Waiting-Time & Lomb-Scargle & Folding

PERIODIC ANALYSIS OF FRB121102

NAOC

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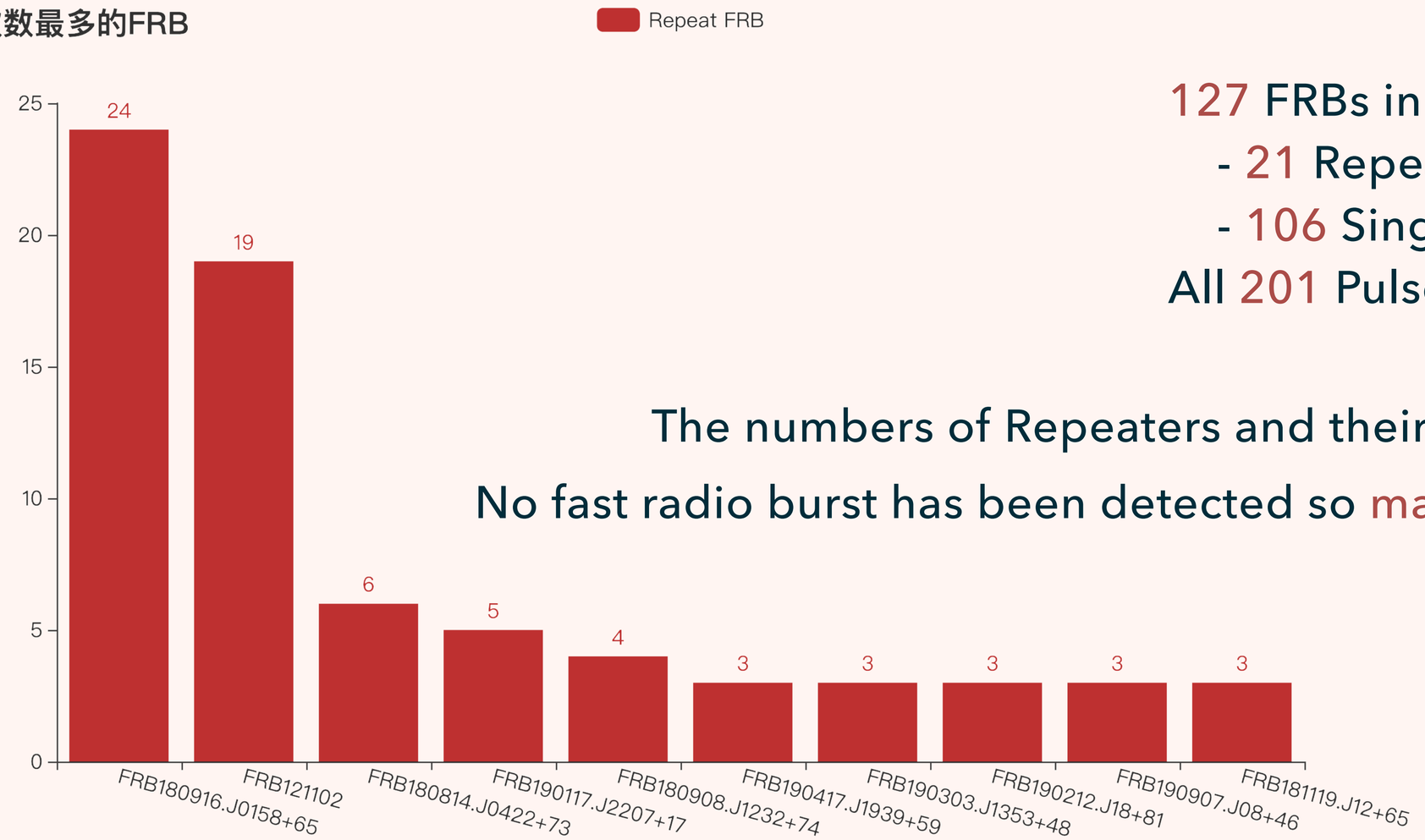
2020/08/28

INTRODUCTION

- From 2019.08.30 to 2019.10.21, the pulses of FRB121102 was observed by FAST.
- PRESTO and HEIMDALL gave more than 10,000 pulse candidates, and finally 1, 659 reliable pulses were confirmed.
- Because of the small number of repeaters and the number of pulses, it was difficult to effectively analyze the period of the FRBs.
- FRBCAT contains 201 bursts from 127 FRBs. For FRB121102, in addition to the 19 bursts given in FRBCAT.

FRBCAT

爆发次数最多的FRB



127 FRBs in FRBCAT

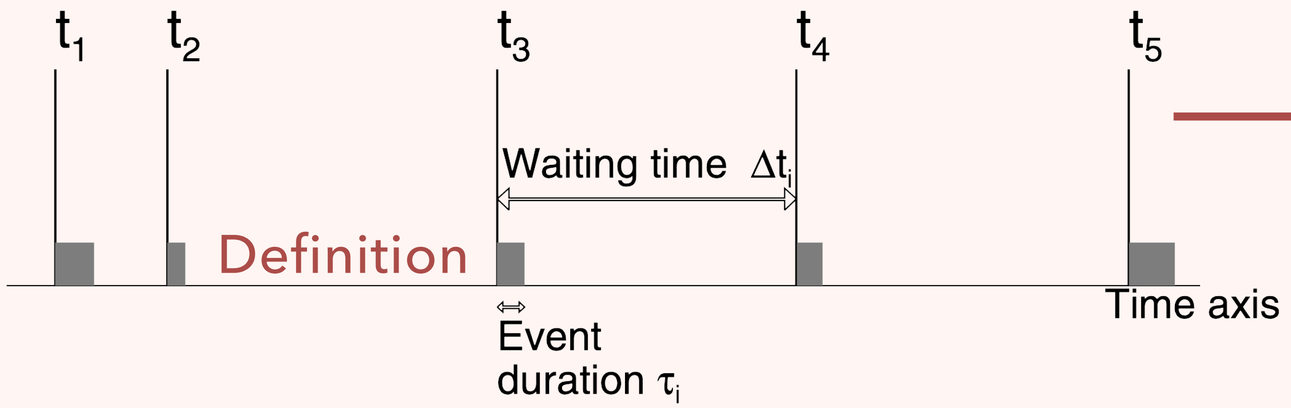
- 21 Repeaters with 95 Pulses
- 106 Single Pulse

All 201 Pulses

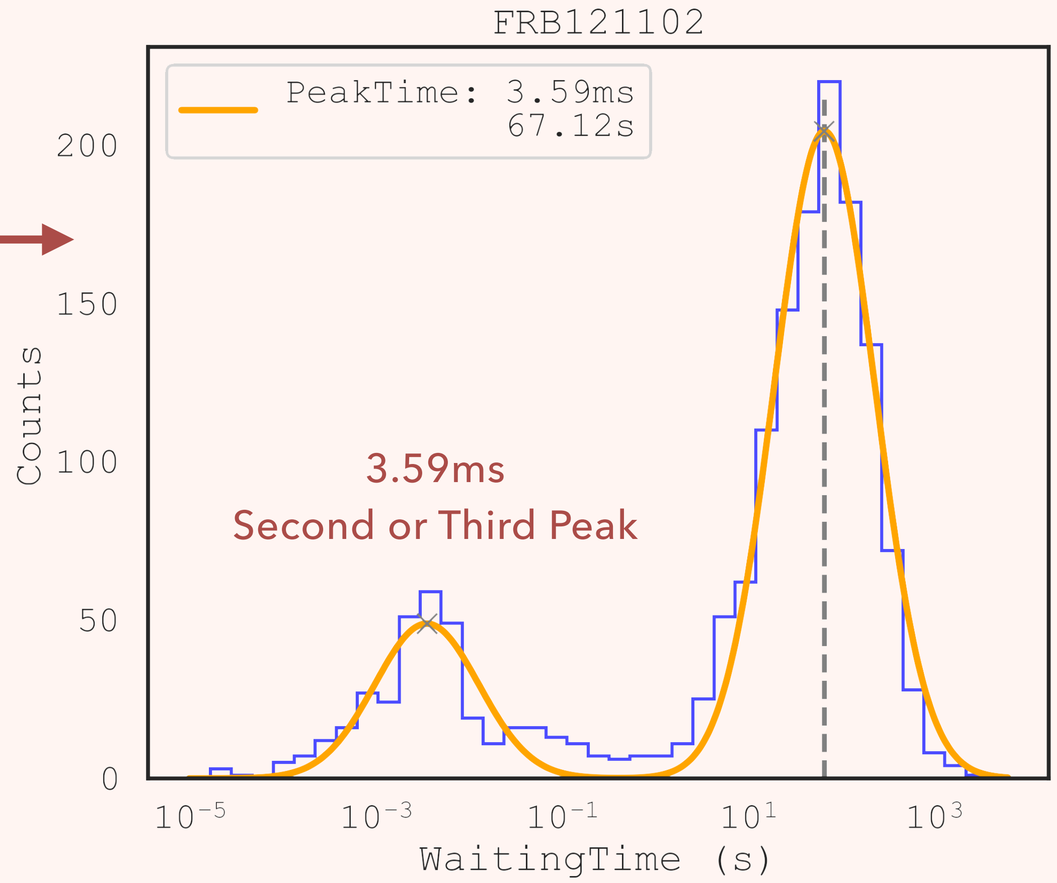
The numbers of Repeaters and their pulses are small.

No fast radio burst has been detected so many pulses as FRB121102.

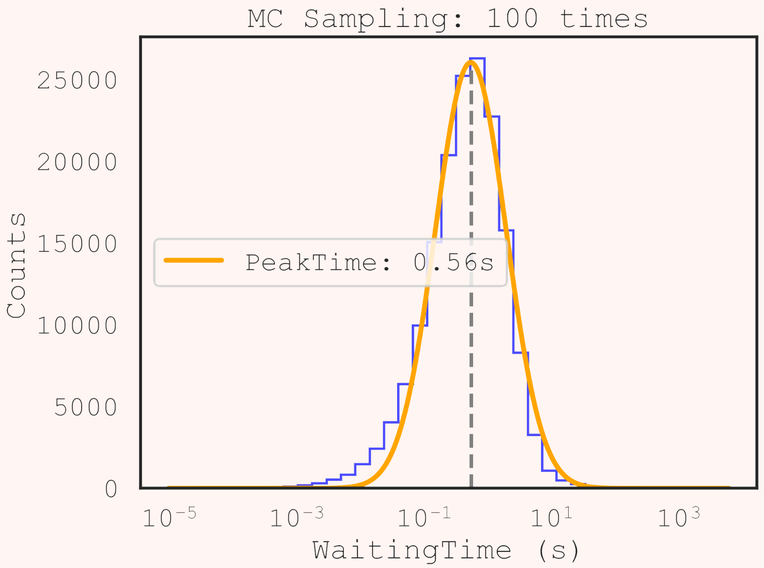
WAITING-TIME

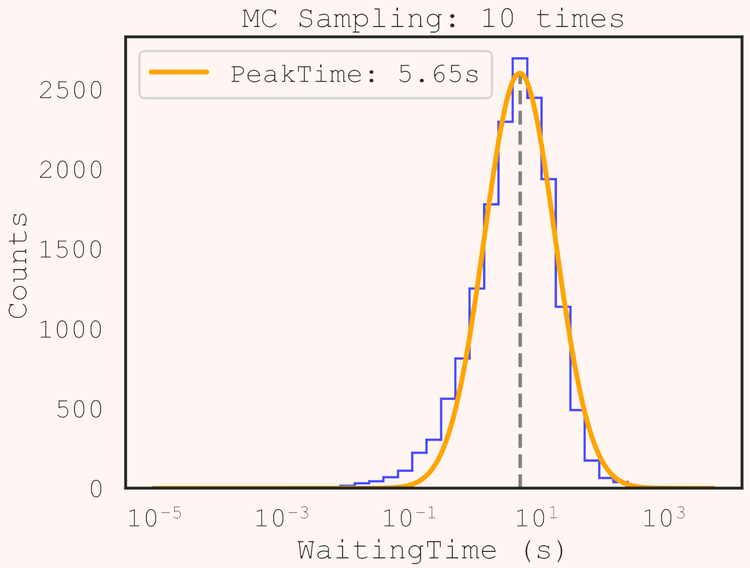


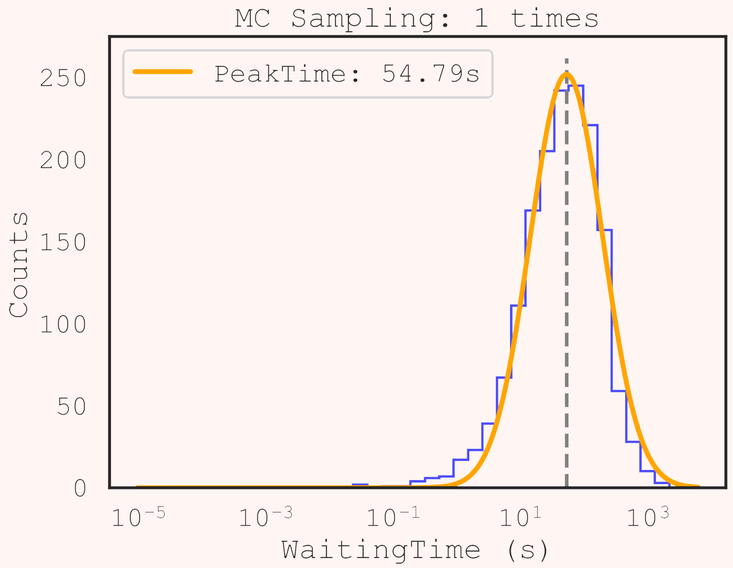
Differentiate a time series.

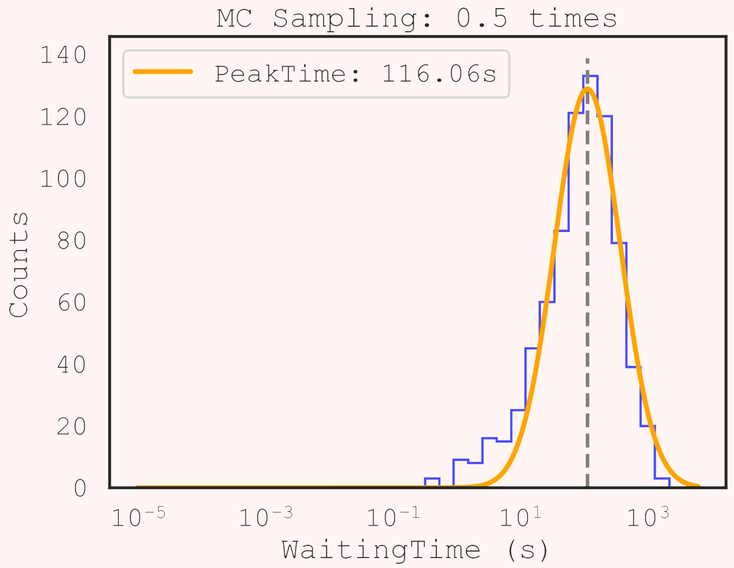


Credit: Bak, P. (1993). Self-organized criticality in astrophysics. *ceau*, 281-293.









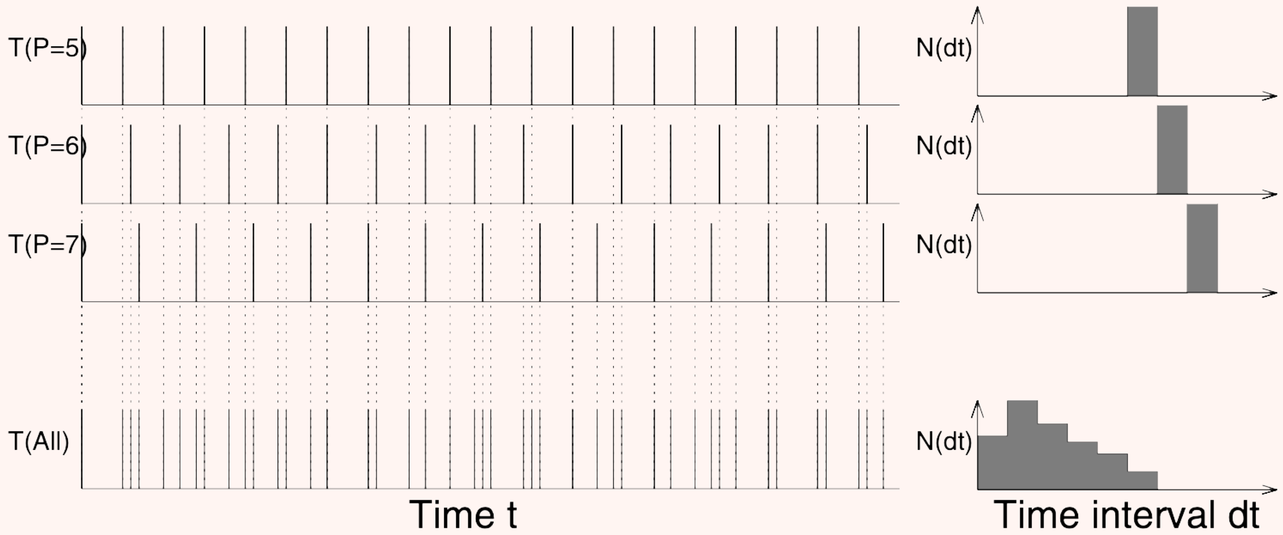
MONTE-CARLO

Sampling pulses:

- 100 times of FRB121102: 0.56 s
- 10: 5.65 s
- 1: 54.79 s
- 0.5: 116.06 s

Similar distribution with the real data;
Close peak times when the sampling points are of the same order with real data;
Log-normal distribution is not due to an instrumental effect and is consistent with emission from a source that emits FRBs randomly.

Waiting-time cannot distinguish whether it is truly random or random from multiple patterns.



Credit: Bak, P. (1993). Self-organized criticality in astrophysics. *ceau*, 281-293.

LOMB-SCARGLE

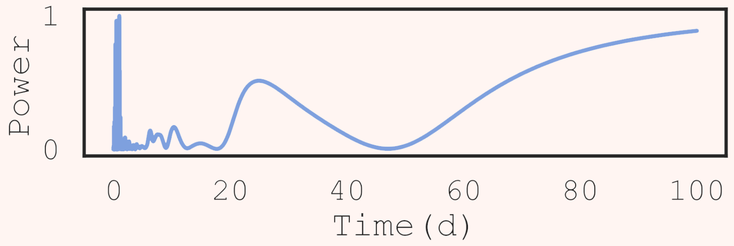
Fourier & Least-squares methods

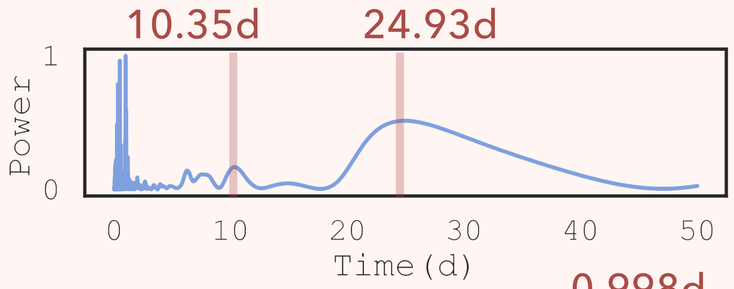
Suitable for Non-uniform sampling!

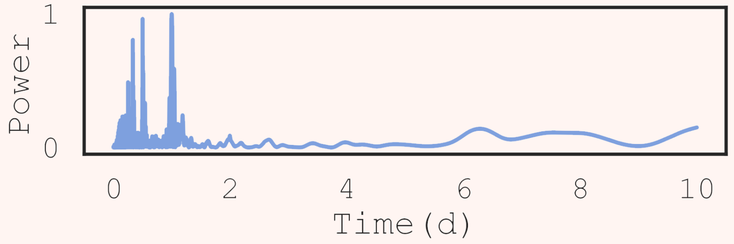
Fourier or Phase-folding or Least-squares

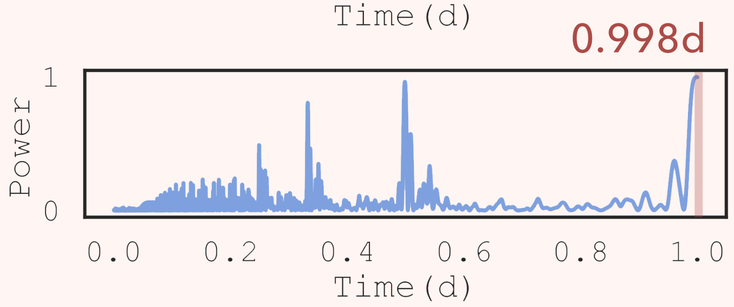
Fitting a model to the data at each candidate frequency and selecting the frequency that maximizes the likelihood.

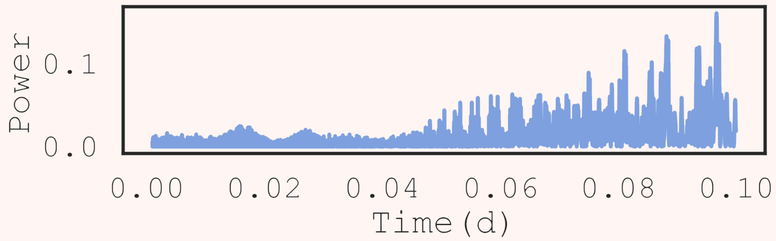
DAY PERIOD

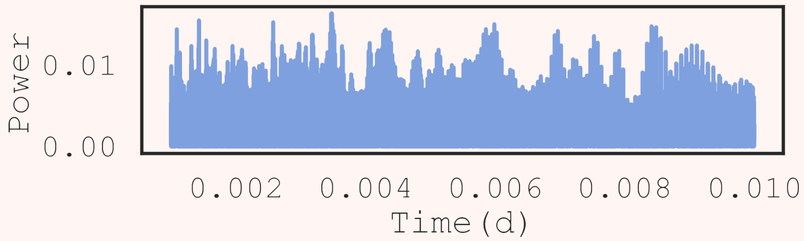


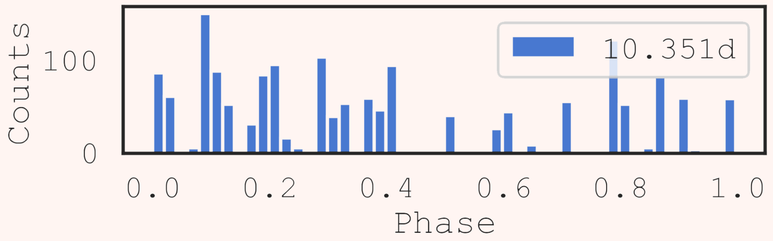


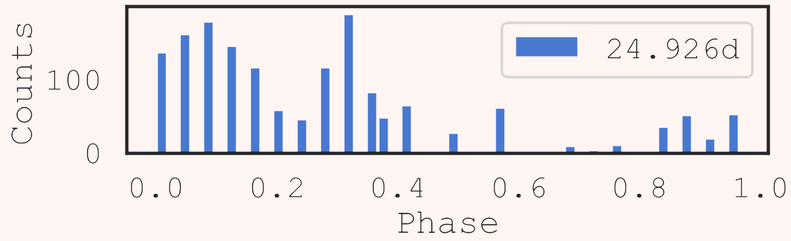




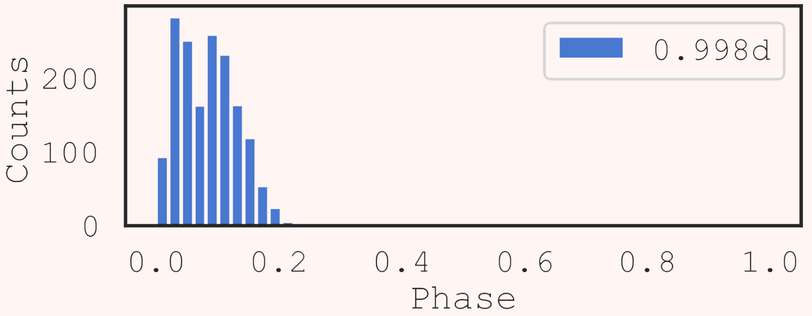








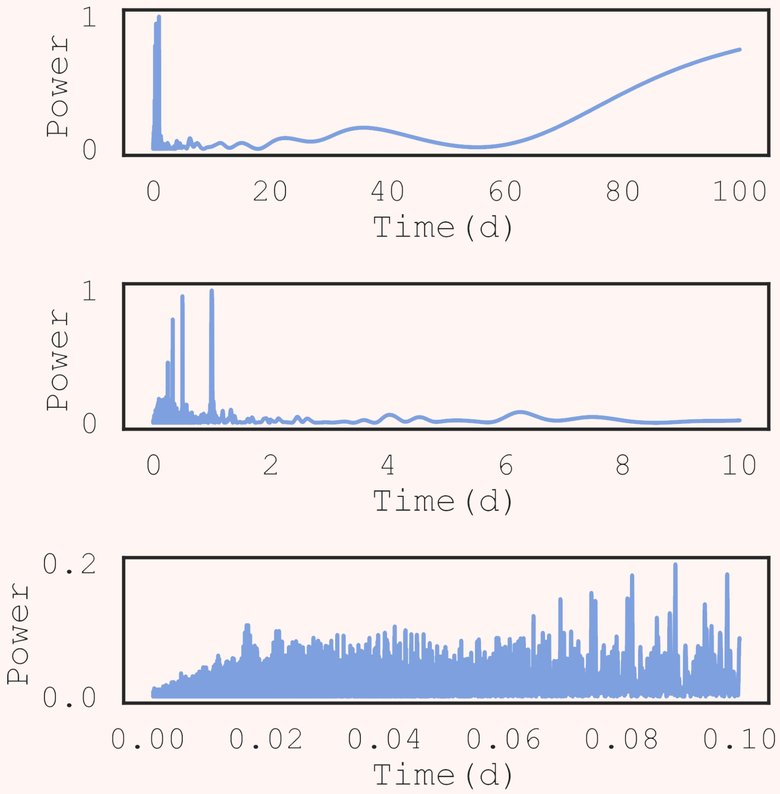
Observation Effect!

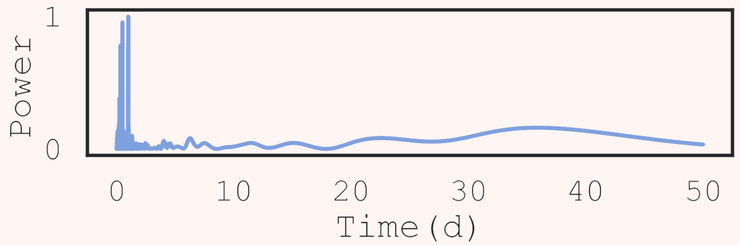


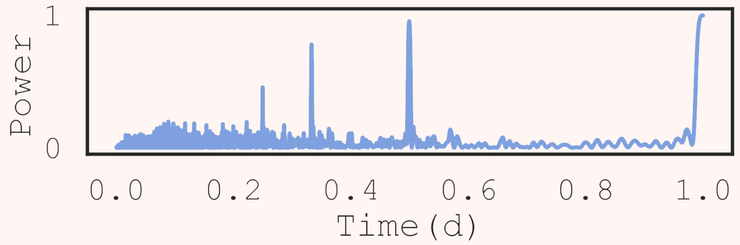
According to peak time, folding the TOAs (folding is more intuitive), only the ~1d peak time can make a good result.

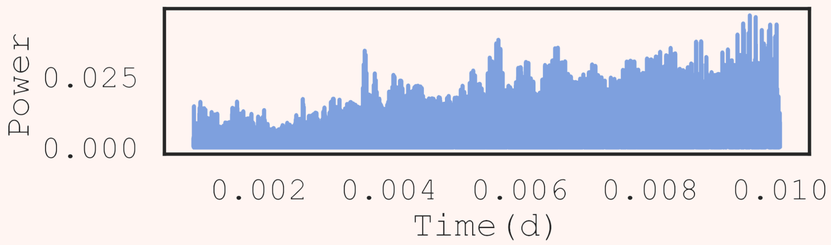
DAY PERIOD

Peaks around 10d & 25d are reduced.





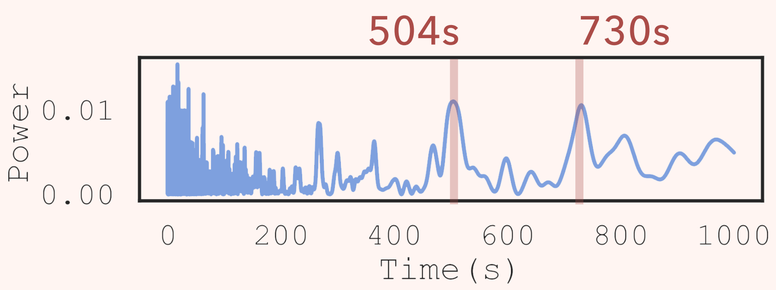


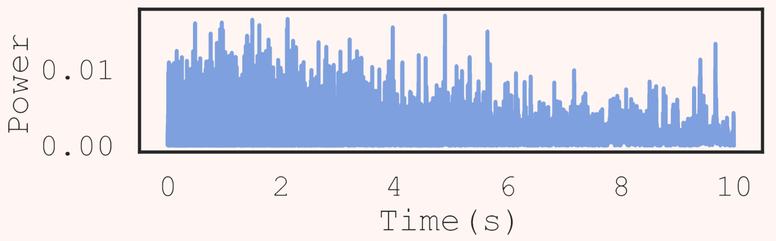


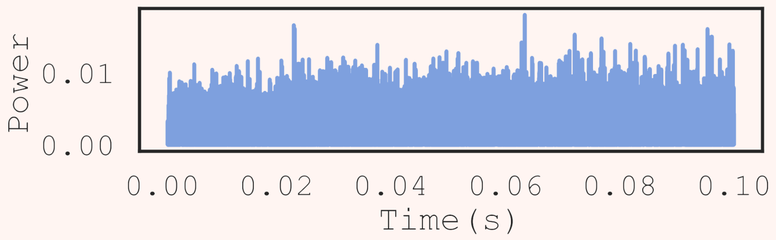
Fill the observation gap (someday without observation or no bursts caught) with the distribution of waiting time.

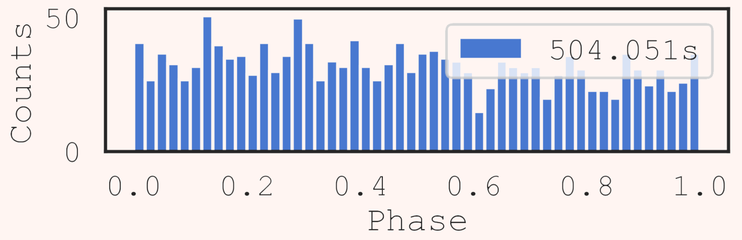
10d/25d periods come from observation gap.

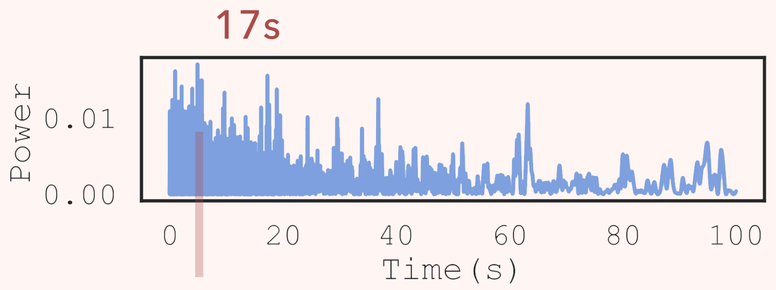
SECOND PERIOD

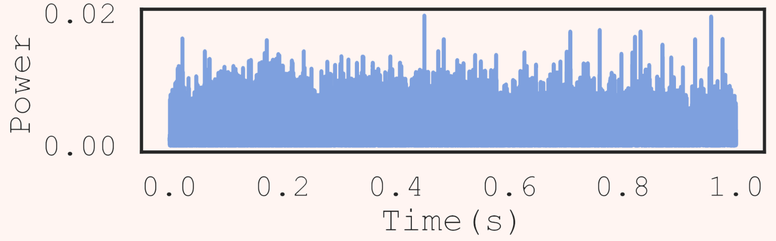


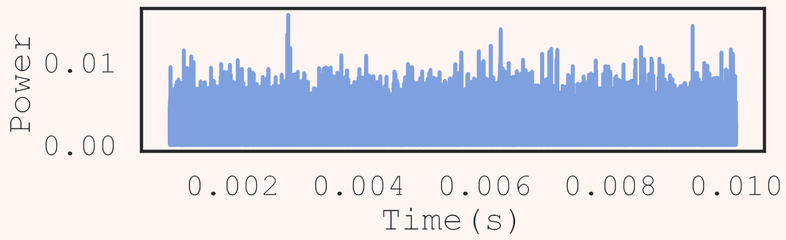


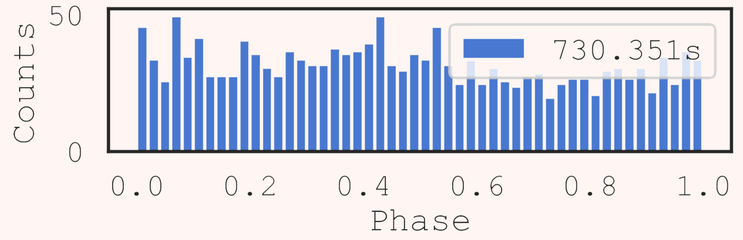


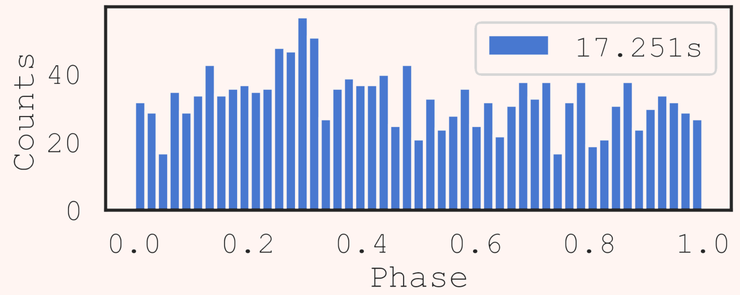






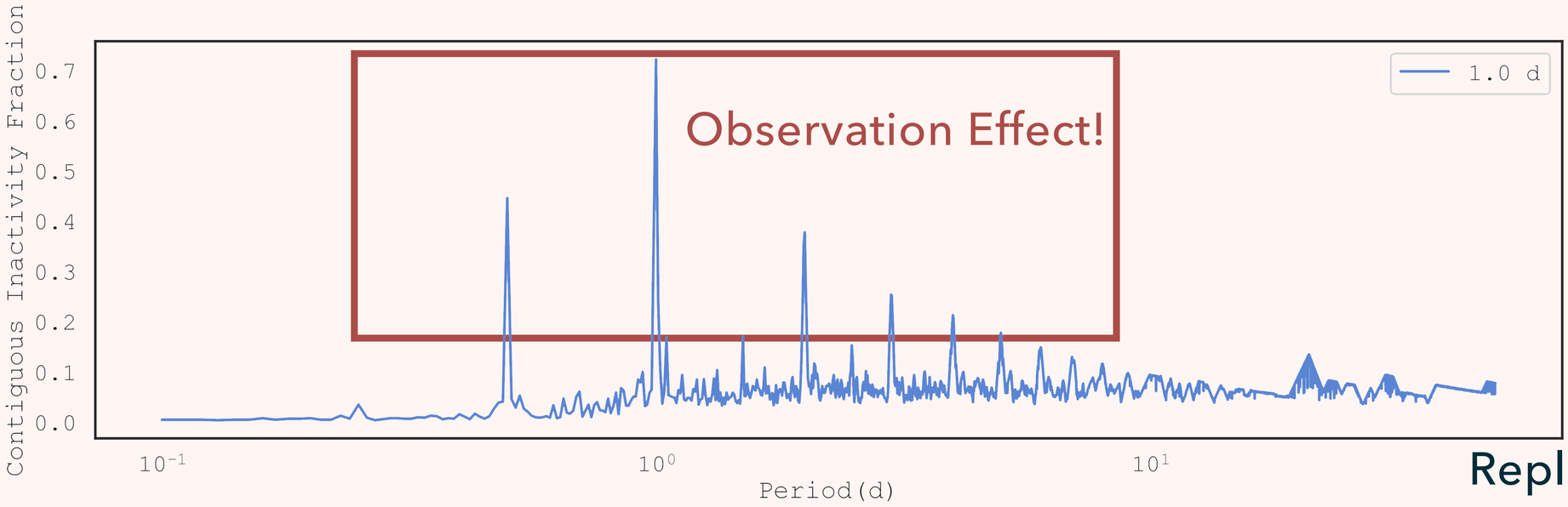






Align all TOAs according to the first TOA at a day, folding the TOAs by peak time, no good folding result.

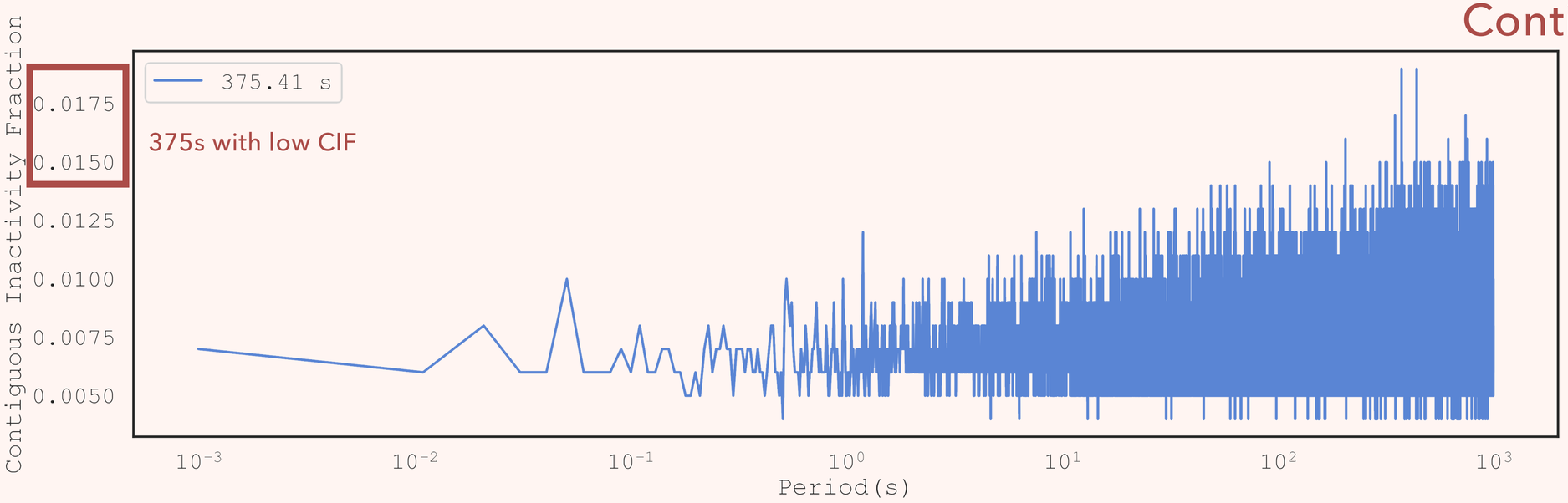
Low Power of Fitting (<0.02)



FOLDING

Phase folding method
with different criteria

Replace SNR with
Contiguous Inactivity Fraction



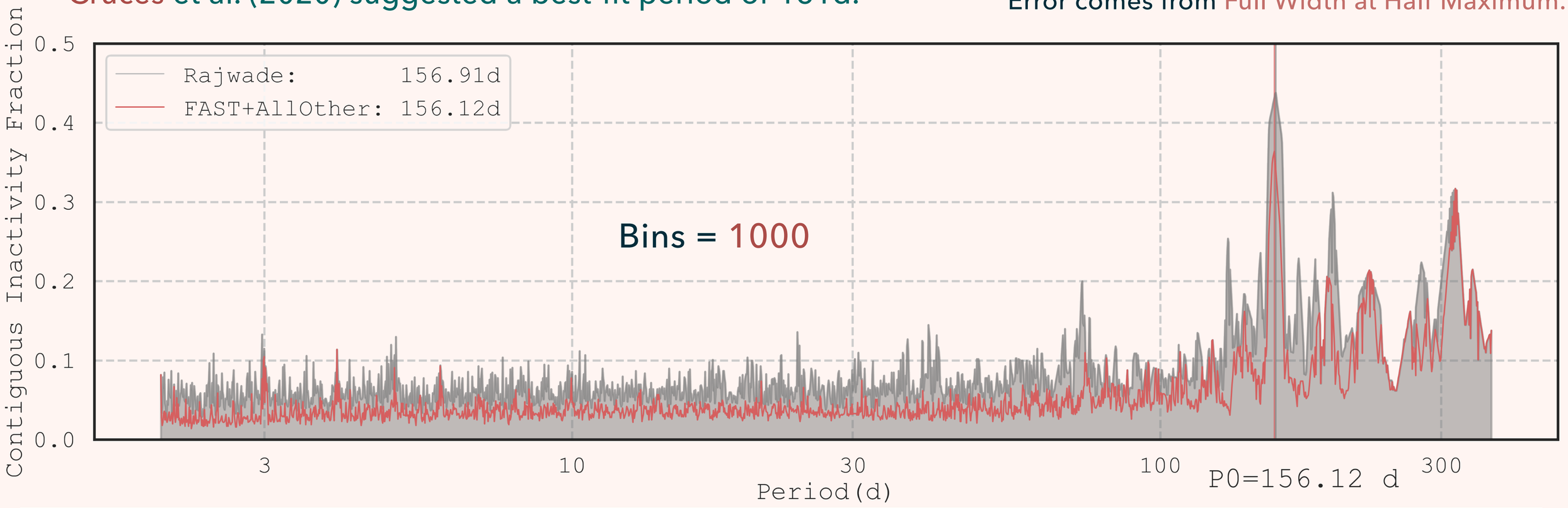
Get rid of the power increase caused by a large number of pulses in the frequency range, which may appear When applying LS method to a mixed dataset of FAST and Other telescope.

FOLDING-POWER

Rajwade et al. (2020) suggested a period of 156.9d.
Cruces et al. (2020) suggested a best-fit period of 161d.

Rajwade: 156.9 d -5.8 +5.3
FAST+Rajwade+Cruces: 156.1 d -4.1 +5.3

Error comes from Full Width at Half Maximum.



FOLDING-PHASE

Rajwade et al. (2020) suggested a period of 156.9d.
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Rajwade: 156.9 d -5.8 +5.3
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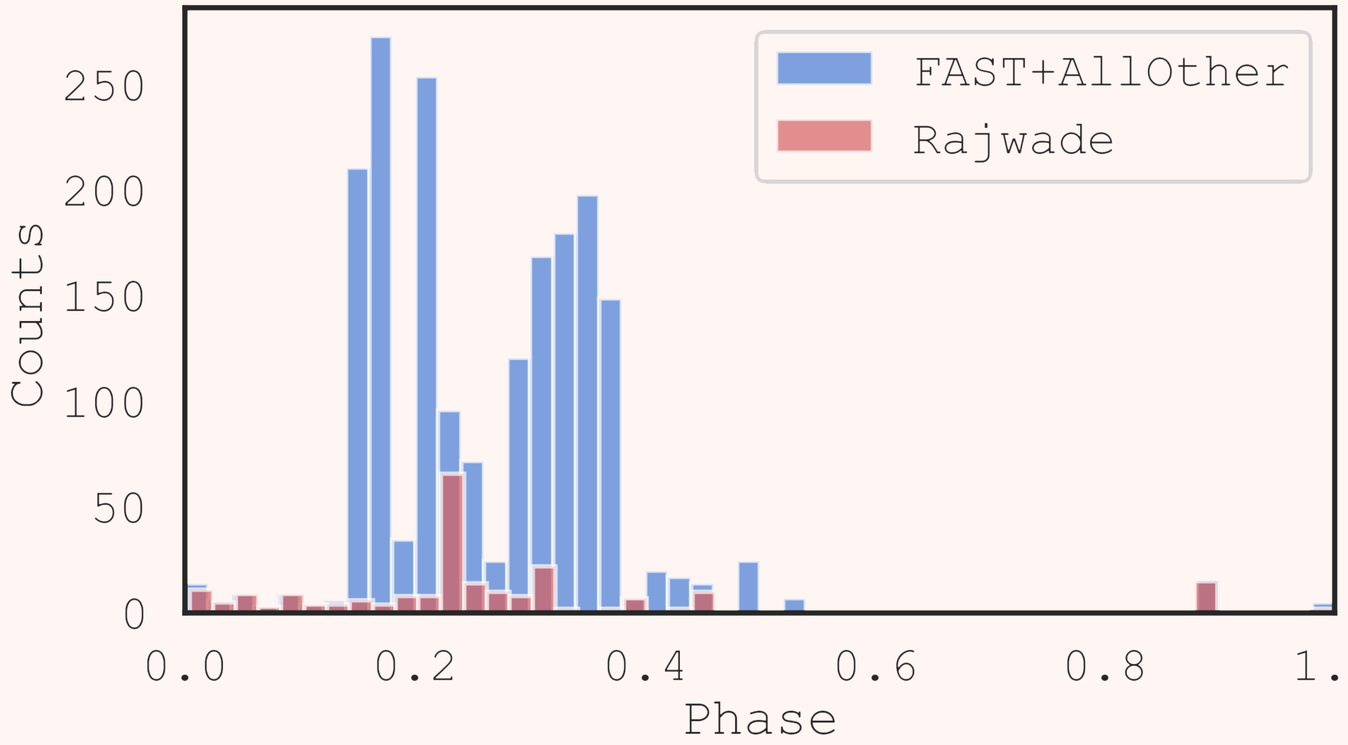


Phase 63.6%

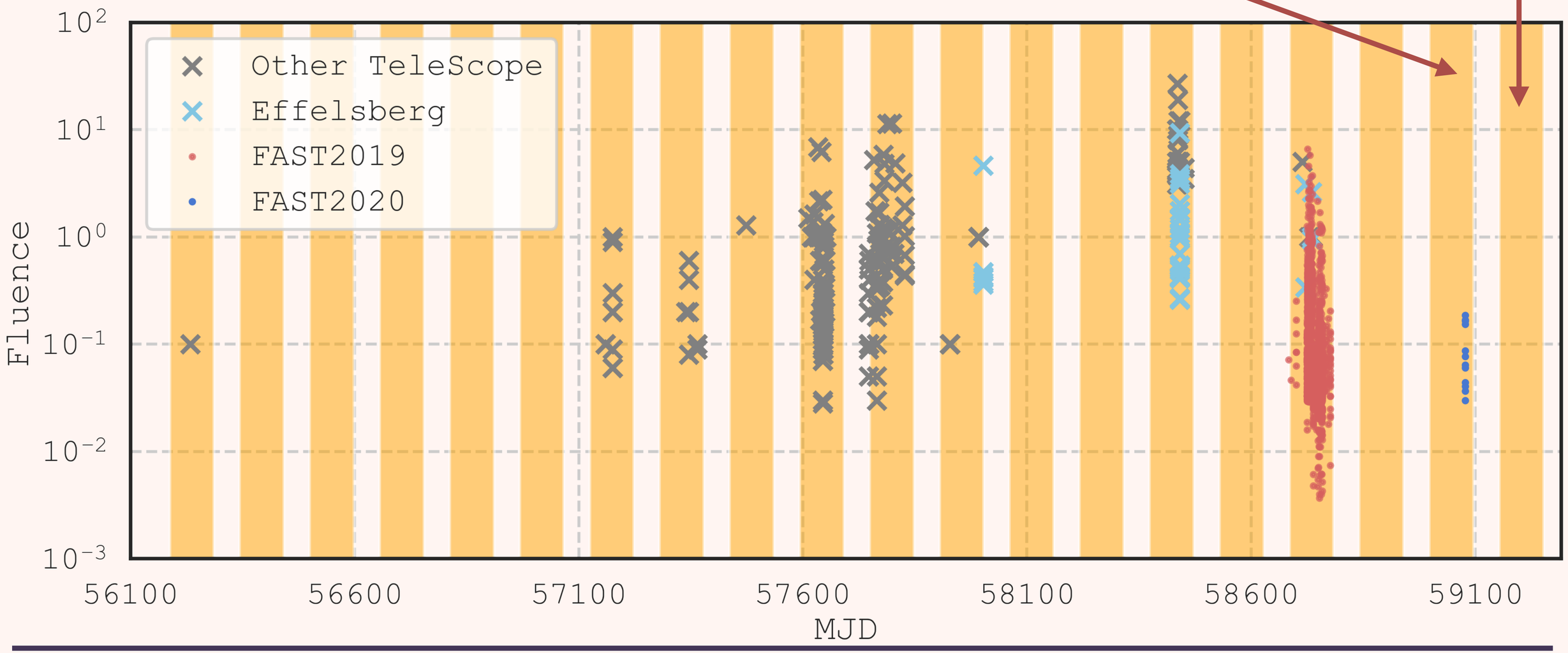
ATel#13959

157D ?

Orange range: 156.12d x 63.6%

Start: 2020.05.28
End: 2020.09.04

Start: 2020.10.31
End: 2021.02.07



SUMMARY

- Unfortunately, at present, we have not found the effective period of FRB121102 within the observation period (1ms - 53d).
- The ~4ms peak time in Waiting Time is caused by the second or third pulse in a burst.
- We cannot rule out the possibility of 157d as the active period of FRB121102.
- From the current results, it can be considered that FRB121102 may be randomly emitted during the active period of 157d.
- Observations at Aug. 16-17 & Aug. 23 also found new pulse activity of FRB121102.
- However, if we only observe as the period of 157d, this period will become a man-made bias.

THANKS

Q&A