Cloud-Connected data analysis software for silicon photovoltaic cell characterization

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Introduction

- Characterization is a key step in determining the quality of experimental solar cells.
- Researchers currently use manual methods for analysis of characterization data.
- Improving the data collection and analysis process will improve throughput and data reporting accuracy.
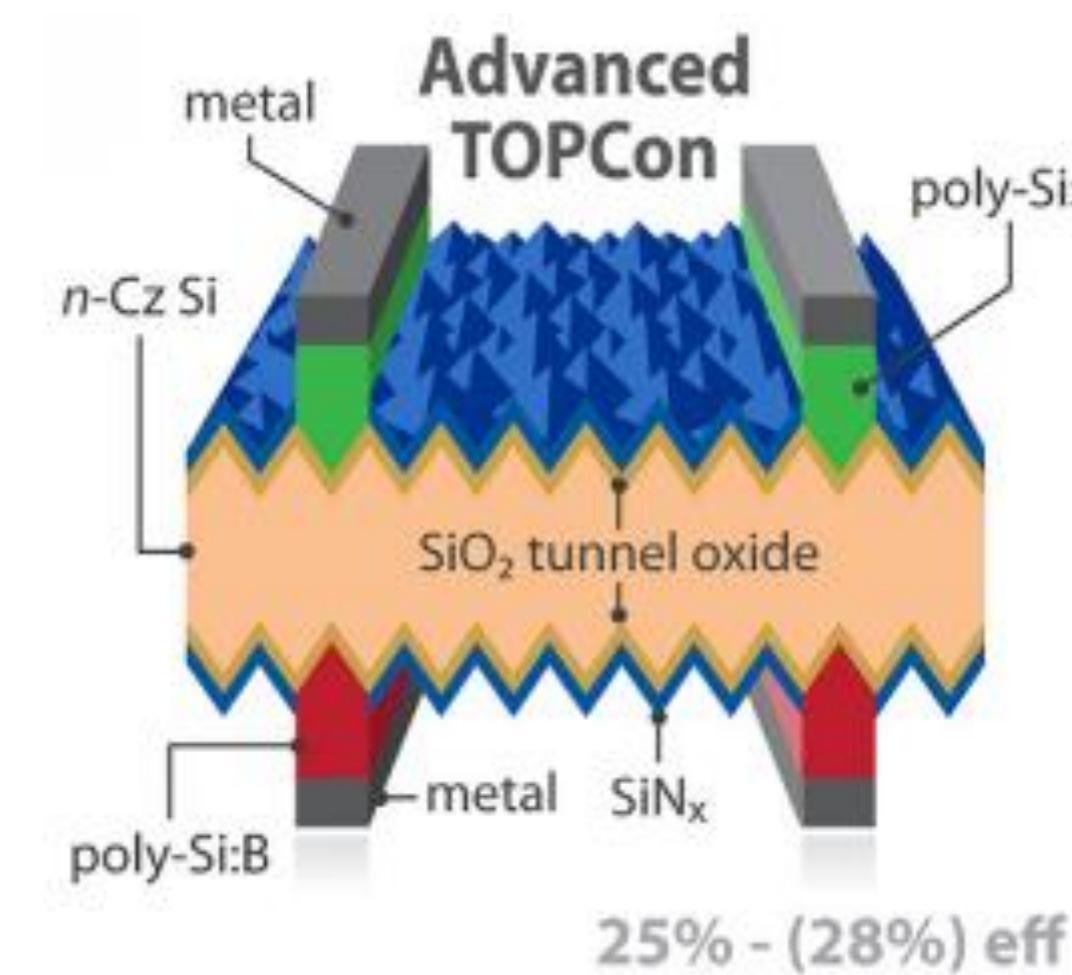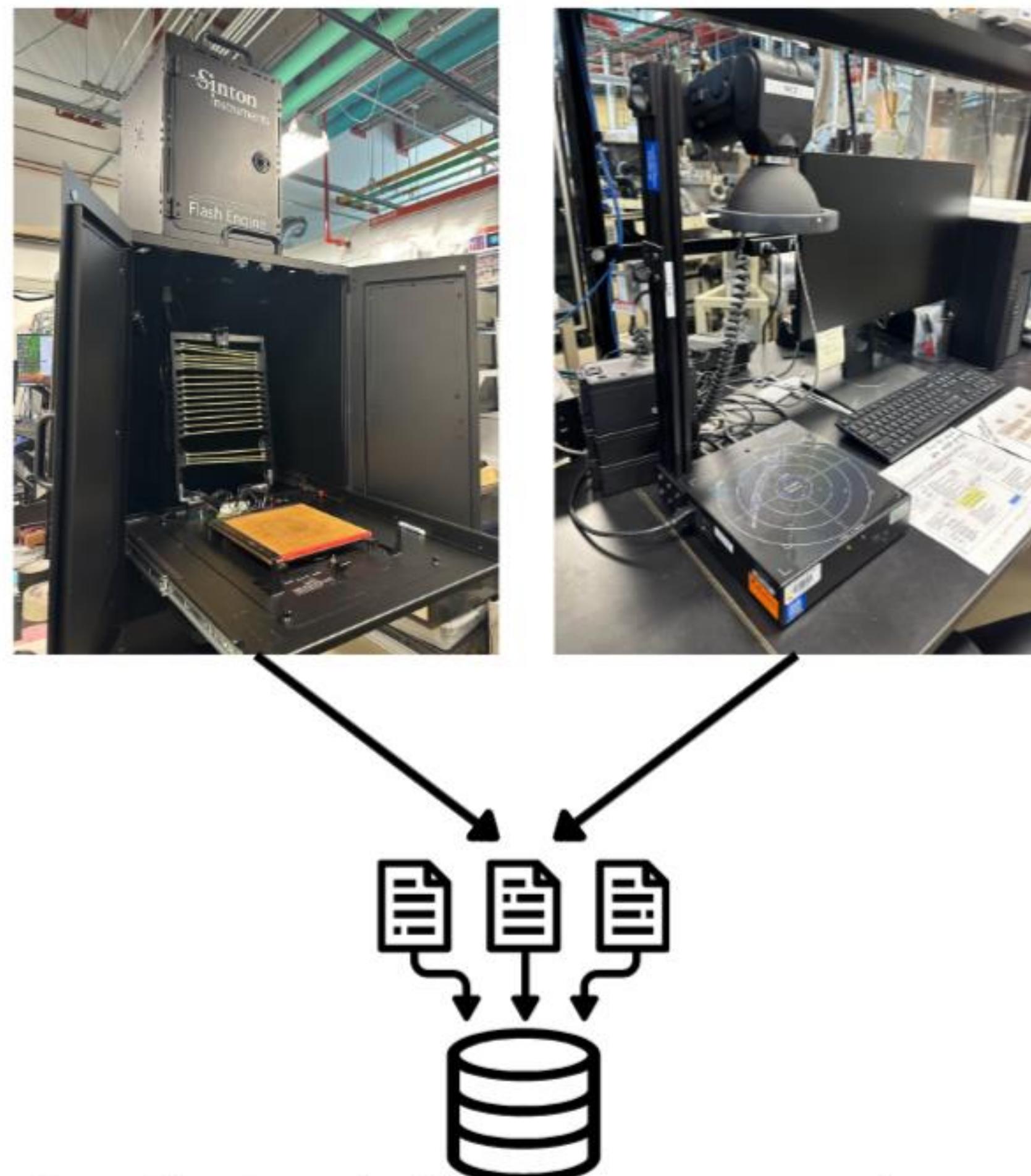

Figure 1. One of the cell types that silicon photovoltaic (PV) researchers are fabricating and testing.

Research Questions:

a) Can we design a software tool to pull data from network connected characterization tools for access on researchers personal devices?

b) Can we automate steps of the data analysis process?

Process

Step 1: Interface with lab characterization tools

Data files from the Sinton instruments are harvested to a vast cloud store.

Selected files are downloaded from the cloud store to the users local drive using the tool.

Files are read from the users local and data populates in the tool.
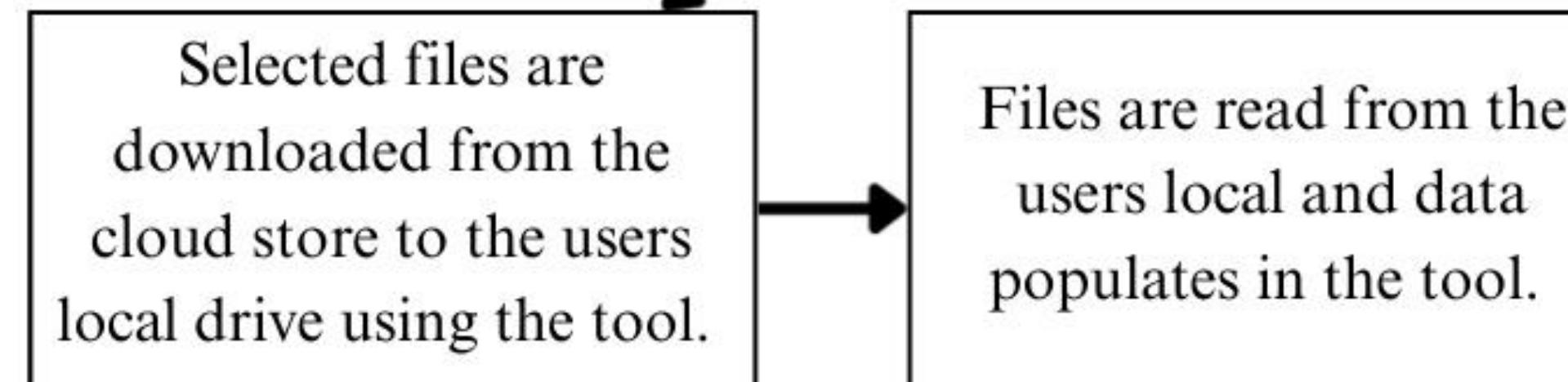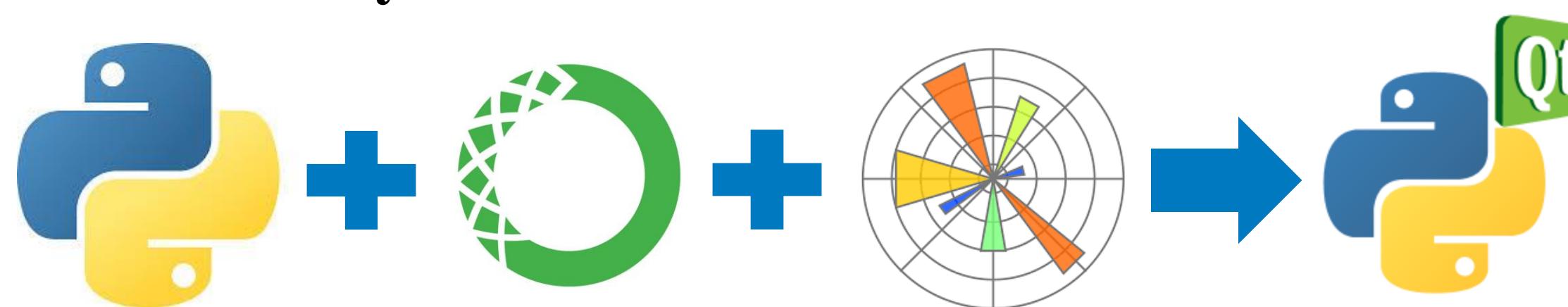
Figure 2. Data flow from characterization instruments, to cloud storage, then to the tool

Step 2: Creating data analysis scripts in an anaconda python environment to read important cell properties from data files and create plots using matplotlib.

Step 3: Linking these scripts together with a graphical user interface (GUI), allowing users to switch between files and analysis methods with ease.

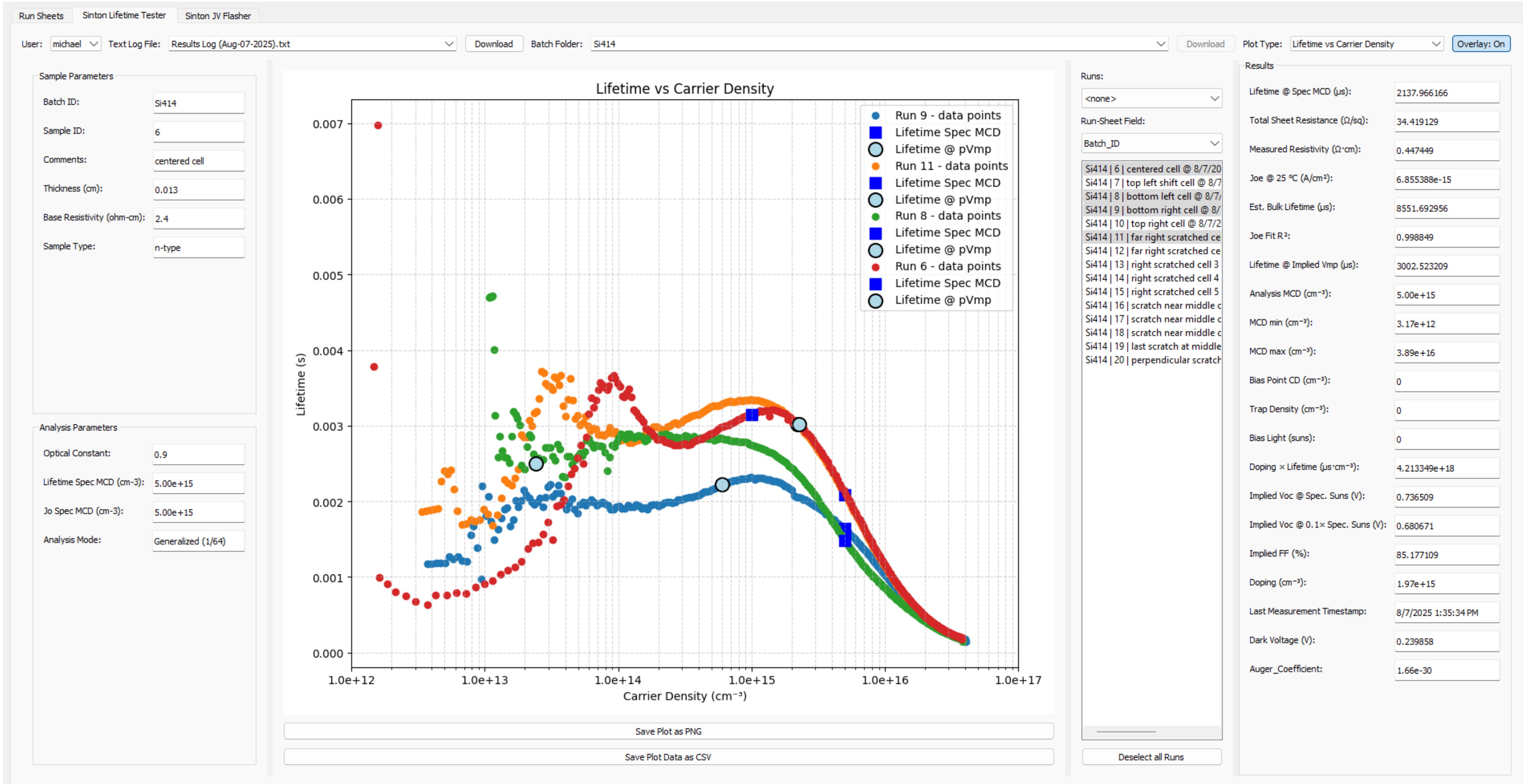## Results from developed python code

Figure 3. An example of using the Sinton lifetime data analysis page to automatically plot overlaid carrier lifetime vs carrier density data from multiple cell samples.
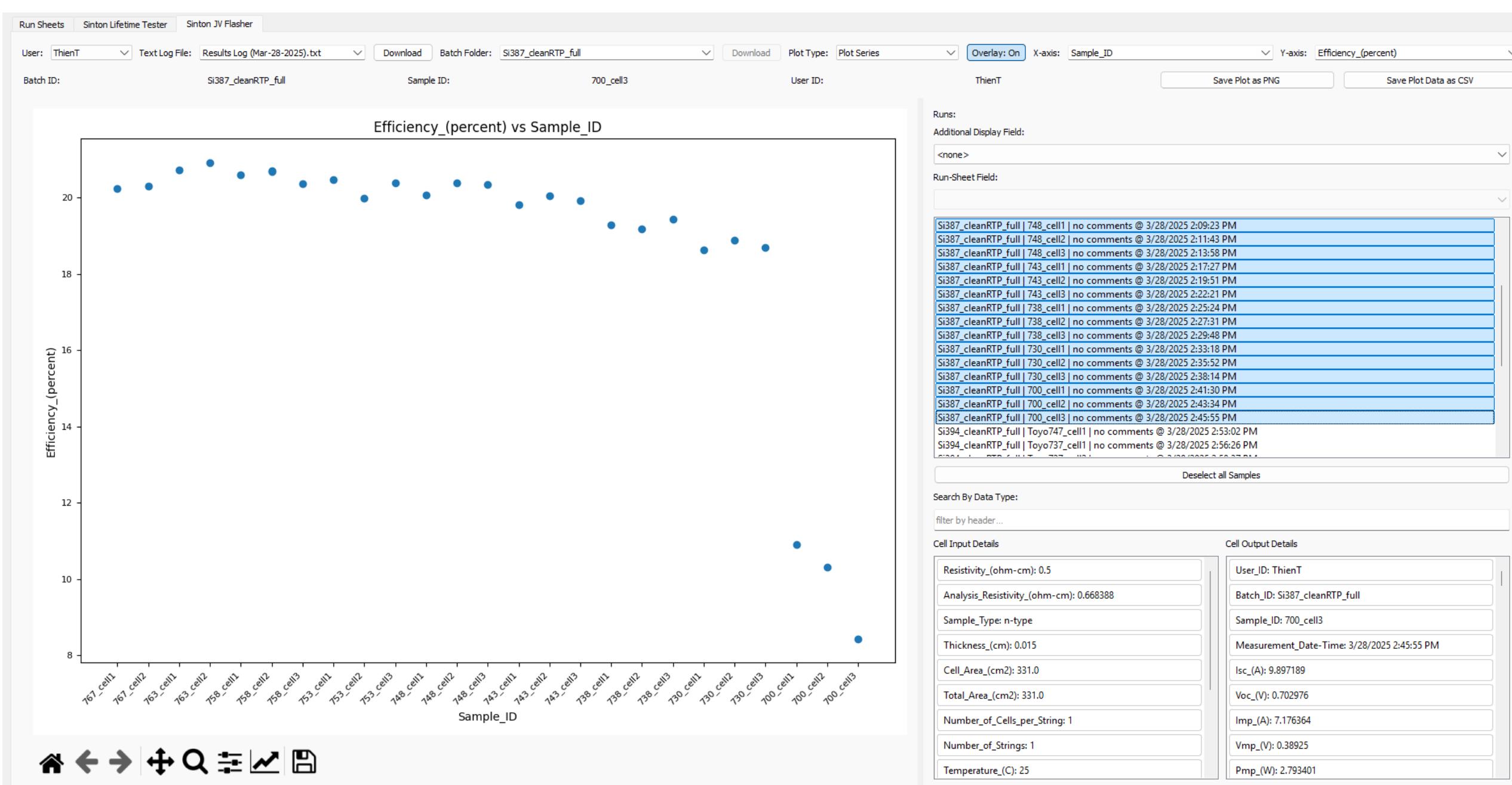

Figure 4. Series plotting allows users to plot any combination of two data variables on a scatter plot. This feature works for many samples at once.

Figure 5. Run sheets are used by researchers to organize experiments and cell fabrication steps. The tool allows users to find a run sheet, select a sample, and instantly download that sample's data for plotting and analysis.

Figure 6. The file tree created by the tool on the user's local disk drive.

Conclusions and future work

- The tool has been distributed for use and bug reporting to the silicon PV group using a package manager called UV.
- There is a lot of future work with this project:
  1. Adding machine learning (ML) features for data analysis
  2. Connecting more characterization instruments to the tool
  3. File searching by QR code scan (mobile app)

Acknowledgements

Reference:
P. Verlinden, D. L. Young, G. Xiong, M. O. Reese, L. M. Mansfield, M. Powalla, S. Paetel,   R. M. France, P. T. Chiu, and N. M. Haegel, "Photovoltaic device innovation for a solar future," Device 1, 100013 (2023).