

# KIC 012356051

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
012356051-02	OBS	No	484.430404	172.624434	1662.4	5.676	11.5	6.6	0.31	3389	1.26	0.02
012356051-03	OBS	No	443.946888	541.869560	1474.9	9.097	10.7	6.5	0.31	3389	1.19	0.02

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
012356051-02	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_CHASES_MARSHALL—LPP_DV—LPP_ALT—ALL_TRANS_CHASES—MOD_POS_DV—MOD_NONUNIQ_ALT—MOD_TER_ALT—MOD_POS_ALT—CENT_FEW_DIFFS
012356051-03	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_CHASES_MARSHALL—LPP_DV—ALL_TRANS_CHASES—MOD_NONUNIQ_DV—MOD_TER_DV—MOD_POS_DV

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

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

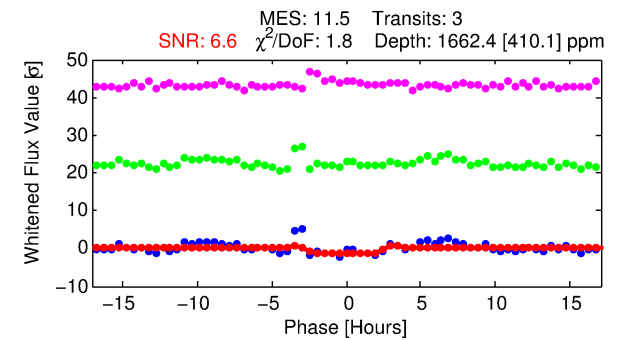
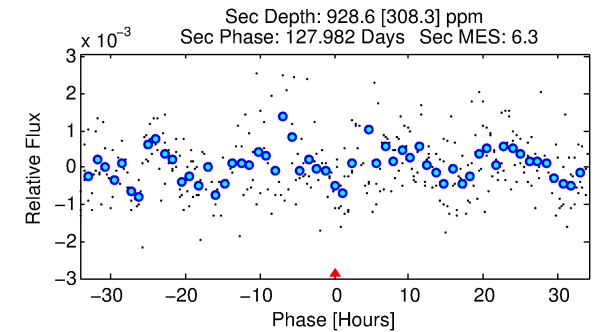
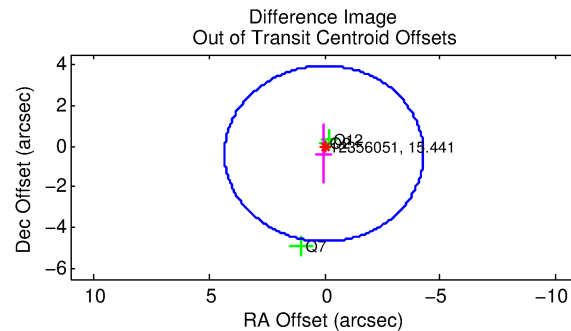
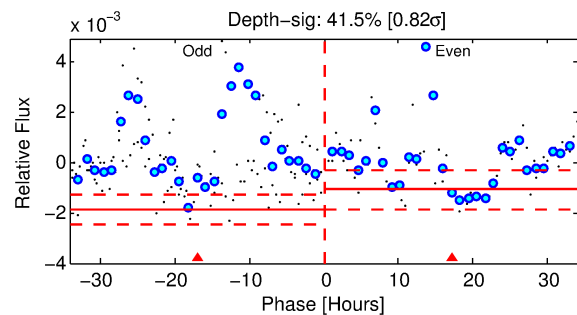
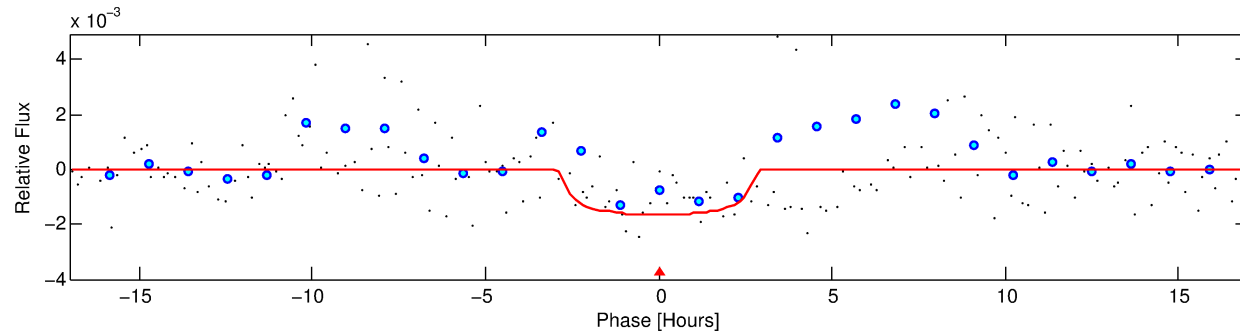
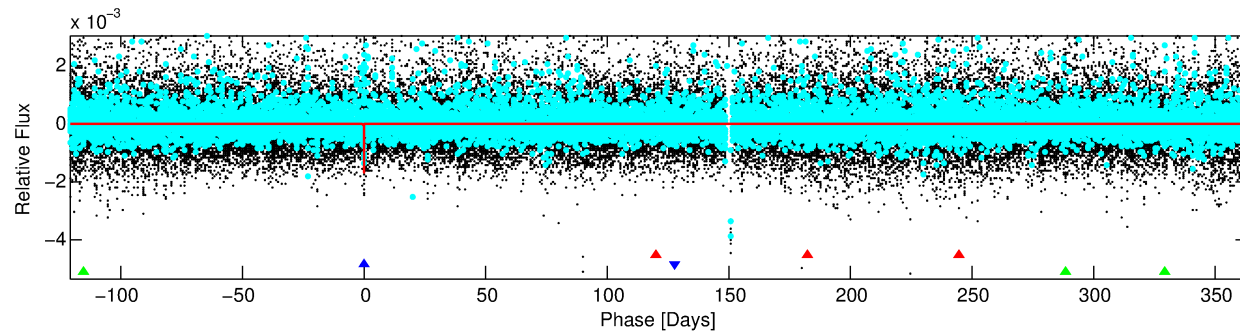
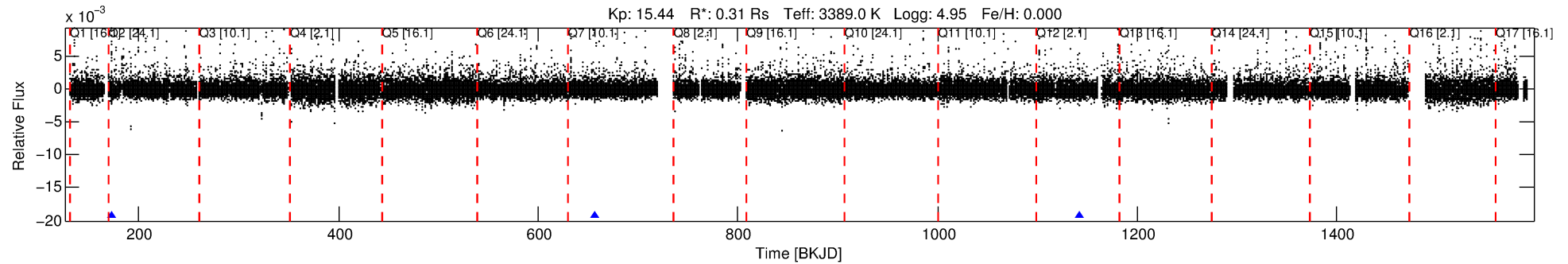
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

## Ephemeris Match Information For 012356051-02

No Significant Match Found

# DV One-Page Summary

KIC: 12356051 Candidate: 2 of 3 Period: 484.430 d



## DV Fit Results:

Period = 484.43040 [0.01352] d  
Epoch = 172.6244 [0.0175] BKJD  
Rp/R\* = 0.0375 [0.0496]  
a/R\* = 628.54 [3511.16]  
b = 0.38 [12.44]  
Seff = 0.02 [0.00]  
Teq = 92 [3] K  
Rp = 1.26 [1.67] Re  
a = 0.8115 [0.0677] AU  
Ag = 213122.37 [568201.55] [0.38 $\sigma$ ]  
Teffp = 3055 [2035] K [1.46 $\sigma$ ]

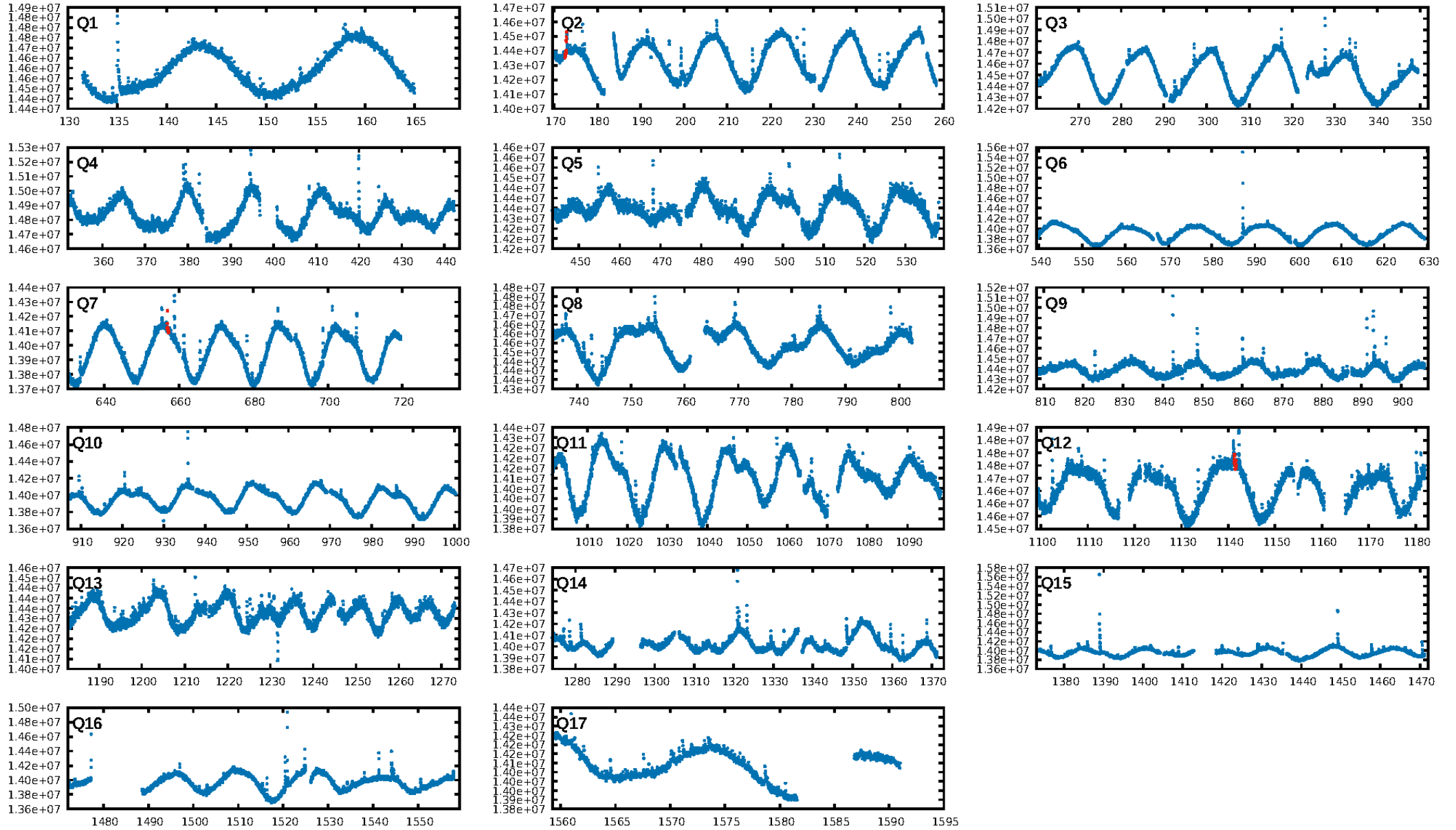
## DV Diagnostic Results:

ShortPeriod-sig: 100.0% [90.62 $\sigma$ ]  
LongPeriod-sig: 100.0% [228.09 $\sigma$ ]  
ModelChiSquare2-sig: 20.7%  
ModelChiSquareGof-sig: 81.9%  
**Bootstrap-pfa: 1.15e-11**  
RollingBand-fgt: 1.00 [3/3]  
GhostDiagnostic-chr: 5.326  
Centroid-sig: 46.7%  
Centroid-so: 1.007 arcsec [0.99 $\sigma$ ]  
OotOffset-rm: 0.365 arcsec [0.25 $\sigma$ ]  
OotOffset-st: 1/1/1/0 [3]  
KicOffset-rm: 0.431 arcsec [0.32 $\sigma$ ]  
KicOffset-st: 1/1/1/0 [3]  
DiffImageQuality-fgm: 0.67 [2/3]  
DiffImageOverlap-fno: 1.00 [3/3]

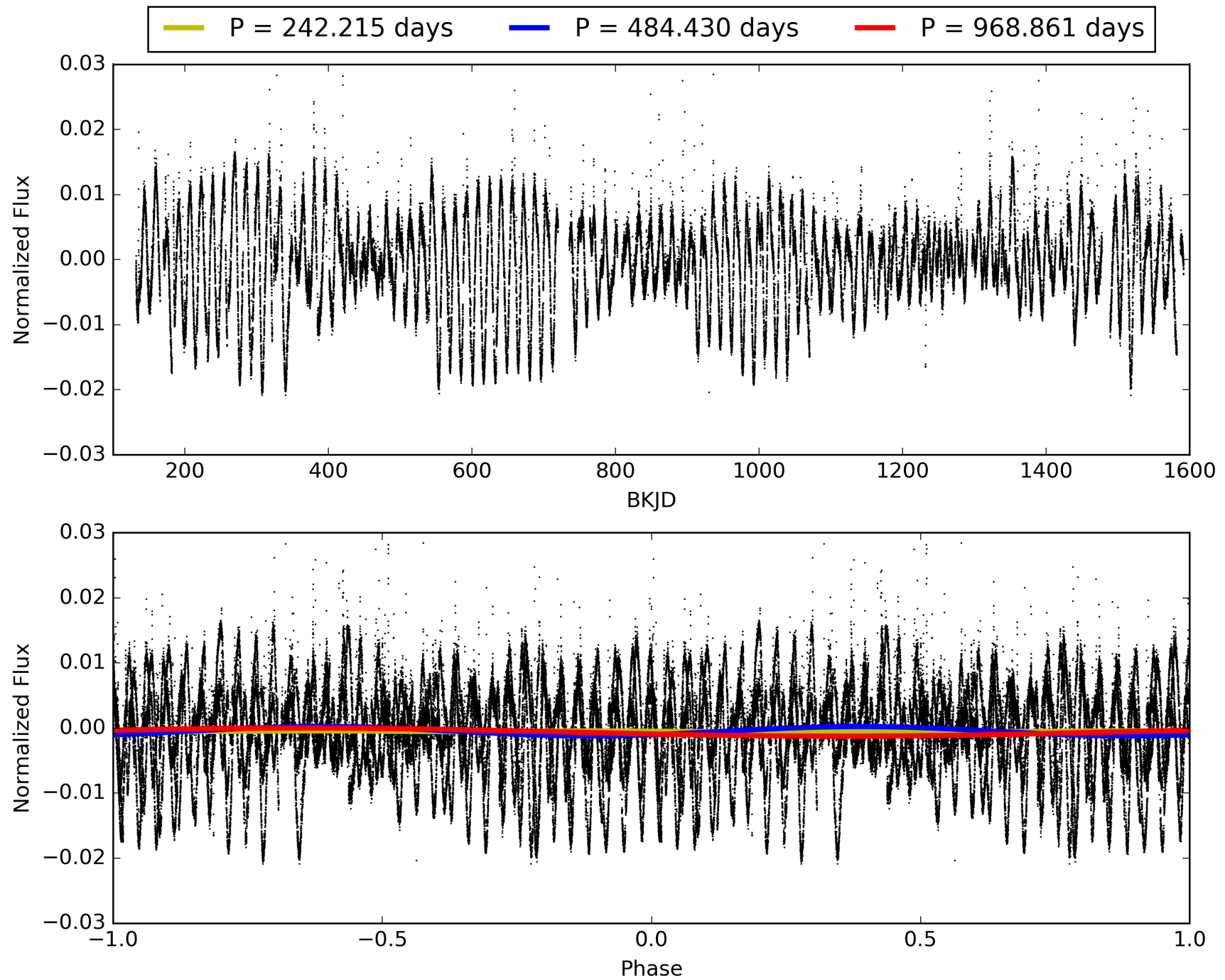
Software Revision: svn+ssh://murzim/repo/soc/tags/release/9.3.42@60958 -- Date Generated: 29-Jan-2016 10:15:41 Z

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

# TCE 012356051-02, PDC Light Curves

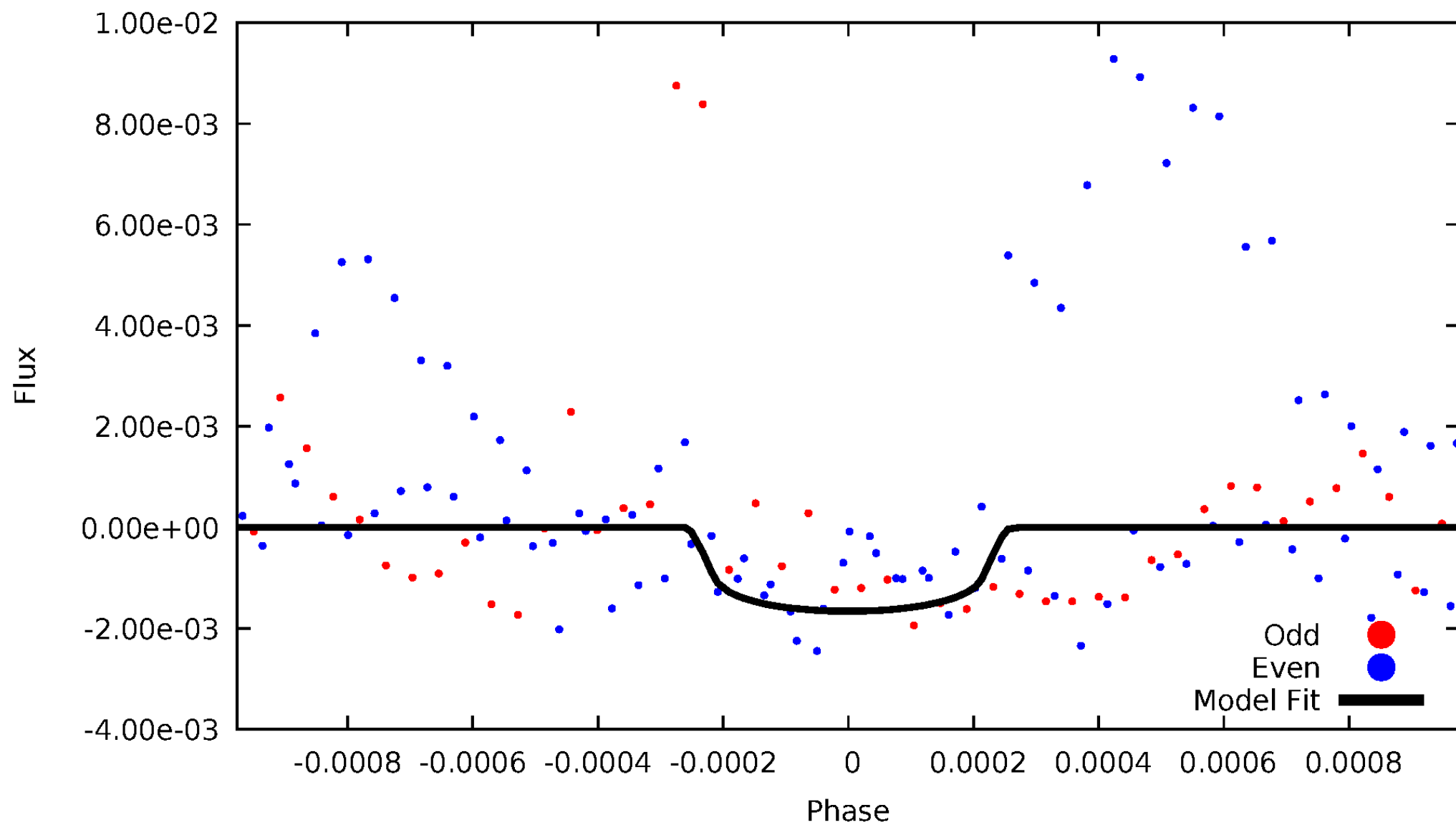


# TCE 012356051-02



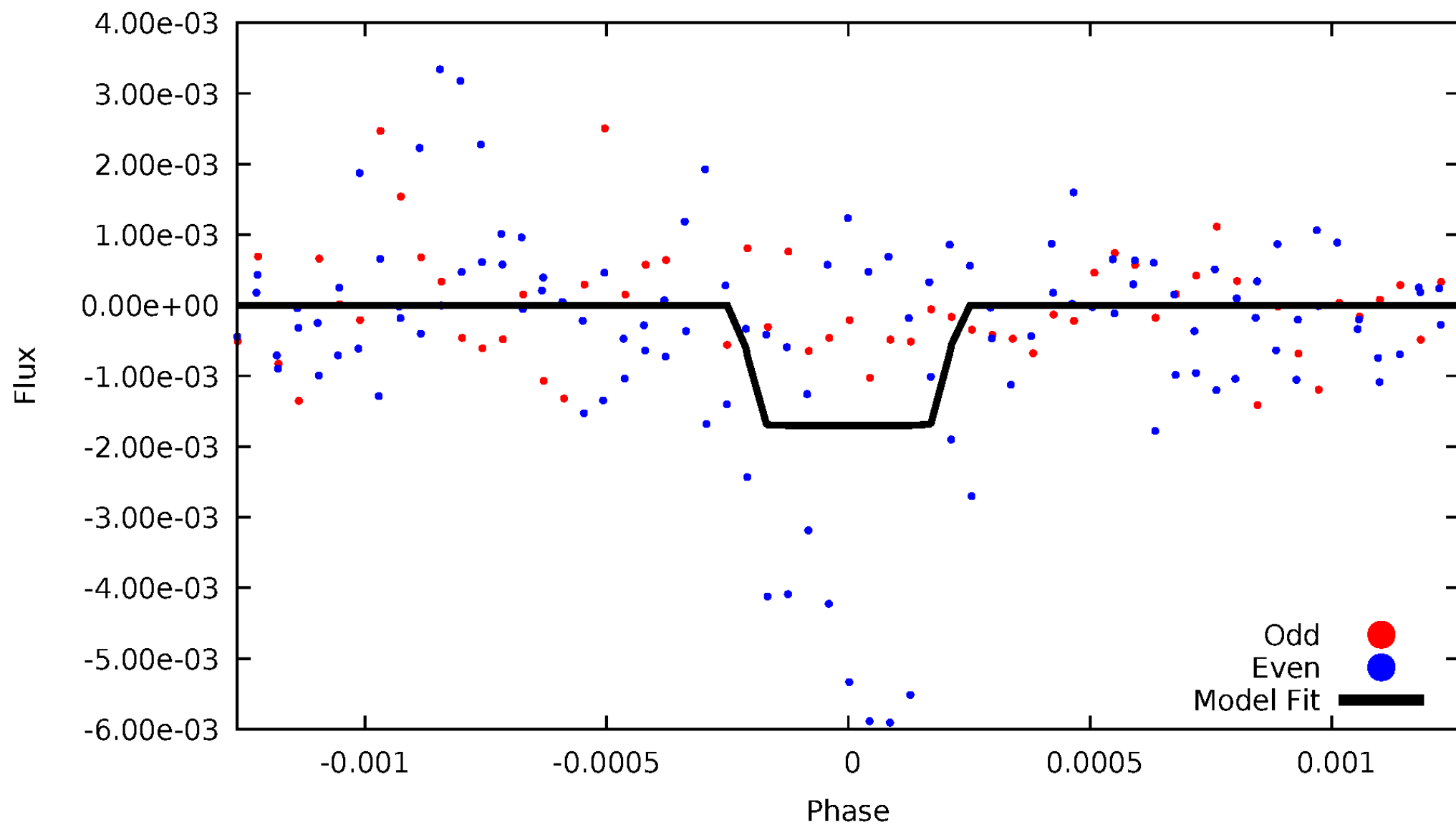
# DV Odd/Even

TCE 012356051-02



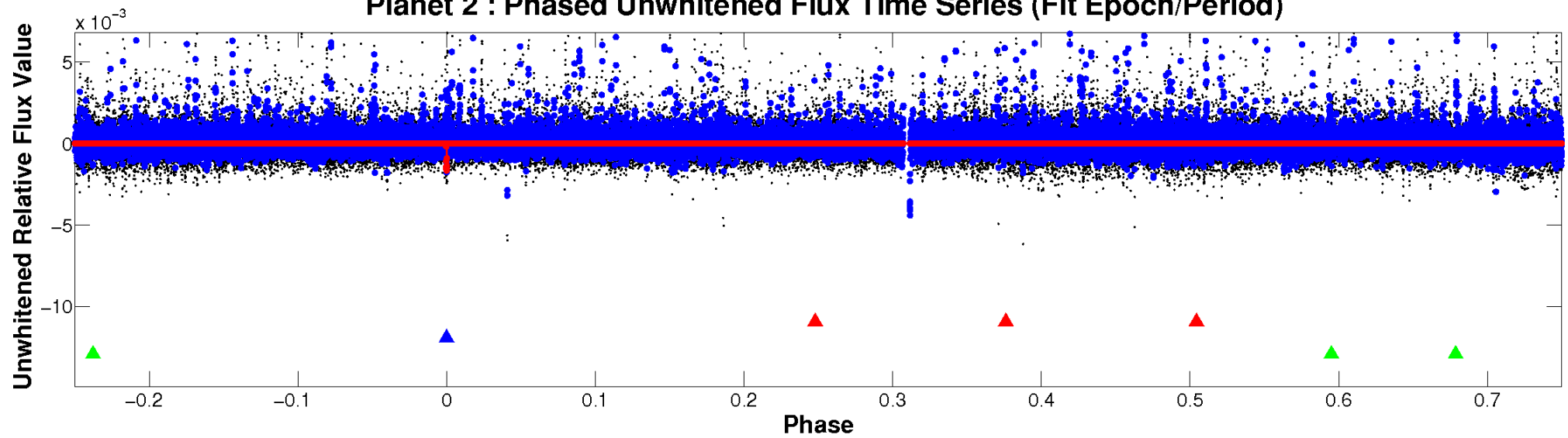
# ALT Odd/Even

TCE 012356051-02

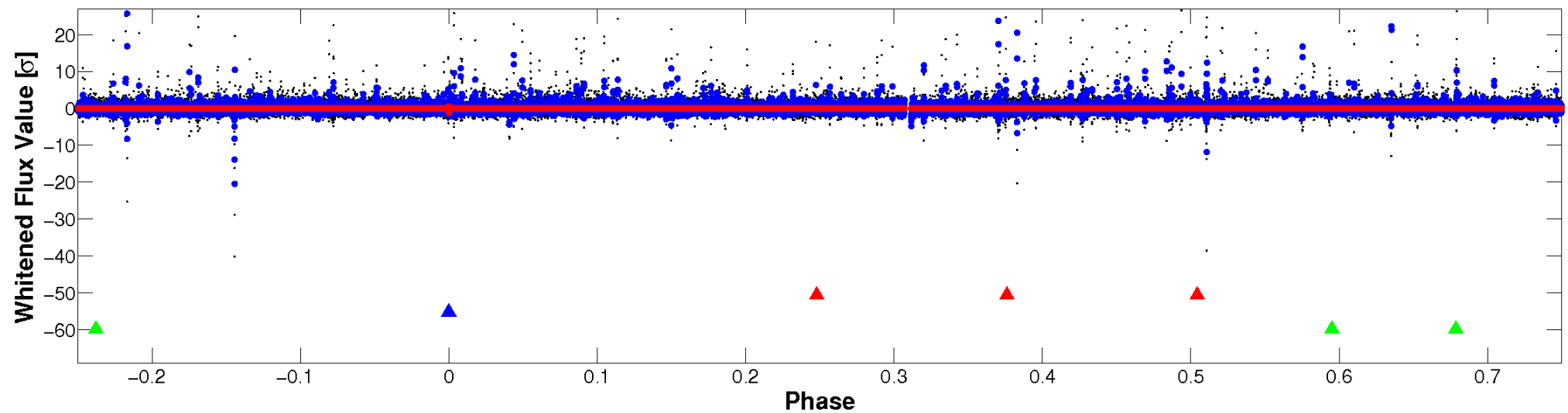


# Non-Whitened Vs. Whitened Light Curve

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

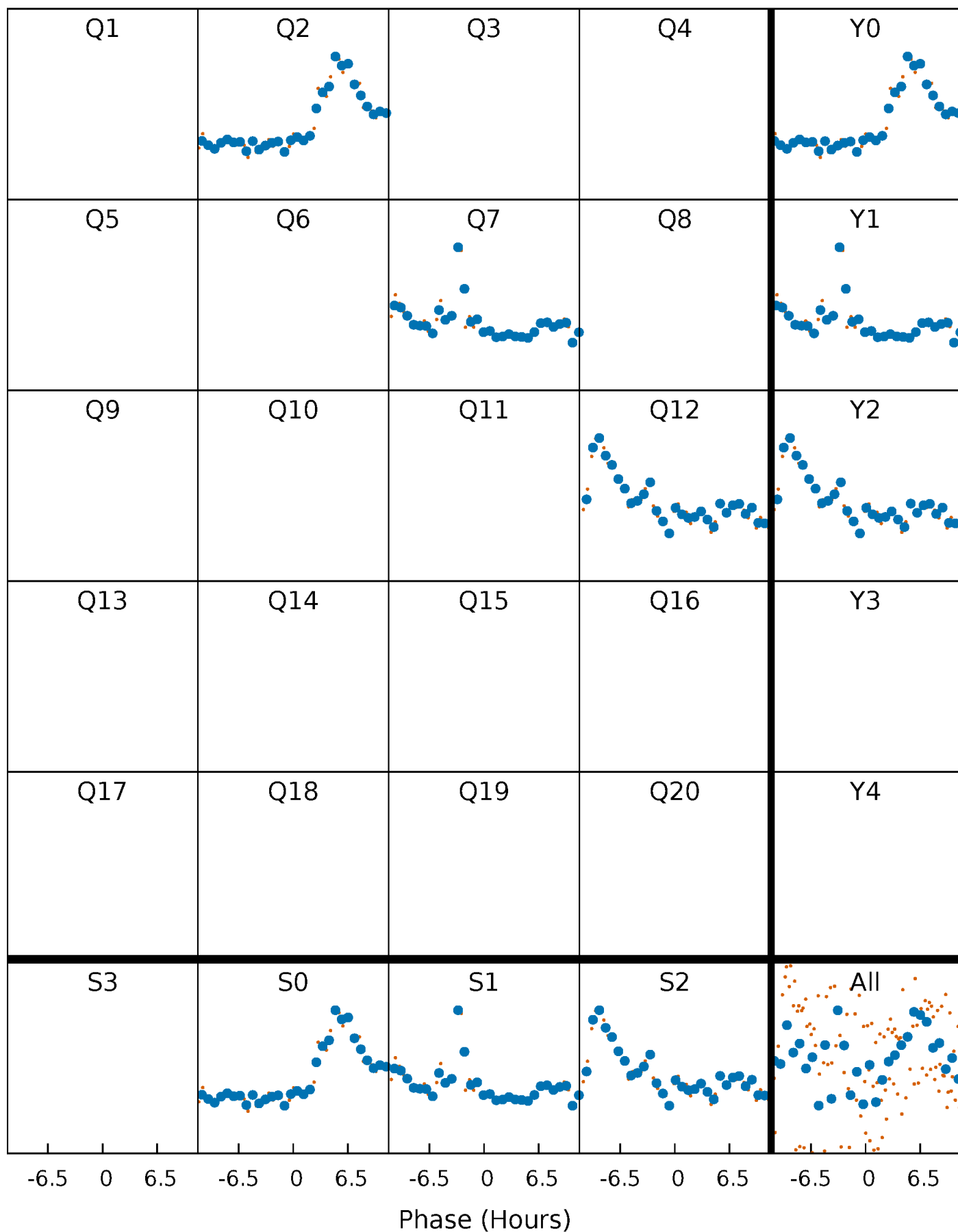


## Planet 2 : Phased Whitened Flux Time Series (Fit Epoch/Period)



# PDC Quarter-Phased Transit Curves

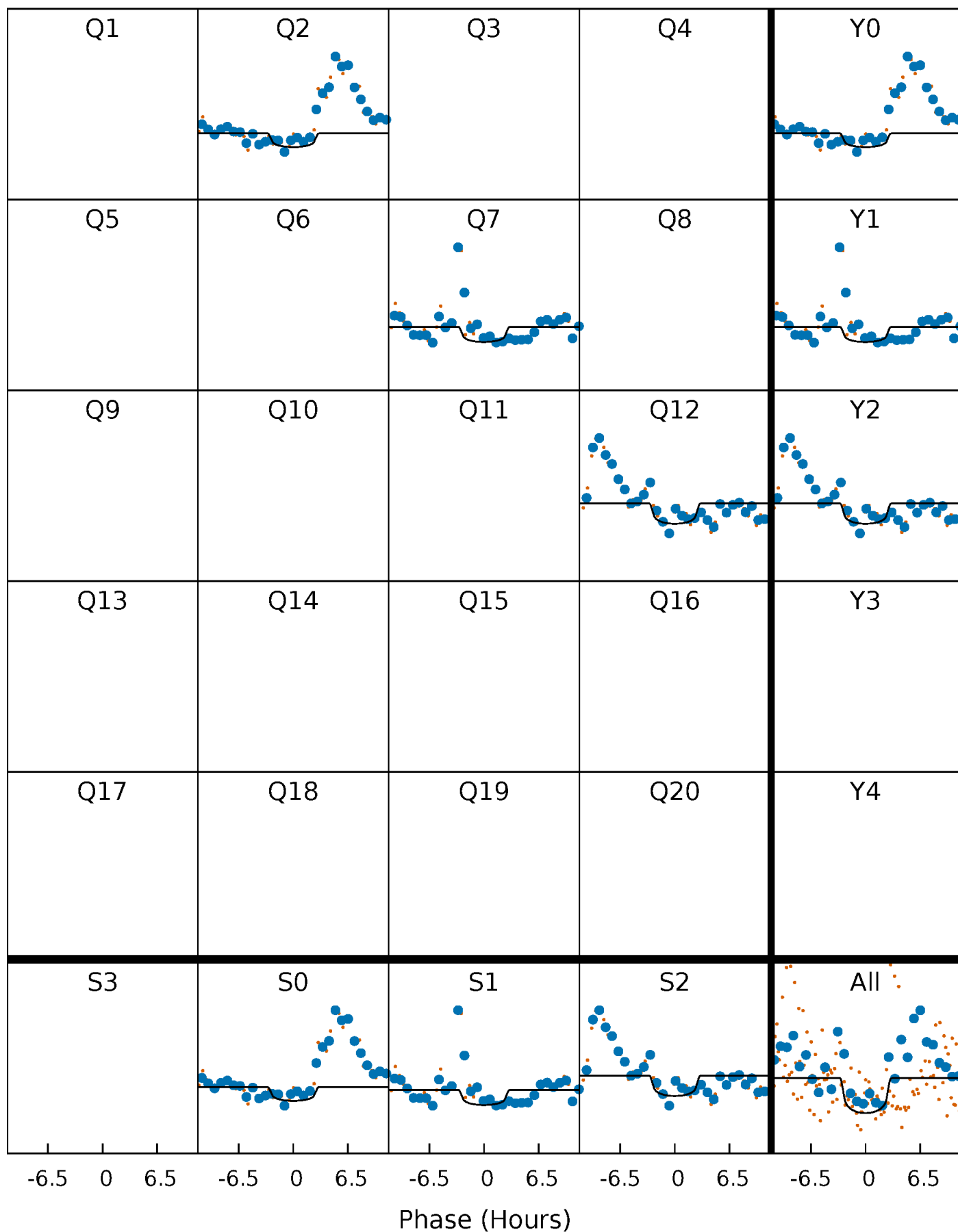
TCE 012356051-02     $P=484.430404$  Days     $T_0=172.624434$  (BKJD)





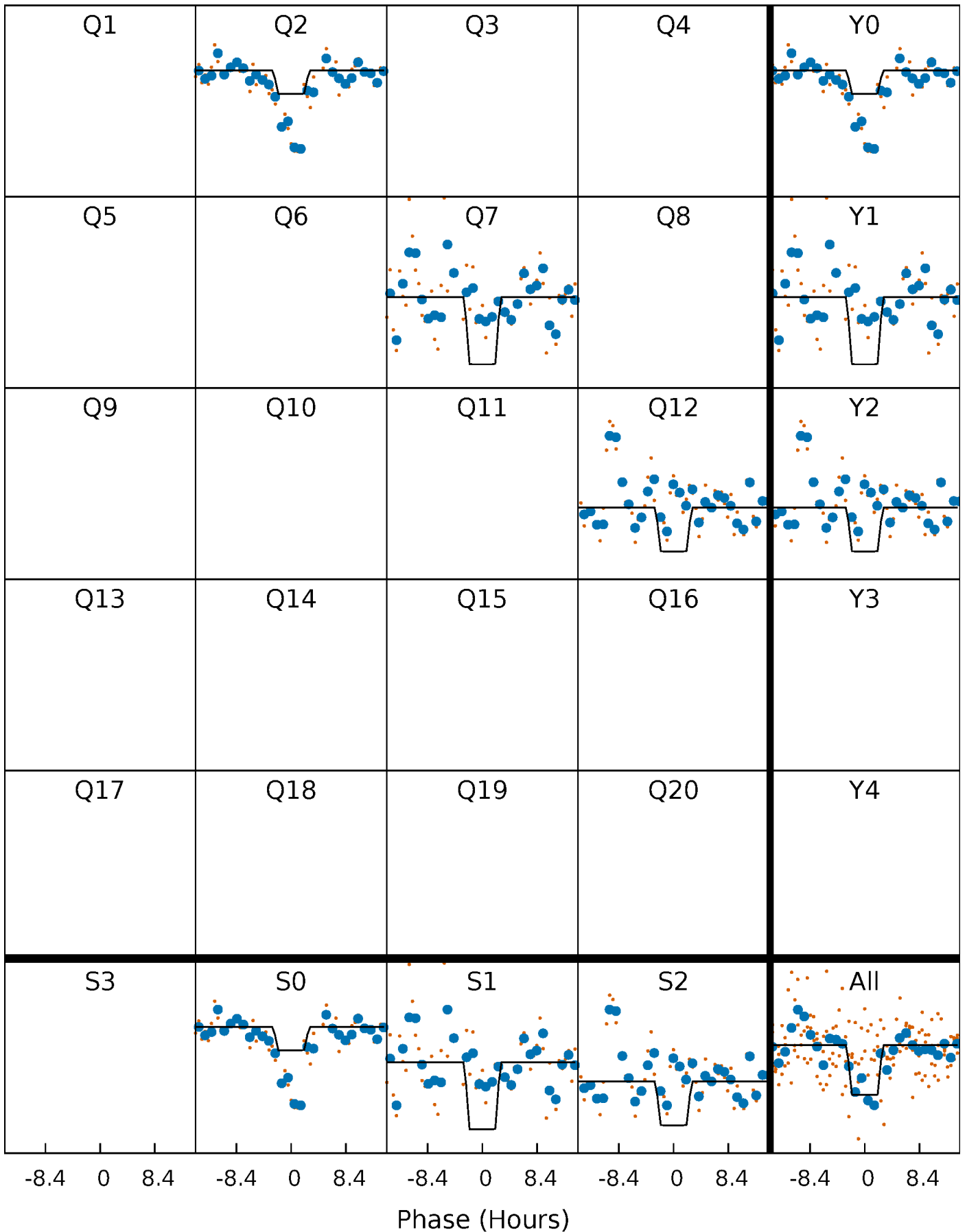
# DV Quarter-Phased Transit Curves

TCE 012356051-02     $P=484.430404$  Days     $T_0=172.624434$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

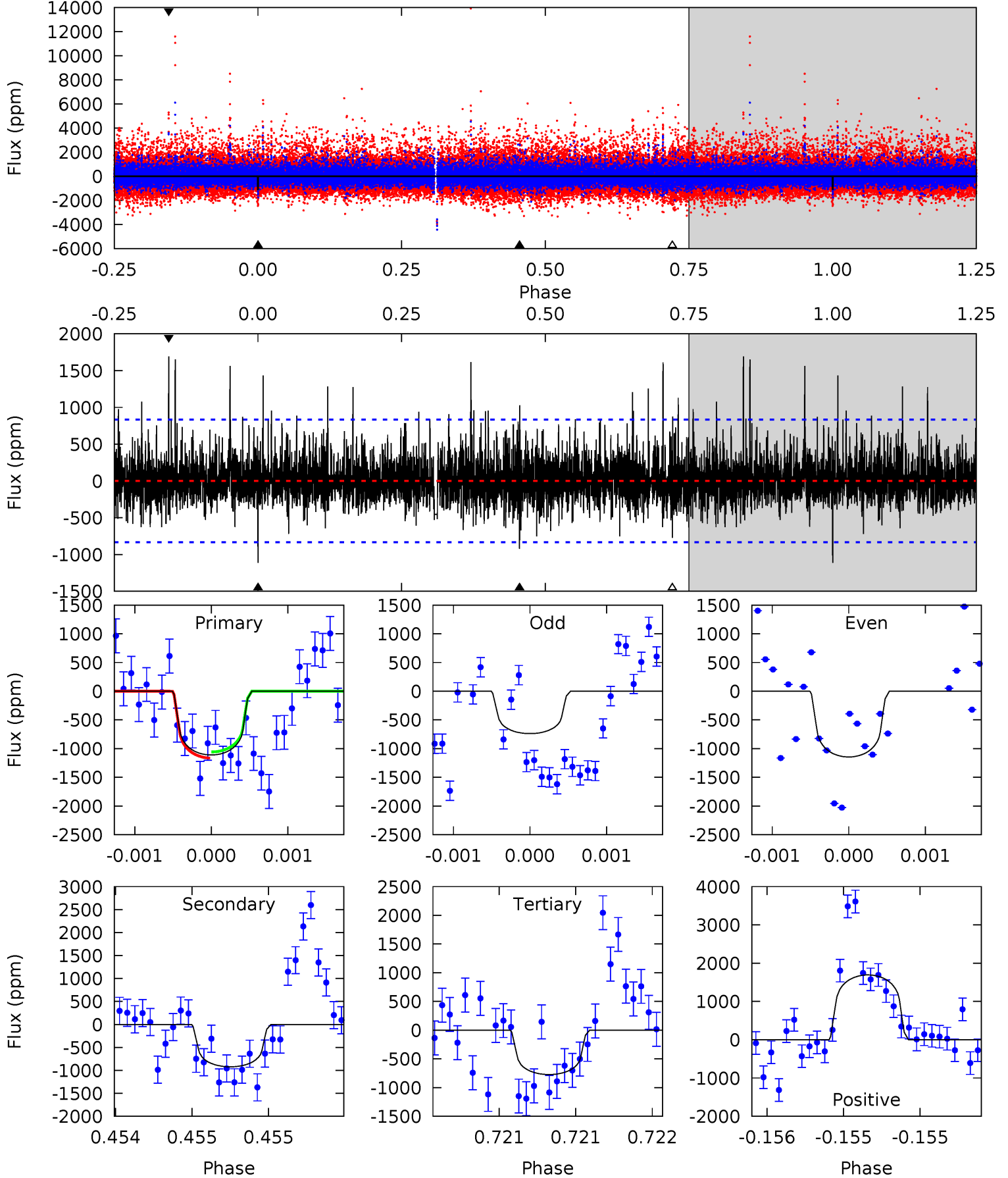
TCE 012356051-02     $P=484.418407$  Days     $T_0=172.665522$  (BKJD)



# DV Model-Shift Uniqueness Test

012356051-02, P = 484.430404 Days, E = 172.624434 Days

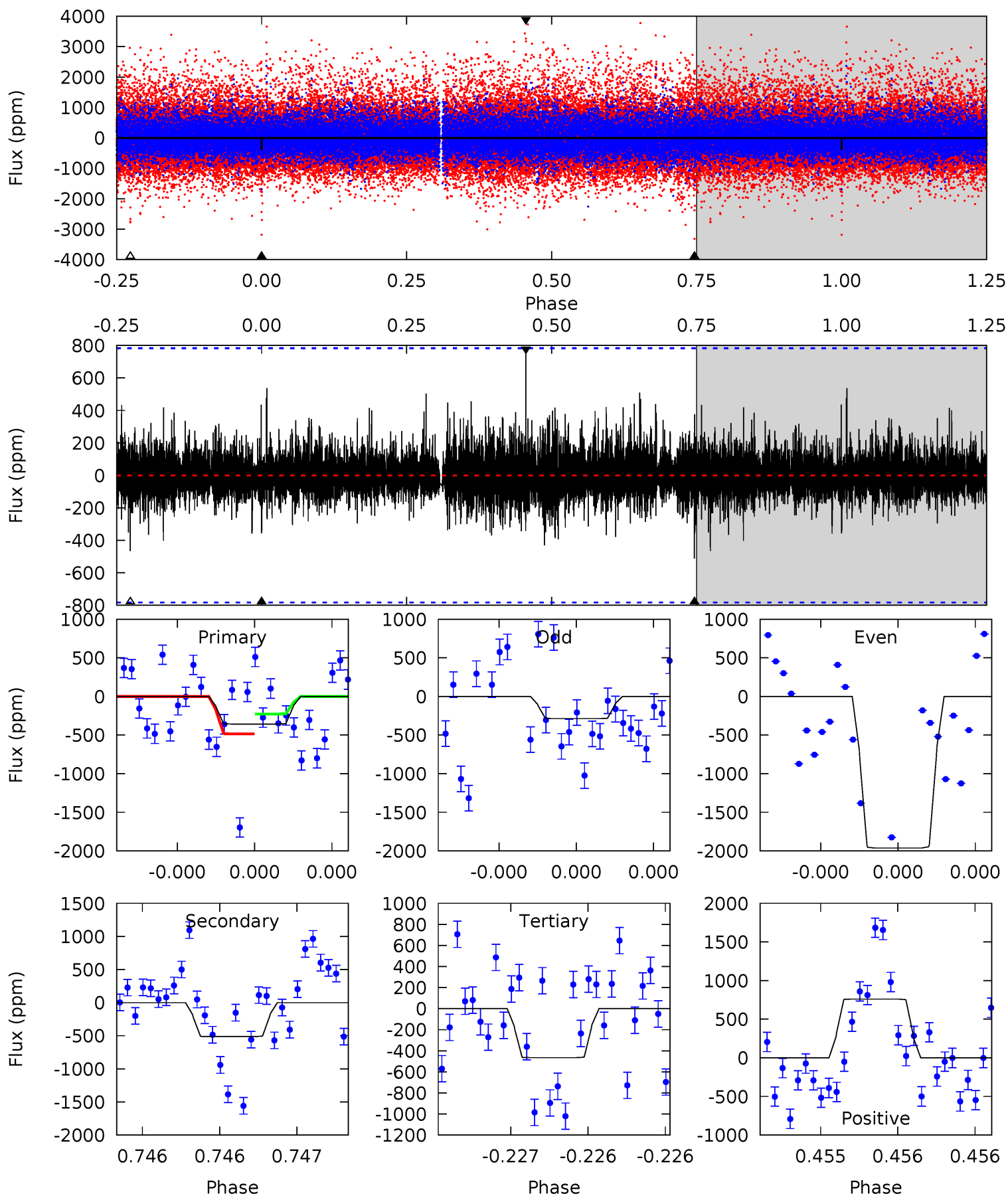
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
7.42	6.17	5.16	11.3	5.57	3.47	1.69	2.26	-3.89	1.00	-5.15	1.00	1.01	0.60	0.36



# Alt Model-Shift Uniqueness Test

012356051-02, P = 484.418407 Days, E = 172.665522 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
2.55	3.66	3.33	5.44	5.60	3.53	0.73	-0.78	-2.89	0.33	-1.78	6.16	5.35	0.60	0.92



### Stellar Parameters For KIC 012356051

	$T_{\text{eff}} (K)$	$\log(g)$	[Fe/H]	$R (R_{\odot})$	$M (M_{\odot})$	$p_{\star} (\text{g}\cdot\text{cm}^{-3})$
	$3389^{+40}_{-40}$	$4.946^{+0.045}_{-0.036}$	$0.000^{+0.100}_{-0.100}$	$0.307^{+0.035}_{-0.035}$	$0.303^{+0.043}_{-0.039}$	$14.800^{+3.587}_{-2.654}$
	+1%/-1%	+1%/-1%	+inf%/-inf%	+11%/-11%	+14%/-13%	+24%/-18%
Source	PHO2	PHO2	PHO2	DSEP		

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

### Secondary Eclipse Parameters for KIC 012356051-02 / KOI

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{\text{max}} (K)$	$T_{\text{obs}} (K)$	$A_{\text{obs}}$
DV	$-923 \pm 150$	$1.70^{+1.46}_{-1.10}$	$128^{+3}_{-3}$	$2913^{+1150}_{-446}$	$114650^{+816980}_{-83178}$
Alt.	$-511 \pm 140$	$1.76^{+1.50}_{-1.09}$	$128^{+3}_{-3}$	$2668^{+826}_{-379}$	$56684^{+365115}_{-40099}$

$T_{\text{max}}$  = 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  $A_{\text{obs}} \gg 1.0$

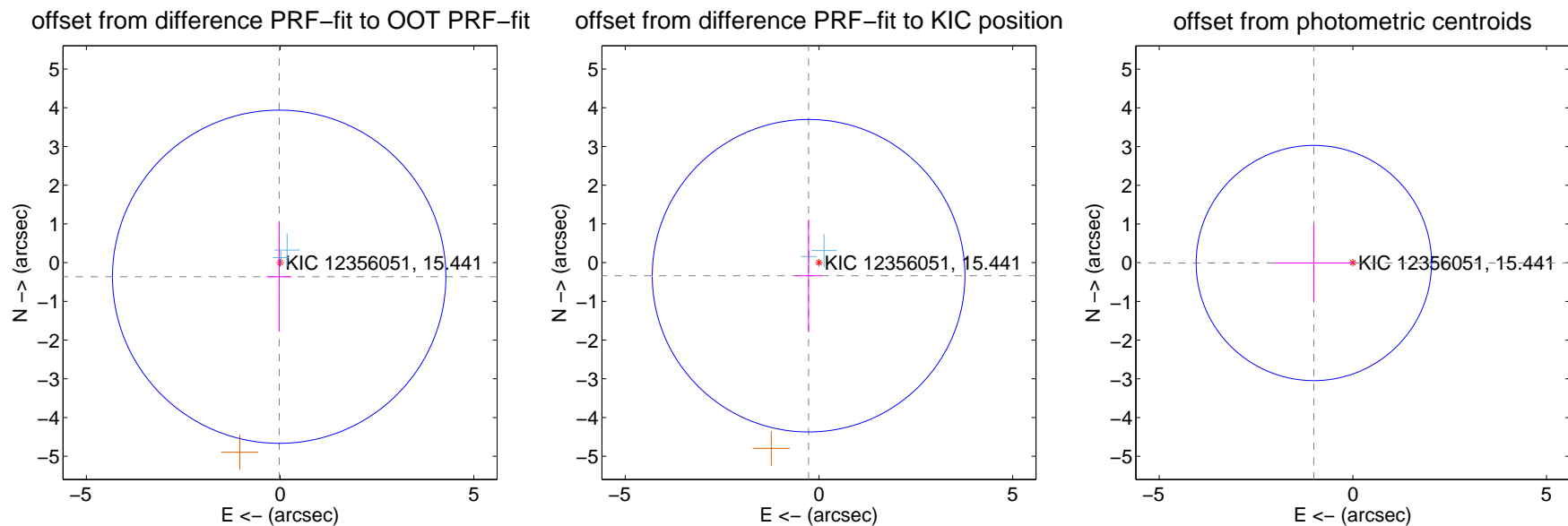
## DV Centroid Data

Supplemental centroid analysis for 012356051-02. Kepler magnitude: 15.44. Transit SNR 6.57

There are 2 quarters with good PRF difference image offsets

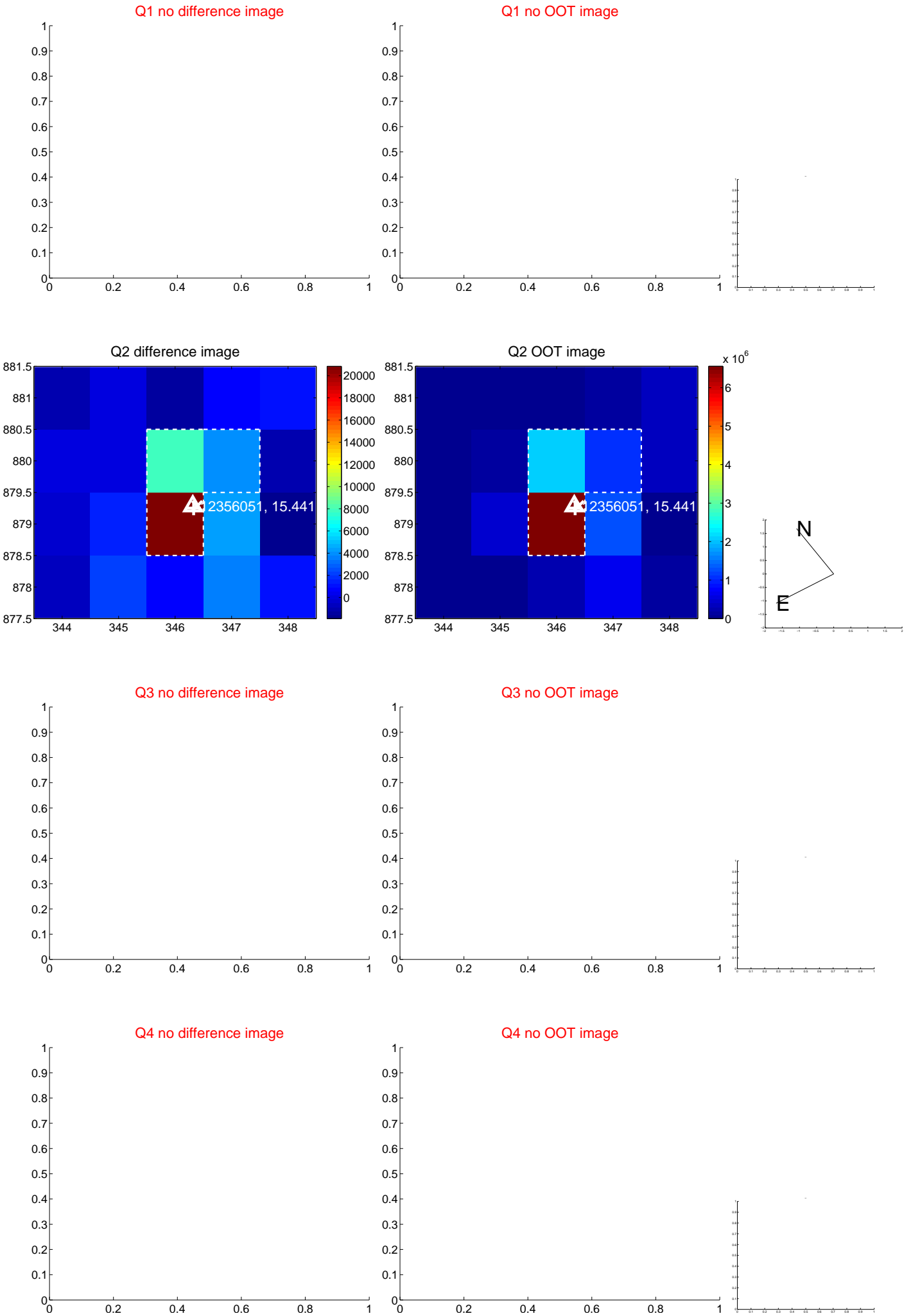
The direct PRF centroid is offset from the target star catalog position by about 0.05 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.365 \pm 1.434$	0.25	$0.024 \pm 0.319$	$-0.364 \pm 1.417$
PRF-fit source offset from KIC position	$0.431 \pm 1.345$	0.32	$0.268 \pm 0.350$	$-0.338 \pm 1.451$
photometric centroid source offset	$1.01 \pm 1.01$	0.99	$1.01 \pm 1.01$	$-0.01 \pm 1.01$

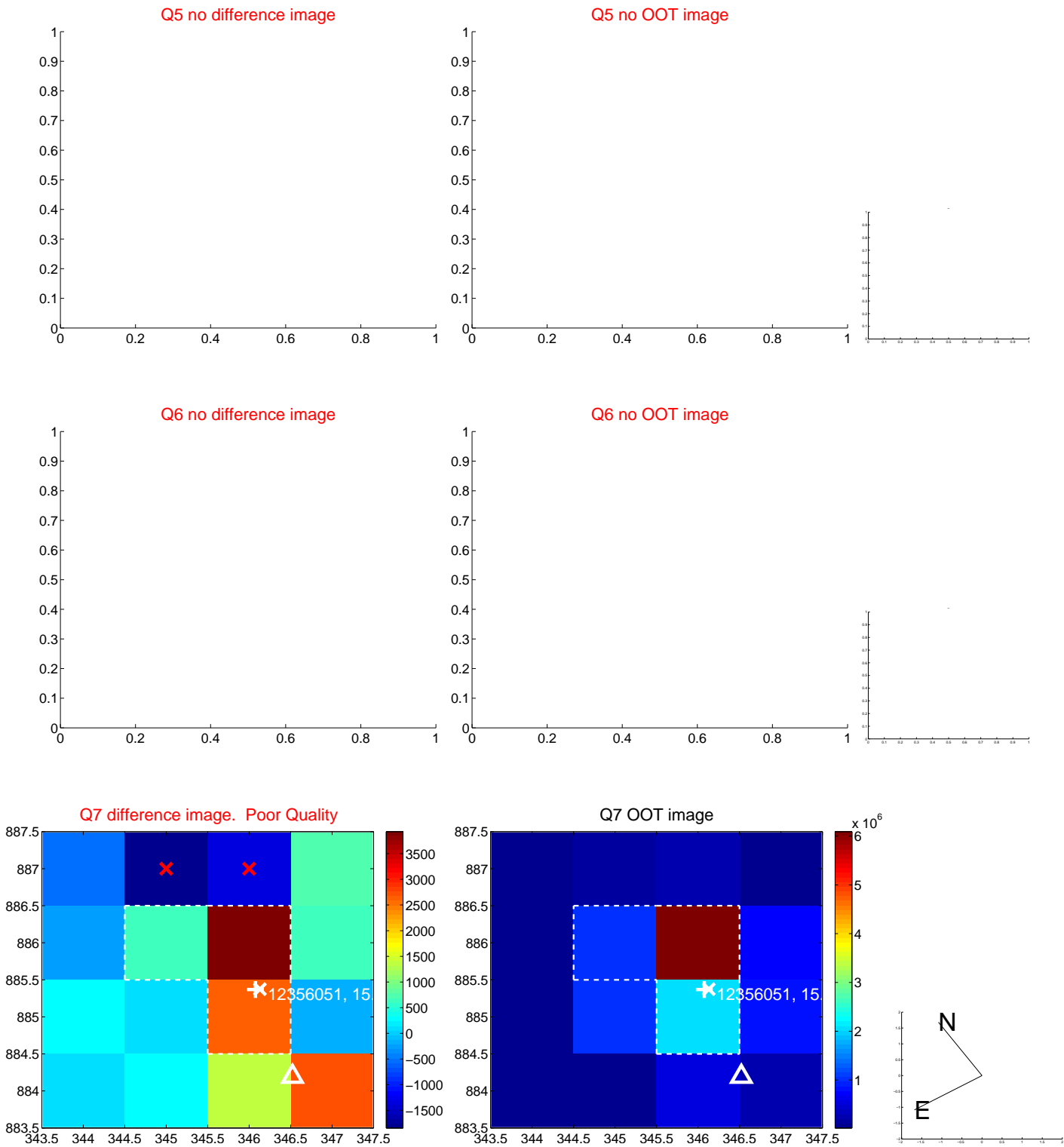


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. Sky blue crosses: good quarterly centroid offsets; Vermillion crosses: bad quarterly centroid offsets; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: three- $\sigma$ . 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.

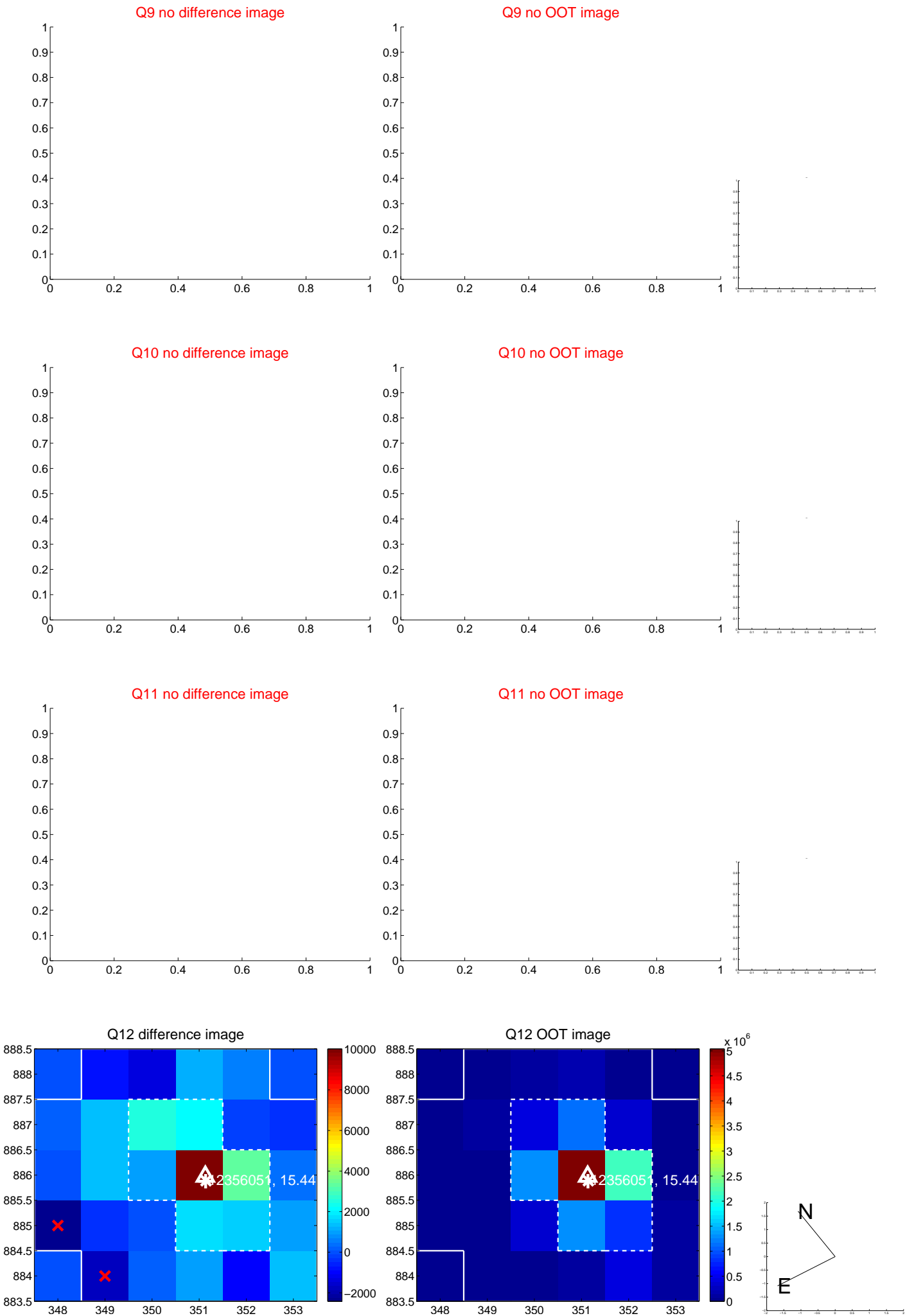


white ×: KIC target position; +: OOT centroid; △: difference centroid. red ✕: large negative pixel value.





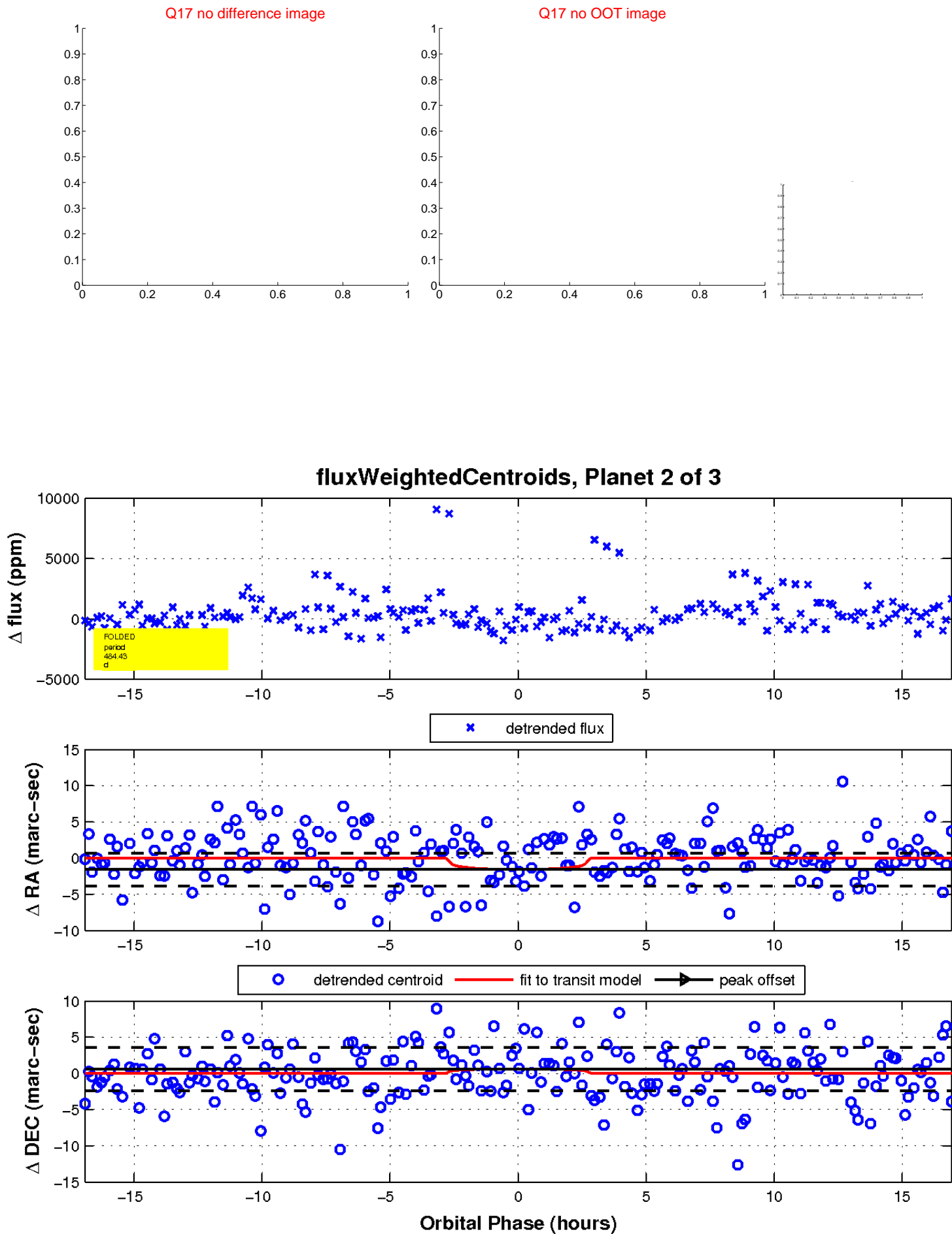
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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

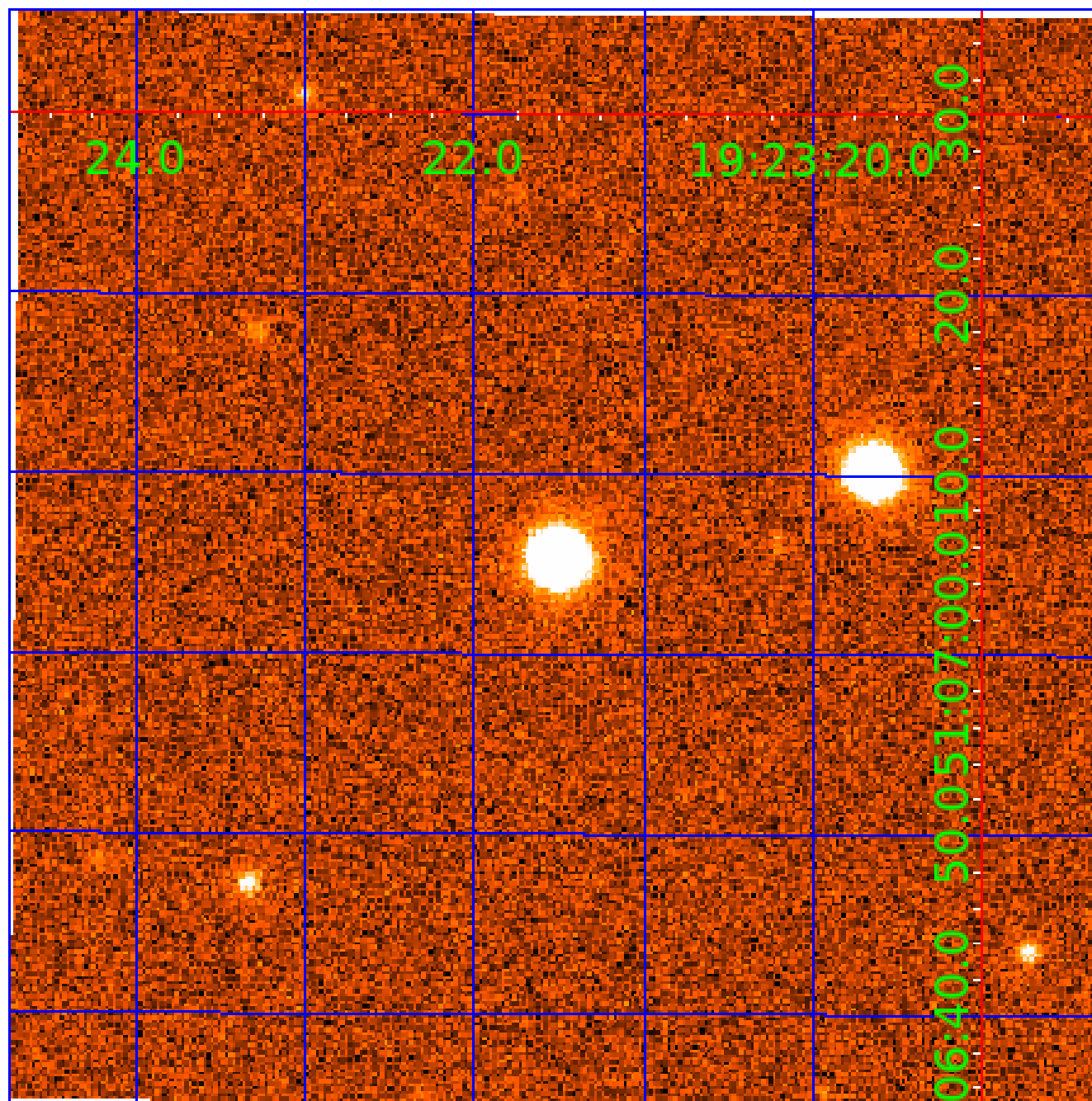


white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



UKIRT Image

Declination



# KIC 012356051

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
012356051-02	OBS	No	484.430404	172.624434	1662.4	5.676	11.5	6.6	0.31	3389	1.26	0.02
012356051-03	OBS	No	443.946888	541.869560	1474.9	9.097	10.7	6.5	0.31	3389	1.19	0.02

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
012356051-02	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_CHASES_MARSHALL—LPP_DV—LPP_ALT—ALL_TRANS_CHASES—MOD_POS_DV—MOD_NONUNIQ_ALT—MOD_TER_ALT—MOD_POS_ALT—CENT_FEW_DIFFS
012356051-03	OBS	FP	0.00	1	0	0	0	INDIV_TRANS_CHASES_MARSHALL—LPP_DV—ALL_TRANS_CHASES—MOD_NONUNIQ_DV—MOD_TER_DV—MOD_POS_DV

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

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

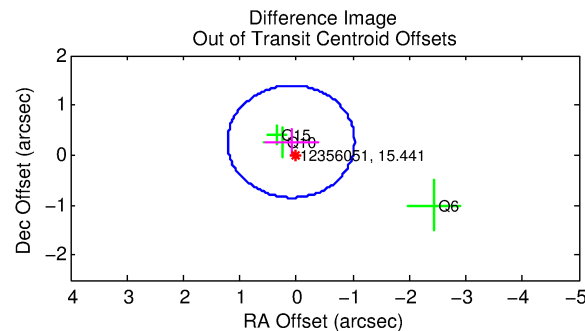
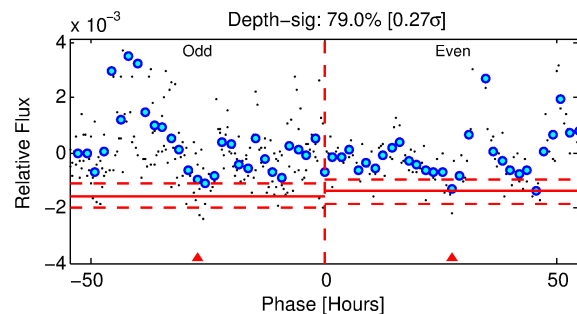
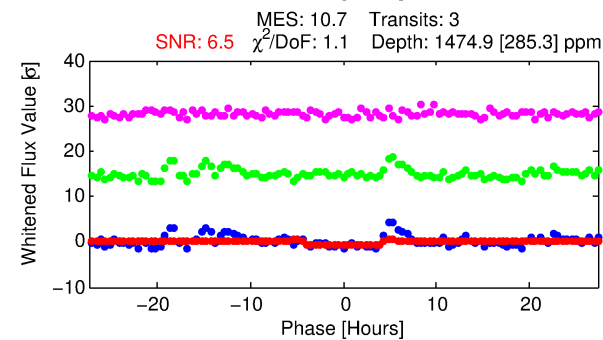
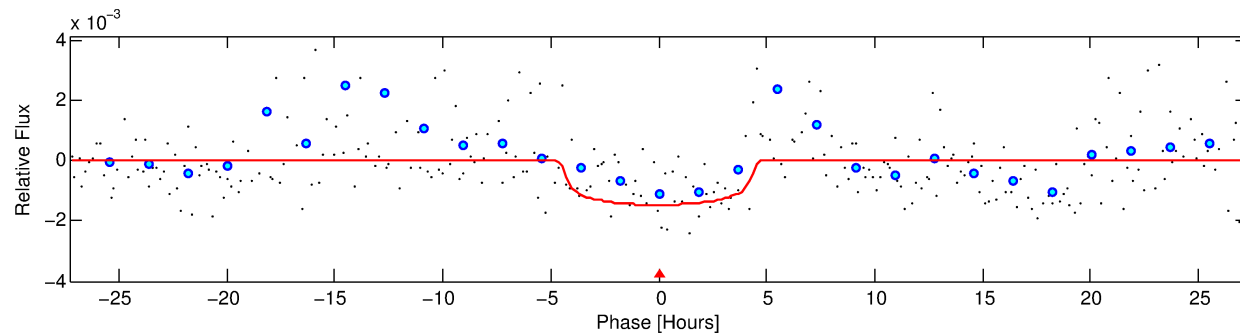
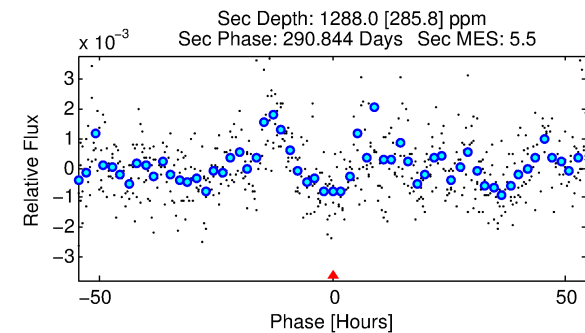
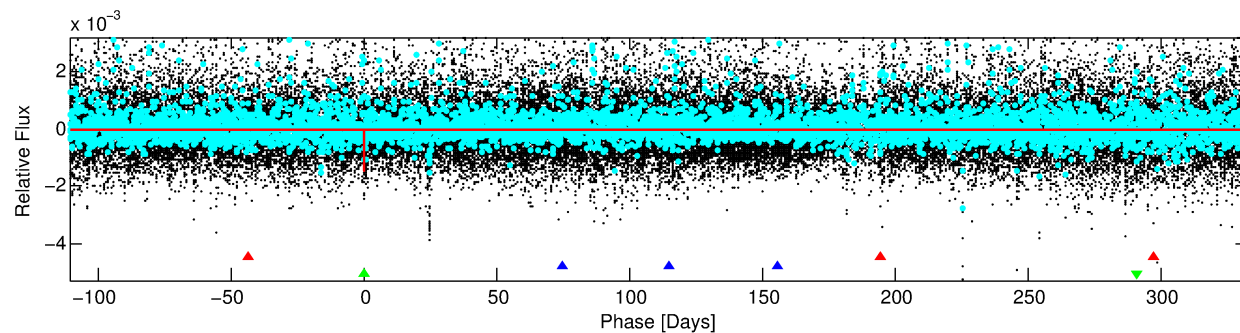
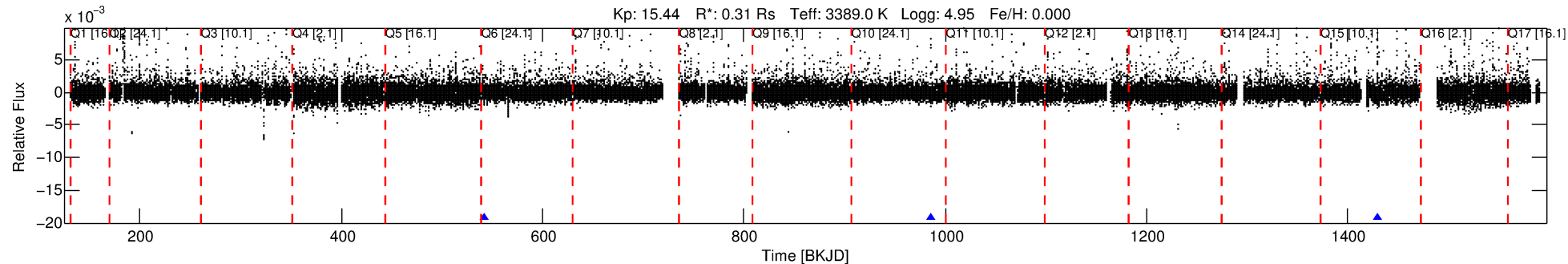
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

## Ephemeris Match Information For 012356051-03

No Significant Match Found

# DV One-Page Summary

KIC: 12356051 Candidate: 3 of 3 Period: 443.947 d



## DV Fit Results:

Period = 443.94689 [0.01259] d  
Epoch = 541.8696 [0.0163] BKJD  
Rp/R\* = 0.0355 [0.0235]  
a/R\* = 351.33 [966.80]  
b = 0.43 [5.25]  
Seff = 0.02 [0.00]  
Teq = 95 [3] K  
Rp = 1.19 [0.80] Re  
a = 0.7656 [0.0639] AU  
Ag = 293693.99 [395319.17] [0.74 $\sigma$ ]  
Teffp = 3408 [1144] K [2.90 $\sigma$ ]

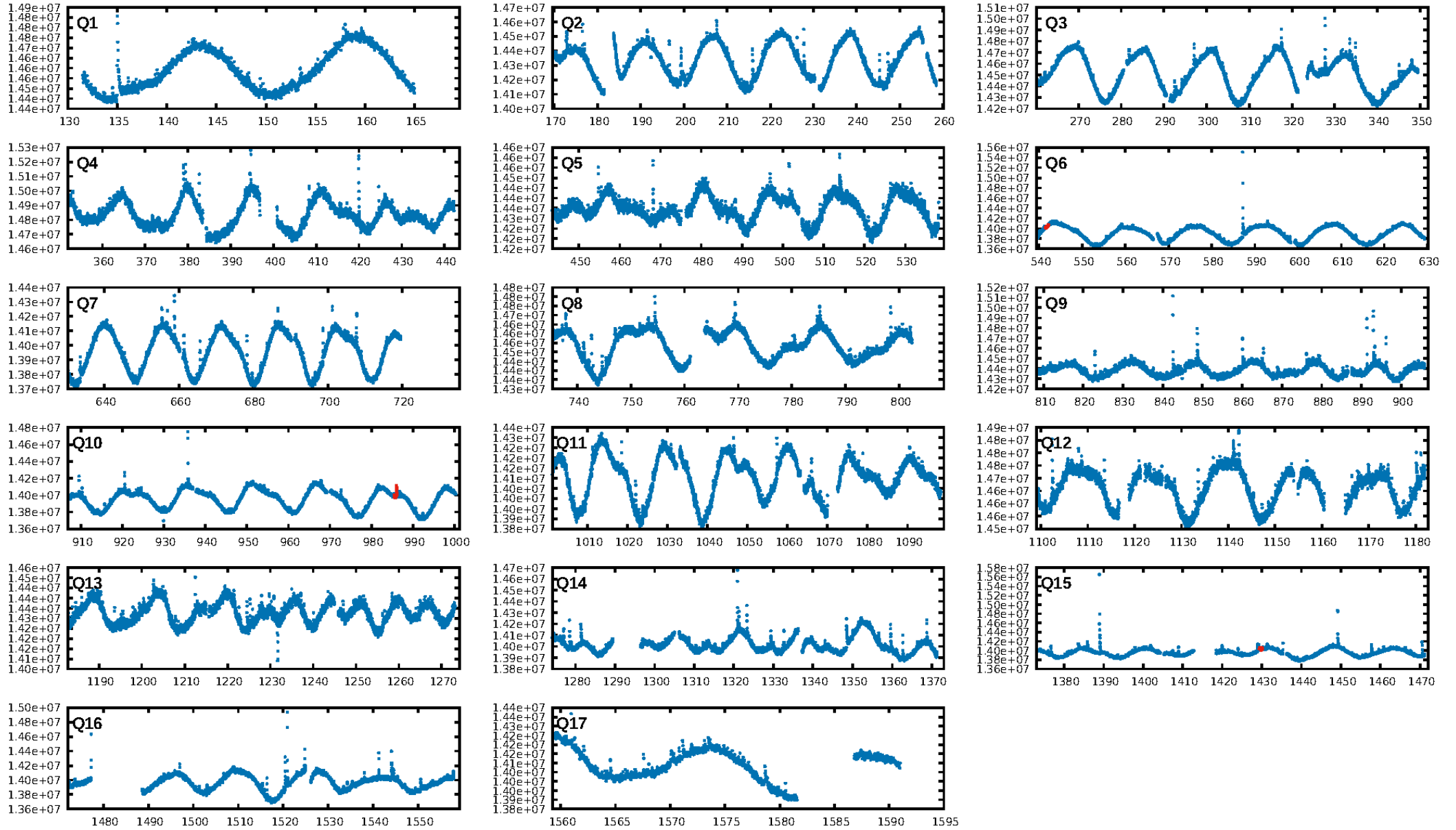
## DV Diagnostic Results:

ShortPeriod-sig: N/A  
LongPeriod-sig: 100.0% [90.62 $\sigma$ ]  
ModelChiSquare2-sig: 23.6%  
ModelChiSquareGof-sig: 98.8%  
**Bootstrap-pfa: 2.34e-11**  
RollingBand-fgt: 1.00 [3/3]  
GhostDiagnostic-chr: 4.215  
Centroid-sig: 98.2%  
Centroid-so: 0.369 arcsec [0.41 $\sigma$ ]  
OotOffset-rm: 0.288 arcsec [0.77 $\sigma$ ]  
OotOffset-st: 2/1/0/0 [3]  
KicOffset-rm: 0.401 arcsec [0.65 $\sigma$ ]  
KicOffset-st: 2/1/0/0 [3]  
DiffImageQuality-fgm: 1.00 [3/3]  
DiffImageOverlap-fno: 1.00 [3/3]

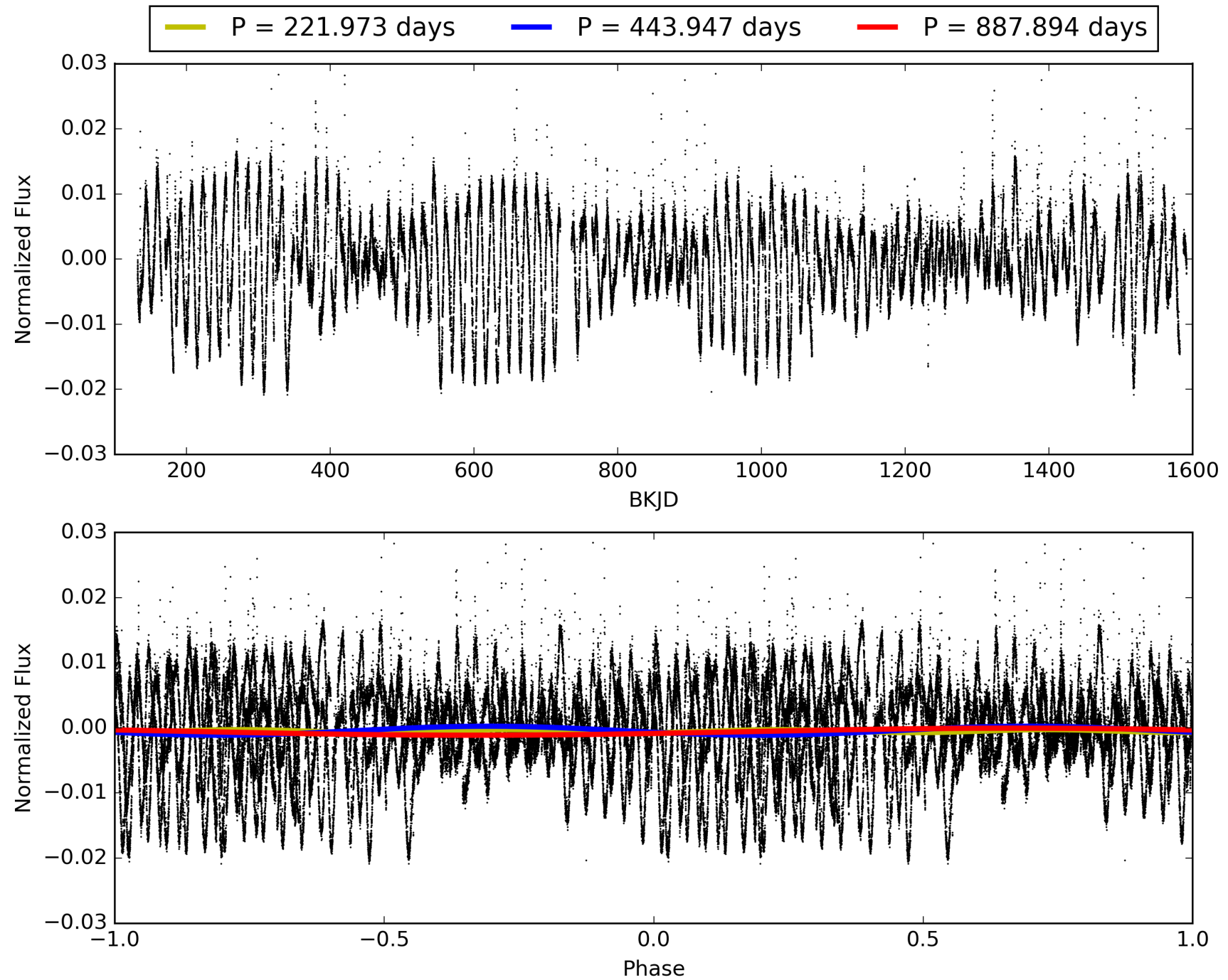
Software Revision: svn+ssh://murzim/repo/soc/tags/release/9.3.42@60958 -- Date Generated: 29-Jan-2016 10:15:52 Z

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

# TCE 012356051-03, PDC Light Curves



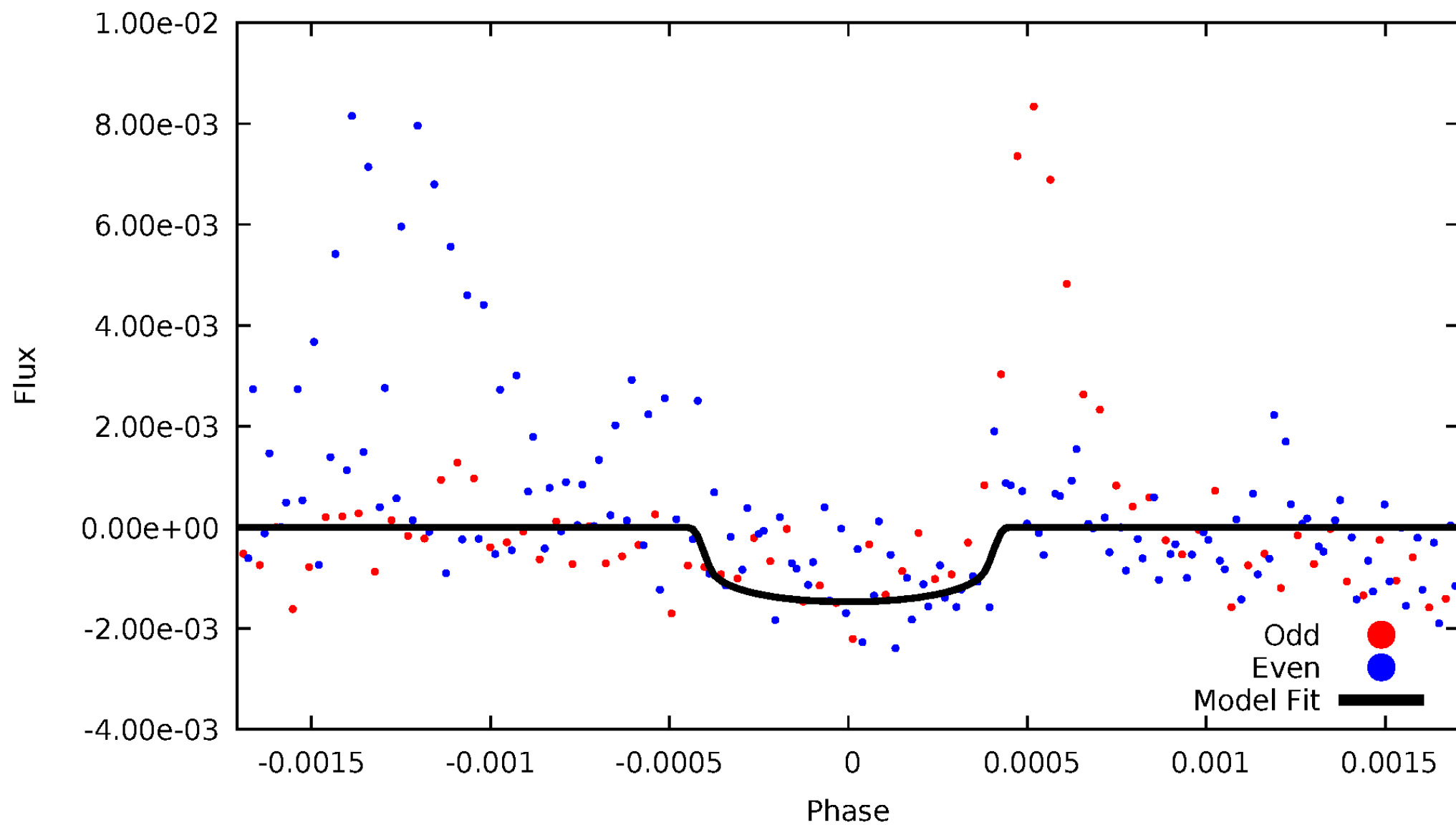
# TCE 012356051-03





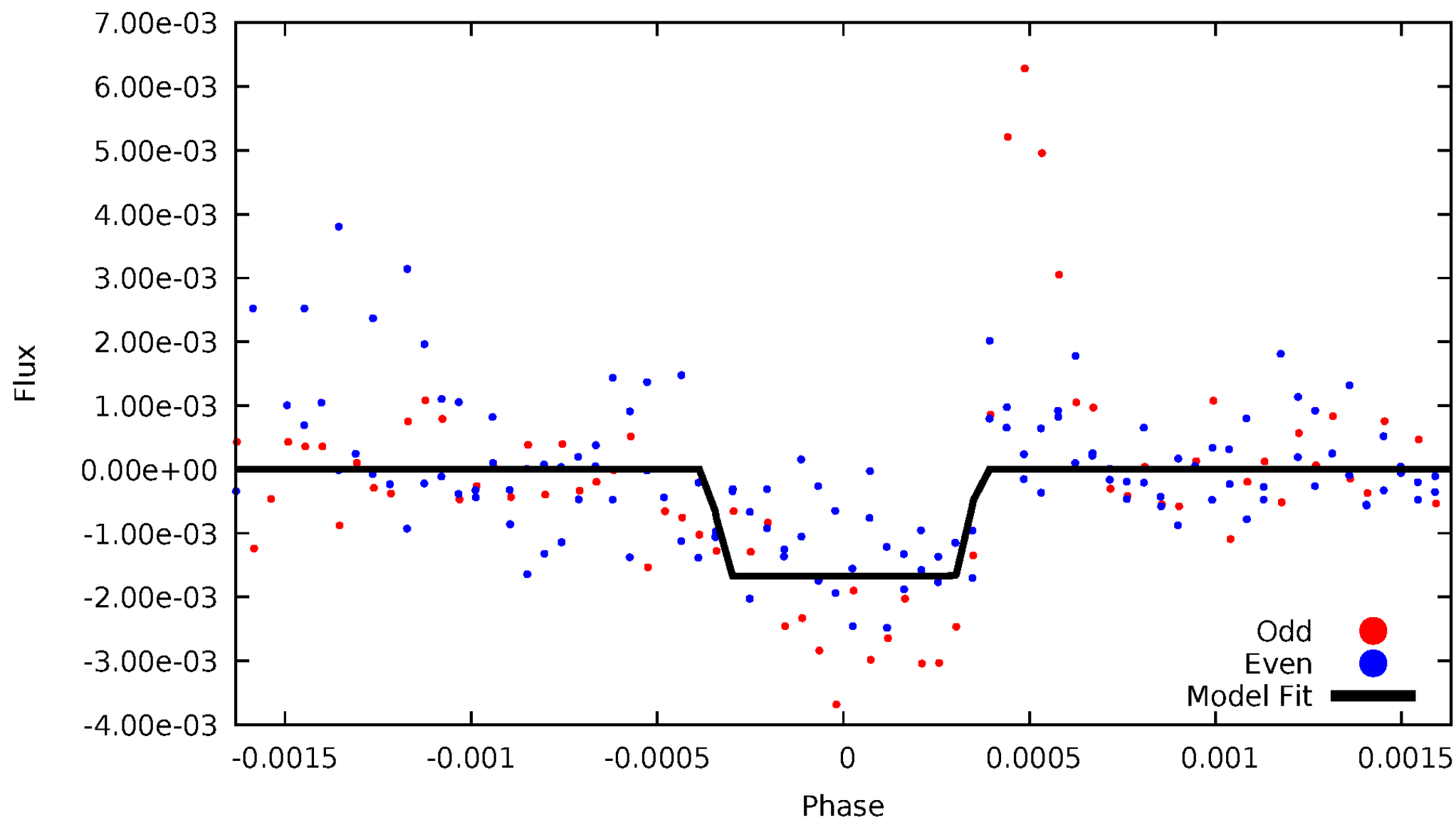
# DV Odd/Even

TCE 012356051-03



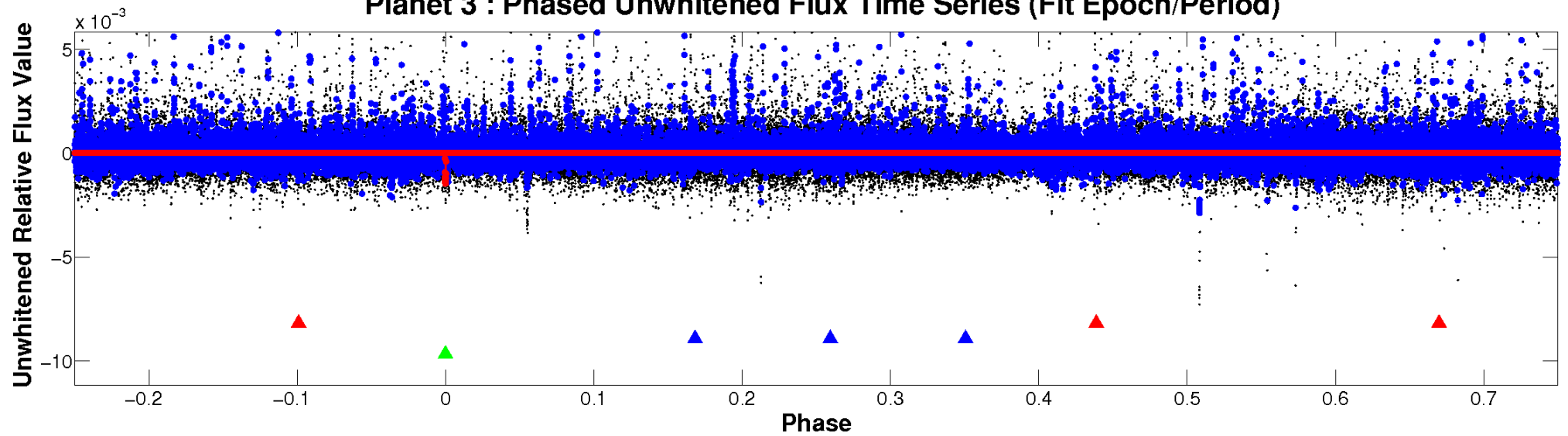
# ALT Odd/Even

TCE 012356051-03

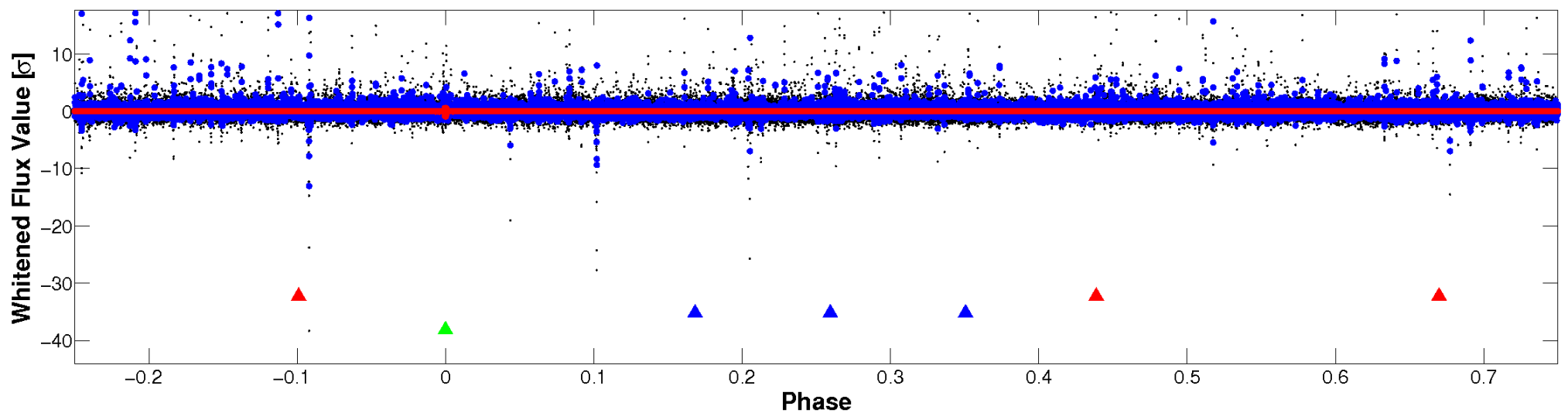


# Non-Whitened Vs. Whitened Light Curve

Planet 3 : Phased Unwhitened Flux Time Series (Fit Epoch/Period)

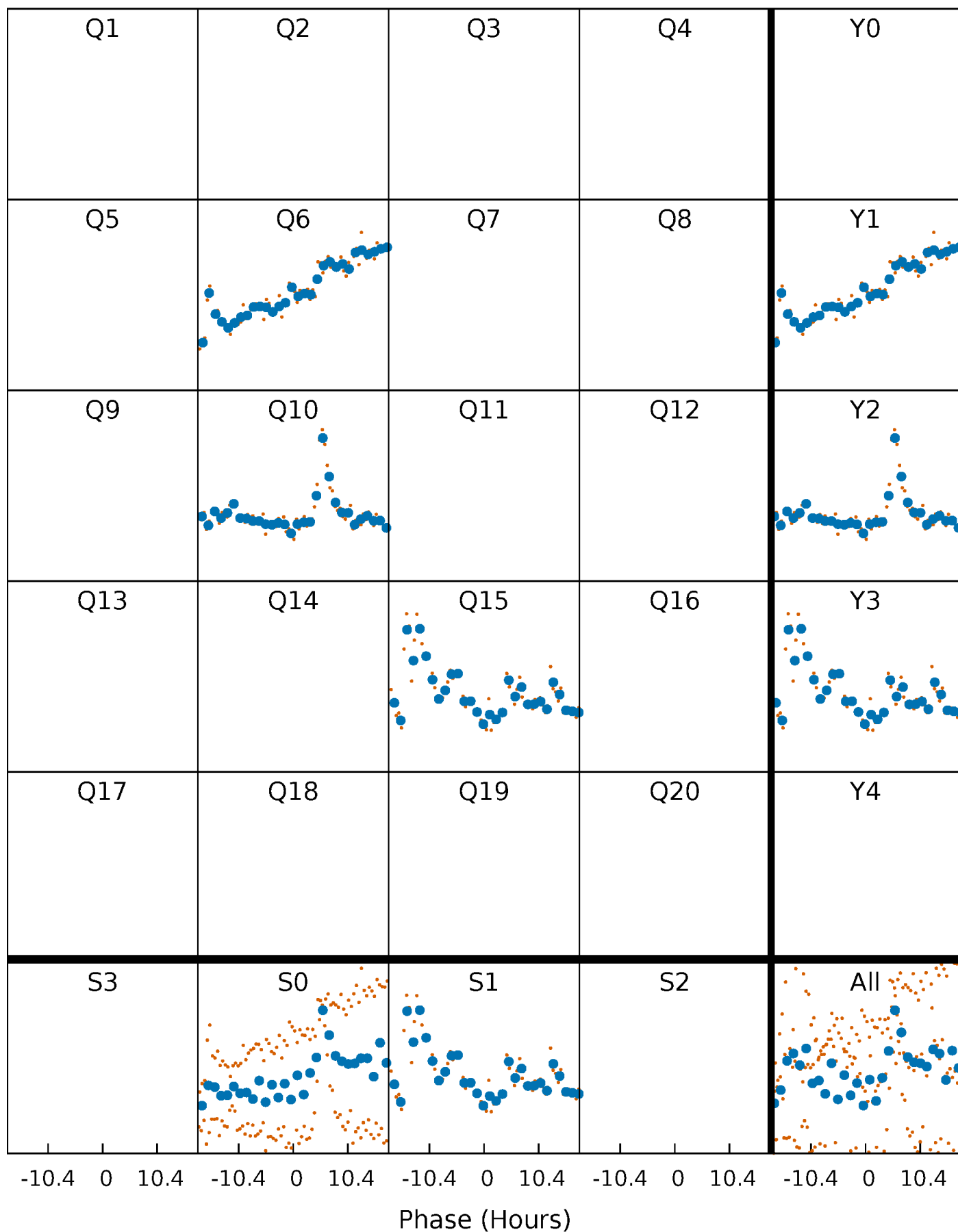


Planet 3 : Phased Whitened Flux Time Series (Fit Epoch/Period)



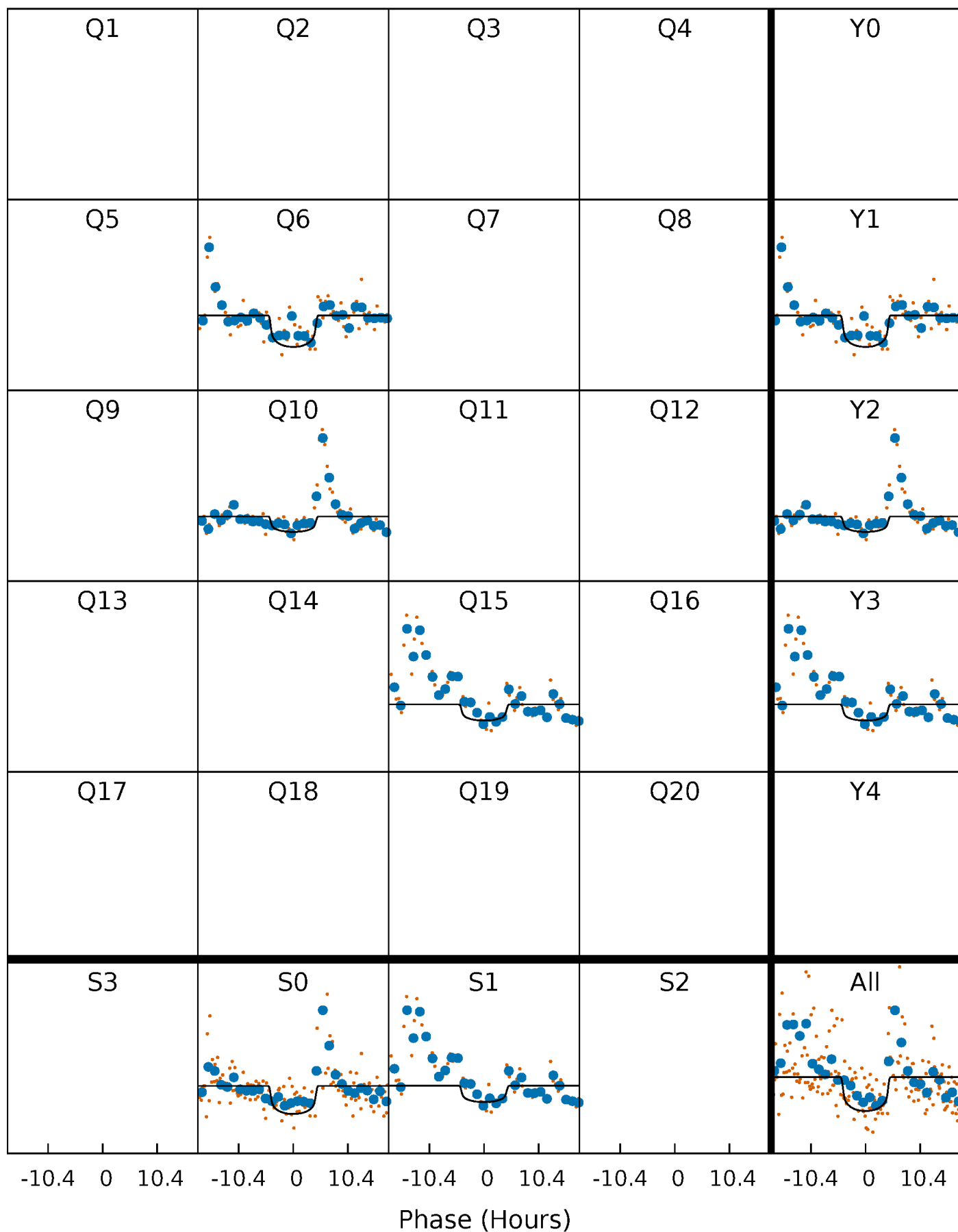
# PDC Quarter-Phased Transit Curves

TCE 012356051-03     $P=443.946888$  Days     $T_0=541.869560$  (BKJD)



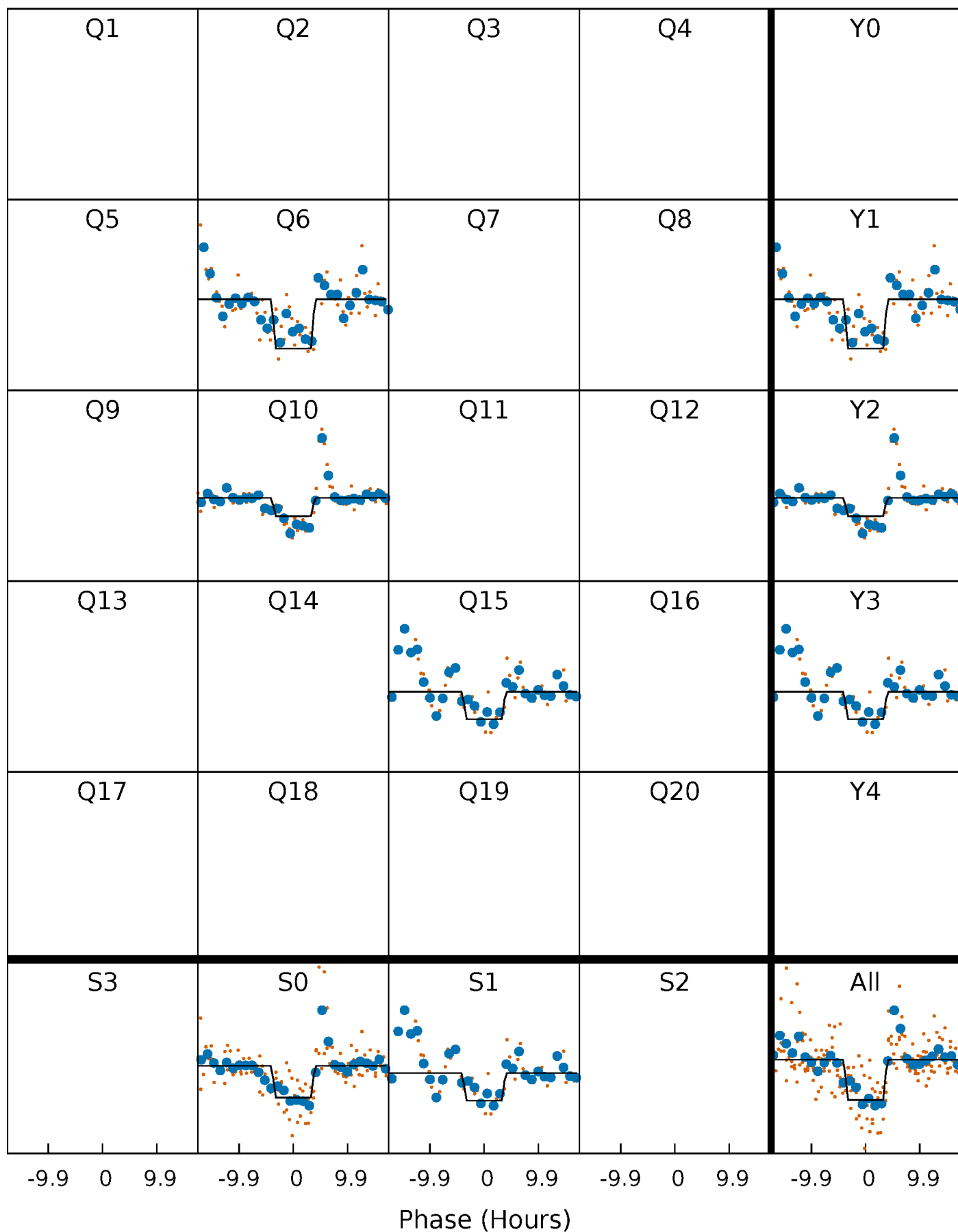
# DV Quarter-Phased Transit Curves

TCE 012356051-03     $P=443.946888$  Days     $T_0=541.869560$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

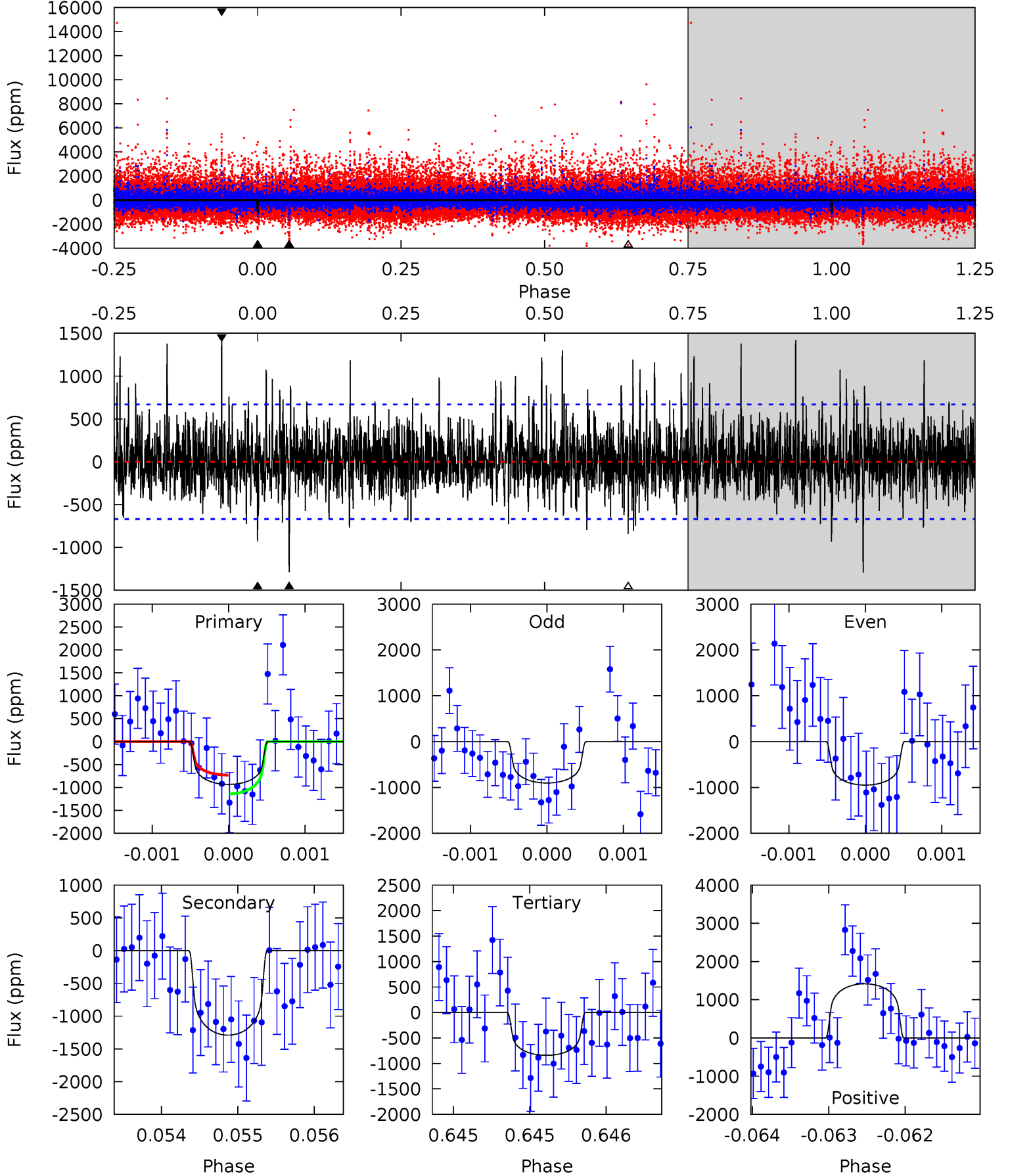
TCE 012356051-03     $P=443.939525$  Days     $T_0=541.890621$  (BKJD)



# DV Model-Shift Uniqueness Test

012356051-03, P = 443.946888 Days, E = 97.922672 Days

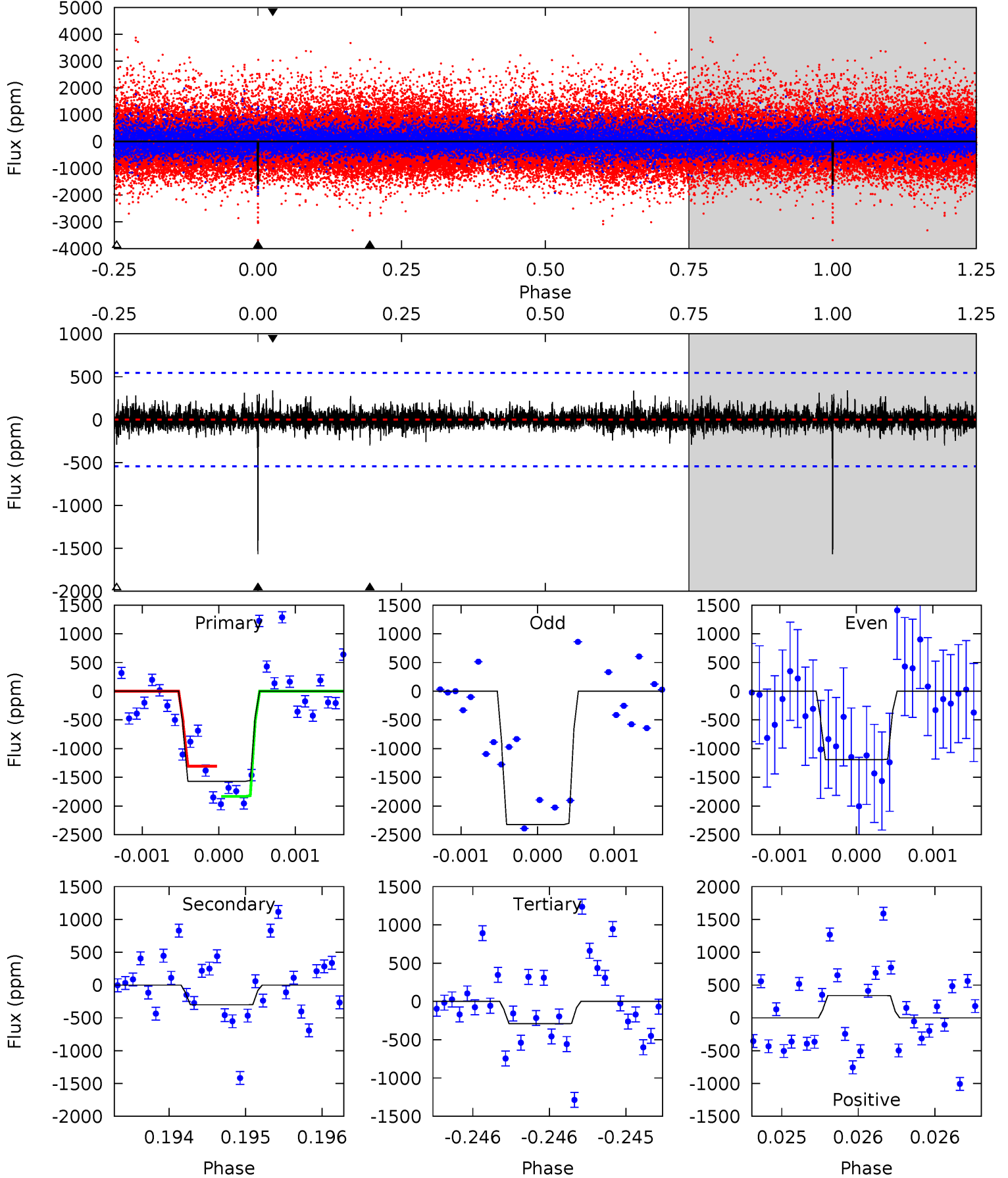
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
7.65	10.6	6.88	11.6	5.48	3.33	2.14	0.76	-3.96	3.68	-1.05	0.14	1.01	0.52	1.68



# Alt Model-Shift Uniqueness Test

012356051-03, P = 443.939525 Days, E = 97.951096 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
15.9	3.03	2.94	3.45	5.51	3.38	0.64	12.9	12.4	0.09	-0.41	5.43	1.18	0.18	2.65





### Stellar Parameters For KIC 012356051

	$T_{\text{eff}}(K)$	$\log(g)$	[Fe/H]	$R (R_{\odot})$	$M(M_{\odot})$	$p_{\star} (\text{g}\cdot\text{cm}^{-3})$
	$3389^{+40}_{-40}$	$4.946^{+0.045}_{-0.036}$	$0.000^{+0.100}_{-0.100}$	$0.307^{+0.035}_{-0.035}$	$0.303^{+0.043}_{-0.039}$	$14.800^{+3.587}_{-2.654}$
	+1%/-1%	+1%/-1%	+inf%/-inf%	+11%/-11%	+14%/-13%	+24%/-18%
Source	PHO2	PHO2	PHO2	DSEP		

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

### Secondary Eclipse Parameters for KIC 012356051-03 / KOI

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{max} (K)$	$T_{obs} (K)$	$A_{obs}$
DV	$-1290 \pm 122$	$1.27^{+0.77}_{-0.71}$	$132^{+3}_{-3}$	$3341^{+1056}_{-440}$	$255639^{+1075246}_{-153544}$
Alt.	$-300 \pm 99$	$1.37^{+0.75}_{-0.65}$	$132^{+3}_{-3}$	$2649^{+546}_{-303}$	$50394^{+135392}_{-31940}$

$T_{max}$  = Theoretical Maximum Planetary Temperature

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

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

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

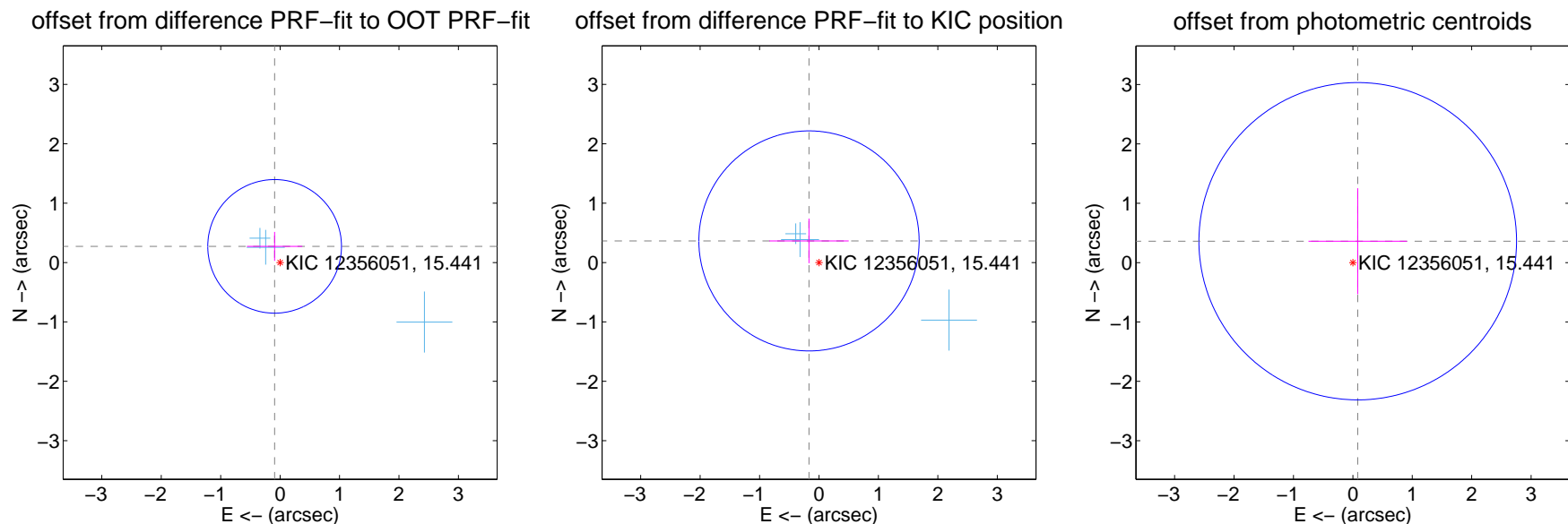
## DV Centroid Data

Supplemental centroid analysis for 012356051-03. Kepler magnitude: 15.44. Transit SNR 6.51

There are 3 quarters with good PRF difference image offsets

The direct PRF centroid is offset from the target star catalog position by about 0.09 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.288 \pm 0.375$	0.77	$0.092 \pm 0.464$	$0.272 \pm 0.244$
PRF-fit source offset from KIC position	$0.401 \pm 0.617$	0.65	$0.168 \pm 0.668$	$0.364 \pm 0.375$
photometric centroid source offset	$0.37 \pm 0.89$	0.41	$-0.08 \pm 0.83$	$0.36 \pm 0.89$



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.

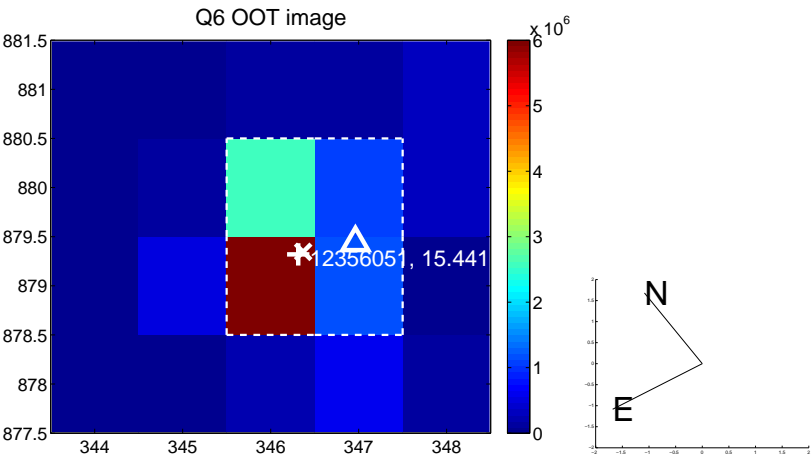
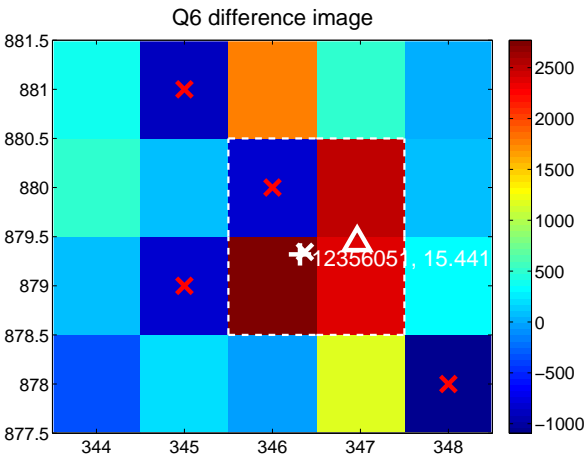


white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.

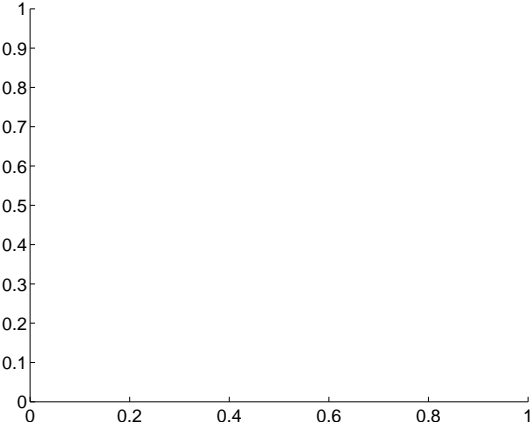
Q5 no difference image



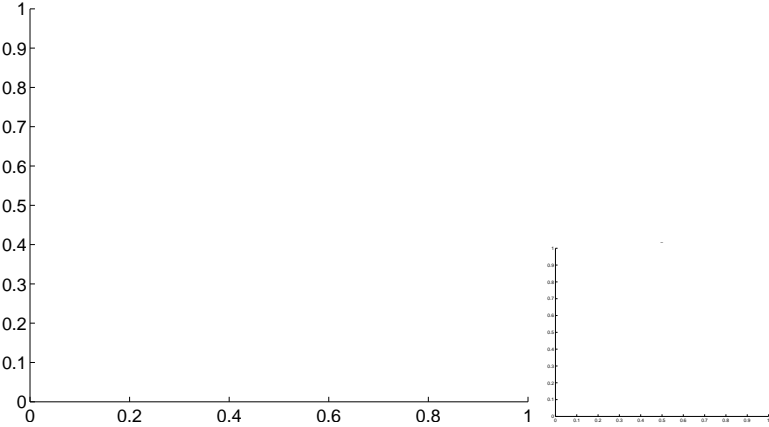
Q5 no OOT image



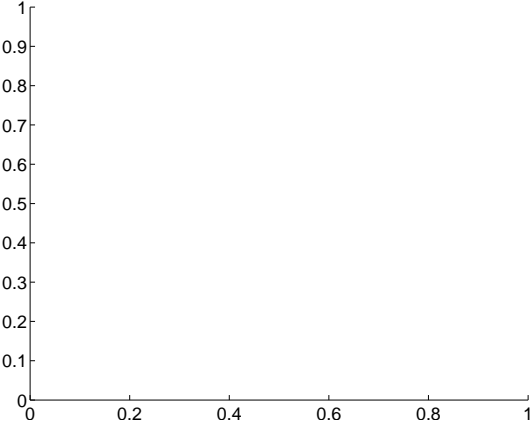
Q7 no difference image



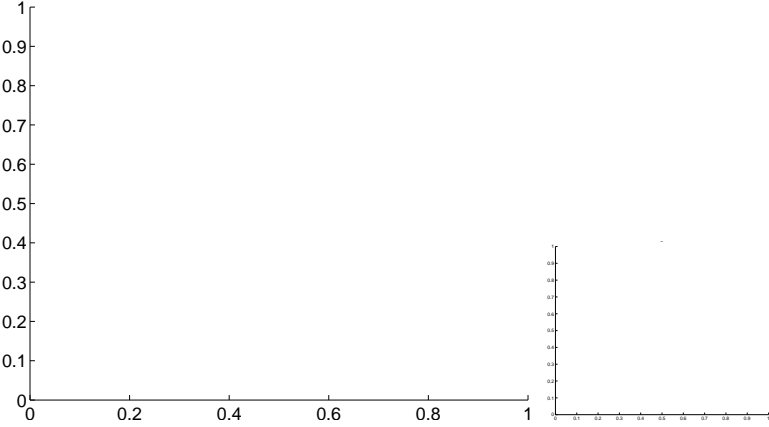
Q7 no OOT image



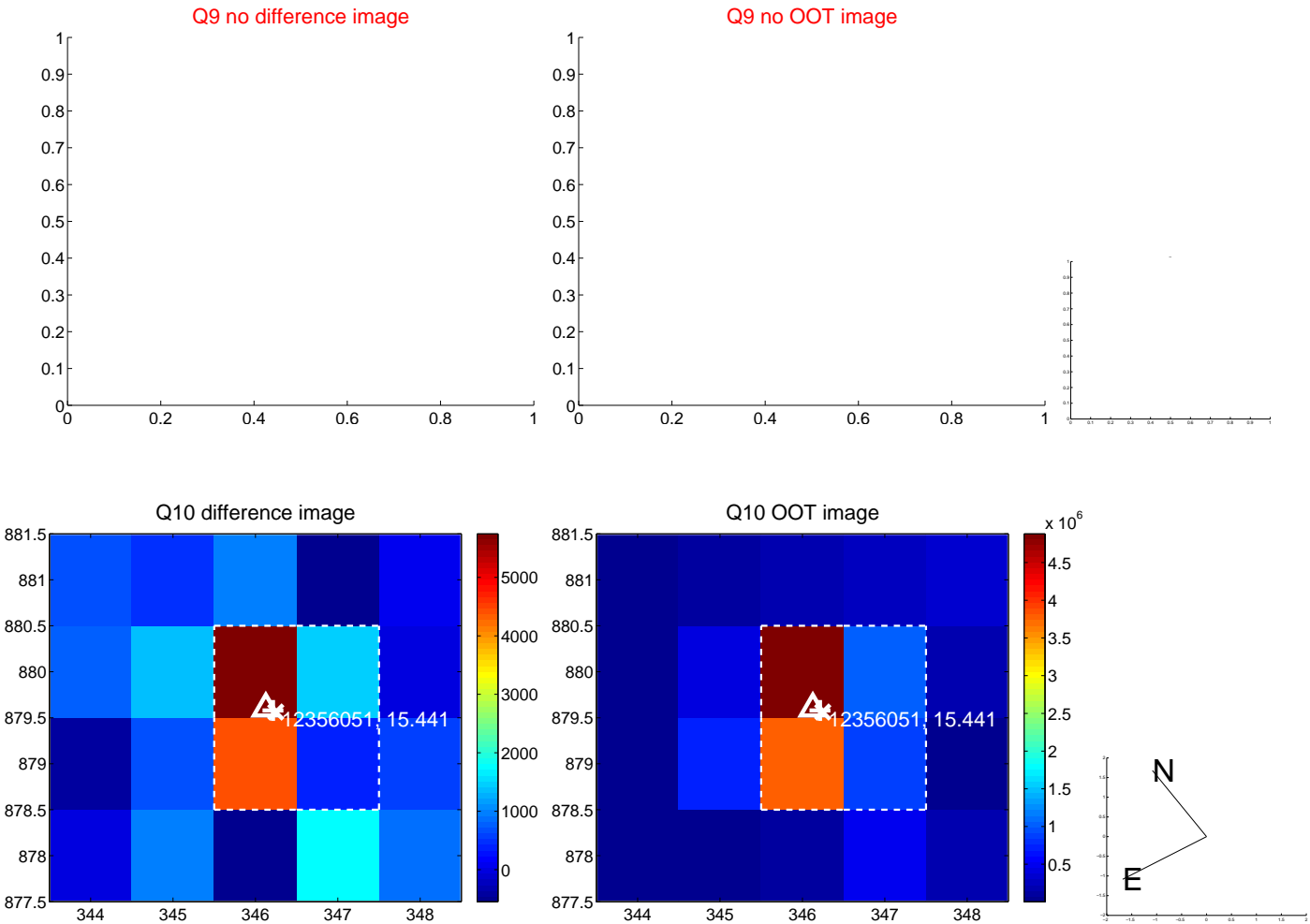
Q8 no difference image



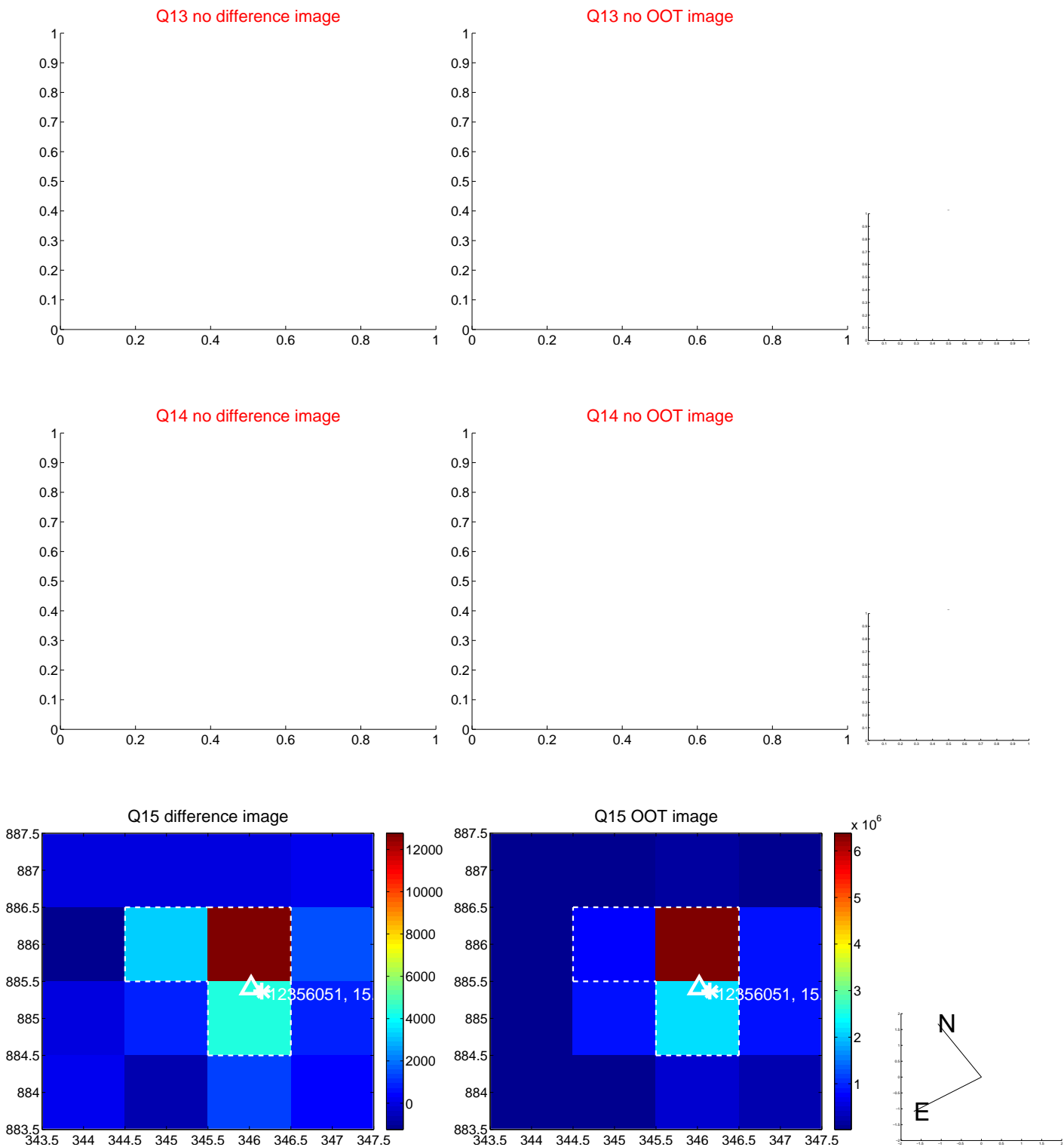
Q8 no OOT image



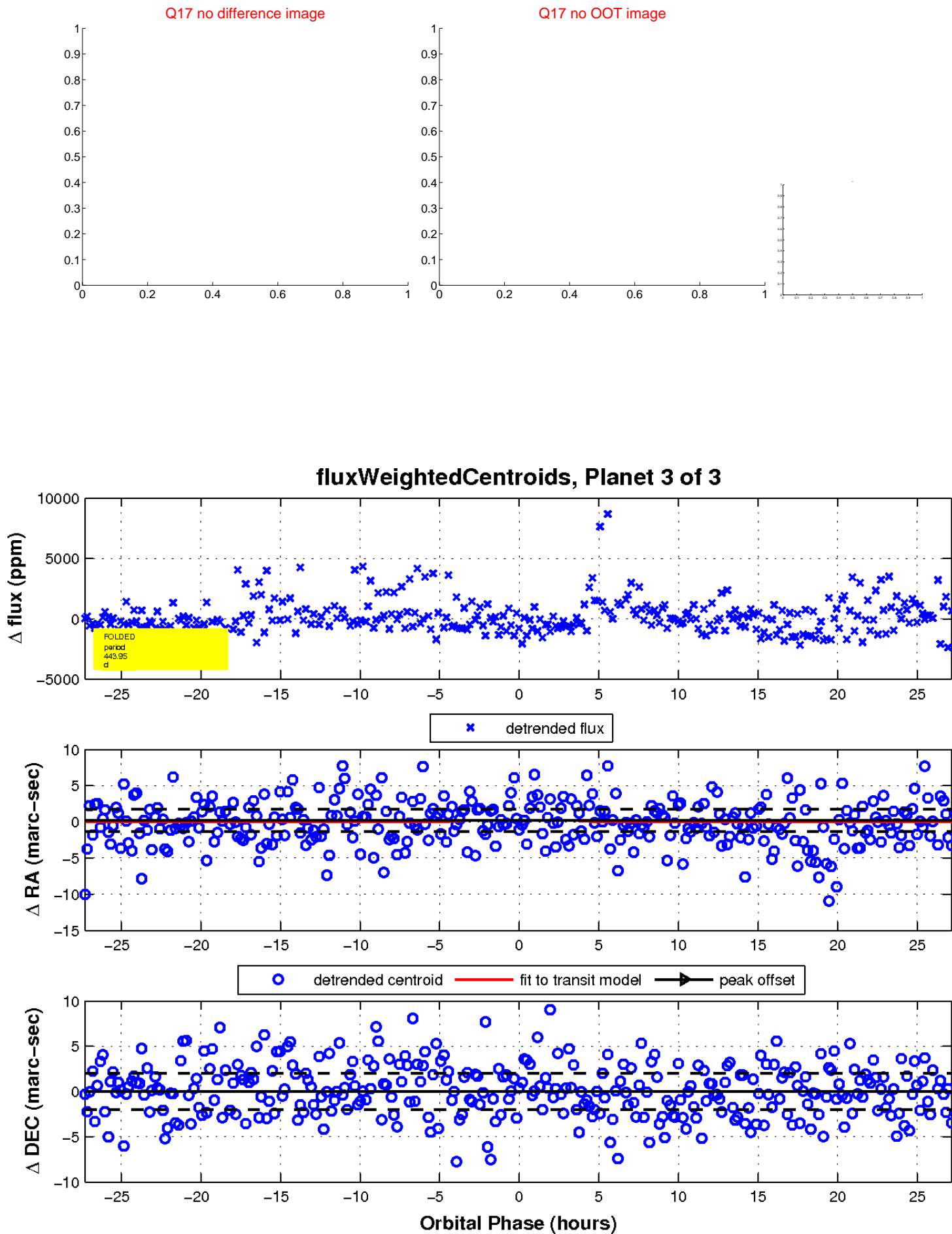
white ×: KIC target position; +: OOT centroid; △: difference centroid. red ✕: large negative pixel value.



white ×: KIC target position; +: OOT centroid; △: difference centroid. red ✕: large negative pixel value.



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



UKIRT Image

Declination

