



Clock data checking

Yuko Hanado (Retired NICT, Japan)





Table of contents

BIPM Summer School:
"Clock data checking"
September 11, 2025.

1. Does the data show true clock quality?
2. Tips for detecting bad data
3. Summary and important note



1. Does the data show true clock quality?

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■ Why is the data checking so important?

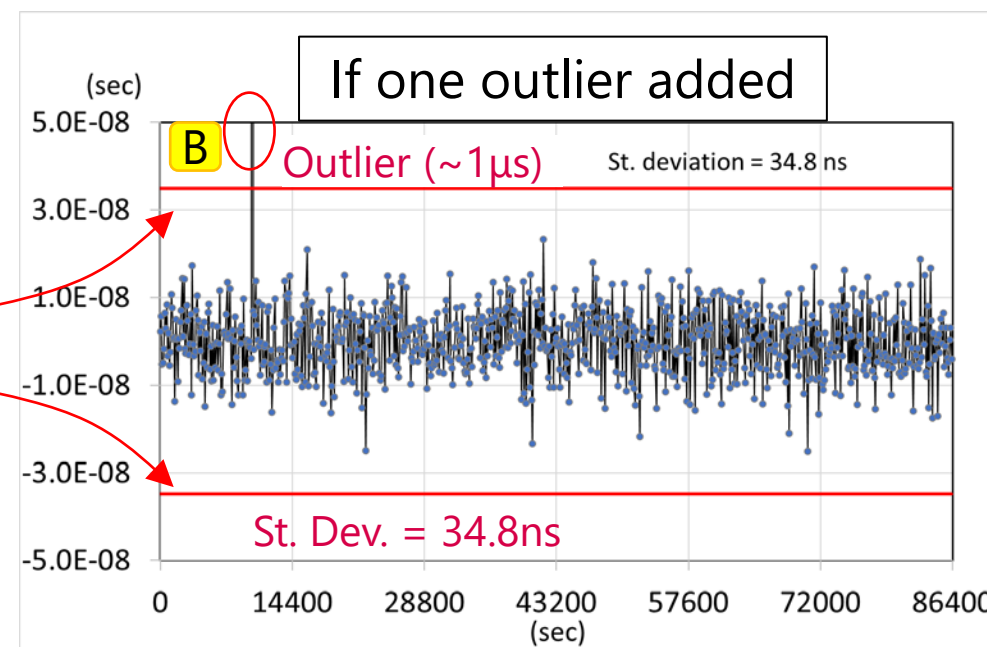
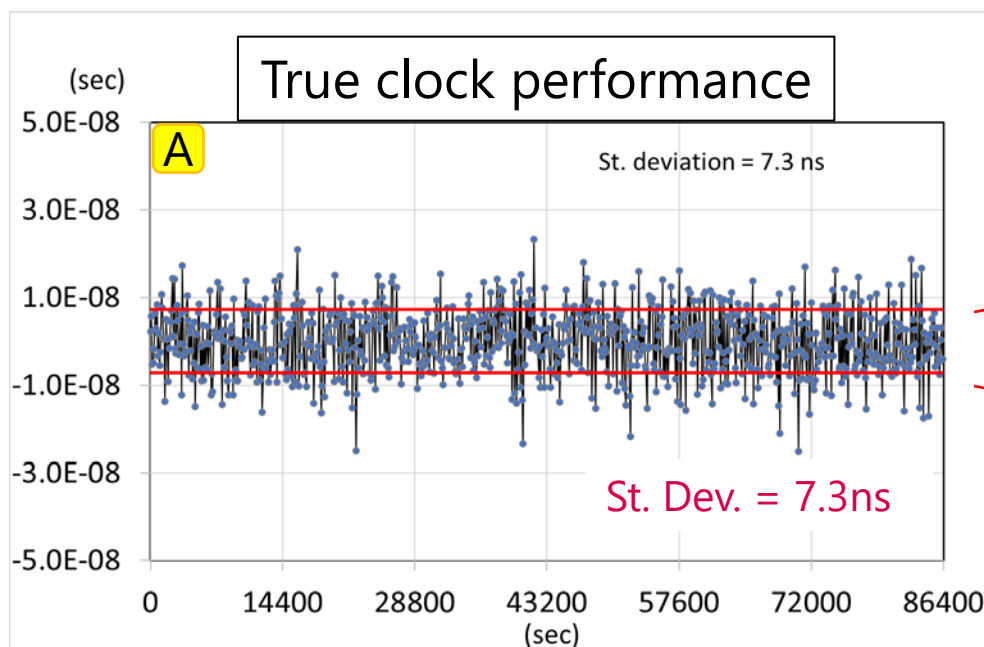
← Because, bad data added at the measurement may mask the actual quality of your clocks.

- Example-1: Degraded evaluation due to outliers
- Example-2: Overlooking outliers due to a large slope
- Example-3: Overlooking abnormal trend masked by large noise

1. Does the data show true clock quality?

● Example-1: Degraded evaluation due to outliers

- If outliers (usually due to the instrumental trouble) are included, the standard deviation may look worse than true performance of the clock.

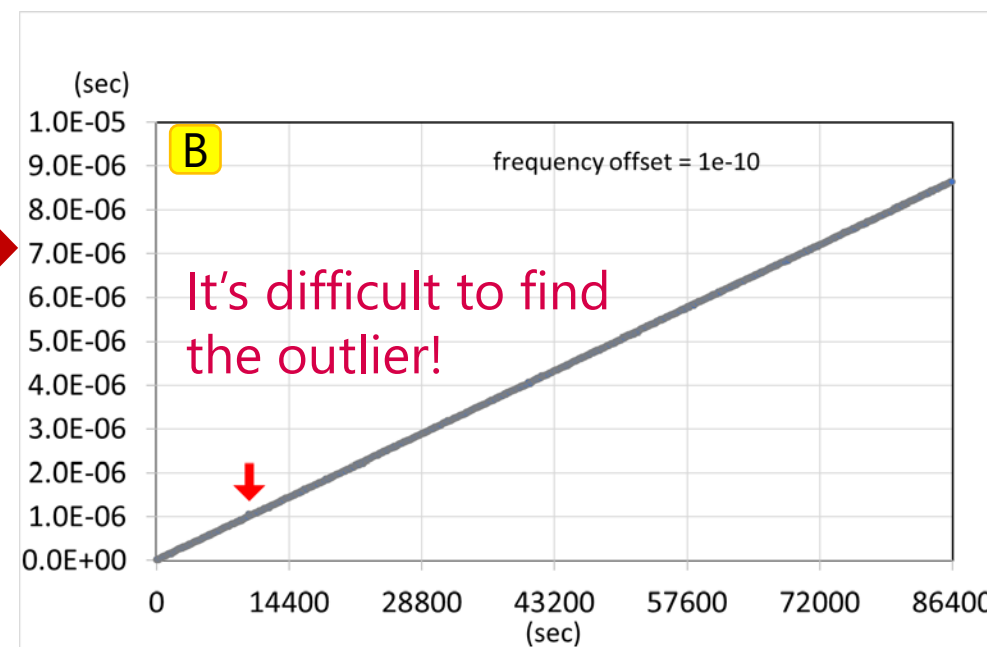
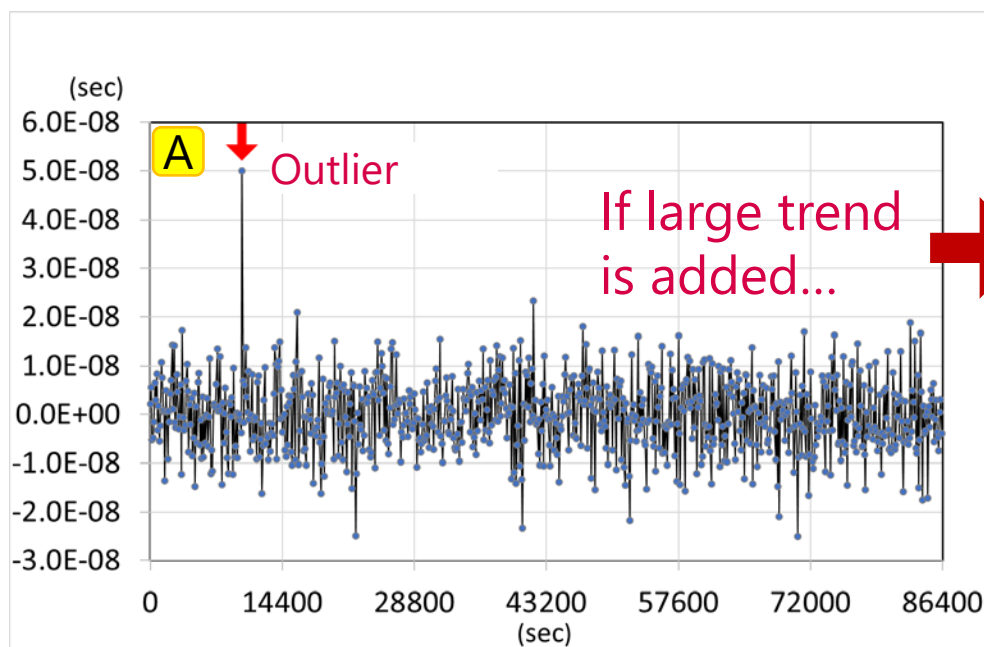




1. Does the data show true clock quality?

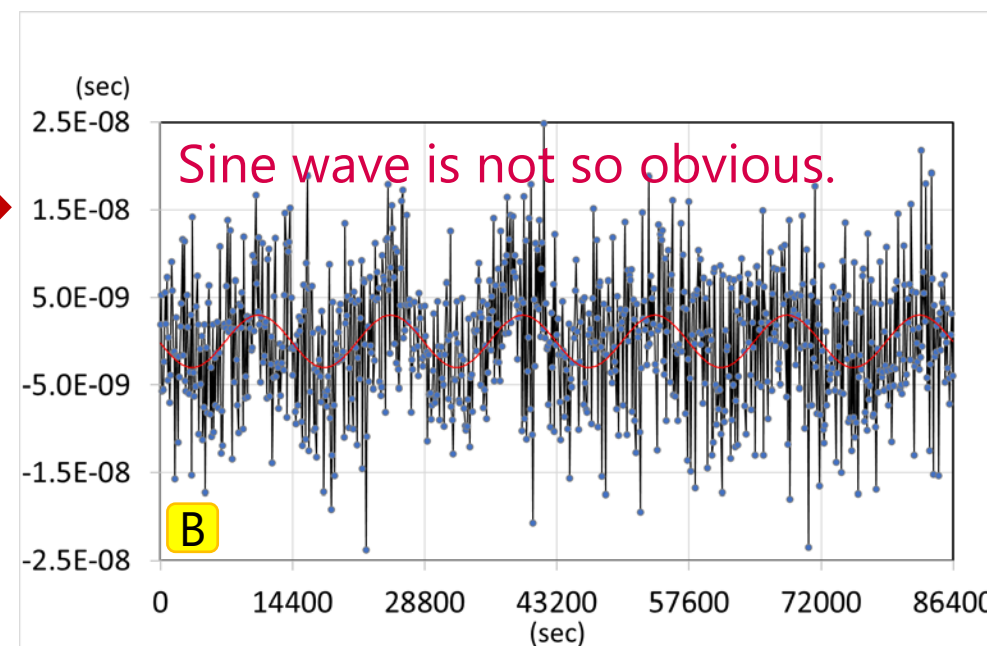
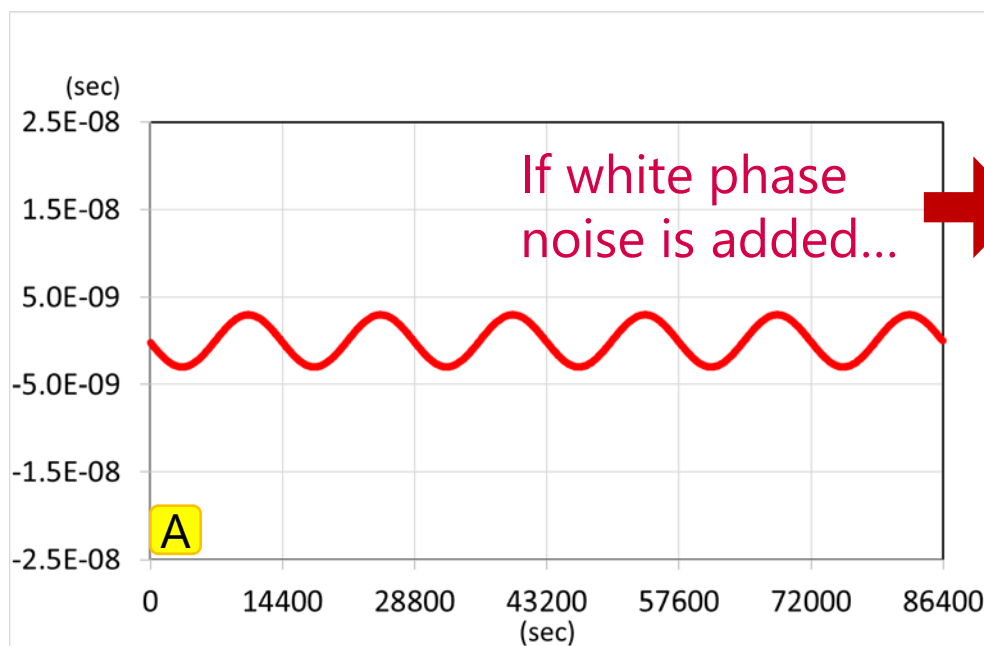
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- Example-2: Overlooking outliers due to a large slope
 - If a large trend exists in addition, outliers are hidden so that we overlook them.



1. Does the data show true clock quality?

- Example-3: Overlooking abnormal trend masked by large noise
 - Inversely, systematic trends are hidden in the noise.
 - ✂ Air conditioner and AC noise may add such periodic trend.



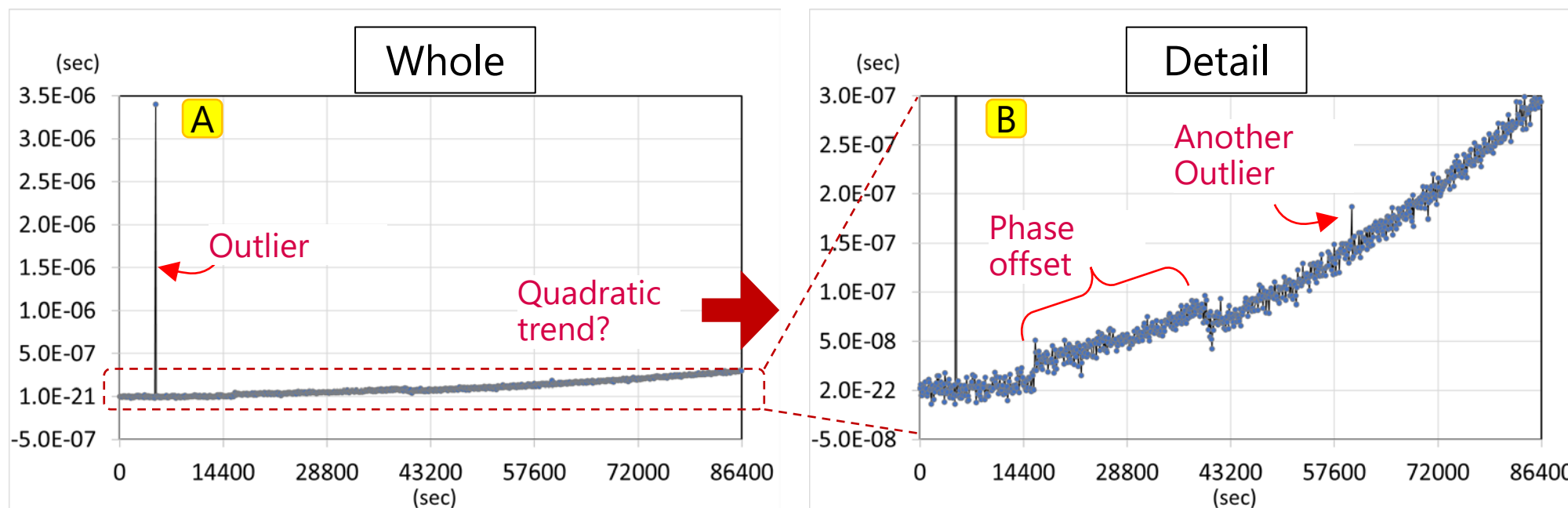


2. Tips for detecting bad data

- Several simple methods for checking the clock data:
 - Tip-1: plotting the whole data set + zooming the scale,
 - Tip-2: Removing evident trends,
 - Tip-3: Smoothing (moving average),
 - Tip-4: Checking the continuity of data sampling,
 - Tip-5: Checking the distribution of sampled data.

2. Tips for detecting bad data

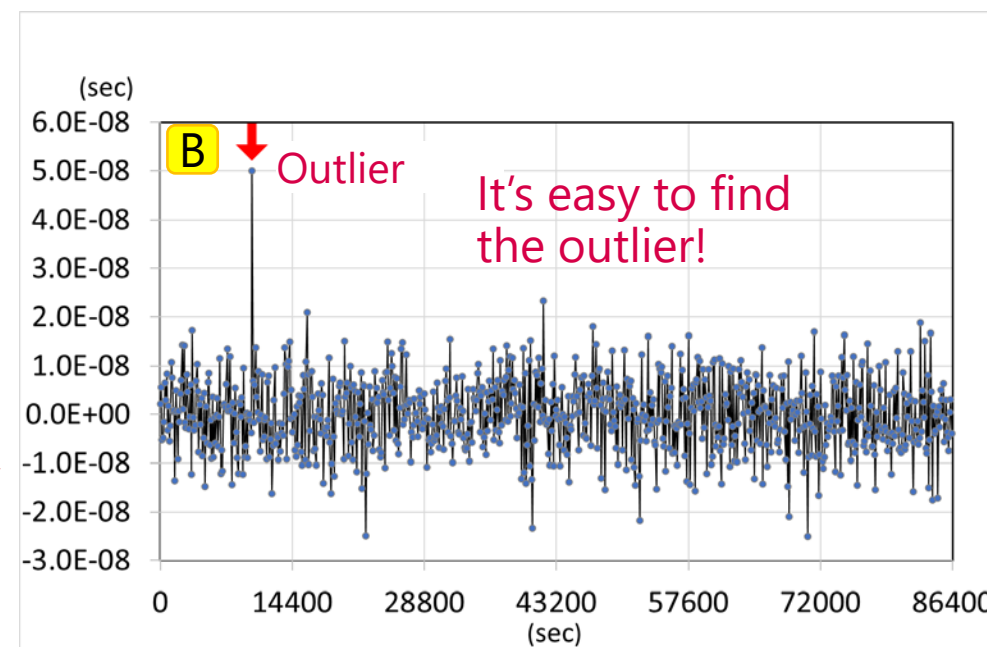
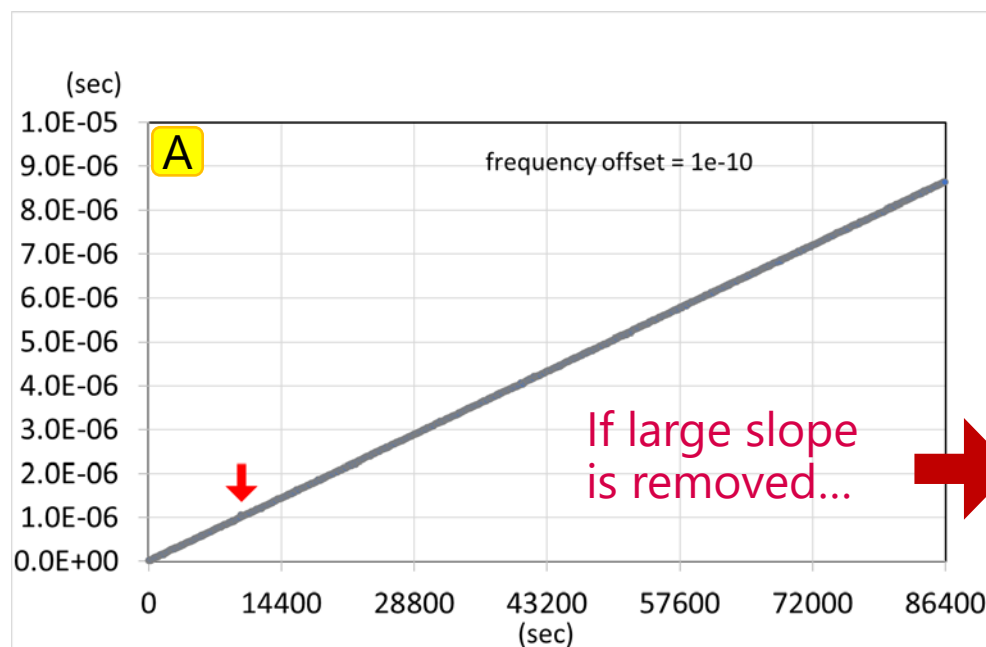
- Tip-1: Plotting the whole data set + zooming the scale
 - Plotting the whole data set is effective for grasping general tendency.
 - In addition, let's expand the scale and check the detail.



2. Tips for detecting bad data

- Tip-2: Removing evident trends

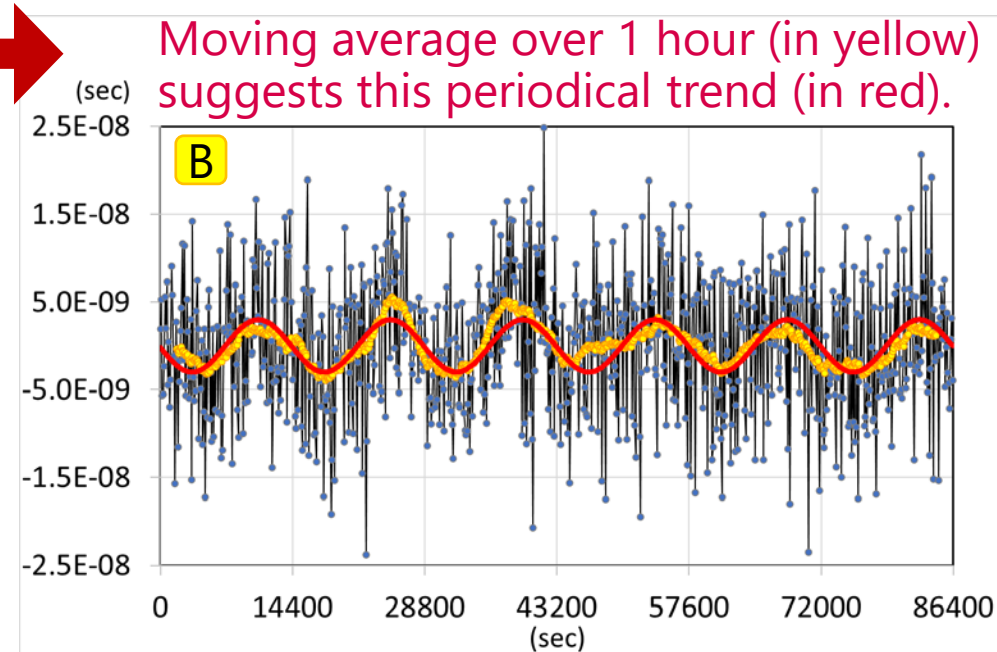
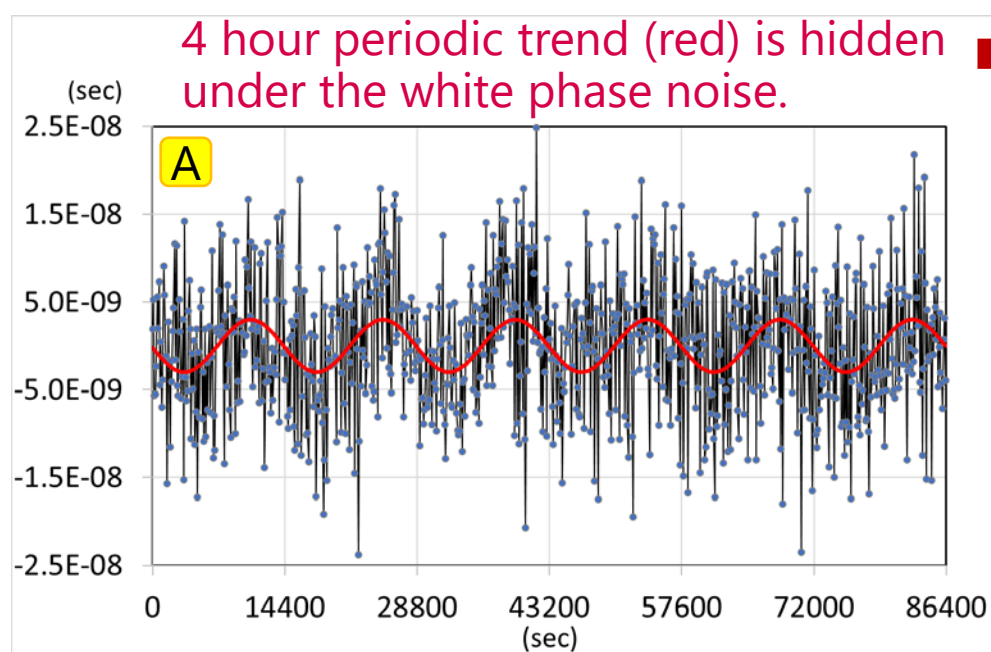
- Removing an evident trend helps to detect outliers or small other trends.



2. Tips for detecting bad data

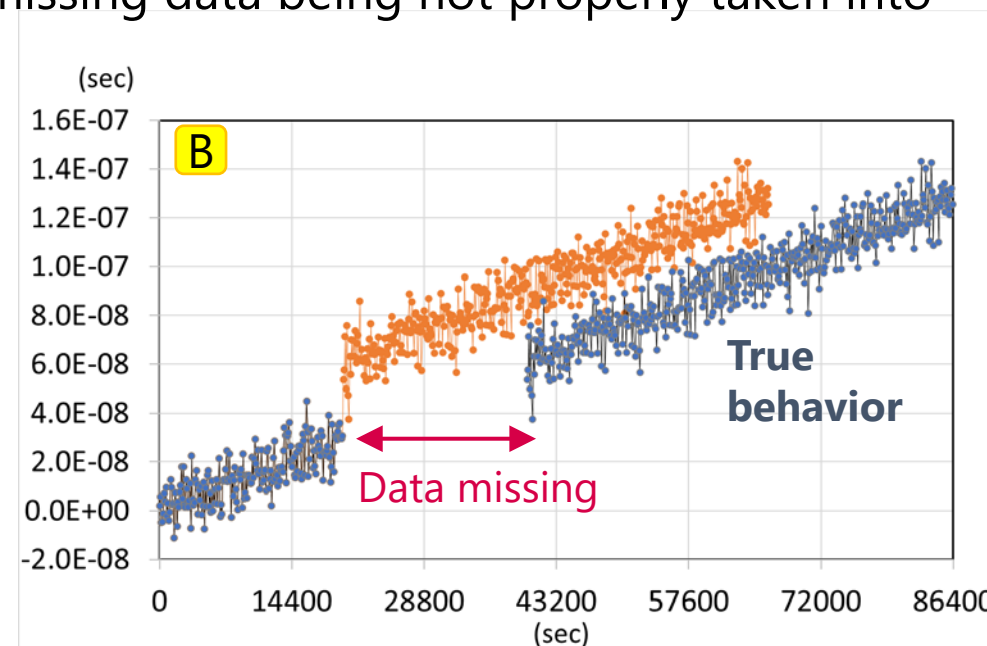
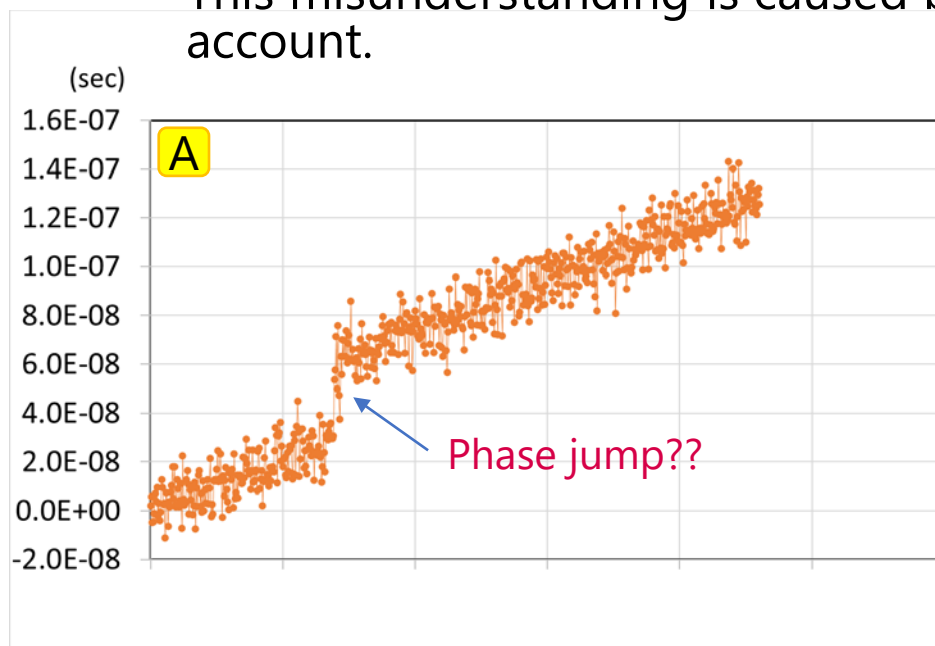
- Tip-3: Smoothing (moving averaging)

- Moving average helps to detect a long-term trend.
 - ✂ Note that fluctuations shorter than the average interval are not visible.



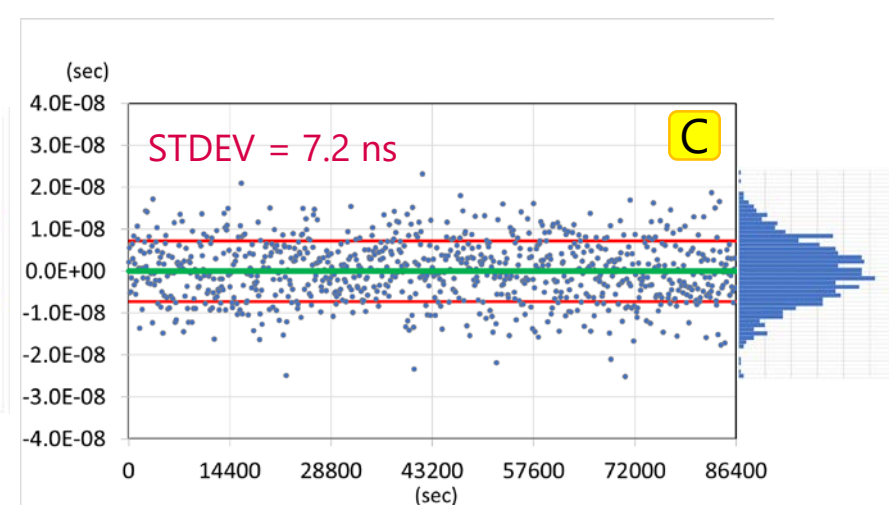
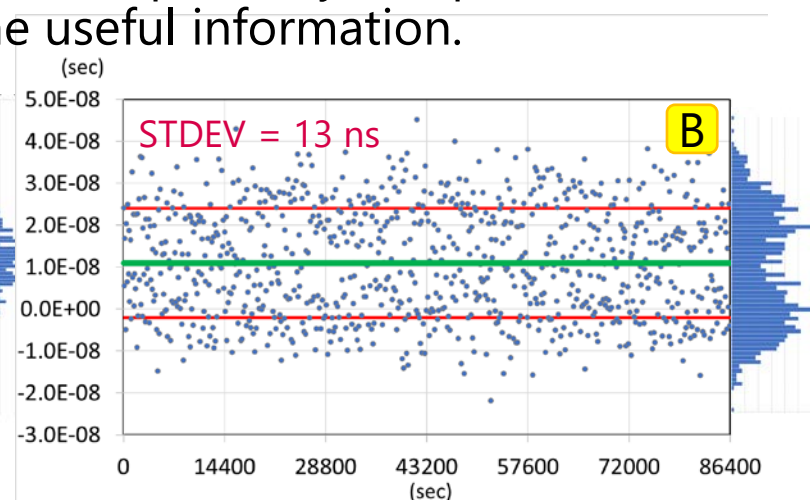
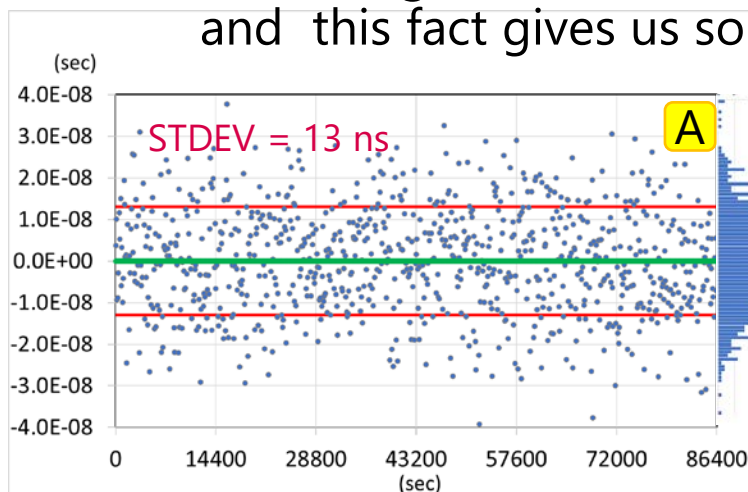
2. Tips for detecting bad data

- Tip-4: Checking the continuity of sampling duration
 - Overlooking of missing data can create false discontinuity of the data.
 - In (A), there seems to be a phase jump, but it is a misunderstanding due to the absence of correct time stamping.
 - This misunderstanding is caused by missing data being not properly taken into account.



2. Tips for detecting bad data

- Tip-5: Checking the distribution of sampled data
 - Abnormal data distribution may identify some troubles in the process.
 - (A) and (B) show the same standard deviation, but **the data distributions are different**.
 - In fact, plot (B) is the result of occasional phase jumps of 20ns has been occurred in the C data. If without such 20ns phase jump in (B), the true clock performance would be like (C).
 - However, it is difficult to know that from the plot and STDEV only.
 - Observing the distribution of (B) precisely, the peak offset around 20 ns can be seen, and this fact gives us some useful information.





3. Summary and important note

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- Data checking is so important to know the true condition of your data.
- Several tips can be used for detecting bad data or strange behavior.
- Data checking may help to improve your UTC(k) time scale and the data submitted for UTC.
- If anomalies are detected, please investigate their origin and try to remove the originating cause.
 - Bad data tell you so much information of the systems!
- It's not recommended to only remove bad data.
 - If the anomalies are due to system trouble, other future measurement data may include other anomalies. In such a case, removing the spotted bad data may not be enough.
 - Please check the origin of anomalies and judge how to treat the data.



Thank you very much
for your kind attention!

To get points, please try the exercise
with the related Python tool!

