Rame-Hart Model 290

Contact Angle Goniometer

PROCEDURES

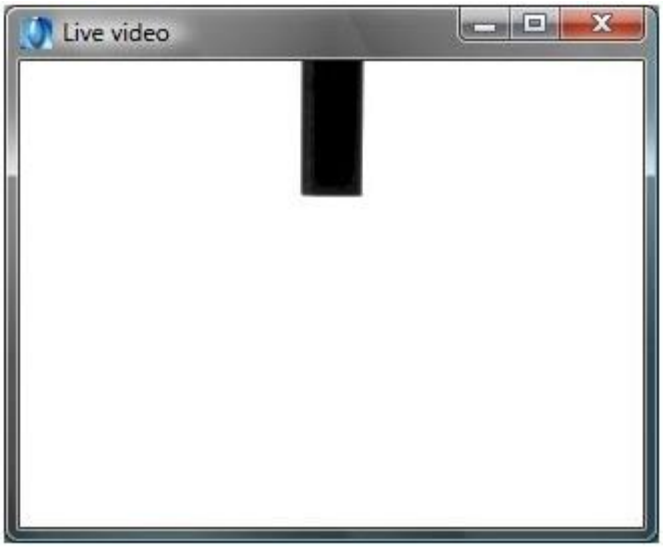
Instructions

(A) How to Measure a Contact Angle with DROPimage
(B) How to Measure a Surface Tension with DROPimage

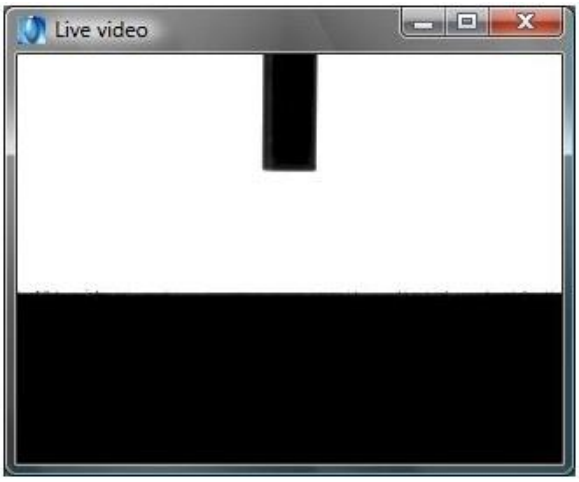
(A) How to Measure a Contact Angle with DROPimage

1. First, the goniometer and DROPimage program must be set up completely and ready for use. The light source should be turned on and the camera ready to use. (Make sure the lens cap is taken off the camera.) Also, the stage should be leveled to allow accurate contact angle measurement. For setup instructions, refer to "F1 Series User Guide". To level the stage, go to the Contact Angle tool and click on Setup. Observe the value for the tilt. Locate the leveling stage near the center of the imagine windows and focus it. Now, using the thumbscrew on the right side of the stage's underside, adjust the leveling stage until the tilt value becomes 0.

2. Now adjust the position of the microsyringe assembly so that the bottom of the needle appears about a fourth of a way down in the Live videowindow screen. Position the needle so that it is vertically in the center of the window screen and make sure it is focused without any blurred edges. To focus the needle, adjust the knobs on the microsyringe fixture to position the needle into focus. The needle should appear as follows:



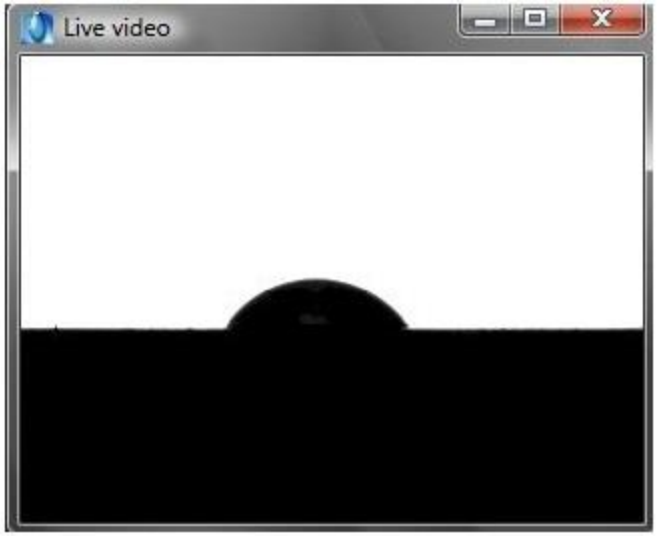
3. After you focus the needle, you must now raise the stage using the Z axis. (Z axis shown in photo below.) Make sure the stage is level so that it will be an accurate contact angle measurement. Raise the stage to about just below the midpoint of the window screen (this is important because the farther the stage is away from the horizontal midpoint, the camera lens begins to give the stage a curved effect when it appears on the Live video window screen). Once the stage is raised, use the Y axis to focus the stage so that there are no blurred edges. With the stage focused and raised, the Live video screen should appear as follows:



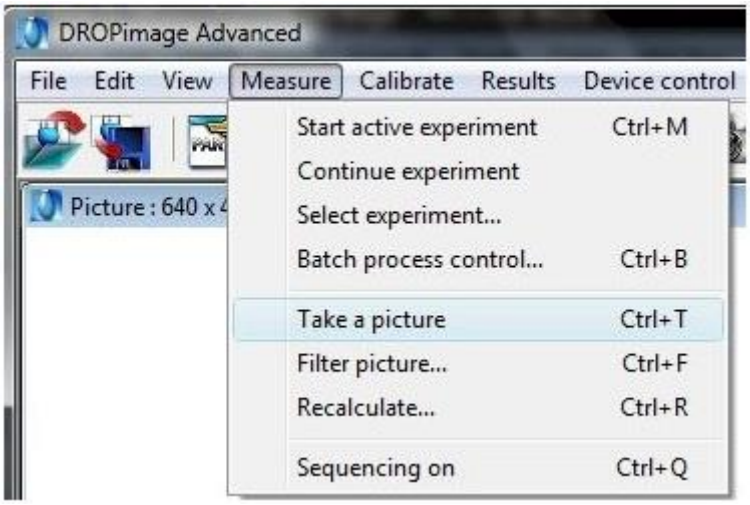
4. Now, you are ready to create a drop. To determine the size of the drop you need, the horizontal increments on the microsyringe determine the volume of a drop. (These increments are shown in the photo below.) From one increment to another is 2 microliters. For example, if you desire a drop of 4 microliters, twist the microsyringe over 2 increments on the horizontal measurements. See photo for step 4.

5. Moving over 2 increments creates a drop of liquid at the end of the needle which appears on the live video screen. Lower the microsyringe needle slowly using the thumbscrew on the microsyringe fixture until the drop comes in contact with the stage. Once the drop touches the stage, slowly raise the needle so that it releases and creates a drop on the stage. See photos for drop releasing process.

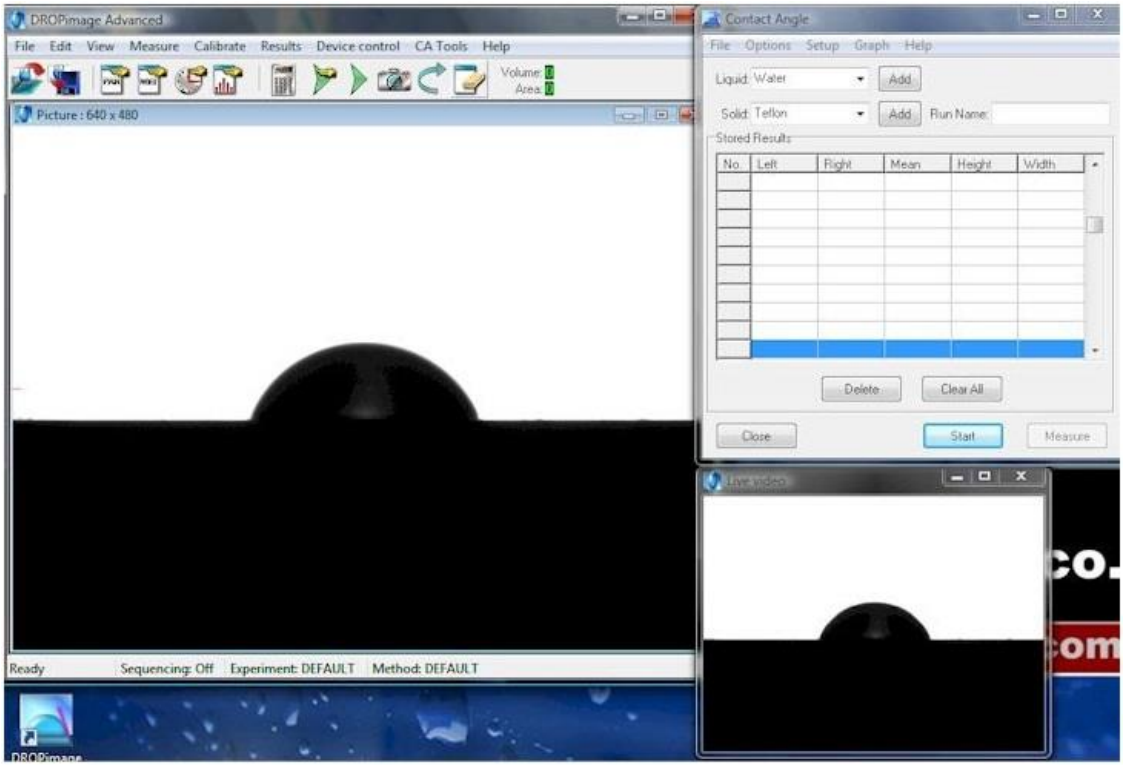
Now, raise the needle so that it does not appear in the live video screen. Your screen should appear as follows:



6. To measure the contact angle of the new drop, first, you must take a picture of the drop by clicking on Measure in the main menu bar and then clicking on Take a Picture. You can also quickly take a picture by pressing on the keyboard Ctrl+T or clicking on the cameraicon in the menu bar. This action places a picture still of the drop on the main image window screen. See photo for example of step 6



7. Next, click on CA Toolsand then on Contact Angle to open the Contact Angle tool. A new window should pop up with Contact Angle written in its title bar. Arrange the live video window, the main image window, and the Contact angle window so that your screen now looks similar to the photo shown on the right.



8. In the new window titled Contact Angle, there are spaces for Liquid,Solid, Run Name, and Stored Results. The Liquid space has a drop down menu which you must use to choose which liquid you are using to create the drop in your experiment. If the liquid you are using is not listed, click on ADD, next to the liquid space, and a new window will pop up. Fill in all the information that is available about the liquid in the appropriate blank spaces then click OK. The new liquid along with all of its properties will be available now in the pull down menu.

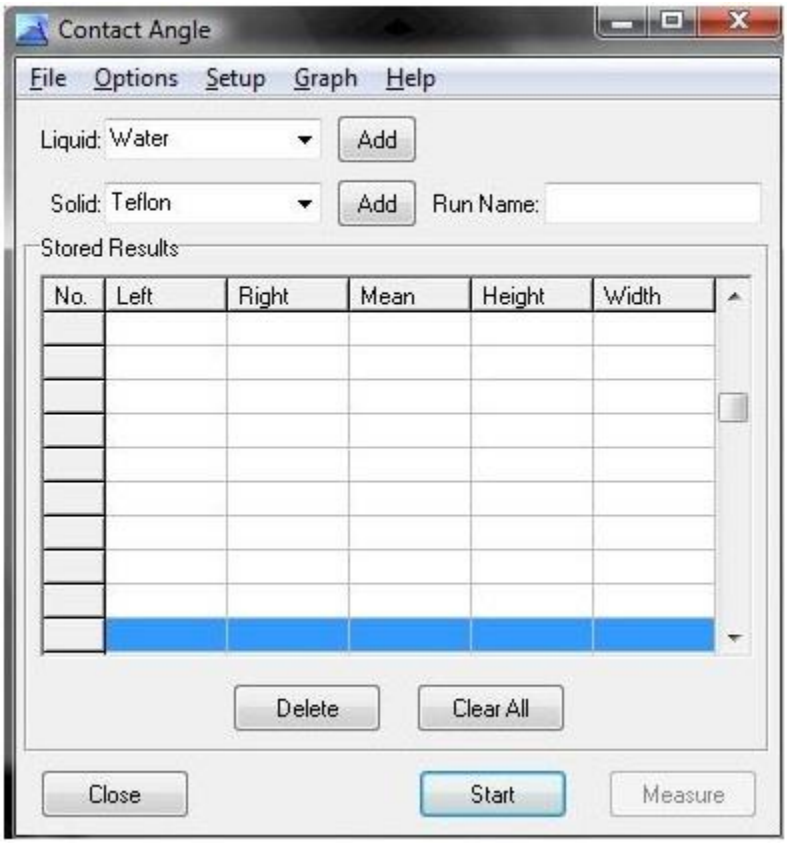
   The Solid space has also a drop down menu which you must use to choose what solid you are testing the drop on. If the drop down menu does not list the solid which you are using, then click on ADD which is next to the Solid drop down menu. Fill in all the information

that is available about the solid in the appropriate blank spaces and then click OK. The new solid along with all of its properties will be available now in the pull down menu.

The Run Name identifies a series of angle measurements of the drop. This series of measurements is called a "run". A run name is not necessary to make a contact angle measurement; it is simply for identification purposes.

The Stored Results box is where the program automatically records the angle measurements.

Here is an example of the Contact Angle window:

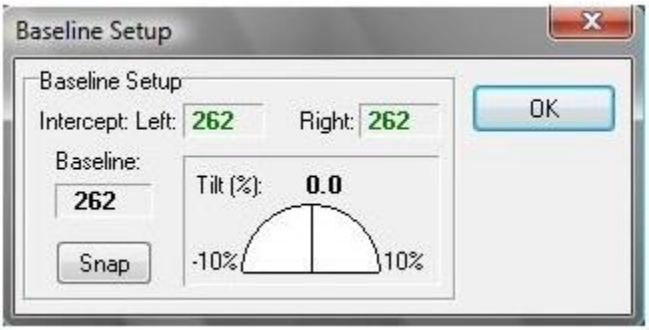


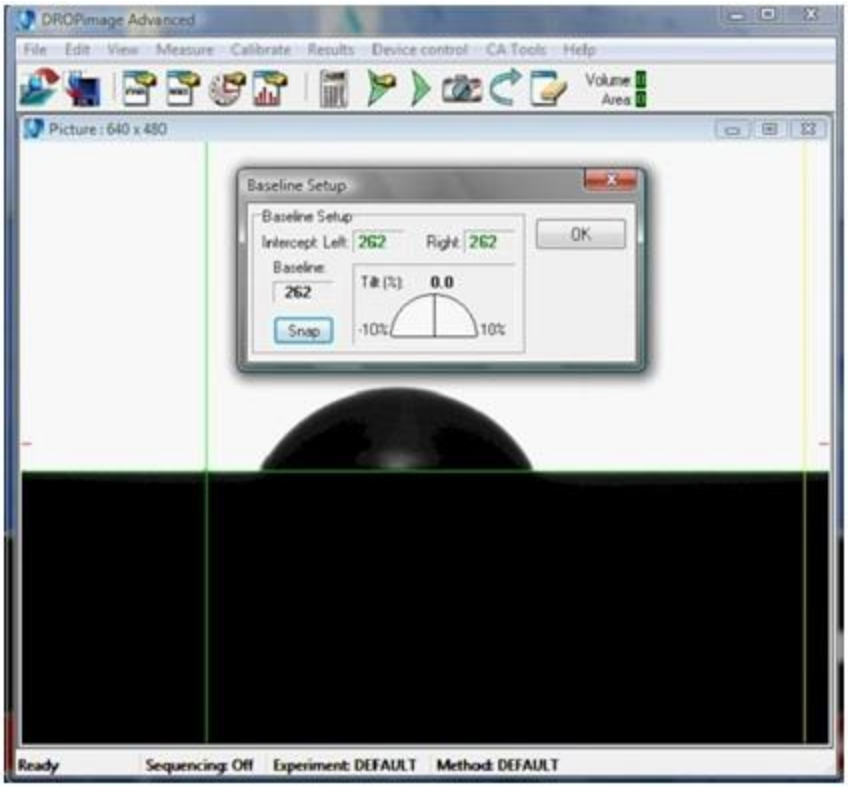
9. Once the Liquid and Solid spaces have been filled in, click on Setup in the Contact Angle window menu bar. A new small window will pop up with the title Baseline setup. Also on the Picture screen new horizontal and vertical lines will appear.

   First, adjust the green vertical line by simply clicking on the window screen to the left of the drop. Make sure it is not touching the drop but that there is a small space between the line and the drop. The yellow line should already be positioned to the right of the drop where it is not touching it or the wall of the application window. Second, look at the Baseline setup new pop up window and observe the number for Tilt. That number for the tilt should be 0.0. If it's not 0.0, then use the knob adjustments on the stage plate to tilt the stage until the application reads 0.0 tilt. Once you have 0.0 tilt, click on snap which

should be located in the lower left hand corner of the Baseline setup pop up window. That action snaps a green line along the baseline of the picture.

See image below for examples.

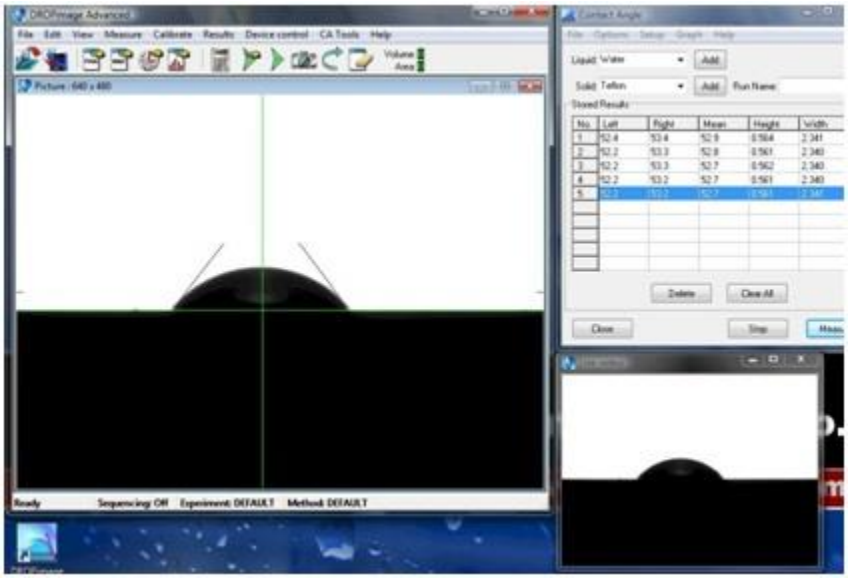




10. Next, in the Contact Angle window, click on the Start button which now allows you to measure the contact angle and also there appears a horizontal and vertical line.

    First, adjust the vertical line so that it passes through the center of the drop. The horizontal line should already be in place along the baseline. Second, once the green lines are in place, click on the Measure button which takes one measurement for every click. The contact angle measurement information is recorded into the Stored Results space in the Contact Angle window. Once you have collected all the necessary measurements, click on the Stop button to finish the process.

See image for step 10 as shown:



Make sure the baseline is located BELOW the midway point.

If you place the baseline above the midway, then DROPimage will not function properly as the software is designed to look for pendant drops when the baseline is above the midway marks and a sessile drop when the baseline is below the midway marks.

(B) How to Measure a Surface Tension with DROPimage

Surface tension is measured using a pendant drop of liquid while the external phase consists of a gas - typically air. (When the external phase is an immiscible liquid, the measurement is called interfacial tension.) Since the drop phase is denser than the external phase, we use a hanging pendant.

The following products are used with this experiment:

- rame-hart Model 290 Standard Goniometer with DROPimage

- Microsyringe (p/n 100-10-20, included with Model 250)

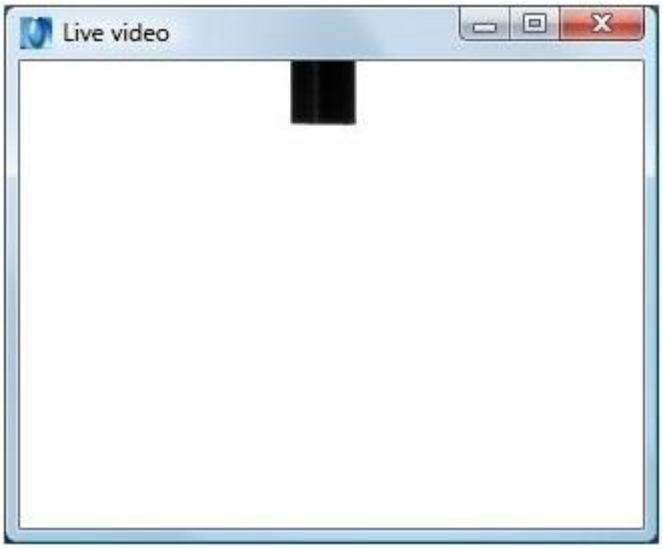
- 22g Stainless Steel Straight Needle (p/n 100-10-12-22, included with Model 250)

Goal

The goal of this experiment is to take ten surface tension measurements over 10 seconds while the drop is at ambient temperature, humidity and pressure.

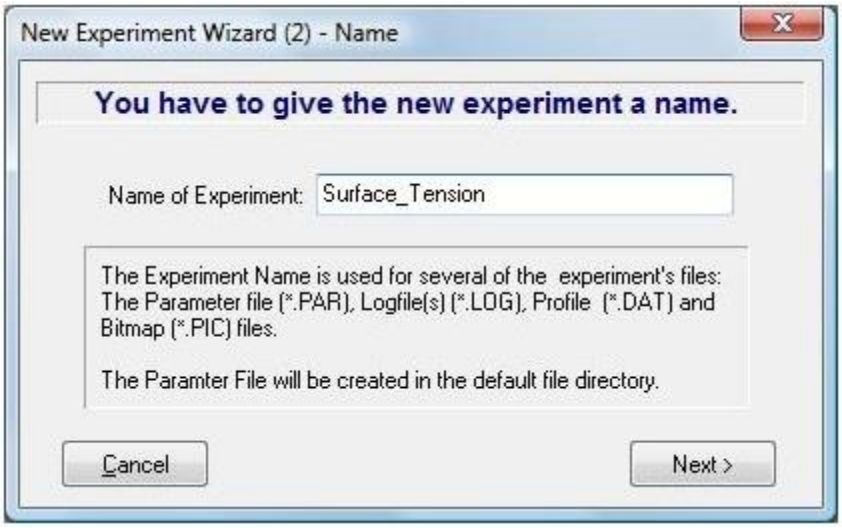
Procedure

1. Verify that the instrument is setup according the instructions provided and has been calibrated.
2. Fill the microsyringe assembly with the test liquid.
3. Attach the straight needle to the syringe firmly.
4. Turn the dispensing knob on the microsyringe to remove air from the needle.
5. Start the DROPimage Advanced software.
6. Install the microsyringe in the fixture and adjust it so that the tip of the needle is visible in the center top of the DROPimage live image window as shown below.

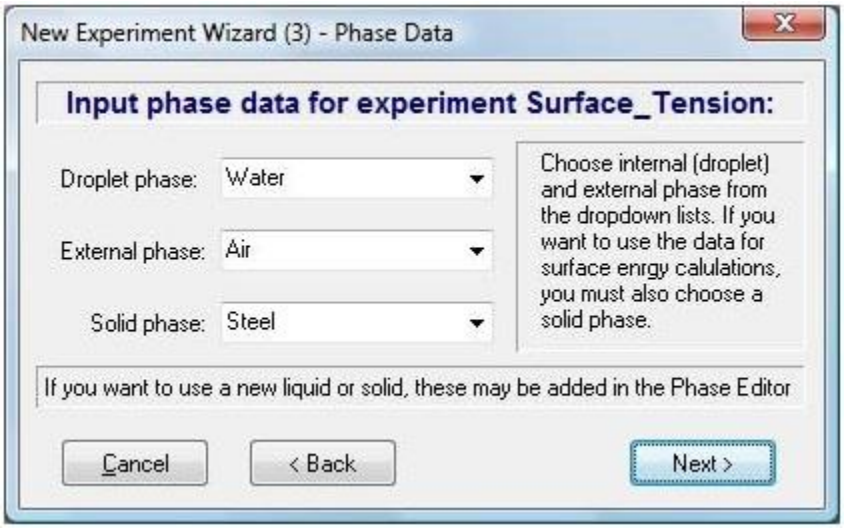


7. Next, let's begin a new experiment using the Experiment Wizard. Click on File &gt New Experiment Wizard. Or simply hit Ctrl-Ton the keyboard.

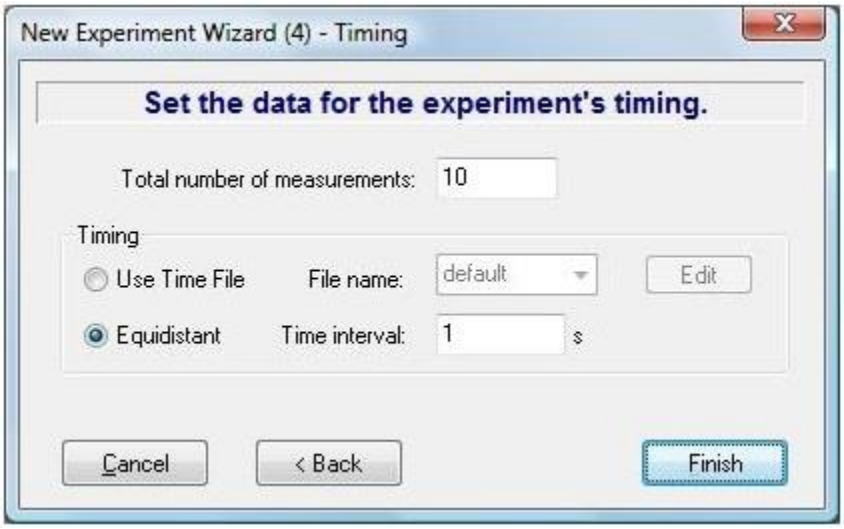
8. We will use the first choice "Surface Tension - Pendant".
9. Click Next.
10. On the next screen, enter an experiment name. We will use "Surface_Tension".



11. Click Next.
12. On the next screen we will enter the phase data. For the droplet phase, select the liquid you are using from the list. Note that if the liquid is not in the list, you will first need to add it using the Phase Editor. Select the External phase - in this case, water. And then the solid phase which is steel (the needle).

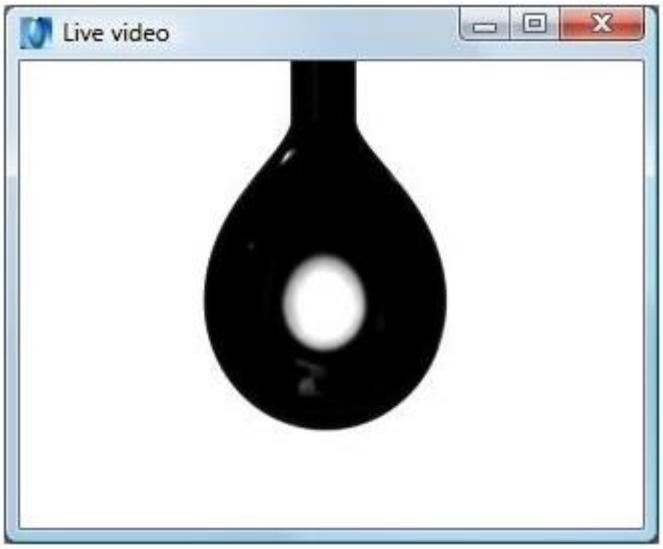


13. Click Next.
14. Now enter "10" for the number of measurements. For the timing, you can use an existing time file - or create a new one - we will use the Equidistant option and set the "Time Interval" to "1" which means that the measurements will be taken one second apart.

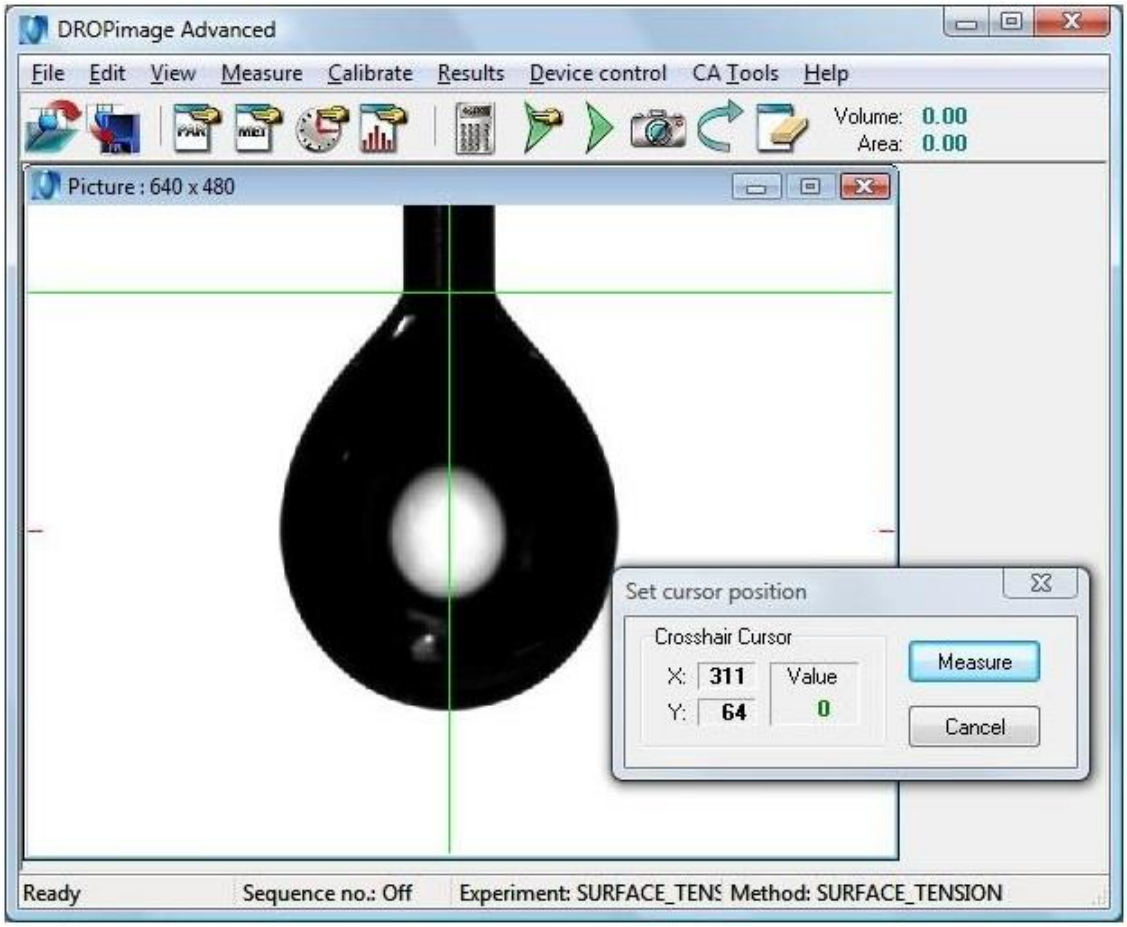


15. Click Finish.
16. At this point, DROPimage has created a Parameter and Method file for your experiment. Click Yesto run it.

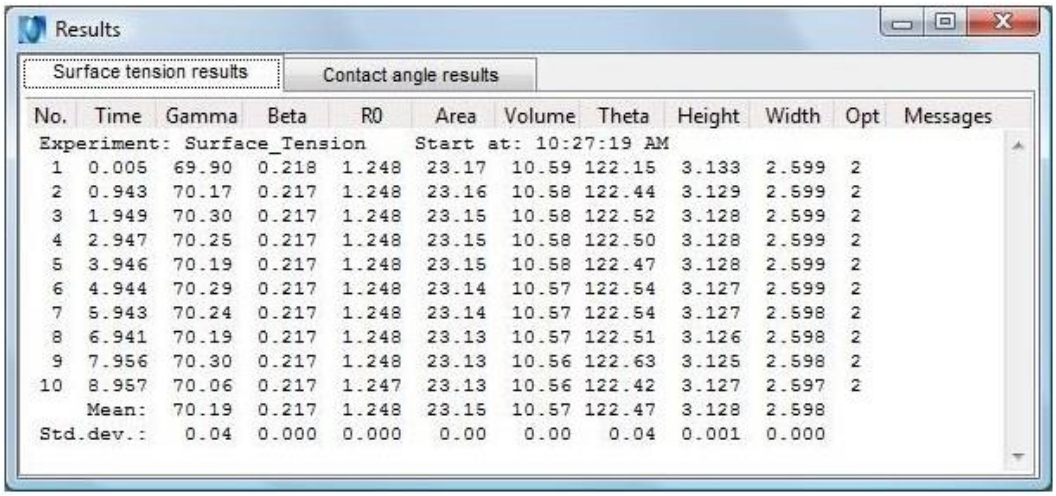
17. Now you will need to dispense your test liquid in order to produce a pendant drop similar to the one shown below. As a rule of thumb you want to use enough volume to produce a drop that is stable and not so large that it releases itself from the needle.



18. With the drop created, now is a good time to make sure that your lighting is set properly. The background should be white while the needle and perimeter of the drop should be black. The interface between the drop and the external phase should be crisp. If not, focus and take a new picture.
19. Place the crosshairs so that the horizontal line passes through the interface between the needle and the drop and the vertical line passes through the center of the drop and needle as shown above.
20. When you are ready, click Measure on the "Set cursor position" dialog box. The experiment will now begin.



21. The results window will now appear if it's not already on your desktop and look similar to the one shown below.



No.	Time	Gamma	Beta	R0	Area	Volume	Theta	Height	Width	Opt	Messages
Experiment: Surface_Tension					Start at: 10:27:19 AM						
1	0.005	69.90	0.218	1.248	23.17	10.59	122.15	3.133	2.599	2	
2	0.943	70.17	0.217	1.248	23.16	10.58	122.44	3.129	2.599	2	
3	1.949	70.30	0.217	1.248	23.15	10.58	122.52	3.128	2.599	2	
4	2.947	70.25	0.217	1.248	23.15	10.58	122.50	3.128	2.599	2	
5	3.946	70.19	0.217	1.248	23.15	10.58	122.47	3.128	2.599	2	
6	4.944	70.29	0.217	1.248	23.14	10.57	122.54	3.127	2.599	2	
7	5.943	70.24	0.217	1.248	23.14	10.57	122.54	3.127	2.598	2	
8	6.941	70.19	0.217	1.248	23.13	10.57	122.51	3.126	2.598	2	
9	7.956	70.30	0.217	1.248	23.13	10.56	122.63	3.125	2.598	2	
10	8.957	70.06	0.217	1.247	23.13	10.56	122.42	3.127	2.597	2	
Mean:		70.19	0.217	1.248	23.15	10.57	122.47	3.128	2.598		
Std.dev.:		0.04	0.000	0.000	0.00	0.00	0.04	0.001	0.000		

22. The results window provides the following information:
    1. No. - run number, e.g., 1,2,3...

2. Time - precise time in seconds of measurement relative to the start of the current run.
3. Gamma - surface tension in mN/m.
4. Beta - shape factor; as a rule a number between 0.2 and 0.4 is good.
5. RO - The radius of curvature at the drop's apex in mm.
6. Area - The drop surface area in mm^2.
7. Volume - The drop volume in mm^3.
8. Theta - The contact angle at the drop limit (horizontal) baseline.
9. Height - The total measured distance from baseline to the drop apex in mm.
10. Width - The dimension in mm at the maximum width.
11. Opt - The number of optimizations performed.
12. Messages - Errors or other messages.

Congratulations. You've now successfully measured surface tension. If you want to make changes to your experiment use the Method Editor and Phase Editor to change the settings.