



**Data Validation (DV) Report**  
**for TESS ID 417676622**  
**Sectors 15 - 15**

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

21-Sep-2019 10:40:55 Z

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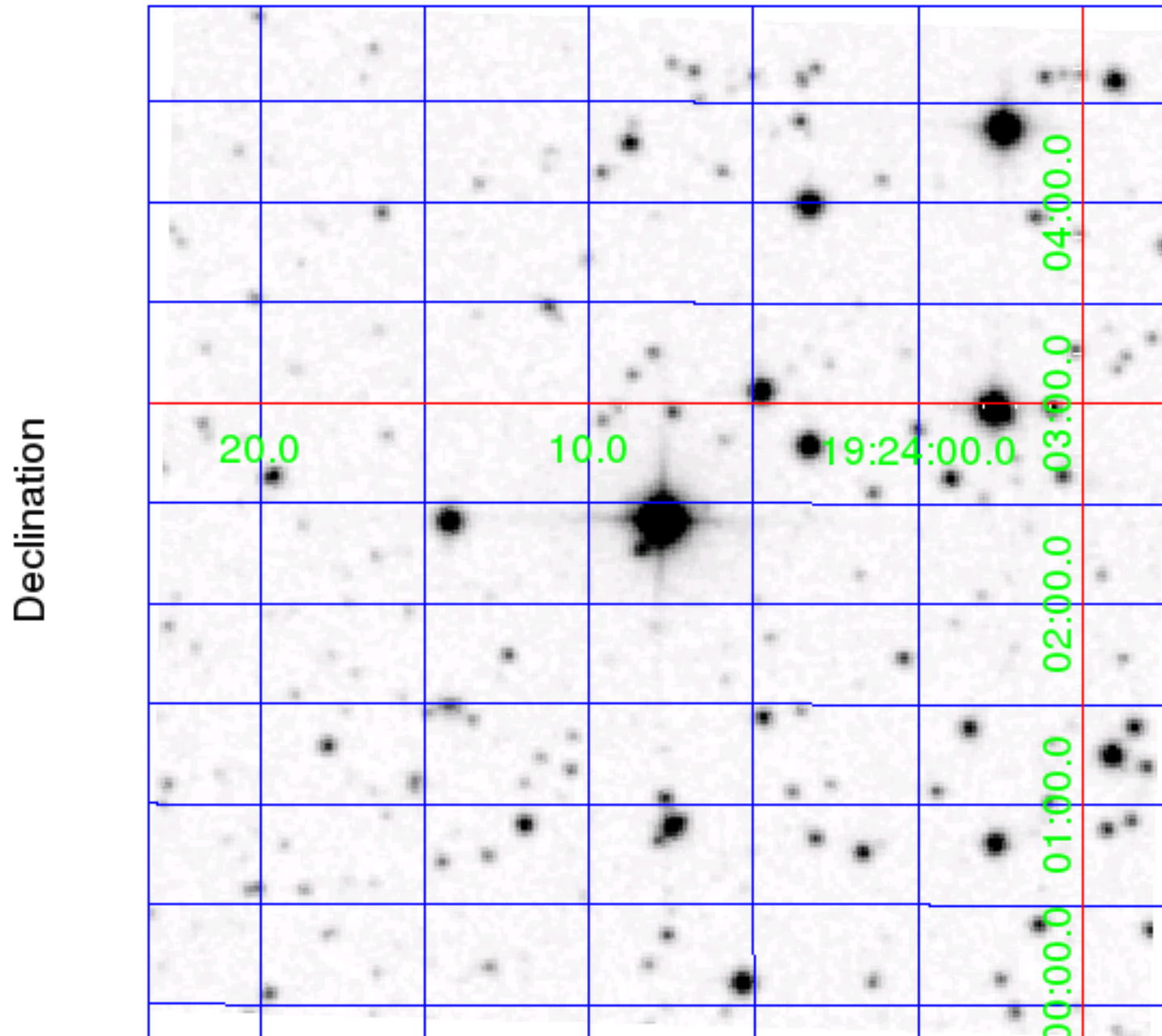
# 1 Summary

Target Properties	Value	Uncertainty	Units	Provenance
Catalog ID	417676622			
TOI ID	-			
TESS Name	-			
RA	291.03235838	0	degrees	TIC8
Dec	49.04025783	0	degrees	TIC8
Magnitude	9.509	0.006		TIC8
Radius	1.259	0.068	Solar radii	TIC8
Effective Temperature	5875	138	Kelvin	TIC8
log(g)	4.265	0.08022	cm/sec <sup>2</sup>	TIC8
[M/H]	0.126	0.0039935	Solar metallicity	TIC8
Stellar Density	0.533	0.103	Solar density	TIC8-Derived
Limb Darkening Coefficient 1	0.58522			
Limb Darkening Coefficient 2	-0.072451			
Limb Darkening Coefficient 3	0.36715			
Limb Darkening Coefficient 4	-0.21306			
Number of Planet Candidates	1			
TOI Model	toi-plus-2019-09-20.csv			
TESS Names Model	-			
External TCE Model	-			
Software Revision	spoc-4.0.9-20190919			
Date Report Generated	21-Sep-2019 10:40:55 Z			

Sector	Target Table	Camera/ CCD	Crowding Metric	Flux Fraction
15	169	2:3	0.9779	0.8564

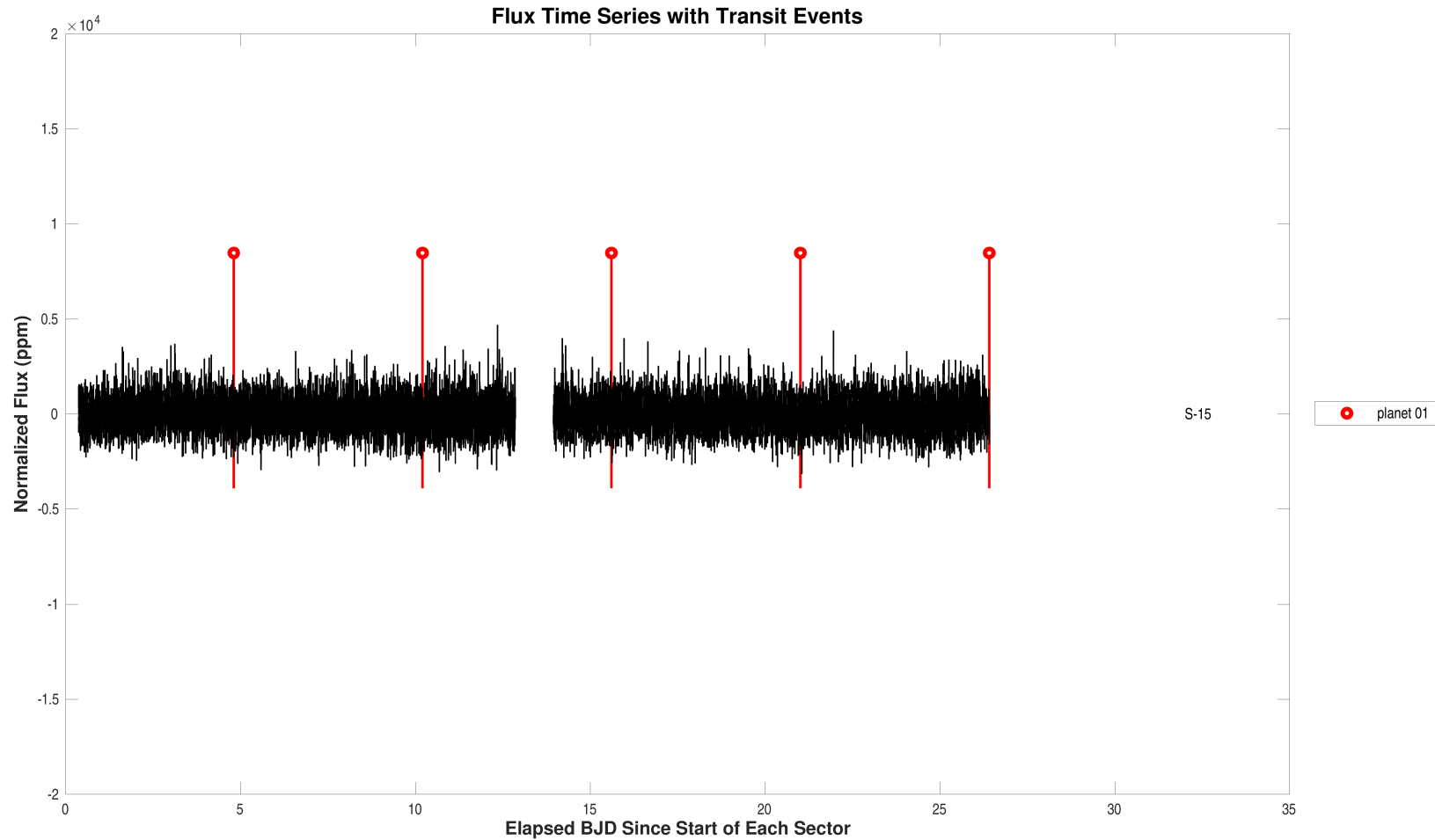
Planet Candidate	TOI ID	TESS Name	TOI Correlation	Period (days)	Period Ratio	Epoch (BTJD)	Semi-major Axis (AU)	Radius (Re)	Seff	Teq (K)	False Alarm	Suspected EB
1	-	-	-	5.401	1.00	1715.804	0.06	2.5	447.1	1173	1.67e-17	false

## 2 Survey Image

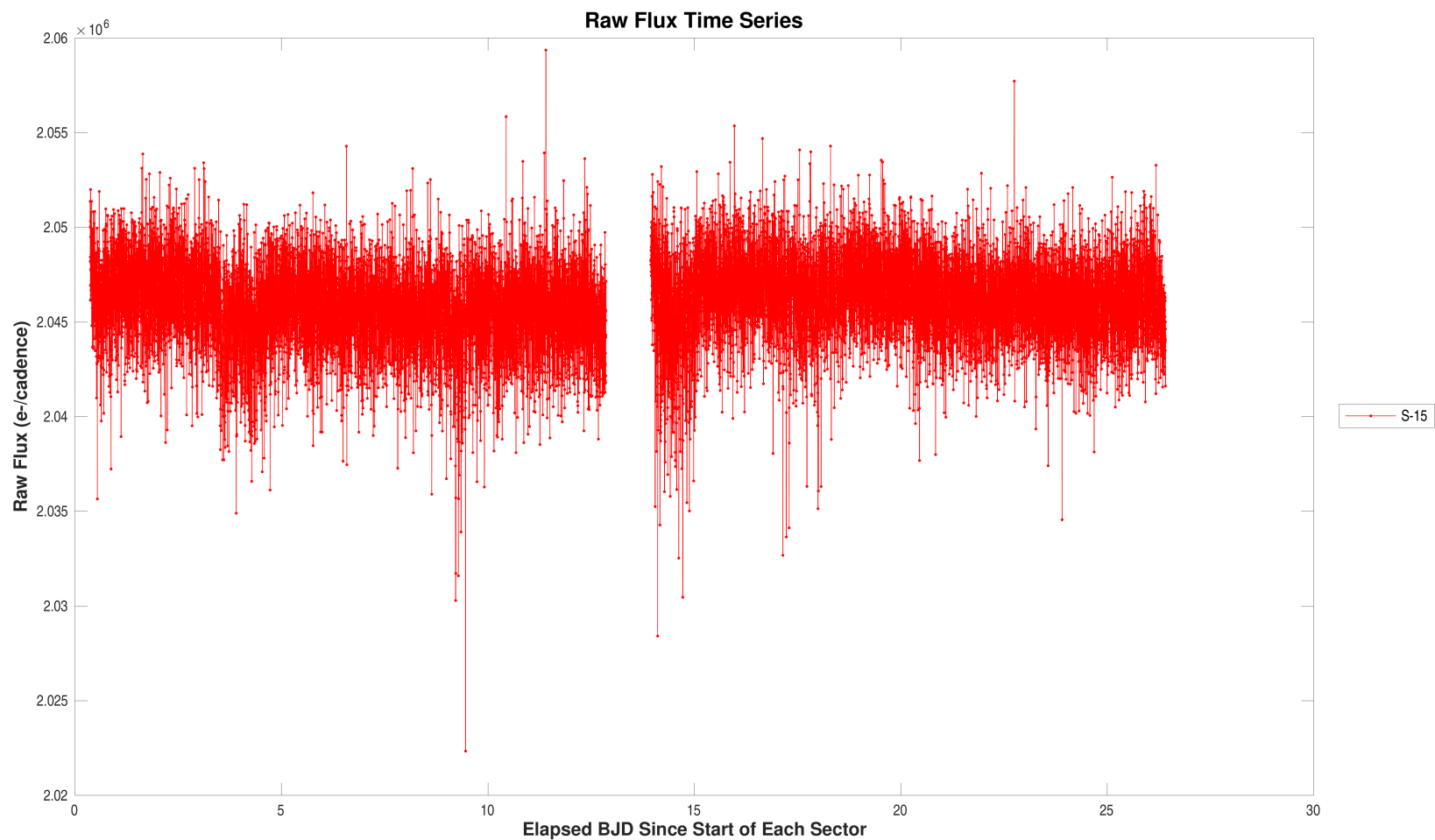


Digitized Sky Survey (DSS) red image. The 5' x 5' image is centered on the J2000 coordinates of target (417676622).

### 3 Flux Time Series



Summary plot of sector-stitched flux time series and transits for target 417676622, 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 15, target table 169, start BJD is 2458711. Open `./summary-plots/0000000417676622-00-flux-dv-fit-15-169.fig`



Summary plot of raw flux time series. For the data of sector 15, target table 169, start BJD is 2458711.

Open `./summary-plots/0000000417676622-00-raw-flux-15-169.fig`

## 4 Dashboards

## Planet Candidate 1

<b>Model Fitter</b>	<b>Stellar Radius</b> 1.3 ± 0.1 Solar units		<b>Core Aperture Correlation Statistic</b> Value = 4.52 Significance = 100.00%		<b>Ghost Diagnostic Test</b>	
	Period = 5.4 ± 0.0 days Depth = 384 ± 53 ppm Planet Radius = 2.5 ± 3.0 Earth radii Semi-major Axis = 0.1 ± 0.0 AU Effective Stellar Flux = 447.1 ± 71.1 Equilibrium Temperature = 1173 ± 47 Kelvin Chi-squared/DoF = 0.8 SNR = 7.8		<b>Halo Aperture Correlation Statistic</b> Value = -0.01 Significance = 49.54%  <b>Core/Halo Ratio</b> Ratio = -390.97			
<b>Eclipsing Binary Discrimination Test</b>	<b>Odd-Even Depth Comparison Statistic</b> Value = 3.51e-03 Significance = 95.27%		<b>Offsets Relative to Out of Transit Centroid</b> Source RA Offset = -5.58e-01 ± 2.77e+00 arcsec (-0.20 $\sigma$ ) Source Dec Offset = -1.21e+01 ± 3.35e+00 arcsec (-3.60 $\sigma$ ) Source Offset Distance = 1.21e+01 ± 3.35e+00 arcsec (3.61 $\sigma$ )  <b>Offsets Relative to TIC Position</b> Source RA Offset = -3.17e-01 ± 2.77e+00 arcsec (-0.11 $\sigma$ ) Source Dec Offset = -1.07e+01 ± 3.35e+00 arcsec (-3.20 $\sigma$ ) Source Offset Distance = 1.07e+01 ± 3.35e+00 arcsec (3.20 $\sigma$ )		<b>Difference Image Centroid Offsets</b>	
	<b>Shorter Period Comparison Statistic</b> Value = <i>N/A</i> Significance = <i>N/A</i>		<b>Longer Period Comparison Statistic</b> Value = <i>N/A</i> Significance = <i>N/A</i>		False Alarm = 1.67e-17 Transit Count = 4 Max Multiple Event Statistic = 7.6	
<b>Bootstrap Test</b>						

Summary of model fitter results and validation test results for target 417676622, 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

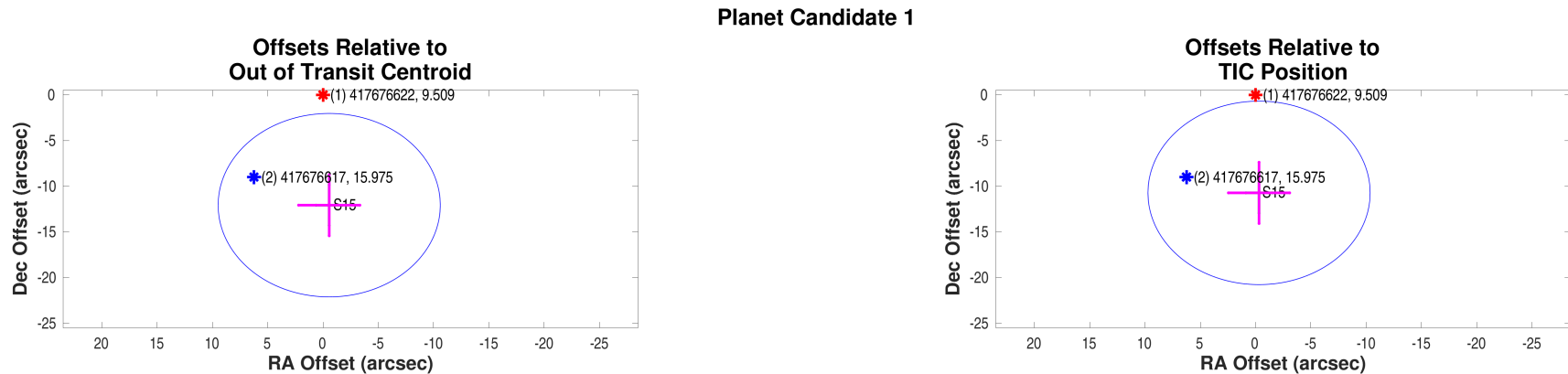
#### Multi-Sector Average PRF Fit of the Difference Images

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

	RA	Dec	Units
Offset	$-0.5582 \pm 2.77e + 00$	$-12.0709 \pm 3.35e + 00$	arcseconds
Offset/ $\sigma$	-0.20	-3.60	
Offset Distance	$12.0838 \pm 3.35e + 00$		arcseconds
Offset Distance/ $\sigma$	3.61		
$3\sigma$ Radius	10.0456		arcseconds

Mean offset from the TIC RA and Dec

	RA	Dec	Units
Offset	$-0.3166 \pm 2.77e + 00$	$-10.7238 \pm 3.35e + 00$	arcseconds
Offset/ $\sigma$	-0.11	-3.20	
Offset Distance	$10.7285 \pm 3.35e + 00$		arcseconds
Offset Distance/ $\sigma$	3.20		
$3\sigma$ Radius	10.0476		arcseconds

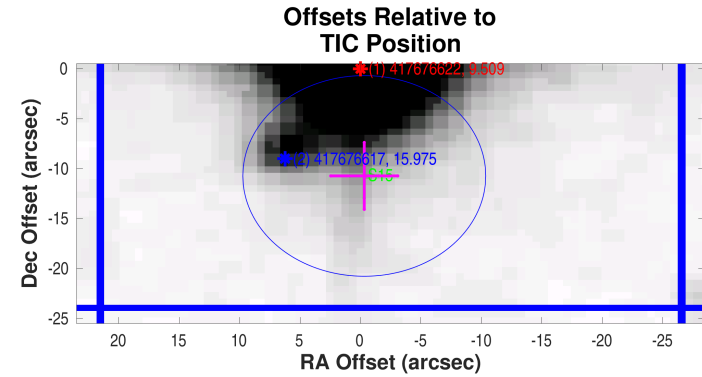
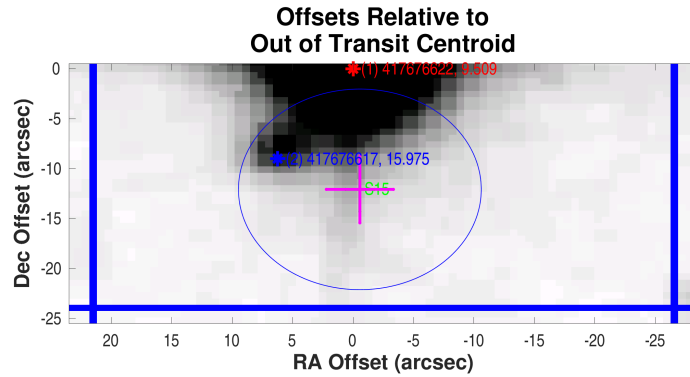


Difference image centroid offsets for target 417676622, planet candidate 1. Left: difference image PRF centroid offsets in RA and Dec with respect to the per sector out-of-transit centroids for the given target. Right: difference image PRF centroid offsets in RA and Dec with respect to the TC coordinates 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/0000000417676622-01-difference-image-centroid-offsets.fig`



## Planet Candidate 1



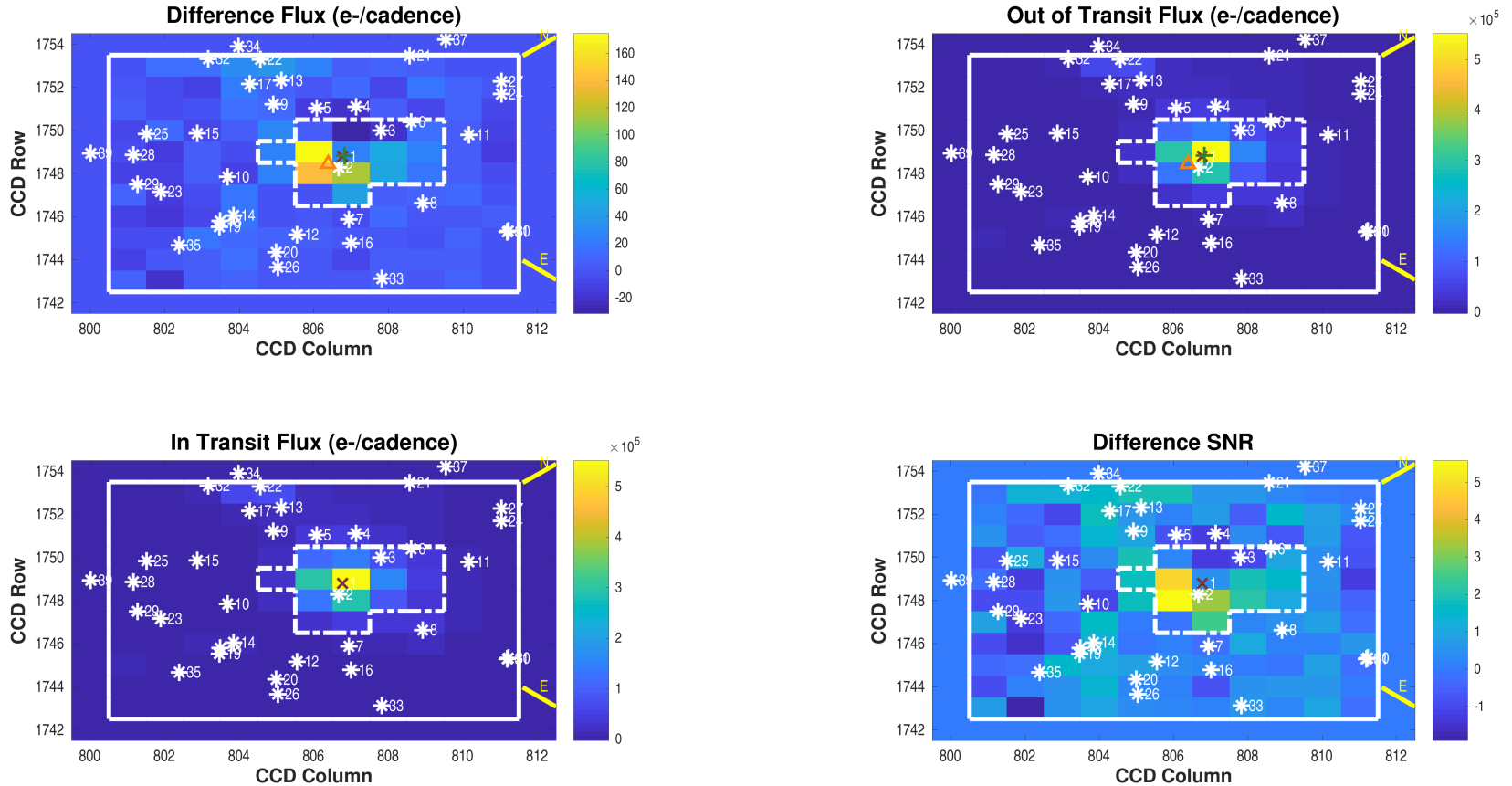
Difference image centroid offsets for target 417676622, planet candidate 1, displayed on survey image for given target. Left: difference image PRF centroid offsets in RA and Dec with respect to the per sector out-of-transit centroids for the given target. Right: difference image PRF centroid offsets 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/0000000417676622-01-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 15 / Target Pixel Table 169



Difference image for target 417676622, 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 = 4; number of valid in-transit cadences = 384; number of in-transit cadence gaps = 0; number of valid out-of-transit cadences = 890; number of out-of-transit cadence gaps = 10. Difference image quality metric = 0.83 (good).

Open `./planet-01/difference-image/0000000417676622-01-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	$1748.84 \pm 2.32e - 05$	$806.82 \pm 2.16e - 05$	pixels	$291.03239967 \pm 7.58e - 07$	$49.04057508 \pm 7.46e - 07$	degrees
Difference Image Centroid	$1748.45 \pm 1.03e - 01$	$806.38 \pm 9.58e - 02$	pixels	$291.03216314 \pm 5.06e - 04$	$49.03722205 \pm 6.19e - 04$	degrees
Offset	$-0.3888 \pm 1.03e - 01$	$-0.4414 \pm 9.58e - 02$	pixels	$-0.5582 \pm 1.19e + 00$	$-12.0709 \pm 2.23e + 00$	arcseconds
Offset/ $\sigma$	-3.79	-4.61		-0.47	-5.41	
Offset Distance	$0.5882 \pm 1.09e - 01$		pixels	$12.0838 \pm 2.23e + 00$		arcseconds
Offset Distance/ $\sigma$	5.40			5.43		

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

	Row	Column	Units	RA	Dec	Units
TIC Reference Centroid	$1748.80 \pm 1.32e - 04$	$806.77 \pm 1.27e - 04$	pixels	$291.03229730 \pm 0.00e + 00$	$49.04020089 \pm 0.00e + 00$	degrees
Difference Image Centroid	$1748.45 \pm 1.03e - 01$	$806.38 \pm 9.58e - 02$	pixels	$291.03216314 \pm 5.06e - 04$	$49.03722205 \pm 6.19e - 04$	degrees
Offset	$-0.3515 \pm 1.03e - 01$	$-0.3861 \pm 9.58e - 02$	pixels	$-0.3166 \pm 1.19e + 00$	$-10.7238 \pm 2.23e + 00$	arcseconds
Offset/ $\sigma$	-3.43	-4.03		-0.26	-4.81	
Offset Distance	$0.5221 \pm 1.09e - 01$		pixels	$10.7285 \pm 2.23e + 00$		arcseconds
Offset Distance/ $\sigma$	4.79			4.82		

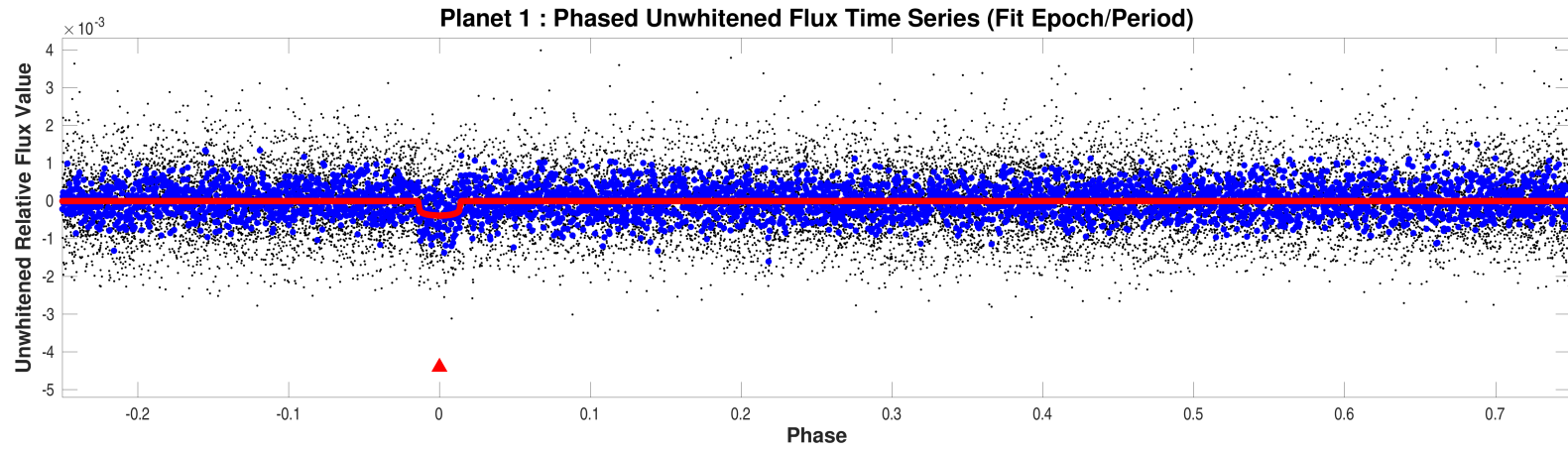
## 5.2 Difference Image TIC Key

Index	Catalog ID	Mag	RA (degrees)	Dec (degrees)	Distance (arcsec)
1	417676622	9.509	291.03229730	49.04020089	0.00
2	417676617	15.975	291.03494404	49.03770034	10.96
3	417676632	16.759	291.03095944	49.04920869	32.58
4	417676636	13.516	291.01988601	49.05097693	48.61
5	417676629	13.405	291.01383731	49.04643499	49.00
6	417676639	17.224	291.03347712	49.05406278	49.98
7	417676607	17.221	291.05185794	49.02908020	61.10
8	417676621	13.217	291.05921033	49.04010984	63.51
9	417676625	17.201	291.00559379	49.04248220	63.55
10	417676601	15.834	291.01950153	49.02387576	66.07
11	417676643	16.968	291.04674956	49.05792589	72.35
12	417676591	17.407	291.04787121	49.02060060	79.56
13	417676630	16.937	290.99996012	49.04775700	81.02
14	417676588	16.990	291.03184031	49.01730183	82.44
15	417676606	16.718	291.00176242	49.02874181	83.03
16	417676602	17.098	291.05921337	49.02488736	84.11
17	417676626	15.605	290.99582090	49.04370725	87.00
18	417676585	13.848	291.03125870	49.01480209	91.47
19	417676581	17.092	291.03282090	49.01364671	95.60
20	417676586	15.431	291.04963900	49.01501409	99.48
21	417676649	13.227	291.01370775	49.06634596	103.84
22	417676633	11.409	290.99031249	49.04946071	104.54
23	417676582	16.625	291.01287256	49.01384990	105.36
24	417676653	17.327	291.04004340	49.06909709	105.62
25	417676598	15.080	290.99359220	49.02316203	110.03
26	417676578	17.368	291.05425456	49.01240913	112.67
27	417676656	15.338	291.03637624	49.07145011	112.91
28	417676589	17.111	290.99756846	49.01781566	114.94
29	417676579	15.792	291.00691296	49.01272140	115.65
30	1882970156	17.125	291.08149235	49.04415201	116.96
31	417676628	16.315	291.08154706	49.04386723	116.97
32	417676627	16.312	290.98162140	49.04390809	120.33
33	417676593	16.401	291.07469331	49.02152379	120.54
34	417676634	15.944	290.98293188	49.04950749	121.22
35	417676572	17.128	291.03166973	49.00584042	123.71
36	417676648	17.228	291.06785273	49.06576225	124.53
37	417676660	16.954	291.01489679	49.07326246	125.91
38	417676640	17.158	290.97993285	49.05431343	133.61

<b>Index</b>	<b>Catalog ID</b>	<b>Mag</b>	<b>RA (degrees)</b>	<b>Dec (degrees)</b>	<b>Distance (arcsec)</b>
39	417676580	14.161	290.99013252	49.01346530	138.44
40	417676647	16.845	290.98508361	49.06542038	143.73
41	417676658	11.462	290.98913142	49.07275078	155.27
42	417676574	15.996	290.98454271	49.00673955	164.96

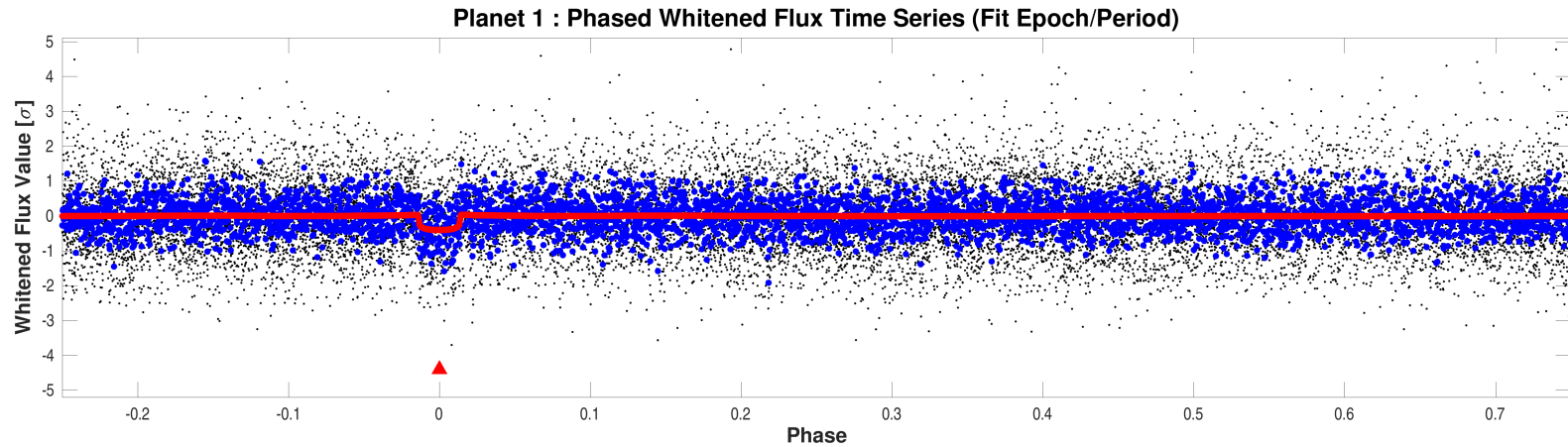
RA, Dec and Distances are corrected for proper motion. This table may not contain all of the objects shown.

## 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.

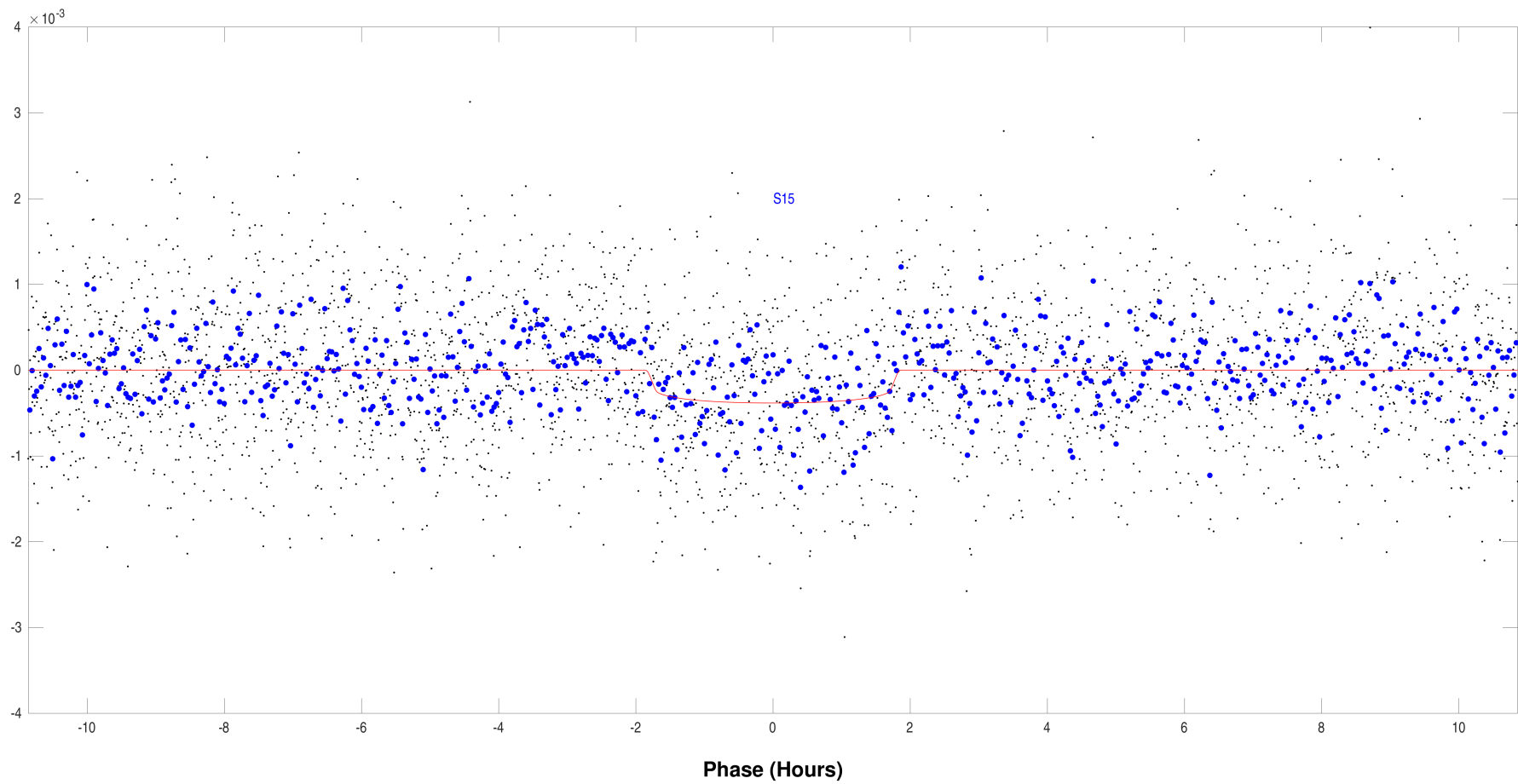
Open `./summary-plots/0000000417676622-01-phased-unwhitened-flux-time-series.fig`



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/0000000417676622-01-phased-whitened-flux-time-series.fig`

## Planet: 1 Phased Unwhitened Flux Time Series by Sector



Phased unwhitened flux time series by sector for target 417676622, planet candidate 1. Period = 5.401 days; transit epoch = 1715.8036 BTJD.  
Open `./summary-plots/0000000417676622-01-phased-unwhitened-flux-time-series-by-sector.fig`



## 7 Planet Candidate 1

### 7.1 Model Fitter: All Transits

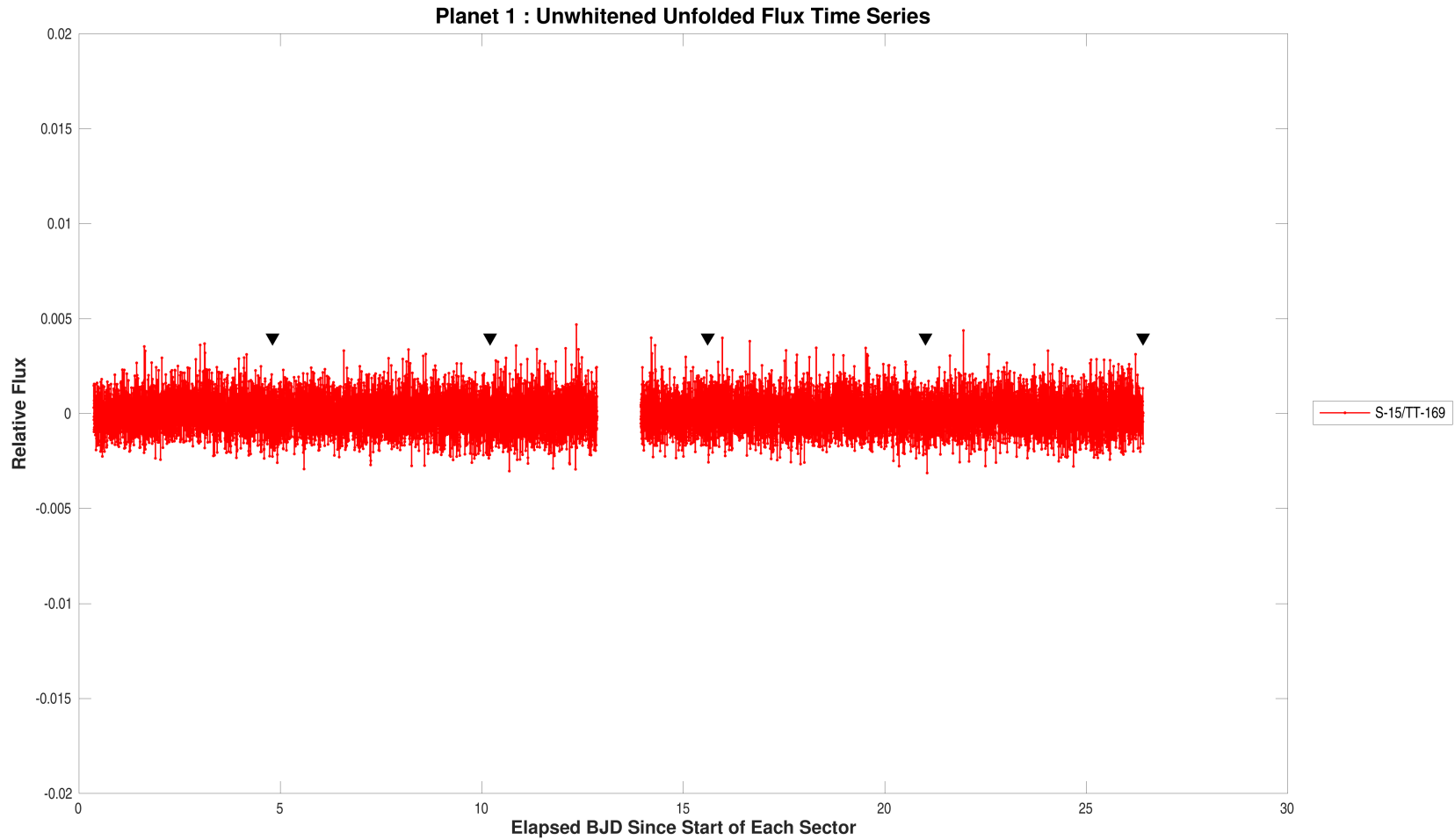
Model Characteristic	Name
Transit Model	mandel-agol_geometric_transit_model
Limb Darkening Model	claret_tess_nonlinear_limb_darkening_model

TCE Parameter	Value	Units
Trial Transit Pulse Duration	3.5	hours
Transit Epoch	1715.7941887	TJD
Orbital Period	5.4055533	days
Maximum SES	4.5	
Maximum MES	7.6	
Robust Statistic	7.6	
Chi Square Goodness of Fit Statistic (DoF)	475.4 (418)	
Chi Square2 Statistic (DoF)	0.6 (7.9)	
Threshold for Desired PFA		

DoF: Degrees of Freedom

Parameter	Value	Uncertainty	Units
SNR	7.8		
Orbital Period	5.4010163	2.5152e-03	days
Transit Epoch	1715.8036052	5.3594e-03	BTJD
Impact Parameter	0.3021	2.0881e+01	
Planet Radius to Star Radius Ratio	0.0182747	2.2160e-02	
Semi-major Axis to Star Radius Ratio	11.1076	7.6186e+01	
Planet Radius	2.5124	3.0496e+00	Earth radii
Semi-major Axis	0.0615	4.3930e-03	AU
Effective Stellar Flux	447.0665	7.1095e+01	Goldilocks
Equilibrium Temperature	1173	4.6625e+01	Kelvin
Stellar Density	0.6312	1.2987e+01	Solar density
Transit Depth	384	5.2872e+01	ppm
Transit Duration	3.6182	9.8186e-01	hours
Transit Ingress Duration	0.0715	1.0777e+00	hours
Eccentricity	0.0000	0.0000e+00	
Peri Longitude	0.0000	0.0000e+00	degrees
Model Chi Square Statistic (DoF)	1862.5 (2306.5)		
Model Chi Square Goodness of Fit Statistic (DoF)	298.4 (506)		
Model Chi Square2 Statistic (DoF)	2.4 (4)		

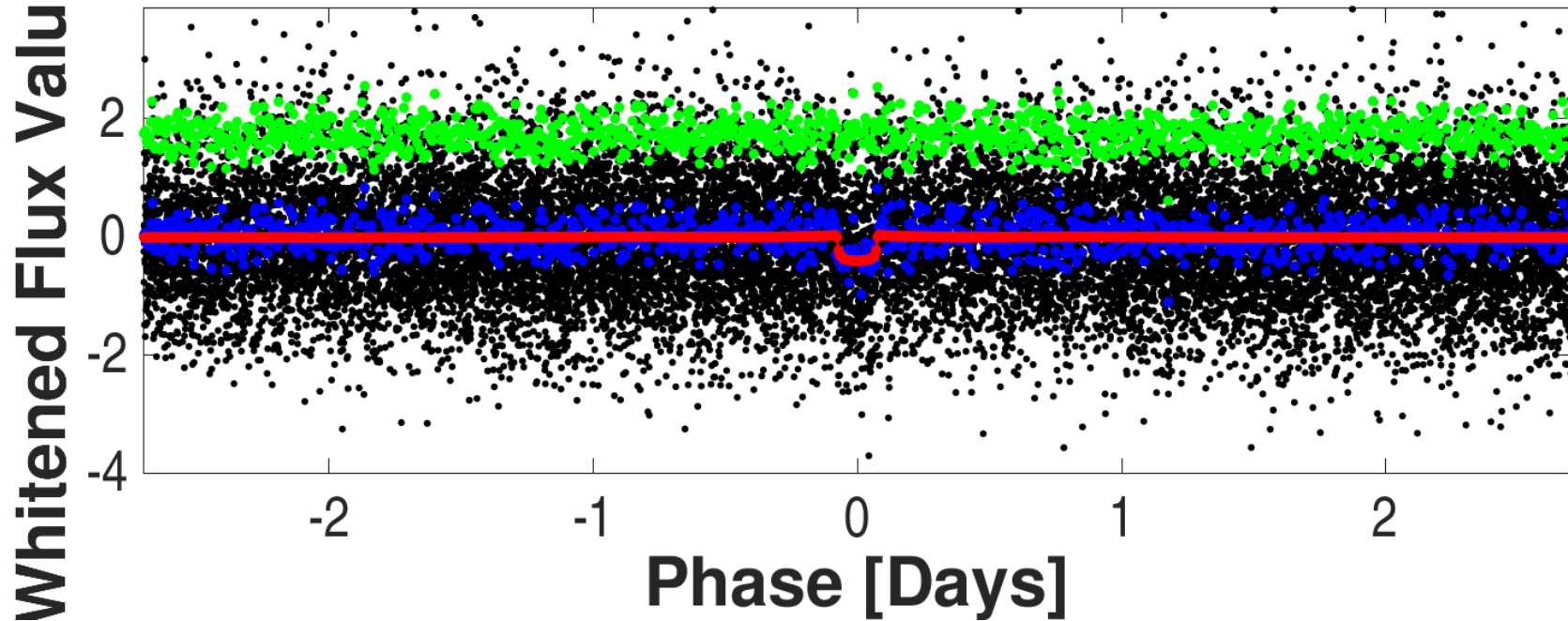
DoF: Degrees of Freedom



Flux time series for CatId 417676622, Planet candidate 1 in the unwhitened domain. For the data of Sector-15/TargetTableId-169, start BJD is 2458711. Transit event markers indicate the location of transits of the given planet candidate. All transits fit completed with full convergence.

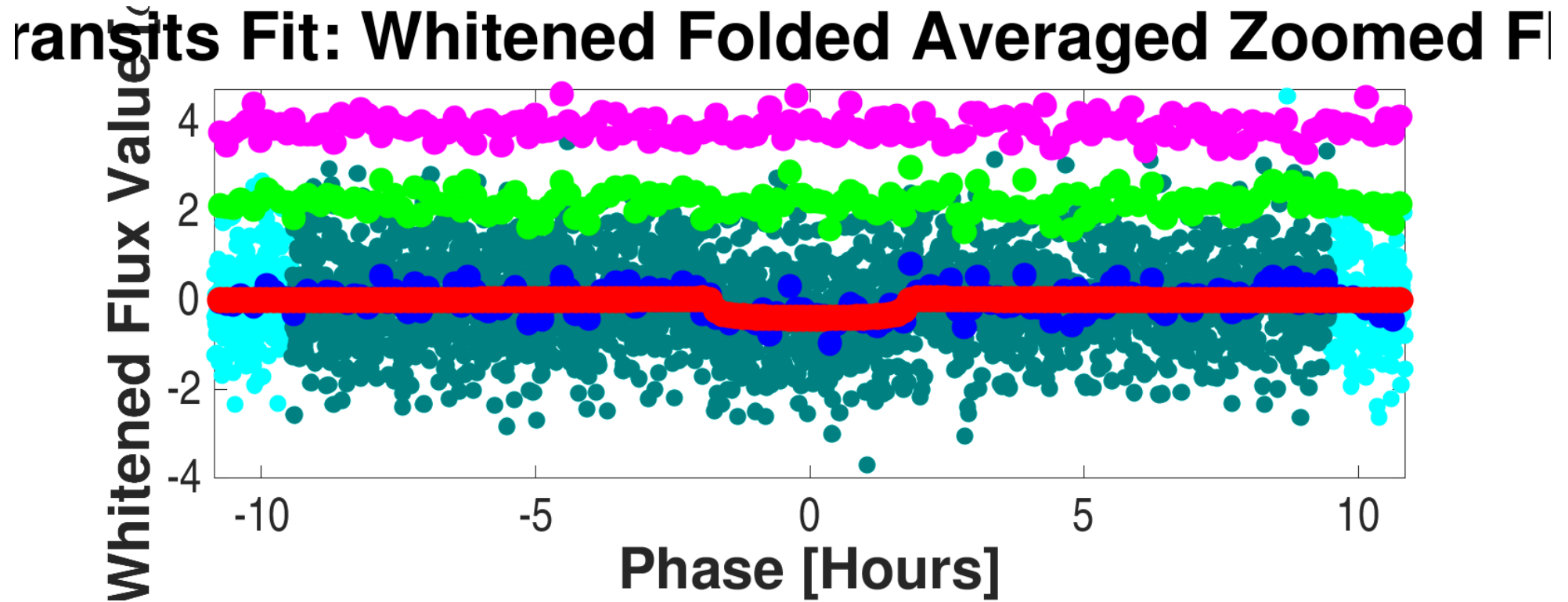
Open `./planet-01/planet-search-and-model-fitting-results/all-transits-fit/0000000417676622-01-all-unwhitened-15-169.fig`

# All Transits Fit: Whitenened Folded Averaged Flux T



Folded flux time series for CatId 417676622, 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/0000000417676622-01-all-whitened.fig`



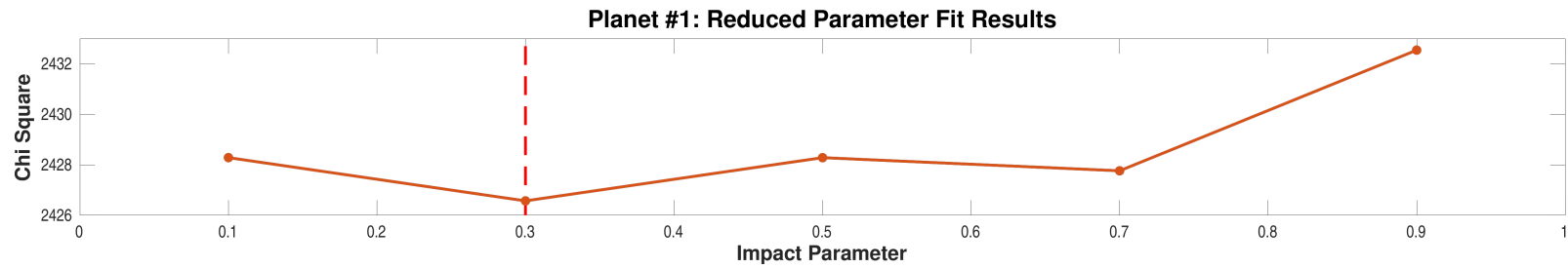
Folded flux time series for CatId 417676622, Planet candidate 1 in the whitened domain, zoomed on the transit. The flux data whose robust weights are larger/smaller than 0.1 are plotted in dark green/cyan dots, respectively. Values are averaged into 1 cadence wide bins. The blue dots represent the averaged 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/0000000417676622-01-all-whitened-zoomed.fig`

## 7.2 Model Fitter: Reduced Parameter Fit Results

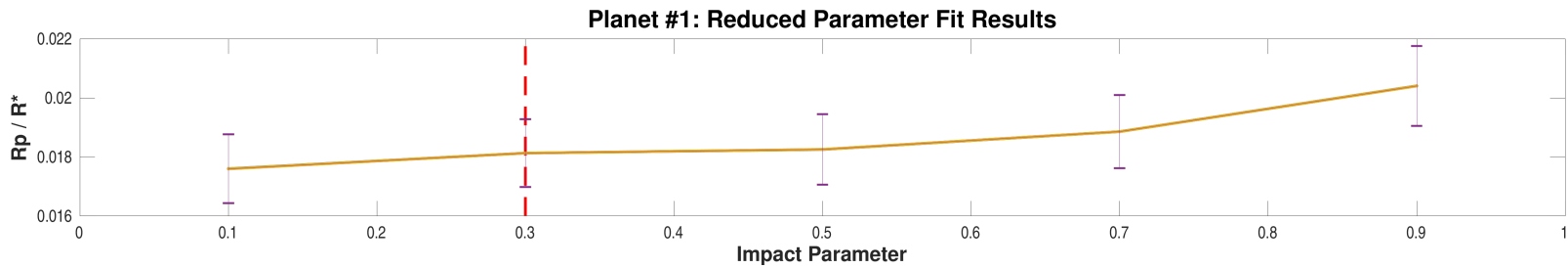
<b>Impact Parameter</b>	<b>SNR</b>	<b>Model Chi Square</b>	<b>Planet Radius to Star Radius</b>	<b>Uncert</b>	<b>Semi-major Axis to Star Radius</b>	<b>Uncert</b>	<b>Transit Depth (ppm)</b>	<b>Uncert</b>	<b>Transit Duration (hours)</b>	<b>Uncert</b>
0.10	7.9	2428.3	0.0176016	1.1654e-03	10.8744	5.7503e-01	361	4.7584e+01	3.8490	2.0338e-01
0.30	8.0	2426.6	0.0181309	1.1470e-03	11.0859	5.1886e-01	378	4.7540e+01	3.6272	1.6906e-01
0.50	7.9	2428.3	0.0182539	1.1935e-03	9.9551	5.0963e-01	370	4.8145e+01	3.6867	1.8802e-01
0.70	7.9	2427.8	0.0188579	1.2420e-03	8.2438	4.3483e-01	369	4.8365e+01	3.7245	1.9536e-01
0.90	7.7	2432.5	0.0204067	1.3502e-03	5.4102	3.0678e-01	366	4.8154e+01	3.7214	2.1101e-01

Highlighted row is the best reduced-parameter model fit.



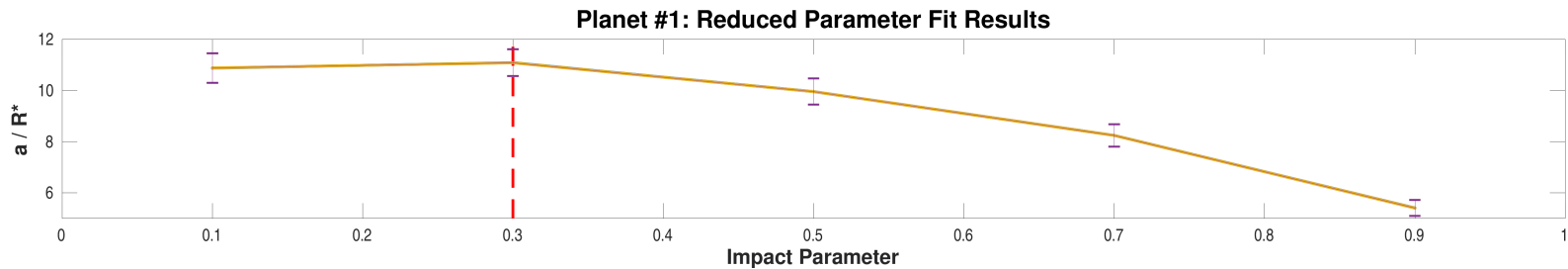
Model chi squares of reduced parameter fits vs. impact parameter for CatId 417676622, Planet candidate 1. The fit result with the minimum chi square is marked with a dashed line in the plot.

Open `./planet-01/planet-search-and-model-fitting-results/reduced-parameter-fits/0000000417676622-01-reduced-fits-chi-square.fig`



Ratios of planet radius to star radius of reduced parameter fits vs. impact parameter for CatId 417676622, 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/0000000417676622-01-reduced-fits-rp-over-rstar.fig`



Ratios of semimajor axis to star radius of reduced parameter fits vs. impact parameter for CatId 417676622, 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/0000000417676622-01-reduced-fits-a-over-rstar.fig`

### 7.3 Model Fitter: Trapezoidal Fit Results

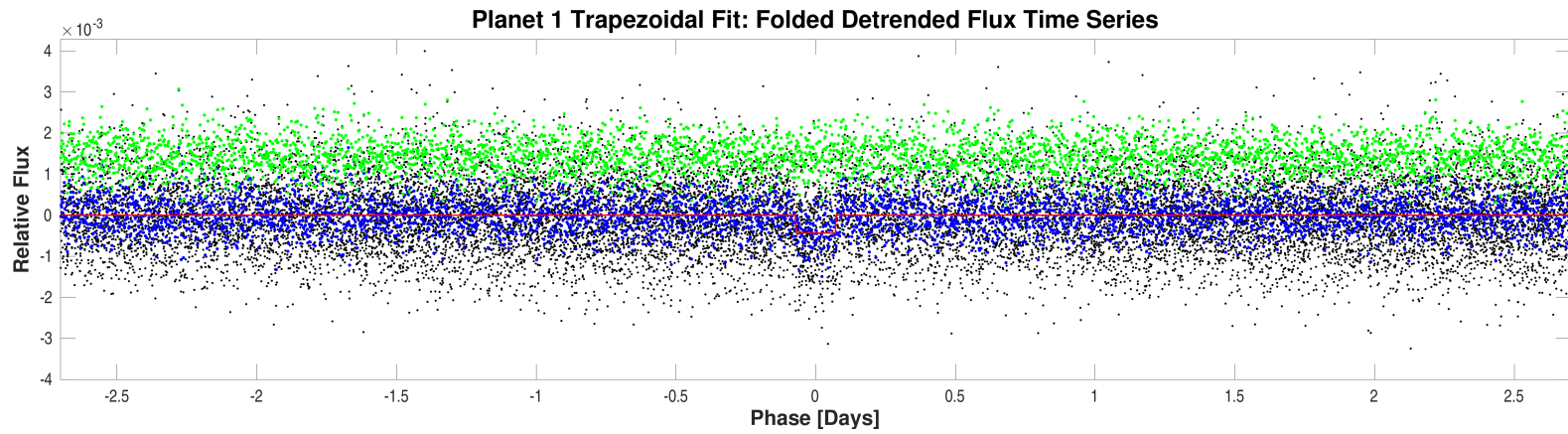
Model Characteristic	Name
Transit Model	trapezoidal_model
Limb Darkening Model	

TCE Parameter	Value	Units
Trial Transit Pulse Duration	3.5	hours
Transit Epoch	1715.7941887	TJD
Orbital Period	5.4055533	days
Maximum SES	4.5	
Maximum MES	7.6	
Robust Statistic	7.6	
Chi Square Goodness of Fit Statistic (DoF)	475.4 (418)	
Chi Square2 Statistic (DoF)	0.6 (7.9)	
Threshold for Desired PFA		

DoF: Degrees of Freedom

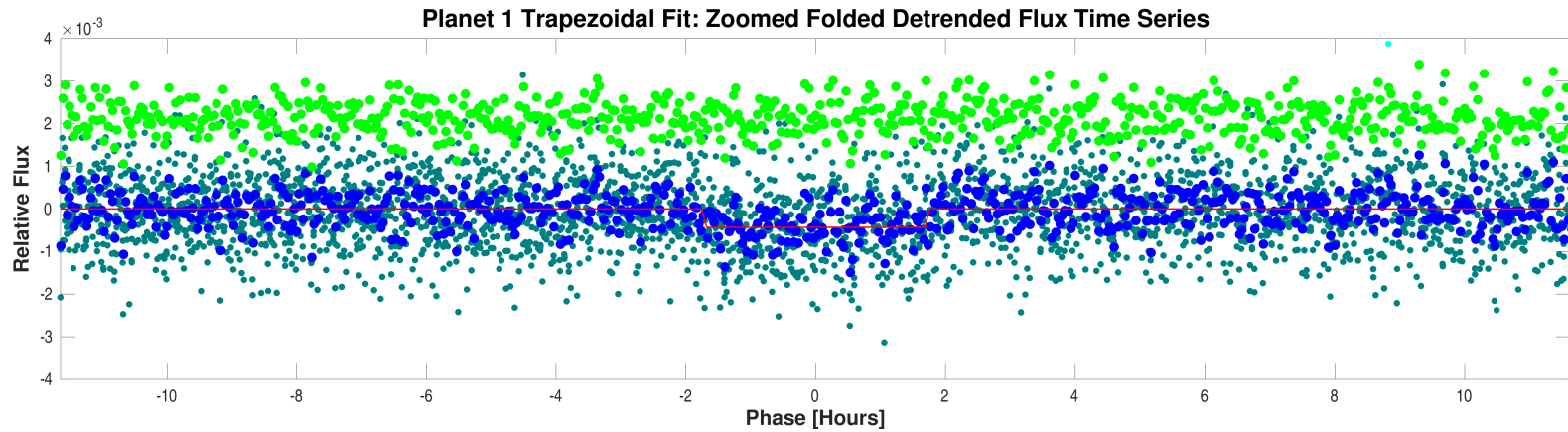
Parameter	Value	Uncertainty	Units
SNR	10.7		
Orbital Period	5.4055533		days
Transit Epoch	1715.7894463		BTJD
Transit Depth	435		ppm
Transit Duration	3.8800		hours
Transit Ingress Duration	0.4396		hours
Model Chi Square Statistic (DoF)	18654.4 (3747)		

DoF: Degrees of Freedom



Folded detrended flux time series for CatId 417676622, Planet candidate 1 and folded trapezoidal model light curve.

Open `./planet-01/planet-search-and-model-fitting-results/trapezoidal-model-fit/0000000417676622-01-all-trapezoidal.fig`



Zoomed folded detrended flux time series for CatId 417676622, Planet candidate 1 and folded trapezoidal model light curve.

Open `./planet-01/planet-search-and-model-fitting-results/trapezoidal-model-fit/0000000417676622-01-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	5.4056		days		
Transit Duration	3.5		hours		
Maximum MES	7.6				
Secondary Phase	3.0736		days		
Secondary MES	1.5				
Minimum Phase	-0.78333		days		
Minimum MES	-2.2				
Median MES	-0.1				
MAD MES	0.5489				
Robust Statistic	1.5				
Secondary Depth	92.8	5.6827e+01	ppm		
Geometric Albedo	30.6	7.6750e+01		0.3862	34.97
Planet Effective Temperature	4266	2.6696e+03	Kelvin	1.1586	12.33

### 7.4.2 Eclipsing Binary Discrimination Test

Result	Value	Value in Sigmas	Significance (%)
Odd Even Transit Depth Comparison Statistic	3.5133e-03	0.0593	95.27

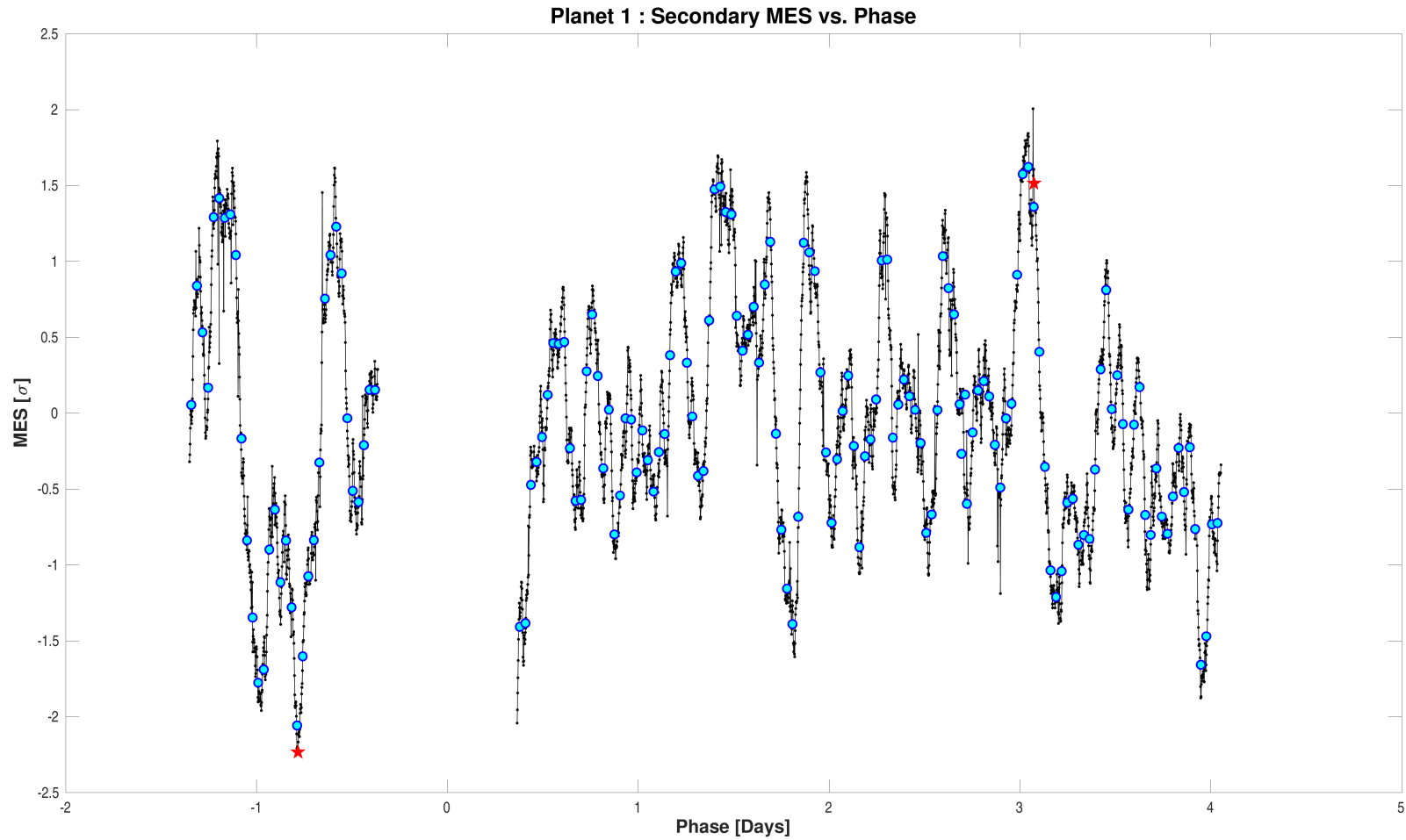
**7.4.3 Bootstrap Test**

<b>Result</b>	<b>Value</b>
False Alarm Probability	1.6717e-17
Bootstrap Threshold for Desired PFA	6.2
MES Mean	1.41
MES Standard Deviation	0.73
Transit Count	4

**7.4.4 Ghost Diagnostic Test**

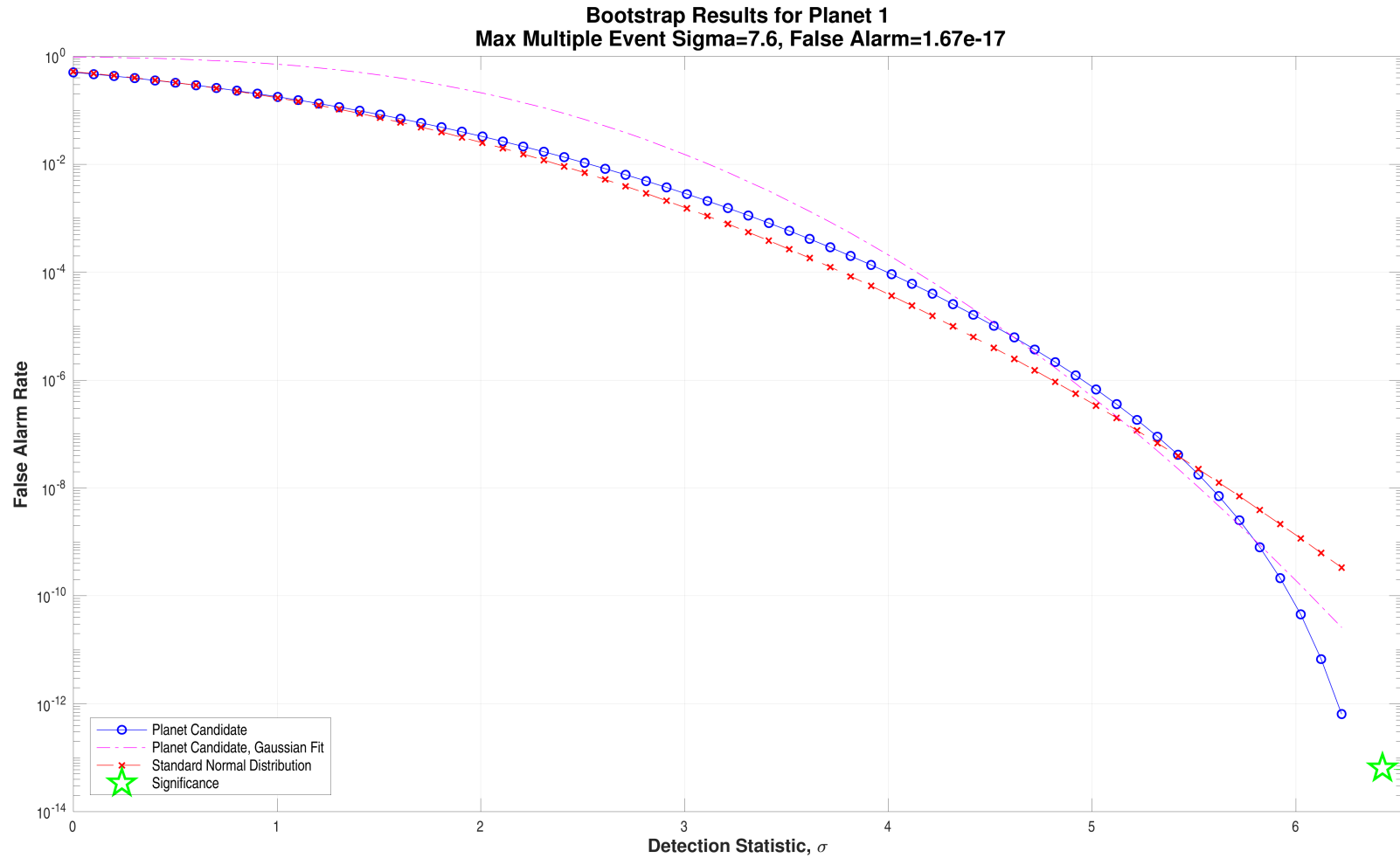
<b>Result</b>	<b>Value</b>	<b>Significance (%)</b>
Maximum MES	7.6	
SNR	7.8	
Core Aperture Statistic	4.5195e+00	100.00
Halo Aperture Statistic	-1.1560e-02	49.54
Ratio of Core/Halo Aperture Statistics	-3.9097e+02	

## 7.4.5 Validation Test Figures



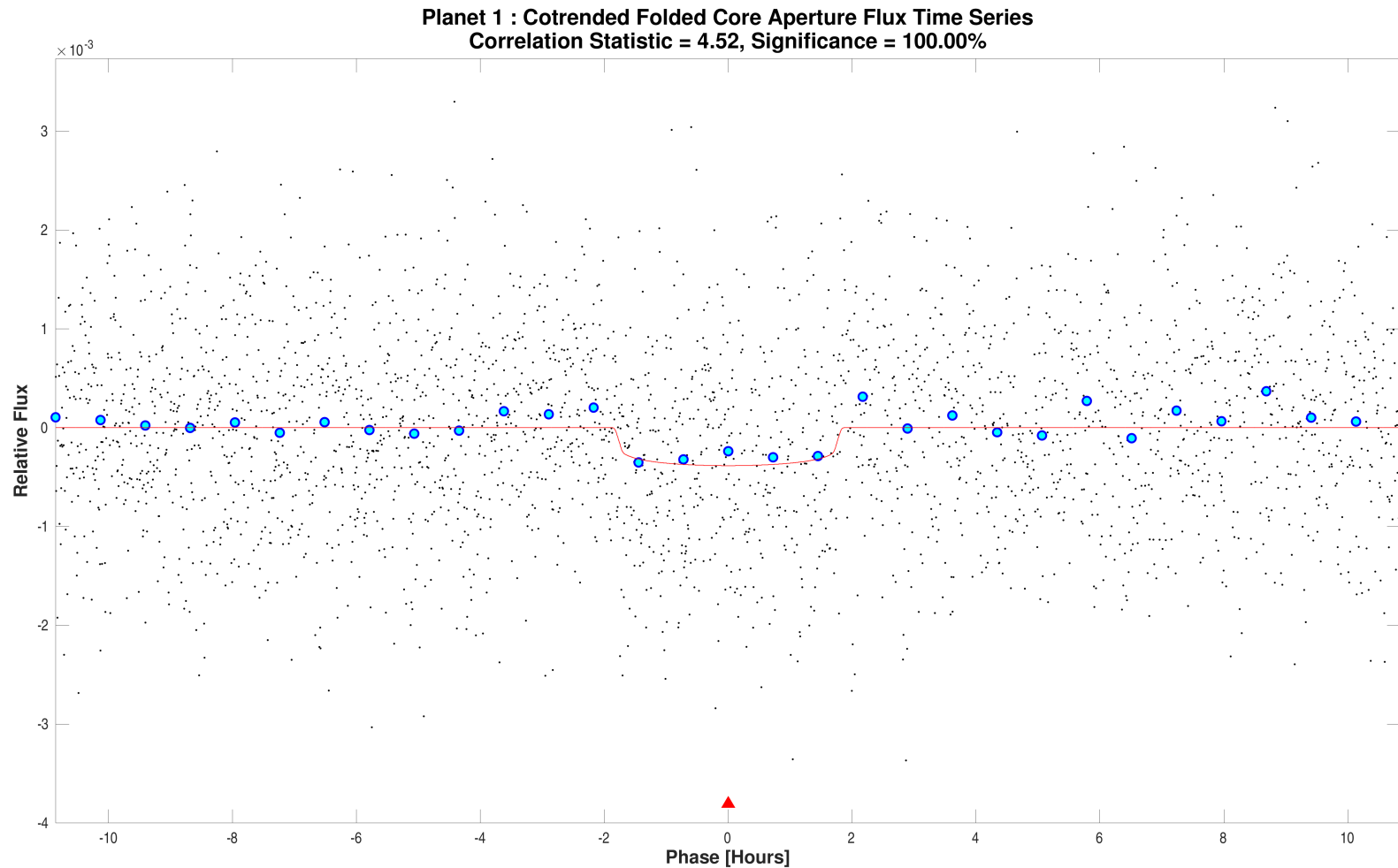
The primary event has been set to zero and both the max and min of the resulting MES vs. Phase are marked with a red star. The best matched pulse duration in hours is 3.5. The maximum secondary MES and corresponding phase are 1.5146 and 3.0736 days respectively. The minimum secondary MES and corresponding phase are -2.2331 and -0.78333 days respectively.

Open `./planet-01/report-summary/0000000417676622-01-weak-secondary-diagnostic.fig`



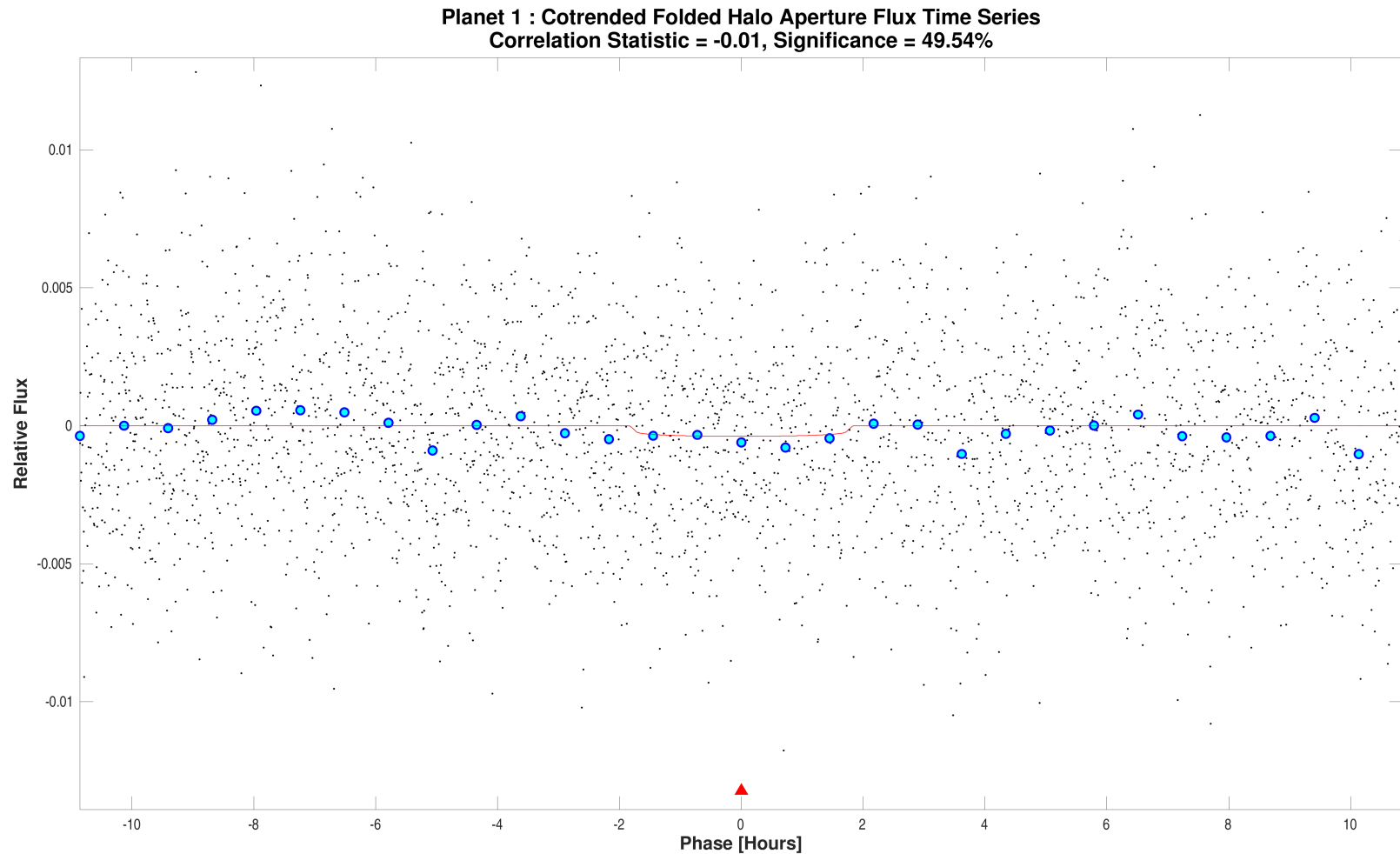
Bootstrap results for target 417676622, planet 1. Cumulative sum of the probabilities (derived from the histogram of counts) from upper tail to the search transit threshold; false alarm probability is indicated by the star. The Gaussian equivalent threshold for this false alarm probability is 8.4339. The threshold on this distribution that achieves the same false alarm rate as a 7.1 sigma threshold on a Gaussian distribution is 6.2274.

Open `./planet-01/bootstrap-results/0000000417676622-01-bootstrap-false-alarm.fig`



Optical ghost diagnostic core aperture flux time series for target 417676622, 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/000000417676622-01-core-unwhitened-cotrended-zoomed-model.fig`

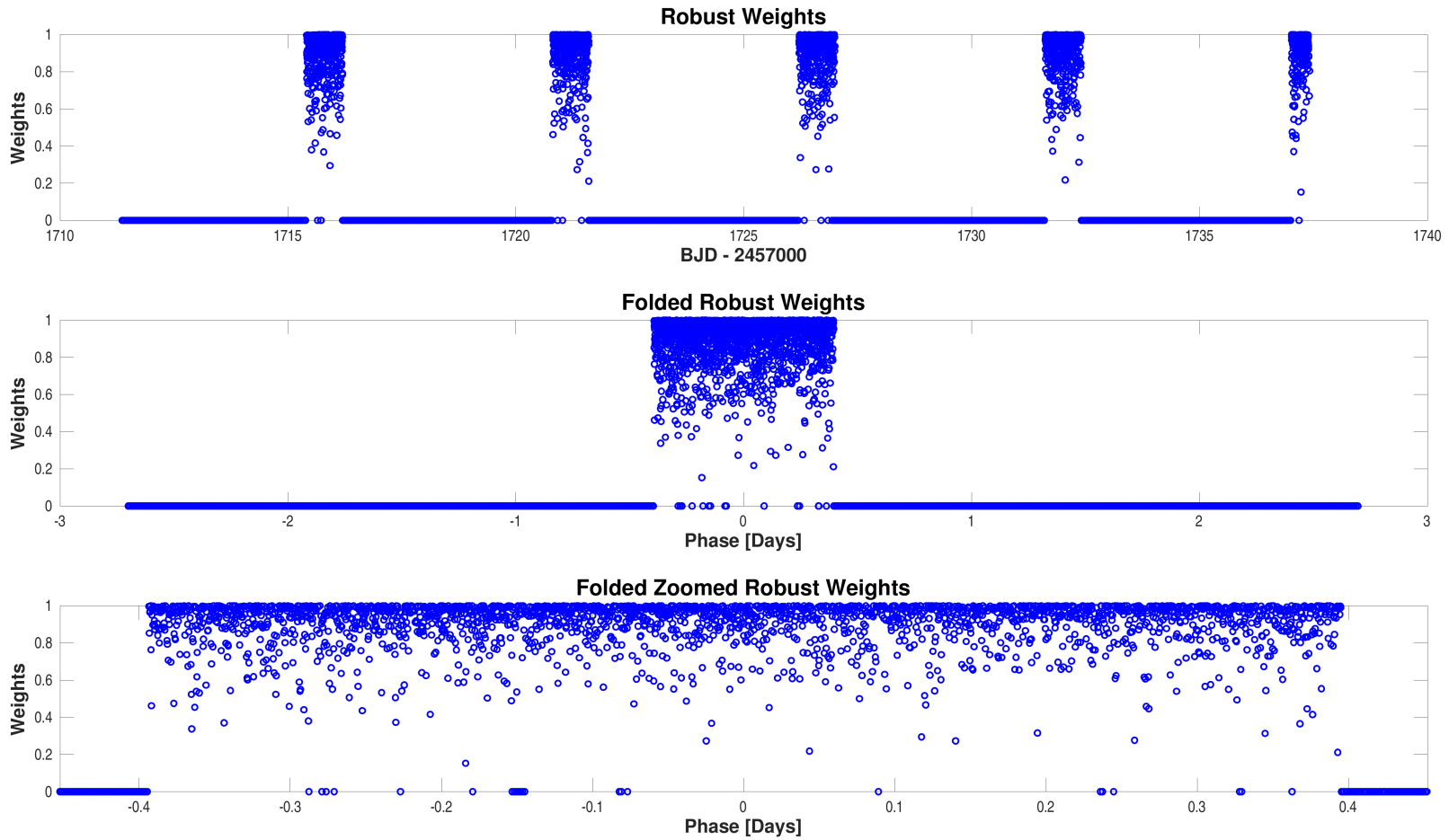


Optical ghost diagnostic halo aperture flux time series for target 417676622, planet candidate 1. The unwhitened time series is phase folded at the orbital period associated with the planet candidate and centered on the epoch of the first transit. The time series was first cotrended against spacecraft 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/000000417676622-01-halo-unwhitened-cotrended-zoomed-model.fig`

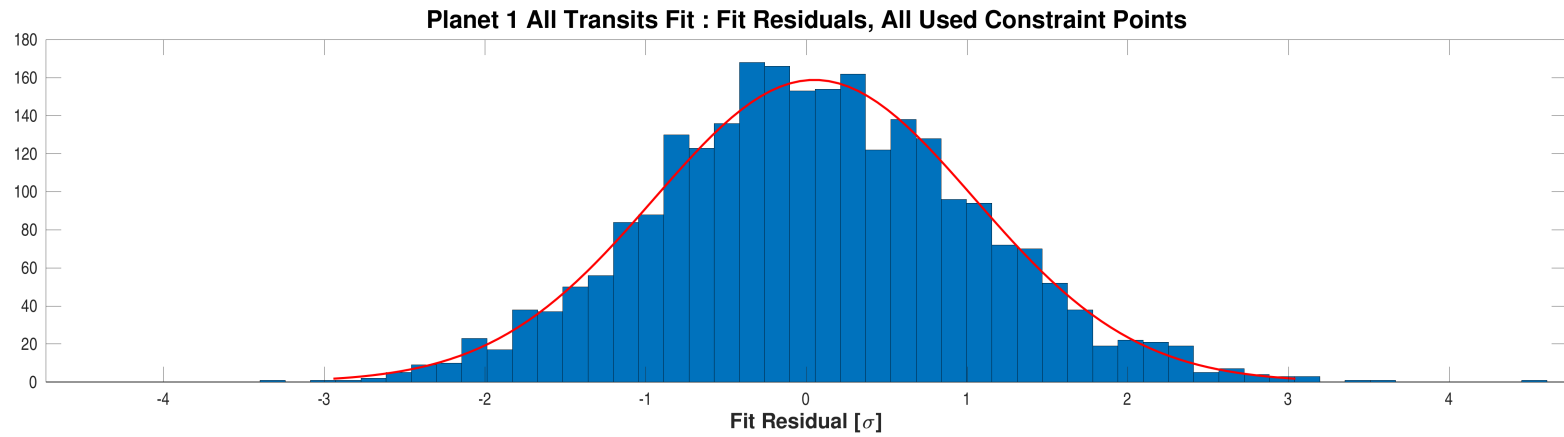
## Appendix A Planet Candidate 1

### A.1 Model Fitter: All Transits



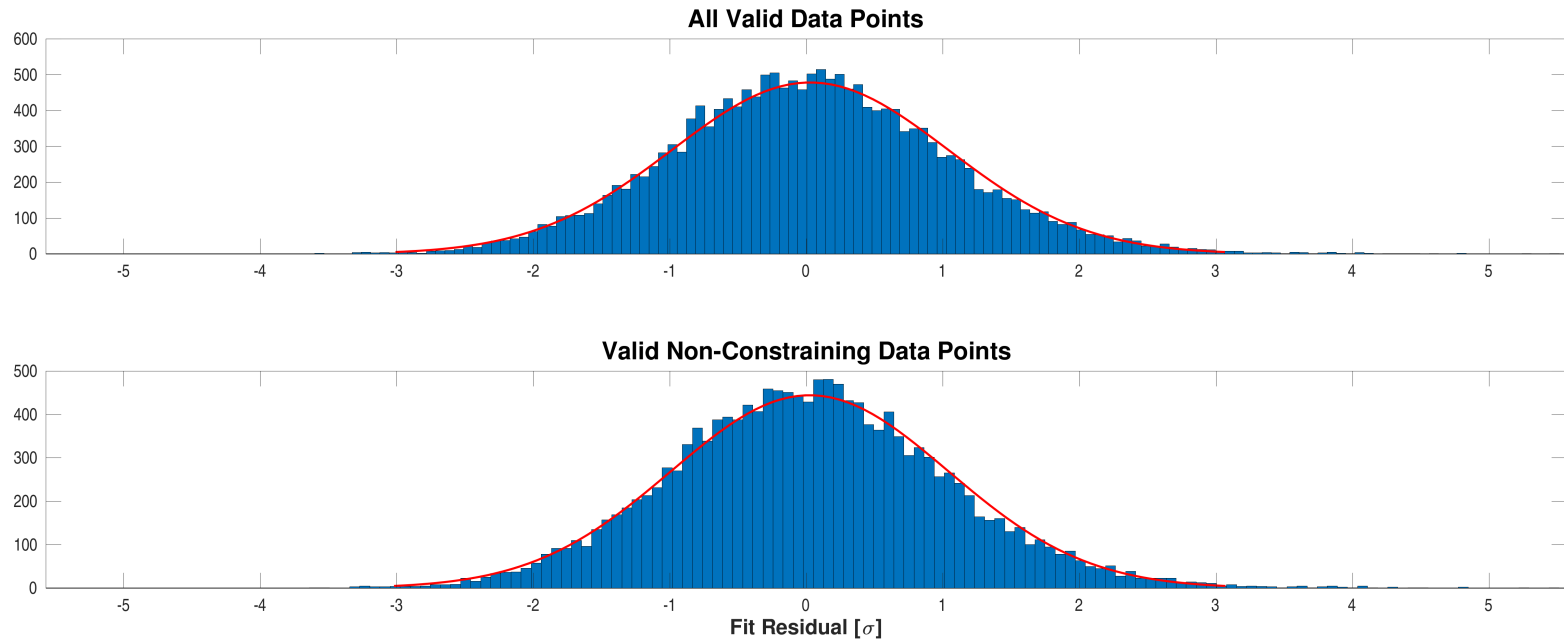
Robust weights distribution for CatId 417676622, Planet candidate 1. Top plot: all data points. Middle plot: all data points, folded per the fitted period and epoch. Bottom plot: all data points, folded and zoomed.

Open `./planet-01/planet-search-and-model-fitting-results/all-transits-fit/0000000417676622-01-all-robust-weights.fig`



Fit residuals distribution for CatId 417676622, 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/000000417676622-01-all-histo-used.fig`



Fit residuals distribution for CatId 417676622, 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.

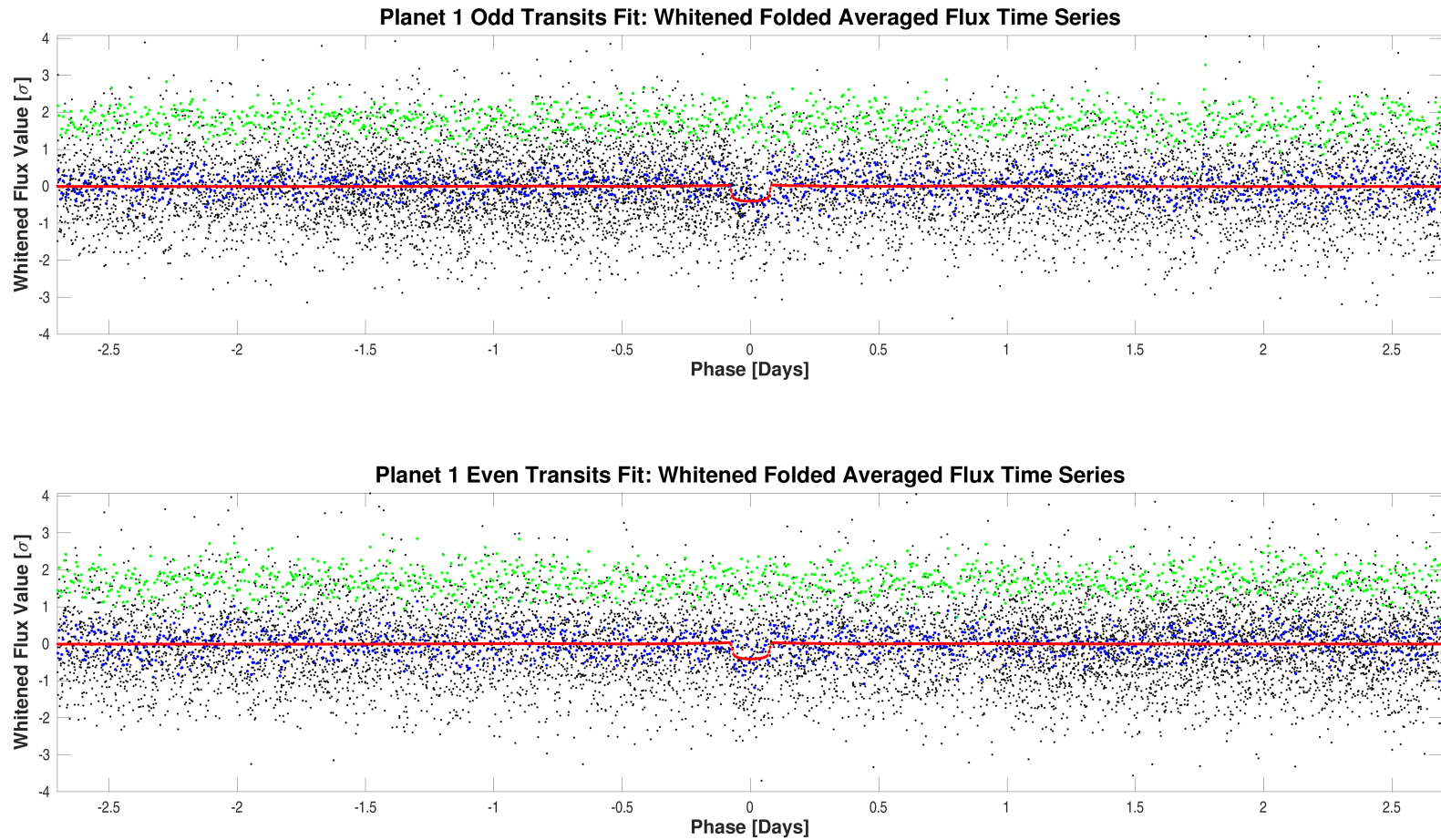
Open `./planet-01/planet-search-and-model-fitting-results/all-transits-fit/000000417676622-01-all-histo-all-and-unused.fig`



## A.2 Model Fitter: Odd &amp; Even Transits

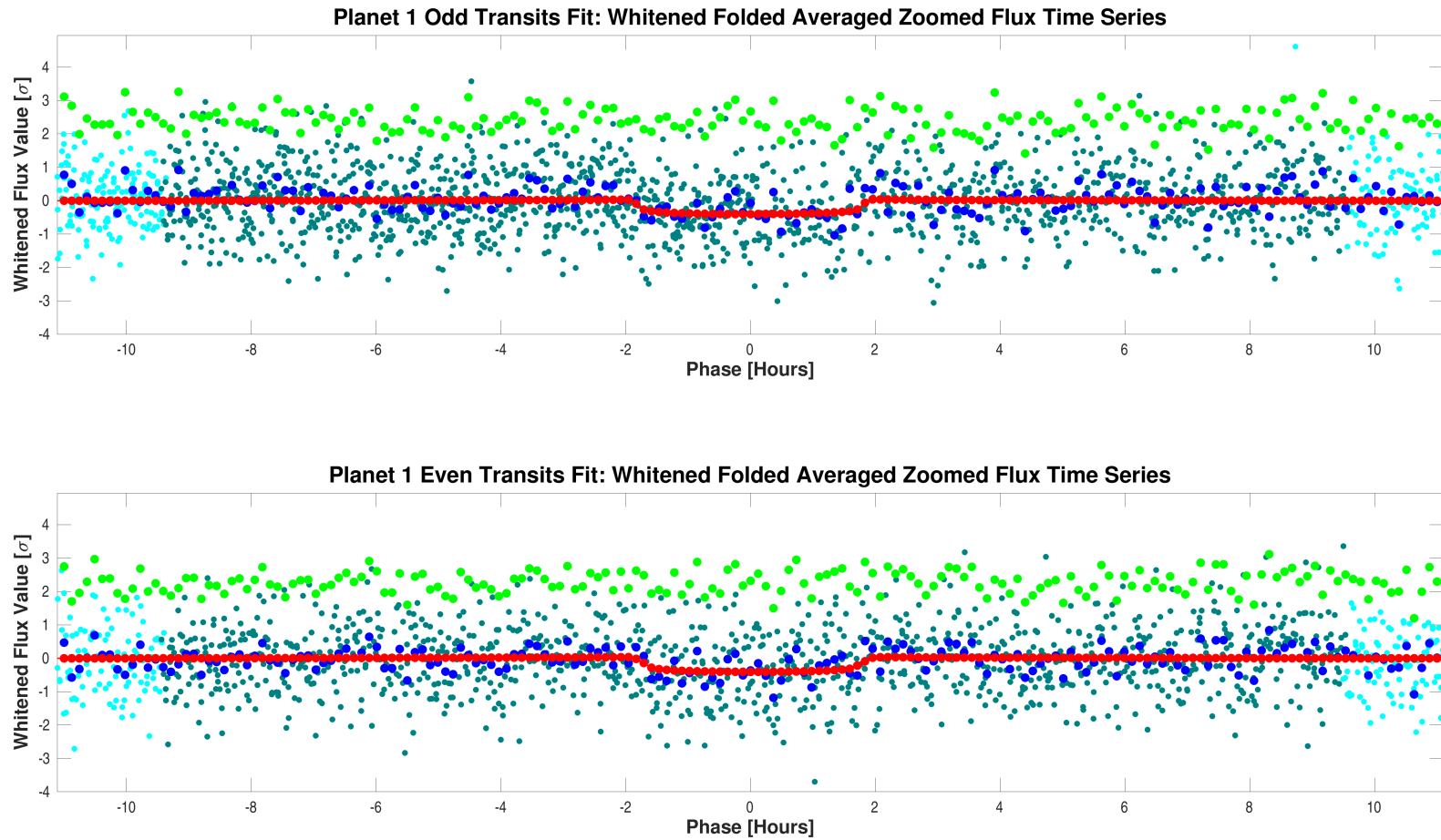
Parameter	Odd Transits Value	Odd Transits Uncertainty	Even Transits Value	Even Transits Uncertainty	Units	$\frac{\text{Difference}}{\ \text{Uncertainty}\ }$
SNR	5.9		5.2			
Orbital Period	5.4027767	3.4366e-03	5.3994947	4.8548e-03	days	5.5178e-01
Transit Epoch	1715.7989363	7.1555e-03	1721.2061554	6.7933e-03	BTJD	6.2866e-01
Impact Parameter	0.2577	3.9352e+01	0.2861	3.4186e+01		5.4441e-04
Planet Radius to Star Radius Ratio	0.0181504	3.4381e-02	0.0183294	3.4091e-02		3.6985e-03
Semi-major Axis to Star Radius Ratio	10.9966	1.1799e+02	11.1458	1.1726e+02		8.9731e-04
Planet Radius	2.4953	4.7286e+00	2.5199	4.6887e+00	Earth radii	3.6969e-03
Semi-major Axis	0.0616	4.3940e-03	0.0615	4.3923e-03	AU	4.0125e-03
Effective Stellar Flux	446.8722	7.1065e+01	447.2344	7.1124e+01	Goldilocks	3.6025e-03
Equilibrium Temperature	1173	4.6621e+01	1173	4.6631e+01	Kelvin	3.6025e-03
Stellar Density	0.6120	1.9700e+01	0.6381	2.0138e+01	Solar density	9.2423e-04
Transit Depth	380	7.2562e+01	387	8.0325e+01	ppm	5.9273e-02
Transit Duration	3.7031	1.5214e+00	3.6228	1.4883e+00	hours	3.7717e-02
Transit Ingress Duration	0.0708	1.6692e+00	0.0711	1.6433e+00	hours	1.1973e-04
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)	1869.4 (2303.4)		1869.4 (2303.4)			

DoF: Degrees of Freedom



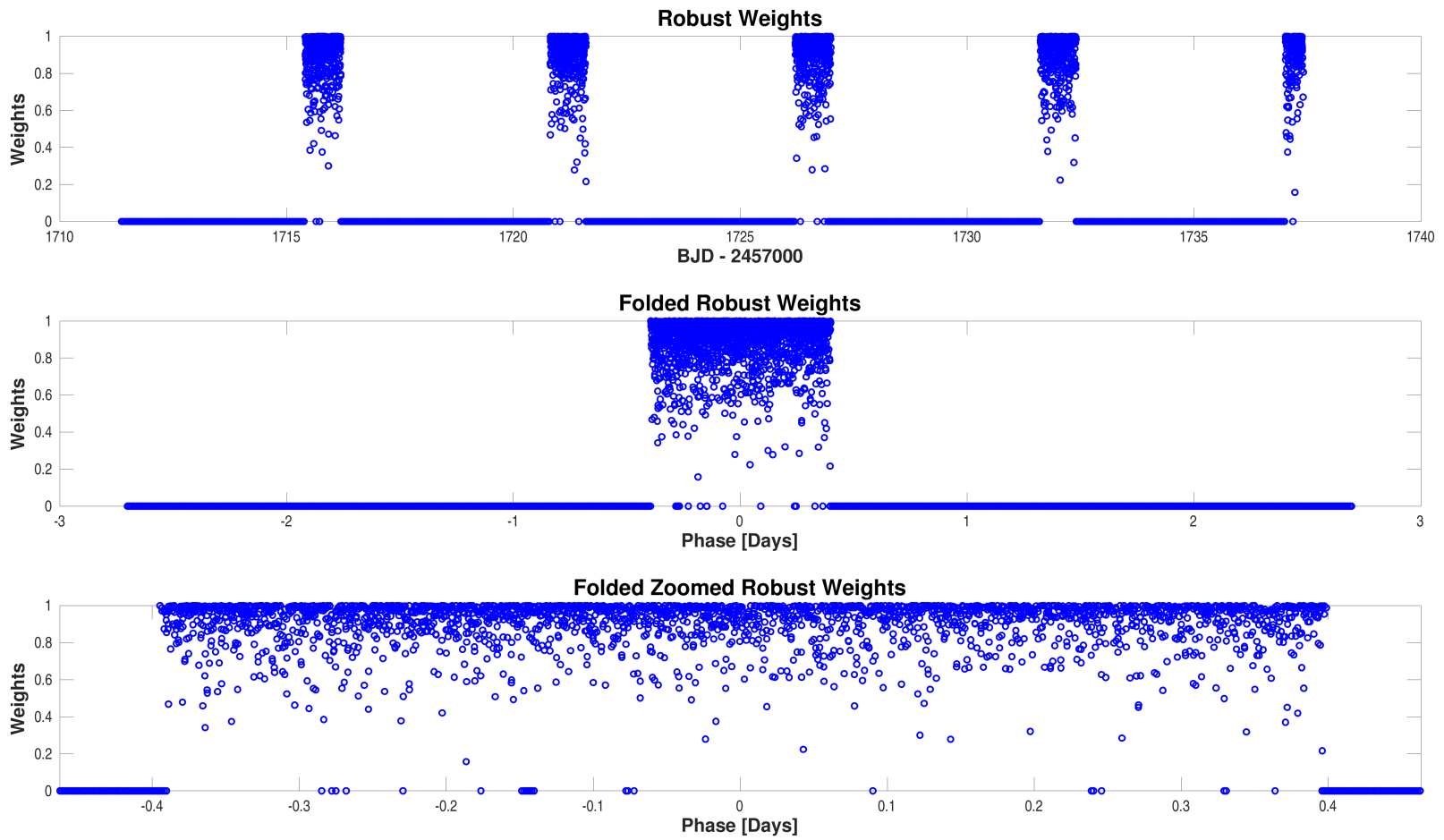
Folded flux time series for CatId 417676622, Planet candidate 1 in the whitened domain is plotted in black dots. Values are averaged into 1 cadence wide bins. The blue dots represent the averaged values of the folded flux time series; the red dots represent the averaged values of the folded model light 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/0000000417676622-01-odd-even-whitened.fig`



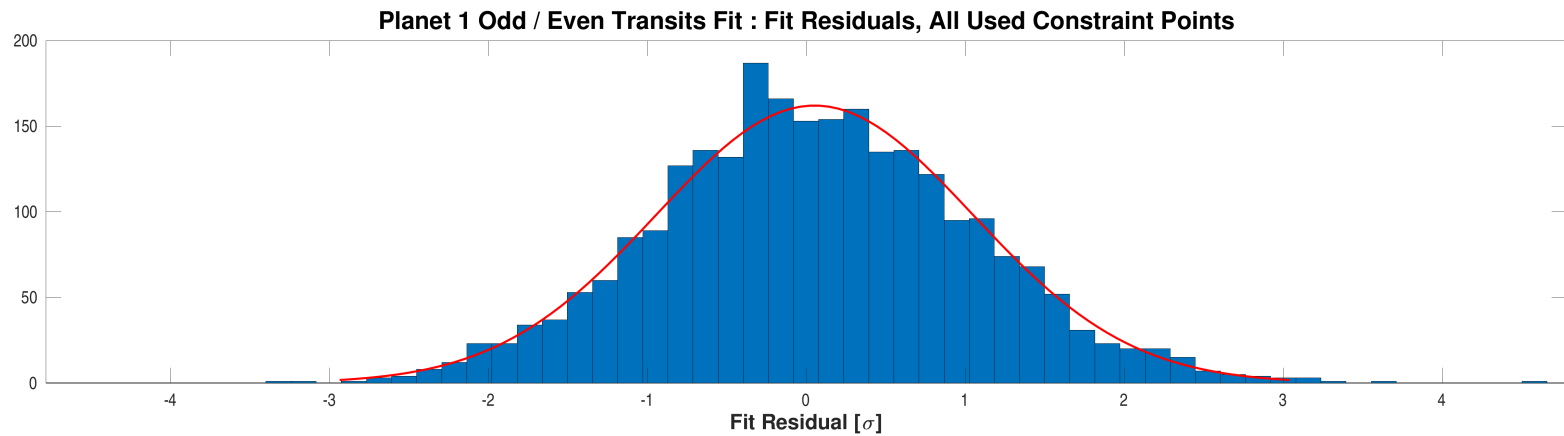
Folded flux time series for CatId 417676622, Planet candidate 1 in the whitened domain, zoomed on the transit. The flux data whose robust weights are larger/smaller than 0.1 are plotted in dark green/cyan dots, respectively. Values are averaged into 1 cadence wide bins. The blue dots represent the averaged 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/0000000417676622-01-odd-even-whitened-zoomed.fig`



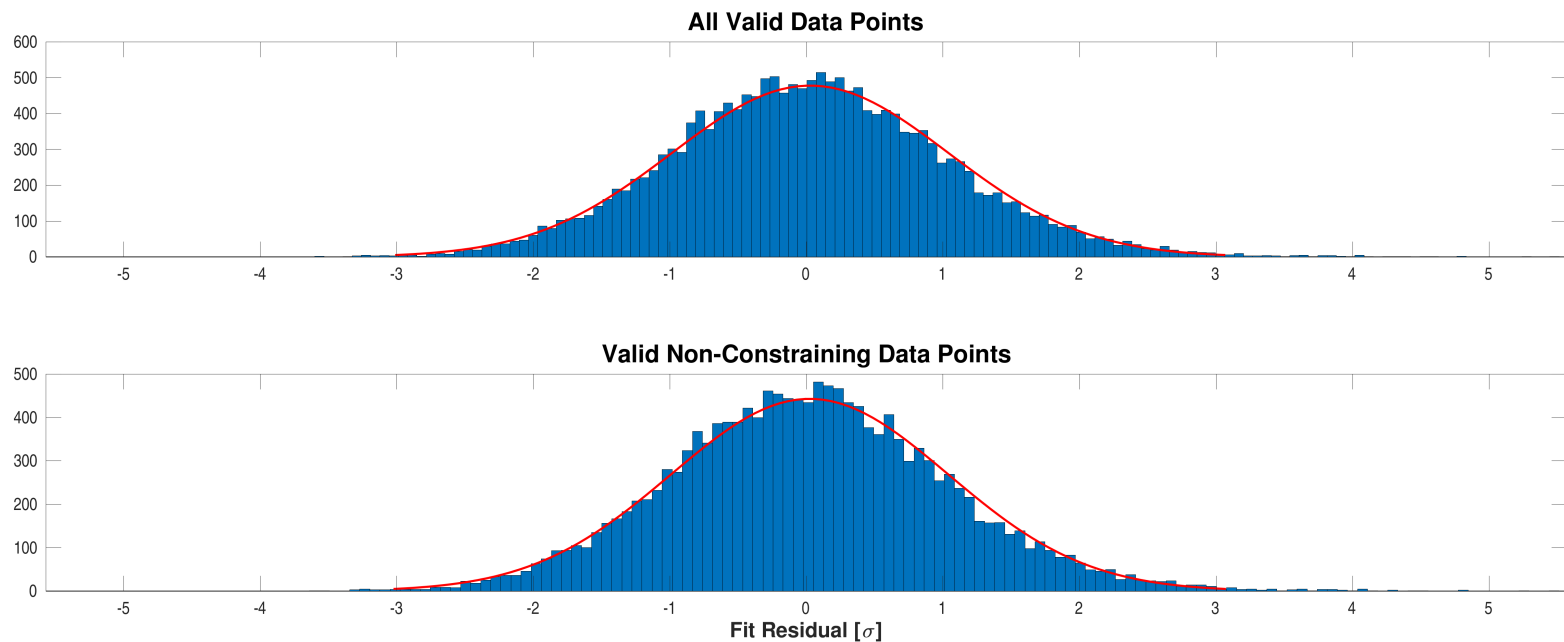
Robust weights distribution for CatId 417676622, Planet candidate 1. Top plot: all data points. Middle plot: all data points, folded per the fitted period and epoch. Bottom plot: all data points, folded and zoomed.

Open `./planet-01/planet-search-and-model-fitting-results/odd-even-transits-fit/0000000417676622-01-odd-even-robust-weights.fig`



Fit residuals distribution for CatId 417676622, 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.

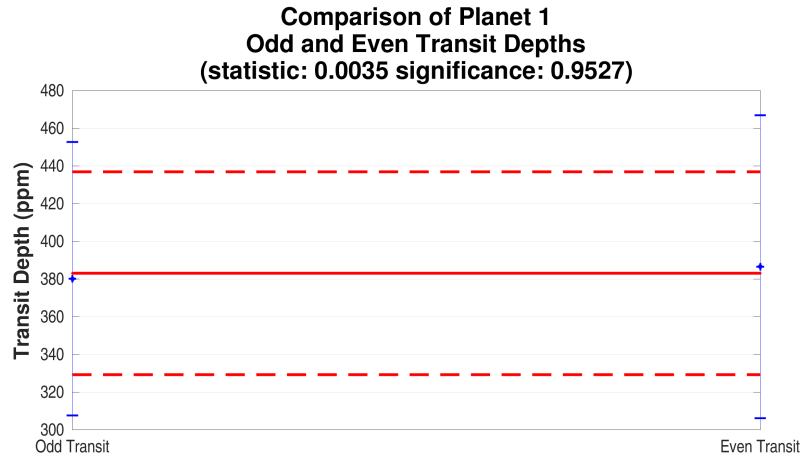
Open `./planet-01/planet-search-and-model-fitting-results/odd-even-transits-fit/0000000417676622-01-odd-even-histo-used.fig`



Fit residuals distribution for CatId 417676622, 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/0000000417676622-01-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 417676622, planet 1. A significance level close to 1/0 favors a transiting planet/an eclipsing binary. Open `./planet-01/binary-discrimination-test-results/0000000417676622-01-eclipsing-binary-discrimination-tests.fig`

## Appendix B Alerts

This target did not trigger any alerts.