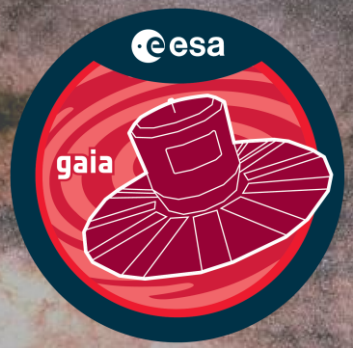
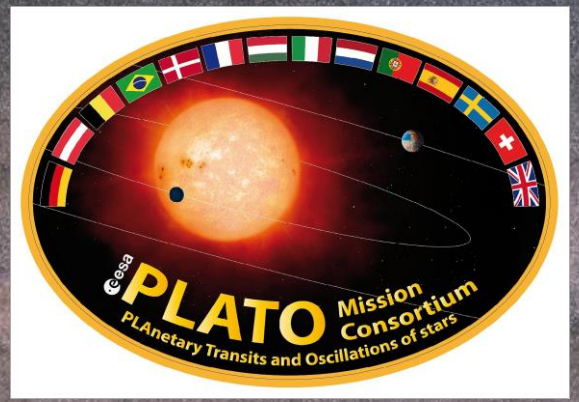
Gaia-PLATO Synergy

Tsevi Mazeh
and
Shay Zucker, Aviad Panahi





PLATO Meeting, Oct. 19th 2022

Gaia–TESS synergy:
Improving the identification of transit candidates

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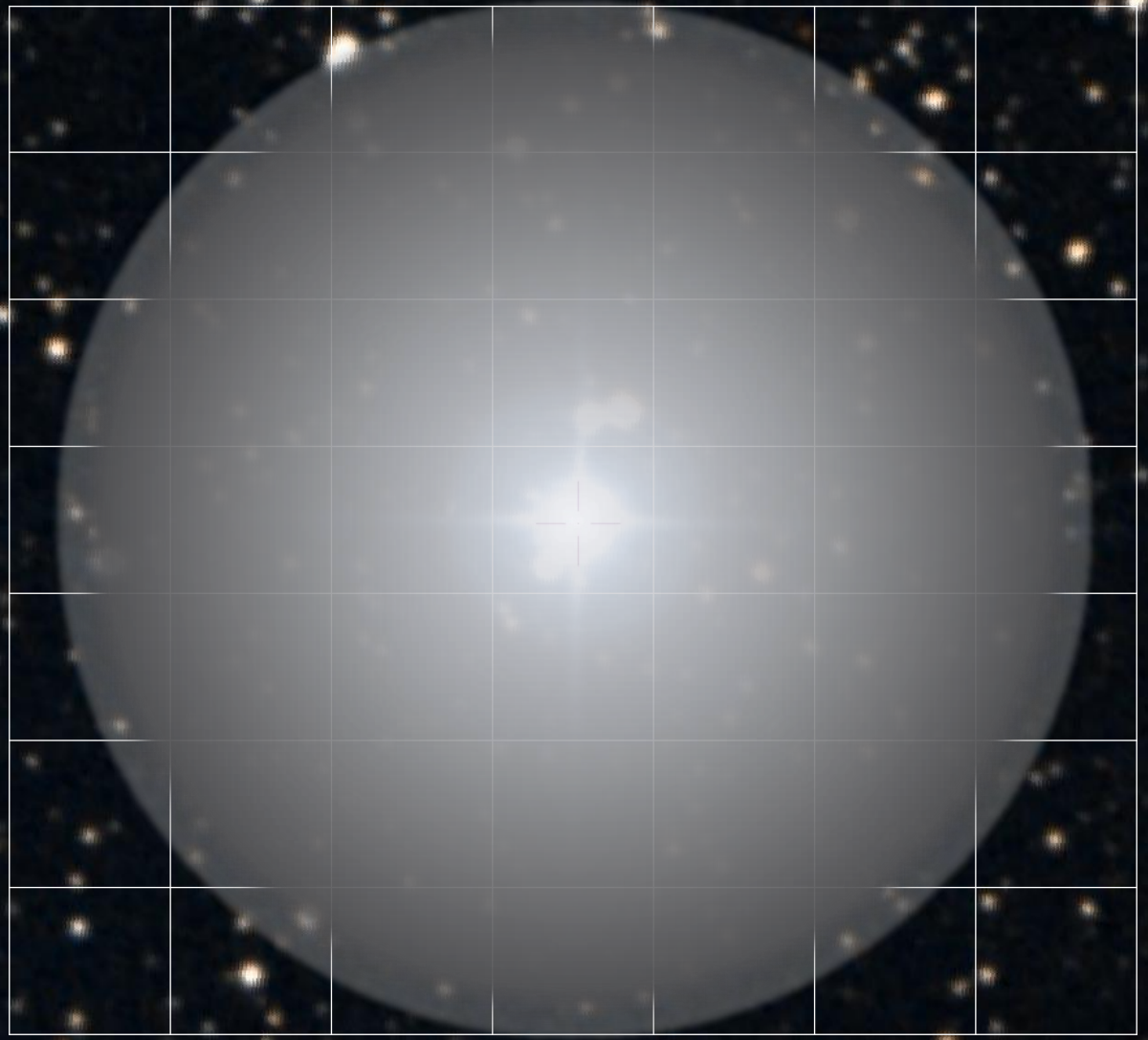
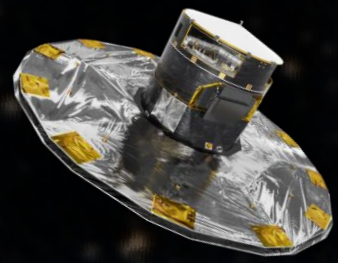
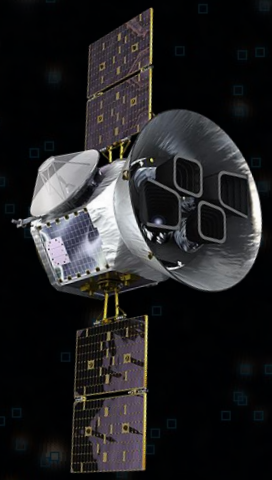
TESS pixels

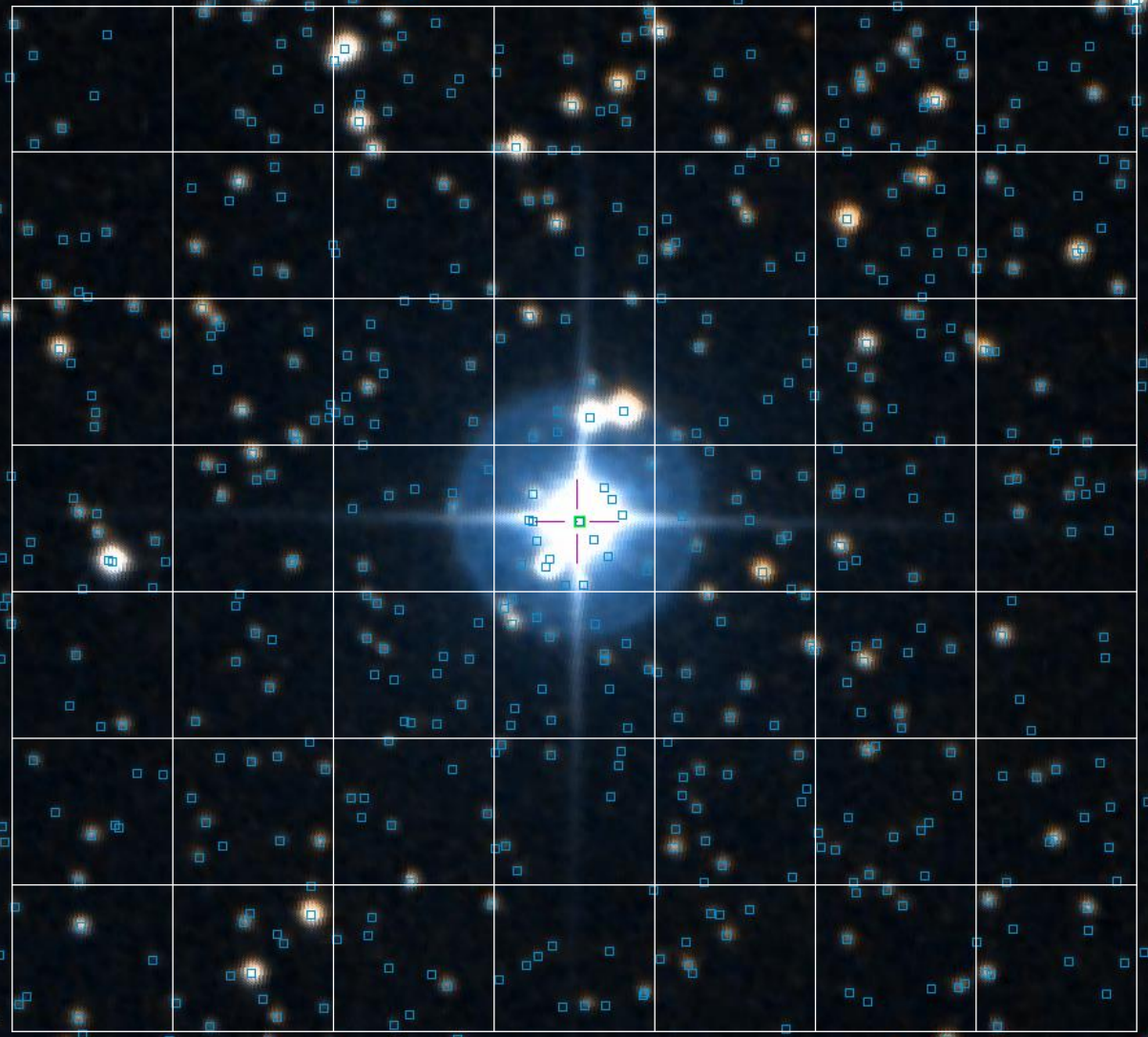
21 arcsec

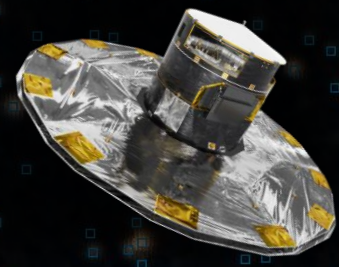




TESS pixels







11.74' x 5.976'

Method outline:

- Cone search around TESS candidate (RA,DEC) – 1 arcmin radius
- ”Focused” BLS on every source in cone

$$P \pm 3\sigma,\ d \pm 3\sigma$$

- Add Gaussian priors:

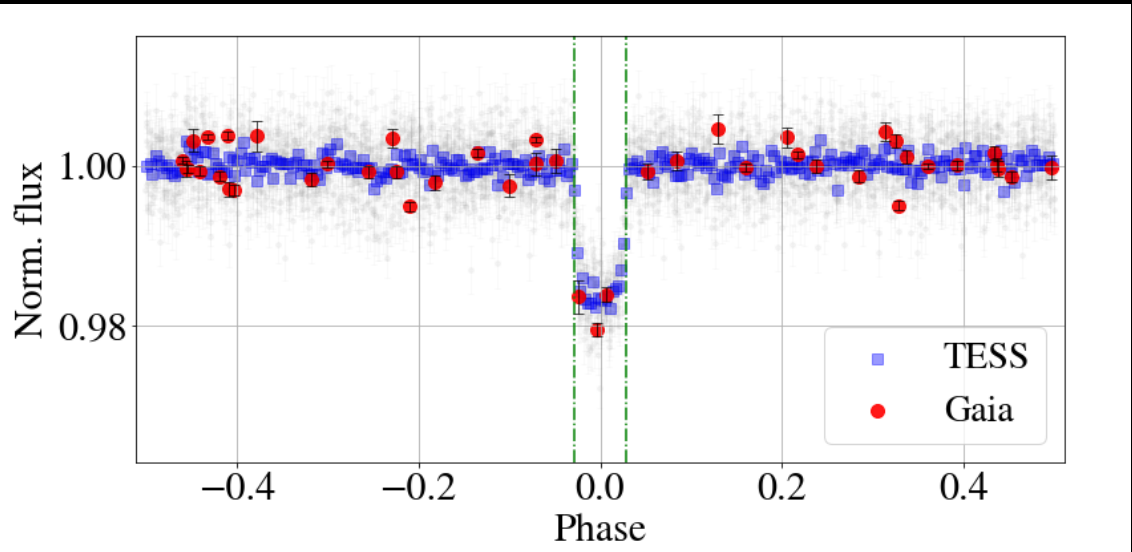
$$\left(\frac{P - P_{\text{TOI}}}{\Delta P_{\text{TOI}}}\right)^2 + \left(\frac{T - T_{\text{TOI}}}{\Delta T_{extended}}\right)^2 + \left(\frac{d - d_{\text{TOI}}}{\Delta d_{\text{TOI}}}\right)^2 \quad ;\ \Delta T_{extended} = \sqrt{\Delta T_{\text{TOI}}^2 + (N_{orbits} \cdot \Delta P_{\text{TOI}})^2}$$

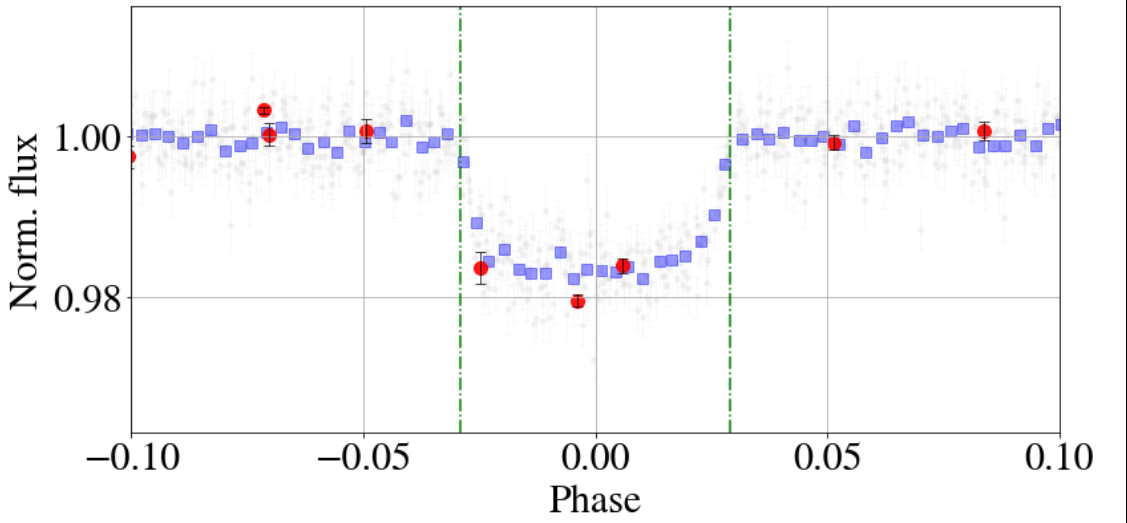
- Sort by TSNR
- Visual inspection, Gaia+TESS photometry

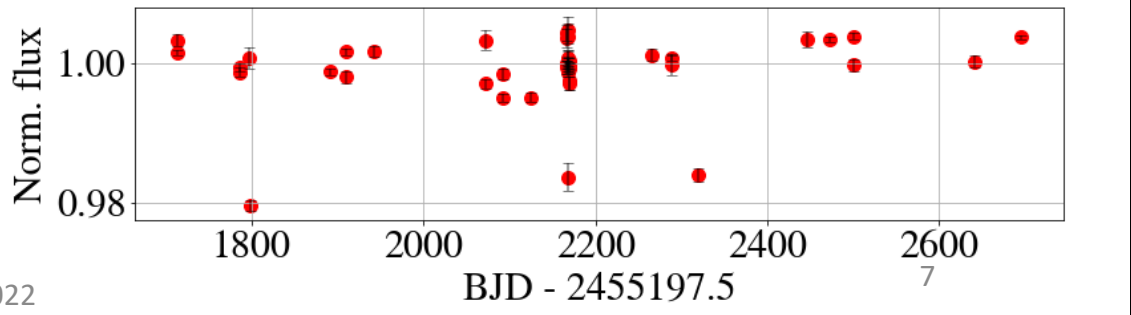
Example: On-target confirmation

TOI 4293.01

Period [days]	1.6242109 ± 0.0000041
TESS Depth [%]	1.9434 ± 0.0002
G mag	13.1
N points	47





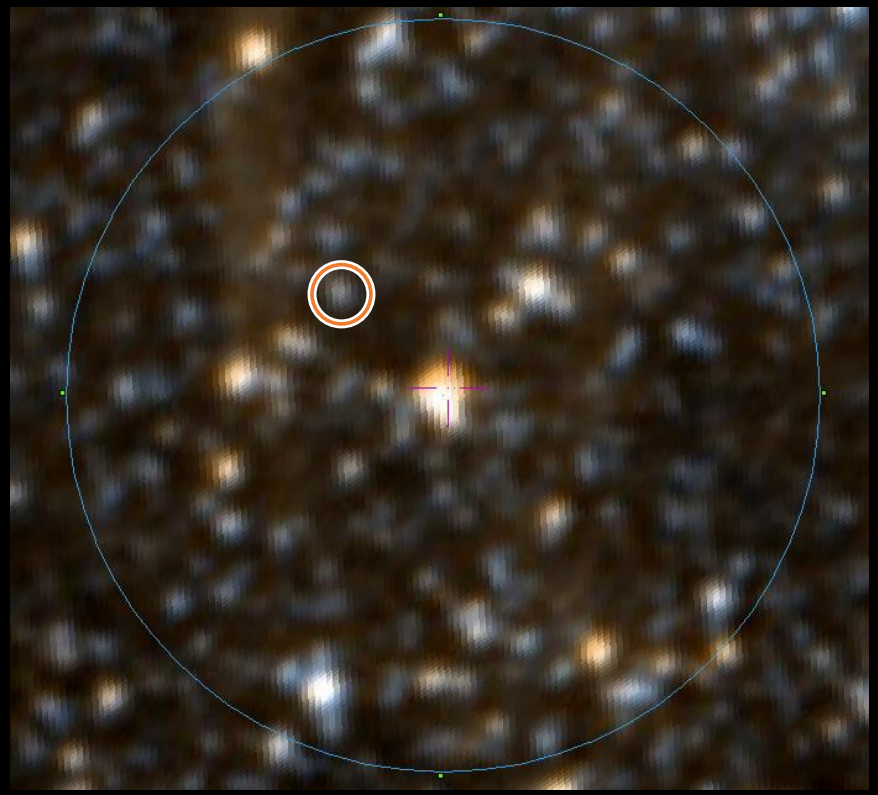


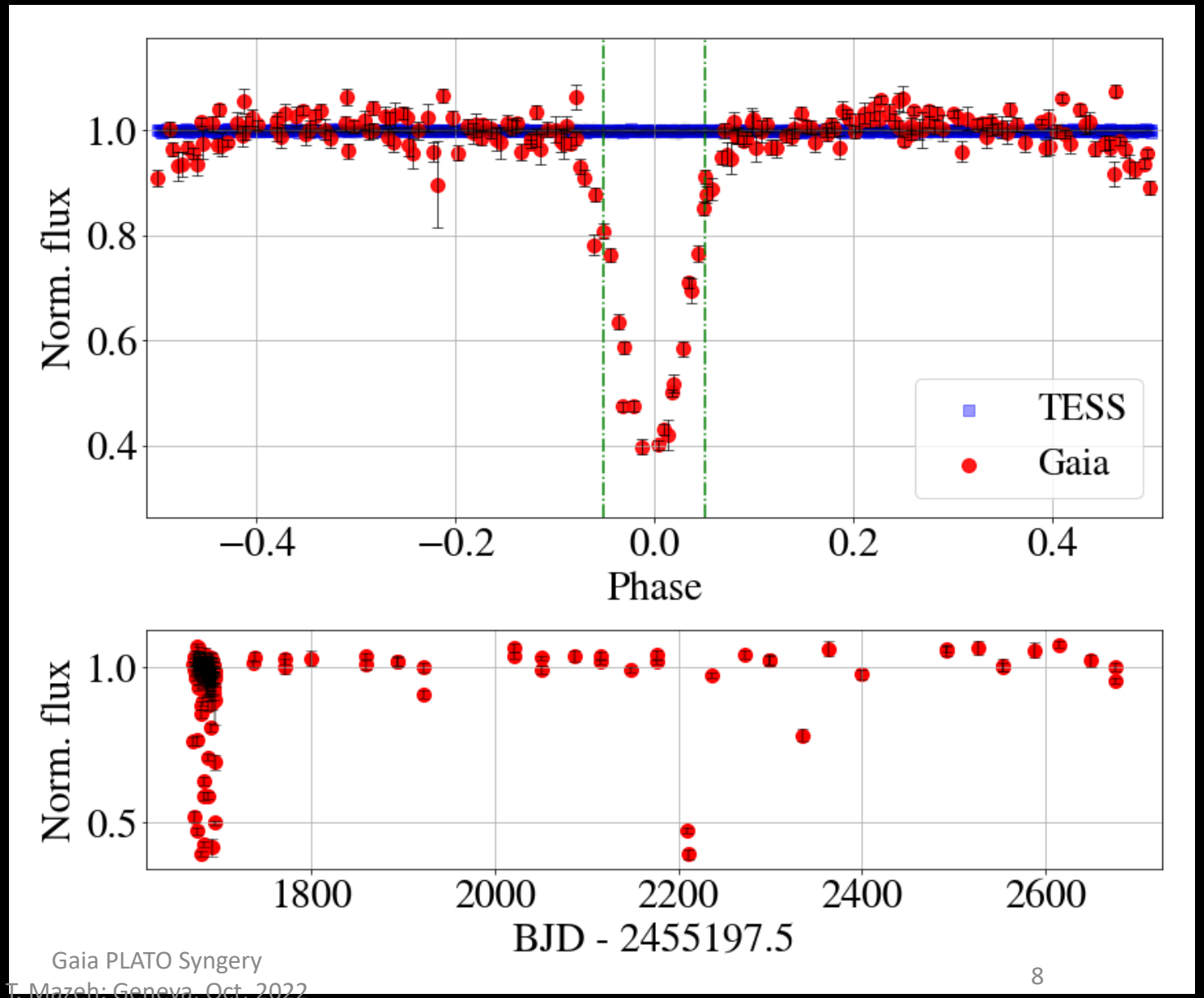
Example: Background Eclipsing Binary (BEB)

TOI $4xxx.01$

Period [days]	3.907712 ± 0.000046
TESS Depth [%]	0.599 ± 0.0048

	BEB	**Targer star**
G mag	19.0	13.4
N points	201	207



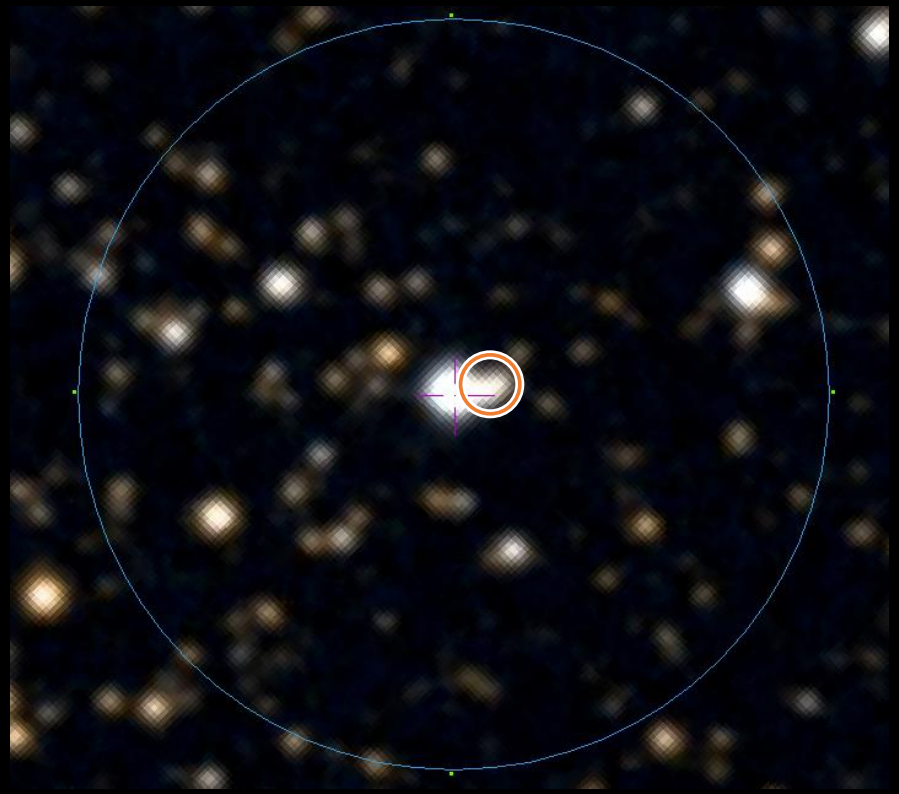


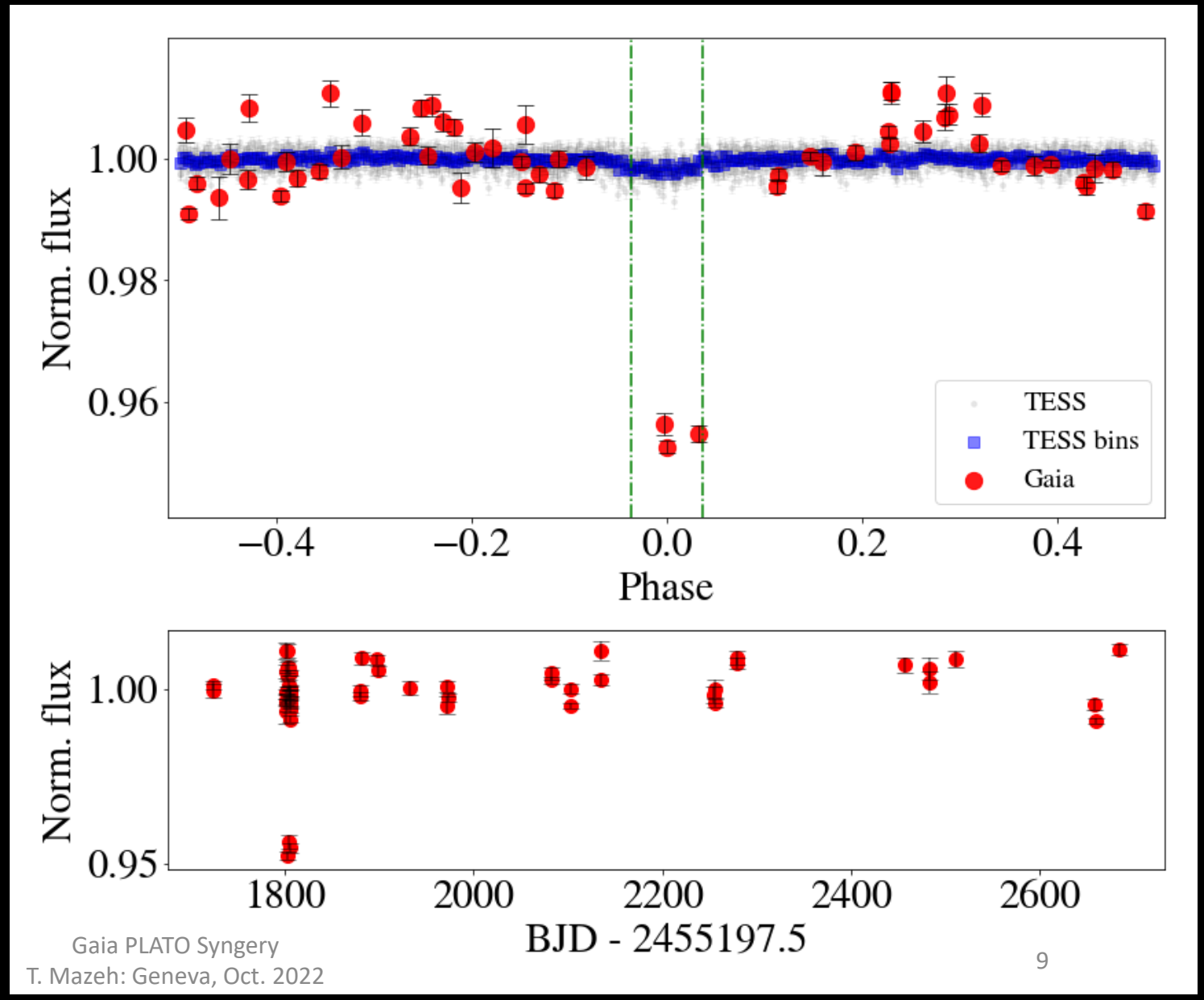
Example: Background Eclipsing Binary (BEB)

TOI $3xxx.01$

Period [days]	1.29978 ± 0.00034
TESS Depth [%]	0.7140 ± 0.0012

	BEB	**Targer star**
G mag	15.8	13.0
N points	56	56



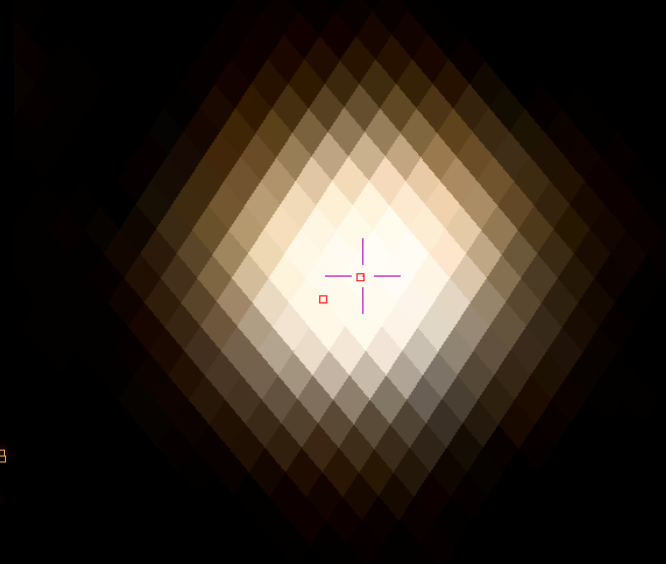


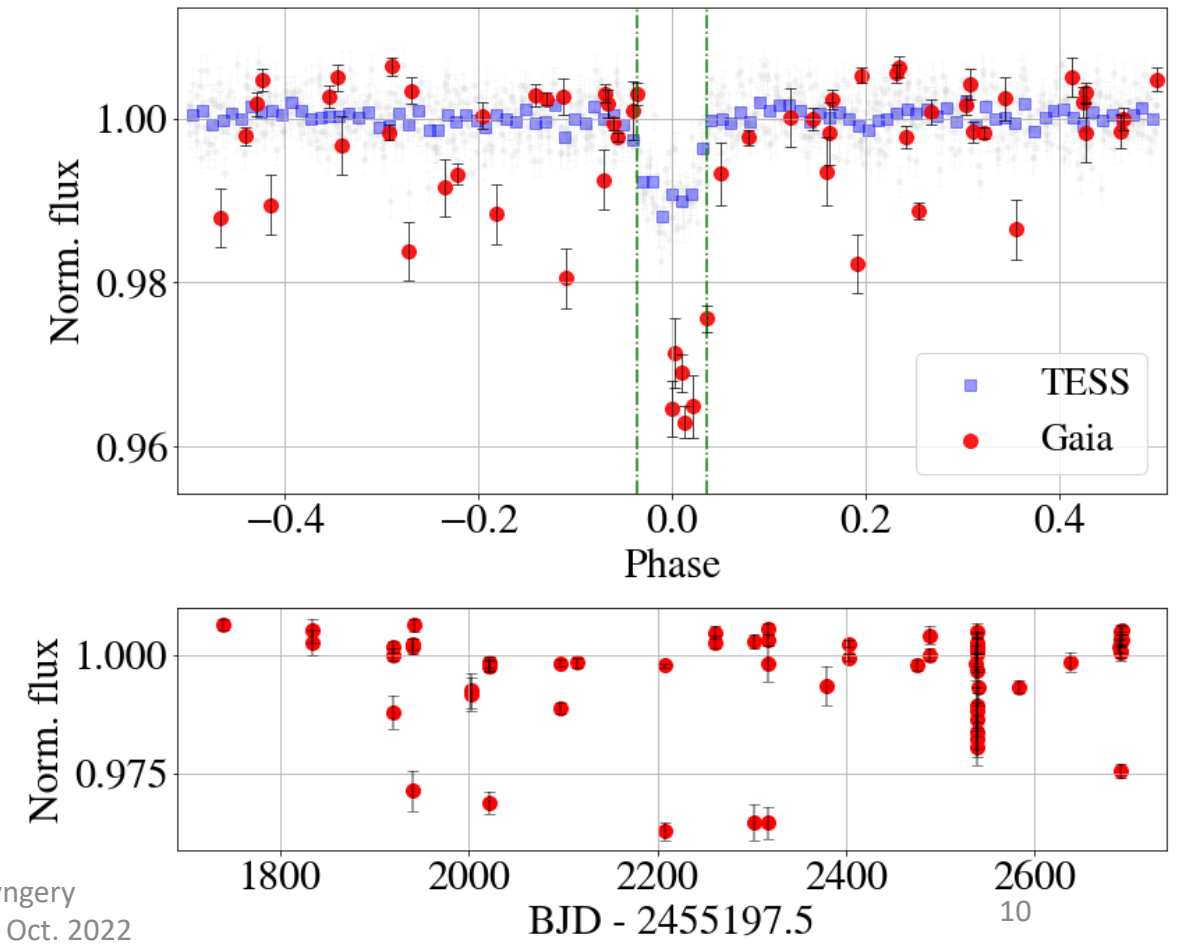
Example: On-target confirmation in a binary system

TOI 3722.01

Star	α (J2016.0) h:m:s	δ (J2016.0) d:m:s	$\mu_{\alpha*}$ mas yr^{-1}	μ_δ mas yr^{-1}	ϖ mas	G mag	$G_{BP} - G_{RP}$ mag
A	3:21:18.05	+63:43:56.75	3.361 ± 0.021	-3.038 ± 0.029	1.403 ± 0.030	14.6773 ± 0.0028	1.204 ± 0.062
B	3:21:17.89	+63:43:57.37	3.602 ± 0.018	-2.542 ± 0.022	1.449 ± 0.026	14.6342 ± 0.0028	1.164 ± 0.027

Period [days]	1.078948 ± 0.000061
TESS Depth [%]	1.341 ± 0.00069
N points	63
Projected separation [AU]	830 ± 10





Summary of PHASE-II TESS-Gaia synergy

$Pr \propto N_{pt} P^{-2/3}$

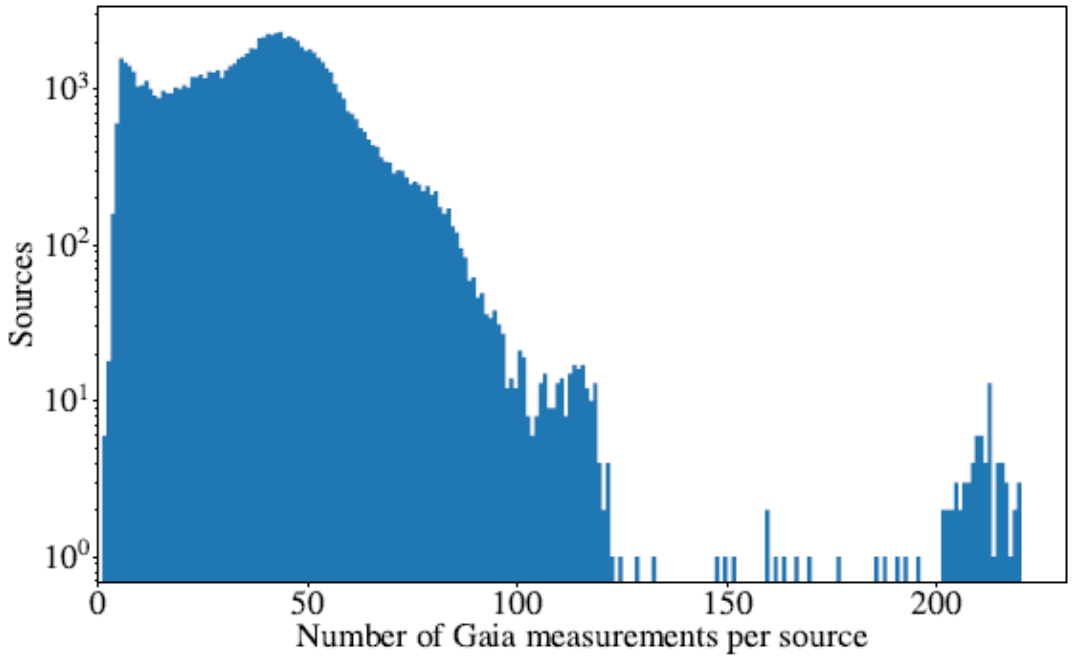


Fig. 6. Phase II: Number of Gaia measurements per star for all 89 460 objects around the 1600 TOIs in Phase II. We note the cluster of stars with more than 200 measurements, which is due to the scanning law of Gaia at the beginning of the mission (see text).

Summary of PHASE-II TESS-Gaia synergy

$Pr \propto N_{pt} P^{-2/3}$

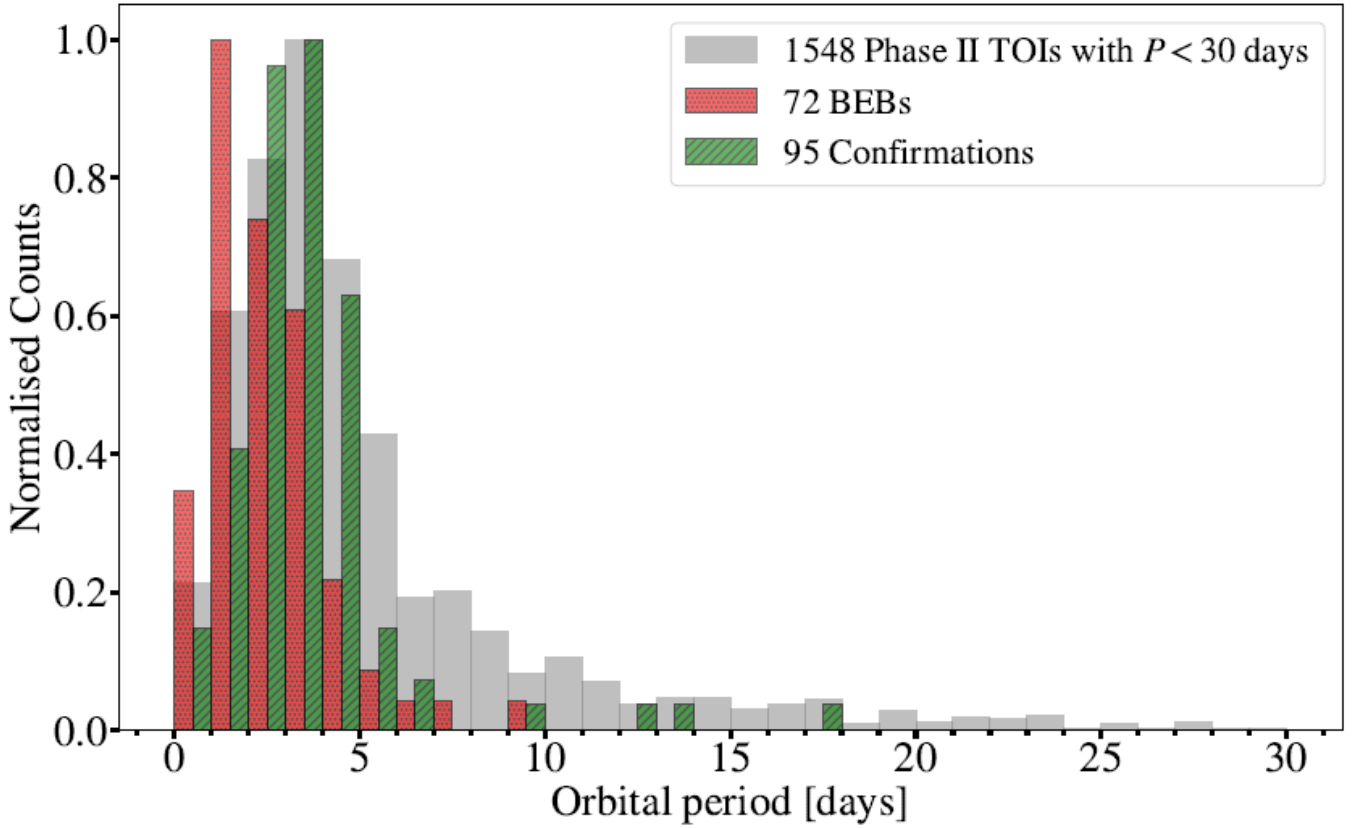


Fig. 10. Phase II: Normalized distribution of orbital periods for all TOIs up to a period of 30 days (gray) and detected on-target confirmations (lined green) and BEBs (dotted red).

Summary of PHASE-II TESS-Gaia synergy

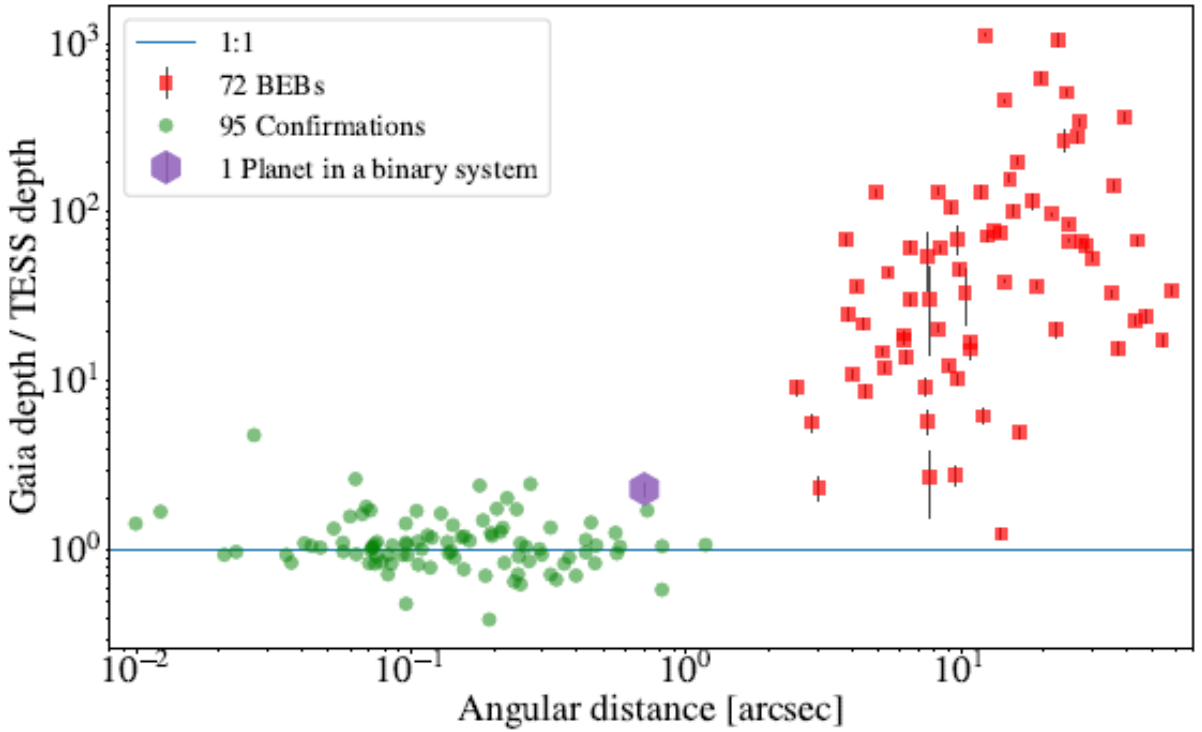


Fig. 8. Phase II: Transit depth ratios versus angular distance between the TOI targets and the Gaia detections, either BEBs or on-target confirmations. We omitted the transit-depth uncertainties for the on-target confirmations. For most of the BEBs, the uncertainties are smaller than the square sizes.

Summary of PHASE-II TESS-Gaia synergy

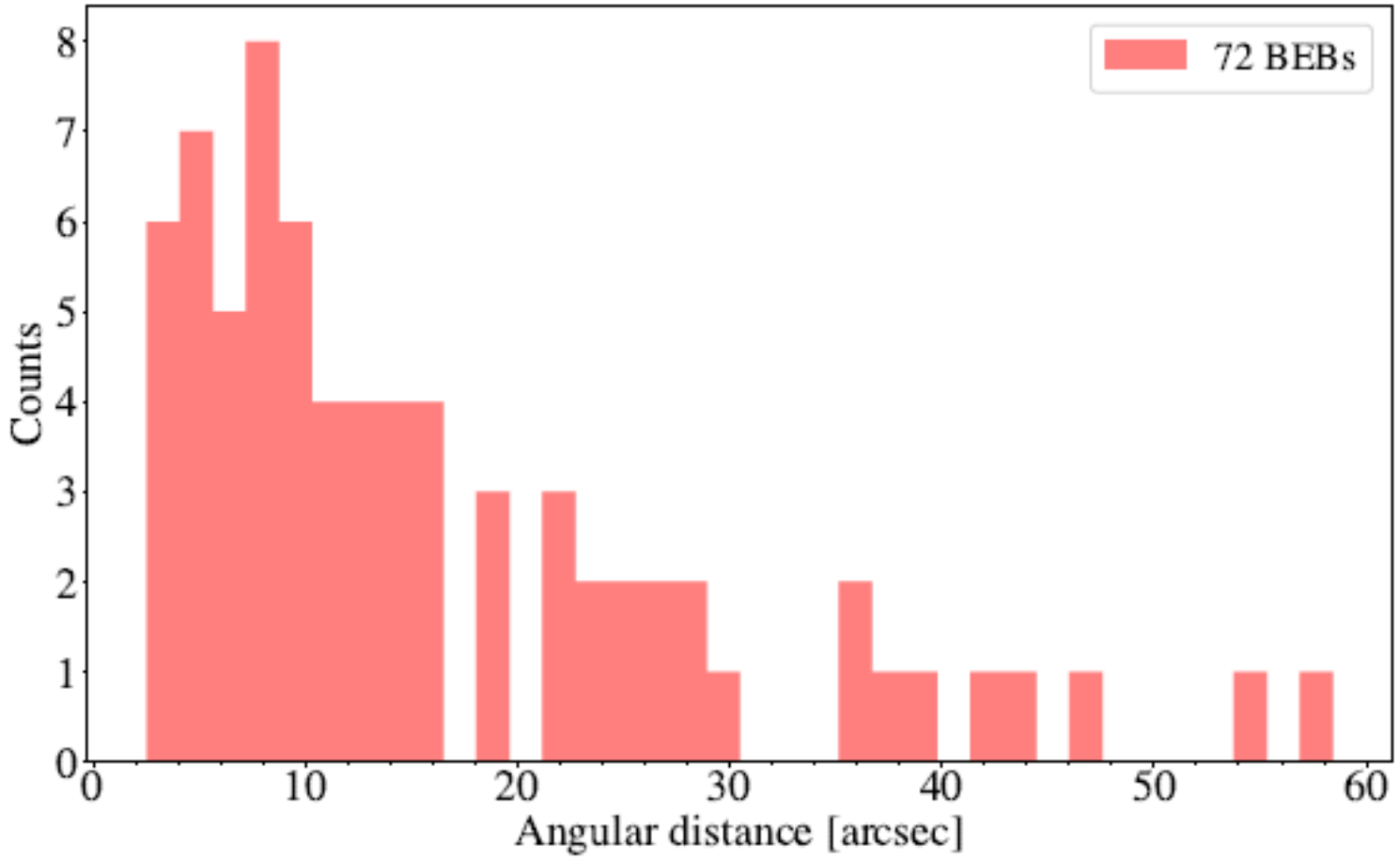


Fig. 9. Phase II: Angular distances of BEBs from their TOIs.

Non-Single Stars

Gaia Data Release 3:
Stellar multiplicity, a teaser for the hidden treasure

F. Arenou , C. Babusiaux , M.A. Barstow , S. Faigler , A. Jorissen , P. Kervella , T. Mazeh , N. Mowlavi , P. Panuzzo , J. Sahlmann , S. Shahaf , A. Sozzetti et al.

nss_acceleration_astro Acceleration	246 947
nss_two_body_orbit Orbital	134 598
AstroSpectroSB1	33 467
SB1 or SB2	186 905
Eclipsing-Binary Candidates	2 184 477

Non-Single Stars

Transiting planets in wide binaries

Transiting planets in CPM binaries

Transiting planets with wide planets

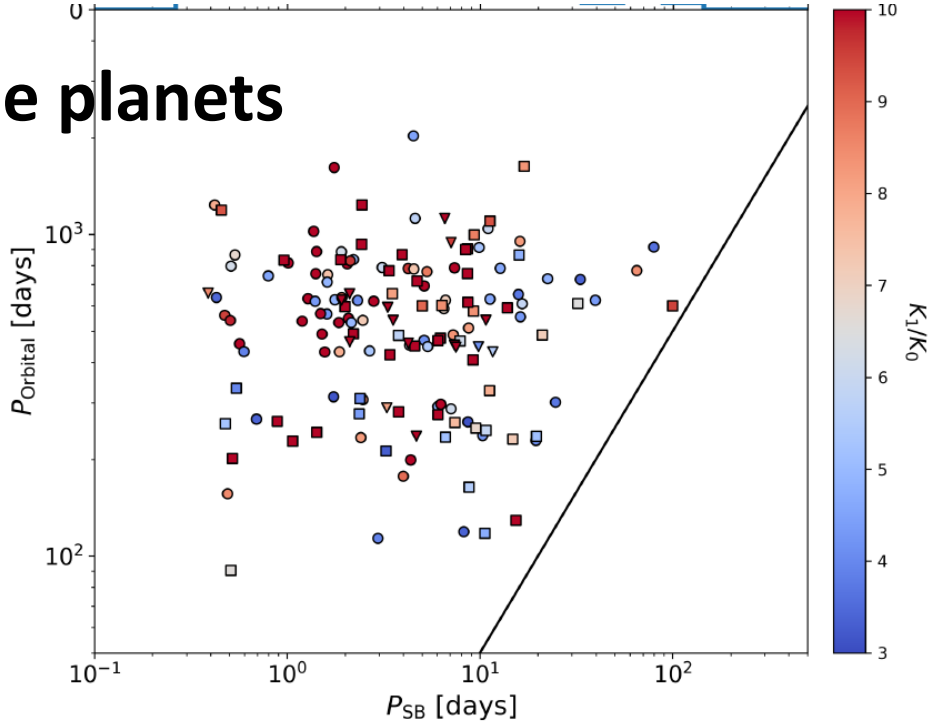


Fig. 51. Distribution of outer vs inner periods for triple systems found matching `Orbital` with SB1 (circles), SB2 (squares) and SB2C solutions (triangles), coloured by the ratio of spectroscopic over astrometric semi-amplitudes. The solid line shows the limit $P_{\rm Orbital} = 5\ P_{\rm SB}$. Top panel: Integrated distribution of inner periods.


Thank you