

# KIC 008176650

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
008176650-01	OBS	0960.01	15.801101	145.551177	37556.2	6.385	1526.5	1426.8	0.79	5383	15.66	33.63
008176650-02	OBS	No	15.801172	139.247515	744.4	4.843	28.3	29.4	0.79	5383	2.51	33.63

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
008176650-01	OBS	FP	0.00	0	1	0	0	MOD_SEC_DV—MOD_SEC_ALT—HAS_SEC_TCE
008176650-02	OBS	FP	0.00	1	1	0	0	IS_SEC_TCE

**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 008176650-01

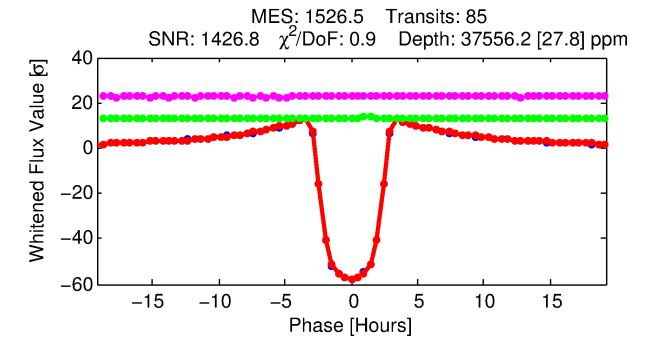
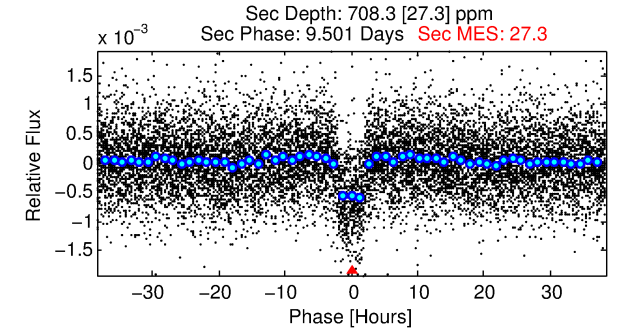
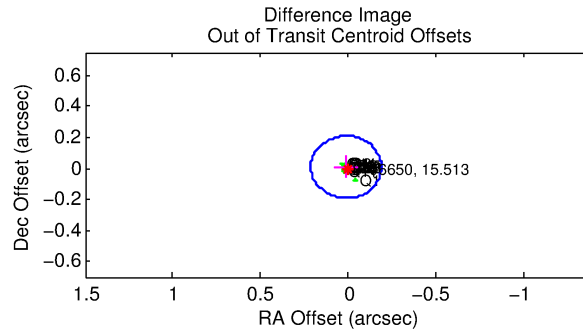
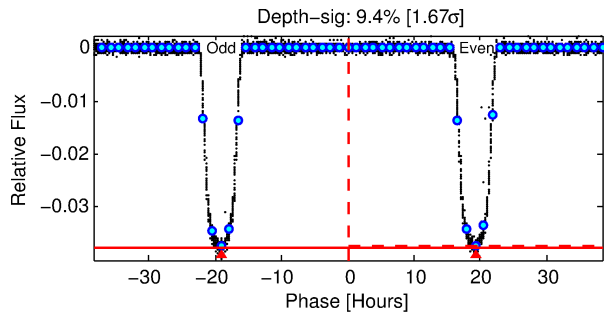
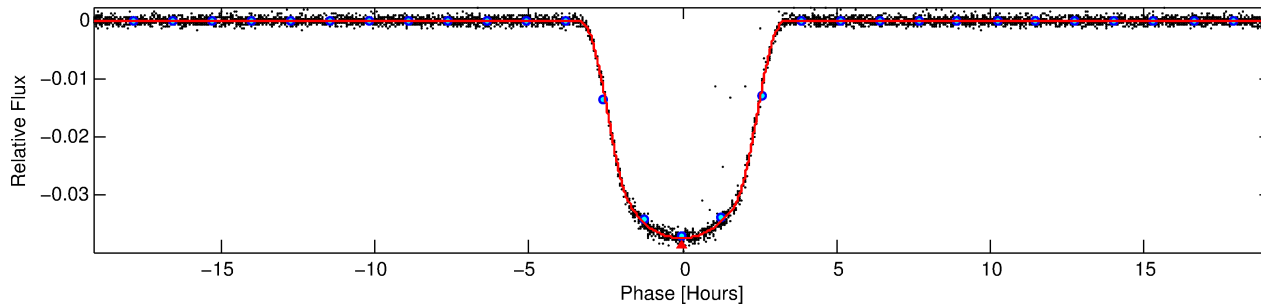
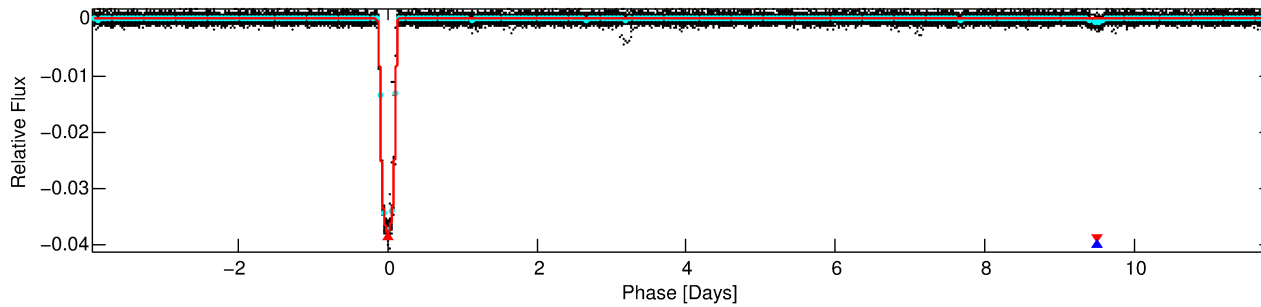
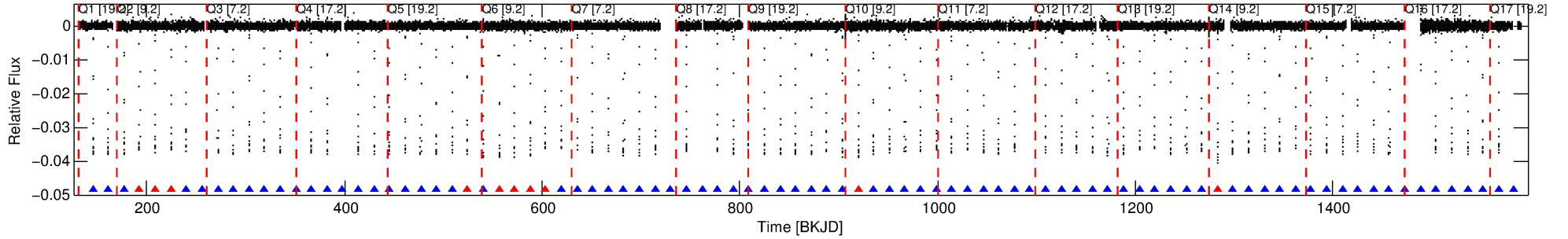
No Significant Match Found

# DV One-Page Summary

KIC: 8176650 Candidate: 1 of 2 Period: 15.801 d

KOI: K00960.01 Corr: 1.000

Kp: 15.51 R\*: 0.79 Rs Teff: 5383.0 K Logg: 4.59 Fe/H: -0.100



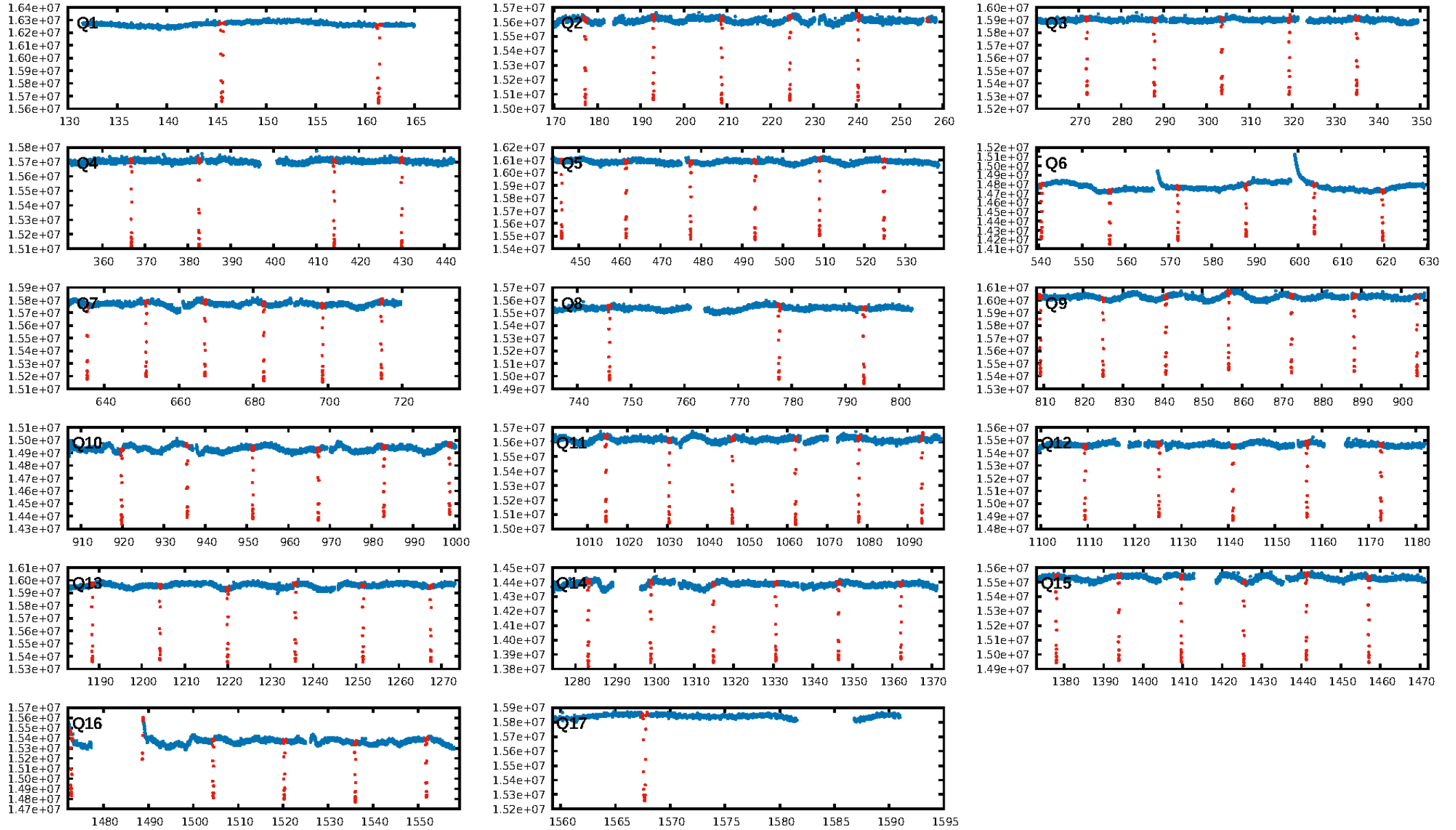
## DV Fit Results:

Period = 15.80110 [0.00000] d  
Epoch = 145.5512 [0.0001] BKJD  
Rp/R\* = 0.1818 [0.0001]  
a/R\* = 20.05 [0.05]  
b = 0.52 [0.00]  
Seff = 33.64 [8.41]  
Teq = 614 [38] K  
Rp = 15.66 [2.84] Re  
a = 0.1180 [0.0179] AU  
Ag = 22.14 [4.95] [4.27σ]  
Teffp = 2059 [64] K [19.37σ]

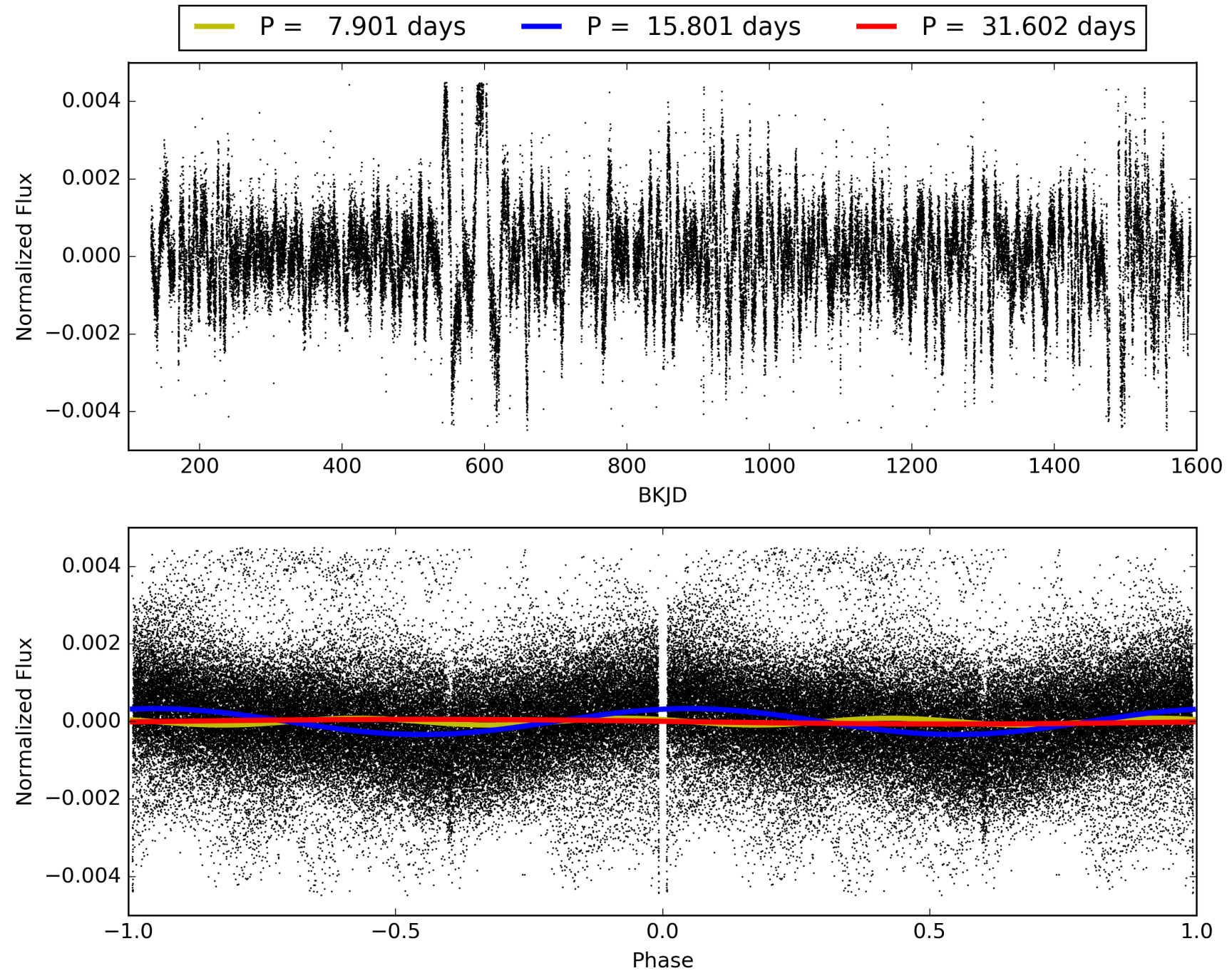
## DV Diagnostic Results:

ShortPeriod-sig: N/A  
LongPeriod-sig: 0.0% [0.00σ]  
ModelChiSquare2-sig: 0.0%  
ModelChiSquareGof-sig: 100.0%  
Bootstrap-pfa: 0.00e+00  
RollingBand-fgt: 0.88 [72/82]  
GhostDiagnostic-chr: 5.466  
Centroid-sig: 0.0%  
Centroid-so: 0.136 arcsec [17.18σ]  
OotOffset-rm: 0.017 arcsec [0.25σ]  
KicOffset-rm: 0.041 arcsec [0.60σ]  
OotOffset-st: 4/4/4/5 [17]  
KicOffset-st: 4/4/4/5 [17]  
DiffImageQuality-fgm: 1.00 [17/17]  
DiffImageOverlap-fno: 1.00 [17/17]

# TCE 008176650-01, PDC Light Curves

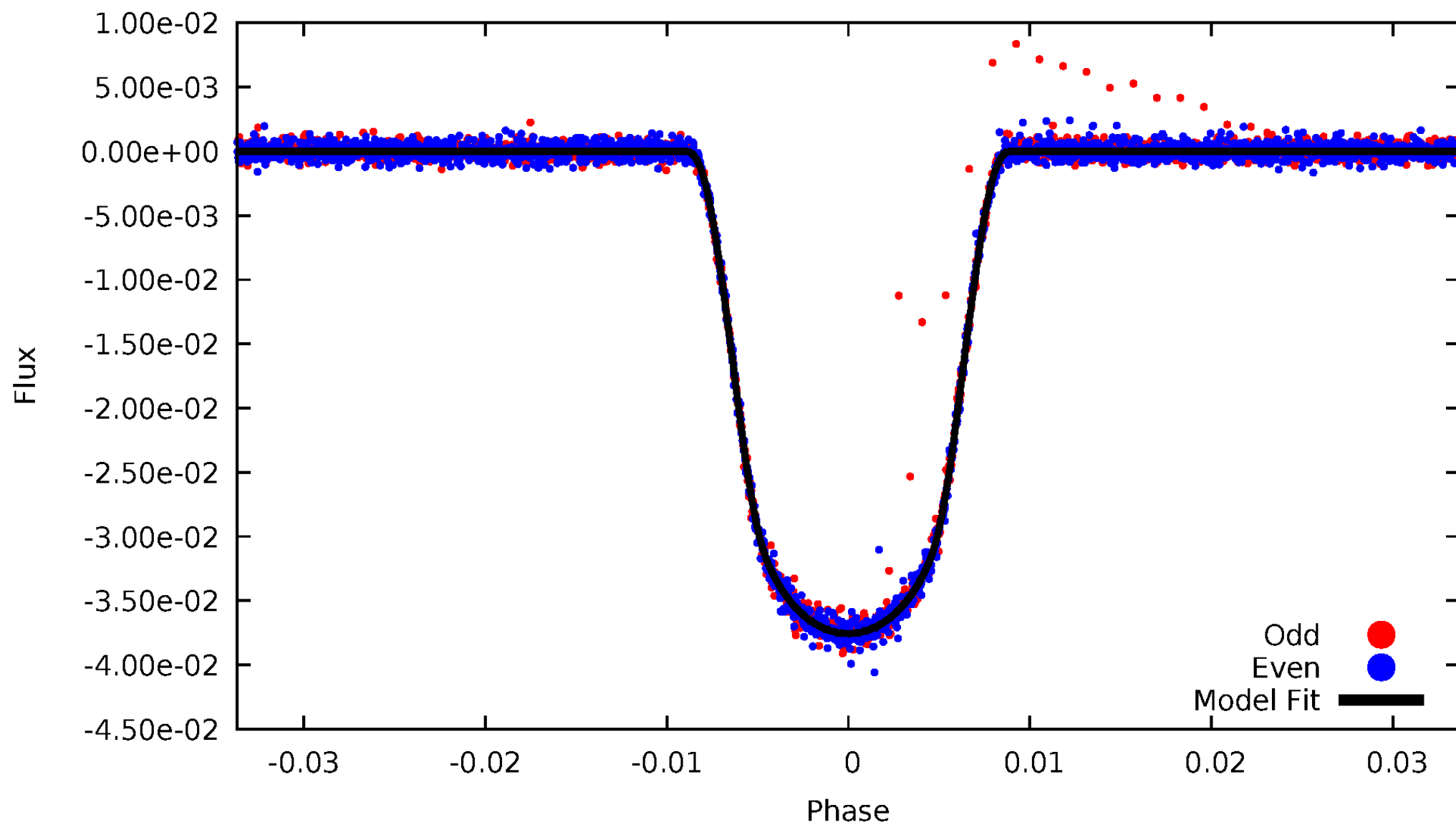


TCE 008176650-01



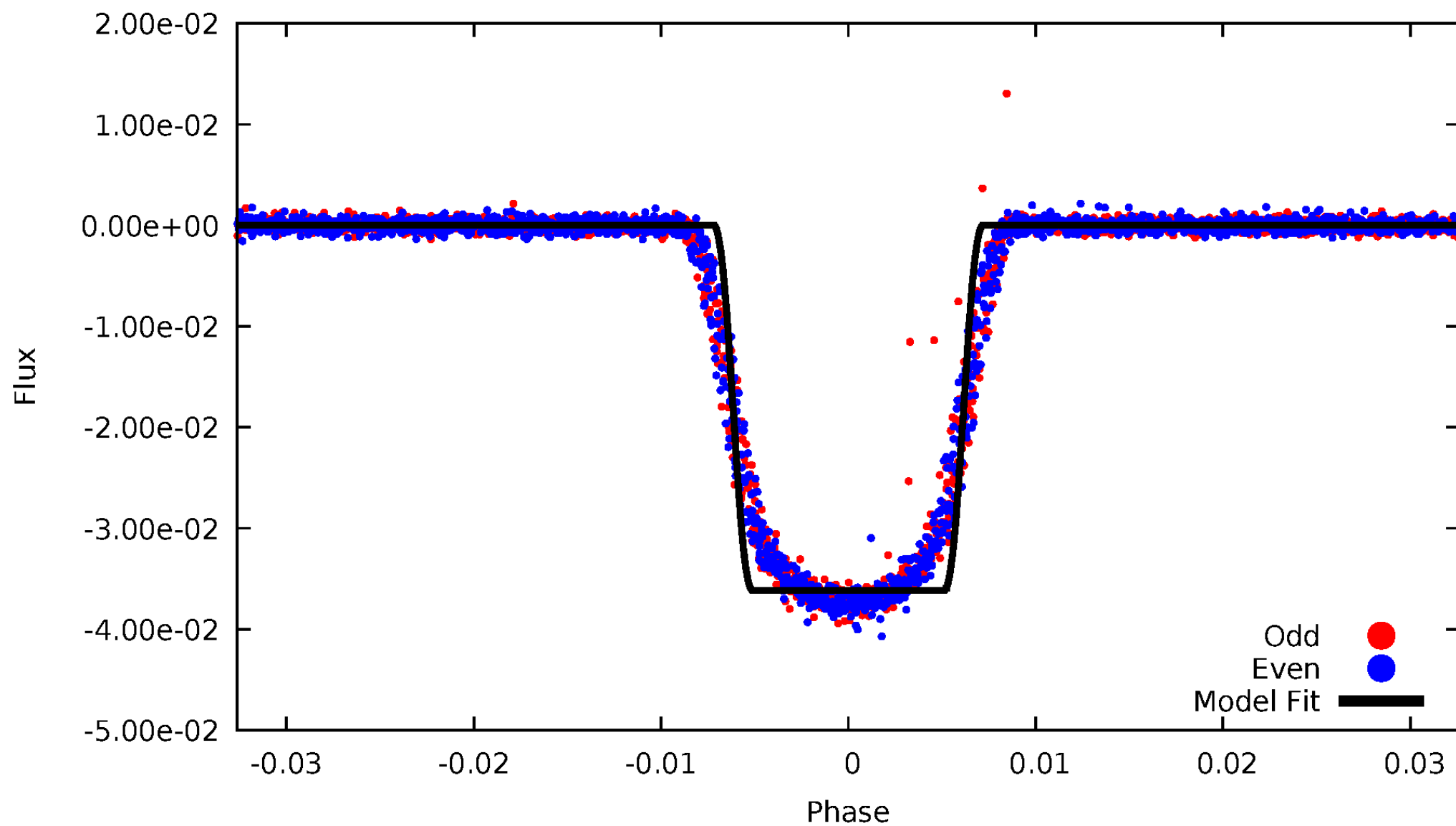
# DV Odd/Even

TCE 008176650-01



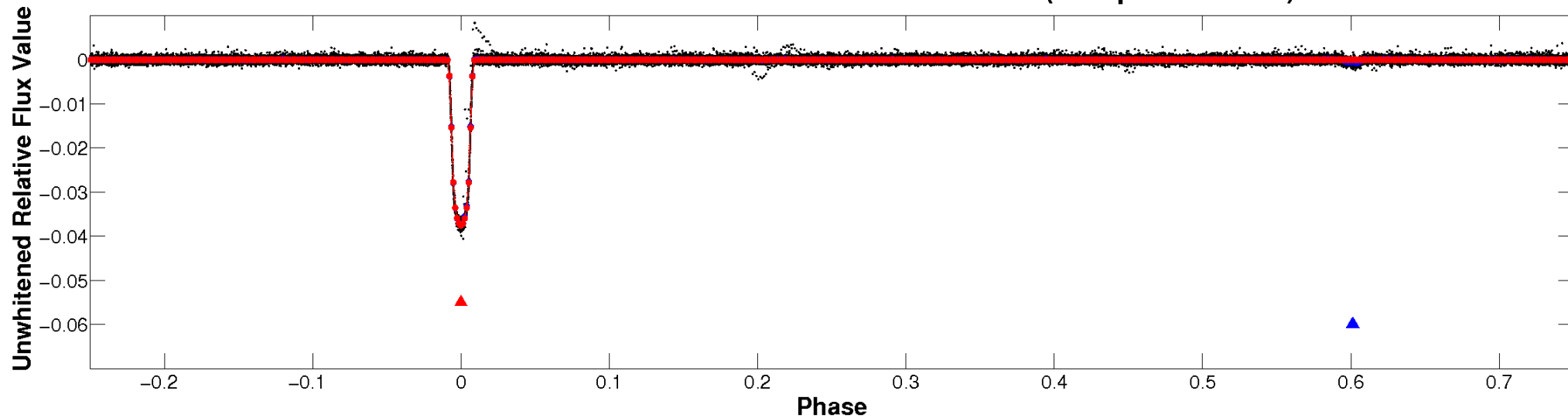
# ALT Odd/Even

TCE 008176650-01

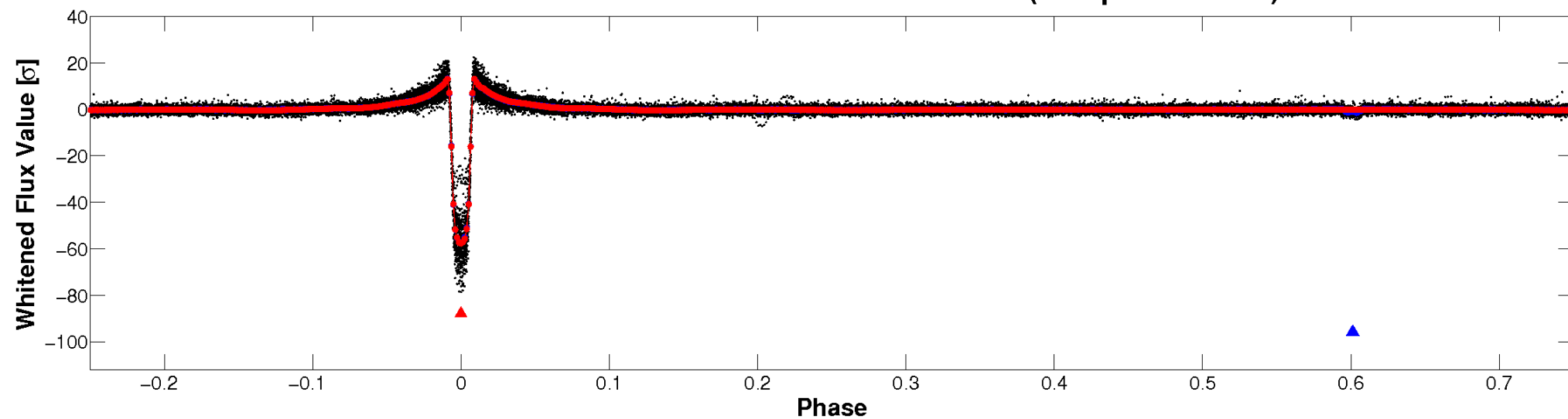


# Non-Whitened Vs. Whitened Light Curve

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

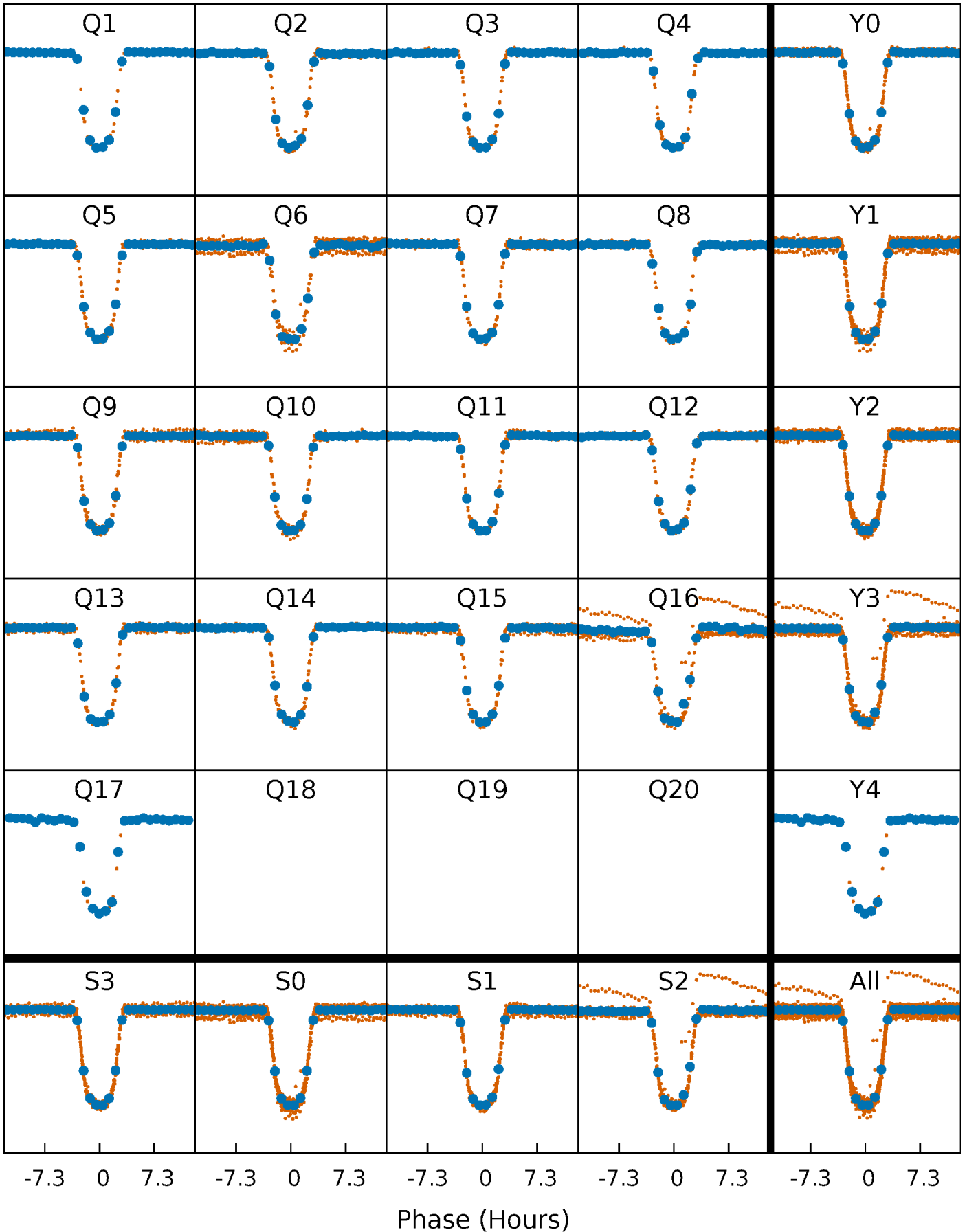


Planet 1 : Phased Whitened Flux Time Series (Fit Epoch/Period)



# PDC Quarter-Phased Transit Curves

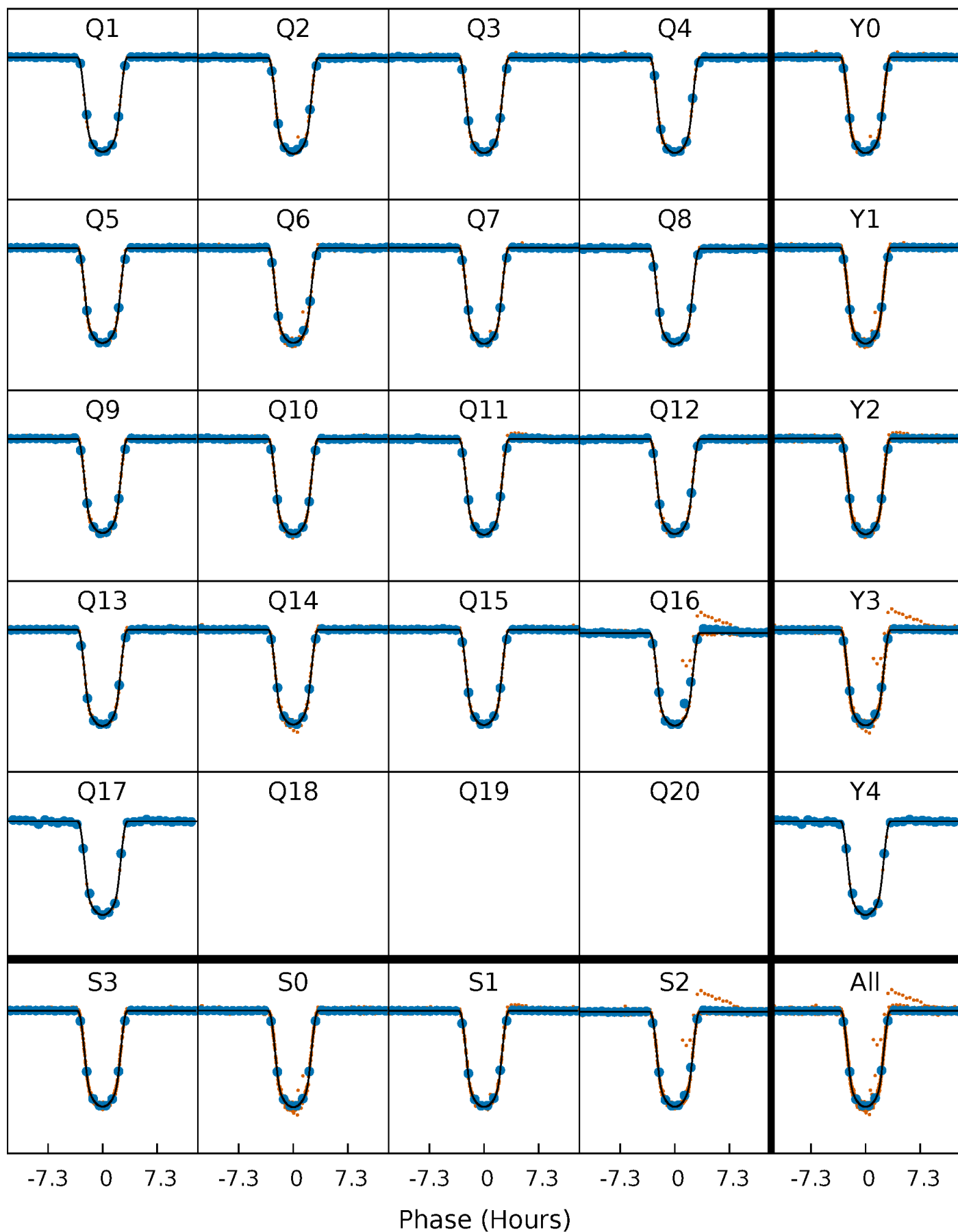
TCE 008176650-01 P= 15.801101 Days  $T_0=145.551177$  (BKJD)





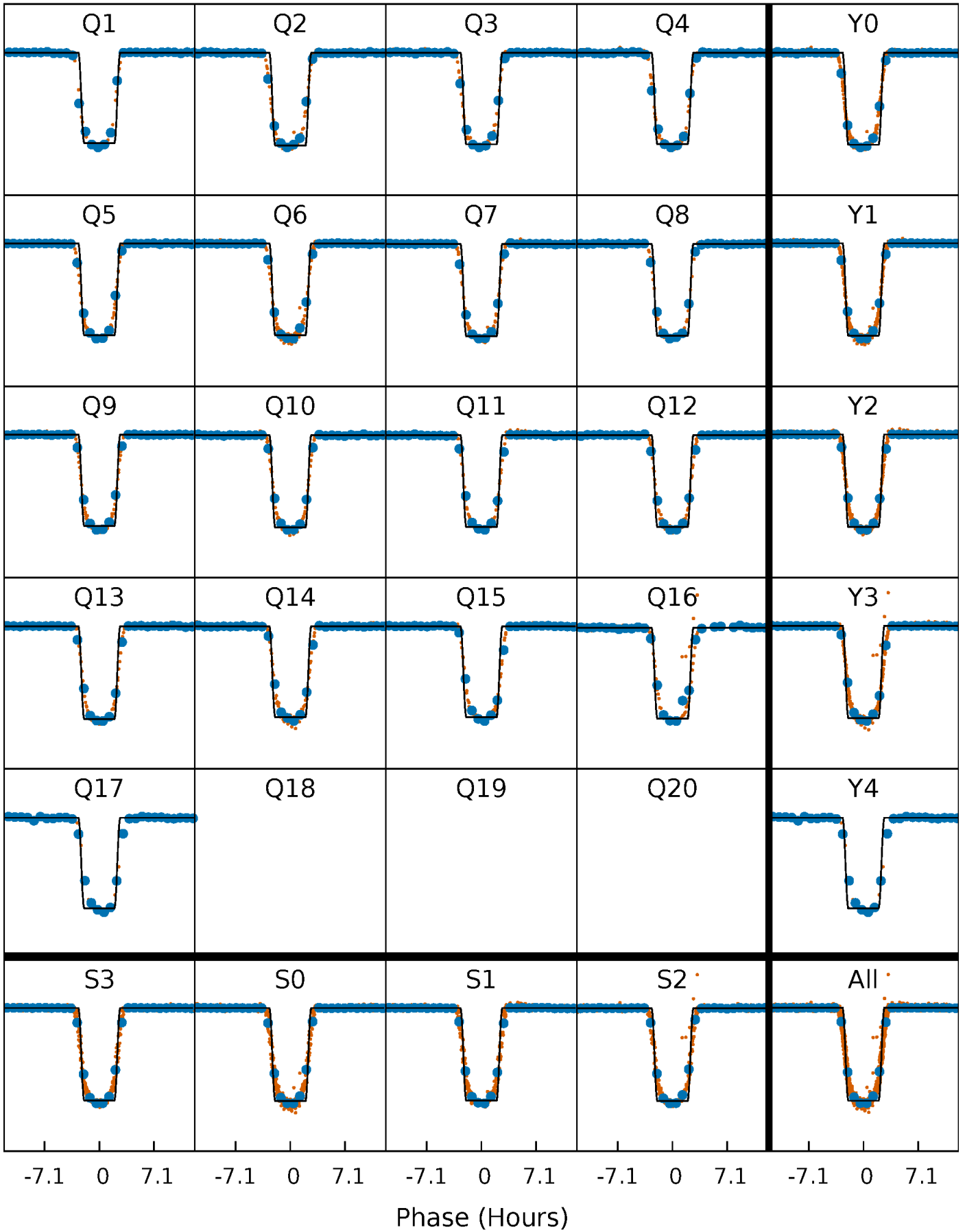
# DV Quarter-Phased Transit Curves

TCE 008176650-01 P= 15.801101 Days  $T_0=145.551177$  (BKJD)



# Alt. Detrend Quarter-Phased Transit Curves

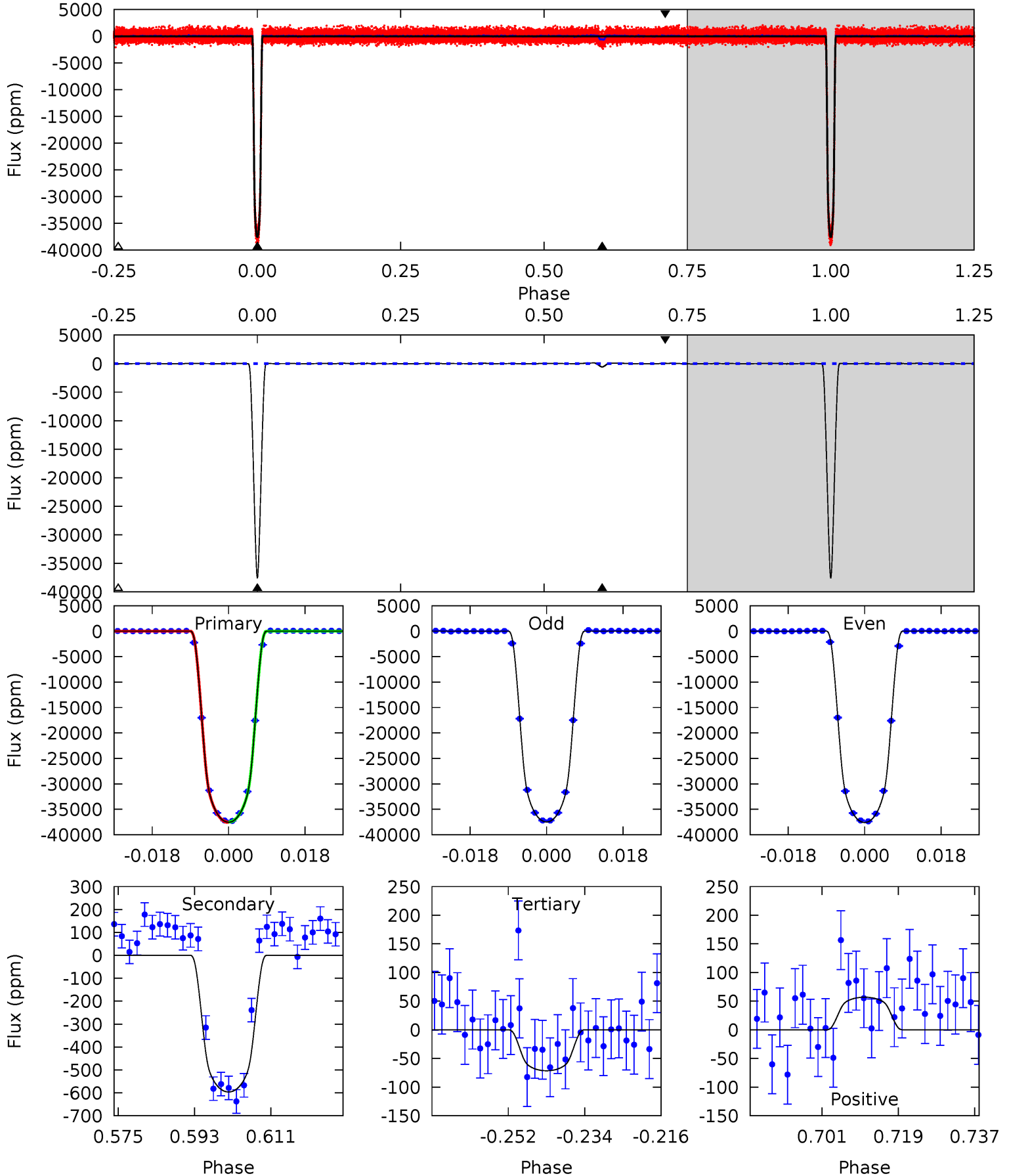
TCE 008176650-01 P= 15.800906 Days  $T_0=145.559781$  (BKJD)



# DV Model-Shift Uniqueness Test

008176650-01, P = 15.801101 Days, E = 129.750076 Days

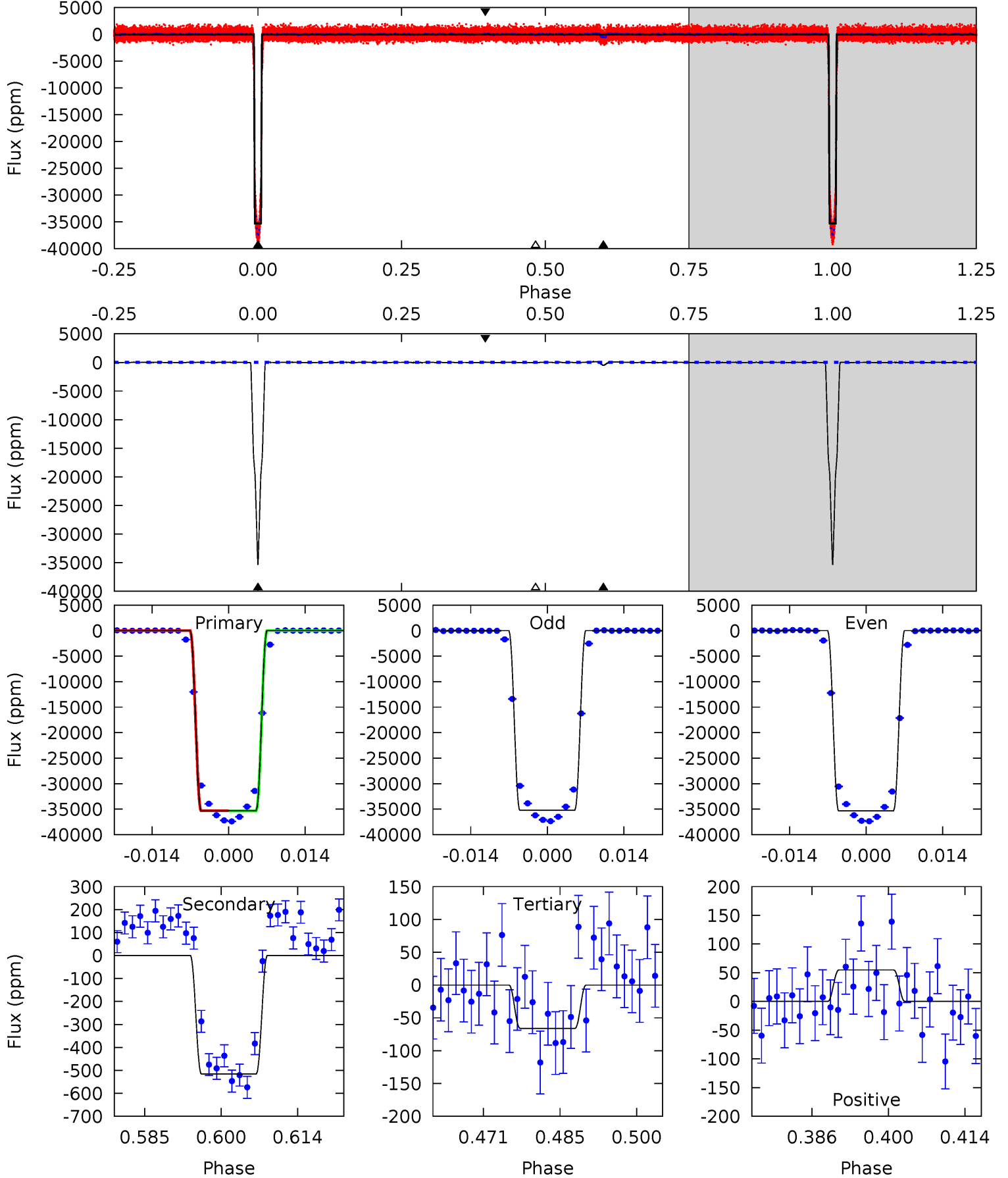
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
2579	41.0	4.91	3.91	4.91	2.37	2.03	2574	2575	36.0	37.0	3.84	0.99	0.00	1.87



# Alt Model-Shift Uniqueness Test

008176650-01, P = 15.800906 Days, E = 129.758875 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
1927	28.2	3.61	3.00	4.96	2.45	1.34	1923	1924	24.6	25.2	2.90	0.99	0.00	0.97



### Stellar Parameters For KIC 008176650

	$T_{\text{eff}} (K)$	$\log(g)$	$[\text{Fe}/\text{H}]$	$R (R_{\odot})$	$M (M_{\odot})$	$p_{\star} (\text{g}\cdot\text{cm}^{-3})$
	$5383^{+159}_{-143}$	$4.587^{+0.030}_{-0.120}$	$-0.100^{+0.300}_{-0.300}$	$0.789^{+0.143}_{-0.061}$	$0.885^{+0.070}_{-0.104}$	$2.537^{+0.406}_{-0.909}$
	+3%/-3%	+1%/-3%	+300%/-300%	+18%/-8%	+8%/-12%	+16%/-36%
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 008176650-01 / KOI 0960.01

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{\text{max}} (K)$	$T_{\text{obs}} (K)$	$A_{\text{obs}}$
DV	$-596 \pm 15$	$15.93^{+1.68}_{-0.81}$	$873^{+42}_{-33}$	$2726^{+47}_{-44}$	$18^{+2}_{-3}$
Alt.	$-516 \pm 18$	$16.68^{+1.40}_{-0.89}$	$873^{+40}_{-33}$	$2645^{+45}_{-43}$	$14^{+1}_{-2}$

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

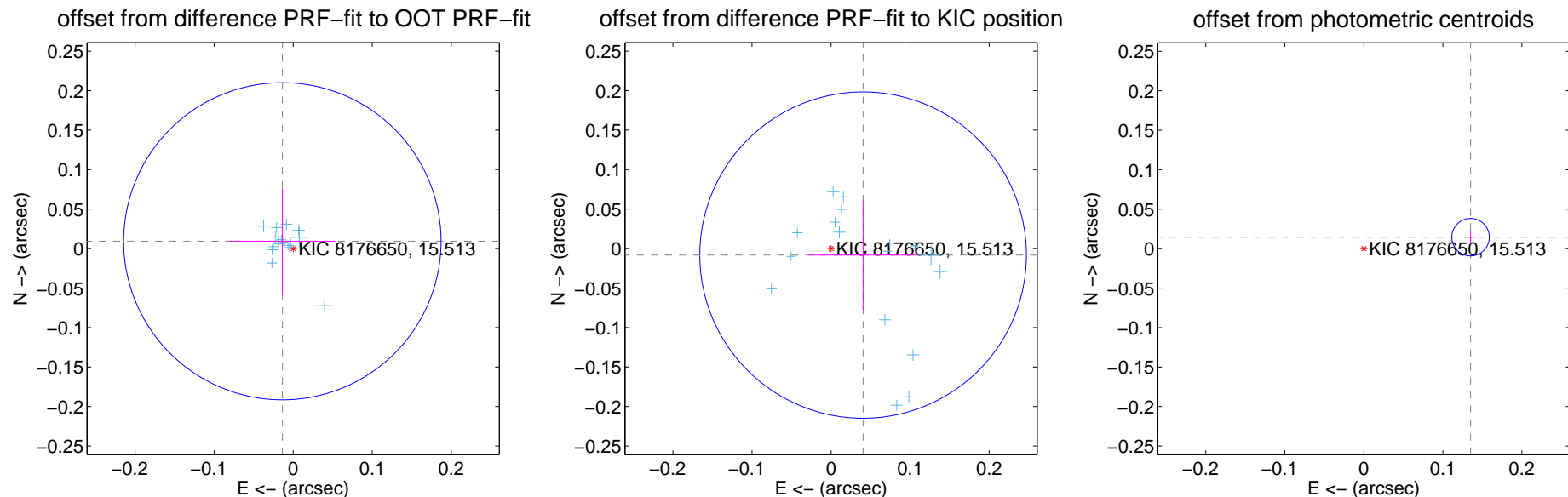
## DV Centroid Data

Supplemental centroid analysis for 008176650-01. Kepler magnitude: 15.51. Transit SNR 1426.75

There are 17 quarters with good PRF difference image offsets

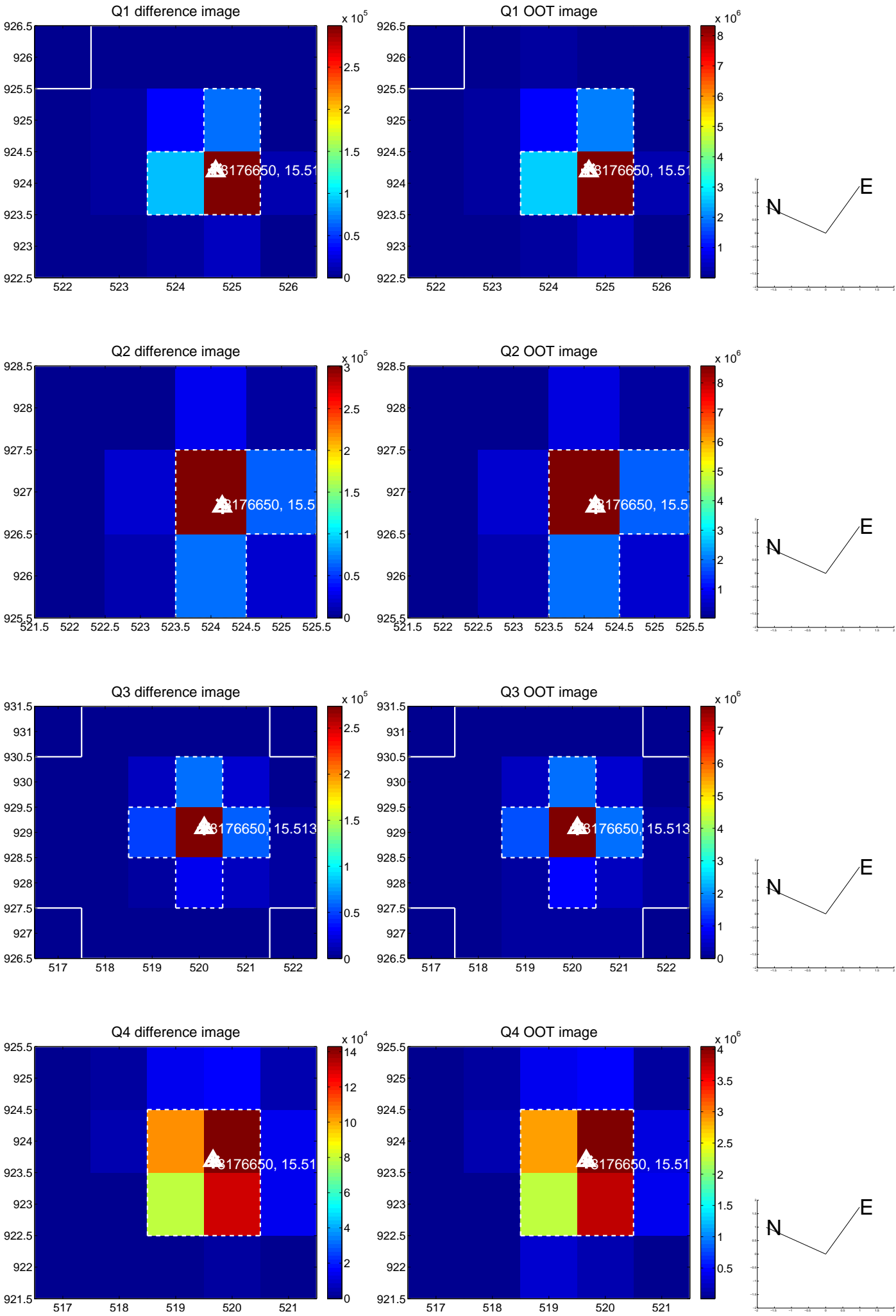
The direct PRF centroid is offset from the target star catalog position by about 0.12 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.017 \pm 0.067$	0.25	$0.014 \pm 0.067$	$0.009 \pm 0.067$
PRF-fit source offset from KIC position	$0.041 \pm 0.069$	0.60	$-0.041 \pm 0.069$	$-0.008 \pm 0.069$
photometric centroid source offset	$0.14 \pm 0.01$	17.18	$-0.14 \pm 0.01$	$0.01 \pm 0.01$

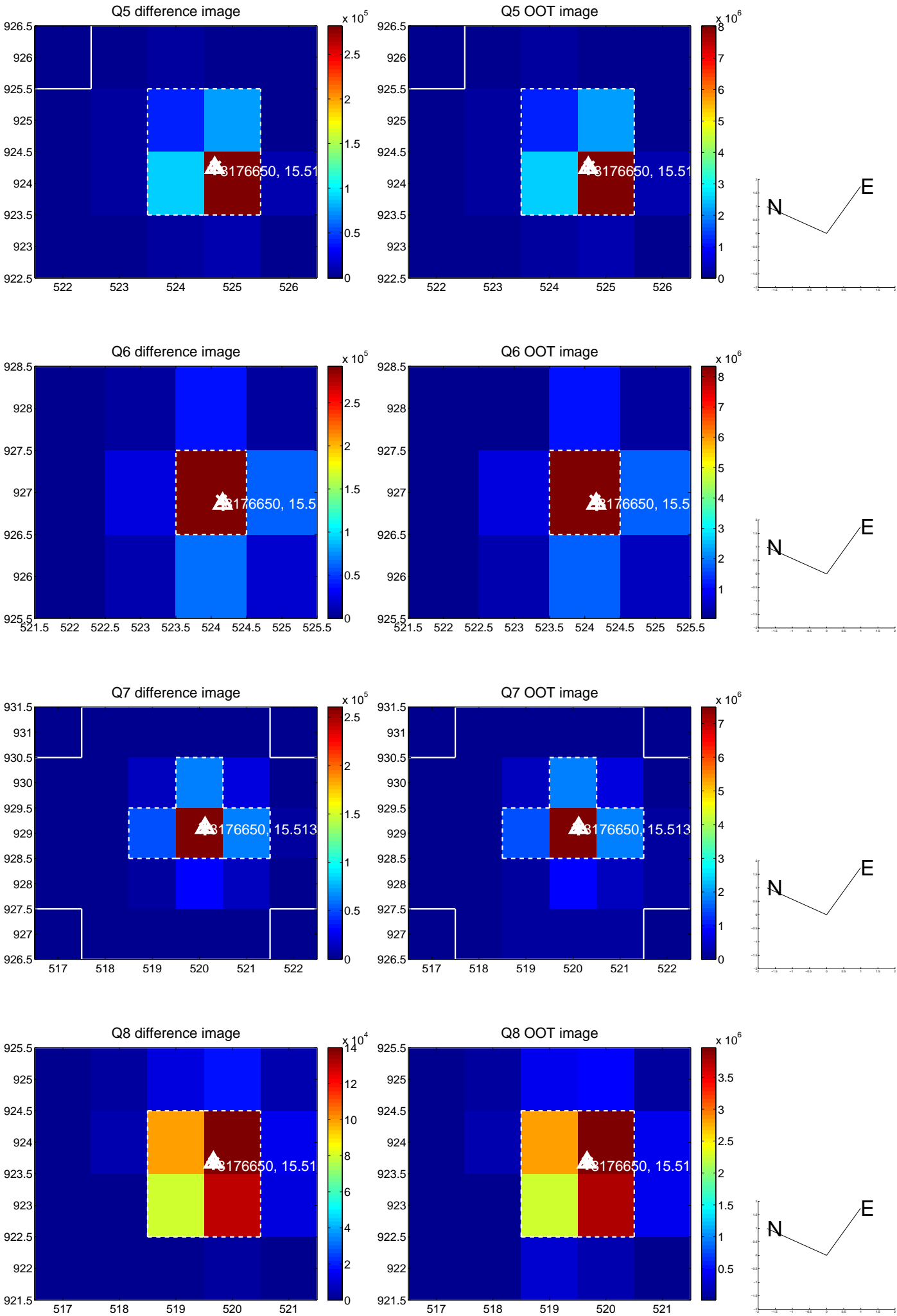


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses: good quarterly centroid offsets**; **Vermillion crosses: bad quarterly centroid offsets**; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: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

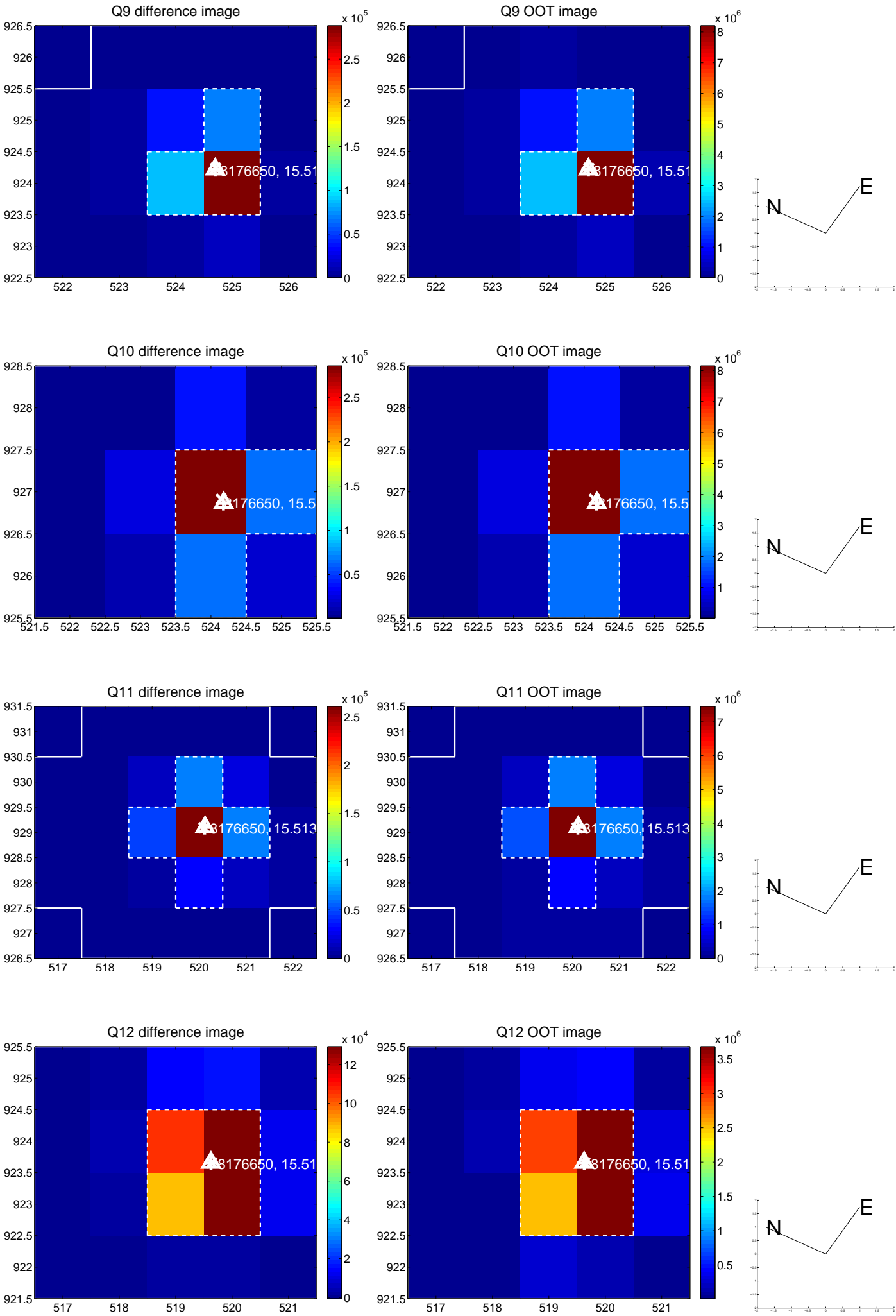


white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.

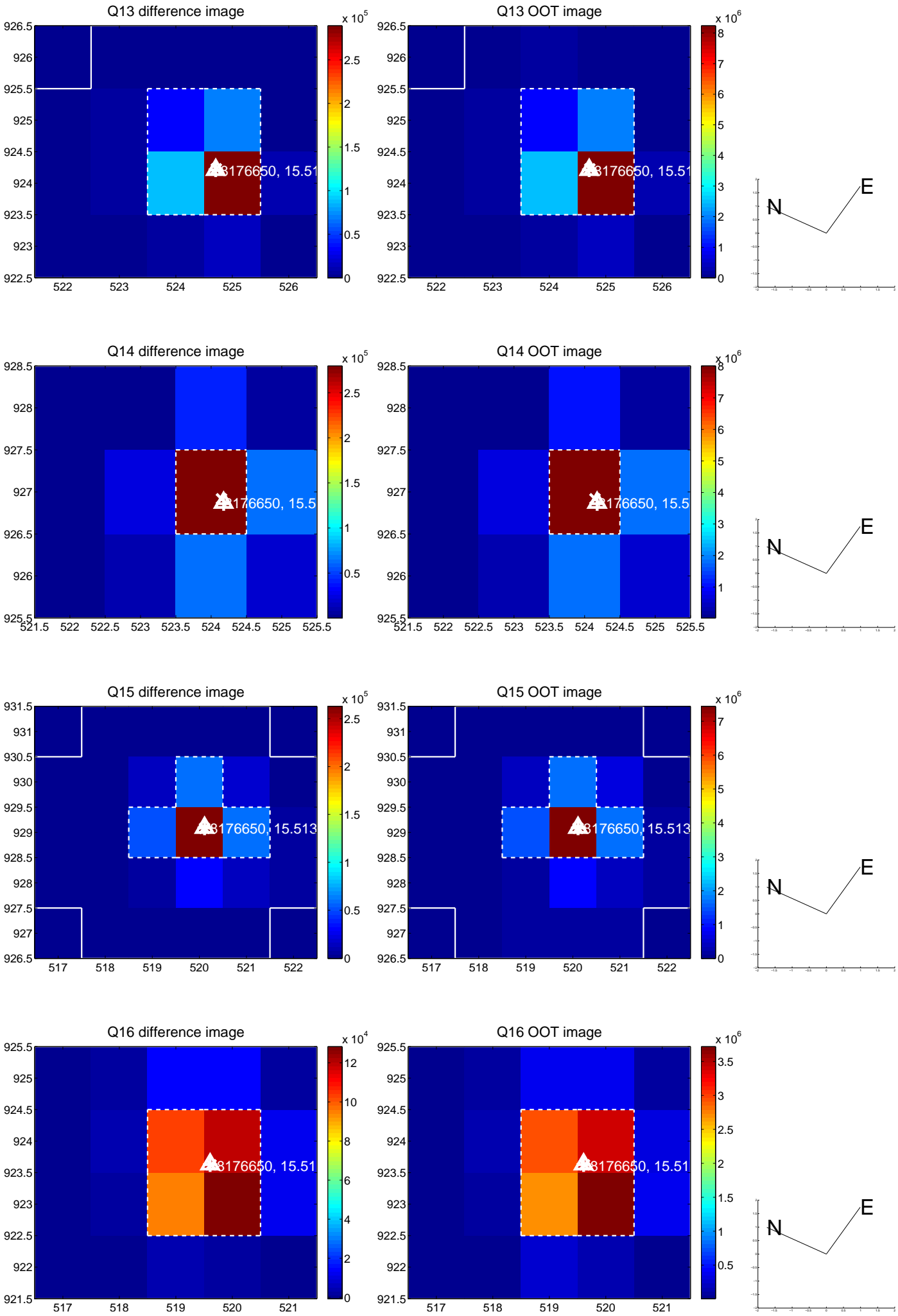




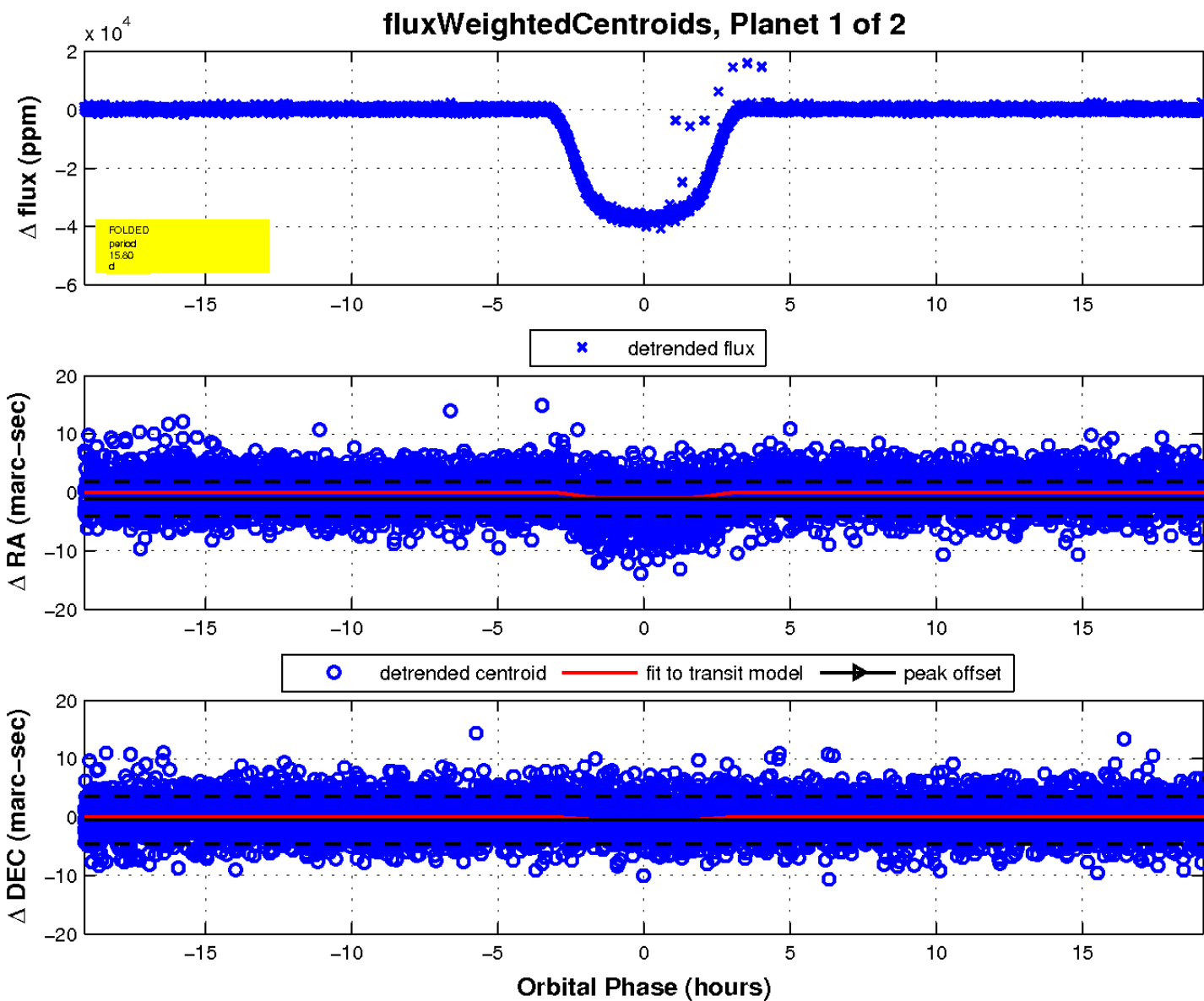
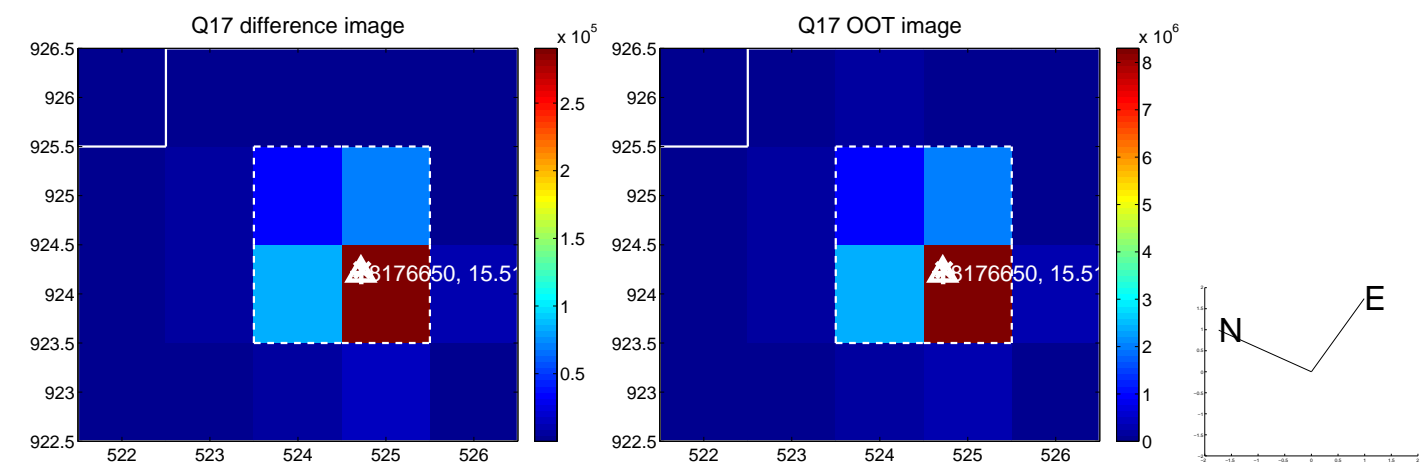
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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

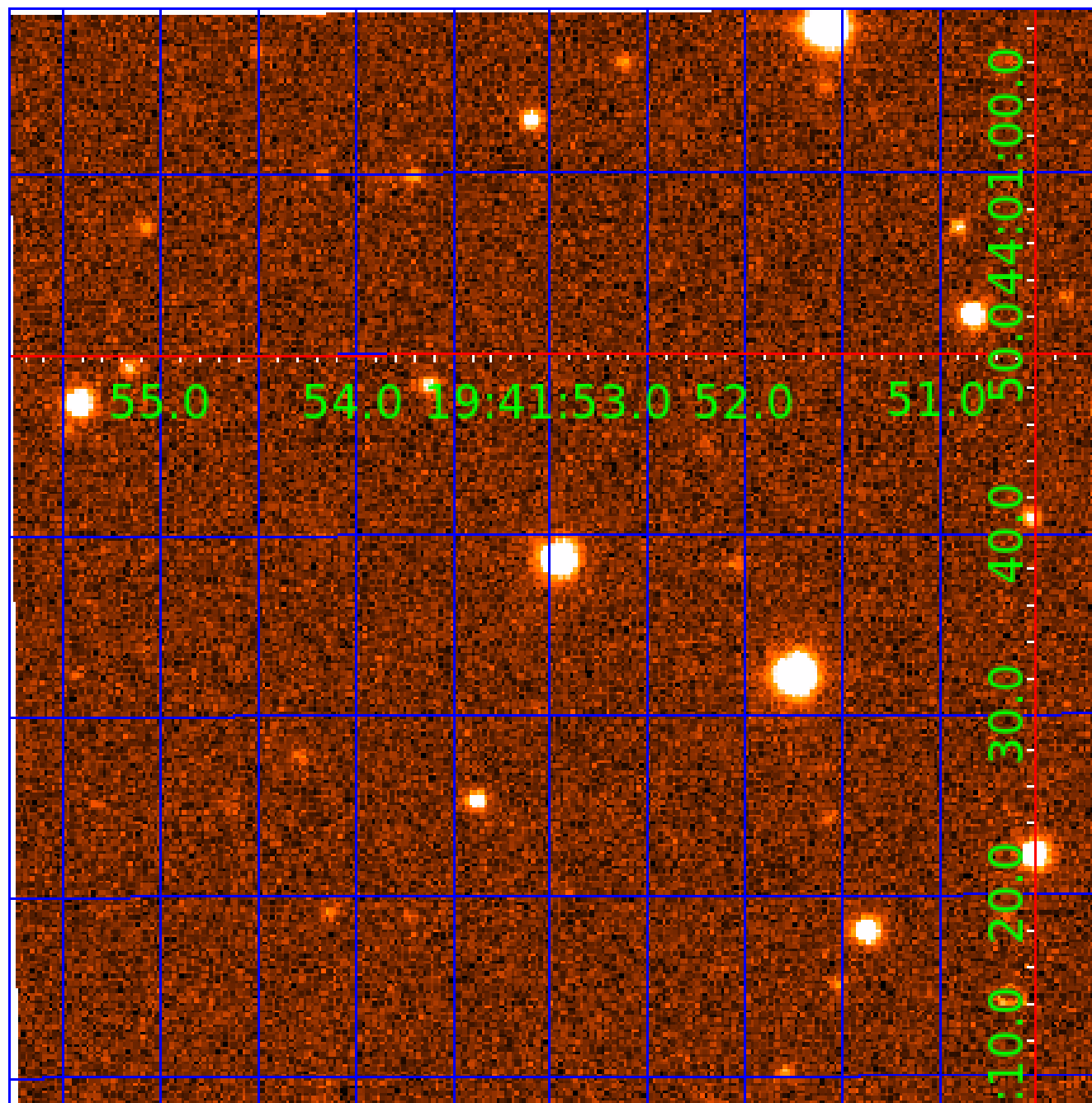


white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



UKIRT Image

Declination



# KIC 008176650

## 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)	$R_p$ ( $R_{\oplus}$ )	$S_p$ ( $S_{\oplus}$ )
008176650-01	OBS	0960.01	15.801101	145.551177	37556.2	6.385	1526.5	1426.8	0.79	5383	15.66	33.63
008176650-02	OBS	No	15.801172	139.247515	744.4	4.843	28.3	29.4	0.79	5383	2.51	33.63

## Robovetter Results

TCE	Run Type	Disp	Score	N	S	C	E	Comments
008176650-01	OBS	FP	0.00	0	1	0	0	MOD_SEC_DV—MOD_SEC_ALT—HAS_SEC_TCE
008176650-02	OBS	FP	0.00	1	1	0	0	IS_SEC_TCE

**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.

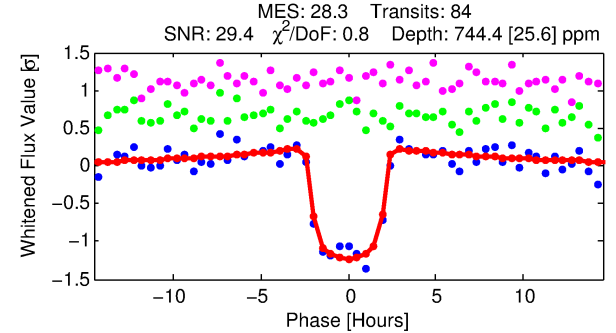
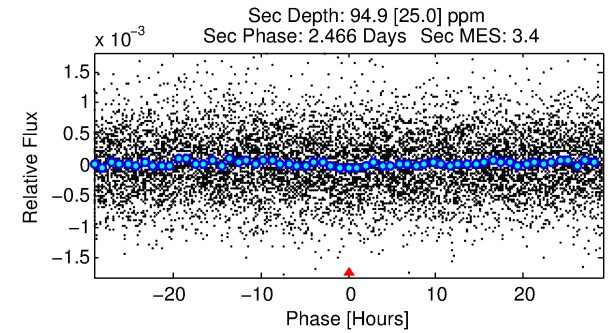
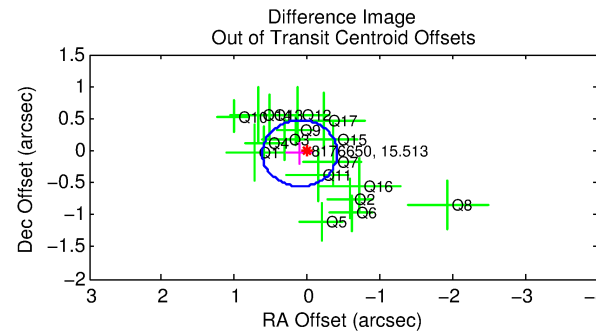
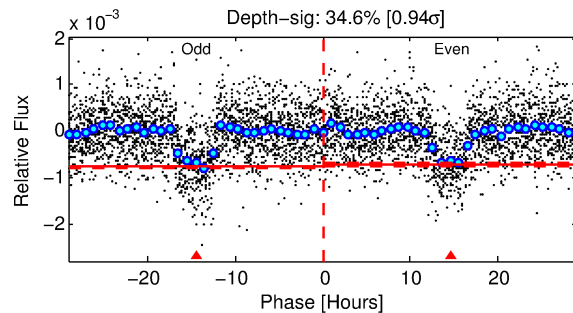
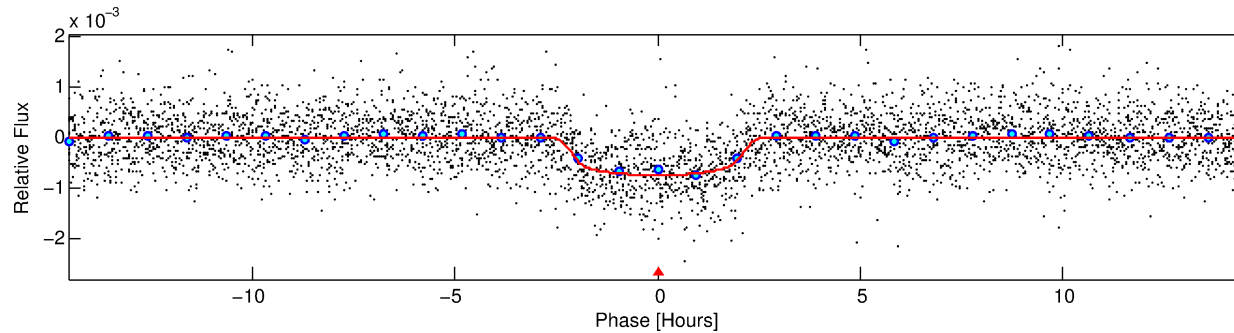
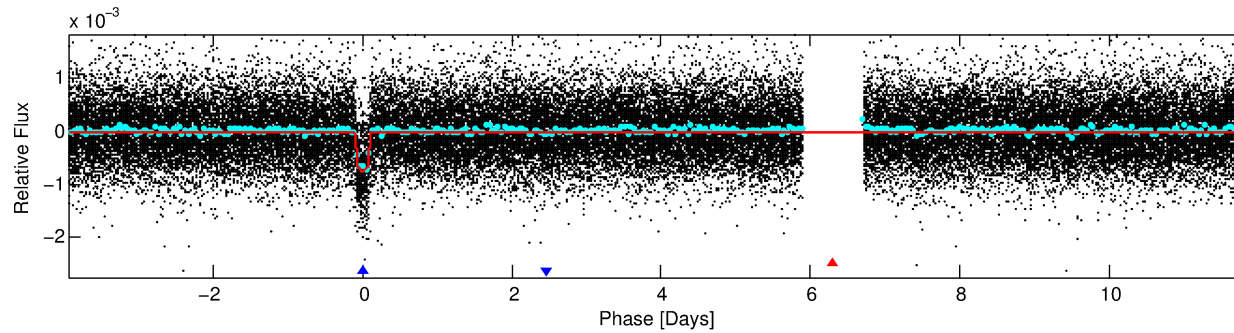
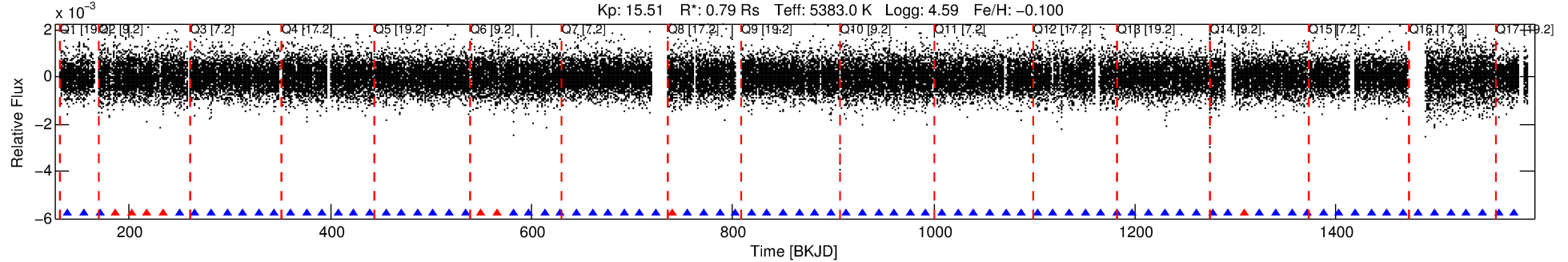
## Ephemeris Match Information For 008176650-02

No Significant Match Found

# DV One-Page Summary

KIC: 8176650 Candidate: 2 of 2 Period: 15.801 d  
KOI: K00960 Corr: No Ephemeris Match

Kp: 15.51 R\*: 0.79 Rs Teff: 5383.0 K Logg: 4.59 Fe/H: -0.100



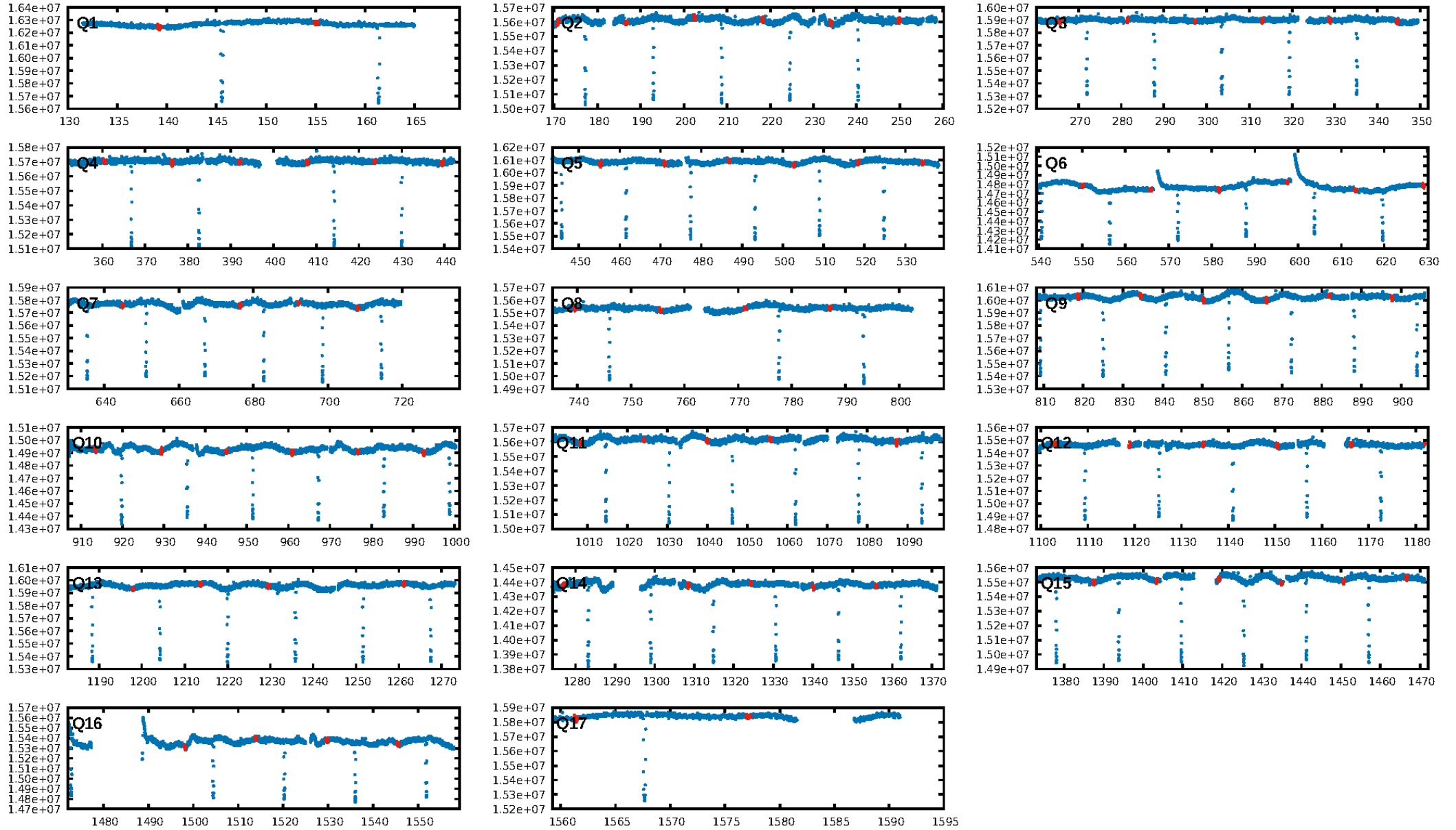
## DV Fit Results:

Period = 15.80117 [0.00006] d  
Epoch = 139.2475 [0.0030] BKJD  
Rp/R\* = 0.0291 [0.0024]  
a/R\* = 13.83 [4.55]  
b = 0.87 [0.10]  
Seff = 33.63 [8.41]  
Teq = 614 [38] K  
Rp = 2.51 [0.50] Re  
a = 0.1180 [0.0179] AU  
Ag = 115.43 [44.07] [2.60σ]  
Teffp = 3112 [259] K [9.52σ]

## DV Diagnostic Results:

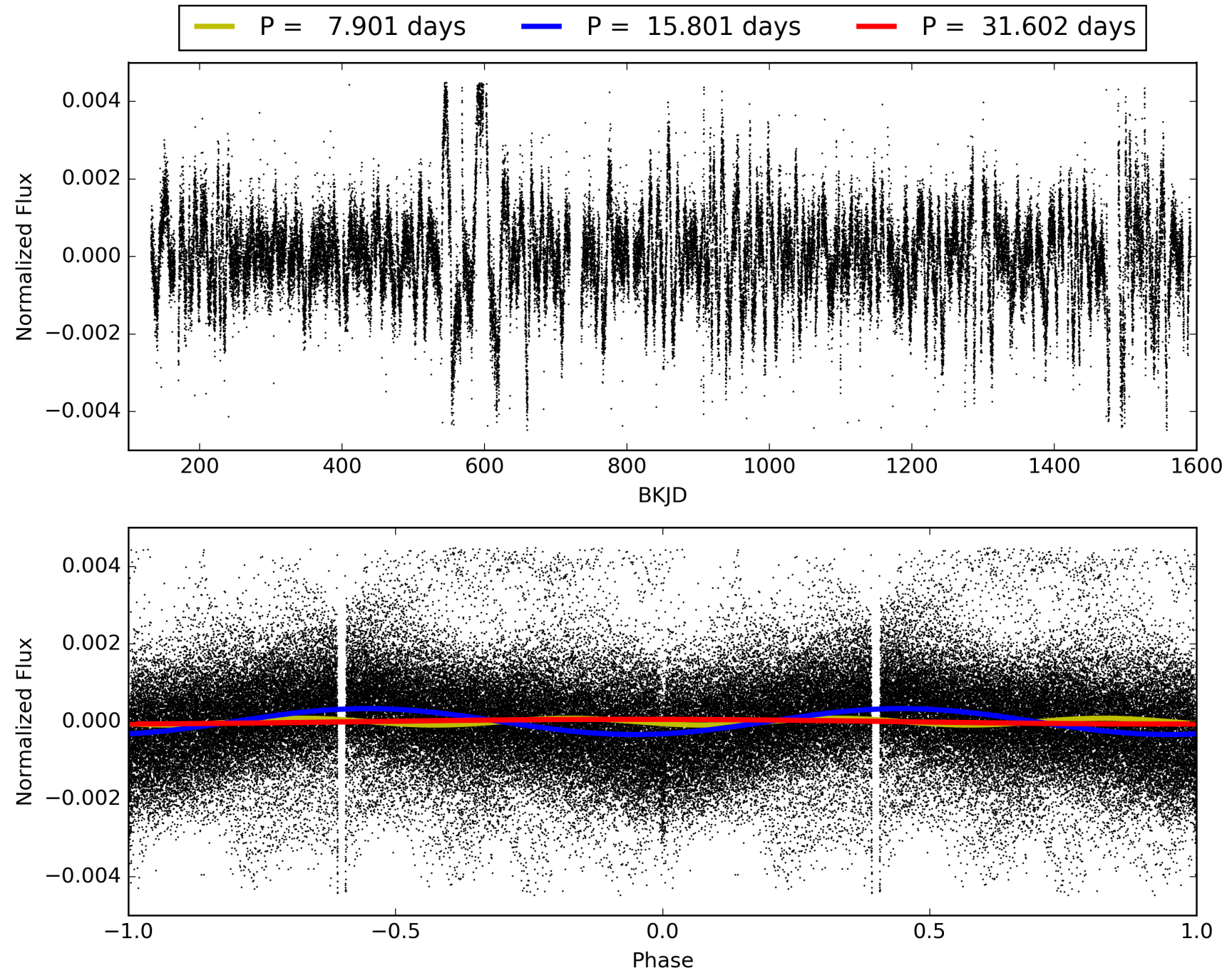
ShortPeriod-sig: 0.0% [0.00σ]  
LongPeriod-sig: N/A  
ModelChiSquare2-sig: 99.7%  
ModelChiSquareGof-sig: 100.0%  
Bootstrap-pfa: 3.73e-169  
RollingBand-fgt: 0.90 [72/80]  
GhostDiagnostic-chr: 2.507  
Centroid-sig: 0.9%  
Centroid-so: 0.727 arcsec [1.60σ]  
OotOffset-rm: 0.111 arcsec [0.65σ]  
KicOffset-rm: 0.052 arcsec [0.30σ]  
OotOffset-st: 4/4/4/5 [17]  
KicOffset-st: 4/4/4/5 [17]  
DiffImageQuality-fgm: 1.00 [17/17]  
DiffImageOverlap-fno: 1.00 [17/17]

# TCE 008176650-02, PDC Light Curves





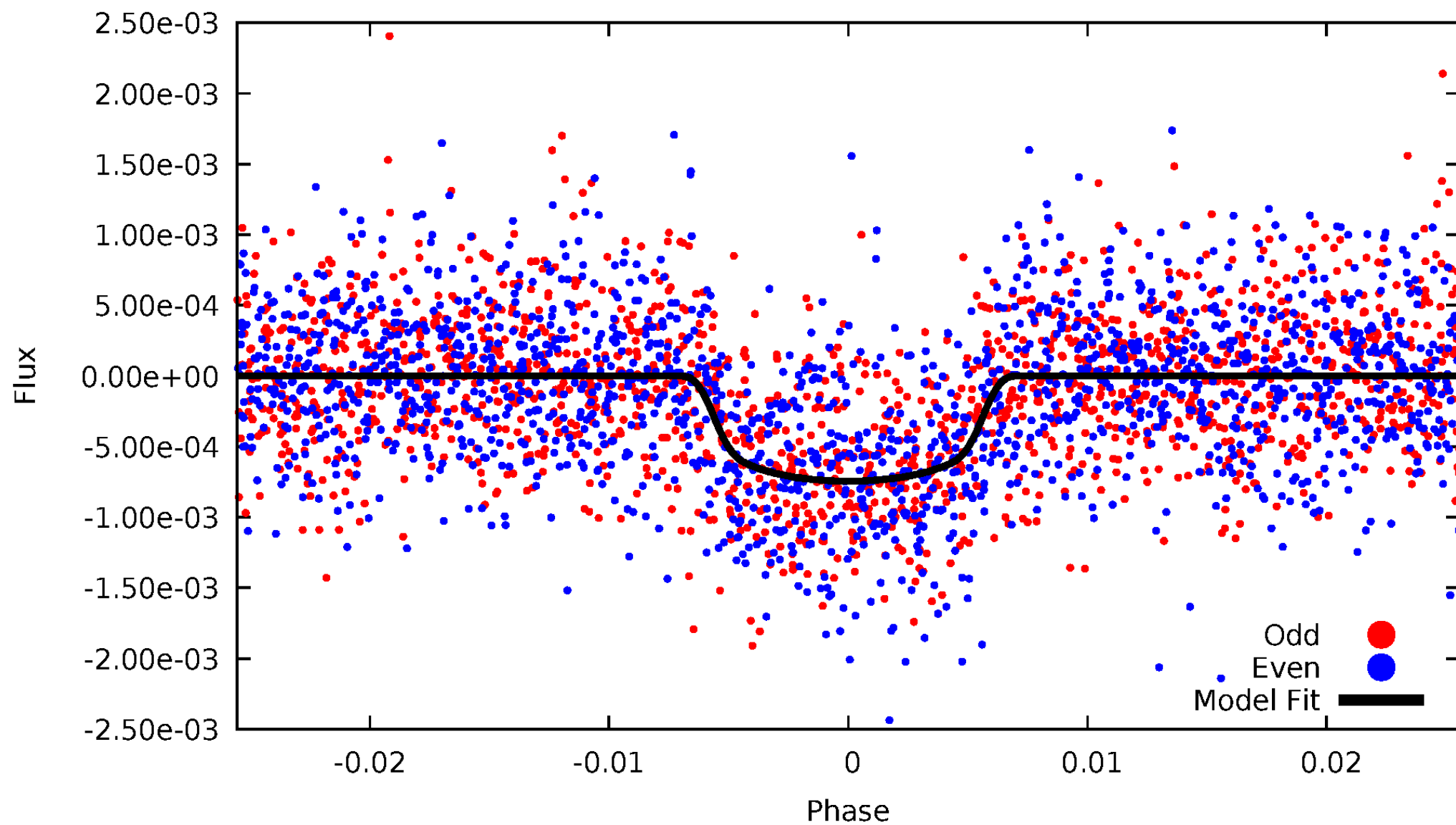
TCE 008176650-02





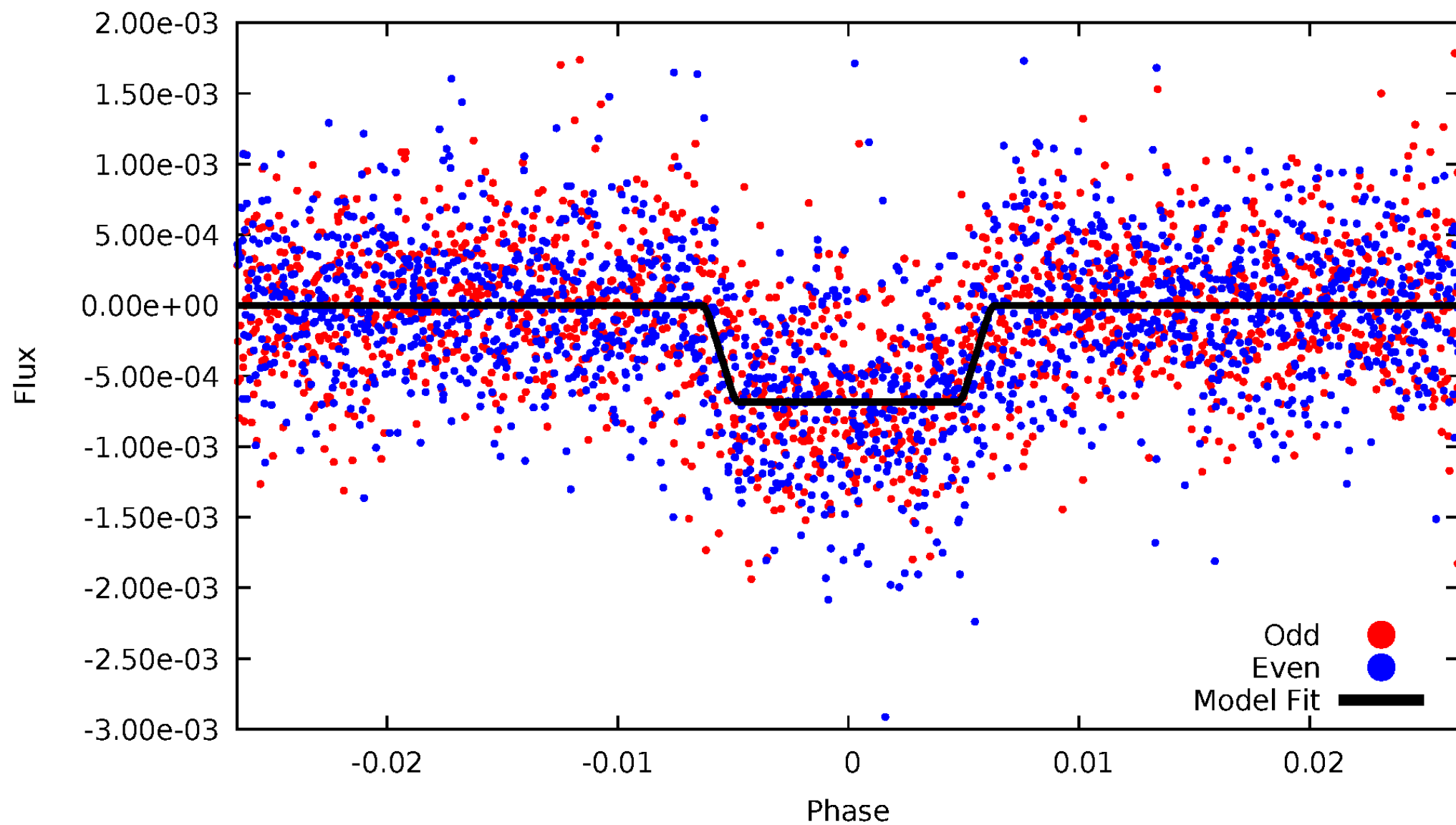
# DV Odd/Even

TCE 008176650-02



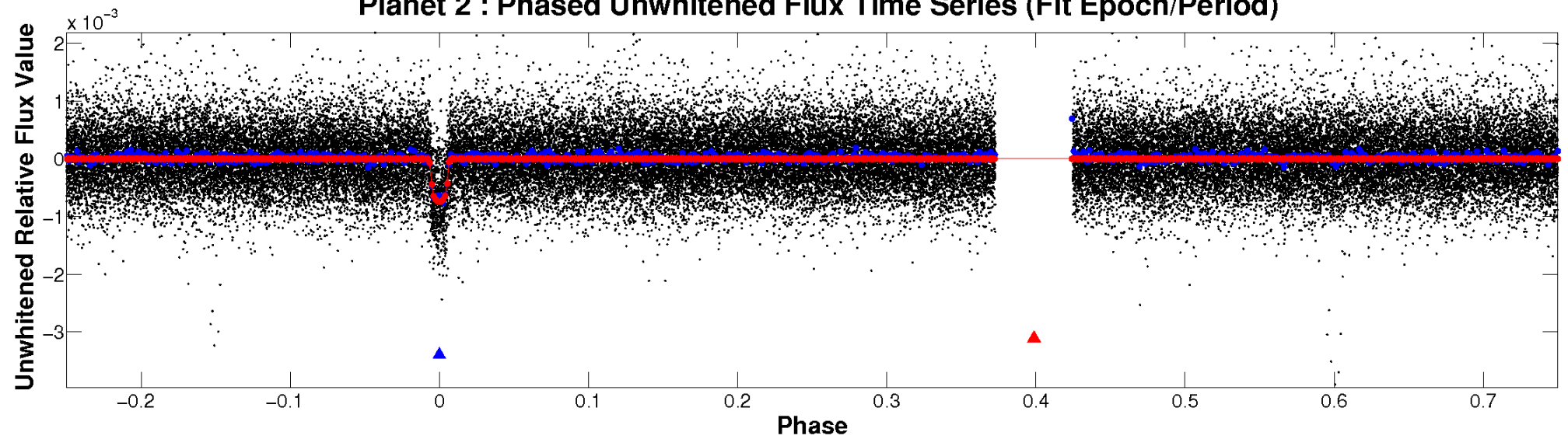
# ALT Odd/Even

TCE 008176650-02

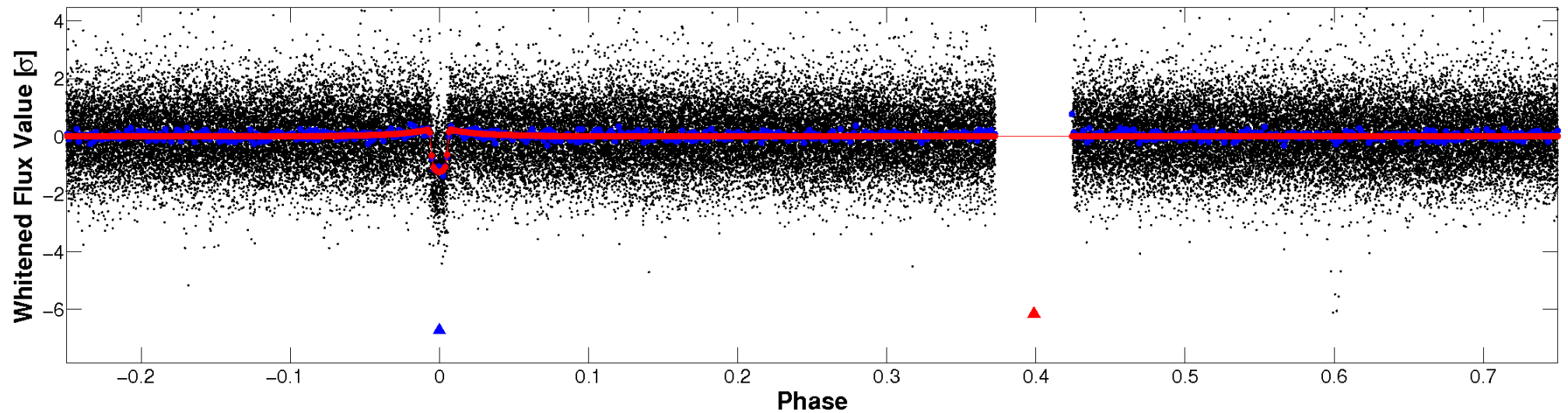


# Non-Whitened Vs. Whitened Light Curve

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

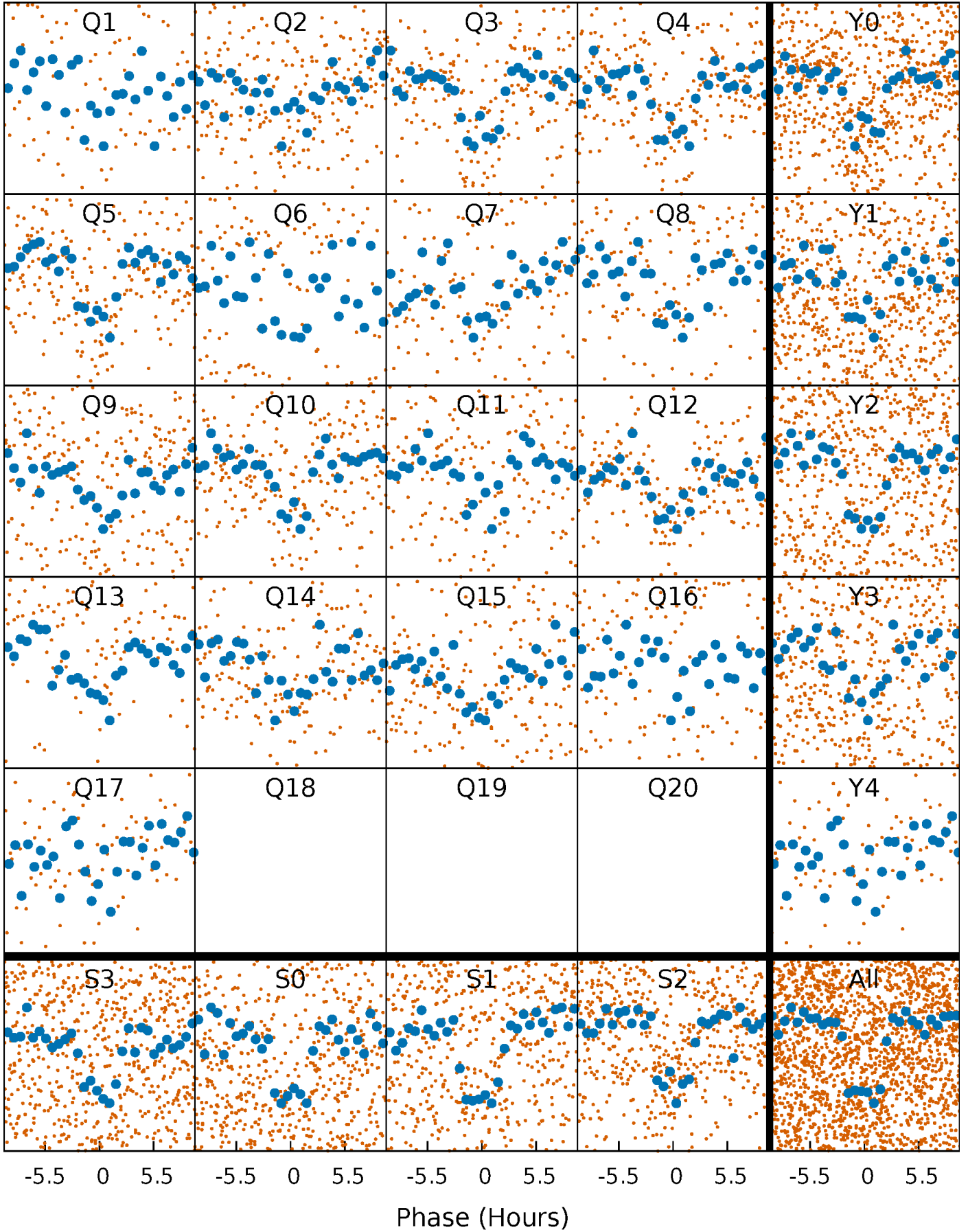


**Planet 2 : Phased Whitened Flux Time Series (Fit Epoch/Period)**



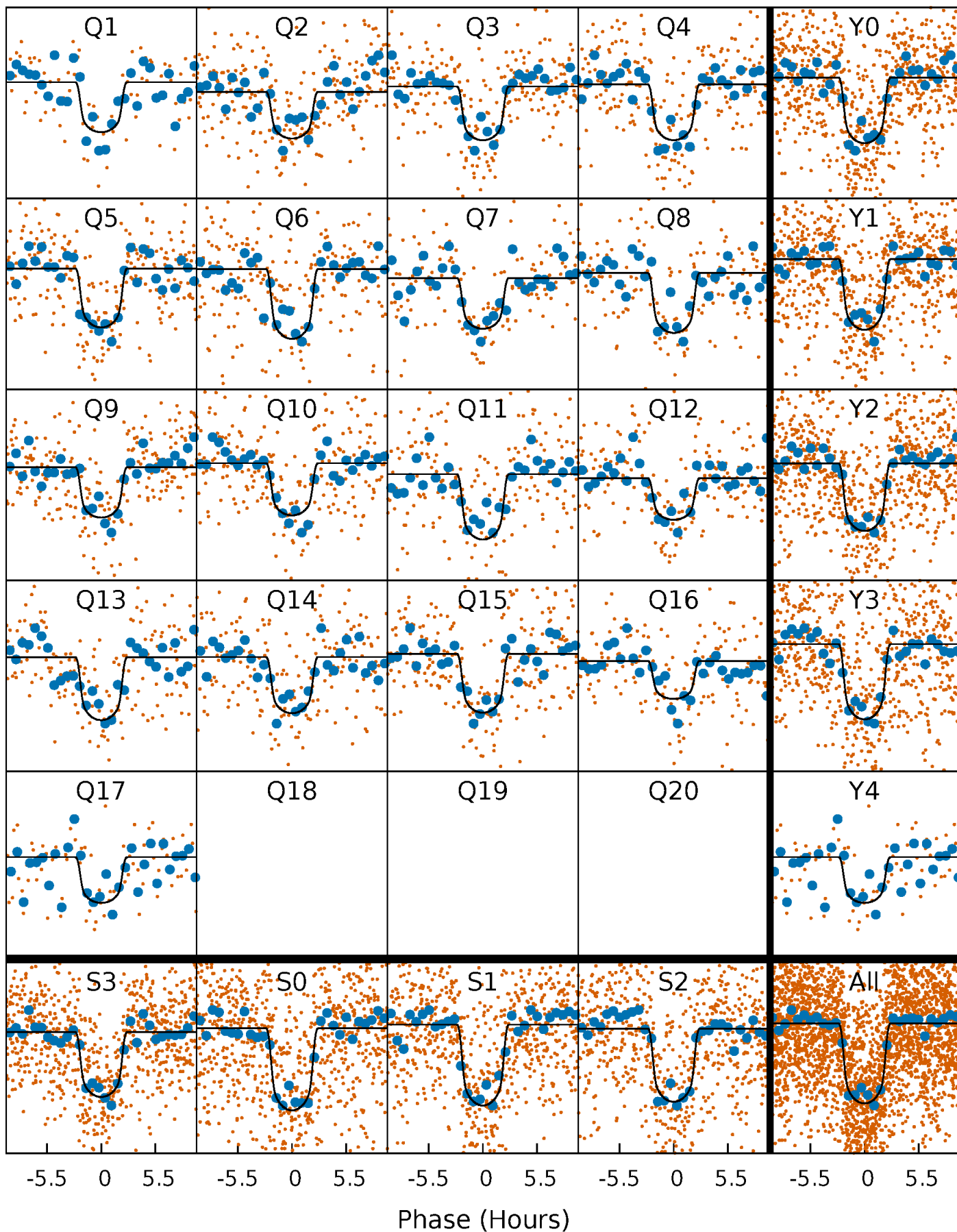
# PDC Quarter-Phased Transit Curves

TCE 008176650-02 P= 15.801172 Days  $T_0=139.247515$  (BKJD)



# DV Quarter-Phased Transit Curves

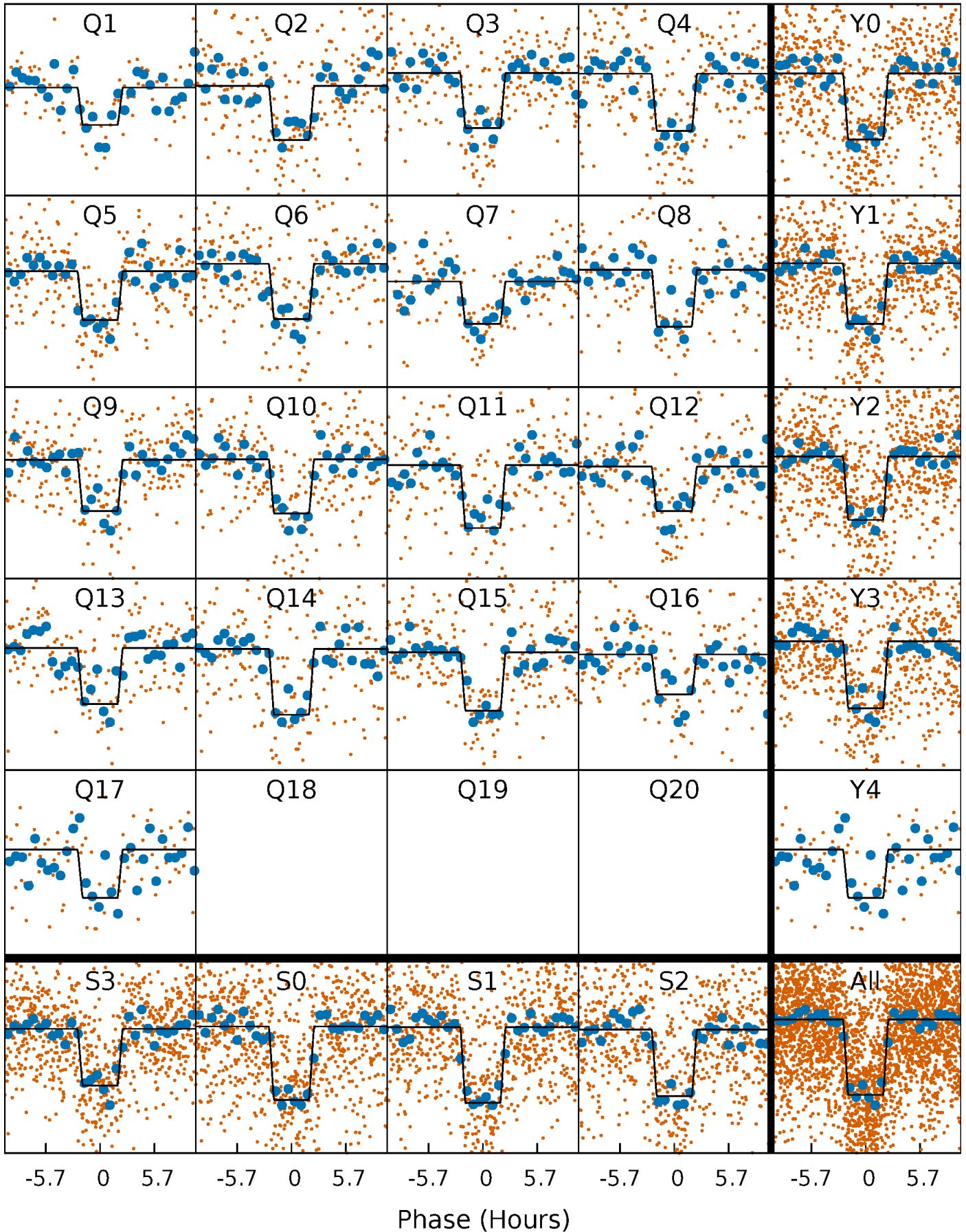
TCE 008176650-02 P= 15.801172 Days  $T_0=139.247515$  (BKJD)





# Alt. Detrend Quarter-Phased Transit Curves

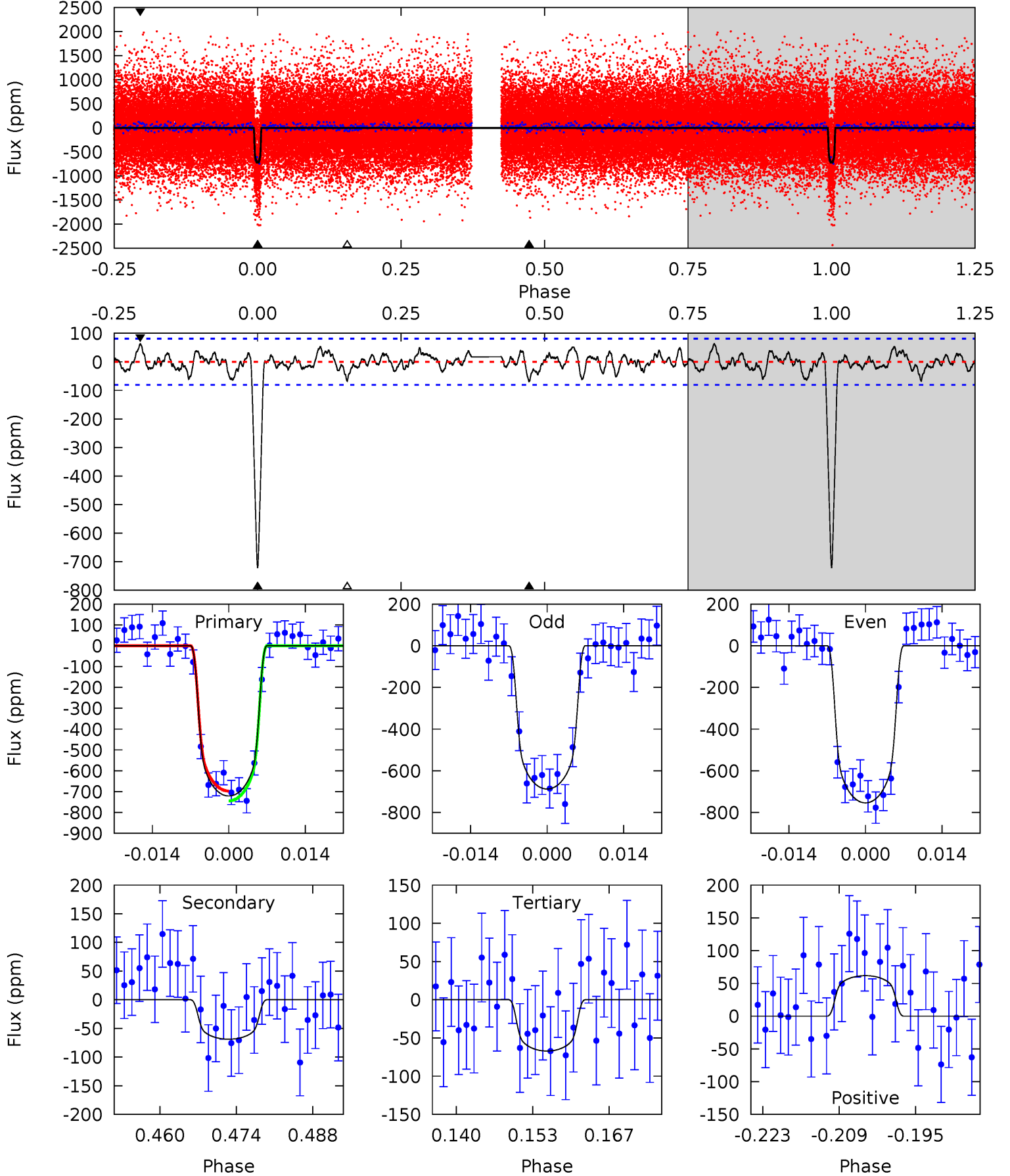
TCE 008176650-02 P= 15.801057 Days  $T_0=139.252403$  (BKJD)



# DV Model-Shift Uniqueness Test

008176650-02,  $P = 15.801172$  Days,  $E = 123.446343$  Days

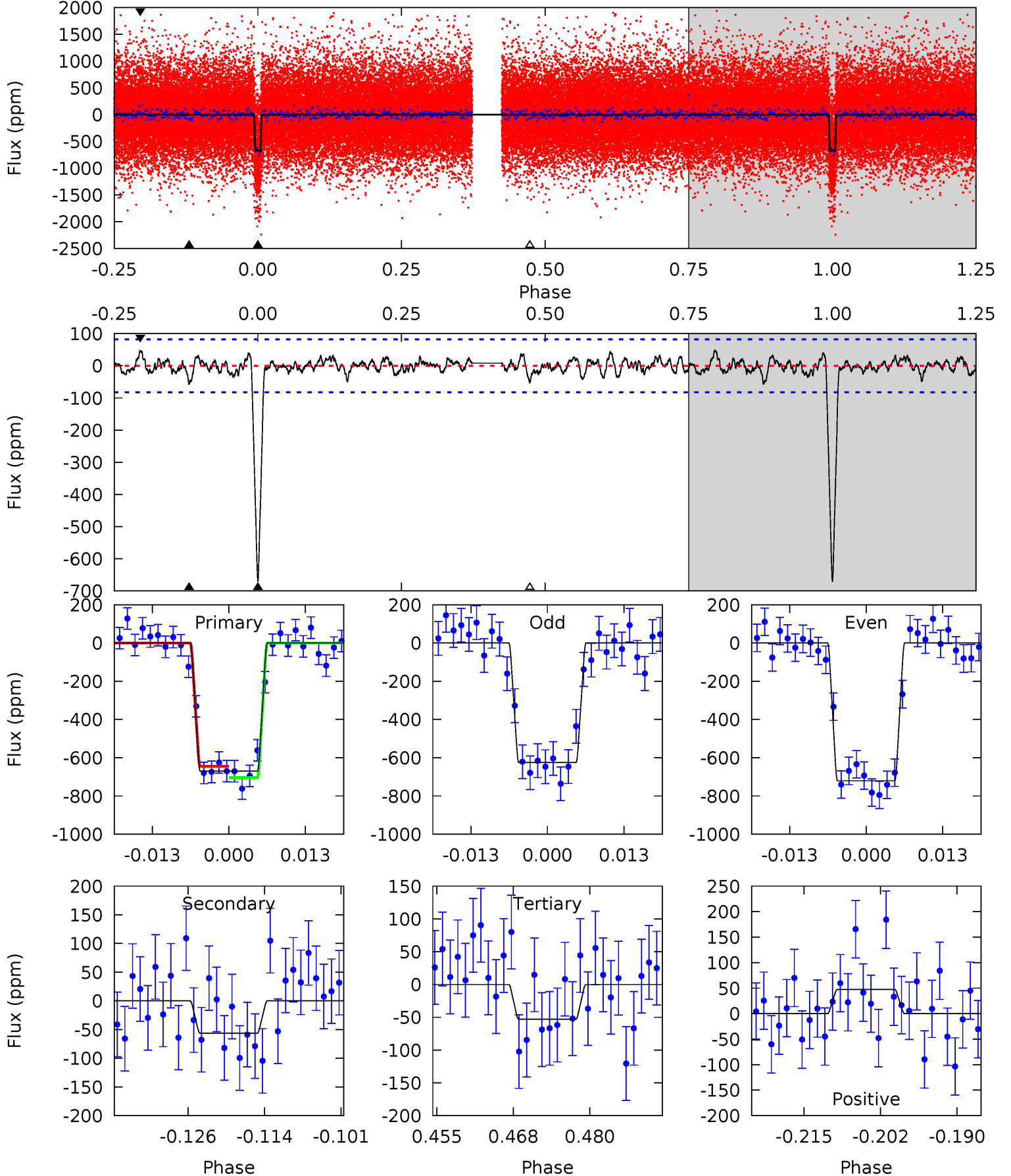
Pri	Sec	Ter	Pos	FA <sub>1</sub>	FA <sub>2</sub>	F <sub>Red</sub>	Pri-Ter	Pri-Pos	Sec-Ter	Sec-Pos	Odd-Evn	DMM	Shape	TAT
44.2	4.22	4.12	3.79	4.96	2.46	1.42	40.1	40.4	0.10	0.43	2.05	1.01	0.08	1.45



# Alt Model-Shift Uniqueness Test

008176650-02,  $P = 15.801057$  Days,  $E = 123.451346$  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
40.5	3.40	3.19	2.86	4.98	2.49	0.99	37.3	37.6	0.21	0.54	2.87	0.98	0.07	1.79





### Stellar Parameters For KIC 008176650

	$T_{\text{eff}} (K)$	$\log(g)$	$[\text{Fe}/\text{H}]$	$R (R_{\odot})$	$M (M_{\odot})$	$p_{\star} (\text{g}\cdot\text{cm}^{-3})$
	$5383^{+159}_{-143}$	$4.587^{+0.030}_{-0.120}$	$-0.100^{+0.300}_{-0.300}$	$0.789^{+0.143}_{-0.061}$	$0.885^{+0.070}_{-0.104}$	$2.537^{+0.406}_{-0.909}$
	+3%/-3%	+1%/-3%	+300%/-300%	+18%/-8%	+8%/-12%	+16%/-36%
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 008176650-02 / KOI

Detrend	Depth (ppm)	$R_p (R_{\oplus})$	$T_{\text{max}} (K)$	$T_{\text{obs}} (K)$	$A_{\text{obs}}$
DV	$-69 \pm 16$	$2.57^{+0.30}_{-0.26}$	$874^{+40}_{-36}$	$3391^{+169}_{-171}$	$78^{+27}_{-22}$
Alt.	$-56 \pm 17$	$2.31^{+0.30}_{-0.26}$	$873^{+39}_{-33}$	$3398^{+184}_{-217}$	$79^{+36}_{-27}$

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

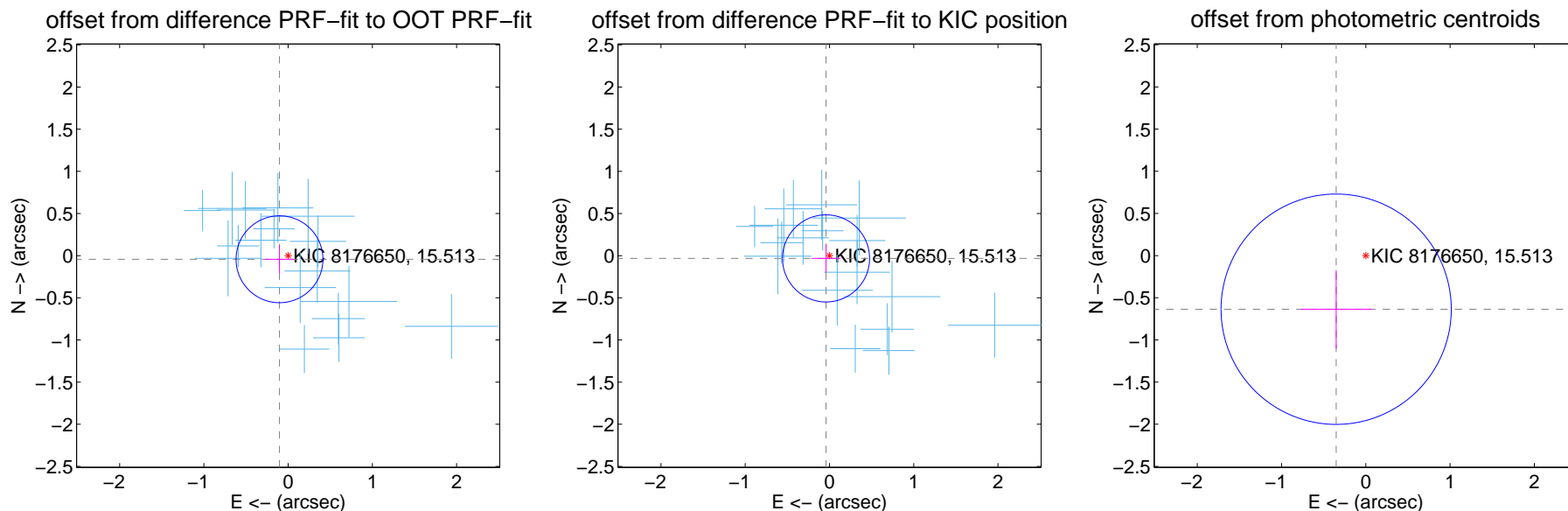
## DV Centroid Data

Supplemental centroid analysis for 008176650-02. Kepler magnitude: 15.51. Transit SNR 29.44

There are 17 quarters with good PRF difference image offsets

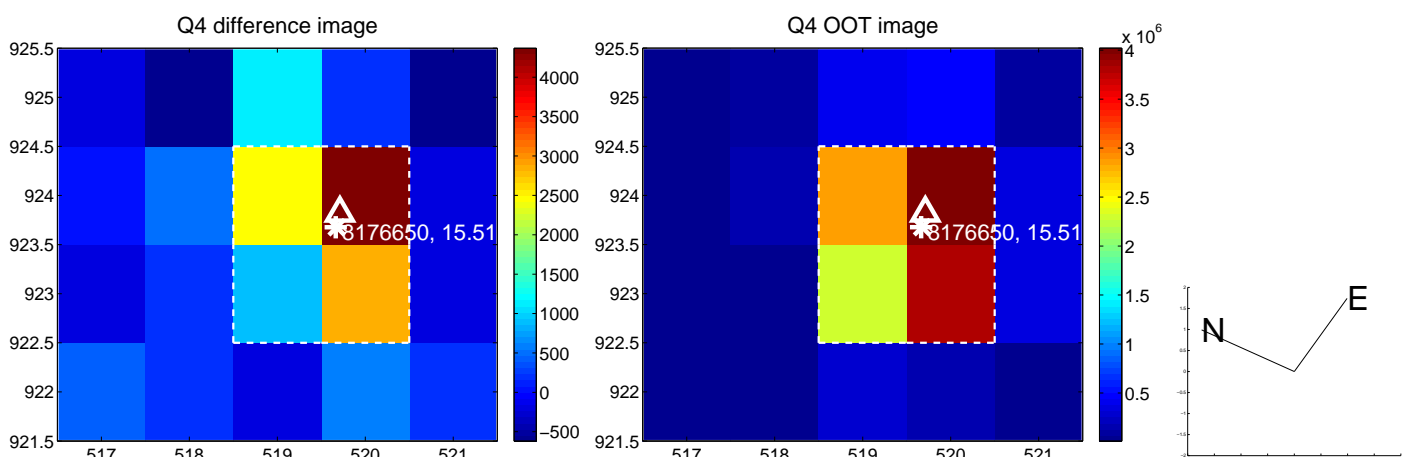
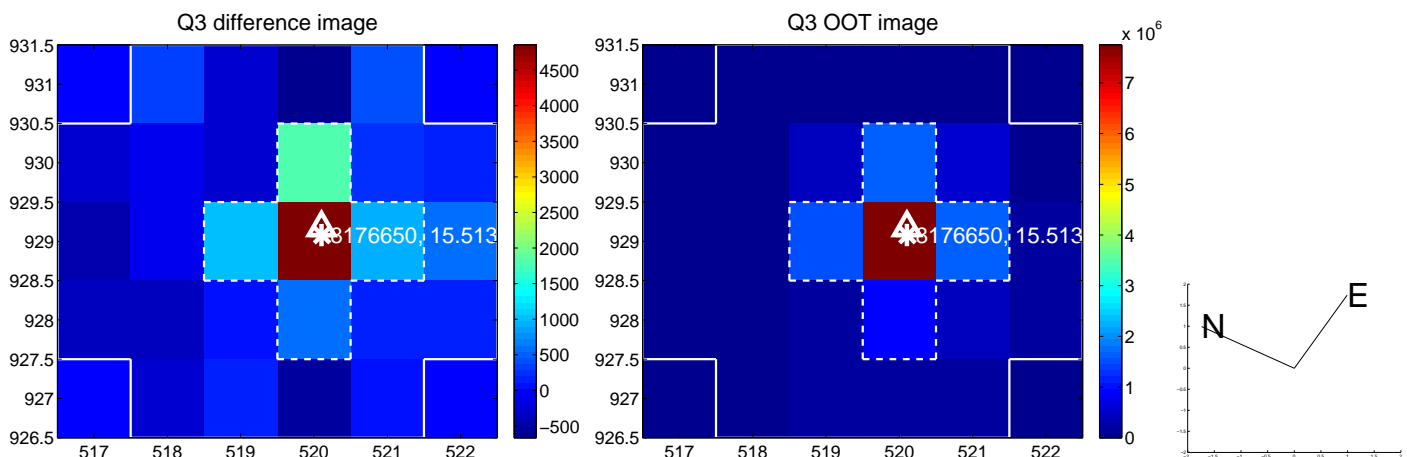
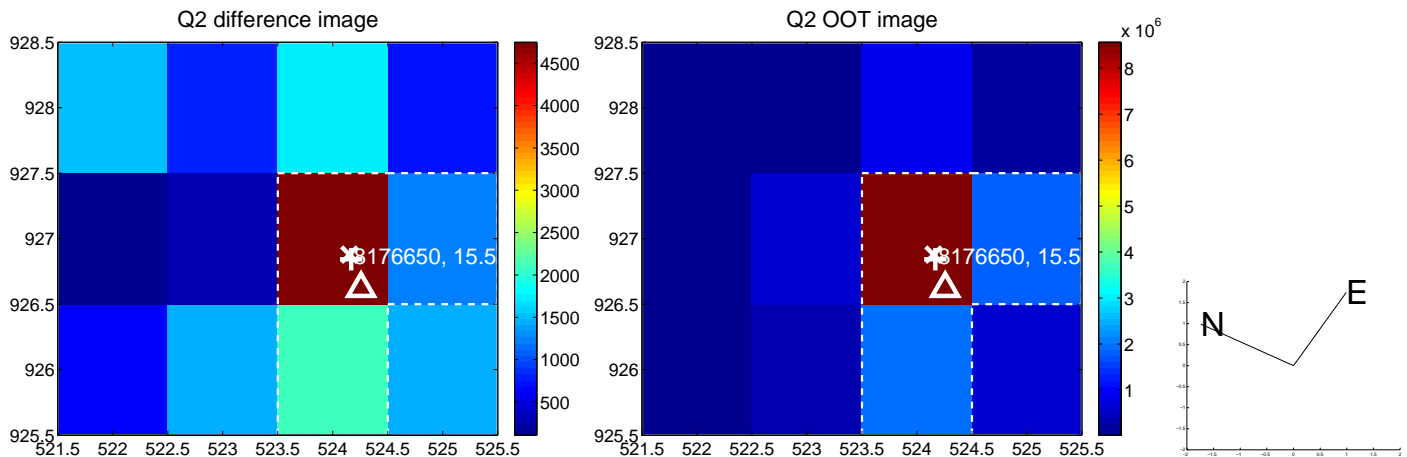
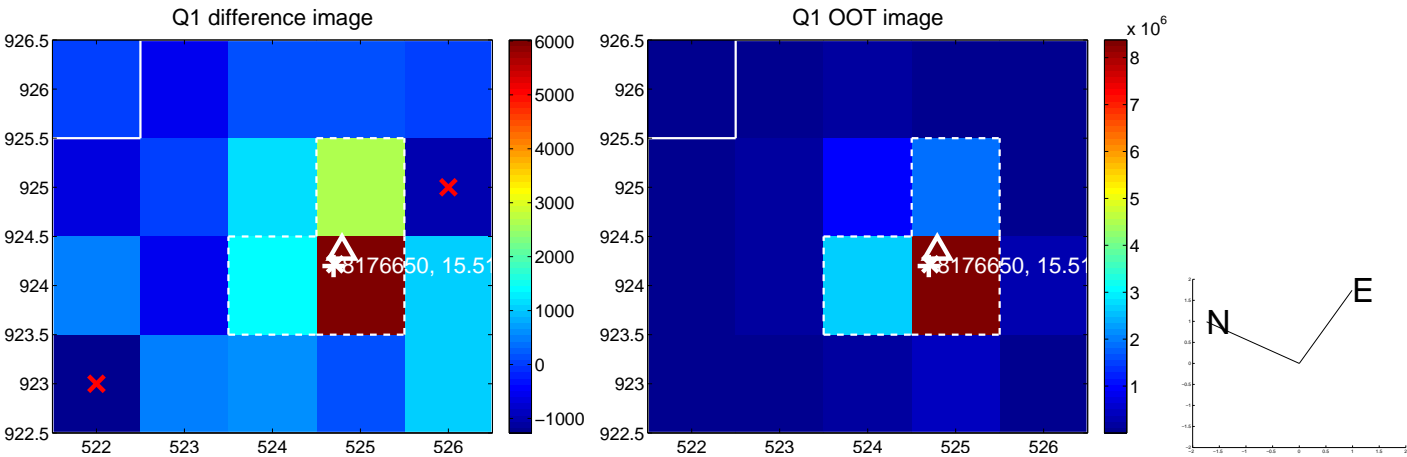
The direct PRF centroid is offset from the target star catalog position by about 0.12 arcsec

	Distance in arcsec	Distance / $\sigma$	$\Delta$ RA	$\Delta$ Dec
PRF-fit source offset from OOT	$0.111 \pm 0.172$	0.65	$0.102 \pm 0.172$	$-0.043 \pm 0.168$
PRF-fit source offset from KIC position	$0.052 \pm 0.172$	0.30	$0.041 \pm 0.173$	$-0.033 \pm 0.171$
photometric centroid source offset	$0.73 \pm 0.46$	1.60	$0.35 \pm 0.42$	$-0.64 \pm 0.47$

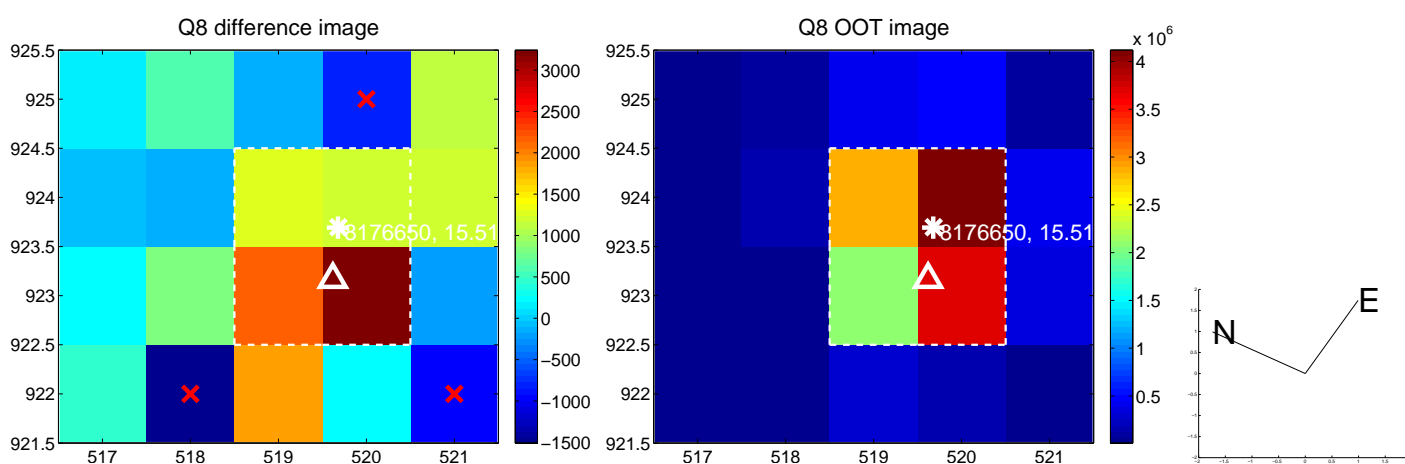
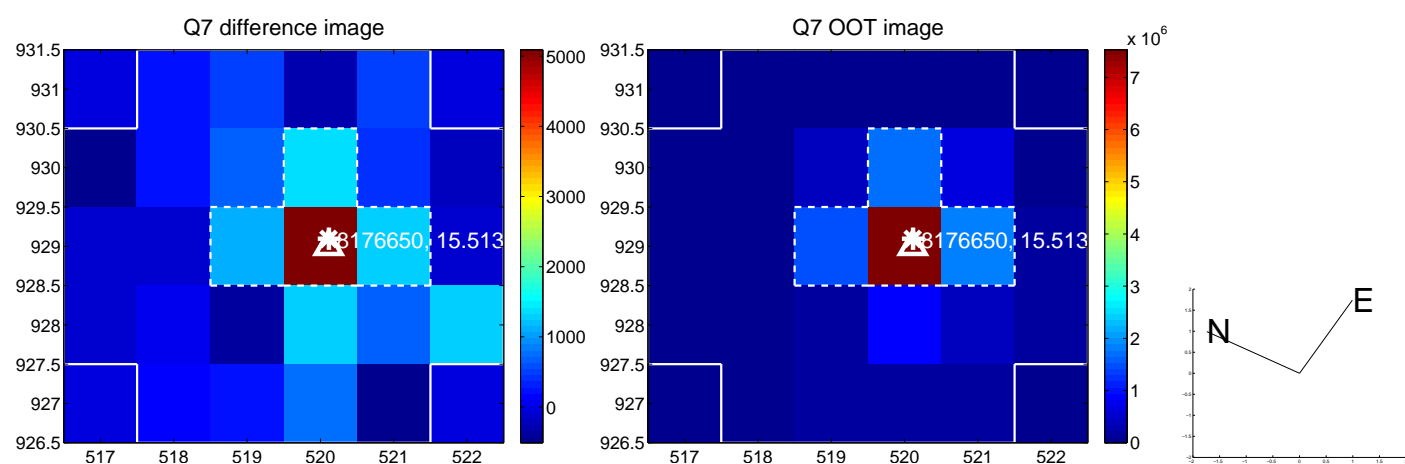
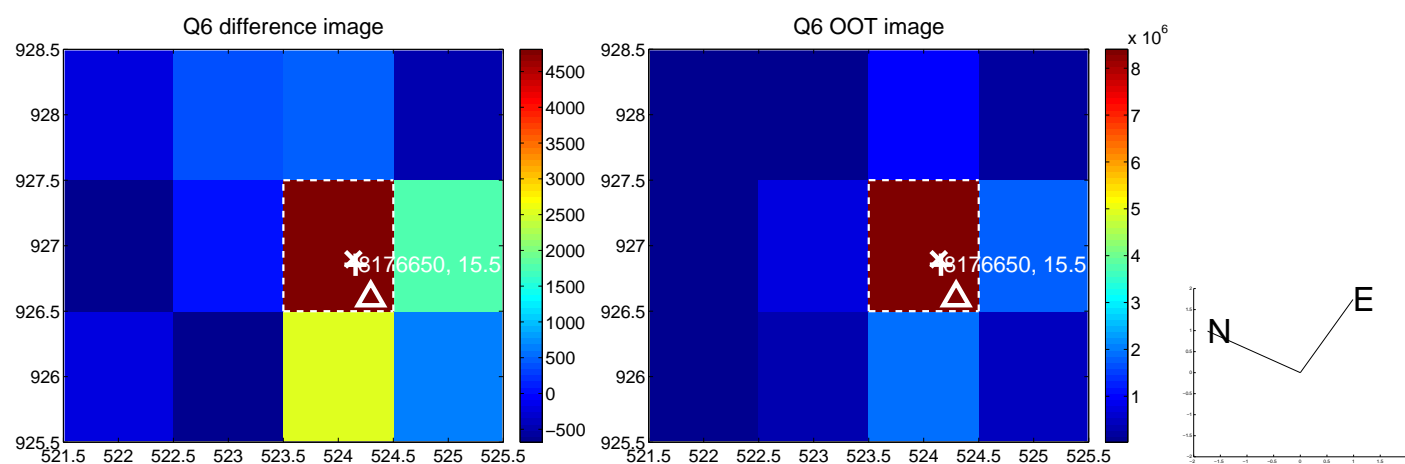
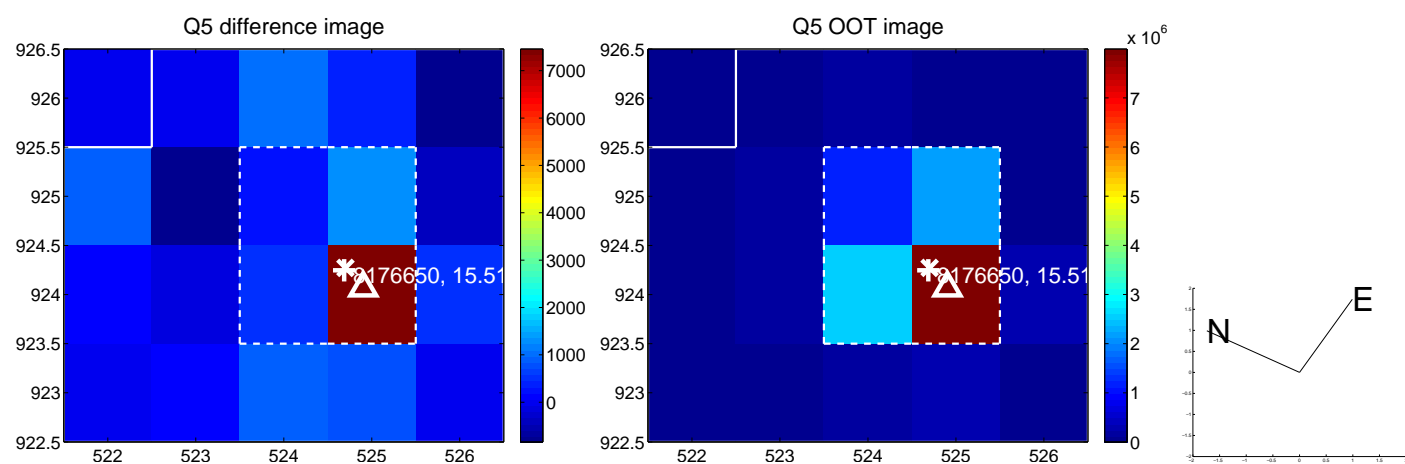


Centroid source offsets from the target star reconstructed from PRF and photometric centroids. **Sky blue crosses:** good quarterly centroid offsets; **Vermillion crosses:** bad quarterly centroid offsets; magenta cross: average over quarters. Length of the crosses: one- $\sigma$  uncertainty. Blue circle: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

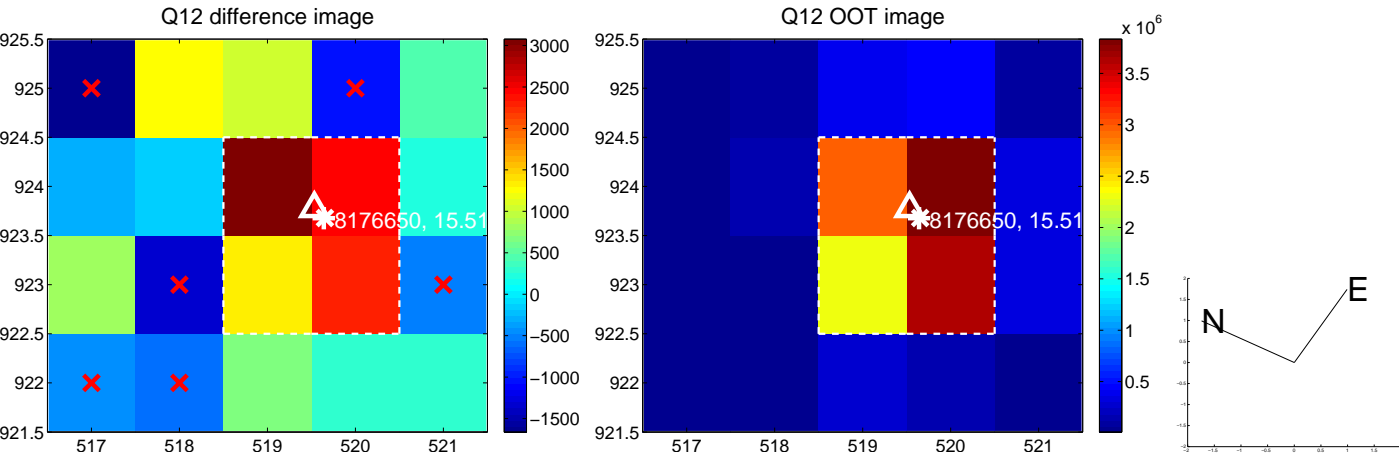
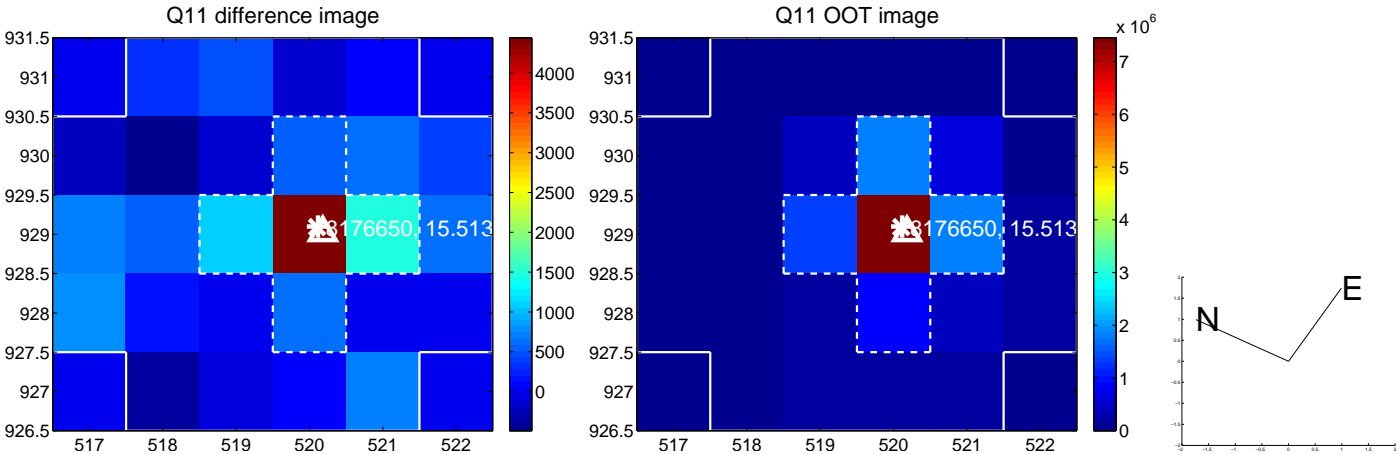
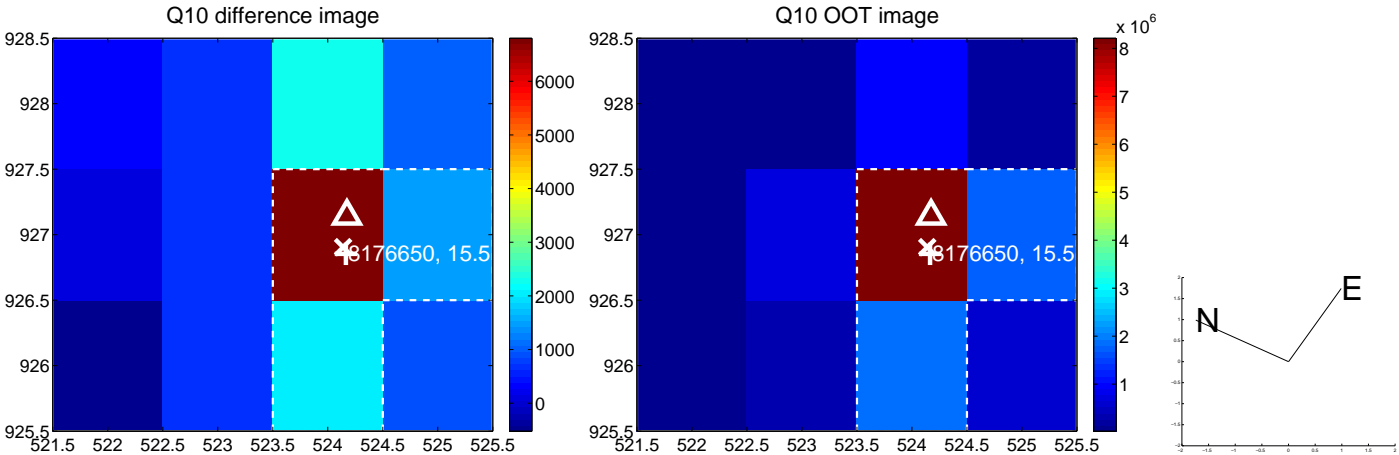
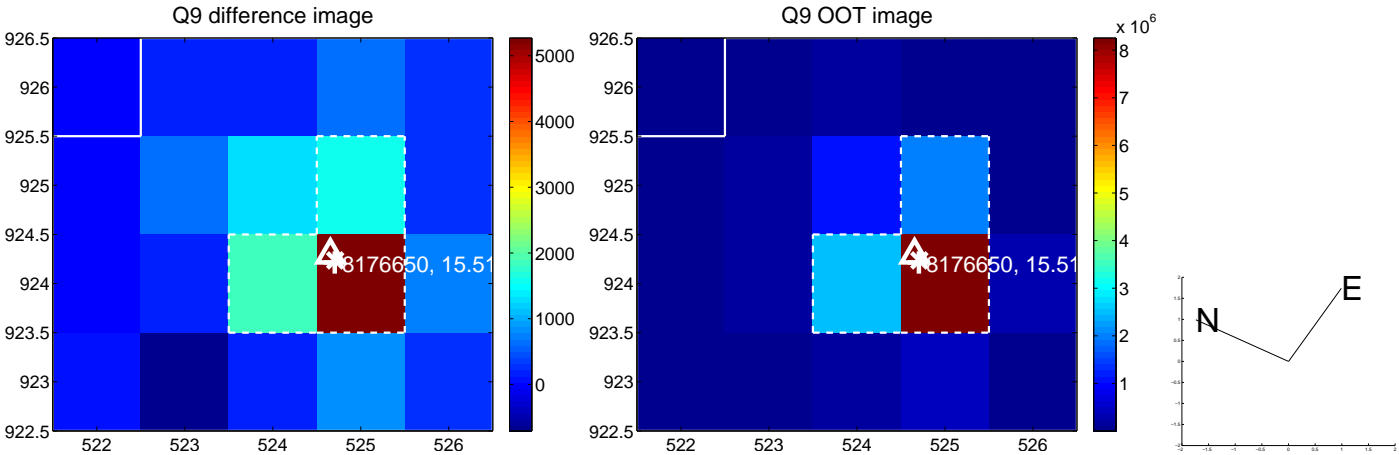
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



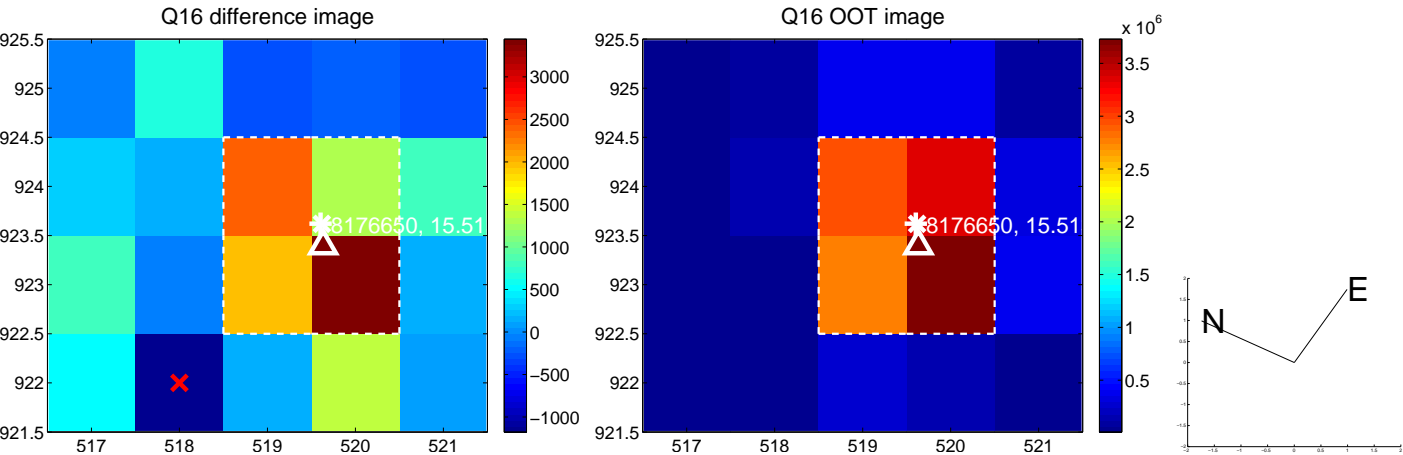
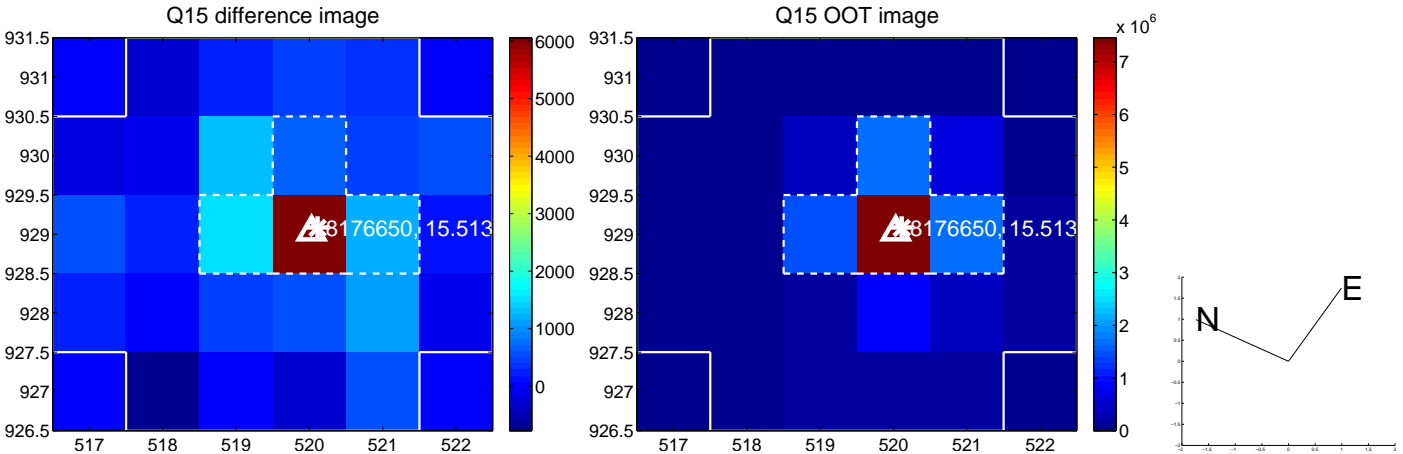
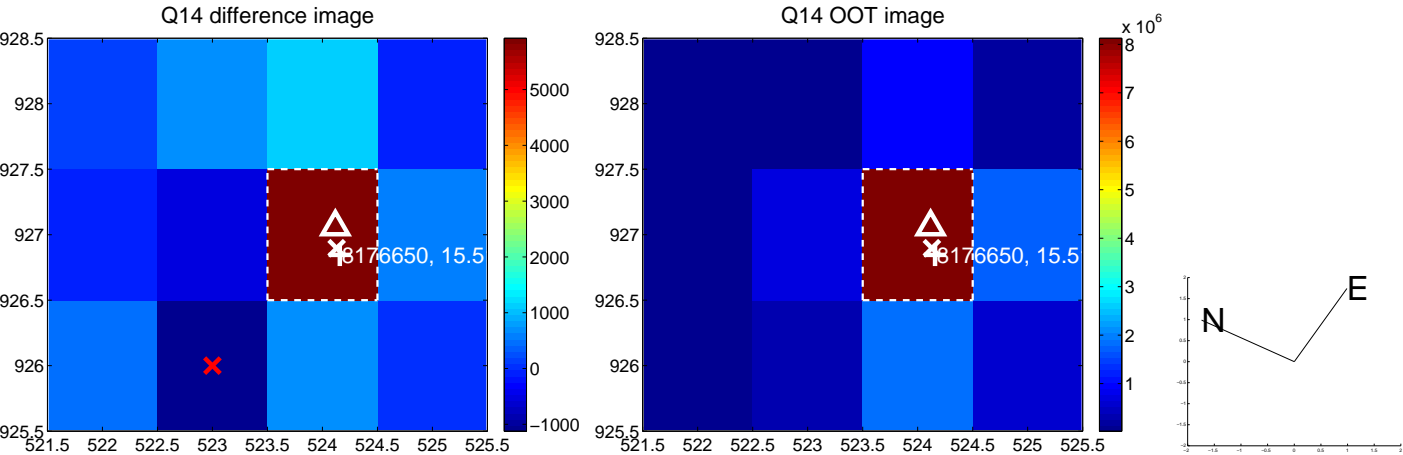
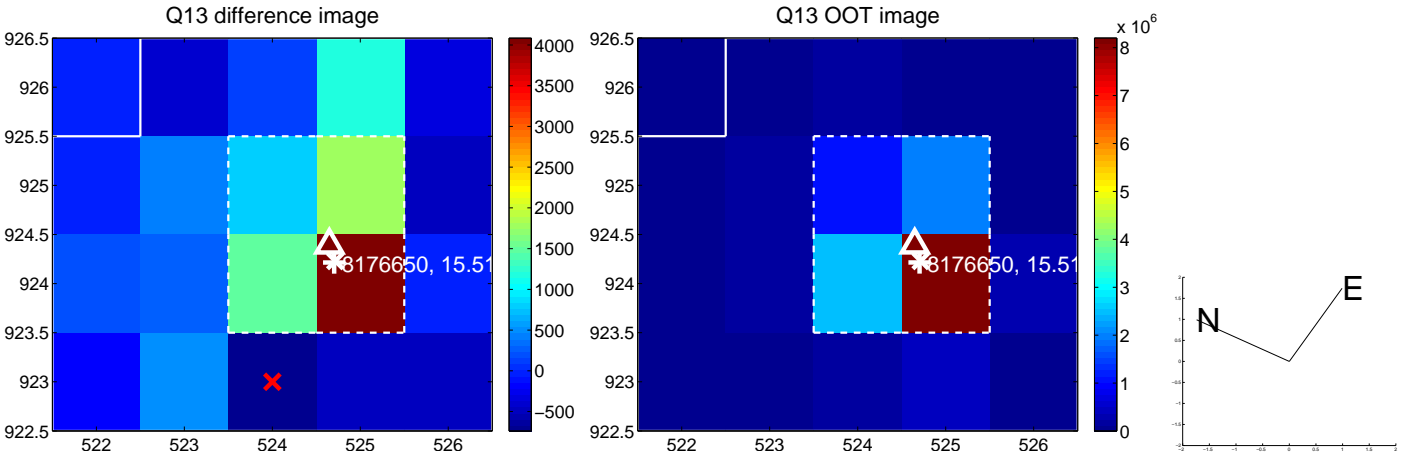
white  $\times$ : KIC target position;  $+$ : OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value



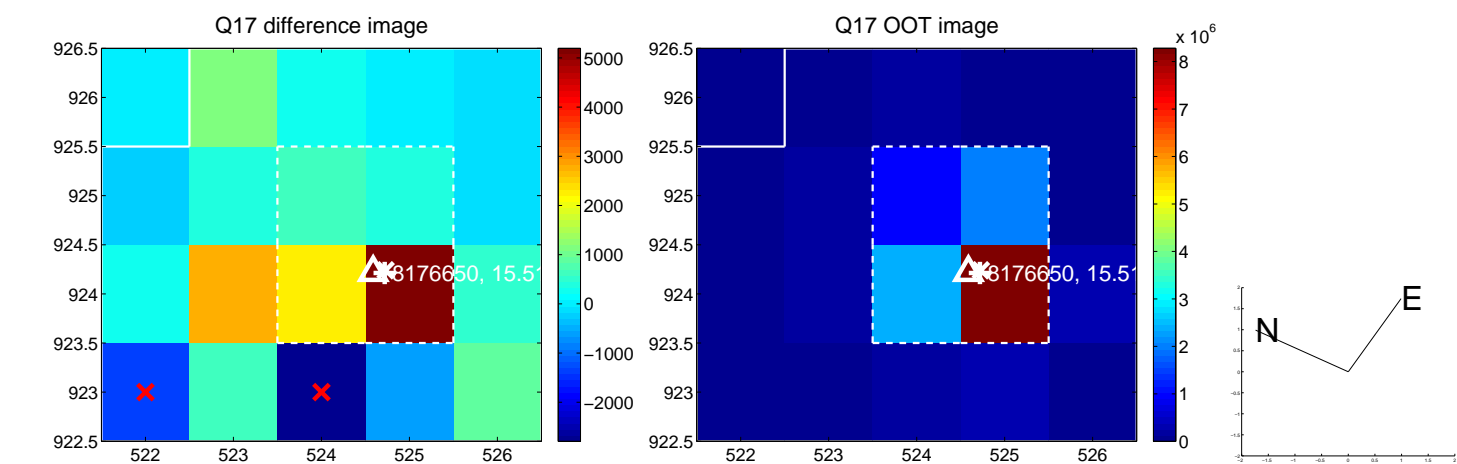
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



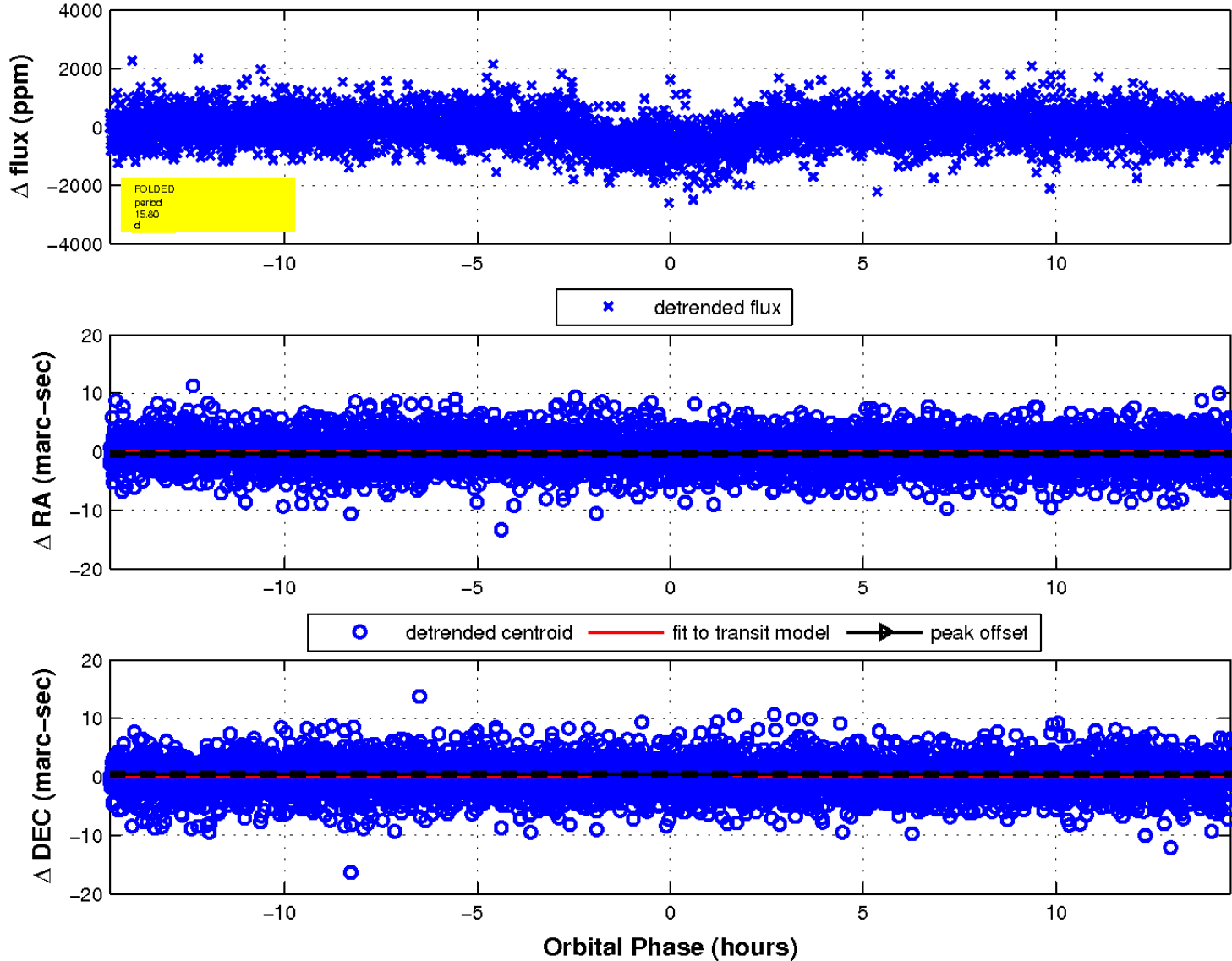
white  $\times$ : KIC target position; +: OOT centroid;  $\triangle$ : difference centroid. red  $\times$ : large negative pixel value.



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



fluxWeightedCentroids, Planet 2 of 2



# UKIRT Image

Declination

