# A QUICK GUIDE TO CAPSTONE SOFTWARE

Hardware configuration

- After you start the Pasco Capstone software, you can find the Hardware Setup tool in the Tools palette.
- In general, the interface will automatically recognizes all PASSPORT sensors that you plugged into its inputs. For other sensors, click the input port into which you plugged the sensor. A drop down menu of sensors will appear. Select your sensor from the list of choices and the sensor's icon will be added to the picture of the interface.
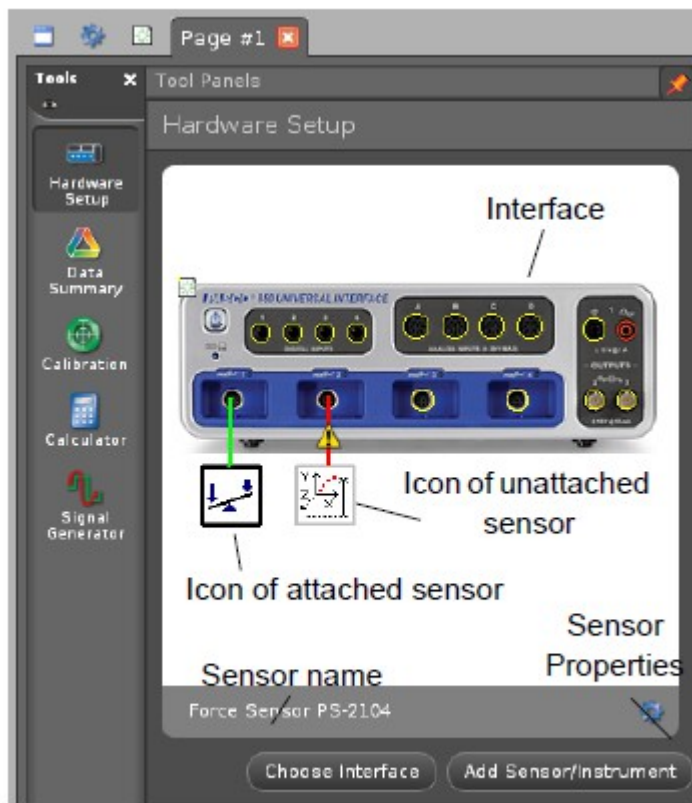
Hardware Setup panel

- If you opened a saved Capstone file with different sensor connections, you may observe an exclamation mark triangle (⚠) indicates that the sensor is not connected or detected.
- You may configure the sensor by clicking the Sensor Properties icon in the lower right of the Hardware Setup tool.
- You may configure the sample rate of the sensor in Capstone. Note that the software may become irresponsive at high sample rates. Try remove graphs and displays to rectify this (or reduce the sample rate). You may also limit the number of samples by one of the following methods:
  1. Limit the total number of data points by reducing the data capturing time using the manual *Start* and *Stop.*
  2. Limit the total number of data points by setting Recording Conditions. There two type of conditions you can set: time-based or measurement-based. For example, for a force sensor, you can start recording when the force is larger or smaller than a predetermined

value, and stop recording in 2 seconds after the start condition is met.
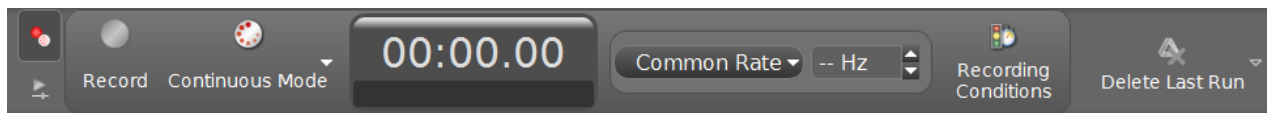
Taking measurements

- Click the Record button at the left end of the Controls palette to begin collecting data. The Record button changes shape to become the Stop button. Click the Stop button to end data collection.


Record button, Stop button, and Experiment clock

- Repeat the process to collect multiple runs of data.
- To see a previous run of data in the display, click the Data Management button in the display's Tool bar and select the run (e.g., Run #2) from the menu. To delete a specific run of data, click the drop-down menu part of the Delete Last Run button in the Controls palette and select the run of data from the list page.
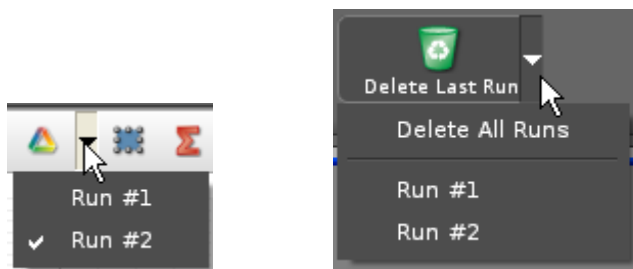

Data and Graph

- After data collection, you can view the data in a table or graph in Capstone. Choosing the desired variables to display in the table or graph at the dropdown menu. You can also input the data manually by selecting the *Create New* option.
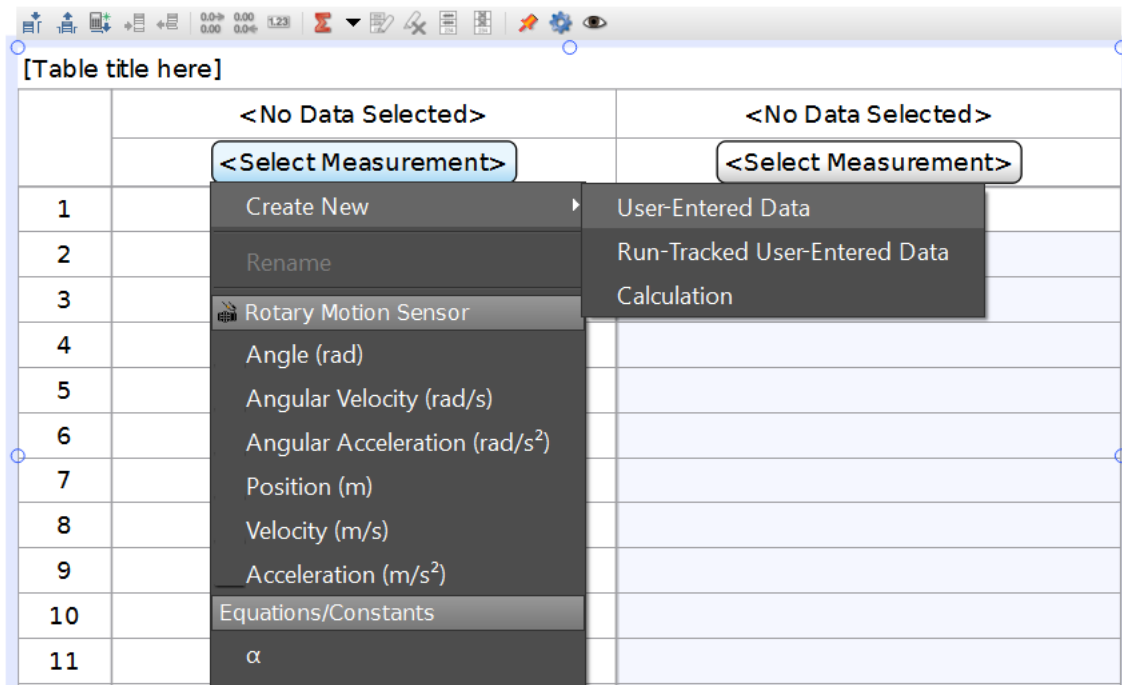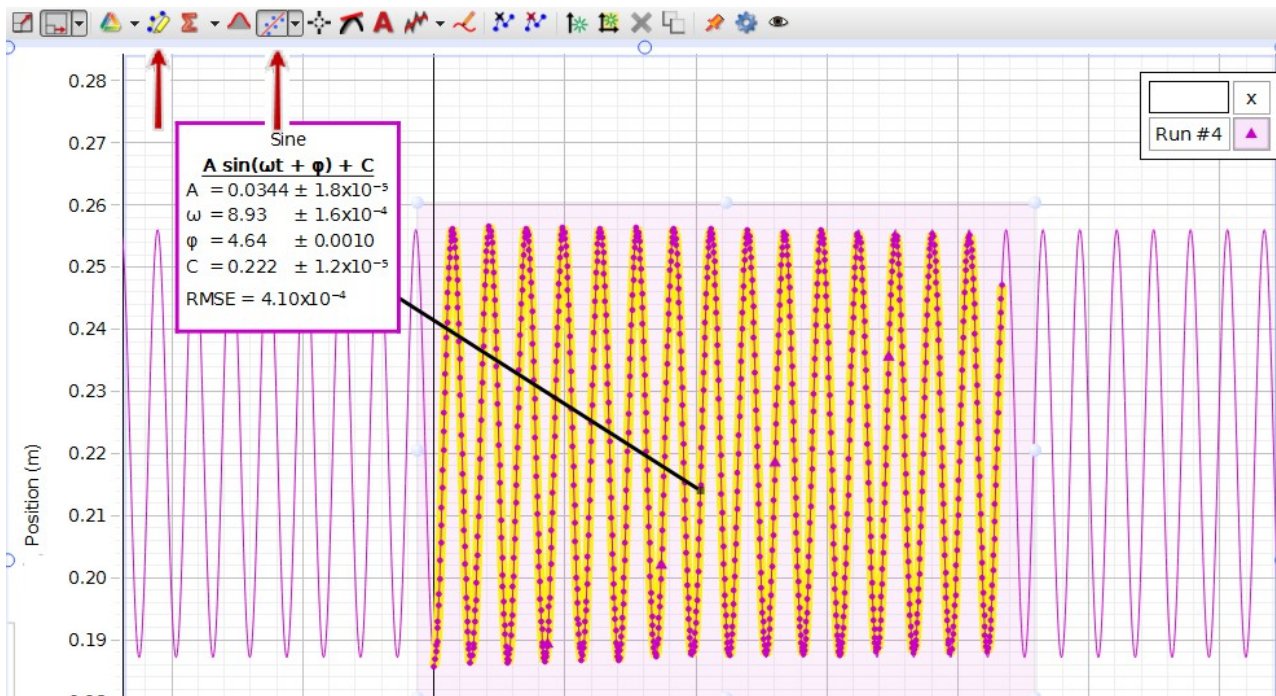
Select or create data in *Table*

- You can use the Calculator tool to perform complex calculations using a combination of math functions, measurements, user-defined data, constants, and text labels including symbols.
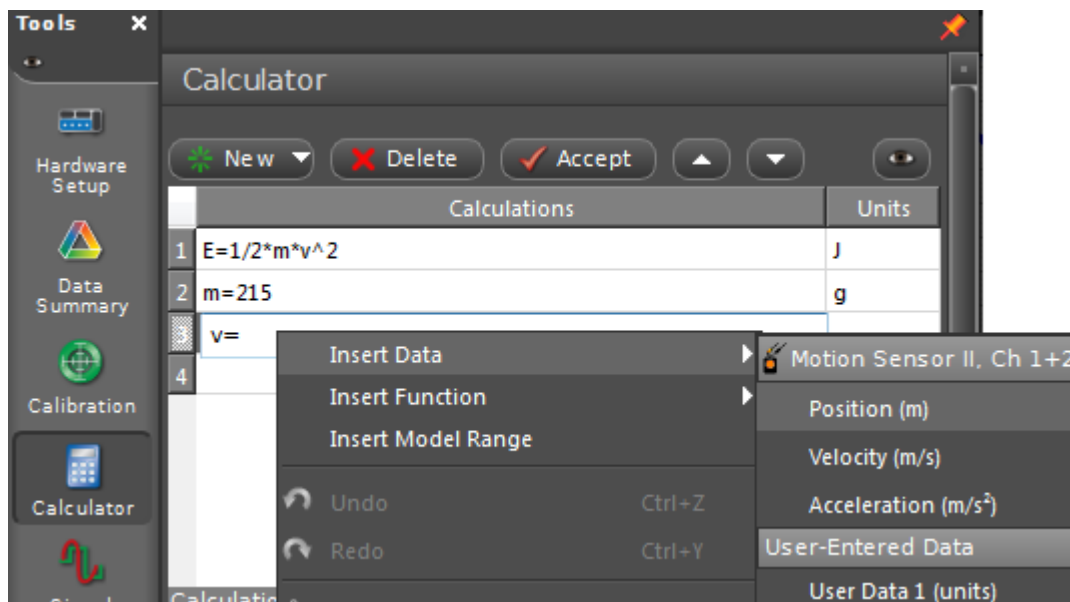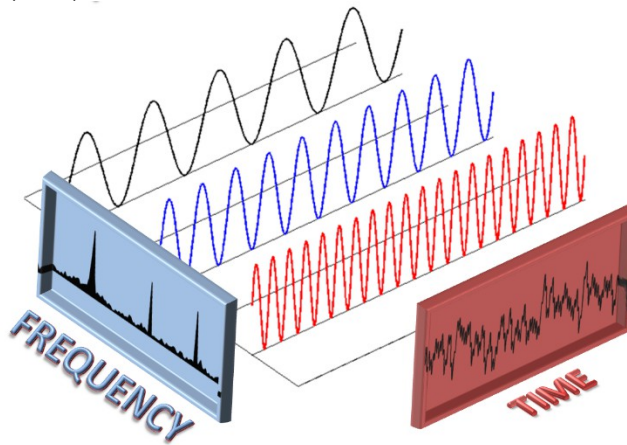

Calculator Tool

- The Curve fit tool provides a convenient way to fit your data to a model. First select the region of data you want to perform a curve fit using the Highlight tool 🖉, then choose a model using the dropdown menu ✦ ▾ and apply to active data.

Sine
A sin(ωt + φ) + C
A = 0.0344 ± 1.8x10⁻⁵
ω = 8.93 ± 1.6x10⁻⁴
φ = 4.64 ± 0.0010
C = 0.222 ± 1.2x10⁻⁵

RMSE = 4.10x10⁻⁴

The data selection tool and curve fit tool

- Fast Fourier Transform (FFT)

A signal can be represented in both frequency and time domain. One can use FFT to conveniently transform the signal from one domain to the other. Image Courtesy: http://groups.csail.mit.edu/netmit/sFFT/algorithm.html

- To perform a FFT to the data in Capstone, drag from the *Displays* palette the *FFT tool* FFT and select the desired parameter on the y-axis. Note that you may need select the data set using the button to activate the computation for FFT.
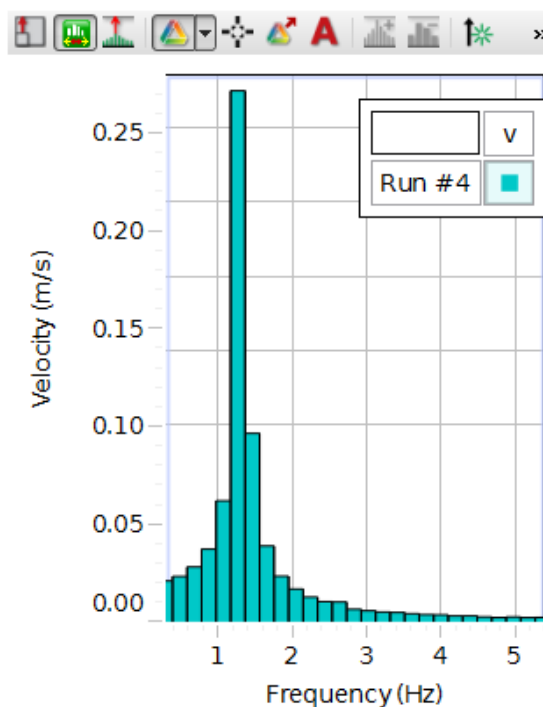
Fast Fourier Transform

Data files

- Recorded data is contained within the PASCO Capstone file (identified by the .cap extension).
- You may export the data to a .txt or .csv file for processing in your favourite third-party software (e.g. Excel, Python, Matlab, Origin, etc.).

Preliminary Exercise

Before starting compulsory experiments, you must get a short training in using the Capstone software to process experimental data. This exercise will allow you to familiarize yourself with the equipment and analysis tools. You are allowed to MP 126 to exercise in the use of the software on Monday proceeding the first lab session of the term.

- Training exercise: http://www.physics.utoronto.ca/students/undergraduate-courses/course-homepages/phy180h1lab/capstone

Resources and references

More resources are available on the Pasco website for Capstone and 850 Universal Interface
- http://www.pasco.com/file_downloads/product_manuals/PASCO-Capstone-User-Guide-UI-5401.pdf
- http://www.pasco.com/prodCatalog/UI/UI-5000_850-universal-interface/index.cfm

Note on the installation of Capstone

Capstone software is available in all the lab computers and in the computers in room MP257. You can also download Capstone software from the Pasco website and install it in your personal computer. The link is: http://www.pasco.com/family/pasco-capstone/index.cfm. As of Capstone version 1.4.0.4, when installing, make sure to install to the default folder, otherwise the program may crash when you open an existing experiment file.