National Research Council
NRC·CNRC Canada

National Institute for Nanotechnology

NanoMi Optics

User Manual

Version 1.1

August 2022

UNIVERSITY OF ALBERTA

THE UNIVERSITY OF BRITISH COLUMBIA

Contents

1. Introduction

NanoMi Optics is a software that was developed initially in MATLAB by Misa Hayashida with the National Research Council's National Institute for Nanotechnology at the University of Alberta. The software was translated to Python by students at the University of British Columbia.

1.1. Overview

NanoMi Optics software allows users to plan, visualize, and optimize NanoMi transmission electron microscope settings. The user can adjust each lens setting and view the effect of the adjustments on the electron beams and magnification. The electron microscope settings are displayed in a diagram and are downloadable in csv format. The settings calculated using the software are intended for later use on an actual NanoMi transmission electron microscope.

1.2. User Groups

National Research Council of Canada nanotechnology researchers at the University of Alberta.

2. Getting Started

2.1. Licensing & Cautions

Note the following licences associated with this software:
National Research Council of Canada :
https://nrc.canada.ca/en/research-development/intellectual-property-licensing
Python:
https://docs.python.org/3/license.html
Matplotlib:
https://matplotlib.org/stable/users/project/license.html
NumPy/SciPy:
https://numpy.org/doc/stable/license.html

When using this software, ensure to follow the National Research Council of Canada's Intellectual Property policy.

2.2. Set-up Considerations

The NanoMi Optics software uses tools that users need to download on their machine. If you want to download and run the software on your machine, you must verify that your machine has permission to download Python and batch files required. If you are unsure if your machine has permission, please contact your IT support service.

3. Installation Guide

Use the following guides to install NanoMi Optics software on your Windows machine.

3.1. Windows Install

1. A compatible version of **Python** (Python >=3.9) must be installed.
    a. See: https://www.python.org/downloads/windows/
2. Extract the full source code to a folder on your machine.
    a. Go to the GitHub repository, and click the green button that says "Code" then **Download Zip.**
    b. Extract the zip file. (Unzip the file)
    c. See: https://github.com/UBCO-COSC-499-Summer-2022/matlab-to-python-application-translation-project2-nrc.git
3. Navigate into the **NanoMi Optics folder**.
4. Run the `install.py` file in the folder with Python. This installs the software.
    a. You can do this by right clicking on the file and click **with Python.**
5. Run the `main.py` file in the folder with Python. This runs the software.
    a. You can do this by right clicking on the file and click **with Python.**

3.2. Mac/Linux Install

1. A compatible version of Python (Python >=3.9) must be installed.
    a. Using a package manager such as `brew` or `apt` is recommended.
        i. `brew install python@3.9`
        ii. `sudo apt install python3.9`
2. Install supporting libraries for Tcl/Tk.
    a. `brew install python-tk`
    b. `sudo apt install python3-tk`
3. Extract the full source code to a folder on your machine.
    a. Go to the GitHub repository, and click the green button that says "Code," then click **Download Zip.**
    b. Go to the GitHub repository, and click the green button that says "Code" then **Download Zip.**
    c. Extract the zip file. (Unzip the file)
    d. See: https://github.com/UBCO-COSC-499-Summer-2022/matlab-to-python-application-translation-project2-nrc.git
4. Navigate into the **NanoMi Optics folder**.
5. Run the `install.py` file in the folder with Python. This installs the software.
    a. You can do this by right clicking on the file and click **with Python.**
6. Run its `main.py` file in the folder with Python. This runs the software.
    a. You can do this by right clicking on the file and click **with Python.**

3.3. Executables

The user can also run Nanomi Optics using an executable file (EXE file). Executables are easily run on Windows machines. Simply download the file onto your machine, double-click on the file in your directory, and the software will begin.

4. System Organization & Navigation

NanoMi Optics software has two **control** panels, one **Results** panel, and one results **Diagram.**

In the **Settings Above Sample** panel, the user can change the settings for the **C1**, **C2**, and **C3** lenses, which are the lenses that rest above the sample in the electron microscope. Drag the sliders with your mouse, type a value into the spinbox, or click the arrows on the spinbox to change the focal length setting for each lens. To change the mode of the sliders, use the **Mode** drop-down menu to choose **Cf** mode or **Ur** mode. The default mode is **Cf.** The **On/Off** toggle switches the lens on or off and enables or disables the slider.

In the **Settings Below Sample** panel, the user can change the settings for the electron beam **Distance** and the **Objective**, **Intermediate**, and **Projective** lenses. These are the lenses that rest below the sample in the electron microscope. Drag the sliders with your mouse, type a value into the spinbox, or click the arrows on the spinbox to change settings. The **On/Off** toggle switches the lens on or off and enables or disables the slider. To **optimize** a specific lens' value, click on the radio button for that lens in the **Auto Setting** frame. The slider will be disabled and when the other lens values are adjusted, the selected lens value will be optimized. Choose an **Image mode** for optimization using the radio buttons, either Image mode or Diffraction mode. Image mode optimizes the selected lens settings so that the red coloured ray approaches 0 as close as possible. Diffraction mode optimizes the selected lens setting so that red ray and green ray approach each other as close as possible.

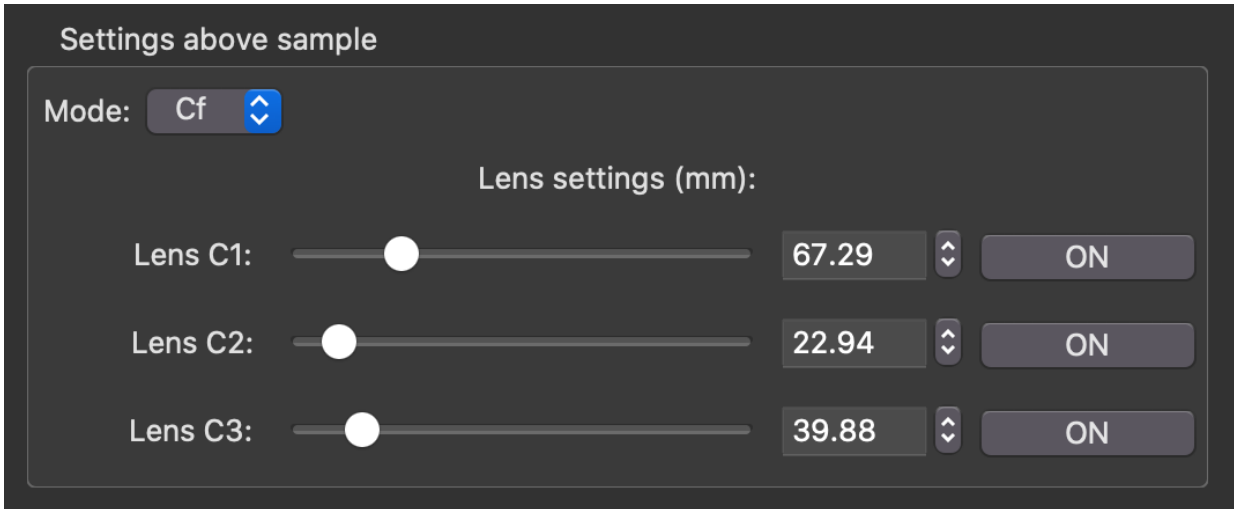
In the **Results** panel, view the values of the lenses and magnification as adjustments to the settings are made. When satisfied with the settings, save the results in CSV format by clicking the **Save** button. A popup window will appear to prompt the user to save the results in the desired area on their machine. Reset the software to its initial values by using the **Reset** button. The save button and reset button are both located at the bottom of the window.

The results **Diagram** is a diagram of a NanoMi transmission electron microscope. From left to right (top to bottom in an electron microscope), the rectangles on the diagram are the microscope's **Anode**, **Condenser Aperture**, **C1** lens, **C2** lens, **C3** lens, **sample**, **Objective** lens, **Intermediate** lens, **Projective** lens, and **Scintillator**. There are four electron beams displayed going through the microscope. Each electron beam is a different colour for differentiation. The green circles indicate where the electron beams crossover. As the user adjusts the settings, the electron beams adjust accordingly. The tools at the bottom of the diagram adjust the diagram's view, including zooming in and out. The home button resets the diagram to the original view. The four arrow button allows the user to drag around the view. The microscope button allows the user to zoom in on the diagram. The save button will save the image on the user's machine. The back arrow is the undo button and the forward arrow is the redo button.

5. NanoMi Optics Step-by-Step

Note to the user: there is no specific order in which adjustments must be made. Adjust until you are satisfied with the settings.

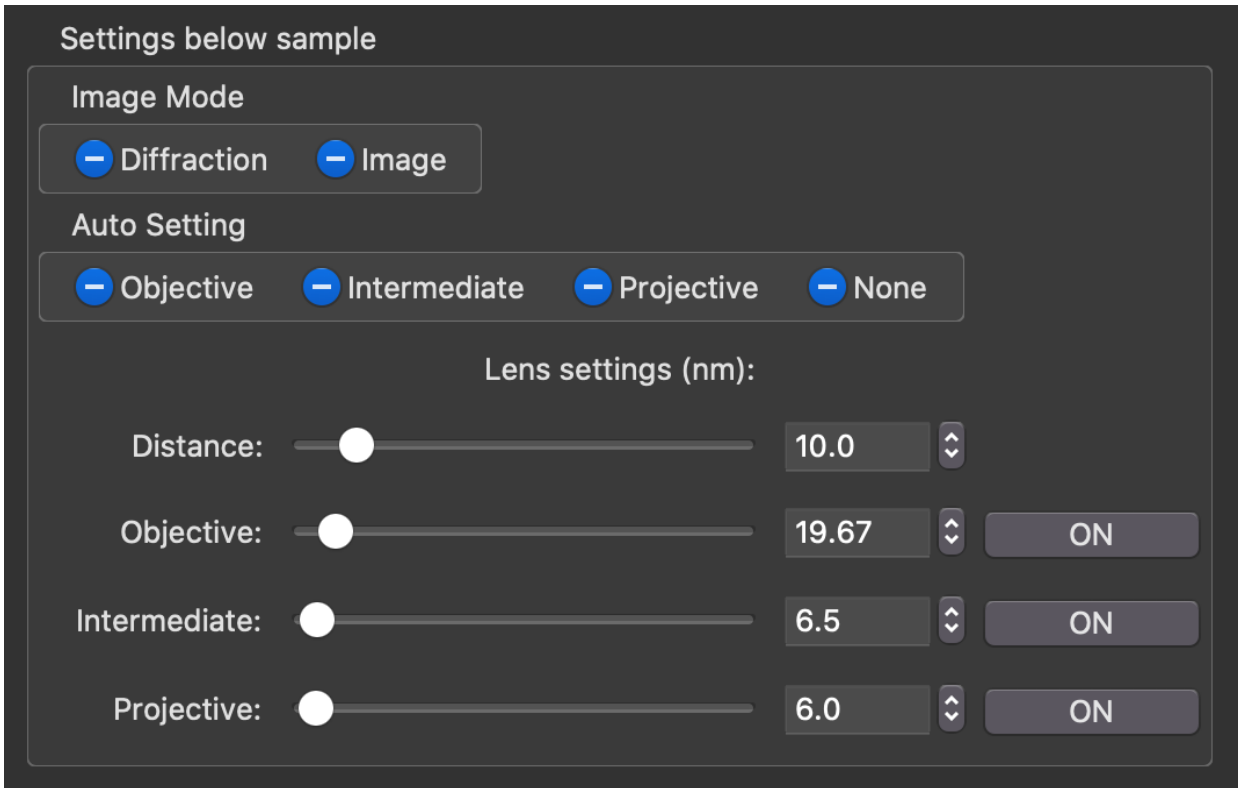
1. Adjusting the upper lenses



- Mode: Select whether to adjust the lens settings in **Cf** mode or **Ur** mode using the drop down menu. The default mode is **Cf.**

1. Select which lens, **C1, C2,** or **C3** to adjust.
2. Drag the slider, type a value into the textbox, or click on the up and down arrows to change the lens values. View the lens value changing in the textbox.
3. Click on/off button to turn on and off the lens.
4. View the changes made in the **Results** panel and **Diagram**. The changes will be updated simultaneously.

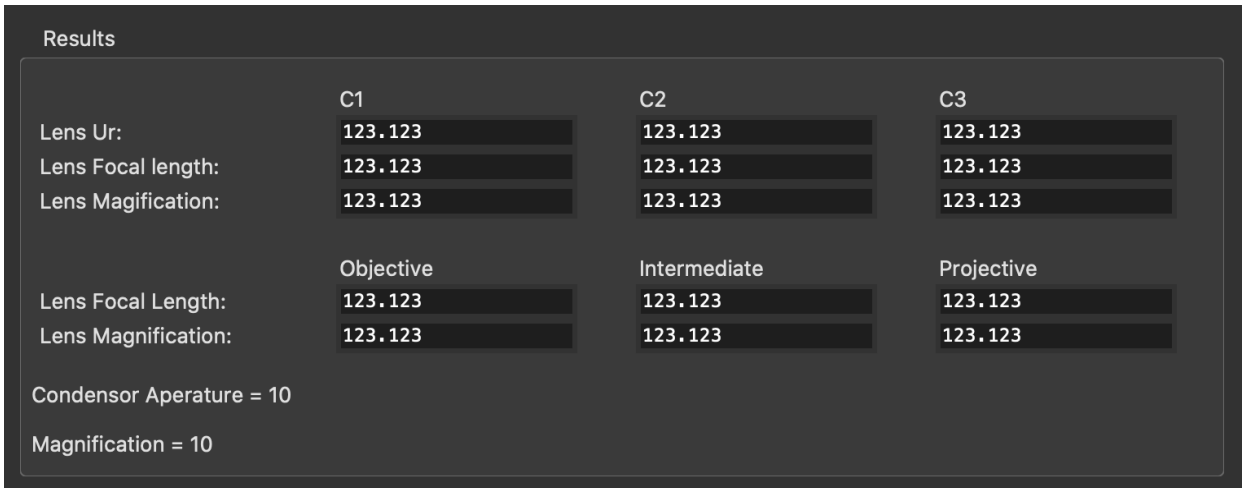
2. Adjusting the lower lenses



1. Select **Distance** or one of the three lenses, **Objective, Intermediate, or Projective** to adjust.
2. Drag the slider, type a value into the textbox, or click on the up and down arrows to change the lens values. View the lens value changing in the textbox.
3. Click on/off button to turn on and off the lens.
4. View the changes made in the **Results** panel and **Diagram**. The changes will be updated simultaneously.

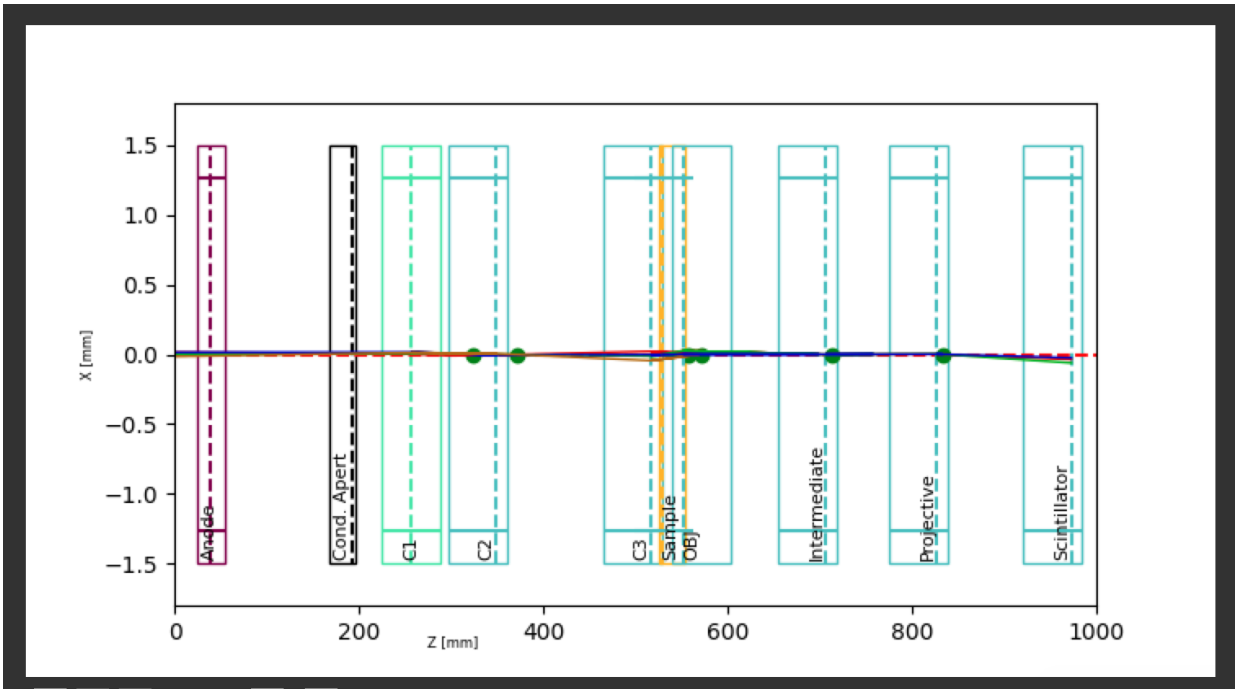
- **Image Mode:** Select which image mode with one of the two radio buttons: **Diffraction** or **Image.** One of these radio buttons will always be selected.
- **Auto Setting:** To optimize one of the lens settings, select the radio button for the lens to optimize. The lens' settings will now be optimized and changed based on the other lens' values. To turn off Auto Setting, select the **None** radio button. One of these radio buttons will always be selected.

3. Results Panel

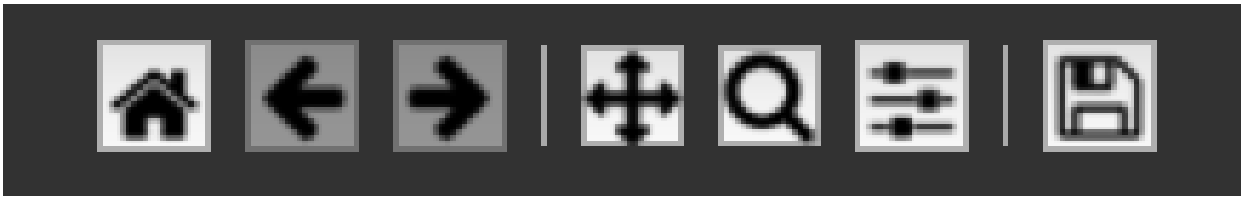


- View the results as the settings are adjusted.
- For the **C1, C2,** and **C3** lenses, the Lens Ur, Lens Focal Length, and Lens Magnification are displayed here in a table.
- For the **Objective**, **Intermediate** and **Projective** lenses, the Lens Focal Length and Lens Magnification are displayed in the table.
- The **Condenser Aperture** value and electron microscope's **Magnification** are displayed.
- When satisfied with the settings, click the **Save Results** button at the bottom of the window to save the results in this table in CSV format onto your machine.
- Reset the software by clicking the **Reset** button at the bottom of the window.

4. Diagram



- As adjustments to the settings are being made, the user will view them here in this diagram of a **NanoMi** transmission electron microscope.
- The X axis is named Z. The Y axis is named X. They are measured in millimetres. The domain and range of the diagram change depending on the shape of the electron beams.
- The top of the microscope is the left of the diagram, where the electron beams are transmitted. The bottom of the microscope is to the right.
- Descriptions of the rectangular boxes from left to right: The pink box is the **Anode**. The black box is the **Condenser Aperture**. The lightest blue box is the **C1** Lens. The other blue boxes are the **C2** lens, **C3** lens, **Objective** lens, **Intermediate** lens, **Projective** lens, and the **Scintillator**. The yellow box in the centre is where the **sample** rests in the microscope.
    - None of these boxes drawn on the diagram move. The boxes might appear like they are moving, but it is the electron beams that are moving and the size of the diagram adjusting according to the electron beams' shape.
- The red dashed line going through the middle of the diagram horizontally indicates the centre of the diagram.
- The four lines going through each of the sensors are the four **electron beams**. They are each a different colour for differentiation. The green dots are the **crossover points.**



- The home button resets the diagram to the original view.
- The left-pointing arrow is the undo button.
- The right-pointing arrow is the redo button.
- The four arrow button allows the user to drag around the view.
- The microscope button allows the user to zoom in on the diagram.
    - To zoom into the diagram, drag the mouse to draw a box over the desired magnified area.
- The save button will save the image on the user's machine.

6. Troubleshooting and Support

6.1. Error Messages

- Incorrect Python version - Ensure that you have the correct Python version. There might have been an old version of Python already installed on your machine. In your Command Prompt, run:
    - `python --version`
- Python not installed in PATH - Ensure that Python is installed in the proper location on your machine. If the following runs and displays the correct version of Python, you have correctly installed it on your PATH variable. In your Command Prompt, run:
    - `python --version`
- Batch not running - Download the file on your machine and double-click on the file to start. If using Command Prompt, ensure that you are navigated to your batch file.

6.2. Support

If you are using NanoMi Optics software and notice there are errors, inconsistencies, or need other additional assistance, please contact Dr. Misa Hayashida at the National Institute for Nanotechnology with the National Research Council of Canada at the University of Alberta.

Appendix A - Record of Changes

Record of Changes:

Version	Date DD/MM/YYYY	Author	Description of Changes
1.0	10/07/2022	Jasmine Mishra	Creation of User Manual.
1.1	16/08/2022	Jasmine Mishra	Finished adding all requirements

Appendix B - Notes to the Author

This document is a User Manual for NanoMi Optics software. The final document should be delivered in an electronically searchable format. The manual should stand on its own with all elements explained for readers.

When modifying this document, the author should note that:

- When significant changes are made to the software, this document needs updating
    - Note modifications made to this document in Appendix A
- This document uses Open Sans font for accessibility and readability
- Headings are left aligned, bolded, and size 18 font (except appendixes)
- There is a 12 font soft space between paragraphs and headings
- Keep consistent styling