

# KIC 012470844

## Q1-17 DR25 TCE Parameters

TCE	Run Type	KOI?	Period (Days)	Epoch (BKJD)	Depth (ppm)	Duration (Hours)	MES	SNR	$R_{\star}$ ( $R_{\odot}$ )	$T_{\star}$ (K)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
012470844-01	OBS	0790.01	8.472379	131.800026	1127.0	2.809	39.9	45.2	0.79	5354	2.90	75.50
012470844-02	OBS	0790.02	60.419174	181.160689	865.2	5.108	15.1	16.7	0.79	5354	2.43	5.50

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
012470844-01	OBS	PC	1.00	0	0	0	0	NO_COMMENT
012470844-02	OBS	PC	0.99	0	0	0	0	NO_COMMENT

**Notes:** OBS = Observed. INJ = Injected. INV = Inverted. SCR = Scrambled.

N = Not Transit-Like. S = Stellar Eclipse. C = Centroid Offset. E = Ephemeris Match.

See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

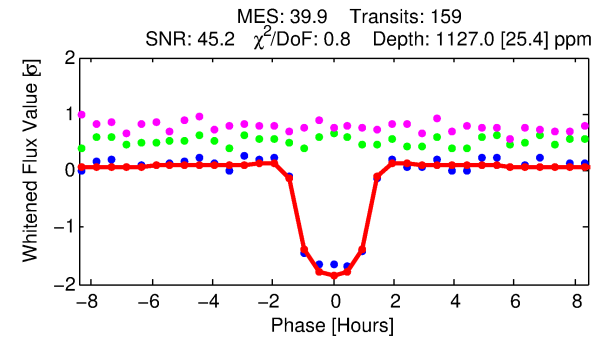
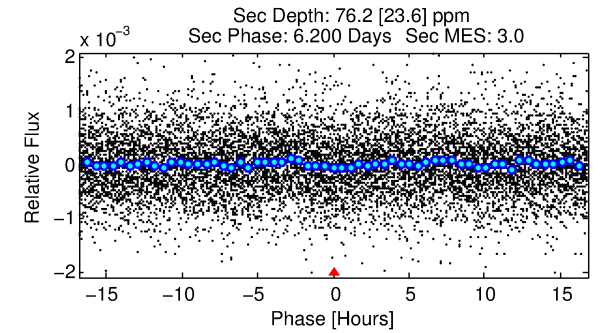
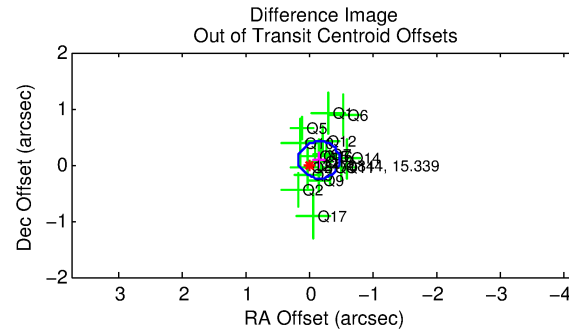
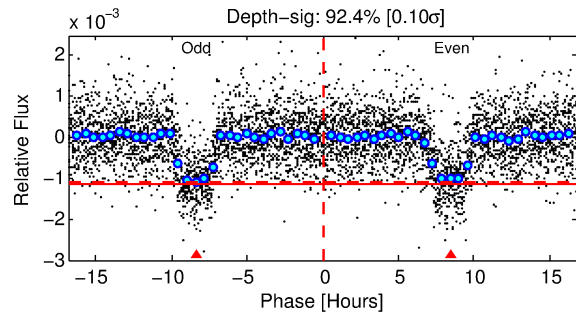
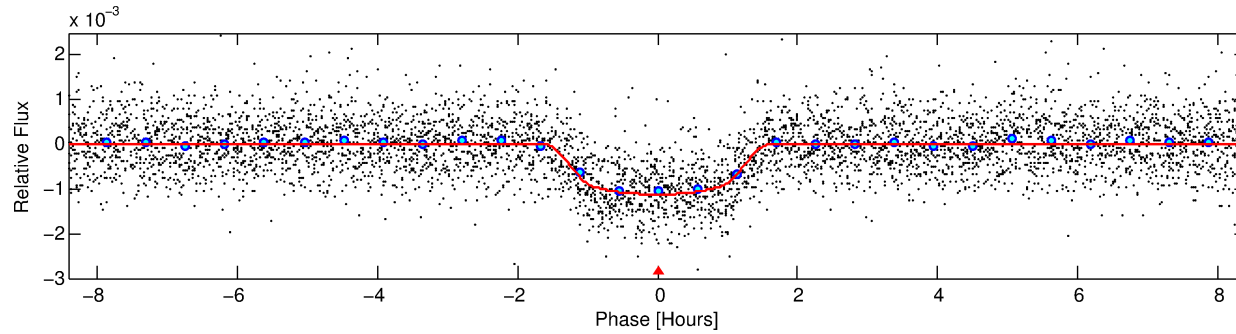
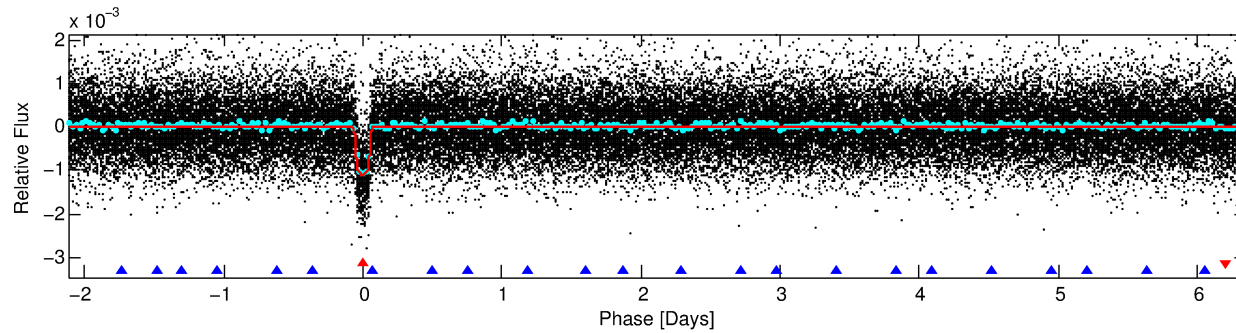
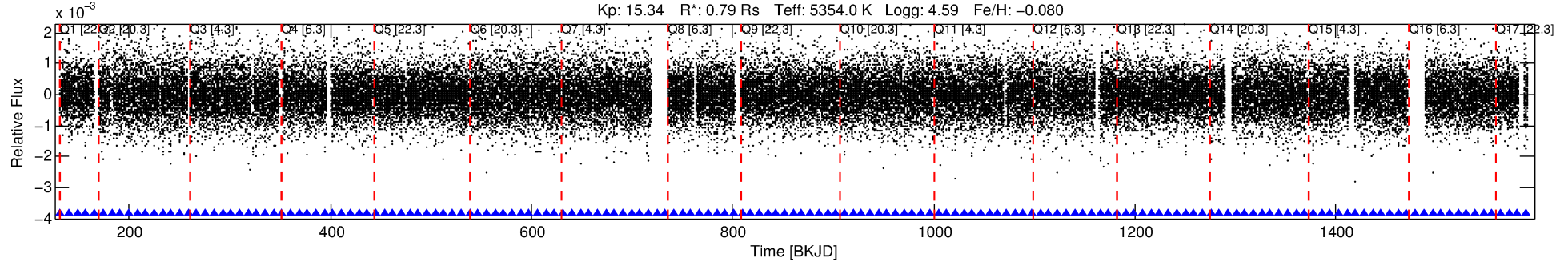
## Ephemeris Match Information For 012470844-01

No Significant Match Found

# DV One-Page Summary

KIC: 12470844 Candidate: 1 of 2 Period: 8.472 d  
KOI: K00790.01 Name: Kepler-233b Corr: 0.983

Kp: 15.34 R\*: 0.79 Rs Teff: 5354.0 K Logg: 4.59 Fe/H: -0.080



## DV Fit Results:

Period = 8.47238 [0.00001] d  
Epoch = 131.8000 [0.0013] BKJD  
Rp/R\* = 0.0337 [0.0064]  
a/R\* = 16.01 [11.82]  
b = 0.77 [0.41]  
Seff = 75.50 [16.67]  
Teq = 752 [41] K  
Rp = 2.90 [0.69] Re  
a = 0.0778 [0.0097] AU  
Ag = 30.16 [15.80] [1.85σ]  
Teffp = 2723 [343] K [5.71σ]

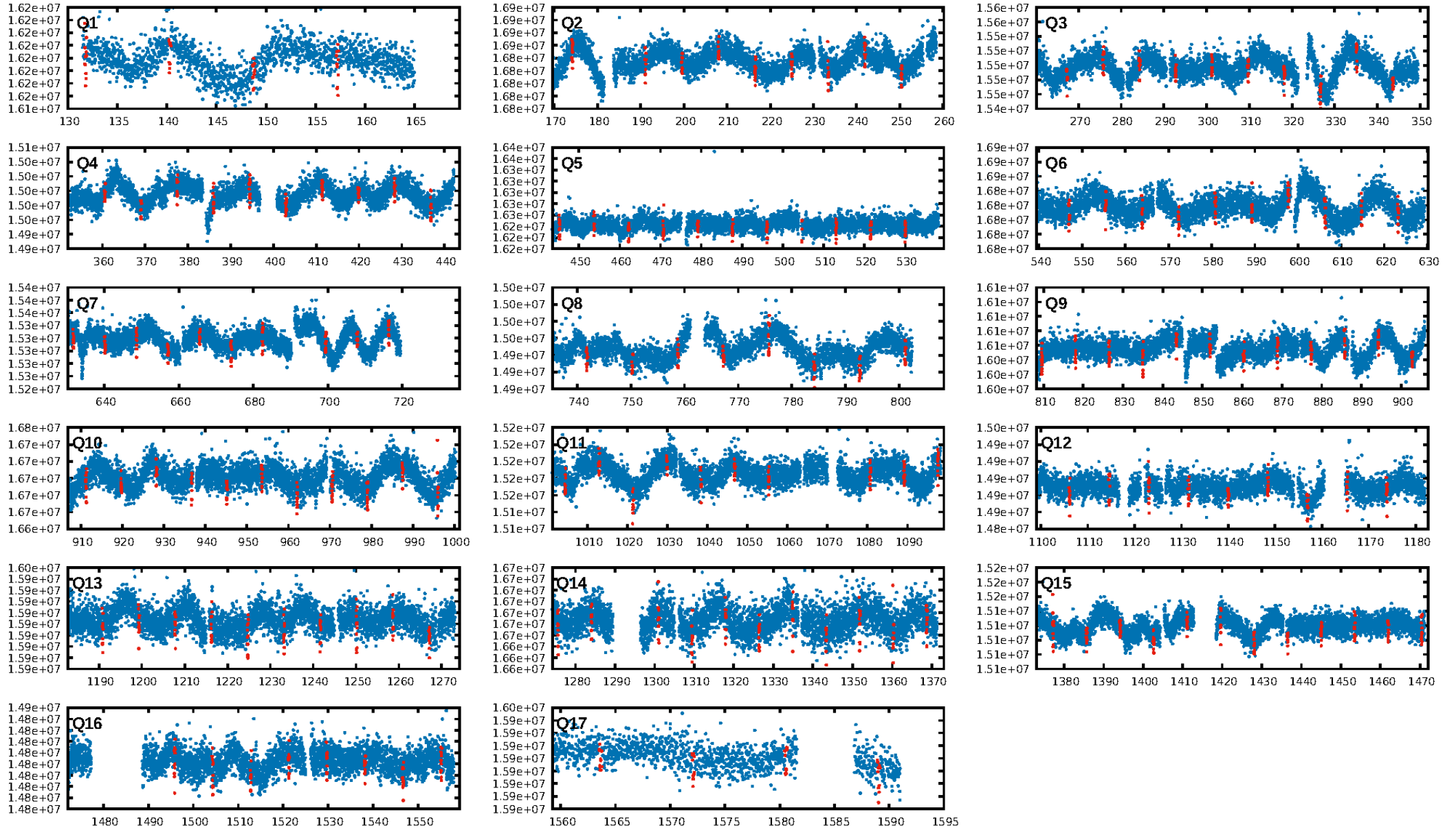
## DV Diagnostic Results:

ShortPeriod-sig: N/A  
LongPeriod-sig: 100.0% [213.85σ]  
ModelChiSquare2-sig: 100.0%  
ModelChiSquareGof-sig: 100.0%  
Bootstrap-pfa: 0.00e+00  
RollingBand-fgt: 1.00 [151/151]  
GhostDiagnostic-chr: 3.453  
Centroid-sig: 4.6%  
Centroid-so: 1.197 arcsec [4.04σ]  
OotOffset-rm: 0.172 arcsec [1.57σ]  
KicOffset-rm: 0.106 arcsec [1.10σ]  
OotOffset-st: 4/4/4/5 [17]  
KicOffset-st: 4/4/4/5 [17]  
DiffImageQuality-fgm: 1.00 [17/17]  
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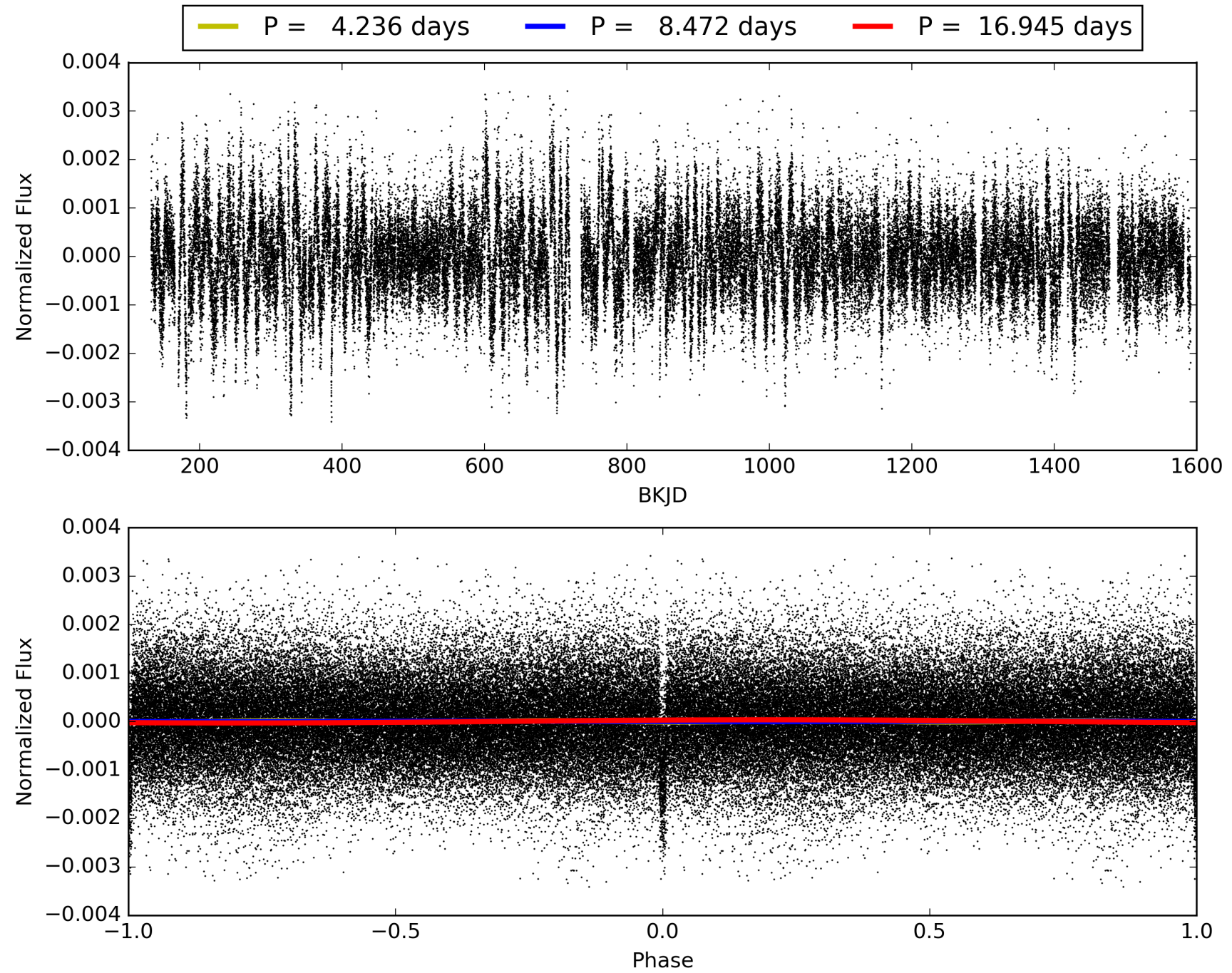
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This Data Validation Report Summary was produced in the Kepler Science Operations Center Pipeline at NASA Ames Research Center

# TCE 012470844-01, PDC Light Curves

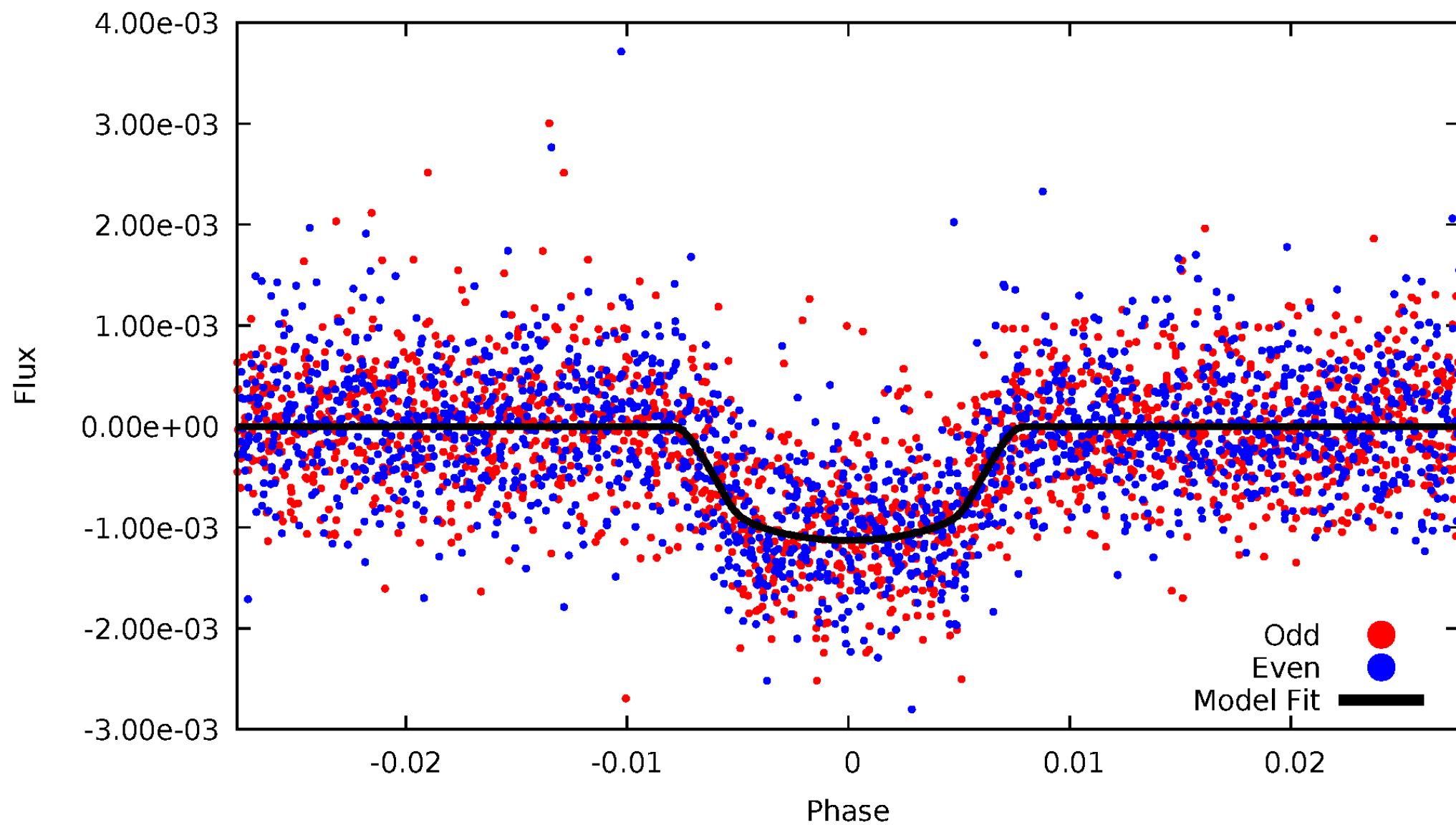


TCE 012470844-01



# DV Odd/Even

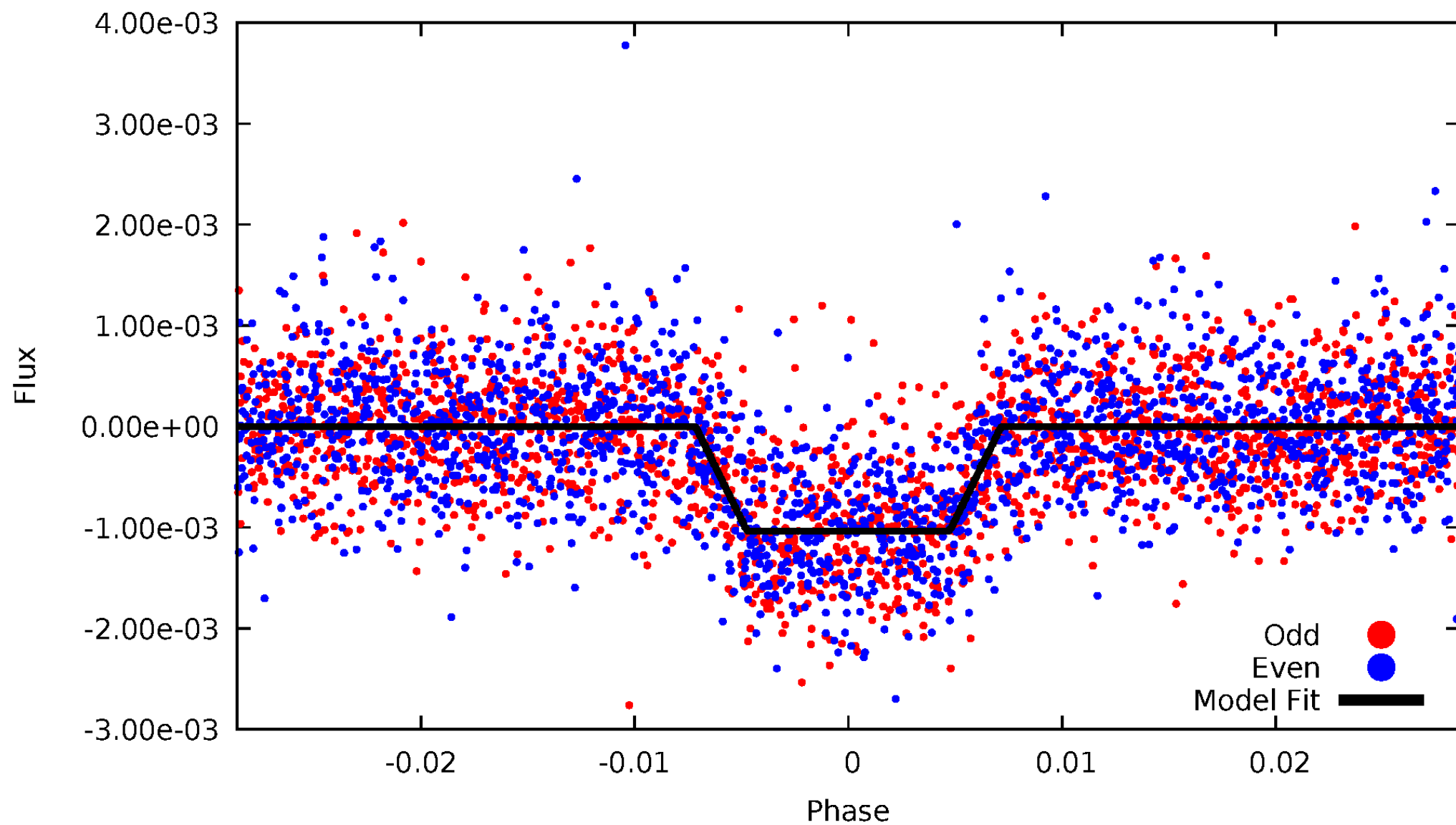
TCE 012470844-01





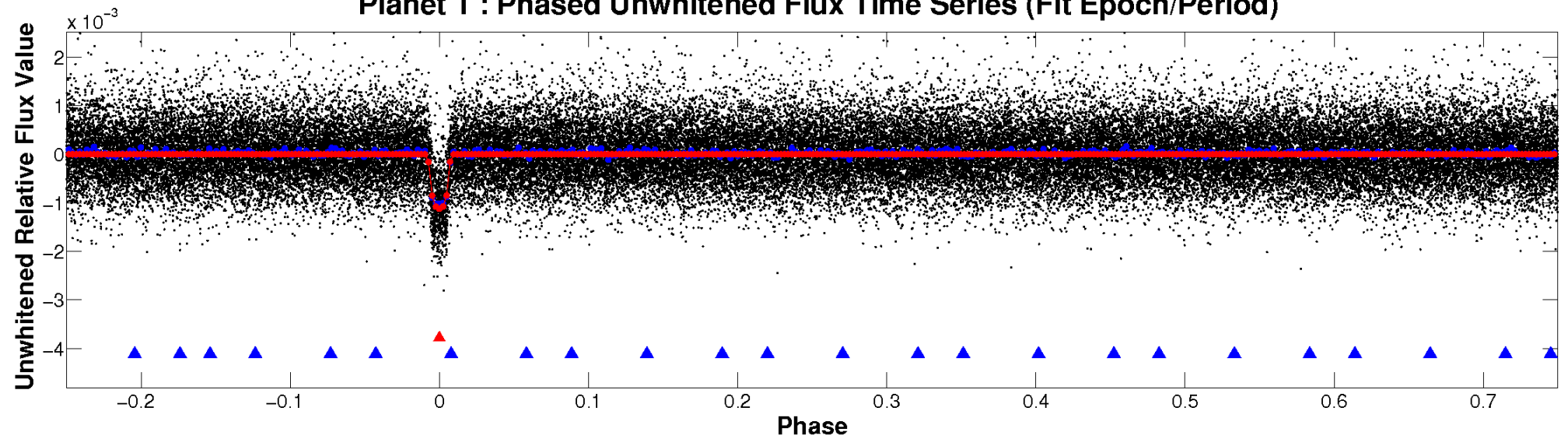
# ALT Odd/Even

TCE 012470844-01

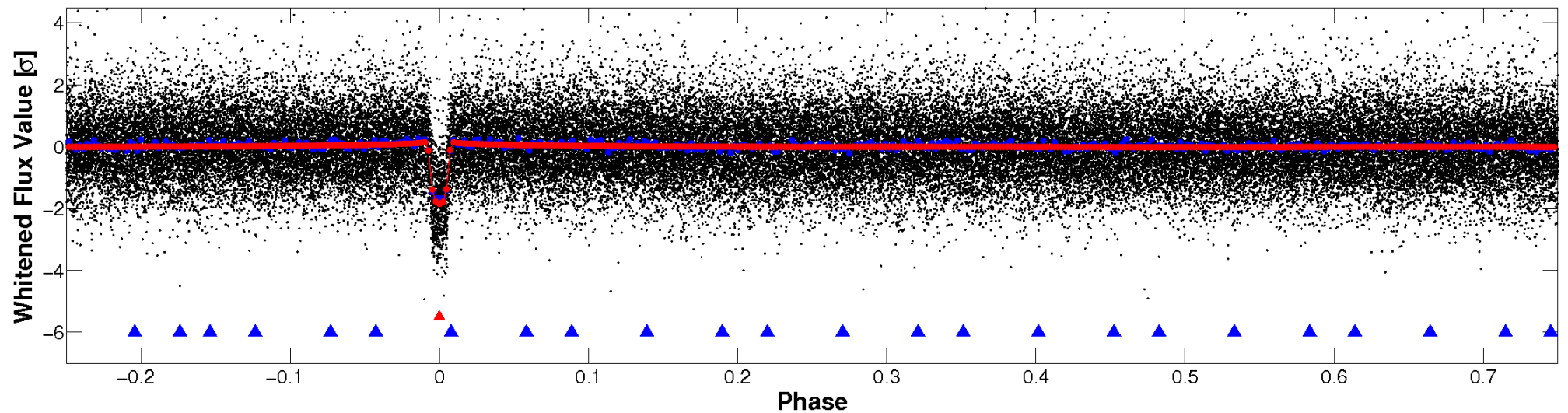


# Non-Whitened Vs. Whitened Light Curve

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

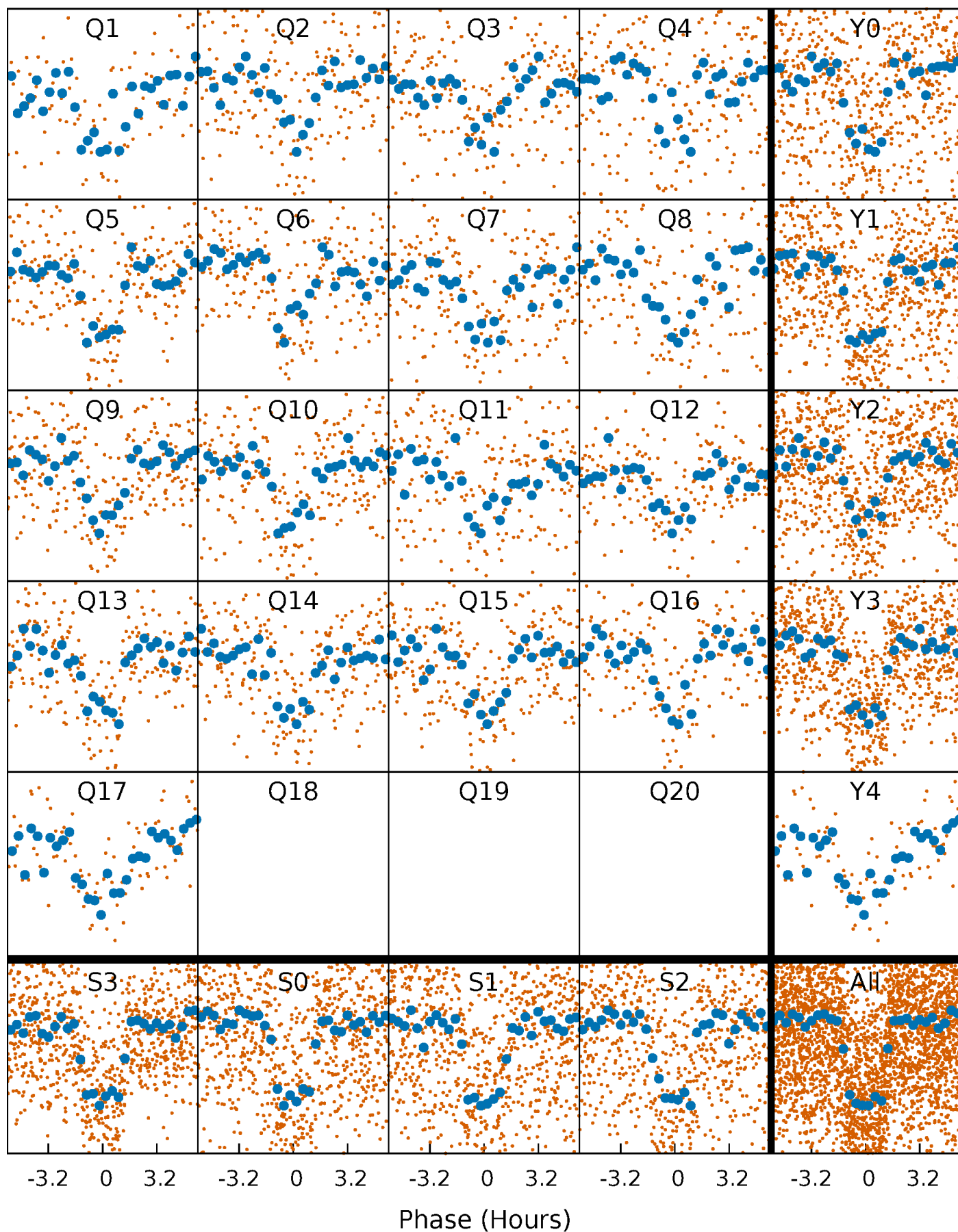


**Planet 1 : Phased Whitened Flux Time Series (Fit Epoch/Period)**



# PDC Quarter-Phased Transit Curves

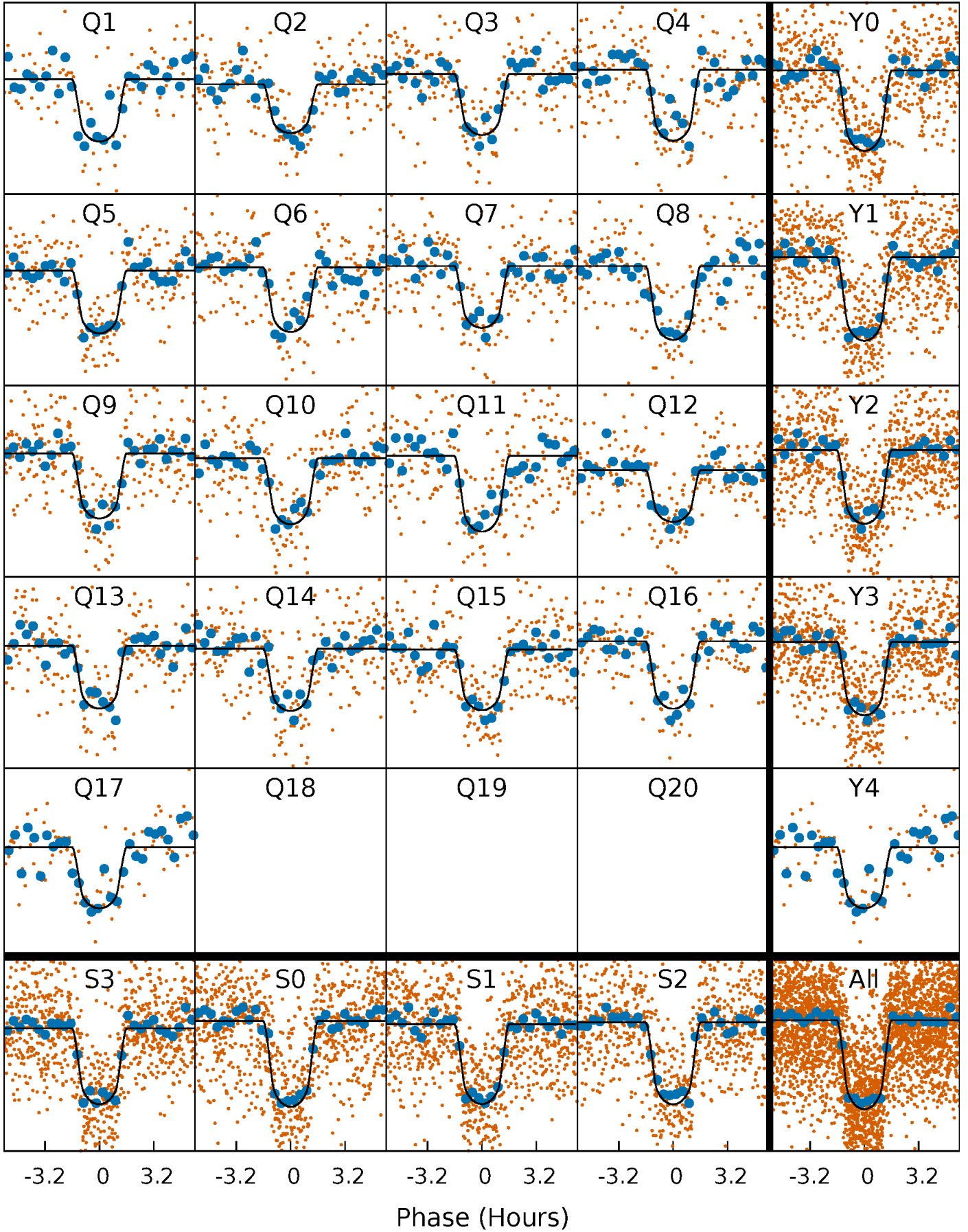
TCE 012470844-01 P= 8.472379 Days  $T_0=131.800026$  (BKJD)





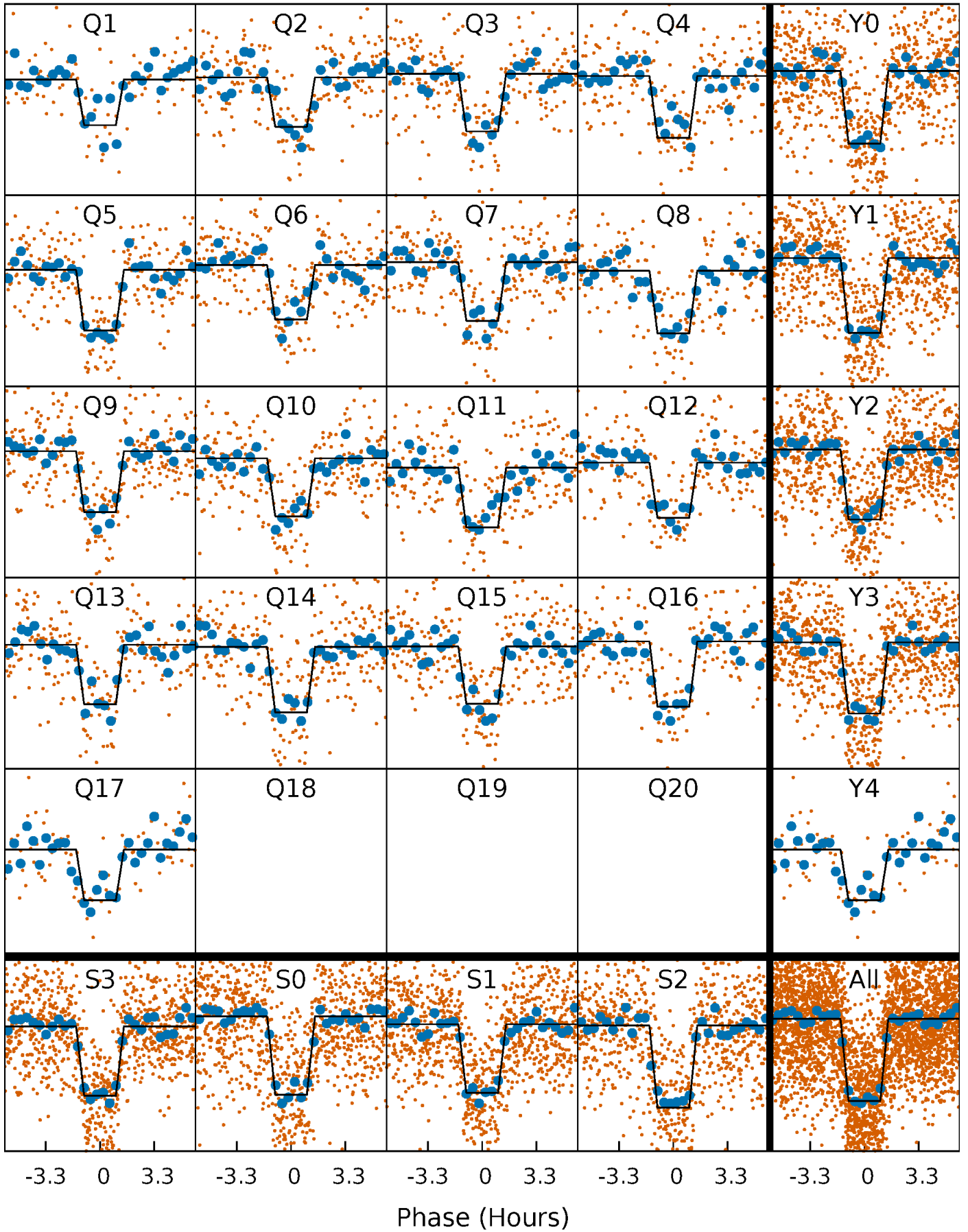
# DV Quarter-Phased Transit Curves

TCE 012470844-01 P= 8.472379 Days  $T_0=131.800026$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

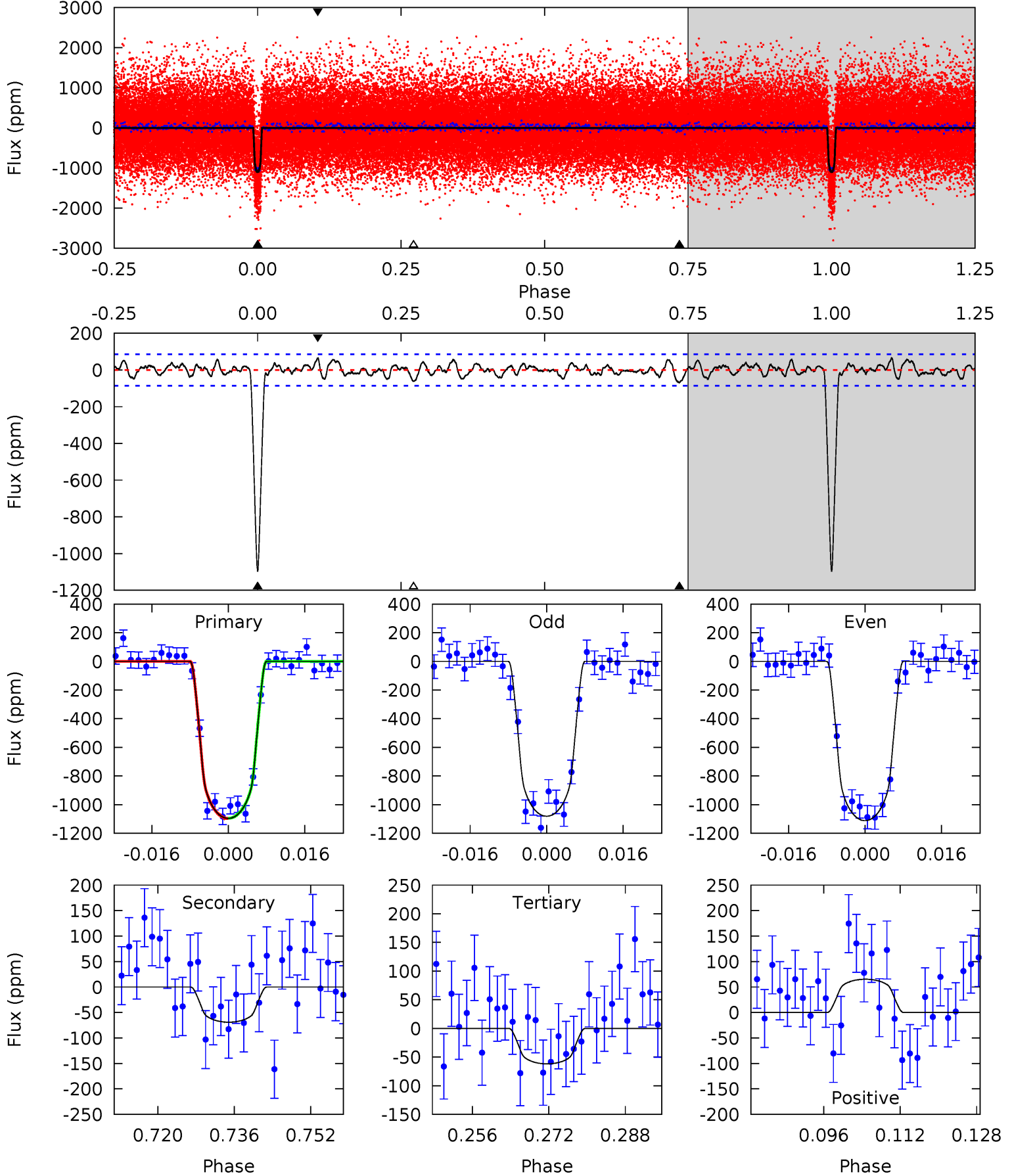
TCE 012470844-01 P= 8.472462 Days  $T_0=131.793020$  (BKJD)



# DV Model-Shift Uniqueness Test

012470844-01, P = 8.472379 Days, E = 123.327647 Days

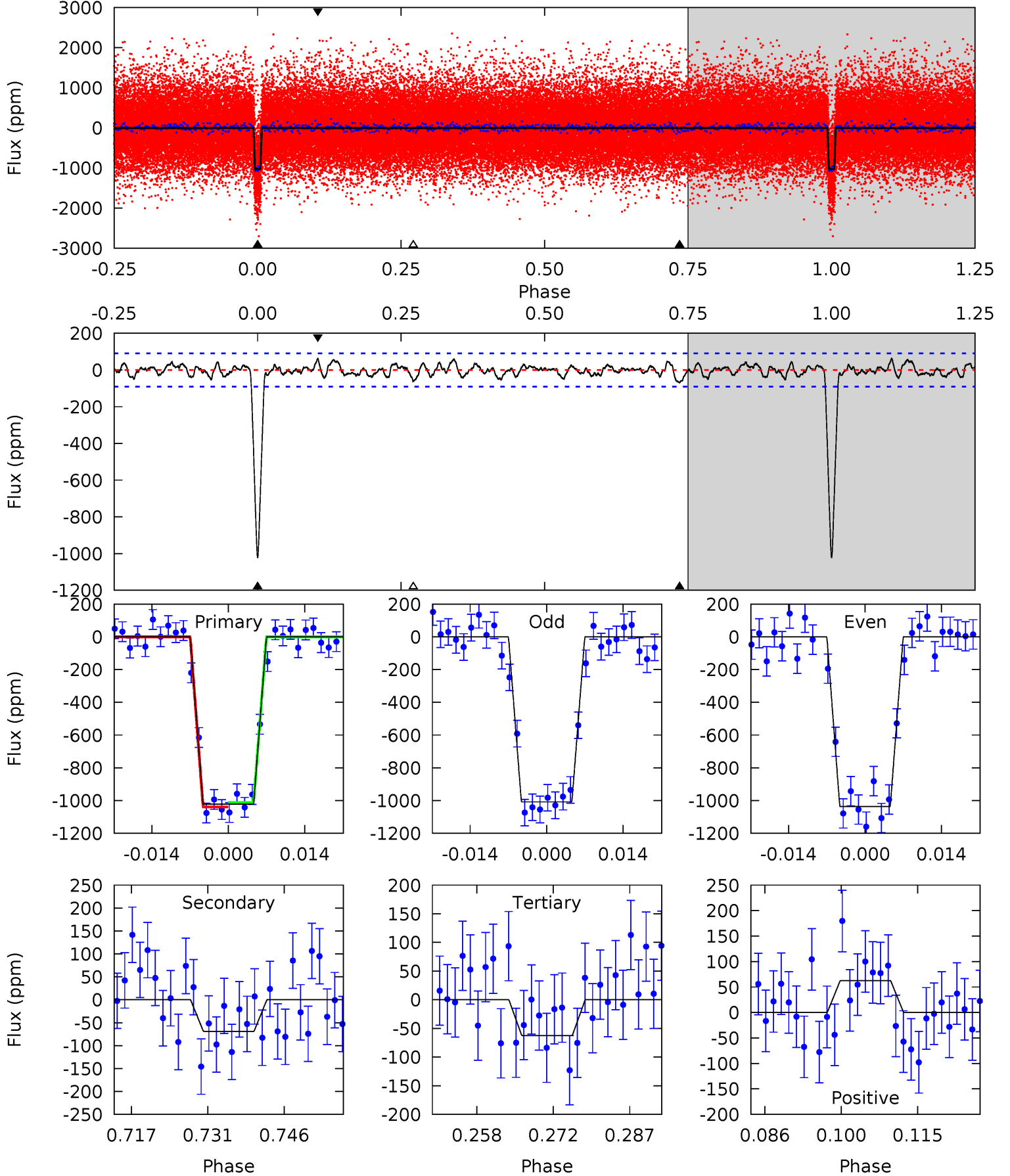
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
63.0	3.97	3.56	3.76	4.94	2.41	1.35	59.5	59.3	0.41	0.21	0.89	0.99	0.06	0.05



# Alt Model-Shift Uniqueness Test

012470844-01, P = 8.472462 Days, E = 123.320558 Days

Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
55.9	3.78	3.41	3.41	4.96	2.45	1.24	52.5	52.5	0.37	0.37	0.77	1.02	0.06	0.74



### Stellar Parameters For KIC 012470844

	$T_{\text{eff}} (K)$	$\log(g)$	$[\text{Fe}/\text{H}]$	$R (R_{\odot})$	$M (M_{\odot})$	$p_{\star} (\text{g}\cdot\text{cm}^{-3})$
	$5354^{+159}_{-159}$	$4.587^{+0.032}_{-0.104}$	$-0.080^{+0.300}_{-0.300}$	$0.788^{+0.113}_{-0.066}$	$0.884^{+0.061}_{-0.113}$	$2.542^{+0.438}_{-0.787}$
	+3%/-3%	+1%/-2%	+375%/-375%	+14%/-8%	+7%/-13%	+17%/-31%
Source	PHO1	KIC0	KIC0	DSEP		

KIC = Kepler Input Catalog; PHO = Photometry; SPE = Spectroscopy; AST = Asteroseismology  
 TRA = Transits; DESP = Dartmouth Models; MULT = Multiple Models

### Secondary Eclipse Parameters for KIC 012470844-01 / KOI 0790.01

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{\text{max}} (K)$	$T_{\text{obs}} (K)$	$A_{\text{obs}}$
DV	$-69 \pm 17$	$2.96^{+0.63}_{-0.57}$	$1066^{+48}_{-38}$	$3223^{+259}_{-227}$	$25^{+17}_{-9}$
Alt.	$-69 \pm 18$	$2.84^{+0.59}_{-0.61}$	$1063^{+49}_{-39}$	$3255^{+287}_{-236}$	$28^{+20}_{-11}$

$T_{\text{max}}$  = Theoretical Maximum Planetary Temperature

$T_{\text{obs}}$  = Observed Planetary Temperature (Assuming  $A=0.3$ )

$A_{\text{obs}}$  = Observed Albedo (Assuming  $T=0$ )

If a secondary eclipse is present, the system is likely an EB if  $T_{\text{obs}} \gg T_{\text{max}}$  AND  $A_{\text{obs}} \gg 1.0$



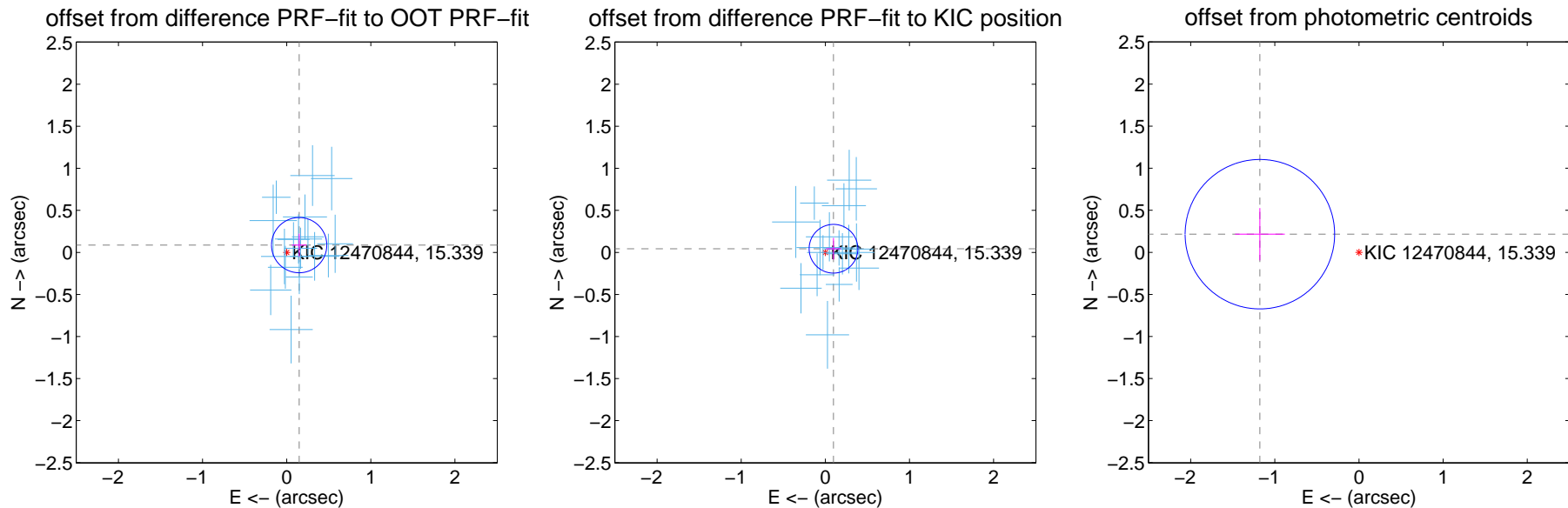
## DV Centroid Data

Supplemental centroid analysis for 012470844-01. Kepler magnitude: 15.34. Transit SNR 45.17

There are 17 quarters with good PRF difference image offsets

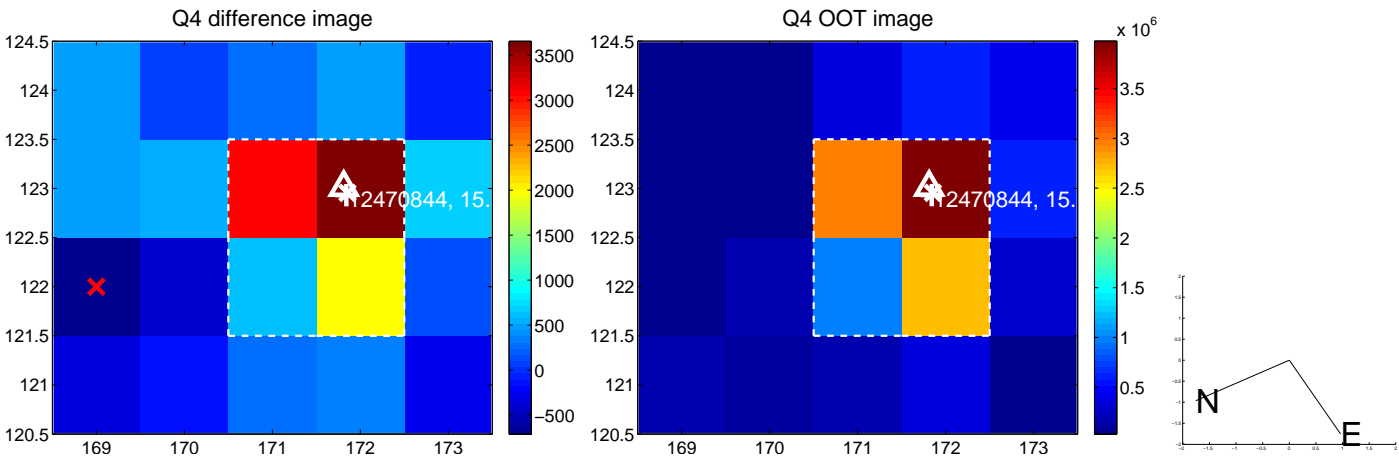
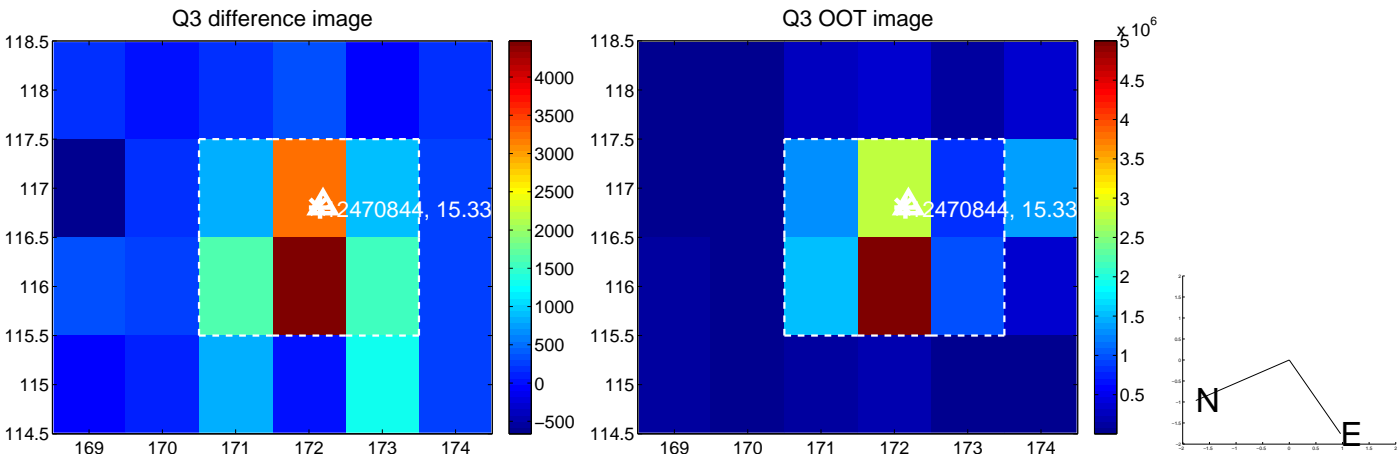
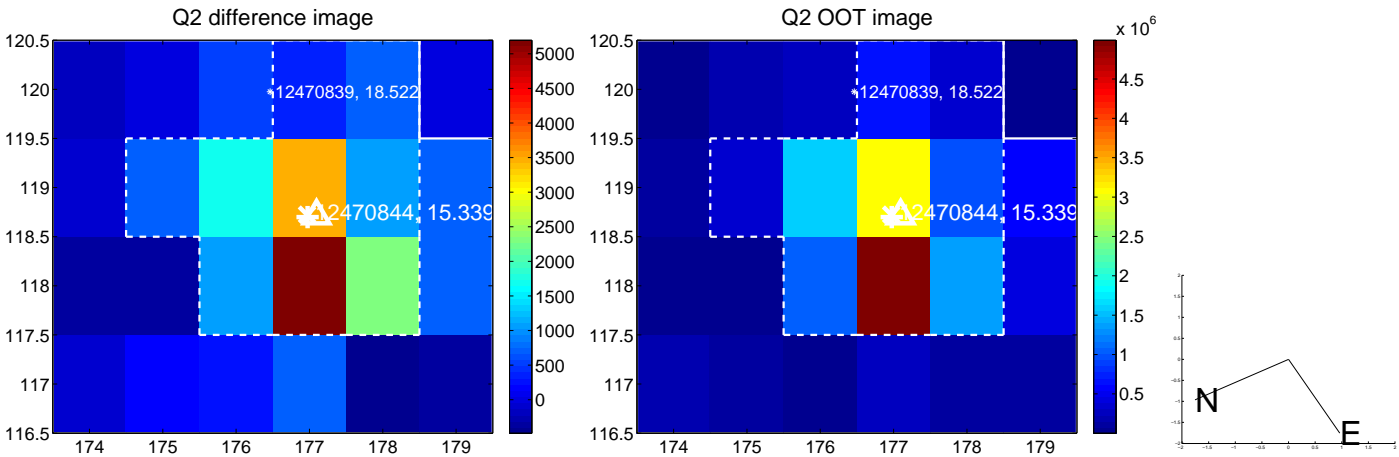
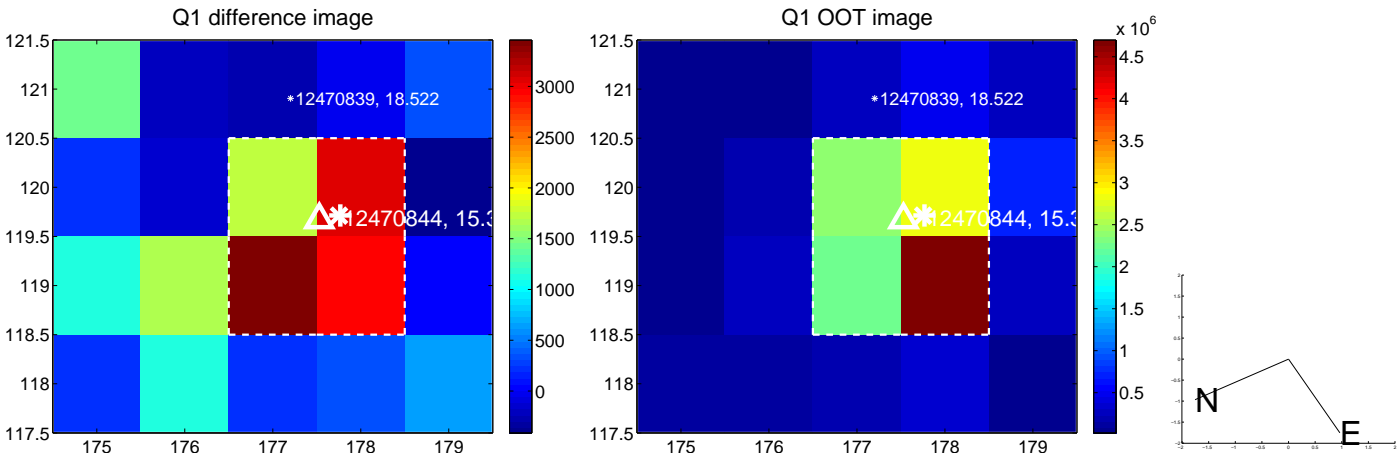
The direct PRF centroid is offset from the target star catalog position by about 0.07 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.172 \pm 0.109$	1.57	$-0.148 \pm 0.086$	$0.087 \pm 0.136$
PRF-fit source offset from KIC position	$0.106 \pm 0.097$	1.10	$-0.097 \pm 0.089$	$0.044 \pm 0.129$
photometric centroid source offset	$1.20 \pm 0.30$	4.04	$1.18 \pm 0.30$	$0.22 \pm 0.31$

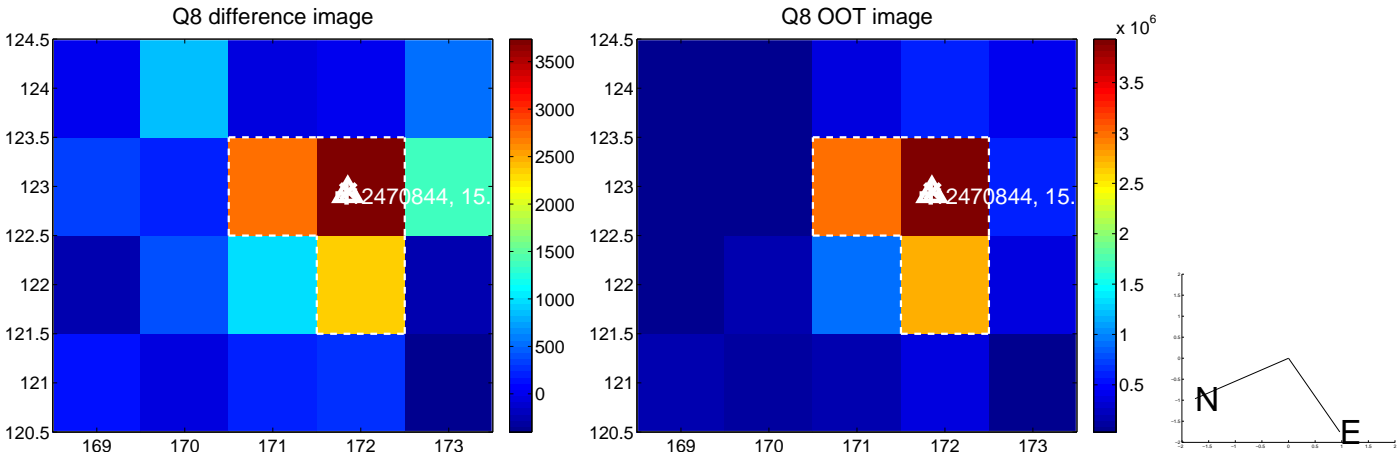
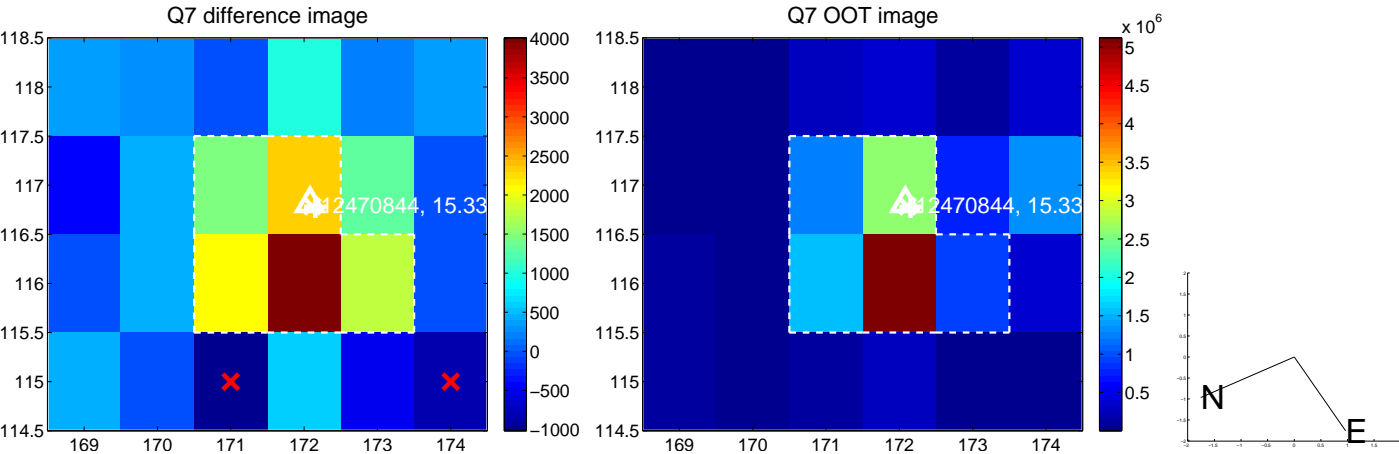
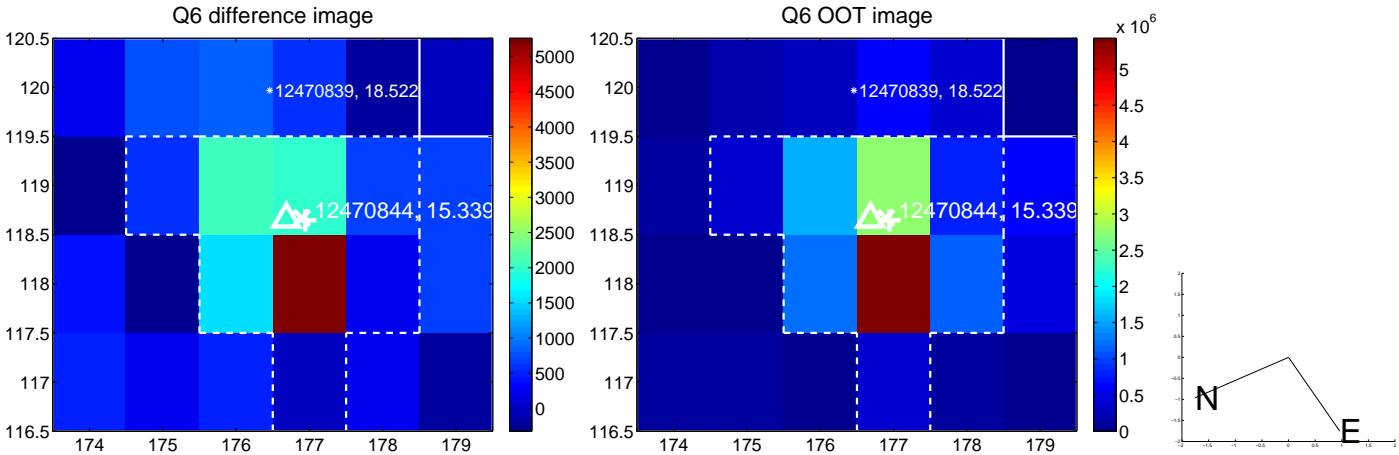
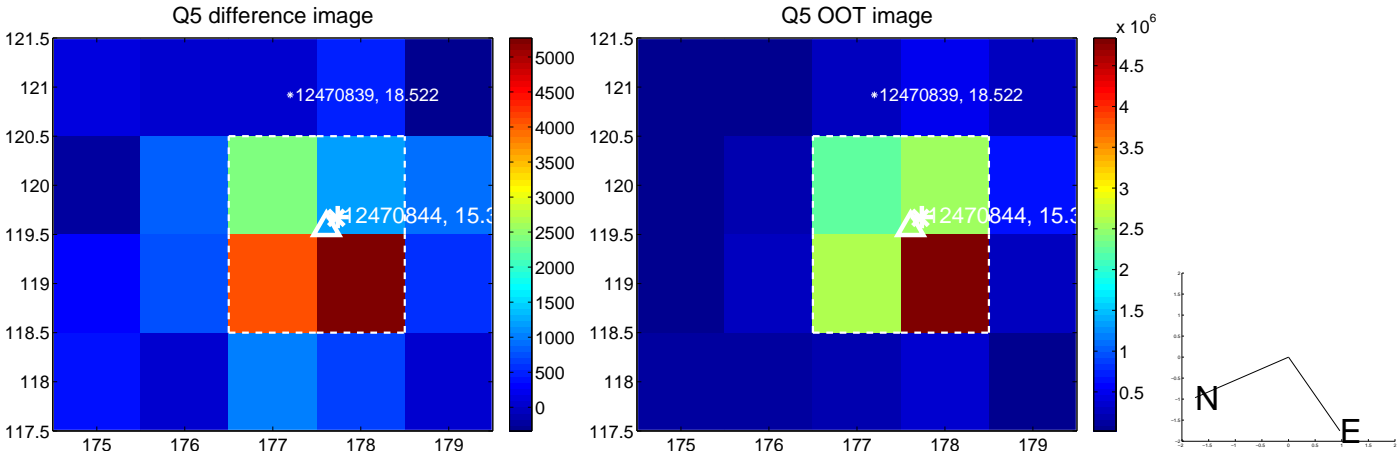


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses:** good quarterly centroid offsets; **Vermillion crosses:** bad quarterly centroid offsets; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: three- $\sigma$ . Red \*: target star. Blue \*: Other stars. Text next to a star gives its KIC ID and kepmag. KIC IDs > 15,000,000 are from the UKIRT catalog.

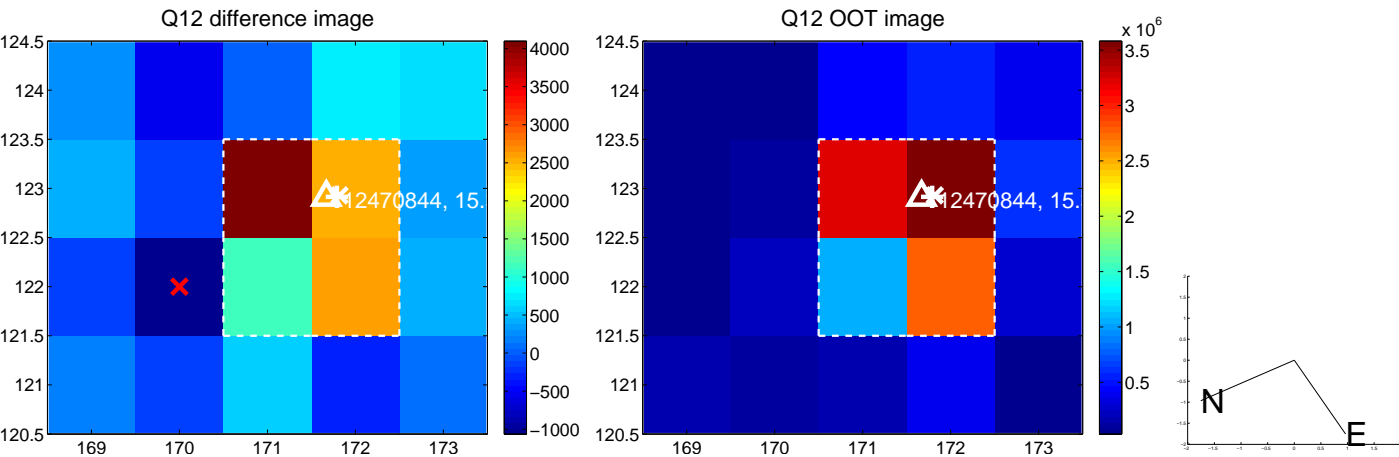
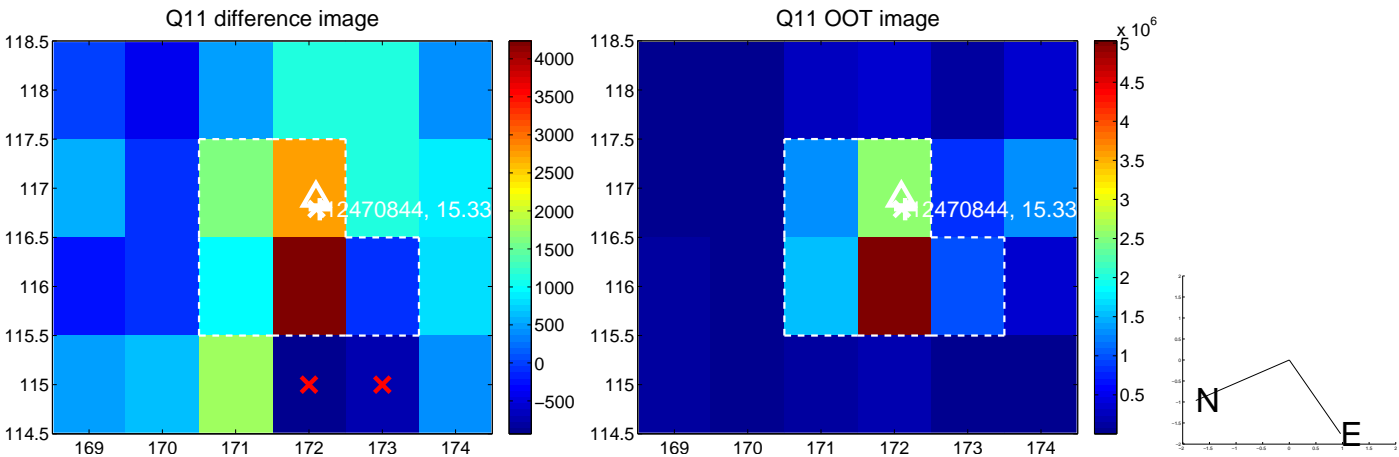
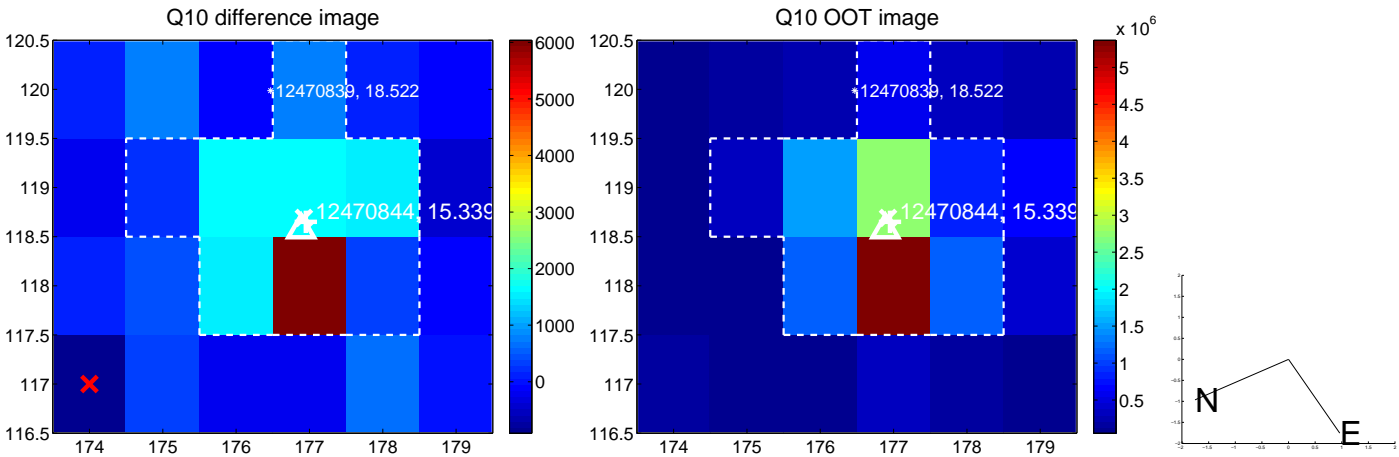
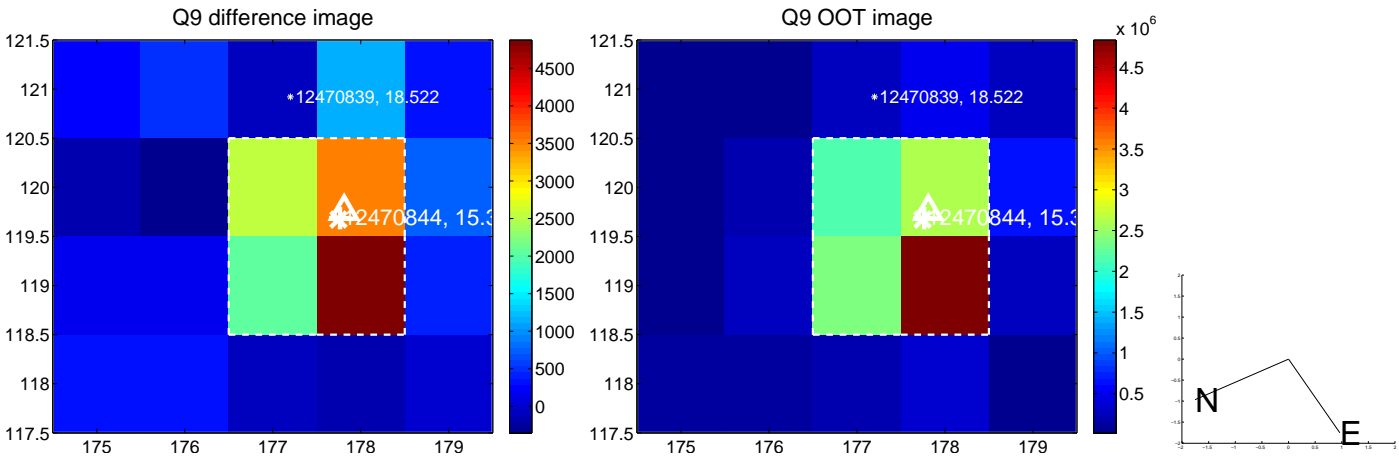
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



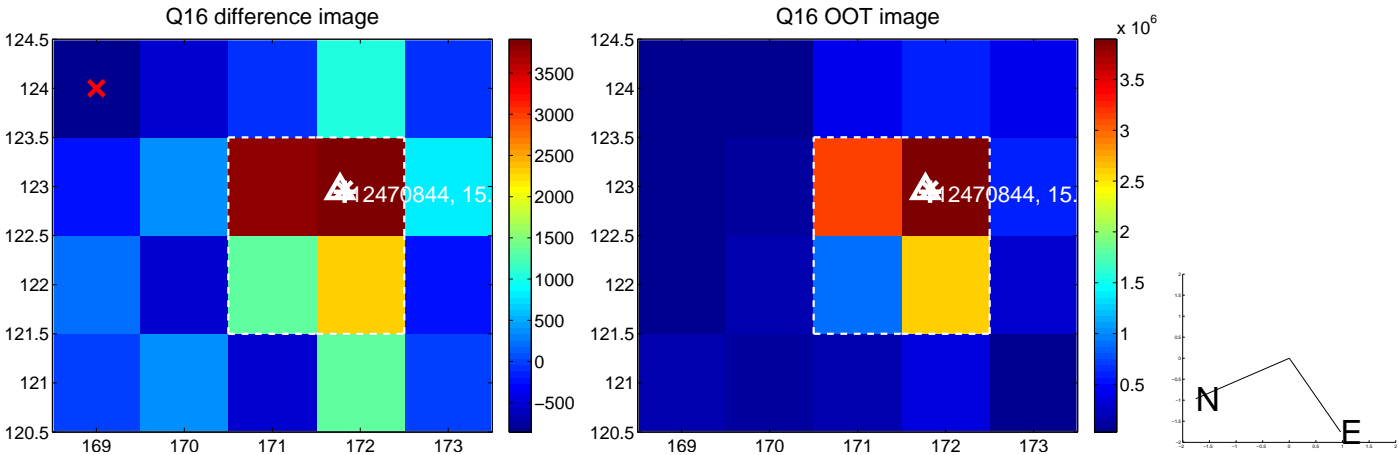
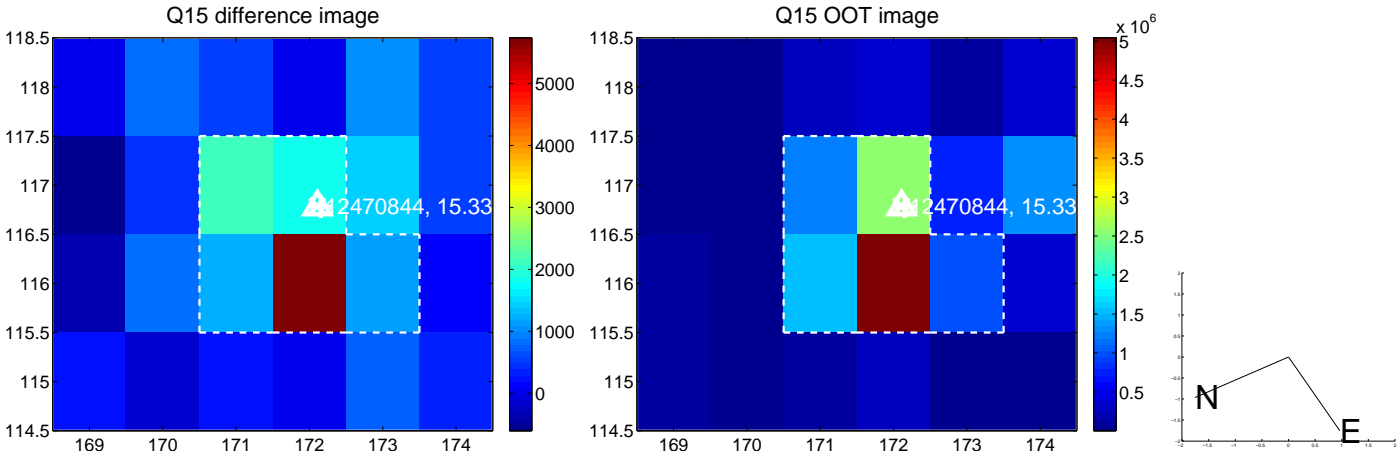
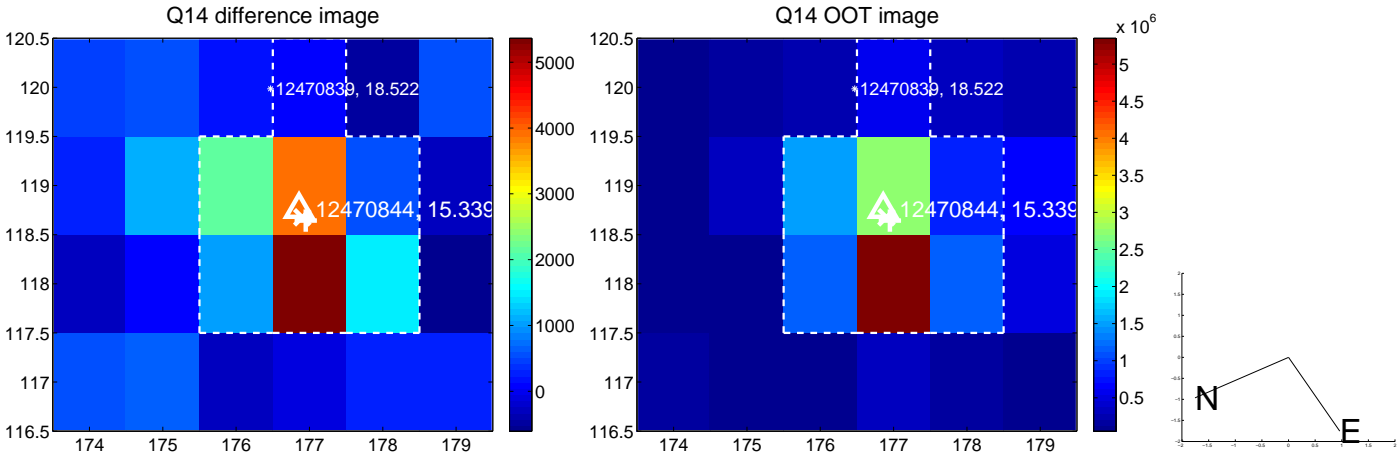
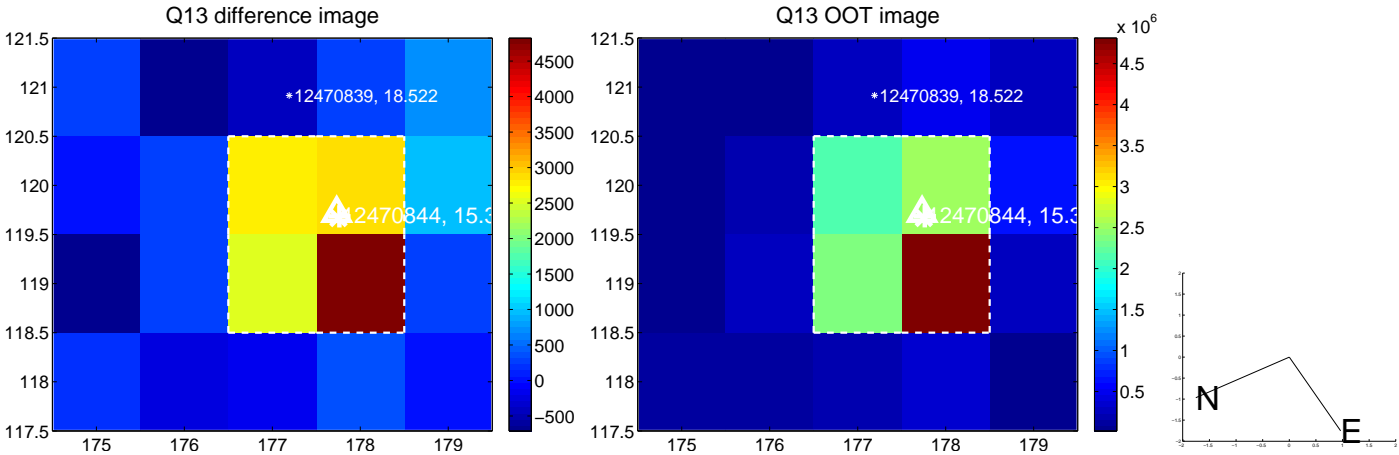
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.

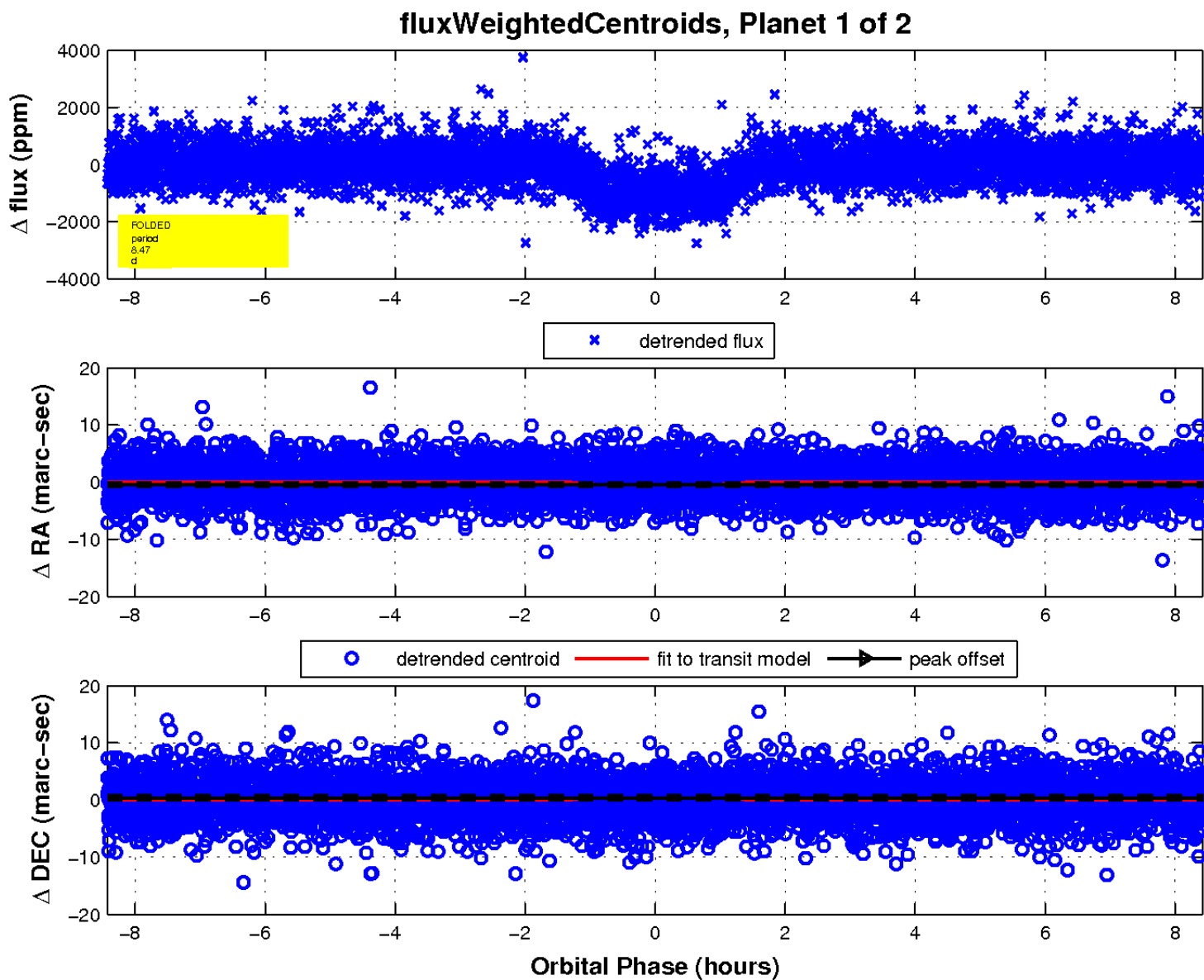
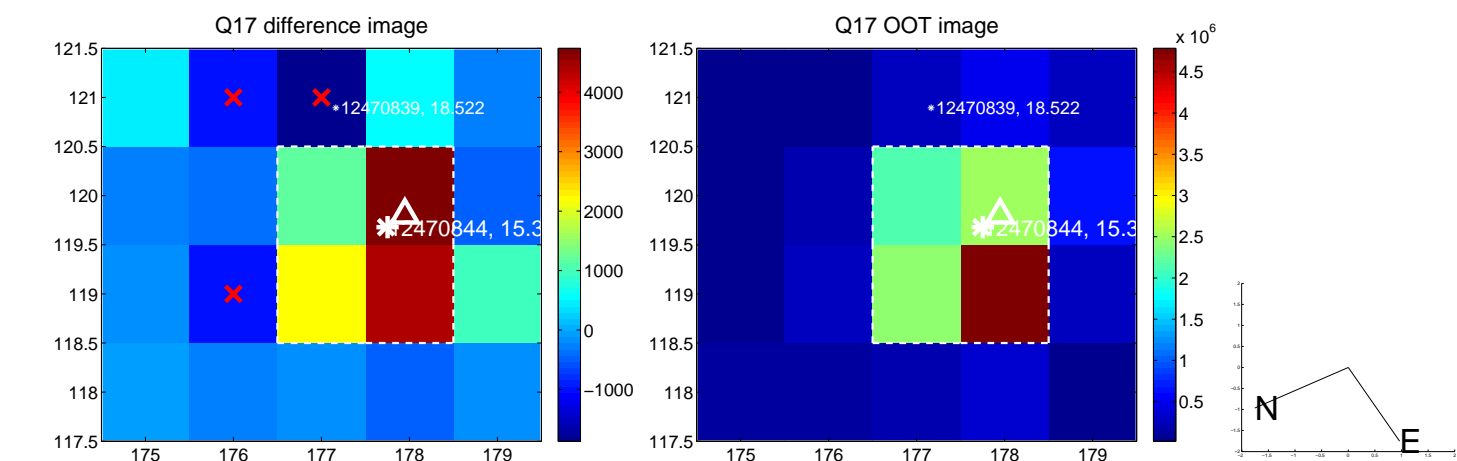


white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



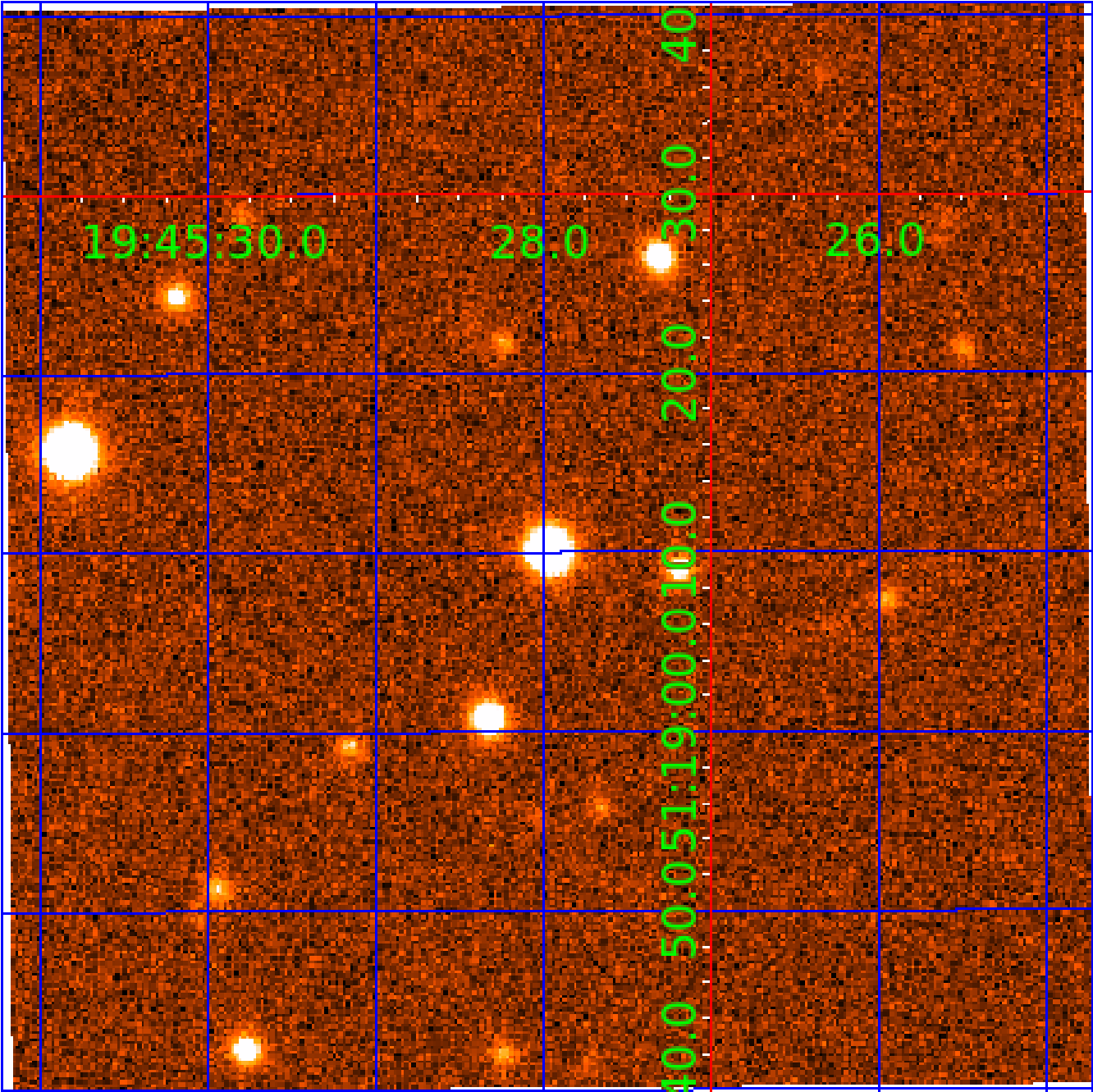


white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



UKIRT Image

Declination



# KIC 012470844

## Q1-17 DR25 TCE Parameters

TCE	Run Type	KOI?	Period (Days)	Epoch (BKJD)	Depth (ppm)	Duration (Hours)	MES	SNR	$R_{\star}$ ( $R_{\odot}$ )	$T_{\star}$ (K)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
012470844-01	OBS	0790.01	8.472379	131.800026	1127.0	2.809	39.9	45.2	0.79	5354	2.90	75.50
012470844-02	OBS	0790.02	60.419174	181.160689	865.2	5.108	15.1	16.7	0.79	5354	2.43	5.50

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
012470844-01	OBS	PC	1.00	0	0	0	0	NO_COMMENT
012470844-02	OBS	PC	0.99	0	0	0	0	NO_COMMENT

**Notes:** OBS = Observed. INJ = Injected. INV = Inverted. SCR = Scrambled.

N = Not Transit-Like. S = Stellar Eclipse. C = Centroid Offset. E = Ephemeris Match.

See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

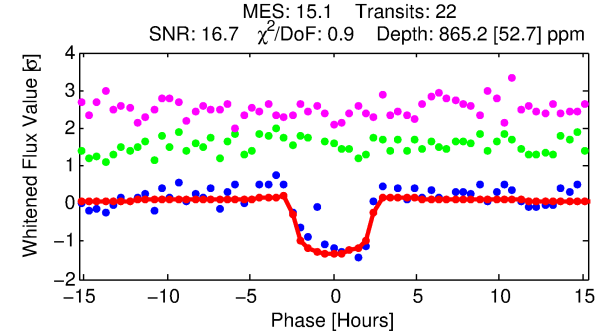
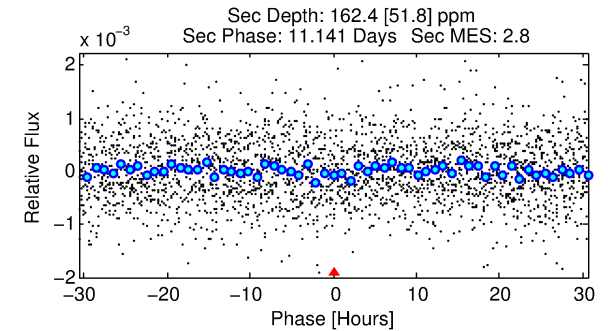
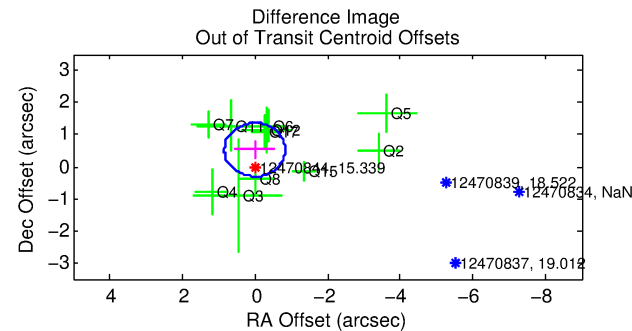
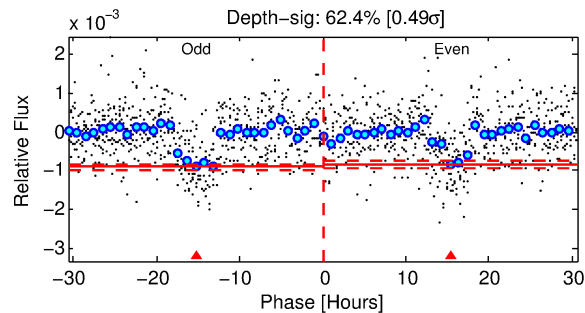
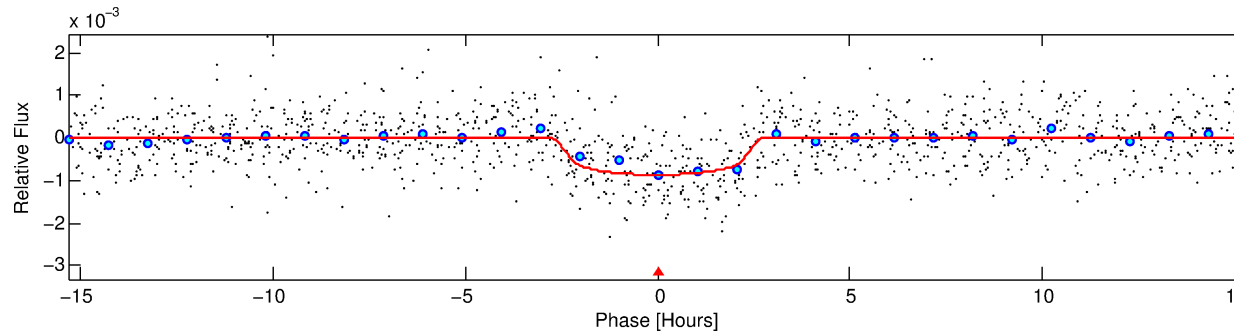
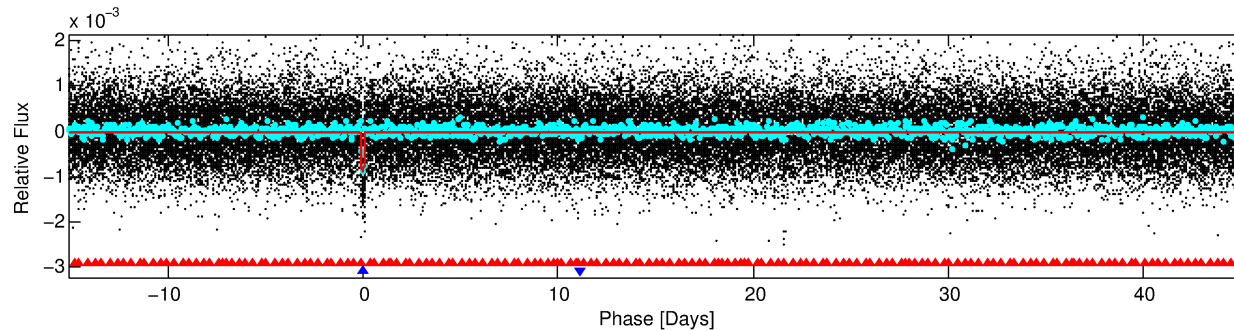
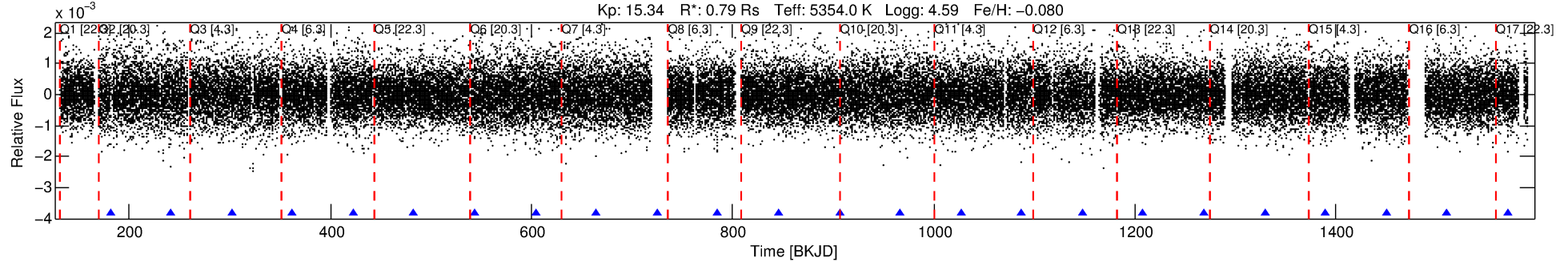
## Ephemeris Match Information For 012470844-02

No Significant Match Found

# DV One-Page Summary

KIC: 12470844 Candidate: 2 of 2 Period: 60.419 d  
KOI: K00790.02 Name: Kepler-233c Corr: 0.974

Kp: 15.34 R\*: 0.79 Rs Teff: 5354.0 K Logg: 4.59 Fe/H: -0.080



## DV Fit Results:

Period = 60.41917 [0.00043] d  
Epoch = 181.1607 [0.0061] BKJD  
Rp/R\* = 0.0282 [0.0177]  
a/R\* = 72.54 [174.94]  
b = 0.64 [2.24]  
Seff = 5.50 [1.21]  
Teq = 391 [22] K  
Rp = 2.43 [1.56] Re  
a = 0.2883 [0.0359] AU  
Ag = 1258.58 [1644.28] [0.76σ]  
Teffp = 3596 [1167] K [2.75σ]

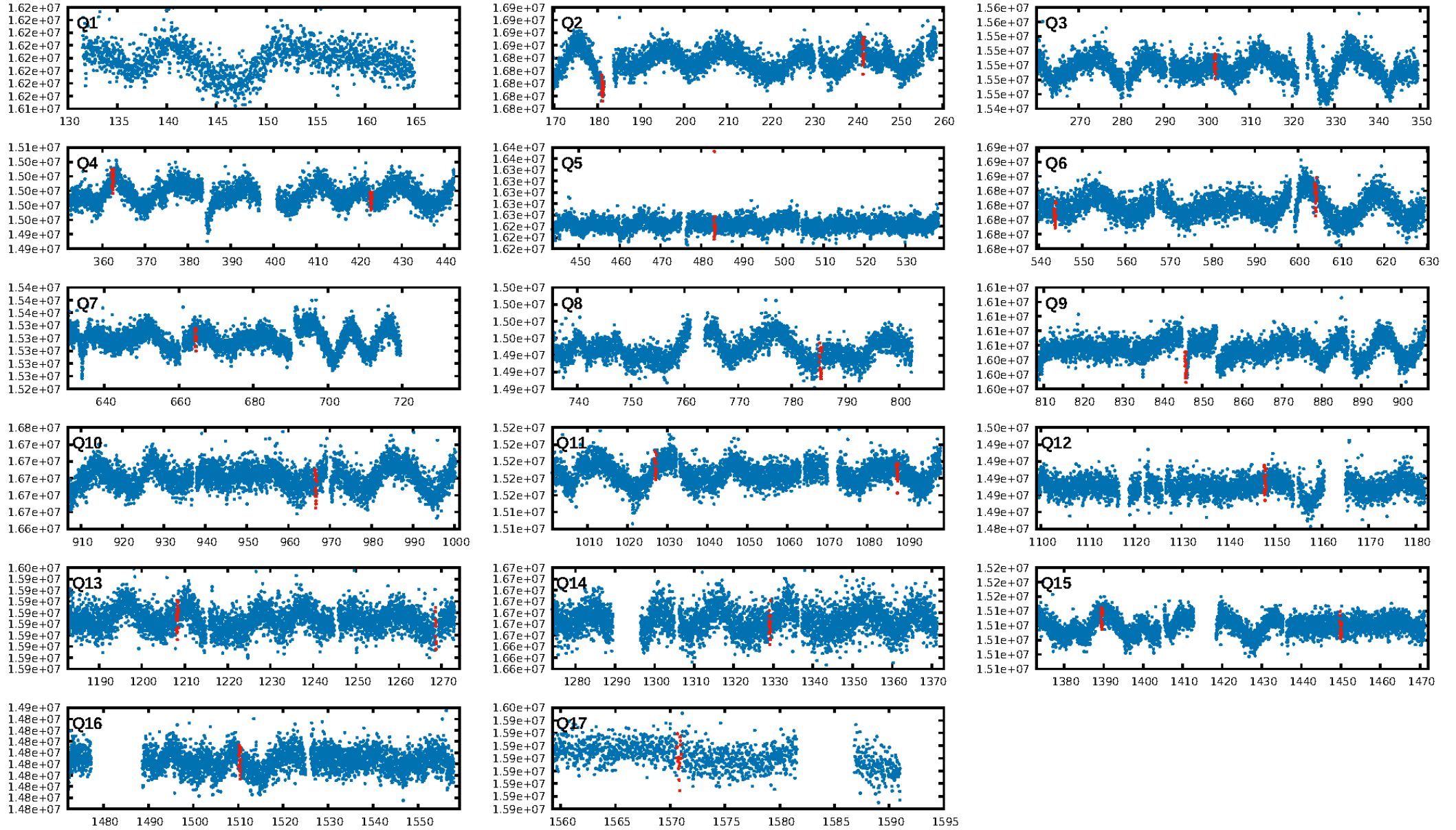
## DV Diagnostic Results:

ShortPeriod-sig: 100.0% [213.85σ]  
LongPeriod-sig: N/A  
ModelChiSquare2-sig: 42.2%  
ModelChiSquareGof-sig: 100.0%  
Bootstrap-pfa: 5.70e-49  
RollingBand-fgt: 1.00 [21/21]  
GhostDiagnostic-chr: 2.868  
Centroid-sig: 42.4%  
Centroid-so: 0.265 arcsec [0.33σ]  
OotOffset-rm: 0.529 arcsec [1.90σ]  
KicOffset-rm: 0.465 arcsec [1.60σ]  
OotOffset-st: 2/4/3/2 [11]  
KicOffset-st: 2/4/3/2 [11]  
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DiffImageOverlap-fno: 0.85 [11/13]

Software Revision: svn+ssh://murzim/repo/soc/tags/release/9.3.42@60958 -- Date Generated: 29-Jan-2016 00:07:55 Z

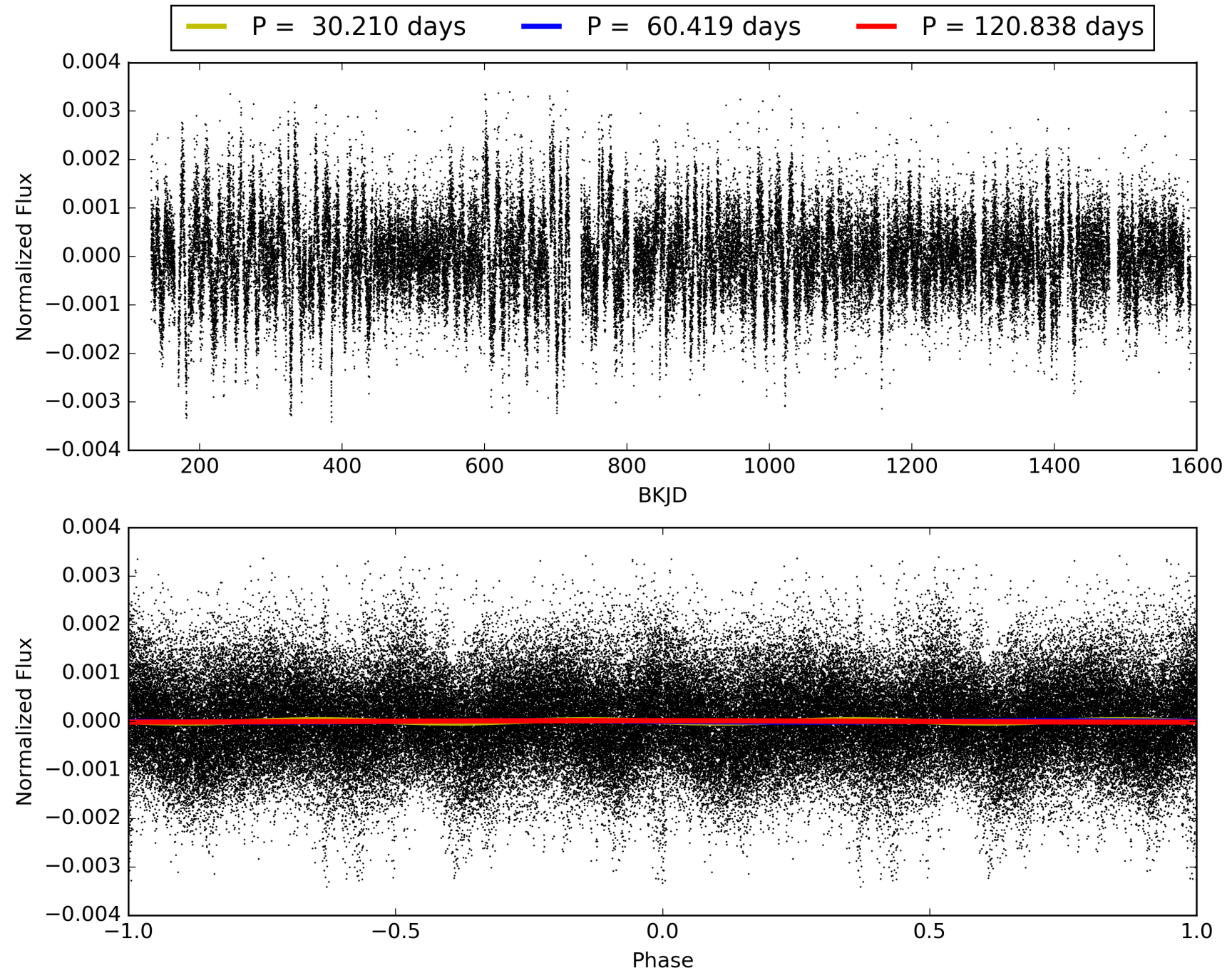
This Data Validation Report Summary was produced in the Kepler Science Operations Center Pipeline at NASA Ames Research Center

# TCE 012470844-02, PDC Light Curves



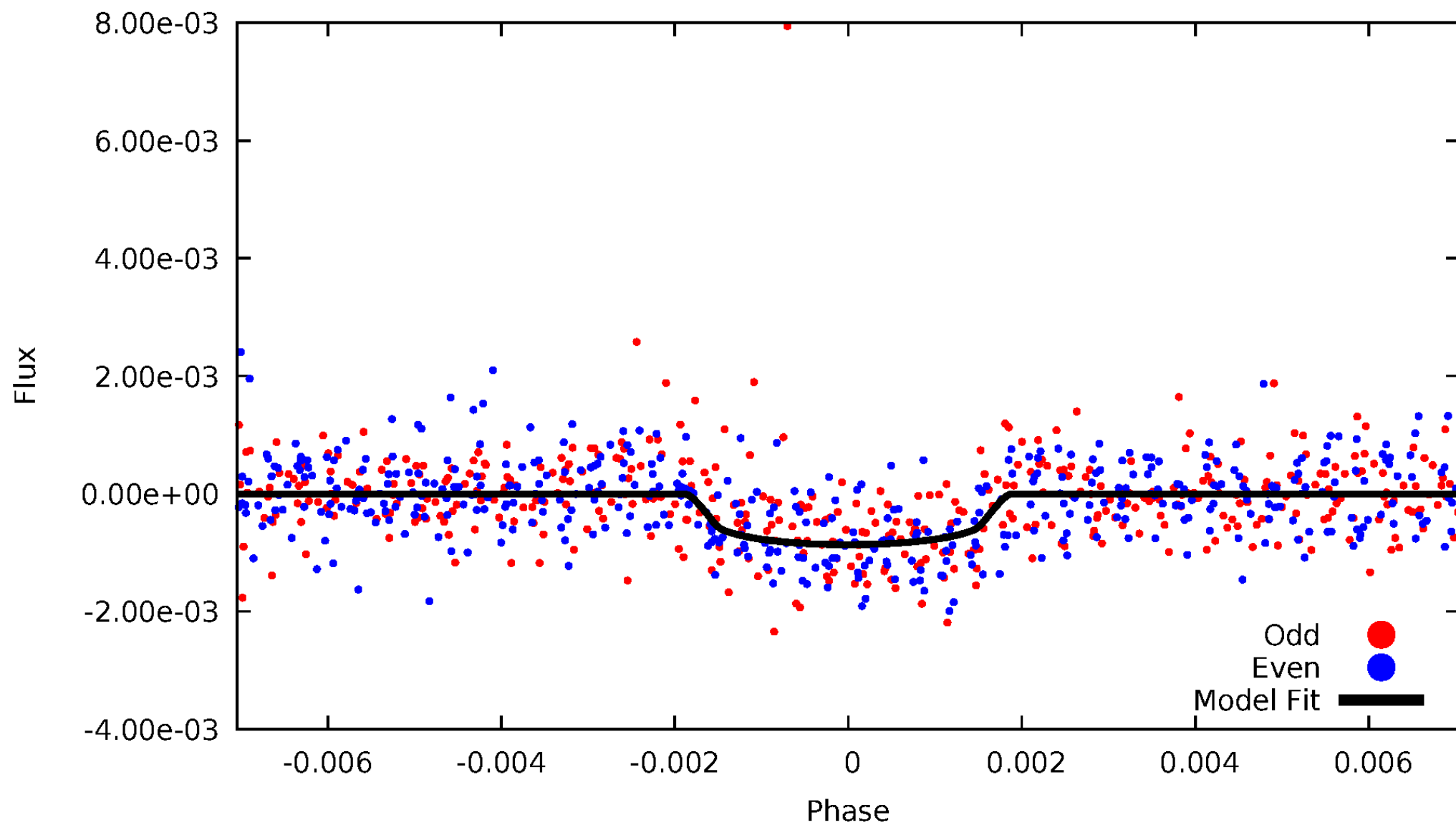


TCE 012470844-02



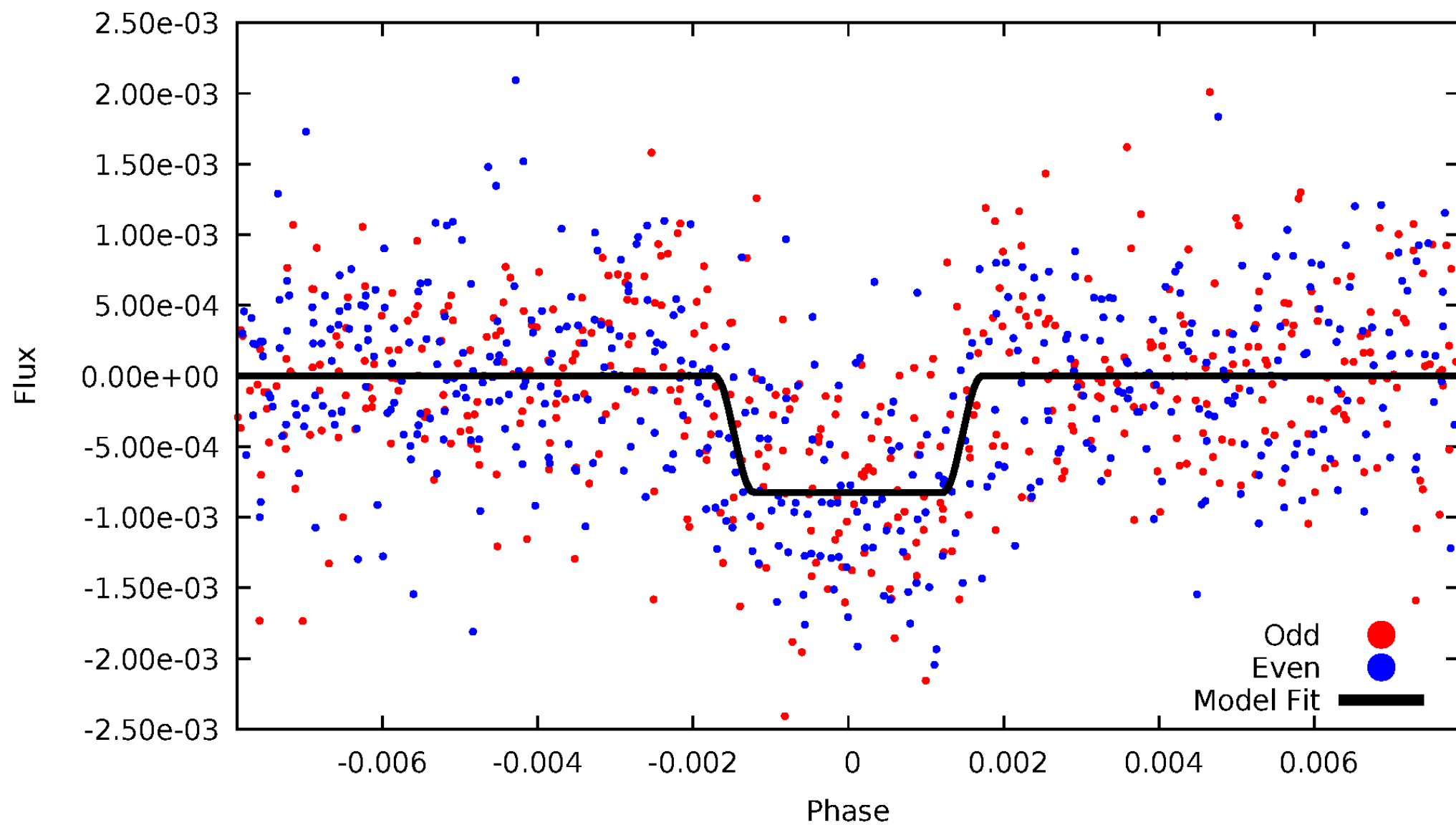
# DV Odd/Even

TCE 012470844-02



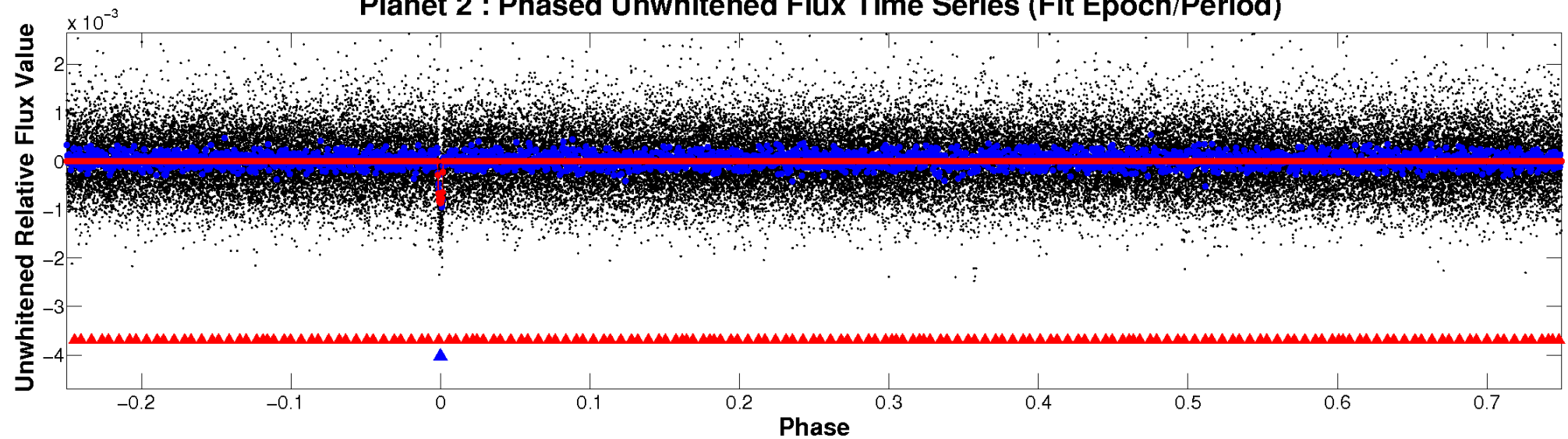
# ALT Odd/Even

TCE 012470844-02

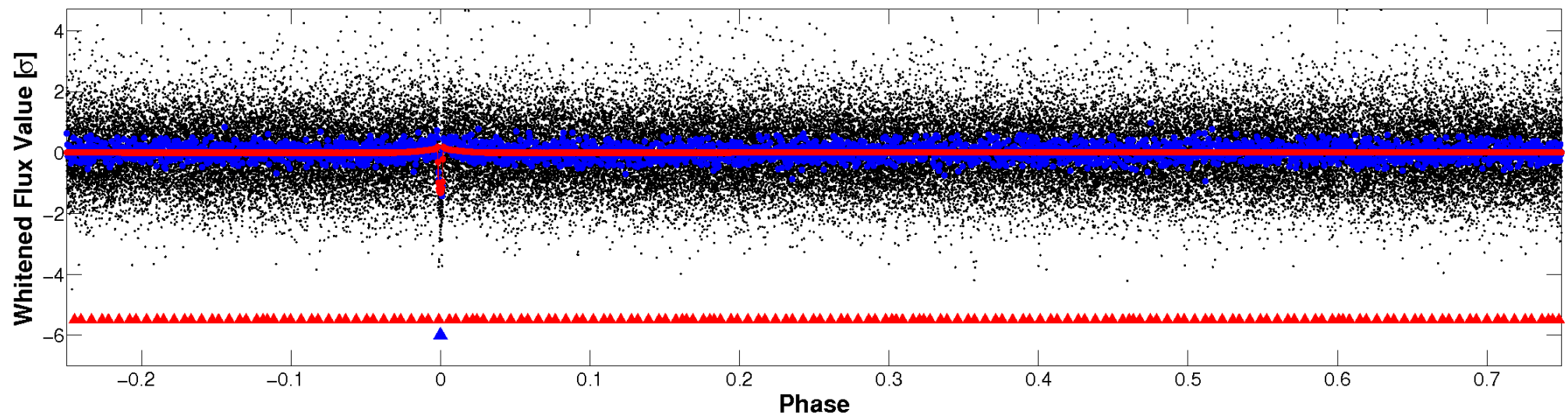


# Non-Whitened Vs. Whitened Light Curve

## Planet 2 : Phased Unwhitened Flux Time Series (Fit Epoch/Period)

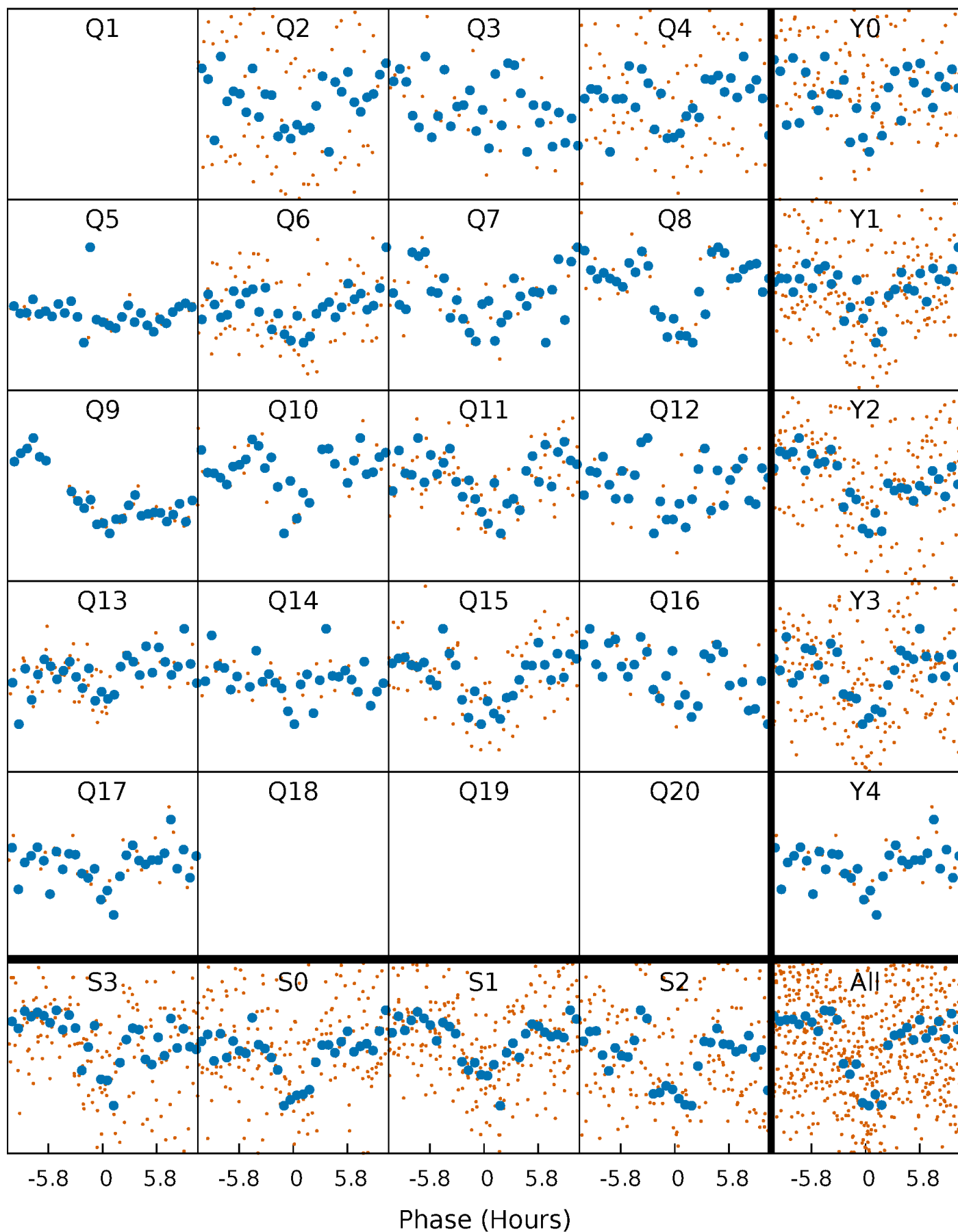


## Planet 2 : Phased Whitened Flux Time Series (Fit Epoch/Period)



# PDC Quarter-Phased Transit Curves

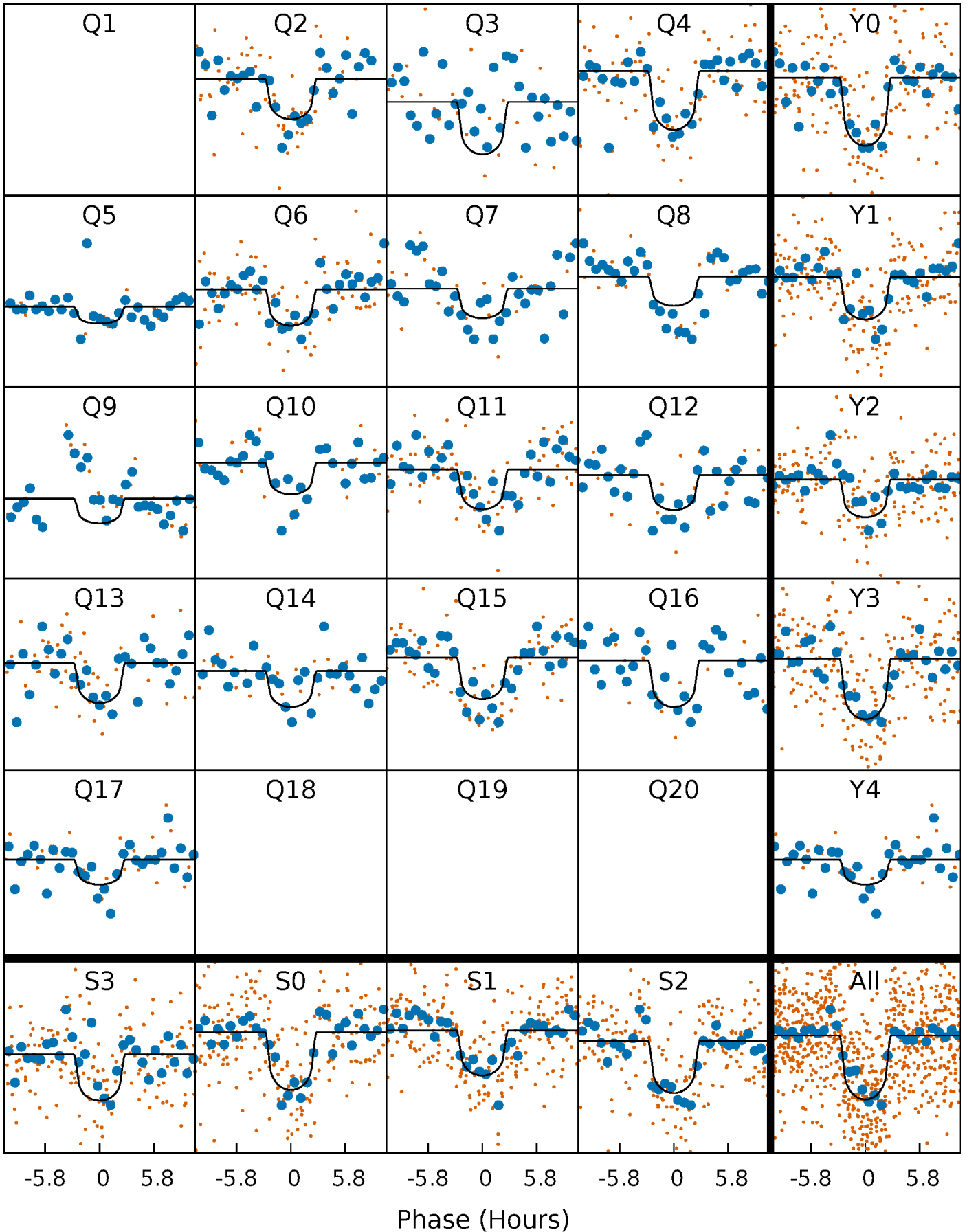
TCE 012470844-02 P= 60.419174 Days  $T_0=181.160689$  (BKJD)





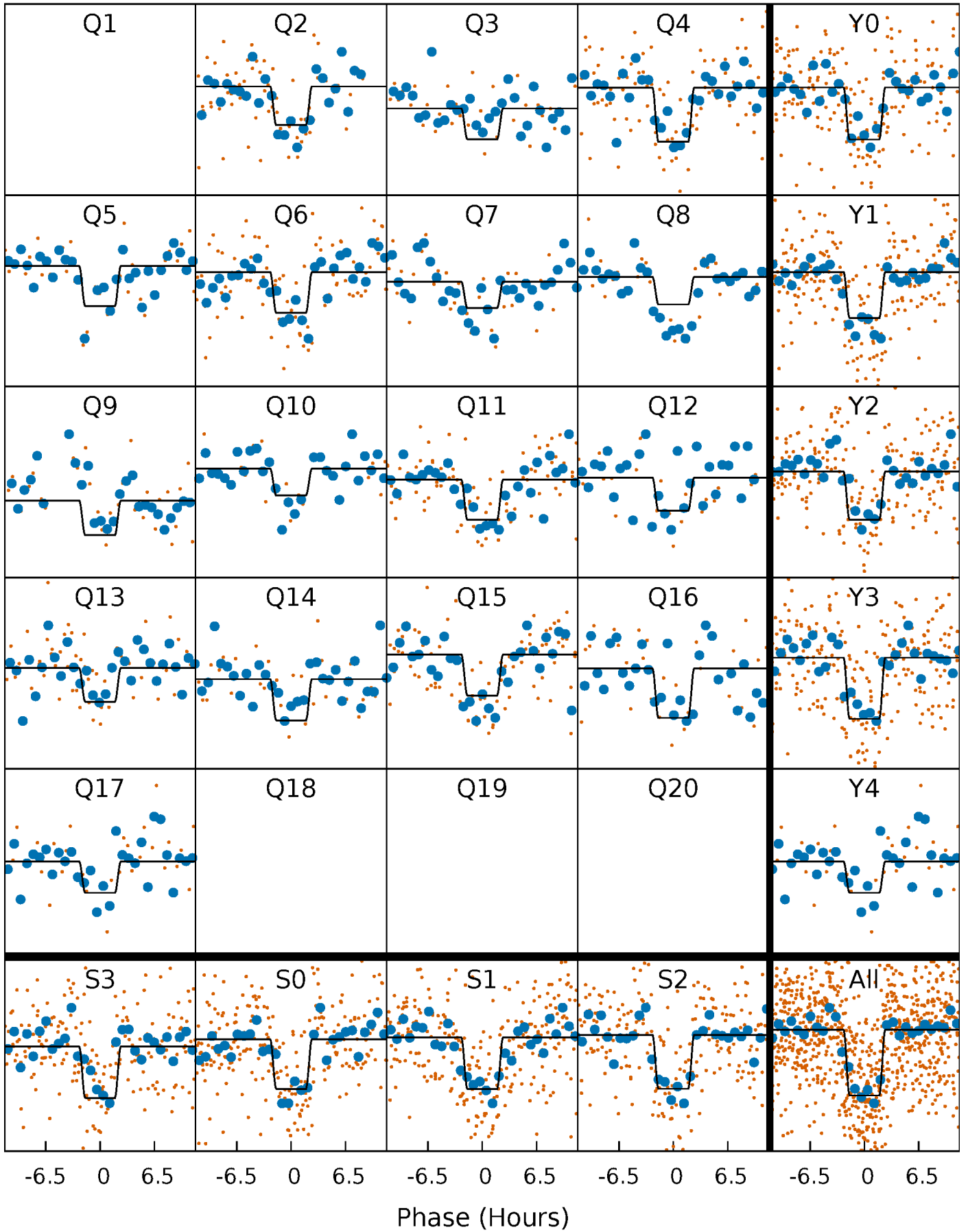
# DV Quarter-Phased Transit Curves

TCE 012470844-02     $P = 60.419174$  Days     $T_0 = 181.160689$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

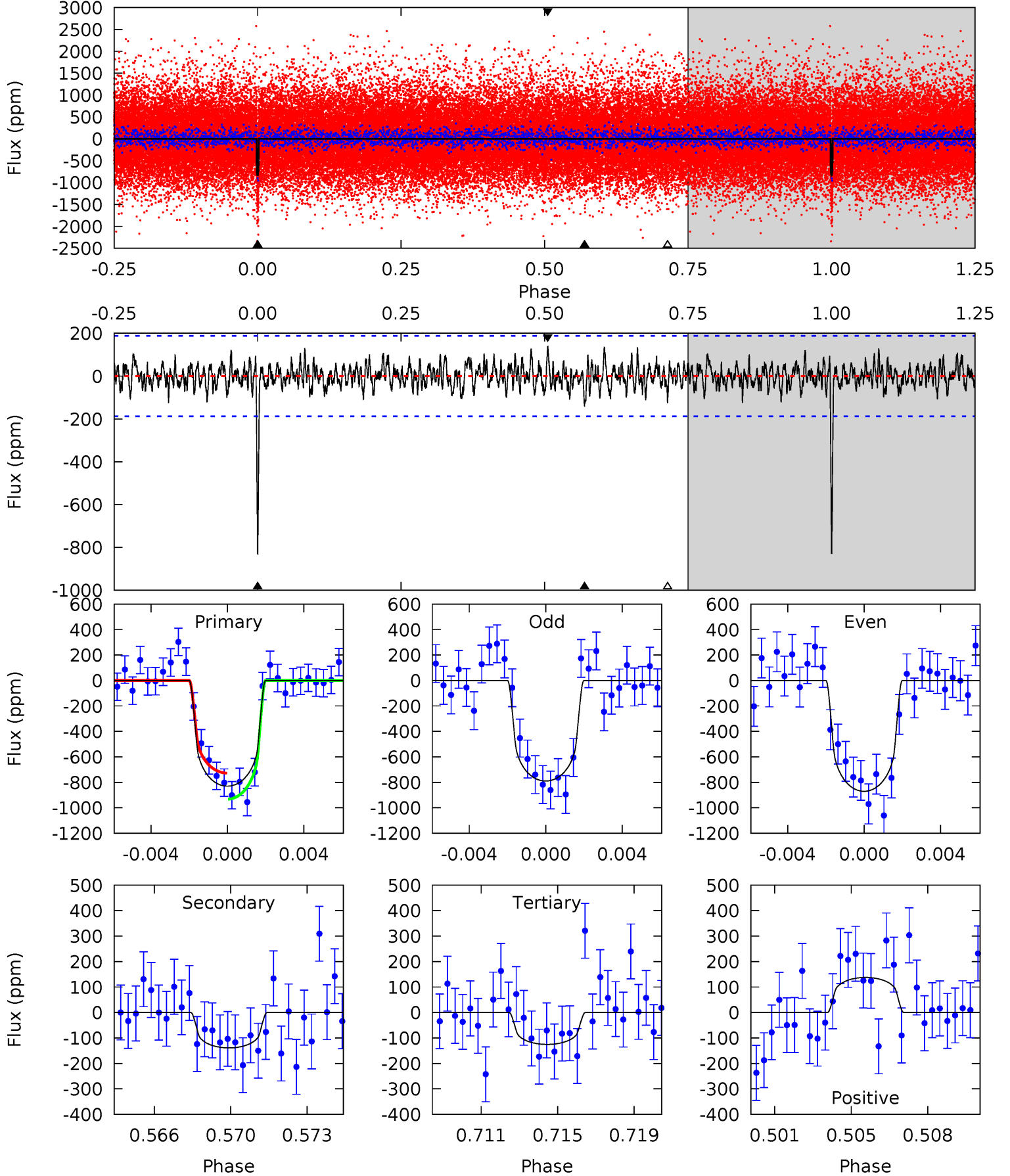
TCE 012470844-02 P= 60.419968 Days  $T_0=181.157601$  (BKJD)



# DV Model-Shift Uniqueness Test

012470844-02,  $P = 60.419174$  Days,  $E = 120.741515$  Days

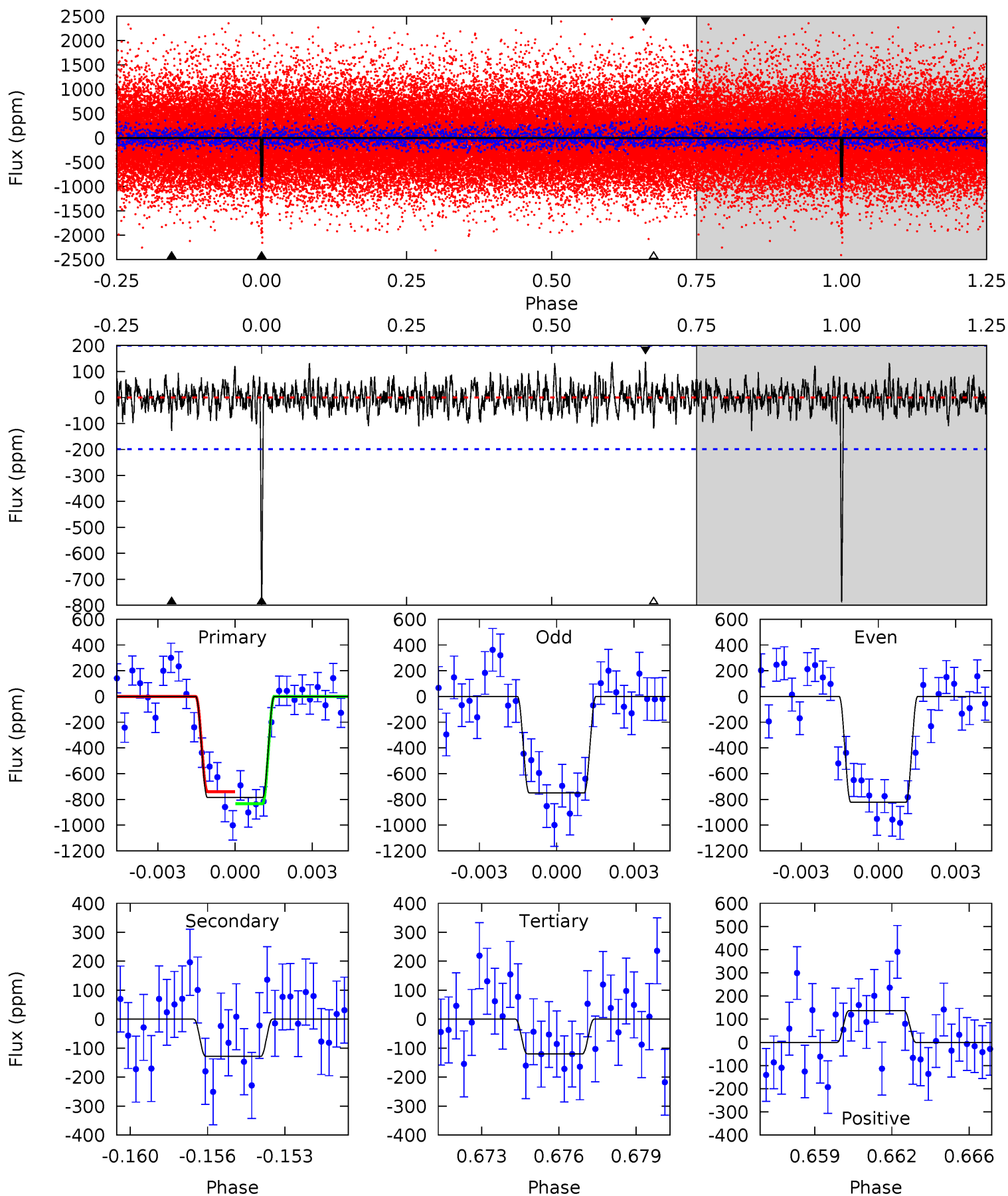
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
23.0	3.85	3.47	3.81	5.21	2.89	1.22	19.5	19.2	0.38	0.04	1.12	0.92	0.14	2.84



# Alt Model-Shift Uniqueness Test

012470844-02, P = 60.419968 Days, E = 120.737633 Days

Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
20.6	3.37	3.14	3.59	5.23	2.93	1.04	17.5	17.0	0.23	-0.22	0.96	0.99	0.15	1.22



### Stellar Parameters For KIC 012470844

	$T_{\text{eff}} (K)$	$\log(g)$	$[\text{Fe}/\text{H}]$	$R (R_{\odot})$	$M (M_{\odot})$	$p_{\star} (\text{g}\cdot\text{cm}^{-3})$
	$5354^{+159}_{-159}$	$4.587^{+0.032}_{-0.104}$	$-0.080^{+0.300}_{-0.300}$	$0.788^{+0.113}_{-0.066}$	$0.884^{+0.061}_{-0.113}$	$2.542^{+0.438}_{-0.787}$
	+3%/-3%	+1%/-2%	+375%/-375%	+14%/-8%	+7%/-13%	+17%/-31%
Source	PHO1	KIC0	KIC0	DSEP		

KIC = Kepler Input Catalog; PHO = Photometry; SPE = Spectroscopy; AST = Asteroseismology  
 TRA = Transits; DESP = Dartmouth Models; MULT = Multiple Models

### Secondary Eclipse Parameters for KIC 012470844-02 / KOI 0790.02

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{\text{max}} (K)$	$T_{\text{obs}} (K)$	$A_{\text{obs}}$
DV	$-139 \pm 36$	$2.55^{+1.65}_{-1.30}$	$554^{+24}_{-21}$	$3780^{+1165}_{-597}$	$914^{+3113}_{-591}$
Alt.	$-128 \pm 38$	$2.61^{+1.54}_{-1.34}$	$554^{+23}_{-20}$	$3675^{+1096}_{-499}$	$797^{+2586}_{-483}$

$T_{\text{max}}$  = Theoretical Maximum Planetary Temperature

$T_{\text{obs}}$  = Observed Planetary Temperature (Assuming  $A=0.3$ )

$A_{\text{obs}}$  = Observed Albedo (Assuming  $T=0$ )

If a secondary eclipse is present, the system is likely an EB if  $T_{\text{obs}} \gg T_{\text{max}}$  AND  $A_{\text{obs}} \gg 1.0$

## DV Centroid Data

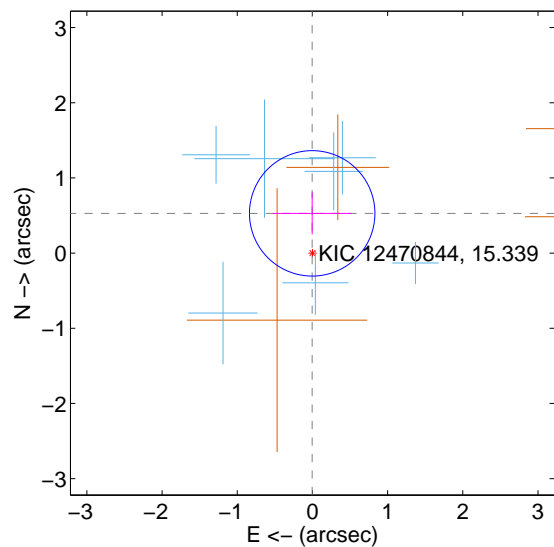
Supplemental centroid analysis for 012470844-02. Kepler magnitude: 15.34. Transit SNR 16.65

There are 7 quarters with good PRF difference image offsets

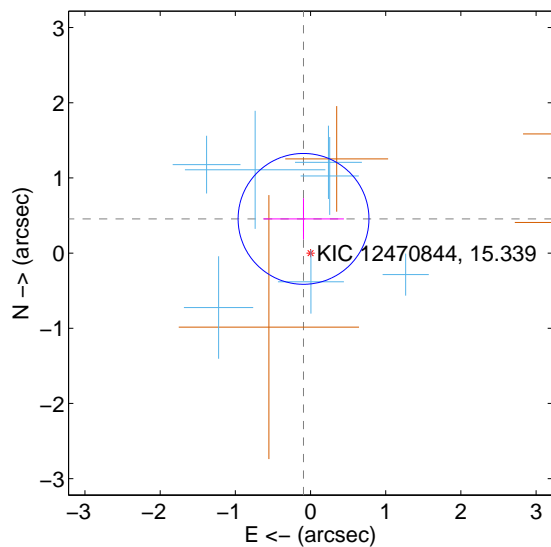
The direct PRF centroid is offset from the target star catalog position by about 0.07 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.529 \pm 0.278$	1.90	$0.003 \pm 0.524$	$0.529 \pm 0.278$
PRF-fit source offset from KIC position	$0.465 \pm 0.290$	1.60	$0.093 \pm 0.537$	$0.455 \pm 0.275$
photometric centroid source offset	$0.27 \pm 0.81$	0.33	$-0.06 \pm 0.77$	$0.26 \pm 0.81$

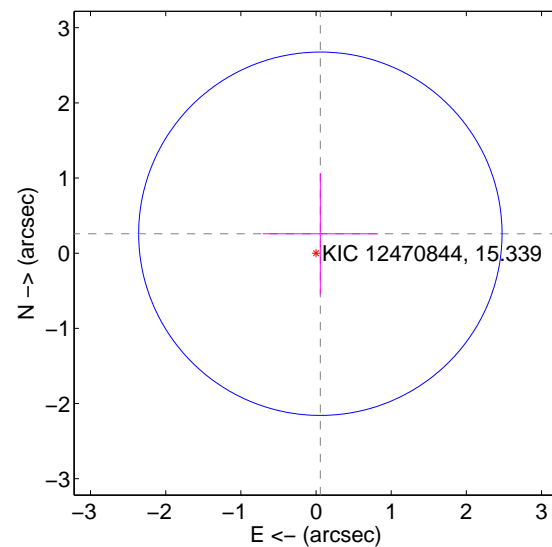
offset from difference PRF-fit to OOT PRF-fit



offset from difference PRF-fit to KIC position

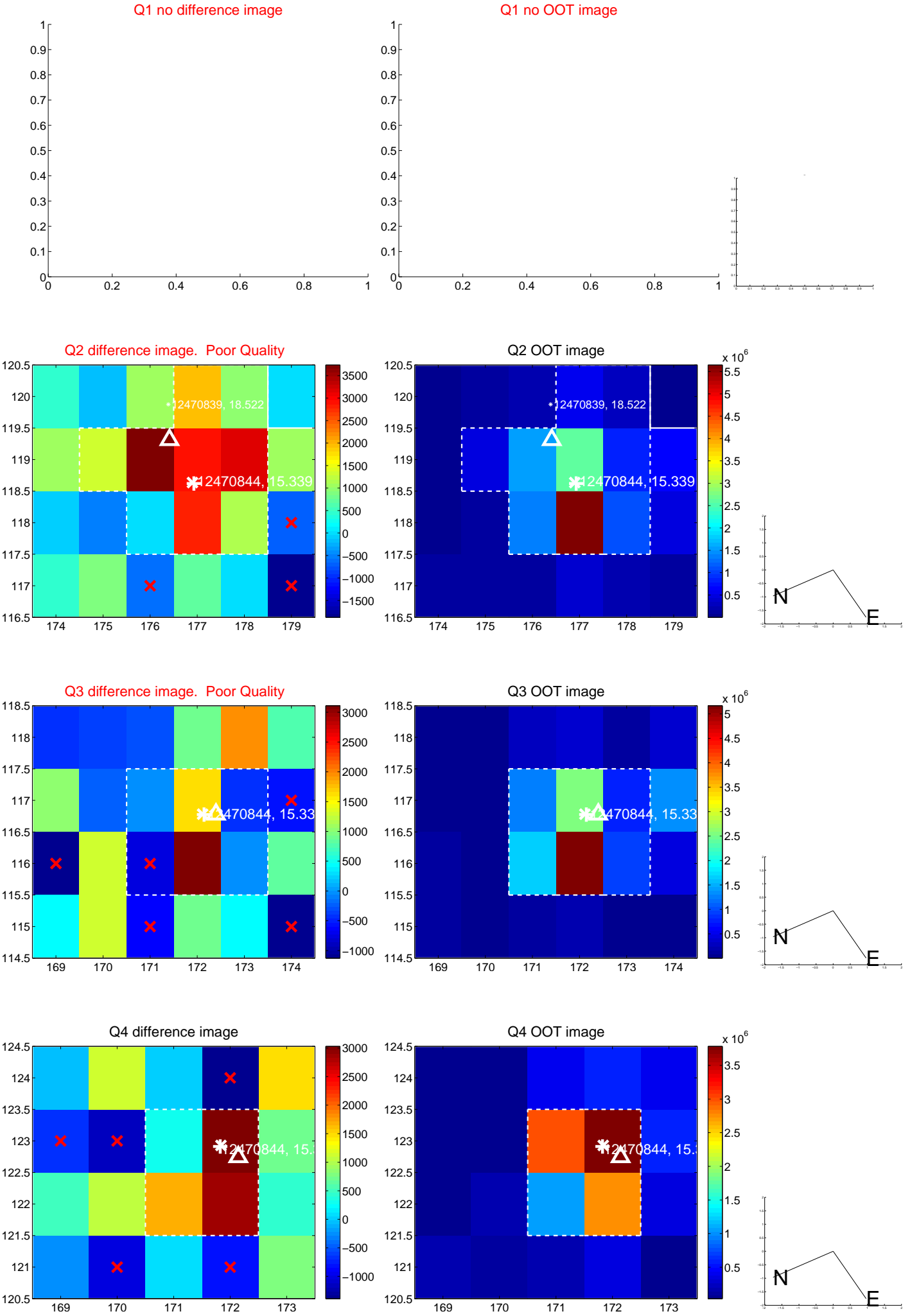


offset from photometric centroids



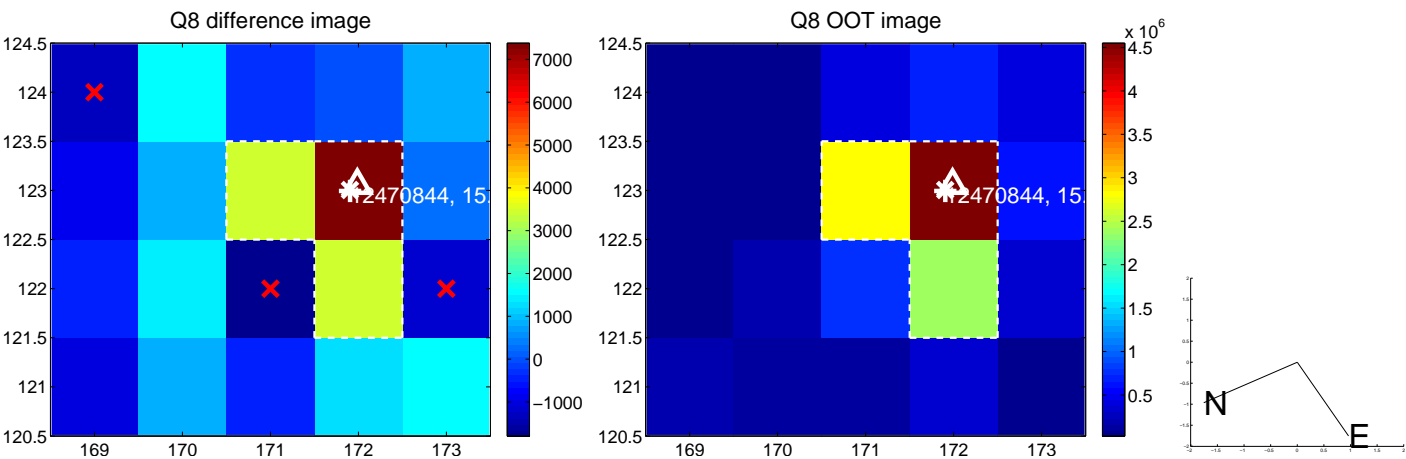
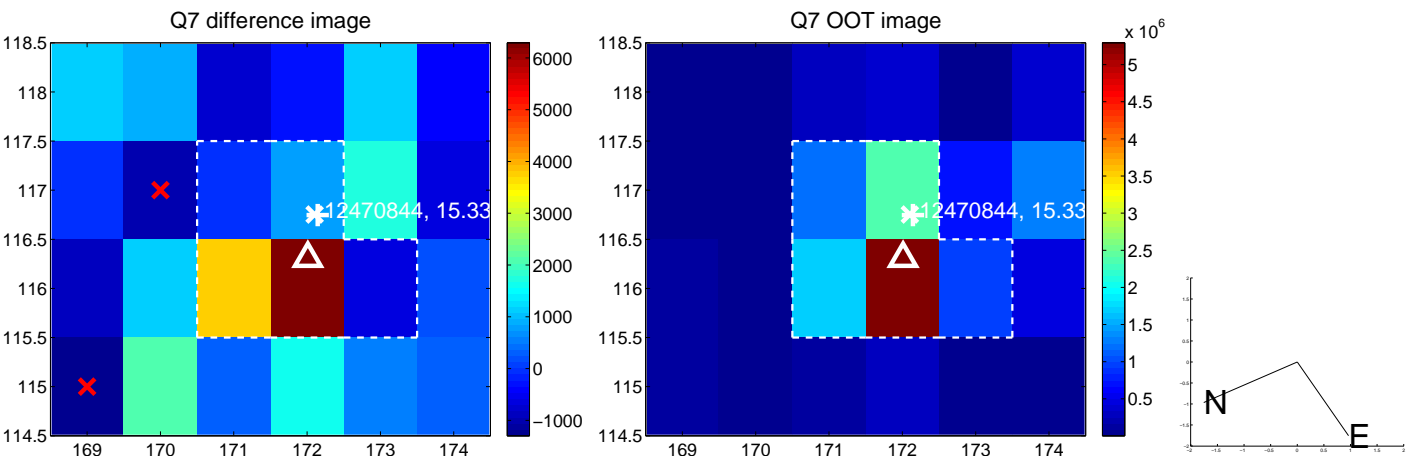
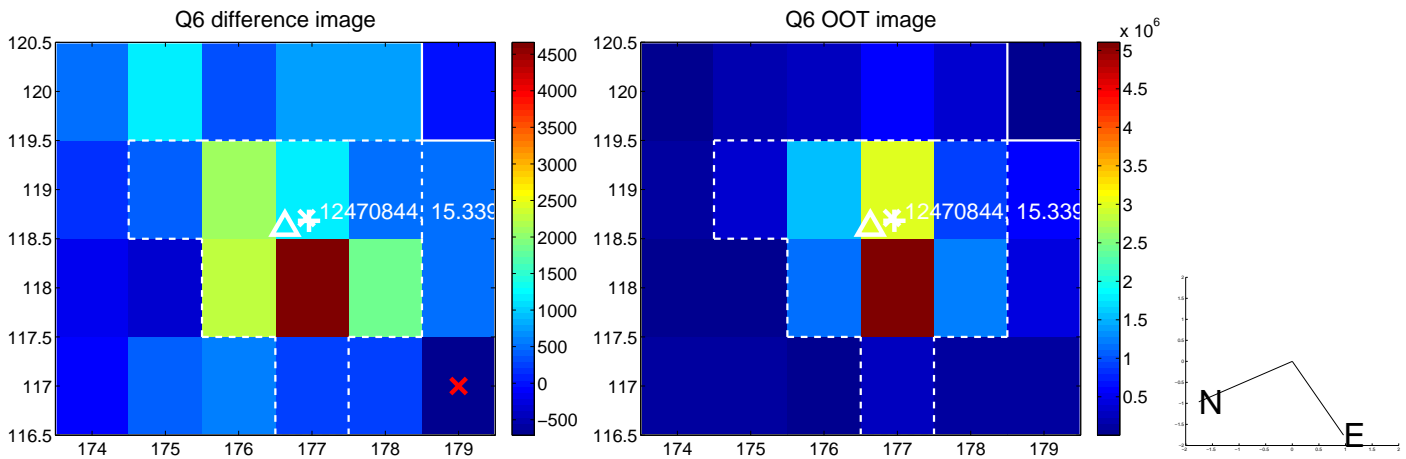
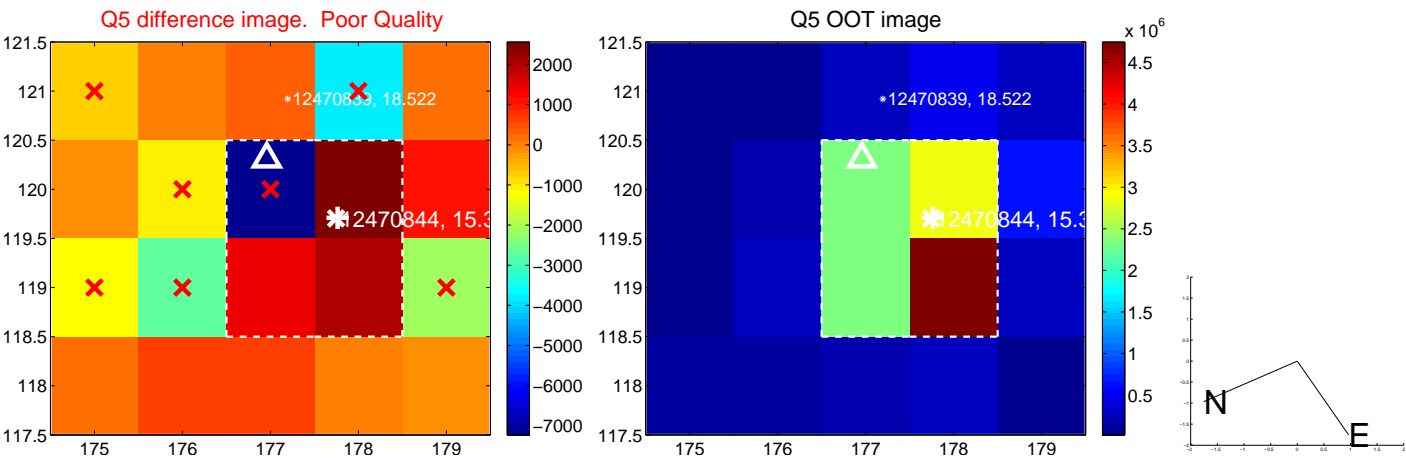
Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses: good quarterly centroid offsets; Vermillion crosses: bad quarterly centroid offsets**; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: three- $\sigma$ . Red \*: target star. Blue \*: Other stars. Text next to a star gives its KIC ID and kepmag. KIC IDs > 15,000,000 are from the UKIRT catalog.

white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.

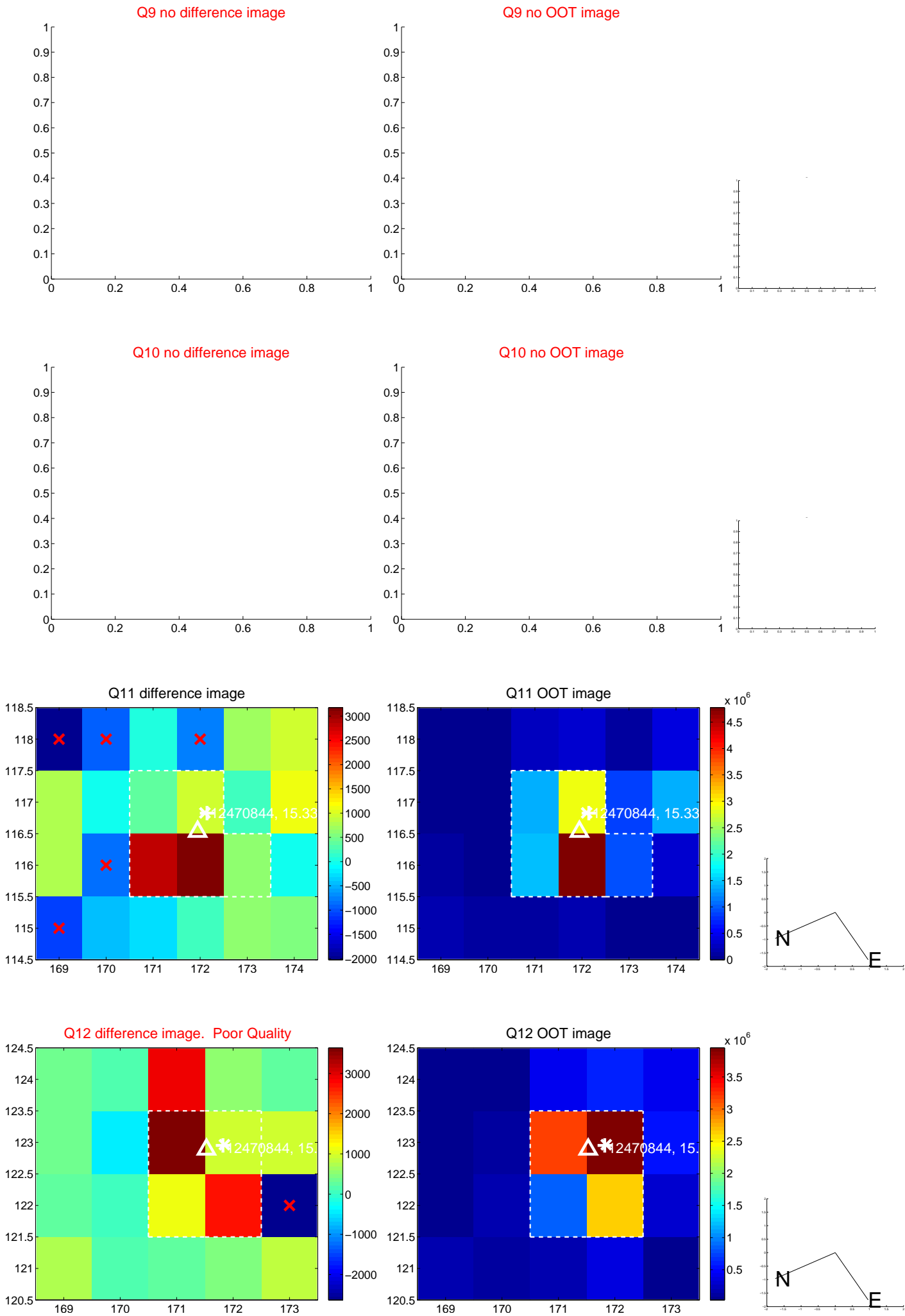




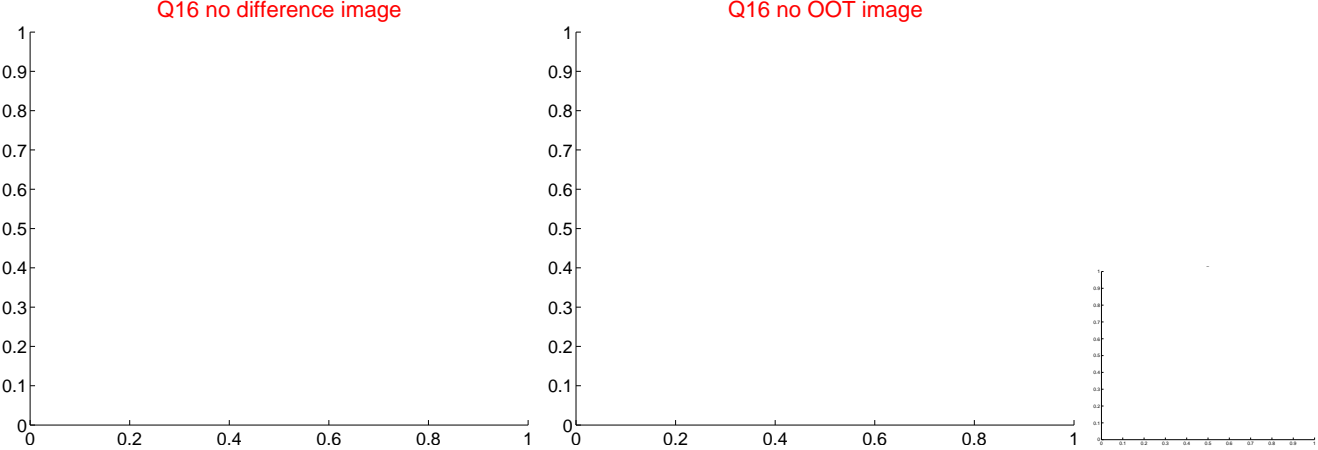
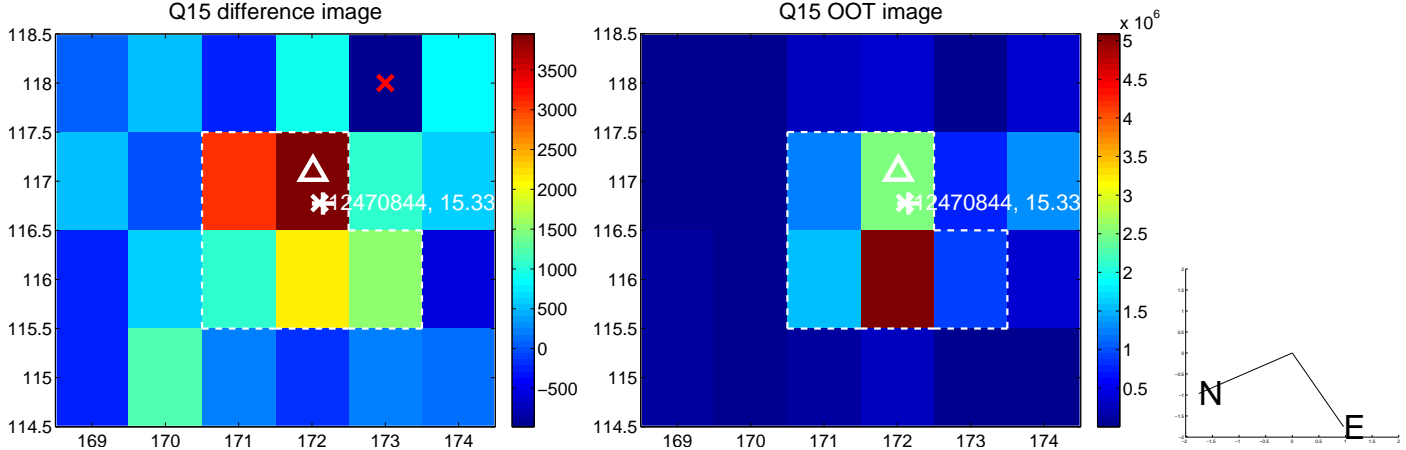
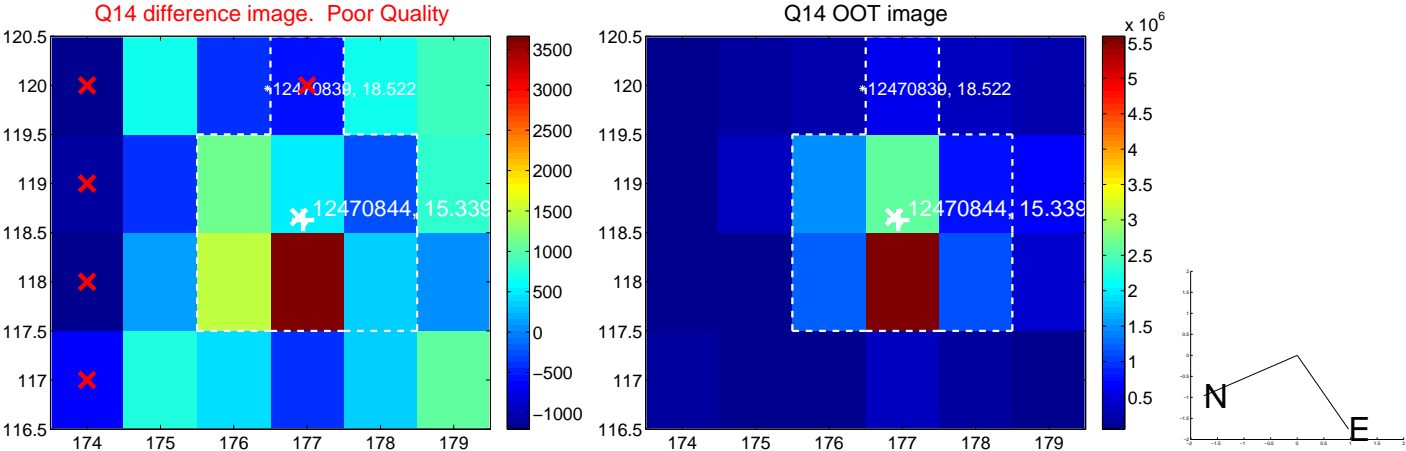
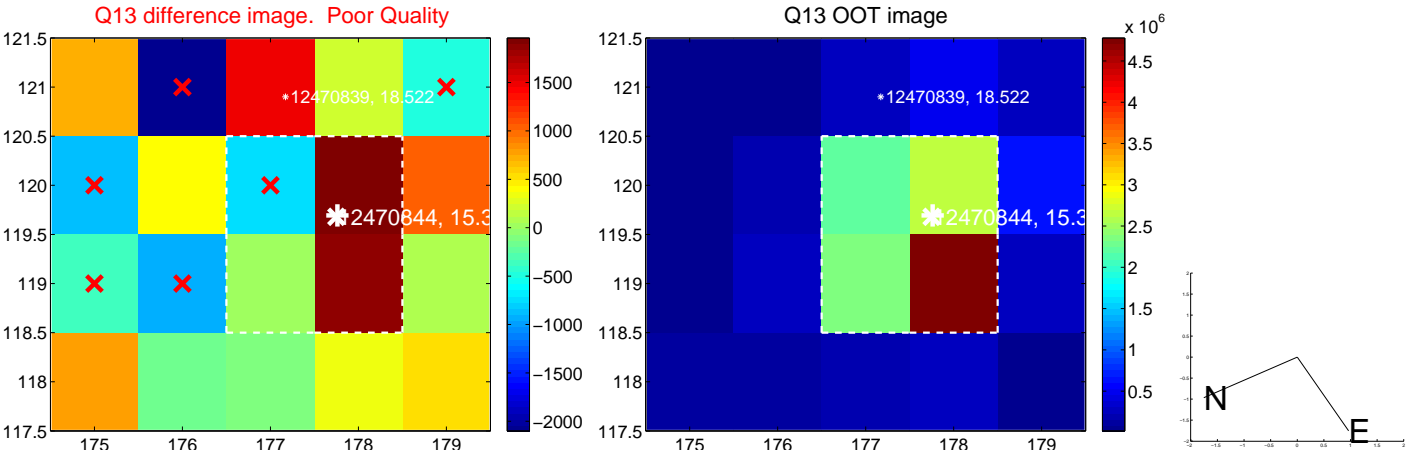
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



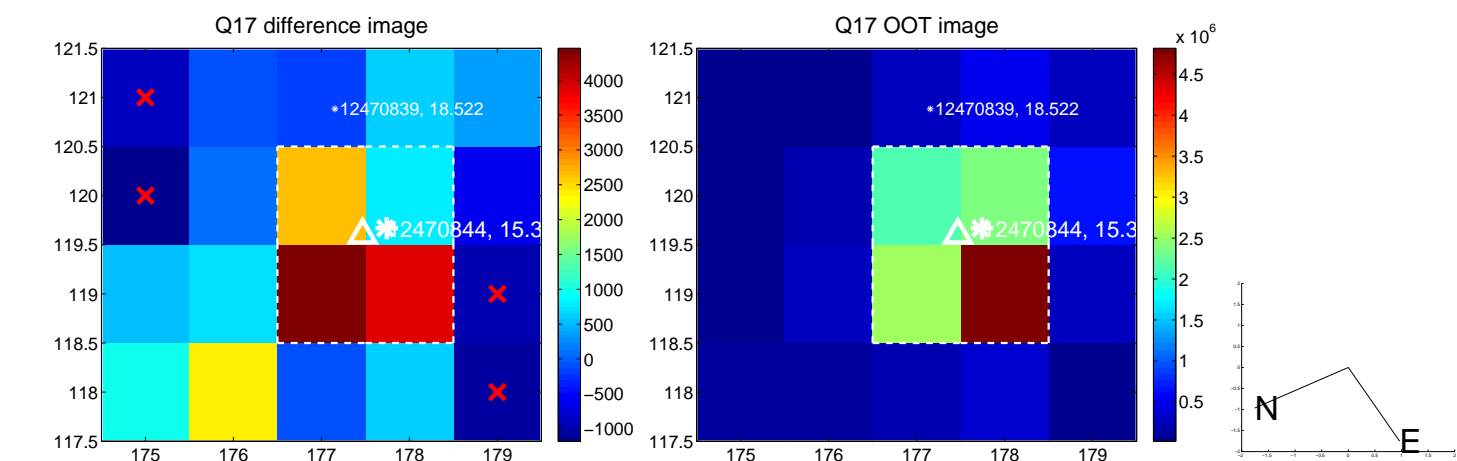
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



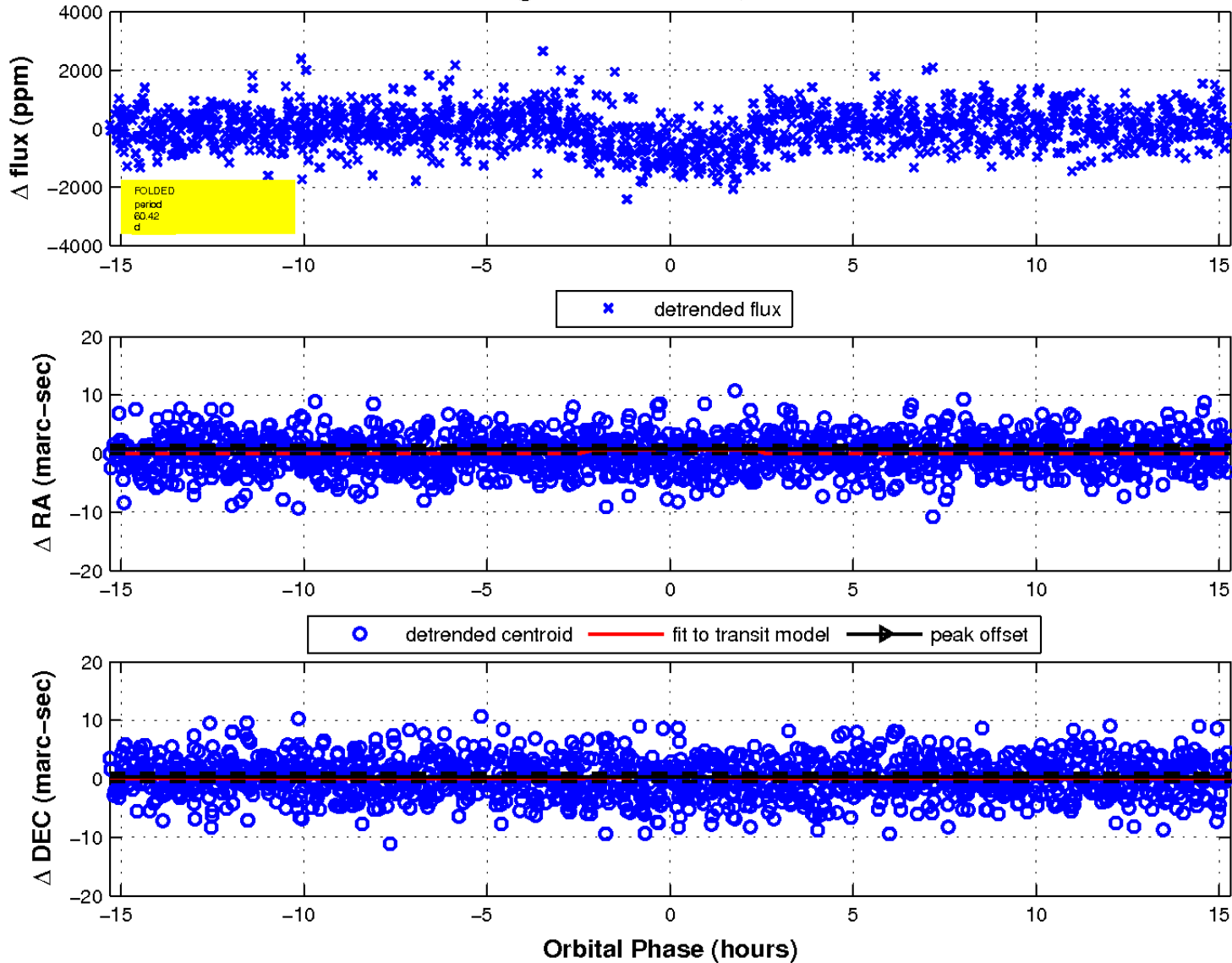
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



fluxWeightedCentroids, Planet 2 of 2



UKIRT Image

Declination

