

# Short guide to Fiji [Fiji Is Just ImageJ]

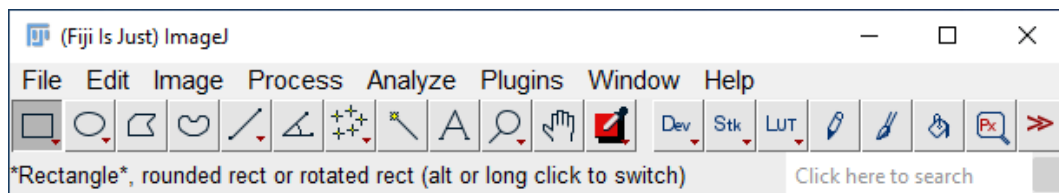
This short guide will only show you some basic functions and some tricks for the analysis of the LEEM images. A detailed guide can be found at <https://imagej.net/learn/>

## 1 What is Fiji?

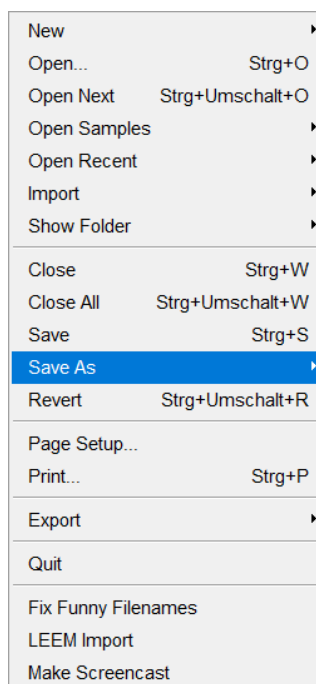
Fiji is a free and open source image processing package based on ImageJ. It has a huge range of plugins that aid in scientific image processing and analysis. You do not need to install it, instead simply download it and save the folder. For the lab course in LEEM we will give you a version which already includes some additional plugins. The basic version can be found at <https://fiji.sc/>

## 2 Basic functions

After starting Fiji you will see the following window. In addition to different menus it shows you some basic tools and a search bar.

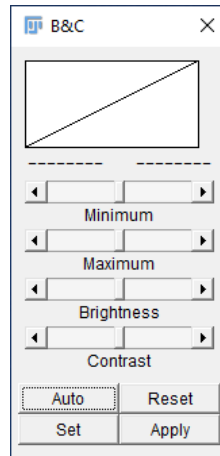


1. To open any image just drag and drop it from your file browser into the Fiji window.
2. Images can be saved in various file formats. Just open the menu "File" and then select "Save as".

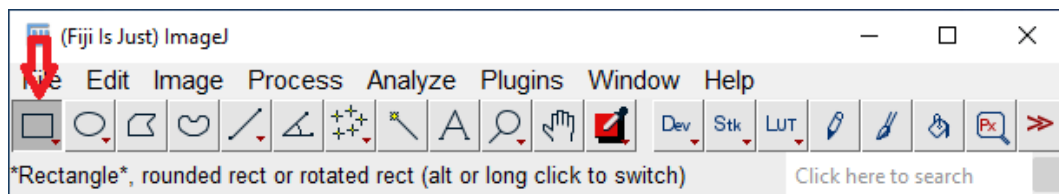


3. Images can be duplicated with the combination of [Ctrl]+[Shift]+[D]. You can also find this function in the "Image" menu.

- The LEEM images will be saved as 16 bit images. Your monitor is not able to display this in full. Therefore you have to adapt the brightness and contrast to best visualise interesting features in your images. The tool for that can be opened with [Ctrl]+[Shift]+[C] or found in the "Image" menu under "Adjust". The "Auto" button tries to find the optimal distribution for the selected region of the image.

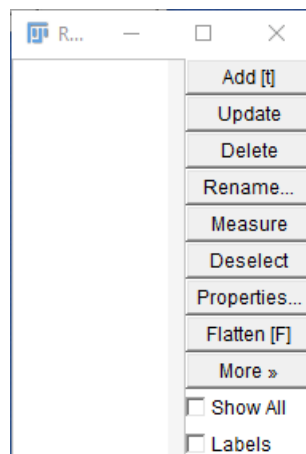


- Sometimes you only want to work with a part of the image. Fiji offers different selection tools for this. They can all be found in the main menu, e.g. the rectangle. The rectangle

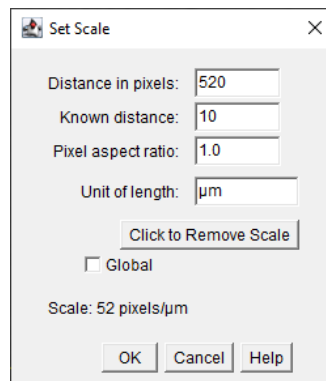


and oval selection tool offer different versions which can be selected with a right-click. If you have an active selection inside your image and then duplicate it, it will ask if it should only duplicate the active selection. The automatic adaption of brightness and contrast will only consider the selected region.

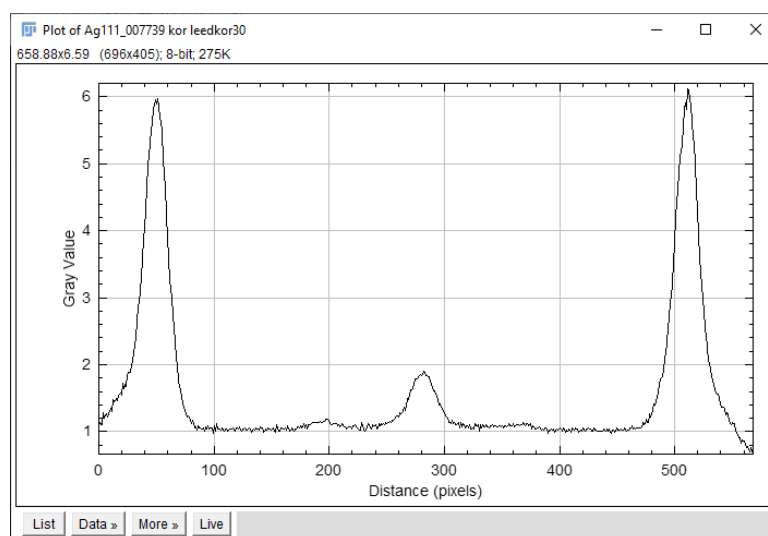
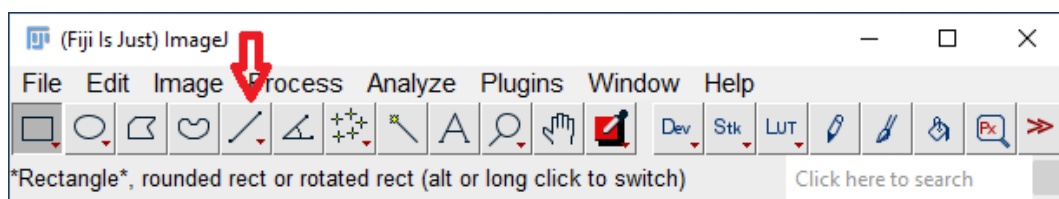
- It is possible to save a selection, so that you can use it for different images as well. For this open the "ROI manager" found inside the "Analyze" menu inside "Tools". An active selection can be added to the manager by clicking "Add [t]" and then saved with "Save..." which is found inside "More»".



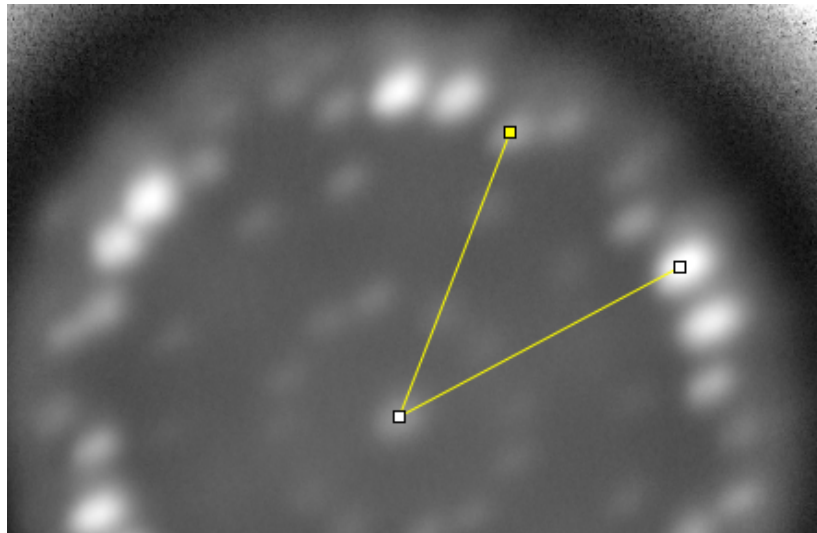
7. To display a scale bar on top of your image you first have to set the scale with "Set Scale..." inside the Analyze menu. Afterwards you can use "Scale Bar" inside "Tools" inside the "Analyze" menu.



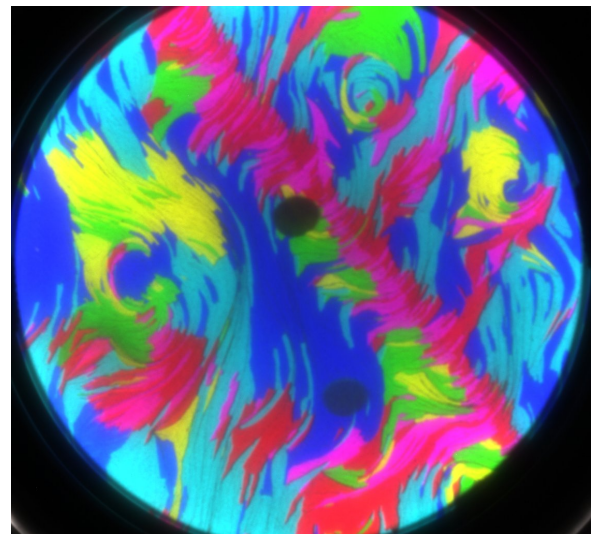
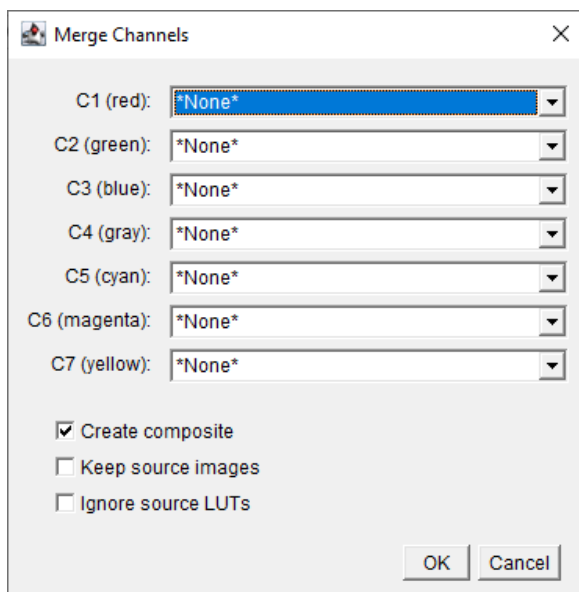
8. If you have a line as selection on your image, you can then press [Ctrl]+[K] to plot the intensity profile. Alternatively this function can be found inside the "Analyze" menu. In the LEEM lab course you will need this function to measure the distance between two LEED spots.



9. Next to the line selection there is a tool to measure the angle between two lines. After you select it, just click on three spots on your image. The measured angle will be displayed in the main window.



10. In the lab course on LEEM you will measure different dark field images from the same region. Fiji offers a simple way to superimpose them. The function "Merge channels" is found inside "Color" inside the "Image" menu. Here you can assign the various dark field images to the different color channels

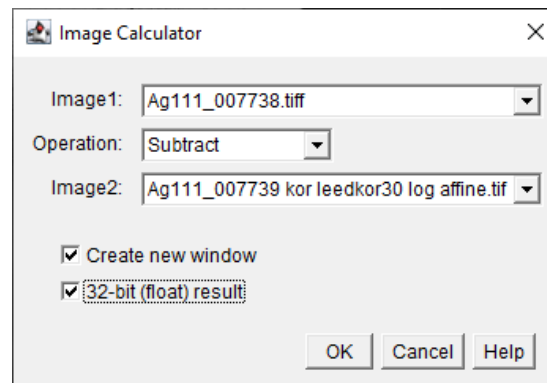


### 3 Image correction

The detector system of LEEM introduces systematic errors and noise in the form of added dark counts and a non-uniform gain. Therefore we want to correct the images using a dark count image, which was taken without illumination and a flat field image, that shows the non-uniform gain.

$$I_{\text{corr}}(x, y) = \frac{I(x, y) - DC(x, y)}{FF(x, y) - DC(x, y)} \quad (1)$$

In Fiji you can use the image calculator found inside the "Process" menu to perform calculations between two images.



## 4 Contrast enhancement for LEED

In the lab course you used the LEEM instrument in an energy-integrated mode. Therefore the inelastic background is still visible in the LEED images, resulting in a non-optimal contrast. This can be improved by the following sequence:

1. Duplicate the corrected image.
2. Apply a minimum filter, followed by a maximum filter and finally a gaussian blur onto the duplicate. The filters can all be found inside "Filters" inside the "Process" menu. Use the same radius for all three filters. 30 pixels should be a good value for your images.
3. Divide your original corrected image by the now changed duplicate.

## 5 Affine transformation

The LEEM instrument additionally causes LEED images to be distorted. This can be seen in images, where the edge of the projection of the Ewald sphere is visible. Instead of a circle you will see an oval. The following steps will correct this:

1. Place a circular selection on your image using the specular LEED spot as origin. For this use the oval selection tool and keep both [Ctrl] and [Shift] pressed.
2. Overlay the selection by pressing [Ctrl]+[B]
3. The function "Interactive Affine" inside the "Transform" menu inside "Plugins" displays three small crosses onto the image. You can drag them around, seeing the real time change of the image. Try to get the edge of the projection of the Ewald sphere as close to the circular selection as possible. Confirm with the [Return]-key.

Keep in mind, that this will change the distances between different spots!