Data Validation (DV) Report
for TESS ID 164652245
Sectors 14 - 14

**This Data Validation Report was produced in the
TESS Science Processing Operations Center (SPOC) Pipeline
at NASA Ames Research Center**

13-Sep-2019 10:59:47 Z

Contents

1 Summary

Target Properties	Value	Uncertainty	Units	Provenance
Catalog ID	164652245			
TOI ID	-			
TESS Name	-			
RA	284.05961574	0	degrees	TIC8
Dec	44.51816368	0	degrees	TIC8
Magnitude	9.0638	0.006		TIC8
Radius	0.791	0.036	Solar radii	TIC8
Effective Temperature	5391	104	Kelvin	TIC8
log(g)	4.614	0.076483	cm/sec^2	TIC8
[M/H]	-0.300	0.1	Solar metallicity	TIC8
Stellar Density	1.897	0.345	Solar density	TIC8-Derived
Limb Darkening Coefficient 1	0.5316			
Limb Darkening Coefficient 2	-0.0531			
Limb Darkening Coefficient 3	0.4468			
Limb Darkening Coefficient 4	-0.26			
Number of Planet Candidates	1			
TOI Model	toi-plus-2019-08-29.csv			
TESS Names Model	-			
External TCE Model	-			
Software Revision	spoc-4.0.8-20190912			
Date Report Generated	13-Sep-2019 10:59:47 Z			

Sector	Target Table	Camera/ CCD	Crowding Metric	Flux Fraction
14	167	2:3	0.9332	0.8791

Planet Candidate	TOI ID	TESS Name	TOI Correlation	Period (days)	Period Ratio	Epoch (BTJD)	Semi-major Axis (AU)	Radius (Re)	Seff	Teq (K)	False Alarm	Suspected EB
1	-	-	-	20.686	1.00	1688.248	0.14	1.7	22.7	557	1.05e-28	false

2 Survey Image
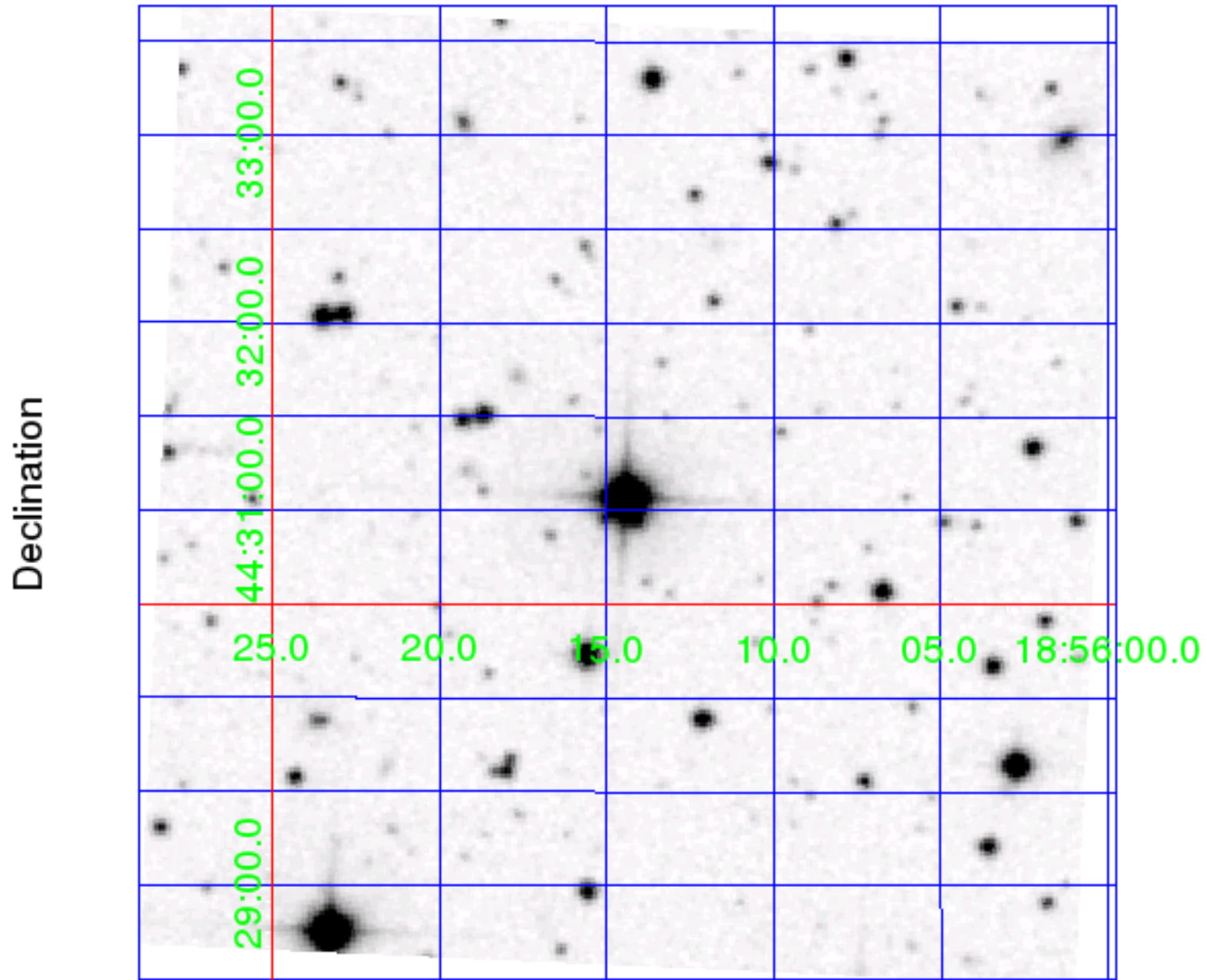
Digitized Sky Survey (DSS) red image. The 5' x 5' image is centered on the J2000 coordinates of target (164652245).

3   Flux Time Series
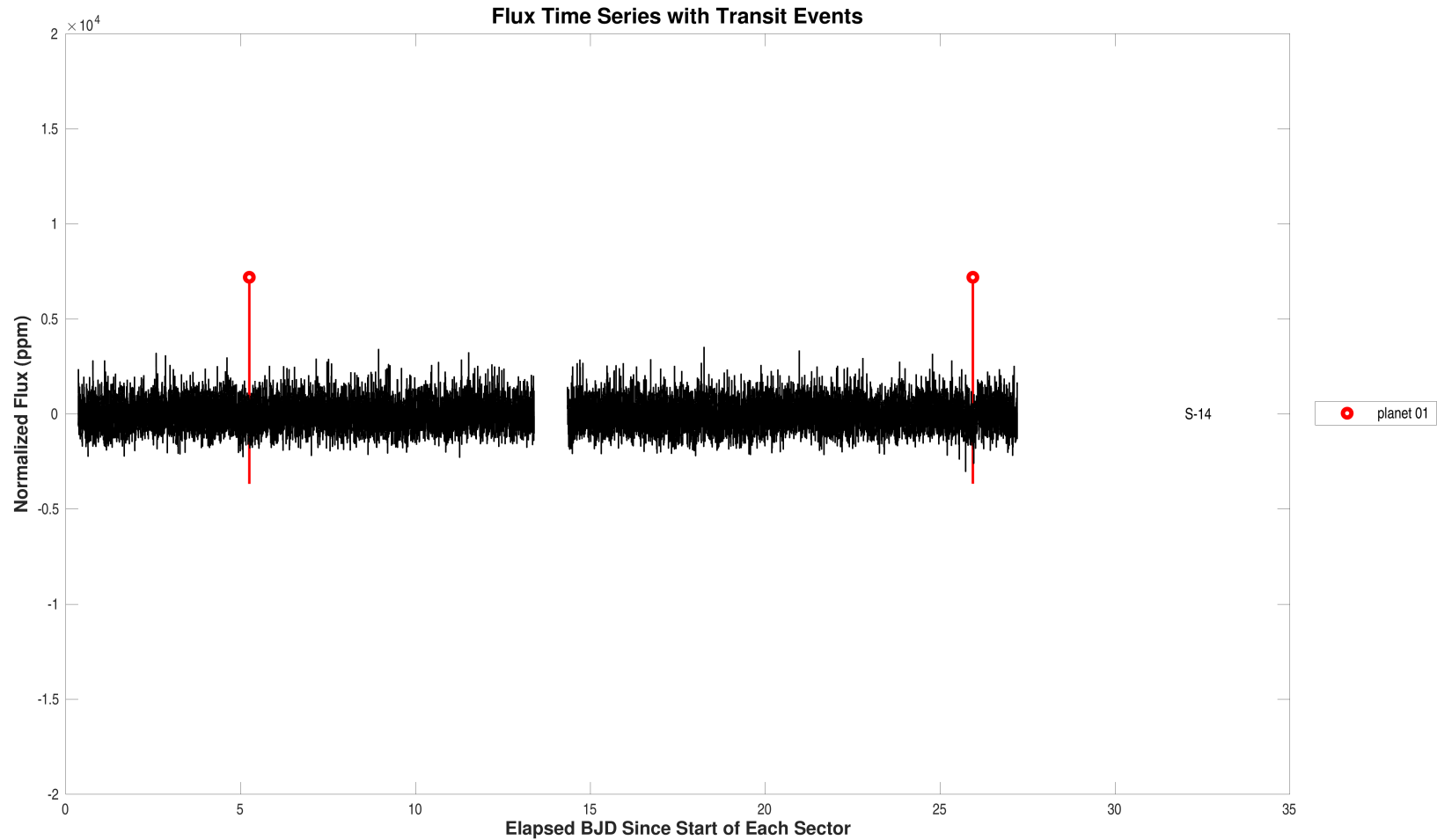
Summary plot of sector-stitched flux time series and transits for target 164652245, marked with DV fitted epoch/period (or TPS epoch/period if fit was not successful). Transits of identified planets are labeled with epoch BTJD and orbital period. For the data of sector 14, target table 167, start BJD is 2458683.
Open `./summary-plots/0000000164652245-00-flux-dv-fit-14-167.fig`
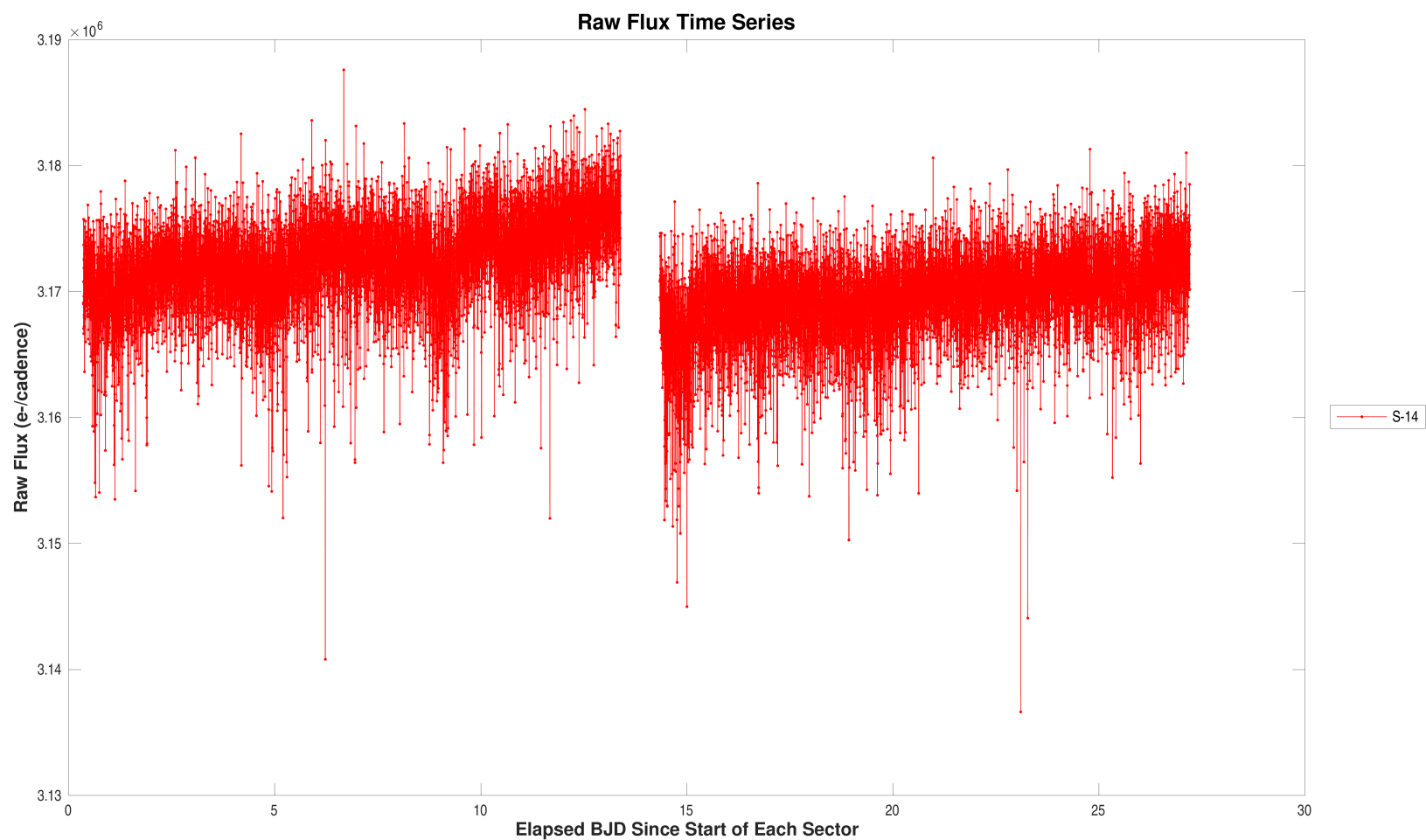
Summary plot of raw flux time series. For the data of sector 14, target table 167, start BJD is 2458683.
Open `./summary-plots/0000000164652245-00-raw-flux-14-167.fig`

4 Dashboards

Planet Candidate 1

Model Fitter	**Stellar Radius** 0.8 ± 0.0 Solar units	**Core Aperture Correlation Statistic** Value = 2.18 Significance = 98.53%	Ghost Diagnostic Test
	Period = 20.7 ± 0.0 days Depth = 460 ± 69 ppm Planet Radius = 1.7 ± 1.6 Earth radii Semi-major Axis = 0.1 ± 0.0 AU Effective Stellar Flux = 22.7 ± 3.3 Equilibrium Temperature = 557 ± 20 Kelvin Chi-squared/DoF = 0.9 SNR = 7.3	**Halo Aperture Correlation Statistic** Value = 2.69 Significance = 99.65% **Core/Halo Ratio** Ratio = 0.81	
Eclipsing Binary Discrimination Test	**Odd-Even Depth Comparison Statistic** Value = 7.74e+00 Significance = 0.54%	**Offsets Relative to Out of Transit Centroid** Source RA Offset = 3.32e+00 ± 2.66e+00 arcsec (1.25 σ) Source Dec Offset = 3.56e+00 ± 2.76e+00 arcsec (1.29 σ) Source Offset Distance = 4.86e+00 ± 2.71e+00 arcsec (1.79 σ) **Offsets Relative to TIC Position** Source RA Offset = 3.67e+00 ± 2.66e+00 arcsec (1.38 σ) Source Dec Offset = 3.86e+00 ± 2.76e+00 arcsec (1.40 σ) Source Offset Distance = 5.33e+00 ± 2.71e+00 arcsec (1.96 σ)	Difference Image Centroid Offsets
	Shorter Period Comparison Statistic Value = N/A Significance = N/A	**Longer Period Comparison Statistic** Value = N/A Significance = N/A	False Alarm = 1.05e-28 Transit Count = 2 Max Multiple Event Statistic = 7.4	Bootstrap Test

Summary of model fitter results and validation test results for target 164652245, planet candidate 1. In general, green denotes that the candidate is likely a planet, while red denotes that the candidate is unlikely to be a planet. Cyan denotes that no data is available. The color of the Model Fitter block is: green, when the SNR of the fit is greater than or equal to 10; yellow, if the SNR is greater than or equal to 7.1 but less than 10; red, if the SNR is less than 7.1 or if the fitter failed. The color of the Ghost Diagnostic Test and Eclipsing Binary Discrimination Test blocks are: green, when the significance is within 2-sigma; yellow, when the significance is between 2- and 3-sigma; red when the significance is greater than 3-sigma. The color of the Difference Image Centroid Offsets block is: green, when the max offset distance sigma is less than or equal to 2; yellow, when the max sigma is between 2 and 3; red when the max sigma is greater than 3. The color of the Bootstrap Test block is green whenever the false alarm probability is less than 10^{-12}, low enough to limit the total number of false alarms from a four year mission to less than one. If the false alarm probability is greater than 10^{-12}, the color of the Bootstrap Test block is: green, when the false alarm probability is less than or equal to the CCDF of a Gaussian distribution at the observed maximum multiple event statistic; yellow when the false alarm probability is between 1 and 2 times that of a Gaussian distribution at the max multiple event statistic; and red when the false alarm probability is more than 2 times that of a Gaussian distribution at the max multiple event statistic.

5   Pixel Level Diagnostics

To reduce clutter, the catalog IDs in the difference images have been replaced by indices representing distance from the target star. The mapping between the indices and the catalog IDs is found in a table at the end of this section.

5.1   Planet Candidate 1

Multi-Sector Average PRF Fit of the Difference Images

**Mean offset from the PRF fit to the out of transit image**

	RA	Dec	Units
Offset	$3.3173 \pm 2.66e + 00$	$3.5569 \pm 2.76e + 00$	arcseconds
Offset/σ	1.25	1.29	
Offset Distance	$4.8637 \pm 2.71e + 00$		arcseconds
Offset Distance/σ	1.79		
3σ Radius	8.1446		arcseconds

Mean offset from the TIC RA and Dec

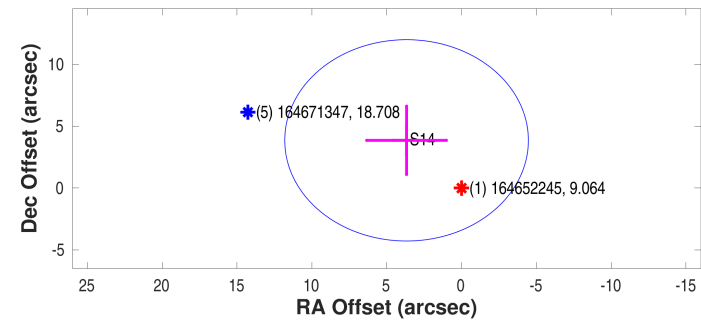|	RA	Dec	Units
Offset	$3.6703 \pm 2.66e + 00$	$3.8632 \pm 2.76e + 00$	arcseconds
Offset/σ	1.38	1.40	
Offset Distance	$5.3287 \pm 2.71e + 00$		arcseconds
Offset Distance/σ	1.96		
3σ Radius	8.1418		arcseconds

Planet Candidate 1
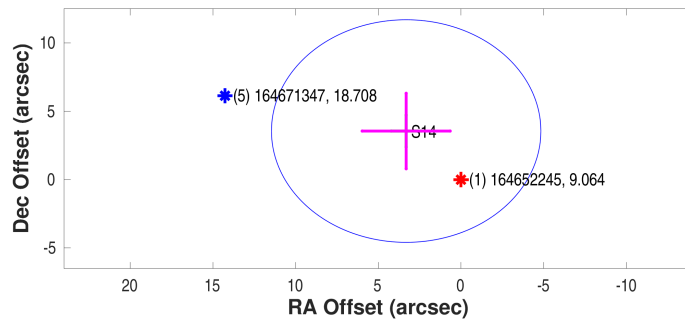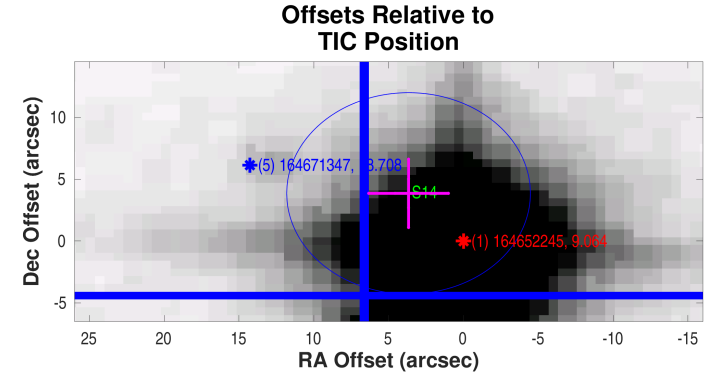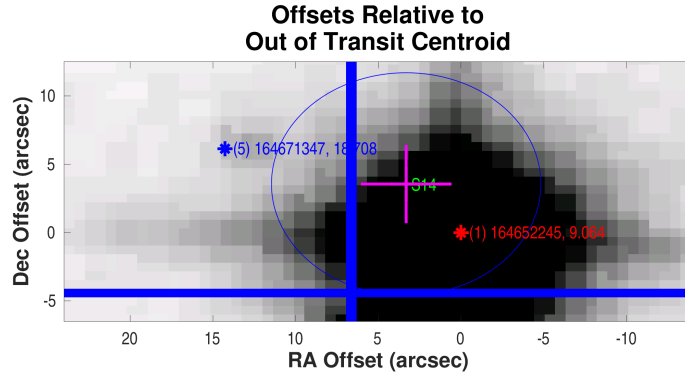

Difference image centroid offsets for target 164652245, planet candidate 1. Left: difference image PRF centroid offsets in RA and Dec with respect to the per sector out-of-transit centroids for the given target. Right: difference image PRF centroid offsets in RA and Dec with respect to the TC coordinates of the given target. Symbol key: green cross: per sector centroid offsets with 1-sigma error bars in RA and Dec; magenta cross: robust weighted mean offset over all sectors with 1-sigma error bars in RA and Dec; blue circle: 3-sigma radius of confusion for weighted mean offset; red asterisk: location of target star; blue asterisk: location of other TIC objects in the neighborhood. TIC ID and magnitude are noted in the text associated with each marked object. A constant error term of 2.5000 arcseconds has been added in quadrature to the computed uncertainty in the RA and Dec components of the robust mean offset.
Open `./planet-01/difference-image/0000000164652245-01-difference-image-centroid-offsets.fig`
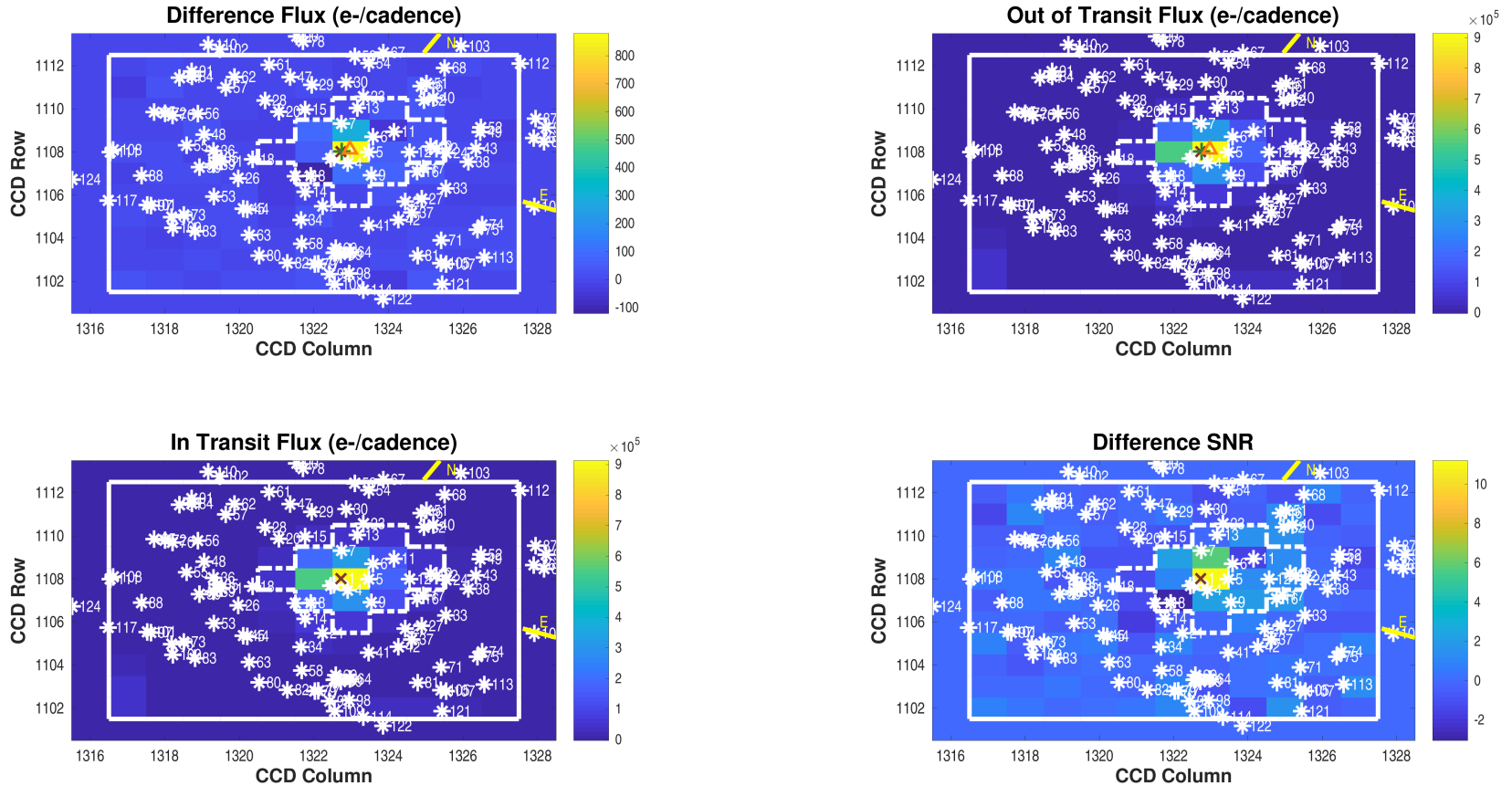
Planet Candidate 1

Difference image centroid offsets for target 164652245, planet candidate 1, diplayed on survey image for given target. Left: difference image PRF centroid offsets in RA and Dec with respect to the per sector out-of-transit centroids for the given target. Right: difference image PRF centroid offsets in RA and Dec with respect to the TIC coordinates of the given target. Symbol key: green cross: per sector centroid offsets with 1-sigma error bars in RA and Dec; magenta cross: robust weighted mean offset over all sectors with 1-sigma error bars in RA and Dec; blue circle: 3-sigma radius of confusion for weighted mean offset; red asterisk: location of target star; blue asterisk: location of other TIC objects in the neighborhood. TIC ID and magnitude are noted in the text associated with each marked object. A constant error term of 2.5000 arcseconds has been added in quadrature to the computed uncertainty in the RA and Dec components of the robust mean offset.
Open `./planet-01/difference-image/0000000164652245-01-difference-image-centroid-offsets-survey.fig`

Difference Image Summary Metrics

Number of Difference Images	Number of Metrics	Number of Good Metrics	Fraction of Good Metrics	Quality Threshold
1	1	1	1.0000	0.70

Difference Image
Planet Candidate 1 / Sector 14 / Target Pixel Table 167

Difference image for target 164652245, planet candidate 1, sector 14, target pixel table 167. Upper left: difference between mean flux out-of-transit and in-transit; upper right: mean out-of-transit flux; lower left: mean in-transit flux; lower right: difference between mean flux out-of-transit and in-transit after normalizing by the uncertainty in the difference for each pixel. The optimal aperture is outlined with a white dash-dotted line in each panel and the target mask is outlined with a solid white line. Symbol key: x: target position from TIC RA and Dec converted to CCD coordinates via motion polynomials; *: position of nearby TIC objects converted to CCD coordinates via motion polynomials; +: PRF-fit location of target from out-of-transit image; triangle: PRF-fit location of transit source from the difference image. Number of transits = 2; number of valid in-transit cadences = 243; number of in-transit cadence gaps = 5; number of valid out-of-transit cadences = 576; number of out-of-transit cadence gaps = 8. Difference image quality metric = 0.89 (good).
Open ./planet-01/difference-image/0000000164652245-01-difference-image-14-167.fig

PRF Fit of the Difference Image

Offset from the PRF fit to the out of transit image

	Row	Column	Units	RA	Dec	Units
Out of Transit Image Centroid	$1108.02 \pm 2.30e-05$	$1322.75 \pm 2.18e-05$	pixels	$284.05929161 \pm 6.06e-07$	$44.51851362 \pm 5.97e-07$	degrees
Difference Image Centroid	$1108.11 \pm 5.84e-02$	$1322.97 \pm 6.07e-02$	pixels	$284.06058394 \pm 3.55e-04$	$44.51950163 \pm 3.26e-04$	degrees
Offset	$0.0876 \pm 5.84e-02$	$0.2188 \pm 6.07e-02$	pixels	$3.3173 \pm 9.11e-01$	$3.5569 \pm 1.17e+00$	arcseconds
Offset/σ	1.50	3.61		3.64	3.03	
Offset Distance	$0.2357 \pm 5.93e-02$		pixels	$4.8637 \pm 1.05e+00$		arcseconds
Offset Distance/σ	3.98			4.63		

Offset from the TIC RA and Dec converted to pixels via motion polynomials

	Row	Column	Units	RA	Dec	Units
TIC Reference Centroid	$1108.01 \pm 1.03e-04$	$1322.72 \pm 1.03e-04$	pixels	$284.05915408 \pm 0.00e+00$	$44.51842852 \pm 0.00e+00$	degrees
Difference Image Centroid	$1108.11 \pm 5.84e-02$	$1322.97 \pm 6.07e-02$	pixels	$284.06058394 \pm 3.55e-04$	$44.51950163 \pm 3.26e-04$	degrees
Offset	$0.0937 \pm 5.84e-02$	$0.2406 \pm 6.07e-02$	pixels	$3.6703 \pm 9.11e-01$	$3.8632 \pm 1.17e+00$	arcseconds
Offset/σ	1.61	3.96		4.03	3.30	
Offset Distance	$0.2582 \pm 5.93e-02$		pixels	$5.3287 \pm 1.05e+00$		arcseconds
Offset Distance/σ	4.35			5.08		

5.2 Difference Image TIC Key

Index	Catalog ID	Mag	RA (degrees)	Dec (degrees)	Distance (arcsec)
1	164652245	9.064	284.05915408	44.51842852	0.00
2	164652238	12.277	284.05877100	44.51646400	7.14
3	164652234	15.275	284.05828865	44.51609967	8.67
4	164652236	17.178	284.06236845	44.51611429	11.73
5	164671347	18.708	284.06471499	44.52013422	15.54
6	1716723721	18.991	284.06302708	44.52410902	22.74
7	1716723722	18.988	284.05462628	44.52521283	27.05
8	164652212	18.191	284.05721387	44.51065886	28.41
9	164652224	16.886	284.06902126	44.51476602	28.55
10	1716723718	19.181	284.05422953	44.50956368	34.33
11	1716723840	18.588	284.06630471	44.52670716	35.00
12	1716723844	19.979	284.07271713	44.52285503	38.29
13	1716723859	18.234	284.05520347	44.52997927	42.80
14	1716723719	20.622	284.05874763	44.50642989	43.21
15	1716723720	19.326	284.04516070	44.52616779	45.46
16	1716723841	18.314	284.07740763	44.51864140	46.86
17	1716723842	20.108	284.07811519	44.51985717	48.94
18	1716723717	19.334	284.04309280	44.51076877	49.60
19	1716723845	19.950	284.07593174	44.52557110	50.16
20	1716723726	17.888	284.04035146	44.52392081	52.16
21	164652196	12.356	284.06453305	44.50415990	53.19
22	164671339	14.341	284.07742623	44.52540814	53.21
23	1716723863	20.653	284.05449626	44.53308911	54.12
24	164671340	15.156	284.08005125	44.52502602	58.66
25	1716723702	19.834	284.08003073	44.51066616	60.44
26	164652200	17.448	284.04333135	44.50529116	62.34
27	1716723843	19.884	284.08279373	44.51240788	64.44
28	1716723723	19.141	284.03578015	44.52574093	65.52
29	1716723730	19.791	284.04239192	44.53255330	66.61
30	164652270	16.709	284.04872603	44.53544521	66.85
31	1716723709	19.795	284.03724943	44.50824469	67.12
32	1716723860	19.972	284.06704176	44.53621237	67.15
33	1716723837	20.055	284.08579568	44.51651468	68.73
34	1716723698	20.619	284.06254188	44.49944169	68.90
35	164652208	17.480	284.03578767	44.50886128	69.16
36	1716723714	17.795	284.03394830	44.51026384	71.06
37	1716723694	18.418	284.08311484	44.50847167	71.19
38	164671341	18.587	284.08587447	44.52432390	71.80

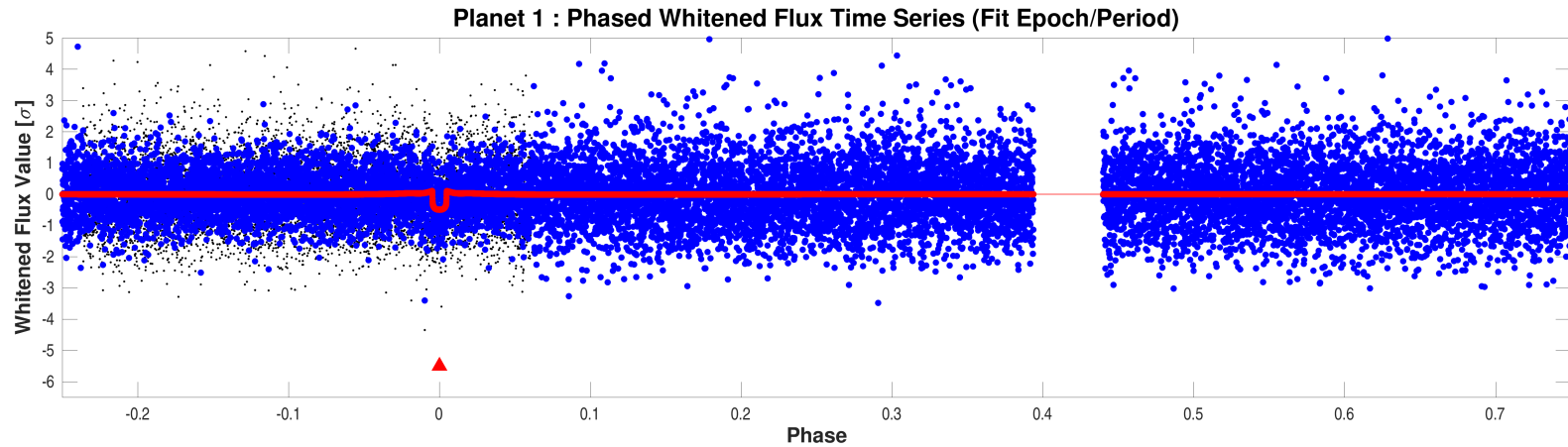| Index	Catalog ID	Mag	RA (degrees)	Dec (degrees)	Distance (arcsec)
39	1716723708	19.066	284.03621591	44.50699759	71.83
40	164652276	17.482	284.06844225	44.53738930	72.30
41	1716723700	17.965	284.07678176	44.50252648	72.97
42	1716723701	18.751	284.08168905	44.50585328	73.45
43	1716723846	19.599	284.08512696	44.52805561	75.14
44	164652188	14.381	284.05025024	44.49844472	75.48
45	1716723710	17.153	284.04935128	44.49834133	76.57
46	1716723866	19.270	284.06412500	44.53940056	76.57
47	1716723727	18.523	284.03687962	44.53296210	77.50
48	1716723715	18.641	284.02944922	44.51356458	78.23
49	1716723847	20.367	284.08330205	44.53229323	79.58
50	1716723713	19.956	284.03389779	44.50539548	80.03
51	164652282	17.439	284.06474059	44.54041154	80.43
52	1716723848	19.414	284.08266524	44.53339663	80.91
53	1716723707	19.327	284.04156825	44.49935765	82.17
54	1716723862	20.173	284.05005711	44.54149290	86.25
55	164652210	14.102	284.02775632	44.50980680	86.36
56	164652244	18.218	284.02475479	44.51812580	88.31
57	1716723724	19.548	284.02594425	44.52623625	89.76
58	1716723696	19.842	284.06657993	44.49379491	90.71
59	1716723861	19.526	284.04616012	44.54219707	91.84
60	164671374	16.815	284.07405076	44.49491485	92.89
61	1716723729	20.607	284.03075378	44.53452213	93.12
62	1716723725	19.337	284.02589962	44.52933596	93.96
63	164652176	18.837	284.05490967	44.49239393	94.36
64	164671373	18.694	284.07746987	44.49494386	96.74
65	508566099	19.736	284.07476616	44.49386624	97.08
66	164671376	15.660	284.07452839	44.49372283	97.30
67	164652294	16.745	284.05116608	44.54497019	97.73
68	1716723865	20.667	284.06572456	44.54534983	98.37
69	1716723697	17.587	284.07605648	44.49375966	98.84
70	164652230	16.173	284.02010394	44.51601413	100.61
71	1716723693	19.166	284.09343698	44.50377303	102.60
72	1716723716	20.008	284.01823097	44.51608636	105.38
73	1716723703	18.882	284.03869542	44.49295254	105.68
74	1716723838	20.700	284.09895283	44.51015284	106.41
75	1716723839	20.322	284.09883272	44.50869611	107.71
76	164671331	14.346	284.09484968	44.53434831	108.07

RA, Dec and Distances are corrected for proper motion. This table may not contain all of the objects shown.

6 Phased Light Curves
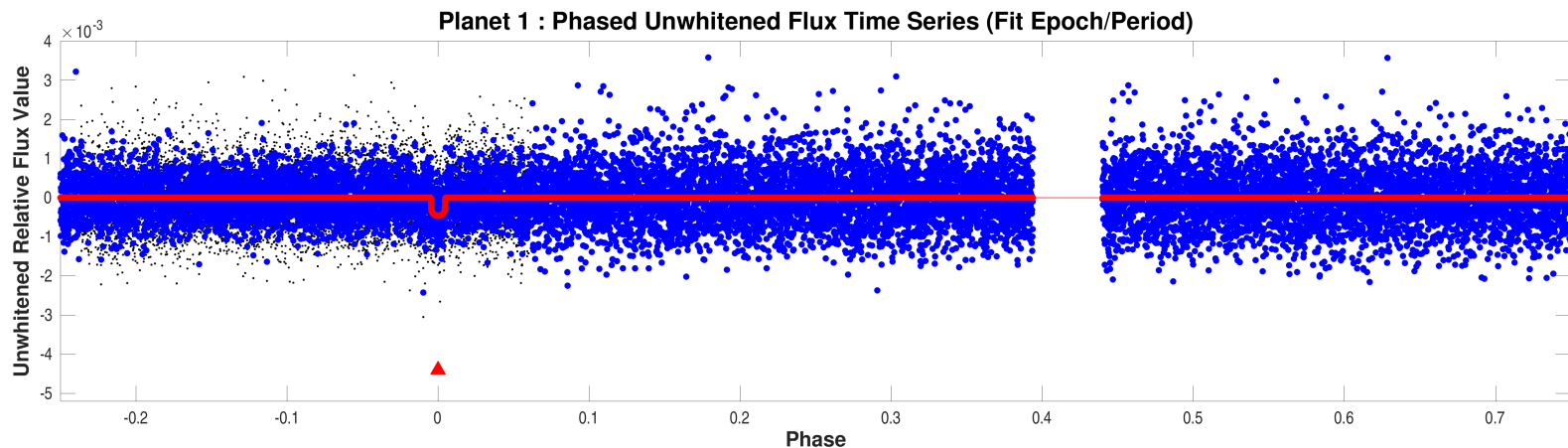
Phased unwhitened flux time series is plotted in black dots. When all transits fit completed with full or secondary convergence, the phase is determined with the fitted epoch and period; otherwise, the phase is determined with the TPS epoch and period. The values of the phased unwhitened flux time series averaged in one cadence wide bins are plotted in bigger blue dots. When all transits fit completes with full or secondary convergence, the averaged values of the phased unwhitened fitted model light curve are plotted in red dots. Transit event markers in different colors indicate the locations of the transits of all planet candidates. The transits of the same planet candidate are labeled with the markers of the same color, for example, blue markers for transits of plane candidate #1, red markers for transits of planet candidate #2, etc.
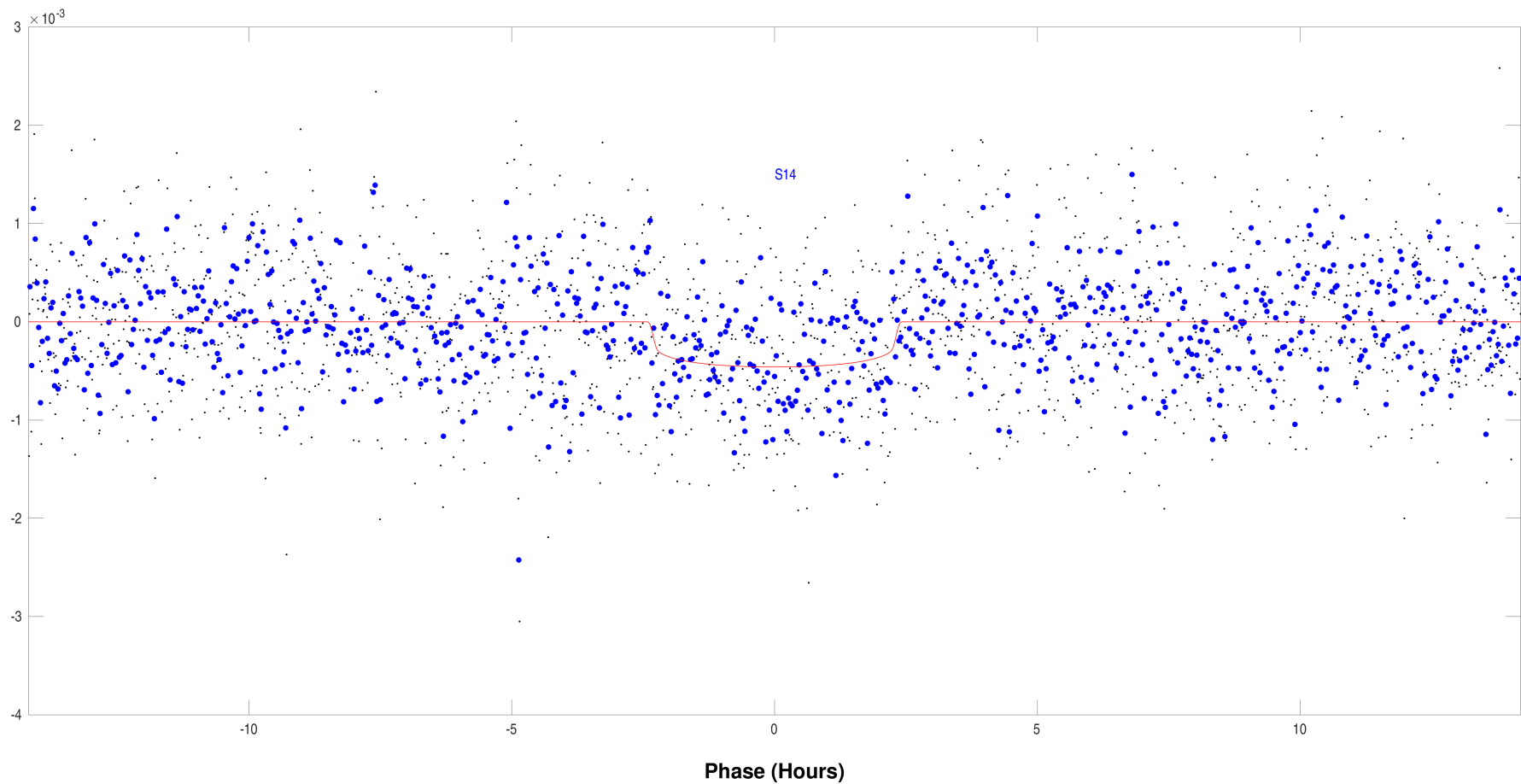
Open `./summary-plots/0000000164652245-01-phased-unwhitened-flux-time-series.fig`

Planet 1 : Phased Whitened Flux Time Series (Fit Epoch/Period)

Phased whitened flux time series is plotted in black dots. When all transits fit completed with full or secondary convergence, the phase is determined with the fitted epoch and period; otherwise, the phase is determined with the TPS epoch and period. The values of the phased whitened flux time series averaged in one cadence wide bins are plotted in bigger blue dots. When all transits fit completes with full or secondary convergence, the averaged values of the phased whitened fitted model light curve are plotted in red dots. Transit event markers in different colors indicate the locations of the transits of all planet candidates. The transits of the same planet candidate are labeled with the markers of the same color, for example, blue markers for transits of plane candidate #1, red markers for transits of planet candidate #2, etc.
Open ./summary-plots/0000000164652245-01-phased-whitened-flux-time-series.fig

Planet: 1   Phased Unwhitened Flux Time Series by Sector

Phased unwhitened flux time series by sector for target 164652245, planet candidate 1. Period = 20.6863 days; transit epoch = 1688.2482 BTJD.
Open `./summary-plots/0000000164652245-01-phased-unwhitened-flux-time-series-by-sector.fig`
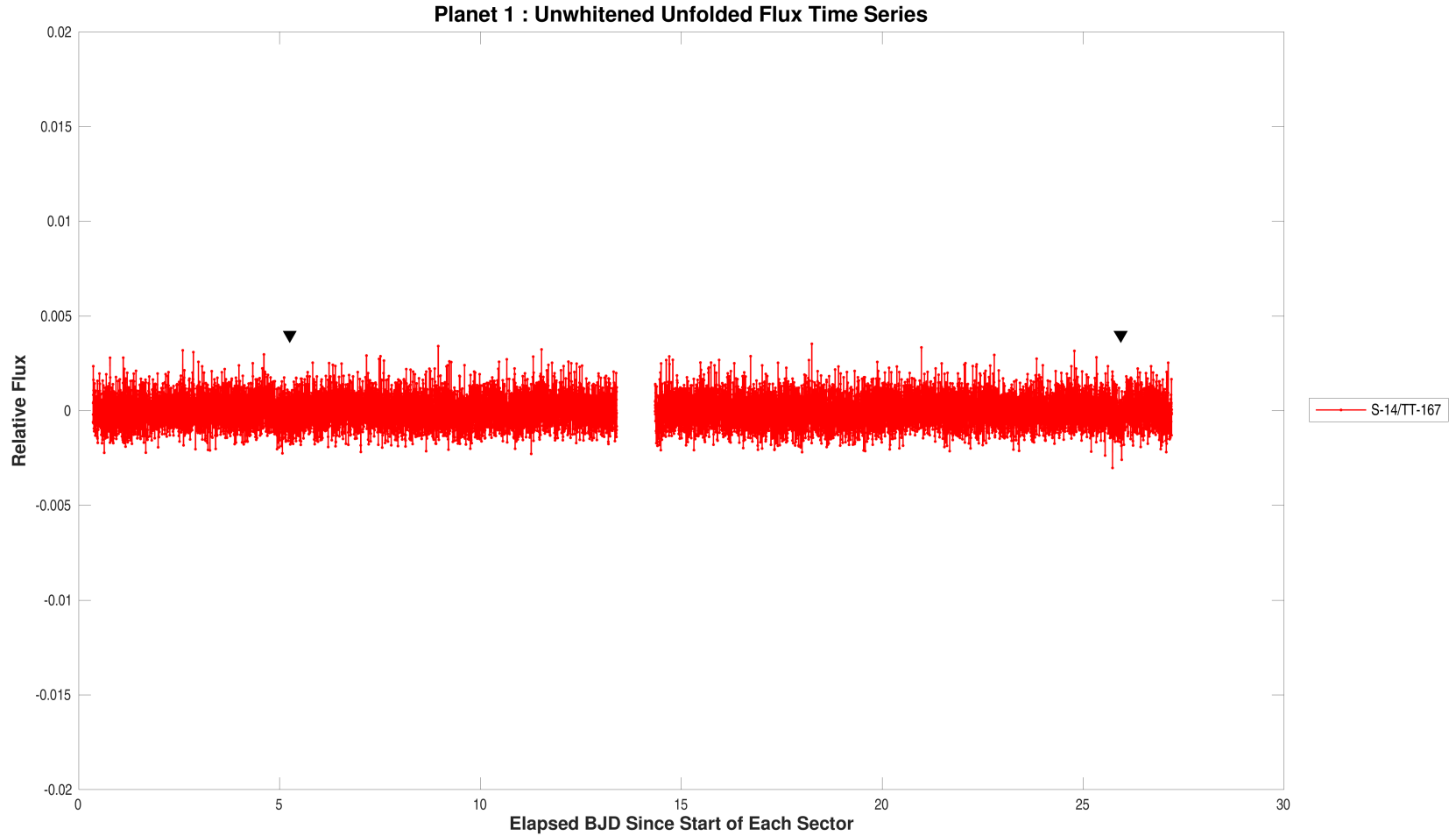
7 Planet Candidate 1

7.1 Model Fitter: All Transits

Model Characteristic	Name
Transit Model	mandel-agol_geometric_transit_model
Limb Darkening Model	claret_tess_nonlinear_limb_darkening_model

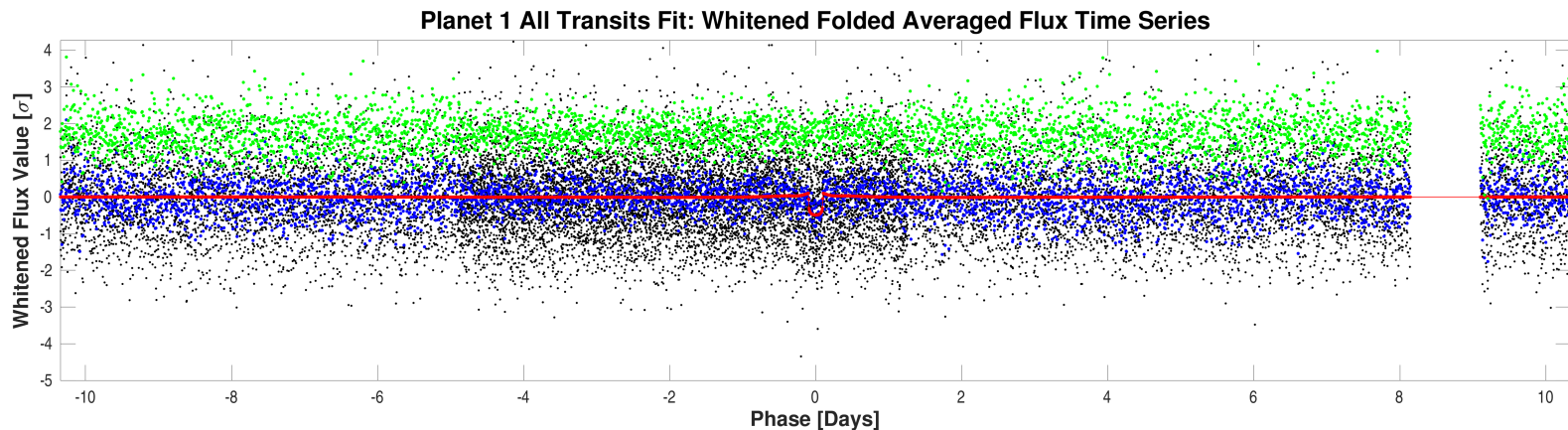| TCE Parameter	Value	Units
Trial Transit Pulse Duration	5.0	hours
Transit Epoch	1688.2462841	TJD
Orbital Period	20.6972141	days
Maximum SES	7.5	
Maximum MES	7.4	
Robust Statistic	6.8	
Chi Square Goodness of Fit Statistic (DoF)	273.4 (294)	
Chi Square2 Statistic (DoF)	5.4 (5.4)	
Threshold for Desired PFA		

DoF: Degrees of Freedom

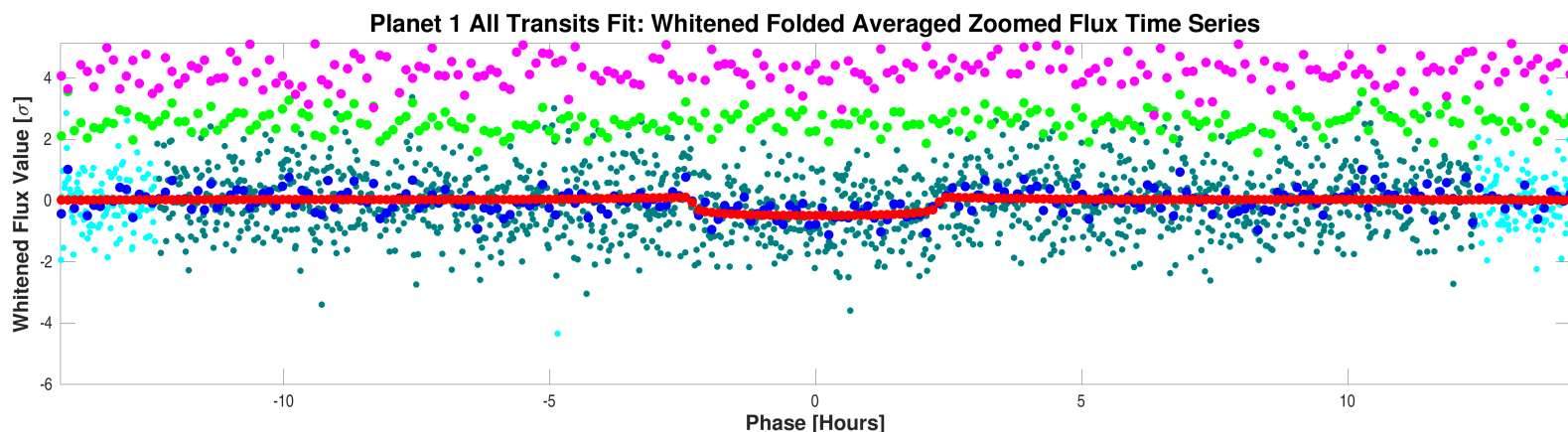| Parameter	Value	Uncertainty	Units
SNR	7.3		
Orbital Period	20.6863485	7.8126e-03	days
Transit Epoch	1688.2482135	5.6022e-03	BTJD
Impact Parameter	0.2381	2.0570e+01	
Planet Radius to Star Radius Ratio	0.0198739	1.9056e-02	
Semi-major Axis to Star Radius Ratio	33.1252	1.7110e+02	
Planet Radius	1.7170	1.6482e+00	Earth radii
Semi-major Axis	0.1445	9.5686e-03	AU
Effective Stellar Flux	22.6832	3.2623e+00	Goldilocks
Equilibrium Temperature	557	2.0013e+01	Kelvin
Stellar Density	1.1412	1.7683e+01	Solar density
Transit Depth	460	6.9240e+01	ppm
Transit Duration	4.7319	1.0099e+00	hours
Transit Ingress Duration	0.0977	1.1057e+00	hours
Eccentricity	0.0000	0.0000e+00	
Peri Longitude	0.0000	0.0000e+00	degrees
Model Chi Square Statistic (DoF)	1200.8 (1339.0)		
Model Chi Square Goodness of Fit Statistic (DoF)	180.6 (290)		
Model Chi Square2 Statistic (DoF)	3.6 (1)		

DoF: Degrees of Freedom

Flux time series for CatId 164652245, Planet candidate 1 in the unwhitened domain. For the data of Sector-14/TargetTableId-167, start BJD is 2458683. Transit event markers indicate the location of transits of the given planet candidate. All transits fit completed with full convergence.

Open `./planet-01/planet-search-and-model-fitting-results/all-transits-fit/0000000164652245-01-all-unwhitened-14-167.fig`

Planet 1 All Transits Fit: Whitened Folded Averaged Flux Time Series

Folded flux time series for CatId 164652245, Planet candidate 1 in the whitened domain is plotted in black dots. Values are averaged into 1 cadence wide bins. The blue dots represent the averaged values of the folded flux time series; the red dots represent the averaged values of the folded model light curve of the all transits fit; the green dots are the averaged folded fit residuals, vertically offset for clarity. All transits fit completed with full convergence.

Open ./planet-01/planet-search-and-model-fitting-results/all-transits-fit/0000000164652245-01-all-whitened.fig

Planet 1 All Transits Fit: Whitened Folded Averaged Zoomed Flux Time Series

Folded flux time series for CatId 164652245, Planet candidate 1 in the whitened domain, zoomed on the transit. The flux data whose robust weights are larger/smaller than 0.1 are plotted in dark green/cyan dots, respectively. Values are averaged into 1 cadence wide bins. The blue dots represent the averaged values of the folded flux time series; the red dots represent the averaged values of the fitted model light curve of the all transits fit; the green dots are the averaged folded fit residuals, vertically offset for clarity. Magenta dots are the averaged values of the folded flux time series, with a phase shift of 0.5 relative to the blue dots, vertically offset for clarity. All transits fit completed with full convergence.
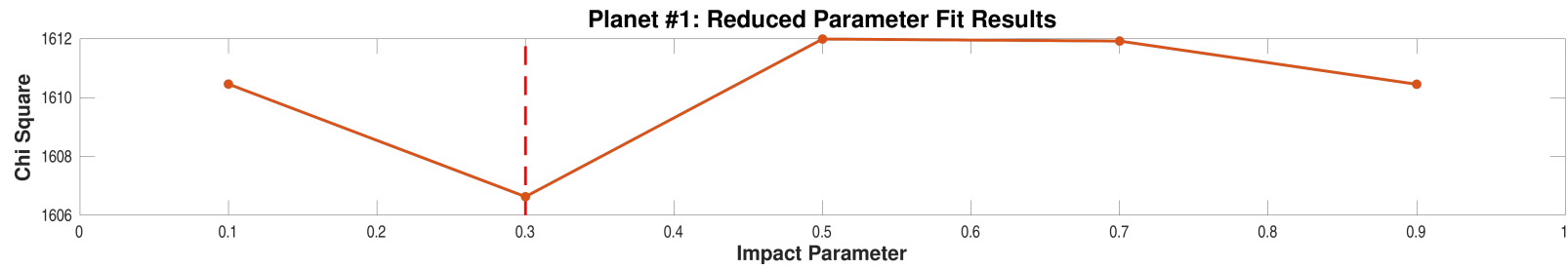
Open ./planet-01/planet-search-and-model-fitting-results/all-transits-fit/0000000164652245-01-all-whitened-zoomed.fig

7.2   Model Fitter: Reduced Parameter Fit Results

Impact Parameter	SNR	Model Chi Square	Planet Radius to Star Radius	Uncert	Semi-major Axis to Star Radius	Uncert	Transit Depth (ppm)	Uncert	Transit Duration (hours)	Uncert
0.10	7.4	1610.5	0.0195683	1.3395e-03	33.1998	1.2090e+00	450	6.1254e+01	4.8319	1.7569e-01
0.30	7.5	1606.6	0.0198551	1.3585e-03	32.1018	1.2682e+00	456	6.2076e+01	4.7999	1.8963e-01
0.50	7.4	1612.0	0.0200933	1.3924e-03	28.1876	1.1281e+00	451	6.2135e+01	4.9887	2.0088e-01
0.70	7.4	1611.9	0.0208105	1.4434e-03	23.2414	1.0138e+00	450	6.2125e+01	5.0575	2.2733e-01
0.90	7.2	1610.5	0.0224416	1.6222e-03	14.9685	9.1653e-01	439	6.3651e+01	5.1333	3.9677e-01

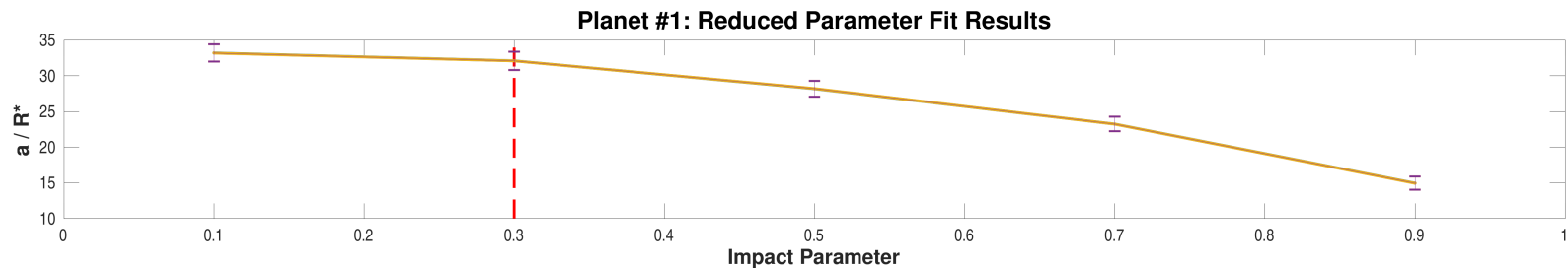Highlighted row is the best reduced-parameter model fit.

Model chi squares of reduced parameter fits vs. impact parameter for CatId 164652245, Planet candidate 1. The fit result with the minimum chi square is marked with a dashed line in the plot.
Open ./planet-01/planet-search-and-model-fitting-results/reduced-parameter-fits/0000000164652245-01-reduced-fits-chi-square.fig
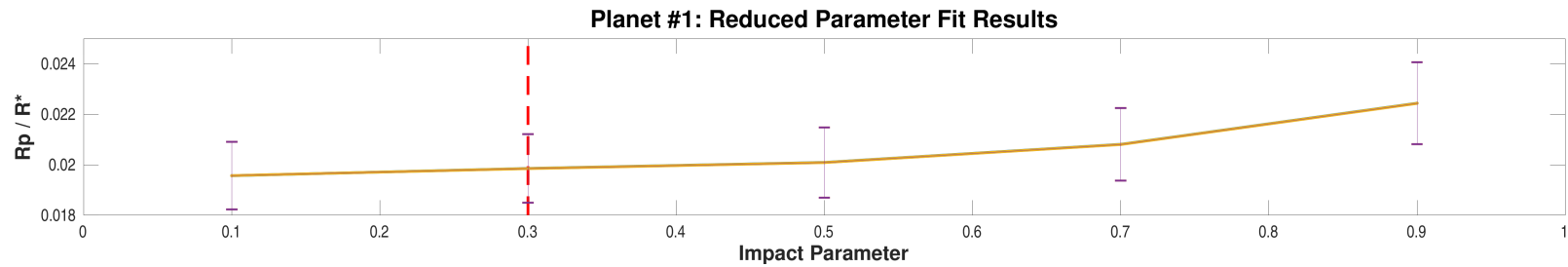
Ratios of planet radius to star radius of reduced parameter fits vs. impact parameter for CatId 164652245, Planet candidate 1. The fit result with the minimum chi square is marked with a dashed line in the plot.
Open ./planet-01/planet-search-and-model-fitting-results/reduced-parameter-fits/0000000164652245-01-reduced-fits-rp-over-rstar.fig

Ratios of semimajor axis to star radius of reduced parameter fits vs. impact parameter for CatId 164652245, Planet candidate 1. The fit result with the minimum chi square is marked with a dashed line in the plot.
Open ./planet-01/planet-search-and-model-fitting-results/reduced-parameter-fits/0000000164652245-01-reduced-fits-a-over-rstar.fig
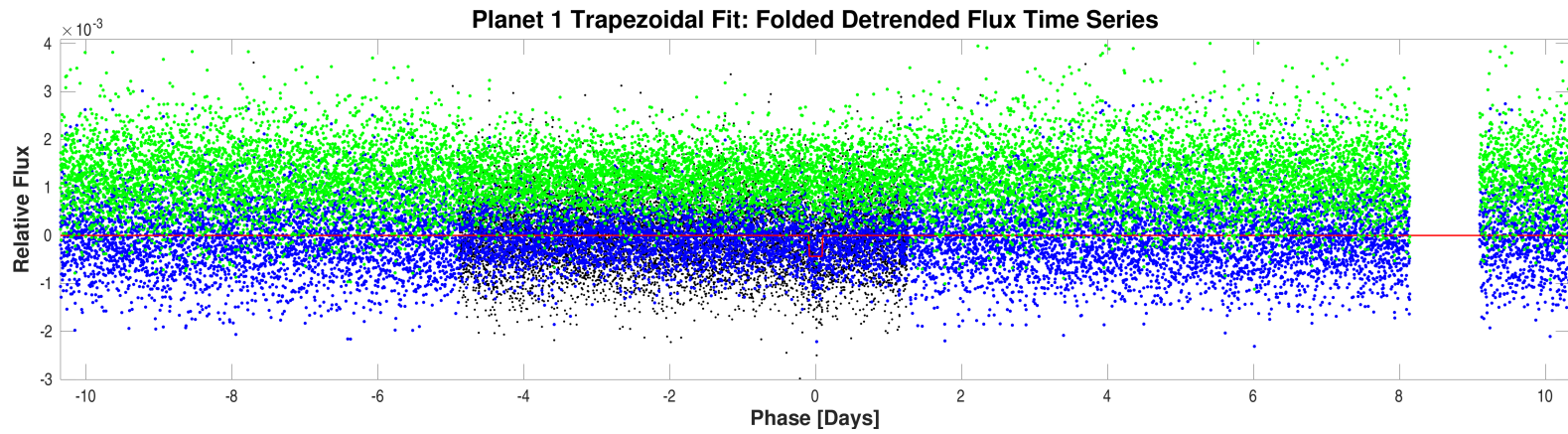
7.3   Model Fitter: Trapezoidal Fit Results

Model Characteristic	Name
Transit Model	trapezoidal_model
Limb Darkening Model	

TCE Parameter	Value	Units
Trial Transit Pulse Duration	5.0	hours
Transit Epoch	1688.2462841	TJD
Orbital Period	20.6972141	days
Maximum SES	7.5	
Maximum MES	7.4	
Robust Statistic	6.8	
Chi Square Goodness of Fit Statistic (DoF)	273.4 (294)	
Chi Square2 Statistic (DoF)	5.4 (5.4)	
Threshold for Desired PFA		

DoF: Degrees of Freedom

Parameter	Value	Uncertainty	Units
SNR	9.2		
Orbital Period	20.6972141		days
Transit Epoch	1688.2519348		BTJD
Transit Depth	435		ppm
Transit Duration	5.4862		hours
Transit Ingress Duration	1.0963		hours
Model Chi Square Statistic (DoF)	19896.6 (2368)		

DoF: Degrees of Freedom

Folded detrended flux time series for CatId 164652245, Planet candidate 1 and folded trapezoidal model light curve.
Open ./planet-01/planet-search-and-model-fitting-results/trapezoidal-model-fit/0000000164652245-01-all-trapezoidal.fig
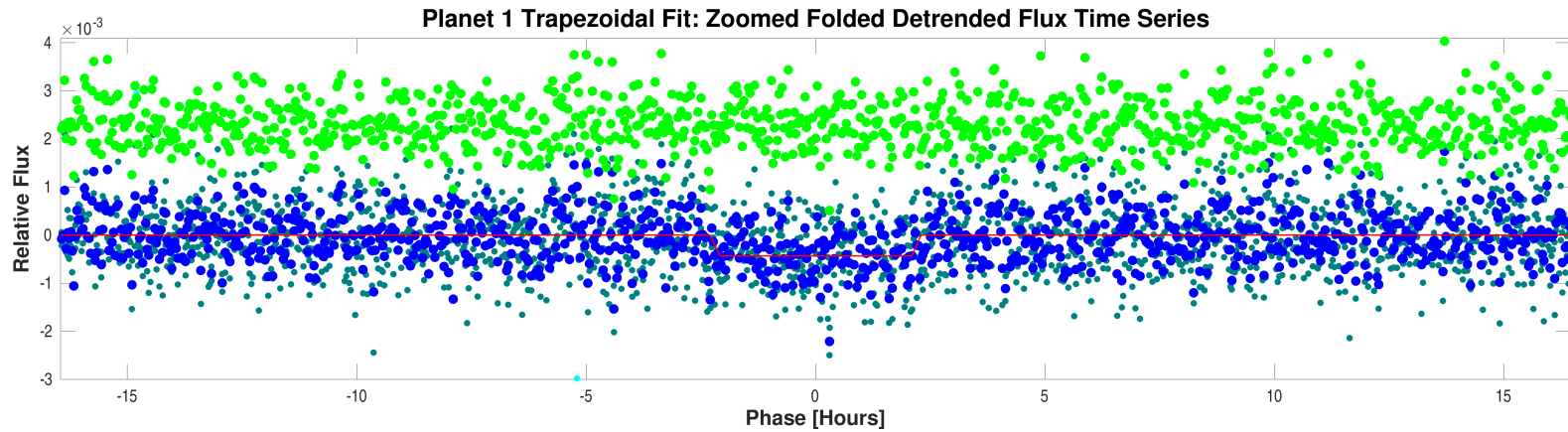
Zoomed folded detrended flux time series for CatId 164652245, Planet candidate 1 and folded trapezoidal model light curve.
Open ./planet-01/planet-search-and-model-fitting-results/trapezoidal-model-fit/0000000164652245-01-all-trapezoidal-zoomed.fig

7.4   Validation Tests

The Centroid Test and Eclipsing Binary Discrimination Test are chi-squared hypothesis tests. For these tests, a significance of 100% favors a planet, while 0% indicates an unlikely planet.

7.4.1   Weak Secondary Test

Result	Value	Uncertainty	Units	Statistic in Sigmas	Significance (%)
Orbital Period	20.6972		days		
Transit Duration	5		hours		
Maximum MES	7.4				
Secondary Phase	-1.1389		days		
Secondary MES	1.6				
Minimum Phase	-0.875		days		
Minimum MES	-2.4				
Median MES	-0.1				
MAD MES	0.58662				
Robust Statistic	2.3				
Secondary Depth	153.1	6.3504e+01	ppm		
Geometric Albedo	596.9	1.1735e+03		0.5079	30.58
Planet Effective Temperature	4254	2.0881e+03	Kelvin	1.7705	3.83

7.4.2   Eclipsing Binary Discrimination Test

Result	Value	Value in Sigmas	Significance (%)
Odd Even Transit Depth Comparison Statistic	7.7378e+00	2.7817	0.54

7.4.3   Bootstrap Test

Result	Value
False Alarm Probability	1.0507e-28
Bootstrap Threshold for Desired PFA	4.5
MES Mean	1.58
MES Standard Deviation	0.53
Transit Count	2

7.4.4   Ghost Diagnostic Test

Result	Value	Significance (%)
Maximum MES	7.4	
SNR	7.3	
Core Aperture Statistic	2.1786e+00	98.53
Halo Aperture Statistic	2.6944e+00	99.65
Ratio of Core/Halo Aperture Statistics	8.0858e-01	

7.4.5   Validation Test Figures
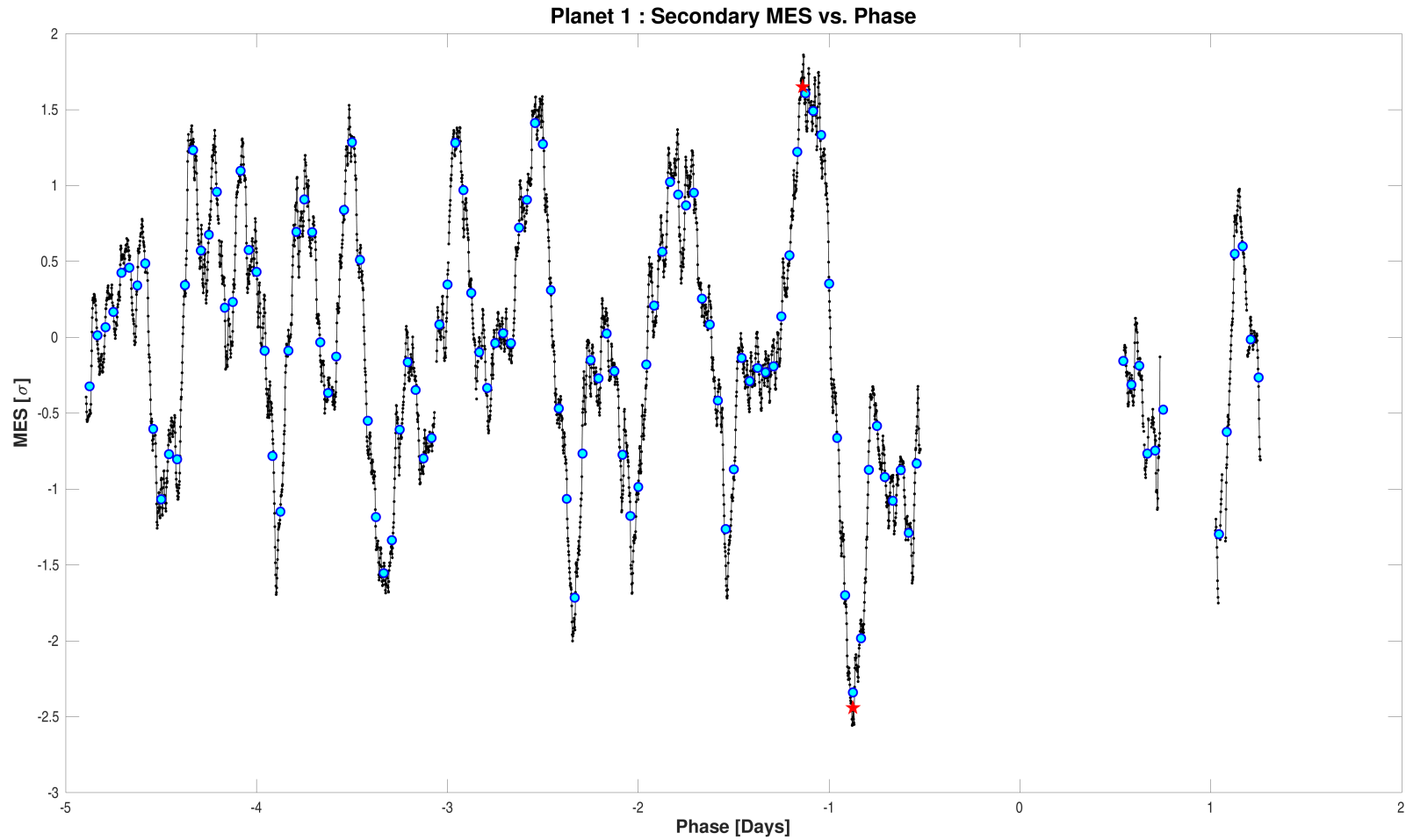
The primary event has been set to zero and both the max and min of the resulting MES vs. Phase are marked with a red star. The best matched pulse duration in hours is 5. The maximum secondary MES and corresponding phase are 1.65 and -1.1389 days respectively. The minimum secondary MES and corresponding phase are -2.4405 and -0.875 days respectively.

Open `./planet-01/report-summary/0000000164652245-01-weak-secondary-diagnostic.fig`

Bootstrap Results for Planet 1
Max Multiple Event Sigma=7.4, False Alarm=1.05e-28
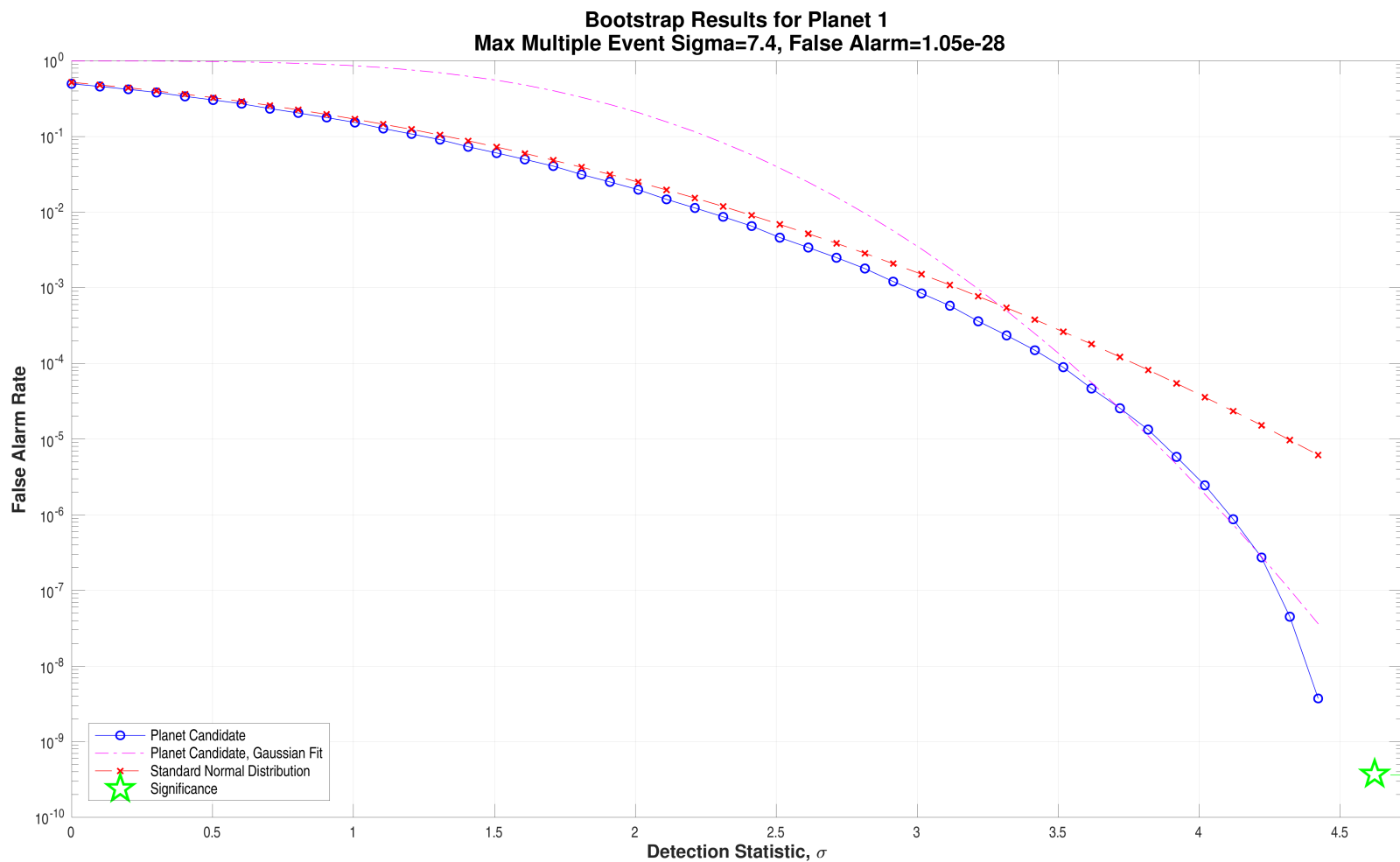
Bootstrap results for target 164652245, planet 1. Cumulative sum of the probabilities (derived from the histogram of counts) from upper tail to the search transit threshold; false alarm probability is indicated by the star. The Gaussian equivalent threshold for this false alarm probability is 11.0538. The threshold on this distribution that achieves the same false alarm rate as a 7.1 sigma threshold on a Gaussian distribution is 4.5226.

Open `./planet-01/bootstrap-results/0000000164652245-01-bootstrap-false-alarm.fig`

Planet 1 : Cotrended Folded Core Aperture Flux Time Series
Correlation Statistic = 2.18, Significance = 98.53%
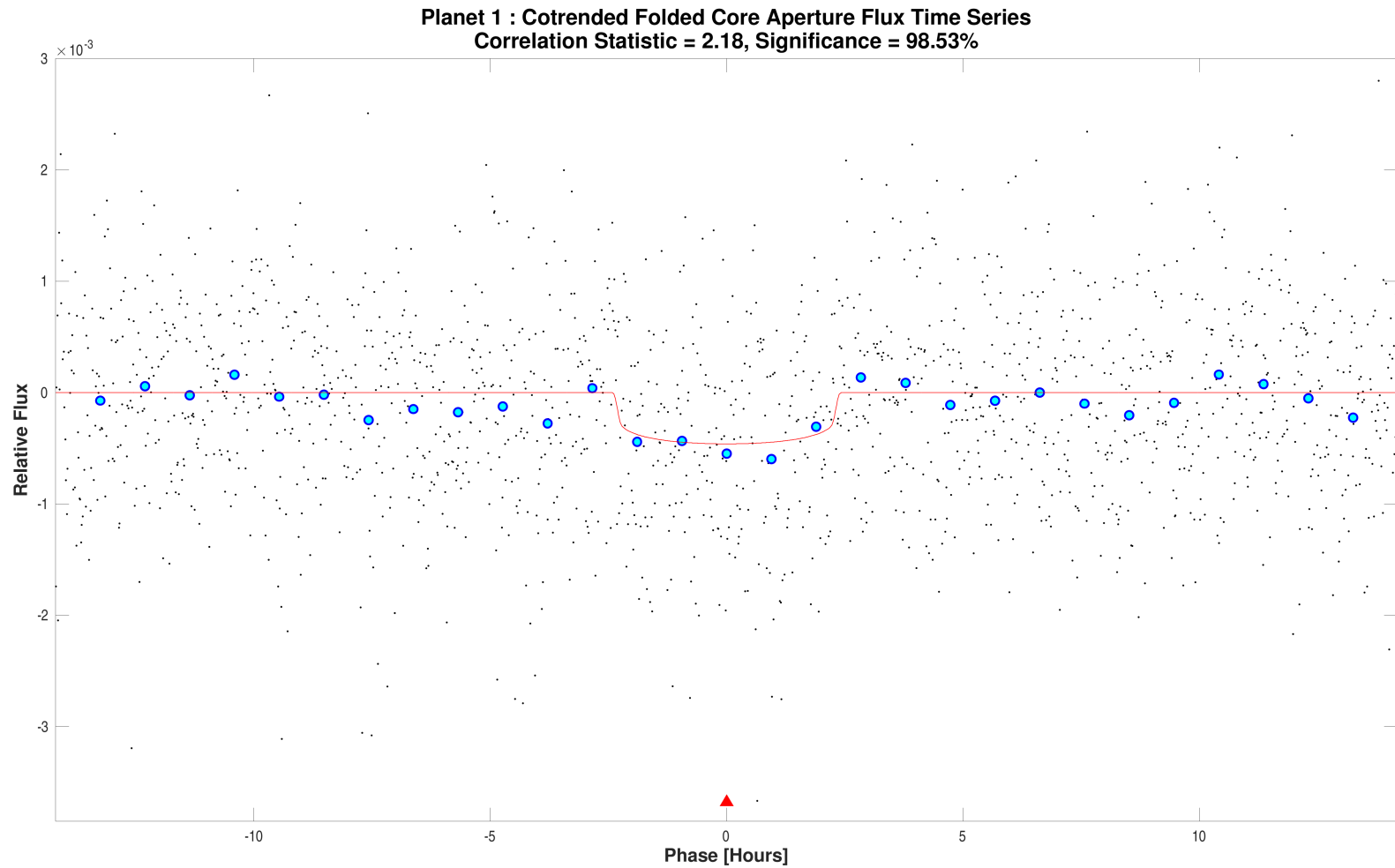
Optical ghost diagnostic core aperture flux time series for target 164652245, planet candidate 1. The unwhitened time series is phase folded at the orbital period associated with the planet candidate and centered on the epoch of the first transit. The time series was first cotrended against spacecraft engineering data, motion proxies, and/or cotrending basis vectors (CBVs) to remove systematic effects. Flux time series data represent the mean per pixel flux in the core or haloaperture; phase folded data points are shown in the figure with black dots. Binned and averaged phase folded flux values are marked with filled blue circles. The unwhitened transit model light curve is displayed in the figure with a red line. The value and significance of the core aperture correlation statistic are displayed in the figure title if the statistic was successfully computed.

Open `./planet-01/ghost-diagnostic-results/0000000164652245-01-core-unwhitened-cotrended-zoomed-model.fig`

Planet 1 : Cotrended Folded Halo Aperture Flux Time Series
Correlation Statistic = 2.69, Significance = 99.65%
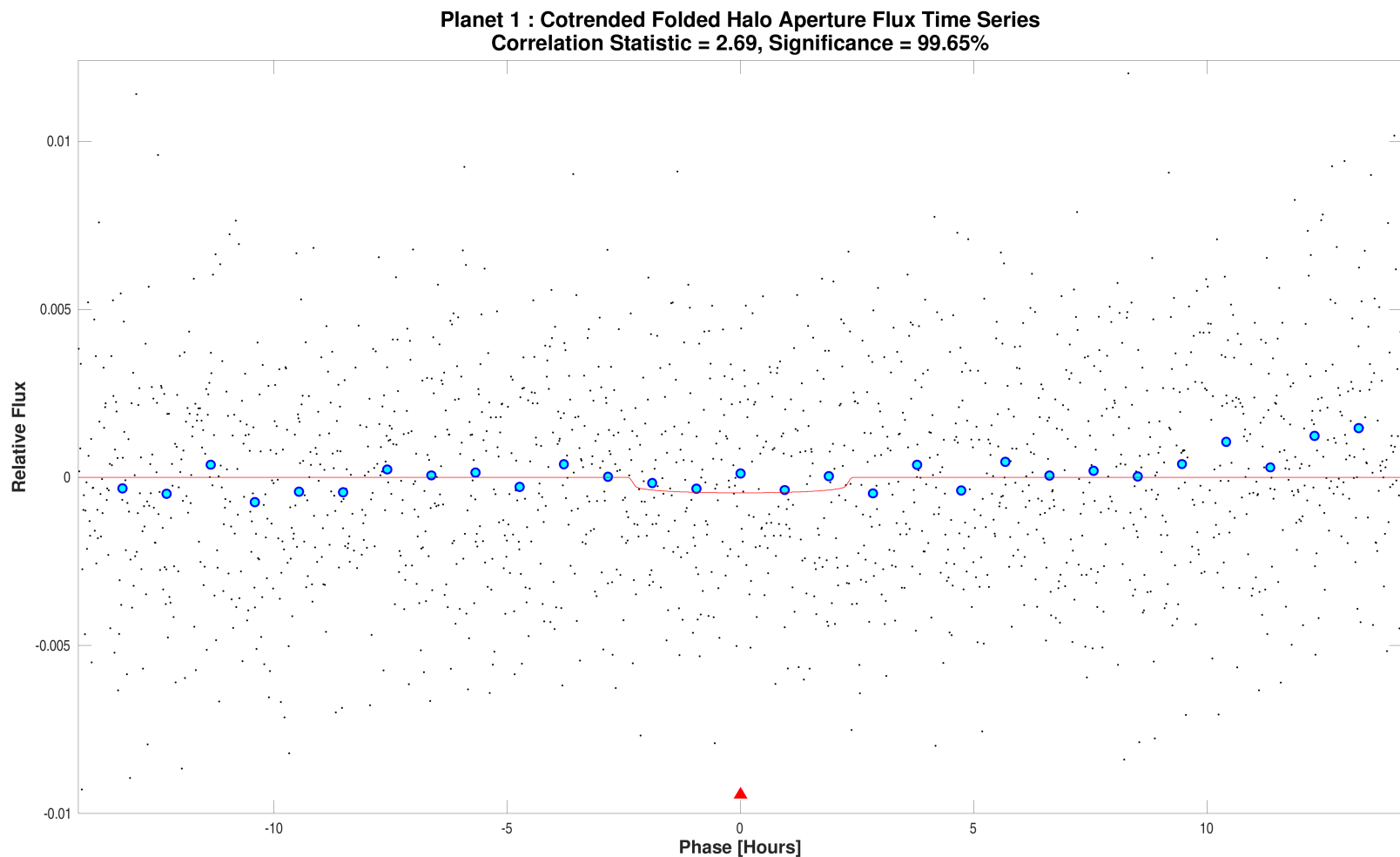
Optical ghost diagnostic halo aperture flux time series for target 164652245, planet candidate 1. The unwhitened time series is phase folded at the orbital period associated with the planet candidate and centered on the epoch of the first transit. The time series was first cotrended against spacecraft engineering data, motion proxies, and/or cotrending basis vectors (CBVs) to remove systematic effects. Flux time series data represent the mean per pixel flux in the core or haloaperture; phase folded data points are shown in the figure with black dots. Binned and averaged phase folded flux values are marked with filled blue circles. The unwhitened transit model light curve is displayed in the figure with a red line. The value and significance of the halo aperture correlation statistic are displayed in the figure title if the statistic was successfully computed.

Open ./planet-01/ghost-diagnostic-results/0000000164652245-01-halo-unwhitened-cotrended-zoomed-model.fig

Appendix A   Planet Candidate 1

A.1   Model Fitter: All Transits
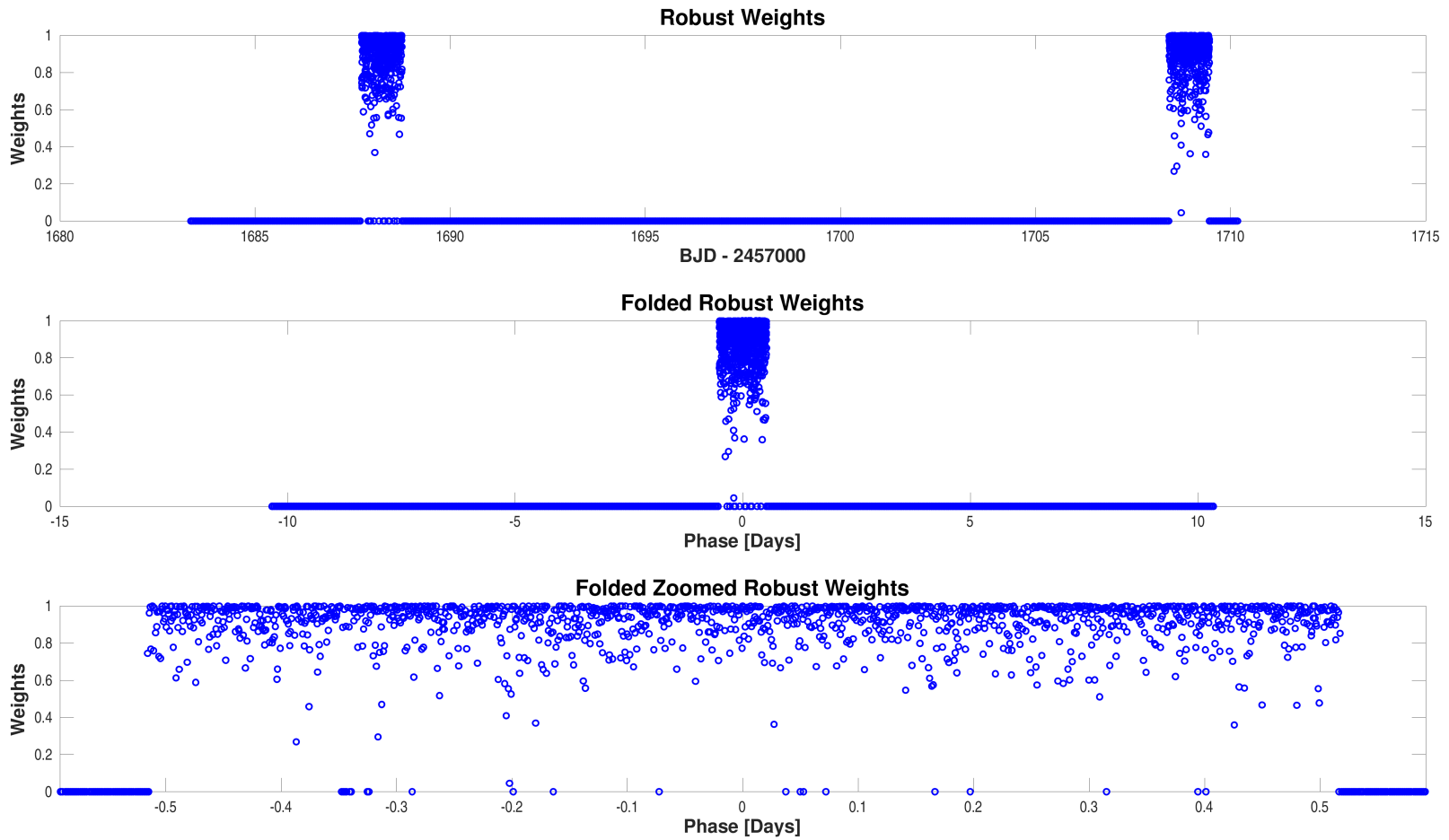
Robust weights distribution for CatId 164652245, Planet candidate 1. Top plot: all data points. Middle plot: all data points, folded per the fitted period and epoch. Bottom plot: all data points, folded and zoomed.

Open `./planet-01/planet-search-and-model-fitting-results/all-transits-fit/0000000164652245-01-all-robust-weights.fig`
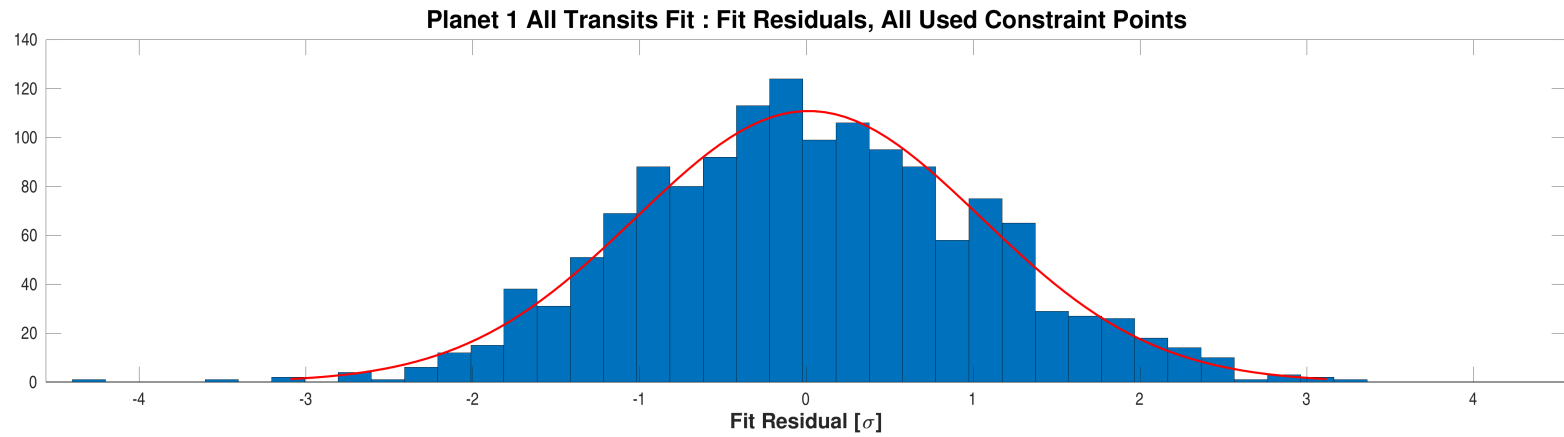
Fit residuals distribution for CatId 164652245, Planet candidate 1. Only the valid data points used to constrain the fit are shown here. A Gaussian fit to the histogram is shown in red.
Open ./planet-01/planet-search-and-model-fitting-results/all-transits-fit/0000000164652245-01-all-histo-used.fig
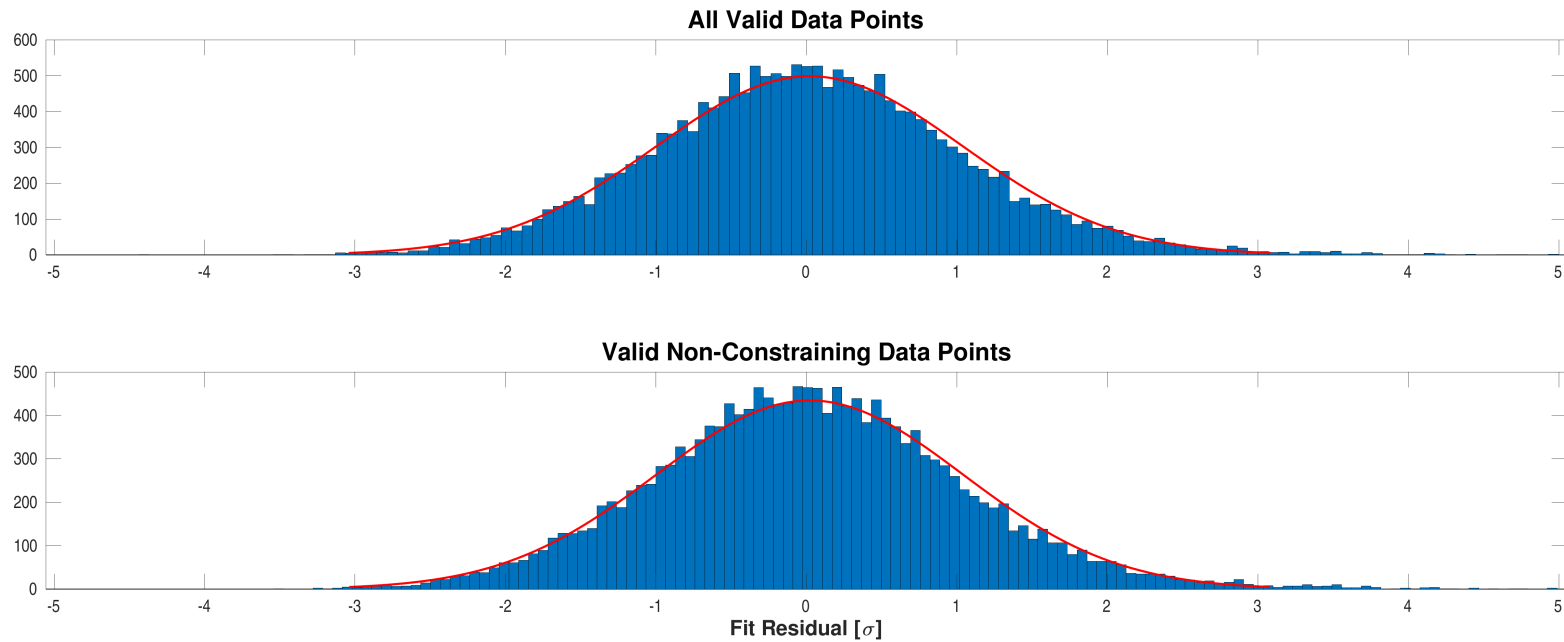

Fit residuals distribution for CatId 164652245, Planet candidate 1. Top plot: all valid data. Bottom plot: valid data not used to constrain fit (due to distance from a transit). Gaussian fits to the histograms are shown in red.
Open ./planet-01/planet-search-and-model-fitting-results/all-transits-fit/0000000164652245-01-all-histo-all-and-unused.fig
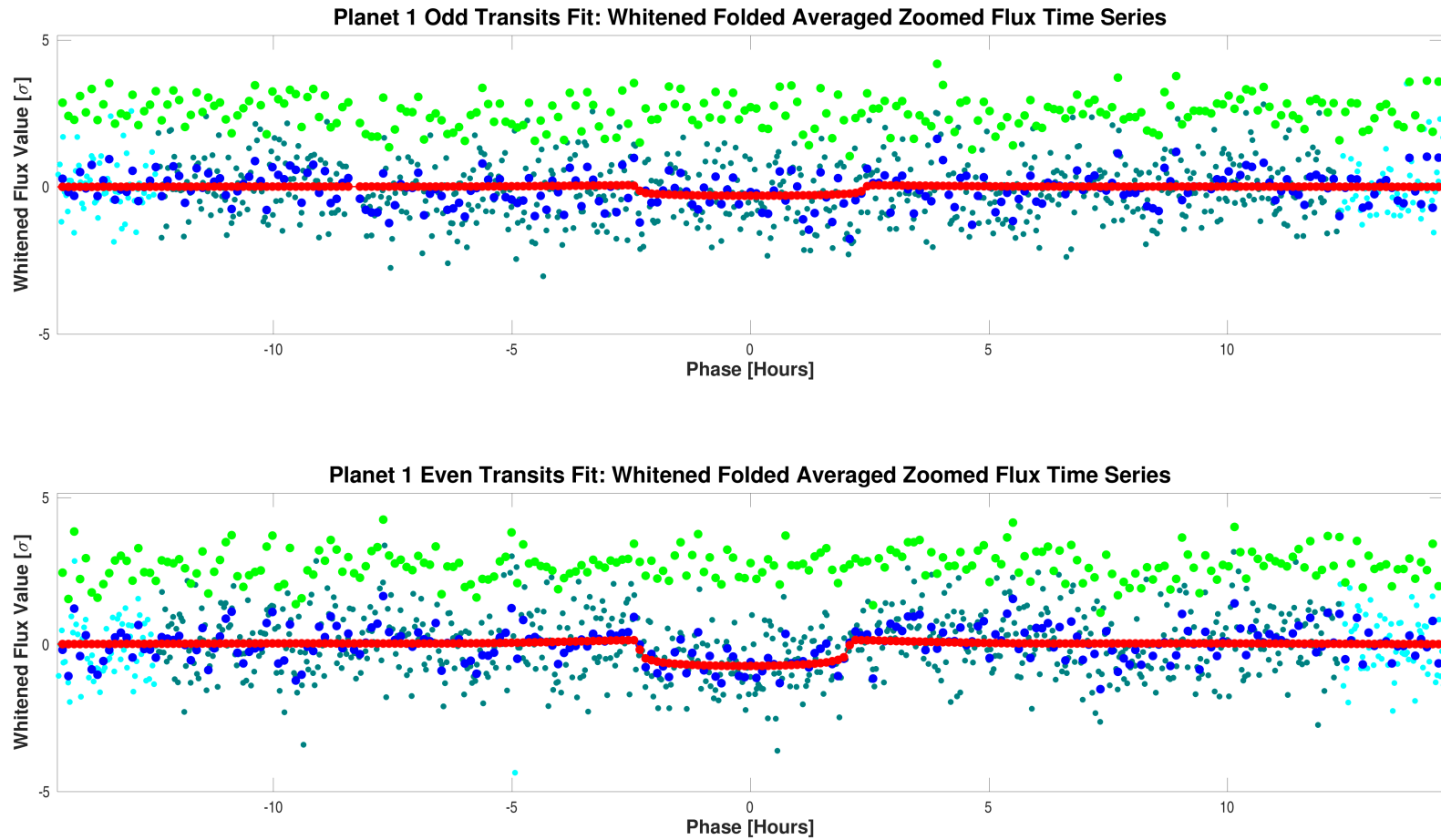
A.2 Model Fitter: Odd & Even Transits

| Parameter	Odd Transits Value	Odd Transits Uncertainty	Even Transits Value	Even Transits Uncertainty	Units	Difference ‖Uncertainty‖
SNR	3.0		7.4			
Orbital Period	20.6883169	0.0000e+00	20.6883169	0.0000e+00	days	
Transit Epoch	1688.2498339	9.0311e-03	1708.9322337	3.8168e-03	BTJD	4.0275e-01
Impact Parameter	0.1399	1.3276e+02	0.3302	9.3036e+00		1.4296e-03
Planet Radius to Star Radius Ratio	0.0152854	5.3077e-02	0.0240587	1.5461e-02		1.5870e-01
Semi-major Axis to Star Radius Ratio	32.8129	6.1843e+02	33.9849	1.1653e+02		1.8623e-03
Planet Radius	1.3206	4.5860e+00	2.0785	1.3391e+00	Earth radii	1.5865e-01
Semi-major Axis	0.1446	9.5692e-03	0.1446	9.5692e-03	AU	0.0000e+00
Effective Stellar Flux	22.6803	3.2619e+00	22.6803	3.2619e+00	Goldilocks	0.0000e+00
Equilibrium Temperature	557	2.0012e+01	557	2.0012e+01	Kelvin	0.0000e+00
Stellar Density	1.1090	6.2703e+01	1.2321	1.2674e+01	Solar density	1.9247e-03
Transit Depth	274	1.0409e+02	667	9.5463e+01	ppm	2.7817e+00
Transit Duration	4.8444	2.7086e+00	4.5089	8.3134e-01	hours	1.1840e-01
Transit Ingress Duration	0.0744	3.0709e+00	0.1186	8.9191e-01	hours	1.3821e-02
Eccentricity	0.0000	0.0000e+00	0.0000	0.0000e+00		
Peri Longitude	0.0000	0.0000e+00	0.0000	0.0000e+00	degrees	
Model Chi Square Statistic (DoF)	1195.5 (1337.7)		1195.5 (1337.7)			

DoF: Degrees of Freedom
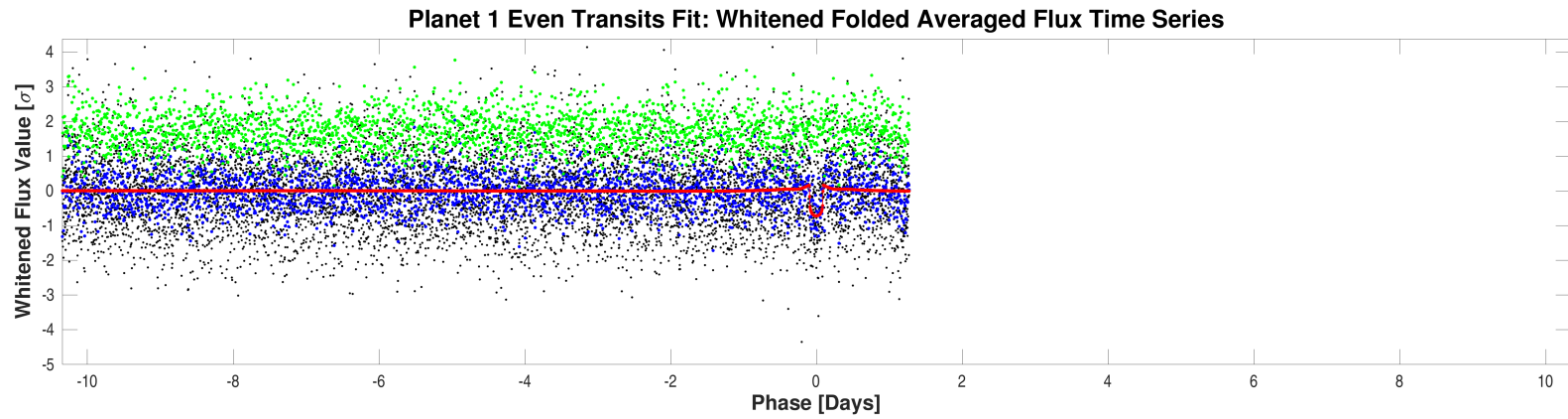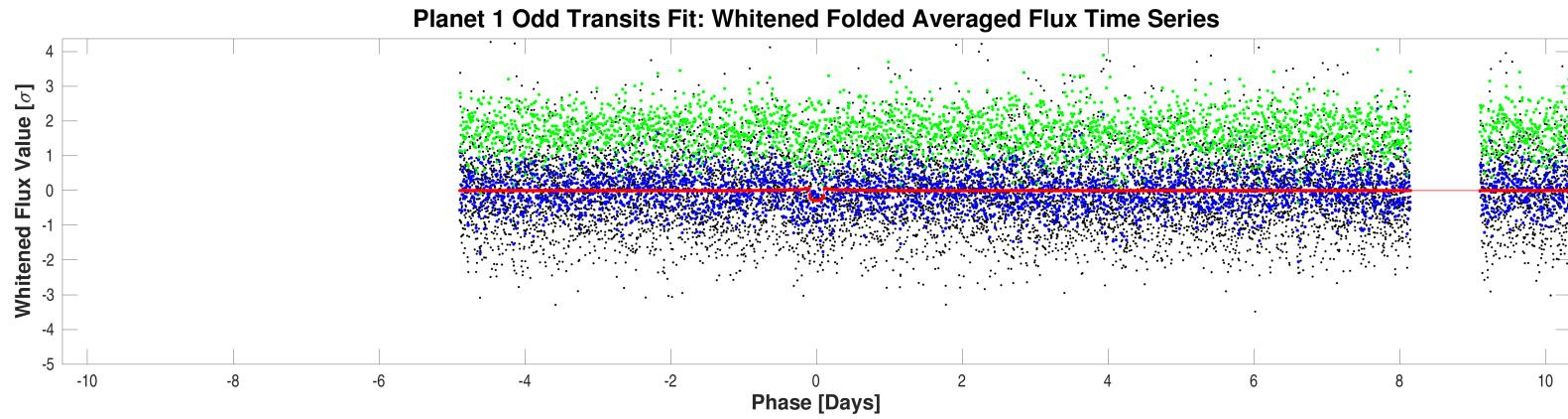
Folded flux time series for CatId 164652245, Planet candidate 1 in the whitened domain is plotted in black dots. Values are averaged into 1 cadence wide bins. The blue dots represent the averaged values of the folded flux time series; the red dots represent the averaged values of the folded model light curve of the odd/even transits fit; the green dots are the averaged folded fit residuals, vertically offset for clarity. Odd-even transits fit completed with full convergence.
Open `./planet-01/planet-search-and-model-fitting-results/odd-even-transits-fit/0000000164652245-01-odd-even-whitened.fig`

Folded flux time series for CatId 164652245, Planet candidate 1 in the whitened domain, zoomed on the transit. The flux data whose robust weights are larger/smaller than 0.1 are plotted in dark green/cyan dots, respectively. Values are averaged into 1 cadence wide bins. The blue dots represent the averaged values of the folded flux time series; the red dots represent the averaged values of the fitted model light curve of the odd/even transits fit; the green dots are the averaged folded fit residuals, vertically offset for clarity. Magenta dots are the averaged values of the folded flux time series, with a phase shift of 0.5 relative to the blue dots, vertically offset for clarity. Odd-even transits fit completed with full convergence.

Open `./planet-01/planet-search-and-model-fitting-results/odd-even-transits-fit/0000000164652245-01-odd-even-whitened-zoomed.fig`
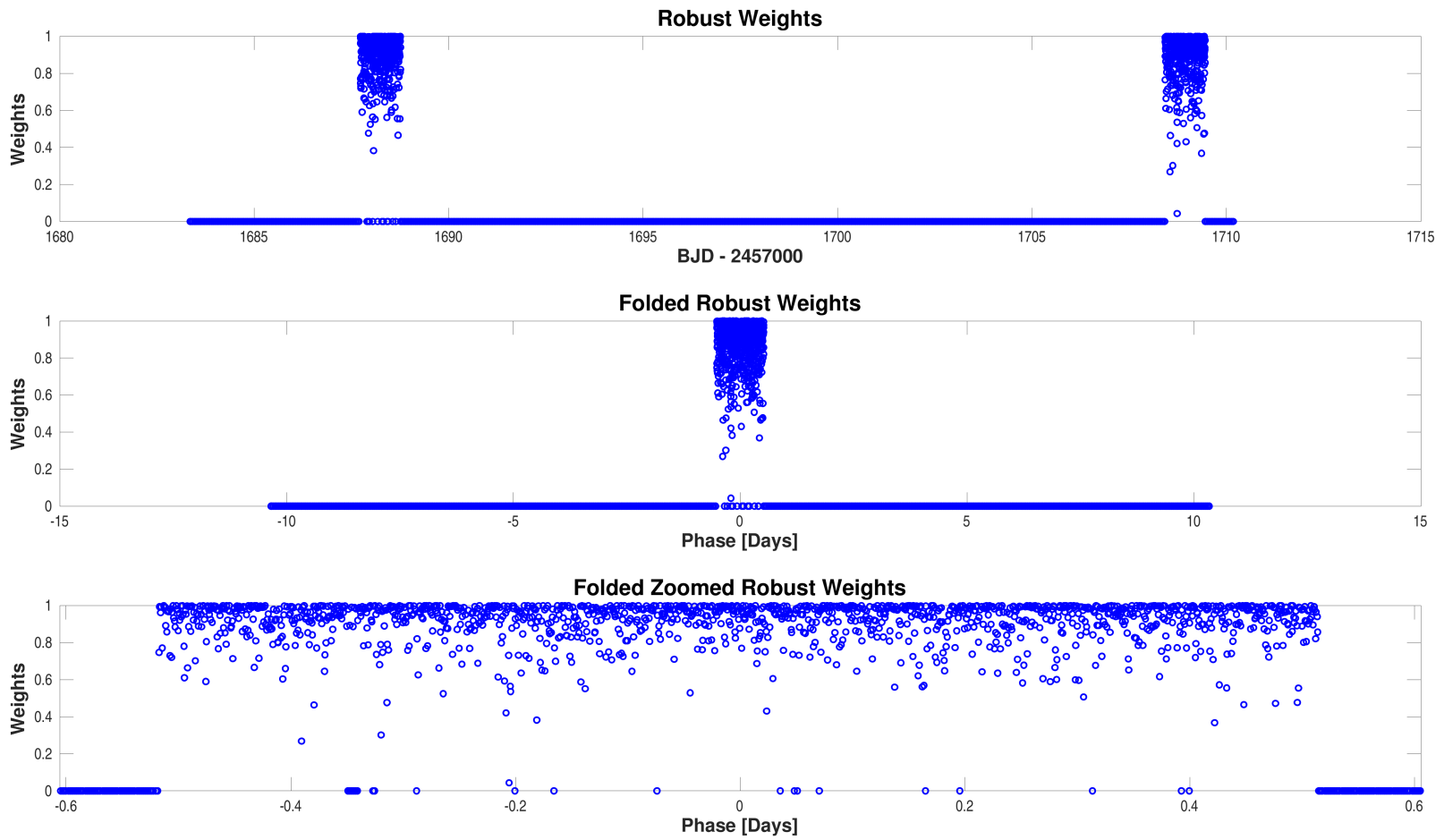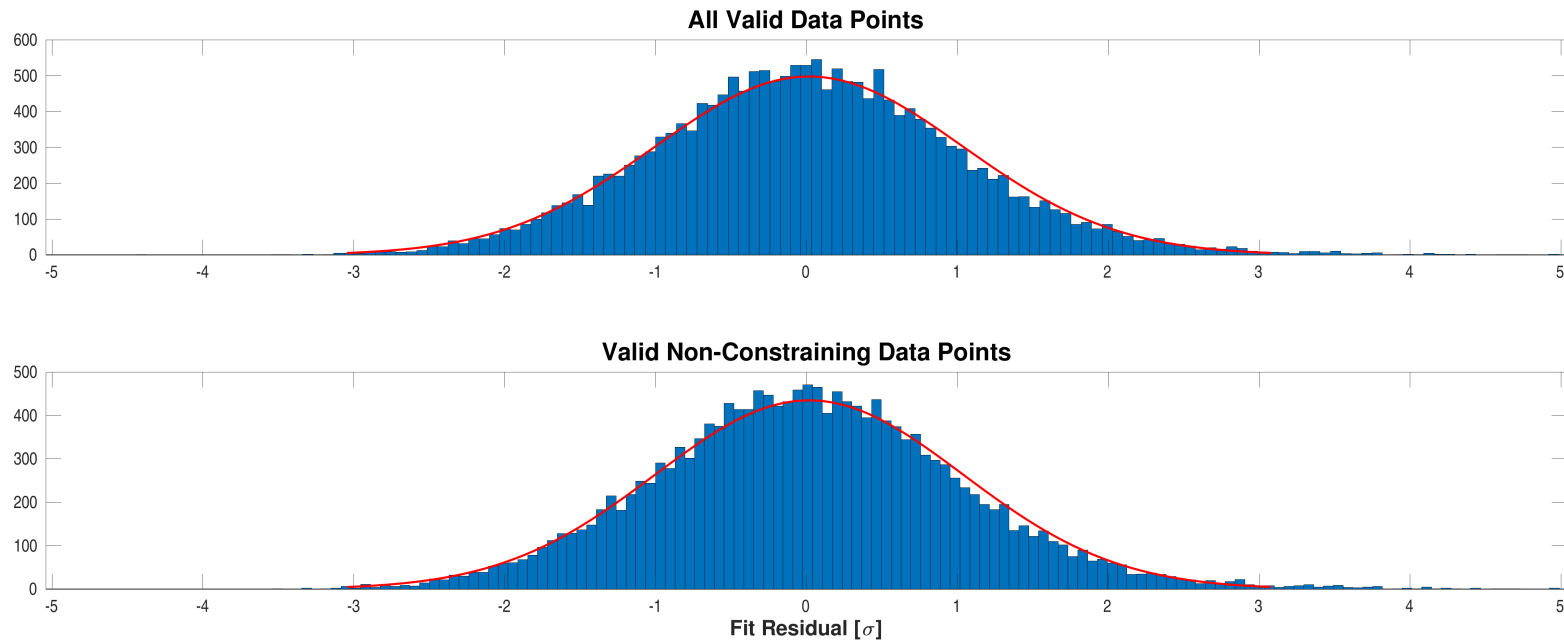
Robust weights distribution for CatId 164652245, Planet candidate 1. Top plot: all data points. Middle plot: all data points, folded per the fitted period and epoch. Bottom plot: all data points, folded and zoomed.

Open ./planet-01/planet-search-and-model-fitting-results/odd-even-transits-fit/0000000164652245-01-odd-even-robust-weights.fig
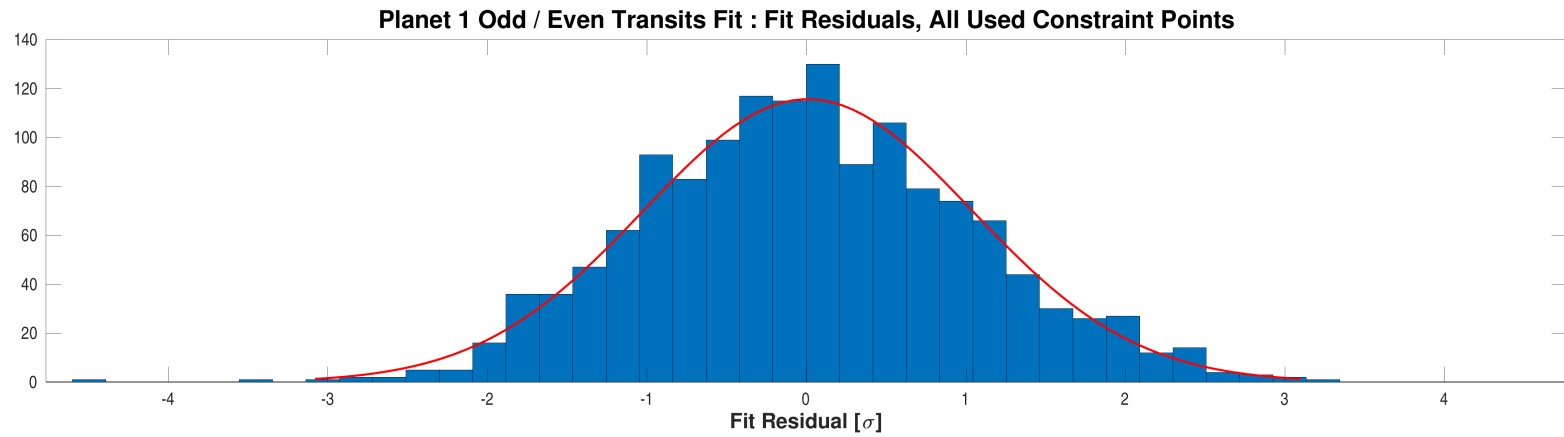
Fit residuals distribution for CatId 164652245, Planet candidate 1. Only the valid data points used to constrain the fit are shown here. A Gaussian fit to the histogram is shown in red.
Open ./planet-01/planet-search-and-model-fitting-results/odd-even-transits-fit/0000000164652245-01-odd-even-histo-used.fig


Fit residuals distribution for CatId 164652245, Planet candidate 1. Top plot: all valid data. Bottom plot: valid data not used to constrain fit (due to distance from a transit). Gaussian fits to the histograms are shown in red.
Open ./planet-01/planet-search-and-model-fitting-results/odd-even-transits-fit/0000000164652245-01-odd-even-histo-all-and-unused.fig

A.3 Eclipsing Binary Discrimination Test
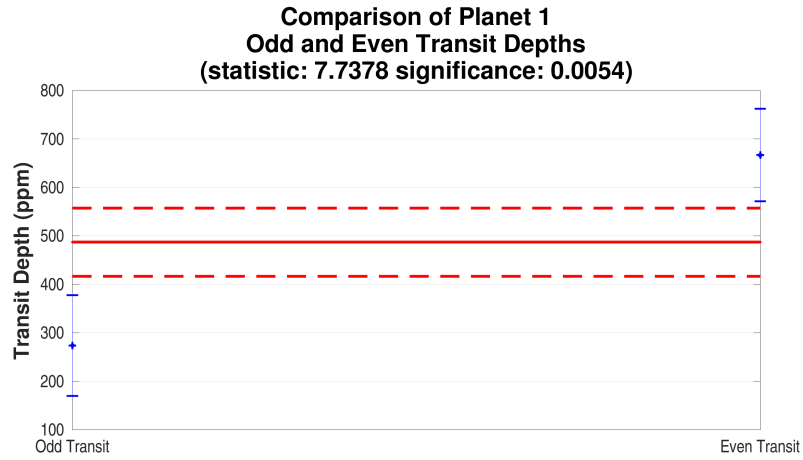
Top-left: Diagnostic plot of Odd/Even Transit Depth Test for catId 164652245, planet 1. A significance level close to 1/0 favors a transiting planet/an eclipsing binary. Open `./planet-01/binary-discrimination-test-results/0000000164652245-01-eclipsing-binary-discrimination-tests.fig`

Appendix B   Alerts

This target did not trigger any alerts.