Vernier Force-probe Calibration

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A simple spring balance is cheap and easy to use but is less accurate than people assume. Vernier force-probes are just as easy to use but they too are not accurate unless carefully calibrated. The graph below shows the difference in force-probe reading as the probe is rotated through 90°, and shows the inaccuracy when measuring the weight of a hanging mass of 100 grams when the probe has been zeroed in the horizontal position.

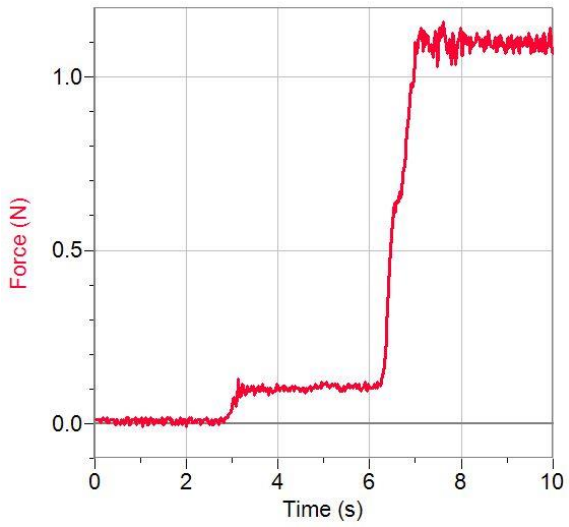

Fig 1 – calibration errors.

Zero setting

1 When using a Lab Pro only, zero the force-probe from that. Tap the display and set the zero in the panel.

Fig 2 – the zero setting panel on the Lab Pro.

2 When using a computer running Logger Pro, zero all probes from the keyboard. Press **Control … zero** and click OK on the panel that appears on the screen.

3 If calibration is required go to **Experiment …. Set up sensors …. Show all interfaces.** Open the menu panel by clicking on a force probe icon (see figure 3).

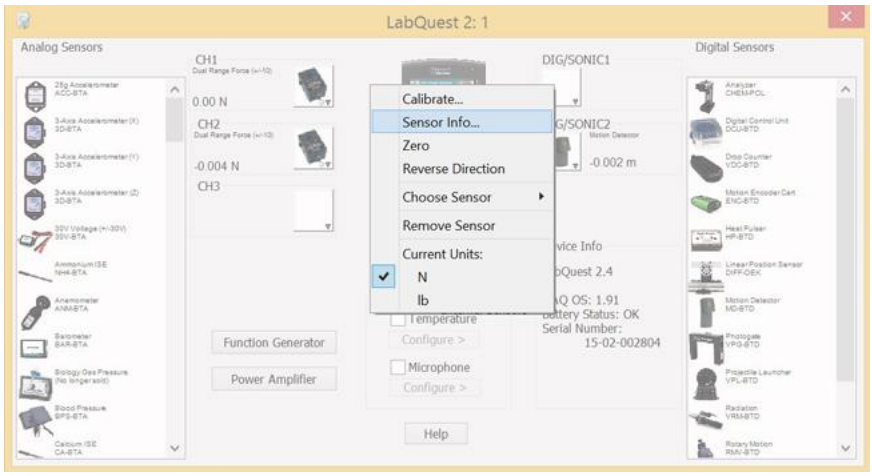

Fig 3 – the *Set up Sensors* panel in Logger pro with the force-probe window opened by clicking on the force-probe icon top-centre-left.

Calibrating a force-probe

1 Select **Calibrate now** in the settings menu (figure 3). The new panel is below.

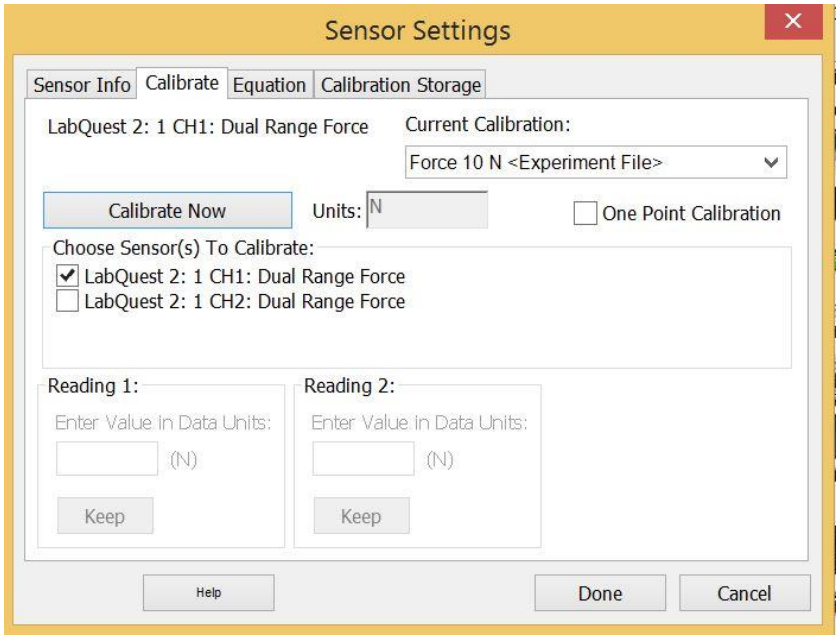

Fig 4 – the force-probe calibration panel in Logger Pro.

2 Hold the probe in the vertical position (hook down), set the left hand panel to zero and click **Keep**.

3 Hang a weight (a mass of 500 g) and set the weight in the right hand panel to (4.90 N). Click **Keep** and **Done**. The completed calibration panel is shown in figure 5.

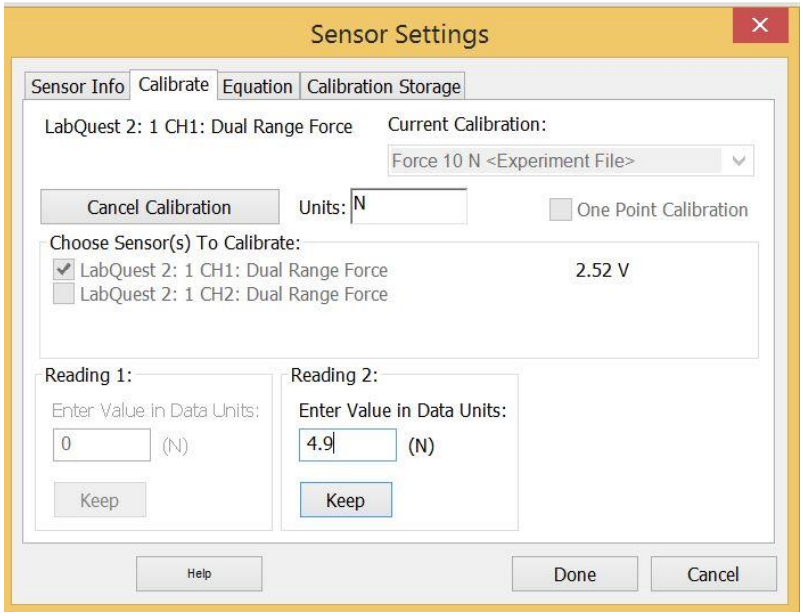

Fig 5 – the completed force-probe calibration panel.

4 To calibrate in the horizontal position follow the same procedure with the probe horizontal and hang the 4.9 N weight over a free running pulley.

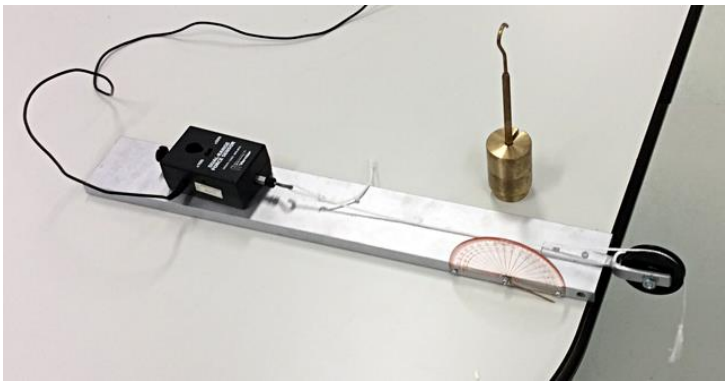

Fig 6 – force-probe calibration in the horizontal position.

5 To calibrate a second force-probe repeat the procedure above, or, put the recently calibrated probe on the bench and link it to the next one with a rubber band.

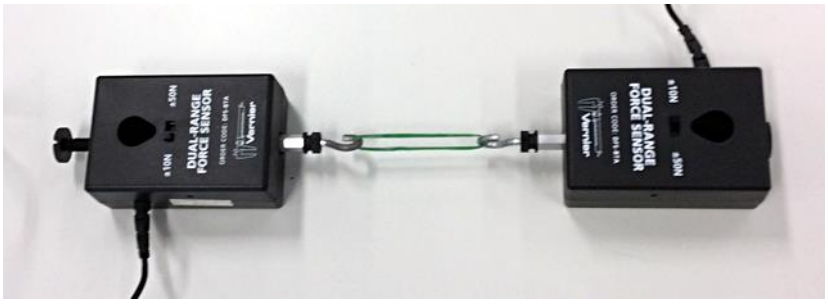

Fig 7 – a calibrated force-probe (left) linked to a second probe.

Zero the next probe from a new **Calibrate now** panel. Stretch the rubber, keeping both probes aligned. Enter the value from probe one in the right-hand calibration panel. Click **Keep** and **Done**.

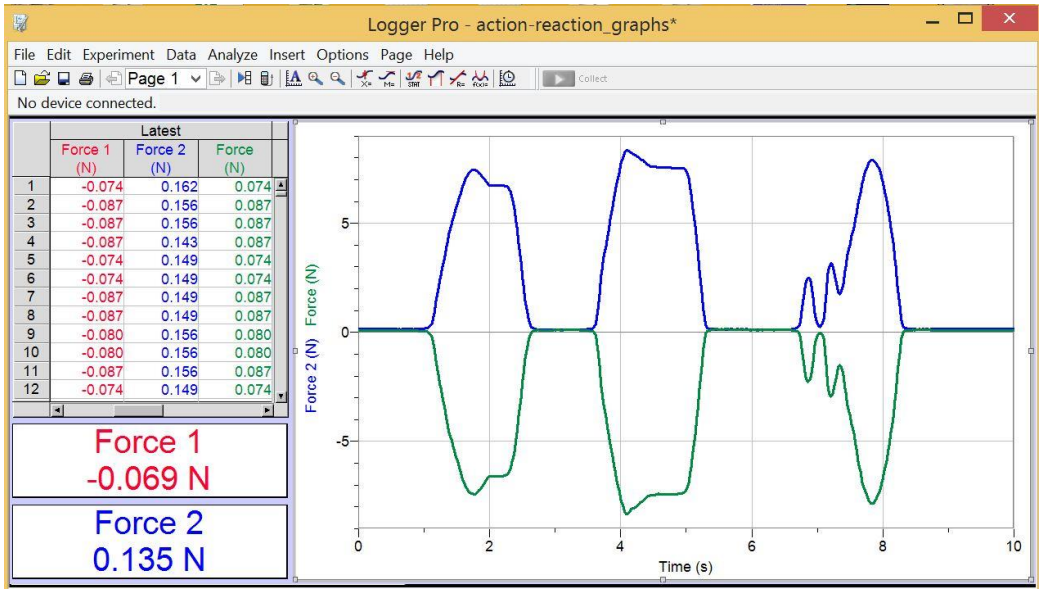

Fig 8 – force/time graphs made by hand with two force-probes linked by a rubber band.

Note: displays in real time in the style of figure 7 provide compelling illustrations of Newton's so called First law. The net-force on the rubber band is zero. If the presence of the rubber band is ignored, the display illustrates the Third law: *action and reaction are equal and opposite*. It is perhaps worth noting that Newton's contribution was the Third law. The first two were due in several forms to his predecessors. Extensive referencing of sources was neither required nor expected in the seventeenth century.