



Data Validation (DV) Report  
for TESS ID 89020549  
Sectors 1 - 1

**PRELIMINARY**

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

28-Aug-2018 21:28:09 Z

## Contents

1	Summary	1
2	Survey Image	2
3	Flux Time Series	3
4	Dashboards	5
5	Pixel Level Diagnostics	6
5.1	Planet Candidate 1 . . . . .	6
5.2	Difference Image TIC Key . . . . .	10
6	Phased Light Curves	11
7	Planet Candidate 1	14
7.1	Model Fitter: All Transits . . . . .	14
7.2	Model Fitter: Reduced Parameter Fit Results . . . . .	18
7.3	Model Fitter: Trapezoidal Fit Results . . . . .	20
7.4	Validation Tests . . . . .	22
7.4.1	Weak Secondary Test . . . . .	22
7.4.2	Eclipsing Binary Discrimination Test . . . . .	22
7.4.3	Bootstrap Test . . . . .	23
7.4.4	Ghost Diagnostic Test . . . . .	23
7.4.5	Validation Test Figures . . . . .	24
	Appendices	28
A	Planet Candidate 1	28
A.1	Model Fitter: All Transits . . . . .	28
A.2	Model Fitter: Odd & Even Transits . . . . .	30
A.3	Eclipsing Binary Discrimination Test . . . . .	35
B	Alerts	36

PRELIMINARY

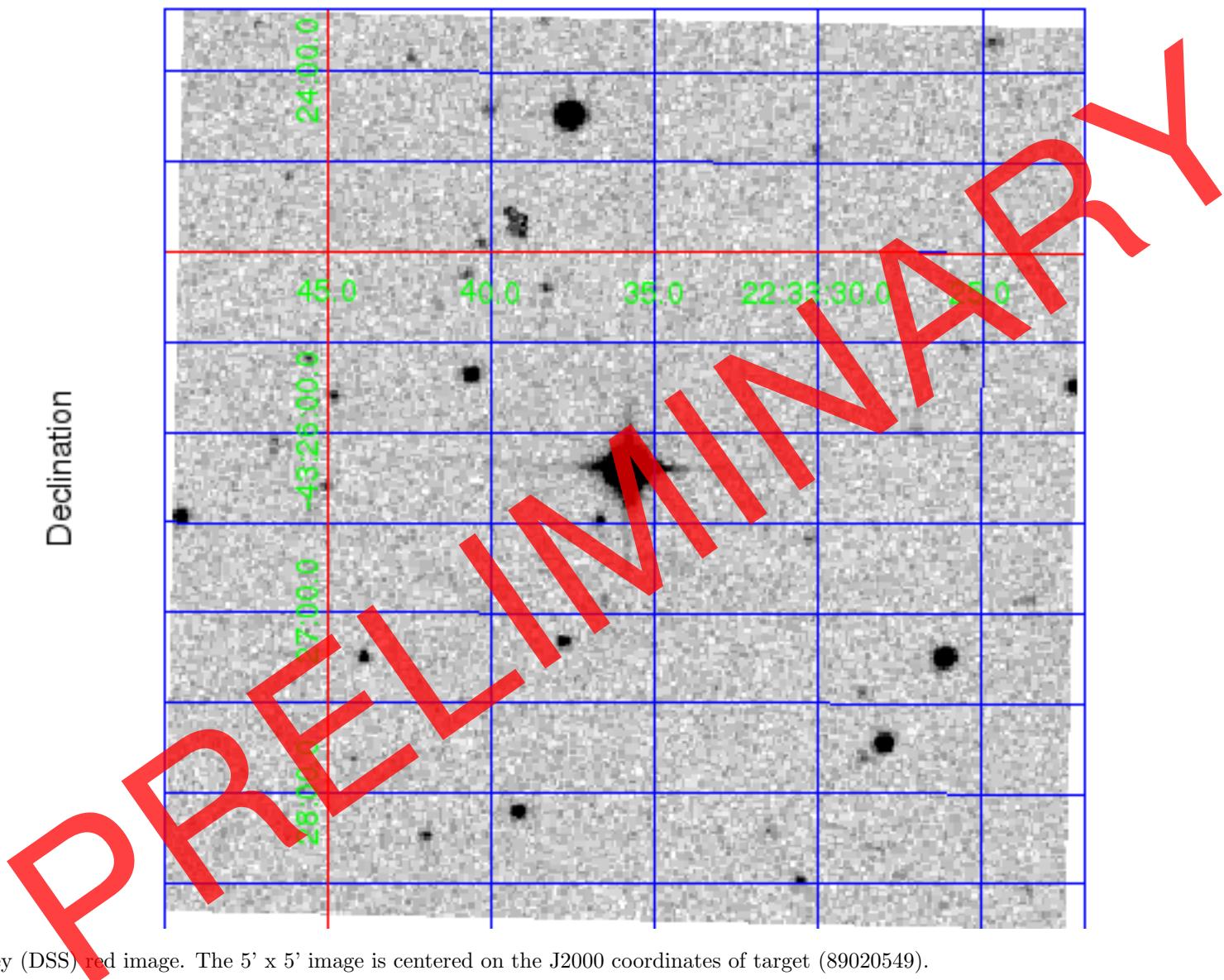
## 1 Summary

Target Properties	Value	Uncertainty	Units	Provenance
Catalog ID	89020549			
TOI ID	-			
TESS Name	-			
RA	338.39942000	0	degrees	TIC7
Dec	-43.43662800	0	degrees	TIC7
Magnitude	10.803	0.018		TIC7
Radius	0.879	0.177	Solar radii	TIC7
Effective Temperature	5673	188	Kelvin	TIC7
log(g)	4.554	0.4189	cm/sec <sup>2</sup>	TIC7
[M/H]	0.000	0	Solar metallicity	Solar
Stellar Density	1.485	1.463	Solar density	TIC7-Derived
Limb Darkening Coefficient 1	0.59915			
Limb Darkening Coefficient 2	-0.19225			
Limb Darkening Coefficient 3	0.56421			
Limb Darkening Coefficient 4	-0.29573			
Number of Planet Candidates	1			
TOI Model	-			
TESS Names Model	-			
External TCE Model	-			
Software Revision	spoc-3.3.28-20180822-4-gde84ede605			
Date Report Generated	28-Aug-2018 21:28:09 Z			

Sector	Target Table	Camera/CCD	Crowding Metric	Flux Fraction
1	128	2:3	0.9993	0.8774

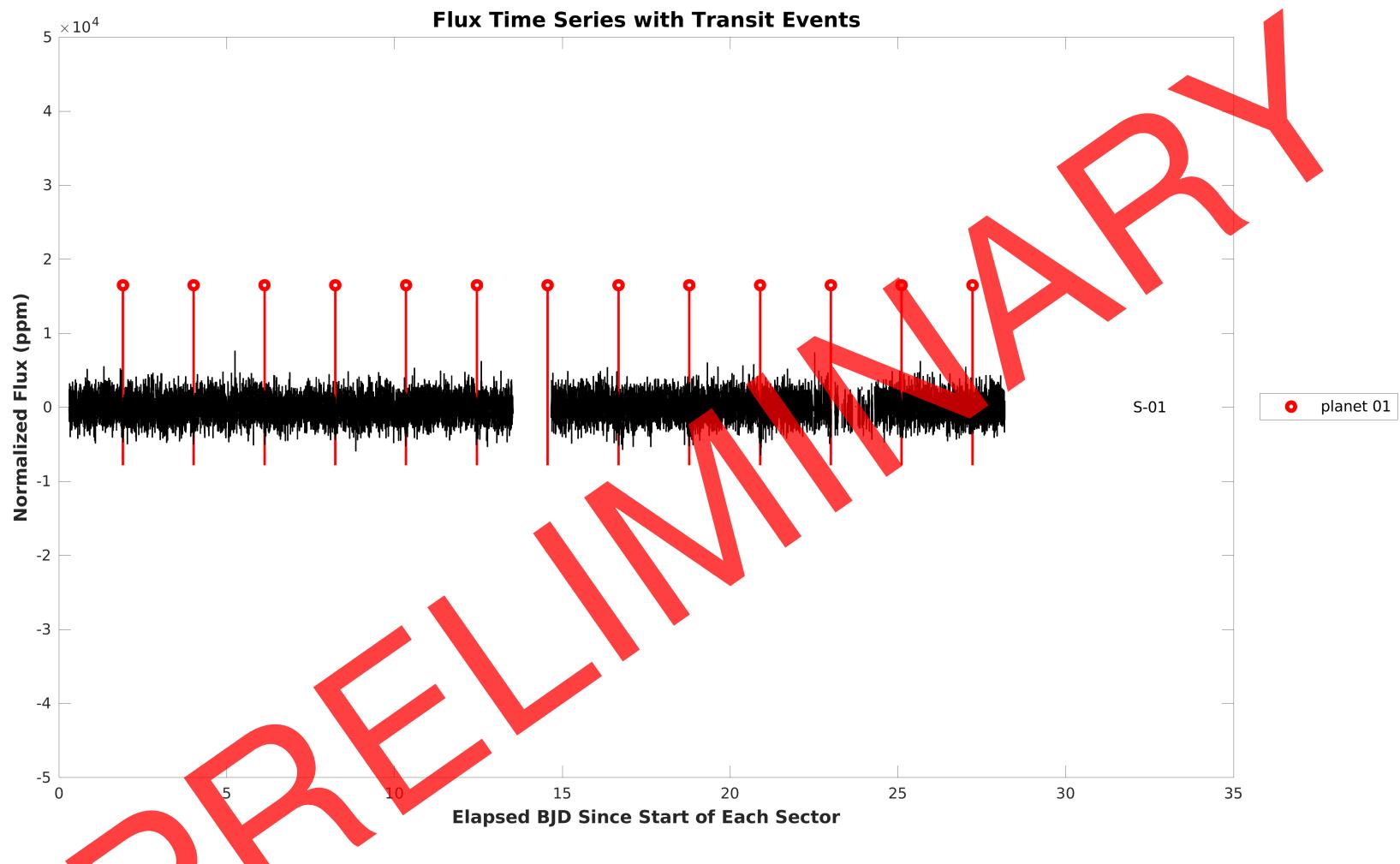
Planet Candidate	TOI ID	TESS Name	TOI Correlation	Period (days)	Period Ratio	Epoch (BTJD)	Semi-major Axis (AU)	Radius (Re)	Seff	Teq (K)	False Alarm	Suspected EB
1	-	-	-	2.109	1.00	1326.904	0.03	3.3	687.4	1306	1.30e-54	false

## 2 Survey Image

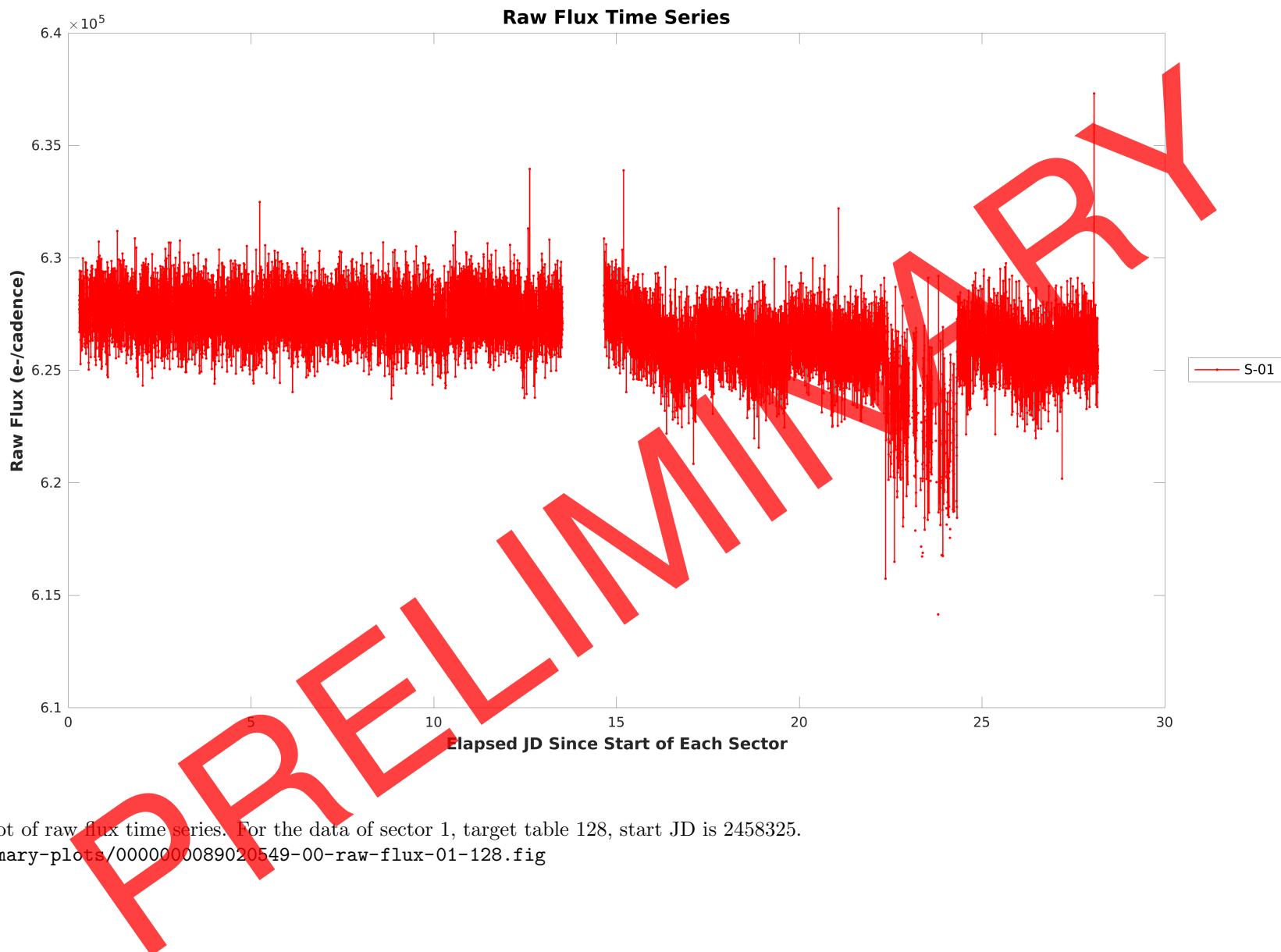


Digitized Sky Survey (DSS) red image. The 5' x 5' image is centered on the J2000 coordinates of target (89020549).

### 3 Flux Time Series



Summary plot of sector-stitched flux time series and transits for target 89020549, 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 1, target table 128, start BJD is 2458325.  
Open [./summary-plots/000000089020549-00-flux-dv-fit-01-128.fig](#)



## 4 Dashboards

### Planet Candidate 1

Model Fitter	<b>Stellar Radius</b> $0.9 \pm 0.2$ Solar units	<b>Core Aperture Correlation Statistic</b> Value = 9.65 Significance = 100.00%	<b>Ghost Diagnostic Test</b>
	Period = $2.1 \pm 0.0$ days Depth = $1379 \pm 85$ ppm Planet Radius = $3.3 \pm 1.6$ Earth radii Semi-major Axis = $0.0 \pm 0.0$ AU Effective Stellar Flux = $687.4 \pm 460.6$ Equilibrium Temperature = $1306 \pm 219$ Kelvin Chi-squared/DoF = 0.8 SNR = 18.7	<b>Halo Aperture Correlation Statistic</b> Value = 1.75 Significance = 95.96%  <b>Core/Halo Ratio</b> Ratio = 5.53	
Eclipsing Binary Discrimination Test	<b>Odd-Even Depth Comparison Statistic</b> Value = $1.04e-02$ Significance = 91.89%	<b>Offsets Relative to Out of Transit Centroid</b> Source RA Offset = $3.49e+00 \pm 2.60e+00$ arcsec (1.34 $\sigma$ ) Source Dec Offset = $-1.07e+01 \pm 2.69e+00$ arcsec (-3.98 $\sigma$ ) Source Offset Distance = $1.13e+01 \pm 2.68e+00$ arcsec (4.20 $\sigma$ )  <b>Offsets Relative to TIC Position</b> Source RA Offset = $3.59e+00 \pm 2.60e+00$ arcsec (1.38 $\sigma$ ) Source Dec Offset = $-1.06e+01 \pm 2.69e+00$ arcsec (-3.94 $\sigma$ ) Source Offset Distance = $1.12e+01 \pm 2.68e+00$ arcsec (4.18 $\sigma$ )	<b>Difference Image Centroid Offsets</b>
	<b>Shorter Period Comparison Statistic</b> Value = N/A Significance = N/A	<b>Longer Period Comparison Statistic</b> Value = N/A Significance = N/A	<b>Bootstrap Test</b>
PRELIMINARY		<b>False Alarm</b> = $1.30e-54$ <b>Transit Count</b> = 13 <b>Max Multiple Event Statistic</b> = 15.4	

Summary of model fitter results and validation test results for target 89020549, planet candidate 1. In general, green denotes that the candidate is likely a planet, while red denotes that the candidate is unlikely to be a planet. Cyan denotes that no data is available. The color of the Model Fitter block is: green, when the SNR of the fit is greater than or equal to 10; yellow, if the SNR is greater than or equal to 7.1 but less than 10; red, if the SNR is less than 7.1 or if the fitter failed. The color of the Ghost Diagnostic Test and Eclipsing Binary Discrimination Test blocks are: green, when the significance is within 2-sigma; yellow, when the significance is between 2- and 3-sigma; red when the significance is greater than 3-sigma. The color of the Difference Image Centroid Offsets block is: green, when the max offset distance sigma is less than or equal to 2; yellow, when the max sigma is between 2 and 3; red when the max sigma is greater than 3. The color of the Bootstrap Test block is green whenever the false alarm probability is less than  $10^{-12}$ , low enough to limit the total number of false alarms from a four year mission to less than one. If the false alarm probability is greater than  $10^{-12}$ , the color of the Bootstrap Test block is: green, when the false alarm probability is less than or equal to the CCDF of a Gaussian distribution at the observed maximum multiple event statistic; yellow when the false alarm probability is between 1 and 2 times that of a Gaussian distribution at the max multiple event statistic; and red when the false alarm probability is more than 2 times that of a Gaussian distribution at the max multiple event statistic.

## 5 Pixel Level Diagnostics

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

### 5.1 Planet Candidate 1

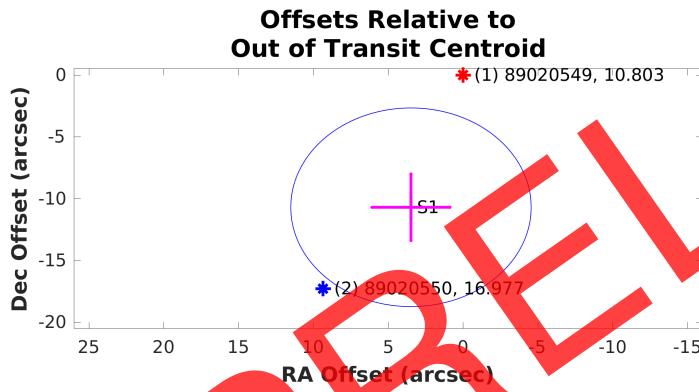
#### Multi-Sector Average PRF Fit of the Difference Images

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

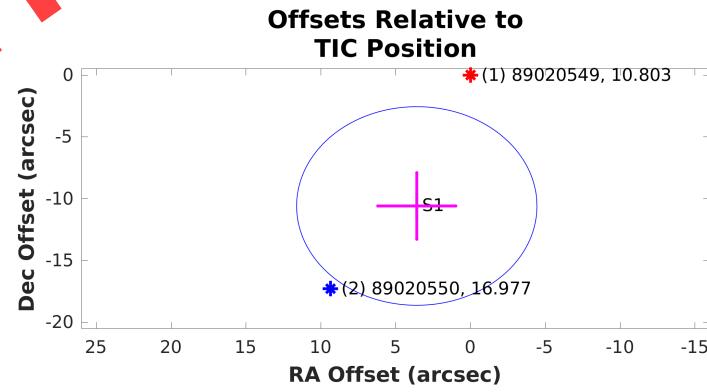
	RA	Dec	Units
Offset	$3.4877 \pm 2.60e + 00$	$-10.6979 \pm 2.69e + 00$	arcseconds
Offset/ $\sigma$	1.34	-3.98	
Offset Distance	$11.2521 \pm 2.68e + 00$		arcseconds
Offset Distance/ $\sigma$	4.20		
$3\sigma$ Radius	8.0340		arcseconds

Mean offset from the TIC RA and Dec

	RA	Dec	Units
Offset	$3.5881 \pm 2.60e + 00$	$-10.5924 \pm 2.69e + 00$	arcseconds
Offset/ $\sigma$	1.38	-3.94	
Offset Distance	$11.1836 \pm 2.68e + 00$		arcseconds
Offset Distance/ $\sigma$	4.18		
$3\sigma$ Radius	8.0323		arcseconds

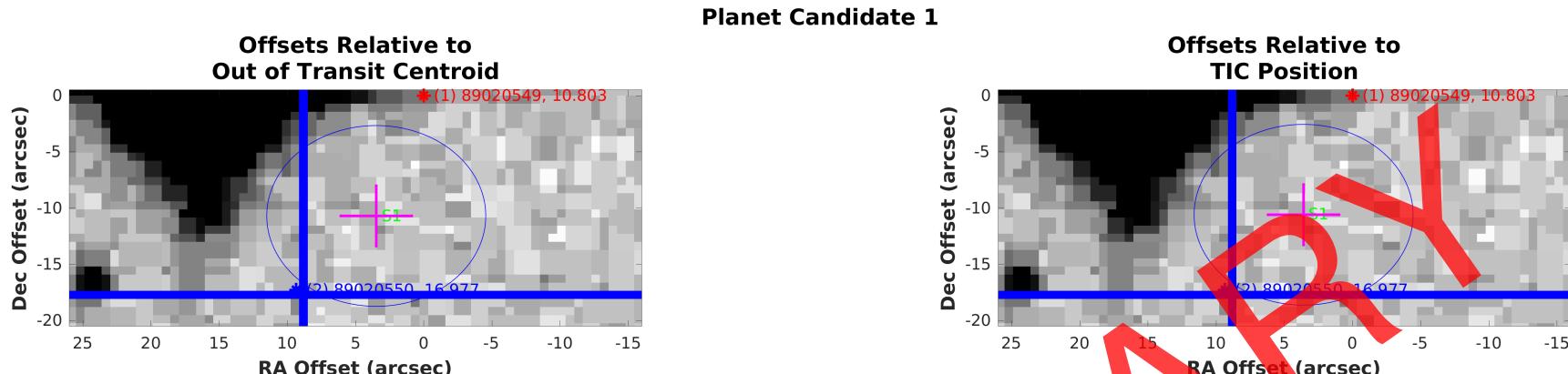


Planet Candidate 1



Difference image centroid offsets for target 89020549, 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/0000000089020549-01-difference-image-centroid-offsets.fig`



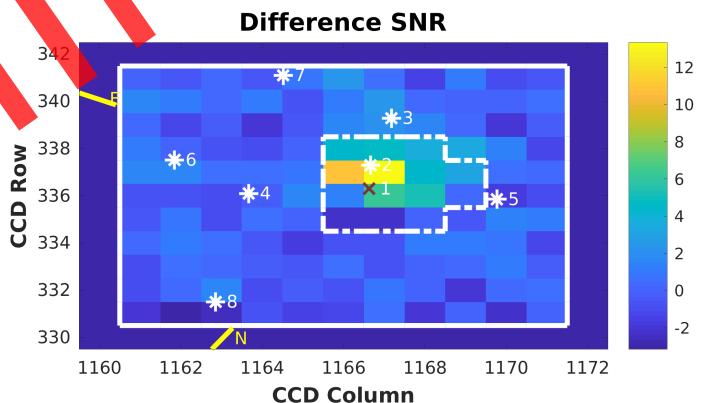
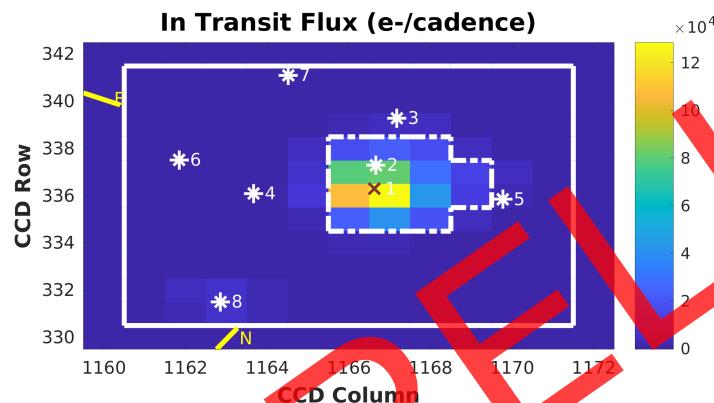
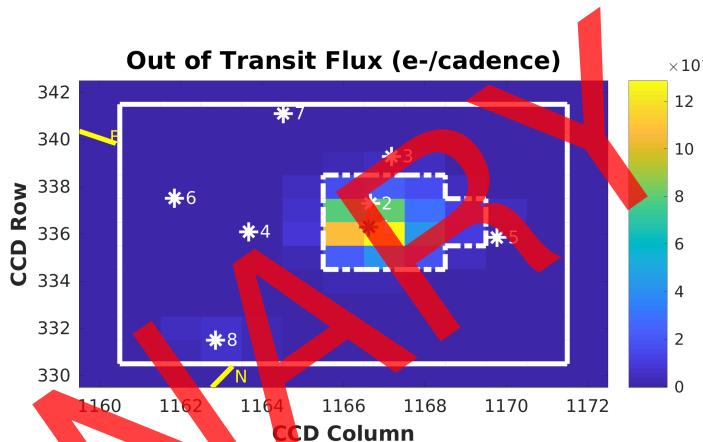
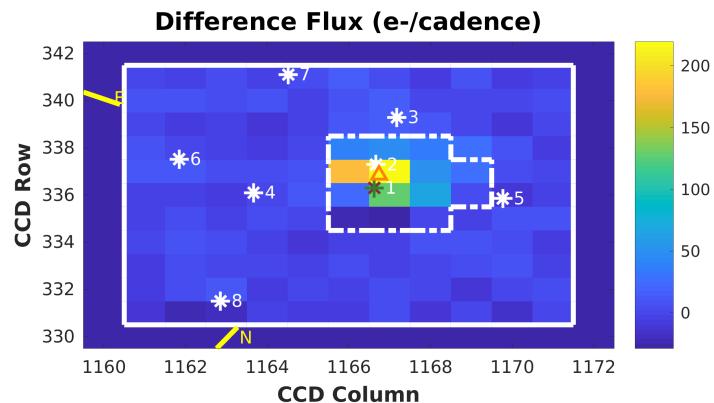
Difference image centroid offsets for target 89020549, planet candidate 1, displayed on survey image for given target. Left: difference image PRF centroid offsets in RA and Dec with respect to the per sector out-of-transit centroids for the given target. Right: difference image PRF centroid offsets in 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/000000089020549-01-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 1 / Target Pixel Table 128**



Difference image for target 89020549, planet candidate 1, sector 1, target pixel table 128. 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 = 10; number of valid in-transit cadences = 516; number of in-transit cadence gaps = 16; number of valid out-of-transit cadences = 1314; number of out-of-transit cadence gaps = 8. Difference image quality metric = 0.95 (good).

Open [./planet-01/difference-image/000000089020549-01-difference-image-01-128.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	$336.30 \pm 3.65e - 05$	$1166.62 \pm 4.24e - 05$	pixels	$338.39970723 \pm 9.79e - 07$	$-43.43687714 \pm 1.00e - 06$	degrees
Difference Image Centroid	$336.86 \pm 4.82e - 02$	$1166.74 \pm 4.82e - 02$	pixels	$338.40104144 \pm 2.78e - 04$	$-43.43984879 \pm 2.73e - 04$	degrees
Offset	$0.5571 \pm 4.82e - 02$	$0.1210 \pm 4.82e - 02$	pixels	$3.4877 \pm 7.27e - 01$	$-10.6979 \pm 9.82e - 01$	arcseconds
Offset/ $\sigma$	11.56	2.51		4.80		-10.90
Offset Distance	$0.5701 \pm 4.82e - 02$		pixels	$11.2521 \pm 9.62e - 01$		arcseconds
Offset Distance/ $\sigma$	11.83			11.69		

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

	Row	Column	Units	RA	Dec	Units
TIC Reference Centroid	$336.30 \pm 1.78e - 04$	$1166.63 \pm 1.59e - 04$	pixels	$338.39966883 \pm 0.00e + 00$	$-43.43690646 \pm 0.00e + 00$	degrees
Difference Image Centroid	$336.86 \pm 4.82e - 02$	$1166.74 \pm 4.82e - 02$	pixels	$338.40104144 \pm 2.78e - 04$	$-43.43984879 \pm 2.73e - 04$	degrees
Offset	$0.5549 \pm 4.82e - 02$	$0.1141 \pm 4.82e - 02$	pixels	$3.5881 \pm 7.27e - 01$	$-10.5924 \pm 9.82e - 01$	arcseconds
Offset/ $\sigma$	11.52	2.37		4.94		-10.79
Offset Distance	$0.5665 \pm 4.82e - 02$		pixels	$11.1836 \pm 9.61e - 01$		arcseconds
Offset Distance/ $\sigma$	11.75			11.64		

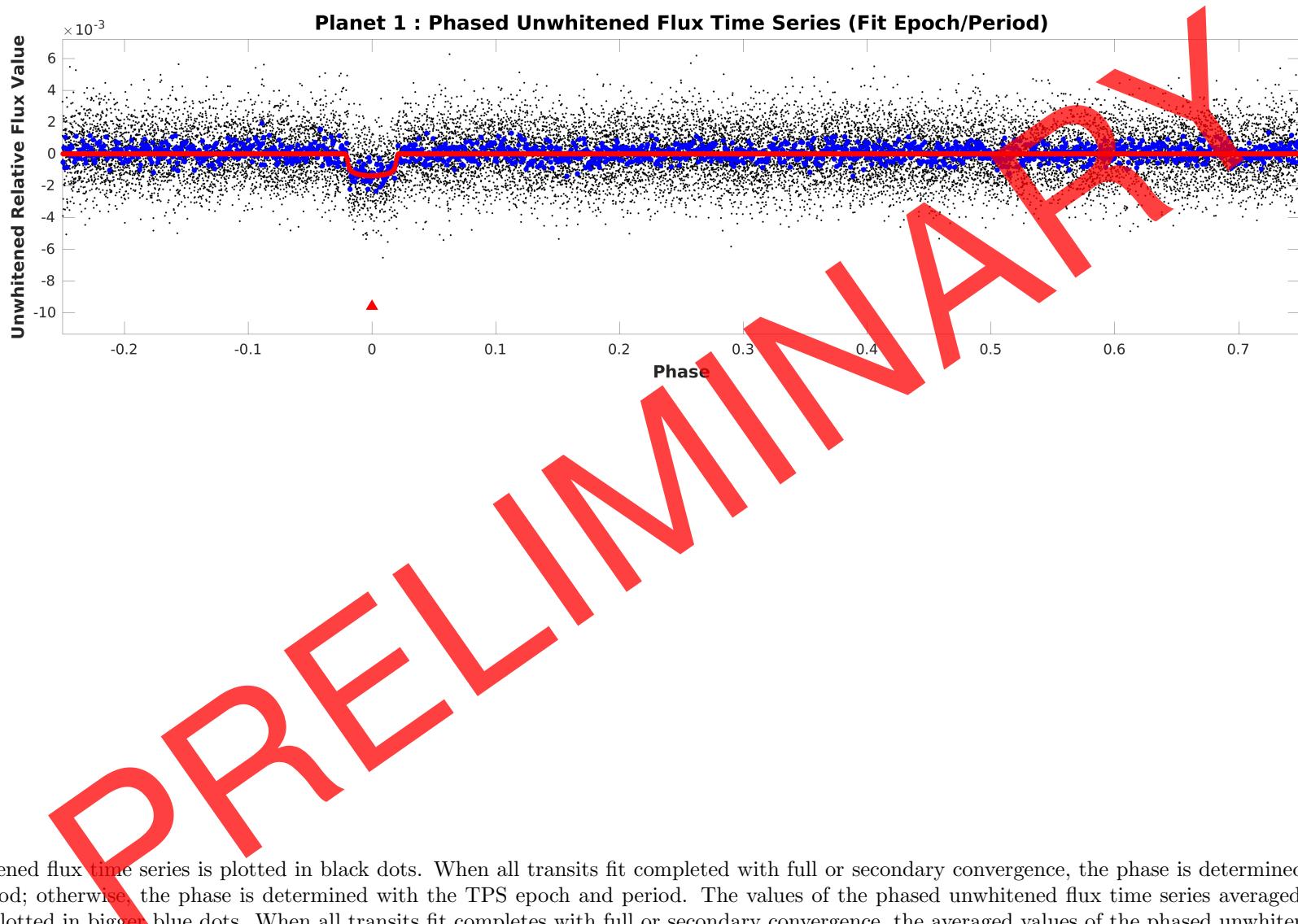
## 5.2 Difference Image TIC Key

Index	Catalog ID	Mag	RA (degrees)	Dec (degrees)	Distance (arcsec)
1	89020549	10.803	338.39966883	-43.43690646	0.00
2	89020550	16.977	338.40325004	-43.44170648	19.65
3	89020552	17.441	338.40747613	-43.45255095	59.90
4	89020543	16.022	338.41906519	-43.42792304	60.14
5	89020551	18.071	338.37642950	-43.44325513	64.91
6	89040022	17.907	338.43705700	-43.42975600	101.07
7	89020554	17.328	338.43270007	-43.45398945	106.01
8	89020540	13.835	338.40679706	-43.40393448	120.15
9	89020553	15.458	338.35898904	-43.45396568	122.80
10	89020555	16.021	338.36680546	-43.46189969	124.40

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

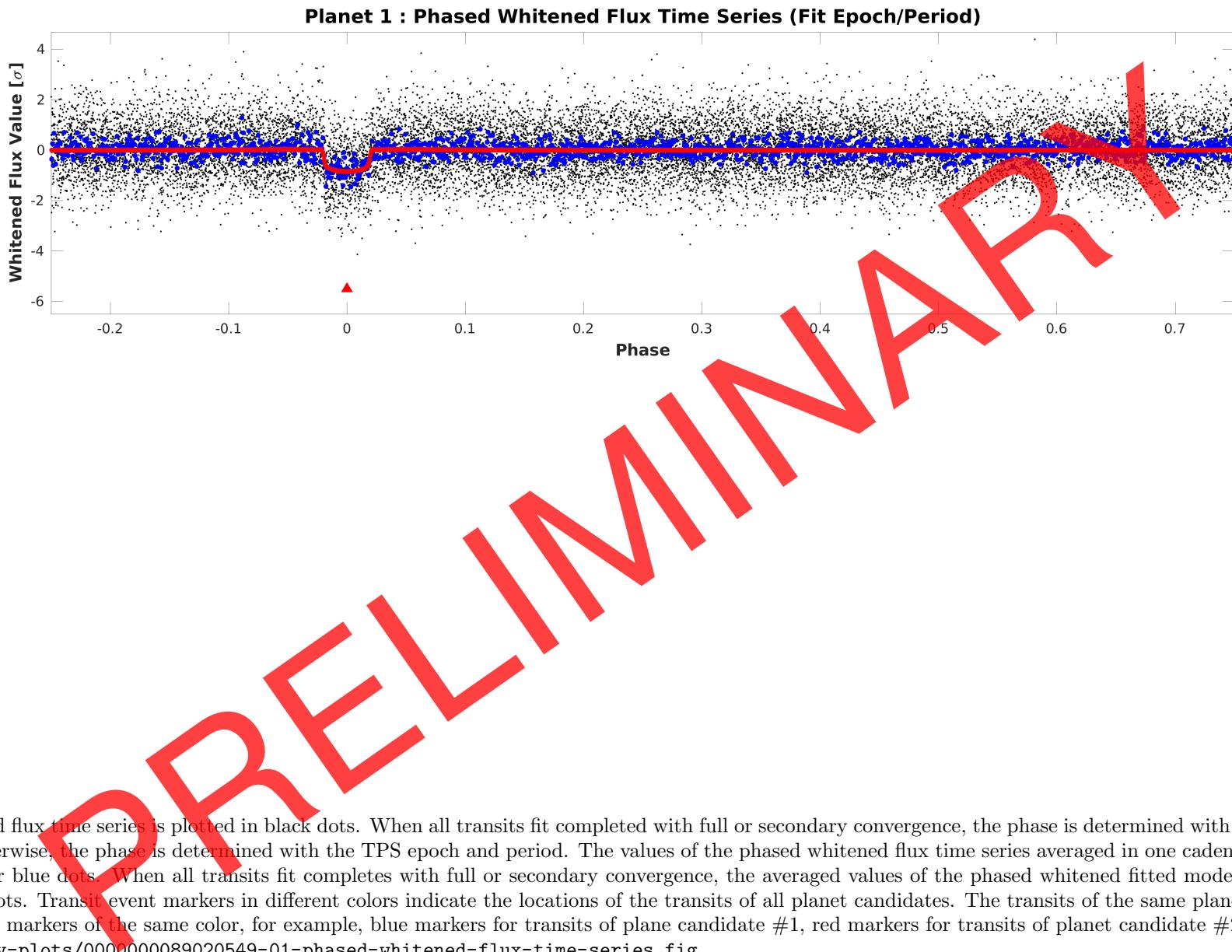
PRELIMINARY

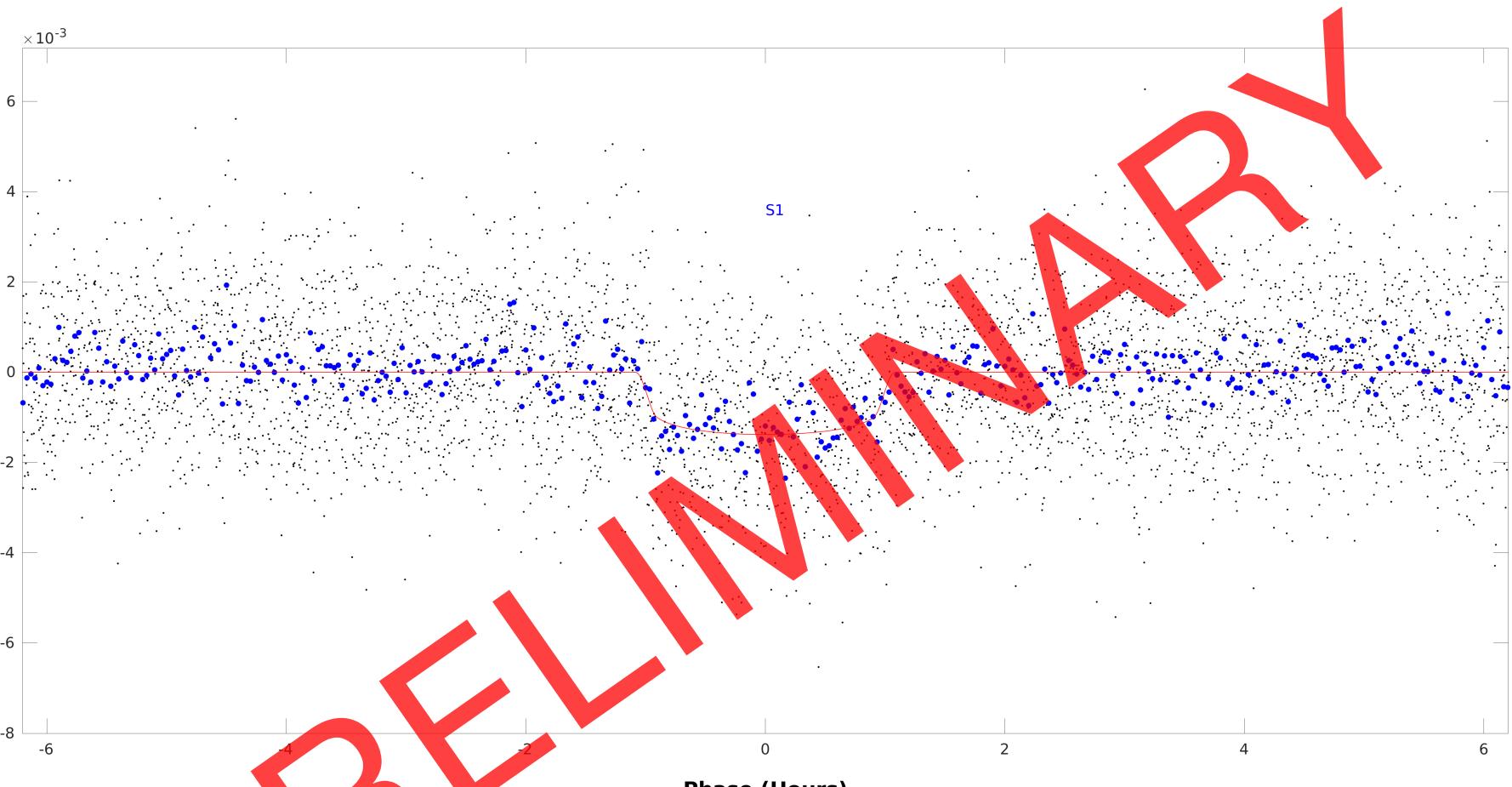
## 6 Phased Light Curves



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 planet candidate #1, red markers for transits of planet candidate #2, etc.

Open [./summary-plots/000000089020549-01-phased-unwhitened-flux-time-series.fig](#)



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

Phased unwhitened flux time series by sector for target 89020549, planet candidate 1. Period = 2.1093 days; transit epoch = 1326.904 BTJD.  
Open [./summary-plots/000000089020549-01-phased-unwhitened-flux-time-series-by-sector.fig](#)

## 7 Planet Candidate 1

### 7.1 Model Fitter: All Transits

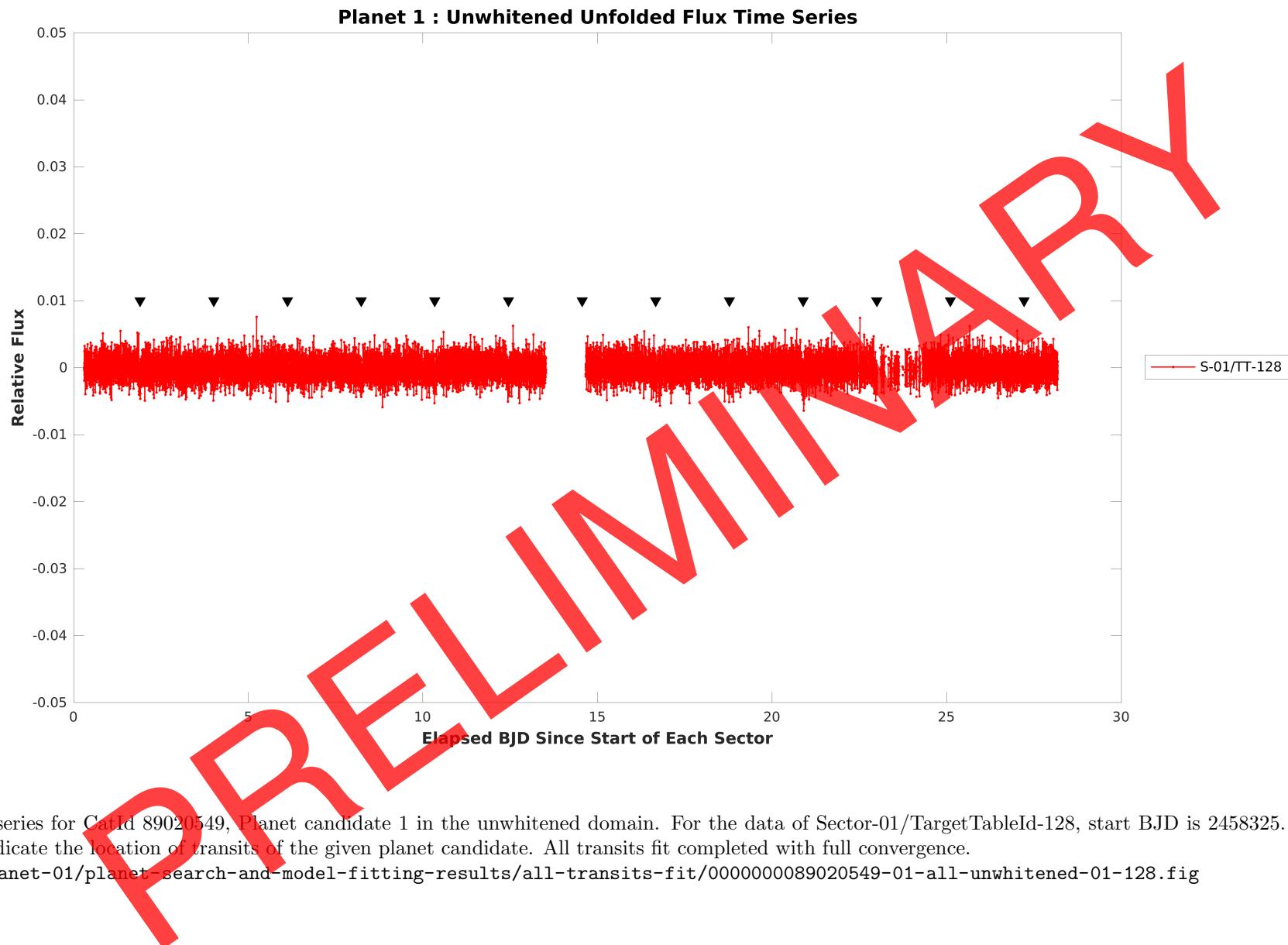
Model Characteristic	Name
Transit Model	mandel-agol_geometric_transit_model
Limb Darkening Model	claret_tess_nonlinear_limb_darkening_model

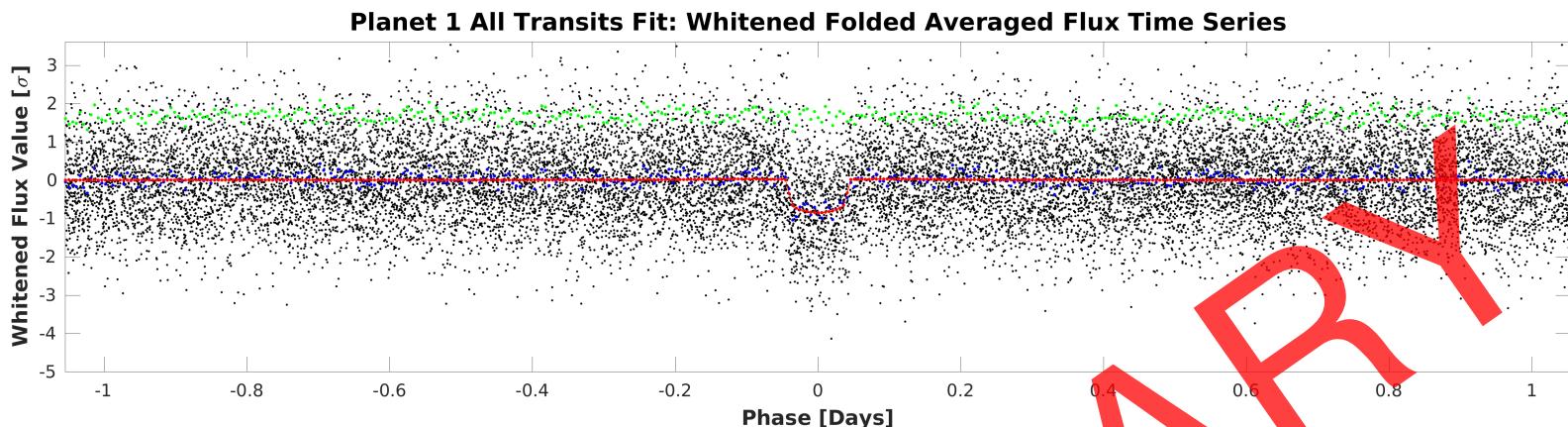
TCE Parameter	Value	Units
Trial Transit Pulse Duration	2.0	hours
Transit Epoch	1326.9006000	TJD
Orbital Period	2.1089411	days
Maximum SES	5.6	
Maximum MES	15.4	
Robust Statistic	17.8	
Chi Square Goodness of Fit Statistic (DoF)	665.7 (620)	
Chi Square2 Statistic (DoF)	7.8 (38.4)	
Threshold for Desired PFA		

DoF: Degrees of Freedom

Parameter	Value	Uncertainty	Units
SNR	18.7		
Orbital Period	2.1093068	2.5038e-04	days
Transit Epoch	1326.9039832	1.7683e-03	BTJD
Impact Parameter	0.2487	9.2767e+00	
Planet Radius to Star Radius Ratio	0.0344537	1.5694e-02	
Semi-major Axis to Star Radius Ratio	7.8483	1.8857e+01	
Planet Radius	3.3071	1.6464e+00	Earth radii
Semi-major Axis	0.0323	1.1252e-02	AU
Effective Stellar Flux	687.4289	4.6063e+02	Goldilocks
Equilibrium Temperature	1306	2.1877e+02	Kelvin
Stellar Density	1.4598	1.0522e+01	Solar density
Transit Depth	1379	8.4678e+01	ppm
Transit Duration	2.0683	3.5794e-01	hours
Transit Ingress Duration	0.0736	3.9469e-01	hours
Eccentricity	0.0000	0.0000e+00	
Peri Longitude	0.0000	0.0000e+00	degrees
Model Chi Square Statistic (DoF)	3002.5 (3551.2)		
Model Chi Square Goodness of Fit Statistic (DoF)	465.2 (783)		
Model Chi Square2 Statistic (DoF)	6.6 (11)		

DoF: Degrees of Freedom

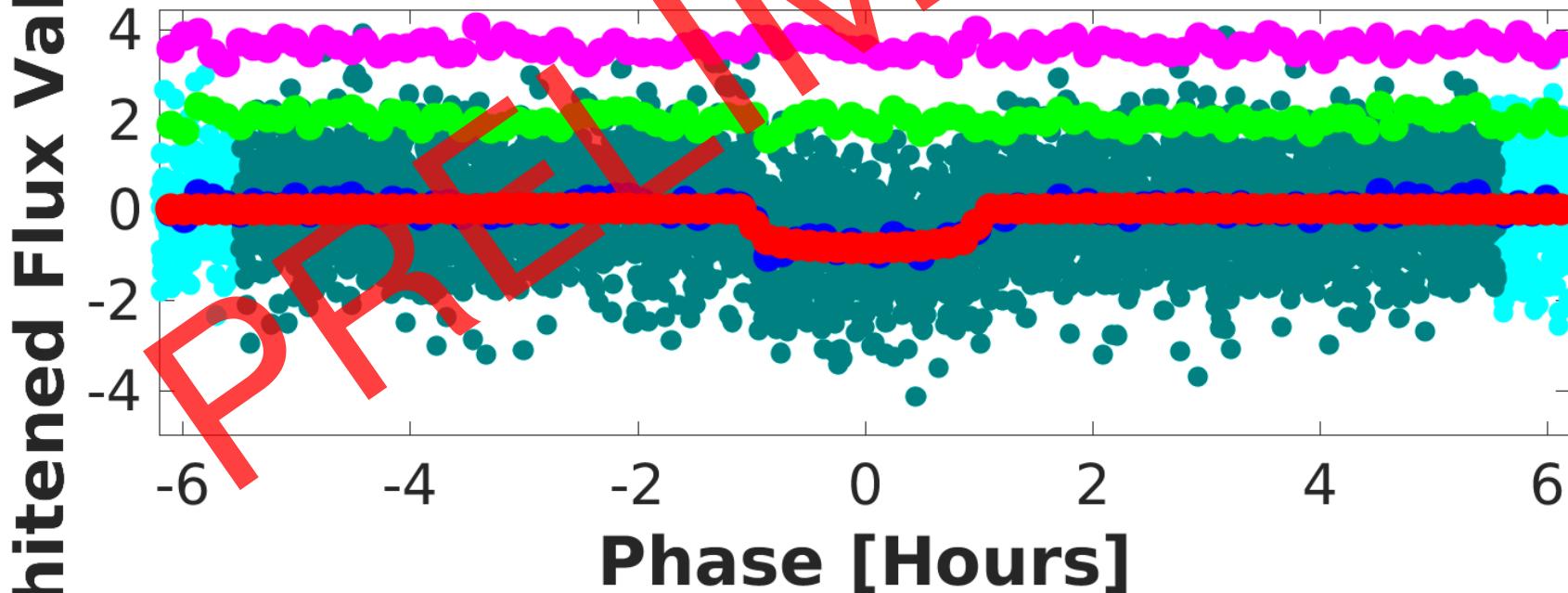




Folded flux time series for CatId 89020549, Planet candidate 1 in the whitened domain is plotted in black dots. Values are averaged into 1 cadence wide bins. The blue dots represent the averaged values of the folded flux time series; the red dots represent the averaged values of the folded model light 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/0000000089020549-01-all-whitened.fig](#)

## Transit Fit: Whitened Folded Averaged Zoom



Folded flux time series for CatId 89020549, 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/000000089020549-01-all-whitened-zoomed.fig](#)

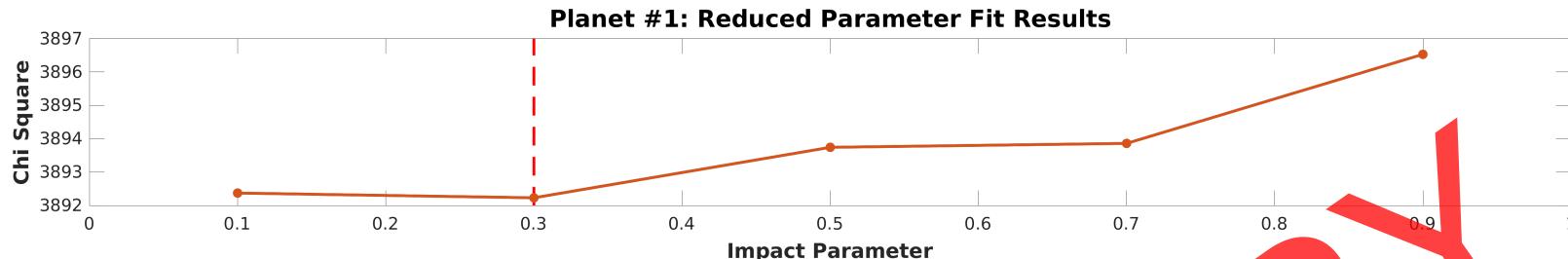
PRELIMINARY

## 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	19.3	3892.4	0.0342111	9.3958e-04	8.1308	2.1488e-01	1373	7.5053e+01	2.0457	5.3977e-02
0.30	19.3	3892.2	0.0344878	9.4760e-04	7.8031	2.0778e-01	1374	7.5139e+01	2.0515	5.4577e-02
0.50	19.3	3893.7	0.0350870	9.6803e-04	7.0855	1.9328e-01	1373	7.5352e+01	2.0719	5.6580e-02
0.70	19.2	3893.9	0.0360818	1.0137e-03	5.7624	1.7124e-01	1352	7.5529e+01	2.1581	6.4635e-02
0.90	19.2	3896.5	0.0394003	1.1164e-03	3.5880	1.2481e-01	1352	7.5998e+01	2.4212	8.7676e-02

Highlighted row is the best reduced-parameter model fit.

PRELIMINARY



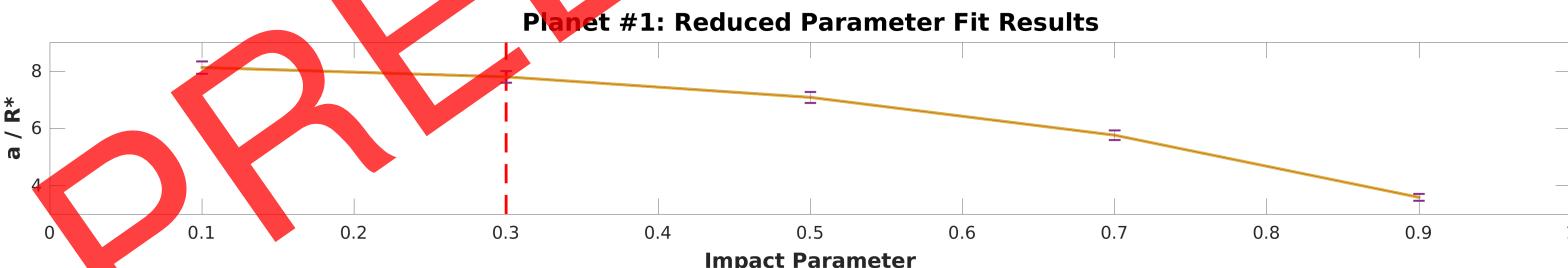
Model chi squares of reduced parameter fits vs. impact parameter for CatId 89020549, Planet candidate 1. The fit result with the minimum chi square is marked with a dashed line in the plot.

Open [./planet-01/planet-search-and-model-fitting-results/reduced-parameter-fits/000000089020549-01-reduced-fits-chi-square.fig](#)



Ratios of planet radius to star radius of reduced parameter fits vs. impact parameter for CatId 89020549, 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/000000089020549-01-reduced-fits-rp-over-rstar.fig](#)



Ratios of semimajor axis to star radius of reduced parameter fits vs. impact parameter for CatId 89020549, 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/000000089020549-01-reduced-fits-a-over-rstar.fig](#)

### 7.3 Model Fitter: Trapezoidal Fit Results

Model Characteristic	Name
Transit Model	trapezoidal_model
Limb Darkening Model	

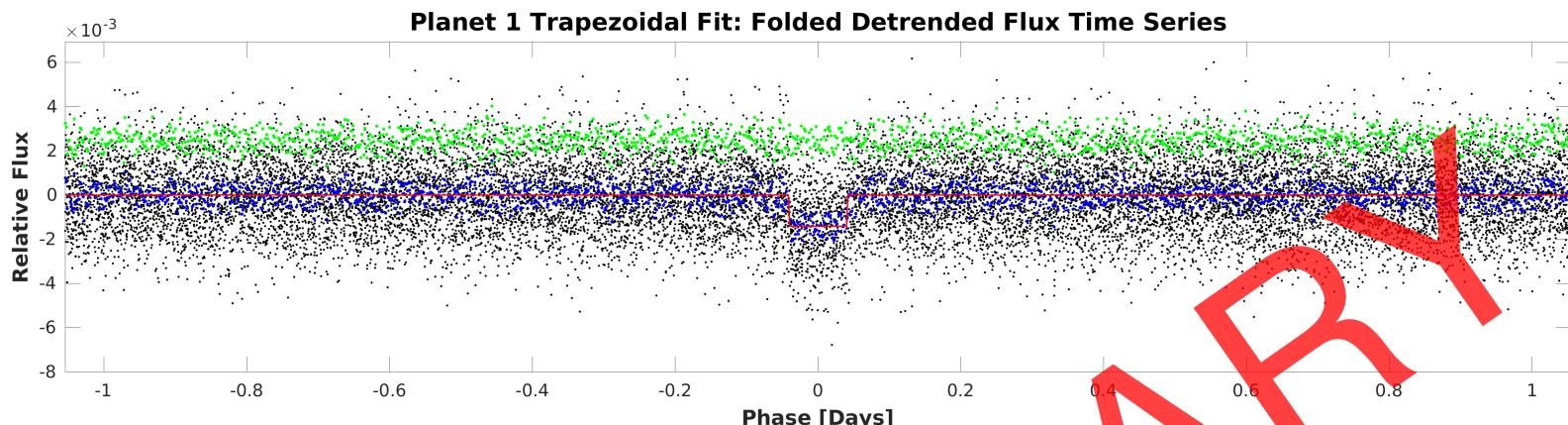
TCE Parameter	Value	Units
Trial Transit Pulse Duration	2.0	hours
Transit Epoch	1326.9006000	TJD
Orbital Period	2.1089411	days
Maximum SES	5.6	
Maximum MES	15.4	
Robust Statistic	17.8	
Chi Square Goodness of Fit Statistic (DoF)	665.7 (620)	
Chi Square2 Statistic (DoF)	7.8 (38.4)	
Threshold for Desired PFA		

DoF: Degrees of Freedom

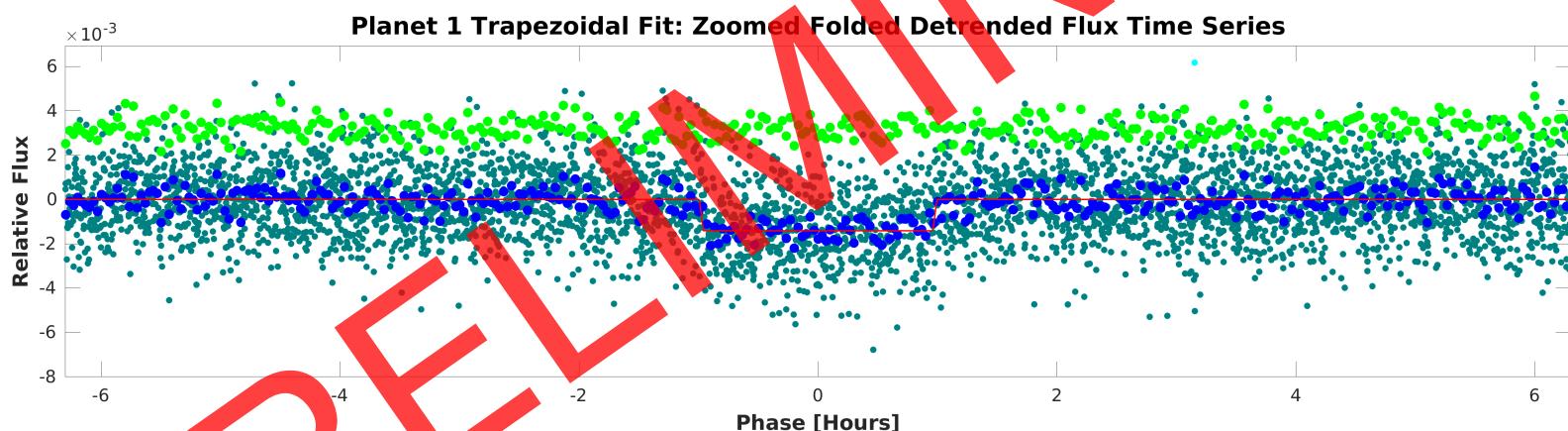
Parameter	Value	Uncertainty	Units
SNR	22.7		
Orbital Period	2.1089411		days
Transit Epoch	1326.9065570		BTJD
Transit Depth	1413		ppm
Transit Duration	2.1015		hours
Transit Ingress Duration	0.1462		hours
Model Chi Square Statistic (DoF)	18240.9 (5600)		

DoF: Degrees of Freedom

PRELIMINARY



Folded detrended flux time series for CatId 89020549, Planet candidate 1 and folded trapezoidal model light curve.  
Open ./planet-01/planet-search-and-model-fitting-results/trapezoidal-model-fit/000000089020549-01-all-trapezoidal.fig



Zoomed folded detrended flux time series for CatId 89020549, Planet candidate 1 and folded trapezoidal model light curve.  
Open ./planet-01/planet-search-and-model-fitting-results/trapezoidal-model-fit/000000089020549-01-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	2.1089		days		
Transit Duration	2		hours		
Maximum MES	15.4				
Secondary Phase	0.30694		days		
Secondary MES	2.7				
Minimum Phase	0.54922		days		
Minimum MES	-2.3				
Median MES	-0.1				
MAD MES	0.81633				
Robust Statistic	2.5				
Secondary Depth	198.9	7.4628e+01	ppm		
Geometric Albedo	10.4	1.2366e+01		0.7686	22.25
Planet Effective Temperature	3630	9.0210e+02	Kelvin	2.5034	0.61

### 7.4.2 Eclipsing Binary Discrimination Test

Result	Value	Value in Sigmas	Significance (%)
Odd Even Transit Depth Comparison Statistic	1.0360e-02	0.1018	91.89

#### 7.4.3 Bootstrap Test

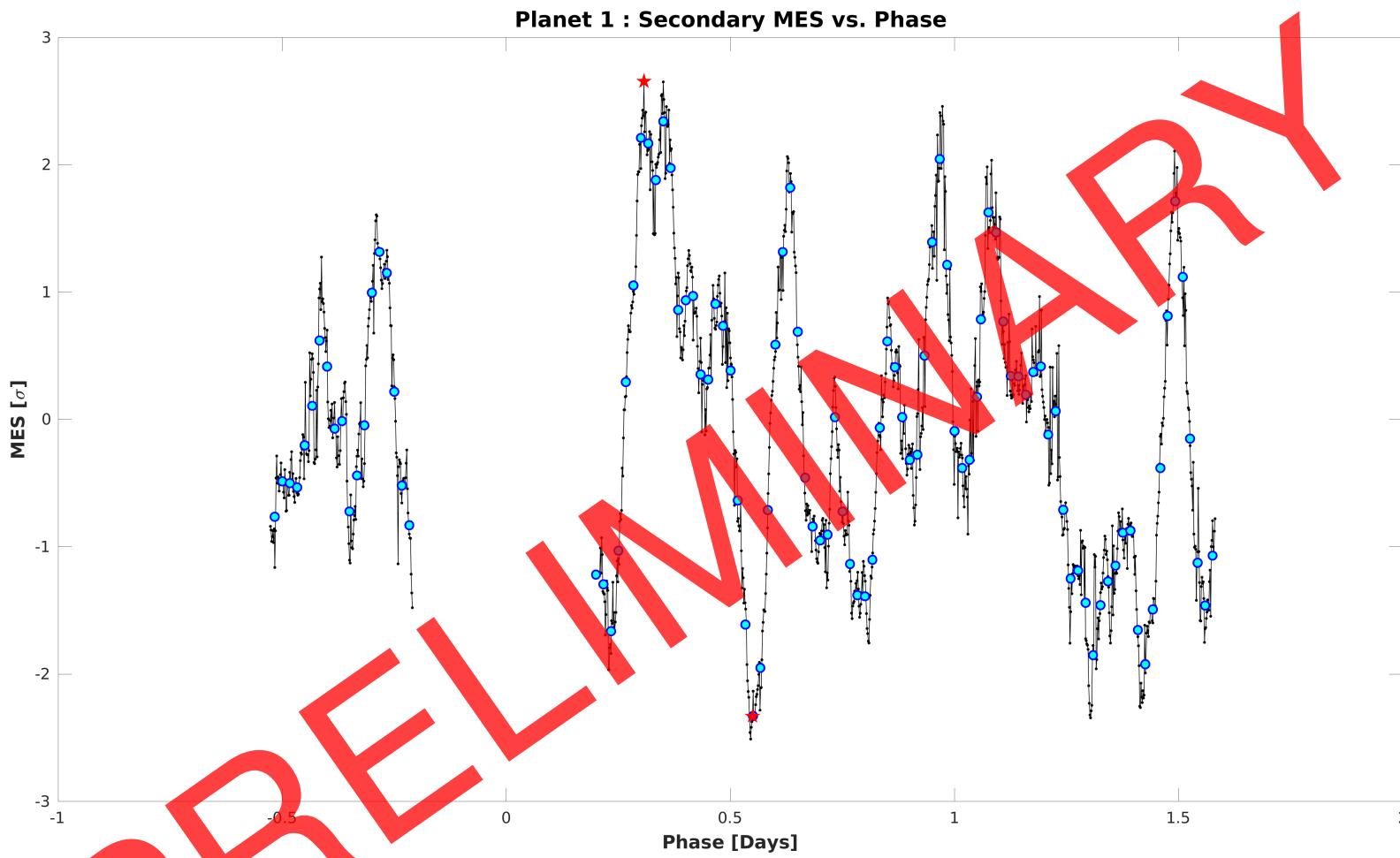
Result	Value
False Alarm Probability	1.2987e-54
Bootstrap Threshold for Desired PFA	7.0
MES Mean	-0.10
MES Standard Deviation	1.00
Transit Count	13

#### 7.4.4 Ghost Diagnostic Test

Result	Value	Significance (%)
Maximum MES	15.4	
SNR	18.7	
Core Aperture Statistic	9.6536e+00	100.00
Halo Aperture Statistic	1.7466e+00	95.96
Ratio of Core/Halo Aperture Statistics	5.5271e+00	

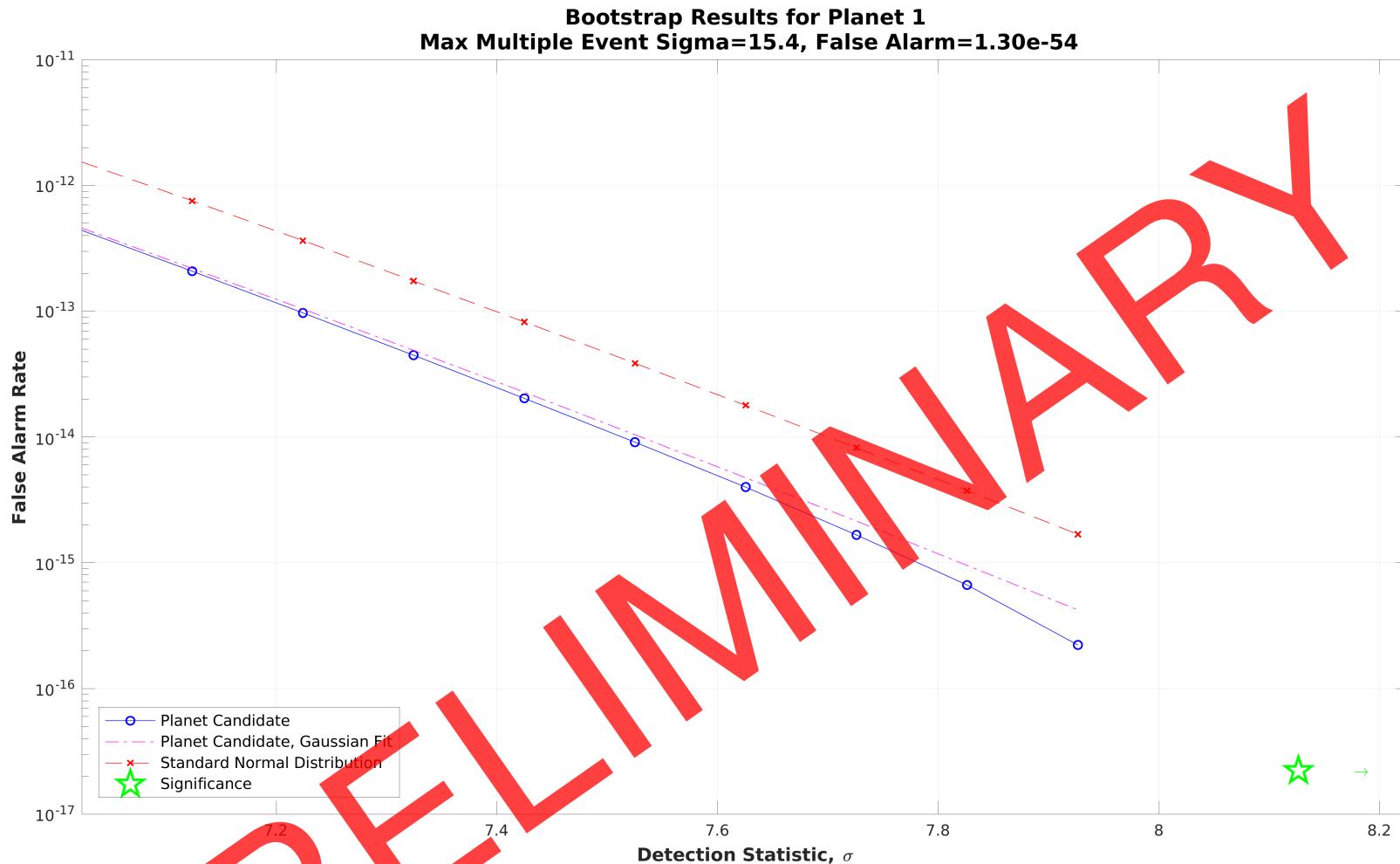
PRELIMINARY

#### 7.4.5 Validation Test Figures



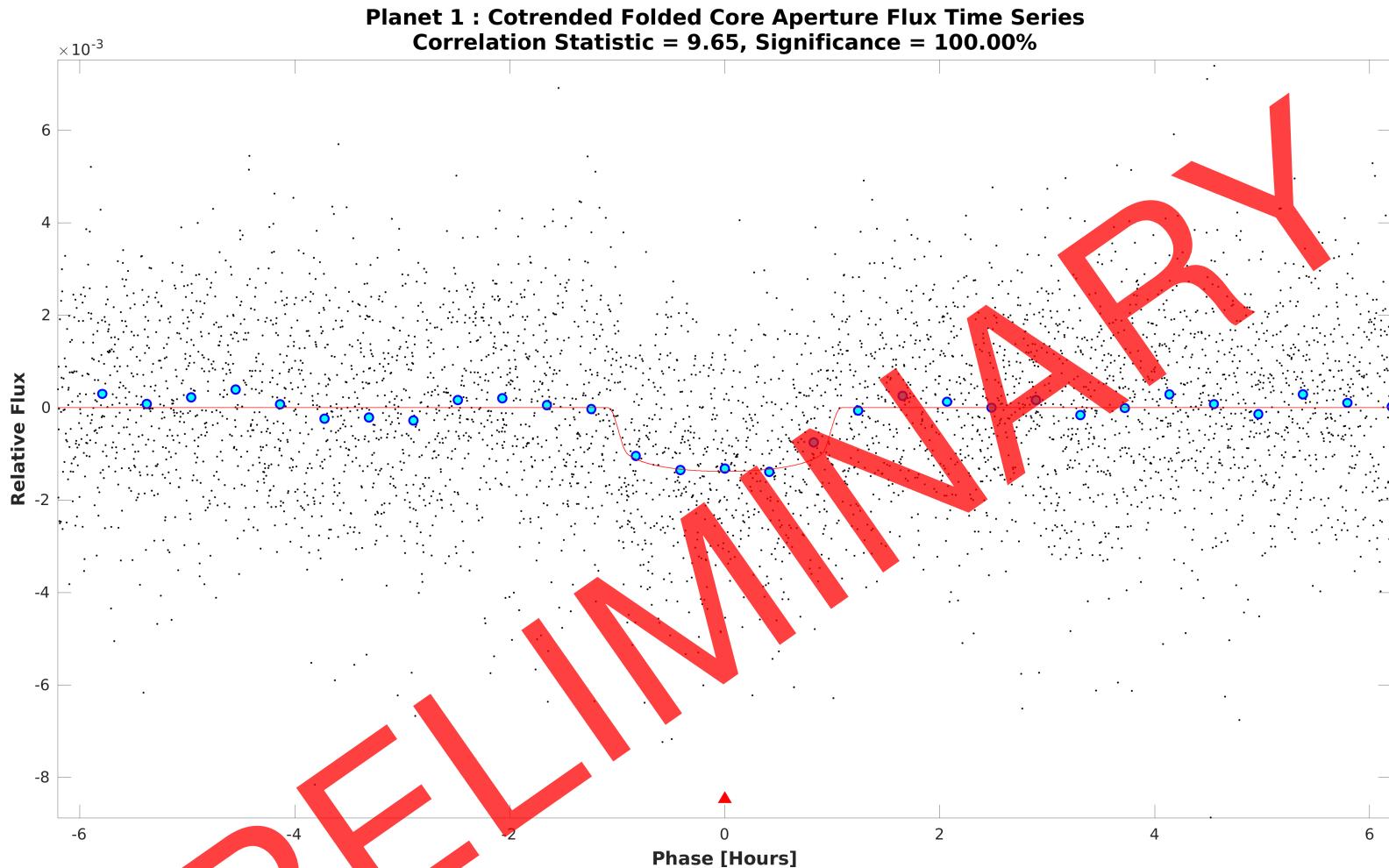
The primary event has been set to zero and both the max and min of the resulting MES vs. Phase are marked with a red star. The best matched pulse duration in hours is 2. The maximum secondary MES and corresponding phase are 2.6566 and 0.30694 days respectively. The minimum secondary MES and corresponding phase are -2.3314 and 0.54922 days respectively.

Open [./planet-01/report-summary/0000000089020549-01-weak-secondary-diagnostic.fig](#)



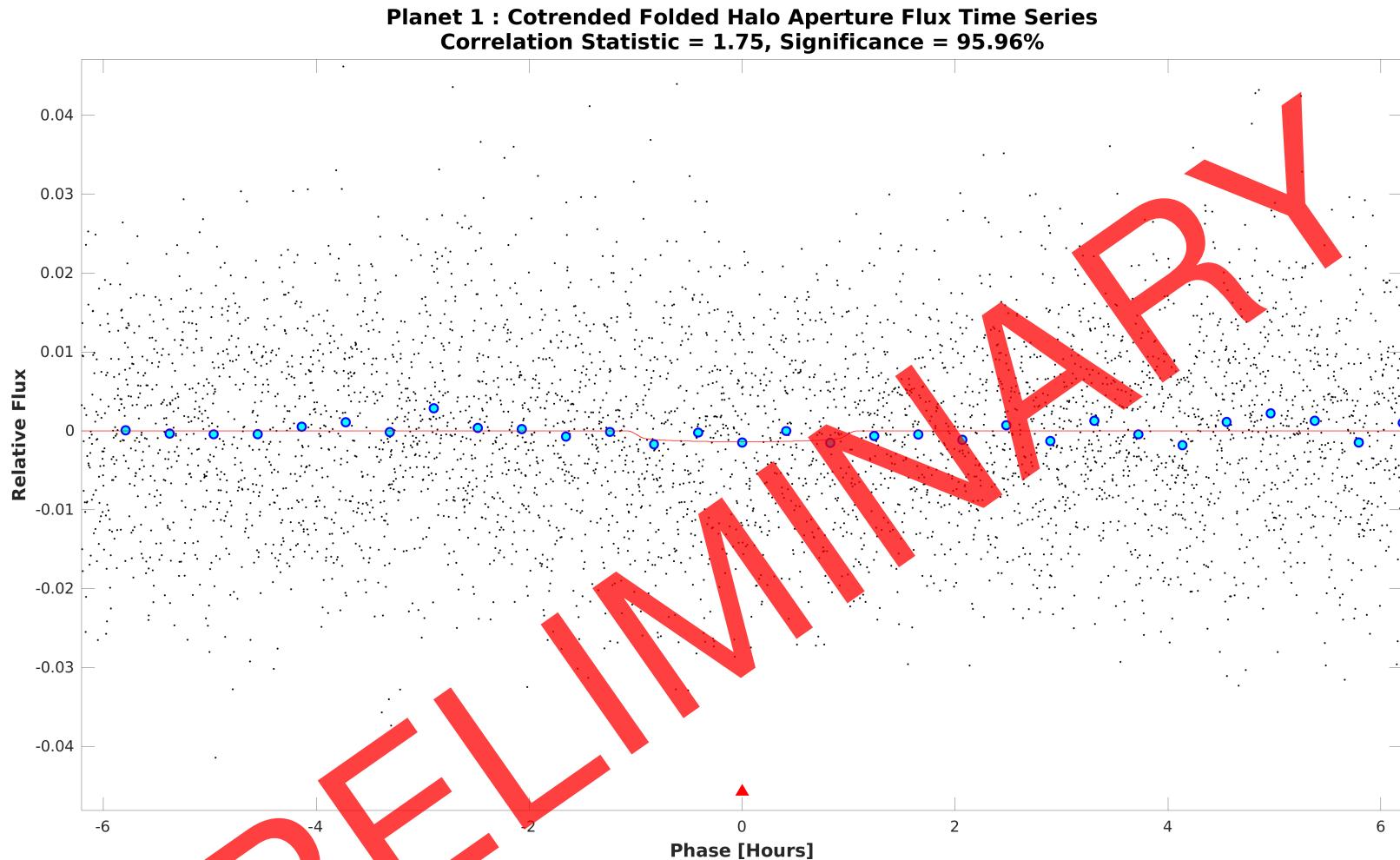
Bootstrap results for target 89020549, planet 1. Cumulative sum of the probabilities (derived from the histogram of counts) from upper tail to the search transit threshold; false alarm probability is indicated by the star. The Gaussian equivalent threshold for this false alarm probability is 15.5186. The threshold on this distribution that achieves the same false alarm rate as a 7.1 sigma threshold on a Gaussian distribution is 6.9854.

Open [./planet-01/bootstrap-results/000000089020549-01-bootstrap-false-alarm.fig](#)



Optical ghost diagnostic core aperture flux time series for target 89020549, 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/0000000089020549-01-core-unwhitened-cotrended-zoomed-model.fig](#)

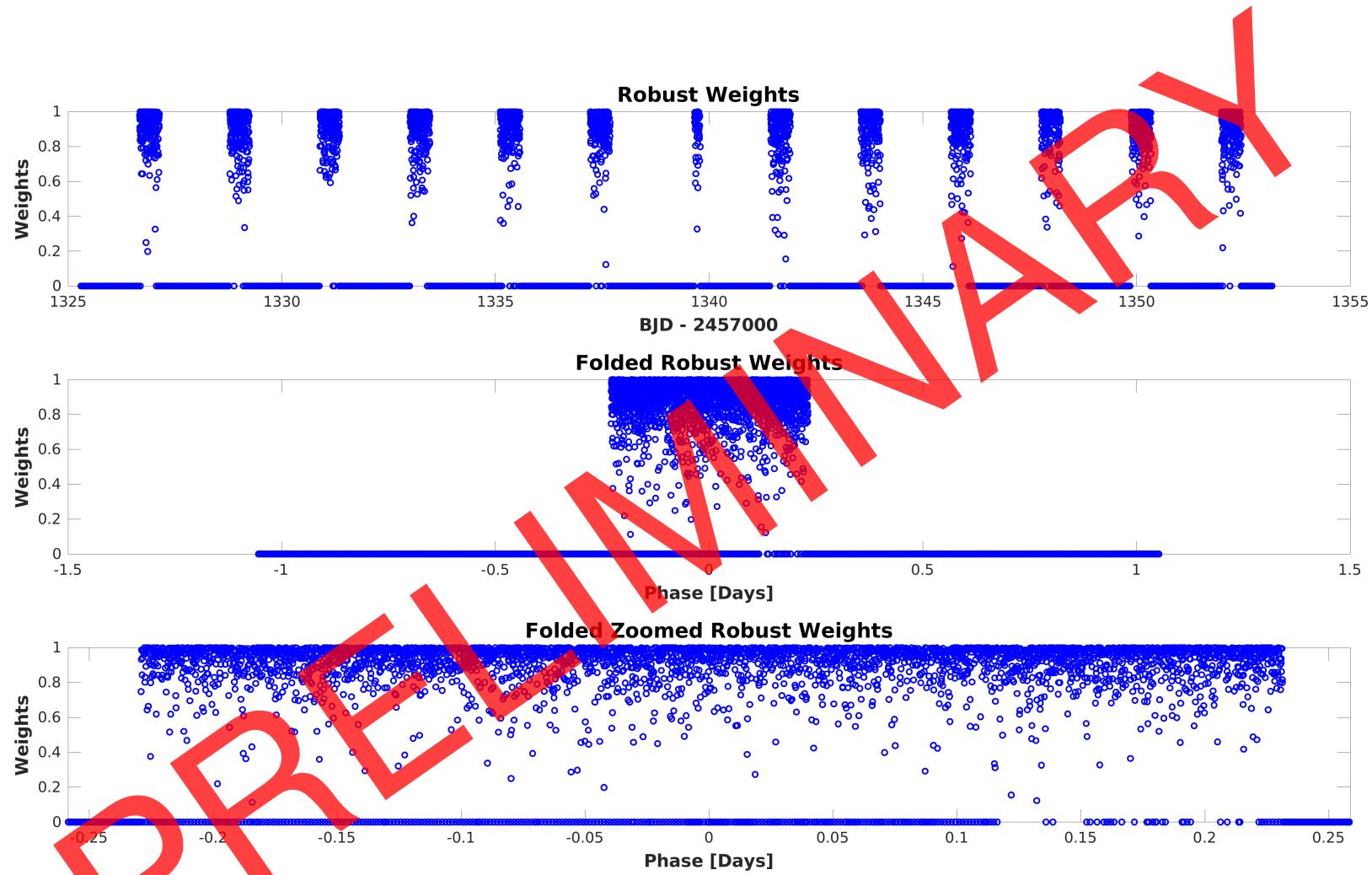


Optical ghost diagnostic halo aperture flux time series for target 89020549, planet candidate 1. The unwhitened time series is phase folded at the orbital period associated with the planet candidate and centered on the epoch of the first transit. The time series was first cotrended against spacecraft 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/0000000089020549-01-halo-unwhitened-cotrended-zoomed-model.fig](#)

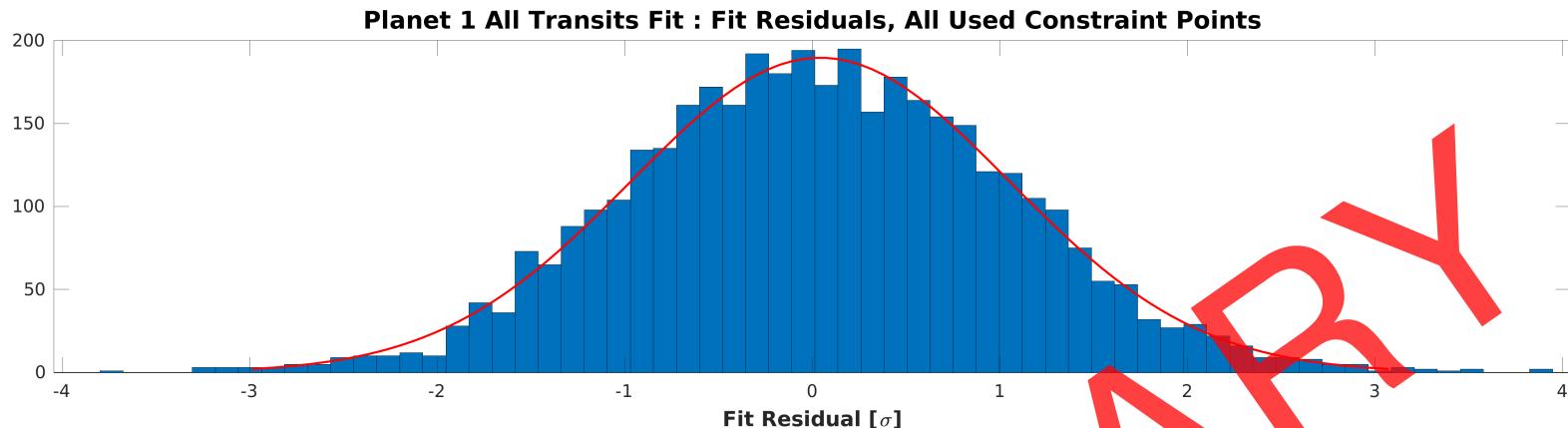
## Appendix A Planet Candidate 1

### A.1 Model Fitter: All Transits

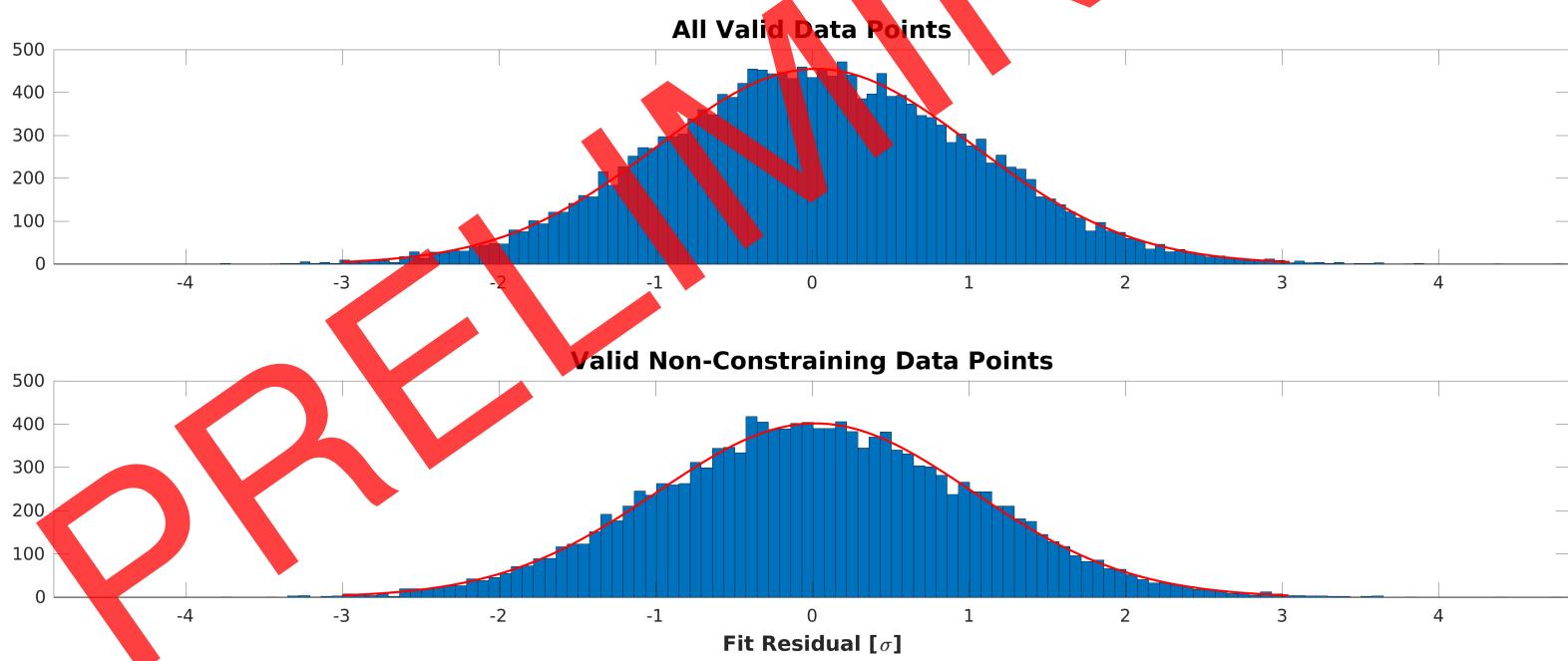


Robust weights distribution for CatId 89020549, Planet candidate 1. Top plot: all data points. Middle plot: all data points, folded per the fitted period and epoch. Bottom plot: all data points, folded and zoomed.

Open [./planet-01/planet-search-and-model-fitting-results/all-transits-fit/0000000089020549-01-all-robust-weights.fig](#)



Open [./planet-01/planet-search-and-model-fitting-results/all-transits-fit/000000089020549-01-all-histo-used.fig](#)



Fit residuals distribution for CatId 89020549, 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/000000089020549-01-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 $\ \text{Uncertainty}\ $
SNR	13.0		13.3			
Orbital Period	2.1092774	3.2328e-04	2.1093432	3.9935e-04	days	1.2803e-01
Transit Epoch	1326.9033501	2.3115e-03	1329.0135946	2.4199e-03	BTJD	2.8022e-01
Impact Parameter	0.2592	1.3183e+01	0.0273	1.4702e+02		1.5707e-03
Planet Radius to Star Radius Ratio	0.0345444	2.3435e-02	0.0341066	2.5306e-02		1.2693e-02
Semi-major Axis to Star Radius Ratio	7.8446	2.8083e+01	8.1451	3.2102e+01		7.0469e-03
Planet Radius	3.3158	2.3460e+00	3.2738	2.5165e+00	Earth radii	1.2214e-02
Semi-major Axis	0.0323	1.1252e-02	0.0323	1.1252e-02	AU	4.2208e-05
Effective Stellar Flux	687.4417	4.6064e+02	687.4131	4.6062e+02	Goldilocks	4.3879e-05
Equilibrium Temperature	1306	2.1877e+02	1306	2.1877e+02	Kelvin	4.3879e-05
Stellar Density	1.4577	1.5656e+01	1.6317	1.9292e+01	Solar density	7.0016e-03
Transit Depth	1385	1.2383e+02	1367	1.2440e+02	ppm	1.0178e-01
Transit Duration	2.0641	5.3827e-01	2.0507	5.4879e-01	hours	1.7397e-02
Transit Ingress Duration	0.0741	5.9151e-01	0.0680	5.9655e-01	hours	7.2152e-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)	3005.0 (3547.5)		3005.0 (3547.5)			

DoF: Degrees of Freedom



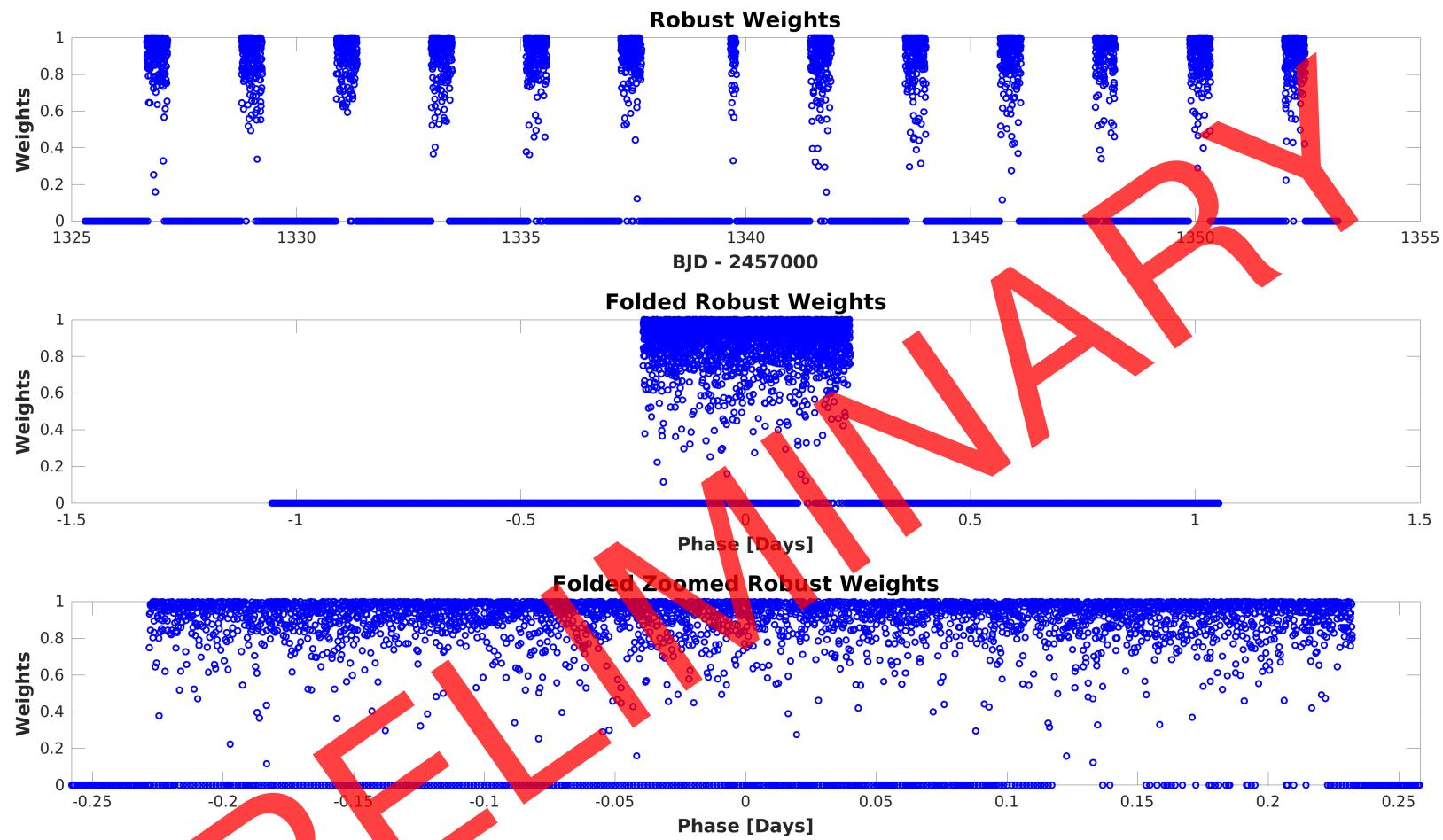
Folded flux time series for CatId 89020549, Planet candidate 1 in the whitened domain is plotted in black dots. Values are averaged into 1 cadence wide bins. The blue dots represent the averaged values of the folded flux time series; the red dots represent the averaged values of the folded model light 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/000000089020549-01-odd-even-whitened.fig](#)



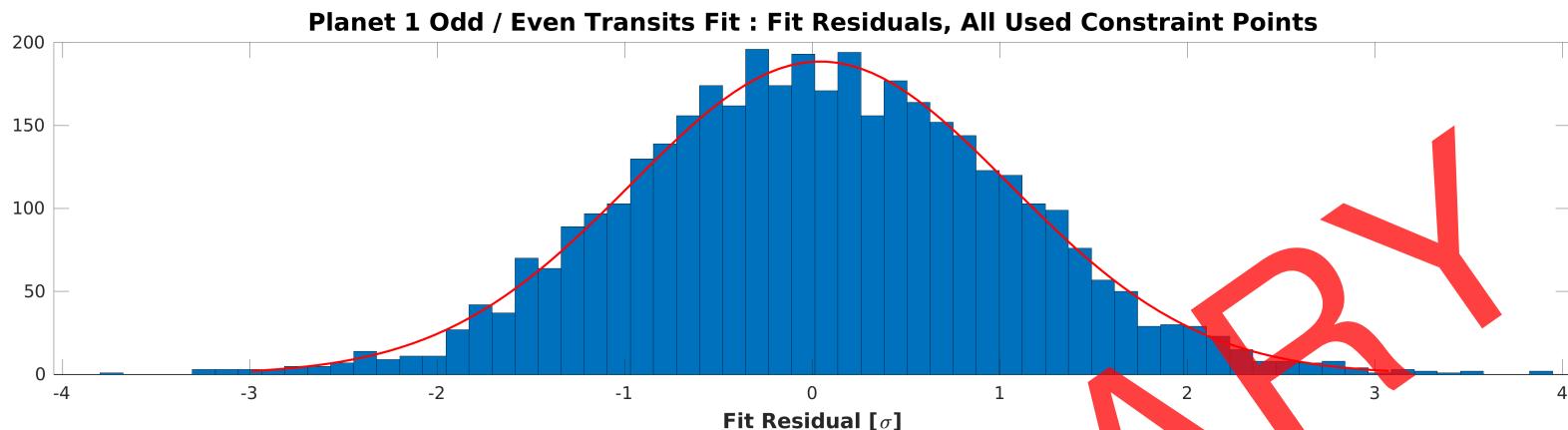
Folded flux time series for CatId 89020549, Planet candidate 1 in the whitened domain, zoomed on the transit. The flux data whose robust weights are larger/smaller than 0.1 are plotted in dark green/cyan dots, respectively. Values are averaged into 1 cadence wide bins. The blue dots represent the averaged 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/000000089020549-01-odd-even-whitened-zoomed.fig](#)

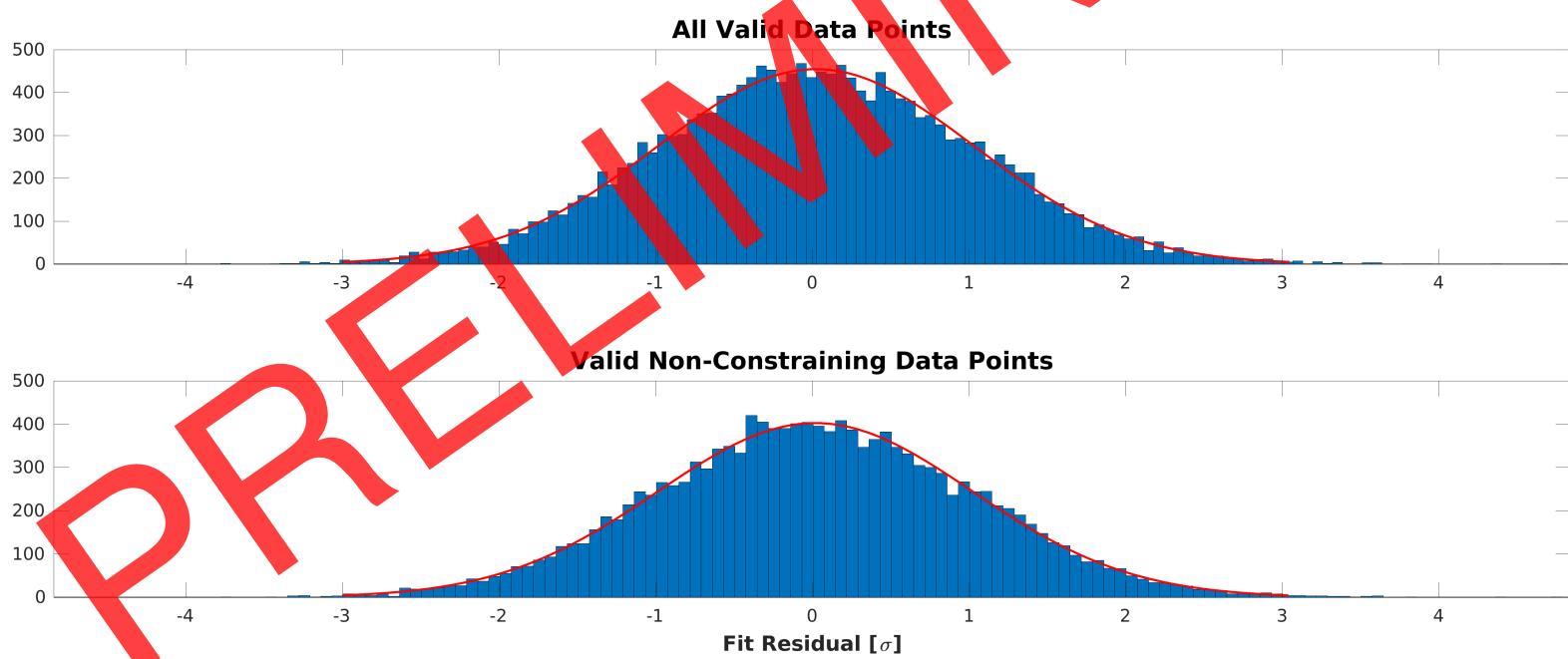


Robust weights distribution for CatId 89020549, Planet candidate 1. Top plot: all data points. Middle plot: all data points, folded per the fitted period and epoch. Bottom plot: all data points, folded and zoomed.

Open [./planet-01/planet-search-and-model-fitting-results/odd-even-transits-fit/0000000089020549-01-odd-even-robust-weights.fig](#)

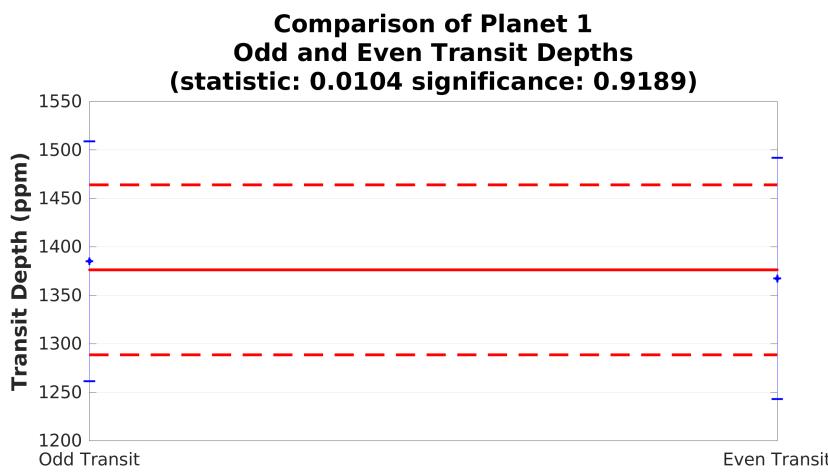


Open [./planet-01/planet-search-and-model-fitting-results/odd-even-transits-fit/000000089020549-01-odd-even-histo-used.fig](#)



Open [./planet-01/planet-search-and-model-fitting-results/odd-even-transits-fit/000000089020549-01-odd-even-histo-all-and-unused.fig](#)

### A.3 Eclipsing Binary Discrimination Test



**PRELIMINARY**

Top-left: Diagnostic plot of Odd/Even Transit Depth Test for catId 89020549, planet 1. A significance level close to 1/0 favors a transiting planet/an eclipsing binary.  
Open [./planet-01/binary-discrimination-test-results/000000089020549-01-eclipsing-binary-discrimination-tests.fig](#)

## Appendix B Alerts

Time	Severity	Message
1359.3931	warning	TOI matching is disabled (target=1, catId=89020549, component=performDvToiMatching)

PRELIMINARY