Appendix B. Test Control Using Bluehill® and LabVIEW®

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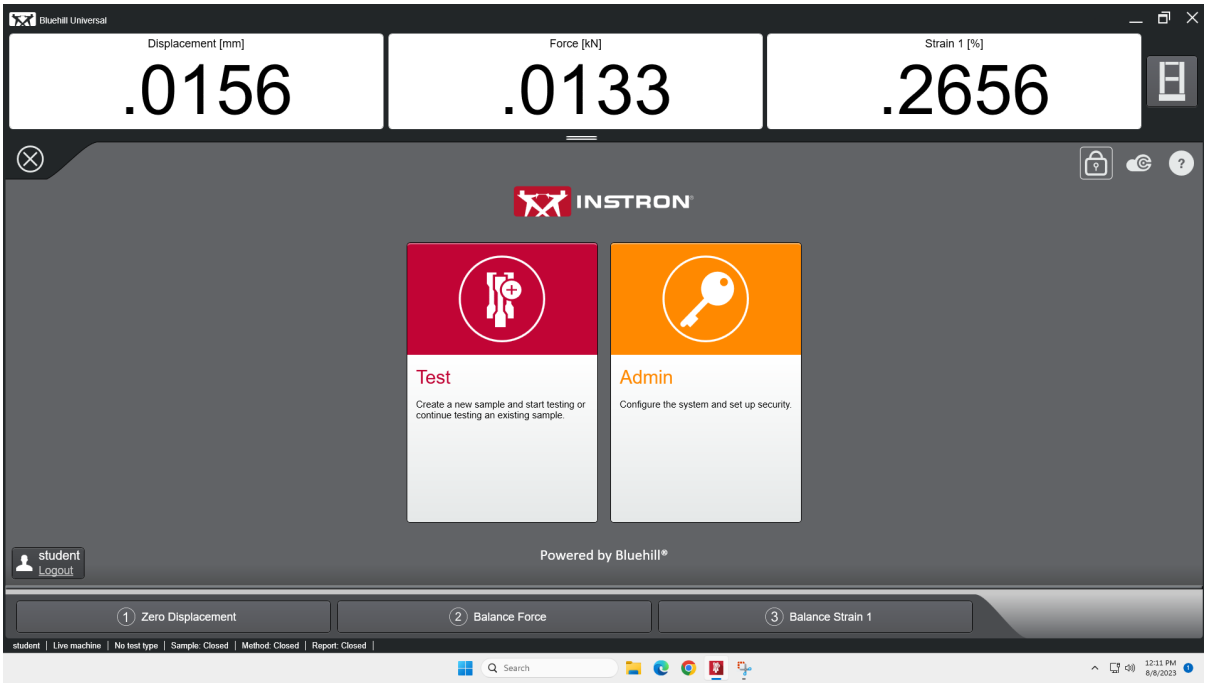
Load frame test control using Bluehill

Load frame testing in this laboratory is performed with Instron® Bluehill® software, employing custom test methods developed in-house by laboratory personnel. Bluehill controls the load frame and measures and records the test data. See Appendix C regarding data files.

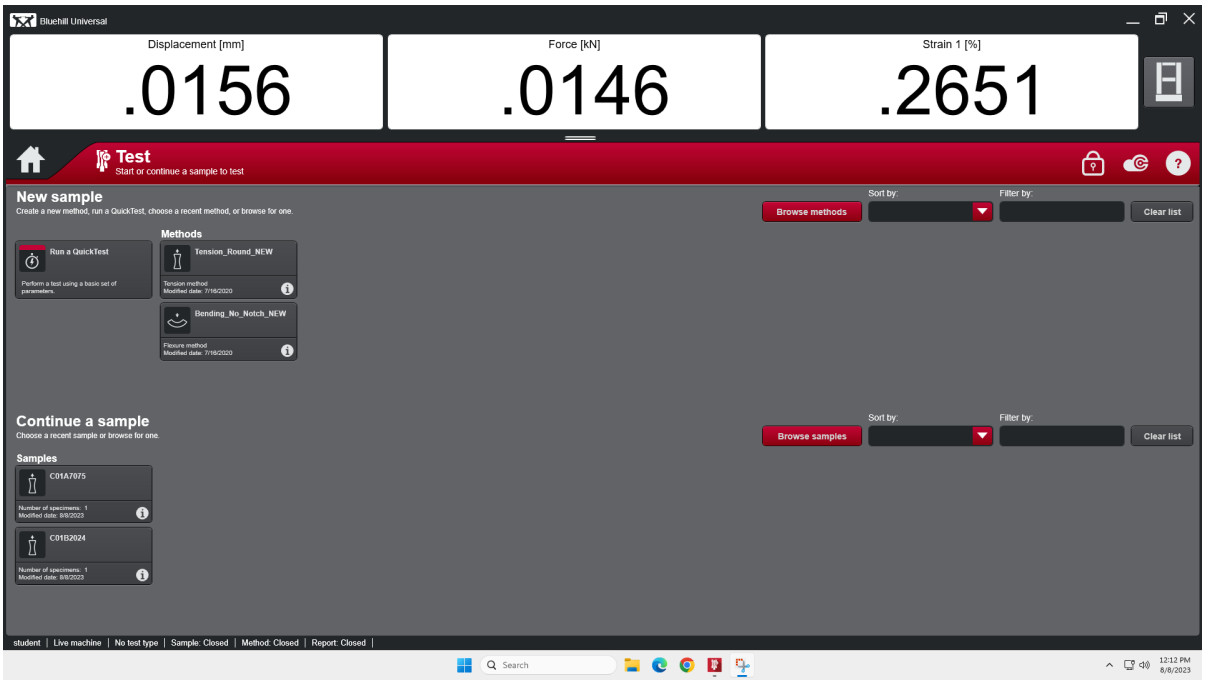
Home screen

The Bluehill Home screen supports many tasks, but **testing is the task of interest for students.** The Home screen will usually not be displayed, because students do not need to use it. If the Home screen is displayed, click on 'Test' to bring up the Test Screen shown on the next page.



Test screen

The **Test** screen will usually be displayed at the beginning of the lab period and all load frame testing will commence from the **Test** screen shown:



- The screen refers to "creating a new sample", which will be understood to mean "conducting a new test" with a sample size of one ("one physical specimen, one test, one data file").

- The three large numerical displays from left to right are crosshead position in mm (Displacement), measured load in kilonewtons (Force), and measured strain as a percentage of extensometer gage length (Strain 1).

- The upper list shows test methods most recently used. The test methods have names that suggest their applications and characteristics.

- The lower list shows the most recently conducted tests (samples).

- The frame icon at the upper right provides access to load frame hardware and is not for student use.

Overview of running a test with Bluehill

To run a test, the following steps are executed in sequence (safety glasses must always be worn during testing):

1) Prepare the load frame and test specimen for the test as appropriate.

2) Run the appropriate Bluehill test method.

3) Name the test sample data output file according to the prescribed naming convention.

4) Enter the initial test parameters, including specimen dimensions and other specimen parameters such as hardness and heat-treat condition, as appropriate.

5) Mount the specimen in the loading fixtures.

6) Attach the extensometer for strain measurement unless it is specifically not being used.

7) Run and observe the test, stopping the test when appropriate (auto or manual stop).

8) After the test is stopped unload the specimen, if necessary, using the frame control panel and the load display. Note: specimen fracture may or may not occur and the test may be stopped automatically or manually, depending on the test design parameters.

9) Remove the extensometer first and then remove the specimen.

10) Obtain and enter the specimen's final dimensions and enter any fracture surface observations and test notes.

11) Finish the test and save the test sample data output file.

Items 1, 5, 6, 8, and 9 are addressed in Appendix A.

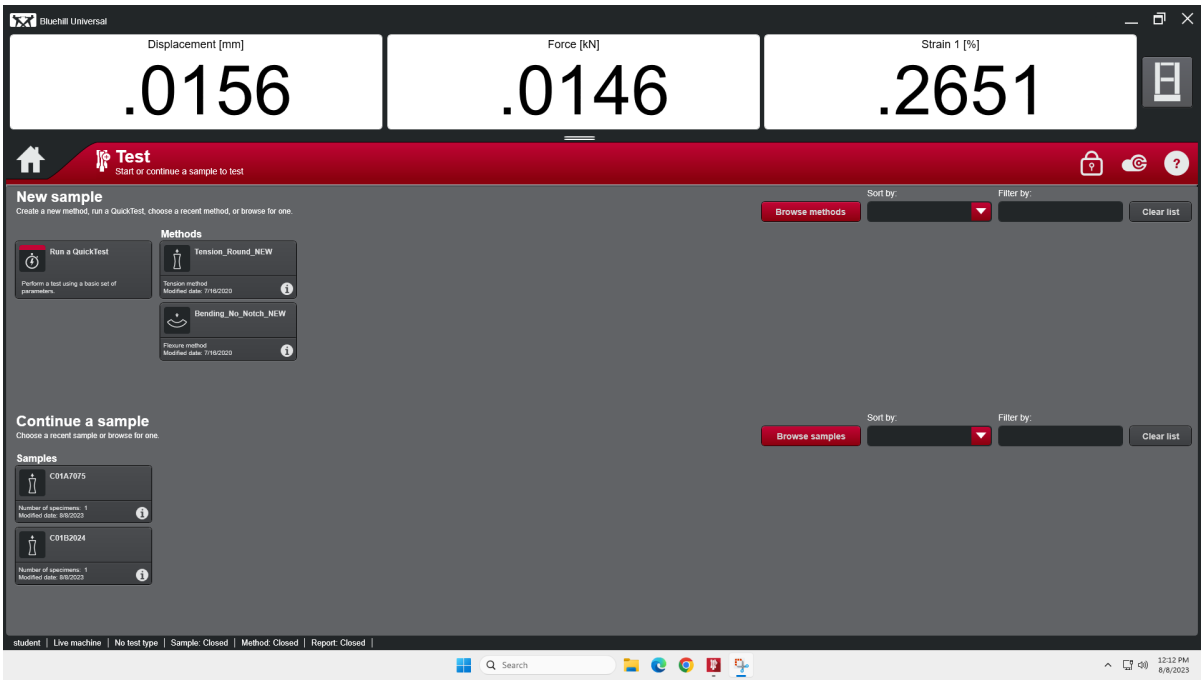
Appendix C addresses data output file content and formatting.

The bold items 2-4, 7, 10, and 11 specifically have to do with running Bluehill software test methods and are best illustrated with an example which follows.

Example of running a test with Bluehill

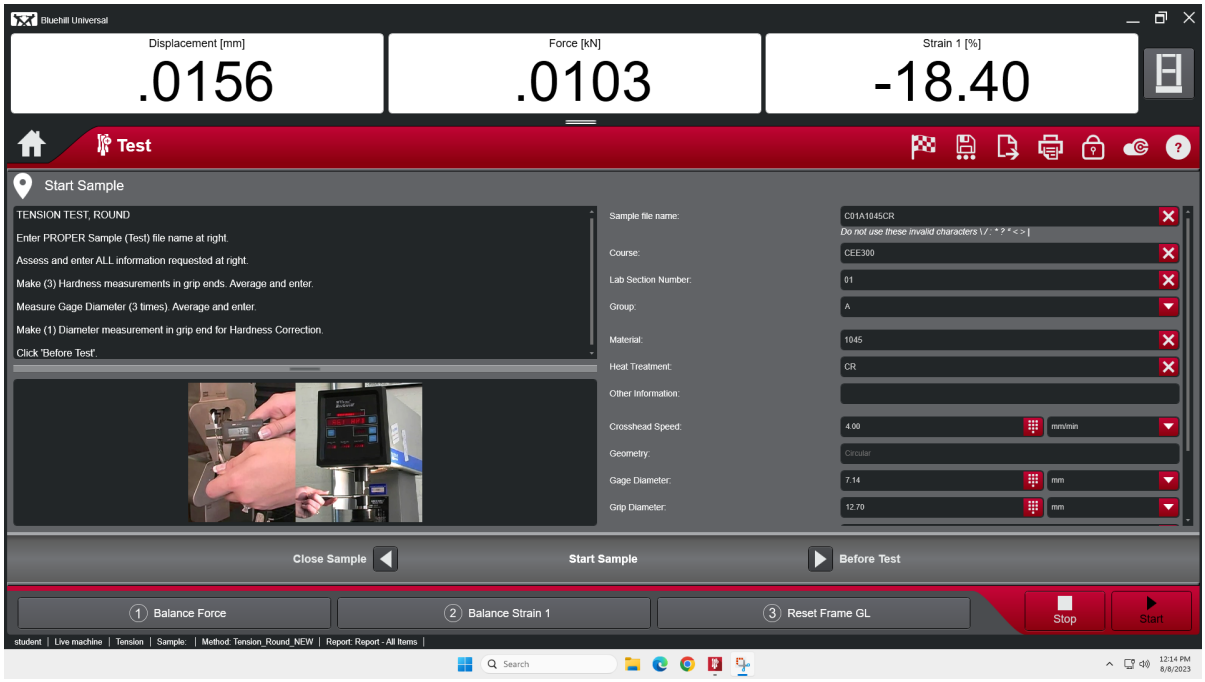
This example shows the running of a uniaxial tension test of a round test specimen (circular cross-sectional area) with Bluehill and a custom test method. The material tested is 1045 cold-rolled steel.

1) Prepare the load frame and test specimen for the test as appropriate (see Appendix A).
2) **Run the appropriate test method.**



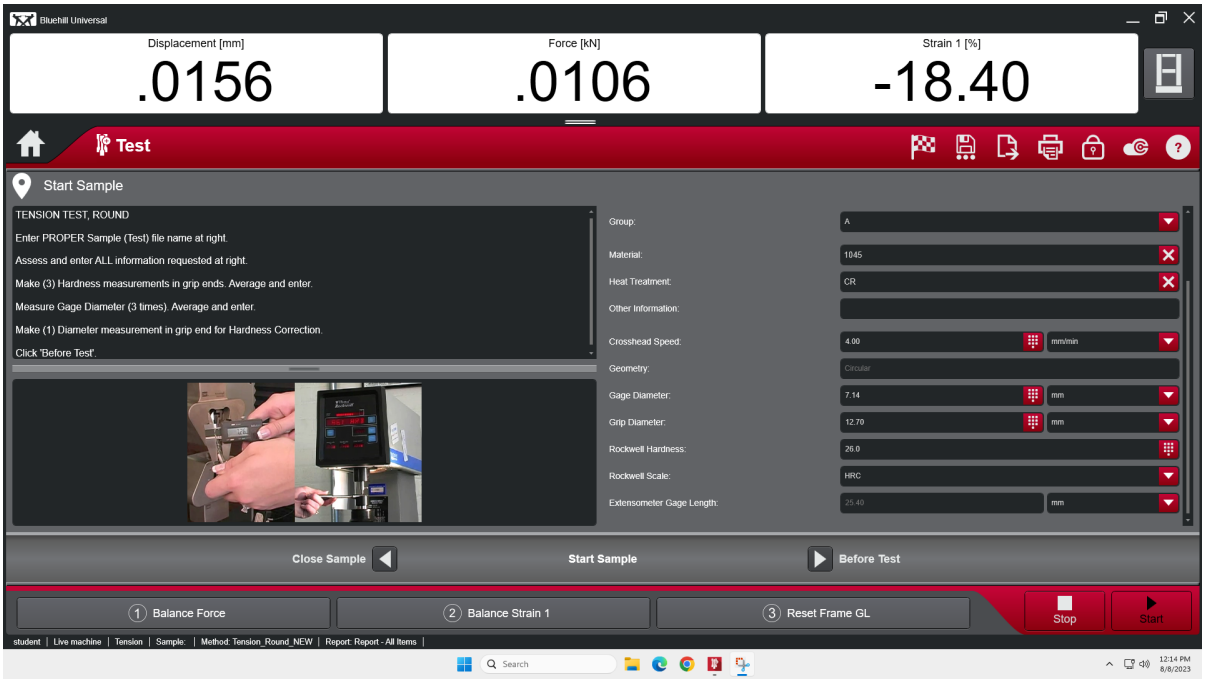
- Note the other test methods for various specimen types (most recently used).
- For this example, click the test method ‘Tension_Round_New’.

3) Name the test sample data output file according to the prescribed naming convention.



- Follow the instructions on the left.
- Enter the test sample filename at the right top field (C01A1045CR in this case).
- The file naming convention will be detailed on a summary sheet at the load frame workstation.
- The data output file will be directed to a predetermined output directory.

4) Enter the initial test parameters, including specimen dimensions and other specimen parameters such as hardness and heat-treat condition, as appropriate.



- Follow the instructions on the left.
- Complete the data field entries on the right as follows:

  Course: self-evident, in this case CEE300-TAM324.

  Lab Section Number: the numerical section number, in this case 01 (do not put 'AB').

  Group: the student group's assigned letter (the load frame letter), in this case A.

  Material: the numerical designator of the material being tested, in this case 1045 (a plain carbon steel).

  Heat treatment: as applicable, in this case CR since the material is cold-rolled.

  Other information: an optional note or other comment, in this case not applicable.

  Crosshead speed: self-evident, an appropriate speed is used, in this case 4 mm/min.

  Geometry: fixed by the test method, in this case Circular (cross sectional area).

  Gage Diameter: the specimen gage diameter (average of three readings), in this case 7.14 mm.

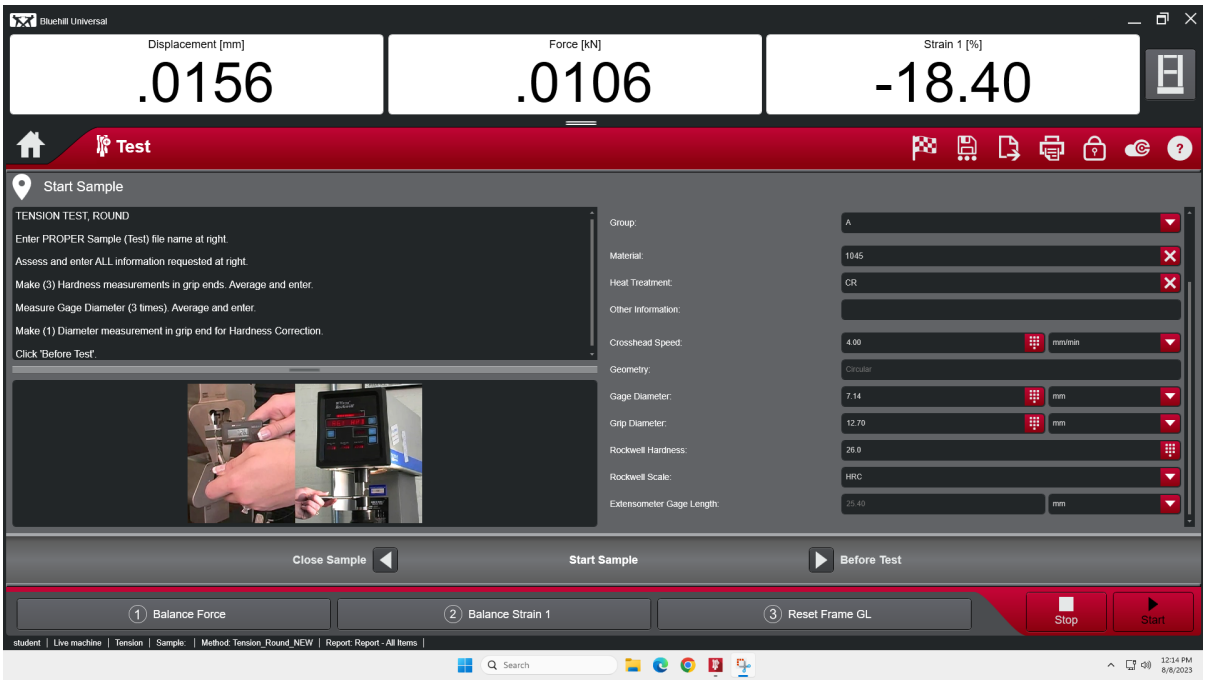
  Grip Diameter: the specimen grip diameter, in this case 12.70 mm.

Rockwell Hardness: the numerical Rockwell hardness value (average of three readings, measured in the specimen grip), in this case 26.0 HRC.

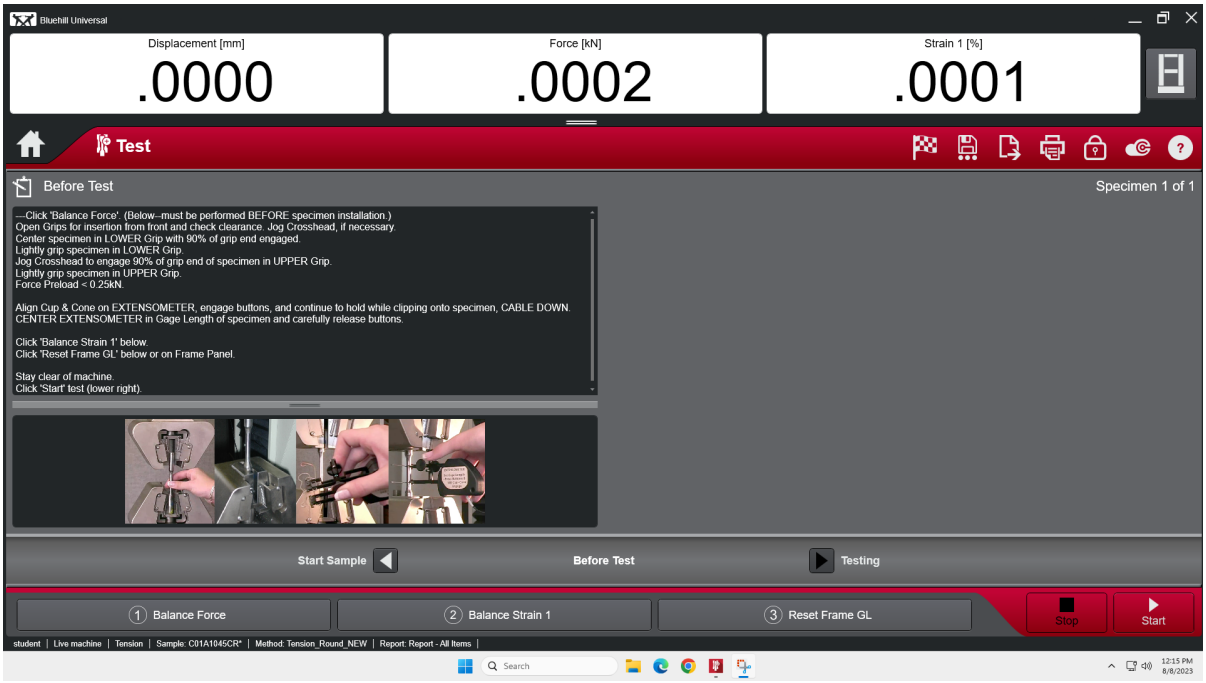
Rockwell Scale: pull down the menu and select either HRC or HRB scale as appropriate, in this case HRC.

Extensometer Gage Length: fixed according to the extensometer used, in this case 25.4 mm.

All these fields and additional test parameters will be written to the test sample data output file along with the instrumented temporal test measurement data (see Appendix C).



- After filling in the fields, click 'Before Test' at the lower right.



5) Mount the test specimen in the loading fixtures (see on-screen instructions and Appendix A).
6) Attach the extensometer for strain measurement unless it is specifically not being used (see on-screen instructions and Appendix A).

- Follow the on-screen instructions to mount the specimen in the loading fixtures and install the extensometer on the specimen.

- Across the bottom of the screen are selections for ‘Balance Force’, ‘Balance Strain 1’, and ‘Reset Frame GL’. GL stands for Gage Length.

- ‘Balance’ or ‘Reset’ means to numerically zero a live measurement readout.

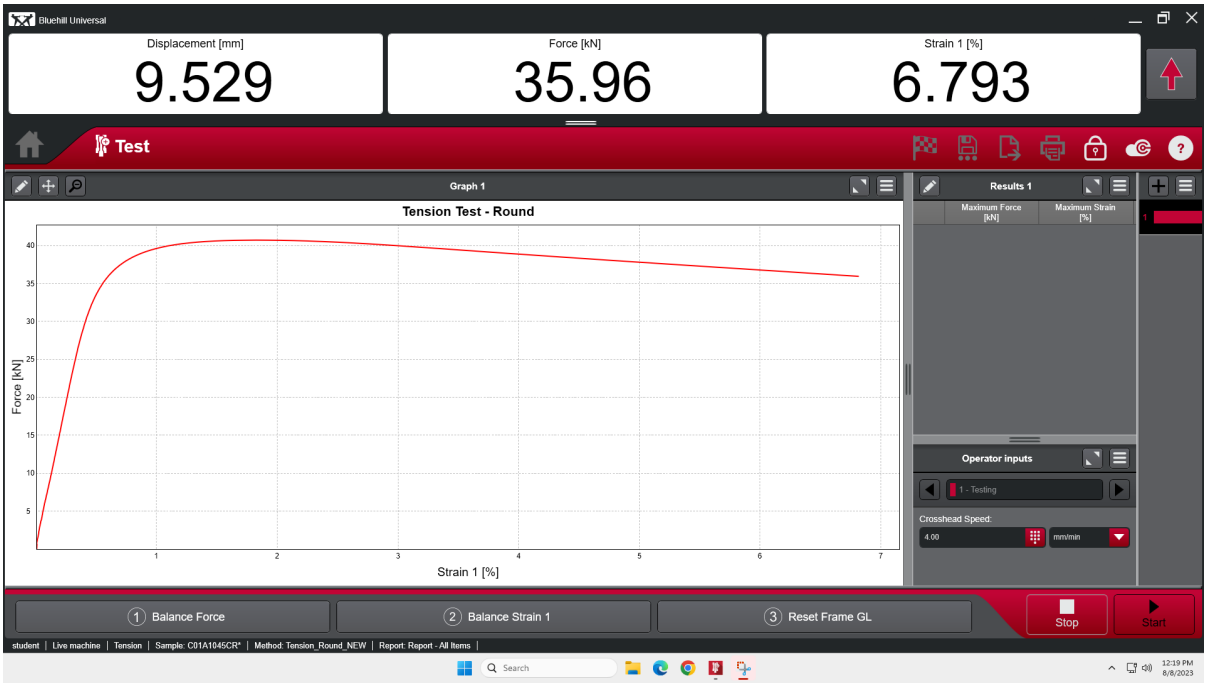
- Balance the Force BEFORE mounting the test specimen in the fixtures.

- Balance the strain channel (‘Balance Strain 1’) AFTER mounting the extensometer.

- ‘Reset Frame GL’ LAST to zero the crosshead position (Displacement) prior to the test start.

- Stay clear of the machine and click ‘Start’ at the lower right to begin the test.

7) Run and observe the test.



- The test will commence and progress automatically, updating the real-time displacement, force, and strain displays.

- Note the red arrow icon at the upper right showing the upward crosshead travel direction for this tensile test. It would point down for a compression or bending test.

- A load (Force) vs. engineering strain (Strain 1) curve is displayed as the test progresses.

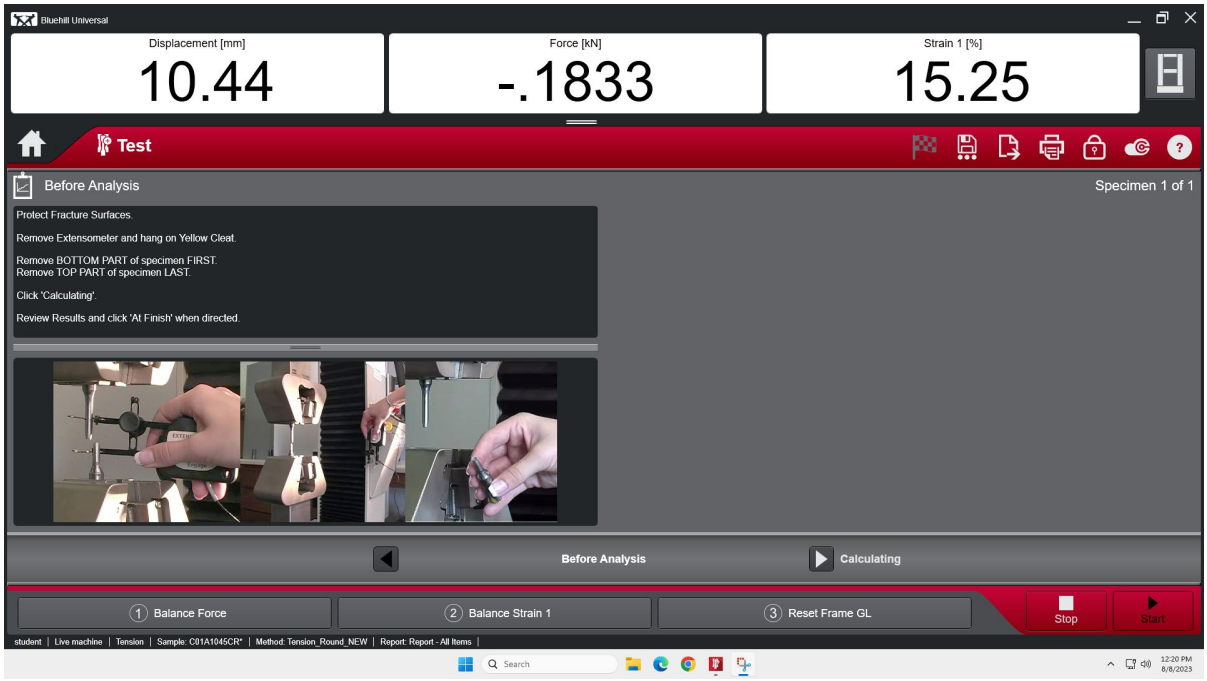
- Different plot variables can be displayed during the test by double-clicking on the plot axes' labels and selecting new plot variables. Force vs. displacement or force vs. time are two examples that might be displayed. *This would have no effect on what data are recorded in the test sample data output file (see Appendix C). The data output selections are fixed by the test method and cannot be readily changed.*

- This test should stop automatically upon test specimen fracture because this test method is set to detect and interpret a rapid change in force as specimen fracture. Some test methods will be stopped manually, but these will be announced ('Stop' at lower right).

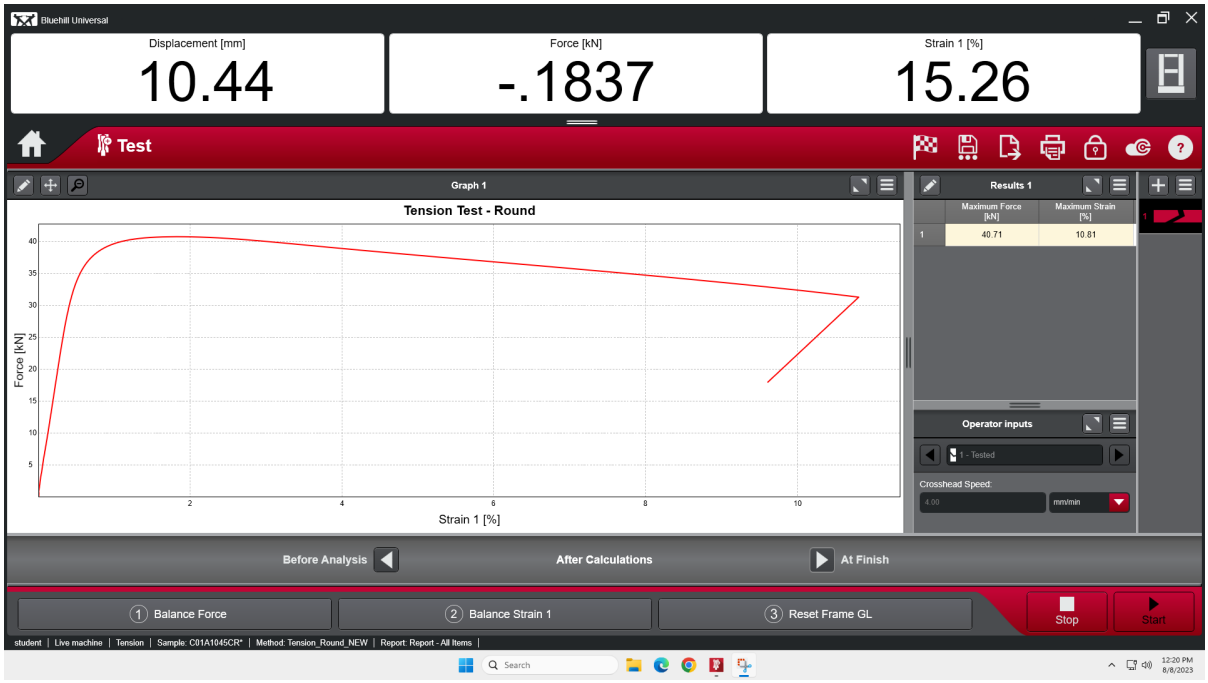
- After the test is stopped, the screen on the next page will appear.

8) After the test is stopped unload the specimen if necessary, using the frame control panel and the load display. Note: specimen fracture may or may not occur, and the test may be stopped automatically or manually, depending on the test design parameters.

9) Remove the extensometer and then remove the specimen.



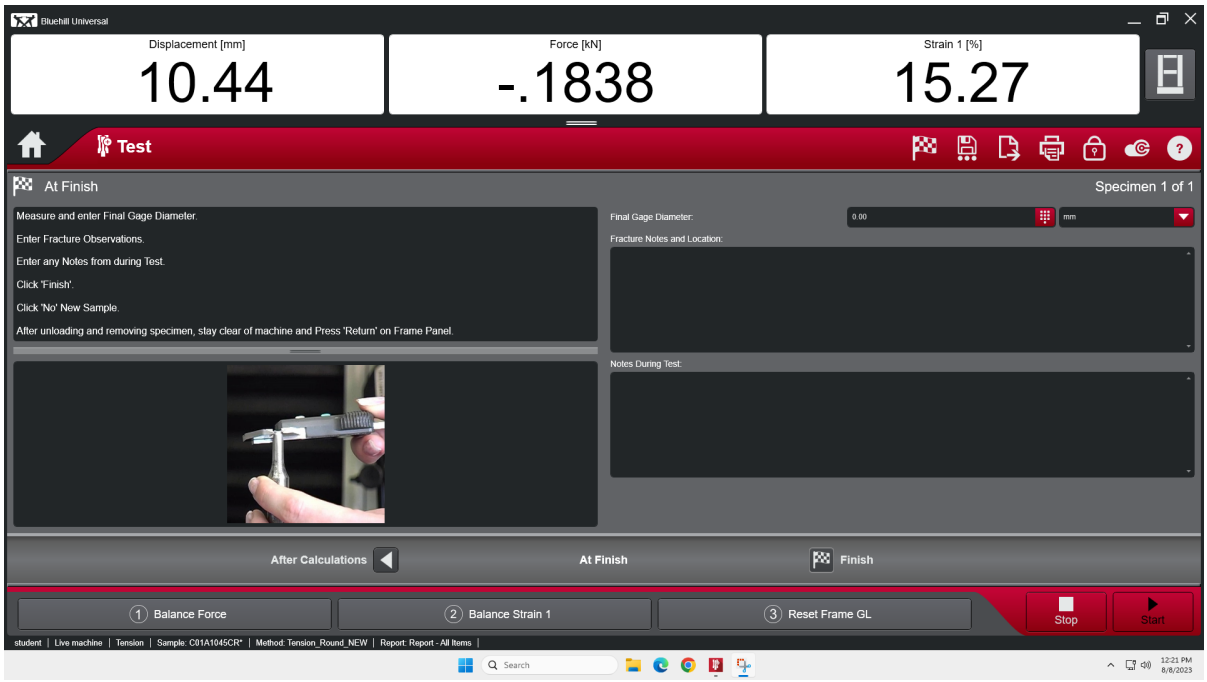
- Following the on-screen instructions, remove the extensometer and store it properly.
- Remove the test specimen parts from the fixtures.
- Click ‘Calculating’ at lower right.



- The data plot will be displayed again for review, along with certain values of interest such as maximum force and maximum strain.

- Click ‘At Finish’ at lower right.

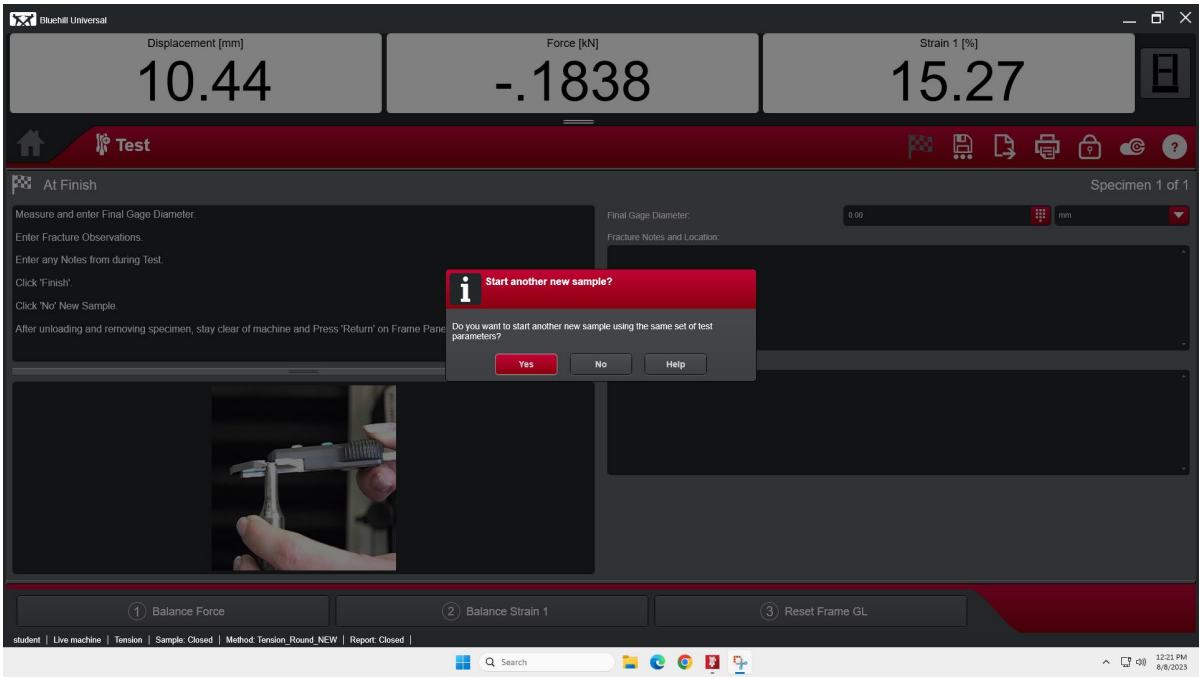
10) Obtain and enter the specimen final dimensions and fracture surface observations.



- Enter the final specimen dimension(s), fracture observations, and any general notes about the test.

- Click ‘Finish’ at lower right.

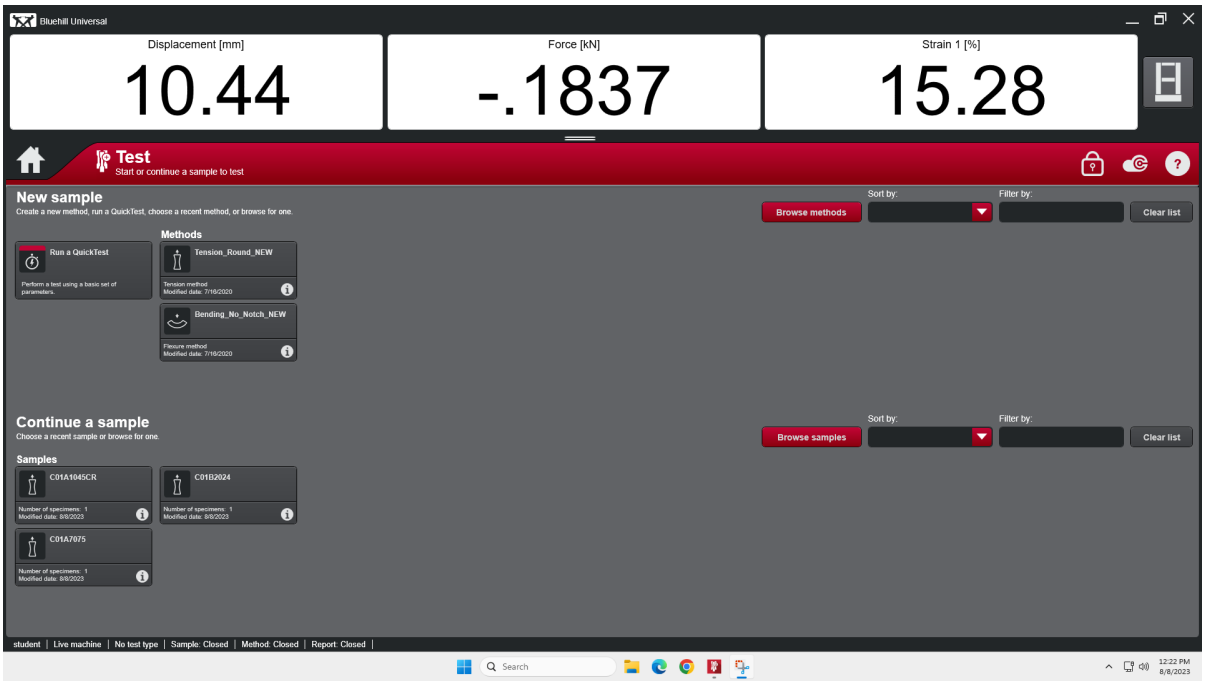
11) Finish the test sample and save the test sample data output file. "Finish the test" is taken to mean "Finish the sample".



- A dialog box will appear asking if you want to start another new sample using the same set of test parameters. ***THE ANSWER TO THIS IS ALWAYS "NO".***

- Click **'No'.**

- The test sample data will be saved to the sample output file and the **Test** screen will reappear.



- Notice the completed test sample is shown as the most recently conducted test sample.
- Bluehill is now ready to run another test.
- The data output file will be posted to the laboratory web page after the lab period is over as described in Appendix C, so students do not need to obtain a copy of their data output files during the lab period.

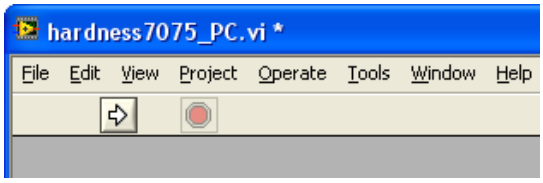
This concludes the test example using Bluehill control software.

The next section describes laboratory testing and data entry using LabVIEW software for experiments not employing the load frames.

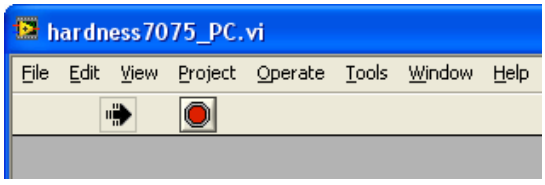
Testing and data entry using LabVIEW

Running a virtual instrument

The palette at the ***upper left*** of a LabVIEW virtual instrument panel is either in standby mode:

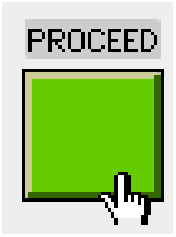


or run mode:



LabVIEW Controls and Displays

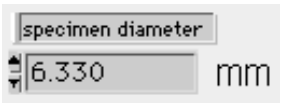
Buttons and Switches



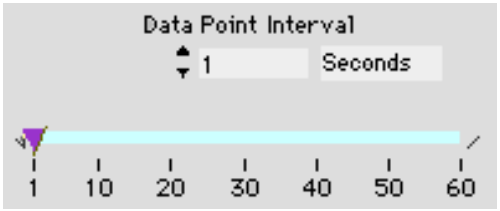
Toggle switches alternate states with repeated clicking of the Operating Tool:

Control Displays

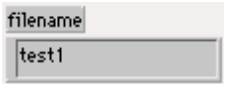
The *digital control display* is identified by the arrows on the left side. The display is altered by clicking on the box and editing the entry by highlighting, deleting, typing the desired number, and pressing *enter,* or clicking outside the display:



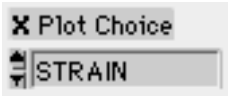
The numerical *slide control* graphically denotes the magnitude of the value in the digital display and often indicates the range of acceptable values. The slide can be moved with the operating tool like a physical slide. Numbers are input directly in the same manner as the plain digital display:



The *text control* accepts text entries. The display is altered in the same way as the digital control. Remember to press *enter* to complete the entry:



The *text ring* contains a menu of selections that scroll when the arrows on the left are clicked. Clicking on the text ring box displays the entire menu:



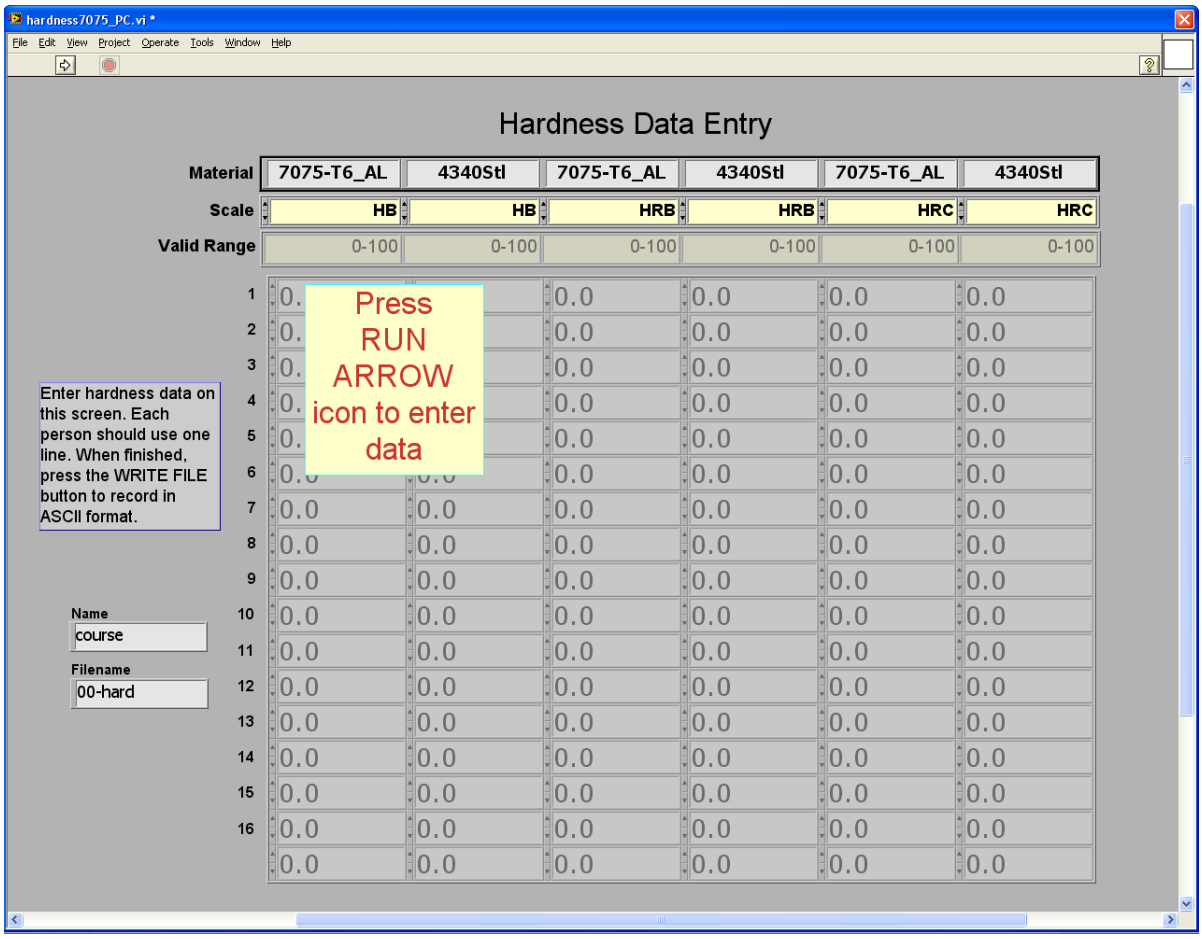
Indicators

The *digital indicator* (Position) and the *text indicator* (X units) shown are "read only" devices and are used to inform the user of settings, *e.g.*, current position data and preset units. Changes are not possible.

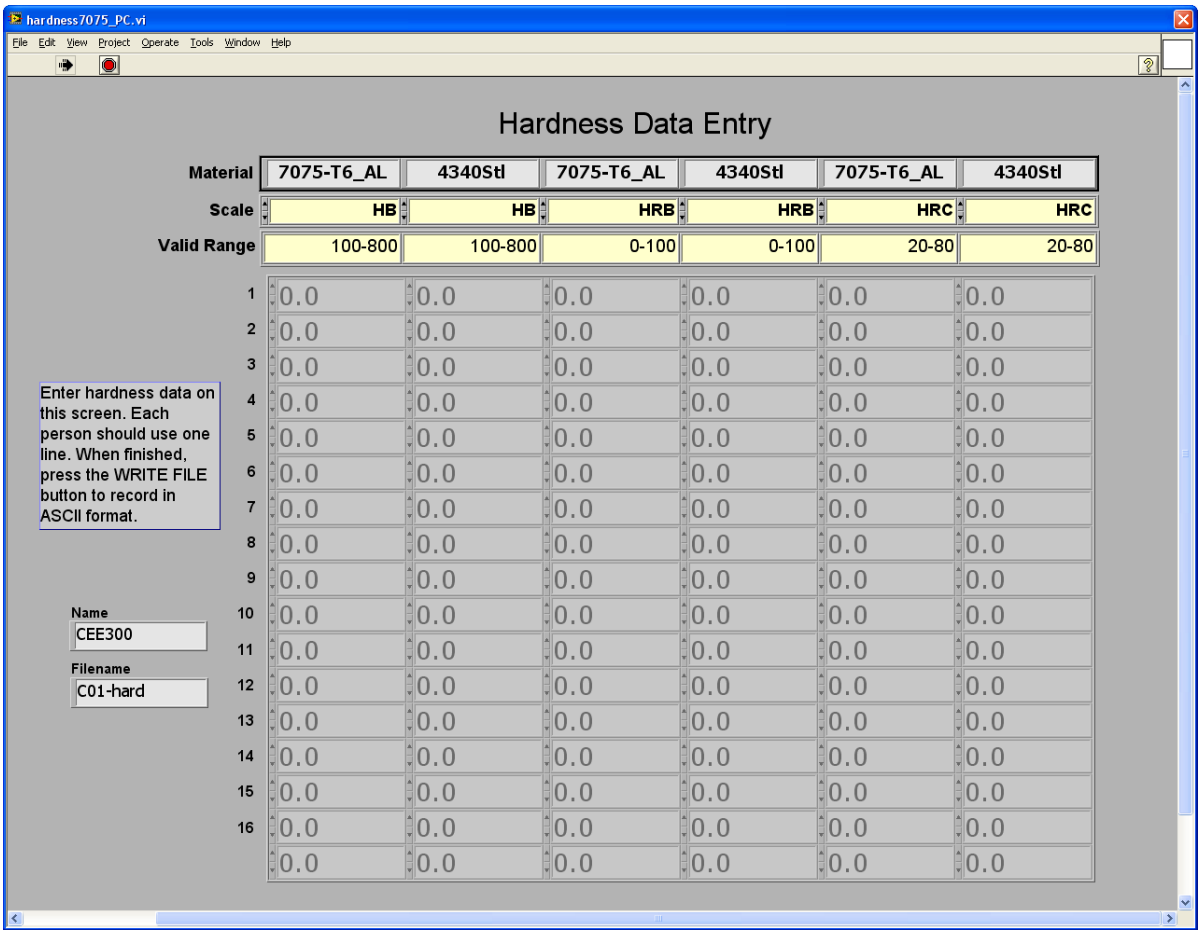
LabVIEW data entry example

The following is an example of using LabVIEW to enter a table of numerical hardness values from three different hardness scales for a specific aluminum and steel, *which is typically the first LabVIEW application encountered by students in the lab.*

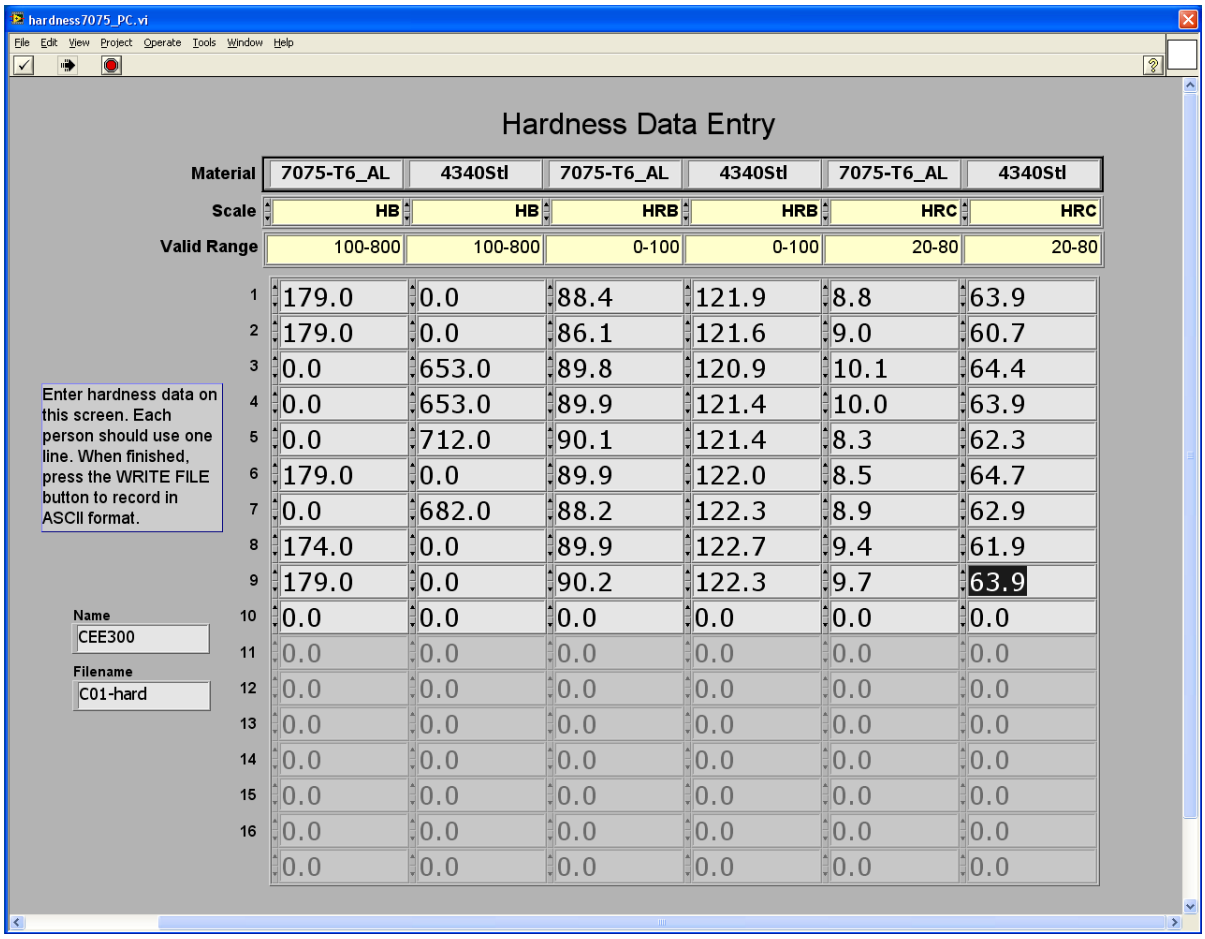
The LabVIEW virtual instrument (or *program*) will already be loaded on the computer. This will be the case for all lab experiments. This example starts from the standby mode:



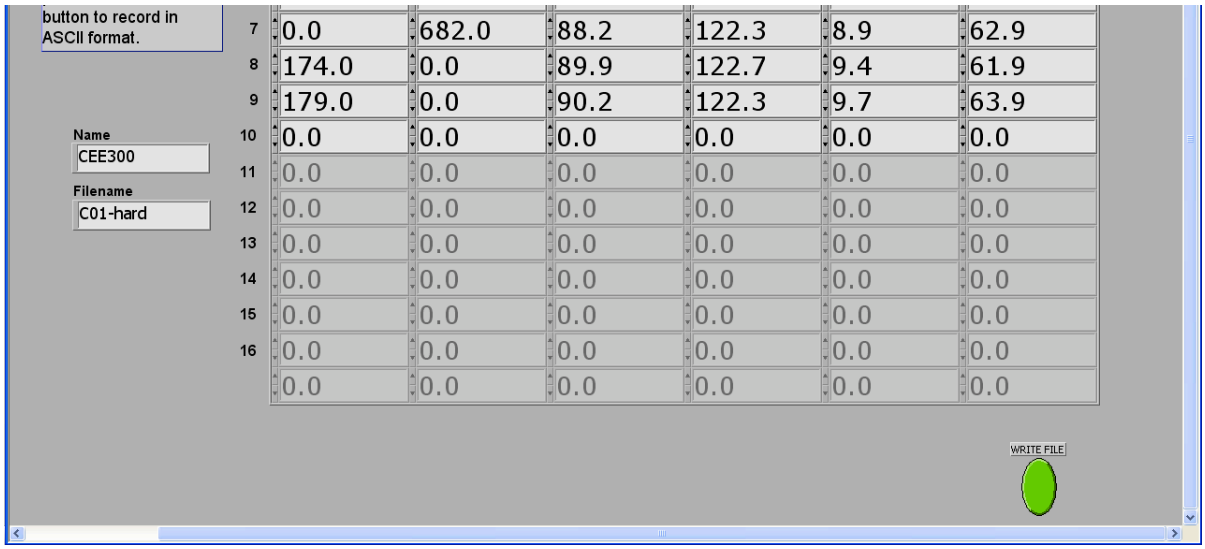
- A prompt to press the run button is displayed.
- Upon running the program, enter the course name and appropriate data output file name.
- See Appendix C regarding data files.



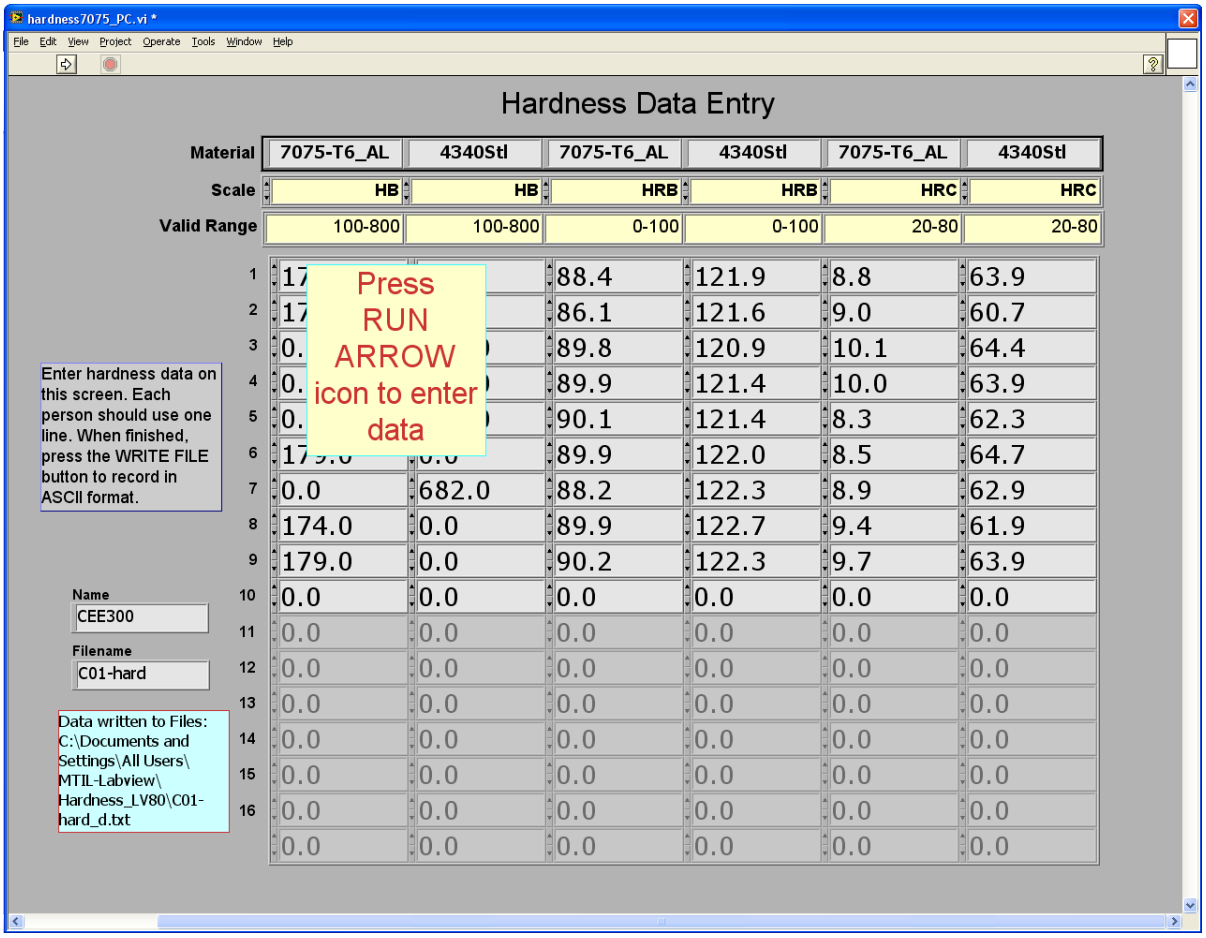
- The course name and the file name are displayed upon entry.
- Use the mouse (or tab and shift-tab) to move around the table entries and enter the measured numerical data.
- Do not change the scales or the materials, as these are determined before the lab period.



- The numerical entries have all been made.
- Corrections can be made, but only prior to writing (saving) the data file.
- Scrolling down in this application will reveal the WRITE FILE button:



- After data entry is complete, clicking the WRITE FILE button will write the data file to disk and display the location to which the file was written.
- *Note - unless announced otherwise, this task is typically performed by the course TAs or lab personnel at the end of lab.*



- The run button is ready to be pressed again, to start a new data entry session and output file.
- Any further specific instructions will be issued by the course TAs as appropriate.

LabVIEW is also employed for testing machine control and data logging for experiments involving torque, impact, fracture toughness, hardenability, phase diagrams, and creep. The course TAs will familiarize students with these applications as appropriate during the specific experiments.

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