

Surface Tension Measurements (Krüss DSA-30)

Version of 2024-11-20.

1. Introduction

This user manual explains how to measure the surface tension of any liquid using the Pendant Drop method with droplet pictures taken with the Krüss DSA-30 measurement system. This method uses the open source ImageJ manipulation software (<https://imagej.net/Welcome>), together with the Pendant drop module (http://imagej.net/Pendent_Drop). All the credits go to Adrian Daerr, author of this wonderful module.¹


¹ A. Daerr and A. Mogue, *Pendent_Drop: An ImageJ Plugin to Measure the Surface Tension from an Image of a Pendent Drop*. Journal of Open Research Software, 4: e3 (2016), DOI: [10.5334/jors.97](https://doi.org/10.5334/jors.97)

2. Login & Image settings

WARNING: Users should already have access to the Krüss DSA-30 before following this guide. In particular, they should be familiar with the procedure to prepare and use the manual syringe option, described in step 7 of the Krüss DSA-30 user manual (see also step 5 of this guide):

<http://cmi.epfl.ch/metrology/files/KrussDSA30/krussDSA30.std.manual.pdf>

- Login for “Kruess DSA-30” with CAE on zone 16 (CMi+1 corridor) pc/accounting computer.

 Z16 Kruss DSA-30 - Drop Shape Analyzer

- Switch on the DSA-30 main power.
- Double-click on the DSA4 icon to start the software.
- Adjust the zoom level to 2x and brightness to 50% (O-Con tab). Higher brightness

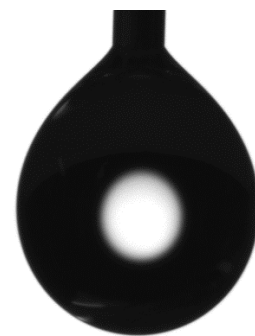
settings are not recommended, as the image will be overly saturated resulting in an inaccurate measurement of the drop dimensions.

- In case of very small or very big drops, the zoom can be adjusted. However it will be necessary to measure the scale in pixels. The saved image will be 780x580 pixels. Using the length etalon provided by Krüss, make sure to determine the scale of your image in pixels/mm. Pixel position is directly readable in the live “ImageView” tab.



Krüss length etalon, distance between the two lines is 5mm

3. Generating the drop and saving the image



- Generate the drop: With the manual syringe, dispense the liquid with the micrometer knob until drop reaches an optimal size. The size of the drop should be as big as possible (just before it falls from the nozzle).

Depending on the surface tension and density of the liquid, the optimal volume can vary.

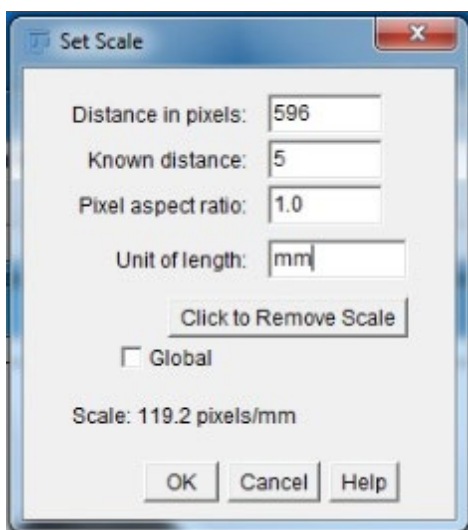
- Adjust the focus, freeze the image and then save it by right clicking on the “ImageView” tab → “Save as”. The image will be saved as “BMP”.
- Close the DSA4 software when all images are saved.
- Open your “BMP” file with MS paint, and save it back to “JPG” file format.

4. Surface Tension Measurement with ImageJ

- Start the ImageJ manipulation software by double-clicking its respective icon.



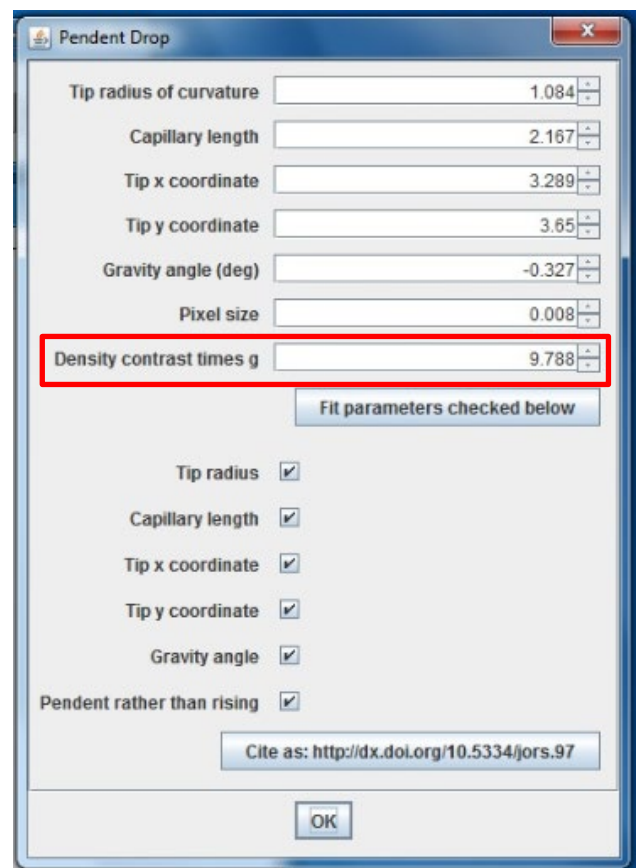
- Open your image: “File → Open”.
- The first step will be to set the image scale. Go to: “Analyse → Set Scale” and enter your pixel count for the 5mm distance of the Krüss length etalon. For zoom 2x, scale should be about 119 pixels/mm. When done, confirm with “OK”.



- Set the region of interest (ROI) by drawing a box around the drop. Adjust the position of the top line to exactly match the end of the dispense nozzle.



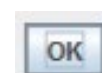
- Next, go to: “Plugins → Drop Analysis → Pendent Drop” to start the surface tension measurement plugin.
- In the pendent drop interface, calculate and set the “Density contrast times g” parameter. To calculate this parameter, find the density contrast between your liquid and air in [g/ml] and multiply by the gravitational acceleration $g = 9.807 \text{ m/s}^2$ (Note: density of air is $\rho = 0.0012 \text{ g/ml}$)



- Once the above parameter is correctly set, click “Fit parameters checked below” and wait for the algorithm to compute.



- When done, the red contour should match the shape of your droplet. To conclude the calculation and display the result window, just click “OK” at the bottom of the module window.



- The results window will pop up. Look for the surface tension value which will be given in [mN/m] and the droplet volume in [ul].

surface tension	volume
71.447794667...	7.9942282289...

- Repeat the operation for all liquids, Make sure to adjust the “Density contrast times g” when changing the liquid.
- When finished, make sure to logout of the Krüss on the zone 16 computer.

5. Manual Syringe Preparation

Warning: Test liquids for the Krüss need to be approved by the CMi Staff before being used with the manual-dispense syringes! These liquids are handled in the CMi cleanroom following a generic [SOP](https://cmiaccess.epfl.ch/restricted/files/SOP_Krüss_Chemicals.pdf). Check here for details: https://cmiaccess.epfl.ch/restricted/files/SOP_Krüss_Chemicals.pdf

This section describes the steps in the preparation of a manual syringe to use with position S-5 of the dosing unit.

- **Always wear appropriate gloves, goggles and clothing when manipulating liquids!**
- **Make sure to prepare the syringe in a well-ventilated area. Zone 13 wet benches with proper exhaust are recommended.**
- Manual, disposable syringes are available in the drawer of the work table.
- Remove the plastic plunger from the syringe.
- Transfer the rubber from the plastic plunger to the metallic micrometer dispense plunger. See image below.



- Push the plunger into the disposable syringe. Rotate the holding clip to the top of the plunger. See image below.



- Pump the liquid from its bottle or an appropriate beaker.
- Rotate the holding clip towards its clipped position. Push some liquid and air bubbles back into the tank.
- Clip the micrometer plunger to the disposable syringe.
- Select the appropriate needle and insert it into the syringe. **Red: stainless steel needle. Purple: teflon needle.** See image below.



- Insert the syringe into the S-5 slot of the dosing unit. **Take care with the tubes of the automatic-dispense syringes!**