

EFA-GUI User Manual

The objective of EFA-GUI is to transition from manual single-particle analysis to an automated, high-throughput workflow. Users can perform statistical shape analysis, harmonic sensitivity studies, and contour reconstruction using an interactive Python-based Streamlit graphical user interface (GUI).

The software is available through two deployment modes:

- **Web Application:** <https://efa-gui.streamlit.app/>
- **Local Installation (PyPI):** <https://pypi.org/project/efa-gui/>

Both deployment modes provide identical functionality.

Option A: Use the Web Application

1. Open the application:
 - <https://efa-gui.streamlit.app/>
 - If the application is inactive, wait for it to wake up.
2. Upload your prepared particle dataset and specify the image scaling factor (px/mm).
3. Alternatively, download and use the example dataset:
 - test_data.csv
 - GitHub repository: <https://github.com/aidanaboribayeva/Computational-Elliptic-Fourier-Analysis>
4. For the provided test dataset, use:
 - Scaling factor: **77 px/mm**

Option B: Install and Run Locally

Quick Installation

Open a terminal or command prompt and run:

```
pip install efa-gui
```

Verify the installation:

```
efa-gui-self-test
```

Launch the application:

```
efa-gui
```

Recommended Installation Using a Virtual Environment (PowerShell)

```
python -m venv env  
Set-ExecutionPolicy -Scope Process -ExecutionPolicy Bypass
```

```
.\env\Scripts\Activate.ps1
python -m pip install --upgrade pip
python -m pip install efa-gui
python -c "import efa_gui; print(efa_gui.__version__)"
efa-gui-self-test
efa-gui
```

Installation in Jupyter or Notebook Environments

```
python -m pip install efa-gui
python -c "import efa_gui; print(efa_gui.__version__)"
efa-gui-self-test
efa-gui
```

Automated Self-Test

To verify that the software is installed correctly and functioning as expected, run:

```
efa-gui-self-test
```

The automated self-test loads the sample dataset, executes Module 3, and compares the generated shape indices against validated reference values.

The test is successful if the following message is displayed:

```
Self-test passed: sample CSV loaded, Module 3 ran, and reference indices matched.
```

Workflow

Module 1: Reconstruction

- Select an individual particle.
- Adjust the harmonic order slider from 1 to 40.
- Observe the reconstruction error and how the reconstructed contour converges toward the original particle shape.

Module 2: Sensitivity Analysis

- Apply different harmonic orders to the entire dataset.
- Evaluate how shape descriptors, such as Asymmetry, stabilize as the number of harmonics increases.

Module 3: Statistical Analysis

- Generate distribution plots for:
 - Elongation
 - Angularity
 - Roughness

- Export the correlation matrix to identify potentially redundant shape descriptors.

Important Notes

Streamlit Wake-Up

After periods of inactivity, the hosted Streamlit application may enter a sleep state. When visiting the web application, you may need to click:

"Yes, get this app back!"

and wait a few moments for the application to restart.

Unique Particle IDs

Each particle in the dataset must have a unique identification number. These IDs are used throughout the application to perform particle-specific calculations and statistical analyses.

Processing Time

For larger datasets (approximately 100 particles or more), increasing the harmonic order may increase computation time. Wait until the **"Running"** indicator in the upper-right corner disappears before proceeding with further analyses.

Citation

If you use this software in your research, please cite:

Boribayeva, A., Sultaniyar, S., Lukmanov, I., Baigarina, A., Rojas-Solórzano, L. R., Curtis, J. S., Govender, N., & Golman, B. (2026). *Integrated characterization, classification, and quasi-3D reconstruction of highly irregular particles using multiscale shape descriptors for predictive DEM flow simulation*. Powder Technology, 122435. DOI: 10.1016/j.powtec.2026.122435