Data Validation (DV) Report
for TESS ID 28230919
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 11:05:53 Z

Contents

1 Summary

Target Properties	Value	Uncertainty	Units	Provenance
Catalog ID	28230919			
TOI ID	1144			
TESS Name	-			
RA	297.70936440	0	degrees	TIC8
Dec	48.08086038	0	degrees	TIC8
Magnitude	8.5077	0.006		TIC8
Radius	0.760	0.048	Solar radii	TIC8
Effective Temperature	4778	113	Kelvin	TIC8
log(g)	4.563	0.086511	cm/sec^2	TIC8
[M/H]	0.300	0.05268	Solar metallicity	TIC8
Stellar Density	1.755	0.367	Solar density	TIC8-Derived
Limb Darkening Coefficient 1	0.74654			
Limb Darkening Coefficient 2	-0.70802			
Limb Darkening Coefficient 3	1.2035			
Limb Darkening Coefficient 4	-0.48308			
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 11:05:53 Z			

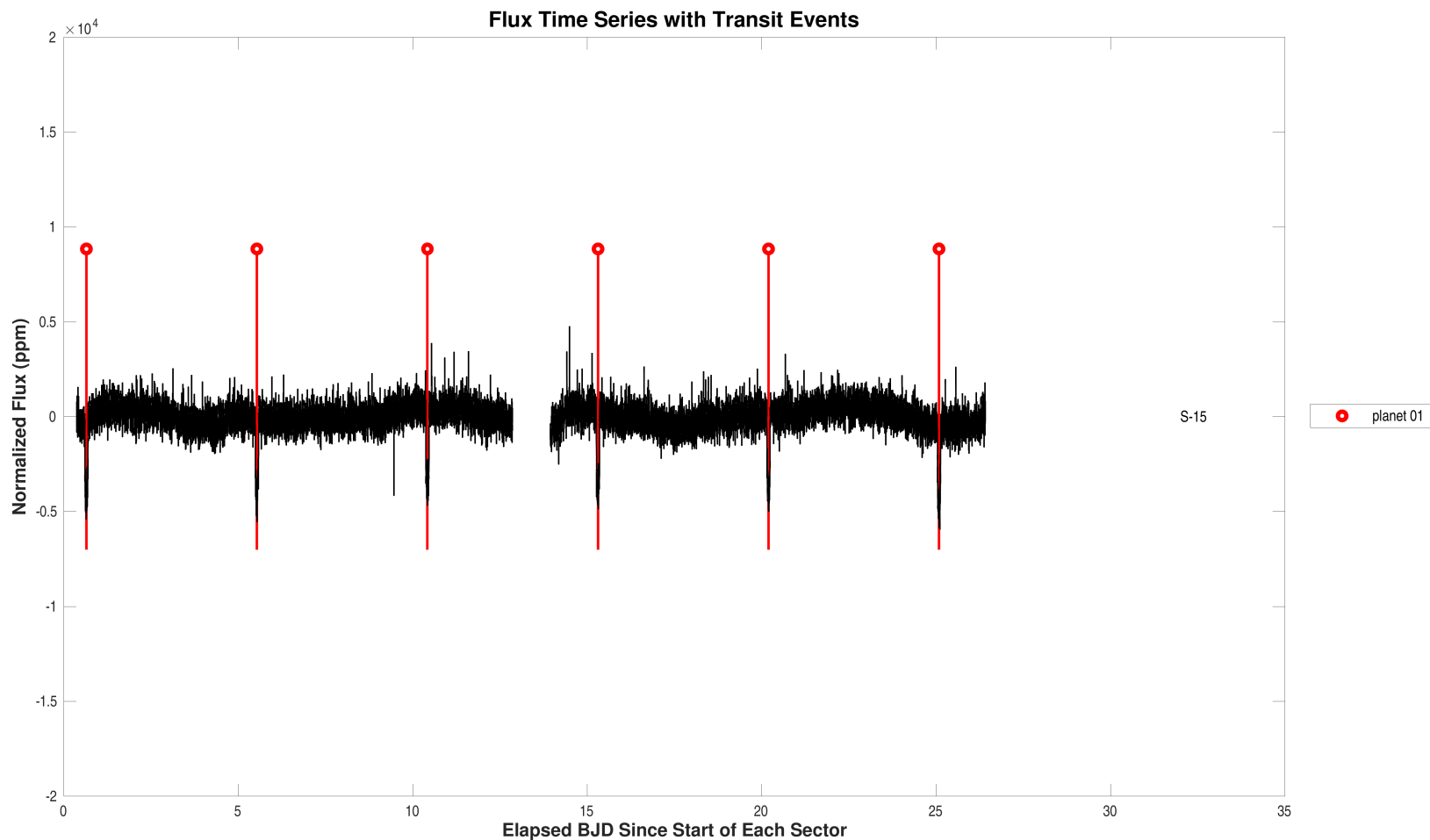| Sector	Target Table	Camera/ CCD	Crowding Metric	Flux Fraction
15	169	2:3	0.9823	0.8793

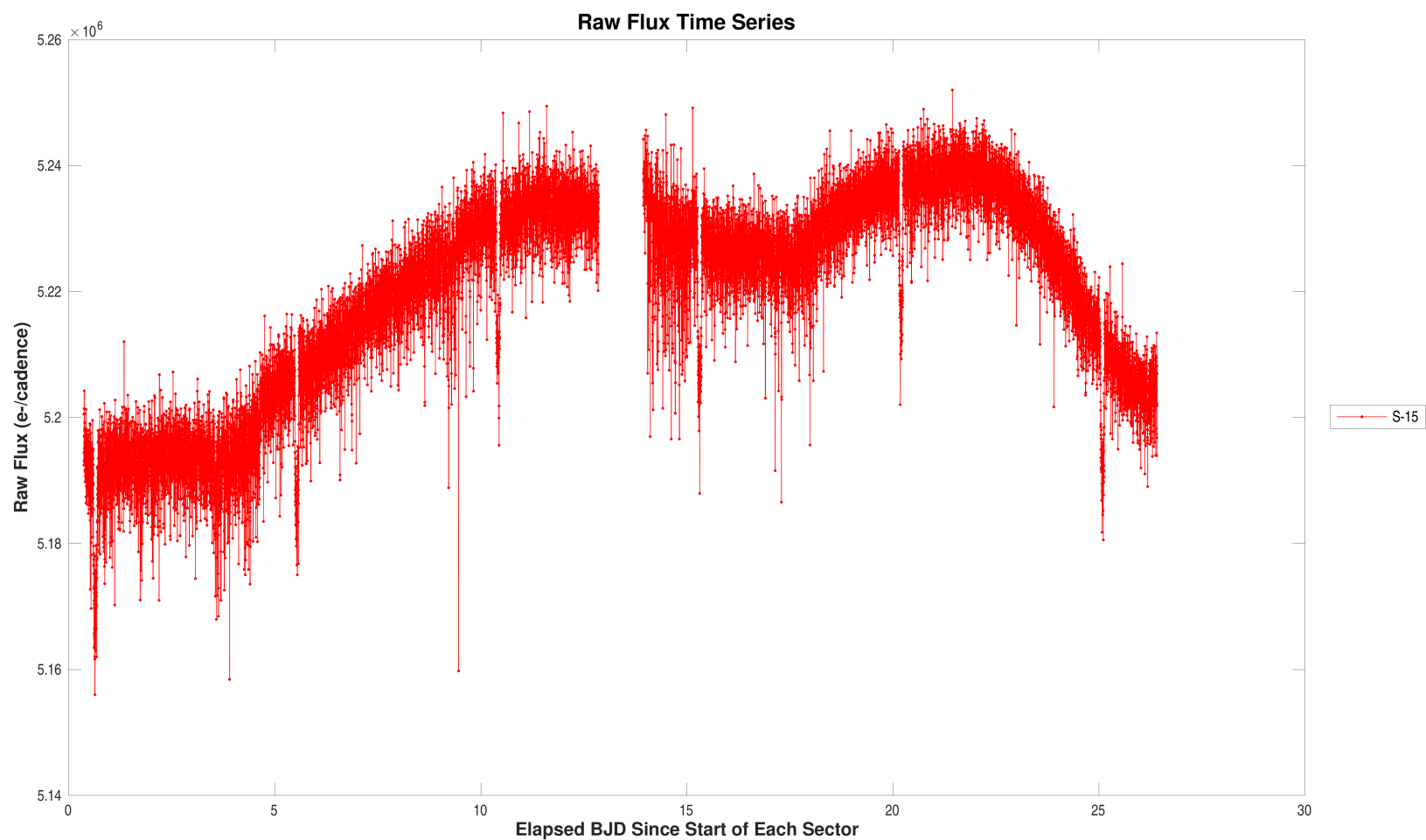| Planet Candidate	TOI ID	TESS Name	TOI Correlation	Period (days)	Period Ratio	Epoch (BTJD)	Semi-major Axis (AU)	Radius (Re)	Seff	Teq (K)	False Alarm	Suspected EB
1	1144.01	-	0.95	4.888	1.00	1711.646	0.05	4.9	100.9	808	0.00e+00	false

2   Survey Image

Digitized Sky Survey (DSS) red image. The 5' x 5' image is centered on the J2000 coordinates of target (28230919).

3 Flux Time Series

Summary plot of sector-stitched flux time series and transits for target 28230919, 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/0000000028230919-00-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/0000000028230919-00-raw-flux-15-169.fig`

4   Dashboards

Planet Candidate 1

Model Fitter	**Stellar Radius** 0.8 ± 0.0 Solar units	**Core Aperture Correlation Statistic** Value = 37.45 Significance = 100.00% **Halo Aperture Correlation Statistic** Value = 15.90 Significance = 100.00% **Core/Halo Ratio** Ratio = 2.36	Ghost Diagnostic Test
	Period = 4.9 ± 0.0 days Depth = 4252 ± 46 ppm Planet Radius = 4.9 ± 0.4 Earth radii Semi-major Axis = 0.1 ± 0.0 AU Effective Stellar Flux = 100.9 ± 17.0 Equilibrium Temperature = 808 ± 34 Kelvin Chi-squared/DoF = 0.8 SNR = 93.2		

Eclipsing Binary Discrimination Test	**Odd-Even Depth Comparison Statistic** Value = 1.14e-01 Significance = 73.56%		**Offsets Relative to Out of Transit Centroid** Source RA Offset = -8.45e-01 ± 2.50e+00 arcsec (-0.34 σ) Source Dec Offset = 2.23e+00 ± 2.50e+00 arcsec (0.89 σ) Source Offset Distance = 2.39e+00 ± 2.50e+00 arcsec (0.95 σ) **Offsets Relative to TIC Position** Source RA Offset = -8.13e-01 ± 2.50e+00 arcsec (-0.32 σ) Source Dec Offset = 3.08e+00 ± 2.50e+00 arcsec (1.23 σ) Source Offset Distance = 3.19e+00 ± 2.50e+00 arcsec (1.27 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 = 6 Max Multiple Event Statistic = 78.8	Bootstrap Test

Summary of model fitter results and validation test results for target 28230919, 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
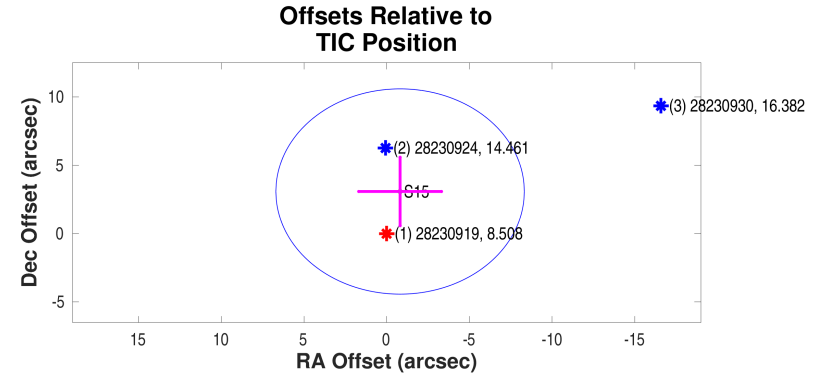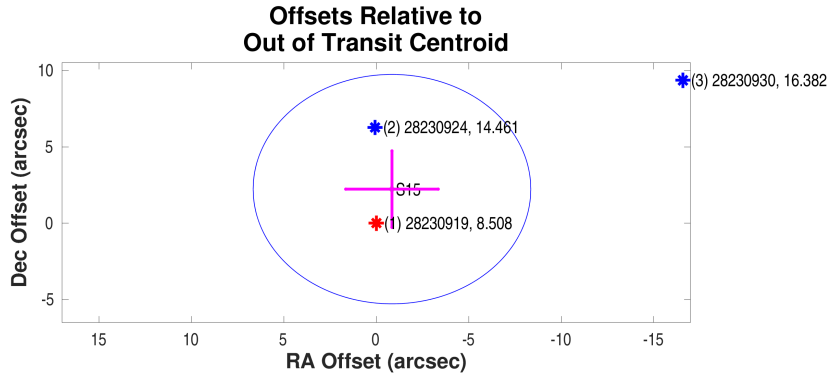
Multi-Sector Average PRF Fit of the Difference Images

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

	RA	Dec	Units
Offset	$-0.8451 \pm 2.50e + 00$	$2.2304 \pm 2.50e + 00$	arcseconds
Offset/σ	-0.34	0.89	
Offset Distance	$2.3851 \pm 2.50e + 00$		arcseconds
Offset Distance/σ	0.95		
3σ Radius	7.5106		arcseconds

Mean offset from the TIC RA and Dec

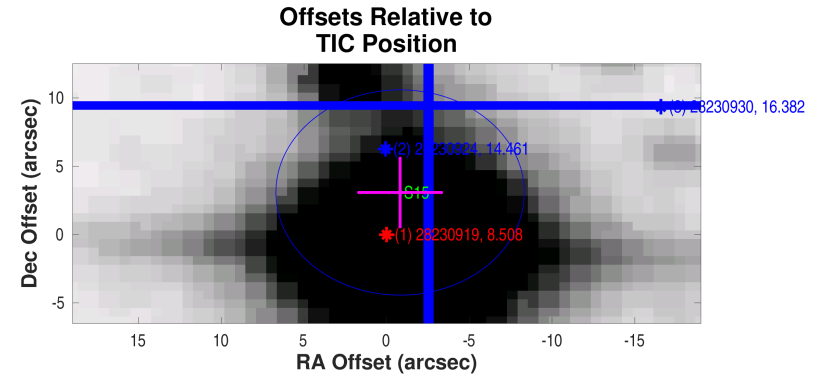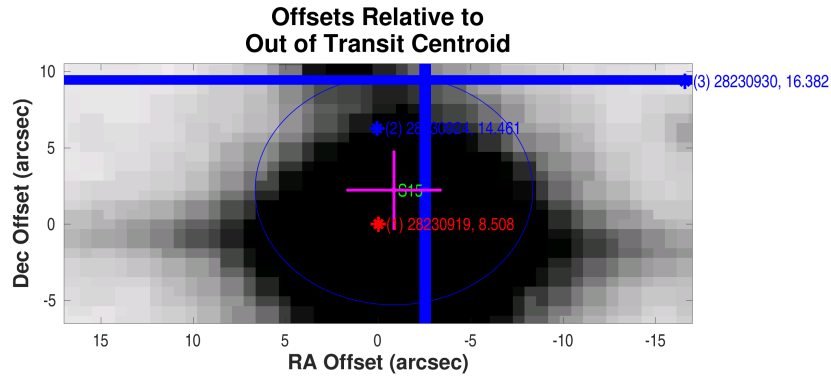|	RA	Dec	Units
Offset	$-0.8126 \pm 2.50e + 00$	$3.0849 \pm 2.50e + 00$	arcseconds
Offset/σ	-0.32	1.23	
Offset Distance	$3.1902 \pm 2.50e + 00$		arcseconds
Offset Distance/σ	1.27		
3σ Radius	7.5110		arcseconds

Planet Candidate 1

Difference image centroid offsets for target 28230919, 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/0000000028230919-01-difference-image-centroid-offsets.fig`
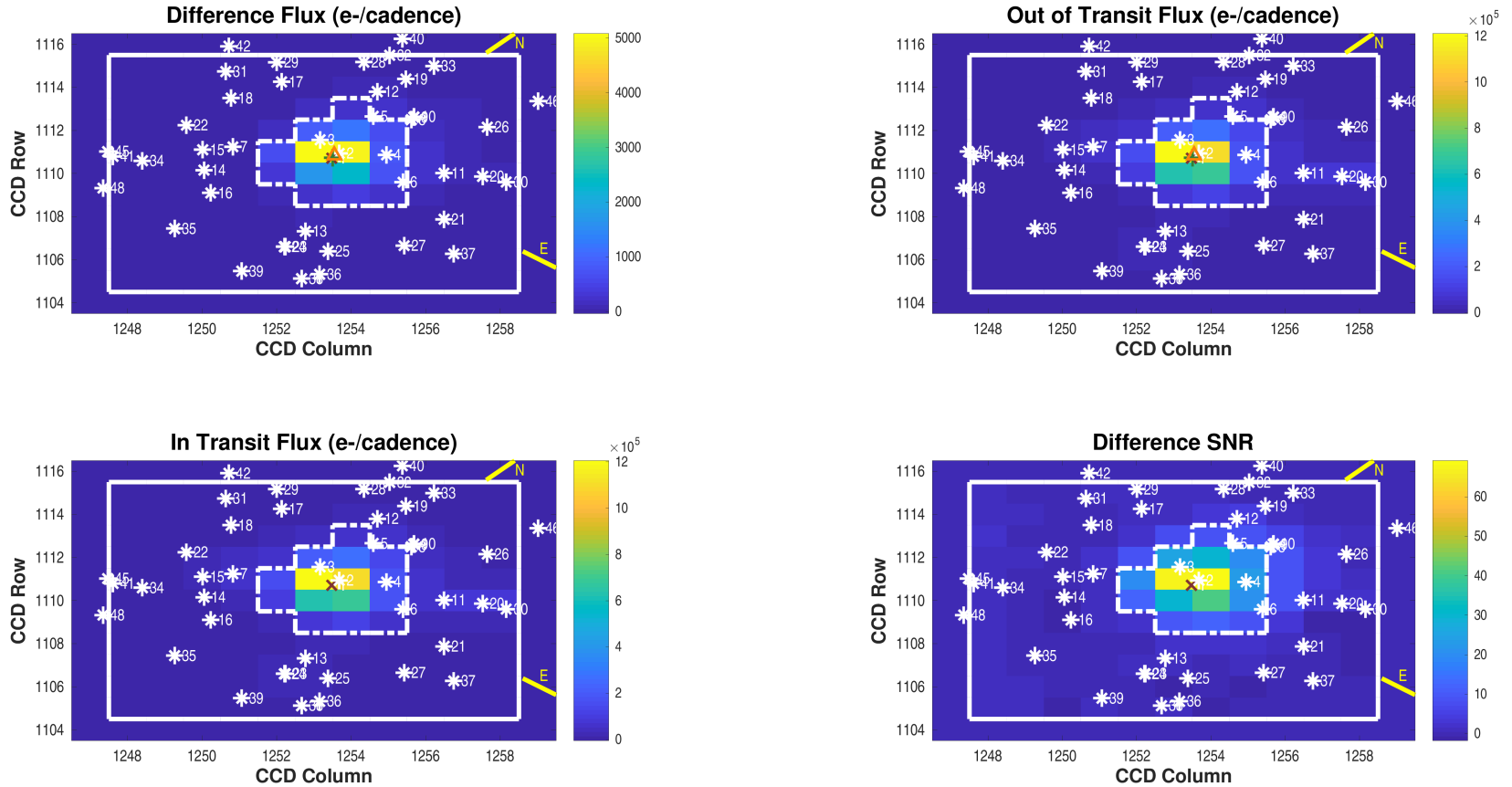
Planet Candidate 1

Difference image centroid offsets for target 28230919, 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/0000000028230919-01-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 28230919, 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 = 6; number of valid in-transit cadences = 330; number of in-transit cadence gaps = 3; number of valid out-of-transit cadences = 897; number of out-of-transit cadence gaps = 3. Difference image quality metric = 1.00 (good).
Open `./planet-01/difference-image/0000000028230919-01-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	$1110.74 \pm 1.43e-05$	$1253.51 \pm 1.37e-05$	pixels	$297.71040754 \pm 6.09e-07$	$48.08236987 \pm 5.96e-07$	degrees
Difference Image Centroid	$1110.85 \pm 7.06e-03$	$1253.55 \pm 6.62e-03$	pixels	$297.71005614 \pm 4.00e-05$	$48.08298942 \pm 3.82e-05$	degrees
Offset	$0.1091 \pm 7.06e-03$	$0.0393 \pm 6.62e-03$	pixels	$-0.8451 \pm 9.62e-02$	$2.2304 \pm 1.38e-01$	arcseconds
Offset/σ	15.46	5.94		-8.78	16.21	
Offset Distance	$0.1160 \pm 6.94e-03$		pixels	$2.3851 \pm 1.35e-01$		arcseconds
Offset Distance/σ	16.71			17.61		

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

	Row	Column	Units	RA	Dec	Units
TIC Reference Centroid	$1110.71 \pm 1.05e-04$	$1253.48 \pm 1.04e-04$	pixels	$297.71039403 \pm 0.00e+00$	$48.08213250 \pm 0.00e+00$	degrees
Difference Image Centroid	$1110.85 \pm 7.06e-03$	$1253.55 \pm 6.62e-03$	pixels	$297.71005614 \pm 4.00e-05$	$48.08298942 \pm 3.82e-05$	degrees
Offset	$0.1399 \pm 7.06e-03$	$0.0674 \pm 6.62e-03$	pixels	$-0.8126 \pm 9.62e-02$	$3.0849 \pm 1.38e-01$	arcseconds
Offset/σ	19.82	10.18		-8.45	22.42	
Offset Distance	$0.1553 \pm 6.89e-03$		pixels	$3.1902 \pm 1.37e-01$		arcseconds
Offset Distance/σ	22.52			23.29		

5.2 Difference Image TIC Key

Index	Catalog ID	Mag	RA (degrees)	Dec (degrees)	Distance (arcsec)
1	28230919	8.508	297.71039403	48.08213250	0.00
2	28230924	14.461	297.71042281	48.08387398	6.27
3	28230930	16.382	297.70349700	48.08473118	19.04
4	28230935	16.028	297.71927055	48.08821983	30.59
5	28230950	15.888	297.70683673	48.09472406	46.13
6	28230926	14.519	297.72929436	48.08432615	46.14
7	28230906	12.164	297.68980328	48.07472075	56.25
8	1881918644	15.465	297.71450206	48.09778996	57.23
9	28230962	14.250	297.71430000	48.09853700	59.80
10	1881918645	15.282	297.71420742	48.09863435	60.11
11	28230941	16.147	297.73424508	48.09019138	64.28
12	28230969	14.972	297.70111410	48.10010332	68.44
13	28230891	16.289	297.72471426	48.06477354	71.35
14	28230896	14.128	297.69074471	48.06714542	71.72
15	28230901	14.623	297.68519071	48.07113501	72.40
16	28230889	15.959	297.69786765	48.06321760	74.46
17	28230946	14.739	297.68153617	48.09264180	79.05
18	28230927	15.030	297.67677050	48.08436603	81.26
19	28230982	15.197	297.70293828	48.10546956	85.91
20	28230947	11.649	297.74198555	48.09334278	86.03
21	28230920	15.120	297.74627603	48.08088157	86.41
22	28230905	15.784	297.67589255	48.07448004	87.43
23	28230875	13.373	297.72515400	48.05969200	88.24
24	10000766665	12.607	297.72500600	48.05959700	88.41
25	28230887	16.251	297.73394004	48.06298790	89.20
26	28230977	15.758	297.72993896	48.10376731	90.97
27	28230903	14.850	297.74603310	48.07160352	93.72
28	28230980	16.130	297.69102568	48.10475683	93.83
29	28230954	15.588	297.67555025	48.09614443	97.81
30	28230948	14.762	297.74763000	48.09452744	100.05
31	28230939	16.121	297.66887889	48.08922195	103.06
32	28230988	15.823	297.69383181	48.10866326	103.48
33	28230992	15.676	297.70450675	48.11087687	104.44
34	28230886	15.836	297.67733087	48.06296910	105.27
35	28230861	14.596	297.70076153	48.05244308	109.36
36	28230870	15.283	297.73843558	48.05750815	111.39
37	28230907	16.406	297.75698715	48.07484339	115.09
38	28230867	16.427	297.73636335	48.05484751	116.40

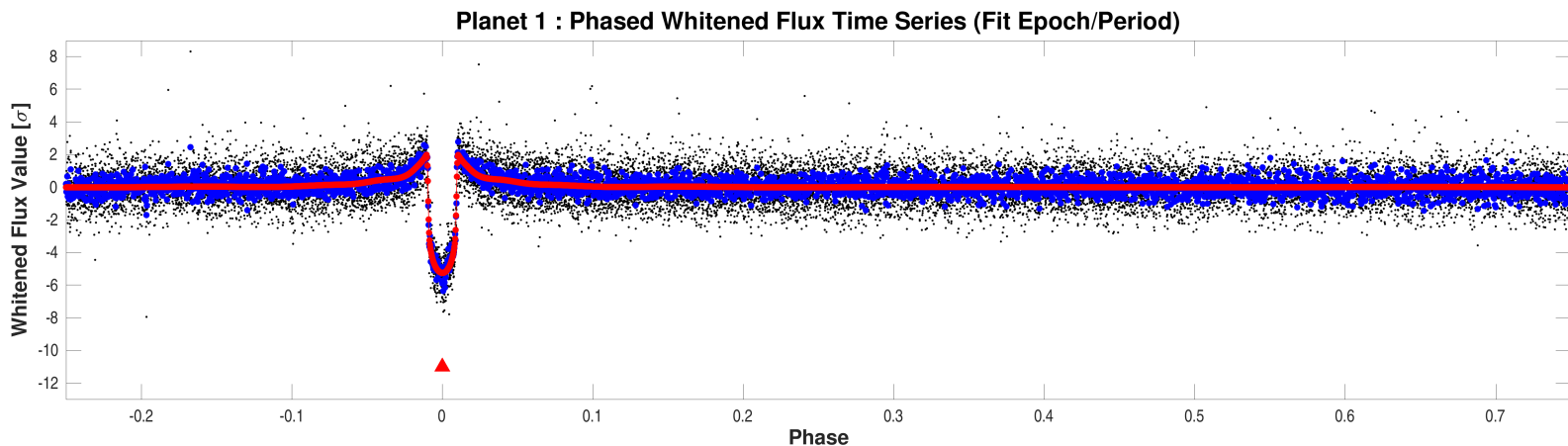| Index	Catalog ID	Mag	RA (degrees)	Dec (degrees)	Distance (arcsec)
39	28230858	14.557	297.72376716	48.05046215	118.46
40	28230998	15.532	297.69180059	48.11325402	120.63
41	28230879	16.235	297.67099374	48.06093112	121.67
42	28230949	15.180	297.66284620	48.09463437	122.89
43	28230991	13.333	297.67919856	48.10958730	124.09
44	1881921589	15.524	297.67919956	48.10980748	124.72
45	28230880	13.453	297.66878325	48.06141529	124.81
46	28231001	15.580	297.73225641	48.11402819	126.29
47	28230989	14.289	297.74600860	48.10879006	128.63
48	28230863	14.122	297.67747163	48.05357525	129.76
49	28230966	15.952	297.75981861	48.09976120	134.75
50	28230994	12.717	297.74589504	48.11118650	135.02
51	28230974	15.626	297.75864115	48.10258501	137.42
52	28230857	14.743	297.67087066	48.04986900	150.09
53	28230985	16.026	297.75993410	48.10825017	151.78
54	28231003	12.076	297.66864927	48.11500188	155.18
55	28230999	16.319	297.66436424	48.11364178	158.50

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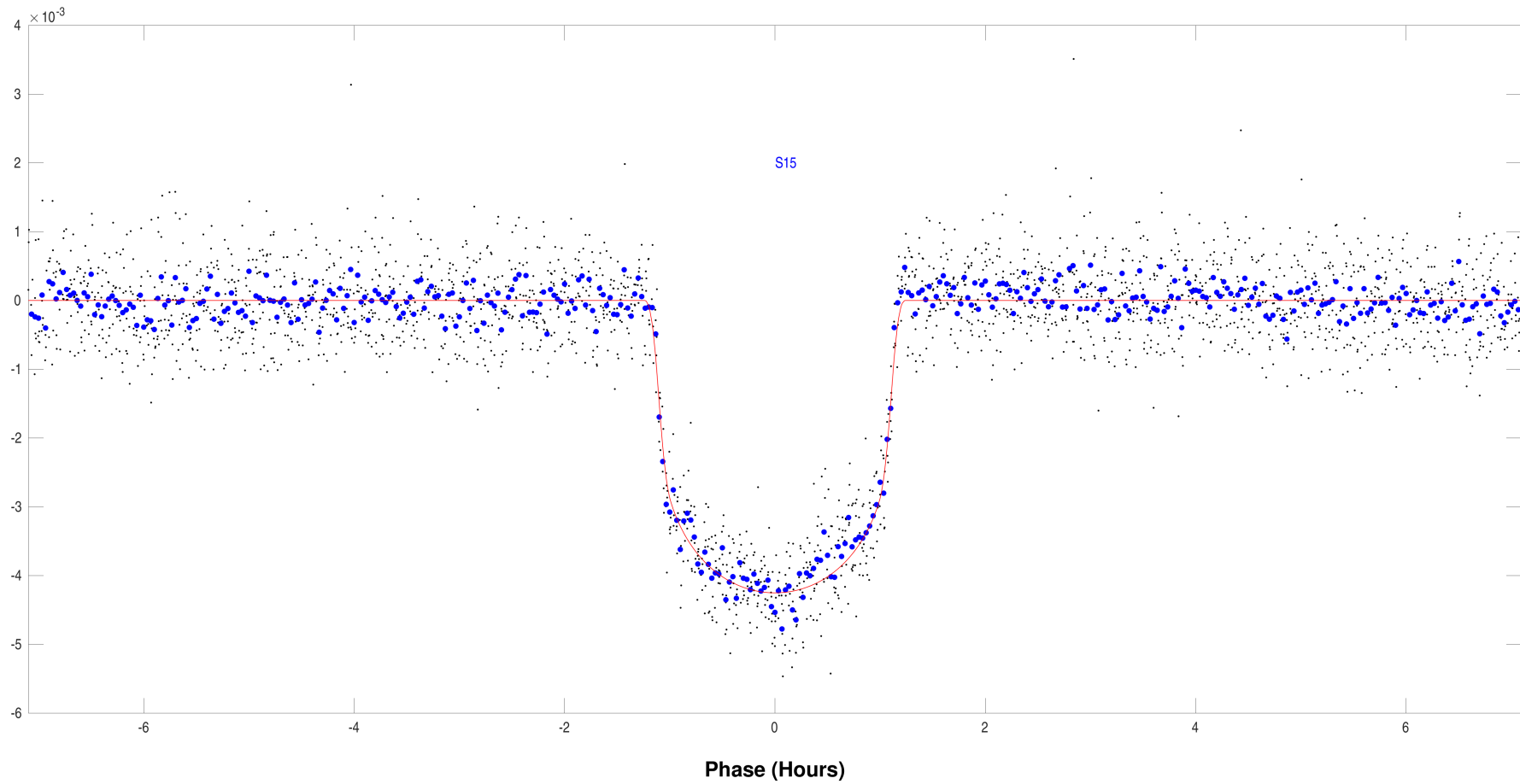
6   Phased Light Curves

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/0000000028230919-01-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/0000000028230919-01-phased-whitened-flux-time-series.fig`

Planet: 1   Phased Unwhitened Flux Time Series by Sector

S15

Phase (Hours)

Phased unwhitened flux time series by sector for target 28230919, planet candidate 1. Period = 4.8876 days; transit epoch = 1711.646 BTJD.
Open `./summary-plots/0000000028230919-01-phased-unwhitened-flux-time-series-by-sector.fig`
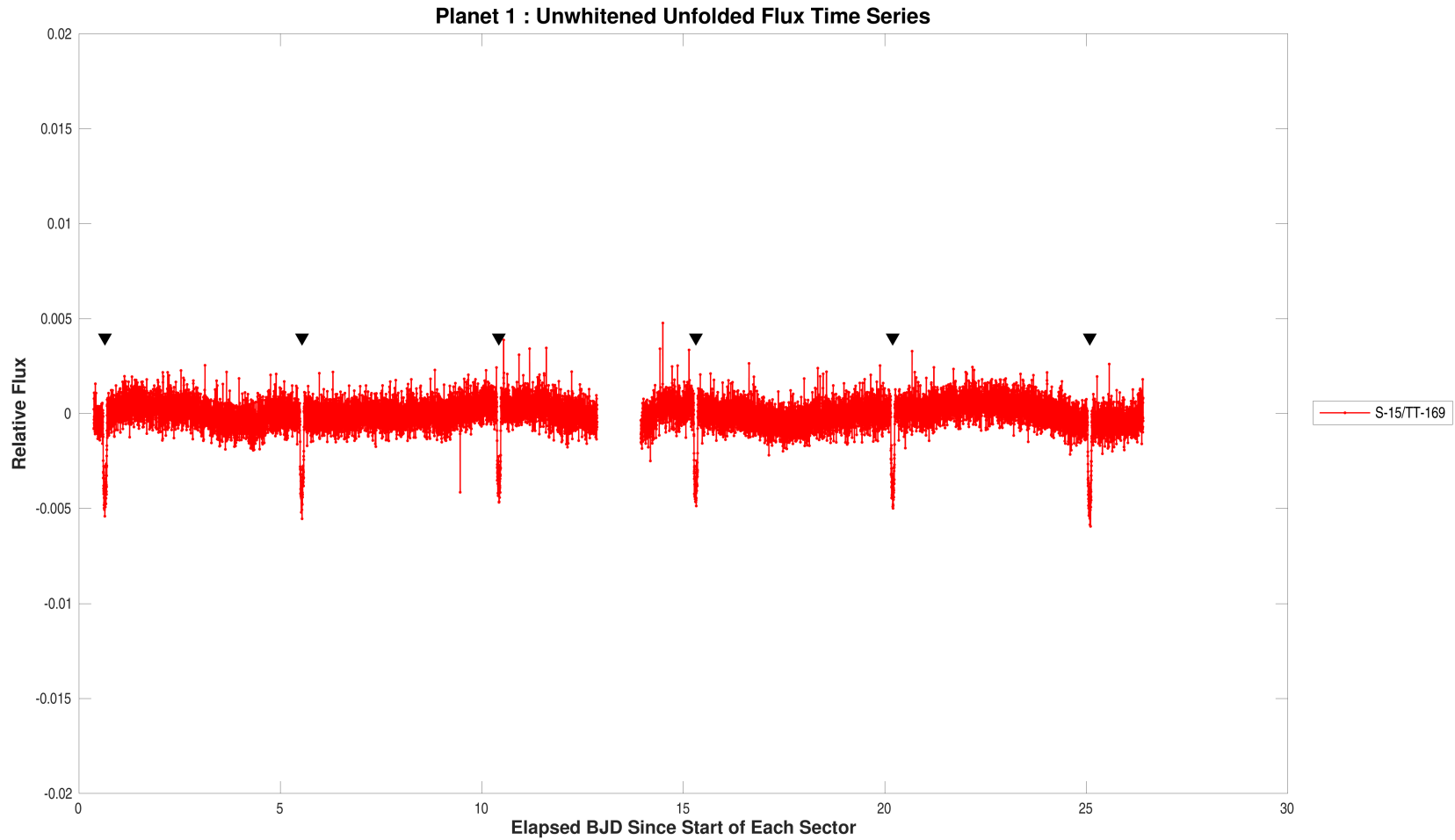
7 Planet Candidate 1

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

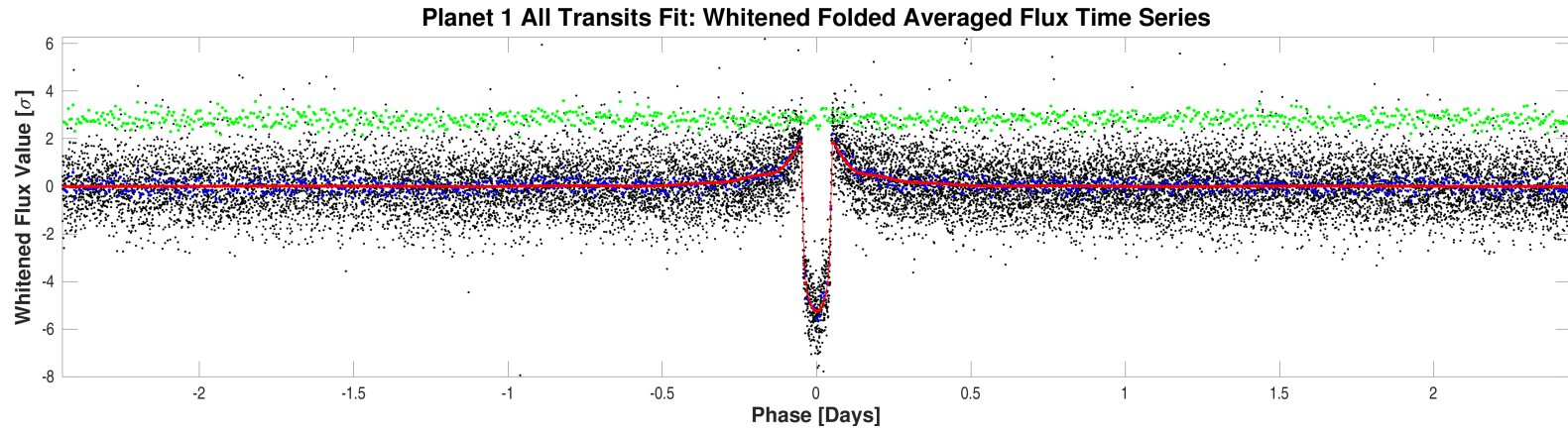| TCE Parameter	Value	Units
Trial Transit Pulse Duration	2.5	hours
Transit Epoch	1711.6441905	TJD
Orbital Period	4.8874979	days
Maximum SES	40.1	
Maximum MES	78.8	
Robust Statistic	74.0	
Chi Square Goodness of Fit Statistic (DoF)	1056.0 (371)	
Chi Square2 Statistic (DoF)	176.0 (456.7)	
Threshold for Desired PFA		

DoF: Degrees of Freedom

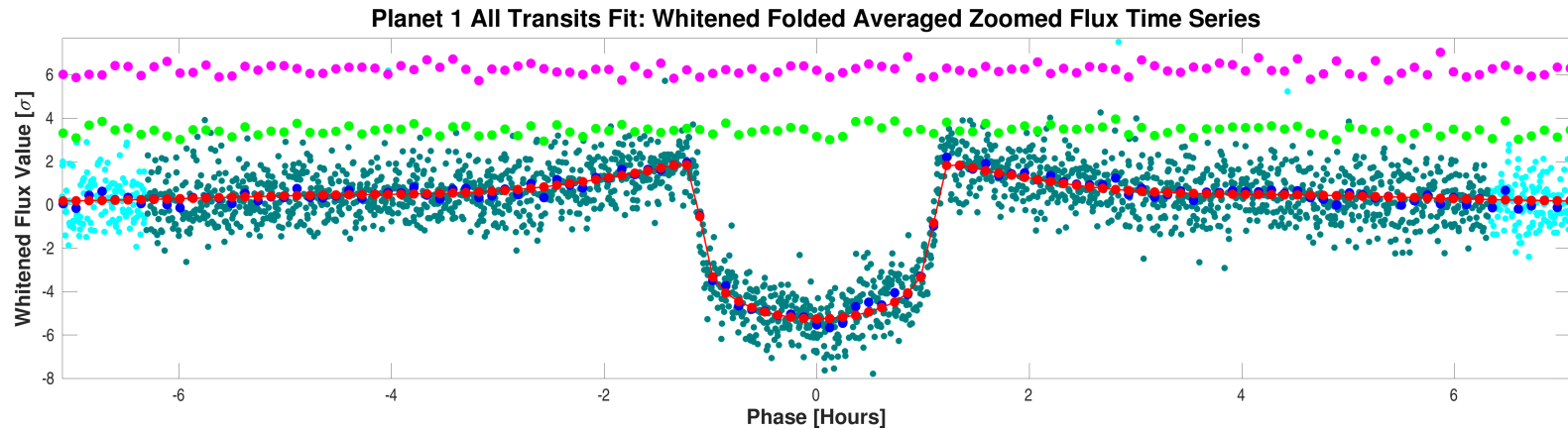| Parameter	Value	Uncertainty	Units
SNR	93.2		
Orbital Period	4.8875798	1.0675e-04	days
Transit Epoch	1711.6460460	3.2573e-04	BTJD
Impact Parameter	0.0512	3.2972e+00	
Planet Radius to Star Radius Ratio	0.0588152	2.5501e-03	
Semi-major Axis to Star Radius Ratio	16.7052	2.7807e+00	
Planet Radius	4.8789	3.7536e-01	Earth radii
Semi-major Axis	0.0517	4.0714e-03	AU
Effective Stellar Flux	100.8706	1.6987e+01	Goldilocks
Equilibrium Temperature	808	3.4030e+01	Kelvin
Stellar Density	2.6218	1.3093e+00	Solar density
Transit Depth	4252	4.5779e+01	ppm
Transit Duration	2.3654	4.4868e-02	hours
Transit Ingress Duration	0.1319	5.0100e-02	hours
Eccentricity	0.0000	0.0000e+00	
Peri Longitude	0.0000	0.0000e+00	degrees
Model Chi Square Statistic (DoF)	1730.0 (2065.5)		
Model Chi Square Goodness of Fit Statistic (DoF)	259.6 (446)		
Model Chi Square2 Statistic (DoF)	3.1 (5)		

DoF: Degrees of Freedom

Flux time series for CatId 28230919, 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/0000000028230919-01-all-unwhitened-15-169.fig`

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

Folded flux time series for CatId 28230919, 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/0000000028230919-01-all-whitened.fig`

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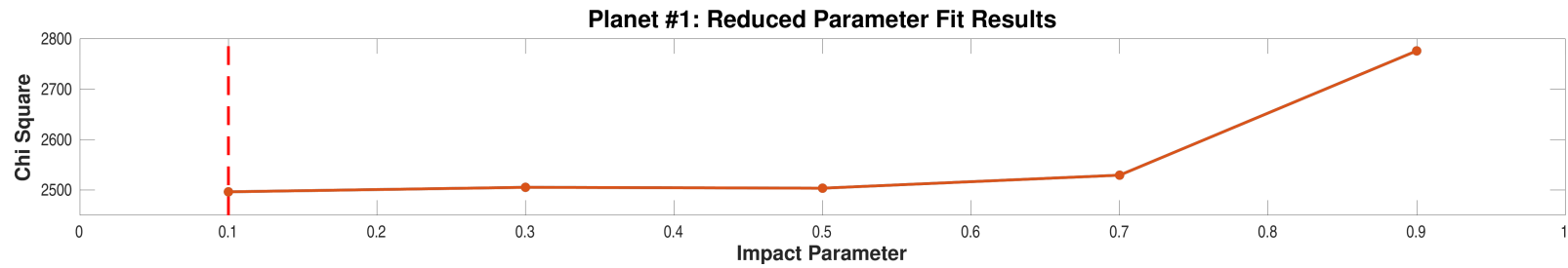

Folded flux time series for CatId 28230919, Planet candidate 1 in the whitened domain, zoomed on the transit. The flux data whose robust weights are larger/smaller than 0.1 are plotted in dark green/cyan dots, respectively. Values are averaged into 1 cadence wide bins. The blue dots represent the averaged 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/0000000028230919-01-all-whitened-zoomed.fig`

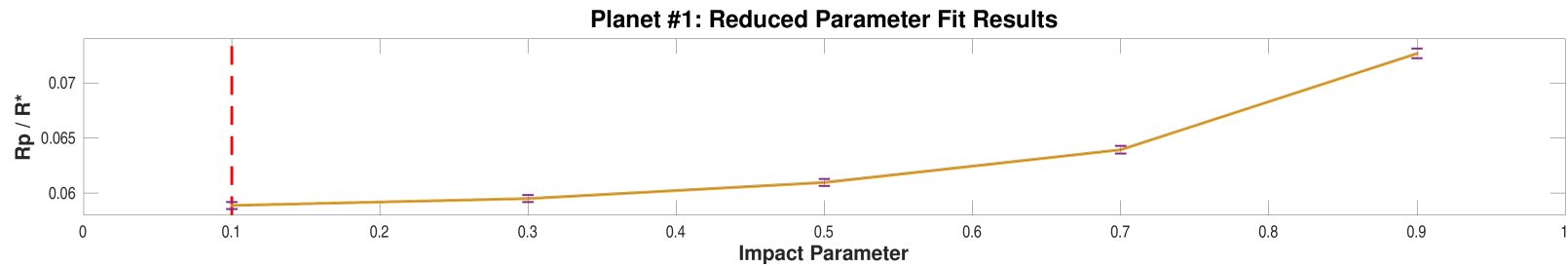## 7.2   Model Fitter: Reduced Parameter Fit Results

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	97.2	2496.5	0.0588845	3.0954e-04	16.6438	6.7929e-02	4254	4.4482e+01	2.3665	9.6499e-03
0.30	97.1	2505.4	0.0595124	3.1414e-04	15.9681	6.6067e-02	4254	4.4657e+01	2.3781	9.8353e-03
0.50	96.9	2503.6	0.0609684	3.2290e-04	14.5228	6.2621e-02	4252	4.4778e+01	2.4090	1.0393e-02
0.70	97.1	2529.4	0.0639356	3.4184e-04	12.0403	5.8307e-02	4250	4.5151e+01	2.4908	1.2100e-02
0.90	94.8	2775.8	0.0726568	4.4098e-04	7.7124	6.0322e-02	4369	5.2153e+01	2.8477	2.2429e-02

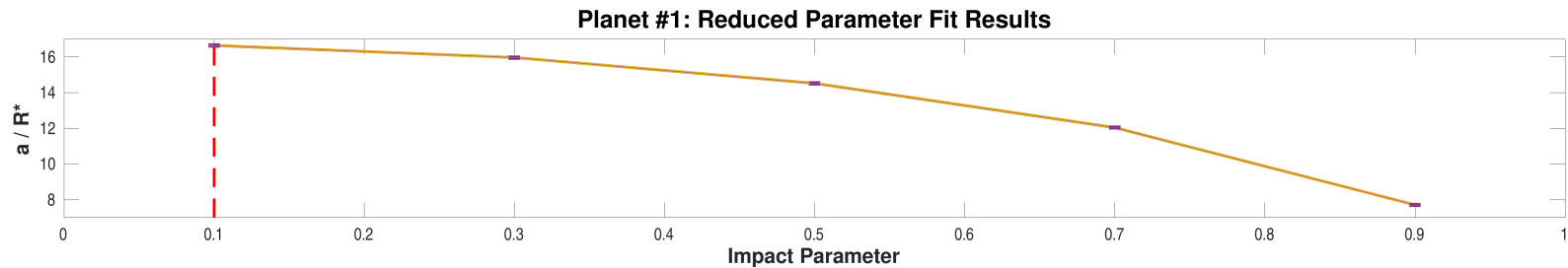Highlighted row is the best reduced-parameter model fit.

Model chi squares of reduced parameter fits vs. impact parameter for CatId 28230919, 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/0000000028230919-01-reduced-fits-chi-square.fig

Ratios of planet radius to star radius of reduced parameter fits vs. impact parameter for CatId 28230919, 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/0000000028230919-01-reduced-fits-rp-over-rstar.fig

Ratios of semimajor axis to star radius of reduced parameter fits vs. impact parameter for CatId 28230919, 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/0000000028230919-01-reduced-fits-a-over-rstar.fig

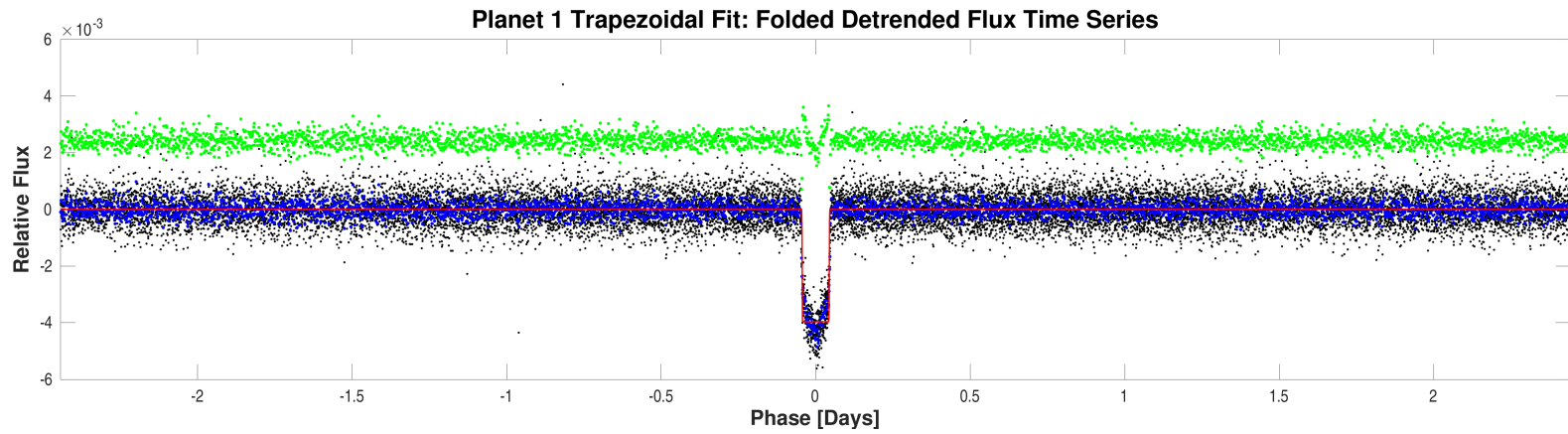## 7.3   Model Fitter: Trapezoidal Fit Results

Model Characteristic	Name
Transit Model	trapezoidal_model
Limb Darkening Model	

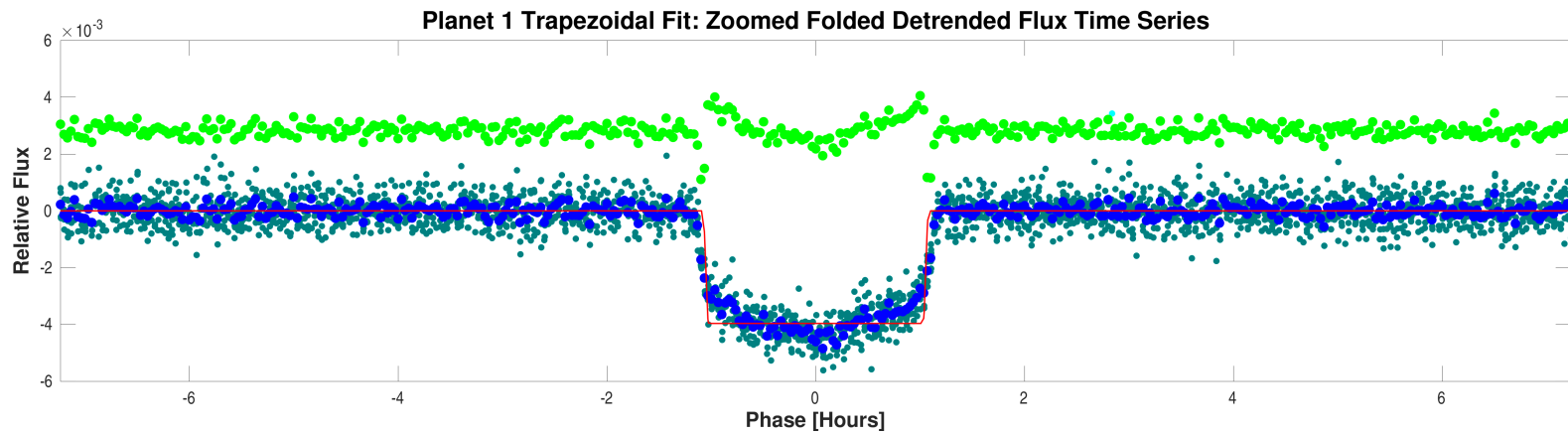| TCE Parameter	Value	Units
Trial Transit Pulse Duration	2.5	hours
Transit Epoch	1711.6441905	TJD
Orbital Period	4.8874979	days
Maximum SES	40.1	
Maximum MES	78.8	
Robust Statistic	74.0	
Chi Square Goodness of Fit Statistic (DoF)	1056.0 (371)	
Chi Square2 Statistic (DoF)	176.0 (456.7)	
Threshold for Desired PFA		

DoF: Degrees of Freedom

Parameter	Value	Uncertainty	Units
SNR	138.4		
Orbital Period	4.8874979		days
Transit Epoch	1711.6462721		BTJD
Transit Depth	3965		ppm
Transit Duration	2.4113		hours
Transit Ingress Duration	0.3022		hours
Model Chi Square Statistic (DoF)	18696.2 (3471)		

DoF: Degrees of Freedom

Folded detrended flux time series for CatId 28230919, Planet candidate 1 and folded trapezoidal model light curve.
Open ./planet-01/planet-search-and-model-fitting-results/trapezoidal-model-fit/0000000028230919-01-all-trapezoidal.fig

Zoomed folded detrended flux time series for CatId 28230919, Planet candidate 1 and folded trapezoidal model light curve.
Open ./planet-01/planet-search-and-model-fitting-results/trapezoidal-model-fit/0000000028230919-01-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	4.8875		days		
Transit Duration	2.5		hours		
Maximum MES	78.8				
Secondary Phase	1.6333		days		
Secondary MES	2.3				
Minimum Phase	-0.80833		days		
Minimum MES	-2.6				
Median MES	-0.0				
MAD MES	0.59413				
Robust Statistic	1.9				
Secondary Depth	107.7	5.5737e+01	ppm		
Geometric Albedo	6.6	3.6106e+00		1.5643	5.89
Planet Effective Temperature	2007	2.6757e+02	Kelvin	4.4430	0.00

7.4.2   Eclipsing Binary Discrimination Test

Result	Value	Value in Sigmas	Significance (%)
Odd Even Transit Depth Comparison Statistic	1.1407e-01	0.3377	73.56

7.4.3   Bootstrap Test

Result	Value
False Alarm Probability	0.0000e+00
Bootstrap Threshold for Desired PFA	9.1
MES Mean	-1.52
MES Standard Deviation	1.50
Transit Count	6

7.4.4   Ghost Diagnostic Test

Result	Value	Significance (%)
Maximum MES	78.8	
SNR	93.2	
Core Aperture Statistic	3.7451e+01	100.00
Halo Aperture Statistic	1.5896e+01	100.00
Ratio of Core/Halo Aperture Statistics	2.3560e+00	

7.4.5 Validation Test Figures

Planet 1 : Secondary MES vs. Phase

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 2.5. The maximum secondary MES and corresponding phase are 2.2692 and 1.6333 days respectively. The minimum secondary MES and corresponding phase are -2.595 and -0.80833 days respectively.

Open `./planet-01/report-summary/0000000028230919-01-weak-secondary-diagnostic.fig`

Bootstrap Results for Planet 1
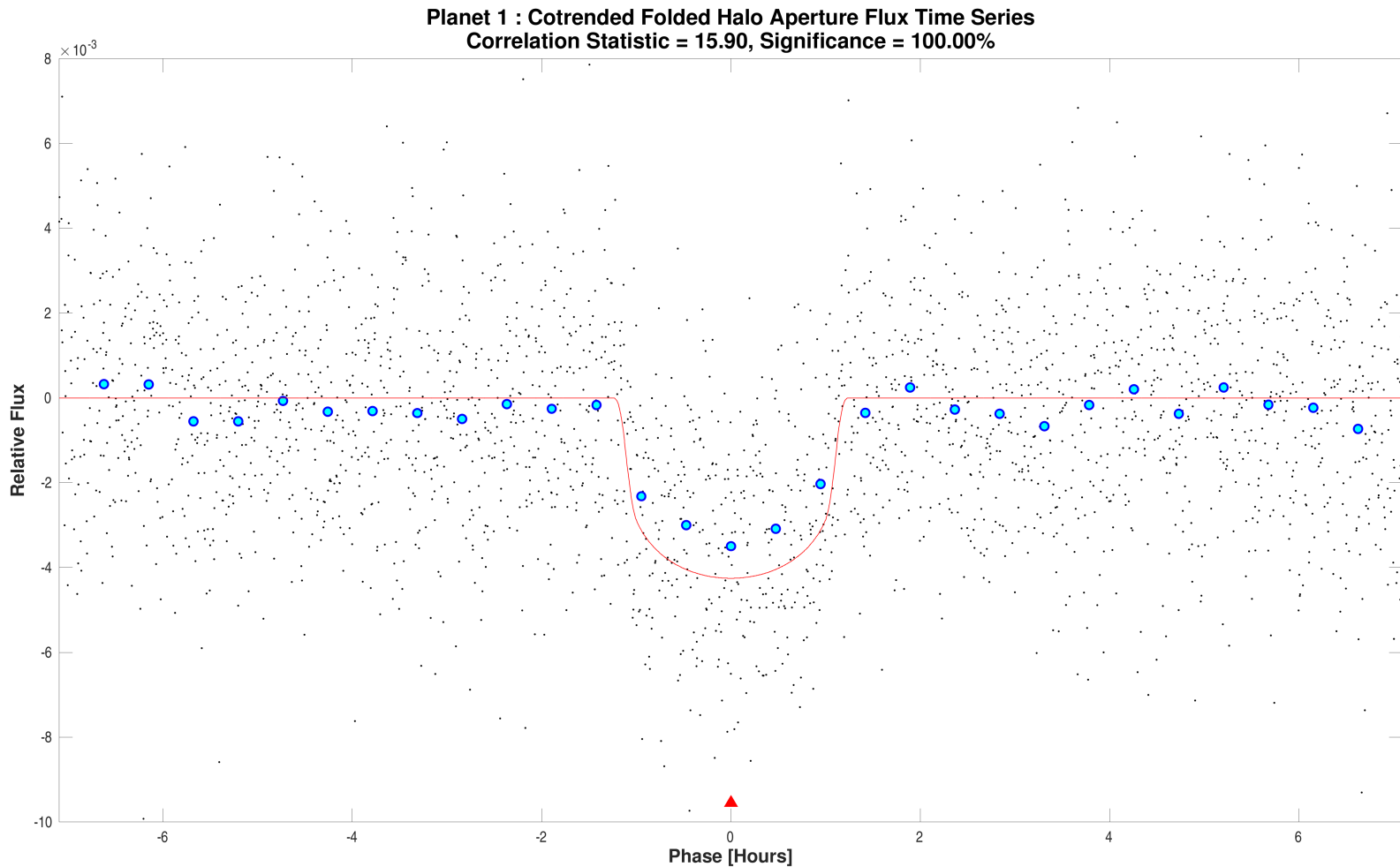**Max Multiple Event Sigma=78.8, False Alarm=0.00e+00**

Bootstrap results for target 28230919, 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 9.1458.
Open `./planet-01/bootstrap-results/0000000028230919-01-bootstrap-false-alarm.fig`

Planet 1 : Cotrended Folded Core Aperture Flux Time Series
Correlation Statistic = 37.45, Significance = 100.00%

Optical ghost diagnostic core aperture flux time series for target 28230919, 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.

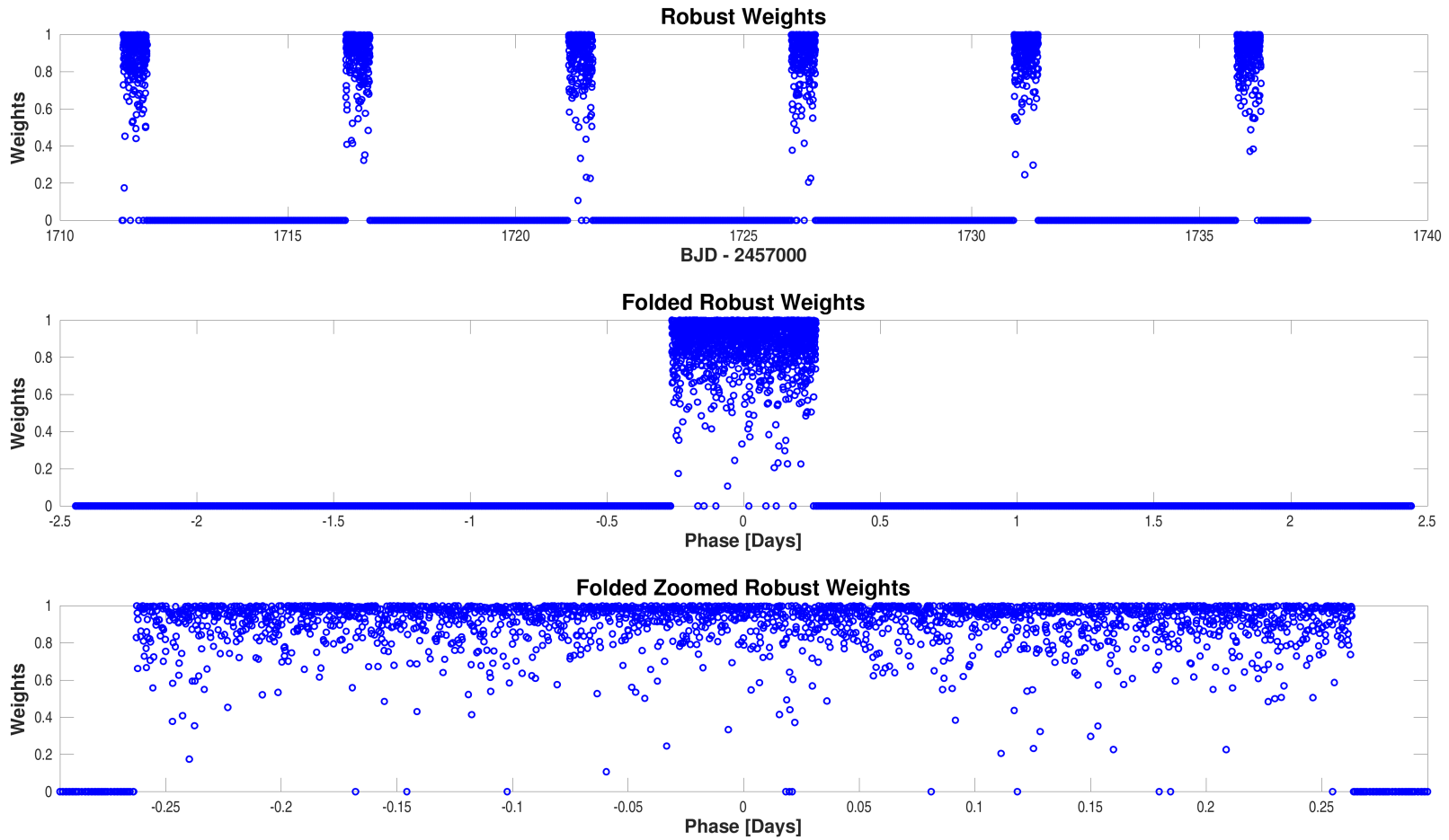Open `./planet-01/ghost-diagnostic-results/0000000028230919-01-core-unwhitened-cotrended-zoomed-model.fig`

Planet 1 : Cotrended Folded Halo Aperture Flux Time Series
Correlation Statistic = 15.90, Significance = 100.00%

Optical ghost diagnostic halo aperture flux time series for target 28230919, 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.

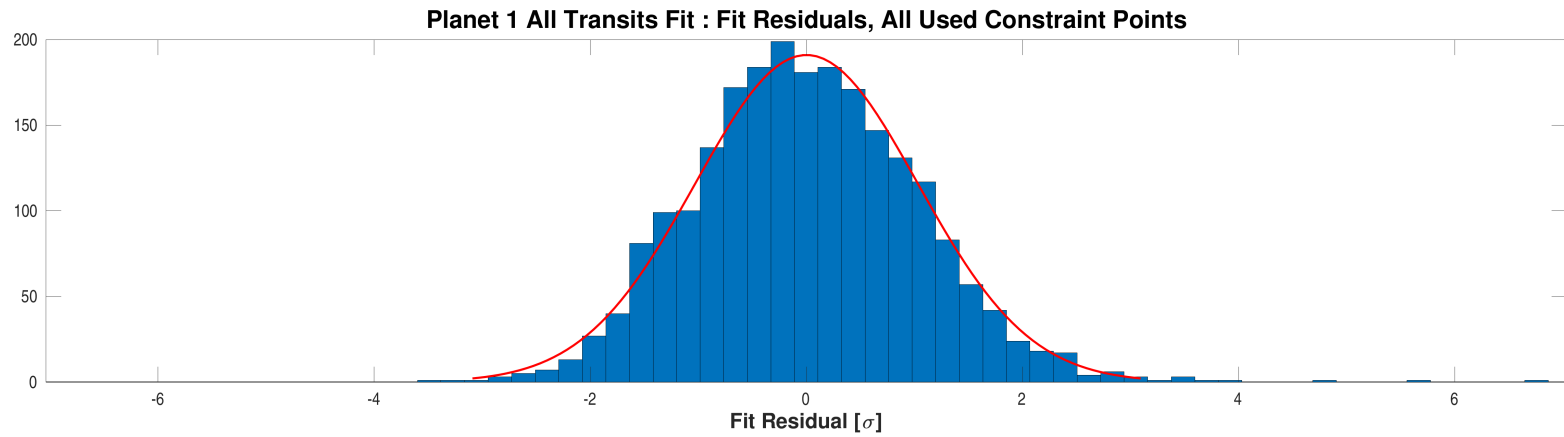Open ./planet-01/ghost-diagnostic-results/0000000028230919-01-halo-unwhitened-cotrended-zoomed-model.fig

Appendix A Planet Candidate 1
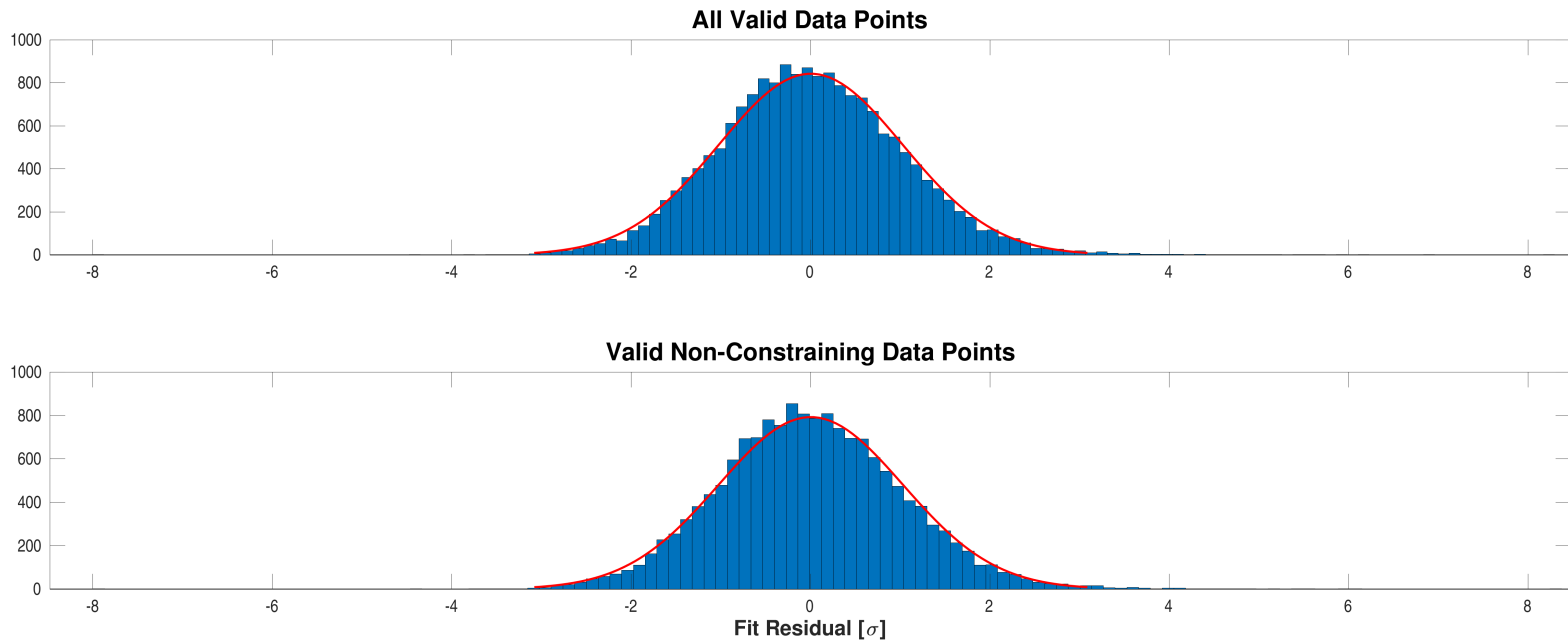
A.1 Model Fitter: All Transits

Robust weights distribution for CatId 28230919, 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/0000000028230919-01-all-robust-weights.fig`

Fit residuals distribution for CatId 28230919, 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/0000000028230919-01-all-histo-used.fig
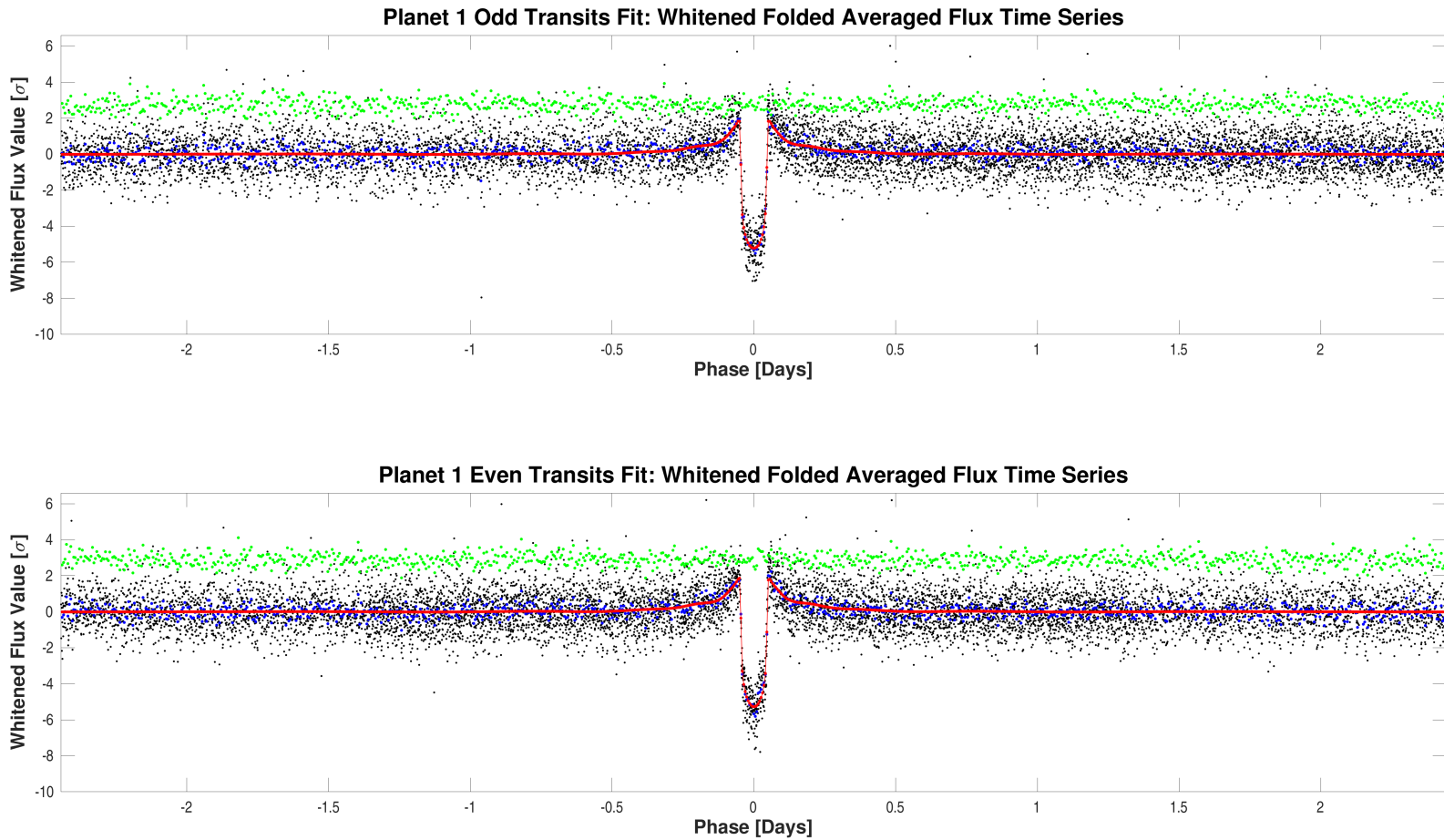

Fit residuals distribution for CatId 28230919, Planet candidate 1. Top plot: all valid data. Bottom plot: valid data not used to constrain fit (due to distance from a transit). Gaussian fits to the histograms are shown in red.

Open ./planet-01/planet-search-and-model-fitting-results/all-transits-fit/0000000028230919-01-all-histo-all-and-unused.fig
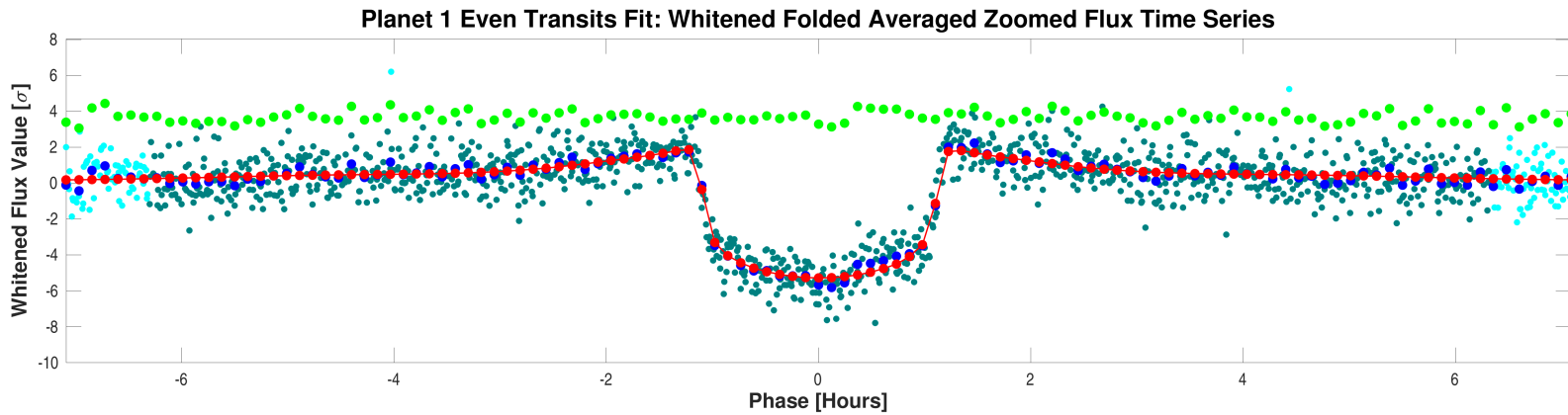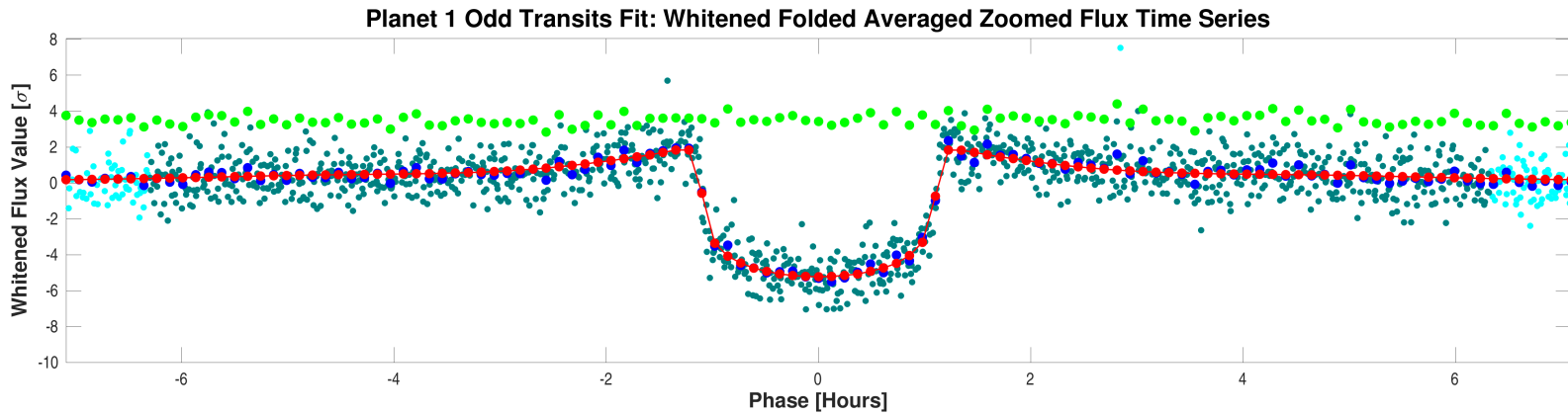
A.2   Model Fitter: Odd & Even Transits

Parameter	Odd Transits Value	Odd Transits Uncertainty	Even Transits Value	Even Transits Uncertainty	Units	Difference ‖Uncertainty‖
SNR	65.8		66.0			
Orbital Period	4.8875740	1.5834e-04	4.8875527	1.5905e-04	days	9.5068e-02
Transit Epoch	1711.6459203	4.0871e-04	1716.5338138	4.1385e-04	BTJD	5.3930e-01
Impact Parameter	0.0100	2.4441e+01	0.0228	1.0431e+01		4.8107e-04
Planet Radius to Star Radius Ratio	0.0586854	3.6733e-03	0.0589025	3.5885e-03		4.2261e-02
Semi-major Axis to Star Radius Ratio	16.7414	4.0251e+00	16.7036	3.9067e+00		6.7357e-03
Planet Radius	4.8681	4.3425e-01	4.8861	4.3017e-01	Earth radii	2.9452e-02
Semi-major Axis	0.0517	4.0714e-03	0.0517	4.0714e-03	AU	2.6127e-05
Effective Stellar Flux	100.8707	1.6987e+01	100.8713	1.6987e+01	Goldilocks	2.4439e-05
Equilibrium Temperature	808	3.4030e+01	808	3.4030e+01	Kelvin	2.4439e-05
Stellar Density	2.6389	1.9034e+00	2.6211	1.8391e+00	Solar density	6.7265e-03
Transit Depth	4236	6.4567e+01	4267	6.4929e+01	ppm	3.3774e-01
Transit Duration	2.3627	6.4408e-02	2.3680	6.3093e-02	hours	5.9731e-02
Transit Ingress Duration	0.1311	7.1950e-02	0.1319	7.0429e-02	hours	8.0535e-03
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)	1740.0 (2063.5)		1740.0 (2063.5)			

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
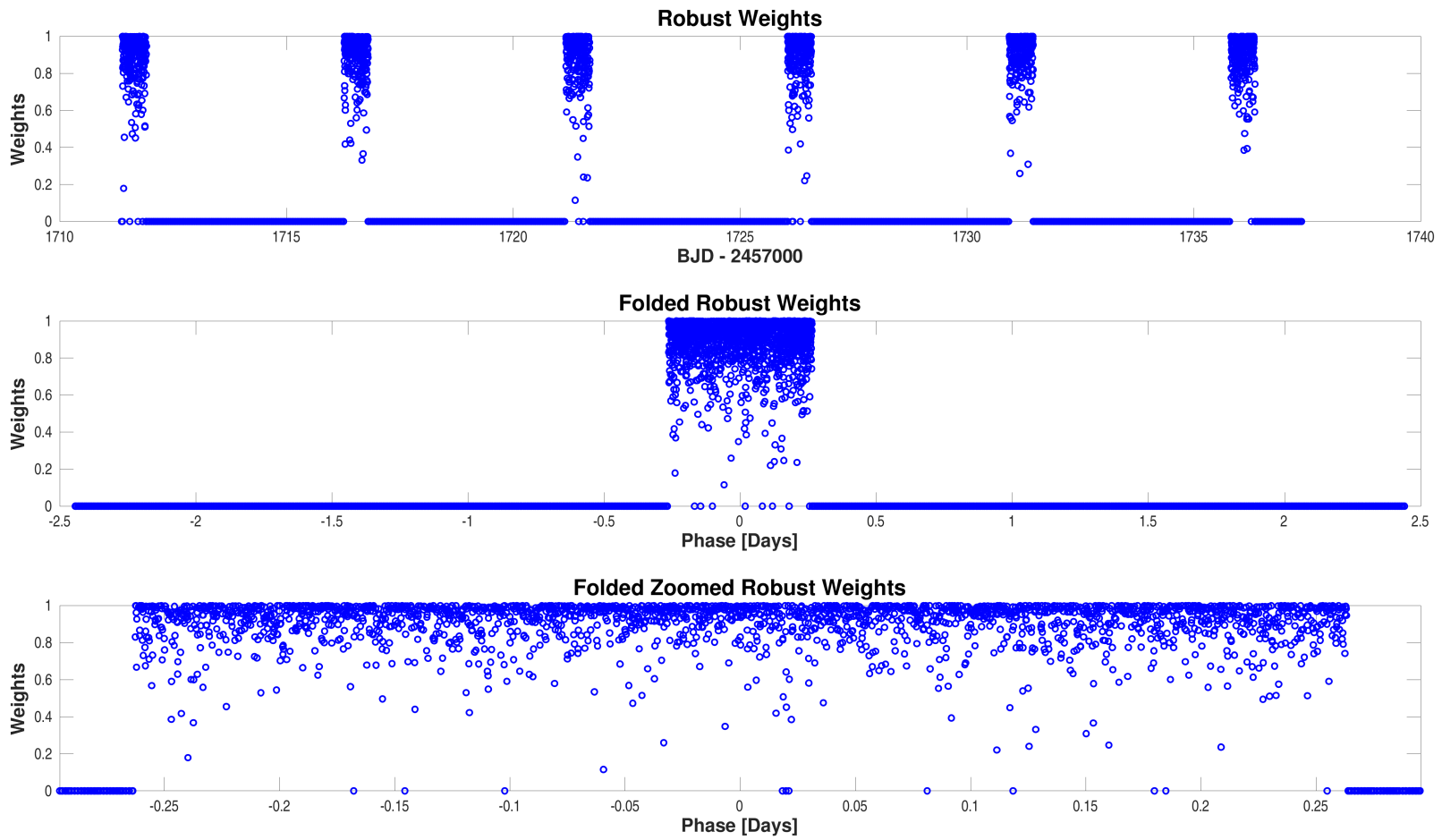
Folded flux time series for CatId 28230919, Planet candidate 1 in the whitened domain is plotted in black dots. Values are averaged into 1 cadence wide bins. The blue dots represent the averaged values of the folded flux time series; the red dots represent the averaged values of the folded model light 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/0000000028230919-01-odd-even-whitened.fig`
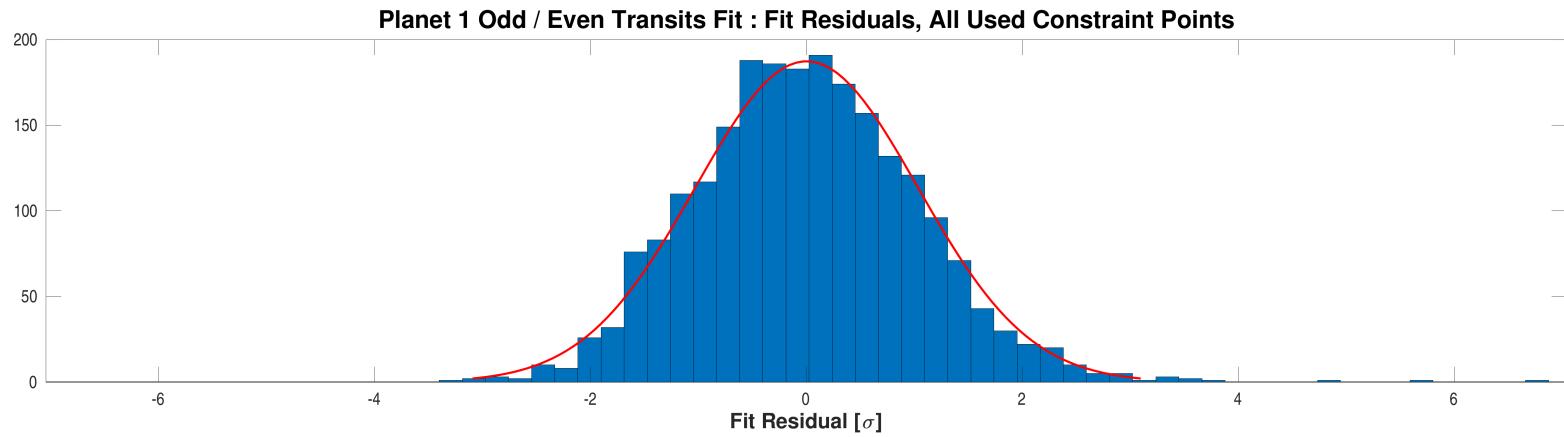
Planet 1 Odd Transits Fit: Whitened Folded Averaged Zoomed Flux Time Series

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

Folded flux time series for CatId 28230919, 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/0000000028230919-01-odd-even-whitened-zoomed.fig
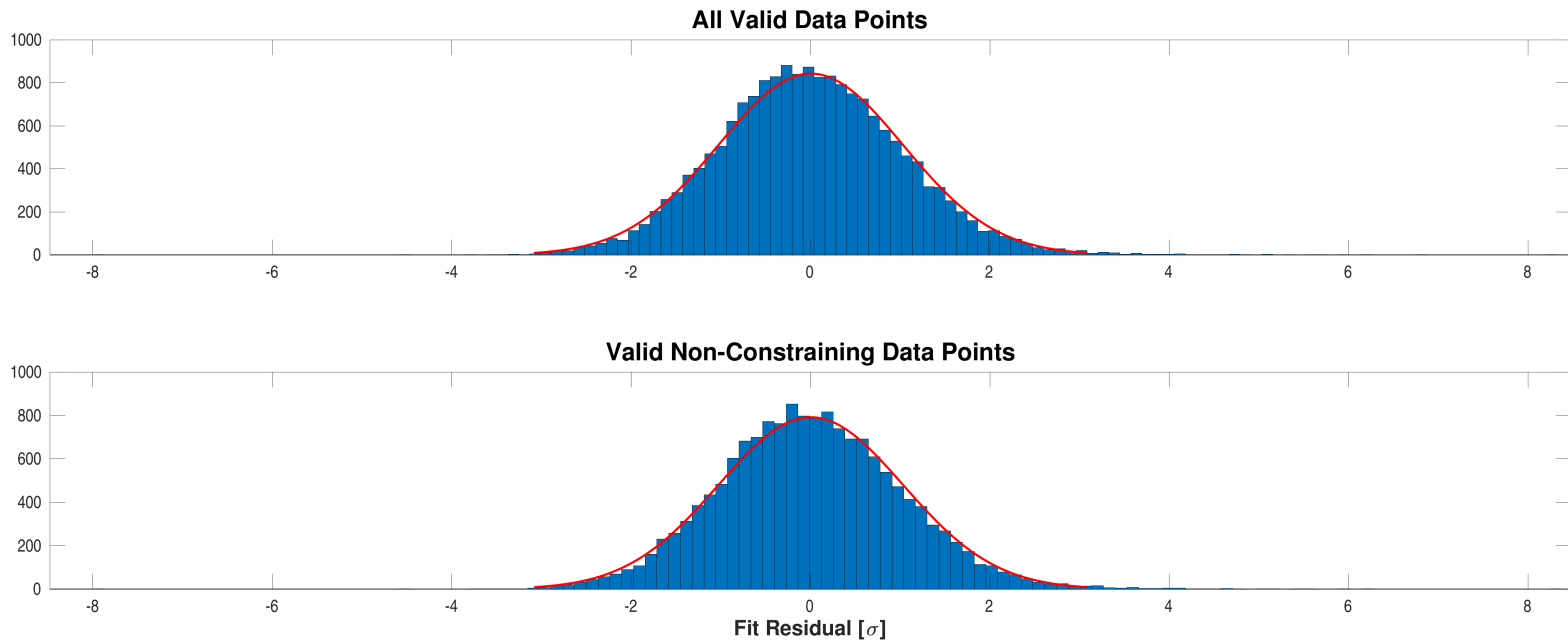
Robust weights distribution for CatId 28230919, Planet candidate 1. Top plot: all data points. Middle plot: all data points, folded per the fitted period and epoch. Bottom plot: all data points, folded and zoomed.

Open `./planet-01/planet-search-and-model-fitting-results/odd-even-transits-fit/0000000028230919-01-odd-even-robust-weights.fig`

Fit residuals distribution for CatId 28230919, 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.
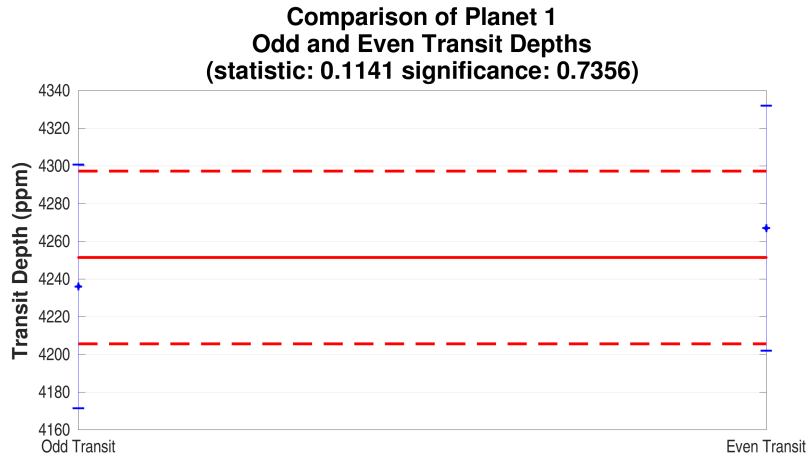Open ./planet-01/planet-search-and-model-fitting-results/odd-even-transits-fit/0000000028230919-01-odd-even-histo-used.fig

Fit residuals distribution for CatId 28230919, 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/0000000028230919-01-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 28230919, planet 1. A significance level close to 1/0 favors a transiting planet/an eclipsing binary.
Open ./planet-01/binary-discrimination-test-results/0000000028230919-01-eclipsing-binary-discrimination-tests.fig

Appendix B Alerts

This target did not trigger any alerts.