

# KIC 004633570

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
004633570-01	OBS	0446.01	16.709160	141.337757	837.3	2.769	32.8	35.2	0.67	4621	2.28	14.76
004633570-02	OBS	0446.02	28.551543	156.925747	812.4	4.187	28.1	30.1	0.67	4621	2.11	7.22

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
004633570-01	OBS	PC	1.00	0	0	0	0	CENT_KIC_POS
004633570-02	OBS	PC	0.90	0	0	0	0	CENT_KIC_POS

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

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

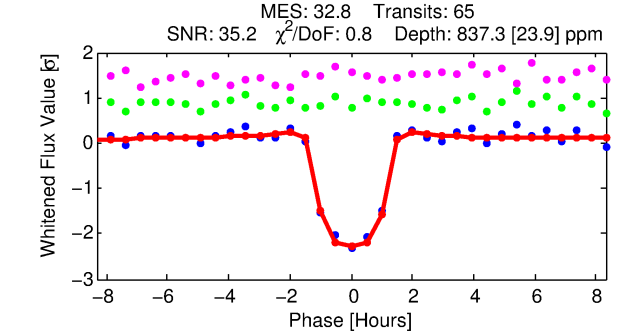
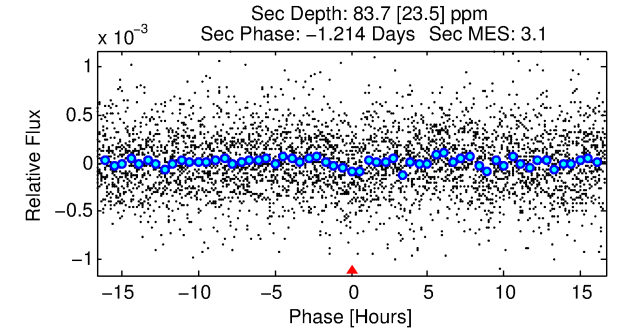
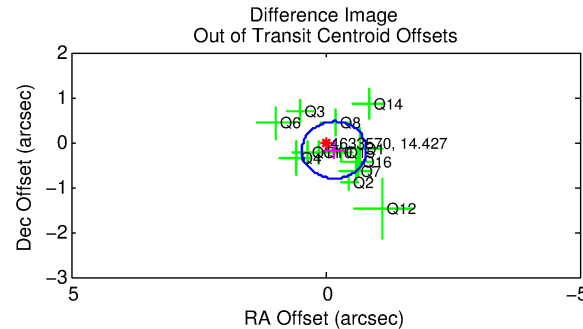
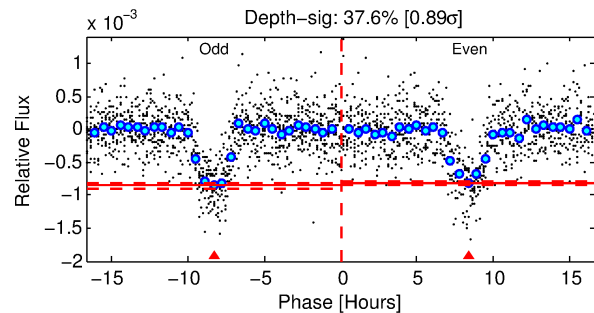
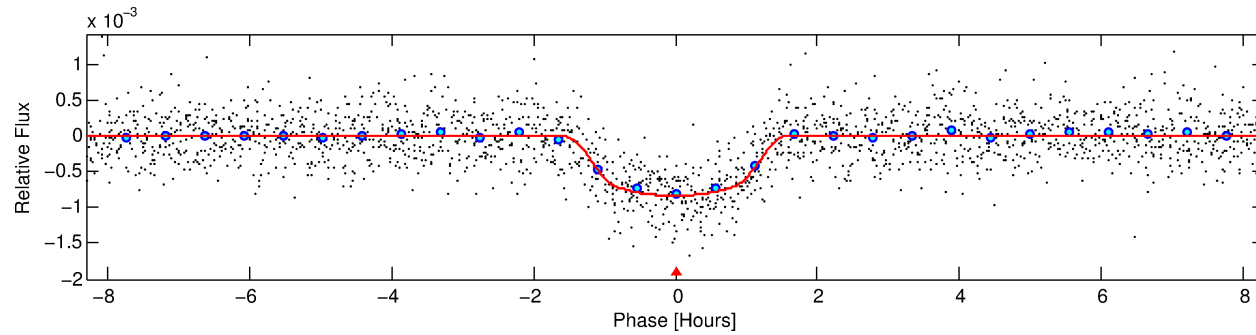
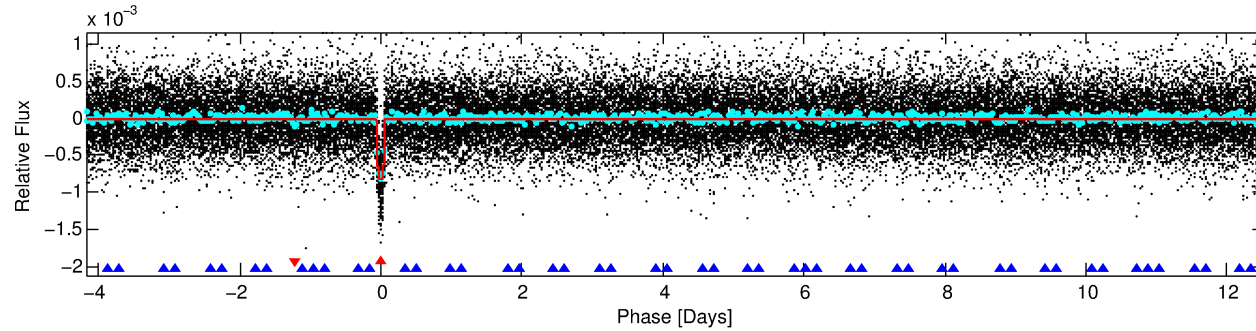
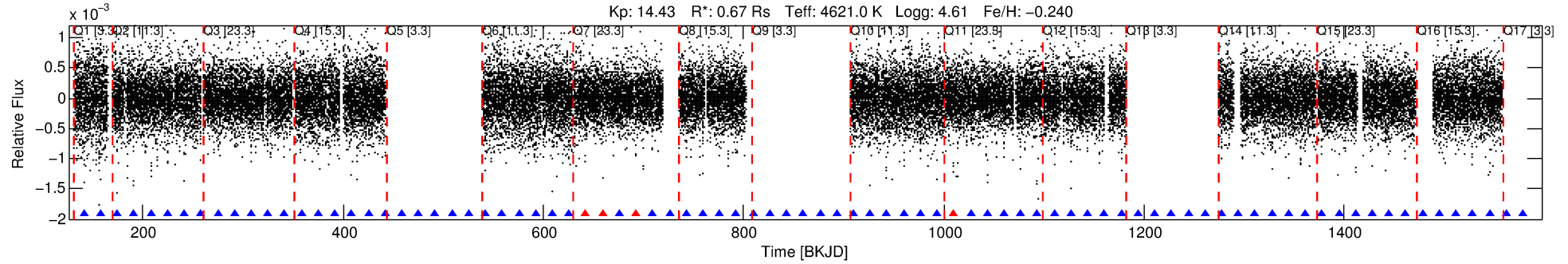
See [http://exoplanetarchive.ipac.caltech.edu/docs/API\\_kepcandidate\\_columns.html#proj\\_disp\\_col](http://exoplanetarchive.ipac.caltech.edu/docs/API_kepcandidate_columns.html#proj_disp_col) for comment definitions.

## Ephemeris Match Information For 004633570-01

No Significant Match Found

# DV One-Page Summary

KIC: 4633570 Candidate: 1 of 2 Period: 16.709 d  
KOI: K00446.01 Name: Kepler-158b Corr: 0.952



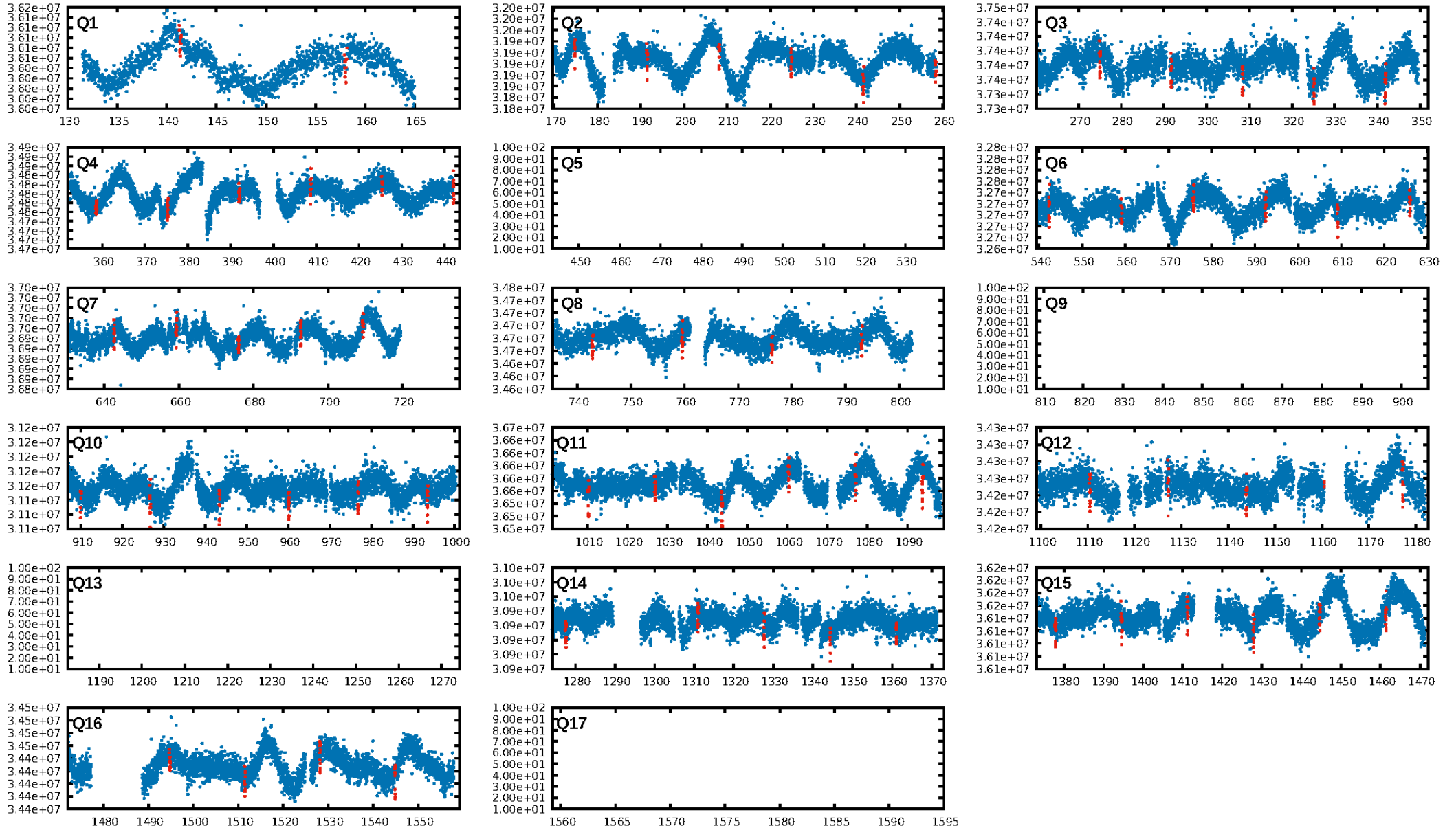
## DV Fit Results:

Period = 16.70916 [0.00003] d  
Epoch = 141.3378 [0.0017] BKJD  
Rp/R\* = 0.0313 [0.0049]  
a/R\* = 26.13 [14.13]  
b = 0.86 [0.17]  
Seff = 14.76 [2.28]  
Teff = 500 [19] K  
Rp = 2.28 [0.41] Re  
a = 0.1111 [0.0079] AU  
Ag = 109.00 [47.15] [2.29 $\sigma$ ]  
Teffp = 2497 [273] K [7.30 $\sigma$ ]

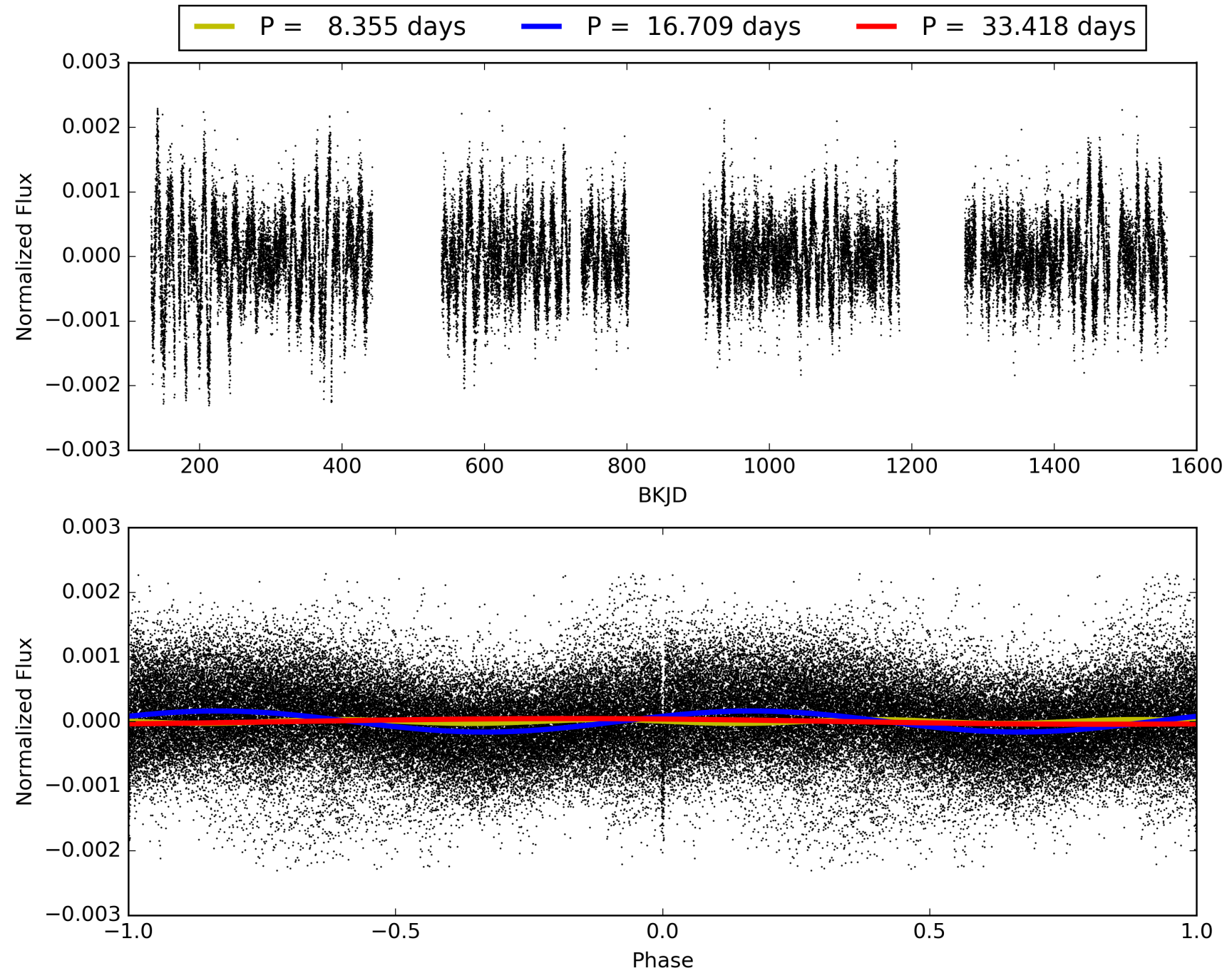
## DV Diagnostic Results:

ShortPeriod-sig: N/A  
LongPeriod-sig: 100.0% [56.62 $\sigma$ ]  
ModelChiSquare2-sig: 88.0%  
ModelChiSquareGof-sig: 100.0%  
Bootstrap-pfa: 4.14e-226  
RollingBand-fgt: 0.94 [59/63]  
GhostDiagnostic-chr: 5.066  
Centroid-sig: 0.2%  
Centroid-so: 0.875 arcsec [2.55 $\sigma$ ]  
OotOffset-rm: 0.246 arcsec [1.16 $\sigma$ ]  
KicOffset-rm: 0.406 arcsec [2.13 $\sigma$ ]  
OotOffset-st: 4/4/4/1 [13]  
KicOffset-st: 4/4/4/1 [13]  
DiffImageQuality-fgm: 1.00 [13/13]  
DiffImageOverlap-fno: 1.00 [13/13]

# TCE 004633570-01, PDC Light Curves

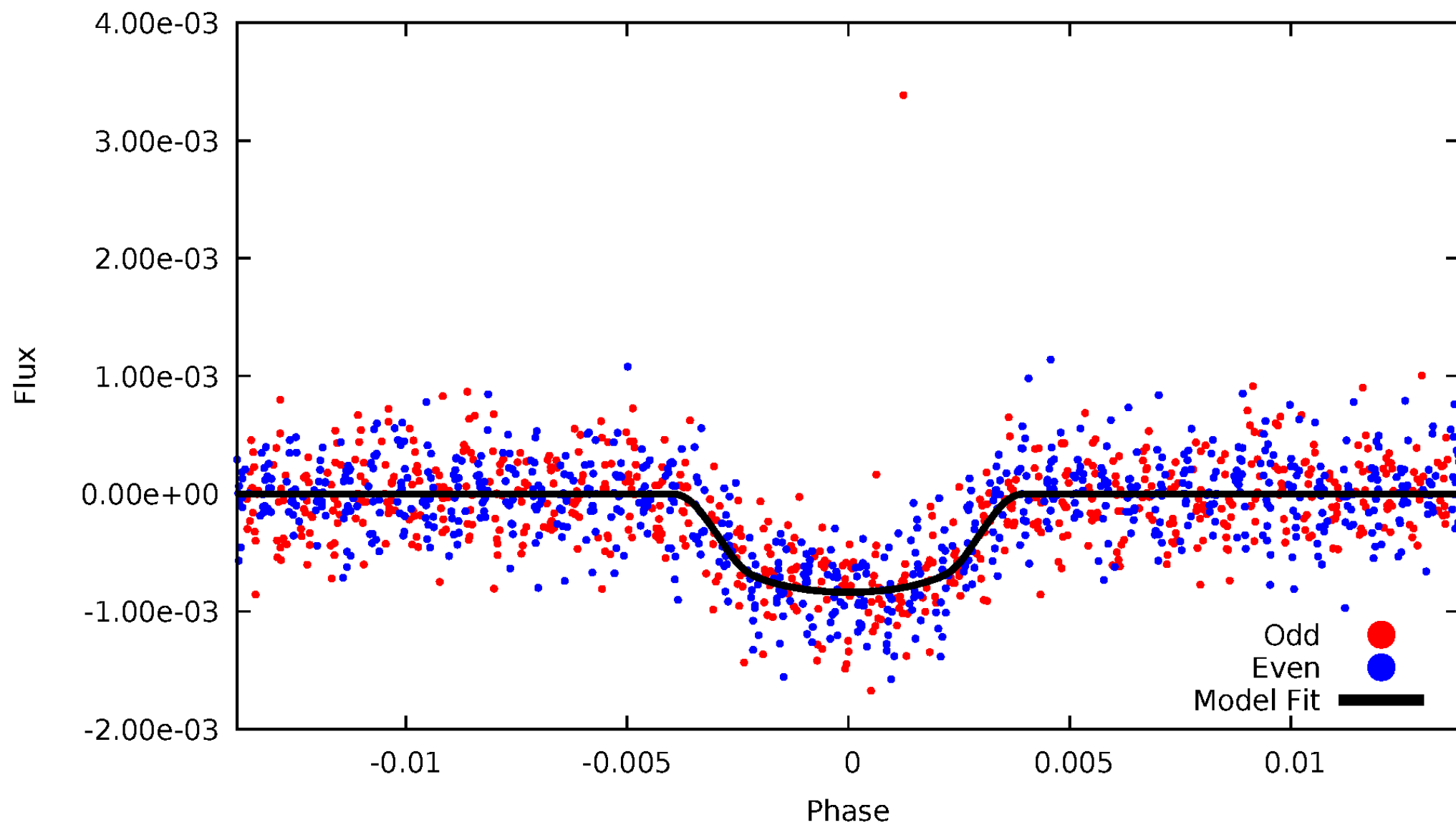


TCE 004633570-01



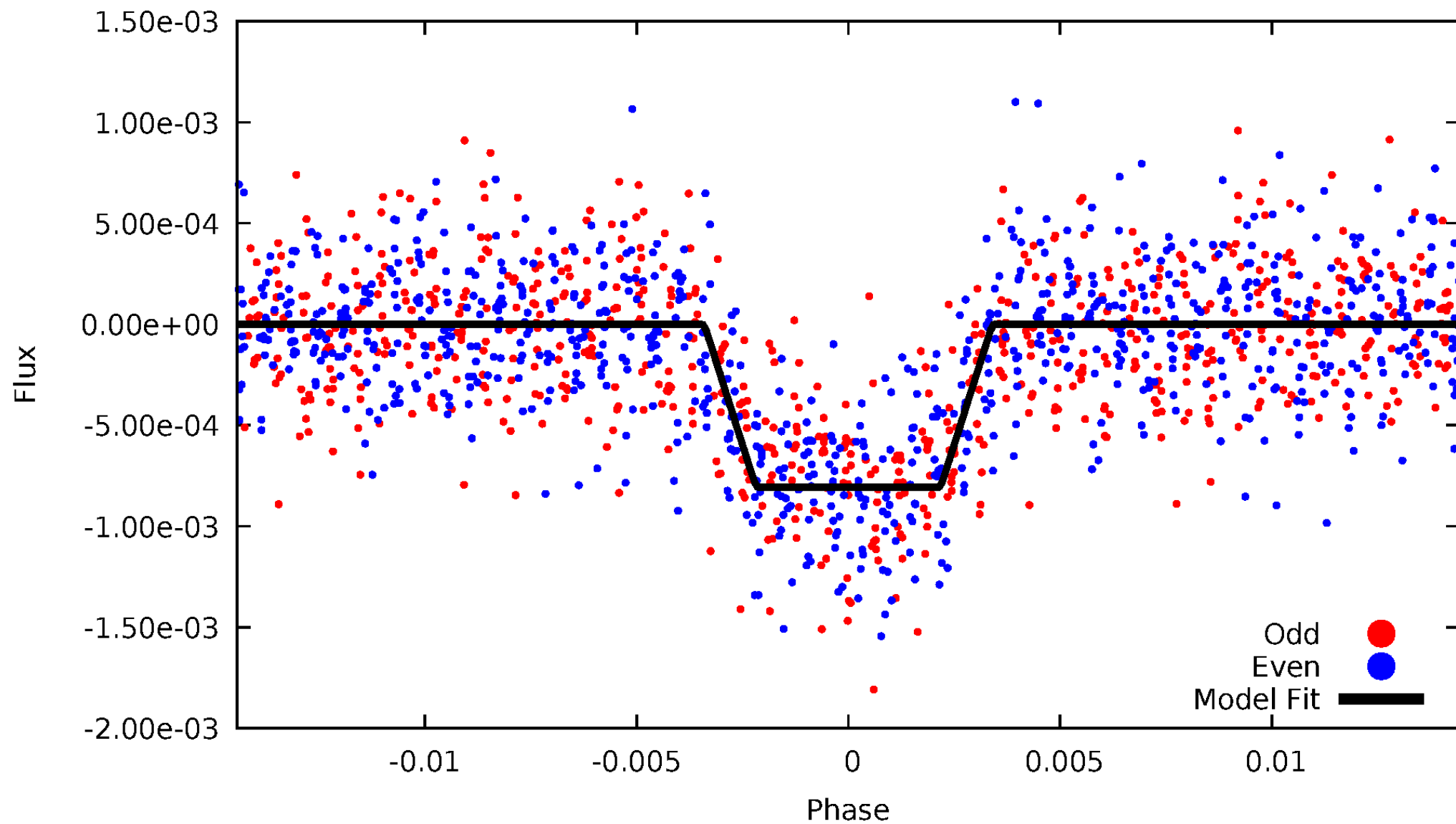
# DV Odd/Even

TCE 004633570-01



# ALT Odd/Even

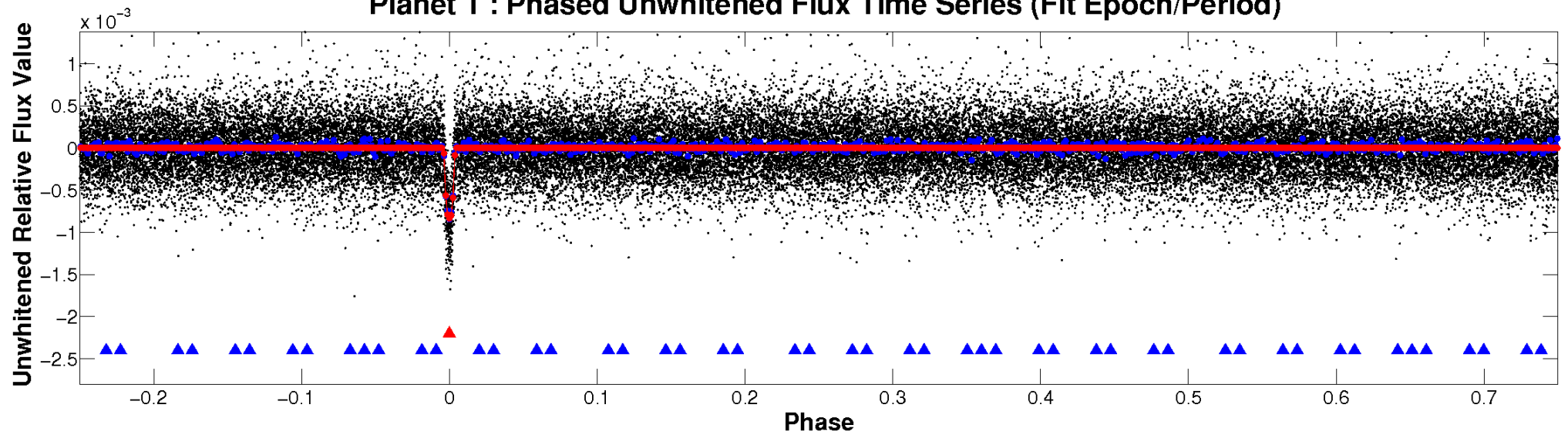
TCE 004633570-01



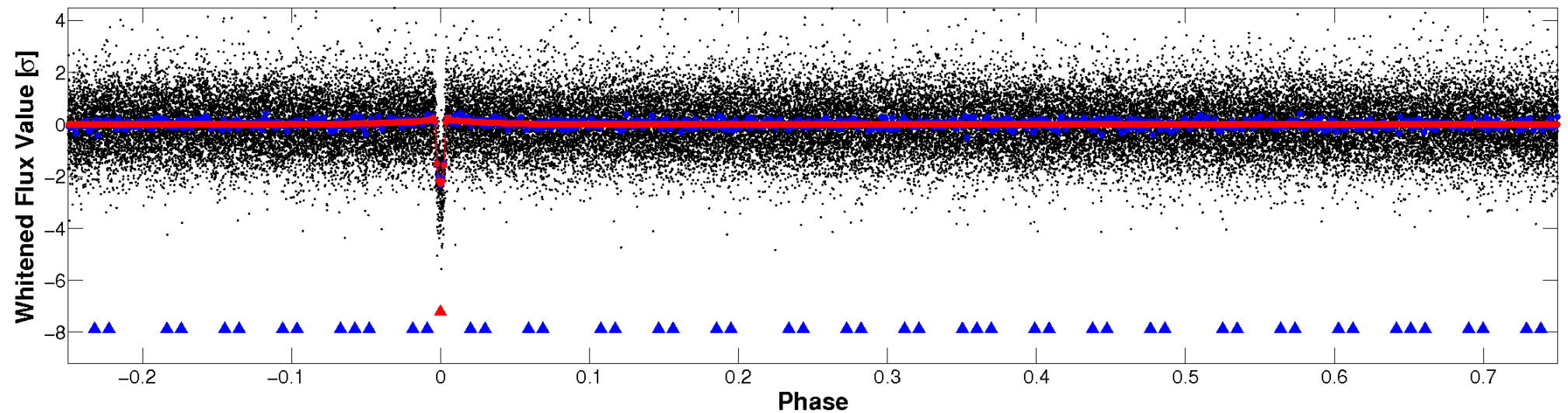


# Non-Whitened Vs. Whitened Light Curve

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

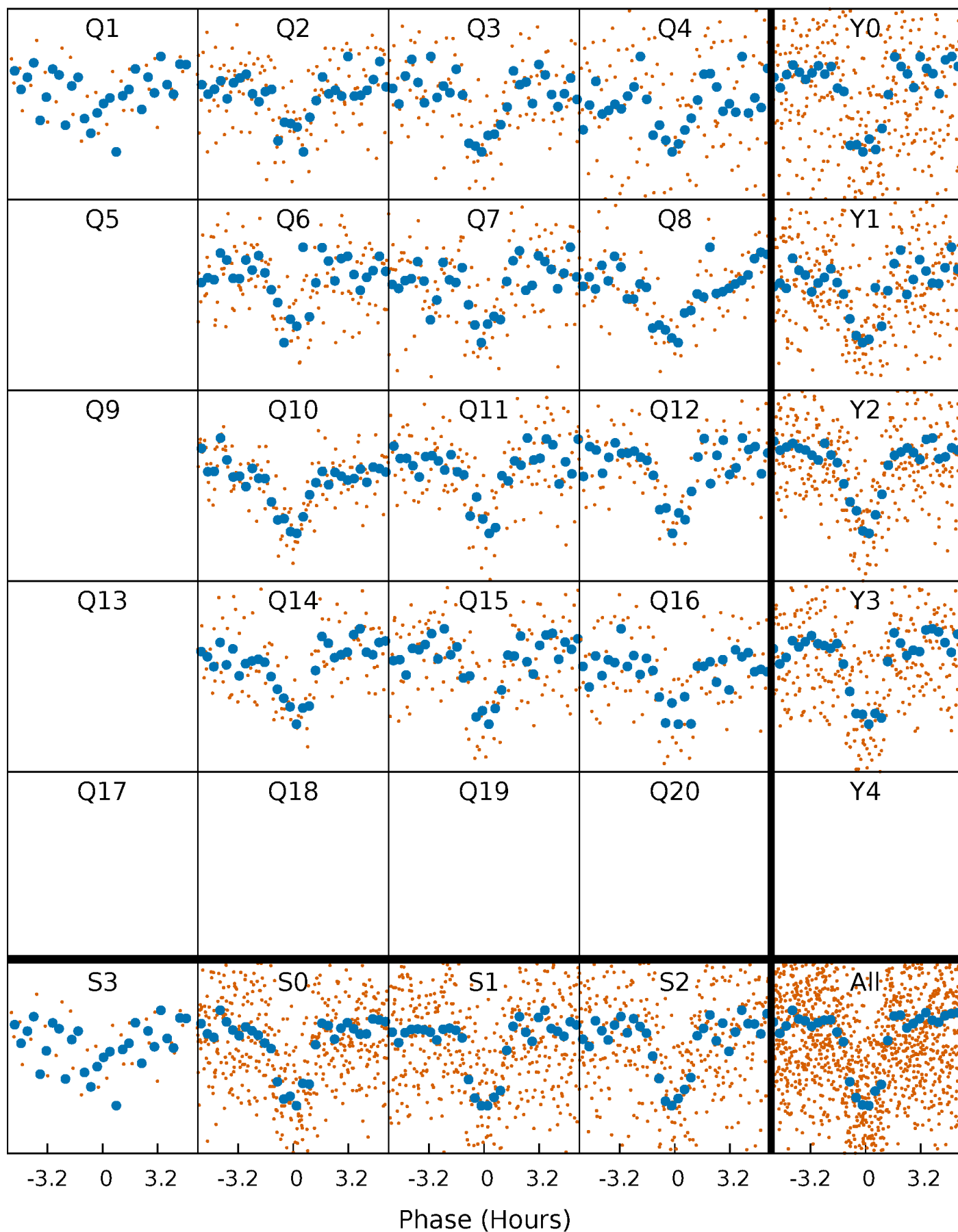


**Planet 1 : Phased Whitened Flux Time Series (Fit Epoch/Period)**



# PDC Quarter-Phased Transit Curves

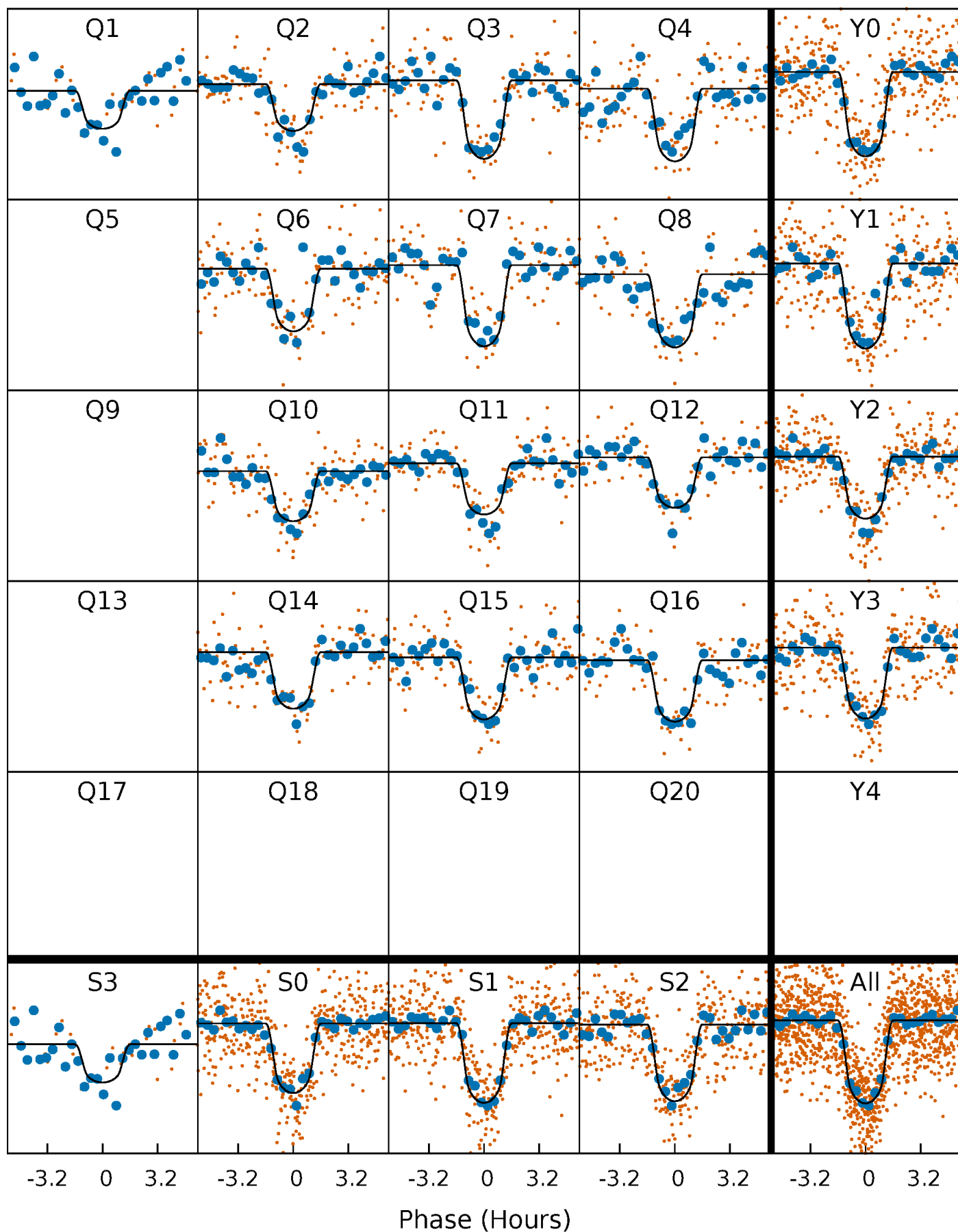
TCE 004633570-01 P= 16.709160 Days  $T_0=141.337757$  (BKJD)





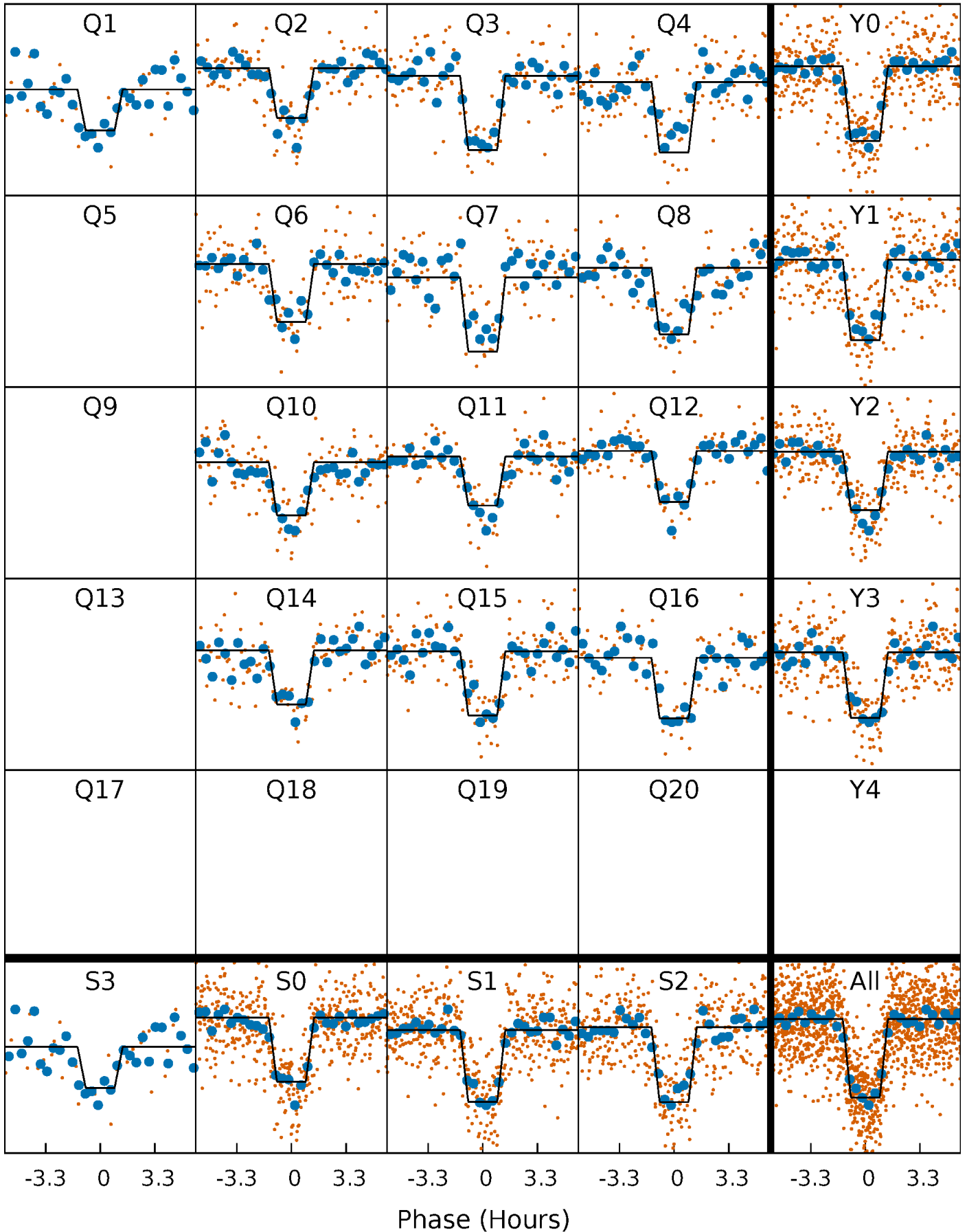
# DV Quarter-Phased Transit Curves

TCE 004633570-01 P= 16.709160 Days  $T_0=141.337757$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

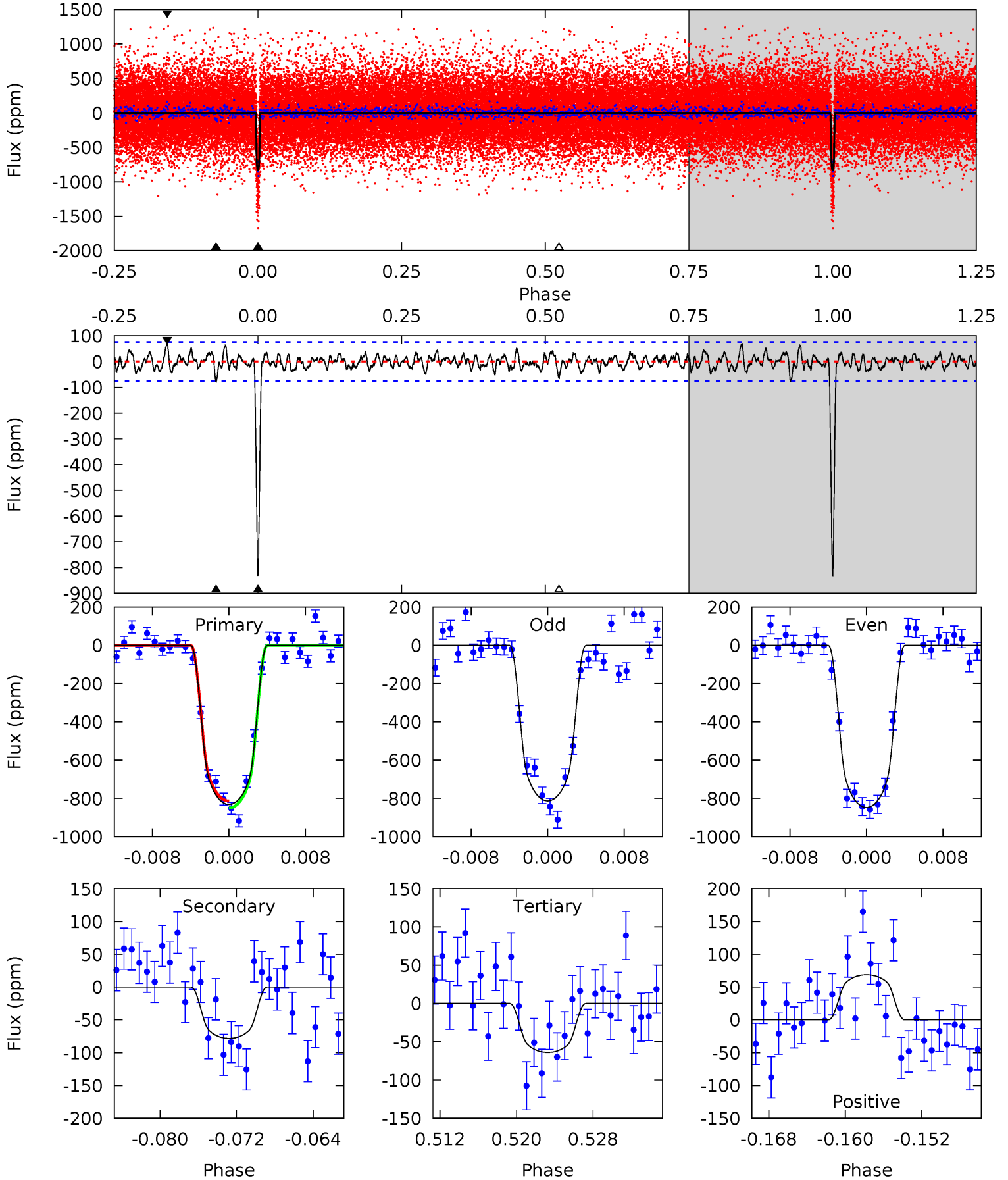
TCE 004633570-01 P= 16.709077 Days  $T_0=141.341188$  (BKJD)



# DV Model-Shift Uniqueness Test

004633570-01,  $P = 16.709160$  Days,  $E = 124.628597$  Days

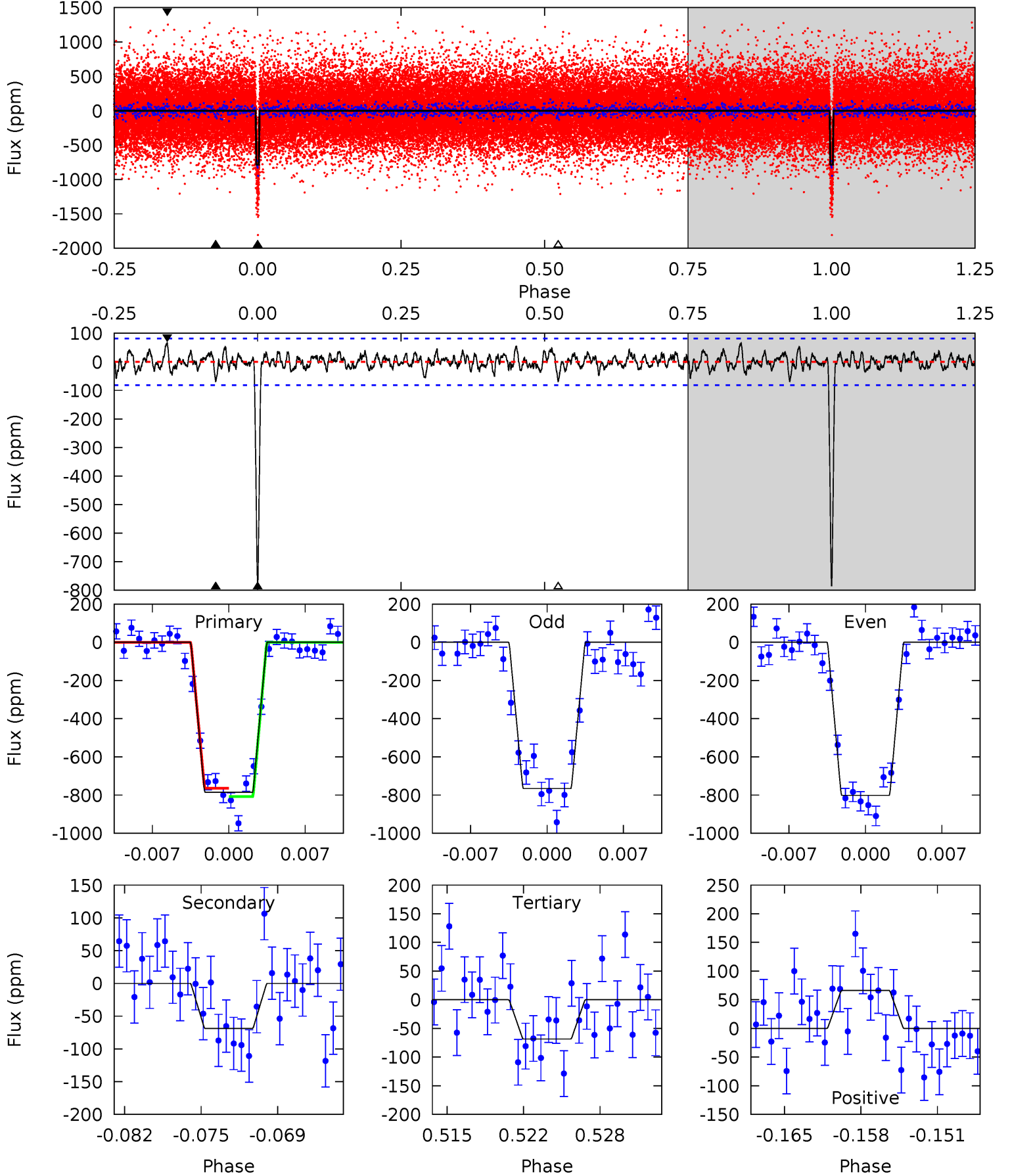
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
55.5	5.22	4.27	4.58	5.07	2.65	1.38	51.2	50.9	0.95	0.63	1.15	0.96	0.08	1.22



# Alt Model-Shift Uniqueness Test

004633570-01,  $P = 16.709077$  Days,  $E = 124.632111$  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
48.9	4.29	4.27	4.13	5.10	2.70	1.24	44.7	44.8	0.02	0.16	1.10	0.95	0.08	1.35



### Stellar Parameters For KIC 004633570

	$T_{\text{eff}}(K)$	$\log(g)$	[Fe/H]	$R (R_{\odot})$	$M(M_{\odot})$	$p_{\star} \text{ (g}\cdot\text{cm}^{-3}\text{)}$
	$4621^{+124}_{-137}$	$4.605^{+0.052}_{-0.028}$	$-0.240^{+0.300}_{-0.300}$	$0.668^{+0.054}_{-0.059}$	$0.656^{+0.073}_{-0.049}$	$3.098^{+0.715}_{-0.401}$
	+3%/-3%	+1%/-1%	+125%/-125%	+8%/-9%	+11%/-7%	+23%/-13%
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 004633570-01 / KOI 0446.01

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{max} \text{ (K)}$	$T_{obs} \text{ (K)}$	$A_{obs}$
DV	$-78 \pm 15$	$2.25^{+0.37}_{-0.38}$	$696^{+22}_{-23}$	$3036^{+186}_{-162}$	$107^{+49}_{-34}$
Alt.	$-69 \pm 16$	$2.06^{+0.41}_{-0.38}$	$695^{+21}_{-25}$	$3046^{+222}_{-179}$	$109^{+65}_{-38}$

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

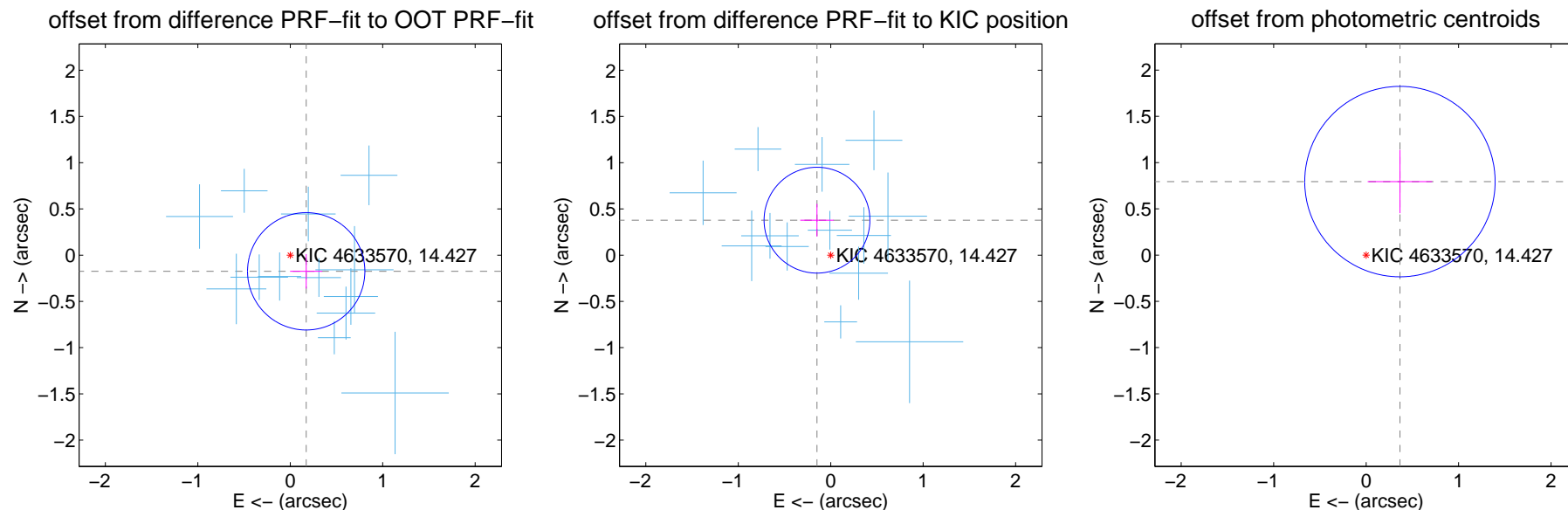
## DV Centroid Data

Supplemental centroid analysis for 004633570-01. Kepler magnitude: 14.43. Transit SNR 35.17

There are 13 quarters with good PRF difference image offsets

The direct PRF centroid is offset from the target star catalog position by about 0.72 arcsec

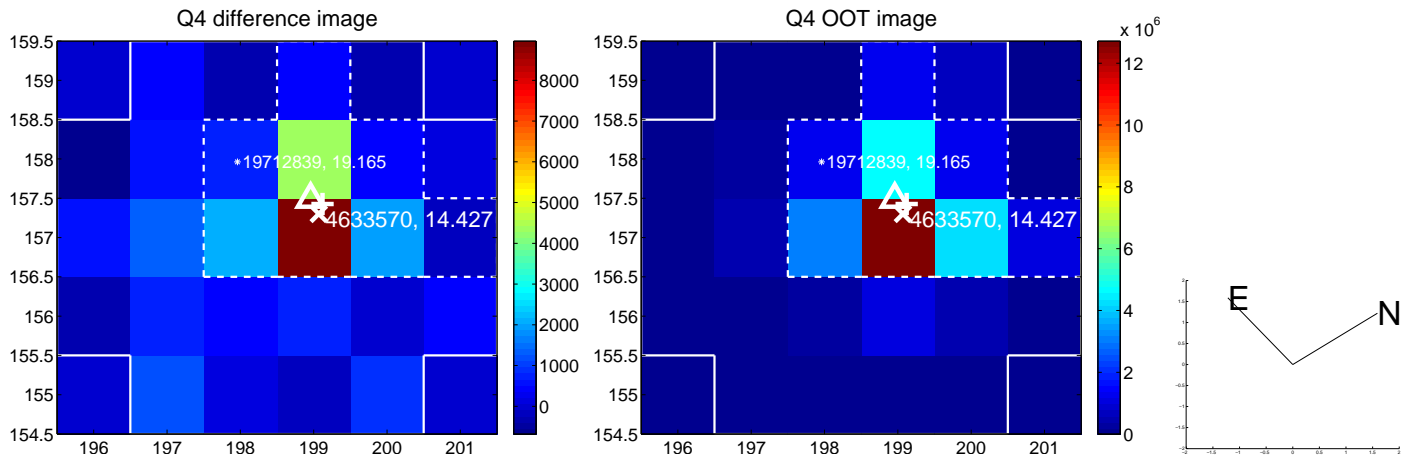
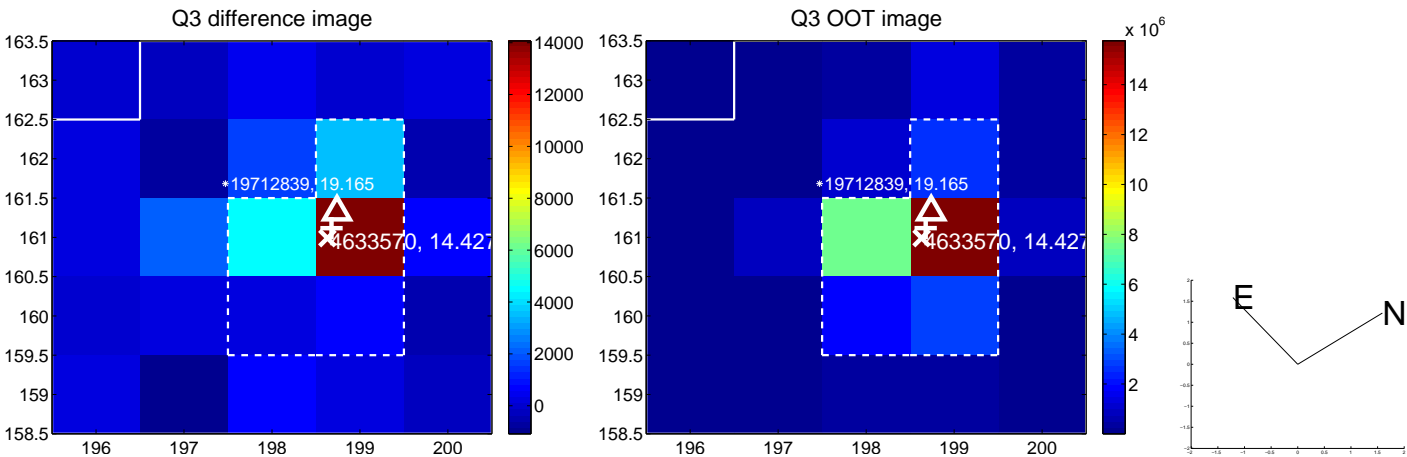
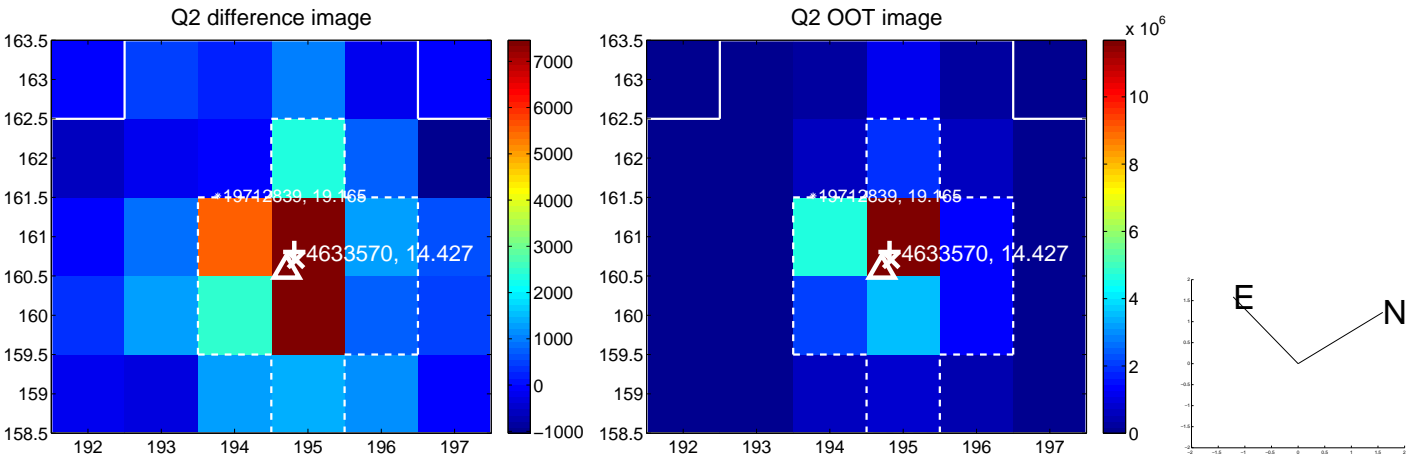
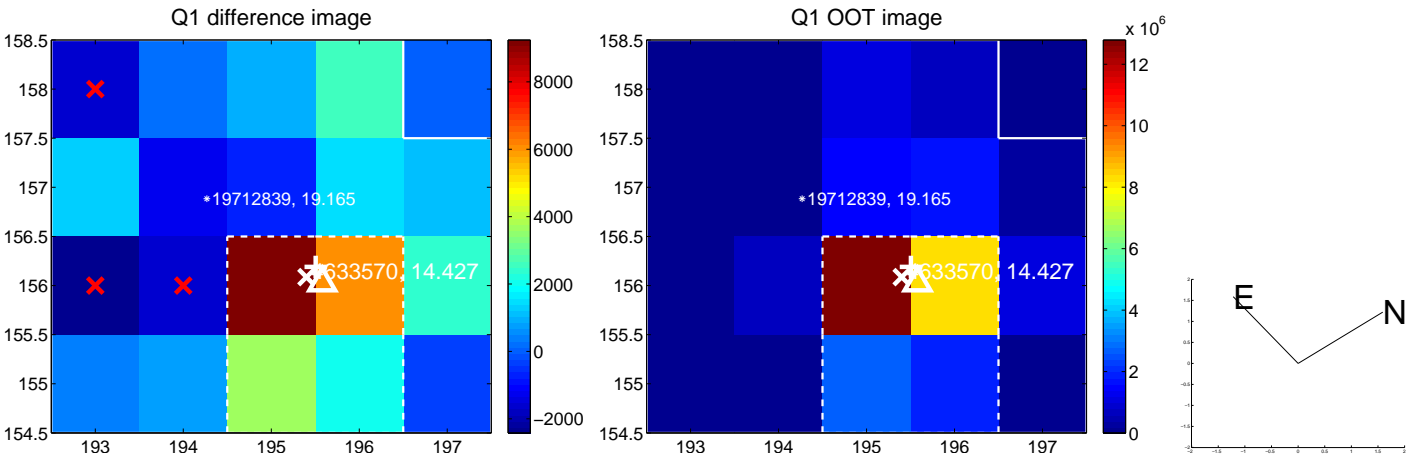
	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.246 \pm 0.212$	1.16	$-0.172 \pm 0.174$	$-0.175 \pm 0.187$
PRF-fit source offset from KIC position	$0.406 \pm 0.191$	2.13	$0.149 \pm 0.181$	$0.378 \pm 0.176$
photometric centroid source offset	$0.87 \pm 0.34$	2.55	$-0.37 \pm 0.35$	$0.79 \pm 0.34$



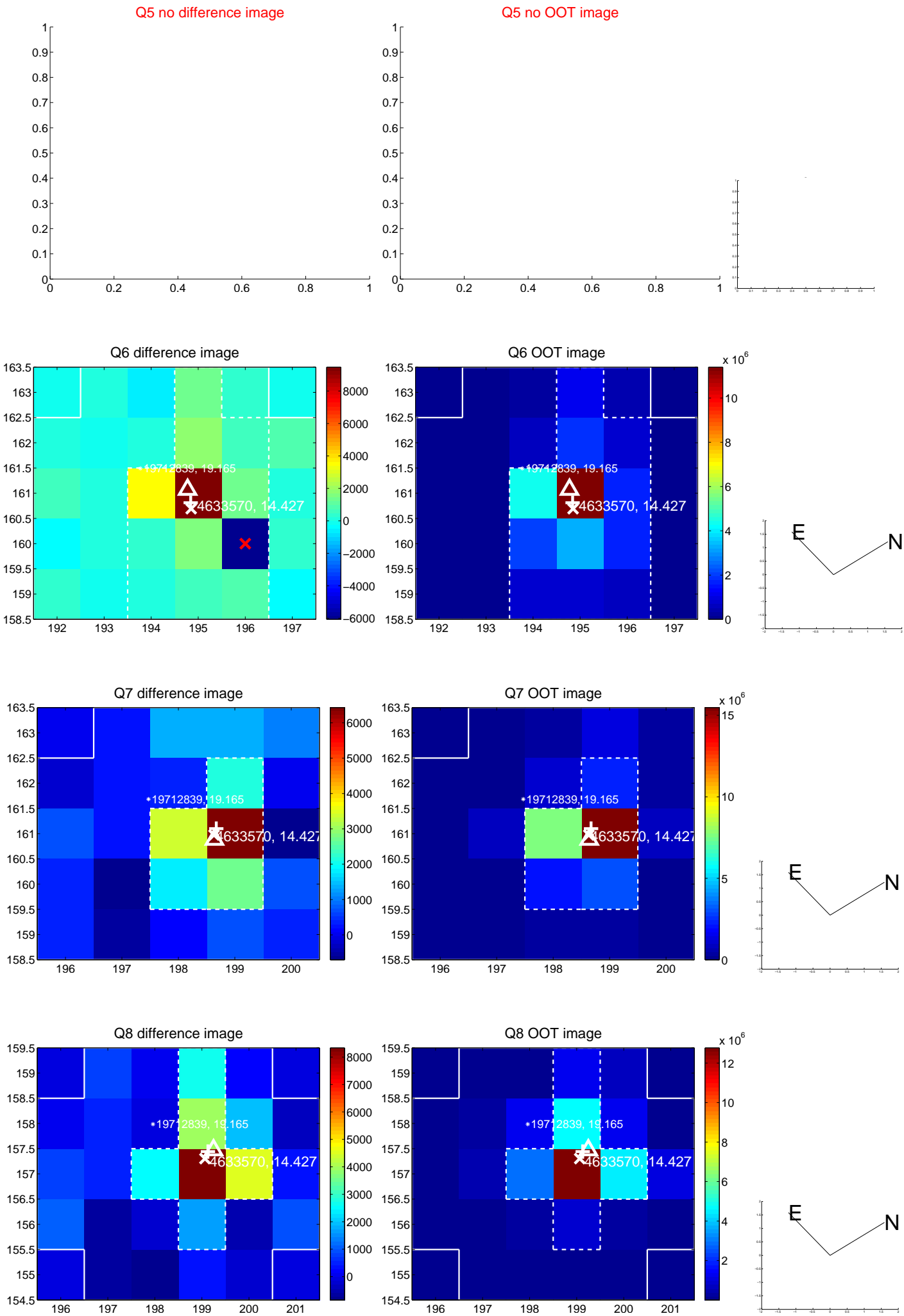
Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses:** good quarterly centroid offsets; **Vermillion crosses:** bad quarterly centroid offsets; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: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



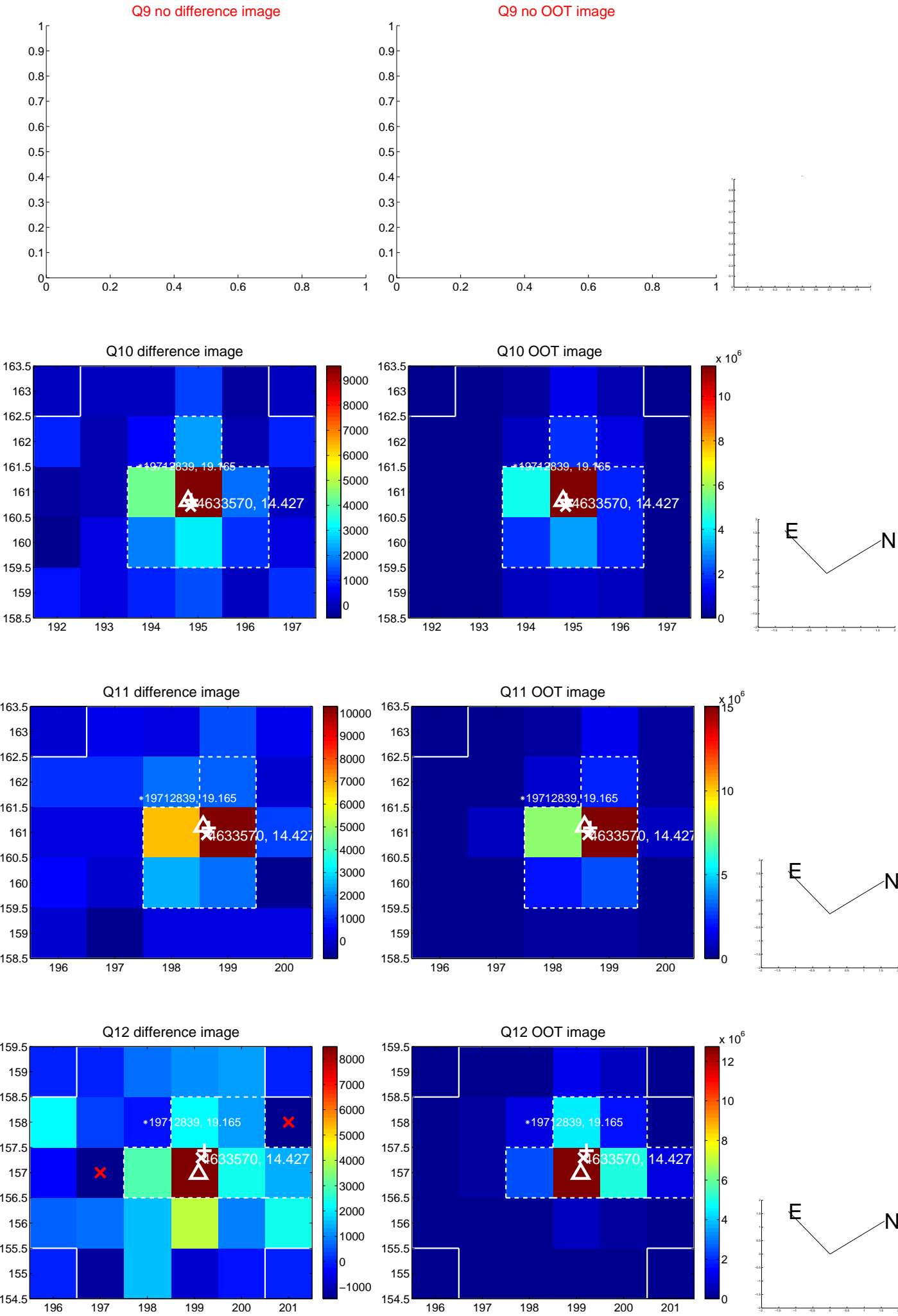
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



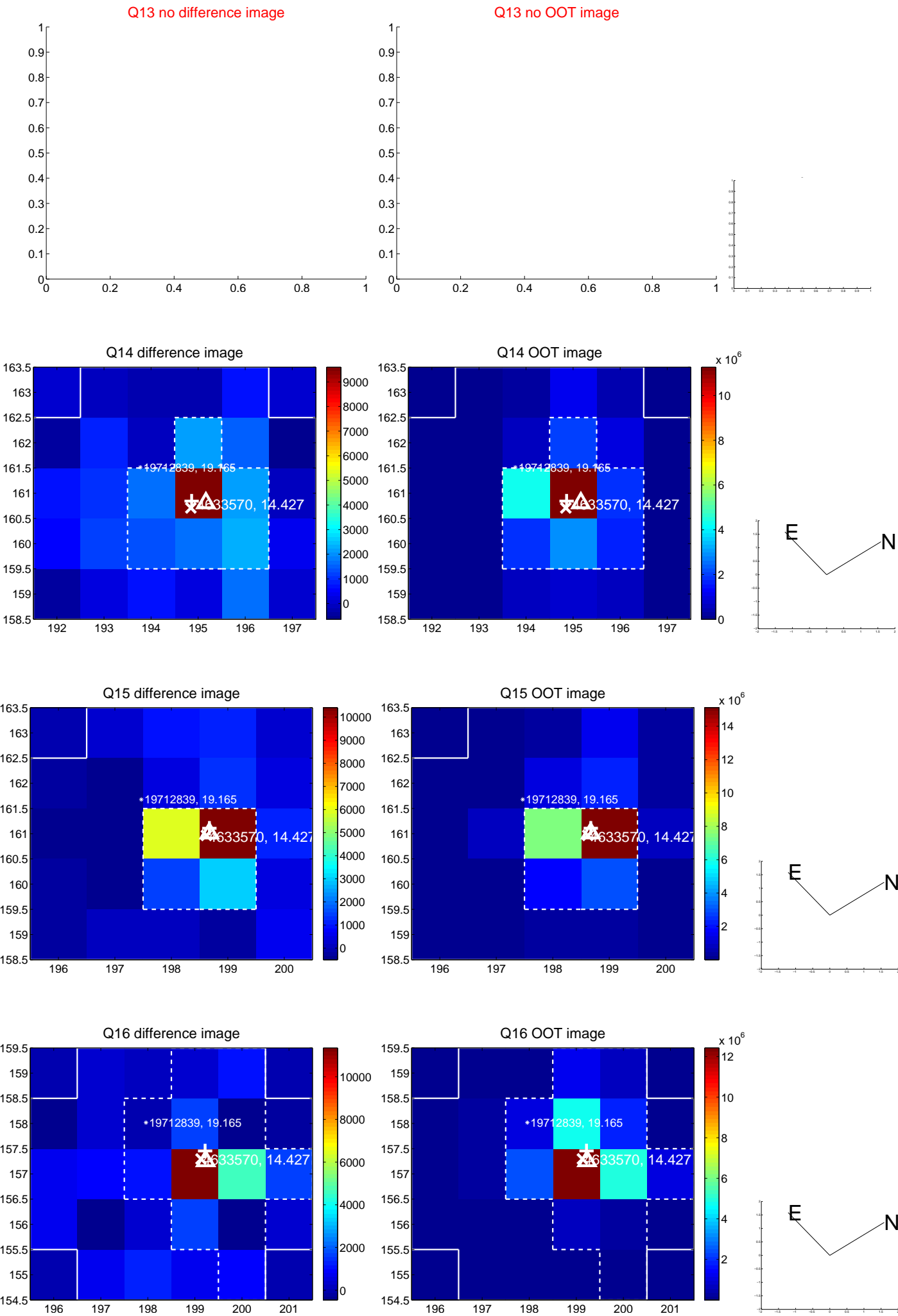
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



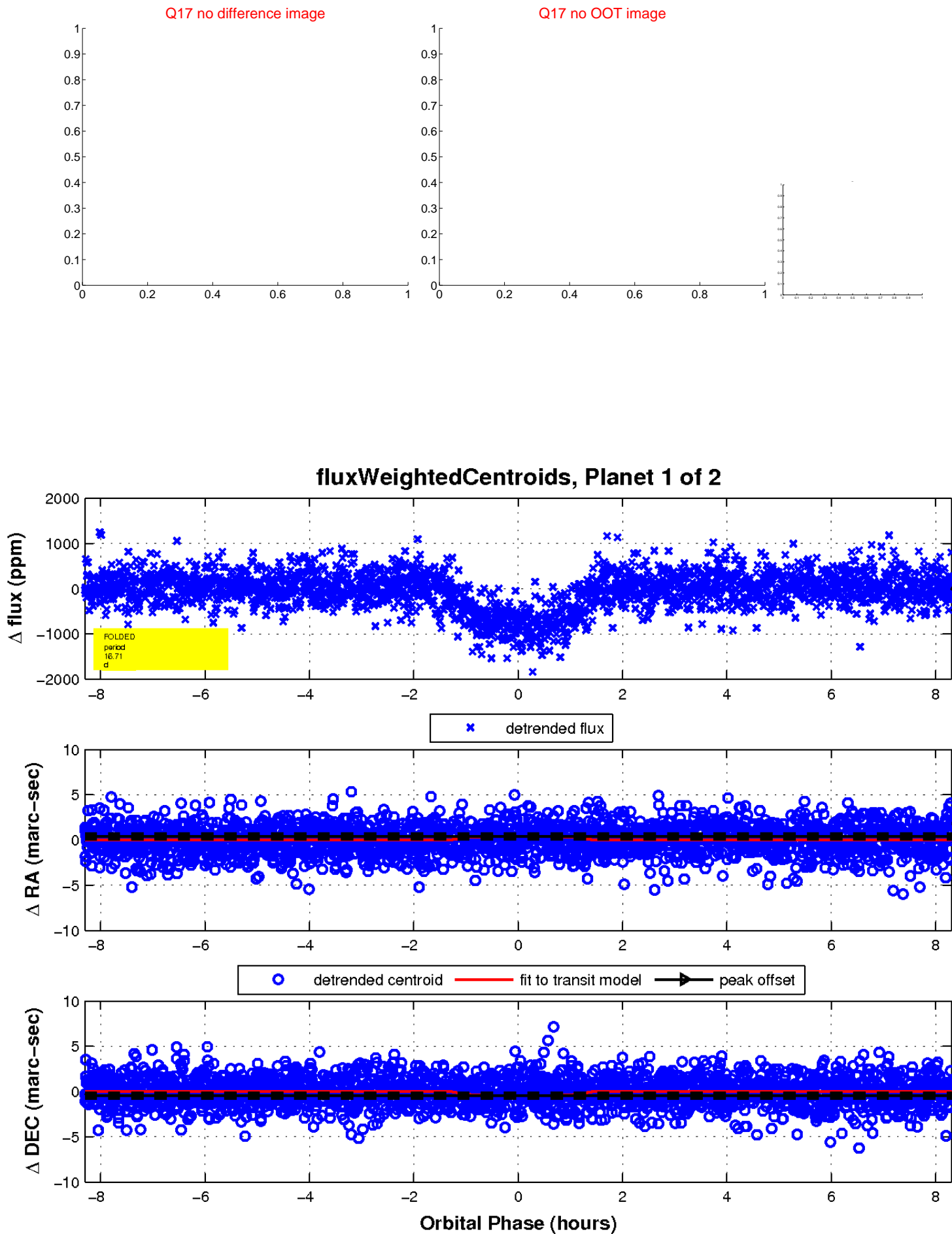
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



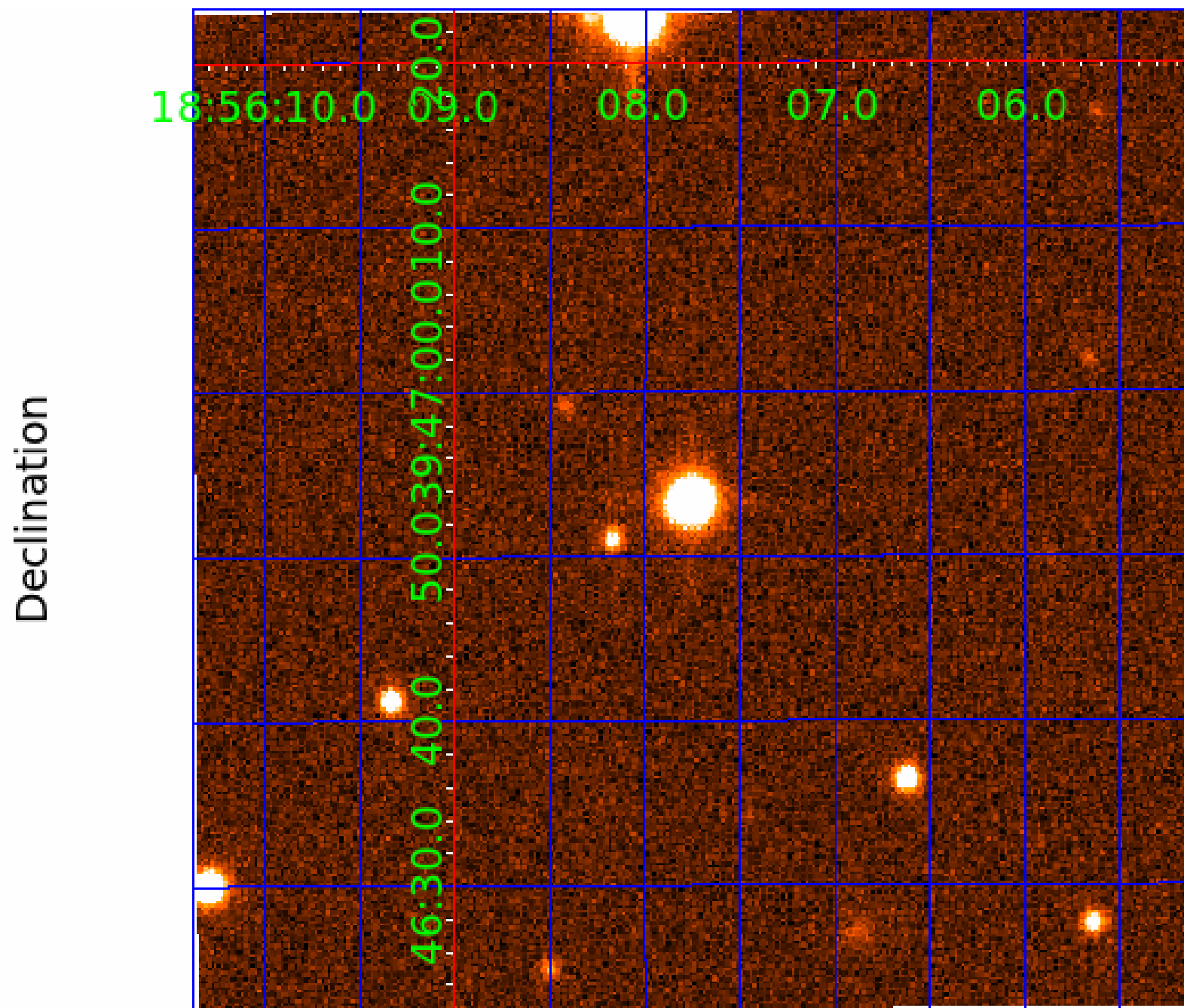
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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



UKIRT Image





# KIC 004633570

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
004633570-01	OBS	0446.01	16.709160	141.337757	837.3	2.769	32.8	35.2	0.67	4621	2.28	14.76
004633570-02	OBS	0446.02	28.551543	156.925747	812.4	4.187	28.1	30.1	0.67	4621	2.11	7.22

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
004633570-01	OBS	PC	1.00	0	0	0	0	CENT_KIC_POS
004633570-02	OBS	PC	0.90	0	0	0	0	CENT_KIC_POS

**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.

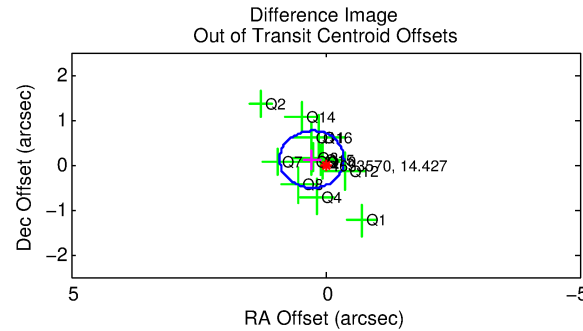
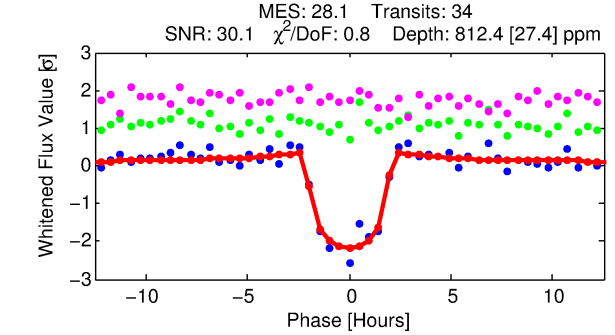
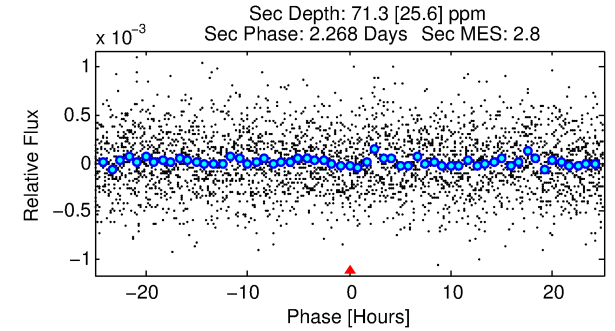
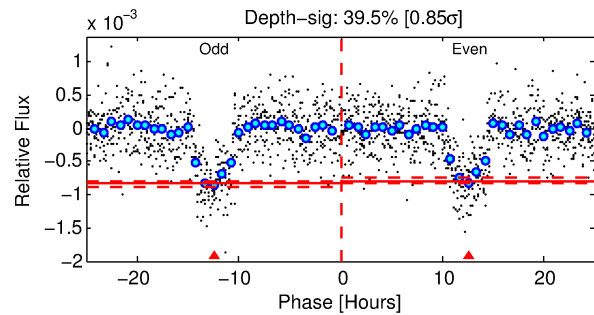
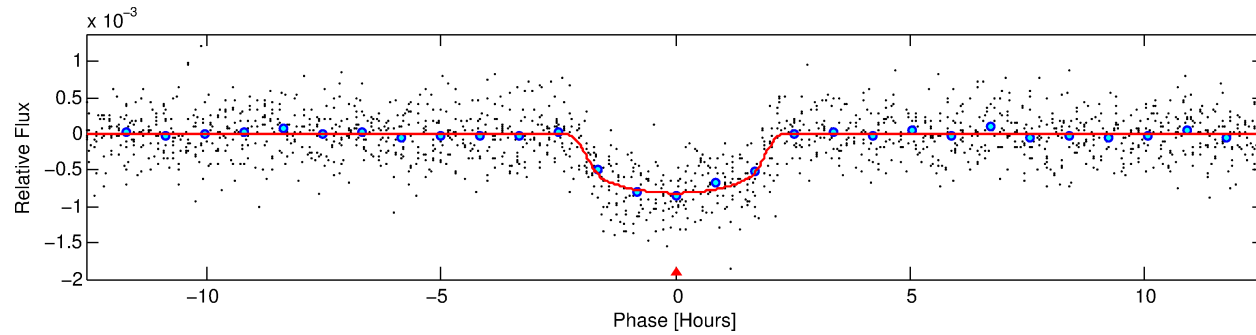
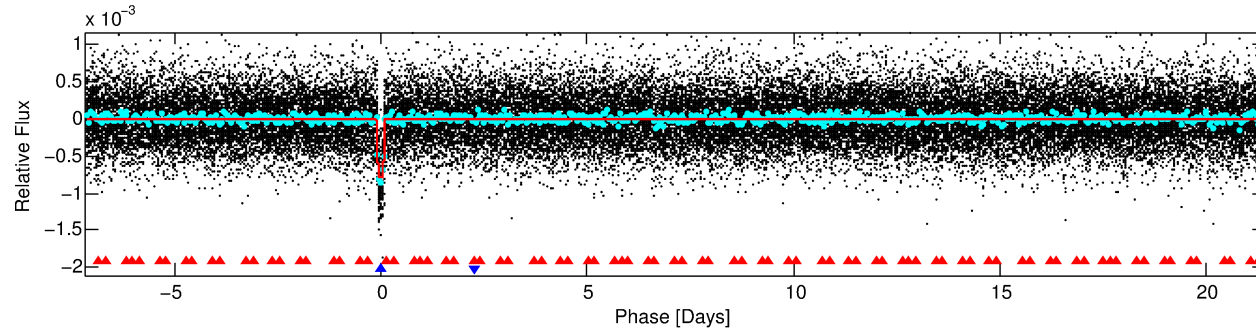
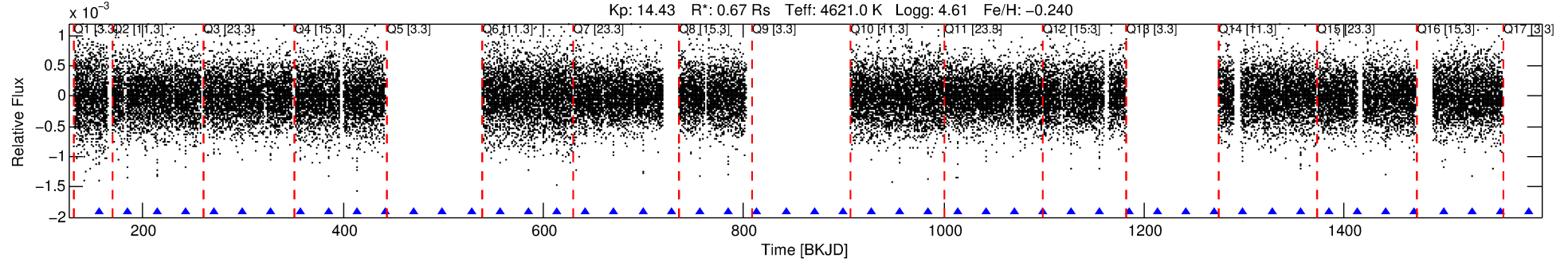
## Ephemeris Match Information For 004633570-02

No Significant Match Found

# DV One-Page Summary

KIC: 4633570 Candidate: 2 of 2 Period: 28.552 d  
KOI: K00446.02 Name: Kepler-158c Corr: 0.988

Kp: 14.43 R\*: 0.67 Rs Teff: 4621.0 K Logg: 4.61 Fe/H: -0.240



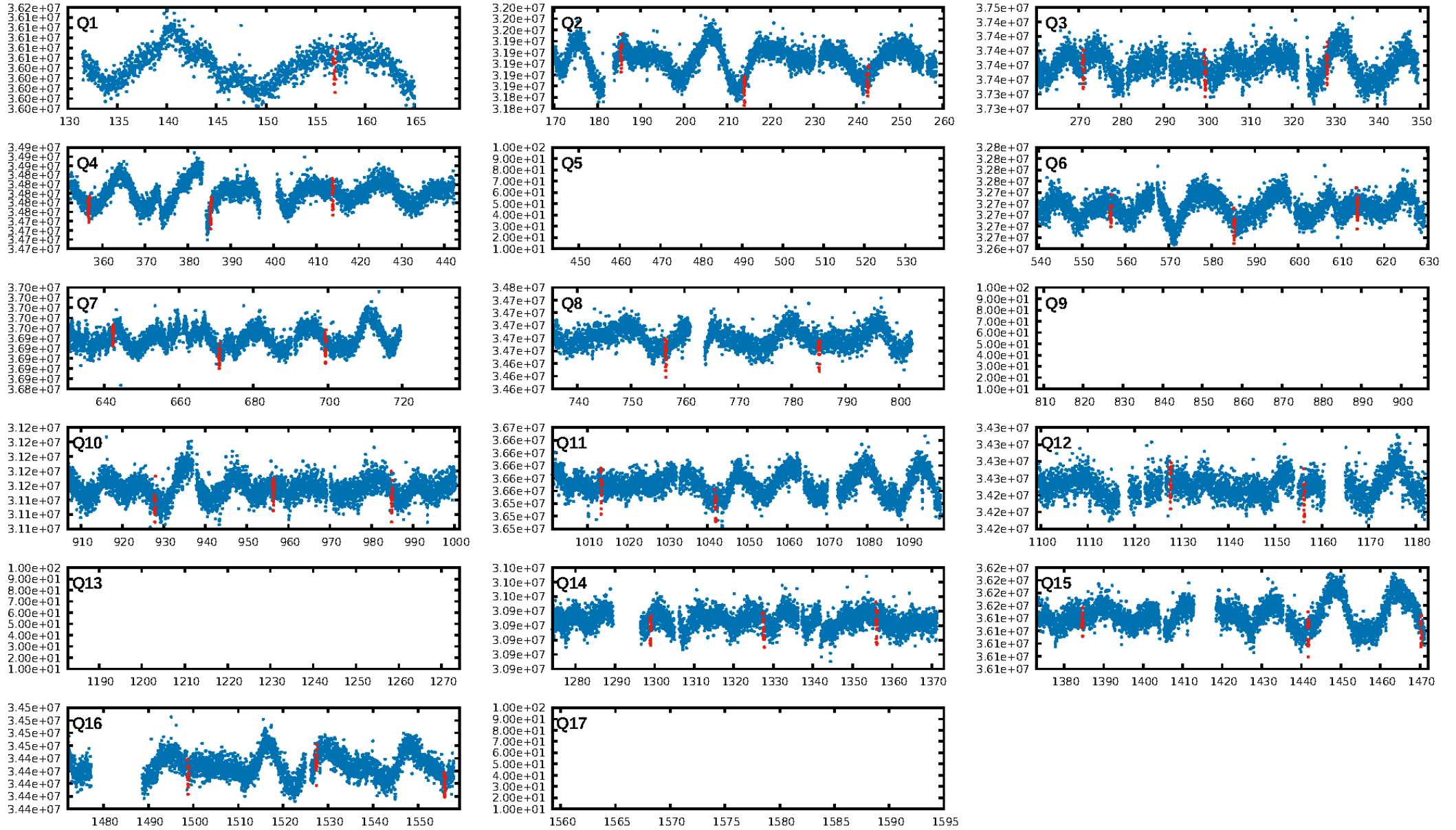
## DV Fit Results:

Period = 28.55154 [0.00009] d  
Epoch = 156.9257 [0.0026] BKJD  
Rp/R\* = 0.0290 [0.0069]  
a/R\* = 35.10 [27.63]  
b = 0.78 [0.41]  
Seff = 7.23 [1.12]  
Teff = 418 [16] K  
Rp = 2.11 [0.54] Re  
a = 0.1588 [0.0113] AU  
Ag = 221.90 [133.91] [1.65σ]  
Teffp = 2495 [379] K [5.48σ]

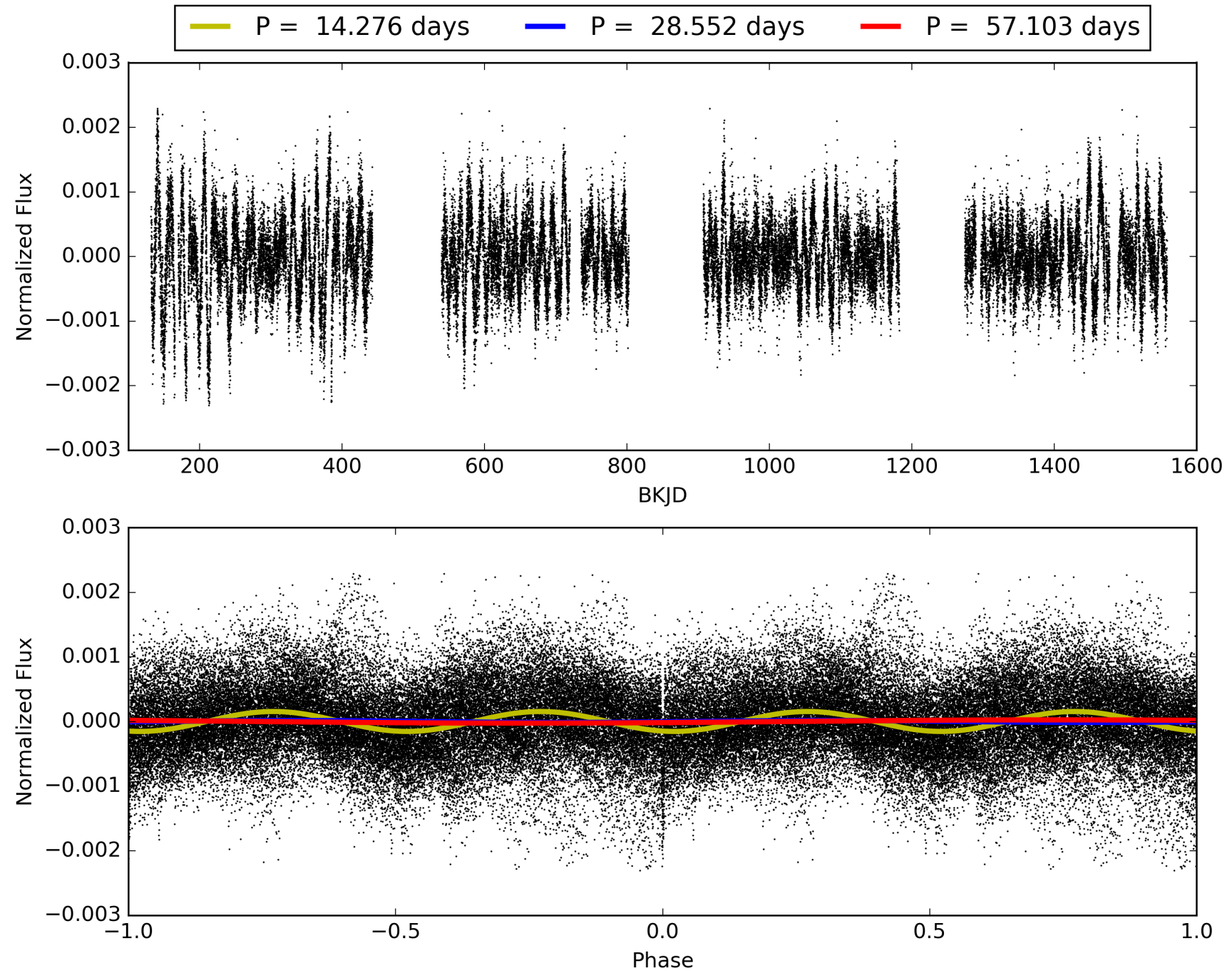
## DV Diagnostic Results:

ShortPeriod-sig: 100.0% [56.62σ]  
LongPeriod-sig: N/A  
ModelChiSquare2-sig: 73.8%  
ModelChiSquareGof-sig: 100.0%  
Bootstrap-pfa: 2.40e-163  
RollingBand-fgt: 1.00 [33/33]  
GhostDiagnostic-chr: 9.159  
Centroid-sig: 15.2%  
Centroid-so: 0.238 arcsec [0.58σ]  
OotOffset-rm: 0.291 arcsec [1.38σ]  
OotOffset-st: 4/4/4/1 [13]  
KicOffset-rm: 0.856 arcsec [3.79σ]  
KicOffset-st: 4/4/4/1 [13]  
DiffImageQuality-fgm: 1.00 [13/13]  
DiffImageOverlap-fno: 1.00 [13/13]

# TCE 004633570-02, PDC Light Curves

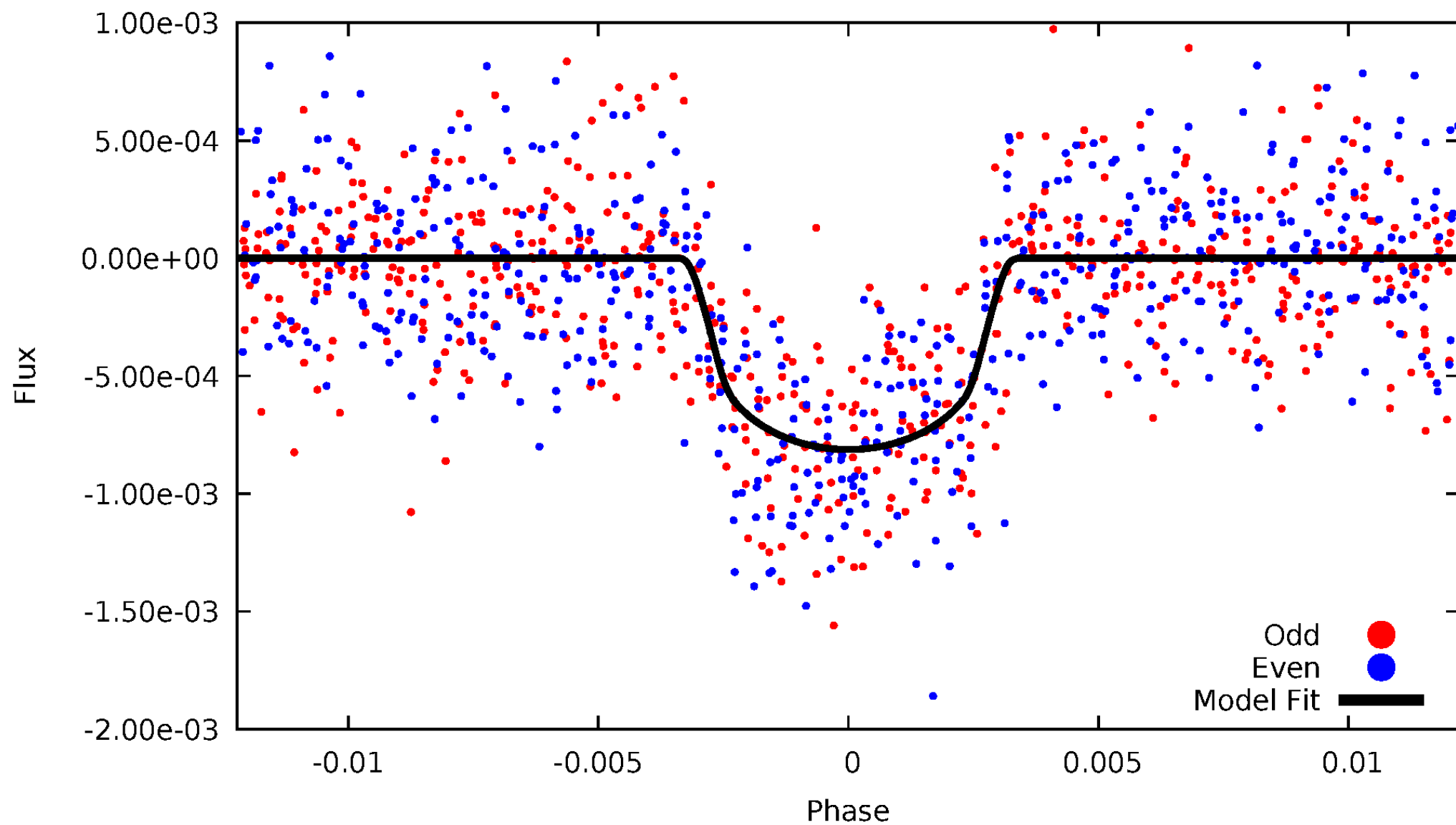


TCE 004633570-02



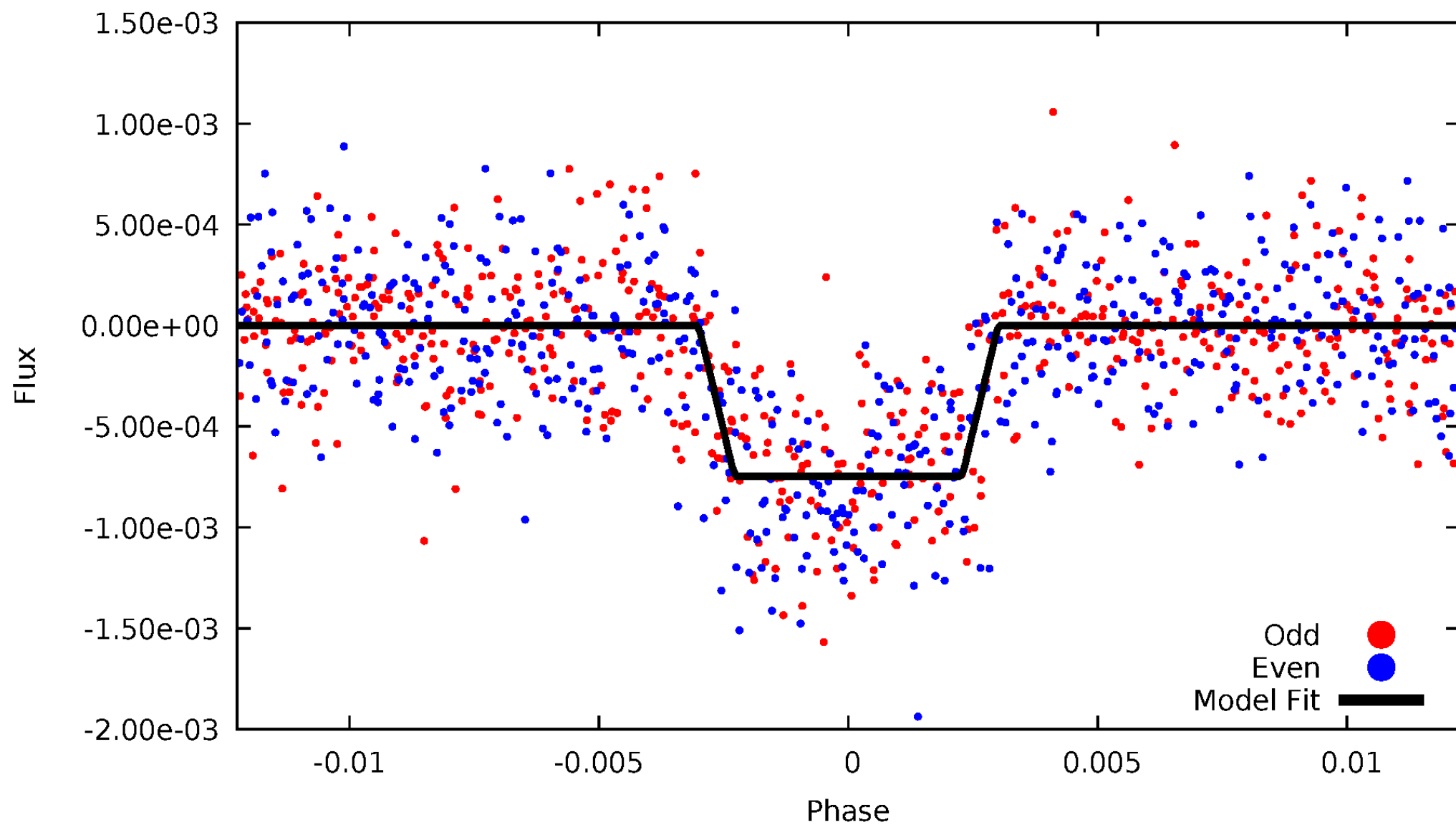
DV Odd/Even

TCE 004633570-02



ALT Odd/Even

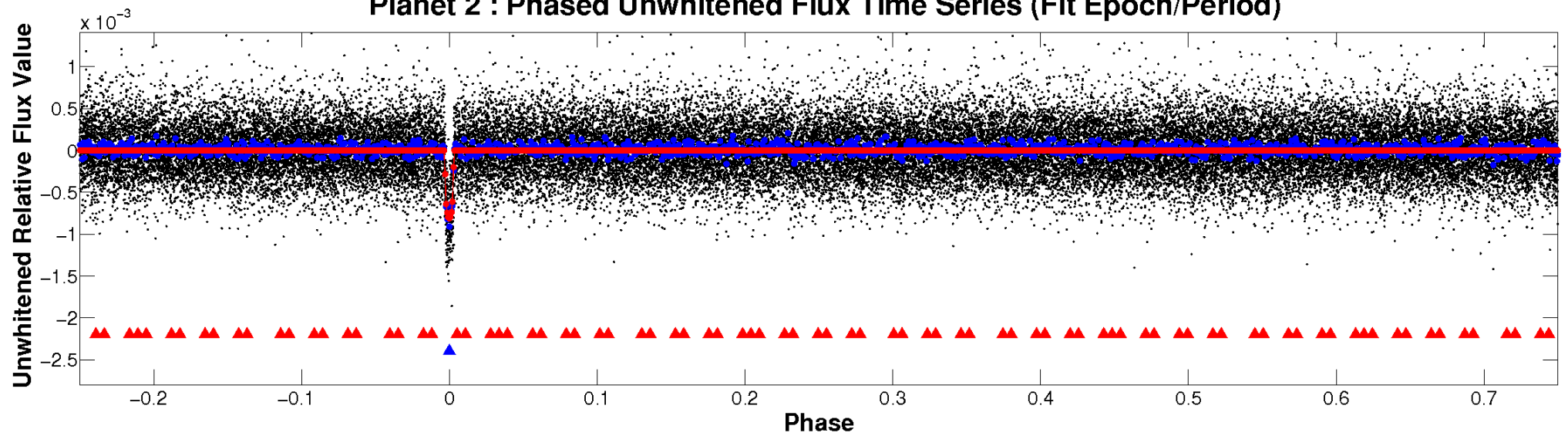
TCE 004633570-02



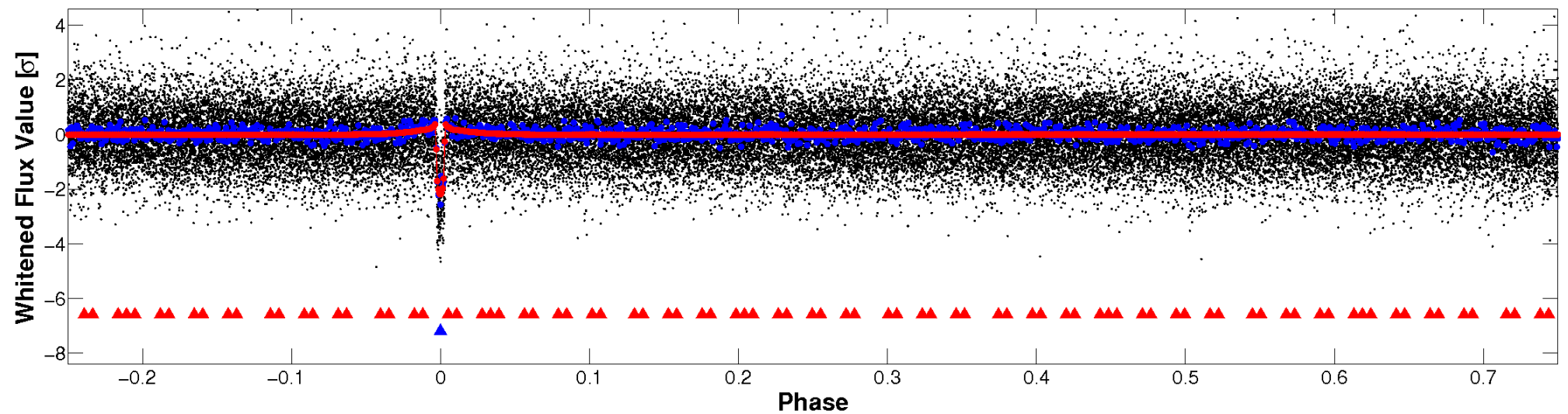


# Non-Whitened Vs. Whitened Light Curve

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

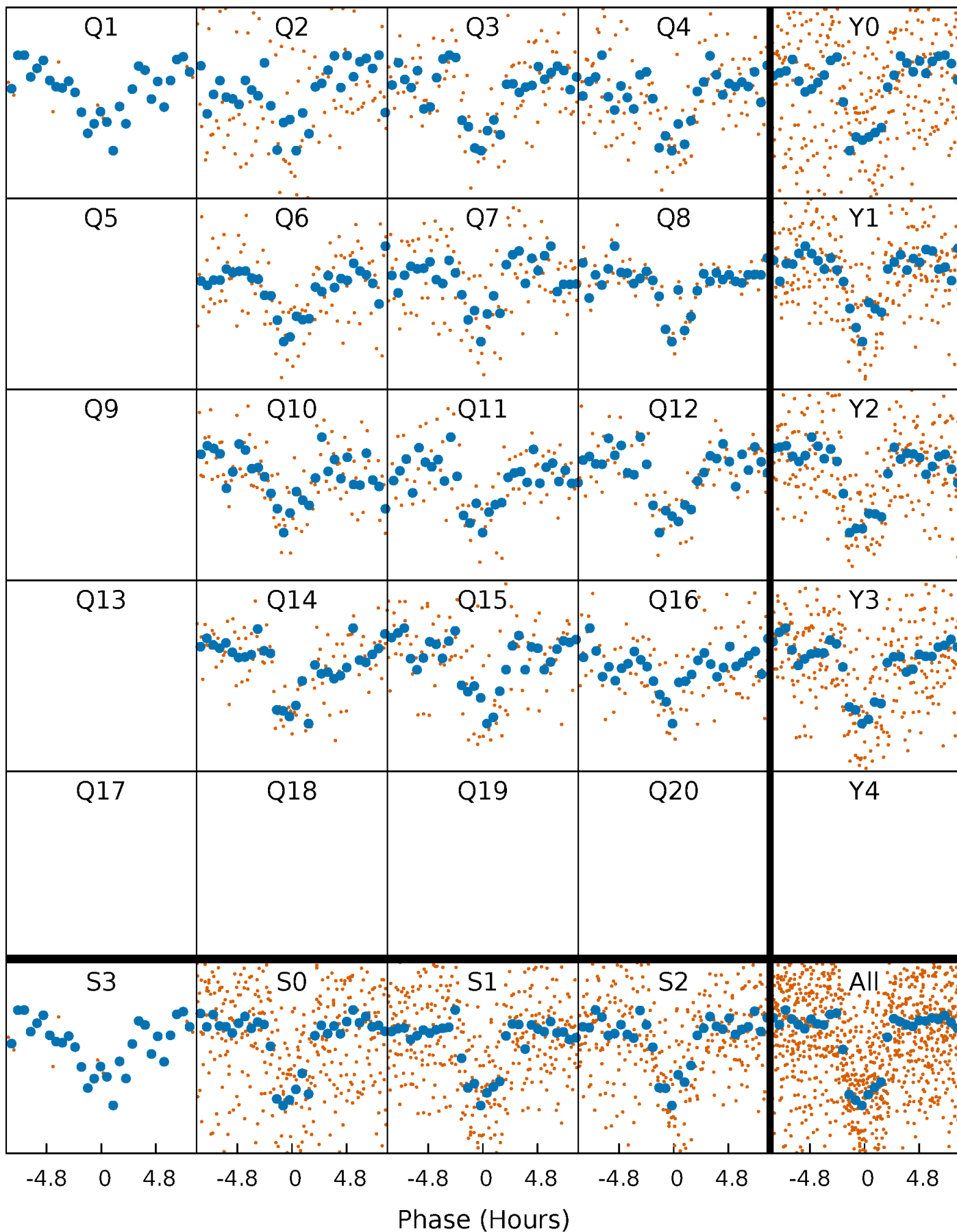


## Planet 2 : Phased Whitened Flux Time Series (Fit Epoch/Period)



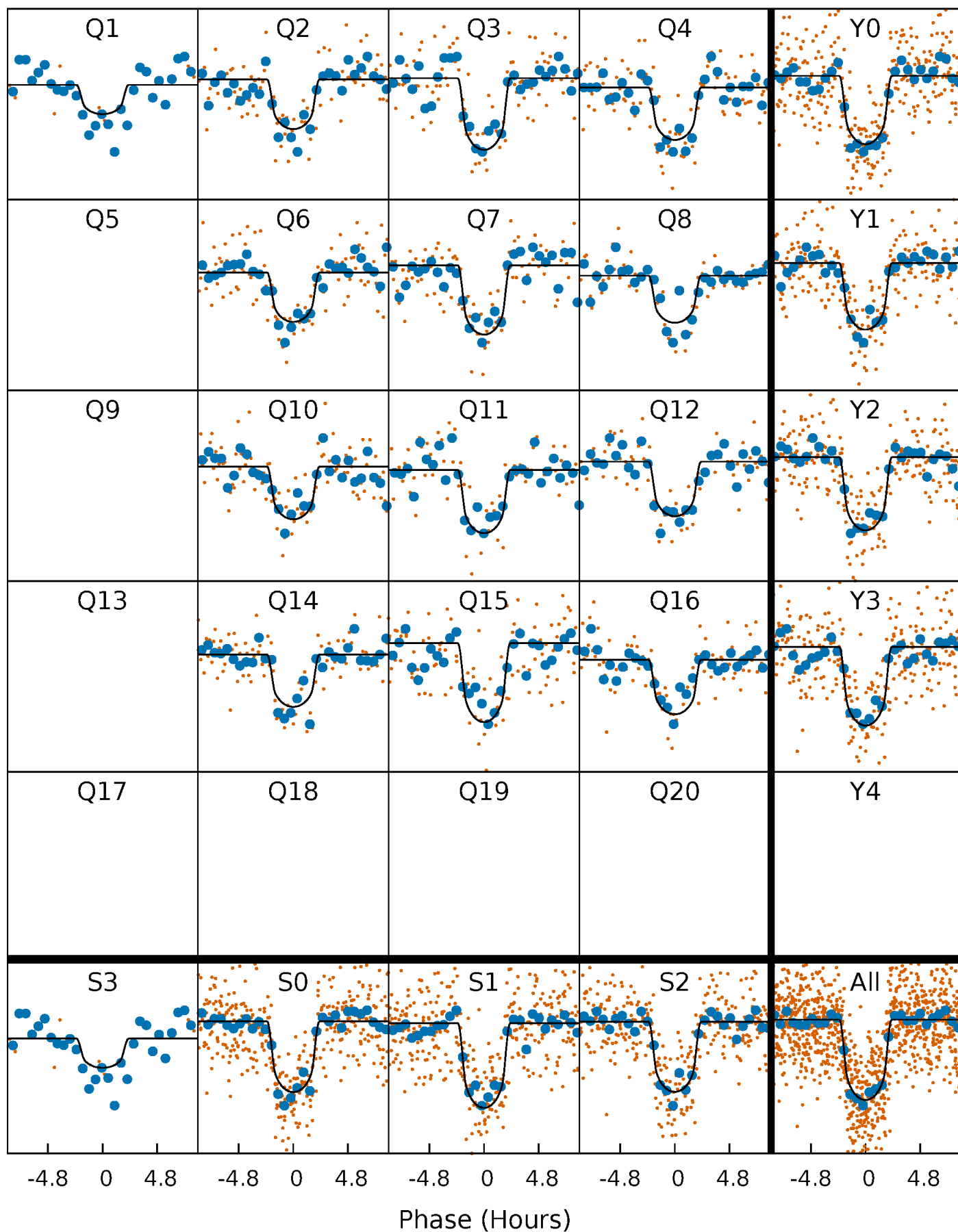
# PDC Quarter-Phased Transit Curves

TCE 004633570-02 P= 28.551543 Days  $T_0=156.925747$  (BKJD)



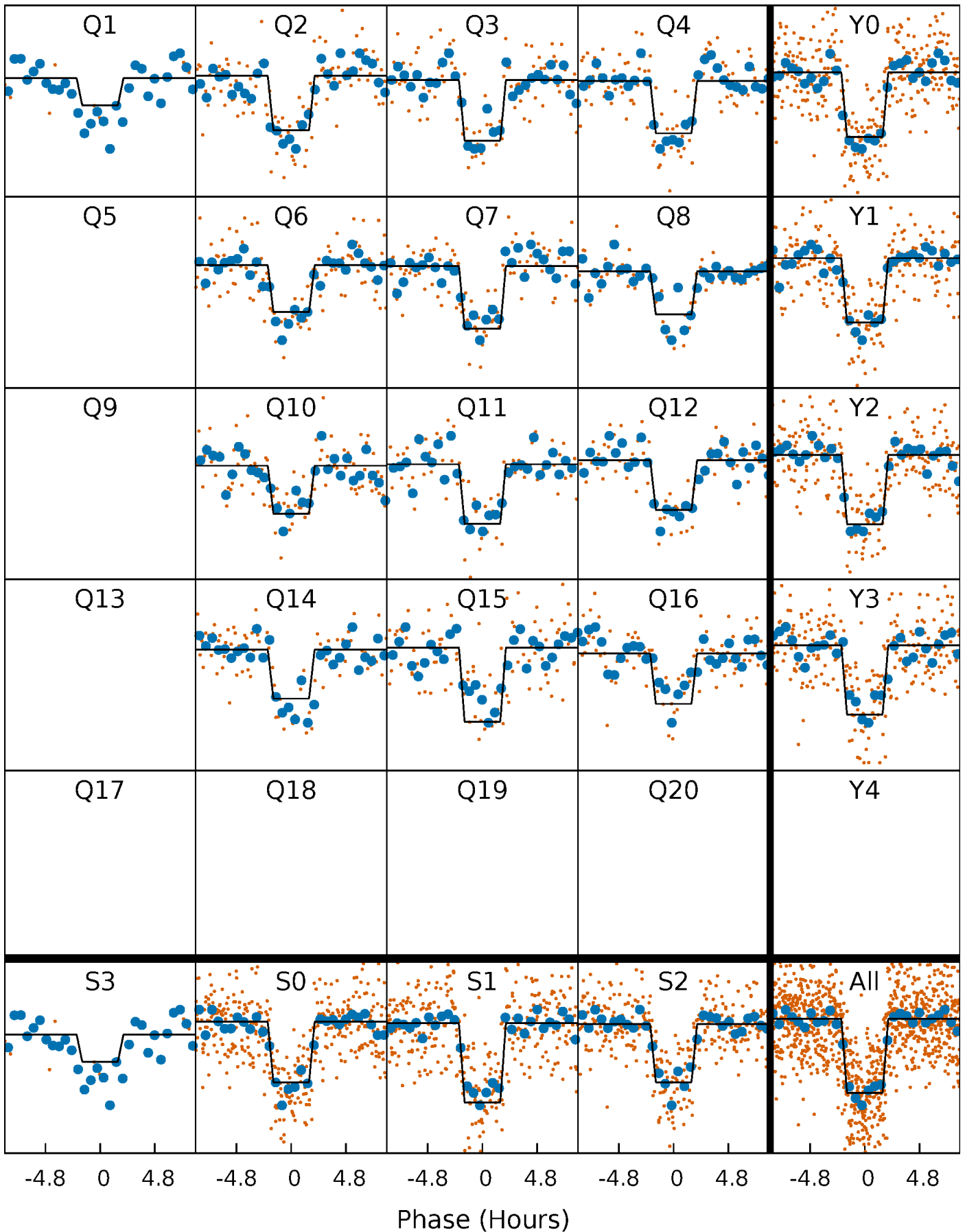
# DV Quarter-Phased Transit Curves

TCE 004633570-02 P= 28.551543 Days  $T_0=156.925747$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

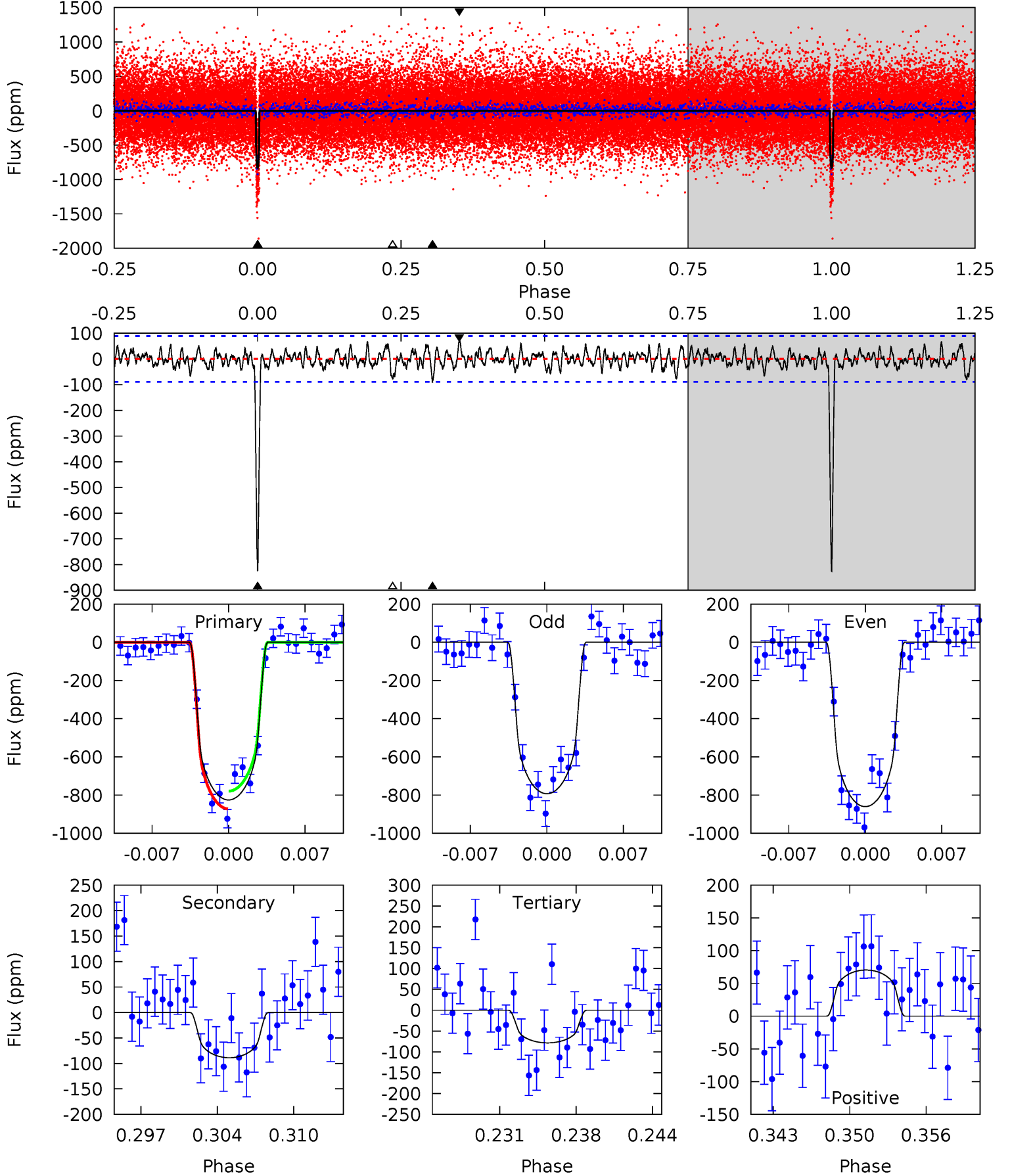
TCE 004633570-02 P= 28.551212 Days  $T_0=156.934340$  (BKJD)



# DV Model-Shift Uniqueness Test

004633570-02,  $P = 28.551543$  Days,  $E = 128.374204$  Days

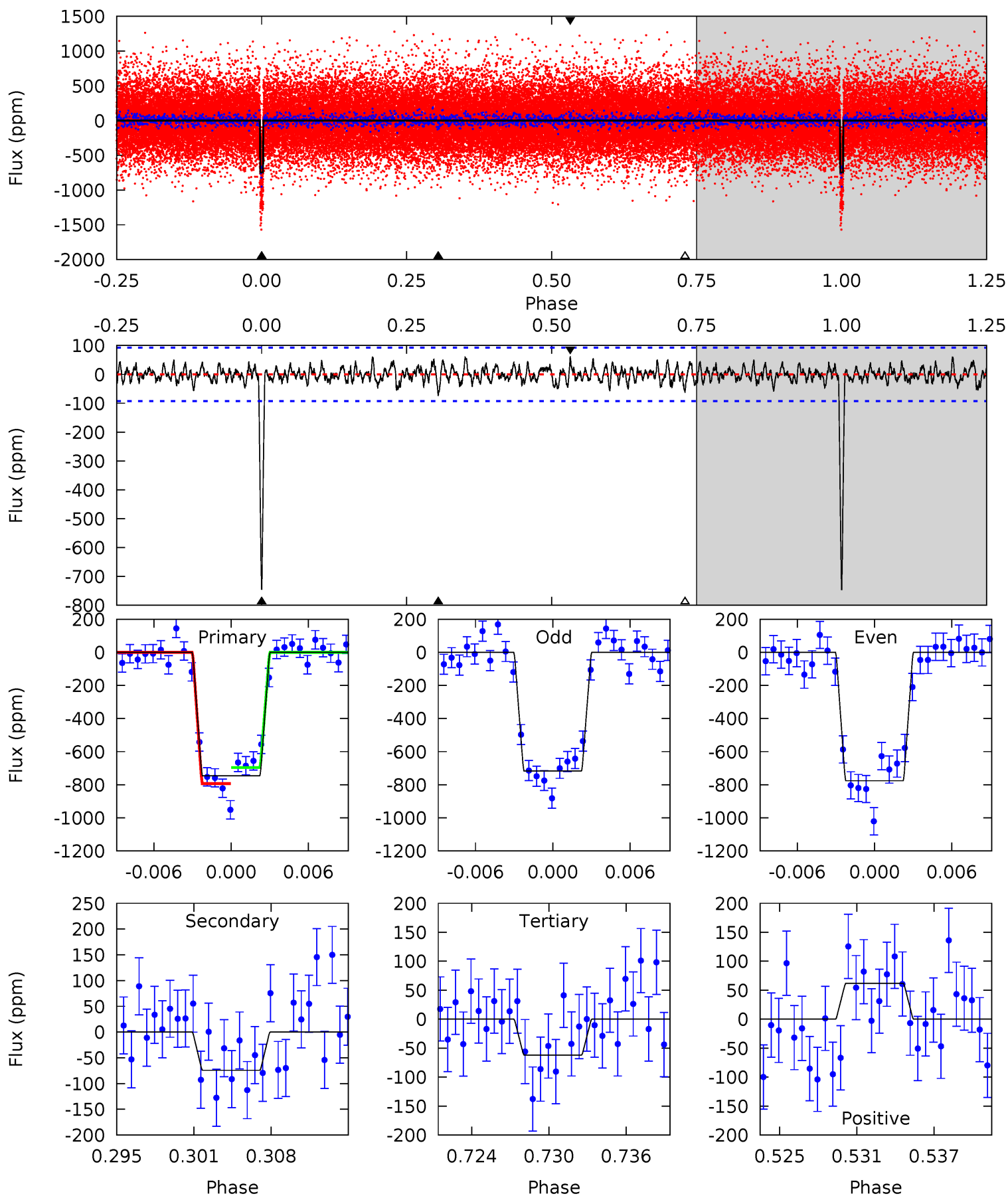
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
47.3	5.08	4.49	4.03	5.11	2.72	1.42	42.8	43.3	0.59	1.05	1.94	1.02	0.08	2.67



# Alt Model-Shift Uniqueness Test

004633570-02, P = 28.551212 Days, E = 128.383128 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
41.3	4.10	3.43	3.43	5.12	2.75	1.16	37.8	37.8	0.67	0.67	1.61	1.00	0.08	2.70





### Stellar Parameters For KIC 004633570

	$T_{\text{eff}}(K)$	$\log(g)$	[Fe/H]	$R (R_{\odot})$	$M(M_{\odot})$	$p_{\star} (g \cdot \text{cm}^{-3})$
	$4621^{+124}_{-137}$	$4.605^{+0.052}_{-0.028}$	$-0.240^{+0.300}_{-0.300}$	$0.668^{+0.054}_{-0.059}$	$0.656^{+0.073}_{-0.049}$	$3.098^{+0.715}_{-0.401}$
	+3%/-3%	+1%/-1%	+125%/-125%	+8%/-9%	+11%/-7%	+23%/-13%
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 004633570-02 / KOI 0446.02

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{max} (K)$	$T_{obs} (K)$	$A_{obs}$
DV	$-89 \pm 17$	$2.09^{+0.56}_{-0.51}$	$580^{+19}_{-19}$	$3139^{+313}_{-204}$	$279^{+225}_{-105}$
Alt.	$-74 \pm 18$	$1.99^{+0.51}_{-0.51}$	$580^{+18}_{-19}$	$3113^{+311}_{-242}$	$257^{+219}_{-106}$

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

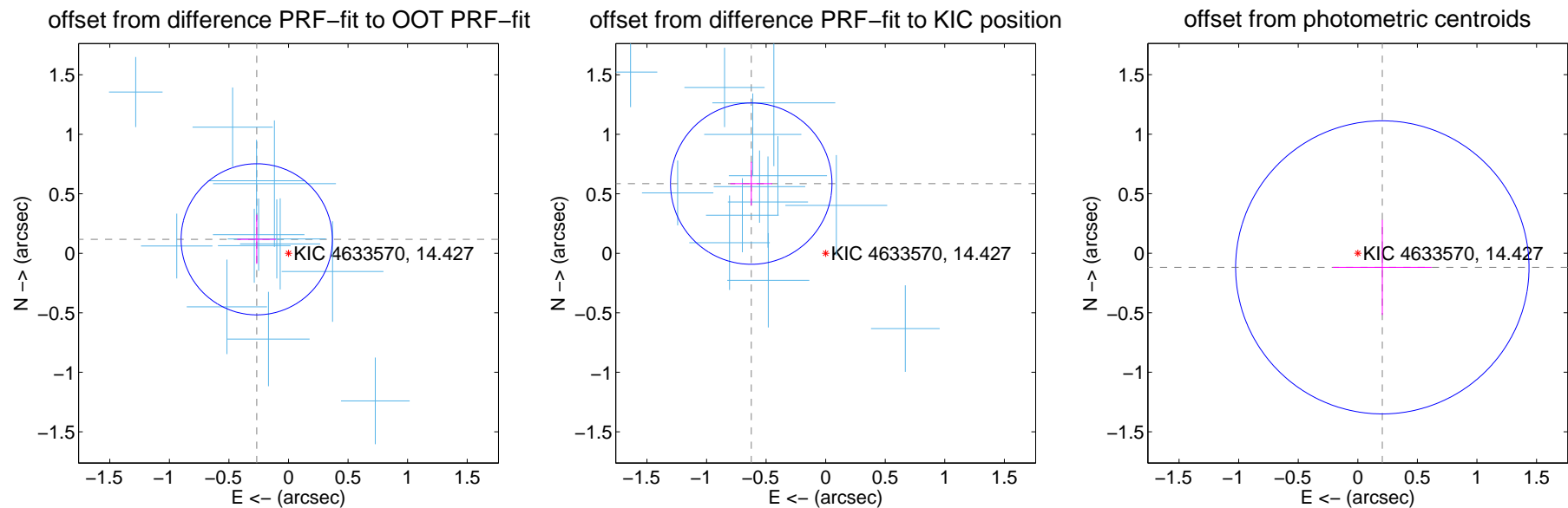
## DV Centroid Data

Supplemental centroid analysis for 004633570-02. Kepler magnitude: 14.43. Transit SNR 30.07

There are 13 quarters with good PRF difference image offsets

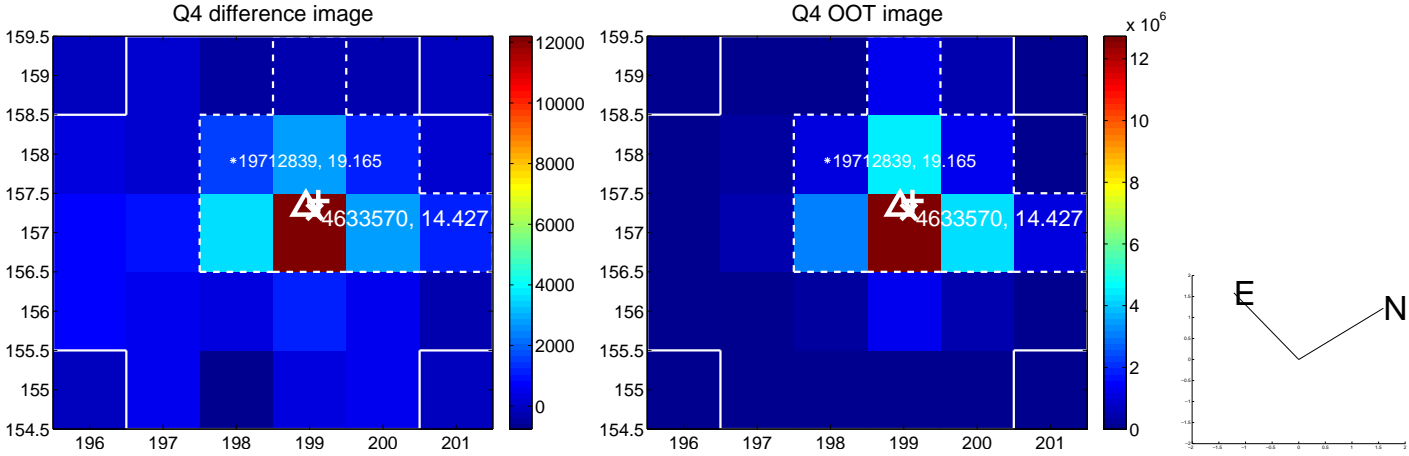
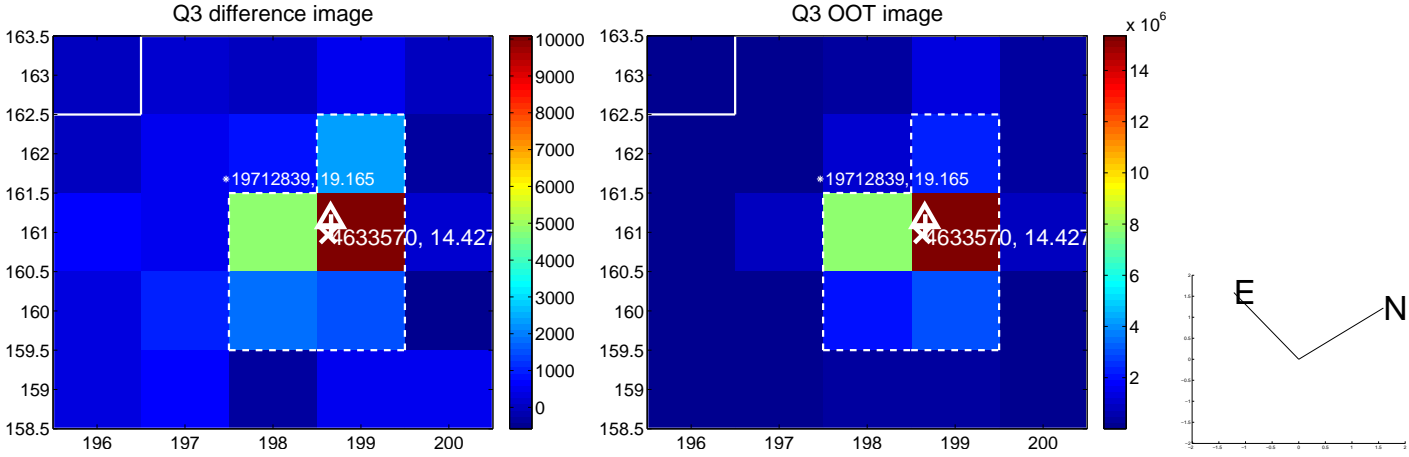
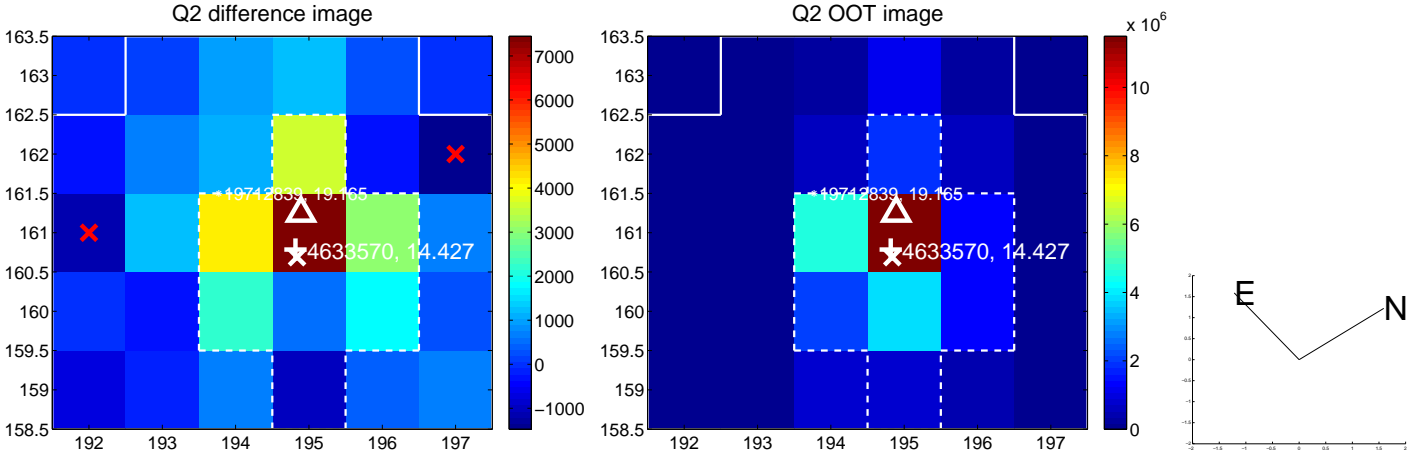
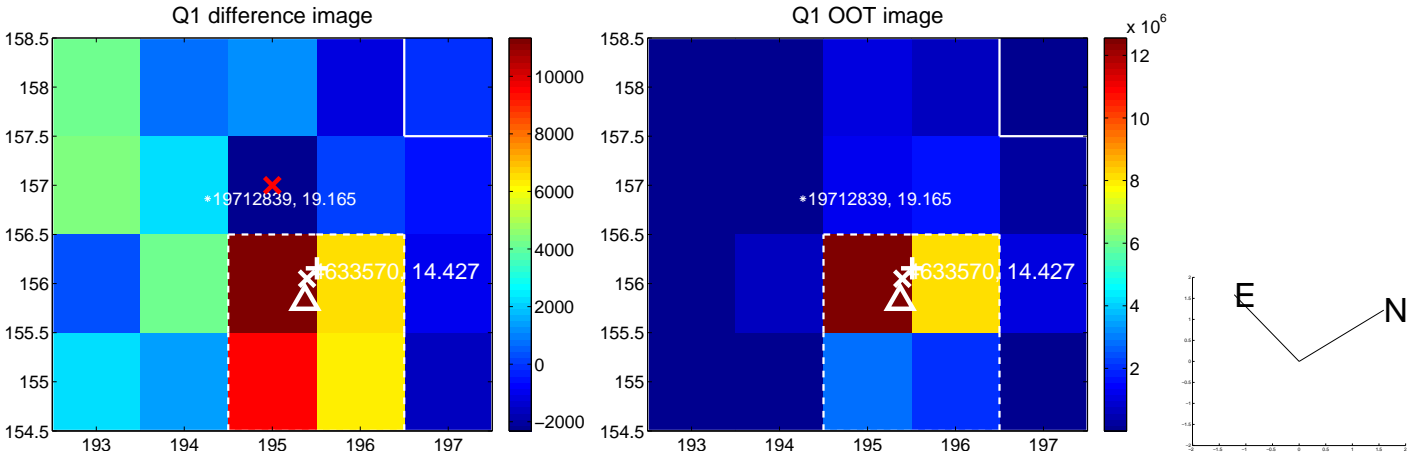
The direct PRF centroid is offset from the target star catalog position by about 0.75 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.291 \pm 0.212$	1.38	$0.267 \pm 0.163$	$0.117 \pm 0.206$
PRF-fit source offset from KIC position	<b><math>0.856 \pm 0.226</math></b>	<b>3.79</b>	$0.625 \pm 0.176$	$0.585 \pm 0.183$
photometric centroid source offset	$0.24 \pm 0.41$	0.58	$-0.21 \pm 0.41$	$-0.12 \pm 0.40$

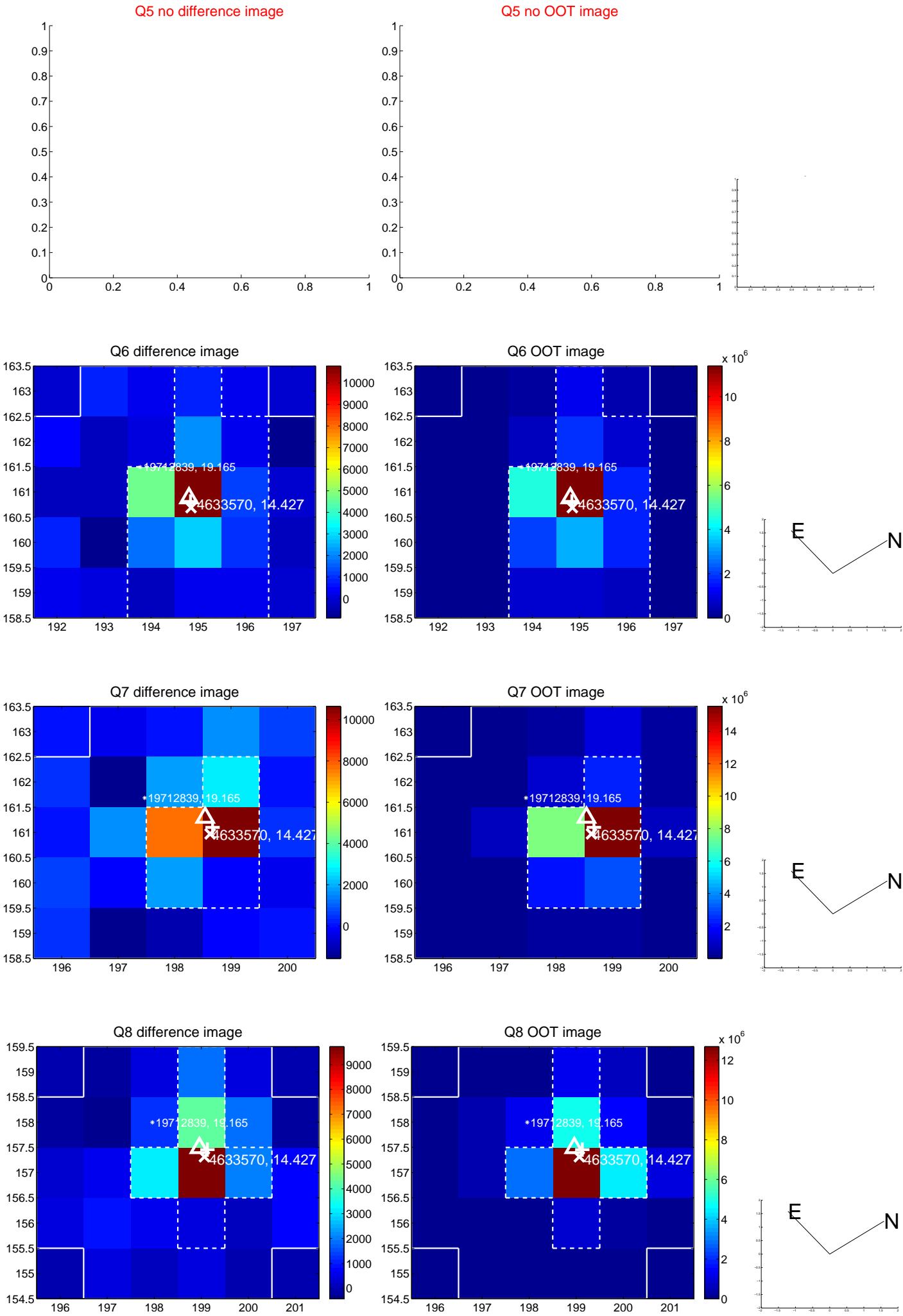


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses: good quarterly centroid offsets; Vermillion crosses: bad quarterly centroid offsets**; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: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

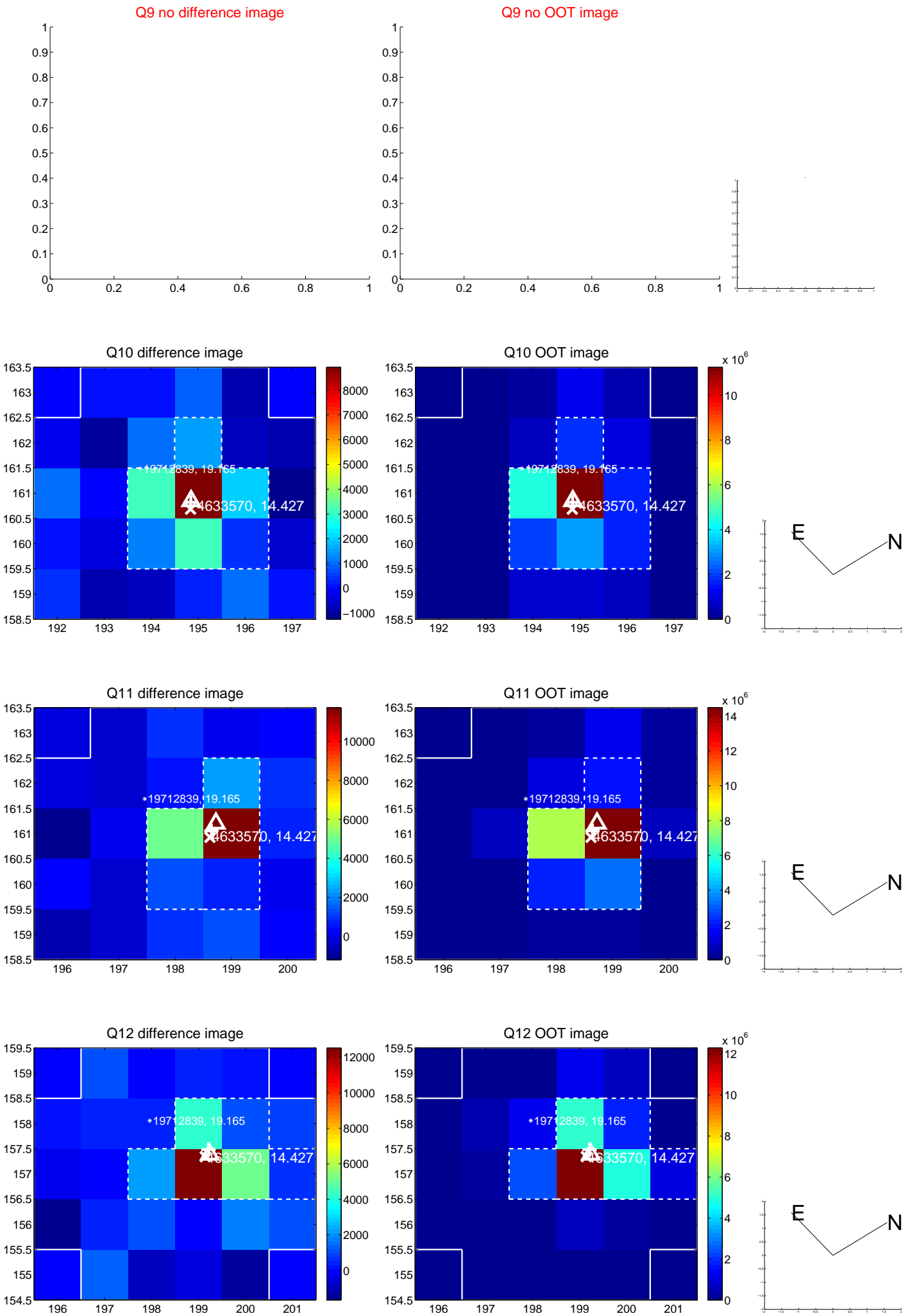
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



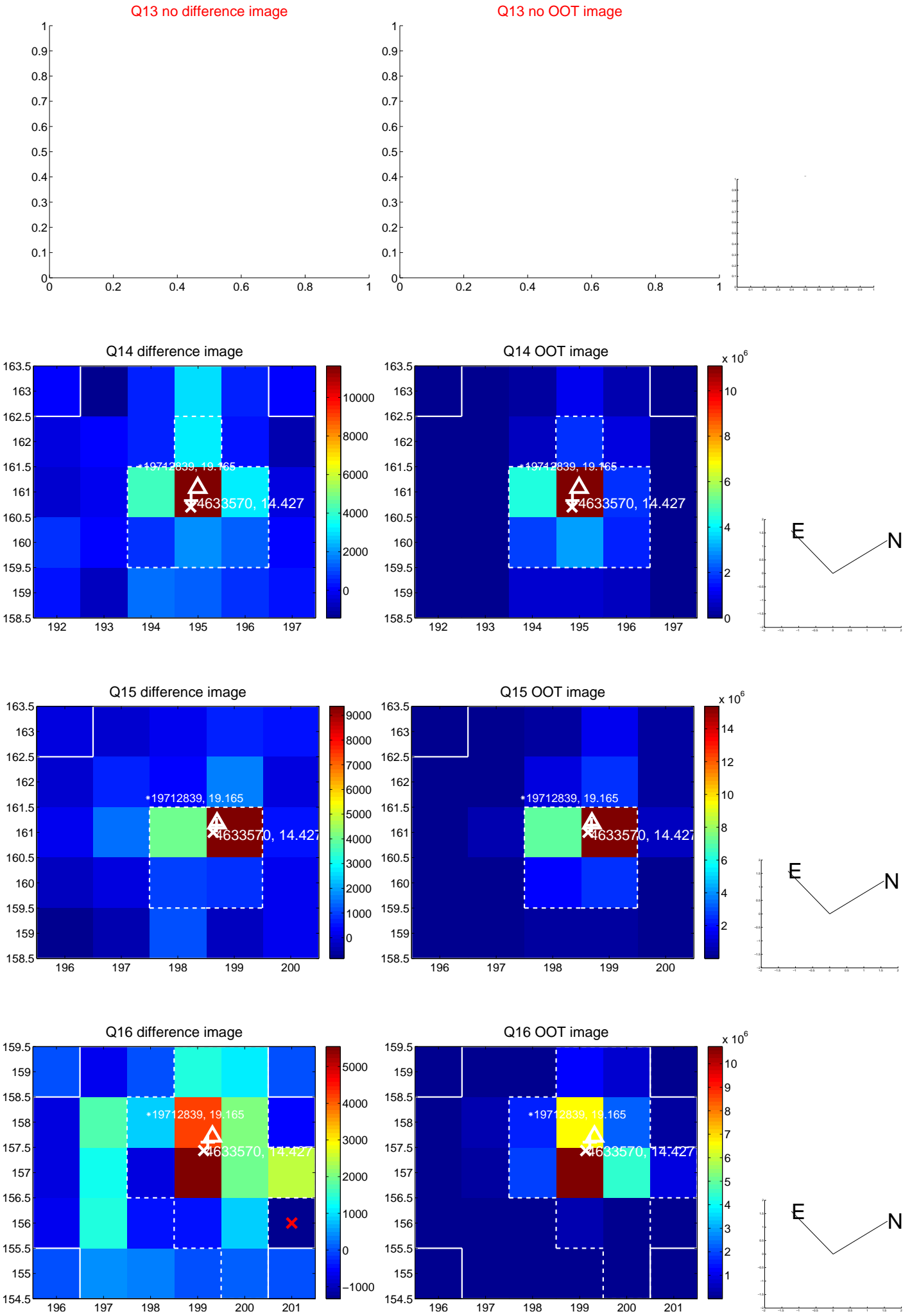
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



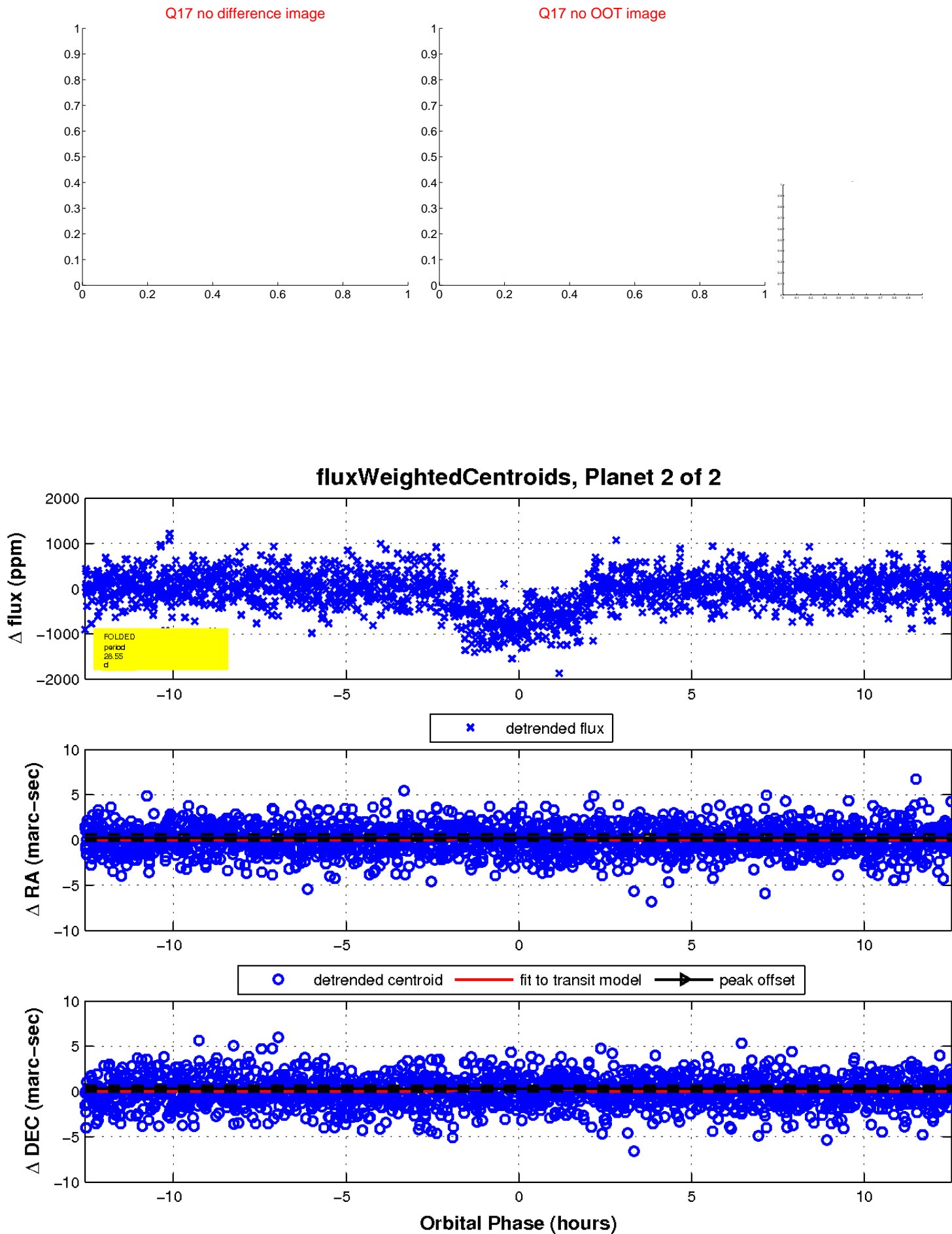
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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

