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# Development of Omni-SLR System: (3) Timing/software subsystem

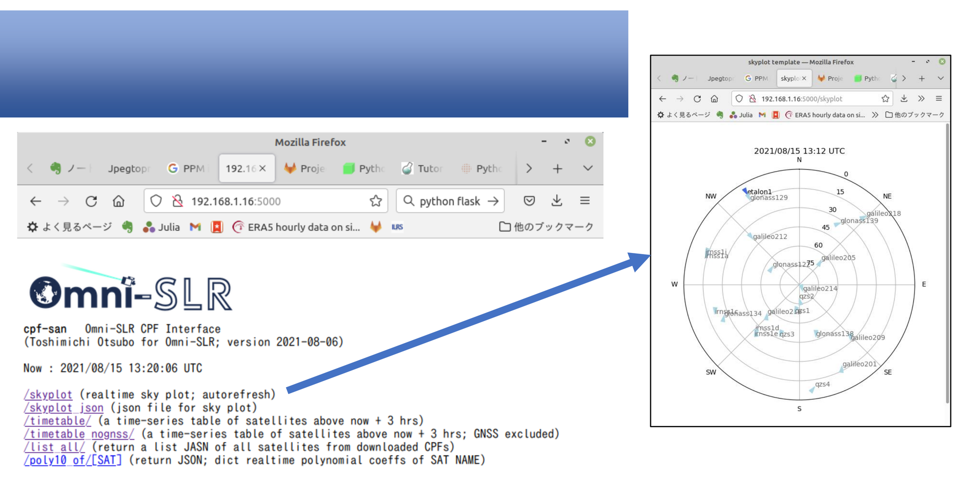
Yusuke Yokota (1), Toshimichi Otsubo (2), Hiroshi Araki (3),
Takehiro Matsumoto (4) and Kenji Kouno (1)

(1) Institute of Industrial Science, University of Tokyo, Japan,
(2) Hitotsubashi University, Kunitachi, Japan, (3) NAOJ, Mitaka, Japan, (4) JAXA, Tsukuba, Japan

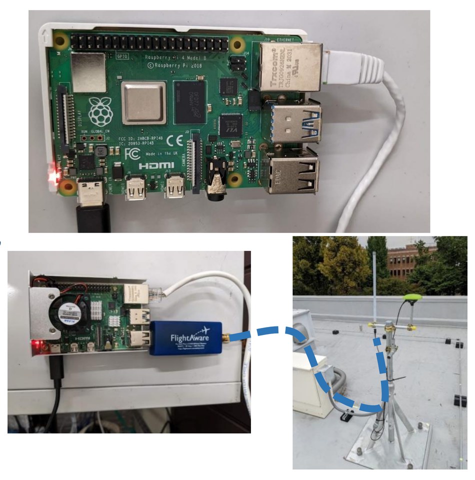
## Graphic & Control

**Development goals**

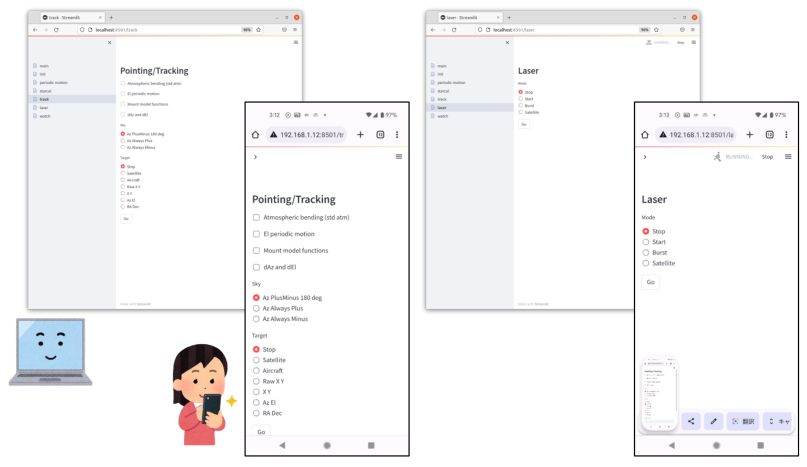
- **Distributed system**
- **Low electric power**



- Small tasks assigned to Raspberry Pis "*-san"
  "cpf-san": downloading and processing CPF predictions
  "adsb-san" (with FlightAware dongle): monitoring realtime air traffic
  "laser-san": generating trigger signals for CRYLAS laser
  "gps-san": monitoring Jackson-lab GNSS receiver
  "mets-san": collecting meteorological data from Vaisala barometer etc
- Communications with Raspberry Pis
  House-made web-tool using Flask
  Simple user interface via browsers
  Two-way data/command flow



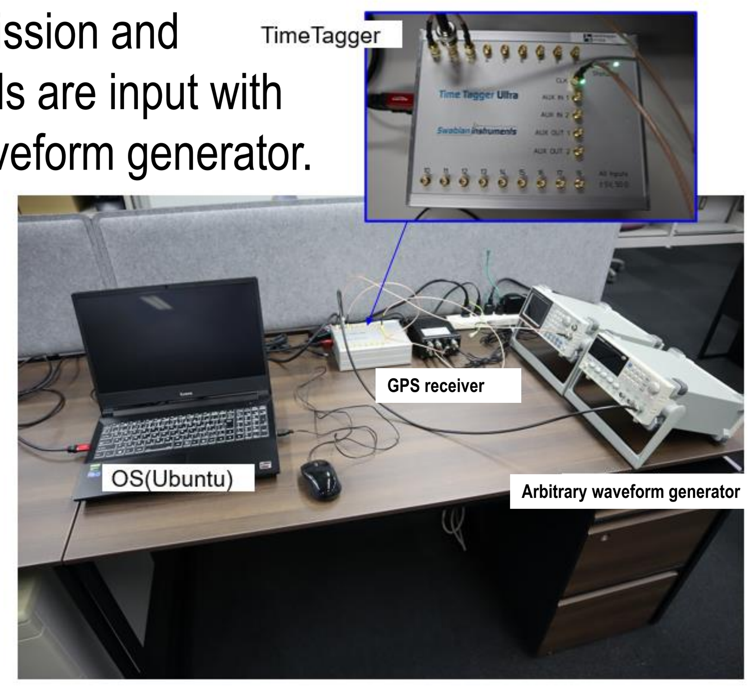

It is a policy to build all basic software with python. The GUI and controller by Streamlit can be handled on PCs and smartphones.



## Timing system

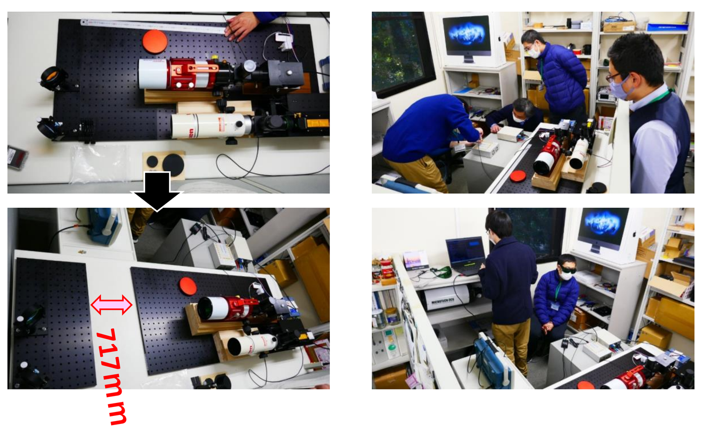
Timing is measured by Swabian Instrument's Time Tagger Ultra.
It is about 2 million yen, and it is cheap, but the handling method for SLR is not established, so it is newly developed.

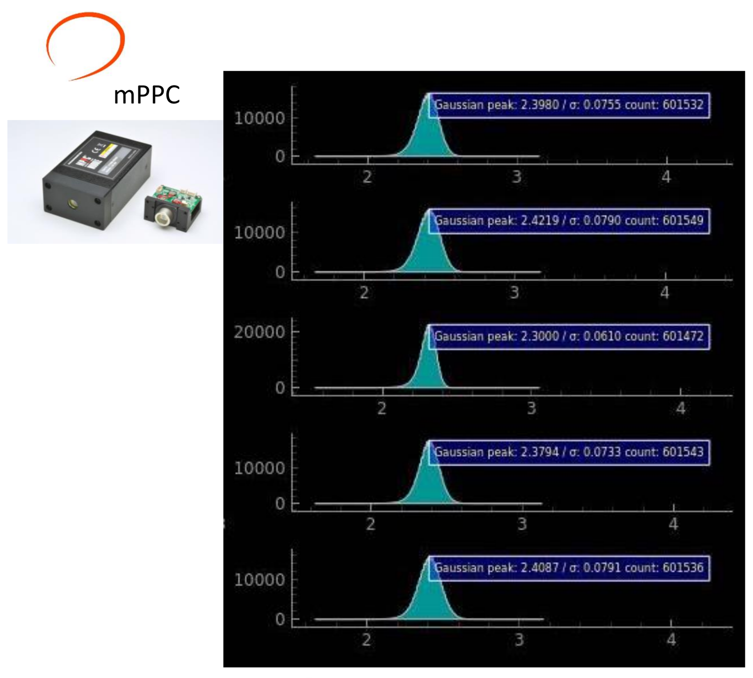
Pseudo transmission and reception signals are input with an arbitrary waveform generator.



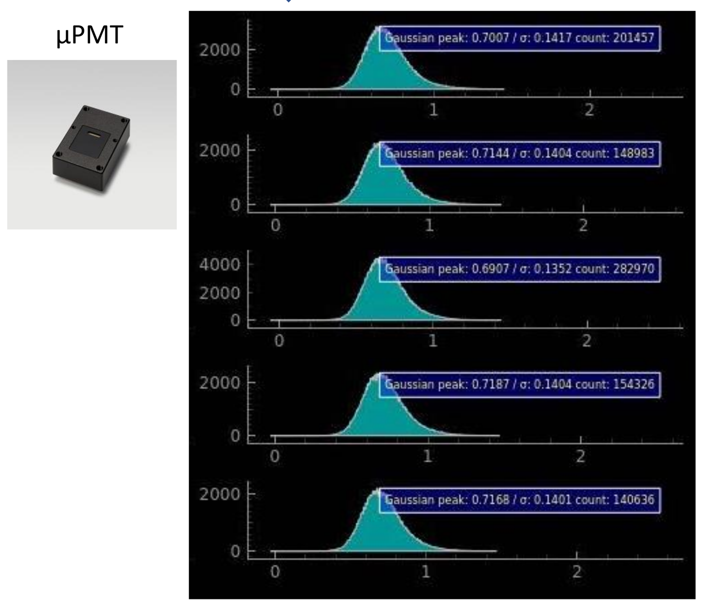

## Detector test

The feasibility of the optical system was confirmed by a range finding test for an indoor target. We also investigated detectors and confirmed that Hamamatsu Photonics mPPC was superior to μPMT in terms of variability and accuracy of detection timing.



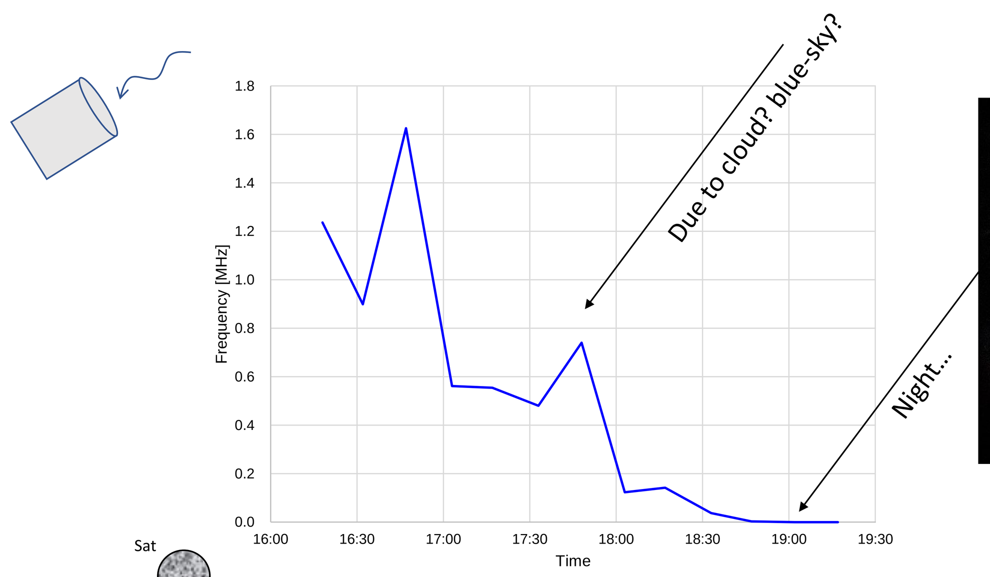



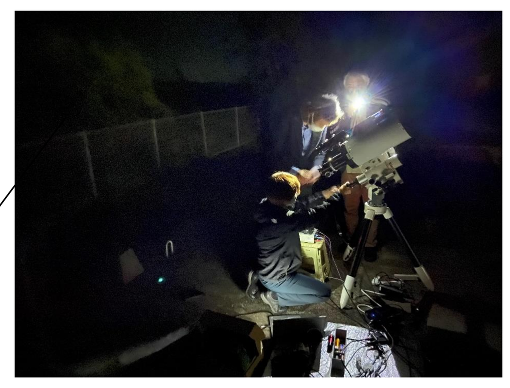

RMS = about 7cm

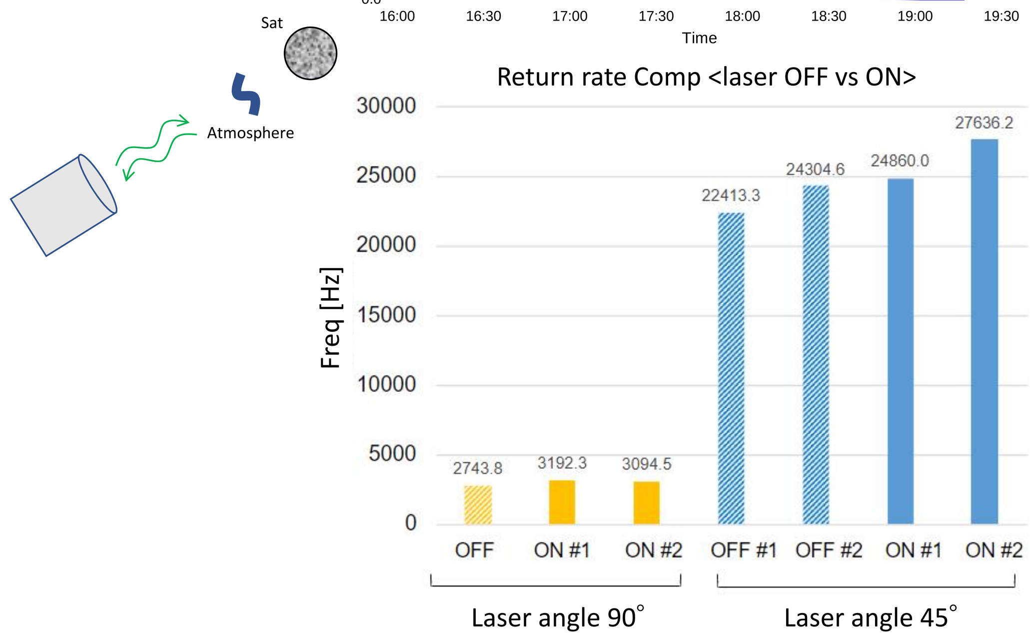



RMS = about 14cm

## Background noise & Atmospheric reflection



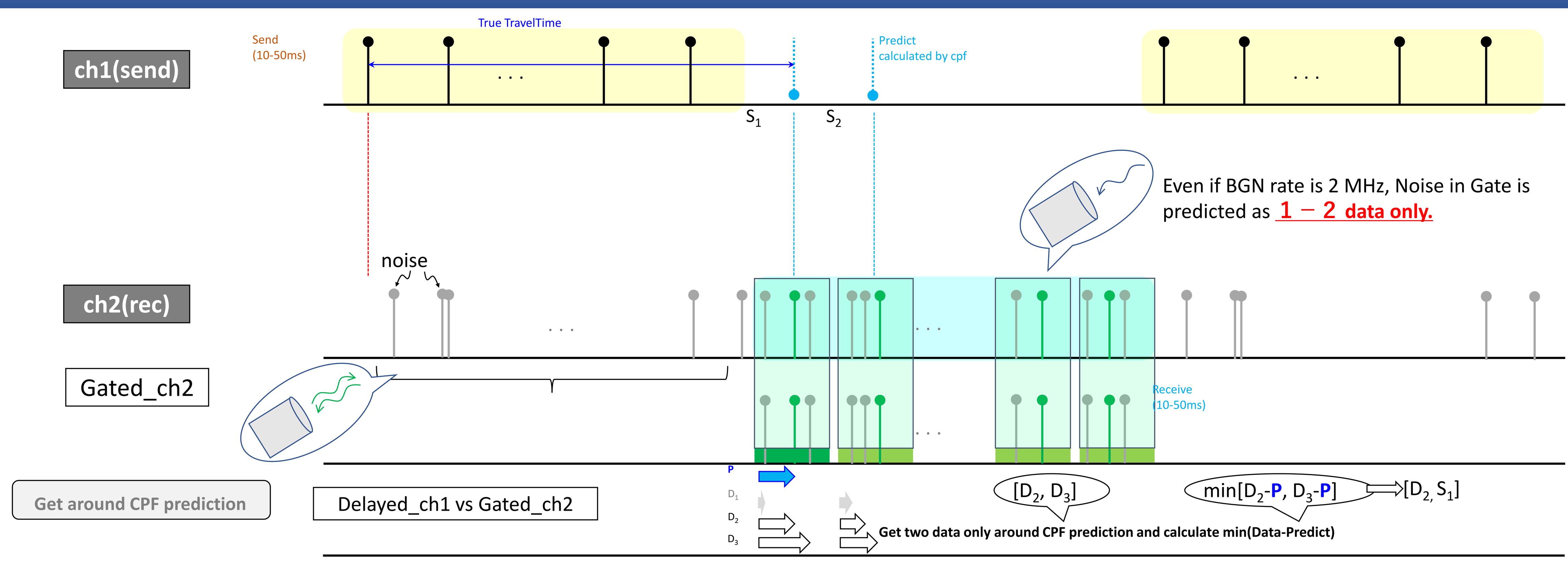






How much does Omni-SLR receive background noise (BGN)? We observed BGN (upper graph; ND5 filtering). Also, atmospheric reflection was observed and is believed not to be main noise source (bottom graph).

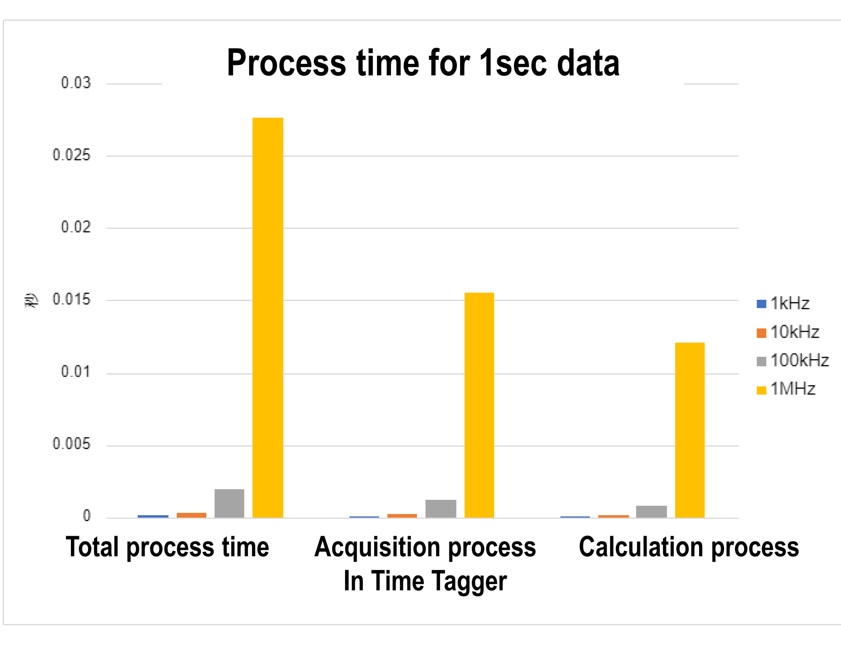
## Timing data acquisition

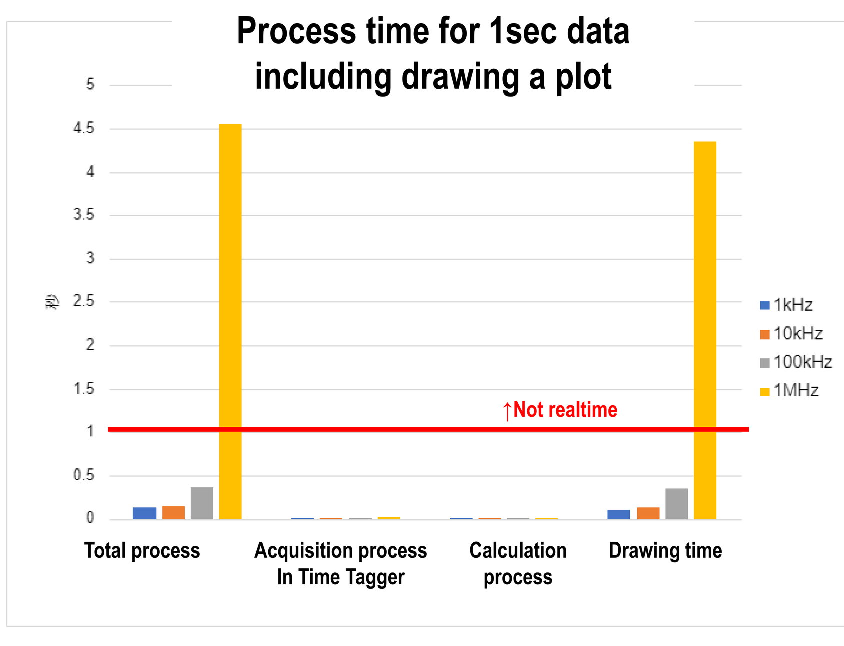
Low-cost PC & Time Tagger have a limit about detection speed and data size. We considered and proposed a detection algorithm in a limited machine system as this fig. Using burst laser sending and CPF prediction (1st column), data that should be processed is largely reduced (2nd~4th columns).
From this method, high-rate (kHz) SLR observation can be performed under our limited system.




## Process time comparison

This detection method can detect pseudo MHz data (left graph).
On the other hands, when drawing all the data, MHz data cannot be drawn in real-time. (This is due to python system and PC spec).
Here, data must be thinned for real-time drawing.




## To-do's

* Sophistication and generalization of GUI.

* Verification with actual data (short-range targets/satellites). I would like to accumulate data by next year.

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