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Automation of Historical Calibration Data Using a Python GUI

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Motivation

Background:

- The Primary Standards Laboratory (PSL) at Sandia maintains current and historical calibration data.
- The DC Lab currently stores this calibration data in Excel files.
- When new calibrations are performed, these data files must be updated, and new analyses must be computed.

Current Problem:

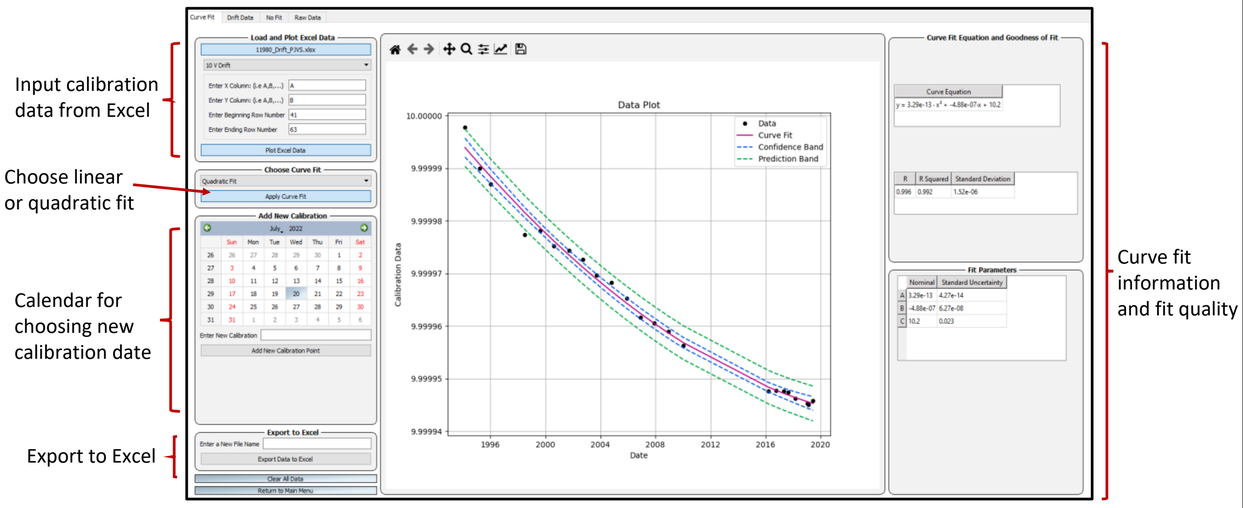
- Using Excel leads to manual entries, excess copy and pasting, and unintended errors.
- The same computations are performed for each new set of calibrations on every asset, and are entered manually. This can be tedious and time consuming.

Goal: The goal of this project was to streamline calibration data analysis by creating a user-friendly, Python-based Graphical User Interface (GUI). This GUI will help automate the computations and automatically plot the data, thus emulating the current Excel capabilities.

Results

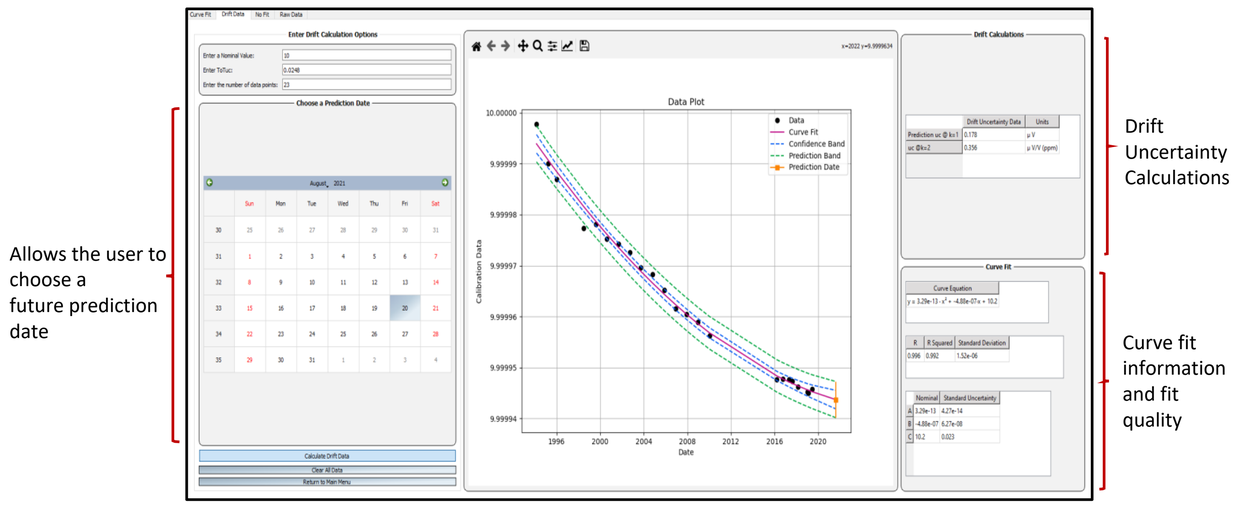
Curve Fit Tab

- Allows the user to quickly import data from Excel.
- Plots the data along with the associated curve fit, confidence band, and prediction band.[1]
- Allows the user to toggle between a quadratic and linear fit providing an easy method of determining which option provides a better fit for the data.
- Allows the user to determine if fitting a curve to the data set is a good analysis method.



Drift/Prediction Tab

- Many devices calibrated in the DC Lab will drift over time. Predicting the behavior of a device ensures that it is as accurate as possible throughout the entire interval between calibrations.
- This tab allows the user to choose a future date and provides the predicted value at that time along with the uncertainty associated with this prediction.



Approach

- Write Python code to fully automate analysis of calibration data.
- Software used:
  - Anaconda with Python 3.9
  - Python's PyQt5 package for creating the GUI
  - Matplotlib to handle graphing
  - SciPy to compute the curve fit calculations

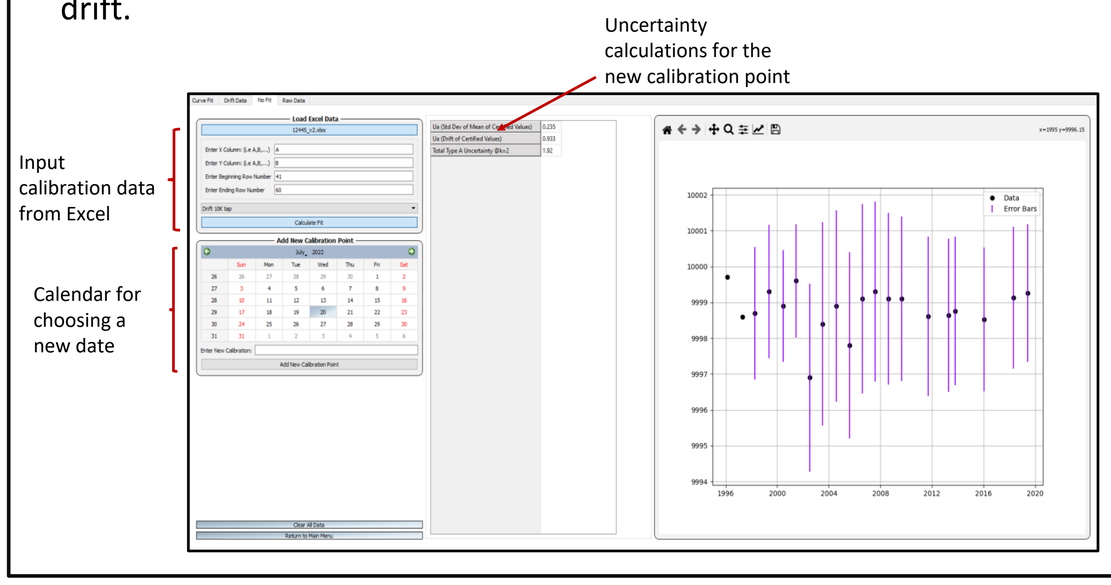
Challenging Aspects

- Minimizing effort and input by the user while still maintaining the program's flexibility was one of the most interesting difficulties.
- Transporting data across different excel files needs to be performed with care to avoid overwriting previous data or corrupting the file.
- The curve fit, confidence band, and prediction band calculations and plots frequently broke.
- Handling sets of dates presented many problems. Not all functions and packages handle dates the same way.
- The Anaconda platform for Python needs to be set up very carefully to work properly.

Results

No Fit Tab

- Some data sets are too small or too noisy to fit a curve. This tab allows users to still perform some analyses of these types of data sets.
- When a new calibration is added, the shift from the previous calibration and the mean of the entire set of calibrations is computed. The root sum square of the set of means and set of shifts' standard deviations are computed to obtain the new calibration point's total uncertainty.
- This analysis option is instrumental when analyzing data sets with no obvious drift.



Conclusion

- The Python GUI was developed using DC voltage standard (zener) calibration files in the DC Lab. The GUI fully automates historical data analysis and inputs new calibration data. Curve fit options have been implemented and uncertainties calculated.

Future Work

- The GUI will be modified to include full automation of high voltage and resistance calibration data.

References:

1. Crowder, S., Delker, C., Forrest, E., & Martin, N. (2020). *Introduction to Statistics in Metrology.* Springer.

Acknowledgements:

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