Data Validation (DV) Report
for TESS ID 158324245
Sectors 14 - 26

Contents

1 Summary

Target Properties	Value	Uncertainty	Units	Provenance
Catalog ID	158324245			
TOI ID	1161			
TESS Name	-			
RA	286.97119800	0	degrees	TIC8
Dec	46.86835500	0	degrees	TIC8
Magnitude	9.567	0.018		TIC8
Radius	1.000	0.000	Solar radii	Solar
Effective Temperature	7986	177	Kelvin	TIC8
log(g)	4.438	0	cm/sec^2	Solar
[M/H]	0.000	0	Solar metallicity	Solar
Stellar Density	1.000	0.000	Solar density	Solar
Limb Darkening Coefficient 1	0.4523			
Limb Darkening Coefficient 2	0.52984			
Limb Darkening Coefficient 3	-0.68058			
Limb Darkening Coefficient 4	0.2541			
Number of Planet Candidates	1			
TOI Model	csv-file-toi-catalog-07-29-20-edited.csv			
TESS Names Model	-			
External TCE Model	-			
Software Revision	spoc-5.0.5-20200728			
Date Report Generated	03-Aug-2020 04:31:34 Z			

Sector	Target Table	Camera/ CCD	Crowding Metric	Flux Fraction
14	167	2:3	0.5020	0.9459
15	169	2:3	0.4966	0.9482
26	254	2:4	0.5019	0.9458

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	1161.01	-	0.99	1.764	1.00	1683.554	0.03	9.5	4461.2	2084	0.00e+00	false

2 Survey Image
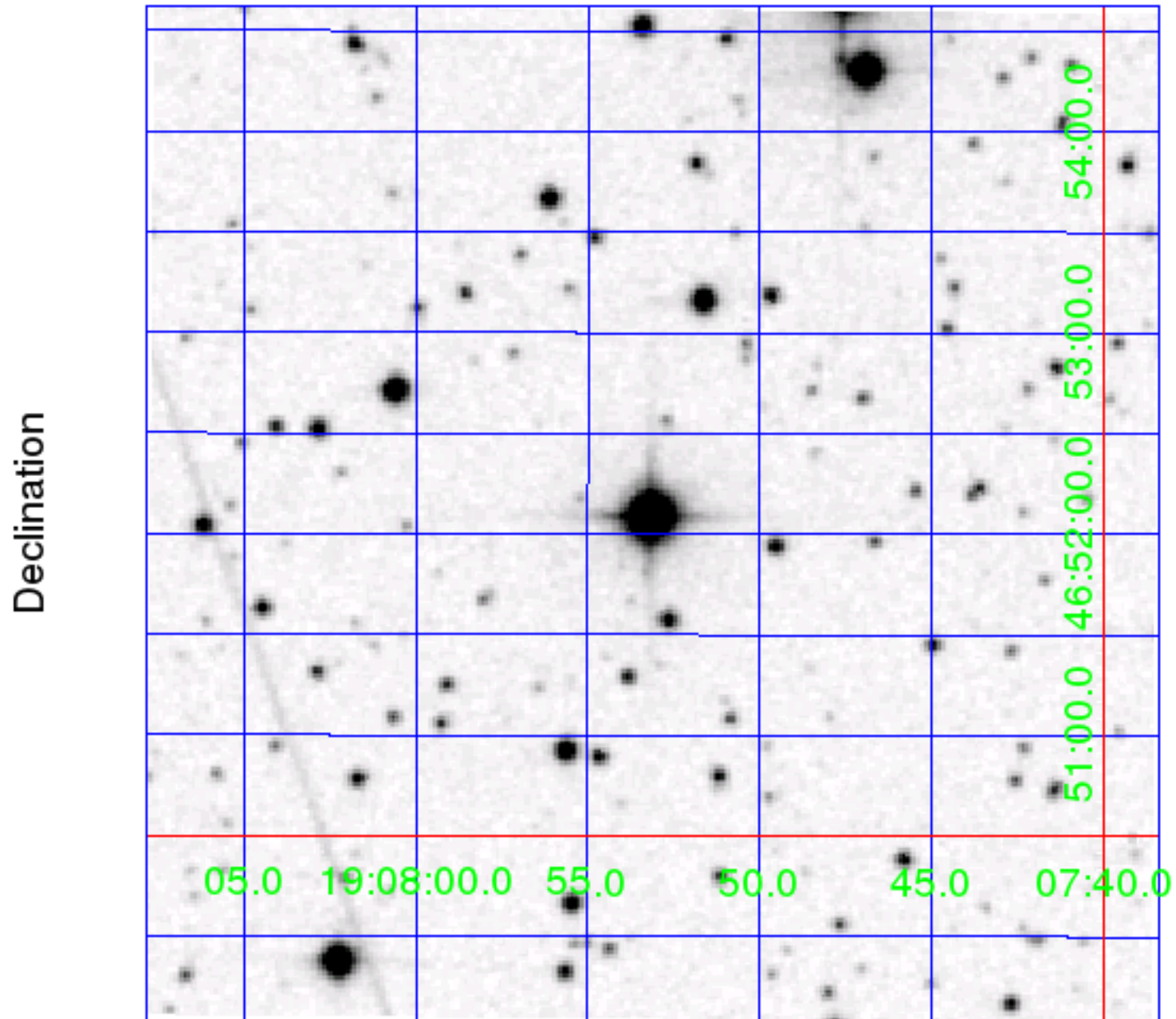
Digitized Sky Survey (DSS) red image. The 5' x 5' image is centered on the J2000 coordinates of target (158324245).

3   Flux Time Series
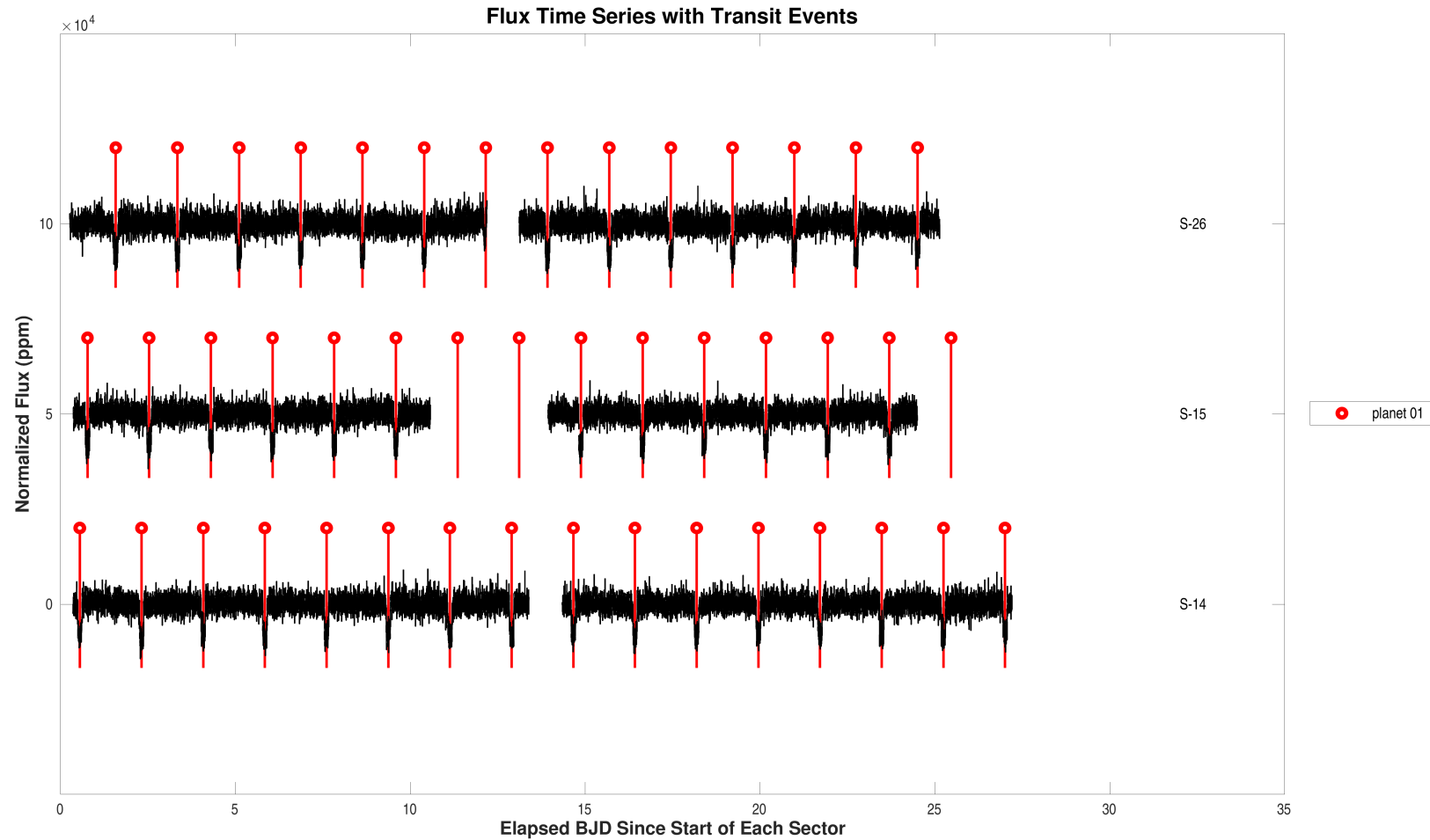
Summary plot of sector-stitched flux time series and transits for target 158324245, marked with DV fitted epoch/period (or TPS epoch/period if fit was not successful). Transits of identified planets are labeled with epoch BTJD and orbital period. For the data of sector 14, target table 167, start BJD is 2458683 and the vertical offset is 0 ppm. For the data of sector 15, target table 169, start BJD is 2458711 and the vertical offset is 50000 ppm. For the data of sector 26, target table 254, start BJD is 2459010 and the vertical offset is 100000 ppm.
Open `./summary-plots/0000000158324245-00-flux-dv-fit-14-167.fig`
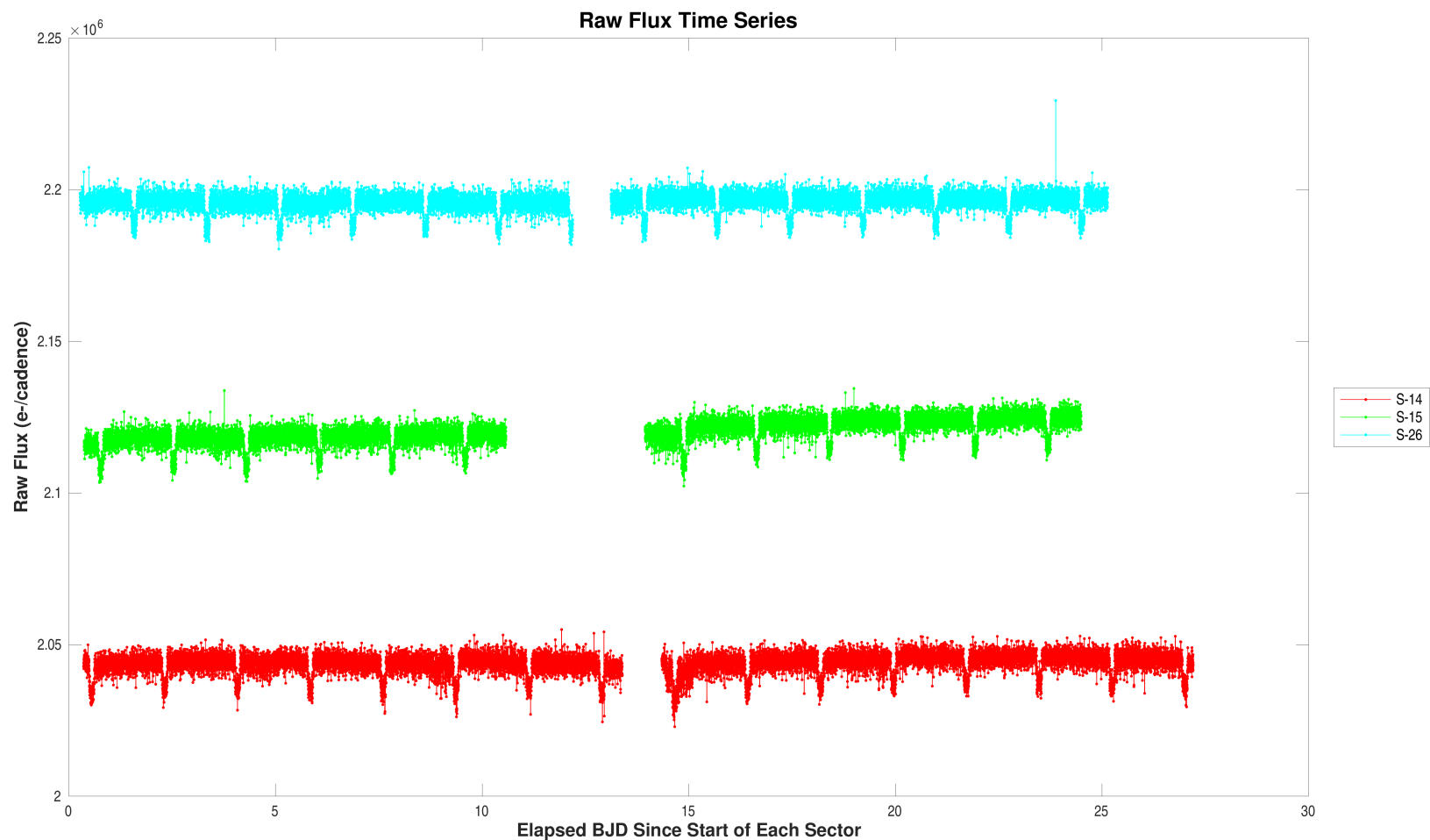
Summary plot of raw flux time series. For the data of sector 14, target table 167, start BJD is 2458683 and the vertical offset is 0 electrons/cadence. For the data of sector 15, target table 169, start BJD is 2458711 and the vertical offset is 76000 electrons/cadence. For the data of sector 26, target table 254, start BJD is 2459010 and the vertical offset is 152000 electrons/cadence.

Open `./summary-plots/0000000158324245-00-raw-flux-14-167.fig`

4   Dashboards

Planet Candidate 1

Model Fitter	Stellar Radius		Core Aperture Correlation Statistic	Ghost Diagnostic Test
	1.0 ± 0.0 Solar units		Value = 121.34 Significance = 100.00%	
	Period = 1.8 ± 0.0 days Depth = 8449 ± 48 ppm Planet Radius = 9.5 ± 0.0 Earth radii Semi-major Axis = 0.0 ± 0.0 AU Effective Stellar Flux = 4461.2 ± 395.9 Equilibrium Temperature = 2084 ± 46 Kelvin Chi-squared/DoF = 0.8 SNR = 176.3		**Halo Aperture Correlation Statistic** Value = 13.09 Significance = 100.00% **Core/Halo Ratio** Ratio = 9.27	
Eclipsing Binary Discrimination Test	**Odd-Even Depth Comparison Statistic** Value = 2.61e-01 Significance = 60.93%		**Offsets Relative to Out of Transit Centroid** Source RA Offset = 6.63e-01 ± 2.52e+00 arcsec (0.26 σ) Source Dec Offset = -4.04e-02 ± 2.52e+00 arcsec (-0.02 σ) Source Offset Distance = 6.64e-01 ± 2.52e+00 arcsec (0.26 σ) **Offsets Relative to TIC Position** Source RA Offset = 1.21e-01 ± 2.80e+00 arcsec (0.04 σ) Source Dec Offset = 9.08e-01 ± 2.51e+00 arcsec (0.36 σ) Source Offset Distance = 9.16e-01 ± 2.52e+00 arcsec (0.36 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 = 0.00e+00 Transit Count = 200 Max Multiple Event Statistic = 106.9	Bootstrap Test

Summary of model fitter results and validation test results for target 158324245, 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

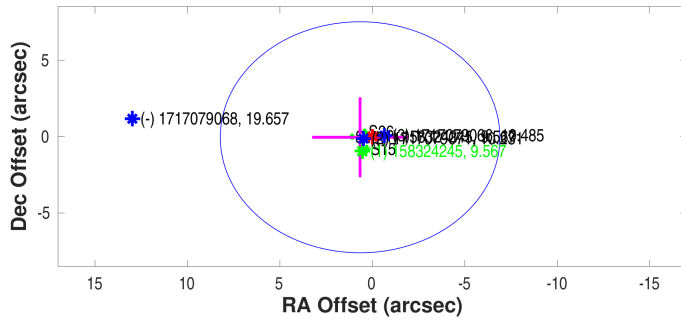**Mean offset from the PRF fit to the out of transit image**

	RA	Dec	Units
Offset	$0.6632 \pm 2.52e + 00$	$-0.0404 \pm 2.52e + 00$	arcseconds
Offset/σ	0.26	-0.02	
Offset Distance	$0.6644 \pm 2.52e + 00$		arcseconds
Offset Distance/σ	0.26		
3σ Radius	7.5635		arcseconds

Mean offset from the TIC RA and Dec

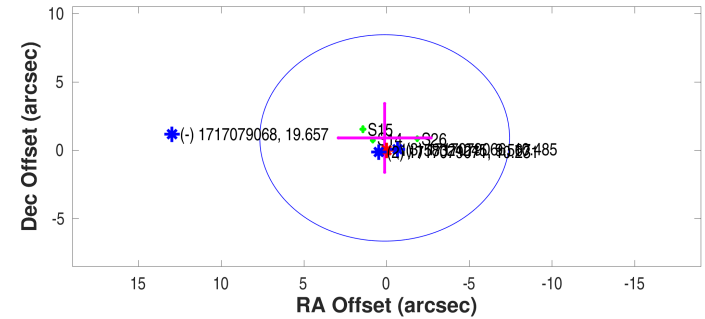|	RA	Dec	Units
Offset	$0.1209 \pm 2.80e + 00$	$0.9077 \pm 2.51e + 00$	arcseconds
Offset/σ	0.04	0.36	
Offset Distance	$0.9157 \pm 2.52e + 00$		arcseconds
Offset Distance/σ	0.36		
3σ Radius	7.5517		arcseconds

Planet Candidate 1

Difference image centroid offsets for target 158324245, 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 (out-of-transit centroid in left panel and TIC position in right panel); green asterisk: TIC location of target star with respect to out-of-transit centroid; 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/0000000158324245-01-difference-image-centroid-offsets.fig`

Planet Candidate 1
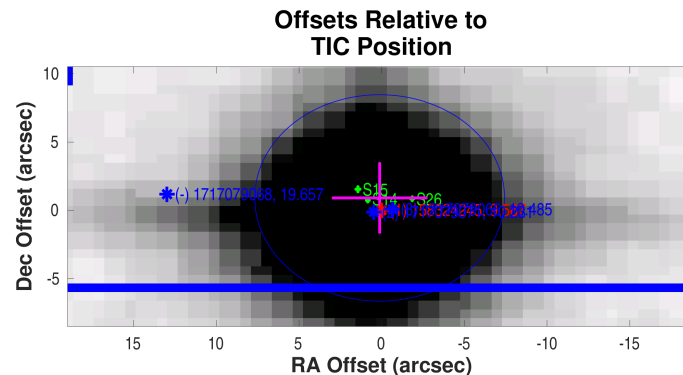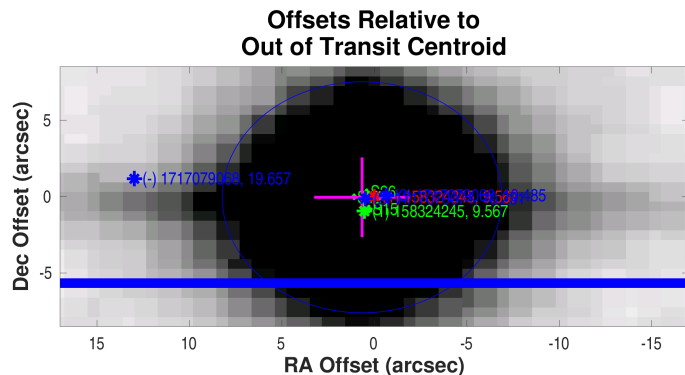
**Offsets Relative to
Out of Transit Centroid**

**Offsets Relative to
TIC Position**



Difference image centroid offsets for target 158324245, 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 (out-of-transit centroid in left panel and TIC position in right panel); green asterisk: TIC location of target star with respect to out-of-transit centroid; 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/0000000158324245-01-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
3	3	3	1.0000	0.70

Difference Image
Planet Candidate 1 / Sector 14 / Target Pixel Table 167
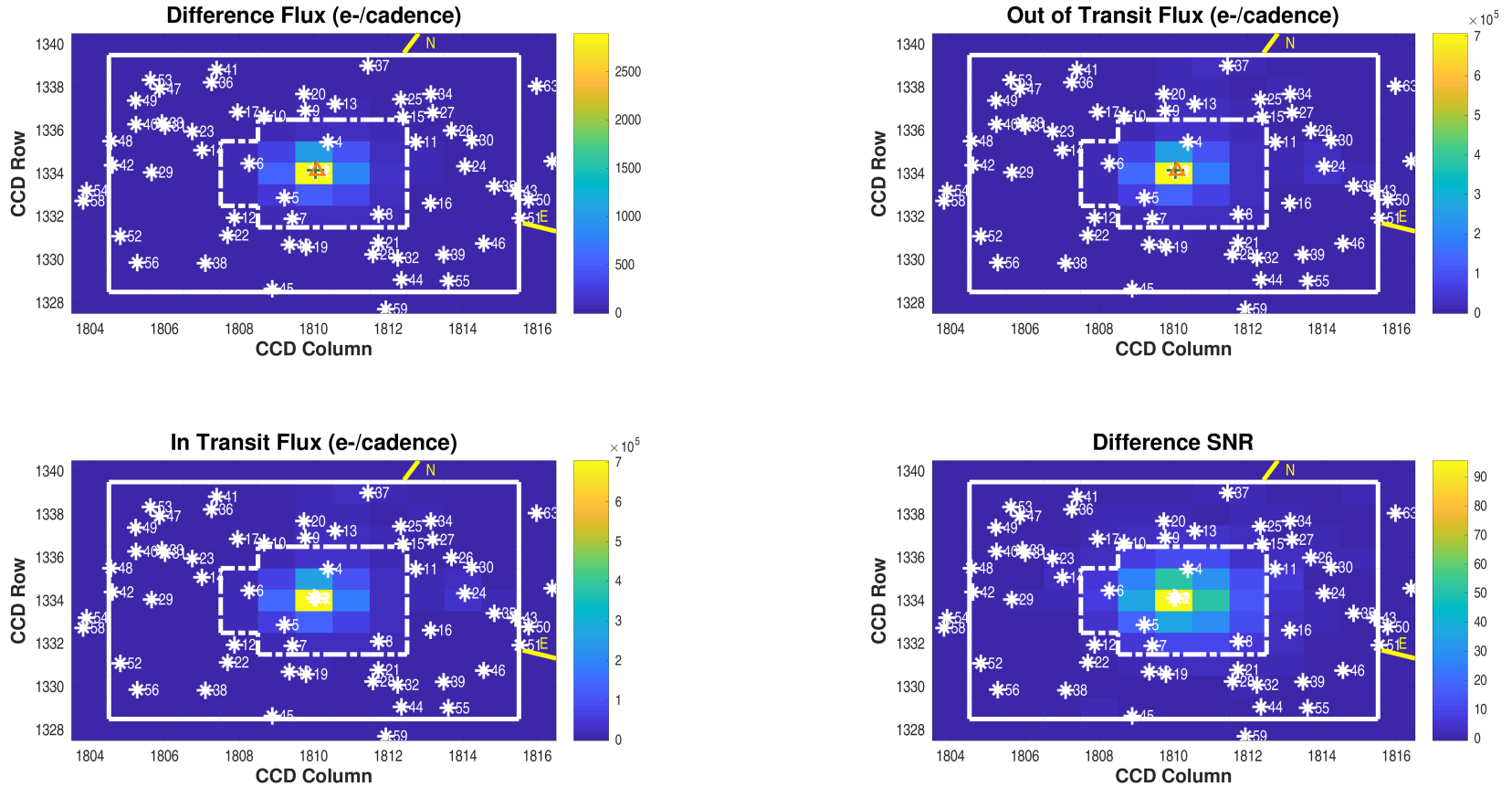
Difference image for target 158324245, planet candidate 1, sector 14, target pixel table 167. Upper left: difference between mean flux out-of-transit and in-transit; upper right: mean out-of-transit flux; lower left: mean in-transit flux; lower right: difference between mean flux out-of-transit and in-transit 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 = 15; number of valid in-transit cadences = 1222; number of in-transit cadence gaps = 15; number of valid out-of-transit cadences = 2992; number of out-of-transit cadence gaps = 32. Difference image quality metric = 1.00 (good).
Open ./planet-01/difference-image/0000000158324245-01-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	$1334.15 \pm 1.15e-05$	$1810.04 \pm 1.26e-05$	pixels	$286.97108183 \pm 6.42e-07$	$46.86846805 \pm 6.26e-07$	degrees
Difference Image Centroid	$1334.13 \pm 5.42e-03$	$1810.09 \pm 5.78e-03$	pixels	$286.97152650 \pm 3.33e-05$	$46.86846654 \pm 3.07e-05$	degrees
Offset	$-0.0209 \pm 5.42e-03$	$0.0475 \pm 5.78e-03$	pixels	$1.0944 \pm 8.21e-02$	$-0.0054 \pm 1.10e-01$	arcseconds
Offset/σ	-3.86	8.22		13.33	-0.05	
Offset Distance	$0.0519 \pm 5.79e-03$		pixels	$1.0945 \pm 8.21e-02$		arcseconds
Offset Distance/σ	8.97			13.33		

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

	Row	Column	Units	RA	Dec	Units
TIC Reference Centroid	$1334.11 \pm 1.10e-04$	$1810.04 \pm 1.11e-04$	pixels	$286.97118607 \pm 0.00e+00$	$46.86826471 \pm 0.00e+00$	degrees
Difference Image Centroid	$1334.13 \pm 5.42e-03$	$1810.09 \pm 5.78e-03$	pixels	$286.97152650 \pm 3.33e-05$	$46.86846654 \pm 3.07e-05$	degrees
Offset	$0.0160 \pm 5.42e-03$	$0.0503 \pm 5.78e-03$	pixels	$0.8379 \pm 8.21e-02$	$0.7266 \pm 1.10e-01$	arcseconds
Offset/σ	2.96	8.70		10.21	6.58	
Offset Distance	$0.0528 \pm 5.70e-03$		pixels	$1.1091 \pm 9.62e-02$		arcseconds
Offset Distance/σ	9.26			11.52		

Difference Image
Planet Candidate 1 / Sector 15 / Target Pixel Table 169
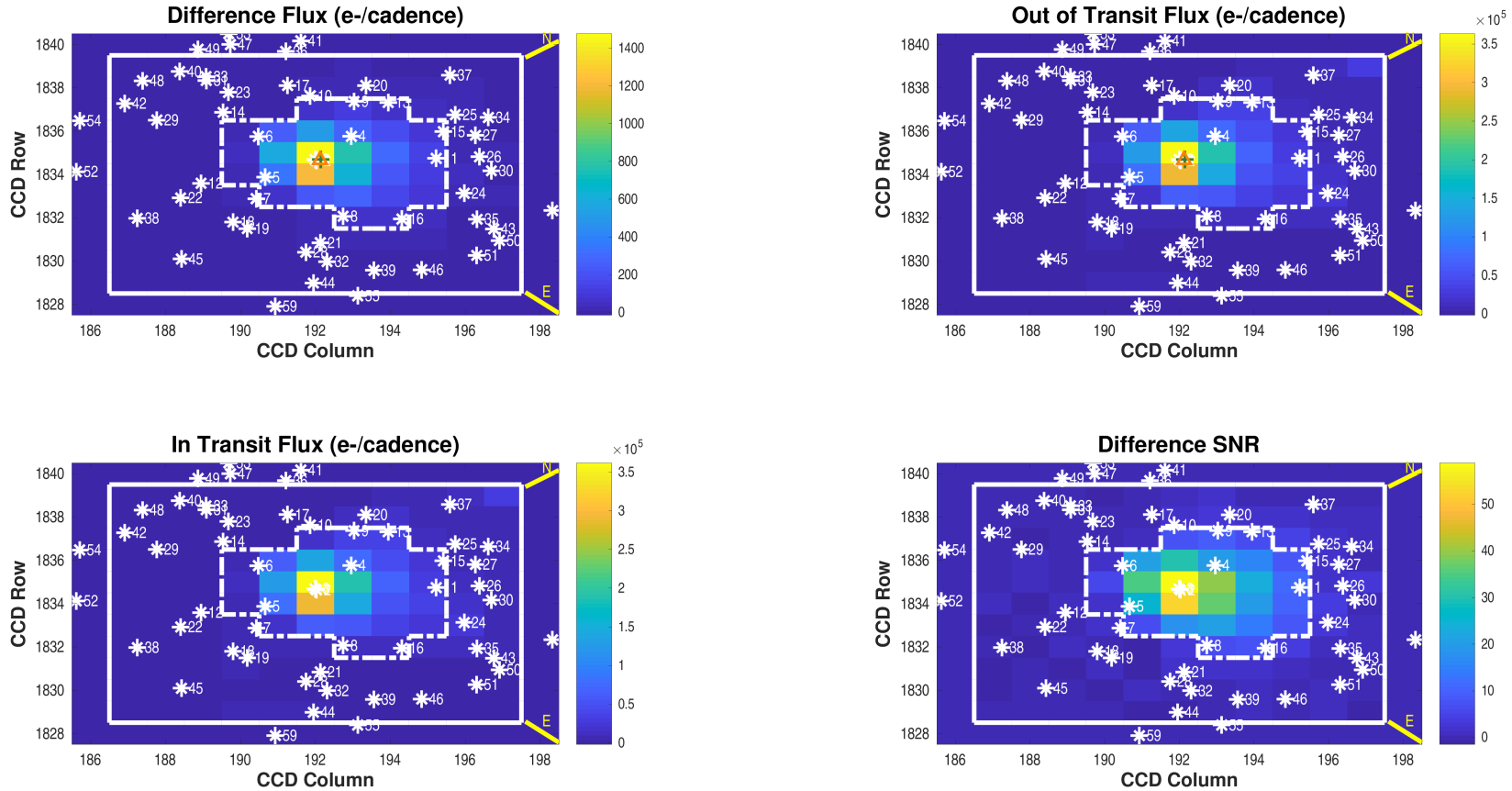
Difference image for target 158324245, planet candidate 1, sector 15, target pixel table 169. Upper left: difference between mean flux out-of-transit and in-transit; upper right: mean out-of-transit flux; lower left: mean in-transit flux; lower right: difference between mean flux out-of-transit and in-transit 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 = 12; number of valid in-transit cadences = 971; number of in-transit cadence gaps = 19; number of valid out-of-transit cadences = 2406; number of out-of-transit cadence gaps = 33. Difference image quality metric = 1.00 (good).
Open ./planet-01/difference-image/0000000158324245-01-difference-image-15-169.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	$1834.70 \pm 1.94e-05$	$192.14 \pm 1.83e-05$	pixels	$286.97165041 \pm 1.25e-06$	$46.86891726 \pm 1.23e-06$	degrees
Difference Image Centroid	$1834.66 \pm 8.76e-03$	$192.12 \pm 8.26e-03$	pixels	$286.97176928 \pm 4.80e-05$	$46.86869355 \pm 4.93e-05$	degrees
Offset	$-0.0367 \pm 8.76e-03$	$-0.0210 \pm 8.26e-03$	pixels	$0.2926 \pm 1.18e-01$	$-0.8053 \pm 1.78e-01$	arcseconds
Offset/σ	-4.19	-2.54		2.48	-4.53	
Offset Distance	$0.0423 \pm 8.80e-03$		pixels	$0.8568 \pm 1.74e-01$		arcseconds
Offset Distance/σ	4.81			4.93		

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

	Row	Column	Units	RA	Dec	Units
TIC Reference Centroid	$1834.66 \pm 2.26e-04$	$192.02 \pm 2.06e-04$	pixels	$286.97118602 \pm 0.00e+00$	$46.86826436 \pm 0.00e+00$	degrees
Difference Image Centroid	$1834.66 \pm 8.76e-03$	$192.12 \pm 8.26e-03$	pixels	$286.97176928 \pm 4.80e-05$	$46.86869355 \pm 4.93e-05$	degrees
Offset	$-0.0021 \pm 8.77e-03$	$0.1067 \pm 8.26e-03$	pixels	$1.4356 \pm 1.18e-01$	$1.5451 \pm 1.78e-01$	arcseconds
Offset/σ	-0.24	12.92		12.16	8.70	
Offset Distance	$0.1068 \pm 8.26e-03$		pixels	$2.1091 \pm 1.49e-01$		arcseconds
Offset Distance/σ	12.93			14.15		

Difference Image
Planet Candidate 1 / Sector 26 / Target Pixel Table 254
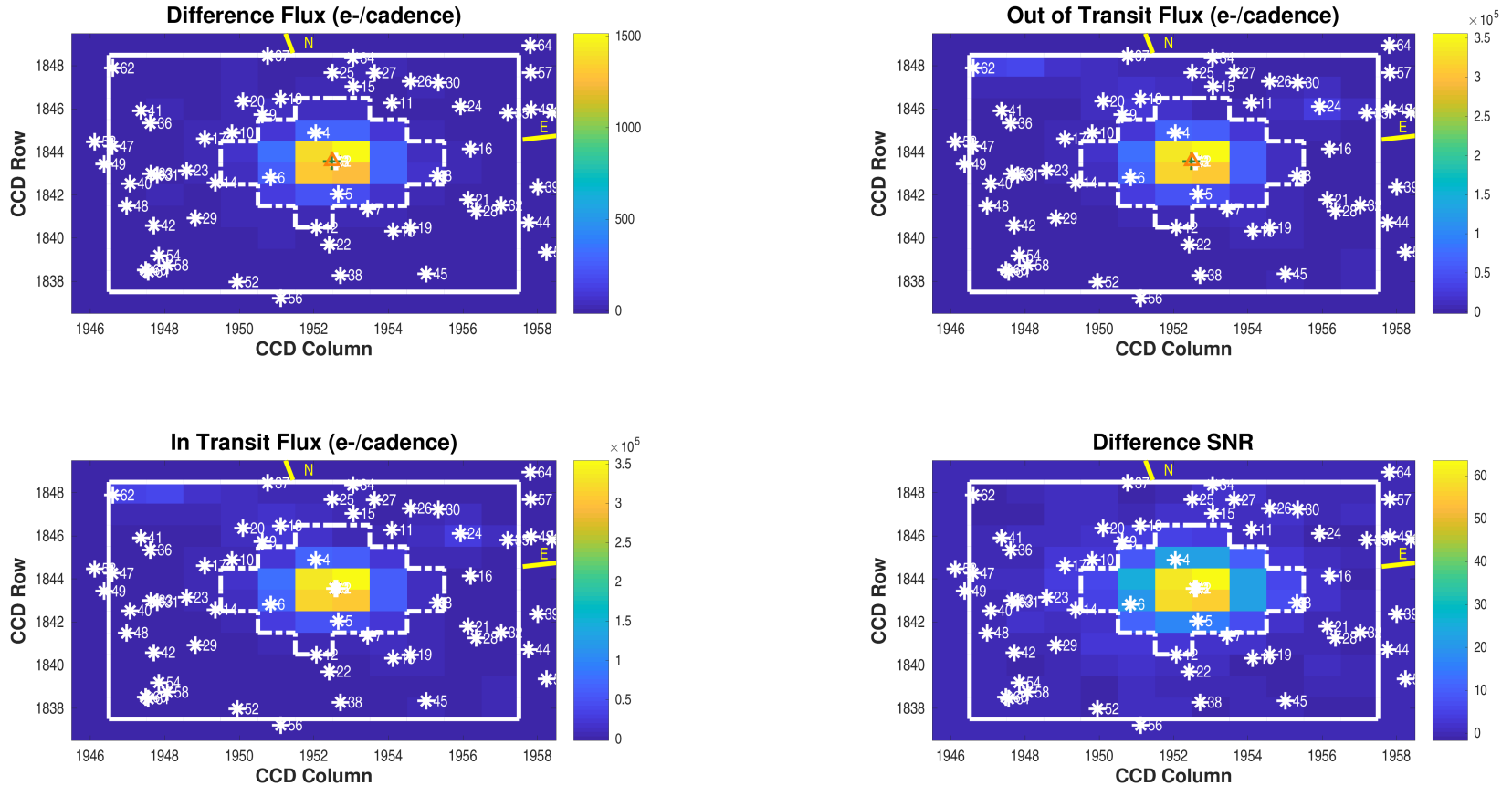
Difference image for target 158324245, planet candidate 1, sector 26, target pixel table 254. Upper left: difference between mean flux out-of-transit and in-transit; upper right: mean out-of-transit flux; lower left: mean in-transit flux; lower right: difference between mean flux out-of-transit and in-transit 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 = 13; number of valid in-transit cadences = 1061; number of in-transit cadence gaps = 10; number of valid out-of-transit cadences = 2603; number of out-of-transit cadence gaps = 41. Difference image quality metric = 1.00 (good).
Open ./planet-01/difference-image/0000000158324245-01-difference-image-26-254.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	$1843.56 \pm 1.41e-05$	$1952.47 \pm 1.45e-05$	pixels	$286.97026596 \pm 1.54e-06$	$46.86841106 \pm 1.13e-06$	degrees
Difference Image Centroid	$1843.58 \pm 6.39e-03$	$1952.49 \pm 6.48e-03$	pixels	$286.97043469 \pm 3.72e-05$	$46.86849599 \pm 3.64e-05$	degrees
Offset	$0.0187 \pm 6.39e-03$	$0.0172 \pm 6.48e-03$	pixels	$0.4153 \pm 9.15e-02$	$0.3057 \pm 1.31e-01$	arcseconds
Offset/σ	2.93	2.66		4.54	2.33	
Offset Distance	$0.0254 \pm 6.47e-03$		pixels	$0.5157 \pm 1.09e-01$		arcseconds
Offset Distance/σ	3.93			4.73		

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

	Row	Column	Units	RA	Dec	Units
TIC Reference Centroid	$1843.56 \pm 1.97e-04$	$1952.59 \pm 2.70e-04$	pixels	$286.97118552 \pm 0.00e+00$	$46.86826060 \pm 0.00e+00$	degrees
Difference Image Centroid	$1843.58 \pm 6.39e-03$	$1952.49 \pm 6.48e-03$	pixels	$286.97043469 \pm 3.72e-05$	$46.86849599 \pm 3.64e-05$	degrees
Offset	$0.0219 \pm 6.40e-03$	$-0.1007 \pm 6.48e-03$	pixels	$-1.8480 \pm 9.14e-02$	$0.8474 \pm 1.31e-01$	arcseconds
Offset/σ	3.43	-15.54		-20.21	6.46	
Offset Distance	$0.1031 \pm 6.46e-03$		pixels	$2.0330 \pm 9.80e-02$		arcseconds
Offset Distance/σ	15.95			20.74		

5.2 Difference Image TIC Key

Index	Catalog ID	Mag	RA (degrees)	Dec (degrees)	Distance (arcsec)
1	158324245	9.567	286.97118580	46.86826266	0.00
2	1717079071	10.231	286.97137947	46.86822645	0.49
3	1717079066	10.485	286.97091772	46.86828267	0.66
4	1717079064	18.371	286.96928399	46.87624416	29.11
5	158324254	15.139	286.96891618	46.85975138	31.15
6	158324249	15.354	286.95607687	46.86605235	38.03
7	158324260	16.158	286.97389237	46.85504241	48.06
8	1717078740	17.841	286.99135896	46.86148802	55.32
9	1717079634	18.052	286.95956611	46.88258138	58.95
10	158324230	17.879	286.95167646	46.87874463	61.07
11	158324226	17.838	286.98779758	46.88171057	63.37
12	158324264	17.193	286.96154129	46.85166578	64.29
13	158324219	13.319	286.96474565	46.88612179	66.22
14	158324248	17.028	286.94405331	46.86636730	67.13
15	158324216	18.095	286.98107410	46.88712494	72.13
16	1717079356	18.504	287.00054337	46.86744773	72.32
17	158324232	17.362	286.94542335	46.87808195	72.60
18	158324268	15.898	286.97735737	46.84844246	72.95
19	158324267	13.937	286.98128954	46.84886863	74.11
20	158324218	15.673	286.95660556	46.88663372	75.24
21	158324261	16.787	286.99581306	46.85441984	78.47
22	158324271	16.230	286.96284822	46.84692169	79.52
23	1717079072	17.398	286.93899538	46.87042327	79.61
24	158324229	12.901	287.00195322	46.87871689	84.56
25	158324209	16.663	286.97784951	46.89133802	84.67
26	158324217	17.115	286.99351251	46.88671632	86.21
27	158324211	16.956	286.98670139	46.89000581	87.09
28	158324265	16.797	286.99651555	46.85120094	87.52
29	158324258	16.312	286.93688268	46.85777417	92.49
30	158324220	17.276	286.99931016	46.88558500	93.17
31	1717079086	18.012	286.93240274	46.87005254	95.67
32	158324263	17.224	287.00223641	46.85189330	96.50
33	158324238	16.655	286.93124692	46.87068575	98.69
34	158324206	14.422	286.98335564	46.89450303	99.10
35	158394203	14.922	287.01134104	46.87561754	102.32
36	158324222	17.247	286.93527513	46.88376829	104.54
37	158324200	16.132	286.96559670	46.89761604	106.56
38	158324280	16.234	286.96262779	46.83864442	108.69

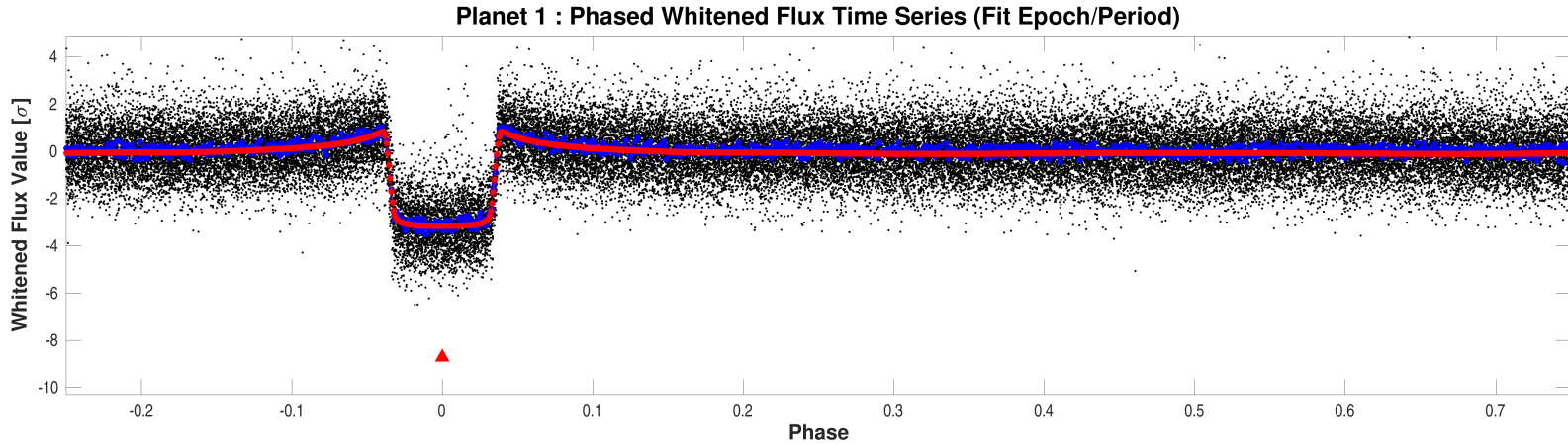| Index	Catalog ID	Mag	RA (degrees)	Dec (degrees)	Distance (arcsec)
39	158394184	16.666	287.01145407	46.85550241	109.24
40	158324244	18.150	286.92600370	46.86868272	111.21
41	158324213	17.562	286.93435220	46.88726054	113.56
42	158324259	17.641	286.92749677	46.85715365	114.73
43	158394204	16.500	287.01657375	46.87575282	114.92
44	158324272	15.702	287.00656125	46.84667003	116.72
45	158324282	14.885	286.98073894	46.83642780	116.99
46	158394189	15.509	287.01813758	46.86081220	118.63
47	158324228	18.022	286.92536654	46.87890055	119.10
48	158324252	18.091	286.92339314	46.86301996	119.13
49	158324236	18.176	286.92214368	46.87454176	122.80
50	158394201	17.687	287.02072024	46.87438230	123.89
51	158394198	17.378	287.02180005	46.86931013	124.63
52	158324279	15.895	286.94039799	46.84004420	126.74
53	158324227	16.445	286.92199591	46.88059015	128.95
54	158324266	17.666	286.92605316	46.84923257	130.51
55	158394176	17.816	287.01656488	46.84931724	130.87
56	158324284	17.100	286.94817843	46.83455131	133.92
57	158394210	17.892	287.01956941	46.88536149	134.05
58	158324273	17.392	286.92699661	46.84647854	134.09
59	1717078729	18.066	287.00787731	46.83845822	140.24
60	158324275	16.848	286.92207213	46.84589923	145.24
61	1717079077	18.074	286.92248641	46.84534575	145.51
62	1717079089	17.938	286.93200162	46.89912822	147.13
63	158324198	17.681	287.00439543	46.90302867	149.48
64	1717079369	18.252	287.02176023	46.89244372	151.90
65	158324199	17.638	286.92138374	46.90046416	168.71
66	1717079096	17.827	286.92113719	46.90107582	170.67

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

6   Phased Light Curves
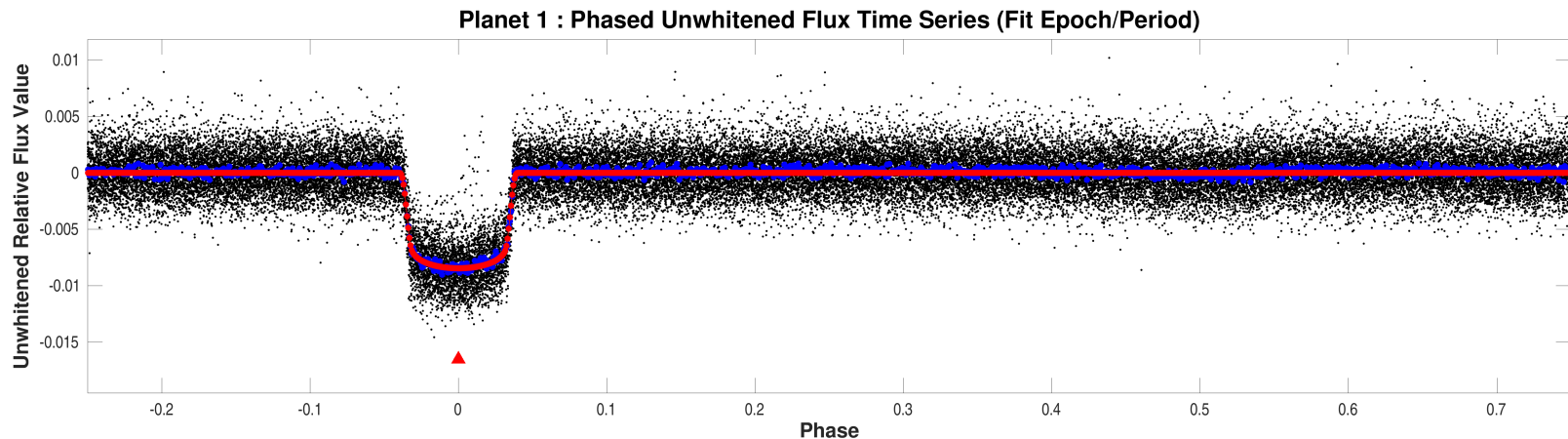
Phased unwhitened flux time series is plotted in black dots. When all transits fit completed with full or secondary convergence, the phase is determined with the fitted epoch and period; otherwise, the phase is determined with the TPS epoch and period. The values of the phased unwhitened flux time series 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.
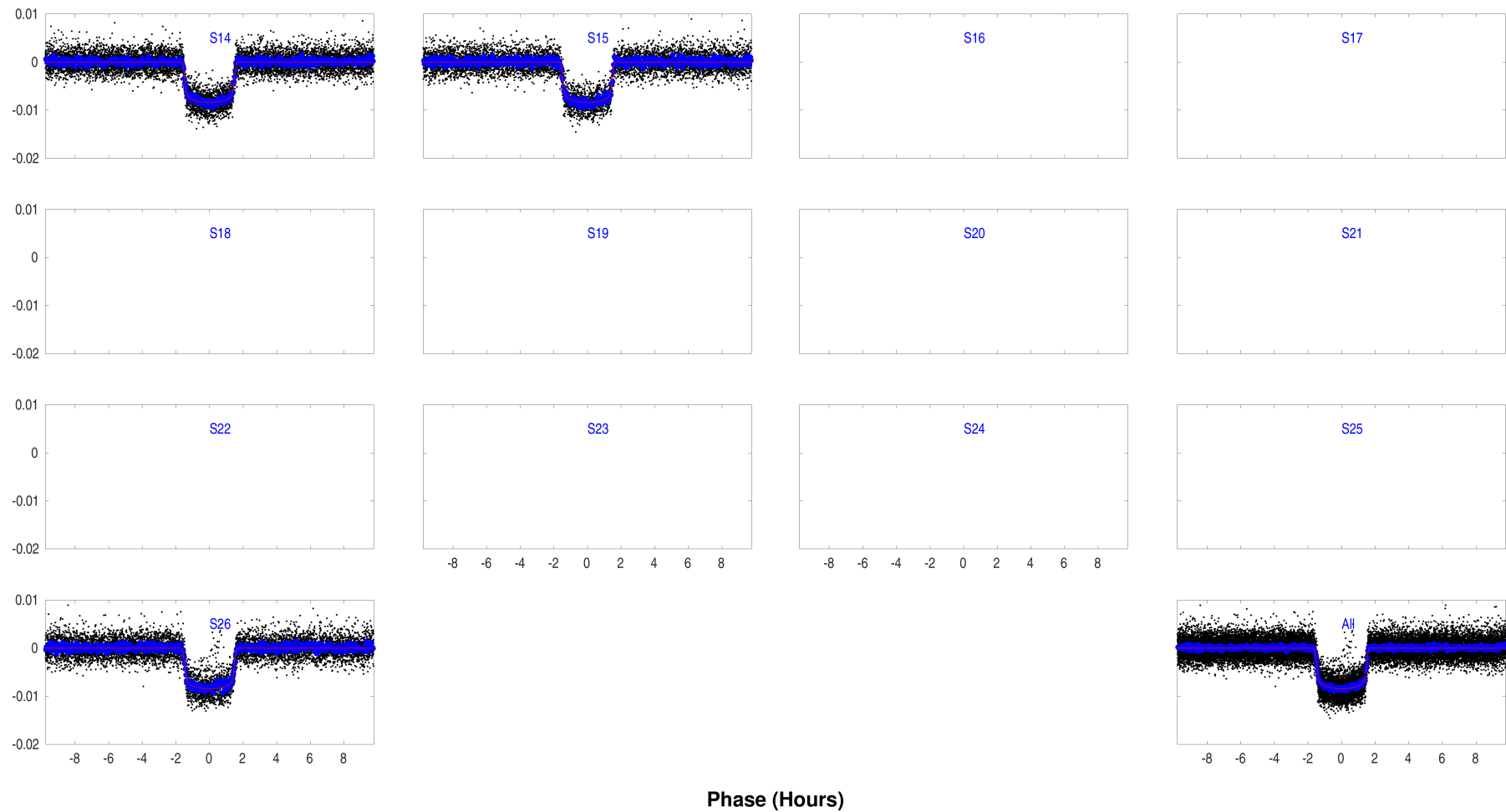
Open `./summary-plots/0000000158324245-01-phased-unwhitened-flux-time-series.fig`

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/0000000158324245-01-phased-whitened-flux-time-series.fig`

Planet: 1   Phased Unwhitened Flux Time Series by Sector

Phase (Hours)

Phased unwhitened flux time series by sector for target 158324245, planet candidate 1. Period = 1.7636 days; transit epoch = 1683.5539 BTJD.
Open `./summary-plots/0000000158324245-01-phased-unwhitened-flux-time-series-by-sector.fig`

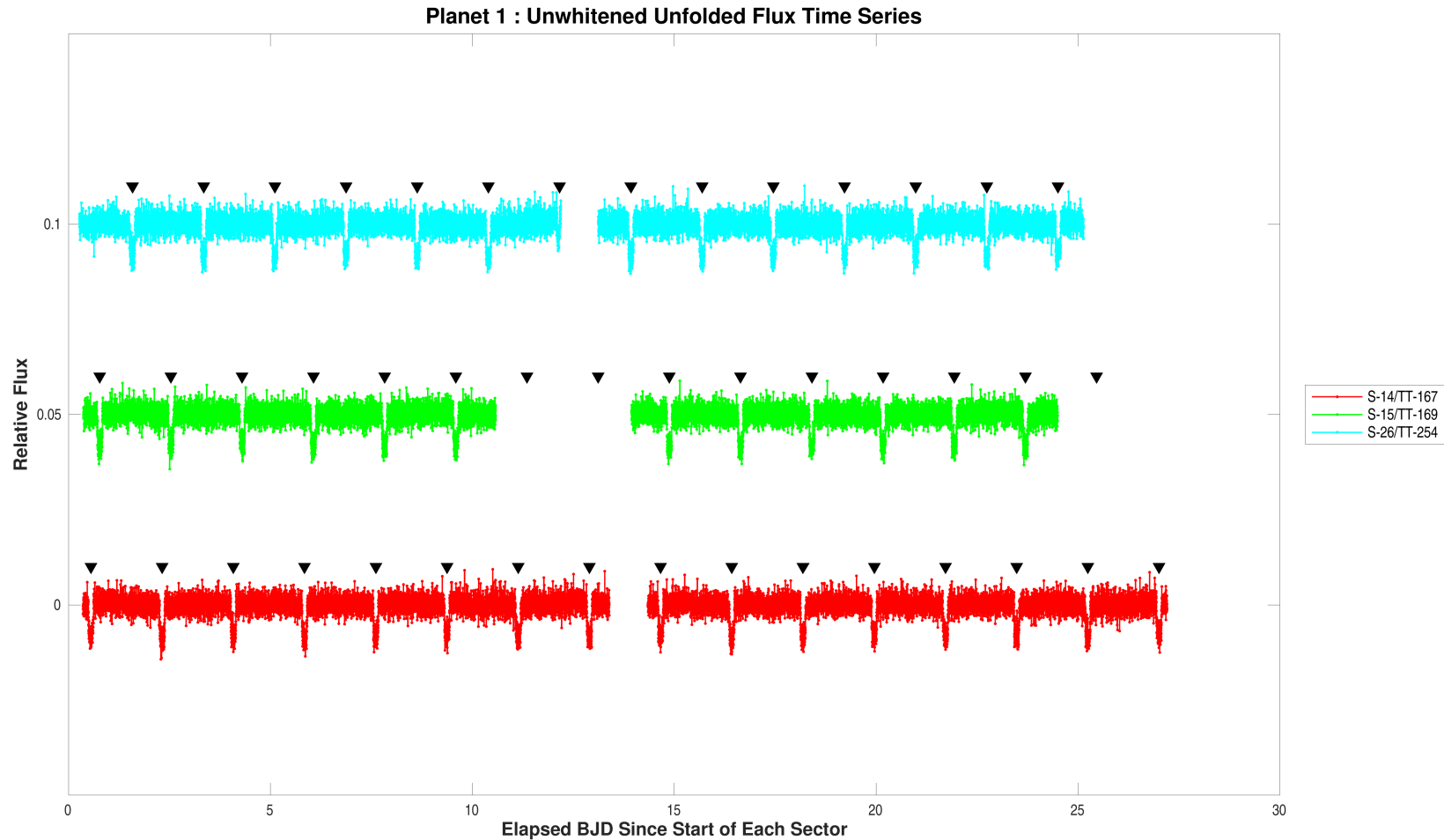# 7 Planet Candidate 1

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

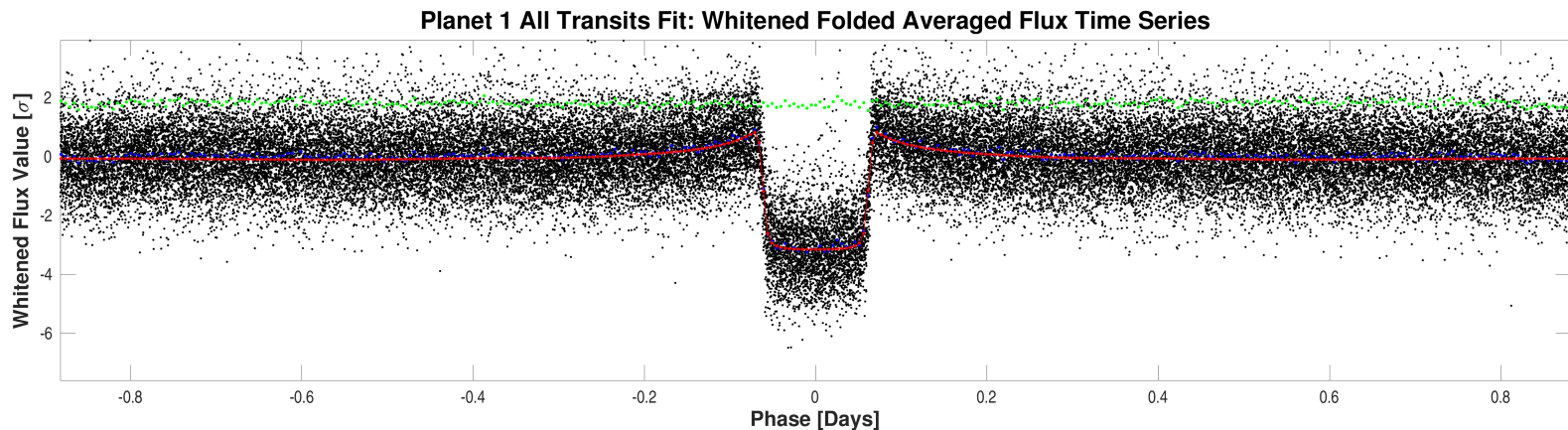| TCE Parameter	Value	Units
Trial Transit Pulse Duration	3.0	hours
Transit Epoch	1683.5462861	TJD
Orbital Period	1.7636912	days
Maximum SES	25.5	
Maximum MES	106.9	
Robust Statistic	162.7	
Chi Square Goodness of Fit Statistic (DoF)	6149.7 (3679)	
Chi Square2 Statistic (DoF)	1018.6 (2250.3)	
Threshold for Desired PFA		

DoF: Degrees of Freedom

Parameter	Value	Uncertainty	Units
SNR	176.3		
Orbital Period	1.7635849	1.7386e-06	days
Transit Epoch	1683.5538559	1.3503e-04	BTJD
Impact Parameter	0.0641	4.9992e-01	
Planet Radius to Star Radius Ratio	0.0871302	4.3905e-04	
Semi-major Axis to Star Radius Ratio	4.5377	1.3888e-01	
Planet Radius	9.5120	4.7931e-02	Earth radii
Semi-major Axis	0.0286	1.8785e-08	AU
Effective Stellar Flux	4461.1680	3.9594e+02	Goldilocks
Equilibrium Temperature	2084	4.6249e+01	Kelvin
Stellar Density	0.4036	3.7056e-02	Solar density
Transit Depth	8449	4.7941e+01	ppm
Transit Duration	3.2540	1.8593e-02	hours
Transit Ingress Duration	0.2658	1.8278e-02	hours
Eccentricity	0.0000	0.0000e+00	
Peri Longitude	0.0000	0.0000e+00	degrees
Model Chi Square Statistic (DoF)	15477.5 (18895.2)		
Model Chi Square Goodness of Fit Statistic (DoF)	2472.3 (4239)		
Model Chi Square2 Statistic (DoF)	74.6 (41)		

DoF: Degrees of Freedom
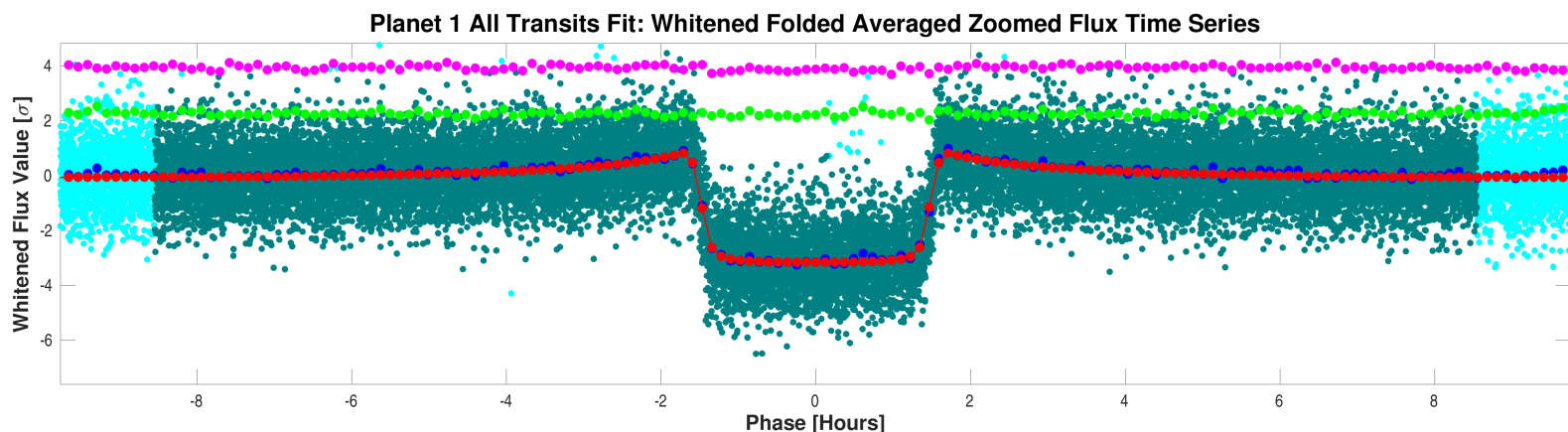
Planet 1 : Unwhitened Unfolded Flux Time Series

Flux time series for CatId 158324245, Planet candidate 1 in the unwhitened domain. For the data of Sector-14/TargetTableId-167, start BJD is 2458683 and the vertical offset is 0. For the data of Sector-15/TargetTableId-169, start BJD is 2458711 and the vertical offset is 0.05. For the data of Sector-26/TargetTableId-254, start BJD is 2459010 and the vertical offset is 0.1. 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/0000000158324245-01-all-unwhitened-14-167.fig`

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

Folded flux time series for CatId 158324245, 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/0000000158324245-01-all-whitened.fig`

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

Folded flux time series for CatId 158324245, 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.
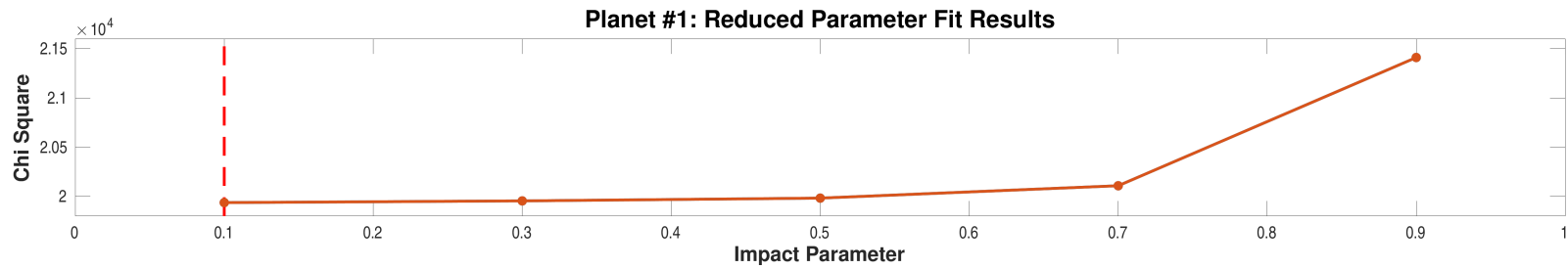
Open `./planet-01/planet-search-and-model-fitting-results/all-transits-fit/0000000158324245-01-all-whitened-zoomed.fig`

7.2   Model Fitter: Reduced Parameter Fit Results

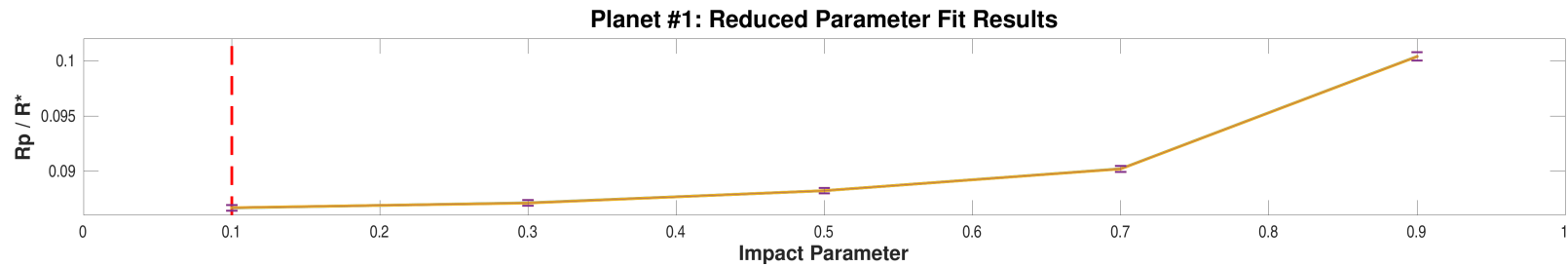| Impact Parameter	SNR	Model Chi Square	Planet Radius to Star Radius	Uncert	Semi-major Axis to Star Radius	Uncert	Transit Depth (ppm)	Uncert	Transit Duration (hours)	Uncert
0.10	182.1	19936.6	0.0866687	2.4986e-04	4.5192	9.2680e-03	8354	4.7906e+01	3.2584	6.7834e-03
0.30	182.0	19954.1	0.0871195	2.5163e-04	4.3425	9.1683e-03	8355	4.7998e+01	3.2820	7.0635e-03
0.50	181.9	19982.2	0.0882258	2.5585e-04	3.9671	8.9719e-03	8372	4.8276e+01	3.3432	7.7924e-03
0.70	177.8	20108.0	0.0902081	2.7050e-04	3.3308	8.8818e-03	8361	4.9806e+01	3.4971	9.8852e-03
0.90	171.3	21410.3	0.1003864	3.7529e-04	2.3010	9.9906e-03	9103	6.5084e+01	4.0905	2.0581e-02

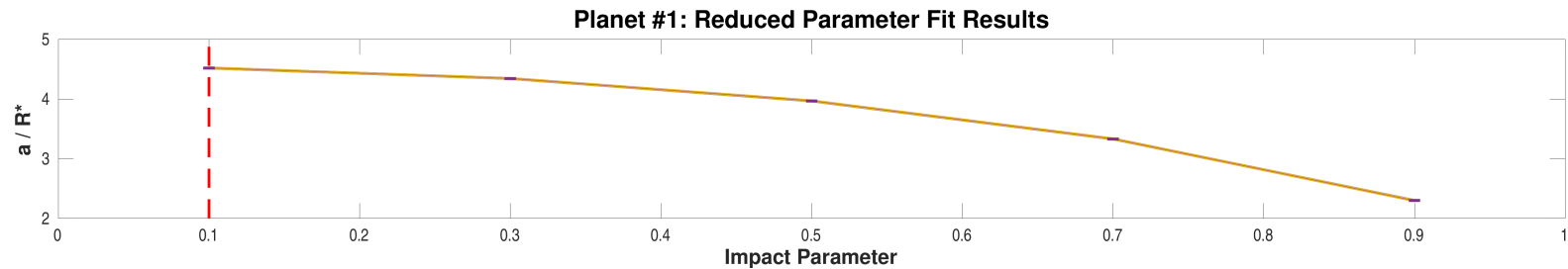Highlighted row is the best reduced-parameter model fit.

Model chi squares of reduced parameter fits vs. impact parameter for CatId 158324245, 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/0000000158324245-01-reduced-fits-chi-square.fig

Ratios of planet radius to star radius of reduced parameter fits vs. impact parameter for CatId 158324245, 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/0000000158324245-01-reduced-fits-rp-over-rstar.fig

Ratios of semimajor axis to star radius of reduced parameter fits vs. impact parameter for CatId 158324245, 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/0000000158324245-01-reduced-fits-a-over-rstar.fig
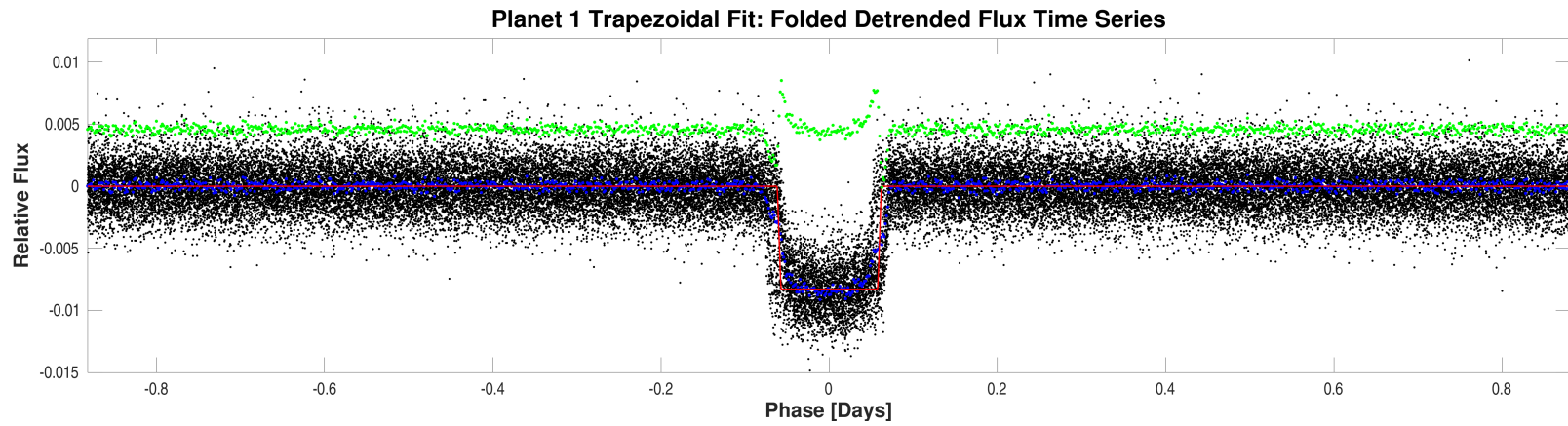
7.3   Model Fitter: Trapezoidal Fit Results

Model Characteristic	Name
Transit Model	trapezoidal_model
Limb Darkening Model	

| TCE Parameter	Value	Units
Trial Transit Pulse Duration	3.0	hours
Transit Epoch	1683.5462861	TJD
Orbital Period	1.7636912	days
Maximum SES	25.5	
Maximum MES	106.9	
Robust Statistic	162.7	
Chi Square Goodness of Fit Statistic (DoF)	6149.7 (3679)	
Chi Square2 Statistic (DoF)	1018.6 (2250.3)	
Threshold for Desired PFA		

DoF: Degrees of Freedom

Parameter	Value	Uncertainty	Units
SNR	247.8		
Orbital Period	1.7636912		days
Transit Epoch	1683.5461786		BTJD
Transit Depth	8304		ppm
Transit Duration	3.7094		hours
Transit Ingress Duration	0.8427		hours
Model Chi Square Statistic (DoF)	56829.3 (25495)		

DoF: Degrees of Freedom

Planet 1 Trapezoidal Fit: Folded Detrended Flux Time Series

Folded detrended flux time series for CatId 158324245, Planet candidate 1 and folded trapezoidal model light curve.
Open ./planet-01/planet-search-and-model-fitting-results/trapezoidal-model-fit/0000000158324245-01-all-trapezoidal.fig

Planet 1 Trapezoidal Fit: Zoomed Folded Detrended Flux Time Series
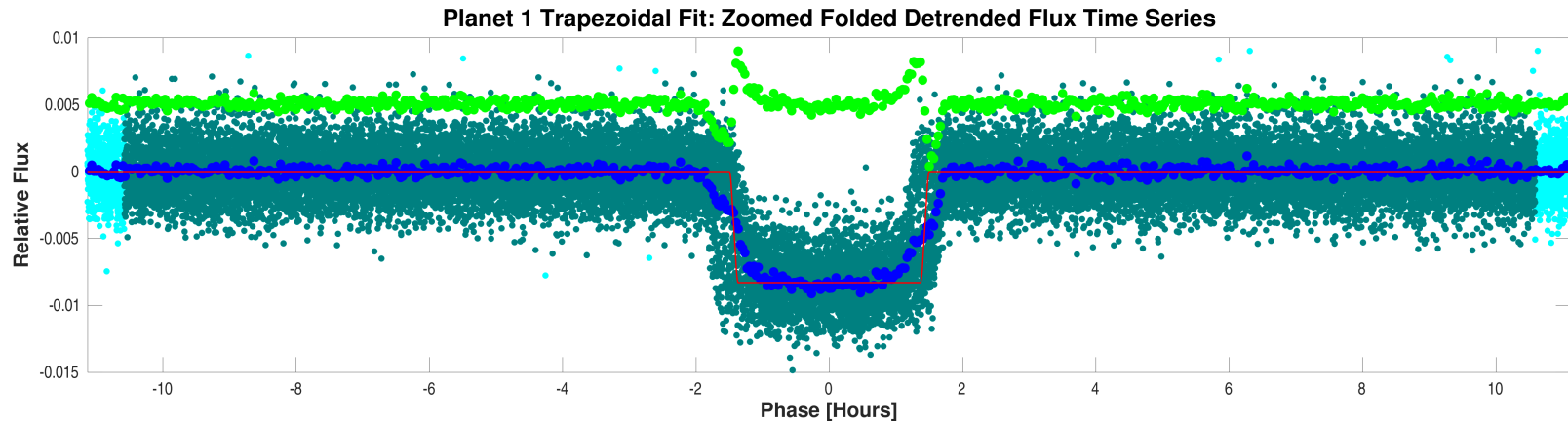
Zoomed folded detrended flux time series for CatId 158324245, Planet candidate 1 and folded trapezoidal model light curve.
Open ./planet-01/planet-search-and-model-fitting-results/trapezoidal-model-fit/0000000158324245-01-all-trapezoidal-zoomed.fig

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	1.7637		days		
Transit Duration	3		hours		
Maximum MES	106.9				
Secondary Phase	0.87361		days		
Secondary MES	6.1				
Minimum Phase	1.1181		days		
Minimum MES	-4.2				
Median MES	-1.8				
MAD MES	1.1285				
Robust Statistic	5.7				
Secondary Depth	264.7	4.3994e+01	ppm		
Geometric Albedo	1.3	2.1892e-01		1.4380	7.52
Planet Effective Temperature	3451	1.6278e+02	Kelvin	8.0753	0.00

7.4.2   Eclipsing Binary Discrimination Test

Result	Value	Value in Sigmas	Significance (%)
Odd Even Transit Depth Comparison Statistic	2.6113e-01	0.5110	60.93

7.4.3   Bootstrap Test

Result	Value
False Alarm Probability	0.0000e+00
Bootstrap Threshold for Desired PFA	7.2
MES Mean	-0.04
MES Standard Deviation	1.02
Transit Count	200

7.4.4   Ghost Diagnostic Test

Result	Value	Significance (%)
Maximum MES	106.9	
SNR	176.3	
Core Aperture Statistic	1.2134e+02	100.00
Halo Aperture Statistic	1.3094e+01	100.00
Ratio of Core/Halo Aperture Statistics	9.2674e+00	

7.4.5   Validation Test Figures
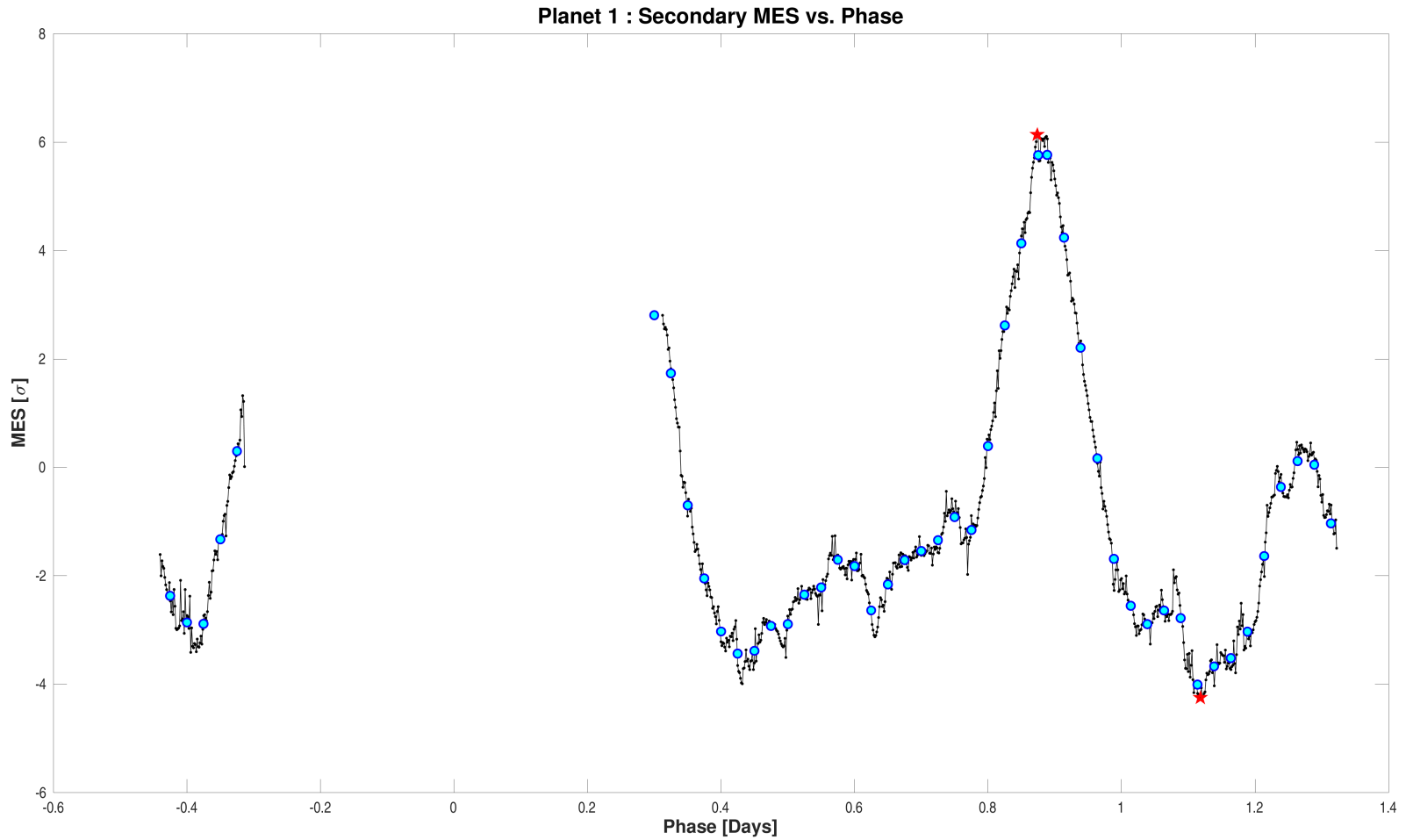
The primary event has been set to zero and both the max and min of the resulting MES vs. Phase are marked with a red star. The best matched pulse duration in hours is 3. The maximum secondary MES and corresponding phase are 6.1408 and 0.87361 days respectively. The minimum secondary MES and corresponding phase are -4.248 and 1.1181 days respectively.

Open `./planet-01/report-summary/0000000158324245-01-weak-secondary-diagnostic.fig`

Bootstrap Results for Planet 1
Max Multiple Event Sigma=106.9, False Alarm=0.00e+00
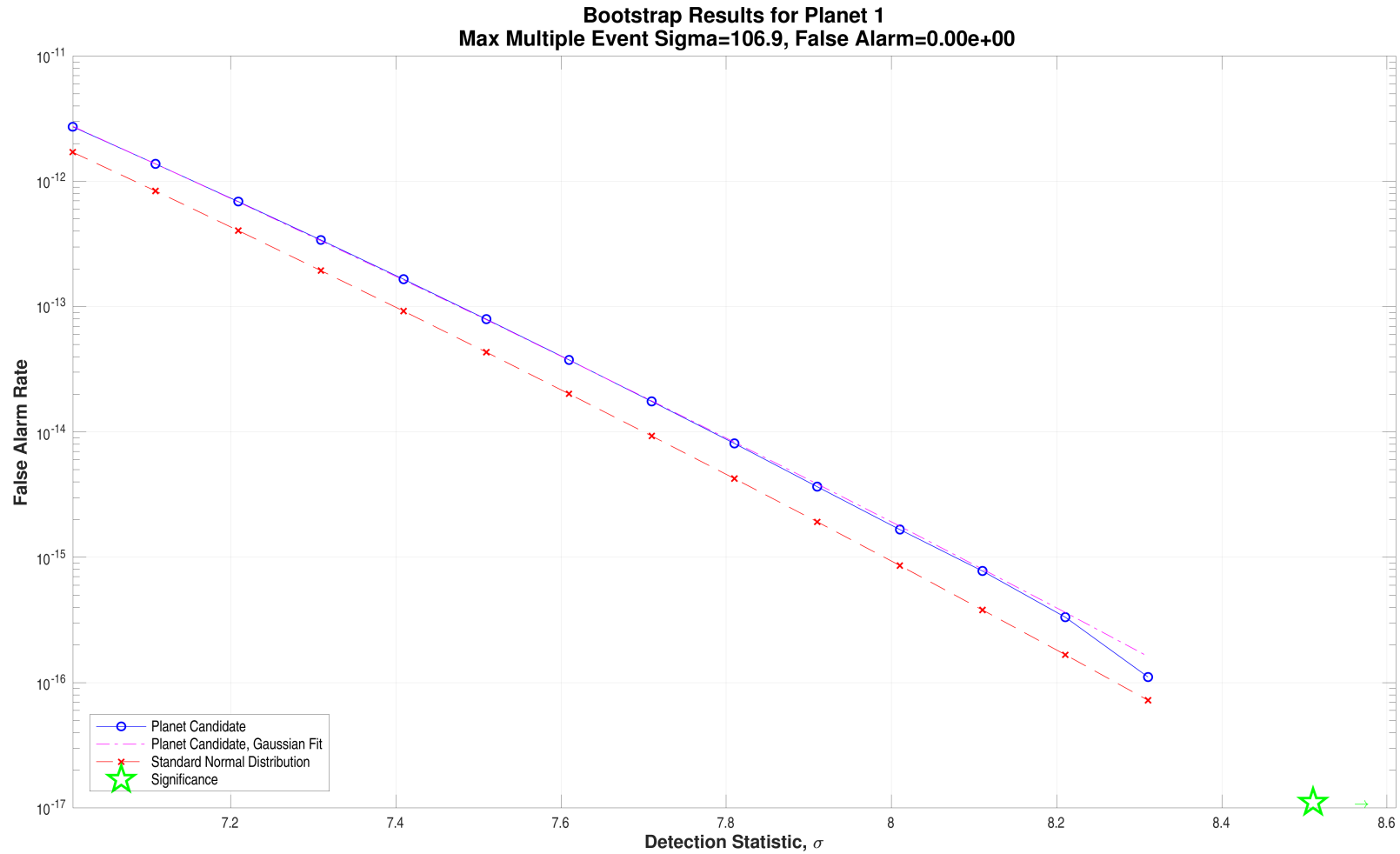
Bootstrap results for target 158324245, planet 1. Cumulative sum of the probabilities (derived from the histogram of counts) from upper tail to the search transit threshold; false alarm probability is indicated by the star. The Gaussian equivalent threshold for this false alarm probability is Inf. The threshold on this distribution that achieves the same false alarm rate as a 7.1 sigma threshold on a Gaussian distribution is 7.2284.

Open `./planet-01/bootstrap-results/0000000158324245-01-bootstrap-false-alarm.fig`

Planet 1 : Cotrended Folded Core Aperture Flux Time Series
Correlation Statistic = 121.34, Significance = 100.00%
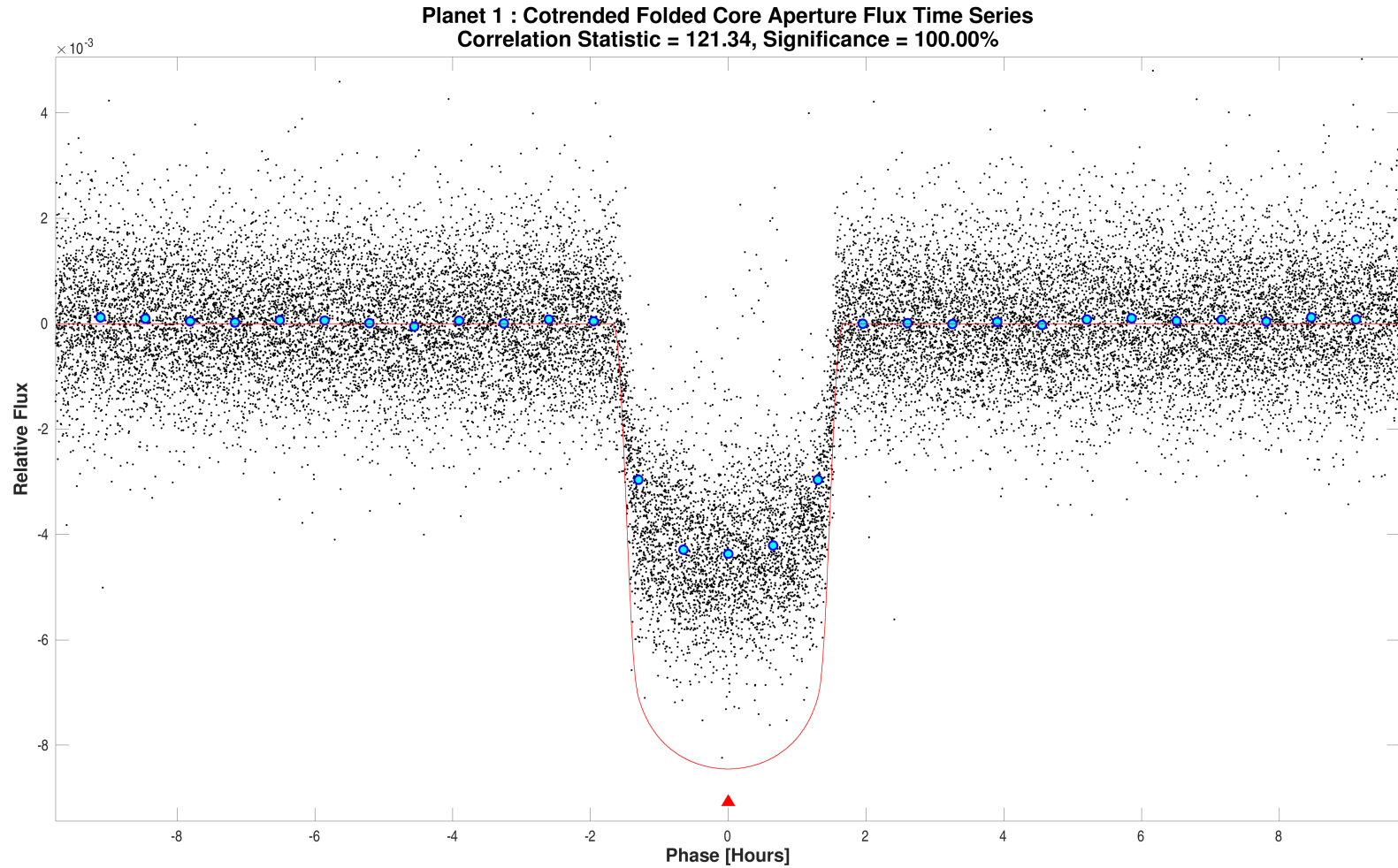
Optical ghost diagnostic core aperture flux time series for target 158324245, planet candidate 1. The unwhitened time series is phase folded at the orbital period associated with the planet candidate and centered on the epoch of the first transit. The time series was first cotrended against spacecraft 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.

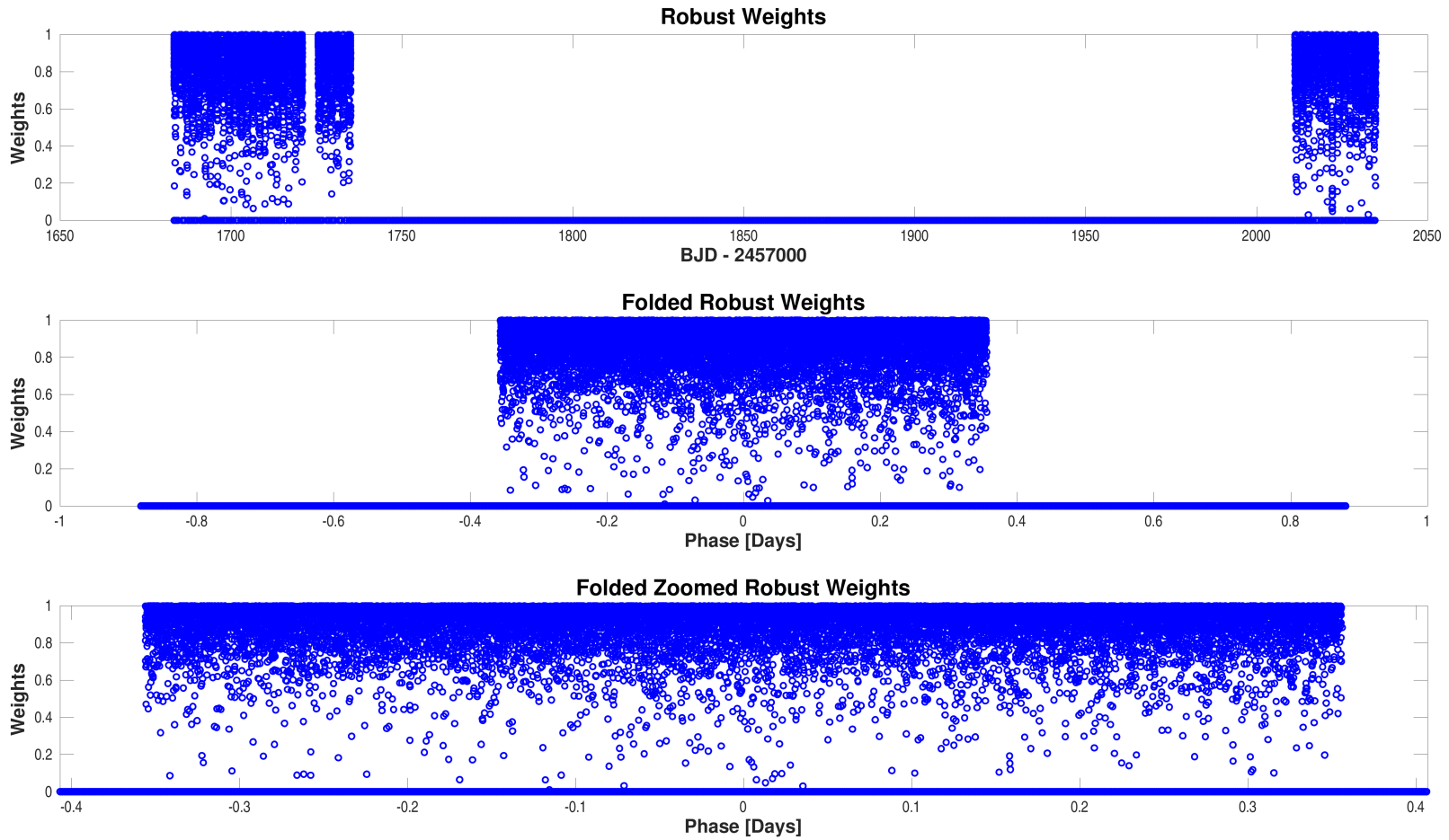Open ./planet-01/ghost-diagnostic-results/0000000158324245-01-core-unwhitened-cotrended-zoomed-model.fig

Planet 1 : Cotrended Folded Halo Aperture Flux Time Series
Correlation Statistic = 13.09, Significance = 100.00%
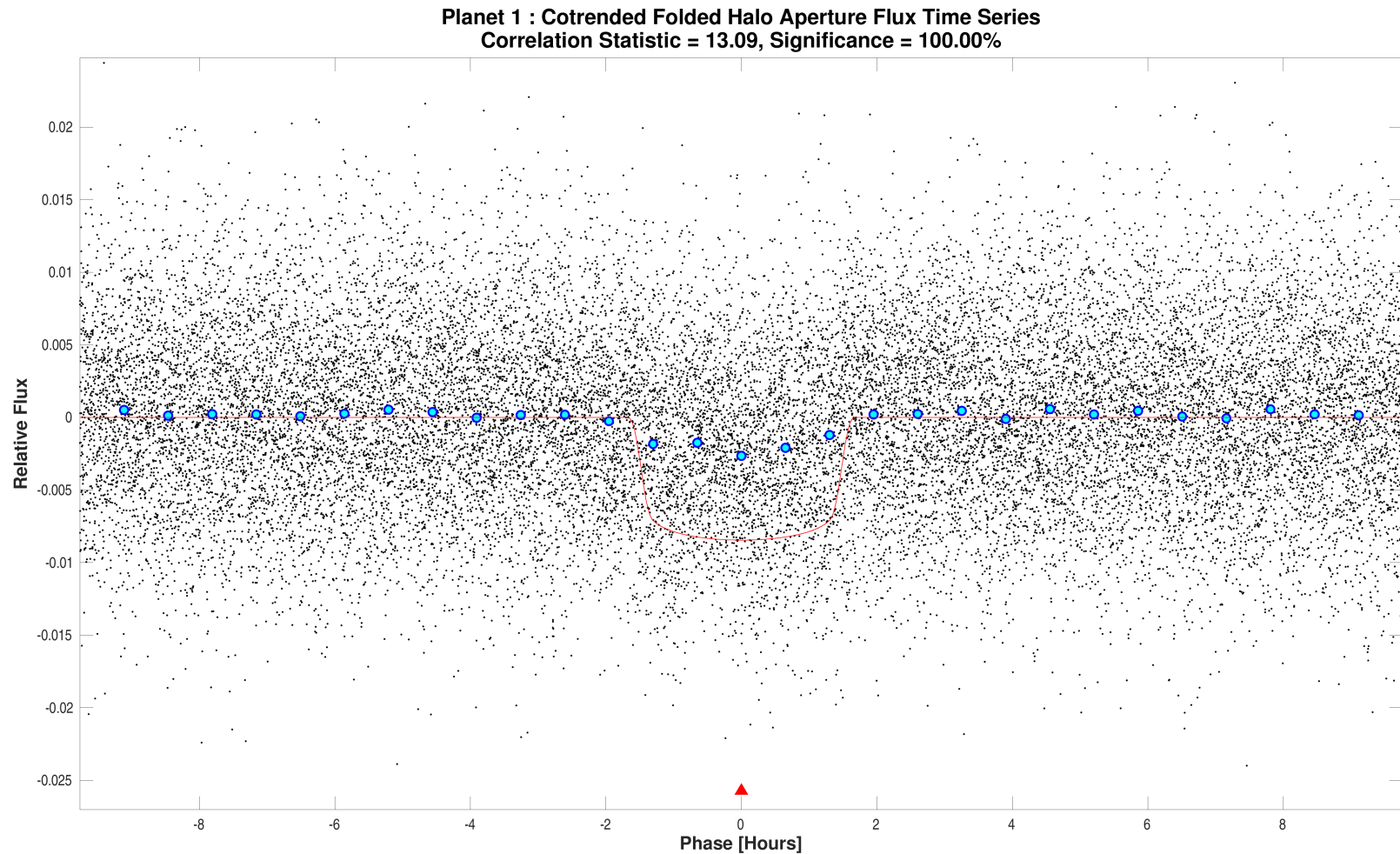
Optical ghost diagnostic halo aperture flux time series for target 158324245, planet candidate 1. The unwhitened time series is phase folded at the orbital period associated with the planet candidate and centered on the epoch of the first transit. The time series was first cotrended against spacecraft 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/0000000158324245-01-halo-unwhitened-cotrended-zoomed-model.fig

# Appendix A   Planet Candidate 1

A.1   Model Fitter: All Transits

Robust weights distribution for CatId 158324245, 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/0000000158324245-01-all-robust-weights.fig`
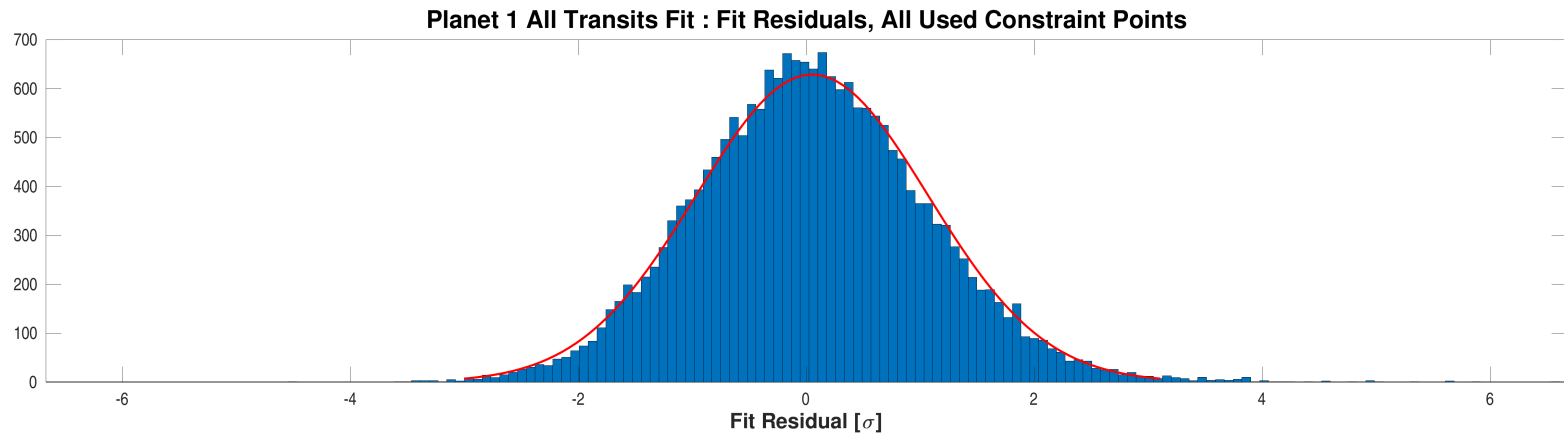
Planet 1 All Transits Fit : Fit Residuals, All Used Constraint Points

Fit residuals distribution for CatId 158324245, 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/0000000158324245-01-all-histo-used.fig
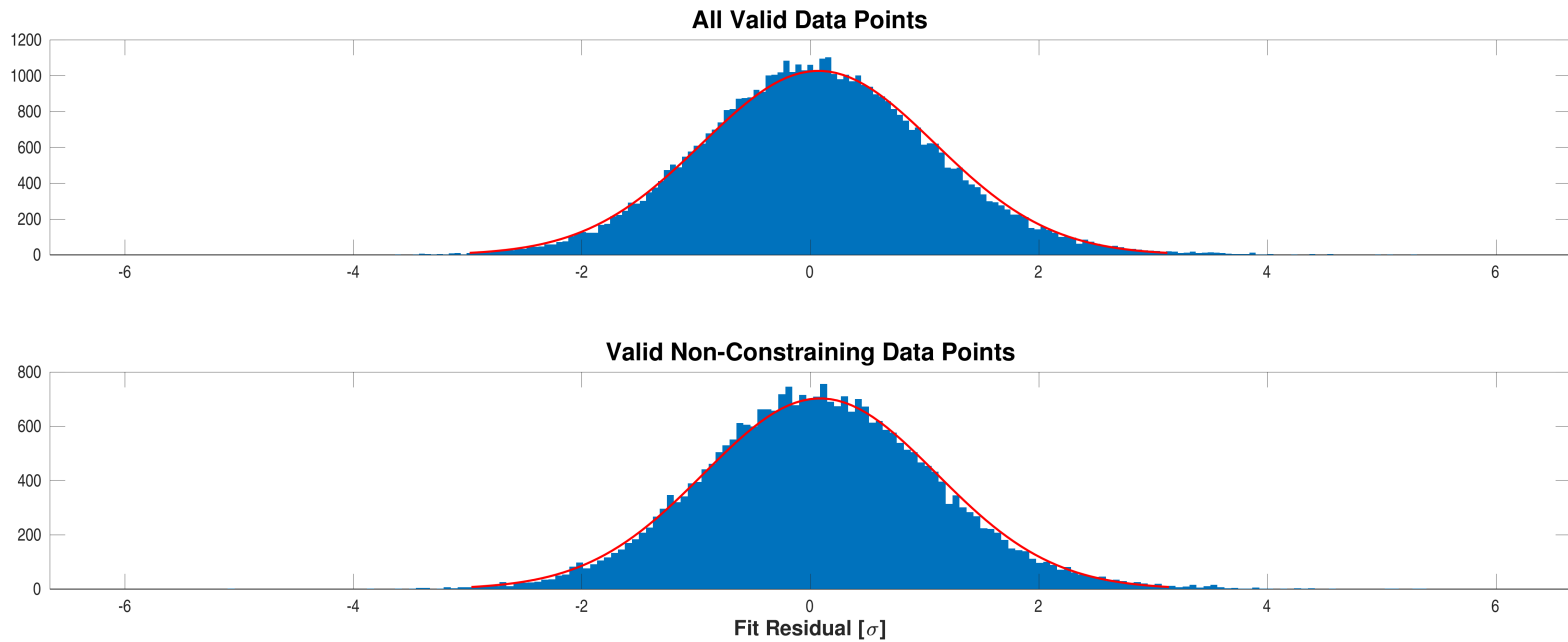
All Valid Data Points

**Valid Non-Constraining Data Points**

Fit residuals distribution for CatId 158324245, 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/0000000158324245-01-all-histo-all-and-unused.fig
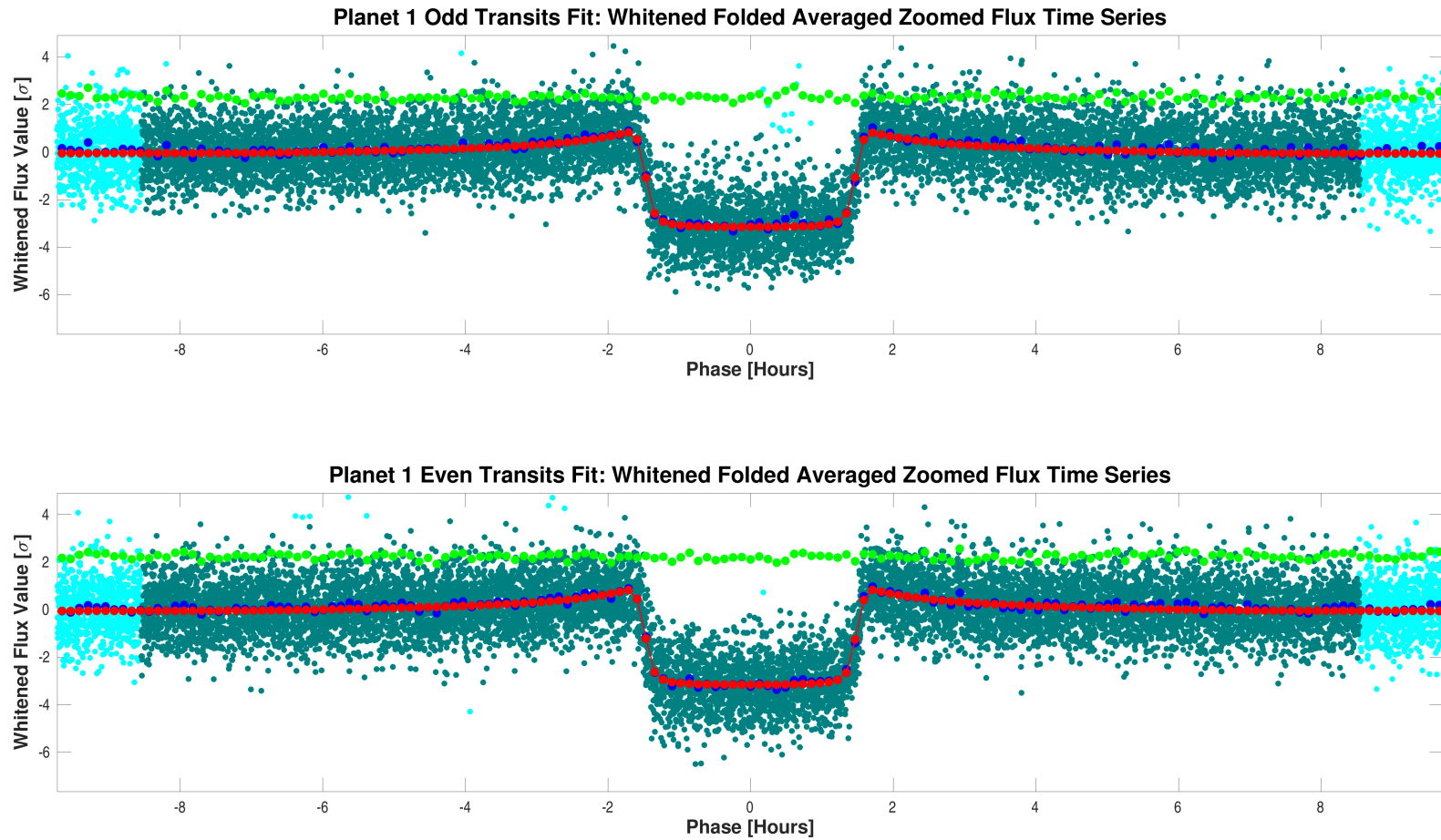
A.2   Model Fitter: Odd & Even Transits

Parameter	Odd Transits Value	Odd Transits Uncertainty	Even Transits Value	Even Transits Uncertainty	Units	Difference ‖Uncertainty‖
SNR	123.9		125.5			
Orbital Period	1.7635844	2.4978e-06	1.7635823	2.4071e-06	days	5.9162e-01
Transit Epoch	1683.5538682	1.9374e-04	1685.3177101	1.8707e-04	BTJD	9.5397e-01
Impact Parameter	0.0505	9.1729e-01	0.0454	9.8617e-01		3.7991e-03
Planet Radius to Star Radius Ratio	0.0870216	6.3233e-04	0.0872747	6.1865e-04		2.8616e-01
Semi-major Axis to Star Radius Ratio	4.5588	2.0151e-01	4.5282	1.9321e-01		1.0976e-01
Planet Radius	9.5001	6.9032e-02	9.5278	6.7538e-02	Earth radii	2.8616e-01
Semi-major Axis	0.0286	2.6987e-08	0.0286	2.6007e-08	AU	5.9162e-01
Effective Stellar Flux	4461.1699	3.9594e+02	4461.1768	3.9594e+02	Goldilocks	1.2362e-05
Equilibrium Temperature	2084	4.6249e+01	2084	4.6249e+01	Kelvin	1.2362e-05
Stellar Density	0.4093	5.4270e-02	0.4011	5.1337e-02	Solar density	1.0971e-01
Transit Depth	8430	6.8761e+01	8480	6.8545e+01	ppm	5.1101e-01
Transit Duration	3.2404	2.6670e-02	3.2642	2.6010e-02	hours	6.3866e-01
Transit Ingress Duration	0.2640	2.6205e-02	0.2665	2.5563e-02	hours	7.0606e-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)	15483.0 (18893.7)		15483.0 (18893.7)			

DoF: Degrees of Freedom
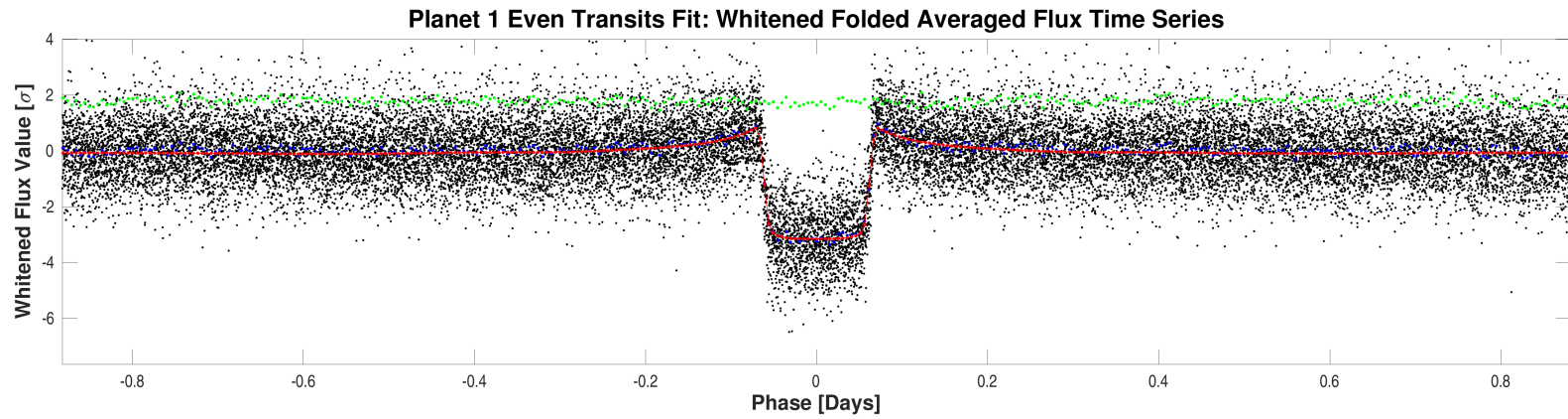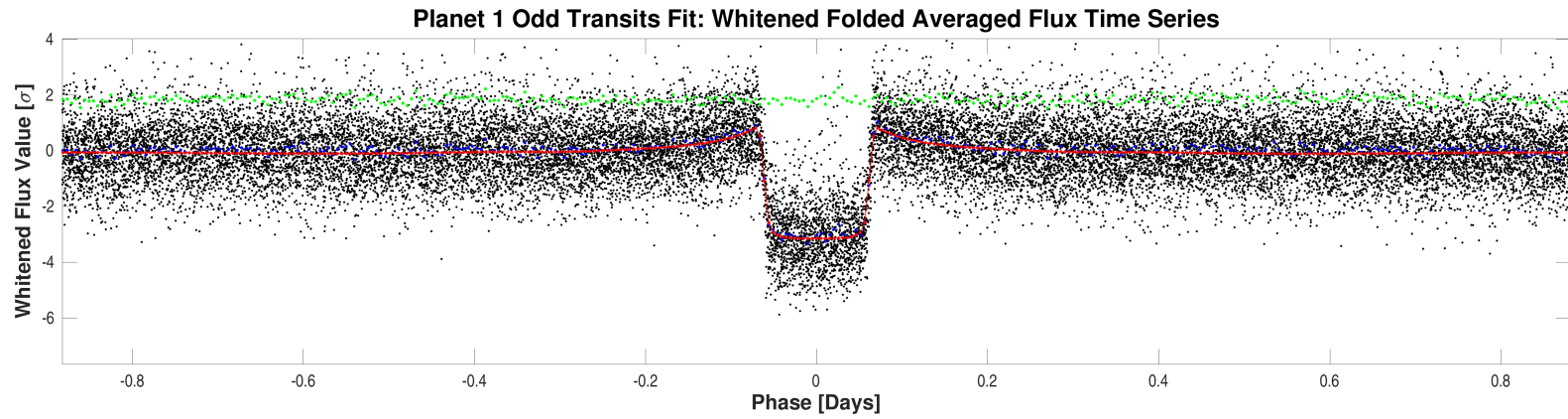
Planet 1 Odd Transits Fit: Whitened Folded Averaged Flux Time Series

**Planet 1 Even Transits Fit: Whitened Folded Averaged Flux Time Series**

Folded flux time series for CatId 158324245, 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/0000000158324245-01-odd-even-whitened.fig`

Folded flux time series for CatId 158324245, 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/0000000158324245-01-odd-even-whitened-zoomed.fig`
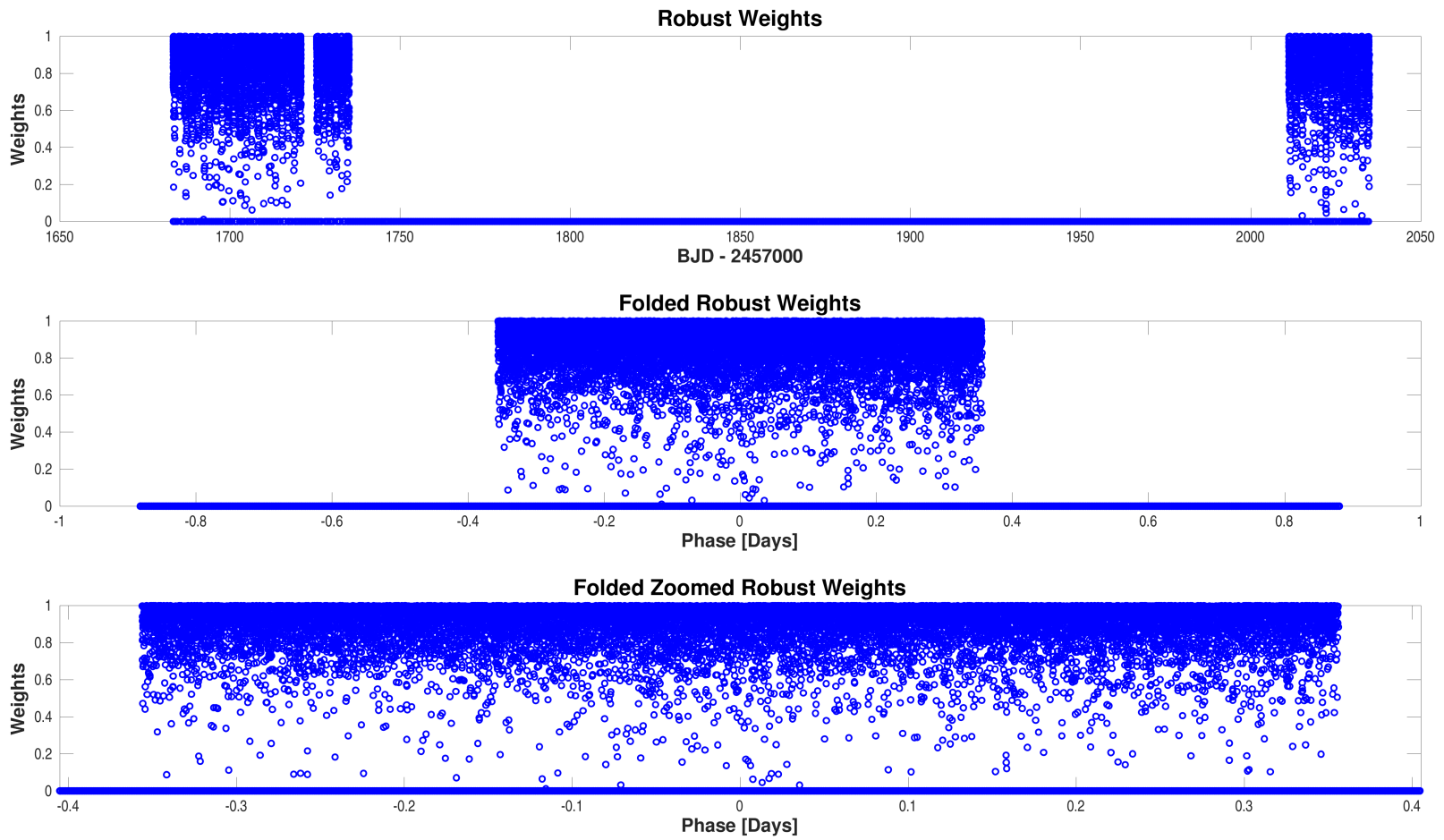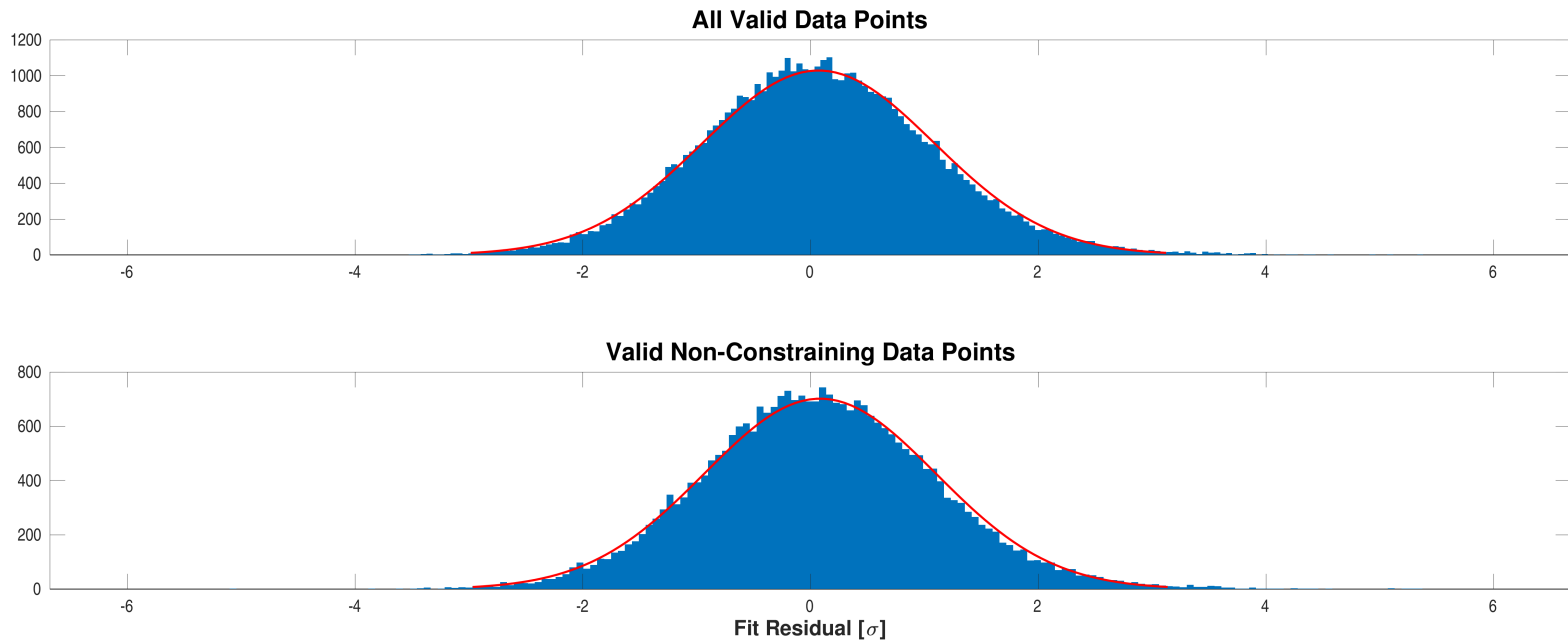
Robust weights distribution for CatId 158324245, Planet candidate 1. Top plot: all data points. Middle plot: all data points, folded per the fitted period and epoch. Bottom plot: all data points, folded and zoomed.

Open `./planet-01/planet-search-and-model-fitting-results/odd-even-transits-fit/0000000158324245-01-odd-even-robust-weights.fig`
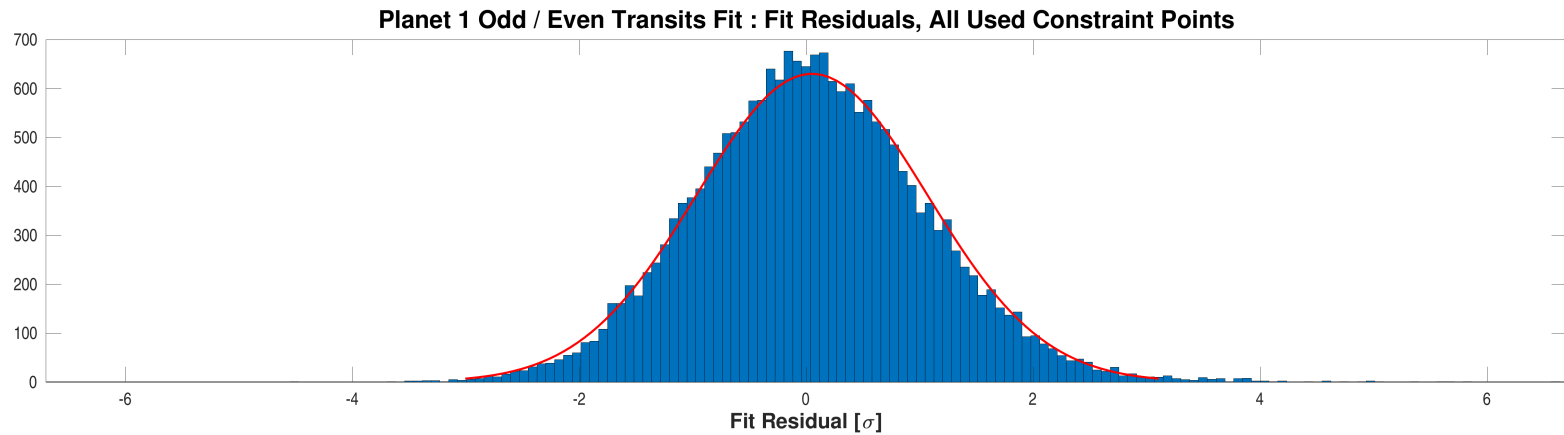
Fit residuals distribution for CatId 158324245, Planet candidate 1. Only the valid data points used to constrain the fit are shown here. A Gaussian fit to the histogram is shown in red.
Open ./planet-01/planet-search-and-model-fitting-results/odd-even-transits-fit/0000000158324245-01-odd-even-histo-used.fig


Fit residuals distribution for CatId 158324245, 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/0000000158324245-01-odd-even-histo-all-and-unused.fig

A.3 Eclipsing Binary Discrimination Test
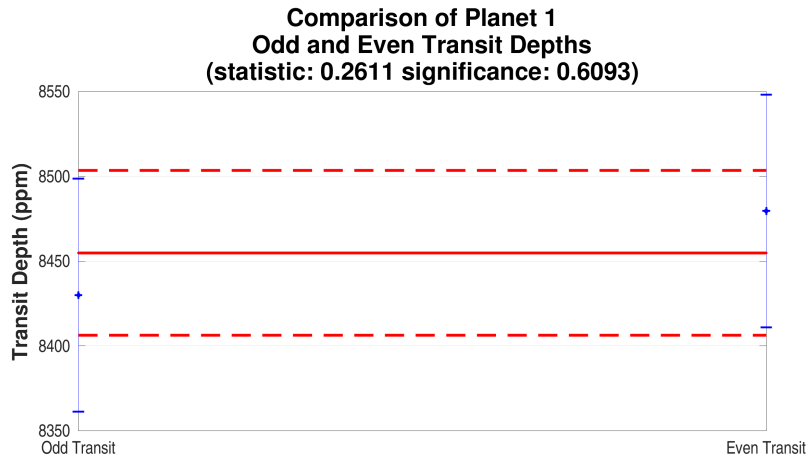
Top-left: Diagnostic plot of Odd/Even Transit Depth Test for catId 158324245, planet 1. A significance level close to 1/0 favors a transiting planet/an eclipsing binary. Open `./planet-01/binary-discrimination-test-results/0000000158324245-01-eclipsing-binary-discrimination-tests.fig`

Appendix B   Alerts

This target did not trigger any alerts.