

Development of Python-Based Software for Remote Time and Frequency Standard Calibration In Indonesia

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INTRODUCTION

As a direct realization of the second, cesium atomic clocks are used as local frequency standards not only for calibration purposes but also for time signal dissemination in disaster systems and telecommunications. The SNSU Time and Frequency Laboratory, as the National Metrology Institute (NMI), manages the primary time and frequency standards in Indonesia and has begun developing calibration services for cesium atomic clocks to meet domestic needs.

SYSTEM OVERVIEW

Cesium Atomic Clock calibration can be performed using the common-view method. This method allows calibration to be conducted remotely without the need to ship the artifact. It involves comparing the GNSS Time values to the cesium atomic clock, referred to as RefSys, between the standard and the Unit Under Calibration (UUC). The RefSys values are obtained from a file called CGGTTS. Previously, the remote calibration algorithm for cesium atomic clocks has been developed in Indonesia. To analyze this extensive data, specialized software needs to be developed.

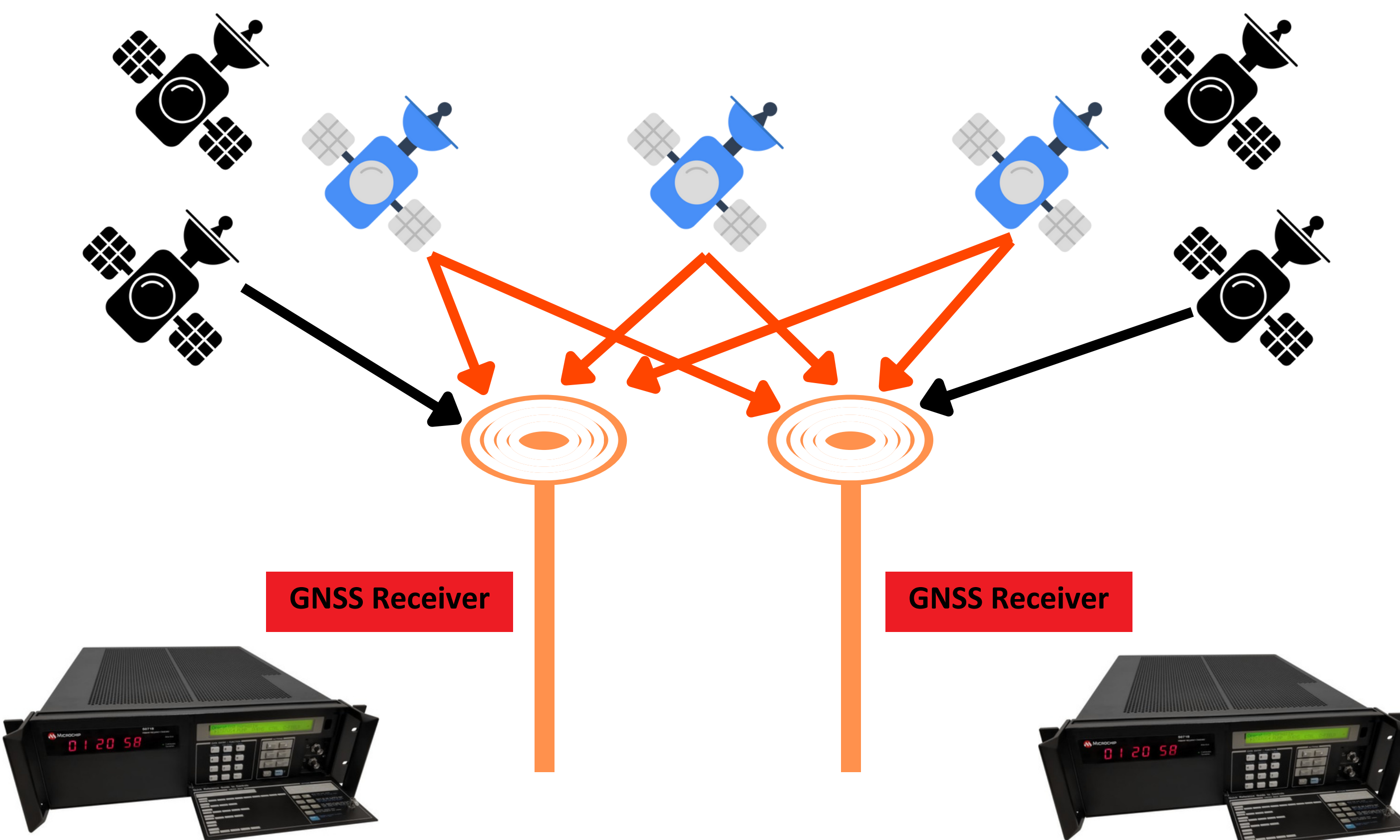


Fig 1. Common-view Method Illustration

SYSTEM OVERVIEW

The software has been successfully developed to analyze CGGTTS data using the common-view method. Users simply need to place all Standard and UUC files into their respective folders.

Then, within the software, users select the folder containing the CGGTTS files. Next, they choose the CGGTTS files to be analyzed for each UUC and Standard. The user inputs the first Modified Julian Date (MJD) to be analyzed, and for subsequent analyses, the date will automatically update. By clicking "Analyze," the program processes the data according to the designed algorithm. This process can be repeated for other CGGTTS files, and when complete, users can click "Done". The software will generate a Microsoft Excel file containing all the analysis data, step-by-step details, and a summary of the analysis. The software's user interface is shown in Figure 2.

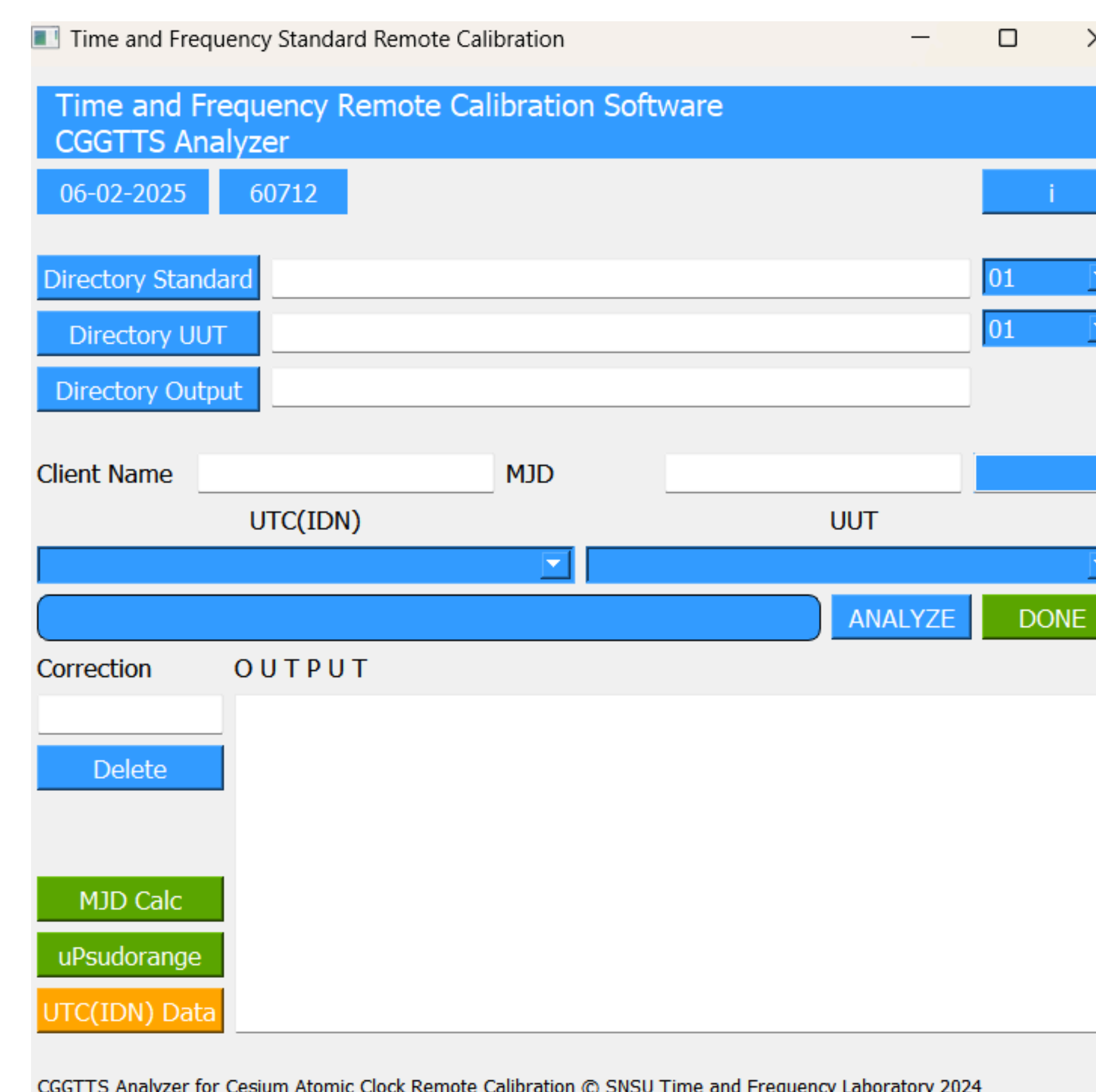


Fig 2. Remote Time and Frequency Calibration Software User Interface

The software algorithm is as follows:

- Read the values of SAT/PRN, STTIME, and REFSYS from each CGGTTS file for both the Standard and UUC.
- Correct the Standard RefSys values using the Circular-T values obtained via the BIPM Circular-T API.
- Multiply the SAT/PRN value by the STTIME value to generate the RefVal. Then, the REFSYS values will be sorted based on the RefVal.
- Matching RefVal values from the Standard and UUC will be aligned, while non-matching values, along with their corresponding REFSYS values, will be removed.
- Calculate the common-view difference values.

The software also includes additional features, such as a date converter between MJD and Gregorian formats and a pseudorange uncertainty calculator based on the data from the Standard CGGTTS file.

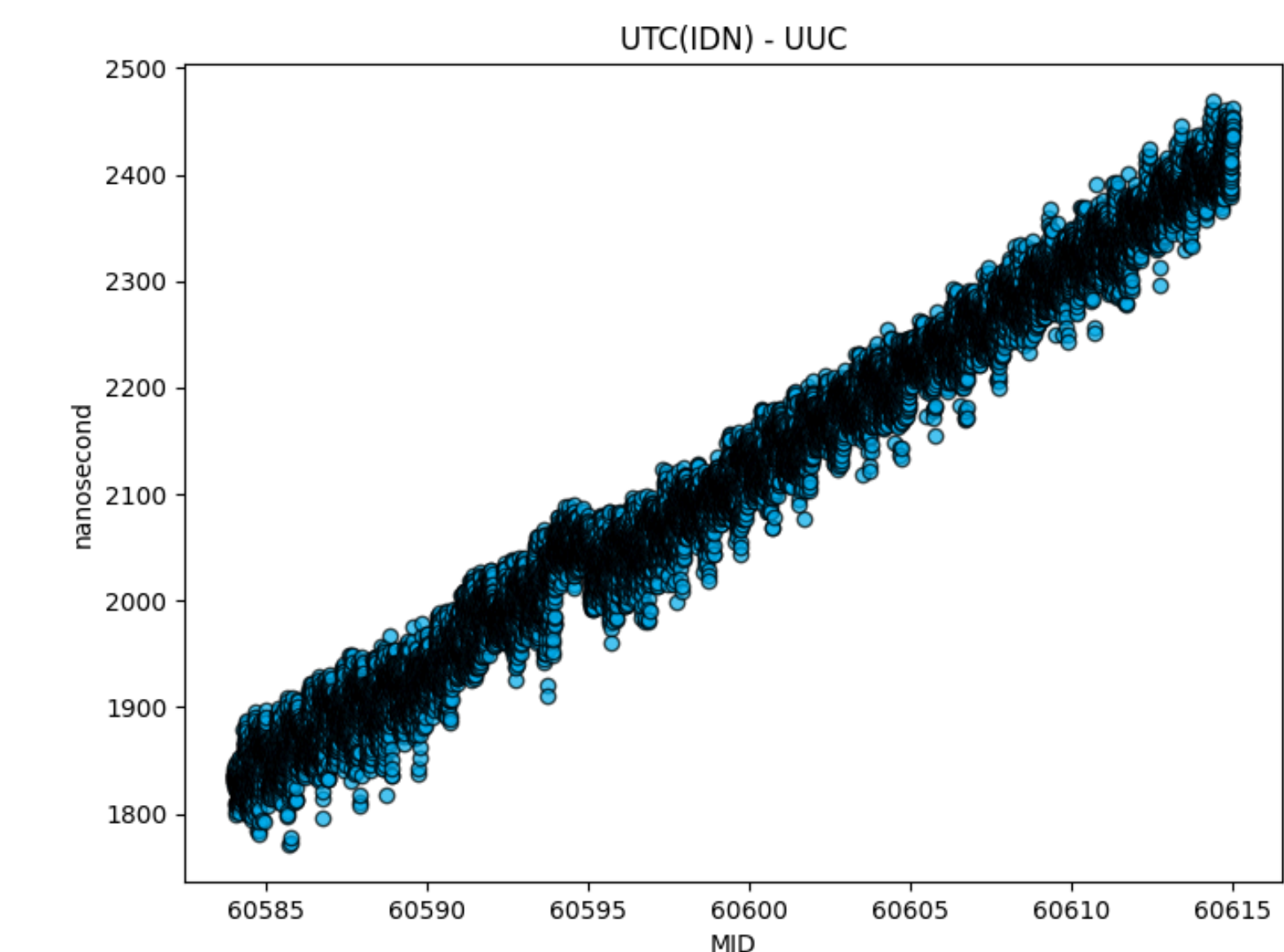


Fig 3. Graph Result

FUTURE DEVELOPMENT

A system capable of analyzing CGGTTS and TXT file types will soon be developed to simplify data analysis while maintaining data quality and originality. This system will also be designed to analyze all data from an entire month with a single click and to automatically detect the version of CGGTTS data. Additionally, features for detecting time steps or value jumps will be included to support calibration result analysis.. This system will further enable faster and more efficient distribution of calibration results.

CONCLUSION

The software's proficiency in analyzing CGGTTS files on multiple devices under test supports its efficacy in practical applications, affirming its role as a dependable tool for data analysis in relevant fields. The developed software is capable of performing correction calculations in the remote calibration of cesium atomic clocks using the common view method effectively. This software is ready to be used in calibration services.

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