The TESS view of AGB pulsators: opportunities and limitations

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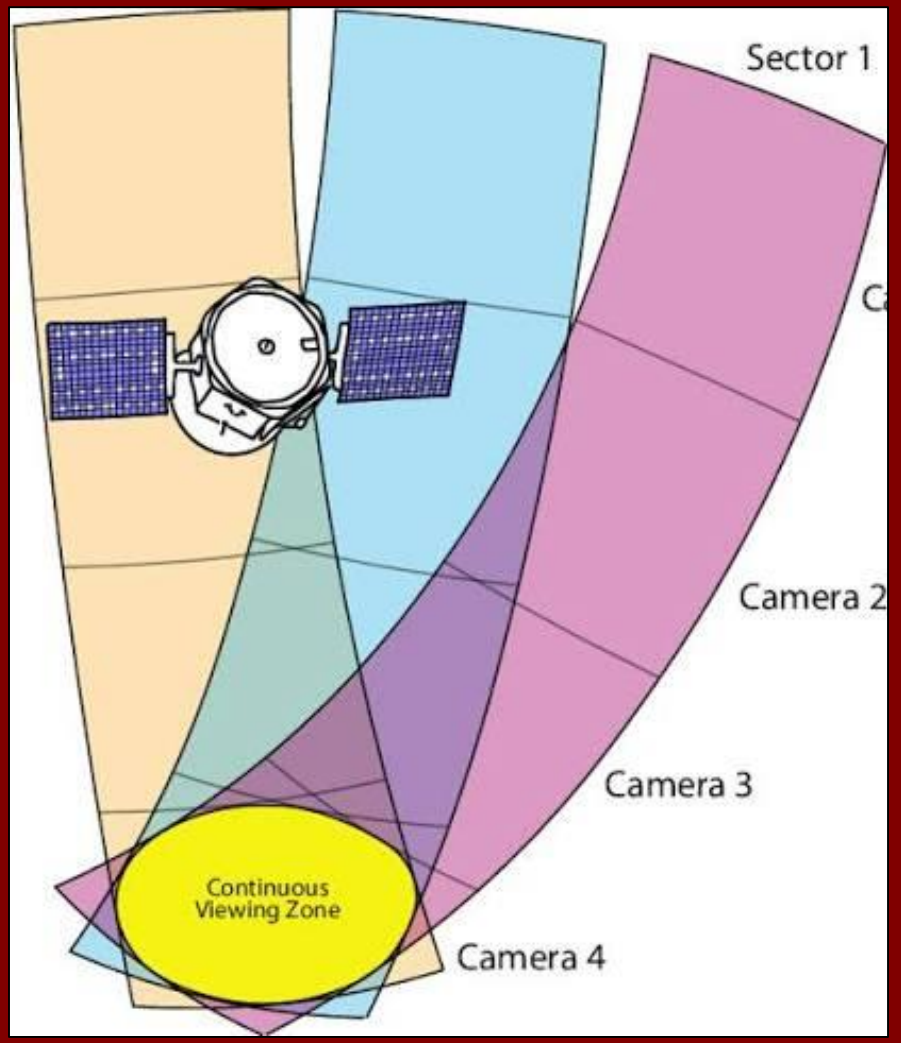
[2]HUN-REN CSFK Konkoly Observatory

FIKUT NEXTGEN 2026

04/11 2026

Transiting Exoplanet Survey Satellite (TESS)

- all-sky mission, 24° x 96° sectors for 27 days each
- overlapping areas: year long data in Continuous Viewing Zones (CVZ, ~10° around ecliptic poles)
- LMC in Southern CVZ
- FFI cadence: 30 min (Years 1-2), 10 min (Years 3-4), 200 sec (Years 5+)
- photometry from FFIs: Quick Look Pipeline (QLP, T < ~14, *Huang+ 2020*), TESS–Gaia Light Curves (TGLC, T < 16, *Han & Brandt 2023*)
- **challenges: 21” px size (blends), scattered light**



Barcley, Pepper, Quintana 2018 (https://www.researchgate.net/figure/An-illustration-showing-the-first-three-sectors-of-the-TESS-observing-plan_fig1_324536350)

AGB — asymptotic giant branch: evolved, cool, luminous, ~0.5-8 $M_\odot$
RGB — red giant branch

RV Tauri

- low-mass, post-AGB
- type II Cepheids with alternating cycles
- RVb: varying mean mag.
- 20-80 days

semiregular variables (SRV)

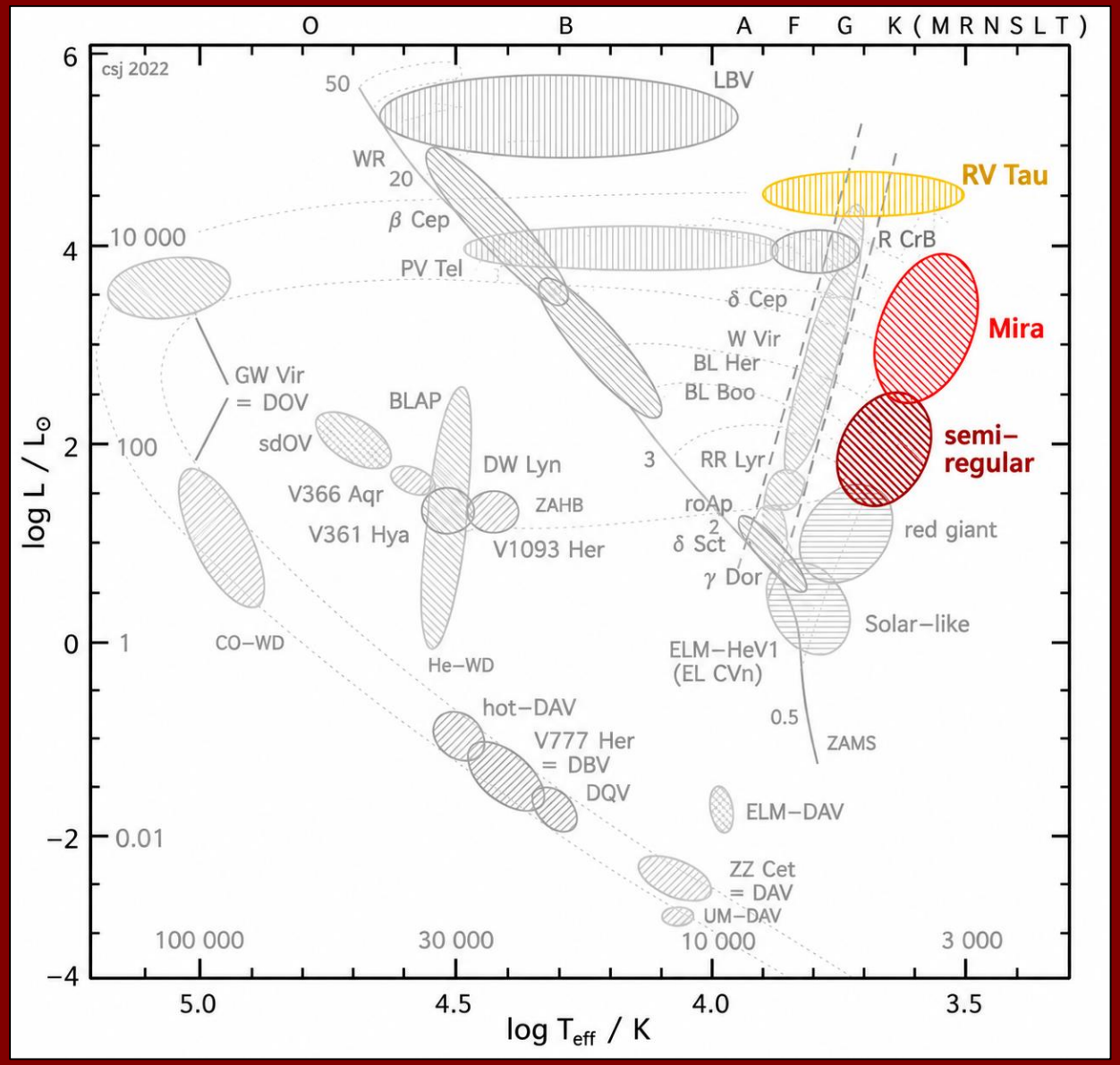
- RGB/AGB
- periodic and irregular behaviour
- long secondary periods (LSP)
- 20-2000 days

OGLE small amplitude red giants (OSARG)

- mostly RGB + AGB
- *Wray, Eyer, Paczyński 2004*
- 10-100 days
- amplitude: ~0.001-0.1 mag. in I band
- also exhibit LSP

AGB or RGB?

- overlapping on HRD
- OGLE: period-luminosity
- *Anderson, Koblischke, Laurent 2024*: improve TRGB method by dividing populations with P-L sequences of small amplitude red giants



Studies with TESS so far

- few in this area
- *Kayhan & Şahin 2025*: analyse combined ground-based and TESS data of DF Cygni, an RVb star
- *Zhou 2026*: classify 468 LPVs with TESS and SuperWASP
- Mori, Karakas, Campbell 2025: initial masses of S-type AGB stars with ASAS-SN and TESS
- **goal: obtain useful light curves for analysis by stitching the segments correctly**

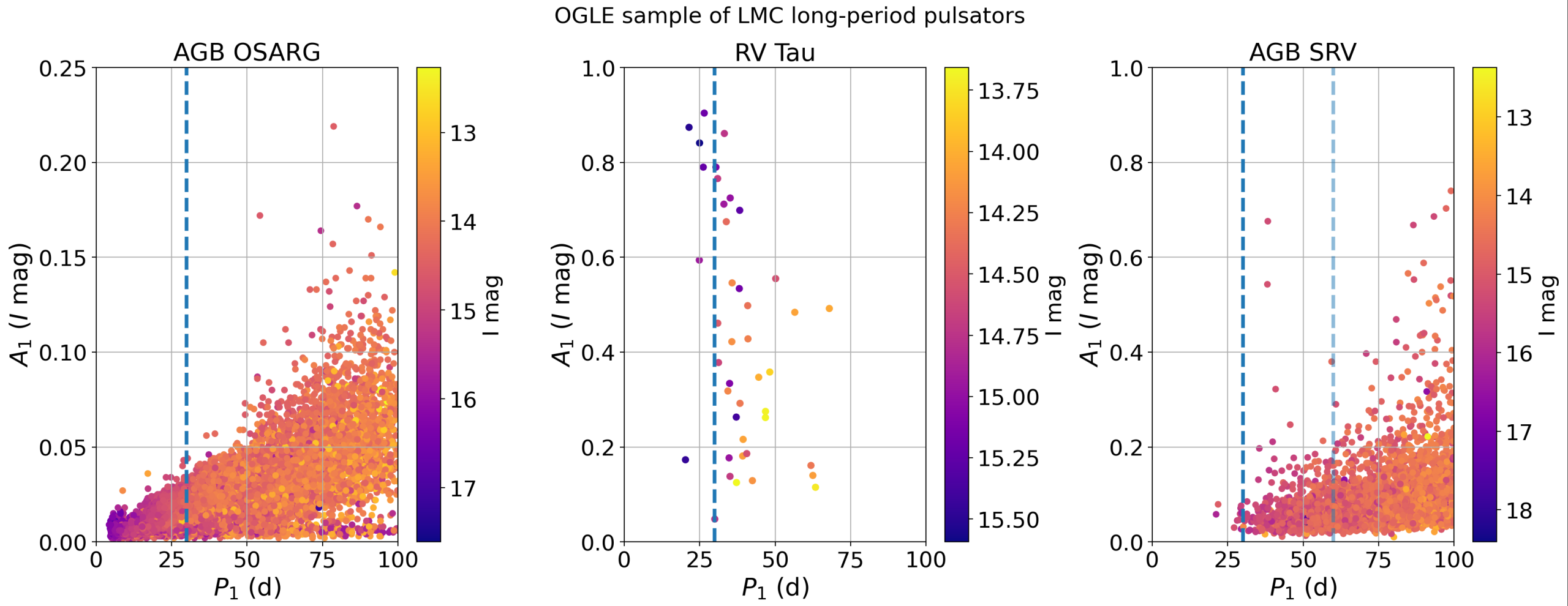
Target selection

- for visual inspection + developing pipeline
- estimate overall potential
- sources: Variable Star Index (VSX), OGLE
- QLP and/or TGLC data avaliable
- preferably in CVZ
- starting with the shortest periods and most cycles

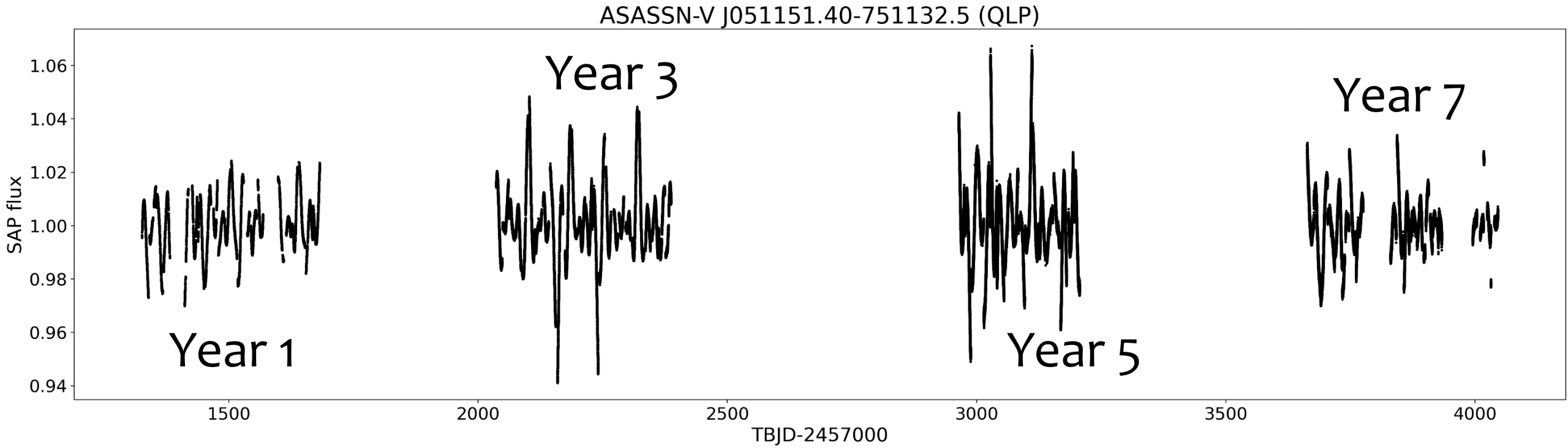
	RV Tauri*	AGB SRV	AGB OSARG
MW	223	634	0
LMC	43	632	84
total	**273**	**1 266**	**84**
QLP	215	291	20
TGLC	78	1 040	77

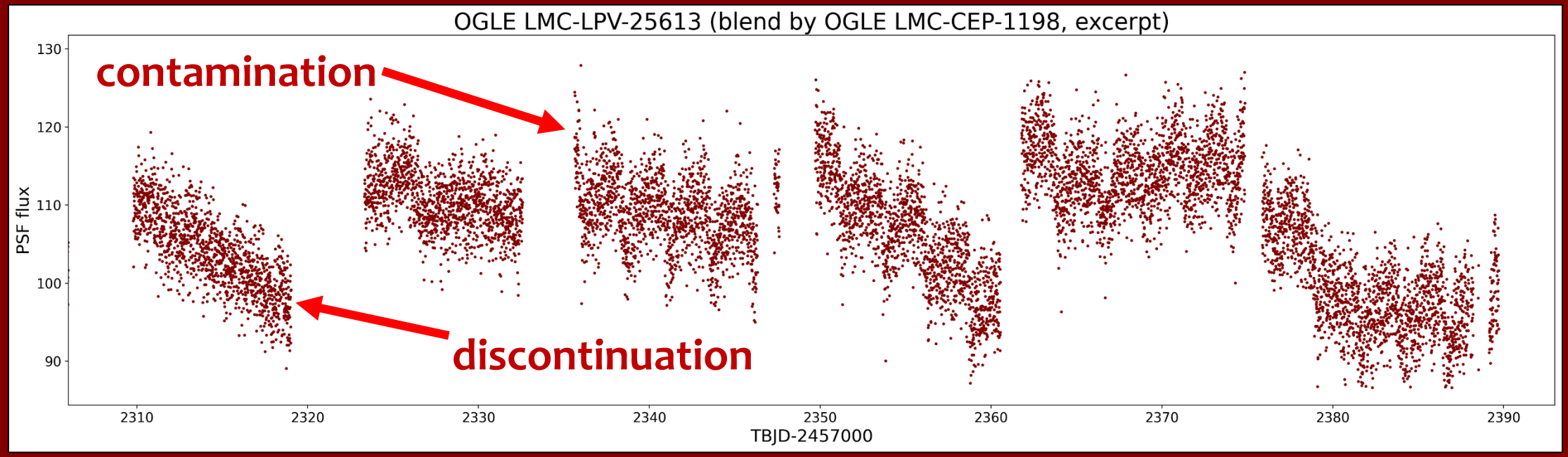
*only 49 are in CVZ in VSX and OGLE combined

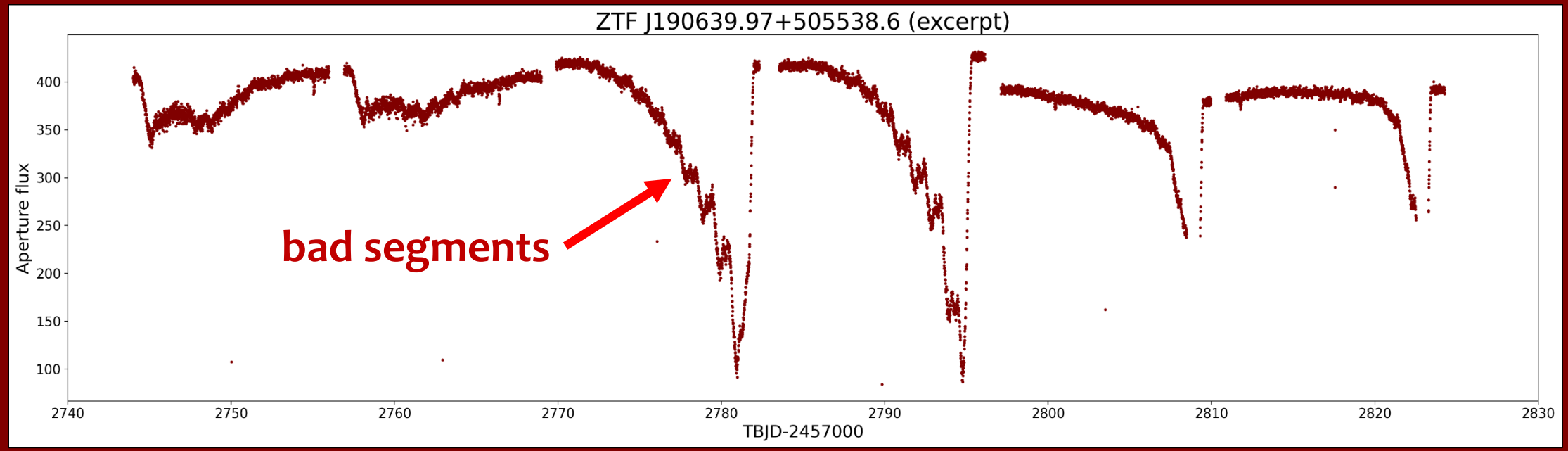
Periods and amplitudes in the LMC



Total data for a star in the Southern CVZ

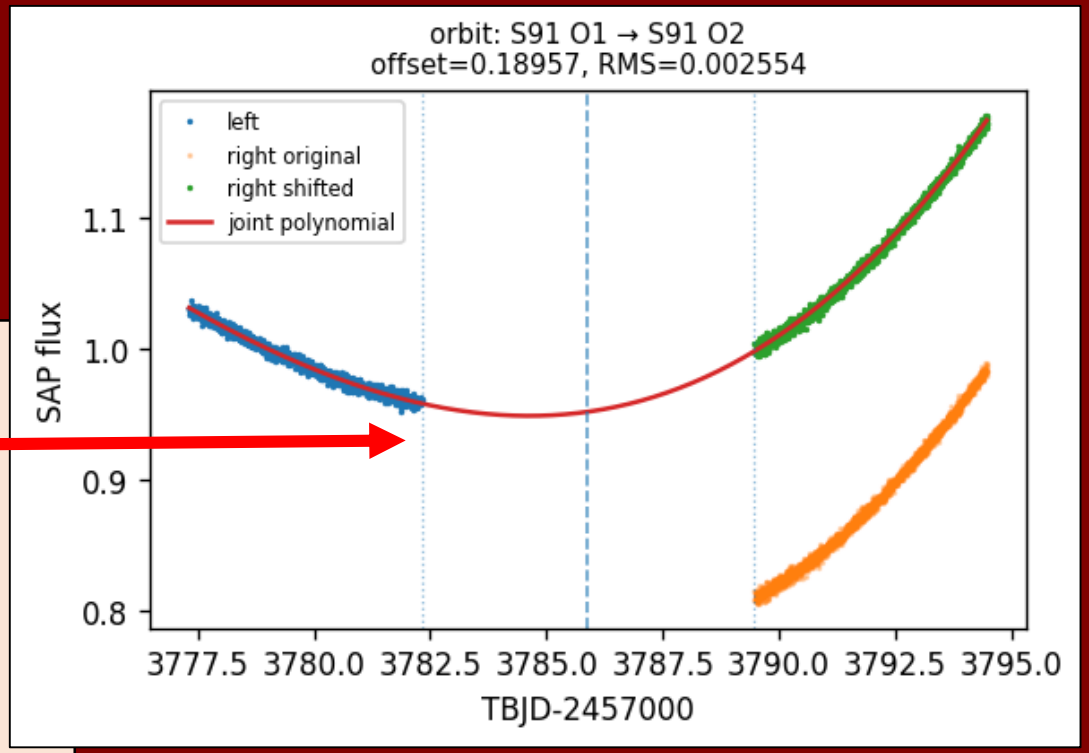


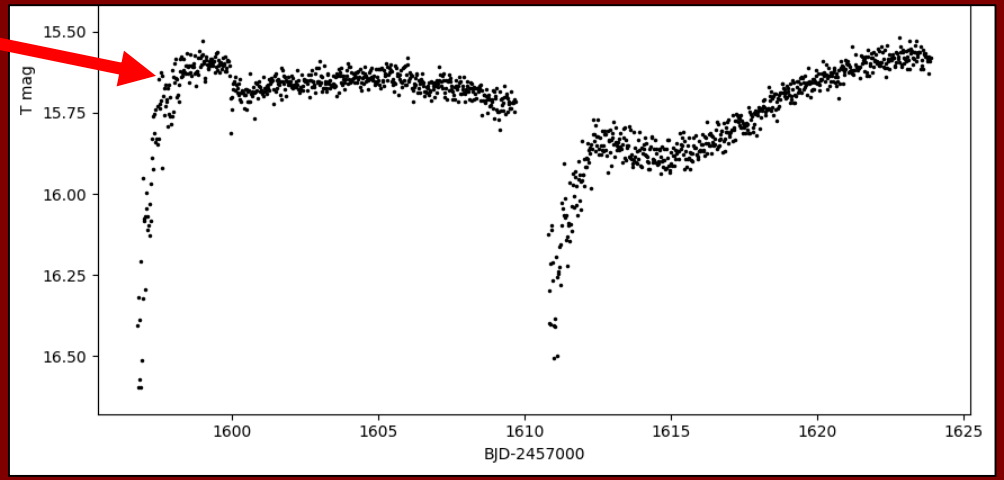

OGLE LMC-LPV-25613 (blend by OGLE LMC-CEP-1198, excerpt)
contamination
discontinuation
PSF flux
TBJD-2457000


ZTF J190639.97+505538.6 (excerpt)
bad segments
Aperture flux
TBJD-2457000

Our method

- problem: jumps between orbits and sectors in light curves
- fixing them by polynomial fitting the edges (3rd order worked best)
- bad segments need to be cleaned
- no amplitude scaling
- cannot rely on periods due to semiregular nature
- cannot detrend -> making LSPs hard to detect

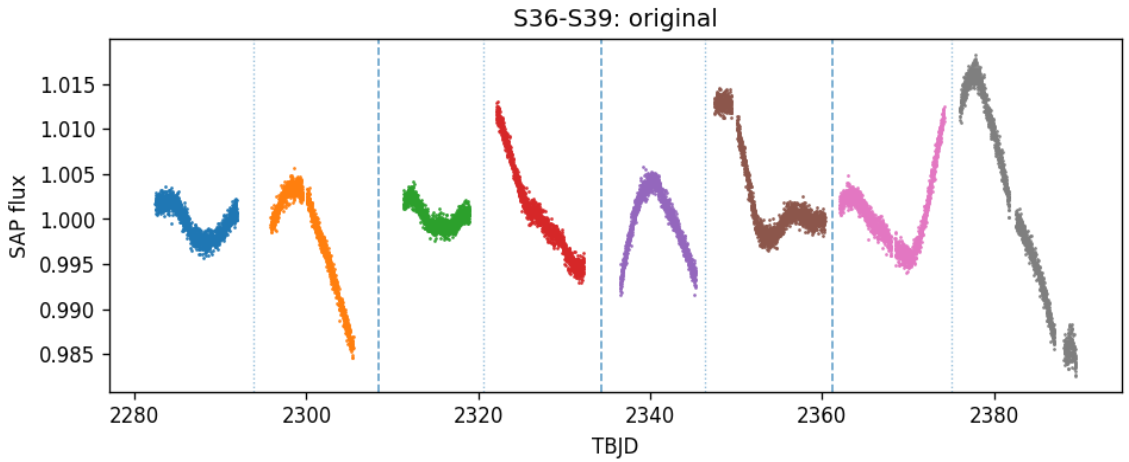


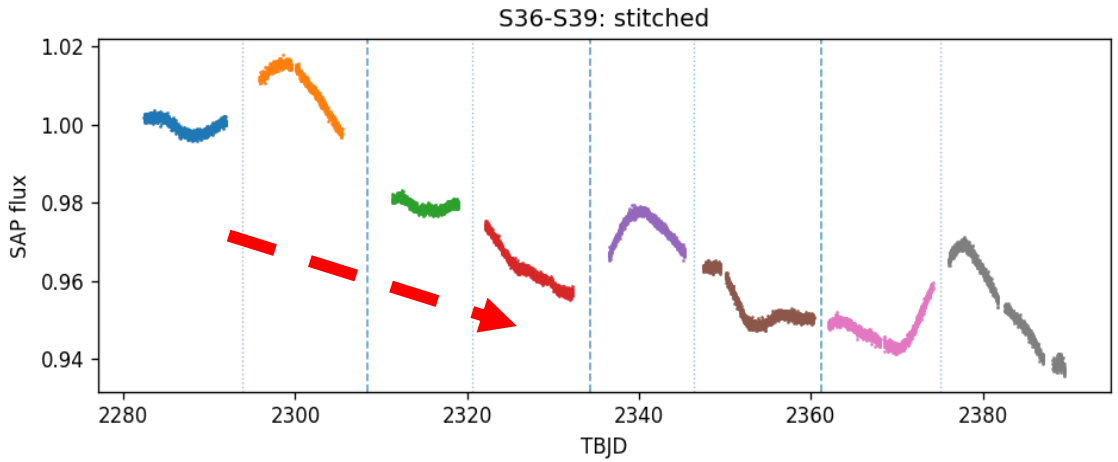


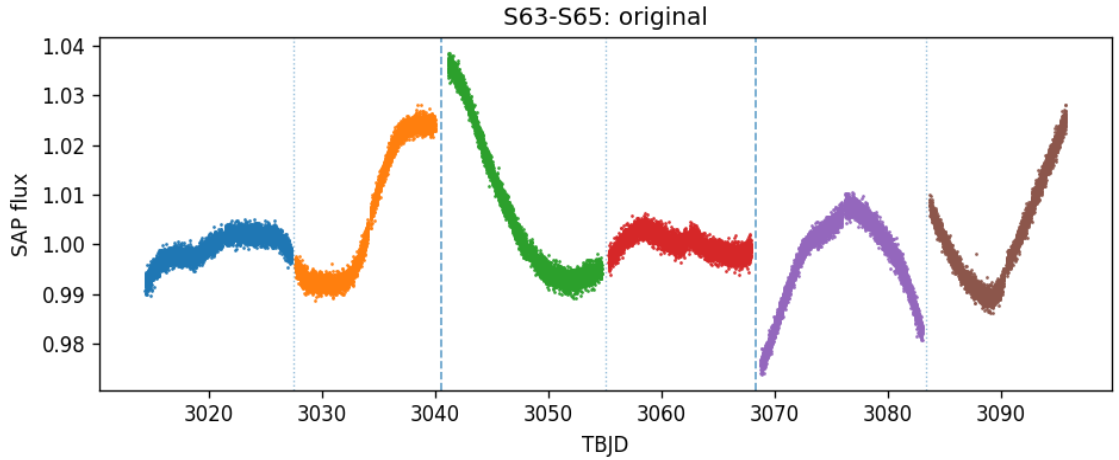
Original

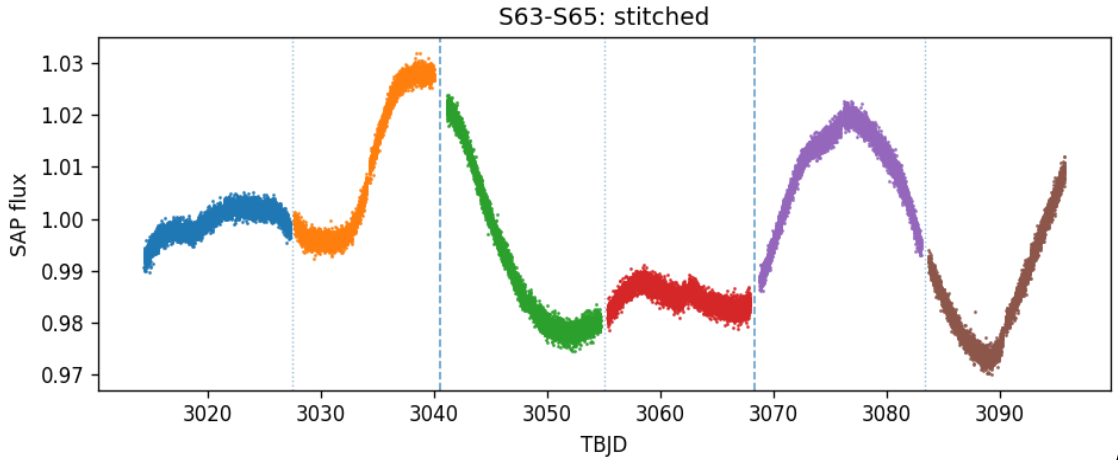
Stitched

TIC 397146868

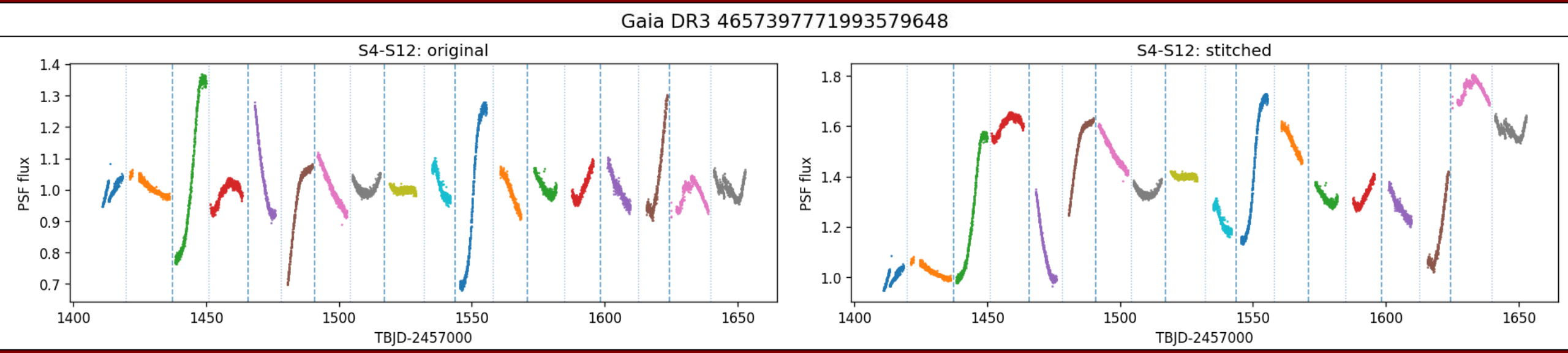






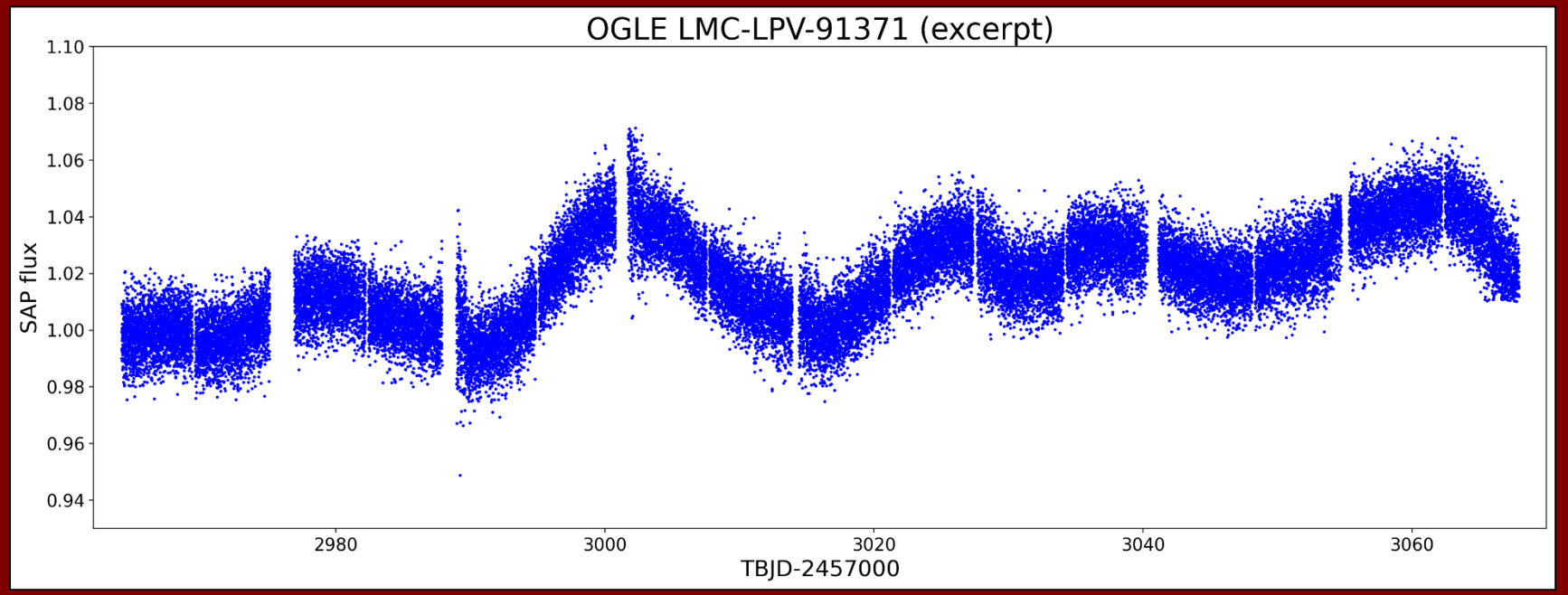


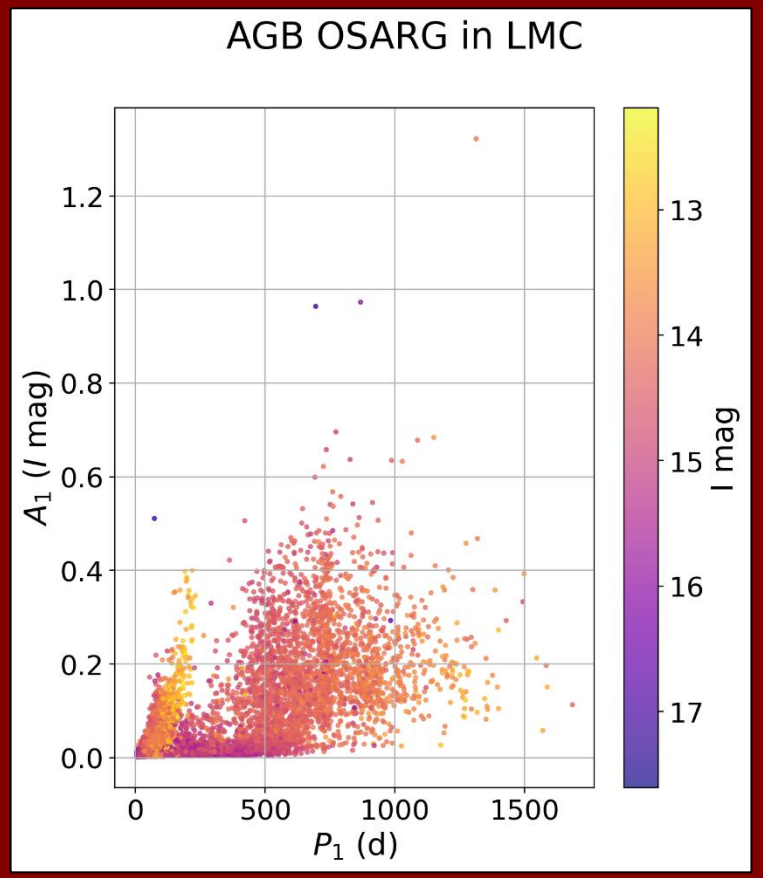
RV Tauri variables



- least numerous
- only a handful in CVZs (number of observed cycles: 3 - 35)
- overall decent LC quality, but scarce data

OSARG

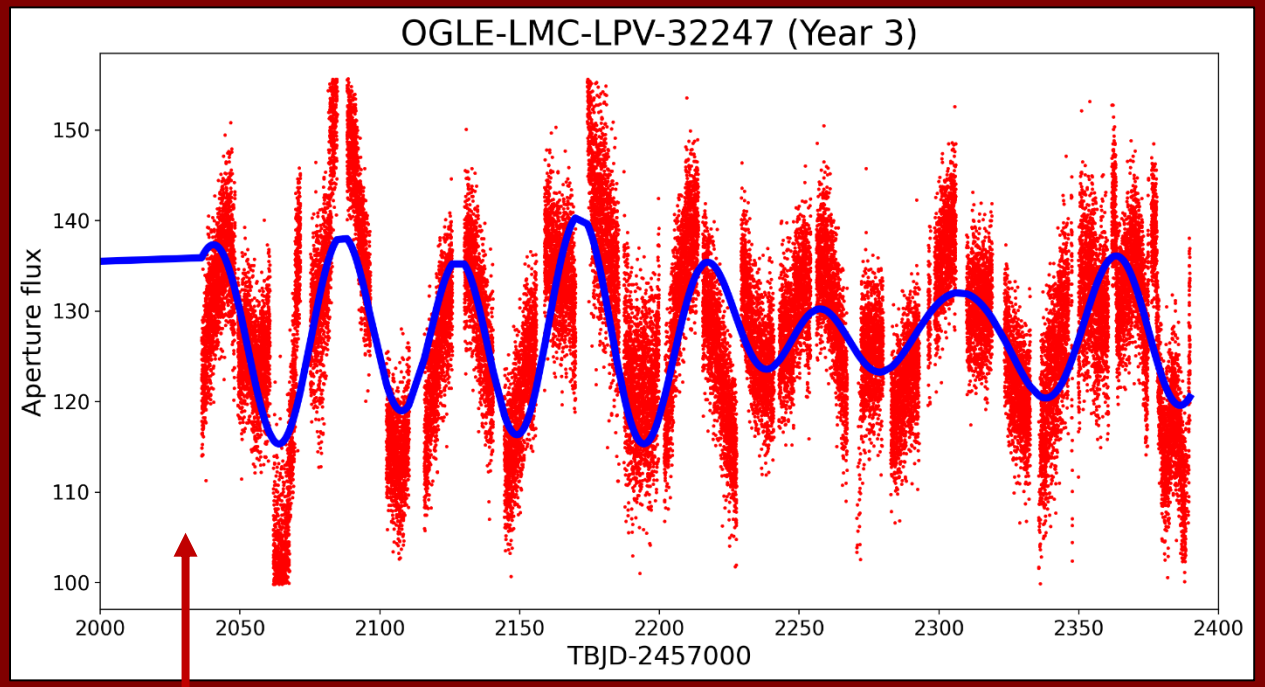




- close to 300 000 in total, but poor quality
- clear periodicity is rarely seen
- too small amplitudes
- larger amplitudes at the cost of longer periods

Semiregular var.

- most promising, often no offset-stitching required
- characterized by multiple periods (OGLE lists 3)
- -> perform prewhitening* with the three dominant periods
- **-> check fitting, compare with OGLE (or VSX) periods**

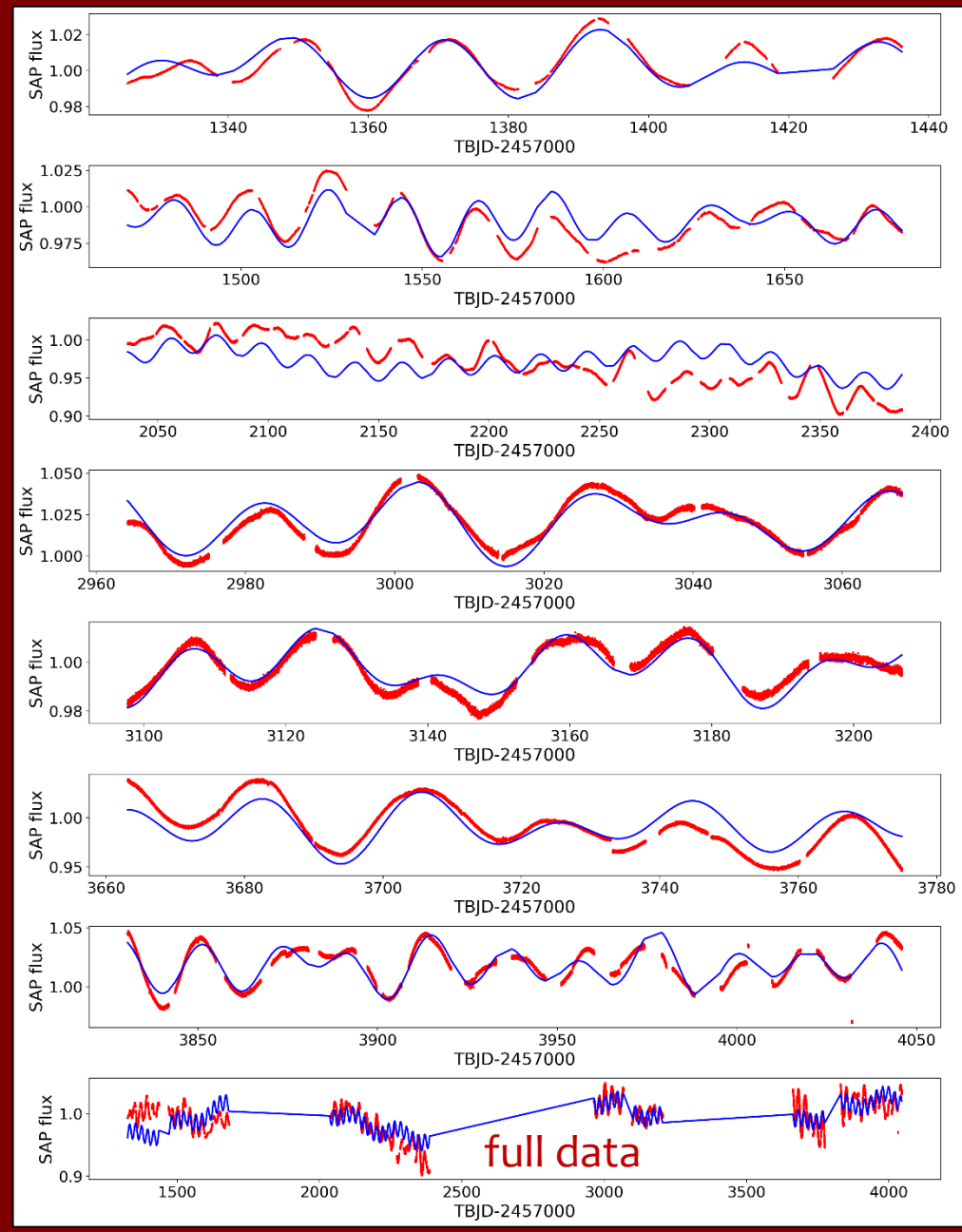


Periods with TESS (days)		
45.684 ± 0.008	40.341 ± 0.009	66.96 ± 0.03
	OGLE periods	
45.615	645.6	67.67

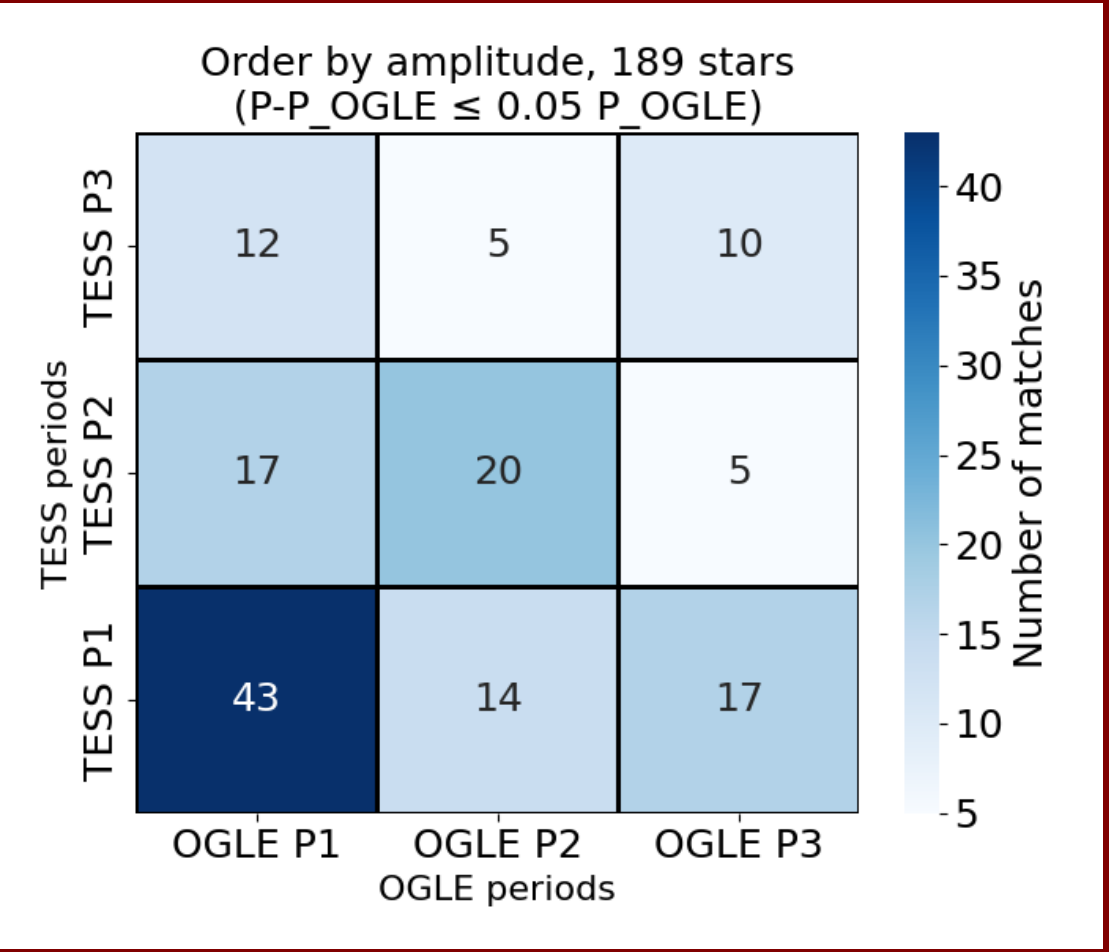
*standard Fourier analysis with the Seismolab Python package by Attila Bódi

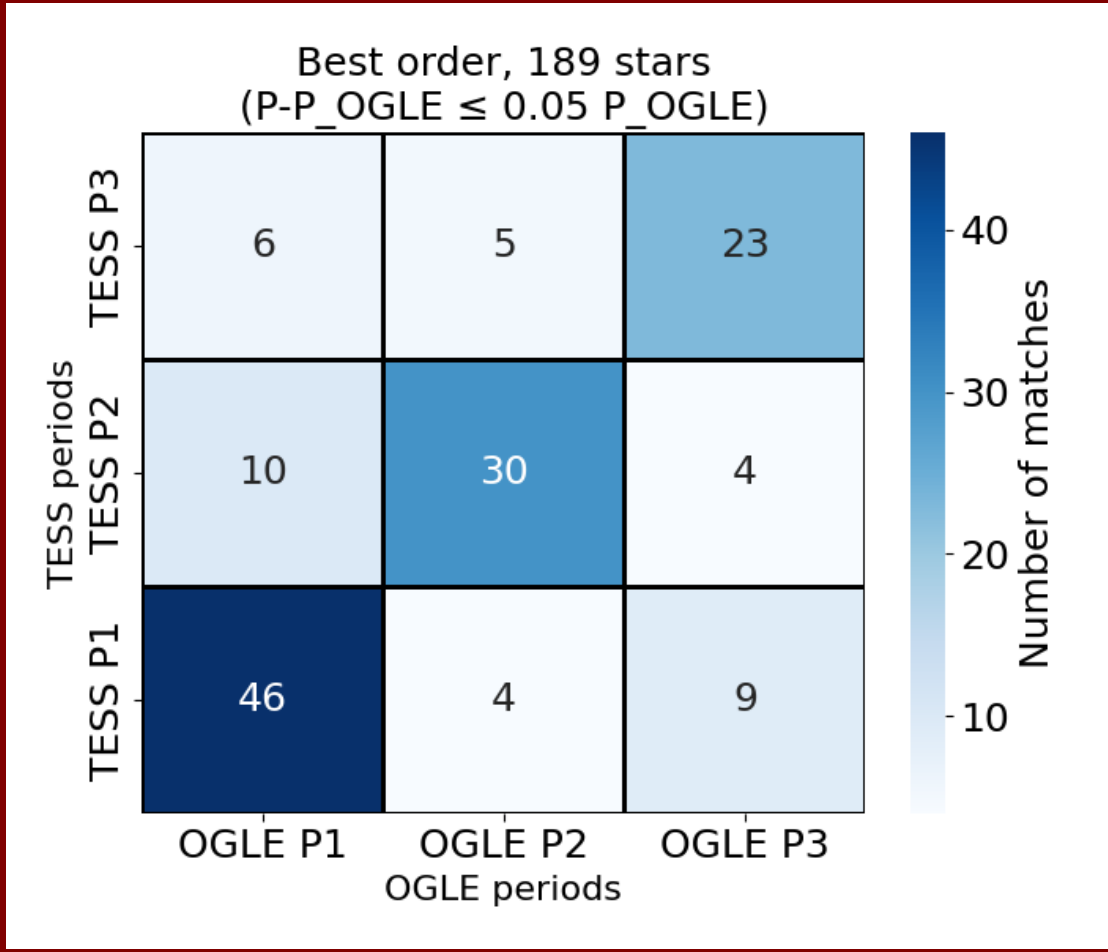
Semiregular variables

- visual inspection of fits -> *subjective* subsample of good candidates (**1 266 -> 454 stars**)
- aquire periods on full stitched / original LC and individual segments -> find best fit
- **„good” TESS target: better that 1% / 5% accuracy for at least 1 period**

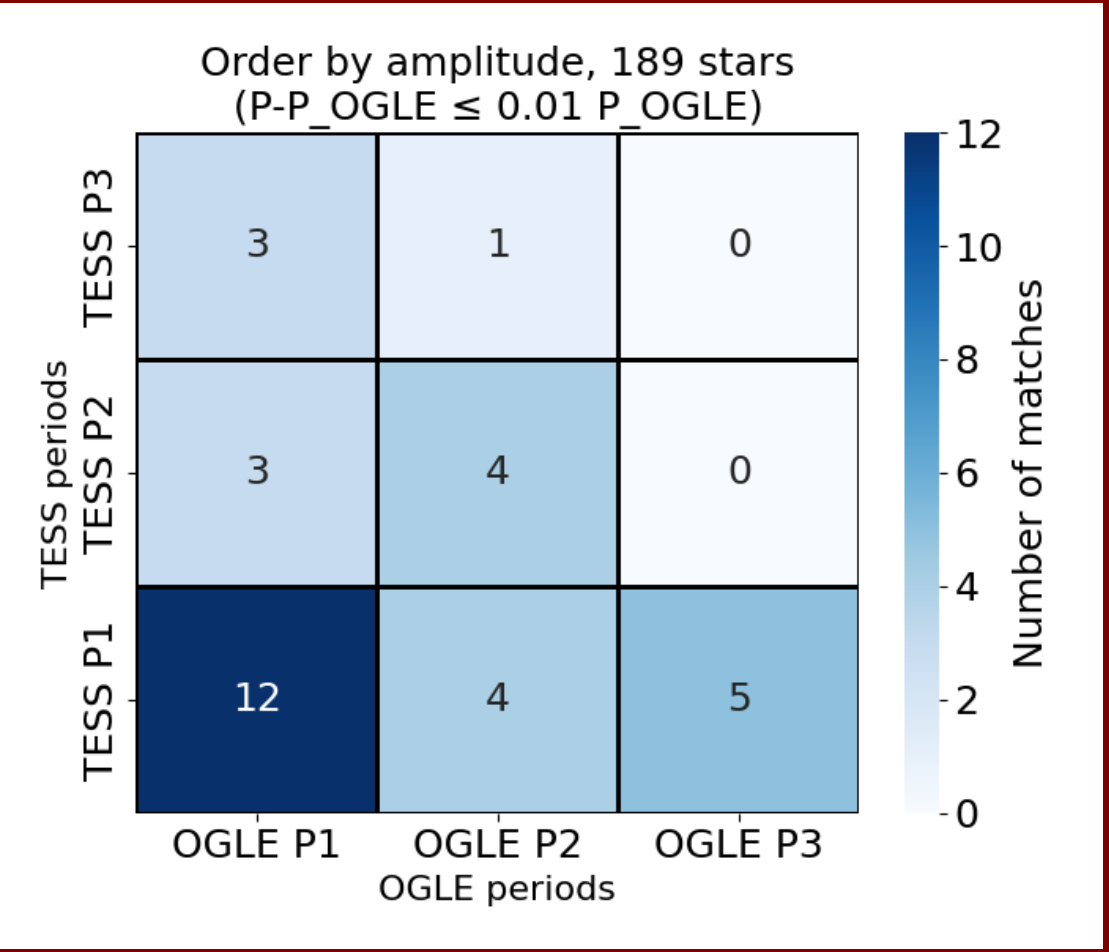


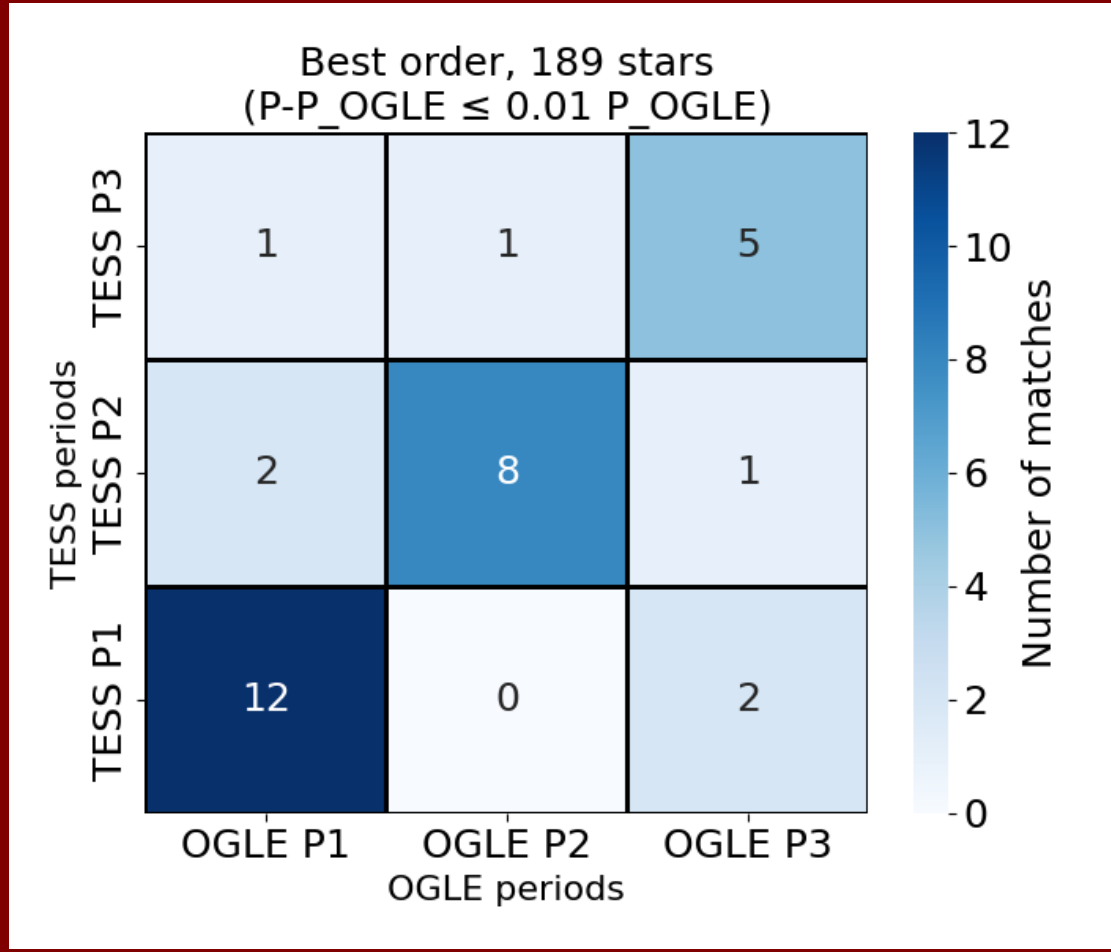
SRV results (tolerance: 5%)





SRV results (tolerance: 1%)





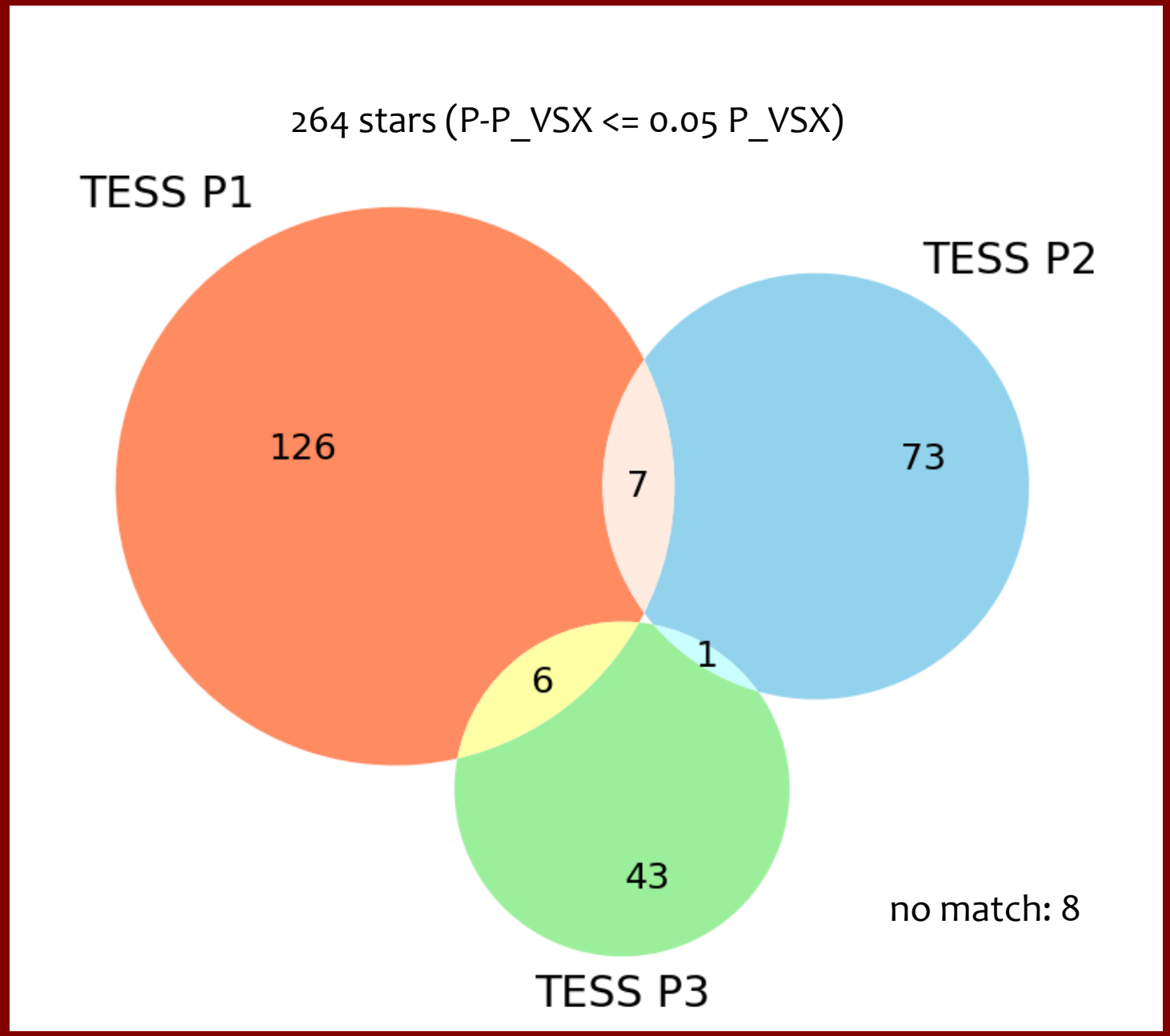
SRV results

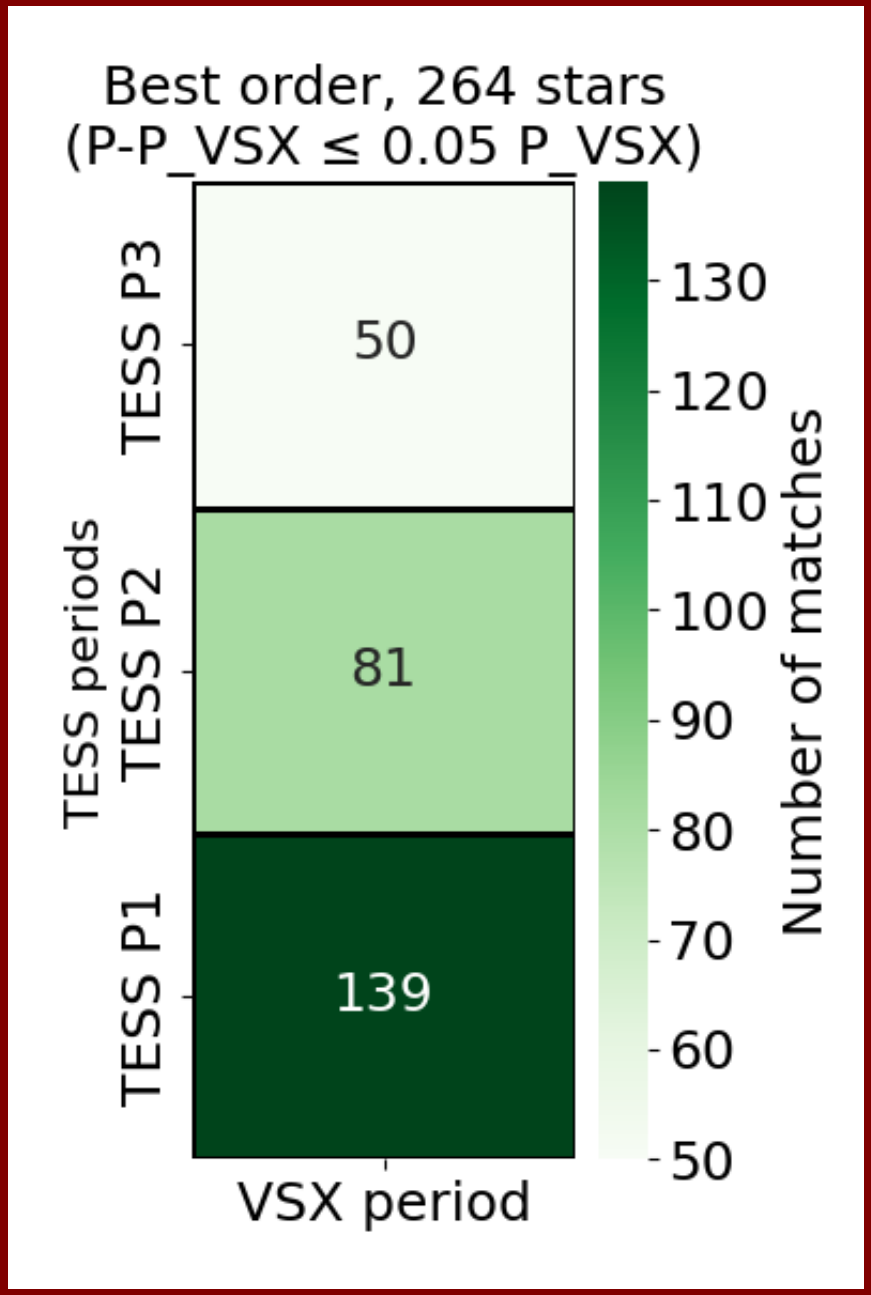
A: 5% tolerance
B: 1%

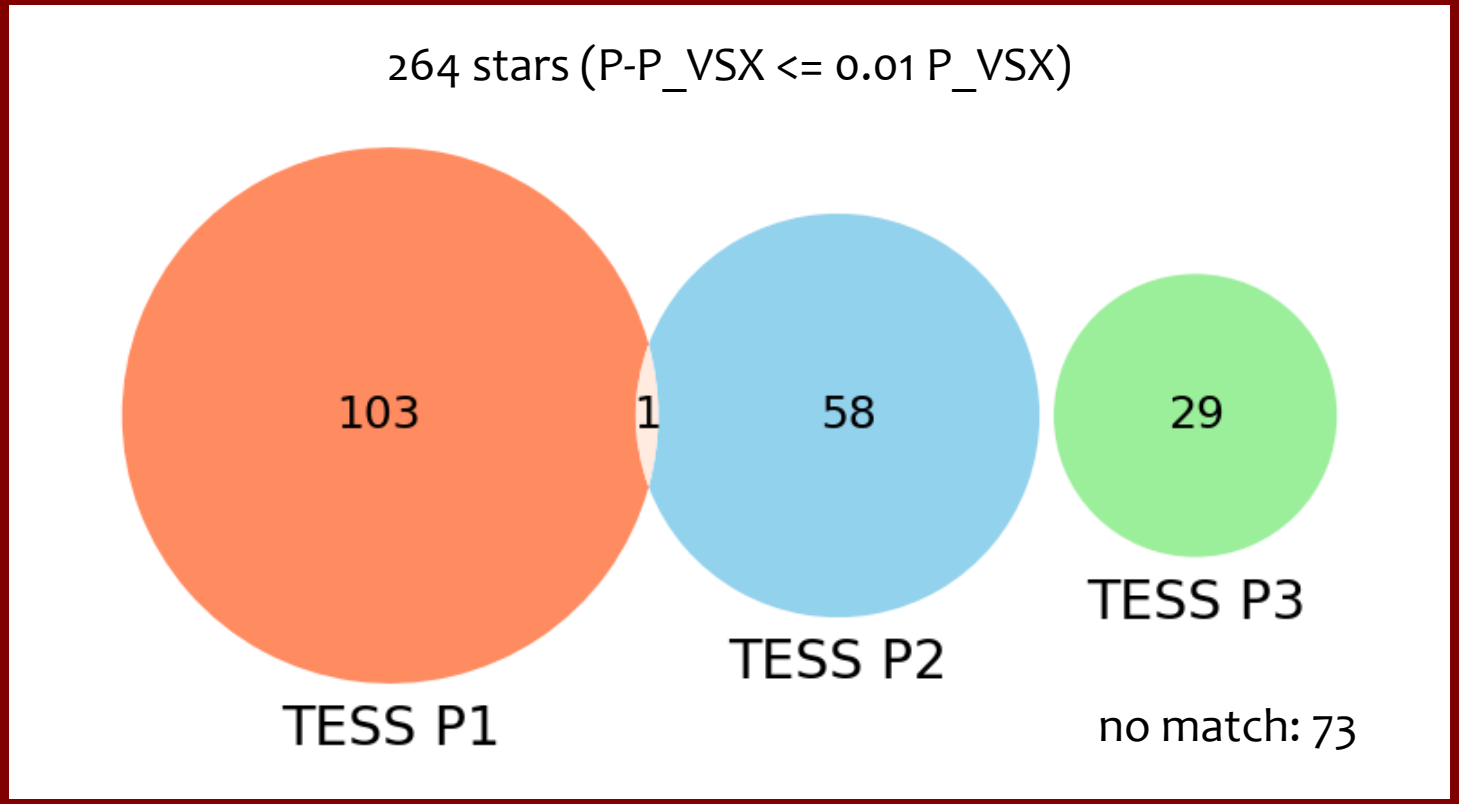
- VSX matches among 264 candidates with no OGLE period: 97% (A) / 72% (B)
- total percentage of good targets (best order): **28% (A) / 17% (B)**
- 2 period matches (OGLE): 36 (A) / 3 (B)
- all three periods: 6 (A) / 0 (B)
- best method (original, stitched, segments) and photometry (QLP, TGLC) was selected for each star

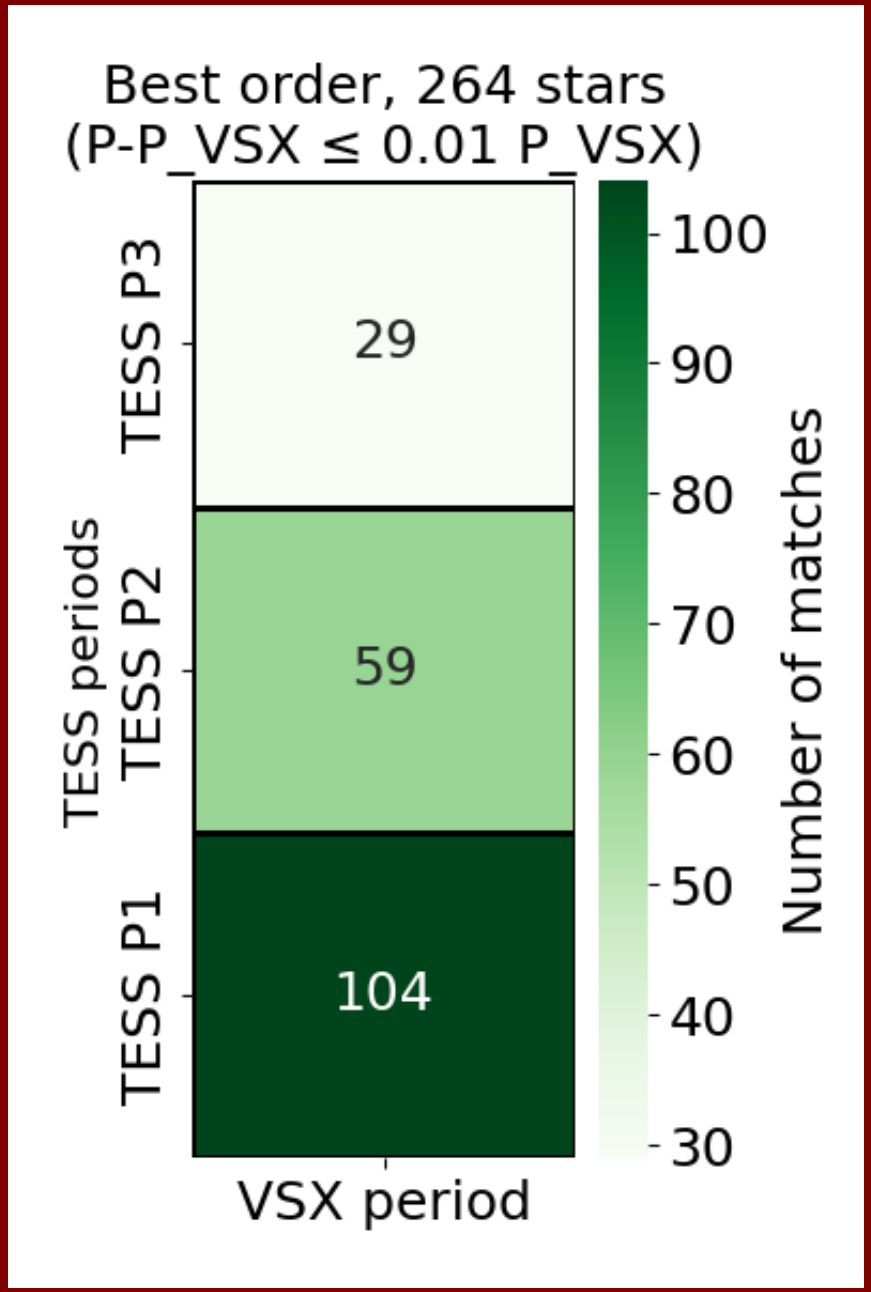
Conclusions

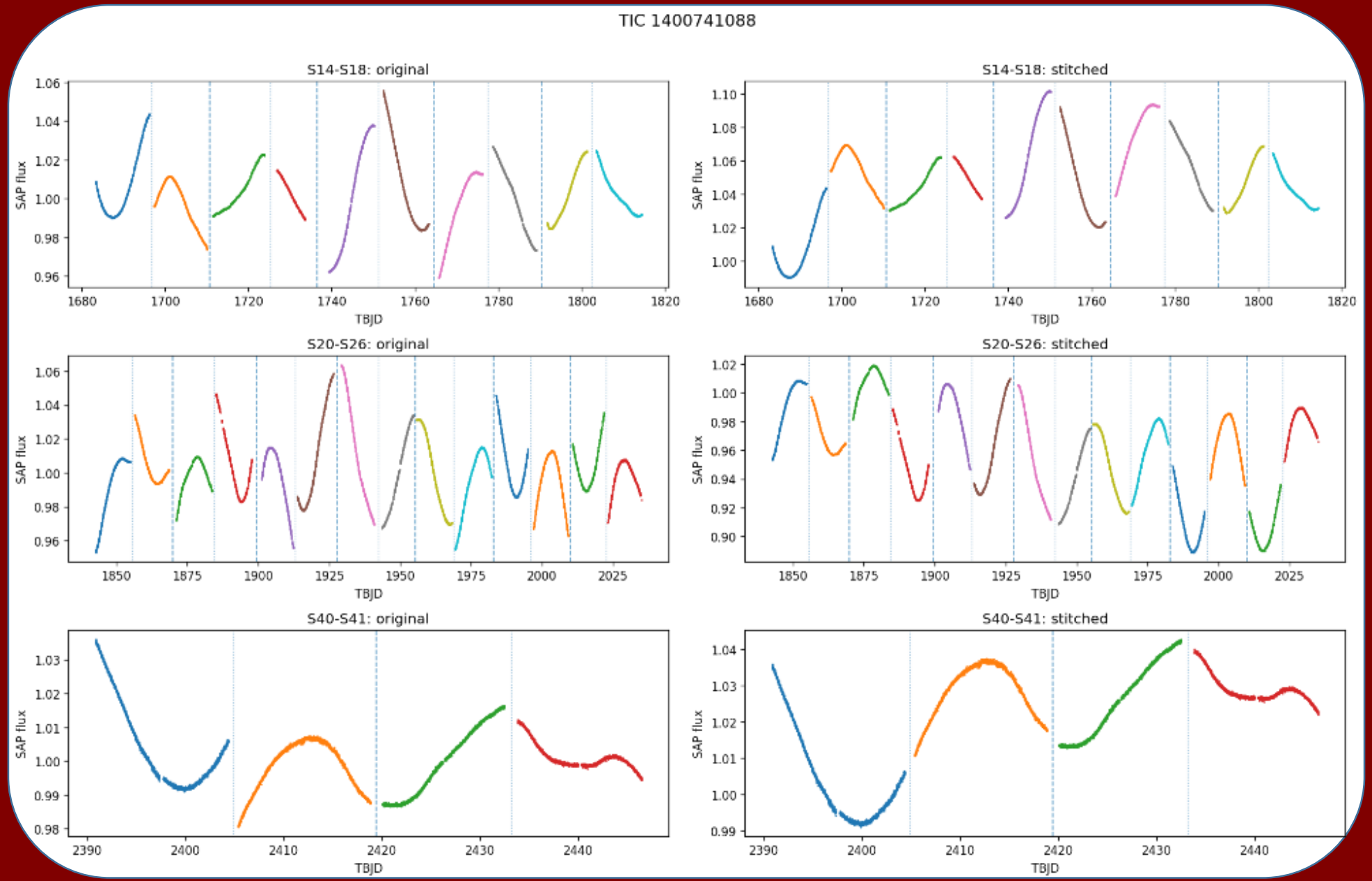
- OSARG, RV Tau: few targets for analysis
- **SRV: moderate yield, long secondary periods are uncertain due to trends**
- future work:
  - TESS Year 8 data: better overlapping of middle latitudes, access to more targets
  - **intristic changes: difference beteween TESS years and slicing OGLE data may help decide**

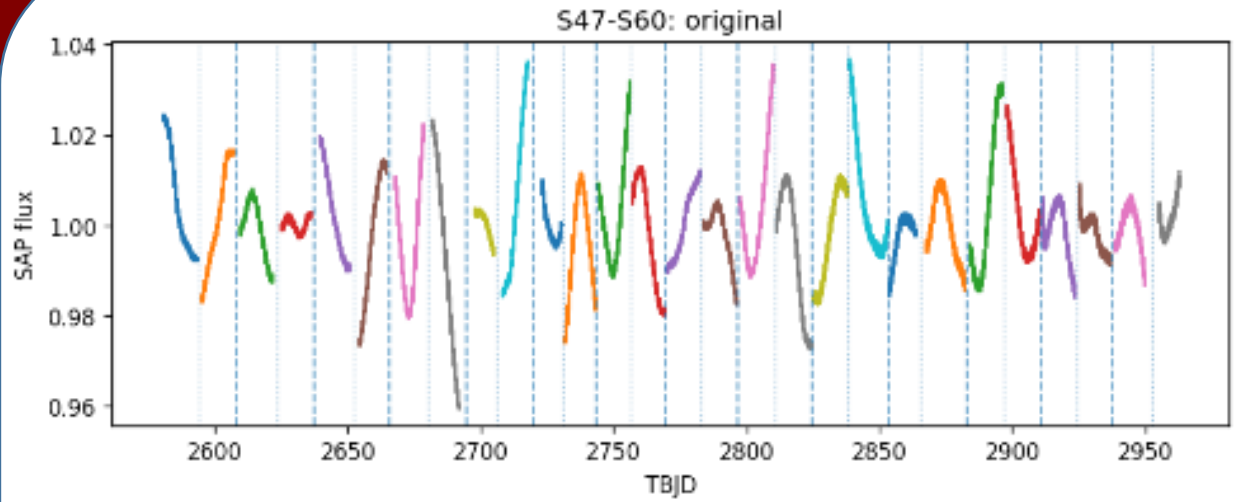

264 stars (P-P_VSX <= 0.05 P_VSX)
TESS P1
TESS P2
TESS P3
126
73
43
7
6
1
no match: 8

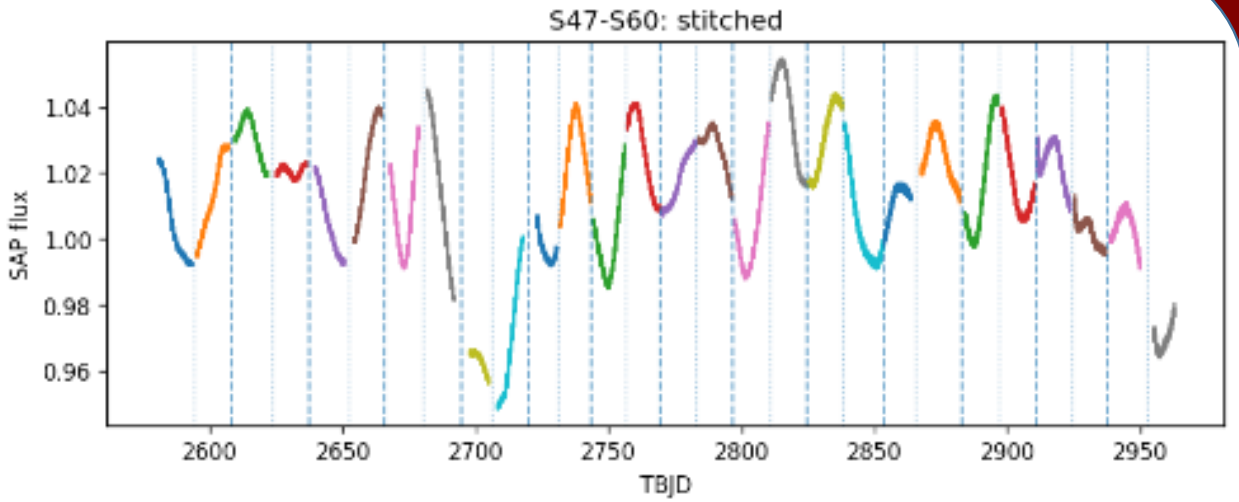

Best order, 264 stars
(P-P_VSX ≤ 0.05 P_VSX)
TESS periods
TESS P3
TESS P2
TESS P1
50
81
139
VSX period
Number of matches
130
120
110
100
90
80
70
60
50

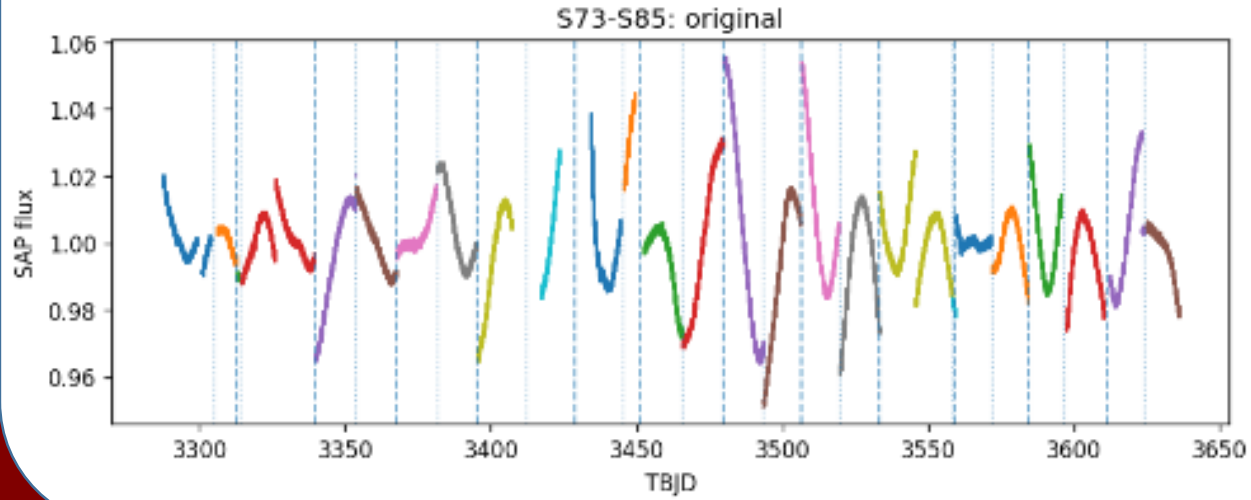

264 stars (P-P_VSX <= 0.01 P_VSX)
103
1
58
29
TESS P1
TESS P2
TESS P3
no match: 73

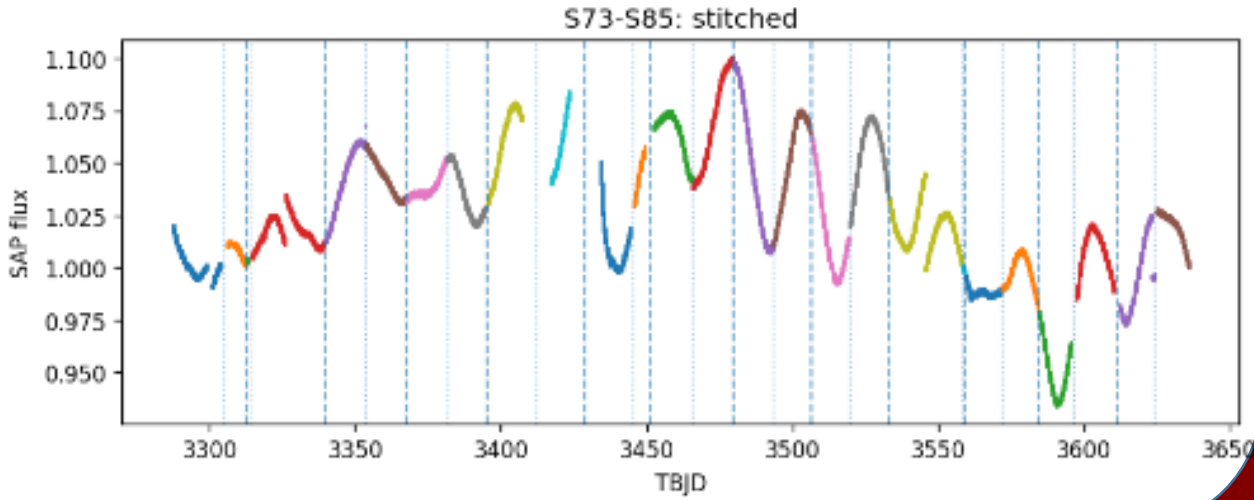

Best order, 264 stars
(P-P_VSX ≤ 0.01 P_VSX)
TESS periods
TESS P3
TESS P2
TESS P1
29
59
104
VSX period
Number of matches
100
90
80
70
60
50
40
30


TIC 1400741088
S14-S18: original
S14-S18: stitched
S20-S26: original
S20-S26: stitched
S40-S41: original
S40-S41: stitched
SAP flux
TBJD

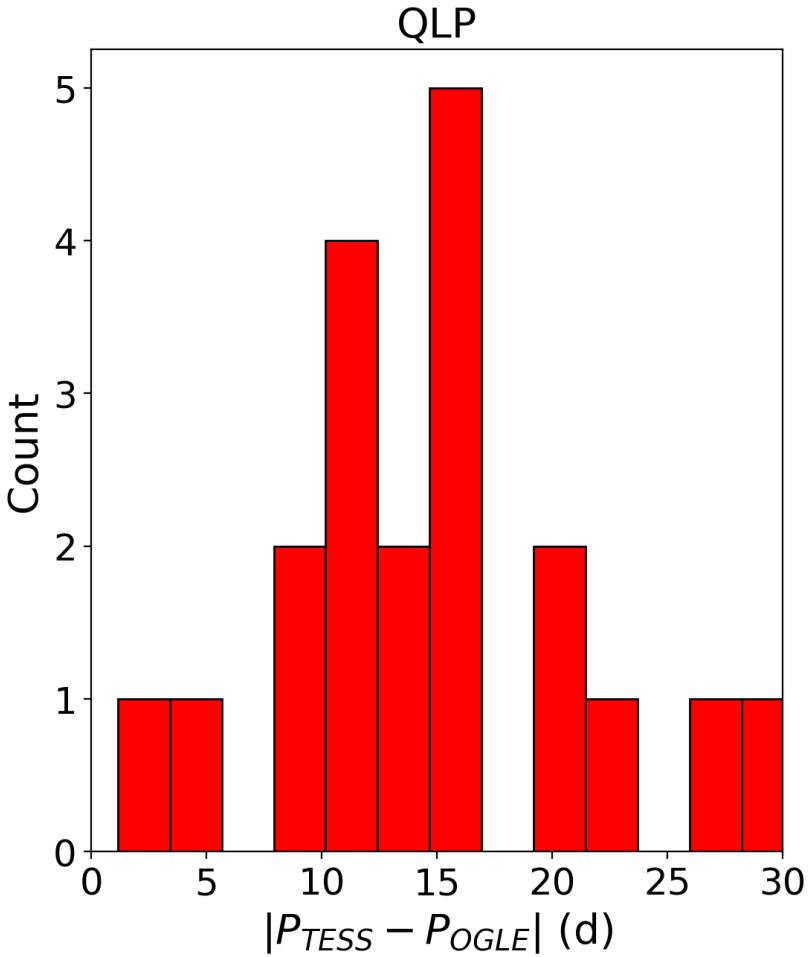

S47-S60: original
SAP flux
TBJD

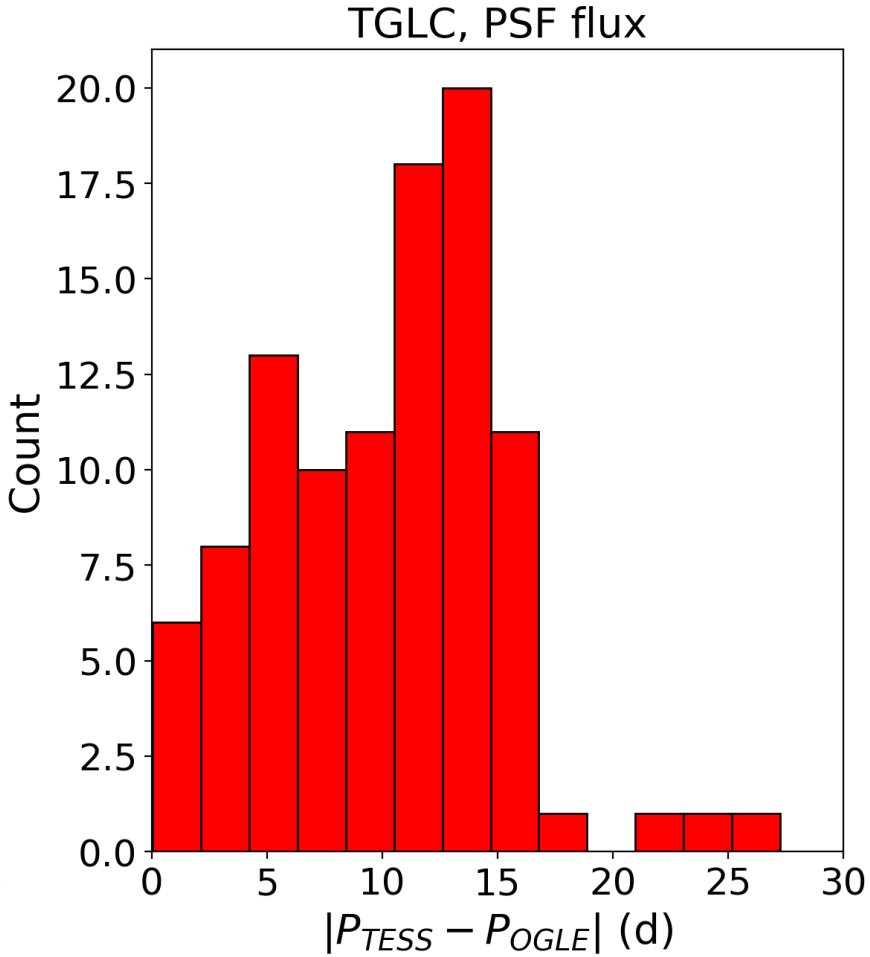

S47-S60: stitched
SAP flux
TBJD

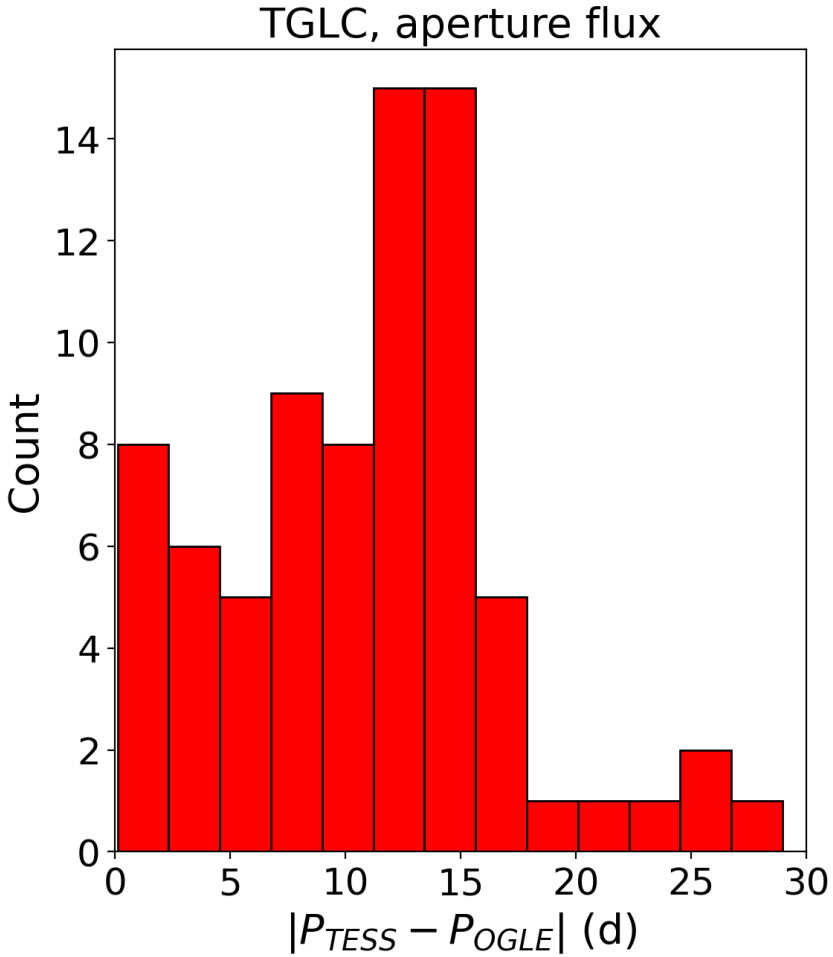

S73-S85: original
SAP flux
TBJD


S73-S85: stitched
SAP flux
TBJD

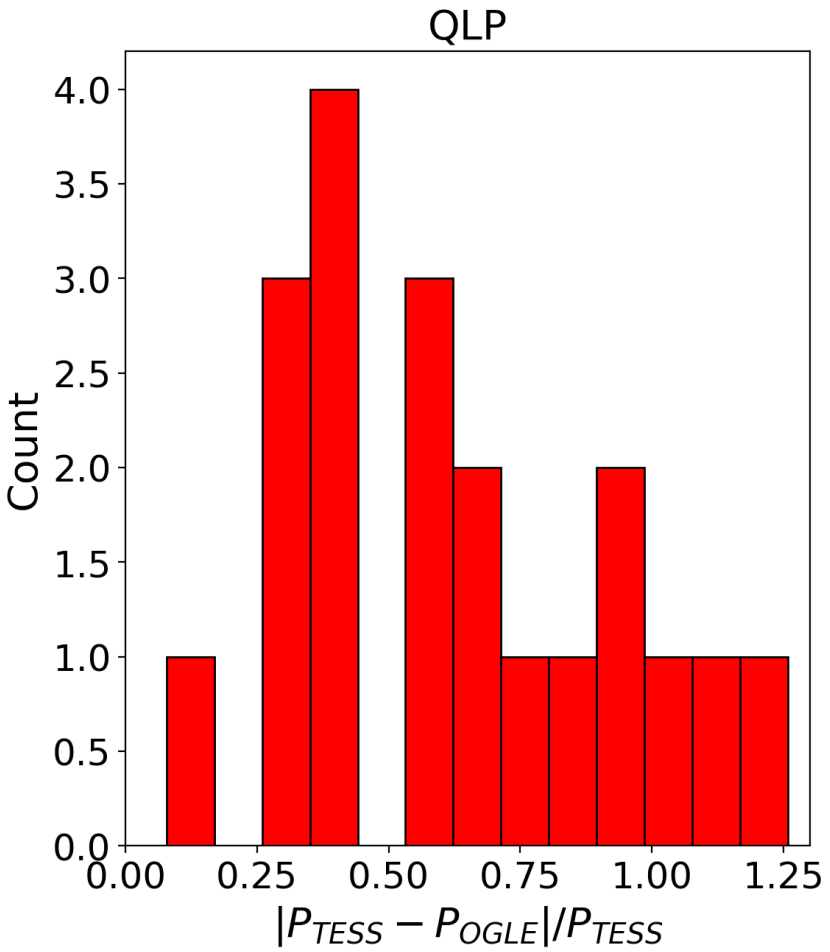
Period differences: AGB OSARG

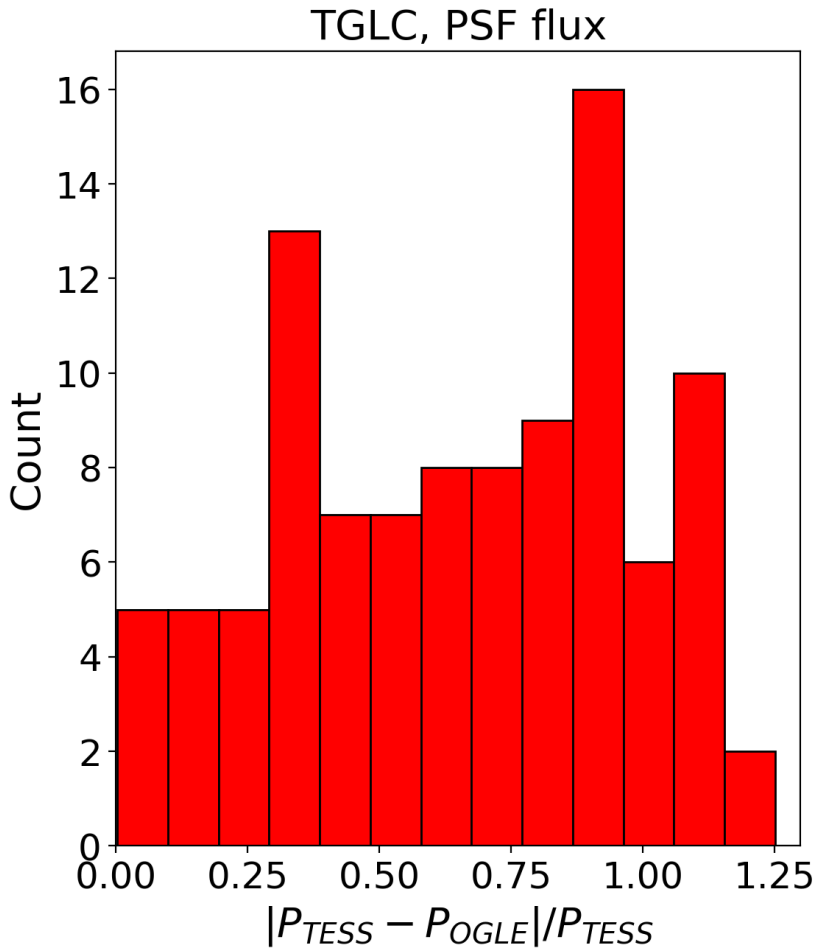


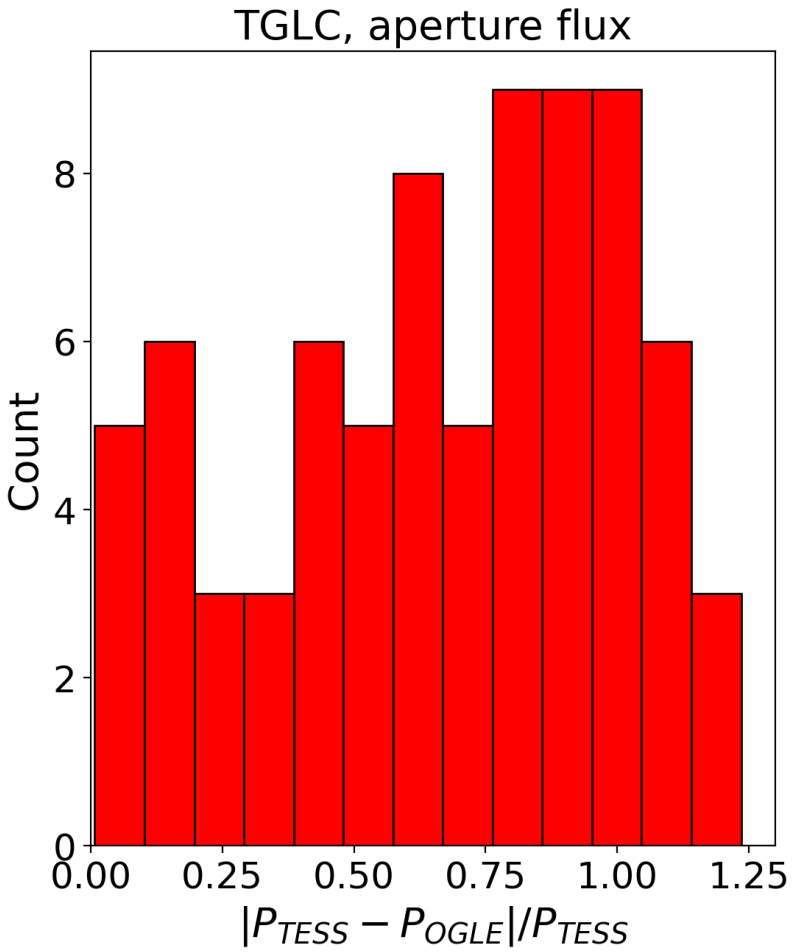




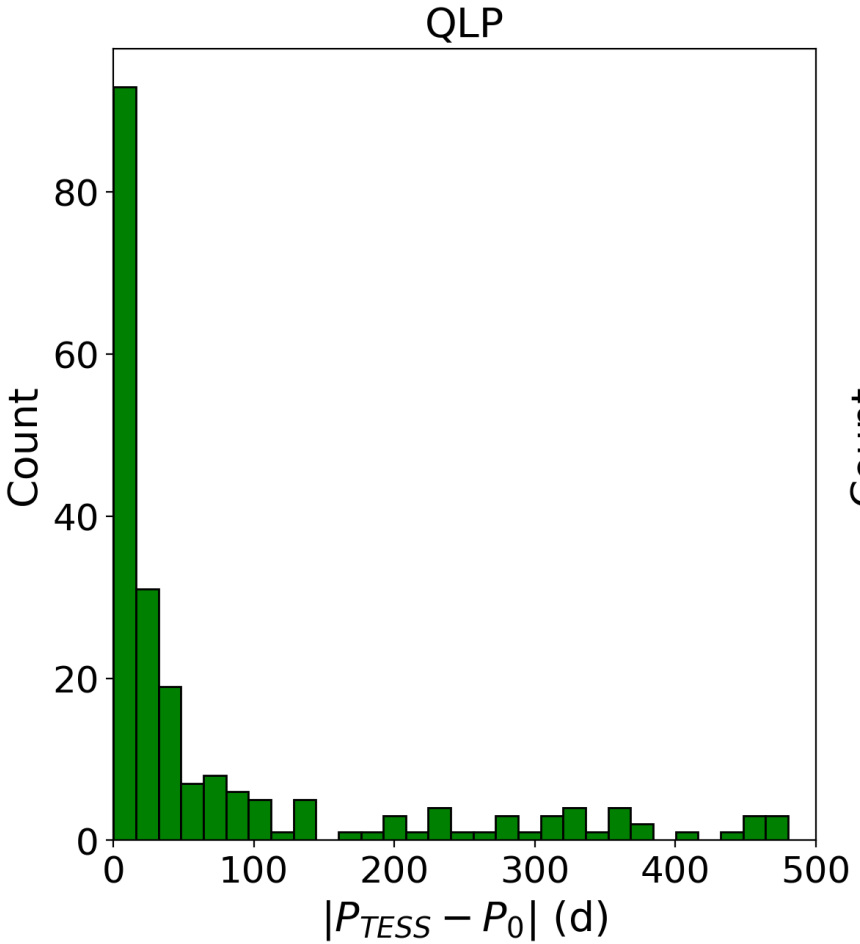
Relative period differences: AGB OSARG

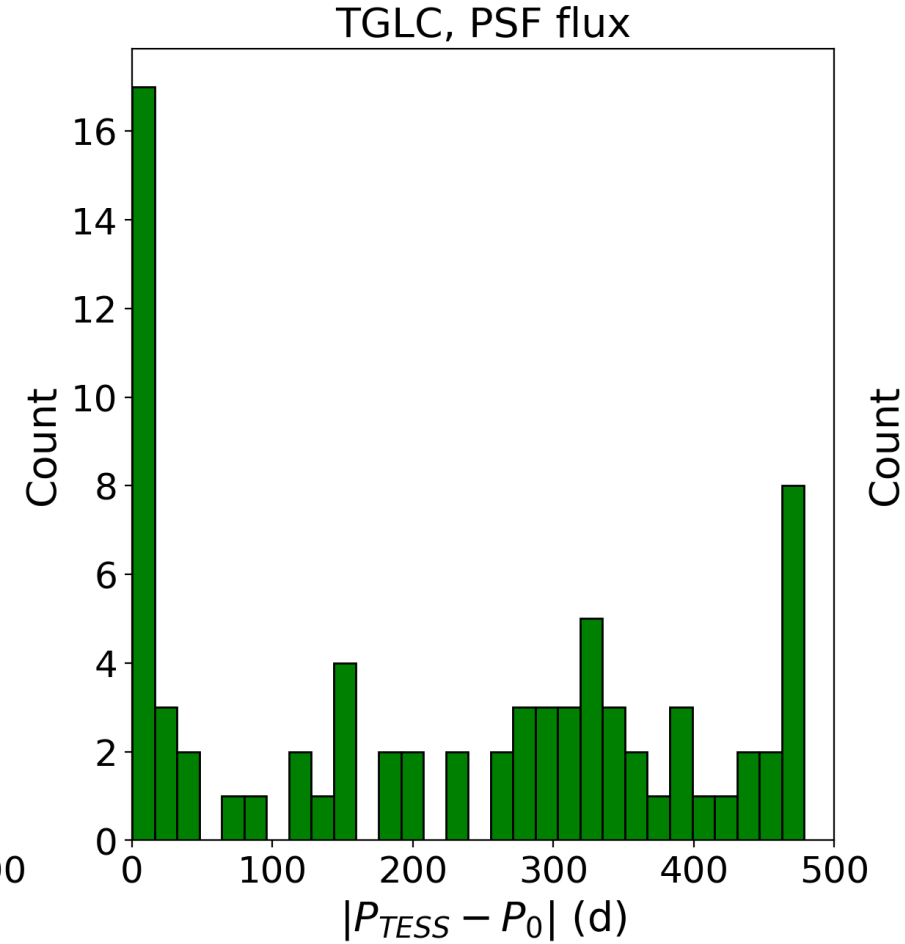


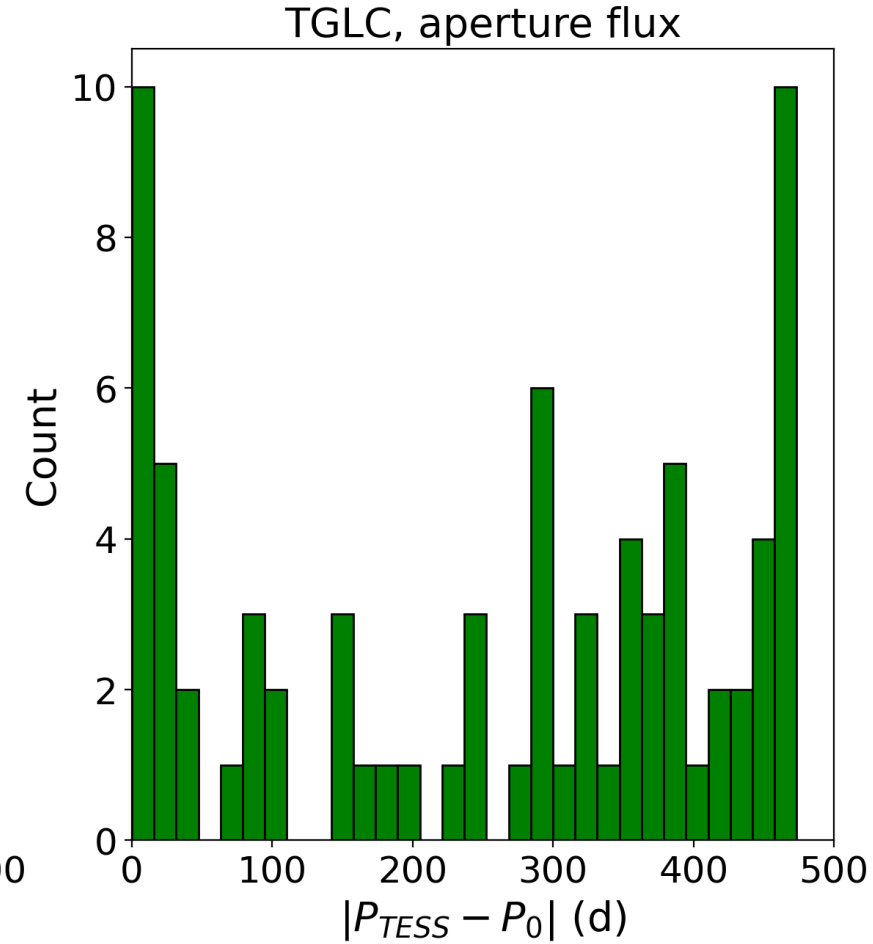




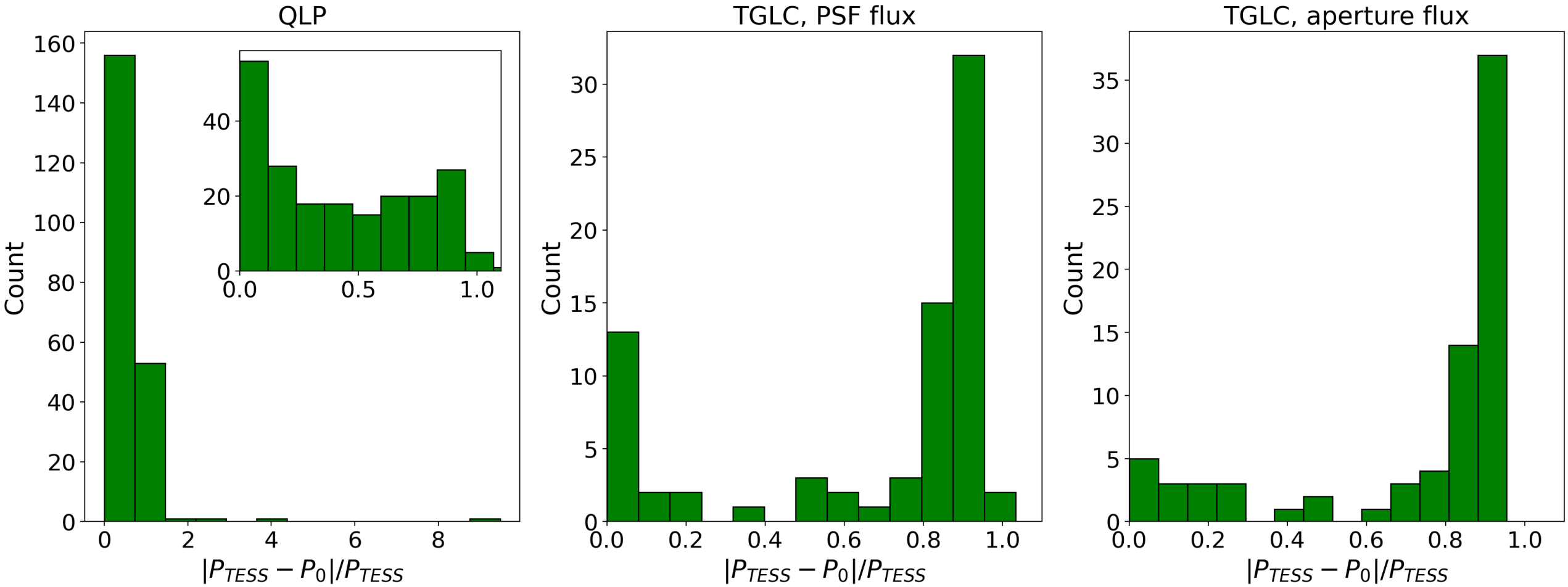
Period differences: RV Tau



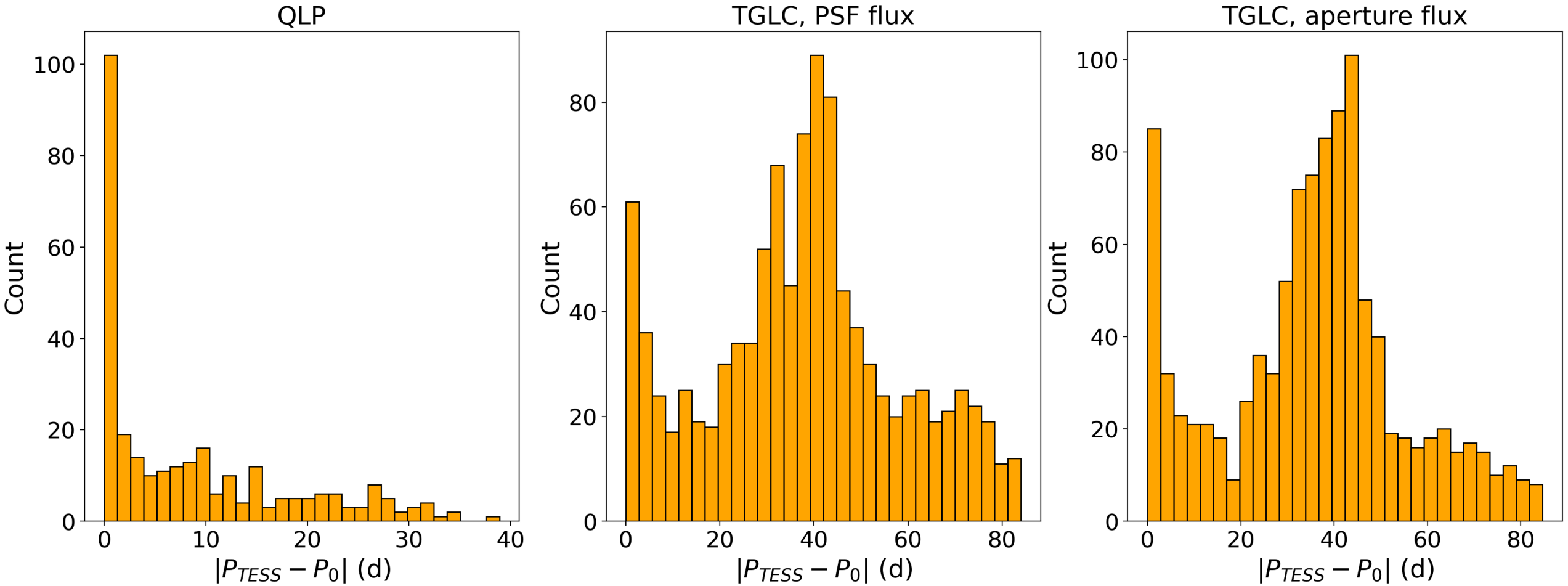




Relative period differences: RV Tau



Period differences: AGB SRV



Relative period differences: AGB SRV

