The potential of mobile sensor technology in physics education

Chris Isaac Larnder & Michael Pagano

John Abbott College

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Students are immersed in a digital culture

1650 : Classical mechanics

example application: throwing a ball

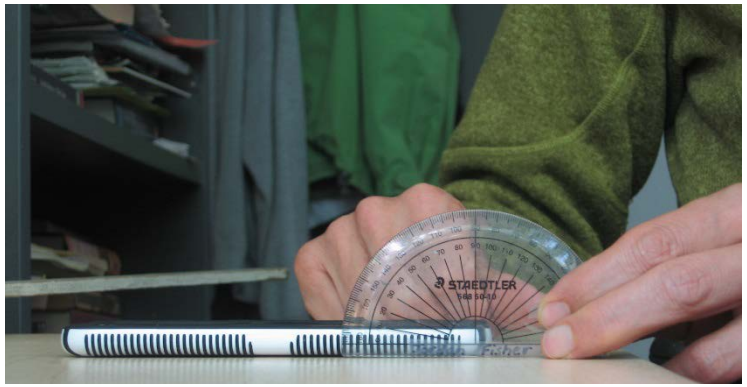
2010: Smart phones

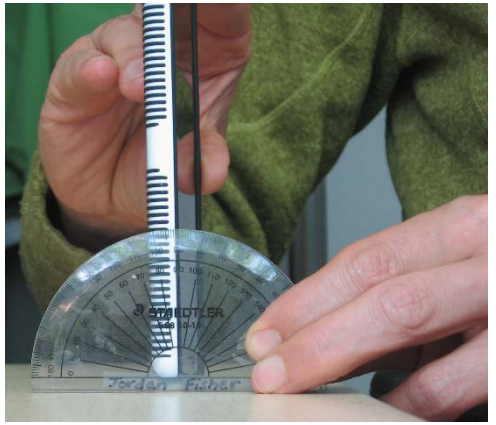
example application: accelerometer sensors detecting human motion!

Sample lab: static vectors

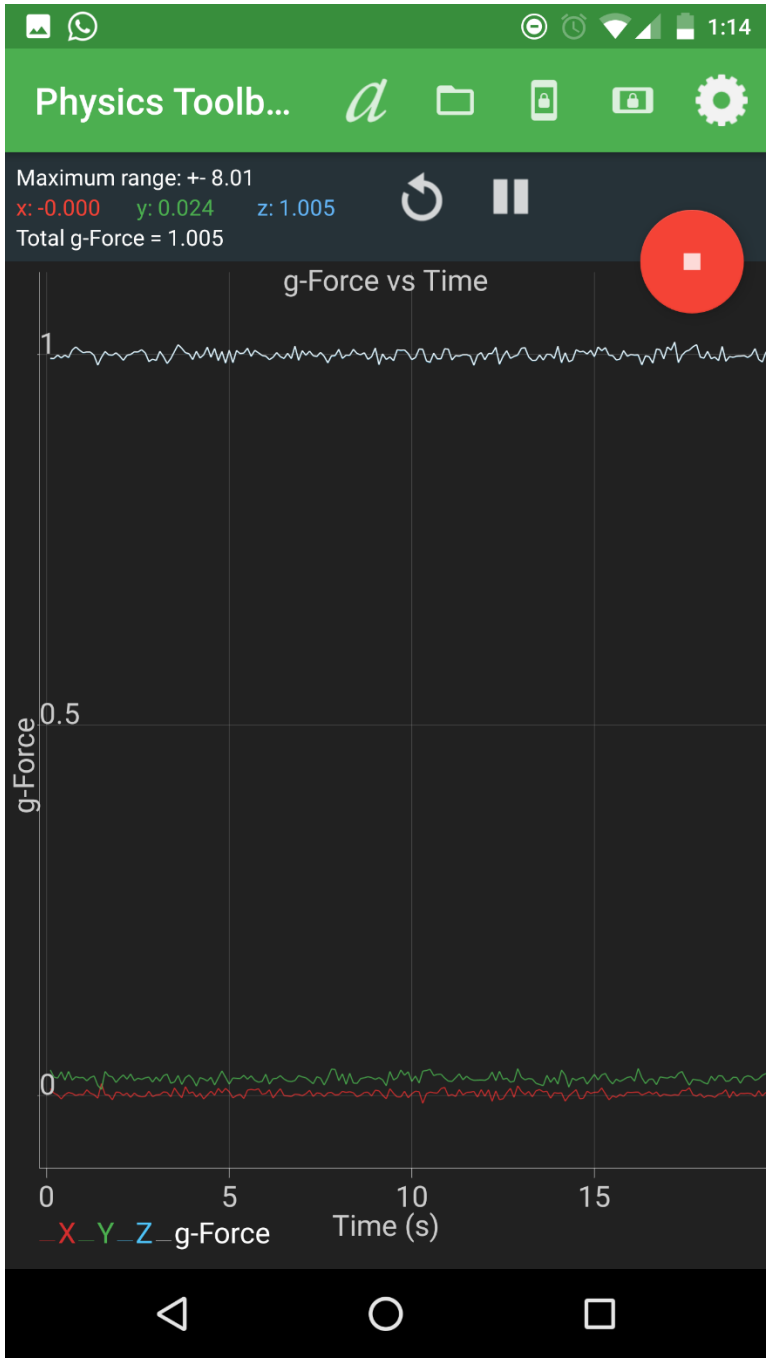
- Learning basic vector skills:
  - Very important
  - Very boring!
- Existing lab activity:
  - “Force Table”
- New activity:
  - landscape/portrait “tilt” function in cell phones !

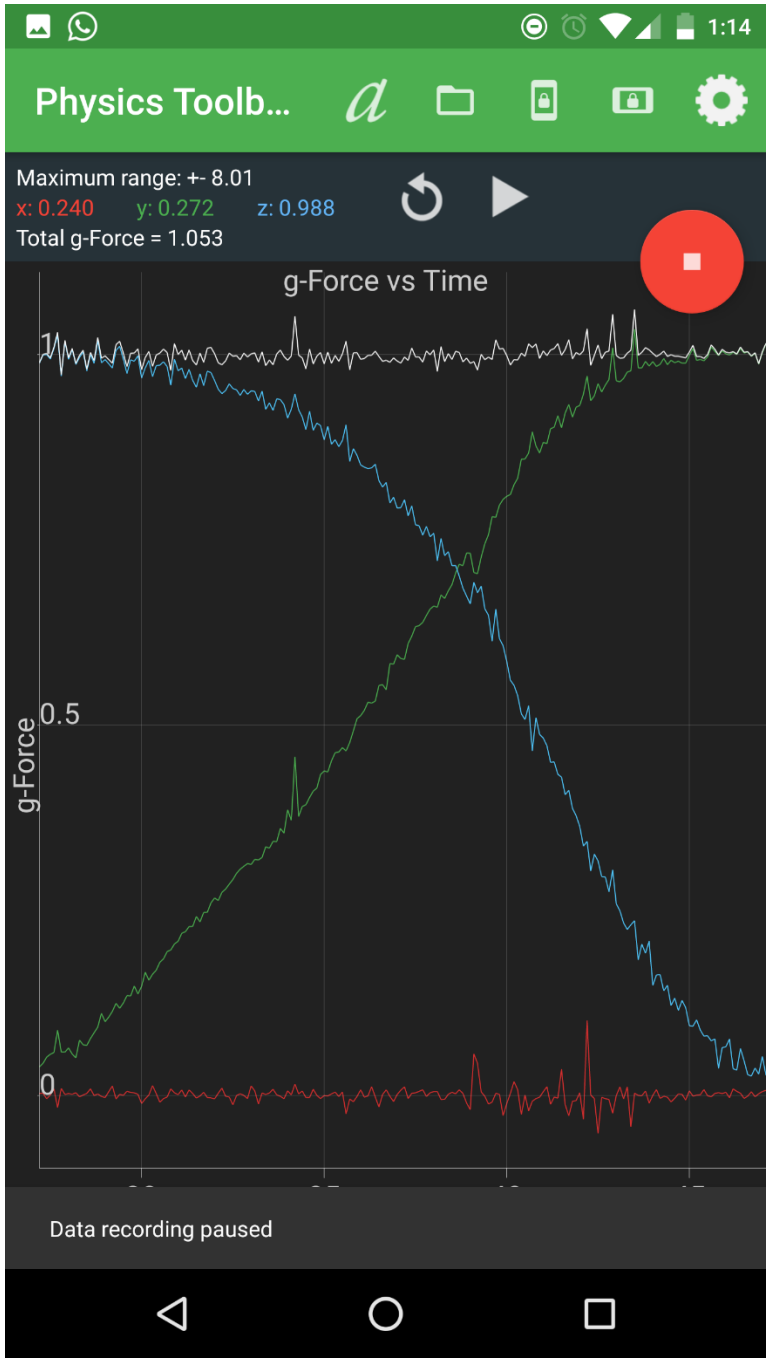
Direct measurement of static orientation





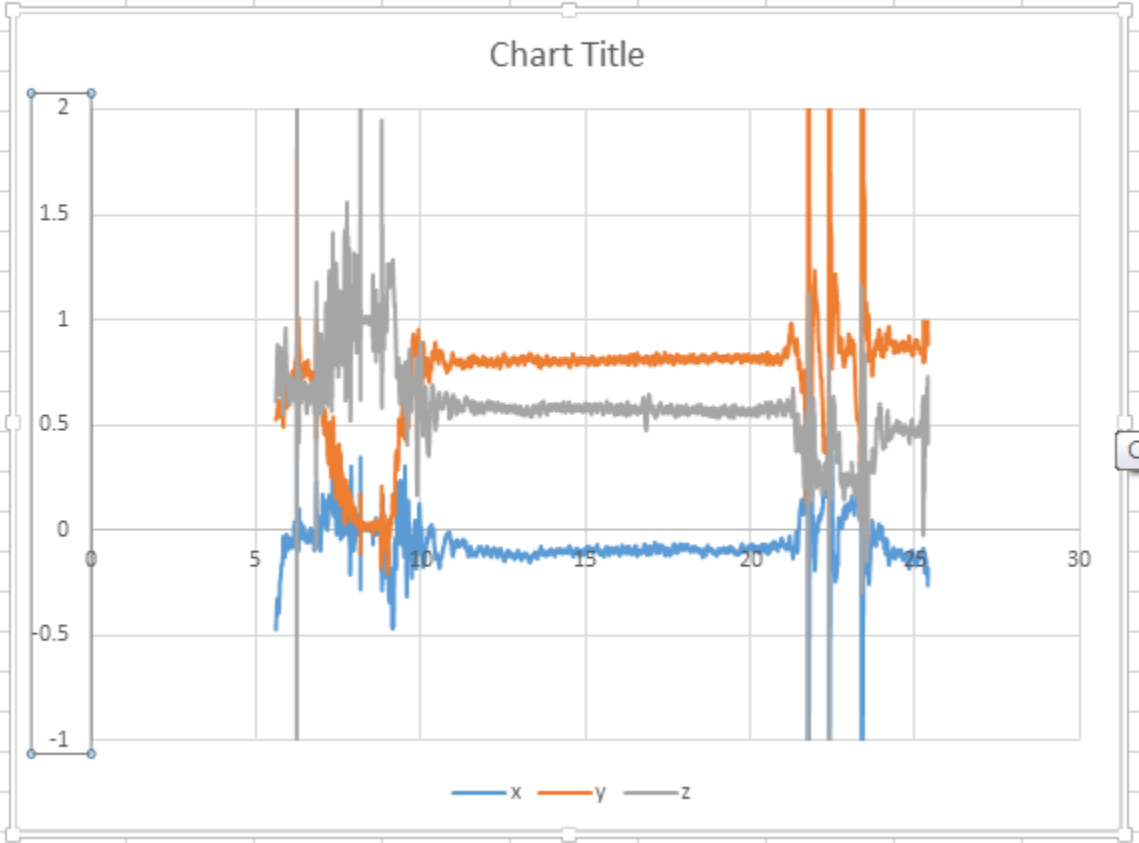
Real-time display of vector components





Cell-phone data to spreadsheet

time	x	y	z
5.6	-0.472	0.534	0.625
5.601	-0.469	0.524	0.617
5.602	-0.461	0.527	0.611
5.604	-0.458	0.526	0.63
5.606	-0.445	0.53	0.633
5.609	-0.44	0.532	0.648
5.611	-0.425	0.538	0.657
5.614	-0.421	0.534	0.673
5.616	-0.406	0.53	0.705
5.619	-0.39	0.543	0.706
5.621	-0.383	0.543	0.724
5.624	-0.364	0.542	0.729
5.627	-0.354	0.545	0.757
5.631	-0.347	0.545	0.768
5.633	-0.336	0.548	0.785
5.636	-0.333	0.556	0.814
5.638	-0.339	0.573	0.835
5.64	-0.325	0.576	0.842
5.643	-0.334	0.566	0.854
5.646	-0.332	0.573	0.865
5.648	-0.335	0.57	0.872
5.65	-0.34	0.568	0.882
5.654	-0.339	0.567	0.882
5.657	-0.351	0.573	0.88
5.659	-0.36	0.583	0.871



Format Axis

AXIS OPTIONS | TEXT OPTIONS

AXIS OPTIONS

Bounds

Minimum -1.0 Reset

Maximum 2.0 Reset

Units

Major 0.5 Auto

Minor 0.1 Auto

Horizontal axis crosses

Automatic

Axis value 0.0

Maximum axis value

Display units None

Show display units label on chart

Logarithmic scale Base 10

Values in reverse order

TICK MARKS

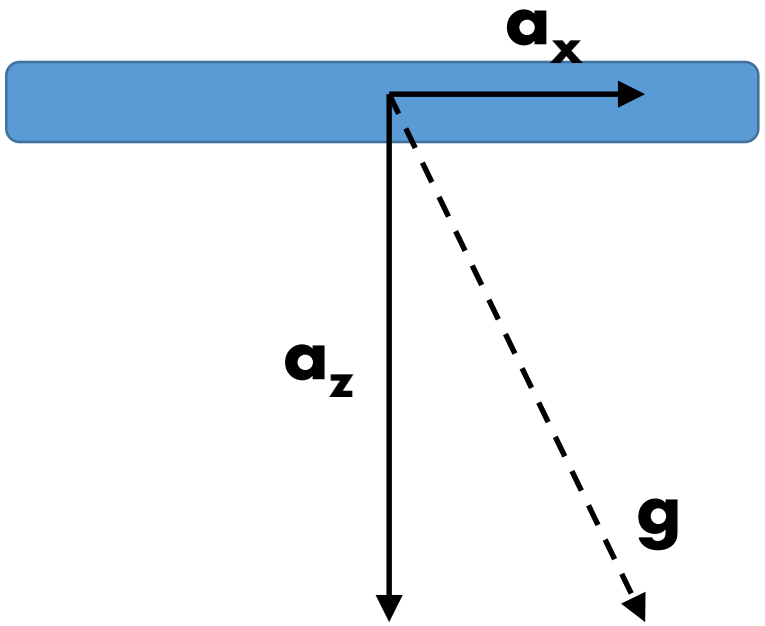
Additional trigonometric review exercise ?

Sample lab: static vectors

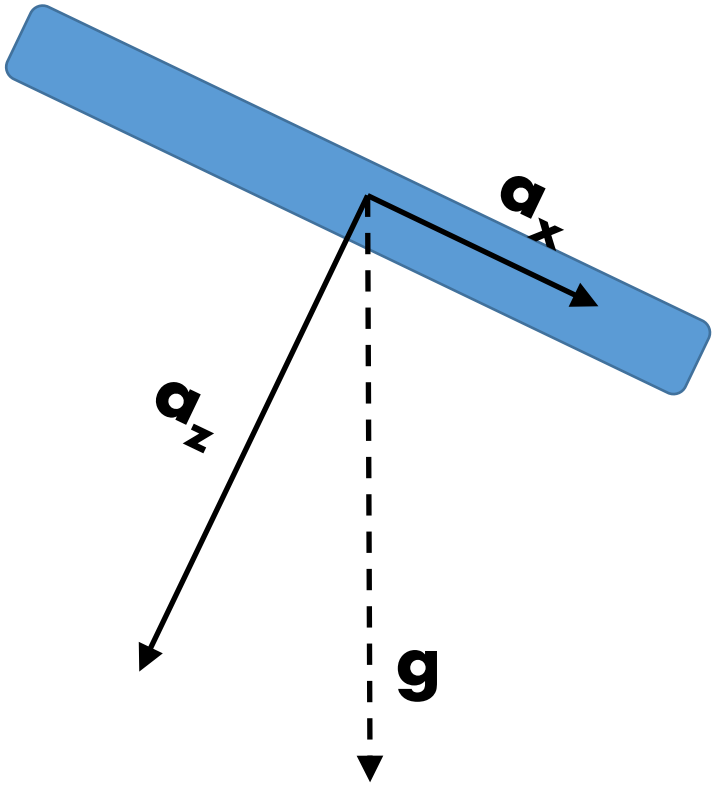
- Determine “critical tilt angle” for your phone.
  - Are portrait and landscape angles the same? Compare with others.
- Record accelerometer data at the critical tilt angle
- Form a vector
  - Magnitude: compare with $g = 9.8\ m/s^2$
  - Direction: compare with critical tilt angle
- Phone orientation from “blind data”
  - In portrait or landscape mode? Facing up or down?

Local vs. global coordinate systems

Local data coordinates



Terrestrial coordinates

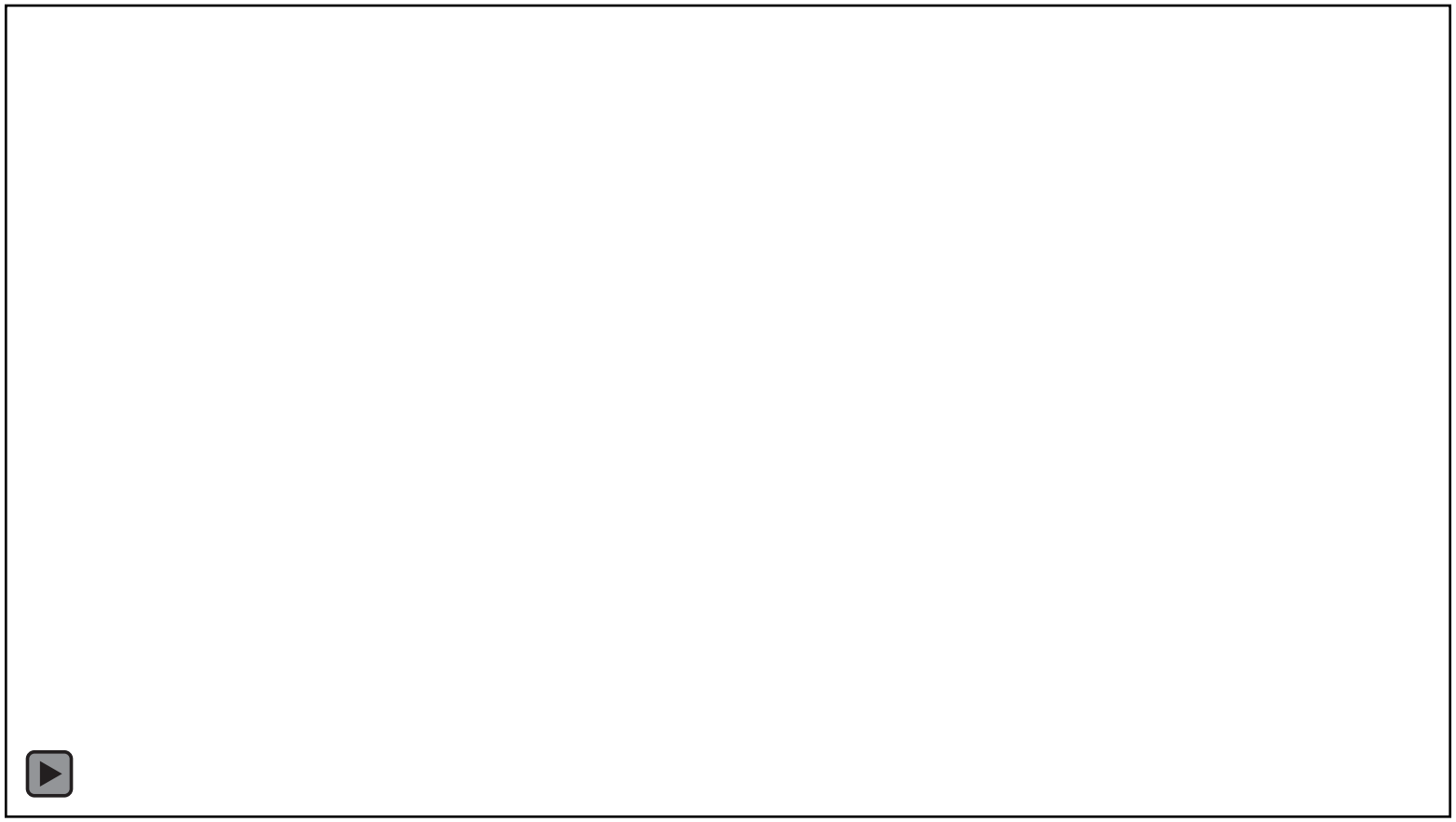


Local vs. global coordinate systems

- Fundamental conceptual element in physics
- Develops visualization skills

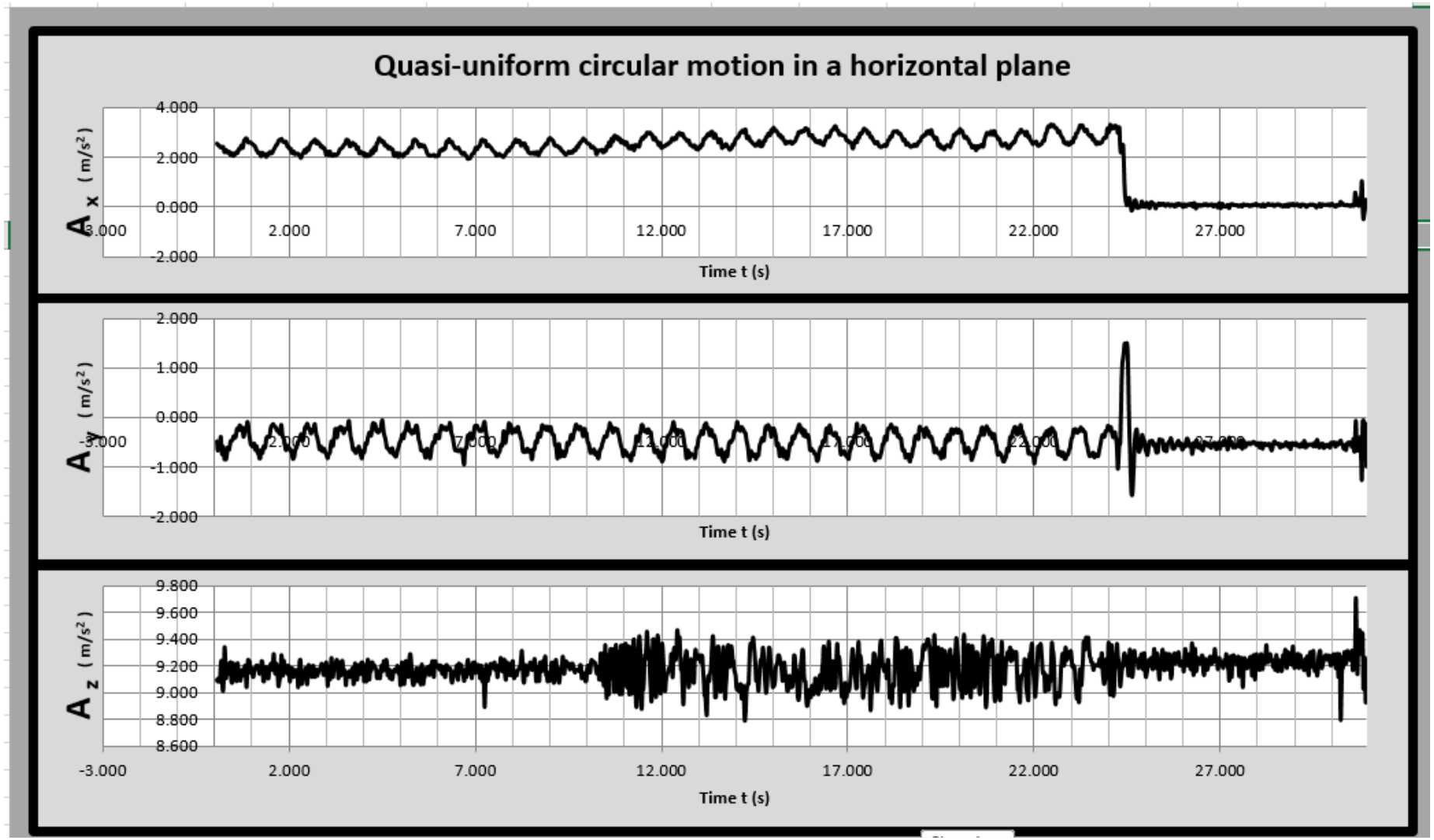
- Good preparation for
  - Free-body diagram analysis
  - Radial-tangential “moving” coordinate systems
  - Change-of-perspective geometry essential to understanding magnetism.

Circular motion: initial exploration



(Using stand-alone accelerometer)

Circular motion: initial exploration



Invitation: Collaborators and Early adopters!

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