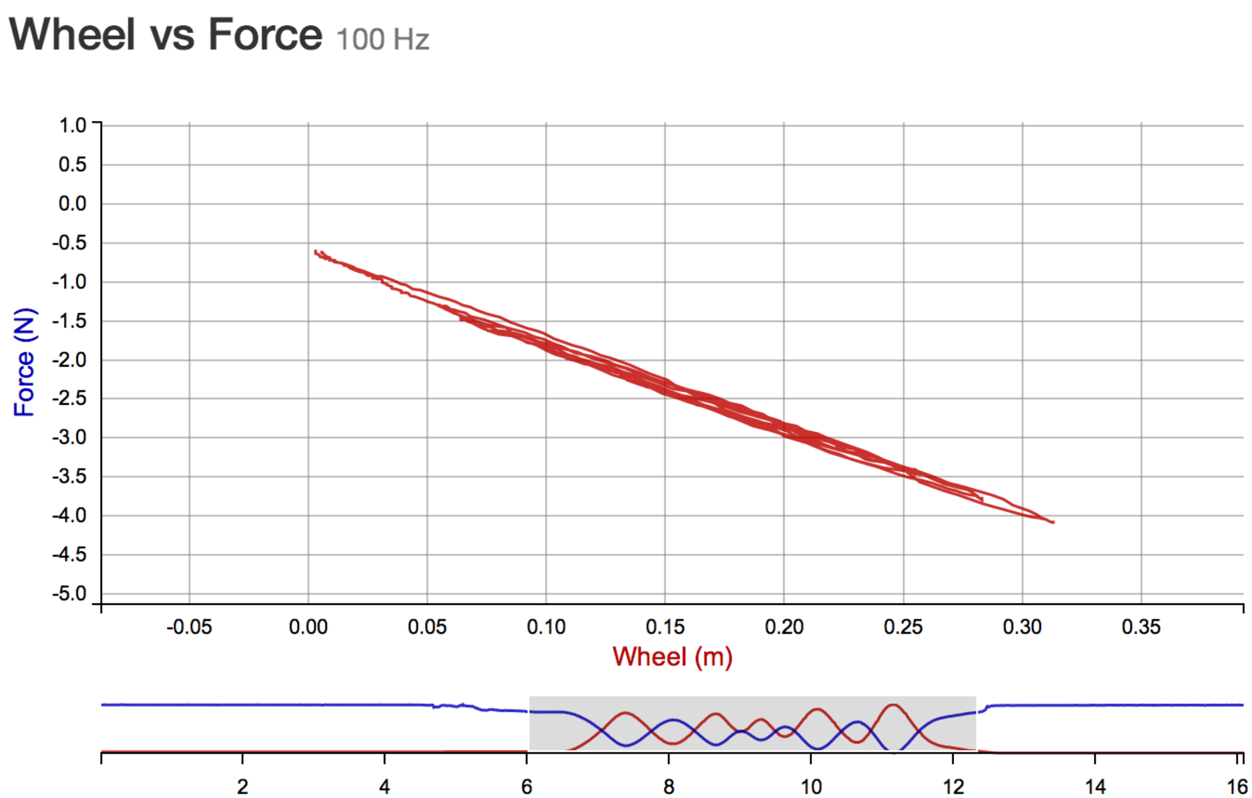


Newton's Laws

(Force & Wheel sensors)

Attach extension spring to force probe. Roll device while holding spring. Use parametric plot to measure spring constant (F = -kx)



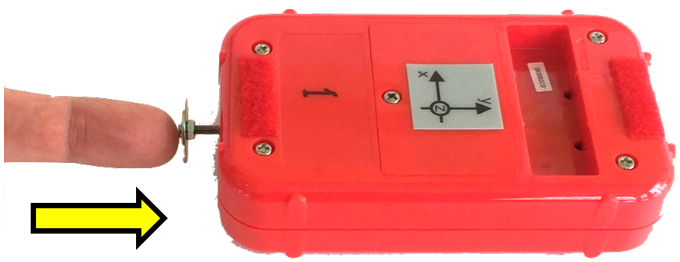


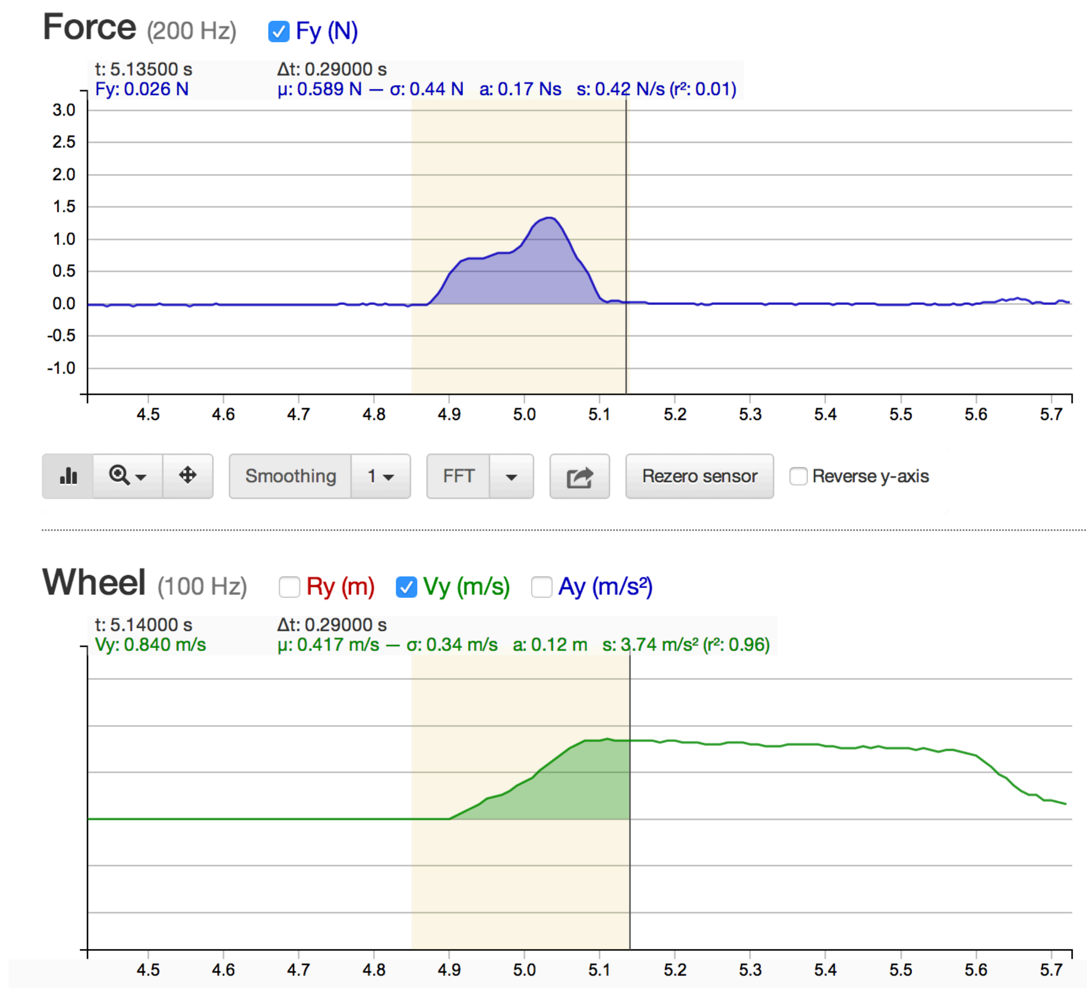
Newton's Laws

(Force & Wheel sensors)

Push quickly on the force sensor and plot force vs velocity

Integrate Fdt during the push and show that it equals ΔP

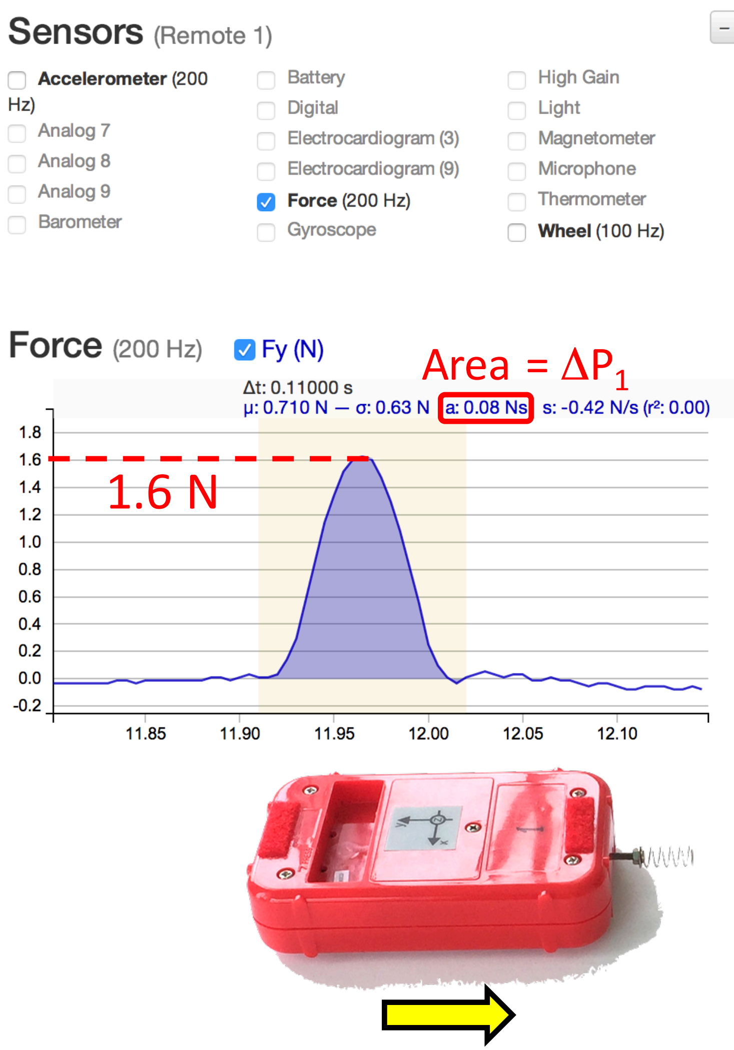


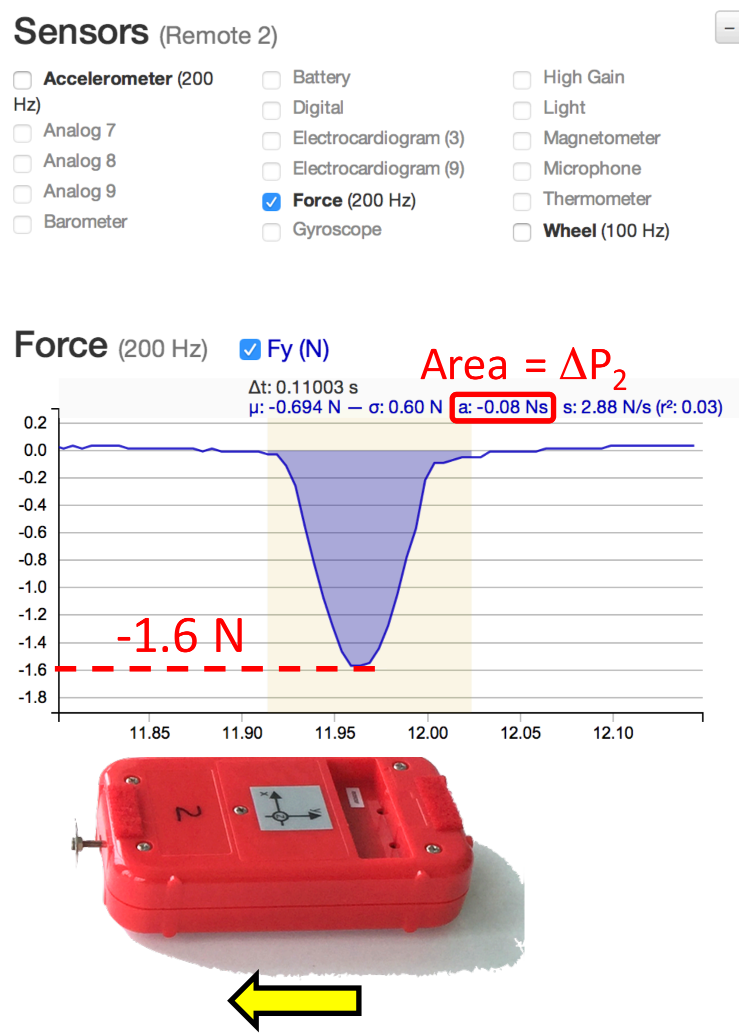


Newton's Laws

(Two devices & Two force sensors)

Read both force sensors during head-on collision to illustrate Newton's Third law as well as Conservation of Momentum



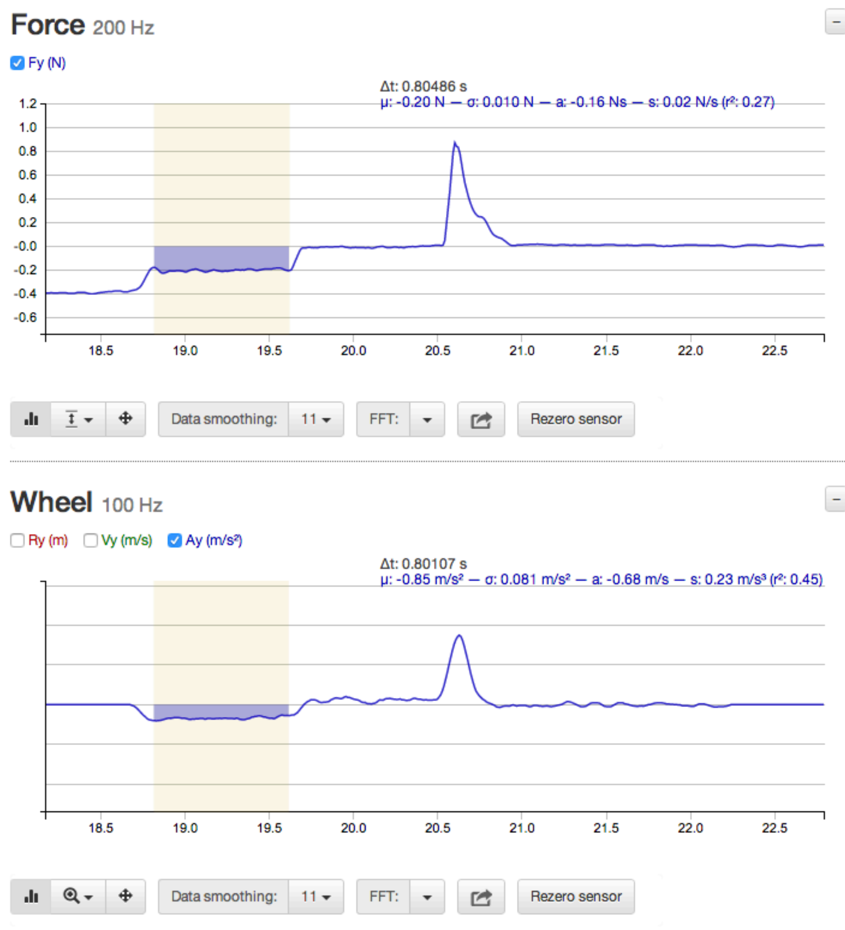


Newton's Laws

(Modified Atwood's Machine using one devices + box)

Read both force sensors and wheel of rolling device.

Study acceleration vs Tension, F_{net} , find friction, much more.



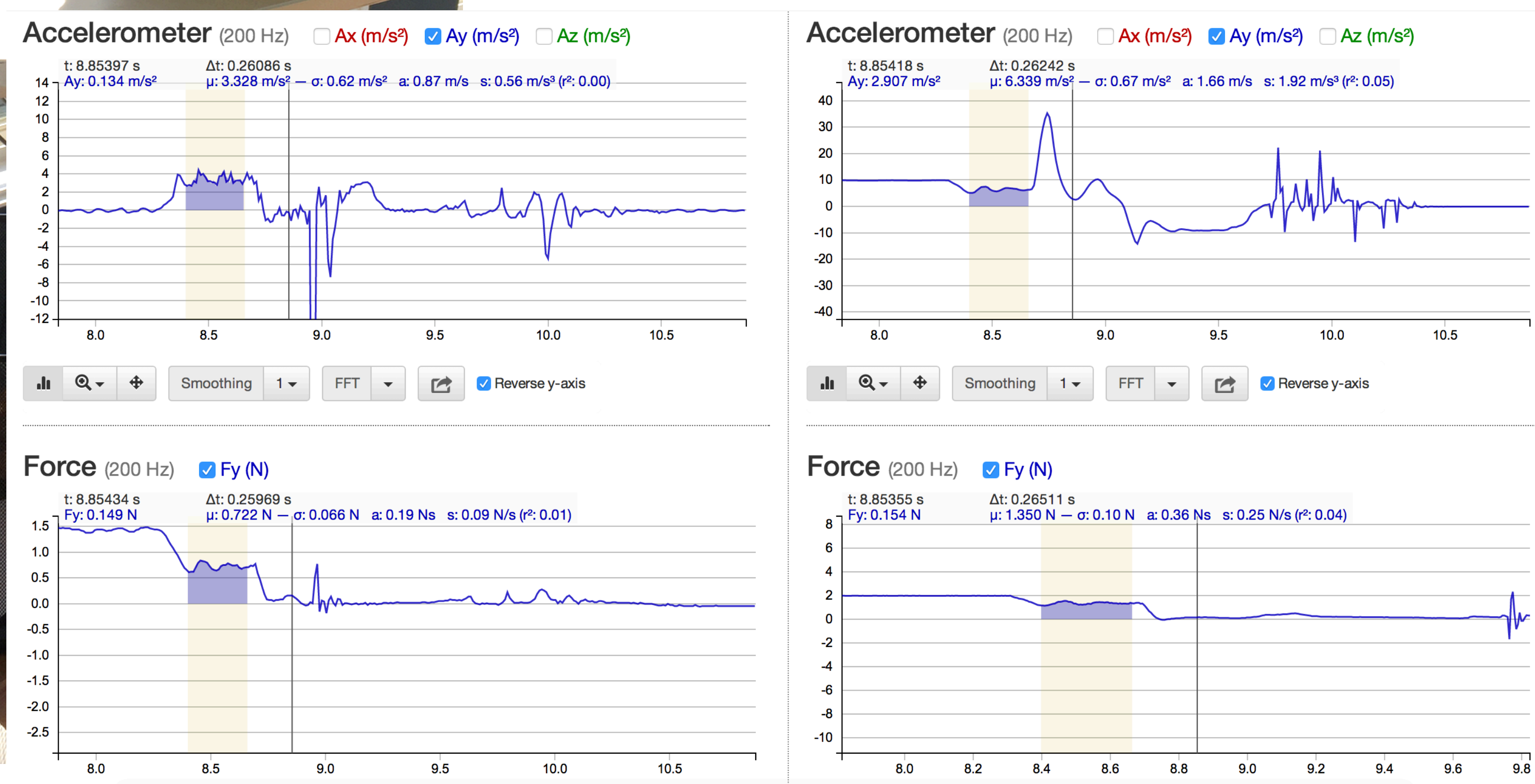
Newton's Laws

(Modified Atwood's Machine using two devices)

Read both force sensors and wheel of rolling device.

Study F_{net} on both units, rolling friction, and string-table friction...

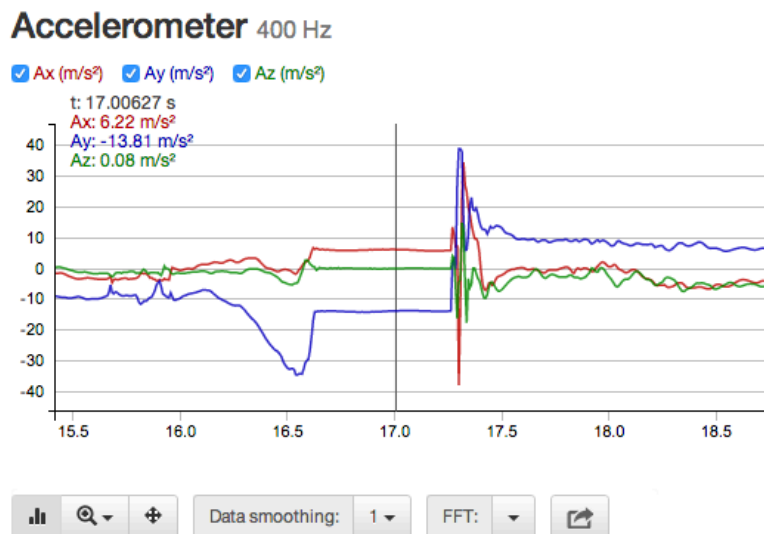
There are many measurements in this activity and a lot for students to do and understand. At UIUC we take 2 hours for the students just to figure out how to use the data from the hanging mass to measure g.

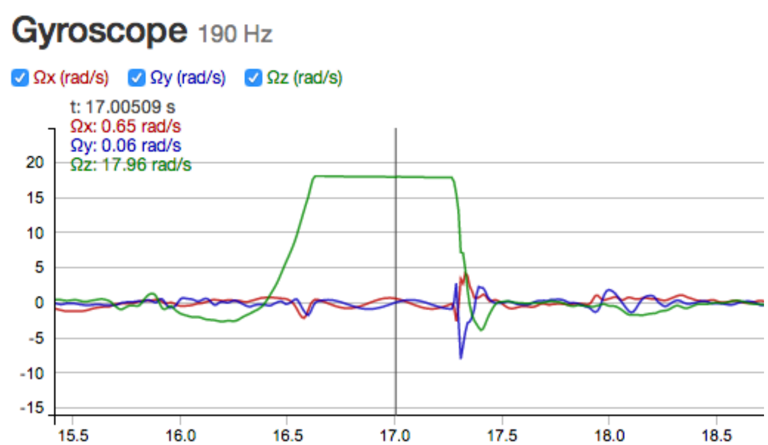


Newton's Laws

(Gyroscope & Accelerometer)

Toss IOLab into the air so that it spins around z-axis while in free-fall. Correlate ω_z (gyroscope) and (a_x, a_y) (accelerometer) to study centripetal acceleration: $a_c = \omega^2 R$.



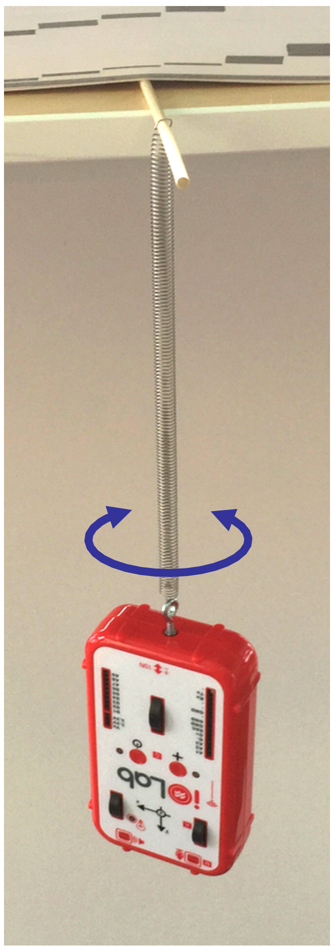


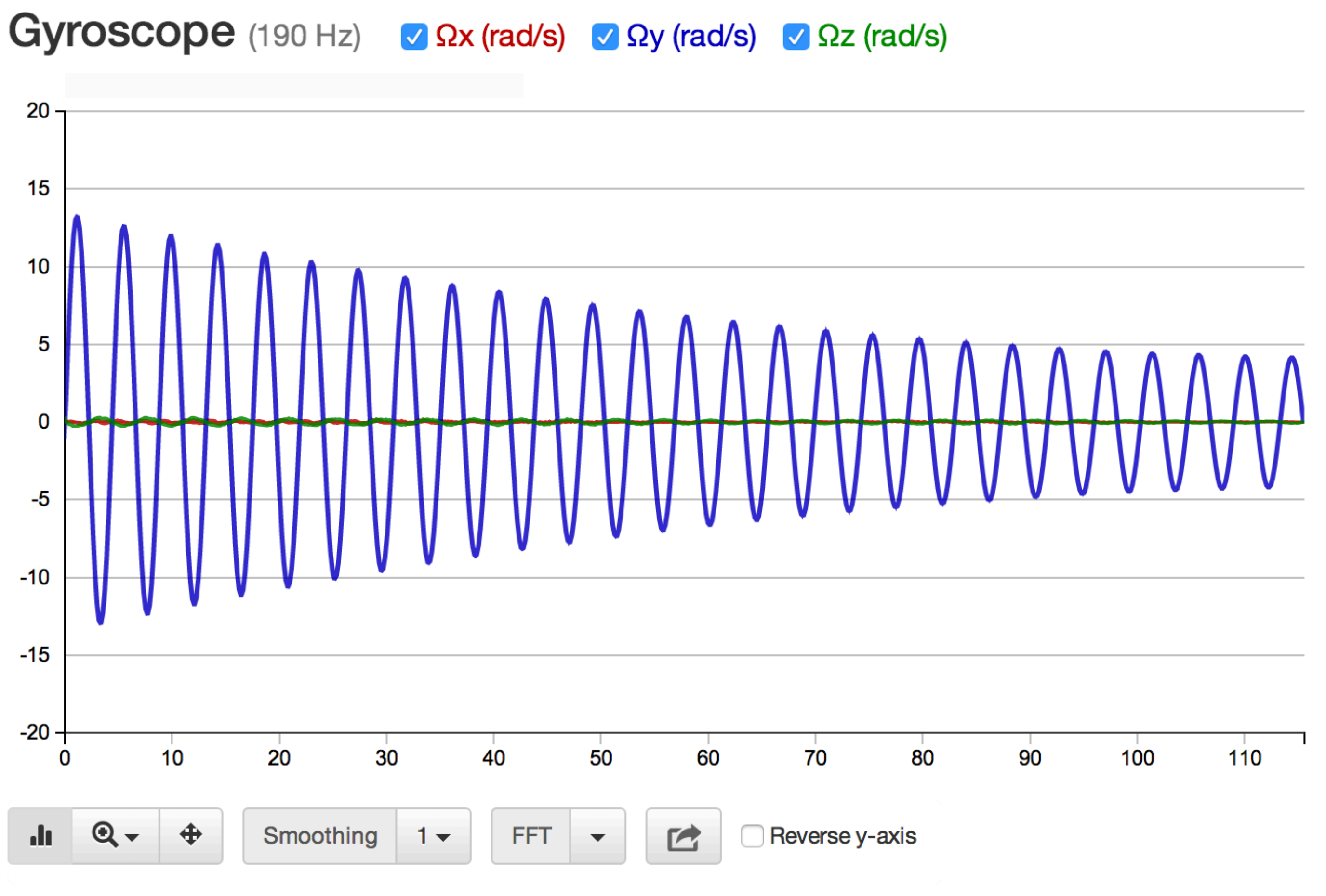
Simple Harmonic Motion

(Gyroscope sensor)

Use IOLab to build a torsion pendulum

Observe that period is independent of amplitude



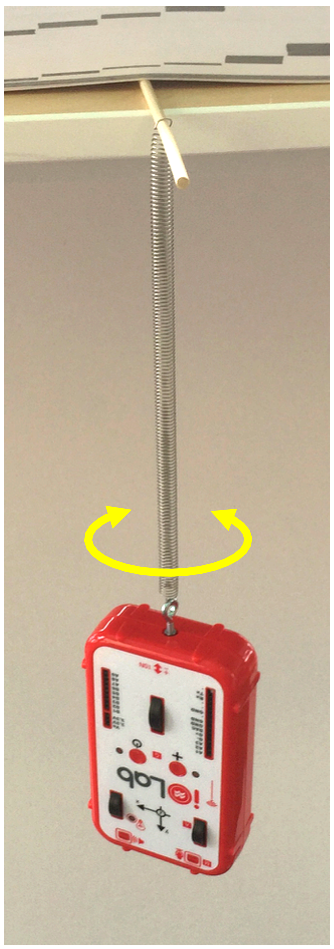


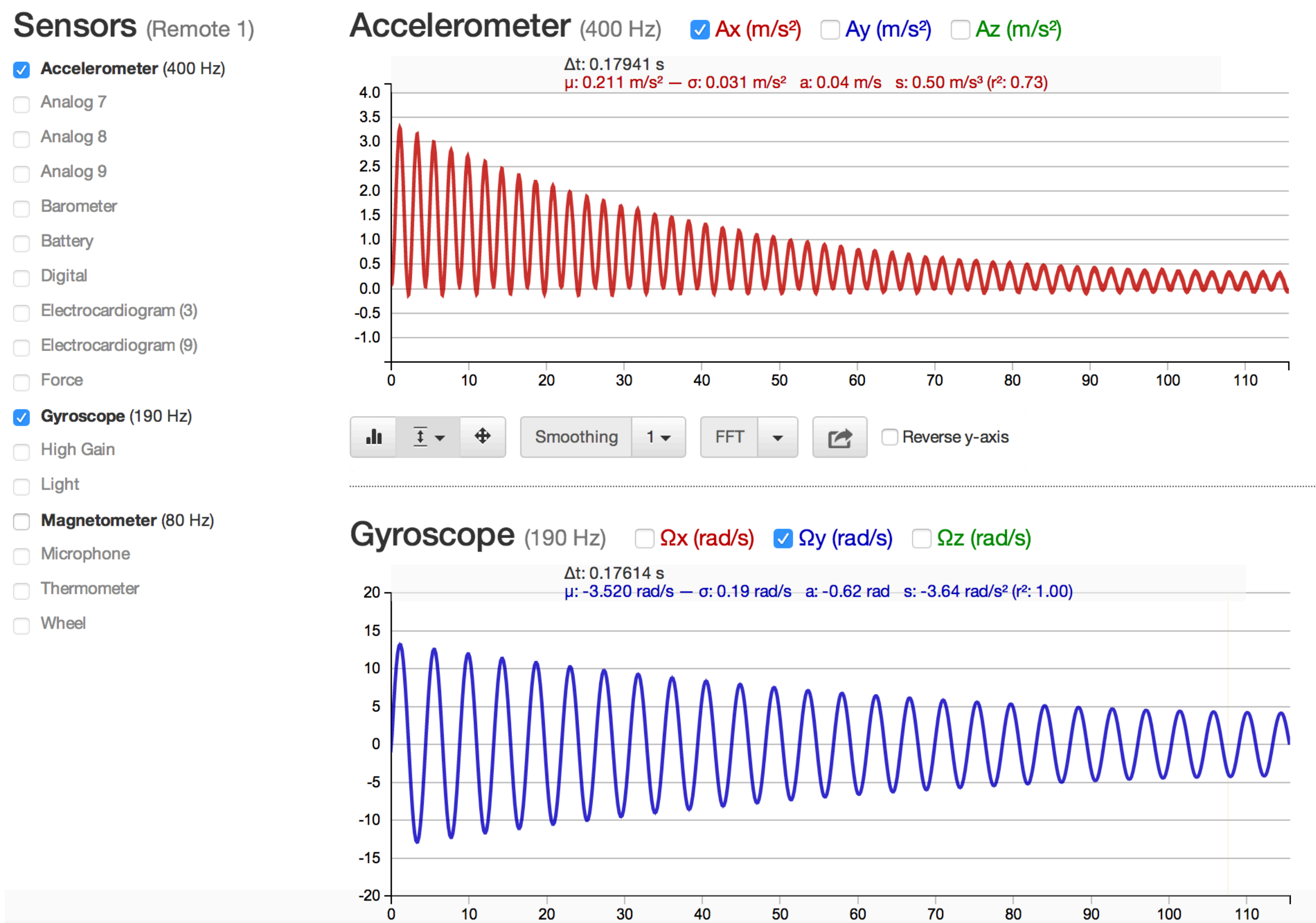
Simple Harmonic Motion

(Gyroscope and Accelerometer sensors)

Use IOLab to build a torsion pendulum

Study correlation between ω and a_x (centripetal acceleration).



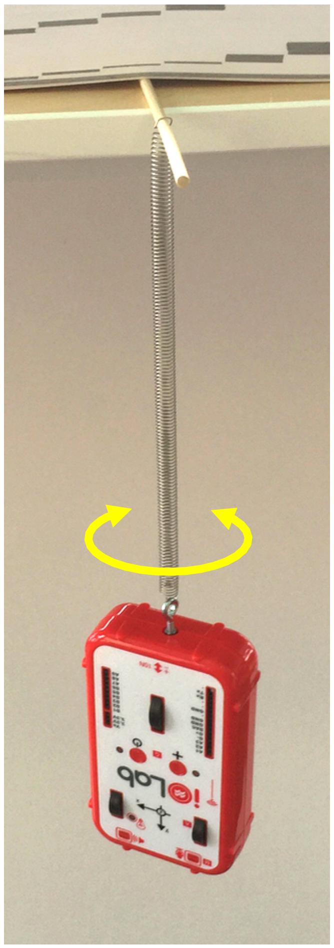


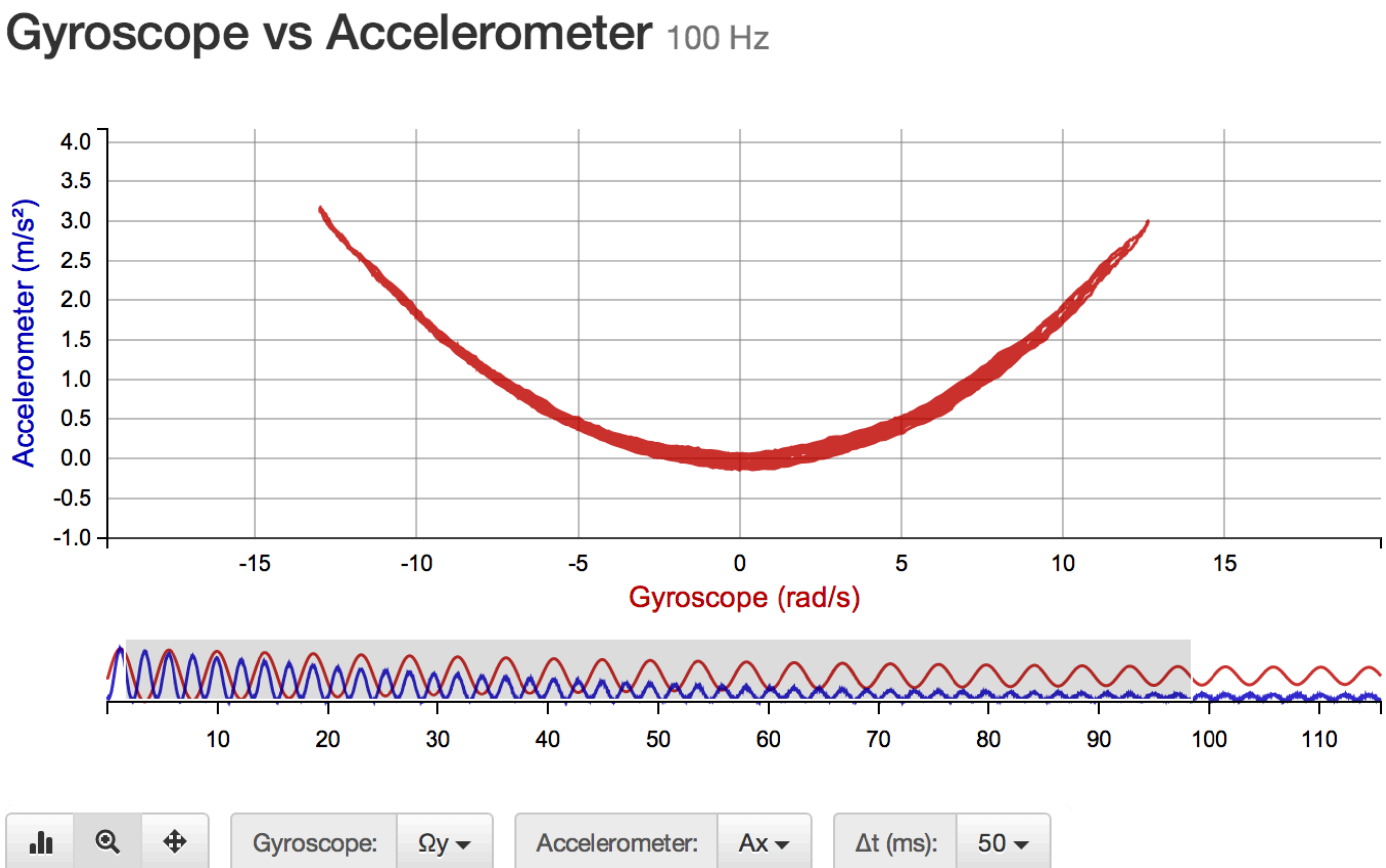
Simple Harmonic Motion

(Gyroscope and Accelerometer sensors)

Use IOLab to build a torsion pendulum

Use parametric plot of a_x vs ω_y plot to find quadratic $a_c = \omega^2 R$.





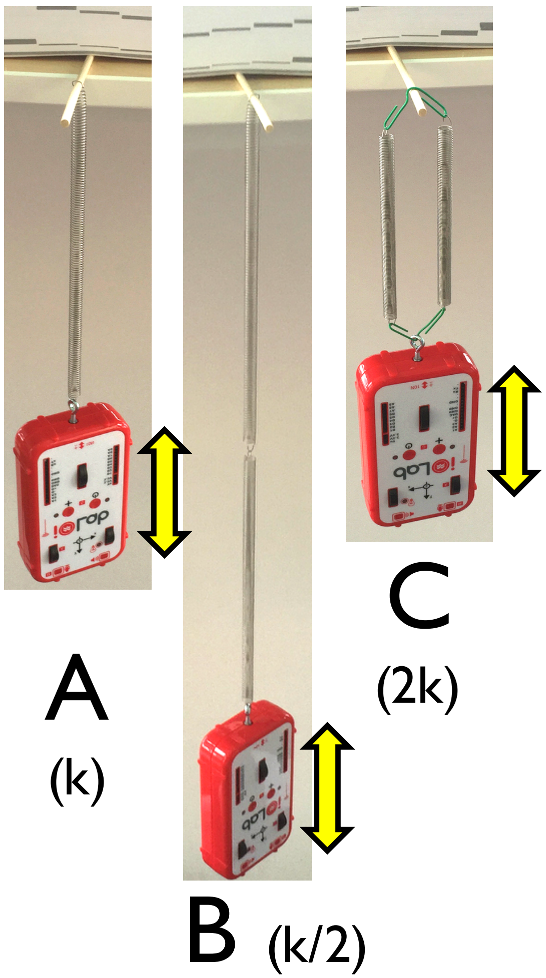
Simple Harmonic Motion

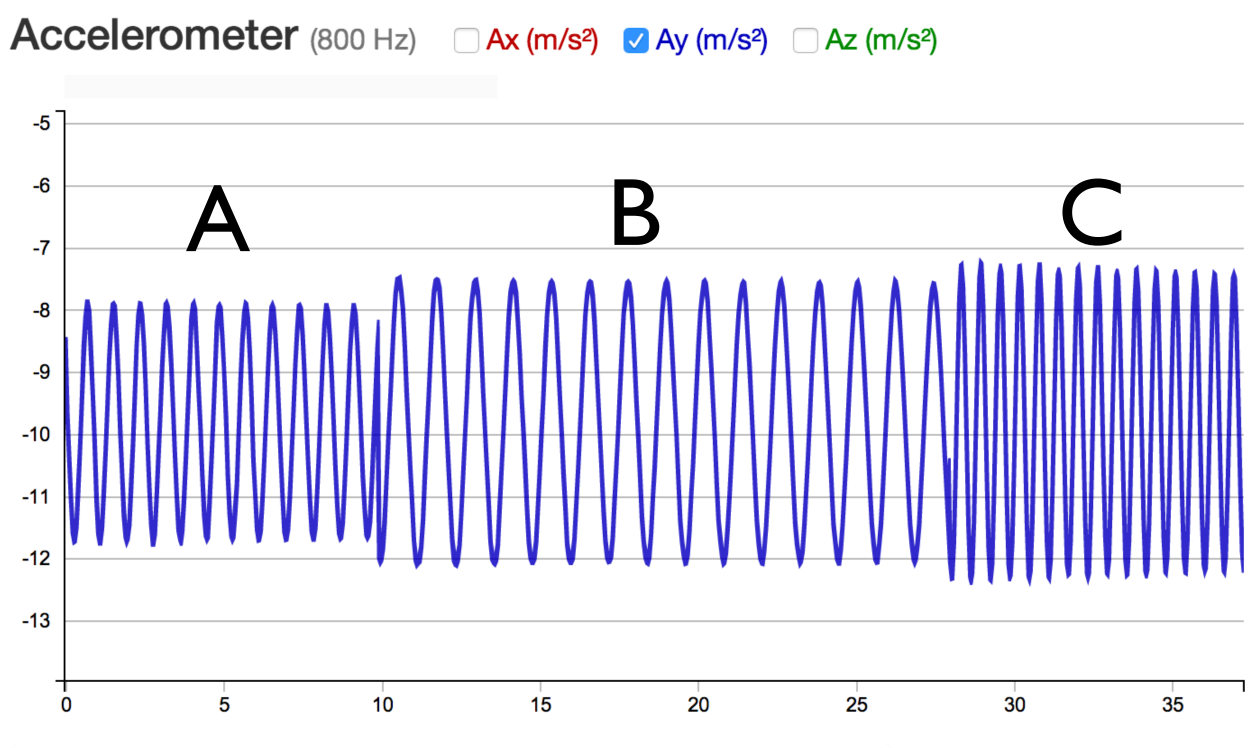
(Accelerometer sensor)

Use IOLab as an oscillating mass on a spring.

Study ω versus effective k and mass to find $\omega^2 = k/m$.

Change k by hooking up springs in series and in parallel.



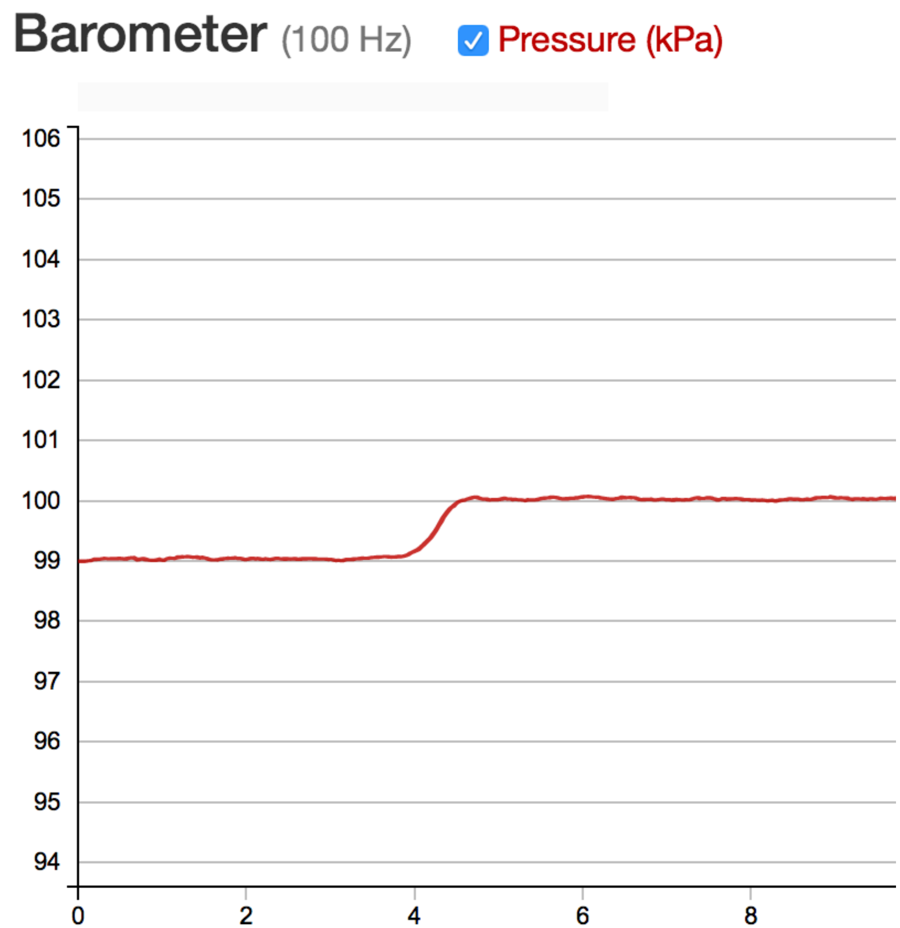


Force & Pressure

(Pressure sensor)

Put IOLab in a Ziploc bag. Use pressure change and area to calculate the weight of a book or other heavy object.

(Weight = ΔPressure * Area)

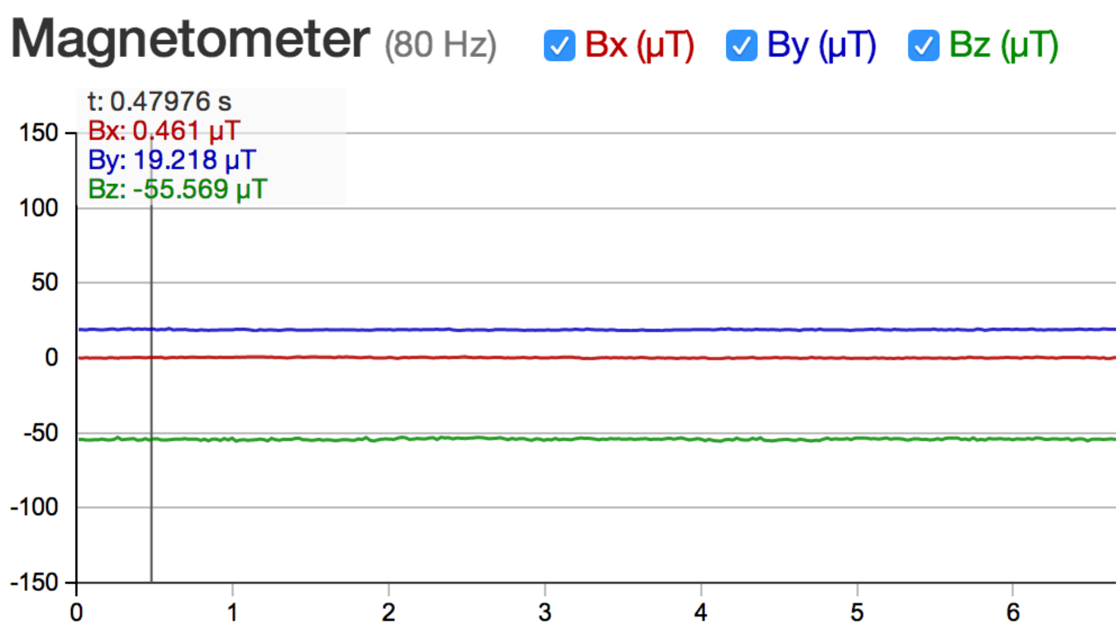


Magnetic Fields

(Magnetometer)

Find the direction of the Earths field where you live.

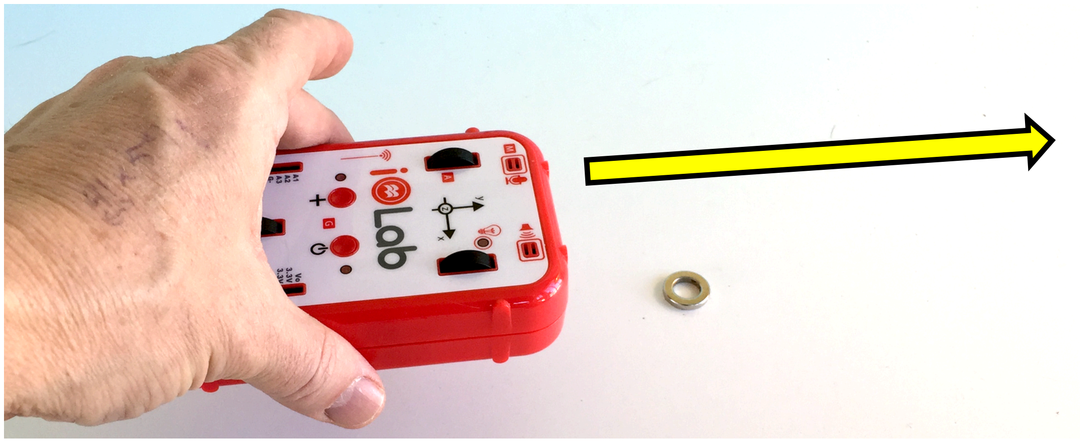
(Adjust device on a horizontal table until Bx = 0 and By = positive and notice the large negative magnitude of Bz. Calculate downward dip-angle.)

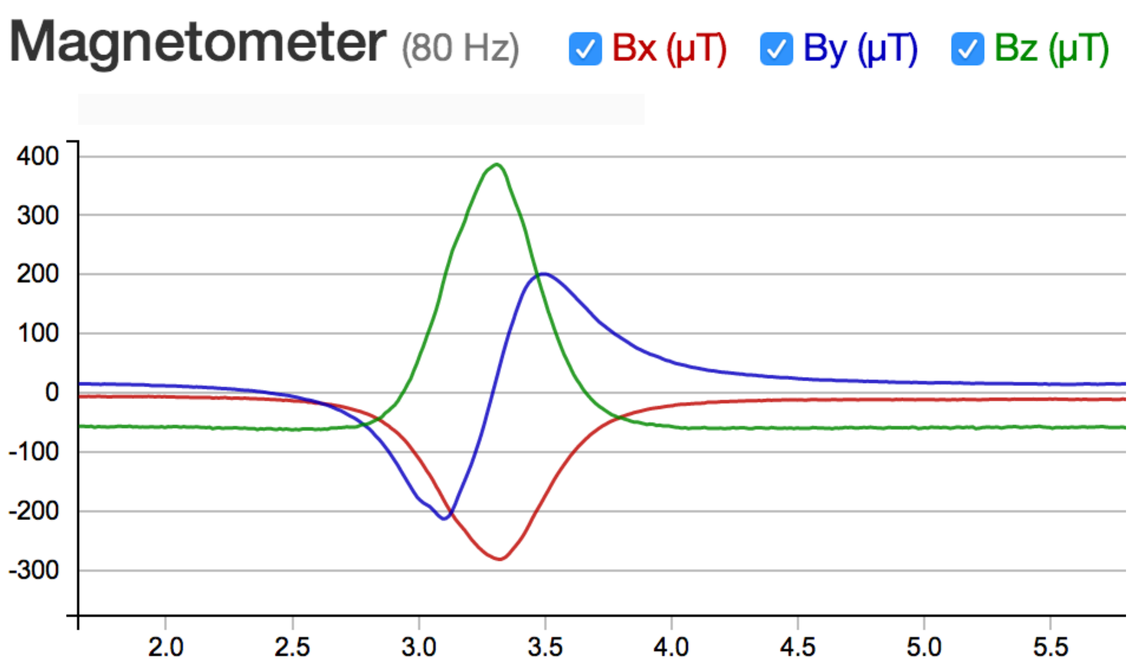


Magnetic Fields

(Magnetometer)

Investigate field in 3D as you move device over a permanent magnet.

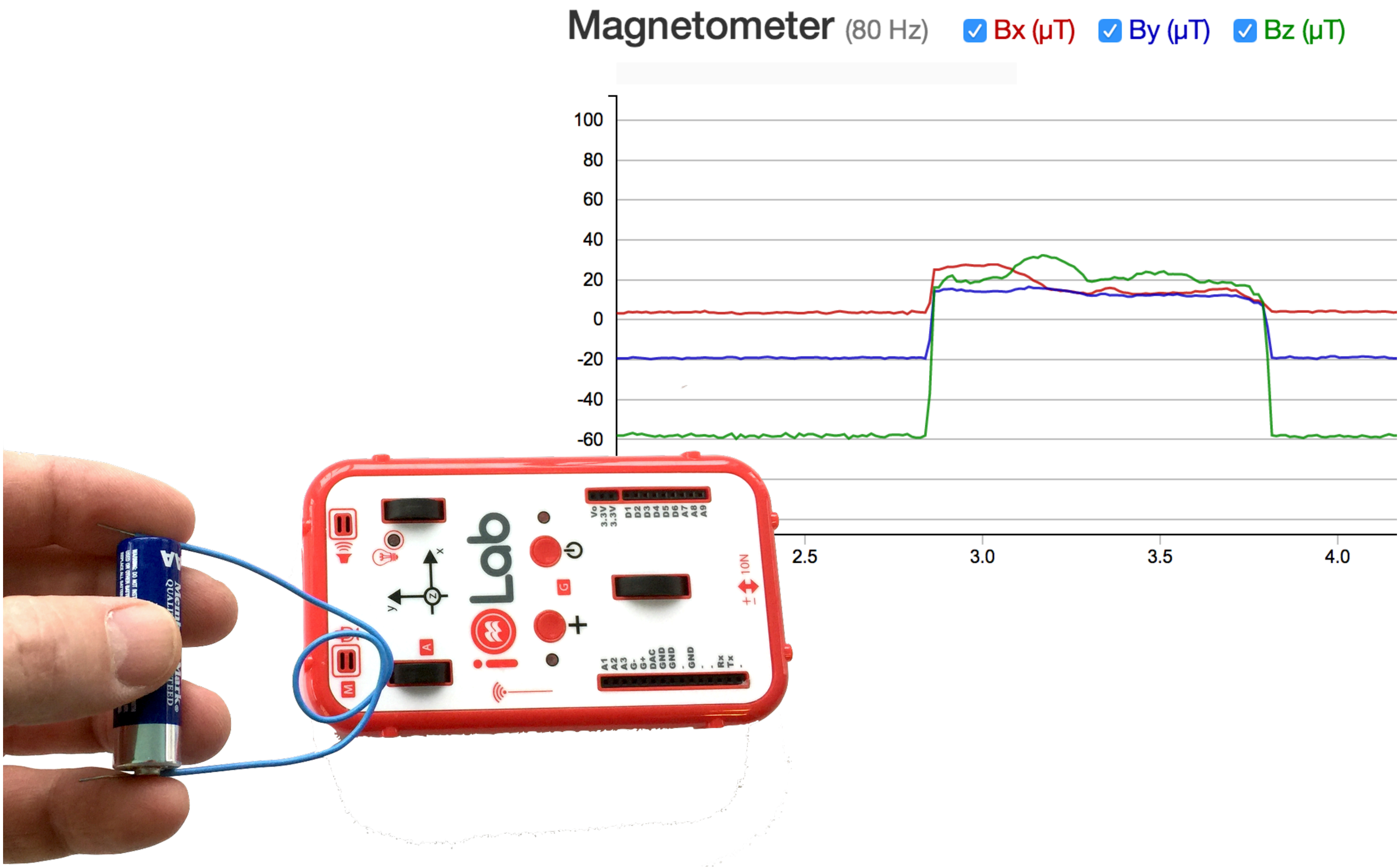




Magnetic Fields

(Magnetometer)

Investigate field in 3D as you energize a current loop near device.



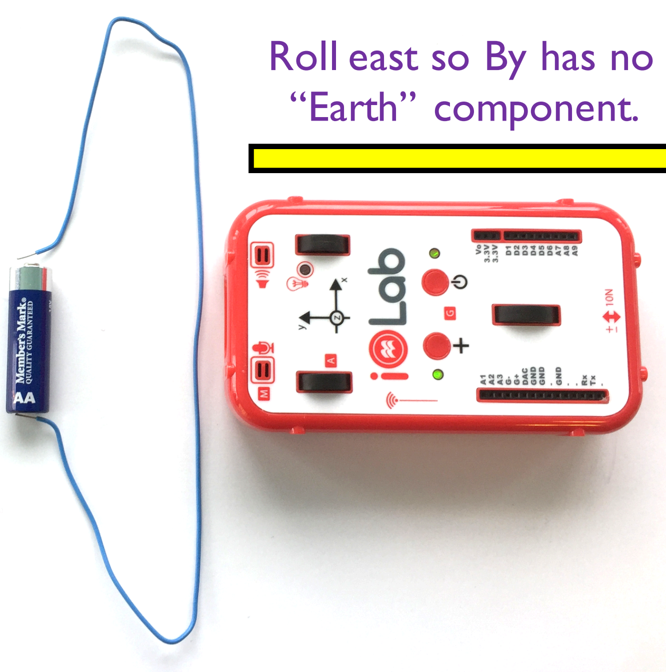
Magnetic Fields

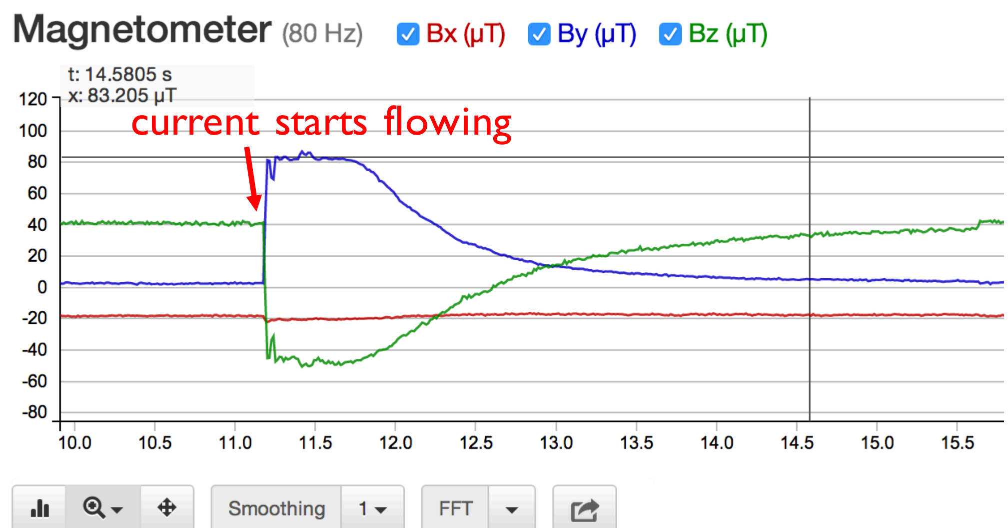
(Magnetometer & Wheel)

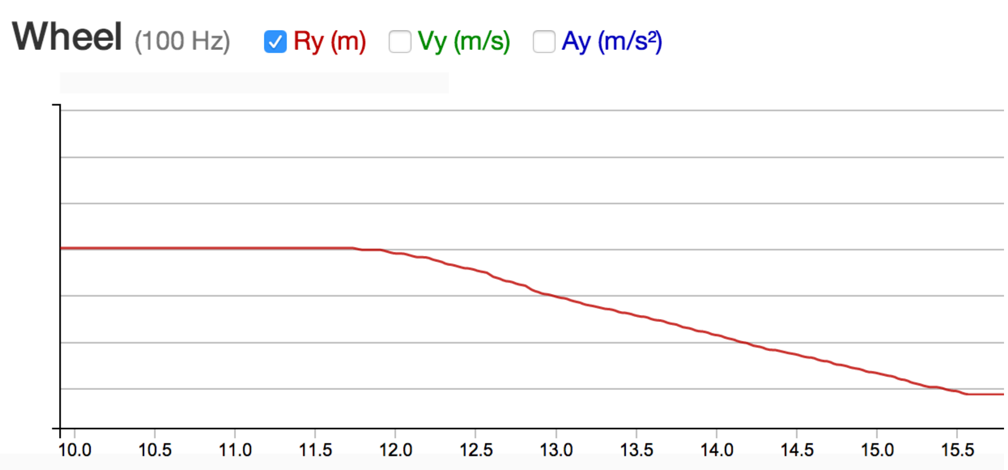
Investigate field from a straight current-carrying wire.

(Direction of field given by right-hand-rule. Magnitude proportional to 1/R.)

Roll east so By has no "Earth" component.







Magnetic Fields

(Magnetometer & Wheel)

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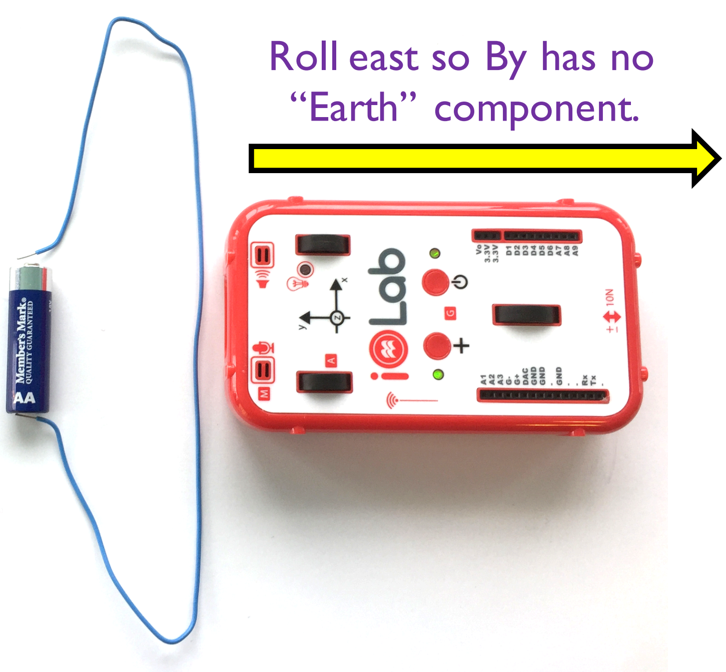
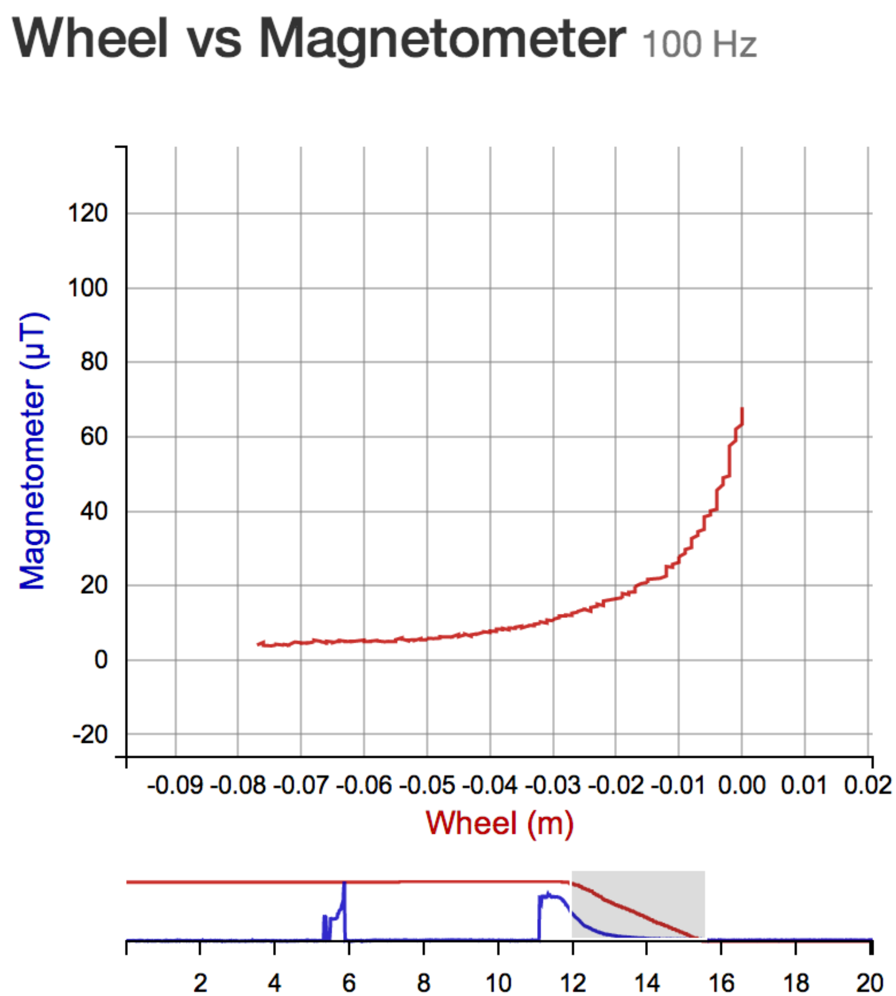


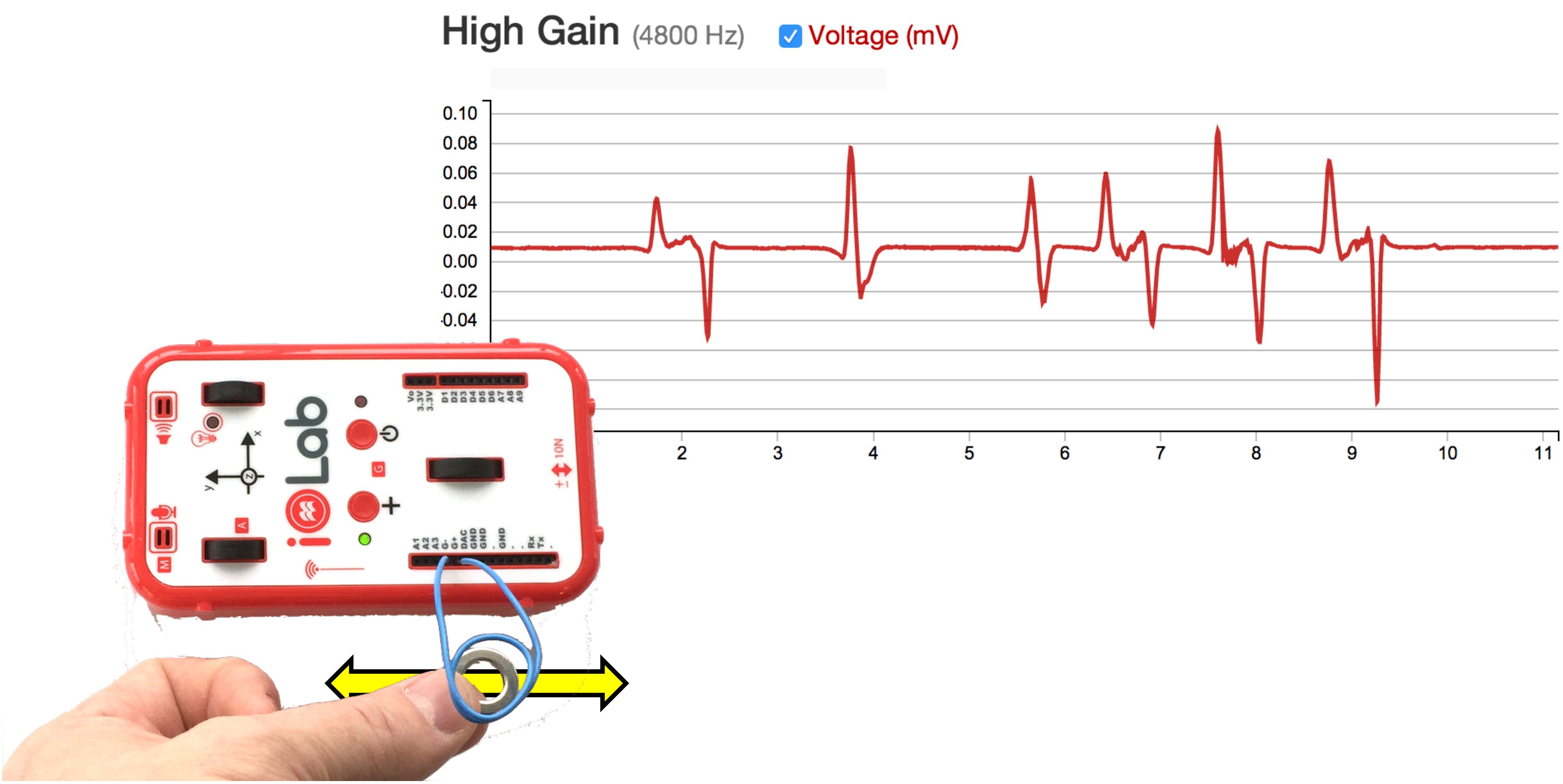


Magnetic Induction

(High Gain G+/G- Input)

Move permanent magnet or current loop near loop of wire connected to G+/G- inputs to investigate Faradays Law.

(Direction of induced *emf* given by right-hand-rule. Magnitude proportional to $d\phi/dt$)



Magnetic Induction

(High Gain G+/G- Input)

Spin permanent magnet near loop
connected to G+/G- inputs to investigate Faradays Law.

(Direction of induced *emf* given by right-hand-rule. Magnitude proportional to ω.